

Phil-Mont Mobile Radio Club

Radio Frequency Interference

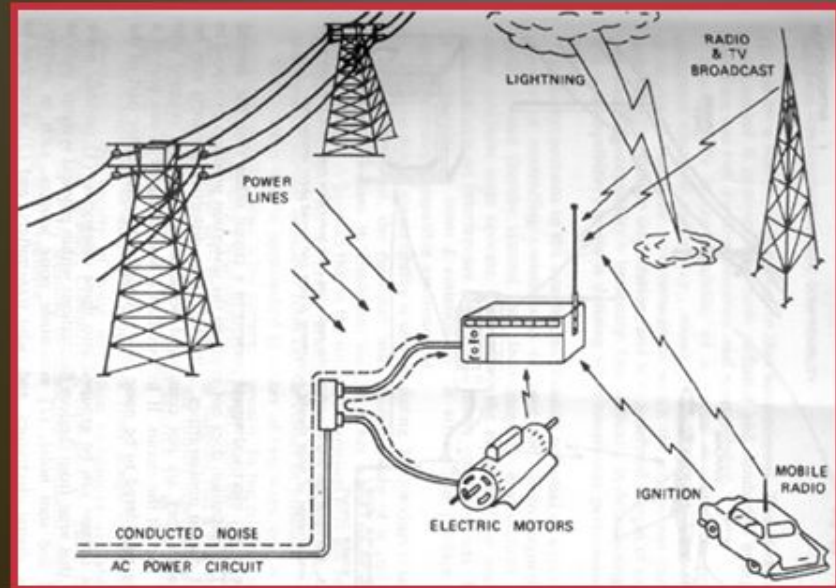
September 13, 2017

K3EUI Barry

What is EMI?

A basic working definition

- EMI (Electromagnetic Interference) is broadly defined as any unwanted electrical or electromagnetic energy that causes undesirable responses, degraded performance, or failure in electronic equipment.
- For our purposes we are usually concerned with radiated and conducted EMI in electronic equipment in command, control, information and communication systems.



Sources of EMI

Natural sources

lightning, solar flares, interstellar events, pulsars
the “Big Bang” radiation

Human activities

any sparking device, defective thermostats
radio transmitters

Subdivisions of EMI

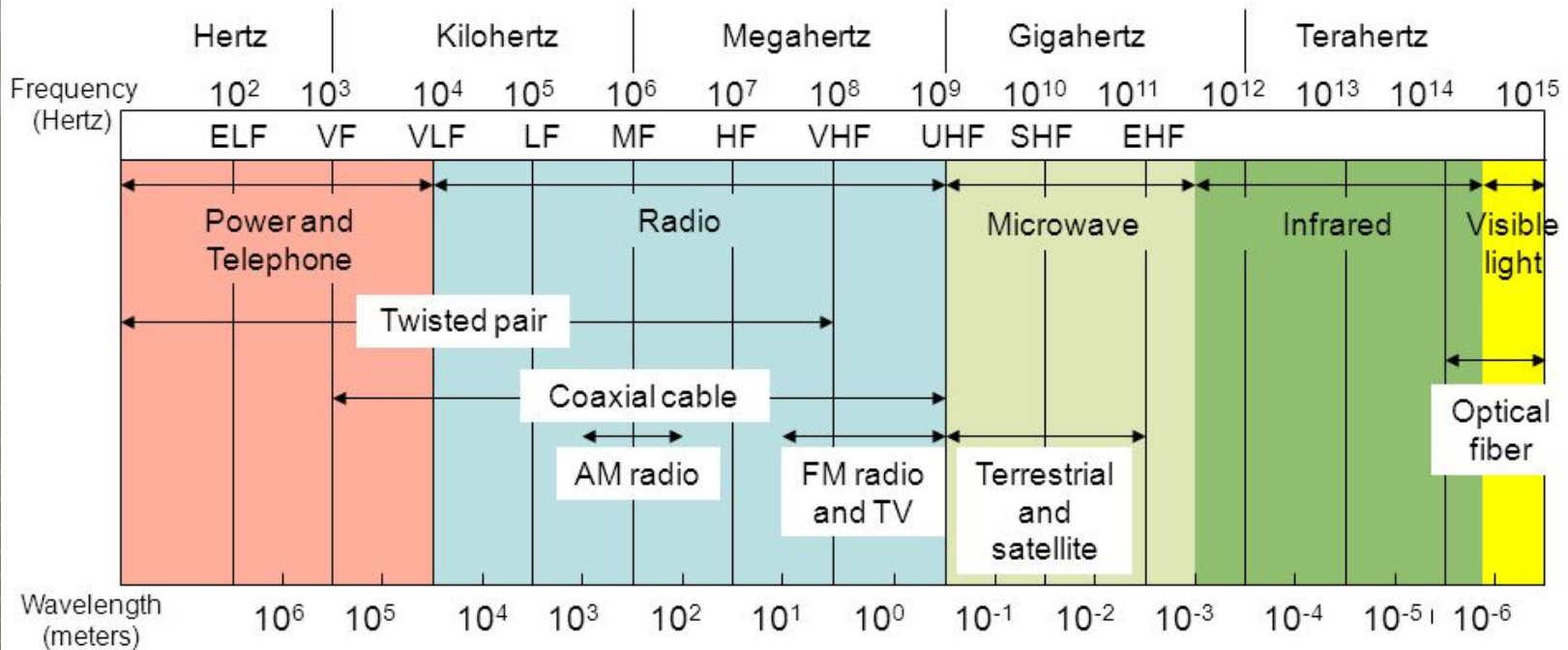
BCI = broadcast band interference
(AM radio 500 – 1600 kHz)

TVI = television interference (VHF/UHF)

Stereo interference

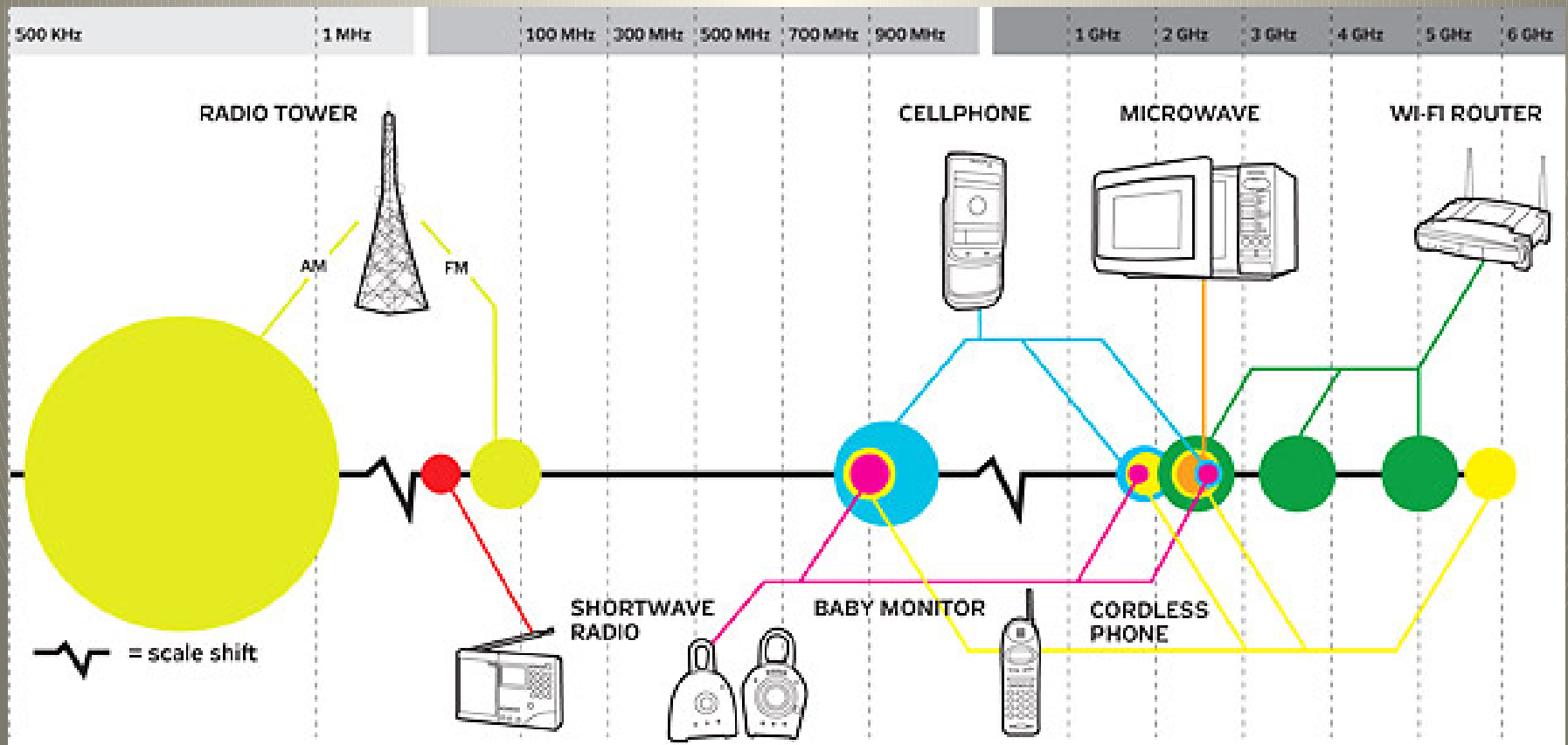
Telephone interference

Electromagnetic Spectrum



Wavelength $\lambda = c / f$

Typical frequencies of devices



Electric arcs produce broad-band “noise”

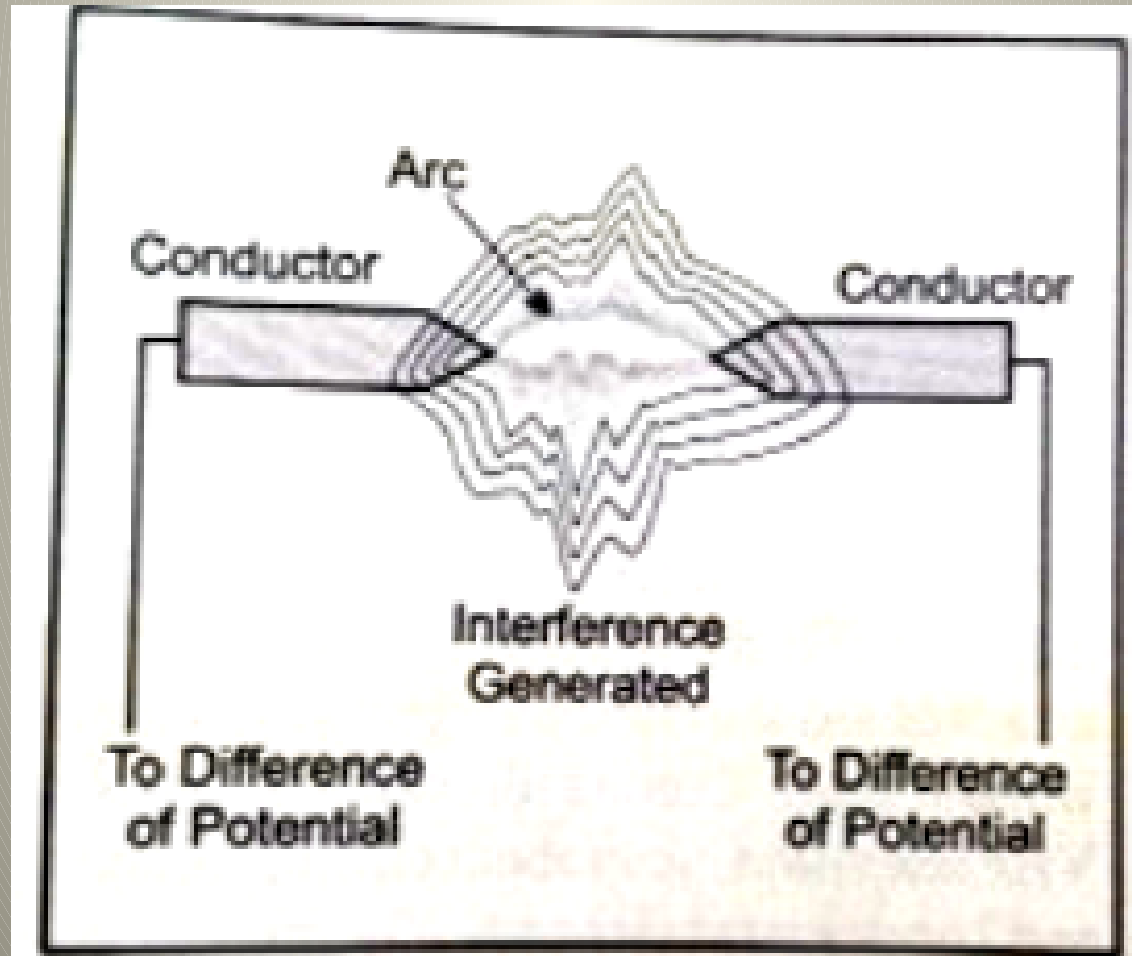


Figure 11.1—Representation of an electrical arc.

