

# InterLab<sup>®</sup>

## Final Report on NG 2.5 HMI

**Report Reference:** MDE\_BOSCH\_1407\_FCCa  
acc. Title 47 CFR chapter I part 15 subpart C  
FCC ID YBN-NG25HMI  
IC: 9595A-NG25HMI

**Date:** December 17, 2014

**Test Laboratory:**

7 layers AG  
Borsigstrasse 11  
40880 Ratingen  
Germany



**Note:**

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

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## 1 Administrative Data

### 1.1 Project Data

*Project Responsible:* Carsten Steinröder  
*Date Of Test Report:* 2014/12/04  
*Date of first test:* 2014/11/25  
*Date of last test:* 2014/12/04

### 1.2 Applicant Data

*Company Name:* Robert Bosch Car Multimedia GmbH  
*Street:* Robert-Bosch-Strasse 200  
*City:* 31139 Hildesheim  
*Country:* Germany  
*Contact Person:* Mr. Torsten Sahn  
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*Department:* Approval CM/QMM2  
*Phone:* +49 5121/ 49 - 4644  
*Fax:* +49 711/ 811 505-4644  
*E-Mail:* torsten.sahm@de.bosch.com

### 1.3 Test Laboratory Data

The following list shows all places and laboratories involved for test result generation:

#### 7 layers DE

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*Company Name :* 7 layers AG  
*Street :* Borsigstrasse 11  
*City :* 40880 Ratingen  
*Country :* Germany  
*Contact Person :* Mr. Michael Albert  
*Phone :* +49 2102 749 201  
*Fax :* +49 2102 749 444  
*E Mail :* Michael.Albert@7Layers.com

#### Laboratory Details

| <i>Lab ID</i> | <i>Identification</i>                    | <i>Responsible</i>                         | <i>Accreditation Info</i>               |
|---------------|--|--|---|
| Lab 1         | Radiated Emissions                       | Mr. Marco Kullik<br>Mr. Robert Machulec    | DAkKS-Registration no. D-PL-12140-01-01 |
| Lab 2         | Regulatory Bluetooth<br>RF Test Solution | Mr. Jimmy Chatheril<br>Mr. Sören Berentzen | DAkKS-Registration no. D-PL-12140-01-01 |

### 1.4 Signature of the Testing Responsible



Carsten Steinröder  
 responsible for tests performed in: Lab 1, Lab 2



7 layers AG, Borsigstr. 11  
 40880 Ratingen, Germany  
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### 1.5 Signature of the Accreditation Responsible



Accreditation scope responsible person  
 responsible for Lab 1, Lab 2

## 2 Test Object Data

### 2.1 General OUT Description

The following section lists all OUTs (Object's Under Test) involved during testing.

#### OUT: NG 2.5 HMI

**Manufacturer:**

Company Name: Please see applicant data

Contact Person: -

**Parameter List:**

| Parameter name       | Value      |
|----------------------|------------|
| Antenna Gain         | 1.6 (dBi)  |
| DC Power Supply      | 12 (V)     |
| highest channel (BT) | 2480 (MHz) |
| lowest channel (BT)  | 2402 (MHz) |
| mid channel (BT)     | 2441 (MHz) |

## 2.2 Detailed Description of OUT Samples

### **Sample : aa01**

|                           |                  |                     |       |
|---------------------------|------------------|---------------------|-------|
| <i>OUT Identifier</i>     | NG 2.5 HMI       |                     |       |
| <i>Sample Description</i> | conducted sample |                     |       |
| <i>Serial No.</i>         | 6114293A1000016X |                     |       |
| <i>HW Status</i>          | DSB5.1           |                     |       |
| <i>SW Status</i>          | 14.6A002         |                     |       |
| <i>Nominal Voltage</i>    | 12 V             | <i>Normal Temp.</i> | 20 °C |

### **Parameter List:**

| <i>Parameter Description</i>      | <i>Value</i> |
|-----------------------------------|--------------|
| <b>Parameter for Scope FCC_v2</b> |              |
| Antenna Gain                      | 1.6 (dBi)    |
| Frequency_high                    | 2480 (MHz)   |
| Frequency_low                     | 2402 (MHz)   |
| Frequency_mid                     | 2441 (MHz)   |

### **Sample : ac01**

|                           |                  |                     |       |
|---------------------------|------------------|---------------------|-------|
| <i>OUT Identifier</i>     | NG 2.5 HMI       |                     |       |
| <i>Sample Description</i> | radiated sample  |                     |       |
| <i>Serial No.</i>         | 6114293A1000051X |                     |       |
| <i>HW Status</i>          | DSB5.1           |                     |       |
| <i>SW Status</i>          | 14.6A002         |                     |       |
| <i>Nominal Voltage</i>    | 12 V             | <i>Normal Temp.</i> | 20 °C |

### **Parameter List:**

| <i>Parameter Description</i>      | <i>Value</i> |
|-----------------------------------|--------------|
| <b>Parameter for Scope FCC_v2</b> |              |
| Antenna Gain                      | 1.6 (dBi)    |
| Frequency_high                    | 2480 (MHz)   |
| Frequency_low                     | 2402 (MHz)   |
| Frequency_mid                     | 2441 (MHz)   |

## 2.3 OUT Features

### Features for OUT: NG 2.5 HMI

| <i>Designation</i>                | <i>Description</i>   | <i>Allowed Values</i> | <i>Supported Value(s)</i> |
|-----------------------------------|--|-----------------------|---------------------------|
| <b>Features for scope: FCC_v2</b> |  |                       |                           |
| BT                                | EUT supports Bluetooth data rate of 1 Mbps with GFSK modulation in the band 2400 MHz - 2483.5 MHz                    |                       |                           |
| DC                                | The OUT is powered by or connected to DC   |                       |                           |
| EDR2                              | EUT supports Bluetooth using data rate of 2 Mbps with PI/4 DQPSK modulation in the band 2400 MHz - 2483.5 MHz        |                       |                           |
| EDR3                              | EUT supports Bluetooth using data rate of 3 Mbps with 8DPSK modulation in the band 2400 MHz - 2483.5 MHz             |                       |                           |
| Iant                              | Integral Antenna: permanent fixed antenna, which may be built-in, designed as an indispensable part of the equipment |                       |                           |
| TantC                             | temporary antenna connector, which may be only built-in for testing, designed as an example part of the equipment    |                       |                           |

## 2.4 Auxiliary Equipment

| <i>AE No.</i> | <i>Type Designation</i> | <i>Serial No.</i> | <i>HW Status</i> | <i>SW Status</i> | <i>Description</i>            |
|---------------|-------------------------|-------------------|------------------|------------------|-------------------------------|
| AE 4          |                         |                   |                  |                  | Patch-Cable Cat.6 (1m)        |
| AE 3          |                         |                   |                  |                  | USB 2.0 Adapter               |
| AE 1          | DUB-E100                |                   |                  |                  | D-Link USB - Ethernet Adapter |
| AE 2          | DUB-E100                |                   |                  |                  | D-Link USB - Ethernet Adapter |

## 2.5 Setups used for Testing

For each setup a relation is given to determine if and which samples and auxiliary equipment is used. The left side list all OUT samples and the right side lists all auxiliary equipment for the given setup.

| <i>Setup No.</i>                   | <i>List of OUT samples</i> |                           | <i>List of auxiliary equipment</i> |                               |
|------------------------------------|----------------------------|---------------------------|------------------------------------|-------------------------------|
|                                    | <i>Sample No.</i>          | <i>Sample Description</i> | <i>AE No.</i>                      | <i>AE Description</i>         |
| <b>aa01_cond (conducted setup)</b> |                            |                           |                                    |                               |
|                                    | <i>Sample: aa01</i>        | conducted sample          | AE 4                               | Patch-Cable Cat.6 (1m)        |
|                                    |                            |                           | AE 3                               | USB 2.0 Adapter               |
|                                    |                            |                           | AE 1                               | D-Link USB - Ethernet Adapter |
|                                    |                            |                           | AE 2                               | D-Link USB - Ethernet Adapter |
| <b>ac01_rad (radiated setup)</b>   |                            |                           |                                    |                               |
|                                    | <i>Sample: ac01</i>        | radiated sample           | AE 4                               | Patch-Cable Cat.6 (1m)        |
|                                    |                            |                           | AE 3                               | USB 2.0 Adapter               |
|                                    |                            |                           | AE 1                               | D-Link USB - Ethernet Adapter |
|                                    |                            |                           | AE 2                               | D-Link USB - Ethernet Adapter |

### 3 Results

#### 3.1 General

**Documentation of tested devices:**

Available at the test laboratory.

**Interpretation of the test results:**

The results of the inspection are described on the following pages, where 'Conformity' or 'Passed' means that the certification criteria were verified and that the tested device is conform to the applied standard.

In cases where 'Declaration' is printed, the required documents are available in the manufacturers product documentation.

In cases where 'not applicable' is printed, the test case requirements are not relevant to the specific equipment implementation.

**Note:**

1) The laboratory environmental conditions are available and recorded in the Interlab System.

2) Special Software for testing:  
 The OUT was connected to a Laptop via Serial/USB connection to set the test modes.  
 The OUT could be set into Bluetooth Test Modes by using a terminal program.  
 The specific test modes could be set and controlled by the signalling unit "CBT" by Rohde&Schwarz over the air.  
 The OUT was disconnected from the Laptop during testing.

