HF59B

27 MHz (UBB27) / 700 Mhz (LogPer) - 2,7 GHz (3,3 GHz: -3dB)

English

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RF-Analyser

High Frequency Analyser for Frequencies from 700 MHz to 2.7 (3.3) GHz

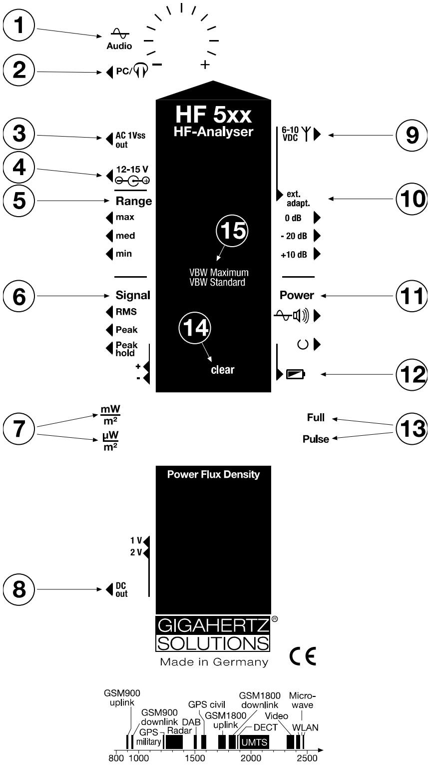
Manual

Rev. 7.3 – 1804

English

Contents

Functions and Controls



typ. HF-Services (MHz)

The HF component of the meter is shielded against interference by an internal metal box at the antenna input (shielding factor approx. 35 - 40 dB)

1) Volume control for the audio analysis
2) Jack, 3.5 mm: AC output for the modulated part of the signal, for audio analysis via PC or headset (mono).
3) Normed AC output 1 Volt peak-peak, proportional to the field strength.
4) Jack, 12-15 Volt DC for charging the battery. AC adapter for 230 Volt/50 Hz and 60 Hz is included. For other voltages/frequencies please get an equivalent local AC adaptor with the output parameters 12 - 15 Volt DC / >100mA.
   Caution: If an alkaline battery is used, under no circumstances should the power adapter be connected at the same time, otherwise the battery may explode.
5) Measurement ranges
   max = 19.99 mW/m² (= 19,990 µW/m²)
   med = 199.9 µW/m²
   min = 19.99 µW/m²
   Scaling differs when applying an amplifier or damper!
6) Selector switch for signal evaluation. Standard setting: “Peak”. In the Peak hold mode you can choose a time setting for the droop rate (Standard = “+”). The Peak hold value can be manually reset by pressing (14) “clear”.
7) A little bar on the very left of the LCD indicates the unit of the numerical reading:
   bar on top = **m**W/m² (Milliwatts/m²)
   bar on bottom = **µ**W/m² (Microwatts/m²)
8) DC output for additional instruments, e.g. data logging devices for longterm recordings (1 V DC full scale, scalable to 2 V DC).
9) Connecting socket for antenna cable. The antenna is inserted into the cross slot at the top side of the instrument.
10) Power Level Adapter Switch for external optional amplifier or attenuator only (these are not part of the standard scope of supply). For regular use of the instrument, the switch should be in pos. “0 dB”. (Any other position will shift the decimal point to an incorrect position).
11) ON/OFF switch. ⏦ 🔊 = On with audio analysis mode.
12) Load indicator
13) Signal fraction: “Full” = total signal strength. “Pulse” = pulsed/ amplitude modulated part of the signal. The latter setting minimizes the instrument’s noise to a fraction of the normal level (of importance for particularly small signals).
14) Push button to reset peak hold. (Push and hold for 2 seconds or until the reading no longer drops)
15) Switch for selection of the Video Bandwidth. **Standard setting: “VBW Standard”**

Switches for rarely used functions are recessed in the casing of the instrument.

Contents of the package

Meter, attachable antenna incl. cable, rechargeable battery pack (in the meter), mains adapter, manual.

Getting Started

Connecting the LogPer Antenna 

Screw the angle connector of the antenna connection into the uppermost right socket of the HF analyser. It is sufficient to tighten the connection with your fingers. (Do not use a wrench or other tools because over tightening may damage the threads). This SMA connector with its gold-plated contacts is the highest quality commercial HF connector available in that size.

At the tip of the antenna, there are two LEDs for monitoring the proper function of all connections of the antenna and the cable during operation. The red LED checks the cable, the green one the antenna itself, both ok if the LEDs are lit.

Slide the antenna into the vertical/cross shaped slot at the rounded top end of the HF analyser. Make sure the antenna cable has no tension and lies below the instrument. It may help to loosen the SMA-connector temporarily to let the cable fall into a “relaxed” position.

Do not bend or stretch the antenna cable!

