HF38B

RF Analyzer for Frequencies from 800 MHz to 2.5 GHz

Instruction Manual

It is imperative to carefully study the instruction manual prior to using the RF analyzer.

Much important information regarding safety, use and maintenance is provided herein.

Professional Technology

With the RF analyzers, GIGAHERTZ SOLUTIONS© sets **new standards** in RF 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, some of which have patents pending, as well as highly sophisticated production engineering.

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

We appreciate the confidence you showed when purchasing the RF Analyzer HF35C. With the confidence that your expectations will be met, we wish you great success in collecting useful information with this RF analyzer.

In addition to this instruction manual, our partners and we also offer **User Workshops** on how to optimize the use of our testing equipment as well as efficient shielding strategies.

If you should encounter any problems, please contact us immediately. We are here to help you in a professional, efficient and customer-friendly manner.

Contents

Safety Instructions:

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

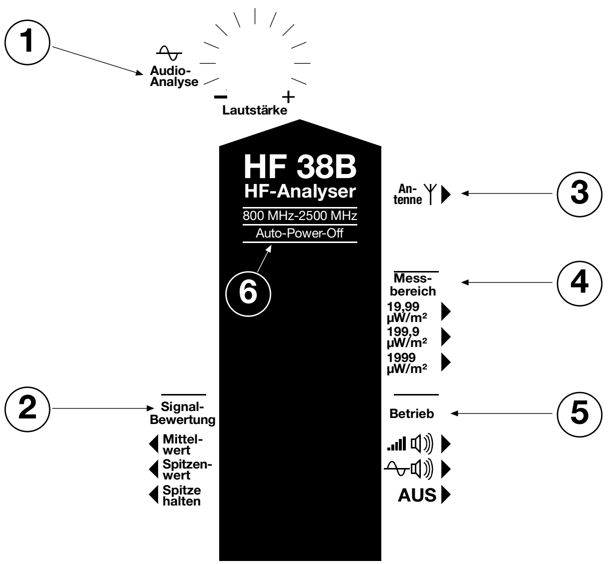
The RF analyzer should never come into contact with water or be used outdoors during rain. Clean the case only from the outside, using a slightly moist cloth. Do not use cleaners or sprays.

Prior to cleaning the RF 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 RF 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 the like. Do not let it drop or try to manipulate its electronics inside when the case is open.

This RF analyzer should only be used for the purposes described herein and only in combination with supplied or recommended accessories.

Functions & Controls



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

1) Volume control of the speaker for the audio analysis. While using the signal patterns - whose sound levels are directly proportional to their field strength – for analysis, the volume control should be turned completely to the left.

2) Switch for selecting signal assessment. Default setting: Peak value

3) Connector socket for antenna cable. The antenna itself can be fit vertically into a slot at the top end of the RF analyzer.

4) Switch for selecting measurement ranges

fine	=	19.99	mW/m^2
medium	=	199.9	µW/m^2
coarse	=	1999	µW/m^2

The factory setting is in uW/m^2 (indicated through a little bar at the bottom of the display) Amplifier and attenuator available (each factor 100) Please contact us.

5) On/Off Switch. At the uppermost position a signal proportional to the field strength is added. At the middle position the audio analysis is enabled (1).

6) The RF analyzer is equipped with an Auto-Power-Off-Function in order to prevent unintended discharging of the battery.

Contents of RF Analyzer

RF Analyzer, detachable antenna with antenna cable, alkali-manganese battery (possibly built-in the instrument), comprehensive instruction manual.

Getting Started

Turning On

If no display is activated, insert new battery. (See section „Changing Battery“)

Battery Voltage Check

If the „low-batt.“ indicator appears vertically in the center of the display, measurement values are not reliable anymore. In this case, change the battery. This RF analyzer requires a high-quality alkali-manganese battery with a 9-volt nominal voltage. 9-volt rechargeable batteries are not recommended.

Function Testing

Basics

Any RF analyzer can only be calibrated with a certain measurement **tolerance**, which is also affected by environmental conditions and the age of the instrument.

This tolerance becomes especially unpleasantly noticeable in values close to zero („offset“ or „zero point deviation“). It is therefore common practice among manufacturers of testing equipment in this price range to simply ignore this crucial tolerance value. This of course does not mean that the tolerance value would not exist, but it looks better! Beside a reasonable range of functions, the most important aspect of using a testing instrument is to be sure that the stated tolerances are also met. The tolerance values technically achievable in the RF testing technology are several times higher than those in the ELF range.

