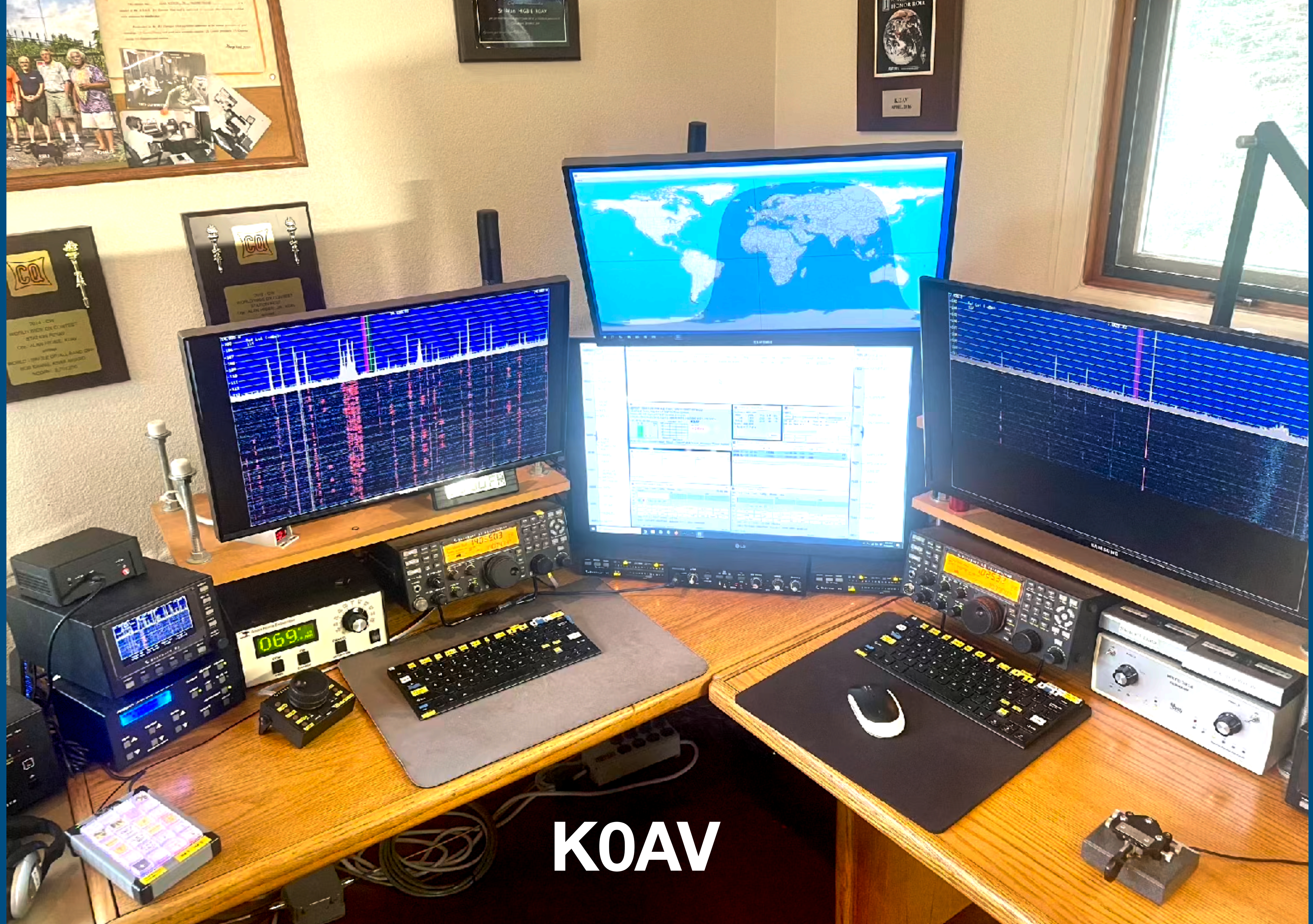


Finding and Fixing RFI Sources

Alan Higbie - K0AV
Colorado Springs



K0AV

The problem:

- **Signal-to-Noise Ratio**
 - **SNR = S/N Ratio:**
 - **Difficulty hearing weaker signals**
- **Number of RFI sources increasing**
- **Result:**
 - **Impacts our enjoyment**

Improving Signal-to-Noise Ratio ?

- Increase signal strength
 - Better locations
 - Higher gain antennas
- Decrease noise
 - Directional antennas
 - Locating & Eliminating RFI sources

We will discuss:

- Goal

- Find and Eliminate RFI Sources

- Troubleshooting process

- Basic approach
 - Pitfalls to avoid

- Locating RFI source(s)

- Best Practices

- Tools

- Receivers
 - Antennas for hunting

- Eliminating RFI source(s)

- Filters
 - Working with utilities

- Case study:

- Years-long RFI problems
 - Happy ending

- Resources - the best resources

- Q & A

RFI Sources found - my immediate area:

- Refrigerator
- Furnace
- Wi-fi Extender
- Power supplies
- Computer monitors
- Laptop displays
- Garage door opener
- Shop lights
- Fish tank heater
- Solar array
- Wi-Fi Router
- Touch Lamp
- Defective power line hardware
- Grow lights
- Paper shredder

Multiple sources are common

- Hunt them one at a time.
 - Identify each - signature
 - Close listening
 - Stay focused
 - Peeling back layers of an onion
- Examples of the layers:
 - Arcing on multiple power poles
 - Different devices
 - On at different times
 - Different headings

Locating takes priority!

- Goal is to eliminate the RFI source.
- Can't fix what you can't find.
- Priority: Find it.

Tools for locating RFI . . .

- Brain

- Attitude
- Mental focus
- aided by RFI Log

- Receivers

- HF & VHF-UHF
- Portable HF receiver
 - w/ external antenna jack
 - HF & VHF-UHF
 - SDR receiver & software & tablet PC

- Antennas

- HF
- VHF-UHF
- Attenuators
- Pre-amplifiers for loops

Attitude - Avoid Mental Traps

- Start with: Somewhere is a source - causing increased noise floor.
- It's not magic! — “It's Just Physics”
- Don't jump to conclusion - Keep Open Mind
- Don't waste much time on WHAT *it is* - Avoid rabbit holes - *shorten the timeline to the fix.*
- Focus on: WHERE it is.

Attitude - Avoid Mental Traps (continued)

- Focus on finding the source raising your noise floor.
 - Don't waste time sniffing out every wall wart and appliance which generates noise.
 - . . . only track sources getting to your antenna & receiver on the band of interest.
- Confirm what you track in the field - is what is affecting your radio's noise floor.
- Expect to be walking around neighborhood with DF loop, etc.
- Hopefully, its on your property.

Noise Survey & Long-Term Monitoring

- Set up receiver, (SDR receiver with software)
- Listen (let it run) for *long time*
- Listen and watch:
 - May be a matter of days
 - or, (even) months.
 - (consider) When band not open.
- Keep RFI log of observations
 - -dBm (Noise Floor levels)
 - (more exact than S-meter readings)
 - Use same mode - not FM
 - Receiver settings - consistent
 - Antenna used - and beam heading - same
- Dates & times when active
- Photos of display - with reference in log
- Signal Characteristics (“signature”)
 - Broadband vs. narrowband?
 - Steady vs. intermittent?
 - Moving?
 - Repeating across spectrum?
 - Changing with environmental factors?
 - Crackling? popping?
 - 120 cycle pattern?
 - Zoom in to look closely?
 - Zoom out for a wide look?

RFI Log - continued

Also, write down your:

- Random observations
- Hunches
- “Plan”
- Next steps

October 17, 2025 - Friday

23:20 z (5:20 PM local)

14.030 MHz

- WEATHER
 - Temp: = 67 deg. F.
 - Precip: none
 - Sky cover: sunny & clear
 - Relative humidity: 14 %
 - Pressure: = 29.62 in. HG
 - Wind: 6 mph from ESE (gusts to 15 mph)
- SETTINGS
 - Beam Heading = 67 degrees
 - Span = 25 kHz
 - AVG = 20
 - P3's REF LVL = - 119 dBm
- Noise Floor = - 112 dBm
- Characteristics: :
 - NF pops up intermittently,
 - Peaks at -102 dBm (10 dB higher)
 - But intermittently, pops go up to -97 dBm (15 dB higher)
 - some Scratchy sounding @ 67 deg.
- PLAN:
 - Awaiting hardware to be replaced
 - Currently scheduled for Mon., Oct.20.

“Power-Off at Home” Test

- What is this?
 - Cut off power to your home.
 - Radio on battery.
- Why do this early?
 - Because:
 - High % of RFI sources ultimately determined to be in the amateur's own home.
 - per ARRL RFI lab
 - per power utility RFI specialists

“Power-Off at Home” Test

- **IMPORTANT**
- Set up station's receiver to run on battery.
- Take notes - and photo of scope before.
- Shut off any battery chargers, UPS, etc.
- Shut off all power at main service panel - as enters the house
- Practical consideration - when family not home
- Listen on receiver
- Hope RFI goes off with power, i.e. under your control.

