

# FCC Measurement/Technical Report on TOBY-L201 LTE/3G data only module

FCC ID: XPYTOBYL201  
IC: 8595A-TOBYL201

**Test Report Reference:** MDE\_UBLOX\_2015\_FCC\_01

**Test Laboratory:**

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Germany



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

**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

#### **Type of Authorization**

Certification for a cellular mobile device.

#### **Applicable FCC Rules**

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2 and 27, (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 27; Miscellaneous Wireless Communications Services  
Subpart C – Technical standards

§ 27.50 – Power and duty cycle limits

§ 27.53 – Emission limits

§ 27.54 – Frequency stability

The tests were selected and performed with reference to:

- FCC Public Notice 971168 applying "Measurement guidance for certification of licensed digital transmitters" 971168 D01 v03r01, 2018-04-09
- ANSI C63.26: 2015

## 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 Cellular Mobile Devices from FCC and ISED Canada

#### FCC Part 27

| Measurement                            | FCC reference       | ISED reference                                                                                        |
|----------------------------------------|---------------------|-------------------------------------------------------------------------------------------------------|
| RF Output Power                        | § 2.1046<br>§ 27.50 | RSS-GEN Issue 5, 6.12<br>RSS-130 Issue 2, 4.6.2/4.6.3<br>RSS-139 Issue 3, 6.5<br>RSS-199 Issue 3, 4.4 |
| Peak to Average-Ratio                  | § 27.50             | RSS-130 Issue 2: 4.6.1<br>RSS 139 Issue 3: 6.5<br>RSS-199 Issue 3, 4.4                                |
| Emission and Occupied bandwidth        | § 2.1049            | RSS-GEN Issue 5, 6.7                                                                                  |
| Spurious Emission at Antenna Terminals | § 2.1051<br>§ 27.53 | RSS-GEN Issue 5, 6.13<br>RSS-130 Issue 2: 4.7.1/4.7.2<br>RSS-139 Issue 3, 6.6<br>RSS-199 Issue 3, 4.5 |
| Band Edge Compliance                   | § 2.1051<br>§ 27.53 | RSS-GEN Issue 5, 6.13<br>RSS-130 Issue 2: 4.7.1/4.7.2<br>RSS-139 Issue 3, 6.6<br>RSS-199 Issue 3, 4.5 |
| Frequency stability                    | § 2.1055<br>§ 27.54 | RSS-GEN Issue 5, 6.11<br>RSS-130 Issue 2: 4.5<br>RSS-139 Issue 3: 6.4<br>RSS-199 Issue 3, 4.3         |
| Field strength of spurious radiation   | § 2.1053<br>§ 27.53 | RSS-GEN Issue 5, 6.13<br>RSS-130 Issue 2: 4.7.1/4.7.2<br>RSS-139 Issue 3: 6.6<br>RSS-199 Issue 3, 4.5 |

### 1.3 MEASUREMENT SUMMARY / SIGNATURES

#### 47 CFR CHAPTER I FCC PART 27

#### § 2.1046 § 27.50

##### Subpart C

RF Output Power

The measurement was performed according to ANSI C63.26: 2015

#### Final Result

| OP-Mode                                                                                       | Setup    | Date       | FCC    | IC     |
|-----------------------------------------------------------------------------------------------|----------|------------|--------|--------|
| Technology, Radio Technology, Operating Frequency, ChBW, Ressource Blocks, Measurement method |          |            |        |        |
| EUTRA, eFDD 13 16QAM, high channel, 5 MHz, 1, conducted                                       | S01_ZZ04 | 2020-08-05 | Passed | Passed |
| EUTRA, eFDD 13 16QAM, high channel, 5 MHz, 5, conducted                                       | S01_ZZ04 | 2020-08-05 | Passed | Passed |
| EUTRA, eFDD 13 16QAM, low channel, 5 MHz, 1, conducted                                        | S01_ZZ04 | 2020-08-05 | Passed | Passed |
| EUTRA, eFDD 13 16QAM, low channel, 5 MHz, 5, conducted                                        | S01_ZZ04 | 2020-08-05 | Passed | Passed |
| EUTRA, eFDD 13 16QAM, mid channel, 5 MHz, 1, conducted                                        | S01_ZZ04 | 2020-08-05 | Passed | Passed |
| EUTRA, eFDD 13 16QAM, mid channel, 5 MHz, 5, conducted                                        | S01_ZZ04 | 2020-08-05 | Passed | Passed |
| EUTRA, eFDD 13 QPSK, high channel, 5 MHz, 1, conducted                                        | S01_ZZ04 | 2020-08-05 | Passed | Passed |
| EUTRA, eFDD 13 QPSK, high channel, 5 MHz, 3, conducted                                        | S01_ZZ04 | 2020-08-05 | Passed | Passed |
| EUTRA, eFDD 13 QPSK, high channel, 5 MHz, 6, conducted                                        | S01_ZZ04 | 2020-08-05 | Passed | Passed |
| EUTRA, eFDD 13 QPSK, low channel, 5 MHz, 1, conducted                                         | S01_ZZ04 | 2020-08-05 | Passed | Passed |
| EUTRA, eFDD 13 QPSK, low channel, 5 MHz, 3, conducted                                         | S01_ZZ04 | 2020-08-05 | Passed | Passed |
| EUTRA, eFDD 13 QPSK, low channel, 5 MHz, 6, conducted                                         | S01_ZZ04 | 2020-08-05 | Passed | Passed |
| EUTRA, eFDD 13 QPSK, mid channel, 5 MHz, 1, conducted                                         | S01_ZZ04 | 2020-08-05 | Passed | Passed |
| EUTRA, eFDD 13 QPSK, mid channel, 5 MHz, 3, conducted                                         | S01_ZZ04 | 2020-08-05 | Passed | Passed |
| EUTRA, eFDD 13 QPSK, mid channel, 5 MHz, 6, conducted                                         | S01_ZZ04 | 2020-08-05 | Passed | Passed |
| EUTRA, eFDD 13 16QAM, mid channel, 10 MHz, 1, conducted                                       | S01_ZZ04 | 2020-08-05 | Passed | Passed |
| EUTRA, eFDD 13 16QAM, mid channel, 10 MHz, 5, conducted                                       | S01_ZZ04 | 2020-08-05 | Passed | Passed |
| EUTRA, eFDD 13 QPSK, mid channel, 10 MHz, 1, conducted                                        | S01_ZZ04 | 2020-08-05 | Passed | Passed |
| EUTRA, eFDD 13 QPSK, mid channel, 10 MHz, 3, conducted                                        | S01_ZZ04 | 2020-08-05 | Passed | Passed |
| EUTRA, eFDD 13 QPSK, mid channel, 10 MHz, 6, conducted                                        | S01_ZZ04 | 2020-08-05 | Passed | Passed |

#### 47 CFR CHAPTER I FCC PART 27

#### § 2.1053 § 27.53

##### Subpart C

Field strength of spurious radiation

The measurement was performed according to ANSI C63.26: 2015

#### Final Result

| OP-Mode                                                                                       | Setup    | Date       | FCC    | IC     |
|-----------------------------------------------------------------------------------------------|----------|------------|--------|--------|
| Technology, Radio Technology, Operating Frequency, ChBW, Ressource Blocks, Measurement method |          |            |        |        |
| EUTRA, eFDD 13 QPSK, high channel, 5 MHz, 1, radiated                                         | S01_AH04 | 2020-07-16 | Passed | Passed |
| EUTRA, eFDD 13 QPSK, low channel, 5 MHz, 1, radiated                                          | S01_AH04 | 2020-07-16 | Passed | Passed |
| EUTRA, eFDD 13 QPSK, mid channel, 5 MHz, 1, radiated                                          | S01_AH04 | 2020-07-16 | Passed | Passed |

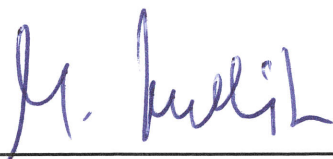
N/A: Not applicable

N/P: Not performed

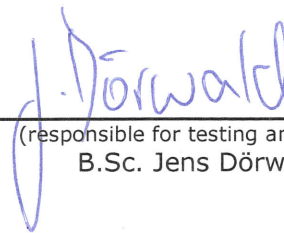
## 2 REVISION HISTORY

| Report version control |              |                    |                  |
|------------------------|--------------|--------------------|------------------|
| Version                | Release date | Change Description | Version validity |
| initial                | 2020-08-14   | --                 | Valid            |
| --                     | --           | --                 | --               |

