

# FCC Measurement/Technical Report on

## Host-based multiradio module with Wi-Fi, Bluetooth and NFC

### EMMY-W161

in WLAN 2.4 GHz and  
Bluetooth LE mode

FCC ID: EMMY-W161: XPYEMMYW161  
IC: EMMY-W161: 8595A-EMMYW161

**Test Report Reference:** MDE\_UBLOX\_1551\_FCCc\_Rev1

**Test Laboratory:**

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Germany



**Note:**

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

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## 1 APPLIED STANDARDS AND TEST SUMMARY

### 1.1 APPLIED STANDARDS

#### **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 (10-1-15 Edition). The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

Part 15, Subpart 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 1:

The tests were selected and performed with reference to the FCC Public Notice "GUIDANCE FOR PERFORMING COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEMS (DTS) OPERATING UNDER §15.247, 558074 D01 DTS Meas Guidance v03r05, 2016-04-08". ANSI C63.10-2013 is applied.

#### Note 2:

Not all possible operating modes were tested. Worst case operating modes were determined at the beginning of the test period.

#### Note 3:

Bluetooth LE mode uses the same GFSK modulation like Bluetooth BDR mode, but

- fewer channels (up to 40 instead of up to 80) in the same frequency band

- and for this device lower output power (max. 5 dBm instead of max. 10 dBm).

Bluetooth BDR mode is therefore worse for "Transmitter spurious radiated emissions" and "Band Edge Compliance Radiated" and cover also Bluetooth LE mode.

#### Note 4:

Bluetooth LE Mode => GFSK modulation, for test "Transmitter spurious radiated emissions" and "Band Edge Compliance Radiated" please refer to test report "MDE\_UBLOX\_1551\_FCCh", where the same EUT were tested in Bluetooth BDR mode.

## 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 4: 8.8                                      |
| Occupied bandwidth                          | § 15.247 (a) (2)              | RSS-247 Issue 1: 5.2 (1)                                  |
| Peak conducted output power                 | § 15.247 (b) (3), (4)         | RSS-247 Issue 1: 5.4 (4)                                  |
| Transmitter spurious RF conducted emissions | § 15.247 (d)                  | RSS-Gen Issue 4: 6.13 / 8.9/8.10;<br>RSS-247 Issue 1: 5.5 |
| Transmitter spurious radiated emissions     | § 15.247 (d);<br>§ 15.209 (a) | RSS-Gen Issue 4: 6.13 / 8.9/8.10;<br>RSS-247 Issue 1: 5.5 |
| Band edge compliance                        | § 15.247 (d)                  | RSS-247 Issue 1: 5.5                                      |
| Power density                               | § 15.247 (e)                  | RSS-247 Issue 1: 5.2 (2)                                  |
| Antenna requirement                         | § 15.203 / 15.204             | RSS-Gen Issue 4: 8.3                                      |
| Receiver spurious emissions                 | –                             | –                                                         |

### 1.3 MEASUREMENT SUMMARY / SIGNATURES

#### 47 CFR CHAPTER I FCC PART 15 Subpart C § 15.207

##### §15.247

Conducted Emissions at AC Mains

The measurement was performed according to ANSI C63.10

#### Final Result

| OP-Mode                      | Setup     | FCC    | IC     |
|------------------------------|-----------|--------|--------|
| Operating mode<br>worst case | S161_aa01 | Passed | Passed |

#### 47 CFR CHAPTER I FCC PART 15 Subpart C § 15.247 (a) (2)

##### §15.247

Occupied Bandwidth (6 dB)

The measurement was performed according to ANSI C63.10

#### Final Result

| OP-Mode                               | Setup     | FCC    | IC     |
|---------------------------------------|-----------|--------|--------|
| Radio Technology, Operating Frequency |           |        |        |
| Bluetooth LE, high                    | S161_bb01 | Passed | Passed |
| Bluetooth LE, low                     | S161_bb01 | Passed | Passed |
| Bluetooth LE, mid                     | S161_bb01 | Passed | Passed |
| WLAN b, high                          | S161_bb01 | Passed | Passed |
| WLAN b, low                           | S161_bb01 | Passed | Passed |
| WLAN b, mid                           | S161_bb01 | Passed | Passed |
| WLAN g, high                          | S161_bb01 | Passed | Passed |
| WLAN g, low                           | S161_bb01 | Passed | Passed |
| WLAN g, mid                           | S161_bb01 | Passed | Passed |
| WLAN n 20 MHz, high                   | S161_bb01 | Passed | Passed |
| WLAN n 20 MHz, low                    | S161_bb01 | Passed | Passed |
| WLAN n 20 MHz, mid                    | S161_bb01 | Passed | Passed |
| WLAN n 40 MHz, high                   | S161_bb01 | Passed | Passed |
| WLAN n 40 MHz, low                    | S161_bb01 | Passed | Passed |
| WLAN n 40 MHz, mid                    | S161_bb01 | Passed | Passed |

#### 47 CFR CHAPTER I FCC PART 15 Subpart C

##### §15.247

Occupied Bandwidth (99%)

The measurement was performed according to ANSI C63.10

#### Final Result

##### OP-Mode

Radio Technology, Operating Frequency

| Setup     | FCC | IC     |
|-----------|-----|--------|
| S161_bb01 | N/A | Tested |
| S161_bb01 | N/A | Tested |
| S161_bb01 | N/A | Tested |
| S161_bb01 | N/A | Tested |
| S161_bb01 | N/A | Tested |
| S161_bb01 | N/A | Tested |
| S161_bb01 | N/A | Tested |
| S161_bb01 | N/A | Tested |
| S161_bb01 | N/A | Tested |
| S161_bb01 | N/A | Tested |
| S161_bb01 | N/A | Tested |
| S161_bb01 | N/A | Tested |
| S161_bb01 | N/A | Tested |
| S161_bb01 | N/A | Tested |
| S161_bb01 | N/A | Tested |

Remark: No applicable limit. Measurement results for information purpose.

#### 47 CFR CHAPTER I FCC PART 15 Subpart C

#### § 15.247 (b) (3)

##### §15.247

Peak Power Output

The measurement was performed according to ANSI C63.10

#### Final Result

##### OP-Mode

Radio Technology, Operating Frequency, Measurement method

| Setup     | FCC    | IC     |
|-----------|--------|--------|
| S161_bb01 | Passed | Passed |
| S161_bb01 | Passed | Passed |
| S161_bb01 | Passed | Passed |
| S161_bb01 | Passed | Passed |
| S161_bb01 | Passed | Passed |
| S161_bb01 | Passed | Passed |
| S161_bb01 | Passed | Passed |
| S161_bb01 | Passed | Passed |
| S161_bb01 | Passed | Passed |
| S161_bb01 | Passed | Passed |
| S161_bb01 | Passed | Passed |
| S161_bb01 | Passed | Passed |
| S161_bb01 | Passed | Passed |
| S161_bb01 | Passed | Passed |
| S161_bb01 | Passed | Passed |
| S161_bb01 | Passed | Passed |
| S161_bb01 | Passed | Passed |
| S161_bb01 | Passed | Passed |
| S161_bb01 | Passed | Passed |
| S161_bb01 | Passed | Passed |

**47 CFR CHAPTER I FCC PART 15 Subpart C**  
**§15.247**

**§ 15.247 (d)**

Spurious RF Conducted Emissions

The measurement was performed according to ANSI C63.10

**Final Result**

| <b>OP-Mode</b>                        | <b>Setup</b> | <b>FCC</b> | <b>IC</b> |
|---------------------------------------|--------------|------------|-----------|
| Radio Technology, Operating Frequency |              |            |           |
| Bluetooth LE, high                    | S161_bb01    | Passed     | Passed    |
| Bluetooth LE, low                     | S161_bb01    | Passed     | Passed    |
| Bluetooth LE, mid                     | S161_bb01    | Passed     | Passed    |
| WLAN b, high                          | S161_bb01    | Passed     | Passed    |
| WLAN b, low                           | S161_bb01    | Passed     | Passed    |
| WLAN b, mid                           | S161_bb01    | Passed     | Passed    |
| WLAN g, high                          | S161_bb01    | Passed     | Passed    |
| WLAN g, low                           | S161_bb01    | Passed     | Passed    |
| WLAN g, mid                           | S161_bb01    | Passed     | Passed    |
| WLAN n 20 MHz, high                   | S161_bb01    | Passed     | Passed    |
| WLAN n 20 MHz, low                    | S161_bb01    | Passed     | Passed    |
| WLAN n 20 MHz, mid                    | S161_bb01    | Passed     | Passed    |
| WLAN n 40 MHz, high                   | S161_bb01    | Passed     | Passed    |
| WLAN n 40 MHz, low                    | S161_bb01    | Passed     | Passed    |
| WLAN n 40 MHz, mid                    | S161_bb01    | Passed     | Passed    |

**47 CFR CHAPTER I FCC PART 15 Subpart C**  
**§15.247**

**§ 15.247 (d)**

Spurious RF Conducted Emissions in restricted bands

The measurement was performed according to ANSI C63.10

**Final Result**

| <b>OP-Mode</b>                                           | <b>Setup</b> | <b>FCC</b> | <b>IC</b> |
|----------------------------------------------------------|--------------|------------|-----------|
| Radio Technology, Operating Frequency, Measurement range |              |            |           |
| WLAN b, additional channel, 9 kHz - 24 GHz               | S161_bb01    | Passed     | Passed    |
| WLAN b, high, 9 kHz - 24 GHz                             | S161_bb01    | Passed     | Passed    |
| WLAN b, low, 9 kHz - 24 GHz                              | S161_bb01    | Passed     | Passed    |
| WLAN b, mid, 9 kHz - 24 GHz                              | S161_bb01    | Passed     | Passed    |
| WLAN g, additional channel, 9 kHz - 24 GHz               | S161_bb01    | Passed     | Passed    |
| WLAN g, high, 9 kHz - 24 GHz                             | S161_bb01    | Passed     | Passed    |
| WLAN g, low, 9 kHz - 24 GHz                              | S161_bb01    | Passed     | Passed    |
| WLAN g, mid, 9 kHz - 24 GHz                              | S161_bb01    | Passed     | Passed    |
| WLAN n 20 MHz, additional channel, 9 kHz - 24 GHz        | S161_bb01    | Passed     | Passed    |
| WLAN n 20 MHz, high, 9 kHz - 24 GHz                      | S161_bb01    | Passed     | Passed    |
| WLAN n 20 MHz, low, 9 kHz - 24 GHz                       | S161_bb01    | Passed     | Passed    |
| WLAN n 20 MHz, mid, 9 kHz - 24 GHz                       | S161_bb01    | Passed     | Passed    |
| WLAN n 40 MHz, additional channel, 9 kHz - 24 GHz        | S161_bb01    | Passed     | Passed    |
| WLAN n 40 MHz, high, 9 kHz - 24 GHz                      | S161_bb01    | Passed     | Passed    |
| WLAN n 40 MHz, low, 9 kHz - 24 GHz                       | S161_bb01    | Passed     | Passed    |
| WLAN n 40 MHz, mid, 9 kHz - 24 GHz                       | S161_bb01    | Passed     | Passed    |



**47 CFR CHAPTER I FCC PART 15 Subpart C**  
**§15.247**

**§ 15.247 (d)**

**Transmitter Spurious Radiated Emissions**

The measurement was performed according to ANSI C63.10

**Final Result**

**OP-Mode**

Radio Technology, Operating Frequency, Measurement range

WLAN b, high, 1 GHz - 26 GHz

**Setup**

**FCC**

**IC**

S161\_bb01

Passed

Passed

WLAN b, high, 30 MHz - 1 GHz

S161\_bb01

Passed

Passed

WLAN b, high, 9 kHz - 30 MHz

S161\_bb01

Passed

Passed

WLAN b, low, 1 GHz - 26 GHz

S161\_bb01

Passed

Passed

WLAN b, low, 30 MHz - 1 GHz

S161\_bb01

Passed

Passed

WLAN b, low, 9 kHz - 30 MHz

S161\_bb01

Passed

Passed

WLAN b, mid, 1 GHz - 26 GHz

S161\_bb01

Passed

Passed

WLAN b, mid, 30 MHz - 1 GHz

S161\_bb01

Passed

Passed

WLAN b, mid, 9 kHz - 30 MHz

S161\_bb01

Passed

Passed

**47 CFR CHAPTER I FCC PART 15 Subpart C**  
**§15.247**

**§ 15.247 (d)**

**Band Edge Compliance Conducted**

The measurement was performed according to ANSI C63.10

**Final Result**

**OP-Mode**

Radio Technology, Operating Frequency, Band Edge

Bluetooth LE, high, high

**Setup**

**FCC**

**IC**

S161\_bb01

Passed

Passed

Bluetooth LE, low, low

S161\_bb01

Passed

Passed

WLAN b, high, high

S161\_bb01

Passed

Passed

WLAN b, low, low

S161\_bb01

Passed

Passed

WLAN g, high, high

S161\_bb01

Passed

Passed

WLAN g, low, low

S161\_bb01

Passed

Passed

WLAN n 20 MHz, high, high

S161\_bb01

Passed

Passed

WLAN n 20 MHz, low, low

S161\_bb01

Passed

Passed

WLAN n 40 MHz, high, high

S161\_bb01

Passed

Passed

WLAN n 40 MHz, low, low

S161\_bb01

Passed

Passed

**47 CFR CHAPTER I FCC PART 15 Subpart C**  
**§15.247**

**§ 15.247 (d)**

**Band Edge Compliance Radiated**

The measurement was performed according to ANSI C63.10

**Final Result**

**OP-Mode**

Radio Technology, Operating Frequency, Band Edge

WLAN b, high, high

**Setup**

**FCC**

**IC**

S161\_bb01

Passed

Passed

Remark: Due to 50 Ohm termination at the antenna port no radiated WLAN signal measurable. Please refer to "Band Edge Compliance Conducted at Restricted Band".

**47 CFR CHAPTER I FCC PART 15 Subpart C**  
**§15.247**

**§ 15.247 (d)**

Band Edge Compliance Conducted at Restricted Band

The measurement was performed according to ANSI C63.10

**Final Result**

**OP-Mode**

Radio Technology, Operating Frequency, Band Edge

WLAN b, additional channel, high

WLAN b, high, high

WLAN b, mid, high

WLAN g, additional channel, high

WLAN g, high, high

WLAN g, mid, high

WLAN n 20 MHz, additional channel, high

WLAN n 20 MHz, high, high

WLAN n 20 MHz, mid, high

WLAN n 40 MHz, additional channel, high

WLAN n 40 MHz, high, high

WLAN n 40 MHz, mid, high

**Setup**

**FCC**

**IC**

S161\_bb01

Passed

Passed

S161\_bb01

Passed

Passed

S161\_bb01

Passed

Passed

S161\_bb01

Passed

Passed

S161\_bb01

Passed

Passed

S161\_bb01

Passed

Passed

S161\_bb01

Passed

Passed

S161\_bb01

Passed

Passed

S161\_bb01

Passed

Passed

S161\_bb01

Passed

Passed

S161\_bb01

Passed

Passed

S161\_bb01

Passed

Passed

**47 CFR CHAPTER I FCC PART 15 Subpart C**  
**§15.247**

**§ 15.247 (e)**

Power Density

The measurement was performed according to ANSI C63.10

**Final Result**

**OP-Mode**

Radio Technology, Operating Frequency

Bluetooth LE, high

Bluetooth LE, low

Bluetooth LE, mid

WLAN b, high

WLAN b, low

WLAN b, mid

WLAN g, high

WLAN g, low

WLAN g, mid

WLAN n 20 MHz, high

WLAN n 20 MHz, low

WLAN n 20 MHz, mid

WLAN n 40 MHz, high

WLAN n 40 MHz, low

WLAN n 40 MHz, mid

**Setup**

**FCC**

**IC**

S161\_bb01

Passed

Passed

S161\_bb01

Passed

Passed

S161\_bb01

Passed

Passed

S161\_bb01

Passed

Passed

S161\_bb01

Passed

Passed

S161\_bb01

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S161\_bb01

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S161\_bb01

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S161\_bb01

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S161\_bb01

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S161\_bb01

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Passed

S161\_bb01

Passed

Passed

**47 CFR CHAPTER I FCC PART 15 Subpart C**  
**§15.247**

**§ 15.247 (d)**

Simultaneous Transmission - Spurious Radiated Emissions  
The measurement was performed according to ANSI C63.10

**Final Result**

**OP-Mode**

Active Transmitters  
NFC + WLAN 2.4 GHz

**Setup**

S161\_ad01

**FCC**

Passed

**IC**

Passed



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(responsible for accreditation scope)  
Dipl.-Ing. Andreas Petz



(responsible for testing and report)  
Dipl.-Ing. Wolfgang Richter

**1.4 REVISION HISTORY**

| Report version control |              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                  |
|------------------------|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| Version                | Release date | Change Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Version validity |
| initial                | 2016-06-16   | --                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | invalid          |
| rev_1                  | 2016-08-05   | 1.1: Applicable FCC rules updated to 10-1-15 Edition,<br>KDB 558074 D01 DTS Meas Guidance updated to v03r05,<br>2016-04-08 Edition,<br>Note 3 added (Justification for Bluetooth LE-mode),<br>Reference to FCC Public Notice DA 00-705 deleted (not applicable),<br>3.1: EUT description changed for clarification from "test vehicle" to "evaluation board",<br>3.2: Sample ad01 added,<br>3.7: Duty cycle information added,<br>4.2 to 4.4: Bandwidth and output power re-measured with lower declared output power,<br>4.3.1: Test description corrected<br>4.4.2: Reference to Frequency Hopping Systems deleted (not applicable)<br>4.11: Power density re-measured with lower declared output power,<br>4.12: Chapter Simultaneous Transmission added | valid            |

## 2 ADMINISTRATIVE DATA

### 2.1 TESTING LABORATORY

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

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

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

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

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

### 2.2 PROJECT DATA

Responsible for testing and report: Dipl.-Ing. Wolfgang Richter  
Employees who performed the tests: documented internally at 7Layers  
Date of Report: 2016-08-05  
Testing Period: 2016-01-28 to 2016-08-03

### 2.3 APPLICANT DATA

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

### 2.4 MANUFACTURER DATA

Company Name: please see applicant data  
Address:  
  
Contact Person:

### 3 TEST OBJECT DATA

#### 3.1 GENERAL EUT DESCRIPTION

|                                          |                                                                                                                                                                                                                                                                                                                                                                |
|------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Kind of Device product description       | WLAN 2.4 GHz, 5 GHz, BT, NFC, SRD (5.8 GHz) - Single Antenna                                                                                                                                                                                                                                                                                                   |
| Product name                             | Host-based multiradio module with Wi-Fi, Bluetooth and NFC                                                                                                                                                                                                                                                                                                     |
| Type                                     | EMMY-W161                                                                                                                                                                                                                                                                                                                                                      |
| <b>Declared EUT data by the supplier</b> |                                                                                                                                                                                                                                                                                                                                                                |
| Voltage Type                             | DC                                                                                                                                                                                                                                                                                                                                                             |
| Voltage Level                            | normal: 3.3 V DC<br>low: 3.0 V DC<br>high: 3.6 V DC                                                                                                                                                                                                                                                                                                            |
| Modulation Type                          | Bluetooth LE: GFSK<br>WLAN: DSSS, OFDM, HT20 MCS0 – MCS7, HT40 MCS0 –MCS7<br>please see each test protocol                                                                                                                                                                                                                                                     |
| General product description              | EMMY-W161 and EMMY-W163 are ultra-compact multi-radio modules providing Wi-Fi, Classic Bluetooth, Bluetooth low energy and NFC mode of operation.<br>It is designed for both simultaneous and independent operations of: <ul style="list-style-type: none"> <li>• Wi-Fi IEEE 802.11ac and a/b/g/n</li> <li>• Dual-mode Bluetooth 4.2</li> <li>• NFC</li> </ul> |
| Specific product description for the EUT | EMMY-W161: Shielded module, single antenna pin for WLAN 802.11 ac/a/b/g/n and Bluetooth communication                                                                                                                                                                                                                                                          |
| The EUT provides the following ports:    | - DC power supply<br>- antenna port<br>- signal ports                                                                                                                                                                                                                                                                                                          |
| Data rates                               | Bluetooth LE, GFSK: 1 Mbit/s<br>WLAN b: please see chapter "WLAN Power Table"<br>WLAN g: please see chapter "WLAN Power Table"<br>WLAN n 20 MHz: please see chapter "WLAN Power Table"<br>WLAN n 40 MHz: please see chapter "WLAN Power Table"                                                                                                                 |
| Power levels                             | Bluetooth LE: 5 dBm<br>WLAN: please see chapter "WLAN Power Table"                                                                                                                                                                                                                                                                                             |

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

### 3.2 EUT MAIN COMPONENTS

| Sample Name      | Sample Code                                                                                                                                                   | Description          |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| DE1015031aa01    | aa01                                                                                                                                                          | Radiated Sample "#1" |
| Sample Parameter | Value                                                                                                                                                         |                      |
| Integral Antenna | Antenna on evaluation board (target platform):<br>Antenova, Type A10194, SMD chip antenna, 1.8 dBi Peak gain in 2.4 GHz band, 4.1 dBi Peak gain in 5 GHz band |                      |
| Serial No.       | -                                                                                                                                                             |                      |
| HW Version       | 03                                                                                                                                                            |                      |
| SW Version       | N/A                                                                                                                                                           |                      |
| Comment          | -                                                                                                                                                             |                      |

| Sample Name      | Sample Code                                                                                                                                                   | Description           |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| DE1015031ad01    | ad01                                                                                                                                                          | Radiated Sample "#1c" |
| Sample Parameter | Value                                                                                                                                                         |                       |
| Antenna          | Antenna on evaluation board (target platform):<br>Antenova, Type A10194, SMD chip antenna, 1.8 dBi Peak gain in 2.4 GHz band, 4.1 dBi Peak gain in 5 GHz band |                       |
| Serial No.       | -                                                                                                                                                             |                       |
| HW Version       | 03                                                                                                                                                            |                       |
| SW Version       | N/A                                                                                                                                                           |                       |
| Comment          | -                                                                                                                                                             |                       |

| Sample Name      |              | Sample Code                                                                                                                                                                                                                    |                                    | Description            |            |
|------------------|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|------------------------|------------|
| DE1015031bb01    |              | bb01                                                                                                                                                                                                                           |                                    | Conducted Sample "#2a" |            |
| Sample Parameter |              | Value                                                                                                                                                                                                                          |                                    |                        |            |
| Antenna          |              | Antenna connector on evaluation board (target platform):<br>The following antennas are designated for 2.4 and 5 GHz WLAN transmission on EMMY-W161, as well as Bluetooth on EMMY-W161. - Table 2 of Test Object Specification: |                                    |                        |            |
|                  |              |                                                                                                                                                                                                                                |                                    | Peak gain [dBi]        |            |
| #                | Manufacturer | Part number                                                                                                                                                                                                                    | Antenna type                       | 2.4 GHz band           | 5 GHz band |
| W1               | Antenova     | A10194<br>[1]                                                                                                                                                                                                                  | SMD chip antenna<br>10x10x0.9 [mm] | 1.8                    | 4.1        |
| W2               | Linx         | ANT-DB1-RAF-RPS<br>[4]                                                                                                                                                                                                         | Dual-band dipole antenna           | 2.5                    | 4.6        |
| W3               | Taoglas      | GW.40.2153                                                                                                                                                                                                                     | Dual-band dipole antenna           | 3.74                   | 2.5        |
| W4               | Taoglas      | GW.59.3153<br>[5]                                                                                                                                                                                                              | Dual-band dipole antenna           | 2.37                   | 2.93       |
| W5               | Walsin       | RFDPA870900SBLB8G1                                                                                                                                                                                                             | Dual-band dipole antenna           | 2                      | 3          |
| W6               | Linx         | ANT-2.4-CW-RCT-RP<br>[3]                                                                                                                                                                                                       | Single-band dipole antenna         | 2.2                    | N/A        |
| W7               | Delock       | 88395 [6]                                                                                                                                                                                                                      | Dual-band dipole antenna           | 1.5                    | 2.1        |
| Serial No.       |              | -                                                                                                                                                                                                                              |                                    |                        |            |
| HW Version       |              | 03                                                                                                                                                                                                                             |                                    |                        |            |
| SW Version       |              | N/A                                                                                                                                                                                                                            |                                    |                        |            |
| Comment          |              | -                                                                                                                                                                                                                              |                                    |                        |            |

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

### 3.3 WLAN POWER TABLE

#### Declared Power limits vs channel for FCC

| Modulation group        | WLAN TX Power in dBm at frequency in MHz |      |      |      |      |      |      |      |      |      |      |      |      |
|-------------------------|------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|
|                         | 2412                                     | 2417 | 2422 | 2427 | 2432 | 2437 | 2442 | 2447 | 2452 | 2457 | 2462 | 2467 | 2472 |
| DSSS 1, 2, 5.5, 11 Mbps | 18                                       | 18   | 18   | 18   | 18   | 18   | 18   | 18   | 18   | 18   | 18   | 15   | 13   |
| OFDM 6, 9, 12, 18 Mbps  | 13                                       | 16   | 16   | 16   | 16   | 16   | 16   | 16   | 16   | 15   | 13   | 10   | 9    |
| OFDM 24, 36 Mbps        | 13                                       | 16   | 16   | 16   | 16   | 16   | 16   | 16   | 16   | 15   | 13   | 10   | 9    |
| OFDM 48, 54 Mbps        | 13                                       | 13   | 13   | 13   | 13   | 13   | 13   | 13   | 13   | 13   | 13   | 9    | 9    |
| HT20 MCS0, MCS1, MCS2   | 13                                       | 15   | 16   | 16   | 16   | 16   | 16   | 16   | 16   | 16   | 12   | 10   | 9    |
| HT20 MCS3, MCS4         | 13                                       | 15   | 16   | 16   | 16   | 16   | 16   | 16   | 16   | 16   | 12   | 9    | 9    |
| HT20 MCS5, MCS6, MCS7   | 13                                       | 13   | 13   | 13   | 13   | 13   | 13   | 13   | 13   | 13   | 12   | 9    | 9    |

| Modulation group      | WLAN TX Power in dBm at frequency in MHz |      |      |      |      |      |      |      |      |
|-----------------------|------------------------------------------|------|------|------|------|------|------|------|------|
|                       | 2422                                     | 2427 | 2432 | 2437 | 2442 | 2447 | 2452 | 2457 | 2462 |
| HT40 MCS0, MCS1, MCS2 | 11                                       | 11   | 13   | 14   | 14   | 13   | 10   | 7    | 6    |
| HT40 MCS3, MCS4       | 11                                       | 11   | 13   | 14   | 14   | 13   | 10   | 7    | 6    |
| HT40 MCS5, MCS6, MCS7 | 11                                       | 12   | 13   | 13   | 13   | 13   | 11   | 8    | 7    |

Remark: Please see detailed EUT settings in the test protocols.

### 3.4 ANCILLARY EQUIPMENT

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

| Device                             | Details<br>(Manufacturer, Type Model, OUT Code) | Description    |
|------------------------------------|-------------------------------------------------|----------------|
| Evaluation board (target platform) | u-blox , 03, -, -                               | u-blox EVB-W16 |



### 3.5 AUXILIARY EQUIPMENT

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

| Device                              | Details<br>(Manufacturer, HW, SW, S/ N) | Description    |
|-------------------------------------|-----------------------------------------|----------------|
| AC/DC power supply<br>(115 V 60 Hz) | PeakTech, -, -, 081062045               | PeakTech 6005D |

### 3.6 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       |
|-----------|-----------------------------------------------------------|---------------------------------|
| S161_aa01 | DE1015031aa01,<br>evaluation board,<br>AC/DC power supply | Setup for radiated measurement  |
| S161_ad01 | DE1015031ad01,<br>evaluation board,<br>AC/DC power supply | Setup for radiated measurement  |
| S161_bb01 | DE1015031bb01,<br>evaluation board,<br>AC/DC power supply | Setup for conducted measurement |

### 3.7 OPERATING MODES

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

#### 3.7.1 TEST CHANNELS

##### WLAN

##### 20 MHz Test Channels:

Channel:

Frequency [MHz]

| 2.4 GHz ISM<br>2400 - 2483.5 MHz |      |      |
|----------------------------------|------|------|
| low                              | mid  | high |
| 1                                | 6    | 13   |
| 2412                             | 2437 | 2472 |

##### 40 MHz Test Channels:

Channel:

Frequency [MHz]

| low  | mid  | high |
|------|------|------|
| 3    | 6    | 11   |
| 2422 | 2437 | 2462 |

##### BT LE Test Channels:

Channel:

Frequency [MHz]

| 2.4 GHz ISM<br>2400 - 2483.5 MHz |      |      |
|----------------------------------|------|------|
| low                              | mid  | high |
| 0                                | 19   | 39   |
| 2402                             | 2440 | 2480 |

In case of testing another channel, the measurement summary state "additional channel" and the channel or centre frequency of the operating frequency is stated in the test protocol.

Duty cycle = 100 %

### 3.8 PRODUCT LABELLING

#### 3.8.1 FCC ID LABEL

Please refer to the documentation of the applicant.

#### 3.8.2 LOCATION OF THE LABEL ON THE EUT

Please refer to the documentation of the applicant.

## 4 TEST RESULTS

### 4.1 CONDUCTED EMISSIONS AT AC MAINS

Standard **FCC Part 15 Subpart C**

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

#### 4.1.1 TEST DESCRIPTION

The test set-up was made in accordance to the general provisions of ANSI C 63.10. The Equipment Under Test (EUT) was setup in a shielded room to perform the conducted emissions measurements in a typical installation configuration. The EUT was powered from 50 $\mu$ H || 50 Ohm Line Impedance Stabilization Network (LISN). The LISN's unused connections were terminated with 50 Ohm loads.

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

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

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

EMI receiver settings:

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

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

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

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

EMI receiver settings:

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

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

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

The highest value is reported.

