



# HF Noise Mitigation



**RATPAC**  
Radio Amateur Training Planning  
And Activities Committee

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- \* This is a HUGE subject, we can only scratch the surface:
  - \* What is “noise”?
  - \* What are the different types of noise?
  - \* How to deal with noise
    - \* What we are really talking about here is “noise mitigation”
  - \* Using cheap AM radios and SDRs to track noise



\* **Outline**

- \* In radio terms: “**Noise**” is an unwanted signal from sources other than a transmitted signal source
- \* It’s also a signal that does not convey any information; is of random frequency, amplitude and pattern
- \* Electrical noise is defined as any unwanted electrical signal that falls within the passband of the receiver
- \* **Noise** can either be internal or external
  - \* Internal - within the radio itself
  - \* External - from external sources



\* **What is noise?**

- \* Not to be confused with “interference”

- \* Interference is defined as:

- \* A form of external noise which means “to disturb or detract from”

- \* Interference is when information signals from one source produce frequencies that fall outside their allocated bandwidth and interfere with information signals from another source

- \* Examples: Splatter, key-clicks, harmonic interference

\* Interference

## \*Types of noise

- \*Natural (solar, atmospheric, extraterrestrial)
- \*“Man-Made” or Industrial

\*Some types of noise we can control

\*Some we can't:



# \*What is noise?

## \* Natural noise

### \* Solar/Cosmic

- \* The Sun, by its temperature is a huge wideband RF source

- \* There are 3 components:

  - \* Background (normal noise- sun at 6000 degrees K!)

  - \* Slowly varying component (differing temperature areas of the sun)

  - \* Burst component- Coronal Mass Ejections/ Solar flares

- \* Extraterrestrial - From other stars and galaxies



# \* Natural Noise

## \* Atmospheric

- \* Thermal noise from atmosphere
- \* Lightning (large electrostatic discharge) 3.5 million hits per day!
- \* Snow static (smaller electrostatic discharge)
- \* Mostly random frequency and polarization



\* Natural Noise

- \* The field strength of atmospheric noise varies approximately inversely with the frequency
  - \* The higher the frequency, the lower the atmospheric noise
- \* Large atmospheric noise is generated in low and medium frequency bands while very little noise is generated in the VHF and UHF bands
- \* Further VHF and UHF components of noise are limited to the line-of-sight, so less severe above 30 MHz

## \* Atmospheric Noise

## \* Many causes

- \* Noise internal to radio itself
    - \* SDR Radios suffer much less from this problem
  - \* Switching power supplies (wall warts, switching mode power supplies)
    - \* Good= Heavy    Bad=Light
    - \* Best to eliminate them altogether, if possible
  - \* Computers (RF hash)
  - \* Plasma televisions
  - \* Street lights
  - \* Fluorescent and light ballasts
  - \* Power line noise
  - \* LEDs and grow lights
- \* Is mostly vertically polarized (near field)



# \* Man-made noise

\* Most of these “man made” noise sources are things we can control (to an extent)

\* It’s all about going after the source, if possible!

\* **Man-made Noise**

# \* How to mitigate receive noise?

## \* Antennas-

- \* Verticals are noisy
- \* Yagis are less noisy (Horizontal polarization, and directional)

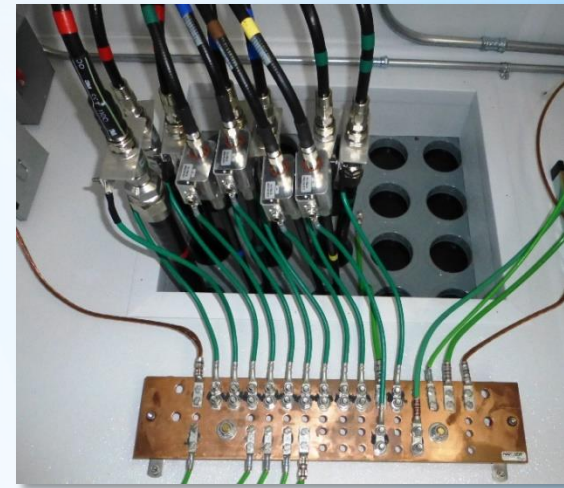
## \* Proper bonding and grounding of equipment