COMMENT: -



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



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



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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-12140-01-01 | D-PL-12140-01-02 | D-PL-12140-01-03  
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: 2019-12-16

#### 3.2 PROJECT DATA

Responsible for testing and report: B.Sc. Jens Dörwald  
Employees who performed the tests: documented internally at 7Layers  
Date of Report: 2020-08-14  
Testing Period: 2020-07-16 to 2020-07-16

#### 3.3 APPLICANT DATA

Company Name: u-blox AG  
Address: Zürcherstrasse 68  
8800 Thalwil  
Switzerland  
Contact Person: Mr. Giulio Comar

#### 3.4 MANUFACTURER DATA

Company Name: please see Applicant Data  
Address:  
Contact Person:

## 4 TEST OBJECT DATA

### 4.1 GENERAL EUT DESCRIPTION

|                                          |                            |
|------------------------------------------|----------------------------|
| Kind of Device product description       | LTE/ 3G data only module   |
| Product name                             | TOBY-L201                  |
| Type                                     | -                          |
| <b>Declared EUT data by the supplier</b> |                            |
| Power Supply Type                        | DC                         |
| General product description              | The EUT is LTE/ 3G module. |
| Nominal Voltage / Frequency              | 3.8 V DC                   |

### 4.2 EUT MAIN COMPONENTS

| Sample Name      | Sample Code     | Description     |
|------------------|-----------------|-----------------|
| EUT A            | DE1015014ah04   | radiated sample |
| Sample Parameter | Value           |                 |
| Serial No.       | 358502065335351 |                 |
| HW Version       | 218C00          |                 |
| SW Version       | 20.05           |                 |
| Comment          | -               |                 |

| Sample Name      | Sample Code     | Description      |
|------------------|-----------------|------------------|
| EUT B            | DE1015014zz04   | conducted sample |
| Sample Parameter | Value           |                  |
| Serial No.       | 358502065335377 |                  |
| HW Version       | 218C00          |                  |
| SW Version       | 20.05           |                  |
| 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, OUT Code) | Description |
|--------|-------------------------------------------------|-------------|
| -      | -                                               | -           |

#### 4.4 AUXILIARY EQUIPMENT

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

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

#### 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_AH04 | EUT A               | radiated sample           |
| S01_ZZ04 | EUT B               | conducted sample          |

#### 4.6 OPERATING MODES

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

##### 4.6.1 TEST CHANNELS

FCC Part 27

| LTE-M1 eFDD 13 CH-BW=5MHz | LOW   | MID   | HIGH  |
|---------------------------|-------|-------|-------|
| Channel                   | 23205 | 23230 | 23255 |
| Frequency [MHz]           | 779.5 | 782.0 | 784.5 |

| LTE-M1 eFDD 13 CH-BW=10MHz | LOW | MID   | HIGH |
|----------------------------|-----|-------|------|
| Channel                    | -   | 23230 | -    |
| Frequency [MHz]            | -   | 782.0 | -    |

## 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 RF OUTPUT POWER

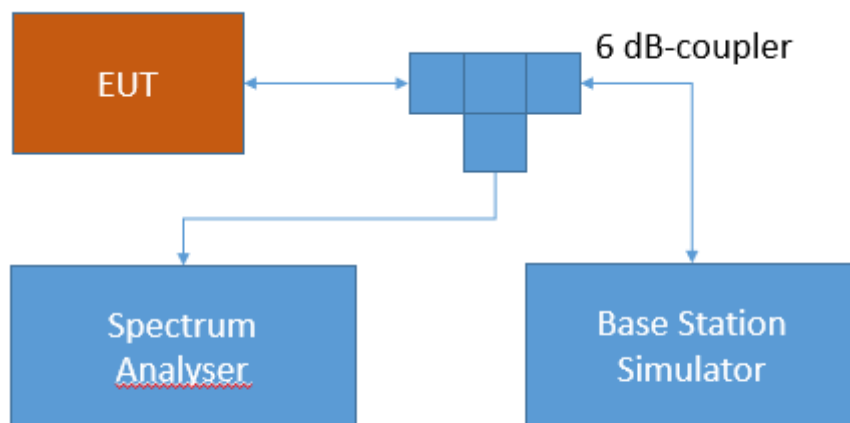
Standard **FCC PART 27 Subpart C**

**The test was performed according to:**  
ANSI C63.26: 2015

#### 5.1.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the applicable RF Output power test case per § 2.1046 and RSS-GEN 6.12. The limit and the requirements come from the applicable rule part and ISSED RSS-Standard for the operating band of the cellular device.

The EUT was connected to the test setup according to the following diagram:



Test Setup FCC Part 22/24/27/90 Cellular;  
RF Output power

The attenuation of the measuring and stimulus path are known for each measured frequency and are considered.

The Spectrum Analyzer settings can be directly found in the measurement diagrams.

#### 5.1.2 TEST REQUIREMENTS / LIMITS

**FCC Part 27; Miscellaneous Wireless Communication Services**

**Subpart C – Technical standards**

## **§ 27.50 - Power limits and duty cycle**

### **Band 13:**

(b) The following power limits apply to transmitters operating in the 746-758 MHz, 775-788 MHz and 805-806 MHz bands:

(10) Portable stations (hand-held devices) transmitting in the 746-757 MHz, 776-788 MHz, and 805-806 MHz bands are limited to 3 watts ERP.

### **RSS-130; 4.6.3 Transmitter Output Power**

The e.r.p. shall not exceed 3 watts for portable equipment and indoor fixed subscriber equipment.

### **Band 12:**

c) The following power and antenna height requirements apply to stations transmitting in the 600 MHz band and the 698-746 MHz band:

(10) Portable stations (hand-held devices) in the 600 MHz uplink band and the 698-746 MHz band, and fixed and mobile stations in the 600 MHz uplink band are limited to 3 watts ERP.

### **RSS-130; 4.6.3 Transmitter Output Power**

The e.r.p. shall not exceed 3 watts for portable equipment and indoor fixed subscriber equipment.

### **Band 4/10/66:**

d) The following power and antenna height requirements apply to stations transmitting in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz and 2180-2200 MHz bands:

(4) Fixed, mobile, and portable (hand-held) stations operating in the 1710-1755 MHz band and mobile and portable stations operating in the 1695-1710 MHz and 1755-1780 MHz bands are limited to 1 watt EIRP. Fixed stations operating in the 1710-1755 MHz band are limited to a maximum antenna height of 10 meters above ground. Mobile and portable stations operating in these bands must employ a means for limiting power to the minimum.

### **RSS-139; 6.5 Transmitter Output Power**

The equivalent isotropically radiated power (e.i.r.p.) for mobile and portable transmitters shall not exceed one watt.

### **Band 17:**

(c) The following power requirements apply to stations transmitting in the 600 MHz band and the 698-746 MHz band:

(10) Portable stations (hand-held devices) in the 600 MHz uplink band and the 698-746 MHz band, and fixed and mobile stations in the 600 MHz uplink band are limited to 3 watts ERP.

### **RSS-130; 4.6.3 Transmitter Output**

The e.r.p. shall not exceed 3 watts for portable equipment and indoor fixed subscriber equipment.

### **Band 7:**

(h) The following power limits shall apply in the BRS and EBS:

(2) Mobile and other user stations. Mobile stations are limited to 2.0 watts EIRP. All user stations are limited to 2.0 watts transmitter output power.

#### **RSS-199; 4.4 Transmitter output power and equivalent isotropically power (e.i.r.p.)**

The transmitter output power shall be measured in terms of average value.

For mobile subscriber equipment, the e.i.r.p. shall not exceed 2 W. For fixed subscriber equipment, the transmitter output power shall not exceed 2 W and the e.i.r.p. shall be limited to 40 W.

For equipment with multiple antennas, the transmitter output power and e.i.r.p shall be measured according to ANSI C63.26-2015.

