FCC Measurement/Technical Report on

HDR311

FCC ID: S7Y-BD3

Test Report Reference: MDE_ELEM_1701_FCCc_rev01

Test Laboratory:
7layers GmbH
Borsigstrasse 11
40880 Ratingen
Germany

Deutsche Akkreditierungsstelle D-PL-12140-01-00

Table of Contents

1.1 Applied Standards 3
1.2 FCC-IC Correlation Table 4
1.3 Measurement Summary / Signatures 5

2 Administrative Data 6
2.1 Testing Laboratory 6
2.2 Project Data 6
2.3 Applicant Data 6
2.4 Manufacturer Data 6

3 Test object Data 7
3.1 General EUT Description 7
3.2 EUT Main components 8
3.3 Ancillary Equipment 9
3.4 Auxiliary Equipment 9
3.5 EUT Setups 9
3.6 Operating Modes 10
3.7 Product labelling 10

4 Test Results 11
4.1 Transmit spurious emissions radiated 11

5 Test Equipment 15

6 Antenna Factors, Cable Loss and Sample Calculations 16
6.1 LISN R&S ESH3-Z5 (150 kHz – 30 MHz) 16
6.2 Antenna R&S HFH2-Z2 (9 kHz – 30 MHz) 17
6.3 Antenna R&S HL562 (30 MHz – 1 GHz) 18
6.4 Antenna R&S HF907 (1 GHz – 18 GHz) 19
6.5 Antenna EMCO 3160-09 (18 GHz – 26.5 GHz) 20
6.6 Antenna EMCO 3160-10 (26.5 GHz – 40 GHz) 21
6.7 Antenna SGH-19 (40 GHz – 60 GHz) 22
6.8 Antenna SGH-12 (60 GHz – 90 GHz) 23
6.9 Antenna SGH-08 (90 GHz – 140 GHz) 24
6.10 Antenna SGH-05 (140 GHz – 220 GHz) 25
6.11 Antenna SGH-03 (220 GHz – 325 GHz) 26

7 Setup Drawings 27

8 Measurement Uncertainties 28

9 Photo Report 28

Applied Standards and Test Summary

1.1 APPLIED STANDARDS

Type of Authorization
Certification for a Radar Unit.

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Part 95 (23-10-17 Edition). The following subparts are applicable to the results in this test report.

Part 95, Subpart M – The 76-81 GHz Band Radar Service

FCC §95.3379 76-81 GHz Band Radar Service unwanted emissions limits

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 the 76 – 81 GHz Band Radar Service from FCC and ISED Canada

Measurement	FCC reference	ISED reference
Radiated Power Limits	§95.3367	RSS-251 Issue 1: 5.2.2
Unwanted Emission Limits	§95.3379	RSS-251 Issue 1: 5.3
Frequency Stability of Fundamental Emissions	§95.3379	RSS-251 Issue 1: 5.4

Remarks:

1. According RSS-251 the frequency band is limited 76 – 77 GHz
2. Field disturbance sensors operating within the 76-77 GHz band are restricted to vehicle-mounted field disturbance sensors (vehicular radar) applications and to applications of fixed radar systems used at airports.

1.3 MEASUREMENT SUMMARY / SIGNATURES

FCC §95.3379
Transmit Spurious Emissions Radiated

		Final Result
OP-Mode Radio Technology, Operating Frequency, Measurement range	**Setup**	**FCC**
Radar System, 77 GHz, 90 GHz – 140 GHz	Setup_ac01	Passed
Radar System, 77 GHz, 140 GHz – 220 GHz	Setup_ac01	Passed
Radar System, 77 GHz, 220 GHz – 231 GHz	Setup_ac01	Passed

Revision History

Report version control			
Version	**Release date**	**Change Description**	**Version validity**
initial	2018-02-27	--	invalid
rev01	2018-03-26	Product name changed on page 7	valid

(responsible for accreditation scope)
Dipl.-Ing. Daniel Gall

(responsible for testing and report)
B.Sc. Jens Dörwald

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

2 ADMINISTRATIVE DATA

2.1 TESTING LABORATORY

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

This facility has been fully described in a report submitted to the ISED and accepted 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
FCC Designation Number:	DE0015
FCC Test Firm Registration:	929146
Responsible for accreditation scope:	Dipl.-Ing. Daniel Gall
Report Template Version:	2017-10-25

