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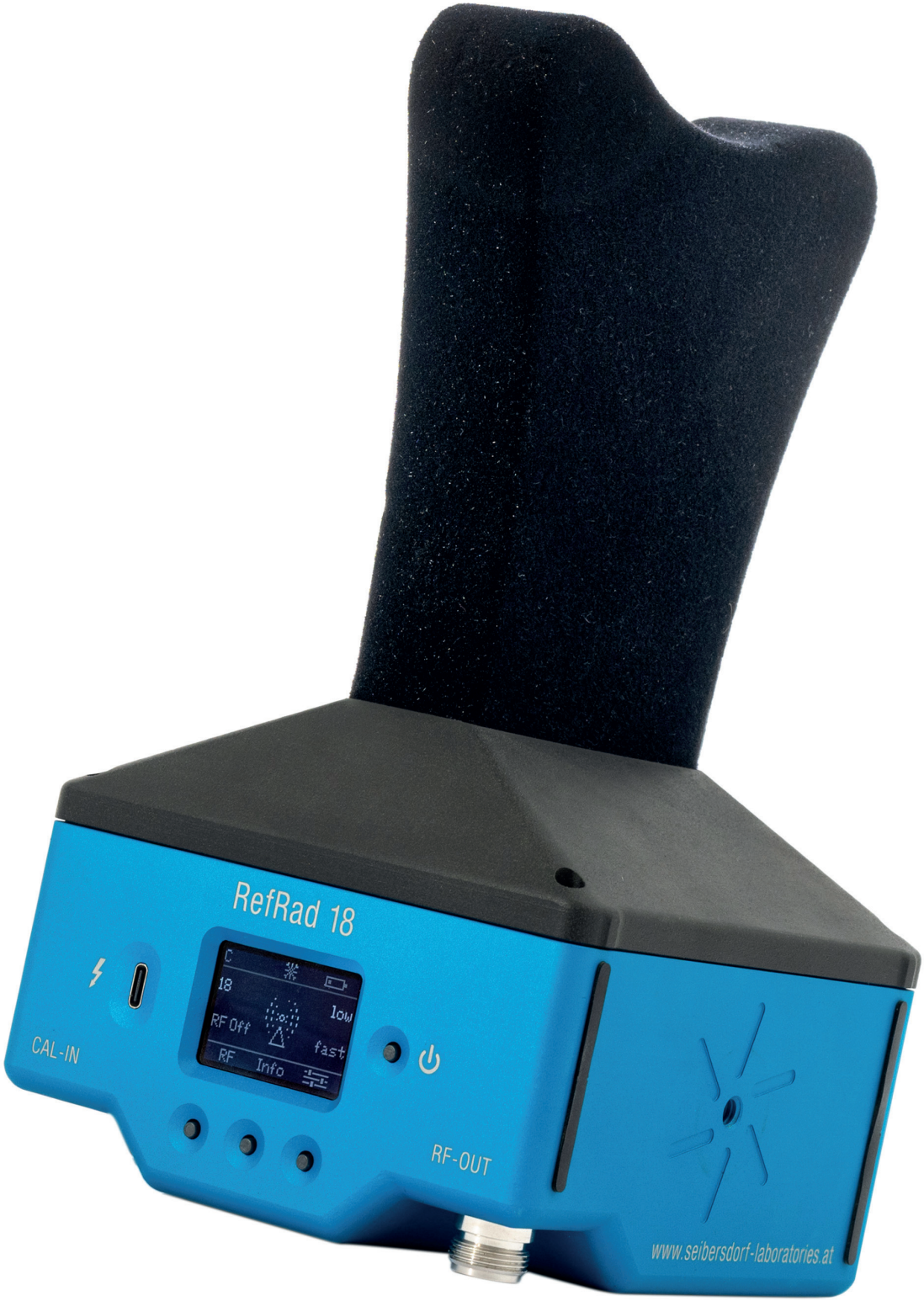

MANUAL

RefRad 18 - Reference Radiator Model 18

SEIBERSDORF LABORATORIES

MANUAL
RefRad 18

RefRad 18 – Reference Radiator

01.10.2025
Version 1.0

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1. INTRODUCTION

The RefRad 18 by Seibersdorf Laboratories is a next-generation reference radiator designed for radiated and conducted EMC and EMF testing in the frequency range of 1 GHz to 18 GHz. It supports measurement system verification, reduces the risk of costly re-testing, and ensures compliance with ISO/IEC 17025 requirements for equipment validation.

This compact, battery-powered generator features a **built-in directional antenna**, delivering:

- **High output power**
- **Two selectable field strength levels**
- **Flat frequency response**
- **Excellent frequency stability**

These attributes make the RefRad 18 a **reliable and flexible tool** for engineers conducting quality assurance in EMC test environments.

Background

Seibersdorf Laboratories has a long-standing tradition in developing reference radiators:

- **1990:** The original RefRad was introduced to validate EMC test sites using a wireless signal source.
- **2003:** RefRad 3000 extended the concept with a broader frequency range, enabling quick system checks of field strength measurements.
- **2007:** RefRad X integrated the comb generator into the antenna body, improved radiation symmetry, and introduced clock synchronization with EMI receivers for enhanced signal-to-noise ratio.
- **2023:** A modernized RefRad X added OLED display, increased battery life, and a frequency calibration feature with OCXO, eliminating the need for a fiber link.
- **2025:** RefRad 18 using a new principle für signal generation is introduced

About this Manual

This manual provides detailed instructions for using the RefRad 18 and its accessories in:

- **System checks with radiated fields**
- **Field strength transfer**
- **Shielding attenuation measurements**

It also includes technical specifications and radiation pattern data.

2. INSTALLATION AND OPERATION

ATTENTION!

Before using RefRad 18 please read this operating manual!

2.1. Handling

For maximum durability, please avoid carrying or lifting the RefRad 18 by its antenna. Use the handle instead. The handle is intended for safe removal from the transport case, placement back into the case, and for all routine handling.

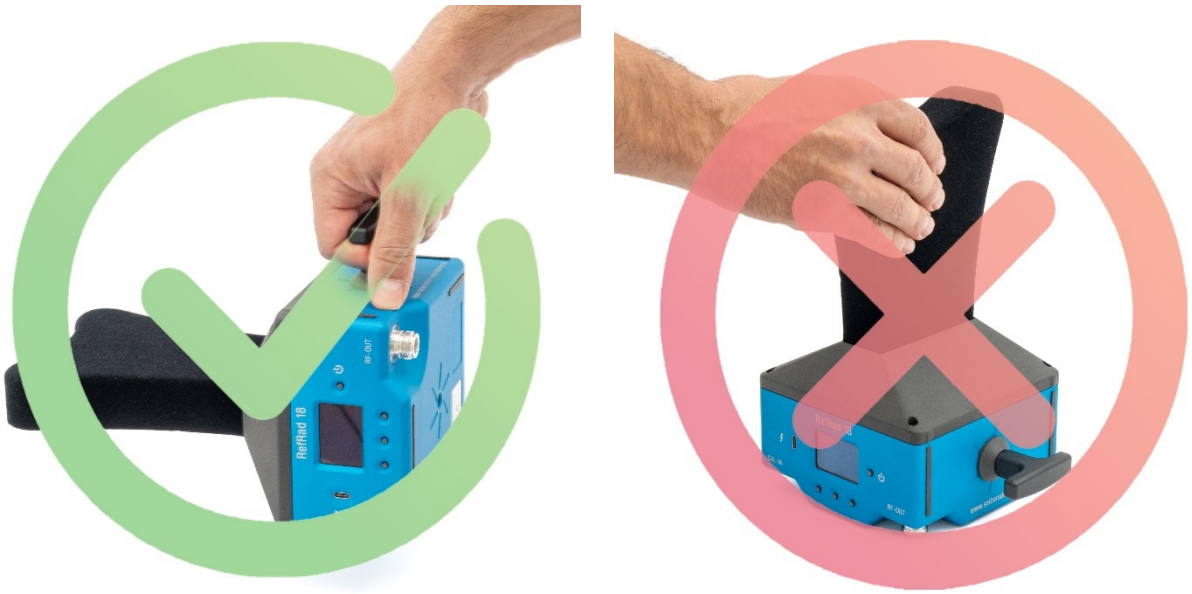

Figure 1: Handling

2.2. Contents of set

Table 1 shows the components of RefRad 18 set.

		RefRad 18
RefRad 18 Reference radiator		✓
Battery charger		✓
CAL cable		✓
Mounting rod		✓
Handle		✓
Transport case		✓
Software CalStan 11		**optional**

Table 1: Contents of RefRad 18

2.3. Placing into operation

2.3.1. Switching RefRad 18 On and Off

ON:

Press ON/OFF button for **1 sec.** until **"Seibersdorf Laboratories"** is indicated in the display.

Figure 2: ON/OFF symbol

The same settings that were used during the last measurement are automatically activated and displayed, except RF Output, which is always OFF when RefRad 18 is switched on. The display symbols are explained in **Figure 5**.

ATTENTION!

Consider the environment when operating RefRad 18 with the antenna as RF-Output to avoid any RF disturbances.

Make sure to use the antenna only in a properly shielded environment.

OFF:

The RefRad 18 can only be switched OFF from the main screen by pressing ON/OFF button for **3 sec.** until **"Goodbye!"** is indicated.