## \* Ferrites- Jim Brown, K9YC, has excellent information on this (use “Type 31” material”!)

## \* Learn to use the controls on your radio!

## \* Move antennas away from noise sources- not always feasible....

## \* Consider an external “noise canceler” device



# \* Noise Mitigation



**Power line noise at W7VO**



**Common Mode Chokes on lowband antenna feedlines at W7VO**

- \* Simplified: It's all about the signal to noise ratio:

$$SN = \frac{\text{power of signal}}{\text{power of noise}}$$



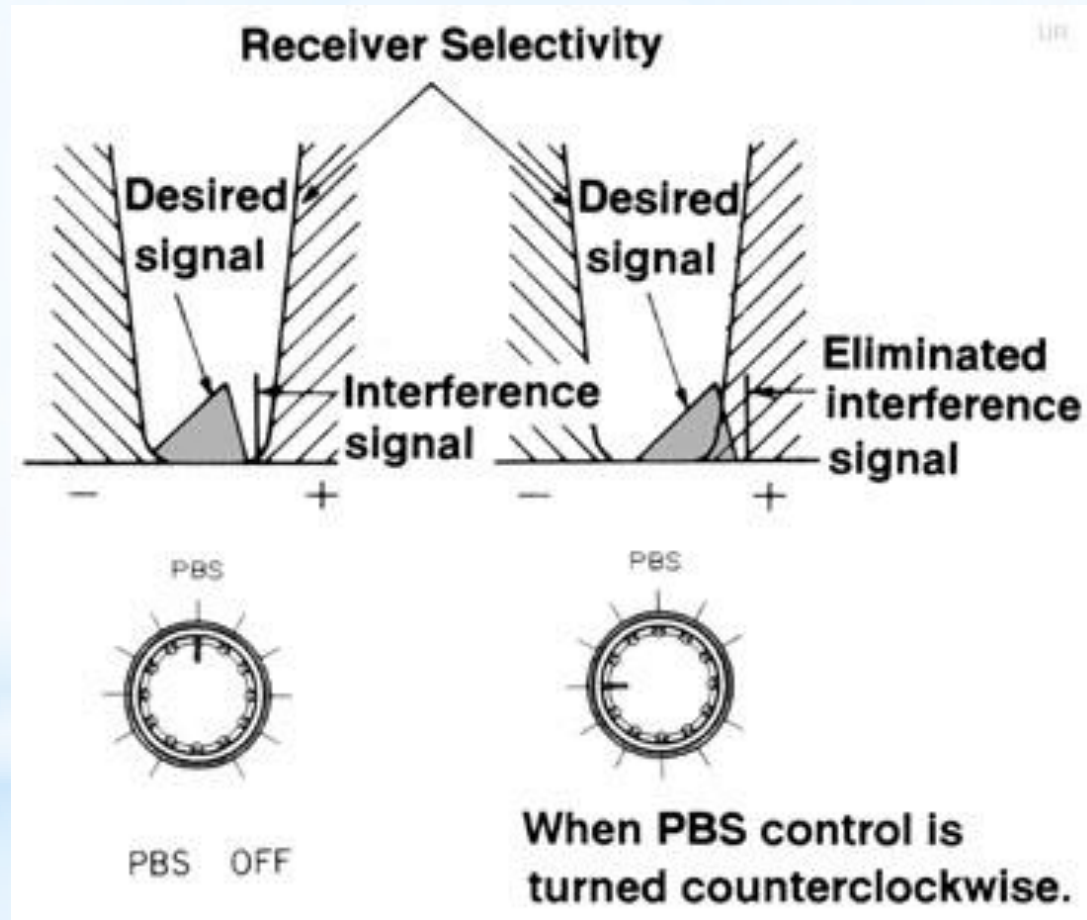
- \* To mitigate: Increase level of signal, or decrease the level of noise
- \* Radio “noise blankers” work best on impulse noise

\* Noise  
Mitigation

- \* Turn down RF Gain on radio, turn off Pre-Amps
  - \* (Especially on 40-160 meters. LEAVE OFF!)
- \* Use attenuator (ATT) on 80 and 160 meters to keep noise from overloading receiver AGC (use 6 TO 20 dB, as needed!)
- \* Use narrower IF filters, or narrow IF bandwidth:  
500 Hz/250 Hz CW, 2K or 1.8K phone
  - \* No filters? Add them!
- \* Use IF Passband (IF Shift) tuning to narrow range
- \* Play with your Digital Signal Processing (DSP) settings (if you have them)

