FCC Measurement/Technical Report on

WPT transceiver (source)

WCA NFC 2.0

FCC ID: KR5WCANFC20
IC: 7812D-WCANFC20

Report Reference: MDE_CONTI_2031_FCC_01

Test Laboratory:
7layers GmbH
Borsigstrasse 11
40880 Ratingen
Germany

Deutsche
Akkreditierungsstelle
D-PL-12140-01-01
D-PL-12140-01-02
D-PL-12140-01-03

Table of Contents

1 Summary

1.1 Technical Report Summary

Type of Authorization

Certification for an intentional radiator: 125 kHz transmitter and tagging system

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2 and 15 (10-1-19 Edition). The following subparts are applicable to the results in this test report.

Part 2, Subpart J – Equipment Authorization Procedures, Certification

Part 15, Subpart C – Intentional Radiators

§ 2.1049 Occupied bandwidth

§ 15.205 Restricted bands of operation

§ 15.207 Conducted limits

§ 15.209 Radiated emission limits; general requirements

Note:
ANSI C63.10-2013 is applied.

Summary Test Results:

The EUT complied with all performed tests as listed in sub-clause 1.3 Measurement Summary / Signatures.

1.2 FCC-IC Correlation Table

WPT Devices

Measurement	FCC reference	IC reference
Conducted emissions on AC Mains	§ 15.207	RSS-216 Issue 2 & Amdt. 1 2020: 6.2.2.1 ICES-001 Issue 5: 4, 5, 7.1.1 CAN/CSA-CEI/IEC CISPR 11:04
Transmitter spurious radiated emissions	§ 15.209	RSS-216 Issue 2 & Amdt. 1 2020: 6.2.2.2 ICES-001 Issue 5: 4, 5, 7.1.1 CAN/CSA-CEI/IEC CISPR 11:04
Restricted Bands	§ 15.205	RSS-Gen Issue 5 & Amdt. 1 2019: 8.10 RSS-216 Issue 2 & Amdt. 1 2020: 6.2.3
Wanted Emission (Carrier)	§ 15.209	RSS-216 Issue 2 & Amdt. 1 2020: 6.2.2.2 ICES-001 Issue 5: 4, 5, 7.1.1 CAN/CSA-CEI/IEC CISPR 11:04
Other requirements, e.g. Transmitter frequency stability	–	RSS-Gen Issue 5 & Amdt. 1 2019: 6.11/8.11
Receiver spurious emissions	–	RSS-216 Issue 2 & Amdt. 1 2020: 6.2.2.1 ICES-001 Issue 5: 4, 5, 7.1.1 CAN/CSA-CEI/IEC CISPR 11:04
Occupied bandwidth	§ 2.1049	RSS-Gen Issue 5 & Amdt. 1 2019: 6.7

Notes:
This EUT is classified as WPT Transmitter Type 3 / Category I Radio Apparatus.
Precise / exhaustive versions of the Standards:
ICES-001: ICES-001, Issue 5, July 2020

1.3 Measurement Summary / Signatures

47 CFR Chapter I FCC Part 15, Subpart C §15.209

Radiated Emissions
The measurement was performed according to ANSI C63.10

OP-Mode	Setup	Port	Final Result
WPT_act	Setup_01	Enclosure	passed

47 CFR Chapter I FCC Part 15, Subpart C §15.209

Peak Output Power
The measurement was performed according to ANSI C63.10

OP-Mode	Setup	Port	Final Result
WPT_act	Setup_01	Enclosure	passed

47 CFR Chapter I FCC Part 15, Subpart C §15.207

Conducted Emissions AC Power line
The measurement shall be performed according to ANSI C63.10

OP-Mode	Setup	Port	Final Result
–	–	–	N/A (1)

47 CFR Chapter I FCC Part 2, Subpart J §2.1049

Occupied Bandwidth
The measurement was performed according to ANSI C63.10

OP-Mode	Setup	Port	Final Result
WPT_act	Setup_01	Enclosure	performed

RSS-Gen 6.11/8.11

Frequency Stability
The measurement shall be performed according to ANSI C63.10

OP-Mode	Setup	Port	Final Result
–	–	–	N/A (2)

Notes:

N/A = Not applicable
(1) The EUT is DC powered. It is only intendent for the use in vehicles.
(2) Not required per 8.11.
performed = no limit is applicable to the test result.

1.4 Revision History

Version	Release date	Change Description	Version validity
initial	2020-12-10	--	valid

Responsible for Accreditation Scope: _____

Responsible for Test Report: _____

7 layers GmbH, Borsigstr. 11
40880 Ratingen, Germany
Phone +49 (0)2102 749 0

2 Administrative Data

2.1 Testing Laboratory

Company Name:	7layers GmbH
Address:	Borsigstr. 11 40880 Ratingen Germany
Laboratory accreditation no:	DAkkS D-PL-12140-01-01 | -02 | -03
ISED CAB Identifier	DE0007; ISED#: 3699A
FCC Designation Number:	DE0015
FCC Test Firm Registration:	929146
Responsible for accreditation scope:	Dipl.-Ing. Marco Kullik
Report Template Version:	2020-12-04

2.2 Project Data

Responsible for testing and report:	Dipl.-Ing. Andreas Petz
Employees who performed the tests:	documented internally at 7Layers
Date of Report:	2020-12-10
Testing Period:	2020-11-03 to 2020-11-09

2.3 Applicant Data

Company Name:	Continental Automotive GmbH
Address:	Siemensstrasse 12 93055 Regensburg Germany
Contact Person:	Mrs. Lavinia-Carolina Grecu

2.4 Manufacturer Data

Company Name:	please see applicant data
Address:	
Contact Person:	

3 Test object Data

3.1 General EUT Description

Equipment under Test	Wireless Charging Module
Product Name	WCA NFC 2.0
Type Designation:	–
Kind of Device:	126.6 kHz Transceiver Wireless Power Transfer
Voltage Type:	DC
Voltage level:	12 V nominal and tested voltage

3.1.1. General product description:

The EUT is a Wireless Charging Device which is intended to charge devices like mobile phones. It is capable to deliver a power of up to 15 W to a wireless charging receiver.

Two radio technologies are implemented:
1. Wireless charging transceiver operating at 126.6 kHz nominal frequency.
2. NFC transceiver operating at 13.56 MHz nominal frequency:
   An integral or external (dedicated) antenna can be used.

The test setups incl. the auxiliaries are provided by the applicant.
The tests have been carried out using an additional “spacer” between the EUT and AUX 1–3 providing a short gab between the devices. The spacer is made of acrylic glass.
For the test purpose, test cables have been used representing the cable harness that will be assembled later in the car with a length of approx. 1 m.

The auxiliaries are not subject of this test report but may impact test results.

The device is intended for professional installation only.

3.1.2. Specific product description for the EUT:

For a detailed description please refer to the documentation provided by the applicant.

3.1.3. The EUT provides the following ports:

Enclosure
DC connector
CAN
Detection front/rear version

Note: The three latter ports are combined in one connector.

3.2 EUT Main components

Type, S/N, Short Descriptions etc. used in this Test Report

Short Description	Equipment under Test	Type Designation	Serial No.	HW Status	SW Status
EUT A (Code: DE1439001ac01)	WCA NFC 2.0	–	–	C2	009_001_104

Note: The short description is used to simplify the identification of the EUT in this test report.

3.3 Ancillary Equipment

For the purposes of this test report, ancillary equipment is defined as equipment which is used in conjunction with the EUT to provide operational and control features to the EUT. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Ancillary Equipment can influence the test results.

Short Description	Equipment under Test	Type Designation	Serial No.	HW Status	SW Status
–	–	–	–	–	–

3.4 Auxiliary Equipment

For the purposes of this test report, auxiliary equipment is defined as equipment which is used temporarily to enable operational and control features especially used for the tests of the EUT which is not used during normal operation or equipment that is used during the tests in combination with the EUT but is not subject of this test report. It is necessary to configure the system in a typical fashion, as a customer would normally use it.
But nevertheless Auxiliary Equipment can influence the test results.

