

**Test Report acc. to FCC Title 47 CFR Part 15
relating to
Mikrometal s.r.o.
BULLETSEEKER speed tester**

**Title 47 – Telecommunication
Part 15 - Radio Frequency Devices
Subpart C – Intentional Radiators
Measurement Procedure:
ANSI C63.4-2014
ANSI C63.10-2013**



Deutsche
Akkreditierungsstelle
D-PL-12053-01-03

MANUFACTURER

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TESTING LABORATORY

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RELEVANT STANDARD

Title	47 - Telecommunication
Part	15 - Radio Frequency Devices
Subpart	Subpart C – Intentional Radiators - Section 15.258
Measurement procedure	ANSI C63.10-2013

EQUIPMENT UNDER TEST (EUT)

Equipment category	Doppler radar
Trade name	BULLETSEEKER
Type designation	BULLETSEEKER speed tester
Serial no.	---
Variants	---

Test result summary

Clause	FCC Rules	Requirements headline	Test result		
8.1	§ 15.203	Antenna requirement	Pass	Fail	Not [*]
8.2	§ 15.207 (a)	AC power line conducted limits	Pass	Fail	Not [*]
8.3	§ 15.258 (b)	Radiated power (EIRP)	Pass	Fail	Not [*]
8.4	§ 15.258 (c)	Transmitter spurious emission	Pass	Fail	Not [*]
8.5	§ 15.258 (b) (4)	Occupied Bandwidth	Pass	Fail	Not [*]
8.6	§ 15.258 (d)	Frequency stability	Pass	Fail	Not [*]
8.7	§ 1.1310 & § 2.1091	RF radiation exposure	Pass	Fail	Not [*]

* Not tested

If statements on conformity are made in this report, decision rules according to DIN EN ISO / IEC 17025: 2018, 7.8.6 have been applied. If these decision-making rules are not already specified in the applied standards, procedure 1 according to IEC Guide 115 ed.1.0 2007 (accuracy method) was used in the measurement / test procedures on which this report is based.

The equipment passed all the conducted tests	Yes	No
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Signature		
Name	Mr. Anup Shrestha	Mr. Ralf Trepper
Date of issue	2022-05-17	2022-05-17

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1. Table of contents

Revision	Date of issue	Creator	Content of change
00	2022.05.17	RT	Initial release

Table 0-1: Table of contents

Note: If the document has been changed by revision number, all previous documents are no longer valid and must be destroyed.

2. Introduction

This test report is **not an expert opinion** and consists of:

- Test result summary
- List of contents
- Introduction and further information
- Performance assessment
- Detailed test information

All pages have been numbered consecutively and bear the TÜV NORD Hochfrequenztechnik GmbH & Co. KG logo, the test report number, the date, the test specification in its current version as well as the type designation of the EUT. The total numbers of pages in this report is **46**.

The tests were carried out in a representative assembly and in accordance with the test methods and/or requirements stated in:

FCC Title 47 CFR Part 15 Subpart C Section 15.255, ANSI C63.10-2013

The sample of the product was received on:

- 2021-12-16

The tests were carried out in the following period of time:

- 2022-01-21 - 2022-02-04

3. Testing laboratory

TÜV NORD Hochfrequenztechnik GmbH & Co. KG,
LESKANPARK, Gebäude 10
Waltherstr. 49-51
51069 Köln
Germany

Phone: +49 221 8888950

FCC Registration Number: 763407

Accredited by:

DAkkS Deutsche Akkreditierungsstelle GmbH
DAkkS accreditation number: D-PL-12053-01-00

4. Applicant

Company name : Mikrometal s.r.o.
Address : Vsetatska 307
27715 Tisice-Chrast
Country : Czech Republic
Telephone : +420 777304053
Fax : ---
Email : bastian@mikrometal.cz
Date of order : 2021-12-02
References : Mr. Raimund Bastian

5. Product

Sample of the following apparatus was submitted for testing:

Manufacturer : Longseeker s.r.o.
Trademark : BULLETSEEKER
Type designation : **BULLETSEEKER speed tester**
Serial number : ---
Hardware version : 1.0
Variant : ---
Software release : v0.20
Type of equipment : Doppler radar
Power used : 3.3 to 4.7 V DC
Frequency used : 122.5 GHz
Generated or used frequencies : 25.0 MHz (crystal),
122.5 GHz (center frequency)
ITU emission class : 301KN0N
FCC ID : 2A575BULLETSEEKER

For issuing this report the following product documentation was used:

Title	Description	Version
Rio Installation Manual	Installation Manual	---
Technical manual	Instructions BS HS	Instructions BS HS engl final 21-april-2022.docx

For issuing this report the following product documentation was used:

Description	Date	Identifications
External photographs of the Equipment Under Test (EUT)	2022-05-17	Annex no. 1
Internal photographs of the Equipment Under Test (EUT)	2022-05-17	Annex no. 2
Channel occupancy / bandwidth	2022-05-17	Annex no. 3
Label sample	2022-05-17	Annex no. 4
Functional description / User Manual	2022-05-17	Annex no. 5
Test setup photos	2022-05-17	Annex no. 6
Block diagram	2022-05-17	Annex no. 7
Operational description	2022-05-17	Annex no. 8
Schematics	2022-05-17	Annex no. 9
Parts list	2022-05-17	Annex no. 10

6. Conclusions, observations and comments

The test report will be filed at TÜV NORD Hochfrequenztechnik GmbH & Co. KG for a period of 10 years following the issue of this report. It may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of TÜV NORD Hochfrequenztechnik GmbH & Co. KG.

The results of the tests as stated in this report are exclusively applicable to the EUT as identified in this report. TÜV NORD Hochfrequenztechnik GmbH & Co. KG cannot be held liable for properties of the EUT that have not been observed during these tests.

TÜV NORD Hochfrequenztechnik GmbH & Co. KG assumes the sample to comply with the requirements of FCC Title 47 CFR Part 15 for the respective test sector, if the test results turn out positive.

Comments: ---

7. Operational description

7.1 EUT details

The BULLETSEEKER is a radar-based measuring system for recording projectile velocities from handguns and rifles.

7.2 EUT configuration

Test description for peak power, bandwidths and frequency stability measurements:

After switch on the continuous transmitting test sample, the device starts to work. No additional equipment or operating software is required

Test description for all spurious emission measurements:

After switch on the continuous transmitting test sample, the device starts to work. No additional equipment or operating software is required

Test description for all other measurements in normal operation mode:

After powering the module, it stays in unpowered condition until the button is pressed. Once pressed, the Microcontroller initializes the board peripherals, namely Bluetooth module and PLL. The Module then stays in a waiting state and accepts a Bluetooth connection. If the connection is not established within 5 minutes, the module will turn off again. Once a connection is established, the Radio Frontend is powered up and will be locked to 122.5 GHz by the PLL within few microseconds. The Module then stays in operational mode and constantly checks if a target Doppler frequency is detected.

7.3 EUT measurement description

AC Powerline conducted measurements

The EUT was directly connected with an AC/USB 5v 1a charging adapter to the artificial mains network. It has been tested with the activated EUT in continuous measuring mode. The typical voltage of 120 V AC / 60 Hz is provided on the artificial mains network.

Radiated measurements

After switch on, the device starts to work. No additional equipment or operating software is required.

The EUT was tested in a typical fashion. During preliminary emission tests, the EUT was operated in the continuous measuring mode for worst case emission mode investigation. Therefore, the final qualification testing was completed with the EUT operated in continuous measuring mode. All tests were performed in a semi-anechoic chamber (SAC) with the EUT's typical voltage: 4.7 V DC.

In order to establish the maximum radiation, firstly, there have been viewed all orthogonal adjustments of the test samples, secondly the test sample have been rotated at all adjustments around the own axis between 0° and 360°, and thirdly, the antenna polarization between horizontal and vertical had been varied.

Radiated measurements from 9 kHz – 30 MHz, 30MHz – 1 GHz and above 1 GHz were performed using a small loop antenna, Linear polarized Logarithmic Periodic Broadband Antenna and stacked Logarithmic-Periodic Broadband Antenna for linear polarized respectively with a measuring distance of 3 m inside SAC.

Radiated measurements above 1 GHz is made by placing loose-laid RF absorber material on the ground plane.

Additionally, radiated emission measurements above 1 GHz are made using calibrated linearly polarized antennas, which may have a smaller beam width (main lobe) than do the antennas used for frequencies below 1 GHz. The measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response. The measurement antenna may have to be higher or lower than the EUT, depending on the radiation pattern of the emission and staying aimed at the emission source for receiving the maximum signal.

Environmental Conditions during the tests

Temperature: 21 – 26°C // Relative Humidity: 35 – 45 % // Air Pressure: 1005 – 1013 hPa

8.1 Antenna requirement

8.1.1 Regulation

According to FCC §15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §15.211, §15.213, §15.217, §15.219, or §15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

8.1.2 Result

Antenna Type	Antenna description	Frequency GHz	Gain dBi	Number of Antennas
Patch Antenna	Integrated in ITRA_120_002 120-GHz Highly Integrated IQ Transceiver with Antennas on Chip	122 – 123	10.0	1 * Rx 1 * TX

The equipment passed the conducted tests	Yes	No	Not
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Test setup photos / test results are attached	Yes	No	Annexe no.: 5
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8.2 AC line conducted limits

8.2.1 Regulation

According to FCC §15.207 (a), except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Conducted Limits		
Frequency of Emission	Quasi-Peak (QP)	Average (AV)
MHz	dB μ V	dB μ V
0.15 - 0.5	66 to 56*	56 to 46*
0.5 - 5	56	46
5 -30	60	50
*Decreases with the logarithm of the frequency		

(b) The limit shown in paragraph (a) of this section shall not apply to carrier current systems operating as intentional radiators on frequencies below 30 MHz. In lieu thereof, these carrier current systems shall be subject to the following standards:

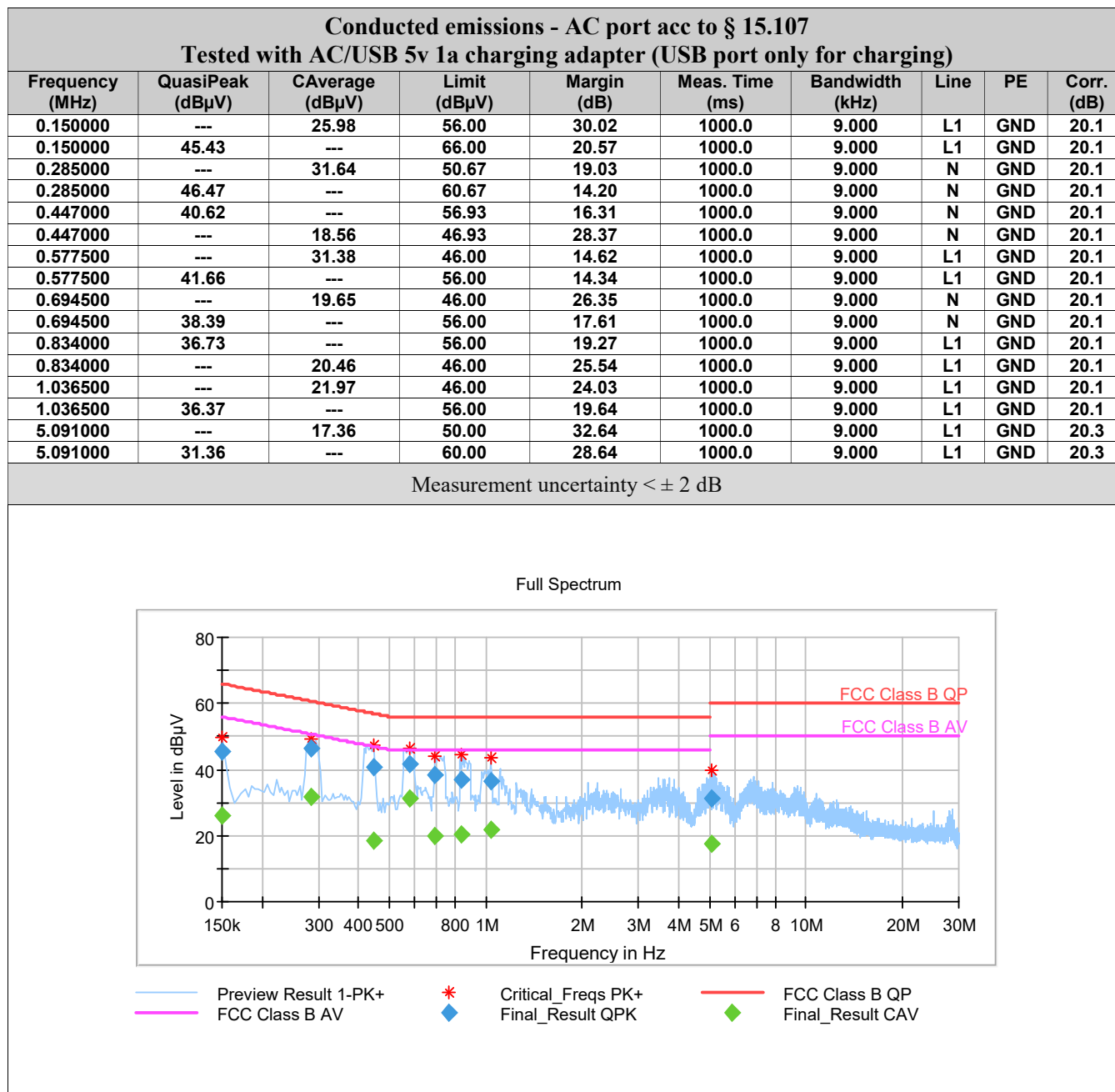
- 1) For carrier current system containing their fundamental emission within the frequency band 535–1705 kHz and intended to be received using a standard AM broadcast receiver: no limit on conducted emissions.
- (2) For all other carrier current systems: 1000 μ V within the frequency band 535–1705 kHz, as measured using a 50 μ H/50 ohms LISN.
- (3) Carrier current systems operating below 30 MHz are also subject to the radiated emission limits in §15.205, §15.209, §15.221, §15.223, or §15.227, as appropriate.

(c) Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. Devices that include, or make provisions for, the use of battery chargers which permit operating while charging, AC adapters or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

8.2.2 Test procedures

The EUT and the additional equipment (if required) are connected to the main power through a line impedance stabilization network (LISN). The LISN must be appropriate to ANSI C63.10-2013. Additional equipment must also be connected to a second LISN with the same specifications described in the above section (if required).

8.2.3 Result



Test Cables used	K ISN 2
Test equipment used	272, 551, 665, 606

The equipment passed the conducted tests	Yes	No	No *
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Test setup photos / test results are attached	Yes	No	Annex no.: 6
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8.3 Radiated peak power (EIRP)

8.3.1 Regulation

According to FCC §15.258 (b) Emission levels within the 116-123 GHz, 174.8-182 GHz, 185-190 GHz and 244-246 GHz bands shall not exceed the following equivalent isotropically radiated power (EIRP) limits as measured during the transmit interval:

- (1) The average power of any emission shall not exceed 40 dBm and the peak power of any emission shall not exceed 43 dBm; or
- (2) For fixed point-to-point transmitters located outdoors, the average power of any emission shall not exceed 82 dBm and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi. The peak power of any emission shall not exceed 85 dBm and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi. The provisions in this paragraph (b)(2) for reducing transmit power based on antenna gain shall not require that the power levels be reduced below the limits specified in paragraph (b)(1) of this section.
- (3) The peak power shall be measured with a detection bandwidth that encompasses the entire occupied bandwidth within the intended band of operation, e.g., 116-123 GHz, 174.8-182 GHz, 185-190 GHz or 244-246 GHz. The average emission levels shall be measured over the actual time period during which transmission occurs.
- (4) Transmitters with an emission bandwidth of less than 100 MHz must limit their peak radiated power to the product of the maximum permissible radiated power (in milliwatts) times their emission bandwidth divided by 100 MHz. For the purposes of this paragraph (b)(4), emission bandwidth is defined as the instantaneous frequency range occupied by a steady state radiated signal with modulation, outside which the radiated power spectral density never exceeds 6 dB below the maximum radiated power spectral density in the band, as measured with a 100 kHz resolution bandwidth spectrum analyzer. The center frequency must be stationary during the measurement interval, even if not stationary during normal operation (e.g., for frequency hopping devices).