2.2 PROJECT DATA

Responsible for testing and report:	B.Sc. Jens Dörwald
Employees who performed the tests:	documented internally at 7Layers
Date of Report:	2018-03-26
Testing Period:	2018-02-14 to 2018-02-14

2.3 APPLICANT DATA

Company Name:	Element Materials Technology
Address:	Unit E South Orbital Trading Park Hedon Road Hull, HU9 1NJ United Kingdom
Contact Person:	Mr. Alexander Toohie

2.4 MANUFACTURER DATA

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

3 TEST OBJECT DATA

3.1 GENERAL EUT DESCRIPTION

Kind of Device product description	Radar Unit
Product name	HDR311 Series
Declared EUT data by the supplier	
Voltage Type	DC
Voltage Level	24 V
Tested Modulation Type	FMCW
Output Power	51 dBm
Operational Bandwidth	1 GHz
General product description	The EUT is a 76 - 77 GHz ground Radar.
Specific product description	The EUT is a Radar unit for tracking ground targets such as vehicles or debris, operating in the 76 - 77 GHz band.
Ports of the device	DC LAN
Antenna	1°x3° internal lens antenna
Special software used for testing	Radar View Lite – Client viewing software

The main components of the EUT are listed and described in chapter 3.2 EUT Main components.

3.2 EUT MAIN COMPONENTS

Sample Name	**Sample Code**	**Description**
DE1296000	ac01	radiated sample
Sample Parameter	**Value**	
Integral Antenna	1°x3° lens antenna	
Serial No.	HDR311X-0963-16	
HW Version	HDR311	
SW Version	1.0.0.292	
Comment	-	

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.

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

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.

Device	**Details (Manufacturer, HW, SW, S/N)**	**Description**
AUX1: Power Supply	NAVATECH RADAR AMR5-24, -, -, -	-

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	**Combination of EUTs**	**Description and Rationale**
Setup_ac01	ac01 + AUX1	radiated sample

3.6 OPERATING MODES

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

Radar System TX on 77 GHz

3.7 PRODUCT LABELLING

3.7.1FCC ID LABEL

Please refer to the documentation of the applicant.

3.7.2LOCATION OF THE LABEL ON THE EUT

Please refer to the documentation of the applicant.

4 TEST RESULTS

4.1 TRANSMIT SPURIOUS EMISSIONS RADIATED

Standard **FCC Part 95 Subpart M**

The test was performed according to:
ANSI C63.10

4.1.1TEST 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 $A = \pi r^2$ (with r = 0.6 m) in the fully-anechoic chamber.
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 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, if the beamwidth of the receiving antenna covers the entire EUT, otherwise the height of the receiving antenna was varied.
The EUT is turned continuously during the measurement across the elevation axis.
The measurement distance is 0.5 m.

EMI receiver settings:
-Trace: Maxhold
- Detector: Average
- RBW = 1 MHz
- VBW = 3 MHz

4.1.2TEST REQUIREMENTS / LIMITS

According to FCC95 Subpart M §95.3379:

(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.

4.1.3TEST PROTOCOL

Ambient temperature:	23 °C
Air Pressure:	1010 hPa
Humidity:	29 %

Setup_ac01:

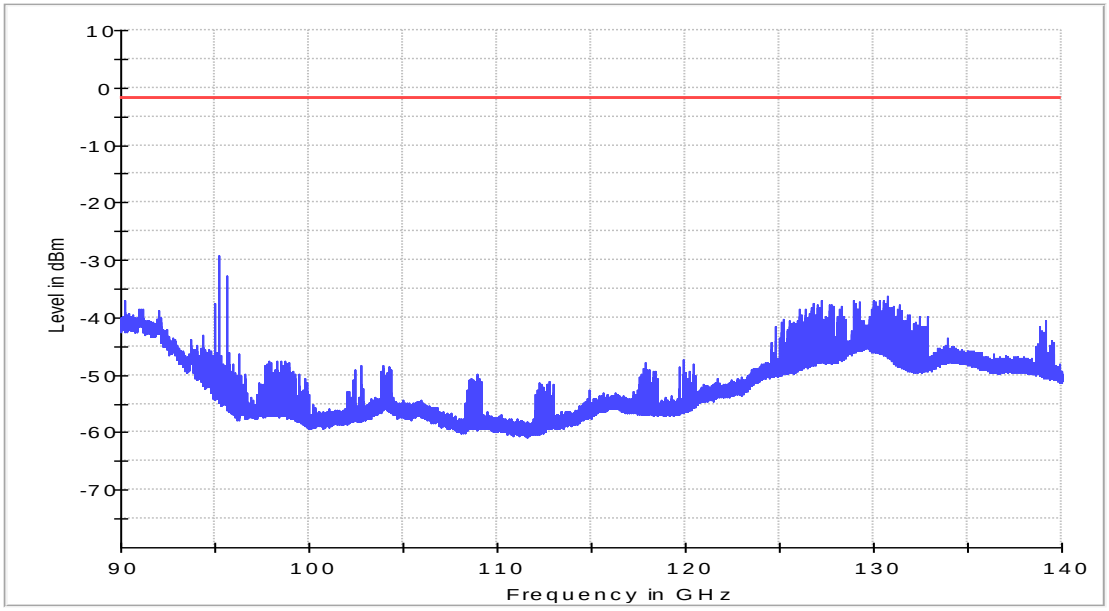
TX Freq. [GHz]	Spurious Freq. [GHz]	Spurious Level [dBm]	Detector	RBW [kHz]	Limit [dBm]	Margin to Limit [dB]
77.0		- - -	Average	1000	- - -	- - -

