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# Locating and Killing Receiver Interference

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August, 2019



**WB9JPS . COM**

# Agenda

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- Types of noise and interference
- Typical noise sources
- Finding the noise
- Noise mitigation
- Your rights per the FCC
- References

**NOTE: While this talk focuses on noise arriving at your receiver, some of the mitigation techniques also apply where your transmitter is interfering with other equipment, e.g., getting into the stereo.**

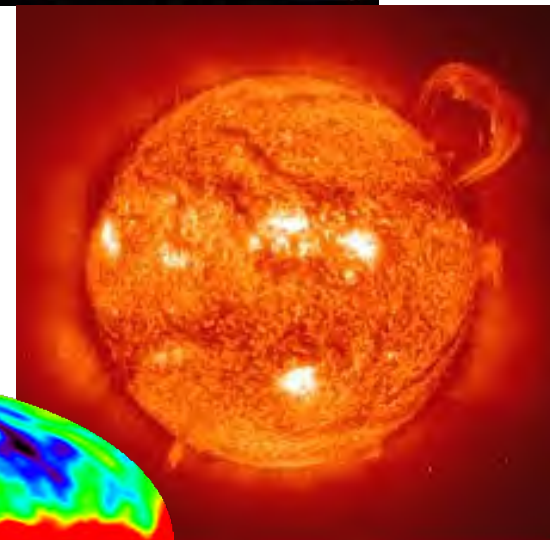
# Types of noise and interference

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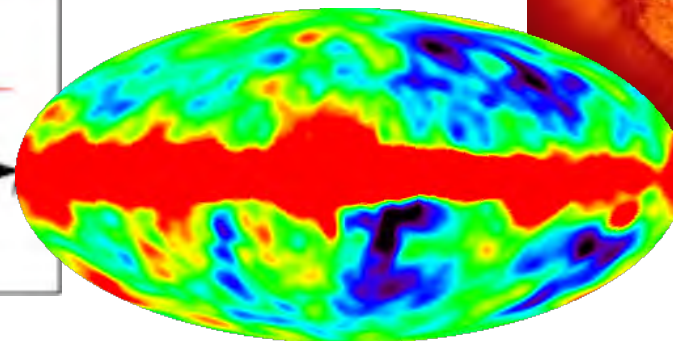
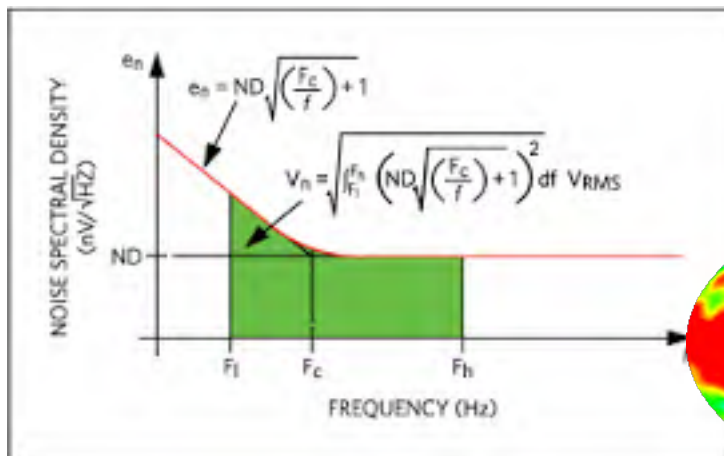
- Natural
  - A case where all-natural isn't better!
- Intentional emitters
- Unintentional emitters

# Nature gives us “baseline” RF noise that we can't do much about

- Lightning
- Solar activity
- Cosmic background
- Thermal noise



QRN



# **Intentional emitters** are other legal transmitters, including other hams

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- Strong signals may overload your receiver
- Multiple signals can mix (*intermodulate*) and appear at unexpected frequencies
- Licensed =
  - FCC regulated
  - Legal leverage
  - Negotiable



# **Unintentional emitters** are almost always the problem... It gets worse every year!

Many electrical devices not designed to be transmitters may radiate interference



# There are tools and techniques to help locate interference sources

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- Spectral fingerprinting
- Power-down until it goes away
- Radio direction finding
- Ultrasonic detection (for arcs)

