

# FCC Measurement/Technical Report on

## RF-Sensor

## RF-360

FCC ID: 2AO3N-TH87P6EROZ

IC ID: 23389-TH87P6EROZ

**Test Report Reference:** MDE\_DEDRONE\_1803\_FCCa\_rev1

### Test Laboratory:

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Germany



#### Note:

The following test results relate only to the devices specified in this document. This report shall not be reproduced in parts without the written approval of the test laboratory.

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## 1 APPLIED STANDARDS AND TEST SUMMARY

### 1.1 APPLIED STANDARDS

#### **Applicable FCC Rules**

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2 and 15 (10-1-18 Edition). The following subparts are applicable to the results in this test report.

#### **Part 2, Subpart J - Equipment Authorization Procedures, Certification**

#### **Part 15, Subpart B – Unintentional Radiators**

§ 15.107 Conducted limits

§ 15.109 Radiated emission limits; general requirements

§ 15.111 Antenna power conduction limits for receivers.

§ 15.121 Scanning receivers and frequency converters used with scanning receivers.

Note:

ANSI C63.4–2014 is applied.

## 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 Information Technology Equipment (ITE) from FCC and IC

| Measurement                            | FCC reference | IC reference          |
|----------------------------------------|---------------|-----------------------|
| Conducted Emissions<br>(AC Power Line) | §15.107       | ICES-003 Issue 6: 6.1 |
| Radiated Spurious Emissions            | §15.109       | ICES-003 Issue 6: 6.2 |

## Remarks:

1. FCC Part 15 subpart B, ICES 003 and CISPR 22 contain different definitions of Class A and Class B limits, i.e. which class is applicable to which kind of EUT.  
ICES 003 and CISPR 22 distinguish between the location where the EUT is intended to operate whilst FCC refers to the method of commercial distribution (distributive trades).
2. The correct assignment of the appropriate class to the concrete EUT is not scope of this test report!
3. A radio apparatus that is specifically subject to an Industry Canada Radio Standard Specification (RSS) and which contains an ITE is not subject to ICES-003 provided the ITE is used only to enable operation of the radio apparatus and the ITE does not control additional functions or capabilities.
4. ISM (Industrial, Scientific or Medical) radio frequency generators, though they may contain ITE, are excluded from the definition of ITE and are not subject to ICES-003. They are instead subject to the Interference-Causing Equipment Standard ICES-001, which specifically addresses ISM radio frequency generators.

### 1.3 MEASUREMENT SUMMARY / SIGNATURES

#### 47 CFR CHAPTER I FCC PART 15 Subpart B

#### § 15.107 Class A / Class B

Conducted Emissions at AC mains

The measurement was performed according to ANSI C63.4

**Final Result**

##### OP-Mode

AC mains connection, Test setup

AC, computer peripheral

POE, computer peripheral

##### Setup

S01\_AA01

S02\_AA01

##### FCC

Passed

Passed

##### IC

Passed

Passed

#### 47 CFR CHAPTER I FCC PART 15 Subpart B

#### § 15.109 Class A / Class B

Radiated Emissions

The measurement was performed according to ANSI C63.4

**Final Result**

##### OP-Mode

AC mains connection, Measurement range, Test setup

AC, 1 GHz - 18 GHz, computer peripheral

AC, 30 MHz - 1 GHz, computer peripheral

POE, 1 GHz - 18 GHz, computer peripheral

POE, 30 MHz - 1 GHz, computer peripheral

##### Setup

S01\_AA01

S01\_AA01

S02\_AA01

S02\_AA01

##### FCC

Passed

Passed

Passed

Passed

##### IC

Passed

Passed

Passed

Passed

#### 47 CFR CHAPTER I FCC PART 15 Subpart B

#### § 15.111 Class B

Antenna power conduction limits for receivers

The measurement was performed according to ANSI C63.4

**Final Result**

##### OP-Mode

AC mains connection, Measurement range, Test setup

AC, 1 GHz - 18 GHz, computer peripheral

AC, 30 MHz - 1 GHz, computer peripheral

POE, 1 GHz - 18 GHz, computer peripheral

POE, 30 MHz - 1 GHz, computer peripheral

##### Setup

S01\_AA01

S01\_AA01

S02\_AA01

S02\_AA01

##### FCC

Passed <sup>1)</sup>

Passed <sup>1)</sup>

Passed <sup>1)</sup>

Passed <sup>1)</sup>

##### IC

Passed <sup>1)</sup>

Passed <sup>1)</sup>

Passed <sup>1)</sup>

Passed <sup>1)</sup>

#### 47 CFR CHAPTER I FCC PART 15 Subpart B

#### § 15.121 Class B

Scanning receivers and frequency converters used with scanning receivers.

##### OP-Mode

-

##### Setup

-

**Final Result**

##### FCC

N/A <sup>2)</sup>

##### IC

N/A <sup>2)</sup>

N/A: Not applicable

N/P: Not performed

1) The devices antennas are embedded, permanently attached, therefore part §15.111 (b) is applicable, which references the radiated emission limitations in this part (§15.109).

2) The device provides no speech communication and don't has analog voice audio circuitries therefore §15.121 is not applicable

## 2 REVISION HISTORY

| Report version control |              |                                                       |                  |
|------------------------|--------------|-------------------------------------------------------|------------------|
| Version                | Release date | Change Description                                    | Version validity |
| initial                | 2019-06-11   | --                                                    | invalid          |
| rev1                   | 2019-09-12   | Applicable §15.111 and §15.121 was added as reference | valid            |

COMMENT: -



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



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



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### 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: 2019-02-12

#### 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: 2019-09-12  
Testing Period: 2019-03-12 to 2019-04-05

#### 3.3 APPLICANT DATA

Company Name: Dedrone Holding Inc.  
Address: 220 Sansome Street, 6th Floor  
San Francisco CA 94104  
United States  
Contact Person: Robin Jäger

#### 3.4 MANUFACTURER DATA

Company Name: Dedrone GmbH  
Address: Miramstraße 87  
34123 Kassel  
Germany  
Contact Person: Robin Jäger

## 4 TEST OBJECT DATA

### 4.1 GENERAL EUT DESCRIPTION

|                                          |                                                                                                          |
|------------------------------------------|----------------------------------------------------------------------------------------------------------|
| Kind of Device<br>product description    | The RF-360 is a passive, network-attached sensor for the detection of frequencies (RF) and WiFi signals. |
| Product name                             | RF-Sensor                                                                                                |
| Type                                     | RF-360                                                                                                   |
| <b>Declared EUT data by the supplier</b> |                                                                                                          |
| Power Supply Type                        | AC                                                                                                       |
| Nominal Voltage /<br>Frequency           | 120 V                                                                                                    |
| Test Voltage /<br>Frequency              | 120 V                                                                                                    |
| Highest internal<br>frequency            | 5875 MHz                                                                                                 |
| General Description                      |                                                                                                          |
| Ports                                    | AC, PoE                                                                                                  |

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

### 4.2 EUT MAIN COMPONENTS

| Sample Name      | Sample Code        | Description                |
|------------------|--------------------|----------------------------|
| Sample #aa01     | aa01               | Radiated test sample #aa01 |
| Sample Parameter | Value              |                            |
| Serial No.       | DR03601908P1001023 |                            |
| HW Version       | 1                  |                            |
| SW Version       | 4-gbcc27bf         |                            |
| 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<br>(Manufacturer, Type Model, S/N)                            | Description                                                                                                                                |
|--------------|-----------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| Laptop RE 02 | Fujitsu Lifebook E series E782, 2012-08, Win7 Prof. Engl., DSCM004672 |                                                                                                                                            |
| AC Adapter   | Fujitsu Ltd. PJW1942NA, 13300281B                                     |                                                                                                                                            |
| TFT Display  | LG L17MB-P, 412WAPL0U560                                              |                                                                                                                                            |
| Mouse        | Logitech M-BT58, HC60915A2XC                                          |                                                                                                                                            |
| Keyboard     | CHERRY RS 6000 USB ON, G 0000273 2P28                                 |                                                                                                                                            |
| PoE adapter  | ZyXEL, PoE12-HP, S/N: S160H42003015                                   | The <b>PoE12-HP</b> is a single-port PoE injector that delivers both power and data to other PoE devices via a single CAT-5 Ethernet cable |

### 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<br>(Manufacturer, Type Model, HW, SW, S/N) | Description |
|--------|----------------------------------------------------|-------------|
| -      | -                                                  | -           |

### 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 A,              |                           |
| S02_AA01 | EUT A, PoE adapter  |                           |

## 4.6 OPERATING MODES

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

### 4.6.1 TEST MODES

The device is powered via AC or PoE. All receives are activated during testing.

