HF59B

HF Analyzer for Frequencies from 800 MHz to 2.5 GHz (to 3.3 GHz with additional tolerance; ready for Frequencies from 27 MHz with optional Antenna)

Instruction Manual

Revision 4.5

This manual will be continuously updated, improved and expanded. You will find the current version at your local distributors homepage or at 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.

Professional Technology

With the HF analyzers, GIGAHERTZ SOLUTIONS© sets new standards in HF testing. Professional measurement engineering is offered with a unique price/performance ratio - the only one of its kind worldwide. This was made possible through the consistent use of innovative integrated components, as well as highly sophisticated production engineering. Some features have patents pending.

The HF analyzer you purchased allows a competent assessment of HF exposures between 800 MHz and 2.5 (3.3) GHz, with optional antenna down to 27 MHz. From a building biology perspective, this particular frequency range is particularly relevant because cellular phones, cordless phones, microwave ovens as well as next-generation technologies such as UMTS/3G or Bluetooth and WLAN all make extensive use of it.

We appreciate the confidence you have shown in purchasing this HF Analyzer. With the confidence that your expectations will be met, we wish you great success in collecting valuable information with this HF analyzer.

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

Functions & Controls	2
Getting Started	3
Introduction to Properties and Measurement of HF Radiation	4
Step-by-Step-Instruction to HF-Measurement	5
Limiting values, recommendations and precautions	11
Audio Frequency Analysis	12
Analysis of the modulated / pulsed signal	13
Use of Signal Outputs	13
Battery management	14
Remediation and Shielding	15
Warranty	15
Conversion tables	16

Safety Instructions:

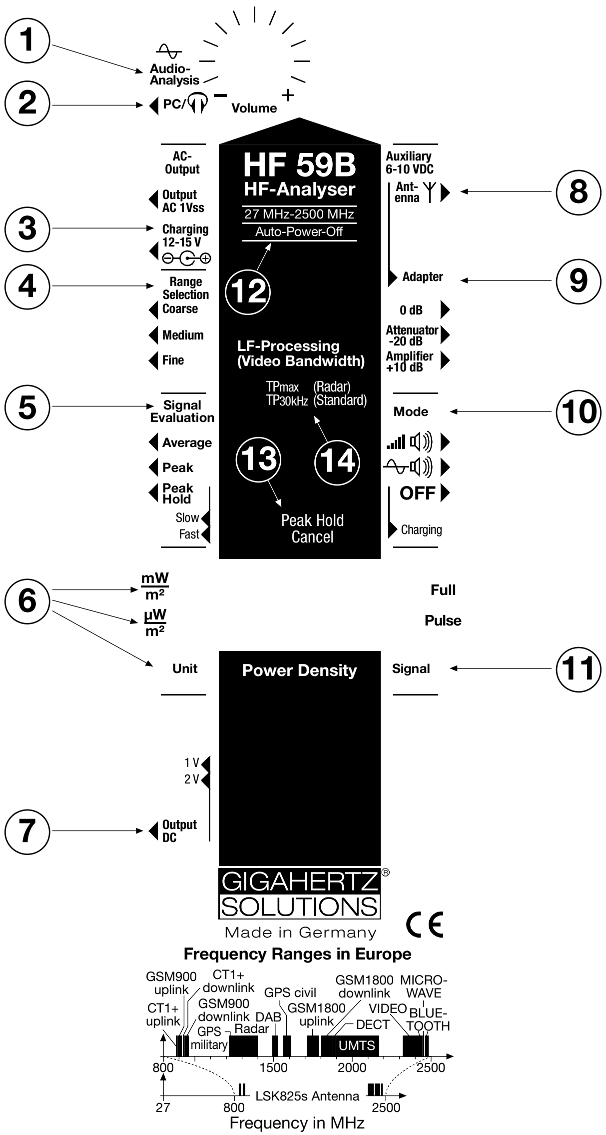
It is imperative to carefully study the instruction manual prior to using the HF analyzer. Important information regarding safety, use and maintenance is provided herein.

The HF analyzer 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.

