

EMC

**ElectroMagnetic
Compatibility**

S.A.R.L. RAE Chapter 28

EMC

Social Aspect

Being a 'neighbourly' Radio Amateur...

Technical

Assessing the 'issue' as a technically qualified person or group.
Correcting the 'issue'.

Breaking News!



Noisy LEDs annoy: send us your suspects!

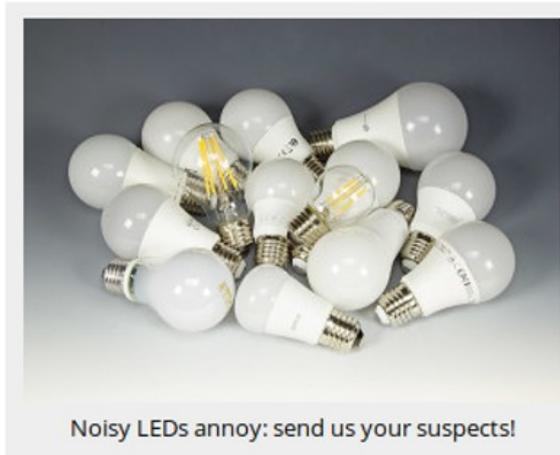
🕒 April 25, 2018 | 10:34

A press release back in September 2017 by the DARC (the amateur radio club of Germany) announced their concern for a significant increase in environmental RF noise causing interference to radio communications, broadcast radio and even DAB reception. They lay the blame firmly at the door of LED lighting and the widespread use of poorly designed and (RF) noisy LED products.

Tests carried out by Elektor on these LED lamps (and also LED lighting strips) confirmed their suspicions. The Federal Network Agency now welcomes our initiative to get you to send in any suspect LED lamp so we can carry out tests on them.

A few days ago, we were contacted by the Federal Network Agency who is the recognized government authority responsible for RF spectrum surveillance regarding product electromagnetic compatibility equivalent to the Federal Communications Commission (FCC) in the US. They are keen to support our efforts to identify offending LED products. The Federal Network Agency referred to our article ***Electromagnetic Interference from LED Lamps*** featured in the Elektor Magazine edition 2/2018 (March & April) and expressly welcomed our invitation to our readers to send us any suspect lamps. The Federal Agency asked us to keep them up to date about on the results of our tests so they can apply pressure to get the worst offenders withdrawn from sale.

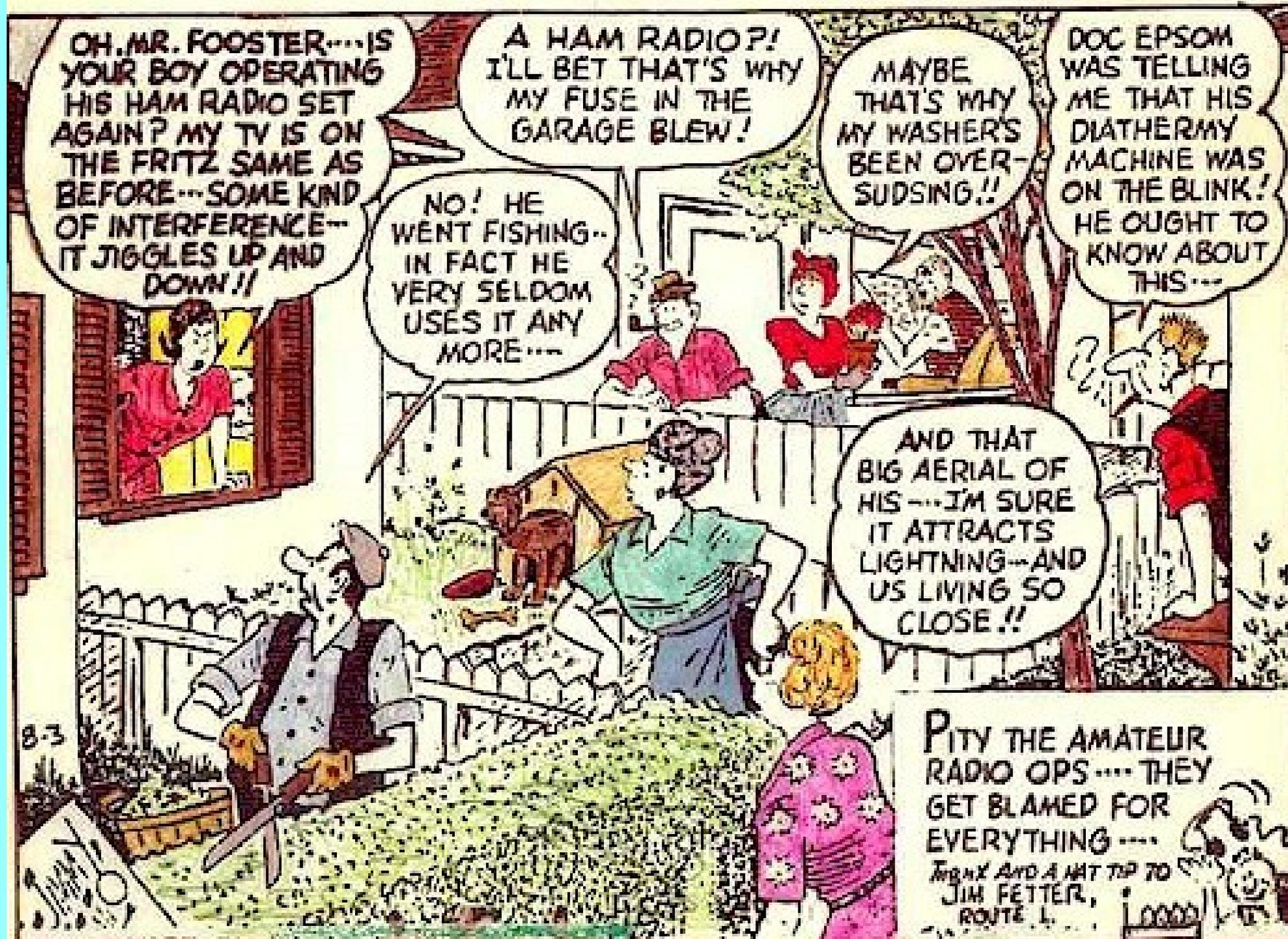
Sounds like a deal! We can all do without noisy environments, so again we put out a call to all readers and radio amateurs alike:



Noisy LEDs annoy: send us your suspects!

April 25th
2018

THEY'LL DO IT EVERY TIME :- :-:- by Hatlo



OH, MR. FOOSTER... IS YOUR BOY OPERATING HIS HAM RADIO SET AGAIN? MY TV IS ON THE FRITZ SAME AS BEFORE... SOME KIND OF INTERFERENCE... IT JIGGLES UP AND DOWN!!

A HAM RADIO?! I'LL BET THAT'S WHY MY FUSE IN THE GARAGE BLEW!

MAYBE THAT'S WHY MY WASHER'S BEEN OVER-SUDSING!!

DOC EPSOM WAS TELLING ME THAT HIS DIATHERMY MACHINE WAS ON THE BLINK! HE OUGHT TO KNOW ABOUT THIS...

NO! HE WENT FISHING.. IN FACT HE VERY SELDOM USES IT ANY MORE...

