# FCC Measurement/Technical Report on

# AMKC4J-14H092-AA

FCC ID: L2CCT150F
IC: 3659A-CT150F

**Report Reference:** MDE_JABIL_1701_FCCd_rev01

**Test Laboratory:**
7layers GmbH
Borsigstrasse 11
40880 Ratingen
Germany

DAkkS Deutsche Akkreditierungsstelle D-PL-12140-01-00

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# 1 SUMMARY

## 1.1 TECHNICAL REPORT SUMMARY

**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 (10-1-14 Edition) and 15 (10-1-14 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

§ 15.205 Restricted bands of operation

§ 15.207 Conducted limits

§ 15.209 Radiated emission limits; general requirements

§ 15.249 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, 5725-5875 MHz, and 24.0-24.25 GHz.

Note:
ANSI C63.10–2013 is applied.

**Summary Test Results:**

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

## 1.2 CORRELATION OF MEASUREMENT REQUIREMENTS FOR GENERAL RADIO EQUIPMENT FROM FCC AND IC

**General radio equipment**

| Measurement | FCC reference | IC reference |
|---|---|---|
| Conducted emissions on AC Mains | § 15.207 | RSS-Gen Issue 5: 8.8 |
| Transmitter spurious radiated emissions | § 15.209 | RSS-Gen Issue 5: 6.13/8.9/8.10;<br>RSS-210 Issue 9: 2.5 |
| Field strength of Fundamental | § 15.249 | RSS-210 Issue 9: 2.5.1<br>RSS-Gen Issue 5: 6.12, 8.9 |
| Operation within the bands 902-928 MHz, 2400-2483.5 MHz, 5725-5875 MHz, and 24.0-24.25 GHz. | §15.249 | RSS-210, Issue 9: Annex B |

## 1.3 MEASUREMENT SUMMARY

| **FCC Part 15, Subpart C** | **§ 15.207** | | |
|---|---|---|---|
| Conducted emissions (AC power line) | | | |
| The measurement was performed according to ANSI C63.10 | | | 2013 |
| **OP-Mode** | **Setup** | **Port** | **Final Result** |
| – | – | – | N/A |

| **FCC Part 15, Subpart C** | **§ 15.249 (a)** | | |
|---|---|---|---|
| Field strength of Fundamental / Radiated power output | | | |
| The measurement was performed according to ANSI C63.10 | | | 2013 |
| **OP-Mode** | **Setup** | **Port** | **Final Result** |
| op-mode 1 | Setup_01 | Enclosure | passed |

| **FCC Part 15, Subpart C** | **§ 15.249 (a), § 15.35 (b), § 15.209** | | |
|---|---|---|---|
| Field Strength of Harmonics / Spurious radiated emissions | | | |
| The measurement was performed according to ANSI C63.10 | | | 2013 |
| **OP-Mode** | **Setup** | **Port** | **Final Result** |
| op-mode 1 | Setup_01 | Enclosure | passed |

| **FCC Part 15, Subpart C** | **§ 15.249 (a)** | | |
|---|---|---|---|
| Frequency Stability | | | |
| The measurement was performed according to ANSI C63.10 | | | 2013 |
| **OP-Mode** | **Setup** | **Port** | **Final Result** |
| op-mode 1 | Setup_01 | Enclosure | passed |

N/A not applicable (the EUT is powered by DC)

## Revision History

| **Report version control** | | | |
|---|---|---|---|
| **Version** | **Release date** | **Change Description** | **Version validity** |
| initial | 2019-02-04 | -- | invalid |
| rev01 | 2019-02-15 | test case frequency stability added | valid |

Responsible for Accreditation Scope:

Responsible for Test Report:

7 layers GmbH, Borsigstr. 11
40880 Ratingen, Germany
Phone +49 (0)2102 749 0

# 2 ADMINISTRATIVE DATA

## 2.1 TESTING LABORATORY

| | |
|---|---|
| Company Name: | 7Layers GmbH |
| Address | Borsigstr. 11<br>40880 Ratingen<br>Germany |

This facility has been fully described in a report submitted to the ISED 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-12140-01-00 |
| FCC Designation Number: | DE0015 |
| FCC Test Firm Registration: | 929146 |
| Responsible for accreditation scope: | Dipl.-Ing. Marco Kullik |
| Report Template Version: | 2017-07-14 |

## 2.2 PROJECT DATA

| | |
|---|---|
| Responsible for testing and report: | B.Sc. Jens Dörwald |
| Date of Test(s): | 2018-11-28 to 2019-01-28 |
| Date of Report: | 2019-02-15 |

## 2.3 APPLICANT DATA

| | |
|---|---|
| Company Name: | Jabil Circuit Belgium N.V |
| Address: | Kempische Steenweg 297<br>Industriezone Noord 1000/1920<br>B 3500 Hasselt |
| Contact Person: | Mr. Kim Van Gelder |

## 2.4 MANUFACTURER DATA

| | |
|---|---|
| Company Name: | Aptiv Service US LLC |
| Address: | 999 Republic Drive Suite 100<br>Allen Park, MI 48101<br>USA |
| Contact Person: | Mr. William Hynes |

# 3 TEST OBJECT DATA

## 3.1 GENERAL EUT DESCRIPTION

**General product description:**

| | |
|---|---|
| Kind of Device product description | OBDII Dongle, operating in 902 MHz frequency band |
| Product name | AMKC4J-14H092-AA |
| Type | - |
| **Declared EUT data by the supplier** | |
| Voltage Type | DC |
| Normal Voltage | 13.0 V |
| Low Voltage | 6.0 V |
| High Voltage | 16.0 V |
| Normal Temperature | 23 °C |
| Low Temperature | -20 °C |
| High Temperature | +55 °C |
| Specific product description for the EUT | The EUT is an OBD Dongle including Cellular technologies e.g. LTE, SRD RF-technologies and 2.4GHz WLAN. The operating frequency is 902 MHz. |
| The EUT provides the following ports: | Enclosure |
| Special software used for testing | The applicant provided a software to set the device in the different operating modes. |

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

## 3.2 EUT MAIN COMPONENTS

| Sample Name | Sample Code | Description |
|---|---|---|
| DE1102006 | aa01 | radiated sample |
| **Sample Parameter** | **Value** | |
| Serial No. | 1PD000MP | |
| HW Version | B1.6 | |
| SW Version | Modem Firmware: SWI9X07Y_02.18.05.00 000000 jenkins 2018/07/19 17:40:21<br>Aurix Firmware: v0.87<br>Linux kernel : 3.2.6<br>Jabil_tools: 3.2.8 | |
| Comment | - | |

| Sample Name | Sample Code | Description |
|---|---|---|
| DE1102006 | ab01 | conducted sample |
| **Sample Parameter** | **Value** | |
| Serial No. | 1PD000MP | |
| HW Version | B1.6 | |
| SW Version | Modem Firmware: SWI9X07Y_02.18.05.00 000000 jenkins 2018/07/19 17:40:21<br>Aurix Firmware: v0.87<br>Linux kernel : 3.2.6<br>Jabil_tools: 3.2.8 | |
| Comment | - | |

**General description of ancillary equipment**

| Device | Details (Manufacturer, Type Model, OUT Code) | Reason for using |
|---|---|---|
| --- | --- | --- |

**General description of auxiliary equipment**

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

## 3.3 EUT SETUPS

This chapter describes the combination of EUTs and ancillary equipment used for testing.

| Setup No. | Combination of EUTs | Description |
|---|---|---|
| Setup_AA01 | DE1102006aa01 | Setup for radiated measurements |
| Setup_AB02 | DE1102006ab01 | Setup for conducted measurements |

## 3.4 OPERATING MODES

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

| Op. Mode | Description of Operating Modes | Remarks |
|---|---|---|
| op-mode 1 | Continuous modulated | Transmitter sends continuously modulated signal |
| op-mode 2 | Continuous wave | Transmitter sends a non-modulated carrier |

Remark: In continuous modulated mode the EUT reads a Tag and transmits a modulated carrier

## 3.5 PRODUCT LABELLING

### 3.5.1 FCC ID label

Please refer to the documentation of the applicant.

### 3.5.2 IC LABEL

Please refer to the documentation of the applicant.