#### 4.1.2 TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart C, §15.207

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

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

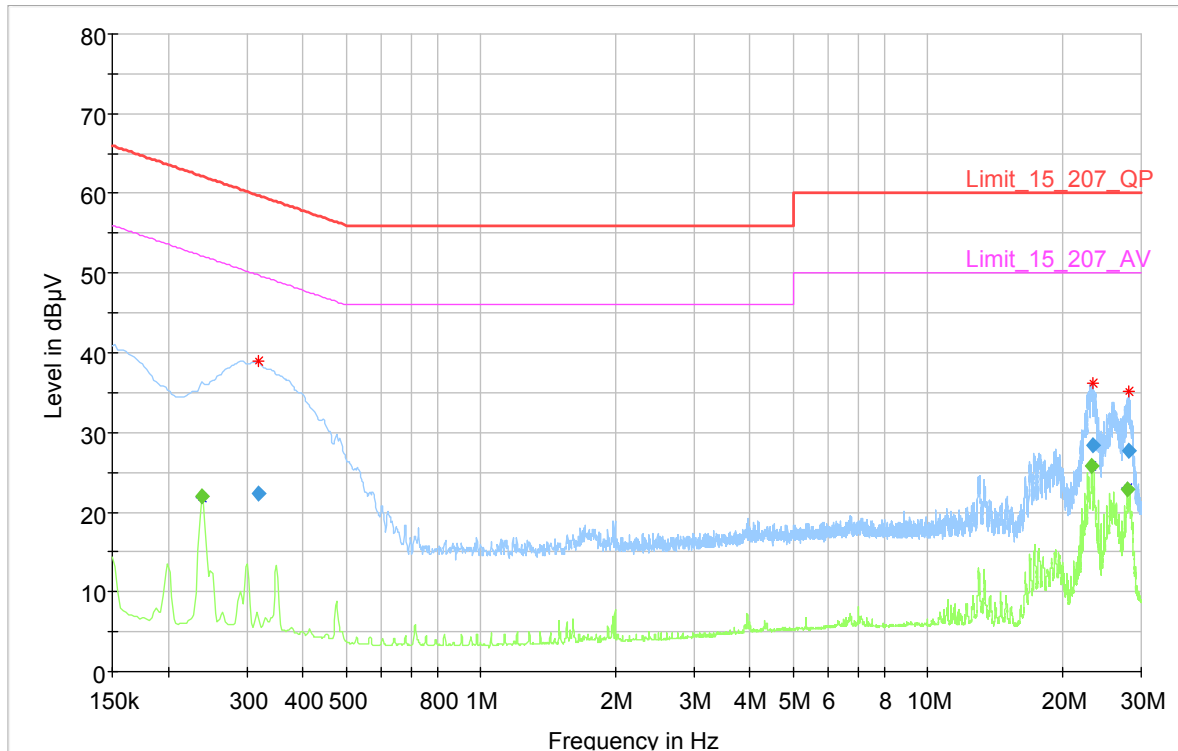
#### 4.1.3 TEST PROTOCOL

Temperature: 24 °C  
Air Pressure: 992 hPa  
Humidity: 34 %

| Power line | Frequency [MHz] | Measured value QP [dBμV] | Measured value AV [dBμV] | QP Limit [dBμV] | AV Limit [dBμV] | Margin QP [dB] | Margin AV [dB] |
|------------|-----------------|--------------------------|--------------------------|-----------------|-----------------|----------------|----------------|
| N          | -               | -                        | -                        | -               | -               | > 20           | > 20           |
| L          | -               | -                        | -                        | -               | -               | > 20           | > 20           |

Remark: Measured at 120 V 60 Hz input of lab power supply, WLAN 2.4 GHz, CH 6, CW, set EUT target power: 18 dBm

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



#### Critical\_Freqs

| Frequency (MHz) | MaxPeak (dBµV) | Average (dBµV) | Limit (dBµV) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Line | PE  | Corr. (dB) |
|-----------------|----------------|----------------|--------------|-------------|-----------------|-----------------|------|-----|------------|
| 0.237750        | ---            | 21.86          | 52.17        | 30.31       | ---             | ---             | L1   | GND | 10.1       |
| 0.318750        | 38.89          | ---            | 59.74        | 20.85       | ---             | ---             | L1   | GND | 10.1       |
| 23.223750       | ---            | 25.87          | 50.00        | 24.13       | ---             | ---             | N    | FLO | 11.1       |
| 23.322750       | 36.17          | ---            | 60.00        | 23.83       | ---             | ---             | L1   | GND | 11.1       |
| 27.946500       | ---            | 23.01          | 50.00        | 26.99       | ---             | ---             | N    | FLO | 11.2       |
| 28.239000       | 35.22          | ---            | 60.00        | 24.78       | ---             | ---             | N    | FLO | 11.2       |

#### Final\_Result

| Frequency (MHz) | QuasiPeak (dBµV) | Average (dBµV) | Limit (dBµV) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Line | PE  | Corr. (dB) |
|-----------------|------------------|----------------|--------------|-------------|-----------------|-----------------|------|-----|------------|
| 0.237750        | ---              | 22.01          | 52.17        | 30.16       | 1000.0          | 9.000           | L1   | GND | 10.1       |
| 0.318750        | 22.32            | ---            | 59.74        | 37.42       | 1000.0          | 9.000           | L1   | GND | 10.1       |
| 23.223750       | ---              | 25.72          | 50.00        | 24.28       | 1000.0          | 9.000           | N    | FLO | 11.1       |
| 23.322750       | 28.44            | ---            | 60.00        | 31.56       | 1000.0          | 9.000           | L1   | GND | 11.1       |
| 27.946500       | ---              | 22.78          | 50.00        | 27.22       | 1000.0          | 9.000           | N    | FLO | 11.2       |
| 28.239000       | 27.64            | ---            | 60.00        | 32.36       | 1000.0          | 9.000           | N    | FLO | 11.2       |

#### 4.1.5 TEST EQUIPMENT USED

##### Conducted Emissions

## 4.2 OCCUPIED BANDWIDTH (6 DB)

Standard      **FCC Part 15 Subpart C**

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

### 4.2.1 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 results recorded were measured with the modulation which produce the worst-case (smallest) emission bandwidth.

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): 300 kHz
- Span: 30 / 50 MHz (for 20 / 40 MHz nominal bandwidth)
- Trace: Maxhold
- Sweeps: 2000
- Sweep time: 20 ms
- Detector: Peak

### 4.2.2 TEST REQUIREMENTS / LIMITS

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

Systems using digital modulation techniques may operate in the 902-928 MHz and 2400-2483.5 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

#### 4.2.3 TEST PROTOCOL

Ambient temperature: 23 °C  
 Air Pressure: 1017 hPa  
 Humidity: 41 %  
 BT LE GFSK

| Band        | Channel No. | Frequency [MHz] | 6 dB Bandwidth [kHz] | Limit [kHz] | Margin to Limit [kHz] |
|-------------|-------------|-----------------|----------------------|-------------|-----------------------|
| 2.4 GHz ISM | 0.0         | 2402.0          | 757.5                | 500.0       | 257.5                 |
|             | 19.0        | 2440.0          | 745.5                | 500.0       | 245.5                 |
|             | 39.0        | 2480.0          | 751.5                | 500.0       | 251.5                 |

Ambient temperature: 23 °C  
 Air Pressure: 1017 hPa  
 Humidity: 41 %  
 WLAN b-Mode; 20 MHz

| Mode         | Set EUT target power | Frequency [MHz] | 6 dB Bandwidth [MHz] | Limit [MHz] | Margin to Limit [MHz] |
|--------------|----------------------|-----------------|----------------------|-------------|-----------------------|
| DSSS, 11Mbit | 18.0                 | 2412.0          | 9.9                  | 0.5         | 9.4                   |
| DSSS, 11Mbit | 18.0                 | 2437.0          | 9.6                  | 0.5         | 9.1                   |
| DSSS, 11Mbit | 18.0                 | 2462.0          | 10.3                 | 0.5         | 9.8                   |
| DSSS, 11Mbit | 13.0                 | 2472.0          | 9.3                  | 0.5         | 8.8                   |

WLAN g-Mode; 20 MHz

| Band          | Set EUT target power | Frequency [MHz] | 6 dB Bandwidth [MHz] | Limit [MHz] | Margin to Limit [MHz] |
|---------------|----------------------|-----------------|----------------------|-------------|-----------------------|
| OFDM, 54 Mbps | 13.0                 | 2412.0          | 16.4                 | 0.5         | 15.9                  |
| OFDM, 36 Mbps | 16.0                 | 2437.0          | 16.1                 | 0.5         | 15.6                  |
| OFDM, 54 Mbps | 9.0                  | 2472.0          | 16.5                 | 0.5         | 16.0                  |

WLAN n-Mode; 20 MHz

| Band       | Set EUT target power | Frequency [MHz] | 6 dB Bandwidth [MHz] | Limit [MHz] | Margin to Limit [MHz] |
|------------|----------------------|-----------------|----------------------|-------------|-----------------------|
| OFDM, MCS6 | 13.0                 | 2412.0          | 17.3                 | 0.5         | 16.8                  |
| OFDM, MCS3 | 16.0                 | 2437.0          | 16.9                 | 0.5         | 16.4                  |
| OFDM, MCS6 | 9.0                  | 2472.0          | 17.6                 | 0.5         | 17.1                  |

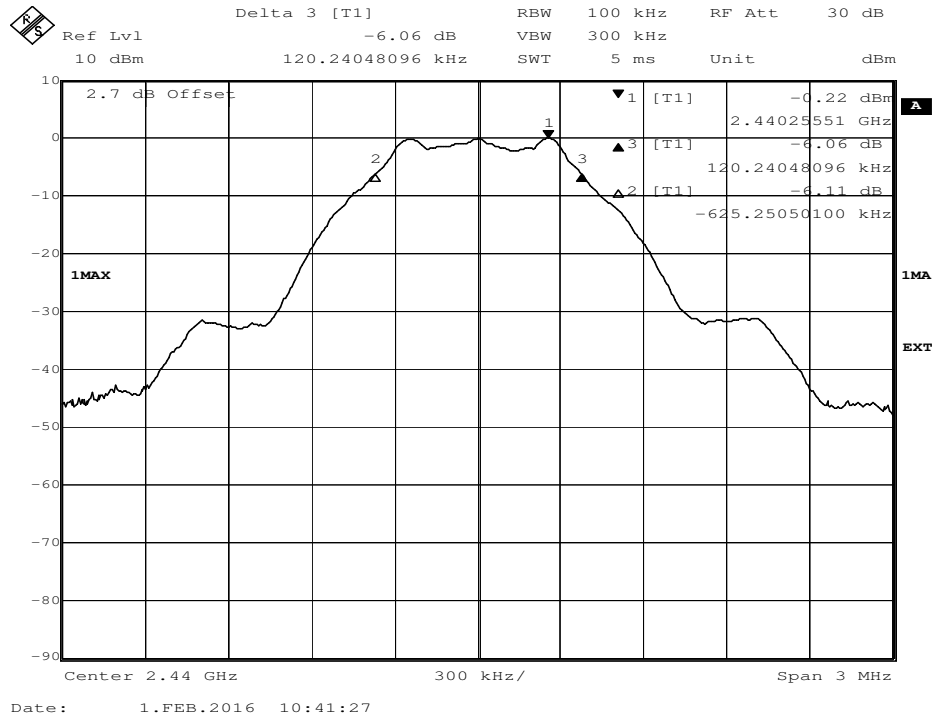
WLAN n-Mode; 40 MHz

| Band       | Set EUT target power | Frequency [MHz] | 6 dB Bandwidth [MHz] | Limit [MHz] | Margin to Limit [MHz] |
|------------|----------------------|-----------------|----------------------|-------------|-----------------------|
| OFDM, MCS6 | 11.0                 | 2422.0          | 36.6                 | 0.5         | 36.1                  |
| OFDM, MCS4 | 14.0                 | 2437.0          | 36.4                 | 0.5         | 35.9                  |
| OFDM, MCS6 | 7.0                  | 2462.0          | 35.5                 | 0.5         | 35.0                  |

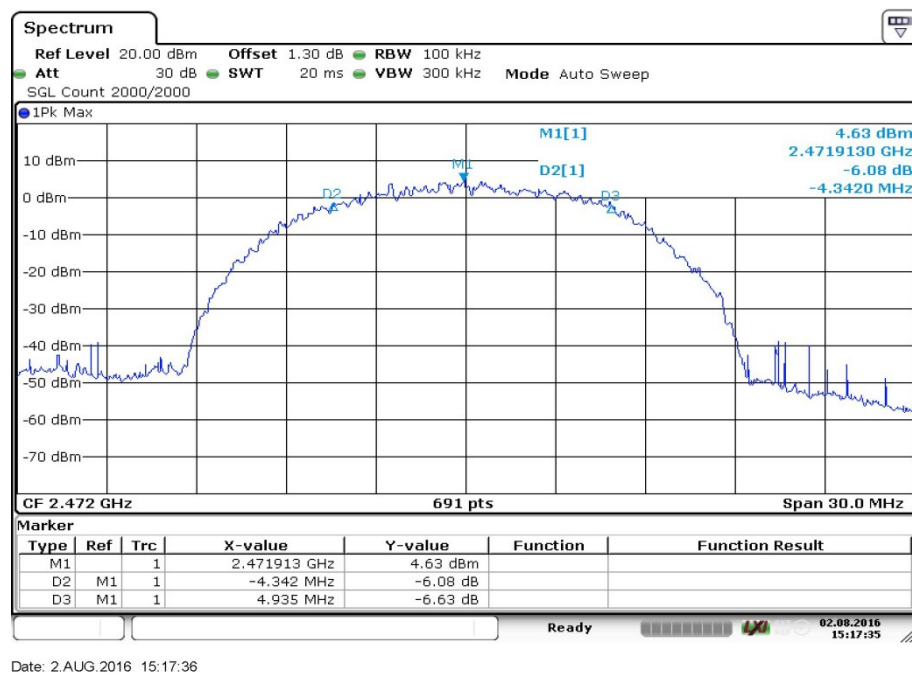
Remark: -

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

Radio Technology = Bluetooth LE, Operating Frequency = mid

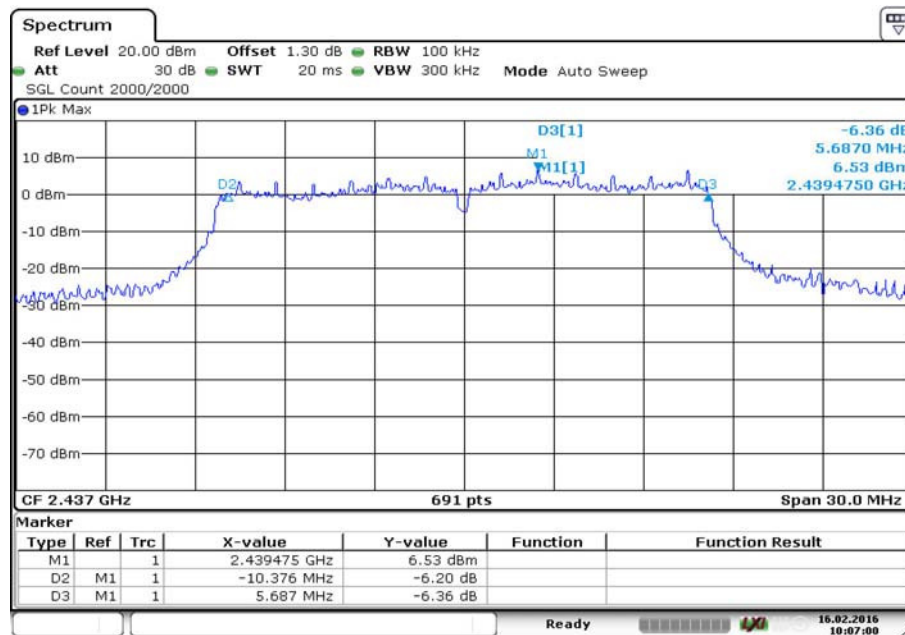


Radio Technology = WLAN b, Operating Frequency = high



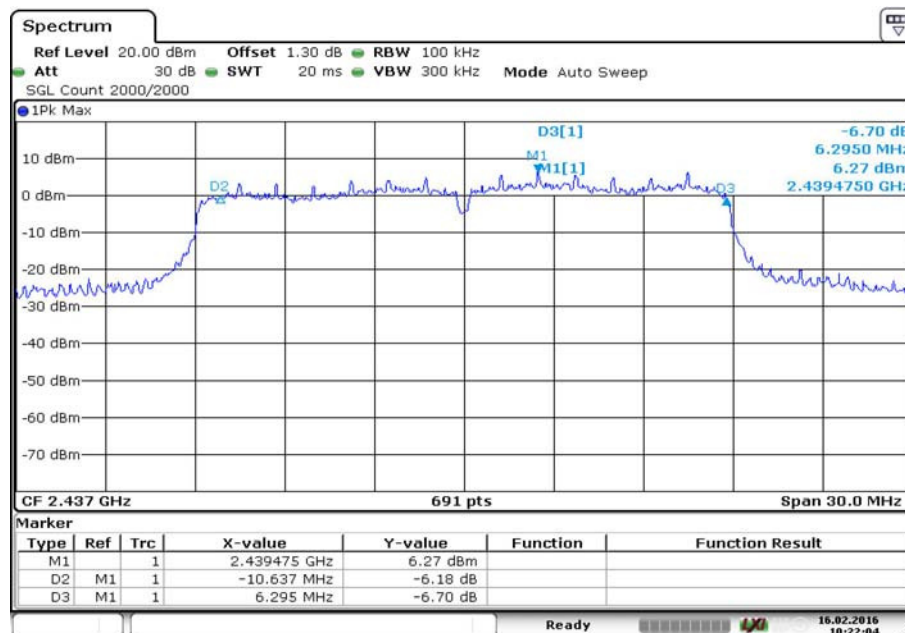


Radio Technology = WLAN g, Operating Frequency = mid



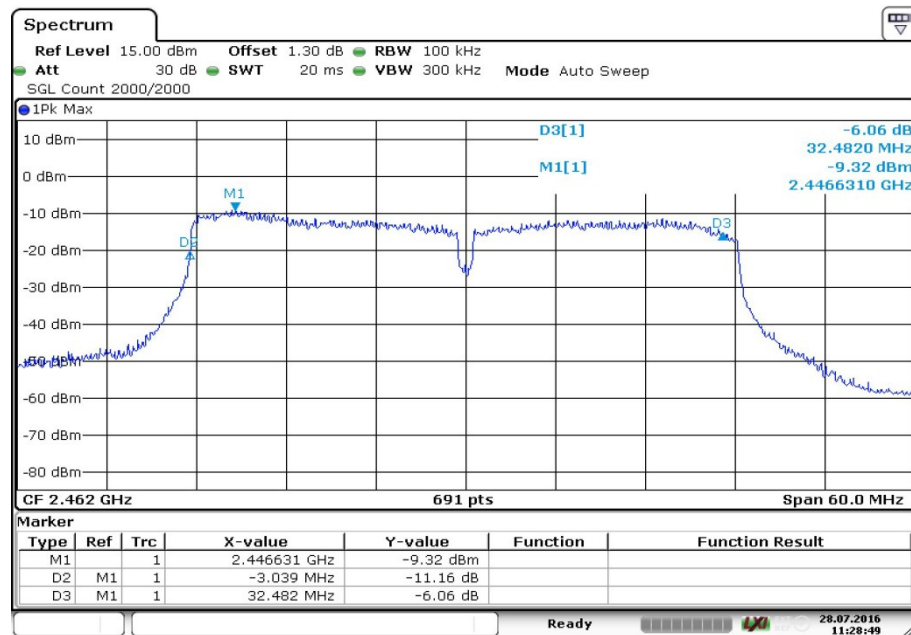
Date: 16.FEB.2016 10:07:00

Radio Technology = WLAN n 20 MHz, Operating Frequency = mid



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Radio Technology = WLAN n 40 MHz, Operating Frequency = high



Date: 28.JUL.2016 11:28:50

#### 4.2.5 TEST EQUIPMENT USED

R&S TS8997

#### 4.3 OCCUPIED BANDWIDTH (99%)

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), 1 % to 5 % of OBW (6 dB):  
BT-LE: 30 kHz, WLAN b, g, n 20 MHz: 500 kHz, WLAN n 40 MHz: 1 MHz
- Video Bandwidth (VBW), approx. 3 x RBW:  
BT-LE: 100 kHz, WLAN b, g, n 20 MHz: 2 MHz, WLAN n 40 MHz: 3 MHz
- Span, 1.5 to 5 x OBW (6dB):  
BT-LE: 3 MHz, WLAN b, g, n 20 MHz: 50 MHz, WLAN n 40 MHz: 100 MHz
- Trace: Maxhold
- Sweeps: 2000
- Sweep time: 20 ms
- Detector: Sample

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. Measurement results for information purpose.

##### 4.3.3 TEST PROTOCOL

Ambient temperature: 23 °C  
Air Pressure: 1017 hPa  
Humidity: 41 %  
BT LE

| Band        | Channel No. | Frequency [MHz] | 99 % Bandwidth [kHz] |
|-------------|-------------|-----------------|----------------------|
| 2.4 GHz ISM | 0.0         | 2402.0          | 1024.6               |
|             | 19.0        | 2440.0          | <b>1024.6</b>        |
|             | 39.0        | 2480.0          | 1020.3               |

Ambient temperature: 23 °C  
 Air Pressure: 1017 hPa  
 Humidity: 41 %  
 WLAN b-Mode; 20 MHz

| Mode          | Set EUT target power | Frequency [MHz] | 99 % Bandwidth [MHz] |
|---------------|----------------------|-----------------|----------------------|
| DSSS, 11 Mbps | 18.0                 | 2412.0          | 13.3                 |
| DSSS, 11 Mbps | 18.0                 | 2437.0          | 13.4                 |
| DSSS, 11 Mbps | 13.0                 | 2472.0          | 12.8                 |

WLAN g-Mode; 20 MHz

| Mode          | Set EUT target power | Frequency [MHz] | 99 % Bandwidth [MHz] |
|---------------|----------------------|-----------------|----------------------|
| OFDM, 54 Mbps | 13.0                 | 2412.0          | 17.0                 |
| OFDM, 36 Mbps | 16.0                 | 2437.0          | 17.2                 |
| OFDM, 54 Mbps | 9.0                  | 2472.0          | 16.7                 |

WLAN n-Mode; 20 MHz

| Mode       | Set EUT target power | Frequency [MHz] | 99 % Bandwidth [MHz] |
|------------|----------------------|-----------------|----------------------|
| OFDM, MCS6 | 13.0                 | 2412.0          | 17.9                 |
| OFDM, MCS3 | 16.0                 | 2437.0          | 18.0                 |
| OFDM, MCS6 | 9.0                  | 2472.0          | 17.7                 |

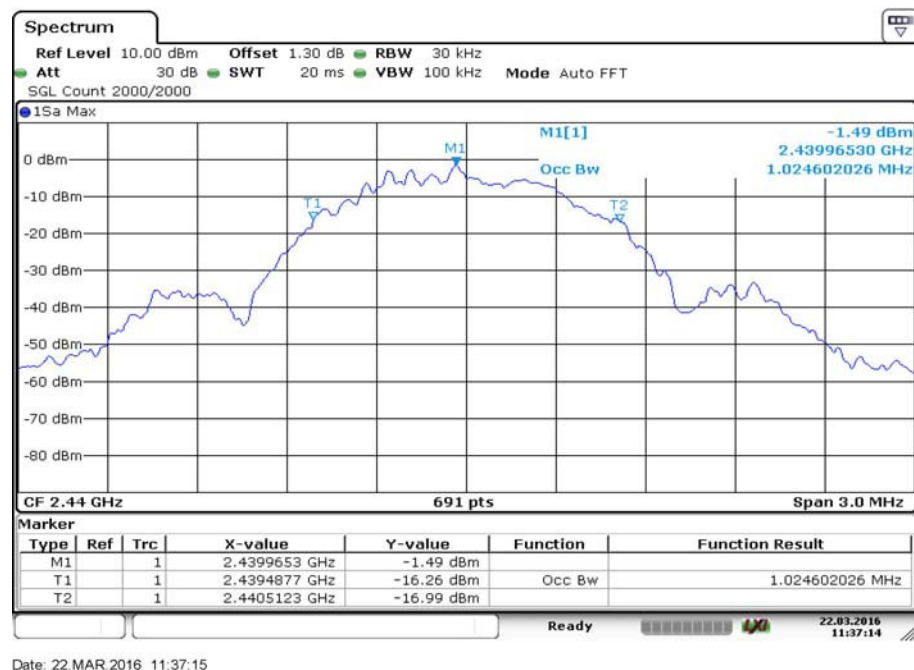
WLAN n-Mode; 40 MHz

| Mode       | Set EUT target power | Frequency [MHz] | 99 % Bandwidth [MHz] |
|------------|----------------------|-----------------|----------------------|
| OFDM, MCS6 | 11.0                 | 2422.0          | 36.6                 |
| OFDM, MCS4 | 14.0                 | 2437.0          | 36.0                 |
| OFDM, MCS6 | 7.0                  | 2462.0          | 36.5                 |

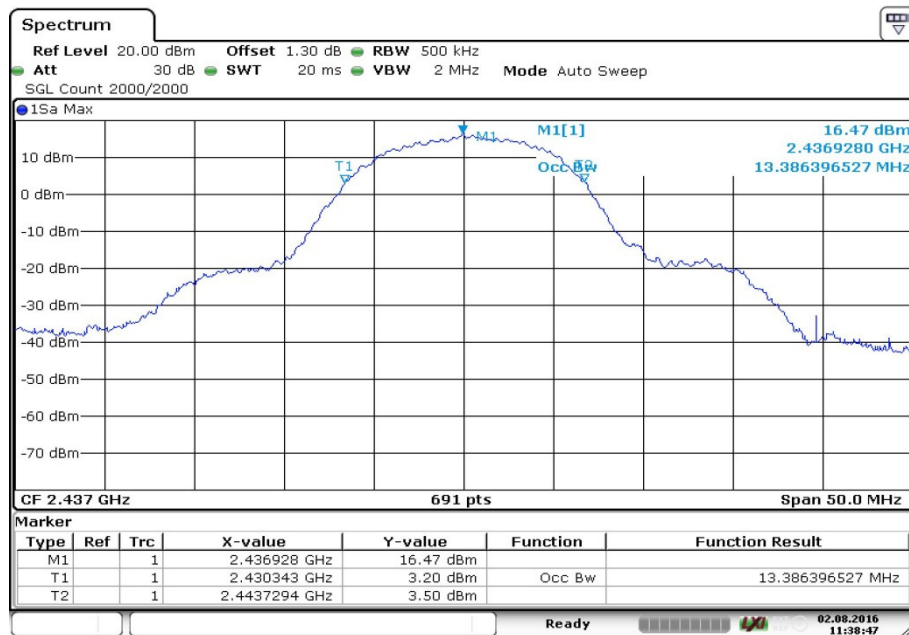
Remark: Please see next sub-clause for the measurement plot.

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

Radio Technology = Bluetooth LE, Operating Frequency = mid

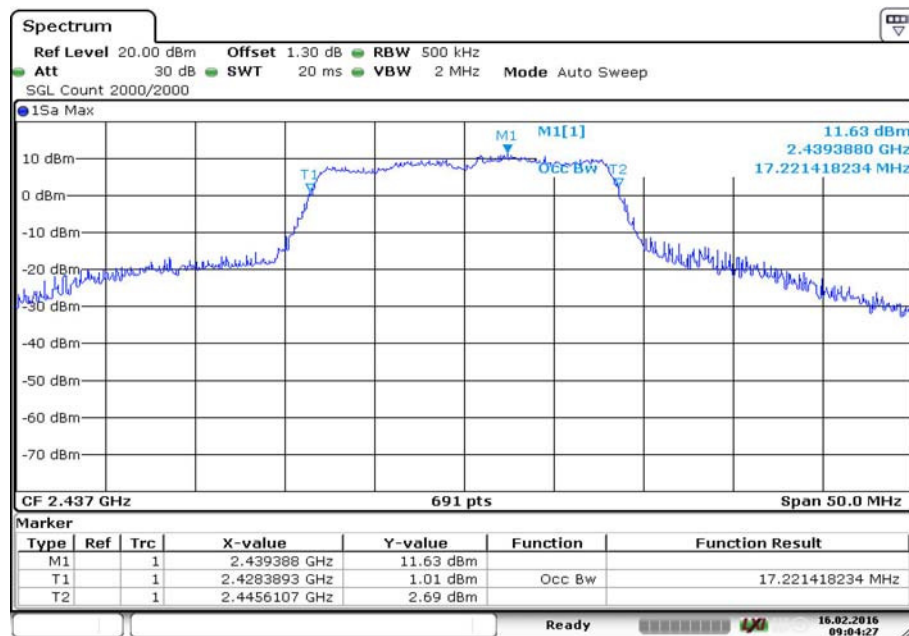


Radio Technology = WLAN b, Operating Frequency = mid



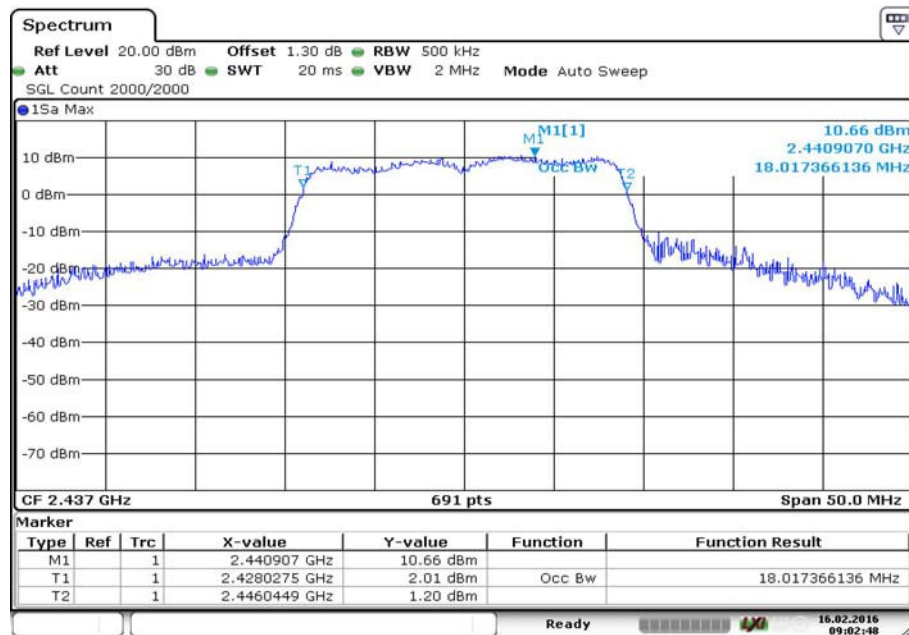
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Radio Technology = WLAN g, Operating Frequency = mid



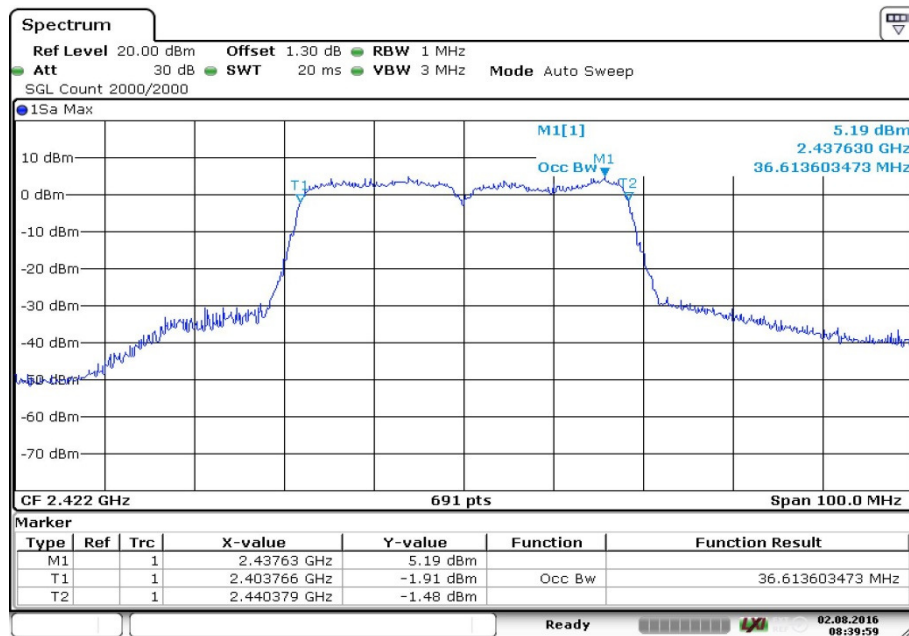
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Radio Technology = WLAN n 20 MHz, Operating Frequency = mid



Date: 16.FEB.2016 09:02:49

Radio Technology = WLAN n 40 MHz, Operating Frequency = low



Date: 2.AUG.2016 08:39:59

#### 4.3.5 TEST EQUIPMENT USED

R&S TS8997

#### 4.4 PEAK POWER OUTPUT

Standard **FCC Part 15 Subpart C**

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

##### 4.4.1 TEST DESCRIPTION

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
- Sweep time: 5 ms
- Detector: Peak

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

##### 4.4.2 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).

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

##### 4.4.3 TEST PROTOCOL

Ambient temperature: 23 °C  
Air Pressure: 1017 hPa  
Humidity: 41 %  
BT LE

| Band        | Channel No. | Frequency [MHz] | Peak Power [dBm] | Limit [dBm] | Margin to Limit [dB] |
|-------------|-------------|-----------------|------------------|-------------|----------------------|
| 2.4 GHz ISM | 0           | 2402.0          | 2.1              | 30.0        | 27.9                 |
|             | 19          | 2440.0          | 2.5              | 30.0        | 27.5                 |
|             | 39          | 2480.0          | 1.6              | 30.0        | 28.4                 |

Ambient temperature: 23 °C

Air Pressure: 1017 hPa  
 Humidity: 41 %  
 WLAN b-Mode; 20 MHz

| Mode          | Set EUT target power | Frequency [MHz] | Peak Power [dBm] | Limit [dBm] | Margin to Limit [dB] |
|---------------|----------------------|-----------------|------------------|-------------|----------------------|
| DSSS, 11 Mbps | 18.0                 | 2412.0          | 26.6             | 30.0        | 3.4                  |
| DSSS, 11 Mbps | 18.0                 | 2437.0          | 26.9             | 30.0        | 3.1                  |
| DSSS, 11 Mbps | 18.0                 | 2462.0          | 23.4             | 30.0        | 6.6                  |
| DSSS, 11 Mbps | 15.0                 | 2467.0          | 20.9             | 30.0        | 9.1                  |
| DSSS, 11 Mbps | 13.0                 | 2472.0          | 20.1             | 30.0        | 9.9                  |