AND THAT BIG AERIAL OF HIS... I'M SURE IT ATTRACTS LIGHTNING--AND US LIVING SO CLOSE!!

8-3

PITY THE AMATEUR RADIO OPS.... THEY GET BLAMED FOR EVERYTHING....
TRYX AND A NAT TIP TO
JIM FETTER,
ROUTE 1.
LOOOO

What you need to know for the Exam

QRN

Naturally occurring radio interference (static) from the sun, aurora, lightning storms, and other atmospheric disturbances.



QRM

Man-made interference, mostly generated by electrical systems and electronic gadgets.



It used to be called '**Interference**'

QRM – **Man-made interference.**

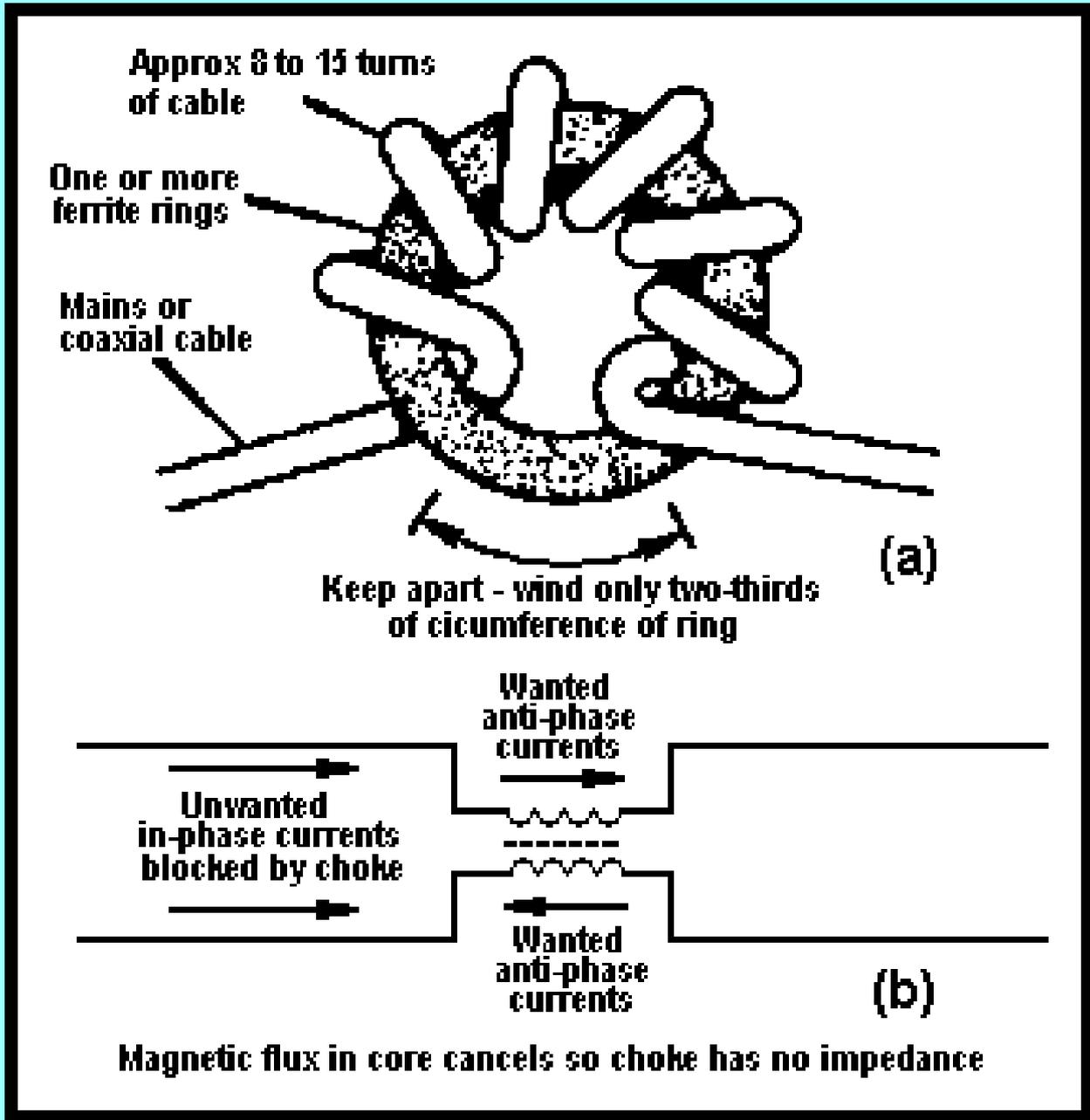
QRN – **Natural interference.**

- What / how does it affect others?
- How bad can it be? [See the 'Last Slide']
- Does it affect Radio Amateurs?
- Can it lead to you losing money?
- It should now be called 'Ether Pollution'...

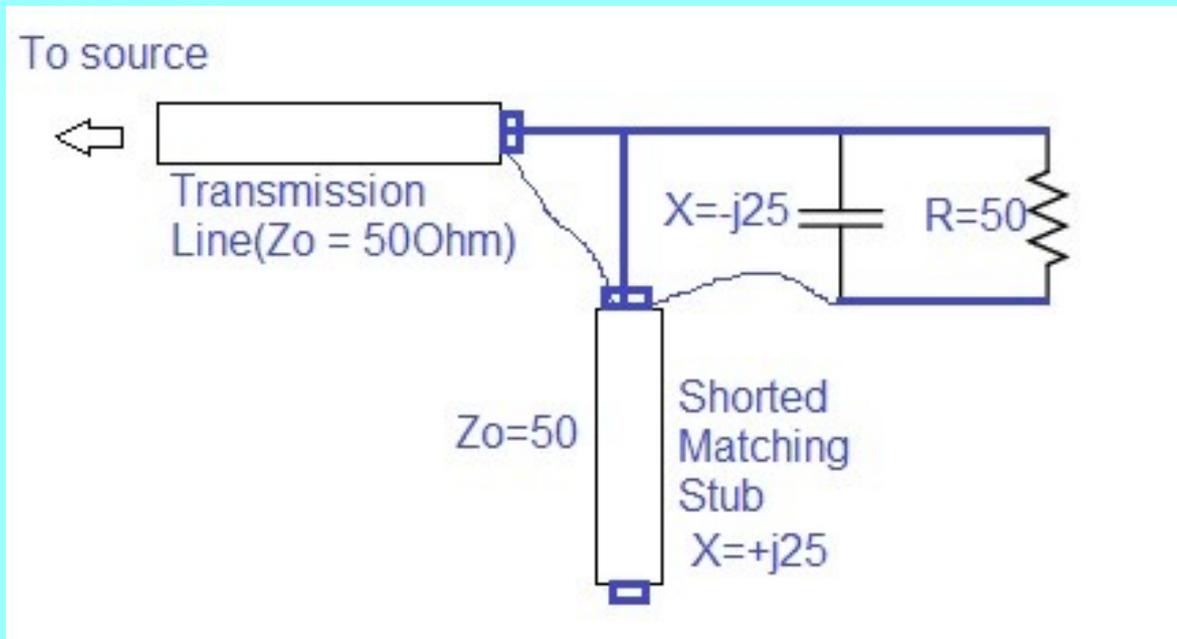
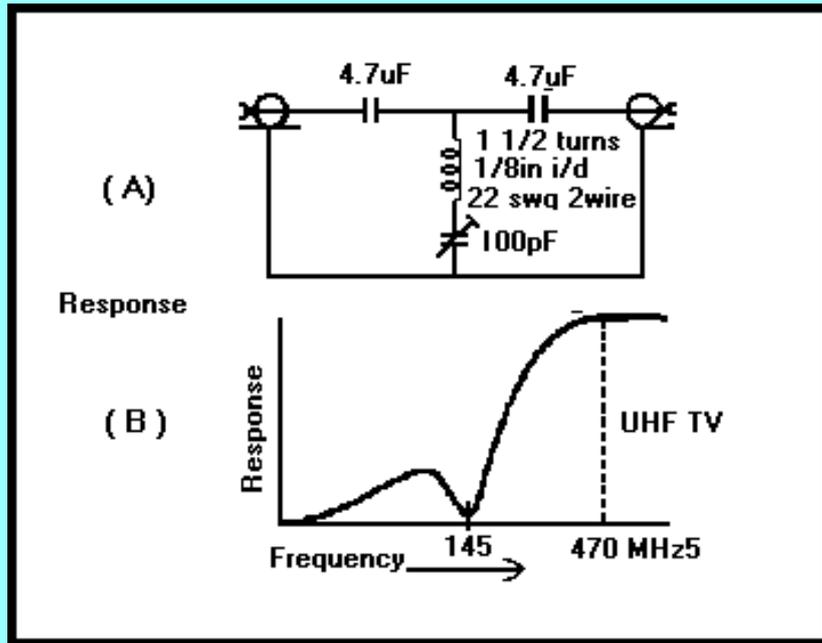
Some Definitions

