

# FCC Measurement/Technical Report on

## LARA-R204

According to: FCC Part 15, Subpart B

**FCC ID: XPY1EIQN2NN**

**IC: 8595A-1EIQN2NN**

**Test Report Reference:** MDE\_UBLOX\_1603\_FCCb

### Test Laboratory:

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40880 Ratingen  
Germany



#### Note:

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

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## 1 APPLIED STANDARDS AND TEST SUMMARY

### 1.1 APPLIED STANDARDS

#### **Applicable FCC Rules**

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

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

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

§ 15.107 Conducted limits

§ 15.109 Radiated emission limits; general requirements

Note:

ANSI C63.4–2014 is applied.

### Summary Test Results:

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

### 1.2 FCC-IC CORRELATION TABLE

#### Correlation of measurement requirements for Information Technology Equipment (ITE) from FCC and IC

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

### Remarks:

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

### 1.3 MEASUREMENT SUMMARY / SIGNATURES

#### **47 CFR CHAPTER I FCC PART 15 Subpart B § 15.107**

Conducted Emissions at AC mains

The measurement was performed according to ANSI C63.4

#### **Final Result**

#### **OP-Mode**

AC mains connection, Test setup

via connected computer device, computer peripheral

#### **Setup**

S01\_AY02

#### **FCC**

Passed

#### **IC**

Passed

#### **47 CFR CHAPTER I FCC PART 15 Subpart B § 15.109**

Radiated Emissions

The measurement was performed according to ANSI C63.4

#### **Final Result**

#### **OP-Mode**

AC mains connection, Measurement range, Test setup

via connected computer device, 1 GHz - 10 GHz, computer peripheral

via connected computer device, 30 MHz - 1 GHz, computer peripheral

#### **Setup**

S01\_AY02

S01\_AY02

#### **FCC**

Passed

Passed

#### **IC**

Passed

Passed



(responsible for accreditation  
scope) Dipl. Bernhard Retka



(responsible for testing and report)  
Patrick Lomax

## 2 ADMINISTRATIVE DATA

### 2.1 TESTING LABORATORY

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

This facility has been fully described in a report submitted to the FCC and accepted under the registration number 96716.

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

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

Laboratory accreditation no: DAKKS D-PL-12140-01-01  
Responsible for accreditation scope: Dipl. Marco Kullik  
Report Template Version: 2016-06-07

### 2.2 PROJECT DATA

Responsible for testing and report: Patrick Lomax  
Employees who performed the tests: documented internally at 7Layers  
Date of Report: 2016-09-24  
Testing Period: 2016-09-10 to 2016-09-22

### 2.3 APPLICANT DATA

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

### 2.4 MANUFACTURER DATA

Company Name: See applicant data  
Address:  
Contact Person:

### 3 TEST OBJECT DATA

#### 3.1 GENERAL EUT DESCRIPTION

|                                          |                                |
|------------------------------------------|--------------------------------|
| Kind of Device<br>product description    | LTE Data module                |
| Product name                             | LARA-R204                      |
| Type                                     | LARA-R204                      |
| <b>Declared EUT data by the supplier</b> |                                |
| Power Supply Type                        | DC                             |
| Comment                                  | DC Power via AC/DC adapter     |
| Test Voltage /<br>Frequency              | 120v/60Hz AC                   |
| Highest internal<br>frequency            | Above 108 MHz                  |
| General Description                      | UMTS/LTE Voice and Data module |
| Ports                                    | USB, RF                        |

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

#### 3.2 EUT MAIN COMPONENTS

| Sample Name      | Sample Code     | Description     |
|------------------|-----------------|-----------------|
| Standard Sample  | AY02            | Standard sample |
| Sample Parameter | Value           |                 |
| HW Version       | 266A00          |                 |
| Serial No.       | 357648070021592 |                 |
| SW Version       | 31.02           |                 |

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

#### 3.3 ANCILLARY EQUIPMENT

For the purposes of this test report, ancillary equipment is defined as equipment which is used in conjunction with the EUT to provide operational and control features to the EUT. It is necessary to configure the system in a typical fashion, as a customer would normally use it. But nevertheless Ancillary Equipment can influence the test results.

| Device          | Details<br>(Manufacturer, Type Model, OUT<br>Code) | Description                         |
|-----------------|----------------------------------------------------|-------------------------------------|
| AC/DC converter | UNIFIVE, UUX324-1215, DE1015039                    | 120v/60Hz to 12v<br>AC/DC converter |

| Device                | Details<br>(Manufacturer, Type Model, OUT Code) | Description           |
|-----------------------|-------------------------------------------------|-----------------------|
| <b>Sample Name</b>    | <b>Description</b>                              |                       |
| AC/DC converter       | AC/DC converter                                 |                       |
| Evaluation test board | u-blox, EVB-WL3, DE1015039                      | Evaluation test board |
| <b>Sample Name</b>    | <b>Description</b>                              |                       |
| Evaluation test board | Evaluation test board                           |                       |

### 3.4 AUXILIARY EQUIPMENT

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

| Device                | Details<br>(Manufacturer, HW, SW, S/N) | Description            |
|-----------------------|----------------------------------------|------------------------|
| L17MB-P               | LG, -, -, 412WAPL0U560                 | TFT Display EMC TFT 5  |
| Lifebook Eseries E781 | Fujitsu, -, -, DSCK013817              | Laptop RE              |
| M-BT58                | Logitech, -, -, HC60915A2XC            | EMC MOUSE 1            |
| PJW1942NA             | Fujitsu, -, -, 13300281B               | AC Adapter 3 Laptop RE |
| RS 6000 USB ON        | CHERRY, -, -, G 0000273 2P28           | EMC KEYBOARD 1         |

### 3.5 EUT SETUPS

This chapter describes the combination of EUTs and equipment used for testing. The rationale for selecting the EUTs, ancillary and auxiliary equipment and interconnecting cables, is to test a representative configuration meeting the requirements of the referenced standards.