### 3.5.3 LOCATION OF THE LABEL ON THE EUT

Please refer to the documentation of the applicant.

# 4 TEST RESULTS

## 4.1 FIELD STRENGTH OF FUNDAMENTAL / RADIATED POWER OUTPUT

**Standard** FCC Part 15, Subpart C

**The test was performed according to** ANSI C63.10

### 4.1.1 TEST DESCRIPTION

Please refer to the description at sub-clause 4.2.1, esp. item no. 3.

### 4.1.2 Test Requirements / Limits

FCC Part 15, Subpart C, §15.249

(a) Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

| Fundamental frequency | Field strength of fundamental (millivolts/meter) | Field strength of harmonics (microvolts/meter) |
|---|---|---|
| 902-928 MHz | 50 (94.0 dBµV/m) | 500 (54.0 dBµV/m) |
| 2400-2483.5 MHz | 50 (94.0 dBµV/m) | 500 (54.0 dBµV/m) |
| 5725-5875 MHz | 50 (94.0 dBµV/m) | 500 (54.0 dBµV/m) |
| 24.0-24.25 GHz | 250 (108.0 dBµV/m) | 2500 (68.0 dBµV/m) |

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

(c) Field strength limits are specified at 3 meters.

(e) As shown in §15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

TEST PROTOCOL

| | |
|---|---|
| Temperature: | 24 °C |
| Air Pressure: | 1009 hPa |
| Humidity: | 38 % |

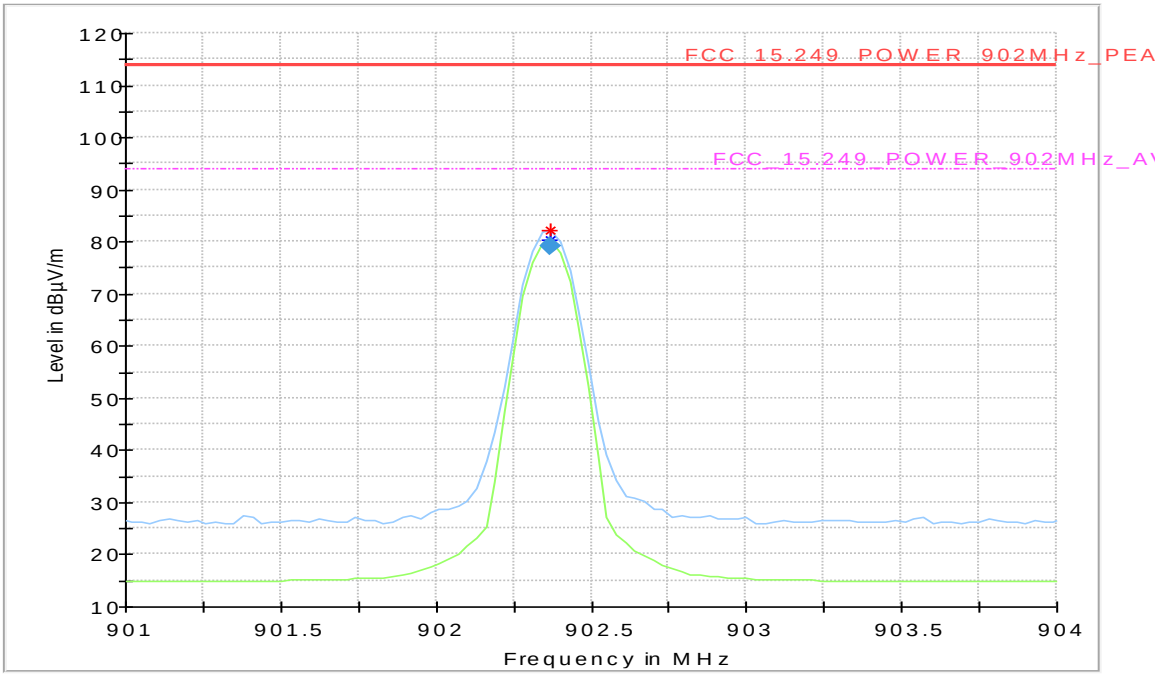
| **Op. Mode** | **Setup** | **Port** |
|---|---|---|
| op-mode 1 | Setup_AA01 | Enclosure |

| **Frequency [MHz]** | **Output power [dBµV/m]** | **Limit [dBµV/m]** | **Margin to Limit [dB]** | **Remarks** |
|---|---|---|---|---|
| 902.4 | 79.13 | 94.0 | 14.87 | Maximum radiated field strength at fundamental frequency |
| 903.4 | 81.58 | 94.0 | 12.42 | Maximum radiated field strength at fundamental frequency |

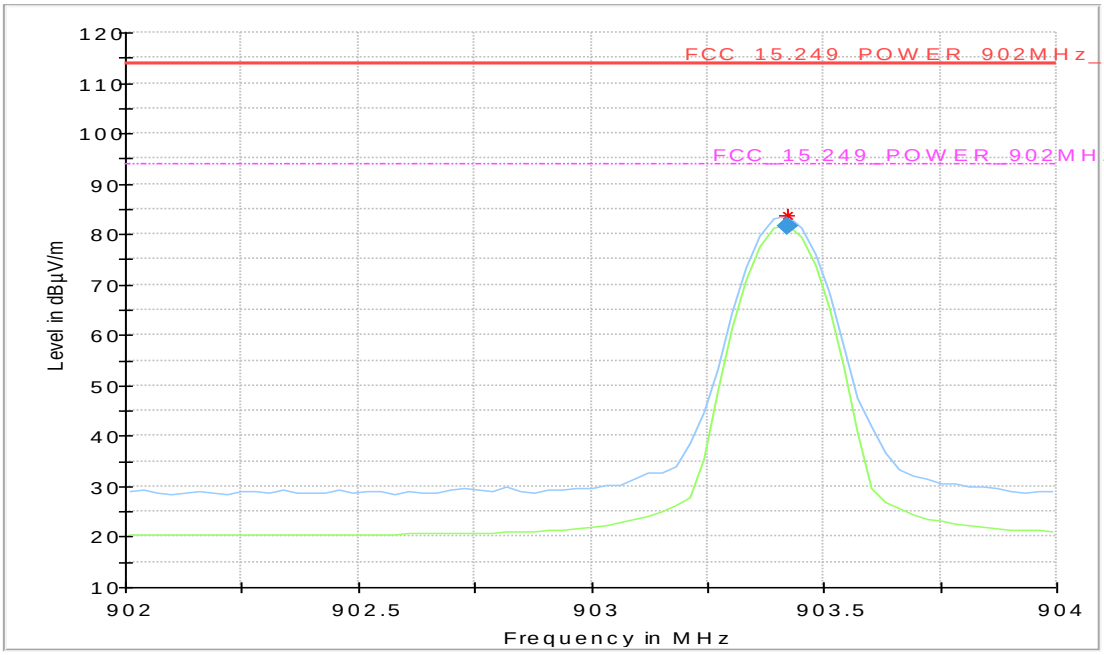
Note: The EUT transmitted continuously non-modulated carrier.

TEST RESULT: Maximum radiated field strength at fundamental frequency

| **FCC Part 15, Subpart C** | **Op. Mode** | **Result** |
|---|---|---|
| | op-mode 1 | passed |




| Frequency (MHz) | CAverage (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) |
|---|---|---|---|---|---|---|---|---|
| 902.370000 | 79.13 | 94.00 | 14.87 | 1000.0 | 100.000 | 106.0 | H | -73.0 |




| Frequency (MHz) | CAverage (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) |
|---|---|---|---|---|---|---|---|---|
| 903.420000 | 81.58 | 94.00 | 12.42 | 1000.0 | 120.000 | 100.0 | H | -198.0 |

## 4.2 FIELD STRENGTH OF HARMONICS / SPURIOUS RADIATED EMISSIONS

**Standard** FCC Part 15, Subpart C

**The test was performed according to** ANSI C63.10

### 4.2.1 Test Description

The test set-up was made in accordance to the general provisions of ANSI C63.10 in a typical installation configuration. The Equipment Under Test (EUT) was set up on a non-conductive table 1.0 x 2.0 m² 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 up to 30 MHz**

The Loop antenna HFH2-Z2 is used.

