

VF2 / VF4

Variable band trap for frequencies from 700 MHz to 3.0 GHz



Operating Manual

Revision 3.2

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.

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Professional Technology

Measurement techniques and components from GIGAHERTZ SOLUTIONS® set new standards for 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. A patent for its main features is pending.

With the VF2 or VF4 filter you can provide qualified expertises concerning the contribution of various frequencies to the total HF immission in an area. The frequency band of this filter is between 700 MHz and 3 GHz, limited by that of the instrument to which it is attached. This range is of particular biological relevance because of the wide-spread use of mobile phones, cordless telephones (DECT) and the future technologies like UMTS (3G) and WIMAX.

We appreciate the confidence you have shown in our product with your purchase. We are convinced, that it will provide you reliable, constructive information.

Should you ever encounter a problem, please contact us! We are ready to assist you quickly and efficiently.

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Safety instructions

Again: Please read this manual carefully **before using your instrument for the first time!** It contains important information for use, safety and maintenance of the filter.

Do not allow the filter to contact with water. Do not use the filter outdoors in the rain. Clean its outside only, and with a slightly moist cloth. No cleaning agent or spray! Before cleaning the filter switch off the meter and remove the filter and all cables from the instrument.

There are no user-serviceable parts inside this instrument.

This device is sensitive to heat, shock and contact. Do not leave it exposed to sun or hot surfaces, do not let it drop, do not open it.

Use it only for purposes it has been designed for. Use it only with instruments or accessories recommended or supplied with it

Explanatory remark:

Information and statements pertaining to the *VF4 only* are printed *in italics*.

Preliminary remarks...**...concerning filter's basic principle and the differences between VF2 and VF4**

The filter's basic principal is that of a variable trap. The VF2 suppresses the set frequency of the filter by a factor of 100. The VF4 suppresses the set frequency of the filter by a factor of 10,000. In practical applications it allows assessment of the individual frequency contributions to the total, full signal. (e.g. WLAN, GSM and UMTS (3G)). The filters can simulate the effect of eliminating a specific source of radiation (e.g. a local Bluetooth network).

...concerning the filter's functioning

Please note that it is technically unavoidable, that a passive filter like this one suppresses neighbouring frequencies to some extent. The suppression is exponentially less the higher the distance from the central frequency.

Even when measuring in broad band mode (slide on "Bypass"), HF readings go up and down considerably when moving through a room. This is for two reasons:

- multiple reflections, particularly in closed rooms or unfavourable outdoor conditions.

- Slightly different directions of the instrument between two readings.

These variations can impair the assessment of individual frequencies. It is advisable to fix the instrument to a certain position and orientation. Thanks to the antenna geometry it may also be placed on any surface¹. Make sure that no other person is in the room while you measure.

...the frequency selector slide

The "slide" of the frequency selector is a mechanical element calling for a compromise between easy sliding against good contact. We opted in favour of good electrical contact. As a result the slide moves tightly.

Handling:

¹ Without the "virtual reflections" of the vertical resonators at conductive areas impairing the measurements. (Patent pending, AZ 103 07 085.0-35)

To shift the slide, hold the **filter** tightly in your right hand and support the instrument loosely with your left. Use your **right thumb only** (not one of your hands!) to move the slide upwards or downwards. It is best to put the thumb on the lower or upper edge of the slide rather than on top. This helps to avoid slipping off.

That means reposition your hand. Cover the full scale in several smaller steps, not in one motion.

Attaching the filter to the instrument

Preparation:

Instruments from type HF35C upwards and produced later than approx. April 2004 have a hole drilled on their face side bottom right corner, which is capped by a black button. Remove this for assembly.

Attaching the filter:

Step 1:

The filter is connected between the antenna cable and the antenna input socket. First, un-screw the antenna cable from the socket. Next, position the filter with the slide facing you. Plug and screw it into the antenna input socket.

