Tracking Radio Noise

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Points I will strive to address today…

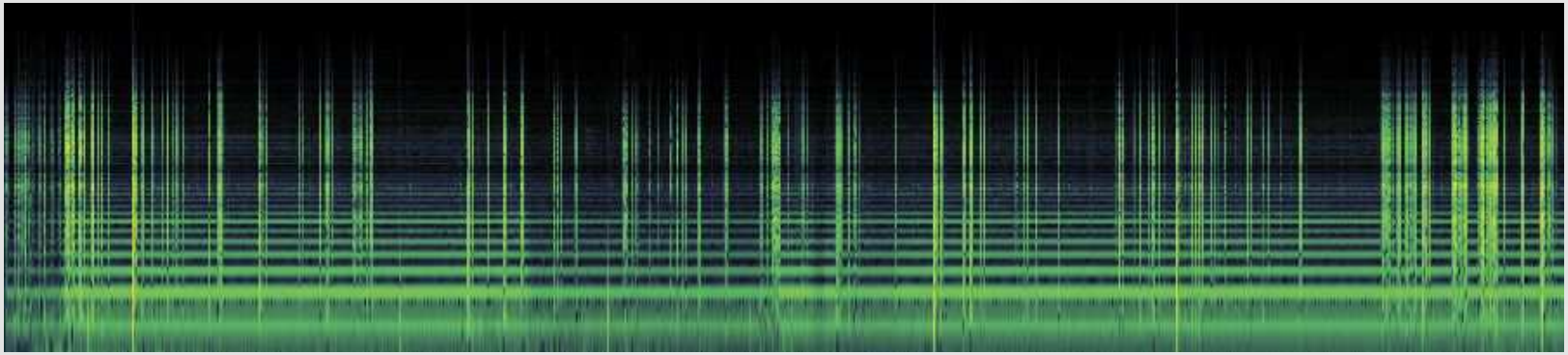
Who? – Radio system users are being impacted.

What? – Communication services losing coverage.

Where? – Techniques for locating noise sources.

When? – The problem is growing over time.

Why? – Does radio noise really matter?



Introduction

Radio hobbyists –

Ham radio operators, shortwave listeners, broadcast DXers, and other enthusiasts are usually quite aware of the growing radio noise issues we face…

But most people are unaware of this "noise pollution" problem – including some broadcast engineers.

Observations

Broadcasters receive many complaints from listeners, staff, or management regarding reception problems…

"Did you try moving the antenna?"

Observations

An increasing number of listeners report deteriorating reception, but they usually don't know why.

When I was with WPR, I found that over 5 years the Audience Services logs showed a 40% increase in complaints related to reception.

"I used to get good reception, but not anymore…"

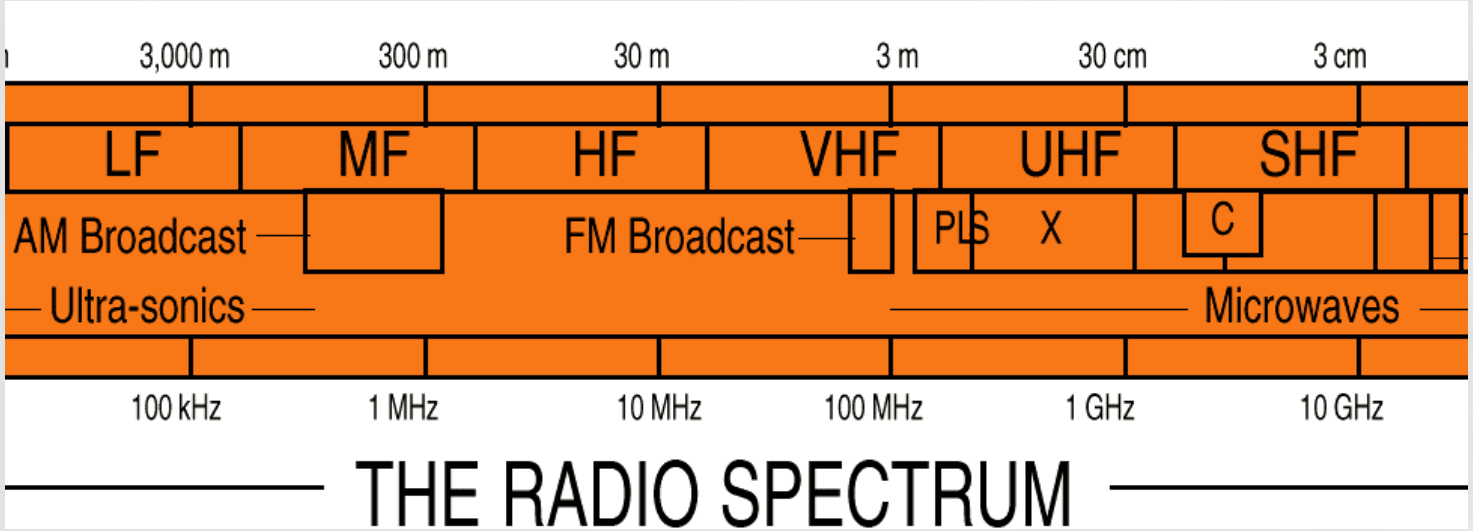
"Did they reduce their power?"

"I just can't tune it in!"

Observations

Awareness of the ambient noise problem seems limited among broadcasters.

Some recognize that AM radio is susceptible to noise interference (an issue raised in the recent “AM Improvement” movement), but most seem unaware of the impact of environmental noise on FM, TV, and other services.



Observations

On AM radios, noise interference is easily heard as pops, clicks, buzzes, and hiss.

Analog TV allowed the viewer to see “snow”, wavy lines in the picture, and other picture defects which provided clues to the nature of the interference.

On the other hand…

FM receivers tend to mask the sound of interference – the listener often just has an inability to get a clear reproduction of the desired station. The signal is perceived as “weak”.

Digital TV has the “cliff effect” – impact of noise is hidden and reception is perfect as long as the signal-to-noise ratio is above a threshold, then you “fall off the cliff” and lose reception. This all-or-nothing experience hides the clues that might help viewers discover the nature of the interference .

FM Field Tests

Not absolute measurements – instead a comparison of outdoor to indoor FM reception conditions.