## 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 CONDUCTED EMISSIONS AT AC MAINS

Standard **FCC Part 15 Subpart B**

**The test was performed according to:**  
ANSI C63.4

#### 5.1.1 TEST DESCRIPTION

The test set-up was made in accordance to the general provisions of ANSI C 63.4. The Equipment Under Test (EUT) was setup in a shielded room to perform the conducted emissions measurements in a typical installation configuration. The EUT was powered from 50 $\mu$ H || 50 Ohm Line Impedance Stabilization Network (LISN). The LISN's unused connections were terminated with 50 Ohm loads.

The measurement procedure consists of two steps. It is implemented into the EMI test software EMC-32 from R&S.

##### **Step 1: Preliminary scan**

Intention of this step is, to determine the conducted EMI-profile of the EUT.

EMI receiver settings:

- Detector: Peak – Maxhold & Average
- Frequency range: 150 kHz – 30 MHz
- Frequency steps: 2.5 kHz
- IF-Bandwidth: 9 kHz
- Measuring time / Frequency step: 100 ms (FFT-based)
- Measurement on phase + neutral lines of the power cords

On basis of this preliminary scan the highest amplitudes and the corresponding frequencies relative to the limit are identified. Emissions above the limit and emissions which are in the 10 dB range below the limit are considered.

##### **Step 2: Final measurement**

Intention of this step is, to determine the highest emissions with the settings defined in the test specification for the frequencies identified in step 1.

EMI receiver settings:

- Detector: Quasi-Peak
- IF Bandwidth: 9 kHz
- Measuring time: 1 s / frequency

At each frequency determined in step 1, four measurements are performed in the following combinations:

- 1) Neutral lead - reference ground (PE grounded)
- 2) Phase lead - reference ground (PE grounded)
- 3) Neutral lead - reference ground (PE floating)
- 4) Phase lead - reference ground (PE floating)

The highest value is reported.

## 5.1.2 TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart B, §15.107

### Class B:

| Frequency (MHz) | QP Limits (dBμV) | AV Limits (dBμV) |
|-----------------|------------------|------------------|
| 0.15 – 0.5      | 66 - 56          | 56 - 46          |
| 0.5 - 5         | 56               | 46               |
| 5 - 30          | 60               | 50               |

### Class A:

| Frequency (MHz) | QP Limits (dBμV) | AV Limits (dBμV) |
|-----------------|------------------|------------------|
| 0.15 – 0.5      | 79               | 66               |
| 0.5 - 30        | 73               | 60               |

## 5.1.3 TEST PROTOCOL

Temperature: 25 °C  
 Air Pressure: 996 hPa  
 Humidity: 30 %  
 Computer Peripheral

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

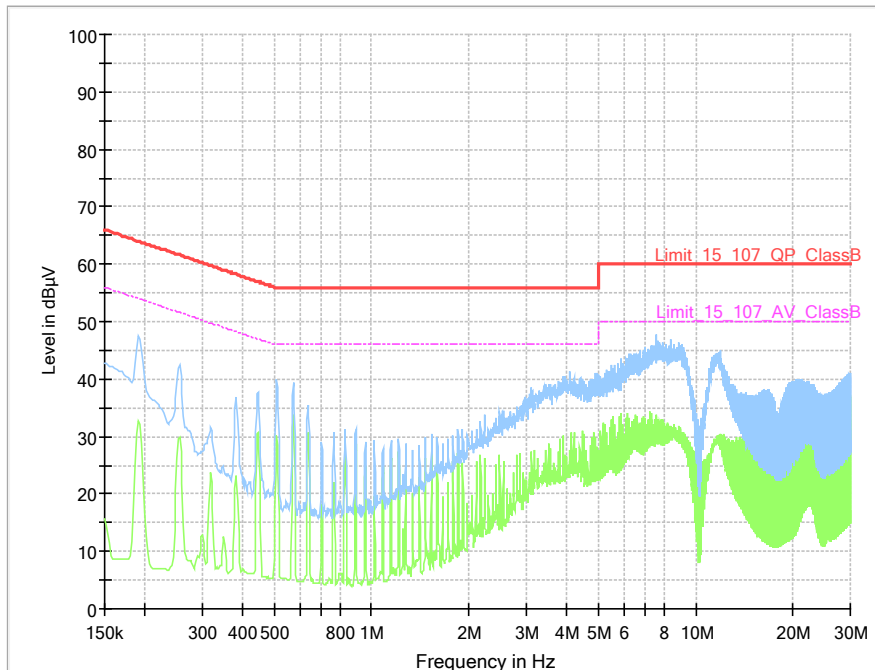
## 5.1.4 MEASUREMENT PLOT

AC mains connection = AC, Test setup = computer peripheral  
 (S01\_AA01)

## Diagram 1.01

### Common Information

|                             |                                                                                                                     |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------|
| Test Description:           | Conducted Emissions                                                                                                 |
| Test Standard:              | FCC §15.107, ANSI C63.4                                                                                             |
| EUT / Setup Code:           | DE1270002aa01 / DR0360                                                                                              |
| Operating Conditions:       | AC, LAN traffic: Detector on: RX 2.4 & 5 GHz, GPS RX,                                                               |
| Operator Name:              | URO                                                                                                                 |
| Comment:                    | computer peripheral setup, 120V/60Hz                                                                                |
| Legend:                     | Trace: blue = PK, green = CISPR AV; Star: red or blue = critical frequency; Rhombus: blue = final QP, green = final |
| Tested Port / used LISN:    | AC mains => ESH3-Z5                                                                                                 |
| Termination of other ports: | AC of AUX => 2nd LISN ESH3-Z5 +50 Ohm                                                                               |



## Final\_Result

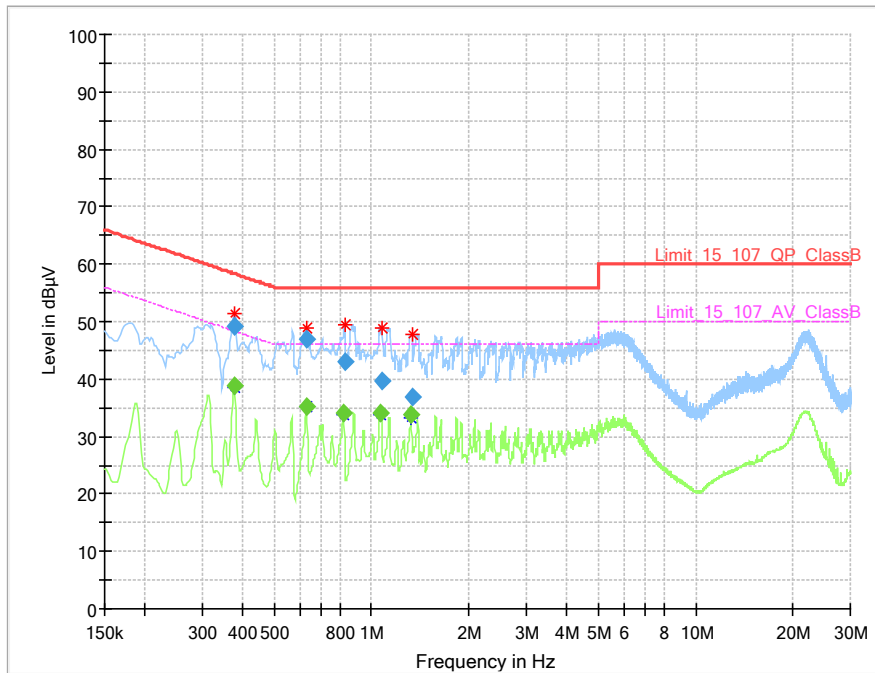
| Frequency (MHz) | QuasiPeak (dBµV) | CAverage (dBµV) | Limit (dBµV) | Margin (dB) | Measurement Time | Bandwidth (kHz) | Line | PE | Correction (dB) |
|-----------------|------------------|-----------------|--------------|-------------|------------------|-----------------|------|----|-----------------|
| ---             | ---              | ---             | ---          | ---         | ---              | ---             |      |    | ---             |

AC mains connection = POE, Test setup = computer peripheral (S02\_AA01)

## Diagram 1.02

## Common Information

|                             |                                                                                                                     |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------|
| Test Description:           | Conducted Emissions                                                                                                 |
| Test Standard:              | FCC §15.107, ANSI C63.4                                                                                             |
| EUT / Setup Code:           | DE1270002aa01 / DR0360                                                                                              |
| Operating Conditions:       | PoE, LAN traffic: Detector on: RX 2.4 & 5 GHz, GPS RX, eFDD5 idle                                                   |
| Operator Name:              | URO                                                                                                                 |
| Comment:                    | computer peripheral setup, 120V/60Hz                                                                                |
| Legend:                     | Trace: blue = PK, green = CISPR AV; Star: red or blue = critical frequency; Rhombus: blue = final QP, green = final |
| Tested Port / used LISN:    | AC mains => ESH3-Z5                                                                                                 |
| Termination of other ports: | AC of AUX => 2nd LISN ESH3-Z5 +50 Ohm                                                                               |