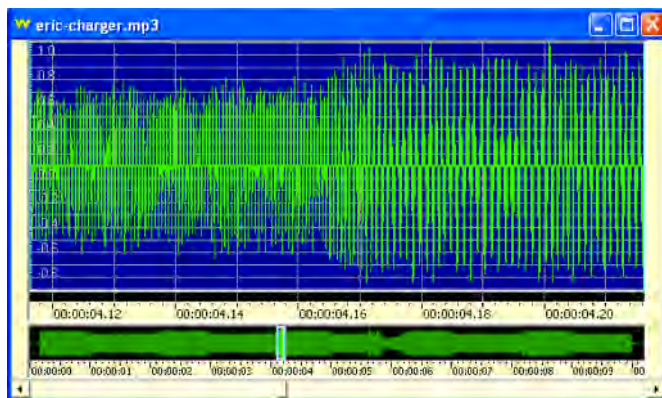




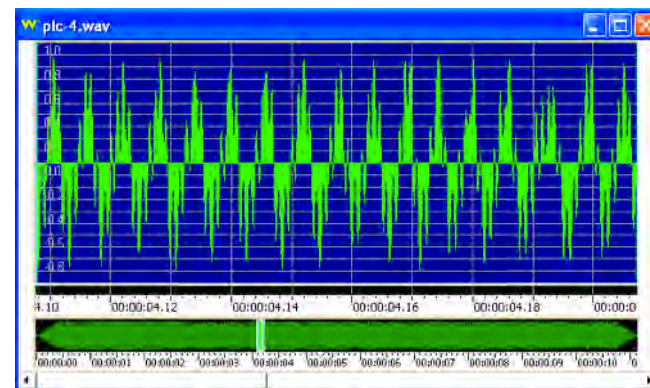
# Fingerprints: What do you hear?

- Tune around. Note frequencies. Is the same signal periodic in time or freq? What interval?
- Listen. 60 Hz hum? Video? Pulses? Voice?
- Record audio, ask others for identification

<http://www.arrl.org/sounds-of-rfi>



Phone charger



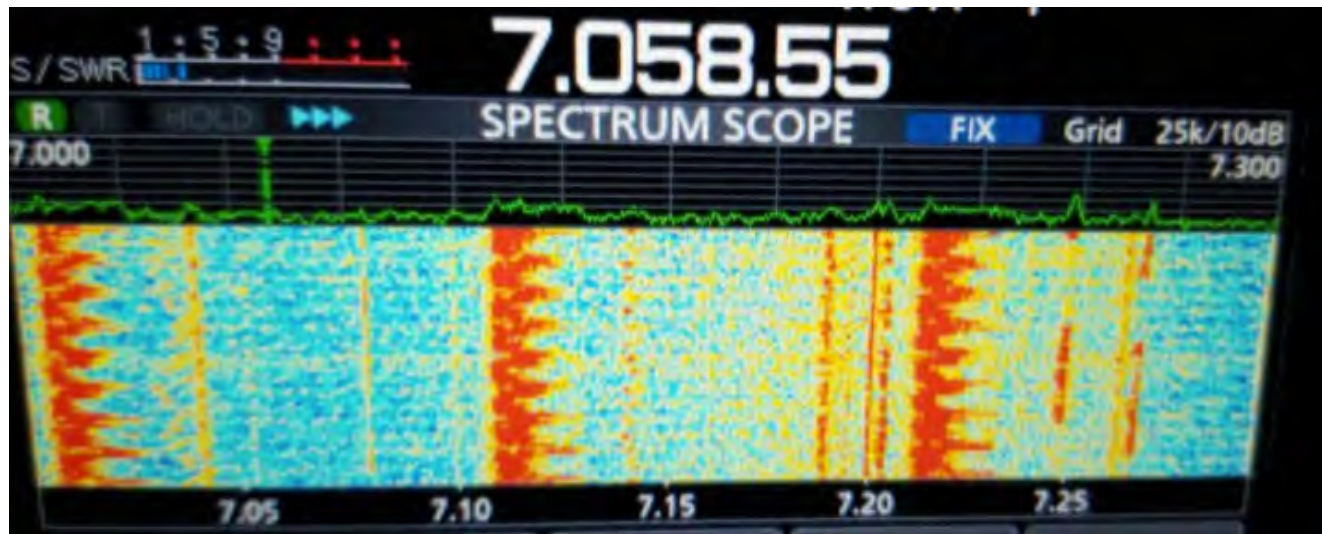
Power Line Control (PLC-4)



