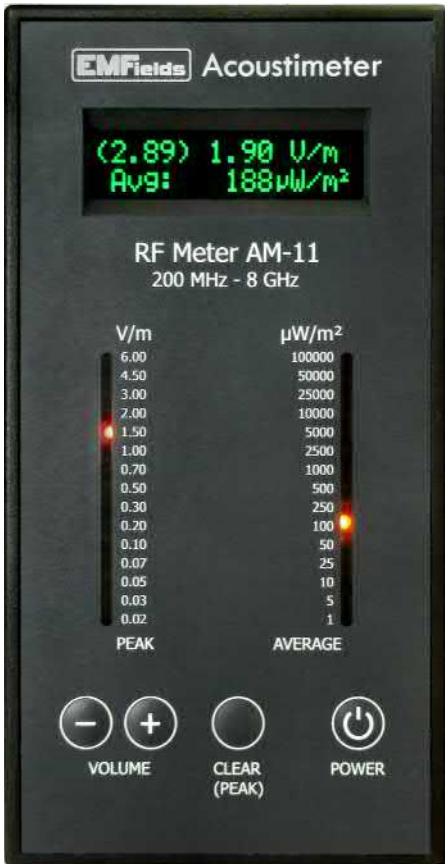


# EMFields



## Acoustimeter User Manual

# Safety Instructions

Please read through these instructions carefully before operating the instrument. These contain important information regarding usage, safety and maintenance.

The instrument is not waterproof and should not be used outdoors in the rain without extra protection. If necessary, please cover the instrument with a clear plastic bag that does not have holes in it.

Exposing the instrument to high temperatures or dropping the meter on to a hard surface may cause it to stop functioning properly.

The meter is sensitive and is intended to measure typical modern environmental exposures.

Do not take it close to high power radiofrequency transmitters or put it inside a microwave oven.

Clean the case using a damp cloth if necessary and do not use chemicals.

This instrument is not intended to be serviced by the user, nor does it need any special maintenance. Unscrewing the case may void the guarantee.

While EMFields considers that the information and opinions given here are accurate, you must rely upon your own skill and judgement when making use of the information contained in this manual.

# Contents

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# Technical Specifications

Typical frequency response using the internal antenna:

200 MHz – 8000 MHz  $\pm$  6dB  $\pm$  0.02 V/m

## Measurement Range:

The LCD displays peak-hold, peak and average values. Updated about 2.5 times per second.

*Note: Peak Hold is reset/cleared using front button*

Peak readings: 0.02 - 6.00 V/m

LED Scale: 15 levels, from 0.02 to 6 V/m

Updated 5 times per second.

Average readings: 1-100,000  $\mu\text{W}/\text{m}^2$

LED Scale: 15 levels, from 1 to 100,000  $\mu\text{W}/\text{m}^2$

Updated 3 times per second.

Note: 100,000  $\mu\text{W}/\text{m}^2$  equals 10  $\mu\text{W}/\text{cm}^2$

The audio can be heard at levels below 0.02 V/m.

## Power

Current: 100 to 150 mA at 3 volts

(2xAA 1.5V Alkaline or NiMH 1.2V rechargeable cells)

Battery Life is typically 15 hours (alkaline) and up to 25 hours (NiMH 2000+ mAh cells). 'Low battery' is indicated.

Working temperature range -20 °C to +40 °C

Dimensions: 190mm x 102mm x 33mm.

Weight: 280g, 330g with batteries.

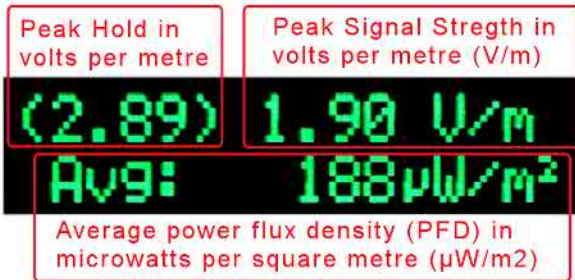
# Introduction

The Acoustimeter will enable you to make quick and informed judgements regarding radiofrequency (RF) Electromagnetic Fields (EMFs) in your environment.

The Acoustimeter measures all RF EMF sources from 200 MHz to 8000 MHz (8 GHz) which, in practical terms, covers most modern wireless communication RF signals that you will be exposed to.

