Hands-On Radio

H. Ward Silver, NØAX, n0ax@arrl.org

Experiment 114

Recording Signals

In Hands-On Radio Experiment 112, we went on the hunt for a cure to my sufferin' stove for RFI caused by my transmitted signal.[1] As hams know, however, RFI works both ways — a ham can receive interference from external sources, too. Tracking down the source of RFI to your operating can be at least as difficult as solving an RFI problem to an appliance in your home. This month, we'll do a neat science experiment with a free software tool you can use not only for RFI hunting but for other jobs as well.
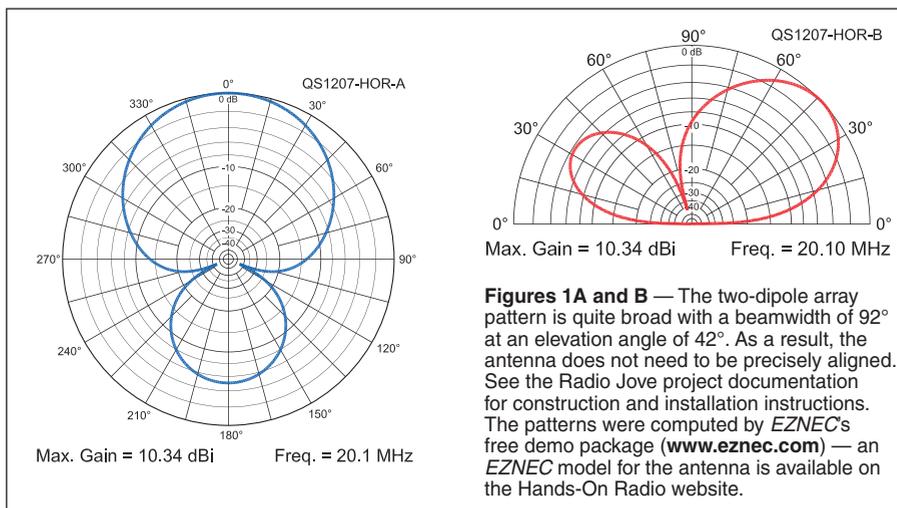
Noise Signatures

When you are receiving an interfering noise signal, one of the first steps in identifying the source is to determine its *signature* — the signal's combination of amplitude and frequency that is almost always unique to that particular noise source. When you tell your tale of woe to your friends, the first question will almost always be, "What does it sound like?" Is it a buzz, a tone, a wide-band rasp…or what? This gives important clues as to what is causing the noise. The frequencies on which you hear the noise are also clues.

Another part of the signature that can be just as important is the signal's behavior in time. For example, does the noise pulse regularly or is it present all the time? Does it appear throughout the day? Does the amplitude vary? All of these are also important clues. For example, HF operators in rural and suburban areas are often quite familiar with the pop… pop…pop… of an electric fence charger.

Sitting at the radio for hours listening to noise is not very exciting, despite what is depicted in the movie *Contact*. Yet it might be very important to learn that your noise comes and goes at regular hours — such as when a local street lamp turns on and off at dusk and dawn. The solution is a data recorder.

By Jove, You've Got It!

I found out about this month's software gadget in the course of helping the St Charles High School Radio Club, (KDØQLW), set up their Radio Jove Project equipment to listen

Max. Gain = 10.34 dBi   Freq. = 20.1 MHz

QS1207-HOR-A

Max. Gain = 10.34 dBi   Freq. = 20.10 MHz

QS1207-HOR-B

Figures 1A and B — The two-dipole array pattern is quite broad with a beamwidth of 92° at an elevation angle of 42°. As a result, the antenna does not need to be precisely aligned. See the Radio Jove project documentation for construction and installation instructions. The patterns were computed by *EZNEC*'s free demo package (**www.eznec.com**) — an *EZNEC* model for the antenna is available on the Hands-On Radio website.
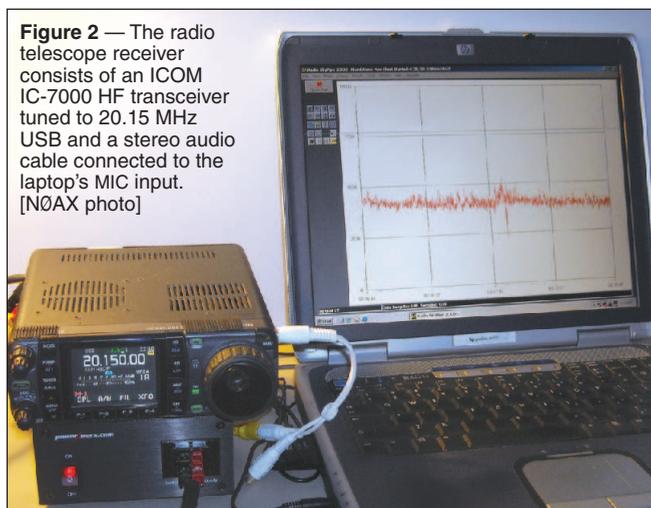