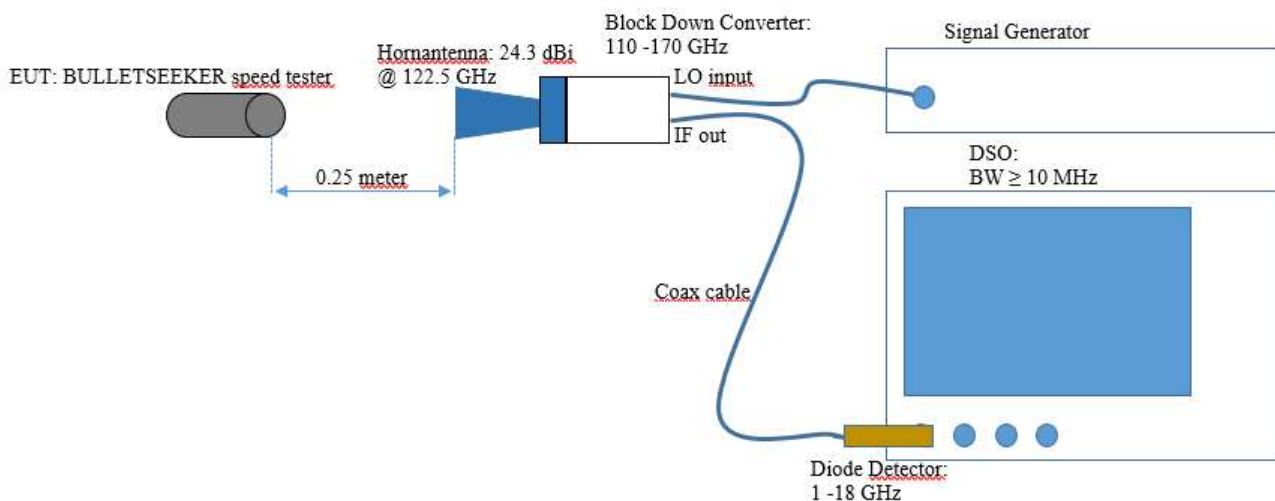
8.3.2 Test Procedure

Maximum measurement distance for the final radiated measurements above 40 GHz was determined according to ANSI C63.10-2013 section 9.8. To achieve maximum level of emission, maximizing procedure was applied according to ANSI C63.10-2013 section 9.8 where initially an exploratory search for emissions was carried out to determine the approximate direction at which each observed emissions emanates from the EUT. Secondly, for each emission observed a final measurement was executed to find the final position, polarization and orientation at which the maximum level of emission was observed. Measurement of the fundamental emission can be done using an RF detector according to the procedure ANSI C63.10-2013 section 9.11.

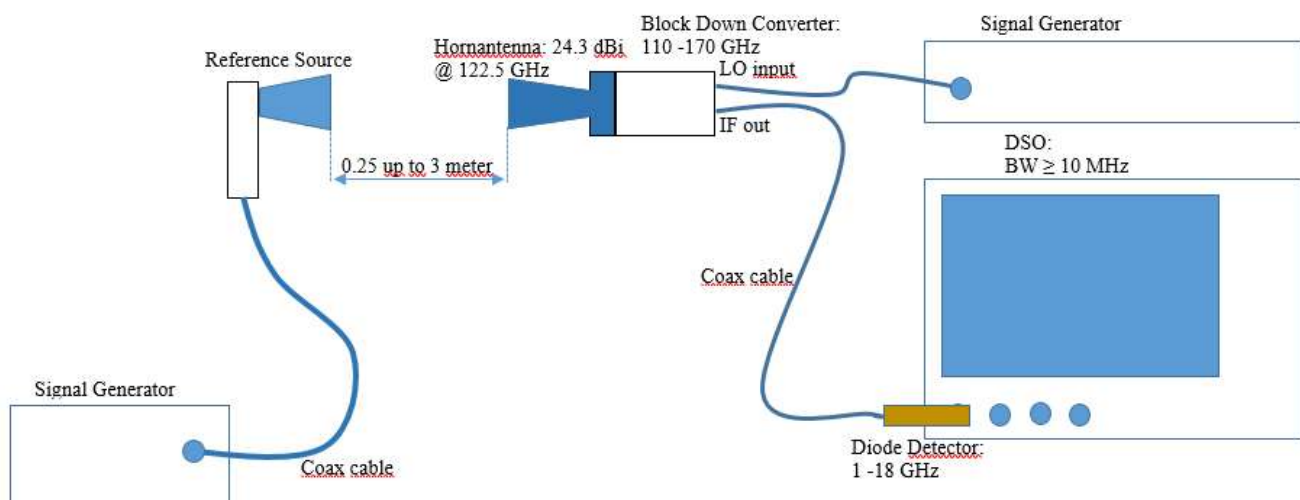
8.3.3 Test setup

Radiated measurements setup (Radiated peak output power)

Measurement of the radiated EUT output level



Measurement of the substituted power level



8.3.4 Result

Test Mode: Transmitting

Radiated peak output power acc. to FCC §15.258 (4)						
frequency	Detector	Polar	SG Level DSO	Substituted EIRP Power	EIRP Limit	Margin
GHz	Type	H/V	mV	dBm	dBm	dB
122.49946	PK	V	4.16	-1.43	17.8*	19.23

Measurement uncertainty: ± 2.5 dB

*Limit calculated according to FCC §15.258 (b)(4) for emission bandwidth (ebw) of less than 100 MHz

$$\text{EIRP}_{\text{limitcalc}} = \text{EIRP}_{\text{limit}} * \text{ebw} / 100 \text{ MHz} = 20000 \text{ mW} * 0.30139 \text{ MHz} / 100 \text{ MHz} = 60.278 \text{ mW} = 17.8 \text{ dBm}$$

Note 1: According to FCC §15.258 (3)

Note 2: The measurement distance is 0.25 m.

Note 3: RF Detector and a DSO with a Bandwidth greater than 10 MHz were used to make the Measurements

Note 4: the measurement performed with radiation method, according to ANSI C63.10-2013 Clause 9.11:

EUT E.I.R.P. measured with RF-detector at a distance: $d = 0.25$ meter

Maximum measured voltage level on DSO: $V = 4.16$ mV

Substitution of EUT E.I.R.P. by using an reference signal of $P_{\text{ref}} = 14.7$ dBm

Change the distance of reference signal until the voltage displayed on the DSO is 4.16 mV.

Detected distance = 1.60 meter

Free Space Loss: $\text{FSPL}(\text{dB}) = 20\log_{10}(d) + 20\log_{10}(f) - 20\log_{10}(4\pi/c)$

where, d = distance in meter // f = frequency in Hz // c = speed of light in ($\text{m} \cdot \text{s}^{-1}$)

$$\text{Max EIRP} = \text{Pref} - \text{FSPL}(1.6\text{m}) + \text{FSPL}(0.25\text{m}) = -1.43 \text{ dBm}$$

Test Mode: Transmitting

Radiated average output power acc. to FCC §15.258 (4)					
frequency	Substituted EIRP Power	Duty cycle	Calculated Average EIRP	Average EIRP Limit	Margin
GHz	dBm	%	dBm	dBm	dB
122.49946	-1.43	100	-1.43	14.8*	16.23

Measurement uncertainty: ± 2.5 dB

*Limit calculated according to FCC §15.258 (b)(4) for emission bandwidth (ebw) of less than 100 MHz

$$\text{Max Average EIRP} = \text{EIRP Power} + 10\log_{10}(\text{duty cycle})$$

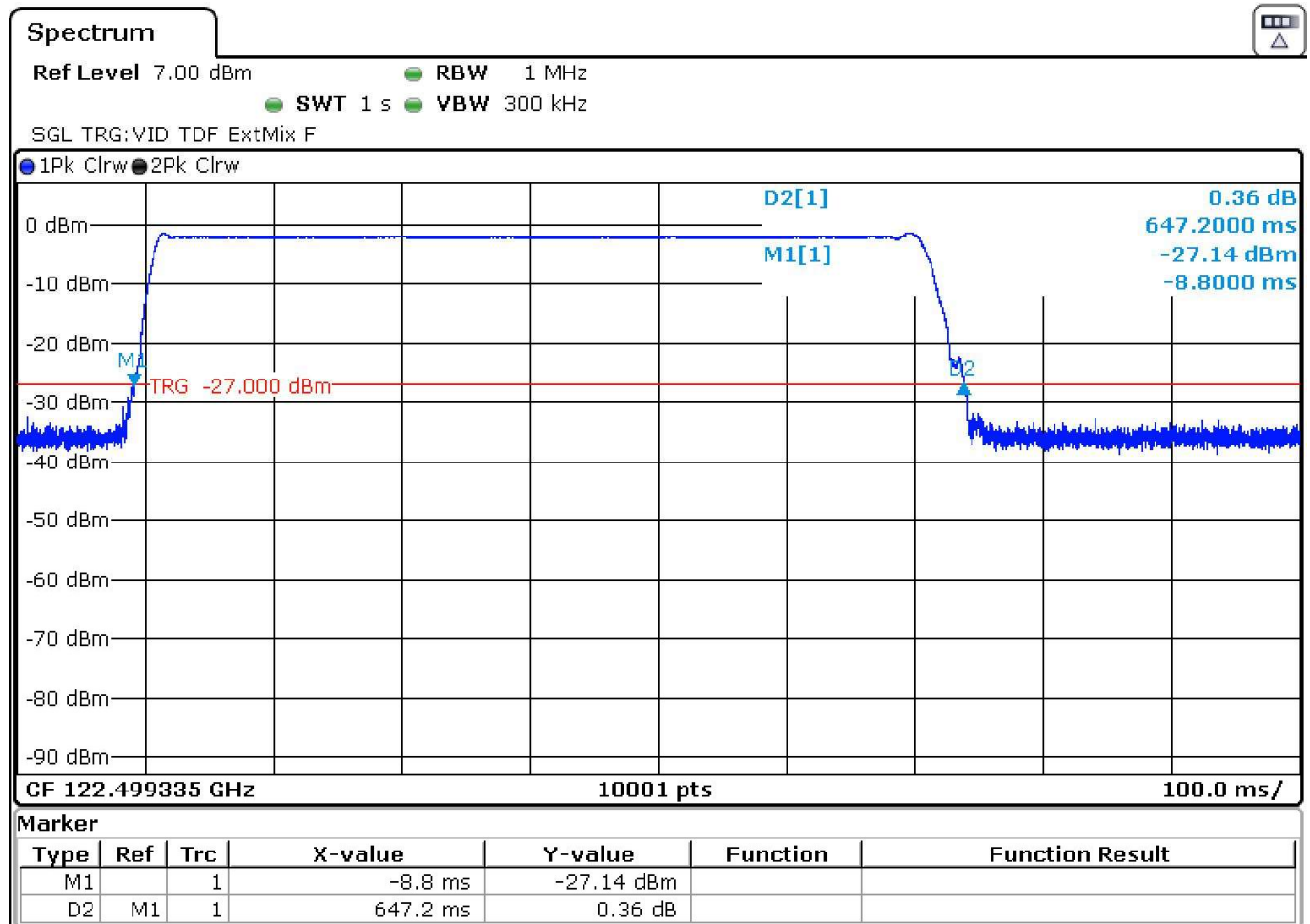
Test Cables used	K163, K164, K167
Test equipment used	221a, 385, 502, 571, 617, 613, 666, 667, 668, 669, 675, 687, 681

The equipment passed the conducted tests	Yes	No	No *
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Test setup photos / test results are attached	Yes	No	Annex no.:
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Duty cycle:

Plot:



Calculation:

Duty cycle ratio = TXon / (TXon + TXoff) * 100%

TXon time always > 100ms therefore the Duty cycle ratio = 100 %

8.4 Transmitter spurious emission up to 40 GHz

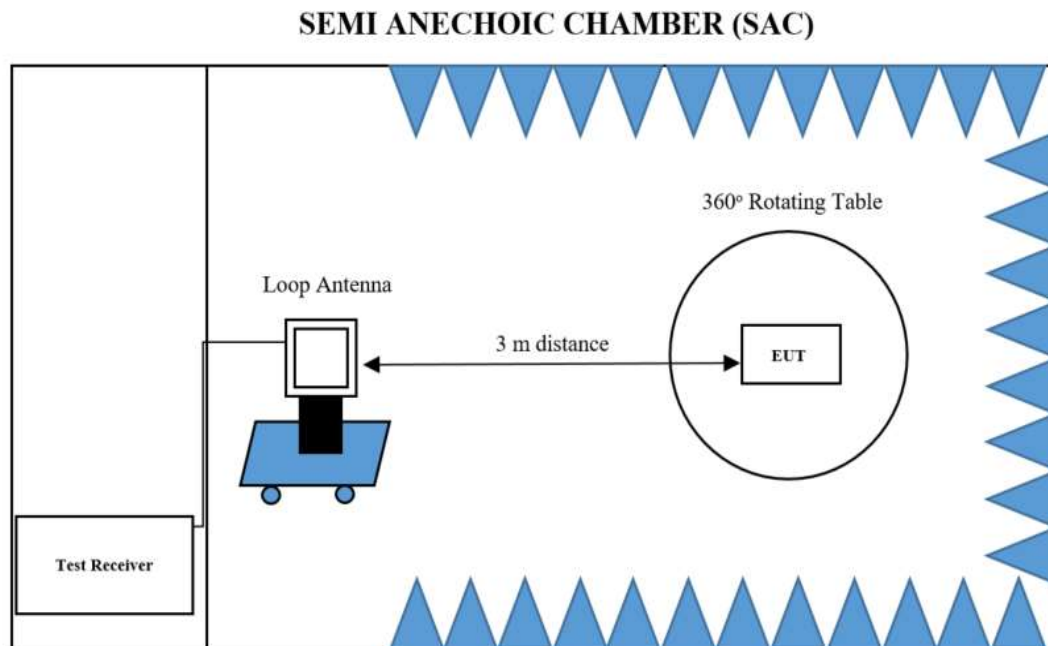
8.4.1 Regulation

According to FCC §15.255 (d), limits on spurious emissions:

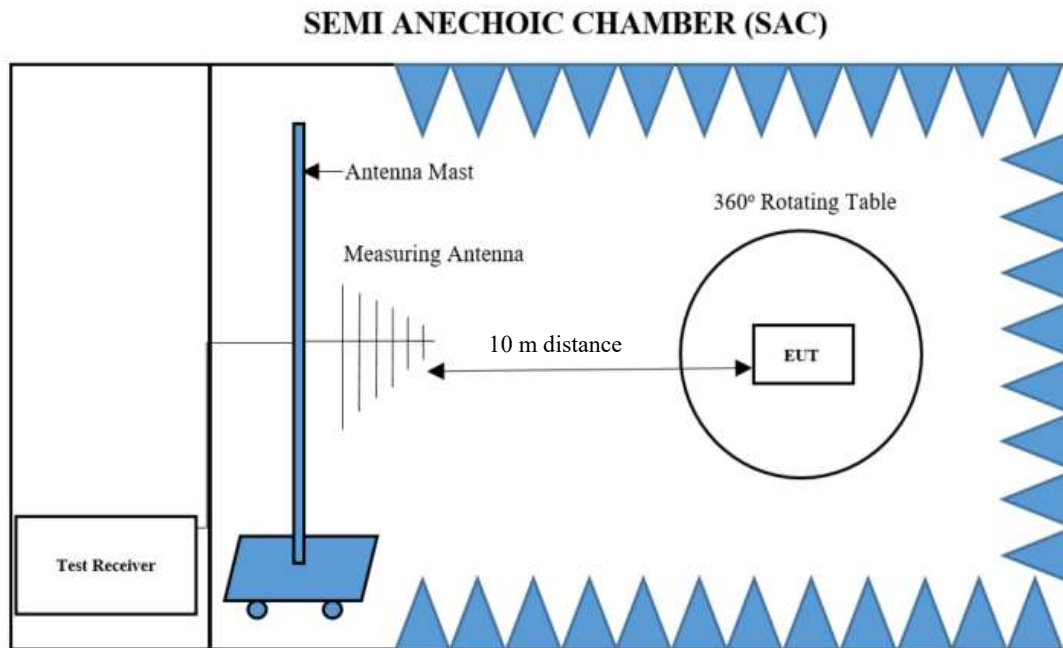
- (1) The power density of any emissions outside the 57-71 GHz band shall consist solely of spurious emissions.
- (1) Radiated emissions below 40 GHz shall not exceed the general limits in §15.209.
- (2) Between 40 GHz and 200 GHz, the level of these emissions shall not exceed 90 pW/cm² at a distance of 3 meters.
- (3) The levels of the spurious emissions shall not exceed the level of the fundamental emission.