## Final\_Result

| Frequency (MHz) | QuasiPeak (dBµV) | CAverage (dBµV) | Limit (dBµV) | Margin (dB) | Meas. Time | Bandwidth (kHz) | Line | PE  | Corr. (dB) |
|-----------------|------------------|-----------------|--------------|-------------|------------|-----------------|------|-----|------------|
| 0.377250        | ---              | 38.73           | 48.34        | 9.61        | 1000.      | 9.000           | N    | FLO | 10.1       |
| 0.379500        | 49.27            | ---             | 58.29        | 9.02        | 1000.      | 9.000           | N    | FLO | 10.1       |
| 0.629250        | ---              | 35.12           | 46.00        | 10.88       | 1000.      | 9.000           | N    | FLO | 10.1       |
| 0.631500        | 46.86            | ---             | 56.00        | 9.14        | 1000.      | 9.000           | N    | FLO | 10.1       |
| 0.818250        | ---              | 34.06           | 46.00        | 11.94       | 1000.      | 9.000           | N    | FLO | 10.1       |
| 0.825000        | 42.91            | ---             | 56.00        | 13.09       | 1000.      | 9.000           | N    | GND | 10.1       |
| 1.070250        | ---              | 34.21           | 46.00        | 11.79       | 1000.      | 9.000           | N    | FLO | 10.2       |
| 1.079250        | 39.55            | ---             | 56.00        | 16.45       | 1000.      | 9.000           | N    | GND | 10.2       |
| 1.322250        | ---              | 33.84           | 46.00        | 12.16       | 1000.      | 9.000           | N    | GND | 10.2       |
| 1.333500        | 37.00            | ---             | 56.00        | 19.00       | 1000.      | 9.000           | N    | GND | 10.2       |

## 5.1.5 TEST EQUIPMENT USED

- Conducted Emissions FCC

## 5.2 RADIATED EMISSIONS

Standard **FCC Part 15 Subpart B**

**The test was performed according to:**  
ANSI C63.4

### 5.2.1 TEST DESCRIPTION

The test set-up was made in accordance to the general provisions of ANSI C63.4 in a typical installation configuration. The Equipment Under Test (EUT) was set up on a non-conductive table 1.0 x 2.0 m<sup>2</sup> in the semi-anechoic chamber. The influence of the EUT support table that is used was evaluated. For the measurement above 1 GHz an absorber field with 30 cm pyramidal absorber is placed between EUT table and antenna (required to fulfil the CISPR 16.1.4 S-VSWR criteria).

The measurement procedure is implemented into the EMI test software EMC32 from R&S.

#### 1. Measurement above 30 MHz and up to 1 GHz

##### **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 – 3 m
- Height variation step size: 2 m
- Polarisation: Horizontal + Vertical

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

##### **Step 2:** Adjustment measurement

In this step the accuracy of the turntable azimuth and antenna height will be improved. This is necessary to find out the maximum value of every frequency.

For each frequency, which was determined the turntable azimuth and antenna height will be adjusted. The turntable azimuth will slowly vary by  $\pm 45^\circ$  around this value. During this action, the value of emission is continuously measured. The turntable azimuth at the highest emission will be recorded and adjusted. In this position, the antenna height will also slowly vary by  $\pm 100$  cm around the antenna height determined. During this action, the value of emission is also continuously measured. The antenna height of the highest emission will also be recorded and adjusted.

- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range:  $\pm 45^\circ$  around the determined value
- Height variation range:  $\pm 100$  cm around the determined value

- Antenna Polarisation: max. value determined in step 1

**Step 3: Final measurement with QP detector**

With the settings determined in step 3, the final measurement will be performed:

EMI receiver settings for step 4:

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

## 2. Measurement above 1 GHz

**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 / Average (up to 7 GHz FFT-based)
- Frequency range: 1 GHz – 18 GHz
- Frequency steps: 250 kHz
- IF-Bandwidth: 1 MHz
- Measuring time / Frequency step: 100 ms (up to 7 GHz) / 500µs (above 7 GHz)
- Turntable angle range:  $-180^{\circ}$  to  $135^{\circ}$
- Turntable step size:  $45^{\circ}$
- Height variation range: 1 – 3.7 m (due to the small antenna lobe, a tilt-mast is used)
- Height variation step size: 0.9 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  $\pm 22.5^{\circ}$  around this value. During this action, the value of emission is continuously measured. The turntable azimuth at the highest emission will be recorded and adjusted. In this position, the antenna height will also slowly vary by  $\pm 45$  cm around the antenna height determined. During this action, the value of emission is also continuously measured. The antenna height of the highest emission will also be recorded and adjusted.

- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 1 MHz
- Measuring time: 100 ms
- Turntable angle range:  $\pm 22.5^{\circ}$  around the determined value
- Height variation range:  $\pm 45$  cm around the determined value
- Antenna Polarisation: max. value determined in step 1

**Step 3: Final measurement with Max-Peak / CISPR-Average detector**

With the settings determined in step 2, the final measurement will be performed:

EMI receiver settings for step 3:

- Detector: Max-Peak / CISPR-Average
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 1 MHz
- Measuring time: 200 ms

After each measurement, a report will be generated which contains a diagram with the results of the preliminary scan and a table with the frequencies, values and polarisation of the results of the final measurement.

## 5.2.2 TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart B, §15.109, Radiated Emission Limits

### Class B:

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

### Class A:

| Frequency (MHz) | Limit (µV/m) | Measurement distance (m) | Limits (dBµV/m) |
|-----------------|--------------|--------------------------|-----------------|
| 30 – 88         | 90@10m       | 3                        | 39.1@10m        |
| 88 – 216        | 150@10m      | 3                        | 43.5@10m        |
| 216 – 960       | 210@10m      | 3                        | 46.4@10m        |
| 960 - 26000     | 300@10m      | 3                        | 49.5@10m        |
| 26000 - 40000   | 300@10m      | 1                        | 49.5@10m        |

The measured values for Class A and for Class B (> 26 GHz) measurements are corrected with an inverse linear distance extrapolation factor (20 dB/decade).

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

Used conversion factor:  $\text{Limit (dBµV/m)} = 20 \log (\text{Limit (µV/m)}/1\mu\text{V/m})$

## 5.2.3 TEST PROTOCOL

Ambient temperature: 23 °C  
 Air Pressure: 999 hPa  
 Humidity: 30 %  
 Computer Peripheral Setup, AC via auxiliary equipment

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

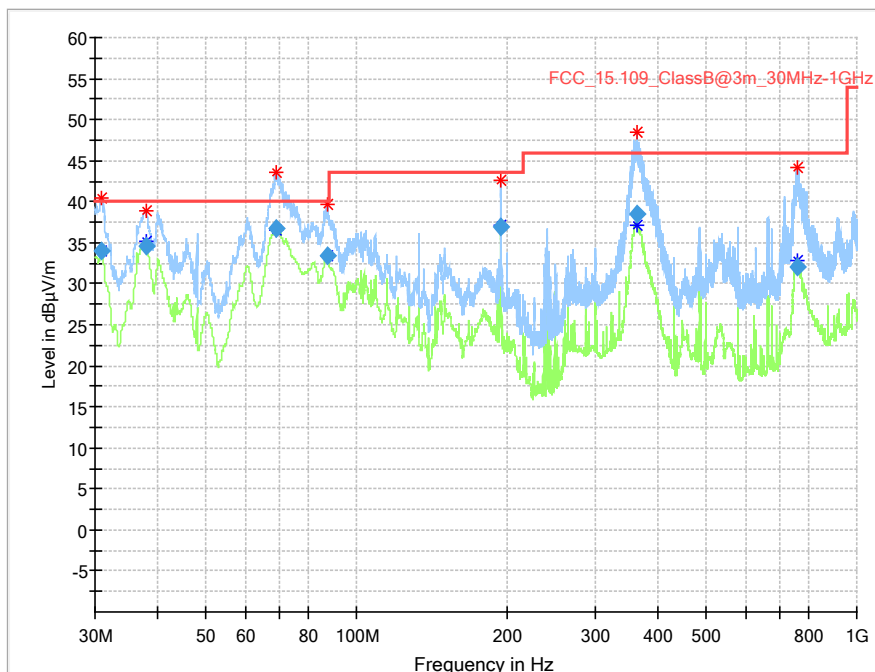
#### 5.2.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