| Setup    | Combination of EUTs                                                                                                                           | Description and Rationale                                                                                                                                                                        |
|----------|-----------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| S01_AY02 | Standard Sample,<br>Evaluation test board,<br>AC/DC converter,<br>L17MB-P, PJW1942NA,<br>Lifebook Eseries E781,<br>M-BT58, RS 6000 USB<br>ON, | Standard radiated setup used for connecting module to a laptop computer (Windows 7 Pro) via USB. Continuous communication is maintained over the USB interface by the use of AT command scripts. |

### 3.6 OPERATING MODES

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

#### 3.6.1 TEST CHANNELS

Testing performed in UMTS FDD4, Channel 20175 (1732.50 MHz)

### 3.7 PRODUCT LABELLING

#### 3.7.1 FCC ID LABEL

Please refer to the documentation of the applicant.

#### 3.7.2 LOCATION OF THE LABEL ON THE EUT

Please refer to the documentation of the applicant.

## 4 TEST RESULTS

### 4.1 CONDUCTED EMISSIONS AT AC MAINS

Standard **FCC Part 15 Subpart B**

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

#### 4.1.1 TEST DESCRIPTION

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

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

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

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

EMI receiver settings:

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

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

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

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

EMI receiver settings:

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

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

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

The highest value is reported.

#### 4.1.2 TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart B, §15.107

##### Class B:

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

##### Class A:

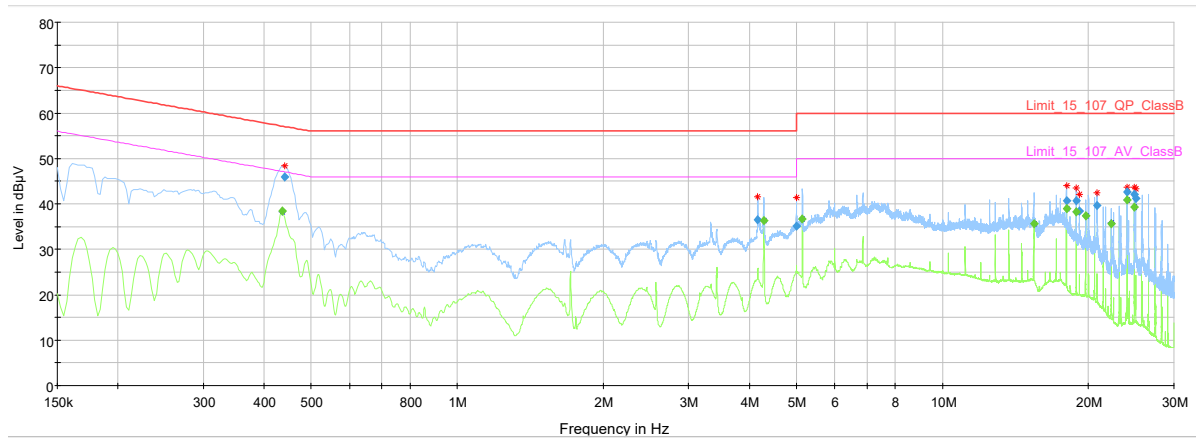
| Frequency (MHz) | QP Limits (dBμV) | AV Limits (dBμV) |
|-----------------|------------------|------------------|
| 0.15 – 0.5      | 79               | 66               |
| 0.5 - 30        | 73               | 60               |

#### 4.1.3 TEST PROTOCOL

| Power line | PE  | Frequency [MHz] | Level [dBμV] | Detector | Limit [dBμV] | Margin [dB] |
|------------|-----|-----------------|--------------|----------|--------------|-------------|
| L1         | GND | 0.4             | 38.4         | AV       | 47.1         | 8.8         |
| L1         | GND | 0.4             | 45.9         | QP       | 57.1         | 11.2        |
| N          | FL  | 4.2             | 36.5         | QP       | 56.0         | 19.5        |
| L1         | GND | 4.3             | 36.3         | AV       | 46.0         | 9.7         |
| N          | GND | 5.0             | 35.1         | QP       | 56.0         | 20.9        |
| L1         | GND | 5.1             | 36.6         | AV       | 50.0         | 13.4        |
| L1         | GND | 15.4            | 35.7         | AV       | 50.0         | 14.4        |
| L1         | GND | 18.0            | 39.0         | AV       | 50.0         | 11.0        |
| L1         | GND | 18.0            | 40.6         | QP       | 60.0         | 19.4        |
| L1         | GND | 18.9            | 40.6         | QP       | 60.0         | 19.4        |
| L1         | GND | 18.9            | 38.2         | AV       | 50.0         | 11.8        |
| L1         | GND | 19.2            | 38.5         | QP       | 60.0         | 21.5        |
| L1         | GND | 19.7            | 37.3         | QP       | 50.0         | 12.7        |
| N          | GND | 20.8            | 39.7         | QP       | 60.0         | 20.3        |
| N          | GND | 22.3            | 35.6         | AV       | 50.0         | 14.4        |
| L1         | GND | 24.0            | 41.0         | AV       | 50.0         | 9.1         |
| L1         | GND | 24.0            | 42.6         | QP       | 60.0         | 17.4        |
| L1         | GND | 24.9            | 39.3         | AV       | 50.0         | 10.7        |
| L1         | GND | 24.9            | 42.1         | QP       | 60.0         | 17.9        |
| L1         | GND | 25.0            | 41.3         | QP       | 60.0         | 18.7        |

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

AC mains connection = via connected computer device, Test setup = computer peripheral



#### 4.1.5 TEST EQUIPMENT USED

Conducted Emissions FCC

## 4.2 RADIATED EMISSIONS

Standard **FCC Part 15 Subpart B**

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

### 4.2.1 TEST DESCRIPTION

The test set-up was made in accordance to the general provisions of ANSI C63.4 in a typical installation configuration. The Equipment Under Test (EUT) was set up on a non-conductive table 1.0 x 2.0 m<sup>2</sup> in the semi-anechoic chamber. The influence of the EUT support table that is used 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-Maxhold / Quasipeak (FFT-based)
- Frequency range: 30 – 1000 MHz
- Frequency steps: 30 kHz
- IF-Bandwidth: 120 kHz
- Measuring time / Frequency step: 100 ms
- Turntable angle range: –180° to 90°
- Turntable step size: 90°
- Height variation range: 1 – 3 m
- Height variation step size: 2 m
- Polarisation: Horizontal + Vertical

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

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

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

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

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

### Step 3: Final measurement with QP detector

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

EMI receiver settings for step 4:

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

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

### 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 90 °.

The turn table step size (azimuth angle) for the preliminary measurement is 45 °.