Figure 2 — The radio telescope receiver consists of an ICOM IC-7000 HF transceiver tuned to 20.15 MHz USB and a stereo audio cable connected to the laptop's MIC input. [NØAX photo]

to noise from the planet Jupiter.[2] This experiment involves building a two dipole array for 20.1 MHz (see the digital edition for a photo of the antenna and club members), connecting a radio, and listening to the receiver's output noise as Jupiter moves through the beam of the array while the Earth rotates. If you have a directional antenna for 15 meters (or can build the two dipole array) you can hear the noise, too. Figure 1 shows the *EZNEC* azimuth and elevation pattern of the array.

Jupiter is a powerful source of noise at HF and was one of the first radio sources identified in the sky by radio astronomers. The noise can be received below 35-40 MHz down to frequencies below 15 MHz, at which the signals are either absorbed or reflected by the ionosphere. Frequencies around 20 MHz are usually recommended — just tune your receiver to a clear frequency around 20 MHz and…then what?

Jovian noise is just like terrestrial noise — crackly pops and crashes that you might hear from any thunderstorm. Listening by ear, there is no obvious signature of either amplitude or frequency so you must use time as your meter stick. The Radio Jove project directs the experimenter to a free program called *Radio-SkyPipe II* (**radiosky. com/skypipeishere.html**) that uses a PC sound card to record the output of a receiver, graph it on a strip-chart like display, and save the data to a file. Once the data is

[1]All previous Hands-On Radio experiments are available to ARRL members at **www.arrl.org/hands-on-radio**.

[2]**radiojove.gsfc.nasa.gov**

recorded, you review it to find the slow rise in noise level from Jupiter passing in front of your antenna.

Taking Measurements

Radio-SkyPipe II couldn't be easier to set up and install. Download and run the self-installing package from the website — you're ready to go. You will be prompted to enter your location (this is an astronomy tool, after all) and select your sampling rate and signal source. The default settings worked fine for me. I purchased the upgrade to the *Pro – Home Use* version so that I could work more easily with the data files. I'm using a slow, old laptop for recording and it seems to handle this simple task just fine.

Connecting the radio is also quite simple — use a plug-to-plug stereo audio cable from the headphone jack to the sound card's MIC input jack. Most readers will have a radio that can receive near 20 MHz or just outside the 15 meter band. Tune to a clear frequency free of local carriers or birdies and plug in the audio cable. Click the START CHART button and the red trace will begin crawling across the display at 10 samples/sec. In the OPTIONS menu, select the STRIP CHART tab and un-check Y AXIS AUTOSCALE. Right-click on the Y axis and click SET Y MIN TO 0. This fixes the vertical scale at 0 to 10000, which is convenient for displaying noise measurements.

Adjust the receiver volume so that the background noise level is around 4000. You'll see the trace move up and down as the volume is adjusted so that the system looks somewhat like that in Figure 2. Point your antenna due south and wait for Jupiter to pass slowly by.

The time at which Jupiter crosses the north-south meridian over your location — called the *transit* — can be found on the Naval Observatory's website (**aa.usno.navy.mil/data/docs/mrst.php**). If you have a medium-to-low local noise level and your antenna is not completely blocked to the south, you'll see a gradual rise and fall in the noise level. After Jupiter passes by, click STOP CHART and save the file to your hard drive. After the file is saved, you'll see the entire session on the display. Maximize the window and use the control buttons at the left to move around. There are extensive on-line Help files available to get you started viewing data. Congratulations — you're a radio astronomer just like Grote Reber, W9GRZ back in the 1930's![3]

Figure 3 shows a portion of the strip chart I obtained on April 11, using the student's dipole array. It covers approximately 2 hours centered on the observed transit time. The 2 hour time period corresponds to 30° of the Earth's daily rotation. (360° × 2 hours / 24 hours = 30°) The Naval Observatory transit times (see Table 1) put the actual transit time at 14:33 (2:33 PM), which is 1933 UTC at my location in St Charles, MO. The slight rise in noise level was observable for a little more than an hour (≈16° of rotation).

