InterLab®

FCC Measurement/Technical Report on

NFC transceiver

WMI2-15W-W205

FCC ID: QWY-WMI2W205W15
IC: 6588A-WMI2W205W15

Report Reference: MDE_PEIKER_1801_FCC04

Test Laboratory:
7layers GmbH
Borsigstrasse 11
40880 Ratingen
Germany

Deutsche Akkreditierungsstelle D-PL-12140-01-00

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1 Summary

1.1 Technical Report Summary

Type of Authorization
Certification for an intentional radiator operating at 13.56 MHz

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 (10-1-18 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

§ 15.205 Restricted bands of operation

§ 15.207 Conducted limits

§ 15.209 Radiated emission limits; general requirements

§ 15.215 Additional provisions to the general radiated emission limitations

§ 15.225 Operation within the band 13.110-14.010 MHz

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

The following tables show the correlation of measurement requirements Radio equipment operating in the Band 13.110-14.010 MHz from FCC and IC.

Radio equipment

Measurement	FCC reference	IC reference
Conducted emissions on AC Mains	§ 15.207	RSS-Gen Issue 5: 8.8
Out-of-band emissions	§ 15.225 (d)	RSS Gen Issue 5: 6.13/8.9/8.10; RSS-210 Issue 9: B.6
In-band emissions	§ 15.225 (a) / (b) / (c)	RSS-210 Issue 9: B.6
Frequency Stability	§ 15.225 (e)	RSS-210 Issue 9: B.6
Antenna requirement	§ 15.203 / 15.204	RSS-Gen Issue 5: 8.3
Receiver spurious emissions	–	RSS-210 Issue 9: 2.3; RSS Gen Issue 5: 5/7 *)
Handling of active and passive tag devices of RFID application	§ 15.225 (f)	RSS Gen Issue 5: 8.7

*) Receivers are exempted from certification besides if operating in stand-alone mode in the frequency range 30–960 MHz or if these are scanner receivers.

1.3 Measurement Summary / Signatures

FCC Part 15, Subpart C	§ 15.207		
Conducted Emissions AC Power line			
The measurement was performed according to ANSI C63.10			
OP-Mode	**Setup**	**Port**	**Final Result**
–	–	–	N/A

FCC Part 15, Subpart C	§15.209		
Radiated Emissions			
The measurement was performed according to ANSI C63.10			
OP-Mode	**Setup**	**Port**	**Final Result**
NFC_ext	Setup_01	Enclosure	passed
NFC_int	Setup_01	Enclosure	passed

FCC Part 15, Subpart C	§ 15.215		
Occupied Bandwidth			
The measurement was performed according to FCC § 2.1049			
OP-Mode	**Setup**	**Port**	**Final Result**
NFC_ext	Setup_01	Enclosure	passed

FCC Part 15, Subpart C	§ 15.225		
Spectrum Mask			
The measurement was performed according to ANSI C63.10			
OP-Mode	**Setup**	**Port**	**Final Result**
NFC_ext	Setup_01	Enclosure	passed
NFC_int	Setup_01	Enclosure	passed

FCC Part 15, Subpart C	§ 15.225		
Frequency Tolerance			
The measurement was performed according to FCC § 2.1055			
OP-Mode	**Setup**	**Port**	**Final Result**
NFC_int	Setup_01	Enclosure	passed

N/A not applicable (the EUT is powered by DC and only intendent for the use in vehicles)

Different variants of the EUT are available:

- WMI2-15W-W205: Assembly with max. hardware integration, "worst-case" behaviour expected, integral or external NFC antenna can be selected for operation
- WMI2-15W-W205-M1: Variant without FAKRA

The results of this test report are obtained with the listed devices, please refer to sub-clauses 3.2–3.5.

1.4 Revision History

Version	Release date	Change Description	Version validity
initial	2019-10-17	--	valid

Responsible for Accreditation Scope: M. Mueller

Responsible for Test Report: D. Gall

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2 Administrative Data

2.1 Testing Laboratory

Company Name:	7layers GmbH
Address	Borsigstr. 11 40880 Ratingen Germany

This facility has been fully described in a report submitted to the FCC and accepted under the registration number 96716 and IC(ISED) under the registration number: Site# 3699A-1

The test facility is also accredited by the following accreditation organisation:

Laboratory accreditation no.:	DAkkS D-PL-12140-01-00
Responsible for Accreditation Scope:	Dipl.-Ing. Marco Kullik
Report Template Version:	2019-10-08

2.2 Project Data

Responsible for testing and report:	Dipl.-Ing. Daniel Gall
Date of Report:	2019-10-17
Testing Period:	2019-07-31 to 2019-08-26

2.3 Applicant Data

Company Name:	Peiker acustic GmbH
Address:	Max-Planck-Straße 28-32 61381 Friedrichsdorf Germany
Contact Person:	Mr. Marco Okhovat-Esfehani

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	Wireless Mobile Interface2-15W
Type Designation:	WMI2-W15W-W205
Kind of Device:	125 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 125 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.
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.

The EUT provides the following ports:

Ports
Enclosure
DC/CAN connector
Connector for either an external NFC antenna or a LED, depending on the variant
Specific connectors to interconnect “peripherals” / units (which are not provided):
FAKRA output from passive antenna coupler, depending on the variant.

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: DE1002020aa01)	NFC Transceiver	WMI2-15W-W205	0000521224	0000	RK46

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
NFCEXTANT	External NFC antenna	peiker LP1456-3, Type-2	1088-111-000-00	HW-48-18	–

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	USB-CAN converter	VSCOM USB-CAN Plus	380101633	–	–
AUX 2	Laptop	Fujitsu Lifebook Model E782	DSCM004654	2012-08	Win7 Prof. Engl.
AUX 3	AC adapter of Laptop	Fujitsu FMV-AC330 FPCAC88	1231808A	2012.03	–
AUX 4	Smartphone (DE1002018SMP1), used as NFC Tag	Samsung S8 (SM-G950F)	R38K7037W3Y	–	Android 8.0.0
AUX 5	Dummy Load FAKRA	50 ohm termination with Leoni Dacar 031 cable (1 m)	–	–	–

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 + NFCEXTANT + AUX 1 + AUX 2 + AUX 3 + AUX 4 +AUX 5	EUT A with external antenna and ancillaries and auxiliaries, representative cables are connected to each connector

3.6 Operating Modes

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

Op. Mode	Description of Operating Modes	Remarks
NFC_int	NFC signal transmitted via integral antenna	EUT is transmitting a continuously modulated signal, radiated by the integral antenna
NFC_ext	NFC signal transmitted via external antenna	EUT is transmitting a continuously modulated signal, radiated by the external antenna

3.7 Special software used for testing

EVTP Test Tool and Macros, 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 EMC32 test software 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
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)
- Detector: Peak-Maxhold
- Frequency range: 0.009 – 0.15 and 0.15 – 30 MHz
- Frequency steps: 0.1 kHz and 5 kHz
- IF–Bandwidth: 0.2 kHz and 10 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 with the following settings will be performed. 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

Step 1: Preliminary scan
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 – 3 m
- Height variation step size: 2 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 by ± 45° around this value. 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 by ± 100 cm around the antenna height determined. 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: ± 45 ° around the determined value
- Height variation range: ± 100 cm around the determined value
- Antenna Polarisation: max. value determined in step 1

Step 3: Final measurement with QP detector
With the settings determined in step 3, the final measurement will be performed:
EMI receiver settings for step 4:
- 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

FCC Part 15, Subpart C, §15.225 (d)
The field strength of any emissions appearing outside of the 13.110–14.010 MHz band shall not exceed the general radiated emission limits in § 15.209.

