InterLab®

# Final Report on

## SARA-R410M-02B CAT-M1 and NB-IoT Module

## FCC ID: XPY2AGQN4NNN
## IC: 8595A-2AGQN4NNN

according to FCC Part 22, Subpart H, Part 24, Subpart E and Part 27, Subpart C

| | |
|---|---|
| **Report Reference:** | MDE_UBLOX_1708_FCCb_rev1 |
| **Date:** | February 08, 2018 |


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


Deutsche Akkreditierungsstelle D-PL-12140-01-00

# 1 Administrative Data

## 1.1 Project Data

| | |
|---|---|
| *Project Responsible:* | Patrick Lomax |
| *Date Of Test Report:* | 2018/02/08 |
| *Date of first test:* | 2017/12/12 |
| *Date of last test:* | 2018/01/12 |

## 1.2 Test Laboratory Data

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

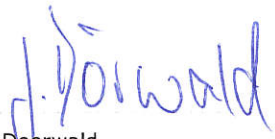
### 7 layers DE

| | |
|---|---|
| *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<br>Mr. Jens Dörwald | DAkkS-Registration no. D-PL-12140-01-00<br>ISEDC OATS registration number 3699A-1<br>FCC accreditation registration number 929146 |
| Lab 2 | Radio Lab | Mr. Dobrin Dobrinov<br>Mr. Daniel Gall | DAkkS-Registration no. D-PL-12140-01-00<br>ISEDC OATS registration number 3699A-1<br>FCC accreditation registration number 929146 |

### 1.3 Signature of the Testing Responsible



Jens Doerwald
responsible for tests performed in: Lab 1, Lab 2

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

### 1.4 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: SARA-R410M-02B**

| | |
|---|---|
| *Type / Model / Family:* | SARA-R410M-02B CAT-M1 and NB-IoT Module<br>FCC ID: XPY2AGQN4NNN<br>IC: 8595A-2AGQN4NNN |
| *Product Category:* | Module |
| ***Manufacturer:*** | |
| *Company Name:* | see applicant data |
| *Contact Person:* | see applicant data |

***Parameter List:***

| *Parameter name* | *Value* |
|---|---|
| AC Power Supply | 120V / 60Hz (V) |
| DC Power Supply | 12V via AC/DC Adapter (V) |
| highest channel | 20649 (848.9MHz) for NB-IoT eFDD5, 19199 (1909.9MHz) for NB-IoT eFDD2, 23179 (715.9MHz) for eFDD12, 23279 (786.9MHz) for NB-IoT eFDD13 |
| lowest channel | 20401 (824.1MHz) for NB-IoT eFDD5, 18601 (1850.1MHz) for NB-IoT eFDD2, 23011 (699.1MHz) for NB-IoT eFDD12, 23181 (777.1MHz) for NB-IoT eFDD13 |
| LTE_Operating Frequencies | See Annex |
| mid channel | 20525 (834.1MHz) for NB-IoT eFDD5, 18900 (1880.0MHz) for NB-IoT eFDD2, 23095 (707.5MHz) for NB-IoT eFDD12, 23230 (782.0MHz) for NB-IoT eFDD13 |

## 2.2 Detailed Description of OUT Samples

**Sample : ah01**

| | | | |
|---|---|---|---|
| *OUT Identifier* | SARA-R410M-02B | | |
| *Sample Description* | Standard Sample | | |
| *Serial No.* | 3527350900140757 | | |
| *HW Status* | 306A05 | | |
| *SW Status* | L0.0.00.00.05.01, A.01.01 | | |
| *Low Voltage* | 3.3 V | *Low Temp.* | -20 °C |
| *High Voltage* | 4.4 V | *High Temp.* | 65 °C |
| *Nominal Voltage* | 3.8 V | *Normal Temp.* | 25 °C |

## 2.3 OUT Features

**Features for OUT: SARA-R410M-02B**

| *Designation* | *Description* | *Allowed Values* | *Supported Value(s)* |
|---|---|---|---|
| **Features for scope: FCC_v2** | | | |
| Eant | removable antenna supplied and type tested with the radio equipment, designed as an indispensable part of the equipment | | |
| eFDD2 | | | |
| eFDD4 | | | |
| eFDD5 | | | |
| eFDD12 | | | |
| eFDD13 | | | |
| TantC | temporary antenna connector, which may be only built-in for testing, designed as an example part of the equipment | | |

## 2.4 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.

| *Setup No.* | *List of OUT samples* | | *List of auxiliary equipment* | |
|---|---|---|---|---|
| | *Sample No.* | *Sample Description* | *AE No.* | *AE Description* |
| **S01_ah01** | | | | |
| | *Sample:* ah01 | Standard Sample | AE AE01 | Evaluation test board |
| | | | AE AE02 | AC/DC converter |

# 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. All tests are performed under environmental conditions within the requirements of the specifications. Environmental conditions are available at the laboratory.

2. The SARA-R410M-02B module is a CAT-M1 and NB-IoT module This repot is related only to the NB-IoT bands 2, 5, 12 and 13.

3. This report replace report MDE_UBLOX_1708_FCCb
Changes made: added BPSK measurements to table of parts 22.5, 24.5 and 27.5.

## 3.2 List of the Applicable Body

(Bodies for Scope: FCC_v2)

| *Designation* | *Description* |
|---|---|
| FCC47CFRChIPART22PUBLIC MOBILE SERVICES | Part 22, Subpart H - Cellular Radiotelephone Service |
| FCC47CFRChIPART24PERSONAL COMMUNICATIONS SERVICES | Part 24, Subpart E - Broadband PCS |
| FCC47CFRChIPART27MISCELLANEOUS WIRELESS COMMUNICATIONS SERVICES | Part 27, Subpart C - Technical Standards |

## 3.3 List of Test Specification

| | |
|---|---|
| *Test Specification:* | **FCC part 2 and 22** |
| *Version* | 10-1-16 Edition |
| *Title:* | PART 2 - GENERAL RULES AND REGULATIONS<br>PART 22 - PUBLIC MOBILE SERVICES |

| *Applicable Errata* | *Activate Date* | *Comment* |
|---|---|---|
| ANSI C63.26-2015 | 17/07/01 | |

| | |
|---|---|
| *Test Specification:* | **FCC part 2 and 24** |
| *Date / Version* | 2015/10/01 Version: 10-1-16 Edition |
| *Title:* | PART 2 - GENERAL RULES AND REGULATIONS<br>PART 24 - PERSONAL COMMUNICATIONS SERVICES |

| *Applicable Errata* | *Activate Date* | *Comment* |
|---|---|---|
| ANSI C63.26-2015 | 17/07/01 | |

| | |
|---|---|
| *Test Specification:* | **FCC part 2 and 27** |
| *Version* | 10-1-16 Edition |
| *Title:* | PART 2 - GENERAL RULES AND REGULATIONS<br>PART 27 - MISCELLANEOUS WIRELESS COMMUNICATIONS SERVICES |

| *Applicable Errata* | *Activate Date* | *Comment* |
|---|---|---|
| ANSI C63.26-2015 | 17/07/01 | |

## 3.4 Summary

| *Test Case Identifier / Name*<br>*Test (condition)* | *Result* | *Date of Test* | *Lab Ref.* | *Setup* |
|---|---|---|---|---|
| **Test Specification: FCC part 2 and 22** | | | | |
| **22.1 RF Power Output §2.1046, §22.913** | | | | |
| 22.1; _RF Power Output Summary §2.1046, §22.913 | Passed | 2018/01/08 | Lab 2 | S01_ah01 |
| **22.2 Frequency stability §2.1055** | | | | |
| 22.2; _Frequency stability Summary §2.1055 | Passed | 2017/12/17 | Lab 2 | S01_ah01 |
| **22.3 Spurious emissions at antenna terminals §2.1051, §22.917** | | | | |
| 22.3; Spurious emissions at antenna terminals summary §2.1051, §22.917 | Passed | 2017/12/17 | Lab 2 | S01_ah01 |
| **22.4 Field strength of spurious radiation §2.1053, §22.917** | | | | |
| 22.4; Field strength of spurious radiation Summary §2.1053, §22.917 | Passed | 2017/12/12 | Lab 1 | S01_ah01 |
| **22.5 Emission and Occupied Bandwidth §2.1049, §22.917** | | | | |
| 22.5; _Emission and Occupied Bandwidth Summary §2.1049, §22.917 | Passed | 2018/01/08 | Lab 2 | S01_ah01 |
| **22.6 Band edge compliance §2.1053, §22.917** | | | | |
| 22.6; _Band edge compliance Summary §2.1053, §22.917 | Passed | 2018/01/08 | Lab 2 | S01_ah01 |
| **22.7 Peak-to-Average Ratio Summary §2.1046** | | | | |
| 22.7; Peak-to-Average Ratio Summary §2.1046 | Passed | 2018/01/08 | Lab 2 | S01_ah01 |
| **Test Specification: FCC part 2 and 24** | | | | |
| **24.1 RF Power Output §2.1046, §24.232** | | | | |
| 24.1; RF Power Output Summary §2.1046, §24.232 | Passed | 2018/01/08 | Lab 2 | S01_ah01 |
| **24.2 Frequency stability §2.1055, §24.235** | | | | |
| 24.2; Frequency stability Summary §2.1055, 24.235 | Passed | 2018/01/08 | Lab 2 | S01_ah01 |
| **24.3 Spurious emissions at antenna terminals §2.1051, §24.238** | | | | |
| 24.3; Spurious emissions at antenna terminals Summary §2.1051, §24.238 | Passed | 2017/12/17 | Lab 2 | S01_ah01 |
| **24.4 Field strength of spurious radiation §2.1053, §24.238** | | | | |
| 24.4; Field strength of spurious radiation Summary §2.1053, §24.238 | Passed | 2017/12/12 | Lab 1 | S01_ah01 |
| **24.5 Emission and Occupied Bandwidth §2.1049, §24.238** | | | | |
| 24.5; Emission and Occupied Bandwidth Summary §2.1049, §24.238 | Passed | 2018/01/08 | Lab 2 | S01_ah01 |
| **24.6 Band edge compliance §2.1053, §24.238** | | | | |
| 24.6; Band edge compliance summary §2.1053, §24.238 | Passed | 2018/01/08 | Lab 2 | S01_ah01 |
| **24.7 Peak-to-Average ratio §2.1046, §24.232** | | | | |
| 24.7; Peak-to-Average Ratio Summary §2.1046, §24.232 | Passed | 2018/01/08 | Lab 2 | S01_ah01 |
| **Test Specification: FCC part 2 and 27** | | | | |
| **27.1 RF Power Output §2.1046, §27.250** | | | | |
| 27.1; RF Power Output Summary §2.1046, §27.250 | Passed | 2018/01/08 | Lab 2 | S01_ah01 |

| Test Case Identifier / Name<br>Test (condition) | Result | Date of Test | Lab Ref. | Setup |
|---|---|---|---|---|
| **27.2 Frequency stability §2.1055, §27.54** | | | | |
| 27.2; Frequency stability Summary §2.1055, §27.54 | Passed | 2018/01/12 | Lab 2 | S01_ah01 |
| **27.3 Spurious emissions at antenna terminals §2.1051, §27.53** | | | | |
| 27.3; Spurious emissions at antenna terminals Summary §2.1051, §27.53 | Passed | 2017/12/17 | Lab 2 | S01_ah01 |
| **27.4 Field strength of spurious radiation §2.1053, §27.53** | | | | |
| 27.4; Field strength of spurious radiation Summary §2.1053, §27.53 | Passed | 2017/12/12 | Lab 1 | S01_ah01 |
| **27.5 Emission and Occupied Bandwidth §2.1049** | | | | |
| 27.5; Emission and Occupied Bandwidth Summary §2.1049 | Passed | 2017/12/17 | Lab 2 | S01_ah01 |
| **27.6 Band edge compliance §2.1053, §27.53** | | | | |
| 27.6; Band edge compliance summary §2.1053, §27.53 | Passed | 2018/01/08 | Lab 2 | S01_ah01 |
| **27.7 Peak-to-Average ratio §2.1046, §27.50** | | | | |
| 27.7; Peak-to-Average Ratio Summary §2.1046, §27.50 | Passed | 2018/01/08 | Lab 2 | S01_ah01 |

## 3.5 Detailed Results

### 3.5.1 22.1 RF Power Output §2.1046, §22.913

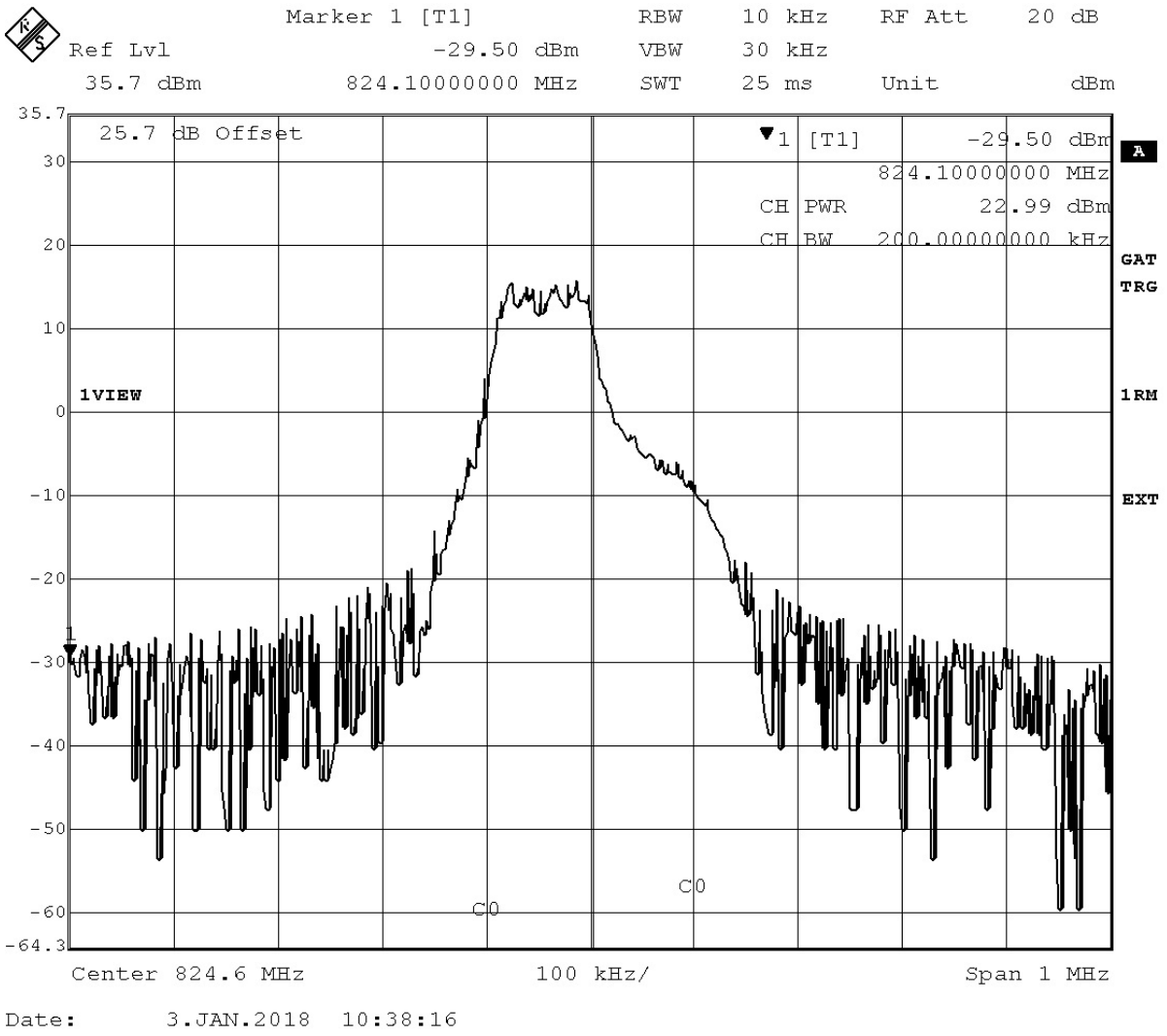
**Test: 22.1; _RF Power Output Summary §2.1046, §22.913**

| | |
|---|---|
| *Result:* | Passed |
| *Setup No.:* | S01_ah01 |
| *Date of Test:* | 2018/01/08 10:21 |
| *Body:* | FCC47CFRChIPART22PUBLIC MOBILE SERVICES |
| *Test Specification:* | FCC part 2 and 22 |

**Detailed Results:**

| Radio Technology | Reference Test Frequencies | Channel | Sub-carrier | RMS Conducted Power (dBm) | FCC EIRP Limit (W) | IC EIRP Limit (W) | Maximum Antenna Gain (dBi) |
|---|---|---|---|---|---|---|---|
| NB-IoT eFDD 5 QPSK | standalone | 20401 | 12 | 20.52 | 11.48 | 11.5 | 20.08 |
| NB-IoT eFDD 5 QPSK | standalone | 20525 | 12 | 20.29 | 11.48 | 11.5 | 20.31 |
| NB-IoT eFDD 5 QPSK | standalone | 20649 | 12 | 20.13 | 11.48 | 11.5 | 20.47 |
| NB-IoT eFDD 5 QPSK | in-band | 20406 | 12 | 20.66 | 11.48 | 11.5 | 19.94 |
| NB-IoT eFDD 5 QPSK | in-band | 20460 | 12 | 20.53 | 11.48 | 11.5 | 20.07 |
| NB-IoT eFDD 5 QPSK | in-band | 20469 | 12 | 20.41 | 11.48 | 11.5 | 20.19 |
| NB-IoT eFDD 5 QPSK | in-band | 20516 | 12 | 20.25 | 11.48 | 11.5 | 20.35 |
| NB-IoT eFDD 5 QPSK | in-band | 20535 | 12 | 20.25 | 11.48 | 11.5 | 20.35 |
| NB-IoT eFDD 5 QPSK | in-band | 20544 | 12 | 20.26 | 11.48 | 11.5 | 20.34 |
| NB-IoT eFDD 5 QPSK | in-band | 20644 | 12 | 20.02 | 11.48 | 11.5 | 20.58 |
| NB-IoT eFDD 5 QPSK | in-band | 20610 | 12 | 19.89 | 11.48 | 11.5 | 20.71 |
| NB-IoT eFDD 5 QPSK | in-band | 20619 | 12 | 20.2 | 11.48 | 11.5 | 20.4 |
| NB-IoT eFDD 5 BPSK | guard-band | 20401 | 12 | 20.52 | 11.48 | 11.5 | 20.08 |
| NB-IoT eFDD 5 BPSK | guard-band | 20501 | 12 | 20.31 | 11.48 | 11.5 | 20.29 |
| NB-IoT eFDD 5 BPSK | guard-band | 20649 | 12 | 20.01 | 11.48 | 11.5 | 20.59 |
| NB-IoT eFDD 5 QPSK | standalone | 20401 | 6 | 21.3 | 11.48 | 11.5 | 19.3 |
| NB-IoT eFDD 5 QPSK | standalone | 20525 | 6 | 21.26 | 11.48 | 11.5 | 19.34 |
| NB-IoT eFDD 5 QPSK | standalone | 20649 | 6 | 21.67 | 11.48 | 11.5 | 18.93 |
| NB-IoT eFDD 5 QPSK | in-band | 20406 | 6 | 22.99 | 11.48 | 11.5 | 17.61 |
| NB-IoT eFDD 5 QPSK | in-band | 20460 | 6 | 21.5 | 11.48 | 11.5 | 19.1 |
| NB-IoT eFDD 5 QPSK | in-band | 20469 | 6 | 21.44 | 11.48 | 11.5 | 19.16 |
| NB-IoT eFDD 5 QPSK | in-band | 20516 | 6 | 21.62 | 11.48 | 11.5 | 18.98 |
| NB-IoT eFDD 5 QPSK | in-band | 20535 | 6 | 21.24 | 11.48 | 11.5 | 19.36 |
| NB-IoT eFDD 5 QPSK | in-band | 20544 | 6 | 21.1 | 11.48 | 11.5 | 19.5 |
| NB-IoT eFDD 5 QPSK | in-band | 20644 | 6 | 21.17 | 11.48 | 11.5 | 19.43 |
| NB-IoT eFDD 5 QPSK | in-band | 20610 | 6 | 21.22 | 11.48 | 11.5 | 19.38 |
| NB-IoT eFDD 5 QPSK | in-band | 20619 | 6 | 21.19 | 11.48 | 11.5 | 19.41 |
| NB-IoT eFDD 5 BPSK | guard-band | 20401 | 6 | 20.83 | 11.48 | 11.5 | 19.77 |
| NB-IoT eFDD 5 BPSK | guard-band | 20501 | 6 | 21.36 | 11.48 | 11.5 | 19.24 |
| NB-IoT eFDD 5 BPSK | guard-band | 20649 | 6 | 21.71 | 11.48 | 11.5 | 18.89 |
| NB-IoT eFDD 5 QPSK | standalone | 20401 | 3 | 22.14 | 11.48 | 11.5 | 18.46 |
| NB-IoT eFDD 5 QPSK | standalone | 20525 | 3 | 21.75 | 11.48 | 11.5 | 18.85 |
| NB-IoT eFDD 5 QPSK | standalone | 20649 | 3 | 22.39 | 11.48 | 11.5 | 18.21 |
| NB-IoT eFDD 5 QPSK | in-band | 20406 | 3 | 20.57 | 11.48 | 11.5 | 20.03 |
| NB-IoT eFDD 5 QPSK | in-band | 20460 | 3 | 21.51 | 11.48 | 11.5 | 19.09 |
| NB-IoT eFDD 5 QPSK | in-band | 20469 | 3 | 21.97 | 11.48 | 11.5 | 18.63 |
| NB-IoT eFDD 5 QPSK | in-band | 20516 | 3 | 21.18 | 11.48 | 11.5 | 19.42 |
| NB-IoT eFDD 5 QPSK | in-band | 20535 | 3 | 21.43 | 11.48 | 11.5 | 19.17 |
| NB-IoT eFDD 5 QPSK | in-band | 20544 | 3 | 21.77 | 11.48 | 11.5 | 18.83 |
| NB-IoT eFDD 5 QPSK | in-band | 20644 | 3 | 21.93 | 11.48 | 11.5 | 18.67 |
| NB-IoT eFDD 5 QPSK | in-band | 20610 | 3 | 21.64 | 11.48 | 11.5 | 18.96 |
| NB-IoT eFDD 5 QPSK | in-band | 20619 | 3 | 22.24 | 11.48 | 11.5 | 18.36 |

| Radio Technology | Reference Test Frequencies | Channel | Sub-carrier | RMS Conducted Power (dBm) | FCC EIRP Limit (W) | IC EIRP Limit (W) | Maximum Antenna Gain (dBi) |
|---|---|---|---|---|---|---|---|
| NB-IoT eFDD 5 BPSK | guard-band | 20401 | 3 | 22.11 | 11.48 | 11.5 | 18.49 |
| NB-IoT eFDD 5 BPSK | guard-band | 20501 | 3 | 21.64 | 11.48 | 11.5 | 18.96 |
| NB-IoT eFDD 5 BPSK | guard-band | 20649 | 3 | 22.28 | 11.48 | 11.5 | 18.32 |
| NB-IoT eFDD 5 QPSK | standalone | 20401 | 1 | 21.56 | 11.48 | 11.5 | 19.04 |
| NB-IoT eFDD 5 QPSK | standalone | 20525 | 1 | 21.31 | 11.48 | 11.5 | 19.29 |
| NB-IoT eFDD 5 QPSK | standalone | 20649 | 1 | 21.17 | 11.48 | 11.5 | 19.43 |
| NB-IoT eFDD 5 QPSK | in-band | 20406 | 1 | 21.47 | 11.48 | 11.5 | 19.13 |
| NB-IoT eFDD 5 QPSK | in-band | 20460 | 1 | 21.61 | 11.48 | 11.5 | 18.99 |
| NB-IoT eFDD 5 QPSK | in-band | 20469 | 1 | 21.57 | 11.48 | 11.5 | 19.03 |
| NB-IoT eFDD 5 QPSK | in-band | 20516 | 1 | 21.82 | 11.48 | 11.5 | 18.78 |
| NB-IoT eFDD 5 QPSK | in-band | 20535 | 1 | 21.69 | 11.48 | 11.5 | 18.91 |
| NB-IoT eFDD 5 QPSK | in-band | 20544 | 1 | 21.87 | 11.48 | 11.5 | 18.73 |
| NB-IoT eFDD 5 QPSK | in-band | 20644 | 1 | 21.2 | 11.48 | 11.5 | 19.4 |
| NB-IoT eFDD 5 QPSK | in-band | 20610 | 1 | 21.38 | 11.48 | 11.5 | 19.22 |
| NB-IoT eFDD 5 QPSK | in-band | 20619 | 1 | 21.25 | 11.48 | 11.5 | 19.35 |
| NB-IoT eFDD 5 QPSK | guard-band | 20401 | 1 | 21.28 | 11.48 | 11.5 | 19.32 |
| NB-IoT eFDD 5 QPSK | guard-band | 20501 | 1 | 21.39 | 11.48 | 11.5 | 19.21 |
| NB-IoT eFDD 5 QPSK | guard-band | 20649 | 1 | 21.11 | 11.48 | 11.5 | 19.49 |
| NB-IoT eFDD 5 BPSK | standalone | 20401 | 1 | 21.86 | 11.48 | 11.5 | 18.74 |
| NB-IoT eFDD 5 BPSK | standalone | 20525 | 1 | 21.73 | 11.48 | 11.5 | 18.87 |
| NB-IoT eFDD 5 BPSK | standalone | 20649 | 1 | 21.79 | 11.48 | 11.5 | 18.81 |
| NB-IoT eFDD 5 BPSK | in-band | 20406 | 1 | 21.78 | 11.48 | 11.5 | 18.82 |
| NB-IoT eFDD 5 BPSK | in-band | 20460 | 1 | 21.97 | 11.48 | 11.5 | 18.63 |
| NB-IoT eFDD 5 BPSK | in-band | 20460 | 1 | 21.97 | 11.48 | 11.5 | 18.63 |
| NB-IoT eFDD 5 BPSK | in-band | 20469 | 1 | 21.61 | 11.48 | 11.5 | 18.99 |
| NB-IoT eFDD 5 BPSK | in-band | 20516 | 1 | 21.75 | 11.48 | 11.5 | 18.85 |
| NB-IoT eFDD 5 BPSK | in-band | 20535 | 1 | 21.72 | 11.48 | 11.5 | 18.88 |
| NB-IoT eFDD 5 BPSK | in-band | 20544 | 1 | 21.6 | 11.48 | 11.5 | 19 |
| NB-IoT eFDD 5 BPSK | in-band | 20644 | 1 | 21.61 | 11.48 | 11.5 | 18.99 |
| NB-IoT eFDD 5 BPSK | in-band | 20610 | 1 | 21.56 | 11.48 | 11.5 | 19.04 |
| NB-IoT eFDD 5 BPSK | in-band | 20619 | 1 | 21.61 | 11.48 | 11.5 | 18.99 |
| NB-IoT eFDD 5 BPSK | guard-band | 20401 | 1 | 21.6 | 11.48 | 11.5 | 19 |
| NB-IoT eFDD 5 BPSK | guard-band | 20501 | 1 | 22 | 11.48 | 11.5 | 18.6 |
| NB-IoT eFDD 5 BPSK | guard-band | 20649 | 1 | 21.38 | 11.48 | 11.5 | 19.22 |




eFDD5 NB-IoT QPSK, Subcarrier 6, Channel 20406

### 3.5.2 22.2 Frequency stability §2.1055

**Test: 22.2; _Frequency stability Summary §2.1055**

| | |
|---|---|
| *Result:* | Passed |
| *Setup No.:* | S01_ah01 |
| *Date of Test:* | 2017/12/17 10:59 |
| *Body:* | FCC47CFRChIPART22PUBLIC MOBILE SERVICES |
| *Test Specification:* | FCC part 2 and 22 |

**Detailed Results:**

| Temp. °C | Duration min | Voltage | Limit Hz | Freq. error Average (Hz) | Freq. error Max. (Hz) | Verdict |
|---|---|---|---|---|---|---|
| -30 | 0 | normal | 2091.25 | -3 | 6 | passed |
| -30 | 5 | | | -5 | 12 | passed |
| -30 | 10 | | | -5 | -8 | passed |
| -20 | 0 | normal | 2091.25 | -6 | -10 | passed |
| -20 | 5 | | | -5 | 3 | passed |
| -20 | 10 | | | 10 | 15 | passed |
| -10 | 0 | normal | 2091.25 | -17 | -16 | passed |
| -10 | 5 | | | -3 | -11 | passed |
| -10 | 10 | | | -6 | -9 | passed |
| 0 | 0 | normal | 2091.25 | -6 | 15 | passed |
| 0 | 5 | | | -17 | 10 | passed |
| 0 | 10 | | | -3 | 12 | passed |
| 10 | 0 | normal | 2091.25 | -11 | 6 | passed |
| 10 | 5 | | | -10 | 12 | passed |
| 10 | 10 | | | -10 | 13 | passed |
| 20 | 0 | low | 2091.25 | -4 | -8 | passed |
| 20 | 5 | | | 6 | 10 | passed |
| 20 | 10 | | | 12 | 16 | passed |
| 20 | 0 | normal = high [1)] | 2091.25 | -3 | 5 | passed |
| 20 | 5 | | | 6 | -6 | passed |
| 20 | 10 | | | 5 | -6 | passed |
| 20 | 0 | high | 2091.25 | 4 | 10 | passed |
| 20 | 5 | | | -6 | -10 | passed |
| 20 | 10 | | | -3 | 6 | passed |
| 30 | 0 | normal | 2091.25 | 5 | -2 | passed |
| 30 | 5 | | | -4 | -3 | passed |
| 30 | 10 | | | -6 | -15 | passed |
| 40 | 0 | normal | 2091.25 | -14 | 12 | passed |
| 40 | 5 | | | -3 | -13 | passed |
| 40 | 10 | | | -12 | -2 | passed |
| 50 | 0 | normal | 2091.25 | 10 | -3 | passed |
| 50 | 5 | | | -3 | -4 | passed |
| 50 | 10 | | | -4 | -6 | passed |

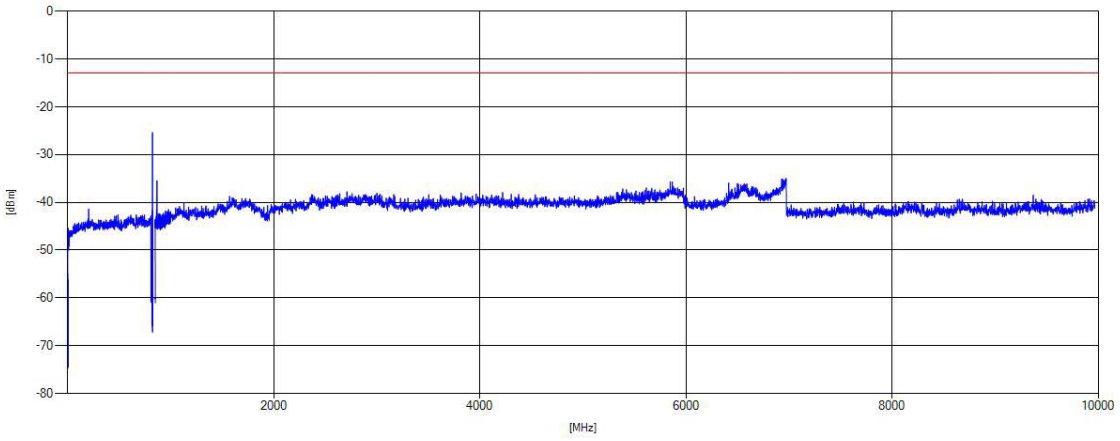
### 3.5.3 22.3 Spurious emissions at antenna terminals §2.1051, §22.917

**Test: 22.3; Spurious emissions at antenna terminals summary §2.1051, §22.917**

| | |
|---|---|
| *Result:* | Passed |
| *Setup No.:* | S01_ah01 |
| *Date of Test:* | 2017/12/17 11:00 |
| *Body:* | FCC47CFRChIPART22PUBLIC MOBILE SERVICES |
| *Test Specification:* | FCC part 2 and 22 |

**Detailed Results:**

| Radio Technology | Channel | Detector | Trace | Resolution Bandwidth /kHz | Frequency /MHz | Max Value /dBm | Limit /dBm | Margin to Limit /dB |
|---|---|---|---|---|---|---|---|---|
| eFDD 5 QPSK NB-IoT | low | rms | maxhold | 5 | 823 | -25.4 | -13 | 12.4 |
| eFDD 5 QPSK NB-IoT | mid | rms | maxhold | - | - | - | -13 | >20 |
| eFDD 5 QPSK NB-IoT | high | rms | maxhold | 5 | 849 | -25.5 | -13 | 12.5 |




eFDD5 NB-IoT QPSK, Channel 20401

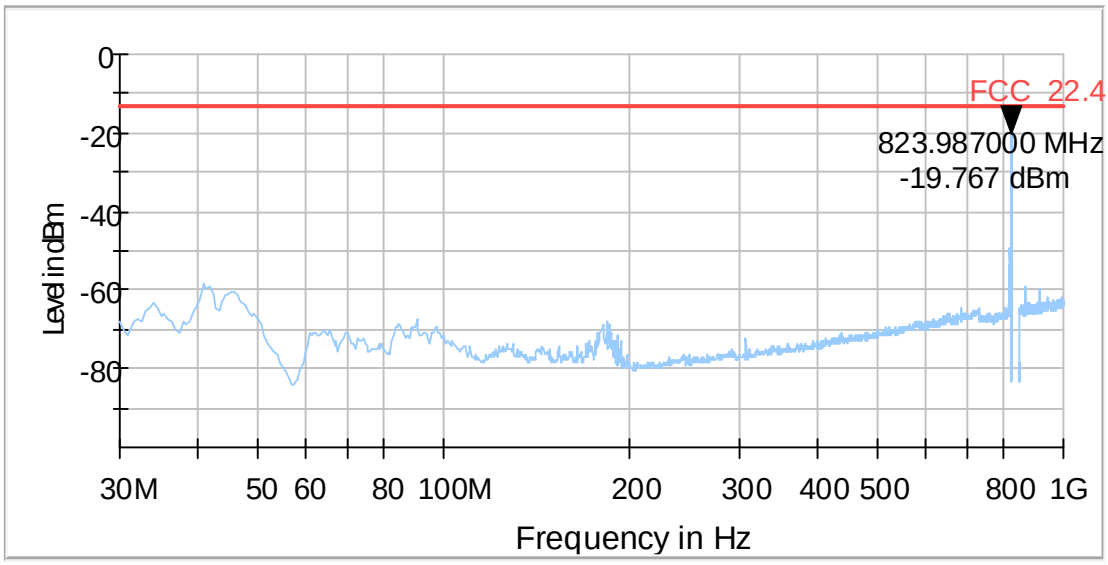
### 3.5.4 22.4 Field strength of spurious radiation §2.1053, §22.917