Sparking or Arcing Sources of RFI

Radio interference

- ▶ Electromagnetic interference, also called radio frequency interference (RFI) when in the radio frequency spectrum, is a disturbance generated by an external source that affects an electrical circuit by electromagnetic induction, electrostatic coupling, or conduction.



Might you be the cause of RFI
in your shack, or your neighbor's home?



Stand up now

**if you have been either
the source or the victim
of RFI**

Remain standing if your shack has
CAUSED RFI

to a neighbor's TV, stereo,
telephone, or toaster

Sit down if you were able to resolve your RFI issue with your neighbor and cure the problem.

Now... for those still standing

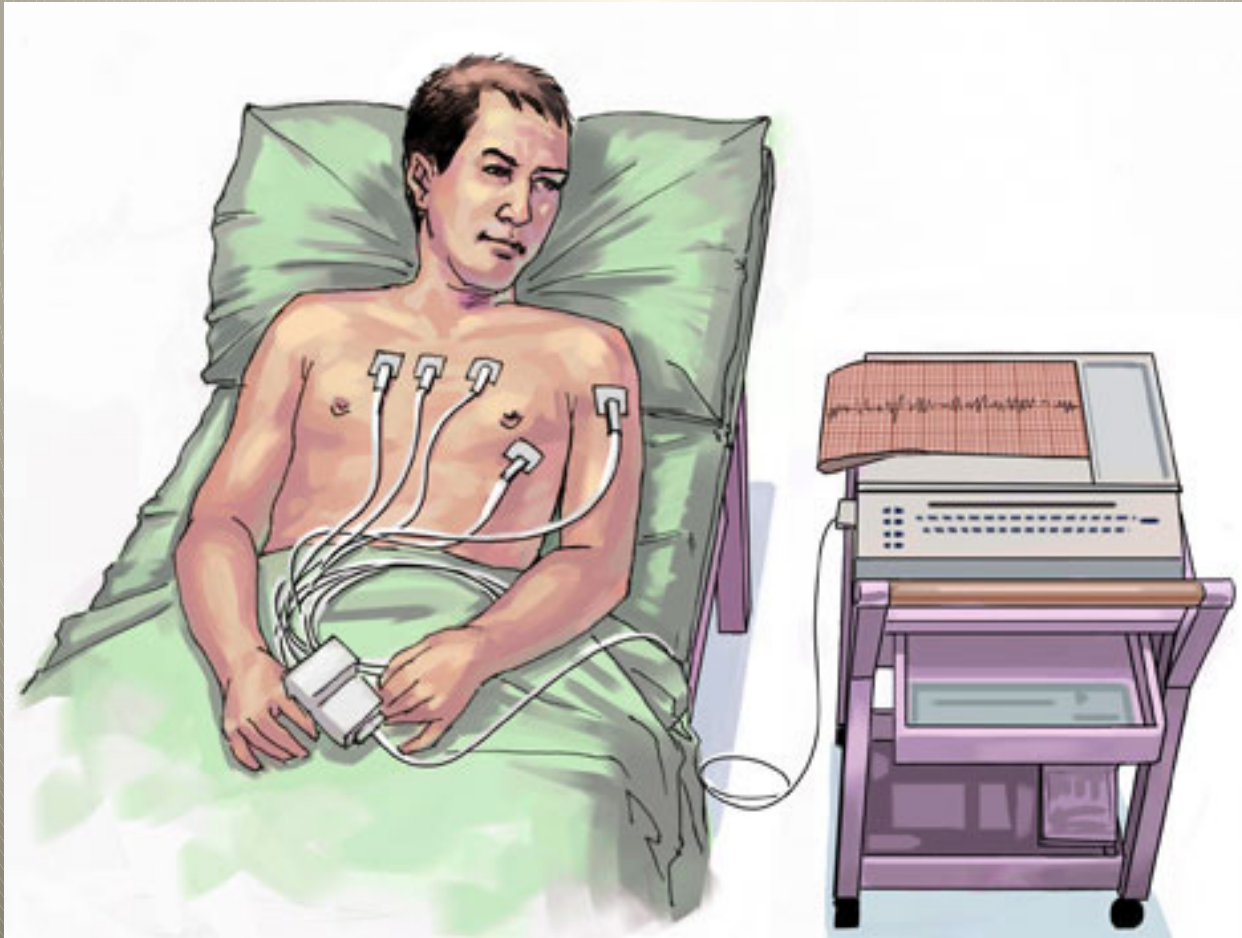
What can you do to resolve your RFI issues? HELP..... ARRL?

Test if your own signal is “clean”

Check for harmonics with a spectrum analyzer or an SDR wide-band radio

Who has the best
(most interesting)
RFI story to share?

Getting an EKG from home leads picking up millivolt signals



A typical EKG (ECG) trace



During my dad's 1960 EKG at
home

K3eui on the floor above was
transmitting CW on 21.1 MHz with a
100 watt Heathkit DX100 and 15m
dipole

The results of the EKG ???

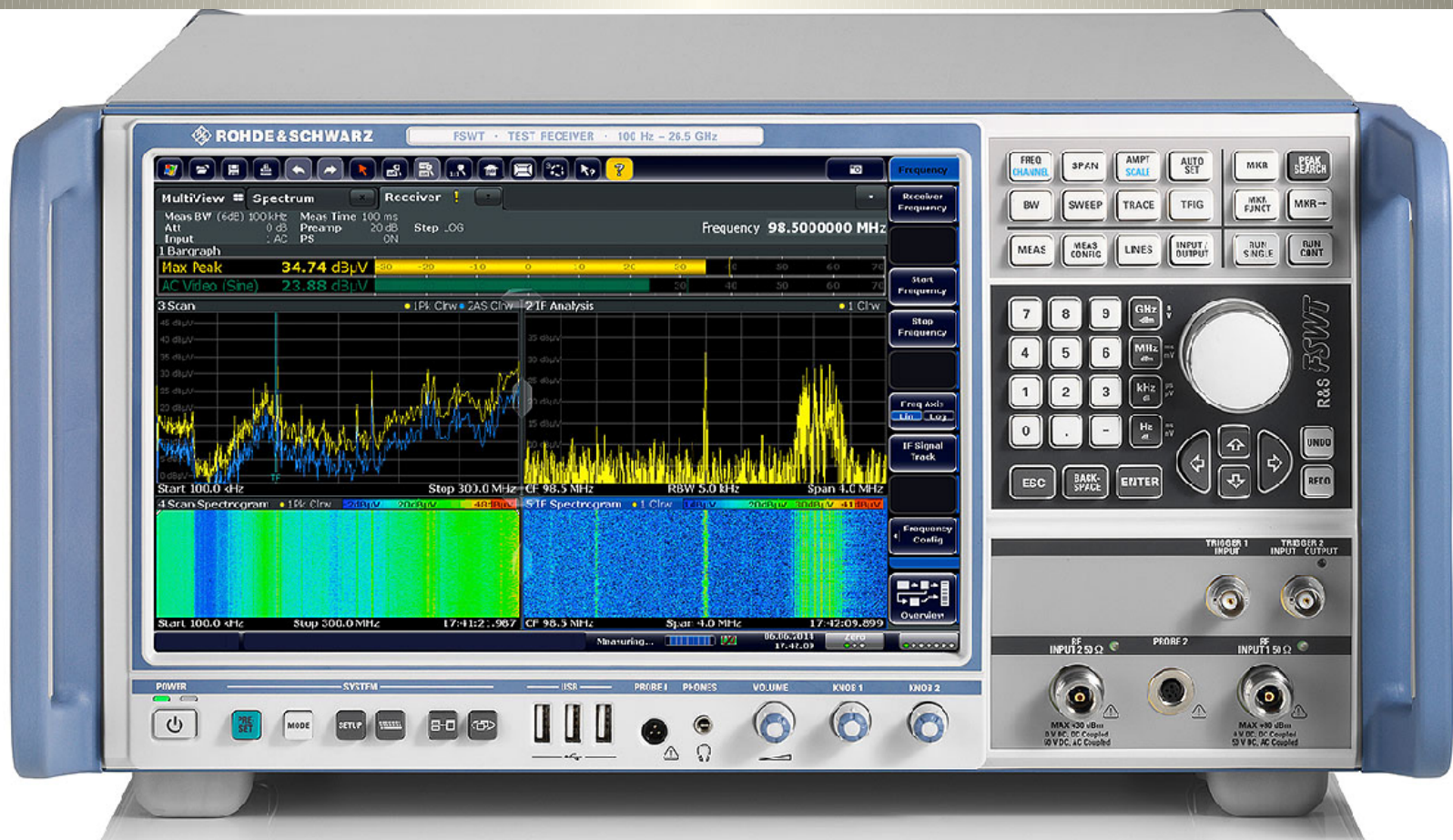
Don't overdrive your amp



An RF Spectrum Analyzer (is a nice tool to have)

