



Advanced Test Equipment Corp.
www.atecorp.com 800-404-ATEC (2832)



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Manual SPECTRAN V4

AARONIA AG
WWW.AARONIA.DE

Made in Germany



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

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

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

Thus, we recommend to buy one of our cost-effective measurement Bundles. Bundles can be purchased from Aaronia at any time by paying the corresponding price difference.

Should you wish to upgrade to a more sophisticated SPECTRAN model, you can do so at any time. All available OPTIONS (like memory expansions or longer-lasting batteries) can just as well be added at any time, depending on model.

Also be sure to utilize our free-of-charge PC analysis software “MCS“, which offers far more features than the base unit, including a large amount of optimised settings for evaluating various signal types, including channel and service provider relationships, PEP measurement and an innovative SIS sweep.

In case of replacement due to an upgrade or exchange, our devices are optimally recycled. In this regard, also check our warranty's terms and conditions in the chapter “The Aaronia warranty”.

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ATTENTION:

Always attach antennas and adapters without excessive force. To attach and release SMA connections, **ONLY use the included plastic SMA tool, as it offers an over-torque protection.**

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

Avoid excessively high temperatures. Do not leave the device on heatings, in direct sunlight or in your car.

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

Do not drop the device or antennas, as they could be damaged or destroyed!
We strongly recommend using our carrycase for storage and transport.

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! Especially the SMA antenna, even though already protected by a soft plastic layer, represents a potential thread (eyes, etc.)!

The device is maintenance-free. **Only** clean it externally with a damp cloth. Do **not** use any kind of detergent.

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:

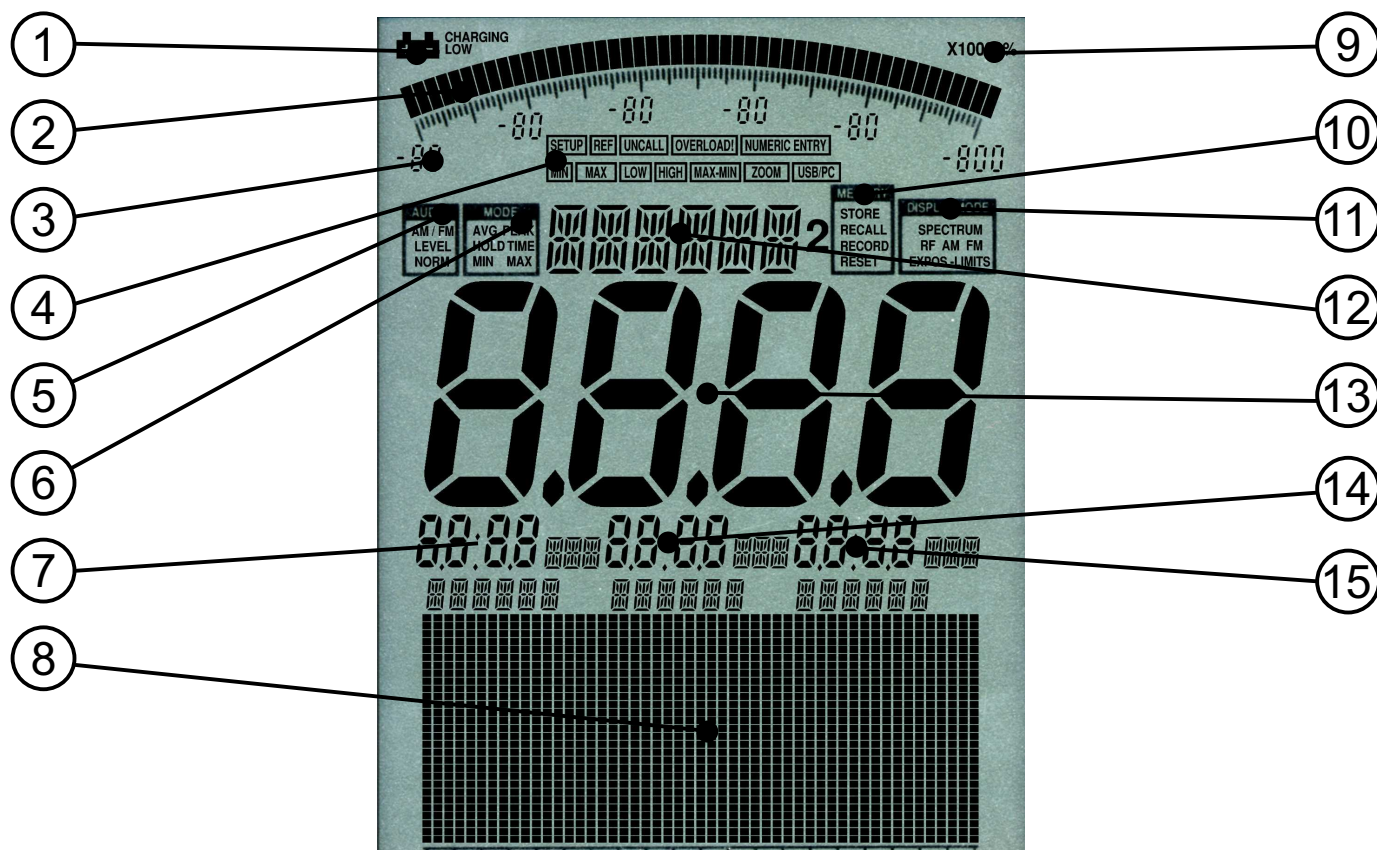
- **With activated PreAmplifier: 0dBm maximum (peak)**
- **HF-6060 V4 & HF-6080 V4 (PreAmplifier OFF): +10dBm maximum (peak)**
- **HF-60100 V4 (PreAmplifier OFF): +20dBm maximum (peak)**

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

The package should include:

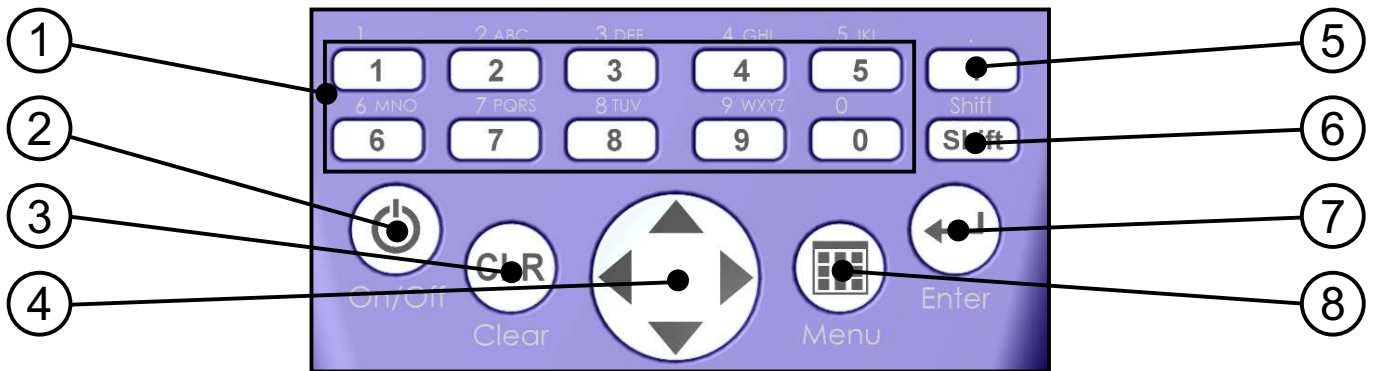
- (1) Aluminum carrycase (not shown here)
 - (2) HyperLOG measurement antenna
 - (3) SMA cable 1m
 - (4) Aaronia handle / miniature tripod
 - (5) Battery charger / power supply with 4 adapters
 - (6) SMA tool
 - (7) SPECTRAN HF-6060 V4, HF-6080 V4 or HF-60100 V4 instrument
 - (8) SMA adapter
- Aaronia 1300mAh Power battery (**already fitted**)





- (1) **BATTERY display**
- (2) **BARGRAPH** (50 segments)
- (3) **Bargraph scaling** (6 number blocks)
- (4) **STATUS field:**
SETUP, REF, UNCALL, OVERLOAD!, NUMERIC ENTRY, MIN, MAX
LOW, HIGH, MAX-MIN, ZOOM, USB/PC
- (5) **AUDIO Status field**
AM/FM, LEVEL, NORM
- (6) **MODE Status field:**
AVG, PEAK, HOLD, TIME, MIN, MAX
- (7) **MARKER block 1**
- (8) **Graphics display (Pixel display)**
- (9) **MULTIPLICATOR field**
- (10) **MEMORY Status field:**
STORE, RECALL, RECORD, RESET
- (11) **DISPLAY MODE Status field:**
SPECTRUM, RF, AM, FM, EXPOS.-LIMITS
- (12) **INFO display**
- (13) **MAIN display**
- (14) **MARKER block 2**
- (15) **MARKER block 3**

Depending on the model, not all display elements may be available!



(1) Numeric block (hotkeys)

- 1 = **TETRA** (380-400MHz)
- 2 = **ISM434** (433-434,8MHz)
- 3 = **LTE800** (780-862MHz)
- 4 = **ISM868** (868-870MHz)
- 5 = **GSM900** (921,2-959,6MHz; cell towers, no cellphones!)
- 6 = **GSM18k** (1800-1880MHz; cell towers, no cellphones!)
- 7 = **UMTS** (2110-2170MHz; cell towers, no cellphones!)
- 8 = **WLan** (2400-2490MHz)
- 9 = **LTE2.6** (2500-2690MHz)
- 0 = **DECT analyzer** (measurement of digital portable DECT phones)

(2) On-/Off button

Turn the instrument on/off

(3) Clear-/Reset button

- 1.) **Reset various sweep parameters to factory defaults**
- 2.) With main menu active: Clear input.

