

Inter**Lab**[®]

Final Report on

FC6000+ (variant HIA)

FCC ID 2AGKOF6000P

IC: 20878-FC6000P

Report Reference: MDE_PARRO_1529_FCCd
acc. 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: 2015/12/02
Date of last test: 2015/12/02

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

Company Name : 7layers GmbH
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

| Lab ID | Identification | Responsible | Accreditation Info |
|--------|--------------------|--------------------------------------|---|
| Lab 1 | Radiated Emissions | Mr. Marco Kullik Mr. Jens Dörwald | DAkKS-Registration no. D-PL-12140-01-01 |

1.4 Signature of the Testing Responsible


Imad Hjije
responsible for tests performed in: Lab 1

1.5 Signature of the Accreditation Responsible

 [B. RETKA]

Accreditation scope responsible person
responsible for Lab 1

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 2AGK0FC6000P
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 : af01

| | | | |
|--------------------|-----------------------|--------------|-------|
| OUT Identifier | FC6000+ | | |
| | FCC ID 2AGK0FC6000P | | |
| | IC: 20878-FC6000P | | |
| Sample Description | BT classic sample HIA | | |
| Serial No. | PF815000BB5G000286 | | |
| 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 | 2441 (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 | | |
| 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 AUX2 | FC6000+_MEZZ_HW0 | T1507-038 | | | Mezzanine |
| AE AUX4 | Inverted F Antenna for 2.4 GHz | | | | PCB antenna |
| AE AUX1 | WB_CEM_FC6XXX_HW03 | | | | 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_AF01 | | | | |
| | Sample: af01 | BT classic sample HIA | AE AUX2 | 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 contains only a reduced test plan which was performed on the variant HIA of the module FC6000+. Reduced radiated spurious emissions tests as well as reduced radiated band edge tests

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.2 Spurious radiated emissions §15.247 (d), §15.35 (b), §15.209 | | | | |
| 15c.2; Frequency = 2480, Mode = BT transmit using 1 Mbps with GFSK modulation, Channel = highest | Passed | 2015/12/02 | Lab 1 | Setup_AF01 |
| 15c.2; Frequency = 2480, Mode = BT transmit using 2 Mbps with PI/4 DQPSK modulation | Passed | 2015/12/02 | Lab 1 | Setup_AF01 |
| 15c.6 Band edge compliance §15.247 (d) | | | | |
| 15c.6; Frequency = 2480, Mode = BT transmit using 1 Mbps with GFSK modulation, Method = radiated | Passed | 2015/12/02 | Lab 1 | Setup_AF01 |
| 15c.6; Frequency = 2480, Mode = BT transmit using 2 Mbps with PI/4 DQPSK modulation, Method = radiated | Passed | 2015/12/02 | Lab 1 | Setup_AF01 |
| 15c.6; Frequency = 2480, Mode = BT transmit using 3 Mbps with 8DPSK modulation, Method = radiated | Passed | 2015/12/02 | Lab 1 | Setup_AF01 |

3.5 Detailed Results

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

Test: 15c.2; Frequency = 2480, Mode = BT transmit using 1 Mbps with GFSK modulation, Channel = highest

Result: Passed
Setup No.: Setup_AF01
Date of Test: 2015/12/02 18:09
Body: FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES
Test Specification: FCC part 2 and 15

Detailed Results:

Traffic Mode FCC 15.247 (15.35b,15.209) TX on 2480 MHz 1-DH1

Frequency range 1 GHz - 25 GHz

| 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 |
|-------------|-----------------|-----------------|-----------------|---------------------------|---------------------------|----------------|----------------|--------|
| Ver + Hor | 74 | 54 | - | - | - | - | - | Passed |
| | | | | | | | | |
| | | | | | | | | |

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

Test: 15c.2; Frequency = 2480, Mode = BT transmit using 2 Mbps with PI/4 DQPSK modulation

Result: Passed
Setup No.: Setup_AF01
Date of Test: 2015/12/02 8:37
Body: FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES
Test Specification: FCC part 2 and 15

Detailed Results:

Traffic Mode FCC 15.247 (15.35b,15.209) TX on 2480 MHz 2-DH1

Frequency range 1 GHz - 8 GHz

| 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 |
|-------------|-----------------|-----------------|-----------------|---------------------------|---------------------------|----------------|----------------|--------|
| Ver + Hor | 74 | 54 | - | - | - | - | - | Passed |
| | | | | | | | | |
| | | | | | | | | |