#### 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, Average
- IF Bandwidth = 1 MHz

#### Step 3:

Spectrum analyser settings for step 3:

- Detector: Peak / Average
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 1 MHz
- Measuring time: 1 s

## 4.2.2 TEST REQUIREMENTS / LIMITS

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

#### Class B:

| Frequency (MHz) | Limit ( $\mu\text{V/m}$ ) | Measurement distance (m) | Limits ( $\text{dB}\mu\text{V/m}$ ) |
|-----------------|---------------------------|--------------------------|-------------------------------------|
| 30 – 88         | 100@3m                    | 3                        | 40.0@3m                             |
| 88 – 216        | 150@3m                    | 3                        | 43.5@3m                             |
| 216 – 960       | 200@3m                    | 3                        | 46.0@3m                             |
| 960 - 26000     | 500@3m                    | 3                        | 54.0@3m                             |
| 26000 - 40000   | 500@3m                    | 1                        | 54.0@3m                             |

#### Class A:

| Frequency (MHz) | Limit ( $\mu\text{V/m}$ ) | Measurement distance (m) | Limits ( $\text{dB}\mu\text{V/m}$ ) |
|-----------------|---------------------------|--------------------------|-------------------------------------|
| 30 – 88         | 90@10m                    | 3                        | 39.1@10m                            |
| 88 – 216        | 150@10m                   | 3                        | 43.5@10m                            |

|               |         |   |          |
|---------------|---------|---|----------|
| 216 – 960     | 210@10m | 3 | 46.4@10m |
| 960 - 26000   | 300@10m | 3 | 49.5@10m |
| 26000 - 40000 | 300@10m | 1 | 49.5@10m |

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

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

Used conversion factor: Limit (dBμV/m) = 20 log (Limit (μV/m)/1μV/m)

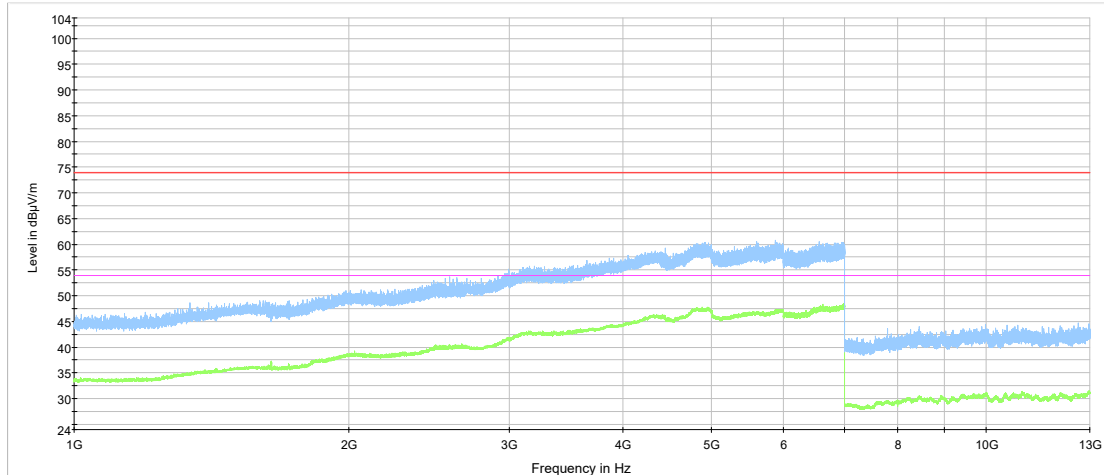
#### 4.2.3 TEST PROTOCOL

| Spurious Freq.<br>[MHz] | Spurious Level<br>[dBμV/m] | Detector | RBW<br>[kHz] | Limit<br>[dBμV/m] | Margin to<br>Limit [dB] |
|-------------------------|----------------------------|----------|--------------|-------------------|-------------------------|
| 39.5                    | 36.4                       | QP       | 120.0        | 40.0              | 3.6                     |
| 48.5                    | 30.6                       | QP       | 120.0        | 40.0              | 9.4                     |
| 69.8                    | 29.5                       | QP       | 120.0        | 40.0              | 10.5                    |
| 82.1                    | 25.9                       | QP       | 120.0        | 40.0              | 14.1                    |
| 86.2                    | 25.5                       | QP       | 120.0        | 40.0              | 14.5                    |
| 117.7                   | 28.8                       | QP       | 120.0        | 43.5              | 14.7                    |
| 133.4                   | 33.0                       | QP       | 120.0        | 43.5              | 10.5                    |
| 194.8                   | 36.3                       | QP       | 120.0        | 43.5              | 7.2                     |
| 356.2                   | 30.6                       | QP       | 120.0        | 46.0              | 15.4                    |