**Step 1:** pre-measurement
- Anechoic chamber
- Antenna distance: 3 m
- Detector: Peak-Maxhold
- Frequency range: 0.009 - 0.15 MHz and 0.15 – 30 MHz
- Frequency steps: 0.05 kHz and 2.25 kHz
- IF–Bandwidth: 0.2 kHz and 9 kHz
- Measuring time / Frequency step: 100 ms (FFT-based)

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:** final measurement
For the relevant emissions determined in step 1, an additional measurement with the following settings will be performed. Intention of this step is to find the maximum emission level.
- Open area test side
- Antenna distance: according to the Standard
- Detector: Quasi-Peak
- Frequency range: 0.009 – 30 MHz
- Frequency steps: measurement at frequencies detected in step 1
- IF–Bandwidth: 0.2 - 10 kHz
- Measuring time / Frequency step: 1 s

**2. 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 ± 45° 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 ± 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: ± 45 ° around the determined value
- Height variation range: ± 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 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 ± 45° for the elevation axis is performed.
The turn table azimuth will slowly vary by ± 22.5°.
The elevation angle will slowly vary by ± 45°
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 C, §15.249

(a) Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

| Fundamental frequency | Field strength of fundamental (millivolts/meter) | Field strength of harmonics (microvolts/meter) |
|---|---|---|
| 902-928 MHz | 50 (94.0 dBµV/m) | 500 (54.0 dBµV/m) |
| 2400-2483.5 MHz | 50 (94.0 dBµV/m) | 500 (54.0 dBµV/m) |
| 5725-5875 MHz | 50 (94.0 dBµV/m) | 500 (54.0 dBµV/m) |
| 24.0-24.25 GHz | 250 (108.0 dBµV/m) | 2500 (68.0 dBµV/m) |

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

(c) Field strength limits are specified at a distance of 3 meters.

(d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

(e) As shown in §15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

FCC Part 15, Subpart C, §15.209, Radiated Emission Limits

| Frequency (MHz) | Limit (µV/m) | Measurement distance (m) | Calculate Limit (dBµV/m @10m) | Limit (dBµV/m) @10m |
|---|---|---|---|---|
| 0.009 – 0.49 | 2400/F (kHz) | 300 | (48.5 – 13.8) + 59.1 dB | 107.6 – 72.9 |
| 0.49 – 1.705 | 24000/F (kHz) | 30 | (33.8 – 23.0) + 19.1 dB | 52.9 – 42.1 |
| 1.705 – 30 | 30 | 30 | 29.5 + 19.1 dB | 39.5 |

| Frequency in MHz | Limit (µV/m) | Measurement distance (m) | Limit (dBµV/m) |
|---|---|---|---|
| 30 – 88 | 100 | 3 | 40.0 |
| 88 – 216 | 150 | 3 | 43.5 |
| 216 – 960 | 200 | 3 | 46.0 |
| above 960 | 500 | 3 | 54.0 |

§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)

§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)

§15.35(c):
[...] when the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds.
As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted [...].

§15.231(b)(3)
The limits on the field strength of the spurious emissions in the above table are based on the fundamental frequency of the intentional radiator.
Spurious emissions shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in this table or to the general limits shown in §15.209, whichever limit permits a higher field strength.

Interpretation of the test laboratory:
The last subordinate clause of §15.231(b)(3) is overruled by §15.205/209, therefore within the restricted bands the limits defined at §15.205/209 and outside the restricted bands the limits defined at §15.231(b) resp. §15.231(e) are applied.

TEST PROTOCOL

Temperature: 24 °C
Air Pressure: 1009 hPa
Humidity: 35 %

MEASUREMENT UP TO 30 MHz

902.4 MHz

| Spurious Freq. [MHz] | Spurious Level [dBµV/m] | Detector | RBW [kHz] | Limit [dBµV/m] | Margin to Limit [dB] |
|---|---|---|---|---|---|
| - | - | - | - | - | - |

903.4 MHz

| Spurious Freq. [MHz] | Spurious Level [dBµV/m] | Detector | RBW [kHz] | Limit [dBµV/m] | Margin to Limit [dB] |
|---|---|---|---|---|---|
| - | - | - | - | - | - |

MEASUREMENT ABOVE 30 MHZ TO 1 GHz

902.4 MHz

| Spurious Freq. [MHz] | Spurious Level [dBµV/m] | Detector | RBW [kHz] | Limit [dBµV/m] | Margin to Limit [dB] |
|---|---|---|---|---|---|
| 41.5 | 27.0 | QP | 120 | 40.0 | 13.0 |

903.4 MHz

| Spurious Freq. [MHz] | Spurious Level [dBµV/m] | Detector | RBW [kHz] | Limit [dBµV/m] | Margin to Limit [dB] |
|---|---|---|---|---|---|
| 41.6 | 26.9 | QP | 120 | 40.0 | 13.1 |

Remark: - No more spurious emissions in the range 15 dB below the limit were found.

MEASUREMENT ABOVE 1 GHz

902.4 MHz

| Spurious Freq. [MHz] | Spurious Level [dBµV/m] | Detector | RBW [kHz] | Limit [dBµV/m] | Margin to Limit [dB] |
|---|---|---|---|---|---|
| | | | | | |

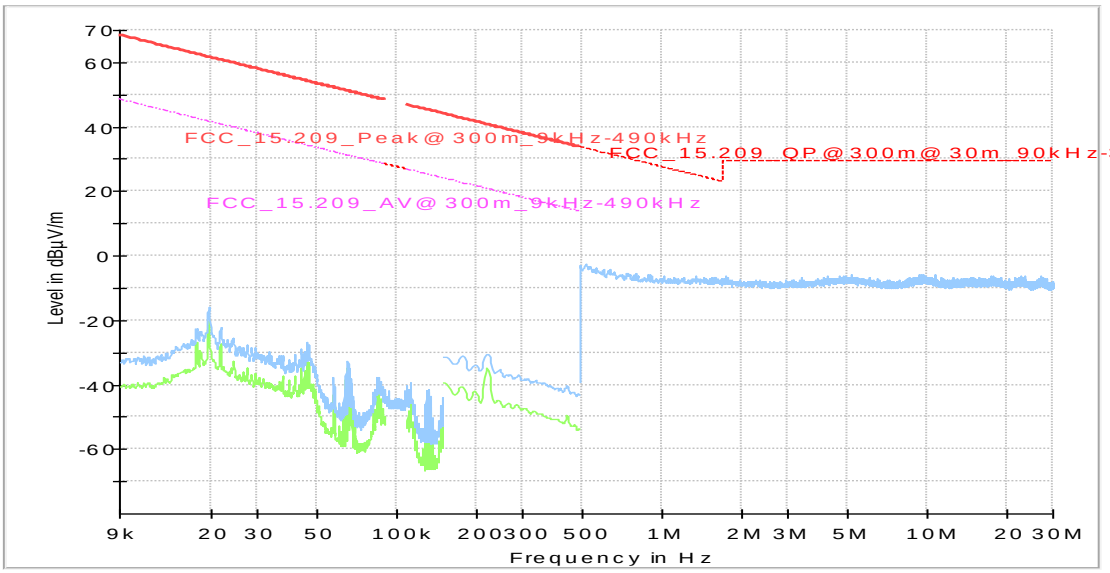
903.4 MHz

| Spurious Freq. [MHz] | Spurious Level [dBµV/m] | Detector | RBW [kHz] | Limit [dBµV/m] | Margin to Limit [dB] |
|---|---|---|---|---|---|
| | | | | | |