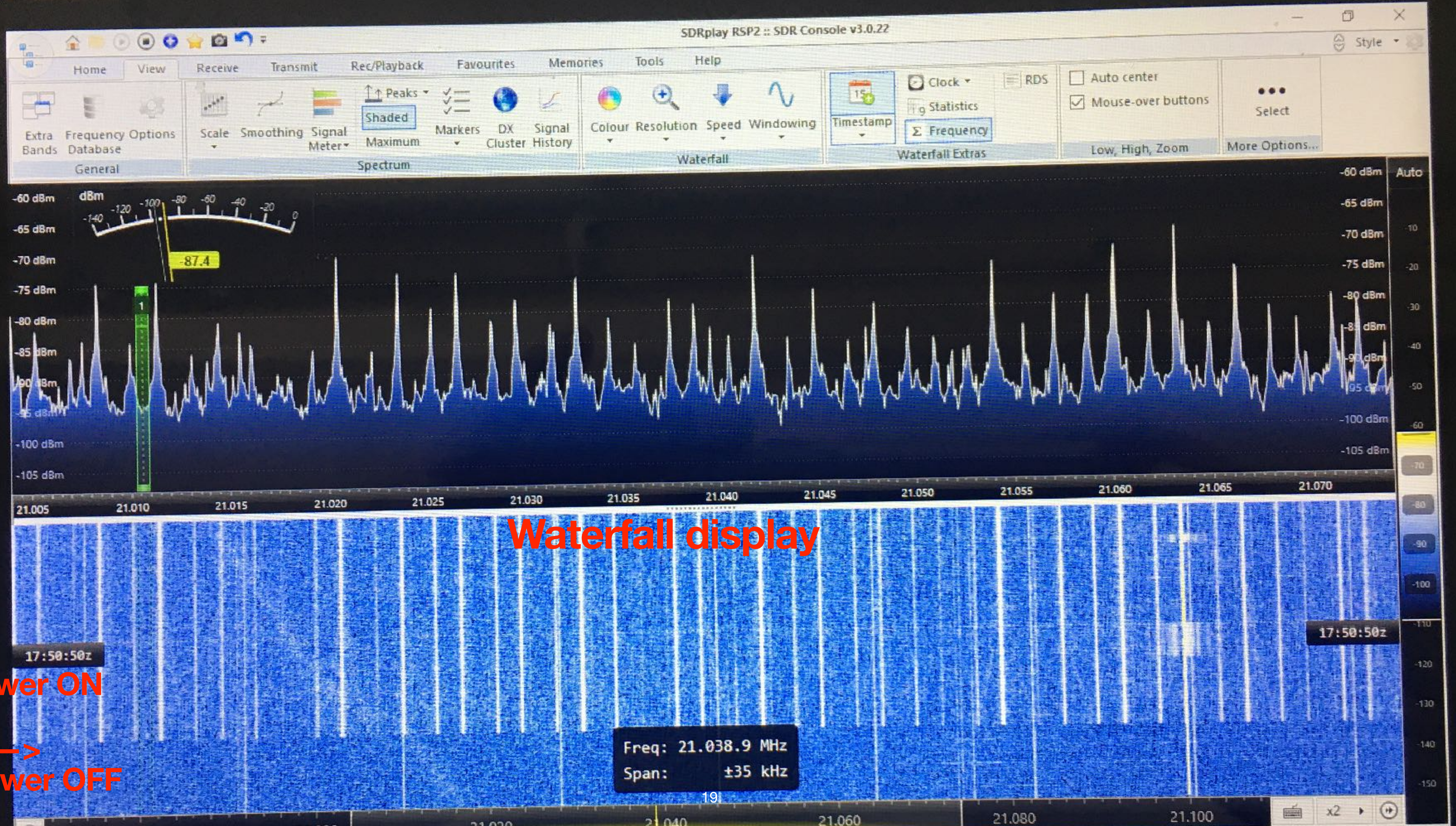
A.C. SERVICE PANEL



CIRCUIT BREAKER BOX

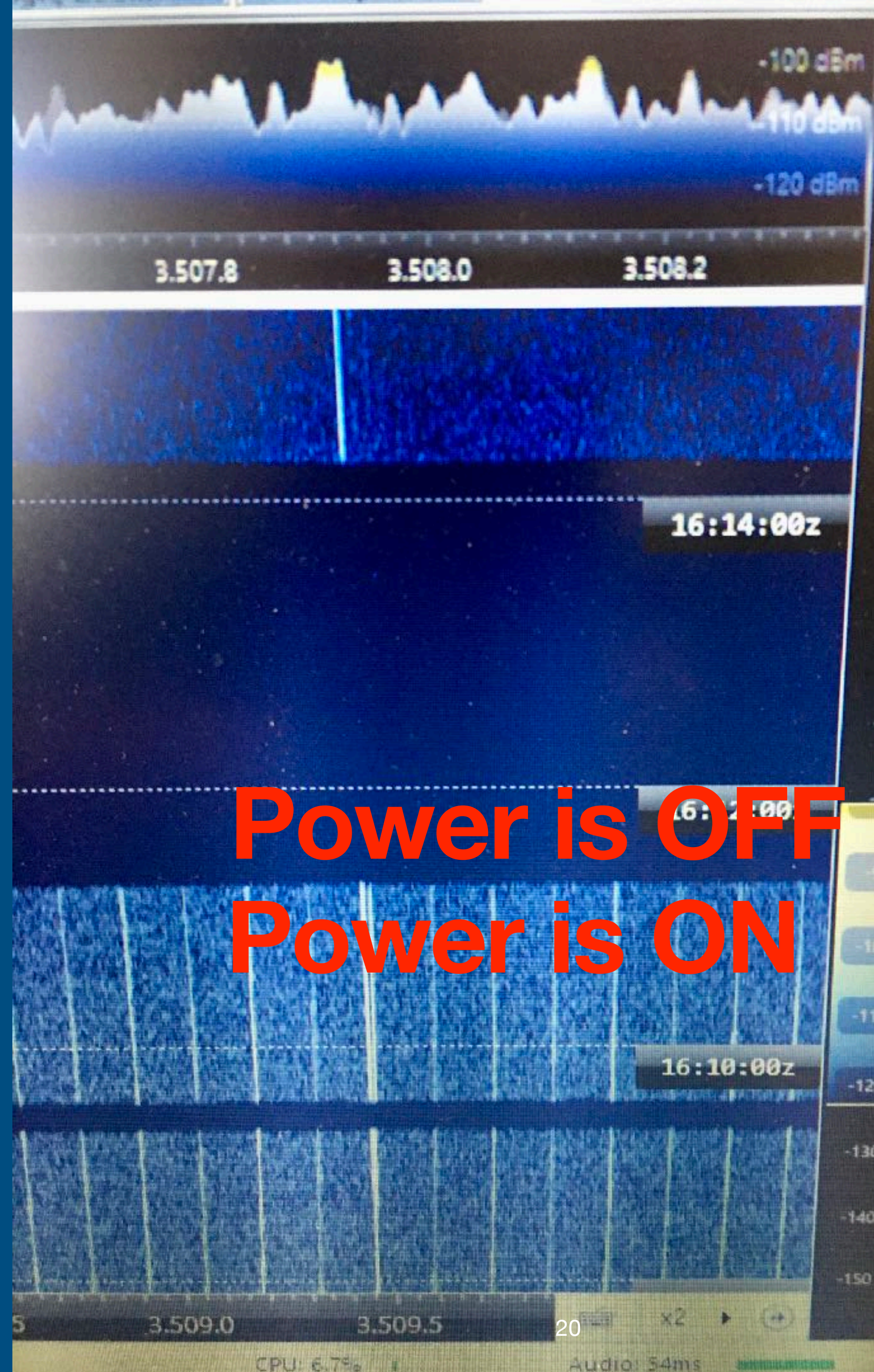


ASUS



Power ON

Power OFF



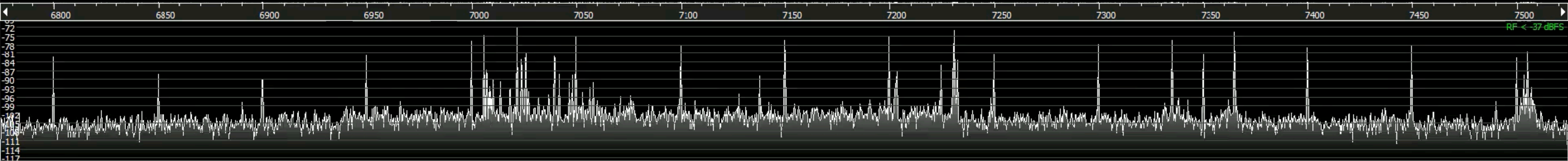
Power switched OFF
----->

Power is OFF
Power is ON

Time going this way

Time going this way

Note:
Bandwidth zoomed way in.
Looking at approx. 1/2 kHz.
Revealing: close spaced signals
----->



RMS **S6 -1 dB**

AM ☒ **ECSS** ☐ **FM** ☐ **LSB** ☐ **USB** ☐ **CW** ☐ **DRM** ☐

LO A 0005.162.000 **Tune 0008.655.000** **FreqMgr** **ExtIO**

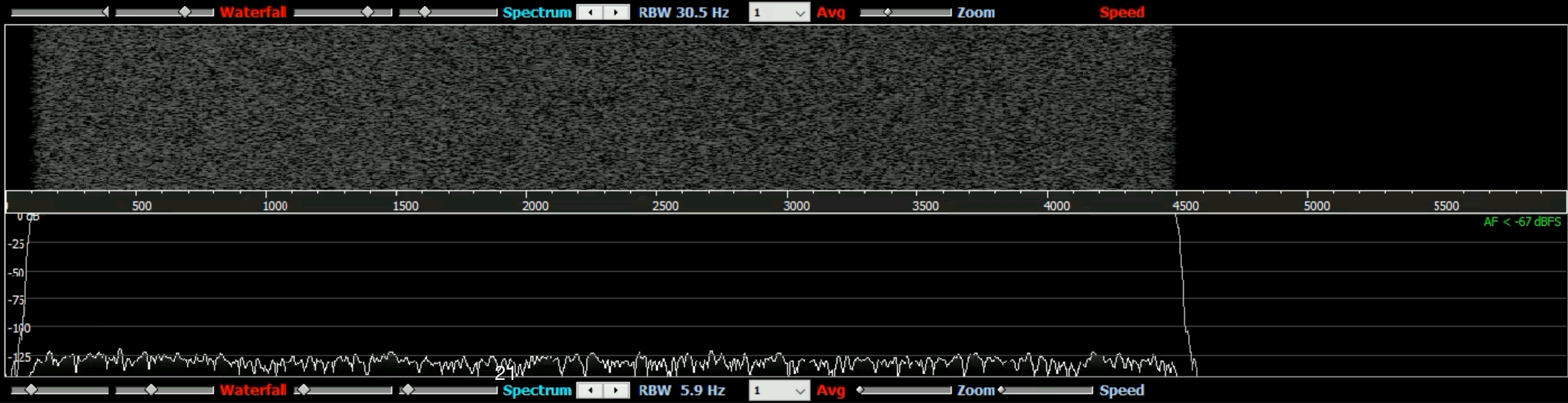
Volume Gain: +25.6 dB

Soundcard [F5] **Bandwidth [F6]** **Options [F7]** **Help / Update [F1]** **Full Screen [F11]** **Stop [F2]** **Minimize [F3]** **Exit [F4]**

NR **NB RF** **NB IF** **AFC** **Mute** **AGC Off** **Notch** **ANotch**

5/29/2022 02:31:28

CPU HDSR: 8% **CPU Total: 10%**



Conducted vs. Radiated RFI

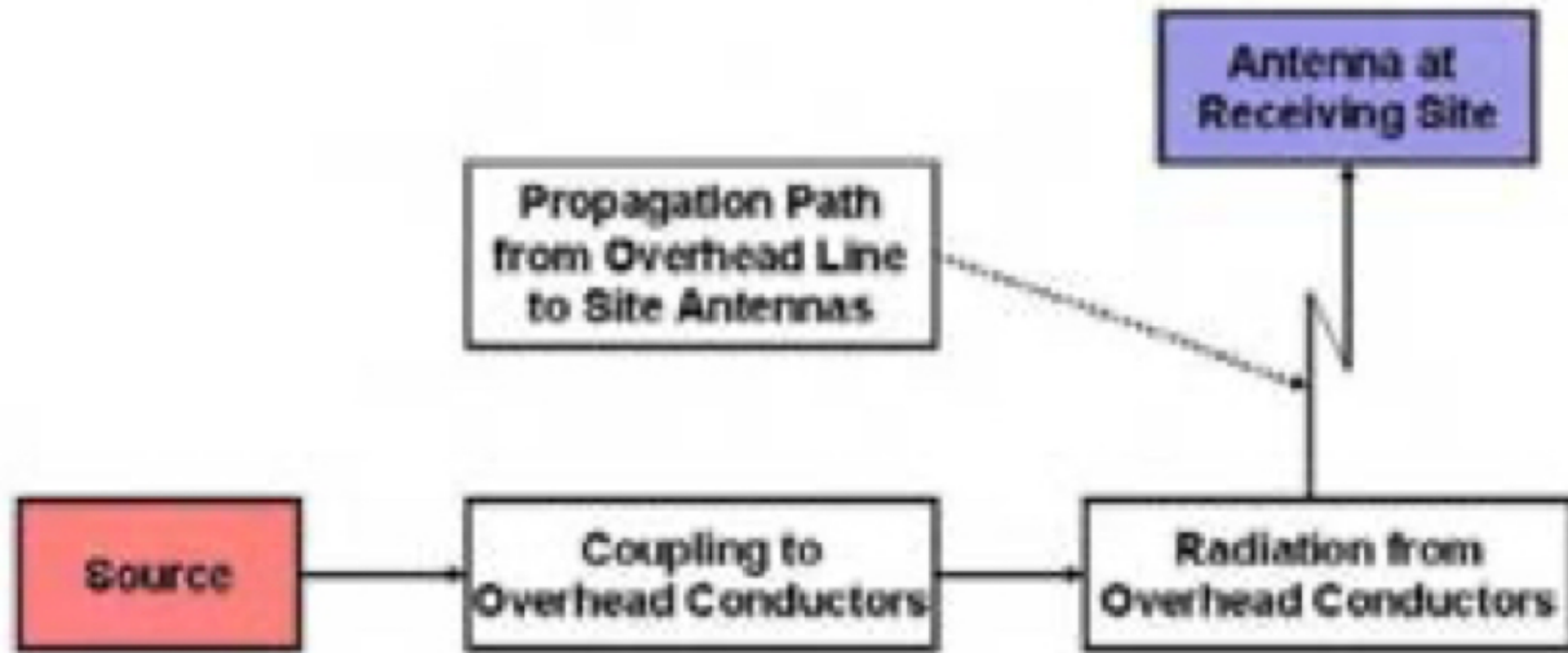


Figure 55 **Block Diagram of Source-to-Victim Path**

Receivers for Hunting RFI - helpful features

- Receiver(s) for multiple frequencies (HF to UHF)
 - Start on frequency where experiencing the RFI
 - VHF-UHF for when close to the source
- Portable - battery operated
- External antenna jack
- AM - SSB - CW (not FM)
- Strength indicator
- Attenuator - in line
 - Prevent overload when get close to source
 - Keep S-meter at mid-scale (more accurate)



