Figure out which house in your neighborhood may be causing radio frequency interference using a small, simple HF loop antenna.

Identify and Track Down

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Dealing with radio frequency interference (RFI) from neighborhood sources is unfortunately a part of the ham radio hobby, especially on the HF bands. On your home receiver, it is usually easy to distinguish between Amateur Radio signals and interference. What is difficult is locating the source of the interfering signal, and that is the first step in getting RFI corrected. Here's how I put together and applied off-the-shelf components to track down the location of RFI sources in my neighborhood. The key components include a portable SSB-mode radio with an external antenna connection. Also needed (see Figure 1) are a broadband amplifier and an un-tuned receive-only magnetic loop antenna that is approximately 23 centimeters in diameter, a 12 V power inserter, and a 12 V power source. The radio's built-in whip antenna gets you within several houses, and the directional loop pinpoints the location.

RFI Basics

Often, the RFI source is in your own home, and you should eliminate that possibility first. To do that, power your receiver from a battery and shut off the main circuit breaker to your home. Also, if you have an uninterruptable power supply (UPS) for your computer and internet equipment, be sure to shut that down too, because digital equipment and switching mode power supplies are often sources of RFI. These will continue to run from a backup power source. You are then left with signals outside of your home.

The biggest source of RFI from my neighborhood, and that of many other hams for the last few years, are SolarEdge solar power systems within 700 feet or less of my station. See "The SolarEdge Story" sidebar for more information on this specific RFI example. While I do use "solar power RFI" as my example, the same methods apply to other RFI sources such as non-FCC compliant grow lights, string lights, power-line noise, and so on.

Once you have identified a signal as RFI, make a note of its characteristics such as the frequency, how it varies with time, and how the audio sounds. Also take note of the time of day when you hear it. For example, solar power RFI will be off when it is dark outside, and grow lights are often controlled with a 24-hour timer.

Using my solar power example, most of the RFI appears at 200 kHz intervals, which are likely the harmonics of a 200 kHz switching frequency.

The SolarEdge Story

Tony Brock-Fisher, K1KP, describes what he found was required to quiet the radio frequency interference (RFI) from a SolarEdge system. See his article, "Can Home Solar Power and Ham Radio Coexist?" in the April 2016 issue of *QST*. It is worth pointing out that solar power can be RFI-free with no modifications to the normal installation — I have such a system. SolarEdge has told me that they plan to make low-RFI components for new future installations. But, as of December 2018, installers are still setting up systems with high-RFI components and installation methods. In addition, even after SolarEdge distributes components with lower emissions, there will be the older high-RFI installations all over the country that new hams or hams who move are likely to encounter. In fairness to SolarEdge, they have been working with ARRL. They have also come out and fixed the installations near me — seven so far, with two more scheduled — after I reported them. However, the job of finding the addresses of each new installation falls on me.

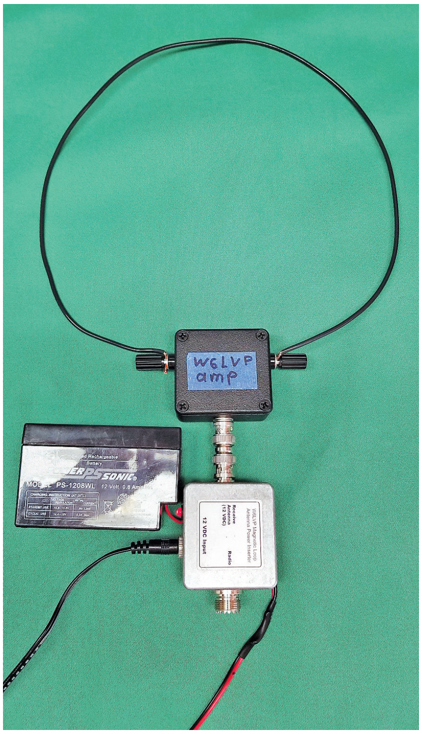

Figure 1 — An un-tuned receive-only magnetic loop, a broadband amplifier, a 12 V power inserter immediately below the pre-amplifier, and a 12 V power source (to the left) are needed, in addition to an SSB-mode receiver.

