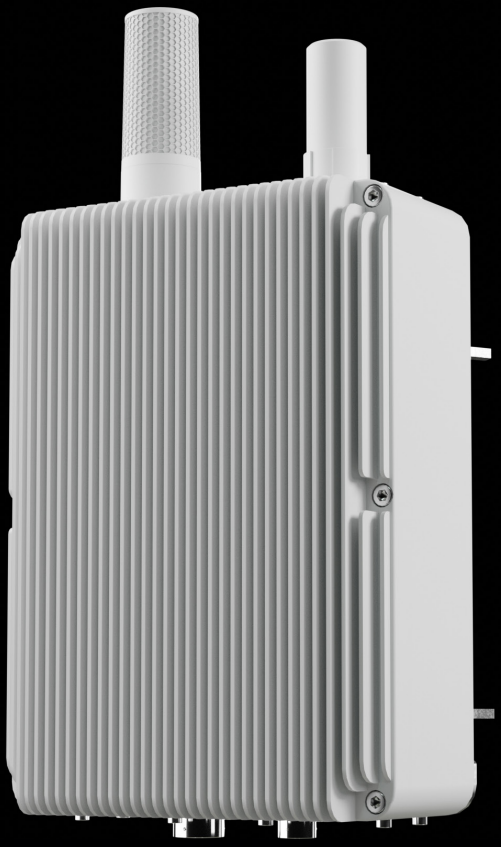
SPECTRAN®V6 RODB

USER MANUAL



Please read the following manual carefully before using your **SPECTRAN®V6 RODB**.
This manual contains important information on how to properly operate this device.

MADE IN GERMANY

AARONIA AG
WWW.AARONIA.DE

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1. Introduction

Dear customer,
by purchasing this SPECTRAN® high-frequency measurement device you acquired a professional piece of equipment which allows measurements of electromagnetic radiation.
The measuring instrument has been constructed according to state-of-the-art technology and fulfills the requirements of the applicable European and national guidelines.

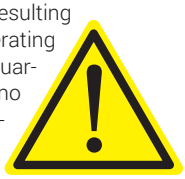
1.1. Liability

This document was compiled with great care and checked for accuracy. Nevertheless mistakes cannot be excluded. We do not take over any liability. We cannot guarantee the completeness, the correctness and the accuracy of information.
We reserve ourselves the right to change our products, specifications and documentations without any notice. We have no obligation for revision of documents and manuals we delivered in the past.

1.2. Warranty

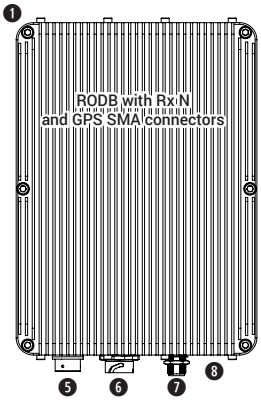
Despite the greatest care in development and production of this device and the free software RTSA-Suite, Aaronia AG only takes liabilities for certain purposes, if this has been assured in writing. No warranty can be assumed for the performance and flawlessness of the software for all usage conditions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