Portable SW Receiver

SHOULD HAVE:

- External antenna jack
- S-meter
- CW-SSB
- HF ham bands



Yaesu FT-817

HF-VHF-UHF

use with portable
yagi antenna

Model M331

Radar Engineers M331



Mini RFI Locator

~ 320-340 MHz

Handheld attached directional antenna
Optimized For Sensitivity & Ease Of Use
Ignition Filter

Antennas for Direction Finding

- Home station beams
- Magnetic loop (with pre-amp)
 - Bidirectional
 - Narrowband
- Portable Flag Loop (WD8DSB)
 - Unidirectional
 - Broadband
- Portable beam antenna - VHF & UHF



Home station directional antennas

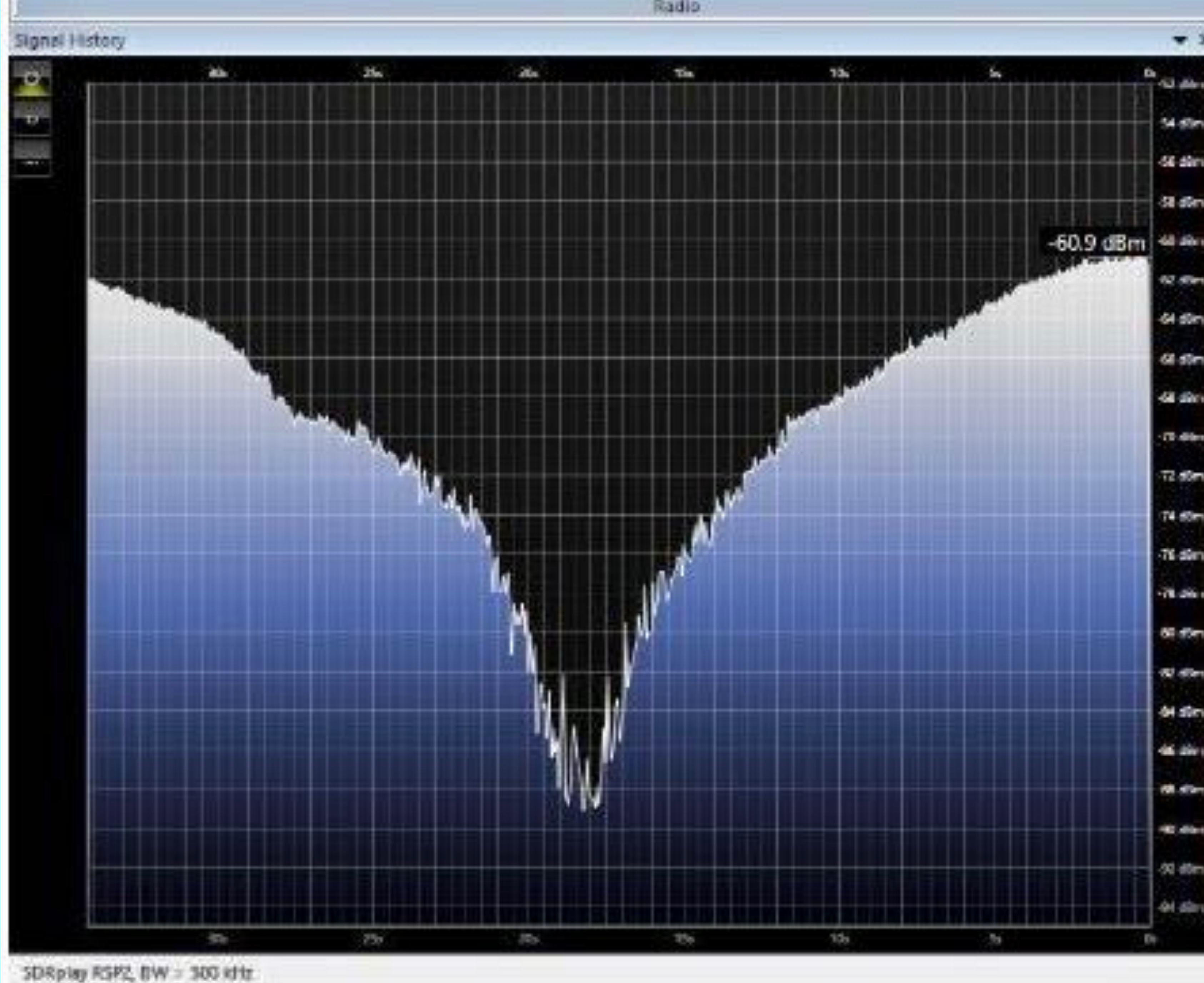


National RF HFDF

- Mag loop
 - built-in pre-amplifier
 - narrow bandwidth
 - bi-directional
 - so must triangulate
 - takes longer
 - portable - hand held
 - broad pattern (null)

SDR

Tablet PC



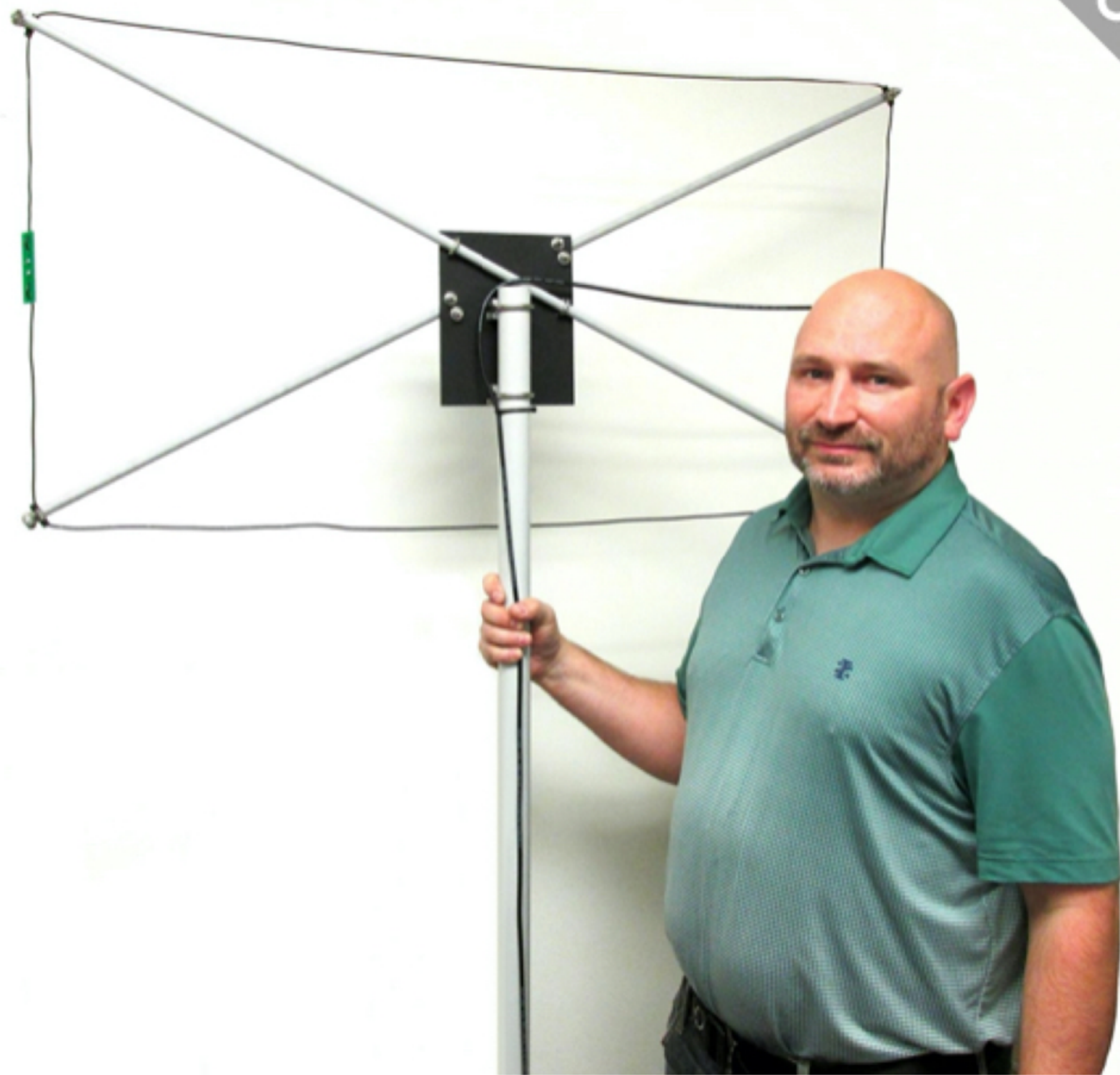
- **Bi-directional**
- **30 dB Null**
- **14 MHz**



Portable Flag

- Early 2021
- Don Kirk - WD8DSB
- Game changer
- Unidirectional
- Broadbanded
- Portable

QST (March, 2021)
construction article





DX Engineering NOISELOOP Portable Receive Flag Antenna Kit DXE-NOISELOOP

Antenna Kit, WD8DSB Portable HF RX Loop, for RFI Search and MW-SW Directional RX, Incl. FG Frame, Wire, Coax-BNC male, Parts, Hdwr., 2 x 4 ft., Kit

\$159.99

Add To Cart

☐ Compare Wish List

Part Number: DXE-NOISELOOP

★★★★★ (15)

In Stock (more than 10 available)