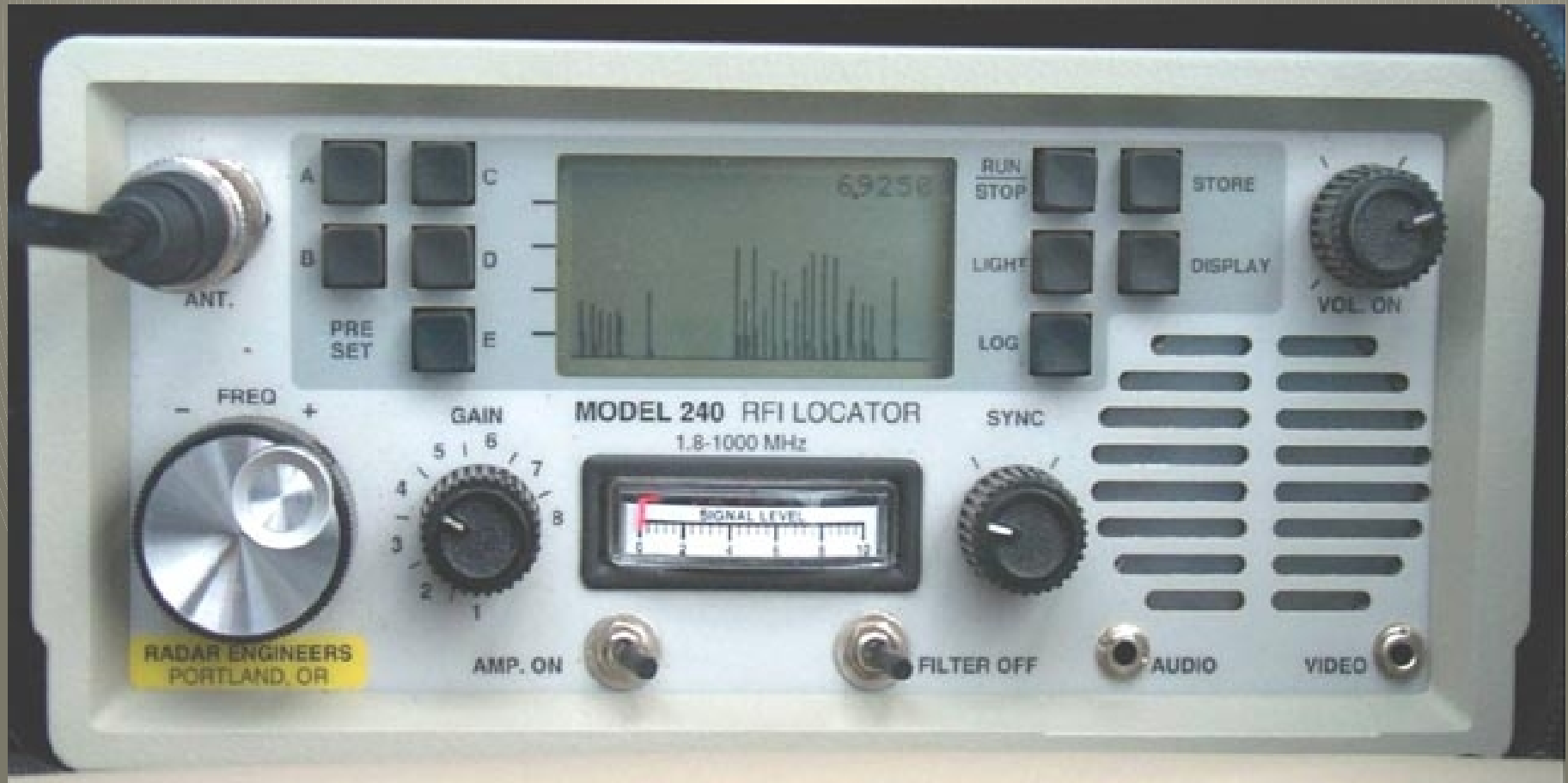


drool



Professional RFI analyzer

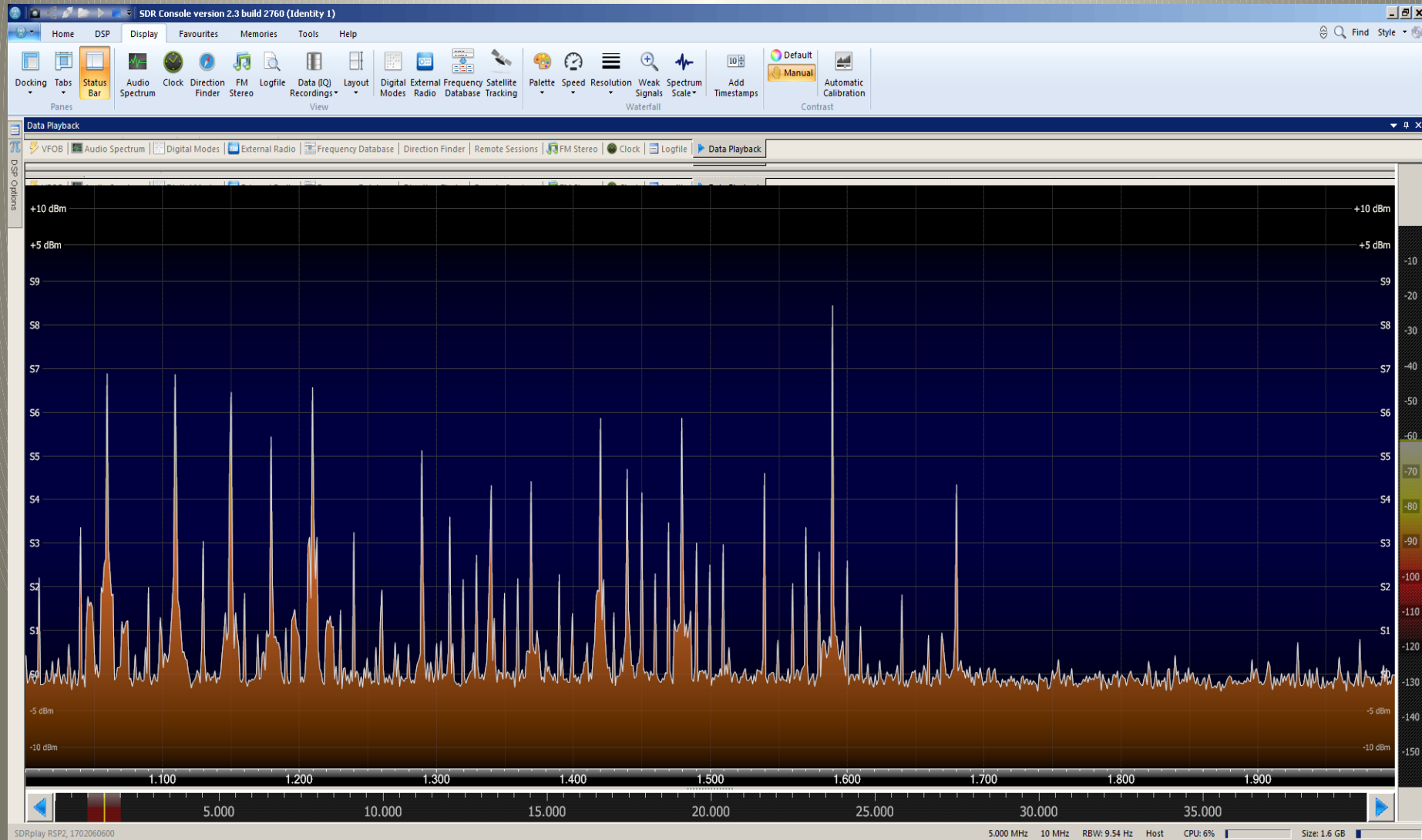
1.8 MHz to 1000 MHz with oscilloscope signature
What every club should buy?



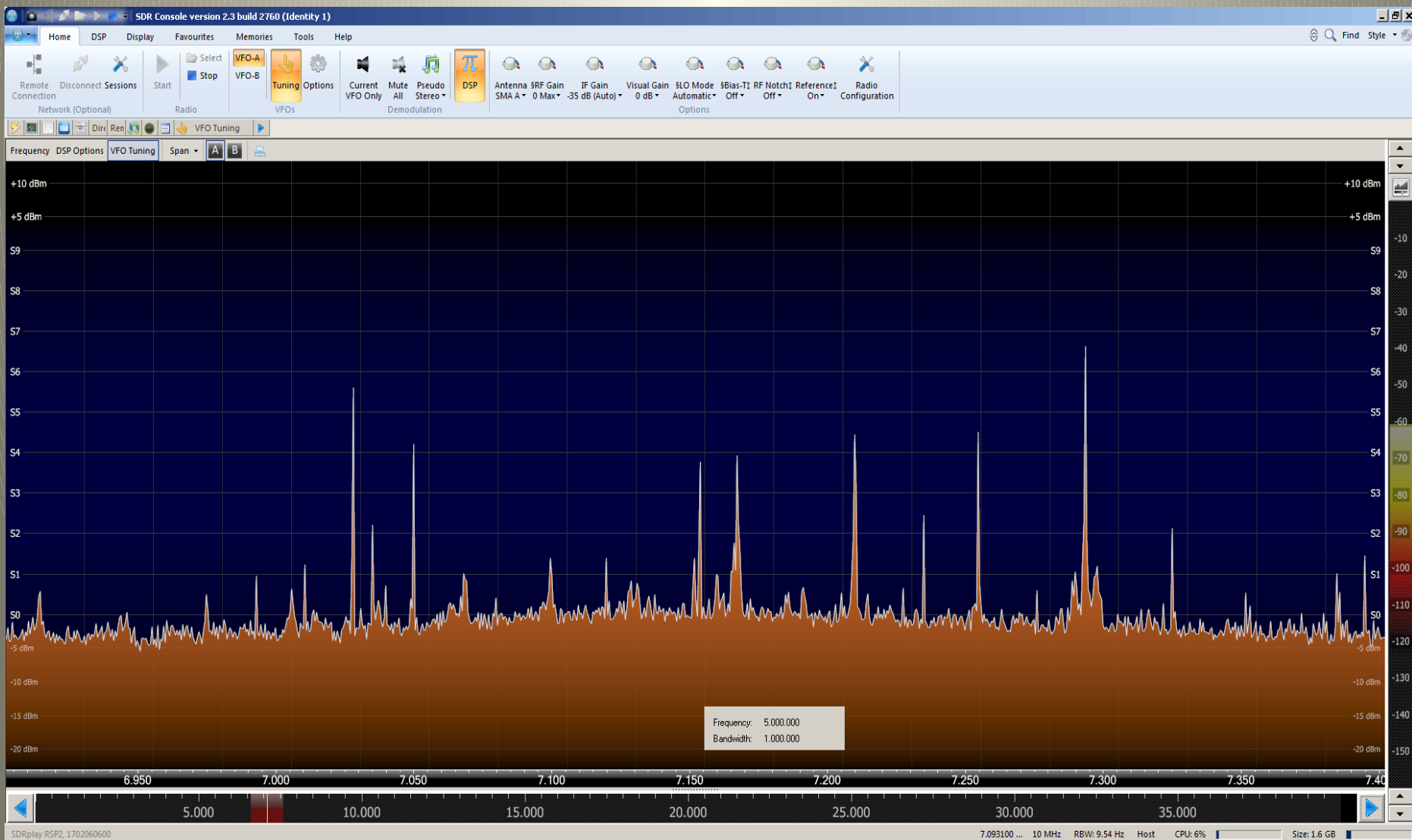
SDR radio \$200 can be a good substitute for an expensive RF Spectrum Analyzer
This unit: 10 kHz to 2000 MHz



