# AMBIENT HF RADIATED NOISE MEASUREMENT PROTOCOL

Alachua County NFARC/ARES
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## Introduction

The purpose of this protocol is to provide quantitative baseline measurements of ambient noise in an area under consideration for an amateur radio or SHARES HF antenna.   Because receiver S-meters are not always calibrated, this protocol provides some more exact figures for expected background noise at important NVIS / HF frequencies.   This may help designers determine in advance whether the proposed siting of the antenna is suitable or is expected to be unsatisfactory.   The equipment required is a spectrum analyzer with reasonable calibration (within 4 dB is probably sufficient in the range of interest).

## Method

### Antenna:

Commercial E-field antennas are available but are expensive.[1]  For our purpose of determining whether an HF antenna is likely to be overwhelmed with interference on the frequencies of interest, a  simple portable small dipole will suffice, operated untuned.

The test antenna can be made by taking a 10-20 foot section of RG-58 coax, and stripping the last foot, bringing out one foot of center conductor and one foot of shield, fastened to some insulating support. In my case I utilized a t-shaped wooden structure made from 1×2 wood.

1 http://www.emcsociety.org/wp/wp-content/uploads/2012/11/Debugging-EMI-problems-with-an-Oscilloscope_June2014.pdf

Fig. 1: Simple home-made test antenna for HF measurements.

**Receiving Measurement Instrument:**
There are hand-held devices sold to measure E-field, but often they provide no frequency information, so impossible to tell if the interference will affect HF communications.[2] More useful will be a calibrated spectrum analyzer, a software-defined radio (SDR) or even a calibrated amateur or general-purpose receiver with a step attenuator box may suffice. For spectrum analyzers, there are inexpensive hand-held devices widely available[3] as well as the more traditional desktop units such as the Siglent SSA3021 model I have used. The Siglent requires 120VAC, which is a disadvantage in the field.

Calibration of a receiver, or an inexpensive SDR receiver, can be helped by the Elecraft XG3 calibrated signal source.[4] The Antuino, when available, may provide a reasonably useful inexpensive spectrum analyzer.[5]

Depending on the environment, a 50 ohm attenuator pad may be inserted to provide protection of the measuring instrument from strong nearby signals. All possible transmitters in the vicinity should be turned off for protection of the measurement device and to increase the accuracy of the background measurement.

The internal noise floor of the measurement instrument should be measured. Because noise is wide band, measurements are strongly influenced by the bandwidth of the measurement made. In this protocol, all measurements were made with a relatively wide bandwidth of 100 kHz, which allowed for fast scans. The internal noise floor of the measurement device must be -95 dBm or lower for useful measurements and ideally might be -100 dBm or better. Figure 2 shows the internal noise floor of the Siglent with a 6dB external protective attenuator was around -104 dBm for 100kHz bandwidth.

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2 http://www.compliance-club.com/pdf/EMCTestingPart1.pdf
3 https://www.amazon.com/Studio-Explorer-WSUB1G-spectrum-analyzer/dp/B0789D75S5
4 https://www.dxengineering.com/parts/ect-xg3
5 http://www.hfsignals.com/index.php/antuino/