Estimated Ship Date: **Today**

Oversize \$7.99

Documentation

Multiple Images



Preamplifier

needed for such a small antenna

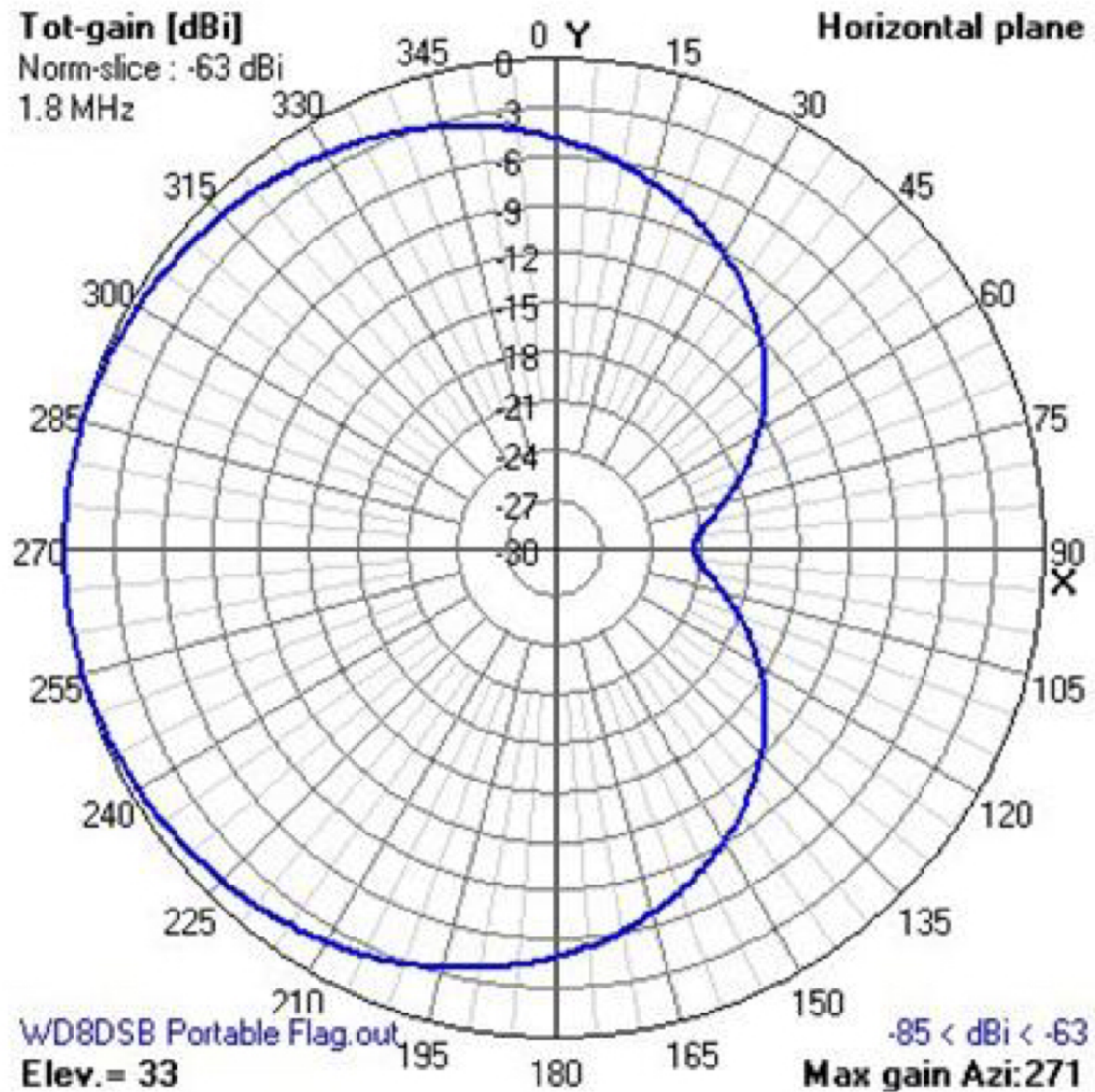
Attenuator

10 dB

20 dB

30 dB

\$175.99



Source is in
direction
of the null

Null toward source ----->



Testing of Portable Flag Loop

- Connected loop to station receiver
- Rotated to RFI was minimum (null)





← — — Portable Flag Antenna

← — — RFI Source

Measure distance
Click on the map to add to your path
Total distance: 471.57 ft (143.73 m)





Ultrasonic Dish

Pinpoint the Spark with Ultrasonic Locators

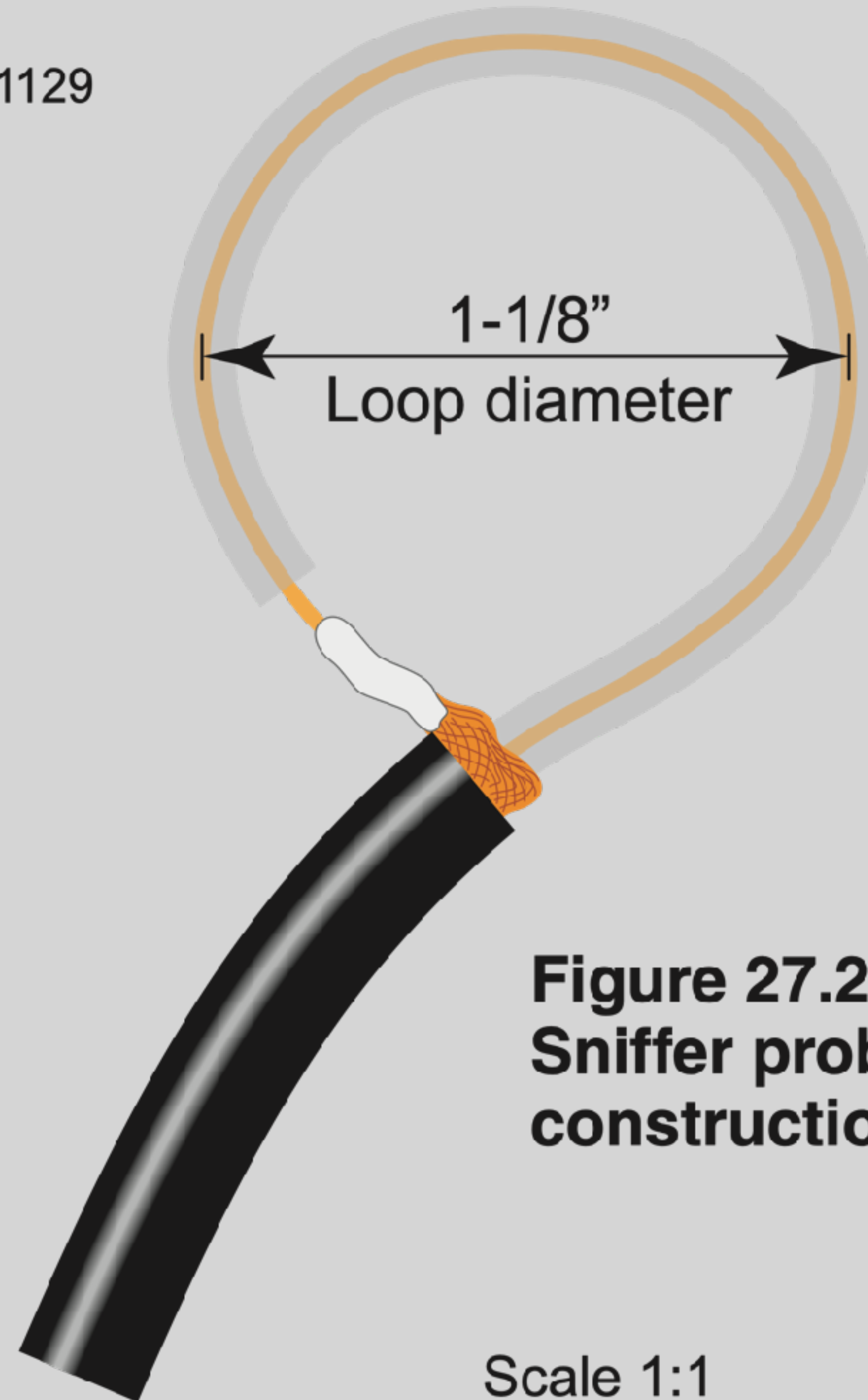
Model 251



Parabolic Pinpointer

Ultrasonic Locator to pinpoint sparking hardware
"Source" Indicating LED
Extremely Sensitive

HBK1129



**Figure 27.21 —
Sniffer probe
construction.**

Scale 1:1

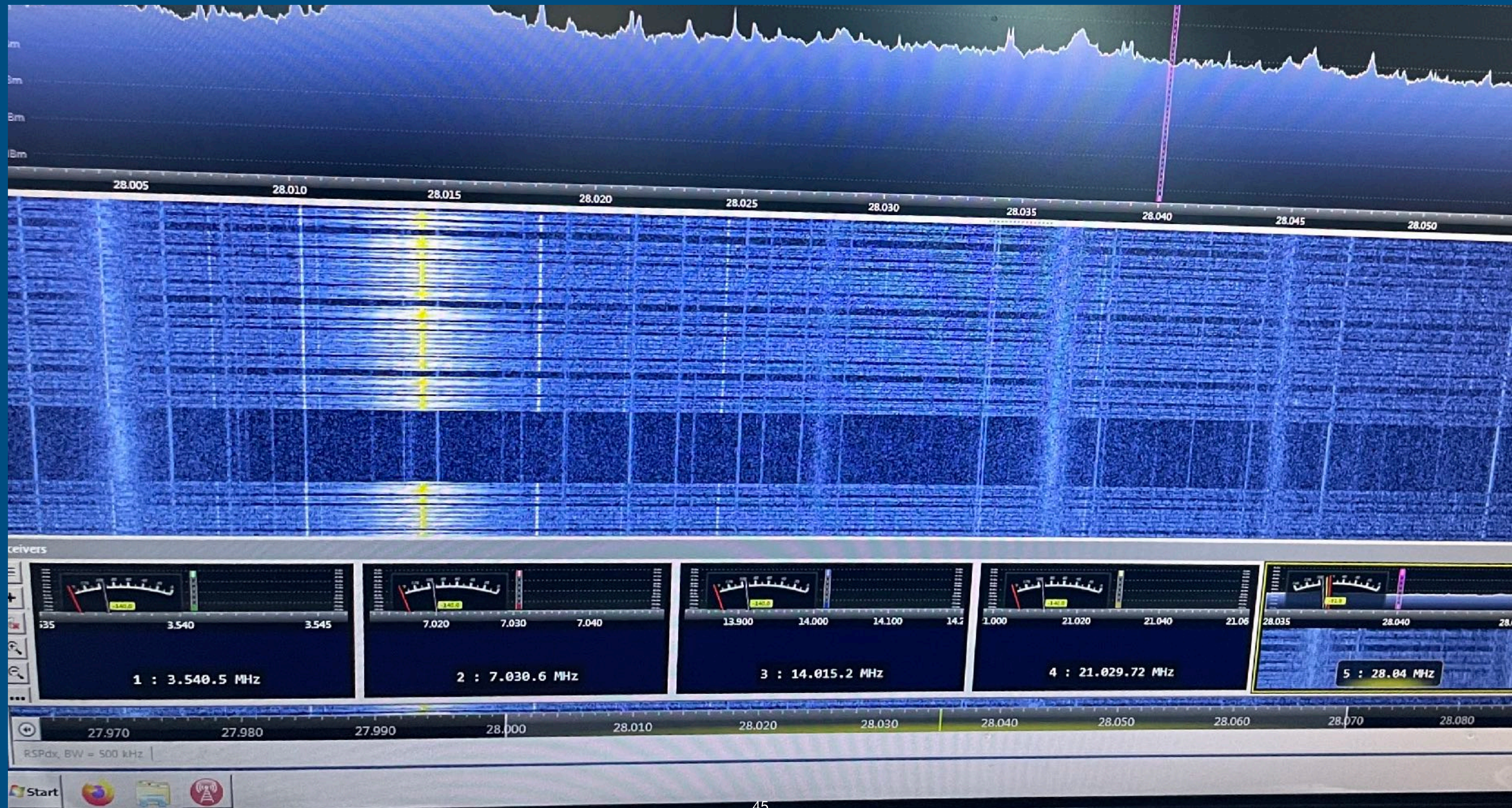
CIRCUIT BREAKER BOX

- With individual or branch circuits
- Connected to loads
- May use sniffer loop as antenna connected to portable HF radio
- May hear which circuit serves the source
- Confirm by cutting off power to that circuit.