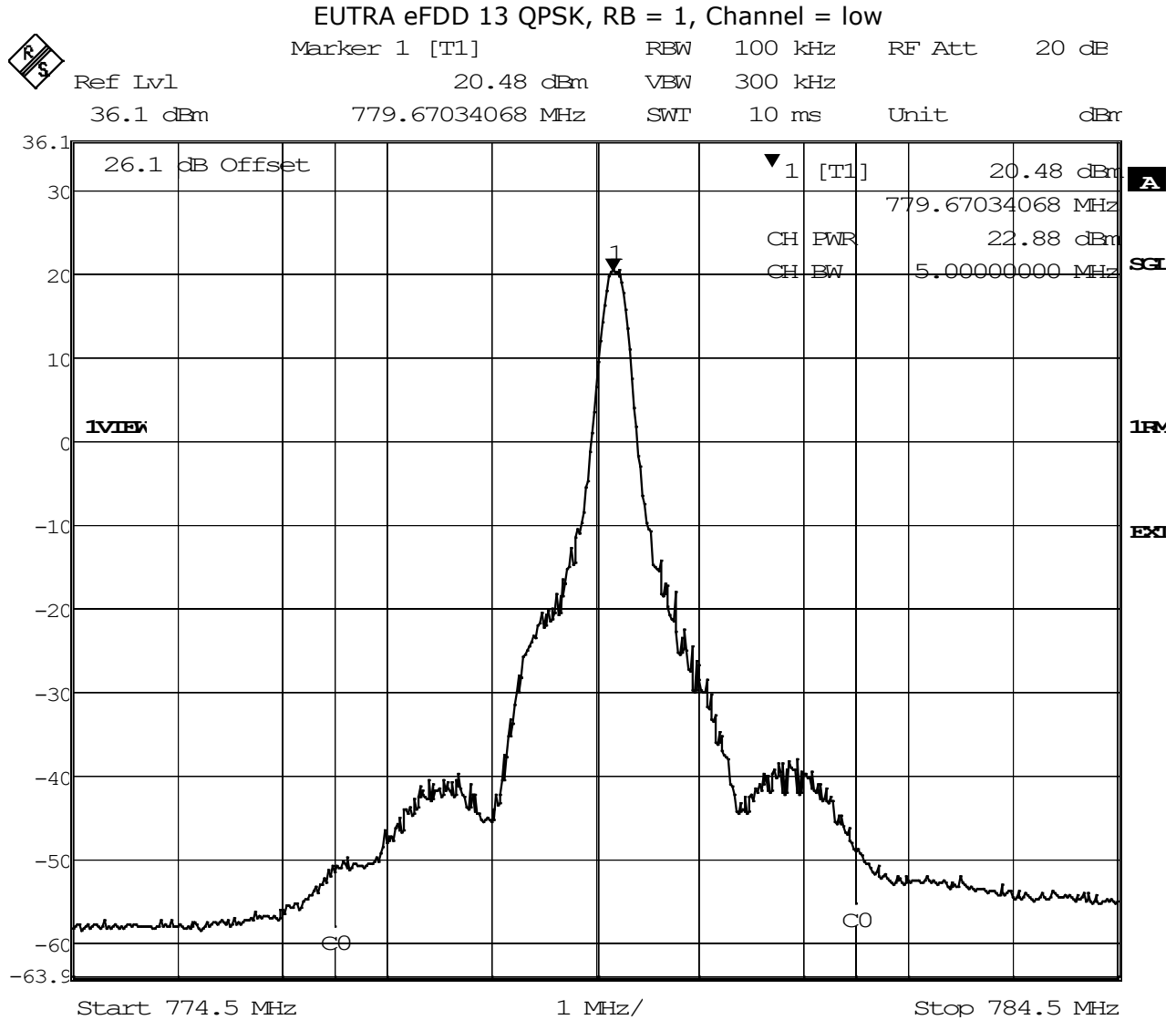
#### **Test Protocol**

Ambient temperature: 24 °C  
Relative humidity: 38 %

| Radio Technology    | Channel | Resource Blocks / Subcarrier | Band-width [MHz] | NEW EUT (zz04)<br>RMS Cond. Power [dBm] | OLD EUT | DEVIATION |
|---------------------|---------|------------------------------|------------------|-----------------------------------------|---------|-----------|
| EUTRA eFDD 13 QPSK  | Low     | 1                            | 5                | <b>22.88</b>                            | 22.02   | 0.86      |
| EUTRA eFDD 13 QPSK  | Low     | 12                           | 5                | 21.89                                   | 21.34   | 0.55      |
| EUTRA eFDD 13 QPSK  | Low     | 25                           | 5                | 21.88                                   | 21.1    | 0.78      |
| EUTRA eFDD 13 QPSK  | Mid     | 1                            | 5                | 21.82                                   | 21.17   | 0.65      |
| EUTRA eFDD 13 QPSK  | Mid     | 12                           | 5                | 20.78                                   | 20.06   | 0.72      |
| EUTRA eFDD 13 QPSK  | Mid     | 25                           | 5                | 22.84                                   | 21.83   | 1.01      |
| EUTRA eFDD 13 QPSK  | High    | 1                            | 5                | 21.65                                   | 20.6    | 1.05      |
| EUTRA eFDD 13 QPSK  | High    | 12                           | 5                | 21.63                                   | 20.76   | 0.87      |
| EUTRA eFDD 13 QPSK  | High    | 25                           | 5                | 21.84                                   | 20.74   | 1.1       |
| EUTRA eFDD 13 16QAM | Low     | 1                            | 5                | 20.59                                   | 19.73   | 0.86      |
| EUTRA eFDD 13 16QAM | Low     | 25                           | 5                | <b>22.76</b>                            | 22.25   | 0.51      |
| EUTRA eFDD 13 16QAM | Mid     | 1                            | 5                | 21.56                                   | 20.76   | 0.8       |
| EUTRA eFDD 13 16QAM | Mid     | 25                           | 5                | 21.61                                   | 21.08   | 0.53      |
| EUTRA eFDD 13 16QAM | High    | 1                            | 5                | 21.81                                   | 21.41   | 0.4       |
| EUTRA eFDD 13 16QAM | High    | 25                           | 5                | 20.61                                   | 20.02   | 0.59      |
| EUTRA eFDD 13 QPSK  | Mid     | 1                            | 10               | 22.82                                   | 21.89   | 0.93      |
| EUTRA eFDD 13 QPSK  | Mid     | 50                           | 10               | 21.84                                   | 21.06   | 0.78      |
| EUTRA eFDD 13 16QAM | Mid     | 1                            | 10               | 21.97                                   | 20.85   | 1.12      |
| EUTRA eFDD 13 16QAM | Mid     | 50                           | 10               | 20.82                                   | 19.98   | 0.84      |

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

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



Date: 5.AUG.2020 15:50:40

### 5.1.4 TEST EQUIPMENT USED

- Radio Lab

## 5.2 FIELD STRENGTH OF SPURIOUS RADIATION

Standard **FCC PART 27 Subpart C**

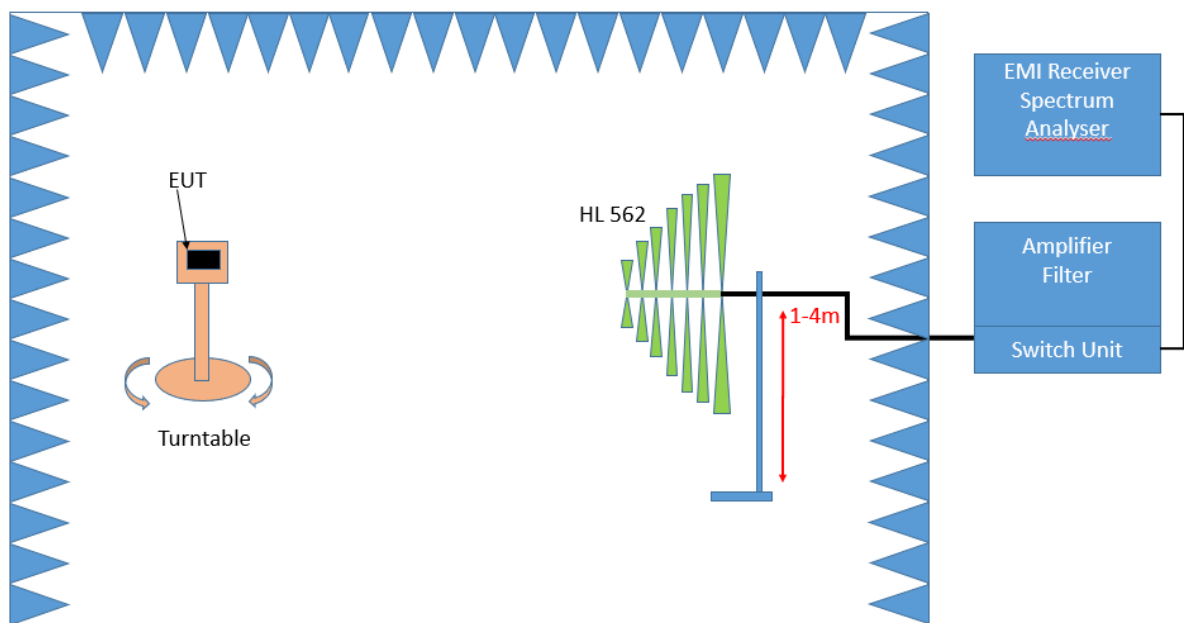
**The test was performed according to:**  
ANSI C63.26: 2015

### 5.2.1 TEST DESCRIPTION

This test case is intended to demonstrate compliance to the applicable radiated spurious emission measurements per § 2.1053 and RSS-GEN 6.13. The limit and requirements come from the applicable rule part and ISSED RSS-Standard for the operating band of the cellular device.