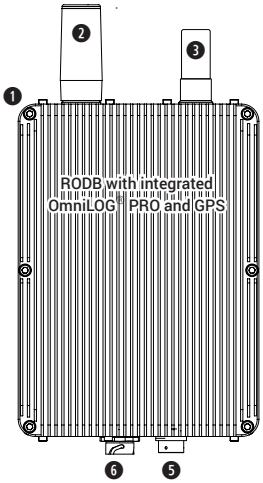
1.3. Safety guidelines

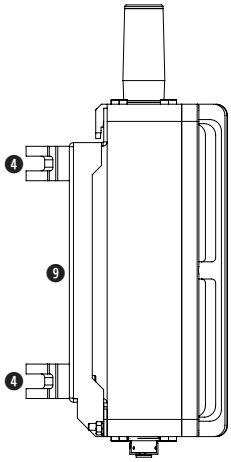


In the event of any damages resulting from failure to follow these operating instructions, the claim under guarantee is discharged. We accept no liability for consequential damages. In the event of property and personal damages resulting from improper handling or failure to follow safety advices, we accept no liability.
For reasons of safety and admissibility (CE) the unauthorized conversion and/or alteration of the product is not permitted. As voltage source, please only use a property mains socket (100-240Volt, 50/60Hz). Make sure that the cable isn't squeezed or damage by sharp edges.
In order to avoid any damage, please read this user manual carefully before starting to use the device. The commissioning should only be performed by qualified and instructed personnel. Never expose the device to water.
Avoid too high temperatures. The device is maintenance-free. Due to the high sensitivity, the sensors and internal hardware of this device are sensitive to shock; hence it should be handled with care.
Even though the device is well secured through the use of counter-sunk screws, it should still not be reachable by children as it could easily be diverted from its intended use. This device is connected to a mains socket and the derived voltages, it is not meant for the hands of children.
Consider the regulations for prevention of industrial accidents for electrical installations and equipment, by government safety organization in industrial facilities. In schools, educational establishments, hobby and self-help workshops the operation of this product must be supervised by trained personnel.

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2.1 Scope of delivery

❶ SPECTRAN® V6 RODB
❷ OmniLOG® PRO (type dependent)
❸ GPS antenna (type dependent)
❹ Mounting clamps (Ø 50 mm)
➖ 230V power supply with cable
❺ Power supply socket
❻ RJ45 network socket
❼ Rx N-connector (type dependent)
❽ GPS SMA connector (type dependent)
❾ Wall mount bracket

2.2 Hardware installation

The Remote Outdoor Box comes with two clamps for mounting on 50 mm diameter round tubes. Fix the box at your location and tighten the clamps with the attached wing nuts.
Alternatively, you can screw the box directly to a wall. Detach the mounting frame, remove the clamps, and screw the frame to the wall. Then, hang and screw the box back onto the frame. Next, plug the power supply into the "supply voltage" socket and connect it to a 230V outlet. To complete the setup, connect the box to your network with an RJ45 cable and refer to section 2.4 for further guidance.

2.3 Technical specifications

Version	SPECTRAN® V6 RODB 250RA-6	
Type	Standalone	Integrated
RTBW	80 / 120 MHz Rx	
Sweep speed	300 / 440 GHz/s	
DANL	-165 dBm/Hz	
Connectors	Power supply, RJ45 network, Rx N, GPS SMA	Power supply, RJ45 network
Rx Antenna	-	OmniLOG® PRO N 1060
GPS	-	Integrated antenna
CPU	Intel Core 14th Gen.	
GPU	Intel UHD Graphics	
RAM	32 GB DDR5	
System SSD	1 TB NVMe	
Operating System	Linux	
Power Supply	230V	
Operating Temperature	-20°C to +40°C	
Dimensions	290 x 210 x 176 mm (inlcuding mounting clamps)	392 x 210 x 176 mm (inlcuding mounting clamps)
Weight	~8,000 g	~8,300 g

ATTENTION! The Remote Outdoor Box may only be installed and operated vertically as shown above. Incorrect installation can cause internal heat damage. Always ensure to never exceed the operating temperature.

2.4 Connecting to your SPECTRAN® V6 RODB

After integrating the SPECTRAN® V6 RODB into a local area network, you can access the configuration and administration interface using an Internet browser.