SDR - Receivers

- Essentially, Spectrum Analyzer
- Hardware / Software (recommendations)
- Spectrum scope
 - X-axis - Frequency.
 - Y-axis - Signal strength.
- Waterfall - underneath
 - adds Time element
 - can see history
- Situational awareness
 - can watch wide range when used with broadband antenna
 - From 1 kHz to 2 GHz
 - Relationships - learn a lot



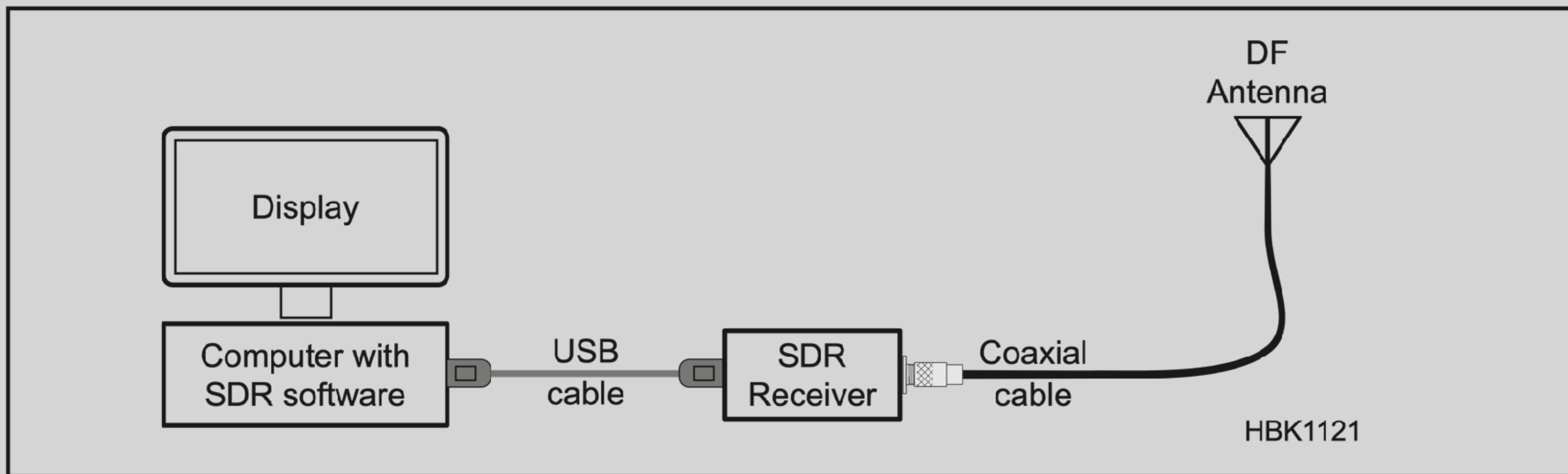
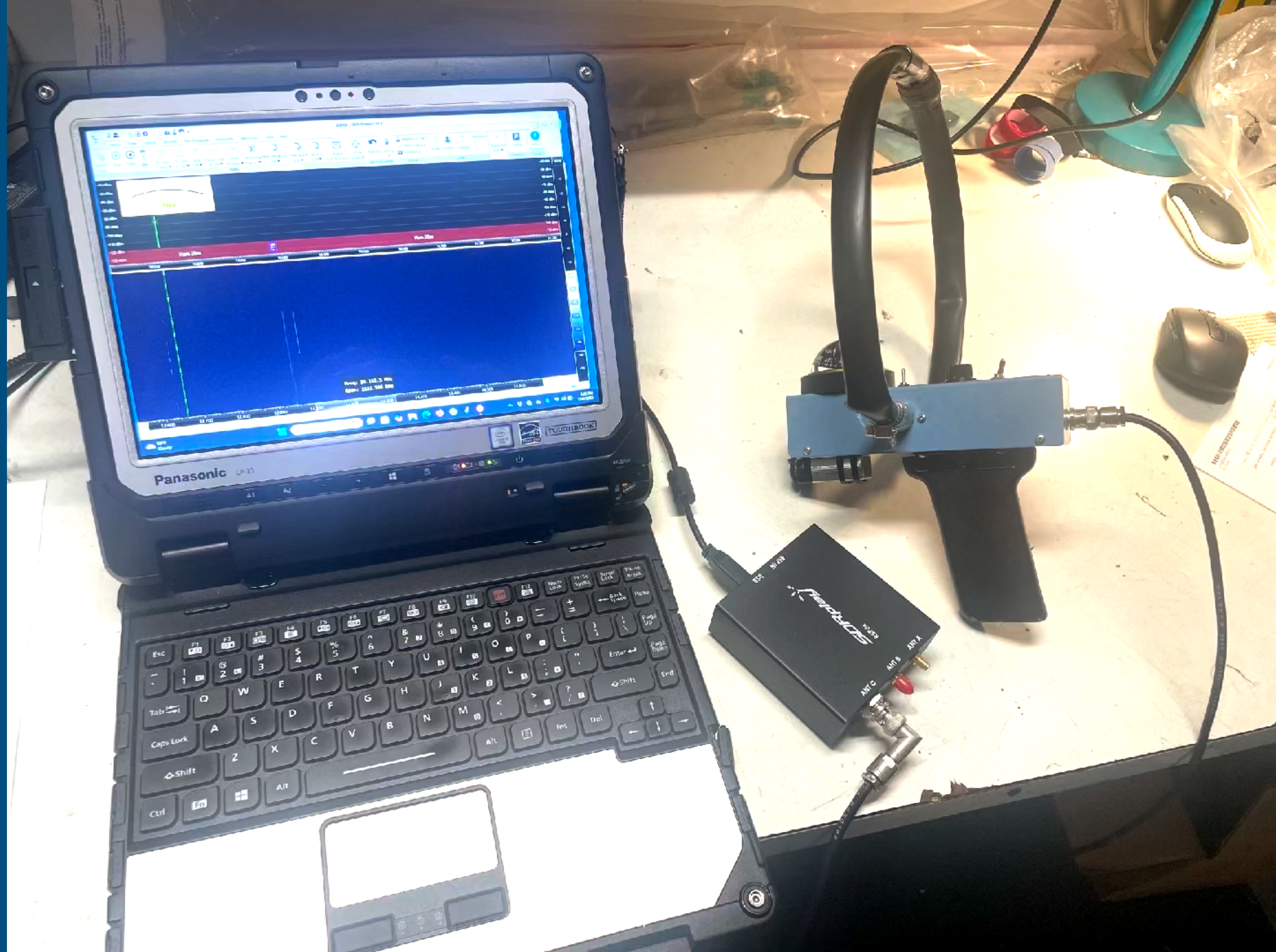


Figure 27.18 — Block diagram of PC+SDR+DF Antenna.



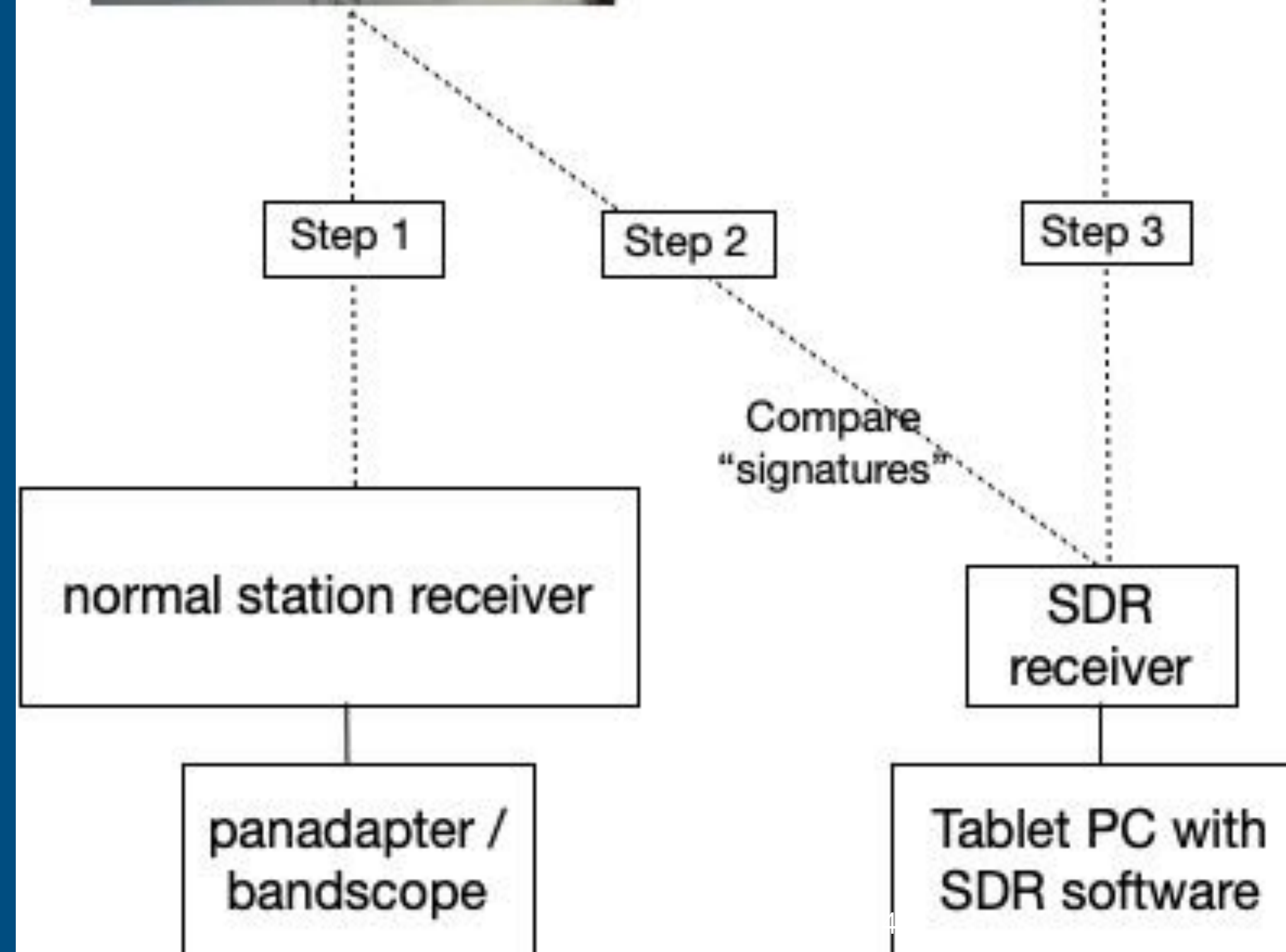
SDR Software - very important

- SDR Console by G4ELI
 - sdr-radio.com
 - Free - but donations appreciated
 - Website - a bit confusing
- Best for RFI tracking - because has **signal history** feature
- Other software:
 - SDR# (SDR sharp)
 - SDR Uno

Normal station antenna



Magnetic loop DF antenna



Common Mistake: When using SDR receiver Rotating the DF Antenna Too Quickly

- **SDR software - DSP - significant latency in signal chain.**
- **Delay of ~ 1 sec. between - pointing antenna at RFI source
- and time signals appear on SDR display (or in the audio).**
- **Accurate DF'ing needs slow, steady antenna rotation.**
- **Tripod.**
- **Repeat.**