AC mains connection = AC, Measurement range = 30 MHz - 1 GHz, Test setup = computer peripheral (S01\_AA01)

### Diagram 2.01

#### Common Information

|                       |                                                                                                |
|-----------------------|------------------------------------------------------------------------------------------------|
| Test Description:     | Radiated Emissions, Test Site: Semi Anechoic Chamber @ 4                                       |
| Test Standard:        | FCC §15.109, ANSI C63.4                                                                        |
| EUT / Setup Code:     | DE1270002aa01                                                                                  |
| Operating Conditions: | AC, LAN traffic: Detector on: RX 2.4 & 5 GHz, GPS RX;                                          |
| Operator Name:        | MER                                                                                            |
| Comment:              | computer peripheral setup, 120V/60Hz                                                           |
| Legend:               | Trace: blue = PK, green = QP; Star: red or blue = critical frequency; Rhombus: blue = final QP |



#### Final Result

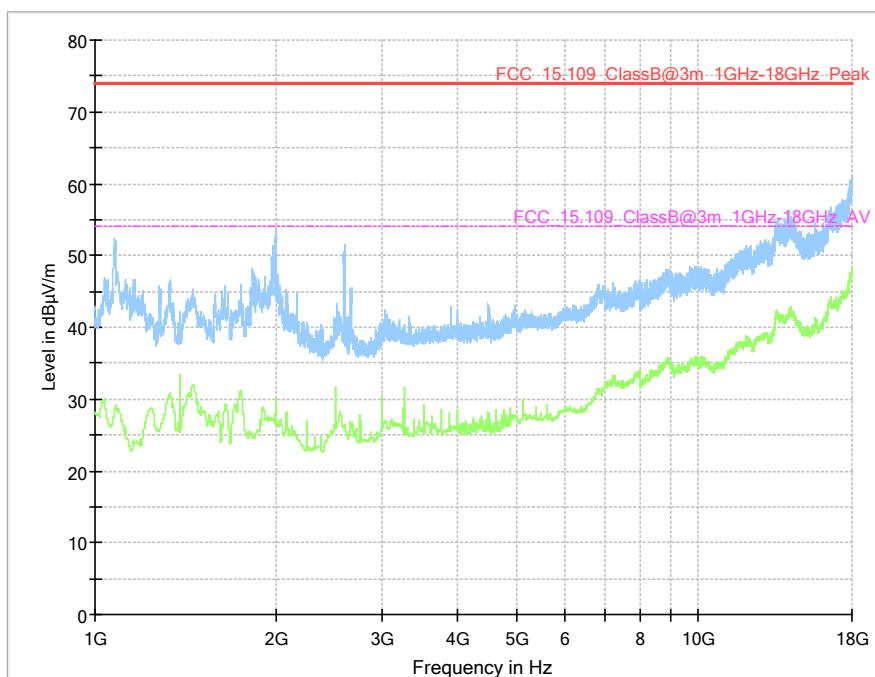
| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Measurement Time | Bandwidth (kHz) | Height (cm) | Pol | Azimuth | Comment |
|-----------------|--------------------|----------------|-------------|------------------|-----------------|-------------|-----|---------|---------|
| 30.870000       | 34.06              | 40.00          | 5.94        | 1000.            | 120.000         | 103.        | V   | -       |         |
| 37.980000       | 34.62              | 40.00          | 5.38        | 1000.            | 120.000         | 105.        | V   | -       |         |
| 69.240000       | 36.75              | 40.00          | 3.25        | 1000.            | 120.000         | 118.        | V   | 132.    |         |
| 87.210000       | 33.44              | 40.00          | 6.56        | 1000.            | 120.000         | 103.        | V   | -       |         |
| 194.07000       | 36.94              | 43.50          | 6.56        | 1000.            | 120.000         | 105.        | V   | 3.0     |         |
| 363.66000       | 38.51              | 46.00          | 7.49        | 1000.            | 120.000         | 119.        | H   | -       |         |
| 762.00000       | 32.10              | 46.00          | 13.90       | 1000.            | 120.000         | 108.        | V   | -       |         |

AC mains connection = AC, Measurement range = 1 GHz - 18 GHz, Test setup = computer peripheral (S01\_AA01)

## Diagram 2.02

### Common Information

Test Description: Radiated Emissions, Test Site: Semi Anechoic Chamber @ 4  
 Test Standard: FCC §15.109, ANSI C63.4  
 EUT / Setup Code: DE1270002aa01  
 Operating Conditions: AC, LAN traffic: Detector on: RX 2.4 & 5 GHz, GPS RX, eFDD2 idle  
 Operator Name: MER  
 Comment: computer peripheral setup, 120V/60Hz  
 Legend: Trace: blue = PK, green = CISPR AV; Star: red or blue = critical frequency; Rhombus: blue = final QP, green = final



### Final Result

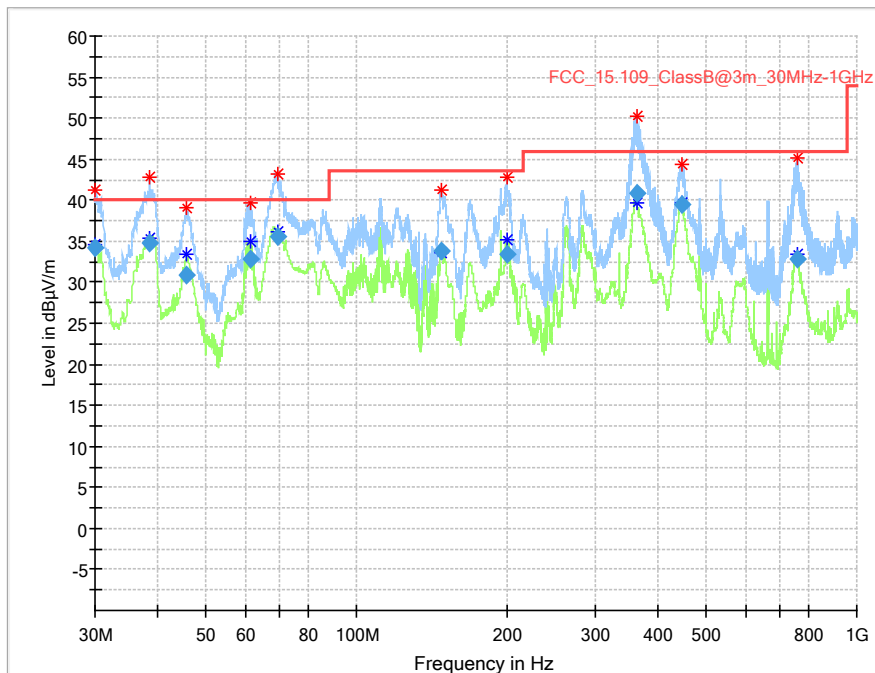
| Frequency (MHz) | MaxPeak (dBµV/m) | CAverage (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Measurement Time | Bandwidth (kHz) | Height (cm) | Pol | Azimuth |
|-----------------|------------------|-------------------|----------------|-------------|------------------|-----------------|-------------|-----|---------|
| ---             | ---              | ---               | ---            | ---         | ---              | ---             | ---         | --- | ---     |

AC mains connection = POE, Measurement range = 30 MHz - 1 GHz, Test setup = computer peripheral (S02\_AA01)

## Diagram 2.03

### Common Information

|                       |                                                                                                |
|-----------------------|------------------------------------------------------------------------------------------------|
| Test Description:     | Radiated Emissions, Test Site: Semi Anechoic Chamber @ 4                                       |
| Test Standard:        | FCC §15.109, ANSI C63.4                                                                        |
| EUT / Setup Code:     | DE1270002aa01                                                                                  |
| Operating Conditions: | PoE, LAN traffic: Detector on: RX 2.4 & 5 GHz, GPS RX;                                         |
| Operator Name:        | MER                                                                                            |
| Comment:              | computer peripheral, 120V/60Hz                                                                 |
| Legend:               | Trace: blue = PK, green = QP; Star: red or blue = critical frequency; Rhombus: blue = final QP |