**Test: 22.4; Field strength of spurious radiation Summary §2.1053, §22.917**

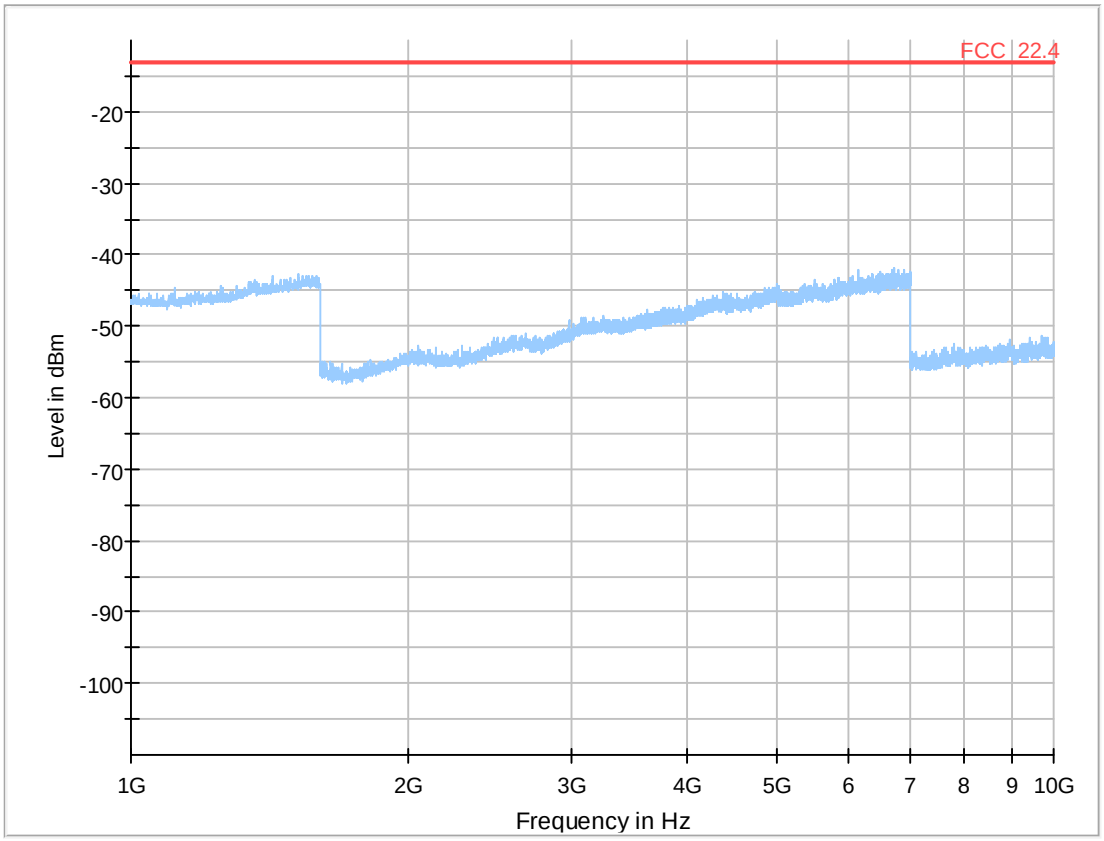
| | |
|---|---|
| *Result:* | Passed |
| *Setup No.:* | S01_ah01 |
| *Date of Test:* | 2017/12/12 11:23 |
| *Body:* | FCC47CFRChIPART22PUBLIC MOBILE SERVICES |
| *Test Specification:* | FCC part 2 and 22 |

**Detailed Results:**

| Radio Technology | Channel | Detector | Trace | Resolution Bandwidth /kHz | Frequency /MHz | Max Value /dBm | Limit /dBm | Margin to Limit /dB |
|---|---|---|---|---|---|---|---|---|
| eFDD 5 QPSK NB-IoT | low | peak | maxhold | 5 | 823.98 | -19.77 | -13 | 6.77 |
| eFDD 5 QPSK NB-IoT | mid | peak | maxhold | - | - | - | -13 | >20 |
| eFDD 5 QPSK NB-IoT | high | peak | maxhold | 5 | 849 | -25.39 | -13 | 12.39 |




eFDD5 NB-IoT QPSK, Channel 20401




eFDD5 NB-IoT QPSK, Channel 20401

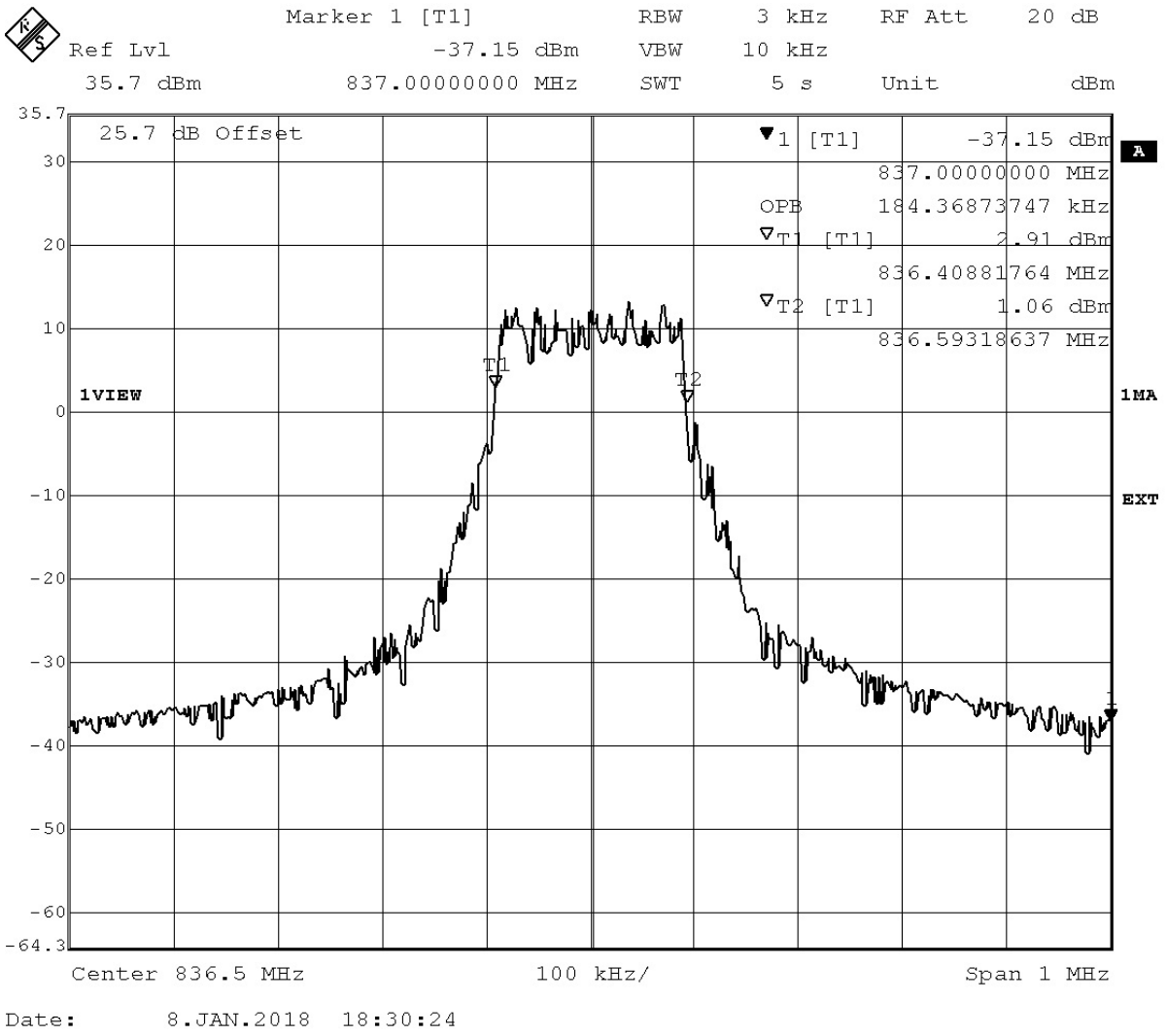
### 3.5.5 22.5 Emission and Occupied Bandwidth §2.1049, §22.917

**Test: 22.5; _Emission and Occupied Bandwidth Summary §2.1049, §22.917**

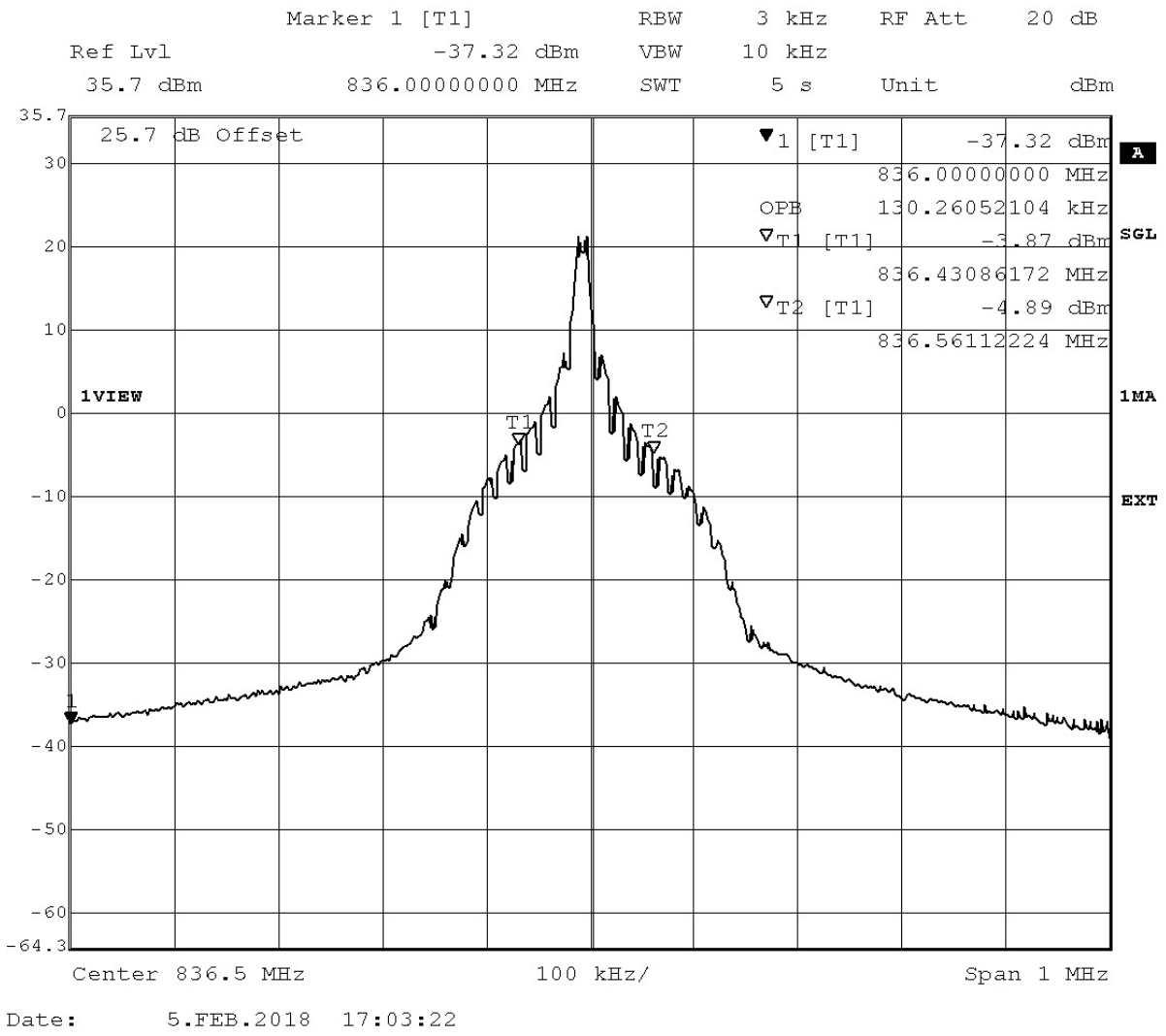
| | |
|---|---|
| *Result:* | Passed |
| *Setup No.:* | S01_ah01 |
| *Date of Test:* | 2018/01/08 11:02 |
| *Body:* | FCC47CFRChIPART22PUBLIC MOBILE SERVICES |
| *Test Specification:* | FCC part 2 and 22 |

**Detailed Results:**

| Radio Technology | Reference Test Frequencies | Channel | Subcarrier | Nominal BW [kHz] | 99 % BW [kHz] |
|---|---|---|---|---|---|
| NB-IoT eFDD 5 QPSK | standalone | 20401 | 12 | 200 | 192.4 |
| NB-IoT eFDD 5 QPSK | standalone | 20525 | 12 | 200 | 184.4 |
| NB-IoT eFDD 5 QPSK | standalone | 20649 | 12 | 200 | 186.4 |
| NB-IoT eFDD 5 QPSK | in-band | 20406 | 12 | 200 | 186.4 |
| NB-IoT eFDD 5 QPSK | in-band | 20460 | 12 | 200 | 186.4 |
| NB-IoT eFDD 5 QPSK | in-band | 20469 | 12 | 200 | 186.4 |
| NB-IoT eFDD 5 QPSK | in-band | 20516 | 12 | 200 | 186.4 |
| NB-IoT eFDD 5 QPSK | in-band | 20535 | 12 | 200 | 184.4 |
| NB-IoT eFDD 5 QPSK | in-band | 20544 | 12 | 200 | 188.4 |
| NB-IoT eFDD 5 QPSK | in-band | 20644 | 12 | 200 | 186.4 |
| NB-IoT eFDD 5 QPSK | in-band | 20610 | 12 | 200 | 188.4 |
| NB-IoT eFDD 5 QPSK | in-band | 20619 | 12 | 200 | 188.4 |
| NB-IoT eFDD 5 QPSK | guard-band | 20401 | 12 | 200 | 186.4 |
| NB-IoT eFDD 5 QPSK | guard-band | 20501 | 12 | 200 | 186.4 |
| NB-IoT eFDD 5 QPSK | guard-band | 20649 | 12 | 200 | 188.4 |
| NB-IoT eFDD 5 BPSK | standalone | 20401 | 1 | 200 | 132.3 |
| NB-IoT eFDD 5 BPSK | standalone | 20525 | 1 | 200 | 130.3 |
| NB-IoT eFDD 5 BPSK | standalone | 20649 | 1 | 200 | 132.3 |
| NB-IoT eFDD 5 BPSK | in-band | 20406 | 1 | 200 | 130.3 |
| NB-IoT eFDD 5 BPSK | in-band | 20460 | 1 | 200 | 130.3 |
| NB-IoT eFDD 5 BPSK | in-band | 20469 | 1 | 200 | 130.3 |
| NB-IoT eFDD 5 BPSK | in-band | 20516 | 1 | 200 | 130.3 |
| NB-IoT eFDD 5 BPSK | in-band | 20535 | 1 | 200 | 128.3 |
| NB-IoT eFDD 5 BPSK | in-band | 20544 | 1 | 200 | 130.3 |
| NB-IoT eFDD 5 BPSK | in-band | 20644 | 1 | 200 | 128.3 |
| NB-IoT eFDD 5 BPSK | in-band | 20610 | 1 | 200 | 132.3 |
| NB-IoT eFDD 5 BPSK | in-band | 20619 | 1 | 200 | 130.3 |
| NB-IoT eFDD 5 BPSK | guard-band | 20401 | 1 | 200 | 130.3 |
| NB-IoT eFDD 5 BPSK | guard-band | 20501 | 1 | 200 | 130.3 |
| NB-IoT eFDD 5 BPSK | guard-band | 20649 | 1 | 200 | 132.3 |




eFDD5 NB-IoT QPSK, Channel 20525




eFDD5 NB-IoT BPSK, Channel 20525

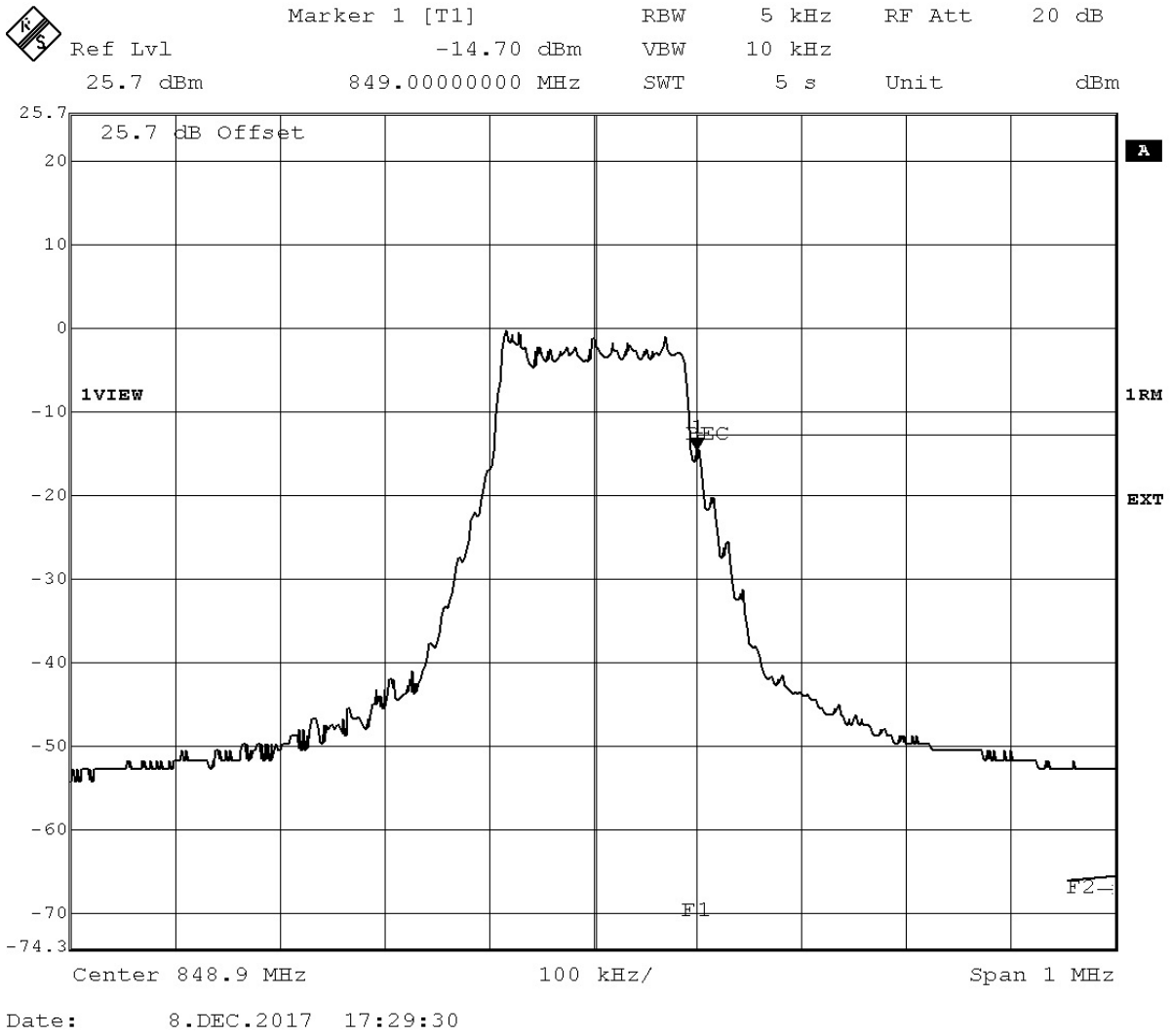
### 3.5.6 22.6 Band edge compliance §2.1053, §22.917

**Test: 22.6; _Band edge compliance Summary §2.1053, §22.917**

| | |
|---|---|
| *Result:* | Passed |
| *Setup No.:* | S01_ah01 |
| *Date of Test:* | 2018/01/08 11:03 |
| *Body:* | FCC47CFRChIPART22PUBLIC MOBILE SERVICES |
| *Test Specification:* | FCC part 2 and 22 |

**Detailed Results:**

| Radio Technology | Reference Test Frequencies | Channel | Sub-carrier | RMS [dBm] | Limit /dBm | Margin to Limit /dB |
|---|---|---|---|---|---|---|
| NB-IoT eFDD 5 QPSK | standalone | 20401 | 12 | -16.55 | -13 | 3.55 |
| NB-IoT eFDD 5 QPSK | standalone | 20649 | 12 | -14.7 | -13 | 1.7 |
| NB-IoT eFDD 5 QPSK | guard-band | 20401 | 12 | -18.5 | -13 | 5.5 |
| NB-IoT eFDD 5 QPSK | guard-band | 20649 | 12 | -20.04 | -13 | 7.04 |
| NB-IoT eFDD 5 BPSK | standalone | 20401 | 1 | -16.71 | -13 | 3.71 |
| NB-IoT eFDD 5 BPSK | standalone | 20649 | 1 | -18.25 | -13 | 5.25 |
| NB-IoT eFDD 5 BPSK | guard-band | 20401 | 1 | -17.28 | -13 | 4.28 |
| NB-IoT eFDD 5 BPSK | guard-band | 20649 | 1 | -18.98 | -13 | 5.98 |




eFDD12 NB-IoT QPSK, Channel 20649

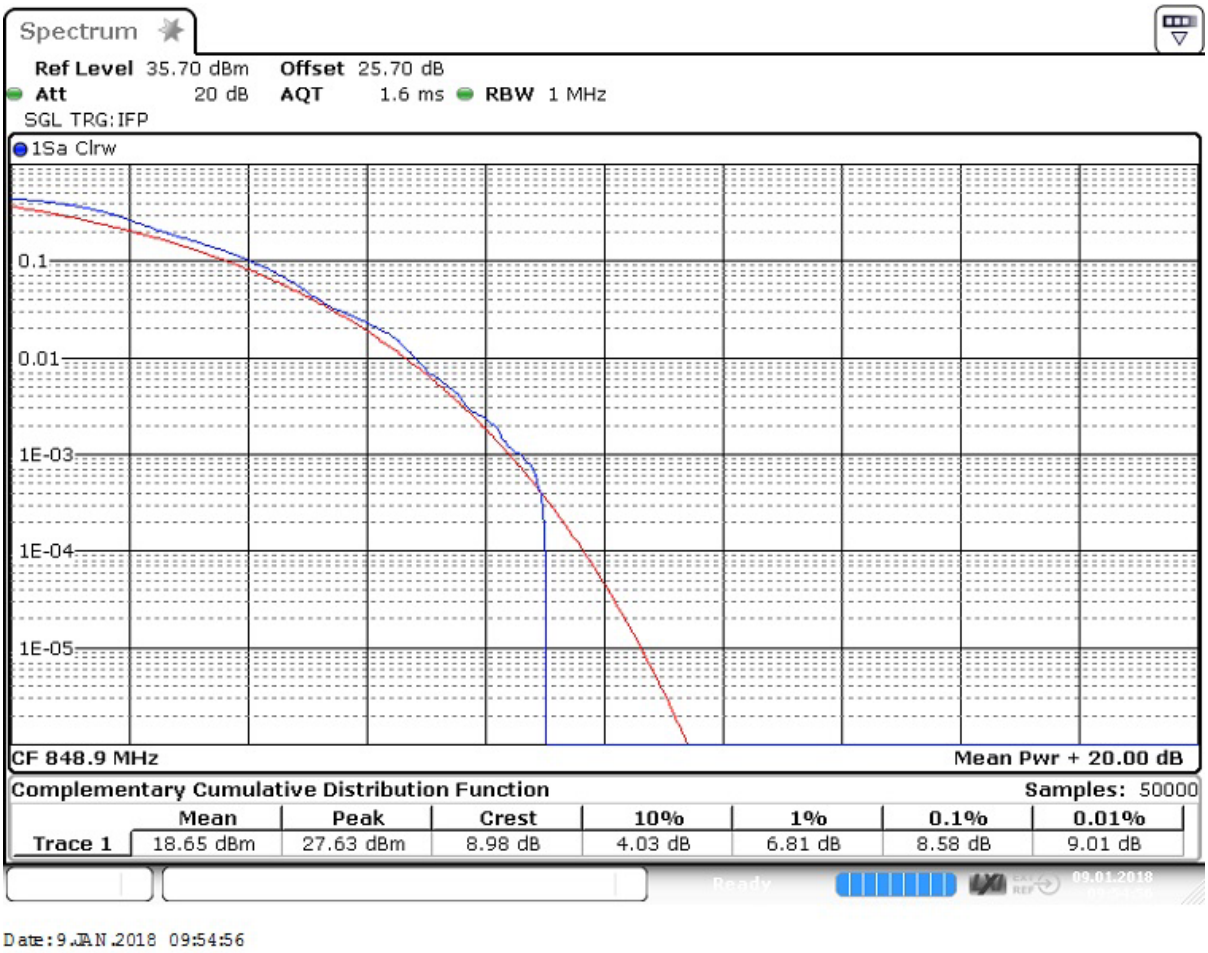
## 3.5.7 22.7 Peak-to-Average Ratio Summary §2.1046

**Test: 22.7; Peak-to-Average Ratio Summary §2.1046**

| | |
|---|---|
| *Result:* | Passed |
| *Setup No.:* | S01_ah01 |
| *Date of Test:* | 2018/01/08 11:08 |
| *Body:* | FCC47CFRChIPART22PUBLIC MOBILE SERVICES |
| *Test Specification:* | FCC part 2 and 22 |

**Detailed Results:**

| Radio Technology | Reference Test Frequencies | Channel | Sub-carrier | Peak to Average Ratio | Limit /dB | Margin to Limit /dB |
|---|---|---|---|---|---|---|
| NB-IoT eFDD 5 QPSK | standalone | 20401 | 12 | 8 | 13 | 5 |
| NB-IoT eFDD 5 QPSK | standalone | 20525 | 12 | 8.43 | 13 | 4.57 |
| NB-IoT eFDD 5 QPSK | standalone | 20649 | 12 | 8.58 | 13 | 4.42 |
| NB-IoT eFDD 5 BPSK | standalone | 20401 | 1 | 4.84 | 13 | 8.16 |
| NB-IoT eFDD 5 BPSK | standalone | 20525 | 1 | 4.49 | 13 | 8.51 |
| NB-IoT eFDD 5 BPSK | standalone | 20649 | 1 | 4.46 | 13 | 8.54 |




eFDD5 QPSK CH20469

### 3.5.8 24.1 RF Power Output §2.1046, §24.232

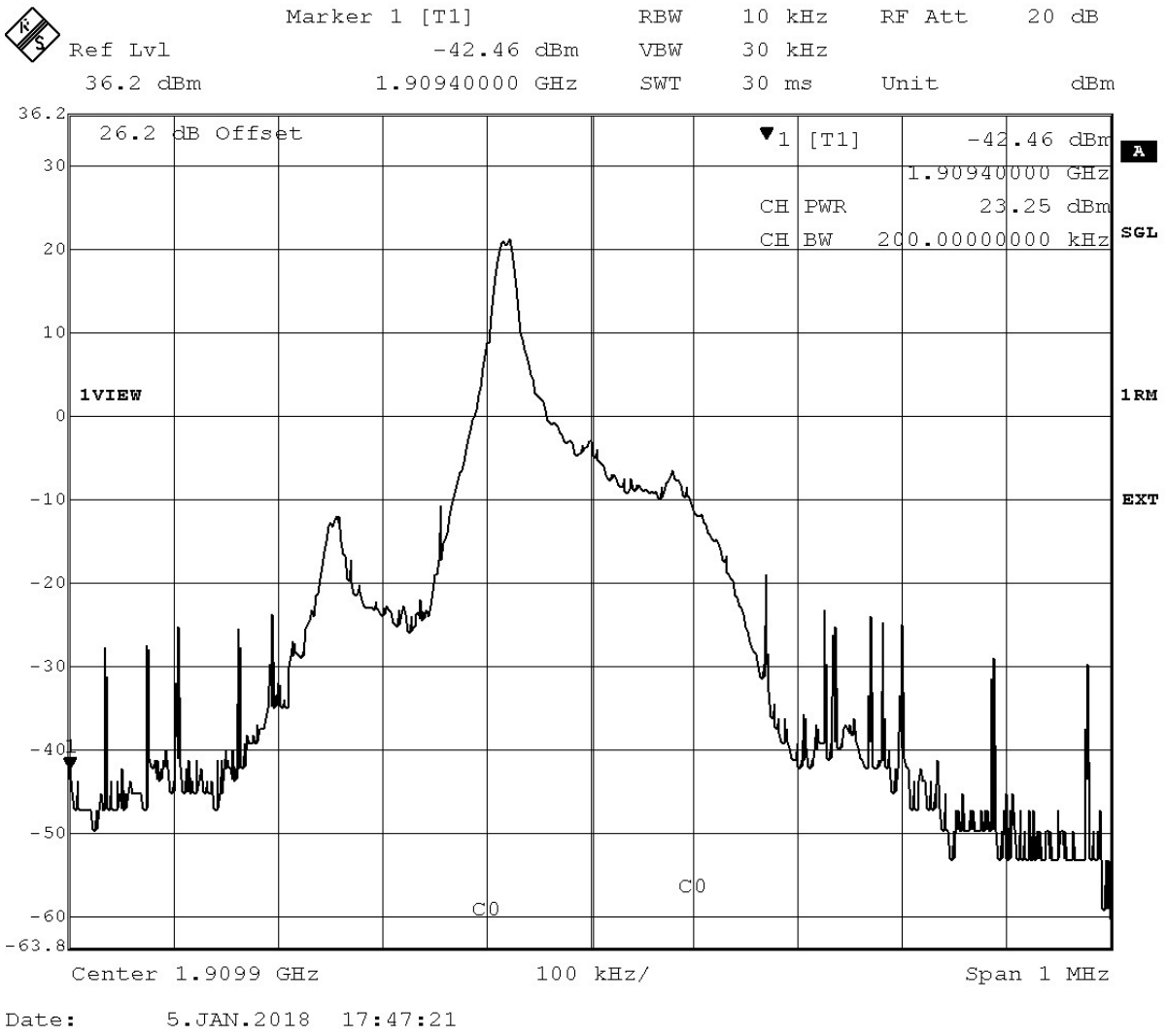
**Test: 24.1; RF Power Output Summary §2.1046, §24.232**

| | |
|---|---|
| *Result:* | Passed |
| *Setup No.:* | S01_ah01 |
| *Date of Test:* | 2018/01/08 11:09 |
| *Body:* | FCC47CFRChIPART24PERSONAL COMMUNICATIONS SERVICES |
| *Test Specification:* | FCC part 2 and 24 |