This includes mobile phone networks (for 5G see p24), local wireless networks such as WiFi (2.4 and 5 GHz), digital cordless phones (DECT), and many other sources that will expose you to RF energy.

Readings are shown on both a 2-line OLED display and two series of graduated LED lights. The LEDs update rapidly, allowing you to quickly gauge the levels in an area and find any hot-spots.



The Acoustimeter also feeds the detected incoming signals to a loudspeaker which will help you to determine what type of signal is being detected.

# Layout of the meter



Key:

1. OLED Display
2. Peak signal LEDs
3. Average power LEDs
4. Volume controls (5 levels, - lower, + higher)
5. Clear (peak) hold button
6. Power button
7. Internal Antenna location
8. Loudspeaker
9. Battery compartment (for 2x AA cells)

# Operation and use

## Setting up for first use

Ensure that the 2 AA batteries are correctly installed. Press the **POWER** button. The LEDs display a moving pattern and the OLED displays a start-up screen.

The audio is off at start-up. Change the volume in pre-set stages by pressing the **VOLUME +** and **VOLUME -** buttons.

To access the instrument menu with information and extra settings, hold down the **CLEAR (PEAK)** button when turning the instrument on, and wait for the initialising sequence to finish.

## Taking measurements

The instrument displays **peak signal strength** and **average power flux density (PFD)** on both the LEDs and LCD. We discuss these in more detail on p17.

It is important to remember that RF EMFs create “hot-spots” due to reflections, so both the position and orientation of the instrument is very important. Moving the instrument small distances can result in noticeable real differences in the detected levels.

To get the most accurate reading, slowly rotate the instrument in each direction until you find the highest reading, and then hold it still to take the measurements. We recommend taking the highest reading found in any one spot.



Ideally hold the meter as shown in the picture. Try to keep the Acoustimeter at least 30cm away from your body when taking readings. Keep your hands towards the bottom of the instrument.

If you wish, the Acoustimeter can also be placed (preferably upright) on a surface.

The “Peak-hold” function will display the highest peak reading measured until the instrument is turned off and on again, or until the **CLEAR (PEAK)** button is pressed.

To turn off the AM11, press the **POWER** button. The AM11 will turn itself off after 8 minutes of inactivity to preserve battery, although you can change this in the settings in the menu (including disabling the auto-off feature entirely).



## Audio

The audio feature allows amplitude changes in the incoming signals to be heard as audio, which can help in determining the type and source of RF.

Many common EMF sources produce a distinct set of sounds via the Acoustimeter, and so with a little practice, you can soon learn to identify a source type via audio. Some sound samples to help you identify different signals are available on:

<http://www.emfields-solutions.com/rf>

Most modern digital EMF sources are “pulsed”, meaning they have an amplitude-modulated signal. However, some sources are not amplitude modulated, including analogue sources, and these will not produce much sound even with the volume turned up. We explain more about this in the “Digital and Analogue signals” section.

It is sometimes possible to hear voices and music when close to powerful broadcast AM radio transmitters. These are outside of the normal RF frequency detection range of the meter, but they are sufficiently powerful transmitters to be picked up.

When no LEDs are illuminated any regular very quiet sounds should generally be ignored as they are due to the internal functioning of the meter. However, incoming pulsing RF signals can still often be heard when the LCD is displaying readings of  $<0.02$  V/m and  $< 1$   $\mu$ W/m<sup>2</sup>.

# EMFs – What to measure?



## What are EMFs?

EMF is usually taken to mean “time-varying electromagnetic field” and cover an enormous spectrum of different phenomenon. These include, but are not limited to, “power frequency” fields (given off by any AC electrical device), mobile communication signals, TV and radio signals, military radars, infra-red, visible light, ultra-violet, x-rays and gamma rays. We provide a brief over-view guide on the next page.

Their interaction with the human body varies and there are few clear correlations between frequency, duration, exposure level and health effects, though there is a great deal of peer-reviewed published evidence of real effects at both high and low exposure levels. Further research into each part of the spectrum and different modulation types is still required. It is almost certain that sensitivity to EMF exposure varies from person to person.

Some electric and magnetic fields are part of the natural environment that life on Earth evolved with. High electric fields cause lightning and magnetic fields from the Earth’s core allow compasses to work. However, we have not evolved with the enormous increase over the last 100 years in radiofrequency exposure (see graphic on page 14), and there is steadily mounting evidence that they may cause unexpected adverse effects on health.

