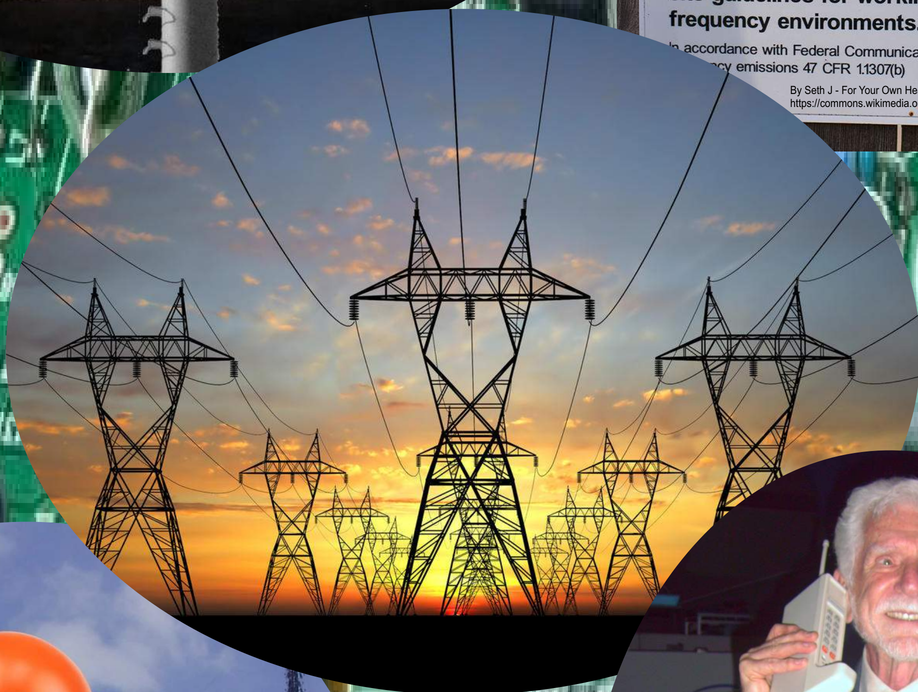
FUN WITH ELECTROSMOG



FUN WITH ELECTROSMOG- INTRODUCTION

What is electrosmog?

Basically, electrosmog is any kind of electromagnetic transmission, of any frequency, however weak or strong they might be.

Your mobile phone is a useful instrument, transmitting electromagnetic waves through the atmosphere in order to make it possible to communicate with other people, but at the same time it is a source of electrosmog.

In practice, any instrument, apparatus or device based on the use of alternate currents (AC) is a source of electrosmog. Some people would call any form of electromagnetic transmission polution of our environment, hence electrosmog.

However, for people like me, it is an opportunity to explore an invisible, mystical universe of strange signals.

On internet there are plenty of articles explaining us about the dangers of electrosmog...

Some personal background

I was raised in a time when electronics was all about running your own pirate station, broadcasting your own music and saying hello to your friends.

We made our own small transmitters and went by station names like Radio Activity, Radio Tamara (the prettiest girl at school), Radio Rat etc. etc.

Our experiments included both medium wave, short wave and FM transmitters, all with only modest success.

Time went by, we grew up and we all went our different ways. Electronics remained a small hobby, and I could use my knowledge to make some experiments for the geological museum where I am employed. Among others a fancy looking geiger counter, an ore detector and an earthquake simulator.

An old project

During the late 90's I built a simple EMI detector while living at a railroad station in the south of Norway. When I turned on the power for the very first time, I experienced what can safely be called either a shock or a revelation. I was met by a sheer cacophony of sounds, humming, pumping, singing, ringing.....a mysterious symphony of electromagnetic radiations emanating from the powerlines of the the railroad. It was beautiful!

I regret I never made any recordings, especially during the nights, both in the summer and winter, when the sounds were at their best.

However, geology is my main occupation, I got a new, more demanding job, and I had to shelve my private electronic projects. But now, due to changing situations, I have time to reanimate some of them, starting with electrosmog.

This is not about science!