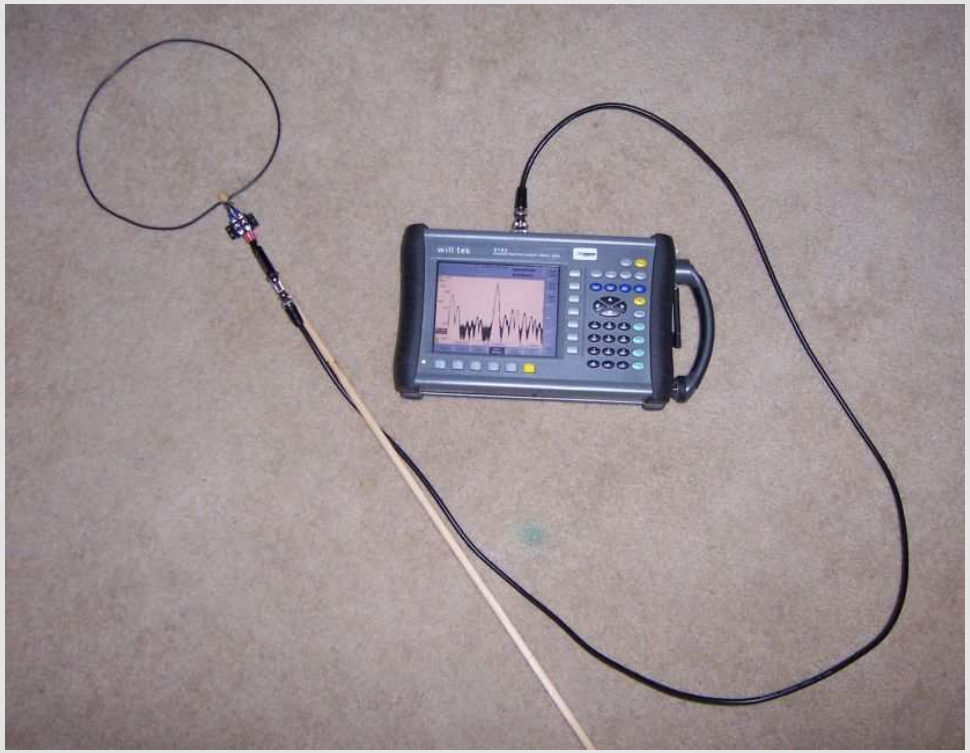
These results would apply to TV reception as well.

Study locations

- Suburban houses
- Urban apartments
- Urban offices

FM Field Tests

Portable spectrum analyzer with home-made loop antenna.