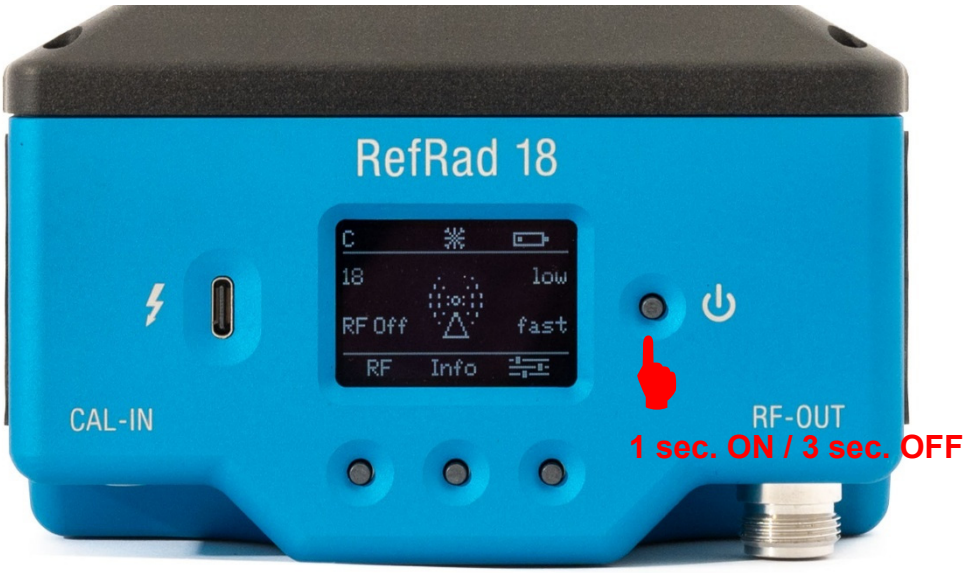

Figure 3: ON/OFF switching process

2.3.2. Display and symbols

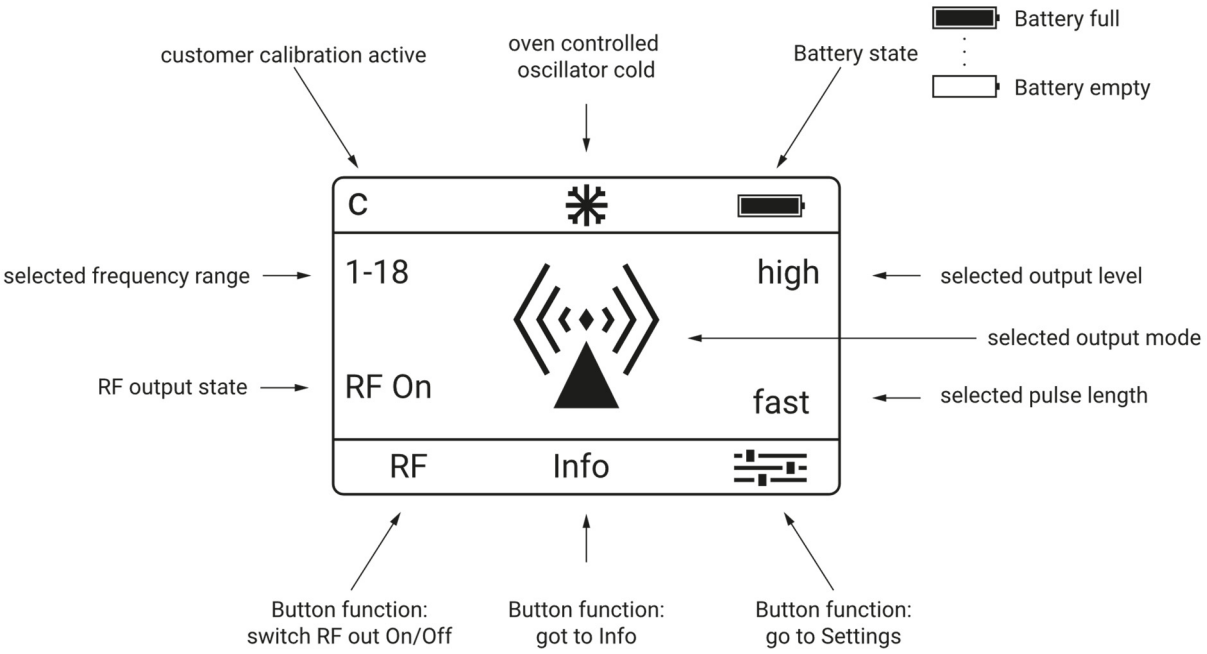

Figure 4: Display symbols

Symbol	Function
	Up
	Down
	Set - change
	Settings
	Oven cold
	Coax output OFF
	Coax output ON
	Radiated output OFF
	Radiated output ON
	Charging
	Charging finished

Figure 5: Symbol definition

2.3.3. RF ON/OFF

By Pressing the **RF** button, the RF output state is toggled between ON and OFF. When entering the Info or Settings menu RF output is set OFF.

2.3.4. Settings selection

By pressing the **Settings** button (⚌), the following parameters can be selected or modified:

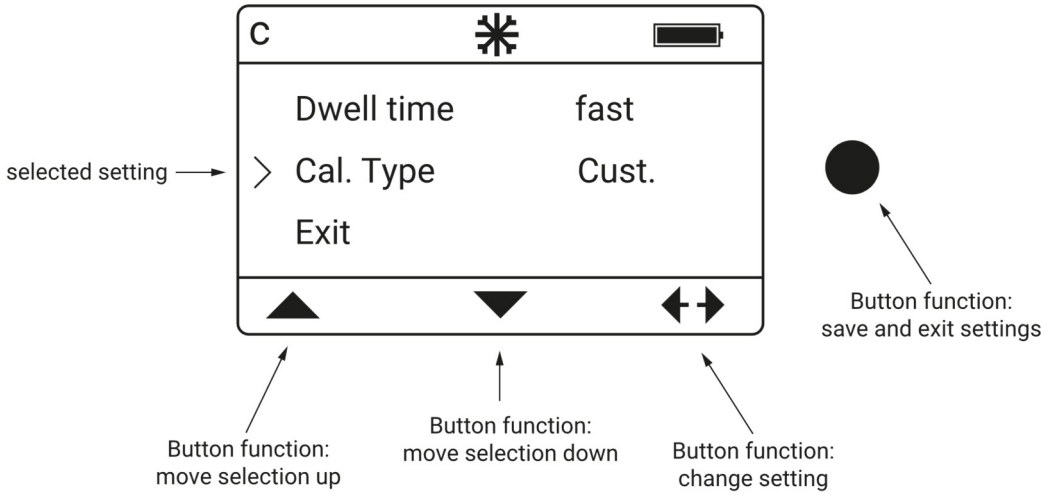

Figure 6: Setting selection

	Menue	Setting	
Frequency Range	F.Range 6 F.Range 18	1 – 6 GHz 1 – 18 GHz	
Dwell Time	slow fast	4 ms 500 µs	
Output Power		Coax:	Ant.
	OutPower low OutPower high	-25 dBm -10 dBm	77 – 85 dBµV/m 87 – 96 dBµV/m
Output Port	OutPort	Coax (conducted) Ant. (radiated)	
Calibration Type	Cal.Type	Cust. (Customer) Fact. (Factory)	

Table 2: Settings selection

2.3.5. Info screen

By pressing the **Info** button, you can view the frequency steps of the RefRad 18 and measurement settings of the spectrum analyzer, depending on the selected mode (slow or fast).

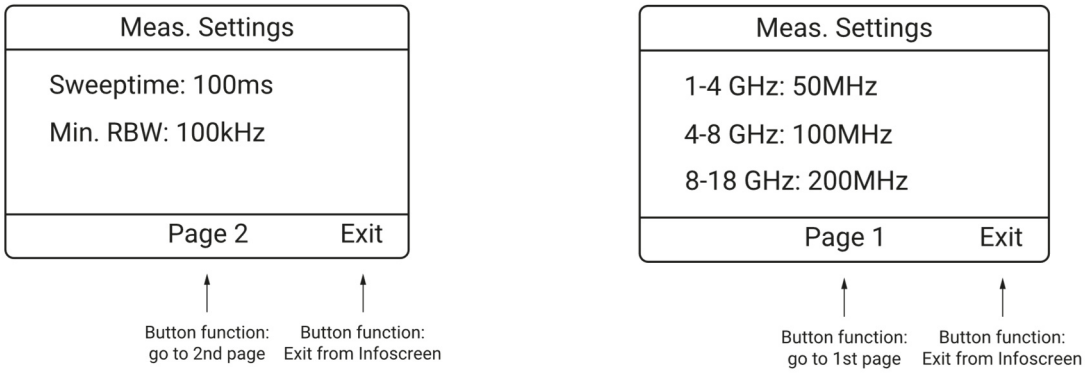

Figure 7: Info screen

2.4. Measurements with RefRad 18

2.4.1. Principle of signal generation

The RefRad 18 uses a different signal generation principle compared to classical comb generators. The required frequencies are generated sequentially instead of simultaneously. The first frequency is valid for a certain dwell time t, then the next frequency is generated for the same time, and so on. After the last frequency, the cycle starts with the first frequency again. The cycle time t_c is therefore calculated by multiplying the number of frequencies n by the dwell time t.

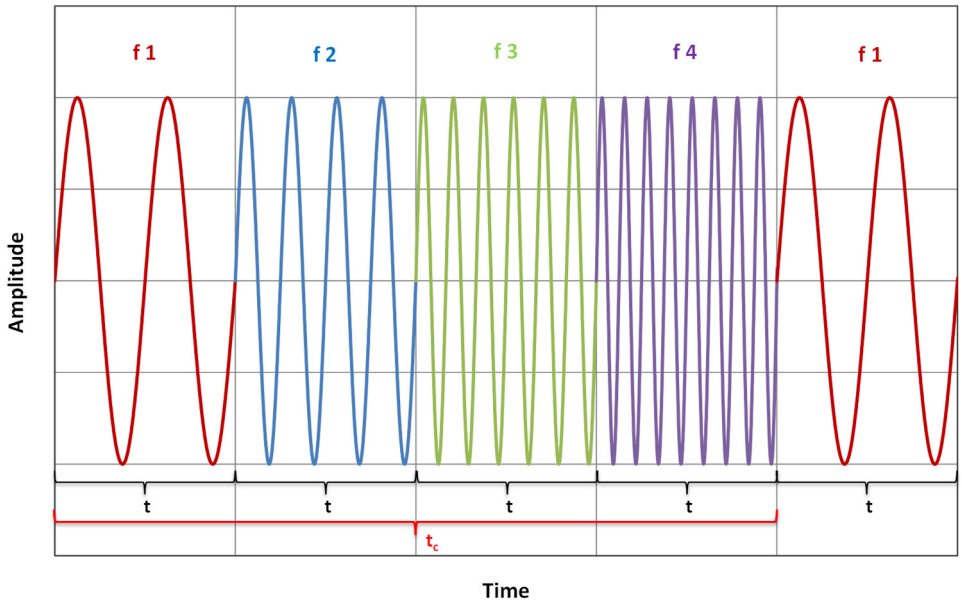

Figure 8: Signal generation principle in time domain for n = 4

The frequencies generated by RefRad 18 are shown in **Table 3** and the step size of the frequencies change over the frequency range for best performance.