# Electromagnetic spectrum guide

| Wavelength | Frequency | Comments  |
|------------|-----------|---|
| 1 pm       |           | Gamma rays     |
| 1 nm       |           | X-rays  |
| 10 nm      |           | Ultraviolet (UV)  |
| 1 μm       | 100 THz   | Visible light  |
| 10 μm      | 10 THz    | Infrared (IR)   |
| 100 μm     | 1 THz     | Far-infrared (FIR)  |
| 1 mm       | 300 GHz   | Research & space comms  |
| 5 mm       | 60 GHz    | Future WiFi band, car radar   |
| 10 mm      | 40 GHz    | Data services, future 5G?   |
|            | 30 GHz    | Data links & space comms  |
|            | 24-29 GHz | 5G** (see note)   |
|            | 6-24 GHz  | Radar, Satellite  |
| 100 mm     | 8 GHz     | Radar, Satellite  |
|            | 6 GHz     | WiFi 6 (802.11ax), 5G-IoT   |
|            | 5 GHz     | WiFi (various bands)  |
|            | 4 GHz     | 5G, data  |
|            | 3 GHz     | 5G (main bands)   |
|            | 2 GHz     | WiFi, DECT, Bluetooth, 3G,  |
|            | 2 GHz     | 4G, 5G, Microwave Ovens   |
|            | 1 GHz     | 3G, 4G, 5G, DECT  |
|            | 900 MHz   | GSM (2G), 4G, 5G  |
|            | 700 MHz   | TV, 4G, 5G  |
| 1 metre    | 300 MHz   | TETRA, various services   |
|            | 200 MHz   | TV, digital radio   |
|            |           |   |
| 3.3 m      | 100 MHz   | Local FM radio (VHF)  |
| 10 m       | 30 MHz    | Long distance radio (SW)  |
| 100 m      | 3 MHz     | AM broadcast radio (MW)   |
| 1 km       | 300 kHz   | AM broadcast radio (LW)   |
| 10 km      | 30 kHz    | Radio-navigation, other   |
| 100 km     | 3 kHz     | Audio frequencies   |
| 1 000 km   | 300 Hz    | Audio frequencies   |
| 10 000 km  | 30 Hz     | Electricity (mains power)   |
| 100 000 km | 3 Hz      | Schumann resonances   |

Acoustimeter AM11

5G\*\*: High-band 5G being developed and slowly rolled out

## Guidance levels

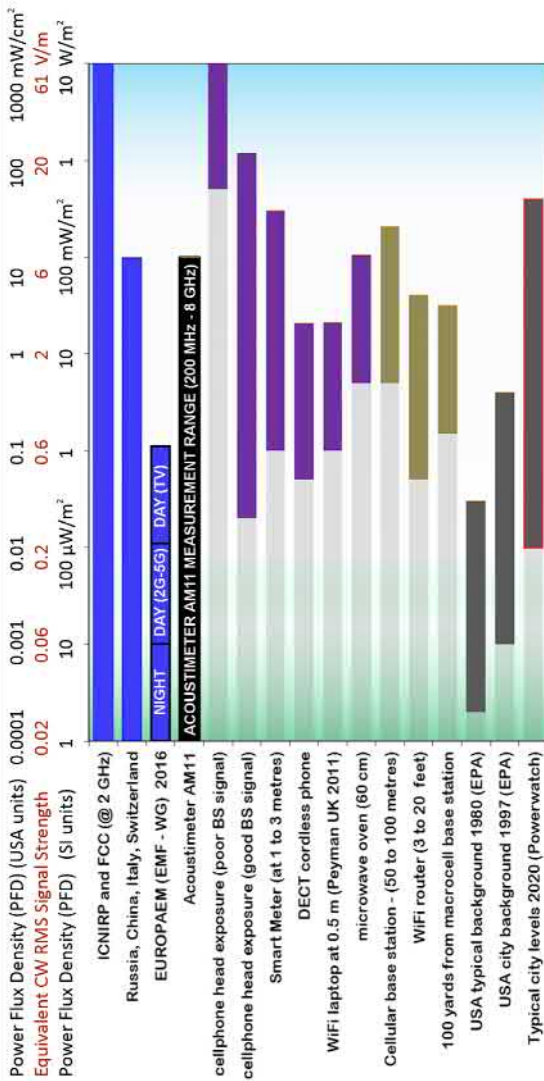
The most widely used exposure guidance is written by the International Commission on Non-Ionising Radiation Protection (ICNIRP). Their guidance levels are set to prevent tissue heating. This allows quite high-level exposures and it states that it is not intended to protect against cancer or any other low-level reported adverse health effects as they do not consider them to be adequately proven. The USA FCC/IEEE guidance levels are similar in that they also allow quite high levels of exposure.

