

InterLab®

FCC Measurement/Technical Report on

TOBY-L200 GSM/UMTS/HSPA/LTE Data  
Module

FCC ID: XPYTOBYL200  
IC:8595A-TOBYL200

**Report Reference:** MDE\_UBLOX\_1408\_FCCc

according to FCC Part 24, Subpart E

**Test Laboratory:**

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Germany



**Note:**

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

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## 0 Summary

### 0.1 Technical Report Summary

#### Type of Authorization

Certification for a GSM/WCDMA/LTE cellular radiotelephone device. This report covers only the LTE portion of this 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

\*Covered by external report.

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 TIA-603-C-2004

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

|                                      | FCC Rule / IC Standard                          |                                                            |                                                                           |                                                            |                                                              |                                                            |
|--------------------------------------|-------------------------------------------------|------------------------------------------------------------|---------------------------------------------------------------------------|------------------------------------------------------------|--------------------------------------------------------------|------------------------------------------------------------|
| Test Case                            | 22 / RSS-132                                    |                                                            | 24 / RSS-133                                                              |                                                            | 27 / RSS-139                                                 |                                                            |
|                                      | Applicable Bands:<br>GSM 850<br>FDD 5<br>E-FDD5 |                                                            | Applicable Bands:<br>GSM 1900<br>FDD 2<br>E-FDD 2                         |                                                            | Applicable Bands:<br>FDD 4<br>E-FDD 4<br>E-FDD 7<br>E-FDD 17 |                                                            |
| Effective (isotropic) Radiated Power | \$2.1046<br>\$22.913<br>AV ERP )                | RSS-GEN,<br>\$4.8<br>RSS-132,<br>\$5.4<br>AV EIRP<br>Power | \$2.1046<br>\$24.232<br>Peak EIRP<br>Power<br>(RMS-equivalent calibrated) | RSS-GEN,<br>\$4.8<br>RSS-133,<br>\$6.4<br>AV EIRP<br>Power | \$2.1046<br>\$27.50 (d)<br>AV EIRP<br>Power                  | RSS-GEN,<br>\$4.8<br>RSS-139;<br>\$6.4<br>AV EIRP<br>Power |
| Occupied Bandwidth                   | \$2.1049                                        | RSS-GEN<br>\$4.6                                           | \$2.1049                                                                  | RSS-GEN<br>\$4.6                                           | \$2.1049                                                     | RSS-GEN<br>\$4.6                                           |
| "Spuri" at Antenna Terminal          | \$2.1051<br>\$22.917                            | RSS-GEN,<br>\$4.9<br>RSS-132,<br>\$5.5                     | \$2.1051<br>\$24.238                                                      | RSS-GEN,<br>\$4.9<br>RSS-132,<br>\$6.5                     | \$2.1051<br>\$27.5 (h)                                       | RSS-GEN,<br>\$4.9<br>RSS-139,<br>\$6.5                     |
| Band Edge compliance                 | \$2.1051<br>\$22.917                            | RSS-GEN,<br>\$4.6                                          | \$2.1051<br>\$24.238                                                      | RSS-GEN,<br>\$4.6                                          | \$2.1051<br>\$27.5 (h)                                       | RSS-GEN,<br>\$4.6                                          |
| Frequency Stability                  | \$2.1055<br>\$22.355                            | RSS-GEN,<br>\$4.7<br>RSS-132,<br>\$5.3                     | \$2.1055<br>\$24.235                                                      | RSS-GEN,<br>\$4.7<br>RSS-132,<br>\$6.3                     | \$2.1055<br>\$27.51                                          | RSS-GEN,<br>\$4.7<br>RSS-139,<br>\$6.3                     |
| Peak to Average Ration               | N/A                                             | RSS-132,<br>\$5.4                                          | \$2.1046<br>\$24.232                                                      | RSS-133,<br>\$6.4                                          | \$2.1046<br>\$27.50 (d)                                      | RSS-139,<br>\$6.4                                          |
| Modulation Characteristics           | \$2.1047                                        | RSS-132,<br>\$5.2                                          | \$2.1047                                                                  | RSS-133,<br>\$6.2                                          | \$2.1047                                                     | RSS-139,<br>\$6.2                                          |
| Field Strength of Spurious Radiation | \$2.1053<br>\$22.917                            | RSS-GEN,<br>\$4.9<br>RSS-132,<br>\$5.5                     | \$2.1053<br>\$24.235                                                      | RSS-GEN,<br>\$4.9<br>RSS-133,<br>\$6.5                     | \$2.1053<br>\$27.51                                          | RSS-GEN,<br>\$4.9<br>RSS-139,<br>\$6.5                     |

\*) Receivers which are part of Transceivers are exempted with respect to Notice 2012-DRS0126.

### Summary Test Results:

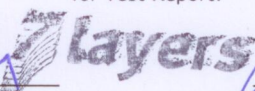
The EUT complied with all performed tests as listed in chapter 0.2 Measurement Summary.

### 0.2 Measurement Summary

|                                         |                          |                                     |                                                                |
|-----------------------------------------|--------------------------|-------------------------------------|----------------------------------------------------------------|
| <b>FCC Part 24, Subpart E</b>           |                          | <b>§2.1046, §24.232</b>             |                                                                |
| RF Power Output                         |                          |                                     |                                                                |
|                                         | <b>Setup</b><br>Setup_01 | <b>Port</b><br>AC Port (power line) | <b>Final Result</b><br>passed<br>08-28-2014                    |
| <b>FCC Part 24, Subpart E</b>           |                          | <b>§2.1055, §24.235</b>             |                                                                |
| Frequency stability                     |                          |                                     |                                                                |
|                                         | <b>Setup</b><br>Setup_02 | <b>Port</b><br>Temp.ant.connector   | <b>Final Result</b><br>passed<br>07-30-2014                    |
| <b>FCC Part 24, Subpart E</b>           |                          | <b>§2.1051, §24.238</b>             |                                                                |
| Spurious emissions at antenna terminals |                          |                                     |                                                                |
|                                         | <b>Setup</b><br>Setup_01 | <b>Port</b><br>Temp.ant.connector   | <b>Final Result</b><br>passed<br>09-04-2014                    |
| <b>FCC Part 24, Subpart E</b>           |                          | <b>§2.1049, §24.238</b>             |                                                                |
| Emission and Occupied Bandwidth         |                          |                                     |                                                                |
|                                         | <b>Setup</b><br>Setup_01 | <b>Port</b><br>Temp.ant.connector   | <b>Final Result</b><br>passed<br>08-27-2014                    |
| <b>FCC Part 24, Subpart E</b>           |                          | <b>§2.1049, §24.238</b>             |                                                                |
| Band edge compliance                    |                          |                                     |                                                                |
|                                         | <b>Setup</b><br>Setup_01 | <b>Port</b><br>Temp.ant.connector   | <b>Final Result</b><br>passed<br>09-04-2014                    |
| <b>FCC Part 24, Subpart E</b>           |                          | <b>§2.1046, §24.232 RSS-133 §64</b> |                                                                |
| Peak-Average Ratio                      |                          |                                     |                                                                |
|                                         | <b>Setup</b><br>Setup_01 | <b>Port</b><br>Temp.ant.connector   | <b>Final Result</b><br>passed<br>09-04-2014                    |
| <b>FCC Part 24, Subpart E</b>           |                          | <b>§2.1046, §24.238</b>             |                                                                |
| Field strength of spurious radiation    |                          |                                     |                                                                |
|                                         | <b>Setup</b><br>na       | <b>Port</b><br>na                   | <b>Final Result</b><br>Not performed<br>see external<br>report |

Responsible for  
Accreditation Scope:

Responsible  
for Test Report:

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## 1 Administrative Data

### 1.1 Testing Laboratory

Company Name: 7Layers AG  
Address Borsigstr. 11  
40880 Ratingen  
Germany

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

The test facility is also accredited by the following accreditation organisation:  
Laboratory accreditation no.: DAkKS D-PL-12140-01-01

Responsible for Accreditation Scope: Dipl.-Ing. Bernhard Retka  
Dipl.-Ing. Robert Machulec  
Dipl.-Ing. Thomas Hoell  
Dipl.-Ing. Marco Kullik  
Dipl.-Ing. Andreas Petz

Report Template Version 2014-09-18

### 1.2 Project Data

Responsible for testing and report: Patrick Lomax  
Date of Test(s): 2014-07-14 to 2014-09-10  
Date of Report: 2014-09-18

### 1.3 Applicant Data

Company Name: u-blox AG  
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Contact Person: Mr. Giulio Comar  
Phone: +41 44 722 7462  
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### 1.4 Manufacturer Data