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

3.5.2 15c.6 Band edge compliance §15.247 (d)

Test: 15c.6; Frequency = 2480, Mode = BT transmit using 1 Mbps with GFSK modulation, Method = radiated

Result: Passed
Setup No.: Setup_AF01
Date of Test: 2015/12/02 8:33
Body: FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES
Test Specification: FCC part 2 and 15

Detailed Results:

| 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 |
|----------|-------------|-----------------|-----------------|-----------------|---------------------------|---------------------------|----------------|----------------|--------|
| 2480 MHz | Ver + Hor | 74 | 54 | 2483.5 | 44.66 | 34.10 | 29.34 | 19.90 | Passed |

Test: 15c.6; Frequency = 2480, Mode = BT transmit using 2 Mbps with PI/4 DQPSK modulation, Method = radiated

Result: Passed
Setup No.: Setup_AF01
Date of Test: 2015/12/02 8:38
Body: FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES
Test Specification: FCC part 2 and 15

Detailed Results:

| 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 |
|----------|-------------|-----------------|-----------------|-----------------|---------------------------|---------------------------|----------------|----------------|--------|
| 2480 MHz | Ver + Hor | 74 | 54 | 2483.5 | 45.15 | 34.62 | 28.85 | 19.38 | Passed |

Test: 15c.6; Frequency = 2480, Mode = BT transmit using 3 Mbps with 8DPSK modulation, Method = radiated

Result: Passed
Setup No.: Setup_AF01
Date of Test: 2015/12/02 8:44
Body: FCC47CFRChIPART15c247RADIO FREQUENCY DEVICES
Test Specification: FCC part 2 and 15

Detailed Results:

| Diagram No. | 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 |
|--------------|----------|-------------|-----------------|-----------------|-----------------|---------------------------|---------------------------|----------------|----------------|--------|
| xxx_yyyy_004 | 2480 MHz | Ver + Hor | 74 | 54 | 2483.5 | 45.22 | 34.29 | 28.78 | 19.71 | Passed |

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

| | | | |
|---------------------|---------------------------------------|-----------------------|-------------------|
| Lab ID: | Lab 1 | | |
| <i>Description:</i> | Anechoic Chamber for radiated testing | | |
| <i>Type:</i> | 10.58x6.38x6.00 m ³ | | |
| | <i>Calibration Details</i> | <i>Last Execution</i> | <i>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 | - | |
| Anechoic Chamber | 10.58 x 6.38 x 6.00 m ³ | none | |
| | <i>Calibration Details</i> | | <i>Last Execution</i> <i>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 | - | |
| EMC camera Nr.2 | CCD-400E | 0005033 | |
| Filter ISDN | B84312-C110-E1 | | |
| Filter Universal 1A | BB4312-C30-H3 | - | |

Test Equipment Auxiliary Equipment for Radiated emissions

| | |
|-----------------------|-------------------------------------|
| Lab ID: | Lab 1 |
| <i>Description:</i> | Equipment for emission measurements |
| <i>Serial Number:</i> | see single devices |

Single Devices for Auxiliary Equipment for Radiated emissions

| <i>Single Device Name</i> | <i>Type</i> | <i>Serial Number</i> | <i>Manufacturer</i> |
|-------------------------------------|----------------------------|----------------------|---|
| Antenna mast | AM 4.0 | AM4.0/180/11920 513 | Maturo GmbH |
| Biconical Broadband Antenna | SBA 9119 | 9119-005 | |
| Biconical dipole | VUBA 9117 | 9117-108 | |
| Broadband Amplifier 1 GHz - 4 GHz | AFS4-01000400-1Q-10P-4 | - | |
| Broadband Amplifier 18 GHz - 26 GHz | JS4-18002600-32-5P | 849785 | |
| Broadband Amplifier 30 MHz - 18 GHz | JS4-00101800-35-5P | 896037 | |
| Cable "ESI to EMI Antenna" | EcoFlex10 | W18.01-2+W38.01-2 | |
| Cable "ESI to Horn Antenna" | SucoFlex | W18.02-2+W38.02-2 | |
| Double-ridged horn | HF 906 | 357357/002 | Rohde & Schwarz GmbH & Co. KG |
| | <i>Calibration Details</i> | | <i>Last Execution</i> <i>Next Exec.</i> |
| | Standard Calibration | | 2015/06/23 2018/06/22 |