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

Frequency in MHz	Limit (µV/m)	Measurement distance (m)	Limits (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)	Limits (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)

4.1.3 Test Protocol

Temperature: 26-27 °C
Air Pressure: 1005-1011 hPa
Humidity: 36-42 %

4.1.3.1 Measurement up to 30 MHz

Op. Mode	Setup	Port
NFC_int	Setup_01	Enclosure

Antenna orientation	EUT orientation	Frequency 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
Vert.&Hor.	Horizontal	–	–	–	–	–	–	–	–	–
Vert.&Hor.	Horizontal	–	–	–	–	–	–	–	–	–

Remark: No (further) spurious emissions in the range 20 dB below the limit found therefore step 2 was not performed.
13.56 MHz is the wanted signal of the EUT.

Op. Mode	Setup	Port
NFC_ext	Setup_01	Enclosure

Antenna orientation	EUT orientation	Frequency 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
Vert.&Hor.	Horizontal	–	–	–	–	–	–	–	–	–
Vert.&Hor.	Horizontal	–	–	–	–	–	–	–	–	–

Remark: No (further) spurious emissions in the range 20 dB below the limit found therefore step 2 was not performed.
13.56 MHz is the wanted signal of the EUT.

4.1.3.2 Measurement above 30 MHz

Op. Mode	Setup	Port
NFC_int	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	40.68	28.6	–	–	40.0	–	–	11.4	–

Remark: No (further) spurious emissions in the range 20 dB below the limit found.

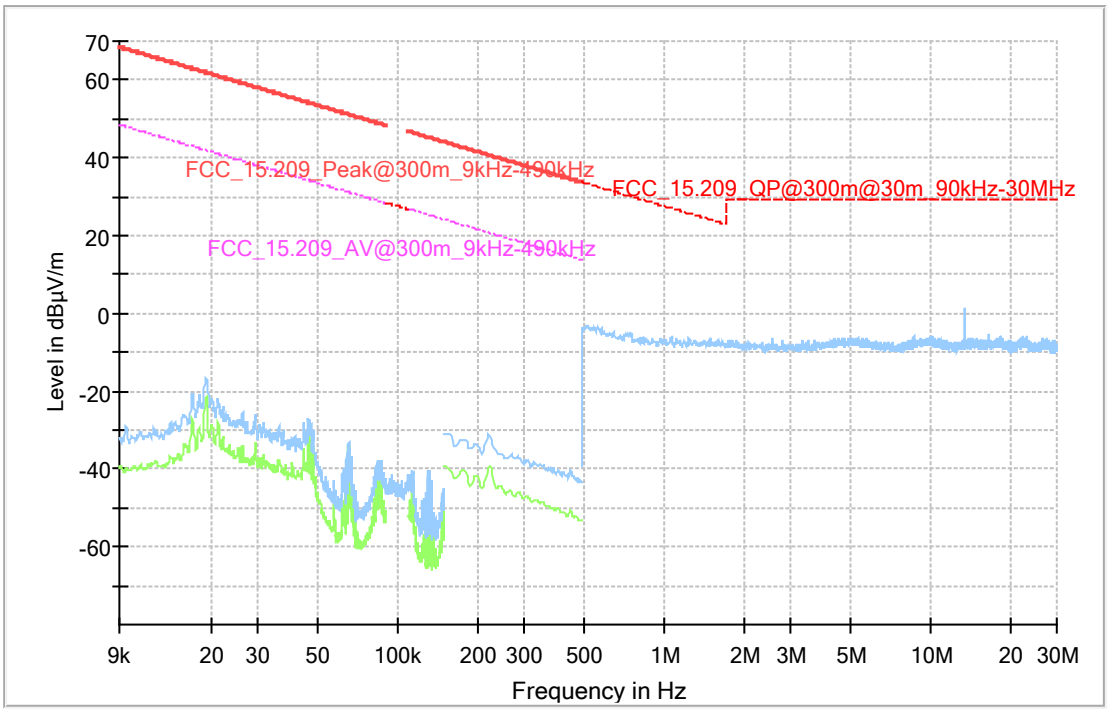
Op. Mode	Setup	Port
NFC_ext	Setup_01	Enclosure

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	40.68	31.6	–	–	40.0	–	–	8.4	–

Remark: No (further) spurious emissions in the range 20 dB below the limit found.

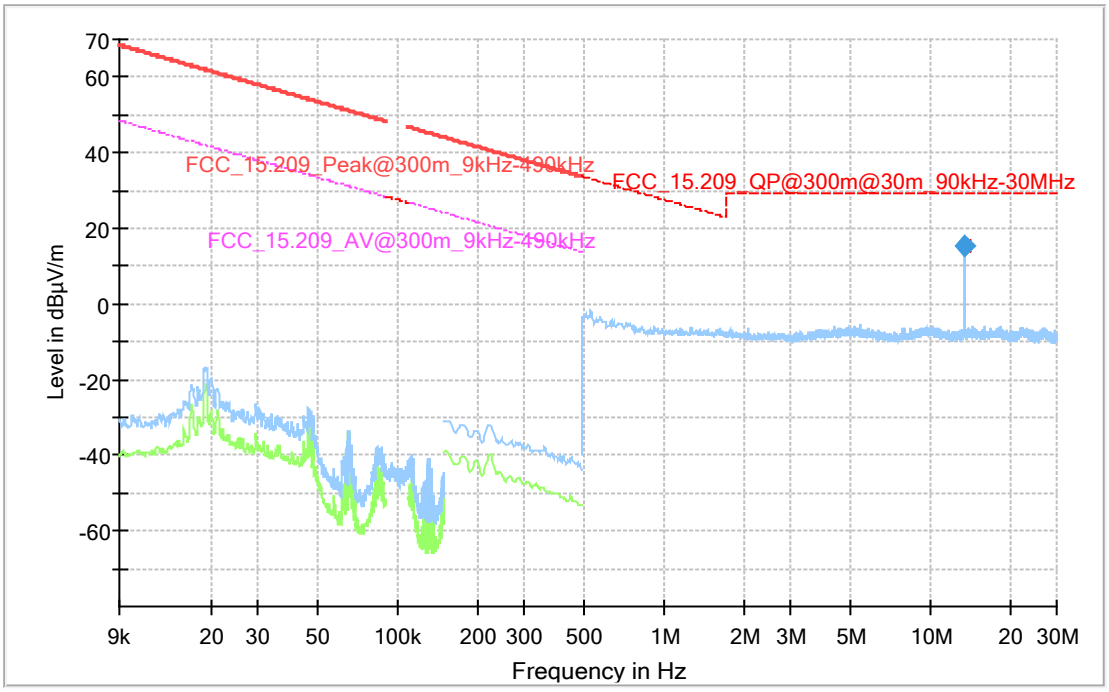
4.1.4 Measurement Plots (worst case)