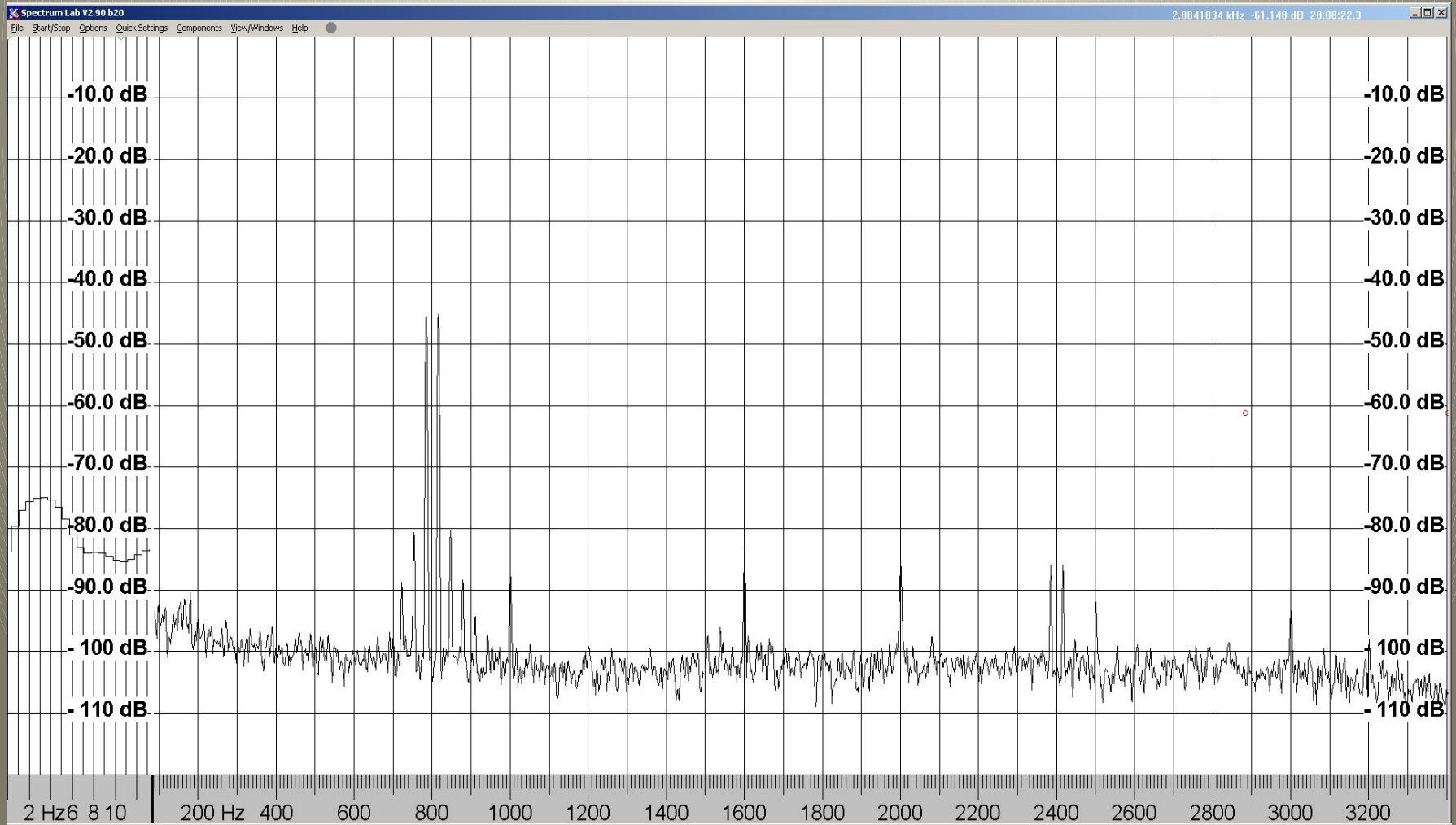
Examining the AM broadcast spectrum 1-2 MHz with SDRplay2 and SDR Console software



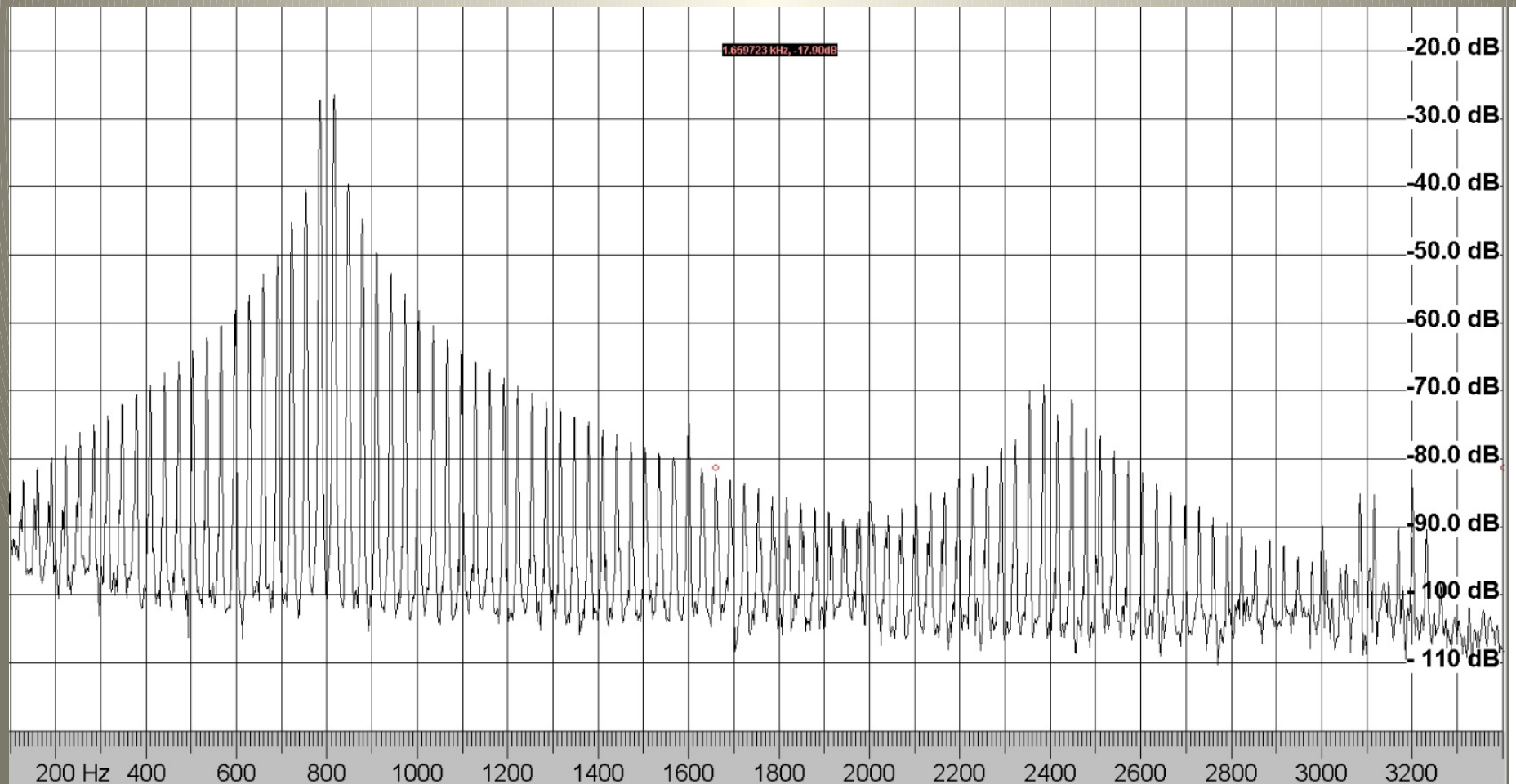
Examining the 40 meter band's signals note strong & wide AM signal near 7295 kHz



Spectrum of a clean PSK31 signal bandwidth less than 100 Hz and traces of a 3rd harmonic at 2400 Hz



Spectrum of a “dirty” and wide PSK31 signal with a 1000 Hz bandwidth and harmonics



Possible Cures on TX side

Insert a “low-pass” filter on an HF rig to reduce harmonics

LP filter has a sharp **cutoff** above 30 MHz

see examples of LP filters on table

Check for feedline radiation or high SWR

(usually shows up as a hot-spot in the shack)

SWR with coax should be reasonable ($< 2:1$)

Lower your power, move the antenna, try a different antenna

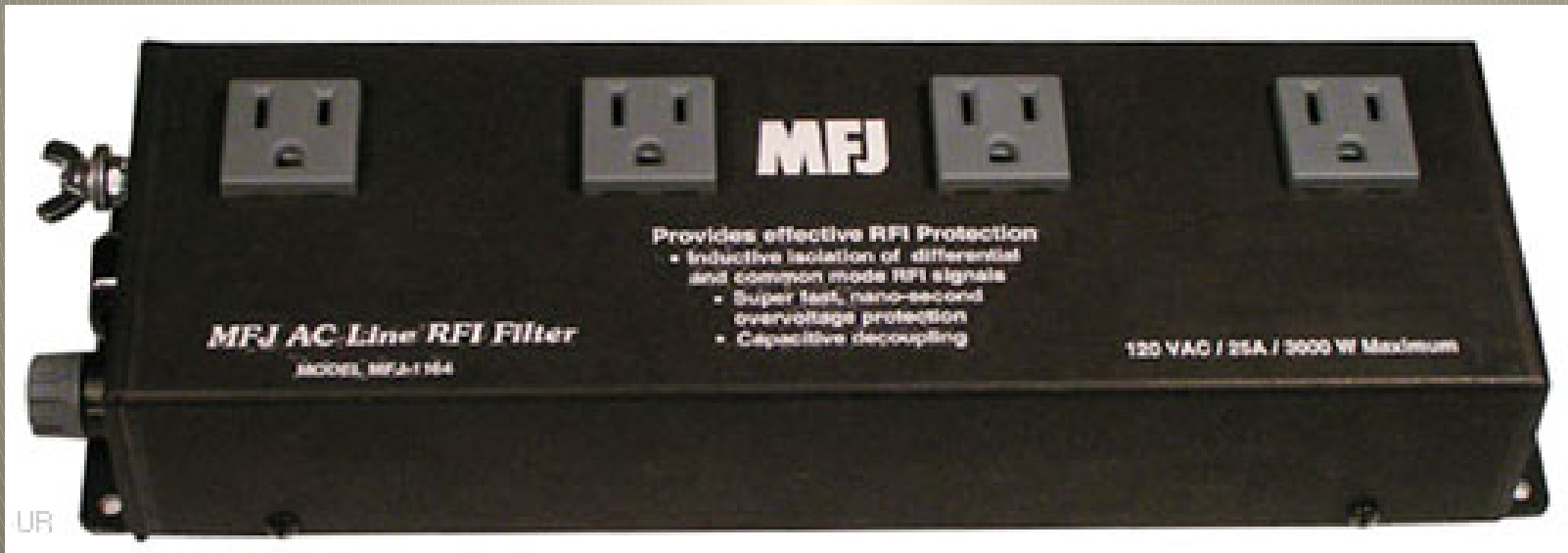
Operate during non-prime hours

RF coax “choke” balun
feeding a balanced dipole with unbalanced coax
(don't connect dipole to the eyebolts!)