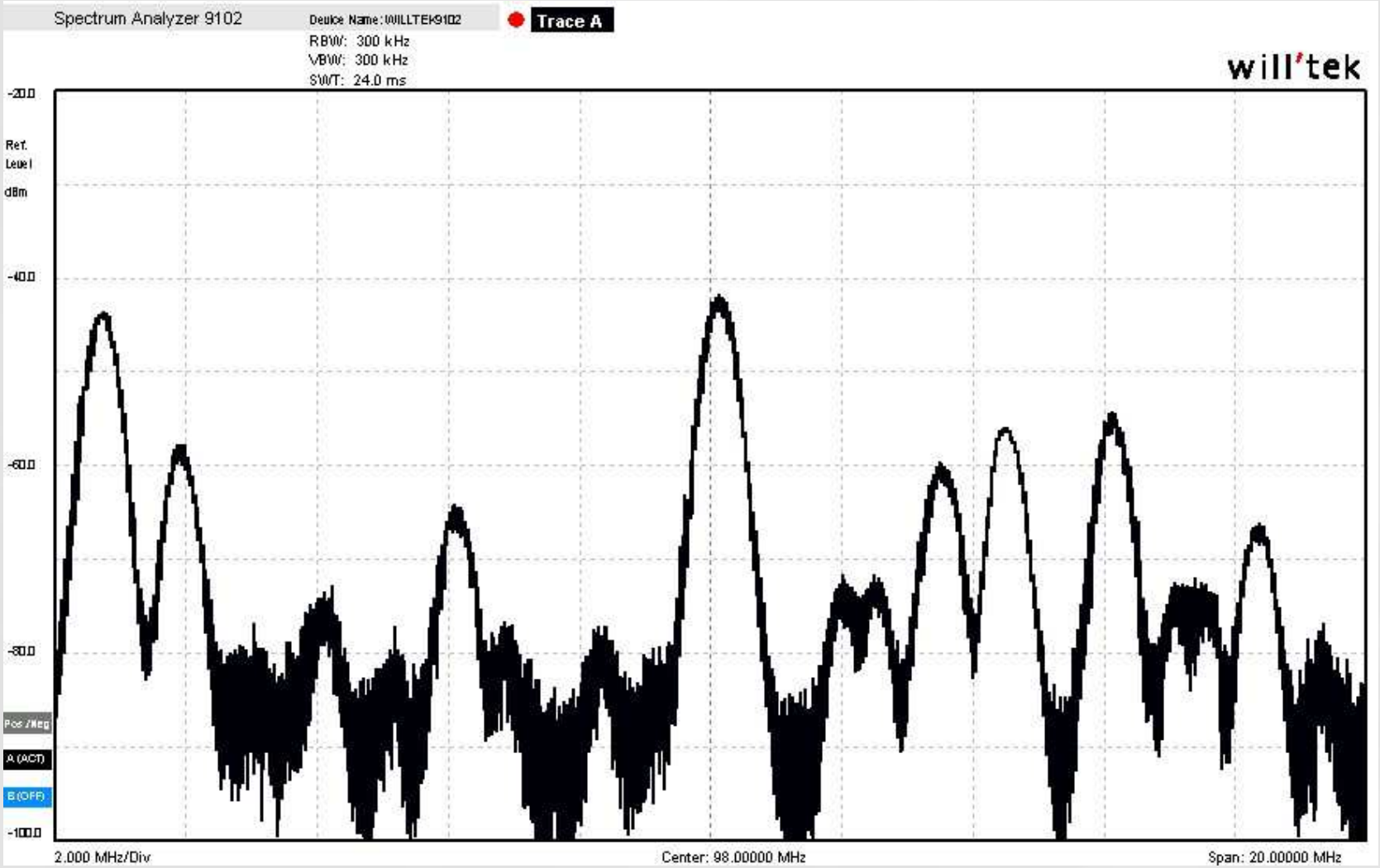


Field Tests

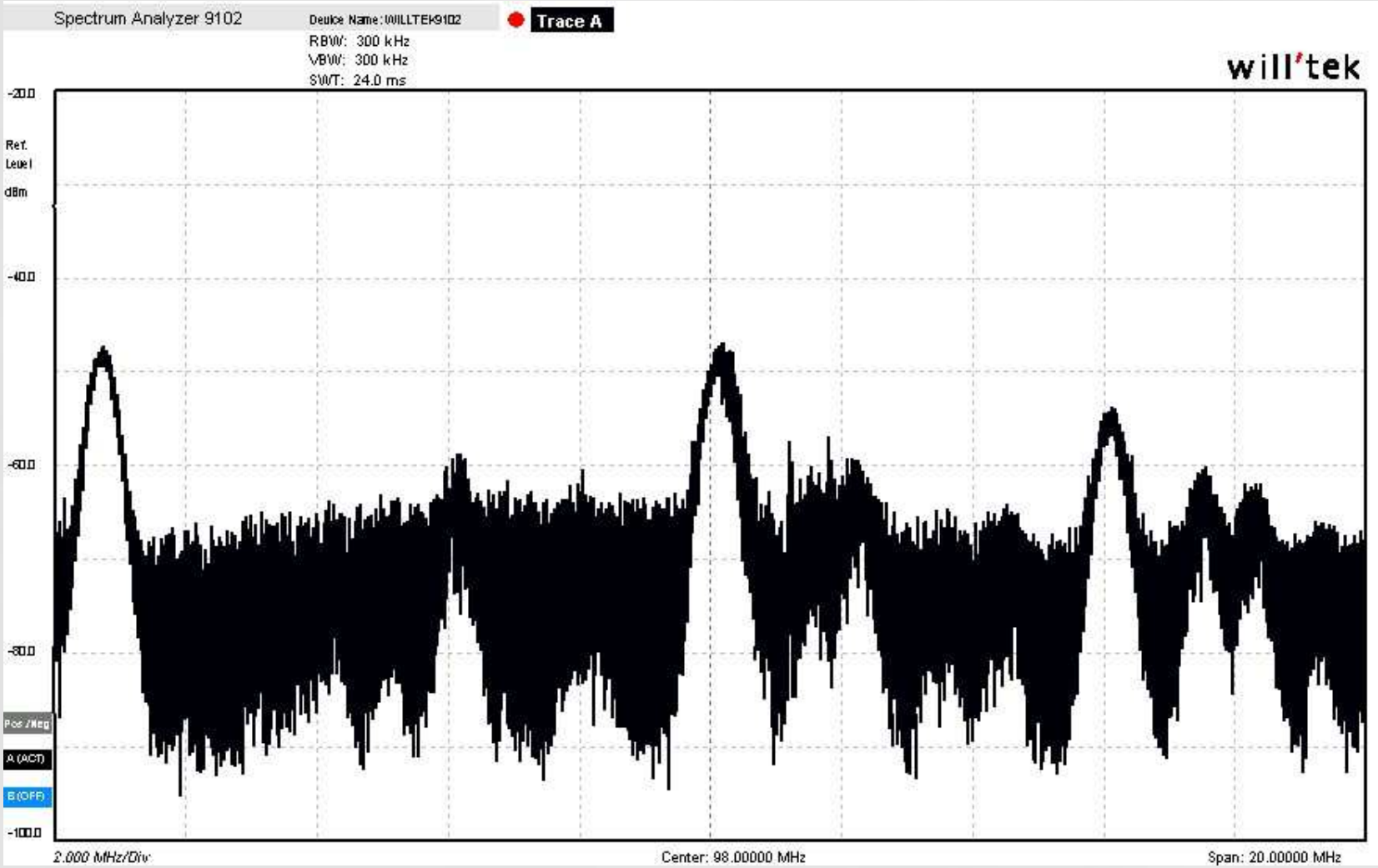
- Suburban homes

Fitchburg, Wisconsin

Outside Suburban Home