4.1.4.1 Below 30 MHz, EUT A, integral NFC antenna



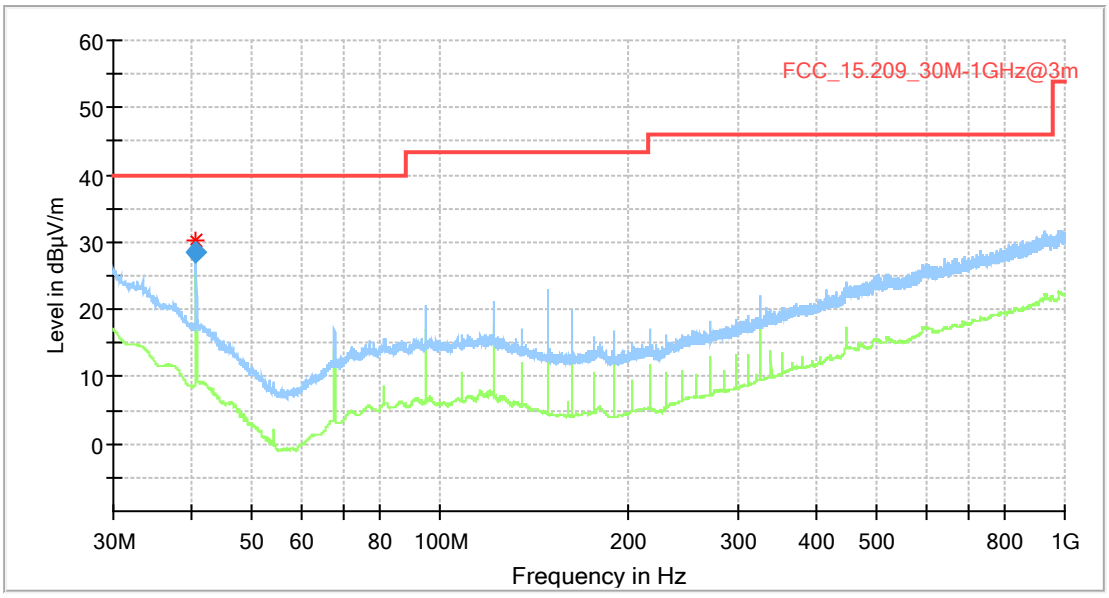
Preview Result 2-AVG
Critical_Freqs AVG
FCC_15.209_Peak@300m_9kHz-490kHz
FCC_15.209_QP@300m@30m_90kHz-30MHz
Final_Result AVG
Preview Result 1-PK+
Critical_Freqs PK+
FCC_15.209_AV@300m_9kHz-490kHz
Final_Result PK+

4.1.4.2 Below 30 MHz, EUT A, external NFC antenna



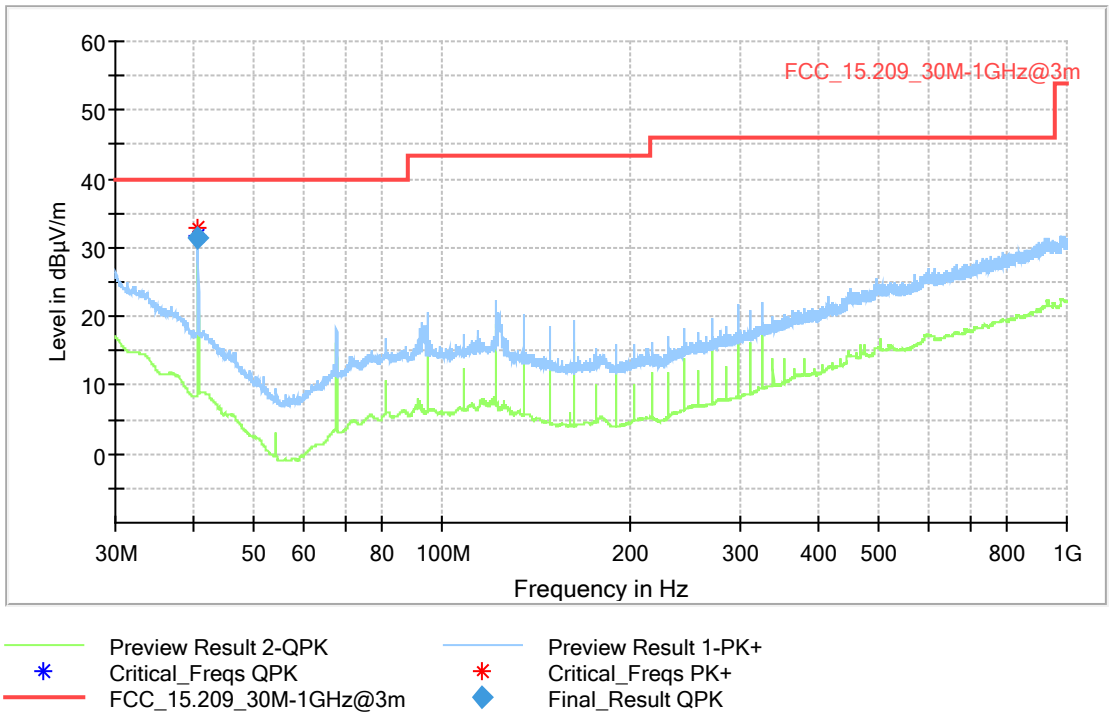
Preview Result 2-AVG
Critical_Freqs AVG
FCC_15.209_Peak@300m_9kHz-490kHz
FCC_15.209_QP@300m@30m_90kHz-30MHz
Final_Result AVG
Preview Result 1-PK+
Critical_Freqs PK+
FCC_15.209_AV@300m_9kHz-490kHz
Final_Result PK+

4.1.4.3 Above 30 MHz, EUT A, integral NFC antenna



Preview Result 2-QPK
Critical_Freqs QPK
FCC_15.209_30M-1GHz@3m
Preview Result 1-PK+
Critical_Freqs PK+
Final_Result QPK

4.1.4.4 Above 30 MHz, EUT A, external NFC antenna



4.1.5 Test Equipment used

- Radiated Emissions

4.2 Occupied bandwidth

Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.31

4.2.1 Test Description

The Equipment Under Test (EUT) was setup in a shielded room to perform the occupied bandwidth measurements.
The reference level is the level of the highest amplitude signal observed from the transmitter at either the fundamental frequency or first-order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical.
The results recorded were measured with the modulation which produces the worst-case (widest) occupied bandwidth.

