

Inter**Lab**[®]
Final Report on
FC6000+ (variant VEA)
FCC ID 2AGKOF6000P
IC: 20878-FC6000P

Report Reference: MDE_PARRO_1529_FCCb
According to: Title 47 CFR chapter I part 15 subpart C

Date: January 14, 2016

Test Laboratory:

7layers GmbH
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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A Bureau Veritas Group Company

1 Administrative Data

1.1 Project Data

Project Responsible: Imad Hjije
Date Of Test Report: 2016/01/14
Date of first test: 2015/12/08
Date of last test: 2015/12/08

1.2 Applicant Data

Company Name: PARROT AUTOMOTIVE SAS
Street: 174, quai de Jemmapes
City: 75010 Paris
Country: France
Contact Person: Mr. Florent SONNERY
Function: Product Qualification Engineer
Department: Tests & Validation
Phone: +33 1 44 52 41 99
Fax: +33 1 48 03 74 00
E-Mail: florent.sonnery@parrot.com

1.3 Test Laboratory Data

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


7 layers DE

| | |
|-------------------------|----------------------------|
| <i>Company Name :</i> | 7layers GmbH |
| <i>Street :</i> | Borsigstrasse 11 |
| <i>City :</i> | 40880 Ratingen |
| <i>Country :</i> | Germany |
| <i>Contact Person :</i> | Mr. Michael Albert |
| <i>Phone :</i> | +49 2102 749 201 |
| <i>Fax :</i> | +49 2102 749 444 |
| <i>E Mail :</i> | Michael.Albert@7Layers.com |

Laboratory Details

| Lab ID | Identification | Responsible | Accreditation Info |
|--------|---------------------------------------|--|---|
| Lab 2 | Regulatory Bluetooth RF Test Solution | Mr. Jimmy Chatheril Mr. Sören Berentzen | DAkkS-Registration no. D-PL-12140-01-01 |

1.4 Signature of the Testing Responsible


Imad Hjije
responsible for tests performed in: Lab 2

1.5 Signature of the Accreditation Responsible

 [B. RETKA]

Accreditation scope responsible person
responsible for 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: FC6000+
FCC ID 2AGKOF6000P
IC: 20878-FC6000P

Product Category: Others
Manufacturer:
Company Name: See applicant data
Contact Person: -

Parameter List:

| Parameter name | Value |
|----------------------------|---|
| DC Power Supply | 3.3 (V) |
| highest internal frequency | below 108 MHz, emission measurement only up to 1 GHz required |

2.2 Detailed Description of OUT Samples

Sample : ad01

| | | | |
|---------------------------|--------------------|---------------------|-------|
| OUT Identifier | FC6000+ | | |
| | FCC ID 2AGKOF6000P | | |
| | IC: 20878-FC6000P | | |
| Sample Description | BLE sample VEA | | |
| Serial No. | PF815004AA5G000021 | | |
| HW Status | 01 | | |
| SW Status | 03.59.02 | | |
| Nominal Voltage | 3.3 V | Normal Temp. | 23 °C |

Parameter List:

| Parameter Description | Value |
|-----------------------------------|------------|
| Parameter for Scope FCC_v2 | |
| Antenna Gain | 2.18 (dBi) |
| Frequency_high | 2480 (MHz) |
| Frequency_low | 2402 (MHz) |
| Frequency_mid | 2440 (MHz) |

2.3 OUT Features

Features for OUT: FC6000+
FCC ID 2AGKOF6000P
IC: 20878-FC6000P

| <i>Designation</i> | <i>Description</i> | <i>Allowed Values</i> | <i>Supported Value(s)</i> |
|-----------------------------------|---|-----------------------|---------------------------|
| Features for scope: FCC_v2 | | | |
| 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 | | |
| Eant | removable antenna supplied and type tested with the radio equipment, designed as an indispensable part of the equipment | | |
| 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 | | |
| Tant | permanent antenna connector, which may be built-in, 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 AUX3 | FC6000+_MEZZ_HW0 | T1507-048 | | | Mezzanine |
| AE AUX4 | Inverted F Antenna for 2.4 GHz | | | | PCB antenna |
| AE AUX1 | WB_CEM_FC6XXX_H W03 | | | | Workbench |

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> |
| Setup_AD01 | | | | |
| | Sample: ad01 | BLE sample VEA | AE AUX3 | Mezzanine |
| | | | AE AUX4 | PCB antenna |
| | | | AE AUX1 | Workbench |

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. This report contains the abbreviated information content pertaining to services rendered. Supporting documentation not included herein is maintained and available at the laboratory.
2. All tests are performed under environmental conditions within the requirements of the specifications. Environmental conditions are available at the laboratory.
3. This test report covers the Bluetooth Low Energy functionality of this device. Normal Bluetooth is reported separately.
4. Radiated spurious emissions is covered by classic BT. Pre-measurement showed this latter is the worst case

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> | FCC part 2 and 15 |
| <i>Version</i> | 10-1-14 Edition |
| <i>Title:</i> | PART 2 - GENERAL RULES AND REGULATIONS PART 15 - RADIO FREQUENCY DEVICES |

3.4 Summary

| <i>Test Case Identifier / Name</i> <i>Test (condition)</i> | <i>Result</i> | <i>Date of Test</i> | <i>Lab</i> <i>Ref.</i> | <i>Setup</i> |
|---|---------------|---------------------|---------------------------|--------------|
| 15c.10 Power density §15.247 (e) | | | | |
| 15c.10; Power density Summary §15.247 (e) | Passed | 2015/12/08 | Lab 2 | Setup_AD01 |
| 15c.11 6dB Bandwidth §15.247 (a) (2) | | | | |
| 15c.11; 6dB Bandwidth Summary §15.247 (a) (2) | Passed | 2015/12/08 | Lab 2 | Setup_AD01 |
| 15c.4 Peak power output §15.247 (b) (1) | | | | |
| 15c.4; Peak power output Summary | Passed | 2015/12/08 | Lab 2 | Setup_AD01 |
| 15c.5 Spurious RF conducted emissions §15.247 (d) | | | | |
| 15c.5; Spurious RF conducted emissions Summary §15.247 (d) | Passed | 2015/12/08 | Lab 2 | Setup_AD01 |
| 15c.6 Band edge compliance §15.247 (d) | | | | |
| 15c.6; Frequency = 2402, Mode = BT transmit using 1 Mbps with GFSK modulation, Method = conducted, band edge = 2400 MHz | Passed | 2015/12/08 | Lab 2 | Setup_AD01 |
| 15c.6; Frequency = 2480, Mode = BT transmit using 1 Mbps with GFSK modulation, Method = conducted, band edge = 2483.5 MHz | Passed | 2015/12/08 | Lab 2 | Setup_AD01 |