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

## 2 Test object Data

### 2.1 General EUT Description

|                                |                               |
|--------------------------------|-------------------------------|
| <b>Equipment under Test:</b>   | GSM/UMTS/HSPA/LTE Data Module |
| <b>Type Designation:</b>       | TOBY-L200                     |
| <b>Kind of Device:</b>         | Module                        |
| <b>(optional)</b>              |                               |
| <b>Voltage Type:</b>           | DC                            |
| <b>Voltage Level:</b>          | 3.8 V                         |
| <b>Tested Modulation Type:</b> | QPSK;16QAM                    |

#### General product description:

The Module is able to operating in the following bands:

GSM 850/1900 900/1800

UMTS/HSDPA/HSUPA FDD1,2,4,5 and 8

LTE eFDD 2,4,5,7 and 17

#### The EUT provides the following ports:

##### Ports

Temporary antenna connector

Enclosure

## 2.2 EUT Main components

### Type, S/N, Short Descriptions etc. used in this Test Report

| Short Description                                                                                                 | Equipment under Test | Type Designation | Serial No.      | HW Status | SW Status |
|-------------------------------------------------------------------------------------------------------------------|----------------------|------------------|-----------------|-----------|-----------|
| EUT A (Code: DE1015003AY09)                                                                                       | GSM/UMTS/LTE Module  | TOBY-L200        | 352251060043772 | 192BA04   | 09.41     |
| EUT B (Code: DE1015003AP07)                                                                                       | GSM/UMTS/LTE Module  | TOBY-L200        | 352251060022016 | 192BA00   | 09.39     |
| Remark: EUT A,B is equipped with a temporary antenna connector. The Module is not sold with a predefined antenna. |                      |                  |                 |           |           |

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

## 2.3 Ancillary Equipment

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

| Short Description | Equipment under Test  | Type Designation | HW Status          | SW Status | Serial no.  | FCC ID |
|-------------------|-----------------------|------------------|--------------------|-----------|-------------|--------|
| AE 1              | AC/DC converter       | UUX324-1215      | -                  | -         | E04-0392137 | -      |
| AE 2              | Evaluation test board | EVb-WL1          | HP02_HW_C S_136000 |           | BS 081110   |        |

## 2.4 Auxiliary Equipment

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

| Short Description | Equipment under Test | Type Designation | Serial no. | HW Status | SW Status | FCC ID |
|-------------------|----------------------|------------------|------------|-----------|-----------|--------|
| *                 |                      |                  |            |           |           |        |

\* No auxiliary equipment was required to operate the module



## 2.5 EUT Setups

This chapter describes the combination of EUTs and equipment used for testing. The rationale for selecting the EUTs, ancillary and auxiliary equipment and interconnecting cables, is to test a representative configuration meeting the requirements of the referenced standards.

| Setup No. | Combination of EUTs | Description and Rationale        |
|-----------|---------------------|----------------------------------|
| Setup_01  | EUT A + AE 1 + AE 2 | setup for conducted measurements |
| Setup_02  | EUT B + AE 1 + AE 2 | setup for conducted measurements |

## 2.6 Operating Modes

The below tables show the test frequencies and channels bandwidths used for testing.

| TEST MODE  | TX / RX   | RF Channel  |             |             |
|------------|-----------|-------------|-------------|-------------|
|            |           | Low         | Mid         | High        |
| LTE eFDD 2 | TX (1.4M) | 18607       | 18900       | 19193       |
|            |           | 1850.7 MHz  | 1880 MHz    | 1909.3 MHz  |
|            | TX (3M)   | CH 18615    | CH 18900    | CH 19185    |
|            |           | 1851.5 MHz  | 1880 MHz    | 1908 MHz    |
|            | TX (5M)   | CH 18625    | CH 18900    | CH 19175    |
|            |           | 1852.5 MHz  | 1880 MHz    | 1907.5 MHz  |
|            | TX (10)   | CH 18650    | CH 18900    | CH 19150    |
|            |           | 1855 MHz    | 1880 MHz    | 1905 MHz    |
|            | TX (15M)  | CH 18675    | CH 18900    | CH 19125    |
|            |           | 1857.5 MHz  | 1880 MHz    | 1902.5 MHz  |
|            | TX (20M)  | CH 18700    | CH 18900    | CH 19100    |
|            |           | 1860 MHz    | 1880 MHz    | 1900 MHz    |
|            | RX (1.4M) | CH 607      | CH 900      | CH 1193     |
|            |           | 1930.7 MHz  | 1960 MHz    | 1989.3 MHz  |
|            | RX (3M)   | CH 615      | CH 900      | CH 1185     |
|            |           | 1931.5 MHz  | 1960 MHz    | 1988.5 MHz  |
|            | RX (5M)   | CH 625      | CH 900      | CH 1175     |
|            |           | 1932.50 MHz | 1880.00 MHz | 1987.5 MHz  |
|            | RX (10M)  | CH 650      | CH 900      | CH 1150     |
|            |           | 1935.00 MHz | 1960.00 MHz | 1985.00 MHz |
|            | RX (15M)  | CH 675      | CH 900      | CH 1125     |
|            |           | 1937.50 MHz | 1960.00 MHz | 1982.50 MHz |
|            | RX (20M)  | CH 700      | CH 900      | CH 1100     |
|            |           | 1940.00 MHz | 1960.00 MHz | 1980.00 MHz |

| eFDD 2 Test configuration |                       |                    |                     |             |                   |
|---------------------------|-----------------------|--------------------|---------------------|-------------|-------------------|
| Setup Number              | Test ITEM             | Channel Band width | Channels tested     | Modulation  | RB Allocation     |
| 01                        | RF OUTPUT POWER       | 1.4 MHz            | 18607, 18900, 19193 | QPSK, 16QAM | 1RB, 3RB, 6RB     |
|                           |                       | 3 MHz              | 18618, 18900, 19185 | QPSK, 16QAM | 1RB, 15RB         |
|                           |                       | 5 MHz              | 18625, 18900, 19175 | QPSK, 16QAM | 1RB , 12RB , 25RB |
|                           |                       | 10 MHz             | 18650, 18900, 19150 | QPSK, 16QAM | 1RB, 50RB         |
|                           |                       | 15 MHz             | 18675, 18900, 19125 | QPSK, 16QAM | 1RB, 36RB, 75RB   |
|                           |                       | 20 MHz             | 18700, 18900, 19100 | QPSK, 16QAM | 1RB, 100RB        |
| 02                        | FREQUENCY STABILITY   | 1.4                | 18900               | QPSK        | 1RB               |
| 01                        | OCCUPIED BANDWIDTH    | 1.4 MHz            | 18607, 18900, 19193 | QPSK, 16QAM | 6RB               |
|                           |                       | 3 MHz              | 18618, 18900, 19185 | QPSK, 16QAM | 15RB              |
|                           |                       | 5 MHz              | 18625, 18900, 19175 | QPSK, 16QAM | 25RB              |
|                           |                       | 10 MHz             | 18650, 18900, 19150 | QPSK, 16QAM | 50RB              |
|                           |                       | 15 MHz             | 18675, 18900, 19125 | QPSK, 16QAM | 75RB              |
|                           |                       | 20 MHz             | 18700, 18900, 19100 | QPSK, 16QAM | 100RB             |
| 01                        | PEAK TO AVERAGE RATIO | 5 MHz              | 18625, 18900, 19175 | QPSK, 16QAM | 25RB              |
| 01                        | BAND EDGE Compliance  | 1.4 MHz            | 18607, 18900, 19193 | QPSK, 16QAM | 6RB / Max offset  |
|                           |                       | 3 MHz              | 18618, 18900, 19185 | QPSK, 16QAM | 15RB/ Max offset  |
|                           |                       | 5 MHz              | 18625, 18900, 19175 | QPSK, 16QAM | 25RB/ Max offset  |
|                           |                       | 10 MHz             | 18650, 18900, 19150 | QPSK, 16QAM | 50RB/ Max offset  |
|                           |                       | 15 MHz             | 18675, 18900, 19125 | QPSK, 16QAM | 75RB/ Max offset  |
|                           |                       | 20 MHz             | 18700, 18900, 19100 | QPSK, 16QAM | 100RB/ Max offset |
| 01                        | CONDUCTED EMISSION    | 5 MHz              | 18625, 18900, 19175 | QPSK, 16QAM | 1RB               |
| NA                        | RADIATED EMISSION     | NA                 | See external report | NA          | NA                |

## 2.7 Special software used for testing

- NA

### 2.7.1 Software to control the EUT directly

- NA

#### **2.7.2 Software to enable control the EUT by a signaling unit**

- NA

### **2.8 Product labeling**

-

#### **2.8.1 FCC ID label**

Please refer to the documentation of the applicant.

#### **2.8.2 Location of the label on the EUT**

Please refer to the documentation of the applicant.