4.2.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.215 (c)
Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in Subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. …

4.2.3 Test Protocol

Temperature: 24 °C
Air Pressure: 1009 hPa
Humidity: 46 %

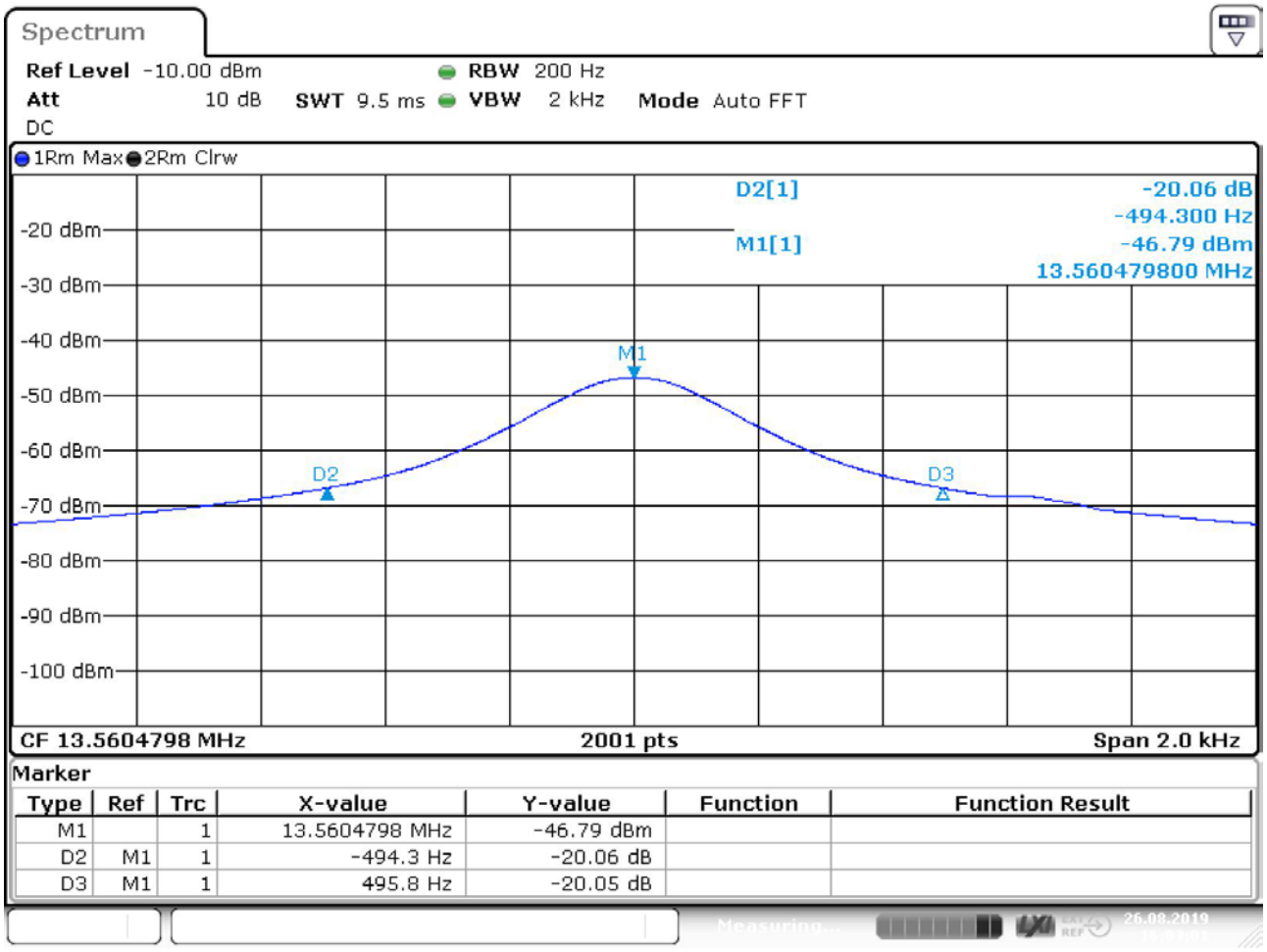
Op. Mode	Setup	Port
NFC_ext	Setup_01	Enclosure

20 dB bandwidth kHz	99% bandwidth kHz	Remarks
0.99	2.13	The 20 dB bandwidth from 13.559984 MHz to 13.560974 MHz is contained within the designated frequency band 13.110 MHz to 14.010 MHz.

Remark: None

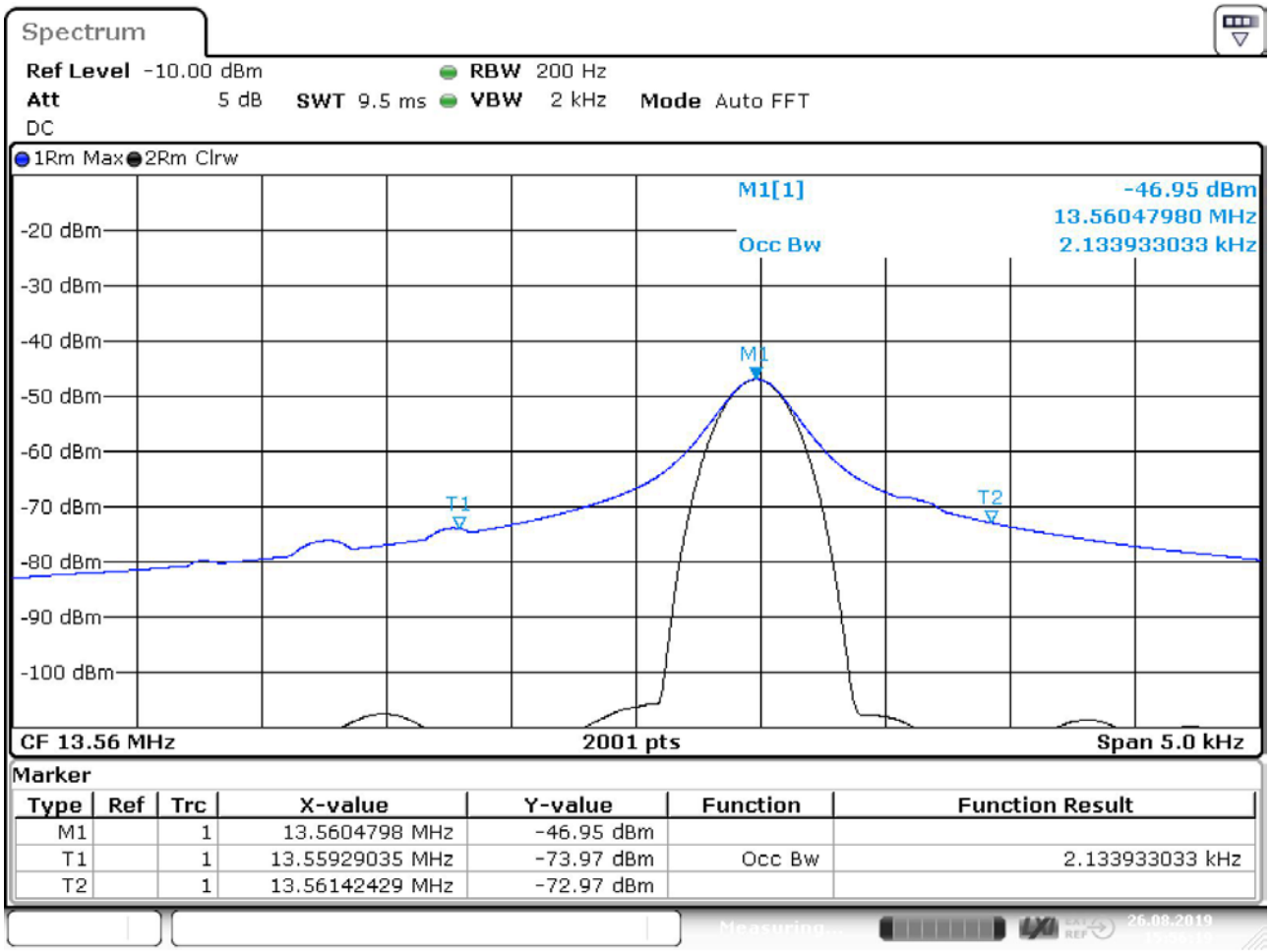
4.2.4 Measurement Plots (worst case)

