

FCC Measurement/Technical Report on Infotainment device LICU

FCC ID: 2AUGZLICU
IC: 25426-LICU

Test Report Reference: MDE_FAKT_1901_FCC03

Test Laboratory:

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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 an Intentional Radiator.

Applicable FCC Rules

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

Part 2, Subpart J - Equipment Authorization Procedures, Certification

Part 15, Subpart C – Intentional Radiators

§ 15.201 Equipment authorization requirement

§ 15.207 Conducted limits

§ 15.209 Radiated emission limits; general requirements

§ 15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz

Note:

The tests were selected and performed with reference to the FCC Public Notice "Guidance for Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating under Section 15.247 of the FCC Rules, 558074 D01 15.247 Meas Guidance v05r02, 2019-04-02". ANSI C63.10-2013 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
DTS (e.g. WLAN 2.4 GHz, BT LE) equipment
from
FCC and IC**

DTS equipment

| Measurement | FCC reference | IC reference |
|---|-------------------------------|---|
| Conducted emissions on AC Mains | § 15.207 | RSS-Gen Issue 5: 8.8 |
| Occupied bandwidth | § 15.247 (a) (2) | RSS-247 Issue 2: 5.2 (a) |
| Peak conducted output power | § 15.247 (b) (3), (4) | RSS-247 Issue 2: 5.4 (d) |
| Transmitter spurious RF conducted emissions | § 15.247 (d) | RSS-Gen Issue 5: 6.13 / 8.9/8.10; RSS-247 Issue 2: 5.5 |
| Transmitter spurious radiated emissions | § 15.247 (d); § 15.209 (a) | RSS-Gen Issue 5: 6.13 / 8.9/8.10; RSS-247 Issue 2: 5.5 |
| Band edge compliance | § 15.247 (d) | RSS-247 Issue 2: 5.5 |
| Power density | § 15.247 (e) | RSS-247 Issue 2: 5.2 (b) |
| Antenna requirement | § 15.203 / 15.204 | RSS-Gen Issue 5: 8.3 |
| Receiver spurious emissions | - | - |

1.3 MEASUREMENT SUMMARY / SIGNATURES

47 CFR CHAPTER I FCC PART 15 § 15.247 (b) (1) (2)
Subpart C §15.247

Peak Power Output

The measurement was performed according to ANSI C63.10

Final Result

| OP-Mode | Setup | Date | FCC | IC |
|--|--------------|-------------|------------|-----------|
| Radio Technology, Operating Frequency, Measurement method | | | | |
| WLAN b-mode, high, conducted | Setup_AC01 | 2019-10-08 | Passed | Passed |
| WLAN b-mode, low, conducted | Setup_AC01 | 2019-10-08 | Passed | Passed |
| WLAN b-mode, mid, conducted | Setup_AC01 | 2019-10-08 | Passed | Passed |

N/A: Not applicable

N/P: Not performed

2 REVISION HISTORY

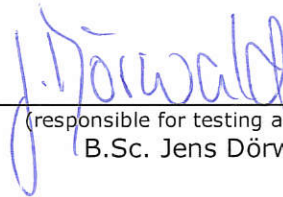
| Report version control | | | |
|------------------------|--------------|--------------------|------------------|
| Version | Release date | Change Description | Version validity |
| initial | 2019-10-16 | -- | valid |
| -- | -- | -- | -- |

COMMENT:

Not all applicable tests were performed, according to "KDB996369 D04 Module Integration Guide v01" only spot checks for conducted output power were performed.



(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: 2019-06-18

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: 2019-10-16

Testing Period: 2019-09-03 to 2019-09-03

3.3 APPLICANT DATA

Company Name: FAKT S.r.l.
Address: Via Lithos, 53
25086 Rezzato (BS)
Italy
Contact Person: Sig. Nicola Scartapacchio

3.4 MANUFACTURER DATA

Company Name: ART S.p.A.
Address: Voc. Pischello, 20
Passignano sul Trasimeno (PG)
Italy
Contact Person: Mr. Riccardo Diamanti

4 TEST OBJECT DATA

4.1 GENERAL EUT DESCRIPTION

| | |
|--|---|
| Kind of Device product description | Infotainment device |
| Product name | LICU |
| Type | LICU |
| Declared EUT data by the supplier | |
| Voltage Type | DC |
| Voltage Level | 12 V |
| Tested Modulation Type | WLAN b-mode |
| General product description | The EUT is vehicular infotainment device including cellular, Bluetooth and WLAN RF technologies. |
| The EUT provides the following ports: | DC Cellular Antenna Bluetooth Antenna GPS Antenna AM/FM Antenna DAB Antenna |
| Tested datarates | 1 Mbps |