#### 3.2 List of the Applicable Body

(Body for Scope: FCC\_v2)

| <i>Designation</i>                           | <i>Description</i>  |
|--|---|
| FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES | Subpart C - Intentional Radiators; 15.247 Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz. |

#### 3.3 List of Test Specification

|                            |   |
|----------------------------|---|
| <i>Test Specification:</i> | <b>FCC part 2 and 15</b>  |
| <i>Version</i>             | 10-1-13 Edition   |
| <i>Title:</i>              | PART 2 - GENERAL RULES AND REGULATIONS<br>PART 15 - RADIO FREQUENCY DEVICES |

### 3.4 Summary

| <i>Test Case Identifier / Name<br/>Test (condition)</i>  | <i>Result</i> | <i>Date of Test</i> | <i>Lab<br/>Ref.</i> | <i>Setup</i> |
|--|---------------|---------------------|---------------------|--------------|
| <b>15c.2 Spurious radiated emissions §15.247 (d), §15.35 (b), §15.209</b>                          |               |                     |                     |              |
| 15c.2; Frequency = 2402 - 2480, Mode = BT transmit using GFSK/PSK Modulation, Maximum Output Power | Passed        | 2014/12/01          | Lab 1               | ac01_rad     |
| <b>15c.3 Occupied bandwidth §15.247 (a) (1)</b>  |               |                     |                     |              |
| 15c.3; Occupied Bandwidth Summary  | Passed        | 2014/11/25          | Lab 2               | aa01_cond    |
| <b>15c.4 Peak power output §15.247 (b) (1)</b>   |               |                     |                     |              |
| 15c.4; Peak power output Summary   | Passed        | 2014/11/25          | Lab 2               | aa01_cond    |
| <b>15c.5 Spurious RF conducted emissions §15.247 (d)</b>   |               |                     |                     |              |
| 15c.5; = BT transmit mode: Low/Mid/High Frequency  | Passed        | 2014/11/25          | Lab 2               | aa01_cond    |
| <b>15c.6 Band edge compliance §15.247 (d)</b>  |               |                     |                     |              |
| 15c.6; Band edge compliance Summary  | Passed        | 2014/12/04          | Lab 2               | aa01_cond    |
|  | Passed        | 2014/12/01          | Lab 1               | ac01_rad     |
| <b>15c.7 Dwell time §15.247 (a) (1) (iii)</b>  |               |                     |                     |              |
| 15c.7; Dwell time Summary  | Passed        | 2014/11/25          | Lab 2               | aa01_cond    |
| <b>15c.8 Channel separation §15.247 (a) (1)</b>  |               |                     |                     |              |
| 15c.8; Channel separation Summary  | Passed        | 2014/11/25          | Lab 2               | aa01_cond    |
| <b>15c.9 Number of hopping frequencies §15.247 (a) (1) (iii)</b>                                   |               |                     |                     |              |
| 15c.9; Number of hopping frequencies Summary   | Passed        | 2014/11/25          | Lab 2               | aa01_cond    |

### 3.5 Detailed Results

#### 3.5.1 15c.2 Spurious radiated emissions §15.247 (d), §15.35 (b), §15.209

**Test: 15c.2; Frequency = 2402 - 2480, Mode = BT transmit using GFSK/PSK Modulation, Maximum Output Power**

|                            |  |
|----------------------------|--|
| <i>Result:</i>             | Passed                                       |
| <i>Setup No.:</i>          | ac01_rad                                     |
| <i>Date of Test:</i>       | 2014/12/01 10:11                             |
| <i>Body:</i>               | FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES |
| <i>Test Specification:</i> | FCC part 2 and 15                            |



**Detailed Results:**

**Frequency range 9 kHz - 1 GHz**

| Modulation | TX Frequency (MHz) | Ant. Polar. | Limit QPK [dBµV] | Frequency [MHz] | Corrected value QPK [dBµV] | Margin QPK [dB] | Result |
|------------|--------------------|-------------|------------------|-----------------|----------------------------|-----------------|--------|
| FSK        | 2402               | Ver + Hor   | 46               | 260             | 37.43                      | 8.57            | Passed |
| FSK        | 2402               | Ver + Hor   | 46               | 405             | 38.04                      | 7.96            | Passed |
| FSK        | 2402               | Ver + Hor   | 46               | 409             | 41.13                      | 4.87            | Passed |
| FSK        | 2441               | Ver + Hor   | 46               | 266             | 40.10                      | 5.90            | Passed |
| FSK        | 2441               | Ver + Hor   | 46               | 405             | 39.83                      | 6.17            | Passed |
| FSK        | 2441               | Ver + Hor   | 46               | 409             | 40.76                      | 5.24            | Passed |
| FSK        | 2480               | Ver + Hor   | 46               | 260             | 37.55                      | 8.45            | Passed |
| FSK        | 2480               | Ver + Hor   | 46               | 266             | 36.49                      | 9.51            | Passed |
| FSK        | 2480               | Ver + Hor   | 46               | 409             | 36.58                      | 9.42            | Passed |

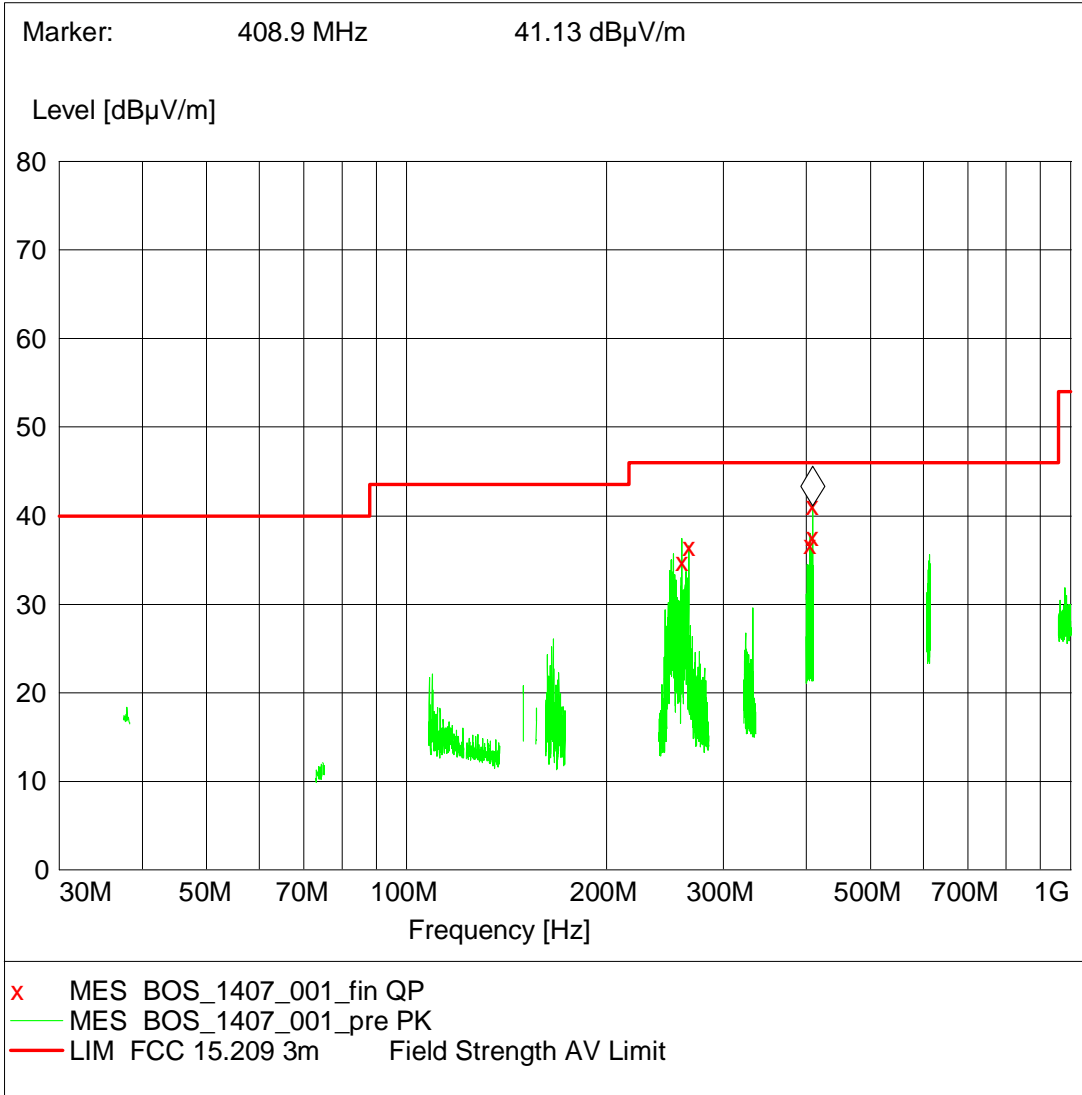
**Frequency range 1 GHz - 25 GHz**

| Modulation | TX Frequency (MHz) | Ant. Polar. | Limit PK [dBµV] | Limit AV [dBµV] | Frequency [MHz] | Corrected value PK [dBµV] | Corrected value AV [dBµV] | Margin PK [dB] | Margin AV [dB] | Result |
|------------|--------------------|-------------|-----------------|-----------------|-----------------|---------------------------|---------------------------|----------------|----------------|--------|
| FSK        | 2402               | Ver + Hor   | 74              | 54              | 1198            | 50.18                     | 43.85                     | 23.82          | 10.15          | Passed |
| FSK        | 2402               | Ver + Hor   | 74              | 54              | 2376            | 49.33                     | 39.90                     | 24.67          | 14.10          | Passed |
| FSK        | 2402               | Ver + Hor   | 74              | 54              | 4834            | 45.97                     | 28.80                     | 28.03          | 25.20          | Passed |
| FSK        | 2441               | Ver + Hor   | 74              | 54              | 1198            | 48.39                     | 40.73                     | 25.61          | 13.27          | Passed |
| FSK        | 2441               | Ver + Hor   | 74              | 54              | 2384            | 59.49                     | 39.76                     | 14.51          | 14.24          | Passed |
| FSK        | 2441               | Ver + Hor   | 74              | 54              | 2485            | 66.23                     | 37.64                     | 7.77           | 16.36          | Passed |
| FSK        | 2441               | Ver + Hor   | 74              | 54              | 4914            | 41.39                     | 25.99                     | 32.61          | 28.01          | Passed |
| FSK        | 2480               | Ver + Hor   | 74              | 54              | 2350            | 56.35                     | 39.76                     | 17.65          | 14.24          | Passed |
| PSK        | 2402               | Ver + Hor   | 74              | 54              | 2363            | 57.02                     | 38.64                     | 16.98          | 15.36          | Passed |
| PSK        | 2402               | Ver + Hor   | 74              | 54              | 2379            | 56.63                     | 35.64                     | 17.37          | 18.36          | Passed |
| PSK        | 2402               | Ver + Hor   | 74              | 54              | 2494            | 55.38                     | 35.30                     | 18.62          | 18.70          | Passed |
| PSK        | 2441               | Ver + Hor   | 74              | 54              | 2344            | 58.47                     | 35.92                     | 15.53          | 18.08          | Passed |
| PSK        | 2441               | Ver + Hor   | 74              | 54              | 2349            | 58.46                     | 35.80                     | 15.54          | 18.20          | Passed |
| PSK        | 2441               | Ver + Hor   | 74              | 54              | 2350            | 59.09                     | 35.58                     | 14.91          | 18.42          | Passed |
| PSK        | 2480               | Ver + Hor   | 74              | 54              | 2339            | 59.74                     | 36.25                     | 14.26          | 17.75          | Passed |
| PSK        | 2480               | Ver + Hor   | 74              | 54              | 2344            | 59.35                     | 36.14                     | 14.65          | 17.86          | Passed |
| PSK        | 2480               | Ver + Hor   | 74              | 54              | 2361            | 56.00                     | 35.51                     | 18.00          | 18.49          | Passed |