# Fingerprints: SDR with panfall display

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- Measure amplitude and frequency
- Track dynamic signals
- Compare before and after mitigation
- Don't forget to **write down** everything

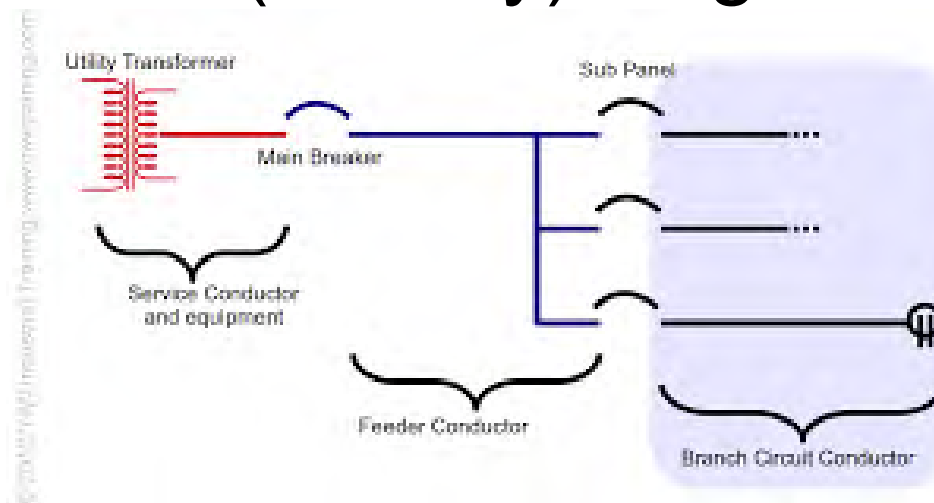


Battery tender observed at AJ6CY

# Power down to quickly find the smoking gun: Start with your own house

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- Unplug everything, then plug in one thing at a time
- Even better, turn off breakers
- See when the noise appears or disappears
- Same with (friendly) neighbors



# Head for the field: Radio direction finding

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- All bands may be useful: MF, HF, VHF
- Directional antennas are most useful
- Walk around, tune around, triangulate