## 3 Test Results

### 3.1 RF Power Output

**Standard**     **FCC Part 24, Subpart E**

**The test was performed according to: FCC §2.1046**

#### 3.1.1 Test Description (conducted 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.
- 4) Important Settings:
- 5) Channel (Frequency): please refer to the detailed results
- 6) 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.
  - 1) Important Settings:
  - 2) Output Power: Maximum
  - 3) Channel: please refer to the detailed results
- 4) 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  $\lambda/2$  dipole).
- 5) 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.
- 6) The test procedure according to TIA-603-C-2004 has been considered.

#### 3.1.2 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.

### 3.1.3 Test Protocol

| Test Band | Bandwidth | Channel | Modulation | RB    | RSM Conducted power (dBm) | FCC EIRP limit (W) | IC EIRP limit per SRSP-503 (W) | Maximum antenna gain (dBi) | Verdict |
|-----------|-----------|---------|------------|-------|---------------------------|--------------------|--------------------------------|----------------------------|---------|
| BAND 2    | 1.4       | Low     | QPSK       | RB 1  | 23.66                     | 2                  | 2                              | 9.34                       | Passed  |
|           |           |         |            | RB 3  | 23.61                     | 2                  | 2                              | 9.39                       | Passed  |
|           |           |         |            | RB 6  | 22.61                     | 2                  | 2                              | 10.39                      | Passed  |
|           |           |         | 16QAM      | RB 1  | 22.55                     | 2                  | 2                              | 10.45                      | Passed  |
|           |           |         |            |       |                           |                    |                                |                            |         |
|           |           |         |            | RB 6  | 21.61                     | 2                  | 2                              | 11.39                      | Passed  |
|           | 1.4       | MID     | QPSK       | RB 1  | 24.09                     | 2                  | 2                              | 8.91                       | Passed  |
|           |           |         |            | RB 3  | 24.04                     | 2                  | 2                              | 8.96                       | Passed  |
|           |           |         |            | RB 6  | 23.22                     | 2                  | 2                              | 9.78                       | Passed  |
|           |           |         | 16QAM      | RB 1  | 23.23                     | 2                  | 2                              | 9.77                       | Passed  |
|           |           |         |            |       |                           |                    |                                |                            |         |
|           |           |         |            | RB 6  | 22.14                     | 2                  | 2                              | 10.86                      | Passed  |
|           | 1.4       | High    | QPSK       | RB 1  | 24.26                     | 2                  | 2                              | 8.74                       | Passed  |
|           |           |         |            | RB 3  | 24.24                     | 2                  | 2                              | 8.76                       | Passed  |
|           |           |         |            | RB 6  | 23.22                     | 2                  | 2                              | 9.78                       | Passed  |
|           |           |         | 16QAM      | RB 1  | 23.22                     | 2                  | 2                              | 9.78                       | Passed  |
|           |           |         |            |       |                           |                    |                                |                            |         |
|           |           |         |            | RB 6  | 22.18                     | 2                  | 2                              | 10.82                      | Passed  |
|           | 3         | Low     | QPSK       | RB 1  | 23.42                     | 2                  | 2                              | 9.58                       | Passed  |
|           |           |         |            | RB 15 | 22.41                     | 2                  | 2                              | 10.59                      | Passed  |
|           |           |         | 16QAM      | RB 1  | 22.52                     | 2                  | 2                              | 10.48                      | Passed  |
|           |           |         |            | RB 15 | 21.38                     | 2                  | 2                              | 11.62                      | Passed  |
|           |           | Mid     | QPSK       | RB 1  | 24.11                     | 2                  | 2                              | 8.89                       | Passed  |
|           |           |         |            | RB 15 | 23.13                     | 2                  | 2                              | 9.87                       | Passed  |
|           |           |         | 16QAM      | RB 1  | 23.33                     | 2                  | 2                              | 9.67                       | Passed  |
|           |           |         |            | RB 15 | 22.11                     | 2                  | 2                              | 10.89                      | Passed  |
|           |           | High    | QPSK       | RB 1  | 24.39                     | 2                  | 2                              | 8.61                       | Passed  |
|           |           |         |            | RB 15 | 23.31                     | 2                  | 2                              | 9.69                       | Passed  |
|           |           |         | 16QAM      | RB 1  | 23.34                     | 2                  | 2                              | 9.66                       | Passed  |
|           |           |         |            | RB 15 | 22.22                     | 2                  | 2                              | 10.78                      | Passed  |

|  |      |      |       |       |       |   |   |       |        |
|--|------|------|-------|-------|-------|---|---|-------|--------|
|  | 5    | Low  | QPSK  | RB 1  | 23.32 | 2 | 2 | 9.68  | Passed |
|  |      |      |       | RB 12 | 22.43 | 2 | 2 | 10.57 | Passed |
|  |      |      |       | RB 25 | 22.28 | 2 | 2 | 10.72 | Passed |
|  |      |      | 16QAM | RB 1  | 22.31 | 2 | 2 | 10.69 | Passed |
|  |      |      |       |       |       |   |   |       |        |
|  |      |      |       | RB 25 | 21.30 | 2 | 2 | 11.7  | Passed |
|  |      | MID  | QPSK  | RB 1  | 24.11 | 2 | 2 | 8.89  | Passed |
|  |      |      |       | RB 12 | 23.10 | 2 | 2 | 9.9   | Passed |
|  |      |      |       | RB 25 | 23.15 | 2 | 2 | 9.85  | Passed |
|  |      |      | 16QAM | RB 1  | 23.19 | 2 | 2 | 9.81  | Passed |
|  |      |      |       |       |       |   |   |       |        |
|  |      |      |       | RB 25 | 22.02 | 2 | 2 | 10.98 | Passed |
|  | 10   | High | QPSK  | RB 1  | 24.24 | 2 | 2 | 8.76  | Passed |
|  |      |      |       | RB 12 | 23.17 | 2 | 2 | 9.83  | Passed |
|  |      |      |       | RB 25 | 23.24 | 2 | 2 | 9.76  | Passed |
|  |      |      | 16QAM | RB 1  | 23.35 | 2 | 2 | 9.65  | Passed |
|  |      |      |       |       |       |   |   |       |        |
|  |      |      |       | RB 25 | 22.13 | 2 | 2 | 10.87 | Passed |
|  |      | Low  | QPSK  | RB 1  | 23.11 | 2 | 2 | 9.89  | Passed |
|  |      |      |       | RB 50 | 22.03 | 2 | 2 | 10.97 | Passed |
|  |      |      |       | RB 1  | 22.07 | 2 | 2 | 10.93 | Passed |
|  |      |      | 16QAM | RB 50 | 21.04 | 2 | 2 | 11.96 | Passed |
|  |      |      |       | RB 1  | 24.11 | 2 | 2 | 8.89  | Passed |
|  |      |      |       | RB 50 | 23.04 | 2 | 2 | 9.96  | Passed |
|  | 15   | MID  | QPSK  | RB 1  | 23.38 | 2 | 2 | 9.62  | Passed |
|  |      |      |       | RB 50 | 21.97 | 2 | 2 | 11.03 | Passed |
|  |      |      |       | RB 1  | 23.86 | 2 | 2 | 9.14  | Passed |
|  |      |      | 16QAM | RB 50 | 22.86 | 2 | 2 | 10.14 | Passed |
|  |      |      |       | RB 1  | 22.90 | 2 | 2 | 10.1  | Passed |
|  |      |      |       | RB 50 | 21.90 | 2 | 2 | 11.1  | Passed |
|  |      | High | QPSK  | RB 1  | 22.90 | 2 | 2 | 10.1  | Passed |
|  |      |      |       | RB 36 | 22.10 | 2 | 2 | 10.9  | Passed |
|  |      |      |       | RB 75 | 21.97 | 2 | 2 | 11.03 | Passed |
|  |      |      | 16QAM | RB 1  | 22.00 | 2 | 2 | 11    | Passed |
|  |      |      |       |       |       |   |   |       |        |
|  |      |      |       | RB 75 | 20.94 | 2 | 2 | 12.06 | Passed |
|  | Low  | MID  | QPSK  | RB 1  | 24.17 | 2 | 2 | 8.83  | Passed |
|  |      |      |       | RB 36 | 21.24 | 2 | 2 | 11.76 | Passed |
|  |      |      |       | RB 75 | 22.98 | 2 | 2 | 10.02 | Passed |
|  |      |      | 16QAM | RB 1  | 23.44 | 2 | 2 | 9.56  | Passed |
|  |      |      |       |       |       |   |   |       |        |
|  |      |      |       | RB 75 | 21.88 | 2 | 2 | 11.12 | Passed |
|  | High | QPSK |       | RB 1  | 23.45 | 2 | 2 | 9.55  | Passed |
|  |      |      |       | RB 36 | 22.10 | 2 | 2 | 10.9  | Passed |



