

FCC Measurement/Technical Report on

W-LAN + Bluetooth Module

1PJ

FCC ID: VPYLBEE5ZZ1PJ

IC: 772C-LBEE5ZZ1PJ

Test Report Reference: MDE_JABIL_2006_FCC_10

Test Laboratory:

7layers GmbH
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Germany



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

Note:

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

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1 APPLIED STANDARDS AND TEST SUMMARY

1.1 APPLIED STANDARDS

Type of Authorization

Certification for a cellular mobile device.

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 2 and 27, (10-1-20 Edition). The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

Part 27; Miscellaneous Wireless Communications Services Subpart C – Technical standards

§ 27.50 – Power and duty cycle limits

§ 27.53 – Emission limits

§ 27.54 – Frequency stability

The tests were selected and performed with reference to:

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

1.2 FCC-IC CORRELATION TABLE

N/A

1.3 MEASUREMENT SUMMARY

47 CFR CHAPTER I FCC PART 27 Subpart C § 2.1053 § 27.53

Field strength of spurious radiation
 The measurement was performed according to ANSI C63.26

| OP-Mode | Setup | Date | Final Result FCC |
|---|----------|------------|------------------|
| Radio Technology, Measurement method eFDD 12 LTE + BT CH 39, radiated > 1 GHz | S01_AE01 | 2022-03-27 | Passed |

47 CFR CHAPTER I FCC PART 27 Subpart C § 2.1053 § 27.53

Field strength of spurious radiation
 The measurement was performed according to ANSI C63.26

| OP-Mode | Setup | Date | Final Result FCC |
|--|----------|------------|------------------|
| Radio Technology, Measurement method eFDD 12 LTE + WLAN 2.4 GHz CH 6, radiated > 1 GHz | S01_AD01 | 2022-03-27 | Passed |

47 CFR CHAPTER I FCC PART 27 Subpart C § 2.1053 § 27.53

Field strength of spurious radiation
 The measurement was performed according to ANSI C63.26

| OP-Mode | Setup | Date | Final Result FCC |
|--|----------|------------|------------------|
| Radio Technology, Measurement method eFDD 13 LTE + WLAN 5 GHz CH 165, radiated > 1 GHz | S01_AD01 | 2022-04-01 | Passed |

2 REVISION HISTORY / SIGNATURES

| Report version control | | | |
|------------------------|--------------|--------------------|------------------|
| Version | Release date | Change Description | Version validity |
| initial | 2022-08-03 | -- | valid |

COMMENT: Not all applicable tests are performed, according to "KDB996369 D04 Module Integration Guide v02" spot checks for radiated spurious emissions tests in simultaneous transmission modes are performed.
 Tests are performed above 1 GHz.

The module was measured within the final end product, which was used as an evaluation board for executing the tests.

This report is a replacement of the report with reference:
 MDE_JABIL_2006_FCC_05_rev01

| | | |
|---|---|--|
|  (responsible for accreditation scope) Dipl.-Ing. Bernhard Retka |  7layers GmbH, Borsigstr. 11 3880 Ratingen, Germany Phone +49 (0)2102 749 0 |  (responsible for testing and report) B.Sc. Jens Dörwald |
|---|---|--|

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| -02 | -03
FCC Designation Number: DE0015
FCC Test Firm Registration: 929146
ISED CAB Identifier: DE0007; ISED#: 3699A
Responsible for accreditation scope: Dipl.-Ing. Bernhard Retka
Report Template Version: 2021-09-09

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: 2022-08-03
Testing Period: 2022-03-27 to 2022-04-01

3.3 APPLICANT DATA

Company Name: Murata Manufacturing Co., Ltd.
Address: 10-1, Higashikotari 1-chome,
Nagaokakyo-shi, Kyoto 617-8555,
Japan
Contact Person:

3.4 MANUFACTURER DATA

Company Name: Please see Applicant Data

Address:

Contact Person:

4 TEST OBJECT DATA

4.1 GENERAL EUT DESCRIPTION

| | |
|--|---|
| Kind of Device product description | W-LAN + Bluetooth Module |
| Product name | W-LAN + Bluetooth Module |
| Type | 1PJ |
| Declared EUT data by the supplier | |
| General product description | The EUT is a W-LAN + Bluetooth module |
| Voltage Level | 3.3 V |
| Voltage Type | DC |
| Special software and power settings used for testing | Software "QRCT" provided by applicant used for setting test modes. |

4.2 EUT MAIN COMPONENTS

| Sample Name | Sample Code | Description |
|------------------|----------------------------------|-----------------|
| EUT ae01 | DE1102015ae01 | Radiated sample |
| Sample Parameter | Value | |
| Serial No. | J213430005 | |
| HW Version | - | |
| SW Version | 234500024538185 | |
| Comment | BT and Cellular test mode sample | |

| Sample Name | Sample Code | Description |
|------------------|------------------------------------|-----------------|
| EUT ad01 | DE1102015ad01 | Radiated sample |
| Sample Parameter | Value | |
| Serial No. | J213430009 | |
| HW Version | UART | |
| SW Version | 234500024538168 | |
| Comment | WLAN and Cellular test mode sample | |

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 |
|----------|---------------------|--------------------------------------|
| S01_AE01 | EUT ae01 | Radiated Setup for BT and Cellular |
| S01_AD01 | EUT ad01 | Radiated Setup for WLAN and Cellular |

4.6 OPERATING MODES / TEST CHANNELS

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

Simultaneous transmissions:

LTE eFDD12 707.5 MHz + 2.4 GHz Bluetooth Classic 1-DH1 2441 MHz

LTE eFDD12 707.5 MHz + 2.4 GHz WLAN b-mode 2437 MHz

LTE eFDD13 782 MHz + 5 GHz WLAN a-mode 5825 MHz

4.7 PRODUCT LABELLING

Please refer to the documentation of the applicant.

5 TEST RESULTS

5.1 FIELD STRENGTH OF SPURIOUS RADIATION

Standard **FCC PART 27 Subpart C**

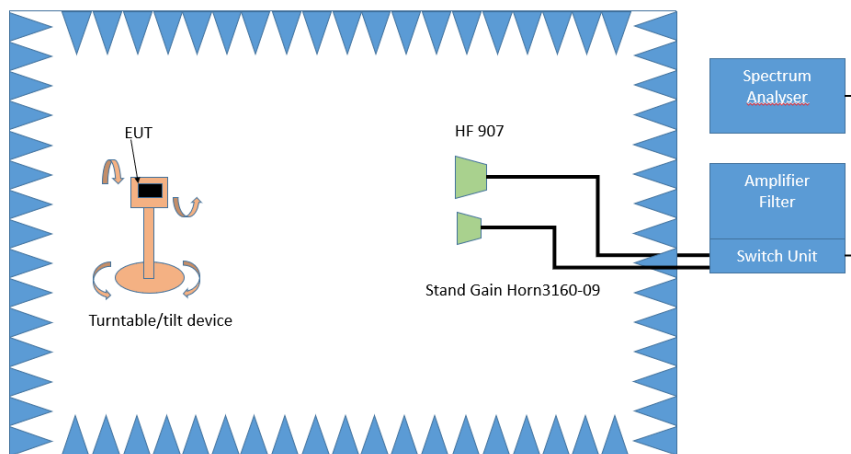
The test was performed according to:
ANSI C63.26: 2015

5.1.1 TEST DESCRIPTION

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

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

Frequency Range: 1 GHz – 26.5 GHz



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

The test set-up is made in accordance to the general provisions of ANSI C63.26 in a typical installation configuration. The Equipment Under Test (EUT) is set up on a non-conductive table (tilt device) in the fully-anechoic chamber.

The measurement procedure is implemented into the EMI test software EMC32 from R&S. Exploratory tests are performed at 3 orthogonal axes to determine the worst-case orientation 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.

Measurement above 1 GHz

Step 1:

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

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

The EUT is turned during the preliminary measurement across the elevation axis, with a step size of 45 °.