MFJ 120 volt “AC line RFI filter”
suppresses RFI with capacitors and inductors

built-in 15 amp fuse and ground lug
(often called “noise suppression”)

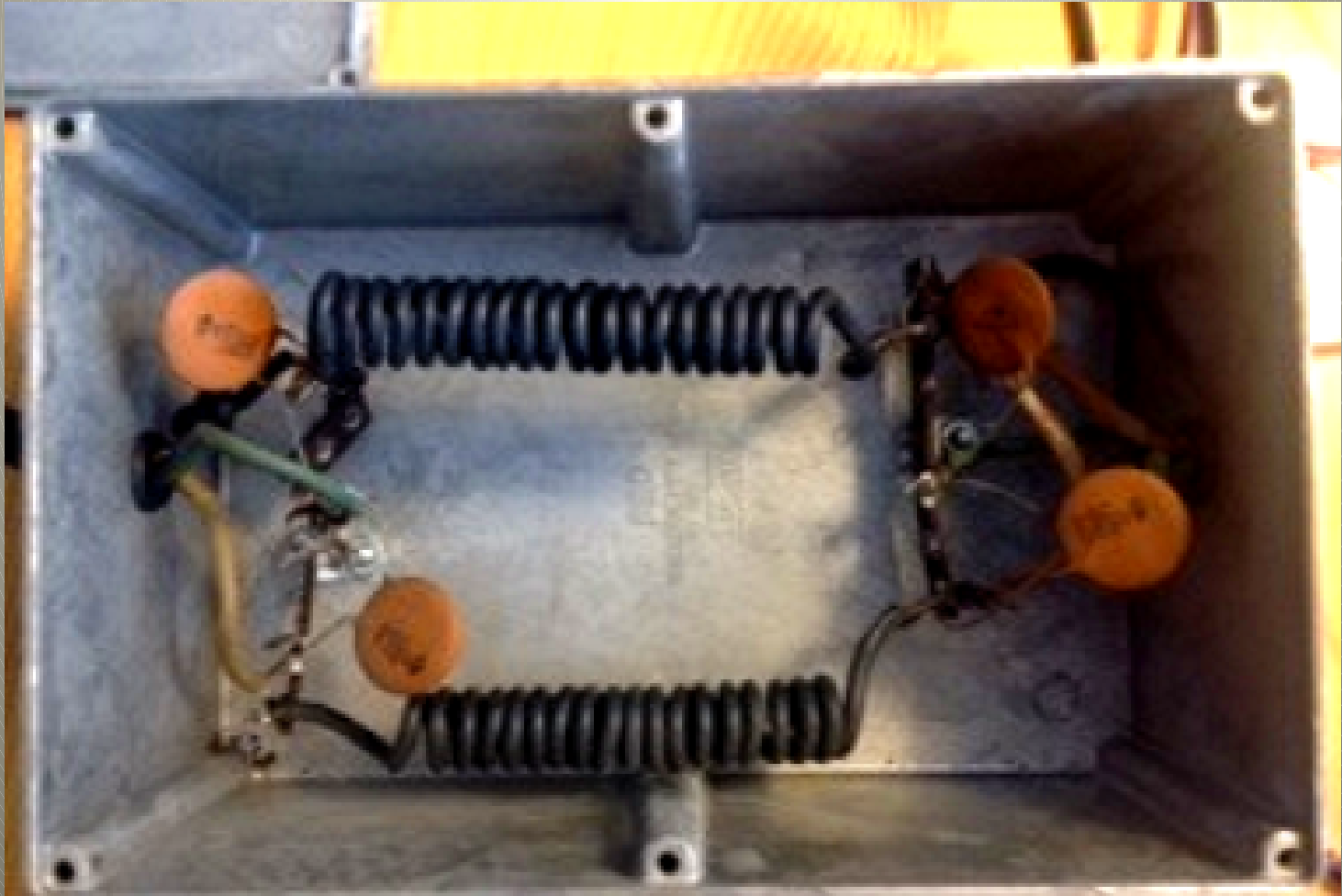


A commercially made AC line filter for
220 volt lines



Homebrew AC line filter

avoids **conducting** RFI to the 120 AC power leads
typical C-L-C (pi) filter



Cures for receiving RFI

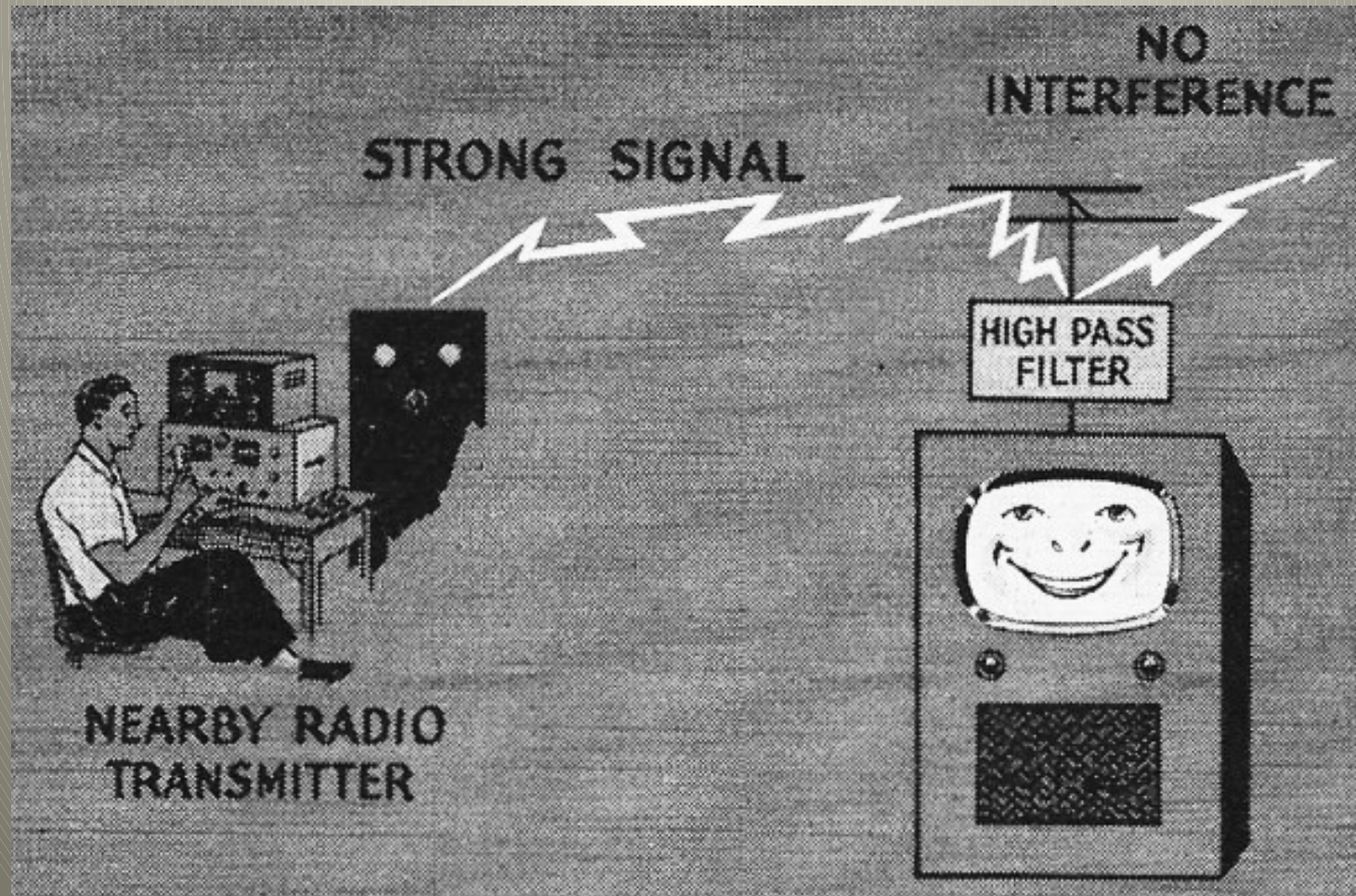
What options do hams have?

Locate source of noise first !!

Get this guy to help track down RFI
in your neighborhood



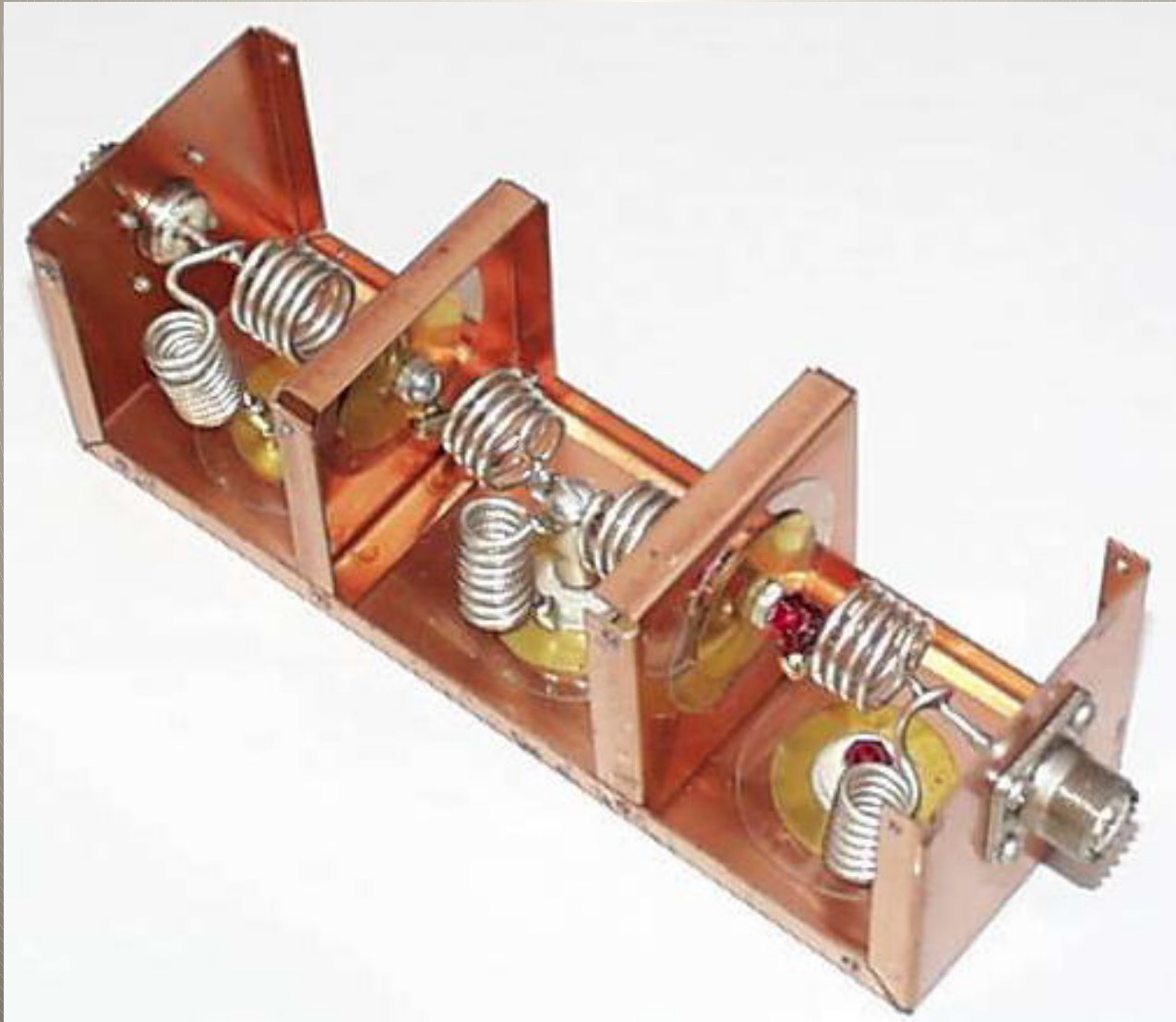
High-Pass filter suppresses RF below a cutoff freq
good to suppress RF from a nearby broadcast station



Add a “low-pass” filter on HF rigs
popular in the old AM days when harmonics
were more prevalent
typical cutoff freq 30 to 50 MHz: 52 ohms
80 dB attenuation !!



An inside view of LP filter



An old high-pass filter (300 ohm feedline)
designed for the older analog TV days
found in my junkbox



Hi Pass filters attenuate RF below 50 MHz





75 OHMS

TV-75-HP

HIGH PASS FILTER

Attenuates 0 to 52 MHz



DRAKE

ASSEMBLED BY DRUMMOND WITH U.S.A. COMPONENTS

75 OHMS

More drastic measures

Install RF chokes on your coax

Install shielded cables for speaker leads

Install telephone filters

Wrap telephone wires in a toroid
“choke”

Has RF has gotten into
your own telephone system ?