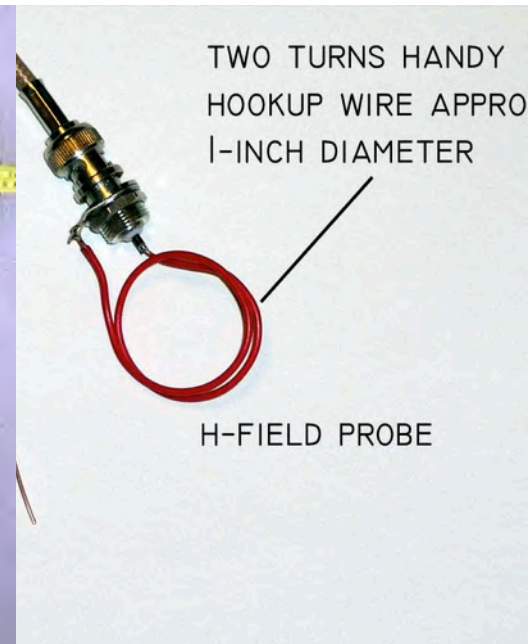
**VHF Yagi**



**HF Loop**

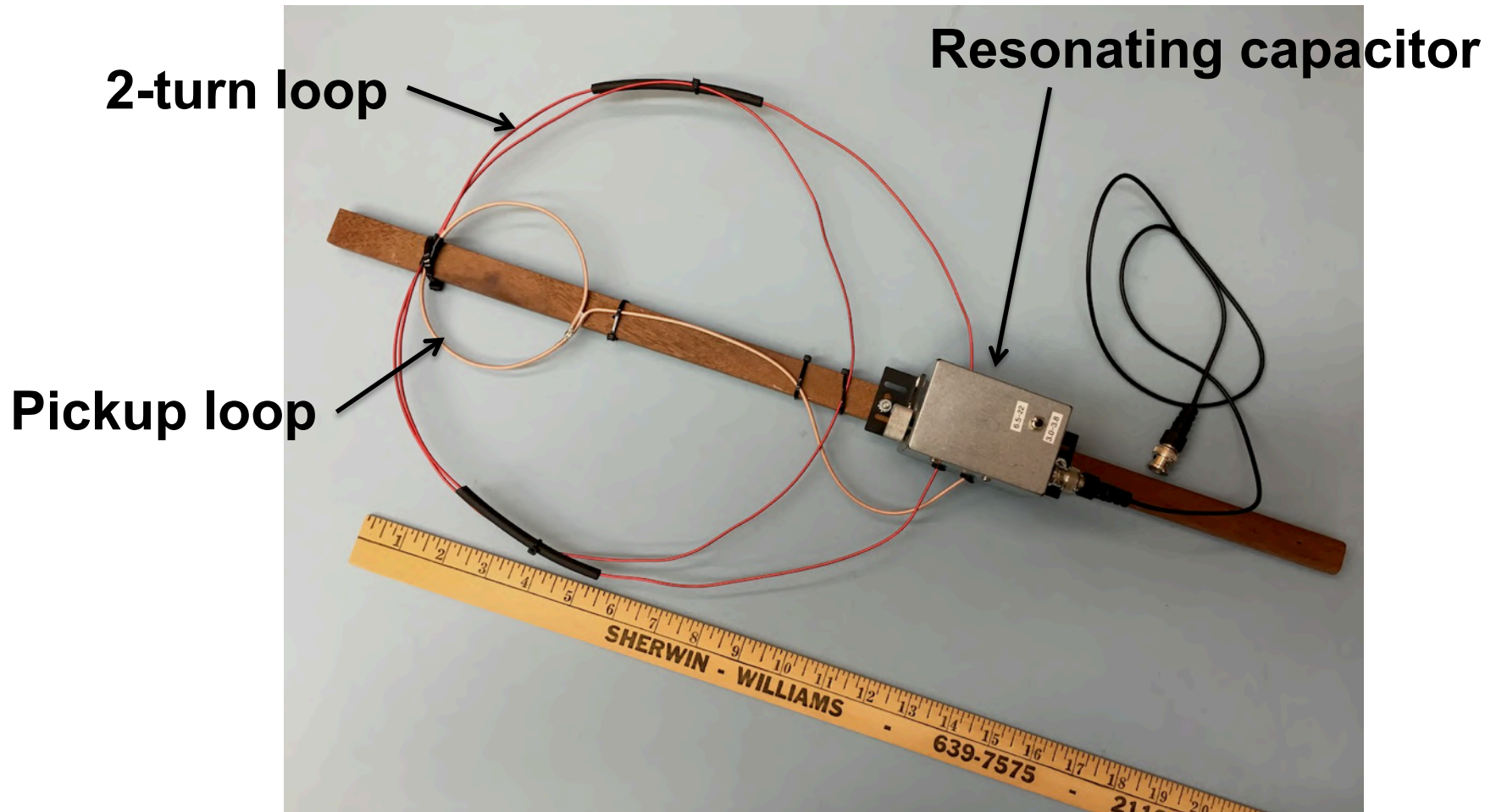


**Sniffer Probe**



# My DF loop design... Simple, cheap

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See my RFI pages at [WB9JPS.COM](http://WB9JPS.COM)

# Direction Finding

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DEMONSTRATION



# Now that you found it...

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# Well, you can do several things

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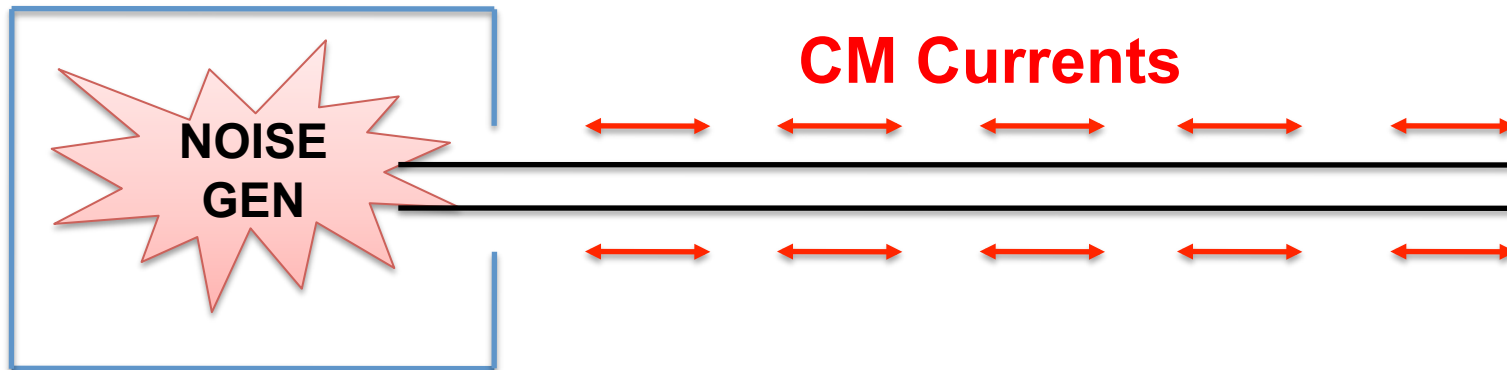
- **Remove** the offending device, or turn it off when you're operating
- **Replace** it with something less noisy
- **Choke, filter, or shield** it to reduce radiation
- **Make your station more resistant** to that interference