WLAN g-Mode; 20 MHz

| Mode          | Set EUT target power | Frequency [MHz] | Peak Power [dBm] | Limit [dBm] | Margin to Limit [dB] |
|---------------|----------------------|-----------------|------------------|-------------|----------------------|
| OFDM, 54 Mbps | 13.0                 | 2412.0          | 22.6             | 30.0        | 7.4                  |
| OFDM, 36 Mbps | 16.0                 | 2417.0          | 24.5             | 30.0        | 5.2                  |
| OFDM, 36 Mbps | 16.0                 | 2437.0          | 25.3             | 30.0        | 4.7                  |
| OFDM, 36 Mbps | 10.0                 | 2467.0          | 16.5             | 30.0        | 13.5                 |
| OFDM, 54 Mbps | 9.0                  | 2472.0          | 16.0             | 30.0        | 14.0                 |

WLAN n-Mode; 20 MHz

| Mode       | Set EUT target power | Frequency [MHz] | Peak Power [dBm] | Limit [dBm] | Margin to Limit [dB] |
|------------|----------------------|-----------------|------------------|-------------|----------------------|
| OFDM, MCS6 | 13.0                 | 2412.0          | 22.9             | 30.0        | 7.1                  |
| OFDM, MCS3 | 15.0                 | 2417.0          | 24.4             | 30.0        | 5.6                  |
| OFDM, MCS3 | 16.0                 | 2437.0          | 26.0             | 30.0        | 4.0                  |
| OFDM, MCS3 | 9.0                  | 2467.0          | 15.8             | 30.0        | 14.2                 |
| OFDM, MCS6 | 9.0                  | 2472.0          | 16.7             | 30.0        | 13.3                 |

WLAN n-Mode; 40 MHz

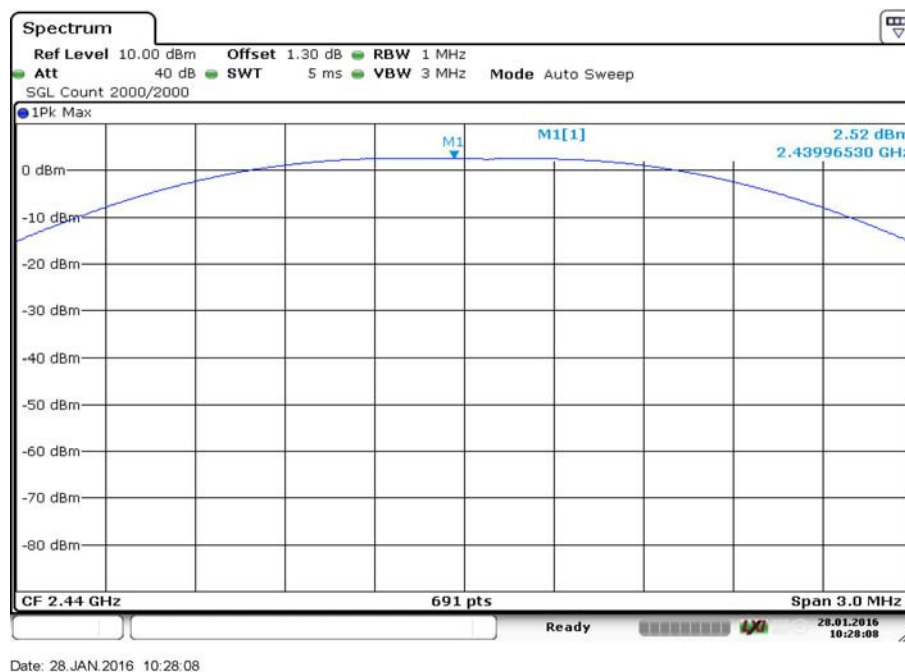
| Mode       | Set EUT target power | Frequency [MHz] | Peak Power [dBm] | Limit [dBm] | Margin to Limit [dB] |
|------------|----------------------|-----------------|------------------|-------------|----------------------|
| OFDM, MCS6 | 11.0                 | 2422.0          | 19.2             | 30.0        | 10.8                 |
| OFDM, MCS4 | 11.0                 | 2427.0          | 19.3             | 30.0        | 10.7                 |
| OFDM, MCS4 | 14.0                 | 2437.0          | 22.7             | 30.0        | 7.3                  |
| OFDM, MCS4 | 13.0                 | 2447.0          | 21.0             | 30.0        | 9.0                  |
| OFDM, MCS6 | 7.0                  | 2462.0          | 13.9             | 30.0        | 16.1                 |

Remark: -

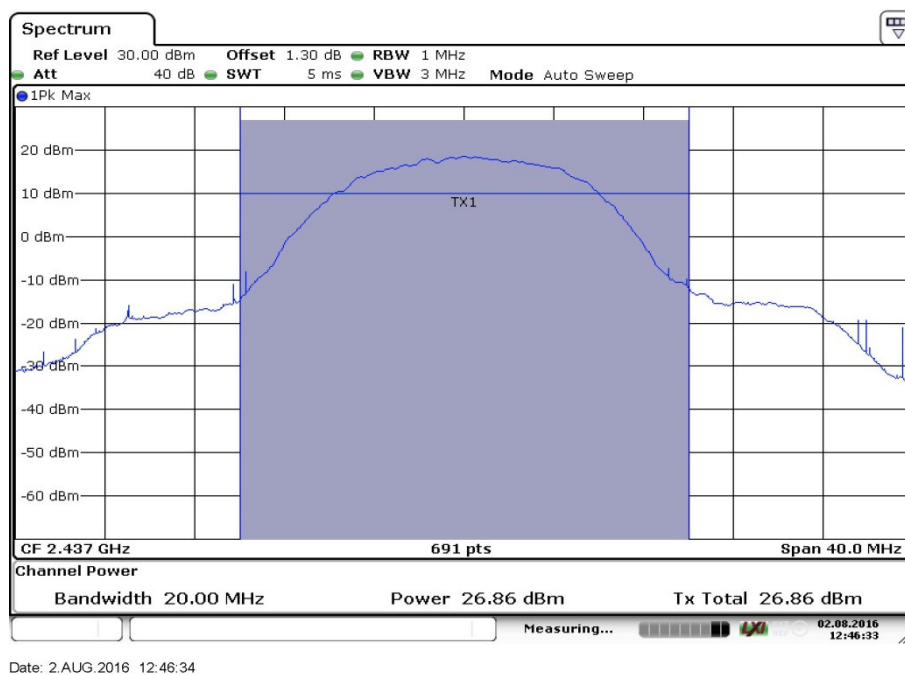


#### 4.4.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

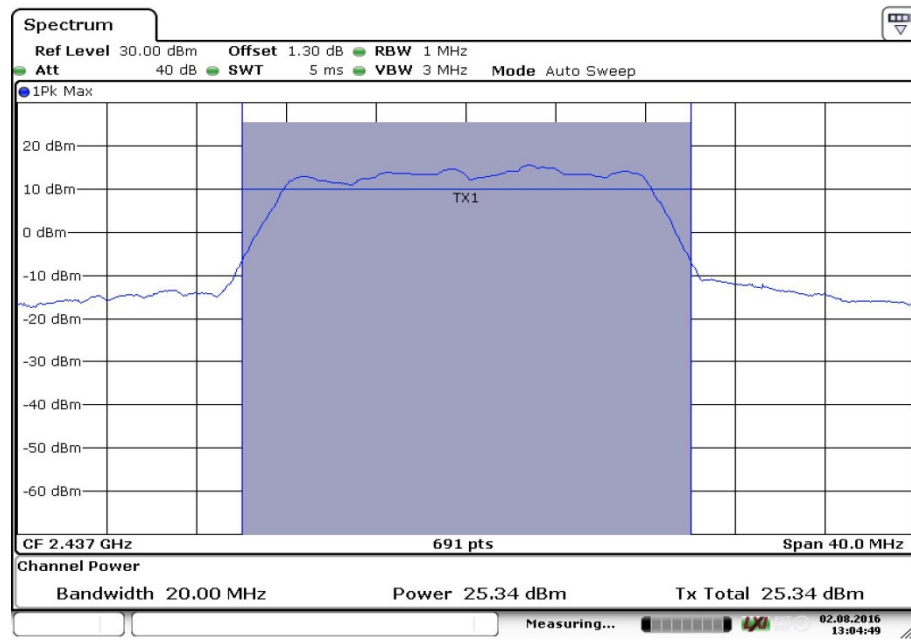
Radio Technology = Bluetooth LE, Operating Frequency = mid, Measurement method = conducted



Radio Technology = WLAN b, Operating Frequency = mid, Measurement method = conducted

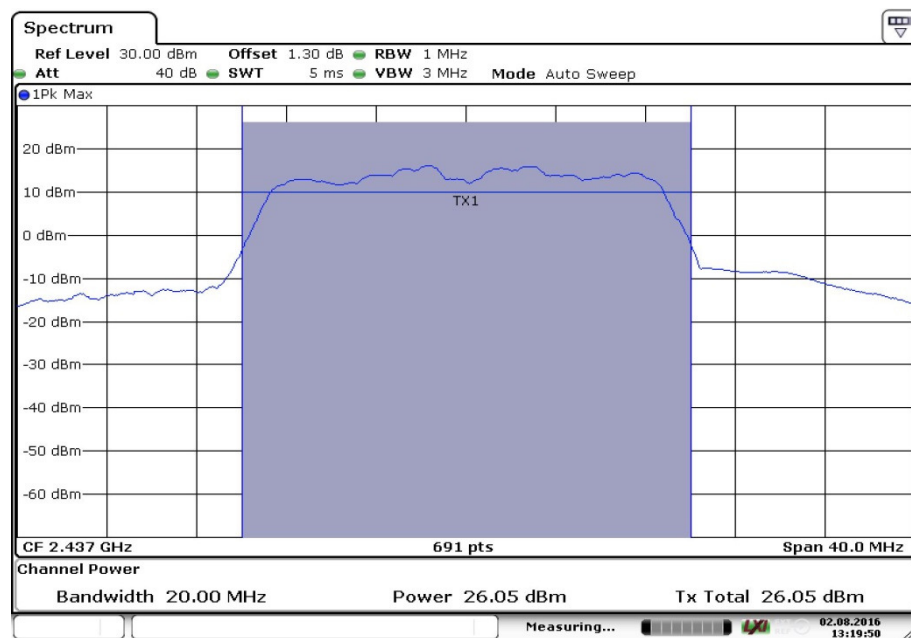


Radio Technology = WLAN g, Operating Frequency = mid, Measurement method = conducted



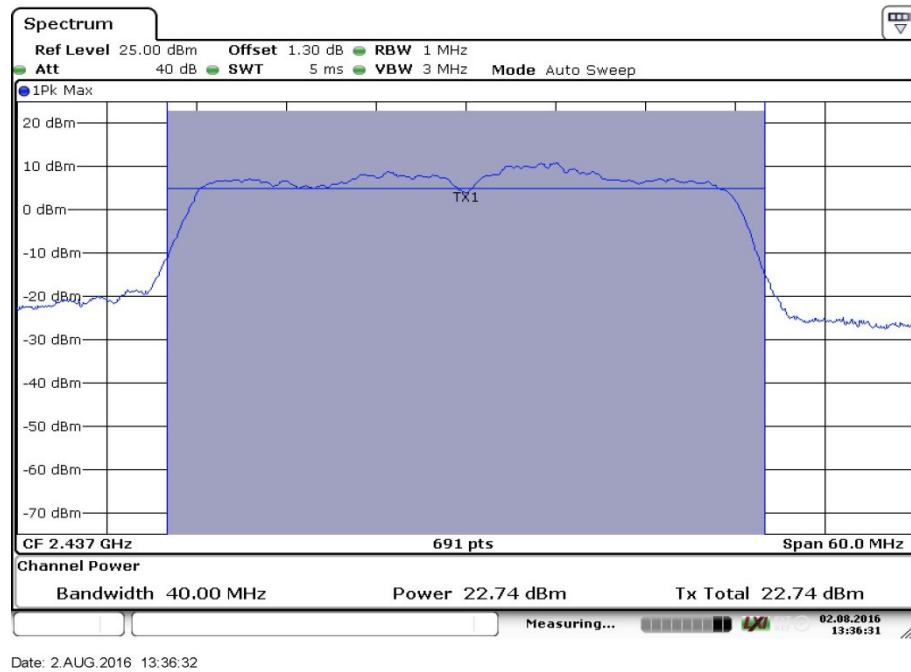
Date: 2.AUG.2016 13:04:50

Radio Technology = WLAN n 20 MHz, Operating Frequency = mid, Measurement method = conducted



Date: 2.AUG.2016 13:19:50

Radio Technology = WLAN n 40 MHz, Operating Frequency = mid, Measurement method = conducted



#### 4.4.5 TEST EQUIPMENT USED

R&S TS8997

## 4.5 SPURIOUS RF CONDUCTED EMISSIONS

Standard **FCC Part 15 Subpart C**

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

### 4.5.1 TEST DESCRIPTION

The Equipment Under Test (EUT) was set up to perform the spurious emissions measurements. The EUT was connected to spectrum analyzer via a short coax cable with a known loss.

Analyzer settings:

- Frequency range: 30 – 25000 MHz
- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Trace: Maxhold
- Sweeps: 2
- Sweep Time: 330 s
- Detector: Peak

The reference value for the measurement of the spurious RF conducted emissions is determined during the test "band edge compliance conducted". This value is used to calculate the 20 dBc limit.

### 4.5.2 TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart C, §15.247 (c)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

#### 4.5.3 TEST PROTOCOL

Ambient temperature: 23 °C  
 Air Pressure: 1017 hPa  
 Humidity: 41 %  
 BT LE GFSK

| Channel No | Channel Center Freq. [MHz] | Spurious Freq. [MHz] | Spurious Level [dBm] | Detector | RBW [kHz] | Ref. Level [dBm] | Limit [dBm] | Margin to Limit [dB] |
|------------|----------------------------|----------------------|----------------------|----------|-----------|------------------|-------------|----------------------|
| 0.0        | 2402.0                     | -                    | -                    | PEAK     | 100.0     | 1.1              | -18.9       | > 20 dB              |
| 19.0       | 2440.0                     | -                    | -                    | PEAK     | 100.0     | 1.1              | -18.9       | > 20 dB              |
| 39.0       | 2480.0                     | -                    | -                    | PEAK     | 100.0     | 0.3              | -19.7       | > 20 dB              |

Ambient temperature: 23 °C  
 Air Pressure: 1017 hPa  
 Humidity: 41 %  
 WLAN b-Mode; 20 MHz

| Mode        | Channel Center Freq. [MHz] | Spurious Freq. [MHz] | Spurious Level [dBm] | Detector | RBW [kHz] | Ref. Level [dBm] | Limit [dBm] | Margin to Limit [dB] |
|-------------|----------------------------|----------------------|----------------------|----------|-----------|------------------|-------------|----------------------|
| DSSS, 1Mbit | 2412.0                     | -                    | -                    | PEAK     | 100.0     | 9.3              | -10.7       | > 20                 |
| DSSS, 1Mbit | 2437.0                     | -                    | -                    | PEAK     | 100.0     | 9.4              | -10.6       | > 20                 |
| DSSS, 1Mbit | 2472.0                     | -                    | -                    | PEAK     | 100.0     | 8.7              | -11.3       | > 20                 |

WLAN g-Mode; 20 MHz

| Mode          | Channel Center Freq. [MHz] | Spurious Freq. [MHz] | Spurious Level [dBm] | Detector | RBW [kHz] | Ref. Level [dBm] | Limit [dBm] | Margin to Limit [dB] |
|---------------|----------------------------|----------------------|----------------------|----------|-----------|------------------|-------------|----------------------|
| OFDM, 54 Mbps | 2412.0                     | -                    | -                    | PEAK     | 100.0     | 5.6              | -14.4       | > 20                 |
| OFDM, 36 Mbps | 2437.0                     | -                    | -                    | PEAK     | 100.0     | 6.3              | -13.7       | > 20                 |
| OFDM, 54 Mbps | 2472.0                     | -                    | -                    | PEAK     | 100.0     | 4.8              | -15.2       | > 20                 |

WLAN n-Mode; 20 MHz

| Mode       | Channel Center Freq. [MHz] | Spurious Freq. [MHz] | Spurious Level [dBm] | Detector | RBW [kHz] | Ref. Level [dBm] | Limit [dBm] | Margin to Limit [dB] |
|------------|----------------------------|----------------------|----------------------|----------|-----------|------------------|-------------|----------------------|
| OFDM, MCS6 | 2412.0                     | -                    | -                    | PEAK     | 100.0     | 5.4              | -14.6       | > 20                 |
| OFDM, MCS3 | 2437.0                     | -                    | -                    | PEAK     | 100.0     | 6.1              | -13.9       | > 20                 |
| OFDM, MCS6 | 2472.0                     | -                    | -                    | PEAK     | 100.0     | 2.7              | -17.3       | > 20                 |

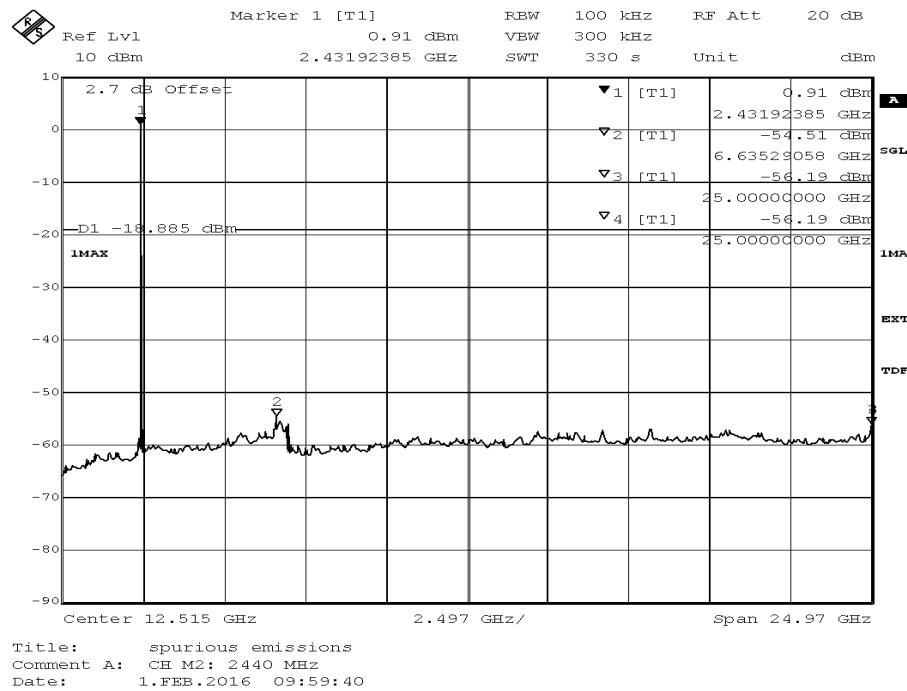
WLAN n-Mode; 40 MHz

| Mode       | Channel Center Freq. [MHz] | Spurious Freq. [MHz] | Spurious Level [dBm] | Detector | RBW [kHz] | Ref. Level [dBm] | Limit [dBm] | Margin to Limit [dB] |
|------------|----------------------------|----------------------|----------------------|----------|-----------|------------------|-------------|----------------------|
| OFDM, MCS6 | 2422.0                     | -                    | -                    | PEAK     | 100.0     | 2.6              | -17.4       | > 20                 |
| OFDM, MCS4 | 2437.0                     | -                    | -                    | PEAK     | 100.0     | 3.8              | -16.2       | > 20                 |
| OFDM, MCS6 | 2462.0                     | -                    | -                    | PEAK     | 100.0     | 0.3              | -19.8       | > 20                 |

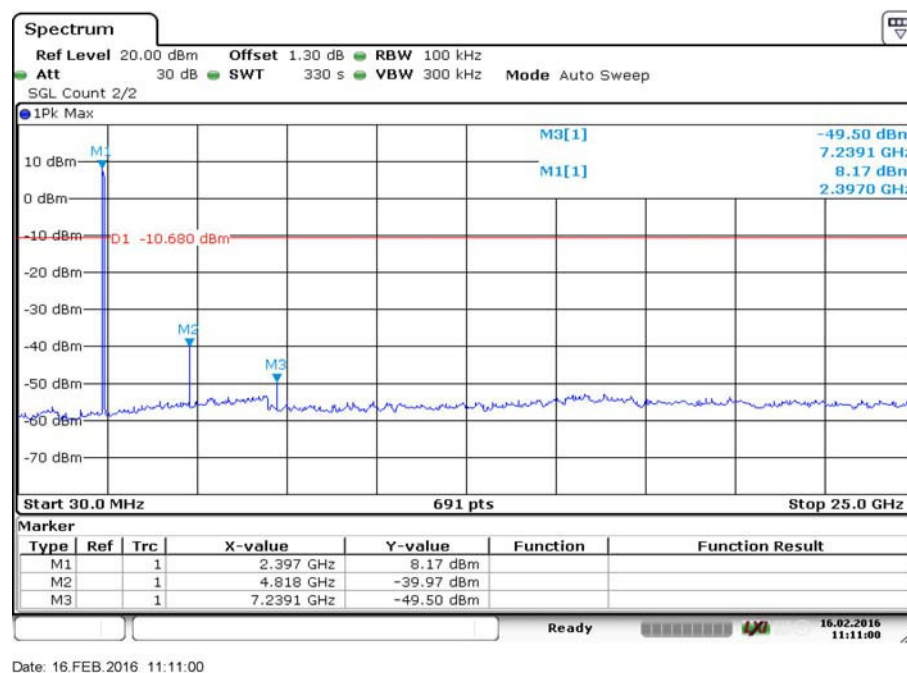
Remark: -

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

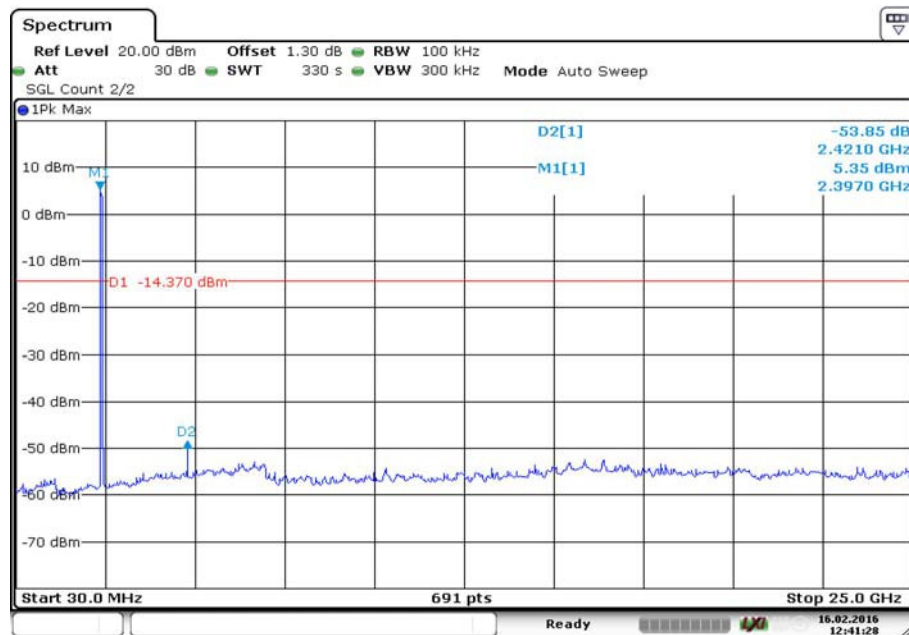
Radio Technology = Bluetooth LE, Operating Frequency = mid



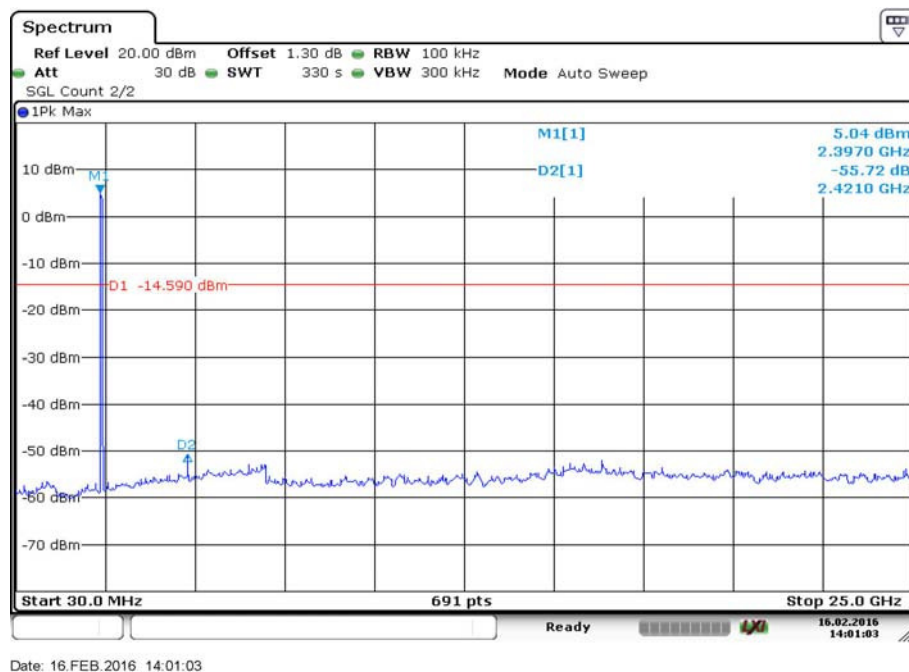
Radio Technology = WLAN b, Operating Frequency = low



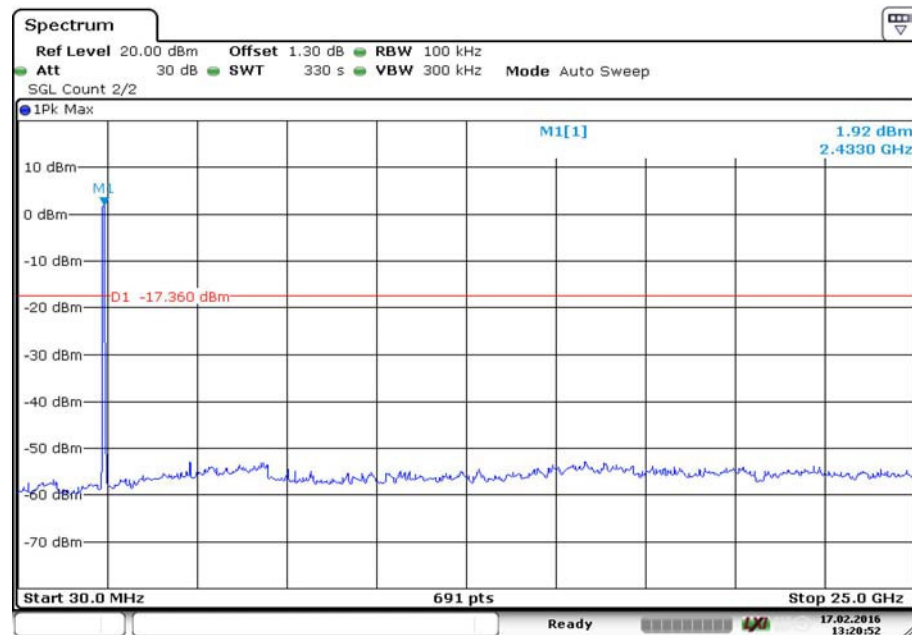
Radio Technology = WLAN g, Operating Frequency = low



Radio Technology = WLAN n 20 MHz, Operating Frequency = low



Radio Technology = WLAN n 40 MHz, Operating Frequency = low



#### 4.5.5 TEST EQUIPMENT USED

R&S TS8997



## 4.6 SPURIOUS RF CONDUCTED EMISSIONS IN RESTRICTED BANDS

Standard **FCC Part 15 Subpart C**

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

### 4.6.1 TEST DESCRIPTION

The Equipment Under Test (EUT) was set up to perform the conducted spurious emissions measurements. The antenna port of the EUT was connected to spectrum analyzer via a short coax cable with a known cable loss  $C_L$ . The measured voltage  $U_{meas}$  at the 50 Ohm input of the analyser was used to calculate the EUT output power at the antenna port:

$$P = U_{meas} + C_L - 107$$

where

$P$  is the output power in dBm

$U_{meas}$  is the measured voltage at the 50 Ohm input of the analyzer in dBμV

$C_L$  is the cable loss of the used cable.

The maximum transmit isotropically antenna gain  $G_i$  (in dBi) was added to the measured output power  $P$  to determine the equivalent isotropically radiated power EIRP.

$$EIRP = P + G_i$$

where

$P$  is the output power in dBm

$G_i$  is maximum transmit antenna gain in dBi.

The resultant EIRP level was converted to an equivalent electric field strength using the following relationship:

$$E = EIRP - 20 \log d + 104.8$$

where

$E$  is the electric field strength in dBμV/m

EIRP is the equivalent isotropically radiated power in dBm

$d$  is the specified measurement distance in m.

The appropriate maximum ground reflection factor was added to the EIRP:

6 dB for frequencies  $\leq 30$  MHz;

4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive; and

0 dB for frequencies  $> 1000$  MHz).

| Frequency range<br>[MHz] | measurement<br>distance $d$<br>[m] | $-20 \log d$<br>[dB] | ground reflection<br>factor<br>[dB] |
|--------------------------|------------------------------------|----------------------|-------------------------------------|
| 0,009 – 0,49             | 300                                | -49,54               | 6                                   |
| 0,49 – 30                | 30                                 | -29,54               | 6                                   |
| 30 – 1000                | 3                                  | -9,54                | 4,7                                 |
| $>1000$                  | 3                                  | -9,54                | 0                                   |

## 1. Measurement up to 30 MHz

### Step 1: pre measurement

This is a preliminary test to identify the highest amplitudes relative to the limit.

- Detector: Peak-Maxhold/ Quasipeak (FFT-based)
- 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 EMI-profile of the EUT. Afterwards the relevant emissions for the final measurement are identified.

### Step 2: final measurement

EMI receiver settings:

- Detector: Peak / Average / Quasi-Peak (depending on frequency)
- Frequency range: 0.009 – 30 MHz
- Frequency steps: measurement at frequencies detected in step 1
- IF-Bandwidth: 0.2 - 10 kHz (depending on frequency)
- Measuring time / Frequency step: 1 s

## 2. Measurement above 30 MHz and up to 1 GHz

### Step 1: pre measurement

This is a preliminary test to identify the highest amplitudes relative to the limit.