\* Things to try

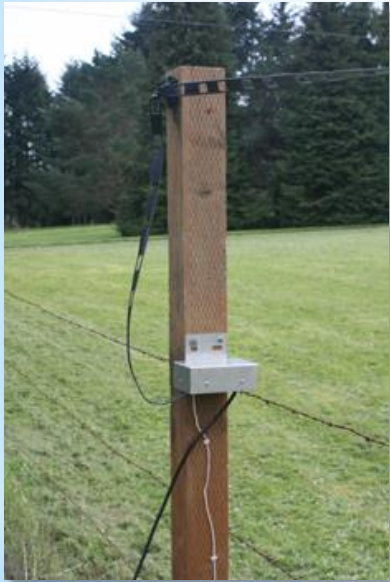
# PASSBAND TUNING(PBT), “IF SHIFT”



\* Use “low noise” receive antennas

\* Beverage

\* Receive Loop to null out noise



\* Noise Mitigation

\* Last resort: Use an External Noise Canceler:

\* MFJ 1025/1026

\* JPS/Timewave ANC-4

\* DX Engineering NCC-1 or NCC-2

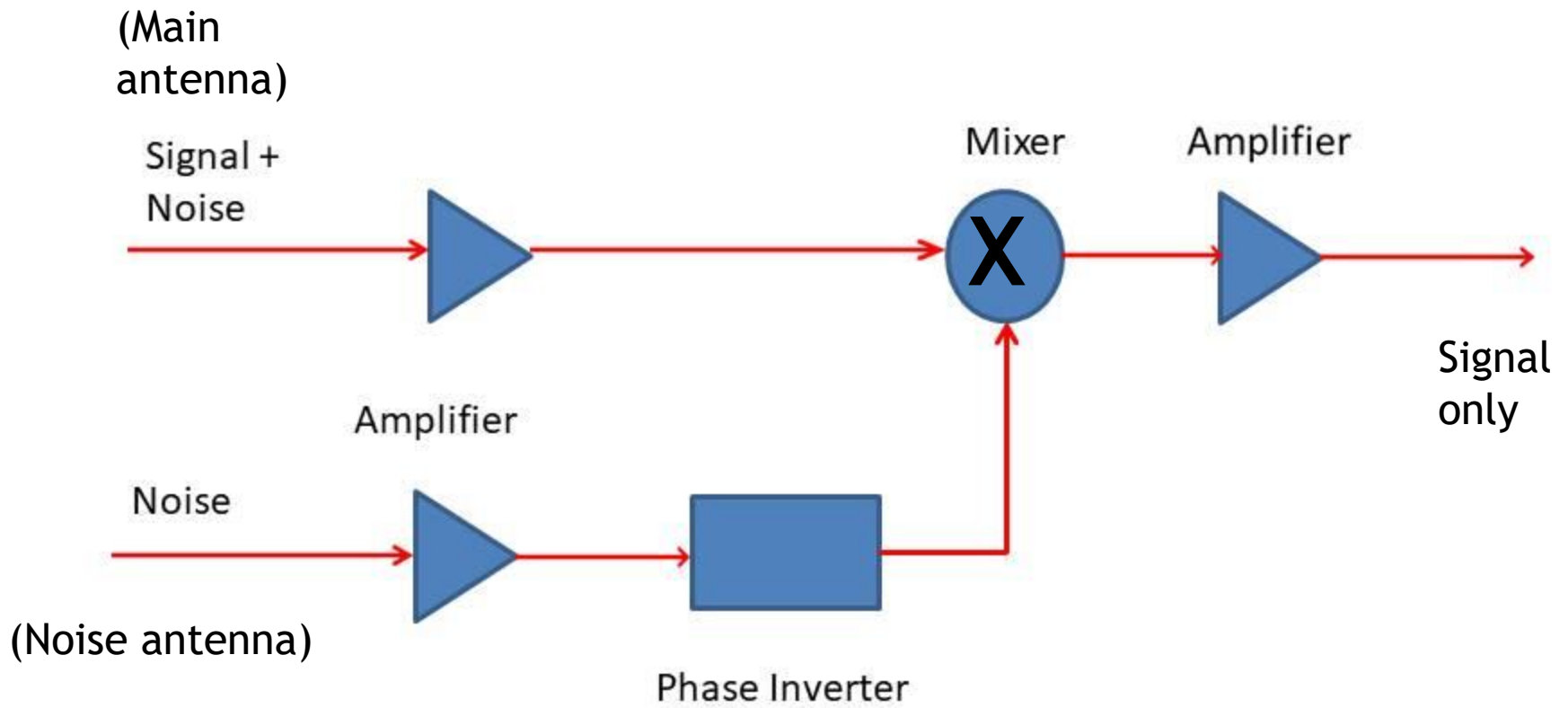


\* Noise Mitigation

- \* Remember: It's all about the Signal to Noise ratio
- \* If we can cancel out noise, all that's left is signal!
- \* Cancellers use a separate low gain “noise antenna”
  - \* Why low gain? Want noise only, not the signal!
  - \* I use a low fence mounted vertical antenna, (mounted close to a power pole), and a very steep inverted vee off my main tower
  - \* Loops work well too, use to null out the signal
- \* They feed a noise reference signal into a mixer at 180 degrees out of phase to cancel out noise, leaving signal intact (in theory...)
- \* Works best on noise that has a consistent pattern, (man-made noise), but will also work on atmospheric noise as well
- \* Note that both the phase and amplitude of noise must match on both antenna inputs in order to cancel the noise
- \* (Your results may vary!)