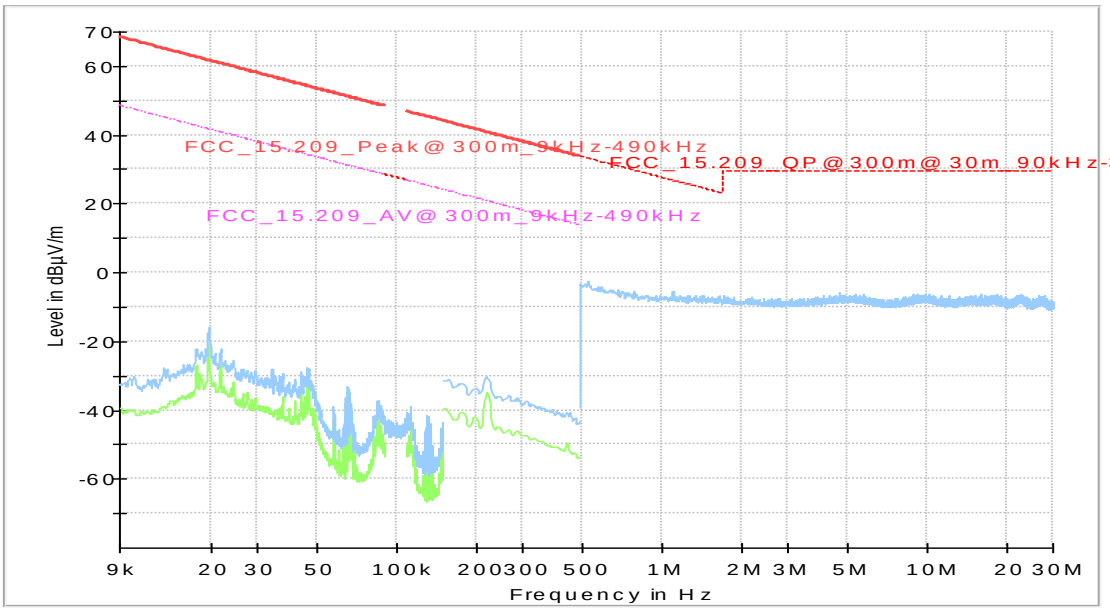
Remarks:
- No more spurious emissions in the range 15 dB below the limit were found.
- The test was performed in the frequency range from 1 GHz to 10 GHz.
- For this test the EUT was sending a continuously modulated signal.
- Please see the measurement plot.
- The EUT is tested in horizontal position.
- wanted signal at 902.4 MHz
- wanted signal at 903.4 MHz

MEASUREMENT PLOTS

RADIATED EMISSIONS (f < 30 MHz)
902.3 MHz

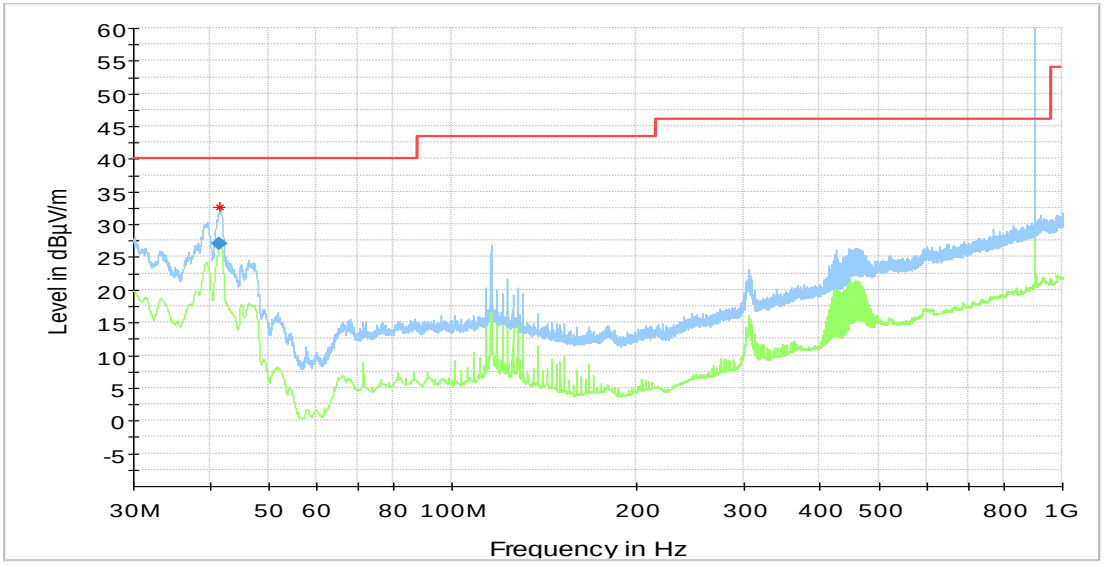



903.4 MHz



RADIATED EMISSIONS (30 MHz < f < 1 GHz)

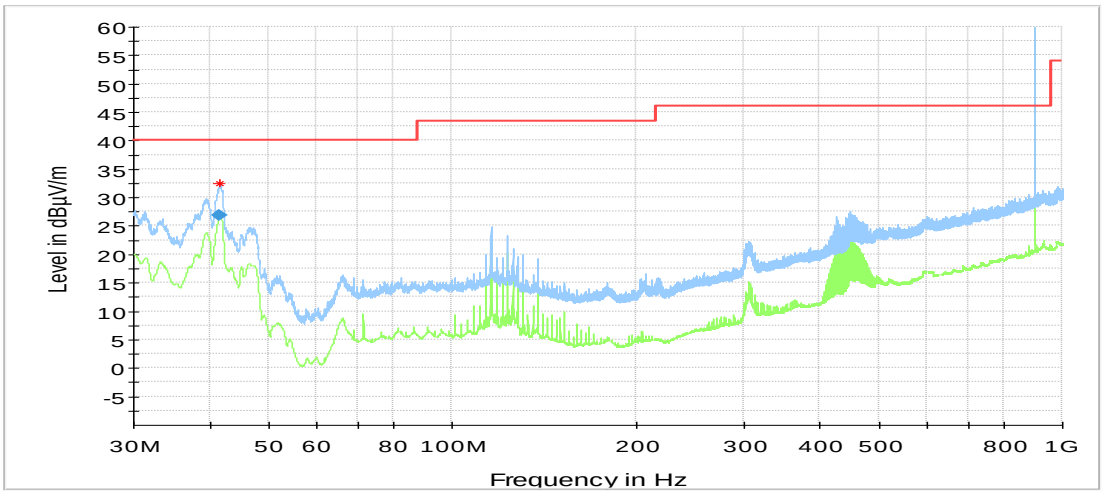
902.4 MHz




| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|---|
| 41.490000 | 27.00 | 40.00 | 13.00 | 1000.0 | 120.000 | 102.0 | V | -185.0 | 12.8 |

COMMENT: wanted signal at 902.4 MHz

903.4 MHz

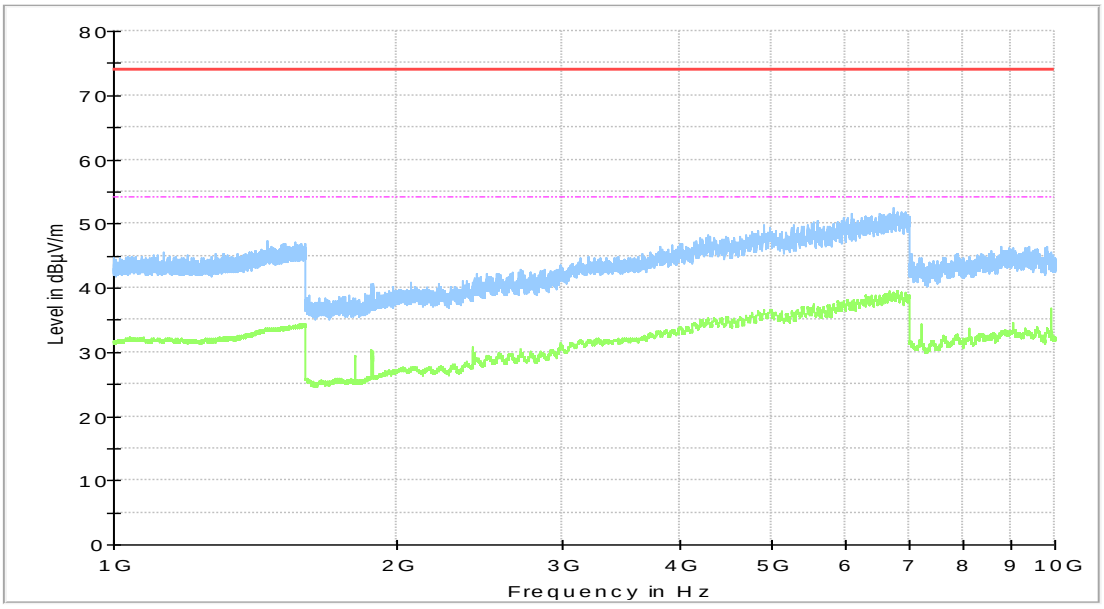



| Frequency (MHz) | QuasiPeak (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB/m) |
|---|---|---|---|---|---|---|---|---|---|
| 41.640000 | 26.86 | 40.00 | 13.14 | 1000.0 | 120.000 | 102.0 | V | 12.0 | 12.6 |