Both ends of the antenna cable are equipped with small ferrite-rolls to improve the antenna characteristics. *Do not remove them!*

The connection of the omni-antenna UBB27 (available as optional accessory for the HF59B, but included in the HF**E**59B-kit) is described in the respective manual.

Checking Battery Status

If the “Low Batt” indicator appears in the center of the display, measurement values are no longer reliable. In this case, the battery needs to be charged.

If there is no display at all upon switching the analyser on, check the connections of the rechargeable battery. If that does not help try to insert a regular 9 Volt alkaline (non-rechargeable) battery (see chapter on battery change). **Caution:** make sure NOT to connect the analyser to a power supply unit/AC adaptor while temporarily operating it with a non-rechargeable battery!

Insert fully charged batteries only.

Note

Each time you make a new selection (e.g. switching to another measurement range), the display will systematically overreact for a moment and show higher values which will, however, droop down within a couple of seconds.

The instrument is now ready for use.

In the next chapter you will find the basics for true, accurate HF-measurement.

Properties of HF Radiation…

Across the specified frequency range (and beyond), HF radiation can cause any of the following effects on the materials exposed to it:

1. Partial permeation
2. Partial reflection
3. Partial absorption.

You may, therefore, come across various extremely differing field distributions within one building, with strong peaks at individual spots (so called “hotspots”).

Minimum Distance
In order to measure the quantity of HF radiation in the common unit “power density” (W/m^2), a certain distance has to be kept from the HF source. The distance depends on the frequency – the higher the frequency the lower the distance. The transition frequency between so called far field and near field conditions is not determined exactly, but here are some typical distances:

- 27 MHz from approx. 27 meters
- 270 MHz from approx. 2.7 meters
- 2700 MHz from approx. 0.27 meters

That means the distances are inversely proportional to the frequencies.

Polarization
When HF radiation is emitted, it is sent off with a “polarization”. In short, the electromagnetic waves propagate either vertically or horizontally. Cellular phone technology, which is of greatest interest to us, is usually vertically polarized, or at an angle below 45°. Due to reflection effects and the many ways in which a cellular handset can be held, we also observe other polarization patterns. Therefore, it is always strongly recommended to measure both polarization planes, which is defined by the orientation of the antenna.

… and Consequences for the Measurements

When testing for HF exposure levels in an apartment, home or property, it is always recommended to **record individual measurements** on a data sheet. Later this will allow you to get a better idea of the complete situation.

It is equally important to repeat **measurements several times**: First, choose different daytimes and weekdays in order not to miss any of the fluctuations, which sometimes can be quite substantial. Second, once in a while, measurements should also be repeated over longer periods of time, since a situation can literally change “overnight”. Major changes in exposure levels can, for instance, already be caused by a transponder only being tilted down by a few degrees (e.g. during installation or repair works on cellular phone transmitters). In particular, however, the worldwide extremely rapid expansion of the cellular phone networks (LTE, 5G) as well as wireless LAN hotspots have a considerable impact on the exposure levels.

Even if you only intend to test indoors, it is recommended first to take measurements **in each direction** outside of the building. This will give you an initial awareness of the “HF tightness” of the building, and also potential HF sources inside the building (e.g. cordless phones, also from neighbours).

Furthermore, you should be aware that taking measurements indoors adds another dimension of testing uncertainties to the specified accuracy of the used HF analyser due to the narrowness of indoor spaces. According to the “theory”, quantitatively accurate HF measurements are basically only reproducible under so-called “free field conditions”, yet we have to measure HF inside buildings because this is the place where we wish to know exposure levels. In order to keep system-immanent measurement uncertainties as low as possible, it is imperative to carefully follow the measurement instructions.

As mentioned earlier in the introduction, even slight changes in the positioning of the HF analyser can already lead to rather substantial fluctuations in measurement values. (This effect is even more prevalent here than in the ELF range.) **It is suggested that exposure assessments are based on the maximum value within a locally defined area** even if this particular value should not exactly coincide with a particular point of interest in, for example, the head area of the bed.

The above suggestion is based on the fact that slightest changes within the environment can already cause rather major changes in the power density of a locally defined area. The person who performs the HF testing, for example, affects the exact point of the maximum value. It is quite possible to have two different readings within 24 hours at exactly the same spot. The maximum value across a locally defined area, however, usually only changes if the HF sources are subject to change. This is why the latter value is much more representative for the assessment of HF exposure.

The descriptions in the following mainly refer to **immission** measurements, i.e. to the definition of the total power flux density relevant for limit value comparisons.

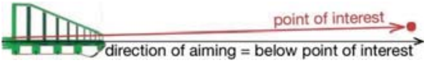
In addition, this device can also be used to identify the source of radiation, and – most important – to determine appropriate shielding measures. The logper antenna which comes with the meter is predestined for this aim. The procedure to determine appropriate shielding methods is described at the end of this chapter in a separate section.