- “Braid Breaker”
- “Coaxial Trap” or “Stub”
- Filters - Low pass, High Pass, Band-pass, Band-Stop.
- Earthing
- “Wide” Signals and “Key Clicks”
- Frequency Stability [‘chirp’]

“Braid Breaker”



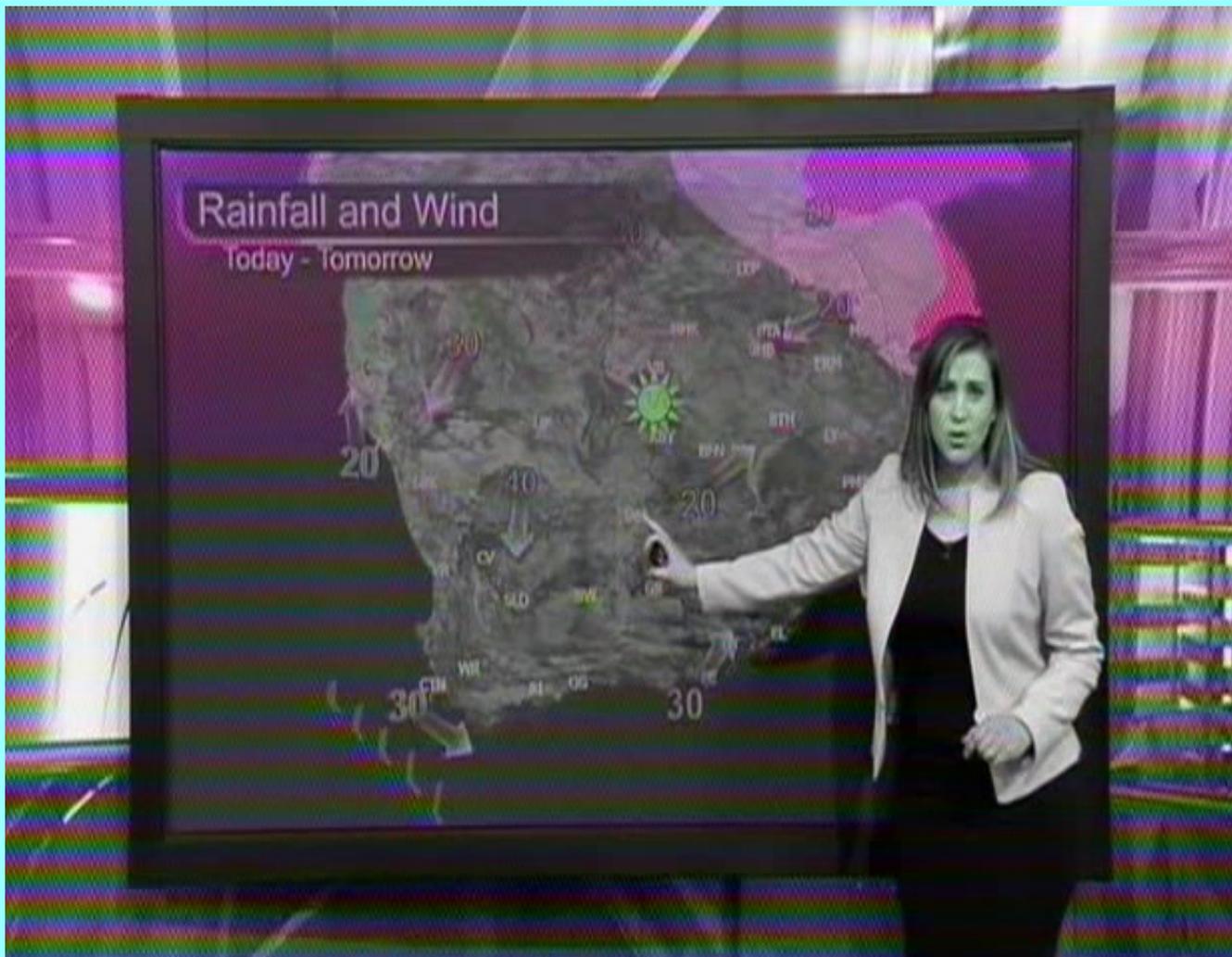
Coaxial Trap or “Stub” or “Band Stop Filter”



Wide Signals and “Key Clicks”

- “Wide Signals” are transmissions that exceed the allocated bandwidth. Caused by over-deviation in FM.
- “Key-clicks” are caused by the transition from one state to another on a morse key.

SABC Weather report – interfering signal switches colour on and off



Note the bands of colour are stationary or gently moving.

This means that the interfering signal is synched or close to the mains frequency.

Remember vertical scan is at 50Hz
Horizontal scan is at 15.625 kHz.

Last slide...first!

The Langley (USA) Air Force Base Rescue Co-ordination Centre reported that its search and rescue satellite was receiving interference on its **121.5 and 243 MHz distress frequencies**. The area over which interference was a problem was around **8 square miles**, which was significant because normal emergency transmitters on these frequencies can only be detected at **ground level for about one mile**. The problem was eventually traced to poor connections on an overhead power line.

(From an FCC Field Operations Bureau news release, 1994.)

How cops are finding "grow ops" with AM radios

Kenneth Wyatt -March 10, 2015

One of my colleagues, Kit Haskins, alerted me to the following article: "How cops are catching grow ops with AM radios". As a long-time EMI engineer, the headline certainly caught my eye. The article was posted by Keith Graves on his blog (PoliceOne.com) in February, 2014. Graves is a police sergeant in the San Francisco area and he described how police were starting to use AM radios in their vehicles to locate illegal indoor marijuana "farms". These "grow ops" are using arrays of large 1000W high pressure sodium or metal halide lamps, driven by electronic ballasts. Most of these ballasts are imported from China and the manufacturers of these have apparently made no attempt at complying with FCC emission standards. Consequently, they produce large amounts of radio frequency interference (RFI).