|  |    |      |       |        |       |   |   |       |        |
|--|----|------|-------|--------|-------|---|---|-------|--------|
|  |    |      |       | RB 75  | 22.56 | 2 | 2 | 10.44 | Passed |
|  |    |      | 16QAM | RB 1   | 22.58 | 2 | 2 | 10.42 | Passed |
|  |    |      |       |        |       |   |   |       |        |
|  |    |      |       | RB 75  | 21.57 | 2 | 2 | 11.43 | Passed |
|  | 20 | MID  | QPSK  | RB 1   | 24.09 | 2 | 2 | 8.91  | Passed |
|  |    |      |       | RB 100 | 23.00 | 2 | 2 | 10    | Passed |
|  |    |      | 16QAM | RB 1   | 23.37 | 2 | 2 | 9.63  | Passed |
|  |    |      |       | RB 100 | 21.95 | 2 | 2 | 11.05 | Passed |
|  |    | Low  | QPSK  | RB 1   | 22.91 | 2 | 2 | 10.09 | Passed |
|  |    |      |       | RB 100 | 22.11 | 2 | 2 | 10.89 | Passed |
|  |    |      | 16QAM | RB 1   | 21.80 | 2 | 2 | 11.2  | Passed |
|  |    |      |       | RB 100 | 21.09 | 2 | 2 | 11.91 | Passed |
|  |    | High | QPSK  | RB 1   | 23.24 | 2 | 2 | 9.76  | Passed |
|  |    |      |       | RB 100 | 22.44 | 2 | 2 | 10.56 | Passed |
|  |    |      | 16QAM | RB 100 | 21.46 | 2 | 2 | 11.54 | Passed |
|  |    |      |       | RB 1   | 22.42 | 2 | 2 | 10.58 | Passed |

## 3.2 Frequency stability

**Standard** FCC Part 24, Subpart E

**The test was performed according to: FCC §2.1055**

### 3.2.1 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  $-30^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$  in increments of  $10^{\circ}\text{C}$ , if not otherwise stated in the detailed results.
- When the EUT did not operate at certain temperature levels, these measurements were left out.

### 3.2.2 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  $-30^{\circ}$  to  $+50^{\circ}$  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  $10^{\circ}$  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.

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

### 3.2.3 Test Protocol

Channel: 18900/ 1.4MHz Bandwidth / 1 Resource Block / QPSK Modulation

| Temp.<br>°C | Duration<br>min | Voltage                           | Limit<br>Hz | Freq.<br>error<br>Max.<br>(Hz) | Verdict |
|-------------|-----------------|-----------------------------------|-------------|--------------------------------|---------|
| -30         | 0               | normal                            | 4700        | -170                           | passed  |
| -30         | 5               |                                   |             | -5                             | passed  |
| -30         | 10              |                                   |             | 20                             | passed  |
| -20         | 0               | normal                            | 4700        | -62                            | passed  |
| -20         | 5               |                                   |             | -17                            | passed  |
| -20         | 10              |                                   |             | -29                            | passed  |
| -10         | 0               | normal                            | 4700        | 60                             | passed  |
| -10         | 5               |                                   |             | -4                             | passed  |
| -10         | 10              |                                   |             | -84                            | passed  |
| 0           | 0               | normal                            | 4700        | 36                             | passed  |
| 0           | 5               |                                   |             | -25                            | passed  |
| 0           | 10              |                                   |             | 152                            | passed  |
| 10          | 0               | normal                            | 4700        | 167                            | passed  |
| 10          | 5               |                                   |             | 115                            | passed  |
| 10          | 10              |                                   |             | -14                            | passed  |
| 20          | 0               | low                               | 4700        | -2                             | passed  |
| 20          | 5               |                                   |             | 23                             | passed  |
| 20          | 10              |                                   |             | 139                            | passed  |
| 20          | 0               | normal<br>=<br>high <sup>1)</sup> | 4700        | -17                            | passed  |
| 20          | 5               |                                   |             | -95                            | passed  |
| 20          | 10              |                                   |             | 23                             | passed  |
| 20          | 0               | high                              | 4700        | -189                           | passed  |
| 20          | 5               |                                   |             | 36                             | passed  |
| 20          | 10              |                                   |             | -78                            | passed  |
| 30          | 0               | normal                            | 4700        | 32                             | passed  |
| 30          | 5               |                                   |             | -160                           | passed  |
| 30          | 10              |                                   |             | 54                             | passed  |
| 40          | 0               | normal                            | 4700        | -115                           | passed  |
| 40          | 5               |                                   |             | -57                            | passed  |
| 40          | 10              |                                   |             | 103                            | passed  |
| 50          | 0               | normal                            | 4700        | 77                             | passed  |
| 50          | 5               |                                   |             | -10                            | passed  |
| 50          | 10              |                                   |             | -69                            | passed  |

### 3.3 Spurious emissions at antenna terminals

Standard      FCC Part 24, Subpart E

**The test was performed according to FCC §2.1051**

#### 3.3.1 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) [ $\geq 1\%$  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

#### 3.3.2 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.

#### 3.3.3 Test Protocol

| Band  | Modulation / BW (MHz) | Channel | detector | trace   | resolution bandwidth /kHz | frequency /MHz | peak value /dBm | margin to limit /dB | limit /dBm | verdict |
|-------|-----------------------|---------|----------|---------|---------------------------|----------------|-----------------|---------------------|------------|---------|
| eFDD2 | QPSK / 5MHz           | 18625   | rms      | maxhold | 100                       | 1848.95        | -25.8           | 12.8                | -13.0      | passed  |
|       |                       |         | rms      | maxhold | 50                        | 1850.00        | -23.5           | 10.5                | -13.0      | passed  |
|       |                       | 18900   | rms      | maxhold | 1000                      | 1961.475       | -41.73          | 28.73               | -13        | passed  |
|       |                       |         | rms      | maxhold | 50                        | 1910.02        | -22.5           | 9.5                 | -13.0      | passed  |
|       |                       |         | rms      | maxhold | 100                       | 1911.09        | -18.3           | 5.3                 | -13.0      | passed  |
|       | 16QAM / 5MHz          | 18625   | rms      | maxhold | 100                       | 1848.89        | -27.4           | 14.4                | -13.0      | passed  |
|       |                       |         | rms      | maxhold | 50                        | 1850.00        | -25.7           | 12.7                | -13.0      | passed  |
|       |                       | 18900   | rms      | maxhold | 1000                      | 1961.475       | -41.73          | 28.73               | -13        | passed  |
|       |                       |         | rms      | maxhold | 50                        | 1910.02        | -23.5           | 10.5                | -13.0      | passed  |
|       |                       |         | rms      | maxhold | 100                       | 1911.14        | -19.3           | 6.3                 | -13.0      | passed  |

no further values have been found with a margin of less than 20 dB

### 3.4 Emission and Occupied Bandwidth

**Standard** FCC Part 24, Subpart E

**The test was performed according to:** FCC §2.1049

#### 3.4.1 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.

The maximum number of resource blocks are used for each channel bandwidth.

#### 3.4.2 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.

### 3.4.3 Test Protocol

The maximum number of resource blocks are used for each channel bandwidth.

| LTE Band 2          |                 |              |           |                   |                 |              |            |
|---------------------|-----------------|--------------|-----------|-------------------|-----------------|--------------|------------|
| Channel BW: 1.4 MHz |                 |              |           | Channel BW: 3 MHz |                 |              |            |
| Channel             | Frequency (MHz) | 99% BW (MHz) |           | Channel           | Frequency (MHz) | 99% BW (MHz) |            |
|                     |                 | QPSK         | 16QAM     |                   |                 | QPSK         | 16QAM      |
| low                 | 1850.7 MHz      | 1.1242485    | 1.1302605 | low               | 1851.5 MHz      | 2.7174349    | 2.72945892 |
| mid                 | 1880 MHz        | 1.1242485    | 1.1122245 | mid               | 1880 MHz        | 2.7174349    | 2.71743487 |
| High                | 1909.3 MHz      | 1.1302605    | 1.1182365 | High              | 1908 MHz        | 2.7174349    | 2.71743487 |

| LTE Band 2       |                 |              |           |                    |                 |              |            |
|------------------|-----------------|--------------|-----------|--------------------|-----------------|--------------|------------|
| Channel BW: 5MHz |                 |              |           | Channel BW: 10 MHz |                 |              |            |
| Channel          | Frequency (MHz) | 99% BW (MHz) |           | Channel            | Frequency (MHz) | 99% BW (MHz) |            |
|                  |                 | QPSK         | 16QAM     |                    |                 | QPSK         | 16QAM      |
| low              | 1852.5 MHz      | 4.5931864    | 4.5691383 | low                | 1855 MHz        | 8.9779559    | 8.97795591 |
| mid              | 1880 MHz        | 4.5691383    | 4.5691383 | mid                | 1880 MHz        | 8.9779559    | 8.97795591 |
| High             | 1907.5 MHz      | 4.5931864    | 4.5931864 | High               | 1905 MHz        | 9.0180361    | 9.01803607 |

| LTE Band 2        |                 |              |           |                    |                 |              |            |
|-------------------|-----------------|--------------|-----------|--------------------|-----------------|--------------|------------|
| Channel BW: 15MHz |                 |              |           | Channel BW: 20 MHz |                 |              |            |
| Channel           | Frequency (MHz) | 99% BW (MHz) |           | Channel            | Frequency (MHz) | 99% BW (MHz) |            |
|                   |                 | QPSK         | 16QAM     |                    |                 | QPSK         | 16QAM      |
| low               | 1857.5 MHz      | 13.587174    | 13.587174 | low                | 1860 MHz        | 17.955912    | 17.9559118 |
| mid               | 1880 MHz        | 13.466934    | 13.587174 | mid                | 1880 MHz        | 17.955912    | 17.9559118 |
| High              | 1902.5 MHz      | 13.527054    | 13.587174 | High               | 1900 MHz        | 17.955912    | 18.0360721 |