The discussions about the dangers of electrosmog don't interest me too much. I am in this respect a layman, and my opinion is just as much worth as any other layman's. The circuits I describe are not scientific tools, but only a means by which we can get access to a world of otherwise invisible signals. Those who are concerned about the dangers of electrosmog will find my simple devices to be very useful in order to get an impression of the extent to which we are exposed to electromagnetic radiation. All others, and I hope especially young, future electronic engineers, will hopefully enjoy a kind of "Alice in Wonderland" experience. Good luck!

ABOUT ELECTROMAGNETIC RADIATION

Introduction

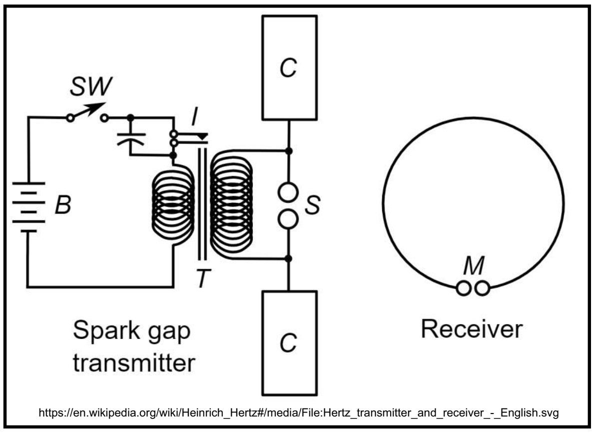
In the year 1887, something happened that would change our world for ever in a very dramatic way. German physicist Heinrich Hertz performed a number of experiments in order to try to prove the theory about electromagnetic radiation as proposed by James Clerk Maxwell in "A Dynamical Theory of the Electromagnetic Field" in 1865.

Hertz's experiments were successful and thereby he laid the foundation of the use of electromagnetic radiation for the purpose of wireless communications.

Many other scientists inspired by these experiments performed their own research, for instance resulting in Marconi's first wireless broadcast of a message over a distance of 6 km in 1897.

From that point on, developments went very fast, and soon the world became more and more tied together by wireless communications. And subsequently, our world became thereby more and more filled by a cacophony of electromagnetic radiation.

As the cliché goes: the rest is history...

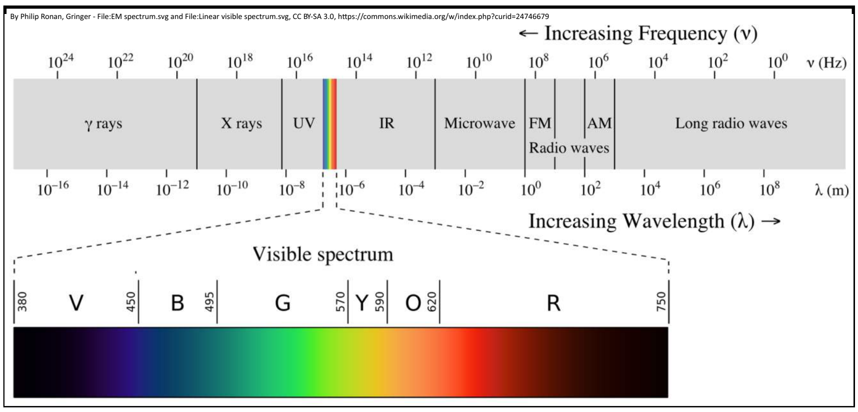


Schematische voorstelling van het experiment waarmee Hertz electromagnetische straling van zender naar ontvanger wist te zenden.

Two different forms of electrosmog detection

As the term electromagnetic radiation already suggests, these radiations are composed of an electrical component and of a magnetic component.

The finer details can be found in the Wikipedia and many other online resources. Important for these experiments is to understand that there are two fundamentally different types of electrosmog detectors.



De electrosmog bevindt zich in deze grafiek rechts van de infrarode straling (IR). In Hertz uitgedrukt vertaald zich dit in alle frequenties vanaf 0 Hertz tot tientallen Gigahertz.

The first type of detector uses a piece of wire or a telescopic antenna to pick up the electric component of the radiation. This corresponds to the way a telescopic antenna receives FM signals.

The second type uses a coil (inductor) to pick up the magnetic component of the elctromagnetic radiations. This corresponds with how a ferrite antenna receives long and medium wave radio stations.

ABOUT THE CIRCUITS

Easy does it!