Frequency range	Frequency steps
1 - 4 GHz	50 MHz
4 - 8 GHz	100 MHz
8 - 18 GHz	200 MHz

Table 3 Frequency steps of RefRad 18

2.4.2. Measuring with a spectrum analyzer

The spectrum analyzer must be set to **zero span** with a sweep time equal to or longer than the cycle time t_c, a proper RBW and **max hold detector**. The center frequency is set to the first measurement frequency: during the time t_c, all frequencies are generated sequentially and when the frequency matches the spectrum analyzer center frequency setting, the level is recorded and read by placing the marker on the peak, see **Figure 9**.
As the RefRad 18 generates signals sequentially, the spectrum analyzer in zero-span mode detects the harmonics of all other frequencies within t_c. These harmonics are always smaller than the intended signal whose amplitude is read out with peak search.

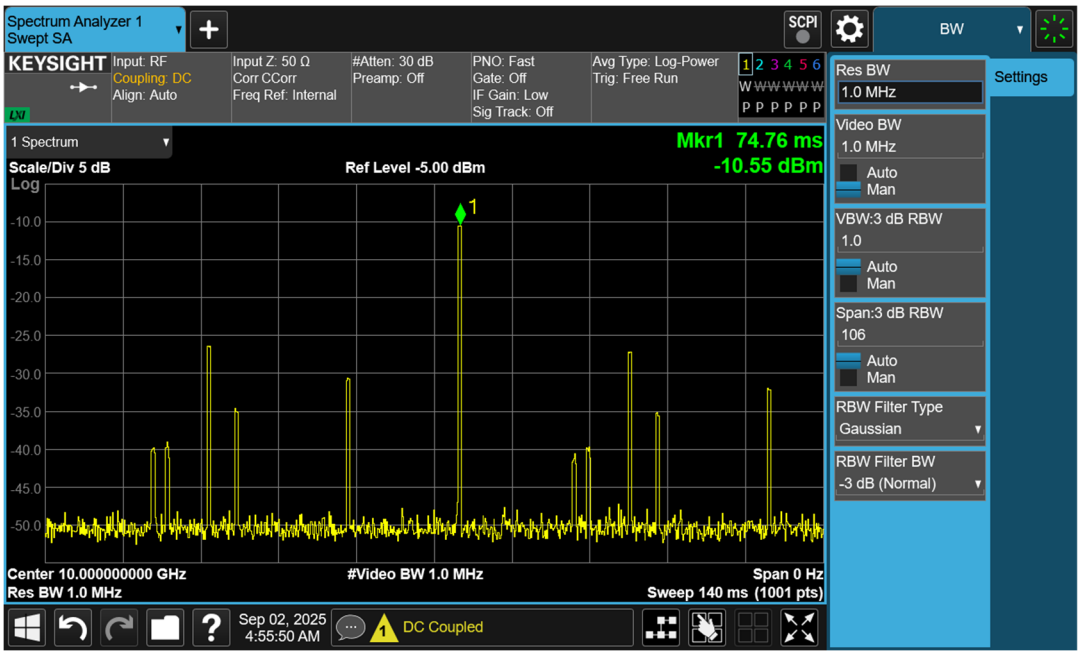

Figure 9: Spectrum analyzer plot, RefRad 18, zero span

When the measurement of the first frequency is complete, the spectrum analyzer is set to the next frequency. This is repeated until the last frequency is measured. The required measurement time t_M is calculated as n times t_c. Example calculations for different settings of the RefRad 18 are given in Table 4.

Frequency range	Number of frequencies	t	Min RBW	t_C	t_M
1 - 6 GHz	81	500 µs	4 kHz	40.5 ms	3.3 s
1 - 18 GHz	151	500 µs	4 kHz	75.5 ms	11.4 s
1 - 6 GHz	81	4 ms	500 Hz	324 ms	26.2 s
1 - 18 GHz	151	4 ms	500 Hz	604 ms	91.2 s

Table 4: Measurement time for different RefRad 18 settings

Dwell time settings of the RefRad 18
The RefRad 18 provides two selectable settings for the dwell time parameter t: 500 µs (fast) and 4 ms (slow) so that you can choose between fast or sensitive measurement, determined by the settling time of the resolution bandwidth (RBW) filter of the spectrum analyzer.

The following condition must be satisfied: $RBW\ [Hz] = \frac{2}{t\ [s]}$

Additional requirement: for precise measurements in zero span the frequency deviation between RefRad 18 and the spectrum analyzer needs to be considered by increasing the RBW by this deviation, see **Figure 10**. With regular Frequency Calibration (see **Section 0**) the RBW and measurement time can be kept low.

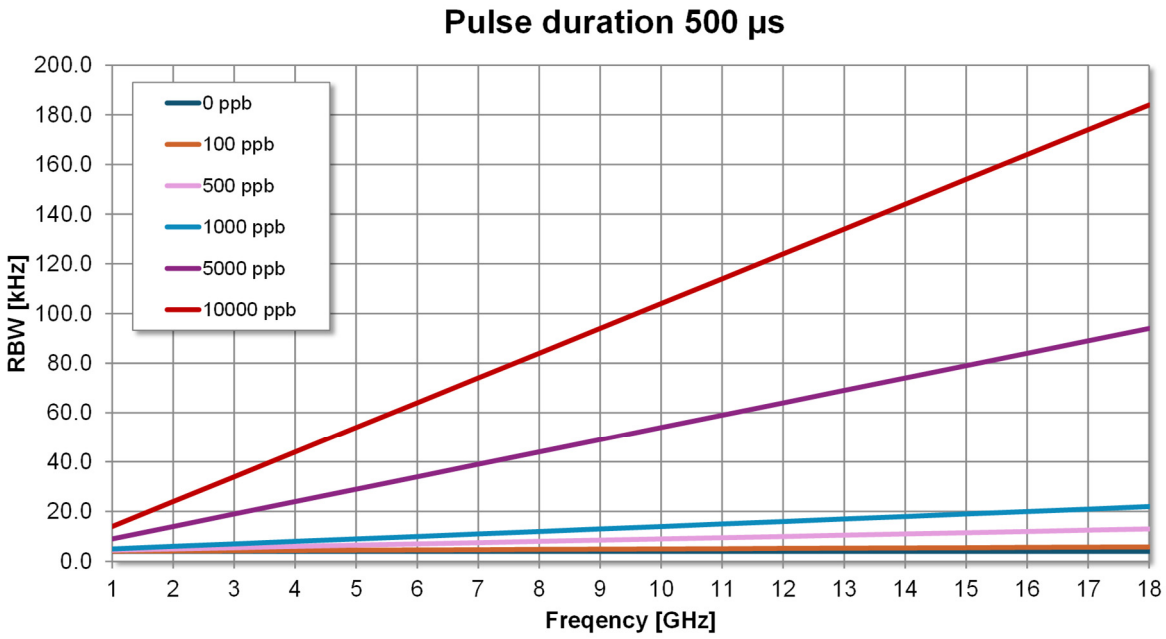

Figure 10: Minimum RBW for 500µs dwell time considering frequency deviation

Short dwell time measurements
When measuring with short dwell time, a larger RBW is required to meet this condition. While this allows for shorter measurement times, it also increases the noise floor measuring with 500 µs dwell time with an RBW below 4 kHz will lead to inaccurate amplitude readings.

Advantages for longer dwell time
In contrast, longer dwell time such as 4 ms permit the use of smaller RBW values - down to 500 Hz. A narrower RBW reduces the noise floor and enhances measurement sensitivity, albeit at the cost of longer measurement time. This is especially advantageous when a high dynamic range is needed, such as in shielding effectiveness measurements.

Measured frequencies
In some applications it is not necessary to measure all the frequencies that are generated by the RefRad 18. For example, in the frequency range 1 - 18 GHz, if results in 1 GHz steps are required, the measurement time is 19 times t_C which is equal to 0.8 s for 500 µs dwell time.

Measurement Software
Calstan 11 can be used for controlling the spectrum analyzer and collecting the data for further processing.

Attention!

Please note that stated time values are based on the signal generation and do not include the spectrum analysers processing time and time for data transfer. Therefore, a longer measurement time t_M will be observed in real measurements, depending on the instrument.

2.4.3. Measuring with an EMI receiver

An EMI receiver can also be used with the next generation reference radiator. In this case the frequency segment list must be set. The measurement time must be set to t_C and the peak detector selected, see **Figure 11**. The same Res BW considerations as for the spectrum analyzer measurement apply.