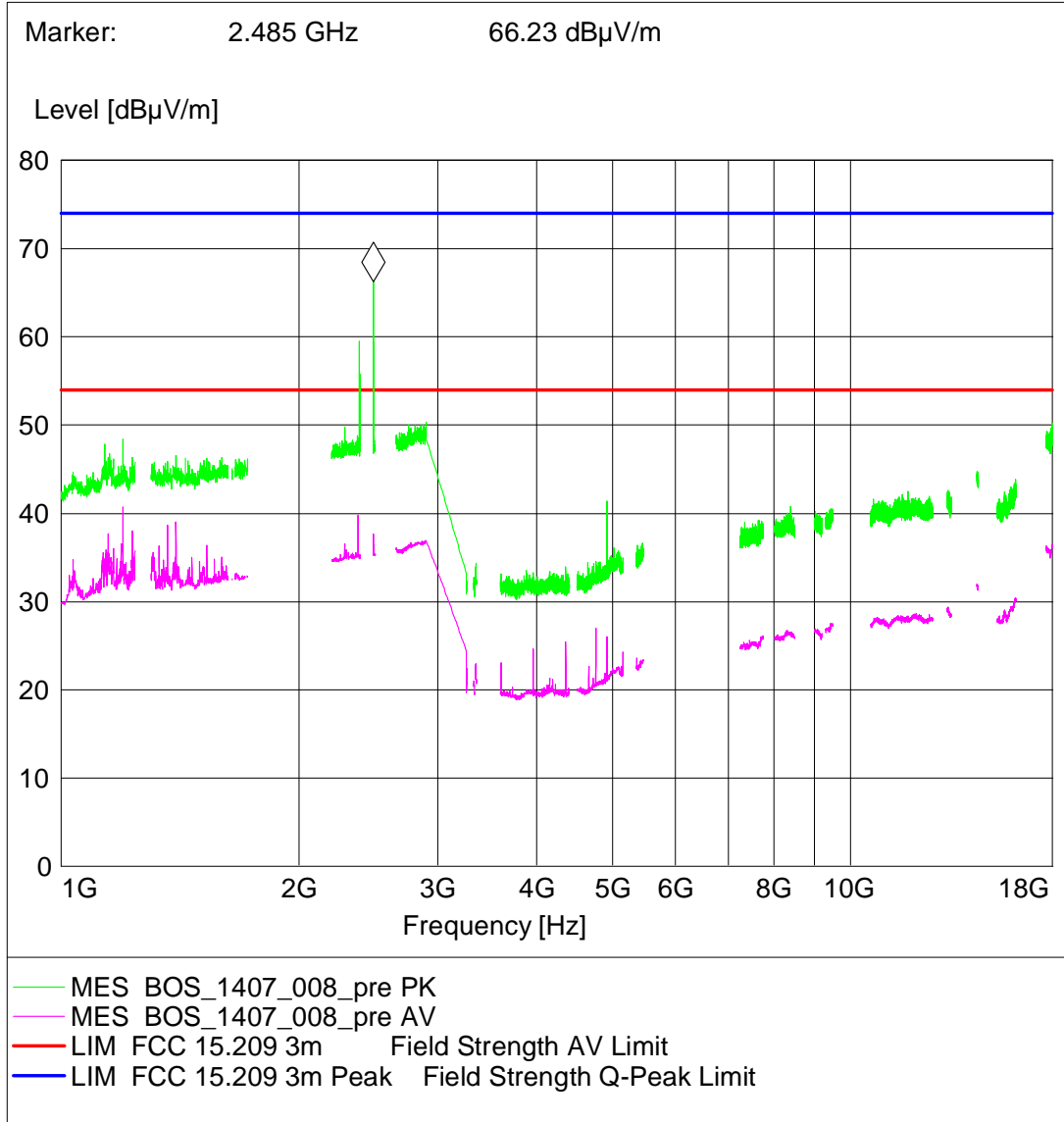
Remark 1: No (further) spurious emissions in the range 20 dB below the limit found.

Remark 2: For PSK modulation, the measurement was performed from 1 GHz up to 8 GHz because no significant spurious emissions were found outside this frequency range in GFSK modes.

WORST CASE PLOT (Frequency range 9 kHz - 1 GHz)



WORST CASE PLOT (Frequency range 1 GHz - 25 GHz)



### 3.5.2 15c.3 Occupied bandwidth §15.247 (a) (1)

#### Test: 15c.3; Occupeid Bandwidth Summary

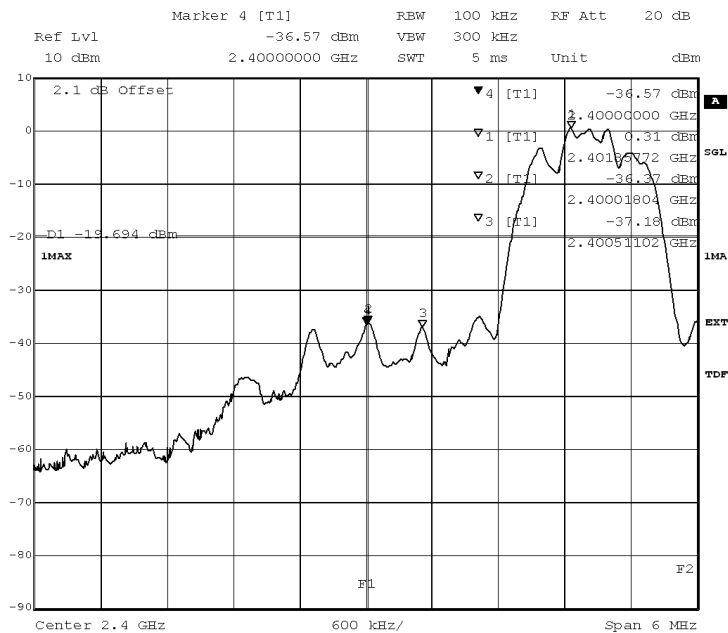
Result: Passed  
 Setup No.: aa01\_cond  
 Date of Test: 2014/11/25 11:27  
 Body: FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES  
 Test Specification: FCC part 2 and 15

#### Detailed Results:

Method = Conducted

##### non-hopping mode

| Modulation | Frequency MHz | Measured value dBm | Reference value dBm | Limit dBm | Margin to limit dB |
|------------|---------------|--------------------|---------------------|-----------|--------------------|
| GFSK       | 2400          | -46.83             | -0.88               | -20.88    | 25.95              |
| 4DQPSK     | 2400          | -36.69             | 0.28                | -19.72    | 16.97              |
| 8DPSK      | 2400          | -36.57             | 0.31                | -19.69    | 16.88              |
| GFSK       | 2483.5        | -61.30             | -0.23               | -20.23    | 41.07              |
| 4DQPSK     | 2483.5        | -62.88             | 1.21                | -18.79    | 44.09              |
| 8DPSK      | 2483.5        | -61.30             | -0.23               | -20.23    | 41.07              |



Title: Band Edge Compliance  
 Comment A: CH B: 2402 MHz  
 Date: 25.NOV.2014 08:49:36

### 3.5.3 15c.4 Peak power output §15.247 (b) (1)

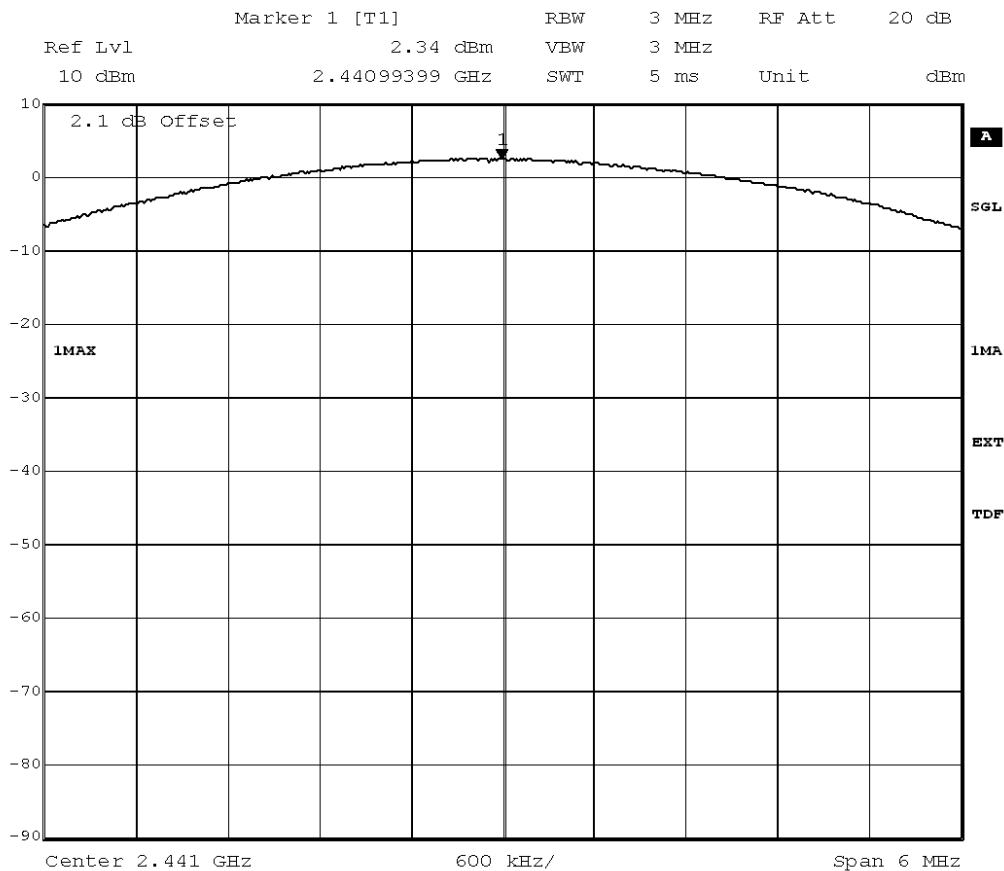
#### Test: 15c.4; Peak power output Summary

|                            |  |
|----------------------------|--|
| <i>Result:</i>             | Passed                                       |
| <i>Setup No.:</i>          | aa01_cond                                    |
| <i>Date of Test:</i>       | 2014/11/25 11:37                             |
| <i>Body:</i>               | FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES |
| <i>Test Specification:</i> | FCC part 2 and 15                            |