Step 2:

Hook/snap the bottom holder of the filter into the 6.5 mm hole, in the bottom right corner of the instrument. It should fit tightly to ensure a rigid connection of the filter to the instrument.

Step 3:

Connect the antenna cable to the filter and tighten the nuts of both connectors (to filter and to instrument) cautiously. Use the clip-on tool supplied with the antenna. Use the utmost caution when using a wrench! Over tightening will strip the threads!

The filter can remain connected to the instrument for normal use. When set to "By-pass" it attenuates all signals in the whole frequency range by a little below – 1 dB,.

While this is well within the tolerance level, we recommend **to multiply the power densities displayed by a factor of 1.2 for exact measurements.**

Even in the position "Bypass" the filter suppresses frequencies below 100 to 200 MHz – for measurements below these frequencies the filter has to be removed.

Please note:

The supplier of the SMA socket and plug guarantees the electrical performance for at least 500 complete cycles of assembly and disassembly. The lower connector (step 3) will suffer from too many cycles.

Snap-on tightening aid

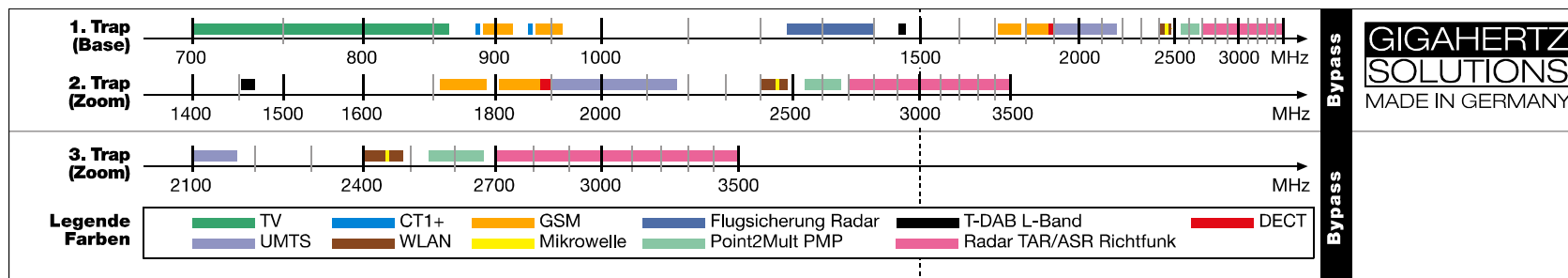
A tightening aid for the nuts of the SMA connectors made from pcb-material is available. It can be snapped on to the nut with moderate resistance. It may remain there for storage. This will be useful if you intend to remove the filter frequently.



The circuit board that is attached to the lower cover of the filter housing extending to the right is meant for „cascading more than one filter, should you want to do this. If not and if you feel it bothers you in your work, you can remove it without any consequences to the measurements.

The Scale on the filter casing

The printed scale on the outer and the bottom face of the filter is shown in the figure to the right. They are identical for VF2 and VF4.



The printed scale on the filters left or inner side are needed for special laboratory analyses not needed for the day-to-day work. They can be ignored here.

How to use these scales will be described in the next chapter.

(UMTS (3G))

How to measure

Never ever set the signal evaluation switch to “Peak hold! This counteracts the very purpose of frequency analysis with a trap filter.

There are **two reasons** for frequency analysis:

- As a tool for remediation.** This is the most important application, the rectification of an unsatisfactory situation.
- Assessment of unknown sources,** i.e. determining the frequency of the source and its associated power density.

Ad A: Frequency analysis as tool for remediation.

Remediation is the most important function of the VF2 and VF4. The objective here is to quantify the contribution of sources of radiation typical for housing appliances to the total immission by frequency and magnitude. The filter traps (eliminates) the frequency it is set to, and one can see without extra efforts, how much the elimination or shielding of that source would help.