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

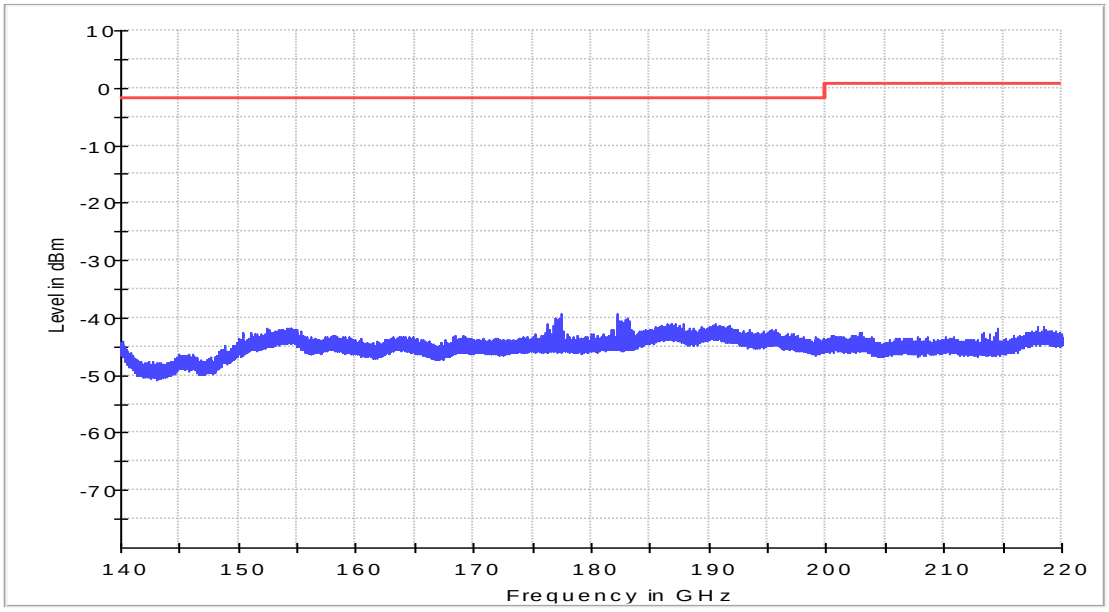
COMMENT:
No (further) spurious emissions in the range 20dB below the limit were found, therefore no measurement values are reported in the tables.