8.4.2 Test setup

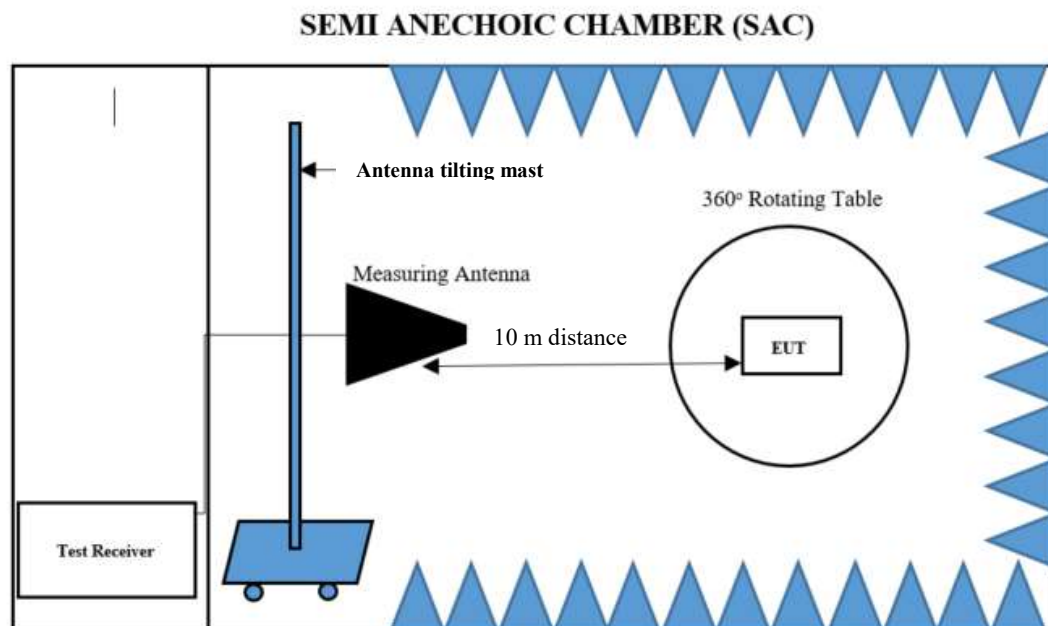
Radiated measurements setup (9 kHz – 30 MHz)



Radiated measurements setup (30 MHz – 1 GHz)



Radiated measurements setup above 1 GHz – 18 GHz



Radiated measurements from 9 kHz – 30 MHz, 30MHz – 1 GHz and 1 GHz – 18 GHz were performed using a small loop antenna, Linear polarized Logarithmic Periodic Broadband Antenna and stacked Logarithmic-Periodic Broadband Antenna for linear polarized respectively with a measuring distance of 3 m inside SAC as shown in the above test setup diagrams. Radiated measurements from 18 GHz – 40 GHz were performed using a horn antenna at a measuring distance of 3 m. Above 40 GHz, the measuring antenna is scanned around the entire perimeter of the EUT in both horizontal and vertical polarization, at the distance of 1.0 m from 40 GHz – 90 GHz and 0.5 m from 90 GHz – 200 GHz.

The radiated emission tests were performed in a 10 meter SAC using the setup accordance with the ANSI C63.10.

8.4.3 Test Procedure

The measurement of harmonic and spurious emissions at or below 40 GHz was performed in accordance with the standard test methods ANSI C63.10-2013 section 6.3 – 6.6. The measurement above 40 GHz was carried out in accordance with the test procedure ANSI C63.10-2013 section 9.12.

In accordance with the FCC subpart A §15.35, frequencies below or equal to 1 GHz, the measurements were done using a quasi-peak detector. For the frequencies from 1 GHz – 40 GHz, all the radiated emission measurements were carried out using a peak and CISPR average detectors. In accordance with the FCC subpart C §15.255, the radiated emission measurements were made using a peak detector.

Radiated emissions test characteristics	
Test distance	10 m, 3 m, 1 m, 0.5 m *
Test instrumentation resolution bandwidth	9 kHz (Below 30 MHz)
	120 kHz (30 MHz - 1,000 MHz)
	1 MHz (Above 1000 MHz)
Receive antenna scan height	1 m - 4 m
Receive antenna polarization	Vertical/horizontal

* At frequencies at or above 30 MHz, measurements may be performed at a distance other than what is specified provided: measurements are not made in the near field except where it can be shown that near field measurements are appropriate due to the characteristics of the device; and it can be demonstrated that the signal levels needed to be measured at the distance employed can be detected by the measurement equipment. Measurements shall not be performed at a distance greater than 30 meters unless it can be further demonstrated that measurements at a distance of 30 meters or less are impractical. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements; inverse-linear-distance-squared for power density measurements).

8.4.4 Calculation of the field strength

The field strength is calculated by the following calculation:

Corrected Level = Receiver Level + Correction Factor (without the use of a pre-amplifier)

Corrected Level = Receiver Level + Correction Factor – Pre-amplifier (with the use of a pre-amplifier)

Receiver Level : Receiver reading without correction factors
Correction Factor : Antenna factor + cable loss

For example:

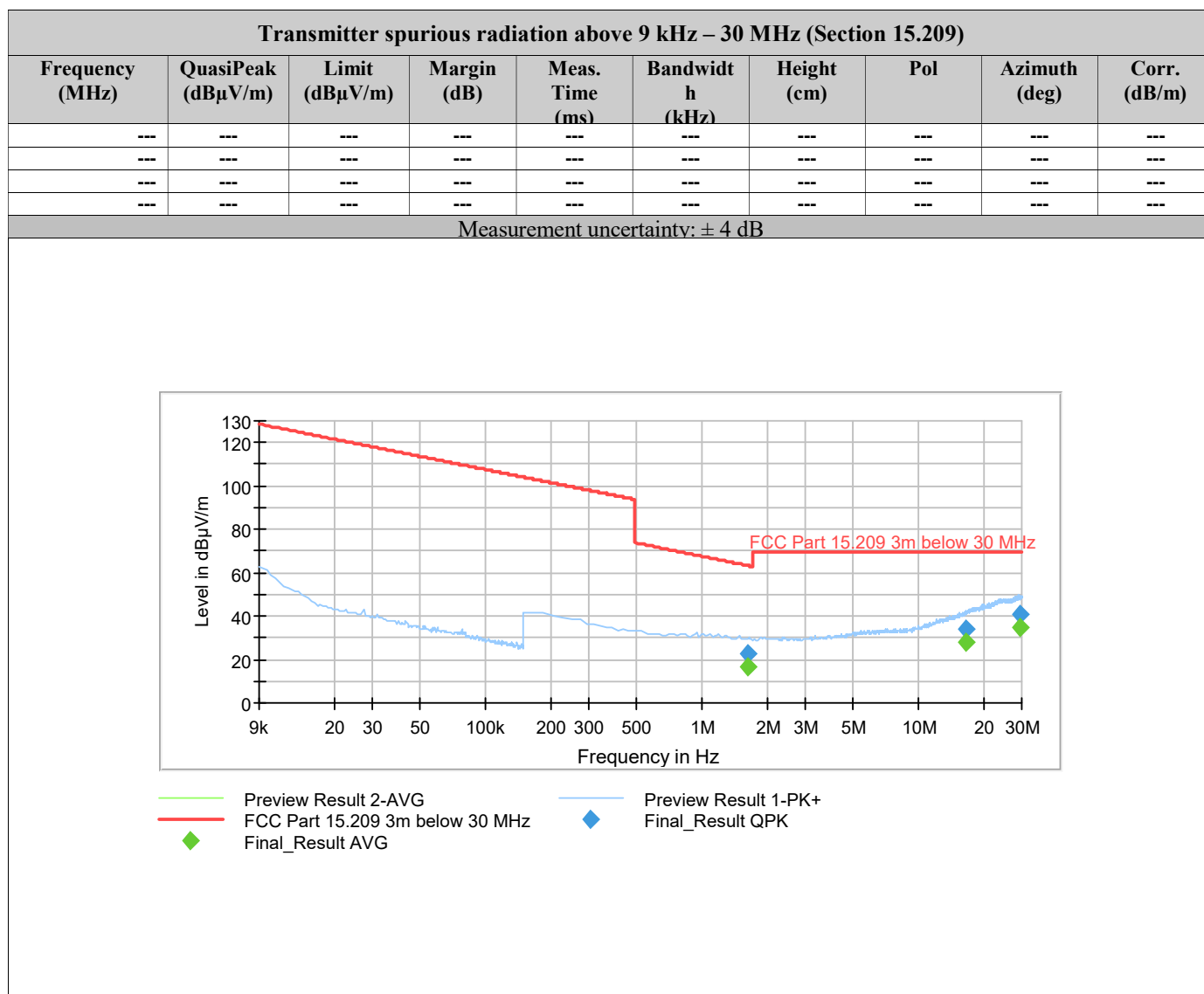
The receiver reading is 32.7 dB μ V. The antenna factor for the measured frequency is +2.5 dB (1/m) and the cable factor for the measured frequency is 0.71 dB, giving a field strength of 35.91dB μ V/m.

The 35.91 dB μ V/m value can be mathematically converted to its corresponding level in μ V/m.

Level in μ V/m = Common Antilogarithm (35.91/20) = 62.44

For test distance other than what is specified, but fulfilling the requirements of Section 15.31 (f) (1) the field strength is calculated by adding additionally an extrapolation factor of 20 dB/decade (inverse linear distance for field strength measurements).

8.4.5 Result



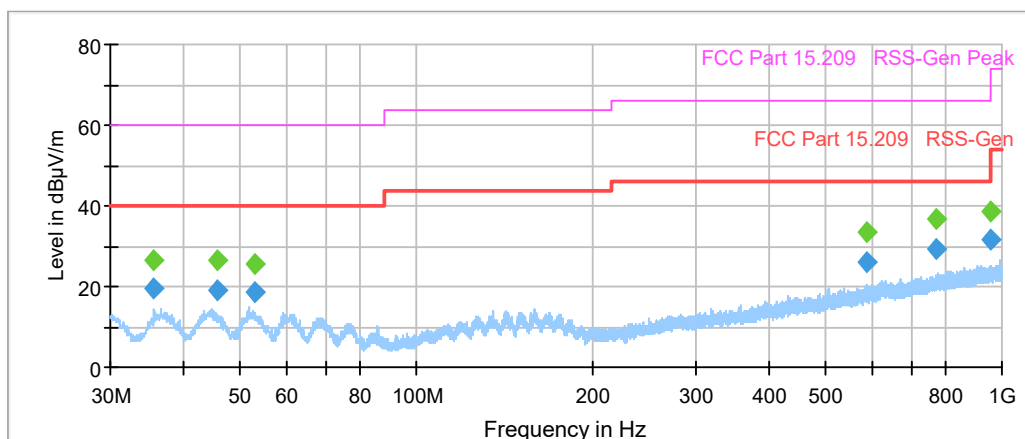
Test Cables used	K60, K102, K166
Test equipment used	23, 660, 665, 667, 668, 669

The equipment passed the conducted tests	Yes	No	Not
Test setup photos / test results are attached	Yes	No	Annex no.: 6

Transmitter spurious radiation above 30 MHz – 1 GHz (Section 15.209)

Frequency (MHz)	QuasiPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
35.500000	---	26.40	60.00	33.60	1000.0	120.000	105.0	137.0	13.3
35.500000	19.33	---	40.00	20.67	1000.0	120.000	105.0	137.0	13.3
45.840000	18.99	---	40.00	21.01	1000.0	120.000	247.0	224.0	14.3
45.840000	---	26.38	60.00	33.62	1000.0	120.000	247.0	224.0	14.3
52.860000	18.59	---	40.00	21.41	1000.0	120.000	250.0	209.0	14.3
52.860000	---	25.72	60.00	34.28	1000.0	120.000	250.0	209.0	14.3
586.980000	---	33.66	66.00	32.34	1000.0	120.000	393.0	71.0	21.7
586.980000	26.17	---	46.00	19.83	1000.0	120.000	393.0	71.0	21.7
774.970000	29.39	---	46.00	16.61	1000.0	120.000	361.0	15.0	24.8
774.970000	---	36.60	66.00	29.40	1000.0	120.000	361.0	15.0	24.8
954.520000	31.68	---	46.00	14.32	1000.0	120.000	105.0	156.0	27.0
954.520000	---	38.50	66.00	27.50	1000.0	120.000	105.0	156.0	27.0

Measurement uncertainty: ± 4 dB



Preview Result 1-PK+ FCC Part 15.209 RSS-Gen
 FCC Part 15.209 RSS-Gen Peak Final_Result QPK
 Final_Result PK+

Test Cables used	K60, K102, K166
Test equipment used	406, 660, 665, 667, 668, 669