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

4.2 EUT MAIN COMPONENTS

| Sample Name | Sample Code | Description |
|------------------|---------------|------------------|
| EUT A | DE1052014ac01 | conducted sample |
| Sample Parameter | Value | |
| Serial No. | AFLIC000X76 | |
| HW Version | 06 | |
| SW Version | 0131 | |
| Comment | - | |

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

4.3 ANCILLARY EQUIPMENT

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

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

4.4 AUXILIARY EQUIPMENT

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

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

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 |
|------------|---------------------|---------------------------|
| Setup_AB01 | EUT A | Conducted setup |

4.6 OPERATING MODES

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

4.6.1 TEST CHANNELS

WLAN
20 MHz Test Channels:
Channel:
Frequency [MHz]

| 2.4 GHz ISM 2400 - 2483.5 MHz | | |
|--|------------|-------------|
| low | mid | high |
| 1 | 6 | 11 |
| 2412 | 2437 | 2462 |

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 PEAK POWER OUTPUT

Standard **FCC Part 15 Subpart C**

The test was performed according to:
ANSI C63.10

5.1.1 TEST DESCRIPTION

FHSS EQUIPMENT:

The Equipment Under Test (EUT) was set up to perform the output power measurements. The results recorded were measured with the modulation which produces the worst-case (highest) output power. The reference level of the spectrum analyzer was set higher than the output power of the EUT.

The EUT was connected to the spectrum analyzer via a short coax cable with a known loss.

Analyzer settings:

- Resolution Bandwidth (RBW): 3 MHz
- Video Bandwidth (VBW): 3 MHz
- Trace: Maxhold
- Sweeps: 2000
- Sweeptime: 5 ms
- Detector: Peak

DTS EQUIPMENT:

The Equipment Under Test (EUT) was set up to perform the output power measurements. The results recorded were measured with the modulation which produces the worst-case (highest) output power. The reference level of the spectrum analyzer was set higher than the output power of the EUT.

The EUT was connected to the spectrum analyzer via a short coax cable with a known loss.

Analyzer settings:

- Resolution Bandwidth (RBW): 1 MHz
- Video Bandwidth (VBW): 3 MHz
- Trace: Maxhold
- Sweeps: 2000
- Sweeptime: 5 ms
- Detector: Peak

The channel power function of the spectrum analyser was used (Used channel bandwidth = DTS bandwidth)

5.1.2 TEST REQUIREMENTS / LIMITS

DTS devices:

FCC Part 15, Subpart C, §15.247 (b) (3)

For systems using digital modulation techniques in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands: 1 watt.

==> Maximum conducted peak output power: 30 dBm (excluding antenna gain, if antennas with directional gains that do not exceed 6 dBi are used).

Frequency Hopping Systems:

FCC Part 15, Subpart C, §15.247 (b) (1)

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

FCC Part 15, Subpart C, §15.247 (b) (2)

For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

Used conversion factor: Limit (dBm) = 10 log (Limit (W)/1mW)

5.1.3 TEST PROTOCOL

Ambient temperature: 24 °C
Humidity: 43 %

| Band | Channel No. | Frequency [MHz] | Peak Power [dBm] | Limit [dBm] | Margin to Limit [dB] |
|-------------|-------------|-----------------|------------------|-------------|----------------------|
| 2.4 GHz ISM | 1 | 2412 | 5.8 | 30.0 | 24.2 |
| | 6 | 2437 | 6.1 | 30.0 | 23.9 |
| | 11 | 2462 | 6.3 | 30.0 | 23.7 |

