SPECTRAN V4

USER MANUAL



Please read the following manual carefully before using your measurement device. This manual contains important information on how to properly operate this unit.

MADE IN GERMANY

AARONIA AG
WWW.AARONIA.COM

INTRODUCTION

1. Introduction 6
1.1. Liability 6
1.2. Warranty 6
1.3. Safety Guidelines 6
1.4. Scope of delivery 7

CONNECTIONS

2. Connections 8
2.1. Jog Dial / volume control 8
2.2. USB Connector 8
2.3. Audio Output 8

POWER CONNECTION

3. Power connection 9
3.1. External DC input (battery charger / mains operation) 9
3.2. Operating with an external power supply 9

OVERVIEW FRONT PANEL

4. Overview front panel 10
4.1. Operating Equipment 10
4.2. Numeric block (hotkeys) 11
4.3. LC Display 12
4.4. The display shows 13

FUNCTIONAL DESCRIPTION

5. Functional description 14
5.1. Technical data 14
5.2. Main menu 15
5.3. Menu items 16
5.3.1. Center (center frequency) 16
5.3.2. Span (frequency range width) 16
5.3.3. fLow & fHigh (start & stop frequency) 16
5.3.4. RBW (bandwidth) 17
5.3.5. VBW (video-filter) 17
5.3.6. SwTime (sweep-time) 18
5.3.7. Reflev (reference-level) 18
5.3.8. Range (dynamics) 18

No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.

FUNCTIONAL DESCRIPTION

5.3.9. Atten (attenuator) 19
5.3.10. PreAmp (internal pre-amplifier / option 020) 19
5.3.11. Demod (Demodulator /audio-analysis) 19
5.3.11.1. Demod (GSM-Decoder) 19
5.3.12. AudInd (Audio-Indicator / “bug tracer” – option 015) 20
5.3.13. Detect (detector type) 20
5.3.14. Disp (display mode) 21
5.3.15. Unit (set unit) 21
5.3.16. MrkCnt (set number of markers) 21
5.3.17. MarkLvl (set starting level for markers) 21
5.3.18. MrkDis (marker display mode) 22
5.3.19. BackBB (change bargraph display mode, option 20x) 22
5.3.20. AntTyp (configure connected antenna) 22
5.3.21. Cable (configure antenna connection cable / attenuator) 22
5.3.22. RefOff (Set Offset or UBBV-Preamplifier) 22
5.3.23. GSMbst (select GSM Burst-Type) 23
5.3.24. GSMdst (GSM Slot-Distance) 23
5.3.25. Calib (in preparation, currently not usable) 23
5.3.26. Bright (Set display brightness) 23
5.3.27. Logger (start recording/Data Logger) 23
5.3.28. RunPrg (run program) 24
5.3.29. Setup (organize programs) 24

FIRST OPERATIONAL STEPS

6. First operational steps 25
6.1. One-hand operation 25
6.2. OmniLOG 90200 26
6.3. Pistol grip 27
6.4. Hardware setup 27

CORRECT MEASUREMENT

7. Correct measurement 28
7.1. Noise floor 28
7.2. Harmonics 28
7.3. Measurement of wireless LAN & cellphones 28
7.4. Attenuator-mode „Auto“ 29
7.5. Sensitivity 29
7.6. Measurement inaccuracy 29
7.7. Cursor and zoom features 30

FIRST MEASUREMENT

8. First measurement 31
8.1. Prepair device 31
8.2. Basics 31
8.3. Measurement 31
8.4. Operation mode „Spectrum analysis“ 31
8.5. Hold-function 32
8.6. The „panning approach“ 33
8.7. Operation mode “Exposure limit calculation” 33
8.8. Operation mode Audio-output (demodulation) 34
8.9. Operation mode broadband detector (Peak power meter) 35
8.10. Manual setting of a frequency range 37

TIPS AND TRICKS

9. Tips and tricks 38
9.1. Quick Zero-span sweep (Time Domain Mode) 38
9.2. „Turbo“Sweep for small frequency ranges 38
9.3. „Turbo“Sweep for larger frequency ranges 38
9.4. Allocating keys with your own measurement settings 38
9.5. Dect analysis 38
9.6. Exposure limit calculation (display in W/m² with „Weak“ signals) 38
9.7. Conversion of measurement results to other units 38
9.8. Correct settings for manual input/measurement 39
9.9. Measurement of satellite TV 39
9.10. Kabelgebundene Messungen 39
9.11. Measurement with a direct cable connection 39

SPECTRUM ANALYSIS BASICS

10. Spectrum analysis basics 40
10.1. What is a frequency range? 40
10.2. Big difference between exposure limits 40
10.3. Application of spectrum analysis 40

PHYSICAL UNITS

11. Physical units 43
11.1. Measuring transmission power (dBm; dBµV) 43
11.2. Field strength [V/m; A/m] and power density [W/m²] 43
11.3. Interesting facts regarding high-frequency formula 43
11.4. Calculating the wavelength in [m] 44
11.5. Calculating the „close-up range“ in [m] 44
11.6. Calculating power density [W/m²] from power [dBm] 44

No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.

TABLES AND EXPOSURE LIMITS

12. Tables and exposure limits 45
12.1. Convesion tables 45
Table 1: Conversion dBm to W/m² with HyperLOG-antenna 45
Table 2: Conversion from W/m² to µW/cm² and mW/cm² 46
Table 3: Conversion from µW/cm² to V/m and A/m 46
Table 4: dBm to dBW and W 46
Table 5: Frequency, wavelength and frequency band denomination 46
Table 6: Power amplification factor and corresponding value in dB 46
12.2. Frequency tables 47
Table 7: Cell phone frequencies and providers 47
Table 8: German GSM900 frequencies and providers 47
Table 9: German GSM1800 frequencies and providers 48
Table 10: German UMTS frequencies and providers 48
12.3. Exposure limits 49
12.4. Device exposure limits 50

GENERAL INFORMATION

13.1. Description / Types | Safety instructions 52
13.2. Disposal | Technical data | CE compliance / Disclaimer 54

1. Introduction

Dear customer,

By purchasing this SPECTRAN high-frequency measurement device you acquired a professional piece of equipment which allows measurement of high-frequency fields.

The measuring instrument has been constructed according to the current state of the art and fulfills the requirements of the applicable European and national guidelines.

Please note: For measurement of low frequency fields (high-voltage lines, traction power, various household appliances etc.) you need additional one of the NF series SPECTRAN models.

1.1. Liability

This document was compiled with great care and checked for accuracy.

But nevertheless mistakes cannot be excluded. We do not take over any liability. We cannot guarantee the completeness, the correctness and the accuracy of information.

We reserve ourselves the right to change our products, specifications and documentations without any notice. We have no obligation for revision of documents and manuals we delivered in the past.

1.2. Warranty

Despite the greatest care in development and production of this device and the software MCS for free; Aaronia AG takes only liabilities for certain purposes, if this has been assured in writing. No warranty can be assumed for the performance and flawlessness of the software for all usage conditions and cases and for the results produced when utilized by the user. No additional guarantees or assurances are made regarding marketability, freedom of defect of title, integration or usability for certain purposes unless they are required in accordance with the law and cannot be limited. Justified guarantee claims are limited to the right of require rectification or replacement delivery. Regarding infringements, violations of patents, rights of ownership or the freedom from interference by third parties, Aaronia AG cannot warrant or guarantee that it is free of error.

1.3. Safety guidelines



In the event of any damages resulting from failure to follow these operating instructions the claim under guarantee is discharged. We accept no liability for consequential damages.

In the event of property and personal damages resulting from improper handling or failure to follow safety advice, we accept no liability.

For reasons of safety and admissibility (CE) the unauthorized conversion and/or alteration of the product is not permitted.

As voltage source please only use a property mains socket (100-240Volt, 50/60Hz). Make sure that the cable isn't squeezed or damage by sharp edges.

In order to avoid any damage, please read this user manual carefully before starting to use the device.

The commissioning should only be performed by qualified and instructed personnel.

Never expose the device to water. Never use it outdoors while it is raining. Otherwise the sensitive electronics could be damaged.

Avoid to high temperatures. Do not leave the device on a heating, in direct sunlight or in your car.

The device is maintenance-free. Only clean it externally with a damp cloth.

Due to the high sensitivity, the sensors and display of this device are sensitive to shock; hence it should be handled with care.

For safekeeping and transport please use the carrycase.

Even though the device is well secured through the use of counter-sunk screws, it should still not be reachable by children as it could easily be diverted from its intended use.

This devices that is connected with mains voltage and derived voltages, is not meant for the hands of children.

Consider the regulations for prevention of industrial accidents for electrical installations and equipment, by government safety organization in industrial facilities.

In schools, educational establishments, hobby and self-help workshops the operation of this product must be supervised by trained personnel.

No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.

1.4. Scope of delivery

The scope of supply includes:

a) SPECTRAN HF 60xx V4 measurement device
b) HyperLOG measurement antenna
c) SMA cable 1m
d) USB cable
e) Aaronia handle / miniature tripod
f) Battery charger / power supply with 4 adapters
g) protection rubber
h) SMA tool
i) SMA adapter
j) Aaronia 1300mAh Power battery (already fitted)
k) Aluminum carrycase

Please check the package contents for completeness before first operation. Reclaim possible missing parts instantly with Aaronia or your Aaronia dealer.



Warning:
Be careful not to overload the instrument's input with excessively strong signals which could permanently damage the highly sensitive circuitry! The maximum allowable peak power at the input of the SPECTRAN V4 is:

- with activated PreAmplifier: 0dBm maximum (peak)
- HF-6060 V4 & HF-6080 V4 (PreAmplifier OFF): +10dBm maximum (peak)
- HF-60100 V4 (PreAmplifier OFF): +20dBm maximum (peak)



2.1. Jog Dial/volume control

The Jog Dial replaces the up/down arrow keys ("turn" the jog dial) and the Enter key (briefly "press" the jog dial). It enables to control the complete menu navigation.

Another function as volume control, if the demodulator activated, As a precaution, before connecting anything to the audio output, you should turn this volume control all the way down to zero to avoid overload.



2.2. USB connector

The 5-pin USB B mini connector on the SPECTRAN allows fast communication with a computer or notebook. With this feature, you can e. g. download data from SPECTRAN's data logger, perform software (firmware) updates or establish a real time connection between your PC and SPECTRAN using the SPECTRAN PC software to perform advanced signal analysis.

For this connection, you need a high-grade, shielded USB 2.0 cable with USB A to Mini USB B 5-pin (see Aaronia accessory list).

Note: We strongly recommend using our own custom built USB cable as these incorporate especially developed EMC shielding and thus drastically reduce any possible interference.



2.3. Audio Output

This is a standard 1.5mm mono phone jack that can be connected to any device which offers an audio input, e. g. PHONO, CD, LINE IN, MIC etc. Depending on the kind of input, you may need an appropriate adapter cable, which you can purchase from any third party dealer. However, our own accessories (for example, our mini earphones) can always be connected directly.

No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.



3. Power connection

All SPECTRAN devices contain a high-performance battery package which is already installed in the unit. However, this battery is not yet charged for safety reasons. Hence, you should charge it with the included charger.

3.1. External DC input (battery charger / mains operation)

For this, connect the charger to a wall socket and plug the mini phone plug into the DC input on the SPECTRAN. Now turn OFF your SPECTRAN and the battery pack will be automatically charged. For the 3000 mAh battery, full charge is reached after about 5 hours. When using the optional USB port charger, the full charge may take up to 36 hours. You can use the device during the loading, but full charging is only possible with a switch-off.

The runtimes are depending on the device, options and settings when fully charged:

HF-2025 Rev. 3	GSM900 measurement Hotkey 5	1300mAh NiMh battery	Runtime Up to 3 hours
		3000mAh LiPo battery	Runtime Up to 10 hours
HF-60100 V4 Including all options	GSM900 measurement Hotkey 5	1300mAh NiMh battery	Runtime Up to 2 hours
		3000mAh LiPo battery	Runtime Up to 6.5 hours

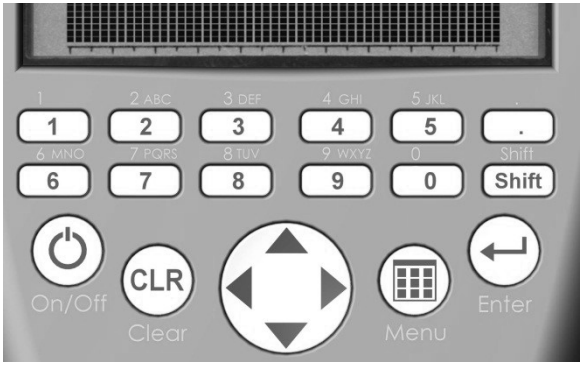
3.2. Operating with an external power supply

As described above, the DC input is meant for charging the internal battery pack. However, it can also be used for operating SPECTRAN independently of the internal battery pack.

Using our optional car power adapter (see accessories list) you can also operate SPECTRAN devices in a car.

If you wish to operate SPECTRAN via the power supply, so please note that the power supply's circuitry will cause additional interference both due to the cable connection and by means of RF radiation. This may lead to wrong measurement results in extreme cases.

Note: You can also connect other DC power sources with an output voltage of 12V, using a 3.5mm phone jack. Polarity of the jack needs to be as follows:
The "inner conductor" must be "+", the "outer conductor" must be "-".

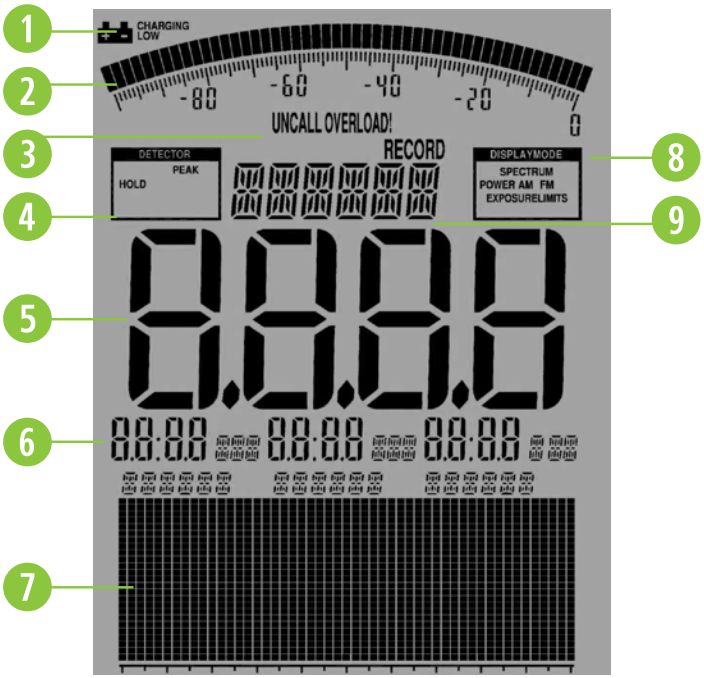


	ON/OFF button	Switches the device on and of
CLR	**Clear/Reset button**	- Sets different sweep-parameter back to factory setting - Clear input, if main menu is active.
	Arrow keys	**With active main menu:** Selection of menu entries **In Spectrum analysis mode:** Right/Left key: Move frequency range by one SPAN **Up/Down key:** move Reference-Level by 10 dB **In Exposure limit calculation mode:** Right/Left key: select Exposure limits or W/m²-display **In Audio mode:** Right/Left key: Increase/decrease center frequency by one RBW (bandwidth) Up/Down key: Increase/decrease RBW (bandwidth)
	Menu button	Call/dismiss main menu for changing various settings.
	Enter button	Switch between the modes Spectrum, exposure limit calculation, audio an broadband detector (if installed) With main menu active: Confirms current input (Enter key)
SHIFT	**Shift button**	**In Spectrum & Exposure limit calculation modes:** Min/Max Detector on/off (on= shows Peak, off =shows no indication and the device works in RMS detector mode)
.	**Dot button**	**In Spectrum & Exposure limit calculation modes:** HOLD on/off **In Audio mode:** Switch between AM/ FM

No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.