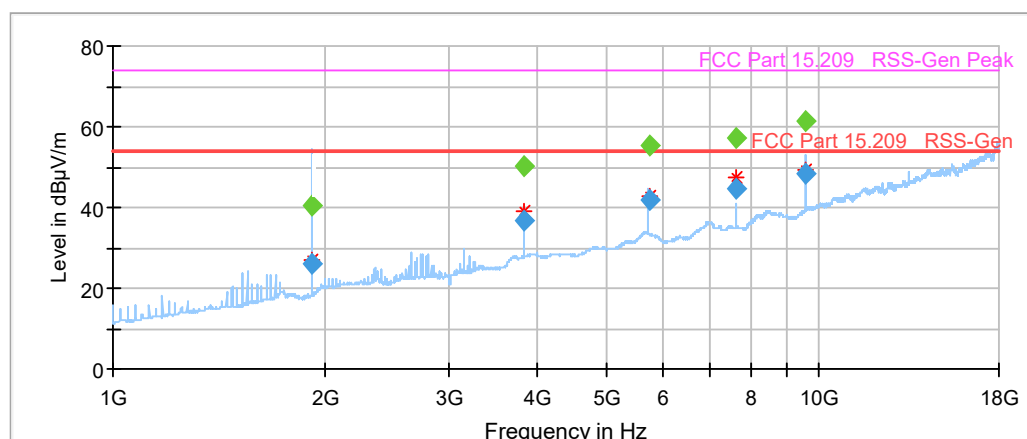
The equipment passed the conducted tests	Yes	No	Not
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Test setup photos / test results are attached	Yes	No	Annex no.: 6
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Transmitter spurious radiation above 1 GHz – 18 GHz (Section 15.209)

Frequency (MHz)	QuasiPeak (dBμV/m)	MaxPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1915.375000	25.97	---	54.00	28.03	1000.0	1000.000	350.0	V	-4.0	32.4
1915.375000	---	40.57	74.00	33.43	1000.0	1000.000	350.0	V	-4.0	32.4
3828.125000	---	50.08	74.00	23.92	1000.0	1000.000	117.0	V	-2.0	41.2
3828.125000	36.74	---	54.00	17.26	1000.0	1000.000	117.0	V	-2.0	41.2
5750.875000	---	55.36	74.00	18.64	1000.0	1000.000	343.0	V	14.0	47.2
5750.875000	41.91	---	54.00	12.09	1000.0	1000.000	343.0	V	14.0	47.2
7656.125000	44.46	---	54.00	9.54	1000.0	1000.000	125.0	V	25.0	49.0
7656.125000	---	57.41	74.00	16.59	1000.0	1000.000	125.0	V	25.0	49.0
9580.375000	48.32	---	54.00	5.68	1000.0	1000.000	357.0	V	11.0	52.8
9580.375000	---	61.53	74.00	12.47	1000.0	1000.000	357.0	V	11.0	52.8

Measurement uncertainty: ± 4.9 dB



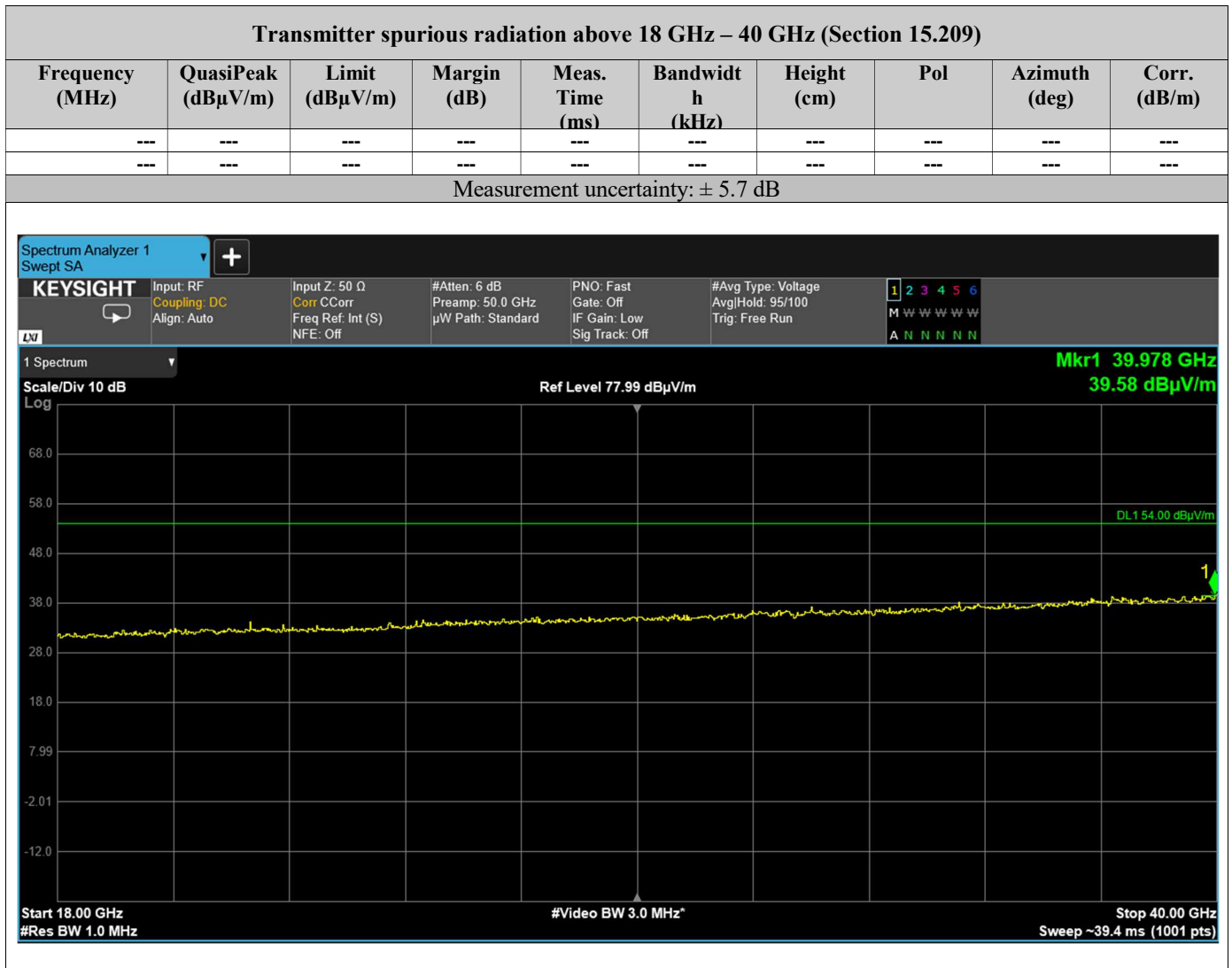
Preview Result 1-RMS
 FCC Part 15.209 RSS-Gen
 Final Result AVG

* Critical Freqs RMS
 FCC Part 15.209 RSS-Gen Peak
 Final Result PK+

Test Cables used	K60, K102, K166
Test equipment used	445a, 660, 665, 667, 668, 669

The equipment passed the conducted tests	Yes	No	No *
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Test setup photos / test results are attached	Yes	No	Annex no.: 6
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Test Cables used	K147, K167
Test equipment used	223a, 442, 443, 660, 666, 667, 668, 669

The equipment passed the conducted tests	Yes	No	N.t.*
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Test setup photos / test results are attached	Yes	No	Annex no.: 6
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8.5 Transmitter spurious emission above 40 GHz

8.5.1 Regulation

Note 1: According to FCC §15.255 (d)(3)

Note 2: The measurement distance is 0.5 m.

Note 3: The Mixers and it's RF cables are calibratet as system, the conversion factor was added into the Spectrum Analyzer.

Note 5: Limit conversion at the specified distance of 3 m

$$\text{EIRP}[\text{dBm}] = 10\log_{10}(4 \cdot \pi \cdot d^2 \cdot \text{PD}[\text{W}/\text{m}^2])$$

where,

PD = Power density at the distance specified by the limit = 90 [pW/cm²]

EIRP = Equivalent isotropically radiated power in [dBm]

d_{meas} : Distance at which the power density limit is specified = 3 [m]

The emission limit of PD = 90 pW/cm² at a distance of 3 meters corresponds to EIRP = -9.9 dBm.

Note 6: radiated output power calculation:

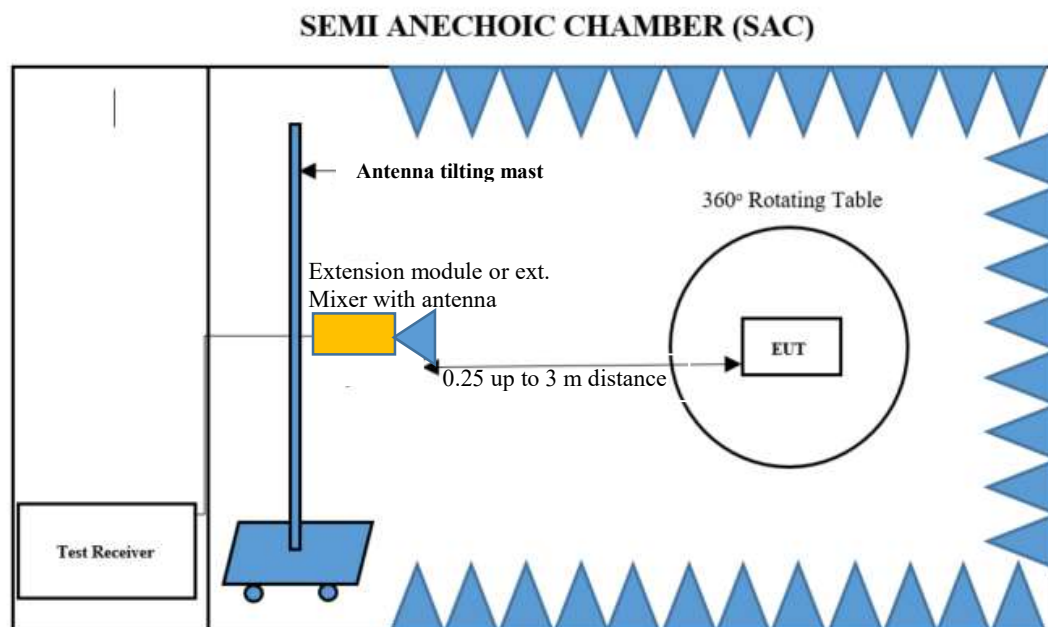
$$\text{EIRP}[\text{dBm}] = \text{RL}[\text{dBm}] + \text{FSPL}[\text{dB}] - \text{G}[\text{dBi}] + \text{CL}[\text{dB}]$$

where,

EIRP = Effective radiated power // RL = Receiver reading // FSPL = Free Space Loss at measurement distance (dB) // G = Antenna gain // CL = conversion loss signal path

8.5.2 Test Procedure

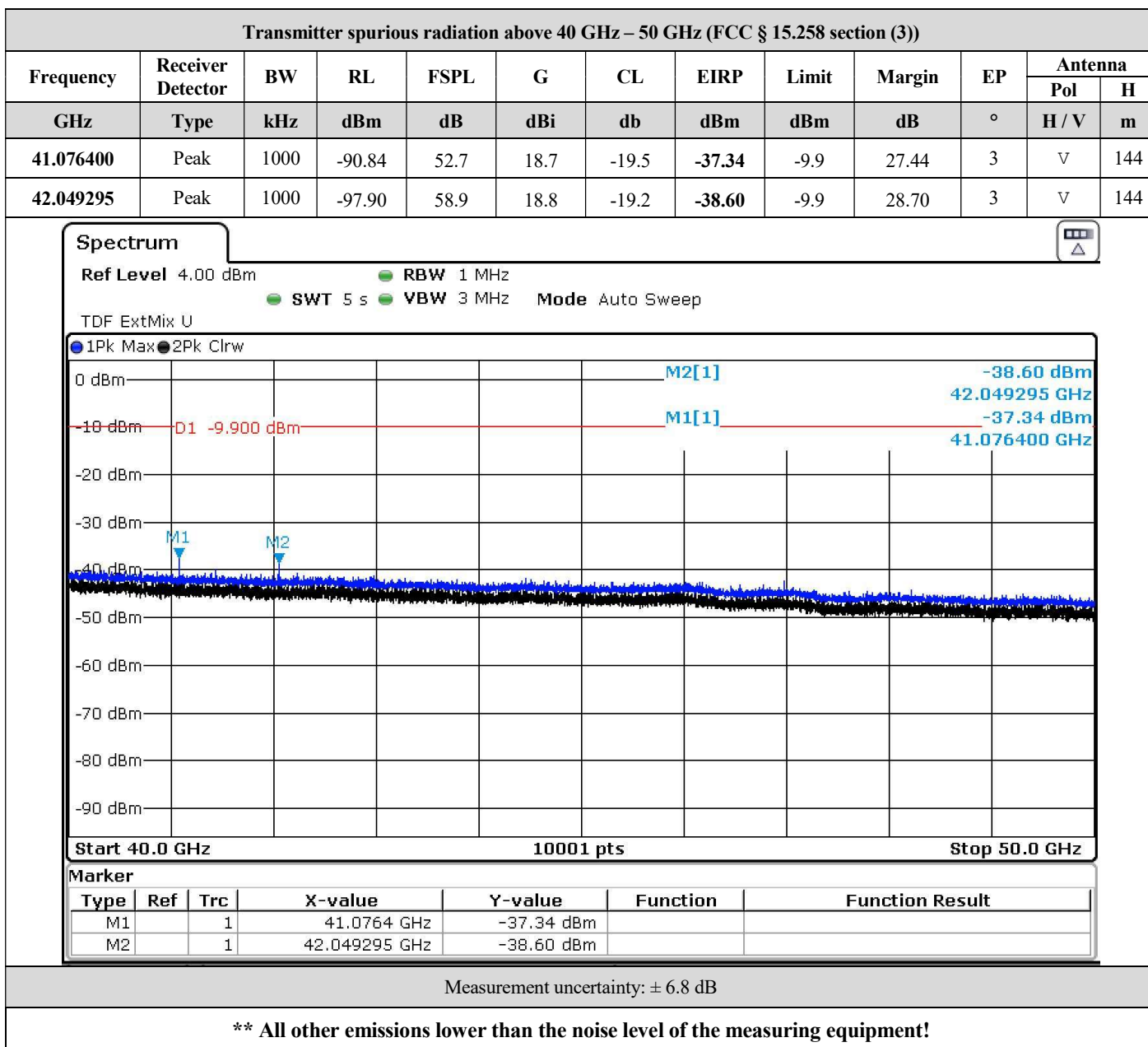
Radiated measurements setup above 40 GHz



The measurement of harmonic and spurious emissions above 40 GHz was carried out in accordance with the test procedure ANSI C63.10-2013 section 9.12.

In accordance with the FCC subpart A §15.35, in accordance with the FCC subpart C §15.255, the radiated emission measurements were made using a peak detector or average detector.