Short Description	Device	Type Designation	Serial No.	HW Status	SW Status
AUX 1	Wireless Power Receiver (WPT client)	Renesas, P9221-R	P9221-R-EVK MM	V2.2	–
AUX 2	Dummy Load DC to simulate constant worst-case / maximum current of WPT client	ARCOL 9.6 ohm / 15 W (connected to AUX 1)	–	–	–

3.5 EUT Setups

This chapter describes the combination of EUTs and equipment used for testing. The rationale for selecting the EUTs, ancillary and auxiliary equipment and interconnecting cables, is to test a representative configuration meeting the requirements of the referenced standards.

Setup No.	Combination of EUTs	Description and Rationale
Setup_01	EUT A + AUX 1 + AUX 2	EUT A with auxiliaries, representative set-up provided by the applicant

3.6 Operating Modes

This chapter describes the operating modes of the EUTs used for testing.

Op. Mode	Description of Operating Modes	Remarks
WPT_act	Maximum power is transferred from the EUT to AUX	EUT is transmitting continuously at 126.6 kHz and information between the EUT and AUX 1 is exchanged by load modulation

3.7 Special software used for testing

Sample with different parameters set in production firmware, provided by the applicant.

3.8 Product labelling

Please refer to the documentation of the applicant.

4 Test Results

4.1 Spurious radiated emissions

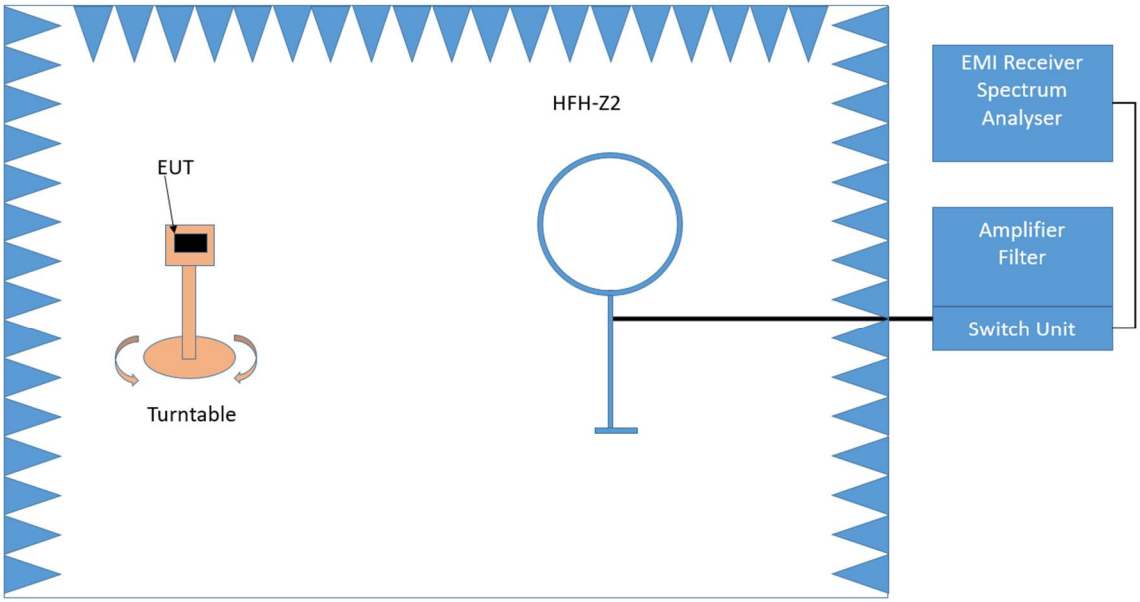
Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C63.10

4.1.1. Test Description

The test set-up was made in accordance to the general provisions of ANSI C63.10 in a typical installation configuration. The Equipment Under Test (EUT) was set up on a non-conductive table 1.0 x 2.0 m² in the semi-anechoic chamber. The influence of the EUT support table that is used between 30–1000 MHz was evaluated.
The measurement procedure is implemented into the EMI test software EMC32 from R&S. (Exploratory) Tests are performed at 3 orthogonal axes to determine the worst-case orientation of a body-worn or handheld EUT. The final test on all kind of EUTs is performed at 2 axes. A pre-check is also performed while the EUT is powered from DC (battery) power in order to find the worst-case operating condition.

1. Measurement up to 30 MHz



Test Setup; Spurious Emission Radiated (SAC), 9 kHz – 30 MHz

The Loop antenna HFH2-Z2 is used.

Step 1: pre measurement
- Anechoic chamber
- Antenna distance: 3 m
- Antenna height: 1 m (lowest part to ground)
- Antenna polarisation: 3 axis
- Detector: Peak-Maxhold
- Frequency range: 0.009 - 0.15 MHz and 0.15 – 30 MHz
- Frequency steps: 0.05 kHz and 2.25 kHz

- IF–Bandwidth: 0.2 kHz and 9 kHz
- Measuring time / Frequency step: 100 ms (FFT-based)

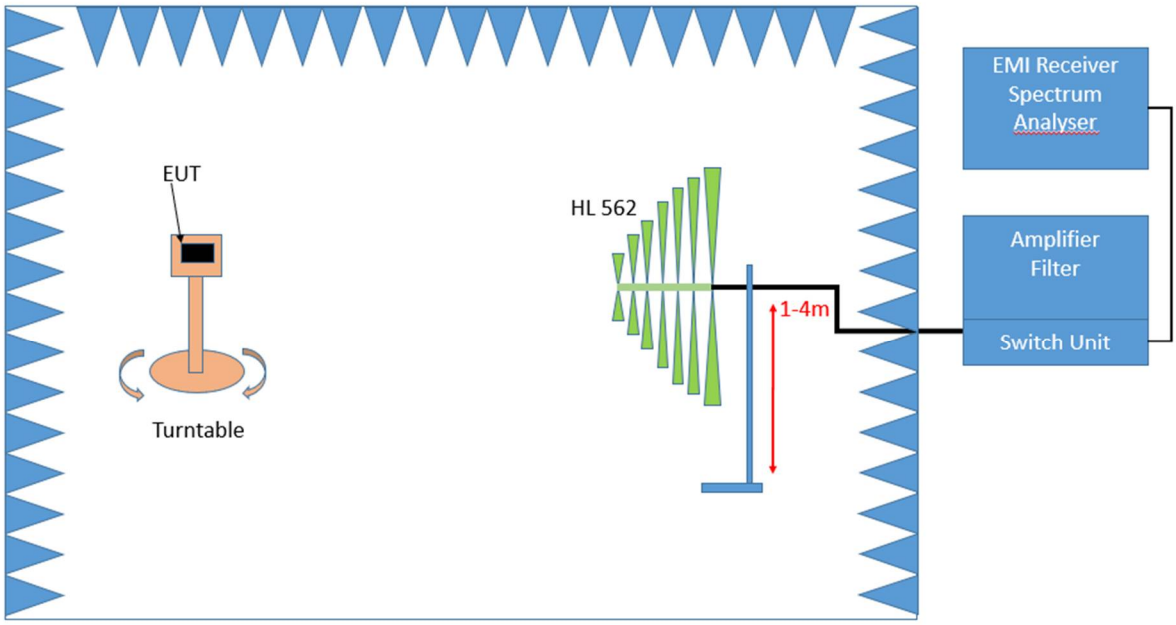
Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

Step 2: final measurement

For the relevant emissions determined in step 1, an additional measurement will be performed with the following changed settings. Intention of this step is to find the maximum emission level.

- Detector: Quasi-Peak besides 9–90 kHz and 110–490 kHz: Average and Peak
- Measuring time / Frequency step: 1 s

2. Measurement above 30 MHz and up to 1 GHz



Test Setup; Spurious Emission Radiated (SAC), 30 MHz- 1GHz

Step 1: Preliminary scan

This is a preliminary test to identify the highest amplitudes relative to the limit.

Settings for step 1:

- Antenna distance: 3 m
- Detector: Peak-Maxhold / Quasipeak (FFT-based)
- Frequency range: 30 – 1000 MHz
- Frequency steps: 30 kHz
- IF–Bandwidth: 120 kHz
- Measuring time / Frequency step: 100 ms
- Turntable angle range: –180° to 90°
- Turntable step size: 90°
- Height variation range: 1 – 4 m
- Height variation step size: 1.5 m
- Polarisation: Horizontal + Vertical

Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

Step 2: Adjustment measurement
In this step the accuracy of the turntable azimuth and antenna height will be improved. This is necessary to find out the maximum value of every frequency.
For each frequency, which was determined the turntable azimuth and antenna height will be adjusted. The turntable azimuth will slowly vary. During this action, the value of emission is continuously measured. The turntable azimuth at the highest emission will be recorded and adjusted. In this position, the antenna height will also slowly vary. During this action, the value of emission is also continuously measured. The antenna height of the highest emission will also be recorded and adjusted.

- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range: 360°
- Height variation range: 1 – 4 m
- Antenna Polarisation: max. value determined in step 1

Step 3: Final measurement with QP detector
With the settings determined in step 2, the final measurement will be performed:
EMI receiver settings for step 3:

- Detector: Quasi-Peak (< 1 GHz)
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 1 s

After the measurement a plot will be generated. It contains a diagram with the results of the preliminary scan and a chart with the frequencies and values of the results of the final measurement.

4.1.2. Test Requirements / Limits

1) FCC Part 15, Subpart C, §15.209, Radiated Emission Limits

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limit (dBµV/m)
0.009 – 0.49	2400/F(kHz)@300m	3	(48.5 – 13.8)@300m
0.49 – 1.705	24000/F(kHz)@30m	3	(33.8 – 23.0)@30m
1.705 – 30	30@30m	3	29.5@30m

The measured values are corrected with an inverse linear distance extrapolation factor (40 dB/decade) according FCC §15.31 (2).

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limit (dBµV/m)
30 – 88	100@3m	3	40.0@3m
88 – 216	150@3m	3	43.5@3m
216 – 960	200@3m	3	46.0@3m
960 - 26000	500@3m	3	54.0@3m
26000 - 40000	500@3m	1	54.0@3m

§15.35(b)
..., there is also a limit on the radio frequency emissions, as measured using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit....

Used conversion factor: Limit (dBµV/m) = 20 log (Limit (µV/m)/1µV/m)

2) RSS-216, 6.2.2.2, Radiated Emission Limits

The raw values obtained at the measurement distance are extrapolated to the FCC's definition distance. The limits defined in RSS-216 are calculated for these FCC's distances in order to include the limits directly in one measurement plot and to demonstrate if compliance is achieved. The verdict related to RSS-216 is basing on the margin which is constant for different distances and i.e. is not altered by these linear transformations.

Limits ICES-001, 3.3.4.1, table 2 (quasi-peak limits) of magnetic field strength:

Frequency in MHz	Limit (RSS-216) (dBµA/m) @3m	Measurement distance (m)	Limit (dBµV/m) @ FCC distance	Comment
0.009 – 0.070	69	3	(40.5)@300m	–
0.07 – 0.15	69 – 39 *)	3	(40.5 – 10.5)@300m	–
0.15 – 0.49	39 – 31.9 *'***)	3	(10.5 – 3.4)@300m	intermediate step
0.49 – 30.0	31.9 – 7 ***)	3	(43.4 – 18.5)@30m	intermediate step

*) Decreasing linearly with logarithm of frequency between 0.07 and 0.15 MHz
***) Decreasing linearly with logarithm of frequency between 0.15 and 30.0 MHz

The alternate 60 cm loop test method and corresponding limits for small residential WPT devices is used for the tests in the frequency range 9 kHz – 30 MHz.

The measured field strength is extrapolated to the distance specified using the formula indicating that the field strength varies as the inverse distance square (40 dB per decade of distance), according to RSS-Gen, 6.5.
For fractal values of definition and reference distance the factor of $40*LOG_{10}(d_{ref}/d_{def})$ applies.
Relation between electrical and magnetic field strength: dBµV = dBµA + 51.5 dB.

Limits ICES-001, 3.3.4.2, table 4 (quasi-peak limits) of electric field strength:

Frequency in MHz	Limit (dBµV/m) OATS or SAC @10m	Limit (dBµV/m) OATS or SAC @3m	Limit (dBµV/m) FAR @3m	SAC Limit (dBµV/m) @ FCC distance
30 – 230	30	40	42 – 35 **)	(40)@3m
230 – 1000	37	47	42	(47)@3m

**) The limit level in dBµV/m decreases linearly with the logarithm of frequency.

Note: OATS = open-area test site, SAC = semi-anechoic chamber, FAR = fully-anechoic room

4.1.3. Test Protocol

Temperature: 21-24 °C
Air Pressure: 1014-1033 hPa
Humidity: 39-42 %

Measurement up to 30 MHz

The measurement is performed in this type of anechoic chamber: SAC
The measurement distance is: 3 m

Op. Mode	Setup	Port
WPT_act	Setup_01	Enclosure

Antenna orien-tation	EUT orien-tation	Fre-quency MHz	Corrected value dBµV/m			Limit dBµV/m	Limit dBµV/m	Limit dBµV/m	Margin dB	Margin dB
			QP	Peak	AV	QP	Peak	AV	QP/Peak	AV
–	–	–	–	–	–	–	–	–	–	–

Measurement above 30 MHz

The measurement is performed in this type of anechoic chamber: SAC
The measurement distance is: 3 m

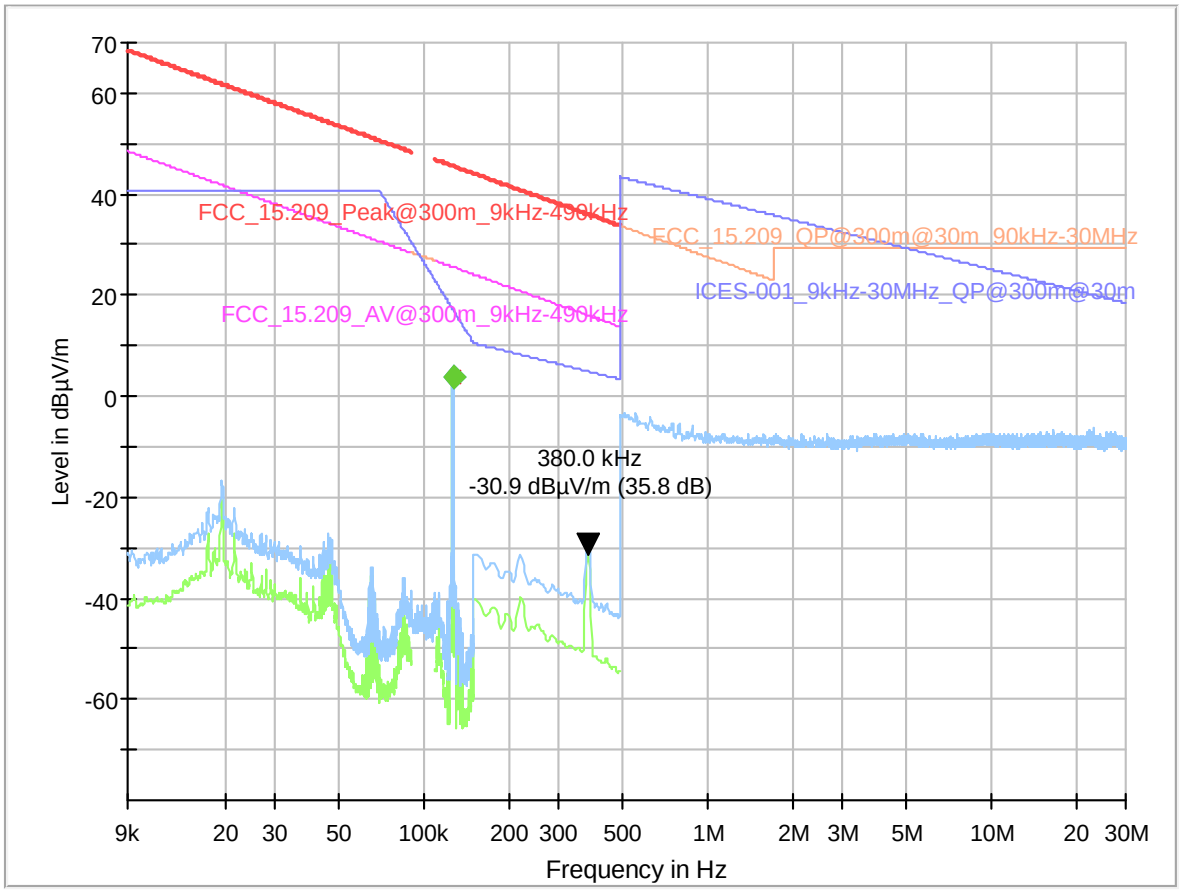
Op. Mode	Setup	Port
WPT_act	Setup_01	Enclosure

Antenna orien-tation	EUT orien-tation	Fre-quency MHz	Corrected value dBµV/m			Limit dBµV/m	Limit dBµV/m	Limit dBµV/m	Margin dB	Margin dB
			QP	Peak	AV	QP	Peak	AV	QP/Peak	AV
Vertical	Vertical	39.54	24.7	–	–	40.0	–	–	15.3	–

Remark: None.