Inside Suburban Home

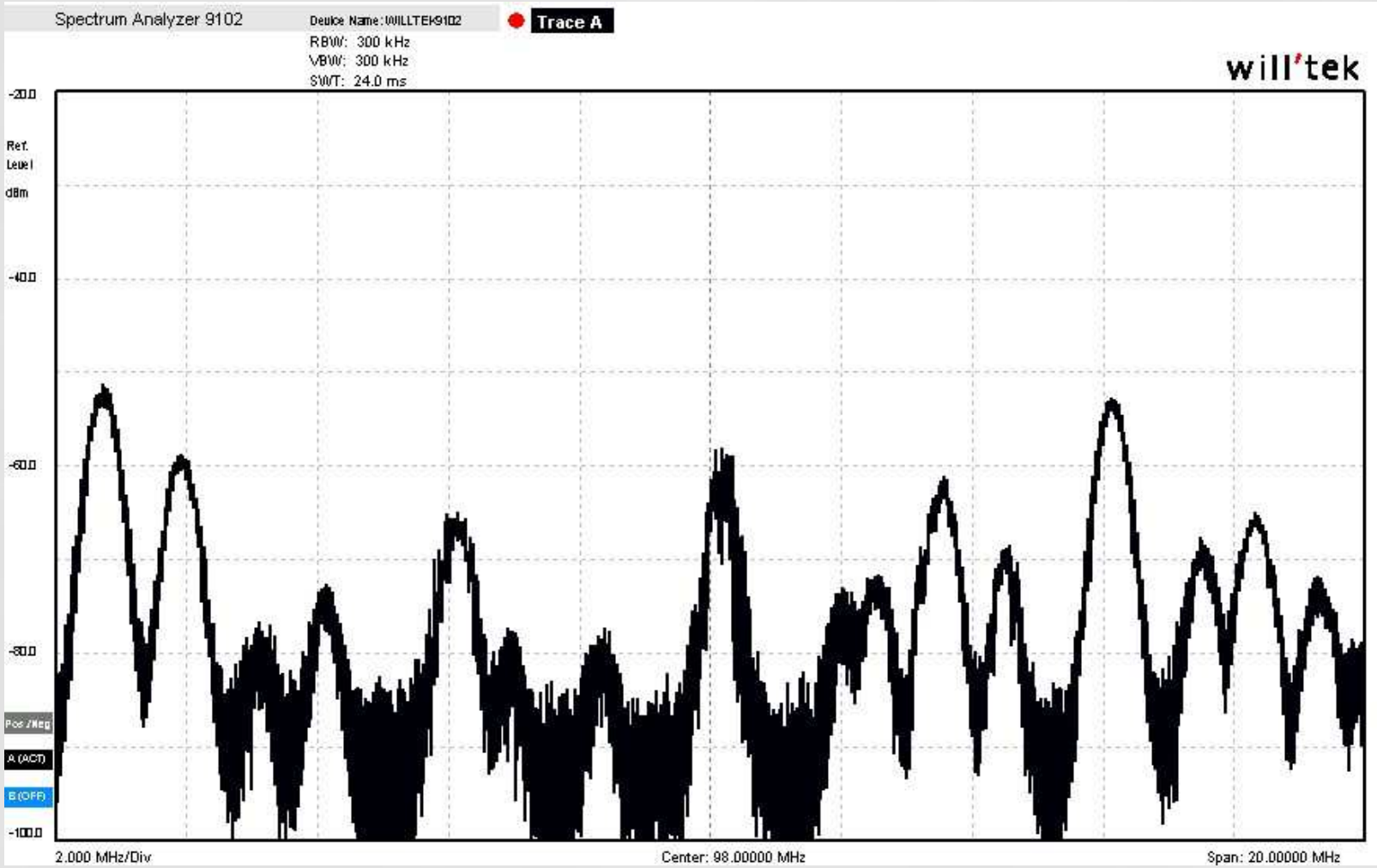


Field Tests

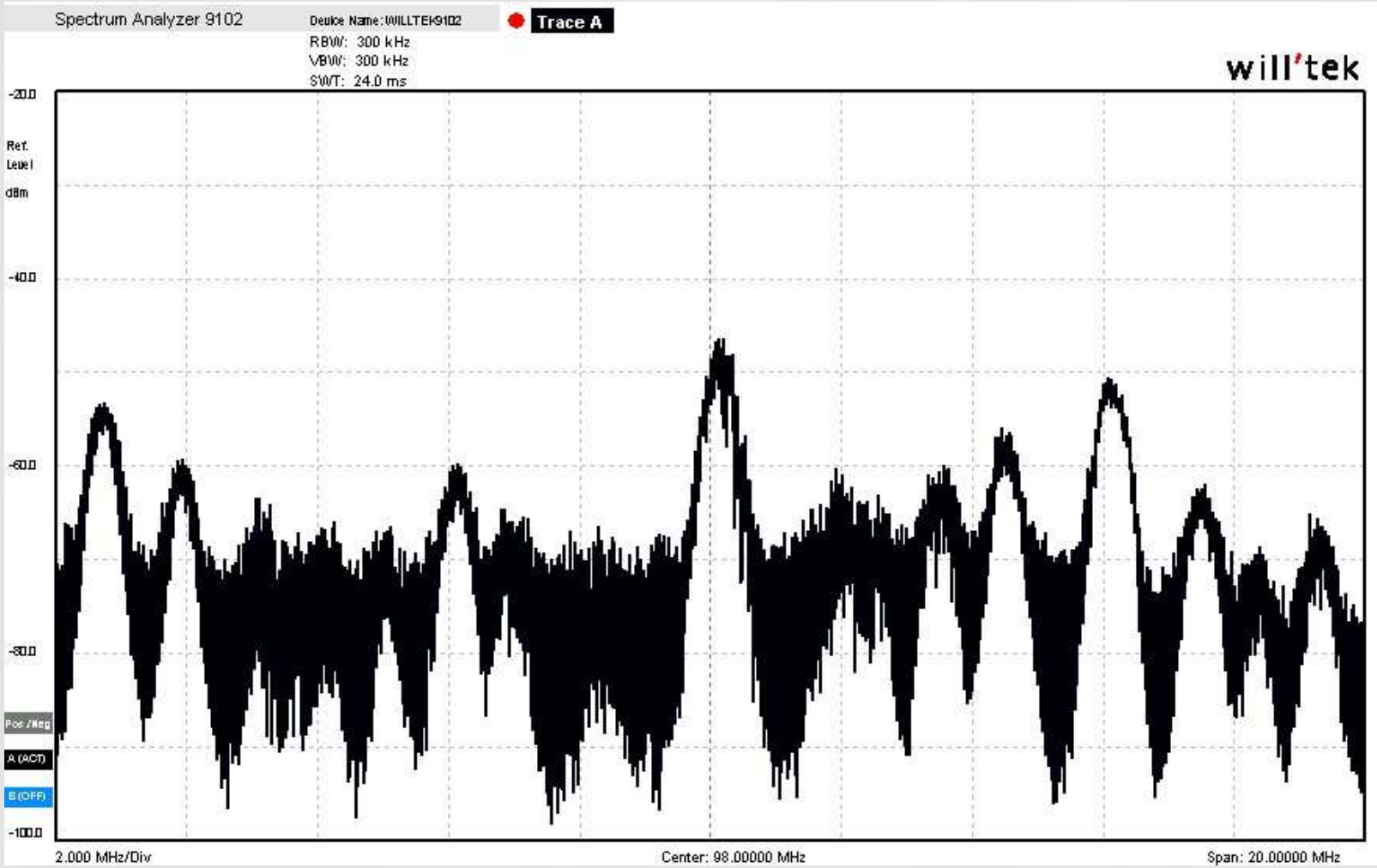
- Urban Apartments

Quisling Apartments - Madison, Wisconsin.