8.5.3 Result



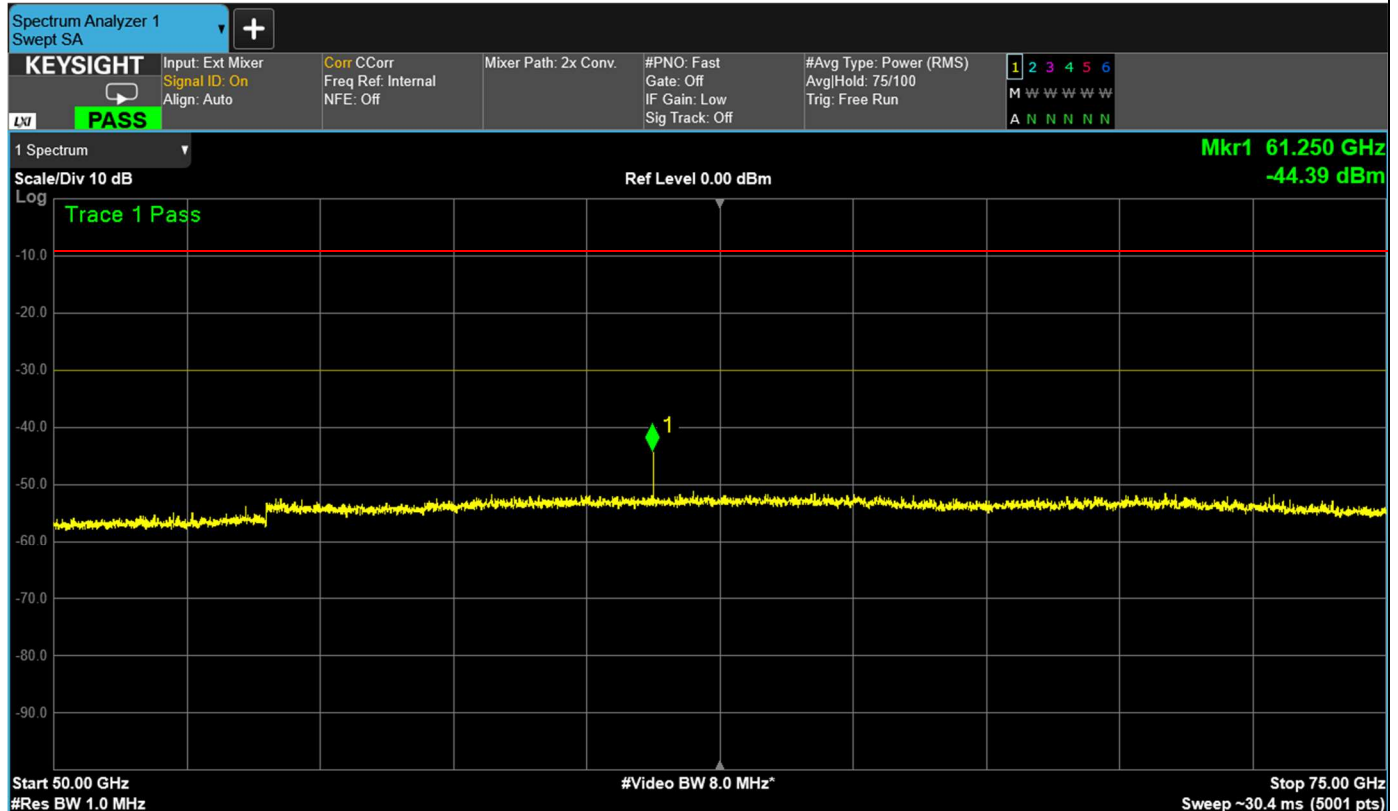
Test Cables used	K163
Test equipment used	502, 515, 518, 660, 667, 668, 669

The equipment passed the conducted tests	Yes	No	Not
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Test setup photos / test results are attached	Yes	No	Annex no.: 6
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Transmitter spurious radiation above 50 GHz – 75 GHz (FCC § 15.258 section (3))

Frequency	Receiver Detector	BW	RL	FSPL	G	CL	EIRP	Limit	Margin	EP	Antenna	
											Pol	H
GHz	Type	kHz	dBm	dB	dB	db	dBm	dBm	dB	°	H / V	m
61.250	Average	1000	-101.09	64.2	25.0	-17.5	-44.39	-9.9	34.49	3	V	144



Measurement uncertainty: ± 6.8 dB

**** All other emissions lower than the noise level of the measuring equipment!**

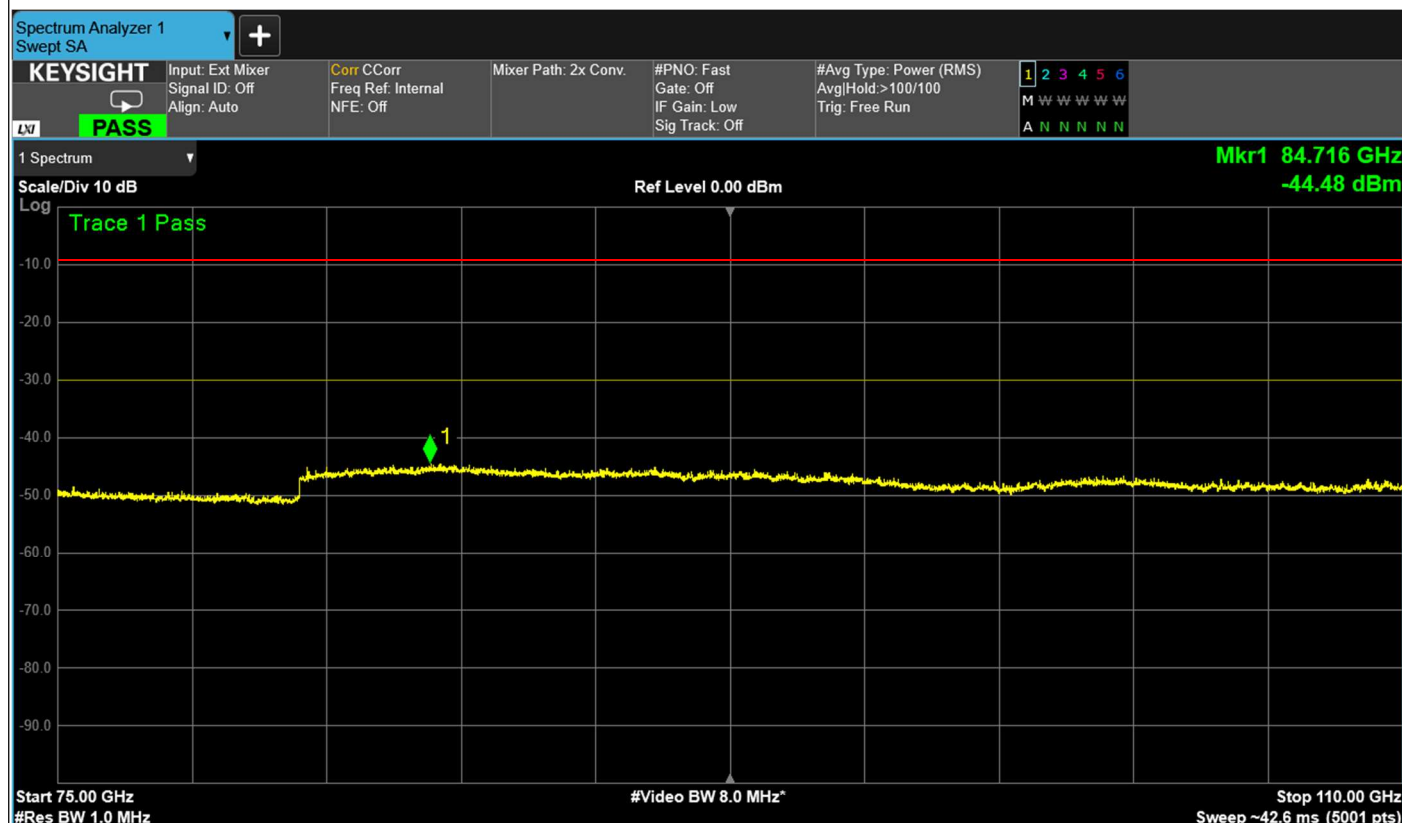
Test Cables used	K163
Test equipment used	384, 763, 660, 666, 667, 668, 669

The equipment passed the conducted tests	Yes	No	N.t. [*]
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Test setup photos / test results are attached	Yes	No	Annex no.: 6
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Transmitter spurious radiation above 75 GHz – 110 GHz (FCC § 15.258 section (3))

Frequency	Receiver Detector	BW	RL	FSPL	G	CL	EIRP	Limit	Margin	EP	Antenna	
GHz	Type	kHz	dBm	dB	dB	dB	dBm	dBm	dB	°	Pol	H
84.716	Average	1000	-101.28	65.0	24.2	-16.0	-44.48	-9.9	34.58	3	V	144



Measurement uncertainty: ± 6.8 dB

**** All other emissions lower than the noise level of the measuring equipment!**

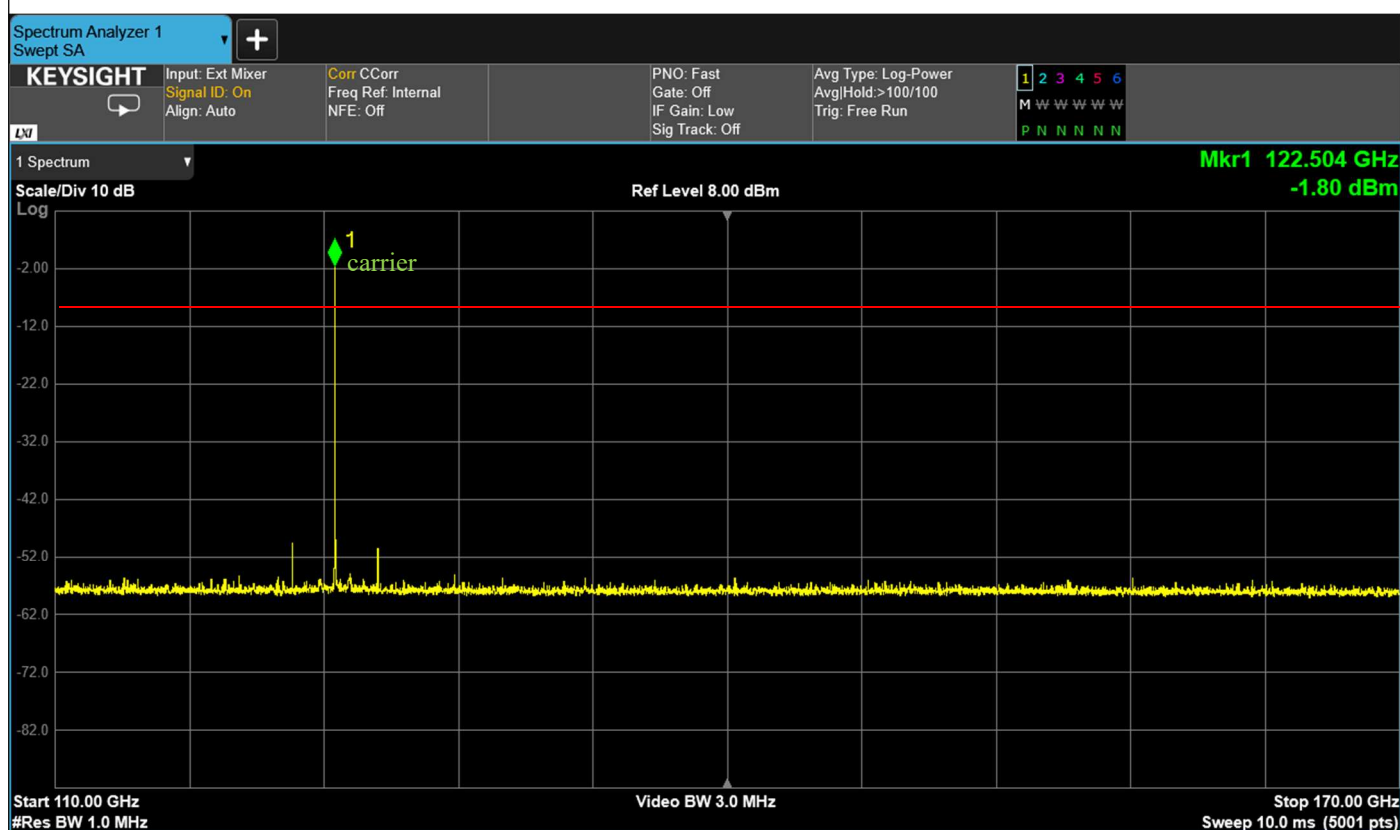
Test Cables used	K163
Test equipment used	385, 764, 660, 666, 667, 668, 669

The equipment passed the conducted tests	Yes	No	N.t. [*]
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Test setup photos / test results are attached	Yes	No	Annex no.: 6
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Transmitter spurious radiation above 110 GHz – 170 GHz (FCC § 15.258 section (3))

Frequency	Receiver Detector	BW	RL	FSPL	G	CL	EIRP	Limit	Margin	EP	Antenna	
											Pol	H
GHz	Type	kHz	dBm	dB	dB	dB	dBm	dBm	dB	°	H / V	m
120.585	Peak	1000	-104.63	68.1	21.5	8.0	-50.03	-9.9	40.13	3	V	142
124.414	Peak	1000	-106.20	68.3	21.7	8.4	-51.20	-9.9	41.3	3	V	142



Measurement uncertainty: ± 6.8 dB

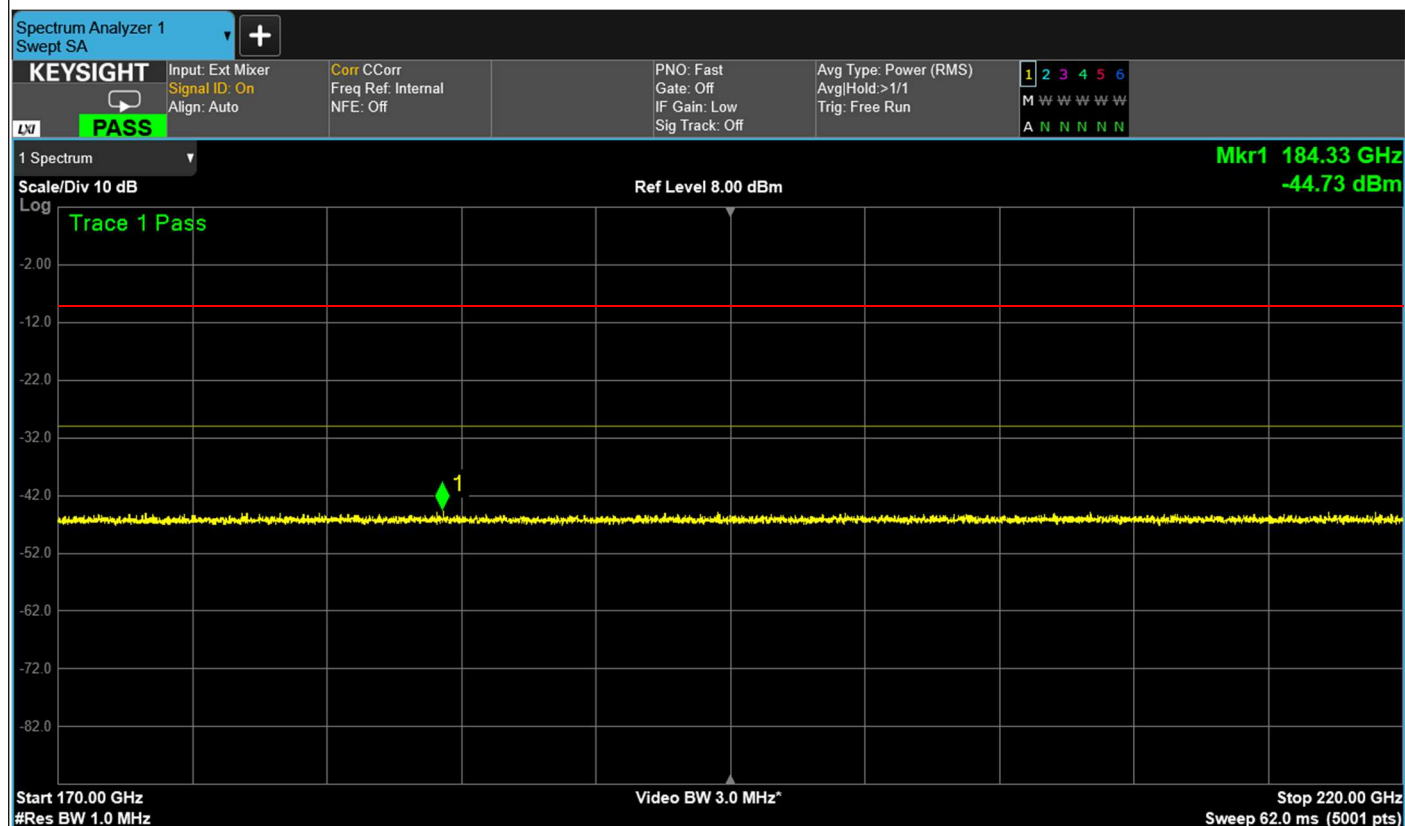
**** All other emissions lower than the noise level of the measuring equipment!**