4.2.4.1 20 dB bandwidth



Date: 26.AUG.2019 16:03:01

4.2.4.2 99% bandwidth



Date: 26.AUG.2019 15:56:20

4.2.5 Test Equipment used

- R&S TS8997

4.3 Spectrum mask

Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.225

4.3.1 Test Description

The test set-up was made in accordance to the general provisions of ANSI C 63.10.
The Equipment Under Test (EUT) was set up on a non-conductive table in the anechoic chamber.
The radiated emissions measurements were made in a typical installation configuration.
The measurement procedure is implemented into the EMI test software EMC32 from R&S.
The Loop antenna HFH2-Z2 is used.

- Semi-anechoic chamber
- Antenna distance: 3 m
- Detector: Quasi-Peak
- Frequency range: 13.06 – 14.06 MHz
- Frequency steps: 5 kHz
- IF–Bandwidth:10 kHz
- Measuring time / Frequency step: 1 s

4.3.2 Test Limits

FCC Part 15, Subpart C, §15.225 (a-d), and §15.209, corrected by the means of the extrapolation of §15.31 due to the reduced measuring distance from 30 m to 3 m.
The merits of the maximum value as well as the limit are referencing to a distance of 30 m.

4.3.3 Test Protocol

Temperature: 27 °C
Air Pressure: 1005 hPa
Humidity: 42 %

Op. Mode	Setup	Port
NFC_ext	Setup_01	Enclosure

Maximum value dBµV/m	Limit dBµV/m	Margin dB	Remarks
15.1	84.0	68.9	measuring distance 3 m

Remark: None

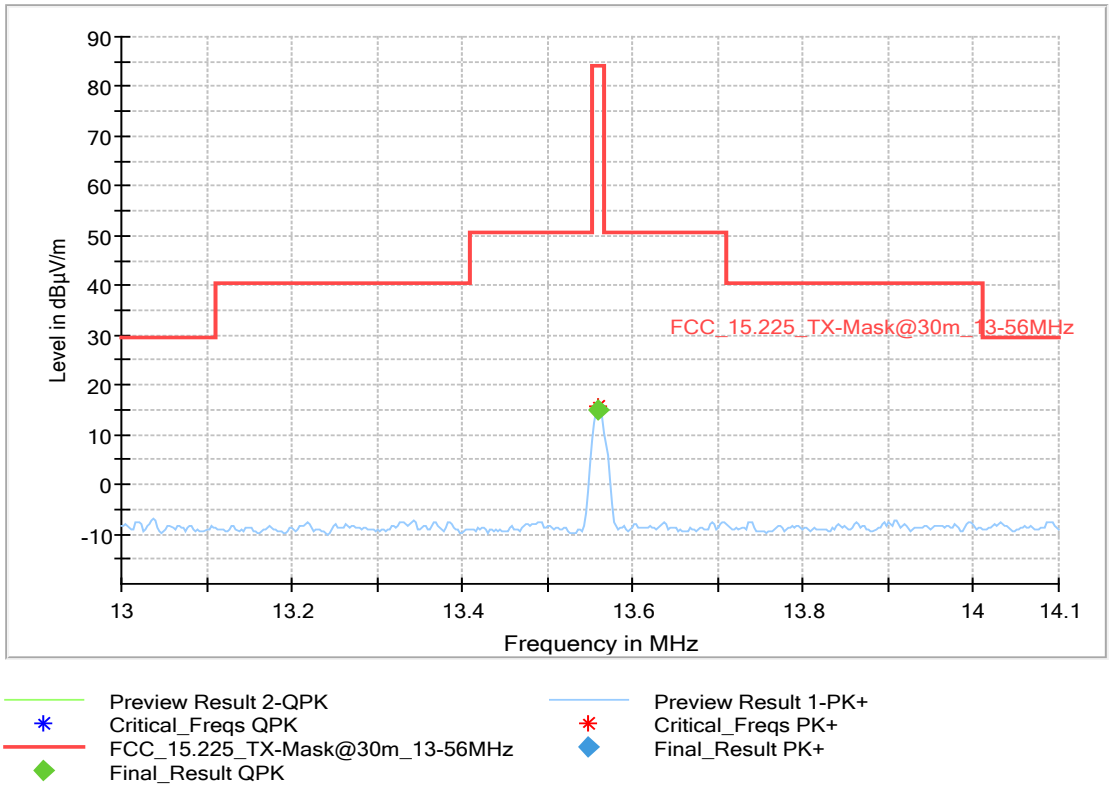
Op. Mode	Setup	Port
NFC_int	Setup_01	Enclosure

Maximum value dBµV/m	Limit dBµV/m	Margin dB	Remarks
6.2	84.0	77.2	measuring distance 3 m

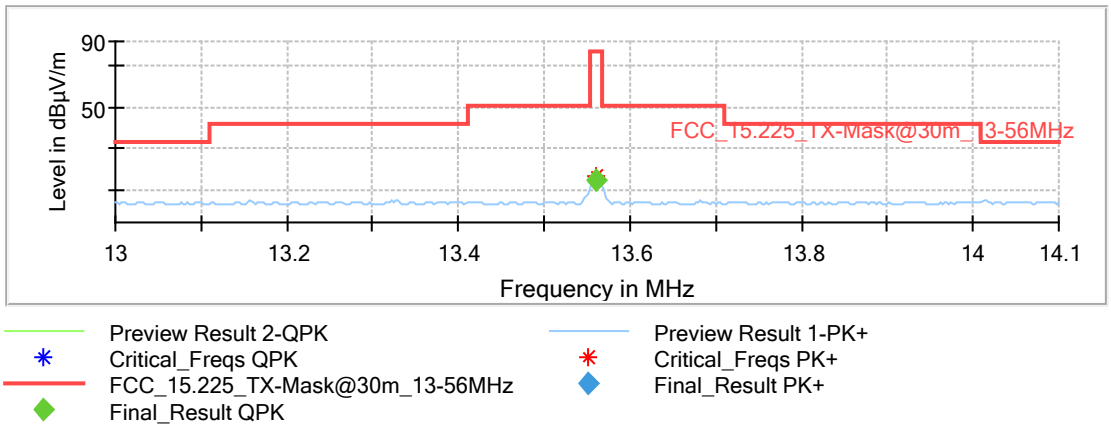
Remark: None

4.3.4 Measurement Plots (worst case)

4.3.4.1 EUT A, Mode NFC_ext



4.3.4.2 EUT A, Mode NFC_int



4.3.5 Test Equipment used

- Radiated Emissions

4.4 Frequency tolerance

Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.225

4.4.1 Test Description

The Equipment Under Test (EUT) is placed in a temperature chamber.
The frequency drift during temperature and voltage variation is measured by the means of a spectrum analyser with frequency counter function.
The temperature was varied from –20 °C to +50 °C. At +20 °C the wider extreme power supply voltages of 8.0 and 16.0 V (instead of 85% and 115%) are applied. After reaching each target temperature and waiting sufficient time allowing the temperature to stabilize, one measurement is performed immediately after powering on the EUT, and two further measurements are performed after 5 and 10 minutes continuous operation of the EUT.