### Final Result

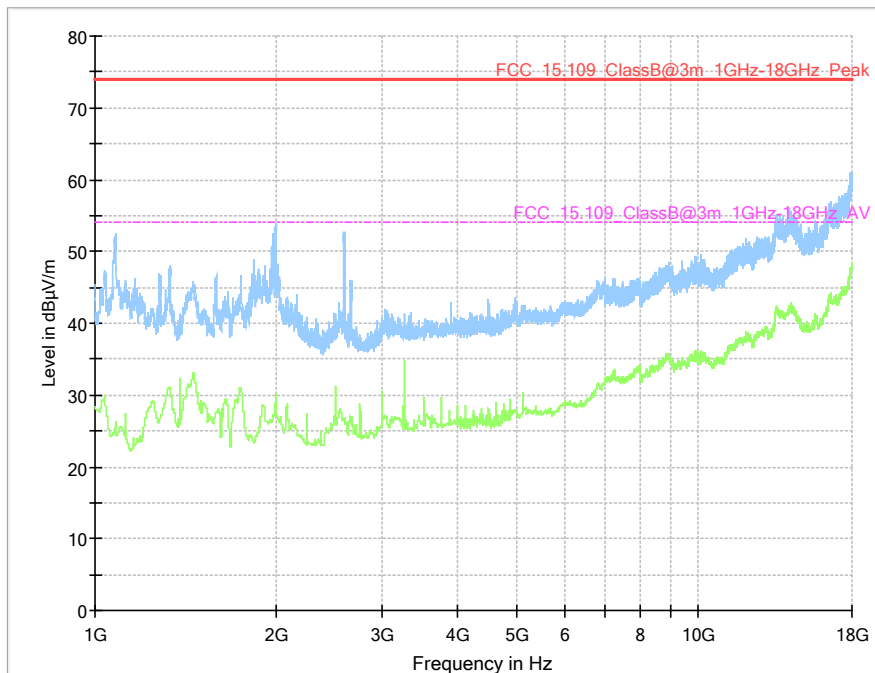
| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Measurement Time | Bandwidth (kHz) | Height (cm) | Pol | Azimuth | Comment |
|-----------------|--------------------|----------------|-------------|------------------|-----------------|-------------|-----|---------|---------|
| 30.090000       | 34.21              | 40.00          | 5.79        | 1000.            | 120.000         | 106.        | V   | -       |         |
| 38.580000       | 34.68              | 40.00          | 5.32        | 1000.            | 120.000         | 104.        | V   | -       |         |
| 45.780000       | 30.93              | 40.00          | 9.07        | 1000.            | 120.000         | 137.        | V   | 9.0     |         |
| 61.260000       | 32.79              | 40.00          | 7.21        | 1000.            | 120.000         | 169.        | V   | -       |         |
| 69.480000       | 35.60              | 40.00          | 4.40        | 1000.            | 120.000         | 172.        | V   | -       |         |
| 148.08000       | 33.71              | 43.50          | 9.79        | 1000.            | 120.000         | 103.        | V   | -       |         |
| 199.74000       | 33.47              | 43.50          | 10.03       | 1000.            | 120.000         | 109.        | V   | -       |         |
| 363.30000       | 40.76              | 46.00          | 5.24        | 1000.            | 120.000         | 103.        | H   | -       |         |
| 446.34000       | 39.50              | 46.00          | 6.50        | 1000.            | 120.000         | 110.        | V   | -       |         |
| 760.02000       | 32.87              | 46.00          | 13.13       | 1000.            | 120.000         | 108.        | V   | -       |         |

AC mains connection = AC, Measurement range = 1 GHz - 18 GHz, Test setup = computer peripheral (S02\_AA01)

## Diagram 2.04

### Common Information

|                       |                                                                                                                     |
|-----------------------|---------------------------------------------------------------------------------------------------------------------|
| Test Description:     | Radiated Emissions, Test Site: Semi Anechoic Chamber @ 4                                                            |
| Test Standard:        | FCC §15.109, ANSI C63.4                                                                                             |
| EUT / Setup Code:     | DE1270002aa01                                                                                                       |
| Operating Conditions: | PoE, LAN traffic: Detector on: RX 2.4 & 5 GHz, GPS RX;                                                              |
| Operator Name:        | MER                                                                                                                 |
| Comment:              | computer peripheral setup                                                                                           |
| Legend:               | Trace: blue = PK, green = CISPR AV; Star: red or blue = critical frequency; Rhombus: blue = final QP, green = final |



### Final\_Result

| Frequency (MHz) | MaxPeak (dBµV / m) | CAverage (dBµV / m) | Limit (dBµV / m) | Margin (dB) | Measurement Time | Bandwidth (kHz) | Height (cm) | Pol | Azimuth | Comment |
|-----------------|--------------------|---------------------|------------------|-------------|------------------|-----------------|-------------|-----|---------|---------|
| ---             | ---                | ---                 | ---              | ---         | ---              | ---             | ---         | --- | ---     | ---     |

### 5.2.5 TEST EQUIPMENT USED

- Radiated Emissions

## 6 TEST EQUIPMENT

- 1 Conducted Emissions FCC  
Conducted Emissions power line for FCC standards

| Ref.No. | Device Name          | Description                                   | Manufacturer                      | Serial Number | Last Calibration | Calibration Due |
|---------|----------------------|-----------------------------------------------|-----------------------------------|---------------|------------------|-----------------|
| 1.1     | Opus10 TPR (8253.00) | ThermoAirpressure Datalogger 13 (Environ)     | Lufft Mess- und Regeltechnik GmbH | 13936         | 2017-04          | 2019-04         |
| 1.2     | Fluke 177            | Digital Multimeter 03 (Multimeter)            | Fluke Europe B.V.                 | 86670383      | 2018-04          | 2020-04         |
| 1.3     | ESH3-Z5              | Two-Line V-Network                            | Rohde & Schwarz                   | 828304/029    | 2017-05          | 2019-05         |
| 1.4     | EP 1200/B, NA/B1     | Amplifier with integrated variable Oscillator | Spitzenberger & Spieß             | B6278         |                  |                 |
| 1.5     | Chroma 6404          | AC Power Source                               | Chroma ATE INC.                   | 64040001304   |                  |                 |
| 1.6     | Shielded Room 02     | Shielded Room for conducted testing, 12qm     | Frankonia                         | -             |                  |                 |
| 1.7     | ESH3-Z5              | Two-Line V-Network                            | Rohde & Schwarz                   | 829996/002    | 2017-05          | 2019-05         |
| 1.8     | ESR 7                | EMI Receiver / Spectrum Analyzer              | Rohde & Schwarz                   | 101424        | 2019-01          | 2020-01         |
| 1.9     | Opus10 THI (8152.00) | ThermoHygro Datalogger 02 (Environ)           | Lufft Mess- und Regeltechnik GmbH | 7489          | 2017-04          | 2019-04         |

- 2 Radiated Emissions  
Lab to perform radiated emission tests

| Ref.No. | Device Name          | Description                               | Manufacturer                       | Serial Number | Last Calibration | Calibration Due |
|---------|----------------------|-------------------------------------------|------------------------------------|---------------|------------------|-----------------|
| 2.1     | NRV-Z1               | Sensor Head A                             | Rohde & Schwarz GmbH & Co. KG      | 827753/005    | 2018-07          | 2019-07         |
| 2.2     | MFS                  | Rubidium Frequency Normal MFS             | Datum GmbH                         | 002           | 2018-10          | 2020-10         |
| 2.3     | Opus10 TPR (8253.00) | ThermoAirpressure Datalogger 13 (Environ) | Lufft Mess- und Regeltechnik GmbH  | 13936         | 2017-04          | 2019-04         |
| 2.4     | ESW44                | EMI Test Receiver                         | Rohde & Schwarz GmbH & Co. KG      | 101603        | 2018-05          | 2019-05         |
| 2.5     | Anechoic Chamber     | 10.58 x 6.38 x 6.00 m <sup>3</sup>        | Frankonia                          | none          | 2018-06          | 2020-06         |
| 2.6     | FS-Z60               | Harmonic Mixer 40 - 60 GHz                | Rohde & Schwarz Messgerätebau GmbH | 100178        | 2016-12          | 2019-12         |
| 2.7     | FS-Z220              | Harmonic Mixer 140 - 220 GHz              | Rohde & Schwarz Messgerätebau GmbH | 101005        | 2017-03          | 2020-03         |