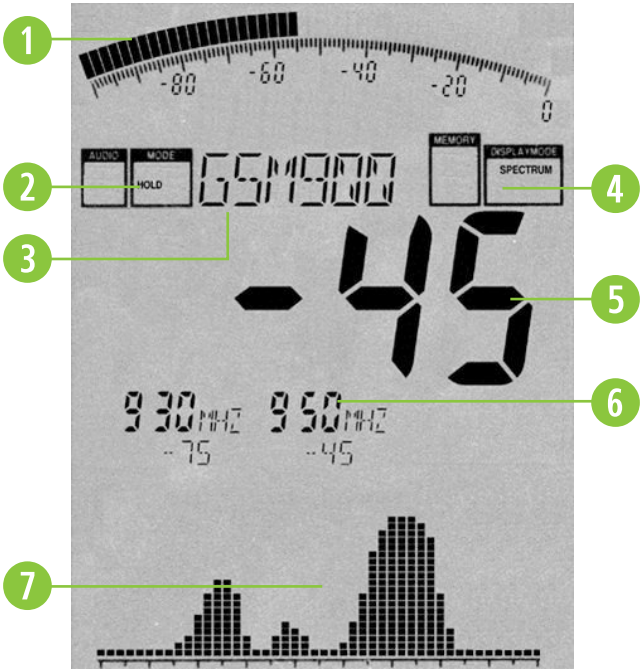
1 = Tetra	(380 – 400 MHz)
2 = ISM434	(433 – 434,8 MHz)
3 = LTE800	(780 – 862 MHz)
4 = ISM868	(868 – 870 MHz)
5 = GSM900	(921,2 – 959,6 MHz / cell towers, no cellphones)
6 = GSM18k	(1800 – 1880 MHz / cell towers, no cellphones)
7 = UMTS	(2110 – 2170 MHz / cell towers, no cellphones)
8 = WLAN	(2400 – 2490 MHz / cell towers, no cellphones)
9 = LTE2.6	(2500 – 2690 MHz)
0 = DECT-Analyzer	(1880 – 1900 MHz) Measurement of digital portable DECT phones



1. Battery display
2. Bargraph (50 segments / scala)
3. Status field
4. Detector display
5. Main display
6. Marker-Block 1, 2, 3
7. Graphic display (Pixel-Field)
8. Display mode
9. Info display

* = UNCALL / OVERLOAD (derzeit in Entwicklung, daher noch ohne Funktion)

No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.

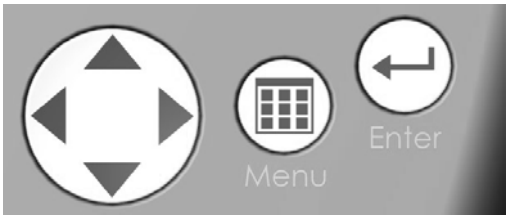


1 **Bargraph** (Trend-display)	Depending on signal strength, the half-circle will grow or shrink. A handy feature for visualizing quickly changing levels. Even handy: If the broadband detector is installed, the bargraph will always show the level measured by the broadband detector.
2 **Mode-status field** (Peak & Hold)	Shows the currently active detector: No display = RMS activated PEAK = Min/Max-Detector activated HOLD = Hold-Modus activated
3 **Info display**	Shows the selected preset (frequency range). Using the keys 0-9, further presets (UMTS, DECT, etc.) are available.
4 **Display-Mode Statusfeld**	Shows the current operation mode. Possible modes are: Spectrum (spectrum analysis), Expos.-Limits (exposure limit calculation), AM/FM (audio output) and RF (power meter, Option 20x).
5 **Main display**	Displays the level (signal strength) of the strongest signal in dBm.
6 **Marker-Block** (1 – 3)	Show frequency and signal strength of the strongest signals. Up to 3 markers can be displayed simultaneously.
7 **Graphic display** (here: spectrum display)	This flexible display field can display a great variety of information, both text and graphics (spectrum, exposure limits, menu text etc.)

	HF-6060 V4	HF-6080 V4	HF-60100 V4
Frequency range	10MHz – 6 GHz	10MHz – 8 GHz	1MHz – 9,4 GHz
DANL	-135dBm (1Hz)	-145dBm (1Hz)	-155dBm (1Hz)
DANL with PreAmplifier	-150dBm (1Hz)	-160dBm (1Hz)	-170dBm (1Hz)
Max. PeakLevel HF Input	+10dBm	+10dBm	+20dBm (opt.+ 40dBm)
Fastest Sample-Time	10ms	10ms	5ms
Filter bandwidth (RBW)	3kHz to 50 MHz	1kHz to 50MHz	200Hz (only with option 002) o 50 MHz
Units of measurment	dBm, dBµV, V/m, A/m, W/m² (dBµV/m, W/cm² etc. via PC software)	dBm, dBµV, V/m, A/m, W/m, dBµV/m, W/cm² etc. via PC software)	dBm, dBµV, V/m, A/m, W/m² (dBµV/m, W/cm² etc. via PC software)
EMC filter	-	-	200Hz, 9kHz, 120kHz, 200 kHz, 1,5MHz, 5MHz
Detectores	RMS, Min/Max	RMS, Min/Max	RMS, Min/Max
Demodulation	AM, FM	AM, FM, PM	AM, FM, PM, GSM
Input	50 Ohm SMA HF-Input (f)	50 Ohm SMA HF-Input (f)	50 Ohm SMA HF-Input (f)
Accuracy	+/- 2dB	+/- 2dB	+/- 1dB
Interface	USB 2.0/1.1	USB 2.0/1.1	USB 2.0/1.1
Weight	Ca. 430 g	Ca. 430 g	Ca. 430 g

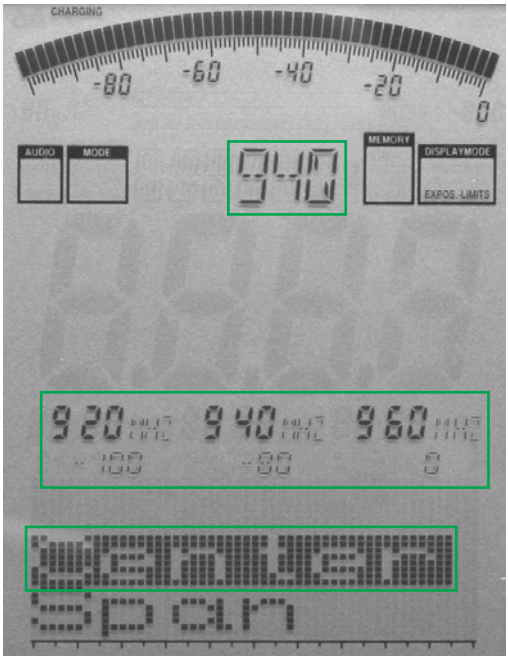
* frequency-dependent

No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.



5.2. Main menu

By pressing the menu button you get to the main menu of the SPECTRAN. From here, you can control the entire device, change various settings, but also do things like starting the data logger or save an recall your own programs By pressing the menu button again, you can exit the menu at any time.



After pressing the menu key, convenient menu navigation is at your disposal: the currently selected menu entry is displayed in inverse (black bar). In this example, “Center” is selected.

For the currently selected menu entry, the current setting is being displayed in „clear text“ on the large info field at the top.

In our example, it is the currently set center frequency (“940”). This way, there is no need to manually call up each menu entry to check its value.

To move between menu entries, use the Up/Down arrow button or the Jog Dial.

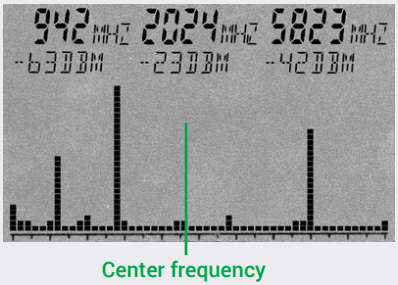
Use the Enter-button to activate the currently selected menu entry, which will allow you to perform input using the keypad or make a selection using the Up/Down arrow keys. Input/selection can be confirmed with the Enter key, which will return you to the menu.

Any changes will only take effect when you finally leave the menu.

Tip: The marker blocks 1 – 3 permanently show the following information, from left to right:
Start-, Center- and Stop-frequencies (each in full MHz)
Below, the current values are shown for (from left to right):
Range, MrkLvl und Reflev.
This is convenient, e. g. it allows you to quickly call the menu during a measurement and check the current frequency range, etc., which is otherwise hardly visible. After checking the values in question, just press the menu key again, and the measurement continues without any change of parameters.

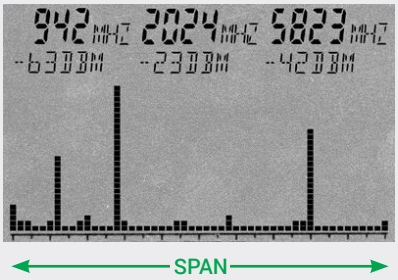
5.3. Menu items

There are two ways to manually set the frequency range:
- **by Center** (center frequency) und **Span** (frequency range width) or
- **by fLow & fHigh** (start- und stop frequency)



5.3.1. Center (center frequency)

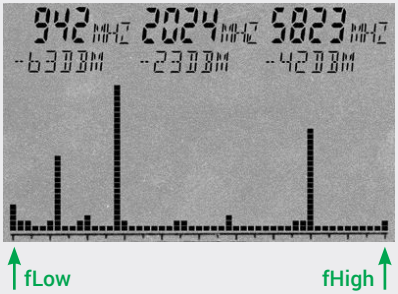
Chooses the frequency displayed in the middle of the readout. When changing the center frequency, the SPAN parameter (see following description) is preserved. Thus, you can quickly evaluate different frequency ranges with identical SPAN and without tedious re-adjustment of start/stop frequencies.



5.3.2. Span (frequency range width)

Span adjusts the width of the sweep. Changes are relative to the aforementioned "center frequency" of the display. By changing span, the start/stop frequencies (see following description) are automatically adjusted to be able to conform to the span. Thus, the span function can be compared to a magnifying glass", though only operates in the X axis.

Example: Say you have set 945 MHz as the center frequency. Now, if you use 10 MHz as the span setting, the sweep will be performed from 940 to 950 MHz. If you enter 200kHz for the span setting, the sweep will be performed from 944.9 to 945.1 MHz, and so forth. In effect, you just increase or decrease the resolution around the center frequency as a reference.

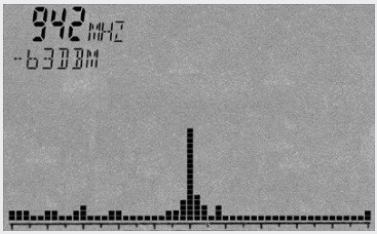


5.3.3. fLow & fHigh (Start- & stop frequency)

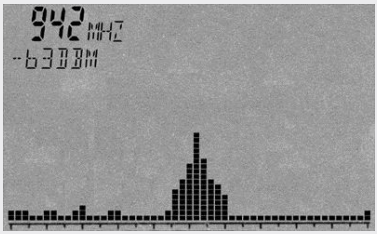
fLow (start frequency) sets the frequency where the sweep should begin, whereas fHigh (stop frequency) sets its ending frequency. From these two, the complete frequency range which gets sweeped is derived.

Tip: Please note that a large frequency range will badly squeeze the display horizontally (in the X axis) and thus significantly reduces measurement accuracy. Individual signals, especially when close together, will often not be distinguishable anymore. However, if you narrow the frequency range, you will be able to analyze the sweep range more precisely. You will be able to see far more details and higher accuracy. A large frequency span is thus mostly useful for a broad overview, not for exact measurements.

No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.



RBW (3MHz)



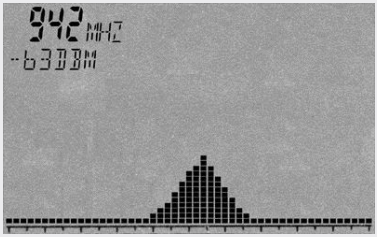
RBW (1MHz)

5.3.4. RBW (bandwidth)

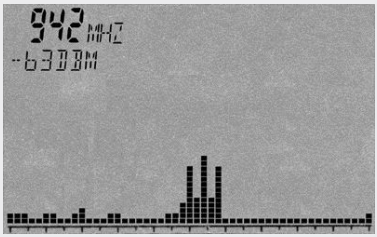
By adjusting bandwidth, you can adjust detail clarity and sensitivity at once.

When bandwidth is set to a very high value or even to FULL, the sweep will be very fast, however, the display becomes comparatively inaccurate and sensitivity is low. Hence, very weak signals will not be picked up anymore.
The smaller the bandwidth, the longer the sweep will take, but the display will be more precise and weaker signals can still be displayed. Thus, for example, a single signal initially sweeped with high bandwidth can turn out to be a number of several narrow, close together signals.

However, this gain in accuracy has its downside in the far longer sweep times.



VBW = Full



VBW - 100 KHz

5.3.5. VBW (video filter)

The video filter is intended for visual smoothing of the signal. The lower the video filter setting, the broader and smoother the display of the signal becomes.

Using this filter, you can mostly suppress unwanted noise, harmonics or sporadic peaks. However, with a very low video filter setting, the display can become less meaningful.

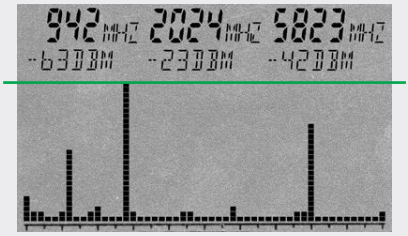
In our example, there might be three separate signals present. However, the low video filter straightens these signals out to become one single “smooth” signal. The alleged noise band around the signal has also been “smoothed out”. Thus, when dealing with weak signals, the highest possible video filter setting should be used.

Tip: By using the Right/Left arrow keys, you can simply move the sweep range by exactly one Span to the right or left.

5.3.6. SwTime (sweep-time)

Sets the amount of time per sample. As a measurement consists of several samples, the time needed to complete an entire measurement cycle will obviously be higher. In general, the higher the sweep time setting, the more precise the measurement, at the cost of being more time consuming.

A Sw Time <= 20ms will activate the UNCALL sign.

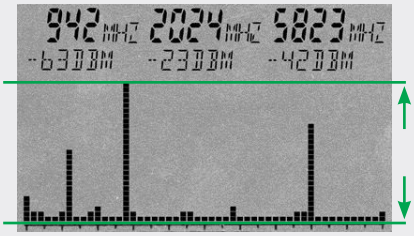


Reflev (reference level) dBm

5.3.7. Reflev (reference level)

The reference level sets the position of the signal display relative to the upper display corner, in dBm. The smaller the setting, the closer you get to the so-called noise floor and the greater the amount of visible interferences.

Tip: Using the Up/Down arrow keys, the reference level can be moved up or down by 10dB at any time.



Range (dynamics)

5.3.8. Range (dynamics)

Range sets the „size" of the visible range. Setting Range to 100dB (maximum) will give you the best possible overview of all signal sources. The vertical bars of the individual signals are virtually being "squeezed" from top to bottom to fit all signals into the display.

On the other hand, when Range is set to 50, more details will become visible, though a few signals might now be "cut off" at the top or bottom (depending on the RefLev setting). In the end, the Range function is comparable to a "magnifying glass", though it only works in the Y axis.

No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.

5.3.9. Atten (attenuator)
The internal attenuator attenuates the signal applied to the input connector by the corresponding amount in dB to avoid overloading the RF input circuitry.
Experienced users can also set this value manually. However, in the majority of cases, you should be sure to leave this setting on the default "Auto" setting!

WARNING: If „Auto „is turned off, it is mandatory to activate an attenuator when applying signals over-20dBm to avoid incorrect results.
Signals beyond 0dBm (peak) can even destroy the input circuitry if no corresponding attenuator is configured.

5.3.10. PreAmp
(internal pre-amplifier / option 020)
The optional internal extremely low-noise PreAmp amplifies the applied signal by approx. 15dB, significantly enhancing the sensitivity of the device. The OFF setting turns the PreAmp off (default), ON activates it.

Please note that obviously, the preamp gives varying performance depending on the measured frequency. Its amplification decreases particularly with very low or very high frequencies. Below 30MHz and above 9GHz, its amplification is almost zero and might even attenuate the signal. Consequently, it should then stay turned off to insure the highest possible sensitivity.

Warning: Only use the PreAmp with very weak signals, as strong signals over 0dBm (peak) can destroy it!

5.3.11. Demod (demodulator/audio analysis)
The demodulator turns pulsing and modulation of up to approx. 3.5kHz into audible signals. SPECTRAN supports three types of demodulation:

AM (**a**mplitude **m**odulation)
FM (**f**requent **m**odulation)
PM (**p**hase **m**odulation)

The dot key can be used to switch between AM and FM at any time.

The demodulator can be turned off by choosing OFF or by pressing the menu key.

Demodulation takes place around the center frequency; bandwidth is controlled by the RBW setting. This allows custom monitoring of individual, small frequency ranges. However, note that the filter is slightly less defined in this mode, meaning that very strong signals on neighboring frequencies might audibly "spill" into the currently selected frequency range as well.

Example: You might be demodulating the signal of a DECT phone (key 0), with a GSM900 transmitter in proximity as well. Depending on antenna alignment, you might also hear the modulation of the GSM signal.

Tip: As demodulation is performed in almost real-time, it is especially suitable for very quick location and assessment of signal sources.