Measuring Noise Floor

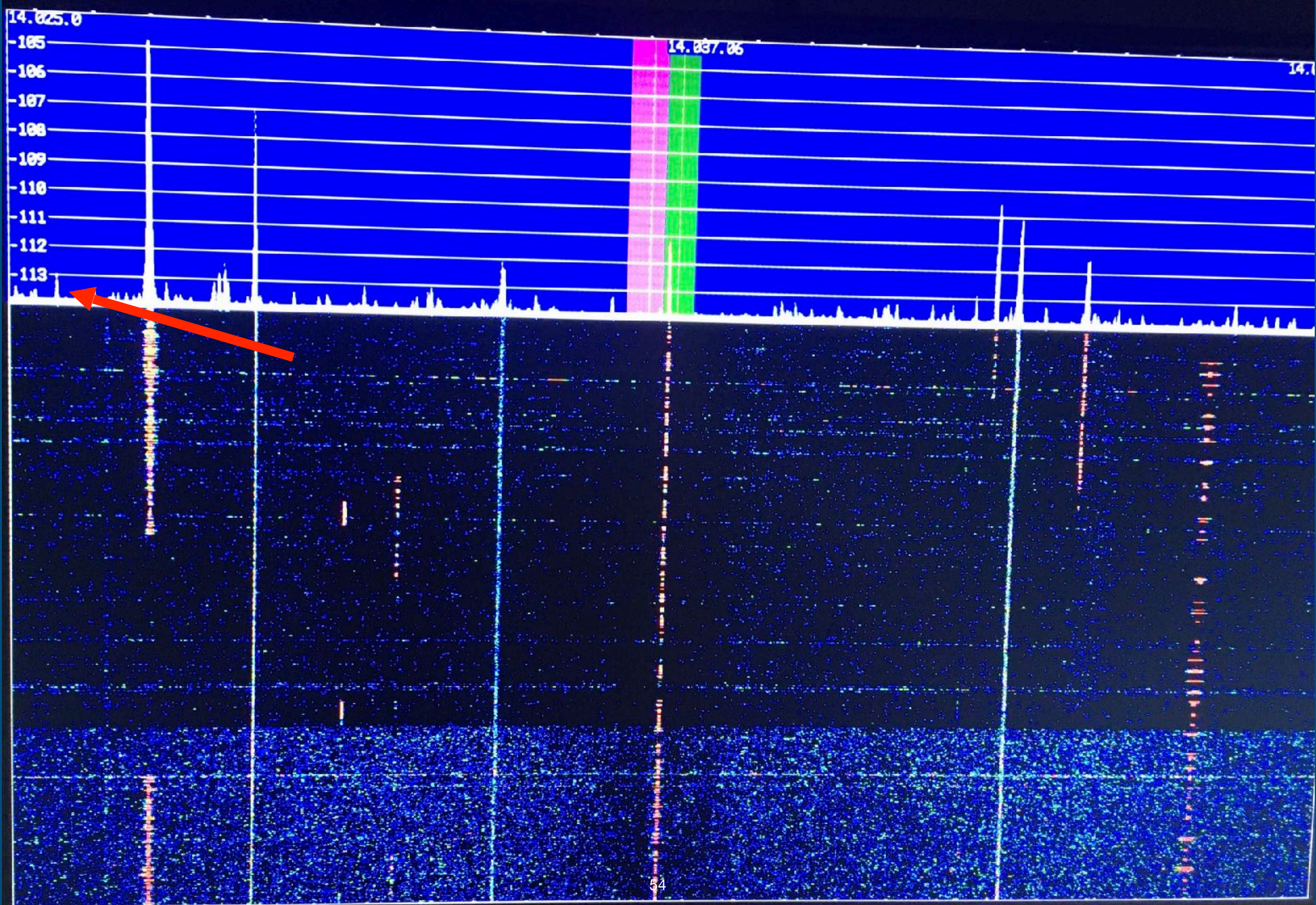
- Goal = to minimize noise floor.
 - improve ability to hear weak signals
- Can't improve what you don't measure.
- Measure noise floor using -dBm strength measurements.
- What is feasible?
- Graphs showing how noise floor varies with frequency.

SDR Software - setup for meaningful NF measurements

- S-units or dBm?
 - Usually both available.
 - dBm more granular than S-units - Can see individual dB changes
 - dBm uses a fixed reference point of one milliwatt. S9 = -73 dBm
 - standard measurement for signal strength
 - consistent across different devices.
- Adjusting SDR display
 - spread out vertical scale
 - Set averaging to high number - visualize the variations
 - Use consistent settings - on both receiver and pan display
 - write down all settings - receiver and display - pan - reference level
- Goal = meaningful noise floor comparisons

Conversion from dBm to S-meter readings

Input dBm	IARU S-meter
0	
-13	S9+60dB
-33	S9+40dB
-53	S9+20dB
-73	S9
-79	S8
-85	S7
-91	S6
-97	S5
-103	S4
-107	
-109	S3
-115	S2
-121	S1
-127	S0
-140	



How to setup SDR-Console to replicate high end RF measuring gear

- SDR-Console Settings for best calibration SDR-Console & SDRPlay RSPDx
- per W8BYA YouTube video
 - <https://youtu.be/qHJE6wa9dVw?si=vKEeN3DJ2DAdj5Ne>
- SDR-Console Home Menu settings:
 - RF Gain = 27 max
 - IF Gain = -35
 - AGC = OFF
 - Visual Gain = -40
- Result:
 - Level reading is very close to measurement by calibrated source fed to the antenna of receiver.
 - Most accurate Noise Floor measurements.

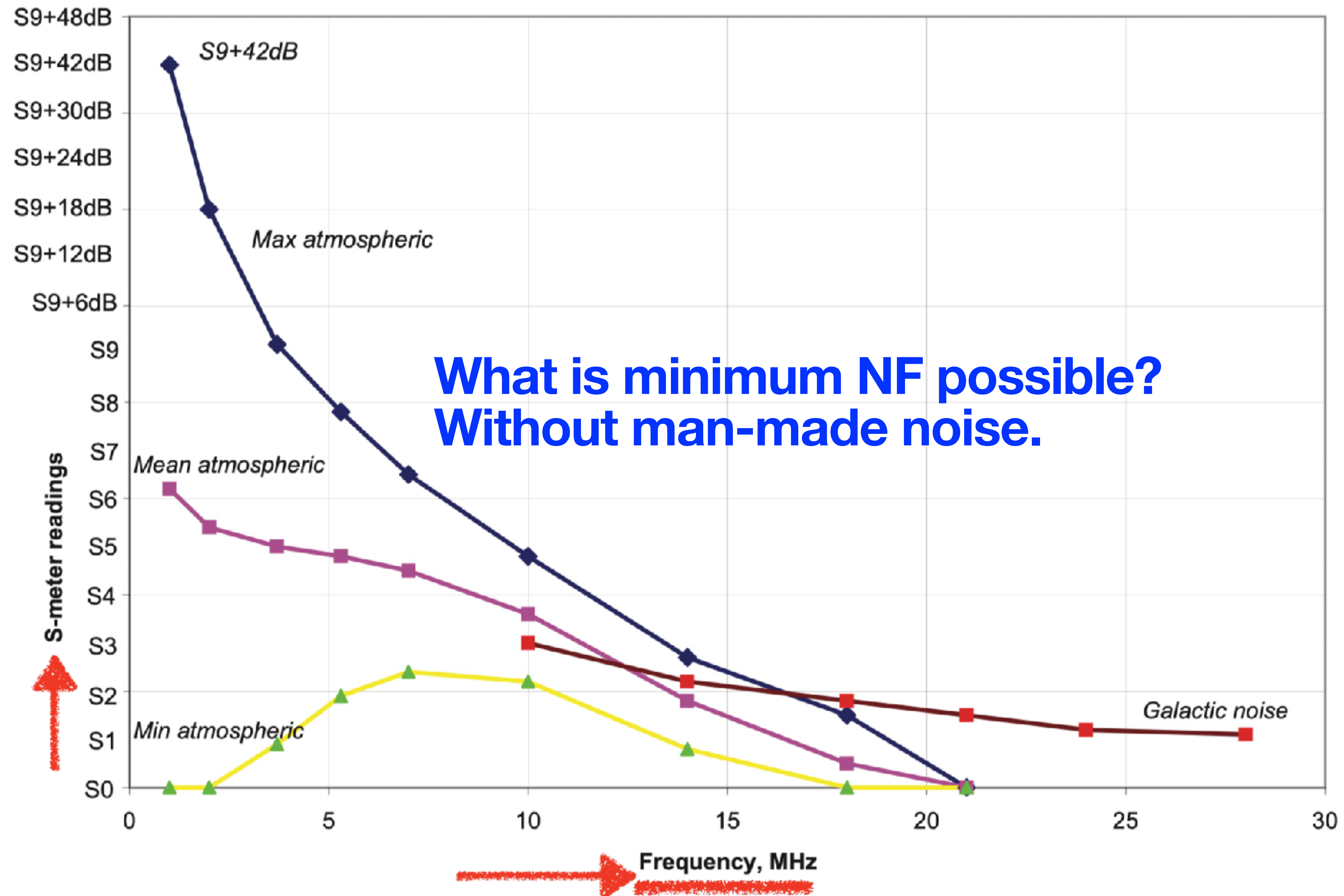


FIGURE 2: S-meter readings of natural noise level.

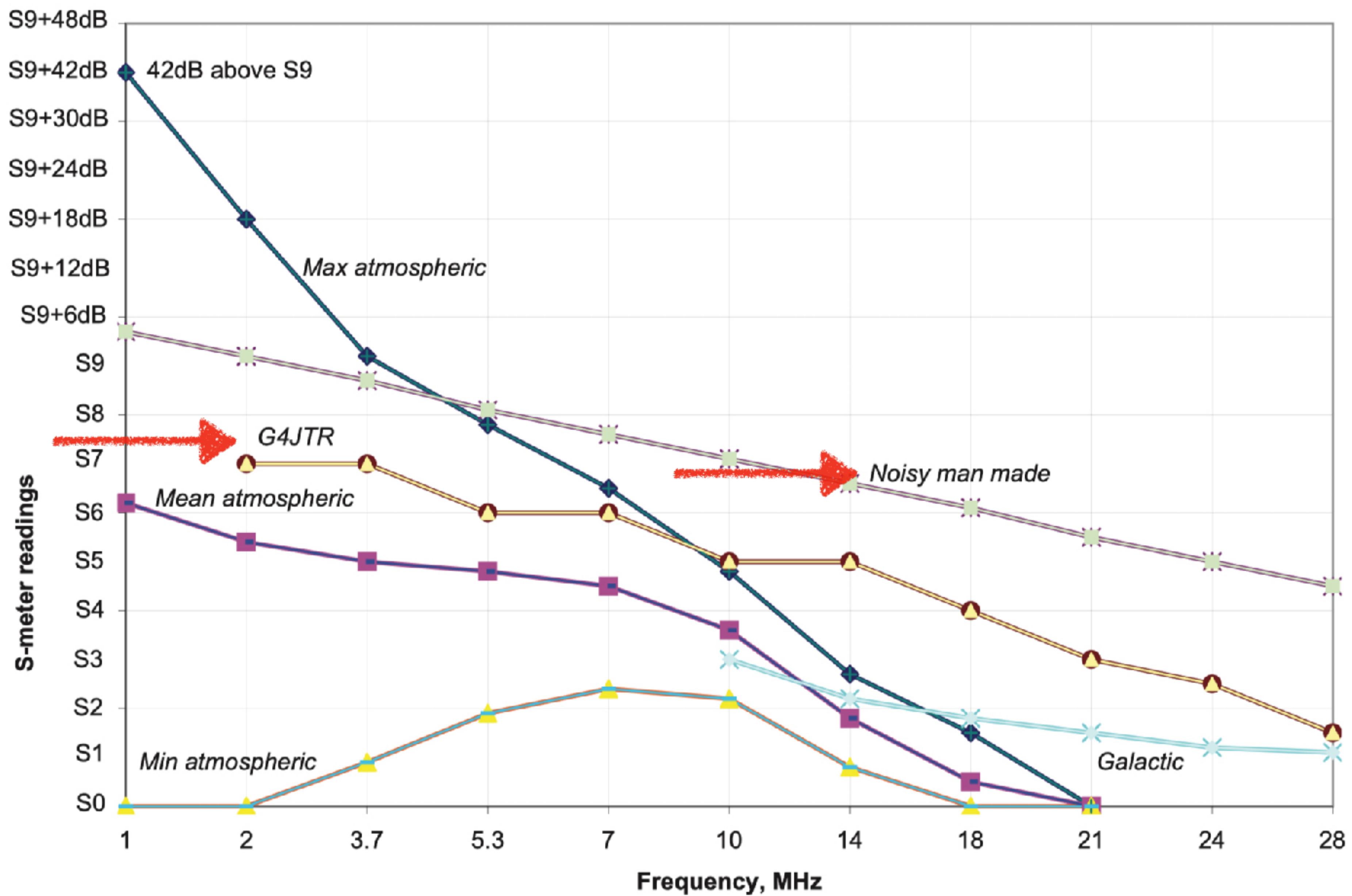


FIGURE 3: S-meter readings of natural noise level plus man made noise.