COMMENT: wanted signal at 903.4 MHz

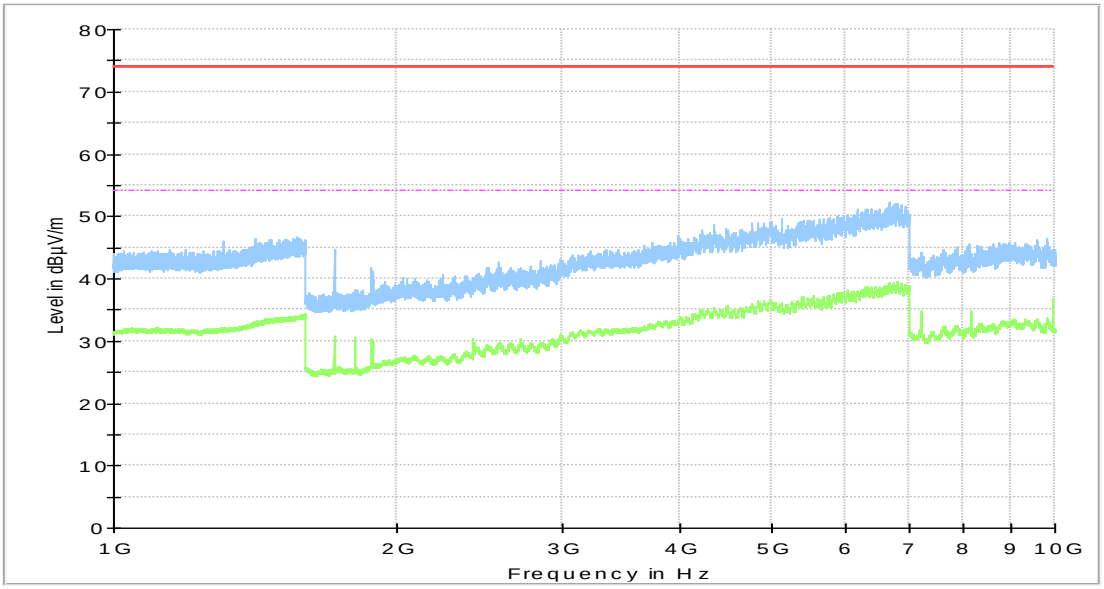
RADIATED EMISSIONS (1 GHz < f < 10 GHz)

902.4 MHz




| Frequency (MHz) | MaxPeak (dBµV/m) | CAverage (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Elevation (deg) |
|---|---|---|---|---|---|---|---|---|---|---|
| --- | --- | --- | --- | --- | --- | --- | --- | | --- | --- |

903.4 MHz




| Frequency (MHz) | MaxPeak (dBµV/m) | CAverage (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Elevation (deg) |
|---|---|---|---|---|---|---|---|---|---|---|
| --- | --- | --- | --- | --- | --- | --- | --- | | --- | --- |

## 4.3 OCCUPIED BANDWIDTH

Standard **FCC Part 15 Subpart C**

**The test was performed according to ANSI C63.10**

### 4.3.1 TEST DESCRIPTION

The Equipment Under Test (EUT) was set up to perform the occupied bandwidth measurements.
The reference level is the level of the highest amplitude signal observed from the transmitter at either the fundamental frequency or first-order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical.
The EUT was connected to spectrum analyzer via a short coax cable with a known loss.
Analyzer settings:

- Resolution Bandwidth (RBW): 5 kHz
- Video Bandwidth (VBW): 10 kHz
- Span: 150 kHz
- Trace: Maxhold
- Sweeptime: 50 ms
- Detector: Max Peak

The 99 % measurement function of the spectrum analyser function was used to determine the 99 % bandwidth.

### 4.3.2 TEST REQUIREMENTS / LIMITS

No applicable limit.

TEST PROTOCOL

Temperature: 23 °C
Air Pressure: 1009 hPa
Humidity: 42 %

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 1 | Setup_AB01 | Enclosure |

| Cannel Frequency [MHz] | 20 dB bandwidth [kHz] | 99% bandwidth [kHz] |
|---|---|---|
| 902.4 | 31.86 | 25.27 |
| 903.4 | 31.56 | 26.45 |

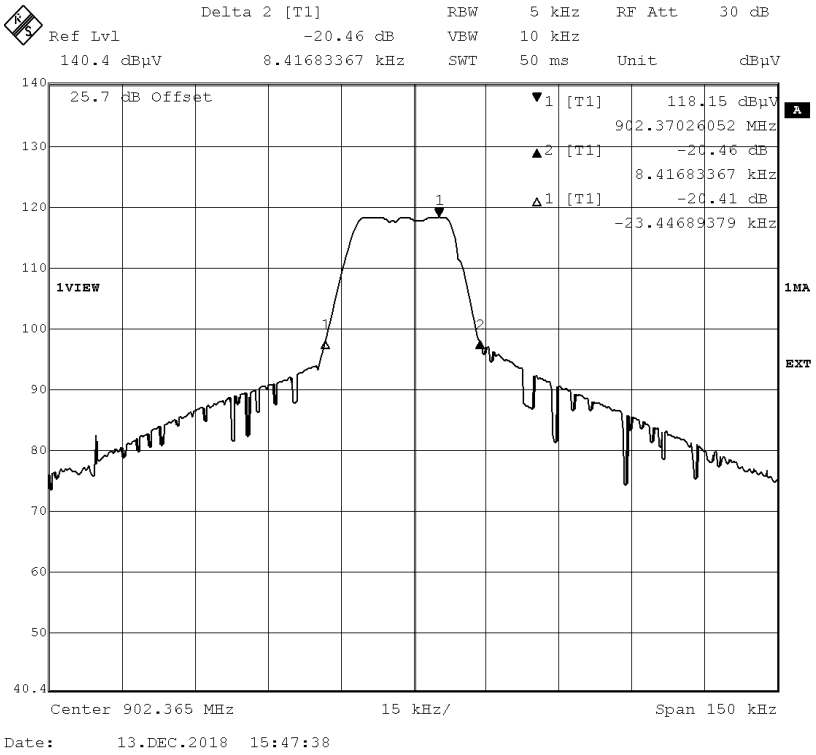
### 4.3.3 TEST RESULT: OCCUPIED BANDWIDTH

| FCC Part 15, Subpart C | Op. Mode | Result |
|---|---|---|
| | op-mode 1 | performed |