Here are some examples



# Most noise is coupled through **Common-Mode** currents

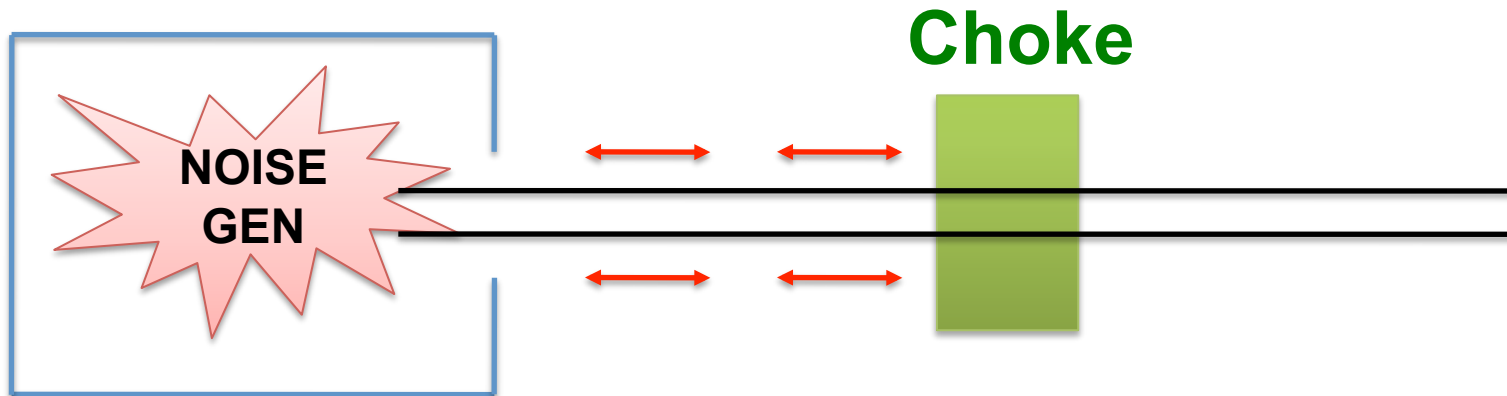
- Current common to all conductors
  - As opposed to **normal-mode** or **differential** signals
- Current on the lines gets **out of** or **into** equipment



- **Current in a wire  $\Leftrightarrow$  electromagnetic radiation**
- **Longer wire = better antenna**

# Common-mode chokes (or transformers) can stop most of these currents

- Insert a **high impedance** in series with both conductors
- Reduces CM current while passing normal-mode (differential) current



- **Less current = less radiation**
- **Choke close to device = shorter antenna**

# Most common-mode chokes are made of ferrite... high impedance and lossy

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High-power choke for antennas



Small clamp-on (VHF-UHF)

# Arch-nemesis: Wall-warts and other switching-type AC adapters

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- Replace switching supplies with linear supplies (find them on ebay)
- Apply common-mode chokes and/or filters to AC line and DC line
- Plug them into a choked outlet strip



**Not all are defective but always be skeptical**

**LED lights contain switching power supplies.  
Some are HORRID for RFI. Fixtures are the worst.**

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- Usually can't fix this. Must replace them.
- Best bet: Only buy trusted name brands that actually pass FCC certification



Real data and recommendations on my new RFI website:

[http://wb9jps.com/Gary\\_Johnson/RFI.html](http://wb9jps.com/Gary_Johnson/RFI.html)

**GE and Feit are proven good; NOT Cree**

# Mobile: Inverters can be very noisy



**This is what it took for K9YC to fix his Samlex 120V 1A inverter**

# Defective power strips: Can generate noise, intermodulate like crazy

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- 90% of these are total crap!!!!
  - Besides being likely noise generators, many are poorly made and **just plain unsafe**
- *Surge suppressor* types are the worst
  - Many active components, MOVs