Preliminary Notes Concerning the Antenna

The supplied logarithmic-periodic antenna (or aerial), has exceptional **directionality**. Thus it becomes possible to reliably locate or “target” specific emission sources in order to determine their contribution to the total HF radiation level – a fundamental prerequisite for effective shielding.

Important:
As the LogPer Antenna provided with this instrument is shielded

against ground influences one should “aim” about 10 degrees below the emitting source one wants to measure. This is to avoid distortions of the reading.



The upper edge of the foremost resonator is a good “aiming aid” for the required angle. It does not matter if the angle gets a little too wide.

Our logarithmic periodic antenna, the “LogPer antenna”, provides a distinct division of the horizontal and vertical polarization plane. Also the frequency response is exceptional. There is a patent pending for its design. (For professionals: For the technically rather difficult measurement of the vertical polarization, it is significantly better shielded against the falsifying ground influences).

The missing directionality of standard telescope antennae is one of the reasons why they are not suited for reliable HF measurements in building biology EMR.

The readings from the instrument’s display always reflect the integral power density at the measurement location coming from the direction the antenna is pointing at.

As the HF59B picks up frequencies below 700 MHz, it has no integrated high pass filter. However the filter HP700 is available for external connection if needed, and is to be placed between the antenna entry and the antenna cable.

In addition, the HF59B is able to capture numerous sources of radiation in the lower HF band which are not pulsed (i.e. amplitude modulated). By their nature these non-pulsed sources are not available for audio analysis. That means you can get a significant reading on the instrument without hearing any audio signal, which makes the interpretation of the readings more difficult. To avoid this source of misinterpretation the instrument marks those “inaudible” signals by a **rattling tone**, the loudness of which is in proportion to its share in the total signal. The frequency of this marking is very low (16 Hertz). An example of it can be found on our homepage. With the switch to the right of the display in the “Pulse” position, these sources of radiation as well as the corresponding rattling “marking” are blanked out.

For a quantitative measurement of frequencies below 700 MHz with the HF59B, Gigahertz Solutions provides the active, horizontally isotropic ultra broadband antenna UBB27_G3 responding to frequencies from 27 MHz right up to more than 3.3 GHz.

LogPer or Omni-Antenna?

Depending on the task, either of the antennas have advantages as well as disadvantages:

- For frequencies below 700 MHz the UBB27 antenna is the only option, as for geometrical reasons the LogPer antenna only starts at 700 MHz.
- For long term data logging in most cases the isotropic observations make most sense: Again UBB27.
- For a quick survey of the total immission (that is: Total exposure to radiation) the UBB also has clear advantages.

- For the determination of appropriate shielding measures, i.e. the location and identification of the source of pollution, the LogPer technology is definitely superior to the isotropic measurement.

When it comes to quantifying the total emission (measurement of the total pollution) in more detail, the pros and cons of the two approaches need to be weighed up:

- On the one hand, under typical measuring conditions, an isotropic measurement has a broader error band by its very nature, and the interpretation of the results is also more difficult. Yet, the measurement is faster and more encompassing.
- On the other hand, the LogPer antenna offers a higher precision and better localization for the same kind of work, and the interpretation of the results is easier. Yet, a comprehensive measurement is more time consuming and restricted to a smaller frequency band.

Step-by-Step-Instruction to HF-Measurement

Procedure for the Quick Overview Measurement:

The HF analyser and antenna are to be checked following the instructions under “Getting Started”.

Set the “Signal” switch to “Peak”.

Then set the measurement range (“Range”) switch to “max”. Only if the displayed measurement values are persistently very low, change to the measurement range “med” or even to “min”.

Note: When switching from “max” to “med”, the volume of the audio signals will increase considerably; between “med” and “min”, there is no difference in volume.

HF radiation exposure can differ at each point and from all directions. Even though the HF field strength of a given space changes far more rapidly than in the lower frequencies, it is neither feasible nor necessary to measure all directions at any given point.

Since there is no need to look at the display during an overview measurement, but only to listen to the **audio signal,** you can easily walk around at a slow pace through the indoor or outdoor spaces in question, constantly panning the antenna or the HF analyser with attached antenna in all directions (forming a horizontal eight). This will provide you with a quick overview of the situation. In indoor spaces, antenna movements towards the ceiling or the floor will also reveal astonishing results.

As already mentioned above, the aim of the quick overview measurement is to identify the zones of local peaks, not to supply exact data.

Quantitative (numeric) Measurement:

Setting:
“Range” (measurement range)

Start with the “Range” switch set to “max”, and only switch to “med” or even “min” if the display constantly shows very low values.

Basic rule for measurement range selection:
As coarse as necessary, as fine as possible.