3.5 Detailed Results

3.5.1 15c.10 Power density §15.247 (e)

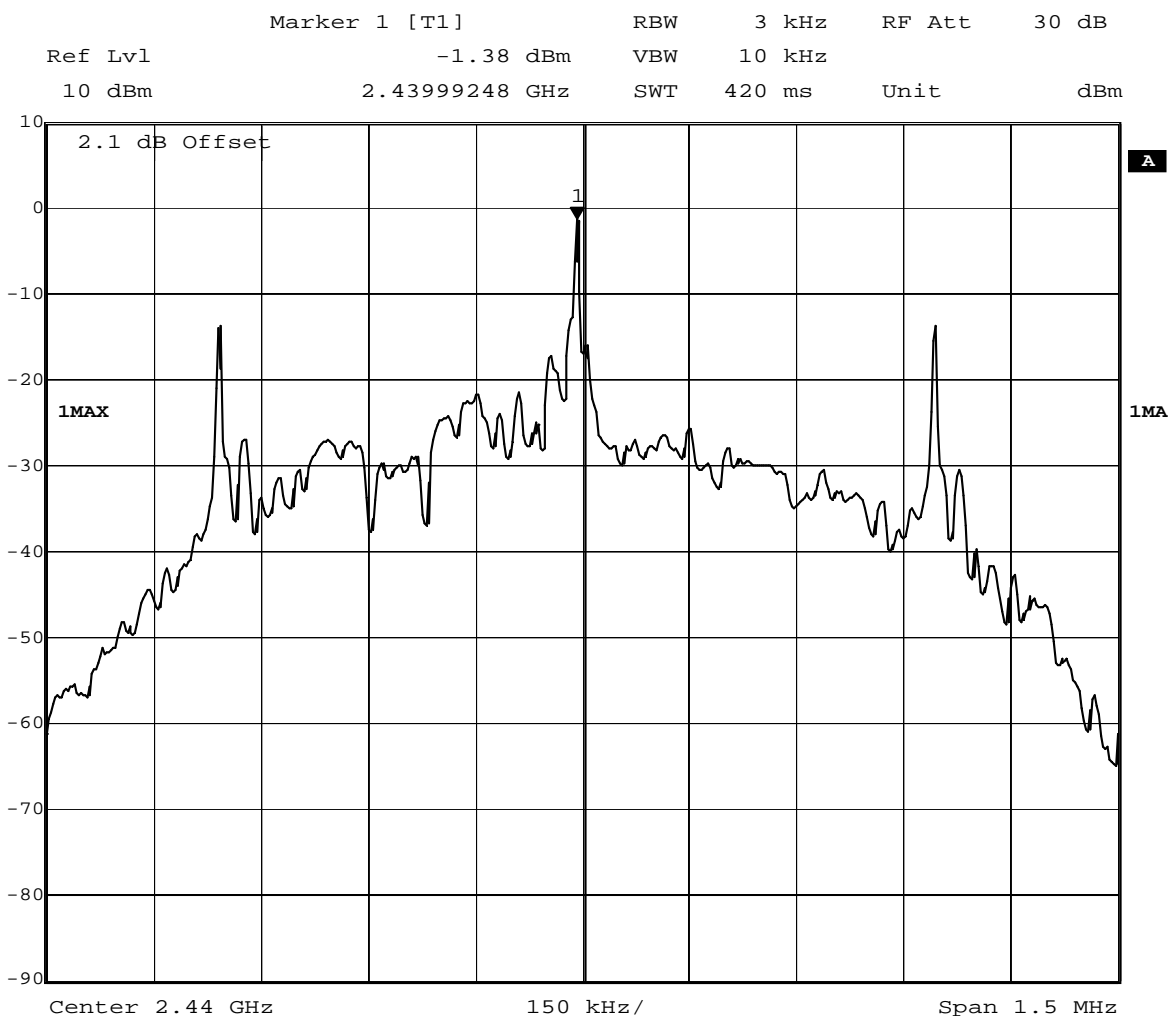
Test: 15c.10; Power density Summary §15.247 (e)

| | |
|----------------------------|--|
| <i>Result:</i> | Passed |
| <i>Setup No.:</i> | Setup_AD01 |
| <i>Date of Test:</i> | 2015/12/08 18:11 |
| <i>Body:</i> | FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES |
| <i>Test Specification:</i> | FCC part 2 and 15 |

Detailed Results:

| | | Power Density | | |
|------------|------------|---------------------|---------------------|---------------------|
| | | 2402 MHz | 2440 MHz | 2480 MHz |
| Modulation | Conditions | Power Density (dBm) | Power Density (dBm) | Power Density (dBm) |
| GFSK | TN, VN | -1.53 | -1.38 | -1.53 |

| | | |
|-----------------------|-------|-----|
| Maximum Power Density | -1.38 | dBm |
|-----------------------|-------|-----|