**Detailed Results:**

| Radio Technology | Reference Test Frequencies | Channel | Sub-carrier | RMS Conducted Power (dBm) | FCC / IC EIRP Limit (W) | Maximum Antenna Gain (dBi) |
|---|---|---|---|---|---|---|
| NB-IoT eFDD 2 QPSK | standalone | 18601 | 12 | 20.72 | 2 | 12.28 |
| NB-IoT eFDD 2 QPSK | standalone | 18900 | 12 | 20.25 | 2 | 12.75 |
| NB-IoT eFDD 2 QPSK | standalone | 19199 | 12 | 20.36 | 2 | 12.64 |
| NB-IoT eFDD 2 QPSK | in-band | 18606 | 12 | 20.22 | 2 | 12.78 |
| NB-IoT eFDD 2 QPSK | in-band | 18660 | 12 | 20.4 | 2 | 12.6 |
| NB-IoT eFDD 2 QPSK | in-band | 18669 | 12 | 20.34 | 2 | 12.66 |
| NB-IoT eFDD 2 QPSK | in-band | 18891 | 12 | 19.23 | 2 | 13.77 |
| NB-IoT eFDD 2 QPSK | in-band | 18910 | 12 | 19.94 | 2 | 13.06 |
| NB-IoT eFDD 2 QPSK | in-band | 18919 | 12 | 20.18 | 2 | 12.82 |
| NB-IoT eFDD 2 QPSK | in-band | 19194 | 12 | 20.42 | 2 | 12.58 |
| NB-IoT eFDD 2 QPSK | in-band | 19160 | 12 | 20.07 | 2 | 12.93 |
| NB-IoT eFDD 2 QPSK | in-band | 19169 | 12 | 20.09 | 2 | 12.91 |
| NB-IoT eFDD 2 QPSK | guard-band | 18601 | 12 | 20.49 | 2 | 12.51 |
| NB-IoT eFDD 2 QPSK | guard-band | 18876 | 12 | 20.13 | 2 | 12.87 |
| NB-IoT eFDD 2 QPSK | guard-band | 19199 | 12 | 20.49 | 2 | 12.51 |
| NB-IoT eFDD 2 QPSK | standalone | 18601 | 6 | 21.47 | 2 | 11.53 |
| NB-IoT eFDD 2 QPSK | standalone | 18900 | 6 | 21.93 | 2 | 11.07 |
| NB-IoT eFDD 2 QPSK | standalone | 19199 | 6 | 21.8 | 2 | 11.2 |
| NB-IoT eFDD 2 QPSK | in-band | 18606 | 6 | 21.32 | 2 | 11.68 |
| NB-IoT eFDD 2 QPSK | in-band | 18660 | 6 | 21.53 | 2 | 11.47 |
| NB-IoT eFDD 2 QPSK | in-band | 18669 | 6 | 21.33 | 2 | 11.67 |
| NB-IoT eFDD 2 QPSK | in-band | 18891 | 6 | 21.74 | 2 | 11.26 |
| NB-IoT eFDD 2 QPSK | in-band | 18910 | 6 | 21.76 | 2 | 11.24 |
| NB-IoT eFDD 2 QPSK | in-band | 18919 | 6 | 21.81 | 2 | 11.19 |
| NB-IoT eFDD 2 QPSK | in-band | 19194 | 6 | 21.86 | 2 | 11.14 |
| NB-IoT eFDD 2 QPSK | in-band | 19160 | 6 | 22.56 | 2 | 10.44 |
| NB-IoT eFDD 2 QPSK | in-band | 19169 | 6 | 21.74 | 2 | 11.26 |
| NB-IoT eFDD 2 QPSK | guard-band | 18601 | 6 | 21.67 | 2 | 11.33 |
| NB-IoT eFDD 2 QPSK | guard-band | 18876 | 6 | 21.74 | 2 | 11.26 |
| NB-IoT eFDD 2 QPSK | guard-band | 19199 | 6 | 22 | 2 | 11 |
| NB-IoT eFDD 2 QPSK | standalone | 18601 | 3 | 21.82 | 2 | 11.18 |
| NB-IoT eFDD 2 QPSK | standalone | 18900 | 3 | 22.87 | 2 | 10.13 |
| NB-IoT eFDD 2 QPSK | standalone | 19199 | 3 | 22.07 | 2 | 10.93 |
| NB-IoT eFDD 2 QPSK | in-band | 18606 | 3 | 21.39 | 2 | 11.61 |
| NB-IoT eFDD 2 QPSK | in-band | 18660 | 3 | 22.59 | 2 | 10.41 |
| NB-IoT eFDD 2 QPSK | in-band | 18669 | 3 | 21.84 | 2 | 11.16 |
| NB-IoT eFDD 2 QPSK | in-band | 18891 | 3 | 22.56 | 2 | 10.44 |
| NB-IoT eFDD 2 QPSK | in-band | 18910 | 3 | 22.71 | 2 | 10.29 |
| NB-IoT eFDD 2 QPSK | in-band | 18919 | 3 | 22.3 | 2 | 10.7 |
| NB-IoT eFDD 2 QPSK | in-band | 19194 | 3 | 22.66 | 2 | 10.34 |
| NB-IoT eFDD 2 QPSK | in-band | 19160 | 3 | 22.23 | 2 | 10.77 |
| NB-IoT eFDD 2 QPSK | in-band | 19169 | 3 | 22.33 | 2 | 10.67 |

| Radio Technology | Reference Test Frequencies | Channel | Sub-carrier | RMS Conducted Power (dBm) | FCC / IC EIRP Limit (W) | Maximum Antenna Gain (dBi) |
|---|---|---|---|---|---|---|
| NB-IoT eFDD 2 QPSK | guard-band | 18601 | 3 | 22.06 | 2 | 10.94 |
| NB-IoT eFDD 2 QPSK | guard-band | 18876 | 3 | 22.54 | 2 | 10.46 |
| NB-IoT eFDD 2 QPSK | guard-band | 19199 | 3 | 22.38 | 2 | 10.62 |
| NB-IoT eFDD 2 QPSK | standalone | 18601 | 1 | 22.84 | 2 | 10.16 |
| NB-IoT eFDD 2 QPSK | standalone | 18900 | 1 | 22.55 | 2 | 10.45 |
| NB-IoT eFDD 2 QPSK | standalone | 19199 | 1 | 22.75 | 2 | 10.25 |
| NB-IoT eFDD 2 QPSK | in-band | 18606 | 1 | 22.62 | 2 | 10.38 |
| NB-IoT eFDD 2 QPSK | in-band | 18660 | 1 | 22.57 | 2 | 10.43 |
| NB-IoT eFDD 2 QPSK | in-band | 18669 | 1 | 22.53 | 2 | 10.47 |
| NB-IoT eFDD 2 QPSK | in-band | 18891 | 1 | 22.53 | 2 | 10.47 |
| NB-IoT eFDD 2 QPSK | in-band | 18910 | 1 | 22.5 | 2 | 10.5 |
| NB-IoT eFDD 2 QPSK | in-band | 18919 | 1 | 22.52 | 2 | 10.48 |
| NB-IoT eFDD 2 QPSK | in-band | 19194 | 1 | 22.3 | 2 | 10.7 |
| NB-IoT eFDD 2 QPSK | in-band | 19160 | 1 | 22.55 | 2 | 10.45 |
| NB-IoT eFDD 2 QPSK | in-band | 19169 | 1 | 22.55 | 2 | 10.45 |
| NB-IoT eFDD 2 QPSK | guard-band | 18601 | 1 | 23.3 | 2 | 9.7 |
| NB-IoT eFDD 2 QPSK | guard-band | 18876 | 1 | 22.52 | 2 | 10.48 |
| NB-IoT eFDD 2 QPSK | guard-band | 19199 | 1 | 23.19 | 2 | 9.81 |
| NB-IoT eFDD 2 BPSK | standalone | 18601 | 1 | 22.6 | 2 | 10.4 |
| NB-IoT eFDD 2 BPSK | standalone | 18900 | 1 | 22.67 | 2 | 10.33 |
| NB-IoT eFDD 2 BPSK | standalone | 19199 | 1 | 22.35 | 2 | 10.65 |
| NB-IoT eFDD 2 BPSK | in-band | 18606 | 1 | 21.72 | 2 | 11.28 |
| NB-IoT eFDD 2 BPSK | in-band | 18660 | 1 | 21.71 | 2 | 11.29 |
| NB-IoT eFDD 2 BPSK | in-band | 18669 | 1 | 21.83 | 2 | 11.17 |
| NB-IoT eFDD 2 BPSK | in-band | 18891 | 1 | 21.68 | 2 | 11.32 |
| NB-IoT eFDD 2 BPSK | in-band | 18910 | 1 | 21.76 | 2 | 11.24 |
| NB-IoT eFDD 2 BPSK | in-band | 18919 | 1 | 21.44 | 2 | 11.56 |
| NB-IoT eFDD 2 BPSK | in-band | 19194 | 1 | 21.7 | 2 | 11.3 |
| NB-IoT eFDD 2 BPSK | in-band | 19160 | 1 | 21.74 | 2 | 11.26 |
| NB-IoT eFDD 2 BPSK | in-band | 19169 | 1 | 21.69 | 2 | 11.31 |
| NB-IoT eFDD 2 BPSK | guard-band | 18601 | 1 | 22.6 | 2 | 10.4 |
| NB-IoT eFDD 2 BPSK | guard-band | 18876 | 1 | 22.29 | 2 | 10.71 |
| NB-IoT eFDD 2 BPSK | guard-band | 19199 | 1 | 23.25 | 2 | 9.75 |




eFDD2 NB-IoT BPSK, Channel 19199

### 3.5.9 24.2 Frequency stability §2.1055, §24.235

**Test: 24.2; Frequency stability Summary §2.1055, 24.235**

| | |
|---|---|
| *Result:* | Passed |
| *Setup No.:* | S01_ah01 |
| *Date of Test:* | 2018/01/08 11:14 |
| *Body:* | FCC47CFRChIPART24PERSONAL COMMUNICATIONS SERVICES |
| *Test Specification:* | FCC part 2 and 24 |

**Detailed Results:**

| Temp. °C | Duration min | Voltage | Limit Hz | Freq. error Average (Hz) | Freq. error Max. (Hz) | Verdict |
|---|---|---|---|---|---|---|
| -30 | 0 | normal | 4700 | -10 | -15 | passed |
| -30 | 5 | | | -9 | -15 | passed |
| -30 | 10 | | | -6 | -12 | passed |
| -20 | 0 | normal | 4700 | -10 | -4 | passed |
| -20 | 5 | | | -12 | -3 | passed |
| -20 | 10 | | | -5 | 10 | passed |
| -10 | 0 | normal | 4700 | -10 | 16 | passed |
| -10 | 5 | | | -12 | 12 | passed |
| -10 | 10 | | | 3 | -3 | passed |
| 0 | 0 | normal | 4700 | -6 | -6 | passed |
| 0 | 5 | | | -18 | -14 | passed |
| 0 | 10 | | | -9 | -13 | passed |
| 10 | 0 | normal | 4700 | 6 | -2 | passed |
| 10 | 5 | | | 9 | -6 | passed |
| 10 | 10 | | | 10 | -4 | passed |
| 20 | 0 | low | 4700 | 4 | -8 | passed |
| 20 | 5 | | | 12 | 14 | passed |
| 20 | 10 | | | 6 | -10 | passed |
| 20 | 0 | normal = high [1)] | 4700 | 12 | -6 | passed |
| 20 | 5 | | | -13 | -15 | passed |
| 20 | 10 | | | 6 | -12 | passed |
| 20 | 0 | high | 4700 | 3 | -9 | passed |
| 20 | 5 | | | -5 | 10 | passed |
| 20 | 10 | | | 4 | 12 | passed |
| 30 | 0 | normal | 4700 | 4 | 7 | passed |
| 30 | 5 | | | 9 | 6 | passed |
| 30 | 10 | | | 8 | 8 | passed |
| 40 | 0 | normal | 4700 | 6 | -2 | passed |
| 40 | 5 | | | -5 | -11 | passed |
| 40 | 10 | | | -6 | -10 | passed |
| 50 | 0 | normal | 4700 | 3 | -9 | passed |
| 50 | 5 | | | -4 | -10 | passed |
| 50 | 10 | | | -10 | -10 | passed |

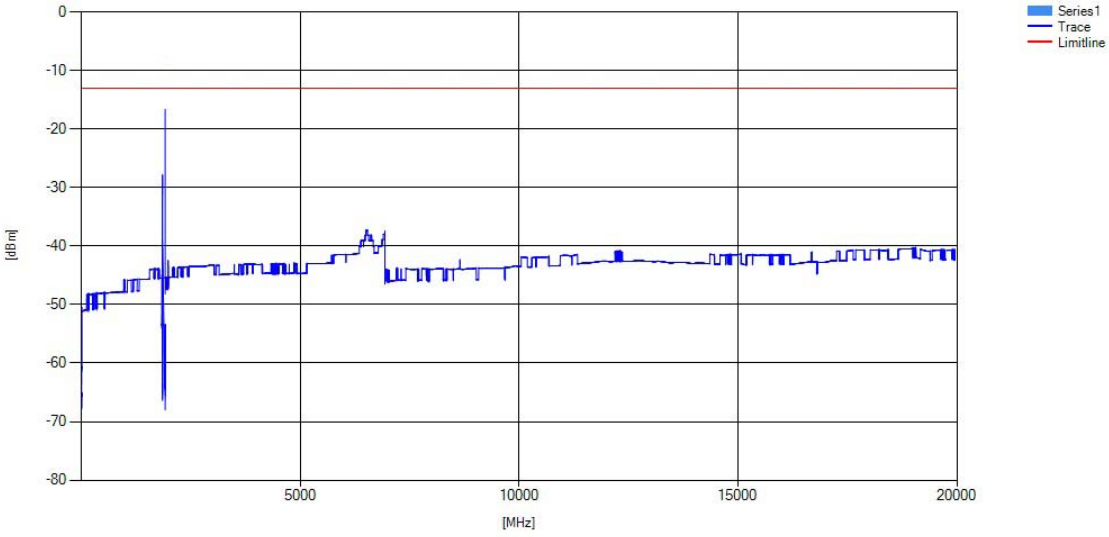
## 3.5.10 24.3 Spurious emissions at antenna terminals §2.1051, §24.238

**Test: 24.3; Spurious emissions at antenna terminals Summary §2.1051, §24.238**

| | |
|---|---|
| *Result:* | Passed |
| *Setup No.:* | S01_ah01 |
| *Date of Test:* | 2017/12/17 11:15 |
| *Body:* | FCC47CFRChIPART24PERSONAL COMMUNICATIONS SERVICES |
| *Test Specification:* | FCC part 2 and 24 |

**Detailed Results:**

| Radio Technology | Channel | Detector | Trace | Resolution Bandwidth /kHz | Frequency /MHz | Max Value /dBm | Limit /dBm | Margin to Limit /dB |
|---|---|---|---|---|---|---|---|---|
| eFDD 2 QPSK NB-IoT | low | rms | maxhold | 5 | 1849.9 | -23.65 | -13 | 10.65 |
| eFDD 2 QPSK NB-IoT | mid | rms | maxhold | - | | | -13 | >20 |
| eFDD 2 QPSK NB-IoT | high | rms | maxhold | 5 | 1910.1 | -15.83 | -13 | 2.83 |




eFDD2 NB-IoT QPSK, Channel 19199

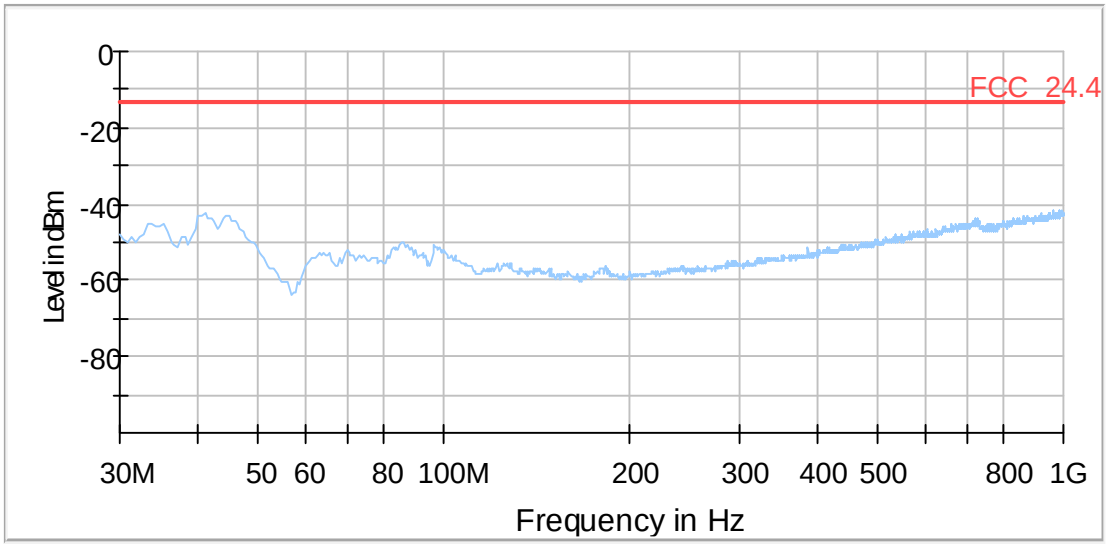
### 3.5.11 24.4 Field strength of spurious radiation §2.1053, §24.238

**Test: 24.4; Field strength of spurious radiation Summary §2.1053, §24.238**

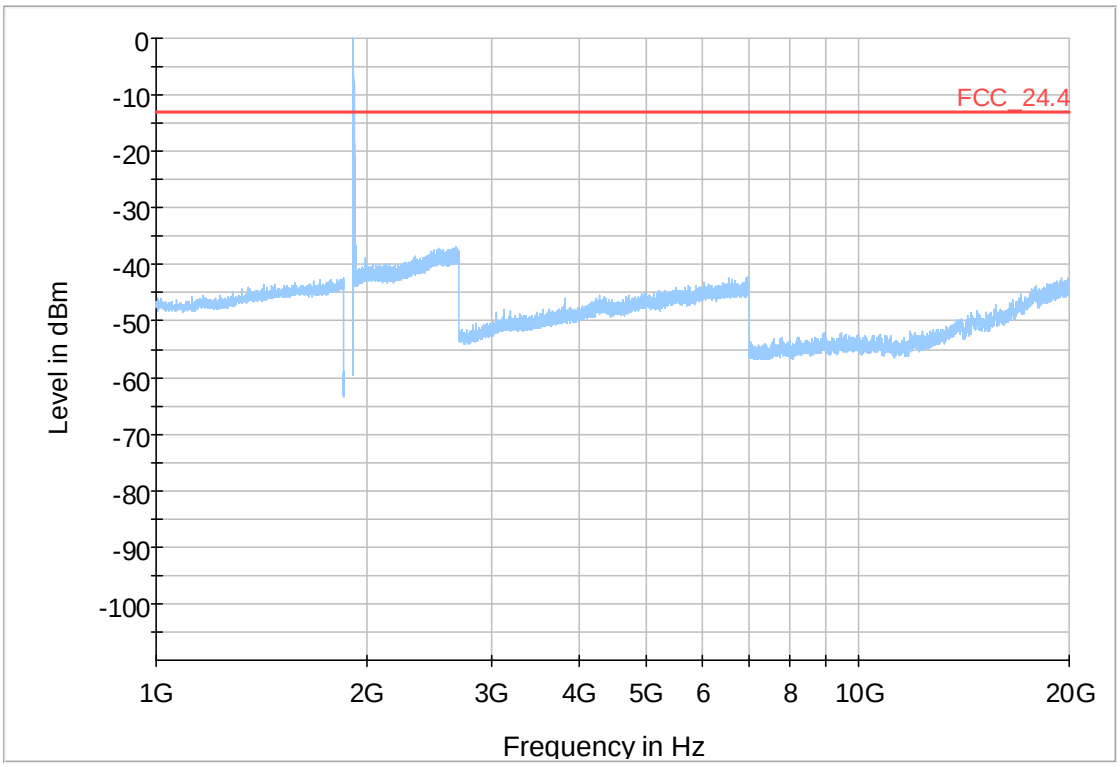
| | |
|---|---|
| *Result:* | Passed |
| *Setup No.:* | S01_ah01 |
| *Date of Test:* | 2017/12/12 11:27 |
| *Body:* | FCC47CFRChIPART24PERSONAL COMMUNICATIONS SERVICES |
| *Test Specification:* | FCC part 2 and 24 |

**Detailed Results:**

| Radio Technology | Channel | Detector | Trace | Resolution Bandwidth /kHz | Frequency /MHz | Max Value /dBm | Limit /dBm | Margin to Limit /dB |
|---|---|---|---|---|---|---|---|---|
| eFDD 2 QPSK NB-IoT | low | peak | maxhold | 2 | 1849.9 | -20.28 | -13 | 7.28 |
| eFDD 2 QPSK NB-IoT | mid | peak | maxhold | - | | | -13 | >20 |
| eFDD 2 QPSK NB-IoT | high | peak | maxhold | 2 | 1910 | -15.62 | -13 | 2.62 |




eFDD2 NB-IoT QPSK, Channel 19199



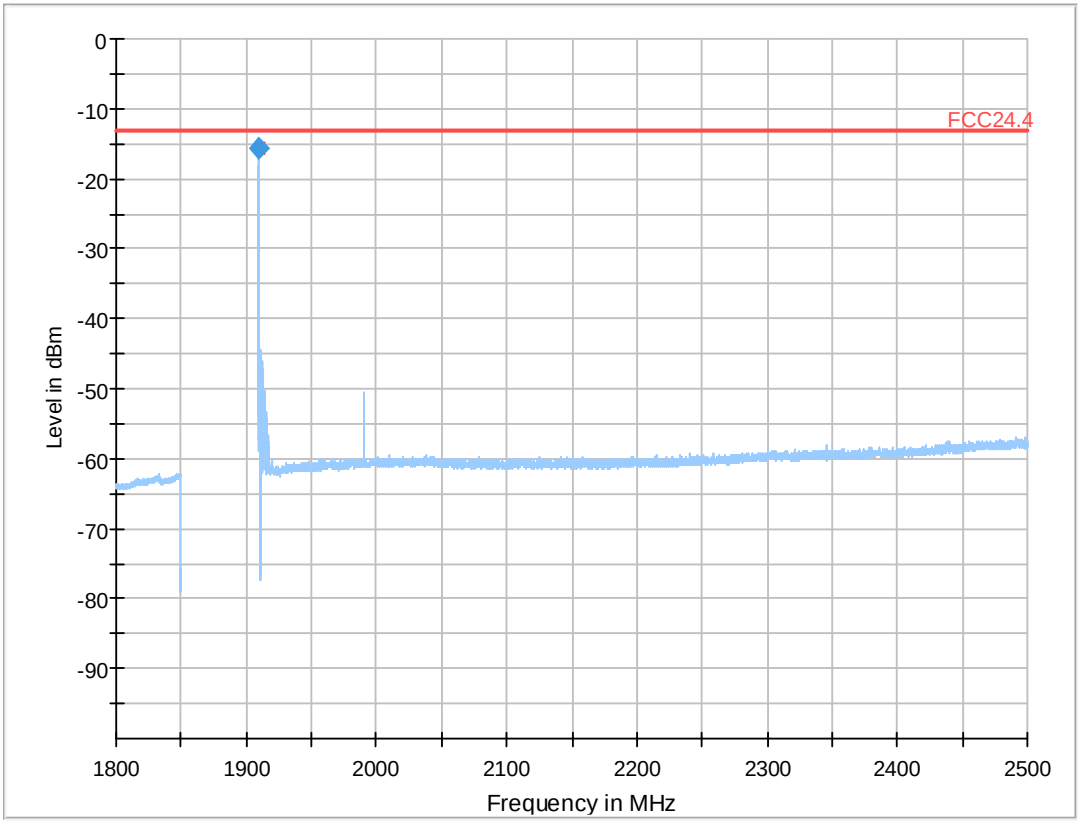

## Critical_Freqs

| Frequency (MHz) | MaxPeak (dBm) | Limit (dBm) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Elevation (deg) | Corr. (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| --- | --- | --- | --- | --- | --- | --- | | --- | --- | --- |

## Final_Result

| Frequency (MHz) | MaxPeak (dBm) | Limit (dBm) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Elevation (deg) | Corr. (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| --- | --- | --- | --- | --- | --- | --- | | --- | --- | --- |

eFDD2 NB-IoT QPSK, Channel 19199




## Final_Result

| Frequency (MHz) | RMS (dBm) | Limit (dBm) | Margin (dB) | Meas. Time (ms) | Bandwidth (kHz) | Height (cm) | Pol | Azimuth (deg) | Elevation (deg) | Corr. (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1910.004000 | -15.62 | -13.00 | 2.26 | 3000.0 | 2.000 | 150.0 | V | -45.0 | 90.0 | -64.7 |

re-measurement: eFDD2 NB-IoT QPSK, Channel 19199

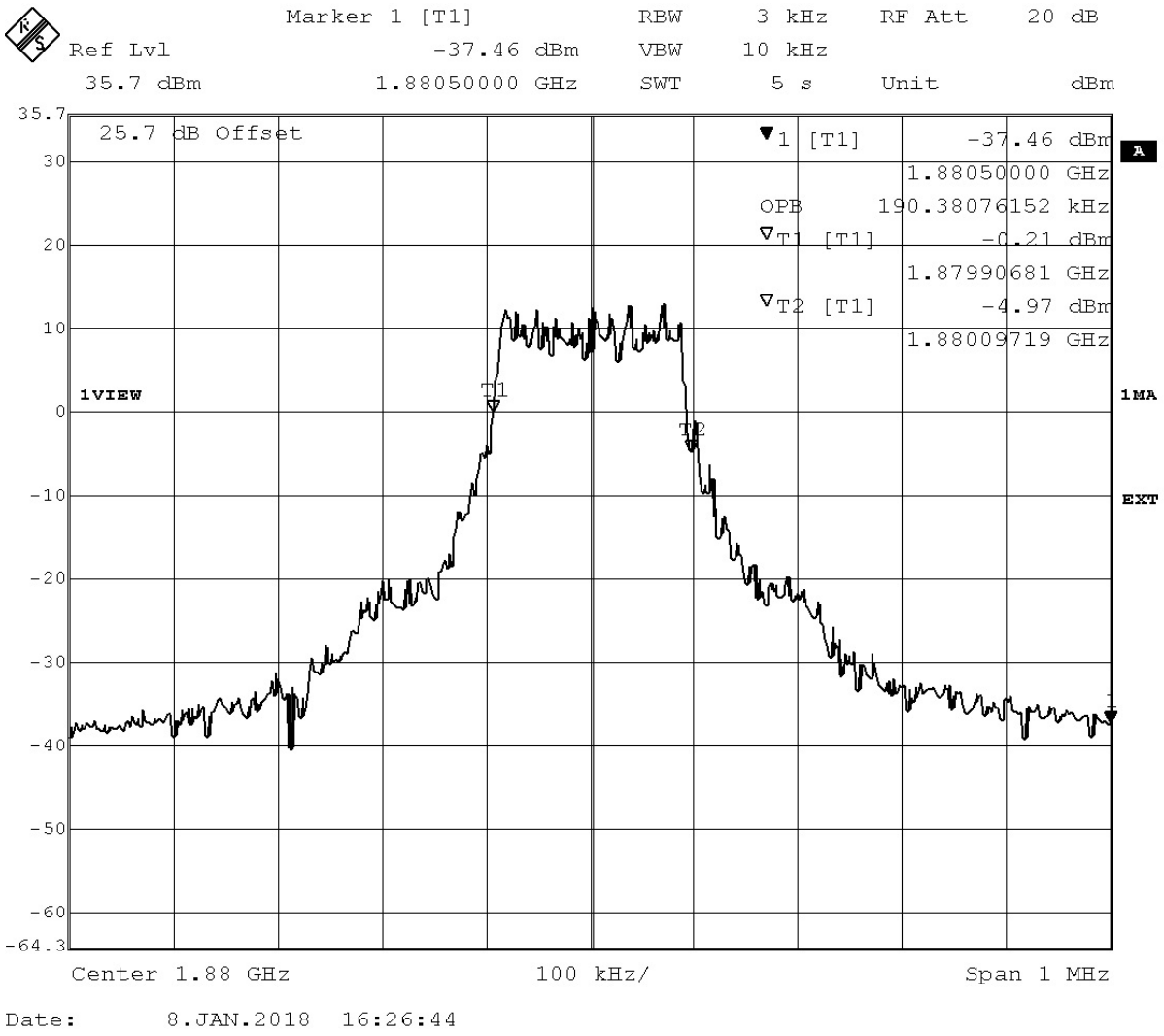
### 3.5.12 24.5 Emission and Occupied Bandwidth §2.1049, §24.238

**Test: 24.5; Emission and Occupied Bandwidth Summary §2.1049, §24.238**

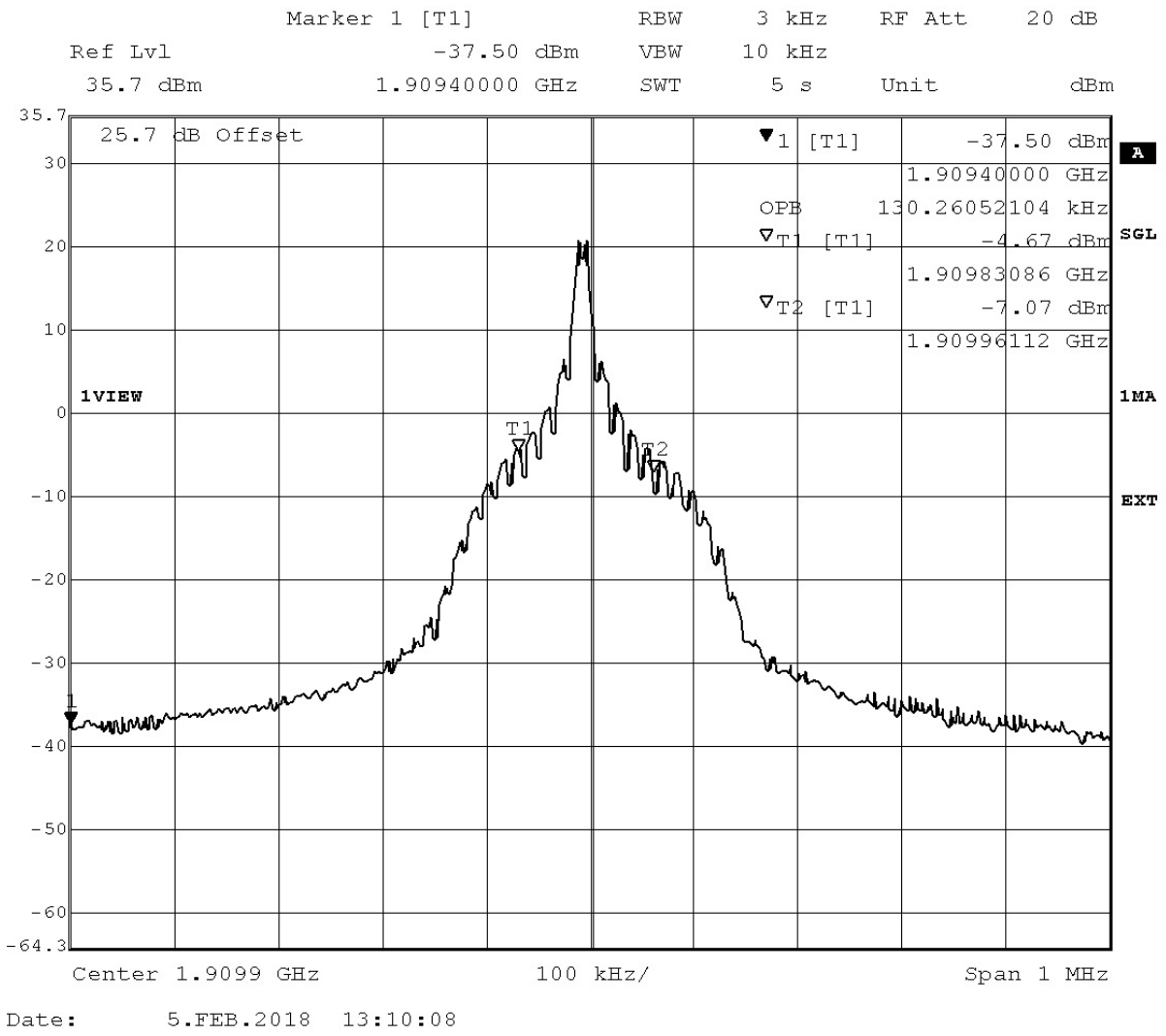
| | |
|---|---|
| *Result:* | Passed |
| *Setup No.:* | S01_ah01 |
| *Date of Test:* | 2018/01/08 11:20 |
| *Body:* | FCC47CFRChIPART24PERSONAL COMMUNICATIONS SERVICES |
| *Test Specification:* | FCC part 2 and 24 |

**Detailed Results:**

| Radio Technology | Reference Test Frequencies | Channel | Subcarrier | Nominal BW [kHz] | 99 % BW [kHz] |
|---|---|---|---|---|---|
| NB-IoT eFDD 2 QPSK | standalone | 18601 | 12 | 200 | 192.4 |
| NB-IoT eFDD 2 QPSK | standalone | 18900 | 12 | 200 | 190.4 |
| NB-IoT eFDD 2 QPSK | standalone | 19199 | 12 | 200 | 192.4 |
| NB-IoT eFDD 2 QPSK | in-band | 18606 | 12 | 200 | 186.4 |
| NB-IoT eFDD 2 QPSK | in-band | 18660 | 12 | 200 | 192.4 |
| NB-IoT eFDD 2 QPSK | in-band | 18669 | 12 | 200 | 190.4 |
| NB-IoT eFDD 2 QPSK | in-band | 18891 | 12 | 200 | 188.4 |
| NB-IoT eFDD 2 QPSK | in-band | 18910 | 12 | 200 | 190.4 |
| NB-IoT eFDD 2 QPSK | in-band | 18919 | 12 | 200 | 190.4 |
| NB-IoT eFDD 2 QPSK | in-band | 19194 | 12 | 200 | 192.4 |
| NB-IoT eFDD 2 QPSK | in-band | 19160 | 12 | 200 | 192.4 |
| NB-IoT eFDD 2 QPSK | in-band | 19169 | 12 | 200 | 192.4 |
| NB-IoT eFDD 2 QPSK | guard-band | 18601 | 12 | 200 | 188.4 |
| NB-IoT eFDD 2 QPSK | guard-band | 18876 | 12 | 200 | 190.4 |
| NB-IoT eFDD 2 QPSK | guard-band | 19199 | 12 | 200 | 192.4 |
| NB-IoT eFDD 2 BPSK | standalone | 18601 | 1 | 200 | 130.3 |
| NB-IoT eFDD 2 BPSK | standalone | 18900 | 1 | 200 | 132.3 |
| NB-IoT eFDD 2 BPSK | standalone | 19199 | 1 | 200 | 130.3 |
| NB-IoT eFDD 2 BPSK | in-band | 18606 | 1 | 200 | 132.3 |
| NB-IoT eFDD 2 BPSK | in-band | 18660 | 1 | 200 | 132.3 |
| NB-IoT eFDD 2 BPSK | in-band | 18669 | 1 | 200 | 130.3 |
| NB-IoT eFDD 2 BPSK | in-band | 18891 | 1 | 200 | 136.3 |
| NB-IoT eFDD 2 BPSK | in-band | 18910 | 1 | 200 | 126.3 |
| NB-IoT eFDD 2 BPSK | in-band | 18919 | 1 | 200 | 130.3 |
| NB-IoT eFDD 2 BPSK | in-band | 19194 | 1 | 200 | 130.3 |
| NB-IoT eFDD 2 BPSK | in-band | 19160 | 1 | 200 | 132.3 |
| NB-IoT eFDD 2 BPSK | in-band | 19169 | 1 | 200 | 130.3 |
| NB-IoT eFDD 2 BPSK | guard-band | 18601 | 1 | 200 | 132.3 |
| NB-IoT eFDD 2 BPSK | guard-band | 18876 | 1 | 200 | 132.3 |
| NB-IoT eFDD 2 BPSK | guard-band | 19199 | 1 | 200 | 130.3 |




eFDD2 NB-IoT QPSK, Channel 18900




eFDD2 NB-IoT QPSK, Channel 19199

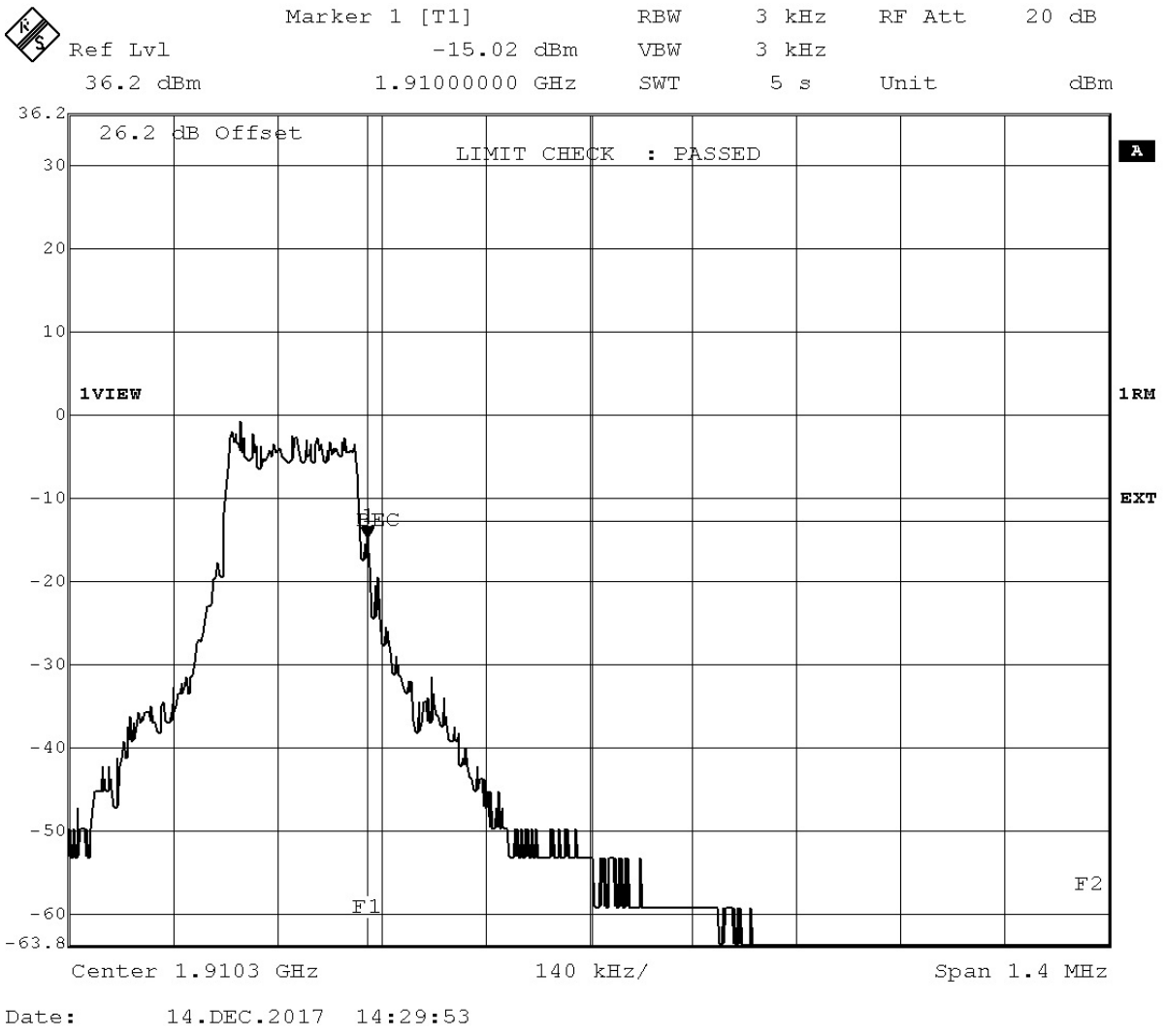
### 3.5.13 24.6 Band edge compliance §2.1053, §24.238