Single Devices for Auxiliary Equipment for Radiated emissions (continued)

| <i>Single Device Name</i> | <i>Type</i> | <i>Serial Number</i> | <i>Manufacturer</i> |
|---|--------------------------------|------------------------|---|
| Double-ridged horn | HF 907 | 102444 | Rohde & Schwarz GmbH & Co. KG |
| | <i>Calibration Details</i> | | <i>Last Execution</i> <i>Next Exec.</i> |
| | Standard Calibration | | 2015/05/11 2018/05/10 |
| Double-ridged horn-duplicated 2015-07-15 10:47:55 | HF 906 | 357357/001 | Rohde & Schwarz GmbH & Co. KG |
| High Pass Filter | 4HC1600/12750-1.5-KK | 9942011 | |
| High Pass Filter | 5HC2700/12750-1.5-KK | 9942012 | |
| High Pass Filter | 5HC3500/18000-1.2-KK | 200035008 | |
| High Pass Filter | WHKX 7.0/18G-8SS | 09 | |
| Horn Antenna Schwarzbeck 15-26.5 GHz BBHA 9170 | BBHA 9170 | BBHA9170262 | |
| Log.-per. Antenna | HL 562 Ultralog | 100609 | Rohde & Schwarz GmbH & Co. KG |
| | <i>Calibration Details</i> | | <i>Last Execution</i> <i>Next Exec.</i> |
| | Standard Calibration | | 2012/12/18 2015/12/17 |
| Log.-per. Antenna (upgraded) | HL 562 Ultralog new biconicals | 830547/003 | Rohde & Schwarz GmbH & Co. KG |
| | <i>Calibration Details</i> | | <i>Last Execution</i> <i>Next Exec.</i> |
| | Standard Calibration | | 2015/06/30 2018/06/29 |
| Loop Antenna | HFH2-Z2 | 829324/006 | Rohde & Schwarz GmbH & Co. KG |
| | <i>Calibration Details</i> | | <i>Last Execution</i> <i>Next Exec.</i> |
| | DKD Calibration | | 2014/11/27 2017/11/27 |
| Standard Gain / Pyramidal Horn Antenna 40 GHz | 3160-10 | 00086675 | |
| Tilt device Maturo (Rohacell) | Antrieb TD1.5-10kg | TD1.5-10kg/024/3790709 | Maturo GmbH |

Test Equipment Auxiliary Test Equipment

Lab ID: **Lab 1**
Description: Single Devices for various Test Equipment
Type: various
Serial Number: none

Single Devices for Auxiliary Test Equipment

| Single Device Name | Type | Serial Number | Manufacturer |
|-------------------------------------|------------------|----------------------------|----------------------------------|
| Broadband Power Divider N (Aux) | 1506A / 93459 | LM390 | |
| Broadband Power Divider SMA | WA1515 | A855 | |
| Digital Multimeter 03 (Multimeter) | Fluke 177 | 86670383 | |
| | | <i>Calibration Details</i> | <i>Last Execution Next Exec.</i> |
| | | Customized calibration | 2013/12/04 2015/12/03 |
| Digital Multimeter 13 (Clamp Meter) | Fluke 325 | 31270091WS | FLUKE |
| Fibre optic link Satellite (Aux) | FO RS232 Link | 181-018 | |
| Fibre optic link Transceiver (Aux) | FO RS232 Link | 182-018 | |
| Isolating Transformer | LTS 604 | 1888 | |
| Notch Filter Ultra Stable (Aux) | WRCA800/960-6EEK | 24 | |
| 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 | FSU26 | 200418 | |
| | | <i>Calibration Details</i> | <i>Last Execution Next Exec.</i> |
| | | Standard calibration | 2015/10/20 2016/10/19 |
| Spectrum Analyzer | FSP3 | 836722/011 | Rohde & Schwarz GmbH & Co. KG |
| | | <i>Calibration Details</i> | <i>Last Execution Next Exec.</i> |
| | | DKD calibration | 2015/06/23 2018/06/22 |
| Vector Signal Generator | SMIQ 03B | 832492/061 | |