Test Cables used	K163
Test equipment used	613, 660, 666, 667, 668, 669, 675, 676, 687

The equipment passed the conducted tests	Yes	No	N.t. [*]
Test setup photos / test results are attached	Yes	No	Annex no.: 6

Transmitter spurious radiation above 170 GHz – 220 GHz (FCC § 15.258 section (3))

Frequency	Receiver Detector	BW	RL	FSPL	G	CL	EIRP	Limit	Margin	EP	Antenna	
GHz	Type	kHz	dBm	dB	dB	db	dBm	dBm	dB	°	H / V	m
184.330	Average	1000	-104.53	71.8	21.2	-9.2	-44.73	-9.9	34.83	3	V	142



Measurement uncertainty: ± 6.8 dB

**** All other emissions lower than the noise level of the measuring equipment!**

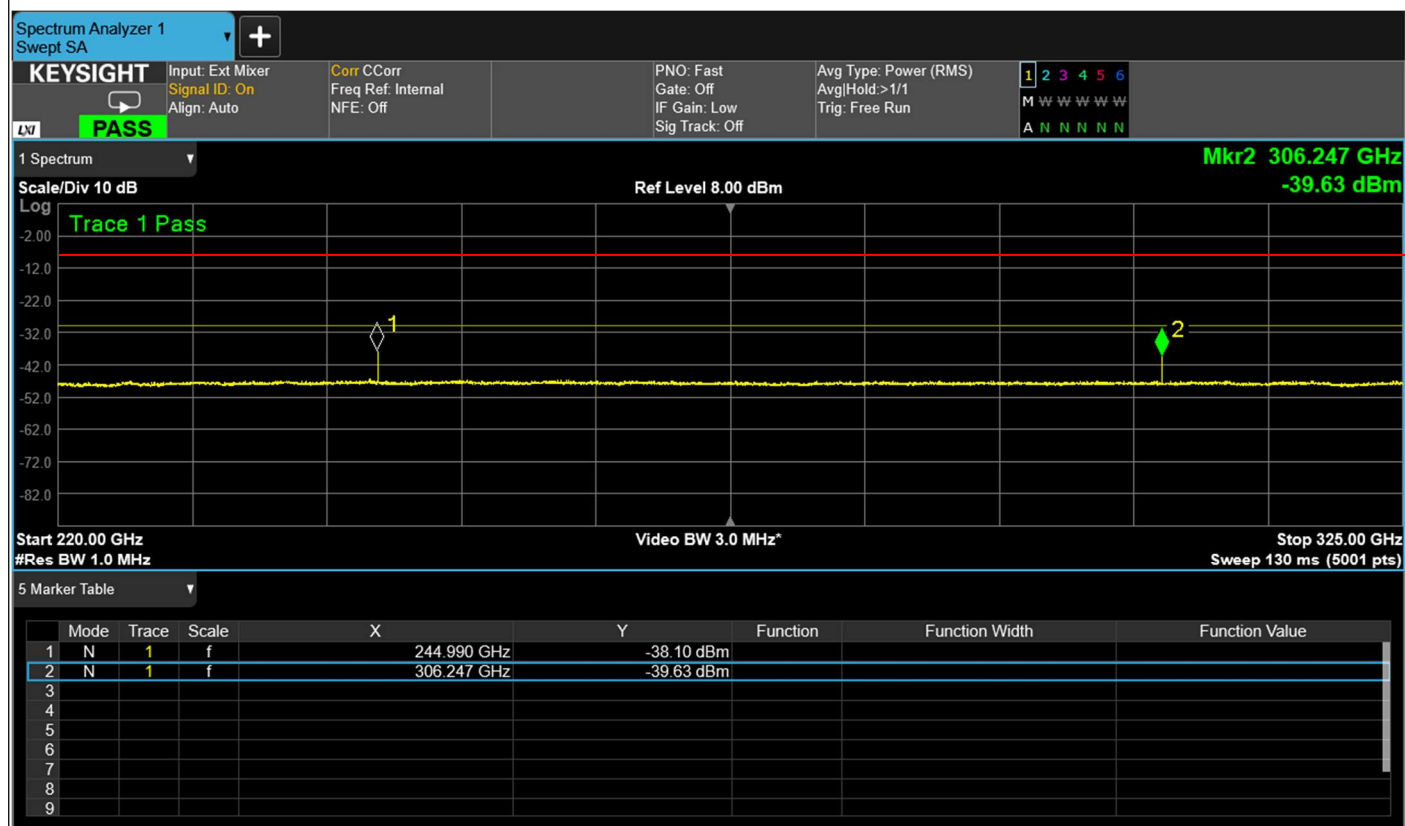
Test Cables used	K163
Test equipment used	613, 660, 666, 667, 668, 669, 677, 678, 688

The equipment passed the conducted tests	Yes	No	N.t. [§]
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Test setup photos / test results are attached	Yes	No	Annex no.: 6
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Transmitter spurious radiation above 220 GHz – 330 GHz (FCC § 15.258 section (3))

Frequency	Receiver Detector	BW	RL	FSPL	G	CL	EIRP	Limit	Margin	EP	Antenna	
GHz	Type	kHz	dBm	dB	dB	dB	dBm	dBm	dB	°	H / V	m
244.990	Average	1000	-101.70	74.2	24.3	-13.7	-38.10	-9.9	28.20	3	V	142
306.247	Average	1000	-101.73	76.2	27.1	-13.0	-39.63	-9.9	29.73	3	V	142



Measurement uncertainty: ± 6.8 dB

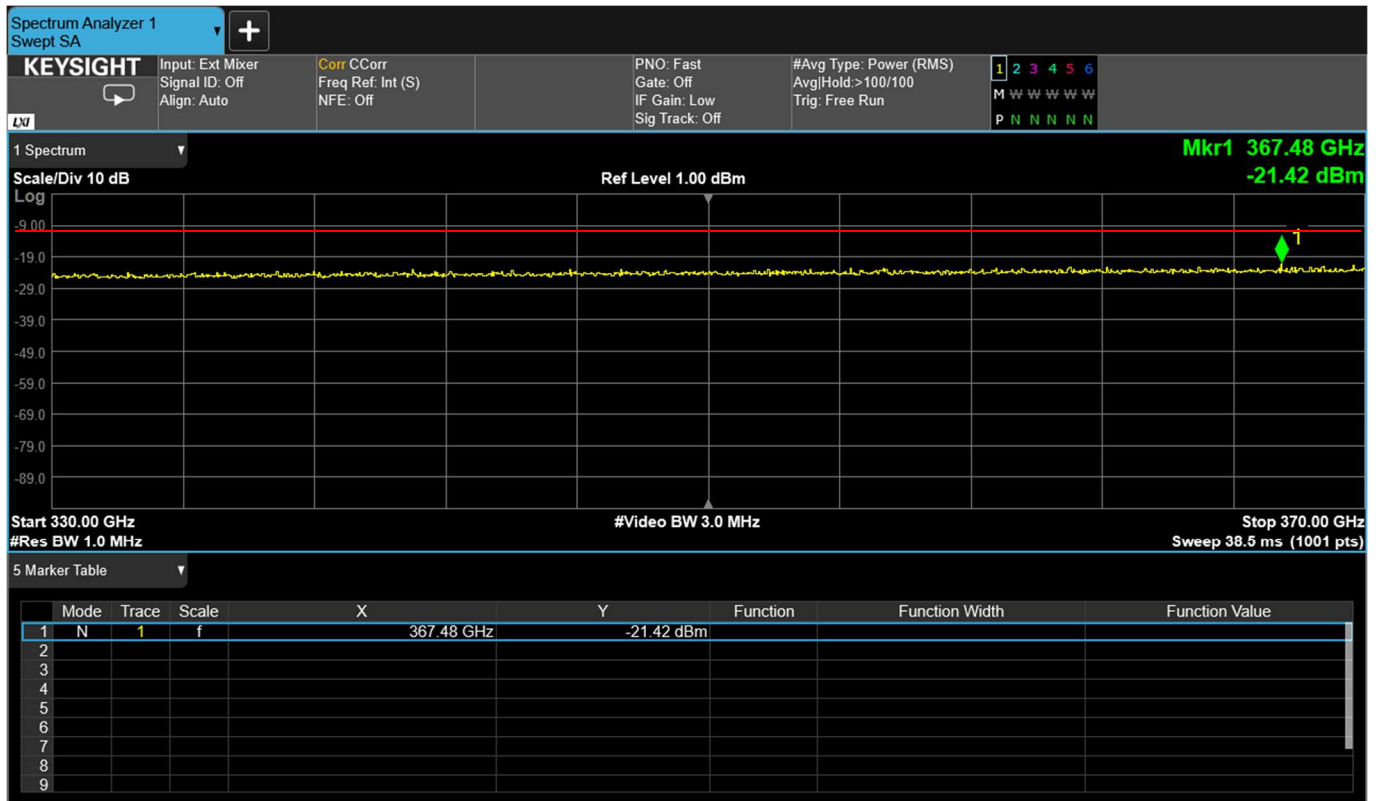
**** All other emissions lower than the noise level of the measuring equipment!**

Test Cables used	K163
Test equipment used	613, 660, 666, 667, 668, 669, 679, 680, 689

The equipment passed the conducted tests	Yes	No	N.t.*
Test setup photos / test results are attached	Yes	No	Annex no.: 6

Transmitter spurious radiation above 330 GHz – 370 GHz (FCC § 15.258 section (3))

Frequency	Receiver Detector	BW	RL	FSPL	G	CL	EIRP	Limit	Margin	EP	Antenna	
											Pol	H
GHz	Type	kHz	dBm	dB	dB	dB	dBm	dBm	dB	°	H / V	m
367.480	Average	1000	-87.22	77.7	24.8	-12.9	-21.42	-9.9	11.52	3	V	142



Measurement uncertainty: ± 6.8 dB

**** All other emissions lower than the noise level of the measuring equipment!**

Test Cables used	K163
Test equipment used	613, 660, 666, 667, 668, 669, 679, 680, 689

The equipment passed the conducted tests	Yes	No	N.t. [*]
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Test setup photos / test results are attached	Yes	No	Annex no.: 6
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8.7 Bandwidth

8.7.1 Regulation

According to FCC § 15.258 (b)(4), Transmitters with an emission bandwidth of less than 100 MHz must limit their peak radiated power to the product of the maximum permissible radiated power (in milliwatts) times their emission bandwidth divided by 100 MHz. For the purposes of this paragraph (b)(4), emission bandwidth is defined as the instantaneous frequency range occupied by a steady state radiated signal with modulation, outside which the radiated power spectral density never exceeds 6 dB below the maximum radiated power spectral density in the band, as measured with a 100 kHz resolution bandwidth spectrum analyzer. The center frequency must be stationary during the measurement interval, even if not stationary during normal operation (e.g., for frequency hopping devices).

According to FCC § 15.258 (d) Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range -20 to + 50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise.

8.7.2 Test Procedure

6 dB Bandwidth and Occupied Bandwidth (99 % Bandwidth) were measured. The Occupied Bandwidth was measured directly from the spectrum analyzer's in-built measurement function with correct analyzer settings (RBW, VBW, detector, span and etc). For 6 dB Bandwidth, the measurement settings and procedure were carried out in accordance with the ANSI C63.10-2013 section 9.3. The bandwidth measurements were also performed in extreme environmental conditions.

8.7.3 Result

Measured 99% BW MHz	Measured 6dB BW MHz
0.71743	0.30139

Test Cables used	K163
Test equipment used	102a, 502, (673+348)

The equipment passed the conducted tests	Yes	No	N/A*
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Test setup photos / test results are attached	Yes	No	Annex no.: 3
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8.8 Frequency tolerance

8.8.1 Regulation

Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range -20 to +50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise.

8.8.2 Test procedures

Stability with respect to ambient temperature:

Supply the EUT with nominal ac voltage, or install a new or fully charged battery in the EUT. If possible, a dummy load should be connected to the EUT, because an antenna near the metallic walls of an environmental test chamber could affect the output frequency of the EUT. If the EUT is equipped with a permanently attached, adjustable-length antenna, the EUT should be placed in the center of the chamber with the antenna adjusted to the shortest length possible. Turn the EUT on, and tune it to one of the number of frequencies required

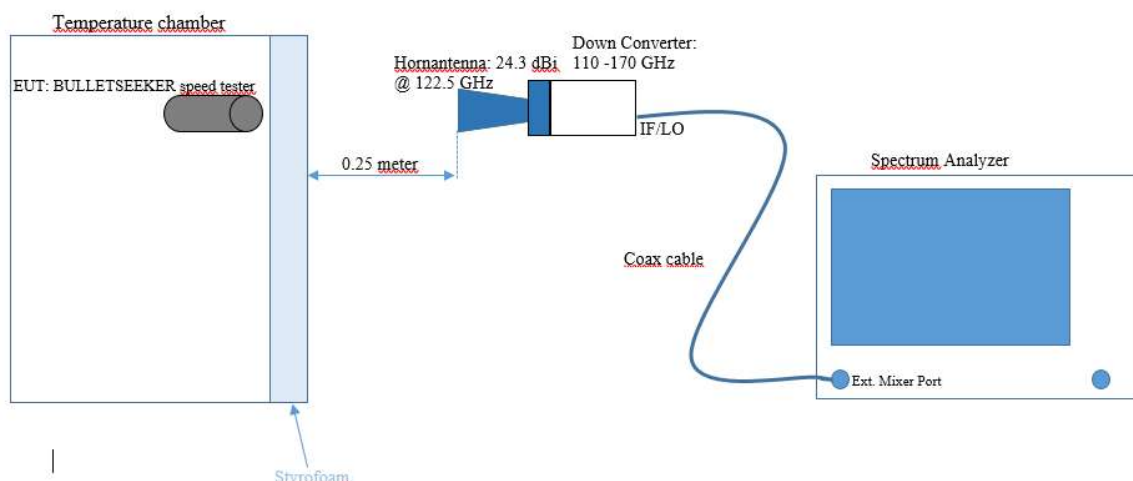
Couple the intentional radiator output to the measuring instrument by connecting an antenna to the measurement instrument with a suitable length of coaxial cable and placing the measurement antenna near the EUT (e.g., 15 cm away) or by connecting a dummy load to the measuring instrument through an attenuator, if necessary.

Supply the EUT with nominal ac voltage, or install a new or fully charged battery in the EUT. Turn the EUT on, and couple its output to the measuring instrument by connecting an antenna to the measurement instrument with a suitable length of coaxial cable.