5.3.11.1. Demod (GSM-Decoder)
With GSM you can activate a powerful GSM-Decoder mode. In this mode the spectrum display will be deactivated. Instead you will see continues decoded GSM data stream.

The following symbols are used:
„*" = Signal can't be decoded (signal is to weak or bad signal
„F" = found FCCH
„S" = found Sync
„0-7" = represent the color code or TSC (Training Sequence) number.

As demodulation is performed in almost real-time, it is especially suitable for very quick location and assessment of signal sources.

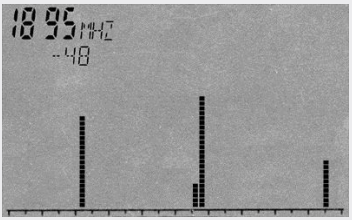
5.3.12. AudInd
(Audio-Indicator / "bug tracer" – option 015)

The AudInd feature allows quick audio-aided location of signal sources (especially "bugs" or "wiretaps"). In this mode, a tone is being emitted whose strength and duration is proportional to the detected signal strength.

Attention: The tone changes only after each sweep completes an corresponds to the highest level detected. So, to sensibly utilize this feature, a very fast sweep is needed. For optimum results, this feature should be used in conjunction with a fast zero-span sweep (Span=0Hz) or using the Power-Meter mode (Option 20x). For best results always use a very short sweep time of 1mS.
"OFF" turns off audio reproduction, "MaxAmp" enables it.

5.3.13. Detect (Detector type)

The Detect option can be used to choose a detector type. Depending on the signal type and measurement standard, different types of detectors are appropriate, the default being
RMS. Currently available types (more are in development) are:



RMS (Root Mean Square)
The square root of the squares of all samples (I^2+Q^2). This detector type has no corresponding symbol in the Mode status field. It can be used to determine the real signal power during sweep time on a certain frequency and is the mandatory detector type for a variety of exposure limit standards, for example, ICNIRP.

MinMax (PEAK)
This detector type compares the current (I^2+Q^2) sample against the strongest formerly acquired sample. The strongest respective sample is being kept and its Min/Max displayed. The Mode status field shows the "Pulse" symbol. This detector is particularly suitable for signals with high crest factors (WiMAX, DVB-T etc.) or frequency hopping (DECT) to determine the crest factor or signal peak. In MinMax mode, signals are displayed with a hatched fill if the signal's corresponding graphic is wide enough to accommodate for this (small Span). The "size" of the portion of the graphic above the hatched part indicates the signal's MinMax value.

After pressing the DECT hotkey (key 0), a DECT phone is being measured (MinMax mode is set automatically). Time Domain mode is being selected as well. An actual DECT signal would reveal itself in the spectrum as a number of sporadically appearing, sharp peaks with varying heights. In contrast, interference from a cellphone would be displayed as a fence like, uniform collection of peaks of almost equal height. As you can see, different signal sources can be easily distinguished. This distinction is even more appealing when using our PC analysis software "MCS", with signals being displayed as 3D graphics in Time Domain mode.

Attention: In MinMax mode, residual noise is always increased by roughly 10dB due to mathematical reasons.

Tip: You can always switch between the RMS and MinMax modes with the shift key – one case where this is useful is determining the crest factor (the difference between RMS and MinMax).

No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.

5.3.14. Disp (display mode)

The Disp setting is used for switching between a few different display modes:

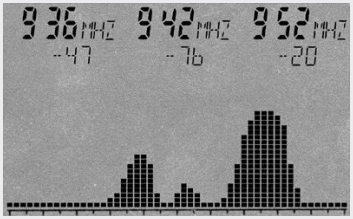
Write
- does not change the display behaviour at all and is the default setting.

PkHold (the Mode status field displays „Hold“)
- disables erasure of the spectrum display

All signals (peaks) ever displeayed by the spectrum display stay visible permanently. Only stronger signals than those previously measured can overwrite the display – this obviously also includes the markers as well as the bargraph (except with the Power meter option.)

Averag – averages the results of several sequential sweeps. A very handy feature for suppressing casual interference or to smooth out the noise floor in order to achieve improved display of very weak signals.

Simply leave this mode on for, say, 24 hours, and see all events that have occurred during that period. The instrument can also be used as a so-called “EVENT Recorder” for catching signal emissions that only occur sporadically: Simply leave the instrument running in this mode until the expected event is “caught”. PkHold mode is also indispensible for standard-compliant measurements using the panning approach (see also chapter “Correct measurement”)



A typical result acquired during a 20 minute car ride with active PkHold mode. Immediately obvious is the exclusive presence of T-Mobile (952 and 942 MHz) as well as Vodafone (936MHz) cell towers.

Tip: You can toggle between PkHold and Write mode at any time by pressing the dot key.

5.3.15. Unit (set unit)

The Unit setting determines the physical unit SPECTRAN utilizes to display measurement results. The currently available units are:
dBm (Decibel Milliwatts)
dBµV (Decibel Microvolts)
V/m (Volts/Meter)
mA/m (MilliAmperes/Meter)
In Exposure limit analysis mode display always includes the power density in W/m² (including Autorange) as well. In effect, this mode provides readings in three units at the same time, if you also count in the Bargraph in dBm.
You can also use this feature to convert measurement results between units. Simply “freeze” the current reading using “PkHold” (Disp menu) and then change to the desired unit – the converted result is displayed immediately.

Tip: You can enforce display of the currently selected unit in the large info field by pressing the menu key twice, which will replace the text displayed in the large info field with the current unit.

5.3.16. MrkCnt (set number of markers)

The MrkCnt setting detemines the number of displayed markers. This can be quite handy should you wish to focus on a particular signal on a single frequency. By setting MrkCnt to “1”, no constantly “jumping” markers will distract you from the actual signal.
Possible values are 1, 2 or 3.

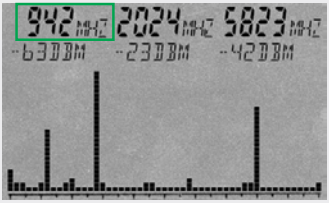
5.3.17.MarkLvl (set starting level for markers)

The MrkLvl setting determines the minimum signal level which will trigger the creation of markers, exposure limit calculation and display in W/m². The available range for this setting is -30dBm to -90dBm.

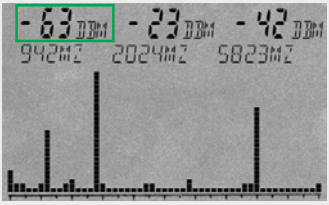
When using the -30dBm setting, markers are only displayed when a very strong signal of -30dBm is present, while at the -90dBm setting, even the smallest signals, albeit many of them might be interference or noise, will trigger marker display. The default setting (-70dBm) delivers optimum results in the majority of cases.

5.3.18. MrkDis (marker display mode)

The marker display mode setting configures marker display itself. As the available fields for marker display vary greatly in size and readability, two different options are available:



Freq. When set to Freq. (frequency), the frequencies of the individual markers are displayed in a bigger size, while the amplitudes (signal levels in dBm) are indicated in a smaller size below.



Ampl. When set to Ampl. (Amplitude), the marker amplitudes (signal levels in dBm) are displayed in the bigger size, while the frequencies are indicated in the smaller size below. In most situations, the Freq. mode is the more appropriate choices, as the marker freq are usually the more important piece of information and thus should be the most readable.

5.3.19. BackBB
(change bargraph display mode, option 20x)

Use BackBB to change the display mode of the bargraph (only if option 20x installed).
Selecting "Spec" will display the highest value of the spectrum display (default) Selecting "BBand" will display the Peak-Power of the power meter (option 20x).
The power meter allows extremely fast broadband detection of RF signal sources in dBm or dBµV, with frequencies of up to 10GHz (12GHz). Detection sensitivity in this mode is around -50dBm (preamp on), depending on frequency. The maximum allowable signal level is approximately +10dBm. Further information can be found in chapter 8.10.

5.3.20. AntTyp
(configure connected antenna)

The AntTyp setting must be configured correctly to reflect the type of antenna connected, as otherwise, mis-measurements can occur. For example, the "HL7025" setting corresponds to the HyperLOG7025 and HyperLOG 4025, "HL7040" to the HyperLOG7040 and so forth.
„HL7025" = HyperLOG7025
„HL7040" = HyperLOG7040
In case no antenna is connected, please use the "None" (0dBi) option.
You can also create your own custom antenna types using our MCS software.

5.3.21. Cable
(configure antenna connection cable / attenuator)

The cable setting must be configured correctly to reflect the type of cable used to connect the antenna to the SPECTRAN instrument, as otherwise, severe mis-measurements can occur.
The "1mStd" setting corresponds to the 1 m SMA cable included with the device. In case no cable is used, please choose "None" here.
The HF-60100 V4 model provides an additional setting labeled "-20dB" to account for the optional external 20dB attenuator. When using the attenuator, this setting is mandatory for receiving correct field strength and power density measurements, enhancing the maximum measurable range to up to +40dBm. You can also create your own custom cable types in our MCS software.

5.3.22. RefOff
(Set Offset or UBBV-Preamplifier)

With RefOff you can set an offset. With "+dB" you can set a positive offset (e. G. cable or attenuator), with "-dB" you can set a negative offset (e. g. preamplifier or antenna). You can only set one offset.

With „UBBV12" you can select our optional 40dB preamplifier. "0dB" (or pressing the CLR key) will set all offsets back to zero (default).

No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.

5.3.23. GSMbst (select GSM Burst-Type)
With GSMbst you can select which bursttype should be used for the main (dBm) display with activated GSM-Decoder (chapter 5.3.13.) You can select:
All (All Bursttyps: Default)
FCCH (Shows „F" at the decoder-display)
SYNC (Shows „S" at the decoder-display)
NonDec (Shows „*" at the decoder-display)
Col.0 – Col.7 (Colorcode 0-7; Shows 0 – 7 at the decoder-display)

5.3.24. GSMdst (GSM Slot-Distance)
With GSMdst you can change the GSM slot distance.

5.3.25.Calib
(in preparation, currently not usable)

5.3.26.Bright (Set display brightness)
The Bright option allows you to change display brightness. Simply turn the Jog Dial until the desired brightness level is reached, and confirm the setting by pressing the Enter key. The new setting will be saved permanently.

5.3.27.Logger (start recording/Data Logger)
With Logger, you can start a long-term recording (Logger) in the current frequency range. Here, the highest reading and the corresponding level and frequency is regularly recorded over and over.
Using this feature, you can create intraday diagrams, for example of wireless LANs. After a bit of post-processing using a PC-based spreadsheet application, the result might e. g. look like the diagram on the left.
After invoking this mode, the following settings will be queried from you:
„**Count**" – Number of log events (possible values are 1 to 9999)
„**Time**" – Length of pauses between individual log events in seconds.
„**FILEId**" – Program number to be used for saving the acquired data. Our PC analysis software can then be utilized to read back the collected data.
Currently the only supported program number is „1000".

After setting up the „FILEId", the memory status field changes to „RECORD" – the logger is now „armed". Press the menu key again to commence recording. During the recording, the number of log events left is displayed briefly in the pixel display each time a log is recorded, allowing you to estimate how much time is left until the recording terminates. Furthermore, a short beep is emitted for each log event. When recording finishes, "RECORD" will disappear from the memory status field, and the acquired data can now be transferred to our "MCS" PC software.
To do this, please select the „File manager" in the SPECTRAN menu of the MCS software. Next, click the file named "logger data" in the "Special" directory. All logger data will immediately appear as a contiguous list or table (first comes level in dBm, then frequency in MHz.) You can use the well-known standard "Copy and Paste" feature to transfer this data somewhere else for further (Graphical) processing – for example, into a spreadsheet application.
The logger always saves the data shown in the highest marker at the sweep display. Therefore be sure to lower the Marker Level, so that you always get a marker otherwise you will have no useful data recorded.



Note: Transferring large amounts of data from SPECTRAN to the PC can take some time – the dBm values are transferred with an accuracy of two decimal places.
Please note that the internal 64K memory can quickly be filled up. Thus, we strongly recommend our 1MB memory expansion (option 001) for using the Logger function.

5.3.28. RunPrg (execute program)

SPECTRAN features its own file system which stores a variety of programs. You can even write your own programs and store them to SPECTRAN's program memory. SETUP's (see below) are also stored as programs.

Each program has its own specific program number. This menu option allows you to recall and execute a particular program by its number. To do this, simply type the corresponding program number. Numbers 300 to 400 are freely available.

Note: It's only possible to save data if no marker is displayed on the device.
Therefore ensure that the marker-level is adjusted low enough.

5.3.29. Setup (organize programs)

With Setup you can organize individual programs and/or configurations using the following options.
„Store" save SPECTRAN's current settings (frequency range, RBW and so forth) as a „mini program". The possible target program numbers are 300 to 400. This way, you can easily save often needed configurations and recall them at a later time using the RunPrg option.
Moreover, you can even create your own hot keys: Simply save your program using a program number between 100 and 109, which will assign your program to keys 0 to 9. Respectively.
You can then recall these settings at any time by simply pressing the corresponding hot key.
In addition, you can use our PC software "MCS" to configure a multitude of further options for each program, among these a program description of up to 6 characters, which will then be displayed in the info display (just like e. g. "GSM900" on hot key 5). By editing the program manually, you can also configure frequencies more precisely.

However, if you do not provide a description this way, the info display will not change nor be cleared. The following information is currently saved by selecting the "Store" function (MCS labels in parentheses):
Start-frequency - rounded to integers kHz (STARTFREQ)
Stop-frequency – rounded to integers kHz (STOPFREQ)
RBW-filter (RESBANDW)
Video-filter (VIDBANDW)
Sweep-Time (SWEEPTIME)
Attenuator (ATTENFAC)
Reference-Level (REFLEVEL)
Display-Range (DISPRANGE)
Detector-Type (PULSMODE)

„**Del**" This option permanently erases a previously saved program. Enter the number of the program to be erased.

„**CalRun**" This option recalibrates the SPECTRAN noise floor on different points within the full frequency range and stores the results permanently.

„**Factor**" This option resets the entire device to factory defaults. This feature is particularly useful for cleaning up a "messed up" configuration.

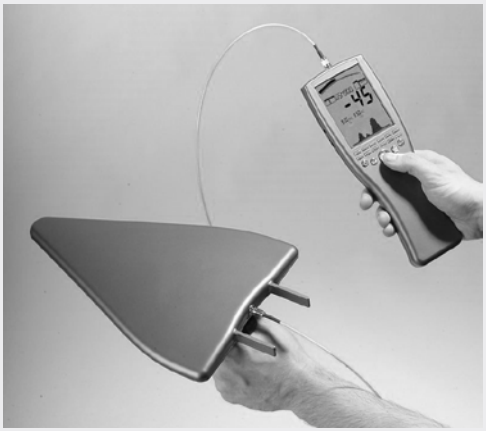
Attention: Please make sure that no RF source disturbs this measurement. Don't connect any antenna, USB cable or power charger. Only start the calibration within a low RF area or room. You get the best results if you use our optional calibration-resistor, which gets connected to the SPECTRAN SMA RF input.

No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.

6. First operational steps
Please, remove the upper protection strip of the LC display.

Connect the HyperLOG antenna and the SPECTRAN device with the SMA-cable.

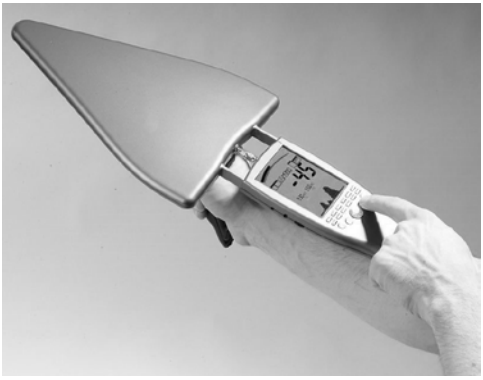
At first connect by hand the SMA-cable to the SMA socket. The cable should be attached carefully. Do not apply excessive force. As soon as a resistance is felt, slightly tighten the plug by using the SMA tool. Again – don't use an excessive force. Never trigger the over torque protection (The SMA-tool has an over torque protection and starts slipping as soon as an excessive force is applied).



Now, attach the other end of the SMA-cable to the HyperLOG antenna. Again, first screw the plug on the socket, and then slightly tighten using the SMA tool. Finally, screw the included "pistol grip" to the bottom side of the HyperLOG antenna, in a way that the HyperLOG antenna points away from you (see picture).

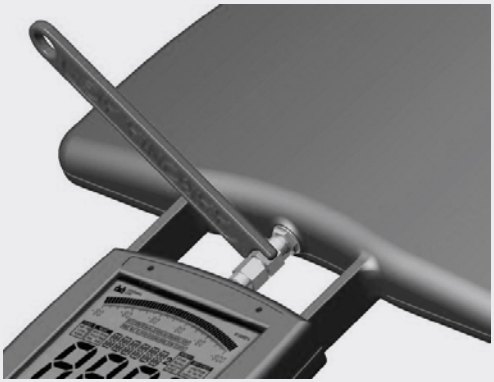
Please perform now a hardware-setup (chapter 6.4.)