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

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

Step 2:

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

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

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

EMI receiver settings (for all steps):

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

Step 3:

Spectrum analyser settings for step 3:

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

5.1.2 TEST REQUIREMENTS / LIMITS

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

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

FCC Part 27; Miscellaneous Wireless Communication Services

Subpart C – Technical standards

§27.53 – Emission limits

Band 12:

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

RSS-130; 4.7.1 General unwanted emissions limits

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

RSS-130; 4.7.2 Additional unwanted emissions limits

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

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

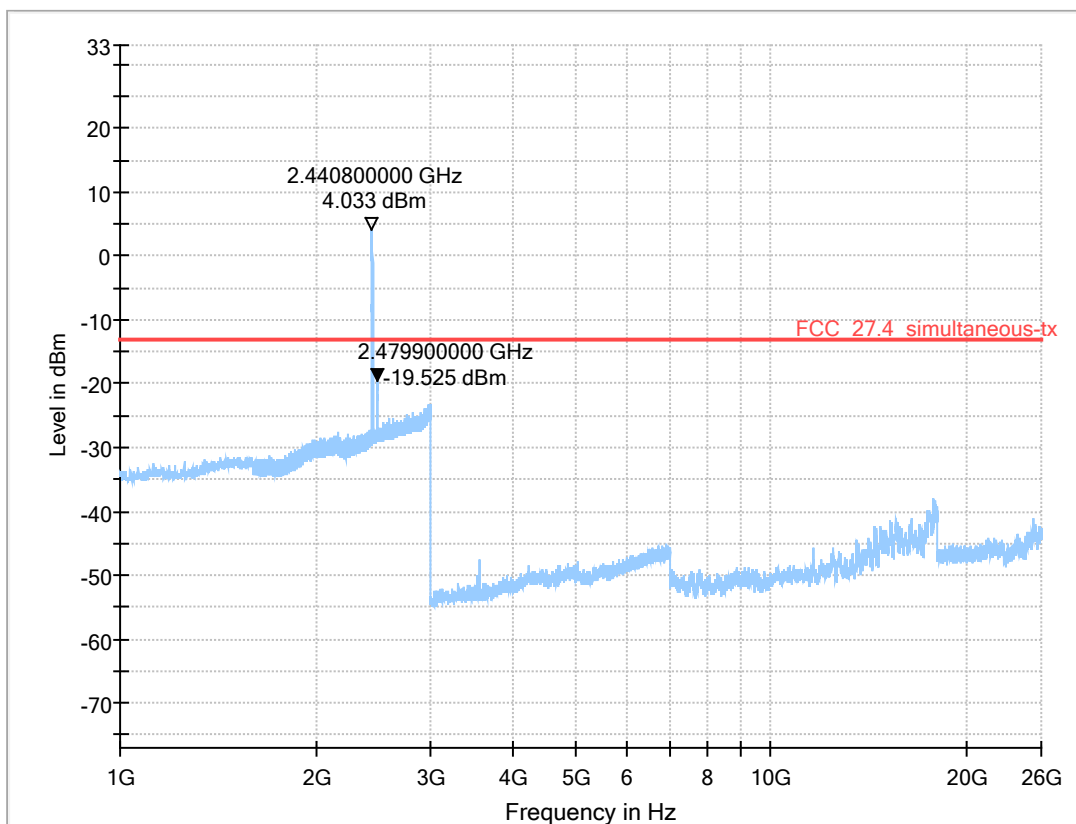
5.1.3 TEST PROTOCOL

Temperature: 22-24 °C
 Humidity: 37-40 %

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

5.1.4 MEASUREMENT PLOTS

Mode: LTE eFDD12 707.5 MHz + 2.4 GHz Bluetooth Classic 1-DH1 2441 MHz
 Setup: S01_AE01