5.1.4 TEST EQUIPMENT USED

- R&S TS8997

6 TEST EQUIPMENT

1 R&S TS8997
EN300328/301893 Test Lab

| Ref.No. | Device Name | Description | Manufacturer | Serial Number | Last Calibration | Calibration Due |
|---------|-----------------------------|--|-----------------------------------|----------------|------------------|-----------------|
| 1.1 | SMB100A | Signal Generator 9 kHz - 6 GHz | Rohde & Schwarz | 107695 | 2017-07 | 2020-07 |
| 1.2 | FSV30 | Signal Analyzer 10 Hz - 30 GHz | Rohde & Schwarz | 103005 | 2018-04 | 2020-04 |
| 1.3 | Fluke 177 | Digital Multimeter 03 (Multimeter) | Fluke Europe B.V. | 86670383 | 2018-04 | 2020-04 |
| 1.4 | Temperature Chamber VT 4002 | Temperature Chamber Vötsch 03 | Vötsch | 58566002150010 | 2018-04 | 2020-04 |
| 1.5 | A8455-4 | 4 Way Power Divider (SMA) | | - | | |
| 1.6 | Opus10 THI (8152.00) | ThermoHygro Datalogger 03 | Lufft Mess- und Regeltechnik GmbH | ID 7482 | 2019-06 | 2021-06 |
| 1.7 | SMBV100A | Vector Signal Generator 9 kHz - 6 GHz | Rohde & Schwarz | 259291 | 2016-10 | 2019-10 |
| 1.8 | OSP120 | Switching Unit with integrated power meter | Rohde & Schwarz | 101158 | 2018-05 | 2021-05 |

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 MHz | Corr. dB | LISN insertion loss ESH3- Z5 dB | cable loss (incl. 10 dB atten- uator) 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 MHz | AF HFH-Z2) dB (1/m) | Corr. dB | cable loss 1 (inside chamber) dB | cable loss 2 (outside chamber) dB | cable loss 3 (switch unit) dB | cable loss 4 (to receiver) dB | distance corr. (-40 dB/ decade) dB | d _{Limit} (meas. distance (limit) m | d _{used} (meas. distance (used) 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)

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

| Frequency MHz | AF R&S HL562 dB (1/m) | Corr. 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 loss 1 (inside chamber) dB | cable loss 2 (outside chamber) dB | cable loss 3 (switch unit) dB | cable loss 4 (to receiver) dB | distance corr. (-20 dB/ decade) dB | d_{Limit} (meas. distance (limit)) m | d_{used} (meas. distance (used)) 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 |

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

| Frequency MHz | AF R&S HL562 dB (1/m) | Corr. dB |
|------------------|--------------------------------|-------------|
| 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 |

| cable loss 1 (inside chamber) dB | cable loss 2 (outside chamber) dB | cable loss 3 (switch unit) dB | cable loss 4 (to receiver) dB | distance corr. (-20 dB/ decade) dB | d_{Limit} (meas. distance (limit)) m | d_{used} (meas. distance (used)) m |
|--|---|---|---|--|--|--|
| 0.29 | 0.04 | 0.23 | 0.02 | -10.5 | 10 | 3 |
| 0.39 | 0.09 | 0.32 | 0.08 | -10.5 | 10 | 3 |
| 0.56 | 0.14 | 0.47 | 0.08 | -10.5 | 10 | 3 |
| 0.73 | 0.20 | 0.59 | 0.12 | -10.5 | 10 | 3 |
| 0.84 | 0.21 | 0.70 | 0.11 | -10.5 | 10 | 3 |
| 0.98 | 0.24 | 0.80 | 0.13 | -10.5 | 10 | 3 |
| 1.04 | 0.26 | 0.89 | 0.15 | -10.5 | 10 | 3 |
| 1.18 | 0.31 | 0.96 | 0.13 | -10.5 | 10 | 3 |
| 1.28 | 0.35 | 1.03 | 0.19 | -10.5 | 10 | 3 |
| 1.39 | 0.38 | 1.11 | 0.22 | -10.5 | 10 | 3 |
| 1.44 | 0.39 | 1.20 | 0.19 | -10.5 | 10 | 3 |
| 1.55 | 0.46 | 1.24 | 0.23 | -10.5 | 10 | 3 |
| 1.59 | 0.43 | 1.29 | 0.23 | -10.5 | 10 | 3 |
| 1.67 | 0.34 | 1.35 | 0.22 | -10.5 | 10 | 3 |
| 1.67 | 0.42 | 1.41 | 0.15 | -10.5 | 10 | 3 |
| 1.87 | 0.54 | 1.46 | 0.25 | -10.5 | 10 | 3 |
| 1.90 | 0.46 | 1.51 | 0.25 | -10.5 | 10 | 3 |
| 1.99 | 0.60 | 1.56 | 0.27 | -10.5 | 10 | 3 |
| 2.14 | 0.60 | 1.63 | 0.29 | -10.5 | 10 | 3 |
| 2.22 | 0.60 | 1.66 | 0.33 | -10.5 | 10 | 3 |
| 2.23 | 0.61 | 1.71 | 0.30 | -10.5 | 10 | 3 |

Sample calculation

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

U = Receiver reading

AF = Antenna factor

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

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

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

Tables show an extract of values.