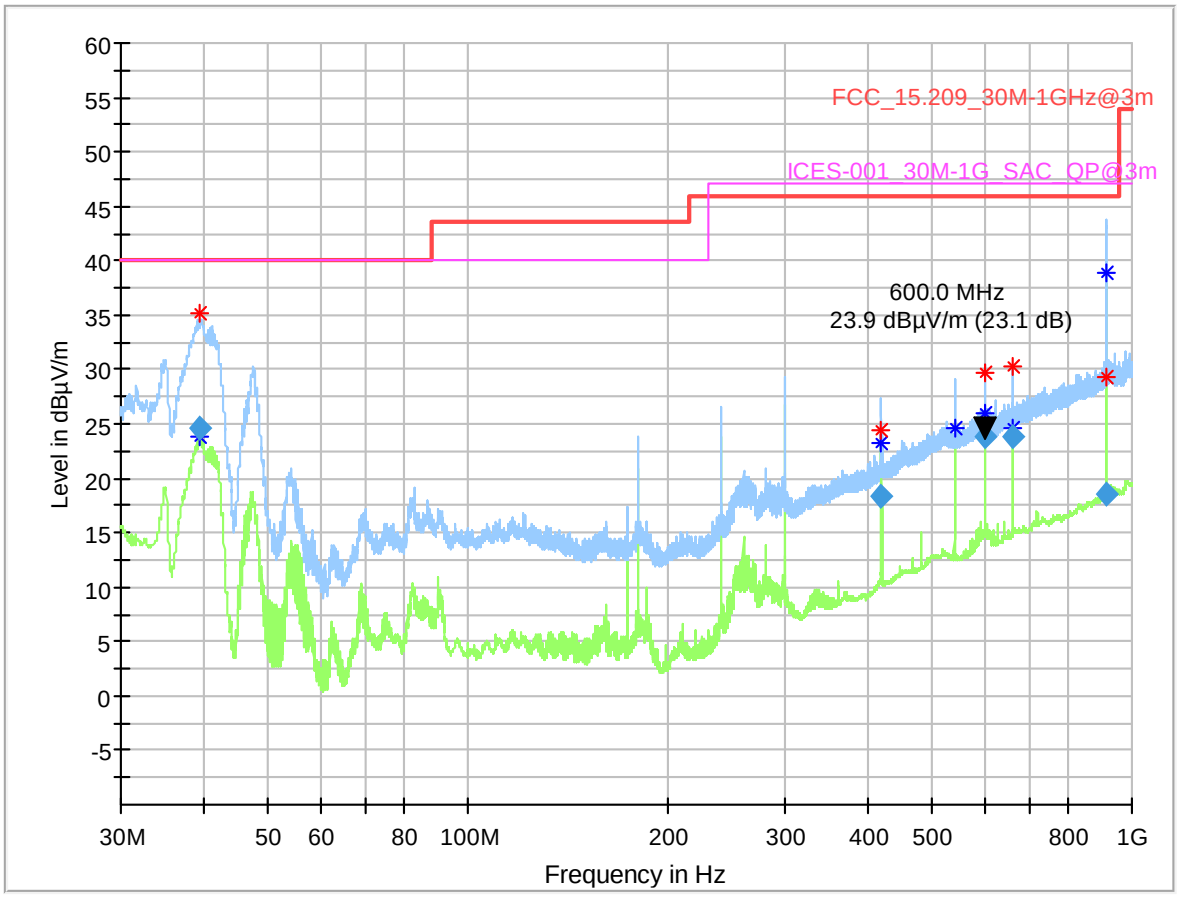
4.1.4. Measurement Plots (worst case)

Below 30 MHz



Notes: The green diamond shows the wanted emission.
The marker value shows the margin () to the different RSS-216 limit.
Blue trace: Peak detector, green trace: QP detector (pre-test), green diamond: QP (1 s)

Above 30 MHz



Final_Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin	Meas. Time (ms)	Bandwidth	Height	Pol	Azimuth	Corr. (dB/m)	Comment
39.540000	24.65	40.00	15.35	1000.0	120.000	102.0	V	140.0	13.9	
420.000000	18.28	46.00	27.72	1000.0	120.000	102.0	H	-177.0	16.4	
599.970000	23.89	46.00	22.11	1000.0	120.000	119.0	V	-82.0	20.1	
660.000000	23.83	46.00	22.17	1000.0	120.000	102.0	V	-120.0	21.2	
914.070000	18.61	46.00	27.39	1000.0	120.000	242.0	V	180.0	24.6	

Note: The marker shows the margin () to the different RSS-216 limit.
Blue trace: Peak detector, green trace: QP detector (pre-test), blue diamond: QP (1 s)

4.1.5. Test Equipment used

- Radiated Emissions

4.2 Peak power output

Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C63.10

4.2.1. Test Description

Please refer to sub-clause 4.1.1.

4.2.2. Test Limits

Please refer to sub-clause 4.1.2.

4.2.3. Test Protocol

Temperature: 23 °C
Air Pressure: 1014 hPa
Humidity: 42 %

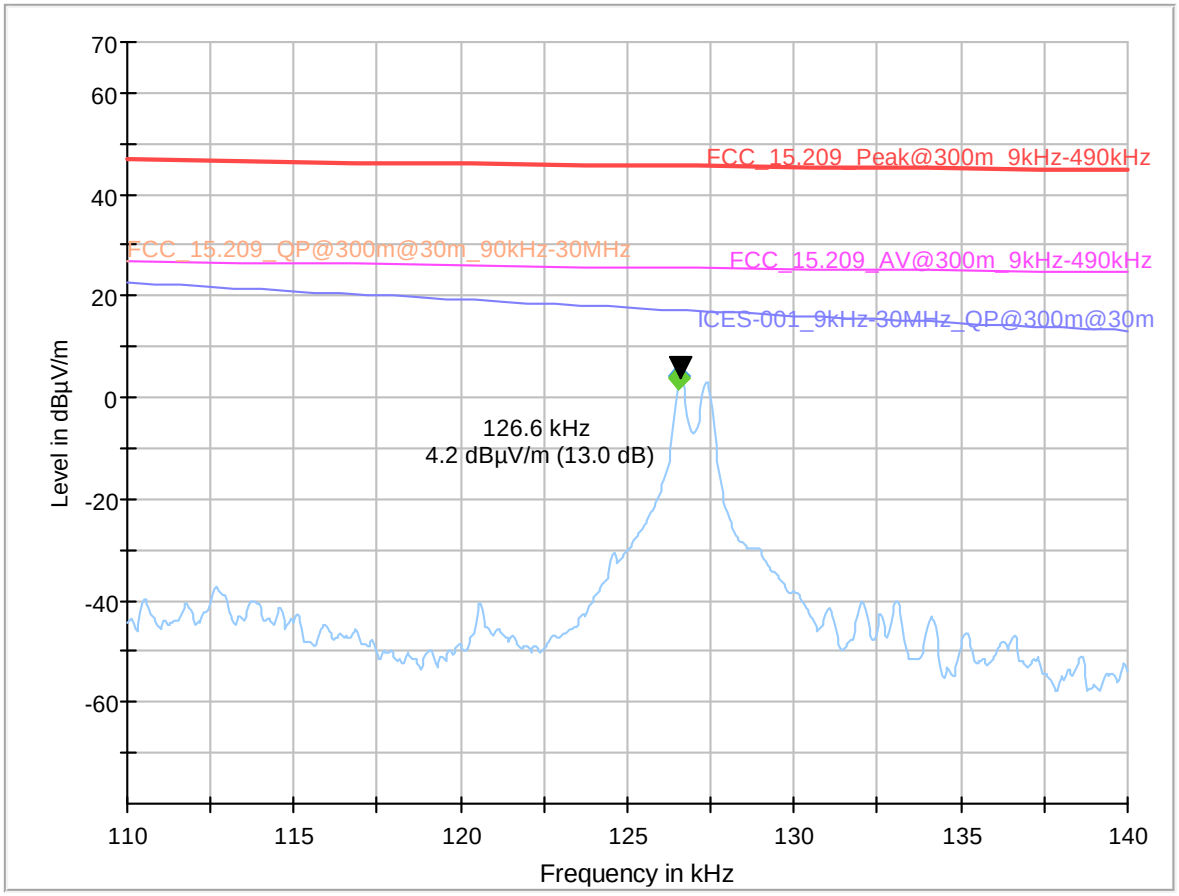
Op. Mode	Setup	Port
WPT_act	Setup_01	Enclosure