Quiet Environment

- 40 meter vertical dipole
- At mid-day
- Island
- Surrounded by salt water
- Indian Ocean
- 3B8M

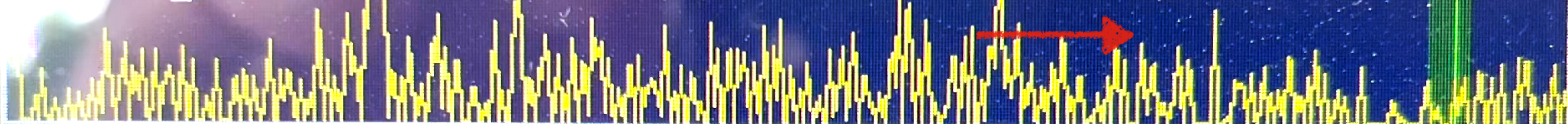
7.031.7

7.055.00

7.056.7

Ref Lvl (-dBm):

114



Daytime Noise floor
40 meter
at 3B8M

S2-1/2

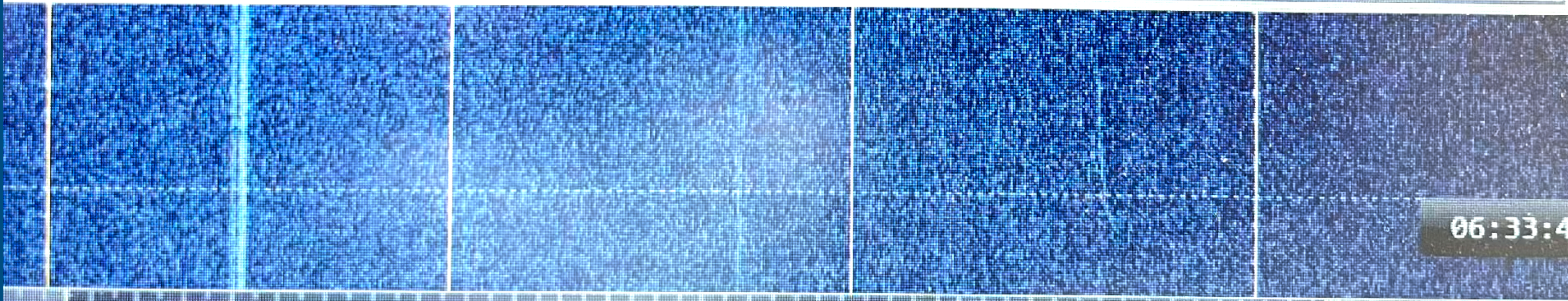
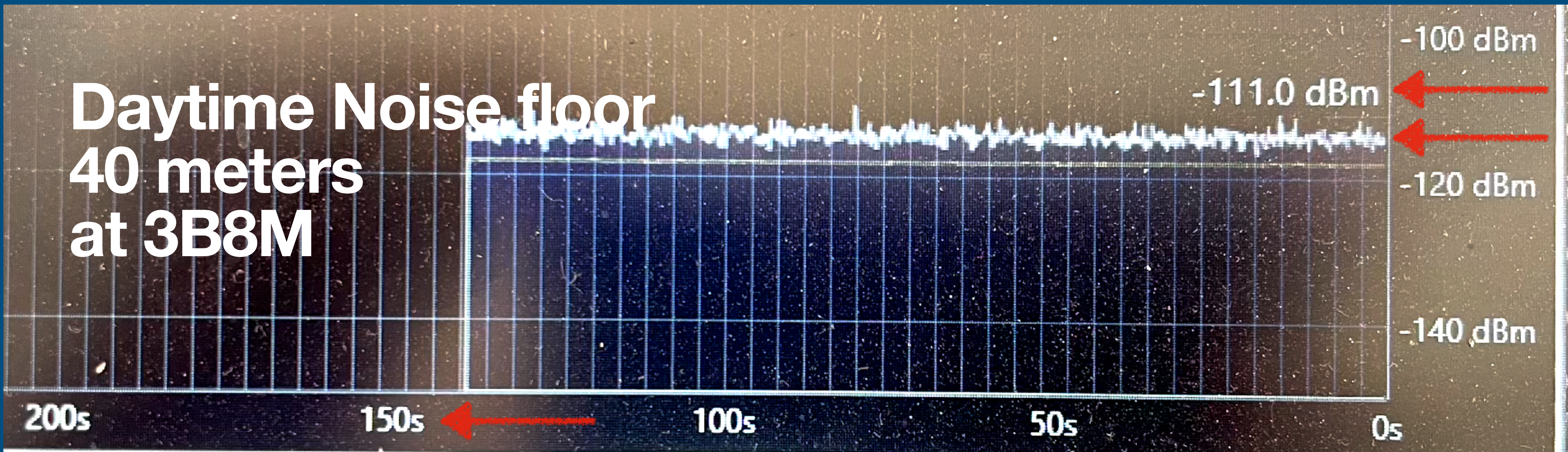
Span 50
SYGA res

Span 25
Lvl Mode

Span 10
Peak

Span 5
FixTrack

Daytime Noise floor 40 meters at 3B8M



06:33:4

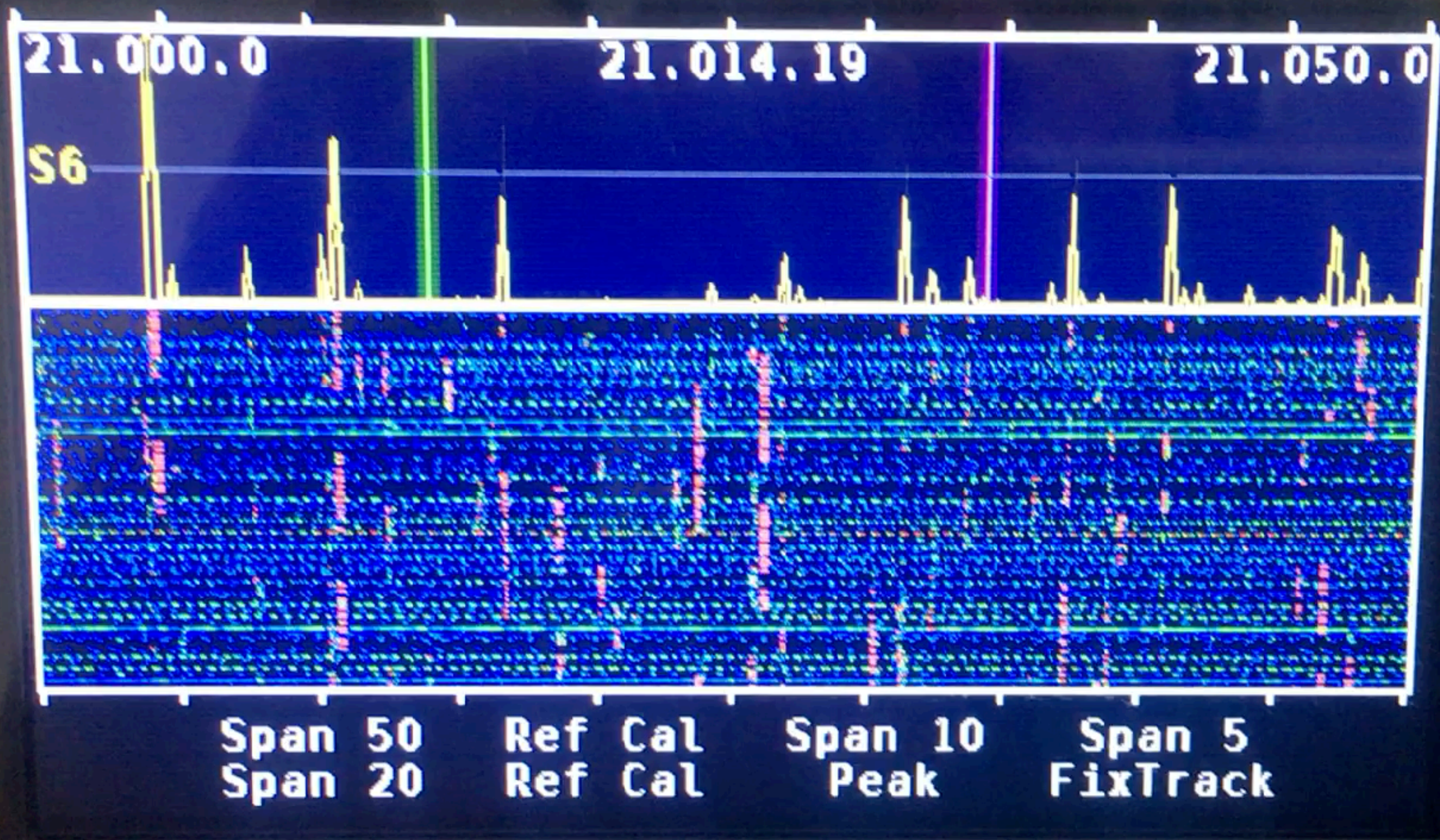
Dense urban environment

HC2GRC
HC0T

Guayaquil Radio Club

- Older part of city
- Power lines
- Data
- Cellular
- Noise floor
- = 24 dB higher than at home.