I consider myself to be an eternal novice regarding electronics. For me the fun of building all kind of devices is the only thing that matters.

These circuits are first of all intended to make it easy for beginning hobbyists to get good results straight away, without risking too many disappointments. Exactly copying the circuits as presented here and following the instructions, should guarantee immediate success.

Greatly varying results

The sounds produced by the different detectors will vary greatly, though in essence the results are comparable depending on the type and frequency range of the detector.

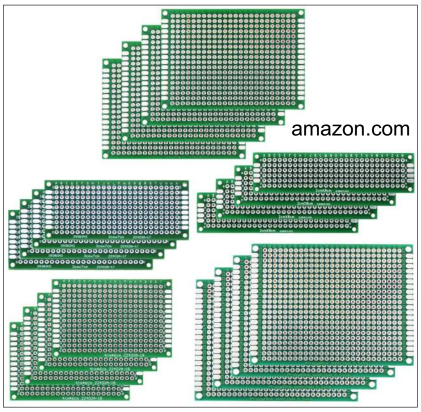
The simplest detectors, be they electric or magnetic, will be very good at picking up the 50/60 Hz from the mains. Some of them can probably receive signals up to several gigahertz, though others are restricted to maybe a couple of hundreds of kilohertz or some megahertz.

Much of it depends on the quality of the components and the construction of the circuit. More will be explained while discussing the individual circuits.

The distance over which these detectors can pick up signals is likewise very much depending on the type of detector and built quality. The use of directional antenna's or large pick-up coils will significantly increase the circuits sensitivity.

Printed Circuit Boards (PCB's)

Prototypes of all circuits have been built on cheap breadboards like the ones shown in the picture to the right. These boards can be bought at eBay or Amazon and make assembling a circuit very easy.



However, I developed PCB's for all the circuits here presented and TIF/JPG images can be downloaded in a separate section. These images come in 2400 DPI and in my experience most inkjet printers will do a fine job printing these images on good quality transparancy sheets. You might have to experiment a bit with the printing options in order to get the desired result. I personally always print the PCB's in photo quality (4800x1200 DPI on a HP 5550).

Do not copy the image shown at the website, you really need to download the linked image in order to get the right resolution!

Look at Youtube for "pcb inkjet transparancy" and you will find several good video's showing you how this technique works. A laser printer might also work, but the ones I tested all gave disappointing results, with uneven edges of the traces and small spots of toner all over the areas that should be free for copper.

THE CIRCUITS

Introduction

All these circuits have been built both on project board and on a PCB with etched copper tracks. They have been tested extensively and when proper care is taken, building them yourselves should result in immediate succes. However, as anyone involved in electronics has experienced, things can go wrong!

Please do not despair, but follow this procedure: check if all components are installed correctly, check if all the connections between the components are correct, check if one of the components might be damaged, and check if all the solder joints are correct by re-soldering them quickly one more time.

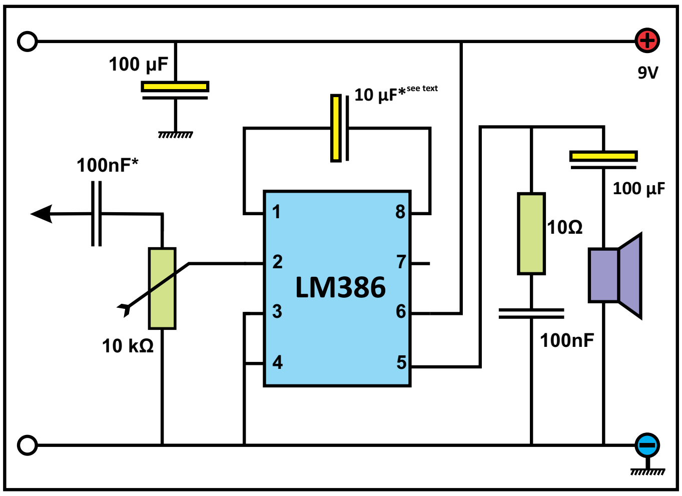
Still not working? Now it might be time to get worried. Join a electronics forum, make ***clear*** pictures of your project, and explain the problem. My experience is that there will always be people willing to help you to find out what is wrong.