What is EMC ?

Electromagnetic compatibility (EMC) is the process of ensuring that equipment that radiates 'electromagnetic radiation', such as an **amateur transmitter**, does not interfere with equipment that may be sensitive to 'electromagnetic radiation', such as **television and radio receivers**. Or even cell phones or tablets.

QRN – Natural Interference

Of course here in SA, lightning is an obvious form of **QRN**.

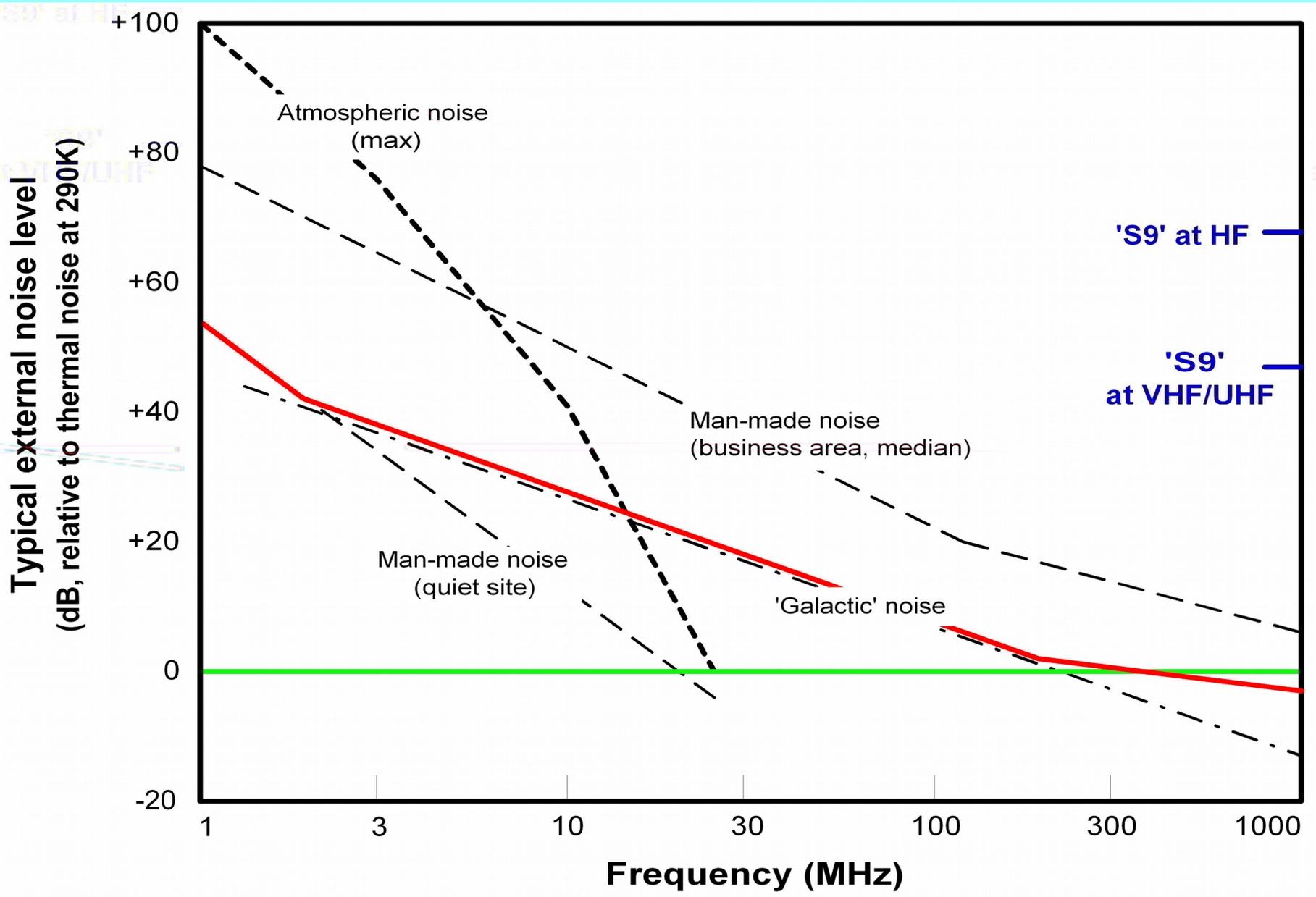
But there is the Sun and other suns in the galaxy creating radio frequencies as well.

This was one of the reasons why Radio Amateurs were given those “useless frequencies.”

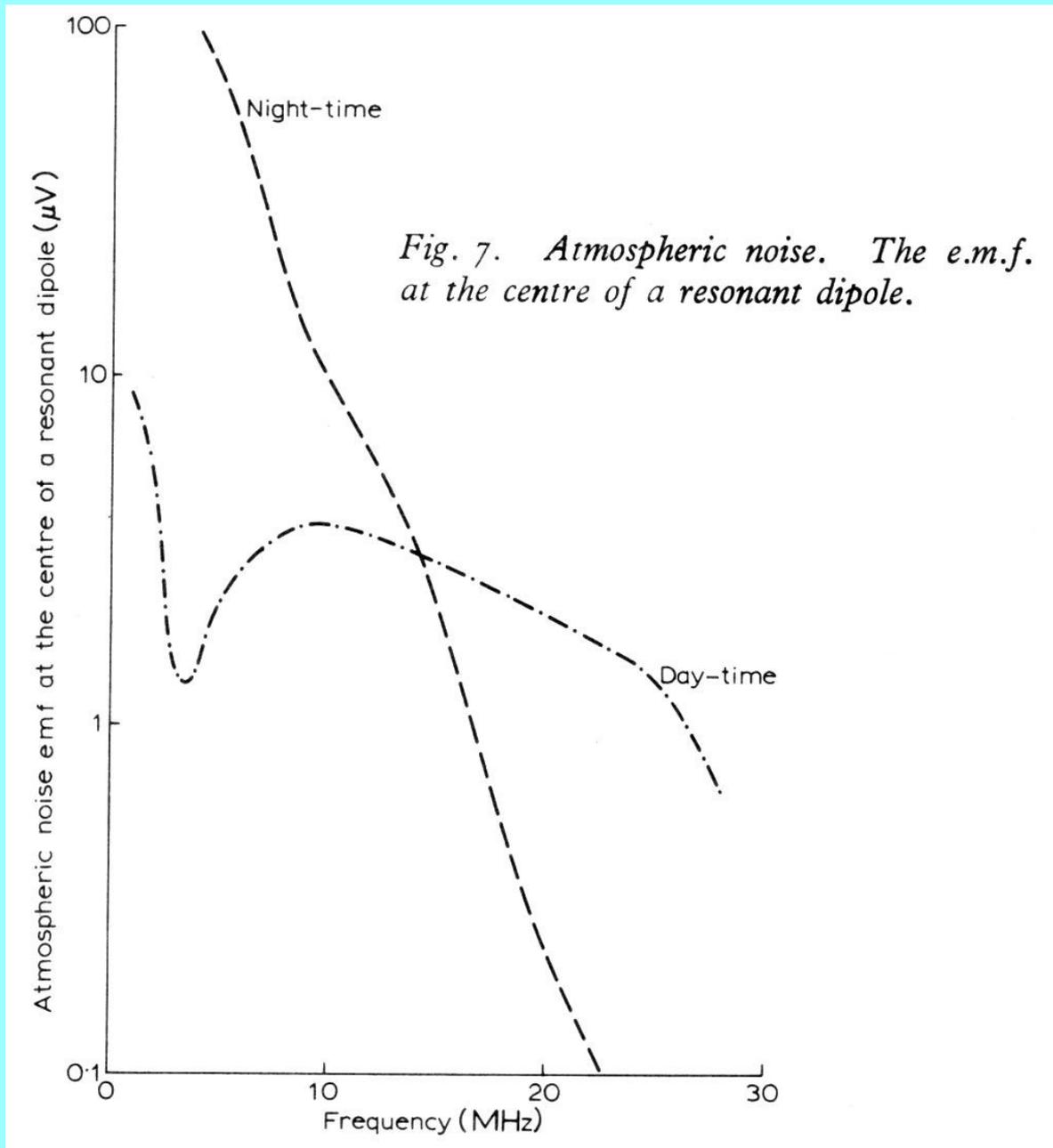
[Note this is why H.F. Sensitivity is not needed at low frequencies. See the graph on the next slide.