4.4.2 Test Limits

FCC Part 15, Subpart C, §15.225 (e): The frequency tolerance of the carrier signal shall be maintained within ±0.01% of the operating frequency over a temperature variation of -20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C.

4.4.3 Test Protocol

Temperature: 26 °C
Air Pressure: 1009 hPa
Humidity: 32 %

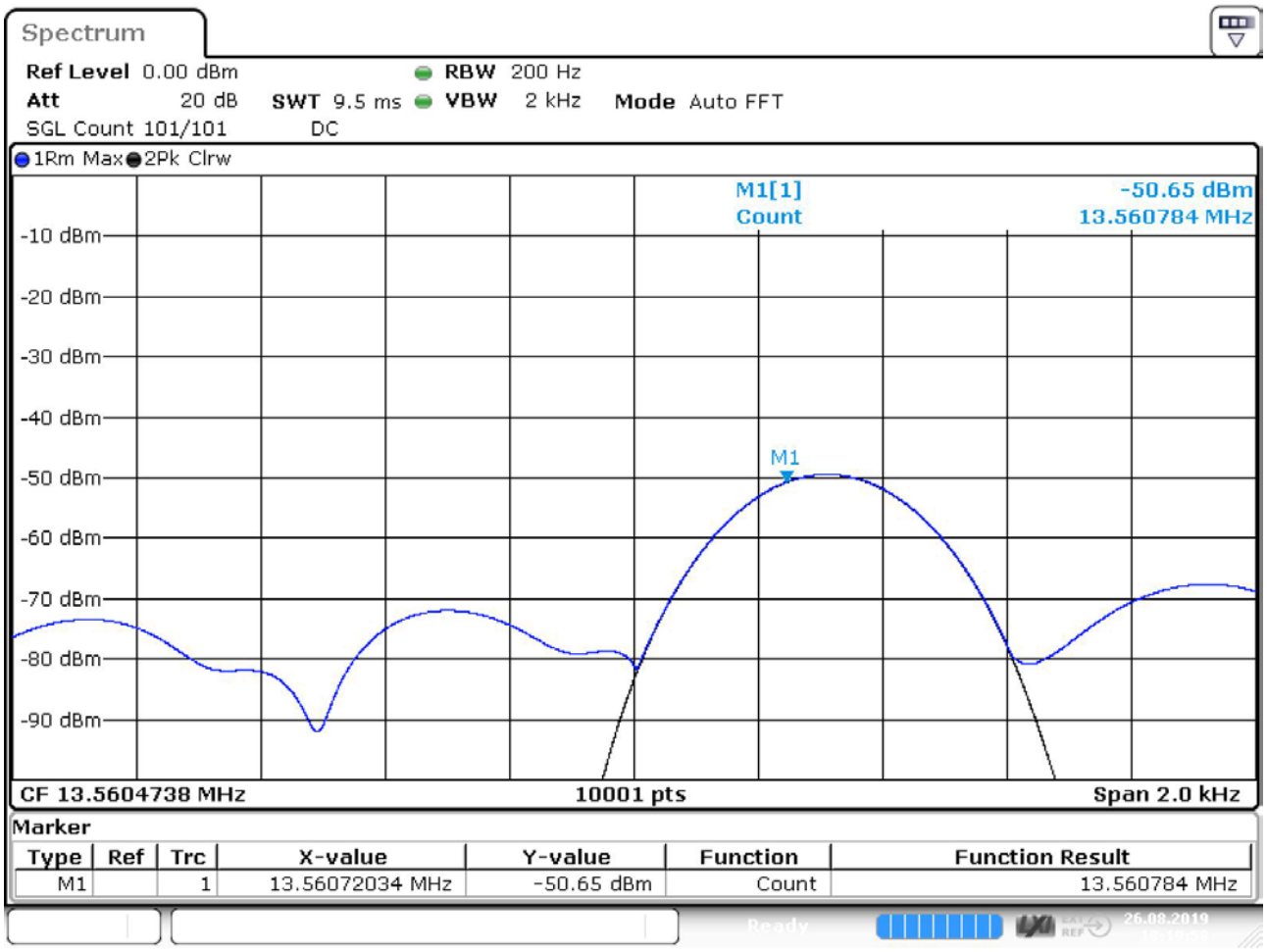
Op. Mode	Setup	Port
NFC_int	Setup_01	Enclosure

Temperature / °C	Voltage / V	Time / min.	Frequency / MHz	Delta / Hz
50	12.0	0	13.560358	358
50	12.0	5	13.560353	353
50	12.0	10	13.560348	348
40	12.0	0	13.560440	440
40	12.0	5	13.560413	413
40	12.0	10	13.560409	409
30	12.0	0	13.560473	473
30	12.0	5	13.560471	471
30	12.0	10	13.560470	470
20	8.0	0	13.560577	577
20	8.0	5	13.560577	577
20	8.0	10	13.560560	560
20	12.0	0	13.560559	559
20	12.0	5	13.560558	558
20	12.0	10	13.560557	557
20	16.0	0	13.560557	557
20	16.0	5	13.560556	556
20	16.0	10	13.560555	555
10	12.0	0	13.560684	684
10	12.0	5	13.560676	676
10	12.0	10	13.560671	671
0	12.0	0	13.560745	745
0	12.0	5	13.560740	740
0	12.0	10	13.560740	740
-10	12.0	0	13.560779	779
-10	12.0	5	13.560777	777
-10	12.0	10	13.560776	776
-20	12.0	0	13.560784	784
-20	12.0	5	13.560700	700
-20	12.0	10	13.560784	784

Remark: The limit is a delta of max. ±1356 Hz (0.01 %).
Extreme voltage values greater than ±15 % chosen within the EUT is specified to operate.