Prior to cleaning the HF analyzer or opening the case, shut it off and unplug all extension cords. There are no user-serviceable parts inside the instrument.

Due to the high sensitivity level, the electronics of the HF analyzer 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 other damaging environments. Do not let it drop or try to manipulate its electronics inside when the case is open.

This HF analyzer should only be used for the purposes described in this manual and only in combination with supplied or recommended accessories.



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

Functions and Controls

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.

3) 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.

4) **Measurement ranges**
coarse = 19.99 mW/m² (=19 990µW/m²)
medium = 199.9 µW/m²
fine = 19.99 µW/m²
Scaling with external amplifier or damper is different!

5) Selector switch for **signal evaluation. Standard setting: "Peak".** In peak hold mode you can choose a time setting for the droop rate (Standard = Slow) With the push button (pos. 13) you can manually reset the peak hold value.

6) 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 = **u**W/m² (Microwatts/m²)

7) DC output, allows you to connect additional instruments, e.g. data logging devices. Scalable to 1 or 2 VDC full scale.

8) Connecting socket for antenna cable. The antenna is inserted into the "cross like" opening at the front tip of the instrument.

9) Power Level Adapter Switch for external optional amplifier or attenuator only. 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.)

10) **ON/OFF switch.** In middle switch-position . .., the audio analysis mode is activated. In upper position setting, you can additionally hear a signal similar to a "Geiger counter", proportional to the field strength[1].

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

12) This instrument has an "Auto-Power-Off function" to avoid unintentional discharge of the battery[2].

13) Push button to reset peak hold. (Push and hold for 2 seconds or until the readings do not further decrease)

14) Switch for choosing the **Video Bandwidth** for the LF-Signal processing. **Standard setting: "TP30kHz"**

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

---

[1] For this feature the volume control should be turned down completely because otherwise the sound mixes with the "audio analysis". Similar to Geiger counter.

[2] The instrument switches off after about 30 Minutes at regular charging level of the battery and after about 3 Minutes when "Low Batt." is displayed on the LCD.

Long and short switches

Some of the switches are recessed in the casing of the instrument to avoid unintentional switching for rarely used functions

Contents of the package

Instrument

Attachable antenna

NiMH rechargeable Batteries
(inside the meter)

AC-Adaptor

Several Adaptor-connectors

Comprehensive instruction manual

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

Getting Started

Connecting the Antenna

Screw the angle connector of the antenna connection into the uppermost right socket of the HF analyzer. 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 has 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 LED’s for monitoring the proper function of all connections of the antenna and the cable during operation. The red one 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 analyzer. 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!

The antenna can be used by attaching it to the top end of the HF analyzer or holding it in your hand. When holding the antenna in your hand, please ensure that your fingers do not touch the first resonator or antenna conductors. Therefore it is recommended to hold it at the opposite end. For a precision measurement, the antenna should not be held with your fingers, but be attached to the designated slot at the top end of the HF analyzer.

There are small ferrite-rolls fitted on the connectors of the antenna cable. They serve the purpose of fine-tuning[3]. *Do not remove them!*

The connection of the UBB27-antenna (option for the HF59B, included in the HFE59B-kit) is described in its manual.

Checking Battery Status

When the “Low Batt“ indicator appears in the center of the display, measurement values are not reliable anymore. In this case the battery needs to be charged.

If there is nothing displayed at all upon switching the analyzer 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 that 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.

[3] Should they loosen they can be glued again with any household glue

Introduction to Properties and Measurement 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/m²), 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:

- At 27 MHz from ca. 27 meters
- At 270 MHz from ca. 2.7 meters
- At 2700 MHz from ca. 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 sometimes is 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 (**vertical** if mounted to the instrument - even if the horizontal “wing” suggests the opposite.)

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 procedure for testing. This is why in most cases several testing 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/3G), 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 analyzer 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, only slight changes in the positioning of the HF analyzer can lead to rather substantial fluctuations in measurement values. (This effect is even more prevalent 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, usually changes only if the HF sources change, which is why the latter value is much more representative of the assessment of HF exposure.