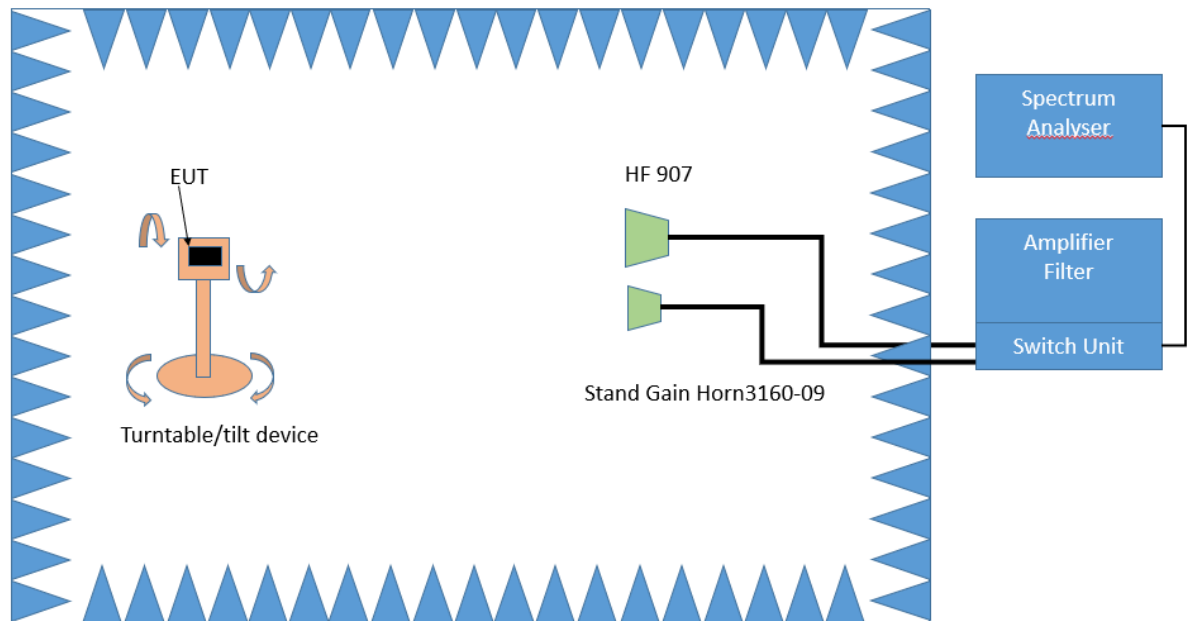
The EUT was connected to the test setup according to the following diagram:

Frequency Range: 30 MHz – 1 GHz:



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

Frequency Range: 1 GHz – 26.5 GHz



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

The test set-up was made in accordance to the general provisions of ANSI C63.26 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 between 30–1000 MHz was evaluated.

The measurement procedure is implemented into the EMI test software EMC32 from R&S. Exploratory tests are performed at 3 orthogonal axes to determine the worst-case orientation of a body-worn or handheld EUT. The final test on all kind of EUTs is also performed at 3 axes. A pre-check is performed while the EUT is powered from a DC power source.

## 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
- RBW: 100 kHz
- VBW: 300 kHz
- Sweep time: coupled
- Turntable angle range:  $-180^{\circ}$  to  $90^{\circ}$
- Turntable step size:  $90^{\circ}$
- 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
- Measured frequencies: in step 1 determined frequencies
- RBW: 100 kHz
- VBW: 300 kHz
- Sweep time: coupled
- 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 RMS detector

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

EMI receiver settings for step 4:

- Detector: RMQ
- Measured frequencies: in step 1 determined frequencies
- RBW: 100 kHz
- VBW: 300 kHz
- Sweep time: 1 s

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

**3. Measurement above 1 GHz**

The following modifications apply to the measurement procedure for the frequency range above 1 GHz:

**Step 1:**

The Equipment Under Test (EUT) was set up on a non-conductive support (tilt device) at 1.5 m height in the fully-anechoic chamber.

All steps were performed with one height (1.5 m) of the receiving antenna only.

The EUT is turned during the preliminary measurement across the elevation axis, with a step size of  $45^\circ$ .

The turn table step size (azimuth angle) for the preliminary measurement is  $45^\circ$ .

- Antenna distance: 3 m
- Detector: Peak
- RBW: 1 MHz
- VBW: 3 MHz
- Sweep time: coupled
- Turntable angle range:  $-180^\circ$  to  $135^\circ$
- Turntable step size:  $45^\circ$
- Polarisation: Horizontal + Vertical

**Step 2:**

Due to the fact, that in this frequency range the test is performed in a fully anechoic room, the height scan of the receiving antenna instep 2 is omitted. Instead of this, a maximum search with a step size  $\pm 45^\circ$  for the elevation axis is performed.

The turn table azimuth will slowly vary by  $\pm 22.5^\circ$ .

The elevation angle will slowly vary by  $\pm 45^\circ$

EMI receiver settings (for all steps):

- Detector: Peak,
- RBW: 1 MHz
- VBW: 3 MHz
- Sweep time: coupled

**Step 3:**

Spectrum analyser settings for step 3:

- Detector: RMS
- Measured frequencies: in step 1 determined frequencies
- RBW: 1 MHz
- VBW: 3 MHz
- Sweep Time: 1 s

## 5.2.2 TEST REQUIREMENTS / LIMITS

**FCC Part 2.1053; Measurement required: Field strength of spurious radiation:**

Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of §2.1049, as appropriate.

**FCC Part 27; Miscellaneous Wireless Communication Services****Subpart C – Technical standards****§27.53 – Emission limits****Band 13**

(c) For operations in the 746-758 MHz band and the 776-788 MHz band, the power of any emission outside the licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, in accordance with the following:

- (1) On any frequency outside the 746-758 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least  $43 + 10 \log (P)$  dB;
- (2) On any frequency outside the 776-788 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least  $43 + 10 \log (P)$  dB;
- (3) On all frequencies between 763-775 MHz and 793-805 MHz, by a factor not less than  $76 + 10 \log (P)$  dB in a 6.25 kHz band segment, for base and fixed stations;
- (4) On all frequencies between 763-775 MHz and 793-805 MHz, by a factor not less than  $65 + 10 \log (P)$  dB in a 6.25 kHz band segment, for mobile and portable stations;
- (5) Compliance with the provisions of paragraphs (c)(1) and (c)(2) of this section is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. However, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of at least 30 kHz may be employed;
- (f) For operations in the 746-758 MHz, 775-788 MHz, and 805-806 MHz bands, emissions in the band 1559-1610 MHz shall be limited to  $-70$  dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and  $-80$  dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

(6) Compliance with the provisions of paragraphs (c)(3) and (c)(4) of this section is based on the use of measurement instrumentation such that the reading taken with any resolution bandwidth setting should be adjusted to indicate spectral energy in a 6.25 kHz segment.

#### **RSS-130; 4.7.1 General unwanted emissions limits**

The unwanted emissions in any 100 kHz bandwidth on any frequency outside the low frequency edge and the high frequency edge of each frequency block range(s), shall be attenuated below the transmitter power,  $P$  (dBW), by at least  $43 + 10 \log_{10} p$  (watts), dB. However, in the 100 kHz band immediately outside of the equipment's frequency block range, a resolution bandwidth of 30 kHz may be employed.