Important note regarding the setting “VBW Maximum”:
A simultaneous setting of “VBW Maximum” and “Full” may cause a clearly two-digital meter noise value, and in combination with “Peak hold” the equilibrium level may after a while even clearly exceed the value of 100. “The higher the better”, though (much to the surprise of non-experts), as the higher the value, the higher the actual video bandwidth, and consequently the better the chance of measuring short pulse widths.

Therefore, in the case of very low field strengths, please use “med” or even “min”, the pre-amplifier HV10, “Pulse” and/or “VBW Standard”.

Recommendations for the range “max”[9]:

Values < 0.15 **m**W/m²: switch to “med”

Values > 0.15 **m**W/m² and < 1.5 **m**W/m²:

Use **preamplifier HV10** to convert the range of 20,000 (max) to a range of 2,000! Alternatively, the larger value applies.

If you intend to do comparative measurements (such as “before vs. after”), please always measure in the same range.

In the case of overload even with the range set to max (display shows “1” on its left side), the sensitivity of the meter can be reduced by a factor of 100 by applying the **attenuator DG20_G3** available as an optional accessory. By setting the “ext. adapt.” switch to -20 dB on your instrument, you will ensure a correct display of the measurement value (please note: there will be an increased noise level).

In the case of especially low values with the “Range” switch set to “min”, the HV10 should also be applied.

[9] In order to maximize the display of power flux densities without having to apply an attenuator, there is a factor of 100 between “med” and “max”. For technical reasons large tolerances are to be expected. .

Measurement Ranges

Range	Bar on LCD	**Instrument as delivered** i.e. **without** preamplifier or attenuator ("ext. adapt." set to "0 dB") displayed value & unit
max		0.01 - 19.99 **m**W/m^2
med		00.1 - 199.9 **µ**W/m^2
min		0.01 - 19.99 **µ**W/m^2

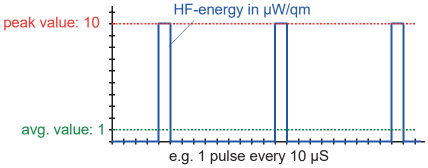
Range	Bar on LCD	**With ext. attenuator DG20** ("ext. adapt." set to "-20 dB") displayed value & unit
max		1 - 1999 **m**W/m^2
med		0.01 - 19.99 **m**W/m^2
min		.001 - 1.999 **m**W/m^2

Range	Bar on LCD	**With ext. amplifier HV10** ("ext. adapt." set to "+10 dB") displayed value & unit
max		1 - 1999 **µ**W/m^2
med		0.01 - 19.99 **µ**W/m^2
min		.001 - 1.999 **µ**W/m^2

Setting: “Signal”

Peak / RMS

The following illustration shows the difference in the evaluation of a pulsed signal if displayed as an average value reading or a peak value reading (“RMS” and “Peak”):



With the switch set to “Peak”, the meter will display the full power flux density of the pulse (10 µW/m^2 in the graph). With the switch set to “RMS”, the meter will take the mean of the power flux density over the total period of time, for instance 1 µW/m^2 in the above graph (= ((1 x 10) + (9 x 0)) / 10).

With the switch set to “Peak” or “Peak hold”, the display will show the “RMS value during the pulse”, which is a common practice in the building biology.

Nevertheless, the “true” mean value is of great interest, too[10]:

- The “official” limit values are always based on mean value examinations. When analysing “official” measurement results, therefore, such as those for instance done for cell phone operators, it may be useful to have a possibility of comparison.
- Different radio services will never have an equal ratio between mean values and peak values. DECT cordless phones, for instance, can have a ratio of as high as 1:100, while for GSM the ratio may vary from 1:1 up to 1:8.
- Especially in the case of the new broadband modulated radio services, such as LTE, the RMS value and – thanks to the crest factor of max. 10 dB – also the arithmetical peak value can both be reliably determined.

Users of professional spectrum analysers please note:

- The value for pulsed radiation shown on the display of the Gigahertz Solutions HF Analysers with the signal switch set to “Peak” corresponds to the equivalent value in μW/m² resulting from the “Max. Peak” function of a modern spectrum analyser (elder spectrum analysers had a similar function mostly called “positive peak”).
- The switch setting “RMS” corresponds the “true RMS” setting of a modern spectrum analyser (elder spectrum analysers have a similar function mostly called “normal detect”, as well as a setting for the video bandwidth adapted to match the pulse).
- In broadband-measurement technology “Videobandwidth” (VBW) is understood differently than in terms of spectrum analysis.

Setting: “Signal”

Peak hold

In the interior, local peak values are mostly subject to strong fluctuations (caused by multiple reflections). In order not to overlook any local maxima (so called hot spots), indoor measurements should, therefore, preferably be done with the “Peak hold” setting.