4.1.4MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

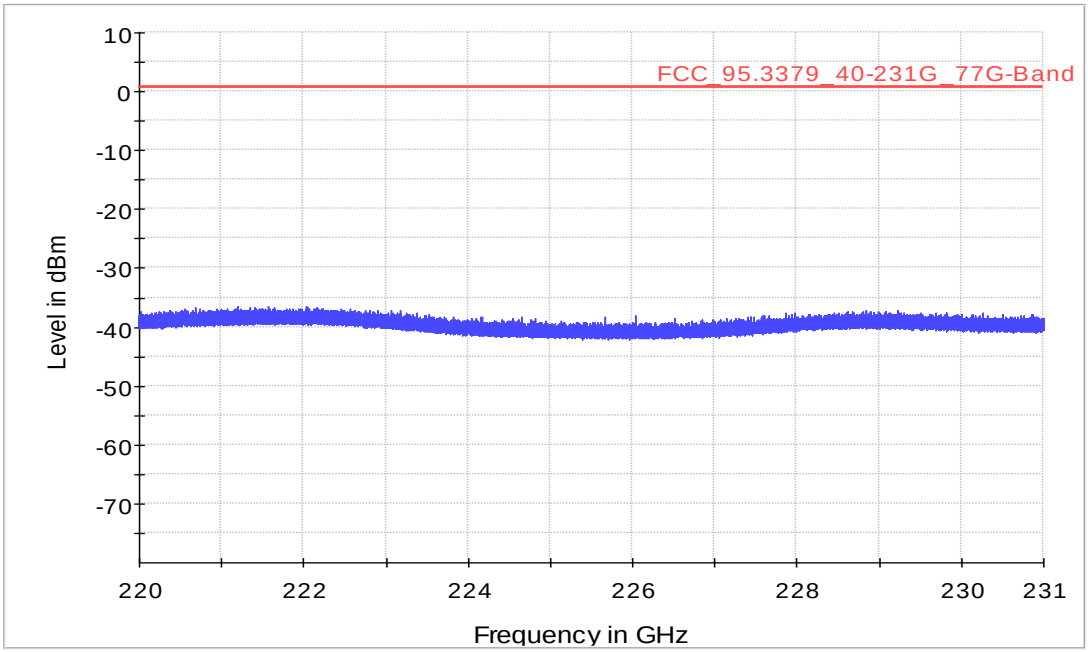
Setup_ac01
vertical EUT position, horizontal antenna polarisation
Radio Technology = Radar System
Measurement range: 90 GHz – 140 GHz



Setup_ac01
vertical EUT position, horizontal antenna polarisation
Radio Technology = Radar System
Measurement range: 140 GHz – 220 GHz



Setup_ac01
vertical EUT position, vertical antenna polarisation
Radio Technology = Radar System
Measurement range: 220 GHz – 231 GHz



4.1.5TEST EQUIPMENT USED

Radiated Emissions

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	Datum MFS	Rubidium Frequency Normal MFS	Datum GmbH	002	2017-10	2018-10
1.2	Fully Anechoic Room	8.80m x 4.60m x 4.05m (l x w x h)	Albatross Projects	P26971-647-001-PRB		
1.3	TT 1.5 WI	Turn Table	Maturo GmbH	-		
1.4	Tilt device Maturo (Rohacell)	Antrieb TD1.5-10kg	Maturo GmbH	TD1.5-10kg/024/3790709		
1.5	FSW 43	Spectrum Analyzer	Rohde & Schwarz	103779	2016-12	2018-12
1.6	Opus10 TPR (8253.00)	ThermoAirpressure Datalogger 13 (Environ)	Lufft Mess- und Regeltechnik GmbH	13936		
1.7	FS-Z60	Harmonic Mixer	Radiometer Physics	100178	2016-12	2019-12
1.8	FS-Z90	Harmonic Mixer	Radiometer Physics	101989	2017-03	2020-03
1.9	FS-Z140	Harmonic Mixer	Radiometer Physics	101007	2017-02	2020-02
1.10	FS-Z220	Harmonic Mixer	Radiometer Physics	101005	2017-04	2020-04
1.11	FS-Z325	Harmonic Mixer	Radiometer Physics	101006	2017-03	2020-03
1.12	SGH-19	Antenna	Millitech	093		
1.13	SGH-12	Antenna	Millitech	326		
1.14	SGH-08	Antenna	Millitech	064		
1.15	SGH-05	Antenna	Millitech	075		
1.16	SGH-03	Antenna	Millitech	060		

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)	distance corr. (-20 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
GHz	dB (1/m)	dB	dB	dB	m	m
26,5	43,4	-11,2	4,4	-15,6	3	0,5
27,0	43,4	-11,2	4,4	-15,6	3	0,5
28,0	43,4	-11,1	4,5	-15,6	3	0,5
29,0	43,5	-11,0	4,6	-15,6	3	0,5
30,0	43,5	-10,9	4,7	-15,6	3	0,5
31,0	43,5	-10,8	4,7	-15,6	3	0,5
32,0	43,5	-10,7	4,8	-15,6	3	0,5
33,0	43,6	-10,7	4,9	-15,6	3	0,5
34,0	43,6	-10,6	5,0	-15,6	3	0,5
35,0	43,6	-10,5	5,1	-15,6	3	0,5
36,0	43,6	-10,4	5,1	-15,6	3	0,5
37,0	43,7	-10,3	5,2	-15,6	3	0,5
38,0	43,7	-10,2	5,3	-15,6	3	0,5
39,0	43,7	-10,2	5,4	-15,6	3	0,5
40,0	43,8	-10,1	5,5	-15,6	3	0,5

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.