Date: 8.DEC.2015 12:47:57

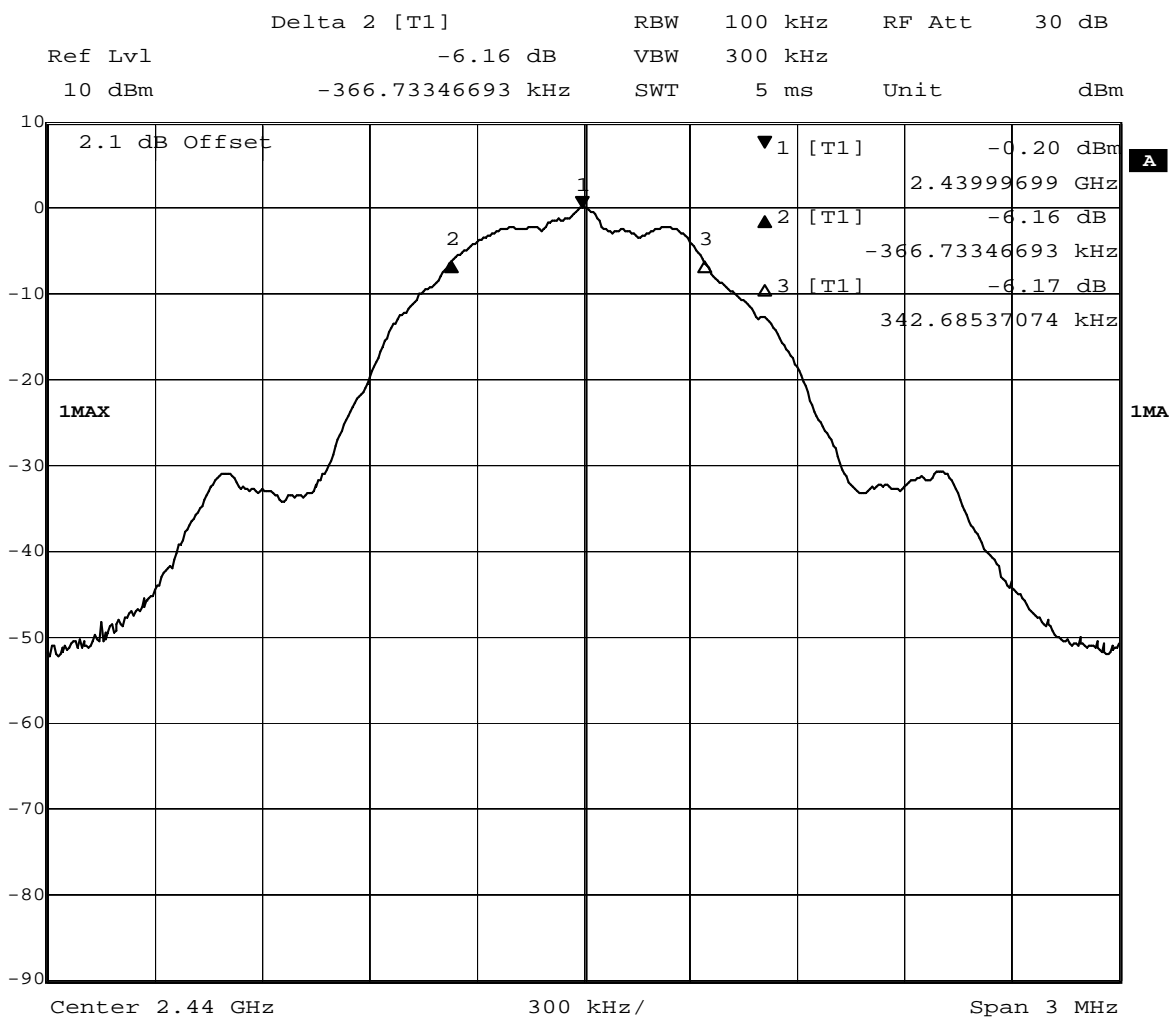
3.5.2 15c.11 6dB Bandwidth §15.247 (a) (2)

Test: 15c.11; 6dB Bandwidth Summary §15.247 (a) (2)

| | |
|----------------------------|--|
| <i>Result:</i> | Passed |
| <i>Setup No.:</i> | Setup_AD01 |
| <i>Date of Test:</i> | 2015/12/08 18:12 |
| <i>Body:</i> | FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES |
| <i>Test Specification:</i> | FCC part 2 and 15 |

Detailed Results:

| Modulation | Frequency | 6dB Bandwidth KHz |
|------------|-----------|-------------------|
| GFSK | 2402 MHz | 709.4 |
| | 2440 MHz | 709.4 |
| | 2480 MHz | 709.4 |