To do this one first records the total power density as per the manual of the instrument used, with the slide set to “Bypass”. Then the slide its set to the frequency of interest known from the audio analysis or other, (e.g. CORDLESS TELEPHONES (DECT) or/and WLAN/Bluetooth). Then the display shows the remaining power density achievable should the source be shielded by -20 dB (-40 dB). When analysing a CORDLESS TELEPHONES (DECT) frequency remember, that the filter as per

its characteristic traps to some extent also neighbouring GSM and UMTS (3G) frequencies. Moving the slide slightly up and down will help to assess this influence. The filter also traps higher harmonics (multiples of the basic frequency) to a considerable extent, see the filter curve on the second but last page. In the case of GSM 900 and GSM 1800 the filter simultaneously traps both, if set to 900 MHz.

Ad B: Assessment of unknown sources

The search always begins with the slide set to “Bypass”. The damping of the filter below and above the trap including “Bypass” is nearly constant (a little less than 1 dB). Beyond 2500 MHz the dampening is slightly higher. To compensate for the filter in the line multiply the displayed numbers by 1.2. For precision measurements of known frequencies and laboratory conditions remove the filter.

First Step, a quick overview

Shift the slide slowly from position “Bypass”, down to the bottom end. That way

you start suppressing the highest frequencies and come to lower and lower ones. There are two different types of observation to look for

- The first “collapse“ of the reading drops to approx. 1/20 to 1/100 of the broadband value (*VF4: to 1/2000 to 1/10000*)². Regardless of whether there are further reductions of the readings, when continuing the downward shifting of the slide. There is **one** dominant source of radiation and the collapse frequency. Continue at **Point 1** below.
- Or in the first collapse of the power level displayed drop to about 1/4 to 3/4 of the original value. In this case other frequencies call for further analysis³. Continue at **Point 2**, next page.

Point 1: One dominant HF frequency.

² For total (i.e. slide at bypass) power density readings of about 200 below the inherent noise of the instrument itself prohibits a total collapse to one hundredth of the broad band reading. Then switch the range to the next finer sensitivity. For higher frequencies, in particular beyond 2.5 GHz, The collapse is sometimes down to 1/20 (*VF4: 1/2000*) only of the broadband value, due to tolerances.

(VF4: The high trapping factor down to 1/20000 of the broadband value nearly always pushes it down to the internal noise level. Switching into a finer sensitivity range is all the more important.)

³ One can at least identify various other frequencies, but their magnitude with limited precision only. In view of random variations of the displayed power levels due to variations of the actual local radiation, small movements of the instrument or the measuring person or other reasons.

The actual measurement is started again in the “Bypass” setting. Record the broadband value. Then move the slide downwards slowly until the readings have dropped for the first time to at least 1/20, in many cases to 1/100 of the initial reading. (*VF4: to almost zero, the random noise, which is independent of the measurement.*) Move the slide slightly up and down to make sure to you achieve the minimum reading. Switch to the finer range if the readings in the coarser range are too close to the inherent instrument noise level. The audio signal can be very helpful in this operation. Find the frequency on the first scale on the outside of the filter designated “First trap,(base)”. (*VF4: If you are already in the random noise zone, either switch to the finer range or put the slide into the middle of the random plateau.*)

Now shift the slide slowly further down. If the first collapse was at above 1400 MHz, then, you localise the second collapse with the attenuation twice as high compared to the first collapse. The frequency now can be read from the second scale designated “2. Trap” with improved accuracy.

For first collapse frequencies beyond 2100 MHz this can be repeated a third time, and the frequency can now be read from the scale “3. Trap”.

Point 2: More than one HF frequency.

The measurement starts with the slide set to “Bypass” as before. Record the power density (base reading). Shift the slide slowly downwards until the readings rise sharply after a first decline. Then find the minimum and note frequency from scale “1. Trap (base)” as well as display reading. The power density at that frequency is the base reading minus the minimum recorded. Continue this until you found all minimums and have recorded the results as above.

