HF58B / HF58B-r / HF59B

High Frequency Analyser
27 MHz (HF59B) / 800 MHz to 2.7 GHz (up to 3.3 GHz with additional tolerance).

Instruction Manual

Revision 6.0 (08/14)
The devices of the professional HF5xx line are of identical configuration. The HF58B-r comes with an additional switchable video bandwidth, and the HF59B has an extended frequency range down to 27 MHz.

This manual is subject to continuous updates, amendments and adjustments. The most current version can always be found for download on your local distributor's homepage or under www.gigahertz-solutions.de
Please carefully review the manual before using the device. It contains important advice for use, safety and maintenance of the device. In addition it provides the background information necessary to make reliable measurements.

Thank you!

We appreciate the confidence you have shown in purchasing this HF Analyser. It will allow a professional analysis of the exposure with high frequency (HF) radiation corresponding to the baubiology recommendations.

Further to this manual you are welcome to have a look at the training videos on our homepage (www.gigahertz-solutions.de) for an optimal use of our measurement technology.

If you should encounter any problems, please contact us immediately. We are here to help.

For your local distributor pls check:

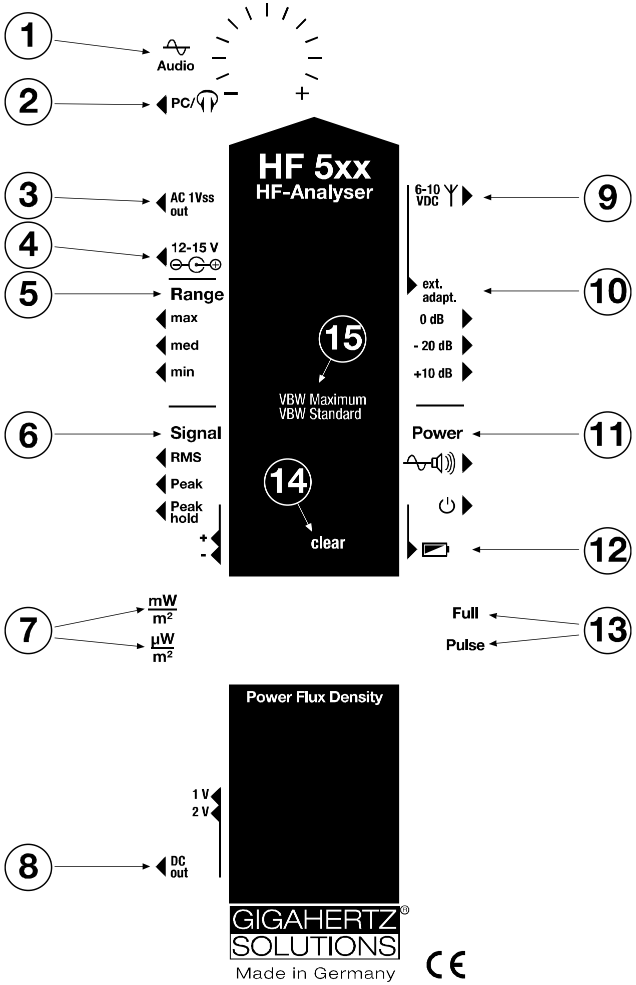
www.gigahertz-solutions.com

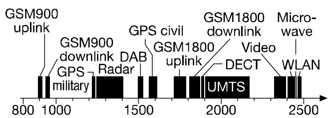
Contents

Safety Instructions:

The HF analyser should never come into contact with water or be used outdoors during rain. Clean the case only from the outside, using a slightly moist cloth. Do not use cleaners or sprays.

Due to the high sensitivity level, the electronics of the HF analyser are very sensitive to heat, impact as well as touch. Therefore do not leave the instrument in the hot sun, on a heating element or in any other damaging environment. Do not let it drop or try to manipulate its electronics inside when the case is open.





typ. HF-Services (MHz)

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

Functions and Controls

1) Volume control for the audio analysis (on/off switch ∿.🔊).

2) Jack, 3.5 mm : AC output for the modulated part of the signal, for audio analysis via PC or headset (mono).

3) Only for HF59B: 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 hold".** 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, allows you to connect additional instruments, e.g. data logging devices for longterm recordings. Scalable to 1 V DC full scale. (For HF59B: scalable to 2 V DC, only for the use of an external display unit).

9) Connecting socket for antenna cable. The antenna is inserted into the cross slot at the front tip of the instrument.