#### **RSS-130; 4.7.2 Additional unwanted emissions limits**

In addition to the limit outlined in section 4.7.1 above, equipment operating in the frequency bands 746-756 MHz and 777-787 MHz shall also comply with the following restrictions:

- a. the power of any unwanted emissions in any 6.25 kHz bandwidth for all frequencies between 763-775 MHz and 793-806 MHz shall be attenuated below the transmitter power,  $P$  (dBW), by at least:
  - i.  $76 + 10 \log_{10} p$  (watts), dB, for base and fixed equipment and
  - ii.  $65 + 10 \log_{10} p$  (watts), dB, for mobile and portable equipment
- b. the e.i.r.p. in the band 1559-1610 MHz shall not exceed  $-70$  dBW/MHz for wideband signal and  $-80$  dBW for discrete emission with bandwidth less than 700 Hz.

#### **Band 12:**

(g) For operations in the 600 MHz band and the 698-746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power ( $P$ ) within the licensed band(s) of operation, measured in watts, by at least  $43 + 10 \log(P)$  dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

#### **RSS-130; 4.7.1 General unwanted emissions limits**

The unwanted emissions in any 100 kHz bandwidth on any frequency outside the low frequency edge and the high frequency edge of each frequency block range(s), shall be attenuated below the transmitter power,  $P$  (dBW), by at least  $43 + 10 \log_{10} p$  (watts), dB. However, in the 100 kHz band immediately outside of the equipment's frequency block range, a resolution bandwidth of 30 kHz may be employed.

#### **RSS-130; 4.7.2 Additional unwanted emissions limits**

In addition to the limit outlined in section 4.7.1 above, equipment operating in the frequency bands 746-756 MHz and 777-787 MHz shall also comply with the following restrictions:

- a. the power of any unwanted emissions in any 6.25 kHz bandwidth for all frequencies between 763-775 MHz and 793-806 MHz shall be attenuated below the transmitter power,  $P$  (dBW), by at least:
  - i.  $76 + 10 \log_{10} p$  (watts), dB, for base and fixed equipment and
  - ii.  $65 + 10 \log_{10} p$  (watts), dB, for mobile and portable equipment
- b. the e.i.r.p. in the band 1559-1610 MHz shall not exceed  $-70$  dBW/MHz for wideband signal and  $-80$  dBW for discrete emission with bandwidth less than 700 Hz.

**Band 4/10/66:**

(h) *AWS emission limits*—(1) *General protection levels*. Except as otherwise specified below, for operations in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz, and 2180-2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least  $43 + 10 \log_{10} (P)$  dB.

**RSS-139; 6.6 Transmitter Unwanted Emissions**

Equipment shall comply with the limits in (i) and (ii) below.

- i. In the first 1.0 MHz bands immediately outside and adjacent to the equipment's smallest operating frequency block, which can contain the equipment's occupied bandwidth, the emission power per any 1% of the emission bandwidth shall be attenuated below the transmitter output power P (in dBW) by at least  $43 + 10 \log_{10} p$  (watts) dB.
- ii. After the first 1.0 MHz outside the equipment's smallest operating frequency block, which can contain the equipment's occupied bandwidth, the emission power in any 1 MHz bandwidth shall be attenuated below the transmitter output power P (in dBW) by at least  $43 + 10 \log_{10} p$  (watts) dB.

**Band 7:**

(m) For BRS and EBS stations, the power of any emissions outside the licensee's frequency bands of operation shall be attenuated below the transmitter power (P) measured in watts in accordance with the standards below. If a licensee has multiple contiguous channels, out-of-band emissions shall be measured from the upper and lower edges of the contiguous channels.

(4) For mobile digital stations, the attenuation factor shall be not less than  $40 + 10 \log (P)$  dB on all frequencies between the channel edge and 5 megahertz from the channel edge,  $43 + 10 \log (P)$  dB on all frequencies between 5 megahertz and X megahertz from the channel edge, and  $55 + 10 \log (P)$  dB on all frequencies more than X megahertz from the channel edge, where X is the greater of 6 megahertz or the actual emission bandwidth as defined in paragraph (m)(6) of this section. In addition, the attenuation factor shall not be less than  $43 + 10 \log (P)$  dB on all frequencies between 2490.5 MHz and 2496 MHz and  $55 + 10 \log (P)$  dB at or below 2490.5 MHz. Mobile Satellite Service licensees operating on frequencies below 2495 MHz may also submit a documented interference complaint against BRS licensees operating on channel BRS Channel 1 on the same terms and conditions as adjacent channel BRS or EBS licensees.

**RSS-199; 4.5 Transmitter unwanted emissions**

In the 1 MHz band immediately outside and adjacent to the channel edge, the unwanted emission power shall be measured with a resolution bandwidth of at least 1% of the occupied bandwidth for base station and fixed subscriber equipment, and 2% for mobile subscriber equipment. Beyond the 1 MHz band, a resolution bandwidth of 1 MHz shall be used. A narrower resolution bandwidth can be used, provided that the measured power is integrated over the full required measurement bandwidth of 1 MHz, or 1% or 2% of the occupied bandwidth, as applicable.

Equipment shall comply with the following unwanted emission limits:

b. for mobile subscriber equipment, the power of any unwanted emissions measured as above shall be attenuated (in dB) below the transmitter power, P (dBW), by at least:

$40 + 10 \log_{10} p$  from the channel edges to 5 MHz away

$43 + 10 \log_{10} p$  between 5 MHz and X MHz from the channel edges, and

$55 + 10 \log_{10} p$  at X MHz and beyond from the channel edges

In addition, the attenuation shall not be less than  $43 + 10 \log_{10} p$  on all frequencies between 2490.5 MHz and 2496 MHz, and  $55 + 10 \log_{10} p$  at or below 2490.5 MHz.

In (b), p is the transmitter power measured in watts and X is 6 MHz or the equipment occupied bandwidth, whichever is greater.

#### **Band 17:**

(g) For operations in the 600 MHz band and the 698-746 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least  $43 + 10 \log (P)$  dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

#### **RSS-130; 4.7.1 General unwanted emissions limits**

The unwanted emissions in any 100 kHz bandwidth on any frequency outside the low frequency edge and the high frequency edge of each frequency block range(s), shall be below the transmitter power, P (dBW), by at least  $43 + 10 \log_{10} p$  (watts), dB. However, in the 100 kHz band immediately outside of the equipment's frequency block range, a resolution bandwidth of 30 kHz may be employed.

#### **RSS-130; 4.7.2 Additional unwanted emissions limits**

In attenuated addition to the limit outlined in section 4.7.1 above, equipment operating in the frequency bands 746-756 MHz and 777-787 MHz shall also comply with the following restrictions:

- a. the power of any unwanted emissions in any 6.25 kHz bandwidth for all frequencies between 763-775 MHz and 793-806 MHz shall be attenuated below the transmitter power, P (dBW), by at least:
  - i.  $76 + 10 \log_{10} p$  (watts), dB, for base and fixed equipment and
  - ii.  $65 + 10 \log_{10} p$  (watts), dB, for mobile and portable equipment
- b. the e.i.r.p. in the band 1559-1610 MHz shall not exceed  $-70$  dBW/MHz for wideband signal and  $-80$  dBW for discrete emission with bandwidth less than 700 Hz.

### 5.2.3 TEST PROTOCOL

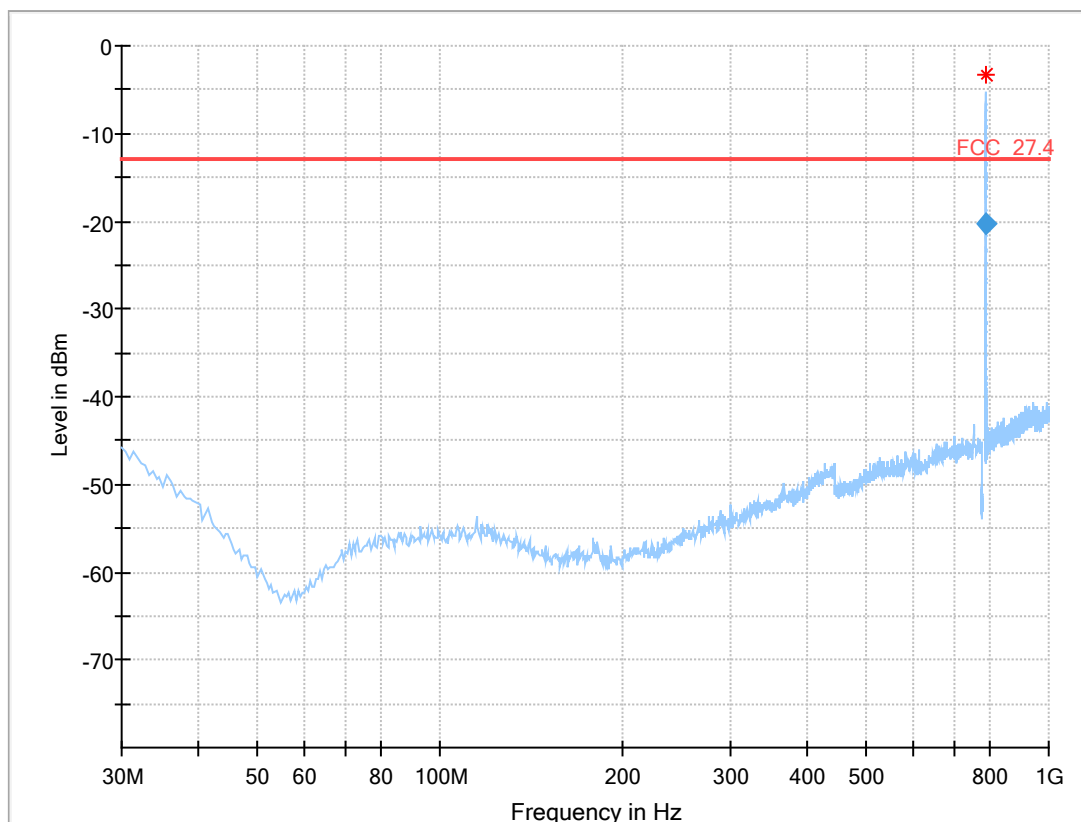
Ambient temperature: 24 °C  
Relative humidity: 38 %