**Test: 24.6; Band edge compliance summary §2.1053, §24.238**

| | |
|---|---|
| *Result:* | Passed |
| *Setup No.:* | S01_ah01 |
| *Date of Test:* | 2018/01/08 11:21 |
| *Body:* | FCC47CFRChIPART24PERSONAL COMMUNICATIONS SERVICES |
| *Test Specification:* | FCC part 2 and 24 |

**Detailed Results:**

| Radio Technology | Reference Test Frequencies | Channel | Sub-carrier | RMS [dBm] | Limit /dBm | Margin to Limit /dB |
|---|---|---|---|---|---|---|
| NB-IoT eFDD 2 QPSK | standalone | 18601 | 12 | -18.46 | -13 | 5.46 |
| NB-IoT eFDD 2 QPSK | standalone | 19199 | 12 | -15.02 | -13 | 2.02 |
| NB-IoT eFDD 2 QPSK | guard-band | 18601 | 12 | -18.54 | -13 | 5.54 |
| NB-IoT eFDD 2 QPSK | guard-band | 19199 | 12 | -15.12 | -13 | 2.12 |
| NB-IoT eFDD 2 BPSK | standalone | 18601 | 1 | -15.18 | -13 | 2.18 |
| NB-IoT eFDD 2 BPSK | standalone | 19199 | 1 | -15.61 | -13 | 2.61 |
| NB-IoT eFDD 2 BPSK | guard-band | 18601 | 1 | -15.23 | -13 | 2.23 |
| NB-IoT eFDD 2 BPSK | guard-band | 19199 | 1 | -16.23 | -13 | 3.23 |




eFDD2 NB-IoT QPSK, Channel 19199

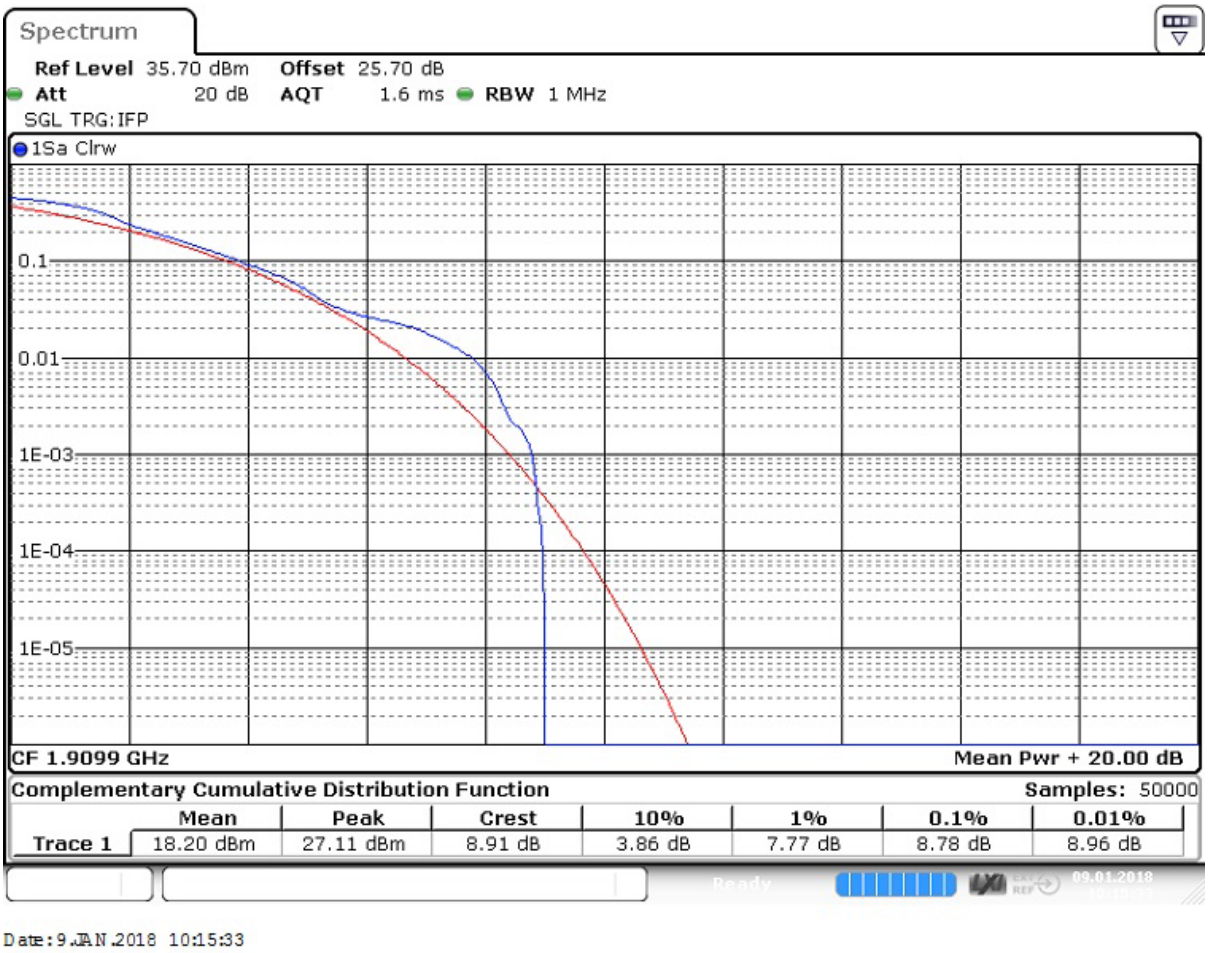
## 3.5.14 24.7 Peak-to-Average ratio §2.1046, §24.232

**Test: 24.7; Peak-to-Average Ratio Summary §2.1046, §24.232**

| | |
|---|---|
| *Result:* | Passed |
| *Setup No.:* | S01_ah01 |
| *Date of Test:* | 2018/01/08 11:22 |
| *Body:* | FCC47CFRChIPART24PERSONAL COMMUNICATIONS SERVICES |
| *Test Specification:* | FCC part 2 and 24 |

**Detailed Results:**

| Radio Technology | Reference Test Frequencies | Channel | Sub-carrier | Peak to Average Ratio | Limit /dB | Margin to Limit /dB |
|---|---|---|---|---|---|---|
| NB-IoT eFDD 2 QPSK | standalone | 18601 | 12 | 8.61 | 13 | 4.39 |
| NB-IoT eFDD 2 QPSK | standalone | 18900 | 12 | 8.58 | 13 | 4.42 |
| NB-IoT eFDD 2 QPSK | standalone | 19199 | 12 | 8.78 | 13 | 4.22 |
| NB-IoT eFDD 2 BPSK | standalone | 18601 | 1 | 4.41 | 13 | 8.59 |
| NB-IoT eFDD 2 BPSK | standalone | 18900 | 1 | 4.9 | 13 | 8.1 |
| NB-IoT eFDD 2 BPSK | standalone | 19199 | 1 | 4.55 | 13 | 8.45 |




eFDD2 QPSK CH19199

### 3.5.15 27.1 RF Power Output §2.1046, §27.250

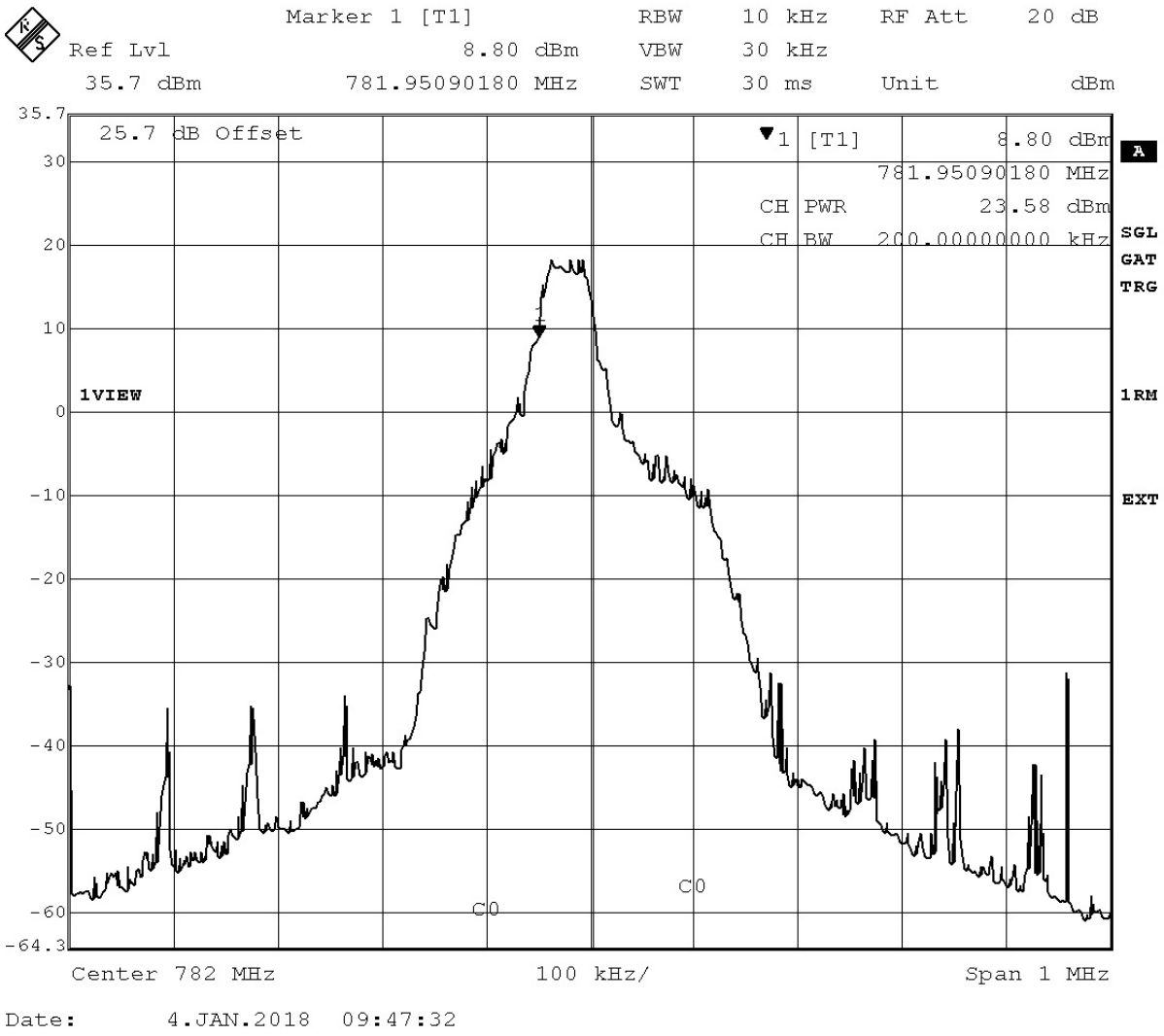
**Test: 27.1; RF Power Output Summary §2.1046, §27.250**

| | |
|---|---|
| *Result:* | Passed |
| *Setup No.:* | S01_ah01 |
| *Date of Test:* | 2018/01/08 9:58 |
| *Body:* | FCC47CFRChIPART27MISCELLANEOUS WIRELESS COMMUNICATIONS SERV |
| *Test Specification:* | FCC part 2 and 27 |

**Detailed Results:**

| Radio Technology | Reference Test Frequencies | Channel | Sub-carrier | RMS Conducted Power (dBm) | FCC / IC EIRP Limit (W) | Maximum Antenna Gain (dBi) |
|---|---|---|---|---|---|---|
| NB-IoT eFDD 12 QPSK | standalone | 23011 | 12 | 21.18 | 1 | 8.82 |
| NB-IoT eFDD 12 QPSK | standalone | 23095 | 12 | 21.04 | 1 | 8.96 |
| NB-IoT eFDD 12 QPSK | standalone | 23179 | 12 | 21.22 | 1 | 8.78 |
| NB-IoT eFDD 12 QPSK | in-band | 23016 | 12 | 21.1 | 1 | 8.9 |
| NB-IoT eFDD 12 QPSK | in-band | 23070 | 12 | 22.36 | 1 | 7.64 |
| NB-IoT eFDD 12 QPSK | in-band | 23079 | 12 | 20.81 | 1 | 9.19 |
| NB-IoT eFDD 12 QPSK | in-band | 23086 | 12 | 20.94 | 1 | 9.06 |
| NB-IoT eFDD 12 QPSK | in-band | 23105 | 12 | 21 | 1 | 9 |
| NB-IoT eFDD 12 QPSK | in-band | 23114 | 12 | 20.97 | 1 | 9.03 |
| NB-IoT eFDD 12 QPSK | in-band | 23174 | 12 | 21.32 | 1 | 8.68 |
| NB-IoT eFDD 12 QPSK | in-band | 23140 | 12 | 20.87 | 1 | 9.13 |
| NB-IoT eFDD 12 QPSK | in-band | 23149 | 12 | 21 | 1 | 9 |
| NB-IoT eFDD 12 QPSK | guard-band | 23011 | 12 | 20.96 | 1 | 9.04 |
| NB-IoT eFDD 12 QPSK | guard-band | 23071 | 12 | 21.08 | 1 | 8.92 |
| NB-IoT eFDD 12 QPSK | guard-band | 23179 | 12 | 21.28 | 1 | 8.72 |
| NB-IoT eFDD 12 QPSK | standalone | 23011 | 6 | 21.89 | 1 | 8.11 |
| NB-IoT eFDD 12 QPSK | standalone | 23095 | 6 | 21.97 | 1 | 8.03 |
| NB-IoT eFDD 12 QPSK | standalone | 23179 | 6 | 22.31 | 1 | 7.69 |
| NB-IoT eFDD 12 QPSK | in-band | 23016 | 6 | 21.94 | 1 | 8.06 |
| NB-IoT eFDD 12 QPSK | in-band | 23070 | 6 | 22.2 | 1 | 7.8 |
| NB-IoT eFDD 12 QPSK | in-band | 23079 | 6 | 21.98 | 1 | 8.02 |
| NB-IoT eFDD 12 QPSK | in-band | 23086 | 6 | 22.19 | 1 | 7.81 |
| NB-IoT eFDD 12 QPSK | in-band | 23105 | 6 | 21.65 | 1 | 8.35 |
| NB-IoT eFDD 12 QPSK | in-band | 23114 | 6 | 21.69 | 1 | 8.31 |
| NB-IoT eFDD 12 QPSK | in-band | 23174 | 6 | 21.94 | 1 | 8.06 |
| NB-IoT eFDD 12 QPSK | in-band | 23140 | 6 | 21.72 | 1 | 8.28 |
| NB-IoT eFDD 12 QPSK | in-band | 23149 | 6 | 21.6 | 1 | 8.4 |
| NB-IoT eFDD 12 QPSK | guard-band | 23011 | 6 | 21.89 | 1 | 8.11 |
| NB-IoT eFDD 12 QPSK | guard-band | 23071 | 6 | 21.98 | 1 | 8.02 |
| NB-IoT eFDD 12 QPSK | guard-band | 23179 | 6 | 22.44 | 1 | 7.56 |
| NB-IoT eFDD 12 QPSK | standalone | 23011 | 3 | 21.79 | 1 | 8.21 |
| NB-IoT eFDD 12 QPSK | standalone | 23095 | 3 | 22.39 | 1 | 7.61 |
| NB-IoT eFDD 12 QPSK | standalone | 23179 | 3 | 23.39 | 1 | 6.61 |
| NB-IoT eFDD 12 QPSK | in-band | 23016 | 3 | 22.48 | 1 | 7.52 |
| NB-IoT eFDD 12 QPSK | in-band | 23070 | 3 | 22.26 | 1 | 7.74 |
| NB-IoT eFDD 12 QPSK | in-band | 23079 | 3 | 22.01 | 1 | 7.99 |
| NB-IoT eFDD 12 QPSK | in-band | 23086 | 3 | 22.01 | 1 | 7.99 |
| NB-IoT eFDD 12 QPSK | in-band | 23105 | 3 | 21.97 | 1 | 8.03 |
| NB-IoT eFDD 12 QPSK | in-band | 23114 | 3 | 22.24 | 1 | 7.76 |
| NB-IoT eFDD 12 QPSK | in-band | 23174 | 3 | 22.65 | 1 | 7.35 |
| NB-IoT eFDD 12 QPSK | in-band | 23140 | 3 | 22 | 1 | 8 |
| NB-IoT eFDD 12 QPSK | in-band | 23149 | 3 | 22.41 | 1 | 7.59 |
| NB-IoT eFDD 12 QPSK | guard-band | 23011 | 3 | 21.79 | 1 | 8.21 |
| NB-IoT eFDD 12 QPSK | guard-band | 23071 | 3 | 22.6 | 1 | 7.4 |
| NB-IoT eFDD 12 QPSK | guard-band | 23179 | 3 | 23.2 | 1 | 6.8 |
| NB-IoT eFDD 12 QPSK | standalone | 23011 | 1 | 21.1 | 1 | 8.9 |
| NB-IoT eFDD 12 QPSK | standalone | 23095 | 1 | 21.12 | 1 | 8.88 |
| NB-IoT eFDD 12 QPSK | standalone | 23179 | 1 | 21.45 | 1 | 8.55 |
| NB-IoT eFDD 12 QPSK | in-band | 23016 | 1 | 21.03 | 1 | 8.97 |
| NB-IoT eFDD 12 QPSK | in-band | 23070 | 1 | 21.22 | 1 | 8.78 |
| NB-IoT eFDD 12 QPSK | in-band | 23079 | 1 | 20.83 | 1 | 9.17 |
| NB-IoT eFDD 12 QPSK | in-band | 23086 | 1 | 21.25 | 1 | 8.75 |
| NB-IoT eFDD 12 QPSK | in-band | 23105 | 1 | 20.89 | 1 | 9.11 |
| NB-IoT eFDD 12 QPSK | in-band | 23114 | 1 | 20.95 | 1 | 9.05 |
| NB-IoT eFDD 12 QPSK | in-band | 23174 | 1 | 21.36 | 1 | 8.64 |
| NB-IoT eFDD 12 QPSK | in-band | 23140 | 1 | 20.69 | 1 | 9.31 |
| NB-IoT eFDD 12 QPSK | in-band | 23149 | 1 | 20.8 | 1 | 9.2 |
| NB-IoT eFDD 12 QPSK | guard-band | 23011 | 1 | 21.04 | 1 | 8.96 |
| NB-IoT eFDD 12 QPSK | guard-band | 23071 | 1 | 21.1 | 1 | 8.9 |
| NB-IoT eFDD 12 QPSK | guard-band | 23179 | 1 | 21.44 | 1 | 8.56 |
| NB-IoT eFDD 12 BPSK | standalone | 23011 | 1 | 21.23 | 1 | 8.77 |
| NB-IoT eFDD 12 BPSK | standalone | 23095 | 1 | 21.52 | 1 | 8.48 |
| NB-IoT eFDD 12 BPSK | standalone | 23179 | 1 | 21.56 | 1 | 8.44 |
| NB-IoT eFDD 12 BPSK | in-band | 23016 | 1 | 21.54 | 1 | 8.46 |
| NB-IoT eFDD 12 BPSK | in-band | 23070 | 1 | 21.66 | 1 | 8.34 |
| NB-IoT eFDD 12 BPSK | in-band | 23079 | 1 | 21.58 | 1 | 8.42 |
| NB-IoT eFDD 12 BPSK | in-band | 23086 | 1 | 21.61 | 1 | 8.39 |
| NB-IoT eFDD 12 BPSK | in-band | 23105 | 1 | 21.59 | 1 | 8.41 |
| NB-IoT eFDD 12 BPSK | in-band | 23114 | 1 | 21.53 | 1 | 8.47 |
| NB-IoT eFDD 12 BPSK | in-band | 23174 | 1 | 21.55 | 1 | 8.45 |

| Radio Technology | Reference Test Frequencies | Channel | Sub-carrier | RMS Conducted Power (dBm) | FCC / IC EIRP Limit (W) | Maximum Antenna Gain (dBi) |
|---|---|---|---|---|---|---|
| NB-IoT eFDD 12 BPSK | in-band | 23140 | 1 | 21.42 | 1 | 8.58 |
| NB-IoT eFDD 12 BPSK | in-band | 23149 | 1 | 21.51 | 1 | 8.49 |
| NB-IoT eFDD 12 BPSK | guard-band | 23011 | 1 | 21.48 | 1 | 8.52 |
| NB-IoT eFDD 12 BPSK | guard-band | 23071 | 1 | 21.7 | 1 | 8.3 |
| NB-IoT eFDD 12 BPSK | guard-band | 23179 | 1 | 21.18 | 1 | 8.82 |
| NB-IoT eFDD 13 QPSK | standalone | 23181 | 12 | 20.94 | 3 | 13.83 |
| NB-IoT eFDD 13 QPSK | standalone | 23230 | 12 | 20.66 | 3 | 14.11 |
| NB-IoT eFDD 13 QPSK | standalone | 23279 | 12 | 21.07 | 3 | 13.7 |
| NB-IoT eFDD 13 QPSK | in-band | 23187 | 12 | 20.62 | 3 | 14.15 |
| NB-IoT eFDD 13 QPSK | in-band | 23221 | 12 | 20.71 | 3 | 14.06 |
| NB-IoT eFDD 13 QPSK | in-band | 23240 | 12 | 20.56 | 3 | 14.21 |
| NB-IoT eFDD 13 QPSK | in-band | 23249 | 12 | 20.79 | 3 | 13.98 |
| NB-IoT eFDD 13 QPSK | in-band | 23273 | 12 | 20.74 | 3 | 14.03 |
| NB-IoT eFDD 13 QPSK | guard-band | 23181 | 12 | 20.82 | 3 | 13.95 |
| NB-IoT eFDD 13 QPSK | guard-band | 23206 | 12 | 20.74 | 3 | 14.03 |
| NB-IoT eFDD 13 QPSK | guard-band | 23279 | 12 | 20.96 | 3 | 13.81 |
| NB-IoT eFDD 13 QPSK | standalone | 23181 | 6 | 21.55 | 3 | 13.22 |
| NB-IoT eFDD 13 QPSK | standalone | 23230 | 6 | 21.52 | 3 | 13.25 |
| NB-IoT eFDD 13 QPSK | standalone | 23279 | 6 | 21.52 | 3 | 13.25 |
| NB-IoT eFDD 13 QPSK | in-band | 23187 | 6 | 21.5 | 3 | 13.27 |
| NB-IoT eFDD 13 QPSK | in-band | 23221 | 6 | 21.42 | 3 | 13.35 |
| NB-IoT eFDD 13 QPSK | in-band | 23240 | 6 | 21.51 | 3 | 13.26 |
| NB-IoT eFDD 13 QPSK | in-band | 23249 | 6 | 22 | 3 | 12.77 |
| NB-IoT eFDD 13 QPSK | in-band | 23273 | 6 | 21.58 | 3 | 13.19 |
| NB-IoT eFDD 13 QPSK | guard-band | 23181 | 6 | 21.48 | 3 | 13.29 |
| NB-IoT eFDD 13 QPSK | guard-band | 23206 | 6 | 21.61 | 3 | 13.16 |
| NB-IoT eFDD 13 QPSK | guard-band | 23279 | 6 | 21.79 | 3 | 12.98 |
| NB-IoT eFDD 13 QPSK | standalone | 23181 | 3 | 22.69 | 3 | 12.08 |
| NB-IoT eFDD 13 QPSK | standalone | 23230 | 3 | 23.58 | 3 | 11.19 |
| NB-IoT eFDD 13 QPSK | standalone | 23279 | 3 | 22.78 | 3 | 11.99 |
| NB-IoT eFDD 13 QPSK | in-band | 23187 | 3 | 22.55 | 3 | 12.22 |
| NB-IoT eFDD 13 QPSK | in-band | 23221 | 3 | 21.42 | 3 | 13.35 |
| NB-IoT eFDD 13 QPSK | in-band | 23240 | 3 | 22.44 | 3 | 12.33 |
| NB-IoT eFDD 13 QPSK | in-band | 23249 | 3 | 22.35 | 3 | 12.42 |
| NB-IoT eFDD 13 QPSK | in-band | 23273 | 3 | 23.46 | 3 | 11.31 |
| NB-IoT eFDD 13 QPSK | guard-band | 23181 | 3 | 21.94 | 3 | 12.83 |
| NB-IoT eFDD 13 QPSK | guard-band | 23206 | 3 | 22.58 | 3 | 12.19 |
| NB-IoT eFDD 13 QPSK | guard-band | 23279 | 3 | 22.25 | 3 | 12.52 |
| NB-IoT eFDD 13 QPSK | standalone | 23181 | 1 | 22.43 | 3 | 12.34 |
| NB-IoT eFDD 13 QPSK | standalone | 23230 | 1 | 22.65 | 3 | 12.12 |
| NB-IoT eFDD 13 QPSK | standalone | 23279 | 1 | 23.01 | 3 | 11.76 |
| NB-IoT eFDD 13 QPSK | in-band | 23187 | 1 | 21.02 | 3 | 13.75 |
| NB-IoT eFDD 13 QPSK | in-band | 23221 | 1 | 20.83 | 3 | 13.94 |
| NB-IoT eFDD 13 QPSK | in-band | 23240 | 1 | 20.9 | 3 | 13.87 |
| NB-IoT eFDD 13 QPSK | in-band | 23249 | 1 | 20.95 | 3 | 13.82 |
| NB-IoT eFDD 13 QPSK | in-band | 23273 | 1 | 20.88 | 3 | 13.89 |
| NB-IoT eFDD 13 QPSK | guard-band | 23181 | 1 | 20.61 | 3 | 14.16 |
| NB-IoT eFDD 13 QPSK | guard-band | 23206 | 1 | 20.79 | 3 | 13.98 |
| NB-IoT eFDD 13 BPSK | standalone | 23181 | 1 | 21.65 | 3 | 13.12 |
| NB-IoT eFDD 13 BPSK | standalone | 23230 | 1 | 21.12 | 3 | 13.65 |
| NB-IoT eFDD 13 BPSK | standalone | 23279 | 1 | 21.17 | 3 | 13.6 |
| NB-IoT eFDD 13 BPSK | in-band | 23187 | 1 | 21.33 | 3 | 13.44 |
| NB-IoT eFDD 13 BPSK | in-band | 23221 | 1 | 21.12 | 3 | 13.65 |
| NB-IoT eFDD 13 BPSK | in-band | 23240 | 1 | 21.1 | 3 | 13.67 |
| NB-IoT eFDD 13 BPSK | in-band | 23249 | 1 | 21.09 | 3 | 13.68 |
| NB-IoT eFDD 13 BPSK | in-band | 23273 | 1 | 20.98 | 3 | 13.79 |
| NB-IoT eFDD 13 BPSK | guard-band | 23206 | 1 | 21.14 | 3 | 13.63 |
| NB-IoT eFDD 13 BPSK | guard-band | 23279 | 1 | 21.09 | 3 | 13.68 |




eFDD13 NB-IoT QPSK, Subcarrier 3, Channel 23230

### 3.5.16 27.2 Frequency stability §2.1055, §27.54

**Test: 27.2; Frequency stability Summary §2.1055, §27.54**

| | |
|---|---|
| *Result:* | Passed |
| *Setup No.:* | S01_ah01 |
| *Date of Test:* | 2018/01/12 10:07 |
| *Body:* | FCC47CFRChIPART27MISCELLANEOUS WIRELESS COMMUNICATIONS SERV |
| *Test Specification:* | FCC part 2 and 27 |

**Detailed Results:**

| Temp. °C | Duration min | Voltage | Limit Hz | Freq. error Average (Hz) | Freq. error Max. (Hz) | Verdict |
|---|---|---|---|---|---|---|
| -30 | 0 | normal | 1955 | -6 | -21 | passed |
| -30 | 5 | | | -4 | -9 | passed |
| -30 | 10 | | | 10 | -10 | passed |
| -20 | 0 | normal | 1955 | -12 | -16 | passed |
| -20 | 5 | | | -15 | -2 | passed |
| -20 | 10 | | | -4 | 14 | passed |
| -10 | 0 | normal | 1955 | -6 | 10 | passed |
| -10 | 5 | | | -9 | 11 | passed |
| -10 | 10 | | | -4 | 14 | passed |
| 0 | 0 | normal | 1955 | 1 | 6 | passed |
| 0 | 5 | | | 3 | 10 | passed |
| 0 | 10 | | | -2 | -11 | passed |
| 10 | 0 | normal | 1955 | -15 | 8 | passed |
| 10 | 5 | | | -10 | -10 | passed |
| 10 | 10 | | | -18 | -7 | passed |
| 20 | 0 | low | 1955 | -4 | 10 | passed |
| 20 | 5 | | | -8 | -12 | passed |
| 20 | 10 | | | 6 | 8 | passed |
| 20 | 0 | normal = high [1)] | 1955 | 2 | -15 | passed |
| 20 | 5 | | | 3 | -3 | passed |
| 20 | 10 | | | 2 | -3 | passed |
| 20 | 0 | high | 1955 | 2 | 4 | passed |
| 20 | 5 | | | -4 | -12 | passed |
| 20 | 10 | | | 6 | 10 | passed |
| 30 | 0 | normal | 1955 | -4 | -11 | passed |
| 30 | 5 | | | -6 | 12 | passed |
| 30 | 10 | | | -3 | 19 | passed |
| 40 | 0 | normal | 1955 | -5 | -12 | passed |
| 40 | 5 | | | -6 | -13 | passed |
| 40 | 10 | | | -3 | -4 | passed |
| 50 | 0 | normal | 1955 | -5 | -6 | passed |
| 50 | 5 | | | -9 | -3 | passed |
| 50 | 10 | | | -7 | -5 | passed |

eFDD12 NB-IoT

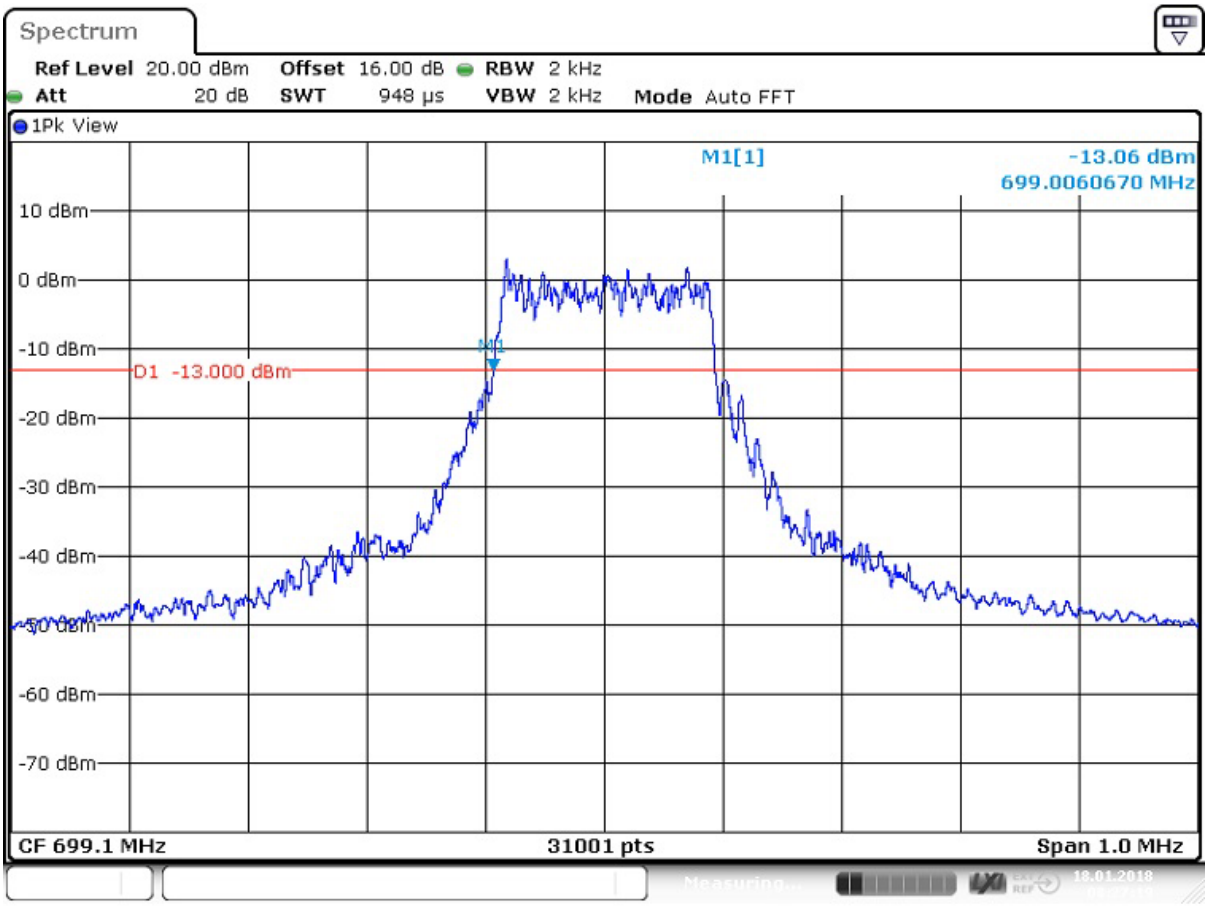
| Temp. °C | Duration min | Voltage | Limit Hz | Freq. error Average (Hz) | Freq. error Max. (Hz) | Verdict |
|---|---|---|---|---|---|---|
| -30 | 0 | normal | 1955 | -14 | -14 | passed |
| -30 | 5 | | | -16 | -6 | passed |
| -30 | 10 | | | -11 | -18 | passed |
| -20 | 0 | normal | 1955 | 13 | -16 | passed |
| -20 | 5 | | | 13 | -14 | passed |
| -20 | 10 | | | 12 | 10 | passed |
| -10 | 0 | normal | 1955 | -10 | 6 | passed |
| -10 | 5 | | | -11 | 8 | passed |
| -10 | 10 | | | -10 | -10 | passed |
| 0 | 0 | normal | 1955 | 23 | -12 | passed |
| 0 | 5 | | | 5 | 10 | passed |
| 0 | 10 | | | 6 | 11 | passed |
| 10 | 0 | normal | 1955 | 12 | 13 | passed |
| 10 | 5 | | | 11 | -10 | passed |
| 10 | 10 | | | 11 | -4 | passed |
| 20 | 0 | low | 1955 | 10 | -12 | passed |
| 20 | 5 | | | 4 | 8 | passed |
| 20 | 10 | | | -6 | -10 | passed |
| 20 | 0 | normal = high [1)] | 1955 | -6 | -1 | passed |
| 20 | 5 | | | -2 | -2 | passed |
| 20 | 10 | | | 1 | 3 | passed |
| 20 | 0 | high | 1955 | 3 | 6 | passed |
| 20 | 5 | | | 4 | 8 | passed |
| 20 | 10 | | | -6 | -12 | passed |
| 30 | 0 | normal | 1955 | 4 | 5 | passed |
| 30 | 5 | | | 3 | 6 | passed |
| 30 | 10 | | | 1 | 17 | passed |
| 40 | 0 | normal | 1955 | 2 | 6 | passed |
| 40 | 5 | | | 6 | 2 | passed |
| 40 | 10 | | | 3 | -4 | passed |
| 50 | 0 | normal | 1955 | -3 | 6 | passed |
| 50 | 5 | | | -4 | 3 | passed |
| 50 | 10 | | | -2 | -12 | passed |

eFDD13 NB-IoT

| LTE eFDD12 | | | | | | |
|---|---|---|---|---|---|---|
| BW (kHz) / Subcarrier | $f_L$ (MHz) | $f_H$ (MHz) | Max. Frequency Error (Hz) | Resulting Freq. (MHz) | Limit (MHz) | Result |
| 200 / 12 | 699.0066 | - | 21 | 699.01 | 698 | Passed |
| | - | 715.992 | 21 | 715.99 | 716 | Passed |