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 |
|---|---|---------------|-------------------------------|
| CMW500 | CMW500 | 107500 | |
| | Calibration Details | | Last Execution Next Exec. |
| | Standard calibration | | 2014/01/27 2016/01/26 |
| Digital Radio Communication Tester | CMD 55 | 831050/020 | Rohde & Schwarz GmbH & Co. KG |
| | Calibration Details | | Last Execution Next Exec. |
| | DKD calibration | | 2014/12/02 2017/12/01 |
| Universal Radio Communication Tester | CMU 200 | 837983/052 | Rohde & Schwarz GmbH & Co. KG |
| | Calibration Details | | Last Execution Next Exec. |
| | DKD calibration | | 2014/12/03 2017/12/02 |
| | HW/SW Status | | Date of Start Date of End |
| | HW options: | | 2007/01/02 |
| | B11, B21V14, B21-2, B41, B52V14, B52-2, B53-2, B54V14, B56V14, B68 3v04, B95, PCMCIA, U65V02 | | |
| Vector Signal Generator | SW options: | 100912 | |
| | 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 | | |
| | SMU200A | | 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

| Single Device Name | Type | Serial Number | Manufacturer | | |
|-------------------------------------|---|---------------|----------------------------------|----------------|-------------|
| EMI Receiver / Spectrum Analyzer | ESR 7 | 101424 | | | |
| | Calibration Details | | | Last Execution | Next Exec. |
| | Initial Factory Calibration | | | 2014/11/13 | 2016/11/12 |
| Personal Computer | Dell | 30304832059 | | | |
| Power Meter | NRVD | 828110/016 | | | |
| | Calibration Details | | | Last Execution | Next Exec. |
| | Standard calibration | | | 2015/05/11 | 2016/05/10 |
| Sensor Head A | NRV-Z1 | 827753/005 | | | |
| | Calibration Details | | | Last Execution | Next Exec. |
| | Standard calibration | | | 2015/05/11 | 2016/05/10 |
| Signal Generator | SMR 20 | 846834/008 | Rohde & Schwarz GmbH & Co. KG | | |
| | Calibration Details | | | Last Execution | Next Exec. |
| | Standard Calibration | | | 2014/06/24 | 2017/06/23 |
| Spectrum Analyzer | ESIB 26 | 830482/004 | Rohde & Schwarz GmbH & Co. KG | | |
| | Calibration Details | | | Last Execution | Next Exec. |
| | Standard Calibration | | | 2014/01/07 | 2016/01/31 |
| | HW/SW Status | | | Date of Start | Date of End |
| | Firmware-Update 4.34.4 from 3.45 during calibration | | | 2009/12/03 | |
| Spectrum Analyzer | FSW 43 | 103779 | | | |
| | Calibration Details | | | Last Execution | Next Exec. |
| | Initial Factory Calibration | | | 2014/11/17 | 2016/11/16 |

Test Equipment Multimeter 03

Lab ID: Lab 1
Description: Fluke 177
Serial Number: 86670383

Single Devices for Multimeter 03

| Single Device Name | Type | Serial Number | Manufacturer | | |
|---------------------------------------|------------------------|---------------|--------------|----------------|------------|
| Digital Multimeter 03 (Multimeter) | Fluke 177 | 86670383 | | | |
| | Calibration Details | | | Last Execution | Next Exec. |
| | Customized calibration | | | 2013/12/04 | 2015/12/03 |

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 | |
| <i>Calibration Details</i> | | | <i>Last Execution</i> <i>Next Exec.</i> |
| Customized calibration | | | 2015/02/27 2017/02/26 |

Test Equipment T/H Logger 12

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

Single Devices for T/H Logger 12

| Single Device Name | Type | Serial Number | Manufacturer |
|---|----------------------|---------------|---|
| ThermoHygro Datalogger 12 (Environ) | Opus10 THI (8152.00) | 12482 | |
| <i>Calibration Details</i> | | | <i>Last Execution</i> <i>Next Exec.</i> |
| Customized calibration | | | 2015/03/10 2017/03/09 |

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 (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 C63.10-2013 is applied.