Interpretation of the results – the problem of higher harmonics

In addition to the basic frequency (“basic harmonic”) selected by the slide position the filter suppresses also frequencies which are multiples of the basic harmonic, yet not as much as the basic, see the graph at the second but last page. What that means for the interpretation, is shown by the following examples together with some rules of thumb.

Rules of thumb for the Interpretation.

- If at the first collapse the readings drop to less than between 1/20 to 1/100 of the initial reading (*VF4: to near zero*) then there is only one dominant frequency.
- If the first collapse brings a minimum reading between ¼ and ¾ the initial value and the frequency at that point is below 1600 MHz, then note also the frequencies of the further collapses and their power densities, being the difference between the initial reading and the minimum displayed.
- First collapse is to less the ¼ to ¾ of the initial reading and the collapse frequency is beyond 1600 MHz: Record all results as above, **But:**
 - Further collapses at half or one third the first frequency might be of “virtual nature” (See examples 2 and 3)
 - Example 3 shows the interpretation for further collapses at other frequencies. Please note, that the power density levels in such cases are only reasonable estimates, good for guiding the remedial work.

Illustrating examples

Assumed reading in „Bypass“: 1000µw/m²

Example 1:

frequency (MHz)	display readings drop to	calculation	= power density at frequency
1800	10	1000-10	about 1000
900	20 to 50	Ignore*	~ 0

Example 2:

frequency (MHz)	display readings drop to	calculation	= power density at frequency
1800	600	1000-600	400
900	“very little”	1000-400-0	600

Example 3, more complicated:

frequency (MHz)	display readings drop to	calculation	= power density at frequency
2400	800	1000-800	200
1800	700	1000-700	300
1200	>800	ignore*	~ 0
900	200	1000-300-200	500
800	>800	ignore*	~ 0

* ignore as this is only a “virtual“ collapse caused by the frequency indicated on the scale 2. Trap or 3. Trap

This characteristic with higher harmonics is certainly hard to digest for a non-expert. However, its big advantage is, that it suppresses simultaneously the lower and the upper GSM band (to some extent also CORDLESS TELEPHONES (DECT)). This eliminates all sources other than those ubiquitous

ones. In particular it facilitates the audio analysis. Due to the suppression techniques. the GSM frequency identified is nearly inaudible and no longer obscures the signals from other neighbouring sources.