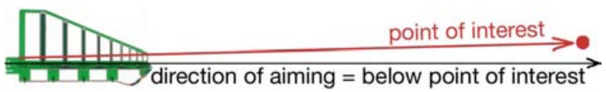
Step-by-Step-Instruction to HF-Measurement

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 <u>below</u> 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 reflect the integral power density in the "antenna lobe". (ie., the antenna is most sensitive, with a rounded peak, to radiation from a direction parallel to its axis with the sensitivity tapering off rapidly with increasing angle of incidence.)

The frequency range of the LogPer aerial supplied covers cellular phone frequencies (e.g. GSM800, GSM1900, TDMA, CDMA, AMPS, iDEN), 2.4-GHz (DECT) cordless phones, frequencies of third generation technologies, such as UMTS, 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 which you would find most pulse-modulated signals, concerned scientists are worried about.

For monitoring of these critical sources of radiation as conveniently as possible the frequency band of the LogPer aerial supplied together with the instrument has been limited intentionally by its design to frequencies above 800 MHz, i.e. frequencies below 800 MHz are suppressed. This reduces the impact of most sources like radio broadcasting, television stations or amateur radio on the measurements to an acceptable level. Yet few very strong sources, e. g. FM broadcast may still be picked up in some intensity. So don't be surprised if your analyzer picks up a local radio station!

In addition, there are 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 downloaded as an MP3 file from our home page. With the switch to the right of the display in the "Pulse" position, these (sources of radiation and the rattling "marking" are blanked out.

To significantly enhance the desirable suppression of frequencies below 800 MHz by the aerial itself one can use the 800 MHz high pass filter which we offer as an extra accessory. This small filter can be screwed between the aerial cable and the instrument itself. We recommend to have it screwed tightly to the aerial cable permanently. Below 600 MHz its dampening exceeds 40 dB (equivalent to a factor of more than 10 000). From 800 MHz to 600 MHz the filter curve drops steeply.

In order to measure frequencies below 800 MHz down to 27 MHz one can use Gigahertz Solutions active horizontally isotropic ultra broad band aerial, the **UBB27**. It can be screwed to the aerial input socket of the instrument.

Information concerning the UBB27 Aerial
This unit comes as an extra accessory to the HF59B kit, but is an included accessory in the HFE59B kit..

Using the UBB27 Aerial, even frequencies below 800 MHz can be measured reliably. It is omni-directional antenna in the horizontal plane. It responds to frequencies from 27 MHz onward to far beyond the upper limit of the range of the HF59B.

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.
- Also 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 has to be identified. To do that the LogPer technique is definitely superior to the isotropic measurement.

When it comes to quantify 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 new **UBB27** now offers an alternative. It remains to be seen, how the community of experts will respond in the next few years.

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. (Set“ On/Off“ switch (“Mode” to:), and turn down the audio analysis knob to low).

Procedure for the
Quick Overview Measurement:

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

First set the measurement range (“Range Selection”) switch to “Coarse”. Only if the displayed measurement values are persistently below ca. 0.10 mW/m^2, change to the measurement range “Medium” (199.9µW/m^2) or to “Fine” (19.99 µ W/m^2).

Set the “Signal Evaluation” 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 at lower frequencies, it is neither feasible nor necessary to measure all directions at any given point.

Since this is not an accurate quantitative measurement, but a quick overview assessment, the antenna can be removed from the top end of the HF analyzer, for convenience. Holding the antenna at its very end as described in “Getting Started”, the polarization plane (vertical or horizontal) can easily be changed with a turn of your wrist. However, you can just as well use the HF analyzer with the antenna attached to it.

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 moving the antenna or the HF analyzer 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.

Note: When switching from „19,99mW/m^2“ to „199,9µW/m^2“ the audio signals gets much louder; Between „199,9µW/m^2“ and „19.99µW/m^2“ there is no difference in loudness.

As already mentioned above, overview measurements are not meant to provide accurate results, but to identify those zones within which local peak values are found.

Quantitative Measurement: Settings

After having identified the relevant measurement points following the instructions in the previous section. The actual testing can begin.