6.1. One-hand operation
Here the HyperLOG antenna and the SPECTRAN device are connected directly to a single compact unit. This offers a few advantages for making adjustments during measurement, as keys can now be pressed all the time using your index finger. However, the HyperLOG antenna cannot be moved independently of SPECTRAN anymore, which might create difficulties in reading the display in certain positions (see picture below).



First, carefully screw the SMA adapter onto the SMA socket on the SPECTRAN. (without much resistance). Do not use excessive force. As soon as you notice a resistance, slightly tighten the connection using the SMA-tool. Again, do not apply excessive force. Do not trigger the over torque protection. Screw by hand the SMA-adapter to the SMA socket with care (see below picture). Next steps on the following page.





Now attach the HyperLOG antenna. For this, the HyperLOG's guide rails need to be pushed carefully and without force into the designated sensor pick-ups on the SPECTRAN until the SMA socket of the HyperLOG antenna snaps and locks into the SMA adapter.
Now manually screw the SMA adapter to the HyperLOG antenna, as described before. While doing so, slightly and continuously push the HyperLOG antenna further into the sensor pickups on the SPECTRAN. As soon as the SMA adapter is screwed to the HyperLOG antenna, slightly tighten the connection with the SMA tool, as described above (see Chapter. 6.4.)



6.2. OmniLOG 90200

The OmniLOG 90200 antenna is available as an option and has been specifically developed for radially isotropic measurements in the GSM (GSM900, GSM1800, GSM 1900), UMTS and 2.4 GHz WLAN frequency ranges. It is an ideal companion for the SPECTRAN V4 instruments, with direct support built-in.

Compared to the HyperLOG-antenna the OmniLOG antenna is suitable for direct radial field strength measurement without any need for alignment. This gives you an almost instant field strength reading.

Due to its extremely small physical dimensions, it is – unlike our HyperLOG antennas – also ideally suited for unobtrusive or concealed measurements.

Simply attach the OmniLOG antenna to the SPECTRAN's SMA socket. Do not apply excessive force when you screw the antenna into position. As soon as a significant amount of resistance can be felt, the antenna should be firmly in place. Make sure the antenna is fitted tightly. You can also rotate it by 45 or 90 degrees as shown on the adjacent picture.

Attention: Please bear in mind that unlike the HyperLOG antennas, the OmniLOG is not directional. Consequently, it cannot be used to pinpoint signal sources. Furthermore, the HyperLOG antennas have considerably more gain, thus allowing measurement of significantly weaker signals than with our OmniLOG antenna.

No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.

6.3. Pistol grip

The pistol grip can be mounted on the HyperLOG antenna as well as on the SPECTRAN. In this way, the measuring instrument can also be set up as a tabletop device.

To do this, open the pistol grip as a mini tripod.



6.4. Hardware setup

Before taking any measurement, you must tell SPECTRAN which antenna and/or which cable is connected. Otherwise serious mis-measurement can occur, as every antenna and every cable has totally different characteristics. All Aaronia antennas and cables have thus been calibrated. You can select these pre-defined calibration data on SPECTRAN, but also you can load own custom calibration settings

As a factory default (on delivery), the recommended configuration "HyperLOG" antenna with "1m SMA cable" is selected. Thus, you do not need to make any changes now if you are using this configuration.

For hardware setup, press the menu key. You will be directed to the main menu.

Now, using the up/down arrow keys or the jog dial, first navigate to the AntTyp menu entry.

Activate the menu entry by pressing the Enter key or clicking the jog dial.

You are now being shown a list of antennas. Using the up/down arrow keys or the jog dial, choose the connected antenna. Here, "HL7025" corresponds to the HyperLOG 7025 etc.

If you do not have an antenna connected, choose "None" as antenna type.

Confirm your entry by pressing the Enter key or clicking the jog dial. You are now beiing taken back to the main menu.

Now, again using the up/down arrow keys or the jog dial, navigate to the menu entry "cable". Activate the menu entry by pressing the Enter key or clicking the jog dial.

You are now being presented a list of cables. Choose the connected cable by using the up/down arrow keys or the jog dial.

The "1mStd" entry corresponds to the 1m SMA cable included with delivery. If there is no cable connected, choose "None" as cable type.

Confirm you selection by pressing the Enter key or clicking the jog dial.

You are now being taken back to the main menu. Press the menu button once more, and the new values are being confirmed and stored.

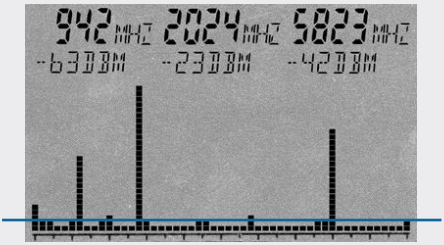
Attention: All settings regarding antennas and cables are stored permanently, even after switching the unit off. Hence, each time you use the unit, you should make sure that the connected antenna and cable really correspond with the settings made in the hardware setup, as otherwise, severe mis-measurement may occur.

7. Correct measurement

Note that when measuring high frequency radiation, you will encounter some „strange characteristics" which can be pretty irritating particularly for novices.
In practice, high frequency radiation rarely constantly fades with distance from the source: due to reflections, diffusion and diffraction (by houses, trees, walls, furniture etc.) massive selective concentration (so called "Hot Spots") is often noticeable, especially inside rooms. Here, the difference in measured signal strength can easily vary by a factor of 10 or 100 in a range of just a few cm. Thus, it is sometimes pretty difficult to find the actual source or the maximum strength of RF radiation.
High-frequency fields are often also measurable on metal objects, as these act as antennas and cause the corresponding „concentration", reflection or forwarding of high frequency radiation. Thus, electrical cables are another medium for high-frequency radiation and can "catch" it and "release" it again at a totally different location. Hence, even well shielded rooms can become "contaminated" again just due to a trivial mains cable. To avoid this, shielded rooms must be equipped with so called mains filters.
Especially, however, the utilization of usual power cables for data transmission (e. g. Internet, signal, video and audio transmission) is a serious source of interference and radiation.

7.1. Noise floor

The so-called noise floor indicates the limit below which real measurements become impossible. Here, only interference will be detected.
Visually, SPECTRAN would display this as a collection of small "points" or bars which either stay statically at the same place or change with every sweep (noise). However, depending on frequency and selected settings, the noise floor can be vastly different and must be determined before starting a measurement.



In the case of SPECTRAN, the noise floor increases with lower frequencies – for example, the noise floor at 100MHz is significantly higher than it is at 5GHz. However, skilled users can usually still "tease out" useful readings and distinguish between noise and even very weak, real signals. Determining the noise floor is relatively straightforward: Simply conduct a "measurement" without an antenna and/or signal source or by connecting a 50 Ohms terminator. Any signals then possibly shown are the noise floor of your instrument.

7.2. Harmonics

A typical effect when working with spectrum analyzers: When dealing with comparatively strong signals, a number of weaker signals with fixed offsets relative to the actual signal appear, the so-called „harmonics". These are "phantom" signals with frequencies that are multiples of actual signals.
For example, a 400MHz signal will also be visible around 800MHz, 1200MHz, 1600MHz etc., a 1800MHz signal will also appear at 3600MHz, 5400MHz and so forth. These are commonly called second harmonic, third harmonic etc.
Thus; when in doubt, one should always consider an additional measurement at half the center frequency. If a correspondingly stronger signal is found there, the previously measured one would be a harmonic.
With the current firmware, SPECTRAN already attenuates harmonics by approximately 30-50dB, depending on signal strength.

7.3. Measurement of wireless LAN & cellphones

To accurately measure WLAN and Cellphones, their peculiarities need to be considered, as both systems are rarely „really active enough" to allow sensible measurements:
For measuring cellphones, you need to actively make a call and talk. Just ringing the other party is often insufficient. Also take into account that cellphones significantly reduce output power as soon as you Stop talking.
When measuring WLAN, you should continuously transfer data. Should the system be operavting in "Pin"-mode only, be sure to use a longer sample-time (5s). Further optimized configurations can be found in our "MCS" PC software.

No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.

7.4. Attenuator-mode „Auto“

This option permits optimum, automatic insertion or bypass of the attenuator. However, a short “test measurement” has to be performed by the instrument before each sweep in order to make a correct decision, which will delay the sweep briefly. The length of this delay depends on the selected sample-time according to the following formula:

Delay = Sample-time/10

However, the maximum delay is just 10mS, corresponding to 100ms sample-time.

For ensuring clean operation in Auto attenuator mode, the sample-time must be set to at least 100mS, as otherwise, intermittent erroneous level readings can occur specifically in the lower frequency ranges.

The delay can be avoided altogether by turning off “Auto“ mode and setting the attenuator manually. (0/10/20/30/40dB).

7.5. Sensitivity

Please note that the noise floor (and therefore sensitivity) in spectrum analyzers can be subject to significant variation depending on frequency.

Even a frequency adjustment of just a few MHz can decisively alter the noise floor characteristics. In general, however, SPECTRAN’s noise floor increases with lower frequencies, while sensitivity decreases.

A practical example: Using the same filter settings, you can measure considerably weaker signals at 5 GHz than at, say 100MHz.

7.6. Measurement inaccuracy

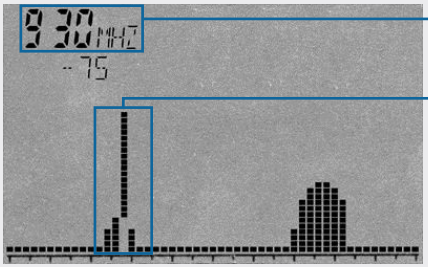
Aaronia states a typical accuracy for each SPECTRAN model. However, this means that higher deviations are entirely possible. Especially when you approach the so-called noise floor or the maximum sensitivity of a spectrum analyzer, accuracy decreases by principle.

Even though SPECTRAN instruments offer an impressive accuracy considering their price, a yet higher measurement inaccuracy than the base instrument itself has is assumed in practice: The reason behind this are further factors which can influence measurement inaccuracy: Some of them are: temperature dependence, repeatability, antenna errors, modulation dependence etc.

According to BUWAL (see also www.BUWAL.ch), one should always expect an extended measurement inaccuracy of at least 35 % even with absolutely professional equipment. So, expressed in dB, you should always expect a rounded +/- 3 dB and consider this in every measurement.

Example: You measure a value of -45dBm. So, the actual result could, according to the mentioned measurement inaccuracy, vary between -42dBm (-45dBm +3dB) and -48dBm (-45dBm -3dB). Thus, as you want to measure exposure due to radiation, you should always assume the highest value, namely -42dBm.





Frequency and **level** at the current cursor position

Cursor (The spectrum portion under the cursor is drawn in invers.)

7.7. Cursor and zoom features

Using the Jog dial, you can activate a cursor in spectrum analysis mode. This cursor allows you to display the exact frequency and signal level of a certain point on the display.

To activate the cursor, simply turn the jog dial and the cursor appears as a line in the spectrum display. You can deactivate the cursor by pressing the menu key twice. The portion of the spectrum display under the cursor is drawn in inverse, so its information is preserved.

By turning the Jog dial, the cursor can be positioned freely on the display. The readout on the large main display as well as the exposure limit display and demodulation now correspond only to the current cursor position. The current frequency and level displays for the cursor are only updated after a complete sweep and shown in the first (leftmost) marker field. Consequently, the auto marker feature is disabled in this mode.

When you press the jog dial after positioning the cursor, you can zoom into a signal. Here, the center-frequency will be shifted to the indicated cursor position and frequency, the span is reduced by one half and a new sweep is initiated. So you have zoomed into the signal by 50%. This function can be utilized as often as you wish until the desired resolution is reached.

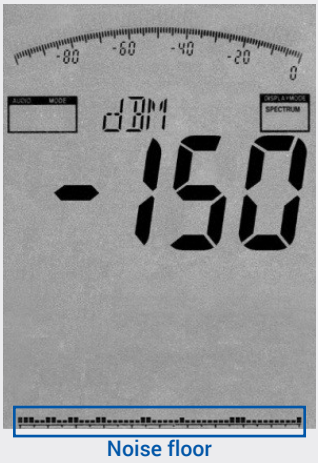
Deactivate the cursor again by pressing the menu button twice.

Attention: The cursor does not get erased when in hold-mode.

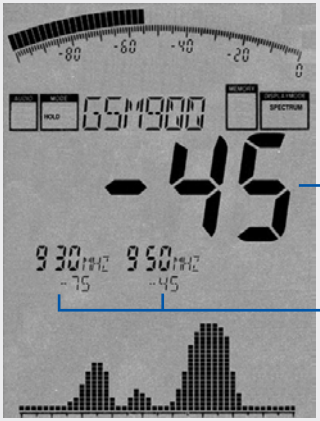
No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.

8. First measurement
Example: measurement of a cell tower.

8.1. Prepare device
- Remove the protective firm at the LC display
- Mounting the HyperLOG antenna (see. chapter. 6)
- Connection of the power supply
- Charging of the battery (see chapter. 3)
- Switch device on (ON/OFF-Taste)
- Device performs automatically a quick calibration.
- Device ready for measurement



Noise floor



8.2. Basics
You should know that there are three different kinds of cell towers (in Germany): GSM900, GSM1800 and UMTS.

8.3. Measurement
As GSM900 has the highest availability, it is measurable almost everywhere and thus optimally suited for explaining usage of SPECTRAN:
Now, simply press the 7 key for setting up optimal parameters for measurement of GSM900 cell towers. The Status display should now show “GSM900”. Now, you only need to choose the correct operation mode.

8.4. Operation mode „Spectrum analysis“
Now press the Enter key until the Display Mode status field reads „Spectrum“. Should you have “good reception” and a properly aligned antenna (this is important), you should now have results similar to those shown in the image on the left. However, should the large Main display show “---“, or “-150”, no signal is being received and you need to change your location or align the antenna differently. During every measurement, a little dot moves from left to right in the Graphics display. Only when this dot reaches the right border, the current measurement is finished an all readings are updated. (Depending on the settings possibly the dot is too fast for the human eye).
The Main display always shows the level of the strongest signal, „-45“ in our example. The higher this figure is (the closer it gets to “0” or a positive value), the stronger the received signal (for example: “-35” or “-25” means a much stronger signal than the “-45” shown in our example.
Directly beneath, a max. of 3 so-called „Markers“ are being displayed. They show the frequencies and levels of the strongest signal sources. In our example we got two Mrkers: Marker 1 at 930MHz at -75dBm and Marker 2 at 950MHz at -45dBm (-45dBm also is being the strongest signal and thus also shown on the Main display).
Beneath the Markers, a graphic with several “hills” is shown. It displays the level distribution over the indicated frequency range. This is the so-called “Spectrum display”.
The higher the „hills, the stronger the signal at the respective frequency. The aforementioned markers display the frequency and level at the peaks of these „hills“.





8.5. Hold-function

As you have probably noticed, the display constantly changes. This is completely normal, as the signal strength of the high frequency radiation also constantly changes. This also depends on the alignment of the antenna. Moving it only a few cm or a different alignment can cause abrupt changes in the readings. Just try it yourself by aligning your antenna differently and checking out the display.

Often you only want to evaluate the highest reading. Though, as the display constantly changes, this can prove rather difficult. To remedy this, the so-called Hold-function is used.

To activate, press the dot key. Hold appears in the mode status field. From now on, only the highest value will be displayed. Also, the spectrum display does not get erased anymore.

The complete display now literally appears “frozen”.

If you press the dot key for a second time, HOLD disappears again from the Mode status field, and the Hold mode is deactivated. For finding the absolute maximum, the so-called „panning approach“ is used.

No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.

8.6. The „panning approach“

When evaluating conformance of exposure limits, usually only the maximum signal is considered. This value can be found using SPECTRAN and the HyperLOG antenna using the so-called “panning approach”. The panning approach is already officially approved in many countries. Application is as follows:

Choose the desired frequency range. In our example, we already did this (GSM900 using the 5 key) and activate HOLD mode (dot key) as explained above. Now turn and tilt the antenna slowly in all directions until the value stops changing completely. You have now determined the signal maximum.

However, should you wish to evaluate the signal maximum in a room, you additionally need to take into account all locations. Walk through the entire room. Measure especially in corners and near windows as these often produces the highest readings. During measurement, the maximum reading will also quickly increase until it finally does not change anymore and “freezes” on its highest level. When measuring a whole room, this may well take a few minutes. The value displayed now is the highest signal level that could be detected in the entire room.