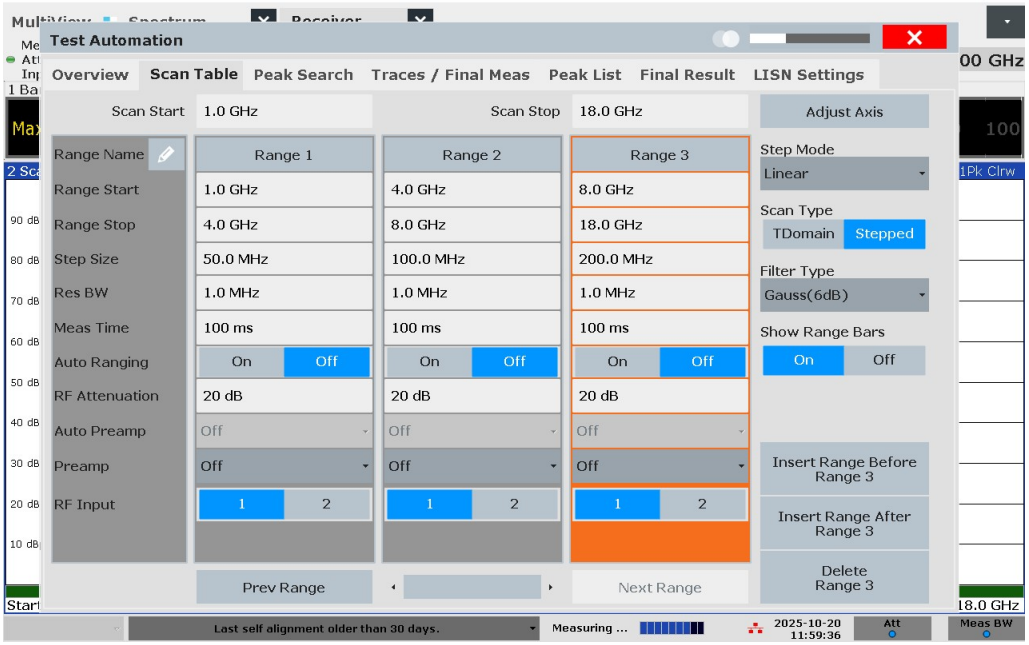

Figure 11: EMI receiver, segment definition, RefRad 18

When the measurement is complete, the trace (see **Figure 12**) can be read from the EMI receiver.

Figure 12: EMI receiver, measured trace, RefRad 18

Typical EMC measurement software can perform these measurements and download the trace data. Alternatively, Calstan 11 can be used.

2.5. Frequency calibration

The local oscillator (OCXO) of the RefRad 18 can be tuned to match the customers EMI receiver reference frequency to increase dynamic range and reduce measurement time.

The RefRad 18 offers two types of frequency calibration:

- Factory calibration
- Customer calibration

2.5.1. Factory calibration:

Factory calibration will be performed by the manufacturer using a very accurate 10 MHz reference source. Factory calibration is active, except customer calibration is set.

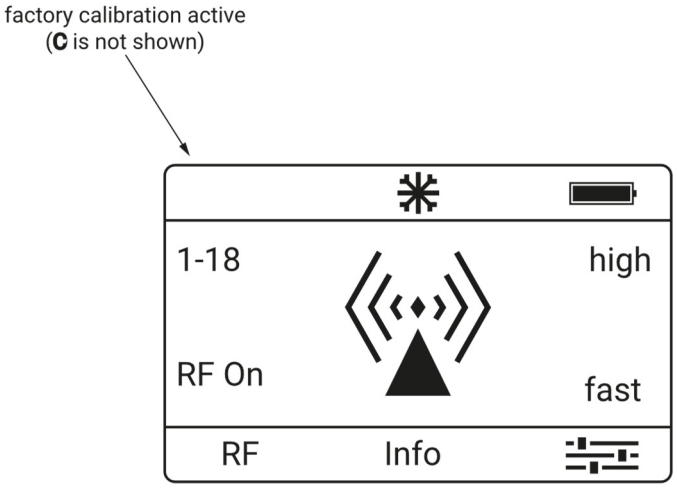

Figure 13: Active factory calibration

2.5.2. Customer calibration:

If necessary (e.g. shielding attenuation measurements), a customer calibration can be performed to match the RefRad 18 and the receiver/spectrum analyzer.

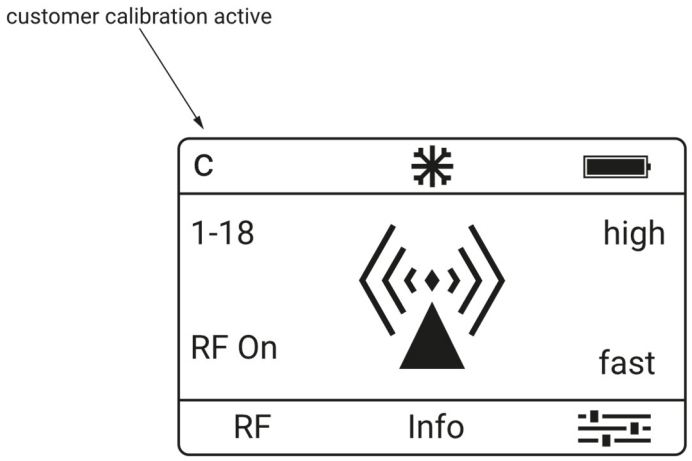

Figure 14: Active customer calibration

For best calibration accuracy, make sure that the instruments are stored and operated within their specified temperature ranges to reduce frequency drift.

- Fully charge the RefRad 18
- Switch on the RefRad 18 and receiver/spectrum analyzer and allow for proper warmup
- Connect the included CAL cable, see **Figure 15**
- After **15 min** warm up time frequency calibration starts automatically, **"Read value"** is indicated (counting down 100 sec.)
- The calibration is stored automatically and activated
- Press exit to get to main screen
- Active customer calibration will be indicated on the display "C", see **Figure 14**
- In case the customer calibration was not possible/succsessful **"Inv Ref.", "Cal Aborted!" or "Nr Step Fail"** is indicated and the previous customer calibration is still active.
- A successfully completed customer calibration replaces the previously saved calibration.

Error information:

- **Inv Ref.:** improper10 MHz reference signal, please check 10 MHz reference signal
- **Cal Aborted!:** calibration aborted by user (Exit button pressed), CAL cable disconnected during measurement
- **Nr Step Fail:** frequency calibration was not possible, please check battery state of the RefRad18, active 10 MHz source

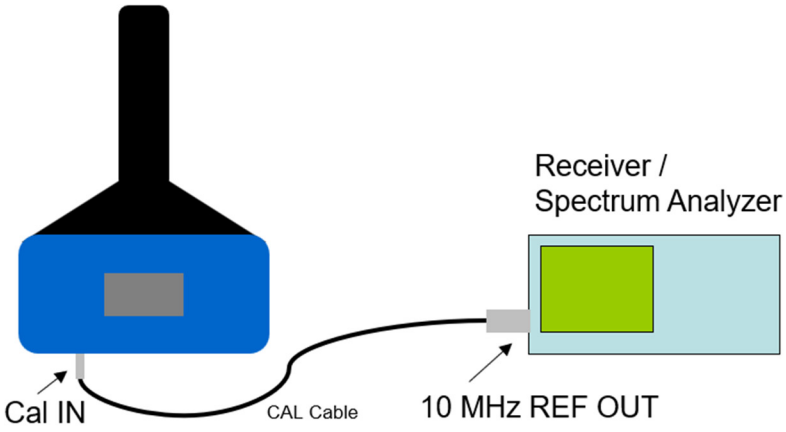

Figure 15: Schematic of the RefRad 18 customer calibration setup

Calibration routine:

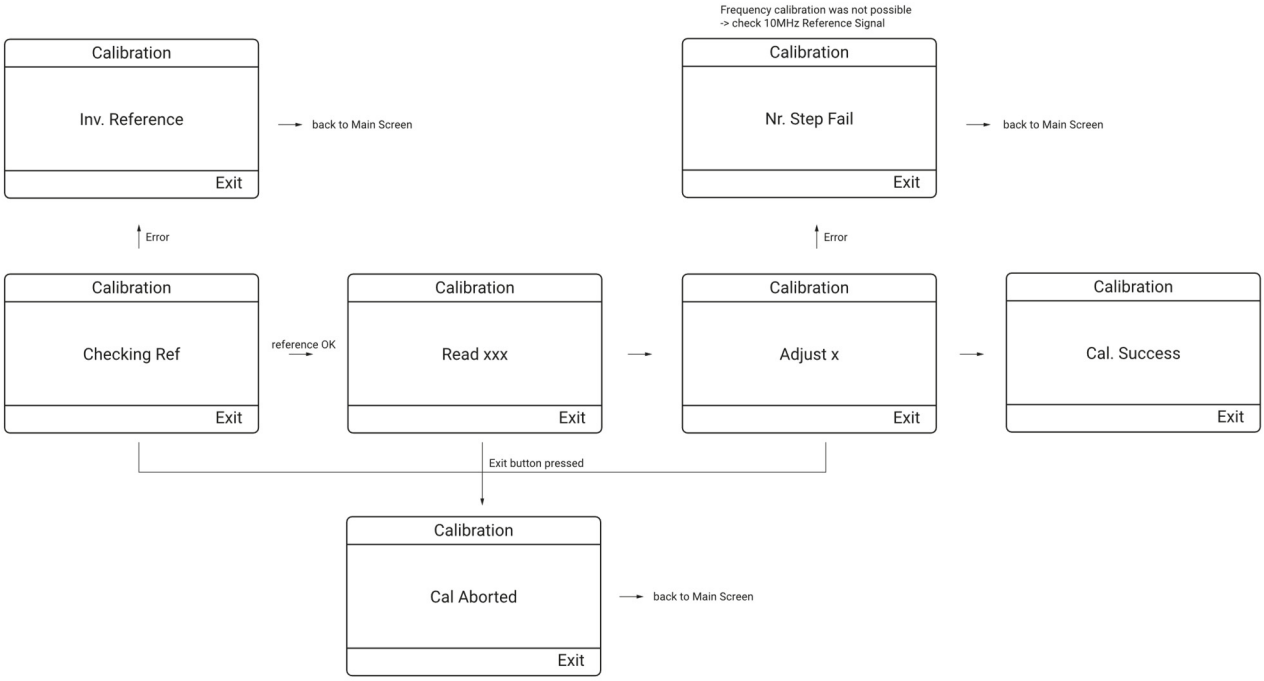

Figure 16: Flow chart calibration routine

Attention!

When the oscillator cold symbol is indicated, frequency calibration is not possible.

To guarantee a precise Frequency calibration, the receiver/spectrum Analyzer must be settled at operating temperature. Recommended warm up time is 30 minutes for modern instruments when the instrument was stored at room temperature.

