FCC Measurement/Technical Report on

Automation Sensor
RAS3-DEV-X

FCC ID: S7Y-MI4
IC: 10942A-MI4

Test Report Reference: MDE_BVUS_2401_FCC_01_REV_02

Test Laboratory:
7layers GmbH
Borsigstrasse 11
40880 Ratingen
Germany

Deutsche
Akkreditierungsstelle
D-PL-12140-01-00

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1 APPLIED STANDARDS AND TEST SUMMARY

1.1 APPLIED STANDARDS

Type of Authorization
Certification for an Intentional Radiator.

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2 and 95 (10-1-23 Edition). The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

Part 95 – Personal Radio Services
Subpart M – The 76 – 81 GHz Band Radar Service

§ 95.3367 76–81 GHz Band Radar Service radiated power limits.

§ 95.3379 76–81 GHz Band Radar Service unwanted emissions limits.

Note:
The tests were selected and performed with reference to:

- FCC Public Notice "EQUIPMENT AUTHORISATION GUIDANCE FOR 76-81 GHz RADAR DEVICES, 653005 D01 76-81 GHz Radars v01r01, 2022-04-25".
- ANSI C63.10-2020 / COR1-2020

Summary Test Results:

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

1.2 FCC-IC CORRELATION TABLE

Correlation of measurement requirements for Vehicular Radar and Airport Fixed or Mobile Radar in the band 76-81 GHz Frequency Band FCC and IC

Measurement	FCC reference	IC reference
AC Power Line Conducted Emissions	§ 15.207	RSS-Gen Issue 5: 8.8
Emission (Occupied) Bandwidth	§ 2.1049	RSS-Gen Issue 5: 6.7 RSS251 Issue 2: Chapter 7
Average Output Power (EIRP)	§ 2.1046 § 95.3367 (a)	RSS-Gen Issue 5: 6.12 RSS251 Issue 2: Chapter 8
Peak Output Power (Spectral Density) (EIRP)	§ 2.1046 § 95.3367 (b)	RSS-Gen Issue 5: 6.12 RSS251 Issue 2: Chapter 9
Unwanted Emissions	§ 2.1053 § 95.3379 (a), (1), (i), (ii), (iii) (2), (i), (ii) (3)	RSS-Gen Issue 5: 6.13 RSS251 Issue 2: Chapter 10
Frequency Stability	§ 2.1055 § 95.3379 (b)	RSS-Gen Issue 5: 6.11 RSS251 Issue 2: Chapter 11

1.3 MEASUREMENT SUMMARY / SIGNATURES

47 CFR CHAPTER I FCC PART 95 Subpart M **§15.207**

AC Power Line Conducted Emissions
The measurement was performed according to ANSI C63.10 (2020) Chapter 6.2 **Final Result**

OP-Mode Radio Technology, Operating Frequency, Measurement range	Setup	Date	FCC	IC
FMCW Radar, 76 – 81 GHz,	-	-	N/A	N/A

47 CFR CHAPTER I FCC PART 95 Subpart M **§2.1049, §95.3379 (b)**

Emission (Occupied) Bandwidth
The measurement was performed according to ANSI C63.10 (2020) Chapter 9.4 **Final Result**

OP-Mode Radio Technology, Operating Frequency, Measurement range	Setup	Date	FCC	IC
FMCW Radar, 76 GHz – 81 GHz	S01_AA02	2025-02-06	Passed	Passed

47 CFR CHAPTER I FCC PART 95 Subpart M **§ 95.2267 (a)**

Average Output Power (EIRP)
The measurement was performed according to ANSI C63.10 (2020) Chapter 9.8 **Final Result**

OP-Mode: Radio Technology, Operating Frequency, Measurement range	Setup	Date	FCC	IC
FMCW Radar, 76 – 81 GHz, 76 GHz – 81 GHz	S01_AA02	2024-08-28	Passed	Passed

47 CFR CHAPTER I FCC PART 95 Subpart M **§ 95.2267 (b)**

Peak Output Power (Spectral Density) (EIRP)
The measurement was performed according to ANSI C63.10 (2020) Chapter 9.8 **Final Result**

OP-Mode: Radio Technology, Operating Frequency, Measurement range	Setup	Date	FCC	IC
FMCW Radar, 76 – 81 GHz, 76 GHz – 81 GHz	S01_AA02	2024-08-28	Passed	Passed

47 CFR CHAPTER I FCC PART 95 Subpart M	**§ 95.3379 (a), (1), (i), (ii), (iii) (2), (i), (ii), (3)**

Unwanted Emissions

The measurement was performed according to: **Final Result**

- ANSI C63.10 (2020), chapter 6.4, 6.5, 6.6.5, 9kHz – 40 GHz
- ANSI C63.10 (2020), Chapter 9.10, > 40GHz

OP-Mode Radio Technology, Operating Frequency, Measurement range, Limit*	**Setup**	**Date**	**FCC**	**IC**
FMCW Radar, 76 – 81 GHz, 9 kHz – 30 MHz, both	S01_AA01	2024-03-07	Passed	Passed
FMCW Radar, 76 – 81 GHz, 30 MHz – 1 GHz, both	S01_AA01	2024-03-07	Passed	Passed
FMCW Radar, 76 – 81 GHz, 1 GHz – 26 GHz, both	S01_AA01	2024-03-06	Passed	Passed
FMCW Radar, 76 – 81 GHz, 26 GHz – 40 GHz, both	S01_AA01	2024-03-07	Passed	Passed
FMCW Radar, 76 – 81 GHz,40 GHz – 60 GHz, FCC	S01_AA02	2024-08-24	Passed	Passed
FMCW Radar, 76 – 81 GHz, 60 GHz – 76 GHz, FCC	S01_AA02	2024-08-24	Passed	Passed
FMCW Radar, 76 – 81 GHz, 81 GHz – 90 GHz, FCC	S01_AA02	2024-08-24	Passed	Passed
FMCW Radar, 76 – 81 GHz, 90 GHz – 140 GHz, FCC	S01_AA02	2024-08-24	Passed	Passed
FMCW Radar, 76 – 81 GHz, 140 GHz – 200 GHz, FCC	S01_AA02	2024-08-24	Passed	Passed
FMCW Radar, 76 – 81 GHz, 200 GHz – 325 GHz, FCC	S01_AA02	2024-08-24	Passed	Passed
FMCW Radar, 76 – 81 GHz,40 GHz – 60 GHz, RSS	S01_AA01	2024-03-07	Passed	Passed
FMCW Radar, 76 – 81 GHz, 60 GHz – 76 GHz, RSS	S01_AA01	2024-03-07	Passed	Passed
FMCW Radar, 76 – 81 GHz, 81 GHz – 90 GHz, RSS	S01_AA01	2024-03-05	Passed	Passed
FMCW Radar, 76 – 81 GHz, 90 GHz – 140 GHz, RSS	S01_AA01	2024-03-05	Passed	Passed
FMCW Radar, 76 – 81 GHz, 140 GHz – 170 GHz, RSS	S01_AA02	2024-08-21	Passed	Passed

47 CFR CHAPTER I FCC PART 95 Subpart M	**§ 95.3379 (b)**

Frequency Stability

The measurement was performed according to ANSI C63.10 (2020), chapter 6.8.1 **Final Result**

OP-Mode Radio Technology, Operating Frequency, Measurement range	**Setup**	**Date**	**FCC**	**IC**
FMCW Radar, 76 – 81 GHz	S01_AA02	2024-08-23 2024-08-24 2024-08-25 2024-08-26	Passed	Passed

*: possible values: both (FCC & RSS), FCC, RSS

N/A: Not applicable
N/P: Not performed

2 REVISION HISTORY

Report version control			
Version	**Release date**	**Change Description**	**Version validity**
initial	2024-09-19	--	invalid
REV_01	2024-12-23	• Chapter 5.2.3: Power integration over OBW for average power – including sample calculation - added.	invalid
REV_02	2025-02-06	• Chapter 5.3.4: Measurement plots for unwanted emission according to RSS-251 in the frequency range 60 – 170 GHz added. • Chapter 1.3: Result entries for unwanted emission > 40 GHz, splitted for FCC and ISED requirements. • Chapter 1.3: Version of ANSI C63.10 set unique to 2020 • Chapter 5.1.4: 99% OBW plot changed	valid

COMMENT: --

(responsible for accreditation scope)
Dipl.-Ing. Marco Kullik

(responsible for testing and report)
Dipl.-Ing Robert Machulec

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

3 ADMINISTRATIVE DATA

3.1 TESTING LABORATORY

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

The test facility is accredited by the following accreditation organisation:

Laboratory accreditation no:	DAkkS D-PL-12140-01-00
FCC Designation Number:	DE0015
FCC Test Firm Registration:	929146
ISED CAB Identifier	DE0007; ISED#: 3699A
Responsible for accreditation scope:	Dipl.-Ing. Marco Kullik
Report Template Version:	2024-03-12

3.2 PROJECT DATA

Responsible for testing and report:	Dipl.-Ing Robert Machulec
Employees who performed the tests:	documented internally at 7Layers
Date of Report:	2025-02-06
Testing Period:	2024-03-05 to 2024-08-28, 2025-02-06

3.3 APPLICANT DATA

Company Name:	Bureau Veritas Electrical and Electronic Product Services
Address:	One Distribution Center Circle, Suite #1 MA 01460 Littleton United States of America
Contact Person:	Mr. Charles Olsen

3.4 MANUFACTURER DATA

Company Name:	Navtech Radar Limited
Address:	Home Farm, Ardington Wantage, Oxfordshire OX12 8PD United Kingdom
Contact Person:	Mr. Richard Poulton

4 TEST OBJECT DATA

4.1 GENERAL EUT DESCRIPTION

Declared EUT data by the supplier	
Kind of Device	Radar Unit
General product description	Industrial radar sensor for safety, efficiency and automation applications, operating in the 76-77GHz band.
Product name	Automation Sensor
Type	RAS3-DEV-X
Voltage Type	DC
Voltage Level	24.0 V
High Temperature:	60.0 °C
Low Temperature:	-20.0 °C
Operating Frequency Range	76.0 – 77.0 GHz
Modulation Type	FMCW
Modulation Period	625 µs
Modulation Bandwidth	970 MHz
Ramp Sweep Time	Appr. 590 µs ms
Duty Cycle	Chirp rate: 66 %
Installation Orientation	Fixed (white radom at the top)
TX-Antenna Polarisation	Linear Horizontal (but the rotation of the antenna will change the polarisation during rotation)
RX-Antenna Polarisation	Linear Horizontal (but the rotation of the antenna will change the polarisation during rotation)
TX-Antenna Boresight Direction	Centre of the mechanical antenna
RX-Antenna Boresight Direction	Centre of the mechanical antenna
TX-Antenna 3 dB Beamwidth	Azimuth = 2.8°, Elevation = 3.4°
RX-Antenna 3 dB Beamwidth	Azimuth = 2.8°, Elevation = 3.4°
Antenna Construction	mechanical scanning antenna
Antenna Gain	34.0 dBi
The EUT provides the following ports:	Ethernet: ≤ 10 m (max. length) DC power: ≤ 10 m (max. length)
Special software used for testing	Web-Browser of the EUT

4.2 EUT MAIN COMPONENTS

Sample Name	Sample Code	Description
EUT aa01	DE1094018aa01	Radiated Sample
Sample Parameter	**Value**	
Serial No.	05609	
HW Version	Pre-production	
SW Version	3.1.1.379	
Comment	-	

Sample Name	Sample Code	Description
EUT aa02	DE1094018aa02	Radiated Sample
Sample Parameter	**Value**	
Serial No.	05609	
HW Version	Pre-production	
SW Version	3.1.1.379	
Comment	-	

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

4.3 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.

Device	Details (Manufacturer, Type Model, OUT Code)	Description
-	-	-

4.4 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.

Device	**Details (Manufacturer, Type Model, HW, SW, S/N)**	**Description**
AUX1	Relec, AMR5-24, -, -, -	AC/DC converter
-	-	-

4.5 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	**Combination of EUTs**	**Description and Rationale**
S01_AA01	EUT aa01 + AUX01	Radiated Setup
S01_AA02	EUT aa02 + AUX01	Radiated Setup

4.6 OPERATING MODES

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

4.6.1 TEST CHANNELS AND MODULATIONS

FMCW Radar Signal with an operational frequency range from

- 76.00 GHz to 77.00 GHz, FMCW, rotating of the antenna switched off

4.7 PRODUCT LABELLING

4.7.1 FCC ID LABEL

Please refer to the documentation of the applicant.

4.7.2 LOCATION OF THE LABEL ON THE EUT

Please refer to the documentation of the applicant.

5 TEST RESULTS

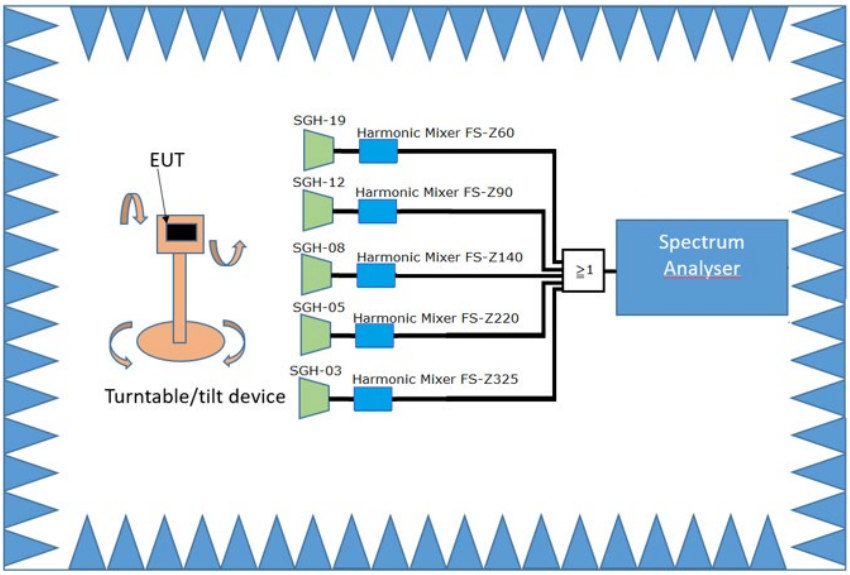
5.1 EMISSION BANDWIDTH

Standard **FCC Part 95M**

The test was performed according to:
ANSI C63.10

5.1.1 TEST DESCRIPTION

The Equipment Under Test (EUT) was set up on a non-conductive support (tilt device) at 1.5 m height in the fully-anechoic chamber.
All steps were performed with one height (1.5 m) of the receiving antenna only.



Test Setup (40 GHz - 320 GHz)

Analyzer settings:

- Resolution Bandwidth (RBW): 1 MHz
- Video Bandwidth (VBW): 3 MHz
- Span: 9 GHz
- Trace: Maxhold
- Sweeps: allow the trace to stabilize
- Sweeptime: 10 s
- Detector: RMS

5.1.2 TEST REQUIREMENTS / LIMITS

§2.1049
The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission.

§95.3379 (b)
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.

RSS-GEN Issue 5 (April 2018), Clause 6.7

The occupied bandwidth or the "99% emission bandwidth" is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs. […]

RSS-251, chapter 8.2
The radar device's occupied bandwidth (i.e. 99% emission bandwidth) shall be contained in the 76-81 GHz frequency band.