(4) Arrow keys

- 1.) With main menu active: Selection of menu entries
- 2.) In **Spectrum analysis** mode:
 - Right/Left keys: Move frequency range by one SPAN.
 - Up/Down keys: Move reference level by 10dB.
- 3.) In **Exposure limit calculation** mode:
 - Right/Left key: Select Exposure limits or W/m² display.
- 4.) In **Audio** mode:
 - Right/Left key: Increase/decrease center frequency by one RBW.
 - Up/Down key: Increase/decrease RBW (bandwidth).

(5) Dot key

- 1.) In **Spectrum & Exposure limit calculation** modes: HOLD on/off.
- 2.) In **Audio** mode: Switch between AM / FM.

(6) Shift key

In **Spectrum & Exposure limit calculation** modes: PULSE on/off.

(7) Enter key

- 1.) **Switches between the modes spectrum analysis, exposure limit calculation, audio and broadband detector (if installed).**
- 2.) With main menu active: Confirms current input (ENTER key)

(8) Menu key

Call/Dismiss **Main menu** for changing various settings.

To explain how to use SPECTRAN, we will perform measurement of a cell tower. While doing so, you will get to know all the different operation modes of SPECTRAN, including the important HOLD function and the “panning approach”: **It is really very simple, just follow these instructions step by step:**



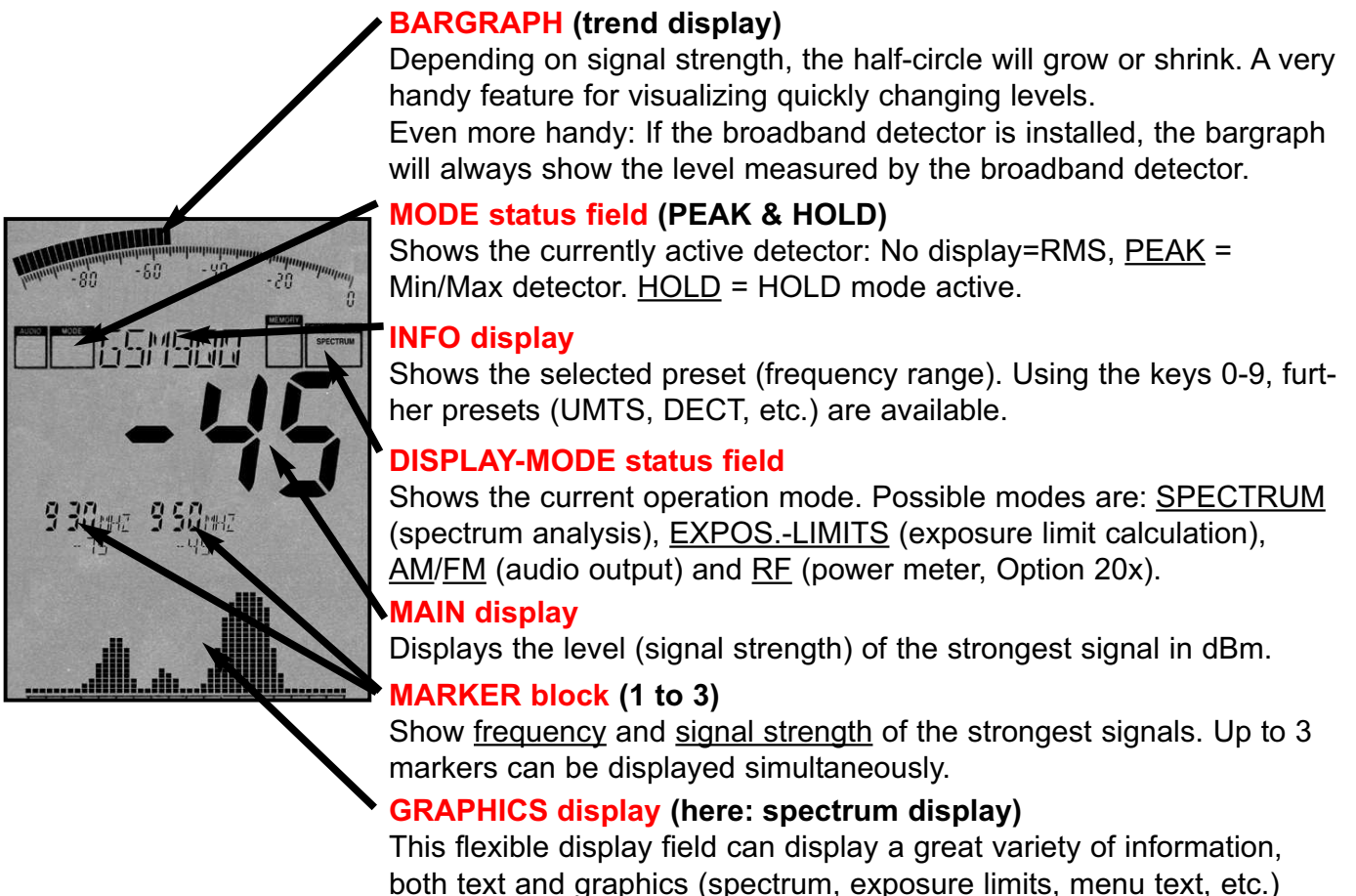
Prepare SPECTRAN for operation as follows:

Remove the protective film from the display. Now attach the triangular HyperLOG-antenna to the SPECTRAN, using the included 1m SMA cable (**more details on page 45**). Should you not yet have charged the internal battery, you can also operate SPECTRAN with the included power supply (**further information on page 47**).

Now press the **On/Off** button found at the **bottom-left** of the device.



SPECTRAN is now powered on and starts a short calibration procedure. To be able to orient yourself better in the following steps, the most important parts of the SPECTRAN display are briefly explained here:



- BARGRAPH (trend display)**
Depending on signal strength, the half-circle will grow or shrink. A very handy feature for visualizing quickly changing levels. Even more handy: If the broadband detector is installed, the bargraph will always show the level measured by the broadband detector.
- MODE status field (PEAK & HOLD)**
Shows the currently active detector: No display=RMS, PEAK = Min/Max detector. HOLD = HOLD mode active.
- INFO display**
Shows the selected preset (frequency range). Using the keys 0-9, further presets (UMTS, DECT, etc.) are available.
- DISPLAY-MODE status field**
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).
- MAIN display**
Displays the level (signal strength) of the strongest signal in dBm.
- MARKER block (1 to 3)**
Show frequency and signal strength of the strongest signals. Up to 3 markers can be displayed simultaneously.
- GRAPHICS 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.)

Now we will perform our measurement as follows: As a basic prerequisite, you should know that there are three different kinds of cell towers (in Germany): **GSM900**, **GSM1800** and **UMTS**.

Optimized measurement parameters are already preprogrammed in SPECTRAN e.g. hotkey **5** (**GSM900**), **6** (**GSM1800**). 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 "**GSM 900**". Now, you only need to choose the correct **operation mode**:

The SPECTRAN devices offer **4 different OPERATION MODES**:

- **SPECTRUM** analysis
- **EXPOSURE LIMIT** calculation
- **AUDIO** output
- **Broadband PEAK-Detector** (RF detector / Powermeter) (Option)

You can change the operation mode at any time using the Enter-key.



5.1 Operation mode Spectrum analysis:

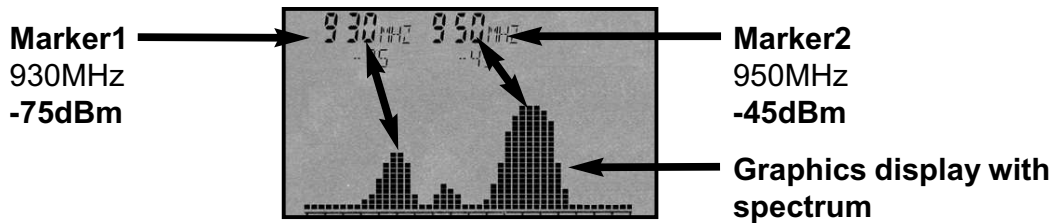
(The DISPLAY MODE status field shows "SPECTRUM")



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 and all readings are updated.

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**" 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 **Markers**: **Marker1** at **930MHz** at **-75dBm** and **Marker2** at **950MHz** at **-45dBm** (**-45dBm** also 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”.

The indicated frequencies allow exact mapping to **origin** and **provider** of the transmitter. **More details on this on page 46 ff., or in the frequency tables on pages 63 ff.**

5.2 The HOLD function

(The MODE status field displays “HOLD”)



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 readings. Just try it yourself by aligning your antenna differently and checking out the display.

Often, you will 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:

5.3 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 produce 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.

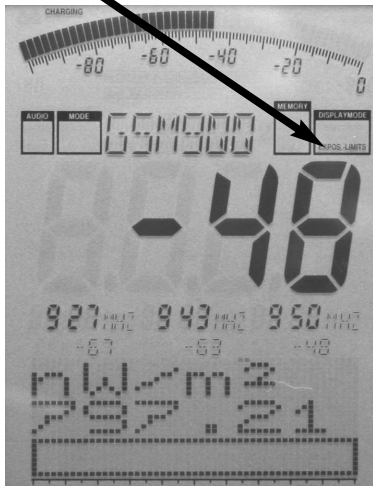
As this antenna is directional, you can even try to find the location of the transmission tower. **However, often, this is only possible outside, as inside rooms, there are too many reflections which produce an erroneous idea of the direction.**

Now, just try to find the maximum in several rooms to get comfortable with the “panning approach” and the important HOLD function.

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. Thus, SPECTRAN offers a separate, very easy to use mode for exposure limit calculation:

5.4 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/m^2] and displayed. The cable and antenna data are already considered in these calculations! Particularly handy: the so-called "Aurorange" function: the W/m^2 display is complemented

with the correct fractional unit automatically:

m = 1/1000 (one thousandth)

μ = 1/1,000,000 (one millionth)

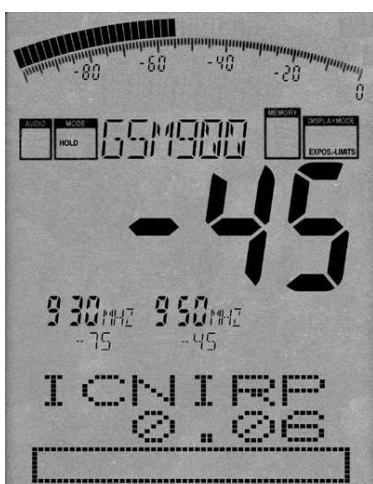
n = 1/1,000,000,000 (one billionth)

p = 1/1,000,000,000,000 (one trillionth)

f = 1/1,000,000,000,000,000 (one quadrillionth)

In our example, the display reads $797.21 \text{ nW}/\text{m}^2$, or **797 billionth** W/m^2 or in other words: $0.000,000,797,21 \text{ W}/\text{m}^2$. As this example clearly shows, one would actually drown in the huge number of "zeros" without the aurorange function.