Setting:
Measurement Range Selection

Select the appropriate switch settings as described under “Quick Overview Measurements“. Basic rule for measurement range selection:

- As coarse as necessary, as fine as possible.

Note:

To allow for as wide a range of power densities to be read out without using an external attenuator, a factor of 100 lies between adjacent ranges. That means for example an actual value of 150 **µ**W/m^2 will be displayed as 150.0 **µ**W/m^2 in the range “Medium” and as 0.15 **m**W/m^2 in the range “Coarse”. Due to technical reasons the tolerances of the instrument are relatively high in this overlapping 1% of the next higher range[4].

Rules of thumb for the interpretation of the results

Readings in the two adjacent sensitivity ranges “Medium” and “Coarse” <u>use the one with the higher value.</u>

Numbers below 0.05 mW/m^2 shown in the range “Coarse” are within the range of its potential zero bias. Use the reading shown in range “Medium”.

[4] Power densities of a few hundred µW/m^2, displayed as 0.01 up to about 0.30 mW/m^2 in the setting "Coarse", are those with the highest measurement uncertainties as % of the actual values. On the other hand setting the switch to "Medium" activates an internal amplifier, which brings with it an additional waviness of up to +/- 1 dB, depending on the actual frequency analysed. Worst case combined to worst case could absorb almost +/- 3 dB, the maximum tolerance of the instrument. For very small readings in "Coarse" that could result in a factor of 4 difference of the corresponding reading with setting "Medium". Numerical example: In "Medium" you read 150.0 µW/m^2. In "Coarse" you could read up to 0.6 mW/m^2 or down to 0.03 mW/m^2 in an extreme case. Normally the differences shown will be much smaller.

For comparative measurements (before / after shielding) use the same range selector position when possible.

Power densities beyond the designed range of the instrument (display shows “1” on its left side with the range set on “Coarse”) can still be measured by inserting the attenuator DG20_G3, available as an optional accessory. By setting the “Adapter” switch to “Attenuator – 20 dB on your instrument ensures the correct display of the measurement.

Also available are two HF preamplifiers for factors 10 (HV10) and 1000 (HV30) as plug-ins into the antenna input socket[5]. Theoretically the HF59B would have a minimum resolution of 0.0001 µW/m², displayed as 0.01 Nanowatt/m². The actual minimum resolution depends on the video bandwidth selected. When the video Bandwidth Switch is set to:

- TPmax (Radar) : Approx. 1 nW/m²
- TP 30kHz (Standard) : Approx. 0.1 nW/m².

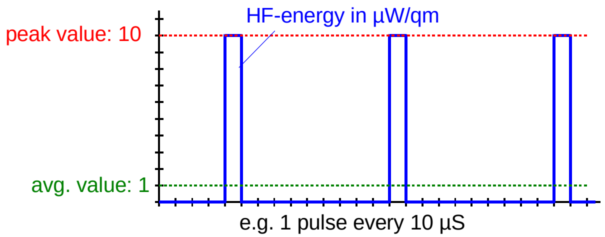
A list of all ranges, which can be measured and displayed, is at the end of this brochure.

[5] The power level adaptor switch is provided for the factor HV10 amplifier only, not for the HV1000. The HV1000, has the decimal point in its correct position. The numbers are displayed in **nano**W/m² instead of µW/m² which is indicated on the LCD.

Setting:
Signal Evaluation

Signal Evaluation – Average / Peak

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 illustration shows the difference in the evaluation of a pulsed signal if displayed as an average value reading or a peak value reading.



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: “Average”.

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 in 2.4-GHz cordless phones.

Signal Evaluation – Peak Hold

Many measuring technicians work with the function “Signal Evaluation” “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 "Peak Hold Cancel. 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 "Peak Hold Cancel" 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.

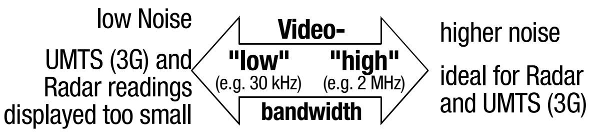
You can chose the (inevitable) droop rate, at which the held peak value decreases over time. Set the switch below the signal evaluation switch (recessed in the casing) to “Slow” or “Fast”. In “Slow” mode it takes about 20 minutes to run out of tolerance, but in order to get an accurate reading the display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

Setting:
LF-Processing - Video Bandwidth

The video bandwidth defines the minimum duration of short pulses that still can be measured by the meter without being distorted.