| Ref.No. | Device Name          | Description                                            | Manufacturer                       | Serial Number      | Last Calibration | Calibration Due |
|---------|----------------------|--------------------------------------------------------|------------------------------------|--------------------|------------------|-----------------|
| 2.8     | SGH-05               | Standard Gain / Pyramidal Horn Antenna (140 - 220 GHz) | RPG-Radiometer Physics GmbH        | 075                |                  |                 |
| 2.9     | HL 562               | Ultralog new biconicals                                | Rohde & Schwarz                    | 830547/003         | 2018-07          | 2021-07         |
| 2.10    | 5HC2700/12750-1.5-KK | High Pass Filter                                       | Trilithic                          | 9942012            |                  |                 |
| 2.11    | ASP 1.2/1.8-10 kg    | Antenna Mast                                           | Maturo GmbH                        | -                  |                  |                 |
| 2.12    | Fully Anechoic Room  | 8.80m x 4.60m x 4.05m (l x w x h)                      | Albatross Projects                 | P26971-647-001-PRB | 2018-06          | 2020-06         |
| 2.13    | Fluke 177            | Digital Multimeter 03 (Multimeter)                     | Fluke Europe B.V.                  | 86670383           | 2018-04          | 2020-04         |
| 2.14    | NRVD                 | Power Meter                                            | Rohde & Schwarz GmbH & Co. KG      | 828110/016         | 2018-07          | 2019-07         |
| 2.15    | HF 906               | Double-ridged horn                                     | Rohde & Schwarz                    | 357357/002         | 2018-09          | 2021-09         |
| 2.16    | JS4-18002600-32-5P   | Broadband Amplifier 18 GHz - 26 GHz                    | Miteq                              | 849785             |                  |                 |
| 2.17    | FSW 43               | Spectrum Analyzer                                      | Rohde & Schwarz                    | 103779             |                  |                 |
| 2.18    | 3160-09              | Standard Gain / Pyramidal Horn Antenna 26.5 GHz        | EMCO Elektronik GmbH               | 00083069           |                  |                 |
| 2.19    | SGH-19               | Standard Gain / Pyramidal Horn Antenna (40 - 60 GHz)   | RPG-Radiometer Physics GmbH        | 093                |                  |                 |
| 2.20    | WHKX 7.0/18G-8SS     | High Pass Filter                                       | Wainwright                         | 09                 |                  |                 |
| 2.21    | 4HC1600/12750-1.5-KK | High Pass Filter                                       | Trilithic                          | 9942011            |                  |                 |
| 2.22    | Chroma 6404          | AC Power Source                                        | Chroma ATE INC.                    | 64040001304        |                  |                 |
| 2.23    | JS4-00102600-42-5A   | Broadband Amplifier 30 MHz - 26 GHz                    | Miteq                              | 619368             |                  |                 |
| 2.24    | TT 1.5 WI            | Turn Table                                             | Maturo GmbH                        | -                  |                  |                 |
| 2.25    | HL 562 Ultralog      | Log.-per. Antenna                                      | Rohde & Schwarz                    | 100609             | 2016-04          | 2019-04         |
| 2.26    | HF 906               | Double-ridged horn                                     | Rohde & Schwarz                    | 357357/001         | 2018-03          | 2021-03         |
| 2.27    | FS-Z325              | Harmonic Mixer 220 - 325 GHz                           | Rohde & Schwarz Messgerätebau GmbH | 101006             | 2017-03          | 2020-03         |
| 2.28    | 3160-10              | Standard Gain / Pyramidal Horn Antenna 40 GHz          | EMCO Elektronik GmbH               | 00086675           |                  |                 |

| Ref.No. | Device Name                   | Description                                            | Manufacturer                       | Serial Number          | Last Calibration | Calibration Due |
|---------|-------------------------------|--------------------------------------------------------|------------------------------------|------------------------|------------------|-----------------|
| 2.29    | SGH-08                        | Standard Gain / Pyramidal Horn Antenna (90 - 140 GHz)  | RPG-Radiometer Physics GmbH        | 064                    |                  |                 |
| 2.30    | SGH-12                        | Standard Gain / Pyramidal HornAntenna (60 - 90 GHz)    | RPG-Radiometer Physics GmbH        | 326                    |                  |                 |
| 2.31    | 5HC3500/18000-1.2-KK          | High Pass Filter                                       | Trilithic                          | 200035008              |                  |                 |
| 2.32    | FS-Z140                       | Harmonic Mixer 90 -140 GHz                             | Rohde & Schwarz Messgerätebau GmbH | 101007                 | 2017-02          | 2020-02         |
| 2.33    | HFH2-Z2                       | Loop Antenna                                           | Rohde & Schwarz                    | 829324/006             | 2018-01          | 2021-01         |
| 2.34    | Opus10 THI (8152.00)          | ThermoHygro Datalogger 12 (Environ)                    | Lufft Mess- und Regeltechnik GmbH  | 12482                  | 2017-03          | 2019-03         |
| 2.35    | ESR 7                         | EMI Receiver / Spectrum Analyzer                       | Rohde & Schwarz                    | 101424                 | 2019-01          | 2020-01         |
| 2.36    | JS4-00101800-35-5P            | Broadband Amplifier 30 MHz - 18 GHz                    | Miteq                              | 896037                 |                  |                 |
| 2.37    | AS 620 P                      | Antenna mast                                           | HD GmbH                            | 620/37                 |                  |                 |
| 2.38    | Tilt device Maturo (Rohacell) | Antrieb TD1.5-10kg                                     | Maturo GmbH                        | TD1.5-10kg/024/3790709 |                  |                 |
| 2.39    | SGH-03                        | Standard Gain / Pyramidal Horn Antenna (220 - 325 GHz) | RPG-Radiometer Physics GmbH        | 060                    |                  |                 |
| 2.40    | FS-Z90                        | Harmonic Mixer 60 - 90 GHz                             | Rohde & Schwarz Messgerätebau GmbH | 101686                 | 2017-03          | 2020-03         |
| 2.41    | ESIB 26                       | Spectrum Analyzer                                      | Rohde & Schwarz                    | 830482/004             | 2018-01          | 2020-01         |
| 2.42    | PAS 2.5 - 10 kg               | Antenna Mast                                           | Maturo GmbH                        | -                      |                  |                 |
| 2.43    | AFS42-00101800-25-S-42        | Broadband Amplifier 25 MHz - 18 GHz                    | Miteq                              | 2035324                |                  |                 |
| 2.44    | AM 4.0                        | Antenna mast                                           | Maturo GmbH                        | AM4.0/180/11920513     |                  |                 |
| 2.45    | HF 907                        | Double-ridged horn                                     | Rohde & Schwarz                    | 102444                 | 2018-07          | 2021-07         |

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

## 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<br>insertion<br>loss<br>ESH3-<br>Z5 | cable<br>loss<br>(incl. 10<br>dB<br>atten-<br>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

$$U_{\text{LISN}} (\text{dB } \mu\text{V}) = U (\text{dB } \mu\text{V}) + \text{Corr. (dB)}$$

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       | Corr. | cable loss 1     | cable loss 2      | cable loss 3  | cable loss 4  | distance corr.  | d <sub>Limit</sub>       | d <sub>used</sub>       |
|-----------|----------|-------|------------------|-------------------|---------------|---------------|-----------------|--------------------------|-------------------------|
| MHz       | dB (1/m) | dB    | (inside chamber) | (outside chamber) | (switch unit) | (to receiver) | (-40 dB/decade) | (meas. distance (limit)) | (meas. distance (used)) |
|           |          |       | 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

$E \text{ (dB } \mu\text{V/m)} = U \text{ (dB } \mu\text{V)} + AF \text{ (dB 1/m)} + Corr. \text{ (dB)}$

U = Receiver reading

AF = Antenna factor

Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)

distance correction =  $-40 * \text{LOG} (d_{\text{Limit}} / d_{\text{used}})$

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)

( $d_{\text{Limit}} = 3 \text{ m}$ )

| Frequency | AF<br>R&S<br>HL562 | Corr. |
|-----------|--------------------|-------|
| MHz       | dB (1/m)           | dB    |
| 30        | 18.6               | 0.6   |
| 50        | 6.0                | 0.9   |
| 100       | 9.7                | 1.2   |
| 150       | 7.9                | 1.6   |
| 200       | 7.6                | 1.9   |
| 250       | 9.5                | 2.1   |
| 300       | 11.0               | 2.3   |
| 350       | 12.4               | 2.6   |
| 400       | 13.6               | 2.9   |
| 450       | 14.7               | 3.1   |
| 500       | 15.6               | 3.2   |
| 550       | 16.3               | 3.5   |
| 600       | 17.2               | 3.5   |
| 650       | 18.1               | 3.6   |
| 700       | 18.5               | 3.6   |
| 750       | 19.1               | 4.1   |
| 800       | 19.6               | 4.1   |
| 850       | 20.1               | 4.4   |
| 900       | 20.8               | 4.7   |
| 950       | 21.1               | 4.8   |
| 1000      | 21.6               | 4.9   |