Maximum deviation from nominal frequency: 784 Hz

4.4.4 Measurement Plots (worst case)



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4.4.5 Test Equipment used

- R&S TS8997

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	2018-10	2020-10
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	2018-05	2019-11
1.5	Anechoic Chamber 01	SAC/FAR, 10.58 m x 6.38 m x 6.00 m	Frankonia	none	2018-06	2020-06
1.6	FS-Z60	Harmonic Mixer 40 - 60 GHz	Rohde & Schwarz Messgerätebau GmbH	100178	2016-12	2019-12
1.7	FS-Z220	Harmonic Mixer 140 - 220 GHz	Rohde & Schwarz Messgerätebau GmbH	101005	2017-03	2020-03
1.8	SGH-05	Standard Gain / Pyramidal Horn Antenna (140 - 220 GHz)	RPG-Radiometer Physics GmbH	075		
1.9	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
1.10	AMF-7D00101800-30-10P-R	Broadband Amplifier 100 MHz - 18 GHz	Miteq			
1.11	5HC2700/12750-1.5-KK	High Pass Filter	Trilithic	9942012		
1.12	ASP 1.2/1.8-10 kg	Antenna Mast	Maturo GmbH	-		
1.13	Anechoic Chamber 03	FAR, 8.80m x 4.60m x 4.05m (l x w x h)	Albatross Projects	P26971-647-001-PRB	2018-06	2020-06
1.14	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2018-04	2020-04
1.15	WRD1920/1980-5/22-5EESD	Tunable Band Reject Filter	Wainwright Instruments GmbH	11		
1.16	TDS 784C	Digital Oscilloscope [SA2] (Aux)	Tektronix	B021311		

Ref. No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
1.17	foRS232 Unit 2	Fibre optic link RS232	PONTIS Messtechnik GmbH	4031516037		
1.18	PONTIS Con4101	PONTIS Camera Controller		6061510370		
1.19	NRVD	Power Meter	Rohde & Schwarz GmbH & Co. KG	828110/016	2019-08	2020-08
1.20	OLS-1 R	Fibre optic link USB 1.1	Ingenieurbüro Scheiba	018		
1.21	HF 906	Double-ridged horn	Rohde & Schwarz	357357/002	2018-09	2021-09
1.22	JS4-18002600-32-5P	Broadband Amplifier 18 GHz - 26 GHz	Miteq	849785		
1.23	FSW 43	Spectrum Analyzer	Rohde & Schwarz	103779	2019-02	2021-02
1.24	3160-09	Standard Gain / Pyramidal Horn Antenna 26.5 GHz	EMCO Elektronic GmbH	00083069		
1.25	foRS232 Unit 1	Fibre optic link RS232	PONTIS Messtechnik GmbH	4021516036		
1.26	FSP3	Spectrum Analyzer	Rohde & Schwarz GmbH & Co. KG	836722/011		
1.27	SGH-19	Standard Gain / Pyramidal Horn Antenna (40 - 60 GHz)	RPG-Radiometer Physics GmbH	093		
1.28	WHKX 7.0/18G-8SS	High Pass Filter	Wainwright Instruments GmbH	09		
1.29	DS 420S	Turn Table 2 m diameter	HD GmbH	420/573/99		
1.30	4HC1600/12750-1.5-KK	High Pass Filter	Trilithic	9942011		
1.31	foUSB-M Converter 2	Fibre optic link USB 2.0	PONTIS Messtechnik GmbH	4471520061		
1.32	WRCD1879.8-0.2/40-10EE	Notch Filter Ultra Stable	Wainwright Instruments GmbH	16		
1.33	Chroma 6404	AC Source	Chroma ATE INC.	64040001304		
1.34	JS4-00102600-42-5A	Broadband Amplifier 30 MHz - 26 GHz	Miteq	619368		
1.35	TT 1.5 WI	Turn Table	Maturo GmbH	-		
1.36	HL 562 ULTRALOG	Biconical-log-per Antenna (30 MHz - 3 GHz)	Rohde & Schwarz GmbH & Co. KG	100609	2019-05	2022-05
1.37	HF 906	Double-ridged horn	Rohde & Schwarz	357357/001	2018-03	2021-03
1.38	foCAN (v 4.0)	Fibre optic link CAN	Audivo GmbH (PONTIS EMC)	492 1607 014		
1.39	FS-Z325	Harmonic Mixer 220 - 325 GHz	Rohde & Schwarz Messgerätebau GmbH	101006	2017-03	2020-03
1.40	3160-10	Standard Gain / Pyramidal Horn Antenna 40 GHz	EMCO Elektronic GmbH	00086675		

Ref. No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
1.41	MA4985-XP-ET	Bore Sight Antenna Mast	innco systems GmbH	none		
1.42	SGH-08	Standard Gain / Pyramidal Horn Antenna (90 - 140 GHz)	RPG-Radiometer Physics GmbH	064		
1.43	A8455-4	4 Way Power Divider (SMA)		-		
1.44	SGH-12	Standard Gain / Pyramidal HornAntenna (60 - 90 GHz)	RPG-Radiometer Physics GmbH	326		
1.45	Air compressor	Anechoic Chamber; 8.8m x 4.6 m x 4.05 m	JUN-AIR Deutschland GmbH	612582		
1.46	foEthernet_M	Fibre optic link Ethernet / Gb-LAN	PONTIS Messtechnik GmbH	4841516023		
1.47	5HC3500/18000-1.2-KK	High Pass Filter	Trilithic	200035008		
1.48	FS-Z140	Harmonic Mixer 90 -140 GHz	Rohde & Schwarz Messgerätebau GmbH	101007	2017-02	2020-02
1.49	OLS-1 M	Fibre optic link USB 1.1	Ingenieurbüro Scheiba	018		
1.50	HFH2-Z2	Loop Antenna	Rohde & Schwarz	829324/006	2018-01	2021-01
1.51	Voltcraft M-3860M	Digital Multimeter 01 (Multimeter)	Conrad	IJ096055		
1.52	Opus10 THI (8152.00)	ThermoHygro Datalogger 12	Lufft Mess- und Regeltechnik GmbH	ID 12482	2019-06	2021-06
1.53	ESR 7	EMI Receiver / Spectrum Analyzer	Rohde & Schwarz	101424	2019-01	2020-01
1.54	foEthernet_M	Fibre optic link Ethernet / Gb-LAN	PONTIS Messtechnik GmbH	4841516022		
1.55	JS4-00101800-35-5P	Broadband Amplifier 30 MHz - 18 GHz	Miteq	896037		
1.56	AS 620 P	Antenna Mast (pneumatic polarisation)	HD GmbH	620/37		
1.57	6005D (30 V / 5 A)	Laboratory Power Supply 120 V 60 Hz	Peaktech	81062045		
1.58	TD1.5-10kg	EUT Tilt Device (Rohacell)	Maturo GmbH	TD1.5-10kg/024/3790709		
1.59	SGH-03	Standard Gain / Pyramidal Horn Antenna (220 - 325 GHz)	RPG-Radiometer Physics GmbH	060		
1.60	FS-Z90	Harmonic Mixer 60 - 90 GHz	Rohde & Schwarz Messgerätebau GmbH	101686	2017-03	2020-03