Russia, China and various other countries have set more restrictive guidance for environmental exposures based on their interpretation of the published scientific evidence.

The most comprehensive current overview of the science came from an experienced group of 15 leading European health scientists and medics (EUROPAEM 2016). They state these are for “the prevention, diagnosis and treatment of EMF-related health problems and illnesses”.

Other reviews and guidance are available including the BioInitiative Reports; Bau-Biologie Guidelines; International Guidelines on Non-Ionising Radiation (IGNIR), which was produced by a UK group as a practical guide to implementing the EUROPAEM guidelines. The graphic on the next page puts all of these in context with typical real-life exposures.

## International Standards and typical modern environmental exposures to microwave radiation



We recommend the EUROPAEM precautionary guidance which assessed all the published scientific and medical evidence  
 A list of the various international and national Standards and guidelines can be found at: [www.emfields-solutions.com/info](http://www.emfields-solutions.com/info)

## Various exposures and effects

The graphic on the next page shows the guidance levels along with a selection of peer-reviewed scientific reports that show adverse effects at relatively low exposure levels.

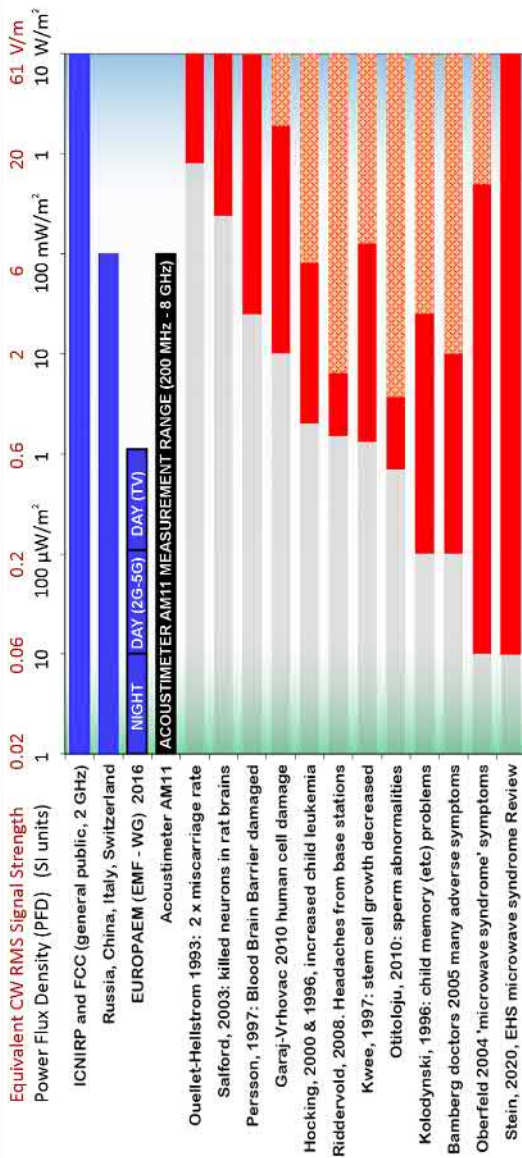
The EUROPAEM Guidance also has an even lower guideline for electrically sensitive people (ES, EHS) which is below  $1 \mu\text{W}/\text{m}^2$  (0.02 V/m) for modern communication signals. This is difficult to achieve in our modern world that is now extremely polluted with pulsing UHF RF signals.

For each of the studies, the solid red part of the bar indicates exposure levels where statistically significant effects were found. The cross-hatched area is based on the assumption that these higher levels will continue to exhibit the effects, but were not directly examined and tested as part of the research.