## **A safe choice: Waber**

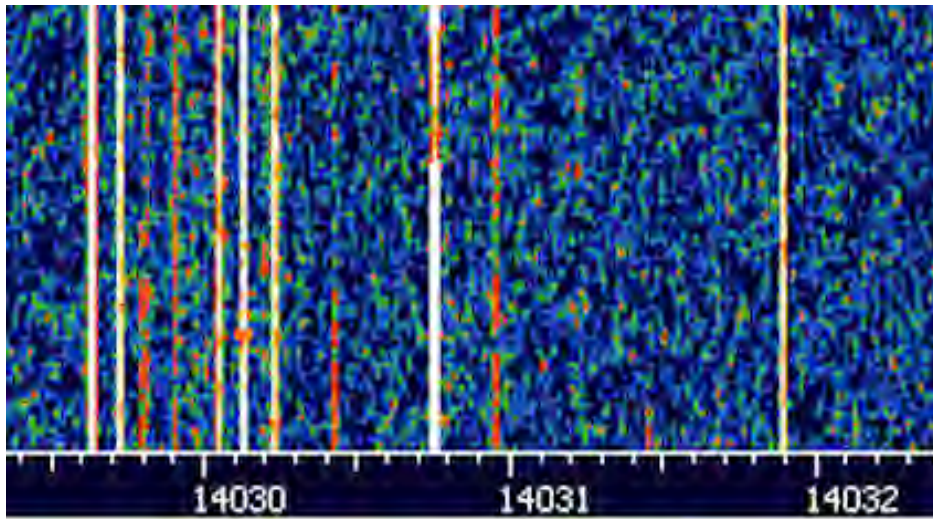
- All metal enclosure
- Quality outlets
- No electronics



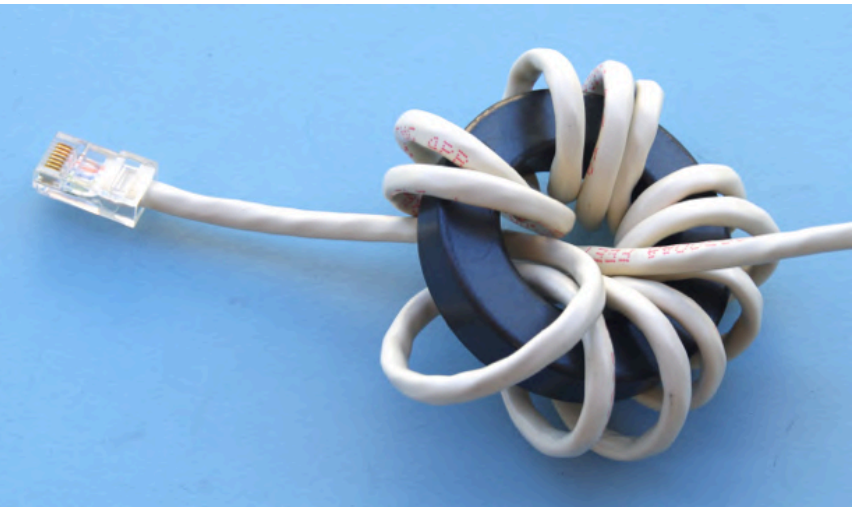
# Ethernet cables can radiate groups of birdies all over the HF bands

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- 10/100 is worse than GigE
- Upgrade all equipment to GigE or go WiFi
- Apply chokes near each end of long cables



**Typical 20m birdies**



**12 turns, type 43**

# Plasma TV... Thankfully they are falling out of favor

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- Video-modulated interference with wide bandwidth on multiple HF bands
- Radiates from the screen!
- Only solution: **Get rid of it.**



# Failing electrical equipment can be tracked and fixed

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- Fluorescent lamps—replace the bulb
  - **Class A (non-consumer)** switching ballasts are also well-known for generating RFI
- Flickering street lights—call the city
- Bad capacitor on an A/C compressor