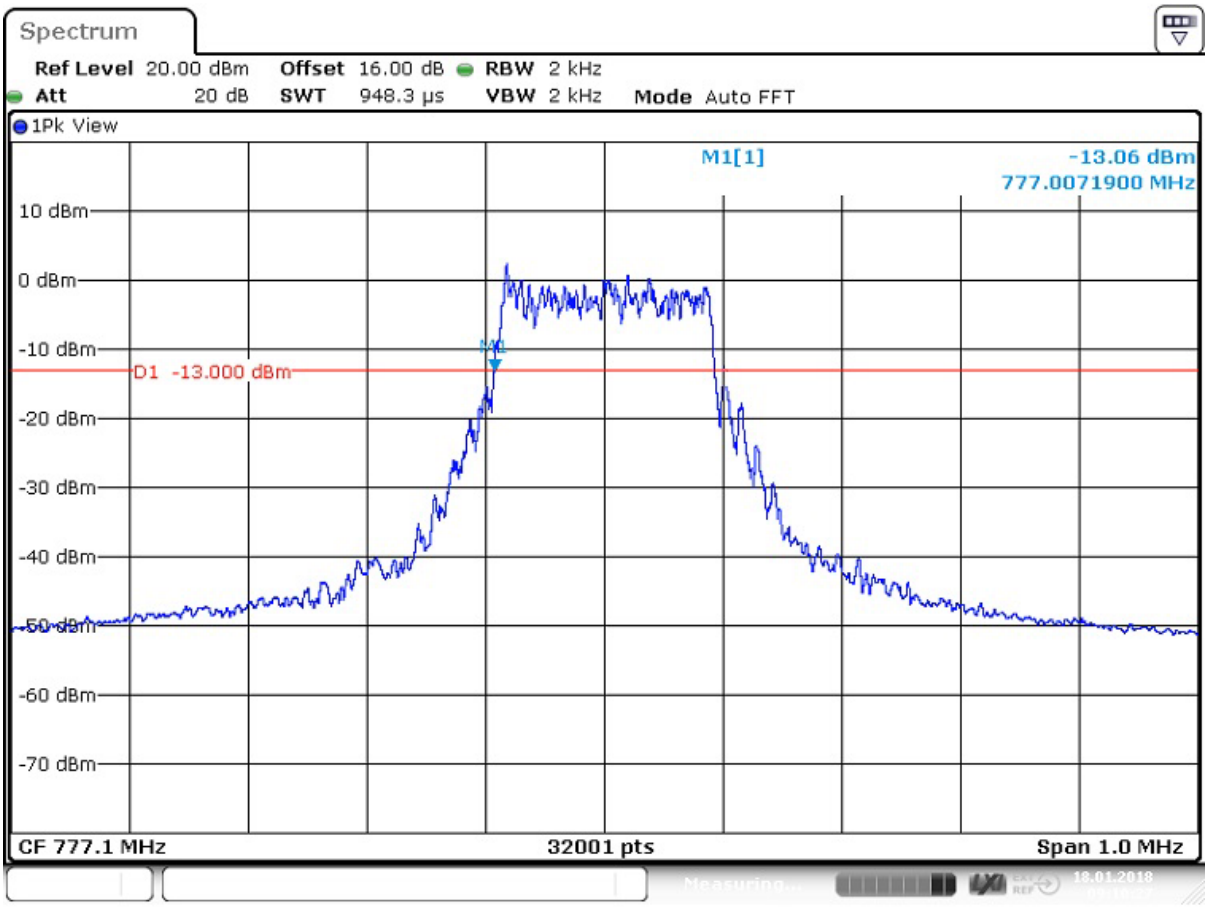
| LTE eFDD13 | | | | | | |
|---|---|---|---|---|---|---|
| BW (kHz) / Subcarrier | $f_L$ (MHz) | $f_H$ (MHz) | Max. Frequency Error (Hz) | Resulting Freq. (MHz) | Limit (MHz) | Result |
| 200 / 12 | 777.0072 | - | 18 | 777.01 | 777 | Passed |
| | - | 786.9921 | 18 | 786.99 | 787 | Passed |

eFDD12 NB-IoT & eFDD13 NB-IoT




Date: 18.JAN.2018 08:27:20

eFDD12 NB-IoT QPSK, Subcarrier 12, Channel 23011




eFDD13 NB-IoT QPSK, Subcarrier 12, Channel 23181

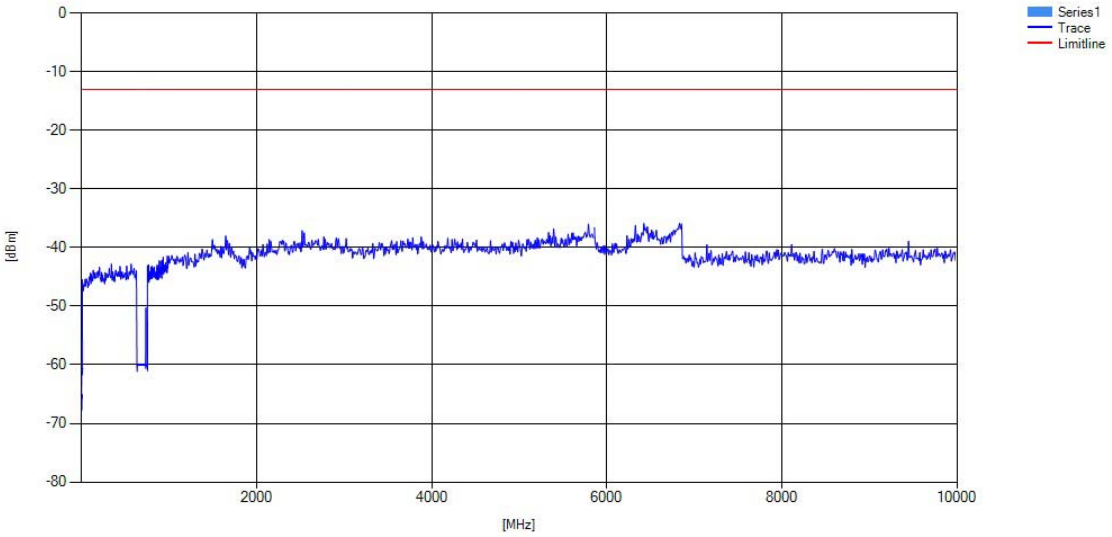
### 3.5.17 27.3 Spurious emissions at antenna terminals §2.1051, §27.53

**Test: 27.3; Spurious emissions at antenna terminals Summary §2.1051, §27.53**

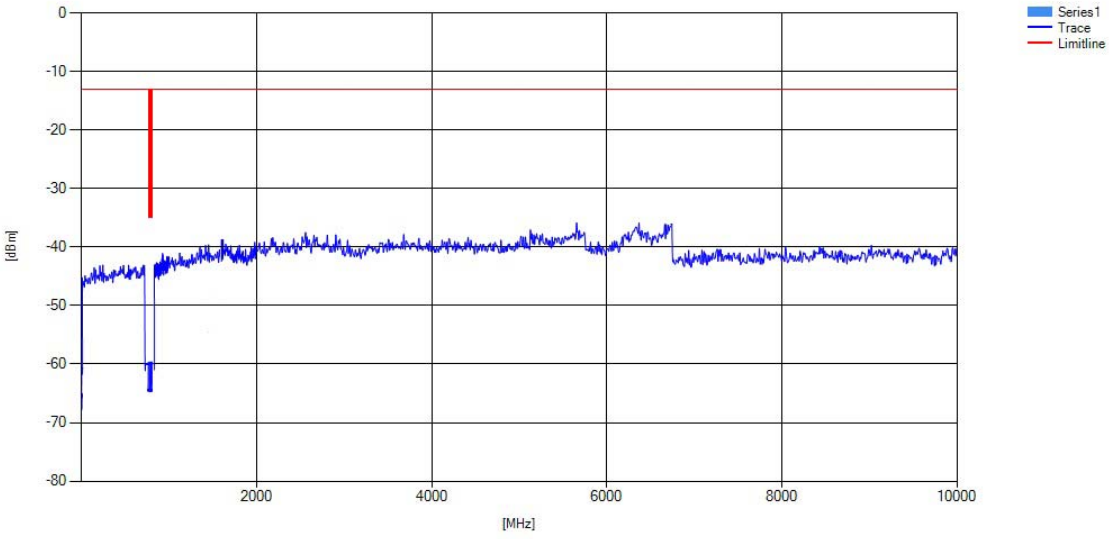
| | |
|---|---|
| *Result:* | Passed |
| *Setup No.:* | S01_ah01 |
| *Date of Test:* | 2017/12/17 10:11 |
| *Body:* | FCC47CFRChIPART27MISCELLANEOUS WIRELESS COMMUNICATIONS SERV |
| *Test Specification:* | FCC part 2 and 27 |

**Detailed Results:**

| Radio Technology | Channel | Detector | Trace | Resolution Bandwidth /kHz | Frequency /MHz | Max Value /dBm | Limit /dBm | Margin to Limit /dB |
|---|---|---|---|---|---|---|---|---|
| eFDD 12 QPSK NB-IoT | low | rms | maxhold | - | - | - | -13 | >20 |
| eFDD 12 QPSK NB-IoT | mid | rms | maxhold | - | - | - | -13 | >20 |
| eFDD 12 QPSK NB-IoT | high | rms | maxhold | - | - | - | -13 | >20 |
| eFDD 13 QPSK NB-IoT | low | rms | maxhold | - | - | - | -13 | >20 |
| eFDD 13 QPSK NB-IoT | mid | rms | maxhold | - | - | - | -13 | >20 |
| eFDD 13 QPSK NB-IoT | high | rms | maxhold | - | - | - | -13 | >20 |




eFDD12 NB-IoT QPSK, Channel 23095




eFDD13 NB-IoT QPSK, Channel 23230

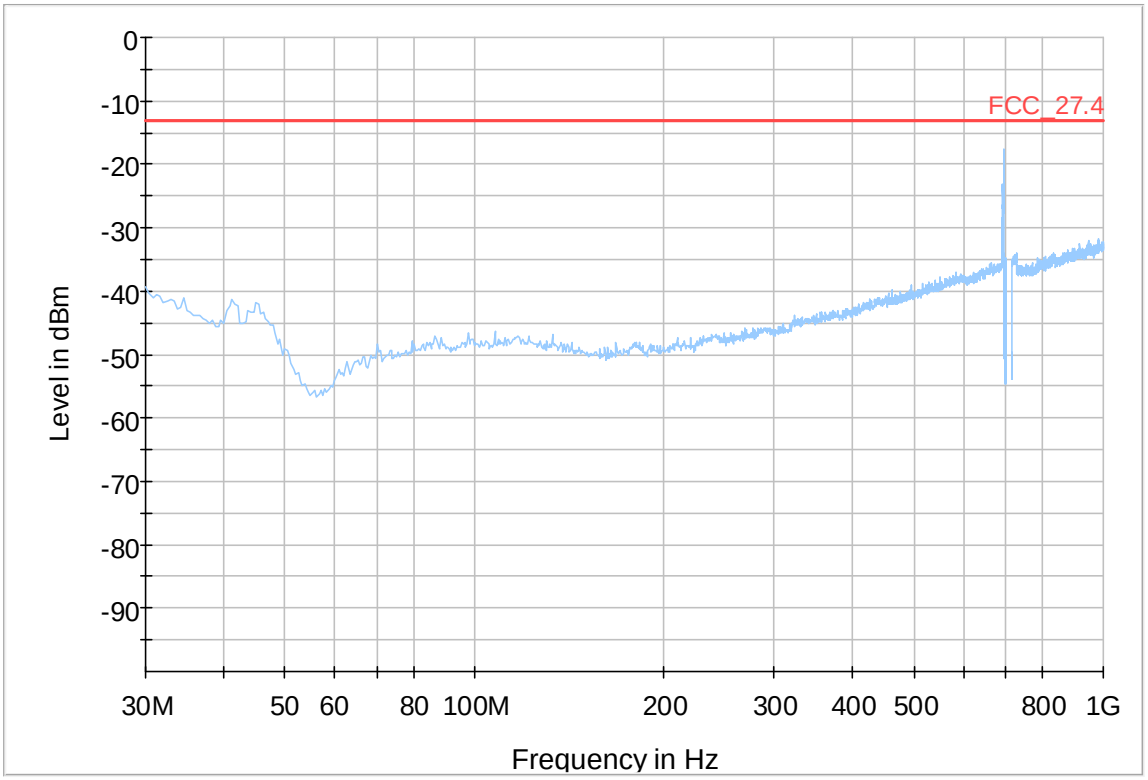
### 3.5.18 27.4 Field strength of spurious radiation §2.1053, §27.53

**Test: 27.4; Field strength of spurious radiation Summary §2.1053, §27.53**

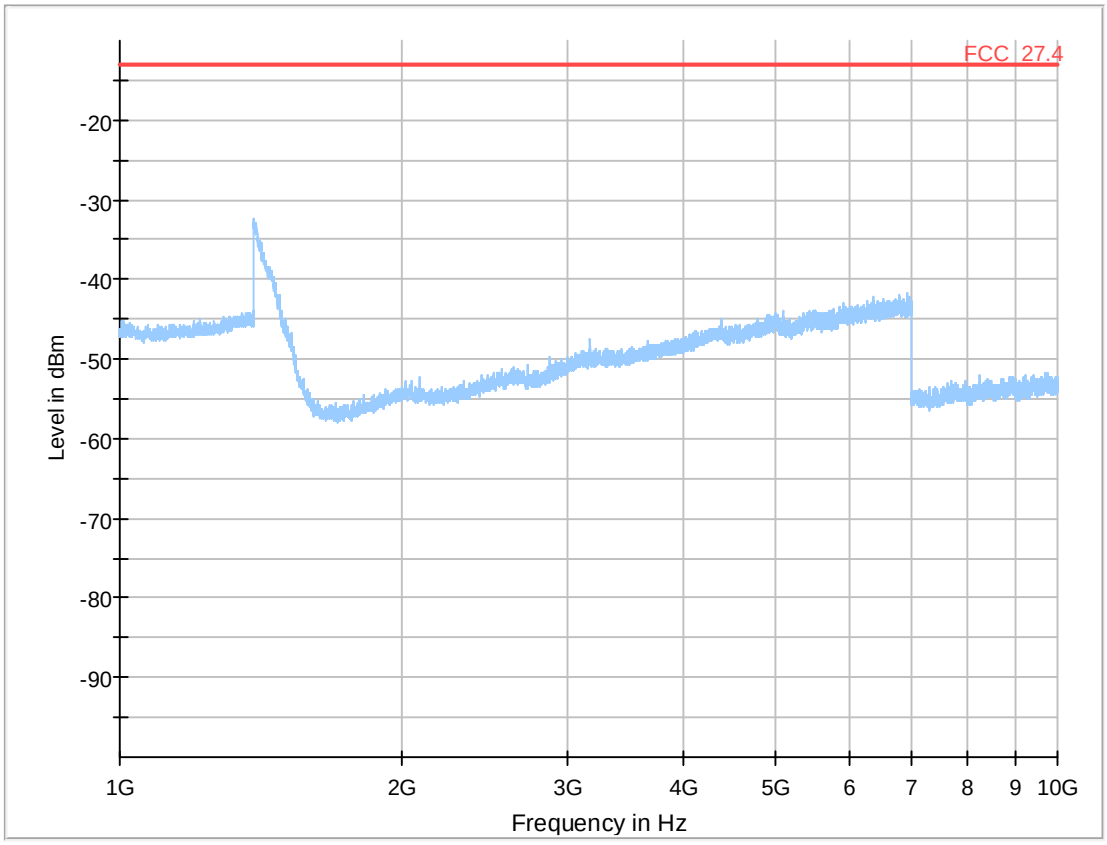
| | |
|---|---|
| *Result:* | Passed |
| *Setup No.:* | S01_ah01 |
| *Date of Test:* | 2017/12/12 11:29 |
| *Body:* | FCC47CFRChIPART27MISCELLANEOUS WIRELESS COMMUNICATIONS SERV |
| *Test Specification:* | FCC part 2 and 27 |

**Detailed Results:**

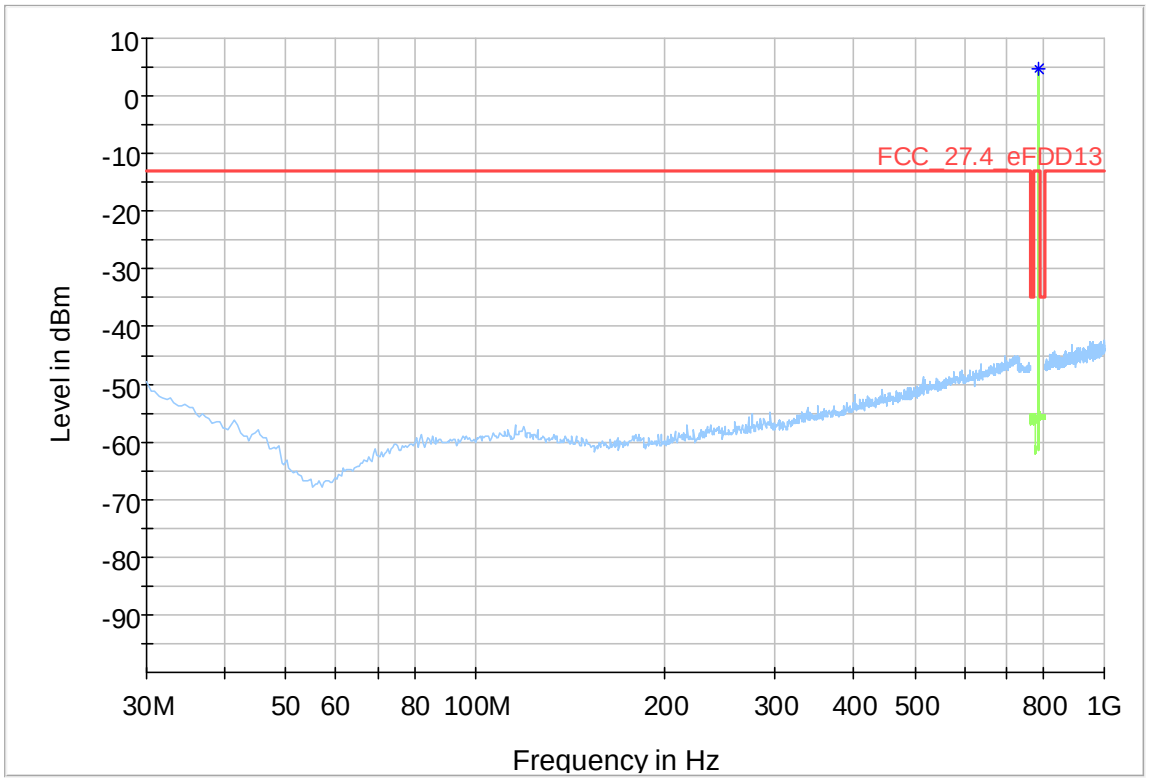
| Radio Technology | Channel | Detector | Trace | Resolution Bandwidth /kHz | Frequency /MHz | Max Value /dBm | Limit /dBm | Margin to Limit /dB |
|---|---|---|---|---|---|---|---|---|
| eFDD 12 QPSK NB-IoT | low | peak | maxhold | 30 | 695.9 | -17.66 | -13 | 4.66 |
| eFDD 12 QPSK NB-IoT | mid | - | maxhold | - | - | - | -13 | >20 |
| eFDD 12 QPSK NB-IoT | high | peak | maxhold | 30 | 716 | -27.81 | -13 | 14.81 |
| eFDD 13 QPSK NB-IoT | low | - | maxhold | - | - | - | -13 | >20 |
| eFDD 13 QPSK NB-IoT | mid | - | maxhold | - | - | - | -13 | >20 |
| eFDD 13 QPSK NB-IoT | high | peak | maxhold | 20 | 787.5 | -27.34 | -13 | 14.34 |



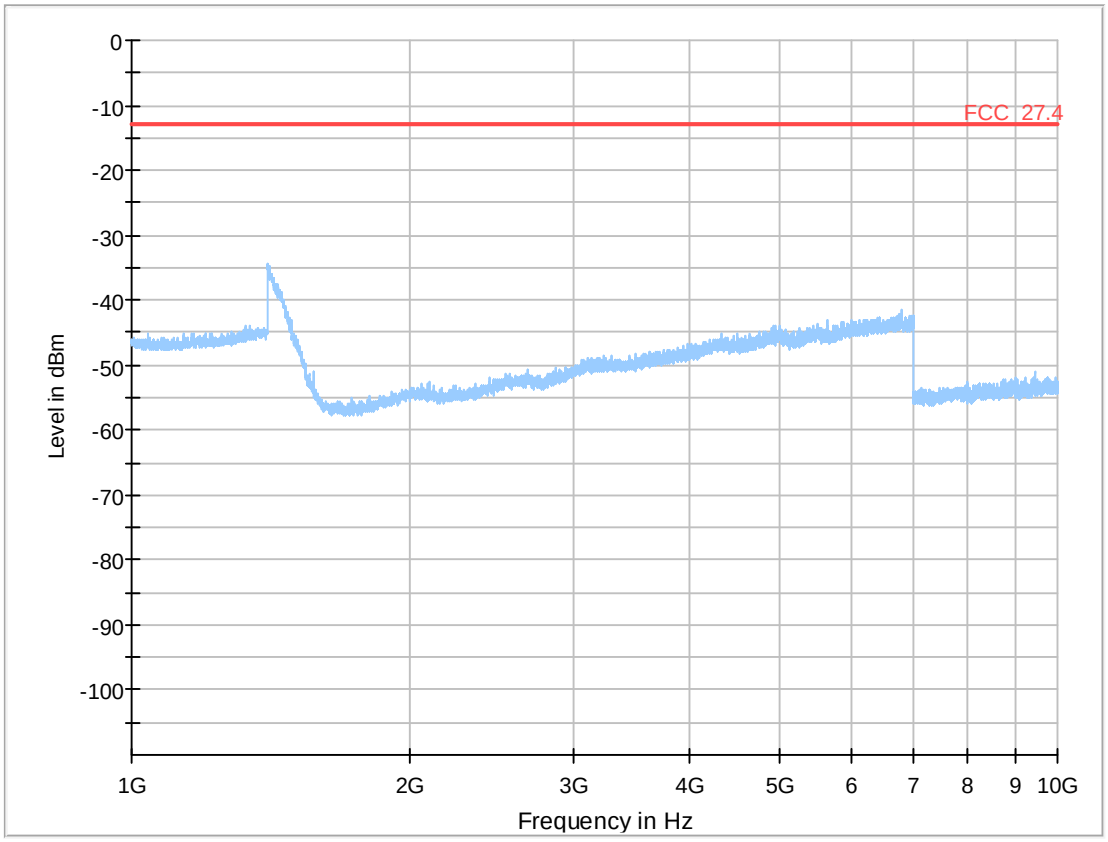

eFDD12 NB-IoT QPSK, Channel 23011



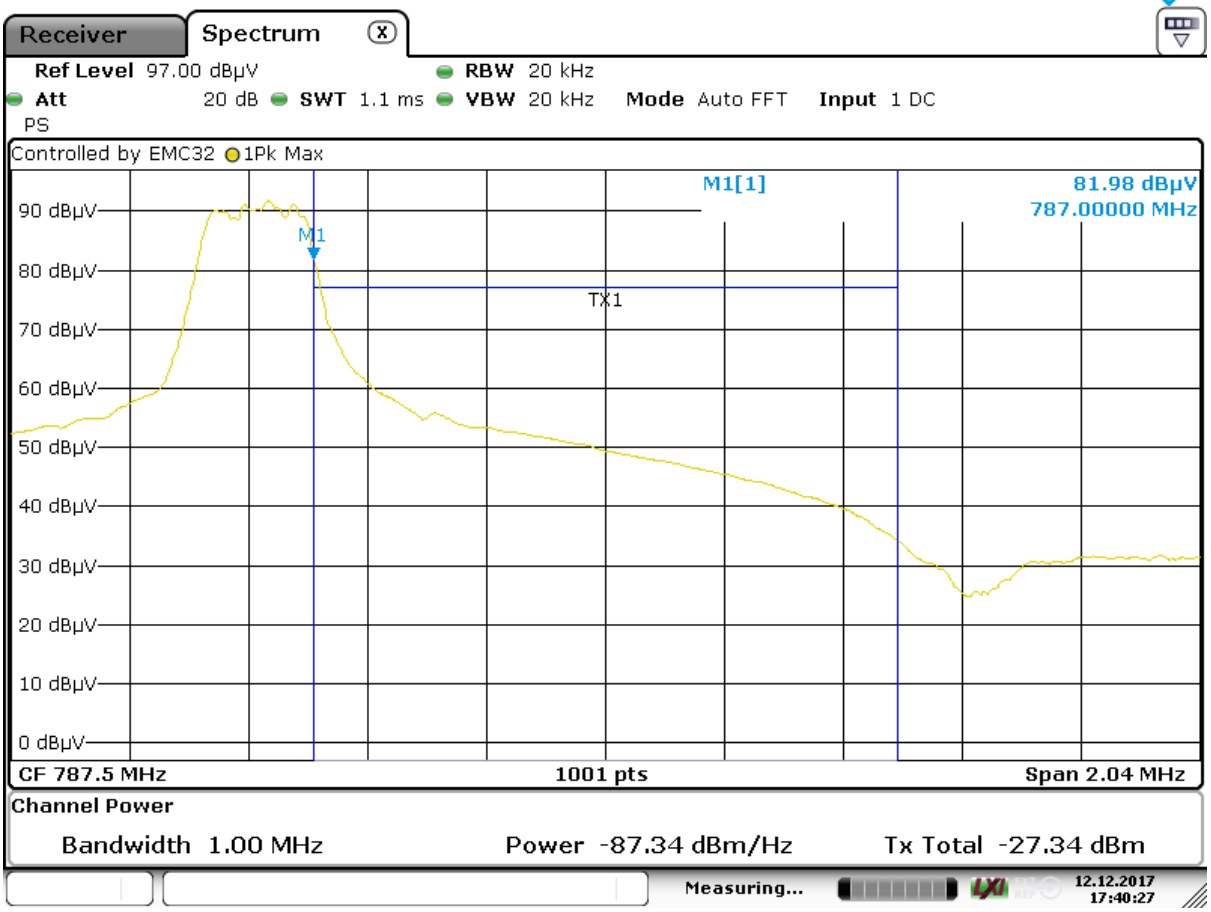

eFDD12 NB-IoT QPSK, Channel 23011




eFDD13 NB-IoT QPSK, Channel 23279




eFDD13 NB-IoT QPSK, Channel 23279




Date: 12.DEC.2017 17:40:27

eFDD13 NB-IoT QPSK, Channel 23279

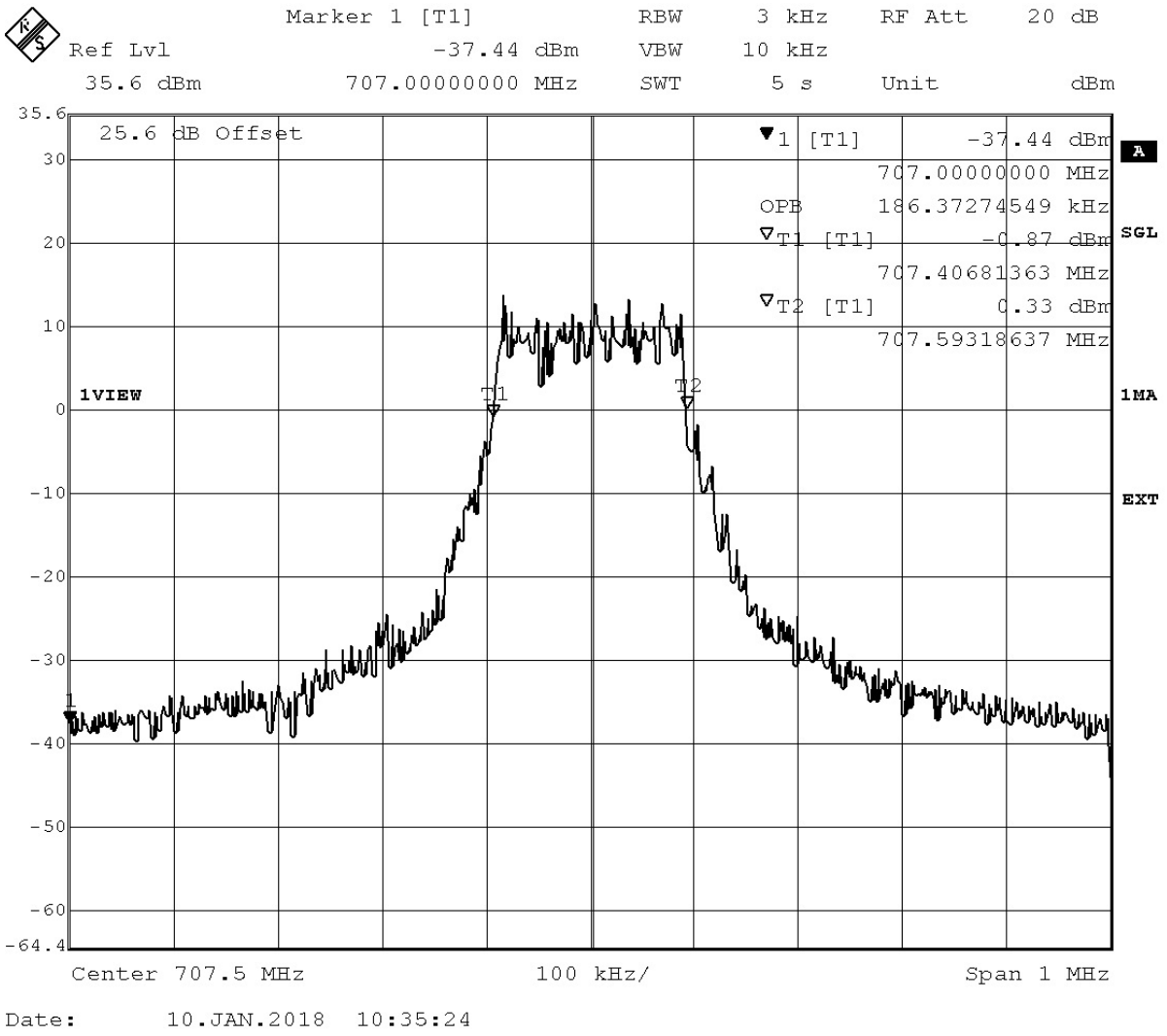
### 3.5.19 27.5 Emission and Occupied Bandwidth §2.1049