# \* Noise Cancelers



How Noise Cancelers work (in theory!)

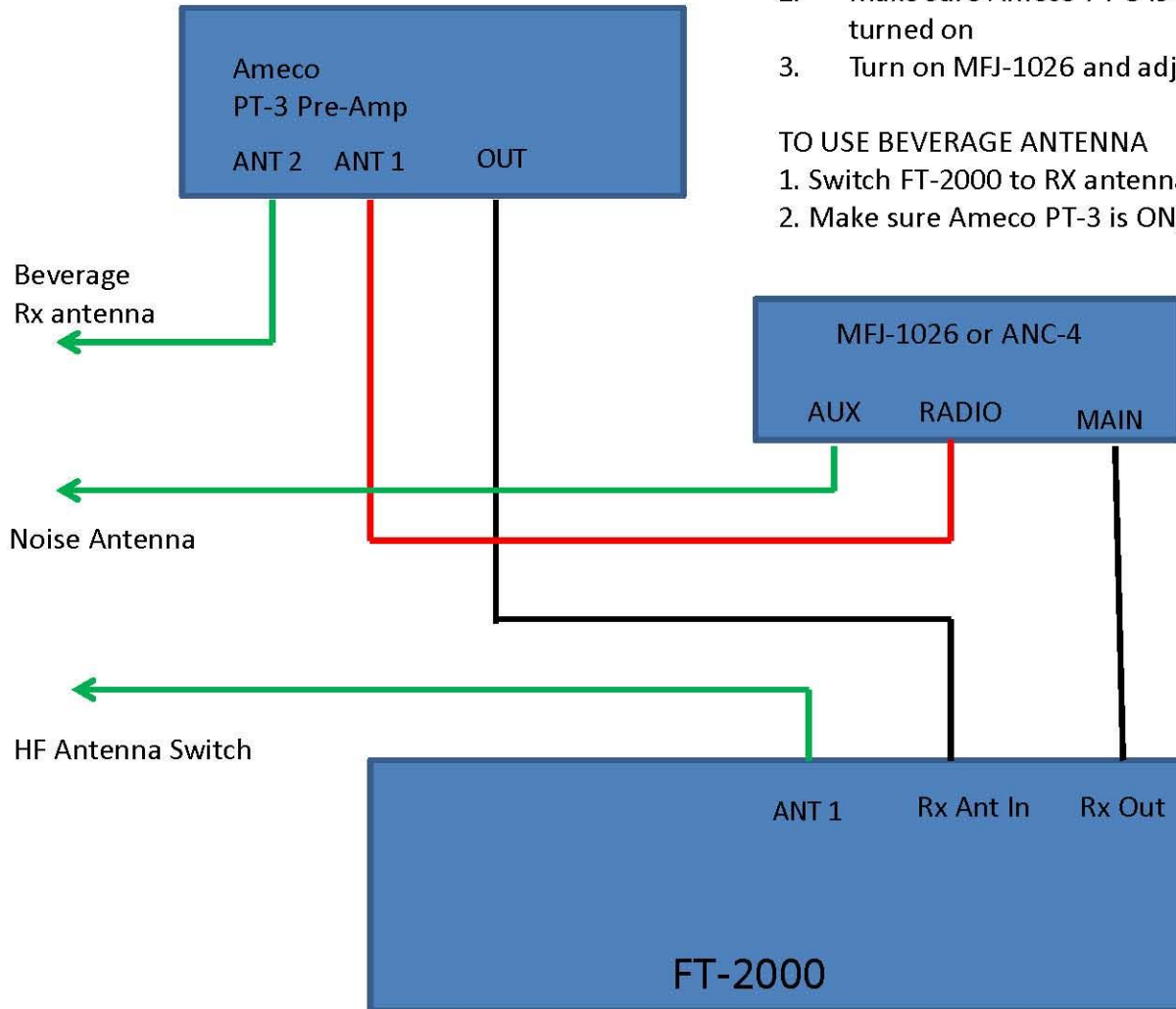


TO USE NOISE CANCELLER:

1. Switch FT-2000 to RX antenna
2. Make sure Ameco PT-3 is set to ANT 1. It does not have to be turned on
3. Turn on MFJ-1026 and adjust as needed

TO USE BEVERAGE ANTENNA

1. Switch FT-2000 to RX antenna
2. Make sure Ameco PT-3 is ON, and set to ANT 2.



MFJ-1026 or ANC-4 Noise Canceller incorporation  
at W7VO

## \* Quick Overview:

- \* To reduce RFI, you must first know RFI exists
- \* To know RFI exists you must first visualize RFI
- \* To visualize RFI you need a different perspective than a typical HF radio can offer
- \* In short, your standard Transceiver is not your friend when it comes to seeing what is happening around the shack



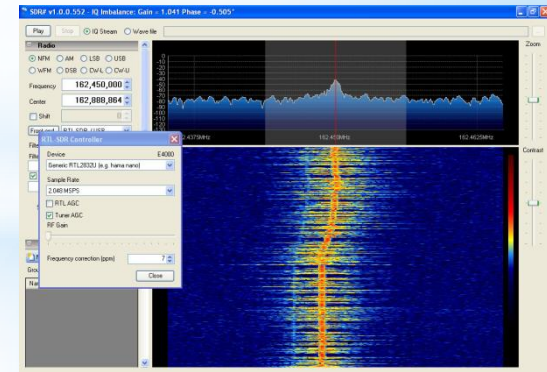
# \* Characterizing your RFI Environment

## \* What does it take to see, not hear RFI?

- \* It takes a SDR plus some software
- \* What is SDR?
- \* SDR stands for Software Defined Radio
- \* A SDR acts like a radio, but it is not your standard radio (Radios use “panadapters, which only look at a slice of spectrum)
- \* A SDR uses your computer to replace the innards of your radio, detection and signal formatting are done mathematically, not electronically, as in a normal radio



# \* Characterizing your RFI Environment



- \* Hams like SDR devices, because they are cheap...
- \* An OK SDR will cost you around \$75.00 used at a Hamfest, or around \$125.00 new.
- \* A cheap SDR will cost you around 20 bucks new
  - \* The cheap ones lack filtering and low frequency capability
- \* A professional grade SDR will cost you thousands