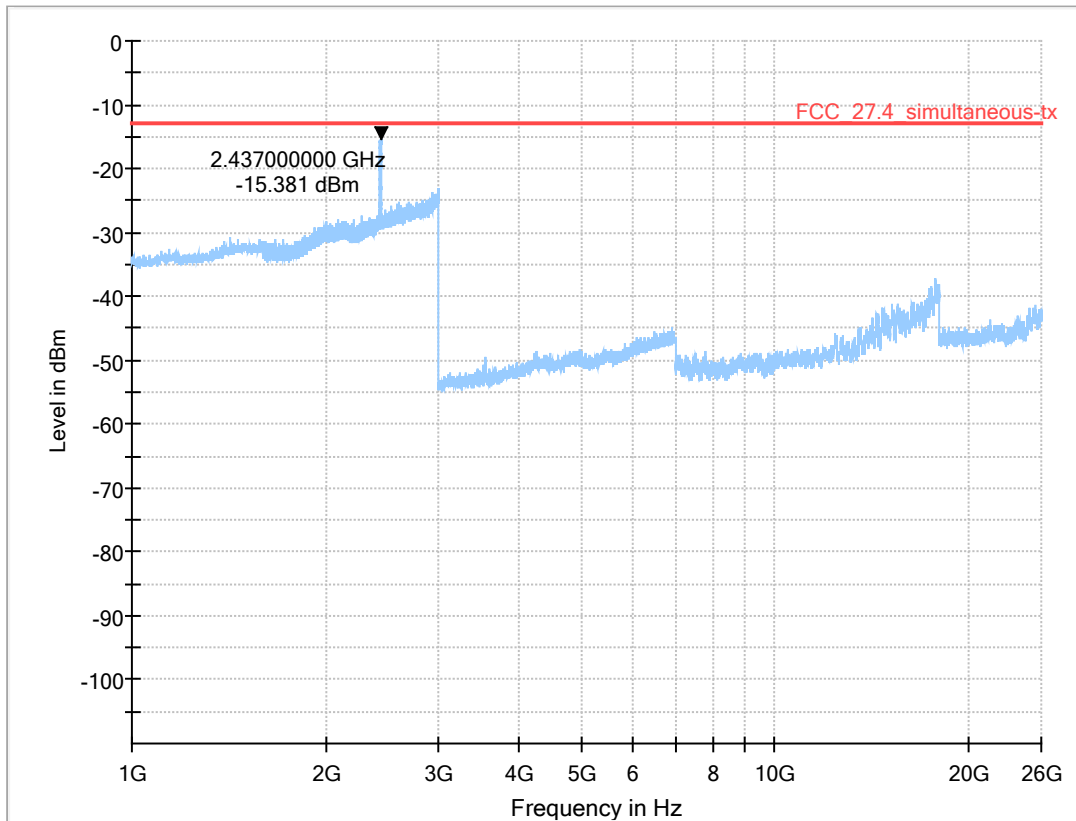


Final Result

| Frequency (MHz) | MaxPeak (dBm) | Limit (dBm) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Elevation (deg) | Corr. (dB) |
|-----------------|---------------|-------------|-------------|-----------------|-----------------|-------------|-----|---------------|-----------------|------------|
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |

Comment: The peak at 2441 MHz is the BT wanted signal and the peak at 2480 MHz is the TX signal from the signaling unit CBT.