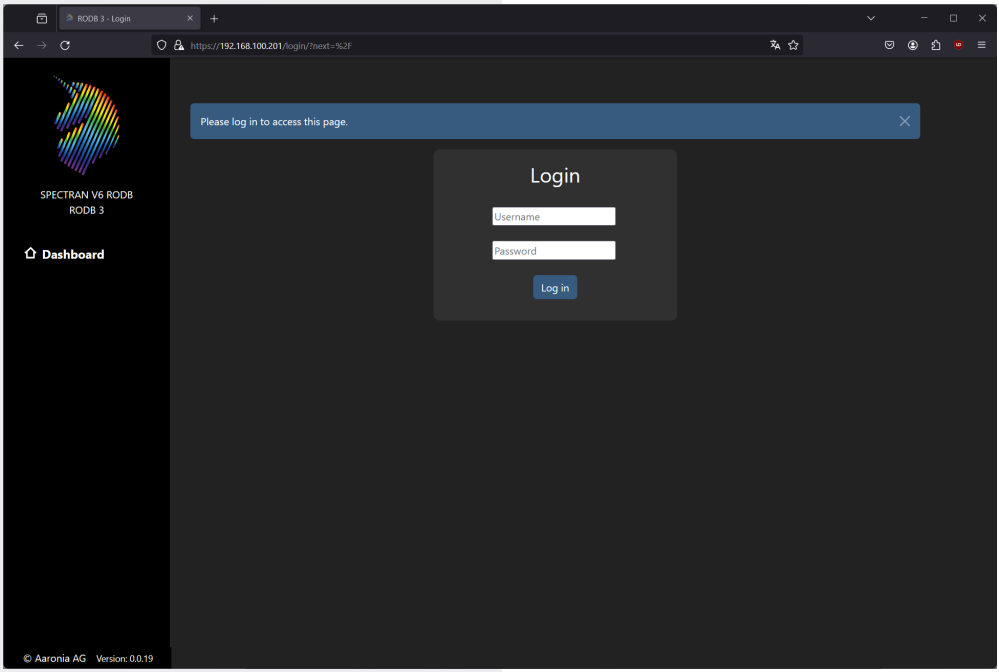
To do this, enter the preconfigured, fixed IP address of the RODB in the address line of the browser and confirm with “ENTER”.

In the following login window, use the login data listed here to access the configuration and administration area of the RODB.

IP ADRESS: **192.168.100.201**

USERNAME: **admin**

PASSWORD: **SpectranV6**



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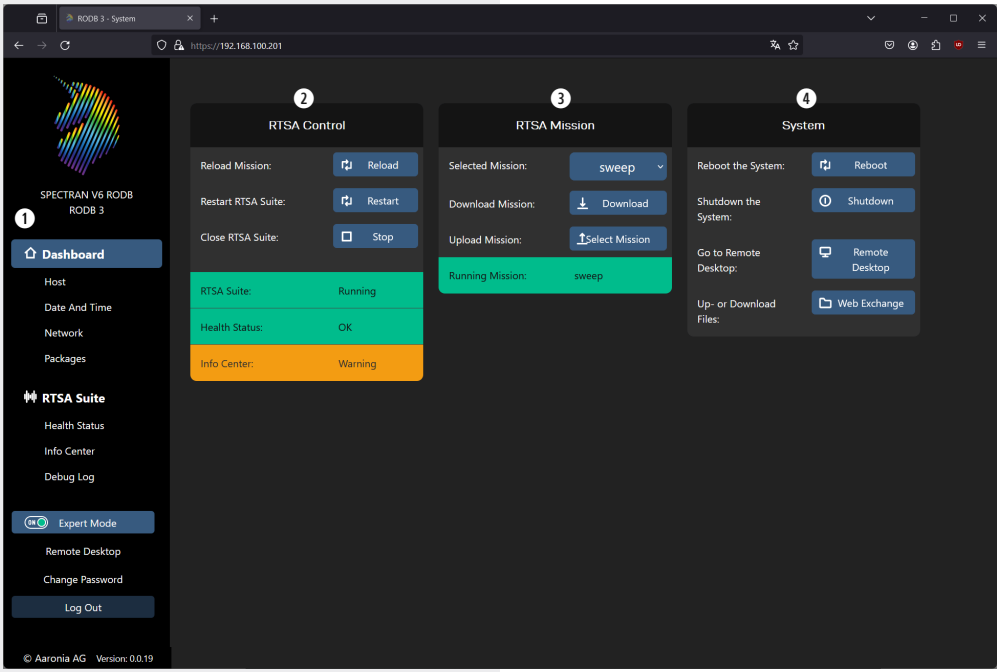
❶ Interface Menu

The name assigned to the RODB is displayed at the top. Below this is the menu, which is reduced to the "Dashboard" in the standard configuration.
To display all menu items, please switch to "Expert Mode" using the corresponding menu button.
WARNING! The "Expert Mode" allows changes that cannot be undone. This can restrict the function of the RODB or make it impossible to operate correctly.

❷ RTSA Control

This panel controls basic functions of the RTSA-Suite PRO software and displays its current status.