Are your telephone wires
“twisted pair” or shielded coaxial
cable?

How did you “cure” your own problem?

How does this work?

STOP radio transmitters from jamming your telephone or slowing your dial-up modem.



Telephone line filters



Typical telephone “filter”



Who has caused RFI to your own
audio stereo amplifier?

What was the cause?

What was the cure?

RFI to your own stereo ?

Did you

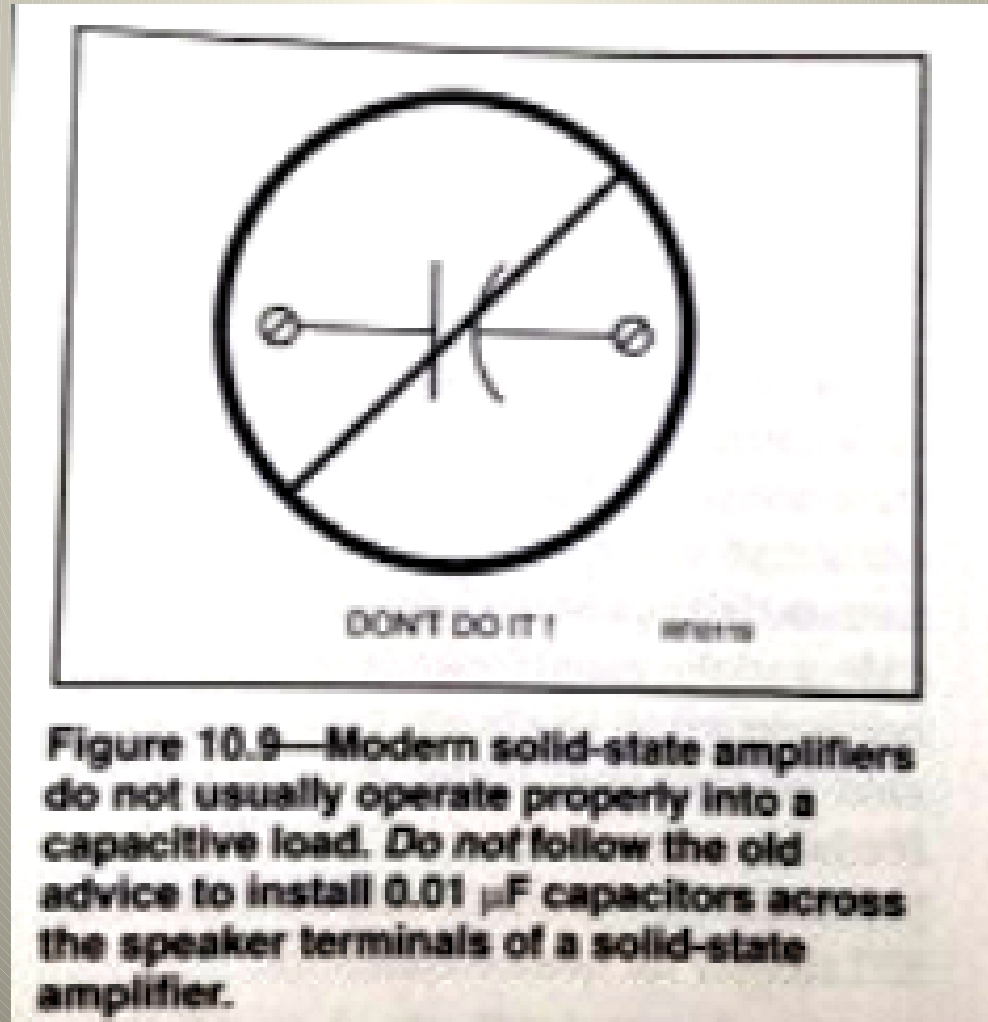
Try shielded coax for speaker wire (RG59)

Try to ground your stereo amp?

Try toroid filters on all audio cables?

OLD cure: put 0.01 uF capacitors across your speaker terminals to “bypass” the RF ?

Warning: do not put bypass capacitors 0.01 μF across the speaker terminals of a solid-state audio amp
The amp can go into HF oscillation and destroy itself!



A “safe” cure for audio amp RFI
common-mode rejection filter for audio **speaker**
wires



Another popular (safe) filter choke
useful on shielded and unshielded cables



What if you are the **recipient** of RFI
noise in your shack?

What can you do now?

Try these

Check if your own shack is the RFI source

Run your rig on battery power

Turn off all potential sources of RFI in your house: LED and CFL lamps, switching power supplies, thermostats, fans, etc.

If source is external to your own home

Walk around your neighborhood with a portable AM (broadcast band) radio tuned to an unused frequency

AM at 1 MHz is very susceptible to arcing RFI sources

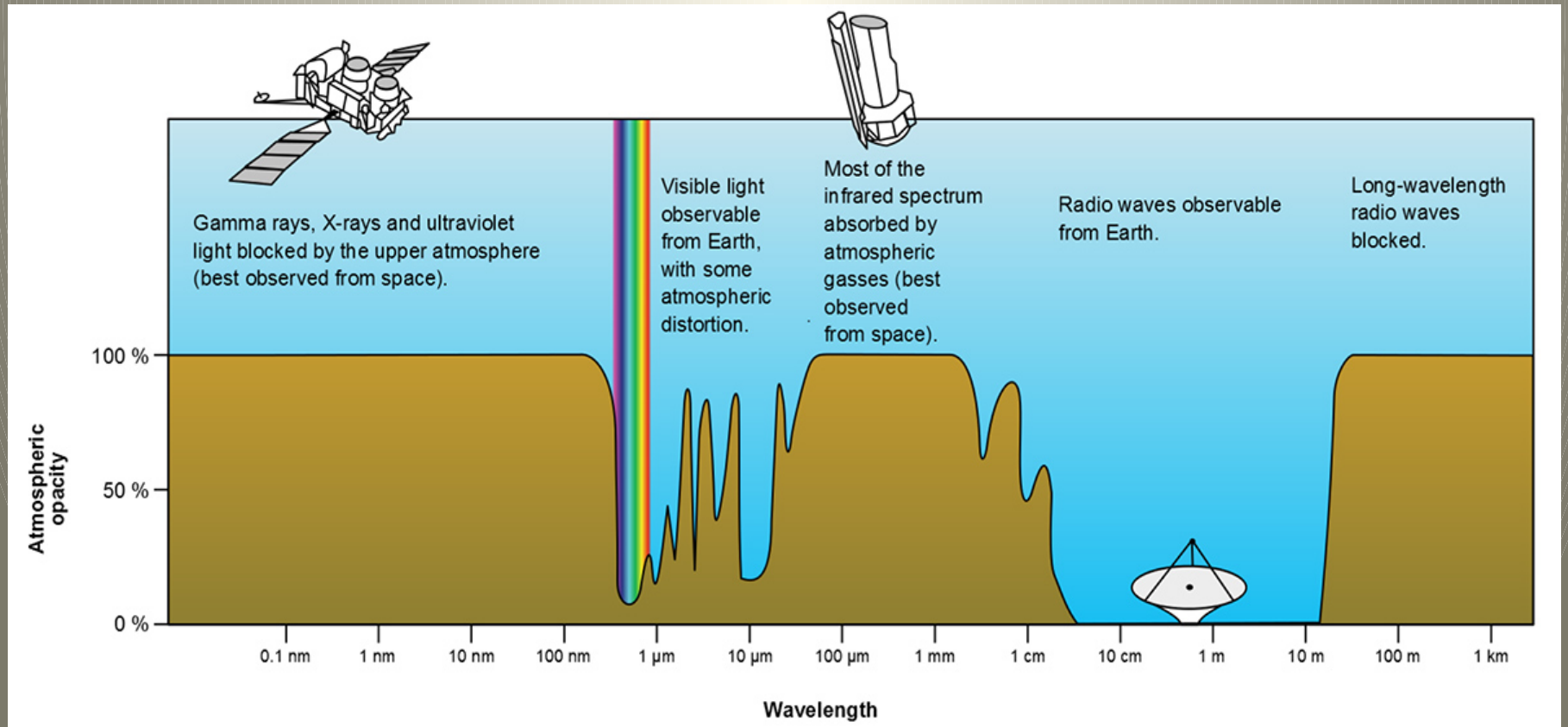
Check utility poles, AC entrance meters, solar cells on roofs, electric dog fences, etc.

You might try this
MFJ “Noise Cancelling” (signal enhancer) device

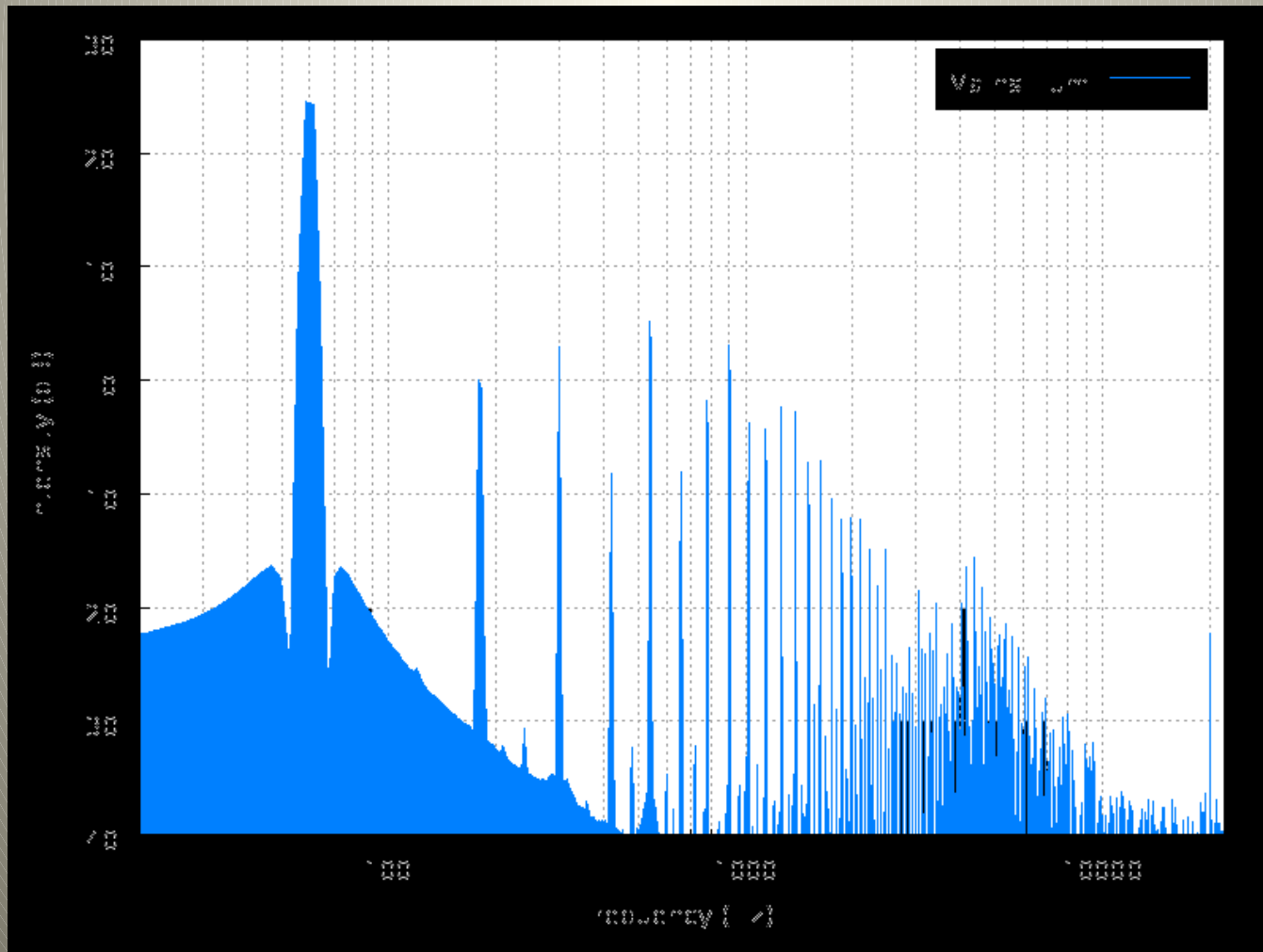
How does it work?