10) Power Level Adapter Switch for external optional amplifier or attenuator only (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**. Using the top switch-position ∿.🔊. activates the audio analysis mode.

12) **Load indicator**

13) **Signal fraction:** In the "Full" mode, the total signal strength is displayed. In the "Pulse" mode, only the pulsed / amplitude modulated part of the signal is displayed.

14) Push button to reset peak hold. (Push and hold for 2 seconds or until the reading no longer drops)

15) For HF58B-r and HF59B only: Switch for choosing the **Video Bandwidth**. **Standard setting: "VBW Standard"**

Typical default settings of major functions are highlighted in the above text.

Long and short switches

Long switches: Standard functions.

Short switches: In order to avoid unintentional switching for rarely used functions, some of the switches are recessed in the casing of the instrument.

Contents of the package

Instrument

Attachable antenna incl. cable

NiMH rechargeable Batteries
(inside the meter)

Mains adapter

Comprehensive instruction manual

Check the HF analyser and its antenna by following the instructions under “Getting Started.“

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 in that size.

Carefully check the tight fit of the connection at the antenna tip. This connection, at the tip of the antenna, must not be opened.

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.

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, break or stretch the antenna cable!

There are small ferrite-rolls fitted on the connectors of the antenna cable. They serve the purpose of fine-tuning[1]. *Do not remove them!*

[1] Should they loosen in the course of time, they can be glued with any household glue

The connection of the UBB27-antenna (optional for the HF59B, but included in the HF**E**59B-kit) is described in its 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. **If a non-rechargeable battery is used, do not connect the analyser to a charger / AC-adaptor !**

Insert fully charged batteries only.

Note

Each time you make a new selection (e.g. switch 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.

Introduction to Properties and Measurements of HF Radiation

This instruction manual focuses on those properties that are particularly relevant for measurements in residential settings.

Across the specified frequency range (and beyond), HF radiation causes the following effects in materials exposed to it:

1. Partial Permeation

2. Partial Reflection

3. Partial Absorption.

The proportions of the various effects depend, in particular, on the exposed material, its thickness and the frequency of the HF radiation. Wood, drywall, roofs and windows, for example, are usually rather transparent spots in a house.

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. In urban areas, however, it is sometimes already so highly deflected that it runs almost horizontally or at a 45-degree angle. 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.

Please note that the LogPer-antenna supplied with this instrument is optimized for one polarization only.

Fluctuations with Regards to Space and Time

Amplification or cancellation effects can occur in certain spots, especially within houses. This is due to reflection and is dependent on the frequencies involved. Most transmitters or cellular handsets emit different amounts of energy during a given day or over longer periods of time, because reception conditions and network usage change constantly.

All the above-mentioned factors affect the measurement technology and especially the measurement procedure. This is why in most cases several measurement sessions are necessary.

Measuring HF Radiation

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 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”. A transponder only needs to be tilted down by a few degrees in order to cause major changes in exposure levels (e.g. during installation or repair of cellular phone transmitters). Most of all it is the enormous speed with which the cellular phone network expands every day that causes changes in exposure levels. In the future we will also have to deal with third generation networks (e.g. UMTS or LTE), which are expected to increase exposure levels considerably since their system design requires much more tightly woven “cells“ of base stations compared to current GSM networks.

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. 2.4 GHz telephones, 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 though this particular value might 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 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.

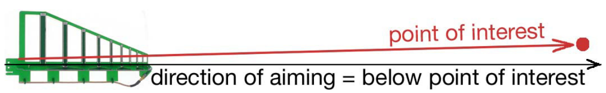
In addition, this device can also be used to identify the source of radiation, and – most important – to determine appropriate shielding measures. The logper antenna which comes with the meter is predestined for this aim.

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. To know exactly the direction from where a given HF radiation source originates is a fundamental prerequisite for effective shielding. 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.

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.

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.

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 (i.e. based on the spatial integral of the "antenna lobe").

The LogPer aerial supplied with the meter covers a frequency range of approx. 800 MHz to 2700 MHz (= 2.7 GHz), i.e. cellular phone frequencies (e.g. GSM900, GSM1800, TDMA, CDMA, AMPS, iDEN), 2.4-GHz (DECT) cordless phones, frequencies of third and fourth generation (3G/4G) technologies, such as UMTS, LTE, WLAN and Bluetooth, as well as other commercial frequency bands and microwave ovens. All the frequencies in between are also included. This is the frequency range in which you would find most of the pulse-modulated signals concerned scientists are worried about.