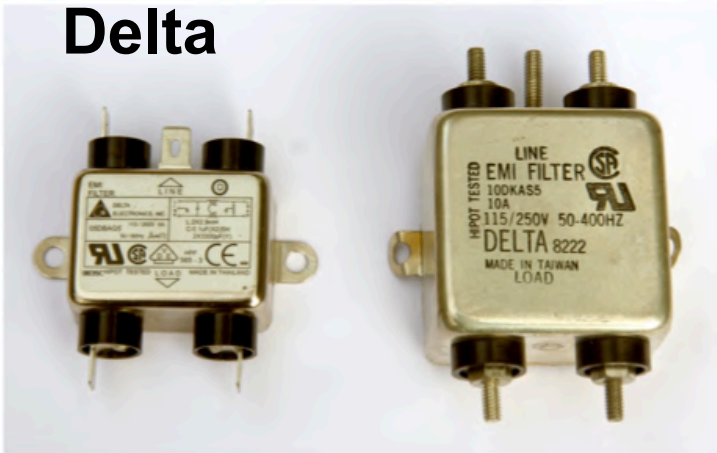


# Filtering AC lines can be effective, but more difficult and expensive to install

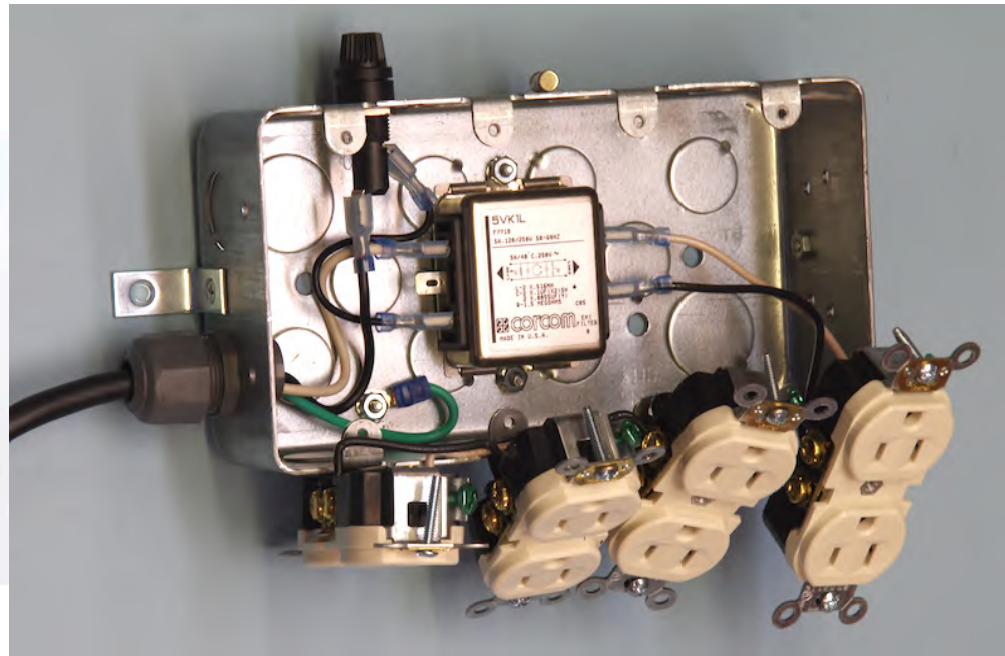
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- Requires fabrication of a **safe** 120 VAC enclosure, or embed the filter inside of equipment

Corcom, Schurter,  
Delta



Wall Wart “Island”



# Heaven forbid that it's a neighbor's solar panel system

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- Can be difficult and expensive to fix
- See *QST* article, April 2016
- SolarEdge “Power optimizer” modules are worst offenders but not often installed
- Some hope: “*FCC issues a Notice of Violation to Solar City for RFI Interference*”

**Every system generates some noise...  
Death by 1000 cuts**





# **HV PG&E power line interference is often challenging to locate and fix**

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- **Use direction finding, starting with HF and moving to VHF then UHF**
- **Write down the pole number**
- **Report to PG&E... and keep bugging them. Document everything.**
- **Then report their lack of response to the PUC, FCC, and ARRL**
- **Iterate for a few years. Good luck.**

# Reduce your station's susceptibility to noise

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- Common-mode chokes on transmission lines and other conductors
  - Prevent radiated noise from getting to your RX
- Low-noise receiving antennas
  - As a rule, horizontal is better than vertical polarization for local QRM rejection
- Use your rig's Noise Blanker (NB) and Noise Reduction (NR) features



# Ferrite common-mode chokes can benefit nearly any antenna

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- Noise on the outside of coax shield is conducted to the antenna then to your RX
- An **EFFECTIVE** choke is required at the feedpoint