Switching impulses can cause “pseudo peaks” which will appear on your display. These can be deleted by pressing and holding the “clear” button for several seconds (while keeping the “clear” button pressed, the measurement will turn into a regular peak measurement). Releasing the “clear” button will trigger the period during which the maximum value is to be determined.

In the “Peak hold” mode, the sound signal remains proportional to the currently measured power flux density. This helps finding the absolute maximum within the measured area.

The droop rate, at which the held peak value decreases over time can be controlled with the “+” and “-” switch. Even after several minutes, the value displayed is still

[10] Users of meters produced by other manufacturers please note: The a.m. conclusions are only feasible for recordings of the true mean value. They do not apply if your meter shows the momentary value of the modulated HF signal only instead of the mean value, which is the case for most meters on the market, even if their specifications state that it will display the mean value.

within the specified tolerance. Nevertheless, the display should be checked frequently in order to obtain the most accurate readings. In the case of very high and short signal peaks, the holding capacity of the "Peak hold" function needs several recurrences (less than a second) to fully load.

Quantitative Measurement:
Determination of Total High Frequency Pollution

As described in Getting Started, attach the LogPer **antenna to the HF analyser.** Hold the HF analyser with a **slightly outstretched arm** because objects (mass) directly behind it "like yourself", have effects on the testing result. Your hand should not get too close to the antenna, but should be near the bottom end of the instrument.

In the area of a **local maximum,** the positioning of the HF analyser should be changed until the highest power density (the most important measurement value) can be located. This can be achieved as follows:

- When **scanning "all directions"** with the LogPer to locate the direction from which the major HF emission(s) originate, move your wrist right and left. For emission sources behind your back, you have to turn around and place your body behind the HF analyser. When scanning with the isotropic UBB27 aerial, it is sufficient to move the instrument to see the field distortions effected by your body.
- Through **rotating the HF analyser**, with attached LogPer antenna, around its longitudinal axis, determine the polarization plane of the HF radiation. When using the UBB27 you only need to do this in locations where radiation from directly below or above cannot be ruled out (multi-storey buildings, town houses, etc)
- **Change the measurement position** and avoid measuring exclusively in one spot, because that spot may have local or antenna-specific cancellation effects.

Some manufacturers of field meters propagate the idea that the effective power density should be obtained by taking measurements of all three axes and calculating the result. Most manufacturers of professional testing equipment, however, do not share this view.

In general, it is well accepted that exposure limit comparisons should be based on the maximum value emitted from the direction of the strongest radiation source. When using the UBB27, of course, the directional component will not apply.

But the details of the situation need to be considered! For example, if a 2.4-GHz telephone inside the house emits a similar level of microwaves as a nearby cellular phone base station outside the house, it would be helpful to first turn off the 2.4-GHz telephone in the house. Now measure the exposure level originating from the outside. After having measured the emission of the 2.4-GHz telephone on its own, the sum of both measurement values could be used for the exposure assessment. (This is necessary only when using the LogPer aerial. The isotropic UBB27 does this in a single measurement).

There is no “official regulation” nor clearly defined testing protocol, because according to national standards setting institutions, as described earlier, quantitatively reliable, targeted and reproducible measurements are only possible under “free field conditions“ but not in indoor environments.

To be on the safe side when comparing limit values, multiply the displayed value by 2 and use the result as basis for the comparison. This method is often used by the building biology professionals to avoid assuming a far lower value of pollution than really existent, especially if the specified downward tolerance of the meter is fully reached. However, please be aware of the fact that the so calculated values may be far too high should the upward tolerance be fully reached.

This measurement uncertainty factor appears to be very high at first, but becomes realistic when taking into account that the same factor is applied even for professional sprectrum analysers.

Cellular phone channel emissions vary with the load. The minimum HF level occurs, when only the control channel operates. It is suggested that measurements should be taken at different times during the day / week in order to find out the times of highest traffic.

Evaluating the different radio services

Please use “Peak hold” and “VBW standard[11]” as standard settings.

The HF59B displays show the sum of the total power density within the frequency range of the most common digital radio services. This means for the often dominating sources GSM, PCT/DECT or the wireless LAN beacon signal (standby-“rattling”), as well as analogue sources: Simply take the readings and compare them to the building biology standard values!

To be able to evaluate the different radio standards, transmission and modulation patterns with one single measurement technology, compensation is required. The following approach is recommended:

CDMA, UMTS/3G, LTE/4G, WiMAX, DVB, Wireless LAN during full data transmission:

The modulation of these high-speed services includes high, needle-like peaks compared to the average power transmitted. Such signals are referred to as “high crest factor” signals.

Measure these signals for 1 or 2 minutes (with peak hold) by slightly panning the meter pointing to the direction of the main source. For the assessment of the peak values of such signals (including the crest factors) keep the standard setting “Peak hold” and “VBW standard”[12].