**Detailed Results:**

|                       |            | Conducted Transmitter Power |                   |                    |                   |                    |                   |
|-----------------------|------------|-----------------------------|-------------------|--------------------|-------------------|--------------------|-------------------|
| Antenna Gain: 1.6 dBi |            | 2402 MHz                    |                   | 2441 MHz           |                   | 2480 MHz           |                   |
| Modulation            | Conditions | Output Power (dBm)          | Output Power (mW) | Output Power (dBm) | Output Power (mW) | Output Power (dBm) | Output Power (mW) |
| GFSK                  | TN, VN     | -0.55                       | 0.88              | 0.14               | 1.03              | -0.02              | 1.00              |
| $\pi/4$ DQPSK         | TN, VN     | 1.42                        | 1.39              | 2.29               | 1.69              | 2.29               | 1.69              |
| 8-DPSK                | TN, VN     | 1.50                        | 1.41              | 2.34               | 1.71              | 2.28               | 1.69              |

|  |             |            |             |           |
|--|-------------|------------|-------------|-----------|
| <b>Max Conducted Output Power (FSK Modulation)</b> | <b>0.14</b> | <b>dBm</b> | <b>1.03</b> | <b>mW</b> |
| <b>Max Conducted Output Power (PSK Modulation)</b> | <b>2.34</b> | <b>dBm</b> | <b>1.71</b> | <b>mW</b> |



Title: Peak outputpower Power  
 Comment A: CH M: 2441 MHz  
 Date: 25.NOV.2014 10:13:36

### 3.5.4 15c.5 Spurious RF conducted emissions §15.247 (d)

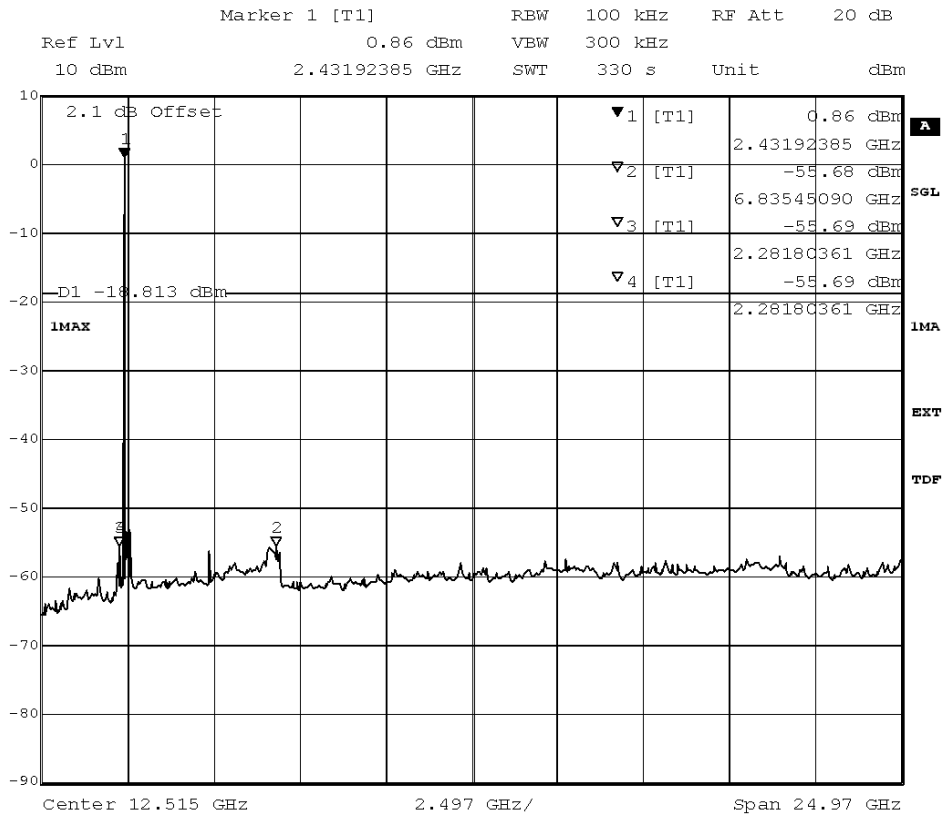
**Test: 15c.5; = BT transmit mode: Low/Mid/High Frequency**

|                            |  |
|----------------------------|--|
| <i>Result:</i>             | Passed                                       |
| <i>Setup No.:</i>          | aa01_cond                                    |
| <i>Date of Test:</i>       | 2014/11/25 12:43                             |
| <i>Body:</i>               | FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES |
| <i>Test Specification:</i> | FCC part 2 and 15                            |

**Detailed Results:**

| Mode / Channel | Frequency of emission MHz | Measured value dBm | Reference value dBm | Limit dBm | Margin to limit dB |
|----------------|---------------------------|--------------------|---------------------|-----------|--------------------|
| GFSK / 2402    | -                         |                    | -0.91               |           | None found         |
| GFSK / 2441    | -                         |                    | -0.18               |           | None found         |
| GFSK / 2480    | -                         |                    | -0.33               |           | None found         |
| 4 DQPSK / 2402 | -                         |                    | 0.10                |           | None found         |
| 4 DQPSK / 2441 | -                         |                    | 0.86                |           | None found         |
| 4 DQPSK / 2480 | -                         |                    | 1.22                |           | None found         |
| 8DPSK / 2402   | -                         |                    | 0.25                |           | None found         |
| 8DPSK / 2441   | -                         |                    | 1.06                |           | None found         |
| 8DPSK / 2480   | -                         |                    | 0.98                |           | None found         |

\* No further peaks found within 20 dB of the limit line.



Title: spurious emissions  
 Comment A: CH M: 2441 MHz  
 Date: 25.NOV.2014 09:53:06



### 3.5.5 15c.6 Band edge compliance §15.247 (d)

#### Test1: 15c.6; Band edge compliance Summary

Result: Passed  
 Setup No.: ac01\_rad  
 Date of Test: 2014/12/01 10:33  
 Body: FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES  
 Test Specification: FCC part 2 and 15

#### Detailed Results: Method = Radiated

| Modulation | TX on    | Ant. Polar. | Limit PK [dBµV] | Limit AV [dBµV] | Frequency [MHz] | Corrected value PK [dBµV] | Corrected value AV [dBµV] | Margin PK [dB] | Margin AV [dB] | Result |
|------------|----------|-------------|-----------------|-----------------|-----------------|---------------------------|---------------------------|----------------|----------------|--------|
| GFSK       | 2480 MHz | Ver + Hor   | 74              | 54              | 2483.5          | 48.05                     | 35.58                     | 25.95          | 18.42          | Passed |
| PI/4 DQPSK | 2480 MHz | Ver + Hor   | 74              | 54              | 2483.5          | 47.39                     | 35.47                     | 26.61          | 18.53          | Passed |
| 8DPSK      | 2480 MHz | Ver + Hor   | 74              | 54              | 2483.5          | 47.91                     | 35.47                     | 26.09          | 18.53          | Passed |

**Test1: 15c.6; Band edge compliance Summary**

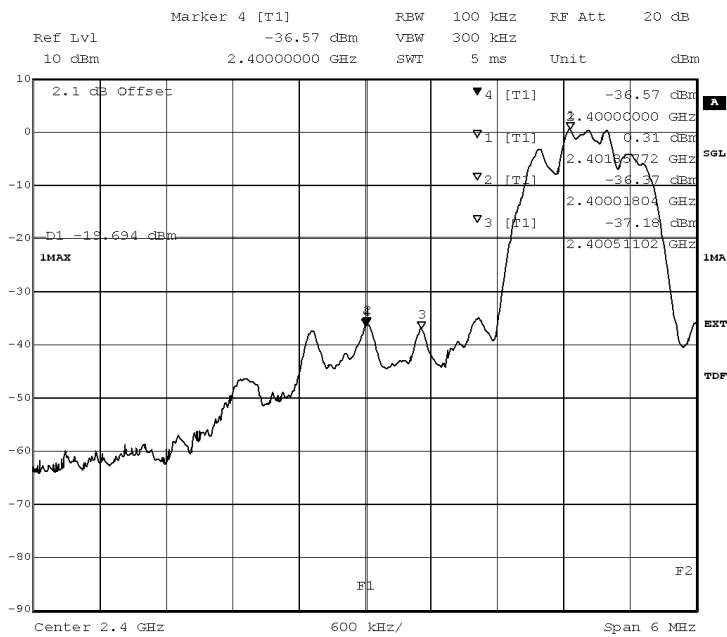
|                            |  |
|----------------------------|--|
| <i>Result:</i>             | Passed                                       |
| <i>Setup No.:</i>          | aa01_cond                                    |
| <i>Date of Test:</i>       | 2014/12/04 12:46                             |
| <i>Body:</i>               | FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES |
| <i>Test Specification:</i> | FCC part 2 and 15                            |

**Detailed Results:**

Method = Conducted

non-hopping mode

| Modulation | Frequency MHz | Measured value dBm | Reference value dBm | Limit dBm | Margin to limit dB |
|------------|---------------|--------------------|---------------------|-----------|--------------------|
| GFSK       | 2400          | -46.83             | -0.88               | -20.88    | 25.95              |
| 4DQPSK     | 2400          | -36.69             | 0.28                | -19.72    | 16.97              |
| 8DPSK      | 2400          | -36.57             | 0.31                | -19.69    | 16.88              |
| GFSK       | 2483.5        | -61.30             | -0.23               | -20.23    | 41.07              |
| 4DQPSK     | 2483.5        | -62.88             | 1.21                | -18.79    | 44.09              |
| 8DPSK      | 2483.5        | -61.30             | -0.23               | -20.23    | 41.07              |

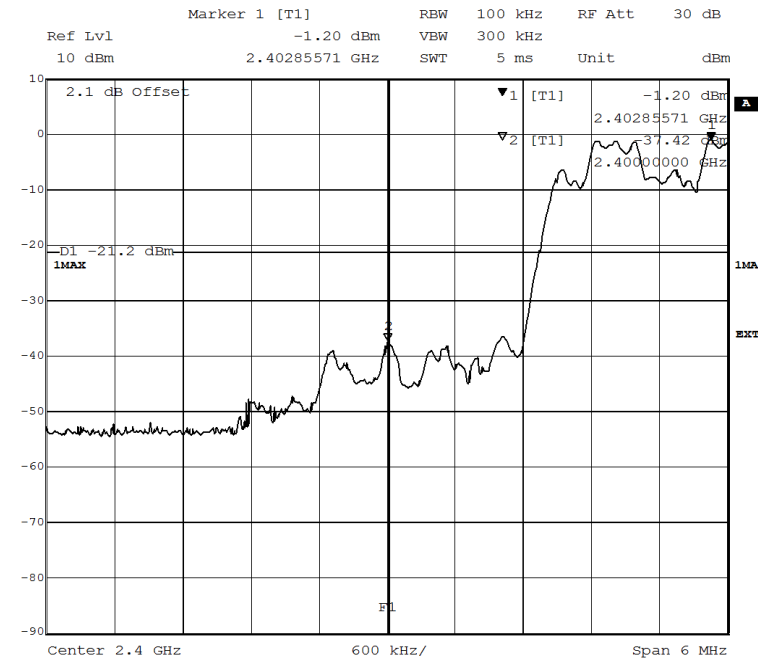


Title: Band Edge Compliance  
 Comment A: CH B: 2402 MHz  
 Date: 25.NOV.2014 08:49:36