Mostly, you will be able to find the highest reading by rotating the antenna to the left or right by 90 degrees, as this corresponds with the alignment of the transmission antennas.
As this antenna is directional, you can even try to find the location of the transmission tower. However, often, this is only possible outside, as inside rooms, there are too many reflections which produce an erroneous idea of the direction.

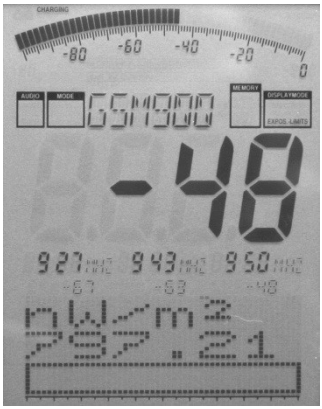
Now, a measurement result is of course not too useful if it cannot be compared to some kind of reference limit. Until now, this has been extremely complicated, using complex tables and converting between units. An often exhausting task even for some professionals, and particularly for the novice.

8.7. Operation mode „Exposure limit calculation“

The display status field shows “Expos.-Limits“

Now press the Enter key until the Display mode status field shows „Expos.-Limits“.

Firstly, the strongest signals are shown along with their frequencies and levels using markers, just like in spectrum mode. The large main display shows the level of the strongest signal, as usual.



In the graphics display below, the strongest signal is converted to power density [W/m²] and displayed. The cable and antenna data are already considered in these calculations. Particularly handy: the so-called “Autorange” function: the w/m² display is complemented with the correct fractional unit automatically:

m = 1/1 000 (one thousandth)
µ = 1/1 000 000 (one millionth)
n = 1/1 000 000 000 (one billionth)
p = 1/1 000 000 000 000 (one trillionth)
f = 1/1 000 000 000 000 000 (one quadrillionth)

As this example clearly shows, one would actually drown in the huge number of “zeros” without the Autorange function.

The practical Hold feature is also available in this mode for keeping the display „smoother“.

You can even display a percentage relative to an exposure limit. As vastly different exposure limits for high frequency fields exist depending on your measurement's purpose, circumstances and/or professional background.
SPECTRAN offers several exposure limits right away. You can change between exposure limits with the left/right arrow keys.
Further explanation of exposure limits can be found in chapter 12.3.
The SPECTRAN firmware supports the following exposure limit models:

ICNIRP = German (and international) exposure limit (complex formula)
Salz 1 = Old Salzburg precautionary value (1mW/m²)
Salz 2 = Salzburg precautionary value outdoors 2002 (10 µW/m²)
Salz 3 = Salzburg precautionary value indoors 2002 (1µW/m²)

In our fictional example, the bargraph display shows approximation to the international ICNIRP limit by 0.06 %. As you can see, with this exposure limit, even a relatively "strong" signal of -45dBm only generates a few hundredth of a percent (namely 0.06 %) of "deflection".

However, if you change to one of the Salzburg limits, the unit will quickly indicate even excess of the exposure limit. When exceeding a limit, the display shows percentages above 100 % (for example 128.00 = excess of exposure limit by 28 %).
When the percentage is greater than 999.99 %, "***.**" is displayed. This indicates overflow.

Please note that the values in the graphic display can slightly change even if the dBm value on the main display is stable, as internally, SPECTRAN also uses the non-visible fractions of the main display value to calculate the figures related to exposure limits.

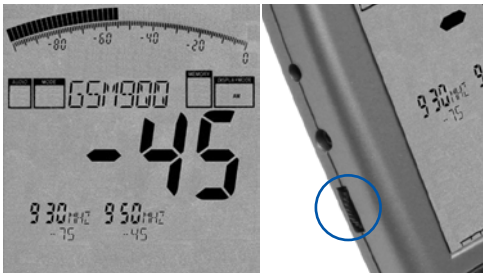
Tip: You can download new and/or updated exposure limits (which are constantly updated due to changed legal situations) from our homepage and keep SPECTRAN up-to-date at all times. You should also check out our PC analysis software, which offers a whole range of additional features and exposure limits.

8.8. Operation mode Audio-Output (demodulation)
The Display mode status field shows „AM" or „FM".

All SPECTRAN models offer a so-called demodulator. The demodulator makes pulsing and modulation of a signal source audible (if it exists).
The frequency-exact, selective acoustic reproduction of a signal can be very helpful with identifying and finding a signal source. As demodulation takes place in real-time, it is also perfectly suited for quickly locating a signal source.

SPECTRAN offers the following demodulation modes:

AM = amplitude modulation
FM = frequency modulation
PM = phase modulation



To switch between AM and FM, please use the dot key. To change to PM, please activate this feature by using the menu and select "Demod".
Volume can be adjusted with the volume control on the left.

In contrast to simple broadband detectors, SPECTRAN performs demodulation only at a certain single frequency (center frequency). Hence, you can selectively "monitor" very narrow, limited frequency ranges. Please note though that in this mode. Filtering is a bit less effective, which might lead to very strong neighboring signals also being audible on the actually selected frequency.

Attention: During audio analysis, the complete display is „frozen" and the pixel display is turned off to free up enough CPU power for demodulation. Hence, only an acoustic reproduction takes place.

No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.

For optimal acoustic reproduction of signals, you can select different filter bandwidths using the Up/Down arrow keys.
The selected filter is displayed in the large Info display. All available RBW filters (for example: 3kHz, 1MHz etc.) are selectable.
Often, you will not be able to exactly „hit" the center frequency of a signal, and demodulation is bad or impossible. Thus, you can fine-tune the center frequency using the right/left arrow keys. The step width used is derived from the selected filter. Should you have chosen, for example, the 1MHz filter, steps are 1MHz wide etc.
When changing the center frequency, it will be shown on the main Info display (full MHz)

Examples:
-Cell towers / cell phones:
A GSM900 / GSM1800 cell tower (keys 5/6) emits a „beeping" or crackling" noise with many interruptions and morse-like „pulsing". This is the so-called "control channel", which is always active and "beeps" exactly at 1733.33Hz. When one or more cell phones are active, you can recognize an additional 217Hz "crackling" noise (similar to morse code).
An optimal reproduction can be achieved with the 1MHz or 3MHz filters.

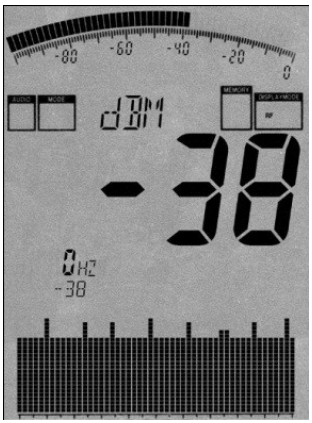
-DECT phones:
An easily recognizable signal source is the base station of a DECT phone (key 0). It produces a 100Hz "humming" sound. You can simply "prove" this by disconnecting the mains from the base station: the hum disappears. When you turn the power back on, the hum will reappear after a few seconds.
Good reproduction quality is achieved by using the 1MHz filter.

Attention: For optimal reproduction of a signal, its level should be at least -70dBm, or preferably stronger than -60dBm.

Tip: Optionally, you can even visualize the demodulation using a LF spectrum analyzer. The SPECTRAN NF series lends itself optimally for this purpose, as the NF-3020 and above offer the required signal input.

8.9. Operation mode broadband detector (Peak-Power-Meter)

The display mode status field displays „RF" of "Power". All SPECTRAN models equipped with the Option 20x feature an integrated RF detector (power meter) which can be utilized to acquire Broadband power measurements in dBm or dBµV up to 10GHz (12GHz). The smallest detectable signal level is around -50dBm (preamp activated), depending on frequency. The maximum level measurable is approximately +10dBm.



Due to technical considerations, frequency display is not possible in this mode, thus only a „0Hz" marker is shown. The graphics display is transformed into a Time Domain display: the variation of signal level in time is visualized. You can change the update speed by altering the sample-time (menu "SwTime"). The large main display and the bargraph show you the measurement result in dBm or dBµV. The noisefloor is about -50dBm.

In contrast to the „Spectrum analysis" mode, SPECTRAN's broadband detector allows straightforward and very fast a realtime display of all peak signal levels in the entire frequency range of the detector. To take advantage of this, sett the SwTime to 1ms using the menu.

By utilizing a high-end, state-of-the art Silicon-Germanium (SiGe) technology detector chip, we even provide detection of ultra-short pulsings. This opens up a whole new range of possibilities: For example, measurement of ultra-short RADAR bursts or other short pulses.

The optional drastically enhanced frequency range of up to 10GHz (12Ghz) is even larger than what the spectrum analysis of SPECTRAN can currently offer (currently 9,4GHz) and thus allows, among others, „detection“ of PAR airport radar in the 9 GHz band.

Obviously, the usefulness of this kind of detector “measurement” is limited in certain ways. For example, no frequency filtering or display takes place (however, you may of course use your own external filters). So, to be perfectly exact, neither power density nor field strength can be displayed; neither can the measurement results be corrected for the utilized antenna. This also implies no useful exposure limit calculations.

However: Should you already know the frequency of a dominant signal source; you can still calculate the power density in w/m² or field strength in V/m resp. A/m of this particular signal. Just note the dBm figure displayed by SPECTRAN and apply the corresponding formula in chapter 11.

These examples also include a table to demonstrate how to achieve a sufficiently exact measurement even with unknown frequencies.

Of course, broadband measurements have their limitations when evaluating the actual emitted signal strength, particularly in the context of modern digital signals. Thus these instructions should be considered with care.

Nonetheless, it’s still a nice technical tool for a „quick assessment“.

To detect a signal maximum, you should definitely use the Hold function (see chapter 8.6) and the so-called „panning approach“ (see chapter 8.7). We recommend this suggestion for this mode in particular, due to the extremely fast display updates. This is the only way to accomplish a useful “measurement”.

Still, the intended application for the broadband option is operation as a power meter. Its high temperature stability guarantees highly reproducible results. The instrument’s input impedance is “standard” 50 Ohms, so a broad range of equipment and antennas can be connected without any troubles. The highest accurady is reached with attenuator = 10dB and PreAmp = Off. Don’t forget the maximum levels in this configuration.

Attention: Take care not to overload the input.

Tip: You can upgrade your instrument with the broadband option at any time. Depending on your model, detectors for up to 10GHz (12GHz) are available.

Tip: If the broadband detector is installed, the bargraph can also be activated (use the BackBB function) to always show the peak signal strength measured by the detector. Even in spectrum analysis mode, where normally the frequency selective measurement result is displayed, the bargraph will then always show the broadband peak power measured by the broadband detector.

No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.

8.10. Manual setting of a frequency range

This way, the frequency range can be configured for one particular application to measure only those signals. Additionally, a smaller frequency range increases sweep speed enormously and improves accuracy.
For setting this frequency range, you only need to know the start- and stop frequencies of the corresponding application and program them in SPECTRAN.

Chapter 12 shows you frequency tables with an excerpt of various radio applications along with their start and stop frequencies.
Subsequently, we will illustrate custom configuration using the new mobile communications standard UMTS as an example. In our case, we only want to find an evaluate UMTS cell towers of the provider „Vodafone". For this, proceed as follows:
First of all, check the UMTS frequency list in chapter 12, table 10.

UMTS uses frequencies between 1,900.1 and 2,200.0MHz. As we only want to measure the cell tower and not the cell phone, we only need the so-called downlink frequency. This frequency, according to the frequency list, ranges from 2,019.7 to 2,200.0MHz. The Vodafone cell towers, according to the list, only use frequencies between 2,110.3 and 2,120.2MHz. These are the start- and stop frequencies we were looking for. Program them as follows:

Press the menu key

Navigate to the menu entry labelled fLow using the arrow keys.

Press the enter key

Now choose the unit to be used for frequency entry. Available choices are Hz, kHz, MHz and GHz. In this case, we will use MHz

Press the enter key

A zero appears on the large main display. Additionally, the big status field reads START. Now, enter the start frequency, in full MHz, using the number keys. In this case, we want to start at 2,110.3MHz. So, enter 2110 (rounded) and correct any typos by pressing the CLR key and repeating the input. When finished, press Enter again for confirmation.

Returning to the main menu the next menu entry fHigh has already been automatically selected.

Press the enter key once more.

Choose the unit to be used for frequency entry. Just as for fLow, we will use MHz.

Confirm with the enter key.

A zero again appears in the main display. Additionally, the status field reads STOP. Now, enter the stop frequency, in full MHz, using the number keys. In our case, we want to measure up to 2,120.2MHz. So, enter 2121 (rounded up) and press Enter again for confirmation.

Enter "2121" (rounded up)

Press the enter key

Returning to the main menu the next menu entry RBW has already been automatically selected.

Press the enter key

A list of various filter bandwidths is displayed next. Choose the 1MHz filter by using the up/down arrow keys

Confirm the new setting by again pressing the enter key.

You are now being returned to the main menu. Finally, press the menu key again, and all settings are being confirmed and the sweep (measurement) starts.

The big status field reads custom, indicating a custom configuration, and the sweep is initiated automatically. Now, only the configured frequency range between 2,110 and 2,121MHz is being sweeped (measured), thus all operation modes (exposure limit calculation, spectrum display) now only refer to this frequency range. Now you can precisely evaluate if a Vodafone UMTS cell tower is active and how strong the signal is.

Tip: If you like, you can save a particular setting as a custom „hotkey". You can find more information on this feature on the following pages.

9.1. Quick Zero-span sweep (Time Domain Mode)

A quick measurement at a fixed frequency almost on real-time is achievable with the so-called zero-span. Should you have found a signal at e. G. hotkey 5 (GSM900), simply set the correct center-frequency using the cursor. Now, set Span to "0" and SwTime to 1mS. The level at the center frequency is now continuously and quickly being updated incl. time domain display.
Ideally suited for locating signal sources and maximums using the "panning approach"

9.2. „Turbo" Sweep for small frequency ranges

SPECTRAN automatically switches to a special „Turbo" sweep mode when certain conditions are met. In this mode, the second and all further sweeps are once again accelerated by roughly 300%, as various sweep parameters of up to 1280 measured samples are being buffered. As such, performance in "Turbo" sweep mode depends on the selected RBW filter and the Span. The maximum usable values are as follows:

3MHz RBW = Maximum usuable Span 96 MHz
1MHz RBW = Maximum usuable Span 32 MHz
300kHz RBW = Maximum usuable Span 9,6MHz
100 kHz RBW = Maximum usuable Span 3,2 MHz
and so on.

As an example, you can monitor the complete Wlan frequency range (90MHz span) with an RBW setting of 3MHz in "Turbo sweep" mode.

9.3. „Turbo" for larger frequency ranges

You can achieve quicker measurements of larger frequency ranges by using the „Full" filter. To do this, set RBW to "Full" and SwTime to 1mS. The result is an extremely fast sweep of even large frequency ranges.

As this mode is also specifically designed to apply less interference processing, it is only recommended for experienced users as a „quick assessment tool".

9.4. Allocating keys with your own measurement settings

The keys 0 to 9 can be allocated with custom configurations (incl. start/stop frequency, RBW etc.) with program numbers 100 to 109 corresponding to the keys 0 to 9.
Simply store the current configuration via the Setpu & Store menu entries using one of these program numbers, and they will be available at any time using the corresponding key. It's even easier with our free PC analysis software "MCS". Here you can even attach info texts.
To recall the factory settings, select "Factor" under the "Setup" menu.

9.5. Dect analysis

Using the „0" key, you can call up the DECT analyser to measure active DECT phones. By pressing the DECT key (0 key) more than once, you can even analyze all 10 channels (display reads: "DECT 0-9") individually according to the DECT standard. You will quickly be able to see which of the 10 channels is currently occupied and even when channel hopping occurs.
This channel separation is particularly practical in Audio mode. Moreover, a very special feature is the AUTOMATIC-DECT-CHANNEL-HOPPING-MODE (DECT Auto-Rotate). It is automatically activated after pressing the DECT key for the first time.
Here, all 10 channels are constantly being measured and displayed one after the other. Like this, you will never miss a channel hop and can e. g. quickly evaluate the strongest detected level on ANY channel by using PkHold. (Chapter 8.6.)

9.6. Exposure limit calculation (display in W/m² with „Weak" signals)

Reduce the „MrkLvl" setting to „-90dB"or even „-110dB".

9.7. Conversion of measurement results to other units

As you know, the PkHold feature can be used to „freeze" the current readings. So, to convert between units, simply activate PkHold and then choose a new unit [V/m, mA/m, dBm, dBµV] in the Unit menu: The previous figure will immediately be converted.

No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.

9.8. Correct settings for manual input/measurement

For this, it is best to use our PC analysis software "MCS". Here, dozens of optimized "profiles" ranging from model making to 5GHz WLAN are available at a mouse click. Further information like channel number, provider etc. is displayed as well. You can use the File manager in MCS to simply "copy" these parameters (for example, to a hotkey) and transfer them to SPECTRAN.