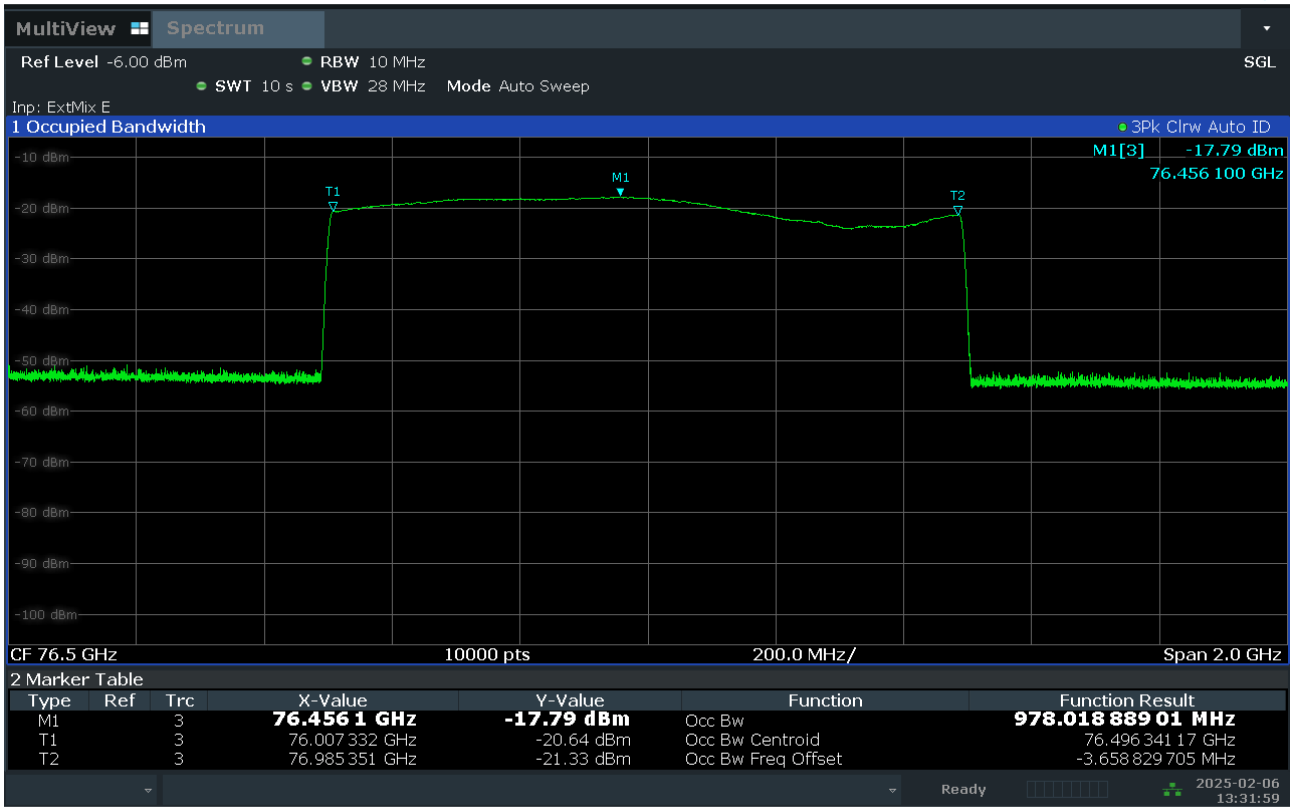
5.1.3 TEST PROTOCOL

Ambient temperature: 21 °C
Air Pressure: 34 hPa
Humidity: 1015 %

Frequency Range: 76.0 - 81.0 GHz						
Operating Frequency	**Lower 99 % Frequency fL [GHz]**	**Upper 99 % Frequency fH [GHz]**	**Lower Band Edge [GHz]**	**Upper Band Edge [GHz]**	**Margin to Lower Limit [MHz]**	**Margin to Upper Limit [MHz]**
Mid	76.0073	76.9854	76.0000	81.0000	0.0073	4.0146

5.1.4 MEASUREMENT PLOT

99 dB Bandwidth



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5.1.5 TEST EQUIPMENT USED

- Radiated Emissions FAR FCC

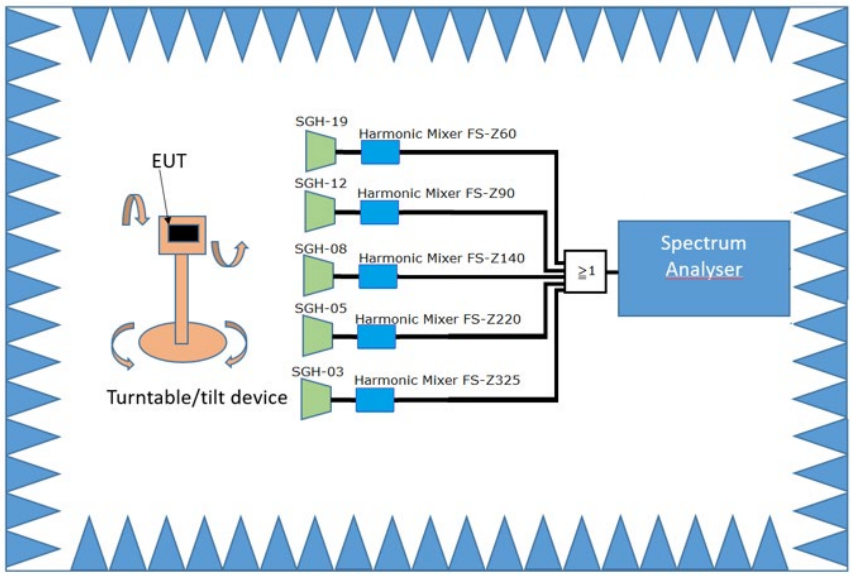
5.2 RADIATED OUTPUT POWER

Standard **FCC Part 95M, § 95.2267 (a), § 95.2267 (b)**

The test was performed according to:
ANSI C63.10, chapter 9.8

5.2.1 TEST DESCRIPTION

The Equipment Under Test (EUT) was set up on a non-conductive support (tilt device) at 1.5 m height in the fully-anechoic chamber.
All steps were performed with one height (1.5 m) of the receiving antenna only.
The EUT is turned during the pre-measurement to find the direction where the highest output power is emitted by the EUT, the turn table step size (azimuth angle) for the measurement is 1°, the Turntable angle range: –180° to +180°. When the position of the highest radiation is detected, the output power is measured in this position.



Test Setup (40 GHz - 320 GHz)

Analyzer settings:

- Resolution Bandwidth (RBW): 1 MHz
- Video Bandwidth (VBW): 3 MHz
- Span: 1000 MHz
- Trace: Maxhold
- Sweeps: allow the trace to stabilize
- Sweeptime: 7 s
- Detector: Peak / Average
- Measurement distance: 3 m

5.2.2 TEST REQUIREMENTS / LIMITS

§95.3367
The fundamental radiated emission limits within the 76-81 GHz band are expressed in terms of Equivalent Isotropically Radiated Power (EIRP) and are as follows:

(a) The maximum power (EIRP) within the 76-81 GHz band shall not exceed 50 dBm based on measurements employing a power averaging detector with a 1 MHz Resolution Bandwidth (RBW).

(b) The maximum peak power (EIRP) within the 76-81 GHz band shall not exceed 55 dBm based on measurements employing a peak detector with a 1 MHz RBW

RSS-251, chapter 8.2
The radar device's total average e.i.r.p. shall not exceed 50 dBm over the occupied bandwidth.

RSS-251, chapter 9.2
The radar device's peak e.i.r.p. spectral density shall not exceed 55 dBm/MHz.

5.2.3 TEST PROTOCOL

Ambient temperature: 25 °C
Air Pressure: 1015 hPa
Humidity: 42 %

Average Power:

Polarisation	Measured Average Power E.I.R.P. [dBm/Mhz]	Integrated Average Power E.I.R.P. [dBm] *)	Limit [dBm]	Margin to Limit [dB]	Margin to Limit for integrated power [dB]	Verdict
Horizontal	**7.7**	**20.7**	**50.0**	**42.3**	**29.3**	**Passed**
vertical	7.7	8.6	50.0	42.3	41.6	Passed

*) Calculation of integrated average power:

1. dilogarithm of all power values within the 99% OBW: $P_{mW} = 10^{(\frac{P_{dBm}}{10})}$
   a. Lower frequency: 76008.5 MHz
   b. Upper frequency: 76982.4 MHz
2. Integration of all values –within the 99% OBW (= 1672 values): 116.2465 mW
3. Logarithm of the integrated value: $P_{dBm} = 10 * \log(P_{mW})$: 20.7 dBm

Peak Power:

Polarisation	Measured Peak Power E.I.R.P. [dBm]	FMCW desensitization factor [dB]	Peak Power E.I.R.P (incl. desensitization factor) [dBm]	Limit [dBm]	Margin to Limit [dB]	Verdict
Horizontal	**40.6**	**0.9**	**41.5**	**55.0**	**13.5**	**Passed**
vertical	28.5	0.9	29.4	55.0	25.6	Passed

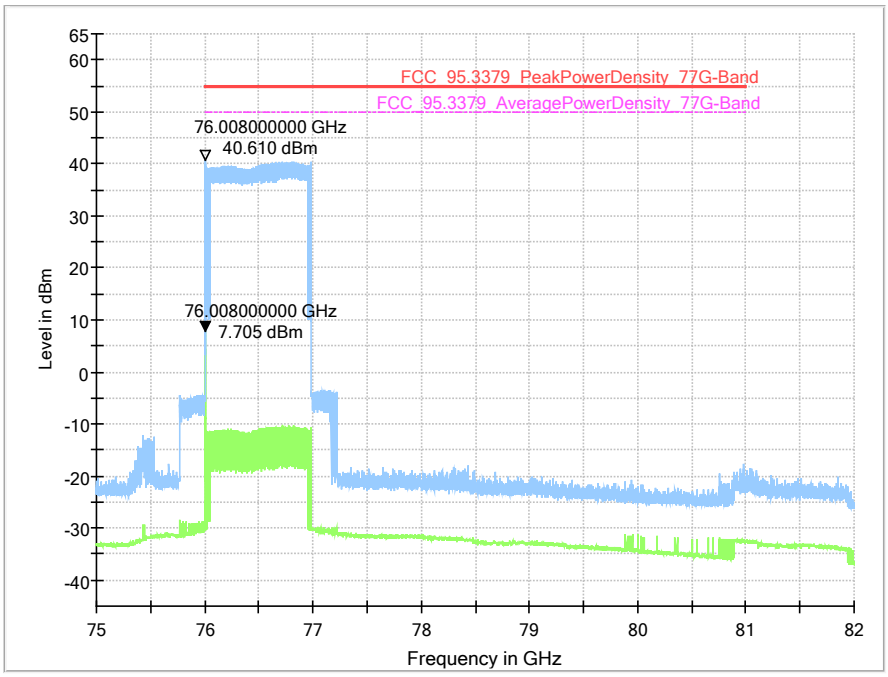
Desensitization Factor:

$$\alpha = \frac{1}{\left(1+\left[\left(\frac{2\times\ln(2)}{\pi}\right)^2\times\left(\frac{BW_{\text{Chirp}}}{T_{\text{Chirp}}\times RBW^2}\right)^2\right]\right)^{0.25}}$$

$BW_{Chirp} = 973\ MHz$
$T_{Chirp} = 590\ \mu s$

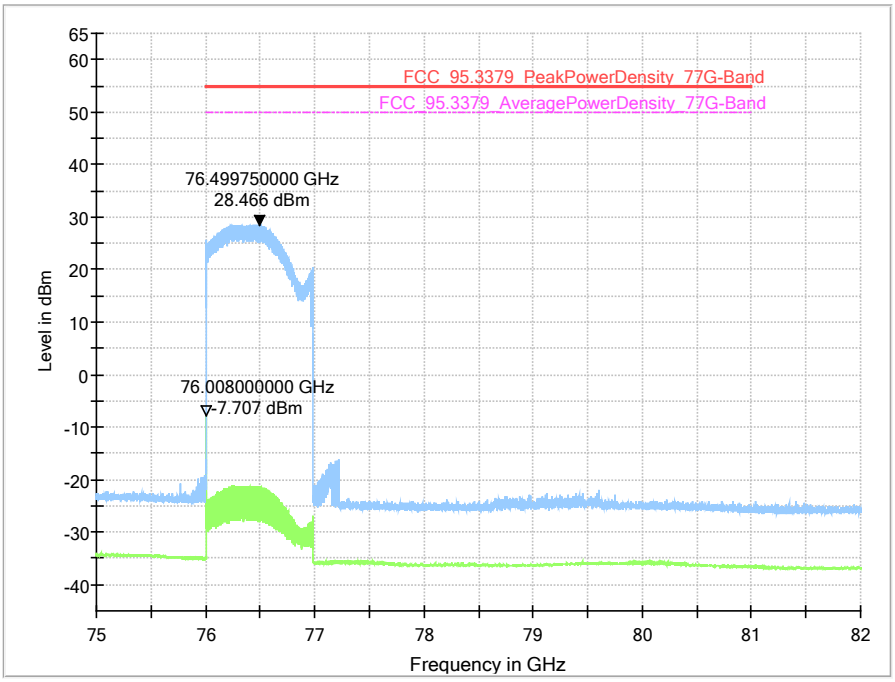
5.2.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

Horizontal Polarisation



The values of the green line – within the 99% OBW – were used to calculate the integrated average power.

Vertical Polarisation



5.2.5 TEST EQUIPMENT USED

- Radiated Emissions FAR FCC

5.3 UNWANTED EMISSIONS

Standard **FCC Part 95 Subpart M**

The test was performed according to:

- ANSI C63.26 (2015) Chapter 6.4, 6.5, 6.6, 9kHz – 40 GHz
- ANSI C63.10 (2020), Chapter 9.10, > 40 GHz

5.3.1 TEST DESCRIPTION

The test set-up was made in accordance to the general provisions of ANSI C63.10 / ANSI C63.26 in a typical installation configuration.

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. The final test on all kind of EUTs is also performed at 3 axes. A pre-check is performed while the EUT is powered.

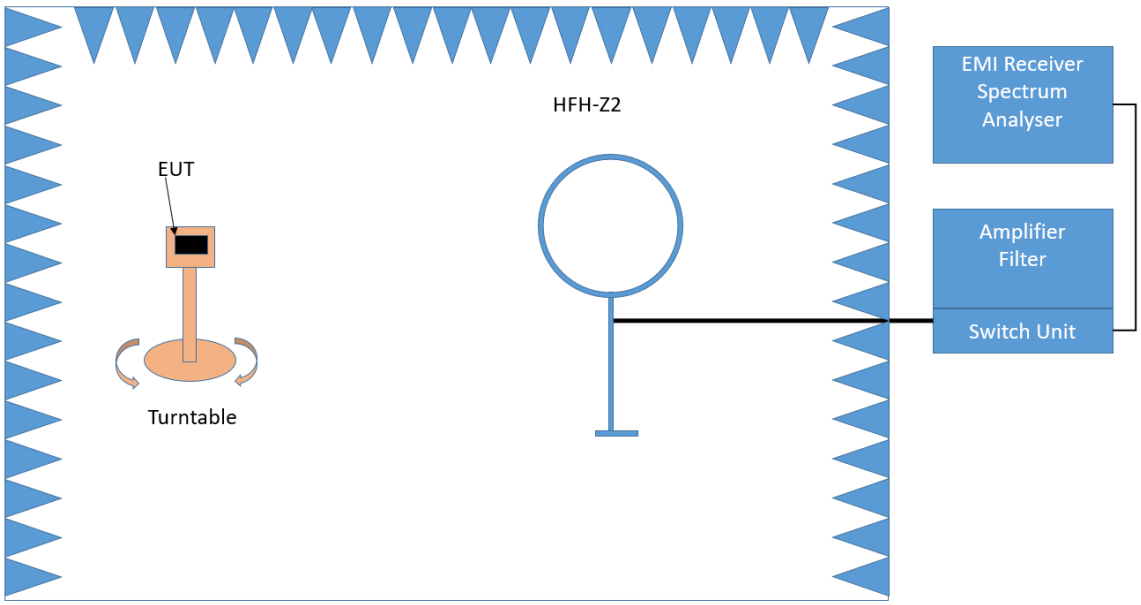
Below 1 GHz:

The Equipment Under Test (EUT) was set up on a non-conductive table in the semi-anechoic chamber. The influence of the EUT support table that is used between 30–1000 MHz was evaluated.

Below 1 GHz:

The Equipment Under Test (EUT) was set up on a non-conductive table in the semi-anechoic chamber. The influence of the EUT support table that is used between 30–1000 MHz was evaluated.