In order to avoid measurement values to be falsified by radiation sources from frequencies below 800 MHz when measuring with the LogPer antenna, the HF58B and the HF58B-r are equipped with an additional internal high pass filter at 800 MHz, causing these lower frequencies to be suppressed.

As the HF59B picks up frequencies below 800 MHz, it has no integrated high pass filter. However the filter 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 800 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 Isotropic Aerial?

The selection depends on the objective of the measurements and is clear in the following cases:

- For frequencies below 800 MHz the UBB27 aerial is the only option, as for geometrical reasons the LogPer antenna only starts at 800 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.
- However, when it comes to improve a given situation by shielding measures, then the location of the emmission of the radiation needs to be identified. To do that the LogPer technique is definitely superior to the isotropic measurement.

When it comes to quantifying the total emission in more detail, then one has to weigh the pros and cons of the two approaches against each other:

- 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. But the measurement is faster and more encompassing.
- On the contrary the LogPer aerial offers a higher precision and better localization for the same kind of work, and the interpretation of the results is easier. But a comprehensive measurement is more time consuming and restricted to a smaller frequency band.

Up to now no reliable and affordable isotropic aerials have been available. That is why most of the current guides to measuring techniques for biological evaluation of buildings consider LogPer aerials only. The UBB27 now offers an alternative. It remains to be seen how the community of experts will respond in the next few years.

Step-by-Step-Instruction to HF-Measurement

Measurements for a Quick Overview

This is helpful to gain insight into the overall situation. Since the actual number values are of secondary interest in this phase, it is usually best to simply follow the audio signals which are proportional to the field strength.

Procedure for the Quick Overview Measurement:

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

First set the measurement range ("Range") switch to "max". Only if the displayed measurement values are persistently below approx. 0.10 mW/m², change to the measurement range "med" (199.9µW/m²) or to "min" (19.99 µ W/m²).

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 loudness.

Set the "Signal" switch to "Peak"

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, you only need to listen to the **audio signal**. It is very easy to walk slowly through in-door or outdoor spaces in question. In doing so, constantly move the antenna or the HF analyser with attached antenna in each direction. This will provide you with a quick overview of the situation. In in-door spaces, antenna movements towards the ceiling or the floor will reveal astonishing results.

Quantitative Measurement:
Settings

Once the relevant measurement points have been identified following the instructions in the previous section, the quantitative and precise measurements can be started.

Setting: **"Range"**

Select the appropriate switch settings as described under "Quick Overview Measurements". Start with the 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.

Recommendations for the range "max"[2]:

Values < 0.15 **m**W/m²: Switch to "med"

Values > 0.15 **m**W/m² up to 1.5mW/m²:

- Ideally use HV10!
- Alternatively the larger value applies.

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

Note: When switching from "min" to "med", there will be no difference in volume.

Power densities beyond the designed range of the instrument (display shows "1" on its left side with the range set to "max") can still be measured by inserting the attenuator DG20_G3, available as an optional accessory. By setting the "ext. adapt." switch to 20 dB[3] on your instrument, you will ensure a correct display of the measurement value.

Also available is a HF preamplifier for a factors 10 (HV10) as a plug-in into the antenna input socket.

A list of all possible ranges can be found at the end of this brochure.

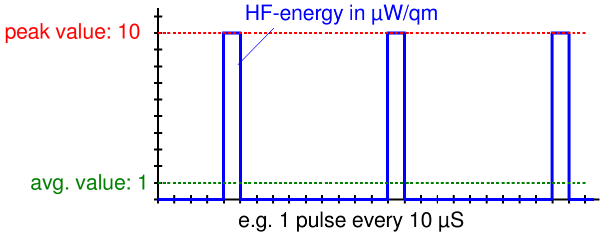
Setting: **Signal - Peak / RMS**

A pulsed signal consists of sections of its time period with high output and another sections with zero output. Their maximum output is the wave peak. The following illus-

[2] There is a factor of 100 between "med" and "max" thus allowing to display as large power flux densities as possible withouth having to apply an attenuator.

[3] Please note that you will have a very high noise level when doing recordings or using peak hold in this combination

tration 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”):



Note: The **peak HF radiation value**, not the average value, is regarded as the measurement of critical “biological effects“. The peak value is displayed in the switch setting: “Peak”. The average value is displayed in the switch setting: “RMS”.

An experienced measuring technician will be able to obtain additional information from the comparison of average and peak values. Basic Rule: The more the two measurement values differ from one another (in 2.4-GHz cordless phones the ratio can be as high as 1:100.), the higher is the potential of a contribution from e.g. a 2.4-GHz cordless phone or other pulsed signal source to the total maximum value.