[11] The VBW of your HF-Analyser is so chosen, that “mistaken additions” cannot occur, even if multiple GSM traffic channels are fully used.

[12] Ideally one would keep the setting "RMS", as the utilized circuitry by its nature ensures the correct display of RMS values independently of the signal's crest fac-

For the compensation of the crest factor multiply the displayed reading by a correction factor. A flat factor of 10 offers a good approximation[13].

Often you will find different telecommunication services performing at the same time. With the help of the audio analysis, you will be able to estimate how much of the total value shown is caused by such high crest factor signals.

Depending on the proportion to the total signal, please apply the following “rules of thumb” for corrections:

- Slightly audible portion of “high crest factor signals”: multiply display reading by 2.
- ~“Fifty-fifty”-ratio:
  multiply display reading by 5
- Dominating “high crest factor signals”:
  multiply display reading by 10.

This adjusted measurement value can now be recorded or compared directly to the building biology recommendations. Taking into account the multiple external factors of measurement uncertainty, this approach is perfectly adequate for an assessment of the total pollution. The use of a frequency filter and service specific correction factors will allow an increased accuracy.[14]

Please note: In the combination of the settings "VBW Maximum", "Range: min" *and* "Peak hold" the the background noise level can sum up to a value of 1.00 or more on the display[15]. In order to reach lower levels you can use the preamplifier HV10.

For obvious reasons the use of a correction factor only makes sense for readings above the noise level.

Radar

For air and sea navigation, a radar antenna slowly rotates around its own axis, thereby emitting a tightly bundled “radar ray”. Even with sufficient signal strength, this ray can only be detected every couple of seconds, for a few milliseconds. This requires special measurement technology.

For an acoustic identification of a radar signal (a short “beep“ which in extreme cases is only repeated approx. every 12 seconds), please proceed as follows:

Select setting “VBW Maximum”. Set signal switch to “Peak hold” and direct the LogPer antenna towards the signal emitting source. Wait

tor. For practical reasons one can nonetheless use the convenient "Peak hold" setting, as with "VBW standard" the readings for RMS and Peak won't differ significantly for the signals in question.

[13] Even if the standards of these radio services specify far higher crest factors, the industry is striving for crest limitation for economic reasons, so that in the longterm the resulting correction won’t exceed a factor of 10.

[14] For the time being with a pure LTE signal (very rare) a factor of 20 may still occur at the peak. For TETRA a factor of 2, and for WLAN (“standby-rattling”) a factor of 4 will be enough.

[15] Inherent to the system: The higher the video bandwidth, the higher the displayed noise level.

for several circles of the radar ray, move the instrument left and right in order to identify the main direction of the source and get the relevant quantitative measurement value.

If the location of the radar station is unknown, it is particularly convenient to use the isotropic UBB27 antenna. However the trade-off is no information of the direction. The long delays between pulses may consume a great deal of time trying to detect signal direction with a LogPer aerial.

Please note that there are radar systems which operate at frequencies between 8.5 and 9.5 GHz (naval, aviation, traffic and weather radar), and which can be measured with our HFW59D.

Smart Meters

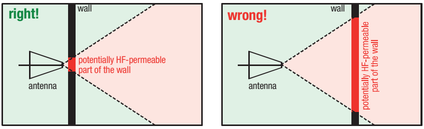
The frequencies / radio services implied are those of common wireless communication standards. The challenge when measuring smart meters emissions lies in their duty cycles. They transmit data in very short, irregular, and unpredictable, but intensive bursts that happen only about every 1 to 10 or even more minutes.

To measure these bursts use the standard setting (Peak hold/VBW standard), keep the meter in the same location and monitor it until a burst occurs.

The HF59B has a patented circuitry that allows for the exact measurement of the extra fast rise times of the bursts even in the "+"-setting for Peak hold.

Identify where the radiation enters a structure

As a first step eliminate sources from within the same room (e.g. cordless phones, wireless routers, etc.). Once this is completed, the remaining radiation will originate from outside. For remedial shielding it is important to identify those parts of the walls (including doors, windows and window frames!), ceiling and floor, which are penetrated by the radiation. To do this one should not stand in the centre of the room, measuring in all directions from there, but monitor the permeable areas with the antenna (LogPer) directed and positioned close to the wall[16]. That is because the antenna lobe widens with increasing frequency. In addition, reflections and cancellations inside rooms make it difficult and often impossible to accurately locate the "leaks". Please see the illustrating sketch below!



The uncertainty of localization with HF-antennas

The shielding itself should be defined and surveyed by a specialist, and in any case the area covered by it should be much larger than the leak.

[16] Please note: In this position the readings on the LCD only indicate relative highs and lows that cannot be interpreted in absolute terms.