For measurement of exceptionally short pulses (e.g. Radar) or specific signals like UMTS/3G an extremely high video bandwidth is needed for accurate readings. The HF59B allows for 2 MHz video bandwidth, an unparalleled high value which guarantees the best accuracy available on this sector.

Use the setting “TPmax” only for measuring radar and UMTS/3G signals, as along with the high video bandwidth comes a higher noise level as illustrated in the picture below.



The standard setting therefore is “TP30kHz”. Only if a Radar signal or UMTS (G3) signal is detected, by means of the audio analysis, the “Tpmax” setting is used.

Some technical background

The circuits processing the incoming high frequencies are only a small fraction of the total circuitry. Their output is a signal proportionate to the power density in the frequency of the modulations or the pulses of the incoming HF signal, i.e. an LF signal in the broadest sense.

The video bandwidth is important for the potential as well as the limitations of an instrument. Your HF analyzer allows you to select between two settings of bandwidth, depending on the objective of the measurement:

- TPmax (Radar): With this setting the full 2 MHz bandwidth is at your disposal. Select this when you have identified Radar or a UMTS/3G signal by audio analysis. Please note that with this setting not only the UMTS/3G and the Radar signals are measured, also any signals from other sources in this frequency range. **With this setting TPmax and the range selector “fine” the noise can be up to a value between 30 and 120 digits.** The tolerance level of bandwidth and associated noise is wide, but the bandwidth is beyond 2 MHz minimum. A high noise level indicates an even higher bandwidth of the instrument[6].

Please note: In view of the unavoidable higher noise associated with the high video bandwidth one should not use TPmax as standard setting.

- TP30kHz (Standard): This should be the standard default setting for general purpose use of the instrument. The video bandwidth is about 30 kHz, which will represent the shortest continuously pulsed signals (e.g. DECT) without distortion. At the same time, even with the range switch on “Fine” the noise is significantly less than with TPmax.

[6] When the setting “Tpmax” and “Peak Hold – slow” is chosen the reading on the display will at first rise for a few second or even minutes, as also minute stochastic peaks will be picked up and retained, which in normal processing would be just “averaged out”. After some time some slightly varying state of equilibrium will be established.

Quantitative Measurement: Determination of Total High Frequency Pollution

As described in Getting Started, attach the LogPer **antenna to the HF analyzer.** Hold the HF analyzer 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 analyzer 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 analyzer. 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 analyzer, 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 (multistorey buildings, town houses, etc)
- C**hange** 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.

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 German national standard-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.

Quantitative Measurement: **Special case 1: UMTS / 3G**

(Universal Mobile Telecommunication System, also known as the third generation of mobile phones.) This technology is designed to process huge amounts of data and has a narrowly meshed network.

For measuring UMTS/3G the switch "Low Frequency" Video Bandwith should be set to "TPmax".

With LogPer aerial and in "Peak " mode identify the main direction of the signal and switch to " Peak Hold – long"

Now "gather" the highest value without moving the meter (use a wooden tripod) for at least 2 minutes in the same position. This is important as because of the signal characteristics of the UMTS/3G signal fluctuations by the factor +/- 6 are common.

To hear samples how a UMTS/3G signal sounds in the audio-analysis please check our website for links to MP3 files.

Please note that when measuring UMTS/3G you should <u>not</u> use the combination of switch-positions "Average" <u>and</u> "Pulse" .

Quantitative Measurement: **Special Case 2: 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.

The HF59B with its video bandwidth of 2 MHz provides this technology. Please use the following procedure to ensure correct readings:

Setting: Video bandwidth to "Tpmax". Signal Evaluation – "Peak". With the help of the audio analysis (a very short "Beep" every couple of seconds), one can clearly identify a radar signal. With this setting and the LogPer antenna you can identify the direction of the source of the signal.