- Reload reloads the currently assigned mission
- Restart restarts the entire software
- Stop closes the entire software
- RTSA Suite: shows the current status of the software
- Health Status: provides information about the health of the software and any current problems
- Info Center: shows whether important information is available in the "Info Center" area (only selectable in "Expert Mode")



❸ RTSA Mission

The "RTSA Mission" panel assigns an available mission to the RTSA-Suite PRO software.

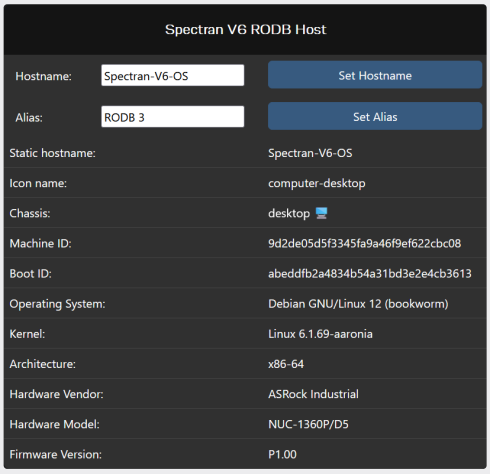
- sweep This drop-down menu shows the currently available missions, after selection the corresponding mission is loaded and started automatically
- Download Downloads the currently selected mission
- Select Mission Uploads externally saved missions to the RODB
- Running Mission: Shows the currently running mission

❹ System

The "System" panel offers basic functions for controlling the RODB.

- Reboot restarts the entire system
- Shutdown shuts down the entire system (**WARNING!** The RODB power supply has to be manually disconnected and reconnected again to restart the RODB)
- Remote Access to the browser-based remote desktop (see 3.10.)
- Web Exchange Remote file manager for up/download

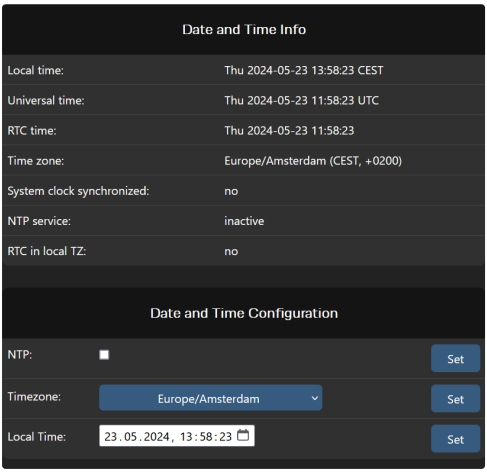
3.2 Host settings



- Set Hostname Sets the unique network host name
- Set Alias Sets an alias for further identification when using multiple RODBs within a network

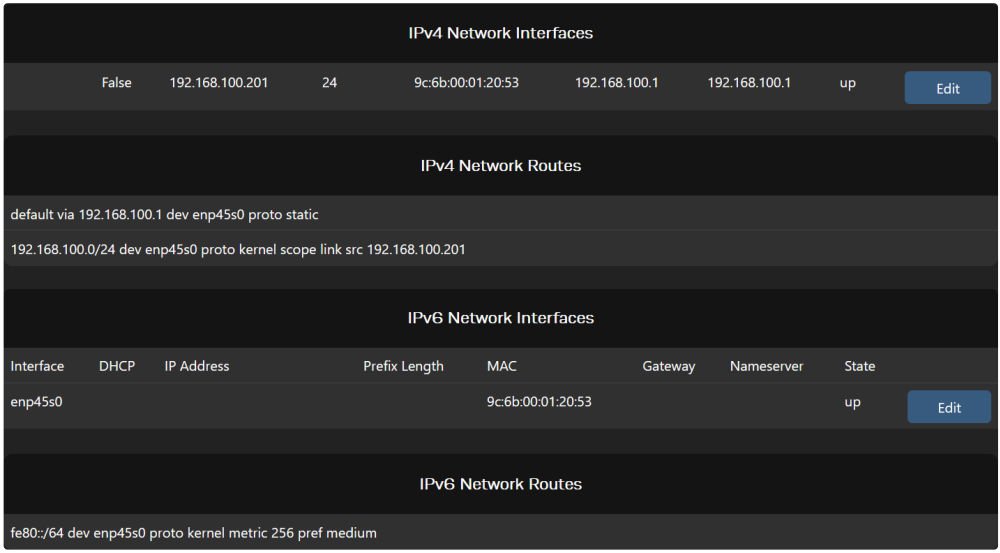
Furthermore, various technical details about the hardware and software of the RODB are listed in tabular form.