| cable<br>loss 1<br>(inside<br>chamber) | cable<br>loss 2<br>(outside<br>chamber) | cable<br>loss 3<br>(switch<br>unit) | cable<br>loss 4<br>(to<br>receiver) | distance<br>corr.<br>(-20 dB/<br>decade) | $d_{\text{Limit}}$<br>(meas.<br>distance<br>(limit)) | $d_{\text{used}}$<br>(meas.<br>distance<br>(used)) |
|----------------------------------------|-----------------------------------------|-------------------------------------|-------------------------------------|------------------------------------------|------------------------------------------------------|----------------------------------------------------|
| dB                                     | dB                                      | dB                                  | dB                                  | dB                                       | m                                                    | m                                                  |
| 0.29                                   | 0.04                                    | 0.23                                | 0.02                                | 0.0                                      | 3                                                    | 3                                                  |
| 0.39                                   | 0.09                                    | 0.32                                | 0.08                                | 0.0                                      | 3                                                    | 3                                                  |
| 0.56                                   | 0.14                                    | 0.47                                | 0.08                                | 0.0                                      | 3                                                    | 3                                                  |
| 0.73                                   | 0.20                                    | 0.59                                | 0.12                                | 0.0                                      | 3                                                    | 3                                                  |
| 0.84                                   | 0.21                                    | 0.70                                | 0.11                                | 0.0                                      | 3                                                    | 3                                                  |
| 0.98                                   | 0.24                                    | 0.80                                | 0.13                                | 0.0                                      | 3                                                    | 3                                                  |
| 1.04                                   | 0.26                                    | 0.89                                | 0.15                                | 0.0                                      | 3                                                    | 3                                                  |
| 1.18                                   | 0.31                                    | 0.96                                | 0.13                                | 0.0                                      | 3                                                    | 3                                                  |
| 1.28                                   | 0.35                                    | 1.03                                | 0.19                                | 0.0                                      | 3                                                    | 3                                                  |
| 1.39                                   | 0.38                                    | 1.11                                | 0.22                                | 0.0                                      | 3                                                    | 3                                                  |
| 1.44                                   | 0.39                                    | 1.20                                | 0.19                                | 0.0                                      | 3                                                    | 3                                                  |
| 1.55                                   | 0.46                                    | 1.24                                | 0.23                                | 0.0                                      | 3                                                    | 3                                                  |
| 1.59                                   | 0.43                                    | 1.29                                | 0.23                                | 0.0                                      | 3                                                    | 3                                                  |
| 1.67                                   | 0.34                                    | 1.35                                | 0.22                                | 0.0                                      | 3                                                    | 3                                                  |
| 1.67                                   | 0.42                                    | 1.41                                | 0.15                                | 0.0                                      | 3                                                    | 3                                                  |
| 1.87                                   | 0.54                                    | 1.46                                | 0.25                                | 0.0                                      | 3                                                    | 3                                                  |
| 1.90                                   | 0.46                                    | 1.51                                | 0.25                                | 0.0                                      | 3                                                    | 3                                                  |
| 1.99                                   | 0.60                                    | 1.56                                | 0.27                                | 0.0                                      | 3                                                    | 3                                                  |
| 2.14                                   | 0.60                                    | 1.63                                | 0.29                                | 0.0                                      | 3                                                    | 3                                                  |
| 2.22                                   | 0.60                                    | 1.66                                | 0.33                                | 0.0                                      | 3                                                    | 3                                                  |
| 2.23                                   | 0.61                                    | 1.71                                | 0.30                                | 0.0                                      | 3                                                    | 3                                                  |

( $d_{\text{Limit}} = 10 \text{ m}$ )

|      |      |      |
|------|------|------|
| 30   | 18.6 | -9.9 |
| 50   | 6.0  | -9.6 |
| 100  | 9.7  | -9.2 |
| 150  | 7.9  | -8.8 |
| 200  | 7.6  | -8.6 |
| 250  | 9.5  | -8.3 |
| 300  | 11.0 | -8.1 |
| 350  | 12.4 | -7.9 |
| 400  | 13.6 | -7.6 |
| 450  | 14.7 | -7.4 |
| 500  | 15.6 | -7.2 |
| 550  | 16.3 | -7.0 |
| 600  | 17.2 | -6.9 |
| 650  | 18.1 | -6.9 |
| 700  | 18.5 | -6.8 |
| 750  | 19.1 | -6.3 |
| 800  | 19.6 | -6.3 |
| 850  | 20.1 | -6.0 |
| 900  | 20.8 | -5.8 |
| 950  | 21.1 | -5.6 |
| 1000 | 21.6 | -5.6 |

|      |      |      |      |       |    |   |
|------|------|------|------|-------|----|---|
| 0.29 | 0.04 | 0.23 | 0.02 | -10.5 | 10 | 3 |
| 0.39 | 0.09 | 0.32 | 0.08 | -10.5 | 10 | 3 |
| 0.56 | 0.14 | 0.47 | 0.08 | -10.5 | 10 | 3 |
| 0.73 | 0.20 | 0.59 | 0.12 | -10.5 | 10 | 3 |
| 0.84 | 0.21 | 0.70 | 0.11 | -10.5 | 10 | 3 |
| 0.98 | 0.24 | 0.80 | 0.13 | -10.5 | 10 | 3 |
| 1.04 | 0.26 | 0.89 | 0.15 | -10.5 | 10 | 3 |
| 1.18 | 0.31 | 0.96 | 0.13 | -10.5 | 10 | 3 |
| 1.28 | 0.35 | 1.03 | 0.19 | -10.5 | 10 | 3 |
| 1.39 | 0.38 | 1.11 | 0.22 | -10.5 | 10 | 3 |
| 1.44 | 0.39 | 1.20 | 0.19 | -10.5 | 10 | 3 |
| 1.55 | 0.46 | 1.24 | 0.23 | -10.5 | 10 | 3 |
| 1.59 | 0.43 | 1.29 | 0.23 | -10.5 | 10 | 3 |
| 1.67 | 0.34 | 1.35 | 0.22 | -10.5 | 10 | 3 |
| 1.67 | 0.42 | 1.41 | 0.15 | -10.5 | 10 | 3 |
| 1.87 | 0.54 | 1.46 | 0.25 | -10.5 | 10 | 3 |
| 1.90 | 0.46 | 1.51 | 0.25 | -10.5 | 10 | 3 |
| 1.99 | 0.60 | 1.56 | 0.27 | -10.5 | 10 | 3 |
| 2.14 | 0.60 | 1.63 | 0.29 | -10.5 | 10 | 3 |
| 2.22 | 0.60 | 1.66 | 0.33 | -10.5 | 10 | 3 |
| 2.23 | 0.61 | 1.71 | 0.30 | -10.5 | 10 | 3 |

#### Sample calculation

$E \text{ (dB } \mu\text{V/m)} = U \text{ (dB } \mu\text{V)} + \text{AF (dB 1/m)} + \text{Corr. (dB)}$

U = Receiver reading

AF = Antenna factor

Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)

distance correction =  $-20 * \text{LOG} (d_{\text{Limit}} / d_{\text{used}})$

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<br>R&S<br>HF907 | Corr. |
|-----------|--------------------|-------|
| MHz       | dB (1/m)           | dB    |
| 1000      | 24.4               | -19.4 |
| 2000      | 28.5               | -17.4 |
| 3000      | 31.0               | -16.1 |
| 4000      | 33.1               | -14.7 |
| 5000      | 34.4               | -13.7 |
| 6000      | 34.7               | -12.7 |
| 7000      | 35.6               | -11.0 |

| cable<br>loss 1<br>(relay +<br>cable<br>inside<br>chamber) | cable<br>loss 2<br>(outside<br>chamber) | cable<br>loss 3<br>(switch<br>unit,<br>atten-<br>uator &<br>pre-amp) | cable<br>loss 4 (to<br>receiver) |  |  |
|------------------------------------------------------------|-----------------------------------------|----------------------------------------------------------------------|----------------------------------|--|--|
| dB                                                         | dB                                      | dB                                                                   | dB                               |  |  |
| 0.99                                                       | 0.31                                    | -21.51                                                               | 0.79                             |  |  |
| 1.44                                                       | 0.44                                    | -20.63                                                               | 1.38                             |  |  |
| 1.87                                                       | 0.53                                    | -19.85                                                               | 1.33                             |  |  |
| 2.41                                                       | 0.67                                    | -19.13                                                               | 1.31                             |  |  |
| 2.78                                                       | 0.86                                    | -18.71                                                               | 1.40                             |  |  |
| 2.74                                                       | 0.90                                    | -17.83                                                               | 1.47                             |  |  |
| 2.82                                                       | 0.86                                    | -16.19                                                               | 1.46                             |  |  |

| Frequency | AF<br>R&S<br>HF907 | Corr. |
|-----------|--------------------|-------|
| MHz       | dB (1/m)           | dB    |
| 3000      | 31.0               | -23.4 |
| 4000      | 33.1               | -23.3 |
| 5000      | 34.4               | -21.7 |
| 6000      | 34.7               | -21.2 |
| 7000      | 35.6               | -19.8 |