| Radio Technology | Channel | Detector | Trace   | Resolution Bandwidth /kHz | Frequency /MHz | Peak Value /dBm | Limit /dBm | Margin to Limit /dB |
|------------------|---------|----------|---------|---------------------------|----------------|-----------------|------------|---------------------|
| eFDD13           | low     | rms      | maxhold | -                         | -              | -               | -          | -                   |
| eFDD13           | mid     | rms      | maxhold | -                         | -              | -               | -          | -                   |
| eFDD13           | high    | rms      | maxhold | 100                       | 787.11         | -20.33          | -13        | 7.33                |

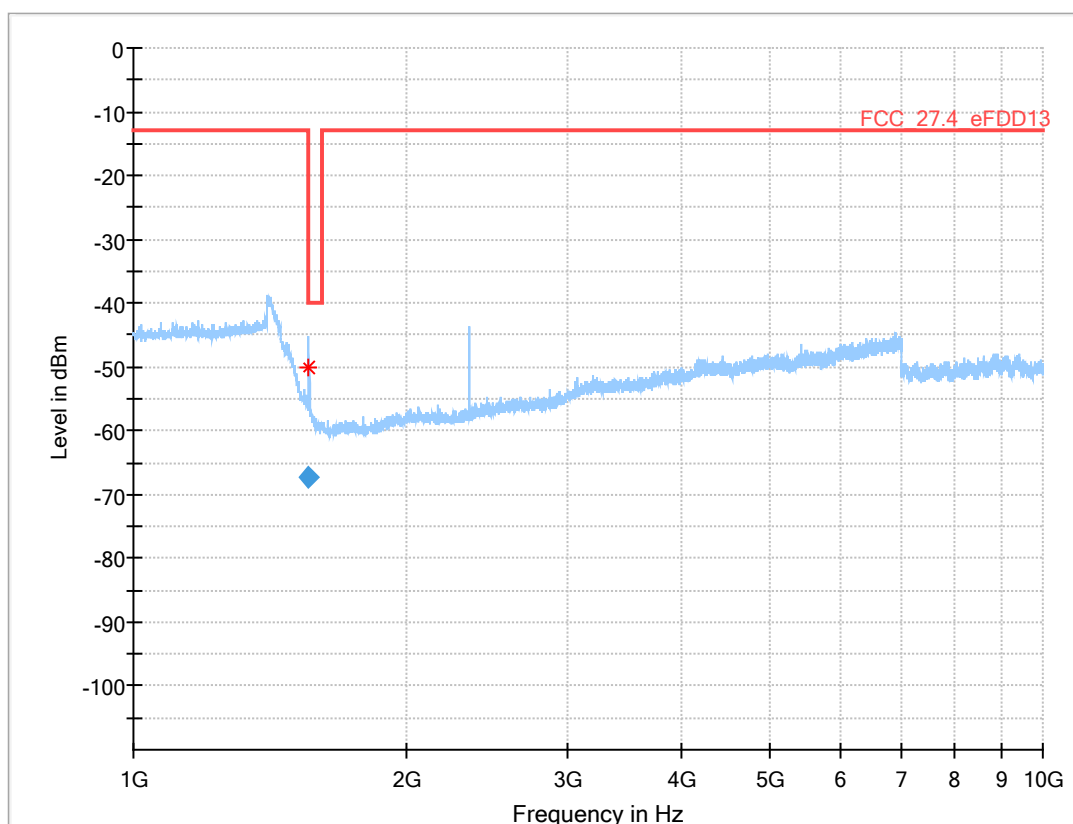
Remark: Please see next sub-clause for the measurement plot.

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

EUTRA eFDD13 QPSK, RB = 1, Channel = high



| Frequency (MHz) | RMS (dBm) | Limit (dBm) | Margin | Meas. Time (ms) | Bandwidth | Height | Pol | Azimuth | Corr. (dB) | Comment               |
|-----------------|-----------|-------------|--------|-----------------|-----------|--------|-----|---------|------------|-----------------------|
| 787.111600      | -20.33    | -13.00      | 7.33   | 1000.0          | 100.000   | 127.0  | H   | -184.0  | -74.6      | 12:04:34 - 2020-08-01 |



| Frequency (MHz) | RMS (dBm) | Limit (dBm) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Elevation (deg) | Corr. (dB) |
|-----------------|-----------|-------------|-------------|-----------------|-----------------|-------------|-----|---------------|-----------------|------------|
| 1560.067        | -67.3     | -40.00      | 27.27       | 1000.0          | 1000.000        | 150.0       | V   | -196.0        | 68.0            | -100.1     |

## 6 TEST EQUIPMENT

- 1 Radiated Emissions  
Lab to perform radiated emission tests

| Ref.No. | Device Name             | Description                                                                | Manufacturer                      | Serial Number      | Last Calibration | Calibration Due |
|---------|-------------------------|----------------------------------------------------------------------------|-----------------------------------|--------------------|------------------|-----------------|
| 1.1     | MFS                     | Rubidium Frequency Normal MFS                                              | Datum GmbH                        | 002                | 2019-10          | 2020-10         |
| 1.2     | N5000/NP                | Filter for EUT, 2 Lines, 250 V, 16 A                                       | ETS-LINDGREN                      | 241515             |                  |                 |
| 1.3     | Opus10 TPR (8253.00)    | T/P Logger 13                                                              | Lufft Mess- und Regeltechnik GmbH | 13936              | 2019-05          | 2021-05         |
| 1.4     | ESW44                   | EMI Receiver / Spectrum Analyzer                                           | Rohde & Schwarz GmbH & Co. KG     | 101603             | 2019-12          | 2021-12         |
| 1.5     | Anechoic Chamber 01     | SAC/FAR, 10.58 m x 6.38 m x 6.00 m                                         | Frankonia                         | none               | 2018-06          | 2020-06         |
| 1.6     | HL 562 ULTRALOG         | Biconical-log-per antenna (30 MHz - 3 GHz) with HL 562E biconicals         | Rohde & Schwarz GmbH & Co. KG     | 830547/003         | 2018-07          | 2021-07         |
| 1.7     | AMF-7D00101800-30-10P-R | Broadband Amplifier 100 MHz - 18 GHz                                       | Miteq                             |                    |                  |                 |
| 1.8     | 5HC2700/12750-1.5-KK    | High Pass Filter                                                           | Trilithic                         | 9942012            |                  |                 |
| 1.9     | ASP 1.2/1.8-10 kg       | Antenna Mast                                                               | Maturo GmbH                       | -                  |                  |                 |
| 1.10    | Anechoic Chamber 03     | FAR, 8.80m x 4.60m x 4.05m (l x w x h)                                     | Albatross Projects                | P26971-647-001-PRB | 2018-06          | 2020-06         |
| 1.11    | SMBV100A                | Vector Signal Generator 9 kHz - 3.2 GHz (GNSS / Broadcast Signalling Unit) | Rohde & Schwarz GmbH & Co. KG     | 260001             | 2018-01          | 2021-01         |
| 1.12    | Fluke 177               | Digital Multimeter 03 (Multimeter)                                         | Fluke Europe B.V.                 | 86670383           | 2018-04          | 2020-04         |
| 1.13    | WRD1920/1980-5/22-5EESD | Tunable Band Reject Filter                                                 | Wainwright Instruments GmbH       | 11                 |                  |                 |
| 1.14    | TDS 784C                | Digital Oscilloscope [SA2] (Aux)                                           | Tektronix                         | B021311            |                  |                 |
| 1.15    | foRS232 Unit 2          | Fibre optic link RS232                                                     | PONTIS Messtechnik GmbH           | 4031516037         |                  |                 |
| 1.16    | PONTIS Con4101          | PONTIS Camera Controller                                                   |                                   | 6061510370         |                  |                 |