Adjust the location of the measurement antenna and the controls on the measuring instrument to obtain a suitable signal level (i.e., a level that will not overload the measuring instrument, but is strong enough to allow measurement of the operating or fundamental frequency of the EUT).

Tune the EUT to any one of the number of frequencies specified. Turn the EUT off, and place it inside an environmental chamber if appropriate. Allow the chamber to stabilize at +20 °C before proceeding. Turn on the EUT, and record the operating frequency of the intentional radiator at startup and two, five, and ten minutes after startup. Turn the EUT off and allow it to cool to the ambient temperature, and then repeat this procedure for the number of the frequencies specified. Four measurements are made at each operating frequency.

8.8.2 Test setup



Stability with respect to input voltage:

Supply the EUT with nominal ac voltage, or install a new or fully charged battery in the EUT. If possible, a dummy load should be connected to the EUT, because an antenna near the metallic walls of an environmental test chamber could affect the output frequency of the EUT. If the EUT is equipped with a permanently attached, adjustable-length antenna, the EUT should be placed in the center of the chamber with the antenna adjusted to the shortest length possible. Turn the EUT on, and tune it to one of the number of frequencies required.

Couple the intentional radiator output to the measuring instrument by connecting an antenna to the measurement instrument with a suitable length of coaxial cable and placing the measurement antenna near the EUT (e.g., 15 cm away) or by connecting a dummy load to the measuring instrument through an attenuator, if necessary.

Adjust the location of the measurement antenna and the controls on the measuring instrument to obtain a suitable signal level (i.e., a level that will not overload the measuring instrument, but is strong enough to allow measurement of the operating or fundamental frequency of the EUT). Turn the EUT off, and place it inside an environmental temperature chamber. For devices that are normally operated continuously, the EUT may be energized while inside the test chamber. For devices that have oscillator heaters, energize only the heater circuit while the EUT is inside the chamber.

Set the temperature control on the chamber to the highest specified EUT operating temperature, and allow the temperature inside the chamber to stabilize at the set temperature before starting frequency measurements.

While maintaining a constant temperature inside the environmental chamber, turn the EUT on and record the operating frequency at startup and two, five, and ten minutes after the EUT is energized. Four measurements in total are made.

Repeat the above procedure until the number of frequencies specified has been measured. After all measurements have been made at the highest specified temperature, turn the EUT off. Repeat the above measurement process for the EUT with the test chamber set at the lowest temperature specified by the regulatory or procuring agency. Measurements shall be made at the number of frequencies specified.

8.7.3 Result

Test conditions	Frequency tolerance			
	Frequency (GHz)			
$T_{nom} = +20^{\circ} C$	f_L Measured	f_H Measured	f_L Limit	f_H Limit
$V_{min} = 3.7 V DC$	122.499056169	122.499705605	116.000	123.000
$V_{nom} = 4.0 V DC$	122.499044671	122.499762099	116.000	123.000
$V_{max} = 4.7 V DC$	122.499013174	122.499748600	116.000	123.000
Measurement uncertainty				$\pm 5 \cdot 10^{-8}$

Test conditions	Frequency tolerance			
	Frequency Measured (GHz)			
$V_{nom} = 4.7 V DC$	f_L Measured	f_H Measured	f_L Limit	f_H Limit
$T_{min} -20^{\circ} C$	122.499685107	122.500261049	116.000	123.000
$T_{min} -10^{\circ} C$	122.499635112	122.500261549	116.000	123.000
$T_{min} 0^{\circ} C$	122.499587616	122.500212054	116.000	123.000
$T_{min} +10^{\circ} C$	122.499497625	122.500117563	116.000	123.000
$T_{min} +20^{\circ} C$	122.499013174	122.499748600	116.000	123.000
$T_{min} +30^{\circ} C$	122.498799695	122.499490626	116.000	123.000
$T_{min} +40^{\circ} C$	122.498788696	122.499543121	116.000	123.000
$T_{min} +50^{\circ} C$	122.498884687	122.499575618	116.000	123.000
Measurement uncertainty				$\pm 5 \cdot 10^{-8}$

Test Cables used	K163
Test equipment used	102a, 502, (673+348)

The equipment passed the conducted tests	Yes	No	Not *
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Test setup photos / test results are attached	Yes	No	Annex no.: 3
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8.8 RF radiation exposure

8.8.1 Regulation

According to FCC § 15.255 (g), Radio frequency devices operating under the provisions of this part are subject to the radio frequency radiation exposure requirements specified in §§1.1307(b), 1.1310, 2.1091, and 2.1093 of this chapter, as appropriate. Applications for equipment authorization of mobile or portable devices operating under this section must contain a statement confirming compliance with these requirements. Technical information showing the basis for this statement must be submitted to the Commission upon request.

Limits for Maximum Permissible Exposure (MPE) (§1.1310, §2.1091)

Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (minutes)
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*(180/f ²)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

Note 1: f = frequency in MHz; * = Plane-wave equivalent power density

Note 2: RF exposure calculation according to §1.1310 and §2.1091

8.8.2 Result

These equations are generally accurate in the far field of an antenna but will over predict power density in the near field, where they could be used for making a “worst case” prediction.

$$S = PG/4\pi R^2$$

where S = power density (in appropriate units, e.g. mW/cm²)

P = power input to the antenna (in appropriate units e.g. mW)

G = power gain of the antenna in the direction of interest relative to the isotropic radiator

R = distance to the center of radiation of the antenna (appropriate units e.g. cm)

$$\text{OR, } S = \text{EIRP}/(4\pi R^2)$$

where, EIRP = equivalent isotropically radiated power

Operating Frequency	EIRP		Power density (S) @ 20 cm	
			Calculated	Limit
GHz	dBm	mW	mW/ cm ²	
122.49946	-1.43	0.72	0.00014	1.0

The equipment passed the conducted tests	Yes	No	Not*
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Test setup photos / test results are attached	Yes	No	
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9. Additional information to the test report

Remarks	Description
N.t. ¹	Not tested, because the antenna is part of the PCB
N.t. ²	Not tested, because the EUT is directly battery powered
N.t. ³	Not tested, because not applicable to the EUT
N.t. ⁴	Not tested, because not ordered

10. List of test equipment

State Mai 20, 2022					
Marking	Manufacturer	SW/Type/Serial-No.	Last Cal./Val.	Next Cal./Val.	No.
1 Measuring Instruments					
Attenuator	Radiall	---	Nov 19	Nov 22	62
Attenuator 3dB	Suhner	6803/17	Nov 19	Nov 22	137
Attenuator 3dB / 18 GHz	Suhner	3dB/18GHz	Nov 19	Nov 22	299
Terminator	Texcan	---	Nov 19	Nov 22	304
Attenuator 6dB / 18 GHz	Suhner	6dB/18GHz	Nov 19	Nov 22	344
Attenuator 20dB / 20GHz	Parzich	40AH-20	Nov 19	Nov 22	354
Terminator	KDI	T173CS	Nov 19	Nov 22	490
Variable transformer	RFT	LS 002	---	---	154a
Variable transformer	Schunt+Ben	---	---	---	155
Power sensor	Marconi	6914	Sep 20	Sep 22	258
Power sensor	Rohde & Schwarz	NRP18SN	Feb 22	Feb 24	651
3-Path Diode Power Sensor 10 MHz to 8 GHz	Rohde & Schwarz	NRP8S	Oct 20	Oct 22	663
3-Path Diode Power Sensor 10 MHz to 18 GHz	Rohde & Schwarz	NRP18S-20	Oct 20	Oct 22	664
Coaxial Directional Coupler	Narda	3003-20	Jan 21	Jan 24	370/342
Coaxial directional coupler	Mini Circuits	ZFDC-20-5	Mai 22	Mai 24	434
Coaxial directional coupler	Narda+Suhner	---	Mar 20	Mar 23	472/492
Coaxial High Pass Filter	Mini circuits	NHP-700	Apr 21	Apr 24	435
Coaxial High Pass Filter	Mini circuits	NHP-200	Apr 21	Apr 24	405
Coaxial High Pass Filter	Mini circuits	NHP-25+	Apr 21	Apr 24	455
High Pass Filter	Mini circuits	VHF-3500+	Apr 21	Apr 24	451
High Pass Filter	Mini circuits	VHF-1200+	Apr 21	Apr 24	452
Bandpass Filter	Schomandl	BN86871	Nov 21	Nov 24	66
Bandpass Filter	Schomandl	BN68673	Nov 21	Nov 24	67
Low Pass Filter	Mini circuits	SLP550	Apr 21	Apr 24	273
Low Pass Filter	Mini circuits	SLP550	Apr 21	Apr 24	274
RF Current Probe 9 kHz – 30 MHz	Rohde & Schwarz	ESH2-Z1	Aug 21	Aug 24	42
Passive Test Probe – 9 kHz – 30 MHz	TÜV NORD	VDE 0876	Apr 21	Apr 24	45
Coaxial Fixed Attenuator DC – 1 GHz	Texscan	HFP50/10	Jul 20	Jul 23	60
8 Wire Impedance Stabilisation Network	Schwarzbeck	CAT5 8158	Nov 21	Nov 23	71a
T-Section - 50 W	Rohde & Schwarz	BN 42441/50	Nov 21	Nov 24	93
RF Current Injection Clamp 0.15 – 1GHz	Lüthi GmbH	EM 101	Nov 19	Nov 22	156
Absorbing Clamp MDS 30MHz – 1GHz	Lüthi GmbH	MDS-21	Nov 19	Nov 22	160
Insertion Unit	Rohde & Schwarz	URV5-Z4	Mai 19	Mai 22	162
Coaxial RF Termination - 0 – 1000 MHz	Telewave Inc.	TWL 35	Nov 21	Nov 24	164
Coaxial RF Termination - 0 – 1000 MHz	Telewave Inc.	TWL 60	Nov 21	Nov 24	165
Fixed Attenuator - DC – 1.5GHz	Bird	Mod/ 8343-060	Apr. 20	Apr. 23	177
Rotary Step Attenuator DC – 2 GHz	Texscan	TA – 50	Mar20	Mar 22	184
CDN up to 230 MHz	MEB	KEN-M 2 /M 3	Dec 21	Dec 23	264
Impulse limiter 10 dB	Rohde & Schwarz	ESH3 Z2	Mai 19	Mai 22	272
Fixed Attenuator - DC – 18 GHz 30 dB	MTS	---	Nov 20	Nov 23	275
Fixed Attenuator - DC – 18 GHz 30 dB	MTS	---	Mai 22	Mai 24	276
Passive Probe - 9 kHz – 30 MHz 2.5 kΩ	RFT	TK 121	Jun 20	Jun 23	302
Passive probe 1.5kΩ	Schwarzbeck	TK 9416	Oct 20	Oct 23	621
Termination Resistor 50 W	Radiall	404011	Nov 21	Nov 23	309
Branching device (4x) 50W	Rohde & Schwarz	892228/20	Sep 19	Sep 22	320
Dummy-Load - 2 – 18 GHz	Narda	MODEL 367NF	Nov 19	Nov 22	343
DC Block Adapter - 0.045 – 26.5 GHz	Hewlett-Packard	11742A	Apr 21	Apr 24	356

Insertion Unit 10V 9 kHz 1000 MHz	Rohde & Schwarz	URV 5-Z2	Mai 19	Mai 22	367
RF Probe 0.02 – 1000 MHz	Rohde & Schwarz	395.2680.02	Mai 19	Mai 22	368
150W attenuator	Weinschel	49-20-33	Oct 19	Oct 22	374
Fixed Coaxial Attenuator - DC – 18 GHz	Weinschel	23-6-34	Feb 20	Feb 23	375
Insertion Unit 9 kHz – 2000 MHz	Rohde & Schwarz	URY-Z2	Oct 19	Oct 22	416
Panoramic Adapter (Monitoring)	Schwarzbeck	PAN1550	---	---	429
DC-BLOCK - DC – 6.0 GHz 50 W	Mini Circuits	BLK-6-N+	Nov 21	Nov 24	462
Terminating resistor 50Ω SMA	---	---	Nov 19	Nov 22	493
Terminating resistor 50Ω SMA	---	SC 60-601-0000-31	Nov 19	Nov 22	497
Fixed Attenuator – 0 – 40 GHz	Anritsu	41KC-10	Nov 19	Nov 22	504
Fixed Attenuator – 0 – 40 GHz	Anritsu	41KC-10	Nov 19	Nov 22	505
Fixed Attenuator – 0 – 40 GHz	Anritsu	41KC-6	Nov 19	Nov 22	506
Fixed Attenuator – 0 – 40 GHz	Anritsu	41KC-3	Nov 19	Nov 22	507
Electric Dummy Load	RA-NAV Lab.	DA-75U	---	---	526
Power Splitter / Combiner	Mini Circuits	ZESC-2-11	Nov 19	Nov 22	527
3 Way Power Splitter / Combiner	Mini Circuits	ZFSC-3-1	Mar 20	Mar 23	529
3 Way Power Splitter / Combiner	Mini Circuits	ZFSC-3-1	Mar 20	Mar 23	530
RF-Attenuator - 6 dB	Haefely	---	Mar 20	Mar 23	540
RF-Attenuator - 1– 120 MHz 12 dB	Haefely	---	Mar 20	Mar 23	541
RF-Attenuator - 1– 120 MHz 39 dB	Haefely	---	Mar 20	Mar 23	542
LISN 9kHz – 30 MHz	Schwarzbeck	NNLA 8120	Aug 20	Aug 22	551
HV Probe P6013A	Tektronix	P6013A	Mai 19	Mai 22	559
VLISN 5μH	Schwarzbeck	8125-1944	Nov 21	Nov 23	585
VLISN 5μH	Schwarzbeck	8125-1945	Nov 21	Nov 23	586
20dB Attenuator, up to 18 GHz	Mini Circuit	BW-N20W5+	Nov 19	Nov 22	594
Step Attenuator - DC-18 GHz 0 to 11 dB	Hewlett-Packard	8494B	Nov 19	Nov 22	604
Analyser Reference System	Spitzenberger & Spies	ARS 16/1	Mar 22	Mar 24	606a/b/c
Capacitive Coupling Clamp 5 kV	Schlöder	SFT 415	Mai 20	Mai 23	608
RF Probes for 50 Ω Receivers	Schwarzbeck	TK 9416	---	---	612
Current probe TRMS	BEHA APROB	CHB35	Oct 19	Oct 22	652
Semi Anechoic Chamber	COMTEST	SAC-3m	Apr 21	Apr 23	660
Maturo Turntable	Maturo	TT2.0SI (SN: TT2.05SI/817 SW: 1.0.0.4473)	---	---	667
Maturo Antenna Mast	Maturo	TAM4.5-E-10kg (SN: 10011/216/2588.01)	---	---	668
Maturo Controller	Maturo	FCU3.0/009/2588.01 (SN: 10014/2019)	---	---	669
Current probe 20 Hz – 100 MHz	Rohde & Schwarz	EZ-17 (0816.2063.03)	Mar 20	Mar 23	670
Coupling Decoupling Network	AMETEK	CDN ST08A	Aug 20	Aug 23	672
BONN HF Switch Matrix DC – 8 GHz	BONN Elektronik	BAS 0080-3	---	---	682
External Directional Coupler	BONN Elektronik	BDC 1060-40/500	Dec 20	Dec 22	683
BI-Directional Coax. Coup. 50-1000 MHz	Narda	3020A	Nov 21	Nov 23	141
Vertical coupling plate	TÜV NORD HFT	---	---	---	265
Measuring table	TÜV NORD HFT	---	---	---	106
Data line coupling network	EM Test AG	CNV 504/ 508	---	---	285
2 Generators					
EFT/Burst Generator	Schlöder	SFT 1400	Mai 20	Mai 22	46a
ESD Generator	Schlöder	SESD 216	Dec 21	Dec 23	653
Signal Generator	Rohde & Schwarz	SMB100A SW 4.20.028.58	Jul 20	Jul 22	571
RF Generator	Rohde & Schwarz	SGT100A	Apr 20	Apr 22	636
Signal Generator	Rohde & Schwarz	SMG	Jun 21	Jun 23	136