For further information about the interaction of EMF and RF with life (people and animals) a good source is the BioInitiative Report. This was produced by some of the most highly experienced EMF/RF bio-effects researchers in the world. It can be read and downloaded here: [www.bioinitiative.org](http://www.bioinitiative.org)

We will also be maintaining up-to-date links with more information on our website: [www.emfields-solutions.com/info](http://www.emfields-solutions.com/info)

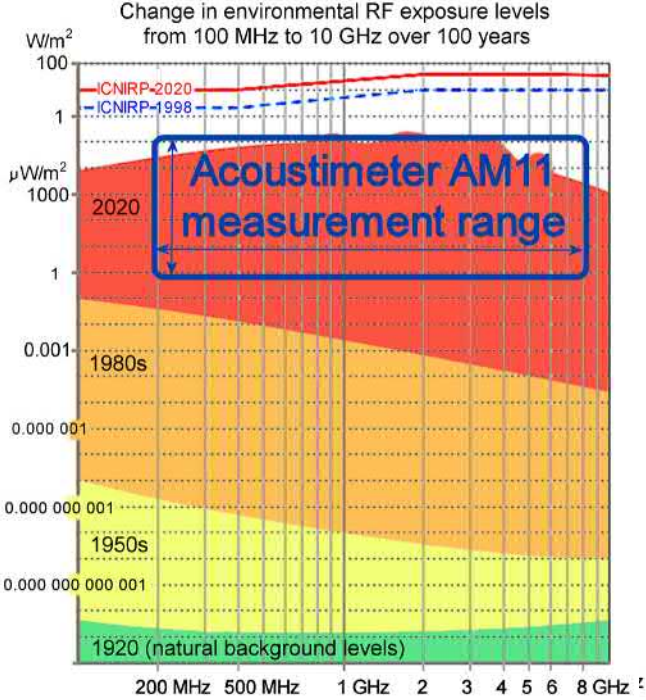
## International Standards and a selection of scientific peer-reviewed health effect reports



There has been almost no funding for low-level RF exposure studies in recent years, these results have not been disproved and so are still valid.

We recommend the EUROPAEM precautionary guidance which assessed all the published scientific and medical evidence  
 A guide to further information on Standards and exposure guidelines can be found at: [www.emfields-solutions.com/info](http://www.emfields-solutions.com/info)

The Acoustimeter is designed specifically to measure the mostly used radio frequency (“RF”) part of the spectrum where our exposure has increased by an incredible amount over recent years and where most of the reported health-related concerns exist.



Modern wireless communication frequencies (in the range from about 100 MHz to over 10 GHz) virtually did not exist on Earth just 100 years ago. Our typical daily exposures are now 1,000,000,000,000,000,000 times greater than they were at these frequencies.



## Why are there two different readings?

We display two different types of reading, as they each represent different but important aspects of your exposure: **Peak Signal Strength** and **Power Flux Density (PFD)**.

**Peak Signal Strength** is the electric field strength, measured in volts per metre (V/m). These readings are on the left column of LEDs and the top line of the OLED display.

**Power Flux Density (PFD)** is the time-averaged power in microwatts per square metre ( $\mu\text{W}/\text{m}^2$ ). These readings are on the right column of LEDs, and the bottom line of the OLED display.

The traditional scientific viewpoint is that the only relevant measurement of high-frequency RF fields is the total amount of absorbed energy from exposure, which causes body tissue heating, measured as PFD. This is the basis of most official international guidelines, and so most legal guidelines and limits are specified as a time-averaged PFD limit.

However, there is now a large body of high-quality scientific and medical evidence demonstrating biological effects from exposure levels far below these standards, and the evidence is strongly suggestive that most of the adverse effects are not related to the total absorbed energy as they occur far below levels of measurable tissue heating.

Published evidence has led us to believe that it is more likely that the electric field component of the field is interacting with the human body or nervous system. If the human body is reacting to specific electric field signals, it is more likely that the peak electric field strength is the more relevant metric.

All RF meters that are adequately sensitive to be able to measure fields at levels below those that cause heating (a few V/m or below  $10,000 \mu\text{W}/\text{m}^2$ ), measure voltage and then calculate the approximate power level. Some do that correctly, and some just display the peak level directly converted and they give incorrectly high readings. The direct conversion only works correctly for continuous non-pulsing (CW) signals.