The LM386 audio amplifier

Common to all detector circuits is the use of the LM386 audio amplifier. This is a reliable component, cheap and requires few external components. The sound quality has been discussed at length on the internet, and no, it does not produce hifi quality sound, but for these detectors it is more than sufficient.

Another important reason to use the same audio amplifier for all circuits is, that this enables a fair comparison of the different circuits.

I bought 50 pcs. of this IC from eBay for less than $3,- postage included, and they work just fine.



The 10µF electrolytic capacitor (elco) between pin 1 and 8 of the LM386 can be added or omitted exactly after your needs. Start without this elco, and see if you get enough sound out of your speaker, or preferrably a headphone or earpieces. If you consider the volume not to be sufficient, you add this elco for extra volume.

Place the 100µF elco always between the power supply and pin 6 (not as shown in the drawing!), and as close as possible to pin 6. As a precaution it might be smart to install a ceramic capacitor of 100nF parallel to the 100µF elco.

Since this amplifier circuit diagram is identical for all detectors, it will be omitted from all detector circuit diagrams. But of course, all detectors are built with the amplifier stage at one and the same PCB.

Instead of using a small 10 kΩ trimmer, and adjusting the sound level once and for all before mounting the PCB in a box, you might consider using a potentiometer instead, and adjust the sound level according the circumstances.

The 100nF capacitor in the input is a film type capacitor.

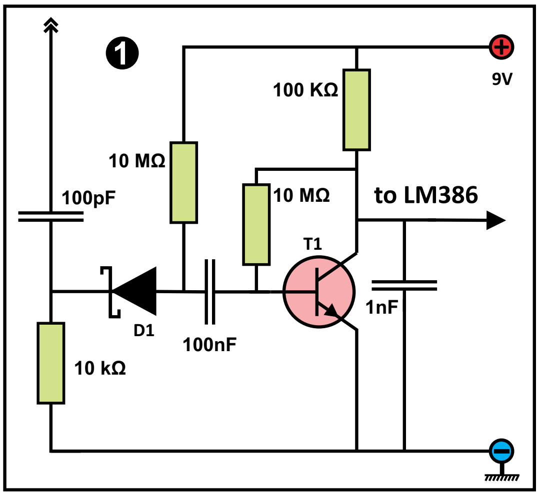
A sensitive diode detector

This is a surprisingly sensitive detector described somewhere else here on techlib.com. Even though it would be possible to omit the transistor amplifier, there seems to be little sense in doing so. The extra sensitivity will make this detector a valuable tool for electrosmog sniffers looking for effectivines.

At Techlib it says that this device should be able to detect microwave signals, though this is difficult to establish with certainty when there is too much electrosmog from other sources present.

Diode D1 is a schottky type diode, which are known for their sensitivity up to several gigahertz. Recommended types are BAT41, 1N5711, 1SS86 or if SMD construction is chosen, try a BAT15 or HMSxxxxx.

Transistor T1 can be any NPN type transistor, preferrably one with high amplification and a low noise figure. Types like the BC549C, BC550C, MPSA18 etc. will work just fine.



A simple FET detector

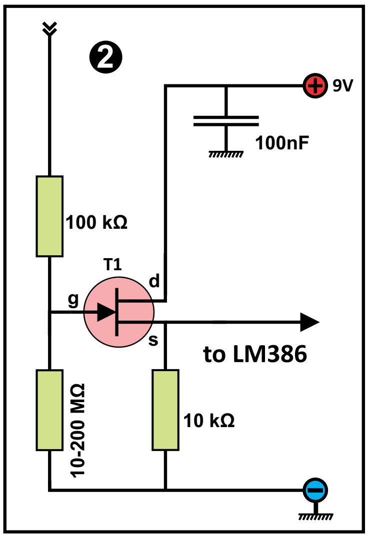
This circuit is identical with my very first EMI detector, and is very sensitive. With nothing more than the short wire as shown in the picture at page 5 it receives a load of signals at a decent volume.

The gate resistor can be any value above 10MΩ, though a value of 100MΩ is highly recommended. The 100kΩ antenna resistor is supposed to protect the FET from being blown up by too high voltages.

I installed a 100nF ceramic capacitor close to the drain of the FET just to be sure.

