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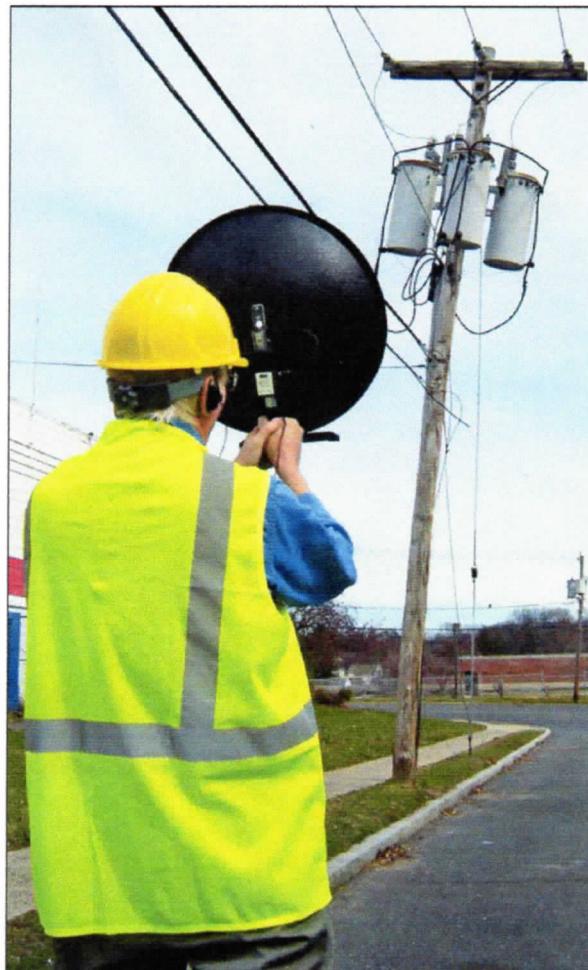
MFJ-5008 Ultrasonic Receiver

A useful tool for pinpointing power line noise sources

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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 direc-

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.

tion 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.

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

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

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 x 18.8 x 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 $\frac{1}{8}$ inch spark gap. A professional grade RADAR Engineers Ultrasonic Receiver picked up the arcing source 200 feet away.



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

bottom of the handle, it maintains the entire instrument in a convenient upright position when not in use.

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 re-

ceiver'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.

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

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*

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.

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

¹Power 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

[Click here for a video overview of the MFJ-5008 Ultrasonic Receiver.](#)



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.

²See "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.

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

LabNation SmartScope Model A14

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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.

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 $\times 1$ or $\times 10$ at-



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

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.