6.7 ANTENNA SGH-19 (40 GHZ – 60 GHZ)

Frequency	AF SGH-19	Corr.	cable loss 1 (inside chamber)	distance corr. (-20 dB/ decade)	d_{Limit} (meas. distance (limit)	d_{used} (meas. distance (used)
GHz	dB (1/m)	dB	dB	dB	m	m
40,0	22,6	-14,6	1	-15,6	3	0,5
40,5	22,7	-14,6	1	-15,6	3	0,5
41,0	22,8	-14,6	1	-15,6	3	0,5
41,5	22,8	-14,6	1	-15,6	3	0,5
42,0	22,9	-14,6	1	-15,6	3	0,5
42,5	22,9	-14,6	1	-15,6	3	0,5
43,0	23	-14,6	1	-15,6	3	0,5
43,5	23	-14,6	1	-15,6	3	0,5
44,0	23	-14,6	1	-15,6	3	0,5
44,5	23,1	-14,6	1	-15,6	3	0,5
45,0	23,1	-14,6	1	-15,6	3	0,5
45,5	23,2	-14,6	1	-15,6	3	0,5
46,0	23,2	-14,6	1	-15,6	3	0,5
46,5	23,2	-14,6	1	-15,6	3	0,5
47,0	23,3	-14,6	1	-15,6	3	0,5
47,5	23,3	-14,6	1	-15,6	3	0,5
48,0	23,3	-14,6	1	-15,6	3	0,5
48,5	23,4	-14,6	1	-15,6	3	0,5
49,0	23,4	-14,6	1	-15,6	3	0,5
49,5	23,4	-14,6	1	-15,6	3	0,5
50,0	23,5	-14,6	1	-15,6	3	0,5
50,5	23,5	-14,6	1	-15,6	3	0,5
51,0	23,5	-14,6	1	-15,6	3	0,5
51,5	23,5	-14,6	1	-15,6	3	0,5
52,0	23,5	-14,6	1	-15,6	3	0,5
52,5	23,6	-14,6	1	-15,6	3	0,5
53,0	23,6	-14,6	1	-15,6	3	0,5
53,5	23,6	-14,6	1	-15,6	3	0,5
54,0	23,6	-14,6	1	-15,6	3	0,5
54,5	23,6	-14,6	1	-15,6	3	0,5
55,0	23,6	-14,6	1	-15,6	3	0,5
55,5	23,6	-14,6	1	-15,6	3	0,5
56,0	23,7	-14,6	1	-15,6	3	0,5
56,5	23,7	-14,6	1	-15,6	3	0,5
57,0	23,7	-14,6	1	-15,6	3	0,5
57,5	23,7	-14,6	1	-15,6	3	0,5
58,0	23,7	-14,6	1	-15,6	3	0,5
58,5	23,7	-14,6	1	-15,6	3	0,5
59,0	23,7	-14,6	1	-15,6	3	0,5
59,5	23,7	-14,6	1	-15,6	3	0,5
60,0	23,7	-14,6	1	-15,6	3	0,5