Generally, the following rules apply to most signal types:

1. An RBW setting of 3MHz and a SwTime of 1ms are usually ideal.

2. Only activate MinMax mode when dealing with pulsed and/or modulated signals.

Tip: We offer the FREE PC analysis software „MCS" for SPECTRAN on our homepage. This really versatile software unleashes SPECTRAN's full potential. Whenever possible, you should use this software for getting everything possible out of your SPECTRAN instrument.

9.9. Measurements of satellite TV

You can directly connect SPECTRAN to your LNB's output (or alternatively, to the attached satellite cable or receiver) in order to perform measurements. However, please note that the receiver supplies a 13/18 V DC voltage to the LNB, which will consequently also be fed into SPECTRAN's input. While SPECTRAN can accept DC voltages of up to 50V, it is always possible for the DC voltage to vary significantly and intermittently exceed acceptable levels, leading to the destruction of SPECTRAN's input.



DC-blocker provides protection from potentially damaging DC voltages for SPECTRAN's input.

We thus strongly recommend you use the optional DC blocker which can simply be inserted before SPECTRAN's input and effectively eliminates any DC voltages. It does not at all influence your measurement.
To eliminate the still existent risk of excess input levels (particularly when utilizing high-gain satellite dishes), you should additionally add our optional 20dB attenuator by simply attaching it to the DC-blocker.

9.10. Measurement with a direct cable connection

Please be careful not to destroy SPECTRAN's input circuitry when conducting measurements with direct cable connections to other equipment (especially in the case of function or RF generators) as such equipment might generate excessively high voltages or power. Even a very short overload can irreversibly destroy SPECTRAN's extremely sensi-



20db Attenuator

To prevent damage due to excess input levels, be sure to always utilize our optional 20dB attenuator in such applications.

Furthermore, always remember to turn off SPECTRAN's internal preamplifier. This will enable you to apply input levels of up to +10dBm (HF-6060 and HF-6080 models) or even up to +20dBm (HF-60100) without having to worry about overload. In addition, all V4 series models can generally accept DC voltages of up to 50 V.

Please choose for a correct measurement the 20dB attenuator in the menu CABLE. ((„-20dB", chapter 5.3.21)

9.11. Settings for GSM measurements

The measurement with 120kHz RBW needs a longer sample time (5000 ms or more) to capture the signal (complete GSM900 frequency range, span 39MHz). The measured value is 10dB too low at this sample time, but the signal is detected.

Increasing the sample time will result in the correct signal strength. Zoom into the signal (1.6MHz span) and reduce the sample time to 2000ms if you use 1000 or more samples. This will give you the correct signal strength.

10.1. What is a frequency range?

Imagine a giant motorway, several kilometers wide, with thousands of lanes. On this motorway, every imaginable kind of vehicle can be found: motorcycles, cars, trucks, etc. To not let them get into each other's way, every lane is reserved for only a single group of road users: e. g., lane 1 only for cyclist, land 3 only for pedestrians, lane 40 only for trucks etc. Depending on the traffic caused by the individual groups, these lanes also have different widths: For example the land reserved for cyclists is far narrower than that reserved for trucks, etc. High frequency ranges, and the road users are applications (for example, a cell phone, a microwave oven, a radio-controlled car lock, in effect all appliances that somehow work with radio waves).

So, every application has its own frequency range for exclusive use. By assigning a separate frequency range for each application, conflicts between different "Road users" can be avoided, so that e. g. a cell phone cannot be disturbed by a microwave oven.

10.2. Big difference between exposure limits

Back to our motorway: Of course, all road users also have their own specific speed limits. For our example, a pedestrian may only walk at up to 5 km7h. Cars, in change, may speed at up to 250 km/h. Exposure limits for radio applications work similarly: Here, however, the word "speed" is replaced by the transmitting power. E. G., a broadcast station may have an enormous transmitting power of 1 000 000W or more, in contrast, a radio-controlled car lock only a few mW (1mW=0.001W) etc. 3 examples of exposure limits in practice.

Frequency range (MHz)	Application	Power limit (W EIRP)
1.880 – 1.900	DECT phones	0,25
2.320 – 2.450	Amateur radio (11 cm)	750
5.725 – 5.825	WLAN 802.11a	0,025

It is easily visible that each radio application may only use one exactly defined frequency range. Also, the high differences in admissible transmitting power are noticeable.

10.3. Use of the spectrum analysis

There are 2 main reasons for application of spectrum analyses:

a. You would like to know which radio applications are active
b. You would like to measure the exposure caused by each of the radio applications separately, e. g. for evaluating exceeding of exposure limits.

Regarding a.:
Let's reconsider our "giant motorway" example:
Remember that every lane was only intended for use by a single kind of vehicle. Now imagine that a huge bridge crossed this motorway, with you standing on the bridge and looking down on the motorway.

Now, for example, you would like to know exactly what is happening on the motorway, and this for every single lane. However, the motorway is incredibly wide, so you would need rather good binoculars to be able to even look a few km far. Let's just imagine that your binoculars have a range of 6km (6000m). Now you would like to know how much traffic there is on a specific lane and how fast it is travelling. So, you'll take a piece of paper and write down the number of the lane and the data you evaluated. Starting at lane 1, you see: nothing – OK, let's go on with lane 2 – nothing either. Now lane 3 – OK, there is some traffic going at 18 km/h. Continuing with lane 4 – Nothing, etc. Until you have reached the last lane. What have you accomplished now? You've performed an analysis of the entire range of lanes from 0 – 6 km. Or, in other words: You performed a range analysis. As you know, to analyze something means breaking it down into smaller parts which can be evaluated. In this case, the 6 km wide motorway was that big "something" and the smaller parts were the individual lanes. The word "range" can now be replaced by the word "Spectrum" and there we are. You have performed a spectrum analysis.

If you now in addition have a lanes plan telling you which lane is assigned to which kind of vehicle, you can exactly determine what kinds of vehicles have just been travelling.

Spectrum analysis in high frequency technology works exactly like that: There are „lanes", here as

No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.

well. Though, these lanes are called frequency ranges. The width of these frequency ranges is measured in the unit Hz (Hertz). However, as the frequency ranges are mostly found in high Hz ranges. Writing them in plain Hz would require huge numbers. Thus, the unit Hz is often extended to MHz (1.000.000Hz) and GHz (1 000 000 000Hz). Like this, the whole thing becomes much clearer. So, 1 000 000 000Hz can also be written as 1 000MHz or 1GHz.

The different kinds of vehicles are called radio applications and have their own abbreviations: e. g. the radio application "UMTS" (the new, digital mobile communications standard) has its own frequency range which spans 1900 to 2200MHz (1.9 – 2.2GHz).

The speed at which the vehicles are travelling can now be replaced by a new expression: the signal strength or level.

So far, we have now explained the used expressions and units. Now, high-frequency analysis works just as our motorway example:

For example, our measurement device should evaluate all frequency ranges from 1MHz to 6 000MHz (in pictures, our 6 000 m wide motorway). Step by step, every frequency range is evaluated precisely. First: 0 to 1MHz, then 1MHz to 2MHz etc. until 6 000MHz. Also, the signal strength of every frequency range is exactly stored. Like this, we also learn what signal strength was present on which frequency range.

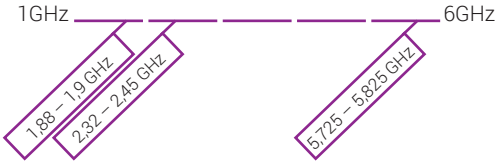
Real-world examples:
Let's assume that we want to exactly evaluate the frequency range from 1GHz to 6GHz, and that the following 3 radio applications were active simultaneously with various signal strengths (in practice it will mostly be a lot more different applications.

Frequency range (MHz)	Application	Reading
1.880 – 1.900	DECT phones	40
2.320 – 2.450	Amateur radio (11 cm)	20
5.725 – 5.825	WLAN 802.11a	80

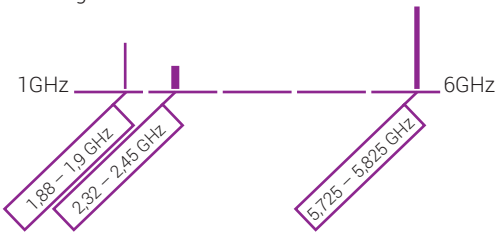
How can this be visually displayed on a measurement device? Well, first, we will map the frequency range from 1GHz to 6GHz on a line from left to right (**X-axis**):



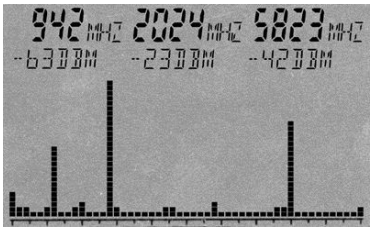
Now, we tag each of the 3 applications depending on their frequency on the right spot of the X-axis and can thus see where they can be found:



Finally, we display the strength of each of the 3 readings as vertical bars on the **Y-axis**.



Additionally, we have also adapted the width of each vertical bar to the width of the respective frequency range of each radio application (the so-called bandwidth.
DECT only has 20MHz (1.880 – 1.900MHz = 20MHz) of bandwidth, a very small range. Amateur radio, in contrast, already uses a far higher bandwidth (2.320-2.450 = 130MHz) usw.
We can now see all information concerning these three signal sources. In practice, this will look similar on the SPECTRAN display.



In this example, we also have 3 main signal sources (from left to right):

Signal 1: 942 MHz mit -63dBm
Signal 2: 2.024 MHz mit -23dBm
Signal 3: 5.823 MHz mit -42dBm

These are displayed as vertical bars. The same rule as in our example applies here, too: The higher the measured signal strength, the higher the bar. Further information regarding each of the bars is displayed from left to right as markers in the upper display area.

Marker 1 (the first bar from the left) is displayed 942MHz; strength -63dBm.
Marker 2 (the second bar) is displayed 2 024MHz; strength -23dBm.
Marker 3 (rightmost bar) is displayed 5.823MHz; strength -42dBm.

The configured frequency range is constantly being scanned. Thus, the display will also constantly change. This is recognizable because of a small dot above the graphics display which moves from left to right. This procedure of continuous scanning is called "sweeping".

So, what kinds of information have we acquired now?

a) In the entire frequency range from 0 – 6GHz, there are 3 main signal sources.

b) The frequency and signal strength of all 3 sources is exactly known.

So, we have acquired a quick overview of what is active in this frequency range.

As the exact frequency of the signal sources is now know, it is easy to determine the exact applications emitting these signals (see also our frequency tables on chapter 12.2. or the more extensive frequency tables on the Aaronia website www.spectran.com).

On the basis of these frequency tables, we can determine for e. g. 942MHz:

937.6 to 944,8MHz = GMS900 (DL) T-Mobile

Meaning that this is a GSM900 cell tower (DL-Download) of the provider "T-Mobile".

No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.

11.1. Measuring transmission power (dBm; dBµV)

Measurements of communications equipment often show extremely big differences between levels. Therefore, it is useful to express signal levels in logarithmic units to avoid "drowning" readings in an endless number of zeros.
Thus, our SPECTRAN HF-2025E e. g. already features a measurable level range of -80dBm to 0dBm. As amplification increases tenfold once every 10dB, "readings" of 0 to 100,000,000 would need to be displayed. Though, these "numeric giants" would be nearly unreadable and result in steady, drastic changes of the displayed values. So, we use the much easier to handle logarithmic unit dB:

As logarithms are dimensionless, logarithmic readings are always relative to a certain reference level, i. e., a relationship between two levels is established. A common reference level that has become a standard in radio technology is 1mW or 1µV. So, logarithmic level readings are expressed in dB **milliwatts** [dBm] or dB **microvolts** [dBµV].

11.2. Field strength (V/m; A/m) and power density (W/m²)

If you don't feed signals directly and instead perform measurements using an antenna, you will mostly want to measure the so-called field strength or power density instead of power. In professional measurement technology, mostly only the "manageable" electric field strength is measured, using the unit V/m. As with dBm, V/m produces manageable readings without endless rows of zeroes. In contrast, cheap broadband instruments often only provide readings of power density (mostly in µW/m²) to confuse the operator with allegedly huge changes in "electrosmog" strength. This is just as if you measured distances on motorways in mm: Frankfurt to Munich = 400,000,00 mm. Certainly impressive, but just pure showiness, as it's just 400km. Manageability and readability is left behind, as the display constantly changes in huge steps. Of course, SPECTRAN can also display power flux density in µW/m² or other "Giga-units". However, in contrast to the aforementioned cheap devices, SPECTRAN offers a practical Autorange feature in W/m²-mode, e. g. instead of displaying an endless number of zeroes; it just displays the corresponding abbreviation f, p, n, µ or m before the unit.

11.3. Interesting facts regarding high-frequency formula

In publications the writers often jump around between units. Consequently, the casual reader often loses track of the relationships between units completely.
SPECTRAN offers functionality to convert between units or directly display measurements in the unit of your choice. Furthermore, we have collected several tables for simple comparison and, correspondingly, conversion of units and values. We also included the most important basics and formulas (chapter 12.1.), dealing with high frequency radiation:
Power density of high-frequency signals is oftentimes measured in W/m² (primarily in Europe) or W/cm² (primarily in the USA). Conversion between these units is simple:

1µW/cm² = 0.01 W/m² = 0.001 mW/cm² or
10 µW/cm² = 0.1 W/m² =0.01 mW/cm² as so on. (Table 2)

Less frequently, values in dBm/m² and dBW/m² can be found. Conversion is similarly simple.

1µW/cm² = 10dBm/m² = -20 dBW/m² or.
10µW/cm² = 20 dBm/m² = -10 dBW/m² etc., respectively.

However, the most frequently used unit is V/m (see table 3). Here you should remember that power flux density S (measured in W/m²) really consists of two separate fields: The electric field E (measured in V/m) and the magnetic field H (measured in A/m). However, as these do not exist separately anymore at high frequencies, their separate indication is not really interesting for RF exposure. However, this is only the case outside the so called close-up range. How you calculate the close-up range and how the relationship between the different radiations works is described below.

Power flux density S (also called electromagnetic field or power density) is calculated as follows:

$$S\left[\frac{W}{m^2}\right] = E\left[\frac{V}{m}\right] * H\left[\frac{A}{m}\right]$$

If „H“ is unknown, the following formula still allows a calculation of S, assuming 377 Ohms as the so-called „field resistance“ of air:

$$S\left[\frac{w}{m^2}\right] = \frac{E^2\left[\frac{V}{m}\right]}{377\ \Omega}$$

In contrast, if E is not known, calculation of S is still possible as follows:

$$S\left[\frac{w}{m^2}\right] = H^2\left[\frac{A}{m}\right] * 377\ \Omega$$

Should you wish to calculate the electric field E, the following formula applies:

$$E\left[\frac{V}{m}\right] = \sqrt{S\left[\frac{w}{m^2}\right] * 377\ \Omega}$$

And the magnetic field H can be calculated like this:

$$H\left[\frac{A}{m}\right] = \sqrt{\frac{S\left[\frac{W}{m^2}\right]}{377\ \Omega}}$$

11.4. Calculating the wavelength in [m]

To calculate the wavelength from the frequency, use the following formula:

$$\lambda = \frac{c}{f}$$

Here, „c“ corresponds to the speed of light in[m/s] (rounded to 300,000km/s in our example), „f“ to the frequency of the radiation in [Hz], and λ to the wavelength in [m].

$$\lambda = \frac{300\,000\,000\,\frac{m}{s}}{900\,000\,000\ Hz} = 0{,}33\ \text{m}$$

(For 900 MHz, the result is 0.33m)

$$\lambda = \frac{300\,000\,000\,\frac{m}{s}}{1\,800\,000\,000\ Hz} = 0{,}17\ \text{m}$$

(For 1 800 MHz, the result is 0.17 m)

$$\lambda = \frac{300\,000\,000\,\frac{m}{s}}{2\,000\,000\,000\ Hz} = 0{,}15\ \text{m}$$

(For 2 GHz, the result is 0.15 m)
Further information concerning wavelength is contained in table 4.

11.5. Calculating the “close-up range” in [m]

If you want to perform a measurement, you need to do this outside of the so-called close-up range of the transmitter. The close-up range depends on the transmitter frequency. According to the aforementioned formula, the close-up-range can be determined quickly. Here, you simply need to multiply the resulting wavelength by a factor of 10 (there are some sources which only use a factor of 3). The result is the close-up range, i. e. the minimum distance to the transmitter in which a realistic and sensible measurement can be achieved.