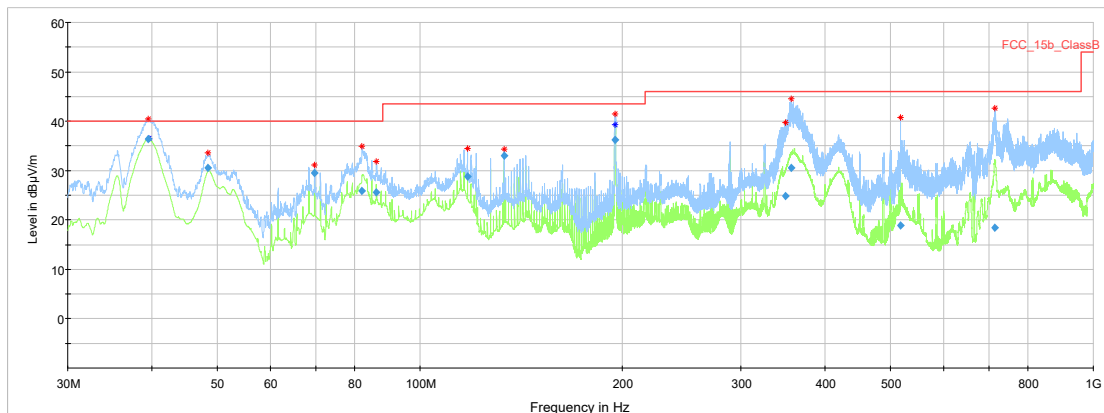
Remark: Please see next sub-clause for the measurement plot.

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

AC mains connection = via connected computer device, Measurement range = 1 GHz - 10 GHz,  
Test setup = computer peripheral



AC mains connection = via connected computer device, Measurement range = 30 MHz - 1 GHz, Test setup = computer peripheral



#### 4.2.5 TEST EQUIPMENT USED

Radiated Emissions FAR  
Radiated Emissions SAC

## 5 TEST EQUIPMENT

- 1 Radiated Emissions FAR  
Lab to perform radiated emission tests i a fully anechoic room

| Ref.No. | Device Name                   | Description                         | Manufacturer                      | Serial Number           | Last Calibration | Calibration Due |
|---------|-------------------------------|-------------------------------------|-----------------------------------|-------------------------|------------------|-----------------|
| 1.1     | WHKX 7.0/18G-8SS              | High Pass Filter                    | Wainwright                        | 09                      |                  |                 |
| 1.2     | 5HC3500/1800 0-1.2-KK         | High Pass Filter                    | Trilithic                         | 200035008               |                  |                 |
| 1.3     | Fully Anechoic Room           | 8.80m x 4.60m x 4.05m (l x w x h)   | Albatross Projects                | P26971-647-001-PRB      |                  |                 |
| 1.4     | TT 1.5 WI                     | Turn Table                          | Maturo GmbH                       | -                       |                  |                 |
| 1.5     | Fluke 177                     | Digital Multimeter 03 (Multimeter)  | Fluke Europe B.V.                 | 86670383                | 2016-02          | 2018-02         |
| 1.6     | Tilt device Maturo (Rohacell) | Antrieb TD1.5-10kg                  | Maturo GmbH                       | TD1.5-10kg/024/37907 09 |                  |                 |
| 1.7     | 5HC2700/1275 0-1.5-KK         | High Pass Filter                    | Trilithic                         | 9942012                 |                  |                 |
| 1.8     | 4HC1600/1275 0-1.5-KK         | High Pass Filter                    | Trilithic                         | 9942011                 |                  |                 |
| 1.9     | ASP 1.2/1.8-10 kg             | Antenna Mast                        | Maturo GmbH                       | -                       |                  |                 |
| 1.10    | JS4-18002600-32-5P            | Broadband Amplifier 18 GHz - 26 GHz | Miteq                             | 849785                  |                  |                 |
| 1.11    | JS4-00101800-35-5P            | Broadband Amplifier 30 MHz - 18 GHz | Miteq                             | 896037                  |                  |                 |
| 1.12    | Opus10 THI (8152.00)          | ThermoHygro Datalogger 12 (Environ) | Lufft Mess- und Regeltechnik GmbH | 12482                   | 2015-03          | 2017-03         |
| 1.13    | JS4-00102600-42-5A            | Broadband Amplifier 30 MHz - 26 GHz | Miteq                             | 619368                  |                  |                 |
| 1.14    | FSW 43                        | Spectrum Analyzer                   | Rohde & Schwarz                   | 103779                  | 2014-11          | 2016-11         |
| 1.15    | SMR 20                        | Signal Generator                    | Rohde & Schwarz                   | 846834/008              | 2014-06          | 2017-06         |
| 1.16    | HL 562 UltraLog               | Log.-per. Antenna                   | Rohde & Schwarz                   | 100609                  | 2016-04          | 2019-04         |
| 1.17    | PAS 2.5 - 10 kg               | Antenna Mast                        | Maturo GmbH                       | -                       |                  |                 |
| 1.18    | HF 907                        | Double-ridged horn                  | Rohde & Schwarz                   | 102444                  | 2015-05          | 2018-05         |

2 Conducted Emissions FCC  
Conducted Emissions power line for FCC standards

| Ref.No. | Device Name          | Description                                   | Manufacturer                      | Serial Number | Last Calibration | Calibration Due |
|---------|----------------------|-----------------------------------------------|-----------------------------------|---------------|------------------|-----------------|
| 2.1     | ESH 3-Z5             | Two-Line V-Network                            | Rohde & Schwarz                   | 828304/029    | 2015-03          | 2017-03         |
| 2.2     | ESR 7                | EMI Receiver / Spectrum Analyzer              | Rohde & Schwarz                   | 101424        | 2014-11          | 2016-11         |
| 2.3     | EP 1200/B, NA/B1     | Amplifier with integrated variable Oscillator | Spitzenberger & Spieß             | B6278         | 2015-07          | 2018-07         |
| 2.4     | Fluke 177            | Digital Multimeter 03 (Multimeter)            | Fluke Europe B.V.                 | 86670383      | 2016-02          | 2018-02         |
| 2.5     | Shielded Room 02     | Shielded Room for conducted testing, 12qm     | Frankonia                         | -             |                  |                 |
| 2.6     | ESIB 26              | Spectrum Analyzer                             | Rohde & Schwarz                   | 830482/004    | 2015-12          | 2017-12         |
| 2.7     | Opus10 THI (8152.00) | ThermoHygro Datalogger 02 (Environ)           | Lufft Mess- und Regeltechnik GmbH | 7489          | 2015-02          | 2017-02         |
| 2.8     | ESH 3-Z5             | Two-Line V-Network                            | Rohde & Schwarz                   | 829996/002    | 2015-03          | 2017-03         |
| 2.9     | Opus10 TPR (8253.00) | ThermoAirpressure Datalogger 13 (Environ)     | Lufft Mess- und Regeltechnik GmbH | 13936         | 2015-02          | 2017-02         |
| 2.10    | Chroma 6404          | AC Power Source                               | Chroma ATE INC.                   | 64040001304   |                  |                 |