Settings:

- 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

### Step 2: final measurement

EMI receiver settings:

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

## 3. Measurement above 1 GHz

### Step 1: pre measurement

Settings:

- Detector: Peak, Average
- IF Bandwidth = 1 MHz

### Step 2: final measurement

Spectrum analyzer settings:

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

#### 4.6.2 TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart C, §15.247 (d)

... In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

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

| Frequency in MHz | Limit (μV/m)     | Measurement distance (m) | Limits (dBμV/m)    |
|------------------|------------------|--------------------------|--------------------|
| 0.009 – 0.49     | 2400/F(kHz)@300m | 3                        | (48.5 – 13.8)@300m |
| 0.49 – 1.705     | 24000/F(kHz)@30m | 3                        | (33.8 – 23.0)@30m  |
| 1.705 – 30       | 30@30m           | 3                        | 29.5@30m           |

| Frequency in MHz | Limit (μV/m) | Measurement distance (m) | Limits (dBμV/m) |
|------------------|--------------|--------------------------|-----------------|
| 30 – 88          | 100@3m       | 3                        | 40.0@3m         |
| 88 – 216         | 150@3m       | 3                        | 43.5@3m         |
| 216 – 960        | 200@3m       | 3                        | 46.0@3m         |
| 960 – 26000      | 500@3m       | 3                        | 54.0@3m         |
| 26000 – 40000    | 500@3m       | 1                        | 54.0@3m         |

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

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

#### 4.6.3 TEST PROTOCOL

Ambient temperature: 21–25 °C  
 Air Pressure: 1002–1020 hPa  
 Humidity: 38–45 %  
 WLAN b-Mode; 20 MHz

| Mode /<br>Set EUT<br>target<br>power | Ch.<br>Center<br>Freq.<br>[MHz] | Spurious<br>Freq. [MHz]                   | Spurious<br>Level<br>[dBμV/ m] | Detec-<br>tor    | RBW<br>[kHz] | Limit<br>[dBμV/ m] | Margin<br>to Limit<br>[dB] |
|--------------------------------------|---------------------------------|-------------------------------------------|--------------------------------|------------------|--------------|--------------------|----------------------------|
| DSSS,<br>1Mbit /<br>18 dBm           | 2412.0                          | 2389.893333<br>4823.700000                | 50.9<br>52.9                   | AV<br>AV         | 1000         | 54<br>54           | 3.1<br>1.1                 |
| DSSS,<br>2Mbit /<br>16 dBm           | 2467.0                          | 2483.500000<br>2483.500000<br>4933.983333 | 61.3<br>51.2<br>52.6           | Peak<br>AV<br>AV | 1000         | 74<br>54<br>54     | 12.7<br>2.8<br>1.4         |
| DSSS,<br>2Mbit /<br>13 dBm           | 2472.0                          | 2484.699500<br>4943.950000<br>4943.950000 | 49.3<br>58.5<br>53.0           | AV<br>Peak<br>AV | 1000         | 54<br>74<br>54     | 4.7<br>15.5<br>1.0         |
| DSSS,<br>11Mbit /<br>18 dBm          | 2412.0                          | 2389.893333<br>2390.000000<br>4823.700000 | 58.5<br>47.3<br>42.5           | Peak<br>AV<br>AV | 1000         | 74<br>54<br>54     | 15.5<br>6.7<br>11.5        |
| DSSS,<br>11Mbit /<br>18 dBm          | 2462.0                          | 2483.527500<br>2483.527500<br>4925.533333 | 56.6<br>44.9<br>45.1           | Peak<br>AV<br>AV | 1000         | 74<br>54<br>54     | 17.4<br>9.1<br>8.9         |
| DSSS,<br>11Mbit /<br>15 dBm          | 2467.0                          | 2483.500000<br>2483.500000<br>4934.633333 | 60.9<br>50.3<br>42.4           | Peak<br>AV<br>AV | 1000         | 74<br>54<br>54     | 13.1<br>3.7<br>11.6        |
| DSSS,<br>11Mbit /<br>16 dBm          | 2472.0                          | 2483.522200<br>2483.538500<br>4943.950000 | 59.9<br>47.7<br>43.8           | Peak<br>AV<br>AV | 1000         | 74<br>54<br>54     | 14.1<br>6.3<br>10.2        |

Remark: -

Ambient temperature: 21–25 °C  
 Air Pressure: 1002–1020 hPa  
 Humidity: 38–45 %  
 WLAN g-Mode; 20 MHz

| Mode /<br>Set EUT<br>target<br>power | Ch.<br>Center<br>Freq.<br>[MHz] | Spurious<br>Freq. [MHz]                   | Spurious<br>Level<br>[dBμV/ m] | Detec-<br>tor    | RBW<br>[kHz] | Limit<br>[dBμV/ m] | Margin to<br>Limit<br>[dB] |
|--------------------------------------|---------------------------------|-------------------------------------------|--------------------------------|------------------|--------------|--------------------|----------------------------|
| OFDM,<br>9Mbit /<br>13 dBm           | 2412.0                          | 2390.000000<br>2390.000000                | 70.7<br>49.9                   | Peak<br>AV       | 1000         | 74<br>54           | 3.3<br>4.1                 |
| OFDM,<br>9Mbit /<br>16 dBm           | 2417.0                          | 2387.360000<br>2387.360000<br>2389.733333 | 70.3<br>50.3<br>53.8           | Peak<br>AV<br>AV | 1000         | 74<br>54<br>54     | 3.7<br>3.7<br>0.2          |
| OFDM,<br>9Mbit /<br>16 dBm           | 2452.0                          | 2483.516500<br>2483.500000                | 67.7<br>48.1                   | Peak<br>AV       | 1000         | 74<br>54           | 6.3<br>5.9                 |
| OFDM,<br>9Mbit /<br>15 dBm           | 2457.0                          | 2483.527500<br>2483.527500                | 69.0<br>47.3                   | Peak<br>AV       | 1000         | 74<br>54           | 5.0<br>6.7                 |
| OFDM,<br>9Mbit /<br>13 dBm           | 2462.0                          | 2483.500000<br>2483.500000                | 73.2<br>53.4                   | Peak<br>AV       | 1000         | 74<br>54           | 0.8<br>0.6                 |
| OFDM,<br>9Mbit /<br>10 dBm           | 2467.0                          | 2484.292000<br>2483.593500                | 70.2<br>53.0                   | Peak<br>AV       | 1000         | 74<br>54           | 3.8<br>1.0                 |
| OFDM,<br>9Mbit /<br>9 dBm            | 2472.0                          | 2483.500000<br>2483.500000                | 72.8<br>52.2                   | Peak<br>AV       | 1000         | 74<br>54           | 1.2<br>1.8                 |
| OFDM,<br>48Mbit /<br>13 dBm          | 2462.0                          | 2483.604500<br>2483.604500                | 71.9<br>52.8                   | Peak<br>AV       | 1000         | 74<br>54           | 2.1<br>1.2                 |
| OFDM,<br>48Mbit /<br>9 dBm           | 2467.0                          | 2483.665500<br>2483.648500                | 67.4<br>53.7                   | Peak<br>AV       | 1000         | 74<br>54           | 2.6<br>0.3                 |
| OFDM,<br>48Mbit /<br>9 dBm           | 2472.0                          | 2483.500000<br>2483.500000                | 71.8<br>49.4                   | Peak<br>AV       | 1000         | 74<br>54           | 2.2<br>4.6                 |
| OFDM,<br>54Mbit /<br>13 dBm          | 2412.0                          | 2390.000000<br>2390.000000                | 67.3<br>49.3                   | Peak<br>AV       | 1000         | 74<br>54           | 6.7<br>4.7                 |
| OFDM,<br>54Mbit /<br>13 dBm          | 2462.0                          | 2483.604500<br>2483.500000                | 71.1<br>52.9                   | Peak<br>AV       | 1000         | 74<br>54           | 2.9<br>1.1                 |
| OFDM,<br>54Mbit /<br>9 dBm           | 2467.0                          | 2483.511000<br>2483.593500                | 64.8<br>52.4                   | Peak<br>AV       | 1000         | 74<br>54           | 9.2<br>1.6                 |
| OFDM,<br>54Mbit /<br>9 dBm           | 2472.0                          | 2483.500000<br>2483.500000                | 70.7<br>51.3                   | Peak<br>AV       | 1000         | 74<br>54           | 3.3<br>2.7                 |

Remark: -

Ambient temperature: 21–25 °C  
 Air Pressure: 1002–1020 hPa  
 Humidity: 38–45 %  
 WLAN n-Mode; 20 MHz

| Mode /<br>Set EUT<br>target<br>power | Ch.<br>Center<br>Freq.<br>[MHz] | Spurious<br>Freq. [MHz]    | Spurious<br>Level<br>[dBμV/ m] | Detec-<br>tor | RBW<br>[kHz] | Limit<br>[dBμV/ m] | Margin to<br>Limit<br>[dB] |
|--------------------------------------|---------------------------------|----------------------------|--------------------------------|---------------|--------------|--------------------|----------------------------|
| HT20,<br>MCS2 /<br>13 dBm            | 2412.0                          | 2389.653333<br>2389.653333 | 70.9<br>49.2                   | Peak<br>AV    | 1000         | 74<br>54           | 3.1<br>4.8                 |
| HT20,<br>MCS2 /<br>15 dBm            | 2417.0                          | 2389.653333<br>2389.653333 | 69.9<br>49.1                   | Peak<br>AV    | 1000         | 74<br>54           | 4.1<br>4.9                 |
| HT20,<br>MCS2 /<br>16 dBm            | 2422.0                          | 2389.813333<br>2389.920000 | 68.6<br>50.2                   | Peak<br>AV    | 1000         | 74<br>54           | 5.4<br>3.8                 |
| HT20,<br>MCS2 /<br>16 dBm            | 2457.0                          | 2483.500000<br>2483.500000 | 73.1<br>50.5                   | Peak<br>AV    | 1000         | 74<br>54           | 0.9<br>3.5                 |
| HT20,<br>MCS2 /<br>12 dBm            | 2462.0                          | 2483.808000<br>2483.588000 | 68.2<br>52.5                   | Peak<br>AV    | 1000         | 74<br>54           | 5.8<br>1.5                 |
| HT20,<br>MCS2 /<br>10 dBm            | 2467.0                          | 2483.610000<br>2483.610000 | 71.2<br>53.8                   | Peak<br>AV    | 1000         | 74<br>54           | 2.8<br>0.2                 |
| HT20,<br>MCS2 /<br>9 dBm             | 2472.0                          | 2483.500000<br>2483.500000 | 70.3<br>53.0                   | Peak<br>AV    | 1000         | 74<br>54           | 3.7<br>1.0                 |
| HT20,<br>MCS4 /<br>15 dBm            | 2417.0                          | 2388.373333<br>2390.000000 | 70.2<br>51.1                   | Peak<br>AV    | 1000         | 74<br>54           | 3.8<br>2.9                 |
| HT20,<br>MCS4 /<br>16 dBm            | 2422.0                          | 2389.760000<br>2389.760000 | 65.4<br>50.0                   | Peak<br>AV    | 1000         | 74<br>54           | 8.6<br>4.0                 |
| HT20,<br>MCS4 /<br>16 dBm            | 2457.0                          | 2483.544000<br>2483.500000 | 72.6<br>51.9                   | Peak<br>AV    | 1000         | 74<br>54           | 1.4<br>2.1                 |
| HT20,<br>MCS4 /<br>12 dBm            | 2462.0                          | 2483.885000<br>2483.588000 | 71.7<br>53.5                   | Peak<br>AV    | 1000         | 74<br>54           | 2.3<br>0.5                 |
| HT20,<br>MCS4 /<br>9 dBm             | 2467.0                          | 2483.549500<br>2483.549500 | 65.3<br>51.2                   | Peak<br>AV    | 1000         | 74<br>54           | 8.7<br>2.8                 |
| HT20,<br>MCS4 /<br>9 dBm             | 2472.0                          | 2483.500000<br>2483.500000 | 72.1<br>49.0                   | Peak<br>AV    | 1000         | 74<br>54           | 1.9<br>5.0                 |
| HT20,<br>MCS6 /<br>13 dBm            | 2412.0                          | 2389.813333<br>2389.815333 | 64.4<br>51.1                   | Peak<br>AV    | 1000         | 74<br>54           | 9.6<br>2.9                 |
| HT20,<br>MCS6 /<br>13 dBm            | 2457.0                          | 2483.687000<br>2483.687000 | 65.6<br>45.4                   | Peak<br>AV    | 1000         | 74<br>54           | 8.4<br>8.6                 |
| HT20,<br>MCS6 /<br>12 dBm            | 2462.0                          | 2483.637500<br>2483.511000 | 70.5<br>54.0                   | Peak<br>AV    | 1000         | 74<br>54           | 3.5<br>0.0                 |
| HT20,<br>MCS6 /<br>9 dBm             | 2467.0                          | 2483.593500<br>2483.593500 | 71.3<br>53.9                   | Peak<br>AV    | 1000         | 74<br>54           | 2.7<br>0.1                 |
| HT20,<br>MCS6 /<br>9 dBm             | 2472.0                          | 2483.544000<br>2483.544000 | 72.4<br>52.6                   | Peak<br>AV    | 1000         | 74<br>54           | 1.6<br>1.4                 |

Remark: -

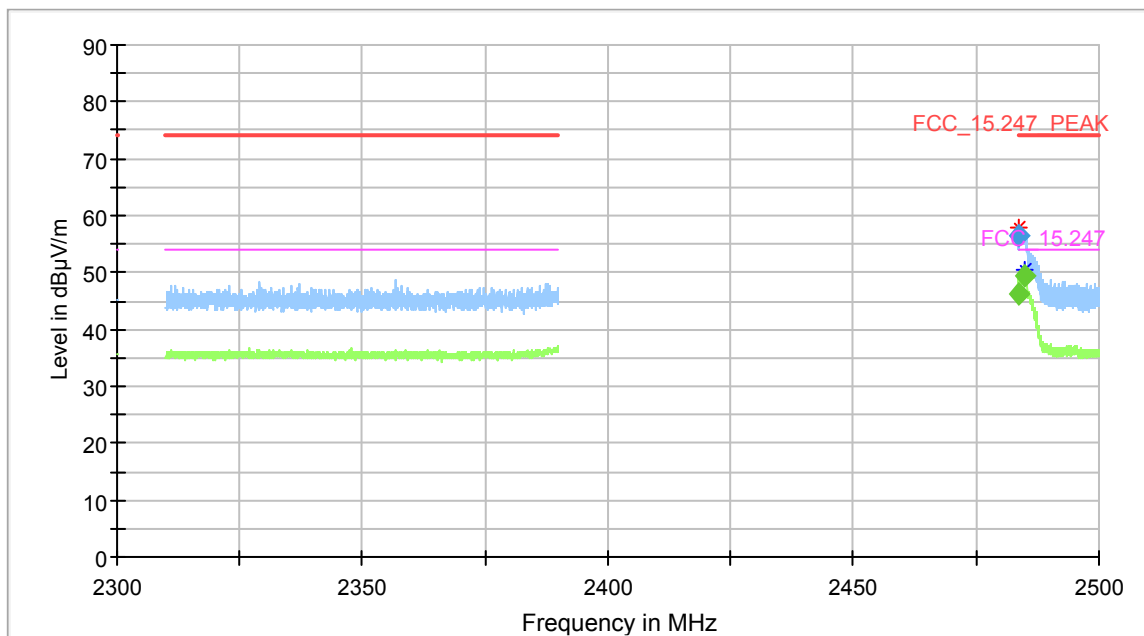
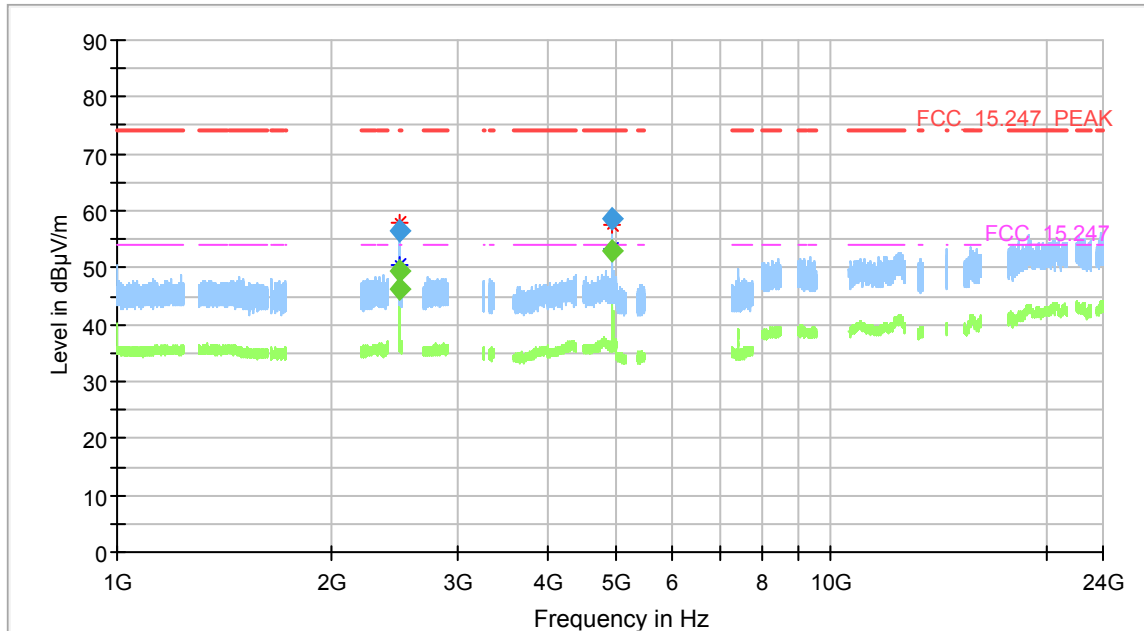
Ambient temperature: 21–25 °C  
 Air Pressure: 1002–1020 hPa  
 Humidity: 38–45 %  
 WLAN n-Mode; 40 MHz

| Mode /<br>Set EUT<br>target<br>power | Ch.<br>Center<br>Freq.<br>[MHz] | Spurious<br>Freq. [MHz]                                  | Spurious<br>Level<br>[dBμV/ m] | Detec-<br>tor            | RBW<br>[kHz] | Limit<br>[dBμV/ m]   | Margin to<br>Limit<br>[dB] |
|--------------------------------------|---------------------------------|----------------------------------------------------------|--------------------------------|--------------------------|--------------|----------------------|----------------------------|
| HT40,<br>MCS0 /<br>11 dBm            | 2422.0                          | 2389.893333<br>2389.893333                               | 73.3<br>50.9                   | Peak<br>AV               | 1000         | 74<br>54             | 0.7<br>3.1                 |
| HT40,<br>MCS0 /<br>11 dBm            | 2427.0                          | 2389.653333<br>2389.653333                               | 69.7<br>50.3                   | Peak<br>AV               | 1000         | 74<br>54             | 4.3<br>3.7                 |
| HT40,<br>MCS0 /<br>13 dBm            | 2432.0                          | 2389.760000<br>2389.760000<br>2483.868500<br>2483.868500 | 71.1<br>51.3<br>69.5<br>45.7   | Peak<br>AV<br>Peak<br>AV | 1000         | 74<br>54<br>74<br>54 | 2.9<br>2.7<br>4.5<br>8.3   |
| HT40,<br>MCS0 /<br>14 dBm            | 2437.0                          | 2389.946667<br>2389.946667<br>2483.860500<br>2483.860500 | 69.2<br>51.8<br>72.6<br>48.6   | Peak<br>AV<br>Peak<br>AV | 1000         | 74<br>54<br>74<br>54 | 4.8<br>2.2<br>1.4<br>5.4   |
| HT40,<br>MCS0 /<br>14 dBm            | 2442.0                          | 2389.973333<br>2389.973333<br>2483.500000<br>2483.500000 | 67.5<br>46.9<br>73.1<br>49.2   | Peak<br>AV<br>Peak<br>AV | 1000         | 74<br>54<br>74<br>54 | 6.5<br>7.1<br>0.9<br>4.8   |
| HT40,<br>MCS0 /<br>13 dBm            | 2447.0                          | 2483.500000<br>2483.500000                               | 74.0<br>51.7                   | Peak<br>AV               | 1000         | 74<br>54             | 0.0<br>2.3                 |
| HT40,<br>MCS0 /<br>10 dBm            | 2452.0                          | 2483.500000<br>2483.500000                               | 68.9<br>48.8                   | Peak<br>AV               | 1000         | 74<br>54             | 5.1<br>5.2                 |
| HT40,<br>MCS0 /<br>7 dBm             | 2457.0                          | 2483.555000<br>2483.736500                               | 61.4<br>49.0                   | Peak<br>AV               | 1000         | 74<br>54             | 12.6<br>5.0                |
| HT40,<br>MCS0 /<br>6 dBm             | 2462.0                          | 2483.505500<br>2483.505500                               | 69.2<br>50.9                   | Peak<br>AV               | 1000         | 74<br>54             | 4.8<br>3.1                 |
| HT40,<br>MCS6 /<br>11 dBm            | 2422.0                          | 2390.000000<br>2390.000000                               | 69.3<br>50.4                   | Peak<br>AV               | 1000         | 74<br>54             | 4.7<br>3.5                 |
| HT40,<br>MCS6 /<br>12 dBm            | 2427.0                          | 2389.626667<br>2389.920000                               | 71.3<br>54.0                   | Peak<br>AV               | 1000         | 74<br>54             | 2.7<br>0.0                 |
| HT40,<br>MCS6 /<br>13 dBm            | 2432.0                          | 2389.920000<br>2389.920000<br>2483.626500<br>2483.511000 | 70.2<br>52.5<br>72.7<br>48.0   | Peak<br>AV<br>Peak<br>AV | 1000         | 74<br>54<br>74<br>54 | 3.8<br>1.5<br>1.3<br>6.0   |
| HT40,<br>MCS6 /<br>13 dBm            | 2447.0                          | 2483.522000<br>2483.500000                               | 71.9<br>53.6                   | Peak<br>AV               | 1000         | 74<br>54             | 2.1<br>0.4                 |
| HT40,<br>MCS6 /<br>11 dBm            | 2452.0                          | 2483.769500<br>2483.769500                               | 67.2<br>53.1                   | Peak<br>AV               | 1000         | 74<br>54             | 6.5<br>0.9                 |
| HT40,<br>MCS6 /<br>8 dBm             | 2457.0                          | 2483.555000<br>2483.505500                               | 70.9<br>51.7                   | Peak<br>AV               | 1000         | 74<br>54             | 3.1<br>2.3                 |
| HT40,<br>MCS6 /<br>7 dBm             | 2462.0                          | 2483.610000<br>2483.610000                               | 69.5<br>54.0                   | Peak<br>AV               | 1000         | 74<br>54             | 4.5<br>0.0                 |

Remark: -

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

Radio Technology = WLAN b-Mode, 2Mbit / 13 dBm, Operating Frequency = high

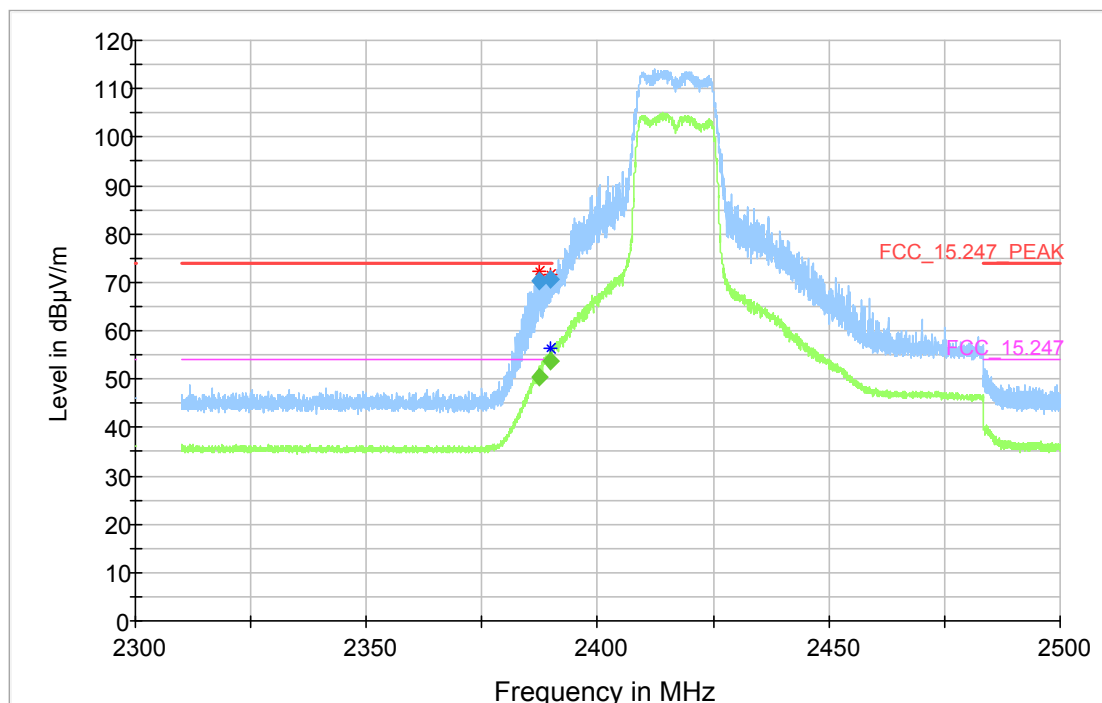
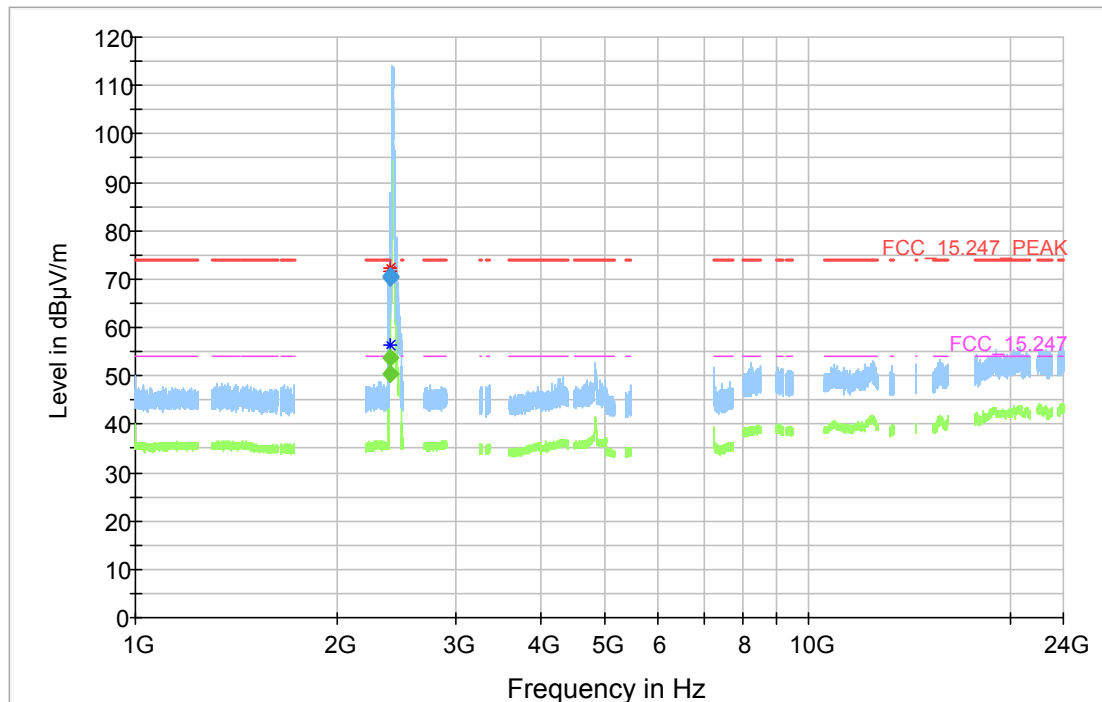


#### Final\_Result

| Frequency (MHz) | MaxPeak (dBμV/m) | CAverage (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Corr. (dB) |
|-----------------|------------------|-------------------|----------------|-------------|-----------------|-----------------|------------|
| 2483.863000     | 56.40            | ---               | 74.00          | 17.60       | 1000.0          | 1000.000        | -5.8       |
| 2483.863000     | ---              | 46.25             | 54.00          | 7.75        | 1000.0          | 1000.000        | -5.8       |
| 2484.699000     | ---              | 49.28             | 54.00          | 4.72        | 1000.0          | 1000.000        | -5.8       |
| 4943.950000     | 58.54            | ---               | 74.00          | 15.46       | 1000.0          | 1000.000        | -5.8       |
| 4943.950000     | ---              | 52.99             | 54.00          | 1.01        | 1000.0          | 1000.000        | -5.8       |



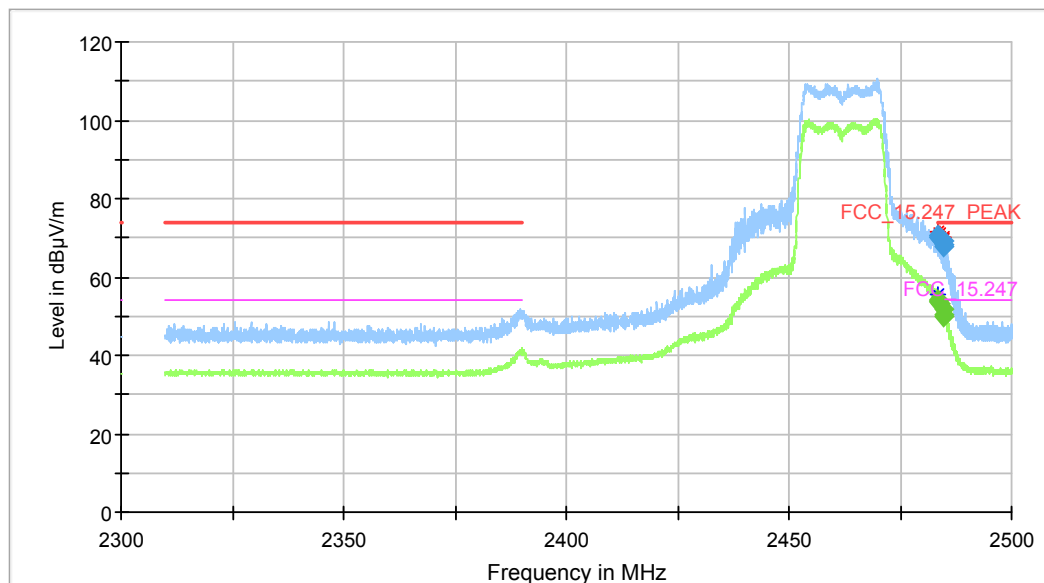
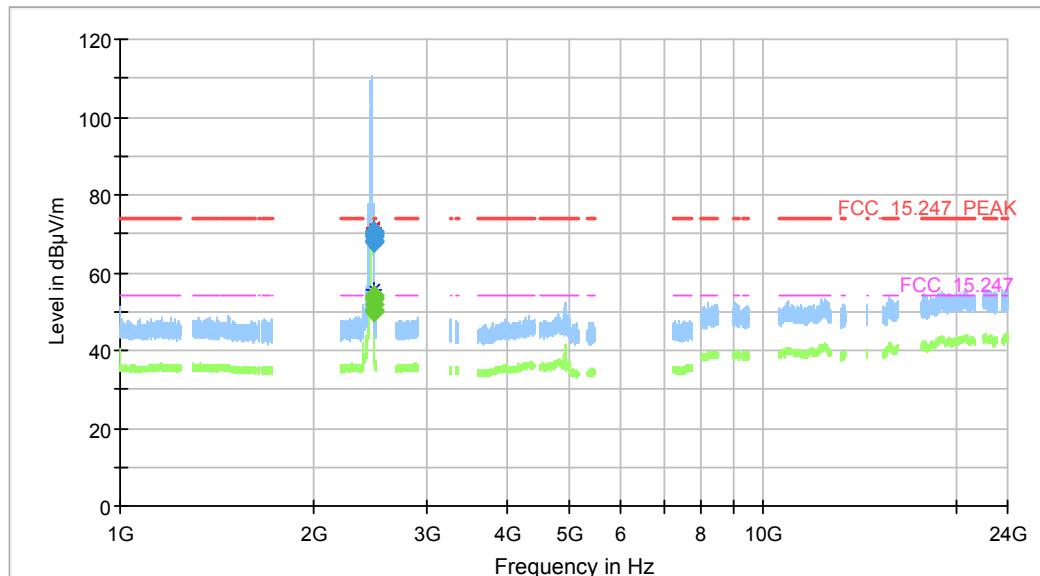
Radio Technology = WLAN g-Mode, 9Mbit / 16 dBm, Operating Frequency = 2417.0 MHz



#### Final\_Result

| Frequency (MHz) | MaxPeak (dBµV/m) | CAverage (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Corr. (dB) |
|-----------------|------------------|-------------------|----------------|-------------|-----------------|-----------------|------------|
| 2387.360000     | ---              | 50.29             | 54.00          | 3.71        | 1000.0          | 1000.000        | -5.8       |
| 2387.360000     | 70.33            | ---               | 74.00          | 3.67        | 1000.0          | 1000.000        | -5.8       |
| 2389.733333     | ---              | 53.82             | 54.00          | 0.18        | 1000.0          | 1000.000        | -5.8       |
| 2389.733333     | 70.61            | ---               | 74.00          | 3.39        | 1000.0          | 1000.000        | -5.8       |

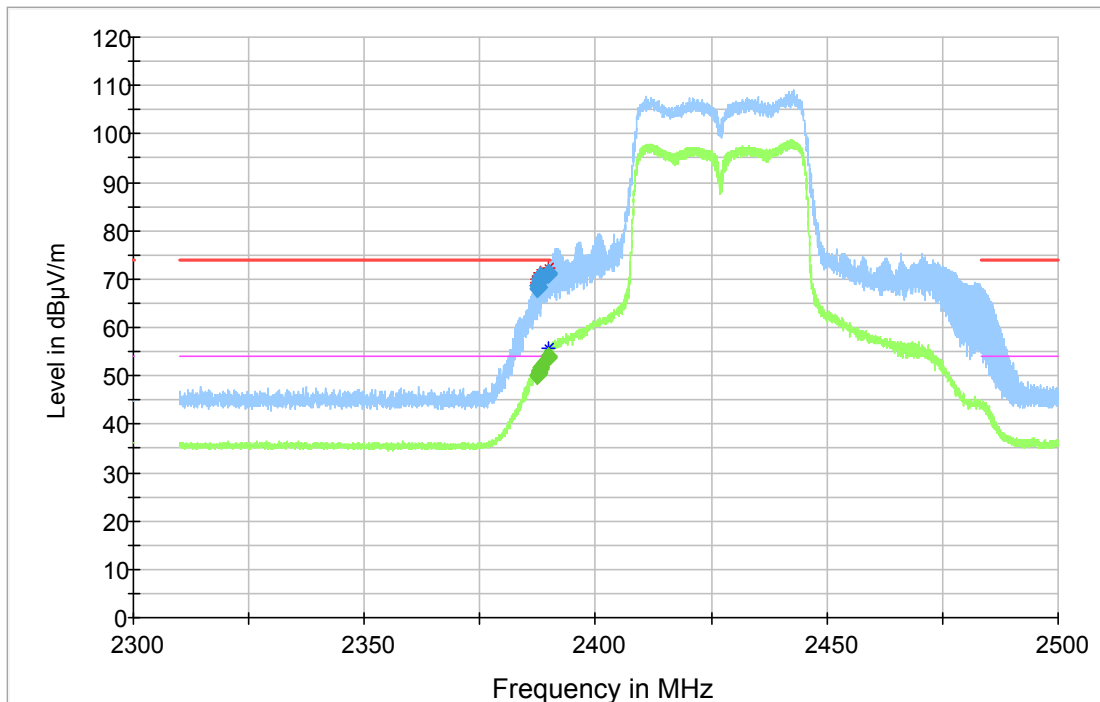
Radio Technology = WLAN n-Mode HT20, MCS6 / 12 dBm, Operating Frequency = 2462.0 MHz