The FET can probably be any type. I tested several types and all of them worked properly. The BF245C I used worked just a little bit better than the J310 and MPF102 I also tried.

The detection occurs in the gate-source region, and is called an infinite impedance detector. Depending on the quality of the FET, it seems probable that this detector is capable of detecting signals up to several hundreds of mehahertz of even higher.

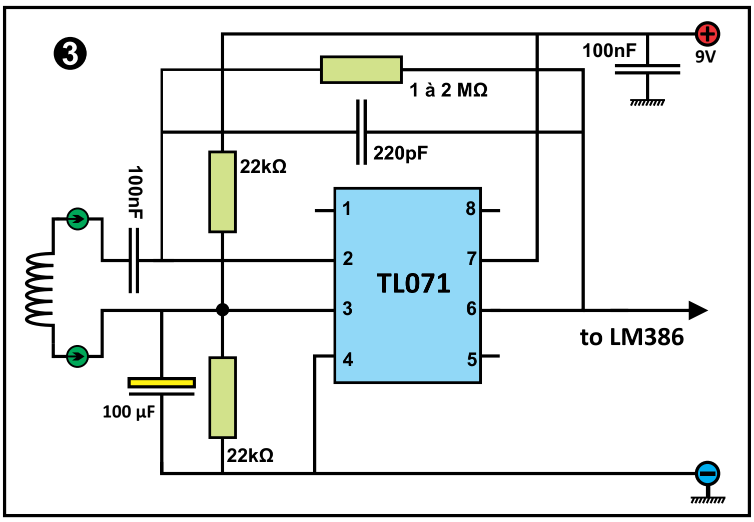


3. A detector with coil

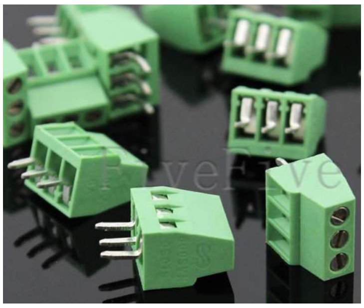
While the first two circuits obviously detect the electric component of the electromagnetic radiation, this one is suitable for detecting the magnetic component. And it does so admirably well.

Since there is no obvious mechanism present for the detection of high frequency signals, it seems reasonable to assume that only signals in the audible range (20-20.000 Hz) can be received.

The value of the resistor between pin 2 and pin 6 of the TL071 can be varied after your need for amplification. Some circuit diagrams use a trimmer of 2MΩ in series with a small resistor. I tested the



circuit with a 10 MΩ trimmer, but any value higher than 1-2 MΩ did not result in noticibly more sound. Instead of waisting a trimmer, I would advice to use a normal resistor.



Some similar circuits don't include the 220pF ceramic capacitor parallel to the feedback resistor. I find that strange, because it seems an absolute requirement for a stable circuit.

The fun part of this circuit is that it allows you to experiment with the coil. All values I tested worked, though a 100mH pull from an ancient television worked best. The PCB is designed to give place to a 3-pole PCB-type terminal block connector. This makes it easy to quickly swap coils.

The sensitivity is great and the use of a potentiometer to adjust the volume according to what source you are sniffing, seems advicable. Holding the detection coil close to a loudspeaker will pick up any sound that is being produced, though of course, not in hifi quality.

A high frequency electrosmog detector

Due to the abundance of high frequency signals in modern society, it is interesting to make a detector that will disregard lower frequency signals. This is easily achieved by the use of monolitic microwave IC's (MMIC).

These broadband IC's can amplify signals up to several gigahertz and are very easy to use. The ERA-5SM+ of MiniCircuits was chosen due to its low price and an upper limit of 4 GHz.