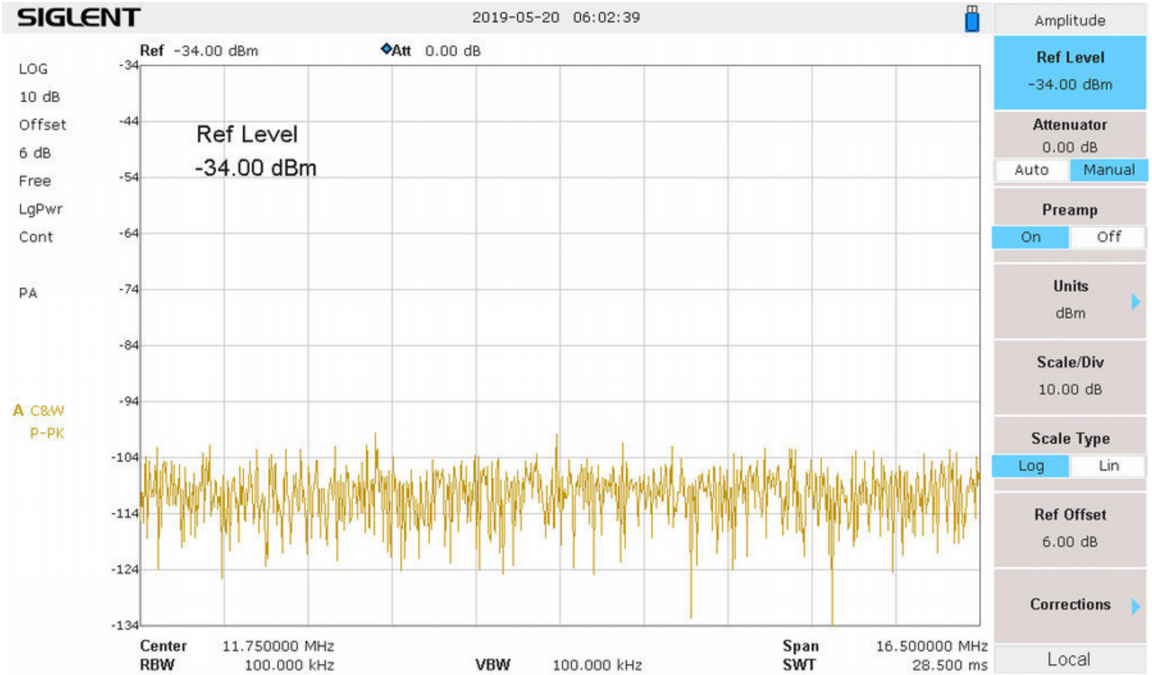


Fig. 2. Internal noise floor measurement of the device with no antenna connected; be certain to properly account for any external attenuators. Bandwidth = 100 kHz. This spectrum is from 3.5 to 20 MHz and shows a noise floor below -104 dBm. To obtain this, only an external 6 dB physical attenuator was utilized, the device preamplifier was engaged and 0 dB of internal attenuation was manually chosen.

**Representative Noise Environments**

In a perfect world, your actual RF noise environment at your proposed antenna location would be so quiet that when you connect the test 2-foot dipole antenna, there would be no additional discernible signals other than actual broadcast stations on frequencies separate from those you will be using. Figure 3 shows a representative residential noise environment – not the quietest due to televisions, cable modems, a solar power household AC system, and ham radio systems – but a workable HF amateur radio environment. To obtain this plot, the spectrum analyzer was powered by a gasoline non-inverter generator, which was found to be quieter than running an AC power line from the house out to the driveway.

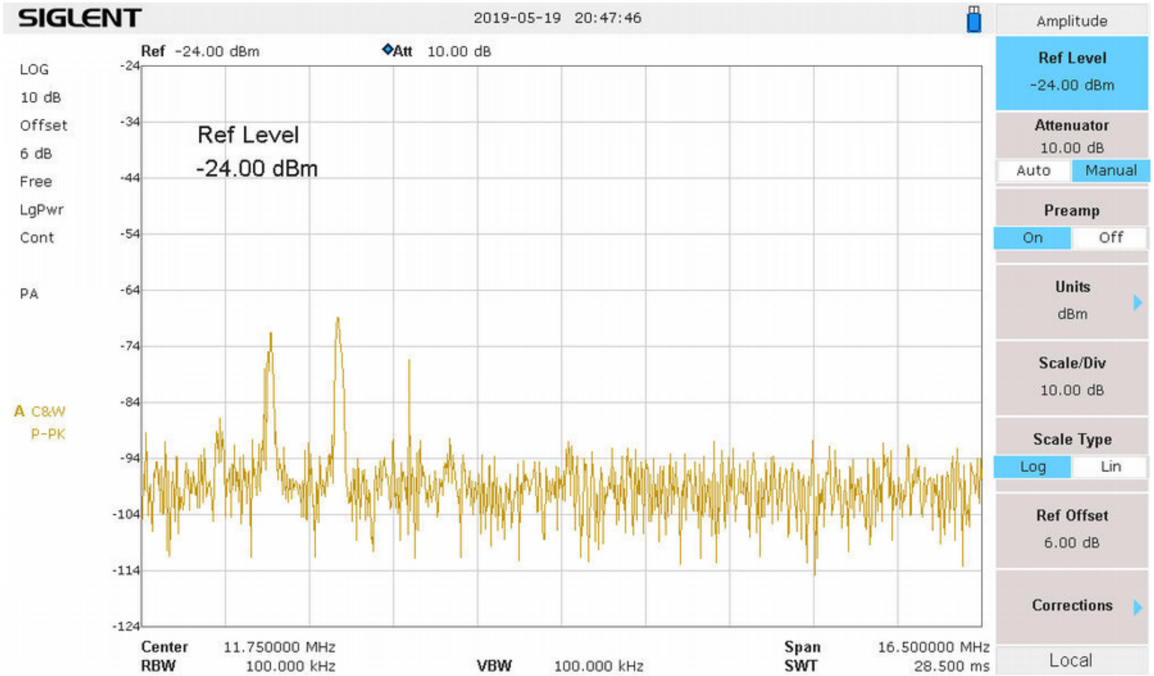


Fig. 3 Representative background measurements using 2 foot dipole at ham radio residence, powered by non-inverter-based gasoline generator. For most frequencies, the RF levels are in the range of -90 dB. There are two notable signals stronger, one at 6 MHz and another just above the 40 meter ham band; these may well be powerful broadcast stations.