Still today, some field meters only display average values. They are of little help when considering the potential health risks associated with pulse-modulated HF radiation since through the “averaging” of steep HF pulses, HF radiation exposure can be underrated up to a factor of 100, such as modern cordless phones (DECT).

Setting: Signal - Peak Hold

Many measuring technicians work with the function “Signal” “Peak hold“. In “Peak hold” mode the highest value of the signal within a defined time span can be obtained /“collected”.

In order to obtain accurate readings you must use the small black button on the meter face labeled "clear”. Failure to clear the LCD display screen by pressing this button, for two seconds, will result in inaccurate readings. While this button is pushed and held, the readings are regular "Peak" readings. If any switch settings are changed while measuring, and also in order to start any new "Peak hold" measurement, you must always first hold this "clear" button for 2 seconds, then release it. This will ensure accurate readings.

In everyday measurement practice this function has great value. The peak value is related to the actual signal situation. This is important because the immission situation can change rapidly with time, direction of the radiation, polarization, and the points of measurements. The “Peak hold” mode guarantees that you do not miss single peaks.

The tone signal works independently of data collection in the peak hold mode. Its sound is proportional to the actual value measured. It helps to identify the location, direction, and polarization of the maximum field strength.

You can chose the (inevitable) droop rate, at which the held peak value decreases over time. Set the switch below the signal evaluation switch (recessed in the casing) to “+” or “-”. In the slow mode it takes about 20 minutes to run out of tolerance, but in order to get an accurate reading the display should be checked frequently. If very short signal peaks occur then the holding capacity of the function needs some recurrences to load fully.

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 (HF59B), 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 (HF59B) you only need to do this in locations, where radiation from directly below or above cannot be ruled out (multistorey 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 standard’s setting institutions, as described earlier, quantitatively reliable, targeted and reproducible measurements are only possible under “free field conditions“ but not in indoor environments.

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

As the standard please set the instrument to “Peak hold” and “VBW standard[4]” (default in the HF58B).

The displays of the meters of this series 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” (default in the HF58B)[5].

For the compensation of the crest factor multiply the displayed reading by a correction factor. A flat factor of 10 offers a good approximation[6].

Often you will find different telecommunication services being present 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.

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

[5] 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 factor. 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.

[6] Even if the standards of these radio services in specify far higher crest factors, the industry strives for crest limitation for economic reasons, so that the resulting correction doesn't exceed a factor of 10.

Depending on the proportion to the total signal, please apply the following "rules of thumb":

- 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.[7]

Note the background noise level. In the combination of settings "VBW Maximum", "Range: min" *and* "Peak hold" noise can sum up to a value of 1.00 or more on the display. 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.

HF58B-r and HF59B:
Select setting "VBW Maximum". Set signal switch to "Peak hold" and direct the LogPer antenna towards the signal emitting source. Wait 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.

HF58B only:
The HF58B does not have the required VBW to perform a quantitative measurement of radio signals.

However the audio analysis identifies even those radar pulses that cannot be measured quantitatively. As long as the radar pulse results in a reading above the surrounding signal level you get a rough estimation by the following procedure:

To begin with use of the "Peak" setting to identify the main direction of the source and to check if the pulses are above the surrounding signal level.

Then switch to "Peak hold". Several circles of the radar ray should be awaited to reach a balance between drop and rise. This can take several minutes. Depending on the type and distance of the radar station, the real flux density will be at least a factor ten higher than the displayed reading.

Please note that there are radar systems that are operated at even higher frequencies than can be measured with these instruments.

Quantitative Measurement:
Smart Meters

The frequencies / radio services implied are those of standard wireless communication standards. The challenge with measuring emissions of smart meters lies in their duty cycles. They transmit data in very short, but intensive bursts that happen only about every 1 to 10 or even more minutes, where the period between the bursts is subject to change unpredictably.

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.

For the HF58B it is helpful to use the "-" ("minus") setting for Peak hold to catch the short bursts.

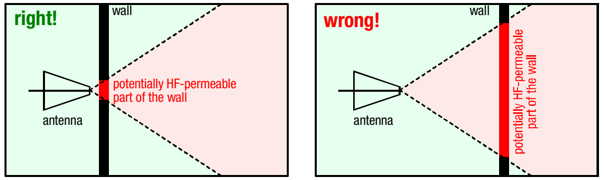
The HF58B-r and HF59B have a patented circuitry that allows for the extra fast rise times of the bursts even in the "+"-setting for Peak hold.