By the way, the practical HOLD feature is also available in this mode for keeping the display "smoother".



Better yet: 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 the *Exposure limits* chapter in this manual.

Just try it for yourself: Select the different limits and compare the results. The available choices in the current firmware are:

ICNIRP = German (and international) exposure limit (a **complex formula**)

Salz 1 = Old Salzburg precautionary value (**1mW/m²**)

Salz 2 = Salzburg precautionary value **outdoors** 2002 (**10μW/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.

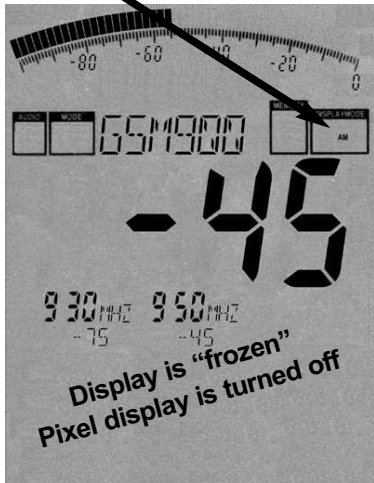
HINT: You can download **new and/or updated exposure limits** (which are constantly updated due to changed legal situations!) from Aaronia’s homepage and keep SPECTRAN up-to-date at all times. You should also check out our PC analysis software, which offers a whole range of additional features and exposure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

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.

One more alternative for finding the location of a signal source or for identification / further processing of signals is the so-called demodulation. Here, modulation and pulsing of signal sources, if they exist, can be converted to sound and thus become audible. SPECTRAN offers a special mode for this:

5.5 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 realtime, it is also perfectly suited for quickly locating a signal source.

SPECTRAN offers two demodulation modes:

AM (amplitude modulation)

FM (frequency modulation).

To switch between the two modes, use the dot key (the DISPLAY MODE status field shows “AM” or “FM”).



Volume can be adjusted with the volume control on the left.

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!

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.

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 cellphones 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.

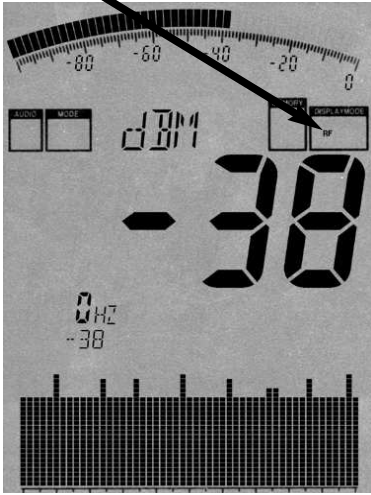
Good reproduction quality is achieved by using the 1MHz filter.

ATTENTION: for optimal reproduction of a signal, its level should be at least -70dBm, even better stronger than -60dBm.

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

5.6 Operation mode **broadband detector** (PEAK power meter):

(The DISPLAY MODE status field displays "RF")



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 dB μ V 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 visualised. **You can change the update speed by altering the Sampletime (menu "SpTime")**. The large main display and the bargraph show you the measurement result in dBm or dB μ V. The noisefloor is about -50dBm.

In addition, a potentially existing amplitude modulation (AM) will be made available on the audio output (feature in development). In that case, the display mode status field will display "AM".

In contrast to the "Spectrum analysis" mode, SPECTRAN's broadband detector allows straightforward and **very fast** REALTIME display of all "PEAK" signal levels in the entire frequency range of the detector. To take advantage of this, set the SpTime 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/m^2 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 18.3 on page 63 (example included).

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 5.2 on page 11) and the so-called "panning approach" (chapter 5.3 on page 12). This suggestion is valid 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 accuracy is reached with attenuator = 10dB and PreAmp = Off. Don't forget the maximum levels in this configuration!

HINT: You can upgrade your instrument with the broadband option **at any time!** Depending on your model, detectors for up to **10GHz (12GHz)** are available. Be sure to contact us should the need arise.

Note:

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.

So, you are seeing TWO different measurement results AT THE SAME TIME: The **broadband "PEAK"** power on the bargraph, and the **frequency selective** measurement on the main display. **A very handy feature.**

So far, we have only used the preset frequencies available on the various hot-keys. However, you can also set a precise frequency range (so-called sweep-range) **manually**. 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.







You will also find an excerpt of various radio applications along with their start and stop frequencies in the frequency tables on pages 66 and 67.

Subsequently, we will illustrate custom configuration using the new mobile communications standard UMTS as an example. In our case, we **only** want to find and evaluate UMTS cell towers of the provider “Vodafone”.

For this, proceed as follows:


First of all, check the UMTS frequency list on **page 67**.


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 2,200.0 MHz. 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 once again. 
- 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. 

You are now being returned to the main menu. The next menu entry **fHigh** has already been automatically selected.

- Press the ENTER key once more. 


- Once again, 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. 

You are now being returned to the main menu. The next menu entry **RBW** has already been selected automatically.

- Press the ENTER key once again. 

- A list of various filter bandwidths is displayed next. Choose the 1MHz filter 

by using the up/down arrow keys, and confirm the new setting by again pressing the ENTER key. 



You are now being returned to the main menu.

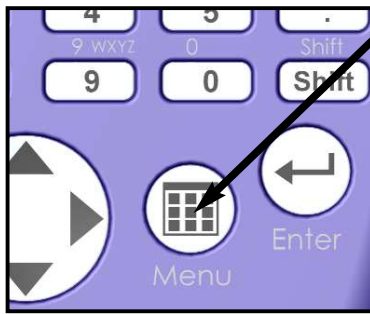
- Finally, press the menu key again, and all settings are being confirmed and the sweep (measurement) starts! The big status field reads **CUSTOM**, indicating a custom configuration, and the sweep is initiated automatically.

Now, **only** the configured frequency range between **2,110 and 2,121MHz** is being swept (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.

HINT: 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.

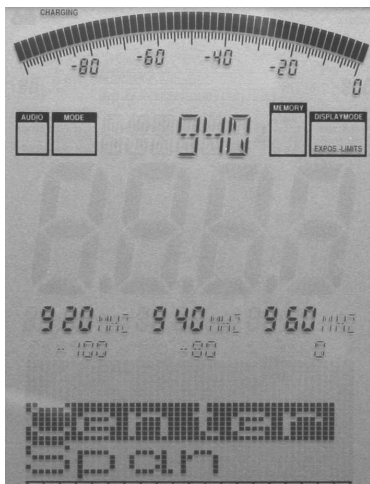
You can find further hints and information about configuring a custom frequency range and further main menu options in the chapter “The main menu“ on the following pages.



By pressing the **menu key**, you get to the heart of SPECTRAN: the menu system.



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



After pressing the menu key, a 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” in 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.

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 and Reflev

This is very convenient: It e.g. 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.

To move between menu entries, use the up/down arrow keys or the Jog Dial.



Use the Enter key 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.



Next, each menu entry will be explained in detail, step by step.

There are **TWO** ways to manually set the frequency range:

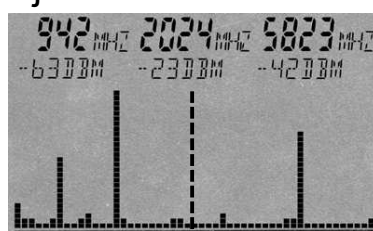
- **Center** (center frequency) and **Span** (frequency range width)

or

- **fLow & fHigh** (start and stop frequency)

7.1 Center (center frequency)

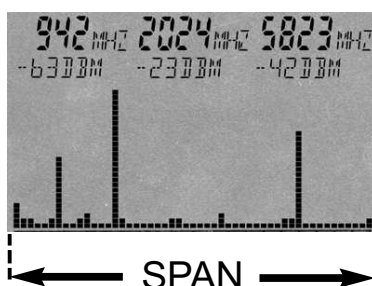
Chooses the frequency displayed in the middle of the readout. When changing the **center frequency**, the **SPAN** parameter (see following description) is preserved. Thus, you can quickly evaluate different frequency ranges with identical **SPAN** and without tedious re-adjustment of **start/stop frequencies**.



Center frequency

7.2 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 operating in the X axis.



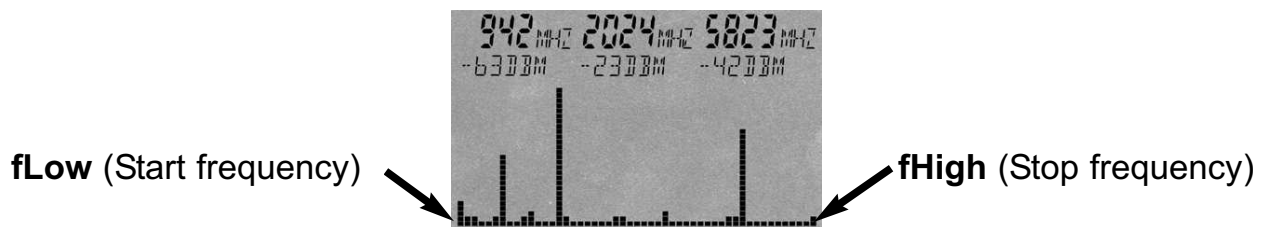
EXAMPLE: Say you have set 945MHz as the **center frequency**. Now, if you use 10MHz as the **span** setting, the sweep will be performed from 940 to 950MHz. If you enter 200kHz for the **span** setting, the sweep will be performed from 944.9 to 945.1 MHz, and so forth. In effect, you just increase or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

HINT: By using the right/left arrow keys, you can simply move the sweep range by exactly one **SPAN** to the right or left.