Method = Conducted

hopping mode

| Modulation | Frequency MHz | Measured value dBm | Reference value dBm | Limit dBm | Margin to limit dB |
|------------|---------------|--------------------|---------------------|-----------|--------------------|
| GFSK       | 2400          | -47.05             | -2.20               | -22.20    | 24.85              |
| 4DQPSK     | 2400          | -37.42             | -1.20               | -21.20    | 16.22              |
| 8DPSK      | 2400          | -37.76             | -1.27               | -21.27    | 16.49              |
| GFSK       | 2483.5        | -54.34             | -2.20               | -22.20    | 32.14              |
| 4DQPSK     | 2483.5        | -54.03             | -0.36               | -20.36    | 33.67              |
| 8DPSK      | 2483.5        | -54.35             | -0.42               | -20.42    | 33.93              |



Date: 4.DEC.2014 13:49:39

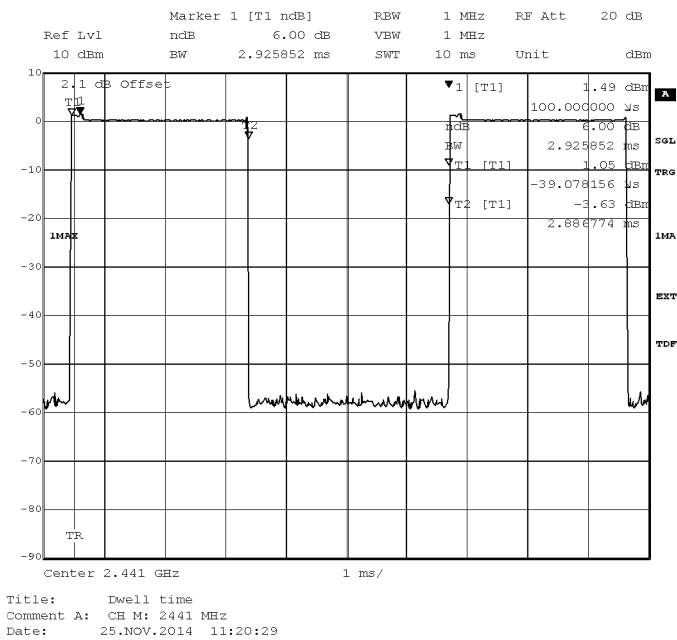
### 3.5.6 15c.7 Dwell time §15.247 (a) (1) (iii)

#### Test: 15c.7; Dwell time Summary

Result: Passed  
 Setup No.: aa01\_cond  
 Date of Test: 2014/11/25 12:18  
 Body: FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES  
 Test Specification: FCC part 2 and 15

#### Detailed Results:

| Modulation | Packet type | Time slot length | Dwell time                              | Dwell time ms |
|------------|-------------|------------------|---|---------------|
| GFSK       | DH5         | 2.91             | time slot length *<br>1600/5 /79 * 31.6 | 371.94        |
| 4-DQPSK    | 2-DH5       | 2.93             | time slot length *<br>1600/5 /79 * 31.6 | 374.51        |
| 8DPSK      | 3-DH5       | 2.93             | time slot length *<br>1600/5 /79 * 31.6 | 374.51        |



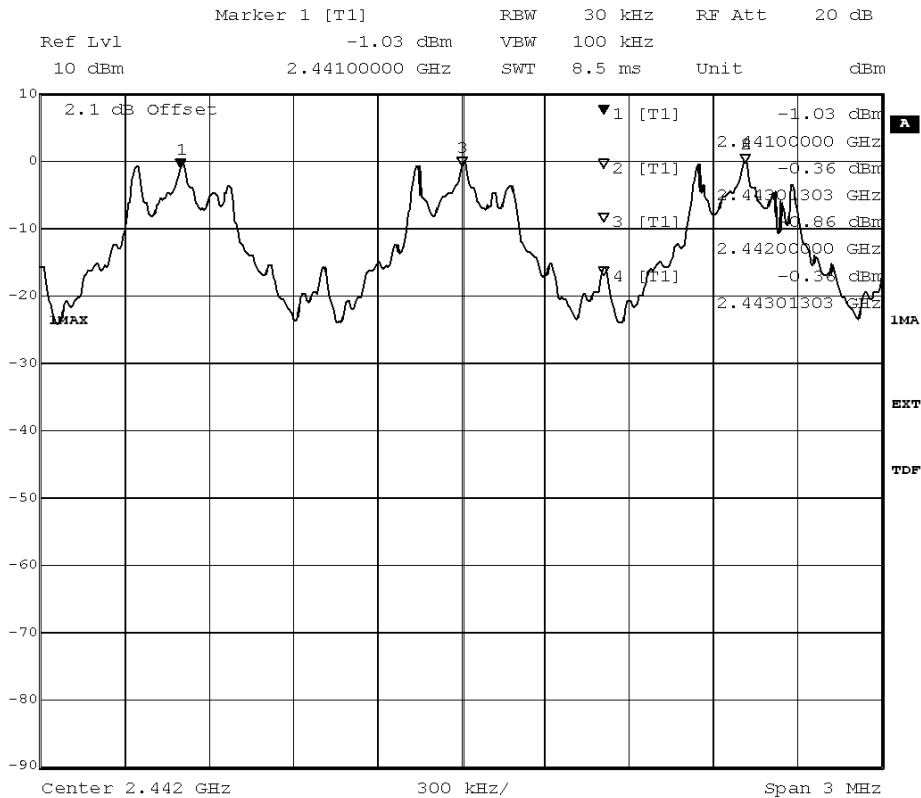
### 3.5.7 15c.8 Channel separation §15.247 (a) (1)

#### Test: 15c.8; Channel separation Summary

Result: Passed  
 Setup No.: aa01\_cond  
 Date of Test: 2014/11/25 11:13  
 Body: FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES  
 Test Specification: FCC part 2 and 15

#### Detailed Results:

| Modulation | Channel Separation |
|------------|--------------------|
| GFSK       | 1 MHz              |
| PI/4 DQPSK | 1 MHz              |
| 8DPSK      | 1 MHz              |



Title: Channel separation  
 Comment A: CH H: Hopping  
 Date: 25.NOV.2014 11:43:25

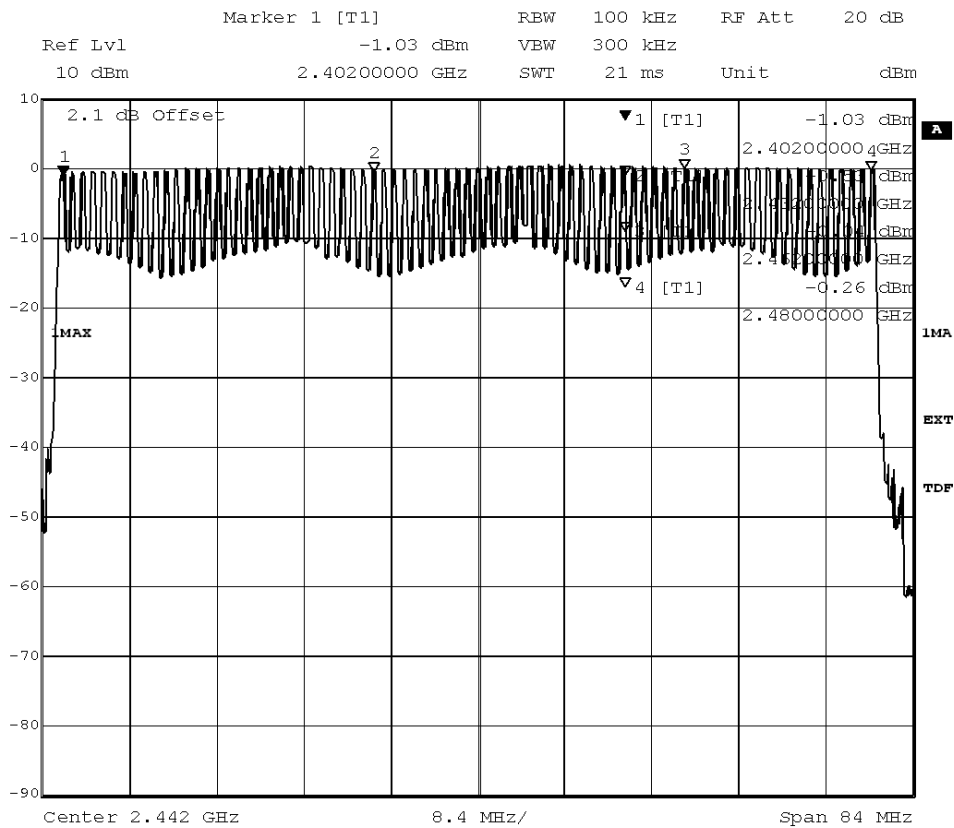
### 3.5.8 15c.9 Number of hopping frequencies §15.247 (a) (1) (iii)

#### Test: 15c.9; Number of hopping frequencies Summary

Result: Passed  
 Setup No.: aa01\_cond  
 Date of Test: 2014/11/25 12:33  
 Body: FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES  
 Test Specification: FCC part 2 and 15

#### Detailed Results:

| Modulation | Number of hopping channels |
|------------|----------------------------|
| GFSK       | 79                         |
| PI/4 DQPSK | 79                         |
| 8DPSK      | 79                         |



Title: Number of hopping frequencies  
 Comment A: CH H: Hopping  
 Date: 25.NOV.2014 12:59:15

## 4 Test Equipment Details

### 4.1 List of Used Test Equipment

The calibration, hardware and software states are shown for the testing period.