Antenna orien-tation	EUT orien-tation	Frequency kHz	Maximum radiated field strength at fundamental frequency (corrected) dBµV/m	Limit dBµV/m	Margin dB
			AV = PK = QP	AV	AV
Parallel	Vertical	126.55	4.2	25.6	21.4
x	Horizontal	126.55	-1.6	25.6	27.2

Note:

x-Orientation	loop plane vertical, vector in measurement axis directed to EUT
y-Orientation	loop plane vertical, vector perpendicular to measurement axis
z-Orientation	loop plane horizontal, normal vector directed to ground

4.2.4. Measurement Plot (worst case)



Note: The marker shows the margin () to the different RSS-216 limit.

4.2.5. Test Equipment used

- Radiated Emissions

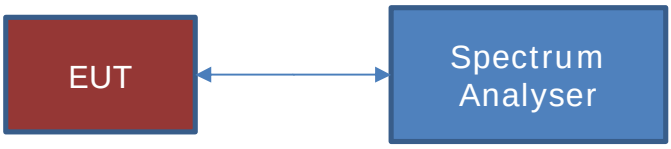
4.3 Occupied bandwidth

Standard FCC Part 2, Subpart J, §2.1049

The test was performed according to: ANSI C63.10

4.3.1. Test Description

The Equipment Under Test (EUT) was setup in a shielded room to perform the occupied bandwidth measurements.
The results recorded were measured with the modulation which produces the worst-case (widest) occupied bandwidth.



Test Setup for conducted tests

4.3.2. Test Requirements / Limits

FCC Part 15, Subpart C, §15.209 does not contain any requirement related to the bandwidth.

4.3.3. Test Protocol

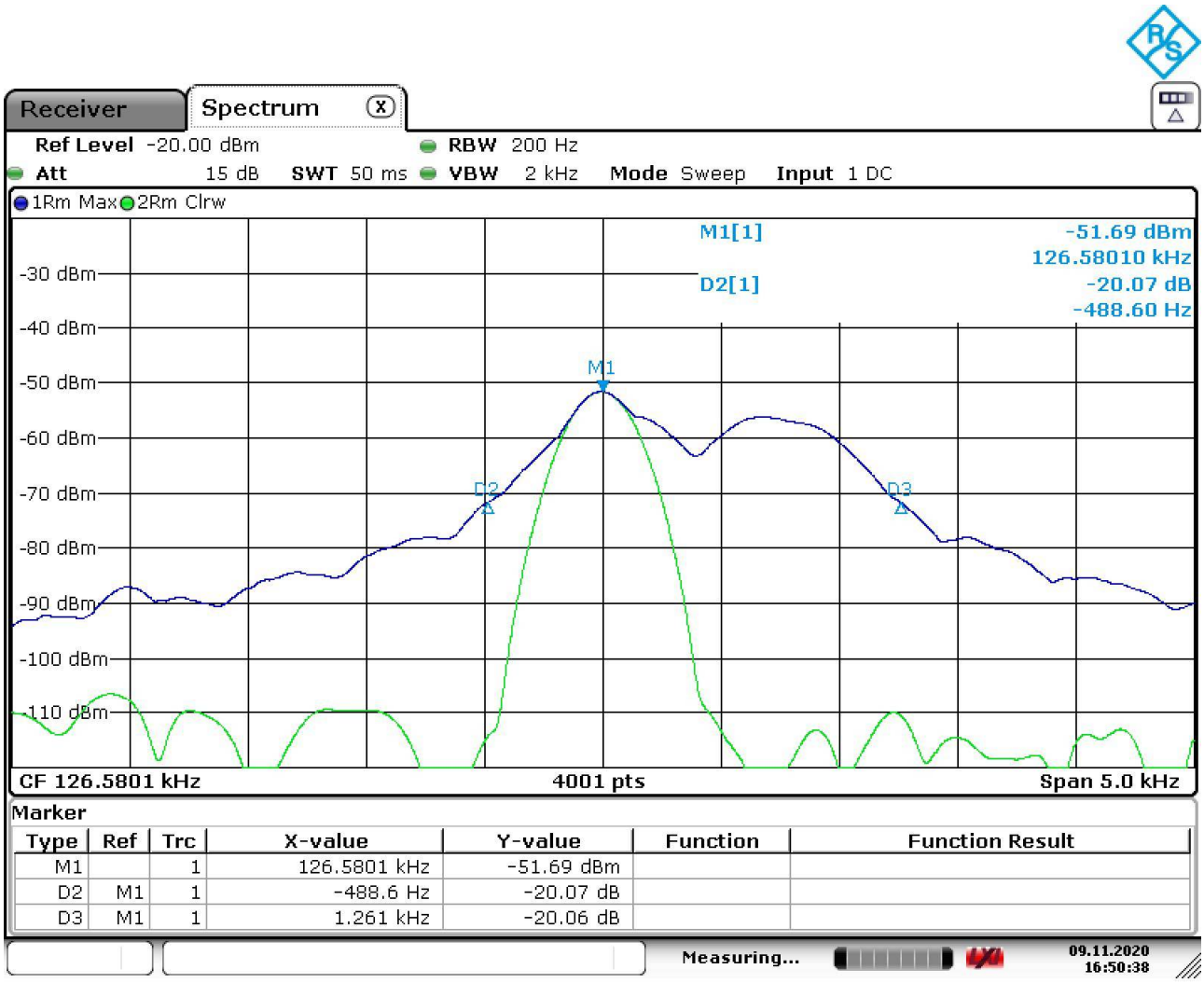
Temperature: 25 °C
Air Pressure: 1016 hPa
Humidity: 42 %