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
- 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)

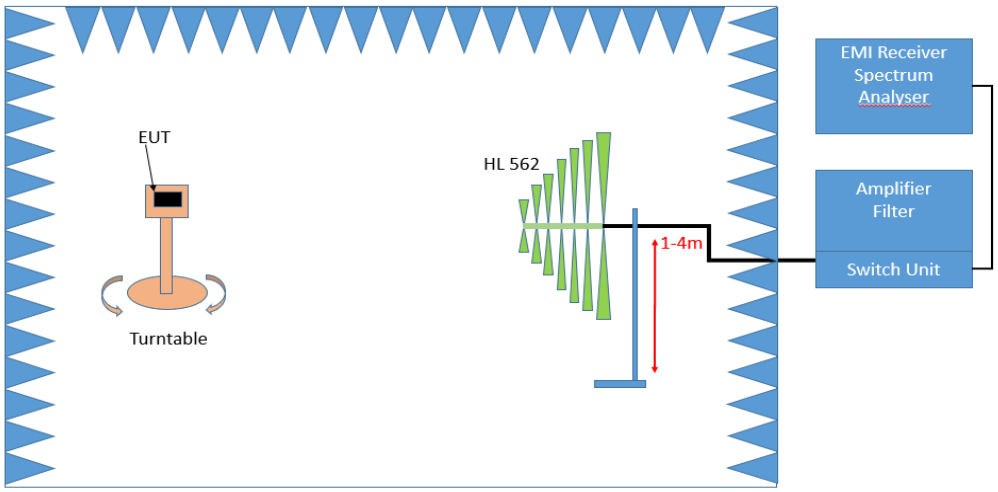
Intention of this step is, to determine the radiated EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

Step 2: final measurement

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

- Detector: Quasi-Peak (9 kHz – 150 kHz, Peak / Average 150 kHz- 30 MHz)
- Frequency range: 0.009 – 30 MHz
- Frequency steps: measurement at frequencies detected in step 1
- IF–Bandwidth: 0.2 - 10 kHz
- Measuring time / Frequency step: 1 s

2. Measurement 30 MHz 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 by 360°. 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 between 1 – 4 meter. 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:

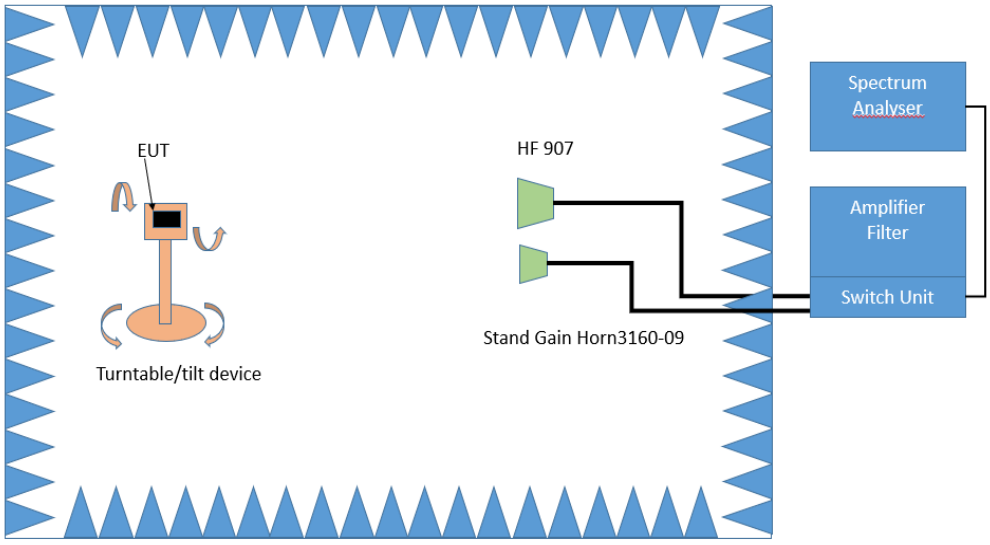
- Detector: Quasi-Peak (< 1 GHz)
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 1 s

After the measurement a plot will be generated which 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.

Above 1 GHz:

The Equipment Under Test (EUT) was set up on a non-conductive support (tilt device) at 1.5 m height in the fully-anechoic chamber.
All steps were performed with one height (1.5 m) of the receiving antenna only.

2. Measurement 1 up to 26 GHz



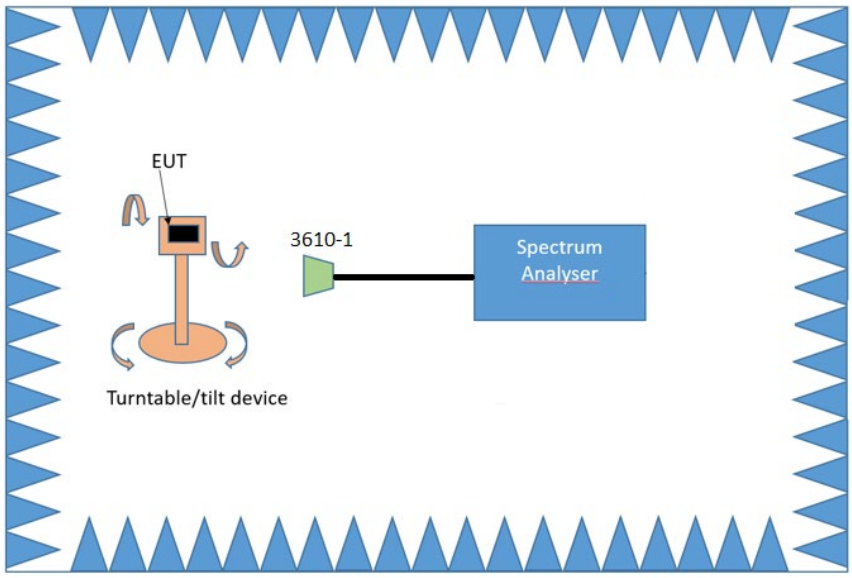
Test Setup; Spurious Emission Radiated (FAC), 1 GHz-26.5 GHz

Step 1:
The EUT is turned during the preliminary measurement across the elevation axis, with a step size of 90 °.
The turn table step size (azimuth angle) for the preliminary measurement is 45 °.
Spectrum analyser settings:
- Detector: Peak, Average
- RBW = 1 MHz
- VBW = 3 MHz

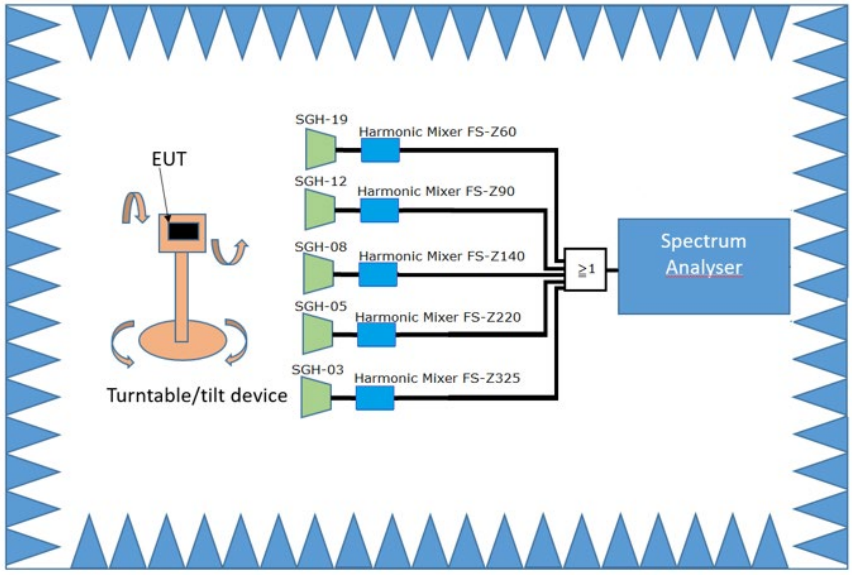
Step 2:
The turn table azimuth will slowly vary by ± 22.5°.
The elevation angle will slowly vary by ± 45°
Spectrum analyser settings:
- Detector: Peak

Step 3:
Spectrum analyser settings for step 3:
- Detector: Peak / CISPR Average
- Measured frequencies: in step 1 determined frequencies
- RBW = 1 MHz
- VBW = 3 MHz
- Measuring time: 1 s

3. Measurement above 26 GHz



Test Setup (26 - 40 GHz)



Test Setup (40 GHz - 320 GHz)

Step 1:
The EUT is turned during the preliminary measurement across the elevation axis, with a step size of 90 °.
The turn table step size (azimuth angle) for the preliminary measurement is 45 °.
Spectrum analyser settings (FCC):
- Detector: Peak, Average, > 90 GHZ Average only
- RBW = 1 MHz
- VBW = 3 MHz

Spectrum analyser settings (RSS):
- Detector: Peak, Average, > 40 GHZ RMS
- RBW = 1 MHz
- VBW = 3 MHz

- Measurement distances:
  - 26 – 40 GHz: 1 m (FCC & RSS)
  - 40 – 60 GHz: 3 m (FCC), 1 m (RSS)
  - 60 – 90 GHz: 3 m (FCC), 1 m (RSS)
  - 90 – 140 GHz: 3 m (FCC), 1 m (RSS)
  - 140 – 220 GHz: 3 m (FCC), 1 m (RSS)
  - 220 – 231 GHz: 3 m (FCC)

Step 2:
The turn table azimuth will slowly vary by ± 22.5°.
The elevation angle will slowly vary by ± 45°
Spectrum analyser settings:
- Detector: Peak

Step 3:
Spectrum analyser settings for step 3 (FCC):
- Detector: Peak / CISPR Average, > 90 GHz CISPR Average only
- Measured frequencies: in step 1 determined frequencies
- RBW = 1 MHz
- VBW = 3 MHz
- Measuring time: 1 s

Spectrum analyser settings for step 3 (RSS):
- Detector: Peak / CISPR Average, > 40 GHz (RMS)
- Measured frequencies: in step 1 determined frequencies
- RBW = 1 MHz
- VBW = 3 MHz
- Measuring time: 1 s

5.3.2 TEST REQUIREMENTS / LIMITS

FCC Part 95, Subpart M, §95.3379 (a)
The power density of any emissions outside the 76–81 GHz band shall consist solely of spurious emissions.
Limits on spurious emissions:

(1) Radiated emissions below 40 GHz shall not exceed the general limits in § 15.209.
(2) The power density of radiated emissions outside the 76-81 GHz band above 40.0 GHz shall not exceed the following, based on measurements employing an average detector with a 1 MHz RBW
(i) For radiated emissions outside the 76-81 GHz band between 40 GHz and 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 600 pW/cm2 at a distance of 3 meters from the exterior surface of the radiating structure.
(ii) For radiated emissions above 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 1000 pW/cm2 at a distance of 3 meters from the exterior surface of the radiating structure

Used limit conversion calculation (FCC):
- PD = EIRP / (4πd²)
- Limit (dBµV/m) = EIRP [dBm] – 20 log (d [m]) + 104.8
- Distance-Correction Factor is: 20 log (d [m]) (if required)

Measurement correction RSS-251, > 40 GHz:
- Measurement value, corrected by far field attenuation, antenna gain and cable loos Reported Value [dBm]= Measurement Value [dBm] + ATT(Far field)[dB] + ATT(cable)[dB] – Antenna Gain [dBi].

Far-Field Consideration > 40 GHz:

$D_{ff} = 2*D^2 / \lambda$

D_{ff} = Far field distance
D = Receiving Antenna size
λ = wavelength

Frequency Range [GHz]	Wavelength λ [m]	Size Measurement Antenna [m]	Worst-Case D_{ff} [m]
40 - 60	0.0050 - 0.0075	0.035	0.49
60 - 90	0.0050 - 0.0033	0.023	0.32
90 - 140	0.0033 - 0.0021	0.015	0.21
140 - 220	0.0021 - 0.0014	0.009	0.12
220 -325	0.0014 - 0.0009	0.006	0.08

RSS 251, chapter 10.2

The radar device's unwanted emissions outside the 76-81 GHz frequency band shall comply with the limits in table 1, below.

Table 1: Unwanted emissions limits outside the 76-81 GHz frequency band

Emission frequency range	Limit	Applicable detector
Below 40 GHz	RSS-Gen general field strength limits for licence-exempt radio apparatus	RSS-Gen requirements
40-162 GHz *	-30 dBm/MHz (e.i.r.p.)	RMS detector
Note: * For radar devices that operate solely in the 76-77 GHz band (i.e. the occupied bandwidth is entirely contained in the 76-77 GHz band), an unwanted emissions limit of 0 dBm/MHz shall apply for the unwanted emission that fall in the 73.5-76 GHz band. Outside of the 73.5-76 GHz band, the unwanted emission limits prescribed in table 1 shall apply.		

5.3.3 TEST PROTOCOL

Ambient temperature: 21 - 26 °C
Air Pressure: 1010 – 1015 hPa
Humidity: 34 -42 %

S01_AA01

Spurious Freq. [MHz]	Spurious Level [dBµV/m]	Detector	RBW [kHz]	Limit [dBµV/m]	Margin to Limit [dB]	Verdict
30.2	29.3	QP	120	40	10.7	Passed
37.1	26.7	QP	120	40	13.3	Passed
960.0	31.9	QP	120	46	14.1	Passed

S01_AA02

Spurious Freq. [MHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Limit [dBm]	Margin to Limit [dB]	Verdict
63011.0	-2.6	Peak	1000	-1.7	0.9	Passed
65543.0	-8.1	Peak	1000	-1.7	6.4	Passed
125804.0	-10.3	Average	1000	-1.7	8.6	Passed
130192.0	-5.5	Average	100ß	-1.7	3.8	Passed
153012.0	-13.1	Average	1000	-1.7	8.6	Passed
186868.0	-11.7	Average	1000	-1.7	11.4	Passed
220525.8	-8.0	Average	1000	-0.8	8.8	Passed
220532.0	-8.0	Average	1000	-0.8	8.8	Passed

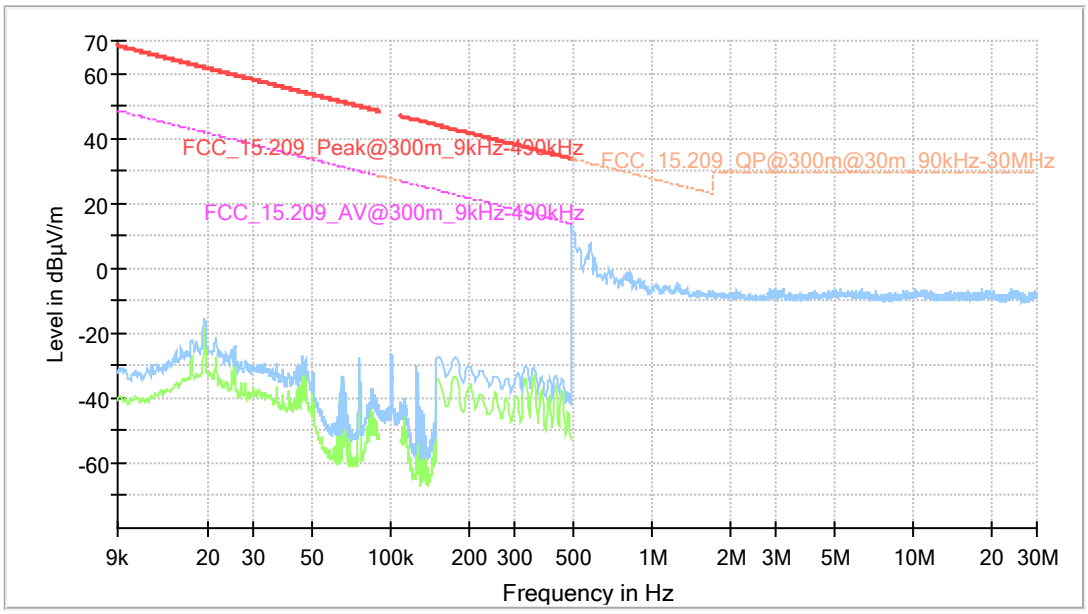
Comment:

- The limit line ”EN_301091_76_GHz-77GHz” in the plots of the RSS-251 in the frequency range > 40 GHz is identical to the limit in table on page 26 of this report

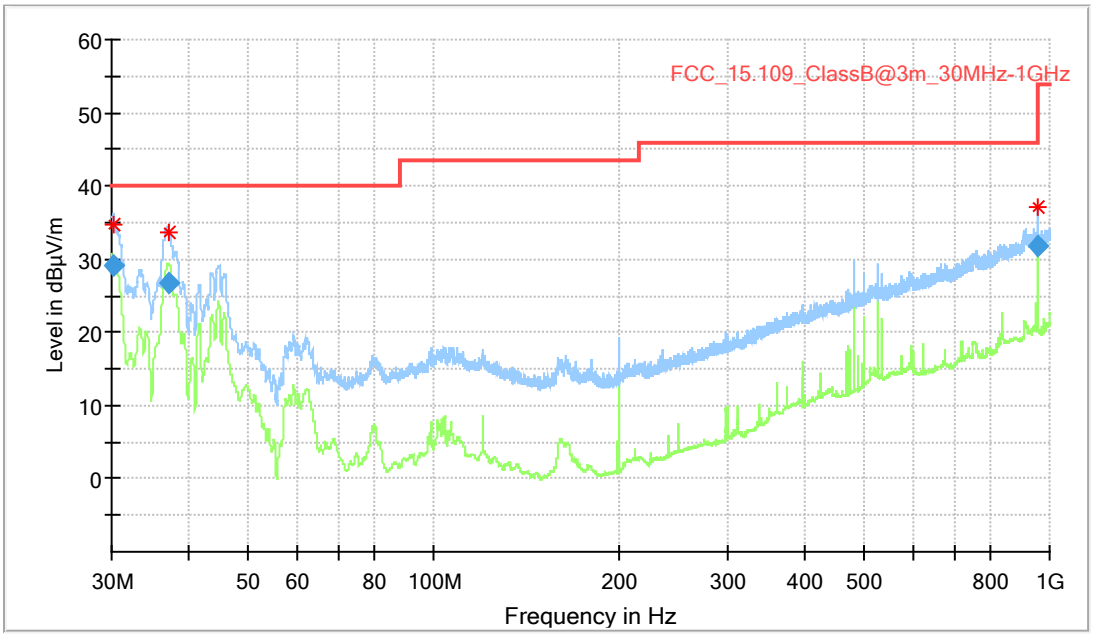
Remark: Please see next sub-clause for the measurement plot.

5.3.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

S01_AA01
9 kHz – 30 MHz



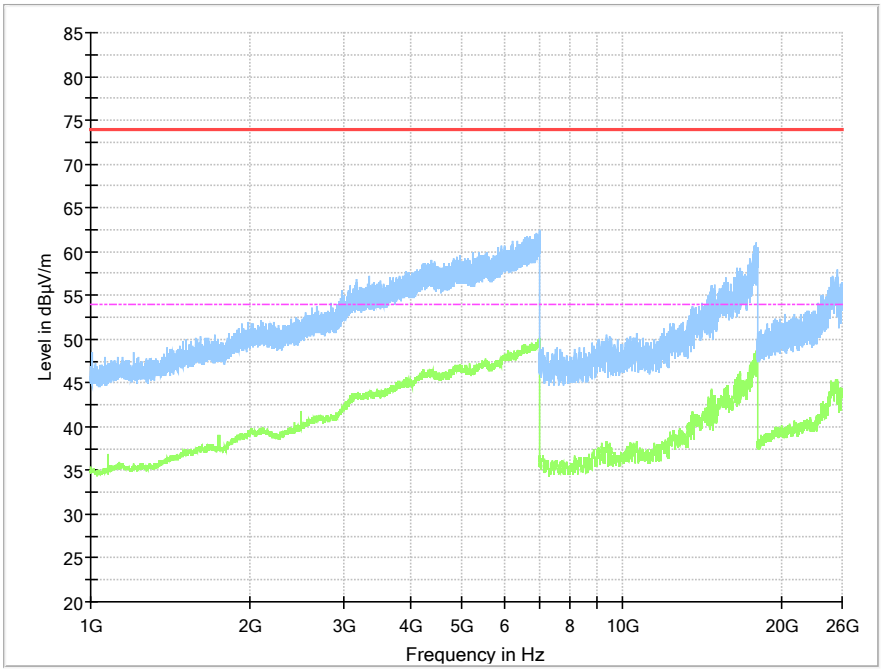
S01_AA01
30 MHz – 1 GHz



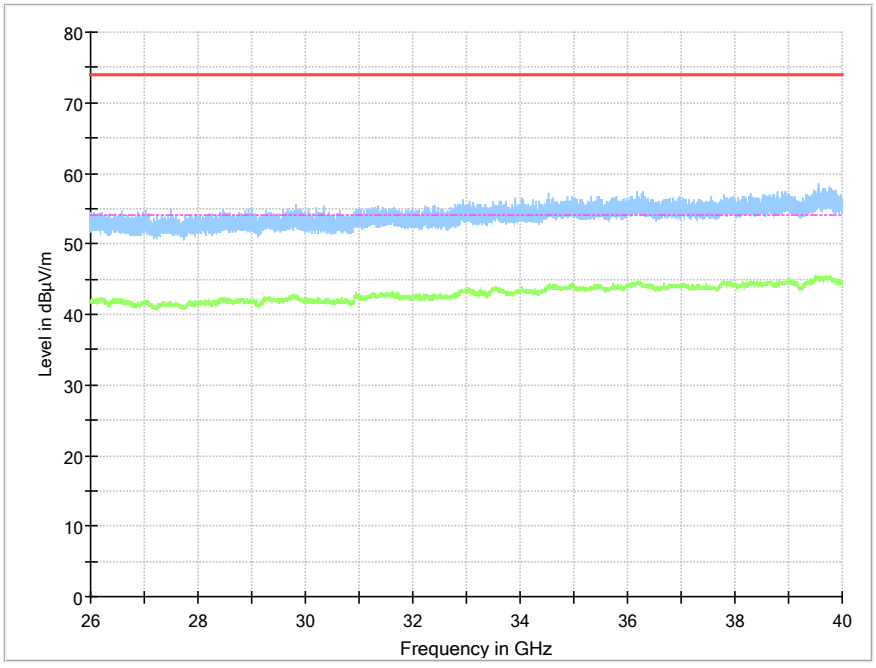
Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
30.180000	29.25	40.00	10.75	1000.0	120.000	106.0	V	111.0	19.1
37.080000	26.69	40.00	13.31	1000.0	120.000	106.0	V	50.0	15.4
959.970000	31.92	46.00	14.08	1000.0	120.000	100.0	V	112.0	28.3

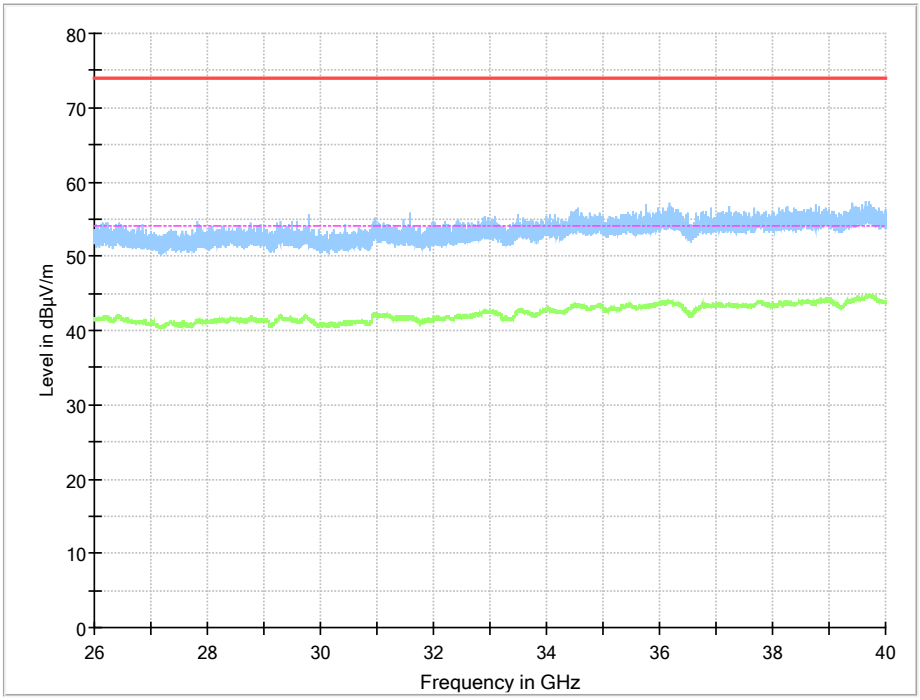
S01_AA01
1 GHz – 26 GHz



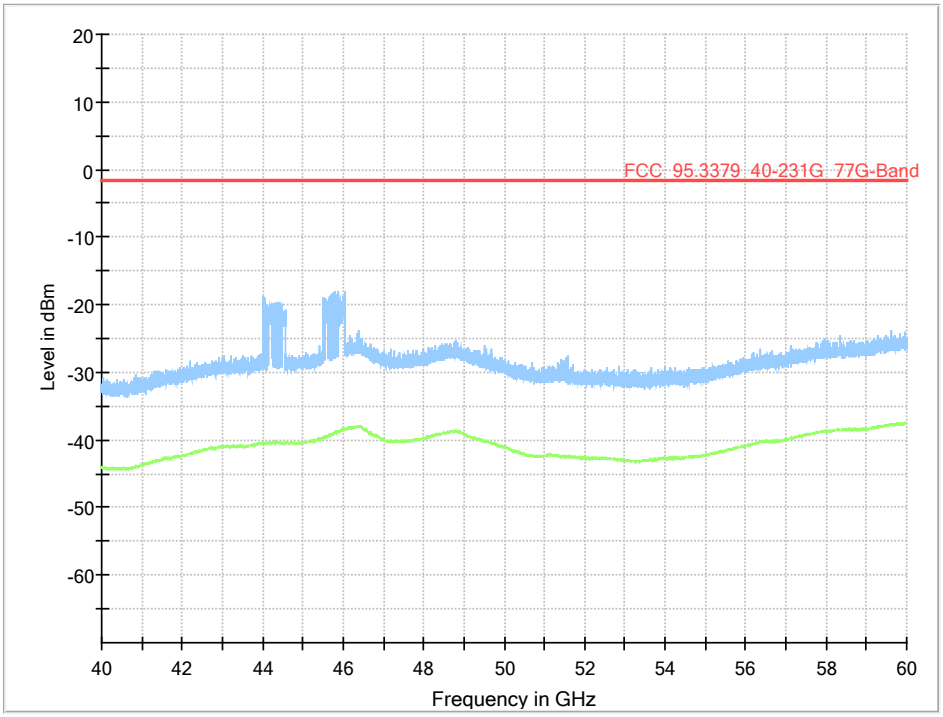
S01_AA01
26 GHz –40 GHz, antenna horizontal



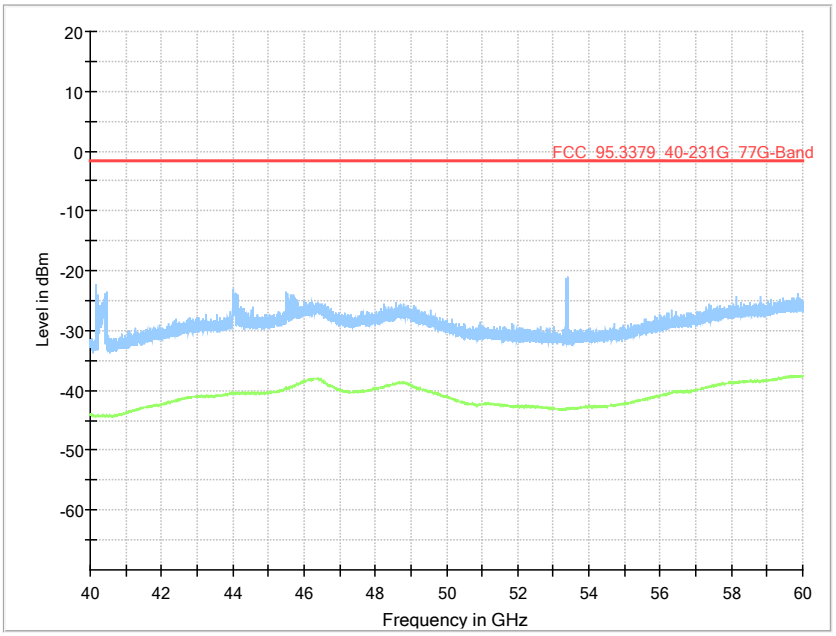
S01_AA01
26 GHz –40 GHz, antenna vertical



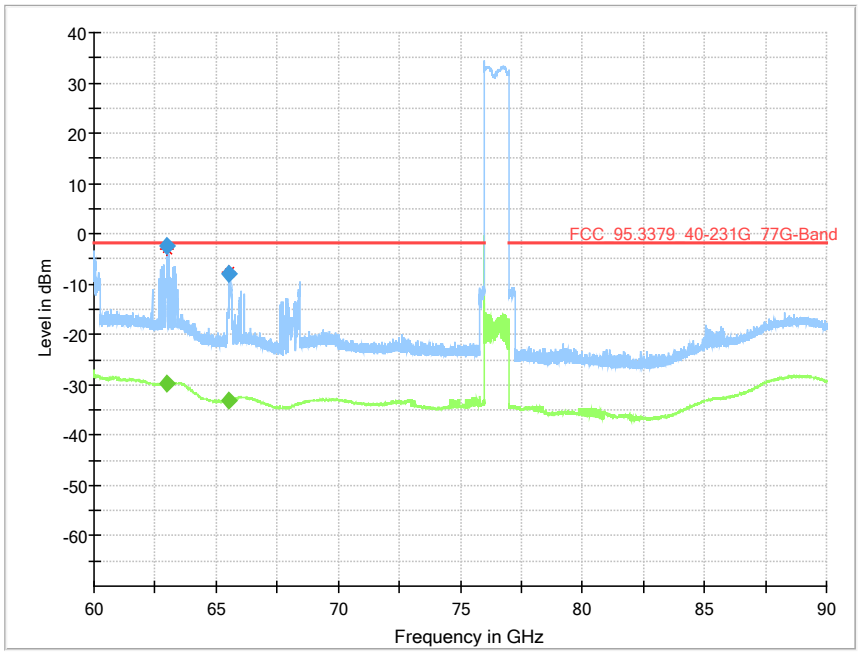
S01_AA02
40 GHz – 60 GHz, antenna horizontal, FCC Limit, Peak & AV detector



S01_AA02
40 GHz – 60 GHz, antenna vertical, FCC Limit, Peak & AV detector



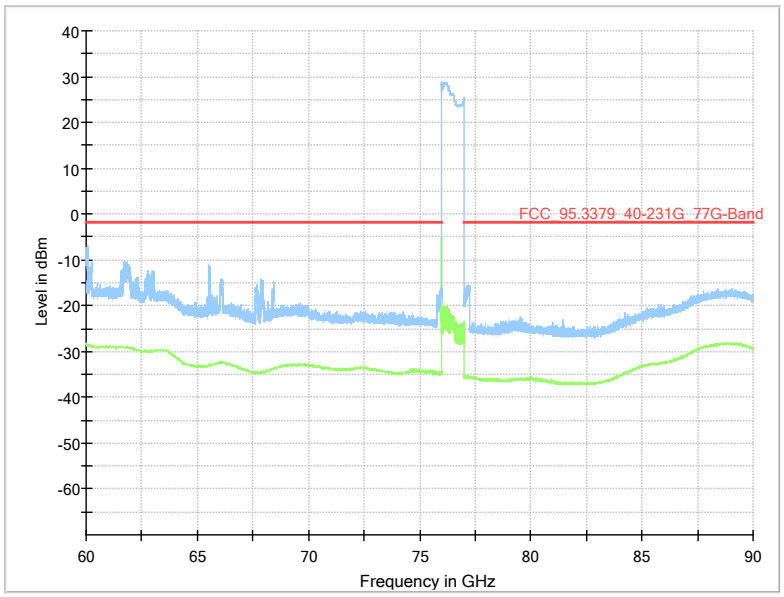
S01_AA02
60 GHz – 90 GHz, horizontal antenna, FCC Limit, Peak & AV detector