#### Test Equipment Anechoic Chamber

|                      |                                       |  |                                  |
|----------------------|---------------------------------------|--|----------------------------------|
| <b>Lab ID:</b>       | <b>Lab 1</b>                          |  |                                  |
| <b>Manufacturer:</b> | Frankonia                             |  |                                  |
| <b>Description:</b>  | Anechoic Chamber for radiated testing |  |                                  |
| <b>Type:</b>         | 10.58x6.38x6.00 m <sup>3</sup>        |  |                                  |
|                      | <i>Calibration Details</i>            |  | <i>Last Execution Next Exec.</i> |
|                      | NSA (FCC)                             |  | 2014/01/09 2017/01/09            |

#### Single Devices for Anechoic Chamber

| <i>Single Device Name</i> | <i>Type</i>                        | <i>Serial Number</i> | <i>Manufacturer</i>              |
|---------------------------|------------------------------------|----------------------|----------------------------------|
| Air compressor            | none                               | -                    | Atlas Copco                      |
| Anechoic Chamber          | 10.58 x 6.38 x 6.00 m <sup>3</sup> | none                 | Frankonia                        |
|                           | <i>Calibration Details</i>         |                      | <i>Last Execution Next Exec.</i> |
|                           | FCC listing 96716 3m Part15/18     |                      | 2014/01/09 2017/01/08            |
| Controller Maturo         | MCU                                | 961208               | Maturo GmbH                      |
| EMC camera                | CE-CAM/1                           | -                    | CE-SYS                           |
| EMC camera Nr.2           | CCD-400E                           | 0005033              | Mitsubishi                       |
| Filter ISDN               | B84312-C110-E1                     |                      | Siemens&Matsushita               |
| Filter Universal 1A       | BB4312-C30-H3                      | -                    | Siemens&Matsushita               |



### Test Equipment Auxiliary Equipment for Radiated emissions

**Lab ID:** Lab 1  
**Description:** Equipment for emission measurements  
**Serial Number:** see single devices

### Single Devices for Auxiliary Equipment for Radiated emissions

| Single Device Name                                 | Type                       | Serial Number          | Manufacturer                     |
|--|----------------------------|------------------------|----------------------------------|
| Antenna mast                                       | AM 4.0                     | AM4.0/180/11920<br>513 | Maturo GmbH                      |
| Biconical Broadband Antenna                        | SBA 9119                   | 9119-005               | Schwarzbeck                      |
| Biconical dipole                                   | VUBA 9117                  | 9117-108               | Schwarzbeck                      |
|  | <i>Calibration Details</i> |                        | <i>Last Execution Next Exec.</i> |
|  | Standard Calibration       |                        | 2012/01/18 2015/01/17            |
| Broadband Amplifier<br>18MHz-26GHz                 | JS4-18002600-32-5P         | 849785                 | Miteq                            |
| Broadband Amplifier<br>1GHz-4GHz                   | AFS4-01000400-1Q-10P-4     | -                      | Miteq                            |
| Broadband Amplifier<br>30MHz-18GHz                 | JS4-00101800-35-5P         | 896037                 | Miteq                            |
| Cable "ESI to EMI<br>Antenna"                      | EcoFlex10                  | W18.01-<br>2+W38.01-2  | Kabel Kusch                      |
| Cable "ESI to Horn<br>Antenna"                     | UFB311A+UFB293C            | W18.02-<br>2+W38.02-2  | Rosenberger Micro-Coax           |
| Double-ridged horn                                 | HF 906                     | 357357/001             | Rohde & Schwarz GmbH &<br>Co. KG |
|  | <i>Calibration Details</i> |                        | <i>Last Execution Next Exec.</i> |
|  | Standard Calibration       |                        | 2012/05/18 2015/05/17            |
| Double-ridged horn                                 | HF 906                     | 357357/002             | Rohde & Schwarz GmbH &<br>Co. KG |
|  | <i>Calibration Details</i> |                        | <i>Last Execution Next Exec.</i> |
|  | Standard Calibration       |                        | 2012/06/26 2015/06/25            |
| High Pass Filter                                   | 4HC1600/12750-1.5-KK       | 9942011                | Trilithic                        |
| High Pass Filter                                   | 5HC2700/12750-1.5-KK       | 9942012                | Trilithic                        |
| High Pass Filter                                   | 5HC3500/12750-1.2-KK       | 200035008              | Trilithic                        |
| High Pass Filter                                   | WHKX 7.0/18G-8SS           | 09                     | Wainwright                       |
| Horn Antenna<br>Schwarzbeck 15-26<br>GHz BBHA 9170 | BBHA 9170                  |                        |                                  |
| Log.-per. Antenna                                  | HL 562 Ultralog            | 100609                 | Rohde & Schwarz GmbH &<br>Co. KG |
|  | <i>Calibration Details</i> |                        | <i>Last Execution Next Exec.</i> |
|  | Standard Calibration       |                        | 2012/12/18 2015/12/17            |
| Log.-per. Antenna                                  | HL 562 Ultralog            | 830547/003             | Rohde & Schwarz GmbH &<br>Co. KG |
| Loop Antenna                                       | HFH2-Z2                    | 829324/006             | Rohde & Schwarz GmbH &<br>Co. KG |
|  | <i>Calibration Details</i> |                        | <i>Last Execution Next Exec.</i> |
|  | DKD Calibration            |                        | 2014/11/27 2017/11/27            |
| Pyramidal Horn<br>Antenna 26,5 GHz                 | 3160-09                    | 00083069               | EMCO Elektronik GmbH             |

### Single Devices for Auxiliary Equipment for Radiated emissions (continued)

| Single Device Name             | Type               | Serial Number          | Manufacturer         |
|--------------------------------|--------------------|------------------------|----------------------|
| Pyramidal Horn Antenna 40 GHz  | 3160-10            | 00086675               | EMCO Elektronik GmbH |
| Tilt device Maturro (Rohacell) | Antrieb TD1.5-10kg | TD1.5-10kg/024/3790709 | Maturro GmbH         |

### Test Equipment Auxiliary Test Equipment

|                       |   |
|-----------------------|---|
| <b>Lab ID:</b>        | <b>Lab 1</b>                              |
| <b>Manufacturer:</b>  | see single devices                        |
| <b>Description:</b>   | Single Devices for various Test Equipment |
| <b>Type:</b>          | various                                   |
| <b>Serial Number:</b> | none                                      |

### Single Devices for Auxiliary Test Equipment

| Single Device Name                 | Type                       | Serial Number | Manufacturer                         |
|------------------------------------|----------------------------|---------------|--------------------------------------|
| Broadband Power Divider N (Aux)    | 1506A / 93459              | LM390         | Weinschel Associates                 |
| Broadband Power Divider SMA        | WA1515                     | A855          | Weinschel Associates                 |
| Digital Multimeter 03 (Multimeter) | Fluke 177                  | 86670383      | Fluke Europe B.V.                    |
|                                    | <i>Calibration Details</i> |               | <i>Last Execution Next Exec.</i>     |
|                                    | Customized calibration     |               | 2013/12/04 2015/12/03                |
| Fibre optic link Satellite (Aux)   | FO RS232 Link              | 181-018       | Pontis                               |
| Fibre optic link Transceiver (Aux) | FO RS232 Link              | 182-018       | Pontis                               |
| Isolating Transformer              | LTS 604                    | 1888          | Thalheimer Transformatorenwerke GmbH |
| Notch Filter Ultra Stable (Aux)    | WRCA800/960-6EEK           | 24            | Wainwright                           |
| Signal Analyzer                    | FSV30                      | 103005        | Rohde & Schwarz GmbH & Co. KG        |
|                                    | <i>Calibration Details</i> |               | <i>Last Execution Next Exec.</i>     |
|                                    | Standard                   |               | 2014/02/10 2016/02/09                |
| Spectrum Analyser                  | FSP3                       | 836722/011    | Rohde & Schwarz GmbH & Co. KG        |
|                                    | <i>Calibration Details</i> |               | <i>Last Execution Next Exec.</i>     |
|                                    | Standard                   |               | 2012/06/13 2015/06/12                |
|                                    | DKD calibration            |               | 2014/11/24 2017/11/23                |
| Spectrum Analyser                  | FSU26                      | 200418        | Rohde & Schwarz GmbH & Co.KG         |
|                                    | <i>Calibration Details</i> |               | <i>Last Execution Next Exec.</i>     |
|                                    | Standard calibration       |               | 2014/07/29 2015/07/28                |
| Vector Signal Generator            | SMIQ 03B                   | 832492/061    | Rohde & Schwarz GmbH & Co.KG         |

### Test Equipment Digital Signalling Devices

**Lab ID:** Lab 1  
**Description:** Signalling equipment for various wireless technologies.

#### Single Devices for Digital Signalling Devices

| Single Device Name                   | Type    | Serial Number  | Manufacturer   |
|--------------------------------------|---------|--|--|
| Bluetooth Signalling Unit CBT        | CBT     | 100589   | Rohde & Schwarz GmbH & Co. KG                        |
| CMW500                               | CMW500  | 107500   | Rohde & Schwarz GmbH & Co. KG                        |
|                                      |         | <i>Calibration Details</i>   |  |
|                                      |         | Standard calibration   | Last Execution: 2014/01/27    Next Exec.: 2016/01/26 |
| Digital Radio Communication Tester   | CMD 55  | 831050/020   | Rohde & Schwarz GmbH & Co. KG                        |
|                                      |         | <i>Calibration Details</i>   |  |
|                                      |         | Standard calibration   | Last Execution: 2011/11/28    Next Exec.: 2014/11/27 |
| Universal Radio Communication Tester | CMU 200 | 102366   | Rohde & Schwarz GmbH & Co. KG                        |
|                                      |         | <i>HW/SW Status</i>  |  |
|                                      |         | Hardware:  | 2007/07/16   |
|                                      |         | B11, B21V14, B21-2, B41, B52V14, B52-2, B53-2, B56V14, B68 3v04, PCMCIA, U65V04  |  |
|                                      |         | Software:  |  |
|                                      |         | K21 4v21, K22 4v21, K23 4v21, K24 4v21, K42 4v21, K43 4v21, K53 4v21, K56 4v22, K57 4v22, K58 4v22, K59 4v22, K61 4v22, K62 4v22, K63 4v22, K64 4v22, K65 4v22, K66 4v22, K67 4v22, K68 4v22, K69 4v22 |  |
|                                      |         | Firmware:  |  |
|                                      |         | µP1 8v50 02.05.06  |  |
|                                      |         | ---  |  |
| Universal Radio Communication Tester | CMU 200 | 837983/052   | Rohde & Schwarz GmbH & Co. KG                        |
|                                      |         | <i>Calibration Details</i>   |  |
|                                      |         | Standard calibration   | Last Execution: 2011/12/07    Next Exec.: 2014/12/06 |
|                                      |         | <i>HW/SW Status</i>  |  |
|                                      |         | HW options:  | 2007/01/02   |
|                                      |         | B11, B21V14, B21-2, B41, B52V14, B52-2, B53-2, B54V14, B56V14, B68 3v04, B95, PCMCIA, U65V02   |  |
|                                      |         | SW options:  |  |
|                                      |         | K21 4v11, K22 4v11, K23 4v11, K24 4v11, K27 4v10, K28 4v10, K42 4v11, K43 4v11, K53 4v10, K65 4v10, K66 4v10, K68 4v10,  |  |
|                                      |         | Firmware:  |  |
|                                      |         | µP1 8v40 01.12.05  |  |
|                                      |         | ---  |  |
|                                      |         | SW:  | 2008/11/03   |
|                                      |         | K62, K69   |  |
| Vector Signal Generator              | SMU200A | 100912   | Rohde & Schwarz GmbH & Co. KG                        |