Date: 8.DEC.2015 12:57:48

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

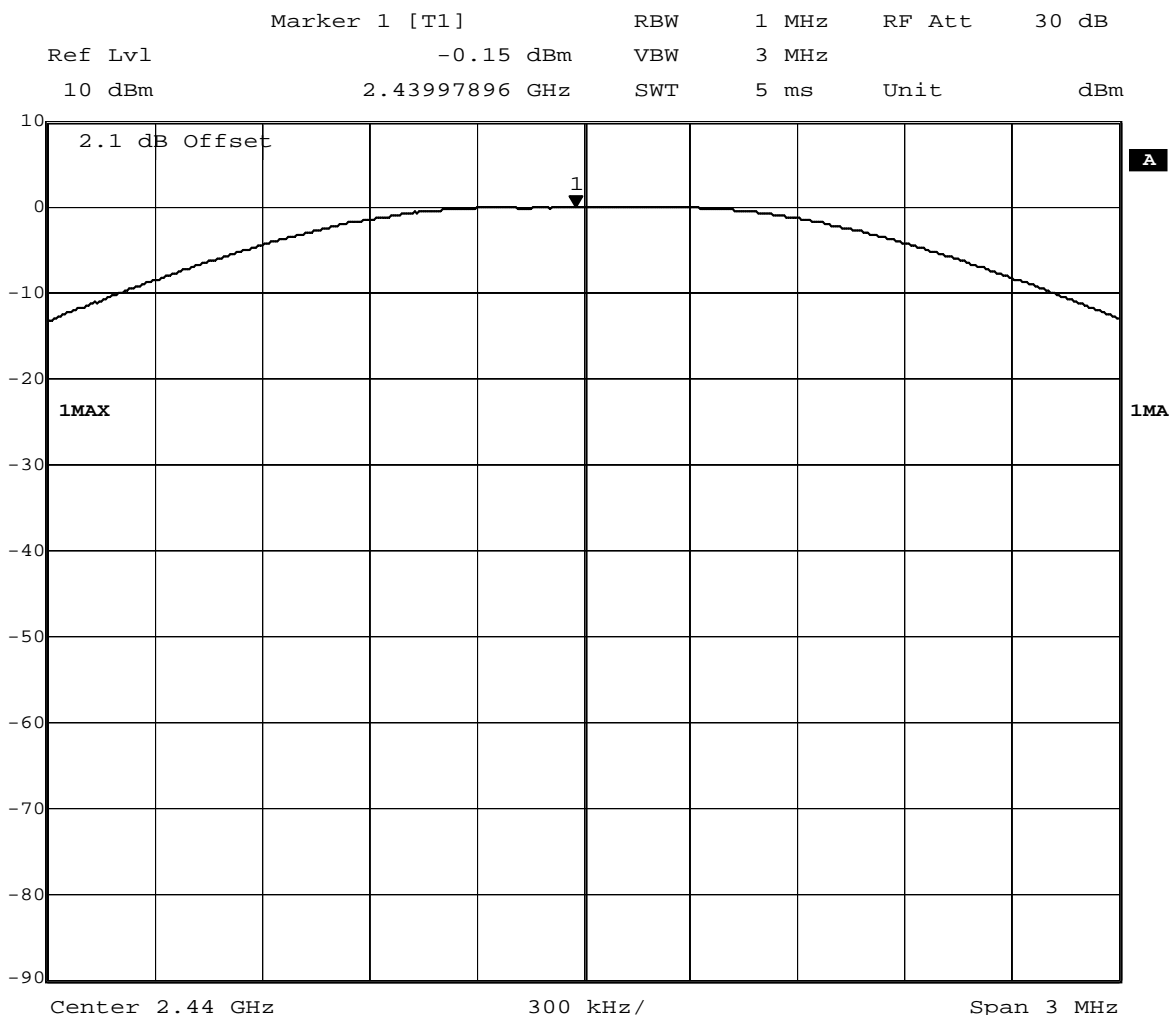
Test: 15c.4; Peak power output Summary

| | |
|----------------------------|--|
| <i>Result:</i> | Passed |
| <i>Setup No.:</i> | Setup_AD01 |
| <i>Date of Test:</i> | 2015/12/08 18:10 |
| <i>Body:</i> | FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES |
| <i>Test Specification:</i> | FCC part 2 and 15 |

Detailed Results:

| | | Conducted Transmitter Power | | | | | |
|------------|------------|-----------------------------|-------------------|--------------------|-------------------|--------------------|-------------------|
| | | 2402 MHz | | 2440 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 | -0.33 | 0.93 | -0.15 | 0.97 | -0.39 | 0.91 |

| | | | | |
|---|-------|-----|------|----|
| Max Conducted Output Power (FSK Modulation) | -0.15 | dBm | 0.97 | mW |
|---|-------|-----|------|----|



Date: 8.DEC.2015 12:18:12

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

Test: 15c.5; Spurious RF conducted emissions Summary §15.247 (d)

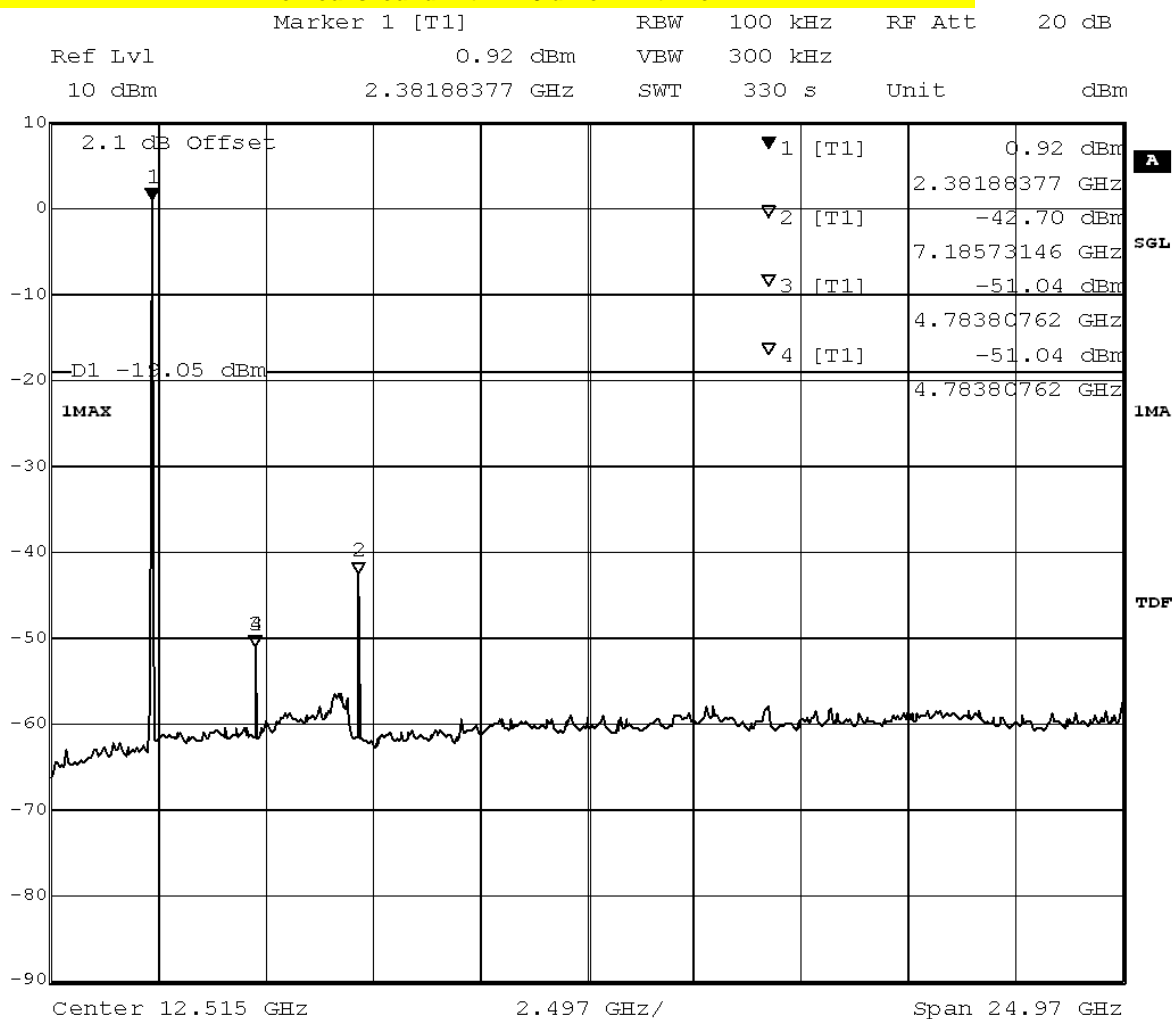
| | |
|----------------------------|--|
| <i>Result:</i> | Passed |
| <i>Setup No.:</i> | Setup_AD01 |
| <i>Date of Test:</i> | 2015/12/08 18:11 |
| <i>Body:</i> | FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES |
| <i>Test Specification:</i> | FCC part 2 and 15 |