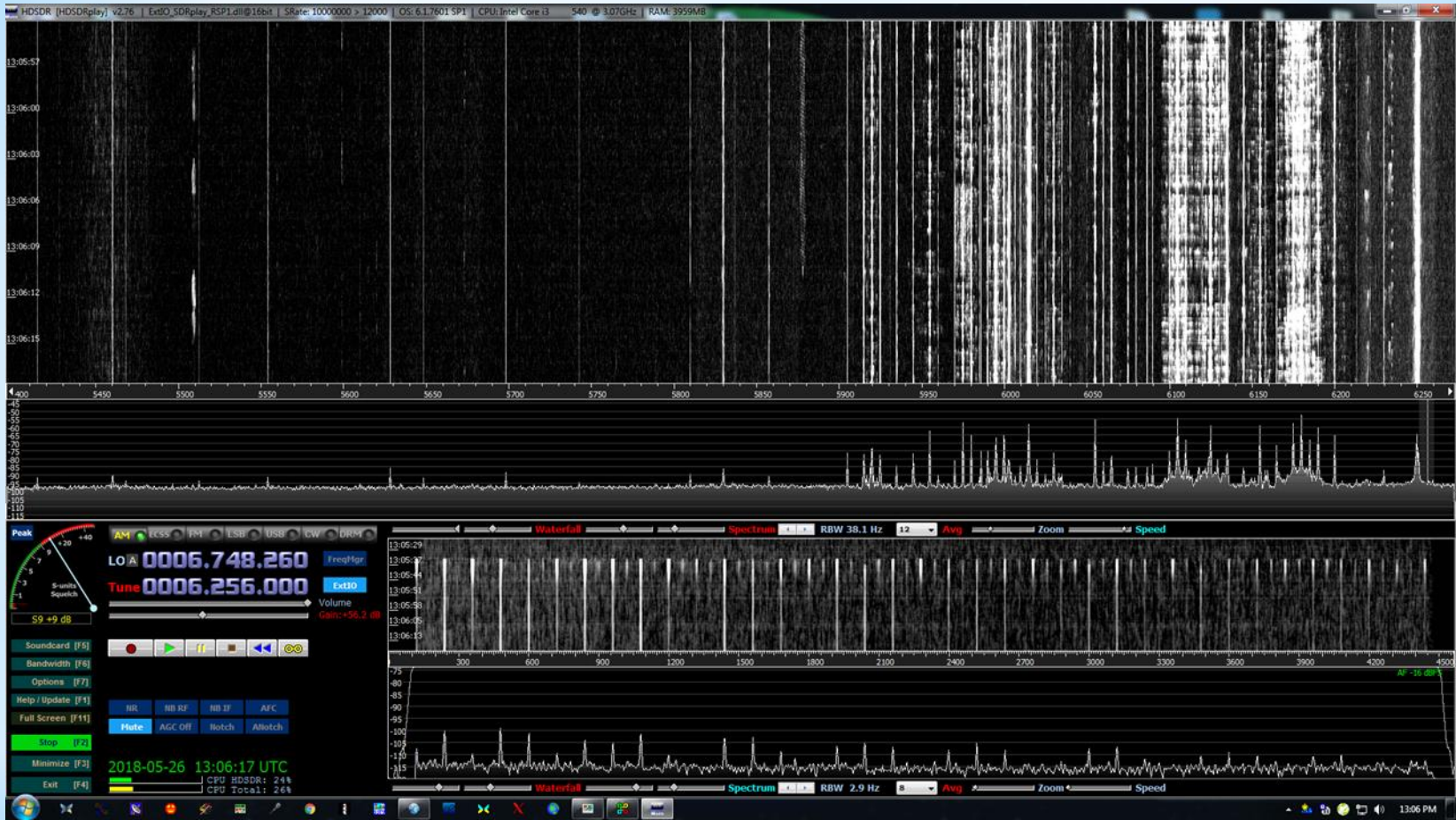


\* **What does a SDR cost?**

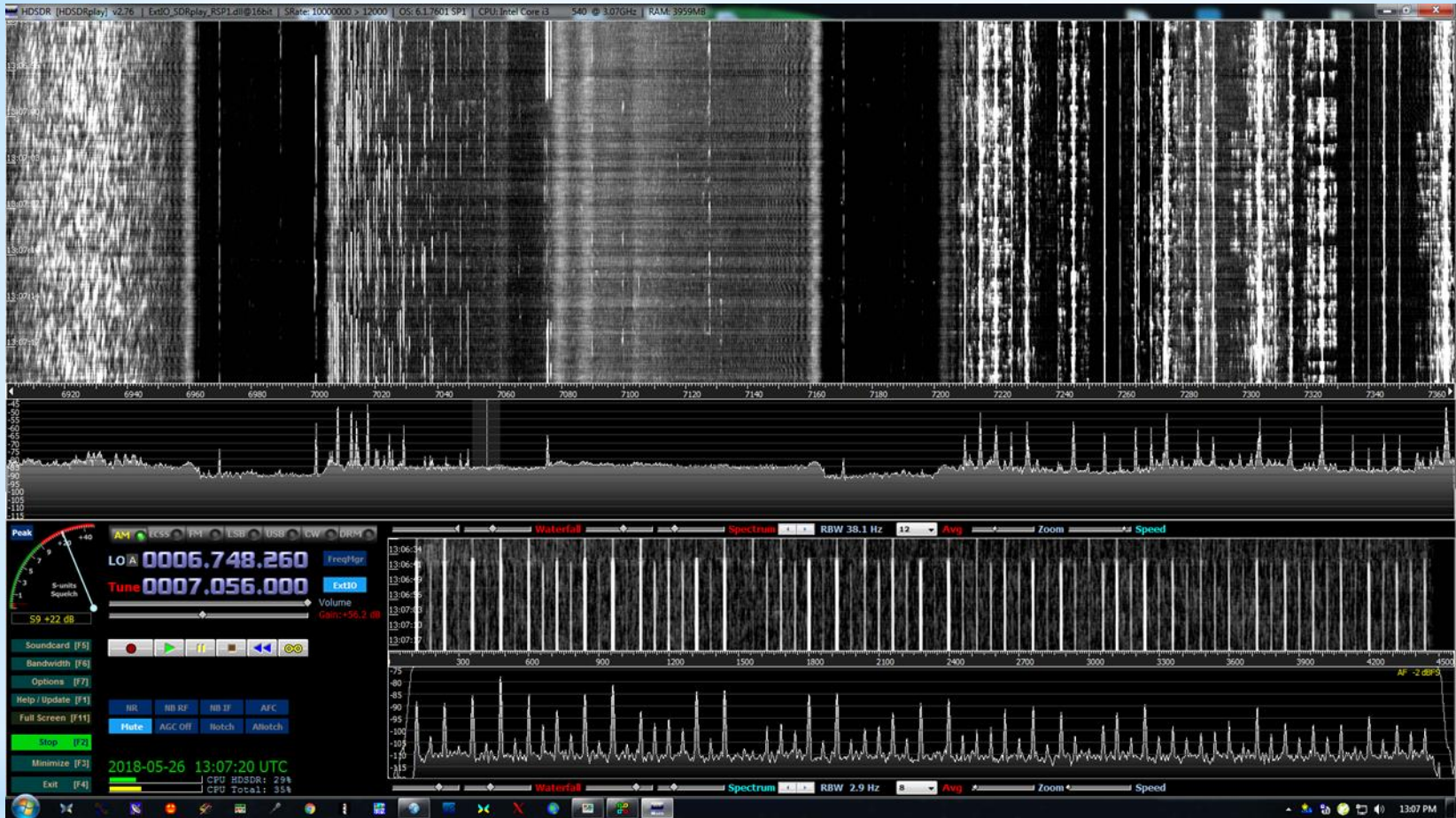
- \* Buy the SDR, make sure it covers the frequency range you want (hint: cheap ones don't cover much HF)
- \* Download and install the software, and drivers
- \* Add a broadcast band filter, if necessary
- \* Start the radio
- \* Learn how to use the radio
- \* I use the SDR# software package, and an RTL-SDR.COM USB dongle as the radio
- \* Dave, NK7Z uses the HDSDR software package, and an SDRPlay RSP-1 as the radio (\$120 range)