7.3 fLow & fHigh (start & stop frequency)

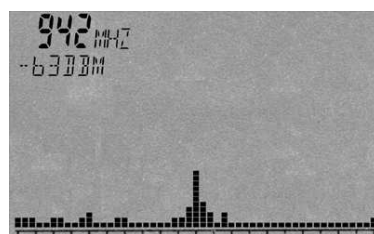
fLow (start frequency) sets the frequency where the sweep should begin, whereas **fHigh** (stop frequency) sets its ending frequency. From these two, the complete **frequency range** which gets swept is derived.

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 detail and **higher accuracy**. A large frequency span is thus mostly useful for a broad overview, **not for exact measurements**.

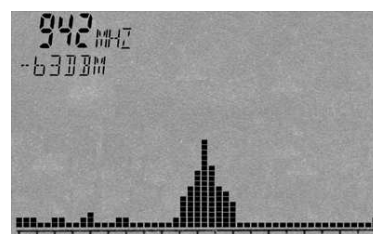


7.4 RBW (bandwidth)

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 swept 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.



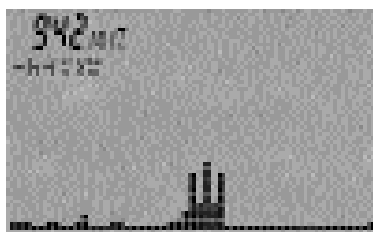
RBW (1MHz)



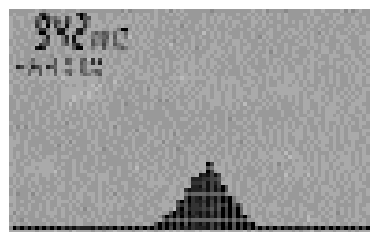
RBW (3MHz)

7.5 VBW (video filter)

The so-called **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.



VBW=Full



VBW=100KHz

7.6 SpTime (sampletime)

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 **Sampletime** setting, the more precise the measurement, at the cost of being more time-consuming.

A SpTime $\leq 20\text{mS}$ will activate the UNCALL sign.

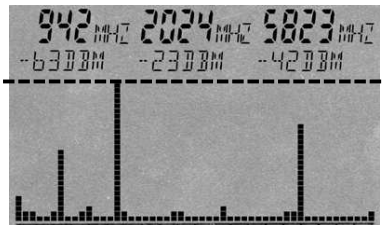
7.7 Reflev (reference level)

The so-called **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 interference.

The **reference level** thus can be used, for example, for **visually** suppressing distracting, weak signals. The higher the **reference level**, the smaller the amount of weak signals and interference that get displayed. Only the “peaks” of the strongest signals will be shown, the rest is “cut off”. Like this, you can, for example, achieve a clearer display of an interesting, strong signal. Though, if you would like to measure very weak signals, the **reference level** should be set as low as possible.

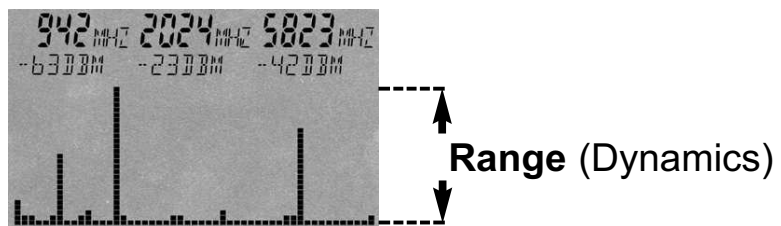
HINT: Using the up/down arrow keys, the **reference level** can be moved up or down by 10dB at any time.

Reflev (reference level) dBm



7.8 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.



7.9 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 mismeasurements. Signals beyond 0dBm (peak) can even destroy the input circuitry if no corresponding attenuator is configured!

7.10 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.

Attention: 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!

7.11 Demod (demodulator / audio analysis / GSM-Decoder)

The **demodulator** turns pulsing and modulation of up to approx. 3.5kHz into audible signals. SPECTRAN supports three **types of demodulation**:

AM (amplitude modulation), **FM** (frequency modulation) and **PM** (phase modulation). 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 neighbouring 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.

With **GSM** you can activate a powerful GSM-Decoder mode.

In this mode the spectrum display will be deactivated. Instead you will see continuous decoded GSM data stream. The following symbols are used:

“*” = Signal can't be decoded (signal is too weak or bad signal. The signal should offer more than -70dBm. At “high” power signal you must deactivate the preamplifier or select the internal attenuator).

“F” = Found FCCH.

“S” = Found Sync.

“0-7” = Represent the colorcode or TSC (Training Sequence) number.

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

7.12 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.

NOTE: The signal-dynamic can be changed at any time by changing the Reference Level.

The tone changes only AFTER each sweep completes and 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.

7.13 Detect (detector type)

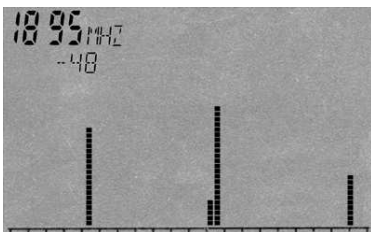
The **Detect** option can be used to choose a detector type. Depending on the signal type and measurement standard, different types of detectors are appropriate, the default being RMS. Currently available types (more are in development) are:

“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”

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 invoked 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.

REMARK: Please note that in MinMax mode, residual noise is always increased by roughly 10dB due to mathematical reasons.

HINT: 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).

7.14 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“ disables** erasure of the spectrum display (the Mode status field displays **“HOLD“**). **All** signals (peaks) ever displayed 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.

HINT: You can use the PkHold mode to create **long-term measurement protocols**:

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 indispensable for standard-compliant measurements using the **panning approach** (see also chapter **“Correct measurement“**)

Exposure limit calculation is another situation where the PkHold mode is **very helpful**: The data acquired with PkHold can be utilized for quick and easy comparison of various exposure limit standards. You do **not** even need to conduct a new measurement each time, as even all marker information is saved along. Simply switch to **Exposure limit calculation** mode after finishing your measurement, and the corresponding result is immediately available.



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 942MHz) as well as Vodafone (936MHz) cell towers.

HINT2: You can toggle between PkHold and Write mode at any time by pressing the doy key.

7.15 Unit (set unit)

The **Unit** setting determines the physical unit SPECTRAN utilizes to display measurement results. The currently available units are:

dBm (DecibelMilliWatts)

dB μ V (DecibelMicroVolts)

V/m (Volts/Meter)

mA/m (MilliAmperes/Meter)

Hint: 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**.

Hint2: 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.

Hint3: 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.

7.16 MrkCnt (set number of markers)

The **MrkCnt** setting determines 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.

7.17 MrkLvl (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.

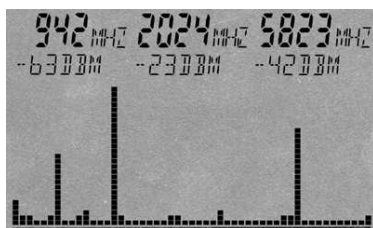
When using the -30dBm setting, **markers** are only displayed when a very strong signal of -30dBm is present, while at the -90dBm setting, even the smallest signals, albeit many of them might be interference or noise, will trigger **marker** display. The default setting (-70dBm) delivers optimum results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

7.18 MrkDis (marker display mode)

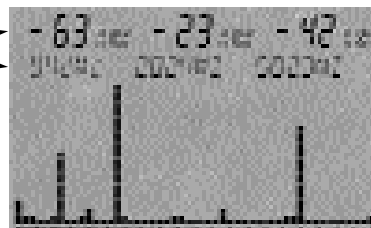
The **marker display mode** setting configures marker display itself. As the available fields for **marker** display vary greatly in size and readability, two different options are available:

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.

When set to **Amp.** (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 choice as the **marker** frequencies are usually the more important piece of information and thus should be the most readable.



Freq. (frequencies in large digits)



Amp. (amplitudes in large digits)

7.19 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 5.6 (operation mode broadband detector).

7.20 AntTyp (configure connected antenna)

The **AntTyp** setting must be configured correctly to reflect the type of antenna connected, as otherwise, mismeasurements can occur. For example, the "**HL7025**" setting corresponds to the HyperLOG7025 and HyperLOG4025, "**HL7040**" to the HyperLOG7040 and HyperLOG4040 and so forth.

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.

7.21 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 “**1m Std**” setting corresponds to the 1m 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 labelled “-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.

7.22 RefOff (Set Offset or UBBV-Preamplifier)

With **RefOff** you can set a 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).

7.23 GSMbst (select GSM Burst-Type)

With **GSMbst** you can select which bursttype should be used for the main (dBm) display with activated GSM-Decoder (see 7.11).

You can select:

All (All Bursttypes; 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)

7.24 GSMdst (Select GSM Slot-Distance)

With **GSMdst** you can change the GSM slot distance.

7.25 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 permanently saved.

7.23 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.

WARNING! 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 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 invoke 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.

ATTENTION: 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 usefull datas recorded..

ATTENTION: Transferring large amounts of data from SPECTRAN to the PC can take some time - the dBm values are transfered with an accuracy of two decimal places.

ATTENTION: Please note that the internal 64K memory can quickly be filled up. Thus, we **strongly** recommend our 1MB memory expansion (Option 001 for 99,95 Euros) for using the Logger function.

7.24 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. SETUPs (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.**

7.25 Setup (organize programs)

With **Setup**, you can organize individual programs and/or configurations using the following options:

“Store” saves SPECTRAN's **current settings** (frequency range, RBW and so forth) as a “mini program“. 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 when invoking the **“Store“** function (MCS labels in parentheses):

- Start frequency (kHz, truncated to integer) (STARTFREQ), see **7.3**
- Stop frequency (kHz, truncated to integer) (STOPFREQ), see **7.3**
- RBW-Filter (RESBANDW), see **7.4**
- Video filter (VIDBANDW), see **7.5**
- Sweep time (SWEEPTIME), see **7.6**
- Attenuator (ATTENFAC), see **7.9**
- Reference level (REFLEVEL), see **7.7**
- Display range (DISPRANGE), see **7.8**
- Detector type (PULSEMODE), see **7.13**

“**CalRun**” recalibrates the SPECTRAN noise floor on different points within the full frequency range and stores the results permanently.