Detailed Results:

| Frequency range 30 MHz - 26 GHz | | | BT transmit using 1 Mbps with GFSK modulation | | |
|---------------------------------|---------------------------|--------------------|---|-----------|--------------------|
| Channel (MHz) | Frequency of emission MHz | Measured value dBm | Reference value dBm | Limit dBm | Margin to limit dB |
| 2402 | ** | -42.70 | 0.95 | -19.05 | 23.65 |
| 2440 | ** | -43.54 | 1.08 | -18.92 | 24.62 |
| 2480 | ** | -44.88 | 0.86 | -19.14 | 25.74 |

* Reference value measured in the Band edge compliance test

** No Peaks found within 20 dB of limit line.



Title: spurious emissions
Comment A: CH B: 2402 MHz
Date: 8.DEC.2015 10:31:40

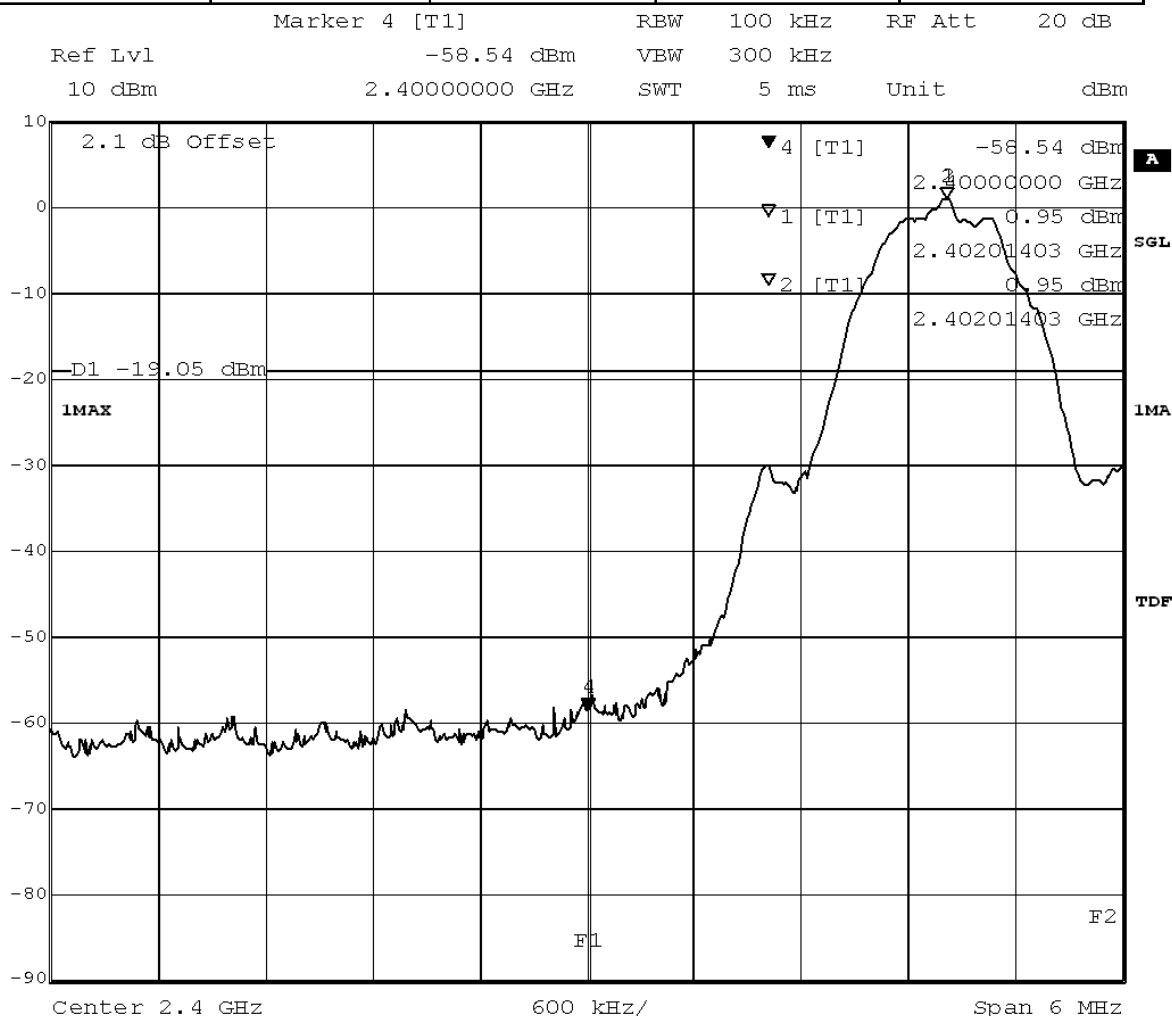
3.5.5 15c.6 Band edge compliance §15.247 (d)