The peak of the noise was later than predicted, however. I took data for several days — stopping and starting the chart twice a day — and saw a similar increase in noise level about the same time, shifting a little bit earlier each day, so I am confident that the noise was from Jupiter. I attribute the timing skew to partial blockage of the antenna beam by the house so that the signals were received best after the planet's transit. An open site with no obstructions and lower background noise would allow better observations but this was fine for a first run.

RFI Sleuthing

As you sort through the charts you collect, you'll no doubt notice other interesting phenomena. You'll see large static crashes and periods of high noise levels. You may see bursts of noise and on/off patterns, as well. In my data, it's clear that noise in my neighborhood builds quite a bit in the late afternoon and early evening as folks drive their cars home from work and begin to run their appliances and gadgets. A neighbor's motorcycle leaves a distinctive peak on the trace from ignition noise, for example.

I've been chasing a loud noise source that seems to appear only in the evenings and nearly wipes out 40 meters. My mobile rig is on my workbench listening and recording so that I can find out when it appears and when it goes away. Maybe that will help me determine what is generating it.

The *Radio-SkyPipe II* software can be used to record any audio signal your sound card can accept as input. You can adjust the sampling parameters to record faster or slower, set up automatic sampling, and so forth. The *Pro* version has a squelch-like option to log only when the input signal is above a specified level. Once you get this software running, I am confident that you'll find it a valuable addition to your electronics and radio toolbox!

[3]**en.wikipedia.org/wiki/Grote_Reber**

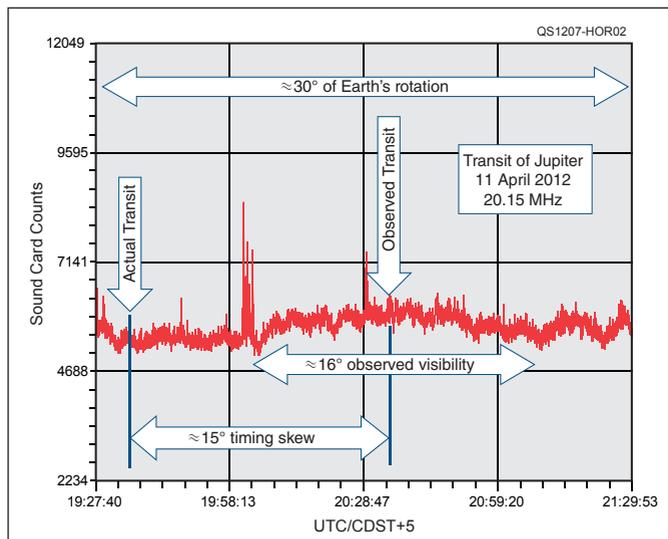| Table 1 Jupiter Transit			
ST. LOUIS, MISSOURI Location: W 90°15'00.0", N38°37'48.0", 100m (Longitude referred to Greenwich meridian)			
Time Zone: 5h 00m west of Greenwich			
Date	Rise Az	Transit Alt.	Set Az.
2012 Apr 10 (Tue)	07:43 69	14:36 67S	21:31 291
2012 Apr 11 (Wed)	07:39 69	14:33 67S	21:28 291
2012 Apr 12 (Thu)	07:36 69	14:30 67S	21:25 291
2012 Apr 13 (Fri)	07:33 69	14:27 67S	21:22 291
2012 Apr 14 (Sat)	07:29 69	14:24 67S	21:19 291
2012 Apr 15 (Sun)	07:26 69	14:21 67S	21:17 291
2012 Apr 16 (Mon)	07:23 69	14:18 67S	21:14 291
Each column contains time and azimuth angle for rise and set or elevation angle and S for South for transit.			

QS1207-HOR02

Figure 3 — This portion of the 11 April strip chart clearly shows the gentle rise in background noise as Jupiter passes by in the early afternoon. Blockage from buildings to the south and southeast results in the shift of the received peak later (westerly) in the day.

And Now for Something You'll Really Like

The noise reported as Jovian in Experiment #114 turns out to have considerably more mundane terrestrial origins. The noise from Jupiter looks rather different as it happens — tune to the Hands-On Radio website (**www.arrl.org/hands-on-radio**) for more information and links to sound files of the *real thing*. Thanks to Whitman Reeve and Dave Typinski, AJ4CO, for the correction.