### **3.5 Band edge compliance**

**Standard** FCC Part 24, Subpart E

**The test was performed according to:** FCC §24.238

#### **3.5.1 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

#### **3.5.2 Test Requirements / Limits**

§ 24.238 Effective radiated power limits

Refer to chapter "Field strength of spurious radiation".



### 3.5.3 Test Protocol

| Band  | Band width (MHz) | Modulation | Resource Blocks / Offset | Channel | Detector | Frequency (MHz) | Peak Value (dBm) | Limit (dBm) | Verdict |
|-------|------------------|------------|--------------------------|---------|----------|-----------------|------------------|-------------|---------|
| eFDD2 | 1.4              | QPSK       | 6 / 0                    | 18607   | Average  | 1850            | -23.56           | -13         | Passed  |
|       |                  |            |                          |         | RMS      | 1850            | -21.65           | -13         | Passed  |
|       |                  |            | 6 / Max                  | 19193   | Average  | 1910            | -22.24           | -13         | Passed  |
|       |                  |            |                          |         | RMS      | 1910            | -20.78           | -13         | Passed  |
|       |                  | 16QAM      | 6 / 0                    | 18607   | Average  | 1850            | -23.85           | -13         | Passed  |
|       |                  |            |                          |         | RMS      | 1850            | -21.65           | -13         | Passed  |
|       |                  |            | 6 / Max                  | 19193   | Average  | 1910            | -23.01           | -13         | Passed  |
|       |                  |            |                          |         | RMS      | 1910            | -21.42           | -13         | Passed  |
| eFDD2 | 3                | QPSK       | 15 / 0                   | 18615   | Average  | 1850            | -26.01           | -13         | Passed  |
|       |                  |            |                          |         | RMS      | 1850            | -22.74           | -13         | Passed  |
|       |                  |            | 15 / Max                 | 19185   | Average  | 1910            | -25.11           | -13         | Passed  |
|       |                  |            |                          |         | RMS      | 1910            | -23.01           | -13         | Passed  |
|       |                  | 16QAM      | 15 / 0                   | 18615   | Average  | 1850            | -27.9            | -13         | Passed  |
|       |                  |            |                          |         | RMS      | 1850            | -24.62           | -13         | Passed  |
|       |                  |            | 15 / Max                 | 19185   | Average  | 1910            | -25.82           | -13         | Passed  |
|       |                  |            |                          |         | RMS      | 1910            | -23.42           | -13         | Passed  |
| eFDD2 | 5                | QPSK       | 25 / 0                   | 18625   | Average  | 1850            | -28.64           | -13         | Passed  |
|       |                  |            |                          |         | RMS      | 1850            | -24.3            | -13         | Passed  |
|       |                  |            | 25 / Max                 | 19175   | Average  | 1910            | -26.6            | -13         | Passed  |
|       |                  |            |                          |         | RMS      | 1910            | -24.15           | -13         | Passed  |
|       |                  | 16QAM      | 25 / 0                   | 18625   | Average  | 1850            | -29.72           | -13         | Passed  |
|       |                  |            |                          |         | RMS      | 1850            | -25.29           | -13         | Passed  |
|       |                  |            | 25 / Max                 | 19175   | Average  | 1910            | -27.44           | -13         | Passed  |
|       |                  |            |                          |         | RMS      | 1910            | -24.78           | -13         | Passed  |
| eFDD2 | 10               | QPSK       | 50 / 0                   | 18650   | Average  | 1850            | -35.74           | -13         | Passed  |
|       |                  |            |                          |         | RMS      | 1850            | -31.31           | -13         | Passed  |
|       |                  |            | 50 / Max                 | 19150   |          |                 |                  |             |         |
|       |                  |            |                          |         |          |                 |                  |             |         |

|           |           |       |          |       |         |       |         |      |        |     |        |
|-----------|-----------|-------|----------|-------|---------|-------|---------|------|--------|-----|--------|
|           |           |       |          |       | Average | 1910  | -29.16  | -13  | Passed |     |        |
|           |           |       |          |       | RMS     | 1910  | -27.44  | -13  | Passed |     |        |
|           |           | 16QAM | 50 / 0   | 18650 |         |       |         |      |        |     |        |
|           |           |       |          |       | Average | 1850  | -36.99  | -13  | Passed |     |        |
|           |           |       | 50 / Max | 19150 |         |       |         |      |        |     |        |
|           |           |       |          |       | RMS     | 1850  | -32.82  | -13  | Passed |     |        |
| eFDD2     | 15        | QPSK  | 75 / 0   | 18675 |         |       |         |      |        |     |        |
|           |           |       |          |       | Average | 1850  | -36.34  | -13  | Passed |     |        |
|           |           |       | 75 / Max | 19125 |         |       |         |      |        |     |        |
|           |           |       |          |       | Average | 1910  | -28.38  | -13  | Passed |     |        |
|           |           | 16QAM | 75 / 0   | 18675 |         |       |         |      |        |     |        |
|           |           |       |          |       | Average | 1850  | -36.99  | -13  | Passed |     |        |
|           |           |       | 75 / Max | 19125 |         |       |         |      |        |     |        |
|           |           |       |          |       | Average | 1910  | -29.16  | -13  | Passed |     |        |
|           |           | eFDD2 | 20       | QPSK  | 100 / 0 | 18700 |         |      |        |     |        |
|           |           |       |          |       |         |       | Average | 1850 | -39.27 | -13 | Passed |
| 100 / Max | 19100     |       |          |       |         |       |         |      |        |     |        |
|           |           |       |          |       | Average | 1910  | -29.44  | -13  | Passed |     |        |
| 16QAM     | 100 / 0   |       |          | 18700 |         |       |         |      |        |     |        |
|           |           |       |          |       | Average | 1850  | -50.18  | -13  | Passed |     |        |
|           | 100 / Max |       |          | 19100 |         |       |         |      |        |     |        |
|           |           |       |          |       | Average | 1910  | -30.32  | -13  | Passed |     |        |

### 3.6 Power to Average Ratio

**Standard** §2.1046, §24.232

**The test was performed according to:** §2.1046, §24.232

A peak to average ratio measurement is performed at the conducted port of the EUT. The spectrum analyzers Complementary Cumulative Distribution Function (CCDF) measurement profile is used to determine the largest deviation between the average and the peak power of the EUT in a given bandwidth.

The CCDF curve shows how much time the peak waveform spends at or above a given average power level. The percent of time the signal spends at or above the level defines the probability for that particular power level.

KDB 971168 v02r01 – Section 5.7.1 was applied.

#### Test Settings

1. The signal analyzer's CCDF measurement profile is enabled
2. Frequency = carrier center frequency
3. Measurement BW > Emission bandwidth of signal
4. The signal analyser was set to collect one million samples to generate the CCDF curve
5. The measurement interval was set depending on the type of signal analysed. For continuous signals (>98% duty cycle), the measurement interval was set to 1ms.