Might the RFI be “extra - terrestrial” ?
Might you be picking up pulsars? solar storms?
UFO com channels?



Typical 60 and 120 Hz “hum” on power lines



Use higher frequencies (VHF/UHF) to pinpoint the local source of interference



This is the way the “pros” find an arcing source of RFI



Using ultrasonic (sound) waves at 40 kHz
to locate nearby sparking sources



Definitely a RFI problem



What might be the problems here ?



High Voltage Transmission lines are rarely an RFI problem



RDF (radio direction finding)

What could be the source of RFI out here?



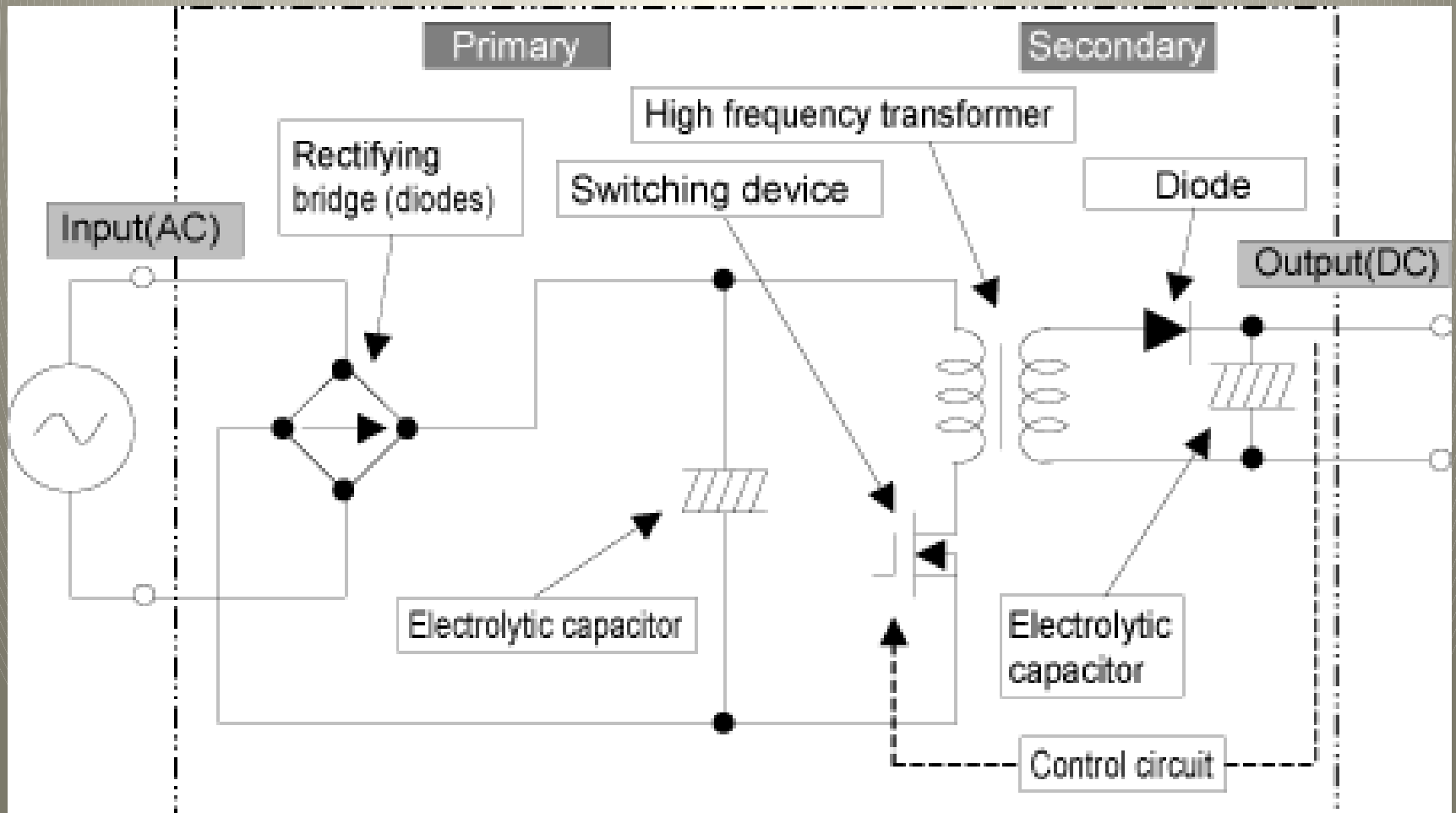
Why are compact fluorescent lamps (CFL)
often an RFI source ?



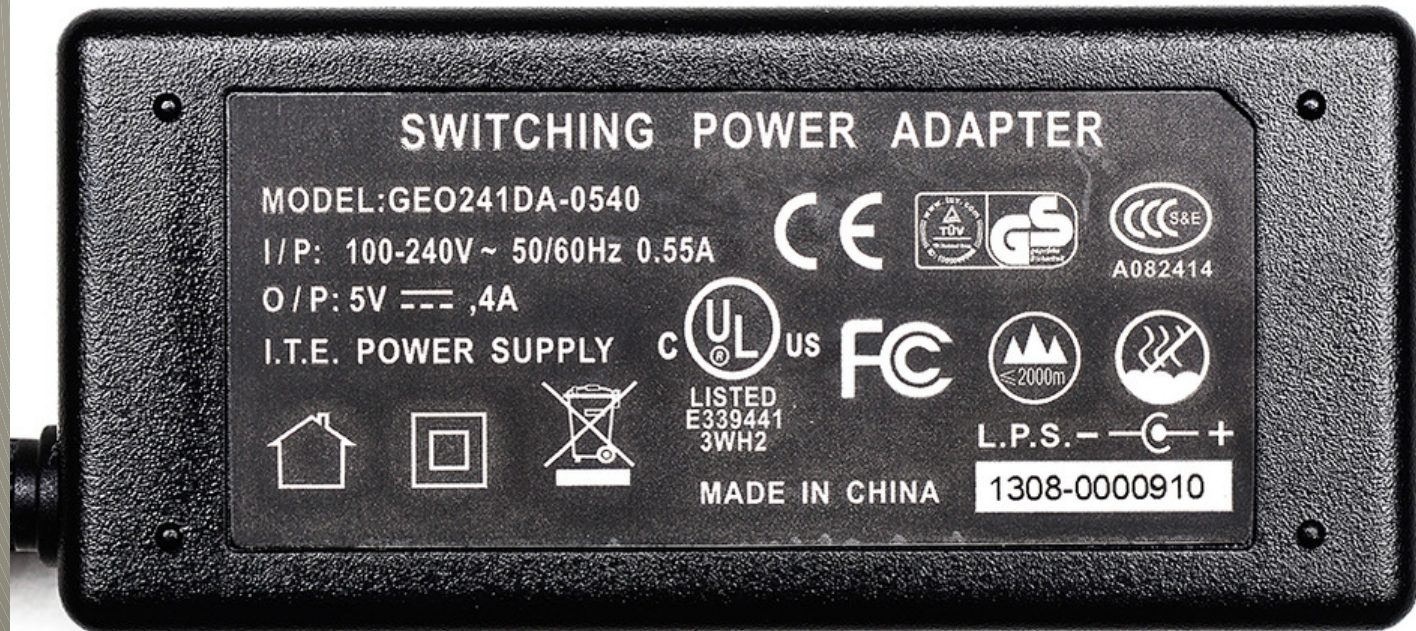
What is a “switching” power supply?
Why is this kind of PS more likely to generate RFI?



Input 120 V AC **60 Hz** but transformer switches at a much higher frequency for better “efficiency”



Watch out for these



Switching Power Supply “noise”
(produces a buzzing sound across the band)

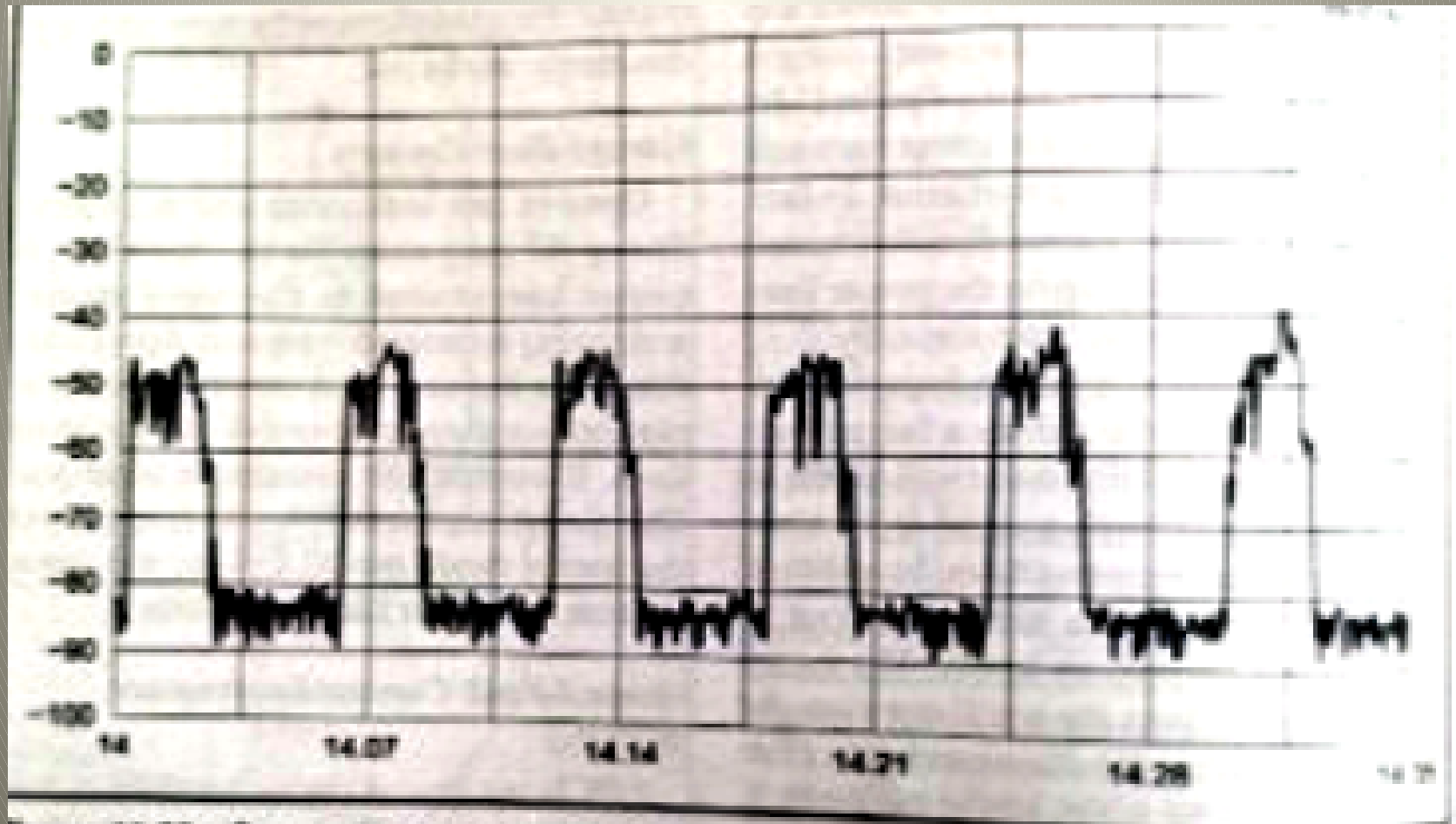


Figure 11.33—Spectral graph of switching-power-supply noise. This can consist of discrete spurs and broadband noise. This example shows spurs across the 20 meter amateur band at approximately 50 kHz intervals.