3 Radiated Emissions SAC  
Lab to perform radiated emission tests in semi anechoic configuration

| Ref.No. | Device Name      | Description                        | Manufacturer       | Serial Number | Last Calibration | Calibration Due |
|---------|------------------|------------------------------------|--------------------|---------------|------------------|-----------------|
| 3.1     | Anechoic Chamber | 10.58 x 6.38 x 6.00 m <sup>3</sup> | Frankonia          | none          | 2014-01          | 2017-01         |
| 3.2     | Air compressor   | none                               |                    | none          |                  |                 |
| 3.3     | MCU              | Controller Maturo                  | Maturo GmbH        | 961208        |                  |                 |
| 3.4     | BB4312-C30-H3x   | Filter Universal 1A                | Siemens&Matsushita | none          |                  |                 |
| 3.5     | CE-CAM/1         | EMC camera                         | CE-SYS             | none          |                  |                 |

| Ref.No. | Device Name        | Description              | Manufacturer                              | Serial Number             | Last Calibration | Calibration Due |
|---------|--------------------|--------------------------|-------------------------------------------|---------------------------|------------------|-----------------|
| 3.6     | CO 2000            | Controller<br>Innco 2000 | Innco innovative<br>constructions<br>GmbH | CO2000/328/124<br>70406/L |                  |                 |
| 3.7     | CCD-400E           | EMC camera<br>Nr.2       | Mitsubishi                                | 0005033                   |                  |                 |
| 3.8     | B84312-C110-<br>E1 | Filter ISDN              | Siemens&Matsushita                        | none                      |                  |                 |

The calibration interval is the time interval between "Last Calibration" and "Calibration Due"

## 6 ANTENNA FACTORS, CABLE LOSS AND SAMPLE CALCULATIONS

This chapter contains the antenna factors with their corresponding path loss of the used measurement path for all antennas as well as the insertion loss of the LISN.

### 6.1 LISN R&S ESH3-Z5 (150 KHZ – 30 MHZ)

| Frequency |  | Corr. | LISN insertion loss ESH3-Z5 | cable loss (incl. 10 dB attenuator) |
|-----------|--|-------|-----------------------------|-------------------------------------|
| MHz       |  | dB    | dB                          | dB                                  |
| 0,15      |  | 10,1  | 0,1                         | 10,0                                |
| 5         |  | 10,3  | 0,1                         | 10,2                                |
| 7         |  | 10,5  | 0,2                         | 10,3                                |
| 10        |  | 10,5  | 0,2                         | 10,3                                |
| 12        |  | 10,7  | 0,3                         | 10,4                                |
| 14        |  | 10,7  | 0,3                         | 10,4                                |
| 16        |  | 10,8  | 0,4                         | 10,4                                |
| 18        |  | 10,9  | 0,4                         | 10,5                                |
| 20        |  | 10,9  | 0,4                         | 10,5                                |
| 22        |  | 11,1  | 0,5                         | 10,6                                |
| 24        |  | 11,1  | 0,5                         | 10,6                                |
| 26        |  | 11,2  | 0,5                         | 10,7                                |
| 28        |  | 11,2  | 0,5                         | 10,7                                |
| 30        |  | 11,3  | 0,5                         | 10,8                                |