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

The following table shows the correlation of measurement requirements for FHSS equipment (e.g. Bluetooth) from FCC and IC Standards.

| Measurement | FCC reference | IC reference |
|---------------------------------|----------------------|---|
| Conducted emissions on AC mains | § 15.207 | RSS-Gen Issue 4: 8.8 |
| Occupied bandwidth | § 15.247 (a) (1) | RSS-247 Issue 1: 5.1 (2) |
| Peak power output | § 15.247 (b) (1),(4) | RSS-247 Issue 1: 5.4 (2) |
| Spurious RF conducted emissions | § 15.247 (d) | RSS-Gen Issue 4: 6.13/8.9/8.10; RSS-247 Issue 1: 5.5 |
| Spurious radiated emissions | § 15.247 (d) | 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 |
| Dwell time | § 15.247 (a)(1)(iii) | RSS-247 Issue 1: 5.1 (4) |
| Channel separation | § 15.247 (a)(1) | RSS-247 Issue 1: 5.1 (2) |
| No. of hopping frequencies | § 15.247 (a)(1)(iii) | RSS-247 Issue 1: 5.1 (4) |
| Hybrid systems (only) | § 15.247 (e), (f) | RSS-247 Issue 1: 5.3 |
| Antenna requirement | § 15.203 / 15.204 | RSS-Gen Issue 4: 8.3 |
| Receiver spurious emissions | - - - | - - - |

Description of Methods of Measurements

Conducted emissions (AC power line)

Standard FCC Part 15, Subpart C

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

Test Description

The test set-up was made in accordance to the general provisions of ANSI C63.10. The Equipment Under Test (EUT) was setup in a shielded room to perform the conducted emissions measurements in a typical installation configuration. The EUT was powered from 50 μ H || 50 Ohm Line Impedance Stabilization Network (LISN). The LISN's unused connections were terminated with 50 Ohm loads. The measurement procedure consists of two steps. It is implemented into the EMI test software 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 (dB μ V) | AV Limit (dB μ V) |
|--------------------------|--------------------------|--------------------------|
| 0.15 – 0.5 | 66 to 56 | 56 to 46 |
| 0.5 – 5 | 56 | 46 |
| 5 – 30 | 60 | 50 |

Used conversion factor: Limit (dB μ V) = 20 log (Limit (μ V)/1 μ V).

Occupied bandwidth

Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C63.10

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.

Peak power output

Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C63.10

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

Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C63.10

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 C63.10,

Test Description

The test set-up was made in accordance to the general provisions of ANSI C63.4 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 μ s (BT Timing 1.25 ms)
- Turntable angle range: -180 to $+180^\circ$
- 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 $+180^\circ$
- 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 (µV/m) | Measurement distance (m) | Limit @ 10 m distance (dBµV/m) |
|-----------------|--------------|--------------------------|------------------------------------|
| 0.009 – 0.49 | 2400/F(kHz) | 300 | 48.5..13.8 + 59.1 dB = 107.6..72.9 |
| 0.49 – 1.705 | 24000/F(kHz) | 30 | 33.8..23.0 + 19.1 dB = 52.9..42.1 |
| 1.705 - 30 | 30 | 30 | 29.5 + 19.1 = 48.6 |

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

§15.35(b)

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

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

Band edge compliance

Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C63.10

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)".

Dwell time

Standard FCC Part 15, Subpart C

The test was performed according to: ANSI C63.10

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 independent from the modulation pattern. The dwell time is calculated by:

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

with:

- hop rate = $1600 \cdot 1/s$ for DH1 packets = 1600 s⁻¹
- hop rate = $1600/3 \cdot 1/s$ for DH3 packets = 533.33 s⁻¹
- hop rate = $1600/5 \cdot 1/s$ for DH5 packets = 320 s⁻¹
- number of hopping channels = 79
- $31.6 \text{ s} = 0.4 \text{ seconds multiplied by the number of hopping channels} = 0.4 \text{ s} \cdot 79$

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: ANSI C63.10

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: ANSI C63.10

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:

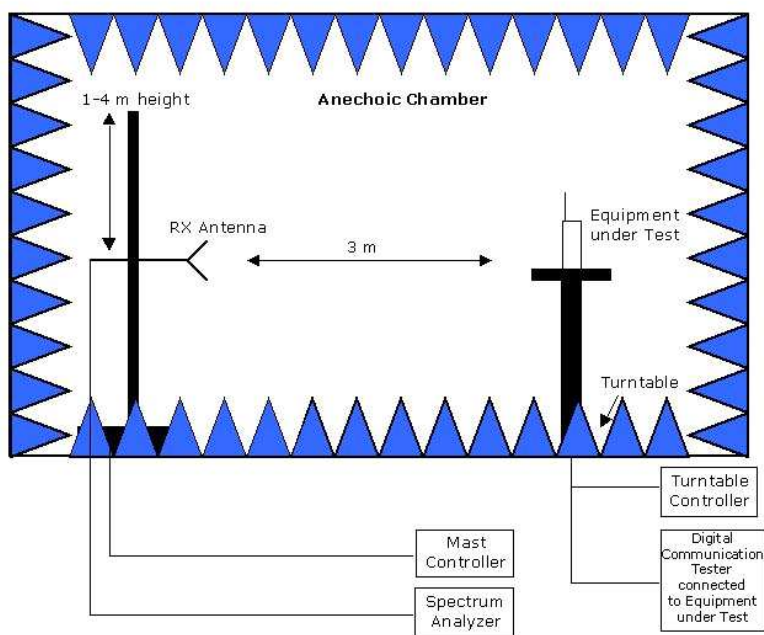
- Detector: Peak-Maxhold
- Centre frequency: 2442 MHz
- Frequency span: 84 MHz
- Resolution Bandwidth (RBW): 100 kHz
- Video Bandwidth (VBW): 300 kHz
- Sweep Time: Coupled