Test: 15c.6; Frequency = 2402, Mode = BT transmit using 1 Mbps with GFSK modulation, Method = conducted, band edge = 2400 MHz

Result: Passed
Setup No.: Setup_AD01
Date of Test: 2015/12/08 18:08
Body: FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES
Test Specification: FCC part 2 and 15

Detailed Results:

| Frequency MHz | Measured value dBm | Reference value dBm | Limit dBm | Margin to limit dB |
|---------------|--------------------|---------------------|-----------|--------------------|
| 2400 | -58.54 | 0.95 | -19.05 | 39.49 |



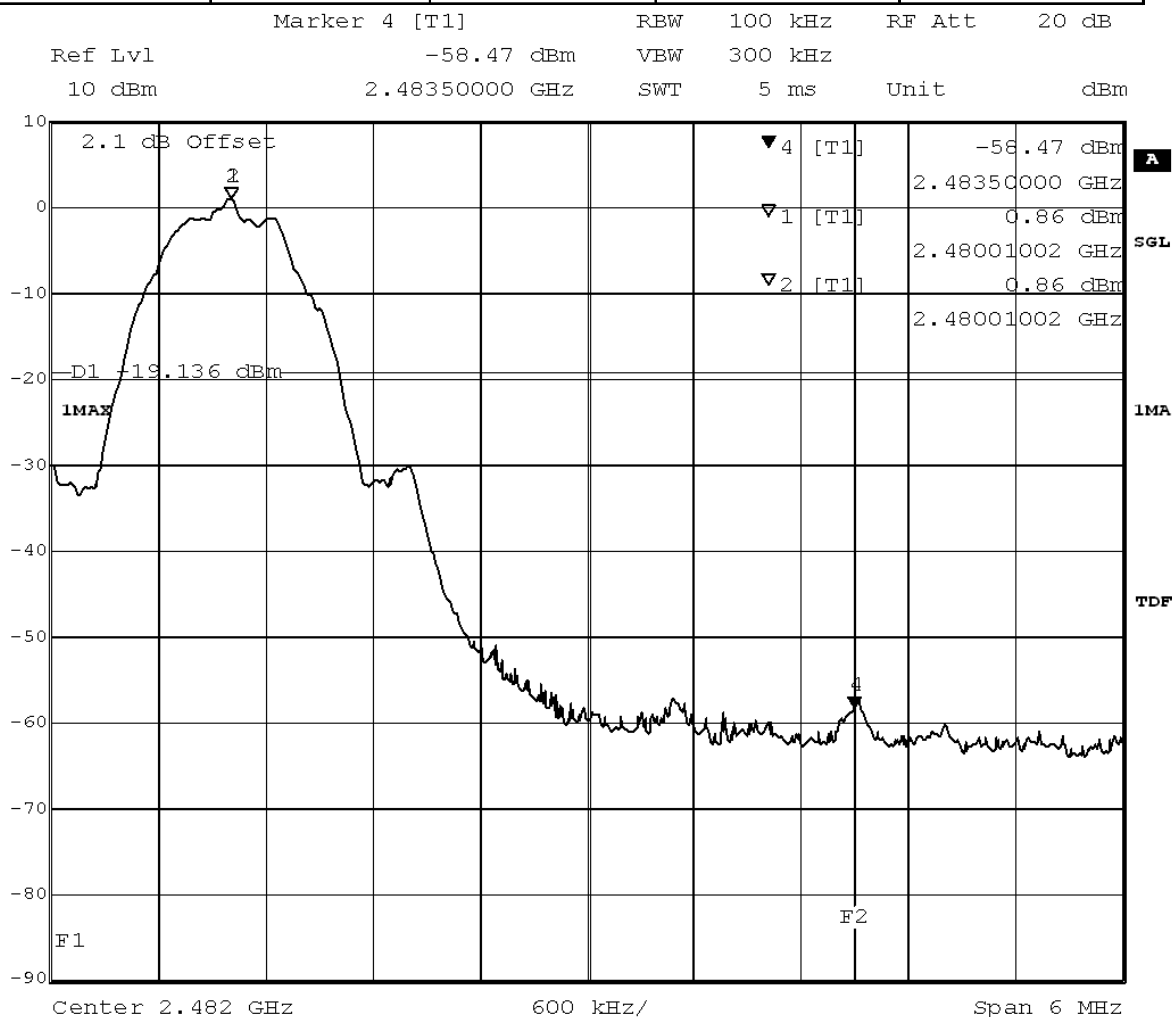
Title: Band Edge Compliance
Comment A: CH B: 2402 MHz
Date: 8.DEC.2015 10:19:37

Test: 15c.6; Frequency = 2480, Mode = BT transmit using 1 Mbps with GFSK modulation, Method = conducted, band edge = 2483.5 MHz

Result: Passed
Setup No.: Setup_AD01
Date of Test: 2015/12/08 18:09
Body: FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES
Test Specification: FCC part 2 and 15

Detailed Results:

| Frequency MHz | Measured value dBm | Reference value dBm | Limit dBm | Margin to limit dB |
|---------------|--------------------|---------------------|-----------|--------------------|
| 2484 | -58.47 | 0.86 | -19.14 | 39.34 |



Title: Band Edge Compliance
Comment A: CH T:2480 MHz
Date: 8.DEC.2015 11:02:07

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 Multimeter 12

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

Single Devices for Multimeter 12

| Single Device Name | Type | Serial Number | Manufacturer |
|------------------------------------|-------|---------------|--------------------------|
| Digital Multimeter 12 (Multimeter) | EX520 | 05157876 | Extech Instruments Corp. |