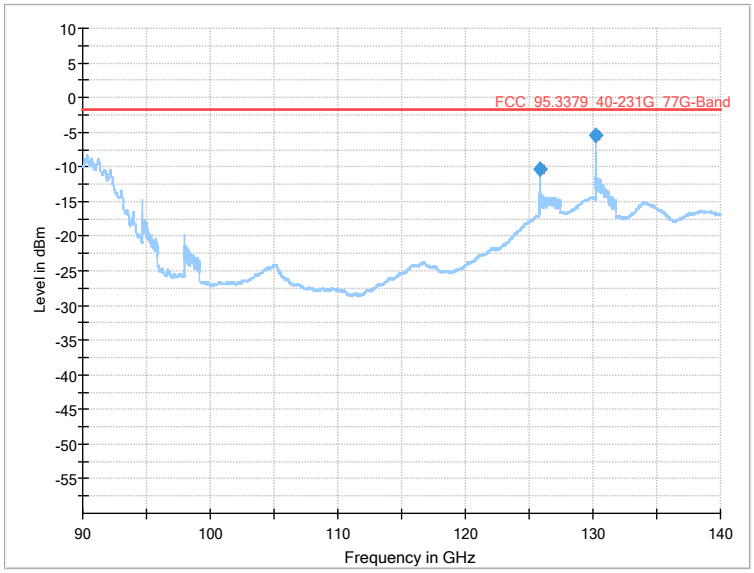
Final Result

Frequency (MHz)	MaxPeak (dBm)	Limit (dBm	Margi n	Meas. Time (ms)	Bandwidt h	Heigh t	Pol	Azimut h	Corr. (dB)	Comment
63011.000	---	---	---	1000.0	1000.000	150.0	H	-180.0	-51.7	11:54:47 - 2024-08-22
63011.000	-2.6	-1.70	0.85	1000.0	1000.000	150.0	H	-180.0	-51.7	11:54:47 - 2024-08-22
65543.000	---	---	---	1000.0	1000.000	150.0	H	-180.0	-51.6	11:54:51 - 2024-08-22
65543.000	-8.1	-1.70	6.38	1000.0	1000.000	150.0	H	-180.0	-51.6	11:54:51 - 2024-08-22

S01_AA02
60 GHz – 90 GHz, vertical antenna, FCC Limit, Peak & AV detector



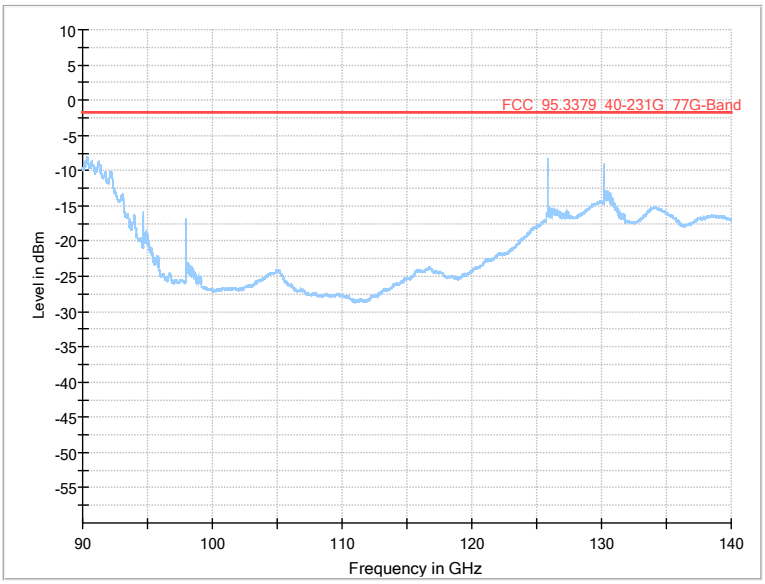
S01_AA01
90 GHz – 140 GHz, horizontal antenna, FCC Limit, AV detector



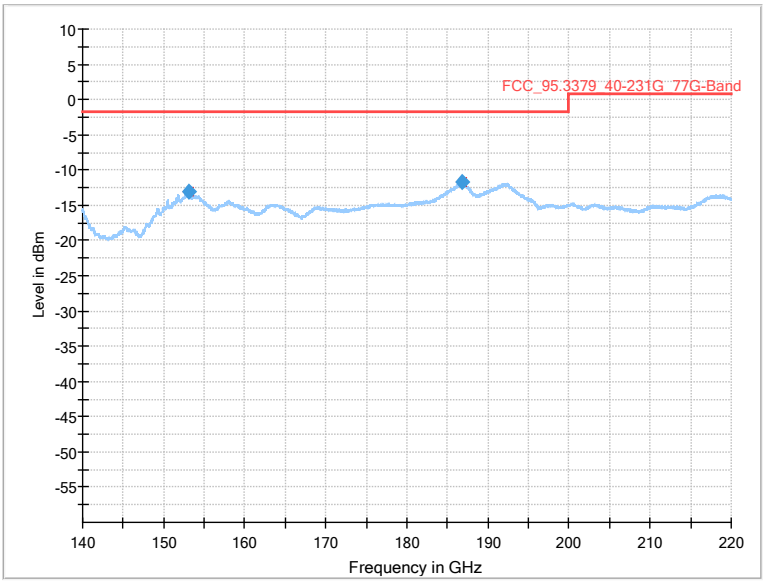
Final Result

Frequency (MHz)	Average (dBm)	Limit (dBm	Margin	Meas. Time (ms)	Bandwidth	Height	Pol	Azimuth	Corr. (dB)	Comment
125804.000	-10.3	-1.70	8.62	10000.0	1000.000	150.0	V	-180.0	-46.6	14:13:36 - 2024-08-22
130192.000	-5.5	-1.70	3.80	10000.0	1000.000	150.0	V	-180.0	-46.4	14:13:36 - 2024-08-22

S01_AA02
90 GHz – 140 GHz, vertical antenna, FCC Limit, AV detector



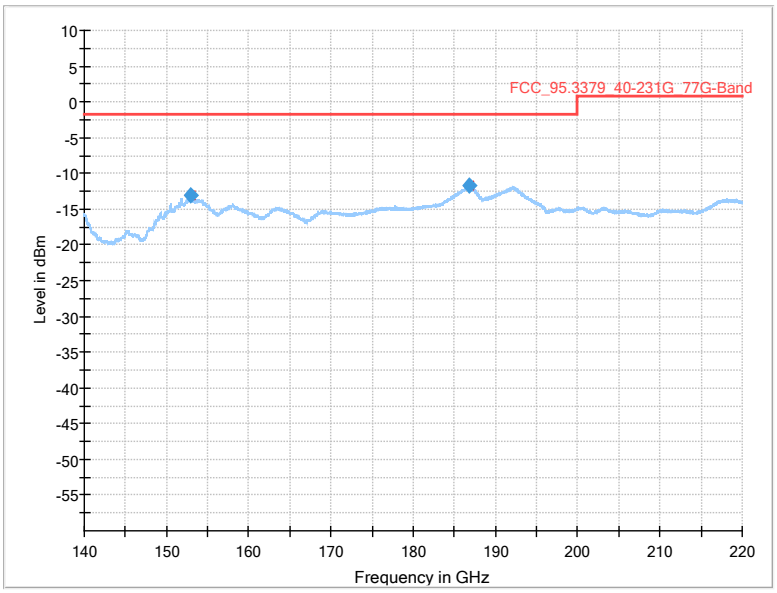
S01_AA02
140 GHz – 220 GHz, horizontal antenna, FCC Limit, AV detector



Final_Result

Frequency (MHz)	Average (dBm)	Limit (dBm	Margin	Meas. Time (ms)	Bandwidth	Height	Pol	Azimuth	Corr. (dB)	Comment
153025.000	-13.1	-1.70	11.43	10000.0	1000.000	150.0	V	-120.0	-44.1	15:03:36 - 2024-08-22
186753.000	-11.7	-1.70	10.03	10000.0	1000.000	150.0	V	-180.0	-43.1	15:03:36 - 2024-08-22

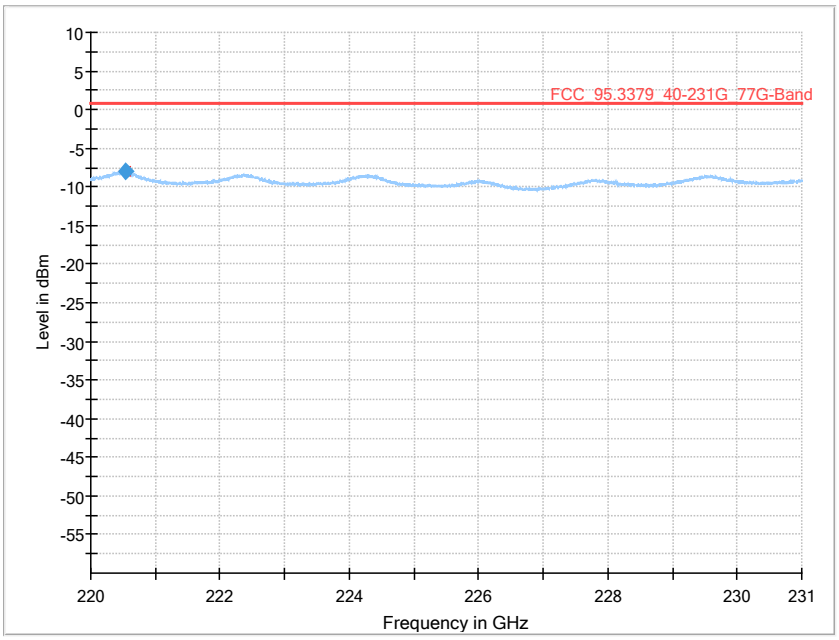
S01_AA02
140 GHz – 220 GHz, vertical antenna, FCC Limit, AV detector



Final_Result

Frequency (MHz)	Average (dBm)	Limit (dBm	Margi n	Meas. Time (ms)	Bandwidt h	Heigh t	Pol	Azimut h	Corr. (dB)	Comment
153012.000	-13.1	-1.70	11.38	10000.0	1000.000	150.0	V	-180.0	-44.1	15:52:12 - 2024-08-22
186868.000	-11.7	-1.70	9.98	10000.0	1000.000	150.0	V	-90.0	-43.1	15:52:12 - 2024-08-22

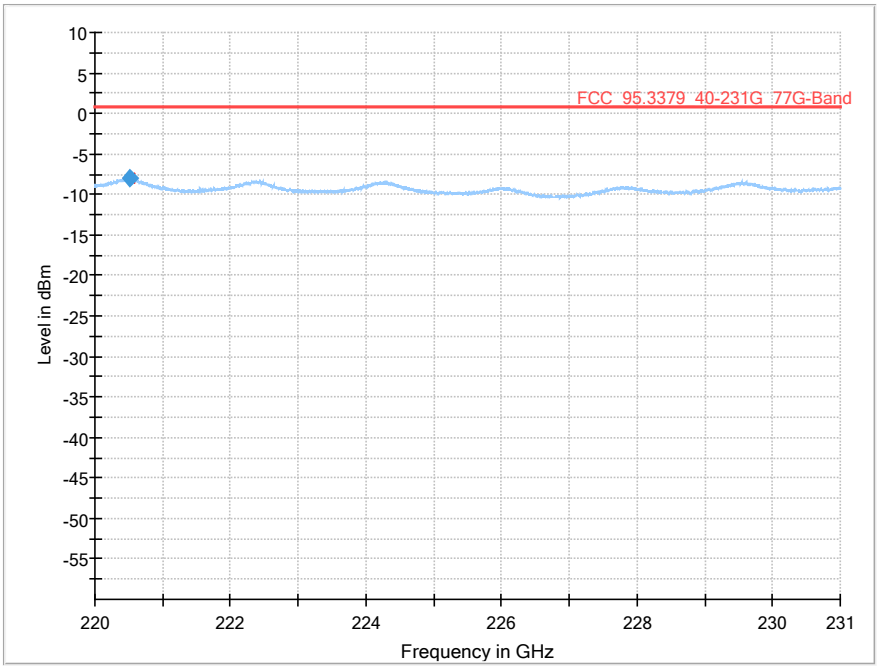
S01_AA02
220 GHz – 231 GHz, horizontal antenna, FCC Limit, AV detector



Final Result

Frequency (MHz)	Average (dBm)	Limit (dBm	Margi n	Meas. Time (ms)	Bandwidt h	Heigh t	Pol	Azimut h	Corr. (dB)	Comment
220532.400	-8.0	0.80	8.84	10000.0	1000.000	150.0	V	-90.0	-40.7	16:16:28 - 2024-08-22

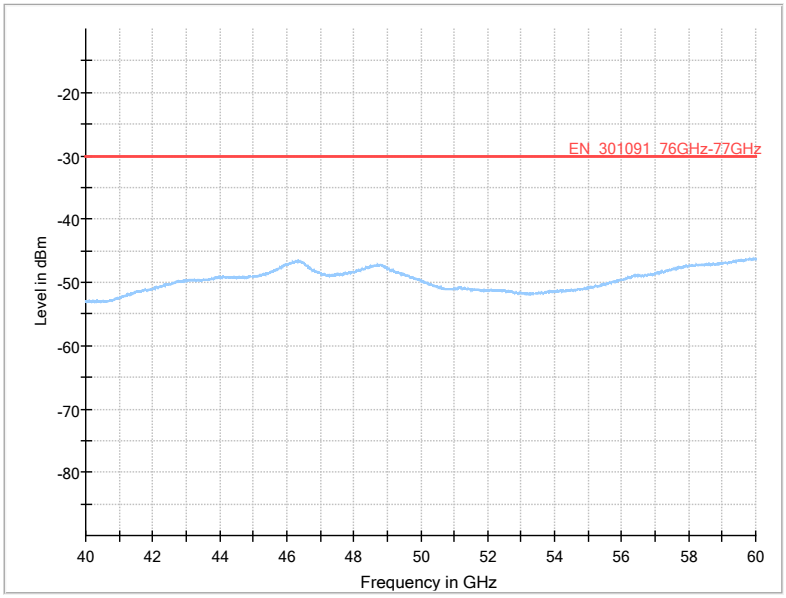
S01_AA02
220 GHz – 231 GHz, vertical antenna, FCC Limit, AV detector



Final Result

Frequency (MHz)	Average (dBm)	Limit (dBm	Margin	Meas. Time (ms)	Bandwidth	Height	Pol	Azimuth	Corr. (dB)	Comment
220525.800	-8.0	0.80	8.80	10000.0	1000.000	150.0	V	30.0	-40.7	16:05:33 - 2024-08-22

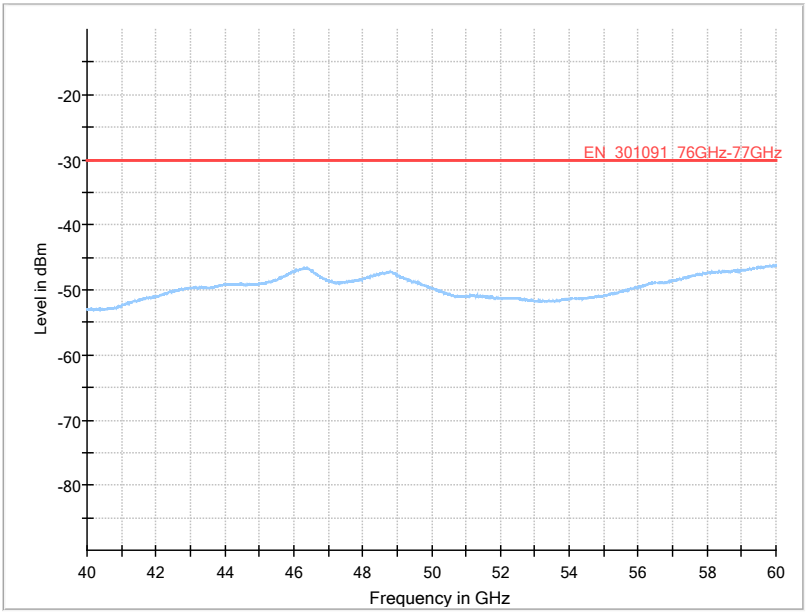
S01_AA01
40 GHz – 60 GHz, antenna horizontal, RSS Limit, RMS detector