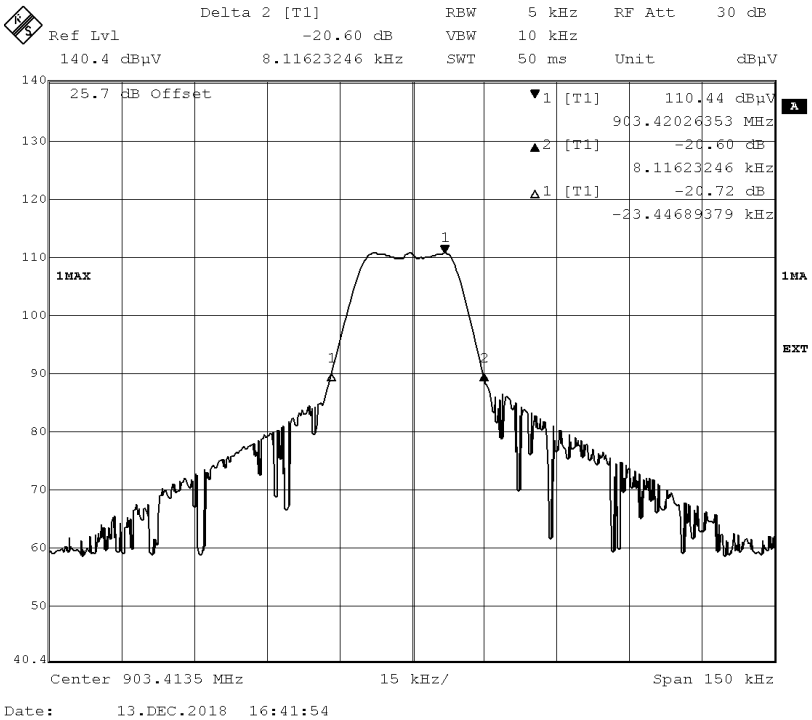
MEASUREMENT PLOTS OCCUPIED BANDWIDTH

20 dB occupied bandwidth

902.4 MHz

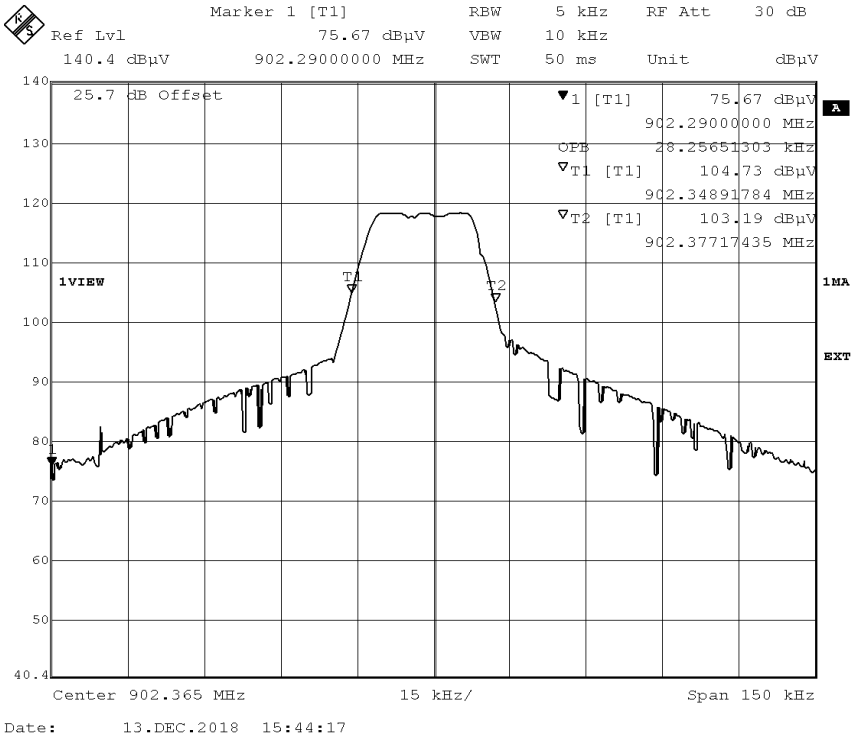



903.4 MHz

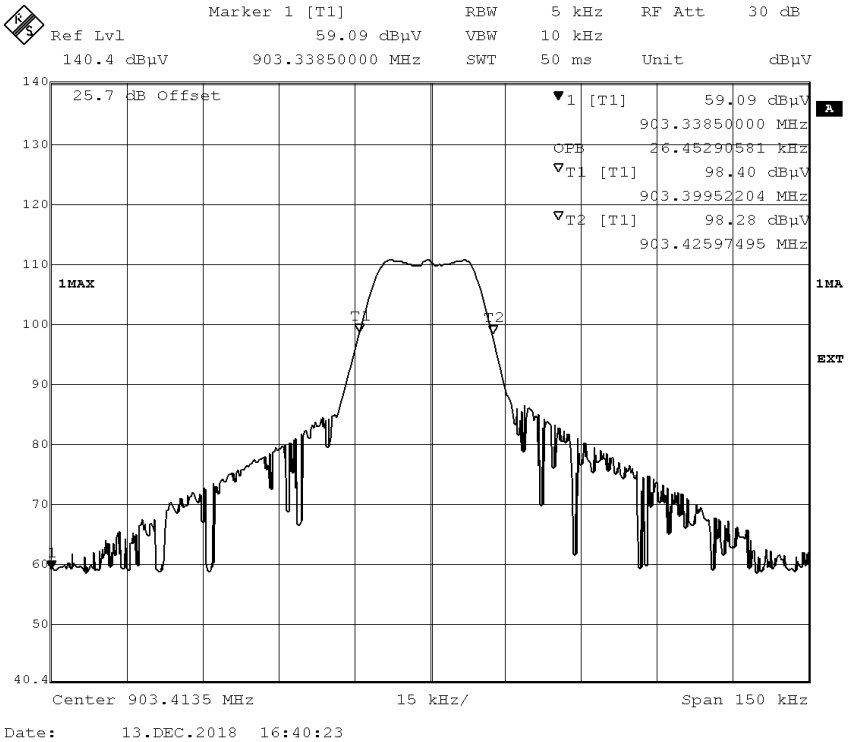


99% occupied bandwidth between T2 and T1 = 23.83 kHz

902.4 MHz




903.4 MHz



## 4.4 FREQUENCY STABILITY

Standard **FCC Part 15 Subpart C**

**The test was performed according to ANSI C63.10**

### 4.4.1 TEST DESCRIPTION

The reference level is the level of the highest amplitude signal observed from the transmitter at either the fundamental frequency or first-order modulation products in all typical modes of operation, including the unmodulated carrier, even if atypical.
The EUT was connected to spectrum analyzer via a short coax cable with a known loss.
Analyzer settings:

- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 1000 kHz
- Span: 1 MHz
- Trace: Maxhold
- Sweeptime: 5 ms
- Detector: Max Peak

### 4.4.2 TEST REQUIREMENTS / LIMITS

The frequency tolerance of the carrier signal shall be maintained within ±0.001% of the operating frequency over a temperature variation of −20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

TEST PROTOCOL

Temperature: 24 °C
Air Pressure: 1006 hPa
Humidity: 38 %

| Op. Mode | Setup | Port |
|---|---|---|
| op-mode 1 | Setup_AB01 | Enclosure |

Reference Frequency: 902.375 MHz

| Temperature [°C] | Voltage [V] | $f_c$ [MHz] | Limit [Hz] | Verdict |
|---|---|---|---|---|
| -20 | normal | 902.36999 | 9023.75 | passed |
| -10 | normal | 902.367986 | 9023.75 | passed |
| 0 | normal | 902.378998 | 9023.75 | passed |
| 10 | normal | 902.365982 | 9023.75 | passed |
| 20 | low | 902.365982 | 9023.75 | passed |
| 20 | normal | 902.367986 | 9023.75 | passed |
| 20 | high | 902.371994 | 9023.75 | passed |
| 30 | normal | 902.367986 | 9023.75 | passed |
| 40 | normal | 902.36999 | 9023.75 | passed |
| 50 | normal | 902.367986 | 9023.75 | passed |

Reference Frequency: 903.425 MHz

| Temperature [°C] | Voltage [V] | $f_c$ [MHz] | Limit [Hz] | Verdict |
|---|---|---|---|---|
| -20 | normal | 903.417986 | 9034.25 | passed |
| -10 | normal | 903.4290581 | 9034.25 | passed |
| 0 | normal | 903.4290581 | 9034.25 | passed |
| 10 | normal | 903.426002 | 9034.25 | passed |
| 20 | low | 903.423998 | 9034.25 | passed |
| 20 | normal | 903.415982 | 9034.25 | passed |
| 20 | high | 903.41999 | 9034.25 | passed |
| 30 | normal | 903.41999 | 9034.25 | passed |
| 40 | normal | 903.415982 | 9034.25 | passed |
| 50 | normal | 903.417986 | 9034.25 | passed |

### 4.4.3 TEST RESULT: FREQUENCY STABILITY

| FCC Part 15, Subpart C | Op. Mode | Result |
|---|---|---|
| | op-mode 1 | passed |