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,

6.8 ANTENNA SGH-12 (60 GHZ – 90 GHZ)

Frequency	AF SGH-19	Corr,	cable loss 1 (inside chamber)	distance corr, (-20 dB/ decade)	d_{Limit} (meas, distance (limit)	d_{used} (meas, distance (used)
GHz	dB (1/m)	dB	dB	dB	m	m
60,00	22,6	-14,6	1	-15,6	3	0,5
60,75	22,7	-14,6	1	-15,6	3	0,5
61,50	22,8	-14,6	1	-15,6	3	0,5
62,25	22,8	-14,6	1	-15,6	3	0,5
63,00	22,9	-14,6	1	-15,6	3	0,5
63,75	22,9	-14,6	1	-15,6	3	0,5
64,50	23	-14,6	1	-15,6	3	0,5
65,25	23	-14,6	1	-15,6	3	0,5
66,00	23	-14,6	1	-15,6	3	0,5
66,75	23,1	-14,6	1	-15,6	3	0,5
67,50	23,1	-14,6	1	-15,6	3	0,5
68,25	23,2	-14,6	1	-15,6	3	0,5
69,00	23,2	-14,6	1	-15,6	3	0,5
69,75	23,2	-14,6	1	-15,6	3	0,5
70,50	23,3	-14,6	1	-15,6	3	0,5
71,25	23,3	-14,6	1	-15,6	3	0,5
72,00	23,3	-14,6	1	-15,6	3	0,5
72,75	23,4	-14,6	1	-15,6	3	0,5
73,50	23,4	-14,6	1	-15,6	3	0,5
74,25	23,4	-14,6	1	-15,6	3	0,5
75,00	23,5	-14,6	1	-15,6	3	0,5
75,75	23,5	-14,6	1	-15,6	3	0,5
76,50	23,5	-14,6	1	-15,6	3	0,5
77,25	23,5	-14,6	1	-15,6	3	0,5
78,00	23,5	-14,6	1	-15,6	3	0,5
78,75	23,6	-14,6	1	-15,6	3	0,5
79,50	23,6	-14,6	1	-15,6	3	0,5
80,25	23,6	-14,6	1	-15,6	3	0,5
81,00	23,6	-14,6	1	-15,6	3	0,5
81,75	23,6	-14,6	1	-15,6	3	0,5
82,50	23,6	-14,6	1	-15,6	3	0,5
83,25	23,6	-14,6	1	-15,6	3	0,5
84,00	23,7	-14,6	1	-15,6	3	0,5
84,75	23,7	-14,6	1	-15,6	3	0,5
85,50	23,7	-14,6	1	-15,6	3	0,5
86,25	23,7	-14,6	1	-15,6	3	0,5
87,00	23,7	-14,6	1	-15,6	3	0,5
87,75	23,7	-14,6	1	-15,6	3	0,5
88,50	23,7	-14,6	1	-15,6	3	0,5
89,25	23,7	-14,6	1	-15,6	3	0,5
90,00	23,7	-14,6	1	-15,6	3	0,5

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,

6.9 ANTENNA SGH-08 (90 GHZ – 140 GHZ)

Frequency	AF SGH-19	Corr,	cable loss 1 (inside chamber)	distance corr, (-20 dB/ decade)	d_{Limit} (meas, distance (limit)	d_{used} (meas, distance (used)
GHz	dB (1/m)	dB	dB	dB	m	m
90,00	22,4	-14,6	1	-15,6	3	0,5
91,25	22,5	-14,6	1	-15,6	3	0,5
92,50	22,6	-14,6	1	-15,6	3	0,5
93,75	22,6	-14,6	1	-15,6	3	0,5
95,00	22,7	-14,6	1	-15,6	3	0,5
96,25	22,7	-14,6	1	-15,6	3	0,5
97,50	22,8	-14,6	1	-15,6	3	0,5
98,75	22,9	-14,6	1	-15,6	3	0,5
100,00	22,9	-14,6	1	-15,6	3	0,5
101,25	23	-14,6	1	-15,6	3	0,5
102,50	23	-14,6	1	-15,6	3	0,5
103,75	23,1	-14,6	1	-15,6	3	0,5
105,00	23,1	-14,6	1	-15,6	3	0,5
106,25	23,1	-14,6	1	-15,6	3	0,5
107,50	23,2	-14,6	1	-15,6	3	0,5
108,75	23,2	-14,6	1	-15,6	3	0,5
110,00	23,3	-14,6	1	-15,6	3	0,5
111,25	23,3	-14,6	1	-15,6	3	0,5
112,50	23,3	-14,6	1	-15,6	3	0,5
113,75	23,4	-14,6	1	-15,6	3	0,5
115,00	23,4	-14,6	1	-15,6	3	0,5
116,25	23,4	-14,6	1	-15,6	3	0,5
117,50	23,5	-14,6	1	-15,6	3	0,5
118,75	23,5	-14,6	1	-15,6	3	0,5
120,00	23,5	-14,6	1	-15,6	3	0,5
121,25	23,5	-14,6	1	-15,6	3	0,5
122,50	23,6	-14,6	1	-15,6	3	0,5
123,75	23,6	-14,6	1	-15,6	3	0,5
125,00	23,6	-14,6	1	-15,6	3	0,5
126,25	23,6	-14,6	1	-15,6	3	0,5
127,50	23,6	-14,6	1	-15,6	3	0,5
128,75	23,6	-14,6	1	-15,6	3	0,5
130,00	23,6	-14,6	1	-15,6	3	0,5
131,25	23,7	-14,6	1	-15,6	3	0,5
132,50	23,7	-14,6	1	-15,6	3	0,5
133,75	23,7	-14,6	1	-15,6	3	0,5
135,00	23,7	-14,6	1	-15,6	3	0,5
136,25	23,7	-14,6	1	-15,6	3	0,5
137,50	23,7	-14,6	1	-15,6	3	0,5
138,75	23,7	-14,6	1	-15,6	3	0,5
140,00	23,7	-14,6	1	-15,6	3	0,5