Ref. No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
1.61	ESIB 26	Spectrum Analyzer	Rohde & Schwarz	830482/004	2018-01	2020-01
1.62	Innco Systems CO3000	Controller for bore sight mast SAC	innco systems GmbH	CO3000/967/393 71016/L		
1.63	NRV-Z1	Sensor Head B	Rohde & Schwarz GmbH & Co. KG	827753/006	2019-08	2020-08
1.64	foCAN (v 4.0)	Fibre optic link CAN	Audivo GmbH (PONTIS EMC)	492 1607 013		
1.65	PAS 2.5 - 10 kg	Antenna Mast	Maturo GmbH	-		
1.66	AFS42-00101800-25-S-42	Broadband Amplifier 25 MHz - 18 GHz	Miteq	2035324		
1.67	WRCA800/960-0.2/40-6EEK	Tunable Notch Filter	Wainwright Instruments GmbH	20		
1.68	AM 4.0	Antenna Mast 4 m	Maturo GmbH	AM4.0/180/11920 513		
1.69	HF 907	Double-ridged horn	Rohde & Schwarz	102444	2018-07	2021-07
1.70	E4408B	Spectrum Analyser (9 kHz to 26.5 GHz)	Agilent Technologies Deutschland GmbH	MY45103714		

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Lab to perform bandwidth test

Ref. No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
2.1	SMB100A	Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz	107695	2017-07	2020-07
2.2	MFS	Rubidium Frequency Standard	Datum-Beverly	5489/001	2019-08	2020-08
2.3	1515 / 93459	Broadband Power Divider SMA (Aux)	Weinschel Associates	LN673		
2.4	FSV30	Signal Analyzer 10 Hz - 30 GHz	Rohde & Schwarz	103005	2018-04	2020-04
2.5	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2018-04	2020-04
2.6	VT 4002	Temperature Chamber	Vötsch	58566002150010	2018-04	2020-04
2.7	A8455-4	4 Way Power Divider (SMA)		-		
2.8	Opus10 THI (8152.00)	ThermoHygro Datalogger 03 (Environ)	Lufft Mess- und Regeltechnik GmbH	7482	2019-06	2021-06
2.9	SMBV100A	Vector Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz	259291	2016-10	2019-10
2.10	OSP120	Switching Unit with integrated power meter	Rohde & Schwarz	101158	2018-05	2021-05

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.

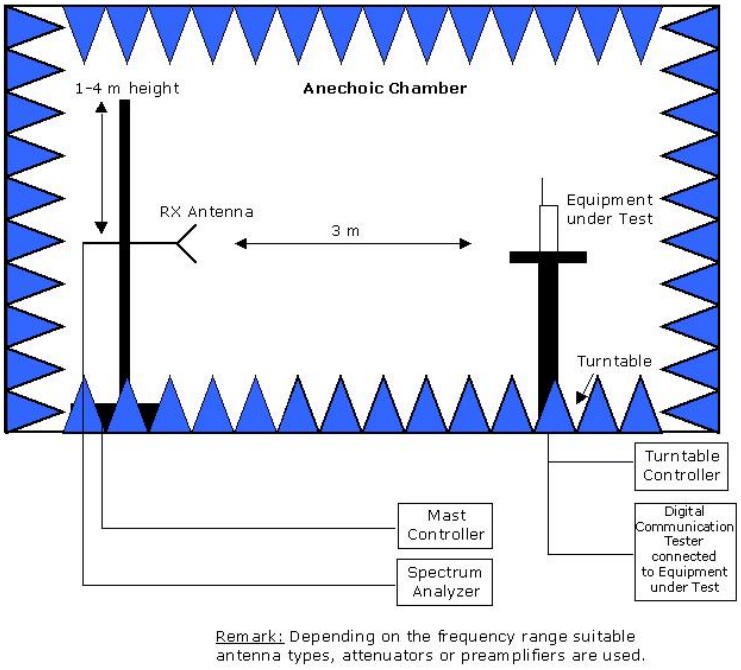
6.6 Antenna EMCO 3160-10 (26.5 GHz – 40 GHz)

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 Setup Drawings



Drawing 1: Setup in the Anechoic chamber:
Measurements below 1 GHz: Semi-anechoic, conducting ground plane.
Measurements above 1 GHz: Fully-anechoic, absorbers on all surfaces.

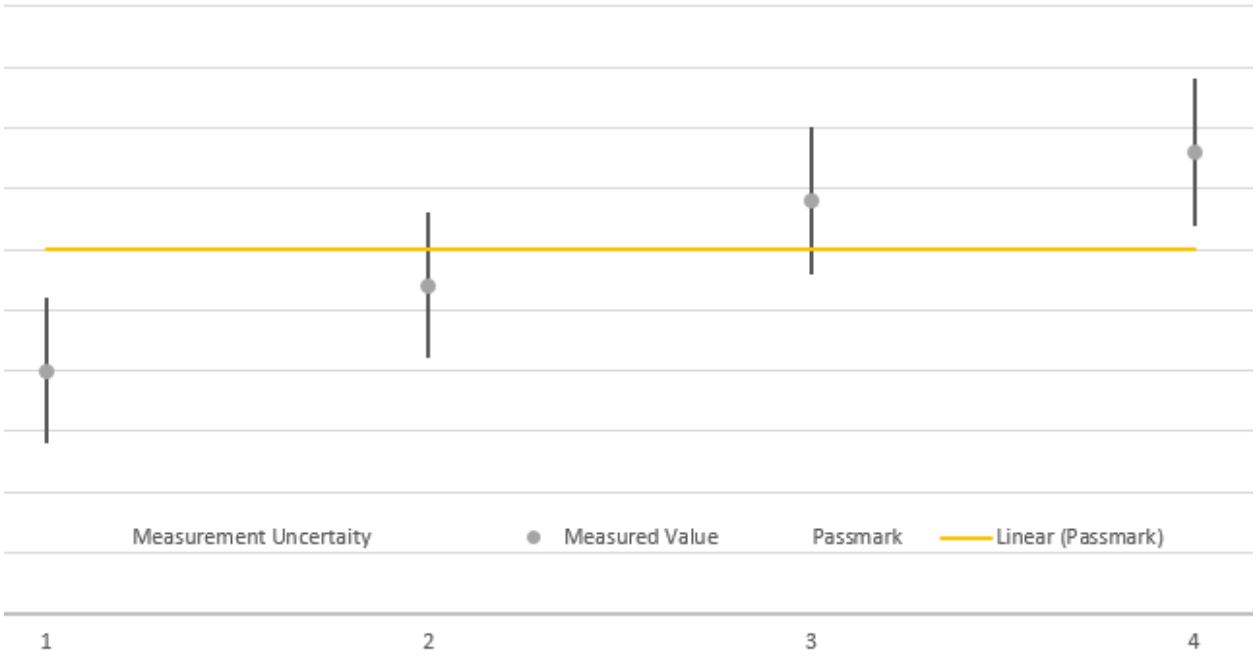
8 Photo Report

Photos are included in an external report.

9 Measurement uncertainty

Test Case	Parameter	Uncertainty
Peak power output	Fieldstrength	± 5.5 dB
Occupied bandwidth	Power Frequency:	± 2.9 dB ± 0.125 kHz
Spurious radiated emissions	Fieldstrength Frequency:	± 5.5 dB ± 11.2 kHz
AC Power Line	Power	± 3.4 dB
Frequency tolerance (frequency counter)	Frequency	± 2 Hz

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.