### Final\_Result

| Frequency (MHz) | MaxPeak (dBμV/m) | CAverage (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Corr. (dB) |
|-----------------|------------------|-------------------|----------------|-------------|-----------------|-----------------|------------|
| 2483.511000     | ---              | 53.99             | 54.00          | 0.01        | 1000.0          | 1000.000        | -5.8       |
| 2483.511000     | 70.12            | ---               | 74.00          | 3.88        | 1000.0          | 1000.000        | -5.8       |
| 2483.637500     | ---              | 53.74             | 54.00          | 0.26        | 1000.0          | 1000.000        | -5.8       |
| 2483.637500     | 70.52            | ---               | 74.00          | 3.48        | 1000.0          | 1000.000        | -5.8       |
| 2483.984000     | ---              | 53.07             | 54.00          | 0.93        | 1000.0          | 1000.000        | -5.8       |
| 2483.984000     | 69.78            | ---               | 74.00          | 4.22        | 1000.0          | 1000.000        | -5.8       |
| 2484.517500     | ---              | 51.54             | 54.00          | 2.46        | 1000.0          | 1000.000        | -5.8       |
| 2484.517500     | 69.00            | ---               | 74.00          | 5.00        | 1000.0          | 1000.000        | -5.8       |
| 2484.781500     | ---              | 50.51             | 54.00          | 3.49        | 1000.0          | 1000.000        | -5.8       |
| 2484.781500     | 68.46            | ---               | 74.00          | 5.54        | 1000.0          | 1000.000        | -5.8       |
| 2484.880500     | ---              | 50.11             | 54.00          | 3.89        | 1000.0          | 1000.000        | -5.8       |
| 2484.880500     | 67.79            | ---               | 74.00          | 6.21        | 1000.0          | 1000.000        | -5.8       |

Radio Technology = WLAN n-Mode HT40, MCS6 / 12 dBm, Operating Frequency = 2427.0 MHz



#### Final\_Result

| Frequency (MHz) | MaxPeak (dBμV/m) | CAverage (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Corr. (dB) |
|-----------------|------------------|-------------------|----------------|-------------|-----------------|-----------------|------------|
| 2387.280000     | ---              | 49.97             | 54.00          | 4.03        | 1000.0          | 1000.000        | -5.8       |
| 2387.280000     | 68.12            | ---               | 74.00          | 5.88        | 1000.0          | 1000.000        | -5.8       |
| 2387.386667     | ---              | 50.06             | 54.00          | 3.94        | 1000.0          | 1000.000        | -5.8       |
| 2387.386667     | 68.47            | ---               | 74.00          | 5.53        | 1000.0          | 1000.000        | -5.8       |
| 2387.466667     | ---              | 50.22             | 54.00          | 3.78        | 1000.0          | 1000.000        | -5.8       |
| 2387.466667     | 68.72            | ---               | 74.00          | 5.28        | 1000.0          | 1000.000        | -5.8       |
| 2387.573333     | ---              | 50.55             | 54.00          | 3.45        | 1000.0          | 1000.000        | -5.8       |
| 2387.573333     | 69.43            | ---               | 74.00          | 4.57        | 1000.0          | 1000.000        | -5.8       |
| 2387.680000     | ---              | 50.58             | 54.00          | 3.42        | 1000.0          | 1000.000        | -5.8       |
| 2387.680000     | 68.34            | ---               | 74.00          | 5.66        | 1000.0          | 1000.000        | -5.8       |
| 2387.760000     | ---              | 51.18             | 54.00          | 2.82        | 1000.0          | 1000.000        | -5.8       |
| 2387.760000     | 69.95            | ---               | 74.00          | 4.05        | 1000.0          | 1000.000        | -5.8       |
| 2387.946667     | ---              | 51.26             | 54.00          | 2.74        | 1000.0          | 1000.000        | -5.8       |
| 2387.946667     | 70.52            | ---               | 74.00          | 3.48        | 1000.0          | 1000.000        | -5.8       |
| 2388.053333     | ---              | 51.71             | 54.00          | 2.29        | 1000.0          | 1000.000        | -5.8       |
| 2388.053333     | 70.74            | ---               | 74.00          | 3.26        | 1000.0          | 1000.000        | -5.8       |
| 2388.133333     | ---              | 51.63             | 54.00          | 2.37        | 1000.0          | 1000.000        | -5.8       |
| 2388.133333     | 70.69            | ---               | 74.00          | 3.31        | 1000.0          | 1000.000        | -5.8       |
| 2389.626667     | ---              | 53.81             | 54.00          | 0.19        | 1000.0          | 1000.000        | -5.8       |
| 2389.626667     | 71.25            | ---               | 74.00          | 2.75        | 1000.0          | 1000.000        | -5.8       |
| 2389.920000     | ---              | 54.00             | 54.00          | 0.00        | 1000.0          | 1000.000        | -5.8       |
| 2389.920000     | 70.81            | ---               | 74.00          | 3.19        | 1000.0          | 1000.000        | -5.8       |

#### 4.6.5 TEST EQUIPMENT USED

Radiated Emissions

## 4.7 TRANSMITTER SPURIOUS RADIATED EMISSIONS

Standard **FCC Part 15 Subpart C**

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

### 4.7.1 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 m<sup>2</sup> in the semi-anechoic chamber. The influence of the EUT support table that is used between 30–1000 MHz was evaluated.

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

#### 1. Measurement 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:  $-180^{\circ}$  to  $90^{\circ}$
- Turntable step size:  $90^{\circ}$
- Height variation range: 1 – 3 m
- Height variation step size: 2 m
- Polarisation: Horizontal + Vertical

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

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

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

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

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

#### **Step 3: Final measurement with QP detector**

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

EMI receiver settings for step 4:

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

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

### **3. Measurement above 1 GHz**

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

#### **Step 1:**

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

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

The EUT is turned during the preliminary measurement across the elevation axis, with a step size of  $90^{\circ}$ .

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

#### **Step 2:**

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

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

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

EMI receiver settings (for all steps):

- Detector: Peak, Average
- IF Bandwidth = 1 MHz

### Step 3:

Spectrum analyser settings for step 3:

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

## 4.7.2 TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart C, §15.247 (d)

... In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

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

| Frequency in MHz | Limit (µV/m)     | Measurement distance (m) | Limits (dBµV/m)    |
|------------------|------------------|--------------------------|--------------------|
| 0.009 – 0.49     | 2400/F(kHz)@300m | 3                        | (48.5 – 13.8)@300m |
| 0.49 – 1.705     | 24000/F(kHz)@30m | 3                        | (33.8 – 23.0)@30m  |
| 1.705 – 30       | 30@30m           | 3                        | 29.5@30m           |

The measured values are corrected with an inverse linear distance extrapolation factor (40 dB/decade) according FCC 15.31 (2).

| Frequency in MHz | Limit (µV/m) | Measurement distance (m) | Limits (dBµV/m) |
|------------------|--------------|--------------------------|-----------------|
| 30 – 88          | 100@3m       | 3                        | 40.0@3m         |
| 88 – 216         | 150@3m       | 3                        | 43.5@3m         |
| 216 – 960        | 200@3m       | 3                        | 46.0@3m         |
| 960 – 26000      | 500@3m       | 3                        | 54.0@3m         |
| 26000 – 40000    | 500@3m       | 1                        | 54.0@3m         |

The measured values above 26 GHz are corrected with an inverse linear distance extrapolation factor (20 dB/decade).

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

Used conversion factor:  $\text{Limit (dBµV/m)} = 20 \log (\text{Limit (µV/m)}/1\mu\text{V/m})$

#### 4.7.3 TEST PROTOCOL

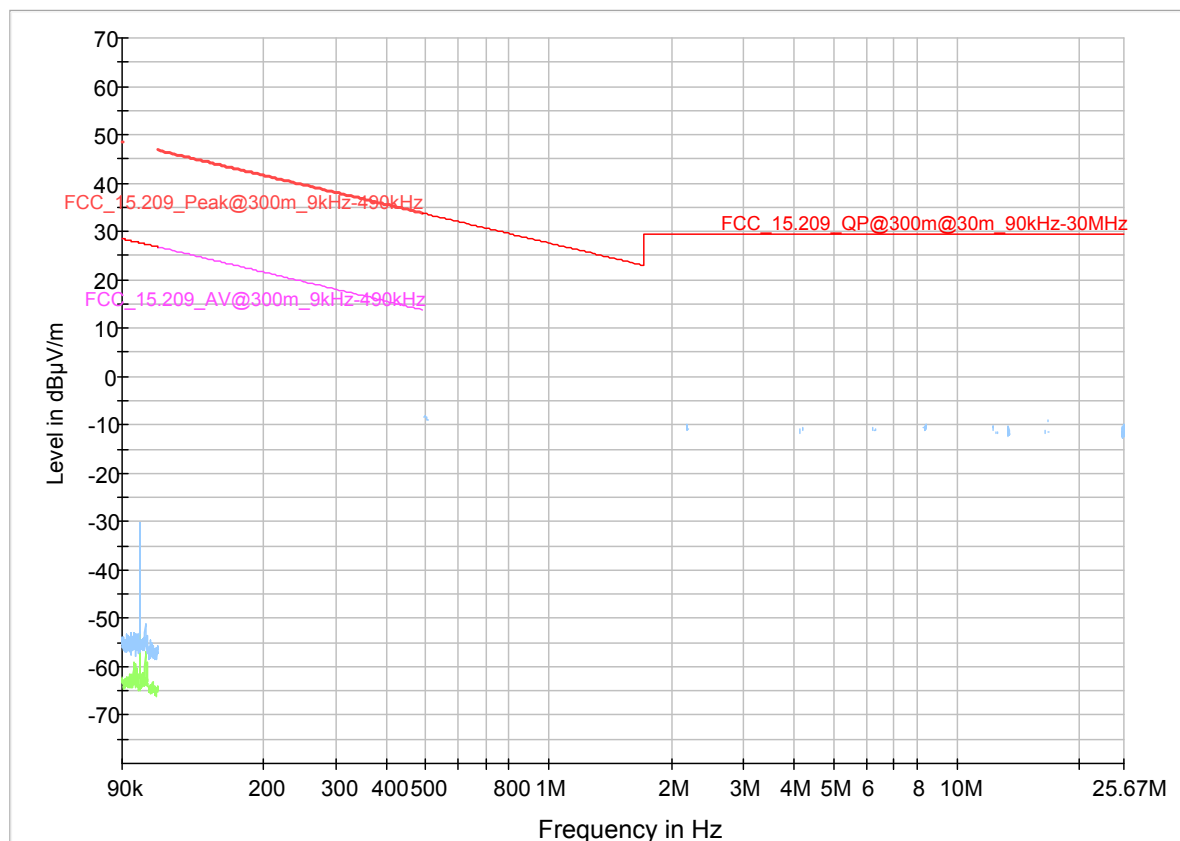
Ambient temperature: 21–25 °C  
 Air Pressure: 1002–1020 hPa  
 Humidity: 38–45 %  
 WLAN b-Mode; 20 MHz

| Mode / Set EUT target power | Ch. Center Freq. [MHz] | Spurious Freq. [MHz] | Spurious Level [dBμV/ m] | Detector | RBW [kHz] | Limit [dBμV/ m] | Margin to Limit [dB] | Limit Type |
|-----------------------------|------------------------|----------------------|--------------------------|----------|-----------|-----------------|----------------------|------------|
| DSSS, 11Mbit / 18 dBm       | 2412.0                 | -                    | noise                    | - - -    | -         | -               | > 9                  | RB         |
| DSSS, 11Mbit / 18 dBm       | 2442.0                 | -                    | noise                    | - - -    | -         | -               | > 9                  | RB         |
| DSSS, 11Mbit / 18 dBm       | 2472.0                 | -                    | noise                    | - - -    | -         | -               | > 9                  | RB         |

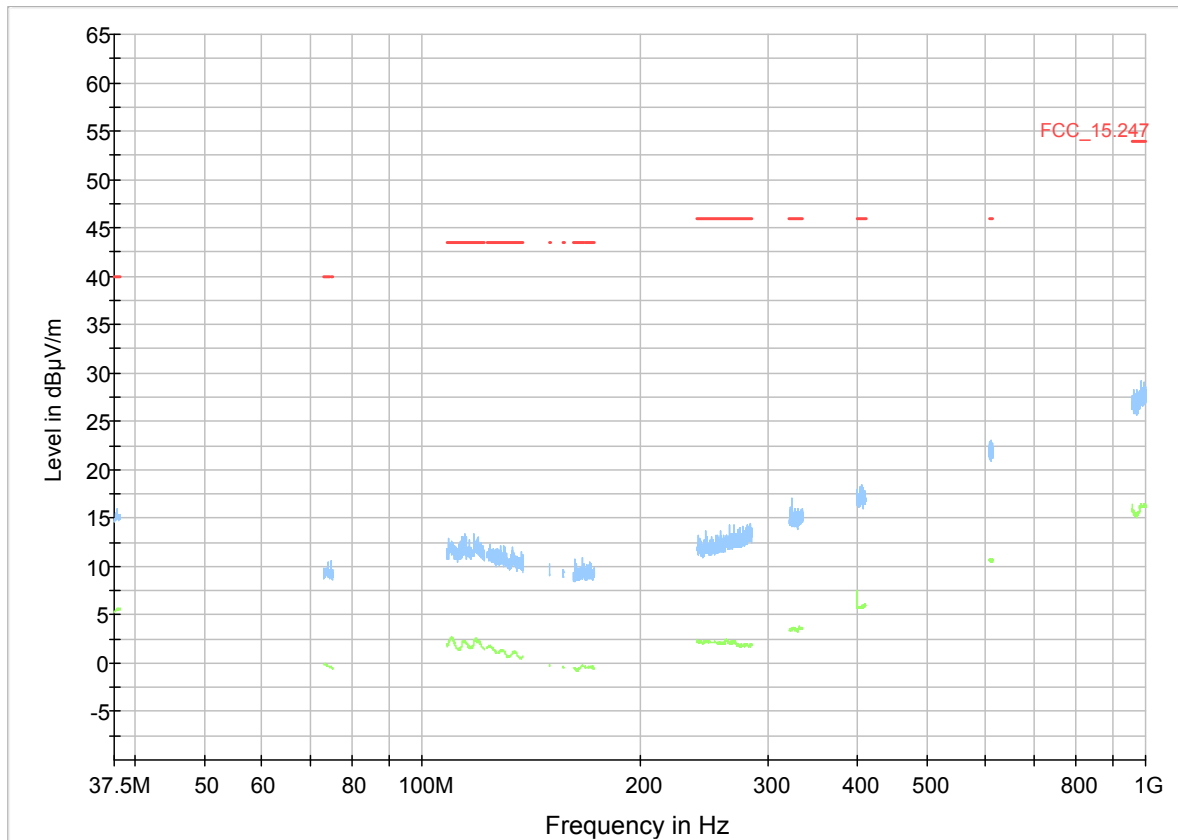
Remark: Antenna port of EUT terminated with 50 Ohm.

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

Radio Technology = WLAN b-Mode, 11Mbit / 18 dBm, Operating Frequency = mid

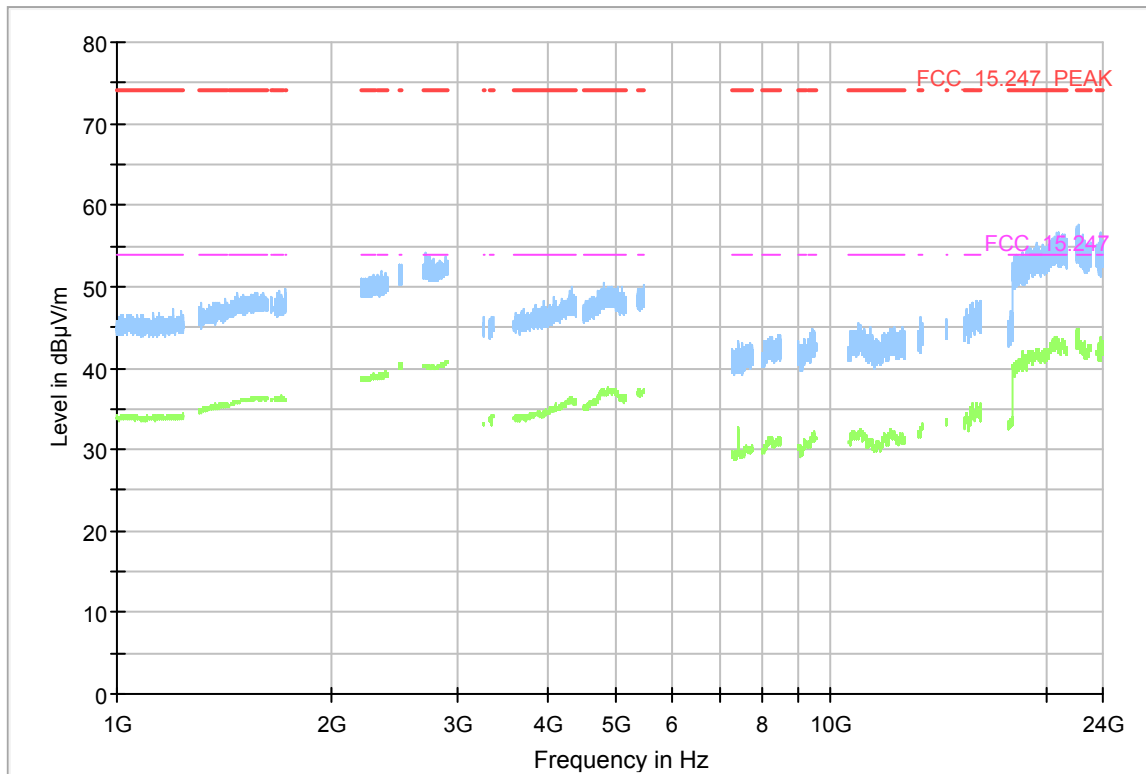


Radio Technology = WLAN b-Mode, 11Mbit / 18 dBm, Operating Frequency = mid





Radio Technology = WLAN b-Mode, 11Mbit / 18 dBm, Operating Frequency = mid



#### 4.7.5 TEST EQUIPMENT USED

Radiated Emissions

## 4.8 BAND EDGE COMPLIANCE CONDUCTED

Standard **FCC Part 15 Subpart C**

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

### 4.8.1 TEST DESCRIPTION

For the conducted measurement, the Equipment Under Test (EUT) is placed in a shielded room. The reference power was measured in the test case "Spurious RF Conducted Emissions". The EUT was connected to the spectrum analyzer via a short coax cable with a known loss.

Analyzer settings:

- Frequency Range 30 MHz – 25 GHz
- Detector: Peak
- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Sweptime: 330 s
- Sweeps: 2
- Trace: Maxhold

### 4.8.2 TEST REQUIREMENTS / LIMITS

FCC Part 15.247 (d)

"In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. ...

If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c))."

For the conducted measurement the RF power at the band edge shall be "at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power..."

#### 4.8.3 TEST PROTOCOL

Ambient temperature: 23 °C  
 Air Pressure: 1017 hPa  
 Humidity: 41 %  
 BT LE GFSK

| Channel No. | Channel Center Frequency [MHz] | Band Edge Freq. [MHz] | Spurious Level [dBm] | Detector | RBW [kHz] | Ref. Level [dBm] | Limit [dBm] | Margin to Limit [dB] |
|-------------|--------------------------------|-----------------------|----------------------|----------|-----------|------------------|-------------|----------------------|
| 0.0         | 2402.0                         | 2400.0                | -48.5                | PEAK     | 100.0     | 1.1              | -18.9       | 29.6                 |
| 39.0        | 2480.0                         | 2483.5                | -54.6                | PEAK     | 100.0     | 0.3              | -19.7       | 34.9                 |

WLAN b-Mode; 20 MHz

| Mode / Set EUT target power | Channel Center Frequency [MHz] | Band Edge Freq. [MHz] | Spurious Level [dBm] | Detector | RBW [kHz] | Ref. Level [dBm] | Limit [dBm] | Margin to Limit [dB] |
|-----------------------------|--------------------------------|-----------------------|----------------------|----------|-----------|------------------|-------------|----------------------|
| DSSS, 1Mbit / 18 dBm        | 2412.0                         | 2400.0                | -33.3                | PEAK     | 100.0     | 9.3              | -10.7       | 22.6                 |
| DSSS, 1Mbit / 18 dBm        | 2472.0                         | 2483.5                | -41.6                | PEAK     | 100.0     | 8.7              | -11.3       | 30.3                 |

WLAN g-Mode; 20 MHz

| Set EUT target power   | Channel Center Frequency [MHz] | Band Edge Freq. [MHz] | Spurious Level [dBm] | Detector | RBW [kHz] | Ref. Level [dBm] | Limit [dBm] | Margin to Limit [dB] |
|------------------------|--------------------------------|-----------------------|----------------------|----------|-----------|------------------|-------------|----------------------|
| OFDM, 54 Mbps / 13 dBm | 2412.0                         | 2400.0                | -30.7                | PEAK     | 100.0     | 5.6              | -14.4       | 16.3                 |
| OFDM, 54 Mbps / 13 dBm | 2472.0                         | 2483.5                | -40.6                | PEAK     | 100.0     | 2.9              | -17.1       | 23.5                 |

WLAN n-Mode; 20 MHz

| Set EUT target power | Channel Center Frequency [MHz] | Band Edge Freq. [MHz] | Spurious Level [dBm] | Detector | RBW [kHz] | Ref. Level [dBm] | Limit [dBm] | Margin to Limit [dB] |
|----------------------|--------------------------------|-----------------------|----------------------|----------|-----------|------------------|-------------|----------------------|
| OFDM, MCS6 / 13 dBm  | 2412.0                         | 2400.0                | -24.6                | PEAK     | 100.0     | 5.4              | -14.6       | 10.0                 |
| OFDM, MCS6 / 13 dBm  | 2472.0                         | 2483.5                | -36.7                | PEAK     | 100.0     | 2.7              | -17.3       | 19.3                 |

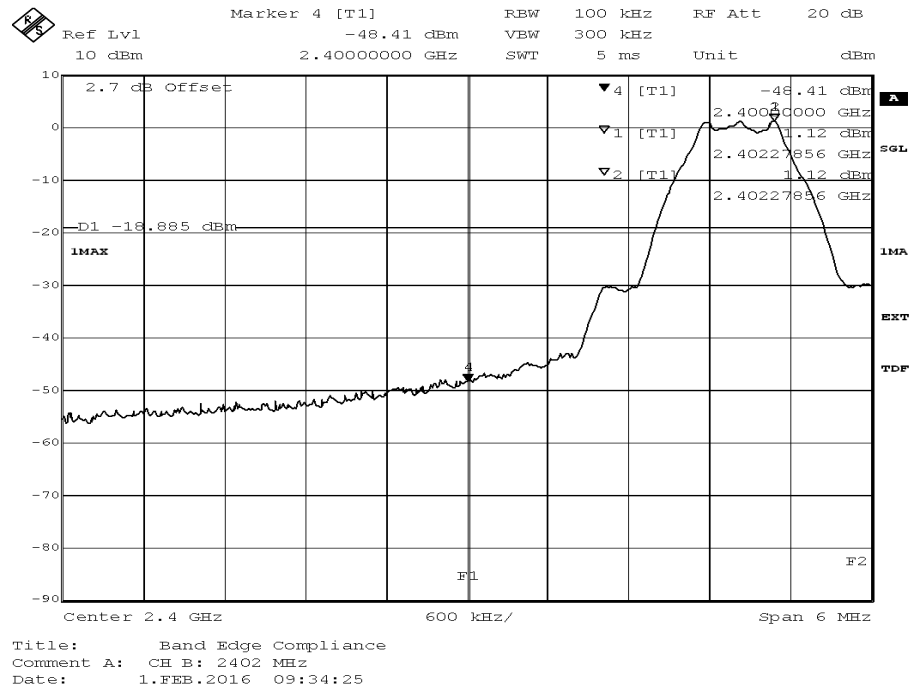
WLAN n-Mode; 40 MHz

| Set EUT target power | Channel Center Frequency [MHz] | Band Edge Freq. [MHz] | Spurious Level [dBm] | Detector | RBW [kHz] | Ref. Level [dBm] | Limit [dBm] | Margin to Limit [dB] |
|----------------------|--------------------------------|-----------------------|----------------------|----------|-----------|------------------|-------------|----------------------|
| OFDM, MCS6 / 12 dBm  | 2422.0                         | 2400.0                | -27.2                | PEAK     | 100.0     | 2.6              | -17.4       | 9.8                  |
| OFDM, MCS6 / 12 dBm  | 2462.0                         | 2483.5                | -32.8                | PEAK     | 100.0     | 0.3              | -19.8       | 13.1                 |

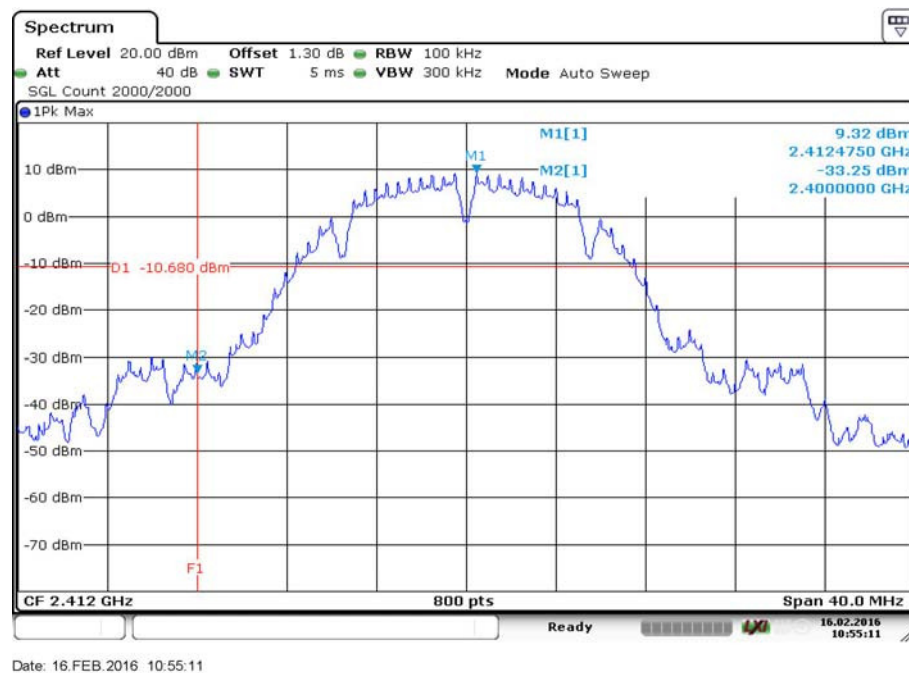
Remark: Please see next sub-clause for the measurement plot.