Example: For a „900MHz cell phone“ the wavelength is:

$$\lambda = \frac{300\,000\,000\,\frac{m}{s}}{900\,000\,000\ Hz} = 0{,}33\ \text{m}$$

Hence, the close-up range is 0.33m * 10 = 3.3m.
It is easy to see, that e. g. measurements taken directly next to the cell phone will definitely result in wrong readings.
Inside the close-up range, E and H fields would need to be measured separately. However, outside the close-up range, both field types are coupled tightly to each other, so knowing the strength of one of them will be enough to derive the other.

11.6. Calculating power density [W/m²] from power [dBm]

Only if you know the transmitter’s frequency you can convert from dBm to W/m². You will also need the antenna gain of the antenna used for measurement. The formula you need looks like this:

$$S = \frac{10^{\left[\frac{-40-4{,}9}{10}\right]}}{1000} * \frac{4 * \pi}{0{,}31579^2} = \frac{0{,}00003236}{1000} * \frac{12{,}566}{0{,}0997} =$$

$$= 0{,}00000408\ \text{W/m}^2 = 4{,}08\ \mu\text{W/m}^2$$

No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.

12.1. Conversion tables

Table 1: Conversion dBm to W/m² with HyperLOG-antenna

Assuming the use of an „idealized" measurement setup, like our HyperLOG antenna with 5dBi gain and one of our 1m RG316U cables with 1dB damping, the following conversion table can be applied to the signal sources below (figures in W/m²)

dBm	GSM900	UMTS	Lambda X	WLAN	GSM1800
10	0,45	2,2	1,34	3,3	1,8
9	0,36	1,8	1,06	2,7	1,4
8	0,28	1,4	0,84	2,1	1,1
7	0,23	1,1	0,67	1,7	0,9
6	0,18	0,89	0,53	1,3	0,72
5	0,14	0,7	0,42	1,06	0,57
4	0,11	0,56	0,34	0,84	0,45
3	0,09	0,44	0,27	0,67	0,36
2	0,07	0,35	0,21	0,53	0,29
1	0,06	0,28	0,17	0,42	0,23
0	0,045	0,022	0,13	0,033	0,018
-10	0,004 5	0,002 2	0,013	0,003 3	0,001 8
-20	0,000 45	0,000 22	0,001 3	0,000 33	0,000 18
-30	0,000 045	0,000 022	0,000 13	0,000 033	0,000 018
-40	0,000 004 5	0,000 002 2	0,000 013	0,000 003 3	0,000 001 8
-50	0,000 000 45	0,000 000 22	0,000 001 3	0,000 000 33	0,000 000 18
-60	0,000 000 045	0,000 000 022	0,000 000 13	0,000 000 033	0,000 000 018

We assumed the following center frequencies (f) here:
GSM900 (f = 900MHz),
GSM1800/DECT (f = 1800MHz),
WLAN/microwave ovens (f = 2450MHz).
Lambda X (f = 1550MHz),
UMTS (f = 2000MHz)

Tip: Even in case you do not know the frequency of the signal source, you can still achieve a comparatively exact field strength measurement by simply using the „Lambda X" column.
This column presents a weighted average of all possible frequencies between 900MHz and 2.4GHz, still giving you an accuracy of approximately +/-4dB. That is still significantly better than the inherent inaccuracy of various rudimentary instruments for field strength measurement available from third parties. The frequency range from 900MHz to 2.4GHz spans a large variety of typically interesting signal sources – for example, all cellular phone networks (GSM900, GSM1800, UMTS) and the respective phones, as well as 2.4GHz WLan and microwave ovens.

The conversion table demonstrates that per 10dB step, power density decreases by a factor of 10. This applies in a similar manner to the 1dB steps, which also change in a constant manner. Consequently, this table permits easy and fast conversion of indicated dBm values (for example, from the optional PWK detector) into PEAK field strength or, respectively, power density in W/m². This table can just as well be used with different antennas, attenuators or cables:
For example, should you be using our 20dB attenuator (option), you would extract those rows from the table whose dBm values are 20dB higher, for example, -10dBm instead of
-30dBm. As a different example, should you be using an antenna with 24dBi gain, you would use those values 19dB lower than the actual reading ((24dBi minus 5dBi [as 5dBi gain is already included in the calculated table values]). For example: -43dBm instead of -24dBm.
If you were using a cable with 5dBi damping, you would need to refer to those values 4dB higher than the measured value (5dB minus 1dB [as 1dB damping is already included in the calculated table values]).
That is -24dBm in place of -28dBm.

Table 2:
Conversion from W/m² to µW/cm² and mW/cm²

0,000.001 W/m²	0,000.1 µW/cm²	0,000.000.1 mW/cm²
0,000.01 W/m²	0,001 µW/cm²	0,000.001 mW/cm²
0,000.1 W/m²	0,01 µW/cm²	0,000.01 mW/cm²
0,001 W/m²	0,1 µW/cm²	0,000.1 mW/cm²
0,01 W/m²	1 µW/cm²	0,001 mW/cm²
0,1 W/m²	10 µW/cm²	0,01 mW/cm²
1 W/m²	100 µW/cm²	0,1 mW/cm²

Table 3:
Conversion from µW/cm² to V/m and A/m

0,000.1 µW/cm²	0,019.4 V/m	0,000.051.5 A/m
0,001 µW/cm²	0,061.4 V/m	0,000.162 A/m
0,01 µW/cm²	0,194 V/m	0,000.515 A/m
0,1 µW/cm²	0,614 V/m	0,001.62 A/m
1 µW/cm²	1,94 V/m	0,005.15 A/m
10 µW/cm²	6,14 V/m	0,016.2 A/m
100 µW/cm²	19,4 V/m	0,051.5 A/m

Table 4:
dBm to dBW and W

0 dBm	-30dBW	0,001W	1mW
-10dBm	-40dBW	0,000.1W	100µW
-20dBm	-50dBW	0,000.01W	10µW
-30dBm	-60dBW	0,000.001W	1µW
-40dBm	-70dBW	0,000.000.1W	100nW
-50dBm	-80dBW	0,000.000.01W	10nW
-60dBm	-90dBW	0,000.000.001W	1nW
-70dBm	-100dBW	0,000.000.000.1W	100pW

dBm = Decibelmilliwatts, dBW = Decibelwatts, W = Watts, mW = Milliwatts, µW=Microwatts, nW= Nanowatts, pW=Picowatts

Table 5: Frequency, wavelength and frequency band denomination

3 Hz-30 Hz	100.000 km - 10.000 km	ULF
30 Hz-300 Hz	10.000 km - 1.000 km	ELF
300 Hz-3 kHz	1.000 km - 100 km	VF
3 kHz-30 kHz	100 km - 10 km	VLF
30 kHz-300 kHz	10 km - 1 km	LF
300 kHz-3 MHz	1 km - 100 m	MF
3 MHz-30 MHz	100 m - 10 m	HF
30 MHz-300 MHz	10 m - 1 m	VHF
300 MHz-3 GHz	1 m - 10 cm	UHF
3 GHz - 30 GHz	10 cm - 1 cm	SHF

Table 6: Power amplification factor and corresponding value in dB:

1	0 dB
2	3 dB
2,5	4 dB
4	6 dB
5	7 dB
8	9 dB
10	10 dB
100	20 dB
1 000	30 dB
10 000	40 dB
100 000	50 dB
1 000 000	60 dB
10 000 000	70 dB

dB = Dezibel

No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.

12.2. Frequency tables

Table 7: Cell phone frequencies and providers

Start-/	Stop-frequency	Abbrevation	Provider
864,1	868,1	CT2	Private
885	887	CT1+ (UL)*	Private
914	915	CT1 (UL)*	Private
930	932	CT1+ (DL)*	Private
959	960	CT1 (DL)*	Private
1.880	1.900	DECT	Private
5.725	5.825	DECT2	Private

All frequency values in MHz.

(UL) = „Uplink" mostly means „portable device" (mobile transmitter, which transmits towards the base station, e. g. a cellphone)

(DL) = „Downlink" mostly means „base station" (fixed transmitter which transmits towards the portable device, e. g. a base station).

* License expired
CT1+: cordless phone (analogue). License expires 1/1/2007 10mW EIRP.
DECT: Base station always transmits even when not handling calls. 250mW EIRP.
DECT2: New generation of cordless phones (DECT successor). 25mW EIRP.

More extensive lists on www.aaronia.com

Table 8:
German GSM900 frequencies and providers

Start-/	Stop-frequency	Abbrevation	Provider
876,2	880	GSM-R (UL)	Deutsche Bahn
880,1	885,1	GSM900 (UL)	E-Plus
885,1	890,1	GSM900 (UL)	O2-Germany
890,2	892,4	GSM900 (UL)	Vodafone
892,6	899,8	GSM900 (UL)	T-Mobile
900	906	GSM900 (UL)	Vodafone
906,2	910,4	GSM900 (UL)	T-Mobile
910,6	914,2	GSM900 (UL)	Vodafone
914,4	914,8	GSM900 (UL)	T-Mobile
921,2	925	GSM-R (DL)	Deutsche Bahn
925,1	930,1	GSM900 (DL)	E-Plus
930,1	935,1	GSM900 (DL)	O2-Germany
935,2	937,4	GSM900 (DL)	Vodafone
937,6	944,8	GSM900 (DL)	T-Mobile
945	951	GSM900 (DL)	Vodafone
951,2	955,4	GSM900 (DL)	T-Mobile
955,6	959,2	GSM900 (DL)	Vodafone
959,4	959,8	GSM900 (DL)	T-Mobile

All frequency values in MHz.

(UL) = "Uplink" mostly means "portable device" (mobile transmitter which transmits towards the base station, e. g. cellphones) Pulsed at 217Hz. Power variable between 20mW-2W (Peak).

(DL) = "Downlink" mostly means "Base-station" (fixed transmitter which transmits towards the portable device, e. g. cell towers). Pulsed at 217Hz. Control channel pulsed at 736Hz. Power variable between 0.5 and 400W ERP. Range of up to 32 km.

More extensive lists are available on the Aaronia website www.aaronia.com. To get the full opportunities, get the free PC analysis software directly from there.

Table 9:
German GSM1800 frequencies and providers

Start-/	Stop-frequency	Abbrevation	Provider
1.710,00	1.725,00	GSM18K (UL)	Military
1.725,20	1.730,00	GSM18K (UL)	T-Mobile
1.730,20	1.752,40	GSM18K (UL)	O 2
1.752,80	1.758,00	GSM18K (UL)	Vodafone
1.758,20	1.780,40	GSM18K (UL)	E Plus
1.805,00	1.820,00	GSM18K (DL)	Military
1.820,20	1.825,00	GSM18K (DL)	T-Mobile
1.825,00	1.847,40	GSM18K (DL)	O 2
1.847,80	1.853,00	GSM18K (DL)	Vodafone
1.853,20	1.875,40	GSM18K (DL)	E Plus

All frequency values in MHz.

(UL) = „Uplink" mostly means „portable device" (mobile transmitter which transmits towards the base station, e. g. cellphones) Pulsed at 217Hz. Power variable between 25mW-1W (Peak).

(DL) = „Downlink" mostly means „Base-station" (fixed transmitter which transmits towards the portable device, e. g. cell towers). Pulsed at 217Hz. Control channel pulsed at 1.736Hz. Power varies between 0.5 to 300W ERP. Range of up to 16km.

More extensive lists are available on the Aaronia website www.aaronia.com.

Table 10:
German UMTS frequencies and providers

Start-/	Stop-frequency	Abbrevation	Provider
1.920,30	1.930,20	UMTS (UL)	Vodafone
1.930,30	1.940,20	UMTS (UL)	Group 3G
1.940,30	1.950,20	UMTS (UL)	e-plus
1.950,00	1.959,90	UMTS (UL)	MobilCom
1.959,90	1.969,80	UMTS (UL)	O2
1.969,80	1.979,70	UMTS (UL)	T-Mobile D
2.110,30	2.120,20	UMTS (DL)	Vodafone
2.120,20	2.130,10	UMTS (DL)	Group 3G
2.130,10	2.140,00	UMTS (DL)	e-plus
2.140,00	2.149,90	UMTS (DL)	MobilCom
2.149,90	2.159,80	UMTS (DL)	O2
2.159,80	2.169,70	UMTS (DL)	T-Mobile D

All frequency values in MHz.

(UL) = „Uplink" mostly means „portable device" (mobile transmitter which transmits towards the base station, e. g. cellphones). Power varies between 2.5mW to 250mW.

(DL) = „Downlink" mostly means „base station" (fixed transmitter which transmits towards the portable device, e. g. cell tower). Power varies between 0.5 to 500W ERP. Range of up to 8 km.

More extensive lists are available on the Aaronia website www.aaronia.com.

No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.

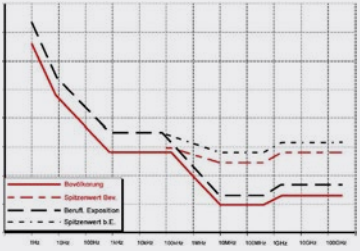
12.3. Exposure limits

For radio transmitters (including mobile phones/ cell towers) internationally approved exposure limits, but also various precautionary limits and recommendations exist. Depending on the context and country, however, exposure limits and recommendations differ vastly.

The German limits are defined by the "Regulierungsbehörde für Telekommunikation und Post (Reg TP)", a subsidiary of the "Bundesministerium für Wirtschaft und Arbeit (BMWA)". They are mainly based on the heat generation caused by high-frequency fields. It is assumed that effects harmful to health only occur when tissue warms by more than 1°C. These exposure limits are mostly accepted by all national and international committees. For Germany, these limits are recorded in the "Verordnung über elektromagnetische Felder (26. BImSchV)" and are mostly derived from the international recommendations. As an approval for the compliance with these exposure limits, radio installations acquire the "reg TP Standortbescheinigung" ("installation certificate").

The German exposure limits are designed for squared averages recorded over intervals of 6 minutes, and are categorized by frequency ranges. Depending on the affected target group, different limits apply. As an example, we will use the limit defined for the general population:

Frequency [MHz]	E-field strength [V/m]	M-field strength [A/m]
1 - 10	87 / √ f	0,73 / √ f
10 - 400	27,5	0,073
400 - 2.000	1,375 * √ f	0,0037 * √ f
2.000 - 300.000	61	0,16



The adjacent diagram shows a visual representation of aforementioned formulas over a frequency range from 1Hz to 100GHz. The graph clearly shows that the formerly widespread broadband RF measurement instruments cannot measure and evaluate these exposure limits correctly as they are not frequency-dependent.

Also, the differences between the exposure limits for a certain target reference group and the corresponding „maximum limits" are well visible.

Example:
For D-Net (GSM900) cell towers, this means that the electrical field strength needs to stay below 1,375 * √935 MHz or approx. 42 V/m.

For E-Net (GSM1800) base stations, this means that the electrical field strength needs to stay below 1,375 * √1800 MHz or approx. 58 V/m.

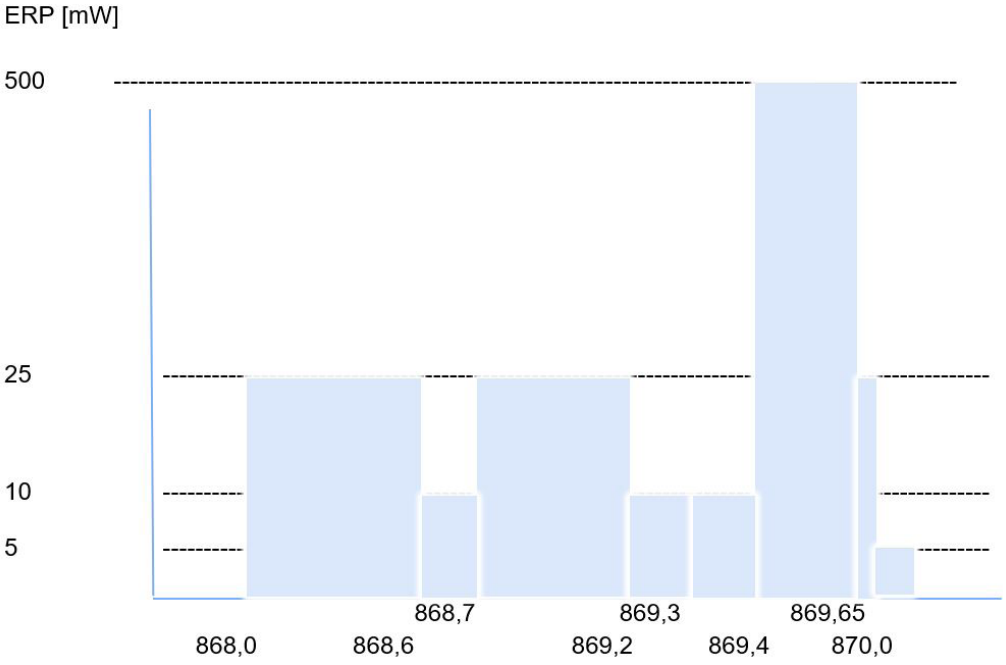
The respective allowed absolute maximums are another 32 times higher.