#### 3.6.1 Test Protocol

| Band  | Bandwidth | Channel | Modulation | Measured Value (dB) | Limit | Verdict |
|-------|-----------|---------|------------|---------------------|-------|---------|
| eFDD5 | 1.4       | 20407   | QPSK       | 5.28                | 13 dB | Passed  |
|       |           | 20525   |            | 5.3                 | 13 dB | Passed  |
|       |           | 20643   |            | 5.07                | 13 dB | Passed  |
|       |           | 20407   | 16-QAM     | 6.17                | 13 dB | Passed  |
|       |           | 20525   |            | 6.2                 | 13 dB | Passed  |
|       |           | 20643   |            | 5.97                | 13 dB | Passed  |

## 4 Test Equipment

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

### Test Equipment Anechoic Chamber

|                      |                                       |                       |                   |
|----------------------|---------------------------------------|-----------------------|-------------------|
| <b>Lab ID:</b>       | <b>Lab 1</b>                          |                       |                   |
| <b>Manufacturer:</b> | Frankonia                             |                       |                   |
| <b>Description:</b>  | Anechoic Chamber for radiated testing |                       |                   |
| <b>Type:</b>         | 10.58x6.38x6.00 m³                    |                       |                   |
|                      | <i>Calibration Details</i>            | <i>Last Execution</i> | <i>Next Exec.</i> |
|                      | NSA (FCC)                             | 2014/01/09            | 2017/01/09        |

### Single Devices for Anechoic Chamber

| <i>Single Device Name</i> | <i>Type</i>                    | <i>Serial Number</i> | <i>Manufacturer</i>   |                   |
|---------------------------|--------------------------------|----------------------|-----------------------|-------------------|
| Air compressor            | none                           | -                    | Atlas Copco           |                   |
| Anechoic Chamber          | 10.58 x 6.38 x 6.00 m³         | none                 | Frankonia             |                   |
|                           | <i>Calibration Details</i>     |                      | <i>Last Execution</i> | <i>Next Exec.</i> |
|                           | FCC listing 96716 3m Part15/18 |                      | 2014/01/09            | 2017/01/08        |
| Controller Maturo         | MCU                            | 961208               | Maturo GmbH           |                   |
| EMC camera                | CE-CAM/1                       | -                    | CE-SYS                |                   |
| EMC camera Nr.2           | CCD-400E                       | 0005033              | Mitsubishi            |                   |
| Filter ISDN               | B84312-C110-E1                 |                      | Siemens&Matsushita    |                   |
| Filter Universal 1A       | B84312-C30-H3                  | -                    | Siemens&Matsushita    |                   |

## 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          | Weinschel Associates                    |
| Coax Attenuator 10dB SMA 2W                                     | 4T-10             | F9401         | Weinschel Associates                    |
| Coax Attenuator 10dB SMA 2W                                     | 56-10             | W3702         | Weinschel Associates                    |
| Coax Attenuator 10dB SMA 2W                                     | 56-10             | W3711         | Weinschel Associates                    |
| Coax Cable Huber&Suhner                                         | Sucotest 2,0m     |               | Huber&Suhner                            |
| Coax Cable Rosenberger Micro Coax FA210A0010003030 SMA/SMA 1,0m | FA210A0010003030  | 54491-2       | Rosenberger Micro-Coax                  |
| Power Meter                                                     | NRVD              | 828110/016    | Rohde & Schwarz GmbH & Co.KG            |
| <i>Calibration Details</i>                                      |                   |               | <i>Last Execution</i> <i>Next Exec.</i> |
| Standard calibration                                            |                   |               | 2014/05/13    2015/05/12                |
| RF Step Attenuator RSP                                          | RSP               | 833695/001    | Rohde & Schwarz GmbH & Co.KG            |
| Rubidium Frequency Standard                                     | Datum, Model: MFS | 5489/001      | Datum-Beverly                           |
| Standard calibration                                            |                   |               | 2014/07/03    2015/07/02                |
| Sensor Head A                                                   | NRV-Z1            | 827753/005    | Rohde & Schwarz GmbH & Co.KG            |
| <i>Calibration Details</i>                                      |                   |               | <i>Last Execution</i> <i>Next Exec.</i> |
| Standard calibration                                            |                   |               | 2014/05/13    2015/05/12                |
| Signal Generator SME                                            | SME03             | 827460/016    | Rohde & Schwarz GmbH & Co.KG            |
| <i>Calibration Details</i>                                      |                   |               | <i>Last Execution</i> <i>Next Exec.</i> |
| Standard calibration                                            |                   |               | 2011/11/25    2014/11/24                |
| Signal Generator SMP                                            | SMP02             | 836402/008    | Rohde & Schwarz GmbH & Co. KG           |
| <i>Calibration Details</i>                                      |                   |               | <i>Last Execution</i> <i>Next Exec.</i> |
| Standard calibration                                            |                   |               | 2013/05/06    2016/05/05                |
| Spectrum Analyser                                               | FSIQ26            | 840061/005    | Rohde & Schwarz GmbH & Co. KG           |
| <i>Calibration Details</i>                                      |                   |               | <i>Last Execution</i> <i>Next Exec.</i> |
| Standard Calibration                                            |                   |               | 2013/02/12    2015/02/11                |

#### Test Equipment Temperature Chamber 05

|                       |                            |
|-----------------------|----------------------------|
| <b>Lab ID:</b>        | <b>Lab 2</b>               |
| <b>Manufacturer:</b>  | see single devices         |
| <b>Description:</b>   | Temperature Chamber VT4002 |
| <b>Type:</b>          | Vötsch                     |
| <b>Serial Number:</b> | see single devices         |

#### Single Devices for Temperature Chamber 05

| Single Device Name            | Type    | Serial Number         | Manufacturer      |
|-------------------------------|---------|-----------------------|-------------------|
| Temperature Chamber Vötsch 05 | VT 4002 | 58566080550010        | Vötsch            |
| <i>Calibration Details</i>    |         | <i>Last Execution</i> | <i>Next Exec.</i> |
| Customized calibration        |         | 2014/03/11            | 2016/03/10        |

#### Test Equipment Auxiliary Test Equipment

|                       |                                           |
|-----------------------|-------------------------------------------|
| <b>Lab ID:</b>        | <b>Lab 1, Lab 2</b>                       |
| <b>Manufacturer:</b>  | see single devices                        |
| <b>Description:</b>   | Single Devices for various Test Equipment |
| <b>Type:</b>          | various                                   |
| <b>Serial Number:</b> | none                                      |

#### Single Devices for Auxiliary Test Equipment

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

## Test Equipment Digital Signalling Devices

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

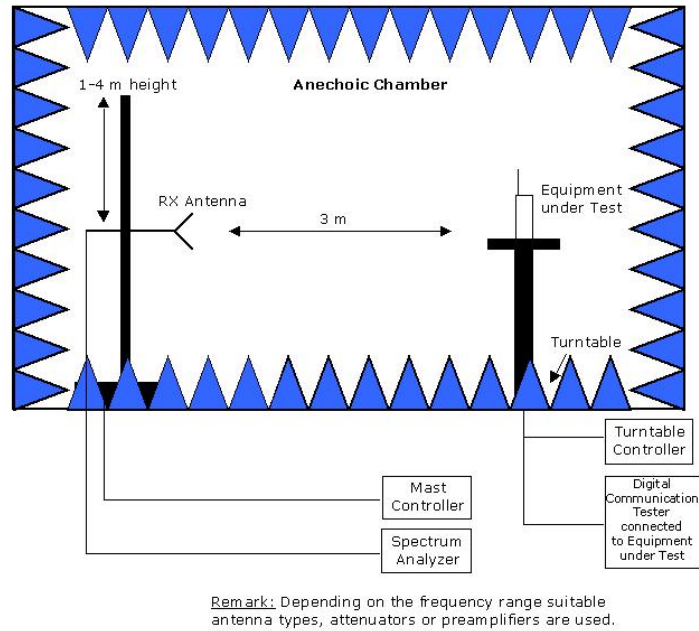
### Single Devices for Digital Signalling Devices