ATTENTION: Please make sure that no RF source disturbs this measurement. Dont 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 (ArtNo 779) which gets connected to the SPECTRAN sma RF input.**

The “**Del**” option permanently erases a previously saved program. Enter the number of the program to be erased.

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

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.

8.1 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 instru-**



↓ **Noise floor** (below this imaginary line)

8.2 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 that of the actual signal. 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.

8.3 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 operating in “Pin“-mode only, be sure to use a longer Sampletime (5s).

Further optimized configurations can be found in our “MCS” PC software!

8.4 Attenuator mode “Auto“

This innovative 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 Sampletime according to the following formula: $\text{Delay} = \text{Sampletime}/10$. However, the maximum delay is just 10mS, corresponding to 100mS Sampletime. For ensuring clean operation in Auto attenuator mode, the Sampletime 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.

8.5 Sensitivity

Please note that the noise floor (and therefore sensitivity) in spectrum analysers 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 5GHz than at, say, 100MHz.**

8.6 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 analyser, 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 **+/- 3dB** and consider this in every measurement!

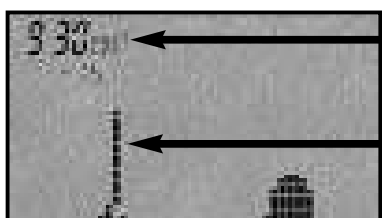
Example: You measure a value of -45dBm. So, the actual result could, according to the mentioned measurement inaccuracy, vary between -42dBm (-45dBm +3dB) and -48dBm (-45dBm - 3dB). Thus, as you want to measure **exposure** due to radiation, you should always assume the **highest** value, namely -42dBm.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

Always add another 3dB to the measurement inaccuracy of your SPECTRAN instrument when conducting measurements.

8.6 The 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.



Frequency and level
at the current cursor position

Cursor
The spectrum portion under the cursor is drawn in inverse

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. An incredibly convenient feature.

Deactivate the cursor again by pressing the menu button twice.

ATTENTION: The cursor does NOT get erased when in HOLD mode!

Quick Zero-span sweep (Time Domain Mode)

A quick measurement at a fixed frequency almost in realtime is achievable with the so-called zero-span. Should you have found a signal on e.g. Hotkey 5 (GSM900), simply set the correct center-frequency using the cursor. Now, set **Span** to "0" and **SpTime** 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".

"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 usable SPAN **96MHz**
- **1MHz RBW** = Maximum usable SPAN **32MHz**
- **300kHz RBW** = Maximum usable SPAN **9.6MHz**
- **100kHz RBW** = Maximum usable SPAN **3.2MHz**, 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.

"Turbo" sweep 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 **SpTime** to 1mS. The result is an extremely fast sweep of even large frequency ranges.

However, note that due to the extremely high filter bandwidth with this setting, both the frequency and level readings now are to be interpreted with care! Furthermore, depending on frequency, signal levels now must exceed -65dBm (at 5GHz) to be detected.

As this mode is also specifically designed to apply less interference processing, it is only recommended for experienced users as a "**quick assessment tool**". Nonetheless, it's still a very handy feature!

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 **Setup & 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.**

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.

See also 7.11

Exposure limit calculation and display in W/m^2 with “weak” signals

Reduce the “MrkLvl” setting to “-90dB” or even “-110dB”.

“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, dB μ V] in the **Unit** menu: The previous figure will immediately be converted.

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 mouseclick. 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.) If possible, only use small frequency ranges (SPAN) below 100 MHz to eliminate interference and/or harmonics and achieve faster sweeps.
- 2.) An **RBW** setting of “3MHz“ and **SpTime** of “1mS“ are usually ideal
- 3.) **ONLY** activate MinMax mode when dealing with pulsed and/or modulated signals.

Analysis on your PC

We offer the FREE PC analysis software “MCS” for SPECTRAN on our homepage. This really versatile PRO software unleashes SPECTRAN’s full potential. Whenever possible, you should use this software for getting everything possible out of your SPECTRAN instrument.

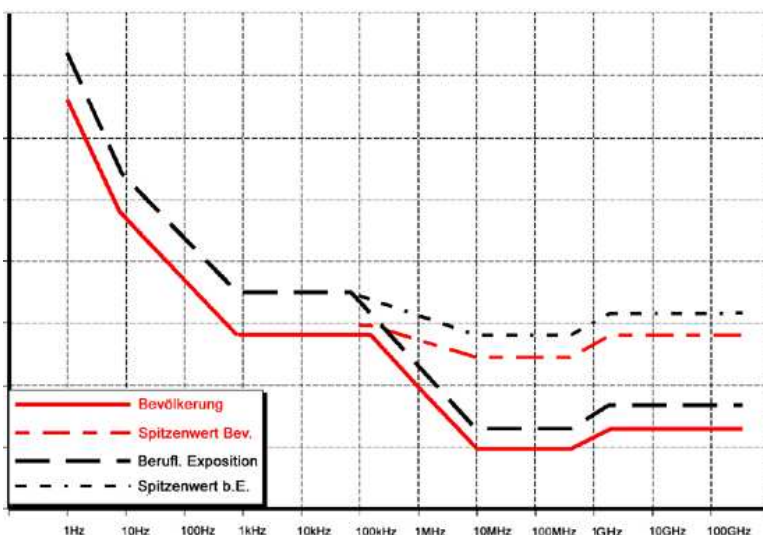
10.1 Exposure limits (for personal safety)

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	$87 / \sqrt{f}$	$0.73 / \sqrt{f}$
10 - 400	27.5	0.073
400 - 2,000	$1.375 * \sqrt{f}$	$0.0037 * \sqrt{f}$
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 $\sqrt{1.375 * 935}$ MHz or approx. 42 V/m.

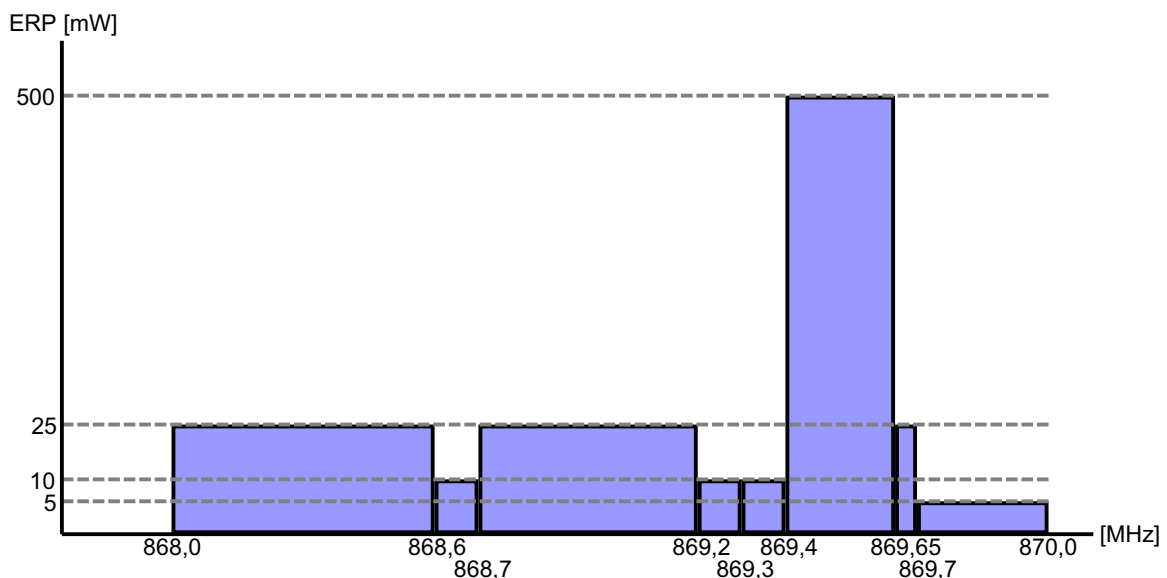
For E-Net (GSM1800) base stations, this means that the electrical field strength needs to stay below $\sqrt{1.375 * 1800}$ MHz or approx. 58 V/m. A huge difference!

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.

10.2 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:



10.3 Limits for ecologically compatible construction

These limits are vastly different to the official personal safety limits: They are mostly **significantly** stricter. Well, this would be fine on its own. However, to our big surprise, in contrast to the highly complex official ICNIRP limits (which are also authoritative in Germany), they have **no** “frequency component” **at all**, meaning that these exposure limits are absolutely **identical** both at e.g. 900MHz and 2GHz.

Thus, professional technicians and experts in the area alike are mightily surprised by this “curious” manner of handling exposure limits. There is a simple explanation though:

The “measurement devices” used in the field of ecologically compatible construction are exclusively based on so-called broadband / diode-detector technology. However, with these instruments, **frequency-selective**, professional measurement is **impossible**. Thusly, **frequency-selective** exposure limits would simply not be feasible for use with these devices. Though, we hope that this will change quickly with SPECTRAN, as the frequency should definitely not just be ignored.

Even though it doesn’t really “feel” quite adequate to support exposure limits (“precautionary limits”) as trivial as these in an instrument like SPECTRAN, we still decided to include the so-called “Salzburger Vorsorgewerte” (“Salzburg precautionary limits”) as a bare minimum.