#### Sample calculation

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

## 6.2 ANTENNA R&S HFH2-Z2 (9 KHZ – 30 MHZ)

| Frequency | AF       | Corr. | cable loss 1     | cable loss 2      | cable loss 3  | cable loss 4  | distance corr.  | d <sub>Limit</sub>       | d <sub>used</sub>       |
|-----------|----------|-------|------------------|-------------------|---------------|---------------|-----------------|--------------------------|-------------------------|
| MHz       | dB (1/m) | dB    | (inside chamber) | (outside chamber) | (switch unit) | (to receiver) | (-40 dB/decade) | (meas. distance (limit)) | (meas. distance (used)) |
|           |          |       | dB               | dB                | dB            | dB            | dB              | m                        | m                       |
| 0,009     | 20,50    | -79,6 | 0,1              | 0,1               | 0,1           | 0,1           | -80             | 300                      | 3                       |
| 0,01      | 20,45    | -79,6 | 0,1              | 0,1               | 0,1           | 0,1           | -80             | 300                      | 3                       |
| 0,015     | 20,37    | -79,6 | 0,1              | 0,1               | 0,1           | 0,1           | -80             | 300                      | 3                       |
| 0,02      | 20,36    | -79,6 | 0,1              | 0,1               | 0,1           | 0,1           | -80             | 300                      | 3                       |
| 0,025     | 20,38    | -79,6 | 0,1              | 0,1               | 0,1           | 0,1           | -80             | 300                      | 3                       |
| 0,03      | 20,32    | -79,6 | 0,1              | 0,1               | 0,1           | 0,1           | -80             | 300                      | 3                       |
| 0,05      | 20,35    | -79,6 | 0,1              | 0,1               | 0,1           | 0,1           | -80             | 300                      | 3                       |
| 0,08      | 20,30    | -79,6 | 0,1              | 0,1               | 0,1           | 0,1           | -80             | 300                      | 3                       |
| 0,1       | 20,20    | -79,6 | 0,1              | 0,1               | 0,1           | 0,1           | -80             | 300                      | 3                       |
| 0,2       | 20,17    | -79,6 | 0,1              | 0,1               | 0,1           | 0,1           | -80             | 300                      | 3                       |
| 0,3       | 20,14    | -79,6 | 0,1              | 0,1               | 0,1           | 0,1           | -80             | 300                      | 3                       |
| 0,49      | 20,12    | -79,6 | 0,1              | 0,1               | 0,1           | 0,1           | -80             | 300                      | 3                       |
| 0,490001  | 20,12    | -39,6 | 0,1              | 0,1               | 0,1           | 0,1           | -40             | 30                       | 3                       |
| 0,5       | 20,11    | -39,6 | 0,1              | 0,1               | 0,1           | 0,1           | -40             | 30                       | 3                       |
| 0,8       | 20,10    | -39,6 | 0,1              | 0,1               | 0,1           | 0,1           | -40             | 30                       | 3                       |
| 1         | 20,09    | -39,6 | 0,1              | 0,1               | 0,1           | 0,1           | -40             | 30                       | 3                       |
| 2         | 20,08    | -39,6 | 0,1              | 0,1               | 0,1           | 0,1           | -40             | 30                       | 3                       |
| 3         | 20,06    | -39,6 | 0,1              | 0,1               | 0,1           | 0,1           | -40             | 30                       | 3                       |
| 4         | 20,05    | -39,5 | 0,2              | 0,1               | 0,1           | 0,1           | -40             | 30                       | 3                       |
| 5         | 20,05    | -39,5 | 0,2              | 0,1               | 0,1           | 0,1           | -40             | 30                       | 3                       |
| 6         | 20,02    | -39,5 | 0,2              | 0,1               | 0,1           | 0,1           | -40             | 30                       | 3                       |
| 8         | 19,95    | -39,5 | 0,2              | 0,1               | 0,1           | 0,1           | -40             | 30                       | 3                       |
| 10        | 19,83    | -39,4 | 0,2              | 0,1               | 0,2           | 0,1           | -40             | 30                       | 3                       |
| 12        | 19,71    | -39,4 | 0,2              | 0,1               | 0,2           | 0,1           | -40             | 30                       | 3                       |
| 14        | 19,54    | -39,4 | 0,2              | 0,1               | 0,2           | 0,1           | -40             | 30                       | 3                       |
| 16        | 19,53    | -39,3 | 0,3              | 0,1               | 0,2           | 0,1           | -40             | 30                       | 3                       |
| 18        | 19,50    | -39,3 | 0,3              | 0,1               | 0,2           | 0,1           | -40             | 30                       | 3                       |
| 20        | 19,57    | -39,3 | 0,3              | 0,1               | 0,2           | 0,1           | -40             | 30                       | 3                       |
| 22        | 19,61    | -39,3 | 0,3              | 0,1               | 0,2           | 0,1           | -40             | 30                       | 3                       |
| 24        | 19,61    | -39,3 | 0,3              | 0,1               | 0,2           | 0,1           | -40             | 30                       | 3                       |
| 26        | 19,54    | -39,3 | 0,3              | 0,1               | 0,2           | 0,1           | -40             | 30                       | 3                       |
| 28        | 19,46    | -39,2 | 0,3              | 0,1               | 0,3           | 0,1           | -40             | 30                       | 3                       |
| 30        | 19,73    | -39,1 | 0,4              | 0,1               | 0,3           | 0,1           | -40             | 30                       | 3                       |

### Sample calculation

$E \text{ (dB } \mu\text{V/m)} = U \text{ (dB } \mu\text{V)} + AF \text{ (dB 1/m)} + Corr. \text{ (dB)}$   
 U = Receiver reading  
 AF = Antenna factor  
 Corr. = sum of single correction factors of used cables, switch unit, distance correction, amplifier (if applicable)  
 distance correction =  $-40 * \text{LOG} (d_{\text{Limit}} / d_{\text{used}})$   
 Linear interpolation will be used for frequencies in between the values in the table.  
 Table shows an extract of values