# 5 MEASUREMENT UNCERTAINTIES

| **Parameter** | **Uncertainty** |
|---|---|
| Radio frequency | ± 0.5 ppm |
| RF power, conducted | ± 1.0 dB |
| Conducted spurious emission of transmitter, valid up to 6 GHz | ± 2.0 dB |
| Conducted emission of receivers | ± 2.0 dB |
| Radiated emission of transmitter, valid up to 6 GHz | ± 4.5 dB |
| Radiated emission of receiver, valid up to 6 GHz | ± 4.5 dB |
| RF level uncertainty for a given BER | ± 1.5 dB |
| Occupied Bandwidth | ± 4.5% |
| Temperature | ± 0.3 °C |
| Humidity | ± 3% |

# 6 TEST EQUIPMENT

**1. Radiated Emissions**

Lab to perform radiated emission tests

| Ref. No. | Device Name | Description | Manufacturer | Serial Number | Last Calibration | Calibration Due |
|---|---|---|---|---|---|---|
| 1.1 | NRV-Z1 | Sensor Head A | Rohde & Schwarz GmbH & Co. KG | 827753/005 | 2018-07 | 2019-07 |
| 1.2 | NRVD | Power Meter | Rohde & Schwarz GmbH & Co. KG | 828110/016 | 2018-07 | 2019-07 |
| 1.3 | MFS | Rubidium Frequency Normal MFS | Datum GmbH | 002 | 2018-10 | 2020-10 |
| 1.4 | Opus10 TPR (8253.00) | ThermoAirpressure Datalogger 13 (Environ) | Lufft Mess- und Regeltechnik GmbH | 13936 | 2017-04 | 2019-04 |
| 1.5 | ESW44 | EMI Test Receiver | Rohde & Schwarz GmbH & Co. KG | 101603 | 2018-05 | 2019-05 |
| 1.6 | Anechoic Chamber | 10.58 x 6.38 x 6.00 m³ | Frankonia | none | 2018-06 | 2020-06 |
| 1.7 | FS-Z60 | Harmonic Mixer 40 - 60 GHz | Rohde & Schwarz Messgerätebau GmbH | 100178 | 2016-12 | 2019-12 |
| 1.8 | FS-Z220 | Harmonic Mixer 140 - 220 GHz | Rohde & Schwarz Messgerätebau GmbH | 101005 | 2017-03 | 2020-03 |
| 1.9 | SGH-05 | Standard Gain / Pyramidal Horn Antenna (140 - 220 GHz) | | 075 | | |
| 1.10 | HL 562 | Ultralog new biconicals | Rohde & Schwarz | 830547/003 | 2018-07 | 2021-07 |
| 1.11 | 5HC2700/12750-1.5-KK | High Pass Filter | Trilithic | 9942012 | | |
| 1.12 | ASP 1.2/1.8-10 kg | Antenna Mast | Maturo GmbH | - | | |
| 1.13 | Fully Anechoic Room | 8.80m x 4.60m x 4.05m (l x w x h) | Albatross Projects | P26971-647-001-PRB | 2018-06 | 2020-06 |
| 1.14 | Fluke 177 | Digital Multimeter 03 (Multimeter) | Fluke Europe B.V. | 86670383 | 2018-04 | 2020-04 |
| 1.15 | HF 906 | Double-ridged horn | Rohde & Schwarz | 357357/002 | | |
| 1.16 | JS4-18002600-32-5P | Broadband Amplifier 18 GHz - 26 GHz | Miteq | 849785 | | |
| 1.17 | FSW 43 | Spectrum Analyzer | Rohde & Schwarz | 103779 | 2016-12 | 2018-12 |
| 1.18 | 3160-09 | Standard Gain / Pyramidal Horn Antenna 26.5 GHz | EMCO Elektronic GmbH | 00083069 | | |
| 1.19 | SGH-19 | Standard Gain / Pyramidal Horn Antenna (40 - 60 GHz) | | 093 | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1.20 | WHKX 7.0/18G-8SS | High Pass Filter | Wainwright | 09 | | |
| 1.21 | 4HC1600/12750-1.5-KK | High Pass Filter | Trilithic | 9942011 | | |
| 1.22 | Chroma 6404 | AC Power Source | Chroma ATE INC. | 64040001304 | | |
| 1.23 | JS4-00102600-42-5A | Broadband Amplifier 30 MHz - 26 GHz | Miteq | 619368 | | |
| 1.24 | TT 1.5 WI | Turn Table | Maturo GmbH | - | | |
| 1.25 | HL 562 Ultralog | Log.-per. Antenna | Rohde & Schwarz | 100609 | 2016-04 | 2019-04 |
| 1.26 | HF 906 | Double-ridged horn | Rohde & Schwarz | 357357/001 | 2018-03 | 2021-03 |
| 1.27 | FS-Z325 | Harmonic Mixer 220 - 325 GHz | Rohde & Schwarz Messgerätebau GmbH | 101006 | 2017-03 | 2020-03 |
| 1.28 | 3160-10 | Standard Gain / Pyramidal Horn Antenna 40 GHz | EMCO Elektronic GmbH | 00086675 | | |
| 1.29 | SGH-08 | Standard Gain / Pyramidal Horn Antenna (90 - 140 GHz) | | 064 | | |
| 1.30 | SGH-12 | Standard Gain / Pyramidal HornAntenna (60 - 90 GHz) | | 326 | | |
| 1.31 | 5HC3500/18000-1.2-KK | High Pass Filter | Trilithic | 200035008 | | |
| 1.32 | FS-Z140 | Harmonic Mixer 90 -140 GHz | Rohde & Schwarz Messgerätebau GmbH | 101007 | 2017-02 | 2020-02 |
| 1.33 | HFH2-Z2 | Loop Antenna | Rohde & Schwarz | 829324/006 | 2018-01 | 2021-01 |
| 1.34 | Opus10 THI (8152.00) | ThermoHygro Datalogger 12 (Environ) | Lufft Mess- und Regeltechnik GmbH | 12482 | 2017-03 | 2019-03 |
| 1.35 | ESR 7 | EMI Receiver / Spectrum Analyzer | Rohde & Schwarz | 101424 | 2019-01 | 2020-01 |
| 1.36 | JS4-00101800-35-5P | Broadband Amplifier 30 MHz - 18 GHz | Miteq | 896037 | | |
| 1.37 | AS 620 P | Antenna mast | HD GmbH | 620/37 | | |
| 1.38 | Tilt device Maturo (Rohacell) | Antrieb TD1.5-10kg | Maturo GmbH | TD1.5-10kg/024/3790709 | | |
| 1.39 | SGH-03 | Standard Gain / Pyramidal Horn Antenna (220 - 325 GHz) | | 060 | | |
| 1.40 | FS-Z90 | Harmonic Mixer 60 - 90 GHz | Rohde & Schwarz Messgerätebau GmbH | 101686 | 2017-03 | 2020-03 |
| 1.41 | ESIB 26 | Spectrum Analyzer | Rohde & Schwarz | 830482/004 | 2018-01 | 2020-01 |
| 1.42 | PAS 2.5 - 10 kg | Antenna Mast | Maturo GmbH | - | | |

| Ref. No. | Device Name | Description | Manufacturer | Serial Number | Last Calibration | Calibration Due |
|---|---|---|---|---|---|---|
| 1.43 | AFS42-00101800-25-S-42 | Broadband Amplifier 25 MHz - 18 GHz | Miteq | 2035324 | | |
| 1.44 | AM 4.0 | Antenna mast | Maturo GmbH | AM4.0/180/11920513 | | |
| 1.45 | HF 907 | Double-ridged horn | Rohde & Schwarz | 102444 | 2018-07 | 2021-07 |

## 2 Radio Lab

Lab to perform conducted tests

| Ref. No. | Device Name | Description | Manufacturer | Serial Number | Last Calibration | Calibration Due |
|---|---|---|---|---|---|---|
| 2.1 | SMB100A | Signal Generator 9 kHz - 6 GHz | Rohde & Schwarz | 107695 | 2017-07 | 2020-07 |
| 2.2 | MFS | Rubidium Frequency Standard | Datum-Beverly | 5489/001 | 2018-07 | 2019-07 |
| 2.3 | FSV30 | Signal Analyzer 10 Hz - 30 GHz | Rohde & Schwarz | 103005 | 2018-04 | 2020-04 |
| 2.4 | Fluke 177 | Digital Multimeter 03 (Multimeter) | Fluke Europe B.V. | 86670383 | 2018-04 | 2020-04 |
| 2.5 | SMP03 | Signal Generator 2 GHz - 27 GHz | Rohde & Schwarz | 833680/003 | 2017-09 | 2020-09 |
| 2.6 | FSIQ26 | Signal Analyser | Rohde & Schwarz | 840061/005 | 2017-05 | 2019-05 |
| 2.7 | Chroma 6404 | AC Power Source | Chroma ATE INC. | 64040001304 | | |
| 2.8 | VT 4002 | Temperature Chamber | Vötsch | 58566002150010 | 2018-04 | 2020-04 |
| 2.9 | WA1515 | Broadband Power Divider SMA | Weinschel Associates | A855 | | |
| 2.10 | A8455-4 | 4 Way Power Divider (SMA) | | - | | |
| 2.11 | Opus10 THI (8152.00) | ThermoHygro Datalogger 03 (Environ) | Lufft Mess- und Regeltechnik GmbH | 7482 | 2017-03 | 2019-03 |
| 2.12 | SMBV100A | Vector Signal Generator 9 kHz - 6 GHz | Rohde & Schwarz | 259291 | 2016-10 | 2019-10 |

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.