3.3 Date and Time settings



Shows the current settings of the RODB system times. In the lower area, the system time can either be obtained via NTP (network time protocol) or set manually.

3.4 Network settings



Configures IPv4 and IPv6 network settings of the RODB. (**WARNING**! Changing the IP address leads to a loss of connection. From this point on, the RODB can only be accessed with the new IP address.)

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3.5 Packages

Installed and Available Aaronia Packages

Update Package List: Update

Use Offline Bundle: RTSA-14245 Upload New

Package	Installed	Candidate	Versions
aaronia-service-certificates	0.0.11	0.0.11	* 0.0.11
aaronia-kernel-tuning	0.0.6	0.0.6	* 0.0.6
aaronia-rtsa-suite	2.6.1.14539	2.6.1.14539	* 2.6.1.14539 2.6.1.14245
aaronia-rodb-xruntime	0.0.8	0.0.8	* 0.0.8
aaronia-service-user	0.0.8	0.0.8	* 0.0.8
linux-image-6.1.69-aaronia	6.1.69-1	6.1.69-1	* 6.1.69-1
aaronia-rodb-config	0.0.8	0.0.8	* 0.0.8
aaronia-rodb-repo	0.0.7	0.0.7	* 0.0.7
aaronia-rodb-cmdserver	0.0.6	0.0.6	* 0.0.6
aaronia-rodb-webserver	0.0.19	0.0.19	* 0.0.19

Displays the installed packages including version numbers on the RODB. If updated packages are available, they can be installed here. Update installs the latest packages that are available for download online. Upload New in combination with the adjacent drop-down menu installs packages that have been stored locally on the RODB.

3.6 RTSA Suite

Aaronia RTSA Suite PRO

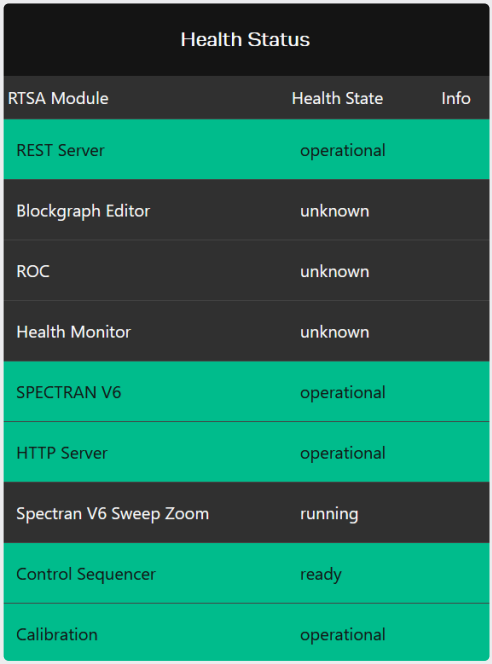
guid:	53280367-8af6-4c55-8a87-e478548e7b78
version:	2.6.1.14539
buildDate:	2023.12.20
copyright:	Copyright @ 2023 Aaronia AG
name:	Aaronia RTSA-Suite PRO
company:	https://aaronia.com
platform:	Linux
path:	/opt/aaronia-rtsa-suite/Aaronia-RTSA-Suite-PRO/Aaronia-RTSA-Suite-PRO
release:	True

Aaronia RTSA Suite Mission

name:	sweep
path:	/home/aaronia/Documents/Aaronia AG/Aaronia RTSA-Suite PRO/Missions/sweep.rmix
version:	1.0
guid:	53f94280-0249-40d4-9b2e-faeef878bfb9
modified:	True
createDate:	06/03/2024 01:50:31
createVersion:	2.6.1.14539
saveDate:	29/04/2024 14:46:57
saveVersion:	2.6.1.14539