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

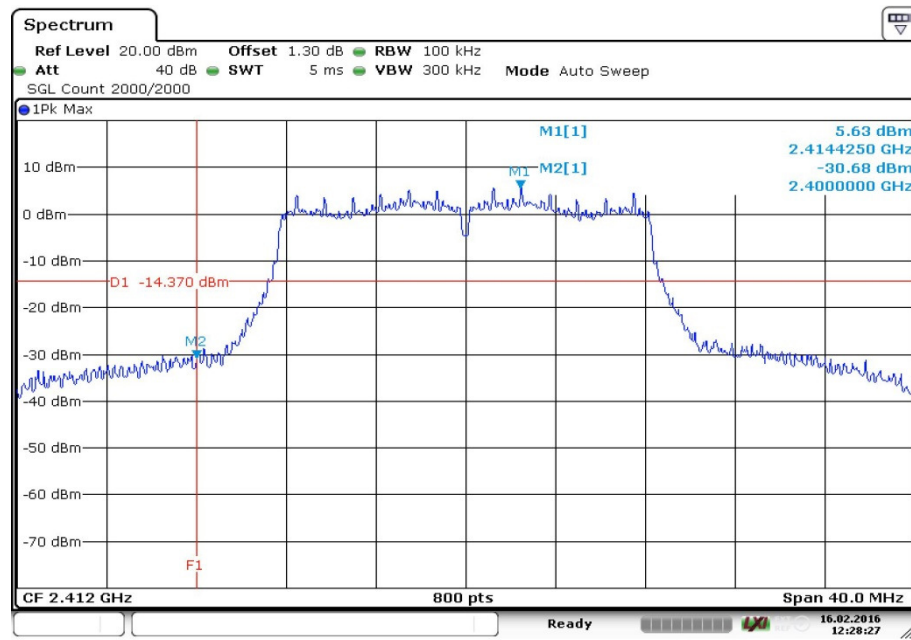
Radio Technology = Bluetooth LE, Operating Frequency = low, Band Edge = low



Radio Technology = WLAN b, Operating Frequency = low, Band Edge = low

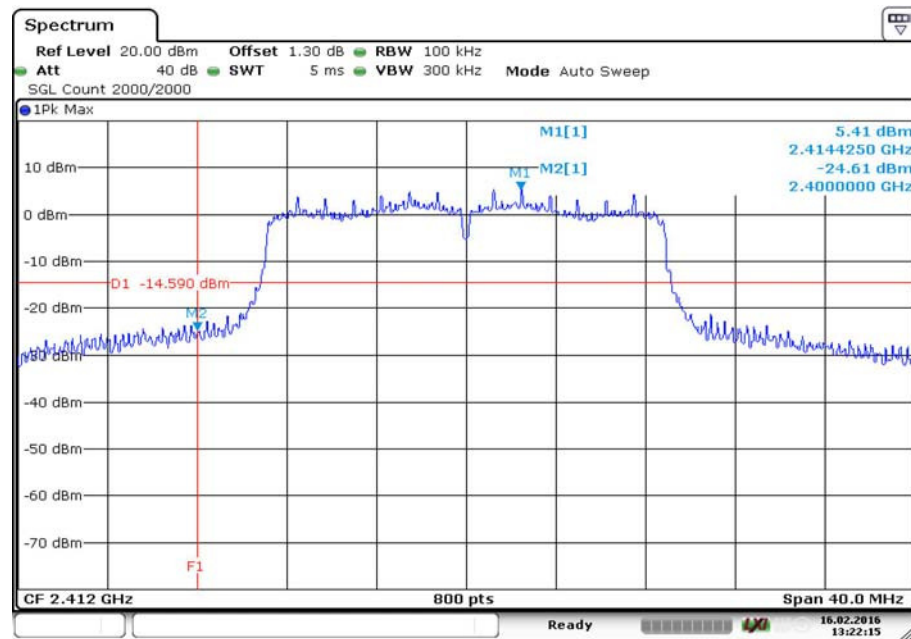


Radio Technology = WLAN g, Operating Frequency = low, Band Edge = low



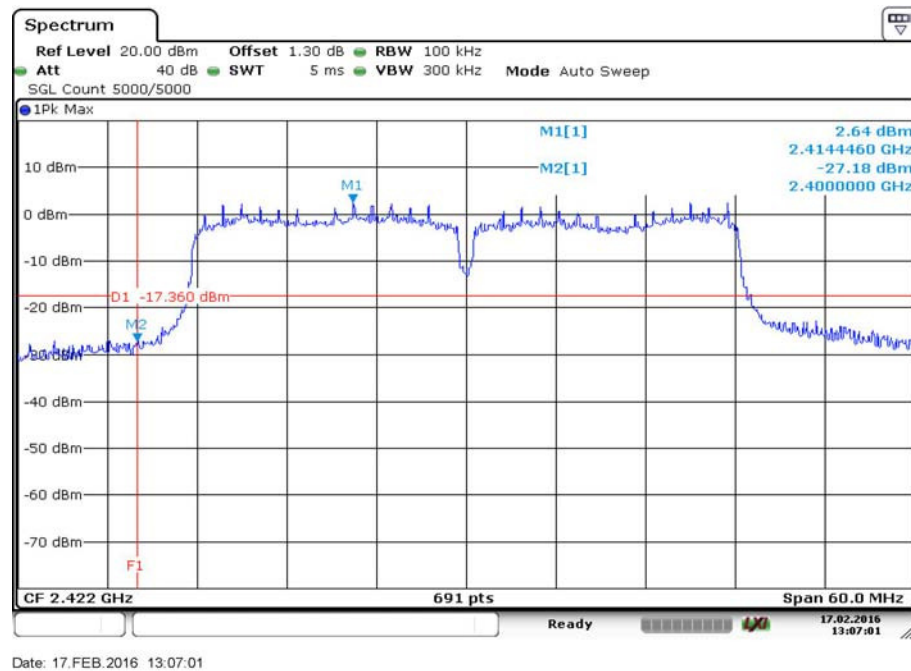
Date: 16.FEB.2016 12:28:28

Radio Technology = WLAN n 20 MHz, Operating Frequency = low, Band Edge = low



Date: 16.FEB.2016 13:22:14

Radio Technology = WLAN n 40 MHz, Operating Frequency = low, Band Edge = low



#### 4.8.5 TEST EQUIPMENT USED

R&S TS8997

#### 4.9 BAND EDGE COMPLIANCE CONDUCTED AT RESTRICTED BAND

Standard **FCC Part 15 Subpart C**

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

##### 4.9.1 TEST DESCRIPTION

Please see test description for the test case "Spurious RF Conducted Emissions in restricted bands"

##### 4.9.2 TEST REQUIREMENTS / LIMITS

For band edges connected to a restricted band, the limits are specified in Section 15.209(a)

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

| Frequency in MHz | Limit (μV/m)     | Measurement distance (m) | Limits (dBμV/m)    |
|------------------|------------------|--------------------------|--------------------|
| 0.009 – 0.49     | 2400/F(kHz)@300m | 3                        | (48.5 – 13.8)@300m |
| 0.49 – 1.705     | 24000/F(kHz)@30m | 3                        | (33.8 – 23.0)@30m  |
| 1.705 – 30       | 30@30m           | 3                        | 29.5@30m           |

| Frequency in MHz | Limit (μV/m) | Measurement distance (m) | Limits (dBμV/m) |
|------------------|--------------|--------------------------|-----------------|
| 30 – 88          | 100@3m       | 3                        | 40.0@3m         |
| 88 – 216         | 150@3m       | 3                        | 43.5@3m         |
| 216 – 960        | 200@3m       | 3                        | 46.0@3m         |
| 960 – 26000      | 500@3m       | 3                        | 54.0@3m         |
| 26000 – 40000    | 500@3m       | 1                        | 54.0@3m         |

§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:  $\text{Limit (dB}\mu\text{V/m)} = 20 \log (\text{Limit } (\mu\text{V/m})/1\mu\text{V/m})$

#### 4.9.3 TEST PROTOCOL

Ambient temperature: 21–25 °C  
 Air Pressure: 1002–1020 hPa  
 Humidity: 38–45 %  
 WLAN b-Mode; 20 MHz

| Mode / Set EUT target power | Ch. Center Freq. [MHz] | Spurious Freq. [MHz]       | Spurious Level [dBμV/ m] | Detector | RBW [kHz] | Limit [dBμV/ m] | Margin to Limit [dB] | Limit Type |
|-----------------------------|------------------------|----------------------------|--------------------------|----------|-----------|-----------------|----------------------|------------|
| DSSS, 2Mbit / 15 dBm        | 2467.0                 | 2483.500000<br>2483.500000 | 61.3<br>51.2             | Peak AV  | 1000      | 74<br>54        | 12.7<br>2.8          | BE         |
| DSSS, 2Mbit / 13 dBm        | 2472.0                 | 2484.699500                | 56.4<br>49.3             | Peak AV  | 1000      | 74<br>54        | 17.6<br>4.7          | BE         |
| DSSS, 11Mbit / 18 dBm       | 2462.0                 | 2483.527500<br>2483.527500 | 56.6<br>44.9             | Peak AV  | 1000      | 74<br>54        | 17.4<br>9.1          | BE         |
| DSSS, 11Mbit / 15 dBm       | 2467.0                 | 2483.500000<br>2483.500000 | 60.9<br>50.3             | Peak AV  | 1000      | 74<br>54        | 13.1<br>3.7          | BE         |
| DSSS, 11Mbit / 13 dBm       | 2472.0                 | 2483.522200<br>2483.538500 | 59.9<br>47.7             | Peak AV  | 1000      | 74<br>54        | 14.1<br>6.3          | BE         |

Remark: -



Ambient temperature: 21–25 °C  
Air Pressure: 1002–1020 hPa  
Humidity: 38–45 %  
WLAN g-Mode; 20 MHz

| Mode / Set EUT target power | Ch. Center Freq. [MHz] | Spurious Freq. [MHz]        | Spurious Level [dBμV/ m] | Detector | RBW [kHz] | Limit [dBμV/ m] | Margin to Limit [dB] | Limit Type |
|-----------------------------|------------------------|-----------------------------|--------------------------|----------|-----------|-----------------|----------------------|------------|
| OFDM, 9Mbit / 16 dBm        | 2452.0                 | 2483.516500<br>2483.500000  | 67.7<br>48.1             | Peak AV  | 1000      | 74<br>54        | 6.3<br>5.9           | BE         |
| OFDM, 9Mbit / 15 dBm        | 2457.0                 | 2483.527500<br>2483.527500  | 69.0<br>47.3             | Peak AV  | 1000      | 74<br>54        | 5.0<br>6.7           | BE         |
| OFDM, 9Mbit / 13 dBm        | 2462.0                 | 2483.500000<br>2483.500000  | 73.2<br>53.4             | Peak AV  | 1000      | 74<br>54        | 0.8<br>0.6           | BE         |
| OFDM, 9Mbit / 10 dBm        | 2467.0                 | 2484.292000<br>2483. 593500 | 70.2<br>53.0             | Peak AV  | 1000      | 74<br>54        | 3.8<br>1.0           | BE         |
| OFDM, 9Mbit / 9 dBm         | 2472.0                 | 2483.500000<br>2483.500000  | 72.8<br>52.2             | Peak AV  | 1000      | 74<br>54        | 1.2<br>1.8           | BE         |
| OFDM, 48Mbit / 13 dBm       | 2462.0                 | 2483.604500<br>2483.604500  | 71.9<br>52.8             | Peak AV  | 1000      | 74<br>54        | 2.1<br>1.2           | BE         |
| OFDM, 48Mbit / 9 dBm        | 2467.0                 | 2483.665500<br>2483.648500  | 67.4<br>53.7             | Peak AV  | 1000      | 74<br>54        | 6.6<br>0.3           | BE         |
| OFDM, 48Mbit / 9 dBm        | 2472.0                 | 2483.500000<br>2483.500000  | 71.8<br>49.4             | Peak AV  | 1000      | 74<br>54        | 2.2<br>4.6           | BE         |
| OFDM, 54Mbit / 13 dBm       | 2462.0                 | 2483.604500<br>2483.500000  | 71.1<br>52.9             | Peak AV  | 1000      | 74<br>54        | 2.9<br>1.1           | BE         |
| OFDM, 54Mbit / 9 dBm        | 2467.0                 | 2483.511000<br>2483.593500  | 64.8<br>52.4             | Peak AV  | 1000      | 74<br>54        | 9.2<br>1.6           | BE         |
| OFDM, 54Mbit / 9 dBm        | 2472.0                 | 2483.500000<br>2483.500000  | 70.7<br>51.3             | Peak AV  | 1000      | 74<br>54        | 3.3<br>2.7           | BE         |

Remark: -

Ambient temperature: 21–25 °C  
 Air Pressure: 1002–1020 hPa  
 Humidity: 38–45 %  
 WLAN n-Mode; 20 MHz

| Mode / Set EUT target power | Ch. Center Freq. [MHz] | Spurious Freq. [MHz]       | Spurious Level [dBμV/ m] | Detector | RBW [kHz] | Limit [dBμV/ m] | Margin to Limit [dB] | Limit Type |
|-----------------------------|------------------------|----------------------------|--------------------------|----------|-----------|-----------------|----------------------|------------|
| HT20, MCS2 / 16 dBm         | 2457.0                 | 2483.500000<br>2483.500000 | 73.1<br>50.5             | Peak AV  | 1000      | 74<br>54        | 0.9<br>3.5           | BE         |
| HT20, MCS2 / 12 dBm         | 2462.0                 | 2483.808000<br>2483.588000 | 68.2<br>52.5             | Peak AV  | 1000      | 74<br>54        | 5.8<br>1.5           | BE         |
| HT20, MCS2 / 10 dBm         | 2467.0                 | 2483.610000<br>2483.610000 | 71.2<br>53.8             | Peak AV  | 1000      | 74<br>54        | 2.8<br>0.2           | BE         |
| HT20, MCS2 / 9 dBm          | 2472.0                 | 2483.500000<br>2483.500000 | 70.3<br>53.0             | Peak AV  | 1000      | 74<br>54        | 3.7<br>1.0           | BE         |
| HT20, MCS4 / 16 dBm         | 2457.0                 | 2483.544000<br>2483.500000 | 72.6<br>51.9             | Peak AV  | 1000      | 74<br>54        | 1.4<br>2.1           | BE         |
| HT20, MCS4 / 12 dBm         | 2462.0                 | 2483.885000<br>2483.588000 | 71.7<br>53.5             | Peak AV  | 1000      | 74<br>54        | 2.3<br>0.5           | BE         |
| HT20, MCS4 / 9 dBm          | 2467.0                 | 2483.549500<br>2483.549500 | 65.3<br>51.2             | Peak AV  | 1000      | 74<br>54        | 8.7<br>2.8           | BE         |
| HT20, MCS4 / 9 dBm          | 2472.0                 | 2483.500000<br>2483.500000 | 72.1<br>49.0             | Peak AV  | 1000      | 74<br>54        | 1.9<br>5.0           | BE         |
| HT20, MCS6 / 13 dBm         | 2457.0                 | 2483.687000<br>2483.687000 | 65.6<br>45.4             | Peak AV  | 1000      | 74<br>54        | 8.4<br>8.6           | BE         |
| HT20, MCS6 / 12 dBm         | 2462.0                 | 2483.637500<br>2483.511000 | 70.5<br>54.0             | Peak AV  | 1000      | 74<br>54        | 3.5<br>0.0           | BE         |
| HT20, MCS6 / 9 dBm          | 2467.0                 | 2483.593500<br>2483.593500 | 71.3<br>53.9             | Peak AV  | 1000      | 74<br>54        | 2.7<br>0.1           | BE         |
| HT20, MCS6 / 9 dBm          | 2472.0                 | 2483.544000<br>2483.544000 | 72.4<br>52.6             | Peak AV  | 1000      | 74<br>54        | 1.6<br>1.4           | BE         |

Remark: -

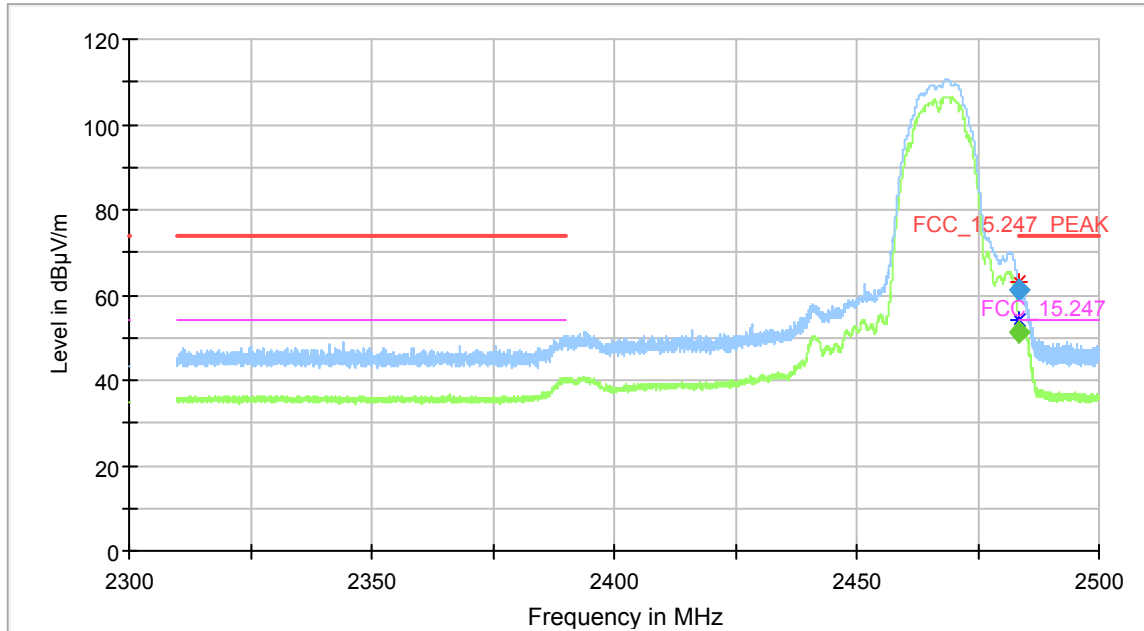
Ambient temperature: 21–25 °C  
 Air Pressure: 1002–1020 hPa  
 Humidity: 38–45 %  
 WLAN n-Mode; 40 MHz

| Mode / Set EUT target power | Ch. Center Freq. [MHz] | Spurious Freq. [MHz]       | Spurious Level [dBμV/ m] | Detector | RBW [kHz] | Limit [dBμV/ m] | Margin to Limit [dB] | Limit Type |
|-----------------------------|------------------------|----------------------------|--------------------------|----------|-----------|-----------------|----------------------|------------|
| HT40, MCS0 / 13 dBm         | 2432.0                 | 2483.868500<br>2483.868500 | 69.5<br>45.7             | Peak AV  | 1000      | 74<br>54        | 4.5<br>8.3           | BE         |
| HT40, MCS0 / 14 dBm         | 2437.0                 | 2483.860500<br>2483.860500 | 72.6<br>48.6             | Peak AV  | 1000      | 74<br>54        | 1.4<br>5.4           | BE         |
| HT40, MCS0 / 14 dBm         | 2442.0                 | 2483.500000<br>2483.500000 | 73.1<br>49.2             | Peak AV  | 1000      | 74<br>54        | 0.9<br>4.8           | BE         |
| HT40, MCS0 / 13 dBm         | 2447.0                 | 2483.500000<br>2483.500000 | 74.0<br>51.7             | Peak AV  | 1000      | 74<br>54        | 0.0<br>2.3           | BE         |
| HT40, MCS0 / 10 dBm         | 2452.0                 | 2483.500000<br>2483.500000 | 68.9<br>48.8             | Peak AV  | 1000      | 74<br>54        | 5.1<br>5.2           | BE         |
| HT40, MCS0 / 7 dBm          | 2457.0                 | 2483.555000<br>2483.736500 | 61.4<br>49.0             | Peak AV  | 1000      | 74<br>54        | 12.6<br>5.0          | BE         |
| HT40, MCS0 / 6 dBm          | 2462.0                 | 2483.505500<br>2483.505500 | 69.2<br>50.9             | Peak AV  | 1000      | 74<br>54        | 4.8<br>3.1           | BE         |
| HT40, MCS6 / 13 dBm         | 2432.0                 | 2483.626500<br>2483.511000 | 72.7<br>48.0             | Peak AV  | 1000      | 74<br>54        | 1.3<br>6.0           | BE         |
| HT40, MCS6 / 13 dBm         | 2447.0                 | 2483.522000<br>2483.500000 | 71.9<br>53.6             | Peak AV  | 1000      | 74<br>54        | 2.1<br>0.4           | BE         |
| HT40, MCS6 / 11 dBm         | 2452.0                 | 2483.769500<br>2483.769500 | 67.2<br>53.1             | Peak AV  | 1000      | 74<br>54        | 6.5<br>0.9           | BE         |
| HT40, MCS6 / 8 dBm          | 2457.0                 | 2483.555000<br>2483.505500 | 70.9<br>51.7             | Peak AV  | 1000      | 74<br>54        | 3.1<br>2.3           | BE         |
| HT40, MCS6 / 7 dBm          | 2462.0                 | 2483.610000<br>2483.610000 | 69.5<br>54.0             | Peak AV  | 1000      | 74<br>54        | 4.5<br>0.0           | BE         |

Remark: -

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

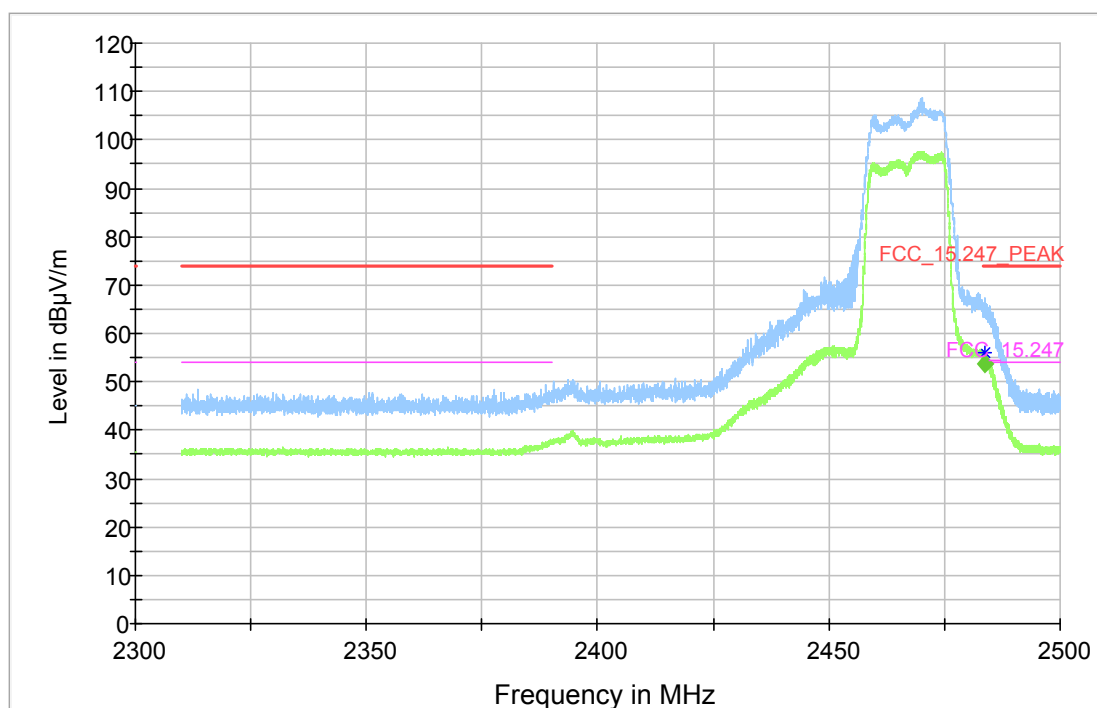
Radio Technology = WLAN b-Mode, 2Mbit / 15 dBm, Operating Frequency = 2467.0 MHz



#### Final\_Result

| Frequency (MHz) | MaxPeak (dBμV/m) | CAverage (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Corr. (dB) |
|-----------------|------------------|-------------------|----------------|-------------|-----------------|-----------------|------------|
| 2483.500000     | 61.33            | ---               | 74.00          | 12.67       | 1000.0          | 1000.000        | -5.8       |
| 2483.500000     | ---              | 51.22             | 54.00          | 2.78        | 1000.0          | 1000.000        | -5.8       |

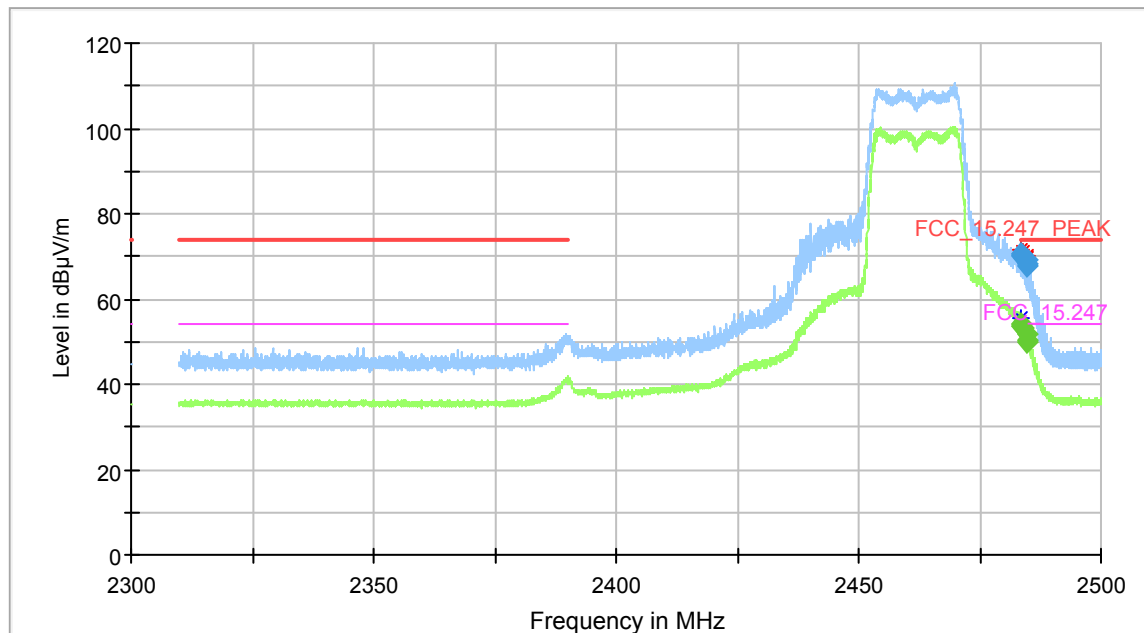
Radio Technology = WLAN g-Mode, 48Mbit / 9 dBm, Operating Frequency = 2467.0 MHz



#### Final\_Result

| Frequency (MHz) | MaxPeak (dBμV/m) | CAverage (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Corr. (dB) |
|-----------------|------------------|-------------------|----------------|-------------|-----------------|-----------------|------------|
| 2483.665500     | 67.41            | ---               | 74.00          | 6.59        | 1000.0          | 1000.000        | -5.8       |
| 2483.648500     | ---              | 51.22             | 54.00          | 2.78        | 1000.0          | 1000.000        | -5.8       |

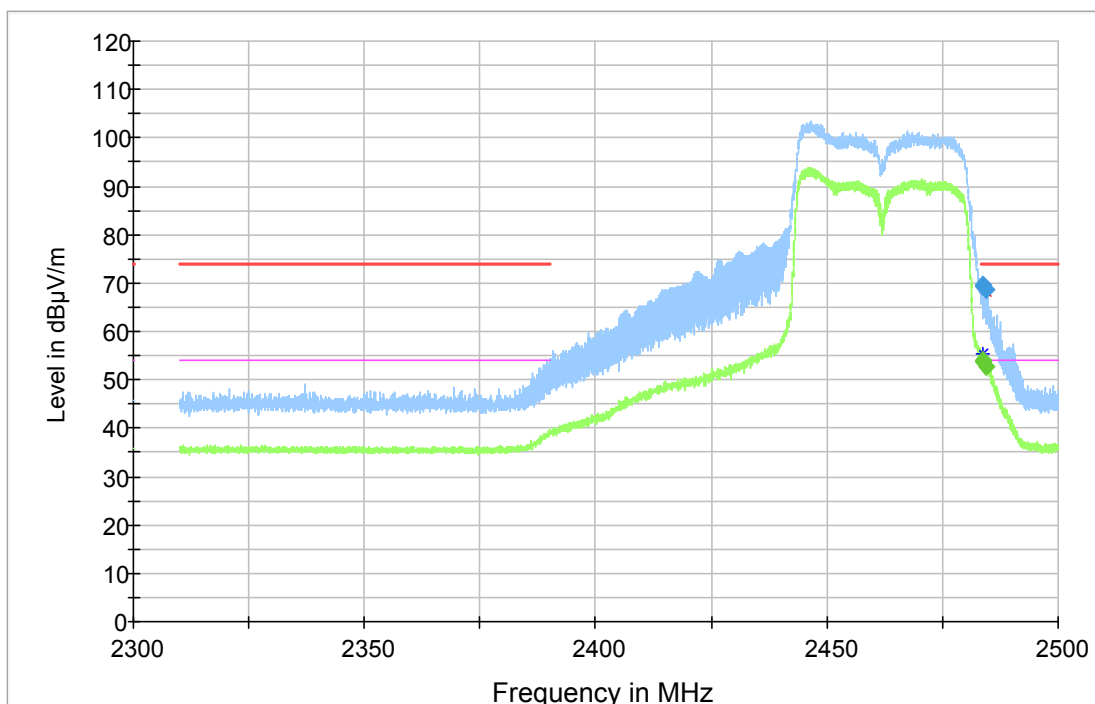
Radio Technology = WLAN n-Mode HT20, MCS6 / 12 dBm, Operating Frequency = 2462.0 MHz



#### Final Result

| Frequency (MHz) | MaxPeak (dBμV/m) | CAverage (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Corr. (dB) |
|-----------------|------------------|-------------------|----------------|-------------|-----------------|-----------------|------------|
| 2483.511000     | ---              | 53.99             | 54.00          | 0.01        | 1000.0          | 1000.000        | -5.8       |
| 2483.511000     | 70.12            | ---               | 74.00          | 3.88        | 1000.0          | 1000.000        | -5.8       |
| 2483.637500     | ---              | 53.74             | 54.00          | 0.26        | 1000.0          | 1000.000        | -5.8       |
| 2483.637500     | 70.52            | ---               | 74.00          | 3.48        | 1000.0          | 1000.000        | -5.8       |
| 2483.984000     | ---              | 53.07             | 54.00          | 0.93        | 1000.0          | 1000.000        | -5.8       |
| 2483.984000     | 69.78            | ---               | 74.00          | 4.22        | 1000.0          | 1000.000        | -5.8       |
| 2484.517500     | ---              | 51.54             | 54.00          | 2.46        | 1000.0          | 1000.000        | -5.8       |
| 2484.517500     | 69.00            | ---               | 74.00          | 5.00        | 1000.0          | 1000.000        | -5.8       |
| 2484.781500     | ---              | 50.51             | 54.00          | 3.49        | 1000.0          | 1000.000        | -5.8       |
| 2484.781500     | 68.46            | ---               | 74.00          | 5.54        | 1000.0          | 1000.000        | -5.8       |
| 2484.880500     | ---              | 50.11             | 54.00          | 3.89        | 1000.0          | 1000.000        | -5.8       |
| 2484.880500     | 67.79            | ---               | 74.00          | 6.21        | 1000.0          | 1000.000        | -5.8       |

Radio Technology = WLAN n-Mode HT40, MCS6 / 7 dBm, Operating Frequency = 2462.0 MHz



#### Final\_Result

| Frequency (MHz) | MaxPeak (dBμV/m) | CAverage (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Corr. (dB) |
|-----------------|------------------|-------------------|----------------|-------------|-----------------|-----------------|------------|
| 2483.610000     | ---              | 53.96             | 54.00          | 0.04        | 1000.0          | 1000.000        | -5.8       |
| 2483.610000     | 69.46            | ---               | 74.00          | 4.54        | 1000.0          | 1000.000        | -5.8       |
| 2483.797000     | ---              | 53.65             | 54.00          | 0.35        | 1000.0          | 1000.000        | -5.8       |
| 2483.797000     | 69.13            | ---               | 74.00          | 4.87        | 1000.0          | 1000.000        | -5.8       |
| 2484.468000     | ---              | 52.73             | 54.00          | 1.27        | 1000.0          | 1000.000        | -5.8       |
| 2484.468000     | 68.60            | ---               | 74.00          | 5.40        | 1000.0          | 1000.000        | -5.8       |

#### 4.9.5 TEST EQUIPMENT USED

Radiated Emissions

#### 4.10 BAND EDGE COMPLIANCE RADIATED

Standard **FCC Part 15 Subpart C**

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

##### 4.10.1 TEST DESCRIPTION

Please see test description for the test case "Spurious Radiated Emissions"

##### 4.10.2 TEST REQUIREMENTS / LIMITS

For band edges connected to a restricted band, the limits are specified in Section 15.209(a)

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

| Frequency in MHz | Limit (μV/m)     | Measurement distance (m) | Limits (dBμV/m)    |
|------------------|------------------|--------------------------|--------------------|
| 0.009 – 0.49     | 2400/F(kHz)@300m | 3                        | (48.5 – 13.8)@300m |
| 0.49 – 1.705     | 24000/F(kHz)@30m | 3                        | (33.8 – 23.0)@30m  |
| 1.705 – 30       | 30@30m           | 3                        | 29.5@30m           |

The measured values are corrected with an inverse linear distance extrapolation factor (40 dB/decade) according FCC 15.31 (2).

| Frequency in MHz | Limit (μV/m) | Measurement distance (m) | Limits (dBμV/m) |
|------------------|--------------|--------------------------|-----------------|
| 30 – 88          | 100@3m       | 3                        | 40.0@3m         |
| 88 – 216         | 150@3m       | 3                        | 43.5@3m         |
| 216 – 960        | 200@3m       | 3                        | 46.0@3m         |
| 960 – 26000      | 500@3m       | 3                        | 54.0@3m         |
| 26000 – 40000    | 500@3m       | 1                        | 54.0@3m         |

The measured values above 26 GHz are corrected with an inverse linear distance extrapolation factor (20 dB/decade).

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

Used conversion factor:  $\text{Limit (dBμV/m)} = 20 \log (\text{Limit (μV/m)}/1\mu\text{V/m})$



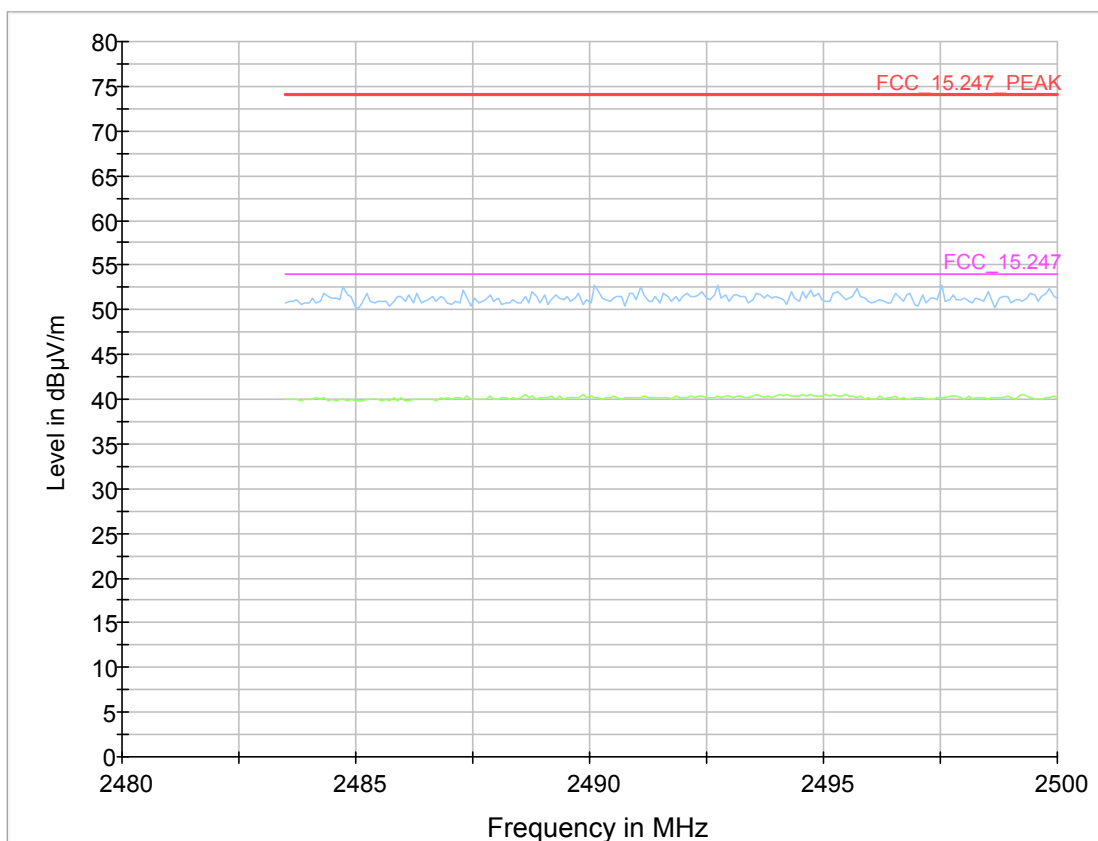
#### 4.10.3 TEST PROTOCOL

Ambient temperature: 21–25 °C  
 Air Pressure: 1002–1020 hPa  
 Humidity: 38–45 %  
 WLAN b-Mode; 20 MHz

| Mode / Set EUT target power | Ch. Center Freq. [MHz] | Spurious Freq. [MHz] | Spurious Level [dBμV/ m] | Detector | RBW [kHz] | Limit [dBμV/ m] | Margin to Limit [dB] | Limit Type |
|-----------------------------|------------------------|----------------------|--------------------------|----------|-----------|-----------------|----------------------|------------|
| DSSS, 11Mbit / 18 dBm       | 2472.0                 | -                    | noise                    | - - -    | -         | -               | > 13                 | RE         |

Remark: Antenna port of EUT terminated with 50 Ohm.