Actual Function Testing

Turn on RF analyzer with the antenna still detached and wait a few seconds until the display has „settled“ down. The displayed value is the background noise plus offset. Values up to 20 digits, that are digits independent of actual decimal points, are within the specified tolerance.

Note

Each time you make a new selection (e.g. switch to another measurement range) the display will overreact and show higher values.

Measurement Instructions

Introduction to the Properties of RF Radiation

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

Across the specified frequency range (and beyond), RF 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 RF 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 RF radiation in the common unit „power density“ (W/m²), a certain distance has to be kept from the RF source. At higher frequencies, this distance measures only a few meters and at lower frequencies a few tens of meters. When the base station of a 2.4-GHz cordless phone or a handset of a cellular phone is placed right in front of the antenna, a very high value will appear on the display. Though this number reflects the high biological relevance of this type of radiation (especially in the near range), the value itself has no meaning.

Polarization

When RF radiation is put on the airwaves, 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 possibilities a cellular handset can be held, we also observe even other polarization patterns. Therefore it is highly recommended to always measure both polarization planes, defined by the orientation of the antenna.

Fluctuations with Regards to Space and Time

Due to reflection, also depending on the respective frequencies involved, amplification or cancellation effects can occur in certain spots, especially within houses. Furthermore 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, especially the testing protocol, which is why in most cases several testing sessions become necessary.

Introduction to RF Measurement Technology

The supplied, logarithmic-periodic antenna has an **exceptional directionality**. Thus it becomes possible to reliably locate or „target“ specific emission sources in order to determine their contribution to the total RF radiation level. To know exactly the direction from where a given RF radiation source originates is a fundamental prerequisite for effective shielding. The missing directionality of standard telescope antennae is one of the reasons, why they are not suited for reliable RF measurements in building biology EMR surveys.

The values shown on the display always reflect the power density of the ambient levels in reference to the spatial integral of the „antenna lobe„, that is to the direction the antenna is pointing towards. In addition to average measurements, this RF analyzer also offers an particularly important technical specification: true **peak measurements**. With regards to pulse-modulated RF radiation not only the average value is calculated, but the total maximum value of each single pulse can be detected. In the case of a 2.4-GHz cordless phone base station, the peak value can be 100 times higher than the average value.

The frequency range of this RF analyzer covers cellular phone frequencies (e.g. GSM800, GSM1900, TDMA, CDMA, AMPS, iDEN), 2.4-GHz cordless phones, frequencies of third generation technologies such as UMTS, WLAN based on bluetooth as well as other commercial frequency bands and microwave ovens. All the frequencies inbetween are of course also included. This is the frequency range within which you find the pulse-modulated signals concerned scientists are most worried about.

In the vicinity of radio and TV towers, major transmitters as well as strong private stations, the RF radiation levels of those lower frequencies can also be the cause of major exposures. From a technical point of view, the use of low-cost telescope antennae to measure their power density levels has to be looked at with a critical eye. For those lower frequency bands, Please ask us for specific solutions for those lower frequencies supplied by GIGAHERTZ SOLUTIONS.

A Special Case: Radar

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

Due to the rectifier circuit we use, weak radar signals are slightly underrated. We approve of this fact because for this price range our circuit design offers a pioneering high sensitivity level for all continuous as well as continuously pulsed signals (from GSM to 2.4 GHz).
Important Note: Because of the longer signal duration at shorter distances from an RF source as especially found in stronger radar signals, this quite slight underrating will then even be considerably less of an inconvenience.

Preparations Prior to Testing

Check the RF analyzer and its antenna by following the instrunctions under „Getting Started."

Connecting the Antenna

Screw the angle connector of the antenna connection into the uppermost right socket of the RF analyzer. It is sufficient to tighten the connection with your fingers. (Do not use a monkey wrench because otherwise the thread might break.)

This SMA connector with gold-plated contacts is the highest quality commercial RF connector in that size.

Carefully check the tight fit of the connection at the antenna tip. This connection at the tip of the antenna should best not be opened.

Slide the antenna into the vertical slot at the rounded top end of the RF analyzer. The antenna can be used either attached to the tope end of the RF analyzer or held in your hand. When holding the antenna in your hand, however, please ensure that the fingers do not touch the first resonator or antenna conductors. Therefore it is recommended to hold it at the opposite end. A simple handle is in preparation. 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 RF analyzer.

Depending on the antenna type, smaller pieces of copper foil may be attached to the actual antenna. Do not remove or damage these pieces because they serve the purpose of fine-tuning.

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 changed.

Taking Actual Measurements

When testing for RF exposure levels at an apartment, a 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 whole situation.