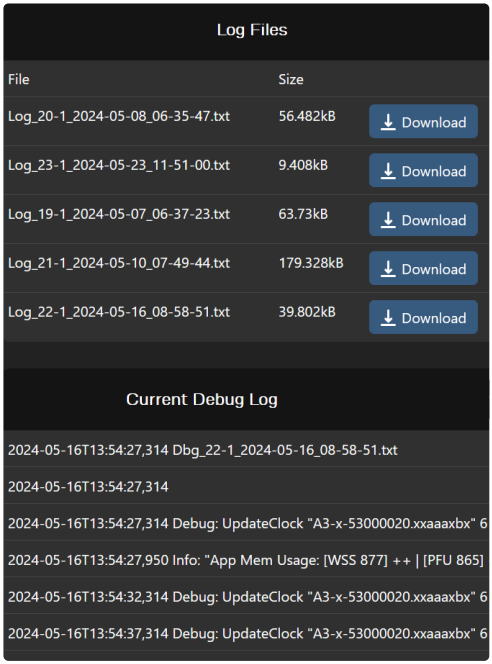
Shows information of the installed RTSA-Suite PRO software and the currently loaded mission.

3.7 Health Status



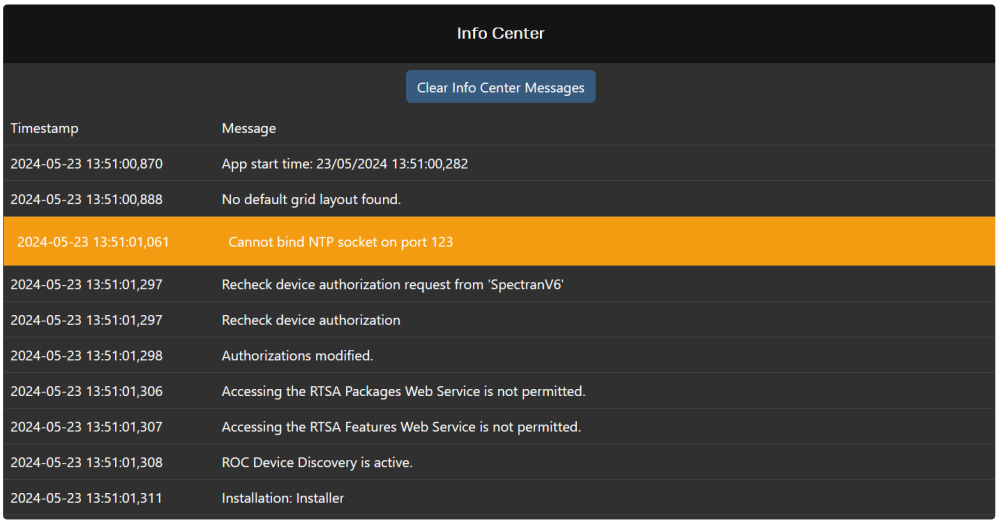
Shows helpful information about the health status of the RTSA-Suite PRO software on the RODB.

3.9 Debug Log



Shows the latest debug information and provides the latest log files for download.