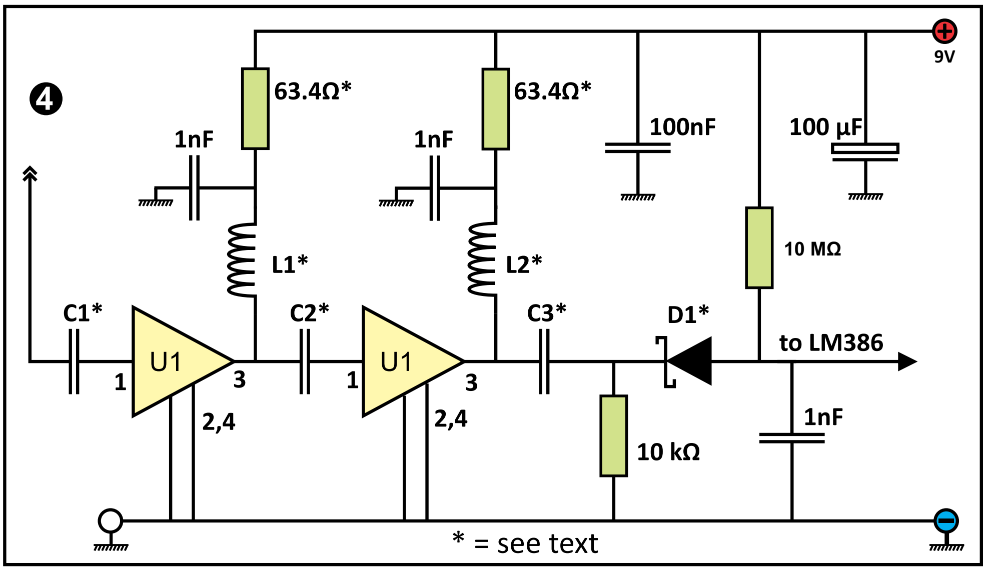
The detector section is identical with that from the diode detector described earlier. But due to the use of the ERA-5 in combination with low value capacitors and inductors, all low frequencies will be filtered out.

The values of C1-3 and L1-2 can be chosen as low or as high as what is considered to be appropriate for a specific purpose. I used 1000pF for C1-3 and 47uH for L1-2 which works well. Lowering these values will make this device less sensitive to lower frequency signals. D1 can be any microwave schottky diode, but a prototype using the 1SS86 worked excellent.

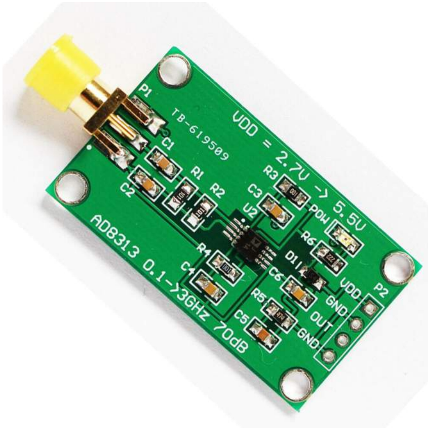
Powering the ERA-5+SM is somewhat complicated, while depending on supplying this MMIC with 4.9V as close as is possible. The datasheet specifies a bias resistor of "exactly" 63,4Ω at 9V. For those who don't have a stock of E96 series resistors, this can be (almost) achieved by placing 62Ω and 1.2Ω resistors in series. However, when using a 9V battery, the voltage will vary so much during use, that this value becomes more or less meaningless.

Unless a voltage regulator is used, use of 62Ω resistors seems a reasonable choice. My prototype worked just fine. However, considering that the ERA-5+SM consumes 65mA, it is recommended to use a 12V power supply (6x 1,5V batteries) and a 9V voltage regulator. Even if only used stationary, the use of a power adaptor is under no circumstance recommended.

The antenna can be a piece of copper wire or more sophisticated tuned or broadband antenna's. It is recommended to try printed board antenna's made by WA5VJB/Kent Electronics (www.wa5vjb.com). That way it is possible to focus on specific frequencies or ranges of frequencies.

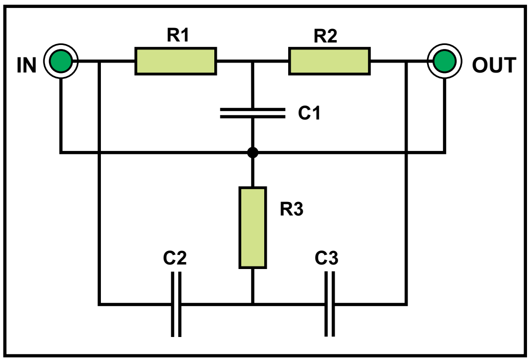


Use of SMD components is recommended, but since this is a non-scientific project, use of through-hole components will produce be acceptable results.