The Acoustimeter displays both the peak signal strength in V/m as well as the power in  $\mu\text{W}/\text{m}^2$ , correctly integrated over some 25,000 readings every second.

The EMFields website has an RF unit converter for continuous RF (CW) signals on this page:

<http://www.emfields-solutions.com/rf>

You may have noticed that different PFD units are used in some regions. We have chosen to use  $\mu\text{W}/\text{m}^2$  on the Acoustimeter, as this is the most commonly used internationally, and these readings can be easily converted into other PFD units.

$$1 \mu\text{W}/\text{cm}^2 = 10,000 \mu\text{W}/\text{m}^2 = 10 \text{ mW}/\text{m}^2 = 0.01 \text{ W}/\text{m}^2$$
$$1 \text{ mW}/\text{cm}^2 = 10 \text{ W}/\text{m}^2 = 10,000,000 \mu\text{W}/\text{m}^2$$

## Explanation of the LED levels

|  | PEAK V/m                     | AVERAGE $\mu\text{W}/\text{m}$ |
|--|------------------------------|--------------------------------|
| Can be this high close to Cordless (DECT) Phones, WiFi devices, Mobile Phones (intermittently), and close to a mobile phone base station   | ~ 6.00<br>~ 4.50<br>~ 3.00   | 100000<br>50000<br>25000       |
| Commonly reported adverse symptoms at these levels include sleep problems, headaches, depression, concentration and memory difficulties, skin irritation and a variety of other symptoms | 2.00<br>1.50<br>1.00         | 10000<br>5000<br>2500          |
| Most people with ES experience adverse health effects above this   | 0.70<br>0.50<br>0.30         | 1000<br>500<br>250             |
| Most people with ES do not experience significant adverse effects below this   | 0.20<br>0.10<br>0.07<br>0.05 | 100<br>50<br>25<br>10          |
| Only highly ES people experience adverse well-being effects below this   | 0.03<br>0.02                 | 5<br>1                         |

~ typical maximum in public areas near base station antennas - can be higher

These levels will cause sensitive people real difficulties

~ maximum in public areas guidance (BioInitiative 2007 & Salzburg 1998)

~ max Wifi and 2G - 5G networks (ideally max daytime levels, EuropaEM 2016)

~ Salzburg 2002 max outside homes  
~ max RF ideally (night, EuropaEM 2016)

~ BioInitiative 2012 max background  
~ Salzburg 2002 max inside homes

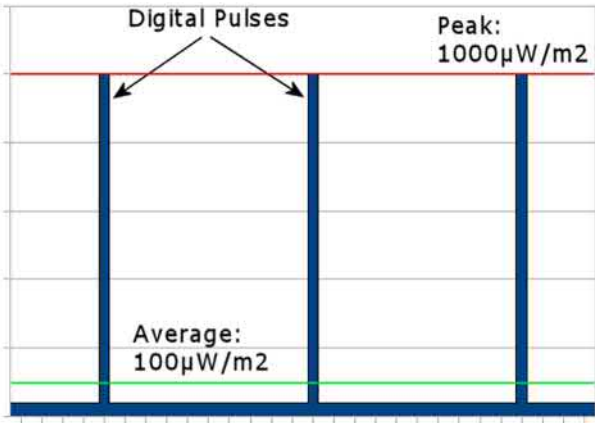
## Digital and Analogue signals

Most modern wireless devices, such as mobile phones, Wi-Fi devices and cordless phones, use a digital system of communicating.

This means they turn the signal on and off at high speeds to represent data, often with wide gaps between data bursts. This produces a non-continuous signal, which we describe as 'pulsing'.

This means that when taking measurements in most environments, you are likely to find that the left peak (V/m) LEDs are higher up the scale than the right PFD ( $\mu\text{W}/\text{m}^2$ ) LEDs.

### A simple digital signal

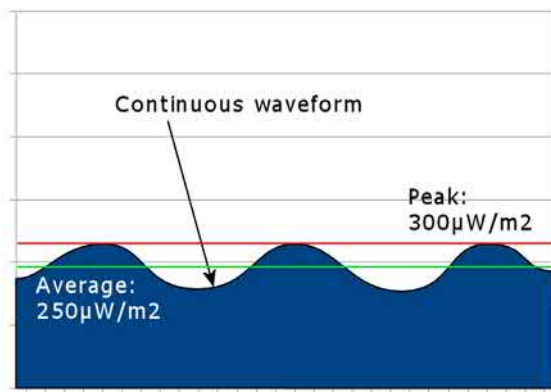


The pulsing is almost always faster and more complex than shown in the diagram, but the principle is similar.