**[K9YC.COM](http://K9YC.COM)**

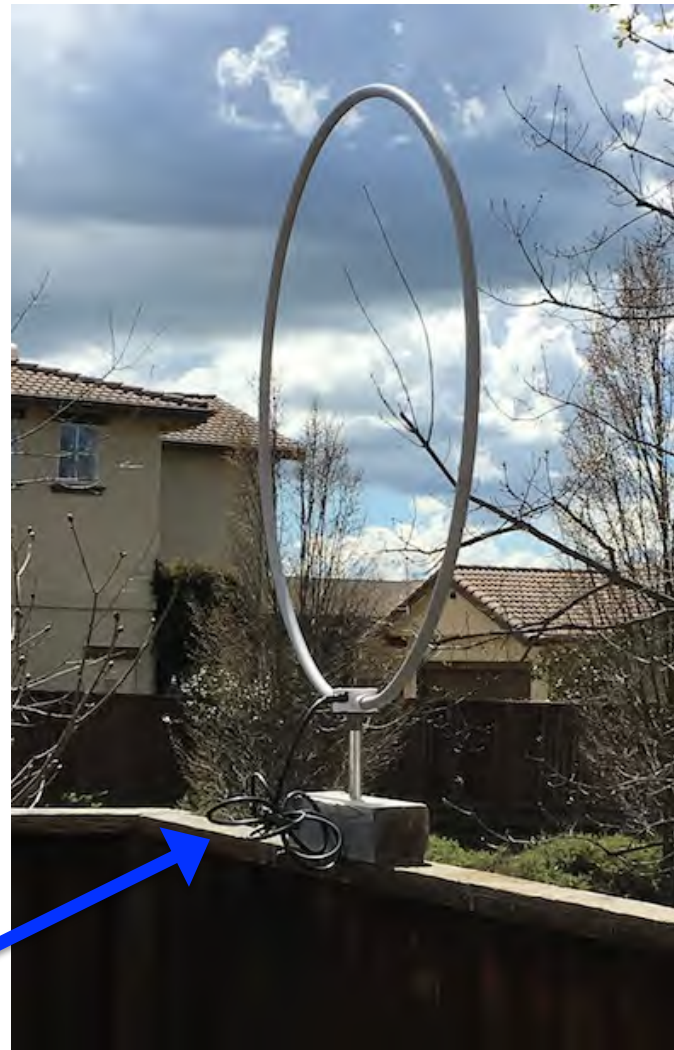
**Article “RFI,  
Ferrites, and  
Common Mode  
Chokes For Hams”**

# Low-noise receiving loop rejects local RFI within ~one wavelength

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- Covers all HF bands
- No tuning required
- Orient to null out QRM
- Some makers:
  - Wellbrook
  - Pixel Technologies
- Resonant loops are also very good

**Common-mode choke**



## **Myth: “I need a better RF ground to reduce my noise”**

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- **Fact:** There is no such thing as an RF ground, due to wavelength, inductance, and skin effect.
- **Fact:** A connection to Earth almost never reduces noise or RFI, and it will often make it worse, because the “ground wire” can act as an antenna.
- **Fact:** A connection to Earth is very important for lightning protection.

# As a licensed ham, the FCC grants you legal rights (and responsibilities)

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- Devices that **cause** harmful interference are at fault and the operator (owner) is legally responsible for fixing it
- Devices that **cannot accept** interference from licensed and legally-operated services are handled the same way
  - So make sure your transmitter is clean

**But as a goodwill gesture,  
you should always help**

# References

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- ARRL: *The ARRL RFI Handbook*
- ARRL RFI pages <http://www.arrl.org/rfi>
- ARRL: *Grounding and Bonding for the Radio Amateur*
- Jim Brown, K9YC
  - <http://k9yc.com/publish.htm>
  - RFI, Ferrites, and Common Mode Chokes For Hams
- Gary Johnson, NA6O
  - [http://wb9jps.com/Gary\\_Johnson/RFI.html](http://wb9jps.com/Gary_Johnson/RFI.html)

# Epilogue: My own RFI disaster

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- 23 LED fixtures installed next door
- Worked with ARRL, FCC, tried to fix
- New neighbor added even more stuff.....
  - Home station is now basically QRT
- See my RFI page for the full story
  - Will be presented at Pacificon

**My final  
solution:  
Go remote!**