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,

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

Frequency	AF SGH-05	Corr,	cable loss 1 (inside chamber)	distance corr, (-20 dB/ decade)	d_{Limit} (meas, distance (limit)	d_{used} (meas, distance (used)
GHz	dB (1/m)	dB	dB	dB	m	m
140,00	22,4	-14,6	1	-15,6	3	0,5
142,00	22,5	-14,6	1	-15,6	3	0,5
144,00	22,5	-14,6	1	-15,6	3	0,5
146,00	22,6	-14,6	1	-15,6	3	0,5
148,00	22,7	-14,6	1	-15,6	3	0,5
150,00	22,7	-14,6	1	-15,6	3	0,5
152,00	22,8	-14,6	1	-15,6	3	0,5
154,00	22,8	-14,6	1	-15,6	3	0,5
156,00	22,9	-14,6	1	-15,6	3	0,5
158,00	22,9	-14,6	1	-15,6	3	0,5
160,00	23	-14,6	1	-15,6	3	0,5
162,00	23	-14,6	1	-15,6	3	0,5
164,00	23,1	-14,6	1	-15,6	3	0,5
166,00	23,1	-14,6	1	-15,6	3	0,5
168,00	23,2	-14,6	1	-15,6	3	0,5
170,00	23,2	-14,6	1	-15,6	3	0,5
172,00	23,3	-14,6	1	-15,6	3	0,5
174,00	23,3	-14,6	1	-15,6	3	0,5
176,00	23,3	-14,6	1	-15,6	3	0,5
178,00	23,4	-14,6	1	-15,6	3	0,5
180,00	23,4	-14,6	1	-15,6	3	0,5
182,00	23,4	-14,6	1	-15,6	3	0,5
184,00	23,5	-14,6	1	-15,6	3	0,5
186,00	23,5	-14,6	1	-15,6	3	0,5
188,00	23,5	-14,6	1	-15,6	3	0,5
190,00	23,5	-14,6	1	-15,6	3	0,5
192,00	23,6	-14,6	1	-15,6	3	0,5
194,00	23,6	-14,6	1	-15,6	3	0,5
196,00	23,6	-14,6	1	-15,6	3	0,5
198,00	23,6	-14,6	1	-15,6	3	0,5
200,00	23,6	-14,6	1	-15,6	3	0,5
202,00	23,7	-14,6	1	-15,6	3	0,5
204,00	23,7	-14,6	1	-15,6	3	0,5
206,00	23,7	-14,6	1	-15,6	3	0,5
208,00	23,7	-14,6	1	-15,6	3	0,5
210,00	23,7	-14,6	1	-15,6	3	0,5
212,00	23,7	-14,6	1	-15,6	3	0,5
214,00	23,7	-14,6	1	-15,6	3	0,5
216,00	23,7	-14,6	1	-15,6	3	0,5
218,00	23,7	-14,6	1	-15,6	3	0,5
220,00	23,7	-14,6	1	-15,6	3	0,5

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,

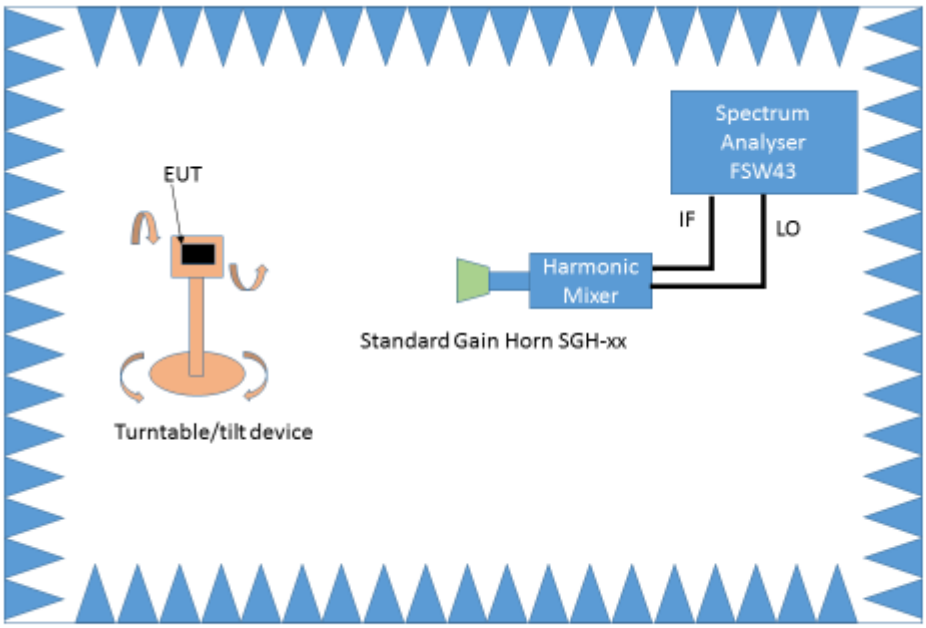
6.11 ANTENNA SGH-03 (220 GHZ – 325 GHZ)