To provide contrast, **Figure 4 demonstrates a terrible environment** – the RF-infested rooftop of our local EOC where an HF antenna had been found to have very significant noise problems below 10 MHz. The exploring antenna discovered broadband noise signals (probably from powerful switching power supplies in backup power systems, uninterruptible power systems, and computers in the building below) that were as much as 30 dB above the residential noise floor.

A 30dB increase in the noise floor means that if a 1 watt transmitter's signal is just readable at the quieter location, it will require a kilowatt transmitter for the noisier location to hear the same incoming signal, all other issues being the same. This will basically destroy HF receiving possibilities.

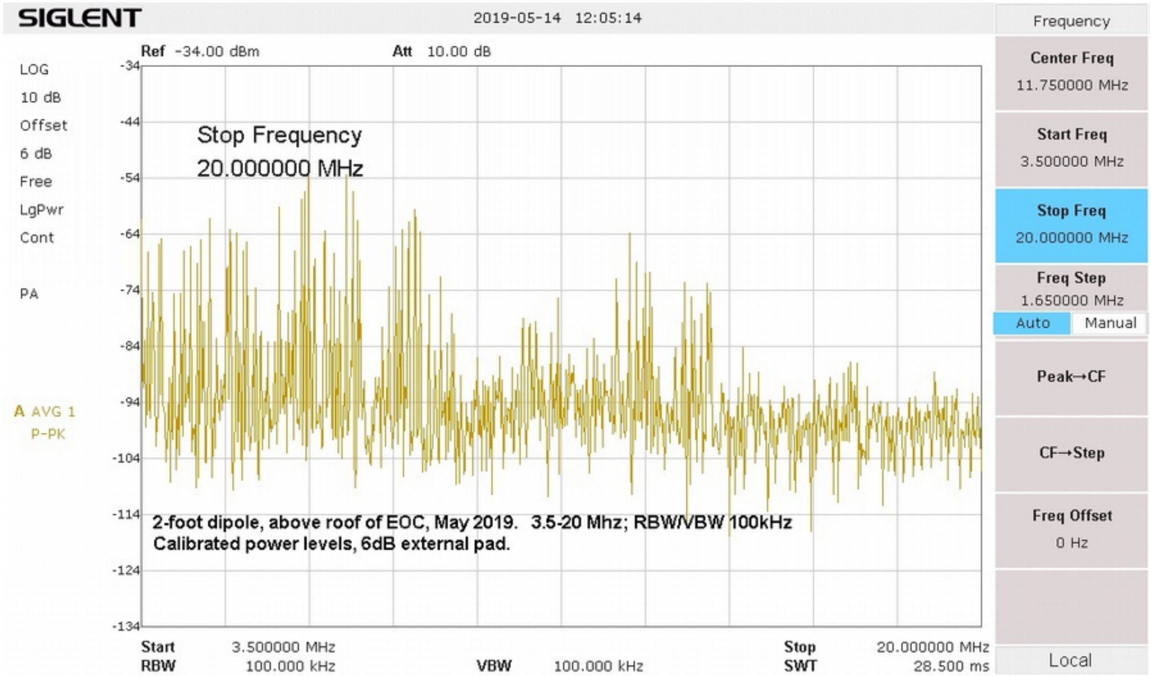


Fig. 4. Representative extremely high interference wide band noise environment – rooftop of our EOC building. 3.5 – 20 MHz. 100 kHz bandwidth. Noise spikes to -60 dBm are quite common, as much as 30 dB more noise than the residential location. Such a noisy location would be expected to seriously impact amateur radio reception of an antenna placed there, **and it did.**[6]

**Conclusion.**

Using readily available measurement devices and a simple protocol antenna, accurate measurements can be made to analyze the likely success of an HF antenna at a home, commercial or government site. Measurements can be expressed in quantities which are familiar to radio professionals (decibels referenced to 1 milliwatt, dBm) and by repeatable methods. This can help better position antennas, guide mitigation techniques where possible, and encourage better design of future power installations to reduce unwanted high frequency RF radiation.

6 https://qsl.net/nf4ac/2019/May14Investigations.pdf