Outside Apartment Building



Inside Apartment

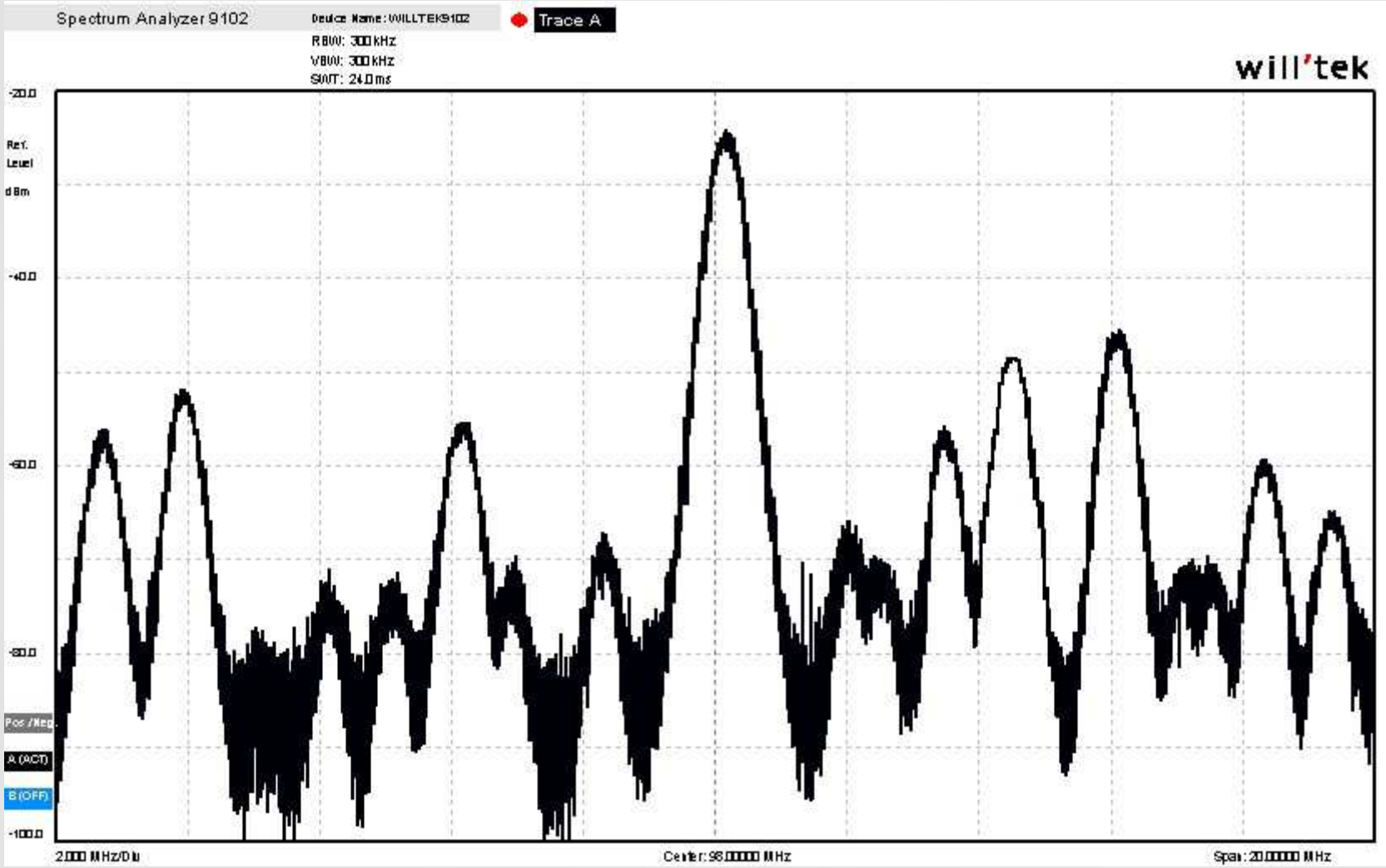


Field Tests

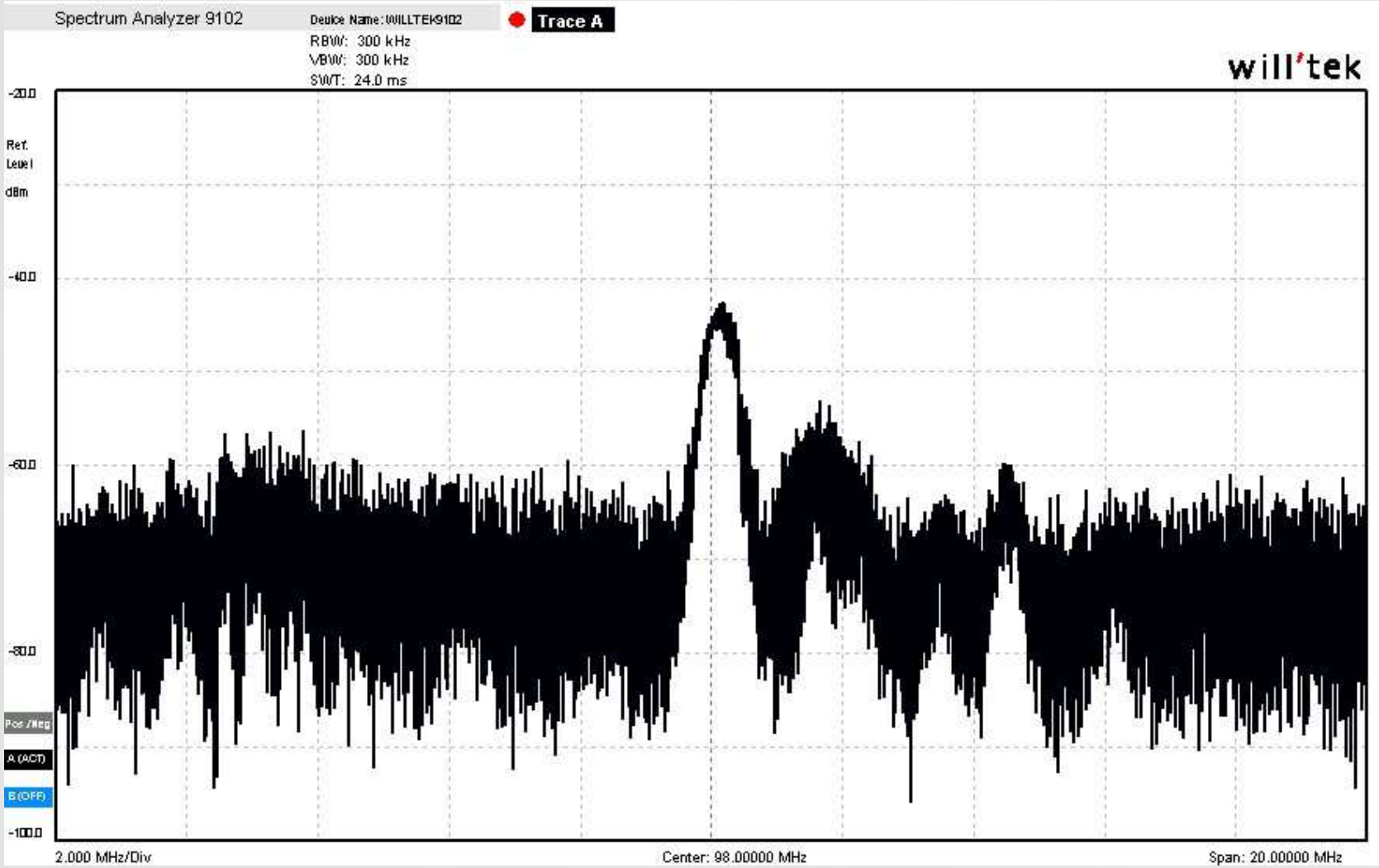
- Urban Offices

UW Vilas Hall - Madison, Wisconsin

Outside Office Building



Inside Office Building



Field Test Results

The increase in noise from outdoor to indoor was dramatic in all cases, sometimes as much as 20 to 30 dB.

Why is this happening?

I contacted several engineers involved in the manufacturer of consumer electronics. They confirm that devices are often being made without adequate concern for their incidental RF radiation.

- Anecdotal reports: prototypes are RFI tested, but actual products are built cheaper and not to tested specs.
- Switching power supplies from third-parties not tested

Why Search for Radio Noise?

We want to find the source of the noise so we can eliminate it completely, or at least be able to locate our radio and/or its antenna away from the culprit.

Our immediate goal is to improve the signal to noise ratio so that good reception is possible.

A longer-range goal is to reduce the overall noise floor in the premises so that all RF devices can work at their best.

Finding Noise Sources

Useful Equipment

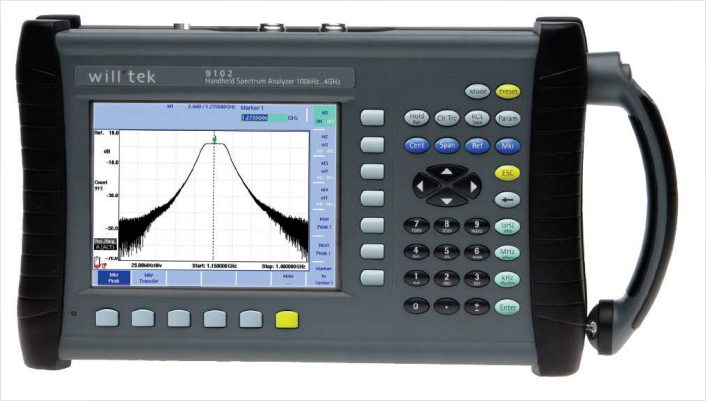
VHF Field Strength Meter

LF/MF Field Strength Meter

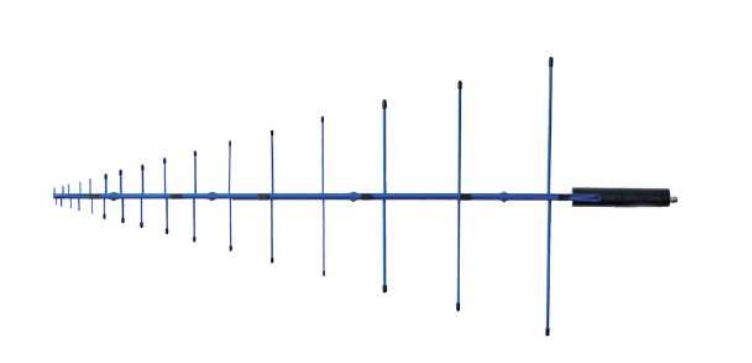
Finding Noise Sources

Useful Equipment

Portable AM Radio
with internal ferrite bar antenna
(sharp signal null off both ends)



Portable Spectrum Analyzer



Handheld Directional Antenna
(signal peak off the smaller end)

Finding Noise Sources

Useful Equipment

Corner-Reflector TV Antenna
Lightweight, folds flat,
easily held with one hand.