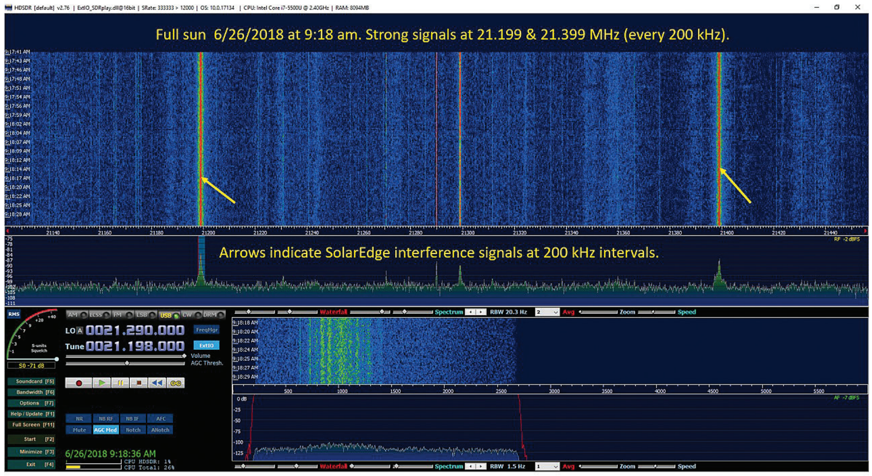

Figure 2 — Solar power system producing RFI on 21.199 and 21.399 MHz.

See the examples at 21.199 and 21.399 in Figure 2. To hear these frequencies using upper SSB mode, tune 1 kHz lower to hear 21.199 MHz at around 1 kHz audio frequency.

If the solar power installation is less than 200 feet away, you may see many signals in addition to the 200 kHz harmonics spread through the band. Note the "squiggly" signals seen in Figure 3. Some of the stronger ones in this example are at 14.040, 14.140, 14.210, and 14.310 MHz.

Searching for RFI

You will need a portable radio that has an SSB mode and an external antenna input in addition to the built-in whip antenna. You will also want an indication of signal strength, such as a bar graph or numerical display. At home, determine if the AM or SSB mode works better for the RFI you are looking for. That will help you determine the mode to use with the portable radio. I use the Tecsun PL-660 radio seen in Figures 4 and 5, but different models may now be available.

Connect your station antenna to the portable radio and note the frequencies, sounds, and strength of the RFI signals you wish to locate. These are the same signals that you will receive on the built-in whip antenna and on the directional loop. Due to the lower gain of portable antennas, you may not hear weaker signals outdoors at your location. But when you get close to the source they will be easily heard, and perhaps even be strong.

The next step is to narrow down the search area. If you have a directional HF beam antenna, use the peak and nulls in the radiation pattern to get an approximate direction of the signal. Depending on the antenna, this could be ±30° of the exact direction. Combine any directional information you have with a map of your neighborhood. Depending on the neighborhood, that could narrow your search down to just a few houses on one or two streets.

I found that searching for RFI with the built-in whip antenna will get you within a few houses, but it is difficult to be exact. Effects such as signal reflections and how the RFI exits the house can throw you off by one or two houses. If you are looking for solar power RFI and there is only one house with solar panels where the signal peaks, your search may be over. However, if you find solar RFI and you see that the nearby houses also have solar panels, you need a portable directional antenna.

A Portable Loop Antenna

The portable loop antenna I built started as the magnetic loop antenna sold by W6LVP. It normally includes a 1-meter diameter loop, a broadband amplifier, and power connected to 12 V. I replaced that loop with a wire 70 centimeters in circumference, which results in a loop diameter of