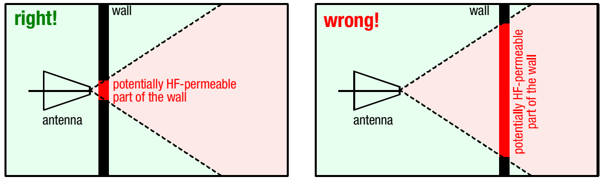
With the signal Evaluation switch set to "Peak Hold" and the LogPer antenna directed towards the signal emitting source. Wait for several circles of the radar ray, move the instrument a little left and right in order to get the relevant maximum reading.

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 that are operated at even higher frequencies that can be measured with this instrument, yet possibly not the full intensity.

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 <u>not</u> 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[7]. 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

[7] 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, recommendations and precautions

Precautionary recommentation for sleeping areas for pulsed radiation

Below 0.1 µW/m²
(SBM 2003)

below 1 µW/m²
(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. 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 2003 cited above classifies power densities of below 1µW/m² as "no anomaly" for non pulsed radiation in sleeping areas, and for pulsed radiation one tenth of that.

The "Bund fuer Umwelt und Naturschutz Deutschland e. V." (BUND) proposes 100 µW/m^2 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 Salzburg, Austria, recommends to reduce its "Salzburger Precautionary Recommendation" from 1 000 µW/m^2 to 1 µW/m^2 inside buildings and 10 µW/m^2 outside. These limits are based on empirical evidence over the past few years.

The ECOLOG-Institute in Hannover, Germany made a recommendation only for outside areas, namely 10000 µW/m^2. 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 0.1 µW/m^2 for pulsed HF frequencies by the SBM 2003.

Audio Frequency Analysis

Many different frequencies within the frequency band between 800MHz and 2.5GHz, are being used by many different services. The audio analysis of the modulated portion of the HF signal, help to **identify the source of a given HF radiation signal**.

First get the HF analyzer 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.

Set the On/OFF switch at .

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 (base station and handset) 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 “volume” (speaker) knob. Note: The power consumption of the speaker is directly proportional to the volume.

The optional variable frequency filters VF2 or VF4 available help to facilitate the audio analysis significantly and at the same time add to its accuracy. They filter out individual frequencies so contributions from other sources can be identified.

On our home page (www.gigahertz-solutions.de) is a link to some typical samples of audio analyses as MP3-files.

For more on acoustical marking of un-pulsed signals see the next section.

Analysis of the modulated / pulsed signal (total / pulse)

The exposure limits of pulsed radiation (acc. to SBM2003) are lower by a factor of 10 than that of non–pulsed signals. It is very important to distinguish between these two types. Without this knowledge you will not be able to determine which limit to apply.

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 analyzers, 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 unpulsed 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 an audio sample can also be downloaded as a MP3 file from our website.

Please note when using the UBB27: The frequency band 27 to 800 MHz, which this antenna handles additionally, contains very many un-pulsed frequencies. One is even more likely to find the “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 un-pulsed 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 PC-audiocard and appropriate software.

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

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

For logging devices or optional external display unit.

When “Full Scale“, is displayed, it has 1 or 2 VDC output, depending on the position of switch 7.

The auto power off function is deactivated if external devices are connected. Nevertheless, the battery is still protected against total discharge.

Further Analysis / Optional Accessories:

Gigahertz Solutions offers a range of preamplifiers and attenuators, to widen the range of power densities which can be processed with this instrument, See section Quantitative Measurement.

Furthermore there are two variable frequency filters ("variable traps") for quantitative separation between different sources of radiation. One of them blocks the selected frequency by 20 dB to one hundredth of its real intensity; the other version blocks by 40 dB for a more accurate reading.

Future developments for this instrument:

1. A digital extension module, which amongst other features will enable to display the results in other units, like e.g. V/m and widen the range displayable to 49990 instead of the present 19990 digits.
2. A digital internal extension module for recording of single readings or for a long term series of readings (data logging) including PC software for their evaluation.