It is just as important that **measurements are repeated several times**: First, choose different daytimes and weekdays to not 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 because a situation can literally change „overnight." A transponder only needs incidentally – e.g. during installation or repair of cellular phone transmitters - to be tilted down by a few degrees in order to cause major changes in exposure levels. But most of all it is the enormous speed with which the cellular phone network expands every day. 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 to first take measurements **in each direction** outside of the building. This will give you first insights into the „RF tightness" of the building and also potential RF sources inside the building (e.g. 2.4 GHz telephones, also from neighbors).

Furthermore you should be aware that taking measurements indoors adds another dimension of testing uncertainties to the specified accuracy of the used RF analyzer due to the tightness of indoor spaces. According to the „pure teachings," quantitatively accurate RF measurements are basically only reproducible under so-called „free field conditions." In spite of that, RF is of course also measured inside of buildings because this is the place where we wish to know exposure levels. In order to keep those 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 RF analyzer can already 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 already cause rather major changes in the power density of a locally defined area. The person who performs the RF testing, for example, affects the exact point of the maximum value. Insofar it is quite possible to have two different readings at the exactly same spot within 24 hours. The maximum value across a locally defined area, however, usually changes only if also the RF sources change, which is why the latter value is much more representative of the assessment of RF exposure.

Quick Overview Measurements

Quick overview measurements are good to gain an overall insight into the situation. Since the actual number values are of secondary interest then, it is usually best to simply follow the audio signals that are proportional to the field strengths (Set „Betrieb (On)“ switch to:).

Procedure:

RF analyzer and antenna are to be checked, following the instructions under „Getting Started.“

First set the measurement range switch to 19.99mW/m^2. Only if displayed measurement values are persistently below ca. 100µW/m^2, change to the measurement range 199.9µW/m^2.

Set the switch „Signalbewertung (signal assessment)“ to „Spitzenwert (peak value)“.

RF radiation exposure can differ at each point and from all directions. Even though the RF field strength of a given space changes far more quickly than at lower frequencies, it is neither possible 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 RF analyzer. Holding the antenna at its very end, the polarization plane (vertical or horizontal) can be easily changed with a turn of your wrist. However, you can just as well use the RF analyzer with the antenna attached to it.

Since there is no need to look at the display during an overview measurement but you only listen to the **audio signal**, it is very easy to slowly walk through the indoor or outdoor spaces in question, thereby constantly moving the antenna or the RF analyzer with attached antenna into each direction. This will provide you with a quick overview of the situation. Especially in indoor spaces, antenna movements towards the ceiling or the floor will reveal astonishing results.

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 Measurements

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

Setting the Measurement Range

Switch setting as described under „Quick Overview Measurements“. Basic rule for measurement range selection: As coarse as necessary, as fine as possible.

When the RF analyzer even goes into overload in the measurement range „1999µW/m^2“, a „1“ will appear at the left-hand side of the display. In this case the measurement values exceed the measurement range of the RF analyzer. By means of an RF damper (a miniature adapter for the antenna socket), an accessory available from Gigahertz Solutions, it is possible to extend the measurement range by a factor of 100.

Signal Assessment

Note: In contrast to the average value, the wave peak of an electromagnetic wave is referred to as peak value. This particular value is regarded as the measure of the critical “biological effects“ of RF radiation.

In “peak hold” mode, the peak value of the signal can be obtained within a defined time frame.

A lot of measuring technicians work with the function “ peak hold “.

Procedure: Gently set the switch “signal evaluation” to “**peak hold**”. This also is the beginning of a defined time frame for the measurement.

In the everyday measurement practice this function has great value. The peak value is related to the actual signal situation. This is important because the situation is subject to change due to of time, direction of the radiation, polarization, and the points of measurements being taken. Therefore it can happen that single peaks can be missed.

Someone with very much experience will be able to obtain additional information from the comparison between 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 the potential contribution from a 2.4-GHz cordless phone signal to the total maximum value or the less channels are being used by cellular phone users.

Still today, some field meters only display average values. They are of little help when considering the potential health risks associated with pulse-modulated RF radiation because through the „averaging" of steep RF pulses, RF radiation exposure can be underrated up to a factor of 100 such as in 2.4-GHz cordless phones.

Actual Measurements

Now the **antenna is attached again to the RF analyzer** because objects (mass) directly behind the RF analyzer also have an effect on the testing result. Hold the RF analyzer with a **slightly outstretched arm**. Your hand should not reach too close to the antenna, but stay near the bottom end of the RF analyzer.