A common example of a digital signal you are likely to be regularly exposed to would be DECT digital cordless phones or WiFi in your home environment. You can hear their 'pulsing' on the Acoustimeter.

4G is a "spikier" signal than 3G, and 5G has more sharp 'pulses' than both. This is thought to make it more bioactive and it also brings the PFD level more in line with the V/m on the LED displays.

### A simple analogue signal



In contrast, an analogue (non-digital) signal, uses a more continuous signal, and instead of turning "on and off" to represent data, will vary the frequency (FM) or strength (AM) at audio frequencies.

Nowadays there are relatively few analogue signals that you are likely to encounter that will not be drowned out by stronger local RF digital communication signals.

## Typical real-life exposures

The AM11 has been tested in hundreds of situations. Although the highest sources in most homes are internal, some RF EMFs come from external sources.

### Indoor Domestic Readings

Most homes have 4 major sources of RF EMFS:

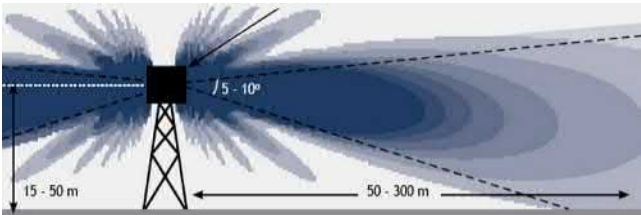
- 1) Cordless Digital (DECT) phones continuously produce fields of up to **4 V/m at 25cm**, and around 1 V/m at 1m. A few models have an eco-DECT setting to reduce the RF when they are not in use.
- 2) WiFi (the access point or router plus all WiFi devices, including smartphones and laptops, but also fixed “smart devices”). Readings of **3 to 6 V/m are normal at 25cm** from WiFi devices, decreasing with distance. WiFi is usually “always-on”.
- 3) Mobile phones. When in use, these devices can easily produce **6 V/m at 25cm**. Many ‘apps’ send data in the background, so storing the phone in a pocket or purse can lead to high exposures.
- 4) Mobile Phone Masts and other external sources increasingly make it difficult to create a low-EMF environment for sensitive individuals. Where there is direct line-of-sight to a mobile phone mast from a window, you can typically find readings of **0.2 to over 1.0 V/m**. Building construction and the mast location and height result in large variations.

## External Readings

Outdoors, readings vary a great deal. The most prevalent outdoor source of RF EMFs are mobile phone masts (base stations). Other external sources can include radar (occasional high blips of up to 6 V/m), Radio/TV transmitters (which may show high average power).

In most urban environments, there are many base-stations, and so continuous readings of 1-3 V/m are often found. In rural environments with no near base-station, readings are usually below 0.2 V/m.

At 100m from a mast, you will typically find readings of 1.5 V/m, falling to 0.5 V/m at 300m. Base-stations have a “main beam” which directs the energy sideways, but there are also various “side-lobes” which can give high readings close to the mast.



## Cars

Modern cars are increasingly a source of EMFs for their passengers, due to inbuilt technology such as Bluetooth. This can lead to much higher than expected readings.

## 5G – Fifth Generation Mobile Phone systems

5G enables fast data speeds for critical applications. It will also connect billions of Internet of Things (IoT) devices. 5G Specifications include about 30 different bandwidths, modulation types and speeds.

4G-LTE is about 500 times faster than 3G. 5G and 5G-NR are about twice as fast as 4-LTE. To start with 5G will only be used for video calls, streaming and large downloads of data and for the next few years 4G-LTE will handle most calls.

**Low-band** (up to 2.5 GHz) offers the advantage of wide-area coverage and the ability to penetrate buildings so that devices can work reliably indoors.

**Mid-band** (2.5 to 5 GHz) offers greater capacity and speed. It has a shorter range and is more easily blocked by solid structures, so more base-stations are needed. Massive MIMO (multiple carriers and targeted beams) can start to be used.