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

| Frequency | AF HFH-Z2) | Corr. | cable loss 1 (inside chamber) | cable loss 2 (outside chamber) | cable loss 3 (switch unit) | cable loss 4 (to receiver) | distance corr. (-40 dB/ decade) | $d_{Limit}$ (meas. distance (limit) | $d_{used}$ (meas. distance (used) |
|---|---|---|---|---|---|---|---|---|---|
| MHz | dB (1/m) | dB | 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 (dB µV/m) = U (dB µV) + AF (dB 1/m) + 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 = -40 * LOG ($d_{Limit}$/ $d_{used}$)
Linear interpolation will be used for frequencies in between the values in the table.
Table shows an extract of values

## ANTENNA R&S HL562 (30 MHZ – 1 GHZ)

**($d_{Limit}$ = 3 m)**

| Frequency | AF R&S HL562 | Corr. | 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) |
|---|---|---|---|---|---|---|---|---|---|
| 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 |

**($d_{Limit}$ = 10 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 (dB µV/m) = U (dB µV) + AF (dB 1/m) + 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 * 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.

ANTENNA R&S HF907 (1 GHZ – 18 GHZ)

| Frequency | AF R&S HF907 | Corr. | cable loss 1 (relay + cable inside chamber) | cable loss 2 (outside chamber) | cable loss 3 (switch unit, atten-uator & pre-amp) | cable loss 4 (to receiver) | | |
|---|---|---|---|---|---|---|---|---|
| MHz | dB (1/m) | dB | dB | dB | dB | dB | | |
| 1000 | 24.4 | -19.4 | 0.99 | 0.31 | -21.51 | 0.79 | | |
| 2000 | 28.5 | -17.4 | 1.44 | 0.44 | -20.63 | 1.38 | | |
| 3000 | 31.0 | -16.1 | 1.87 | 0.53 | -19.85 | 1.33 | | |
| 4000 | 33.1 | -14.7 | 2.41 | 0.67 | -19.13 | 1.31 | | |
| 5000 | 34.4 | -13.7 | 2.78 | 0.86 | -18.71 | 1.40 | | |
| 6000 | 34.7 | -12.7 | 2.74 | 0.90 | -17.83 | 1.47 | | |
| 7000 | 35.6 | -11.0 | 2.82 | 0.86 | -16.19 | 1.46 | | |

| Frequency | AF R&S HF907 | Corr. | cable loss 1 (relay inside chamber) | cable loss 2 (inside chamber) | cable loss 3 (outside chamber) | cable loss 4 (switch unit, atten-uator & pre-amp) | cable loss 5 (to receiver) | used for FCC 15.247 |
|---|---|---|---|---|---|---|---|---|
| MHz | dB (1/m) | dB | dB | dB | dB | dB | dB | |
| 3000 | 31.0 | -23.4 | 0.47 | 1.87 | 0.53 | -27.58 | 1.33 | |
| 4000 | 33.1 | -23.3 | 0.56 | 2.41 | 0.67 | -28.23 | 1.31 | |
| 5000 | 34.4 | -21.7 | 0.61 | 2.78 | 0.86 | -27.35 | 1.40 | |
| 6000 | 34.7 | -21.2 | 0.58 | 2.74 | 0.90 | -26.89 | 1.47 | |
| 7000 | 35.6 | -19.8 | 0.66 | 2.82 | 0.86 | -25.58 | 1.46 | |

| Frequency | AF R&S HF907 | Corr. | 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) |
|---|---|---|---|---|---|---|---|---|
| MHz | dB (1/m) | dB | dB | dB | dB | dB | dB | dB |
| 7000 | 35.6 | -57.3 | 0.56 | 1.28 | -62.72 | 2.66 | 0.94 | 1.46 |
| 8000 | 36.3 | -56.3 | 0.69 | 0.71 | -61.49 | 2.84 | 1.00 | 1.53 |
| 9000 | 37.1 | -55.3 | 0.68 | 0.65 | -60.80 | 3.06 | 1.09 | 1.60 |
| 10000 | 37.5 | -56.2 | 0.70 | 0.54 | -61.91 | 3.28 | 1.20 | 1.67 |
| 11000 | 37.5 | -55.3 | 0.80 | 0.61 | -61.40 | 3.43 | 1.27 | 1.70 |
| 12000 | 37.6 | -53.7 | 0.84 | 0.42 | -59.70 | 3.53 | 1.26 | 1.73 |
| 13000 | 38.2 | -53.5 | 0.83 | 0.44 | -59.81 | 3.75 | 1.32 | 1.83 |
| 14000 | 39.9 | -56.3 | 0.91 | 0.53 | -63.03 | 3.91 | 1.40 | 1.77 |
| 15000 | 40.9 | -54.1 | 0.98 | 0.54 | -61.05 | 4.02 | 1.44 | 1.83 |
| 16000 | 41.3 | -54.1 | 1.23 | 0.49 | -61.51 | 4.17 | 1.51 | 1.85 |
| 17000 | 42.8 | -54.4 | 1.36 | 0.76 | -62.36 | 4.34 | 1.53 | 2.00 |
| 18000 | 44.2 | -54.7 | 1.70 | 0.53 | -62.88 | 4.41 | 1.55 | 1.91 |

**Sample calculation**

E (dB µV/m) = U (dB µV) + AF (dB 1/m) + 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.

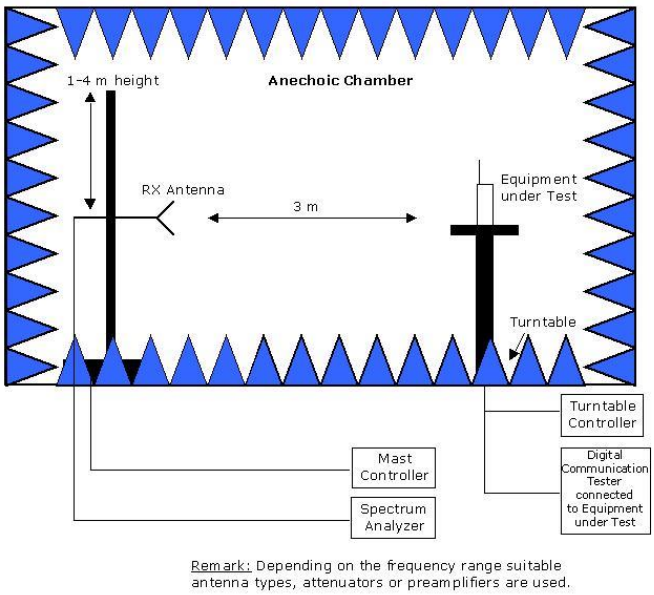
ANTENNA EMCO 3160-09 (18 GHZ – 26.5 GHZ)

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

# 8 SETUP DRAWINGS




**Drawing 1:** Setup in the Anechoic chamber:
Measurements below 1 GHz: Semi-anechoic, conducting ground plane.
Measurements above 1 GHz: Fully-anechoic, absorbers on all surface

# 9 PHOTO REPORT

Photos are included in an external report.