All of the following “precautionary limits” for ecologically compatible construction **can be selected and displayed instantly using SPECTRAN’s “Exposure-limit calculation” mode, by using the right/left arrow keys:**

<u>Salzb1</u> = <u>Salzburg precautionary limit</u> (OLD)	1mW/m²
<u>Salzb1</u> = <u>ECOLOG recommendation indoors</u>	1mW/m²
<u>Salzb2</u> = <u>Salzburg precautionary limit</u> outdoors (2002)	10μW/m²
<u>Salzb3</u> = <u>Salzburg precautionary limit</u> indoors (2002)	1μW/m²
<u>Salzb3</u> = <u>Citizen forum electrosmog</u> for daytime areas (indoors)	1μW/m²

Please take into account that some of these limits are only applicable to certain types of signal sources or frequency bands. You should consult the original “authors” of these limits for the exact and most current modes of application.

Notice:

- 1mW = 1,000μW = 1,000,000nW
- 1μW = 0.001mW = 1,000nW
- 1nW = 0.000,001mW = 0.001μW

You can operate SPECTRAN either with the optionally available **OmniLOG antenna** or with the professional **HyperLOG antenna**:

11.1 Single-handed operation using the OmniLOG antenna:



Our OmniLOG® 90200 antenna is available as an option and has been specifically developed for **radially isotropic** measurements in the GSM (GSM900, GSM1800, GSM1900), UMTS and 2.4GHz WLAN frequency ranges. It is an ideal companion for our SPECTRAN V4 instruments, with direct support built-in.

Unlike our HyperLOG antennas, the OmniLOG 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 SPECTRAN's **SMA socket**. **Do not apply excessive force** when screwing 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.

Finally, you could as well screw the included **“pistol grip“ handle** to the bottom side of your SPECTRAN. This way, you can handle SPECTRAN more easily or place it permanently on e.g. a table (for this, unfold the **handle** to become a miniature tripod).

Please bear in mind that unlike our 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.

The following pages contain detailed instructions on the usage of our HyperLOG antennas.

11.2 Handling with two hands using the HyperLOG antenna:



First, carefully screw the included **SMA cable** to the **SMA socket** on the SPECTRAN. The cable should be attached carefully. **Do not apply excessive force!** As soon as there is resistance, slightly tighten the plug using the **SMA tool**. Again, don't use excessive force. Never trigger the overtorque protection (the **SMA tool** has an overtorque protection and starts slipping as soon as **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, 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 yourself (see picture).

You can now handle the SPECTRAN instrument and the HyperLOG antenna **independently**, with one hand each.

Being able to move and aim the HyperLOG antenna independently from the SPECTRAN can be very handy - for example, for finding the signal maximum using the so-called **panning approach**.

You can still use your thumb to press the buttons on the SPECTRAN while conducting a measurement.

11.3 Single-handed use with attached HyperLOG antenna:



Using this method, you can **directly** attach the HyperLOG antenna to SPECTRAN for both to form 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 cer-

tain positions.

11.0 Antenna mounting and handling



First, carefully screw the **SMA adapter** onto the **SMA socket** on the SPECTRAN. Screwing should be possible 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! Never trigger the over-torque protection (the **SMA tool** features an over-torque protection as soon as **excessive force** is applied).



Now attach the HyperLOG antenna. For this, the HyperLOG's **guide rails** need to be pushed carefully and **without force** into the designated **sensor pickups** 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.



Now attach the included **pistol-like grip** to the bottom side of the HyperLOG antenna such that the antenna and the SPECTRAN device form a single unit and can be handled as shown in the image on the left. The SPECTRAN device itself should be supported by the user's arm. You now have a single, compact, easy to handle measurement package. Using the grip on the HyperLOG antenna, the complete package can easily be adjusted as needed. After unmounting the grip, the measurement package can be stowed completely as-is into the Aaronia carrycase. As such, it is ready-to-use for the next time without further hassle.



12.1 External DC input (battery charger / mains operation)



All SPECTRAN RF measurement 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. 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. Full charge is reached after about 24 hours for the standard 1300mAh battery, and about 36 hours for the optional LiPo 3000mAh version.

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.

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 “-”.

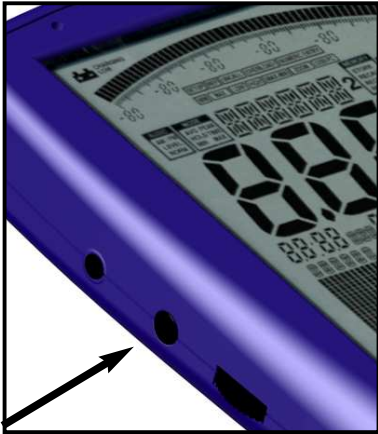
Using our optional car power adapter (see price list), you can also operate SPECTRAN devices in your car.

Should you wish to operate SPECTRAN via the power supply, 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 mismeasurement in extreme cases.**

If you wish to use an adequately clean power supply for long-term measurements, it is recommended to operate SPECTRAN on an external, large battery, which should be able to power SPECTRAN for several weeks. We particularly recommend one of the commercially available “powerbags”, “battery bags” or a comparable product. These often offer a regular 12V car adapter and thus can be used directly with our car power adapter cable.

All cables/devices used for connection to the external DC input must supply a DC voltage of 12V via a standard 3.5mm phone jack (inner conductor PLUS, outer conductor MINUS).

12.2 Audio output



This is a standard 2.5mm mono phone jack that can be connected to any device which offers an audio input. Depending on model and manufacturer, these are labeled differently: 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.

12.3 Jog Dial / volume control



The Jog Dial, like on modern cell phones or PDAs, replaces the up/down arrowkeys (“turn” the jog dial) and the Enter key (briefly “press” the jog dial). Like this, you can e.g. control the complete menu system just with this handy little wheel.

However, with the demodulator activated, this jog dial serves as a volume control. 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.

12.4 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 our 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).

We strongly recommend using our own custom-built USB cables as these incorporate especially developed EMC shielding and thus drastically reduce any possible interference!



Before taking any measurement, you **must** tell SPECTRAN **WHICH** antenna and/or which cable is connected. Otherwise, **SERIOUS** mismeasurement 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 load your 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 HyperLOG7025 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 being 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 “**1m Std**” entry corresponds to the 1m SMA cable included with delivery. If there is no cable connected, choose “**None**” as cable type. 

Confirm your 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 mismeasurement may occur!

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 cyclists, lane 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 lane reserved for cyclists is far narrower than that reserved for trucks, etc. High frequency works exactly like this, just that here, the lanes are the so-called **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 disrupted by a microwave oven.

Big differences 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 km/h. Cars, in change, may speed at up to 300 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
2.320-2450	Amateur radio (11cm)	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.

Why spectrum analysis?

There are 2 main reasons:

1.) You would like to know WHICH radio applications are active

2.) You would like to measure the exposure caused by **each of the radio applications** separately, e.g. for evaluating exceeding of exposure limits.

Regarding 1):

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. Wow, what a mess!

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 18km/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 0-6km. 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 6km 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**! Who would have thought that you are a **Spectrum analyser**!

Jokes aside: 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 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.

But let's go on: 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 1.900 to 2.200MHz (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 6.000m 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:

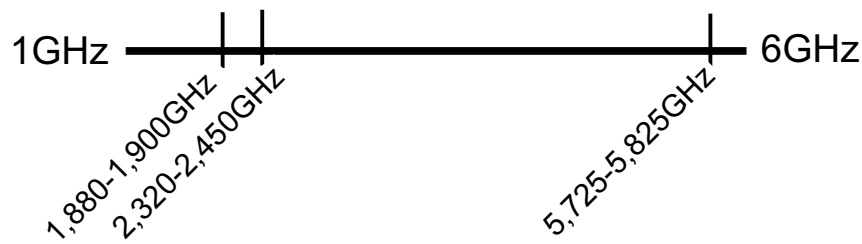
Let's assume that we want to exactly evaluate the **frequency range** from 1GHz to 6GHz, and that the following 3 **radio applications** were active simultaneously with various **signal strengths** (in practice, though, it will mostly be A LOT MORE different applications!):

Frequency range [MHz]	Application	Reading
1.880-1.900	DECT portable phone	40
2.320-2450	Amateur radio (11cm)	20
5.725-5.825	WLAN 802.11a	80

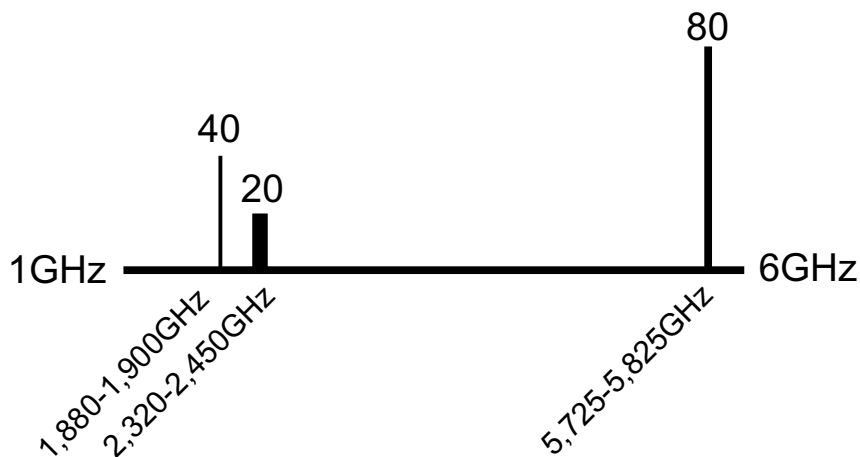
How can this be visually displayed on a measurement device? Well, first, we will map the frequency range from 1GHz to 6GHz on a line from left to right (X-axis):



Ok, this was still pretty simple. 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:



Well, this was again pretty simple. And 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 (1.880-1.990MHz=20MHz) of **bandwidth**, a very small range. Amateur radio, in contrast, already uses a far higher **bandwidth** (2.320-2.450=130MHz) and so on.

Well, this wasn't all that difficult, was it? 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**=942MHz at -63dBm
- Signal#2**=2.024MHz at -23dBm
- Signal#3**=5.823MHz at -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. On the left, **marker 1** is displayed: (the first bar from the left) with 942MHz at -63dBm. In the middle, **marker 2** (the second bar from the left) 2.024MHz at -23dBm. On the right, **marker 3** (the last, rightmost bar) is displayed: 5.823MHz at -42dBm.