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



#### 4.10.5 TEST EQUIPMENT USED

Radiated Emissions

#### 4.11 POWER DENSITY

Standard **FCC Part 15 Subpart C**

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

##### 4.11.1 TEST DESCRIPTION

The Equipment Under Test (EUT) was set up in a shielded room to perform the Power Density measurements.

The results recorded were measured with the modulation which produces the worst-case (highest) power density.

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

Analyzer settings:

- Resolution Bandwidth (RBW): 3 kHz
- Video Bandwidth (VBW): 10 kHz
- Trace: Maxhold
- Sweeps: 2000
- Sweep time: 420 ms (BT-LE), 4.4 ms (WLAN 20 MHz), 8.8 ms (WLAN 40 MHz)
- Detector: Peak

##### 4.11.2 TEST REQUIREMENTS / LIMITS

FCC Part 15, Subpart C, §15.247 (e)

For digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

...

The same method of determining the conducted output power shall be used to determine the power spectral density.

##### 4.11.3 TEST PROTOCOL

Ambient temperature: 23 °C  
Air Pressure: 1017 hPa  
Humidity: 41 %  
BT LE

| Band        | Channel No. | Frequency [MHz] | Power Density [dBm/ 3kHz] | Limit [dBm/ 3kHz] | Margin to Limit [dB] |
|-------------|-------------|-----------------|---------------------------|-------------------|----------------------|
| 2.4 GHz ISM | 0           | 2402.0          | -13.2                     | 8.0               | 21.2                 |
|             | 19          | 2440.0          | -12.7                     | 8.0               | 20.7                 |
|             | 39          | 2480.0          | -13.6                     | 8.0               | 21.6                 |

Ambient temperature: 23 °C  
 Air Pressure: 1017 hPa  
 Humidity: 41 %  
 WLAN b-Mode; 20 MHz

| Mode          | Set EUT target power | Frequency [MHz] | Power Density [dBm/ 3kHz] | Limit [dBm/ 3kHz] | Margin to Limit [dB] |
|---------------|----------------------|-----------------|---------------------------|-------------------|----------------------|
| DSSS, 11 Mbps | 18 dBm               | 2412.0          | -4.3                      | 8.0               | 12.3                 |
| DSSS, 11 Mbps | 18 dBm               | 2437.0          | -4.8                      | 8.0               | 12.8                 |
| DSSS, 11 Mbps | 18 dBm               | 2462.0          | -7.5                      | 8.0               | 15.5                 |
| DSSS, 11 Mbps | 15 dBm               | 2467.0          | -10.7                     | 8.0               | 18.7                 |
| DSSS, 11 Mbps | 13 dBm               | 2472.0          | -11.2                     | 8.0               | 19.2                 |

WLAN g-Mode; 20 MHz

| Mode          | Set EUT target power | Frequency [MHz] | Power Density [dBm/ 3kHz] | Limit [dBm/ 3kHz] | Margin to Limit [dB] |
|---------------|----------------------|-----------------|---------------------------|-------------------|----------------------|
| OFDM, 54 Mbps | 13.0                 | 2412.0          | -11.3                     | 8.0               | 19.3                 |
| OFDM, 36 Mbps | 16.0                 | 2417.0          | -9.8                      | 8.0               | 17.8                 |
| OFDM, 36 Mbps | 16.0                 | 2437.0          | -9.2                      | 8.0               | 17.2                 |
| OFDM, 36 Mbps | 16.0                 | 2462.0          | -11.4                     | 8.0               | 19.4                 |
| OFDM, 36 Mbps | 10.0                 | 2467.0          | -18.0                     | 8.0               | 26.0                 |
| OFDM, 54 Mbps | 9.0                  | 2472.0          | -17.2                     | 8.0               | 26.2                 |

WLAN n-Mode; 20 MHz

| Mode       | Set EUT target power | Frequency [MHz] | Power Density [dBm/ 3kHz] | Limit [dBm/ 3kHz] | Margin to Limit [dB] |
|------------|----------------------|-----------------|---------------------------|-------------------|----------------------|
| OFDM, MCS6 | 13.0                 | 2412.0          | -10.2                     | 8.0               | 18.2                 |
| OFDM, MCS3 | 15.0                 | 2417.0          | -10.1                     | 8.0               | 18.1                 |
| OFDM, MCS3 | 16.0                 | 2437.0          | -8.4                      | 8.0               | 16.4                 |
| OFDM, MCS3 | 9.0                  | 2467.0          | -18.7                     | 8.0               | 26.7                 |
| OFDM, MCS6 | 9.0                  | 2472.0          | -16.3                     | 8.0               | 24.6                 |

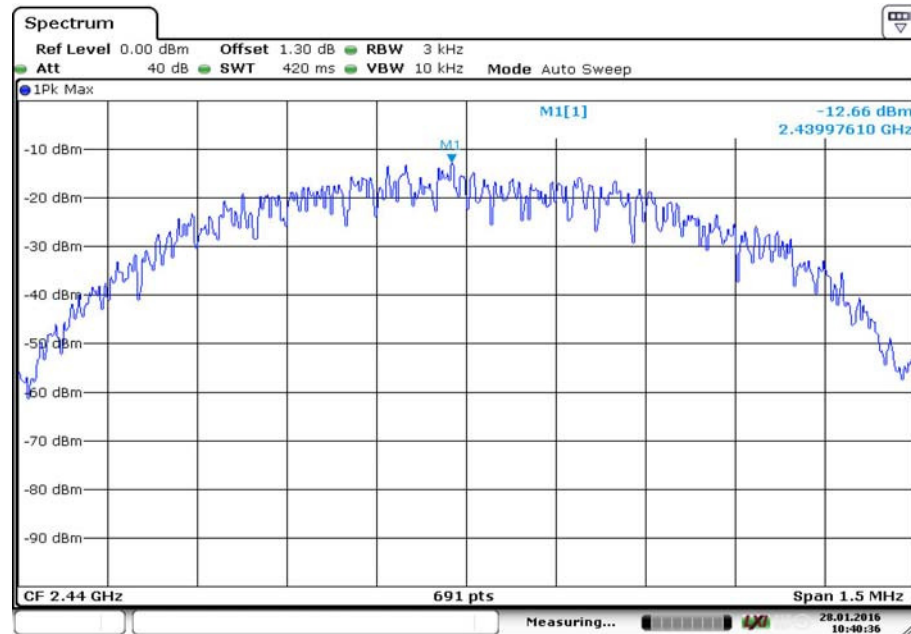
WLAN n-Mode; 40 MHz

| Mode       | Set EUT target power | Frequency [MHz] | Power Density [dBm/ 3kHz] | Limit [dBm/ 3kHz] | Margin to Limit [dB] |
|------------|----------------------|-----------------|---------------------------|-------------------|----------------------|
| OFDM, MCS6 | 11.0                 | 2422.0          | -17.9                     | 8.0               | 25.9                 |
| OFDM, MCS4 | 11.0                 | 2427.0          | -16.7                     | 8.0               | 24.7                 |
| OFDM, MCS4 | 14.0                 | 2437.0          | -13.9                     | 8.0               | 21.9                 |
| OFDM, MCS4 | 13.0                 | 2447.0          | -14.5                     | 8.0               | 22.2                 |
| OFDM, MCS6 | 7.0                  | 2462.0          | -21.8                     | 8.0               | 29.8                 |

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

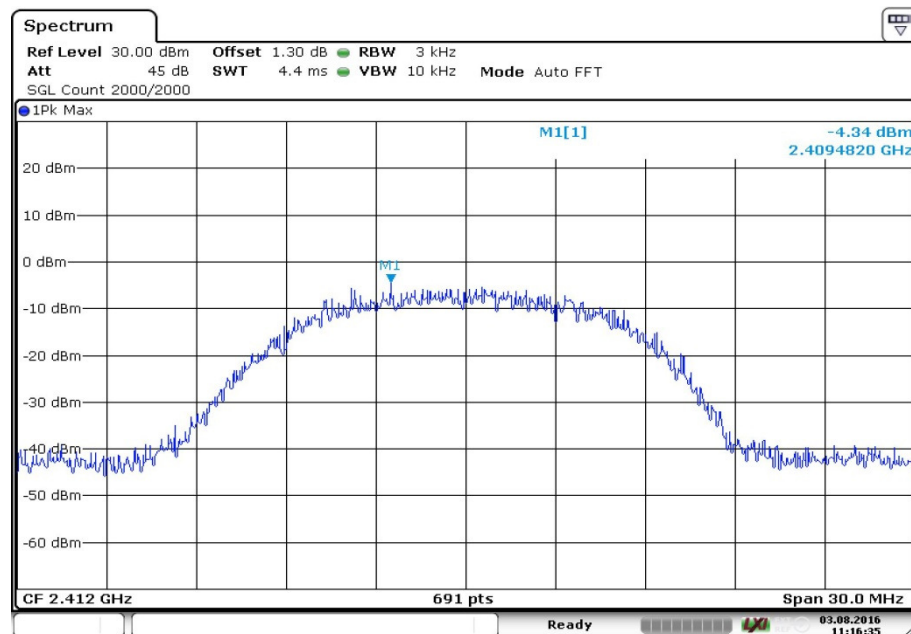
#### 4.11.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")

Radio Technology = Bluetooth LE, Operating Frequency = mid



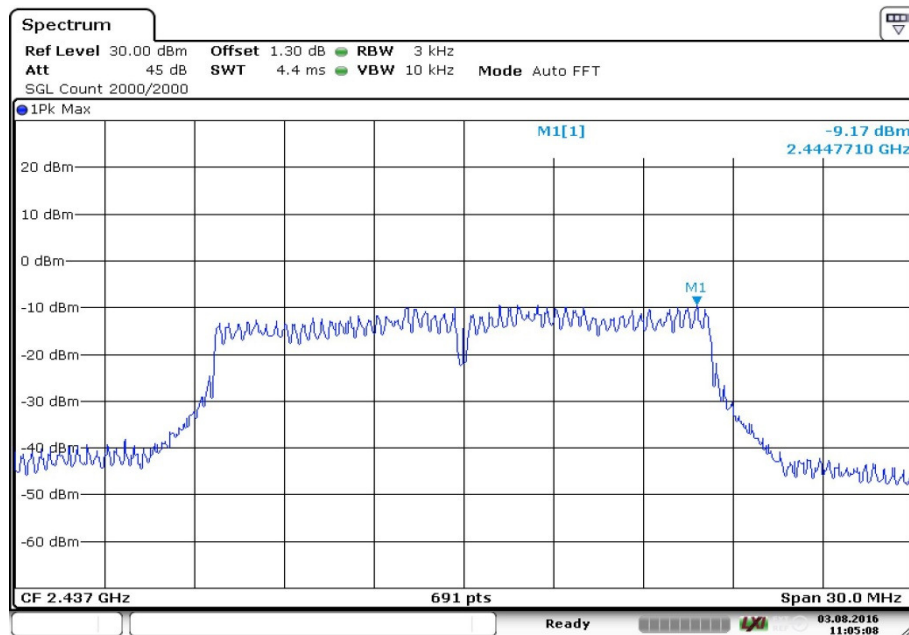
Date: 28 JAN 2016 10:40:36

Radio Technology = WLAN b, Operating Frequency = low



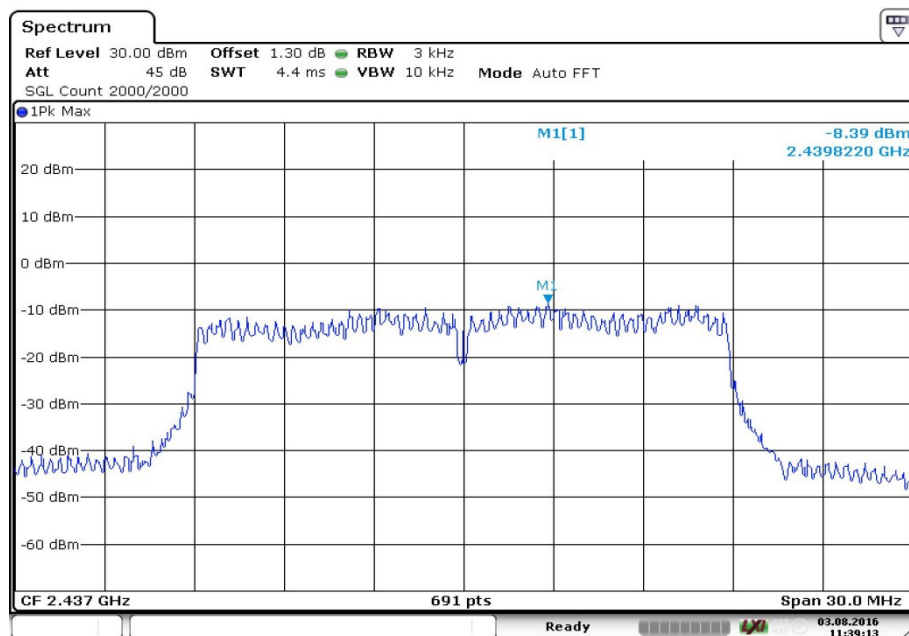
Date: 3.AUG.2016 11:16:35

Radio Technology = WLAN g, Operating Frequency = mid



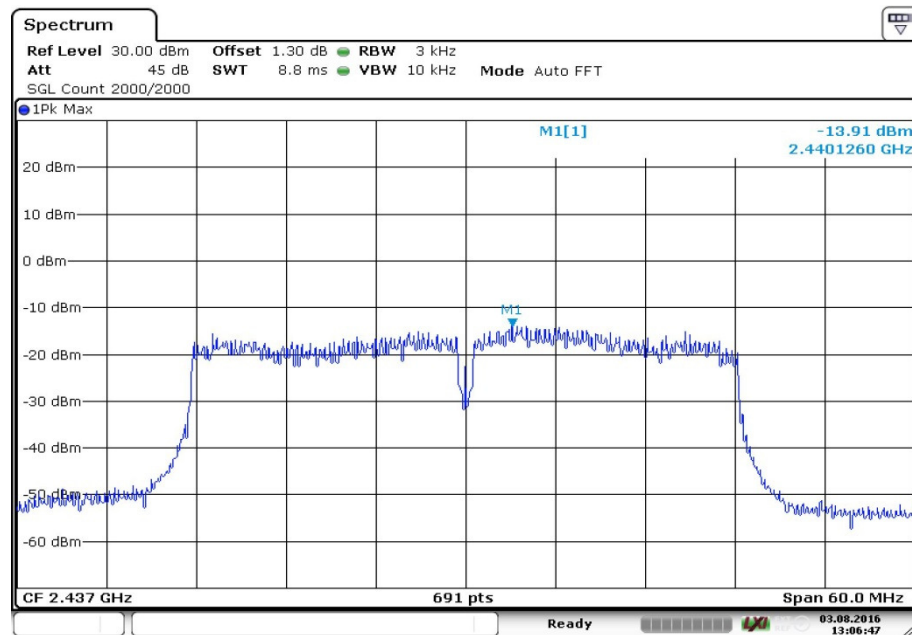
Date: 3.AUG.2016 11:05:09

Radio Technology = WLAN n 20 MHz, Operating Frequency = mid



Date: 3.AUG.2016 11:39:13

Radio Technology = WLAN n 40 MHz, Operating Frequency = high



Date: 3.AUG.2016 13:06:47

#### 4.11.5 TEST EQUIPMENT USED

R&S TS8997

## 4.12 SIMULTANEOUS TRANSMISSION - SPURIOUS RADIATED EMISSIONS

Standard **FCC Part 15 Subpart C**

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

### 4.12.1 TEST DESCRIPTION

Please see test description for the test case "Transmitter Spurious Radiated Emissions"

### 4.12.2 TEST REQUIREMENTS / LIMITS

#### **WLAN 2.4 GHz:**

Please see "Test Requirements / Limits" for the test case "Transmitter Spurious Radiated Emissions"

#### **Additional for NFC:**

FCC §15.225 (d) The field strength of any emissions appearing outside of the 13.110-14.010 MHz band shall not exceed the general radiated emission limits in §15.209.

### 4.12.3 TEST PROTOCOL

| Possible simultaneous operating modes according to applicant' description | Remark                                                                                                        |
|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| NFC + WLAN 2.4 GHz                                                        | Selected worst case operating mode: channel and mode with highest output power                                |
| NFC + BT                                                                  | Not part of this report, covered from worst case mode: NFC + BT + WLAN 5 GHz                                  |
| NFC + BT-LE                                                               | BT-LE covered from BT                                                                                         |
| NFC + WLAN 5 GHz                                                          | Not part of this report, covered from worst case mode: NFC + BT + WLAN 5 GHz                                  |
| NFC + BT + WLAN 5 GHz                                                     | Worst case operating mode, not part of this report, no intended operating mode, only possible with special SW |

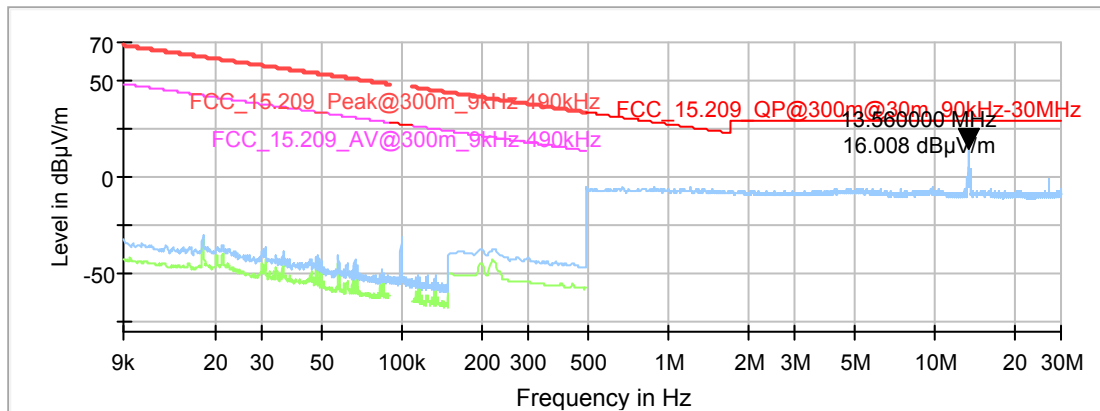
Ambient temperature: 21–25 °C  
 Air Pressure: 1002–1020 hPa  
 Humidity: 38–45 %  
 WLAN b-Mode; 20 MHz

| Mode / Set<br>EUT target<br>power                                             | Ch.<br>Center<br>Freq.<br>[MHz] | Spurious<br>Freq.<br>[MHz] | Spurious<br>Level<br>[dBμV/ m] | Detec-<br>tor | RBW<br>[kHz] | Limit<br>[dBμV/ m]                                   | Margin<br>to Limit<br>[dB] |
|-------------------------------------------------------------------------------|---------------------------------|----------------------------|--------------------------------|---------------|--------------|------------------------------------------------------|----------------------------|
| DSSS,<br>11Mbit /<br>18 dBm<br><br>NFC in<br>continuous<br>modulation<br>mode | 2437.0<br><br>13.56             | 0.009 to 30                | noise                          | - - -         | -            | (13.56 MHz<br>excluded)                              | > 20                       |
| DSSS,<br>11Mbit /<br>18 dBm<br><br>NFC in<br>continuous<br>modulation<br>mode | 2437.0<br><br>13.56             | 40.68                      | 35.1                           | QP            | 120          | 40                                                   | 4.9                        |
| DSSS,<br>11Mbit /<br>18 dBm<br><br>NFC in<br>continuous<br>modulation<br>mode | 2437.0<br><br>13.56             | 2483.50                    | 57.3                           | Peak          | 1000         | 74<br><br>(13.56 MHz<br>and<br>2437 MHz<br>excluded) | 16.7                       |

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

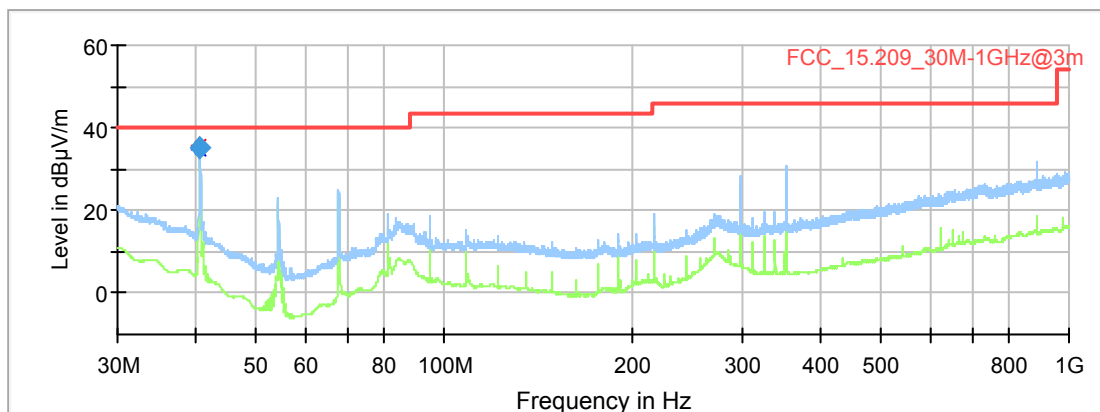


#### 4.12.4 MEASUREMENT PLOT (SHOWING THE HIGHEST VALUE, "WORST CASE")



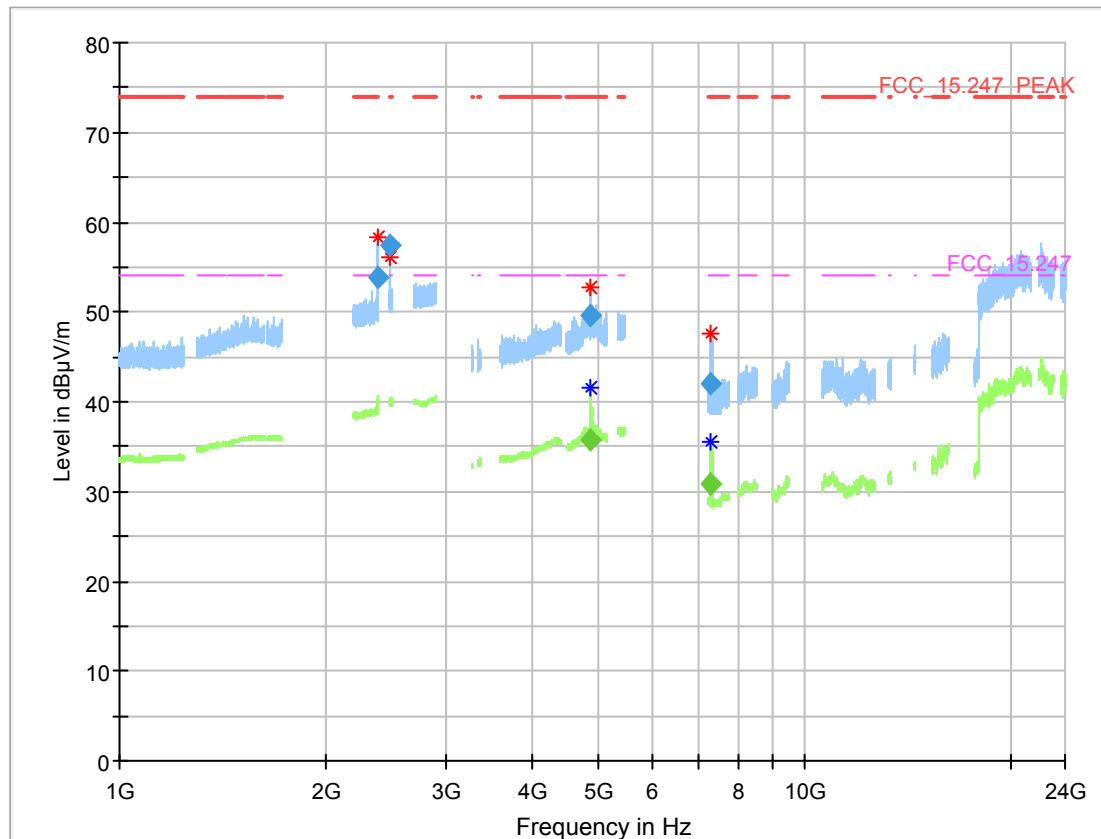
##### Final\_Result

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



##### Final\_Result

| Frequency (MHz) | QuasiPeak (dBμV/m) | Limit (dBμV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Corr. (dB) |
|-----------------|--------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|------------|
| 40.680000       | 35.14              | 40.00          | 4.86        | 1000.0          | 120.000         | 100.0       | V   | -139.0        | 13.3       |



#### Critical\_Freqs

| Frequency (MHz) | MaxPeak (dBµV/m) | Average (dBµV/m) | Limit (dBµV/m) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Elevation (deg) |
|-----------------|------------------|------------------|----------------|-------------|-----------------|-----------------|-------------|-----|---------------|-----------------|
| 2387.920000     | 53.94            | ---              | 74.00          | 20.06       | 1000.0          | 1000.000        | 150.0       | H   | -182.0        | 7.7             |
| 2483.500000     | 57.35            | ---              | 74.00          | 16.65       | 1000.0          | 1000.000        | 150.0       | H   | 148.0         | -2.0            |
| 4874.075000     | ---              | 35.77            | 54.00          | 18.23       | 1000.0          | 1000.000        | 150.0       | H   | 161.0         | -12.2           |
| 4877.487500     | 49.50            | ---              | 74.00          | 24.50       | 1000.0          | 1000.000        | 150.0       | H   | 147.0         | -2.0            |
| 7307.625000     | 41.93            | ---              | 74.00          | 32.07       | 1000.0          | 1000.000        | 150.0       | H   | 148.0         | 10.1            |
| 7312.875000     | ---              | 30.91            | 54.00          | 23.09       | 1000.0          | 1000.000        | 150.0       | H   | 161.0         | -6.1            |

#### 4.12.5 TEST EQUIPMENT USED

##### Radiated Emissions

## 5 TEST EQUIPMENT

### 1 Conducted Emissions Shielded Room 02

| Ref.No. | Device Name          | Description                                   | Manufacturer                      | Serial Number | Last Calibration | Calibration Due |
|---------|----------------------|-----------------------------------------------|-----------------------------------|---------------|------------------|-----------------|
|         | ESH 3-Z5             | Two-Line V-Network                            | Rohde & Schwarz                   | 828304/029    | 2015-03          | 2017-03         |
|         | ESR 7                | EMI Receiver / Spectrum Analyzer              | Rohde & Schwarz                   | 101424        | 2014-11          | 2016-11         |
|         | EP 1200/B, NA/B1     | Amplifier with integrated variable Oscillator | Spitzenberger & Spieß             | B6278         | 2015-07          | 2018-07         |
|         | ESIB 26              | Spectrum Analyzer                             | Rohde & Schwarz                   | 830482/004    | 2015-12          | 2017-12         |
|         | Opus10 THI (8152.00) | ThermoHygro Datalogger 02 (Environ)           | Lufft Mess- und Regeltechnik GmbH | 7489          | 2015-02          | 2017-02         |
|         | ESH 3-Z5             | Two-Line V-Network                            | Rohde & Schwarz                   | 829996/002    | 2015-03          | 2017-03         |
|         | Opus10 TPR (8253.00) | ThermoAirpressure Datalogger 13 (Environ)     | Lufft Mess- und Regeltechnik GmbH | 13936         | 2015-02          | 2017-02         |
|         | CMD 55               | Digital Radio Communication Tester            | Rohde & Schwarz                   | 831050/020    | 2014-12          | 2017-12         |
|         | Chroma 6404          | AC Power Source                               | Chroma ATE INC.                   | 64040001304   |                  |                 |
|         | CMW 500              | CMW 500                                       | Rohde & Schwarz                   | 107500        | 2015-07          | 2017-07         |

### 2 Radiated Emissions Lab to perform radiated emission tests

| Ref.No. | Device Name           | Description                                     | Manufacturer         | Serial Number      | Last Calibration | Calibration Due |
|---------|-----------------------|-------------------------------------------------|----------------------|--------------------|------------------|-----------------|
|         | 3160-09               | Standard Gain / Pyramidal Horn Antenna 26.5 GHz | EMCO Elektronik GmbH | 00083069           |                  |                 |
|         | WHKX 7.0/18G-8SS      | High Pass Filter                                | Wainwright           | 09                 |                  |                 |
|         | 5HC3500/1800 0-1.2-KK | High Pass Filter                                | Trilithic            | 200035008          |                  |                 |
|         | Fully Anechoic Room   | 8.80m x 4.60m x 4.05m (l x w x h)               | Albatross Projects   | P26971-647-001-PRB | 2015-07          | 2018-07         |

| Ref.No. | Device Name                   | Description                               | Manufacturer                      | Serial Number          | Last Calibration | Calibration Due |
|---------|-------------------------------|-------------------------------------------|-----------------------------------|------------------------|------------------|-----------------|
|         | AM 4.0                        | Antenna mast                              | Maturo GmbH                       | AM4.0/180/11920513     |                  |                 |
|         | ESR 7                         | EMI Receiver / Spectrum Analyzer          | Rohde & Schwarz                   | 101424                 | 2014-11          | 2016-11         |
|         | TT 1.5 WI                     | Turn Table                                | Maturo GmbH                       | -                      |                  |                 |
|         | Anechoic Chamber              | 10.58 x 6.38 x 6.00 m <sup>3</sup>        | Frankonia                         | none                   | 2014-01          | 2017-01         |
|         | ESIB 26                       | Spectrum Analyzer                         | Rohde & Schwarz                   | 830482/004             | 2015-12          | 2017-12         |
|         | Tilt device Maturo (Rohacell) | Antrieb TD1.5-10kg                        | Maturo GmbH                       | TD1.5-10kg/024/3790709 |                  |                 |
|         | 5HC2700/12750-1.5-KK          | High Pass Filter                          | Trilithic                         | 9942012                |                  |                 |
|         | AS 620 P                      | Antenna mast                              | HD GmbH                           | 620/37                 |                  |                 |
|         | 4HC1600/12750-1.5-KK          | High Pass Filter                          | Trilithic                         | 9942011                |                  |                 |
|         | ASP 1.2/1.8-10 kg             | Antenna Mast                              | Maturo GmbH                       | -                      |                  |                 |
|         | JS4-18002600-32-5P            | Broadband Amplifier 18 GHz - 26 GHz       | Miteq                             | 849785                 |                  |                 |
|         | JS4-00101800-35-5P            | Broadband Amplifier 30 MHz - 18 GHz       | Miteq                             | 896037                 |                  |                 |
|         | HL 562                        | Ultralog new biconicals                   | Rohde & Schwarz GmbH & Co. KG     | 830547/003             | 2015-06          | 2018-06         |
|         | Opus10 THI (8152.00)          | ThermoHygro Datalogger 12 (Environ)       | Lufft Mess- und Regeltechnik GmbH | 12482                  | 2015-03          | 2017-03         |
|         | JS4-00102600-42-5A            | Broadband Amplifier 30 MHz - 26 GHz       | Miteq                             | 619368                 |                  |                 |
|         | HFH2-Z2                       | Loop Antenna                              | Rohde & Schwarz GmbH & Co. KG     | 829324/006             | 2014-11          | 2017-11         |
|         | FSW 43                        | Spectrum Analyzer                         | Rohde & Schwarz                   | 103779                 | 2014-11          | 2016-11         |
|         | Opus10 TPR (8253.00)          | ThermoAirpressure Datalogger 13 (Environ) | Lufft Mess- und Regeltechnik GmbH | 13936                  | 2015-02          | 2017-02         |
|         | Chroma 6404                   | AC Power Source                           | Chroma ATE INC.                   | 64040001304            |                  |                 |

| Ref.No. | Device Name     | Description                                   | Manufacturer                  | Serial Number | Last Calibration | Calibration Due |
|---------|-----------------|-----------------------------------------------|-------------------------------|---------------|------------------|-----------------|
|         | 3160-10         | Standard Gain / Pyramidal Horn Antenna 40 GHz | EMCO Elektronik GmbH          | 00086675      |                  |                 |
|         | HL 562 Ultralog | Log.-per. Antenna                             | Rohde & Schwarz GmbH & Co. KG | 100609        | 2016-04          | 2019-04         |
|         | PAS 2.5 - 10 kg | Antenna Mast                                  | Maturo GmbH                   | -             |                  |                 |
|         | HF 907          | Double-ridged horn                            | Rohde & Schwarz GmbH & Co. KG | 102444        | 2015-05          | 2018-05         |