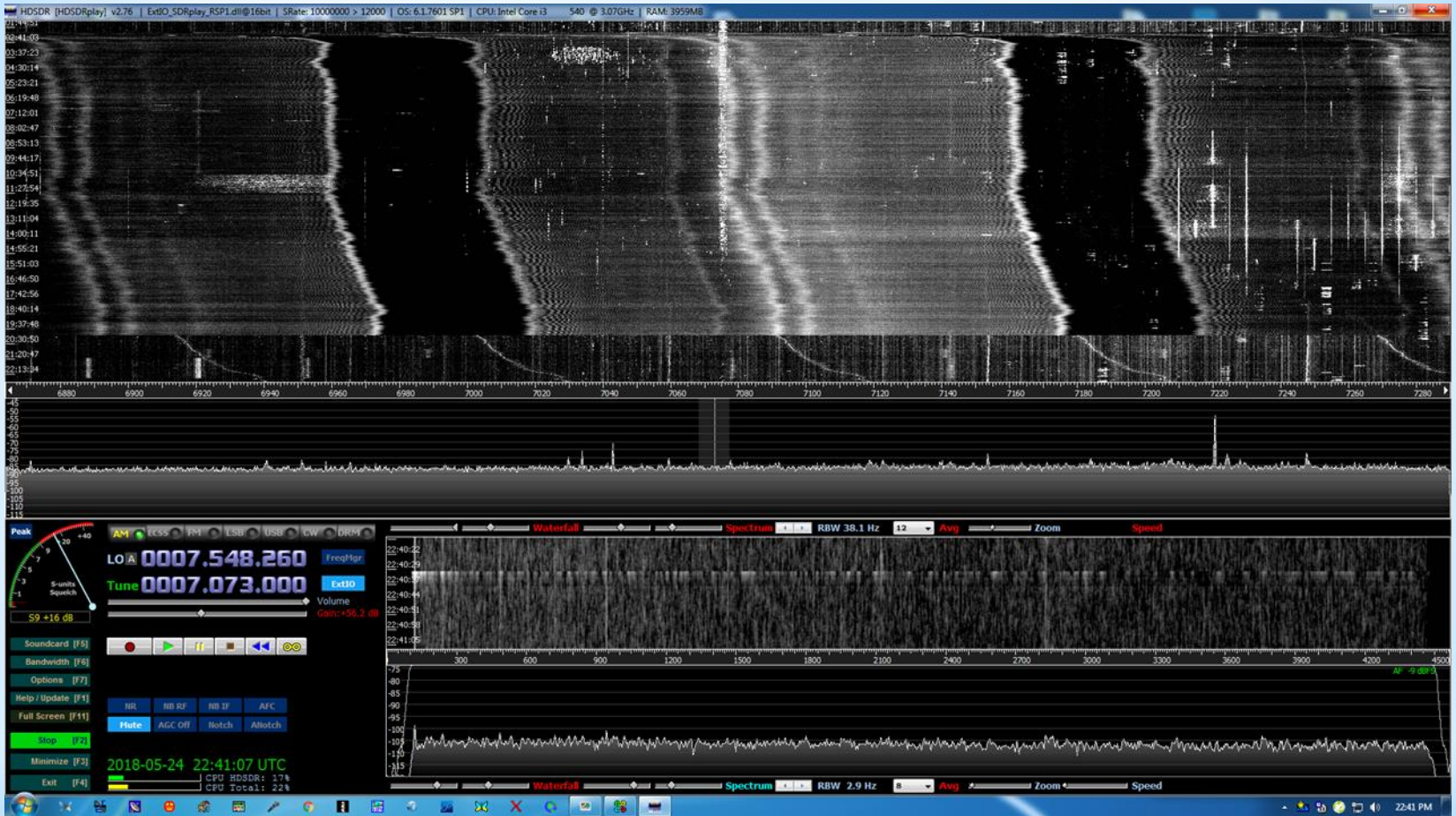
\* **Setting up an SDR**



\*Your first RFI capture



\* 40 Meters



\* Visualizing BFI over time

- \* Now that you see what you are up against you can make sound plans to fix things.
- \* Use suggestions to clean up your shack first.
- \* Next move outside with a loop
- \* Then finish cleaning up RFI
- \* Teach others how to see and clean up RFI
- \* Every time someone removes an RFI source it helps you!
- \* Make captures every month or so...
- \* RFI can pop up with zero warning...

\* I can see my entire RFI  
environment

- \* If you replace your HVAC, ask about RFI
  - \* The variable speed motors are RFI killers in some cases
- \* Some LED light bulbs are horrific emitters of RFI
- \* If you buy a light bulb and it generates RFI return it, and tell them why
- \* Ask manufacturers about RFI every chance you get
- \* Make noise about RFI
- \* In general make RFI part of your purchasing power
- \* Buy only RFI protected products



\* **Make Noise**

- \* **Jim Brown, K9YC** <http://k9yc.com/publish.htm>
- \* **Dave Cole, NK7Z** <http://nk7z.net>
- \* **ARRL book on “Grounding and Bonding for the Radio Amateur?” by Ward Silver, N0AX**
- \* **The ARRL RFI Book:**
  - \* <http://www.arrl.org/shop/The-ARRL-RFI-Book-3rd-Edition>
- \* **ARRL RFI Web Page**
  - \* <http://www.arrl.org/radio-frequency-interference-rfi>
  - \* <http://www.arrl.org/information-for-the-neighbors-of-hams>

 **Resources**



The ARRL

# RFI BOOK

3<sup>rd</sup> Edition

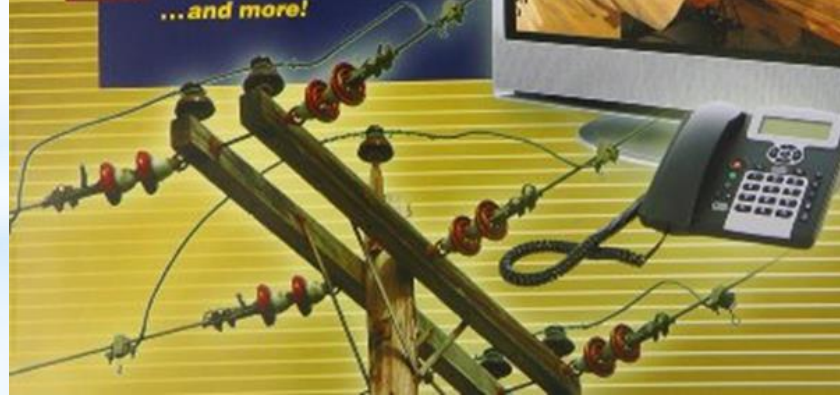
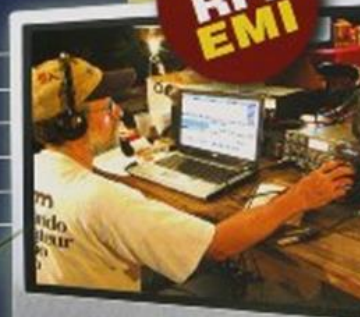
Practical Cures for Radio Frequency Interference

Step-by-step Interference solutions covering:

Telephones  
Power Lines  
Computers  
VHF Intermod

**NEW!** Digital Television  
**NEW!** Hybrid-Electric Vehicles  
*...and more!*

PREVENT  
RFI  
EMI





\*Time for a  
Demonstration!