3. TECHNICAL SPECIFICATIONS, COMPONENTS AND ACCESSORIES

3.1. RefRad 18

Figure 17: RefRad 18 front view

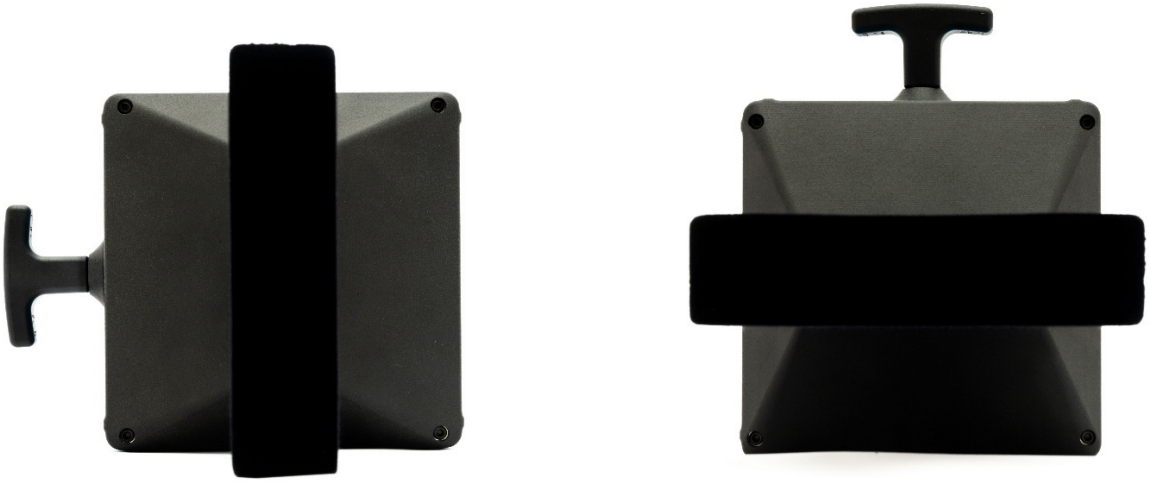

Figure 18: RefRad 18 in vertical polarization (left) and horizontal polarization (right)

3.1.1. Technical specifications

Technical Specifications	
Frequency range	1 – 18 GHz
Frequency steps	1 - 4 GHz 50 MHz 4 – 8 GHz 100 MHz 8 – 18 GHz 200 MHz
Frequency stability after 15min. warm up time	± 20 ppb over temp. range ± 500 ppb max./ year
Amplitude per line (coaxial)	Figure 19
Field strength	Figure 20
Radiation pattern	Figure 21
Amplitude stability	± 0.1 dB, temperature range 15 - 35°C
Frequency Calibration Signal (CAL IN)	Level range: +10 dBm / -10 dBm Waveform: Sine or Square Frequency: 10 MHz ± 25 Hz
Batteries	internal Li-Ion, 62.64Wh (factory serviceable only)
Battery operation time	> 6 hours
Charging time	~ 3 hours
RF-output connector	N-female
Tripod thread	2 x ¼" UNC20 (Handle or tripod) 1 x ⅜" UNC20 (Mounting-Rod)
Climatic operation conditions	Temperature: 15 – 35 °C Humidity: 30 – 80% avoid high humidity and rain
Dimensions of RefRad 18	135 x 135 x 245 mm
Weight of RefRad 18	1.6 kg