| Ref.No. | Device Name            | Description                                     | Manufacturer                   | Serial Number | Last Calibration | Calibration Due |
|---------|------------------------|-------------------------------------------------|--------------------------------|---------------|------------------|-----------------|
| 1.17    | NRVD                   | Power Meter                                     | Rohde & Schwarz GmbH & Co. KG  | 828110/016    | 2019-08          | 2020-08         |
| 1.18    | OLS-1 R                | Fibre optic link USB 1.1                        | Ingenieurbüro Scheiba          | 018           |                  |                 |
| 1.19    | HF 906                 | Double-ridged horn                              | Rohde & Schwarz                | 357357/002    | 2018-09          | 2021-09         |
| 1.20    | JS4-18002600-32-5P     | Broadband Amplifier 18 GHz - 26 GHz             | Miteq                          | 849785        |                  |                 |
| 1.21    | FSW 43                 | Spectrum Analyzer                               | Rohde & Schwarz                | 103779        | 2019-02          | 2021-02         |
| 1.22    | 3160-09                | Standard Gain / Pyramidal Horn Antenna 26.5 GHz | EMCO Elektronik GmbH           | 00083069      |                  |                 |
| 1.23    | foRS232 Unit 1         | Fibre optic link RS232                          | PONTIS Messtechnik GmbH        | 4021516036    |                  |                 |
| 1.24    | FSP3                   | Spectrum Analyzer                               | Rohde & Schwarz GmbH & Co. KG  | 836722/011    |                  |                 |
| 1.25    | WHKX 7.0/18G-8SS       | High Pass Filter                                | Wainwright Instruments GmbH    | 09            |                  |                 |
| 1.26    | DS 420S                | Turn Table 2 m diameter                         | HD GmbH                        | 420/573/99    |                  |                 |
| 1.27    | 4HC1600/12750-1.5-KK   | High Pass Filter                                | Trilithic                      | 9942011       |                  |                 |
| 1.28    | foUSB-M Converter 2    | Fibre optic link USB 2.0                        | PONTIS Messtechnik GmbH        | 4471520061    |                  |                 |
| 1.29    | WRCD1879.8-0.2/40-10EE | Notch Filter Ultra Stable                       | Wainwright Instruments GmbH    | 16            |                  |                 |
| 1.30    | SMB100A                | Signal Generator 100 kHz - 40 GHz               | Rohde & Schwarz Vertriebs-GmbH | 181486        | 2019-11          | 2021-11         |
| 1.31    | JS4-00102600-42-5A     | Broadband Amplifier 30 MHz - 26 GHz             | Miteq                          | 619368        |                  |                 |
| 1.32    | TT 1.5 WI              | Turn Table                                      | Maturo GmbH                    | -             |                  |                 |
| 1.33    | HL 562 ULTRALOG        | Biconical-log-per Antenna (30 MHz - 3 GHz)      | Rohde & Schwarz GmbH & Co. KG  | 100609        | 2019-05          | 2022-05         |
| 1.34    | HF 906                 | Double-ridged horn                              | Rohde & Schwarz                | 357357/001    | 2018-03          | 2021-03         |
| 1.35    | foCAN (v 4.0)          | Fibre optic link CAN                            | Audivo GmbH (PONTIS EMC)       | 492 1607 014  |                  |                 |
| 1.36    | CMW 500                | CMW 500 Flex 2                                  | Rohde & Schwarz GmbH & Co. KG  | 155999-Ei     | 2019-09          | 2022-09         |
| 1.37    | CMU 200                | "CMU1" Universal Radio Communication Tester     | Rohde & Schwarz GmbH & Co. KG  | 102366        | 2017-12          | 2020-12         |
| 1.38    | 3160-10                | Standard Gain / Pyramidal Horn Antenna 40 GHz   | EMCO Elektronik GmbH           | 00086675      |                  |                 |
| 1.39    | MA4985-XP-ET           | Bore Sight Antenna Mast                         | innco systems GmbH             | none          |                  |                 |

| Ref.No. | Device Name          | Description                                            | Manufacturer                                 | Serial Number          | Last Calibration | Calibration Due |
|---------|----------------------|--------------------------------------------------------|----------------------------------------------|------------------------|------------------|-----------------|
| 1.40    | CBT                  | Bluetooth Tester "CBT-02" incl. BLE-Option             | Rohde & Schwarz                              | 100302                 | 2018-03          | 2021-03         |
| 1.41    | CMW 500              | callbox with SUA, BT, 2G, 3G, LTE, AUDIO, UL/DL fading | Rohde & Schwarz GmbH & Co. KG                | 163529-bw              | 2017-07          | 2020-07         |
| 1.42    | A8455-4              | 4 Way Power Divider (SMA)                              |                                              | -                      |                  |                 |
| 1.43    | JUN-AIR Mod. 6-15    | Air Compressor                                         | JUN-AIR Deutschland GmbH                     | 612582                 |                  |                 |
| 1.44    | foEthernet_M         | Fibre optic link Ethernet / Gb-LAN                     | PONTIS Messtechnik GmbH                      | 4841516023             |                  |                 |
| 1.45    | 5HC3500/18000-1.2-KK | High Pass Filter                                       | Trilithic                                    | 200035008              |                  |                 |
| 1.46    | OLS-1 M              | Fibre optic link USB 1.1                               | Ingenieurbüro Scheiba                        | 018                    |                  |                 |
| 1.47    | HFH2-Z2              | Loop Antenna                                           | Rohde & Schwarz                              | 829324/006             | 2018-01          | 2021-01         |
| 1.48    | Voltcraft M-3860M    | Digital Multimeter 01 (Multimeter)                     | Conrad                                       | IJ096055               |                  |                 |
| 1.49    | CMW 500              | callbox, 2G, 3G, LTE, WLAN, BT, Audio                  | Rohde & Schwarz GmbH & Co. KG                | 149268-Qf              | 2018-04          | 2021-04         |
| 1.50    | Opus10 THI (8152.00) | T/H Logger 12                                          | Lufft Mess- und Regeltechnik GmbH            | 12482                  | 2019-06          | 2021-06         |
| 1.51    | UNI-T UT195E         | True RMS Digital Multimeter                            | UNI-T UNI-TREND TECHNOLOGY (CHINA) CO., LTD. | C190729561             |                  |                 |
| 1.52    | foEthernet_M         | Fibre optic link Ethernet / Gb-LAN                     | PONTIS Messtechnik GmbH                      | 4841516022             |                  |                 |
| 1.53    | JS4-00101800-35-5P   | Broadband Amplifier 30 MHz - 18 GHz                    | Miteq                                        | 896037                 |                  |                 |
| 1.54    | AS 620 P             | Antenna Mast (pneumatic polarisation)                  | HD GmbH                                      | 620/37                 |                  |                 |
| 1.55    | 6005D (30 V / 5 A)   | Laboratory Power Supply 120 V 60 Hz                    | Peaktech                                     | 81062045               |                  |                 |
| 1.56    | TD1.5-10kg           | EUT Tilt Device (Rohacell)                             | Maturo GmbH                                  | TD1.5-10kg/024/3790709 |                  |                 |
| 1.57    | Innco Systems CO3000 | Controller for bore sight mast SAC                     | innco systems GmbH                           | CO3000/967/39371016/L  |                  |                 |
| 1.58    | NRV-Z1               | Sensor Head B                                          | Rohde & Schwarz GmbH & Co. KG                | 827753/006             | 2019-08          | 2020-08         |
| 1.59    | HF 907-2             | Double-ridged horn                                     | Rohde & Schwarz                              | 102817                 | 2019-04          | 2022-04         |
| 1.60    | foCAN (v 4.0)        | Fibre optic link CAN                                   | Audivo GmbH (PONTIS EMC)                     | 492 1607 013           |                  |                 |
| 1.61    | PAS 2.5 - 10 kg      | Antenna Mast                                           | Maturo GmbH                                  | -                      |                  |                 |

| Ref.No. | Device Name             | Description                           | Manufacturer                          | Serial Number      | Last Calibration | Calibration Due |
|---------|-------------------------|---------------------------------------|---------------------------------------|--------------------|------------------|-----------------|
| 1.62    | AFS42-00101800-25-S-42  | Broadband Amplifier 25 MHz - 18 GHz   | Miteq                                 | 2035324            |                  |                 |
| 1.63    | WRCA800/960-0.2/40-6EEK | Tunable Notch Filter                  | Wainwright Instruments GmbH           | 20                 |                  |                 |
| 1.64    | AM 4.0                  | Antenna Mast 4 m                      | Maturo GmbH                           | AM4.0/180/11920513 |                  |                 |
| 1.65    | HF 907                  | Double-ridged horn                    | Rohde & Schwarz                       | 102444             | 2018-07          | 2021-07         |
| 1.66    | E4408B                  | Spectrum Analyser (9 kHz to 26.5 GHz) | Agilent Technologies Deutschland GmbH | MY45103714         |                  |                 |