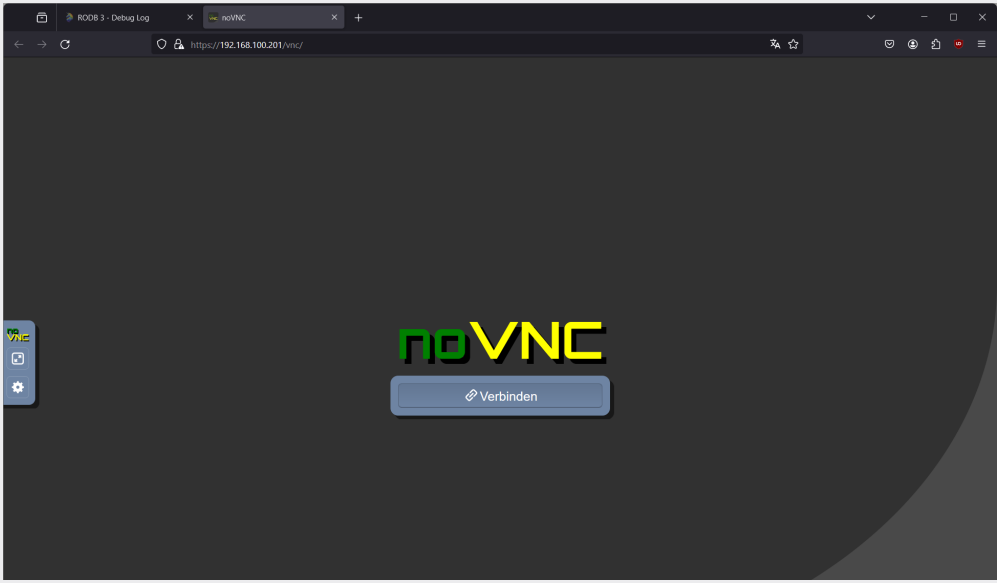
3.8 Info Center



Shows helpful information about the internal RTSA-Suite PRO Log.

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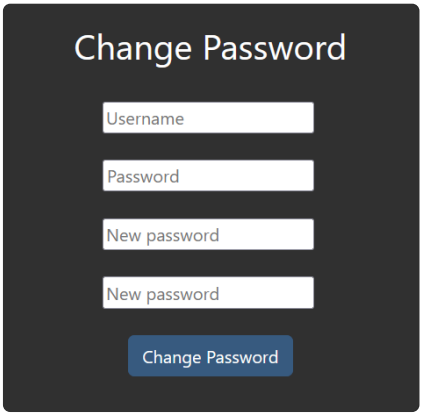
3.10 Remote Desktop



Opens a new browser window to connect to the Remote Desktop interface of the RODB.

PASSWORD: **SpectranV6**

3.11 Change Password



After entering the current login data, the RODB administration password can be changed. (**WARNING**! Changing the password cannot be undone. If the changed password is lost, the RODB must be reset by the manufacturer.)

4.1. Measuring transmission power (dBm; dBµV)

Measurements of communications equipment often show extremely big differences between levels. Therefore, it is useful to express signal levels in logarithmic units to avoid "drowning" readings in an endless number of zeros.
As amplification increases tenfold once every 10dB, "readings" of 0 to 100,000,000 would need to be displayed. Though, these "numeric giants" would be nearly unreadable and result in steady, drastic changes of the displayed values. So, we use the much easier to handle logarithmic unit dB:

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

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

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

4.3. Interesting facts regarding high-frequency formula

In publications the writers often jump around between units. Consequently, the casual reader often loses track of the relationships between units completely.

Power density of high-frequency signals is oftentimes measured in W/m² (primarily in Europe) or W/cm² (primarily in the USA). Conversion between these units is simple:

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

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

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

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

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

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

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4.4. Calculating the wavelength in [m]

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

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

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

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

(For 900 MHz, the result is 0.33m)

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

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

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

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

4.5. Calculating the "close-up range" in [m]

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

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

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

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

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

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

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

= 0,00000408 W/m² = 4,08 µW/m²

5.1. Conversion tables

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

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

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

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

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

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

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

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

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

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

Table 4:
dBm to dBW and W

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

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

Table 5: Frequency, wavelength and frequency band denomination

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

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

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

dB = Dezibel

5.2. Frequency tables

Table 7: Cell phone frequencies and providers

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

All frequency values in MHz.

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

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

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

More extensive lists on www.aaronia.com

Table 8:
German GSM900 frequencies and providers

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

All frequency values in MHz.

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

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

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

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Table 9:
German GSM1800 frequencies and providers

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

All frequency values in MHz.

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

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

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

Table 10:
German UMTS frequencies and providers

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

All frequency values in MHz.

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

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

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

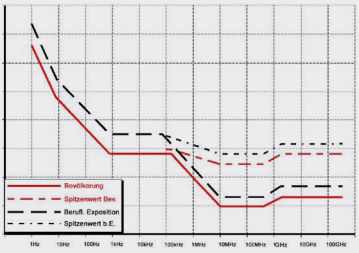
5.3. Exposure limits

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

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

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

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



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

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

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

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

The respective allowed absolute maximums are another 32 times higher.

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

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