**High-band** (24-29, 37-42, 64-71 GHz) will slowly be rolled out from 2020. It offers extreme capacity and speed and will need a different type of meter to measure it. It only has a short range of typically a few hundred meters at most. It will use MIMO, which will create high-exposure hot-spots and will need large numbers of small-cell access points close to users. It is currently practical only for fixed links or line of sight use. Indoor use will usually need a 5G Access Point inside the room.



## **Smart meters**

These are utility meters that use RF to communicate with the supplier. Some are connected in a “mesh” network and communicate frequently. Some use a Mobile Phone network and transmit less often. Some (e.g. Linky) use Power-Line Communication (low frequency RF) and create a lot of “Dirty Electricity” (DE).

## **Other sources**

The AM11 can measure any RF EMFs between 200 and 8000 MHz. This includes (but is not limited to):  
Mobile Phones & Phone Masts: 2G (GSM, CDMA), 3G (EDGE, GPRS, HSPA), 4G-LTE, Low- and Mid-band 5G, TETRA, Wi-Fi bands 802.11A, B, G, N at 2.4 and 5 - 6 GHz, Wireless-enabled laptops, tablets, and PCs  
WI-MAX, Bluetooth & BLE, UHF RFID readers  
Zigbee, Z-wave, and other IoT device protocols  
Internet of Things (IOT) devices, fitness trackers,  
Wireless burglar, fire and security alarms  
Extremely strong signals below 200 MHz

## **The AM11 does not measure the following**

This is because they do not radiate RF EMFs.

Dirty Electricity, Smart Meters that use PLC,  
Near-Field Communications (NFC)  
House wiring, or Power-frequency magnetic or electric fields (Our PF5 meter will measure these)  
Passive UHF RFID tags LF/HF RFID & shop safety tags  
GPS receivers

# Troubleshooting

## **The meter is not working**

Check that the batteries are correctly fitted and are not flat. If the OLED is displaying a reading, then the meter is turned on and working.

## **The meter makes a loud double-beep**

Check for a “Low battery” screen message next time it beeps. Replace the batteries.

## **The instrument readings are varying a lot when I move the Acoustimeter a small amount**

RF EMFs arrive from multiple sources and reflect off many types of surfaces. This results in many small “hotspots” so movement of the Acoustimeter show up these real hot RF exposure spots.

## **The peak signal is high, but the average is low**

This is to be expected from many sources, as most wireless technology uses ‘pulsed’ digital signals.

## **The instrument readings are varying a lot even when the Acoustimeter stays still**

Regular high “blips” every few seconds may be due to a rotating radar transmitter or a Wi-Fi signal. Irregular high readings are produced by mobile phones when they transmit data. Increasingly, the “Internet of Things” (IOT), including Smart Meters, produce intermittent signals.

### **The average power display does not match another instrument I have. Why is this?**

Some meters “convert” peak signals into an average power value which is misleading for modern signals. For digital signals this often results in a displayed power level considerably higher than the real PFD. The AM11 scales are correctly related to each other.

### **The levels are very low (no LEDs lit), but I can just hear a sort of quiet hissing/bubbling noise**

This is the instrument picking up its own internal electronic circuitry working and not external signals. This only happens if the field levels are below 0.02 V/m and no LEDs are lit.

### **It still makes a noise when shielded behind screening materials**

The screening material may have degraded. Also, even small gaps (including above and below you) will let in some RF signals.

Even a 30 dB (99.9%) reduction of 10000  $\mu\text{W}/\text{m}^2$  to 10  $\mu\text{W}/\text{m}^2$  (a 2 V/m signal reduced to 0.06 V/m) will still be showing and sounding on the meter.

### **My mobile phone is showing 1 bar of signal, but the AM11 is reading below 0.02 V/m**

Mobile phones are extremely sensitive to their network signals and can work with extremely low base-station signals. There is no universal meaning for “1 bar” of signal (typically less than 0.001 V/m).

## Warranty

The Acoustimeter comes with a 5-year return-to-base Warranty. The meter is guaranteed to be free of manufacturing defects, but not against wear from normal use, nor damage caused by water or by physical impacts such as from dropping it. Please contact us to arrange a return if required.



## EMFields Solutions Ltd

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Web: [www.emfields-solutions.com](http://www.emfields-solutions.com)

The European WEEE Directive requires recycling of unwanted electronic equipment. Your AM11 can be returned to us for recycling if necessary.

V0813-1