Op. Mode	Setup	Port
WPT_act	Setup_01	Enclosure

20 dBc bandwidth	99% occupied bandwidth
1.75 kHz	1.69 kHz

4.3.4. Measurement Plot (worst case)

20 dBc Bandwidth



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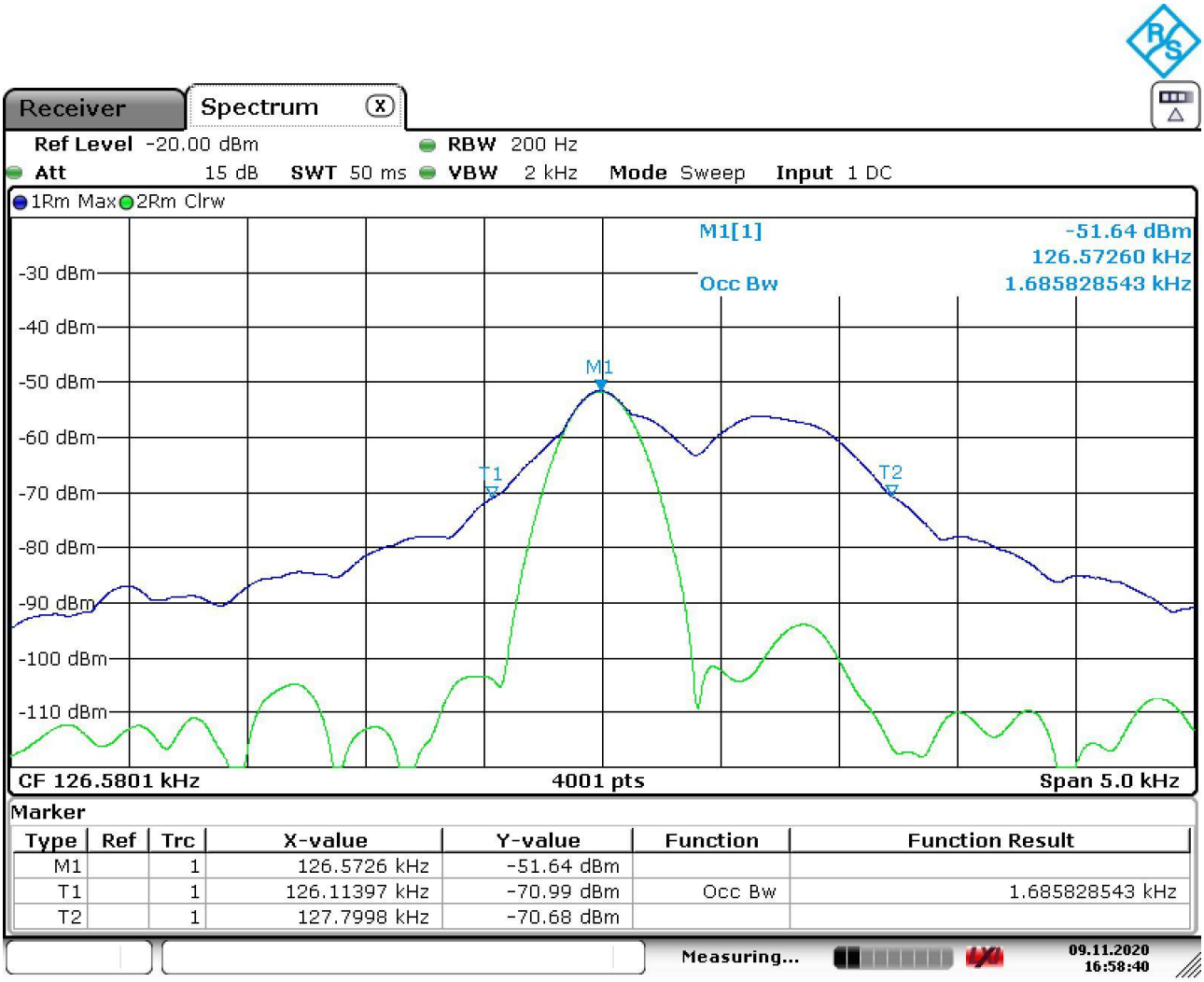
99% Occupied Bandwidth



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4.3.5. Test Equipment used

- Radio Lab

5 Test equipment

1 Radiated Emissions
Lab to perform radiated emission tests

Ref. No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
1.1	MFS	Rubidium Frequency Normal MFS	Datum GmbH	002	2020-11	2022-11
1.2	N5000/NP	Filter for EUT, 2 Lines, 250 V, 16 A	ETS-LINDGREN	241515		
1.3	Opus10 TPR (8253.00)	ThermoAirpressure Datalogger 13	Lufft Mess- und Regeltechnik GmbH	ID 13936	2019-05	2021-05
1.4	ESW44	EMI Receiver / Spectrum Analyzer	Rohde & Schwarz GmbH & Co. KG	101603	2019-12	2021-12
1.5	Anechoic Chamber 01	SAC/FAR, 10.58 m x 6.38 m x 6.00 m	Frankonia	none	2018-06	2021-06
1.6	Anechoic Chamber 03	FAR, 8.80m x 4.60m x 4.05m	Albatross Projects	P26971-647-001-PRB	2018-06	2021-06
1.7	HL 562 ULTRALOG	Biconical-log-per antenna (30 MHz - 3 GHz) with HL 562E biconicals	Rohde & Schwarz GmbH & Co. KG	830547/003	2018-07	2021-07
1.8	AMF-7D00101800-30-10P-R	Broadband Amplifier 100 MHz - 18 GHz	Miteq			
1.9	ASP 1.2/1.8-10 kg	Antenna Mast	Maturo GmbH	-		
1.10	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2020-04	2021-04
1.11	NRVD	Power Meter	Rohde & Schwarz GmbH & Co. KG	828110/016	2020-08	2021-08
1.12	FSW 43	Spectrum Analyzer	Rohde & Schwarz	103779	2019-02	2021-02
1.13	DS 420S	Turn Table 2 m diameter	HD GmbH	420/573/99		
1.14	JS4-00102600-42-5A	Broadband Amplifier 30 MHz - 26 GHz	Miteq	619368		
1.15	TT 1.5 WI	Turn Table	Maturo GmbH	-		
1.16	HL 562 ULTRALOG	Biconical-log-per Antenna (30 MHz - 3 GHz)	Rohde & Schwarz GmbH & Co. KG	100609	2019-05	2022-05
1.17	Air compressor	Anechoic Chamber; 8.8m x 4.6 m x 4.05 m	JUN-AIR Deutschland GmbH	612582		
1.18	HFH2-Z2	Loop Antenna	Rohde & Schwarz	829324/006	2018-01	2021-01

Ref. No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
1.19	Opus10 THI (8152.00)	ThermoHygro Datalogger 12	Lufft Mess- und Regeltechnik GmbH	ID 12482	2019-06	2021-06
1.20	JS4-00101800-35-5P	Broadband Amplifier 30 MHz - 18 GHz	Miteq	896037		
1.21	AS 620 P	Antenna Mast (pneumatic polarisation)	HD GmbH	620/37		
1.22	TD1.5-10kg	EUT Tilt Device (Rohacell)	Maturo GmbH	TD1.5-10kg/024/3790709		
1.23	NRV-Z1	Sensor Head B	Rohde & Schwarz GmbH & Co. KG	827753/006	2020-08	2021-08
1.24	PAS 2.5 - 10 kg	Antenna Mast	Maturo GmbH	-		
1.25	AFS42-00101800-25-S-42	Broadband Amplifier 25 MHz - 18 GHz	Miteq	2035324		
1.26	AM 4.0	Antenna Mast 4 m	Maturo GmbH	AM4.0/180/11920513		

2 Radio Lab
Lab to perform bandwidth test

Ref. No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
2.1	MFS	Rubidium Frequency Standard	Datum-Beverly	5489/001	2020-09	2021-09
2.2	ESR 7	EMI Receiver / Spectrum Analyzer 10 Hz - 7 GHz	Rohde & Schwarz	101424	2019-01	2021-01
2.3	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2020-04	2021-04
2.4	KWP 120/70	Temperature Chamber	Weiss	5922601219001 0	2020-05	2022-05
2.5	A8455-4	4 Way Power Divider (SMA)		-		
2.6	Opus10 THI (8152.00)	ThermoHygro Datalogger 03 (Environ)	Lufft Mess- und Regeltechnik GmbH	7482	2019-06	2021-06

The calibration interval is the time interval between “Last Calibration” and “Calibration Due”.

6 Antenna Factors, Cable Loss and Sample Calculations

This chapter contains the antenna factors with their corresponding path loss of the used measurement path for all antennas as well as the insertion loss of the LISN.

6.1 LISN R&S ESH3-Z5 (150 kHz – 30 MHz)

Frequency		Corr.	LISN insertion loss ESH3-Z5	cable loss (incl. 10 dB atten-uator)
MHz		dB	dB	dB
0,15		10,1	0,1	10,0
5		10,3	0,1	10,2
7		10,5	0,2	10,3
10		10,5	0,2	10,3
12		10,7	0,3	10,4
14		10,7	0,3	10,4
16		10,8	0,4	10,4
18		10,9	0,4	10,5
20		10,9	0,4	10,5
22		11,1	0,5	10,6
24		11,1	0,5	10,6
26		11,2	0,5	10,7
28		11,2	0,5	10,7
30		11,3	0,5	10,8

Sample calculation

U_{LISN} (dB µV) = U (dB µV) + Corr. (dB)
U = Receiver reading
LISN Insertion loss = Voltage Division Factor of LISN
Corr. = sum of single correction factors of used LISN, cables, switch units (if used)
Linear interpolation will be used for frequencies in between the values in the table.