[7] For the time being with LTE a factor of 20 may still occur. For TETRA a factor of 2, for WLAN ("standby-rattling") a factor 4 is enough.

Quantitative Measurement:

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 areas of all 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[8]. That is because the antenna lobe widens with increasing frequency. In addition reflections and cancellations inside rooms make it difficult and often impossible to locate the "leaks" accurately. 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.

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

Limiting values, reference values, and precautionary values

Precautionary recommendation for pulsed radiation in sleeping areas

Below 0.1 µW/m²
(SBM 2008: "no concern")

below 1 µW/m² ("for indoors")
(Landessanitätsdirektion Salzburg, Austria)

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 limits depend on frequencies and in the HF range of interest here they are between 4 and 10 W/m², far beyond 10 million times the recommendations (1 W/m² = 1,000,000 µW/m²). Official limits are determined by the potential heat generation in the human body and 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 standard SBM 2008 cited above classifies power densities of below 1 µW/m² as "no anomaly" for non pulsed radiation in sleeping areas, and for pulsed radiation one tenth of that.

Building biology guideline acc.to SBM-2008
© Baubiologie Maes / IBN

	no concern	**slight** concern	**strong** concern	**extreme** concern
Readings in 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 100 µW/m² outside buildings. In view of the shielding properties of normal building materials, far lower values exist inside buildings.

In February 2002 the Medical Authority of the Federal State of Salzburg, Austria, recommends to reduce its "Salzburger Precautionary Recommendation" from 1,000 µW/m² to 1 µW/m² inside buildings and 10 µW/m² outside. These limits are based on empirical evidence over the past few years.

The ECOLOG-Institute in Hanover, Germany made a recommendation only for outside areas, namely 10,000 µW/m². This is well above the recommendation by building biologists and aims at getting consent also from the industry. This would possibly enable a compromise for a more realistic limit than the government regulations cited above. The authors qualify their recommendation in

- The limit should be applicable to the maximum possible emission of the transmitting stations. As the emission measured depends on the constantly varying actual load, this restricts the normal exposure much further.

- A single station should not contribute more than one third to this total.
- The extensive experience and findings of medical and building biology specialists could not be considered for the proposed limits, as their results are not sufficiently documented. The authors state, that “scientific scrutiny of their recommendations is needed urgently”.
- Not all effects on and in cells found in their research could be considered for the proposed limits, as their damaging potential could not be established with sufficient certainty.

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

Note for owners of cellular phones:

Unimpaired reception of calls 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 Frequency Analysis

Many different frequencies are being used by many different services. The audio analysis of the modulated portion of the HF signal, helps to **identify the source of a given HF radiation signal**.

First get the HF analyser ready for testing by following the instructions in the relevant section.

Important: For the audio analysis switch the small switch on the right of the display to “Pulse”. This will eliminate the content of unpulsed signals, since their acoustical marking (“rattling” with 16 Hz) will make the acoustical analysis difficult.

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 especially 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 familiarize yourself 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.

There is a selection of audio data samples on our homepage (www.gigahertz-solutions.de) – follow “Mulitmedia” – for you to have a listen to.

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

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

The feature to distinguish between these two types of radiation in absolute numbers has been introduced for a broad band instrument of this price range for the first time. This is a significant advantage over the commercial spectrum analysers, with which this differentiation requires extra work.

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

In the “Full” setting, the power densities of all signals in the frequency range of interest are displayed. In “Pulse” setting only those which are amplitude modulated are displayed. Signals like GSM (mobile phone), DECT, Radar and WLAN/Bluethooth and others can have similar intensities in either switch setting. Even within tolerance limits, they have no content of carrier frequency. Superposition and background radiation, however, will mostly lead to a moderate difference in intensity.

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 Mulitmedia).

<u>For HF59B: Please note:</u> When using the UBB27, the frequency band 27 to 800 MHz, which this antenna handles additionally, contains very many unpulsed frequencies. So you are likely to often find a “rattling” marker tone ...

This marking tone will only be audible with the switch to the right of the display set to “Full“. If the switch is set to “Pulse” the circuitry to suppress the content of unpulsed signals is activated. There will be nothing to be marked.

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. Under field conditions like DECT and GSM signals only minimal deviations.

Use of Signal Outputs

AC output:

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

For PC sound card or headphones or PC software please ask or write us.