ELECRAFT P3

DISPLAY

AVERAGE

REF LVL

SCALE

SPAN

CENTER

MKR A

MKR B

SELECT
TAP = QSY

POWER

FN1

FN2

FN3

FN4

MENU

ELECRAFT K3 TRANSCEIVER

1 3 5 7 9 20 40 60



SWR 2 3 RF 50 100

14.062.03

RIT

A CW
REV
TX

VOX QSK ANT1
AGC- F



II

NB
NR

XFIL
FL3

14.023.9

B

SHIFT LO — CUT — HI WIDTH



FREQ
ENT

SCAN

FINE

COARSE

SPEED MIC

PWR

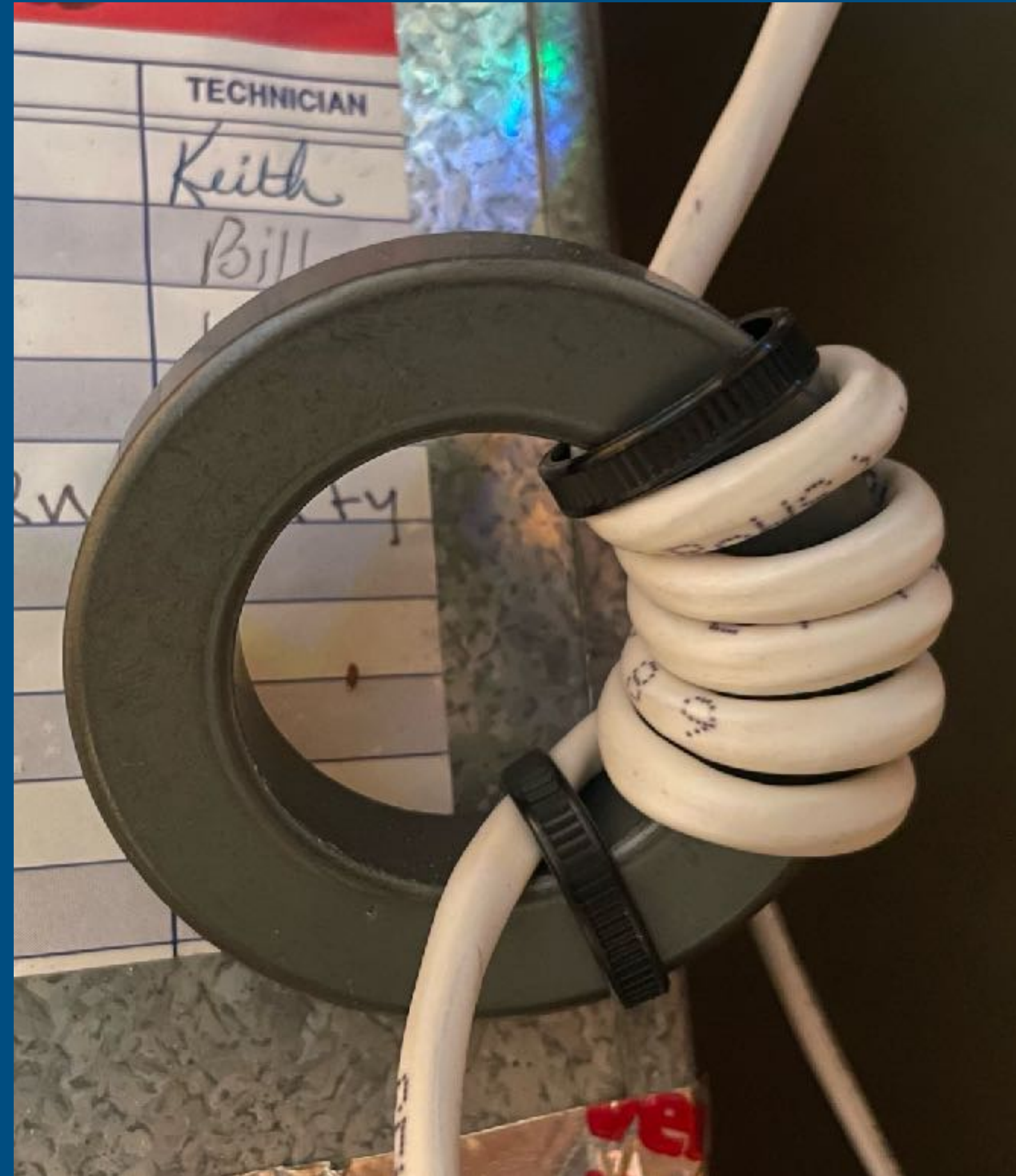
Kiwi SDR

- Listen to various RFI environments
- Kiwi SDR - networked system of SDR's
- Listen to receivers from all over the world
- Huge variation in RFI noise floors
- kiwisdr.com

Suppressing RFI at the source

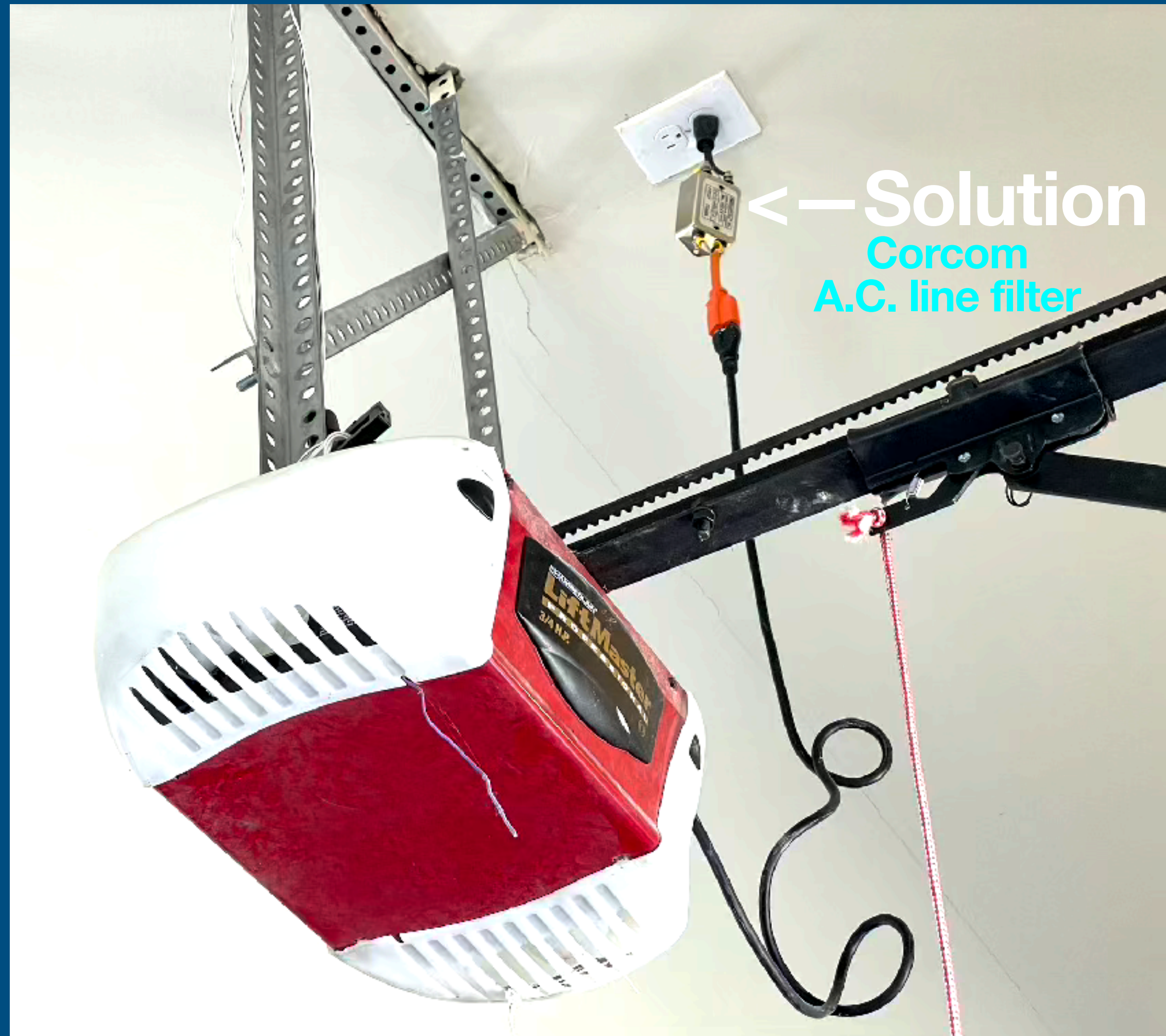
- **Choking Cables:**
 - **Insert common-mode chokes (often ferrite toroids or beads) onto power, control and coaxial cables to block common-mode currents.**
- **Multiple Turns: Wrap cable around ferrite - multiple times for increased impedance and effectiveness.**
- **W2AEW demonstrates how it works:**
 - **YouTube video #84 (10 minutes)**
 - **<https://www.youtube.com/watch?v=81C4IfONt3o>**

Suppressing RFI at the source (continued)



Finding RFI that only appears when transmitting.

Intermodulation



- When multiple signals interact within a system of electronic components.
- Interaction causes new signals at new and different frequencies.
- These are intermodulation products.
- May, cause distortion and noise.
- Locating is very tricky:
 - Because intermittent - only under certain conditions.
 - Try to recreate the problem.
 - Possibly can focus on a product on a particular frequency & then DF (or sniff) it.
- Hunch:
 - Look around for potential devices where interactions happening.
 - Not necessarily an electronic device - may be a metal joint, etc.
 - Hunch - disconnecting or tightening or grounding.

Finding typical signatures for LEDs, grow lights, power lines, solar inverters, etc.?

- Common question.
- Yes - these devices often have characteristic signatures.
- To eliminate the RFI problem - you need to locate the source.
- Be sure you aren't just nerding out to avoid putting on your foil hat and picking up your DF gear.
- May be useful after you've located the source at some private property - and you want to discuss possibilities with the owner.

Getting action from utility

• DO

- Realize you must rely on them to resolve problem (on their equipment)
- Find out who is assigned to sort out RFI issues.
- Don't assume lots of expertise.
- They may like troubleshooting.
- They not have RFI locating equipment
- Do your home work: know where the RFI source is - their system Pole
- Open a "Trouble Ticket" - with a Date - implies ultimate resolution.
- Tell them you have ruled out other sources - its them - Pole#
- Is it something sensitive to outside environment?
- Affected by environment? e.g. changes with wind - temperature - rain.
- Highlight any urgency (e.g. arcing, or you have a contest soon)

Getting action from utility - continued

- **DON'T**

- **Don't imply that you know everything about RFI.**
- **Don't threaten FCC complaint**
 - **timeline extended**
 - **provides an excuse for not doing anything because now in a different department, etc.**

- **SUBJECT: RFI - TROUBLE TICKET - 2025-08-24**
- Hello [utility contact person] ~
- Thanks for your past help a year and a half ago. Up until last June, I've had no RFI at all - and I've really enjoyed it!
- But, now I have another (new) strong, persistent RFI source that I'd like help getting resolved.
 - **#1** - I hope you are still the engineer who can help with RFI - and can help get this resolved?
 - **#2** - This RFI source began interfering with my amateur radio operations back in June (2025). It is very strong and although sometimes intermittent, it is active 90% of the time.
 - **#3** - With direction finding on 431 MHz, I have located the source as being on a CSU pole located exactly 1/4 mile NNE from me.
 - **#4** - The CSU pole location Address: 1501 Vista Place (east side of Vista Place)
 - **#5** - Numbers on CSU pole: 12 F 38-17 13 S14 13BR3 (I can't read the OH numbers on another tag)
 - **#6** - Beyond pinpointing which pole was the source, I was unable to get a feel for what level or what component is involved. My guess would be a lightning arrestor - but that's just a guess.
- Please confirm that I'm on the right track toward getting this one resolved.
 - ~ [Name & contact info] Address: Cell & text: Email:



My power line example

- 4 separate RFI sources - intermittent.
- 10 to 15 dBm - masked many stations.
- ID'ed pole numbers -
- with UHF radio demonstrated source.
- Power company tried to cure piecemeal
- Finally, decided 70-year-old power line poles & hardware needed to be replaced!



RESULTS

- Measured NF on day before the replacement.
- Measured NF on day after the replacement.
- All 4 of the 10-15 dB intermittent sources are gone.
- And, NF dropped an *additional* 5 dBm beyond my best “noise-less” day.

• RESOURCES - *IT IS ALL RIGHT HERE*

- **ARRL's Radio Frequency Interference (RFI) web page:** www.arrl.org/radio-frequency-interference-rfi
- **RFI Reflector:** <http://lists.contesting.com/archives/html/RFI/> (or linked from ARRL RFI page)
 - Archives go back 22 years - search here for answers. Moderator is K3LR. DXEngineering CEO.
 - Experts and "Experts." High SNR. Real experts. RFI noise locating professionals (power utilities) - engineers. Very helpful.
- **WD8DSB** — YouTube channel - Videos of him successfully hunting & fixing RFI. Watching him will put you in the mood.
 - <https://www.youtube.com/@wd8dsb/videos>
- **K9YC** — <http://audiosystemsgroup.com/KillingRXNoiseVisalia.pdf> and other superb articles and application notes - - not just finding - but lots about eliminating RFI.
- **NK7Z** - RFI Signatures - <https://www.nk7z.net/rfi-snapshots/>
- **Naval Postgraduate School RFI Handbooks** (linked from ARRL website RFI page)
 - done by 4 hams for the US Navy "Signal to Noise Enhancement Program" (Mitigation of Radio Noise)
 - Surveyed 20 Navy radio receiving sites around the world
 - 2 studies: (1) On-site RFI sources & Off-site RFI sources
 - go to ARRL website RFI page — and scroll to the bottom for the link - 2 separate PDF's
 - <http://www.arrl.org/power-line-noise-mitigation-handbook-for-naval-and-other-receiving-sites>
 - http://www.arrl.org/files/file/Technology/RFI%20Main%20Page/Naval_RFI_Handbook.pdf