### Test Equipment Emission measurement devices

**Lab ID:** **Lab 1**  
*Description:* Equipment for emission measurements  
*Serial Number:* see single devices

#### Single Devices for Emission measurement devices

| <i>Single Device Name</i>                           | <i>Type</i> | <i>Serial Number</i> | <i>Manufacturer</i>                     |
|---|-------------|----------------------|---|
| Personal Computer                                   | Dell        | 30304832059          | Dell                                    |
| Power Meter   | NRVD        | 828110/016           | Rohde & Schwarz GmbH & Co.KG            |
| <i>Calibration Details</i>                          |             |                      | <i>Last Execution</i> <i>Next Exec.</i> |
| Standard calibration                                |             |                      | 2014/05/13 2015/05/12                   |
| Sensor Head A                                       | NRV-Z1      | 827753/005           | Rohde & Schwarz GmbH & Co.KG            |
| <i>Calibration Details</i>                          |             |                      | <i>Last Execution</i> <i>Next Exec.</i> |
| Standard calibration                                |             |                      | 2014/05/13 2015/05/12                   |
| Signal Generator                                    | SMR 20      | 846834/008           | Rohde & Schwarz GmbH & Co. KG           |
| <i>Calibration Details</i>                          |             |                      | <i>Last Execution</i> <i>Next Exec.</i> |
| Standard Calibration                                |             |                      | 2014/06/24 2017/06/23                   |
| Spectrum Analyzer                                   | ESIB 26     | 830482/004           | Rohde & Schwarz GmbH & Co. KG           |
| <i>Calibration Details</i>                          |             |                      | <i>Last Execution</i> <i>Next Exec.</i> |
| Standard Calibration                                |             |                      | 2014/01/07 2016/01/31                   |
| <i>HW/SW Status</i>                                 |             |                      | <i>Date of Start</i> <i>Date of End</i> |
| Firmware-Update 4.34.4 from 3.45 during calibration |             |                      | 2009/12/03                              |

### Test Equipment Multimeter 12

**Lab ID:** **Lab 2**  
*Description:* Ex-Tech 520  
*Serial Number:* 05157876

#### Single Devices for Multimeter 12

| <i>Single Device Name</i>          | <i>Type</i> | <i>Serial Number</i> | <i>Manufacturer</i>                     |
|------------------------------------|-------------|----------------------|---|
| Digital Multimeter 12 (Multimeter) | EX520       | 05157876             | Extech Instruments Corp.                |
| <i>Calibration Details</i>         |             |                      | <i>Last Execution</i> <i>Next Exec.</i> |
| Customized calibration             |             |                      | 2013/12/04 2015/12/03                   |

### Test Equipment Regulatory Bluetooth RF Test Solution

**Lab ID:** Lab 2  
**Description:** Regulatory Bluetooth RF Tests  
**Type:** Bluetooth RF  
**Serial Number:** 001

#### Single Devices for Regulatory Bluetooth RF Test Solution

| Single Device Name              | Type                       | Serial Number | Manufacturer                     |
|---------------------------------|----------------------------|---------------|----------------------------------|
| ADU 200 Relay Box 7             | Relay Box                  | A04380        | Ontrak Control Systems Inc.      |
| Bluetooth Signalling Unit CBT   | CBT                        | 100302        | Rohde & Schwarz GmbH & Co.KG     |
|                                 | <i>Calibration Details</i> |               | <i>Last Execution Next Exec.</i> |
|                                 | Standard calibration       |               | 2014/08/29 2015/08/28            |
| Power Meter NRVD                | NRVD                       | 832025/059    |                                  |
|                                 | <i>Calibration Details</i> |               | <i>Last Execution Next Exec.</i> |
|                                 | Standard calibration       |               | 2014/08/29 2015/08/28            |
| Power Sensor NRV Z1 A           | PROBE                      | 832279/013    |                                  |
|                                 | <i>Calibration Details</i> |               | <i>Last Execution Next Exec.</i> |
|                                 | Standard calibration       |               | 2014/08/28 2015/08/27            |
| Power Supply                    | NGSM 32/10                 | 2725          |                                  |
|                                 | <i>Calibration Details</i> |               | <i>Last Execution Next Exec.</i> |
|                                 | Standard calibration       |               | 2013/06/20 2015/06/19            |
| Rubidium Frequency Normal MFS   | Datum MFS                  | 002           | Datum GmbH                       |
| Signal Analyser FSQ26           | 1119.6001.26               | 832695/007    | Rohde & Schwarz GmbH & Co.KG     |
| Vector Signal Generator SMIQ03B | SMIQ03B                    | 832870/017    |                                  |
|                                 | <i>Calibration Details</i> |               | <i>Last Execution Next Exec.</i> |
|                                 | Standard calibration       |               | 2013/06/21 2016/06/20            |

### Test Equipment Shielded Room 07

**Lab ID:** Lab 2  
**Description:** Shielded Room 4m x 6m

### Test Equipment T/A Logger 13

**Lab ID:** Lab 1  
**Description:** Lufft Opus10 TPR  
**Type:** Opus10 TPR  
**Serial Number:** 13936

#### Single Devices for T/A Logger 13

| Single Device Name                        | Type                       | Serial Number | Manufacturer                      |
|---|----------------------------|---------------|-----------------------------------|
| ThermoAirpressure Datalogger 13 (Environ) | Opus10 TPR (8253.00)       | 13936         | Lufft Mess- und Regeltechnik GmbH |
|   | <i>Calibration Details</i> |               | <i>Last Execution Next Exec.</i>  |
|   | Customized calibration     |               | 2013/02/07 2015/02/06             |

### Test Equipment T/H Logger 12

**Lab ID:** Lab 1  
*Description:* Lufft Opus10  
*Serial Number:* 12482

#### Single Devices for T/H Logger 12

| <i>Single Device Name</i>           | <i>Type</i>          | <i>Serial Number</i> | <i>Manufacturer</i>                     |
|-------------------------------------|----------------------|----------------------|---|
| ThermoHygro Datalogger 12 (Environ) | Opus10 THI (8152.00) | 12482                | Lufft Mess- und Regeltechnik GmbH       |
| <i>Calibration Details</i>          |                      |                      | <i>Last Execution</i> <i>Next Exec.</i> |
| Customized calibration              |                      |                      | 2013/01/07 2015/01/06                   |

### Test Equipment T/H Logger 15

**Lab ID:** Lab 2  
*Description:* Lufft Opus10  
*Serial Number:* 13985

#### Single Devices for T/H Logger 15

| <i>Single Device Name</i>           | <i>Type</i>          | <i>Serial Number</i> | <i>Manufacturer</i>                     |
|-------------------------------------|----------------------|----------------------|---|
| ThermoHygro Datalogger 15 (Environ) | Opus10 THI (8152.00) | 13985                | Lufft Mess- und Regeltechnik GmbH       |
| <i>Calibration Details</i>          |                      |                      | <i>Last Execution</i> <i>Next Exec.</i> |
| Customized calibration              |                      |                      | 2013/01/07 2015/01/06                   |

### Test Equipment Temperature Chamber 01

**Lab ID:** Lab 2  
*Manufacturer:* see single devices  
*Description:* Temperature Chamber KWP 120/70  
*Type:* Weiss  
*Serial Number:* see single devices

#### Single Devices for Temperature Chamber 01

| <i>Single Device Name</i>    | <i>Type</i> | <i>Serial Number</i> | <i>Manufacturer</i>                     |
|------------------------------|-------------|----------------------|---|
| Temperature Chamber Weiss 01 | KWP 120/70  | 59226012190010       | Weiss Umwelttechnik GmbH                |
| <i>Calibration Details</i>   |             |                      | <i>Last Execution</i> <i>Next Exec.</i> |
| Customized calibration       |             |                      | 2014/03/12 2016/03/11                   |

## **5 Annex**

### **5.1 Additional Information for Report**

### Summary of Test Results

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The EUT complied with all performed tests as listed in the summary section of this report.

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### Technical Report Summary

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#### Type of Authorization :

Certification for an Intentional Radiator (Frequency Hopping Spread Spectrum).

#### 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. 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 and 5725-5850 MHz

#### additional documents

The tests were selected and performed with reference to the FCC Public Notice DA 00-705, released March 30, 2000. Instead of applying ANSI C63.4-1992 which is referenced in the FCC Public Note, the newer ANSI C63.4-2009 is applied.

#### Description of Methods of Measurements

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#### Conducted emissions (AC power line)

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Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C 63.4,

#### Test Description



The test set-up was made in accordance to the general provisions of ANSI C 63.4. The Equipment Under Test (EUT) was setup in a shielded room to perform the conducted emissions measurements in a typical installation configuration. The EUT was powered from 50µH || 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 ES-K1 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
- Frequency range: 150 kHz – 30 MHz
- Frequency steps: 5 kHz
- IF-Bandwidth: 9 kHz
- Measuring time / Frequency step: 20 ms
- 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.

**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).

**Occupied bandwidth**

Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.31

**Test Description**

The Equipment Under Test (EUT) was setup 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 produces the worst-case (widest) occupied bandwidth. The resolution bandwidth for measuring the reference level and the occupied bandwidth was 30 kHz. The EUT was connected to the spectrum analyzer via a short coax cable.

#### Test Requirements / Limits

##### FCC Part 15, Subpart C, §15.247 (a) (1)

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

##### Implication by the test laboratory:

Since the Bluetooth technology defines a fixed channel separation of 1 MHz this design parameter defines the maximum allowed occupied bandwidth depending on the EUT's output power:

1. Under the provision that the system operates with an output power not greater than 125 mW (21.0 dBm) : Implicit Limit: Max. 20 dB BW =  $1.0 \text{ MHz} / 2/3 = 1.5 \text{ MHz}$
2. If the system output power exceeds 125 mW (21.0 dBm): Implicit Limit: Max. 20 dB BW = 1.0 MHz

Used conversion factor: Output power (dBm) =  $10 \log (\text{Output power (W)} / 1\text{mW})$

The measured output power of the system is below 125 mW (21.0 dBm). For the results, please refer to the related chapter of this report. Therefore the limit is determined as 1.5 MHz.

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#### Peak power output

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Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.31

#### Test Description

The Equipment Under Test (EUT) was set up to perform the output power measurements. The resolution bandwidth for measuring the output power was set to 3 MHz. 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.

#### Test Requirements / Limits

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

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:  
(1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt.

Used conversion factor: Limit (dBm) =  $10 \log (\text{Limit (W)}/1\text{mW})$   
==> Maximum Output Power: 30 dBm

---

#### Spurious RF conducted emissions

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Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.31

#### 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:

- Detector: Peak-Maxhold
- Frequency range: 30 – 25000 MHz
- Resolution Bandwidth (RBW): 100 kHz

- Video Bandwidth (VBW): 300 kHz
- Sweep Time: 330 s

The reference value for the measurement of the spurious RF conducted emissions is determined during the test "band edge compliance" (cf. chapter 3.6). This value is used to calculate the 20 dBc limit.