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 | |
| | <i>Calibration Details</i> | | <i>Last Execution</i> <i>Next Exec.</i> |
| | Standard Calibration | | 2015/08/20 2016/08/19 |
| Power Meter NRVD | NRVD | 832025/059 | |
| | <i>Calibration Details</i> | | <i>Last Execution</i> <i>Next Exec.</i> |
| | Standard Calibration | | 2015/08/19 2016/08/18 |
| Power Sensor NRV Z1 A | PROBE | 832279/013 | |
| | <i>Calibration Details</i> | | <i>Last Execution</i> <i>Next Exec.</i> |
| | Standard Calibration | | 2015/08/18 2016/08/17 |
| Power Supply | NGSM 32/10 | 2725 | |
| | <i>Calibration Details</i> | | <i>Last Execution</i> <i>Next Exec.</i> |
| | Standard calibration | | 2015/06/22 2017/06/21 |
| Rubidium Frequency Normal MFS | Datum MFS | 002 | |
| | <i>Calibration Details</i> | | <i>Last Execution</i> <i>Next Exec.</i> |
| | Standard Calibration | | 2015/08/25 2016/08/24 |
| Signal Analyser FSIQ26 | 1119.6001.26 | 832695/007 | |
| Vector Signal Generator SMIQ03B | SMIQ03B | 832870/017 | |
| | <i>Calibration Details</i> | | <i>Last Execution</i> <i>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/H Logger 15

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

Single Devices for T/H Logger 15

| Single Device Name | Type | Serial Number | Manufacturer |
|---|----------------------|---------------|---|
| ThermoHygro Datalogger 15 (Environ) | Opus10 THI (8152.00) | 13985 | |
| <i>Calibration Details</i> | | | <i>Last Execution</i> <i>Next Exec.</i> |
| Customized calibration | | | 2015/03/10 2017/03/09 |

Test Equipment Temperature Chamber 01

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

Single Devices for Temperature Chamber 01

| Single Device Name | Type | Serial Number | Manufacturer |
|---------------------------------|------------|----------------|---|
| Temperature Chamber Weiss 01 | KWP 120/70 | 59226012190010 | |
| <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

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

Technical Report Summary

Type of Authorization :

Certification for an Intentional Radiator (Digital Device / 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 "Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247, 558074 D01 DTS Meas Guidance v03r03, 2015-06-09".

ANSI C63.10-2013 is applied.

Description of Methods of Measurements

Conducted emissions (AC power line)

Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C 63.10,

Test Description

The test set-up was made in accordance with 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 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 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): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Span: 3
- Detector: Peak / Sample (6 dB bandwidth / 99% bandwidth)

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.

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

Peak power output

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 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:

- Detector: Peak

Test Requirements / Limits

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

For systems using digital modulation techniques in the 902-928 MHz and 2400-2483.5 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) = $10 \log (\text{Limit (W)}/1\text{mW})$

Spurious RF conducted emissions

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

Spurious radiated emissions

Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C 63.10,

Test Description

The test set-up was made in accordance to the general provisions of ANSI C63.10 in a typical installation configuration.

The Equipment Under Test (EUT) was set up on a non-conductive table 1.0 x 2.0 m² in the semi-anechoic chamber. The influence of the EUT support table that is used between 30–1000 MHz was evaluated.

The measurement procedure is implemented into the EMI test software ES-K1 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 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 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 $\pm 22.5^\circ$ 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 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 $+22.5^\circ$ 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 1.4 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 standard gain 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 (MHz) | Limit ($\mu\text{V/m}$) | Measurement distance (m) | Limit @ 10 m distance (dB $\mu\text{V/m}$) |
|-----------------|---------------------------|--------------------------|--|
| 0.009 – 0.49 | 2400/F(kHz) | 300 | $48.5..13.8 + 59.1 \text{ dB} = 107.6..72.9$ |
| 0.49 – 1.705 | 24000/F(kHz) | 30 | $33.8..23.0 + 19.1 \text{ dB} = 52.9..42.1$ |
| 1.705 - 30 | 30 | 30 | $29.5 + 19.1 = 48.6$ |

| Frequency (MHz) | Limit ($\mu\text{V/m}$) | Measurement distance (m) | Limit (dB $\mu\text{V/m}$) |
|-----------------|---------------------------|--------------------------|-----------------------------|
| 30 - 88 | 100 | 3 | 40.0 |
| 88 - 216 | 150 | 3 | 43.5 |

| | | | |
|-----------|-----|---|------|
| 216 - 960 | 200 | 3 | 46.0 |
| above 960 | 500 | 3 | 54.0 |

§15.35(b)

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

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

Band edge compliance

Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C 63.10, 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 for radiated measurement:

- 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)".

Power Density

Standard FCC Part 15, Subpart C

The test was performed according to: FCC §15.31

Test Description

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

Analyzer settings:

- Detector: Peak-Maxhold
- Resolution Bandwidth (RBW): 3 kHz
- Video Bandwidth (VBW): 30 kHz
- Sweep Time: Coupled

Test Requirements / Limits

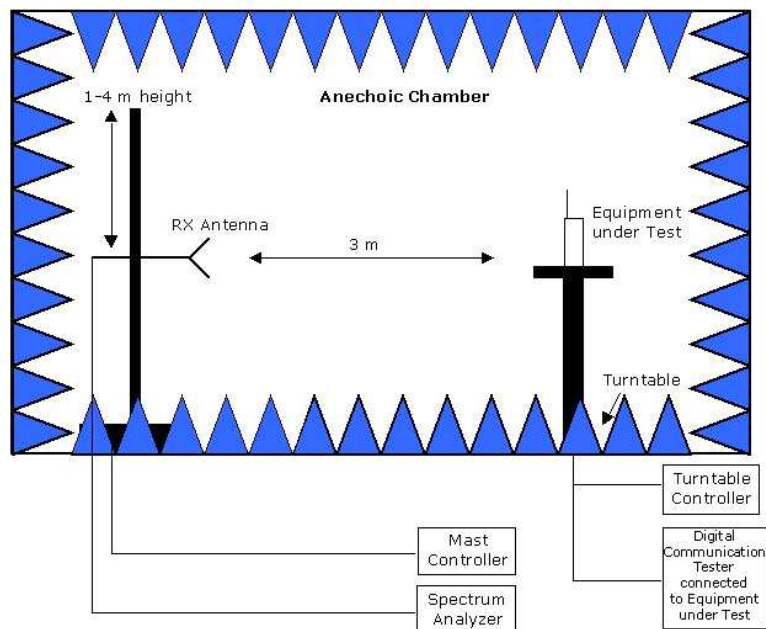
FCC Part 15, Subpart C, §15.247 (e)

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.