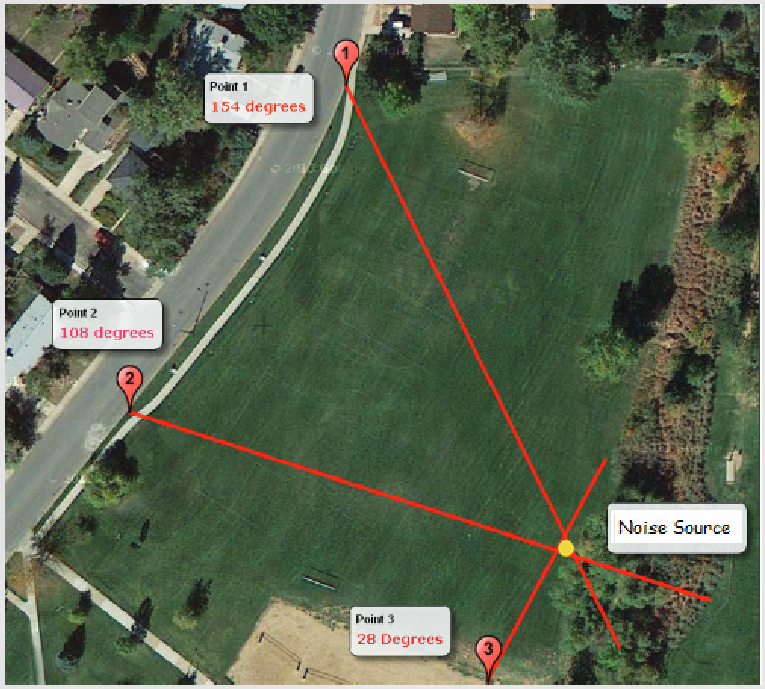
Search Loop On-a-Stick

Finding Noise Sources

A couple good techniques:

Proximity vs Relative Strength

Wander with a portable receiver to find places where the noise is relatively strong.



Directional Triangulation

Use a directional antenna positioned at several separated locations to map out the source of the interference.

Finding Noise Sources

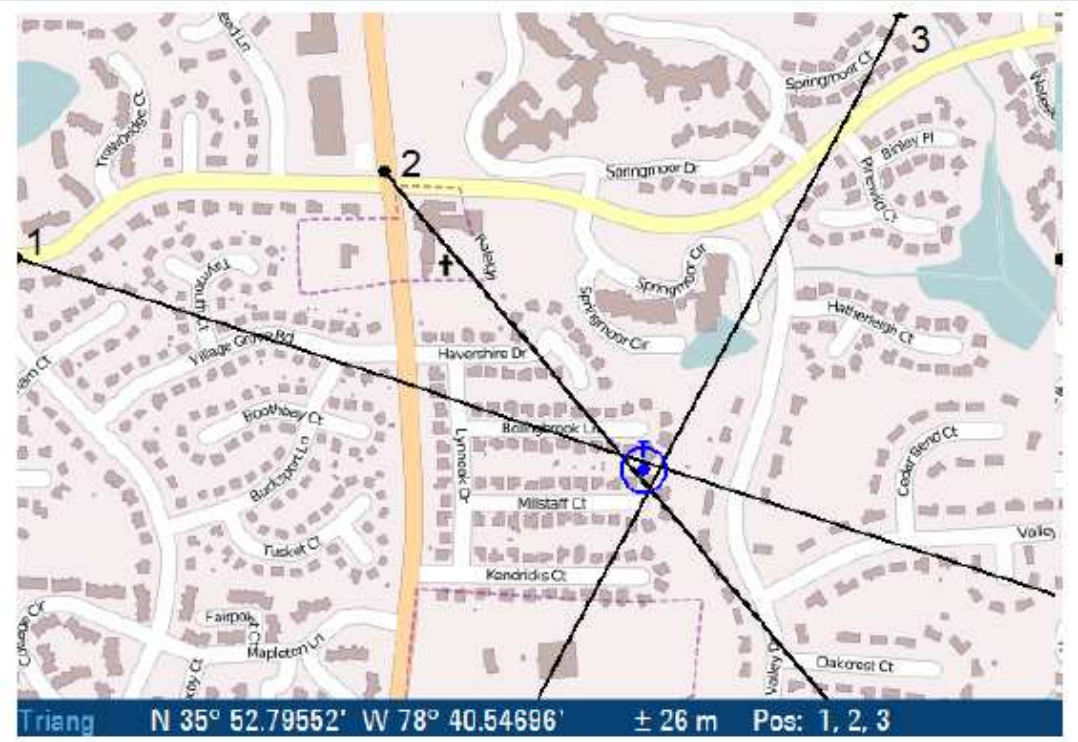
The “Drive-By” method…

Proximity vs Relative Strength

Using a receiver and antenna in a vehicle, drive around
seeking the location(s) where the signal is stronger. See what pattern develops.

Finding Noise Sources

Triangulation – finding where the lines cross…



Using a receiver and directional antenna, measure the compass directions from which the signal is stronger (or nulled out, depending on the design of the antenna).

Demonstration

Use of Portable AM Radio

1971 Motorola Model TP52FL

Battery power is a must.

Demonstration

Ferrite bar antenna

Radios with longer ferrite bar antennas have a tighter signal null off the ends, which helps pin-point the noise source. But any AM “transistor radio” will be useful.

I modified this receiver with a switch in the battery compartment to allow me to disable the automatic gain control (AGC). This improves the clarity of the signal peaks and nulls.

Is the Noise Coming from Inside the House?

1. Listen to the interference on a battery-powered receiver and turn off the "Main" electrical circuit breaker to your property.

2. If the noise goes away you know the offending device is running somewhere on your household power lines. If not, then it is outside somewhere.

3. If it is in your house, you can narrow down the location of the offending equipment by turning the Main breaker back on and when the noise returns, turn off individual branch circuit breakers to winnow down the possible locations to one circuit, often to one room.

“Always On” Electronics

Many modern devices are powered and at least partially operating (and thus potentially making RF noise) whenever they are plugged in – even when turned “off”!