6.2 Antenna R&S HFH2-Z2 (9 kHz – 30 MHz)

Frequency	AF HFH-Z2)	Corr.	cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-40 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	m	m
0,009	20,50	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,01	20,45	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,015	20,37	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,02	20,36	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,025	20,38	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,03	20,32	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,05	20,35	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,08	20,30	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,1	20,20	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,2	20,17	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,3	20,14	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,49	20,12	-79,6	0,1	0,1	0,1	0,1	-80	300	3
0,490001	20,12	-39,6	0,1	0,1	0,1	0,1	-40	30	3
0,5	20,11	-39,6	0,1	0,1	0,1	0,1	-40	30	3
0,8	20,10	-39,6	0,1	0,1	0,1	0,1	-40	30	3
1	20,09	-39,6	0,1	0,1	0,1	0,1	-40	30	3
2	20,08	-39,6	0,1	0,1	0,1	0,1	-40	30	3
3	20,06	-39,6	0,1	0,1	0,1	0,1	-40	30	3
4	20,05	-39,5	0,2	0,1	0,1	0,1	-40	30	3
5	20,05	-39,5	0,2	0,1	0,1	0,1	-40	30	3
6	20,02	-39,5	0,2	0,1	0,1	0,1	-40	30	3
8	19,95	-39,5	0,2	0,1	0,1	0,1	-40	30	3
10	19,83	-39,4	0,2	0,1	0,2	0,1	-40	30	3
12	19,71	-39,4	0,2	0,1	0,2	0,1	-40	30	3
14	19,54	-39,4	0,2	0,1	0,2	0,1	-40	30	3
16	19,53	-39,3	0,3	0,1	0,2	0,1	-40	30	3
18	19,50	-39,3	0,3	0,1	0,2	0,1	-40	30	3
20	19,57	-39,3	0,3	0,1	0,2	0,1	-40	30	3
22	19,61	-39,3	0,3	0,1	0,2	0,1	-40	30	3
24	19,61	-39,3	0,3	0,1	0,2	0,1	-40	30	3
26	19,54	-39,3	0,3	0,1	0,2	0,1	-40	30	3
28	19,46	-39,2	0,3	0,1	0,3	0,1	-40	30	3
30	19,73	-39,1	0,4	0,1	0,3	0,1	-40	30	3

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
distance correction = -40 * LOG (d_{Limit}/ d_{used})
Linear interpolation will be used for frequencies in between the values in the table.
Table shows an extract of values

6.3 Antenna R&S HL562 (30 MHz – 1 GHz)

(d_{Limit} = 3 m)

Frequency	AF R&S HL562	Corr.	cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-20 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	m	m
30	18,6	0,6	0,29	0,04	0,23	0,02	0,0	3	3
50	6,0	0,9	0,39	0,09	0,32	0,08	0,0	3	3
100	9,7	1,2	0,56	0,14	0,47	0,08	0,0	3	3
150	7,9	1,6	0,73	0,20	0,59	0,12	0,0	3	3
200	7,6	1,9	0,84	0,21	0,70	0,11	0,0	3	3
250	9,5	2,1	0,98	0,24	0,80	0,13	0,0	3	3
300	11,0	2,3	1,04	0,26	0,89	0,15	0,0	3	3
350	12,4	2,6	1,18	0,31	0,96	0,13	0,0	3	3
400	13,6	2,9	1,28	0,35	1,03	0,19	0,0	3	3
450	14,7	3,1	1,39	0,38	1,11	0,22	0,0	3	3
500	15,6	3,2	1,44	0,39	1,20	0,19	0,0	3	3
550	16,3	3,5	1,55	0,46	1,24	0,23	0,0	3	3
600	17,2	3,5	1,59	0,43	1,29	0,23	0,0	3	3
650	18,1	3,6	1,67	0,34	1,35	0,22	0,0	3	3
700	18,5	3,6	1,67	0,42	1,41	0,15	0,0	3	3
750	19,1	4,1	1,87	0,54	1,46	0,25	0,0	3	3
800	19,6	4,1	1,90	0,46	1,51	0,25	0,0	3	3
850	20,1	4,4	1,99	0,60	1,56	0,27	0,0	3	3
900	20,8	4,7	2,14	0,60	1,63	0,29	0,0	3	3
950	21,1	4,8	2,22	0,60	1,66	0,33	0,0	3	3
1000	21,6	4,9	2,23	0,61	1,71	0,30	0,0	3	3

(d_{Limit} = 10 m)

30	18,6	-9,9	0,29	0,04	0,23	0,02	-10,5	10	3
50	6,0	-9,6	0,39	0,09	0,32	0,08	-10,5	10	3
100	9,7	-9,2	0,56	0,14	0,47	0,08	-10,5	10	3
150	7,9	-8,8	0,73	0,20	0,59	0,12	-10,5	10	3
200	7,6	-8,6	0,84	0,21	0,70	0,11	-10,5	10	3
250	9,5	-8,3	0,98	0,24	0,80	0,13	-10,5	10	3
300	11,0	-8,1	1,04	0,26	0,89	0,15	-10,5	10	3
350	12,4	-7,9	1,18	0,31	0,96	0,13	-10,5	10	3
400	13,6	-7,6	1,28	0,35	1,03	0,19	-10,5	10	3
450	14,7	-7,4	1,39	0,38	1,11	0,22	-10,5	10	3
500	15,6	-7,2	1,44	0,39	1,20	0,19	-10,5	10	3
550	16,3	-7,0	1,55	0,46	1,24	0,23	-10,5	10	3
600	17,2	-6,9	1,59	0,43	1,29	0,23	-10,5	10	3
650	18,1	-6,9	1,67	0,34	1,35	0,22	-10,5	10	3
700	18,5	-6,8	1,67	0,42	1,41	0,15	-10,5	10	3
750	19,1	-6,3	1,87	0,54	1,46	0,25	-10,5	10	3
800	19,6	-6,3	1,90	0,46	1,51	0,25	-10,5	10	3
850	20,1	-6,0	1,99	0,60	1,56	0,27	-10,5	10	3
900	20,8	-5,8	2,14	0,60	1,63	0,29	-10,5	10	3
950	21,1	-5,6	2,22	0,60	1,66	0,33	-10,5	10	3
1000	21,6	-5,6	2,23	0,61	1,71	0,30	-10,5	10	3

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
distance correction = -20 * LOG (d_{Limit}/ d_{used})
Linear interpolation will be used for frequencies in between the values in the table.
Tables show an extract of values.

6.4 Antenna R&S HF907 (1 GHz – 18 GHz)

Frequency	AF R&S HF907	Corr.	cable loss 1 (relay + cable inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit, atten-uator & pre-amp)	cable loss 4 (to receiver)		
MHz	dB (1/m)	dB	dB	dB	dB	dB		
1000	24,4	-19,4	0,99	0,31	-21,51	0,79		
2000	28,5	-17,4	1,44	0,44	-20,63	1,38		
3000	31,0	-16,1	1,87	0,53	-19,85	1,33		
4000	33,1	-14,7	2,41	0,67	-19,13	1,31		
5000	34,4	-13,7	2,78	0,86	-18,71	1,40		
6000	34,7	-12,7	2,74	0,90	-17,83	1,47		
7000	35,6	-11,0	2,82	0,86	-16,19	1,46		

Frequency	AF R&S HF907	Corr.	cable loss 1 (relay inside chamber)	cable loss 2 (inside chamber)	cable loss 3 (outside chamber)	cable loss 4 (switch unit, atten-uator & pre-amp)	cable loss 5 (to receiver)	used for FCC 15.247
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	
3000	31,0	-23,4	0,47	1,87	0,53	-27,58	1,33	
4000	33,1	-23,3	0,56	2,41	0,67	-28,23	1,31	
5000	34,4	-21,7	0,61	2,78	0,86	-27,35	1,40	
6000	34,7	-21,2	0,58	2,74	0,90	-26,89	1,47	
7000	35,6	-19,8	0,66	2,82	0,86	-25,58	1,46	

Frequency	AF R&S HF907	Corr.	cable loss 1 (relay inside chamber)	cable loss 2 (High Pass)	cable loss 3 (pre-amp)	cable loss 4 (inside chamber)	cable loss 5 (outside chamber)	cable loss 6 (to receiver)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB	dB
7000	35,6	-57,3	0,56	1,28	-62,72	2,66	0,94	1,46
8000	36,3	-56,3	0,69	0,71	-61,49	2,84	1,00	1,53
9000	37,1	-55,3	0,68	0,65	-60,80	3,06	1,09	1,60
10000	37,5	-56,2	0,70	0,54	-61,91	3,28	1,20	1,67
11000	37,5	-55,3	0,80	0,61	-61,40	3,43	1,27	1,70
12000	37,6	-53,7	0,84	0,42	-59,70	3,53	1,26	1,73
13000	38,2	-53,5	0,83	0,44	-59,81	3,75	1,32	1,83
14000	39,9	-56,3	0,91	0,53	-63,03	3,91	1,40	1,77
15000	40,9	-54,1	0,98	0,54	-61,05	4,02	1,44	1,83
16000	41,3	-54,1	1,23	0,49	-61,51	4,17	1,51	1,85
17000	42,8	-54,4	1,36	0,76	-62,36	4,34	1,53	2,00
18000	44,2	-54,7	1,70	0,53	-62,88	4,41	1,55	1,91

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
Linear interpolation will be used for frequencies in between the values in the table.
Tables show an extract of values.