7.4 ANTENNA R&S HF907 (1 GHZ – 18 GHZ)

| Frequency | AF R&S HF907 | Corr. |
|-----------|--------------|-------|
| 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 loss 1 (relay + cable inside chamber) | cable loss 2 (outside chamber) | cable loss 3 (switch unit, attenuator & pre-amp) | cable loss 4 (to 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 R&S 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 loss 1 (relay inside chamber) | cable loss 2 (inside chamber) | cable loss 3 (outside chamber) | cable loss 4 (switch unit, attenuator & pre-amp) | cable loss 5 (to receiver) | used for FCC 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 R&S 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 loss 1 (relay inside chamber) | cable loss 2 (High Pass) | cable loss 3 (pre-amp) | cable loss 4 (inside chamber) | cable loss 5 (outside chamber) | cable loss 6 (to receiver) |
|-------------------------------------|--------------------------|------------------------|-------------------------------|--------------------------------|----------------------------|
| dB | dB | dB | dB | dB | dB |
| 0.56 | 1.28 | -62.72 | 2.66 | 0.94 | 1.46 |
| 0.69 | 0.71 | -61.49 | 2.84 | 1.00 | 1.53 |
| 0.68 | 0.65 | -60.80 | 3.06 | 1.09 | 1.60 |
| 0.70 | 0.54 | -61.91 | 3.28 | 1.20 | 1.67 |
| 0.80 | 0.61 | -61.40 | 3.43 | 1.27 | 1.70 |
| 0.84 | 0.42 | -59.70 | 3.53 | 1.26 | 1.73 |
| 0.83 | 0.44 | -59.81 | 3.75 | 1.32 | 1.83 |
| 0.91 | 0.53 | -63.03 | 3.91 | 1.40 | 1.77 |
| 0.98 | 0.54 | -61.05 | 4.02 | 1.44 | 1.83 |
| 1.23 | 0.49 | -61.51 | 4.17 | 1.51 | 1.85 |
| 1.36 | 0.76 | -62.36 | 4.34 | 1.53 | 2.00 |
| 1.70 | 0.53 | -62.88 | 4.41 | 1.55 | 1.91 |

Sample calculation

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

U = Receiver reading

AF = Antenna factor

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

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

Tables show an extract of values.

7.5 ANTENNA EMCO 3160-09 (18 GHZ – 26.5 GHZ)

| Frequency MHz | AF EMCO 3160-09 dB (1/m) | Corr. dB | cable loss 1 (inside chamber) dB | cable loss 2 (pre- amp) dB | cable loss 3 (inside chamber) dB | cable loss 4 (switch unit) dB | cable loss 5 (to receiver) 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

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

U = Receiver reading

AF = Antenna factor

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

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

Table shows an extract of values.

7.6 ANTENNA EMCO 3160-10 (26.5 GHZ – 40 GHZ)

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

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

U = Receiver reading

AF = Antenna factor

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

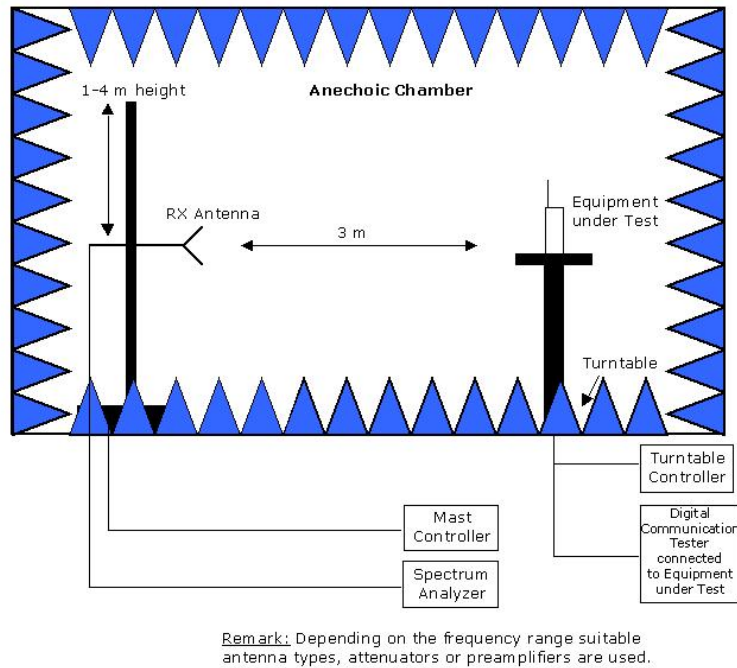
Linear interpolation will be used for frequencies in between the values in the table.