Setup Drawings

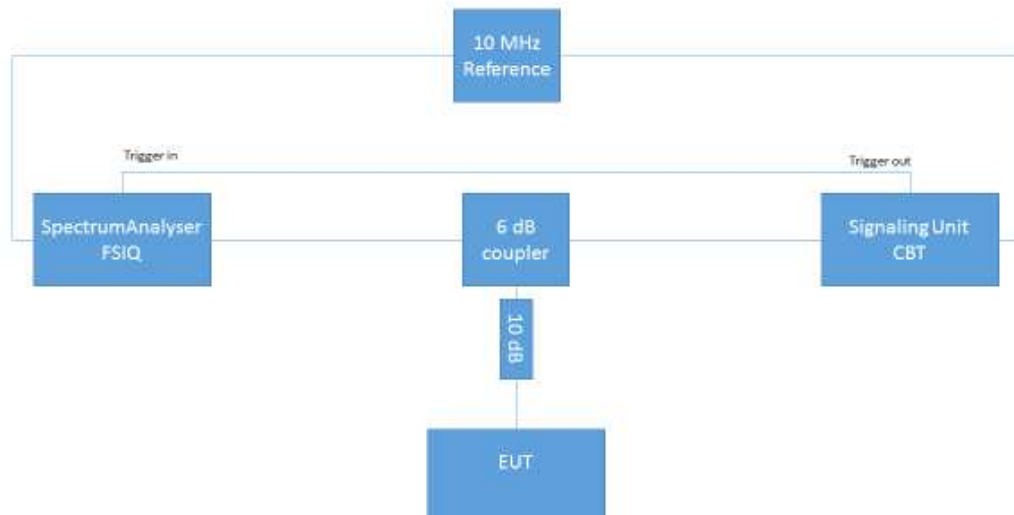


Remark: Depending on the frequency range suitable antenna types, attenuators or preamplifiers are used.

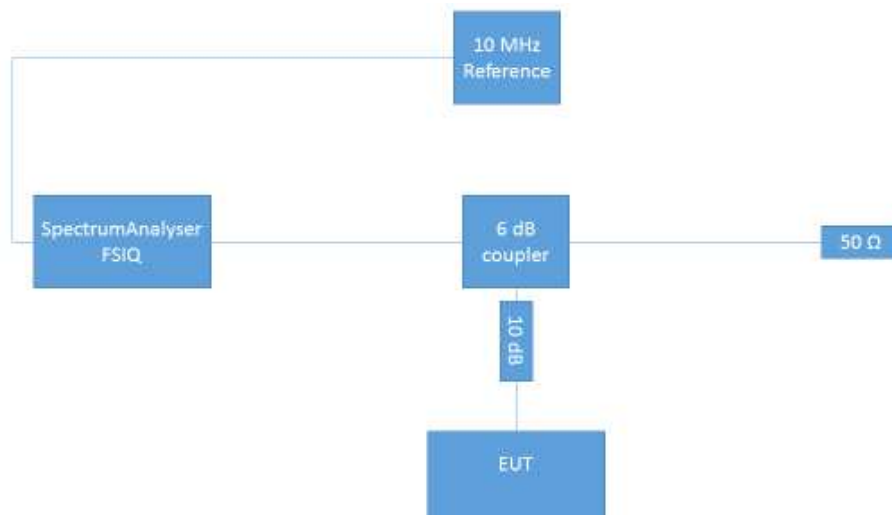
Setup in the Anechoic chamber:

Measurements below 1 GHz: Semi-anechoic, conducting ground plane.

Measurements above 1 GHz: Fully-anechoic, absorbers on all surfaces



Test Setup; Conducted Tests; Bluetooth normal mode (BDR/EDR)



Test Setup; Conducted Tests; Bluetooth Low Energy Mode

September, 2015

To Whom This May Concern

**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; RSS-247 Issue 1: 5.5 |
| Transmitter spurious radiated emissions | § 15.247 (d); § 15.209 (a) | RSS-Gen Issue 4: 6.13 / 8.9/8.10; 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 | – | – |

Measurement Uncertainties

FCC Part 22, 24, 27, 90
IC RSS-132, RSS-133, RSS-139

| Test Case | Parameter | Uncertainty |
|--|--------------------|---|
| RF Power Output | Power | ± 2.2 dB |
| Frequency Stability | Frequency | ± 25 Hz |
| Spurious Emissions at antenna terminal | Power | ± 2.2 dB |
| Field strength of spurious radiation | Power | ± 4.5 dB |
| Emission and Occupied Bandwidth | Power Frequency | ± 2.9 dB GSM: ± 10.6 kHz UMTS, LTE: ± 120.0 kHz |
| Band Edge Compliance | Power Frequency | ± 2.9 dB GSM: ± 14.6 kHz UMTS, LTE: ± 68.0 kHz |

FCC Part 15b
IC ICES-003

| Test Case | Parameter | Uncertainty |
|--------------------------------------|-----------|--------------|
| AC Power Line | Power | ± 3.4 dB |
| Field Strength of spurious radiation | Power+ | ± 5.5 dB |

FCC Part 15c, 15e
IC RSS-210, IC RSS-247

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

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