Are you surrounded by DOGS ?

Why are these often an RFI problem ?



Do you “hear” one of these in your shack ?



YOUR SEARCH IS OVER!

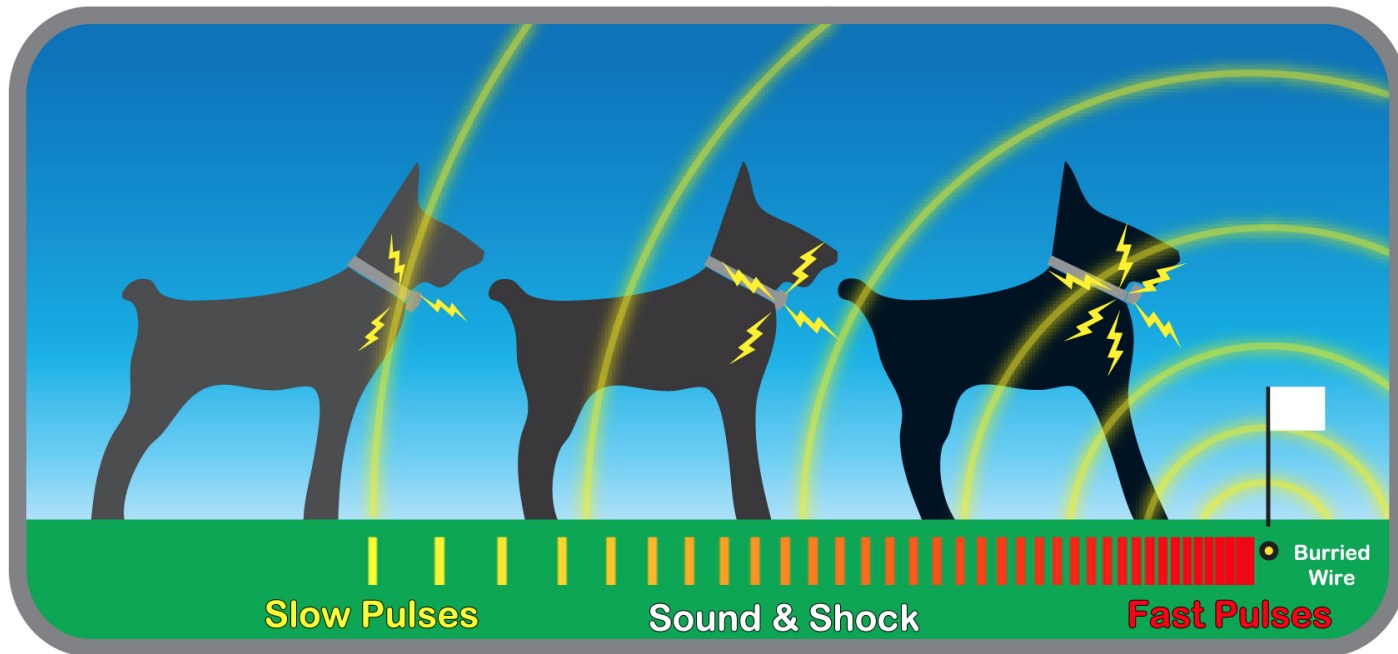
 **Electric Dog Fence**

The Official Electric Dog Fence™ Store

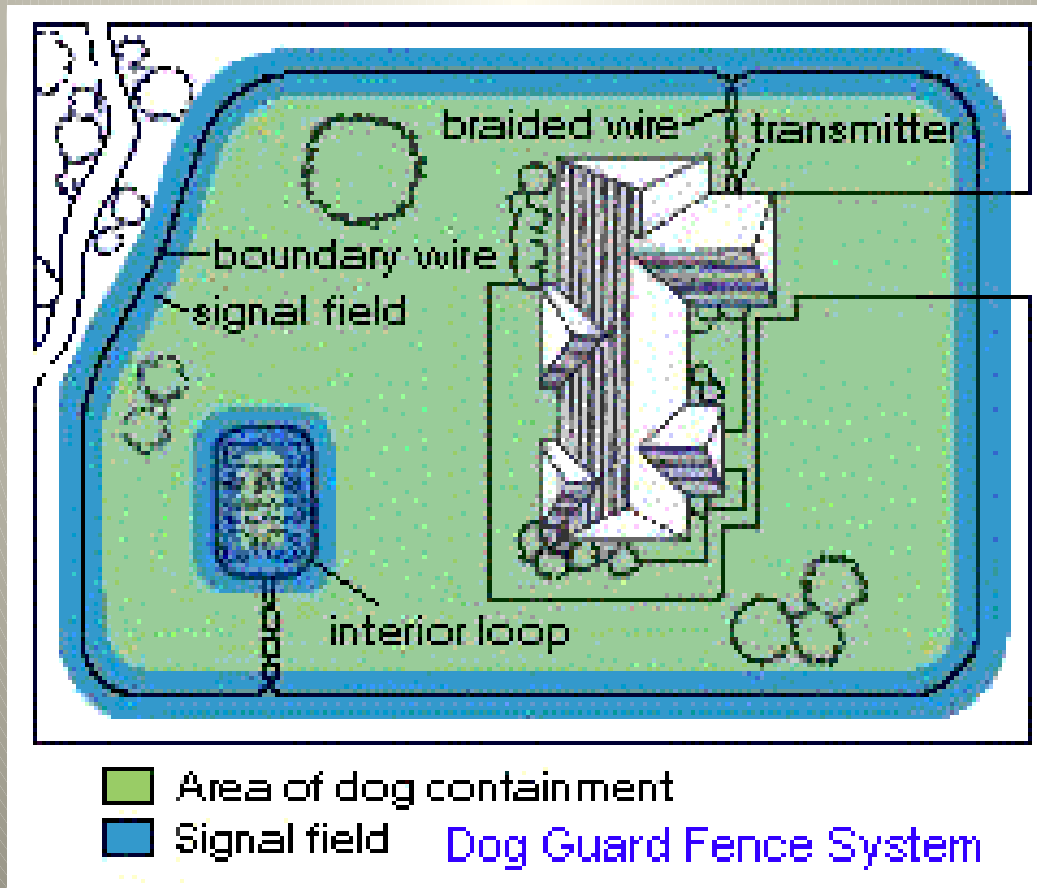
How it is supposed to work

PULSED PROPORTIONAL STIMULUS™



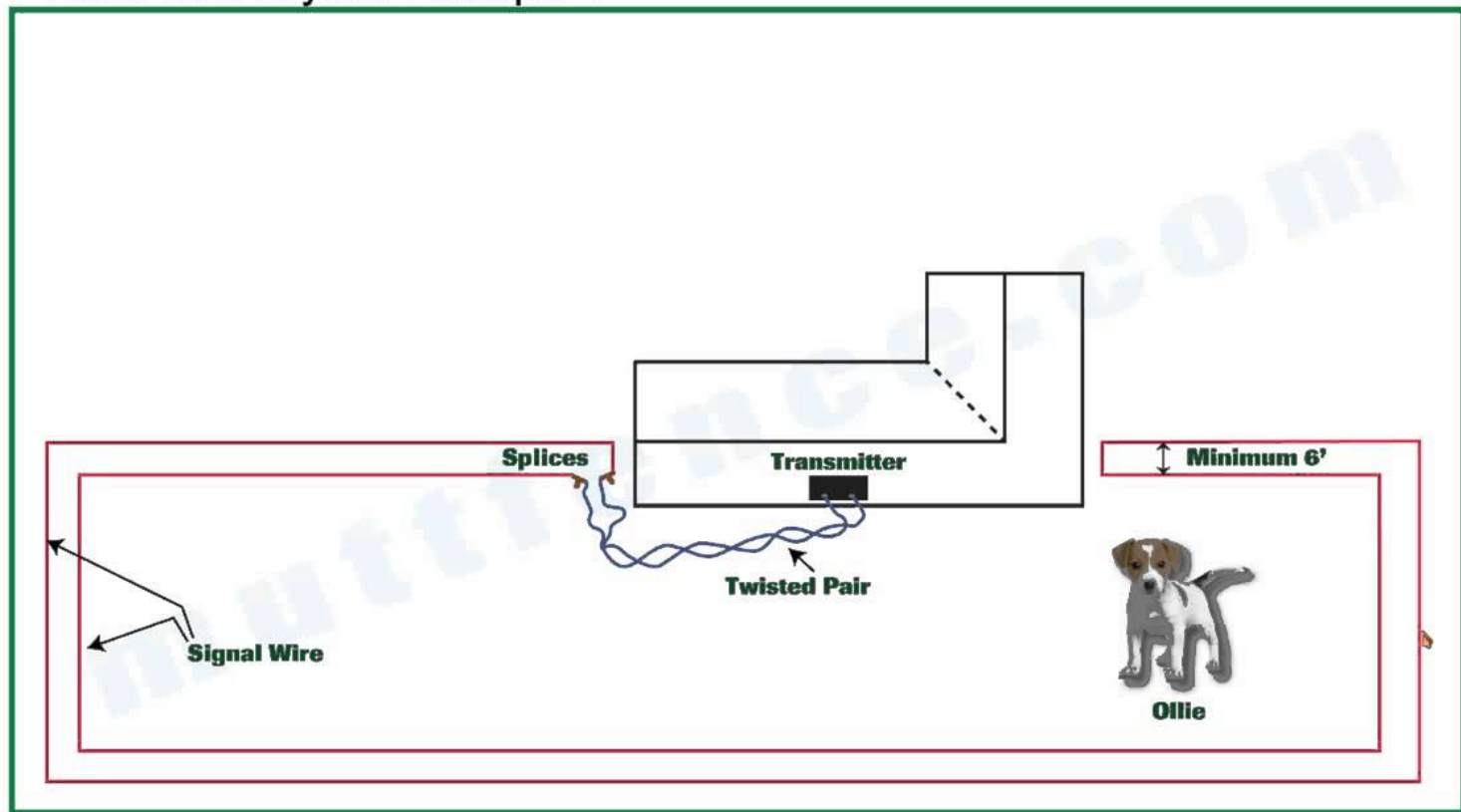
The Collar's Stimulus Pulse Rate is Increased as Your Pet Moves Closer to the Buried Wire Boundary.

Antenna buried under ground



What is a good frequency for an electric dog “fence” ?
How about 0 Hz ?

Back Yard Layout: Example 1



I'm out of time

Thank you for inviting me to talk about

RFI