Final_Result

Frequency (MHz)	RMS (dBm	Limit (dBm	Margin	Meas. Time (ms)	Bandwidth	Height	Pol	Azimuth	Corr. (dB)	Comment
---	---	---	---	---	---	---		---	---	

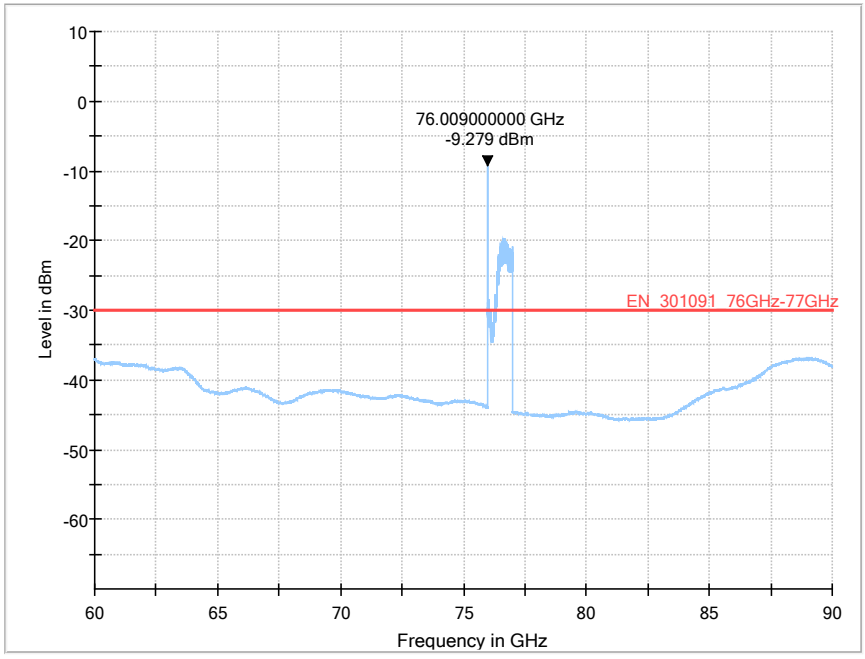
S01_AA01
40 GHz – 60 GHz, antenna vertical, RSS Limit, RMS detector



Final_Result

Frequency (MHz)	RMS (dBm	Limit (dBm	Margin	Meas. Time (ms)	Bandwidth	Height	Pol	Azimuth	Corr. (dB)	Comment
---	---	---	---	---	---	---		---	---	

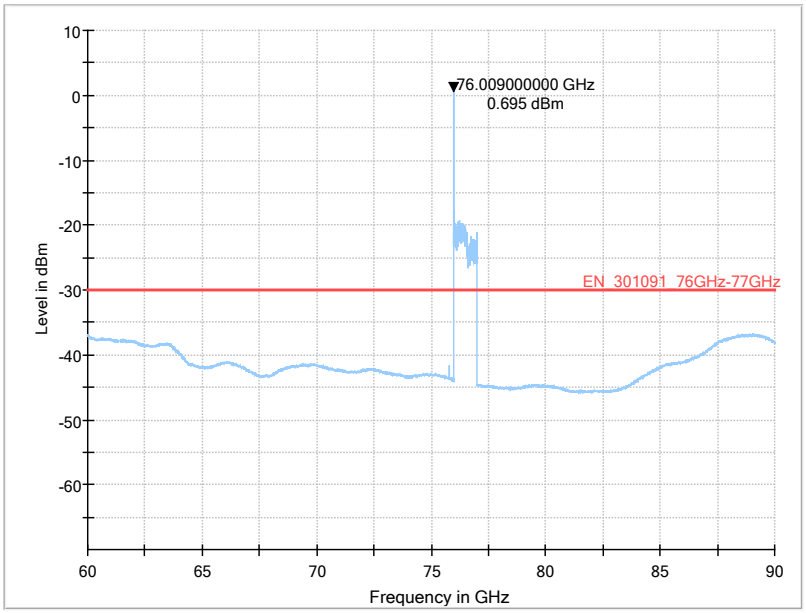
S01_AA01
60 GHz – 90 GHz, antenna horizontal, RSS Limit, RMS detector



Final_Result

Frequency (MHz)	RMS (dBm	Limit (dBm	Margin	Meas. Time (ms)	Bandwidth	Height	Pol	Azimuth	Corr. (dB)	Comment
---	---	---	---	---	---	---		---	---	

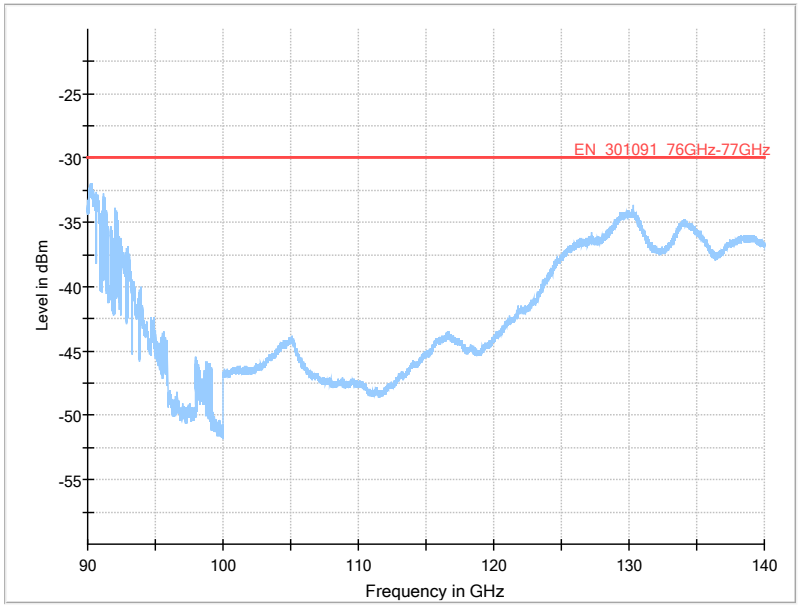
S01_AA01
60 GHz – 90 GHz, antenna vertical, RSS Limit, RMS detector



Final_Result

Frequency (MHz)	RMS (dBm	Limit (dBm	Margi n	Meas. Time (ms)	Bandwidt h	Heigh t	Pol	Azimut h	Corr. (dB)	Comment
---	---	---	---	---	---	---		---	---	

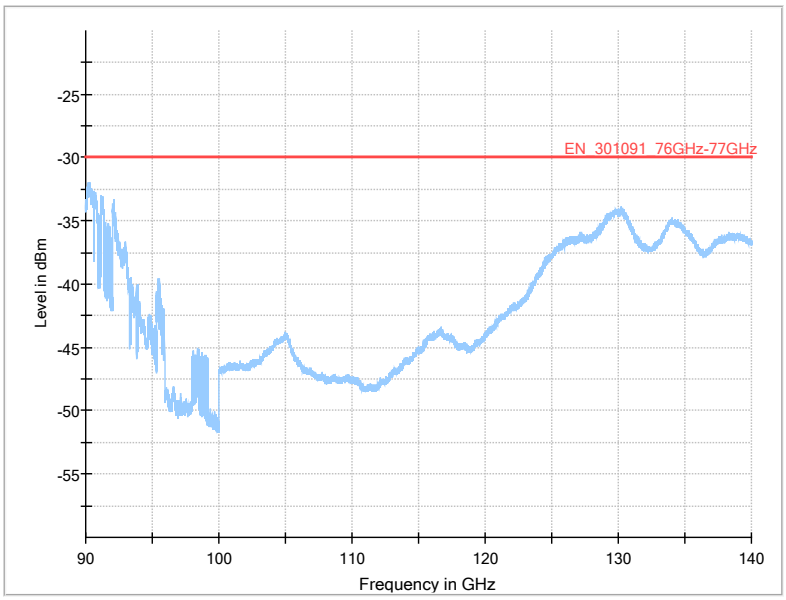
S01_AA01
90 GHz – 140 GHz, antenna horizontal, RSS Limit, RMS detector



Final_Result

Frequency (MHz)	RMS (dBm	Limit (dBm	Margi n	Meas. Time (ms)	Bandwidt h	Heigh t	Pol	Azimut h	Corr. (dB)	Comment
---	---	---	---	---	---	---		---	---	

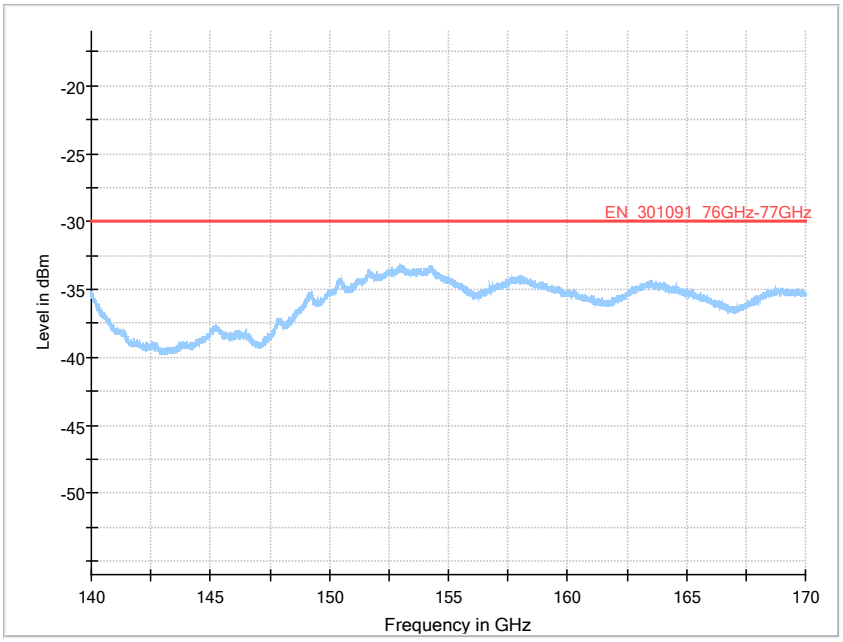
S01_AA01
90 GHz – 140 GHz, antenna vertical, RSS Limit, RMS detector



Final_Result

Frequency (MHz)	RMS (dBm	Limit (dBm	Margi n	Meas. Time (ms)	Bandwidt h	Heigh t	Pol	Azimut h	Corr. (dB)	Comment
---	---	---	---	---	---	---		---	---	

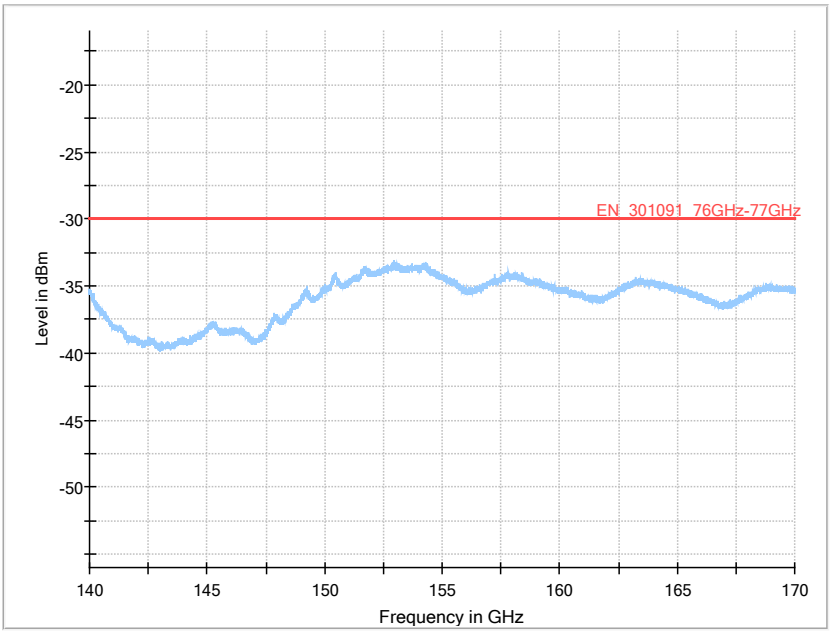
S01_AA02
140 GHz – 170 GHz, antenna horizontal, RSS Limit, RMS detector



Final_Result

Frequency (MHz)	RMS (dBm	Limit (dBm	Margi n	Meas. Time (ms)	Bandwidt h	Heigh t	Pol	Azimut h	Corr. (dB)	Comment
---	---	---	---	---	---	---		---	---	

S01_AA02
140 GHz – 170 GHz, antenna vertical, RSS Limit, RMS detector



Final_Result

Frequency (MHz)	RMS (dBm	Limit (dBm	Margi n	Meas. Time (ms)	Bandwidt h	Heigh t	Pol	Azimut h	Corr. (dB)	Comment
---	---	---	---	---	---	---		---	---	

5.3.5 TEST EQUIPMENT USED

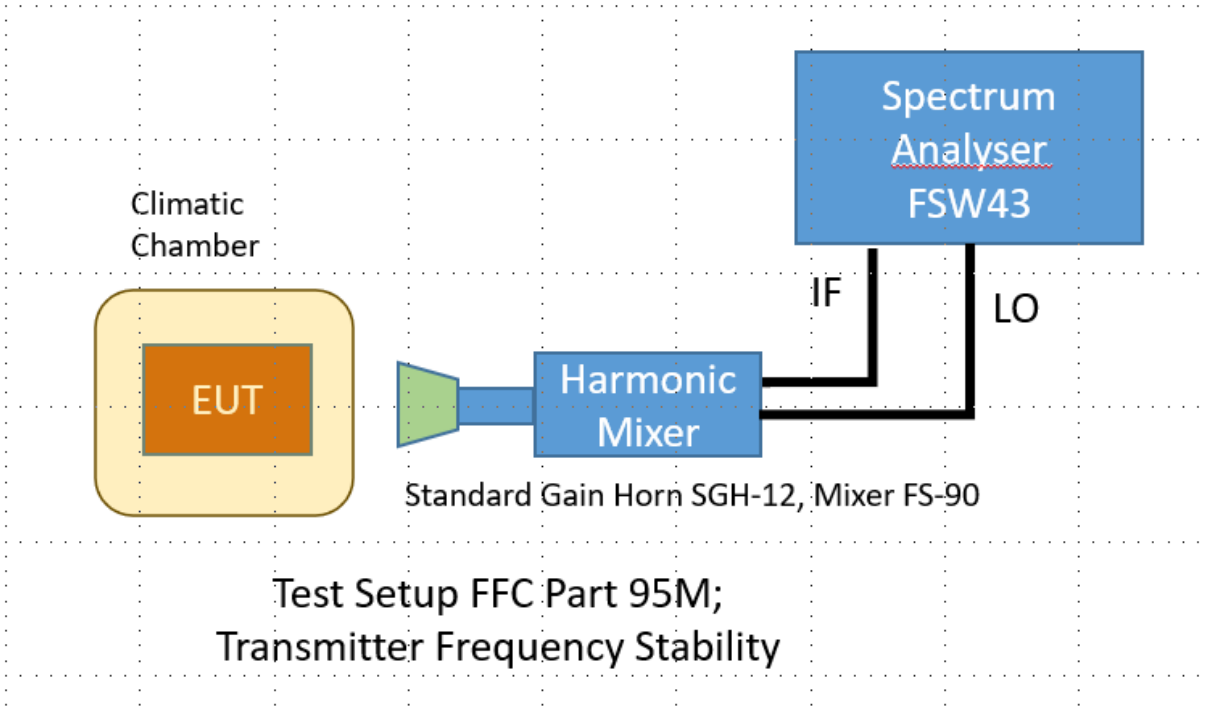
- Radiated Emissions SAC H-Field
- Radiated Emissions SAC
- Radiated Emissions FAR FCC

5.4 FREQUENCY STABILITY

Standard **FCC Part 95 Subpart M**

The test was performed according to:
ANSI C63.10

5.4.1 TEST DESCRIPTION



Test Setup FFC Part 95M;
Transmitter Frequency Stability

5.4.2 TEST REQUIREMENTS / LIMITS

FCC Part 95, Subpart M, §95.3379(b)

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.