SOME IDEA'S FOR FURTHER EXPERIMENTATION

1. A passive 50 Hz filter

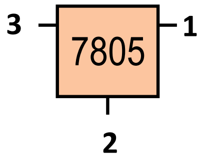


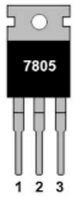
Sometimes the presence of strong 50/60 Hz signals might be an obstacle of major proportions for being able to receive weaker, more interesting signals. I live in Europe, so I tested a 50 Hz passive notch filter. Placing this filter between the antenna and the electrosmog receiver might give some relief.
The passive circuits I found on the internet use different values for the components, but in essence it consists of three resistors and three capacitors.
On a Dutch forum[*1] someone has calculated the ideal values for these components and reports a 50Hz supression of 58 dB.
The values of the Dutch version are:
R1 = R2 = 9,9564 kΩ
R3 = 4,9174 kΩ
C1 = 640 nF
C2 = C3 = 320 nF
The 9,9564 kΩ resistor is achieved by placing 56,2 kΩ and 12,1 kΩ resistors in paralell. The 4,9174 kΩ resistor is achieved by placing 8,25 kΩ and 12,1 kΩ resistors in parallel, and these again in series with a 12 Ω resistor.
Another site[*2] uses other values:
R1 = R2 = 33 kΩ
R3 = 15 kΩ
C1 = 220 nF
C2 = C3 = 100 nF
I do not have the necessary equipment to measure the properties of this filter, and I would encourage some experimentation in order to get the best possible result. Replacing the resistors (partly/completely) with trimmers would make it possible to fine-tune this filter.
For the more advanced hobbyists it might be worthwhile to know that the input impedance is >2,4 kΩ.

1.) www.circuitsonline.net/forum/view/134554/last
2.) www.researchgate.net/figure/50-Hz-twin-T-passive-notch-filter-circuit_fig8_282404009

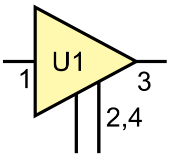
APPENDIX

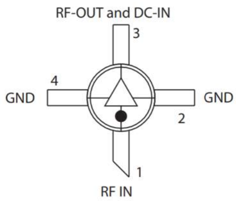
Overview over the components used in these projects.

Voltage regulator: 



1 = input
2 = ground
3 = output

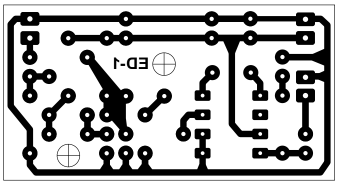
MMIC 

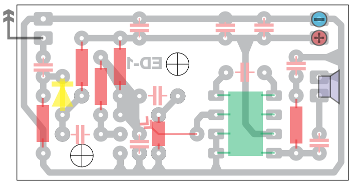


https://www.lazada.co.th/catalog/?q=log+periodic+antenna&_keyori=ss&from=input&spm=a2o4m.home.search.go.38f1515frV9IS0

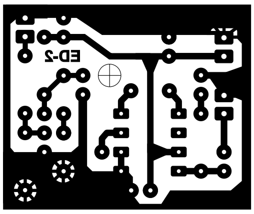
THE PCB's

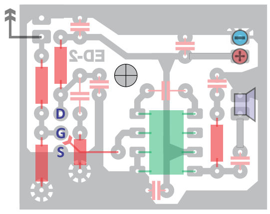
1. A detector with schottky diode



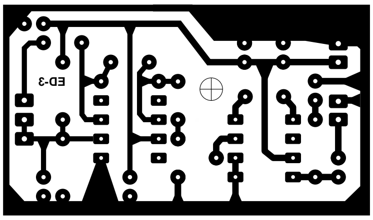


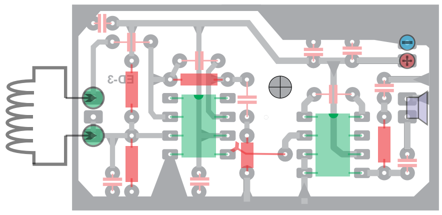
2. A simple FET detector





3. A detector with coil





4. A high frequency electrosmog detector