### 6.3 ANTENNA R&S HL562 (30 MHZ – 1 GHZ)

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

| Frequency | AF<br>R&S<br>HL562 | Corr. | 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)) |
|-----------|--------------------|-------|----------------------------------------|-----------------------------------------|-------------------------------------|-------------------------------------|------------------------------------------|------------------------------------------------------|----------------------------------------------------|
| MHz       | dB (1/m)           | dB    | dB                                     | dB                                      | dB                                  | dB                                  | dB                                       | m                                                    | m                                                  |
| 30        | 18,6               | 0,6   | 0,29                                   | 0,04                                    | 0,23                                | 0,02                                | 0,0                                      | 3                                                    | 3                                                  |
| 50        | 6,0                | 0,9   | 0,39                                   | 0,09                                    | 0,32                                | 0,08                                | 0,0                                      | 3                                                    | 3                                                  |
| 100       | 9,7                | 1,2   | 0,56                                   | 0,14                                    | 0,47                                | 0,08                                | 0,0                                      | 3                                                    | 3                                                  |
| 150       | 7,9                | 1,6   | 0,73                                   | 0,20                                    | 0,59                                | 0,12                                | 0,0                                      | 3                                                    | 3                                                  |
| 200       | 7,6                | 1,9   | 0,84                                   | 0,21                                    | 0,70                                | 0,11                                | 0,0                                      | 3                                                    | 3                                                  |
| 250       | 9,5                | 2,1   | 0,98                                   | 0,24                                    | 0,80                                | 0,13                                | 0,0                                      | 3                                                    | 3                                                  |
| 300       | 11,0               | 2,3   | 1,04                                   | 0,26                                    | 0,89                                | 0,15                                | 0,0                                      | 3                                                    | 3                                                  |
| 350       | 12,4               | 2,6   | 1,18                                   | 0,31                                    | 0,96                                | 0,13                                | 0,0                                      | 3                                                    | 3                                                  |
| 400       | 13,6               | 2,9   | 1,28                                   | 0,35                                    | 1,03                                | 0,19                                | 0,0                                      | 3                                                    | 3                                                  |
| 450       | 14,7               | 3,1   | 1,39                                   | 0,38                                    | 1,11                                | 0,22                                | 0,0                                      | 3                                                    | 3                                                  |
| 500       | 15,6               | 3,2   | 1,44                                   | 0,39                                    | 1,20                                | 0,19                                | 0,0                                      | 3                                                    | 3                                                  |
| 550       | 16,3               | 3,5   | 1,55                                   | 0,46                                    | 1,24                                | 0,23                                | 0,0                                      | 3                                                    | 3                                                  |
| 600       | 17,2               | 3,5   | 1,59                                   | 0,43                                    | 1,29                                | 0,23                                | 0,0                                      | 3                                                    | 3                                                  |
| 650       | 18,1               | 3,6   | 1,67                                   | 0,34                                    | 1,35                                | 0,22                                | 0,0                                      | 3                                                    | 3                                                  |
| 700       | 18,5               | 3,6   | 1,67                                   | 0,42                                    | 1,41                                | 0,15                                | 0,0                                      | 3                                                    | 3                                                  |
| 750       | 19,1               | 4,1   | 1,87                                   | 0,54                                    | 1,46                                | 0,25                                | 0,0                                      | 3                                                    | 3                                                  |
| 800       | 19,6               | 4,1   | 1,90                                   | 0,46                                    | 1,51                                | 0,25                                | 0,0                                      | 3                                                    | 3                                                  |
| 850       | 20,1               | 4,4   | 1,99                                   | 0,60                                    | 1,56                                | 0,27                                | 0,0                                      | 3                                                    | 3                                                  |
| 900       | 20,8               | 4,7   | 2,14                                   | 0,60                                    | 1,63                                | 0,29                                | 0,0                                      | 3                                                    | 3                                                  |
| 950       | 21,1               | 4,8   | 2,22                                   | 0,60                                    | 1,66                                | 0,33                                | 0,0                                      | 3                                                    | 3                                                  |
| 1000      | 21,6               | 4,9   | 2,23                                   | 0,61                                    | 1,71                                | 0,30                                | 0,0                                      | 3                                                    | 3                                                  |

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

|      |      |      |      |      |      |      |       |    |   |
|------|------|------|------|------|------|------|-------|----|---|
| 30   | 18,6 | -9,9 | 0,29 | 0,04 | 0,23 | 0,02 | -10,5 | 10 | 3 |
| 50   | 6,0  | -9,6 | 0,39 | 0,09 | 0,32 | 0,08 | -10,5 | 10 | 3 |
| 100  | 9,7  | -9,2 | 0,56 | 0,14 | 0,47 | 0,08 | -10,5 | 10 | 3 |
| 150  | 7,9  | -8,8 | 0,73 | 0,20 | 0,59 | 0,12 | -10,5 | 10 | 3 |
| 200  | 7,6  | -8,6 | 0,84 | 0,21 | 0,70 | 0,11 | -10,5 | 10 | 3 |
| 250  | 9,5  | -8,3 | 0,98 | 0,24 | 0,80 | 0,13 | -10,5 | 10 | 3 |
| 300  | 11,0 | -8,1 | 1,04 | 0,26 | 0,89 | 0,15 | -10,5 | 10 | 3 |
| 350  | 12,4 | -7,9 | 1,18 | 0,31 | 0,96 | 0,13 | -10,5 | 10 | 3 |
| 400  | 13,6 | -7,6 | 1,28 | 0,35 | 1,03 | 0,19 | -10,5 | 10 | 3 |
| 450  | 14,7 | -7,4 | 1,39 | 0,38 | 1,11 | 0,22 | -10,5 | 10 | 3 |
| 500  | 15,6 | -7,2 | 1,44 | 0,39 | 1,20 | 0,19 | -10,5 | 10 | 3 |
| 550  | 16,3 | -7,0 | 1,55 | 0,46 | 1,24 | 0,23 | -10,5 | 10 | 3 |
| 600  | 17,2 | -6,9 | 1,59 | 0,43 | 1,29 | 0,23 | -10,5 | 10 | 3 |
| 650  | 18,1 | -6,9 | 1,67 | 0,34 | 1,35 | 0,22 | -10,5 | 10 | 3 |
| 700  | 18,5 | -6,8 | 1,67 | 0,42 | 1,41 | 0,15 | -10,5 | 10 | 3 |
| 750  | 19,1 | -6,3 | 1,87 | 0,54 | 1,46 | 0,25 | -10,5 | 10 | 3 |
| 800  | 19,6 | -6,3 | 1,90 | 0,46 | 1,51 | 0,25 | -10,5 | 10 | 3 |
| 850  | 20,1 | -6,0 | 1,99 | 0,60 | 1,56 | 0,27 | -10,5 | 10 | 3 |
| 900  | 20,8 | -5,8 | 2,14 | 0,60 | 1,63 | 0,29 | -10,5 | 10 | 3 |
| 950  | 21,1 | -5,6 | 2,22 | 0,60 | 1,66 | 0,33 | -10,5 | 10 | 3 |
| 1000 | 21,6 | -5,6 | 2,23 | 0,61 | 1,71 | 0,30 | -10,5 | 10 | 3 |