RSS 251, chapter 11

The radar device's occupied bandwidth (i.e. 99% emission bandwidth) shall be maintained within the 76-81 GHz frequency band while subjected to all conditions of operation specified in RSS-Gen.

5.4.3 TEST PROTOCOL

Ambient temperature: 25 °C
Air Pressure: 1011 hPa
Humidity: 44 %

Temp [°C]	Time [min]	Voltage	fcenter [GHz]	Lower 99 % Frequency [GHz]	Upper 99 % Frequency [GHz]	OBW [MHz]	Lower Band Edge [GHz]	Upper Band Edge [GHz]	Margin to Lower Limit [MHz]	Margin to Upper Limit [MHz]
Normal	0	Normal	76.495433	76.0085	76.9824	973.9	76.0000	81.0000	0.0085	4.0176
-20	0	Low	76.494972							
-20	5	Low	76.494978							
-20	10	Low	76.494976							
-20	0	High	76.494980							
-20	5	High	76.494955							
-20	10	High	76.494963							
-10	0	Low	76.494961							
-10	5	Low	76.494961							
-10	10	Low	76.494982							
-10	0	High	76.494960							
-10	5	High	76.494961							
-10	10	High	76.494968							
0	0	Low	76.494962							
0	5	Low	76.494964							
0	10	Low	76.494974							
0	0	High	76.494976							
0	5	High	76.494972							
0	10	High	76.494988							
10	0	Low	76.494970							
10	5	Low	76.494970							
10	10	Low	76.494987							
10	0	High	76.495006							
10	5	High	76.494976							
10	10	High	76.494962							
20	0	Low	76.494982							
20	5	Low	76.494958							
20	10	Low	76.494961							
20	0	High	76.494967							
20	5	High	76.494980							
20	10	High	76.494945							
30	0	Low	76.494971							
30	5	Low	76.494967							
30	10	Low	76.494970							

30	0	High	76.494963
30	5	High	76.494974
30	10	High	76.494979
40	0	Low	76.494975
40	5	Low	76.494954
40	10	Low	76.494980
40	0	High	76.494983
40	5	High	76.494980
40	10	High	76.494972
50	0	Low	76.494977
50	5	Low	76.494973
50	10	Low	76.494960
50	0	High	76.494962
50	**5**	**High**	**76.494941**
50	10	High	76.494965
60	0	Low	76.494972
60	5	Low	76.494976
60	10	Low	76.494983
60	0	High	76.494969
60	5	High	76.494964
60	10	High	76.494967

All centre frequencies measured with a pulsed CW signal, except reference measurement.
The maximum measured frequency deviation is: **0.492 MHz**
The reference measurement has a margin to the lower band edge of **8.5 MHz**

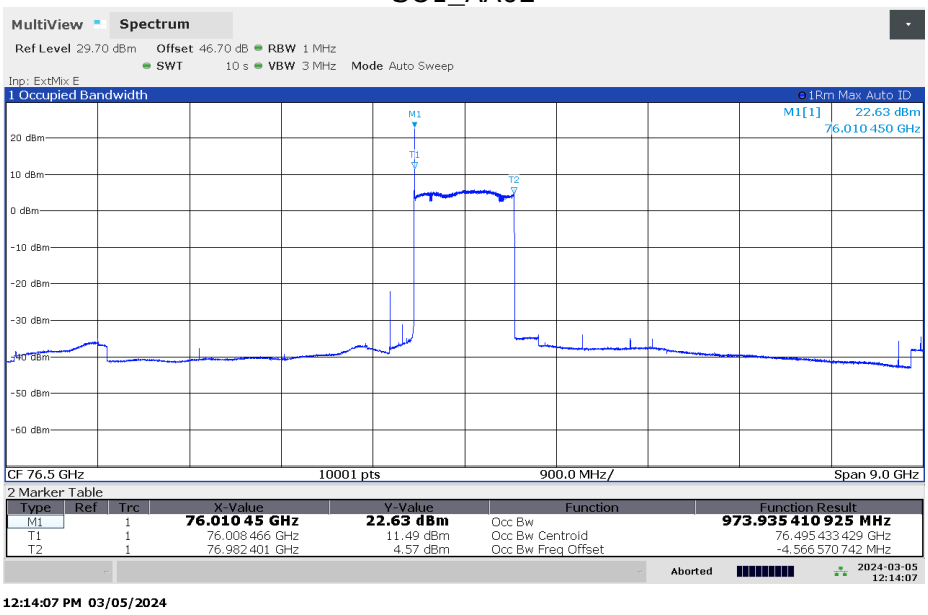
So also, with the biggest measured frequency deviation the signal stays in the allowed frequency band.

For this reason, the verdict of this test case was set to passed!

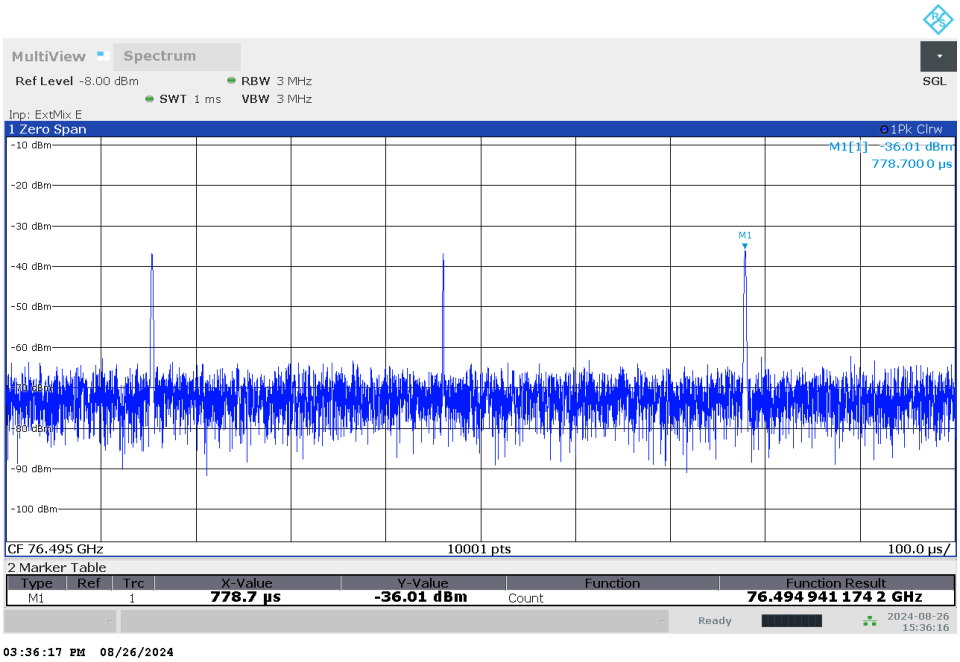
Remark: Please see next sub-clause for the measurement plot.

5.4.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

Reference measurement
Voltage = High; Temperature = 50 °C; Time = 5 min
SO1_AA02



Worst case plot
Voltage = normal; Temperature = 20 °C; Minutes = 10
SO1_AA02



5.4.5 TEST EQUIPMENT USED

- Radio Lab

6 TEST EQUIPMENT

6.1 TEST EQUIPMENT HARDWARE

1 Radiated Emissions SAC H-Field
Radiated emission tests in the H-Field in a semi anechoic room

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
1.1	N5000/NP	Filter for EUT, 2 Lines, 250 V, 16 A	ETS-LINDGREN	241515	N/A	N/A
1.2	Opus10 TPR (8253.00)	T/P Logger 13	Lufft Mess- und Regeltechnik GmbH	13936	2023-12	2025-12
1.3	ESW44	EMI Receiver / Spectrum Analyzer	Rohde & Schwarz GmbH & Co. KG	101603	2024-03	2026-03
1.4	Anechoic Chamber 01	SAC/FAR, 10.58 m x 6.38 m x 6.00 m	Frankonia Germany EMC Solution GmbH	none	N/A	N/A
1.5	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2023-08	2025-08
1.6	Opus10 THI (8152.00)	T/H Logger 10	Lufft Mess- und Regeltechnik GmbH	12488	2023-12	2025-12
1.7	EP 1200/B, NA/B1	AC Source, Amplifier with integrated variable Oscillator	Spitzenberger & Spies GmbH & Co. KG	B6278	N/A	N/A
1.8	DS 420S	Turn Table 2 m diameter	HD GmbH	420/573/99	N/A	N/A
1.9	HFH2-Z2	Loop Antenna + 3 Axis Tripod	Rohde & Schwarz GmbH & Co. KG	829324/006		
1.10	CS-RUB6	Rubidium Frequency Standard	Rohde & Schwarz GmbH & Co. KG	100321	2023-10	2024-10

2 Radiated Emissions SAC

Radiated emission tests in a semi anechoic room

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
2.1	N5000/NP	Filter for EUT, 2 Lines, 250 V, 16 A	ETS-LINDGREN	241515	N/A	N/A
2.2	Opus10 TPR (8253.00)	T/P Logger 13	Lufft Mess- und Regeltechnik GmbH	13936	2023-12	2025-12
2.3	ESW44	EMI Receiver / Spectrum Analyzer	Rohde & Schwarz GmbH & Co. KG	101603	2024-03	2026-03
2.4	Anechoic Chamber 01	SAC/FAR, 10.58 m x 6.38 m x 6.00 m	Frankonia Germany EMC Solution GmbH	none	N/A	N/A
2.5	HL 562 ULTRALOG	Biconical-log-per antenna (30 MHz - 3 GHz) with HL 562E biconicals	Rohde & Schwarz GmbH & Co. KG	830547/003	2021-09	2024-09
2.6	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2023-08	2025-08
2.7	Opus10 THI (8152.00)	T/H Logger 10	Lufft Mess- und Regeltechnik GmbH	12488	2023-12	2025-12
2.8	EP 1200/B, NA/B1	AC Source, Amplifier with integrated variable Oscillator	Spitzenberger & Spies GmbH & Co. KG	B6278	N/A	N/A
2.9	DS 420S	Turn Table 2 m diameter	HD GmbH	420/573/99	N/A	N/A
2.10	CS-RUB6	Rubidium Frequency Standard	Rohde & Schwarz GmbH & Co. KG	100321	2023-10	2024-10
2.11	AM 4.0	Antenna Mast 4 m	Maturo GmbH	AM4.0/180/11920513	N/A	N/A
2.12	MA4985-XP-ET	Bore Sight Antenna Mast	innco systems GmbH	none	N/A	N/A
2.13	HF 907-2	Double-ridged horn	Rohde & Schwarz	102817	2022-07	2025-07

3 Radiated Emissions FAR FCC
Radiated emission tests in a fully anechoic room

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
3.1	Opus10 TPR (8253.00)	T/P Logger 13	Lufft Mess- und Regeltechnik GmbH	13936	2023-12	2025-12
3.2	Innco Systems CO3000	Controller for bore sight mast FAC	-	CO3000/1460/54740522/P	N/A	N/A
3.3	AMF-7D00101800-30-10P-R	Broadband Amplifier 100 MHz - 18 GHz	Miteq	-	N/A	N/A
3.4	Anechoic Chamber 03	FAR, 8.80m x 4.60m x 4.05m (l x w x h)	Albatross Projects	P26971-647-001-PRB	2023-05	2025-05
3.5	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2023-08	2025-08
3.6	JS4-18002600-32-5P	Broadband Amplifier 18 GHz - 26 GHz	Miteq	849785	N/A	N/A
3.7	FSW43	Spectrum Analyzer	Rohde & Schwarz GmbH & Co. KG	103779	2023-04	2025-04
3.8	EP 1200/B, NA/B1	AC Source, Amplifier with integrated variable Oscillator	Spitzenberger & Spies GmbH & Co. KG	B6278	N/A	N/A
3.9	3160-09	Standard Gain / Pyramidal Horn Antenna 26.5 GHz	EMCO Elektronic GmbH	00083069	N/A	N/A
3.10	WHKX 7.0/18G-8SS	High Pass Filter	Wainwright Instruments GmbH	09	N/A	N/A
3.11	MA3000/0800-XP-ET-compact	Bore Sight Antenna Mast	-	-	N/A	N/A
3.12	TT 1.5 WI	Turn Table	Maturo GmbH	-	N/A	N/A
3.13	5HC3500/18000-1.2-KK	High Pass Filter	Trilithic	200035008	N/A	N/A
3.14	Opus 20 THI (8120.00)	ThermoHygro Datalogger	Lufft Mess- und Regeltechnik GmbH	115.0318.0802.033	-	-
3.15	TD1.5-10kg	EUT Tilt Device (Rohacell)	Maturo GmbH	TD1.5-10kg/024/3790709	N/A	N/A
3.16	AFS42-00101800-25-S-42	Broadband Amplifier 25 MHz - 18 GHz	Miteq	2035324	N/A	N/A
3.17	HF 907	Double-ridged horn	Rohde & Schwarz	102444	2021-09	2024-09
3.18	FS-Z60	Harmonic Mixer 40 - 60 GHz	Rohde & Schwarz Messgerätebau GmbH	100178	2023-06	2026-06
3.19	FS-Z220	Harmonic Mixer 140 - 220 GHz	Rohde & Schwarz Messgerätebau GmbH	101005	2023-05	2026-05

Ref.No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
3.20	SGH-05	Standard Gain / Pyramidal Horn Antenna (140 - 220 GHz)	Millitech Inc.	075	N/A	N/A
3.21	SGH-19	Standard Gain / Pyramidal Horn Antenna (40 - 60 GHz)	Millitech Inc.	093	N/A	N/A
3.22	FS-Z325	Harmonic Mixer 220 - 325 GHz	Rohde & Schwarz Messgerätebau GmbH	101006	2023-06	2026-06
3.23	3160-10	Standard Gain / Pyramidal Horn Antenna 40 GHz	EMCO Elektronic GmbH	00086675	N/A	N/A
3.24	MA4985-XP-ET	Bore Sight Antenna Mast	innco systems GmbH	none	N/A	N/A
3.25	SGH-08	Standard Gain / Pyramidal Horn Antenna (90 - 140 GHz)	Millitech Inc.	064	N/A	N/A
3.26	SGH-12	Standard Gain / Pyramidal HornAntenna (60 - 90 GHz)	Millitech Inc.	326	N/A	N/A
3.27	FS-Z140	Harmonic Mixer 90 -140 GHz	Rohde & Schwarz Messgerätebau GmbH	101007	2023-05	2026-05
3.28	SGH-03	Standard Gain / Pyramidal Horn Antenna (220 - 325 GHz)	Millitech Inc.	060	N/A	N/A
3.29	FS-Z90	Harmonic Mixer 60 - 90 GHz	Rohde & Schwarz Messgerätebau GmbH	101686	2023-06	2026-06

4 Radio Lab

Conducted Radio Test Lab

Ref. No.	Device Name	Description	Manufacturer	Serial Number	Last Calibration	Calibration Due
4.1	SMB100A	Signal Generator 9 kHz - 6 GHz	Rohde & Schwarz	107695	2024-07	2027-07
4.2	Fluke 177	Digital Multimeter 03 (Multimeter)	Fluke Europe B.V.	86670383	2023-08	2025-08
4.3	Temperature Chamber VT 4002	Temperature Chamber Vötsch 03	Vötsch	58566002150010	2024-07	2026-07
4.4	FSW43	Signal Analyser	Rohde & Schwarz GmbH & Co. KG	102013	2023-07	2025-07
4.5	Opus10 THI	T/H Logger 03	Lufft Mess- und Regeltechnik GmbH	7482	2023-12	2025-12
4.6	SGH-12	Standard Gain / Pyramidal HornAntenna (60 - 90 GHz)	Millitech Inc.	326	N/A	N/A
4.7	FS-Z90	Harmonic Mixer 60 - 90 GHz	Rohde & Schwarz Messgerätebau GmbH	101686	2023-06	2026-06
4.8	Temperature Chamber KWP 120/70	Temperature Chamber KWP 120/70	Weiss	59226012190010	2024-07	2026-07

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

6.2 TEST EQUIPMENT SOFTWARE

Semi-Anechoic Chamber:

Software	Version
EMC32 Measurement Software	10.60.10
INNCO Mast Controller	1.02.62
INNCO Mast Height	34.10
INNCO Mast Elevation	36.11
MATURO Controller	1.24
MATURO Mast	12.19
MATURO Turn-Table	30.10
Fully-Anechoic Chamber:	
Software	Version
EMC32 Measurement Software	10.60.10
MATURO Controller	1.30
MATURO Turn-Unit	11.10
MATURO Mast	12.10
MATURO Turntable	12.11
INNCO Controller	1.03.02
INNCO Mast Height	34.10
INNCO Mast Elevation	36.11
TS 8997	
WMS32 Measurement Software	11.60.00 (till 2024-03-19), 11.70.00 + Hotfix 01
Conducted AC Emissions:	
Software	Version
EMC32 Measurement Software	10.60.20

7 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.