Note: This is random noise - not synched to anything. Unlike Switch-mode noise which is synched to 50 Hz.]

Radio Frequency Noise



H.F. Noise



H.F. Noise



Low voltage switch-mode power supply on no load.

The ARRL now says that the majority of interference complaints are now switch mode related.

QRM – Man made noise

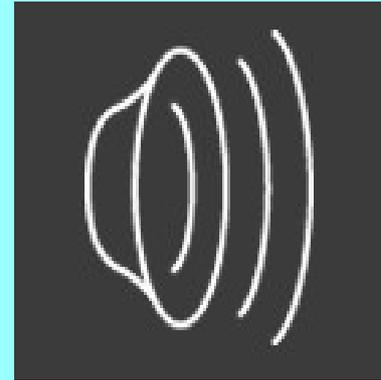
[Having students for neighbours]



This of course will wipe out any chance of an H.F. contact ...

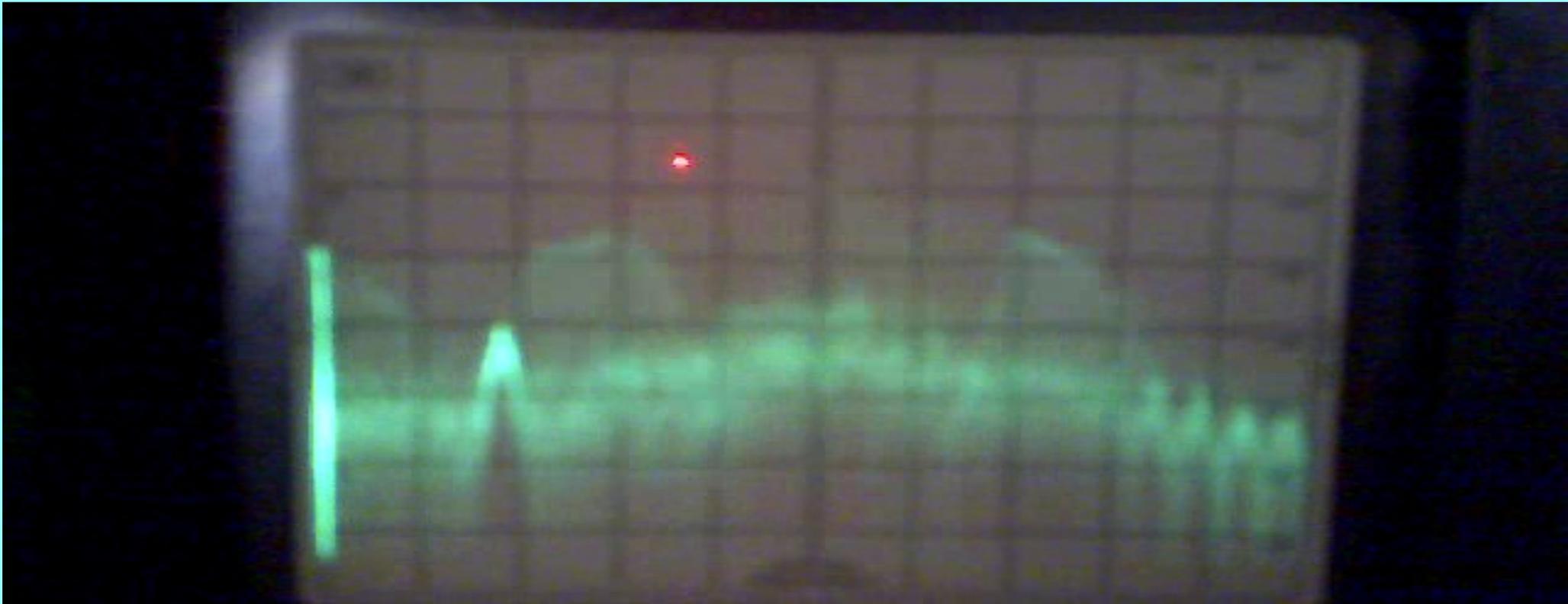
A.R.R.L. Says that the most common interference complaint is now from 'switch-mode' circuits.

Mains borne interference



Spectrum Analyser

[its just a scanning receiver]



^ 0MHz

50MHz

Across the bottom is 0 to 50 MHz. The scan is locked to 50 Hz.
So the interference is generated by a 50 Hz mains signal...

Unintentional Radiators

- Car ignition systems [supposed to be suppressed]
- Electric Fences. [supposed to be suppressed & regulated by I.C.A.S.A.]
- Switch-mode welders, battery chargers and CFL lights. [supposed to have suppression filters & SABS approval.]
- L.E.D. Lights of poor quality. [see video]
- Microwave ovens.
- Personal Computers and peripherals.
- ukqrm.org.uk – for many more 'incidents'.

'Accidental Interference'

The Langley (USA) Air Force Base Rescue Co-ordination Centre reported that its search and rescue satellite was receiving interference on its 121.5 and 243 MHz distress frequencies. The area over which interference was a problem was around 8 square miles, which was significant because normal emergency transmitters on these frequencies can only be detected at ground level for about one mile. The problem was eventually traced to **poor connections on an overhead power line.** (From an FCC Field Operations Bureau news release, 1994.)

Just how many CFL's do you have?

“Channel Africa” is the international broadcasting service of the South African Broadcasting Corporation.



Broadcasting on 9.65 MHz in the 31 metre band.

This 'noise' is generated by a CFL as the radio is brought closer to the light.



It 'wipes out' Radio RSA.

Interference to 'non-receiving' equipment

- Your neighbour listening to your transmission on his hi-fi. It sounds like “Donald Duck”! He says.
- The upstairs flat watching the weather says his tv keeps going black and white.
- You can add your own 'weird' items here!

Intentional Radiators interfering with Receivers

Receiver 'immunity' to external unwanted signals.

Receiver faults and failings. Not designed to function in high levels of R.F. [Check your E.R.P!]