Test Requirements / Limits

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

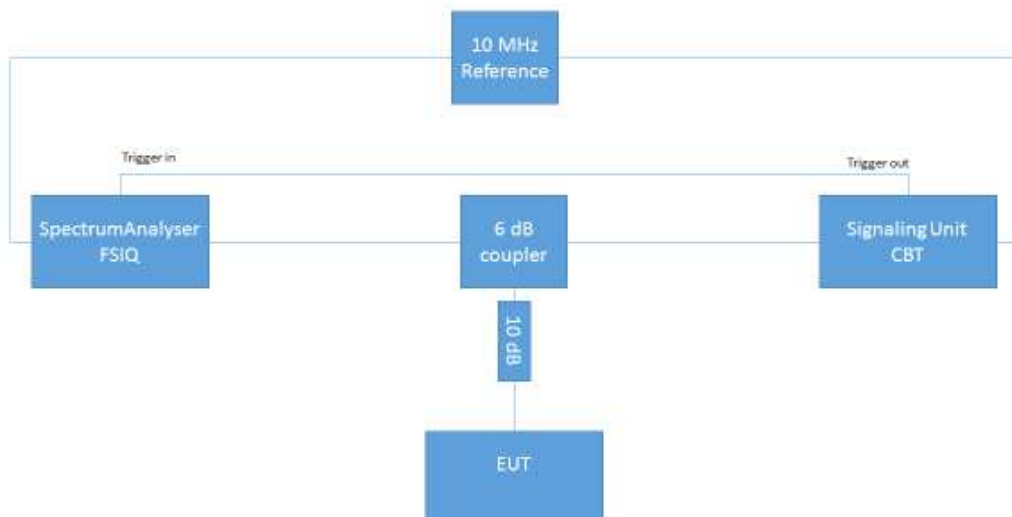
Frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels.

Setup Drawings

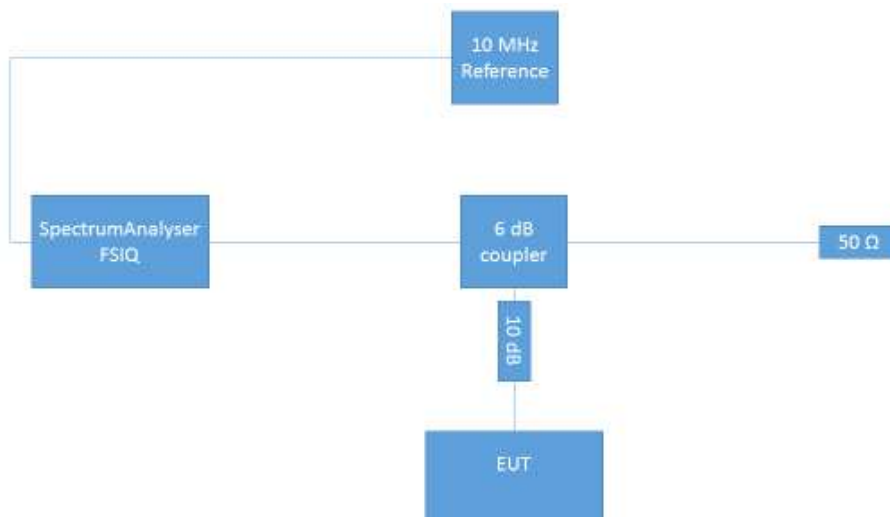


Remark: Depending on the frequency range suitable antenna types, attenuators or preamplifiers are used.

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

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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