In the area of a **local maximum** the positioning of the RF analyzer should be changed until the effective power density (the most interesting measurement value) can be located. This can be achieved as follows:

- Through **scanning** „all directions" to locate the direction from which the major RF emission(s) originate. Move your wrist from right to left. For emission sources behind your back, you have to turn around and place your body again behind the RF analyzer.
- Through **rotating** the RF analyzer with attached antenna around its longitudinal axis to consider the polarization plane of the RF radiation.
- Through **changing** the measurement position („measurement spot") to avoid measuring exclusively in one spot, which might accidentally 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 resultant. 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 a 2.4-GHz telephone inside the house, for instance, emits a similar level of microwaves as a nearby cellular phone base station outside the house, it could be helpful to first turn off the 2.4-GHz telephone inside the house to measure the exposure level originating from the outside. After also 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. Right now we have no clearly defined testing protocol because according to 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.

To be on the safe side, the RF exposure comparison should be based on a value derived from multiplying the display value by the factor 4. This correction factor may appear extremely high at first sight. As soon as put into perspective of professional spectrum analyzers, which already use a factor of 2, however, the relative nature of this factor becomes obvious.

Regardless of the measurement uncertainty technically inherent to the RF analyzer, for measuring cellular phone base stations it is recommended that a factor of up to 4 is put on the displayed measurement value in order to take into account the potential maximum power density at full usage of the network in contrast to the minimum power density. The minimum RF level occurs when only the control channel operates, whose signal strength is unaffected by the number of phone calls being placed at any given time. In order to obtain the most realistic minimum value for calculating the maximum exposure, it is suggested to take measurements at different times during the day, especially at known low-traffic times such as Sunday morning or the like.

Hint for Cellular Phone Users:
Cellular phone reception is still possible well below the strict exposure limits of the *Building Biology Guidelines* for pulse-modulated RF radiation, that is power density levels below 0.1µW/m² or 0.01 nW/cm², respectively.

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 RF signal helps to **identify the source of a given RF radiation**.

First get the RF analyzer ready for testing, following the instructions in the relevant section. For audio analysis, simply turn the volume of the speaker at the upper right knob of the case all the way to the left („-„) because if you are switching to audio analysis while high field strength levels are prevalent rather high volumes can be generated quite suddenly. This, of course, is especially true for measurements that are to be taken without audio analysis. The knob is not fastened with glue to prevent overwinding. However, if you should by accident turn the knob too far, simply turn it back again.

Set the „Betrieb (On)“ knob at ∿ 🔊. Sounds and signals are very difficult to describe in writing. The best way to learn the signals is to approach known RF sources very closely and listen to their specific signal patterns. Without detailed knowledge, the **characteristic signal patterns** of the following RF sources can be easily identified: 2.4-GHz telephones (base station and handset) as well as cellular phones, whose signal patterns can be divided into „during the 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 and some time at night in order to familiarize yourself with the different noises.

The volume can be controlled with the „Lautstärke (speaker)“ knob. Note: The power consumption of the speaker is directly proportional to the volume.

Battery

The RF analyzer requires a high-quality 9-Volt square battery. Due to its rather high power consumption, at least an alkali-manganese battery should be used.

Because rechargeable 9-Volt square batteries have a quite low capacity, they are not recommended. The same applies to cheap zinc-coal batteries. On principle, of course, such batteries could also be used, but their operation time will be considerably shorter.

The RF analyzer comes equipped with a high quality brand name **alkali-manganese battery**.

Changing Batteries

The battery compartment is located on the backside of the case. To open, press down on the fluted arrow and slide off the battery cover towards the bottom end of the RF analyzer. The inserted piece of foam provides a snug fit for the battery to prevent it from rattling. The sliding back of the cover should always require some slight pressure.

Auto-Power-Off

This function conserves energy and extends the total operating time.

1. In case you forgot to turn off the RF analyzer or it was accidentally turned on during transport, it will be automatically shut off after 40 minutes of continuous use.

2. When in the center of the display „low batt.“ appears vertically in-between the digits, the RF analyzer will be turned off after only 3 min in order to avoid unreliable measurements.

Warranty

We provide a two-year warranty for factory defects on the RF analyzer, the antenna and accessories. Thereafter generous fairness rules will apply.

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 a table. The warranty does also include such impact damage if it should ever occur.

RF Analyzer

The analyzer itself is not particularly impact proof: Due to the comparatively heavy battery and the large number of wired components, damage cannot be excluded in this case.

Shielding

Reliable shielding protection for RF radiation is available.

For further information please contact:

Canada und USA:
EnviraTest Inc.
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Umrechnungstabelle

Conversion Table

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	583
0,10	6,14	10,0	61,4	1000	614
0,12	6,73	12,0	67,3	1200	673
0,14	7,36	14,0	72,6	1400	727
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