#### Sample calculation

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

#### 6.4 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.

## 6.5 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.

## 6.6 ANTENNA EMCO 3160-10 (18 GHZ – 26.5 GHZ)

| Frequency | AF<br>EMCO<br>3160-10 | Corr. | 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 <sub>Limit</sub><br>(meas.<br>distance<br>(limit)) | d <sub>used</sub><br>(meas.<br>distance<br>(used)) |
|-----------|-----------------------|-------|----------------------------------------|-----------------------------------------|-------------------------------------|-------------------------------------|------------------------------------------|------------------------------------------------------|----------------------------------------------------|
| GHz       | dB (1/m)              | dB    | dB                                     | dB                                      | dB                                  | dB                                  | dB                                       | m                                                    | m                                                  |
| 26,5      | 43,4                  | -11,2 | 4,4                                    |                                         |                                     |                                     | -15,6                                    | 3                                                    | 0,5                                                |
| 27,0      | 43,4                  | -11,2 | 4,4                                    |                                         |                                     |                                     | -15,6                                    | 3                                                    | 0,5                                                |
| 28,0      | 43,4                  | -11,1 | 4,5                                    |                                         |                                     |                                     | -15,6                                    | 3                                                    | 0,5                                                |
| 29,0      | 43,5                  | -11,0 | 4,6                                    |                                         |                                     |                                     | -15,6                                    | 3                                                    | 0,5                                                |
| 30,0      | 43,5                  | -10,9 | 4,7                                    |                                         |                                     |                                     | -15,6                                    | 3                                                    | 0,5                                                |
| 31,0      | 43,5                  | -10,8 | 4,7                                    |                                         |                                     |                                     | -15,6                                    | 3                                                    | 0,5                                                |
| 32,0      | 43,5                  | -10,7 | 4,8                                    |                                         |                                     |                                     | -15,6                                    | 3                                                    | 0,5                                                |
| 33,0      | 43,6                  | -10,7 | 4,9                                    |                                         |                                     |                                     | -15,6                                    | 3                                                    | 0,5                                                |
| 34,0      | 43,6                  | -10,6 | 5,0                                    |                                         |                                     |                                     | -15,6                                    | 3                                                    | 0,5                                                |
| 35,0      | 43,6                  | -10,5 | 5,1                                    |                                         |                                     |                                     | -15,6                                    | 3                                                    | 0,5                                                |
| 36,0      | 43,6                  | -10,4 | 5,1                                    |                                         |                                     |                                     | -15,6                                    | 3                                                    | 0,5                                                |
| 37,0      | 43,7                  | -10,3 | 5,2                                    |                                         |                                     |                                     | -15,6                                    | 3                                                    | 0,5                                                |
| 38,0      | 43,7                  | -10,2 | 5,3                                    |                                         |                                     |                                     | -15,6                                    | 3                                                    | 0,5                                                |
| 39,0      | 43,7                  | -10,2 | 5,4                                    |                                         |                                     |                                     | -15,6                                    | 3                                                    | 0,5                                                |
| 40,0      | 43,8                  | -10,1 | 5,5                                    |                                         |                                     |                                     | -15,6                                    | 3                                                    | 0,5                                                |

### Sample calculation

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

U = Receiver reading

AF = Antenna factor

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

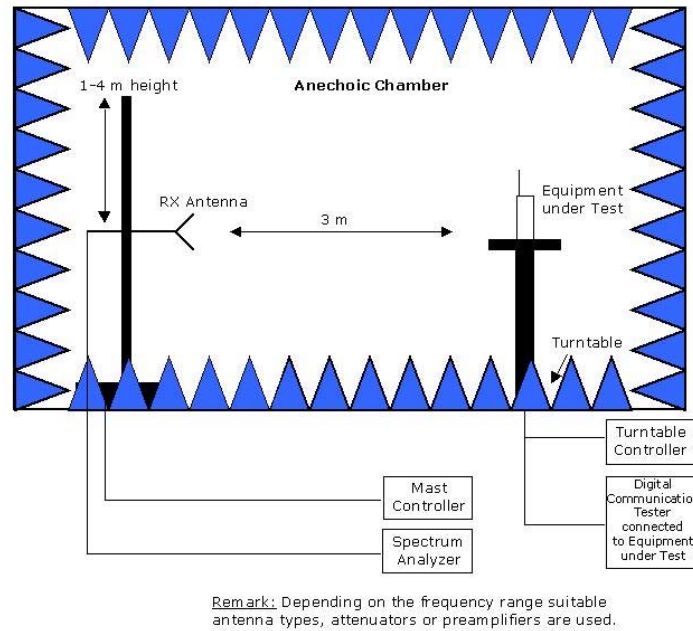
Linear interpolatisation will be used for frequencies in between the values in the table.

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

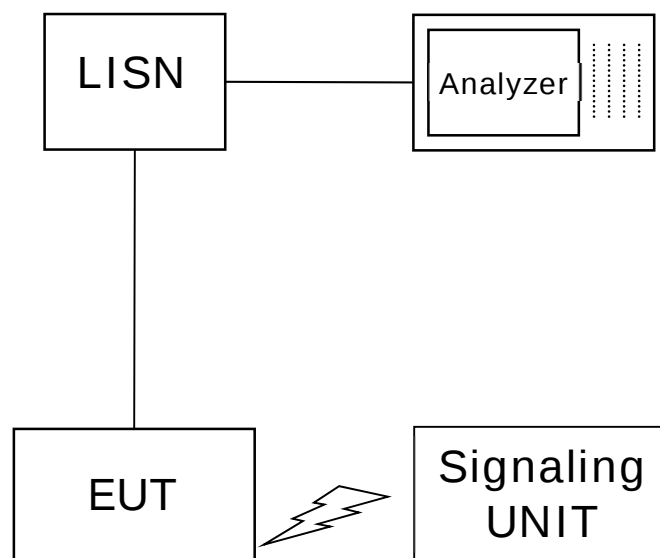
Linear interpolation will be used for frequencies in between the values in the table.

Table shows an extract of values.

## 7 SETUP DRAWINGS



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



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

## 8 MEASUREMENT UNCERTAINTIES

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

## 9 PHOTO REPORT

Please see separate photo report.