Table 5: Technical specifications of RefRad 18

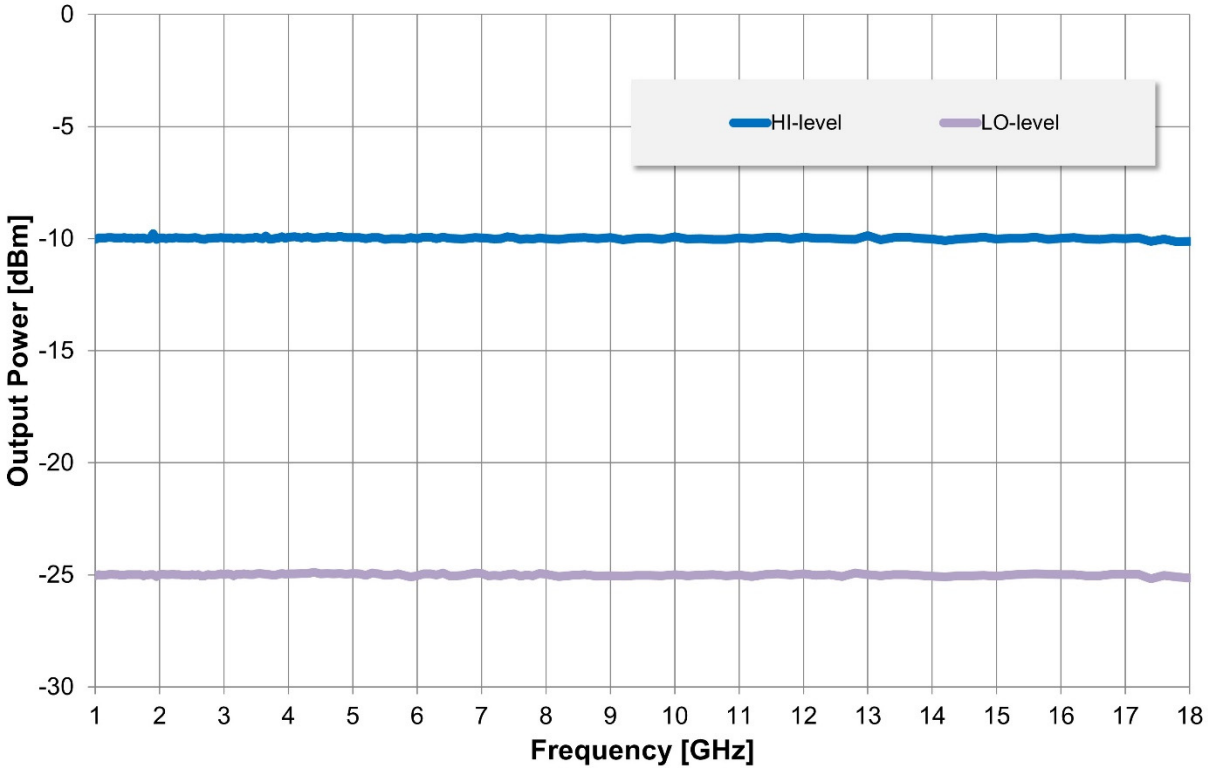

Figure 19: Typical coaxial output power

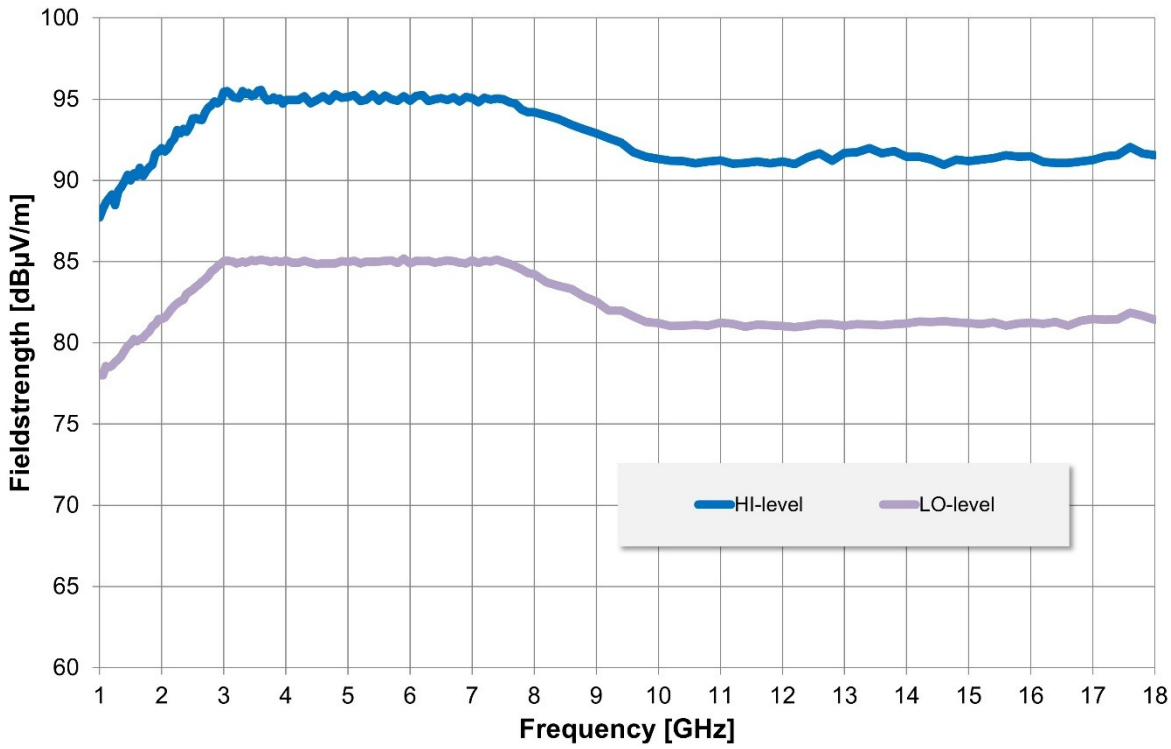

Figure 20: Typical fieldstrength, vertical polarisation at 3m test distance

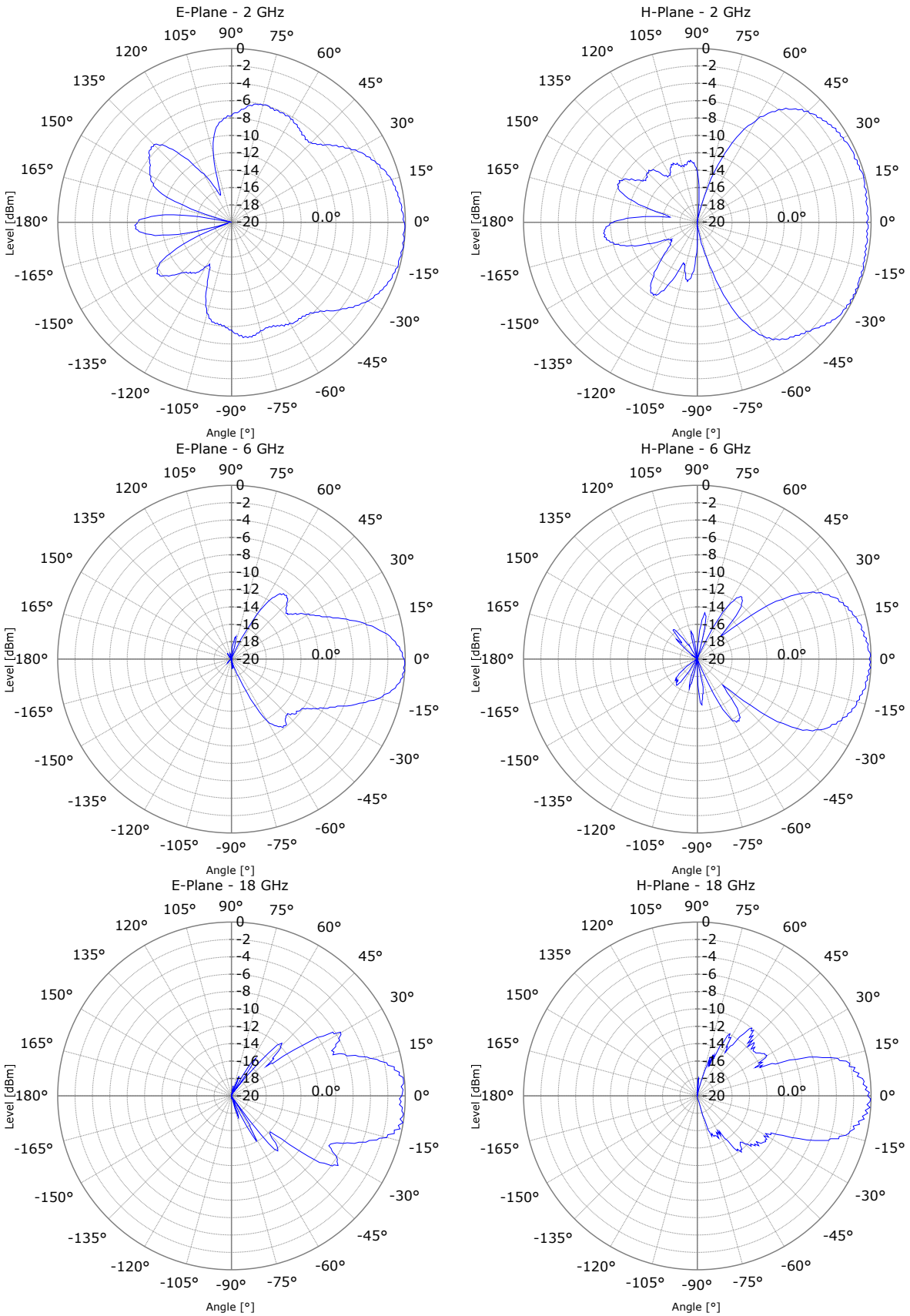

Figure 21: Typical radiation pattern in E- and H- plane

3.2. Mounting-Rod

Figure 22: Mounting-Rod

The Mounting-Rod (**Figure 22**) is used for mounting the RefRad 18 onto antenna stands with 22 mm diameter adapters. **Figure 23** shows the proper mounting.

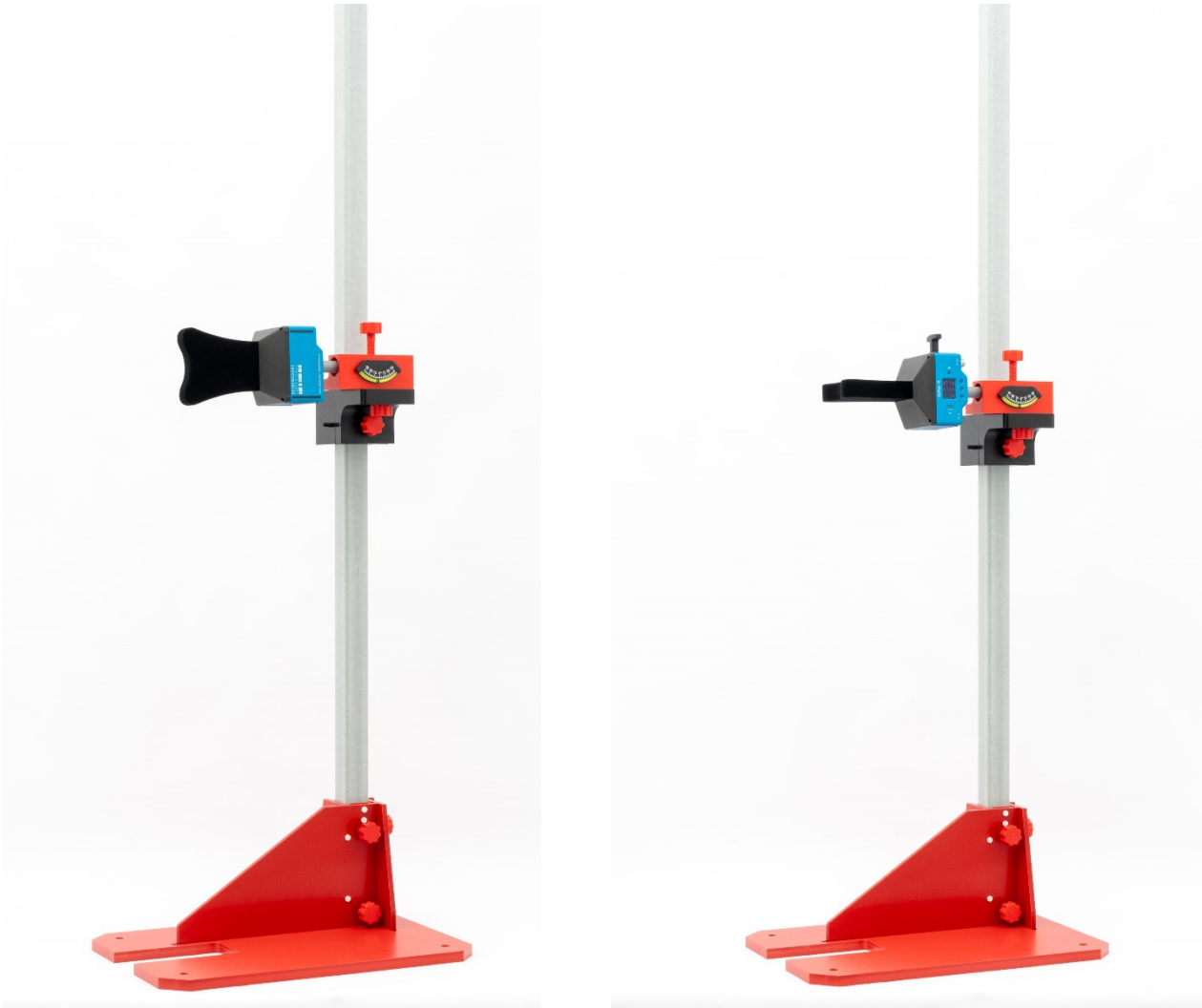

Figure 23: Mounting the RefRad 18 in vertical (left) and horizontal (right) polarization

Technical Specifications	
Material	Aluminium
Dimensions	200 x 22 mm
External thread	⅜” UNC20
Weight	200 g

Table 6: Technical specifications of the Mounting-Rod

3.3. Handle

Only use the handle to lift and carry the RefRad 18. The handle is specifically designed for removing the RefRad 18 from the transport case, returning it to the case, and for general handling.
The handle is screwed on and can be unscrewed, as shown in **Figure 25**

Important: Do not carry, lift, or handle the RefRad 18 by its antenna, as this may damage the instrument.

Figure 24: Handle

Figure 25: Handle installation

Technical Specifications	
Material	Glass fiber reinforced polyamide (PA) thermoplastic, stainless steel
Dimensions	200 x 22 mm
External thread	¼" UNC20
Weight	40 g

Table 7: Technical specifications of the Handle

3.4. Battery Charger

Figure 26: Battery Charger

The built-in batteries of the RefRad 18 are charged with the enclosed Anker Nano 523 Battery Charger. Due to the switch mode power supply and the Anker Nano universal adapter, worldwide use is possible. Please follow the instructions of the enclosed original manual of the charger.

Technical Specifications	
Input	100 - 240 V AC @ 50 - 60 Hz
Connection on the primary side	Euro
Connection on the secondary side	USB-C
Output	5 – 20 V DC, max 47W
Dimensions	88 x 35 x 35 mm
Weight	100 g

Table 8: Technical specifications of the Battery Charger

Attention!

- ONLY USE THE SUPPLIED CHARGER
- INDOOR USE ONLY
- DO NOT USE CHARGER WITH DAMAGED CORD OR PLUG

3.5. Transport Case

Figure 27: Transport Case with RefRad 18 and accessories

Figure 28: Lift out the RefRad 18 by Handle

Technical Specifications	
Dimensions of transport case	52 x 44 x 23 cm
Weight of empty case	5.3 kg
Weight of complete set	7.4 kg

Table 9: Technical specifications of the Transport Case

3.6. Software CalStan 11

CalStan 11 is a software tool for automation of radio frequency (RF) calibrations and measurements. The software controls the instruments via GPIB, USB or LAN, reads the measurement values and computes the results. The purpose of the software is to perform calibrations of test equipment and validations of test setups, such as antennas, cables, EMC test sites, setup tables, etc.

Check at https://rf.seibersdorf-laboratories.at/products-services/products/calstan for the latest version and free demo.

Technical Specifications	
CalStan modules	Site VSWR Measurement NSA Measurement in semi anechoic chambers NSA Measurement in fully anechoic chambers NSIL module Cable Loss Experimental Measurement
Operating systems	Windows 11
Additional hardware	National Instruments GPIB card or GPIB-USB-HS interface LAN interface, USB interface
Installed software	.NET framework version 4.8 (or higher) [1] National Instruments Runtime v18.5 [2] (or higher)

Table 10: Technical specifications of the software CalStan 11

[1] The .NET framework can be downloaded from https://dotnet.microsoft.com/download/dotnet-framework/net48

[2] National Instruments Runtime is usually shipped with the GPIB card.