DC output (2.5 mm jack socket):

For a longterm recording of the display value.

When “Full Scale“ is displayed, it has 1 VDC output, and 2 VDC can be set for HF59B.

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:

- **Attenuators** allowing an upward extension of the measurement range for strong signal sources
- **Frequency filters** 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 HFW59D (2.4 - 10 GHz)

Meters for the low frequencies:

Also for this frequency range, Gigahertz Solutions offers a broad range of professional measurement technology. The new NFA series, for instance, which allows a three-dimensional measurement of alternating electrical and magnetic fields.

All NFA-meters can equally be applied as data loggers for long-term recrodings with our HF analysers (only those with DC output).

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 recharged (until the green charging LED turns off).

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 – rechargeable) batteries do <u>not</u> use a charger or AC-adapter!**

Auto-Power-Off

This function conserves energy and extends the total 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 in order to avoid unreliable measurements. In that case charge the rechargeable battery.
3. The built-in function, Auto-Power-Off, will automatically be de-activated by plugging in a 2.5 mm DC. The function will also automatically be re-activated to prevent a total discharge of the battery by further operation.

Mains operation

The HF analyser can also be supplied with power by using the mains adapter (for instance for long-term measurements). 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.

Warranty

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

Remediation and Shielding

Please call us or send us an e-mail.

We will assist you in any shielding project you might have.

Any professionally implemented shielding solution will be of proven effect. There is a large selection of shielding possibilities, and an individually fitted solution is definitely recommendable.

The shielding effect of the various materials is normally stated in "- dB", e.g. "- 20 dB".

Conversion of shielding effect into reduction of power density

"-10dB" is measured value divided by 10
"-20dB" is measured value divided by 100
"-30dB" is measured value divided by 1000

Please be aware of the manufacturer's notes about the normally achievable shielding effects, as 100% shielding is almost always impossible. Partial shielding reduces the attenuation considerably. That is why shielding of seemingly radiation tight adjacent areas is highly recommended.

Measurement Ranges

Range	Bar on LCD	**Instrument as delivered,** i.e. without preamplifier or attenuator switch "Adapter"("Pegelanpassung") to "0 dB" **Displayed** value & unit
max	▮	0.01 - 19.99 **m**W/m²
med	▮	00.1 - 199.9 **µ**W/m²
min	▮	0.01 - 19.99 **µ**W/m²
Simply read out, no correction factor		

Range	Bar on LCD	**With ext. Attenuator DG20,** switch "Adapter" to "Attenuator -20 dB" **Displayed** value & unit
max	▮	1 - 1999 **m**W/m²
med	▮	0.01 - 19.99 **m**W/m²
min	▮	.001 - 1.999 **m**W/m²
Simply read out, no correction factor		

Range	Bar on LCD	**With ext. Preamplifier HV10,** switch "Adaptor" to "Amplifier +10dB" **Displayed** value & unit
max	▮	00.1 - 1999 **µ**W/m²
med	▮	0.01 - 19.99 **µ**W/m²
min	▮	.001 - 1.999 **µ**W/m²
Simply read out, no correction factor		

Conversion Table W/m² and V/m

nW/m²	**µ**W/m²	**m**W/m²	W/m²	**m**V/m	V/m
0,01	0,00001	0,00000001	0,00000000001	0,0614	0,0000614
0,1	0,0001	0,0000001	0,0000000001	0,194	0,000194
1	0,001	0,000001	0,000000001	0,614	0,000614
10	0,01	0,00001	0,00000001	1,94	0,00194
100	0,1	0,0001	0,0000001	6,14	0,00614
1.000	1	0,001	0,000001	19,4	0,0194
10.000	10	0,01	0,00001	61,4	0,0614
100.000	100	0,1	0,0001	194	0,194
1.000.000	1.000	1	0,001	614	0,614
10.000.000	10.000	10	0,01	1.940	1,94
100.000.000	100.000	100	0,1	6.140	6,14
1000.000.000	1.000.000	1.000	1	19.400	19,4
10.000.000.000	10.000.000	10.000	10	61.400	61,4

mV/m and V/m – figures are rounded!

Why no column „dBm"?

Most recommended limiting values for HF radiation are given in W/m² (sometimes also in V/m), which is why this instrument is displaying in power density, µW/m² resp. mW/m². A display in dBm as e.g. on a spectrum analyser requires transformation by a complicated formula, which depends on frequency and specifics of the antenna used. A "reconversion" therefore does not make sense.

Conversion Table

(µW/m² to V/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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