**Test: 27.5; Emission and Occupied Bandwidth Summary §2.1049**

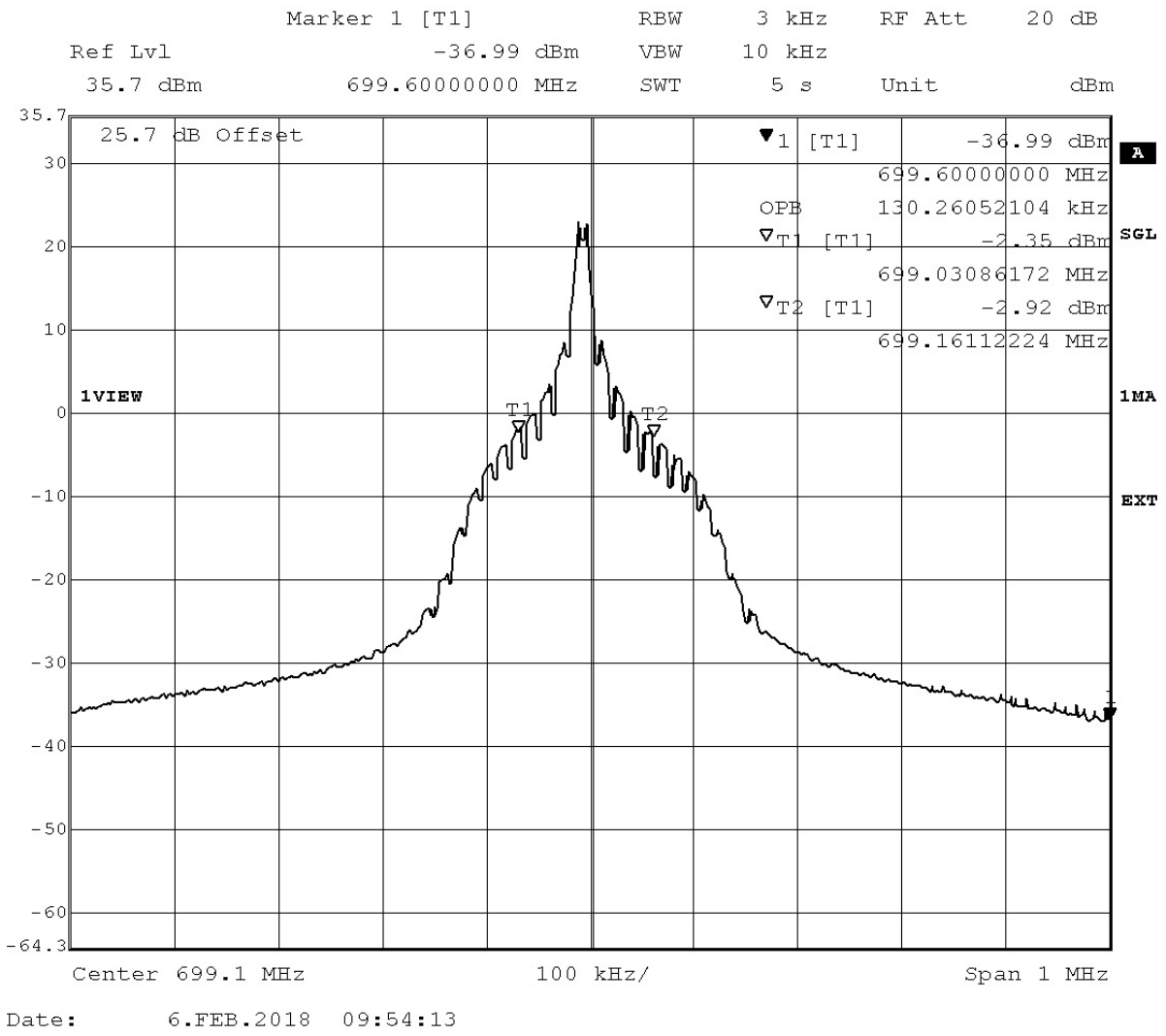
| | |
|---|---|
| *Result:* | Passed |
| *Setup No.:* | S01_ah01 |
| *Date of Test:* | 2017/12/17 10:16 |
| *Body:* | FCC47CFRChIPART27MISCELLANEOUS WIRELESS COMMUNICATIONS SERV |
| *Test Specification:* | FCC part 2 and 27 |

**Detailed Results:**

| Radio Technology | Reference Test Frequencies | Channel | Subcarrier | Nominal BW [kHz] | 99 % BW [kHz] |
|---|---|---|---|---|---|
| NB-IoT eFDD 12 QPSK | standalone | 23011 | 12 | 200 | 184.4 |
| NB-IoT eFDD 12 QPSK | standalone | 23095 | 12 | 200 | 186.4 |
| NB-IoT eFDD 12 QPSK | standalone | 23179 | 12 | 200 | 184.4 |
| NB-IoT eFDD 12 QPSK | in-band | 23016 | 12 | 200 | 186.4 |
| NB-IoT eFDD 12 QPSK | in-band | 23070 | 12 | 200 | 184.4 |
| NB-IoT eFDD 12 QPSK | in-band | 23079 | 12 | 200 | 186.4 |
| NB-IoT eFDD 12 QPSK | in-band | 23086 | 12 | 200 | 188.4 |
| NB-IoT eFDD 12 QPSK | in-band | 23105 | 12 | 200 | 184.4 |
| NB-IoT eFDD 12 QPSK | in-band | 23114 | 12 | 200 | 186.4 |
| NB-IoT eFDD 12 QPSK | in-band | 23174 | 12 | 200 | 186.4 |
| NB-IoT eFDD 12 QPSK | in-band | 23140 | 12 | 200 | 186.4 |
| NB-IoT eFDD 12 QPSK | in-band | 23149 | 12 | 200 | 190.4 |
| NB-IoT eFDD 12 QPSK | guard-band | 23011 | 12 | 200 | 186.4 |
| NB-IoT eFDD 12 QPSK | guard-band | 23071 | 12 | 200 | 184.4 |
| NB-IoT eFDD 12 QPSK | guard-band | 23179 | 12 | 200 | 186.4 |
| NB-IoT eFDD 12 BPSK | standalone | 23011 | 1 | 200 | 130.3 |
| NB-IoT eFDD 12 BPSK | standalone | 23095 | 1 | 200 | 130.3 |
| NB-IoT eFDD 12 BPSK | standalone | 23179 | 1 | 200 | 130.3 |
| NB-IoT eFDD 12 BPSK | in-band | 23016 | 1 | 200 | 130.3 |
| NB-IoT eFDD 12 BPSK | in-band | 23070 | 1 | 200 | 130.3 |
| NB-IoT eFDD 12 BPSK | in-band | 23079 | 1 | 200 | 130.3 |
| NB-IoT eFDD 12 BPSK | in-band | 23086 | 1 | 200 | 132.3 |
| NB-IoT eFDD 12 BPSK | in-band | 23105 | 1 | 200 | 132.3 |
| NB-IoT eFDD 12 BPSK | in-band | 23114 | 1 | 200 | 130.3 |
| NB-IoT eFDD 12 BPSK | in-band | 23174 | 1 | 200 | 130.3 |
| NB-IoT eFDD 12 BPSK | in-band | 23140 | 1 | 200 | 130.3 |
| NB-IoT eFDD 12 BPSK | in-band | 23149 | 1 | 200 | 128.3 |
| NB-IoT eFDD 12 BPSK | guard-band | 23011 | 1 | 200 | 130.3 |
| NB-IoT eFDD 12 BPSK | guard-band | 23071 | 1 | 200 | 130.3 |
| NB-IoT eFDD 12 BPSK | guard-band | 23179 | 1 | 200 | 132.3 |
| NB-IoT eFDD 13 QPSK | standalone | 23181 | 12 | 200 | 186.4 |
| NB-IoT eFDD 13 QPSK | standalone | 23230 | 12 | 200 | 188.4 |
| NB-IoT eFDD 13 QPSK | standalone | 23279 | 12 | 200 | 188.4 |
| NB-IoT eFDD 13 QPSK | in-band | 23187 | 12 | 200 | 184.4 |
| NB-IoT eFDD 13 QPSK | in-band | 23240 | 12 | 200 | 186.4 |
| NB-IoT eFDD 13 QPSK | in-band | 23249 | 12 | 200 | 186.4 |
| NB-IoT eFDD 13 QPSK | in-band | 23221 | 12 | 200 | 184.4 |
| NB-IoT eFDD 13 QPSK | in-band | 23240 | 12 | 200 | 184.4 |
| NB-IoT eFDD 13 QPSK | in-band | 23249 | 12 | 200 | 184.4 |
| NB-IoT eFDD 13 QPSK | in-band | 23273 | 12 | 200 | 186.4 |
| NB-IoT eFDD 13 QPSK | in-band | 23240 | 12 | 200 | 184.4 |
| NB-IoT eFDD 13 QPSK | in-band | 23249 | 12 | 200 | 184.4 |
| NB-IoT eFDD 13 QPSK | guard-band | 23181 | 12 | 200 | 190.4 |
| NB-IoT eFDD 13 QPSK | guard-band | 23206 | 12 | 200 | 190.4 |
| NB-IoT eFDD 13 QPSK | guard-band | 23279 | 12 | 200 | 186.4 |
| NB-IoT eFDD 13 BPSK | standalone | 23181 | 1 | 200 | 132.3 |
| NB-IoT eFDD 13 BPSK | standalone | 23230 | 1 | 200 | 134.3 |
| NB-IoT eFDD 13 BPSK | standalone | 23279 | 1 | 200 | 132.3 |
| NB-IoT eFDD 13 BPSK | in-band | 23187 | 1 | 200 | 132.3 |
| NB-IoT eFDD 13 BPSK | in-band | 23240 | 1 | 200 | 130.3 |
| NB-IoT eFDD 13 BPSK | in-band | 23249 | 1 | 200 | 128.3 |
| NB-IoT eFDD 13 BPSK | in-band | 23221 | 1 | 200 | 130.3 |
| NB-IoT eFDD 13 BPSK | in-band | 23240 | 1 | 200 | 130.3 |
| NB-IoT eFDD 13 BPSK | in-band | 23249 | 1 | 200 | 128.3 |
| NB-IoT eFDD 13 BPSK | in-band | 23273 | 1 | 200 | 128.3 |
| NB-IoT eFDD 13 BPSK | in-band | 23240 | 1 | 200 | 130.3 |
| NB-IoT eFDD 13 BPSK | in-band | 23249 | 1 | 200 | 128.3 |
| NB-IoT eFDD 13 BPSK | guard-band | 23181 | 1 | 200 | 128.3 |
| NB-IoT eFDD 13 BPSK | guard-band | 23206 | 1 | 200 | 126.3 |
| NB-IoT eFDD 13 BPSK | guard-band | 23279 | 1 | 200 | 130.3 |




eFDD12 NB-IoT QPSK, Channel 23095




eFDD12 NB-IoT QPSK, Channel 23011

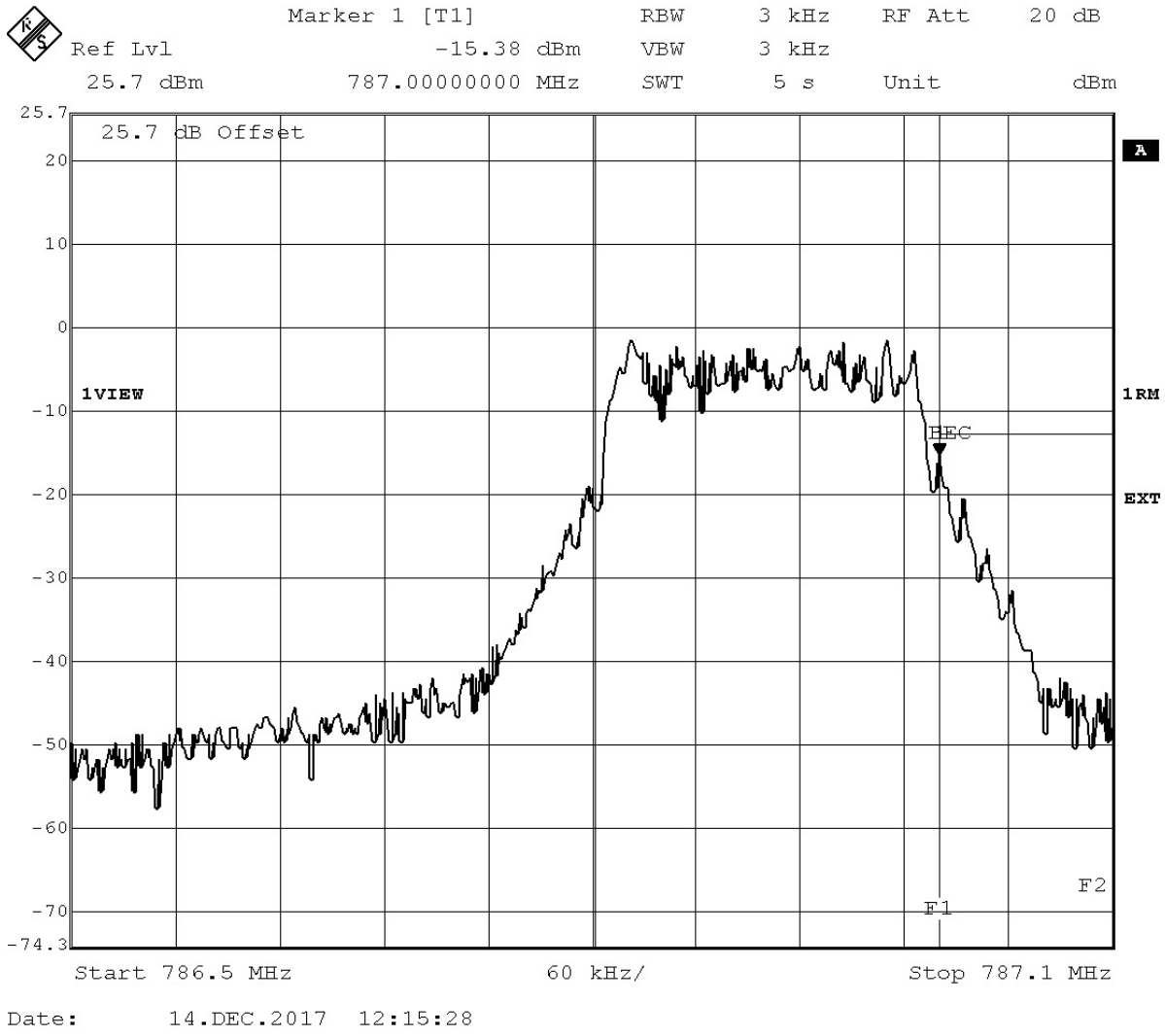
### 3.5.20 27.6 Band edge compliance §2.1053, §27.53

**Test: 27.6; Band edge compliance summary §2.1053, §27.53**

| | |
|---|---|
| *Result:* | Passed |
| *Setup No.:* | S01_ah01 |
| *Date of Test:* | 2018/01/08 10:18 |
| *Body:* | FCC47CFRChIPART27MISCELLANEOUS WIRELESS COMMUNICATIONS SERV |
| *Test Specification:* | FCC part 2 and 27 |

**Detailed Results:**

| Radio Technology | Reference Test Frequencies | Channel | Sub-carrier | RMS [dBm] | Limit /dBm | Margin to Limit /dB |
|---|---|---|---|---|---|---|
| NB-IoT eFDD 12 QPSK | standalone | 23011 | 12 | -18.48 | -13 | 5.48 |
| NB-IoT eFDD 12 QPSK | standalone | 23179 | 12 | -18.13 | -13 | 5.13 |
| NB-IoT eFDD 12 QPSK | guard-band | 23011 | 12 | -20.38 | -13 | 7.38 |
| NB-IoT eFDD 12 QPSK | guard-band | 23179 | 12 | -16.35 | -13 | 3.35 |
| NB-IoT eFDD 12 BPSK | standalone | 23011 | 1 | -16.69 | -13 | 3.69 |
| NB-IoT eFDD 12 BPSK | standalone | 23179 | 1 | -19.26 | -13 | 6.26 |
| NB-IoT eFDD 12 BPSK | guard-band | 23011 | 1 | -16.82 | -13 | 3.82 |
| NB-IoT eFDD 12 BPSK | guard-band | 23179 | 1 | -18.09 | -13 | 5.09 |
| NB-IoT eFDD 13 QPSK | standalone | 23181 | 12 | -18.84 | -13 | 5.84 |
| NB-IoT eFDD 13 QPSK | standalone | 23279 | 12 | -15.38 | -13 | 2.38 |
| NB-IoT eFDD 13 QPSK | guard-band | 23181 | 12 | -19.01 | -13 | 6.01 |
| NB-IoT eFDD 13 QPSK | guard-band | 23279 | 12 | -16.76 | -13 | 3.76 |
| NB-IoT eFDD 13 BPSK | standalone | 23181 | 1 | -15.46 | -13 | 2.46 |
| NB-IoT eFDD 13 BPSK | standalone | 23279 | 1 | -17.46 | -13 | 4.46 |
| NB-IoT eFDD 13 BPSK | guard-band | 23181 | 1 | -17.26 | -13 | 4.26 |
| NB-IoT eFDD 13 BPSK | guard-band | 23279 | 1 | -15.92 | -13 | 2.92 |




eFDD13 NB-IoT QPSK, Channel 23279

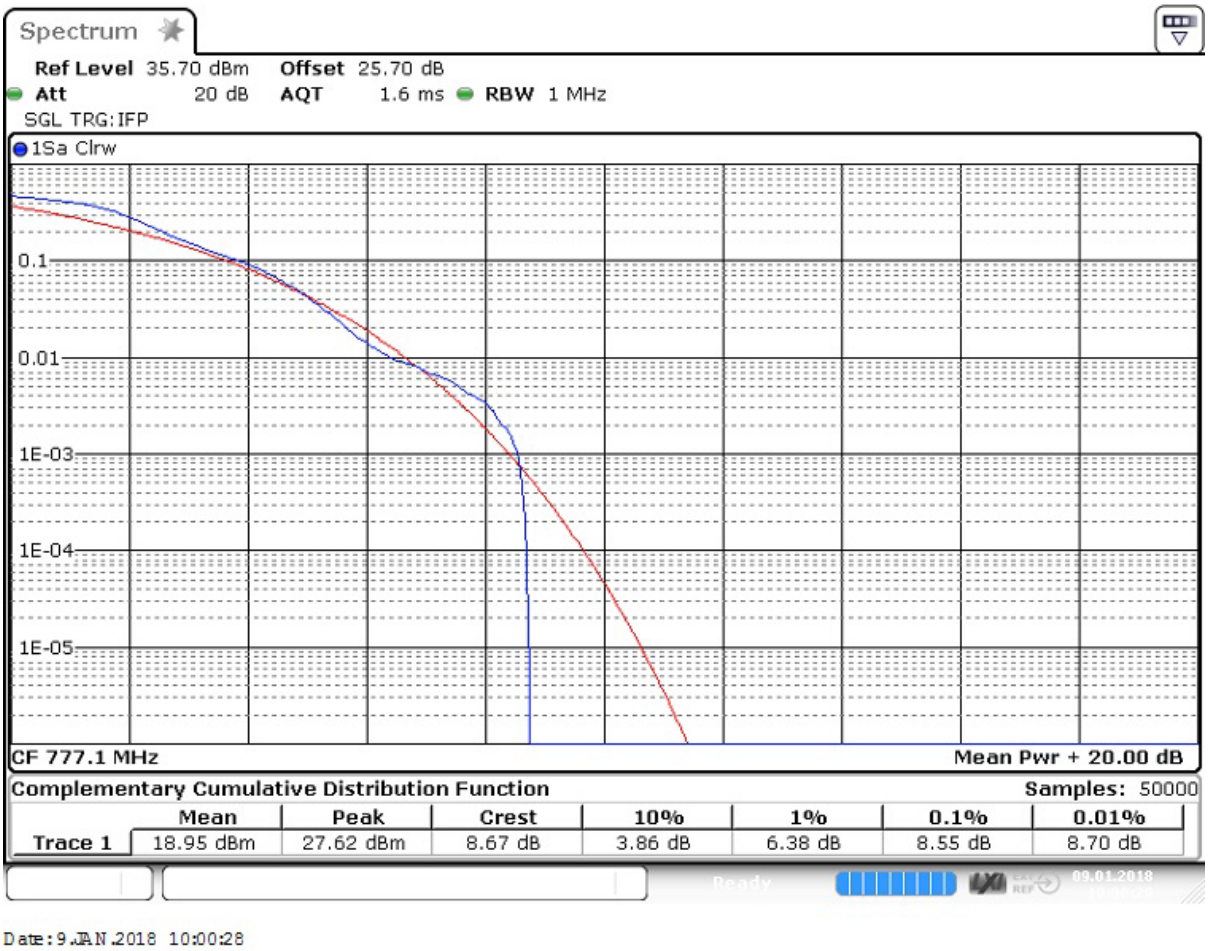
### 3.5.21 27.7 Peak-to-Average ratio §2.1046, §27.50

**Test: 27.7; Peak-to-Average Ratio Summary §2.1046, §27.50**

| | |
|---|---|
| *Result:* | Passed |
| *Setup No.:* | S01_ah01 |
| *Date of Test:* | 2018/01/08 10:20 |
| *Body:* | FCC47CFRChIPART27MISCELLANEOUS WIRELESS COMMUNICATIONS SERV |
| *Test Specification:* | FCC part 2 and 27 |

**Detailed Results:**

| Radio Technology | Reference Test Frequencies | Channel | Sub-carrier | Peak to Average Ratio | Limit /dB | Margin to Limit /dB |
|---|---|---|---|---|---|---|
| NB-IoT eFDD 12 QPSK | standalone | 23011 | 12 | 8.23 | 13 | 4.77 |
| NB-IoT eFDD 12 QPSK | standalone | 23095 | 12 | 8.41 | 13 | 4.59 |
| NB-IoT eFDD 12 QPSK | standalone | 23179 | 12 | 8.38 | 13 | 4.62 |
| NB-IoT eFDD 12 BPSK | standalone | 23011 | 1 | 4.35 | 13 | 8.65 |
| NB-IoT eFDD 12 BPSK | standalone | 23095 | 1 | 4.43 | 13 | 8.57 |
| NB-IoT eFDD 12 BPSK | standalone | 23179 | 1 | 4.49 | 13 | 8.51 |
| NB-IoT eFDD 13 QPSK | standalone | 23181 | 12 | 8.55 | 13 | 4.45 |
| NB-IoT eFDD 13 QPSK | standalone | 23230 | 12 | 8.06 | 13 | 4.94 |
| NB-IoT eFDD 13 QPSK | standalone | 23279 | 12 | 8.2 | 13 | 4.8 |
| NB-IoT eFDD 13 BPSK | standalone | 23181 | 1 | 4.49 | 13 | 8.51 |
| NB-IoT eFDD 13 BPSK | standalone | 23230 | 1 | 4.75 | 13 | 8.25 |
| NB-IoT eFDD 13 BPSK | standalone | 23279 | 1 | 4.49 | 13 | 8.51 |




eFDD13 QPSK CH23181

# 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**
*Description:* Anechoic Chamber for radiated testing

### Single Devices for Anechoic Chamber

| *Single Device Name* | *Type* | *Serial Number* | *Manufacturer* |
|---|---|---|---|
| Air compressor | none | - | |
| Anechoic Chamber | 10.58 x 6.38 x 6.00 m³ | none | |
| Anechoic Chamber | 8.8m x 4.6m x 4.05 m | B83117-S40-X191 | Albatross Projects GmbH |
| 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**
*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 | AM4.0/180/11920513 | 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 | |
| | *Calibration Details* | | *Last Execution* | *Next Execution* |
| | Standard Calibration | | 2015/06/23 | 2018/06/22 |
| Double-ridged horn | HF 907 | 102444 | Rohde & Schwarz GmbH & Co. KG | |
| | *Calibration Details* | | *Last Execution* | *Next Execution* |
| | Standard Calibration | | 2015/05/11 | 2018/05/10 |

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

| *Single Device Name* | *Type* | *Serial Number* | *Manufacturer* |
|---|---|---|---|
| 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 |
| Log.-per. Antenna (upgraded) | HL 562 Ultralog new biconicals | 830547/003 | Rohde & Schwarz GmbH & Co. KG |
| | *Calibration Details* | | *Last Execution* *Next Execution* |
| | Standard Calibration | | 2015/06/30 2018/06/29 |
| Loop Antenna | HFH2-Z2 | 829324/006 | Rohde & Schwarz GmbH & Co. KG |
| 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, Lab 2** |
| *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 | | |
| | *Calibration Details* | | *Last Execution* | *Next Execution* |
| | DAkkS Calibration | | 2016/02/04 | 2018/02/28 |
| Digital Multimeter 13 (Clamp Meter) | Fluke 325 | 31270091WS | FLUKE | |
| | *Calibration Details* | | *Last Execution* | *Next Execution* |
| | DAkkS-Calibration | | 2016/02/04 | 2019/02/28 |
| 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 | |
| | *Calibration Details* | | *Last Execution* | *Next Execution* |
| | DKD calibration | | 2016/02/25 | 2018/02/24 |
| Spectrum Analyser | FSU26 | 200418 | | |
| Spectrum Analyzer | FSP3 | 836722/011 | Rohde & Schwarz GmbH & Co. KG | |
| | *Calibration Details* | | *Last Execution* | *Next Execution* |
| | DKD calibration | | 2015/06/23 | 2018/06/22 |
| Vector Signal Generator | SMIQ 03B | 832492/061 | | |

## Test Equipment Digital Signalling Devices

| | |
|---|---|
| ***Lab ID:*** | **Lab 1, Lab 2** |
| *Description:* | Signalling equipment for various wireless technologies. |

### Single Devices for Digital Signalling Devices

| *Single Device Name* | *Type* | *Serial Number* | *Manufacturer* |
|---|---|---|---|
| CMW500 | CMW500 | 107500 | |
| Digital Radio Communication Tester | CMD 55 | 831050/020 | Rohde & Schwarz GmbH & Co. KG |
| Universal Radio Communication Tester | CMU 200 | 837983/052 | Rohde & Schwarz GmbH & Co. KG |
| 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

| *Single Device Name* | *Type* | *Serial Number* | *Manufacturer* | |
|---|---|---|---|---|
| EMI Receiver / Spectrum Analyzer | ESR 7 | 101424 | | |
| | *Calibration Details* | | *Last Execution* | *Next Execution* |
| | DKD Calibration | | 2016/11/29 | 2018/11/28 |
| Personal Computer | Dell | 30304832059 | | |
| Power Meter | NRVD | 828110/016 | | |
| | *Calibration Details* | | *Last Execution* | *Next Execution* |
| | Standard calibration | | 2017/05/17 | 2018/05/16 |
| Sensor Head A | NRV-Z1 | 827753/005 | | |
| | *Calibration Details* | | *Last Execution* | *Next Execution* |
| | Standard calibration | | 2017/05/18 | 2018/05/17 |
| Signal Generator | SMR 20 | 846834/008 | Rohde & Schwarz GmbH & Co. KG | |
| Spectrum Analyzer | ESIB 26 | 830482/004 | Rohde & Schwarz GmbH & Co. KG | |
| | *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 Execution* |
| | DKD calibration | | 2016/12/02 | 2018/12/01 |

## Test Equipment Multimeter 03

| | |
|---|---|
| ***Lab ID:*** | **Lab 1, Lab 2** |
| *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 Execution* |
| | DAkkS Calibration | | 2016/02/04 | 2018/02/28 |

### Test Equipment Radio Lab Test Equipment

| | |
|---|---|
| ***Lab ID:*** | **Lab 2** |
| *Description:* | Radio Lab Test Equipment |

### Single Devices for Radio Lab Test Equipment

| *Single Device Name* | *Type* | *Serial Number* | *Manufacturer* | |
|---|---|---|---|---|
| Broadband Power Divider SMA | WA1515 | A856 | | |
| Coax Attenuator 10dB SMA 2W | 4T-10 | F9401 | | |
| Coax Attenuator 10dB SMA 2W | 56-10 | W3702 | | |
| Coax Attenuator 10dB SMA 2W | 56-10 | W3711 | | |
| Coax Cable Huber&Suhner | Sucotest 2,0m | | Huber&Suhner | |
| Coax Cable Rosenberger Micro Coax FA210A0010003030 SMA/SMA 1,0m | FA210A0010003030 | 54491-2 | | |
| Power Meter | NRVD | 828110/016 | | |
| | *Calibration Details* | | *Last Execution* | *Next Execution* |
| | Standard calibration | | 2017/05/17 | 2018/05/16 |
| RF Step Attenuator RSP | RSP | 833695/001 | | |
| Rubidium Frequency Standard | Datum, Model: MFS | 5489/001 | | |
| | *Calibration Details* | | *Last Execution* | *Next Execution* |
| | Standard calibration | | 2017/07/11 | 2018/07/10 |
| Sensor Head A | NRV-Z1 | 827753/005 | | |
| | *Calibration Details* | | *Last Execution* | *Next Execution* |
| | Standard calibration | | 2017/05/18 | 2018/05/17 |
| Signal Generator SME | SME03 | 827460/016 | | |
| Signal Generator SMP | SMP02 | 833286/0014 | Rohde & Schwarz GmbH & Co. KG | |
| | *Calibration Details* | | *Last Execution* | *Next Execution* |
| | Standard calibration | | 2016/05/24 | 2019/05/23 |
| Spectrum Analyzer | FSIQ26 | 840061/005 | Rohde & Schwarz GmbH & Co. KG | |

### Test Equipment T/A Logger 13

| | |
|---|---|
| ***Lab ID:*** | **Lab 1, Lab 2** |
| *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 | | |
| | *Calibration Details* | | *Last Execution* | *Next Execution* |
| | Customized calibration | | 2017/04/10 | 2019/04/09 |

### Test Equipment T/H Logger 03

| | |
|---|---|
| ***Lab ID:*** | **Lab 2** |
| *Description:* | Lufft Opus10 |
| *Serial Number:* | 7482 |

#### Single Devices for T/H Logger 03

| *Single Device Name* | *Type* | *Serial Number* | *Manufacturer* |
|---|---|---|---|
| ThermoHygro Datalogger 03 (Environ) | Opus10 THI (8152.00) | 7482 | |

| *Calibration Details* | *Last Execution* | *Next Execution* |
|---|---|---|
| Customized calibration | 2017/03/30 | 2019/03/29 |

### 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 | |

| *Calibration Details* | *Last Execution* | *Next Execution* |
|---|---|---|
| Customized calibration | 2017/03/30 | 2019/03/29 |

### Test Equipment Temperature Chamber 05

| | |
|---|---|
| ***Lab ID:*** | **Lab 2** |
| *Description:* | Temperature Chamber VT4002 |
| *Type:* | Vötsch |
| *Serial Number:* | see single devices |

#### Single Devices for Temperature Chamber 05

| *Single Device Name* | *Type* | *Serial Number* | *Manufacturer* |
|---|---|---|---|
| Temperature Chamber Vötsch 05 | VT 4002 | 58566080550010 | |

| *Calibration Details* | *Last Execution* | *Next Execution* |
|---|---|---|
| Customized calibration | 2016/03/09 | 2018/03/08 |

# 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 a GSM/WCDMA/CDMA2000 cellular radiotelephone device

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 0 to 69. The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

§ 2.1046 Measurement required: RF power output
§ 2.1049 Measurement required: Occupied bandwidth
§ 2.1051 Measurement required: Spurious emissions at antenna terminals
§ 2.1053 Measurement required: Field strength of spurious radiation
§ 2.1055 Measurement required: Frequency stability
§ 2.1057 Frequency spectrum to be investigated

Part 22, Subpart C – Operational and Technical Requirements

§ 22.355 Frequency tolerance

Part 22, Subpart H – Cellular Radiotelephone Service

§ 22.913 Effective radiated power limits
§ 22.917 Emission limitations for cellular equipment

additional documents

ANSI C63.26-2015

Description of Methods of Measurements

RF Power Output

Standard FCC Part 22, Subpart H

The test was performed according to: FCC §2.1046

Test Description (conducted measurement procedure)

1) The EUT was coupled to a Spectrum Analyser and a Digital Communication Tester through a Power Divider. Refer to chapter "Setup Drawings".
2) The total insertion losses for signal path 1 and signal path 2 were measured. The values were used to correct the readings from the Spectrum Analyser and the Digital Communication Tester.
3) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Channel (Frequency): please refer to the detailed results
4) The transmitted power of the EUT was recorded by using a spectrum analyser.

Test Description (radiated measurement procedure)

1) The EUT was placed inside an anechoic chamber. Refer to chapter "Setup Drawings". The EUT was coupled to a Digital Communication Tester which was located outside the chamber via a small signalling antenna.
2) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Channel: please refer to the detailed results
3) A substitution procedure is used so that the readings from the spectrum analyser are corrected and represent directly the equivalent radiated power (related to a lamda/2 dipole).
4) The output power was measured in both vertical and horizontal antenna polarisation during the call is established on the lowest channel, mid channel and on the highest channel. To find the worst case power all orientations (X, Y, Z) of the EUT have been measured.
5) The test procedure according to ANSI C63.26-2015 has been considered.

Test Requirements / Limits

§2.1046 Measurements Required: RF Power Output
(a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in § 2.1033(c)(8). The electrical characteristics of the output terminals when this test is made shall be stated.
§22.913 Effective radiated power limits
(a)(2) Maximum ERP. … The ERP of mobile transmitters and auxiliary test transmitters must not exceed 7 Watts.

---

Emission and Occupied Bandwidth

---

Standard FCC Part 22, Subpart H

The test was performed according to: FCC §2.1049

Test Description

1) The EUT was coupled to a Spectrum Analyser and a Digital Communication Tester through a Power Divider. Refer to chapter "Setup Drawings".
2) The total insertion losses for signal path 1 and signal path 2 were measured. The values were used to correct the readings from the Spectrum Analyser and the Digital Communication Tester.
3) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Channel: please refer to the detailed results
4) Important Analyser Settings:
- Resolution Bandwidth: >1% of the manufacturer’s stated occupied bandwidth
5) The maximum spectral level of the modulated signal was recorded as the reference.
6) The emission bandwidth is measured as follows:
the two furthest frequencies above and below the frequency of the maximum reference level where the spectrum is –26 dB down have to be found.
7) The occupied bandwidth (99% Bandwidth) is measured as follows:
the occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5 percent of the total mean power.

Test Requirements / Limits

§ 2.1049 Measurements required: Occupied bandwidth

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the following conditions (as applicable):

(h) Transmitters employing digital modulation techniques - when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment will be operated. The signal shall be applied through any filter networks, pseudo-random generators or other devices required in normal service. Additionally, the occupied bandwidth shall be shown for operation with any devices used for modifying the spectrum when such devices are optional at the discretion of the user.