7.1 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.

7.2 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

7.3 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.

7.4 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.

7.5 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.

7.6 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	1.0
27.0	43.4	-11.2	4.4				-9.5	3	1.0
28.0	43.4	-11.1	4.5				-9.5	3	1.0
29.0	43.5	-11.0	4.6				-9.5	3	1.0
30.0	43.5	-10.9	4.7				-9.5	3	1.0
31.0	43.5	-10.8	4.7				-9.5	3	1.0
32.0	43.5	-10.7	4.8				-9.5	3	1.0
33.0	43.6	-10.7	4.9				-9.5	3	1.0
34.0	43.6	-10.6	5.0				-9.5	3	1.0
35.0	43.6	-10.5	5.1				-9.5	3	1.0
36.0	43.6	-10.4	5.1				-9.5	3	1.0
37.0	43.7	-10.3	5.2				-9.5	3	1.0
38.0	43.7	-10.2	5.3				-9.5	3	1.0
39.0	43.7	-10.2	5.4				-9.5	3	1.0
40.0	43.8	-10.1	5.5				-9.5	3	1.0

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.

7.7 ANTENNA SGH-19 (40 GHZ – 60 GHZ)

Frequency	AF SGH-19	Corr.		Farfield Att.	Harmonic Mixer FS-Z60
GHz	Gain (dBi)	dB		dB	dB
40.00	22.63	51.40		74.03	10.45
40.50	22.69	51.44		74.13	10.43
41.00	22.75	51.49		74.24	10.88
41.50	22.80	51.55		74.35	11.80
42.00	22.85	51.60		74.45	12.23
42.50	22.90	51.65		74.55	13.02
43.00	22.95	51.70		74.65	13.42
43.50	23.00	51.75		74.75	13.46
44.00	23.04	51.81		74.85	13.92
44.50	23.08	51.87		74.95	13.92
45.00	23.12	51.93		75.05	13.84
45.50	23.17	51.97		75.14	14.49
46.00	23.21	52.03		75.24	15.66
46.50	23.24	52.09		75.33	15.95
47.00	23.28	52.15		75.43	13.82
47.50	23.31	52.21		75.52	13.87
48.00	23.34	52.27		75.61	14.20
48.50	23.37	52.33		75.70	15.02
49.00	23.40	52.39		75.79	14.78
49.50	23.43	52.45		75.88	13.55
50.00	23.45	52.51		75.96	12.60
50.50	23.49	52.63		76.05	11.50
51.00	23.51	52.70		76.14	11.21
51.50	23.52	52.76		76.22	10.96
52.00	23.54	52.83		76.30	10.59
52.50	23.56	52.89		76.39	10.63
53.00	23.58	52.96		76.47	10.18
53.50	23.59	53.01		76.55	10.07
54.00	23.62	53.09		76.63	10.39
54.50	23.62	53.15		76.71	10.38
55.00	23.64	53.21		76.79	10.73
55.50	23.66	53.28		76.87	11.21
56.00	23.67	53.37		76.95	11.91
56.50	23.66	53.40		77.03	12.44
57.00	23.70	53.50		77.10	12.64
57.50	23.68	53.56		77.18	13.32
58.00	23.69	53.63		77.25	13.82
58.50	23.70	53.69		77.33	13.96
59.00	23.71	53.78		77.40	14.03
59.50	23.69	53.83		77.47	14.47
60.00	23.72	51.40		77.55	14.74

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr, (dB)
P (dBm) = U(dBm) - Gain [dB] + FF-Att [dB]
U = Receiver reading
Gain = Antenna gain
The conversion loss of the mixer is automatically corrected in the analyser
Table shows an extract of values,

7.8 ANTENNA SGH-12 (60 GHZ – 90 GHZ)

Frequency	AF SGH-12	Corr.	Farfield Att.	Harmonic Mixer FS-Z90
GHz	Gain (dBi)	dB	dB	dB
60.0	22.5	55.1	77.6	24.4
61.5	22.6	55.1	77.7	23.8
63.0	22.7	55.3	78.0	22.9
64.5	22.8	55.4	78.2	19.8
66.0	22.9	55.5	78.4	19.8
67.5	23.0	55.6	78.6	17.6
69.0	23.1	55.7	78.8	19.0
70.5	23.2	55.8	79.0	18.8
72.0	23.3	55.8	79.1	18.0
73.5	23.3	56.0	79.3	17.2
75.0	23.3	56.2	79.5	17.3
76.5	23.4	56.3	79.7	15.7
78.0	23.5	56.3	79.8	15.1
79.5	23.5	56.5	80.0	15.1
81.0	23.6	56.6	80.2	14.0
82.5	23.5	56.8	80.3	13.9
84.0	23.6	56.9	80.5	15.3
85.5	23.7	56.9	80.6	17.8
87.0	23.6	57.2	80.8	19.3
88.5	23.7	57.2	80.9	21.5
90.0	23.7	57.4	81.1	20.8

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr, (dB)
P (dBm) = U(dBm) - Gain [dB] + FF-Att [dB]
U = Receiver reading
Gain = Antenna gain
The conversion loss of the mixer is automatically corrected in the analyser.
Table shows an extract of values,

7.9 ANTENNA SGH-08 (90 GHZ – 140 GHZ)

Frequency	AF SGH-19	Corr.	Farfield Att.	Harmonic Mixer FS-Z140
GHz	Gain (dBi)	dB	dB	dB
90.0	22.4	58.7	81.1	27.8
92.5	22.5	58.8	81.3	26.4
95.0	22.7	58.8	81.5	24.8
97.5	22.8	59.0	81.8	23.1
100.0	22.9	59.1	82.0	21.4
102.5	23.0	59.2	82.2	21.6
105.0	23.0	59.4	82.4	22.6
107.5	23.1	59.5	82.6	21.4
110.0	23.2	59.6	82.8	20.3
112.5	23.3	59.7	83.0	19.7
115.0	23.4	59.8	83.2	22.4
117.5	23.4	60.0	83.4	22.9
120.0	23.5	60.1	83.6	23.1
122.5	23.6	60.2	83.8	26.0
125.0	23.6	60.3	83.9	29.2
127.5	23.6	60.5	84.1	31.1
130.0	23.6	60.7	84.3	33.7
132.5	23.7	60.7	84.4	29.1
135.0	23.6	61.0	84.6	30.2
137.5	23.7	61.1	84.8	29.7
140.0	23.7	61.2	84.9	27.1

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr, (dB)
P (dBm) = U(dBm) - Gain [dB] + FF-Att [dB]
U = Receiver reading
Gain = Antenna gain
The conversion loss of the mixer is automatically corrected in the analyser.
Table shows an extract of values,

7.10 ANTENNA SGH-05 (140 GHZ – 220 GHZ)

Frequency	AF SGH-19	Corr.		Farfield Att.	Harmonic Mixer FS-Z20
GHz	Gain (dBi)	dB		dB	dB
140.0	22.39	58.68		81.07	30.7
142.0	22.45	58.74		81.19	26.6
144.0	22.52	58.79		81.31	26.7
146.0	22.59	58.83		81.42	27.7
148.0	22.65	58.89		81.54	28.7
150.0	22.71	58.94		81.65	31.0
152.0	22.78	58.98		81.76	30.6
154.0	22.83	59.04		81.87	32.5
156.0	22.89	59.09		81.98	30.7
158.0	22.94	59.15		82.09	30.9
160.0	22.99	59.21		82.20	30.1
162.0	23.04	59.26		82.30	29.8
164.0	23.08	59.33		82.41	31.0
166.0	23.13	59.38		82.51	29.1
168.0	23.18	59.43		82.61	29.6
170.0	23.22	59.49		82.71	30.7
172.0	23.26	59.55		82.81	29.9
174.0	23.29	59.62		82.91	30.3
176.0	23.33	59.68		83.01	30.4
178.0	23.37	59.73		83.10	30.2
180.0	23.39	59.81		83.20	30.5
182.0	23.42	59.87		83.29	30.3
184.0	23.45	59.93		83.38	31.2
186.0	23.49	59.99		83.48	32.4
188.0	23.51	60.06		83.57	30.8
190.0	23.52	60.14		83.66	32.4
192.0	23.55	60.20		83.75	31.7
194.0	23.57	60.27		83.84	30.4
196.0	23.60	60.32		83.92	30.7
198.0	23.60	60.41		84.01	29.4
200.0	23.61	60.48		84.09	29.3
202.0	23.65	60.53		84.18	29.6
204.0	23.65	60.61		84.26	29.3
206.0	23.66	60.69		84.35	29.0
208.0	23.66	60.77		84.43	29.0
210.0	23.70	60.81		84.51	29.5
212.0	23.69	60.90		84.59	28.5
214.0	23.67	61.00		84.67	28.7
216.0	23.71	61.04		84.75	29.1
218.0	23.69	61.14		84.83	30.1
220.0	23.70	61.21		84.91	29.6

Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr, (dB)
P (dBm) = U(dBm) - Gain [dB] + FF-Att [dB]
U = Receiver reading
Gain = Antenna gain
The conversion loss of the mixer is automatically corrected in the analyser.
Table shows an extract of values,

7.11 ANTENNA SGH-03 (220 GHZ – 325 GHZ)

Frequency	AF SGH-05	Corr,	Farfield Att.	Harmonic Mixer FS-Z325
GHz	Gain (dBi)	dB	dB	dB
220,00	22,6	66.23	88.83	33.2
223,00	22,7	66.28	88.95	32.9
226,00	22,7	66.34	89.07	32.2
229,00	22,8	66.39	89.18	33.0
232,00	22,8	66.45	89.29	33.0
235,00	22,9	66.51	89.41	32.7
238,00	23.0	66.57	89.52	33.0
241,00	23.0	66.62	89.62	33.5
244,00	23,1	66.68	89.73	34.9
247,00	23,1	66.75	89.84	36.7
250,00	23,1	66.80	89.94	37.9
253,00	23,2	66.87	90.05	38.7
256,00	23,2	66.93	90.15	38.5
259,00	23,3	66.99	90.25	38.6
262,00	23,3	67.05	90.35	37.8
265,00	23,3	67.12	90.45	35.8
268,00	23,4	67.19	90.55	34.3
271,00	23,4	67.24	90.64	33.4
274,00	23,4	67.31	90.74	32.8
277,00	23,5	67.38	90.83	31.4
280,00	23,5	67.46	90.93	31.1
283,00	23,5	67.51	91.02	32.2
286,00	23,5	67.58	91.11	33.7
289,00	23,6	67.65	91.20	33.9
292,00	23,6	67.73	91.29	34.1
295,00	23,6	67.77	91.38	33.3
298,00	23,6	67.86	91.47	33.0
301,00	23,6	67.95	91.56	33.7
304,00	23,6	68.01	91.64	35.2
307,00	23,7	68.08	91.73	38.2
310,00	23,7	68.14	91.81	38.8
313,00	23,7	68.24	91.90	38.9
316,00	23,7	68.28	91.98	39.0
319,00	23,7	68.37	92.06	38.0
322,00	23,7	68.46	92.14	37.4
325,00	23,7	68.53	92.22	38.1

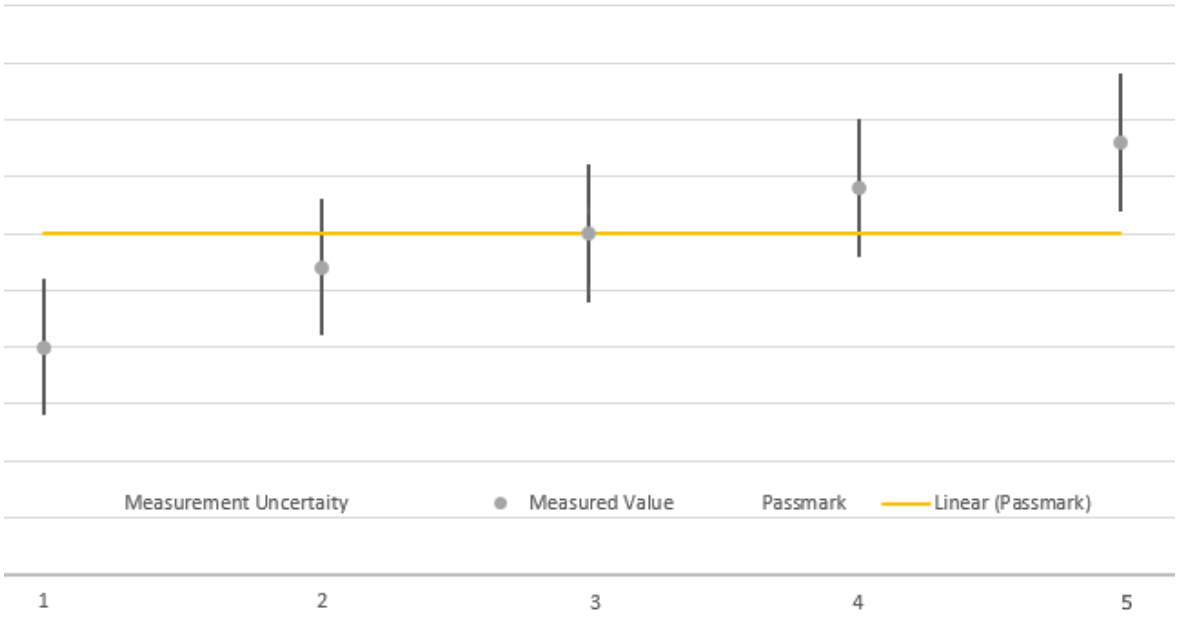
Sample calculation

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + Corr, (dB)
P (dBm) = U(dBm) - Gain [dB] + FF-Att [dB]
U = Receiver reading
Gain = Antenna gain
The conversion loss of the mixer is automatically corrected in the analyser.
Table shows an extract of values,

8 MEASUREMENT UNCERTAINTIES

Test Case	Parameter	Maximum expanded Measurement uncertainty
Radio frequency	Frequency	± 1 x 10^{-7}
AC Power Line	Power	± 3.4 dB
Field Strength of spurious radiation (up to 40 GHz)	Power	± 5.5 dB
Field Strength of spurious radiation (40 to 320 GHz)	Power	± 5.7 dB
Temperature	Temperature	± 1 °C
Humidity	Humidity	± 5 %
DC and low voltages	Voltage	± 3 %

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 to 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	on pass mark	within pass mark	Passed
4	above pass mark	within pass mark	Failed
5	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.

9 PHOTO REPORT

Please see separate photo report.

**********END OF REPORT**********