4. APPLICATIONS

Application	Description
System Check Radiated	**Procedure:** the well-defined field generated by the **RefRad 18** is measured with the EMC/EMF measurement system. This measurement is done once with a well-checked setup as reference, and it is repeated before each measurement campaign. A comparison between the reference and the actual system check ensures the quality of the results. **Advantages:** • convenient detection of defects in the receiving system • suitable for all antennas **Considerations:** • influenced by the test environment (EMF) • influenced by the EUT (EMC) • positioning can be critical
System Check Conducted	**Procedure:** the stable coaxial output signal of **RefRad 18** is measured with the EMC/EMF Receiver. This measurement is done once with a well-checked setup as reference, and it is repeated before each measurement campaign. A comparison between the reference and the actual system check ensures the quality of the results. **Advantages:** • convenient detection of defects in the receiving system • suitable for identifying problems when the radiated system check shows a deviation
Cable Loss measurement	**Procedure:** the stable coaxial output signal of **RefRad 18** is measured with the EMC/EMF Receiver a) using a short cable b) using the cable under calibration and the short cable. The difference between the 2 measurements represents the cable loss. **Advantages:** • convenient for cables that are installed
Shielding Attenuation Measurement	**Procedure:** the **RefRad 18** is used as signal generator and transmit antenna to investigate the shielding attenuation of enclosures. **Advantages:** • high output power guarantees a good signal-to-noise ratio
Proficiency Test	**Procedure:** The **RefRad 18** can be used as a stable, broadband reference source for electromagnetic compatibility (EMC) proficiency tests (inter-laboratory comparisons) It supports the assessment of measurement competence and comparability of EMC laboratories in accordance with ISO/IEC 17025.

5. LITERATURE AND INFORMATION

[1] CISPR 16-2-3, “Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-3: Methods of measurement of disturbances and immunity - Radiated disturbance measurements”

[2] ISO 17025, “General requirements for the competence of testing and calibration laboratories”

[3] Alexander Kriz: “A Novel Approach for a Reference Radiator in Frequency Range above 1 GHz“, EMC Europe 2025, 1. – 5. September 2025, Paris, France

[4] CalStan 11 Manual, https://rf.seibersdorf-laboratories.at/products-services/products/calstan

ANNEX I. WARRANTY

Seibersdorf Labor GmbH, hereinafter referred to as the Seller, warrants that standard Seibersdorf Laboratories products are free from defect in materials and workmanship for a period of two (2) years from the date of shipment.

Standard Seibersdorf Laboratories products include the following:

- Antennas
- Cables
- Reference Radiators
- Software
- Antenna stands and positioners

If the Buyer notifies the Seller of a defect within the warranty period, the Seller will, at the Seller's option, either repair and/or replace products which prove to be defective during the warranty period.
There will be no charge for warranty services performed at the location the Seller designates. The Buyer must, however, prepay inbound shipping costs and any duties or taxes. The Seller will pay outbound shipping cost for a carrier of the Seller's choice, exclusive of any duties or taxes.

This warranty does not apply to:

- Normal wear and tear of materials
- Consumable items such as fuses, batteries, etc.
- Products that have been improperly installed, maintained or used
- Products which have been operated outside the specifications
- Products which have been modified without authorization
- Calibration of products, unless necessitated by defects

THIS WARRANTY IS EXCLUSIVE. NO OTHER WARRANTY, WRITTEN OR ORAL, IS EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE REMEDIES PROVIDED BY THIS WARRANTY ARE THE BUYER'S SOLE AND EXCLUSIVE REMEDIES. IN NO EVENT IS THE SELLER LIABLE FOR ANY DAMAGES WHATSOEVER, INCLUDING BUT NOT LIMITED TO, DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, OR ANY OTHER LEGAL THEORY.

ANNEX II. BATTERY INFORMATION

The RefRad 18 contains a rechargeable Lithium -ion battery pack (62.64Wh).
Anode: Intercalation graphite
Cathode: Lithiated metal oxide (Cobalt, Nickel, Manganese)
Electrolyte**:** Organic carbonate, Lithium hexafluorophosphate

Safety Instructions:

- Do not open, disassemble, crush, or pierce the battery.
- Do not expose the device to fire, high temperatures, or water.
- Only charge the battery using the supplied charger or power adapter.
- Do not short-circuit the battery terminals
- If the device shows signs of battery damage (swelling, leakage, unusual heat), stop using it immediately and contact authorized service.
- Keep away from open flames, hot surfaces, and sources of ignition.
- Storage at room temperature (approx. 20°C) at approx. 20~60% of the nominal capacity. Do not store close to the heating. Avoid direct sunlight.

In the European Union, manufacturing, handling and disposal of batteries is regulated on the basis of the REGULATION (EU) 2023/1542 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 12 July 2023.
Customers find detailed information on disposal in their specific countries using the web site of the European Portable Batteries Association (https://www.epbaeurope.net).

Users outside EU should consider the local law and rules.

Battery should not be disposed in household waste. Please avoid short circuit or damage and contact disposal expert for suitable disposal.

Figure 29: WEEE symbol (Waste Electrical and Electronic Equipment)

ANNEX III. SHIPMENT INFORMATION

This product contains a lithium-ion battery (62.64 Wh). For transport, the product is classified as UN3481: Lithium-ion batteries contained in equipment.

Figure 30: UN3481 lithium battery handling label (min. dimensions 10 x 10cm)

Note:
The UN3481 label must be attached to the transport packaging in accordance with applicable regulation.

- Maximum 30% state of charge
- Do not transport damaged or defective batteries
- Use the original packaging or equivalent protective packing material
- Avoid exposure to high temperatures, moisture, or direct sunlight during transport and storage

The information provided in this chapter was valid at the time of manual creation. Users should verify any updates to regulations before transport.

ANNEX IV. Sample Certificate

A sample calibration certificate of the RefRad18 is given on the following pages.

SEIBERSDORF LABORATORIES

Kalibrierstelle für Antennen und Feldsonden
Calibration Body for Antennas and Field Probes

Akkreditiert durch / *accredited by*
AKKREDITIERUNG AUSTRIA

Kalibrierschein nach ISO/IEC 17025
Calibration Certificate according to ISO/IEC 17025

Kalibrierzeichen
Calibration mark

EH-AXXX/XX
0612

Gegenstand
Object
Reference Radiator

Hersteller & Typ
Manufacturer & Type
Seibersdorf Laboratories RefRad 18

Herstellernummer
Serial number

Auftraggeber
Customer

Auftragsnummer
Order Nr.

Anzahl der Seiten des Kalibrierscheines
Number of pages of the certificate
1 - 4

Datum und Ort der Kalibrierung
Date and place of calibration

Akkreditierung Austria ist Vollmitglied bei der International Laboratory Accreditation Cooperation ILAC und Unterzeichner der MRAs für die Bereiche „Testing, Calibration and Inspection".

Die Kalibrierung erfolgt auf der gesetzlichen Grundlage des Akkreditierungsgesetzes in gültiger Fassung entsprechend den Anforderungen der ÖVE/ÖNORM EN ISO/IEC 17025.

Dieser Kalibrierschein dokumentiert die Rückführbarkeit auf nationale Normale zur Darstellung der physikalischen Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI).

Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.

Akkreditierung Austria is a full member of the International Laboratory Accreditation Cooperation ILAC and a signatory of the MRA for "Testing, Calibration and Inspection".

The calibration is performed in accordance with the Akkreditierungsgesetz in the amended version and the requirements of ÖVE/ÖNORM EN ISO/IEC 17025.

This calibration certificate documents the traceability to national standards, which realize the physical units or measurements according to the International System of Units (SI).

The user is obliged to have the object recalibrated at appropriate intervals.

Dieser Kalibrierschein gilt ausschließlich für den kalibrierten Gegenstand und darf nur vollständig und unverändert weiterverarbeitet werden. Auszüge oder Änderungen sind unzulässig. Kalibrierscheine ohne Unterschrift haben keine Gültigkeit.

This calibration certificate is valid only for the calibrated object and may not be reproduced other than in full. Calibration certificates without signature are not valid.

Datum *Date*	Zeichnungsberechtigter *Authorized person*	Bearbeiter *Person responsible*
	_____	_____

Seibersdorf Labor GmbH | 2444 Seibersdorf, Austria | Tel.: +43 50550 2500 | office@seibersdorf-laboratories.at | www.seibersdorf-laboratories.at
Managing Director: Dr. Markus Neumann | Regional court Wiener Neustadt | Company no: 319187v | VAT: ATU64767504 | Tax no: 192/6571
Certified according to ISO 9001 | Bank details: Erste Bank der Österreichischen Sparkassen AG | IBAN AT112011129114038000 | BIC GIBAATWW

Calibration Procedure

Calibration of the **coaxial output level (P)** is carried out according to the method described in internal process guideline LE-EH-VA-L03 (2022-06) using a spectrum analyser.
A calibrated protective attenuator is used to avoid input overload. The frequency resolution of the measurement is chosen to match the selected comb spectrum.

Test Equipment

Type	**Identification**
Keysight N9010B	LE0212
Cable with Attenuator	LE0275
CalStan 11	E0921

Environmental Conditions

Site Temperature	20°C - 27°C
Site Humidity	30% - 80%

Results

Type	**Description**	**Fig./Table**
Level	1GHz-18GHz	1

Accuracy of Calibration

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k = 2$, which for a normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with EAL Publication EA 4/02.