| Single Device Name                   | Type                                                                                                                                                                                                                                                                                                                                                         | Serial Number | Manufacturer                  |                    |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-------------------------------|--------------------|
| Bluetooth Signalling Unit CBT        | CBT                                                                                                                                                                                                                                                                                                                                                          | 100589        | Rohde & Schwarz GmbH & Co. KG |                    |
|                                      | <i>Calibration Details</i>                                                                                                                                                                                                                                                                                                                                   |               | <i>Last Execution</i>         | <i>Next Exec.</i>  |
|                                      | Standard calibration                                                                                                                                                                                                                                                                                                                                         |               | 2011/11/24                    | 2014/11/23         |
| CMW500                               | CMW500                                                                                                                                                                                                                                                                                                                                                       | 107500        | Rohde & Schwarz GmbH & Co. KG |                    |
|                                      | <i>Calibration Details</i>                                                                                                                                                                                                                                                                                                                                   |               | <i>Last Execution</i>         | <i>Next Exec.</i>  |
|                                      | Standard calibration                                                                                                                                                                                                                                                                                                                                         |               | 2014/01/27                    | 2016/01/26         |
| Digital Radio Communication Tester   | CMD 55                                                                                                                                                                                                                                                                                                                                                       | 831050/020    | Rohde & Schwarz GmbH & Co. KG |                    |
|                                      | <i>Calibration Details</i>                                                                                                                                                                                                                                                                                                                                   |               | <i>Last Execution</i>         | <i>Next Exec.</i>  |
|                                      | Standard calibration                                                                                                                                                                                                                                                                                                                                         |               | 2011/11/28                    | 2014/11/27         |
| Universal Radio Communication Tester | CMU 200                                                                                                                                                                                                                                                                                                                                                      | 102366        | Rohde & Schwarz GmbH & Co. KG |                    |
|                                      | <i>HW/SW Status</i>                                                                                                                                                                                                                                                                                                                                          |               | <i>Date of Start</i>          | <i>Date of End</i> |
|                                      | Hardware:<br>B11, B21V14, B21-2, B41, B52V14, B52-2, B53-2, B56V14, B68 3v04, PCMCIA, U65V04<br>Software:<br>K21 4v21, K22 4v21, K23 4v21, K24 4v21, K42 4v21, K43 4v21, K53 4v21, K56 4v22, K57 4v22, K58 4v22, K59 4v22, K61 4v22, K62 4v22, K63 4v22, K64 4v22, K65 4v22, K66 4v22, K67 4v22, K68 4v22, K69 4v22<br>Firmware:<br>µP1 8v50 02.05.06<br>--- |               | 2007/07/16                    |                    |
| Universal Radio Communication Tester | CMU 200                                                                                                                                                                                                                                                                                                                                                      | 837983/052    | Rohde & Schwarz GmbH & Co. KG |                    |
|                                      | <i>Calibration Details</i>                                                                                                                                                                                                                                                                                                                                   |               | <i>Last Execution</i>         | <i>Next Exec.</i>  |
|                                      | Standard calibration                                                                                                                                                                                                                                                                                                                                         |               | 2011/12/07                    | 2014/12/06         |
|                                      | <i>HW/SW Status</i>                                                                                                                                                                                                                                                                                                                                          |               | <i>Date of Start</i>          | <i>Date of End</i> |
|                                      | HW options:<br>B11, B21V14, B21-2, B41, B52V14, B52-2, B53-2, B54V14, B56V14, B68 3v04, B95, PCMCIA, U65V02<br>SW options:<br>K21 4v11, K22 4v11, K23 4v11, K24 4v11, K27 4v10, K28 4v10, K42 4v11, K43 4v11, K53 4v10, K65 4v10, K66 4v10, K68 4v10,<br>Firmware:<br>µP1 8v40 01.12.05<br>---<br>SW:<br>K62, K69                                            |               | 2007/01/02                    |                    |
|                                      |                                                                                                                                                                                                                                                                                                                                                              |               | 2008/11/03                    |                    |
| Vector Signal Generator              | SMU200A                                                                                                                                                                                                                                                                                                                                                      | 100912        | Rohde & Schwarz GmbH & Co. KG |                    |

## 5 Photo Report

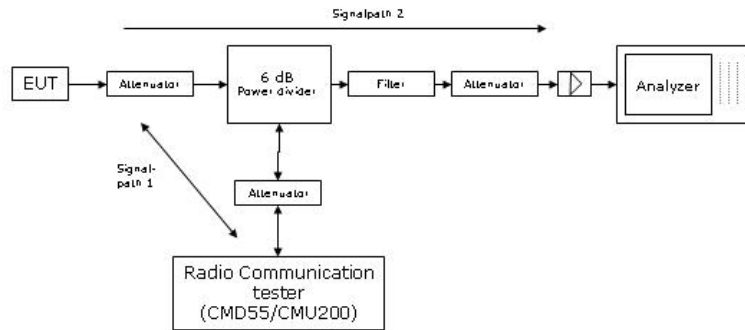
Photos are included in an external report.

## 6 Setup Drawings



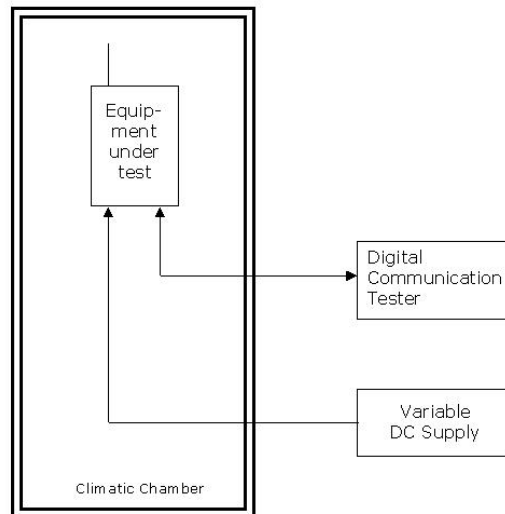
**Drawing 1:** Setup in the anechoic chamber. For measurements below 1 GHz the ground was replaced by a conducting ground plane.





Remark: Depending on the frequency range suitable attenuators and/or filters and/or amplifiers are used.