Guidelines, Limiting and Precautionary Values

The official regulations in many countries specify limits far beyond the recommendations of environmentally oriented doctors, “building biologists” and many scientific institutions, and also those of other countries. They are vehemently criticised, but they are nonetheless “official”. The limit values vary depending on the frequencies looked at, and in the HF range of interest here they are between 4 and 10 W/m², i.e. they exceed the recommendations by far more than 10 million times (1 W/m² = 1,000,000 µW/m²). This point of criticism also applies to the limit values of other countries as well as of the ICRNIP (International Commission on Non-Ionizing Radiation Protection). Official limits are determined by the potential heat generation in the human body and are therefore consequently measurements of averages rather than peaks. This ignores the state of environmental medicine. The “official” limits are far beyond the range of this instrument, which is optimized for accurate measurement of power densities targeted by the building biologists.

The building biology guideline SBM 2015, widely accepted worldwide, classifies the following steps:

Building biology guideline acc. to SBM-2015
© Baubiologie Maes / IBN

Anomaly	**none**	**slight**	**strong**	**extreme**
(µW/m²)	< 0,1	0,1-10	10-1000	> 1000

Critical radio waves, such as pulsed or periodic signals (mobile phones, DECT, WLAN, digital radio, etc.) should be considered more damageable, especially when frequently measured, whereas less critical radio waves, such as unpulsed or non-periodic signals (VHF, short wave, MW, LW, analogue radio, etc.) can be considered less important, especially when less frequently measured.

The "Bund fuer Umwelt und Naturschutz Deutschland e. V." (BUND) proposes a limit value of 100 µW/m² for the outside of buildings. In view of the shielding properties of normal building materials, the values inside buildings should be far lower. In February of 2002, the Medical Authority of the Federal State of Salzburg, Austria, recommended to reduce its “Salzburger Precautionary Recommendation” from 1,000 µW/m² to 1 µW/m² inside buildings and max. 10 µW/m² outside. These limits are based on empirical evidence over the past few years.

In summary it confirms the justification of precautionary limits well below the present legal limits.

Note for users of cellular phones or Wifi:

Unimpaired reception of calls or Wifi is possible with power densities far below even the very strict precautionary recommendation of 0.01 µW/m² for pulsed HF frequencies by the SBM.

Audio Analysis of Modulation

The audio analysis of the modulated portion of the HF signal helps to identify the source of a given HF radiation signal. There is a selection of audio samples on our homepage ("Sound Samples" under RF and EMF Meters / High Frequency).

Important: For the audio analysis please set the switch on the right of the display to "Pulse" in order to eliminate acoustical markings ("rattling" with 16 Hz) of unpulsed signals (please see next chapter for details).

How to proceed:

For audio analysis, simply turn the volume knob of the speaker at the top of the case all the way to the left ("-"). If you are switching to audio analysis while high field strength levels prevail, high volumes can be generated quite suddenly. This is especially true for measurements which are to be taken without audio analysis. The knob is not fastened with glue to prevent over winding. However, if by accident you should turn the knob too far, simply turn it back again. No damage will be caused.

Sounds and signals are very difficult to describe in writing. The best way to learn the signals is to approach known HF sources very closely and listen to their specific signal patterns. Without detailed knowledge, the **characteristic signal patterns** of the following HF sources can be easily identified: 2.4-GHz telephones as well as cellular phones, the signal patterns of which can be divided into "a live connected phone call", "stand-by mode" and of special interest the "establishing of a connection". The typical signal patterns of a cellular phone base station can also be identified this way. For comparison reasons you are well advised to take measurements during high-traffic times, as well as some times during the night, in order to get familiarized with the different noises.

The volume can be controlled with the "audio" knob. Note: The power consumption of the speaker is directly proportional to the volume.

For a quantitative differentiation of the various radio services, we can offer selective frequency filters.

Analysis of the modulated / pulsed signal component (Full/Pulse)

The little switch at the right of the display allows to distinguish between the complete signal including the pulsed part and its pulsed or modulated part only.

As most of the presently used signals have a modulation of 100%, there is mostly only little difference between the two switch settings. Especially in the case of very low field strengths (only few µW/m²), we recommend to use the "Pulse" setting as the instrument noise is more than a factor 10 lower in this setting than in the "Full" setting.

Marking of CW signals

Un-pulsed signals by their very nature are not audible in the audio analysis and therefore easily missed. For that reason they are marked by a uniform "rattling" tone, with its volume proportional to its contents of the total signal. This "marking" has a frequency of 16 Hz, and is also available as audio sample on our website (see “Sound Samples”).

Note concerning the switch setting “Pulse“:

Under special laboratory conditions a signal can be created, which causes an additional deviation from the actual value of up to -3 dB. However, commercially used modulations under field conditions will only show minimal deviations.