| cable<br>loss 1<br>(relay<br>inside<br>chamber) | cable<br>loss 2<br>(inside<br>chamber) | cable<br>loss 3<br>(outside<br>chamber) | cable<br>loss 4<br>(switch<br>unit,<br>atten-<br>uator &<br>pre-amp) | cable<br>loss 5 (to<br>receiver) | used<br>for<br>FCC<br>15.247 |
|-------------------------------------------------|----------------------------------------|-----------------------------------------|----------------------------------------------------------------------|----------------------------------|------------------------------|
| dB                                              | dB                                     | dB                                      | dB                                                                   | dB                               |                              |
| 0.47                                            | 1.87                                   | 0.53                                    | -27.58                                                               | 1.33                             |                              |
| 0.56                                            | 2.41                                   | 0.67                                    | -28.23                                                               | 1.31                             |                              |
| 0.61                                            | 2.78                                   | 0.86                                    | -27.35                                                               | 1.40                             |                              |
| 0.58                                            | 2.74                                   | 0.90                                    | -26.89                                                               | 1.47                             |                              |
| 0.66                                            | 2.82                                   | 0.86                                    | -25.58                                                               | 1.46                             |                              |

| Frequency | AF<br>R&S<br>HF907 | Corr. |
|-----------|--------------------|-------|
| MHz       | dB (1/m)           | dB    |
| 7000      | 35.6               | -57.3 |
| 8000      | 36.3               | -56.3 |
| 9000      | 37.1               | -55.3 |
| 10000     | 37.5               | -56.2 |
| 11000     | 37.5               | -55.3 |
| 12000     | 37.6               | -53.7 |
| 13000     | 38.2               | -53.5 |
| 14000     | 39.9               | -56.3 |
| 15000     | 40.9               | -54.1 |
| 16000     | 41.3               | -54.1 |
| 17000     | 42.8               | -54.4 |
| 18000     | 44.2               | -54.7 |

| cable<br>loss 1<br>(relay<br>inside<br>chamber) | cable<br>loss 2<br>(High<br>Pass) | cable<br>loss 3<br>(pre-<br>amp) | cable<br>loss 4<br>(inside<br>chamber) | cable<br>loss 5<br>(outside<br>chamber) | cable<br>loss 6<br>(to<br>receiver) |
|-------------------------------------------------|-----------------------------------|----------------------------------|----------------------------------------|-----------------------------------------|-------------------------------------|
| dB                                              | dB                                | dB                               | dB                                     | dB                                      | dB                                  |
| 0.56                                            | 1.28                              | -62.72                           | 2.66                                   | 0.94                                    | 1.46                                |
| 0.69                                            | 0.71                              | -61.49                           | 2.84                                   | 1.00                                    | 1.53                                |
| 0.68                                            | 0.65                              | -60.80                           | 3.06                                   | 1.09                                    | 1.60                                |
| 0.70                                            | 0.54                              | -61.91                           | 3.28                                   | 1.20                                    | 1.67                                |
| 0.80                                            | 0.61                              | -61.40                           | 3.43                                   | 1.27                                    | 1.70                                |
| 0.84                                            | 0.42                              | -59.70                           | 3.53                                   | 1.26                                    | 1.73                                |
| 0.83                                            | 0.44                              | -59.81                           | 3.75                                   | 1.32                                    | 1.83                                |
| 0.91                                            | 0.53                              | -63.03                           | 3.91                                   | 1.40                                    | 1.77                                |
| 0.98                                            | 0.54                              | -61.05                           | 4.02                                   | 1.44                                    | 1.83                                |
| 1.23                                            | 0.49                              | -61.51                           | 4.17                                   | 1.51                                    | 1.85                                |
| 1.36                                            | 0.76                              | -62.36                           | 4.34                                   | 1.53                                    | 2.00                                |
| 1.70                                            | 0.53                              | -62.88                           | 4.41                                   | 1.55                                    | 1.91                                |

### Sample calculation

$E \text{ (dB } \mu\text{V/m)} = U \text{ (dB } \mu\text{V)} + \text{AF (dB 1/m)} + \text{Corr. (dB)}$

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<br>EMCO<br>3160-09 | Corr. | cable<br>loss 1<br>(inside<br>chamber) | cable<br>loss 2<br>(pre-<br>amp) | cable<br>loss 3<br>(inside<br>chamber) | cable<br>loss 4<br>(switch<br>unit) | cable<br>loss 5<br>(to<br>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

$E \text{ (dB } \mu\text{V/m)} = U \text{ (dB } \mu\text{V)} + AF \text{ (dB 1/m)} + Corr. \text{ (dB)}$

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<br>GHz | AF<br>EMCO<br>3160-10<br>dB (1/m) | Corr.<br>dB | cable<br>loss 1<br>(inside<br>chamber)<br>dB | cable<br>loss 2<br>(outside<br>chamber)<br>dB | cable<br>loss 3<br>(switch<br>unit)<br>dB | cable<br>loss 4<br>(to<br>receiver)<br>dB | distance<br>corr.<br>(-20 dB/<br>decade)<br>dB | d <sub>Limit</sub><br>(meas.<br>distance<br>(limit)<br>m | d <sub>used</sub><br>(meas.<br>distance<br>(used)<br>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

$E \text{ (dB } \mu\text{V/m)} = U \text{ (dB } \mu\text{V)} + AF \text{ (dB 1/m)} + Corr. \text{ (dB)}$

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.

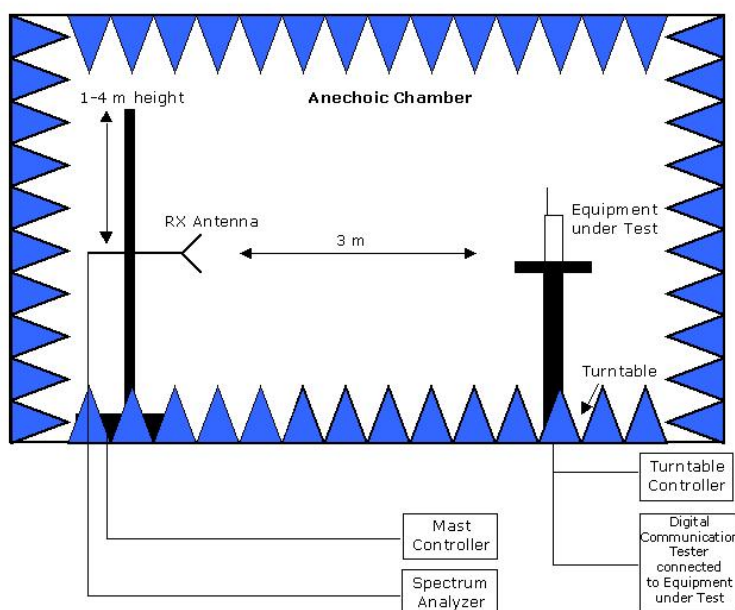
distance correction =  $-20 * \text{LOG} (d_{\text{Limit}} / d_{\text{used}})$

Linear interpolation will be used for frequencies in between the values in the table.

Table shows an extract of values.

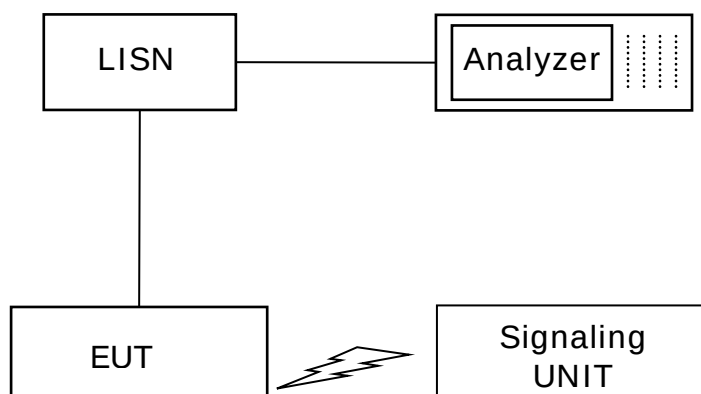
## 8 SETUP DRAWINGS

### Setup Drawings



Remark: Depending on the frequency range suitable antenna types, attenuators or preamplifiers are used.

Setup in the Anechoic chamber. For measurements below 1 GHz the ground was replaced by a conducting ground plane.



Setup in the shielded room for conducted measurements at AC mains port

## 9 MEASUREMENT UNCERTAINTIES

| Test Case                       | Parameter      | Uncertainty  |
|---------------------------------|----------------|--------------|
| Conducted Emissions at AC mains | Voltage        | $\pm 3.4$ dB |
| Radiated Emissions              | Field Strength | $\pm 5.5$ dB |

## 10 PHOTO REPORT

Please see separate photo report.