LG washing machine
7W ■ On but not running
4W ■ Off

Apple TV, first generation
21W ■ On
17W ■ Off

Samsung cable box
28W ■ On and recording
26W ■ Off and not recording

Apple MacBook, plugged in
48W ■ Open, charging
48W ■ Closed, charging
27W ■ Open, fully charged

“Always On” Electronics

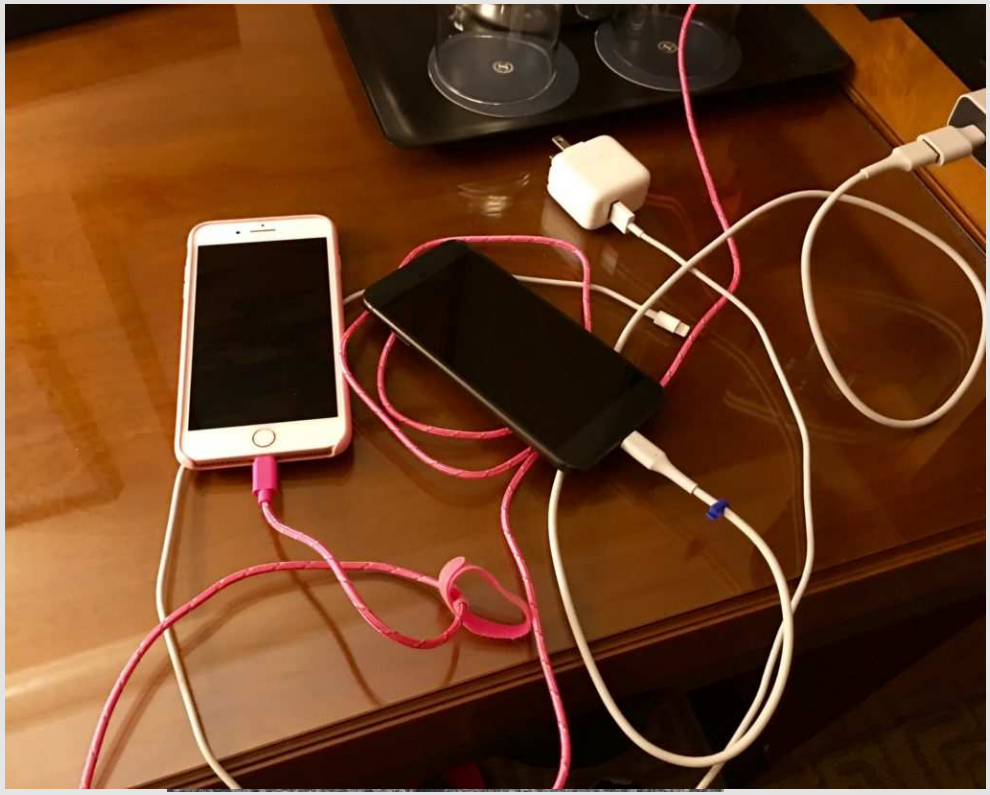
Many modern devices are powered and at least partially operating (and thus potentially making RF noise) whenever they are plugged in – even when turned “off”!

In another example, this phone charger made intense radio interference noise even when not connected to its cellphone.

Examples of Noise Sources

The bedside table is a traditional location for radios. But it is now a common spot cellphone charging too.

The potential for interference is high due to the close coupling of these devices with the broadcast receiver.



Examples of Noise Sources

Kitchens are another traditional radio location that is being invaded by noise-making electronics. A microwave oven made an interfering carrier signal on top of desired FM station, ruining reception on kitchen radio.

Listener unplugged it, then exchanged the oven for a different make/model to restore FM reception.

Examples of Noise Sources

- Broksonic Corporation model CTGV-5463TCT Television set

"Broke-sonic" - a perfect name for this noisy product!

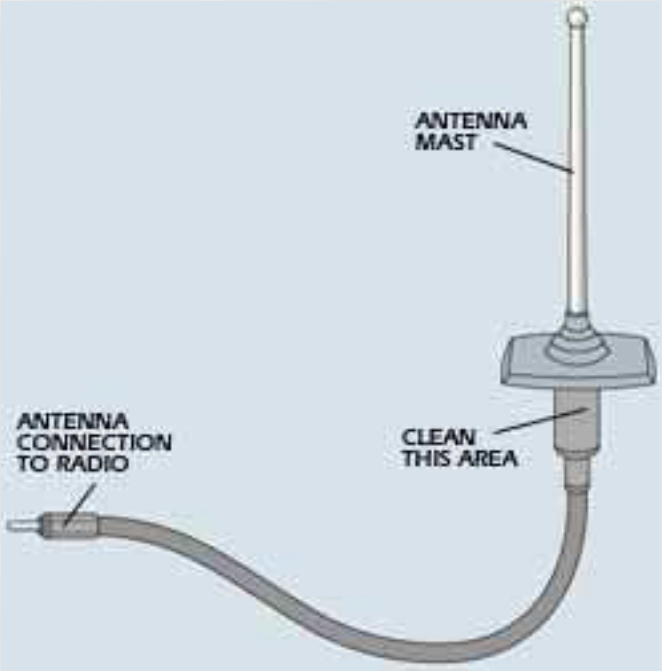
Examples of Noise Sources

Automobiles are suffering from a rising noise floor too.

A portable AM radio can be a good tool in the search for noise sources.

Examples of Noise Sources

Automobile antennas can have grounding problems that increase noise pick-up from the rest of the vehicle…

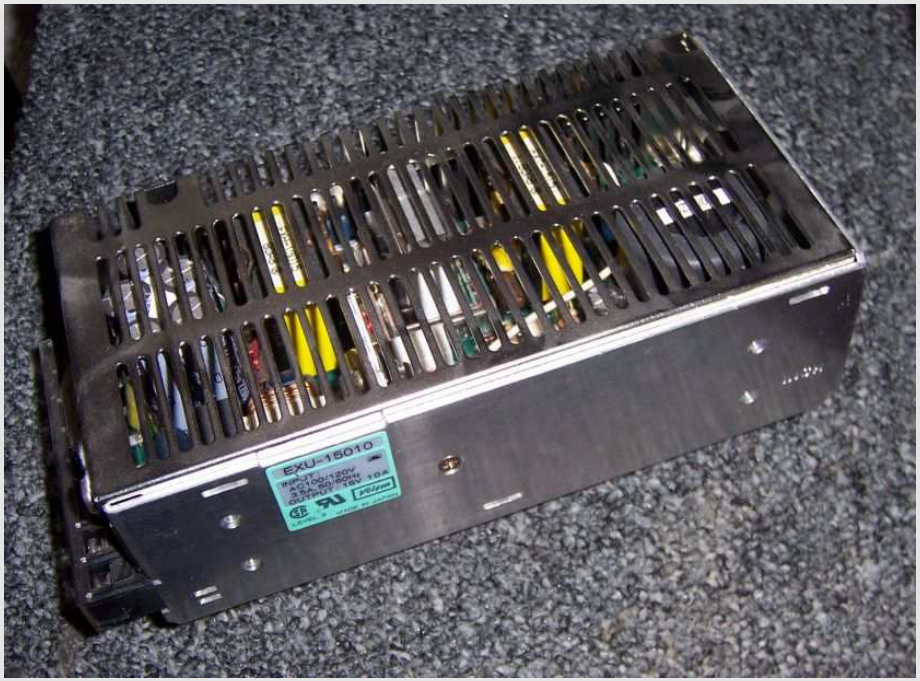


Clean/tighten the antenna mount – it is the connection of the cable shield to the car body panel. Good contact here helps reject noise from sources inside the vehicle.