---

Spurious emissions at antenna terminals

---

Standard FCC Part 22, Subpart H

The test was performed according to FCC §2.1051

Test Description

1) The EUT was coupled to a Spectrum Analyser and a Digital Communication Tester through a Power Divider. Refer to chapter "Setup Drawings".
2) The total insertion losses for signal path 1 and signal path 2 were measured. The values were used to correct the readings from the Spectrum Analyser and the Digital Communication Tester.
3) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Channel: please refer to the detailed results
4) Important Analyser Settings
- [Resolution Bandwidth]:
a) [>=1% of wanted signal bandwidth] in the Span of 1 MHz directly below and above the PCS-Band,
b) otherwise [100 kHz] (or [1 MHz] for accelerated sweep times)
c) [reduced resolution bandwidth] in case the curve of the analyser IF-Filter or the wanted EUT signal leads to an exceeding of the limit, in this case a correction factor was used
- Sweep Time: depending on the transmitting signal, the span and the resolution bandwidth
5) The spurious emissions peaks were measured in the frequency range from 9 kHz to 10 GHz (up to the 10th harmonic) during the call was established

Test Requirements / Limits

§ 2.1051 Spurious emissions at antenna terminals

The radio frequency voltage or power generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in Sec. 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

§ 2.1057 Frequency spectrum to be investigated.

(a) In all of the measurements set forth in Secs. 2.1051 and 2.1053, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the frequency shown below:
(1) If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
(b) Particular attention should be paid to harmonics and subharmonics of the carrier frequency as well as to those frequencies removed from the carrier by multiples of the oscillator frequency. Radiation at the frequencies of multiplier stages should also be checked.
(c) The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value

need not be reported.
(d) Unless otherwise specified, measurements above 40 GHz shall be performed using a minimum resolution bandwidth of 1 MHz.

§ 22.917 Emission limitations for cellular equipment

(a) The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.
Remark of the test laboratory: This is calculated to be -13 dBm.
(b) Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. In the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (i.e. 100 kHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.
(c) Licensees in this service may establish an alternative out of band emission limit to be used at specified band edge(s) in specified geographical areas [...].
(d) If any emission from a transmitter operating in this service results in interference to users of another radio service, the FCC may require a greater attenuation of that emission than specified in this section.

For reporting only spurious emission levels reaching to the 20dB margin to limit were noted.

---

Field strength of spurious radiation

---

Standard FCC Part 22, Subpart H

The test was performed according to: FCC §2.1053

Test Description

1) The EUT was placed inside an anechoic chamber. Refer to chapter "Setup Drawings". The EUT was coupled to a Digital Communication Tester which was located outside the chamber via a small signalling antenna.
2) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Channel: please refer to the detailed results
3) A pre-calibration procedure is used so that the readings from the spectrum analyser are corrected and represent directly the equivalent radiated power (related to a lamda/2 dipole).
4) All spurious radiation measurements were made with spectrum analyser and the appropriate calibrated antennas for the frequency range of 30 MHz to 10 GHz (up to the 10th harmonic of the transmit frequency). The frequency range from 9 kHz to 30 MHz has been examined during the conducted spurious emission measurements.
5) Important Analyser Settings
- [Resolution Bandwidth / Video Bandwidth]:
a) [3 kHz / 10 kHz] in the Span of 1 MHz directly below and above the Band,
b) [10 kHz / 30 kHz] in case the curve of the analyser IF-Filter leads to an exceeding of the limit, in this case a worst case correction factor of 20 dB (1 MHz -> 10 kHz) was used
c) [1 MHz / 3 MHz] otherwise
- Sweep Time: depending on the transmitting signal, the span and the resolution bandwidth
6) The spurious emissions peaks were measured in both vertical and horizontal antenna polarization during the call is established on the lowest channel, mid channel and on the highest channel. To find the worst case peaks all orientations (X, Y, Z) of the EUT have been measured.
7) After this initial test, a final test according to ANSI C63.26-2015 Unwanted Emissions is performed on signals which are identified as being close to the limit. For any emissions found to be within 10 dB of the limit, a specific signal substitution measurement is performed at the frequency of the emission to determine the exact e.i.r.p. value.

Test Requirements / Limits

§ 2.1053 Measurements required: Field strength of spurious radiation.

Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of Sec. 2.1049, as appropriate. For equipment operating on frequencies below 890 MHz, an open field test is normally required, with the measuring instrument antenna located in the far-field at all test frequencies. In the event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurements will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from halfwave dipole antennas.
(b) The measurements specified in paragraph (a) of this section shall be made for the following equipment:
(2) All equipment operating on frequencies higher than 25 MHz.

§ 2.1057 Frequency spectrum to be investigated.

(a) In all of the measurements set forth in Secs. 2.1051 and 2.1053, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the frequency shown below:
(1) If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
(b) Particular attention should be paid to harmonics and subharmonics of the carrier frequency as well as to those frequencies removed from the carrier by multiples of the oscillator frequency. Radiation at the frequencies of multiplier stages should also be checked.
(c) The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.
(d) Unless otherwise specified, measurements above 40 GHz shall be performed using a minimum resolution bandwidth of 1 MHz.

§ 22.917 Emission limitations for cellular equipment

(a) The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.
This is calculated to be -13 dBm (effective radiated power) which corresponds to 84.6 dBµV/m (field strength) in a distance of 3 m.

(b) Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. In the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (i.e. 100 kHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.
(c) Licensees in this service may establish an alternative out of band emission limit to be used at specified band edge(s) in specified geographical areas [...].
(d) If any emission from a transmitter operating in this service results in interference to users of another radio service, the FCC may require a greater attenuation of that emission than specified in this section.

For reporting only spurious emission levels reaching to the 20dB margin to limit were noted.

---

Frequency stability

---

Standard FCC Part 22, Subpart H

The test was performed according to FCC §2.1055

Test Description

1) The EUT was placed inside a temperature chamber.
2) The EUT was coupled to a Digital Communication Tester. Refer to chapter "Setup Drawings".

3) The climatic chamber was cycled down/up to a certain temperature, starting with the EUT minimum temperature.
4) After the temperature was stabilized the EUT was switched on and a call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Mid Channel
5) The frequency error of the EUT was recorded by using an internal measurement function of the Digital Communication Tester immediately after the call was established, five minutes after the call was established and ten minutes after the call was established.
6) This measurement procedure was performed for temperature variation from –30°C to +50°C in increments of 10°C, if not otherwise stated in the detailed results.
When the EUT did not operate at certain temperature levels, these measurements were left out.

Test Requirements / Limits

§2.1055 Measurements required: Frequency stability

(a) The frequency stability shall be measured with variation of ambient temperature as follows:
(1) From -30° to +50° centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.
(b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10° centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.
(d) The frequency stability shall be measured with variation of primary supply voltage as follows:
(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.
(2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.
(3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

§22.355 Frequency tolerance

…the carrier frequency of each transmitter in the Public Mobile Service must be maintained within the tolerances given in table C-1 of this section.

Table C-1.- Frequency Tolerance for Transmitters in the Public Mobile Services

| Frequency range (MHz) | Base, fixed (ppm) | Mobile up to 3 watts (ppm) | Mobile above 3 watts (ppm) |
|---|---|---|---|
| 25 to 50 | 20.0 | 20.0 | 50.0 |
| 50 to 450 | 5.0 | 5.0 | 50.0 |
| 450 to 512 | 2.5 | 5.0 | 5.0 |
| 821 to 896 | 1.5 | 2.5 | 2.5 |
| 928 to 929 | 5.0 | n/a | n/a |
| 929 to 960 | 1.5 | n/a | n/a |
| 2110 to 2220 | 10.0 | n/a | n/aFor the mid |

channel (836.6 MHz) the frequency tolerance is 2.5 ppm (2091.5 Hz).

---

Band edge compliance

---

Standard FCC Part 22, Subpart H

The test was performed according to: FCC §22.913

Test Description

1) The EUT was coupled to a Spectrum Analyser and a Digital Communication Tester through a Power Divider.

Refer to chapter "Setup Drawings".
2) The total insertion losses for signal path 1 and signal path 2 were measured. The values were used to correct the readings from the Spectrum Analyser and the Digital Communication Tester.
3) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Channel: please refer to the detailed results
4) Important Analyser Settings:
- Resolution Bandwidth = Video Bandwidth: >1% of the manufacturer’s stated occupied bandwidth

Test Requirements / Limits

§ 22.917 Emission limitations for cellular equipment

Refer to chapter "Field strength of spurious radiation".

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 a GSM/WCDMA/CDMA2000 cellular radiotelephone device

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 0 to 69. The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

§ 2.1046 Measurement required: RF power output
§ 2.1049 Measurement required: Occupied bandwidth
§ 2.1051 Measurement required: Spurious emissions at antenna terminals
§ 2.1053 Measurement required: Field strength of spurious radiation
§ 2.1055 Measurement required: Frequency stability
§ 2.1057 Frequency spectrum to be investigated

Part 24, Subpart E - Broadband PCS

§ 24.232 Power and antenna height limits
§ 24.235 Frequency stability
§ 24.236 Field strength limits
§ 24.238 Emission limitations for Broadband PCS equipment

additional documents

ANSI C63.26-2015

Description of Methods of Measurements

RF Power Output

Standard: FCC Part 24, Subpart E

The test was performed according to: FCC §2.1046

Test Description (conducted measurement procedure)

1) The EUT was coupled to a Spectrum Analyser and a Digital Communication Tester through a Power Divider. Refer to chapter "Setup Drawings".
2) The total insertion losses for signal path 1 and signal path 2 were measured. The values were used to correct the readings from the Spectrum Analyser and the Digital Communication Tester.
3) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Channel (Frequency): please refer to the detailed results
4) The transmitted power of the EUT was recorded by using a spectrum analyser.

Test Description (radiated measurement procedure)

1) The EUT was placed inside an anechoic chamber. Refer to chapter "Setup Drawings". The EUT was coupled to a Digital Communication Tester which was located outside the chamber via a small signalling antenna.
2) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Channel:  please refer to the detailed results
3) A substitution procedure is used so that the readings from the spectrum analyser are corrected and represent directly the equivalent radiated power (related to a lamda/2 dipole).
4) The output power was measured in both vertical and horizontal antenna polarisation during the call is established on the lowest channel, mid  channel and on the highest channel. To find the worst case power all orientations (X, Y, Z) of the EUT have been measured.
5) The test procedure according to ANSI C63.26-2015 has been considered.

Test Requirements / Limits

§2.1046 Measurements Required: RF Power Output
(a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in § 2.1033(c)(8). The electrical characteristics of the output terminals when this test is made shall be stated.
§24.232 Power and antenna height limits
(c) Mobile/portable stations are limited to 2 watts EIRP peak power and the equipment must employ means to limit the power to the minimum necessary for successful communications.
(e) Peak transmit power must be measured over any interval of continuous transmission using instrumentation calibrated in terms of an rms-equivalent voltage. The measurement results shall be properly adjusted for any instrument limitations, such as detector response times, limited resolution bandwidth capability when compared to the emission bandwidth, sensitivity, etc., so as to obtain a true peak measurement for the emission in question over the full bandwidth of the channel.

Emission and Occupied Bandwidth

Standard: FCC Part 24, Subpart E

The test was performed according to: FCC §2.1049

Test Description

1) The EUT was coupled to a Spectrum Analyser and a Digital Communication Tester through a Power Divider. Refer to chapter "Setup Drawings".
2) The total insertion losses for signal path 1 and signal path 2 were measured. The values were used to correct the readings from the Spectrum Analyser and the Digital Communication Tester.
3) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Channel: please refer to the detailed results
4) Important Analyser Settings:
- Resolution Bandwidth: >1% of the manufacturer’s stated occupied bandwidth
5) The maximum spectral level of the modulated signal was recorded as the reference.
6) The emission bandwidth is measured as follows:
the two furthest frequencies above and below the frequency of the maximum reference level where the spectrum is –26 dB down have to be found.
7) The occupied bandwidth (99% Bandwidth) is measured as follows:
the occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5 percent of the total mean power.

Test Requirements / Limits

§ 2.1049 Measurements required: Occupied bandwidth

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the following conditions (as applicable):

(h) Transmitters employing digital modulation techniques - when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment will be operated. The signal shall be applied through any filter networks, pseudo-random generators or other devices required in normal service. Additionally, the occupied bandwidth shall be shown for operation with any devices used for modifying the spectrum when such devices are optional at the discretion of the user.

---

Spurious emissions at antenna terminals

---

Standard: FCC Part 24, Subpart E

The test was performed according to FCC §2.1051

Test Description

1) The EUT was coupled to a Spectrum Analyser and a Digital Communication Tester through a Power Divider. Refer to chapter "Setup Drawings".
2) The total insertion losses for signal path 1 and signal path 2 were measured. The values were used to correct the readings from the Spectrum Analyser and the Digital Communication Tester.
3) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Channel: please refer to the detailed results
4) Important Analyser Settings
- [Resolution Bandwidth]:
a) [>=1% of wanted signal bandwidth] in the Span of 1 MHz directly below and above the Band,
b) otherwise [1 MHz]
c) [reduced resolution bandwidth] in case the curve of the analyser IF-Filter or the wanted EUT signal leads to an exceeding of the limit, in this case a correction factor was used
- Sweep Time: depending on the transmitting signal, the span and the resolution bandwidth
5) The spurious emissions peaks were measured in the frequency range from 9 kHz to 20 GHz (up to the 10th harmonic) during the call was established

Test Requirements / Limits

§ 2.1051 Spurious emissions at antenna terminals

The radio frequency voltage or power generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in Sec. 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

§ 2.1057 Frequency spectrum to be investigated.

(a) In all of the measurements set forth in Secs. 2.1051 and 2.1053, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the frequency shown below:
(1) If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
(b) Particular attention should be paid to harmonics and subharmonics of the carrier frequency as well as to those frequencies removed from the carrier by multiples of the oscillator frequency. Radiation at the frequencies of multiplier stages should also be checked.
(c) The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.
(d) Unless otherwise specified, measurements above 40 GHz shall be performed using a minimum resolution bandwidth of 1 MHz.

§ 24.238 Emission limitations for Broadband PCS equipment

(a) The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.
Remark of the test laboratory: This is calculated to be -13 dBm.
(b) Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (i.e. 1 MHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.
(c) Licensees in this service may establish an alternative out of band emission limit to be used at specified band edge(s) in specified geographical areas [...].
(d) If any emission from a transmitter operating in this service results in interference to users of another radio service, the FCC may require a greater attenuation of that emission than specified in this section.

For reporting only spurious emission levels reaching to the 20dB margin to limit were noted.

---

Field strength of spurious radiation

---

Standard: FCC Part 24, Subpart E

The test was performed according to: FCC §2.1053

Test Description

1) The EUT was placed inside an anechoic chamber. Refer to chapter "Setup Drawings". The EUT was coupled to a Digital Communication Tester which was located outside the chamber via a small signalling antenna.
2) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Channel: please refer to the detailed results
3) A pre-calibration procedure is used so that the readings from the spectrum analyser are corrected and represent directly the equivalent radiated power (related to a lamda/2 dipole).

4) All spurious radiation measurements were made with spectrum analyser and the appropriate calibrated antennas for the frequency range of 30 MHz to 20 GHz (up to the 10th harmonic of the transmit frequency). The frequency range from 9 kHz to 30 MHz has been examined during the conducted spurious emission measurements.
5) Important Analyser Settings
- [Resolution Bandwidth / Video Bandwidth]:
a) [3 kHz / 10 kHz] in the Span of 1 MHz directly below and above the Band,
b) [10 kHz / 30 kHz] in case the curve of the analyser IF-Filter leads to an exceeding of the limit, in this case a worst case correction factor of 20 dB (1 MHz -> 10 kHz) was used
c) [1 MHz / 3 MHz] otherwise
- Sweep Time: depending on the transmitting signal, the span and the resolution bandwidth
6) The spurious emissions peaks were measured in both vertical and horizontal antenna polarisation during the call is established on the lowest channel, mid channel and on the highest channel. To find the worst case peaks all orientations (X, Y, Z) of the EUT have been measured.
7) After this initial test, a final test according to ANSI C63.26-2015 Unwanted Emissions is performed on signals which are identified as being close to the limit. For any emissions found to be within 10 dB of the limit, a specific signal substitution measurement is performed at the frequency of the emission to determine the exact e.i.r.p. value.

Test Requirements / Limits

§ 2.1053 Measurements required: Field strength of spurious radiation.

Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of Sec. 2.1049, as appropriate. For equipment operating on frequencies below 890 MHz, an open field test is normally required, with the measuring instrument antenna located in the far-field at all test frequencies. In the event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurements will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from halfwave dipole antennas.
(b) The measurements specified in paragraph (a) of this section shall be made for the following equipment:
(2) All equipment operating on frequencies higher than 25 MHz.

§ 2.1057 Frequency spectrum to be investigated.

(a) In all of the measurements set forth in Secs. 2.1051 and 2.1053, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the frequency shown below:
(1) If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
(b) Particular attention should be paid to harmonics and subharmonics of the carrier frequency as well as to those frequencies removed from the carrier by multiples of the oscillator frequency. Radiation at the frequencies of multiplier stages should also be checked.
(c) The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.
(d) Unless otherwise specified, measurements above 40 GHz shall be performed using a minimum resolution bandwidth of 1 MHz.

§ 24.238 Emission limitations for Broadband PCS equipment

(a) The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.
This is calculated to be -13 dBm (effective radiated power) which corresponds to 84.6 dBµV/m (field strength) in a distance of 3 m.

(b) Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (i.e. 1 MHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below

the transmitter power.
(c) Licensees in this service may establish an alternative out of band emission limit to be used at specified band edge(s) in specified geographical areas [...].
(d) If any emission from a transmitter operating in this service results in interference to users of another radio service, the FCC may require a greater attenuation of that emission than specified in this section.

For reporting only spurious emission levels reaching to the 20dB margin to limit were noted.

---

Frequency stability

---

Standard: FCC Part 24, Subpart E

The test was performed according to FCC §2.1055

Test Description

1) The EUT was placed inside a temperature chamber.
2) The EUT was coupled to a Digital Communication Tester. Refer to chapter "Setup Drawings".
3) The climatic chamber was cycled down/up to a certain temperature, starting with the EUT minimum temperature.
4) After the temperature was stabilized the EUT was switched on and a call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Mid Channel
5) The frequency error of the EUT was recorded by using an internal measurement function of the Digital Communication Tester immediately after the call was established, five minutes after the call was established and ten minutes after the call was established.
6) This measurement procedure was performed for temperature variation from –30°C to +50°C in increments of 10°C, if not otherwise stated in the detailed results.
When the EUT did not operate at certain temperature levels, these measurements were left out.

Test Requirements / Limits

§2.1055 Measurements required: Frequency stability

(a) The frequency stability shall be measured with variation of ambient temperature as follows:
(1) From -30° to +50° centigrade for all equipment except that specified in paragraphs
(a) (2) and (3) of this section.
(b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10° centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.
(d) The frequency stability shall be measured with variation of primary supply voltage as follows:
(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.
(2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.
(3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

§24.235 Frequency stability

The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block.

7Layers interpretation of limit:

To ensure that the frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block following limit was used:

+/- 2.5 ppm = 4700 Hz for a frequency of 1880.0 MHz

in accordance with FCC Part 22, Subpart H, §22.355, table C-1: Frequency tolerance for the carrier frequency of mobile transmitters in the Public Mobile Service in the frequency range 821 to 896 MHz.

---

Band edge compliance

---

Standard: FCC Part 24, Subpart E

The test was performed according to: FCC §24.238

Test Description

1) The EUT was coupled to a Spectrum Analyser and a Digital Communication Tester through a Power Divider. Refer to chapter "Setup Drawings".
2) The total insertion losses for signal path 1 and signal path 2 were measured. The values were used to correct the readings from the Spectrum Analyser and the Digital Communication Tester.
3) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester. Important Settings:
- Output Power: Maximum
- Channel: please refer to the detailed results
4) Important Analyser Settings:
- Resolution Bandwidth = Video Bandwidth: >1% of the manufacturer’s stated occupied bandwidth

Test Requirements / Limits

§ 24.238 Effective radiated power limits

Refer to chapter "Field strength of spurious radiation".

Subtests HSDPA

| Sub-test | βc | βd | βd (SF) | βc/βd | βHS (Note1, Note 2) | CM (dB) (Note 3) | MPR (dB) (Note 3) |
|---|---|---|---|---|---|---|---|
| 1 | 2/15 | 15/15 | 64 | 2/15 | 4/15 | 0.0 | 0.0 |
| 2 | 12/15 (Note 4) | 15/15 (Note 4) | 64 | 12/15 (Note 4) | 24/15 | 1.0 | 0.0 |
| 3 | 15/15 | 8/15 | 64 | 15/8 | 30/15 | 1.5 | 0.5 |
| 4 | 15/15 | 4/15 | 64 | 15/4 | 30/15 | 1.5 | 0.5 |

Note 1: $?_{ACK}$, $?_{NACK}$ and $?_{CQI}$ = 30/15 with $\beta_{hs}$ = 30/15 * $\beta_c$ .

Note 2: For the HS-DPCCH power mask requirement test in clause 5.2C, 5.7A, and the Error Vector Magnitude (EVM) with HS-DPCCH test in clause 5.13.1A, and HSDPA EVM with phase discontinuity in clause 5.13.1AA, $?_{ACK}$ and $?_{NACK}$ = 30/15 with $\beta_{hs}$ = 30/15 * $\beta_c$ , and $?_{CQI}$ = 24/15 with $\beta_{hs}$ = 24/15 * $\beta_c$ .

Note 3: CM = 1 for $\beta_c/\beta_d$ =12/15, $\beta_{hs}/\beta_c$=24/15. For all other combinations of DPDCH, DPCCH and HS-DPCCH the MPR is based on the relative CM difference. This is applicable for only UEs that support HSDPA in release 6 and later releases.

Note 4: For subtest 2 the $\beta_c/\beta_d$ ratio of 12/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1, TF1) to $\beta_c$ = 11/15 and $\beta_d$ = 15/15.

Subtests HSUPA

| Subtest | Mode | Loopback Mode | Rel99 RMC | HSDPA FRC | HSUPA Test | Number of E-DPDCH Channels |
|---|---|---|---|---|---|---|
| 1 | Rel6 HSUPA | Test Mode 1 | 12.2kbps RMC | H-Set1 | HSUPA Loopback | 1 |
| 2 | Rel6 HSUPA | Test Mode 1 | 12.2kbps RMC | H-Set1 | HSUPA Loopback | 1 |
| 3 | Rel6 HSUPA | Test Mode 1 | 12.2kbps RMC | H-Set1 | HSUPA Loopback | 2 |
| 4 | Rel6 HSUPA | Test Mode 1 | 12.2kbps RMC | H-Set1 | HSUPA Loopback | 1 |
| 5 | Rel6 HSUPA | Test Mode 1 | 12.2kbps RMC | H-Set1 | HSUPA Loopback | 1 |

| Subtest | Max UL Data Rate (kb/s) | βc/βd | βhs | βed | CM |
|---|---|---|---|---|---|
| 1 | 242.1 | 11/15 | 22/15 | 1309/225 | 1 |
| 2 | 161.3 | 6/15 | 12/15 | 94/75 | 3 |
| 3 | 524.7 | 15/9 | 30/15 | 47/15 | 2 |
| 4 | 197.6 | 2/15 | 4/15 | 56/75 | 3 |
| 5 | 299.6 | 15/15 | 30/15 | 134/15 | 1 |

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 a GSM/WCDMA/CDMA2000 cellular radiotelephone device

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 0 to 69. The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

§ 2.1046 Measurement required: RF power output
§ 2.1049 Measurement required: Occupied bandwidth
§ 2.1051 Measurement required: Spurious emissions at antenna terminals
§ 2.1053 Measurement required: Field strength of spurious radiation
§ 2.1055 Measurement required: Frequency stability
§ 2.1057 Frequency spectrum to be investigated

Part 22, Subpart C – Operational and Technical Requirements

§ 22.355 Frequency tolerance

Part 22, Subpart H – Cellular Radiotelephone Service

§ 22.913 Effective radiated power limits
§ 22.917 Emission limitations for cellular equipment

additional documents

ANSI C63.26-2015

Description of Methods of Measurements

RF Power Output

Standard FCC Part 22, Subpart H

The test was performed according to: FCC §2.1046

Test Description (conducted measurement procedure)

1) The EUT was coupled to a Spectrum Analyser and a Digital Communication Tester through a Power Divider. Refer to chapter "Setup Drawings".
2) The total insertion losses for signal path 1 and signal path 2 were measured. The values were used to correct the readings from the Spectrum Analyser and the Digital Communication Tester.
3) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Channel (Frequency): please refer to the detailed results
4) The transmitted power of the EUT was recorded by using a spectrum analyser.

Test Description (radiated measurement procedure)

1) The EUT was placed inside an anechoic chamber. Refer to chapter "Setup Drawings". The EUT was coupled to a Digital Communication Tester which was located outside the chamber via a small signalling antenna.
2) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Channel: please refer to the detailed results
3) A substitution procedure is used so that the readings from the spectrum analyser are corrected and represent directly the equivalent radiated power (related to a lamda/2 dipole).
4) The output power was measured in both vertical and horizontal antenna polarisation during the call is established on the lowest channel, mid channel and on the highest channel. To find the worst case power all orientations (X, Y, Z) of the EUT have been measured.
5) The test procedure according to ANSI C63.26-2015 has been considered.

Test Requirements / Limits

§2.1046 Measurements Required: RF Power Output
(a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in § 2.1033(c)(8). The electrical characteristics of the output terminals when this test is made shall be stated.
§22.913 Effective radiated power limits
(a)(2) Maximum ERP. … The ERP of mobile transmitters and auxiliary test transmitters must not exceed 7 Watts.

---

Emission and Occupied Bandwidth

---

Standard FCC Part 22, Subpart H

The test was performed according to: FCC §2.1049

Test Description

1) The EUT was coupled to a Spectrum Analyser and a Digital Communication Tester through a Power Divider. Refer to chapter "Setup Drawings".
2) The total insertion losses for signal path 1 and signal path 2 were measured. The values were used to correct the readings from the Spectrum Analyser and the Digital Communication Tester.
3) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Channel: please refer to the detailed results
4) Important Analyser Settings:
- Resolution Bandwidth: >1% of the manufacturer’s stated occupied bandwidth
5) The maximum spectral level of the modulated signal was recorded as the reference.
6) The emission bandwidth is measured as follows:
the two furthest frequencies above and below the frequency of the maximum reference level where the spectrum is –26 dB down have to be found.
7) The occupied bandwidth (99% Bandwidth) is measured as follows:
the occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5 percent of the total mean power.

Test Requirements / Limits

§ 2.1049 Measurements required: Occupied bandwidth

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the following conditions (as applicable):

(h) Transmitters employing digital modulation techniques - when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment will be operated. The signal shall be applied through any filter networks, pseudo-random generators or other devices required in normal service. Additionally, the occupied bandwidth shall be shown for operation with any devices used for modifying the spectrum when such devices are optional at the discretion of the user.

---

Spurious emissions at antenna terminals

---

Standard FCC Part 22, Subpart H

The test was performed according to FCC §2.1051

Test Description

1) The EUT was coupled to a Spectrum Analyser and a Digital Communication Tester through a Power Divider. Refer to chapter "Setup Drawings".
2) The total insertion losses for signal path 1 and signal path 2 were measured. The values were used to correct the readings from the Spectrum Analyser and the Digital Communication Tester.
3) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Channel: please refer to the detailed results
4) Important Analyser Settings
- [Resolution Bandwidth]:
a) [>=1% of wanted signal bandwidth] in the Span of 1 MHz directly below and above the PCS-Band,
b) otherwise [100 kHz] (or [1 MHz] for accelerated sweep times)
c) [reduced resolution bandwidth] in case the curve of the analyser IF-Filter or the wanted EUT signal leads to an exceeding of the limit, in this case a correction factor was used
- Sweep Time: depending on the transmitting signal, the span and the resolution bandwidth
5) The spurious emissions peaks were measured in the frequency range from 9 kHz to 10 GHz (up to the 10th harmonic) during the call was established

Test Requirements / Limits

§ 2.1051 Spurious emissions at antenna terminals

The radio frequency voltage or power generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in Sec. 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

§ 2.1057 Frequency spectrum to be investigated.

(a) In all of the measurements set forth in Secs. 2.1051 and 2.1053, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the frequency shown below:
(1) If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
(b) Particular attention should be paid to harmonics and subharmonics of the carrier frequency as well as to those frequencies removed from the carrier by multiples of the oscillator frequency. Radiation at the frequencies of multiplier stages should also be checked.
(c) The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value

need not be reported.
(d) Unless otherwise specified, measurements above 40 GHz shall be performed using a minimum resolution bandwidth of 1 MHz.

§ 22.917 Emission limitations for cellular equipment

(a) The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.
Remark of the test laboratory: This is calculated to be -13 dBm.
(b) Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. In the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (i.e. 100 kHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.
(c) Licensees in this service may establish an alternative out of band emission limit to be used at specified band edge(s) in specified geographical areas [...].
(d) If any emission from a transmitter operating in this service results in interference to users of another radio service, the FCC may require a greater attenuation of that emission than specified in this section.

For reporting only spurious emission levels reaching to the 20dB margin to limit were noted.

---

Field strength of spurious radiation

---

Standard FCC Part 22, Subpart H

The test was performed according to: FCC §2.1053

Test Description

1) The EUT was placed inside an anechoic chamber. Refer to chapter "Setup Drawings". The EUT was coupled to a Digital Communication Tester which was located outside the chamber via a small signalling antenna.
2) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Channel: please refer to the detailed results
3) A pre-calibration procedure is used so that the readings from the spectrum analyser are corrected and represent directly the equivalent radiated power (related to a lamda/2 dipole).
4) All spurious radiation measurements were made with spectrum analyser and the appropriate calibrated antennas for the frequency range of 30 MHz to 10 GHz (up to the 10th harmonic of the transmit frequency). The frequency range from 9 kHz to 30 MHz has been examined during the conducted spurious emission measurements.
5) Important Analyser Settings
- [Resolution Bandwidth / Video Bandwidth]:
a) [3 kHz / 10 kHz] in the Span of 1 MHz directly below and above the Band,
b) [10 kHz / 30 kHz] in case the curve of the analyser IF-Filter leads to an exceeding of the limit, in this case a worst case correction factor of 20 dB (1 MHz -> 10 kHz) was used
c) [1 MHz / 3 MHz] otherwise
- Sweep Time: depending on the transmitting signal, the span and the resolution bandwidth
6) The spurious emissions peaks were measured in both vertical and horizontal antenna polarization during the call is established on the lowest channel, mid channel and on the highest channel. To find the worst case peaks all orientations (X, Y, Z) of the EUT have been measured.
7) After this initial test, a final test according to ANSI C63.26-2015 Unwanted Emissions is performed on signals which are identified as being close to the limit. For any emissions found to be within 10 dB of the limit, a specific signal substitution measurement is performed at the frequency of the emission to determine the exact e.i.r.p. value.

Test Requirements / Limits

§ 2.1053 Measurements required: Field strength of spurious radiation.

Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of Sec. 2.1049, as appropriate. For equipment operating on frequencies below 890 MHz, an open field test is normally required, with the measuring instrument antenna located in the far-field at all test frequencies. In the event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurements will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from halfwave dipole antennas.
(b) The measurements specified in paragraph (a) of this section shall be made for the following equipment:
(2) All equipment operating on frequencies higher than 25 MHz.

§ 2.1057 Frequency spectrum to be investigated.

(a) In all of the measurements set forth in Secs. 2.1051 and 2.1053, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the frequency shown below:
(1) If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
(b) Particular attention should be paid to harmonics and subharmonics of the carrier frequency as well as to those frequencies removed from the carrier by multiples of the oscillator frequency. Radiation at the frequencies of multiplier stages should also be checked.
(c) The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.
(d) Unless otherwise specified, measurements above 40 GHz shall be performed using a minimum resolution bandwidth of 1 MHz.

§ 22.917 Emission limitations for cellular equipment

(a) The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.
This is calculated to be -13 dBm (effective radiated power) which corresponds to 84.6 dBµV/m (field strength) in a distance of 3 m.

(b) Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. In the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (i.e. 100 kHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.
(c) Licensees in this service may establish an alternative out of band emission limit to be used at specified band edge(s) in specified geographical areas [...].
(d) If any emission from a transmitter operating in this service results in interference to users of another radio service, the FCC may require a greater attenuation of that emission than specified in this section.

For reporting only spurious emission levels reaching to the 20dB margin to limit were noted.

---

Frequency stability

---

Standard FCC Part 22, Subpart H

The test was performed according to FCC §2.1055

Test Description

1) The EUT was placed inside a temperature chamber.
2) The EUT was coupled to a Digital Communication Tester. Refer to chapter "Setup Drawings".

3) The climatic chamber was cycled down/up to a certain temperature, starting with the EUT minimum temperature.
4) After the temperature was stabilized the EUT was switched on and a call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Mid Channel
5) The frequency error of the EUT was recorded by using an internal measurement function of the Digital Communication Tester immediately after the call was established, five minutes after the call was established and ten minutes after the call was established.
6) This measurement procedure was performed for temperature variation from –30°C to +50°C in increments of 10°C, if not otherwise stated in the detailed results.
When the EUT did not operate at certain temperature levels, these measurements were left out.

Test Requirements / Limits

§2.1055 Measurements required: Frequency stability

(a) The frequency stability shall be measured with variation of ambient temperature as follows:
(1) From -30° to +50° centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.
(b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10° centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.
(d) The frequency stability shall be measured with variation of primary supply voltage as follows:
(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.
(2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.
(3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

§22.355 Frequency tolerance

…the carrier frequency of each transmitter in the Public Mobile Service must be maintained within the tolerances given in table C-1 of this section.

Table C-1.- Frequency Tolerance for Transmitters in the Public Mobile Services

| Frequency range (MHz) | Base, fixed (ppm) | Mobile up to 3 watts (ppm) | Mobile above 3 watts (ppm) |
|---|---|---|---|
| 25 to 50 | 20.0 | 20.0 | 50.0 |
| 50 to 450 | 5.0 | 5.0 | 50.0 |
| 450 to 512 | 2.5 | 5.0 | 5.0 |
| 821 to 896 | 1.5 | 2.5 | 2.5 |
| 928 to 929 | 5.0 | n/a | n/a |
| 929 to 960 | 1.5 | n/a | n/a |
| 2110 to 2220 | 10.0 | n/a | n/aFor the mid |

channel (836.6 MHz) the frequency tolerance is 2.5 ppm (2091.5 Hz).