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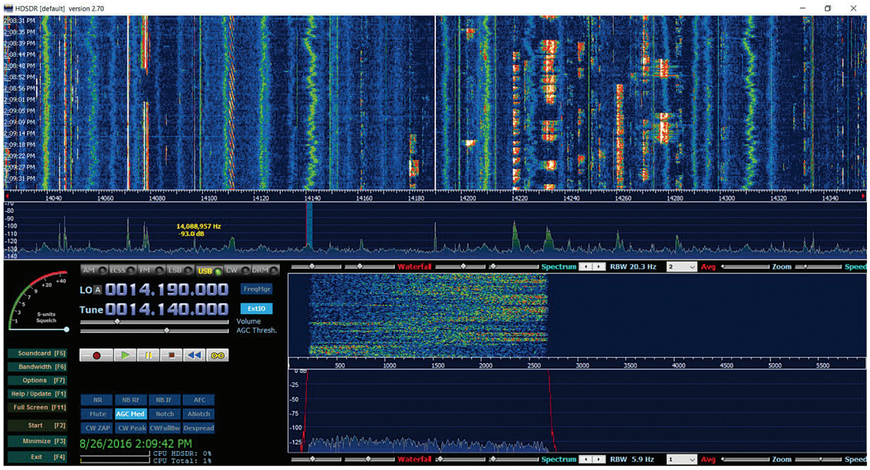


Figure 3 — Solar power system RFI spread throughout the 20-meter band.

Figure 4 — Loop antenna maximum gain is in the plane (edge) of the loop, and results in the full signal strength indication on the SSB-mode receiver.

23 centimeters. This same modification could have been done to any of the other wide-band magnetic receive loop antennas on the market. [The exact loop size is not important as long as it is electrically small enough. The null depth is $-20\log(2C_{\lambda})$ dB and will be shallow if the loop circumference C_{λ} wavelength is too large. Furthermore, the electric field in the null direction is cross-polarized compared to the main loop response, perhaps complicating the interpretation of the source direction. — *Ed.*]

Small un-tuned loops are often used outdoors on a rotator as low-noise receive antennas for the 160-meter and 80-meter bands. The W6LVP loop covers from 135 kHz – 30 MHz without tuning. The 23-centimeter diameter loop has less gain than the original 100-centimeter loop, but still more than enough once you are close. I found the signal strength readings to be about equal for the built-in whip and this small loop. This gives you plenty of sensitivity. In addition, a smaller loop size has a deeper null than a larger loop, which makes determining direction even more precise.

Take another look at Figure 1 as we get into the details of setting up this small loop antenna. The wire loop connects to the amplifier. I used solid #12 AWG wire, and the stiffness is more than adequate to keep its shape. It will make little difference if the loop isn't perfectly round. Below the loop amplifier in Figure 1 is the 12 V power inserter connected with a male-to-male BNC coupling. I used a small 0.8 Ah 12 V battery, shown to the left of the amplifier. An option is to connect the amplifier to the power inserter with a short coax and place the battery and power inserter in your pocket. This leaves one hand to hold the radio, and the other to hold the loop antenna.

Tracking Down RFI

Now that you have your map, radio, and loop antenna, you are ready to walk the area with your portable receiver's built-in whip antenna, or you can drive down the street using a mobile antenna connected to the external antenna input of your portable receiver. Just be aware that some cars have high levels of ignition noise and that may cover up the RFI you are listening for. Finding where the signal peaks should get you within one or two houses of the RFI. Now it's time to pinpoint the exact house with your loop. The radiation pattern of the loop peaks in the plane of the loop, and the null is on the axis of the loop. Figure 4 shows a full-scale reading on the radio (vertical bars on the upper left of the display) when the house is in the plane of the loop. Figure 5 shows zero indicated signal when the axis is facing the house.

Figure 5 — Loop antenna null is on the axis of the loop and results in a zero-indicated signal strength with axis pointed toward the house.

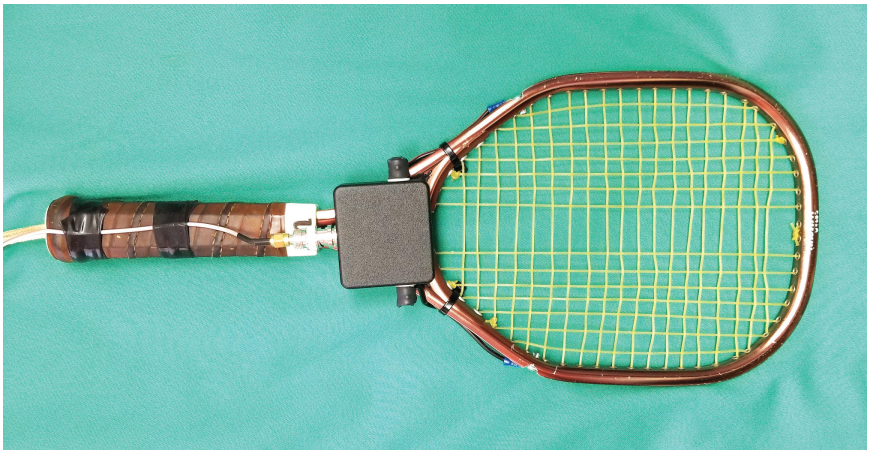


Figure 6 — The loop antenna and amplifier mount constructed from a repurposed racquetball racquet.