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| Ref.No. | Device Name          | Description                                | Manufacturer                      | Serial Number  | Last Calibration   | Calibration Due    |
|---------|----------------------|--------------------------------------------|-----------------------------------|----------------|--------------------|--------------------|
|         | OSP120               | Switching Unit with integrated power meter | Rohde & Schwarz GmbH & Co. KG     | 101158         | 2015-08            | 2016-08            |
|         | A8455-4              | 4 Way Power Divider (SMA)                  |                                   | -              |                    |                    |
|         | Fluke 177            | Digital Multimeter 03 (Multimeter)         | Fluke Europe B.V.                 | 86670383       | 2016-02            | 2018-02            |
|         | Opus10 THI (8152.00) | ThermoHygro Datalogger 03 (Environ)        | Lufft Mess- und Regeltechnik GmbH | 7482           | 2015-02            | 2017-02            |
|         | SMB100A              | Signal Generator 9 kHz - 6 GHz             | Rohde & Schwarz GmbH & Co. KG     | 107695         | 2014-06            | 2017-06            |
|         | VT 4002              | Climatic Chamber                           | Vötsch                            | 58566002150010 | 2016-03            | 2018-03            |
|         | FSV30                | Signal Analyzer 10 Hz - 30 GHz             | Rohde & Schwarz                   | 103005         | 2016-02            | 2018-02            |
|         | SMBV100A             | Vector Signal Generator 9 kHz - 6 GHz      | Rohde & Schwarz GmbH & Co. KG     | 259291         | 2013-08            | 2016-08            |
|         | 1515 / 93459         | Broadband Power Divider SMA (Aux)          | Weinschel Associates              | LN673          |                    |                    |
|         | Datum, Model: MFS    | Rubidium Frequency Standard                | Datum-Beverly                     | 5489/001       | 2015-06<br>2016-06 | 2016-06<br>2017-07 |

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

## 6 ANTENNA FACTORS, CABLE LOSS AND SAMPLE CALCULATIONS

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

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

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

#### Sample calculation

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

U = Receiver reading

LISN Insertion loss = Voltage Division Factor of LISN

Corr. = sum of single correction factors of used LISN, cables, switch units (if used)

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

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

| Frequency<br>MHz | AF<br>HFH-Z2)<br>dB (1/m) | Corr.<br>dB | cable<br>loss 1<br>(inside<br>chamber)<br>dB | cable<br>loss 2<br>(outside<br>chamber)<br>dB | cable<br>loss 3<br>(switch<br>unit)<br>dB | cable<br>loss 4<br>(to<br>receiver)<br>dB | distance<br>corr.<br>(-40 dB/<br>decade)<br>dB | d <sub>Limit</sub><br>(meas.<br>distance<br>(limit)<br>m | d <sub>used</sub><br>(meas.<br>distance<br>(used)<br>m |
|------------------|---------------------------|-------------|----------------------------------------------|-----------------------------------------------|-------------------------------------------|-------------------------------------------|------------------------------------------------|----------------------------------------------------------|--------------------------------------------------------|
| 0,009            | 20,50                     | -79,6       | 0,1                                          | 0,1                                           | 0,1                                       | 0,1                                       | -80                                            | 300                                                      | 3                                                      |
| 0,01             | 20,45                     | -79,6       | 0,1                                          | 0,1                                           | 0,1                                       | 0,1                                       | -80                                            | 300                                                      | 3                                                      |
| 0,015            | 20,37                     | -79,6       | 0,1                                          | 0,1                                           | 0,1                                       | 0,1                                       | -80                                            | 300                                                      | 3                                                      |
| 0,02             | 20,36                     | -79,6       | 0,1                                          | 0,1                                           | 0,1                                       | 0,1                                       | -80                                            | 300                                                      | 3                                                      |
| 0,025            | 20,38                     | -79,6       | 0,1                                          | 0,1                                           | 0,1                                       | 0,1                                       | -80                                            | 300                                                      | 3                                                      |
| 0,03             | 20,32                     | -79,6       | 0,1                                          | 0,1                                           | 0,1                                       | 0,1                                       | -80                                            | 300                                                      | 3                                                      |
| 0,05             | 20,35                     | -79,6       | 0,1                                          | 0,1                                           | 0,1                                       | 0,1                                       | -80                                            | 300                                                      | 3                                                      |
| 0,08             | 20,30                     | -79,6       | 0,1                                          | 0,1                                           | 0,1                                       | 0,1                                       | -80                                            | 300                                                      | 3                                                      |
| 0,1              | 20,20                     | -79,6       | 0,1                                          | 0,1                                           | 0,1                                       | 0,1                                       | -80                                            | 300                                                      | 3                                                      |
| 0,2              | 20,17                     | -79,6       | 0,1                                          | 0,1                                           | 0,1                                       | 0,1                                       | -80                                            | 300                                                      | 3                                                      |
| 0,3              | 20,14                     | -79,6       | 0,1                                          | 0,1                                           | 0,1                                       | 0,1                                       | -80                                            | 300                                                      | 3                                                      |
| 0,49             | 20,12                     | -79,6       | 0,1                                          | 0,1                                           | 0,1                                       | 0,1                                       | -80                                            | 300                                                      | 3                                                      |
| 0,490001         | 20,12                     | -39,6       | 0,1                                          | 0,1                                           | 0,1                                       | 0,1                                       | -40                                            | 30                                                       | 3                                                      |
| 0,5              | 20,11                     | -39,6       | 0,1                                          | 0,1                                           | 0,1                                       | 0,1                                       | -40                                            | 30                                                       | 3                                                      |
| 0,8              | 20,10                     | -39,6       | 0,1                                          | 0,1                                           | 0,1                                       | 0,1                                       | -40                                            | 30                                                       | 3                                                      |
| 1                | 20,09                     | -39,6       | 0,1                                          | 0,1                                           | 0,1                                       | 0,1                                       | -40                                            | 30                                                       | 3                                                      |
| 2                | 20,08                     | -39,6       | 0,1                                          | 0,1                                           | 0,1                                       | 0,1                                       | -40                                            | 30                                                       | 3                                                      |
| 3                | 20,06                     | -39,6       | 0,1                                          | 0,1                                           | 0,1                                       | 0,1                                       | -40                                            | 30                                                       | 3                                                      |
| 4                | 20,05                     | -39,5       | 0,2                                          | 0,1                                           | 0,1                                       | 0,1                                       | -40                                            | 30                                                       | 3                                                      |
| 5                | 20,05                     | -39,5       | 0,2                                          | 0,1                                           | 0,1                                       | 0,1                                       | -40                                            | 30                                                       | 3                                                      |
| 6                | 20,02                     | -39,5       | 0,2                                          | 0,1                                           | 0,1                                       | 0,1                                       | -40                                            | 30                                                       | 3                                                      |
| 8                | 19,95                     | -39,5       | 0,2                                          | 0,1                                           | 0,1                                       | 0,1                                       | -40                                            | 30                                                       | 3                                                      |
| 10               | 19,83                     | -39,4       | 0,2                                          | 0,1                                           | 0,2                                       | 0,1                                       | -40                                            | 30                                                       | 3                                                      |
| 12               | 19,71                     | -39,4       | 0,2                                          | 0,1                                           | 0,2                                       | 0,1                                       | -40                                            | 30                                                       | 3                                                      |
| 14               | 19,54                     | -39,4       | 0,2                                          | 0,1                                           | 0,2                                       | 0,1                                       | -40                                            | 30                                                       | 3                                                      |
| 16               | 19,53                     | -39,3       | 0,3                                          | 0,1                                           | 0,2                                       | 0,1                                       | -40                                            | 30                                                       | 3                                                      |
| 18               | 19,50                     | -39,3       | 0,3                                          | 0,1                                           | 0,2                                       | 0,1                                       | -40                                            | 30                                                       | 3                                                      |
| 20               | 19,57                     | -39,3       | 0,3                                          | 0,1                                           | 0,2                                       | 0,1                                       | -40                                            | 30                                                       | 3                                                      |
| 22               | 19,61                     | -39,3       | 0,3                                          | 0,1                                           | 0,2                                       | 0,1                                       | -40                                            | 30                                                       | 3                                                      |
| 24               | 19,61                     | -39,3       | 0,3                                          | 0,1                                           | 0,2                                       | 0,1                                       | -40                                            | 30                                                       | 3                                                      |
| 26               | 19,54                     | -39,3       | 0,3                                          | 0,1                                           | 0,2                                       | 0,1                                       | -40                                            | 30                                                       | 3                                                      |
| 28               | 19,46                     | -39,2       | 0,3                                          | 0,1                                           | 0,3                                       | 0,1                                       | -40                                            | 30                                                       | 3                                                      |
| 30               | 19,73                     | -39,1       | 0,4                                          | 0,1                                           | 0,3                                       | 0,1                                       | -40                                            | 30                                                       | 3                                                      |

### Sample calculation

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

U = Receiver reading

AF = Antenna factor

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

distance correction =  $-40 * \text{LOG} (d_{\text{Limit}} / d_{\text{used}})$

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

Table shows an extract of values

### 6.3 ANTENNA R&S HL562 (30 MHz – 1 GHz)

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

| Frequency | AF<br>R&S<br>HL562 | Corr. |
|-----------|--------------------|-------|
| MHz       | dB (1/m)           | dB    |
| 30        | 18,6               | 0,6   |
| 50        | 6,0                | 0,9   |
| 100       | 9,7                | 1,2   |
| 150       | 7,9                | 1,6   |
| 200       | 7,6                | 1,9   |
| 250       | 9,5                | 2,1   |
| 300       | 11,0               | 2,3   |
| 350       | 12,4               | 2,6   |
| 400       | 13,6               | 2,9   |
| 450       | 14,7               | 3,1   |
| 500       | 15,6               | 3,2   |
| 550       | 16,3               | 3,5   |
| 600       | 17,2               | 3,5   |
| 650       | 18,1               | 3,6   |
| 700       | 18,5               | 3,6   |
| 750       | 19,1               | 4,1   |
| 800       | 19,6               | 4,1   |
| 850       | 20,1               | 4,4   |
| 900       | 20,8               | 4,7   |
| 950       | 21,1               | 4,8   |
| 1000      | 21,6               | 4,9   |

| cable<br>loss 1<br>(inside<br>chamber) | cable<br>loss 2<br>(outside<br>chamber) | cable<br>loss 3<br>(switch<br>unit) | cable<br>loss 4<br>(to<br>receiver) | distance<br>corr.<br>(-20 dB/<br>decade) | $d_{\text{Limit}}$<br>(meas.<br>distance<br>(limit)) | $d_{\text{used}}$<br>(meas.<br>distance<br>(used)) |
|----------------------------------------|-----------------------------------------|-------------------------------------|-------------------------------------|------------------------------------------|------------------------------------------------------|----------------------------------------------------|
| dB                                     | dB                                      | dB                                  | dB                                  | dB                                       | m                                                    | m                                                  |
| 0,29                                   | 0,04                                    | 0,23                                | 0,02                                | 0,0                                      | 3                                                    | 3                                                  |
| 0,39                                   | 0,09                                    | 0,32                                | 0,08                                | 0,0                                      | 3                                                    | 3                                                  |
| 0,56                                   | 0,14                                    | 0,47                                | 0,08                                | 0,0                                      | 3                                                    | 3                                                  |
| 0,73                                   | 0,20                                    | 0,59                                | 0,12                                | 0,0                                      | 3                                                    | 3                                                  |
| 0,84                                   | 0,21                                    | 0,70                                | 0,11                                | 0,0                                      | 3                                                    | 3                                                  |
| 0,98                                   | 0,24                                    | 0,80                                | 0,13                                | 0,0                                      | 3                                                    | 3                                                  |
| 1,04                                   | 0,26                                    | 0,89                                | 0,15                                | 0,0                                      | 3                                                    | 3                                                  |
| 1,18                                   | 0,31                                    | 0,96                                | 0,13                                | 0,0                                      | 3                                                    | 3                                                  |
| 1,28                                   | 0,35                                    | 1,03                                | 0,19                                | 0,0                                      | 3                                                    | 3                                                  |
| 1,39                                   | 0,38                                    | 1,11                                | 0,22                                | 0,0                                      | 3                                                    | 3                                                  |
| 1,44                                   | 0,39                                    | 1,20                                | 0,19                                | 0,0                                      | 3                                                    | 3                                                  |
| 1,55                                   | 0,46                                    | 1,24                                | 0,23                                | 0,0                                      | 3                                                    | 3                                                  |
| 1,59                                   | 0,43                                    | 1,29                                | 0,23                                | 0,0                                      | 3                                                    | 3                                                  |
| 1,67                                   | 0,34                                    | 1,35                                | 0,22                                | 0,0                                      | 3                                                    | 3                                                  |
| 1,67                                   | 0,42                                    | 1,41                                | 0,15                                | 0,0                                      | 3                                                    | 3                                                  |
| 1,87                                   | 0,54                                    | 1,46                                | 0,25                                | 0,0                                      | 3                                                    | 3                                                  |
| 1,90                                   | 0,46                                    | 1,51                                | 0,25                                | 0,0                                      | 3                                                    | 3                                                  |
| 1,99                                   | 0,60                                    | 1,56                                | 0,27                                | 0,0                                      | 3                                                    | 3                                                  |
| 2,14                                   | 0,60                                    | 1,63                                | 0,29                                | 0,0                                      | 3                                                    | 3                                                  |
| 2,22                                   | 0,60                                    | 1,66                                | 0,33                                | 0,0                                      | 3                                                    | 3                                                  |
| 2,23                                   | 0,61                                    | 1,71                                | 0,30                                | 0,0                                      | 3                                                    | 3                                                  |

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

|      |      |      |
|------|------|------|
| 30   | 18,6 | -9,9 |
| 50   | 6,0  | -9,6 |
| 100  | 9,7  | -9,2 |
| 150  | 7,9  | -8,8 |
| 200  | 7,6  | -8,6 |
| 250  | 9,5  | -8,3 |
| 300  | 11,0 | -8,1 |
| 350  | 12,4 | -7,9 |
| 400  | 13,6 | -7,6 |
| 450  | 14,7 | -7,4 |
| 500  | 15,6 | -7,2 |
| 550  | 16,3 | -7,0 |
| 600  | 17,2 | -6,9 |
| 650  | 18,1 | -6,9 |
| 700  | 18,5 | -6,8 |
| 750  | 19,1 | -6,3 |
| 800  | 19,6 | -6,3 |
| 850  | 20,1 | -6,0 |
| 900  | 20,8 | -5,8 |
| 950  | 21,1 | -5,6 |
| 1000 | 21,6 | -5,6 |

|      |      |      |      |       |    |   |
|------|------|------|------|-------|----|---|
| 0,29 | 0,04 | 0,23 | 0,02 | -10,5 | 10 | 3 |
| 0,39 | 0,09 | 0,32 | 0,08 | -10,5 | 10 | 3 |
| 0,56 | 0,14 | 0,47 | 0,08 | -10,5 | 10 | 3 |
| 0,73 | 0,20 | 0,59 | 0,12 | -10,5 | 10 | 3 |
| 0,84 | 0,21 | 0,70 | 0,11 | -10,5 | 10 | 3 |
| 0,98 | 0,24 | 0,80 | 0,13 | -10,5 | 10 | 3 |
| 1,04 | 0,26 | 0,89 | 0,15 | -10,5 | 10 | 3 |
| 1,18 | 0,31 | 0,96 | 0,13 | -10,5 | 10 | 3 |
| 1,28 | 0,35 | 1,03 | 0,19 | -10,5 | 10 | 3 |
| 1,39 | 0,38 | 1,11 | 0,22 | -10,5 | 10 | 3 |
| 1,44 | 0,39 | 1,20 | 0,19 | -10,5 | 10 | 3 |
| 1,55 | 0,46 | 1,24 | 0,23 | -10,5 | 10 | 3 |
| 1,59 | 0,43 | 1,29 | 0,23 | -10,5 | 10 | 3 |
| 1,67 | 0,34 | 1,35 | 0,22 | -10,5 | 10 | 3 |
| 1,67 | 0,42 | 1,41 | 0,15 | -10,5 | 10 | 3 |
| 1,87 | 0,54 | 1,46 | 0,25 | -10,5 | 10 | 3 |
| 1,90 | 0,46 | 1,51 | 0,25 | -10,5 | 10 | 3 |
| 1,99 | 0,60 | 1,56 | 0,27 | -10,5 | 10 | 3 |
| 2,14 | 0,60 | 1,63 | 0,29 | -10,5 | 10 | 3 |
| 2,22 | 0,60 | 1,66 | 0,33 | -10,5 | 10 | 3 |
| 2,23 | 0,61 | 1,71 | 0,30 | -10,5 | 10 | 3 |

#### Sample calculation

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

U = Receiver reading

AF = Antenna factor

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

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

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

Tables show an extract of values.



#### 6.4 ANTENNA R&S HF907 (1 GHZ – 18 GHZ)

| Frequency | AF<br>R&S<br>HF907 | Corr. |
|-----------|--------------------|-------|
| MHz       | dB (1/m)           | dB    |
| 1000      | 24,4               | -19,4 |
| 2000      | 28,5               | -17,4 |
| 3000      | 31,0               | -16,1 |
| 4000      | 33,1               | -14,7 |
| 5000      | 34,4               | -13,7 |
| 6000      | 34,7               | -12,7 |
| 7000      | 35,6               | -11,0 |

| cable<br>loss 1<br>(relay +<br>cable<br>inside<br>chamber) | cable<br>loss 2<br>(outside<br>chamber) | cable<br>loss 3<br>(switch<br>unit,<br>atten-<br>uator &<br>pre-amp) | cable<br>loss 4 (to<br>receiver) |  |  |
|------------------------------------------------------------|-----------------------------------------|----------------------------------------------------------------------|----------------------------------|--|--|
| dB                                                         | dB                                      | dB                                                                   | dB                               |  |  |
| 0,99                                                       | 0,31                                    | -21,51                                                               | 0,79                             |  |  |
| 1,44                                                       | 0,44                                    | -20,63                                                               | 1,38                             |  |  |
| 1,87                                                       | 0,53                                    | -19,85                                                               | 1,33                             |  |  |
| 2,41                                                       | 0,67                                    | -19,13                                                               | 1,31                             |  |  |
| 2,78                                                       | 0,86                                    | -18,71                                                               | 1,40                             |  |  |
| 2,74                                                       | 0,90                                    | -17,83                                                               | 1,47                             |  |  |
| 2,82                                                       | 0,86                                    | -16,19                                                               | 1,46                             |  |  |

| Frequency | AF<br>R&S<br>HF907 | Corr. |
|-----------|--------------------|-------|
| MHz       | dB (1/m)           | dB    |
| 3000      | 31,0               | -23,4 |
| 4000      | 33,1               | -23,3 |
| 5000      | 34,4               | -21,7 |
| 6000      | 34,7               | -21,2 |
| 7000      | 35,6               | -19,8 |

| cable<br>loss 1<br>(relay<br>inside<br>chamber) | cable<br>loss 2<br>(inside<br>chamber) | cable<br>loss 3<br>(outside<br>chamber) | cable<br>loss 4<br>(switch<br>unit,<br>atten-<br>uator &<br>pre-amp) | cable<br>loss 5 (to<br>receiver) | used<br>for<br>FCC<br>15.247 |
|-------------------------------------------------|----------------------------------------|-----------------------------------------|----------------------------------------------------------------------|----------------------------------|------------------------------|
| dB                                              | dB                                     | dB                                      | dB                                                                   | dB                               |                              |
| 0,47                                            | 1,87                                   | 0,53                                    | -27,58                                                               | 1,33                             |                              |
| 0,56                                            | 2,41                                   | 0,67                                    | -28,23                                                               | 1,31                             |                              |
| 0,61                                            | 2,78                                   | 0,86                                    | -27,35                                                               | 1,40                             |                              |
| 0,58                                            | 2,74                                   | 0,90                                    | -26,89                                                               | 1,47                             |                              |
| 0,66                                            | 2,82                                   | 0,86                                    | -25,58                                                               | 1,46                             |                              |

| Frequency | AF<br>R&S<br>HF907 | Corr. |
|-----------|--------------------|-------|
| MHz       | dB (1/m)           | dB    |
| 7000      | 35,6               | -57,3 |
| 8000      | 36,3               | -56,3 |
| 9000      | 37,1               | -55,3 |
| 10000     | 37,5               | -56,2 |
| 11000     | 37,5               | -55,3 |
| 12000     | 37,6               | -53,7 |
| 13000     | 38,2               | -53,5 |
| 14000     | 39,9               | -56,3 |
| 15000     | 40,9               | -54,1 |
| 16000     | 41,3               | -54,1 |
| 17000     | 42,8               | -54,4 |
| 18000     | 44,2               | -54,7 |

| cable<br>loss 1<br>(relay<br>inside<br>chamber) | cable<br>loss 2<br>(High<br>Pass) | cable<br>loss 3<br>(pre-<br>amp) | cable<br>loss 4<br>(inside<br>chamber) | cable<br>loss 5<br>(outside<br>chamber) | cable<br>loss 6<br>(to<br>receiver) |
|-------------------------------------------------|-----------------------------------|----------------------------------|----------------------------------------|-----------------------------------------|-------------------------------------|
| dB                                              | dB                                | dB                               | dB                                     | dB                                      | dB                                  |
| 0,56                                            | 1,28                              | -62,72                           | 2,66                                   | 0,94                                    | 1,46                                |
| 0,69                                            | 0,71                              | -61,49                           | 2,84                                   | 1,00                                    | 1,53                                |
| 0,68                                            | 0,65                              | -60,80                           | 3,06                                   | 1,09                                    | 1,60                                |
| 0,70                                            | 0,54                              | -61,91                           | 3,28                                   | 1,20                                    | 1,67                                |
| 0,80                                            | 0,61                              | -61,40                           | 3,43                                   | 1,27                                    | 1,70                                |
| 0,84                                            | 0,42                              | -59,70                           | 3,53                                   | 1,26                                    | 1,73                                |
| 0,83                                            | 0,44                              | -59,81                           | 3,75                                   | 1,32                                    | 1,83                                |
| 0,91                                            | 0,53                              | -63,03                           | 3,91                                   | 1,40                                    | 1,77                                |
| 0,98                                            | 0,54                              | -61,05                           | 4,02                                   | 1,44                                    | 1,83                                |
| 1,23                                            | 0,49                              | -61,51                           | 4,17                                   | 1,51                                    | 1,85                                |
| 1,36                                            | 0,76                              | -62,36                           | 4,34                                   | 1,53                                    | 2,00                                |
| 1,70                                            | 0,53                              | -62,88                           | 4,41                                   | 1,55                                    | 1,91                                |

#### Sample calculation

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

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.

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

| Frequency | AF<br>EMCO<br>3160-09 | Corr. | cable<br>loss 1<br>(inside<br>chamber) | cable<br>loss 2<br>(pre-<br>amp) | cable<br>loss 3<br>(inside<br>chamber) | cable<br>loss 4<br>(switch<br>unit) | cable<br>loss 5<br>(to<br>receiver) |
|-----------|-----------------------|-------|----------------------------------------|----------------------------------|----------------------------------------|-------------------------------------|-------------------------------------|
| MHz       | dB (1/m)              | dB    | dB                                     | dB                               | dB                                     | dB                                  | dB                                  |
| 18000     | 40,2                  | -23,5 | 0,72                                   | -35,85                           | 6,20                                   | 2,81                                | 2,65                                |
| 18500     | 40,2                  | -23,2 | 0,69                                   | -35,71                           | 6,46                                   | 2,76                                | 2,59                                |
| 19000     | 40,2                  | -22,0 | 0,76                                   | -35,44                           | 6,69                                   | 3,15                                | 2,79                                |
| 19500     | 40,3                  | -21,3 | 0,74                                   | -35,07                           | 7,04                                   | 3,11                                | 2,91                                |
| 20000     | 40,3                  | -20,3 | 0,72                                   | -34,49                           | 7,30                                   | 3,07                                | 3,05                                |
| 20500     | 40,3                  | -19,9 | 0,78                                   | -34,46                           | 7,48                                   | 3,12                                | 3,15                                |
| 21000     | 40,3                  | -19,1 | 0,87                                   | -34,07                           | 7,61                                   | 3,20                                | 3,33                                |
| 21500     | 40,3                  | -19,1 | 0,90                                   | -33,96                           | 7,47                                   | 3,28                                | 3,19                                |
| 22000     | 40,3                  | -18,7 | 0,89                                   | -33,57                           | 7,34                                   | 3,35                                | 3,28                                |
| 22500     | 40,4                  | -19,0 | 0,87                                   | -33,66                           | 7,06                                   | 3,75                                | 2,94                                |
| 23000     | 40,4                  | -19,5 | 0,88                                   | -33,75                           | 6,92                                   | 3,77                                | 2,70                                |
| 23500     | 40,4                  | -19,3 | 0,90                                   | -33,35                           | 6,99                                   | 3,52                                | 2,66                                |
| 24000     | 40,4                  | -19,8 | 0,88                                   | -33,99                           | 6,88                                   | 3,88                                | 2,58                                |
| 24500     | 40,4                  | -19,5 | 0,91                                   | -33,89                           | 7,01                                   | 3,93                                | 2,51                                |
| 25000     | 40,4                  | -19,3 | 0,88                                   | -33,00                           | 6,72                                   | 3,96                                | 2,14                                |
| 25500     | 40,5                  | -20,4 | 0,89                                   | -34,07                           | 6,90                                   | 3,66                                | 2,22                                |
| 26000     | 40,5                  | -21,3 | 0,86                                   | -35,11                           | 7,02                                   | 3,69                                | 2,28                                |
| 26500     | 40,5                  | -21,1 | 0,90                                   | -35,20                           | 7,15                                   | 3,91                                | 2,36                                |

### Sample calculation

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

U = Receiver reading

AF = Antenna factor

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

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

Table shows an extract of values.

## 6.6 ANTENNA EMCO 3160-10 (26.5 GHz – 40 GHz)

| Frequency<br>GHz | AF<br>EMCO<br>3160-10<br>dB (1/m) | Corr.<br>dB | cable<br>loss 1<br>(inside<br>chamber)<br>dB | cable<br>loss 2<br>(outside<br>chamber)<br>dB | cable<br>loss 3<br>(switch<br>unit)<br>dB | cable<br>loss 4<br>(to<br>receiver)<br>dB | distance<br>corr.<br>(-20 dB/<br>decade)<br>dB | d <sub>Limit</sub><br>(meas.<br>distance<br>(limit)<br>m | d <sub>used</sub><br>(meas.<br>distance<br>(used)<br>m |
|------------------|-----------------------------------|-------------|----------------------------------------------|-----------------------------------------------|-------------------------------------------|-------------------------------------------|------------------------------------------------|----------------------------------------------------------|--------------------------------------------------------|
| 26,5             | 43,4                              | -11,2       | 4,4                                          |                                               |                                           |                                           | -15,6                                          | 3                                                        | 0,5                                                    |
| 27,0             | 43,4                              | -11,2       | 4,4                                          |                                               |                                           |                                           | -15,6                                          | 3                                                        | 0,5                                                    |
| 28,0             | 43,4                              | -11,1       | 4,5                                          |                                               |                                           |                                           | -15,6                                          | 3                                                        | 0,5                                                    |
| 29,0             | 43,5                              | -11,0       | 4,6                                          |                                               |                                           |                                           | -15,6                                          | 3                                                        | 0,5                                                    |
| 30,0             | 43,5                              | -10,9       | 4,7                                          |                                               |                                           |                                           | -15,6                                          | 3                                                        | 0,5                                                    |
| 31,0             | 43,5                              | -10,8       | 4,7                                          |                                               |                                           |                                           | -15,6                                          | 3                                                        | 0,5                                                    |
| 32,0             | 43,5                              | -10,7       | 4,8                                          |                                               |                                           |                                           | -15,6                                          | 3                                                        | 0,5                                                    |
| 33,0             | 43,6                              | -10,7       | 4,9                                          |                                               |                                           |                                           | -15,6                                          | 3                                                        | 0,5                                                    |
| 34,0             | 43,6                              | -10,6       | 5,0                                          |                                               |                                           |                                           | -15,6                                          | 3                                                        | 0,5                                                    |
| 35,0             | 43,6                              | -10,5       | 5,1                                          |                                               |                                           |                                           | -15,6                                          | 3                                                        | 0,5                                                    |
| 36,0             | 43,6                              | -10,4       | 5,1                                          |                                               |                                           |                                           | -15,6                                          | 3                                                        | 0,5                                                    |
| 37,0             | 43,7                              | -10,3       | 5,2                                          |                                               |                                           |                                           | -15,6                                          | 3                                                        | 0,5                                                    |
| 38,0             | 43,7                              | -10,2       | 5,3                                          |                                               |                                           |                                           | -15,6                                          | 3                                                        | 0,5                                                    |
| 39,0             | 43,7                              | -10,2       | 5,4                                          |                                               |                                           |                                           | -15,6                                          | 3                                                        | 0,5                                                    |
| 40,0             | 43,8                              | -10,1       | 5,5                                          |                                               |                                           |                                           | -15,6                                          | 3                                                        | 0,5                                                    |

### Sample calculation

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

U = Receiver reading

AF = Antenna factor

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

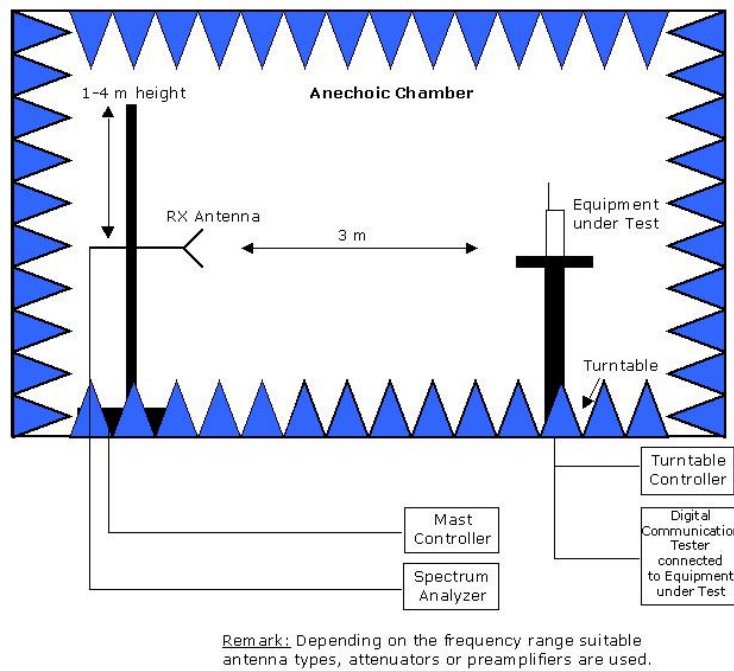
Linear interpolation will be used for frequencies in between the values in the table.

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

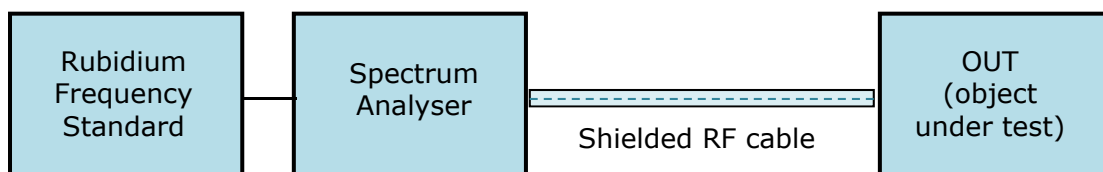
Linear interpolation will be used for frequencies in between the values in the table.

Table shows an extract of values.

## 7 SETUP DRAWINGS



**Drawing 1:** Setup in the anechoic chamber. For measurements below 1 GHz the ground was replaced by a conducting ground plane.



**Drawing 2:** Setup for conducted radio tests.

## 8 MEASUREMENT UNCERTAINTIES

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

## 9 PHOTO REPORT

Please see separate photo report.