Mode: LTE eFDD12 707.5 MHz + 2.4 GHz WLAN b-mode 2437 MHz
Setup: S01_AD01

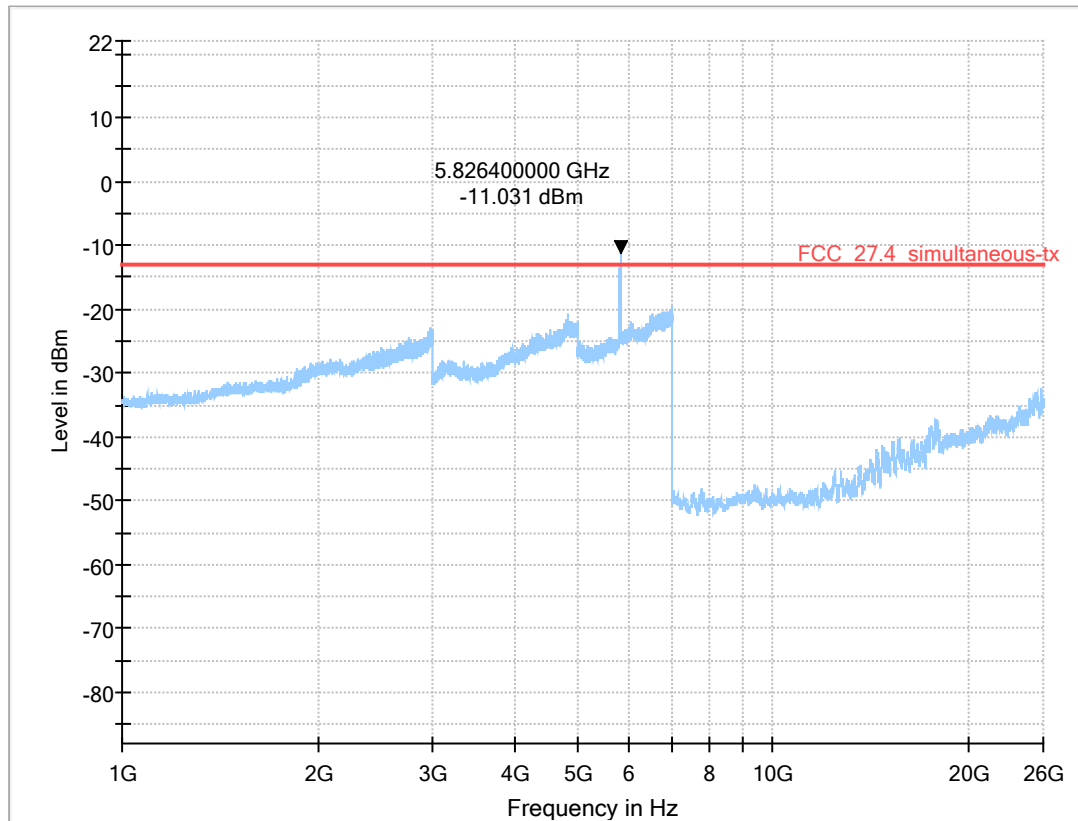


Final Result

| Frequency (MHz) | MaxPeak (dBm) | Limit (dBm) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Elevation (deg) | Corr. (dB) |
|-----------------|---------------|-------------|-------------|-----------------|-----------------|-------------|-----|---------------|-----------------|------------|
| --- | --- | --- | --- | --- | --- | --- | | --- | --- | --- |

Comment: The peak at 2437 MHz is the WLAN wanted signal.

Mode: LTE eFDD13 782 MHz + 5 GHz WLAN a-mode 5825 MHz
 Setup: S01_AD01



Final Result

| Frequency (MHz) | MaxPeak (dBm) | Limit (dBm) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Elevation (deg) | Corr. (dB) |
|-----------------|---------------|-------------|-------------|-----------------|-----------------|-------------|-----|---------------|-----------------|------------|
| --- | --- | --- | --- | --- | --- | --- | | --- | --- | --- |

Comment: The peak at 5826 MHz is the WLAN wanted signal.