Frequency	AF SGH-05	Corr,	cable loss 1 (inside chamber)	distance corr, (-20 dB/ decade)	d_{Limit} (meas, distance (limit)	d_{used} (meas, distance (used)
GHz	dB (1/m)	dB	dB	dB	m	m
220,00	22,6	-14,6	1	-15,6	3	0,5
223,00	22,7	-14,6	1	-15,6	3	0,5
226,00	22,7	-14,6	1	-15,6	3	0,5
229,00	22,8	-14,6	1	-15,6	3	0,5
232,00	22,8	-14,6	1	-15,6	3	0,5
235,00	22,9	-14,6	1	-15,6	3	0,5
238,00	23	-14,6	1	-15,6	3	0,5
241,00	23	-14,6	1	-15,6	3	0,5
244,00	23,1	-14,6	1	-15,6	3	0,5
247,00	23,1	-14,6	1	-15,6	3	0,5
250,00	23,1	-14,6	1	-15,6	3	0,5
253,00	23,2	-14,6	1	-15,6	3	0,5
256,00	23,2	-14,6	1	-15,6	3	0,5
259,00	23,3	-14,6	1	-15,6	3	0,5
262,00	23,3	-14,6	1	-15,6	3	0,5
265,00	23,3	-14,6	1	-15,6	3	0,5
268,00	23,4	-14,6	1	-15,6	3	0,5
271,00	23,4	-14,6	1	-15,6	3	0,5
274,00	23,4	-14,6	1	-15,6	3	0,5
277,00	23,5	-14,6	1	-15,6	3	0,5
280,00	23,5	-14,6	1	-15,6	3	0,5
283,00	23,5	-14,6	1	-15,6	3	0,5
286,00	23,5	-14,6	1	-15,6	3	0,5
289,00	23,6	-14,6	1	-15,6	3	0,5
292,00	23,6	-14,6	1	-15,6	3	0,5
295,00	23,6	-14,6	1	-15,6	3	0,5
298,00	23,6	-14,6	1	-15,6	3	0,5
301,00	23,6	-14,6	1	-15,6	3	0,5
304,00	23,6	-14,6	1	-15,6	3	0,5
307,00	23,7	-14,6	1	-15,6	3	0,5
310,00	23,7	-14,6	1	-15,6	3	0,5
313,00	23,7	-14,6	1	-15,6	3	0,5
316,00	23,7	-14,6	1	-15,6	3	0,5
319,00	23,7	-14,6	1	-15,6	3	0,5
322,00	23,7	-14,6	1	-15,6	3	0,5
325,00	23,7	-14,6	1	-15,6	3	0,5

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



FCC Part 95 M; 76-81 GHz Band Radar Service – Test Setup; Radiated Emissions 40 GHz – 231 GHz

Drawing 1: Setup in the Anechoic chamber, For measurements above 40 GHz

8 MEASUREMENT UNCERTAINTIES

Test Case	Parameter	Uncertainty
AC Power Line	Power	± 3,4 dB
Field Strength of spurious radiation	Power	± 5,5 dB
6 dB / 26 dB / 99% Bandwidth	Power Frequency	± 2,9 dB ± 11,2 kHz
Conducted Output Power	Power	± 2,2 dB
Band Edge Compliance	Power Frequency	± 2,2 dB ± 11,2 kHz
Frequency Stability	Frequency	± 25 Hz
Power Spectral Density	Power	± 2,2 dB

9 PHOTO REPORT

Please see separate photo report,