Loop antennas have a null on the axis in both directions. So, if you are standing in the middle of the street between two houses, you would not be able to determine which house is the source of RFI. To remedy this, start walking along the street from about 100 feet away from the house, to in front of the house, to 100 feet beyond the house. Keep rotating the loop (change its azimuth) and notice the direction that produces a null as you walk. In addition to the indicated signal strength, the volume of the audio also indicates signal strength and you will be able to clearly hear the dip in signal strength as you rotate the loop's null through the direction of the signal source. The direction of the null will stay pointed at the source of RFI as you walk. Keeping the loop about 1 foot away from your body may produce a deeper null. Also, it is normal to see some variations in the direction of the null as you walk due to reflections.

I hope this material will help you reduce your RFI levels.

For extra credit, I turn a racquet into a loop and an attachment for the amplifier. Figure 6 shows what was my former racquetball racquet. I cut away a portion of the frame that would have shorted out the loop. There is no connection across the metal frame in the handle.

Photos by the author.

Randy Standke, KQ6RS, has been a licensed Amateur Radio operator since 1972. He holds a MSEE degree, has authored 10 patents, and has over 40 years experience with antennas and RF systems for military and commercial applications. You can reach Randy at **r55stan@gmail.com**.

For updates to this article, see the *QST* Feedback page at www.arrl.org/feedback.

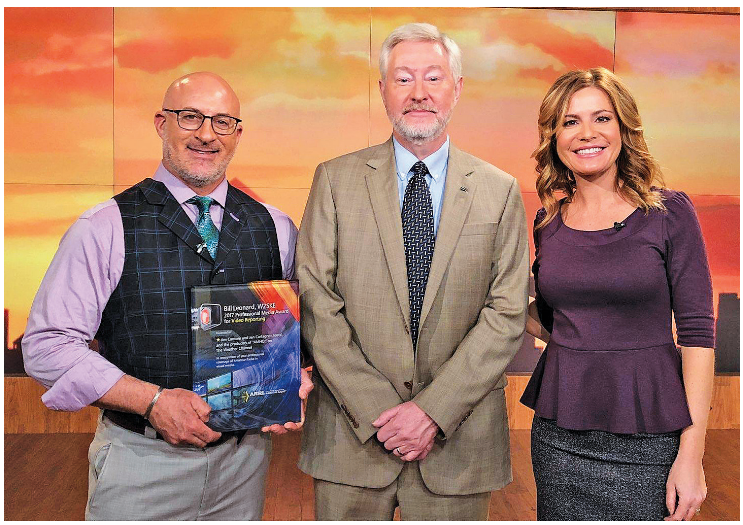
Strays

Live on The Weather Channel

ARRL Southeastern Division Director Greg Sarratt, W4OZK, travelled to Atlanta on Friday, February 15, to make a live, on-air presentation of the ARRL's 2017 Bill Leonard, W2SKE, Professional Media Award for Video Reporting to The Weather Channel's Jim Cantore and Jen Carfagno, of The Weather Channel's AMHQ program.

The award was given to The Weather Channel's AMHQ program co-hosts in recognition of their interview of former ARRL Emergency Preparedness Manager Mike Corey, KI1U, about the organization's efforts to assist the American Red Cross with the response to the devastation caused by Hurricane Maria in Puerto Rico.

Sarratt also presented The Weather Channel co-hosts with a $250 check, as part of the award. The award check has been donated by The Weather Channel to the American Red Cross.



Jim Cantore (left) and Jen Carfagno (right), co-hosts of The Weather Channel's AMHQ program, were presented with ARRL's 2017 Bill Leonard, W2SKE, Professional Media Award for Video Reporting by ARRL Southeastern Division Director Greg Sarratt, W4OZK (center).