Please note:**Cascading of filters:**

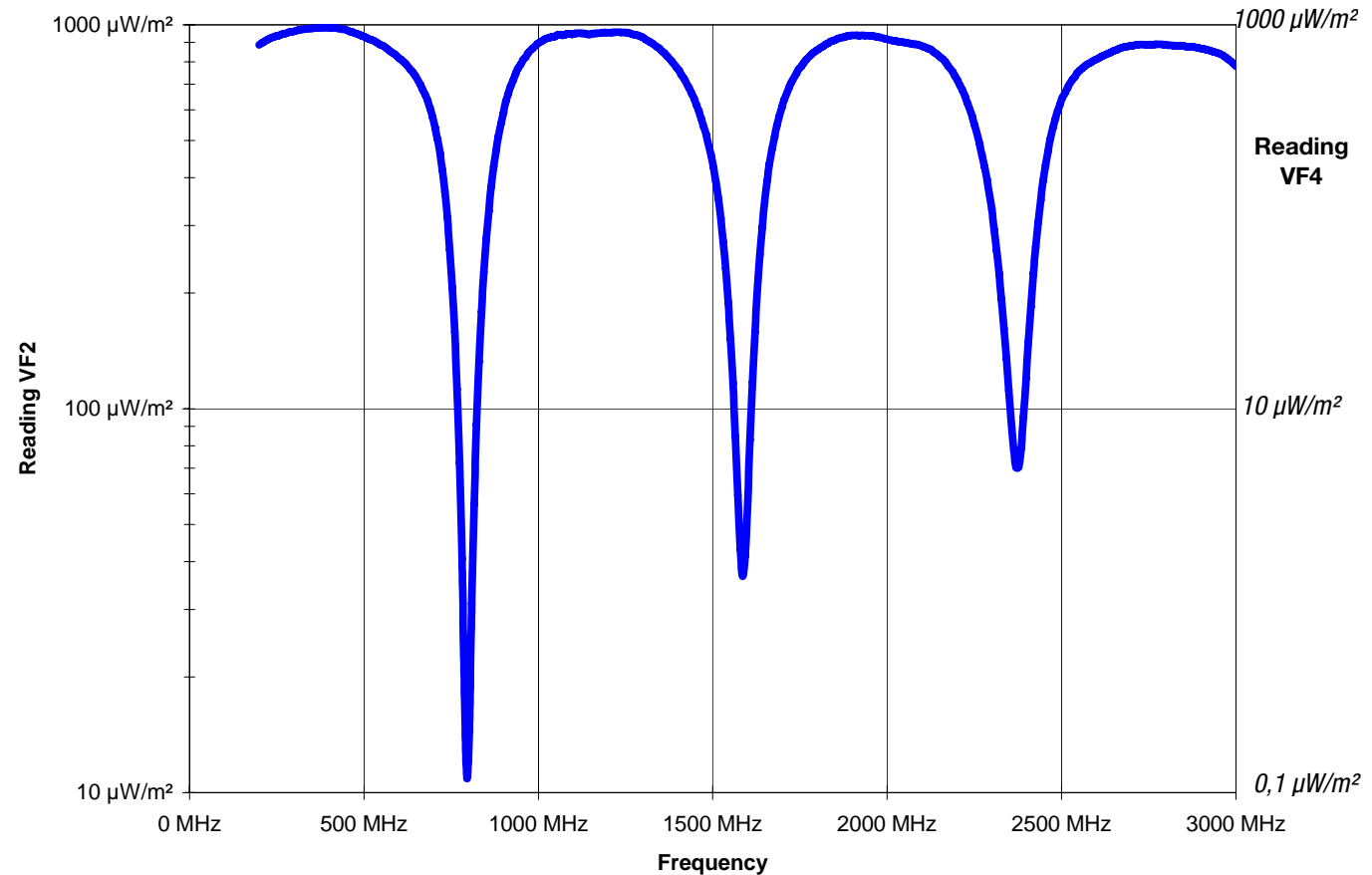
The design of the filter permits „cascading“, i.e. putting up to 3 Filters in series. The filter casings are designed for mechanically stable connection by the users themselves. If, e.g. with two filters, one can retain the radiation of the „first collapse“ frequency trapped, then the work on the remaining sources with the second filter is more exact. They can also be combined with the attenuator or with the module to expand the dynamic range. We plan to develop this as an optional accessory.

To distinguish CORDLESS TELEPHONES (DECT) signals from GSM1800 signals is difficult. Time permitting we will continue our experiments on that matter. So far there seems to be a chance to get at least good quantitative estimates for their power intensities making use of the audio signal. Results will be included in due course in an update of this manual.

Filter characteristic of the VF2 with e.g. the slide set to 800 MHz.

(Read the curve as follows: The radiation at frequency x , which without filter in one would read as $1000 \mu\text{W}/\text{m}^2$, with the filter slide at 800 MHz you will see displayed $y \mu\text{W}/\text{m}^2$.)

The filter can also be used in combination with the horizontal isotropic broadband antenna UBB27. Please note, that the UBB27's wider frequency band below that of the filter, cannot be used in this combination.



Warranty

We provide a two year warranty on factory defects of this filter unit.

Note of caution:

The slide slot of the filter needs to be kept clean. This surface needs to be kept dust and oil free, if not contact will be impaired and unreliable readings will result. To clean first try using oil free compressed air. Be careful when dismounting and mounting the slide. Avoid overstressing the connections, which in view of the relatively long lever arm does not need much force.

Contact

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

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