Antenna / Aerial for lower frequencies

For measurement of signal frequencies above 27 MHz (including: CB radioing, analogue and digital TV and radio TETRA etc.) we offer the compact quasi isotropic **U**ltra **B**road **B**and Aerial **UBB27** with a range from 27 MHz to far into the Gigahertz range. It is included in the HFE59B-kit.

Instrument for yet higher frequencies

For the analysis of yet higher frequencies (up to about 6 GHz, i.e. WLAN, WIMAX and some directional radio sources and flight radar) the HFW35C is available from Gigahertz Solutions. Frequencies below 2.4 GHz are being suppressed by this instrument to ensure precise analysis of these higher frequencies

Available for low frequencies:

Electrosmog is not limited to the Radio Frequency range!

Also for the low frequency range such as power (distribution and domestic installations) including their higher harmonics we offer a broad range of affordably priced instruments with high professional standards.

Please refer to a list of contacts is at the end of this brochure.

Battery Management

Conditioning of the internal rechargeable battery

The instrument comes with a rechargeable internal NiMH-Battery. This should be conditioned to achieve its maximum capacity.

Please proceed as follows:

1. Plug the included, 2.5mm **adapter connector** into either the AC or DC output. This will deactivate the automatic power off function. Switch on the meter until it turns off (which happens automatically shortly before the battery is damaged by "deep discharging")
2. Connect the AC-Power adaptor. The green "Charging" LED should turn on. If not, switch the analyzer on and then off until it turns on.. After 10 to 13 hours the charging process will finish automatically. When charging is complete, the green LED will turn off automatically.
3. Repeat this procedure one or two more times. Repeat every few months to maintain maximum charging capacity.

The rechargeable battery will thank you with a longer life and a full capacity.

Changing the rechargeable Battery

The battery compartment is at the back of the analyzer. 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 not 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 analyzer or it has been turned ON accidentally during transport, it will shut off automatically after 40 minutes of continuous use.
2. If "low batt" appears vertically between the digits in the center of the display, the HF analyzer 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 only be de-activated by plugging in a 2.5mm jack into one of the output sockets AC or DC, see "Conditioning…" two sections up. The function will be re-activated to automatically prevent total discharging of the battery by further operation.

Remediation and Shielding

Please call us or send us an e-mail.

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

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

Conversion of shielding effect into reduction of power density

„-10dB“ is measured value divided by 10
"-15dB" is measured value divided by ~30
"-20dB" is measured value divided by 100
"-25dV" is measured value divided by ~300
"-30dB" is measured value divided by 1000
etc.

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.

Warranty

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

Antenna

Even though the antenna appears to be rather delicate, it is made from a highly durable FR4 base material that can easily withstand a fall from table height.

HF Analyzer

The analyzer itself is not impact proof, due to the comparatively heavy battery and the large number of wired components.

Any damage as a result of misuse is excluded from this warranty

Measurement ranges of the HF59B

Range	Bar on LCD	**Instrument as delivered,** i.e. without preamplifier or attenuator switch "Adapter"("Pegelanpassung") to "0 dB" **Displayed** value & unit
Coarse		0.01 - 19.99 **m**W/m²
Medium		00.1 - 199.9 **µ**W/m²
Fine		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
Coarse		1 - 1999 **m**W/m²
Medium		0.01 - 19.99 **m**W/m²
Fine		.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
Coarse		00.1 - 1999 **µ**W/m²
Medium		0.01 - 19.99 **µ**W/m²
Fine		.001 - 1.999 **µ**W/m²
Simply read out, no correction factor		

Range	Bar on LCD	**With ext. Preamplifier HV30,** switch "Adapter"("Pegelanpassung") to "0 dB" **Displayed** value & unit	**Actual** unit
Coarse		0.01 - 19.99 **m**W/m²	**µ**W/m²
Medium		00.1 - 199.9 **µ**W/m²	**n**W/m²
Fine		0.01 - 19.99 **µ**W/m²	**n**W/m²
Same decimal point, but next smaller unit			

(Coarse = grob; Medium = mittel; Fine = fein)

Conversion Table W/m² and V/m

nW/m²	µW/m²	mW/m²	W/m²	mV/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 analyzer 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

DRU0163