---

Band edge compliance

---

Standard FCC Part 22, Subpart H

The test was performed according to: FCC §22.913

Test Description

1) The EUT was coupled to a Spectrum Analyser and a Digital Communication Tester through a Power Divider.

Refer to chapter "Setup Drawings".
2) The total insertion losses for signal path 1 and signal path 2 were measured. The values were used to correct the readings from the Spectrum Analyser and the Digital Communication Tester.
3) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Channel: please refer to the detailed results
4) Important Analyser Settings:
- Resolution Bandwidth = Video Bandwidth: >1% of the manufacturer’s stated occupied bandwidth

Test Requirements / Limits

§ 22.917 Emission limitations for cellular equipment

Refer to chapter "Field strength of spurious radiation".

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 a GSM/WCDMA/CDMA2000 cellular radiotelephone device

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in
47 CFR Ch.1 Parts 0 to 69. The following subparts
are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

§ 2.1046 Measurement required: RF power output
§ 2.1049 Measurement required: Occupied bandwidth
§ 2.1051 Measurement required: Spurious emissions at antenna terminals
§ 2.1053 Measurement required: Field strength of spurious radiation
§ 2.1055 Measurement required: Frequency stability
§ 2.1057 Frequency spectrum to be investigated

Part 24, Subpart E - Broadband PCS

§ 24.232 Power and antenna height limits
§ 24.235 Frequency stability
§ 24.236 Field strength limits
§ 24.238 Emission limitations for Broadband PCS equipment

additional documents

ANSI C63.26-2015

Description of Methods of Measurements

RF Power Output

Standard: FCC Part 24, Subpart E

The test was performed according to: FCC §2.1046

Test Description (conducted measurement procedure)

1) The EUT was coupled to a Spectrum Analyser and a Digital Communication Tester through a Power Divider. Refer to chapter "Setup Drawings".
2) The total insertion losses for signal path 1 and signal path 2 were measured. The values were used to correct the readings from the Spectrum Analyser and the Digital Communication Tester.
3) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Channel (Frequency): please refer to the detailed results
4) The transmitted power of the EUT was recorded by using a spectrum analyser.

Test Description (radiated measurement procedure)

1) The EUT was placed inside an anechoic chamber. Refer to chapter "Setup Drawings". The EUT was coupled to a Digital Communication Tester which was located outside the chamber via a small signalling antenna.
2) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Channel:  please refer to the detailed results
3) A substitution procedure is used so that the readings from the spectrum analyser are corrected and represent directly the equivalent radiated power (related to a lamda/2 dipole).
4) The output power was measured in both vertical and horizontal antenna polarisation during the call is established on the lowest channel, mid  channel and on the highest channel. To find the worst case power all orientations (X, Y, Z) of the EUT have been measured.
5) The test procedure according to ANSI C63.26-2015 has been considered.

Test Requirements / Limits

§2.1046 Measurements Required: RF Power Output
(a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone, power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in § 2.1033(c)(8). The electrical characteristics of the output terminals when this test is made shall be stated.
§24.232 Power and antenna height limits
(c) Mobile/portable stations are limited to 2 watts EIRP peak power and the equipment must employ means to limit the power to the minimum necessary for successful communications.
(e) Peak transmit power must be measured over any interval of continuous transmission using instrumentation calibrated in terms of an rms-equivalent voltage. The measurement results shall be properly adjusted for any instrument limitations, such as detector response times, limited resolution bandwidth capability when compared to the emission bandwidth, sensitivity, etc., so as to obtain a true peak measurement for the emission in question over the full bandwidth of the channel.

Emission and Occupied Bandwidth

Standard: FCC Part 24, Subpart E

The test was performed according to: FCC §2.1049

Test Description

1) The EUT was coupled to a Spectrum Analyser and a Digital Communication Tester through a Power Divider. Refer to chapter "Setup Drawings".
2) The total insertion losses for signal path 1 and signal path 2 were measured. The values were used to correct the readings from the Spectrum Analyser and the Digital Communication Tester.
3) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Channel: please refer to the detailed results
4) Important Analyser Settings:
- Resolution Bandwidth: >1% of the manufacturer's stated occupied bandwidth
5) The maximum spectral level of the modulated signal was recorded as the reference.
6) The emission bandwidth is measured as follows:
the two furthest frequencies above and below the frequency of the maximum reference level where the spectrum is –26 dB down have to be found.
7) The occupied bandwidth (99% Bandwidth) is measured as follows:
the occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5 percent of the total mean power.

Test Requirements / Limits

§ 2.1049 Measurements required: Occupied bandwidth

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the following conditions (as applicable):

(h) Transmitters employing digital modulation techniques - when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment will be operated. The signal shall be applied through any filter networks, pseudo-random generators or other devices required in normal service. Additionally, the occupied bandwidth shall be shown for operation with any devices used for modifying the spectrum when such devices are optional at the discretion of the user.

---

Spurious emissions at antenna terminals

---

Standard: FCC Part 24, Subpart E

The test was performed according to FCC §2.1051

Test Description

1) The EUT was coupled to a Spectrum Analyser and a Digital Communication Tester through a Power Divider. Refer to chapter "Setup Drawings".
2) The total insertion losses for signal path 1 and signal path 2 were measured. The values were used to correct the readings from the Spectrum Analyser and the Digital Communication Tester.
3) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Channel: please refer to the detailed results
4) Important Analyser Settings
- [Resolution Bandwidth]:
a) [>=1% of wanted signal bandwidth] in the Span of 1 MHz directly below and above the Band,
b) otherwise [1 MHz]
c) [reduced resolution bandwidth] in case the curve of the analyser IF-Filter or the wanted EUT signal leads to an exceeding of the limit, in this case a correction factor was used
- Sweep Time: depending on the transmitting signal, the span and the resolution bandwidth
5) The spurious emissions peaks were measured in the frequency range from 9 kHz to 20 GHz (up to the 10th harmonic) during the call was established

Test Requirements / Limits

§ 2.1051 Spurious emissions at antenna terminals

The radio frequency voltage or power generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in Sec. 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

§ 2.1057 Frequency spectrum to be investigated.

(a) In all of the measurements set forth in Secs. 2.1051 and 2.1053, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the frequency shown below:
(1) If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
(b) Particular attention should be paid to harmonics and subharmonics of the carrier frequency as well as to those frequencies removed from the carrier by multiples of the oscillator frequency. Radiation at the frequencies of multiplier stages should also be checked.
(c) The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.
(d) Unless otherwise specified, measurements above 40 GHz shall be performed using a minimum resolution bandwidth of 1 MHz.

§ 24.238 Emission limitations for Broadband PCS equipment

(a) The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.
Remark of the test laboratory: This is calculated to be -13 dBm.
(b) Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (i.e. 1 MHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.
(c) Licensees in this service may establish an alternative out of band emission limit to be used at specified band edge(s) in specified geographical areas [...].
(d) If any emission from a transmitter operating in this service results in interference to users of another radio service, the FCC may require a greater attenuation of that emission than specified in this section.

For reporting only spurious emission levels reaching to the 20dB margin to limit were noted.

---

Field strength of spurious radiation

---

Standard: FCC Part 24, Subpart E

The test was performed according to: FCC §2.1053

Test Description

1) The EUT was placed inside an anechoic chamber. Refer to chapter "Setup Drawings". The EUT was coupled to a Digital Communication Tester which was located outside the chamber via a small signalling antenna.
2) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Channel: please refer to the detailed results
3) A pre-calibration procedure is used so that the readings from the spectrum analyser are corrected and represent directly the equivalent radiated power (related to a lamda/2 dipole).

4) All spurious radiation measurements were made with spectrum analyser and the appropriate calibrated antennas for the frequency range of 30 MHz to 20 GHz (up to the 10th harmonic of the transmit frequency). The frequency range from 9 kHz to 30 MHz has been examined during the conducted spurious emission measurements.
5) Important Analyser Settings
- [Resolution Bandwidth / Video Bandwidth]:
a) [3 kHz / 10 kHz] in the Span of 1 MHz directly below and above the Band,
b) [10 kHz / 30 kHz] in case the curve of the analyser IF-Filter leads to an exceeding of the limit, in this case a worst case correction factor of 20 dB (1 MHz -> 10 kHz) was used
c) [1 MHz / 3 MHz] otherwise
- Sweep Time: depending on the transmitting signal, the span and the resolution bandwidth
6) The spurious emissions peaks were measured in both vertical and horizontal antenna polarisation during the call is established on the lowest channel, mid channel and on the highest channel. To find the worst case peaks all orientations (X, Y, Z) of the EUT have been measured.
7) After this initial test, a final test according to ANSI C63.26-2015 Unwanted Emissions is performed on signals which are identified as being close to the limit. For any emissions found to be within 10 dB of the limit, a specific signal substitution measurement is performed at the frequency of the emission to determine the exact e.i.r.p. value.

Test Requirements / Limits

§ 2.1053 Measurements required: Field strength of spurious radiation.

Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of Sec. 2.1049, as appropriate. For equipment operating on frequencies below 890 MHz, an open field test is normally required, with the measuring instrument antenna located in the far-field at all test frequencies. In the event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurements will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from halfwave dipole antennas.
(b) The measurements specified in paragraph (a) of this section shall be made for the following equipment:
(2) All equipment operating on frequencies higher than 25 MHz.

§ 2.1057 Frequency spectrum to be investigated.

(a) In all of the measurements set forth in Secs. 2.1051 and 2.1053, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the frequency shown below:
(1) If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
(b) Particular attention should be paid to harmonics and subharmonics of the carrier frequency as well as to those frequencies removed from the carrier by multiples of the oscillator frequency. Radiation at the frequencies of multiplier stages should also be checked.
(c) The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.
(d) Unless otherwise specified, measurements above 40 GHz shall be performed using a minimum resolution bandwidth of 1 MHz.

§ 24.238 Emission limitations for Broadband PCS equipment

(a) The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.
This is calculated to be -13 dBm (effective radiated power) which corresponds to 84.6 dBµV/m (field strength) in a distance of 3 m.

(b) Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater. However, in the 1 MHz bands immediately outside and adjacent to the frequency block a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy provided the measured power is integrated over the full required measurement bandwidth (i.e. 1 MHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below

the transmitter power.
(c) Licensees in this service may establish an alternative out of band emission limit to be used at specified band edge(s) in specified geographical areas [...].
(d) If any emission from a transmitter operating in this service results in interference to users of another radio service, the FCC may require a greater attenuation of that emission than specified in this section.

For reporting only spurious emission levels reaching to the 20dB margin to limit were noted.

---

Frequency stability

---

Standard: FCC Part 24, Subpart E

The test was performed according to FCC §2.1055

Test Description

1) The EUT was placed inside a temperature chamber.
2) The EUT was coupled to a Digital Communication Tester. Refer to chapter "Setup Drawings".
3) The climatic chamber was cycled down/up to a certain temperature, starting with the EUT minimum temperature.
4) After the temperature was stabilized the EUT was switched on and a call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Mid Channel
5) The frequency error of the EUT was recorded by using an internal measurement function of the Digital Communication Tester immediately after the call was established, five minutes after the call was established and ten minutes after the call was established.
6) This measurement procedure was performed for temperature variation from –30°C to +50°C in increments of 10°C, if not otherwise stated in the detailed results.
When the EUT did not operate at certain temperature levels, these measurements were left out.

Test Requirements / Limits

§2.1055 Measurements required: Frequency stability

(a) The frequency stability shall be measured with variation of ambient temperature as follows:
(1) From -30° to +50° centigrade for all equipment except that specified in paragraphs
(a) (2) and (3) of this section.
(b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10° centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.
(d) The frequency stability shall be measured with variation of primary supply voltage as follows:
(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.
(2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.
(3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

§24.235 Frequency stability

The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block.

7Layers interpretation of limit:

To ensure that the frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block following limit was used:

+/- 2.5 ppm = 4700 Hz for a frequency of 1880.0 MHz

in accordance with FCC Part 22, Subpart H, §22.355, table C-1: Frequency tolerance for the carrier frequency of mobile transmitters in the Public Mobile Service in the frequency range 821 to 896 MHz.

---

Band edge compliance

---

Standard: FCC Part 24, Subpart E

The test was performed according to: FCC §24.238

Test Description

1) The EUT was coupled to a Spectrum Analyser and a Digital Communication Tester through a Power Divider. Refer to chapter "Setup Drawings".
2) The total insertion losses for signal path 1 and signal path 2 were measured. The values were used to correct the readings from the Spectrum Analyser and the Digital Communication Tester.
3) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester. Important Settings:
- Output Power: Maximum
- Channel: please refer to the detailed results
4) Important Analyser Settings:
- Resolution Bandwidth = Video Bandwidth: >1% of the manufacturer’s stated occupied bandwidth

Test Requirements / Limits

§ 24.238 Effective radiated power limits

Refer to chapter "Field strength of spurious radiation".

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 a GSM cellular radiotelephone device

Applicable FCC Rules

Prepared in accordance with the requirements of FCC Rules and Regulations as listed in 47 CFR Ch.1 Parts 0 to 69. The following subparts are applicable to the results in this test report.

Part 2, Subpart J - Equipment Authorization Procedures, Certification

§ 2.1046 Measurement required: RF power output
§ 2.1049 Measurement required: Occupied bandwidth
§ 2.1051 Measurement required: Spurious emissions at antenna terminals
§ 2.1053 Measurement required: Field strength of spurious radiation
§ 2.1055 Measurement required: Frequency stability
§ 2.1057 Frequency spectrum to be investigated

Part 27, Subpart C—Technical Standards

§ 27.50 Power and antenna height limits
§ 27.53 Emissions limits
§ 27.54 Frequency stability

additional documents

ANSI C63.26-2015

Description of Methods of Measurements

RF Power Output

Standard FCC Part 27, Subpart C

The test was performed according to: FCC §2.1046

Test Description (conducted measurement procedure)

1) The EUT was coupled to a Spectrum Analyser and a Digital Communication Tester through a Power Divider. Refer to chapter "Setup Drawings".
2) The total insertion losses for signal path 1 and signal path 2 were measured. The values were used to correct the readings from the Spectrum Analyser and the Digital Communication Tester.
3) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Channel (Frequency): please refer to the detailed results
4) The transmitted power of the EUT was recorded by using a spectrum analyser.

Test Description (radiated measurement procedure)

1) The EUT was placed inside an anechoic chamber. Refer to chapter "Setup Drawings". The EUT was coupled to a Digital Communication Tester which was located outside the chamber via a small signalling antenna.
2) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Channel: please refer to the detailed results
3) A substitution procedure is used so that the readings from the spectrum analyser are corrected and represent directly the equivalent radiated power (related to a lamda/2 dipole).
4) The output power was measured in both vertical and horizontal antenna polarisation during the call is established on the lowest channel, mid channel and on the highest channel. To find the worst case power all orientations (X, Y, Z) of the EUT have been measured.
5) The test procedure according to ANSI C63.26-2015 has been considered.

Test Requirements / Limits

§2.1046 Measurements Required: RF Power Output
(a) For transmitters other than single sideband, independent sideband and controlled carrier radiotelephone,

power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in § 2.1033(c)(8). The electrical characteristics of the output terminals when this test is made shall be stated.
§27.50 Power and antenna height limits.
(d) The following power and antenna height requirements apply to stations transmitting in the 1710–1755 MHz and 2110–2155 MHz bands:
(2) Fixed, mobile, and portable (hand-held) stations operating in the 1710–1755 MHz band are limited to a peak EIRP of 1 watt. Fixed stations operating in this band are limited to a maximum antenna height of 10 meters above ground, and mobile and portable stations must employ a means for limiting power to the minimum necessary for successful communications.

---

Emission and Occupied Bandwidth

---

Standard FCC Part 27, Subpart C

The test was performed according to: FCC §2.1049

Test Description

1) The EUT was coupled to a Spectrum Analyser and a Digital Communication Tester through a Power Divider. Refer to chapter "Setup Drawings".
2) The total insertion losses for signal path 1 and signal path 2 were measured. The values were used to correct the readings from the Spectrum Analyser and the Digital Communication Tester.
3) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Channel: please refer to the detailed results
4) Important Analyser Settings:
- Resolution Bandwidth: >1% of the manufacturer’s stated occupied bandwidth
5) The maximum spectral level of the modulated signal was recorded as the reference.
6) The emission bandwidth is measured as follows:
the two furthest frequencies above and below the frequency of the maximum reference level where the spectrum is –26 dB down have to be found.
7) The occupied bandwidth (99% Bandwidth) is measured as follows:
the occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5 percent of the total mean power.

Test Requirements / Limits

§ 2.1049 Measurements required: Occupied bandwidth

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured under the following conditions (as applicable):

(h) Transmitters employing digital modulation techniques - when modulated by an input signal such that its amplitude and symbol rate represent the maximum rated conditions under which the equipment will be operated. The signal shall be applied through any filter networks, pseudo-random generators or other devices required in normal service. Additionally, the occupied bandwidth shall be shown for operation with any devices used for modifying the spectrum when such devices are optional at the discretion of the user.

---

Spurious emissions at antenna terminals

---

Standard FCC Part 27, Subpart C

The test was performed according to FCC §2.1051

Test Description

1) The EUT was coupled to a Spectrum Analyser and a Digital Communication Tester through a Power Divider. Refer to chapter "Setup Drawings".
2) The total insertion losses for signal path 1 and signal path 2 were measured. The values were used to correct the readings from the Spectrum Analyser and the Digital Communication Tester.
3) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Channel: please refer to the detailed results
4) Important Analyser Settings
- [Resolution Bandwidth]:
a) [>=1% of wanted signal bandwidth] in the Span of 1 MHz directly below and above the Band,
b) otherwise [1 MHz]
c) [reduced resolution bandwidth] in case the curve of the analyser IF-Filter or the wanted EUT signal leads to an exceeding of the limit, in this case a correction factor was used
- Sweep Time: depending on the transmitting signal, the span and the resolution bandwidth
5) The spurious emissions peaks were measured in the frequency range from 9 kHz to 18 GHz (up to the 10th harmonic) during the call is established

Test Requirements / Limits

§ 2.1051 Spurious emissions at antenna terminals

The radio frequency voltage or power generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in Sec. 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

§ 2.1057 Frequency spectrum to be investigated.

(a) In all of the measurements set forth in Secs. 2.1051 and 2.1053, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the frequency shown below:
(1) If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
(b) Particular attention should be paid to harmonics and subharmonics of the carrier frequency as well as to those frequencies removed from the carrier by multiples of the oscillator frequency. Radiation at the frequencies of multiplier stages should also be checked.
(c) The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.
(d) Unless otherwise specified, measurements above 40 GHz shall be performed using a minimum resolution bandwidth of 1 MHz.

§ 27.53 Emission limits

(h) For operations in the 1710–1755 MHz and 2110–2155 MHz bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) by at least 43 + 10 log10(P) dB.
Remark of the test laboratory: This is calculated to be -13 dBm.
(1) Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater. However, in the 1 megahertz bands immediately outside and adjacent to the licensee's frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.
(2) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the licensee's frequency block edges, both upper and lower, as the design permits.
(3) The measurements of emission power can be expressed in peak or average values, provided they are expressed in the same parameters as the transmitter power.

For reporting only spurious emission levels reaching to the 20dB margin to limit were noted.

---

Field strength of spurious radiation

---

Standard FCC Part 27, Subpart C

The test was performed according to: FCC §2.1053

Test Description

1) The EUT was placed inside an anechoic chamber. Refer to chapter "Setup Drawings". The EUT was coupled to a Digital Communication Tester which was located outside the chamber via a small signalling antenna.
2) A call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Channel : please refer to the detailed results
3) A pre-calibration procedure is used so that the readings from the spectrum analyser are corrected and represent directly the equivalent radiated power (related to a lamda/2 dipole).
4) All spurious radiation measurements were made with spectrum analyser and the appropriate calibrated antennas for the frequency range of 30 MHz to 18 GHz (up to the 10th harmonic of the transmit frequency). The frequency range from 9 kHz to 30 MHz has been examined during the conducted spurious emission measurements.
5) Important Analyser Settings
- [Resolution Bandwidth / Video Bandwidth]:
a) [3 kHz / 10 kHz] in the Span of 1 MHz directly below and above the Band,
b) [10 kHz / 30 kHz] in case the curve of the analyser IF-Filter leads to an exceeding of the limit, in this case a worst case correction factor of 20 dB (1 MHz -> 10 kHz) was used
c) [1 MHz / 3 MHz] otherwise
- Sweep Time: depending on the transmitting signal, the span and the resolution bandwidth
6) The spurious emissions peaks were measured in both vertical and horizontal antenna polarisation during the call is established on the lowest channel, mid channel and on the highest channel. To find the worst case peaks all orientations (X, Y, Z) of the EUT have been measured.
7) After this initial test, a final test according to ANSI C63.26-2015 Unwanted Emissions is performed on signals which are identified as being close to the limit. For any emissions found to be within 10 dB of the limit, a specific signal substitution measurement is performed at the frequency of the emission to determine the exact e.i.r.p. value.

Test Requirements / Limits

§ 2.1053 Measurements required: Field strength of spurious radiation.

Measurements shall be made to detect spurious emissions that may be radiated directly from the cabinet, control circuits, power leads, or intermediate circuit elements under normal conditions of installation and operation. Curves or equivalent data shall be supplied showing the magnitude of each harmonic and other spurious emission. For this test, single sideband, independent sideband, and controlled carrier transmitters shall be modulated under the conditions specified in paragraph (c) of Sec. 2.1049, as appropriate. For equipment operating on frequencies below 890 MHz, an open field test is normally required, with the measuring instrument antenna located in the far-field at all test frequencies. In the event it is either impractical or impossible to make open field measurements (e.g. a broadcast transmitter installed in a building) measurements will be accepted of the equipment as installed. Such measurements must be accompanied by a description of the site where the measurements were made showing the location of any possible source of reflections which might distort the field strength measurements. Information submitted shall include the relative radiated power of each spurious emission with reference to the rated power output of the transmitter, assuming all emissions are radiated from halfwave dipole antennas.
(b) The measurements specified in paragraph (a) of this section shall be made for the following equipment:
(2) All equipment operating on frequencies higher than 25 MHz.

§ 2.1057 Frequency spectrum to be investigated.

(a) In all of the measurements set forth in Secs. 2.1051 and 2.1053, the spectrum shall be investigated from the lowest radio frequency signal generated in the equipment, without going below 9 kHz, up to at least the frequency shown below:
(1) If the equipment operates below 10 GHz: to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.
(b) Particular attention should be paid to harmonics and subharmonics of the carrier frequency as well as to those frequencies removed from the carrier by multiples of the oscillator frequency. Radiation at the frequencies of multiplier stages should also be checked.
(c) The amplitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be reported.
(d) Unless otherwise specified, measurements above 40 GHz shall be performed using a minimum resolution bandwidth of 1 MHz.

§ 27.53 Emission limits

(h) For operations in the 1710–1755 MHz and 2110–2155 MHz bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) by at least 43 + 10 log10(P) dB.
Remark of the test laboratory: This is calculated to be -13 dBm (effective radiated power) which corresponds to 84.6 dBµV/m (field strength) in a distance of 3 m.
(1) Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 1 megahertz or greater. However, in the 1 megahertz bands immediately outside and adjacent to the licensee's frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.
(2) When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the licensee's frequency block edges, both upper and lower, as the design permits.
(3) The measurements of emission power can be expressed in peak or average values, provided they are expressed in the same parameters as the transmitter power.

For reporting only spurious emission levels reaching to the 20dB margin to limit were noted.

---

Frequency stability

---

Standard FCC Part 27, Subpart C

The test was performed according to FCC §2.1055

Test Description

1) The EUT was placed inside a temperature chamber.
2) The EUT was coupled to a Digital Communication Tester. Refer to chapter "Setup Drawings".
3) The climatic chamber was cycled down/up to a certain temperature, starting with the EUT minimum temperature.
4) After the temperature was stabilized the EUT was switched on and a call was established on a Traffic Channel between the EUT and the Digital Communication Tester.
Important Settings:
- Output Power: Maximum
- Mid Channel
5) The frequency error of the EUT was recorded by using an internal measurement function of the Digital Communication Tester immediately after the call was established, five minutes after the call was established and ten minutes after the call was established.
6) This measurement procedure was performed for temperature variation from –30°C to +50°C in increments of 10°C, if not otherwise stated in the detailed results.
When the EUT did not operate at certain temperature levels, these measurements were left out.

Test Requirements / Limits

§2.1055 Measurements required: Frequency stability

(a) The frequency stability shall be measured with variation of ambient temperature as follows:
(1) From -30° to +50° centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.
(b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10° centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.
(d) The frequency stability shall be measured with variation of primary supply voltage as follows:
(1) Vary primary supply voltage from 85 to 115 percent of the nominal value for other than hand carried battery equipment.
(2) For hand carried, battery powered equipment, reduce primary supply voltage to the battery operating end point which shall be specified by the manufacturer.
(3) The supply voltage shall be measured at the input to the cable normally provided with the equipment, or

at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

§27.54 Frequency stability

The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation.

7Layers interpretation of limit:

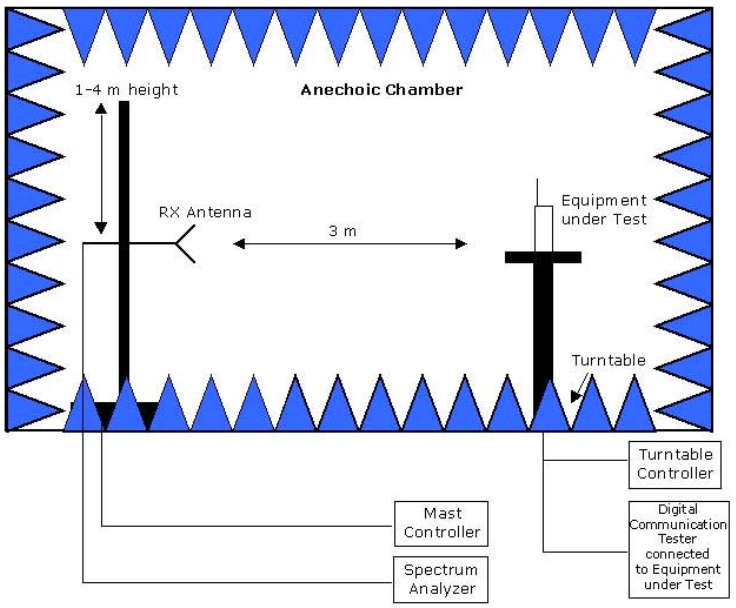
To ensure that the frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block following limit was used:

+/- 2.5 ppm = 4350 Hz for channel 1450, frequency 1740.0 MHz
+/- 2.5 ppm = 4331 Hz for channel 1412, frequency 1732.4 MHz

---

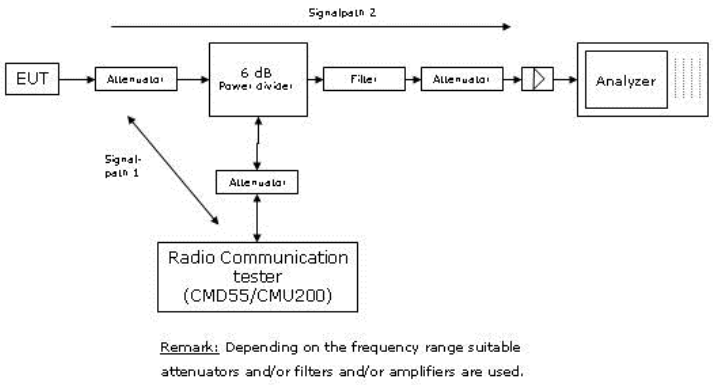
Setup Drawings

---

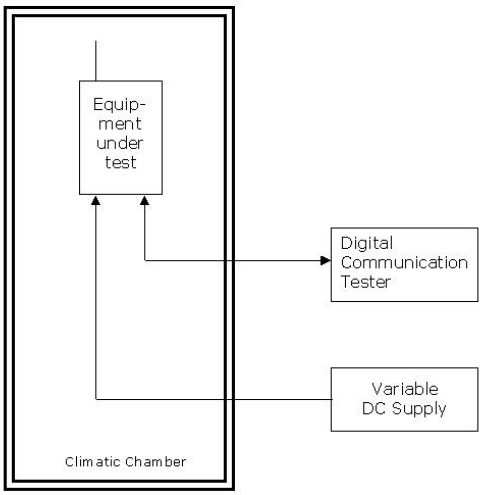



Remark: Depending on the frequency range suitable antenna types, attenuators or preamplifiers are used.

Principle set-up for radiated measurements




Principle set-up for conducted measurements under nominal conditions




Principle set-up for tests under extreme test conditions

| NB-IoT standalone Test frequencies | | | |
|---|---|---|---|
| Band | Range | Channel | Uplink Frequency [MHz] |
| eFDD2 NB-IoT | low | 18601 | 1850.1 |
| | mid | 18900 | 1880 |
| | high | 19199 | 1909.9 |
| | | | |
| eFDD5 NB-IoT | low | 20401 | 824.1 |
| | mid | 20525 | 834.1 |
| | high | 20649 | 848.9 |
| | | | |
| eFDD12 NB-IoT | low | 23011 | 699.1 |
| | mid | 23095 | 707.5 |
| | high | 23179 | 715.9 |
| | | | |
| eFDD13 NB-IoT | low | 23181 | 777.1 |
| | mid | 23230 | 782 |
| | high | 23279 | 786.9 |

| NB-IoT guard-band Test frequencies | | | |
|---|---|---|---|
| Band | Range | Channel | Uplink Frequency [MHz] |
| eFDD2 NB-IoT | low | 18601 | 1850.1 |
| | mid | 18876 | 1877.6 |
| | high | 19199 | 1909.9 |
| | | | |
| eFDD5 NB-IoT | low | 20401 | 824.1 |
| | mid | 20501 | 834.1 |
| | high | 20649 | 848.9 |
| | | | |
| eFDD12 NB-IoT | low | 23011 | 699.1 |
| | mid | 23071 | 705.1 |
| | high | 23179 | 715.9 |
| | | | |
| eFDD13 NB-IoT | low | 23181 | 777.115 |
| | mid | 23206 | 779.615 |
| | high | 23279 | 786.885 |

| NB-IoT in-band Test frequencies | | | |
|---|---|---|---|
| Band | Range | Channel | Uplink Frequency [MHz] |
| eFDD2 NB-IoT | low | 18606 | 1850.6 |
| | low | 18660 | 1855.99 |
| | low | 18669 | 1856.89 |
| | mid | 18891 | 1879.1 |
| | mid | 18910 | 1880.99 |
| | mid | 18919 | 1881.89 |
| | high | 19194 | 1909.4 |
| | high | 19160 | 1905.99 |
| | high | 19169 | 1906.89 |
| | | | |
| eFDD5 NB-IoT | low | 20406 | 824.6 |
| | low | 20460 | 829.99 |
| | low | 20469 | 830.89 |
| | mid | 20516 | 835.6 |
| | mid | 20535 | 837.49 |
| | mid | 20544 | 838.39 |
| | high | 20644 | 848.4 |
| | high | 20610 | 844.99 |
| | high | 20619 | 845.89 |
| | | | |
| eFDD12 NB-IoT | low | 23016 | 699.6 |
| | low | 23070 | 704.99 |
| | low | 23079 | 705.89 |
| | mid | 23086 | 706.6 |
| | mid | 23105 | 708.49 |
| | mid | 23114 | 709.39 |
| | high | 23174 | 715.4 |
| | high | 23140 | 711.99 |
| | high | 23149 | 712.89 |
| | | | |
| eFDD13 NB-IoT | low | 23187 | 777.7 |
| | mid | 23221 | 781.1 |
| | mid | 23240 | 782.99 |
| | mid | 23249 | 783.89 |
| | high | 23273 | 786.3 |

NB-IoT frequencies

## Correlation of measurement requirements for Cellular Equipment from FCC and IC

| Test name – FCC | FCC reference CFR47 | | | | Test name – IC | | IC reference | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Part 2 | Part 22 | Part 24 | Part 27 | | RSS-Gen | RSS-130 SRSP-518 | RSS-132 SRSP-503 | RSS-133 SRSP-510 | RSS-139 SRSP-513 | RSS-199 SRSP-517 |
| | | | | | Issue: | 4, 2014 | 1, 2013 | 3, 2013 | 6, 2013 | 3, 2016 | 3, 2016 |
| RF power output | § 2.1046 | § 22.913 | § 24.232 | § 27.50 | Transmitter output power | 6.12 | 4.4 | 5.4 | 6.4 | 6.5 | 4.4 |
| Frequency stability | § 2.1055 | § 22.355 | § 24.235 | § 27.54 | Frequency stability | 6.11 | 4.3 | 5.3 | 6.3 | 6.4 | 4.3 |
| Spurious emissions at antenna terminals | § 2.1051 | § 22.917 | § 24.238 | § 27.53 | Transmitter unwanted emissions conducted | 6.13 | 4.6 | 5.5 | 6.5 | 6.6 | 4.5 |
| – | – | – | – | – | Receiver unwanted emissions conducted | 5/7 *), 7.1.3 | - | 5.6 | 6.6 | - | - |
| Field strength of spurious radiation | § 2.1053 | § 22.917 | § 24.238 | § 27.53 | Transmitter unwanted emissions radiated | 6.13 | 4.6 | 5.5 | 6.5 | 6.6 | 4.5 |
| – | – | – | – | – | Receiver unwanted emissions radiated | 5/7 *), 7.1.2 | - | 5.6 | 6.6 | - | - |
| Emission and Occupied Bandwidth | § 2.1049 | – | – | – | Emission and Occupied Bandwidth | 6.6 | - | 5.5 | 2.3; 6.5 | - | - |
| Band edge compliance | § 2.1053 | § 22.917 | § 24.238 | § 27.53 | Band edge compliance | 6.13 | 4.6 | 5.5 | 6.5 | 6.6 | 4.5 |

*) Receivers are exempted from certification besides if operating in stand-alone mode in the frequency range 30–960 MHz or if these are scanner receivers.

FCC to ISED Correlation table

# 6 Index