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

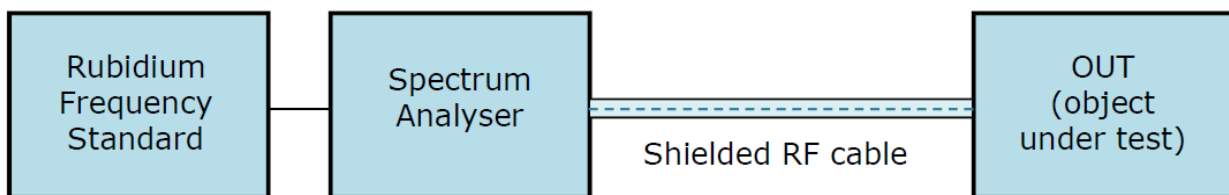
Linear interpolation will be used for frequencies in between the values in the table.

Table shows an extract of values.

8 SETUP DRAWINGS



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

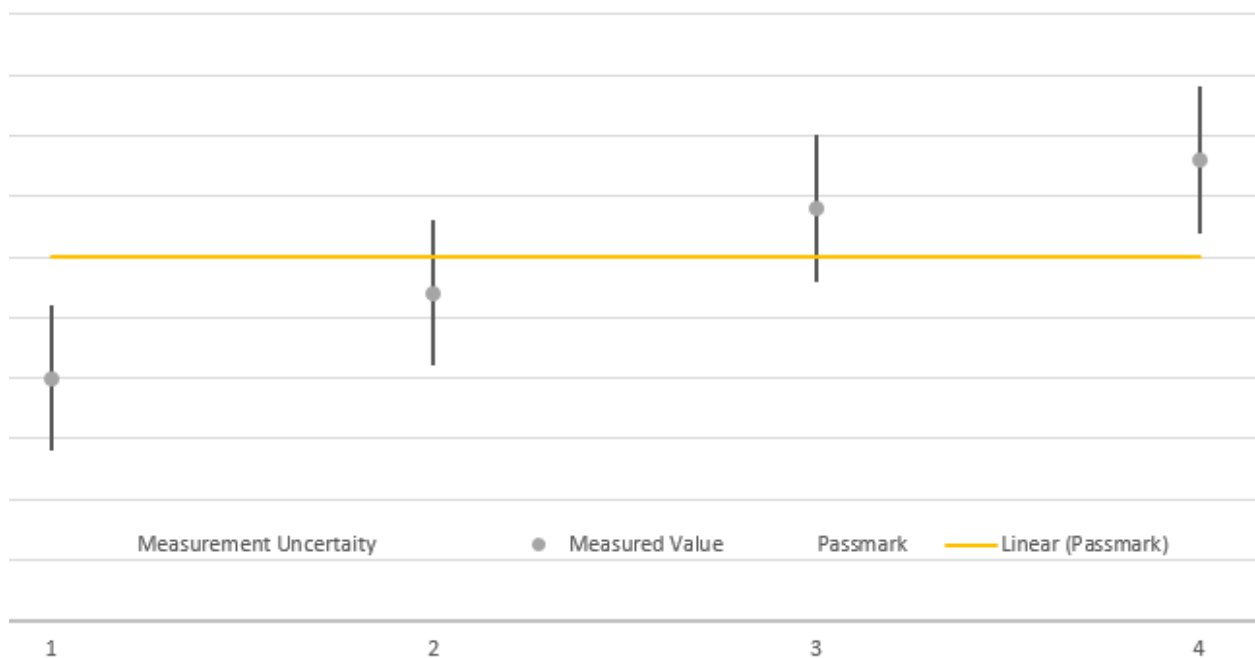


Drawing 2: Setup for conducted radio tests.

9 MEASUREMENT UNCERTAINTIES

| Test Case | Parameter | Uncertainty |
|--------------------------------------|--------------------|--------------------------------|
| AC Power Line | Power | ± 3.4 dB |
| Field Strength of spurious radiation | Power | ± 5.5 dB |
| 6 dB / 26 dB / 99% Bandwidth | Power Frequency | ± 2.9 dB ± 11.2 kHz |
| Conducted Output Power | Power | ± 2.2 dB |
| Band Edge Compliance | Power Frequency | ± 2.2 dB ± 11.2 kHz |
| Frequency Stability | Frequency | ± 25 Hz |
| Power Spectral Density | Power | ± 2.2 dB |

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.

10 PHOTO REPORT

Please see separate photo report.