Use of Signal Outputs

AC output:

The AC output “PC/headset” (3.5 mm jack socket) is meant for an in-depth analysis of the AM/pulsed content of the signal by headset or a corresponding PC-audiocard.

DC output (2.5 mm jack socket)**:**

The DC output is meant for a long-term recording of the display value. If “Full Scale” is displayed, it has 1 VDC output.

The auto power off function is automatically deactivated as soon as external devices are connected, but only as long as there is no threat of total discharge.

Further Analysis / Optional Accessories:

Available from Gigahertz Solutions:

- **The amplifier HV10** for a particularly high resolution, allowing measurements of very weak HF signals.
- **The Attenuator DG20_G10** allowing the measurement of very strong HF signals.
- **A Frequency filter** for a more specific differentiation of the various sources.
- **Meters for HF from 2.4 to 6 or 10 GHz** allowing the analysis of even higher frequencies, i.e. the HFW35C (2.4 - 6 GHz) or the HFW59D (2.4 - 10 GHz)
- **Meters for the low frequencies:** With the NFA series, which allows a three-dimensional measurement of alternating electrical and magnetic fields, Gigahertz Solutions offers a broad range of professional measurement technology also for this frequency range.
- **Data loggers:** All NFA meters can equally be applied as data loggers for long-term recordings.

Battery Management

The instrument comes with a rechargeable, high quality internal NiMH-Battery. The quality of these high-capacity NiMH batteries (far better than NiCd batteries, for instance) can be best maintained if they are almost totally discharged (i.e. used) before being fully re-charged (for > 13 hours or until the green charging LED turns off). The charging procedure is started by switching the meter on and off once only after connecting it to the power supply unit. Hint: Always carry a 9V primary battery with you.

Changing the Rechargeable Battery

The battery compartment is at the back of the analyser. To remove the lid, press on the grooved arrow and pull the cap off. **Insert only rechargeable batteries. If you use regular alkaline (non–re-chargeable) batteries do not use a charger or AC-adapter!**

Auto-Power-Off

This function conserves energy and extends the operating time.

1. In case you have forgotten to turn OFF the HF analyser or it has been turned ON accidentally during transport, it will shut off automatically after 40 minutes.
2. If “LOW BATT” appears vertically between the digits in the center of the display, the HF analyser will turn OFF after 3 min already in order to avoid unreliable measurements. In that case charge the rechargeable battery as soon as possible.
3. Auto-Power-Off is automatically de-activated when DC out is being used. In this case only total discharging is being prevented.

Mains operation

The HF analyser can also be supplied with power by using the mains adapter (for instance for long-term measurements in combination with the NFA). When doing so, please take care to turn the volume button right down to zero (“-”), otherwise you will be hearing the 50 Hertz noise of the mains voltage.

Interferences may, however, also be caused by high frequency couplings through the power supply unit. This can easily be tested by unplugging the power supply unit from the meter while in use. If the measurement value now shows a significant drop, this is a sign of an unwanted coupling.

For long-term measurements, the more reliable solution is to use an external battery with short cable to the power supply jack, or alternatively to apply ring ferrites onto the power supply cable (please see photo).

Warranty

We provide a two year warranty on factory defects of the HF analyser, the antenna and accessories.

Umrechnungstabelle
Conversion Table

(µW/m² - mV/m)

µW/m²	mV/m	µW/m²	mV/m	µW/m²	mV/m
0,01	1,94	1,0	19,4	100	194
-	-	1,2	21,3	120	213
-	-	1,4	23,0	140	230
-	-	1,6	24,6	160	246
-	-	1,8	26,0	180	261
0,02	2,75	2,0	27,5	200	275
-	-	2,5	30,7	250	307
0,03	3,36	3,0	33,6	300	336
-	-	3,5	36,3	350	363
0,04	3,88	4,0	38,8	400	388
0,05	4,34	5,0	43,4	500	434
0,06	4,76	6,0	47,6	600	476
0,07	5,14	7,0	51,4	700	514
0,08	5,49	8,0	54,9	800	549
0,09	5,82	9,0	58,2	900	582
0,10	6,14	10,0	61,4	1000	614
0,12	6,73	12,0	67,3	1200	673
0,14	7,26	14,0	72,6	1400	726
0,16	7,77	16,0	77,7	1600	777
0,18	8,24	18,0	82,4	1800	824
0,20	8,68	20,0	86,8	2000	868
0,25	9,71	25,0	97,1	2500	971
0,30	10,6	30,0	106	3000	1063
0,35	11,5	35,0	115	3500	1149
0,40	12,3	40,0	123	4000	1228
0,50	13,7	50,0	137	5000	1373
0,60	15,0	60,0	150	6000	1504
0,70	16,2	70,0	162	7000	1624
0,80	17,4	80,0	174	8000	1737
0,90	18,4	90,0	184	9000	1842

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