Signal Generator	Marconi	2042	Mai 20	Mai 22	6
Signal Generator	Marconi	2024	Mai 20	Mai 22	213
Puls Generator	EM Test	MPG 200	Cal. before use	Cal. before use	181
Surge Generator	H+H	MIG063 IN S-T	Apr 21	Apr 23	561
3. Antennas					
Loop Ant. 9kHz-30MHz	Schwarzbeck	FMZB1516	Oct 21	Oct 23	23
Biconical Ant. 30-300 MHz	Schwarzbeck	VHA9103/BBA9106	Mai 22	Mai 24	80/616
Double Ridged Horn	Schwarzbeck	BBHA9120C	Feb 22	Feb 24	169
Double Ridged Horn	Schwarzbeck	BBHA 9120A	Mai 20	Mai 24	284
Tri-Log Broadband	Schwarzbeck	VULB9168	Mai 21	Mai 23	406
Broadband Horn 14-40 GHz	Schwarzbeck	BBHA9170	Feb 22	Feb 24	442
Log Per Antenna 0.7-20 GHz	Schwarzbeck	STLP9148	Mai 21	Mai 23	445a
Bilog Ant.	CHASE	CBL6111	Cal. before use	Cal. before use	167
Spectrum analyser Mixer 220 – 325 GHz	Radiometer Physics	SAM325	Aug 21	Aug 23	591
Dual Mode Potter Horn 220-325 GHz	Radiometer Physics	325-WR2	---	---	592
Dual Mode Potter Horn 75-110 GHz	Radiometer Physics	---	---	---	649
Gain Horn Antenna 50-75 GHz	Dorado	GH-15-20	---	---	511
Standard Gain Horn 1.7 – 2.6 GHz	Narda	645	---	---	514
W-band active Sextupler with input drive amplifier	Spacek Labs Inc.	AW-6XW-0	---	---	221a
60 to 65 GHz active frequency quadrupler	Spacek Labs Inc.	A625-4XW-0	---	---	222a
Harmonic Mixer 40-60 GHz	Rohde & Schwarz	FS-Z60	Aug 21	Aug 23	515
Gain Horn Antenna 40-60 GHz	Dorado	GH-19-20	---	---	518
Spectrum analyser Mixer 90-140 GHz	Radiometer Physics	SAM140	Aug 21	Aug 23	545
Dual Mode Potter Horn 90-140 GHz	Radiometer Physics	140-WR8	---	---	547
Spectrum analyser Mixer 140-220GHz	Radiometer Physics	SAM220	Aug 21	Aug 23	450
Dual Mode Potter Horn 140-220 GHz	Radiometer Physics	220-WR5.1	---	---	548
Harmonic Mixer 60-90 GHz	Rohde & Schwarz	FS-Z90	Aug 21	Aug 23	501
Dual Mode Potter Horn 60-90 GHz	Radiometer Physics	90-W12	---	---	549
Gain Horn 33-55 GHz	Dorado	---	---	---	383
Gain Horn 50-75 GHz	Dorado	---	---	---	384
Gain Horn 75-110 GHz	Dorado	---	---	---	385
Standard Gain Ant. 26.5-40 GHz	Maury Microwave	U211C	---	---	532/628
Waveguide Harmonic Mixer 50 – 75 GHz	Keysight	M1971V	Cal. before use	Cal. before use	763
Waveguide Harmonic Mixer 75 – 110 GHz	Keysight	M1971W	Cal. before use	Cal. before use	764
Stacked Log.-Per. Antenna 70 MHz – 10 GHz	Schwarzbeck	STLP 9129	---	---	662
Spectrum/Signal Analyzer Extension Module 110 GHz – 170 GHz (WR-6.5)	Virginia Diodes, Inc.	SAX 637	Mar 20	Mar 22	675
Spectrum/Signal Analyzer Extension Module 140 GHz – 220 GHz (WR-5.1)	Virginia Diodes, Inc.	SAX 636	Mar 20	Mar 22	677
Spectrum/Signal Analyzer Extension Module 220 GHz – 330 GHz (WR-3.4)	Virginia Diodes, Inc.	SAX 635	Mar 20	Mar 22	679
Conical Gain Horn Ant. 110 GHz – 170 GHz [21 dBi]	Virginia Diodes, Inc.	Conical Antenna WR-6.5	---	---	687
Conical Gain Horn Ant. 140 GHz – 220 GHz [21 dBi]	Virginia Diodes, Inc.	Conical Antenna WR-5.1	---	---	688
Diagonal Gain Horn Ant. 220 GHz – 330 GHz [26 dBi]	Virginia Diodes, Inc.	Diagonal Antenna WR-3.4	---	---	689
4. Amplifier					
RF-Power Amplifier 250 kHz – 150 MHz	ENI	3100LA	---	---	123
RF pre-amplifier 100kHz-1.3GHz	HP	8447E	Aug 20	Aug 22	166a
Mitteq amplifier 26.5-40 GHz	Mitteq	---	Apr 22	Apr 24	223a
RF pre-amplifier 1-18GHz	Narda	---	Apr 22	Apr 24	345
Mitteq Amplifier 18-26GHz	Mitteq	---	Apr 20	Apr 22	433

Microwave amplifier 12-28GHz	Schwarzbeck	BBV9719	Apr 22	Apr 24	443
Microwave amplifier 0.5-18GHz	Schwarzbeck	BBV9718	Apr 21	Apr 23	444
RF-Power Amplifier 10kHz-1000 MHz	Poetschke	8100 (Band 1) BHED (Band 2) BHED (Band 3)	---	---	684
RF-Power Amplifier 800 MHz – 4,2 GHz	Amplifier Research	10S1G4	---	---	685
RF-Power Amplifier 4 GHz – 8 GHz	Amplifier Research	35S4G8A	---	---	686
RF-Power Amplifier 0.69 GHz – 6 GHz	Rohde & Schwarz	BBA150-D110/E60	---	---	690

5. Power supplies

Programmable Power Supply	Fluke	PM 2813	---	---	28a
Power Supply	HP	---	---	---	125
Power Supply	Sorensen	LM 30-6	---	---	134a
Power Supply	HP	6034L	---	---	226
Regulated Power Supply	Farnell	AP60-50	---	---	408
Power Supply	EA	PSI 8080-40-DT	---	---	560
Power Supply	HP	6032A	---	---	644

6. Meters

Microwave Frequency Counter	Hewlett-Packard	5351B	Nov 20	Nov 22	432
Temperature test cabinet	Heraeus Vötsch	VMT04/35	---	---	102a
Temperature test cabinet	Brabender	TTE 32/40 H	---	---	87
Digital-Hygro-Thermometer	Greisinger	GFTH95	Nov 19	Nov 22	57a
Volt & RF Power Meter	Rohde & Schwarz	URV35	Cal. before use	Cal. before use	161
Spectrum Analyzer - 9 kHz – 18 GHz	Rohde & Schwarz	FSL18	Jul 20	Jul 22	171a
Multimeter	Gossen Metrawatt	Metrahit pro	Nov 21	Nov 23	215a
Humidity/Temperature Measuring device	TESTO	Testo 625	Nov 21	Nov 23	259a
Volt & RF Power Meter	Rohde & Schwarz	URV35	Cal. before use	Cal. before use	271
Multimeter	Gossen Metrawatt	Metrahit 26S	Sep 20	Sep 22	313
Level and Power Meter - 9 kHz – 3 GHz	Rohde & Schwarz	URY	Apr 22	Apr 24	307
Temperature test device	Ahlhorn	Almemo 2390-5 PT100	Mar 20	Mar 23	401/402
Digital-Vacuum-/Barometer	Greisinger	GDH12AN	Oct 19	Oct 22	558
Digital Storage Oscilloscope	Tektronix	TDS 2012C	Cal. before use	Cal. before use	568
Miniature Flat, Zero-Biased Schottky Detector –0.1– 18 GHz	Narda	4503A-03	Val. before use	Val. before use	613
Digital-Vacuum-/Barometer	Greisinger	GDH-200-14	Nov 21	Nov 23	632
Signal & Spectrum Analyser 10 Hz-30 GHz	Rohde & Schwarz	FSV-30 SW 3.70	Aug 21	Aug 23	502
EMI Test receiver ESW26	Rohde & Schwarz	R&S ESW26 (SN: 101383/26 SW: R&S ESW2.10)	Nov 21	Nov 23	665
Signal analyser Keysight 50GHz	Keysight	UXA N9040B (SN: MY57213006 SW: A.27.02/2020 1.0)	Jan 22	Jan 24	666

7. test/control software

EMC32	Rohde & Schwarz	V10.60.20	---	---	---
Maturo mcApp	Maturo	SW: V3.4.9.4537 (19.04.04)	---	---	---
SPS EMC	Spitzenberger & Spies	SW: V4.1.3	---	---	---
EMV-Soft	Schlöder GmbH	SW: V11.95	---	---	---
ISMISO	EM Test AG	SW:V3.63	---	---	---

11. List of test cables

Internal Cable Number	Connector Type	Frequency Range (MHz)	Cable Length (m)	Manufacturer
3	N	0,5 - 8000	3	Cellflex
4	N	0,5 - 8000	3	Cellflex
4a	BNC	10 – 1500	0.50	Telemeter
12a	N	10 – 265000	6	Huber + Suhner
14a	BNC	10 – 1000	1.00	Telemeter
17a	APC3.5	10 – 26500	2.13	Huber + Suhner
18a	APC3.5	10 – 26500	2.13	Huber + Suhner
22	BNC	10 – 1000	1.50	---
27	BNC	10 – 1000	1.00	Fabrica Milanese Cond.
40	BNC	---	0.50	Aircell
43	SMA	10 – 18000	0.50	Rosenberger
44	SMA	---	0.50	Huber + Suhner
45	SMA	10 – 18000	0.50	Huber + Suhner
48	SMA	---	0.50	Huber + Suhner
49	N	10 – 18000	1.00	Huber + Suhner
50	N	10 – 18000	1.00	Huber + Suhner
51	N	10 – 18000	1.00	Huber + Suhner
52	N	10 – 18000	1.00	Huber + Suhner
54	BNC	10 – 3500	1.00	Aircell
58	N	10 – 18000	2.00	Huber + Suhner
59	N	10 – 18000	1.00	Huber + Suhner
60	N	10 – 18000	2.00	Huber + Suhner
61	N	10 – 18000	1.00	Huber + Suhner
62	SMA	---	0.50	Huber + Suhner
63	SMA	10 – 18000	0.50	Huber + Suhner
64	SMA	10 – 18000	0.50	Huber + Suhner
65	APC3.5	10 – 26500	0.60	---
66	APC3.5	10 – 26500	0.60	---
67	APC3.5	10 – 26500	0.60	---
68	APC3.5	10 – 26500	0.60	---
72	BNC	---	0.40	---
73	BNC	---	0.40	---
76	SMA	10 – 30000	3.00	Gore
79	BNC/N	10 – 1000	5.00	---
80	SMA	---	0.25	Huber + Suhner
87	SMA	10 – 18000	0.15	Huber + Suhner
88	SMA	10 – 18000	0.15	Huber + Suhner
89	SMA	10 – 18000	0.15	Huber + Suhner
90	SMA	10 – 18000	0.15	Huber + Suhner
91	SMA	---	1.50	Huber + Suhner
94	BNC	---	1.10	---
95	BNC	---	0.80	---
96	BNC	---	0.80	---
100	N	10 – 26500	6.00	Rosenberg
101	N	10 – 18000	2.90	Huber + Suhner
102	SMA	10 – 18000	2.00	Huber + Suhner
111	BNC	10 – 1000	0.50	---
112	BNC	10 – 1000	0.50	---
114	SMA	10 – 18000	0.25	Huber + Suhner
116	SMA	10 – 18000	0.25	Huber + Suhner
119	N	10 – 20000	8.00	Jyebao
121	SMA	10 – 18000	1.50	Huber + Suhner

Internal Cable Number	Connector Type	Frequency Range (MHz)	Cable Length (m)	Manufacturer
122	SMA	10 – 18000	2.00	Huber + Suhner
123	SMA	10 – 18000	2.00	Huber + Suhner
145	SMA	10 – 26500	8.00	Huber + Suhner
147	APC3.5	10 – 40000	1.50	Jyebao
148	APC3.5	10 – 40000	3.00	Jyebao
151	SMA	10 – 18000	0.50	Rosenberger
152	SMA	10 – 18000	0.50	Rosenberger
154	BNC	10 – 1000	1.00	---
155	N/BNC	---	0.85	---
157	BNC	---	0.50	---
158	SMA	10 – 26500	2.00	Huber + Suhner
160	SMA	10 – 18000	0.40	Nortel Networks
161	SMA	10 – 18000	1.00	Huber + Suhner
162	APC35	10 – 26500	2.00	Huber + Suhner
163	APC3.5	10 – 26500	2.00	Huber + Suhner
164	APC3.5	10 – 26500	2.00	Huber + Suhner
165	APC2.9	10 – 26500	2.00	Huber + Suhner
166	APC3.5	10 – 40000	---	---
167	APC3.5	10 – 40000	1.00	Jyebao
168	APC3.5	10 – 40000	1.00	Jyebao
169	APC3.5	10 – 40000	1.00	Jyebao
170	APC3.5	10 – 40000	1.00	Jyebao
171	APC3.5	10 – 40000	1.00	Jyebao
172	SAM	---	0.90	Huber + Suhner
173	APC	10 – 26500	2.00	Huber + Suhner
174	APC	10 – 26500	---	Huber + Suhner
175	SMA	10 – 18000	0.40	Huber + Suhner
176	N-SMA	10 – 18000	0.50	Huber + Suhner
188	N	10 – 18000	5.00	Huber + Suhner
EMV 1	BNC	---	2.00	Henn
EMV 2	BNC	10 – 1000	2.00	Henn
EMV 4	BNC	---	9.70	Henn
EMV 5	BNC	---	3.80	Henn
EMV 6	BNC/N	10 – 1000	5.00	Lüthi
EMV 7	BNC	10 – 1000	1.50	Henn
EMV 8	BNC	10 – 1500	1.70	Henn
EMV 9	BNC	10 – 1000	1.70	Henn
EMV 11	BNC	---	5.20	Hasselt
EMV 12	BNC	10 – 1000	2.40	Hasselt
EMV 13	BNC	10 – 1000	4.10	Hasselt
EMV 14	BNC	10 – 1000	2.50	Hasselt
EMV 15	BNC	---	0.90	Henn
EMV 16	Fischer	---	2.00	---
EMV 18a	Fischer	---	1.00	---
EMV 19a	Fischer	---	1.50	---
KISN2	BNC	10 – 2000	4.80	---

End of test report