The highest exposure to high-frequency radiation is mostly caused by the high transmitting powers of TV and radio broadcast towers. Contrary to widespread belief, however, often it's not the cell towers that cause the strongest exposure to radiation in homes – it's often portable phones (so-called DECT phones) or microwaves ovens.

12.4. Device exposure limits

Contrary to the personal safety limits, the so-called device exposure limits are often significantly more restrictive and much more frequency-dependent.

For example, a cellphone has a totally different device exposure limit than a TV broadcast station. Here, the allowed limits can easily vary by a factor of millions! Still, all device exposure limits also need to adhere to the personal safety limits and are thus a subset of those. A particularly restrictive example is the ISM868 band. It offers extreme dynamics inside a very small frequency range:



No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.



MORE ABOUT US

AARONIA.COM

1. Beschreibung und Typen

Portable Handheld Spektrumanlaysatoren mit hoher Empfindlichkeit im Hoch- und Niederfrequenzbereich.

SPECTRAN HF-60100 *(1 MHz - 9,4 GHz | Art. Nr. 101/006)**
SPECTRAN NF-5030 *(1 Hz - 1 MHz | Art. Nr. 101/001)*
SPECTRAN NF-5030 S *(1 Hz - 1 MHz | Art. Nr. 101/003)*

2. Sicherheitshinweise

Zu Ihrem Schutz sollten Sie die Sicherheitshinweise vor der Inbetriebnahme sorgfältig durchlesen.
Sämtliche Montage- und Demontagearbeiten sind von sachkundigem Personal durchzuführen. Sachkundige sind Personen, die aufgrund ihrer Ausbildung und Erfahrung ausreichende Kenntnisse im Umgang mit (Hochfrequenz-) Messtechnik haben, und darüber hinaus mit einschlägigen staatlichen Arbeitsschutz- und Unfallverhütungsvorschriften sowie Richtlinien und allgemein anerkannten Regeln der Technik (z. B. VDE Bestimmungen, DIN-Normen) soweit vertraut sind, dass sie den arbeitssicheren Zustand des Messaufbaus beurteilen können. Der Hersteller übernimmt keine Haftung für Schäden, die durch unsachgemäße Handhabung oder durch Nichteinhaltung der Sicherheitsvorschriften entstanden sind.

- Achten Sie auf die korrekte Befestigung des Messkabels oder eines entsprechenden Adapters am Anschluss des Gerätes.
- Die entsprechenden, jeweils geltenden Normen und Bestimmungen zur Gewährleistung der elektrischen Sicherheit sowie zur Einhaltung der Emissionsgrenzwerte müssen berücksichtigt werden.
- Nationale genehmigungsrechtliche Regelungen für Rundfunkempfangsanlagen sind zu beachten.
- Das Gerät vor jedem Einsatz auf etwaige Beschädigung prüfen.
- Keine mit Flüssigkeiten gefüllten Gegenstände auf das Gerät stellen.
- Das Gerät ist vor Feuchtigkeit, Flüssigkeiten, Tropf- und Spritzwasser zu schützen.
- Das Gerät nicht in Feuchträumen betreiben/lagern und nur in gemäßigtem, nicht tropischem Klima verwenden;
  → vgl. Technische Daten „Relative Luftfeuchtigkeit“
- Den zulässigen Temperaturbereich einhalten;
  → vgl. Technische Daten „Temperaturbereich“
- Gerät nicht direkter Sonneneinstrahlung aussetzen.
- Das Gerät nicht in der Nähe von Wärmequellen aufstellen, z. B. Heizung.
- Das Gerät und seine Komponenten nicht öffnen, verändern oder beschädigen.
- Der Hersteller haftet nicht für Unfälle durch unsachgemäßes Verwenden oder ungesicherte Installation des Gerätes.
- Bei Unfällen sofort ärztliche Hilfe hinzuziehen.
- Öffnen Sie niemals das Gerät ohne vorherige Rücksprache mit dem Herstellerservice! Versuchen Sie niemals ein defektes Gerät selbst zu reparieren.
- Gerät außerhalb der Reichweite von Kindern aufbewahren und betreiben.
- Vom Hersteller angebrachte Schilder und Kennzeichnungen nicht verändern, entfernen oder unkenntlich machen.

Description and types

Portable handheld spectrum analyzers with high sensitivity in the high and low frequency range.

SPECTRAN HF-60100 *(1 MHz - 9.4 GHz | Item No. 101/006)**
SPECTRAN NF-5030 *(1 Hz - 1 MHz | Item No. 101/001)*
SPECTRAN NF-5030 S *(1 Hz - 1 MHz | Item No. 101/003)*

Safety instructions

For your protection, please read the safety instructions carefully before operating the unit.
Assembly and disassembly of the device must be performed by qualified personnel. Qualified personnel are persons who, due to their training and experience, have sufficient knowledge in the handling of (high-frequency) measurement technology and are familiar with the relevant state occupational health and safety and accident prevention regulations, guidelines and generally recognized rules of technology (e.g. electrical engineering regulations and standards) to such an extent that they can assess the safe working condition of the measurement setup.

- Ensure correct attachment of the measuring cable or a corresponding adapter to the output of the device.
- The corresponding respectively applicable standards and regulations to ensure electrical safety as well as compliance with emission limits must be taken into account.
- National licensing regulations for broadcast receiving systems must be observed.
- Check the device for possible damage before each use.
- Do not place any objects filled with liquids on the device.
- Protect the device from moisture, liquids, dripping and splashing water.
- Do not operate the device in damp rooms and use it only in a moderate, non-tropical climate;
  → see technical data „Relative humidity“.
- Observe the permissible temperature range;
  → see technical data „Temperature range“.
- Do not expose the device to direct sunlight.
- Do not set up the device near sources of heat, e.g. heating.
- Do not open, modify or damage the device or its components.
- The manufacturer is not liable for accidents caused by improper use or unsecured installation of the device.
- In case of accidents, seek medical assistance immediately.
- Repairs to the device may only be carried out by Aaronia service. Attempts to carry out repairs on your own will invalidate the warranty.
- Store and operate the device out of the reach of children.
- Do not modify, remove or obscure any signs and markings affixed by the manufacturer.

No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.

Achtung: Das Gerät darf nur ohne Netzteil betrieben werden - kein Dauerbetrieb!

Umgang mit dem Gerät sowie dem zugehörigen Netzteil

- Öffnen Sie niemals das Gerät ohne vorherige Rücksprache mit dem Herstellerservice! Versuchen Sie niemals ein defektes Gerät selbst zu reparieren.
- Das Netzteil darf erst angeschlossen werden, nachdem die Installation vorschriftsmäßig beendet ist.
- Das Berühren Spannung führender Teile ist lebensgefährlich!
- Die Anschlusskontakte des Netzteils nicht mit metallischen Gegenständen oder den Fingern berühren. Die Folge können Kurzschlüsse sein.
- Bei Gewitter sollten Sie das Gerät von der Netzsteckdose trennen. Überspannung kann das Gerät beschädigen.
- Wenn das Netzteil defekt ist bzw. wenn das Gerät sonstige Schäden aufweist, darf es nicht in Betrieb genommen werden.
- Beim Abziehen des Netzteils von der Steckdose am Stecker ziehen - nicht am Kabel.
- Das Gerät darf mit dem zugehörigen Netzteil nur an eine Netzspannung von 100 V - 240 V~, 50/60 Hz angeschlossen werden. Eine Spannungsversorgung per Schutzkleinspannung ist hiervon ausgenommen.
- Bei auffälligem Gerätedefekt, Geruchs- oder Rauchentwicklung oder erheblicher Fehlfunktion das Gerät außer Betrieb nehmen und nicht mehr verwenden. Den Herstellerservice kontaktieren, um eine Überprüfung und/oder Reparatur zu beauftragen.
- Bei längerem Transport bei Kälte und dem anschließenden Wechsel in warme Räume nicht sofort einschalten; Temperaturausgleich abwarten.
- Es ist verboten, Umbauten am Gerät vorzunehmen.
- Beschädigte Geräte bzw. beschädigte Zubehörteile dürfen nicht mehr verwendet werden.
- Es dürfen keine offenen Brandquellen, wie z. B. brennende Kerzen auf das Gerät gestellt werden.
- Lassen Sie Kinder niemals unbeaufsichtigt dieses Gerät benutzen.

Umgang mit Akkus

- Das Gerät nur mit dem für dieses Gerät zugelassenen Akku betreiben.
- Bei falsch eingelegtem Akku besteht Explosionsgefahr!
- Akkukontakte und Gerätekontakte vor dem Einlegen reinigen.
- Vorsicht! Akkus keinen extremen Bedingungen aussetzen, nicht auf Heizkörpern ablegen und nicht direkter Sonnenstrahlung aussetzen!
- Ausgelaufene oder beschädigte Akkus können bei Berührung mit der Haut Verätzungen verursachen. Benutzen Sie in diesem Fall geeignete Schutzhandschuhe. Reinigen Sie das Batteriefach mit einem trockenen Tuch.
- Ersetzen Sie Akkus nur durch Akkus des richtigen Typs und der richtigen Modellnummer.
- Achten Sie darauf, dass Akkus nicht in die Hände von Kindern gelangen. Kinder könnten Akkus in den Mund nehmen und verschlucken. Dies kann zu ernsthaften Gesundheitsschäden führen.
- In diesem Fall sofort einen Arzt aufsuchen! Bewahren Sie deshalb Akkus für Kleinkinder unerreichbar auf.
- Wichtiger Hinweis zur Entsorgung von Batterien/Akkus: Batterien/Akkus können Giftstoffe enthalten, die die Umwelt schädigen. Entsorgen Sie Batterien/Akkus deshalb unbedingt entsprechend der geltenden gesetzlichen Bestimmungen.
- Werfen Sie Batterien/Akkus niemals in den normalen Hausmüll. Sie können verbrauchte Batterien/Akkus bei Ihrem Fachhändler oder an speziellen Entsorgungsstellen unentgeltlich entsorgen.

Attention: The device may only be operated without PSU connection - no continuous operation!

Handling the device and the associated power supply unit

- Never open the device without prior consultation with the manufacturer's service department! Never attempt to repair a defective device yourself.
- The power supply unit may only be connected after the installation has been completed in accordance with the regulations.
- Touching live parts is dangerous to life!
- Do not touch the connection contacts of the power supply unit with metallic objects or your fingers. This may result in short circuits.
- During thunderstorms, you should disconnect the device from the mains socket. Overvoltage can damage the device.
- If the power supply unit is defective or if the device shows other damages, it must not be put into operation.
- When disconnecting the power supply from the socket, pull on the plug - not on the cable.
- The device may only be connected to a mains voltage of 100 V - 240 V~, 50/60 Hz with the associated power supply unit. A voltage supply via safety extra-low voltage is excluded from this.
- If there is a noticeable defect in the device, odor or smoke development or significant malfunction, take the device out of operation and do not use it again. Contact the manufacturer's service department for inspection and/or repair.
- Do not switch on the device immediately if it is transported for a longer period of time in cold conditions and then moved to warm rooms; wait for the temperature to equalize.
- It is forbidden to make any modifications to the device.
- Damaged devices or damaged accessories must not be used any more.
- No open fire sources, such as burning candles, may be placed on the device.
- Never allow children to use this device unsupervised.

Handling rechargeable batteries

- Only operate the device with the rechargeable battery approved for this device.
- There is a risk of explosion if the battery is inserted incorrectly!
- Clean battery contacts and device contacts before inserting.
- Caution. Do not expose batteries to extreme conditions.
- Do not place on radiators, do not expose to direct sunlight!
- Leaking or damaged batteries can cause chemical burns if they come into contact with the skin. In this case, use suitable protective gloves. Clean the battery compartment with a dry cloth.
- Replace rechargeable batteries only with batteries of the correct type and model number.
- Make sure that rechargeable batteries do not get into the hands of children. Children could put rechargeable batteries in their mouths and swallow them. This can lead to serious damage to health.
- In this case, consult a physician immediately! Therefore, keep rechargeable batteries out of the reach of small children.
- Important note on the disposal of batteries/rechargeable batteries: Batteries/rechargeable batteries may contain toxic substances that are harmful to the environment. It is therefore essential to dispose of batteries/battery packs in accordance with the applicable legal regulations.
- Never dispose of batteries/battery packs in normal household waste. You can dispose of used batteries/accumulators free of charge at your specialist dealer or at special disposal points.

3. Entsorgungshinweise

Dieses Produkt darf am Ende seiner Lebensdauer nicht über den normalen Haushaltsabfall entsorgt werden, sondern muss an einem Sammelpunkt für das Recycling von elektrischen und elektronischen Geräten abgegeben werden.

Das Symbol auf dem Produkt, der Gebrauchsanleitung oder der Verpackung weist darauf hin, das die Werkstoffe gemäß ihrer Kennzeichnung wiederverwertbar sind. Mit der Wiederverwendung, der stofflichen Verwertung oder anderen Formen der Verwertung von Altgeräten leisten Sie einen wichtigen Beitrag zum Schutze unserer Umwelt. Bitte erfragen Sie bei der Gemeindeverwaltung die zuständige Entsorgungsstelle.

Disposal instructions

At the end of its service life, this product must not be disposed of with normal household waste, but must be taken to a collection point for the recycling of electrical and electronic equipment.

The symbol on the product, the operating instructions or the packaging indicates this. The materials are recyclable according to their marking. By reusing, recycling or otherwise recovering old equipment, you are making an important contribution to protecting our environment. Please ask your local authority for the responsible disposal point.

4. Technische Daten

Abmessungen (L/B/H)	260 x 86 x 23 mm
Gewicht	430 g
HF Anschluss	SMA
Impedanz	50 Ohm
Akkukapazität	3000 mAh
Relative Luftfeuchtigkeit	<90 % (nicht kondensierend)
Betriebstemperatur	-10°C bis +50°C

Lieferumfang:

SPECTRAN® Handheld Analyzer, Alu-Transportkoffer, DC Power-Kabel, SMA-Werkzeug, Akkuladegerät, Gummischutzhülle, Zigarettenanzünder-Stromadapter, USB-Kabel und Handbuch (Download)

*** HF-60100 (zusätzlich):** Pistolengriff-Ministativ, HyperLOG 60100 Messantenne, SMA (m/m) Plug, 1 m SMA-Kabel

Technical data

Dimensions (L/W/H)	2260 x 86 x 23 mm
Weight	430 g
RF connector	SMA
Impedance	50 Ohm
Battery capacity	3000 mAh
Relative humidity	<90 % (non-condensing)
Operating temperature	-10°C to +50°C

Scope of delivery:

SPECTRAN® Handheld Analyzer, aluminium carrying case, DC power cable, SMA tool, battery charger, protective rubber cover, car power adapter, USB cable and manual (download).

*** HF-60100 (additional):** Pistol grip mini tripod, HyperLOG 60100 measuring antenna, SMA (m/m) plug, 1 m SMA cable

5. CE Konformität / Haftungshinweis

CE

Dieses Gerät trägt das CE-Zeichen und erfüllt alle erforderlichen EU-Normen. Der vollständige Text der EU-Konformitätserklärung ist unter der folgenden Internetadresse verfügbar:
https://downloads.aaronia.com/CE-conf/ce-sp-hfnf.pdf

Die Aaronia AG ist nicht für Produktschäden auf Grund von äußeren Einflüssen, Verschleiß oder unsachgemäßer Handhabung, unbefugter Instandsetzung, Modifikationen oder Unfällen haftbar.

Änderungen und Druckfehler sind vorbehalten (Stand 06/22). Abschrift und Vervielfältigung nur mit Genehmigung des Herausgebers. Aktuelle Versionen der Anleitung finden Sie im Downloadbereich auf *www.aaronia.de*.

CE compliance / Disclaimer

CE

This device is CE marked and complies with all required EU standards. The full text of the EU Declaration of Conformity is available at the following internet address:
https://downloads.aaronia.com/CE-conf/ce-sp-hfnf.pdf

Aaronia AG is not liable for product damage due to external influences, wear or improper handling, unauthorized repair, modifications or accidents.

Changes and misprints are reserved (status 06/22). Copying and reproduction only with permission of the publisher. Current versions of the manual can be found in the download area at *www.aaronia.com*.

No liability is accepted for printing errors and mistakes that may have occurred during the production of this user manual.

AARONIA AG
WWW.AARONIA.COM

Gewerbegebiet Aaronia AG II
Dorfstraße 10a
54597 Strickscheid, Germany

Phone: +49 6556 900310
eMail: mail@aaronia.de
Web: www.aaronia.com

MADE IN GERMANY