#### 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

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#### Spurious radiated emissions

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Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C 63.4,

#### Test Description

The test set-up was made in accordance to the general provisions of ANSI C63.4–2009. The Equipment Under Test (EUT) was set up on a non-conductive table 1.0 x 2.0 m in the semi-anechoic chamber. The influence of the EUT support table that is used between 30–1000 MHz was evaluated. The test was performed at the distance of 3 m between the EUT and the receiving antenna. The measurement procedure is implemented into the EMI test software ES-K1 from R&S. The radiated emissions measurements were made in a typical installation configuration. 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 performed at 2 axes. A pre-check is also performed while the EUT is powered from both AC and DC (battery) power in order to find the worst-case operating condition.

##### 1. Measurement up to 30 MHz

The test set-up was made in accordance to the general provisions of ANSI C63.4. The Equipment Under Test (EUT) was set up on a non-conductive table in the anechoic chamber. The radiated emissions measurements were made in a typical installation configuration. The measurement procedure is implemented into the EMI test software ES-K1 from R&S. The Loop antenna HFH2-Z2 is used.

###### Step 1: pre-measurement

- Anechoic chamber
- Antenna distance: 10 m
- Detector: Peak-Maxhold
- Frequency range: 0.009 – 0.15 and 0.15 – 30 MHz
- Frequency steps: 0.1 kHz and 5 kHz
- IF-Bandwidth: 0.2 kHz and 10 kHz
- Measuring time / Frequency step: 100 ms

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: 200 Hz – 10 kHz
- Measuring time / Frequency step: 100 ms

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

###### Step 1: Preliminary scan

Preliminary test to identify the highest amplitudes relative to the limit.

###### Settings for step 1:

- Detector: Peak-Maxhold
- Frequency range: 30 – 1000 MHz
- Frequency steps: 60 kHz
- IF-Bandwidth: 120 kHz
- Measuring time / Frequency step: 100 µs (BT Timing 1.25 ms)
- Turntable angle range: –180 to +180°

- Turntable step size: 90°
- Height variation range: 1 – 3 m
- Height variation step size: 2 m
- Polarisation: Horizontal + Vertical

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

Step 2: second 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 out the approximate turntable angle and antenna height for each frequency.

- Detector: Peak – Maxhold
- Measured frequencies: in step 1 determined frequencies
- IF – Bandwidth: 120 kHz
- Measuring time: 100 ms
- Turntable angle range: –180 to +180°
- Turntable step size: 45°
- Height variation range: 1 – 4 m
- Height variation step size: 0.5 m
- Polarisation: horizontal + vertical

After this step the EMI test system has determined the following values for each frequency (of step 1):

- Frequency
- Azimuth value (of turntable)
- Antenna height

The last two values have now the following accuracy:

- Azimuth value (of turntable): 45°
- Antenna height: 0.5 m

Step 3: final 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 be slowly varied by +/-22.5° 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 is also slowly varied by +/-25 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: –22.5° to +22.5° around the determined value
- Height variation range: –0.25 m to +0.25 m around the determined value

Step 4: 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

### 3. Measurement above 1 GHz

The following modifications apply to the measurement procedure for the frequency range above 1 GHz: The measurement distance was reduced to 1 m. The results were extrapolated by the extrapolation factor of 20 dB/decade (inverse linear-distance for field strength measurements, inverse linear-distance squared for the power reference level measurements). Due to the fact that in this frequency range a double ridged wave guided horn antenna (up to 18 GHz) and a horn antenna (18–25 GHz) are used, the steps 2–4 are omitted. Step 1 was performed with one height of the receiving antenna only.

EMI receiver settings:

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

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.

For the enhanced data rate packets the test is performed as worst-case-check in order to verify that emissions have a comparable level as found at basic data rate. Typically, the measurement for these packets is performed in the frequency range 1 to 8 GHz but it depends on the emissions found during the test for the basic data rate. Please refer to the results for the used frequency range.

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) | Limit(dBµV/m @10m)  |
|------------------|--------------|--------------------------|---------------------|
| 0.009 – 0.49     | 2400/F(kHz)  | 300                      | Limit (dBµV/m)+30dB |
| 0.49 – 1.705     | 24000/F(kHz) | 30                       | Limit (dBµV/m)+10dB |
| 1.705 - 30       | 30           | 30                       | Limit (dBµV/m)+10dB |

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

§15.35(b)

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

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

Band edge compliance

Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C 63.4, FCC §15.31

Test Description

The procedure to show compliance with the band edge requirement is divided into two measurements: 1. Show compliance of the lower band edge by a conducted measurement and 2. show compliance of the higher band edge by a radiated and conducted measurement.

For the first measurement the EUT is set to transmit on the lowest channel (2402 MHz). The lower band edge is 2400 MHz.

Analyzer settings:

- Detector: Peak
- RBW= 100 kHz
- VBW= 300 kHz

For the second measurement the EUT is set to transmit on the highest channel (2480 MHz). The higher band edge is 2483.5 MHz.

Analyzer settings for conducted measurement:

- Detector: Peak
- RBW= 100 kHz
- VBW= 300 kHz

EMI receiver settings:

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

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.

...

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 measurement of the lower band edge 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..."

For the measurement of the higher band edge the limit is "specified in Section 15.209(a)".

---

#### Dwell time

---

Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.31

#### Test Description

The Equipment Under Test (EUT) was set up to perform the dwell time measurements. The EUT was connected to the spectrum analyzer via a short coax cable. The dwell time is calculated by:

Dwell time = time slot length \* hop rate / number of hopping channels \* 31.6 s

with:

- hop rate =  $1600 * 1/s$  for DH1 packets = 1600 s<sup>-1</sup>
- hop rate =  $1600/3 * 1/s$  for DH3 packets = 533.33 s<sup>-1</sup>
- hop rate =  $1600/5 * 1/s$  for DH5 packets = 320 s<sup>-1</sup>
- number of hopping channels = 79
- 31.6 s = 0.4 seconds multiplied by the number of hopping channels =  $0.4 s * 79$

The highest value of the dwell time is reported.

#### Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (a) (1) (iii)

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Since the Bluetooth technology uses 79 channels this period is calculated to be 31.6 seconds.

---

#### Channel separation

---

Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.31

#### Test Description

The Equipment Under Test (EUT) was set up to perform the channel separation measurements. The channel separation is independent from the modulation pattern.

The EUT was connected to spectrum analyzer via a short coax cable.

Analyzer settings:

- Detector: Peak-Maxhold
- Span: 3 MHz
- Centre Frequency: a mid frequency of the 2.4 GHz ISM band
- Resolution Bandwidth (RBW): 30 kHz
- Video Bandwidth (VBW): 100 kHz
- Sweep Time: Coupled

#### Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (a) (1)  
Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

---

Number of hopping frequencies

---

Standard    FCC Part 15, Subpart C

The test was performed according to: FCC §15.31

Test Description

The Equipment Under Test (EUT) was set up to perform the number of hopping frequencies measurement. The number of hopping frequencies is independent from the modulation pattern. The EUT was connected to spectrum analyzer via a short coax cable.

Analyzer settings:

- Detector: Peak-Maxhold
- Centre frequency: 2442 MHz
- Frequency span: 84 MHz
- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Sweep Time: Coupled

Test Requirements / Limits

FCC Part 15, Subpart C, §15.247 (a) (iii)  
Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels.

\*\*\*\*\*  
FCC and IC Correlation of measurement requirements  
\*\*\*\*\*

The following tables show the correlation of measurement requirements for Bluetooth equipment and Digital Apparatus from FCC and IC standards.

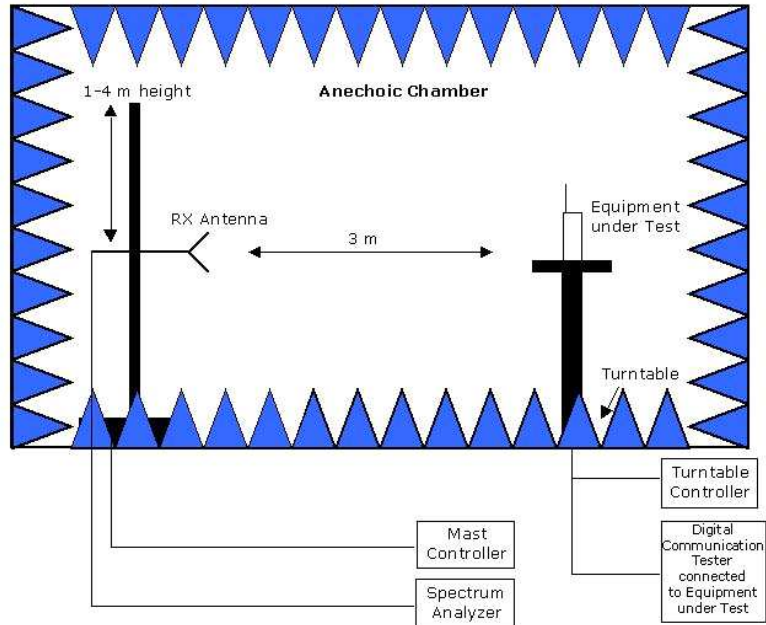
Bluetooth® equipment:

| Measurement                     | FCC reference          | IC reference                             |
|---------------------------------|------------------------|--|
| Conducted emissions on AC mains | § 15.207               | RSS-Gen Issue 3: 7.2.4                   |
| Occupied bandwidth              | § 15.247 (a) (1)       | RSS-210 Issue 8: A8.1                    |
| Peak power output               | § 15.247 (b) (1)       | RSS-210 Issue 8: A8.4                    |
| Spurious RF conducted emissions | § 15.247 (d)           | RSS-Gen Issue 3: 6;RSS-210 Issue 8: A8.5 |
| Spurious radiated emissions     | § 15.247 (d)           | RSS-Gen Issue 3: 6;RSS-210 Issue 8: A8.5 |
| Band edge compliance            | § 15.247 (d)           | RSS-210 Issue 8: A8.5                    |
| Dwell time                      | § 15.247 (a) (1) (iii) | RSS-210 Issue 8: A8.1                    |
| Channel separation              | § 15.247 (a) (1)       | RSS-210 Issue 8: A8.1                    |
| No. of hopping frequencies      | § 15.247 (a) (1) (iii) | RSS-210 Issue 8: A8.1                    |
| Antenna requirement             | § 15.203 / 15.204      | RSS-Gen Issue 8: 7.1.2                   |

Digital Apparatus:

| Measurement                        | FCC reference | IC reference     |
|------------------------------------|---------------|------------------|
| Conducted Emissions(AC Power Line) | §15.107       | ICES-003 Issue 5 |
| Spurious Radiated Emissions        | §15.109       | ICES-003 Issue 5 |

Setup Drawings



Remark: Depending on the frequency range suitable antenna types, attenuators or preamplifiers are used.

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



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