Ugly Duckling
Fower Tousand



Posts: 4470
Joined: Sat Mar 18,
2006 2:24 pm
Closest Airfield:
Brakpan Benoni FABB
Location: Boksburg

Re: Antennas south of Suikerbosrand?

by **Ugly Duckling** » Tue Mar 12, 2013 11:12 am

Wayne Estement was flying a Lambada when this occurred. The transmitters generate signal strengths of Volts per meter at the power levels they are running. Signal levels of that magnitude will saturate electronic circuit input stages. The Rotax has a circuit which runs the "mags".

When we tested the SAAF GPUs for Hoedspruit & Louis Trichardt at Gerotek they bobmarded our kit with signals strengths of 20 Volts/meter from 10kHz to 1GHz. An unterminated wire 1 meter long would have a voltage induced into of 20 volts. Mil-Std-461C

Paul Sabatier EAA Ch 575, SSSA, ERGC, ERFC, AeroClub

Long time Cygnet builder

The object is to fly, it does not matter what the object is!

Causes of Interference

1. The transmitter may be radiating on a frequency that it should not be radiating on.
2. The receiver might be receiving signals that it should not receive.
- 3 The transmitter and receiver may both be working correctly, but something else is translating the transmitted signal to the frequency of the receiver. For **example**, corrosion can cause metal to operate like a rectifier or mixer, re-radiating harmonics of signals transmitted from a nearby transmitter.

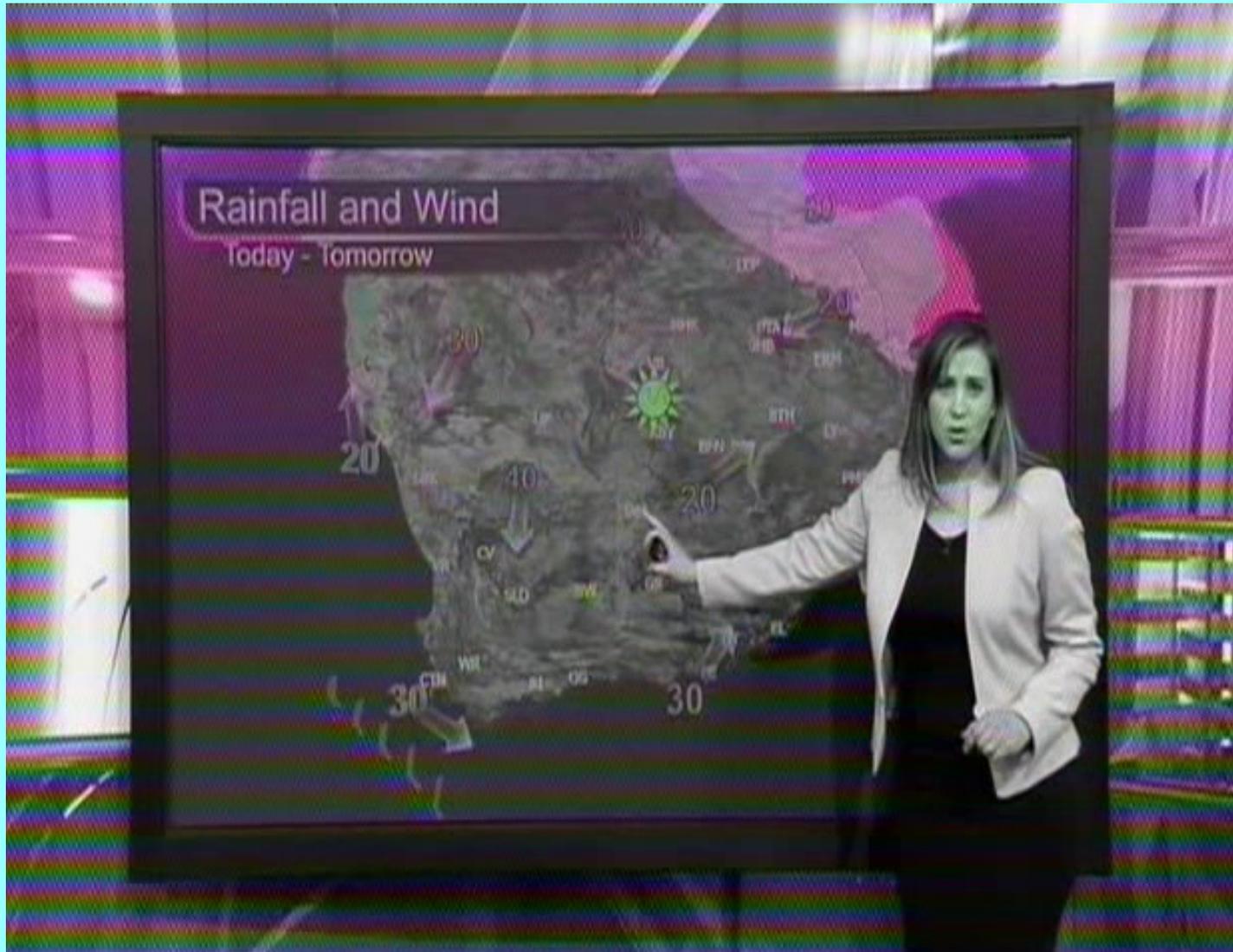
Transmitter Faults

- Harmonic radiation – 2 * operating frequency, 3 * operating frequency, 4 * o.f. ---> n * operating frequency. [Did you notice that most of our 'bands' are harmonically related?]
- Spurious radiating frequencies. Random frequencies across bands etc.
- “Splatter” - overmodulated A.M. Transmitter transmits 'hash' into 'next door' channels.
- Mixer/modulator local oscillator 'leakage'.
- Synthesiser spurious 'leakage'. [cb'ers call it 'bleeding'.]