2 Radio Lab  
Conducted Radio Test Lab

| Ref.No. | Device Name                 | Description                                    | Manufacturer                                 | Serial Number  | Last Calibration | Calibration Due |
|---------|-----------------------------|------------------------------------------------|----------------------------------------------|----------------|------------------|-----------------|
| 2.1     | SMB100A                     | Signal Generator 9 kHz - 6 GHz                 | Rohde & Schwarz                              | 107695         | 2017-07          | 2020-07         |
| 2.2     | 1575                        | Broadband Resistive Power Divider DC to 40 GHz | API Weinschel, Inc.                          | 4070           |                  |                 |
| 2.3     | FSV30                       | Signal Analyzer 10 Hz - 30 GHz                 | Rohde & Schwarz                              | 103005         | 2018-04          | 2020-04         |
| 2.4     | Fluke 177                   | Digital Multimeter 03 (Multimeter)             | Fluke Europe B.V.                            | 86670383       | 2018-04          | 2020-04         |
| 2.5     | WRD1920/1980-5/22-5EESD     | Tunable Band Reject Filter                     | Wainwright Instruments GmbH                  | 11             |                  |                 |
| 2.6     | WRCD1879.8-0.2/40-10EE      | Notch Filter Ultra Stable                      | Wainwright Instruments GmbH                  | 16             |                  |                 |
| 2.7     | FSIQ26                      | Signal Analyser 20 Hz to 26.5 GHz              | Rohde & Schwarz GmbH & Co. KG                | 840061/005     | 2019-06          | 2021-06         |
| 2.8     | Chroma 6404                 | AC Source                                      | Chroma ATE INC.                              | 64040001304    |                  |                 |
| 2.9     | Temperature Chamber VT 4002 | Temperature Chamber Vötsch 03                  | Vötsch                                       | 58566002150010 | 2018-04          | 2020-04         |
| 2.10    | A8455-4                     | 4 Way Power Divider (SMA)                      |                                              | -              |                  |                 |
| 2.11    | Opus10 THI (8152.00)        | T/H Logger 03                                  | Lufft Mess- und Regeltechnik GmbH            | 7482           | 2019-06          | 2021-06         |
| 2.12    | UNI-T UT195E                | True RMS Digital Multimeter                    | UNI-T UNI-TREND TECHNOLOGY (CHINA) CO., LTD. | C190729561     |                  |                 |
| 2.13    | SMBV100A                    | Vector Signal Generator 9 kHz - 6 GHz          | Rohde & Schwarz                              | 259291         | 2019-11          | 2022-11         |
| 2.14    | Temperature Chamber VT 4002 | Temperature Chamber Vötsch 05                  | Vötsch                                       | 58566080550010 | 2018-04          | 2020-04         |

| Ref.No. | Device Name             | Description          | Manufacturer                | Serial Number | Last Calibration | Calibration Due |
|---------|-------------------------|----------------------|-----------------------------|---------------|------------------|-----------------|
| 2.15    | WRCA800/960-0.2/40-6EEK | Tunable Notch Filter | Wainwright Instruments GmbH | 20            |                  |                 |

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<br>MHz | AF<br>HFH-Z2)<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>(-40 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 |
|------------------|---------------------------|-------------|----------------------------------------------|-----------------------------------------------|-------------------------------------------|-------------------------------------------|------------------------------------------------|----------------------------------------------------------|--------------------------------------------------------|
| 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  
 $\text{AF}$  = Antenna factor  
 $\text{Corr.}$  = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)  
 $\text{distance correction} = -20 * \text{LOG} (d_{\text{Limit}} / d_{\text{used}})$   
 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

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

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.

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

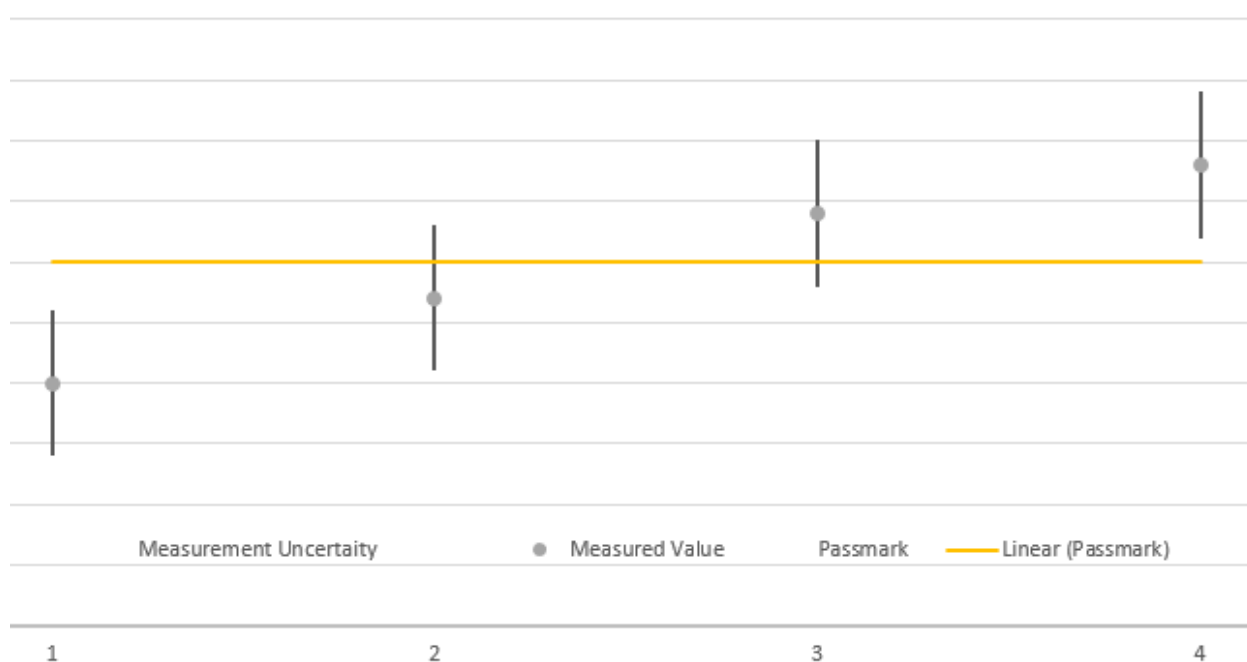
Linear interpolation will be used for frequencies in between the values in the table.

Table shows an extract of values.

## 8 MEASUREMENT UNCERTAINTIES

| Test Case(s)                                                       | Parameter          | Uncertainty                    |
|--------------------------------------------------------------------|--------------------|--------------------------------|
| - Field strength of spurious radiation                             | Field Strength     | $\pm 5.5$ dB                   |
| - Emission and Occupied Bandwidth                                  | Power<br>Frequency | $\pm 2.9$ dB<br>$\pm 11.2$ kHz |
| - RF Output Power<br>- Peak to Average Ratio                       | Power              | $\pm 2.2$ dB                   |
| - Band Edge Compliance<br>- Spurious Emissions at Antenna Terminal | Power<br>Frequency | $\pm 2.2$ dB<br>$\pm 11.2$ kHz |
| - Frequency Stability                                              | Frequency          | $\pm 25$ Hz                    |

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



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

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

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

## 9 PHOTO REPORT

Please see separate photo report.