Notice: 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?

- 1.) In the entire frequency range from 0-6GHz, there are 3 main signal sources.
- 2.) 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 known, it is easy to determine the exact applications emitting these signals (see also our frequency tables on pages 63-65 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 = GSM 900 (DL) T-Mobile meaning that this is a GSM900 celltower (DL=Download) of the provider T-Mobile.

15.1 Measuring transmission power [dBm; dB μ V]

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 10 fold 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 **1 μ V**. So, logarithmic level readings are expressed in dB **milliwatts** [dBm] or dB **microvolts** [dB μ V].

15.2 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 μ W/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 = 400,000,000mm!** 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 μ W/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.

Operators, various governmental authorities and also scientists themselves actually have fun jumping around between units wildly in their publications. Consequently, the casual reader often loses track of the relationships between units completely. To save you from such problems, 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. For our mathematically adept customers, we also included the most important basics and formulas 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 US). Conversion between these units is simple:

1 $\mu\text{W/cm}^2 = 0.01 \text{ W/m}^2 = 0.001 \text{ mW/cm}^2$, or

10 $\mu\text{W/cm}^2 = 0.1 \text{ W/m}^2 = 0.01 \text{ mW/cm}^2$ and so on. (see table 1 on page 64)

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

1 $\mu\text{W/cm}^2 = 10\text{dBm/m}^2 = -20 \text{ dBW/m}^2$, or

10 $\mu\text{W/cm}^2 = 20\text{dBm/m}^2 = -10 \text{ dBW/m}^2$ etc., respectively.

However, the most frequently used unit is **V/m** (see table 2 on page 64). 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:

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

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

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

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:

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

16.1 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]. **Examples:**

$$\lambda = \frac{300\,000\,000 \frac{m}{s}}{900\,000\,000 \text{ Hz}} = 0,33m \text{ (For 900 MHz, the result is 0.33m)}$$

$$\lambda = \frac{300\,000\,000 \frac{m}{s}}{1\,800\,000\,000 \text{ Hz}} = 0,17m \text{ (For 1.8 GHz, the result is 0.17m)}$$

$$\lambda = \frac{300\,000\,000 \frac{m}{s}}{2\,000\,000\,000 \text{ Hz}} = 0,15m \text{ (For 2 GHz, the result is 0.15m)}$$

Further information concerning wavelength is contained in table 4 on page 64.

16.2 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 cellphone”, the wavelength is:

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

Hence, the close-up range is $0.33\text{m} * 10 = \underline{3.3\text{m}}$.

It is easy to see that e.g. measurements taken directly next to the cellphone will definitely result in WRONG readings!

Notice: 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.

16.3 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:

$$S = \frac{10^{\left(\frac{P-G}{10}\right)}}{1000} * \frac{4 * \pi}{\lambda^2}$$

S represents the power density [W/m²], p is the measured power [dBm], λ is the wavelength of the transmitter frequency [m] and G the antenna gain [dBi] (dBd-values can be converted to dBi by adding 2.15).

You can find the dBi antenna gain of the HyperLOG antennas easily by looking at the “antenna.ini” file supplied with our “MCS” PC-Software.

An example:

Say your instrument indicates -40dBm at 950MHz with a HyperLOG 7025 antenna (which has a gain of 4.9dBi at 950MHz). **The result is:**

$$S = \frac{10^{\left(\frac{-40-4.9}{10}\right)}}{1000} * \frac{4 * \pi}{0,31579^2} = \frac{0,00003236}{1000} * \frac{12,566}{0,0997} = \underline{0.00000408 \text{ W/m}^2} = \underline{4.08\mu\text{W/m}^2}$$

Also see the following conversion table!

Table 0 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	Lambda X	GSM1800	UMTS	WLAN
+10	0.45	1.34	1.8	2.2	3.3
+9	0.36	1.06	1.4	1.8	2.7
+8	0.28	0.84	1.1	1.4	2.1
+7	0.23	0.67	0.90	1.1	1.7
+6	0.18	0.53	0.72	0.89	1.3
+5	0.14	0.42	0.57	0.70	1.06
+4	0.11	0.34	0.45	0.56	0.84
+3	0.09	0.27	0.36	0.44	0.67
+2	0.07	0.21	0.29	0.35	0.53
+1	0.06	0.17	0.23	0.28	0.42
0	0.045	0.13	0.018	0.022	0.033
-10	0.0045	0.013	0.0018	0.0022	0.0033
-20	0.00045	0.0013	0.00018	0.00022	0.00033
-30	0.000045	0.00013	0.000018	0.000022	0.000033
-40	0.0000045	0.000013	0.0000018	0.0000022	0.0000033
-50	0.00000045	0.0000013	0.00000018	0.00000022	0.00000033
-60	0.000000045	0.00000013	0.000000018	0.000000022	0.000000033

We assumed the following center frequencies (f) here:

GSM900 (f = 900MHz), Lambda X (f = 1550MHz), GSM1800/DECT (f = 1800MHz), UMTS (f = 2000MHz) and WLAN / microwave ovens (f = 2450MHz).

The conversion tables 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 PEAK 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 5dB 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.

HINT:

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.

Table 1 Conversion from W/m² to μW/cm² and mW/cm²

0.000,001 W/m ²	0.000,1 μW/cm ²	0.000,000,1 mW/cm ²
0.000,01 W/m ²	0.001 μW/cm ²	0.000,001 mW/cm ²
0.000,1 W/m ²	0.01 μW/cm ²	0.000,01 mW/cm ²
0.001 W/m ²	0.1 μW/cm ²	0.000,1 mW/cm ²
0.01 W/m ²	1 μW/cm ²	0.001 mW/cm ²
0.1 W/m ²	10 μW/cm ²	0.01 mW/cm ²
1 W/m ²	100 μW/cm ²	0.1 mW/cm ²

Table 2 Conversion from μW/cm² to V/m and A/m

0.000,1 μW/cm ²	0.019,4 V/m	0.000,051,5 A/m
0.001 μW/cm ²	0.061,4 V/m	0.000,162 A/m
0.01 μW/cm ²	0.194 V/m	0.000,515 A/m
0.1 μW/cm ²	0.614 V/m	0.001,62 A/m
1 μW/cm ²	1.94 V/m	0.005,15 A/m
10 μW/cm ²	6.14 V/m	0.016,2 A/m
100 μW/cm ²	19.4 V/m	0.051,5 A/m

Table 3 dBm to dBW and W (incl. respective fractional units):

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 4 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 5 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 = Decibel

Table 6 Cellphone frequencies and providers

Start/Stop frequency	Abbreviation	Provider
864.1 868.1	CT2	Private
885.0 887.0	CT1+ (UL)*	Private
914.0 915.0	CT1 (UL)*	Private
930.0 932.0	CT1+ (DL)*	Private
959.0 960.0	CT1 (DL)*	Private
1,880 1,900	DECT	Private
5,725 5,825	DECT2	Private

(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

Significantly more extensive lists available on the [Aaronia homepage](#). To get the full "luxury", get our free PC analysis software directly from there!

All frequency values in MHz.

Table 7 German GSM900 frequencies and providers

Start/Stop frequency	Abbreviation	Provider
876.2 880.0	GSM-R (UL)	Deutsche Bahn
880.1 885.1	GSM900 (UL)	E-Plus (NEW)
885.1 890.1	GSM900 (UL)	O2-Germany (NEW)
890.2 892.4	GSM900 (UL)	Vodafone
892.6 899.8	GSM900 (UL)	T-Mobile
900.0 906.0	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
921.2 925.0	GSM-R (DL)	Deutsche Bahn
925.1 930.1	GSM900 (DL)	E-Plus (NEW)
930.1 935.1	GSM900 (DL)	O2-Germany (NEW)
935.2 937.4	GSM900 (DL)	Vodafone
937.6 944.8	GSM900 (DL)	T-Mobile
945.0 951.0	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

(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 1,736Hz. Power variable between 0.5 and 400W ERP. Range of up to 32km.

Significantly more extensive lists available on the [Aaronia homepage](#). To get the full "luxury", get our **free PC analysis software directly from there!**

All frequency values in MHz.

Table 8 German GSM1800 frequencies and providers

Start/Stop frequency	Abbreviation	Provider
1,710.0 1,725.0	GSM18K (UL)	Military
1,725.2 1,730.0	GSM18K (UL)	T-Mobile
1,730.2 1,752.4	GSM18K (UL)	O 2
1,752.8 1,758.0	GSM18K (UL)	Vodafone
1,758.2 1,780.4	GSM18K (UL)	E Plus
1,805.0 1,820.0	GSM18K (DL)	Military
1,820.2 1,825.0	GSM18K (DL)	T-Mobile
1,825.0 1,847.4	GSM18K (DL)	O 2
1,847.8 1,853.0	GSM18K (DL)	Vodafone
1,853.2 1,875.4	GSM18K (DL)	E Plus

(UL) = "Uplink" mostly means "portable device" (portable transmitter which transmits towards the base station, e.g. cellphone). 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 tower). Pulsed at 217Hz. Control channel pulsed at 1,736Hz. Power variable between 0.5 and 300W ERP. Range of up to 16 km.

Significantly more extensive lists available on the [Aaronia homepage](#). To get the full "luxury", get our [free PC analysis software](#) directly from there!

All frequency values in MHz.

Table 9 German UMTS frequencies and providers

Start/Stop frequency	Abbreviation	Provider
1.920,3 1.930,2	UMTS (UL)	Vodafone
1.930,3 1.940,2	UMTS (UL)	Group 3G
1.940,3 1.950,2	UMTS (UL)	e-plus
1.950,0 1.959,9	UMTS (UL)	MobilCom
1.959,9 1.969,8	UMTS (UL)	O2
1.969,8 1.979,7	UMTS (UL)	T-Mobile D
2.110,3 2.120,2	UMTS (DL)	Vodafone
2.120,2 2.130,1	UMTS (DL)	Group 3G
2.130,1 2.140,0	UMTS (DL)	e-plus
2.140,0 2.149,9	UMTS (DL)	MobilCom
2.149,9 2.159,8	UMTS (DL)	O2
2.159,8 2.169,7	UMTS (DL)	T-Mobile D

(UL) = "Uplink" mostly means "portable device" (portable transmitter which transmits towards the base station, e.g. cellphone). Power variable between 2.5mW-250mW (Peak)

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

Significantly more extensive lists available on the [Aaronia homepage](#). To get the full "luxury", get our [free PC analysis software](#) directly from there!