Receiver Faults

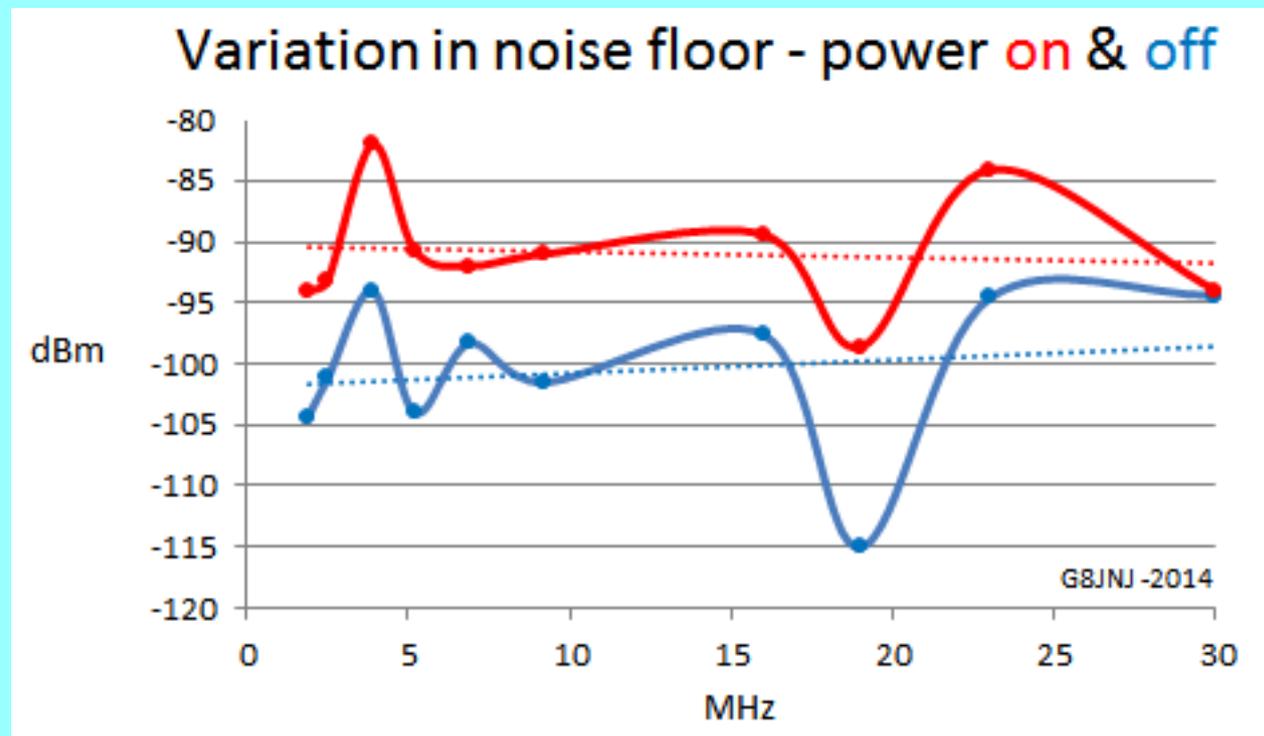
- Broadcast Radio receiver. Medium Wave/ Short Wave radio. [cheap!] Low I.F. Typically 455kHz.
- 2nd channel rejection – **image frequency** rejection is poor.
- Local Oscillator harmonic mixing taking place.
- Intermodulation taking place in receiver due to high power level transmission in the area.

SABC TV Interference

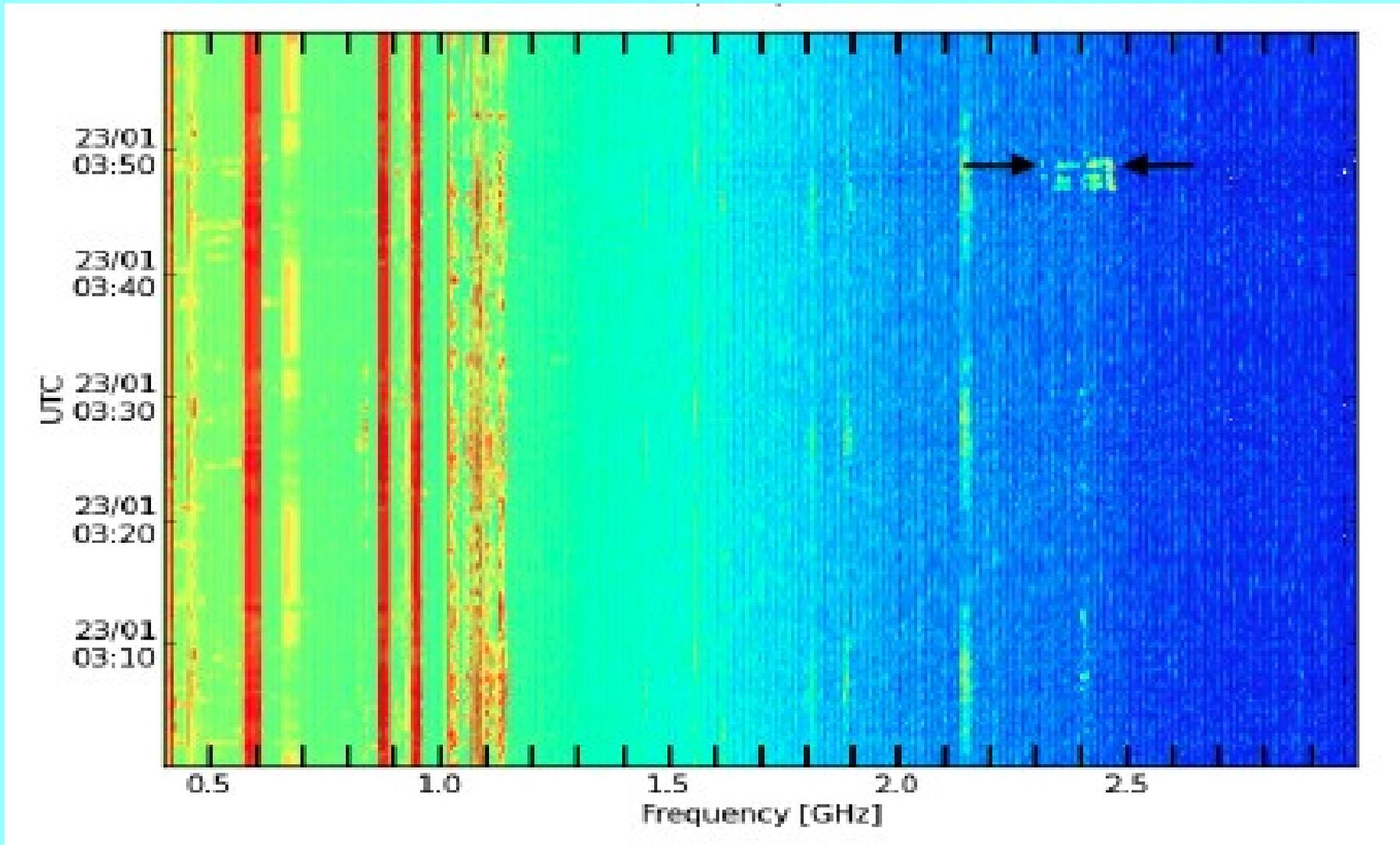


Power Cut! [Load Shedding]

UKQRM are indebted to Radio Amateur, Martin G8JNJ, for sending in a chart demonstrating the difference in radio interference levels when the electronic "junk" around his area is powered up and when the area has lost mains-power. As you can see, it is somewhat quieter when all of the non-EMC-compliant devices are no longer generating radio interference.



The answer is 'out there'...



From theRegister.co.uk - scientists discover 2.4GHz transmissions - from a microwave oven!

EMC is a complex subject.

How to fix it?

[It could occupy the rest of your life!]

It is a 'growing' issue. As more and more electronic devices are being used on a daily basis. Also more switching mode circuits are being used with little or no suppression.

Hacking of electronic devices is also growing at an alarming rate.

The “Internet of things” will provide even more 'issues' for the future of Amateur Radio.

Coupling Mechanisms

There are four basic coupling mechanisms:

- **conductive**
- **capacitive**
- **magnetic or inductive**
- **radiative.**

Any coupling path can be broken down into one or more of these coupling mechanisms working together.

Conductive coupling

Conductive coupling occurs when the coupling path between the source and the receptor is formed by direct contact with a conducting body, for example a transmission line, wire, cable, PCB trace or metal enclosure.

Conducted noise is also characterised by the way it appears on different conductors:

Common-mode or common-impedance coupling:

Noise appears in phase (in the same direction) on two conductors.

Differential-mode coupling:

Noise appears out of phase

(in opposite directions) on two conductors.