5.1.5 TEST EQUIPMENT USED

- Radiated Emissions FAR

6 TEST EQUIPMENT

- 1 Radiated Emissions FAR
Radiated Emissions in a fully anechoic room

| Ref.No. | Device Name | Description | Manufacturer | Serial Number | Last Calibration | Calibration Due |
|---------|-------------------------|---|-----------------------------------|------------------------|------------------|-----------------|
| 1.1 | Opus10 TPR (8253.00) | T/P Logger 13 | Lufft Mess- und Regeltechnik GmbH | 13936 | 2021-10 | 2023-10 |
| 1.2 | AMF-7D00101800-30-10P-R | Broadband Amplifier 100 MHz - 18 GHz | Miteq | | N/A | N/A |
| 1.3 | 5HC2700/12750-1.5-KK | High Pass Filter | Trilithic | 9942012 | N/A | N/A |
| 1.4 | ASP 1.2/1.8-10 kg | Antenna Mast | Maturo GmbH | - | N/A | N/A |
| 1.5 | Anechoic Chamber 03 | FAR, 8.80m x 4.60m x 4.05m (l x w x h) | Albatross Projects | P26971-647-001-PRB | 2021-04 | 2023-04 |
| 1.6 | Fluke 177 | Digital Multimeter 03 (Multimeter) | Fluke Europe B.V. | 86670383 | 2020-04 | 2022-04 |
| 1.7 | JS4-18002600-32-5P | Broadband Amplifier 18 GHz - 26 GHz | Miteq | 849785 | N/A | N/A |
| 1.8 | FSW 43 | Spectrum Analyzer | Rohde & Schwarz | 103779 | 2021-06 | 2023-06 |
| 1.9 | 3160-09 | Standard Gain / Pyramidal Horn Antenna 26.5 GHz | EMCO Elektronik GmbH | 00083069 | N/A | N/A |
| 1.10 | WHKX 7.0/18G-8SS | High Pass Filter | Wainwright Instruments GmbH | 09 | N/A | N/A |
| 1.11 | 4HC1600/12750-1.5-KK | High Pass Filter | Trilithic | 9942011 | N/A | N/A |
| 1.12 | TT 1.5 WI | Turn Table | Maturo GmbH | - | N/A | N/A |
| 1.13 | 3160-10 | Standard Gain / Pyramidal Horn Antenna 40 GHz | EMCO Elektronik GmbH | 00086675 | N/A | N/A |
| 1.14 | 5HC3500/18000-1.2-KK | High Pass Filter | Trilithic | 200035008 | N/A | N/A |
| 1.15 | TD1.5-10kg | EUT Tilt Device (Rohacell) | Maturo GmbH | TD1.5-10kg/024/3790709 | N/A | N/A |
| 1.16 | PAS 2.5 - 10 kg | Antenna Mast | Maturo GmbH | - | N/A | N/A |
| 1.17 | AFS42-00101800-25-S-42 | Broadband Amplifier 25 MHz - 18 GHz | Miteq | 2035324 | N/A | N/A |
| 1.18 | HF 907 | Double-ridged horn | Rohde & Schwarz | 102444 | 2021-09 | 2024-09 |

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

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

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

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

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

Sample calculation

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

U = Receiver reading

AF = Antenna factor

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

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

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 MHz | AF R&S HF907 dB (1/m) | Corr. 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) dB | cable loss 2 (outside chamber) dB | cable loss 3 (switch unit, atten- uator & pre-amp) dB | cable loss 4 (to receiver) 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 MHz | AF R&S HF907 dB (1/m) | Corr. 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) dB | cable loss 2 (inside chamber) dB | cable loss 3 (outside chamber) dB | cable loss 4 (switch unit, atten- uator & pre-amp) dB | cable loss 5 (to receiver) dB | used for FCC 15.247 |
|---|--|---|--|--|------------------------------|
| 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 MHz | AF R&S HF907 dB (1/m) | Corr. 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) dB | cable loss 2 (High Pass) dB | cable loss 3 (pre- amp) dB | cable loss 4 (inside chamber) dB | cable loss 5 (outside chamber) dB | cable loss 6 (to receiver) 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 |
|------------------|-----------------------------------|-------------|
| 18000 | 40.2 | -23.5 |
| 18500 | 40.2 | -23.2 |
| 19000 | 40.2 | -22.0 |
| 19500 | 40.3 | -21.3 |
| 20000 | 40.3 | -20.3 |
| 20500 | 40.3 | -19.9 |
| 21000 | 40.3 | -19.1 |
| 21500 | 40.3 | -19.1 |
| 22000 | 40.3 | -18.7 |
| 22500 | 40.4 | -19.0 |
| 23000 | 40.4 | -19.5 |
| 23500 | 40.4 | -19.3 |
| 24000 | 40.4 | -19.8 |
| 24500 | 40.4 | -19.5 |
| 25000 | 40.4 | -19.3 |
| 25500 | 40.5 | -20.4 |
| 26000 | 40.5 | -21.3 |
| 26500 | 40.5 | -21.1 |