All frequency values in MHz.

The AARONIA warranty

Guaranteed upgrades to “bigger” models

You can exchange your measurement device against a **higher-grade model of the same series** at any time by simply paying the price difference.

For example, if you have purchased a **SPECTRAN HF-6060 V4** and notice that you need a higher sensitivity after some time, you could replace it with the **SPECTRAN HF-60100 V4** by just paying the difference to this model.

However, for taking advantage of this service, you need to have purchased the unit directly from Aaronia Germany!

Guaranteed upgrades to newly developed models

As soon as we present new products, you can replace your model with a new Aaronia measurement instrument of your choice at any time.

This has been realized for the first time in the year 2000, when we introduced the new Multidetektor II series. Customers who sent back their Multidetektor 1 only had to pay half the price for the new Multidetektor II series device. The used, returned units have subsequently been disposed of in an environmentally friendly fashion by Aaronia.

However, for taking advantage of this service, you need to have purchased the unit directly from Aaronia Germany!

10 year warranty on all models

We offer 10 years warranty on our measurement equipment. We **immediately and unbureaucratically** replace or repair defective units.

20.1 Measurement 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 13/18V 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!



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

We thus **strongly** recommend you use our 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.

20.2 Measuring power lines, ISDN, DSL, VDSL etc.



Measurement of a DSL line utilizing our Active differential probe.

You cannot directly perform measurements on power or telecommunication lines like DSL, VDSL etc. as this might either destroy SPECTRAN's input due to excess voltage, or distort the signals being measured.

In such a case, you would need to utilize our optional **Active differential probe**.

Using this probe, you can conduct measurements safely, even directly on 115/230V AC lines. As an additional benefit, your measurement will hardly, if at all, interfere with the signals running through the wire due to the galvanic isolation in the probe.

20.3 Measurements with direct cable connections

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 sensitive input.



Our 20dB Attenuator prevents damage of the SPECTRAN input from too high power.

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 50V**.

20.4 "Listening" to the radio

Using SPECTRAN V4, you can check the transmissions of local (analog) radio or TV broadcasters. Though of course, you will need a suitable antenna and a signal of usable strength. Under favorable conditions, our **OmniLOG antenna** might already be more than sufficient.

To listen to a broadcast transmission, proceed as follows: Set the Center frequency of the broadcast station. Switch SPECTRAN to Audio mode and choose "FM" demodulation mode. A filter bandwidth (RBW) setting of **at least 100kHz** should be chosen in order to achieve optimum results.

Sweep time, Span etc. have no meaning in this mode.

20.5 Noise floor calibration



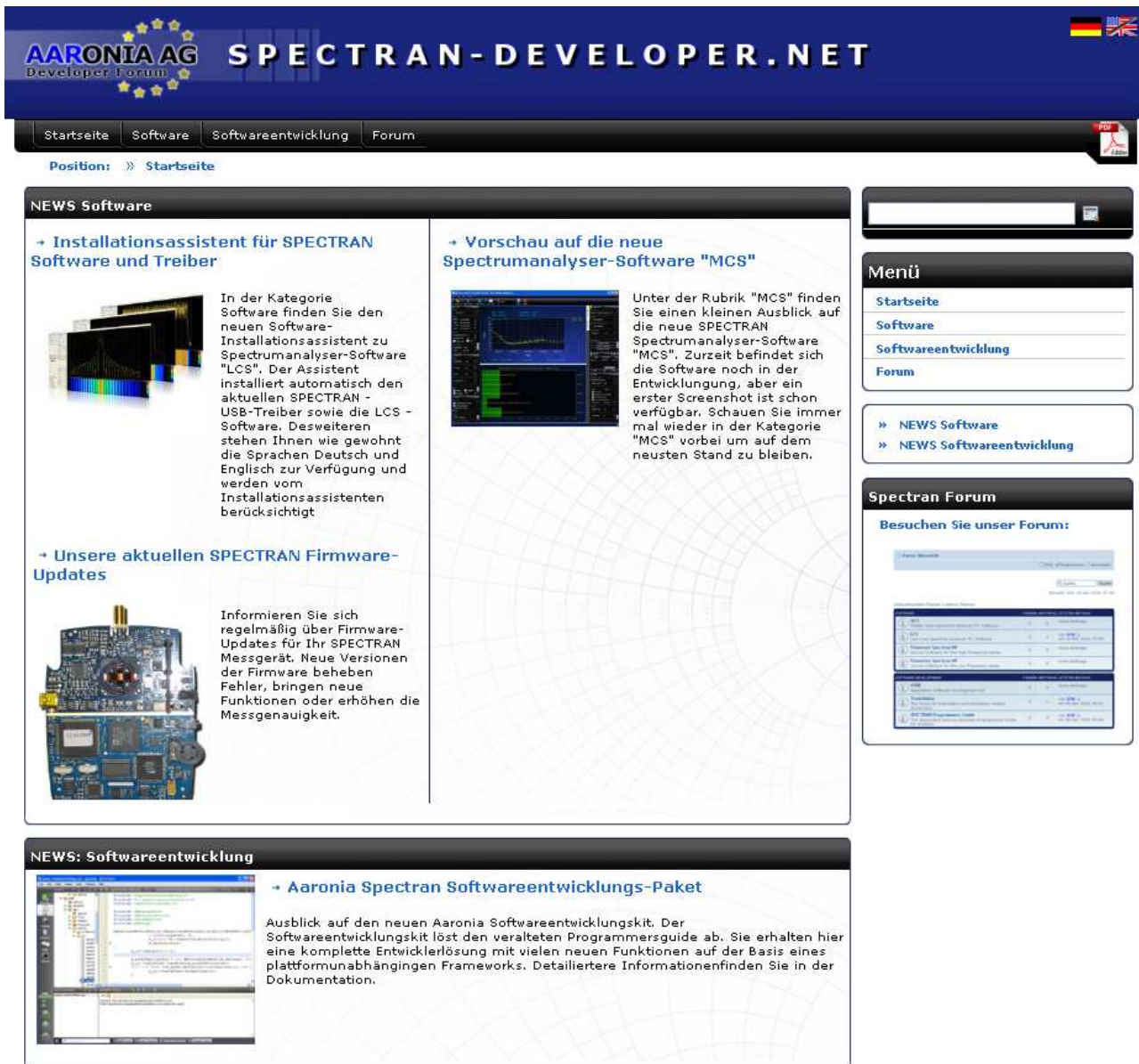
Our Calibration resistor for performing noise floor calibration for the SPECTRAN.

You should renew the noise floor calibration of your SPECTRAN from time to time. For this, you will need to attach our optional calibration resistor to SPECTRAN's input. Next, choose the "CalRun" option in the "Setup" menu.

ATTENTION: Please be sure not to attach USB or external DC power cables to your SPECTRAN during this procedure, as it must be performed in a completely "RF free" environment. This is to insure correct noise floor calibration of the device.

Please visit our **support website**:

http://spectran-developer.net

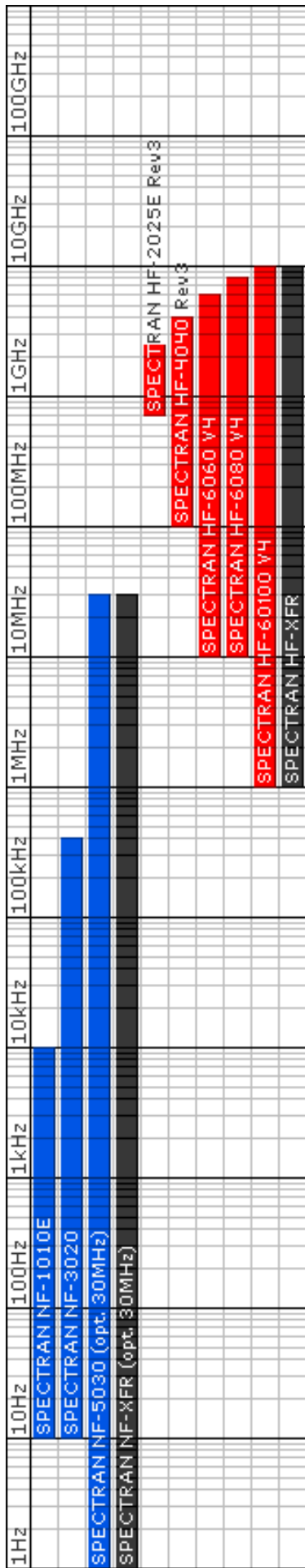


The screenshot shows the website's header with the AARONIA AG logo and navigation tabs for 'Startseite', 'Software', 'Softwareentwicklung', and 'Forum'. The main content area is titled 'NEWS Software' and features three articles: 'Installationsassistent für SPECTRAN Software und Treiber', 'Vorschau auf die neue Spectrumanalyser-Software "MCS"', and 'Unsere aktuellen SPECTRAN Firmware-Updates'. A sidebar on the right contains a search bar, a 'Menü' section with links to 'Startseite', 'Software', 'Softwareentwicklung', and 'Forum', and a 'Spectran Forum' section with a preview of forum posts. A bottom section titled 'NEWS: Softwareentwicklung' features an article about the 'Aaronia Spectran Softwareentwicklungs-Paket'.

This site offers:

- Free **Firmware updates**
- Free **PC Analyzer-Software** (MAC OS, Linux and Windows)
- **P-CODE** programing samples and **SPECTRAN TUNING**
- **User Forum** incl. **FAQ**
- **Latest news** on new Aaronia products

Frequencychart SPECTRAN Spectrum Analyzer



Frequencychart HyperLOG and BicoLOG Antennas and Probes