6.5 Antenna EMCO 3160-09 (18 GHz – 26.5 GHz)

Frequency	AF EMCO 3160-09	Corr.	cable loss 1 (inside chamber)	cable loss 2 (pre-amp)	cable loss 3 (inside chamber)	cable loss 4 (switch unit)	cable loss 5 (to receiver)
MHz	dB (1/m)	dB	dB	dB	dB	dB	dB
18000	40,2	-23,5	0,72	-35,85	6,20	2,81	2,65
18500	40,2	-23,2	0,69	-35,71	6,46	2,76	2,59
19000	40,2	-22,0	0,76	-35,44	6,69	3,15	2,79
19500	40,3	-21,3	0,74	-35,07	7,04	3,11	2,91
20000	40,3	-20,3	0,72	-34,49	7,30	3,07	3,05
20500	40,3	-19,9	0,78	-34,46	7,48	3,12	3,15
21000	40,3	-19,1	0,87	-34,07	7,61	3,20	3,33
21500	40,3	-19,1	0,90	-33,96	7,47	3,28	3,19
22000	40,3	-18,7	0,89	-33,57	7,34	3,35	3,28
22500	40,4	-19,0	0,87	-33,66	7,06	3,75	2,94
23000	40,4	-19,5	0,88	-33,75	6,92	3,77	2,70
23500	40,4	-19,3	0,90	-33,35	6,99	3,52	2,66
24000	40,4	-19,8	0,88	-33,99	6,88	3,88	2,58
24500	40,4	-19,5	0,91	-33,89	7,01	3,93	2,51
25000	40,4	-19,3	0,88	-33,00	6,72	3,96	2,14
25500	40,5	-20,4	0,89	-34,07	6,90	3,66	2,22
26000	40,5	-21,3	0,86	-35,11	7,02	3,69	2,28
26500	40,5	-21,1	0,90	-35,20	7,15	3,91	2,36

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
Linear interpolation will be used for frequencies in between the values in the table.
Table shows an extract of values.

6.6 Antenna EMCO 3160-10 (26.5 GHz – 40 GHz)

Frequency	AF EMCO 3160-10	Corr.	cable loss 1 (inside chamber)	cable loss 2 (outside chamber)	cable loss 3 (switch unit)	cable loss 4 (to receiver)	distance corr. (-20 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
GHz	dB (1/m)	dB	dB	dB	dB	dB	dB	m	m
26,5	43,4	-11,2	4,4				-9.5	3	1
27,0	43,4	-11,2	4,4				-9.5	3	1
28,0	43,4	-11,1	4,5				-9.5	3	1
29,0	43,5	-11,0	4,6				-9.5	3	1
30,0	43,5	-10,9	4,7				-9.5	3	1
31,0	43,5	-10,8	4,7				-9.5	3	1
32,0	43,5	-10,7	4,8				-9.5	3	1
33,0	43,6	-10,7	4,9				-9.5	3	1
34,0	43,6	-10,6	5,0				-9.5	3	1
35,0	43,6	-10,5	5,1				-9.5	3	1
36,0	43,6	-10,4	5,1				-9.5	3	1
37,0	43,7	-10,3	5,2				-9.5	3	1
38,0	43,7	-10,2	5,3				-9.5	3	1
39,0	43,7	-10,2	5,4				-9.5	3	1
40,0	43,8	-10,1	5,5				-9.5	3	1

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr. (dB)
U = Receiver reading
AF = Antenna factor
Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)
Linear interpolation will be used for frequencies in between the values in the table.
distance correction = -20 * LOG (d_{Limit}/ d_{used})
Linear interpolation will be used for frequencies in between the values in the table.
Table shows an extract of values.

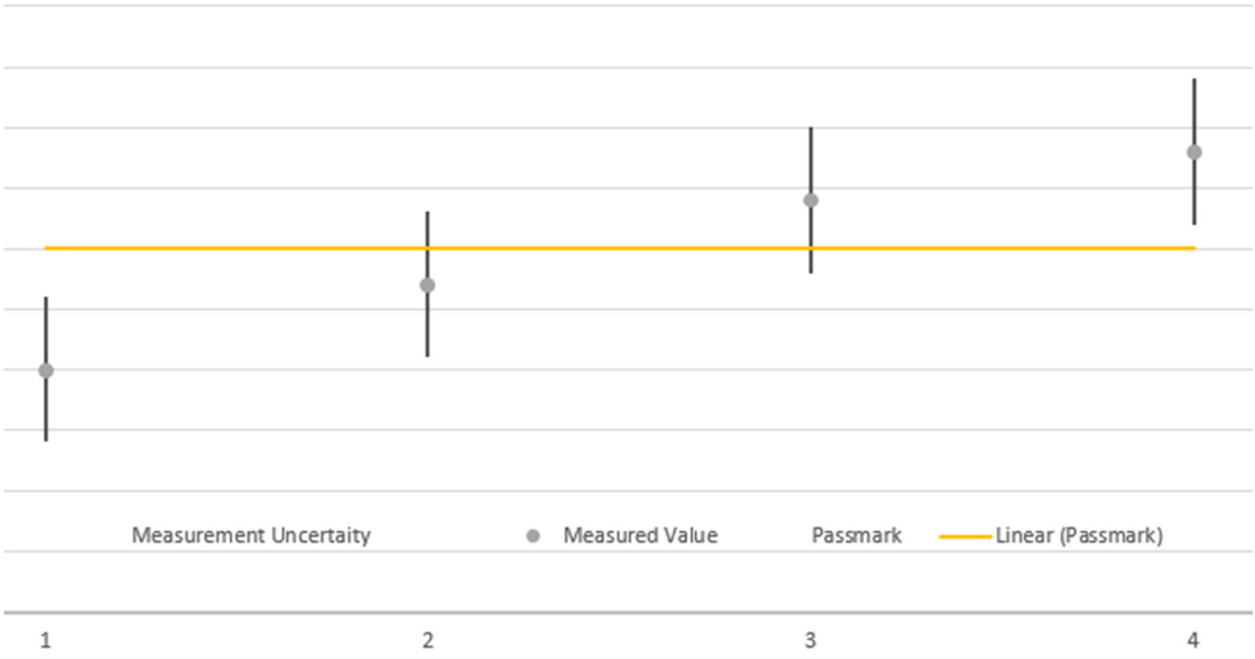
7 Photo Report

Photos are included in an external report.

8 Measurement uncertainty

Test Case	Parameter	Uncertainty
Peak power output	Field Strength	± 5.5 dB
Occupied bandwidth	Power Frequency:	± 2.9 dB ± 0.125 kHz
Spurious radiated emissions	Field Strength Frequency:	± 5.5 dB ± 11.2 kHz
AC Power Line	Power	± 3.4 dB

The measurement uncertainties for all parameters are calculated with an expansion factor (coverage factor) k = 1.96. This means, that the true value is in the corresponding interval with a probability of 95 %.



The verdicts in this test report are given according the above diagram:

Case	Measured Value	Uncertainty Range	Verdict
1	below pass mark	below pass mark	Passed
2	below pass mark	within pass mark	Passed
3	above pass mark	within pass mark	Failed
4	above pass mark	above pass mark	Failed

That means, the laboratory applies, as decision rule (see ISO/IEC 17025:2017), the so called shared risk principle.