Examples of Noise Sources

- Voltek (Volgen) model EXU-15010

  Office equipment power supply



Shielded, but I had to add bypass capacitors to AC input and DC outputs.

Examples of Noise Sources

- Viewsonic Model LSE9901B1250 power supply for monitor

Examples of Noise Sources

- Network modems and router power supplies are particularly troublesome because their noise can be radiated easily from the attached ethernet cables – spreading noise all over the house or office!

This noisy router power supply was replaced with a linear (non-switching) supply purchased from a thrift store.

Examples of Noise Sources

- Lite-On Technology model PA-1650-01
  Toshiba notebook PC power supply

Replace[illegible]er supply

Examples of Noise Sources

- Lumatek LK1000 lighting ballast

Used by “indoor gardening” enthusiasts.

Examples of Noise Sources

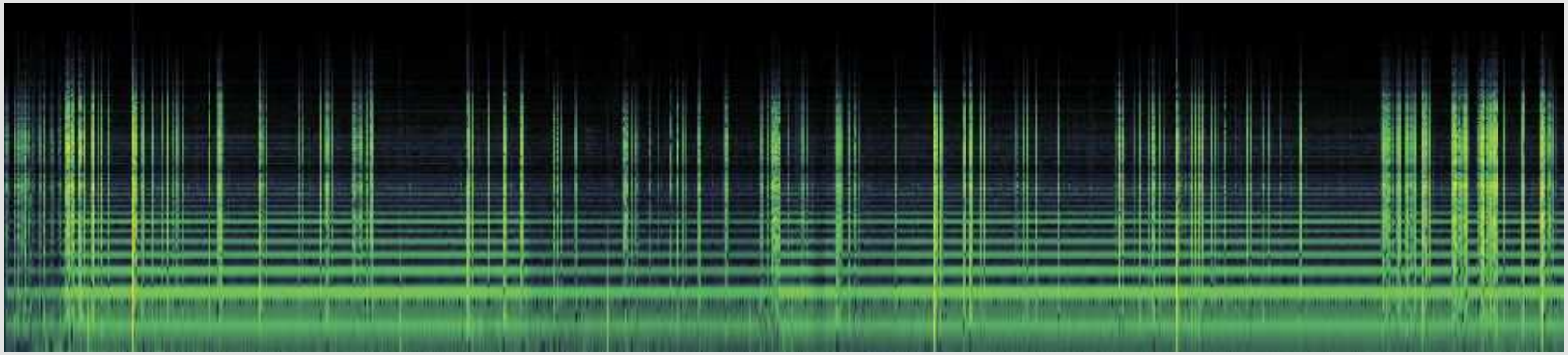
- Failed power line connector

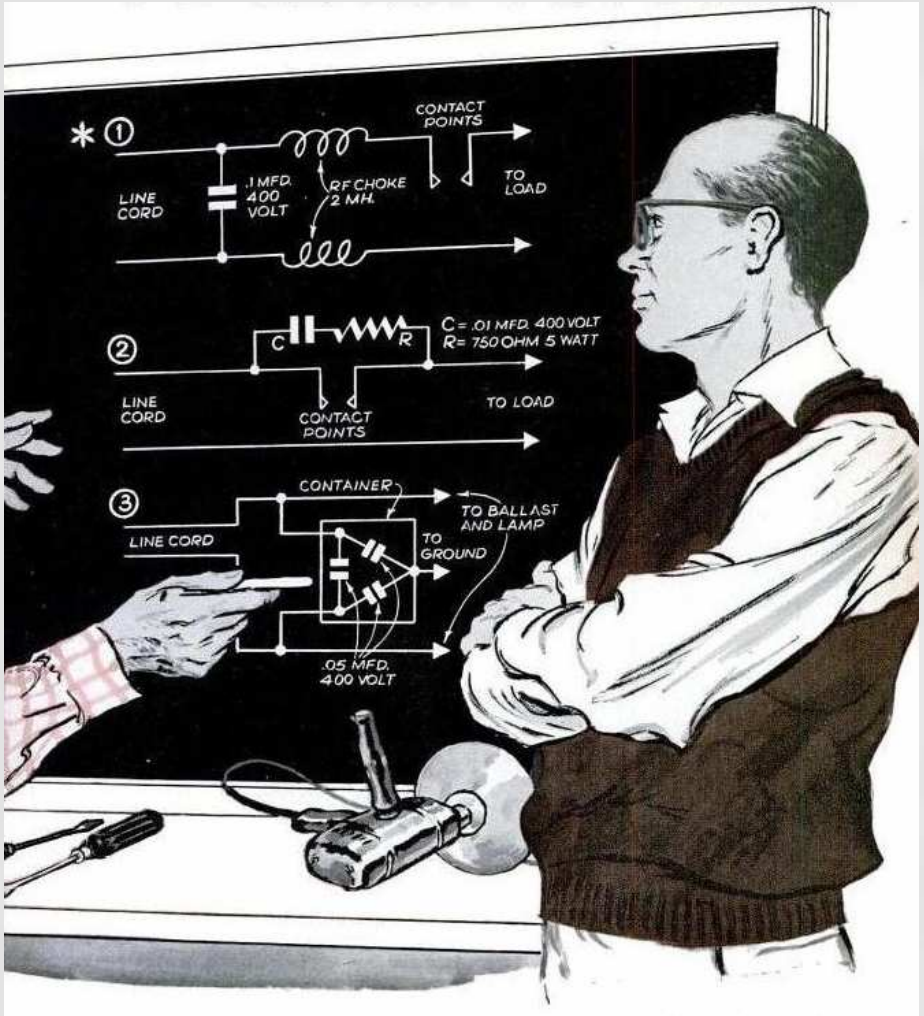
Power companies often only fix dramatic situations like this.

To summarize…

Listeners and viewers of broadcast stations, as well as WiFi, 3G/4G/5G, Bluetooth, and all other users of “wireless” systems are finding reduced signal availability due to the rising noise floor.

I’ve presented some simple ways to start tracking down sources of noise. You can improve reception at your own homes and offices, help individual listeners, and generally preserve the value of our on-air signals.





Questions?

Your observations?

Thank you…

Steve Johnston

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