Inductive coupling

Inductive coupling occurs where the source and receiver are separated by a short distance (typically less than a wavelength).

Strictly, "Inductive coupling" can be of two kinds, electrical induction and magnetic induction. It is common to refer to electrical induction as capacitive coupling, and to magnetic induction as inductive coupling.

Capacitive coupling

Capacitive coupling occurs when a varying electrical field exists between two adjacent conductors typically less than a wavelength apart, inducing a change in voltage across the gap.

Magnetic coupling

Inductive coupling or magnetic coupling (MC) occurs when a varying magnetic field exists between two parallel conductors typically less than a wavelength apart, inducing a change in voltage along the receiving conductor.

Radiative coupling

Radiative coupling or electromagnetic coupling occurs when source and victim are separated by a large distance, typically more than a wavelength.

Source and victim act as radio antennas:

the source emits or radiates an electromagnetic wave which propagates across the open space in between and is picked up or received by the victim.

Practical Methods [you can use]

Low pass filters – to suppress harmonics

High pass filters to lower the level of received unwanted transmissions. **TVI** suppression.

Notch or Band stop filters to suppress high levels of one particular frequency.

Additional **screening** and **filtering** on equipment. Such as **mains filtering** on PC or UPS equipment.

Also ferrite beads and decoupling capacitors...

[refer to the internet for a vast number of solutions]

How do we 'solve' this problem?

EMC [interference] is why we have
REGULATIONS!

The “authority” is I.C.A.S.A.

Who do **you** ask for 'help'?

- 1) Your club.
- 2) Interference complaint...

Some questions to ponder...

Why is there a gap in the TV frequencies at VHF, between 238 and 246 MHz?

Why doesn't ICASA allow F.M. radios [87.5 – 108 MHz] with a local oscillator high in frequency with respect to [wrt] the input frequency?

Unique to SA

[Extract from Sentech Document]

In the past, there has been a prohibition of adding a NICAM (Near Instantaneously Compounded Audio Multiplex) carrier for digital stereo sound to SABCTV channel 13 (246 - 254 MHz) due to its **interference** to the public trunked mobile radio communication services located at 254 MHz and higher.

The problem is made more noticeable by the fact that channel 13 is used with a slightly offset vision carrier of 247.43 MHz rather than the standard 247.25MHz. This was originally done to avoid **interference** from the residual vestigial colour sub-carrier to the **international distress frequency on 243MHz**.

Last slide...

The Langley (USA) Air Force Base Rescue Co-ordination Centre reported that its search and rescue satellite was receiving interference on its **121.5 and 243 MHz distress frequencies**. The area over which interference was a problem was around **8 square miles**, which was significant because normal emergency transmitters on these frequencies can only be detected at **ground level for about one mile**. The problem was eventually traced to poor connections on an overhead power line.

(From an FCC Field Operations Bureau news release, 1994.)

EMC - Two Perspectives

EMC should be looked at from two perspectives: the technical (how to solve the problem) and the legal (who is responsible for solving the problem). If the interfering signal is being generated by equipment that does not need to transmit in order to function, it is this unintentional radiator that is usually at fault since there are strict limits as to how much electromagnetic energy can be radiated by unintentional radiators. If the equipment being affected is not intended to receive radio signals of some kind, the affected equipment is at fault. If a signal from an intentional radiator is affecting equipment that is designed to receive radio signals, the key question is whether the transmitter is operating within the frequency and power limits specified by its licence. If the transmitter is not radiating legally, the exceedances must be fixed. However, if the transmitter is operating correctly and within licence requirements, the problem is being caused by the affected equipment responding to an out-of-band signal, and ultimately it is up to the owner of the affected equipment to have the problem repaired at his or her expense.

Good Neighbours

However, it is advisable for an amateur whose transmissions are causing interference to assist as much as possible in diagnosing the cause of the problem and suggesting solutions.

This is both to maintain a good relation with neighbours and to maintain the good image of amateur radio. Just be wary of making changes to the neighbour's installation, as subsequent problems with the equipment may well be blamed on the helpful radio amateur.

What you need to know for the exam

QRN

Naturally occurring radio interference (static) from the sun, aurora, lightning storms, and other atmospheric disturbances.



Aurora



QRM

Man-made interference, mostly generated by electrical systems and electronic gadgets.



Transmitter 'issues'

The most common transmitter problems are **frequency instability, harmonic radiation, "wide" signals and key clicks.**

Frequency instability requires due attention in design and construction to temperature compensation, mechanical rigidity and suitable buffering of oscillators to avoid **chirp.**

Harmonic radiation can be attenuated by a suitable **lowpass filter.**

Bandwidth

Wide signals are usually caused by setting the microphone gain level too high.

Key clicks are the result of turning the carrier on or off too rapidly.

Receiver problems can be caused by **common-mode** or **differential signals**.

Common-mode signals can be attenuated by a suitable common-mode **choke** (also called a “braid breaker”).

Differential-mode signals require the use of suitable **high-pass** or **bandstop filters** between the antenna and the receiver. Mast-head TV amplifiers are often subject to overloading...

Amplifier Input Overloading

The amplifier may need to be removed or replaced with one that is less subject to overloading.

An **attenuator** can help to diagnose interference being received. If the attenuator attenuates the interference just as much as the signal causing it, the problem is in the **transmitter**.

If the attenuator completely cures the interference or reduces it by much more than the offending signal, the problem is in the receiver. [Typically the 'front-end' is being overloaded by the interfering signal(s)]

Shielding/Screening

Strong electromagnetic fields can couple directly into electronic equipment. The solution is good design of the target electronics and thorough shielding (a Faraday Cage). [i.e. a box inside a box]

Shielding [screening] should not have large holes.

[For ventilation use lots of small holes or mesh]

For coupling that is predominantly magnetic, special enclosures of special materials will be required. [The notes refer to mumetal and other expensive metals]

Transmitter 'issues'

Transmitters can also suffer from cabinet radiations. Fixing these problems is similar to the suggestions for shielding given above.

Don't forget the use of Low-Pass filters to reduce harmonic radiation/transmission.

What to do...

Firstly, ensure your own installation is in good order. Poor connections and joints can be 'entry points' for interfering signals; if you use a booster to overcome a weak signal (e.g. from a loft aerial) it may be more susceptible than using a bigger aerial mounted in a better position. If in doubt we would recommend using a professional installer who can make sure your installation isn't at fault and may even be able to help identify the type of interference.

Next, try removing pieces of equipment in the chain (such as PVR or DVD) in case one of these is susceptible. Try swapping interconnecting leads. Cheap ones can be poorly screened, allowing an 'entry point' for interference. If you have a second TV or radio, check whether this is affected.

If the problem persists, **start keeping a log of when the problem occurs and which channels are disrupted.** Ask your neighbours to do likewise if they are also affected.

If you are happy that your installation isn't faulty, and you think you know the source of the problem, consider approaching the person politely. A short test will show if they are affecting your reception. **Most radio amateurs will try to help you solve the problem. Because most cases of interference are due to breakthrough within your own equipment, filters can often help. Again, many radio amateurs carry a stock of these but for more information see our 'Filters page'.**

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2017 to present

Most of the videos are from Youtube and downloaded using DownloadHelper.

The audio recording were done using an RCA recorder. Even on 'high quality', aliasing is noticeable on the sounds.