References

[1] EA-4/02 M: 2022 Evaluation of the Uncertainty of Measurement in calibration

Figure 1: Level; 1GHz-18GHz

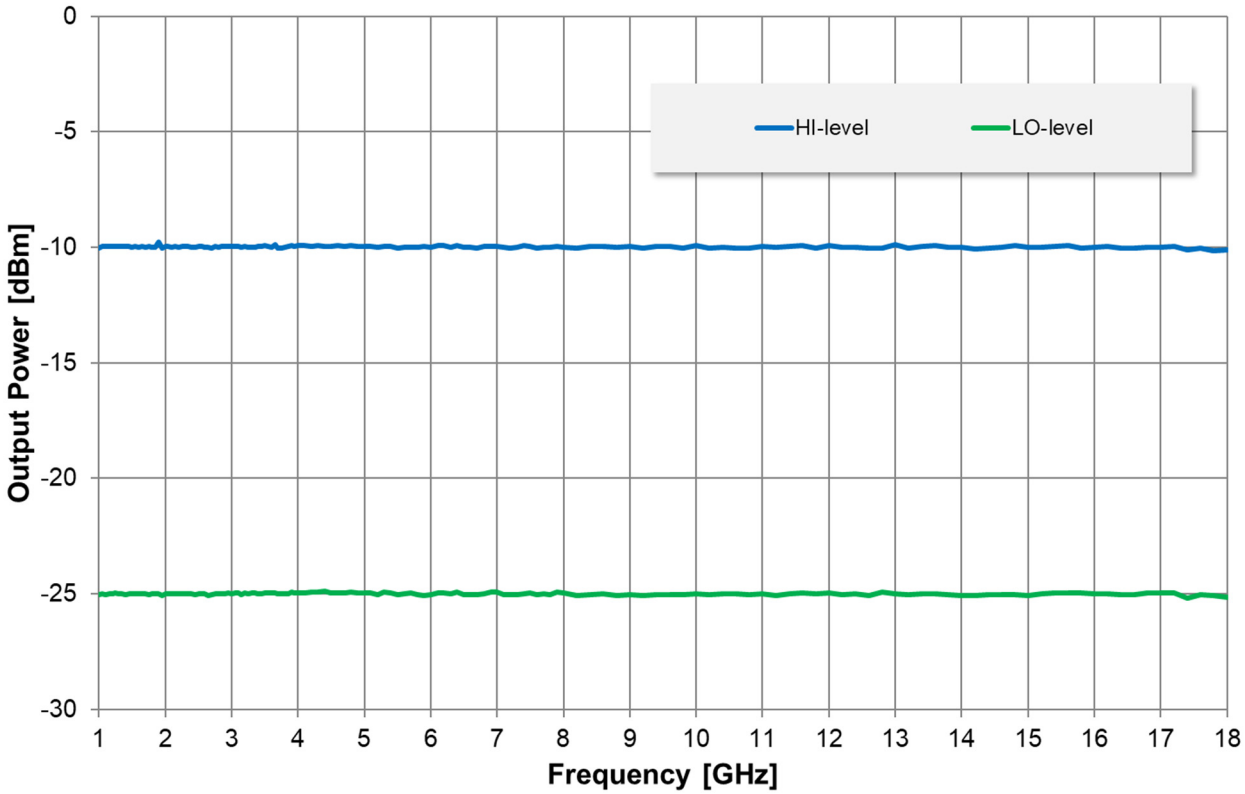

Table 1: Level; 1GHz-18GHz

f [GHz]	P HI [dBm]	P LO [dBm]	U [dB]	f [GHz]	P HI [dBm]	P LO [dBm]	U [dB]	f [GHz]	P HI [dBm]	P LO [dBm]	U [dB]
1	-10.03	-25.03	±1.50	2.4	-9.98	-25.00	±1.50	3.8	-9.99	-25.00	±1.50
1.05	-9.97	-24.98	±1.50	2.45	-9.99	-25.03	±1.50	3.85	-9.97	-24.98	±1.50
1.1	-9.96	-25.02	±1.50	2.5	-9.96	-24.99	±1.50	3.9	-9.91	-24.93	±1.50
1.15	-9.96	-25.01	±1.50	2.55	-9.94	-25.00	±1.50	3.95	-9.98	-24.97	±1.50
1.2	-9.94	-25.00	±1.50	2.6	-9.99	-24.99	±1.50	4	-9.93	-24.95	±1.50
1.25	-9.95	-24.97	±1.50	2.65	-10.01	-25.06	±1.50	4.1	-9.92	-24.96	±1.50
1.3	-9.96	-24.99	±1.50	2.7	-10.03	-25.04	±1.50	4.2	-9.97	-24.93	±1.50
1.35	-9.96	-24.99	±1.50	2.75	-9.98	-25.00	±1.50	4.3	-9.92	-24.93	±1.50
1.4	-9.96	-25.02	±1.50	2.8	-9.98	-25.00	±1.50	4.4	-9.98	-24.89	±1.50
1.45	-9.95	-25.00	±1.50	2.85	-9.96	-25.01	±1.50	4.5	-9.94	-24.96	±1.50
1.5	-9.98	-24.99	±1.50	2.9	-9.96	-24.99	±1.50	4.6	-9.91	-24.94	±1.50
1.55	-9.97	-24.98	±1.50	2.95	-9.95	-24.96	±1.50	4.7	-9.94	-24.95	±1.50
1.6	-10.00	-24.99	±1.50	3	-9.97	-24.98	±1.50	4.8	-9.91	-24.94	±1.50
1.65	-9.98	-25.00	±1.50	3.05	-9.97	-24.95	±1.50	4.9	-9.95	-24.96	±1.50
1.7	-9.98	-24.99	±1.50	3.1	-9.96	-24.98	±1.50	5	-9.95	-24.94	±1.50
1.75	-9.97	-25.04	±1.50	3.15	-10.00	-25.04	±1.50	5.1	-9.95	-24.95	±1.50
1.8	-10.01	-25.01	±1.50	3.2	-9.97	-24.97	±1.50	5.2	-10.00	-25.03	±1.50
1.85	-9.99	-24.99	±1.50	3.25	-9.98	-24.99	±1.50	5.3	-9.94	-24.93	±1.50
1.9	-9.78	-25.00	±1.50	3.3	-10.00	-24.95	±1.50	5.4	-9.96	-24.95	±1.50
1.95	-10.04	-25.07	±1.50	3.35	-9.98	-24.97	±1.50	5.5	-10.04	-25.02	±1.50
2	-9.97	-24.99	±1.50	3.4	-9.97	-24.99	±1.50	5.6	-9.99	-25.01	±1.50
2.05	-9.96	-24.98	±1.50	3.45	-9.97	-24.98	±1.50	5.7	-10.01	-24.96	±1.50
2.1	-9.99	-24.99	±1.50	3.5	-9.93	-24.96	±1.50	5.8	-10.01	-25.02	±1.50
2.15	-9.97	-24.98	±1.50	3.55	-9.98	-24.94	±1.50	5.9	-9.95	-25.08	±1.50
2.2	-9.99	-24.98	±1.50	3.6	-10.00	-24.95	±1.50	6	-9.99	-25.04	±1.50
2.25	-9.94	-24.99	±1.50	3.65	-9.89	-24.97	±1.50	6.1	-9.94	-24.96	±1.50
2.3	-9.97	-24.98	±1.50	3.7	-10.02	-25.00	±1.50	6.2	-9.94	-24.95	±1.50
2.35	-9.97	-25.01	±1.50	3.75	-10.02	-25.01	±1.50	6.3	-10.00	-25.00	±1.50

f [GHz]	P HI [dBm]	P LO [dBm]	U [dB]	f [GHz]	P HI [dBm]	P LO [dBm]	U [dB]	f [GHz]	P HI [dBm]	P LO [dBm]	U [dB]
6.4	-9.93	-24.91	±1.50	9.4	-9.98	-25.02	±1.50	14	-10.01	-25.06	±1.50
6.5	-9.99	-25.04	±1.50	9.6	-9.96	-25.03	±1.50	14.2	-10.09	-25.08	±1.50
6.6	-9.99	-25.03	±1.50	9.8	-10.03	-25.04	±1.50	14.4	-10.02	-25.03	±1.50
6.7	-10.02	-25.02	±1.50	10	-9.92	-24.99	±1.50	14.6	-9.99	-25.03	±1.50
6.8	-9.98	-24.98	±1.50	10.2	-10.02	-25.04	±1.50	14.8	-9.93	-25.02	±1.50
6.9	-9.96	-24.92	±1.50	10.4	-10.01	-25.01	±1.50	15	-10.01	-25.05	±1.50
7	-9.97	-24.93	±1.50	10.6	-10.04	-24.99	±1.50	15.2	-9.99	-25.00	±1.50
7.1	-9.99	-25.04	±1.50	10.8	-10.03	-25.04	±1.50	15.4	-9.98	-24.97	±1.50
7.2	-10.02	-25.03	±1.50	11	-9.97	-25.01	±1.50	15.6	-9.94	-24.96	±1.50
7.3	-10.01	-25.04	±1.50	11.2	-10.00	-25.08	±1.50	15.8	-10.03	-24.97	±1.50
7.4	-9.91	-24.98	±1.50	11.4	-9.96	-24.99	±1.50	16	-9.98	-24.99	±1.50
7.5	-9.96	-24.95	±1.50	11.6	-9.92	-24.96	±1.50	16.2	-9.96	-24.98	±1.50
7.6	-10.04	-25.05	±1.50	11.8	-10.02	-25.00	±1.50	16.4	-10.02	-25.04	±1.50
7.7	-10.00	-25.00	±1.50	12	-9.93	-24.95	±1.50	16.6	-10.03	-25.04	±1.50
7.8	-10.01	-25.04	±1.50	12.2	-9.98	-25.02	±1.50	16.8	-9.98	-24.97	±1.50
7.9	-9.97	-24.94	±1.50	12.4	-9.98	-24.99	±1.50	17	-10.00	-24.97	±1.50
8	-9.99	-24.96	±1.50	12.6	-10.02	-25.07	±1.50	17.2	-9.97	-24.97	±1.50
8.2	-10.04	-25.08	±1.50	12.8	-10.03	-24.92	±1.50	17.4	-10.13	-25.18	±1.50
8.4	-9.96	-25.02	±1.50	13	-9.87	-24.99	±1.50	17.6	-10.02	-25.02	±1.50
8.6	-9.95	-24.98	±1.50	13.2	-10.05	-25.05	±1.50	17.8	-10.14	-25.08	±1.50
8.8	-10.00	-25.05	±1.50	13.4	-9.94	-24.98	±1.50	18	-10.12	-25.14	±1.50
9	-9.94	-25.04	±1.50	13.6	-9.94	-24.98	±1.50				
9.2	-10.05	-25.05	±1.50	13.8	-9.98	-25.02	±1.50				

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