| 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 |
|--|--|--|---|---|
| 0.72 | -35.85 | 6.20 | 2.81 | 2.65 |
| 0.69 | -35.71 | 6.46 | 2.76 | 2.59 |
| 0.76 | -35.44 | 6.69 | 3.15 | 2.79 |
| 0.74 | -35.07 | 7.04 | 3.11 | 2.91 |
| 0.72 | -34.49 | 7.30 | 3.07 | 3.05 |
| 0.78 | -34.46 | 7.48 | 3.12 | 3.15 |
| 0.87 | -34.07 | 7.61 | 3.20 | 3.33 |
| 0.90 | -33.96 | 7.47 | 3.28 | 3.19 |
| 0.89 | -33.57 | 7.34 | 3.35 | 3.28 |
| 0.87 | -33.66 | 7.06 | 3.75 | 2.94 |
| 0.88 | -33.75 | 6.92 | 3.77 | 2.70 |
| 0.90 | -33.35 | 6.99 | 3.52 | 2.66 |
| 0.88 | -33.99 | 6.88 | 3.88 | 2.58 |
| 0.91 | -33.89 | 7.01 | 3.93 | 2.51 |
| 0.88 | -33.00 | 6.72 | 3.96 | 2.14 |
| 0.89 | -34.07 | 6.90 | 3.66 | 2.22 |
| 0.86 | -35.11 | 7.02 | 3.69 | 2.28 |
| 0.90 | -35.20 | 7.15 | 3.91 | 2.36 |

Sample calculation

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

U = Receiver reading

AF = Antenna factor

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

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

Table shows an extract of values.

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

| Frequency 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.

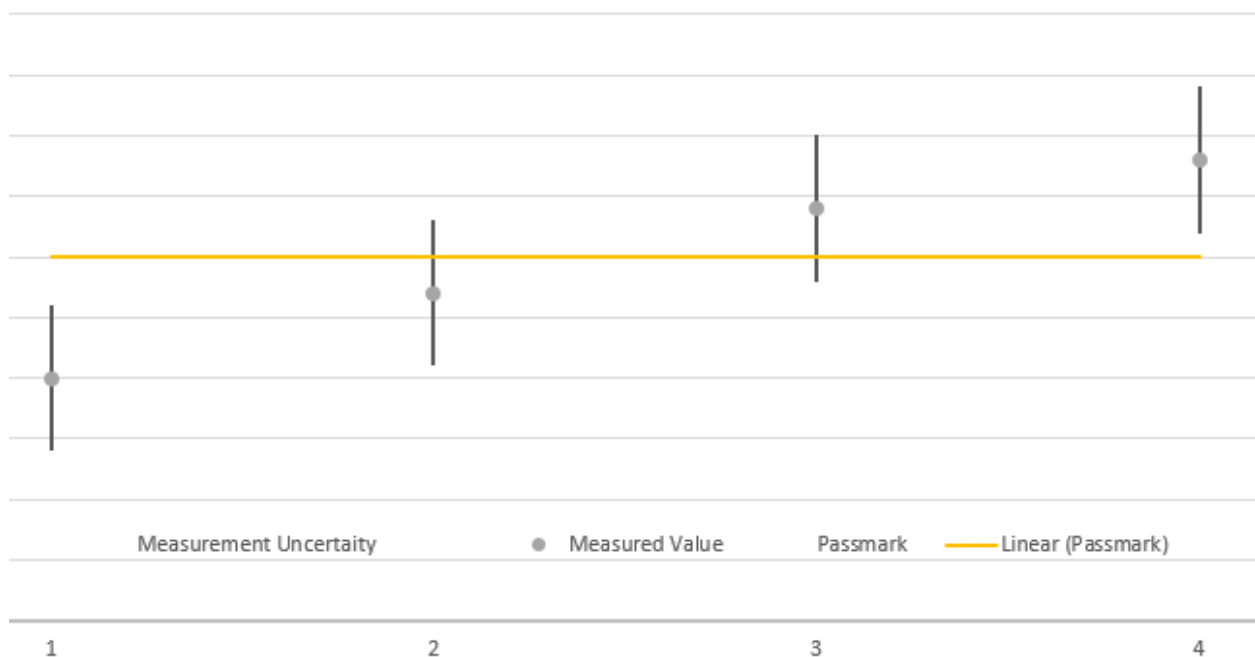
8 PHOTO REPORT

Please see separate photo report.

9 MEASUREMENT UNCERTAINTIES

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

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



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

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

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