Principle set-up for conducted measurements under nominal conditions

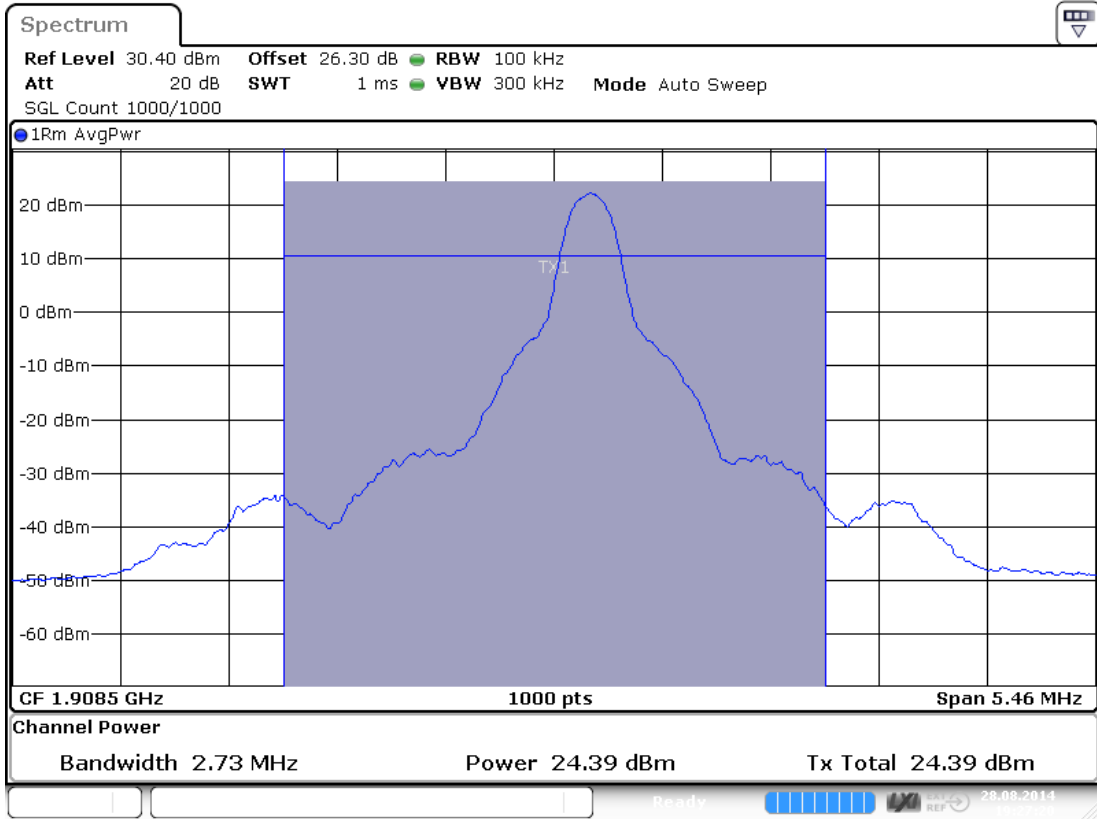


Principle set-up for tests under extreme test conditions

## 7 Annex measurement plots

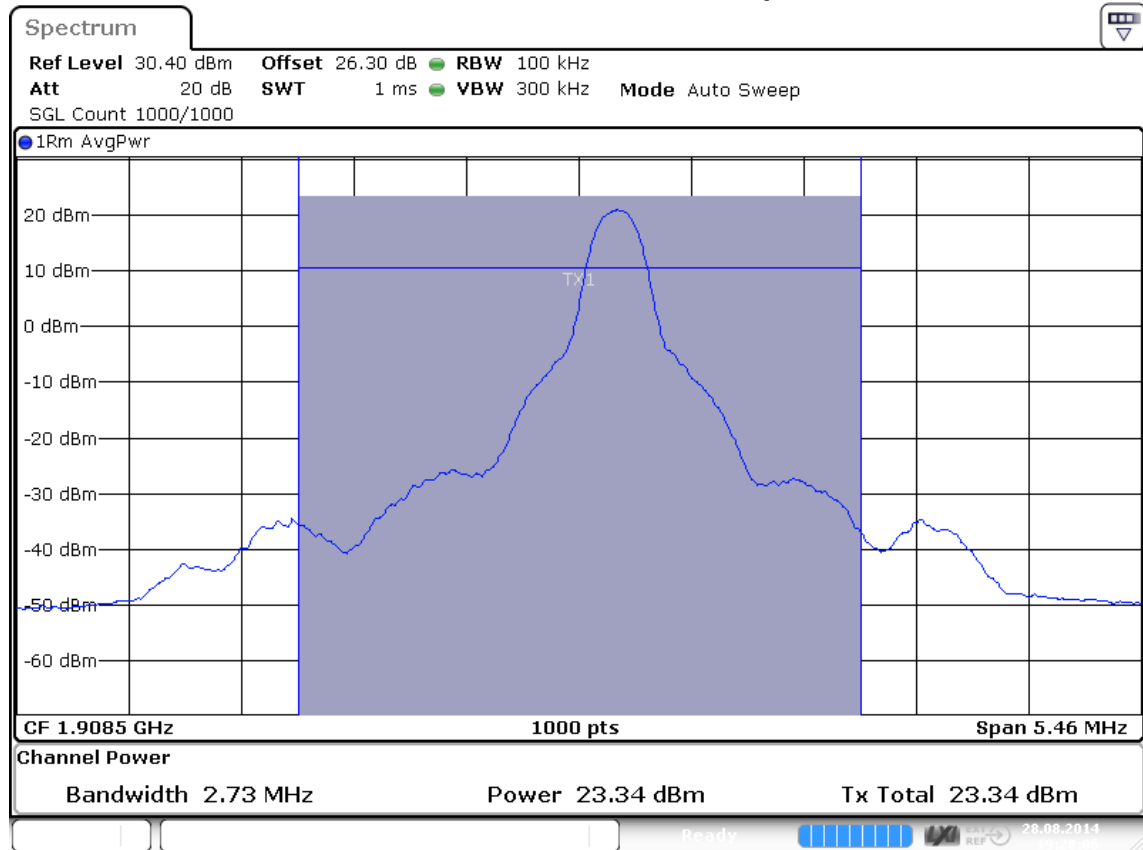
### 7.1 RF Power Output §2.1046, §24.232

Channel 19185, CBW 3MHz, RB/Offset 1/0, Modulation QPSK



Date: 28 AUG 2014 19:27:20

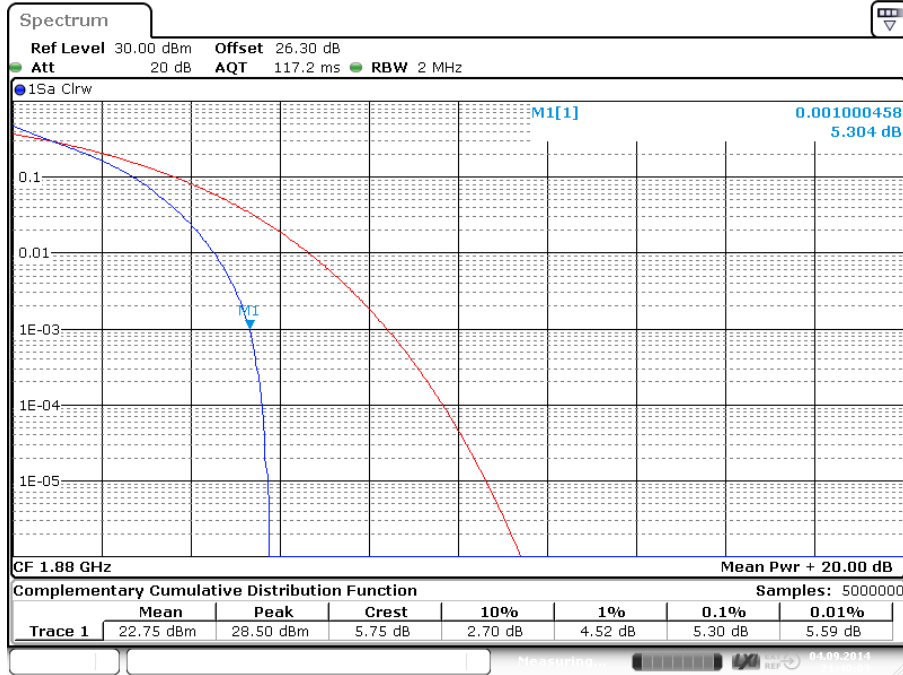
Channel 19185, CBW 3 MHz, RB/Offset 1/0, Modulation 16QAM



Date: 28 AUG 2014 19:28:05

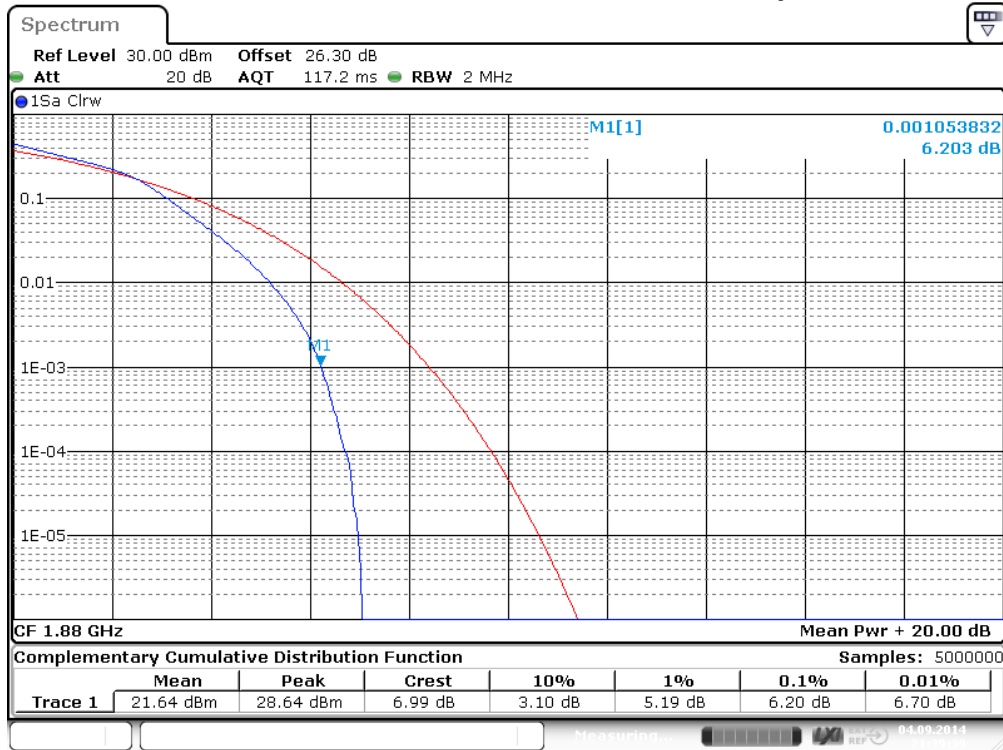
## 7.2 Peak to Average Ratio §2.1046, §24.232

Channel 18900, CBW 1.4MHz, RB/Offset 6/0, Modulation QPSK



Date: 4 SEP 2014 21:40:03

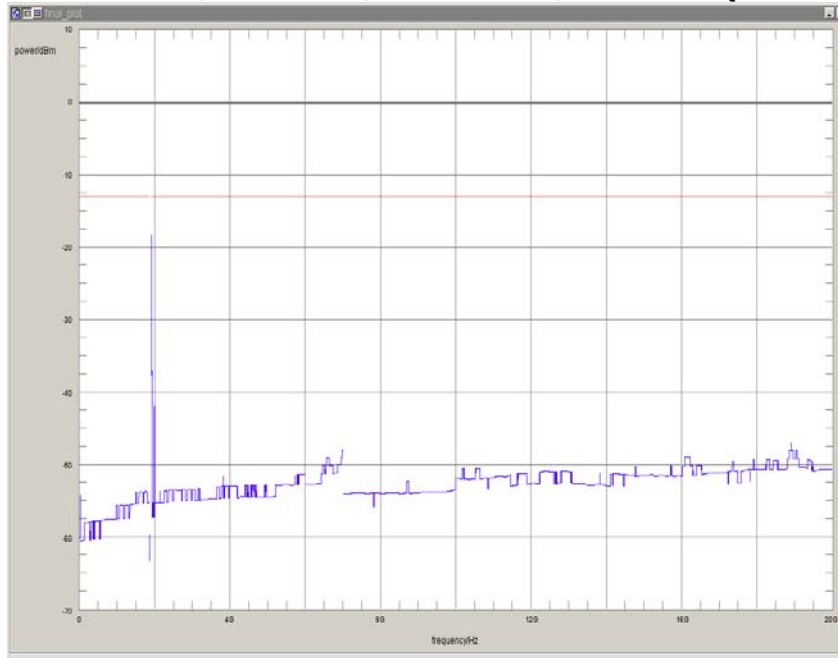
Channel 18900, CBW 1.4MHz, RB/Offset 6/0, Modulation 16QAM



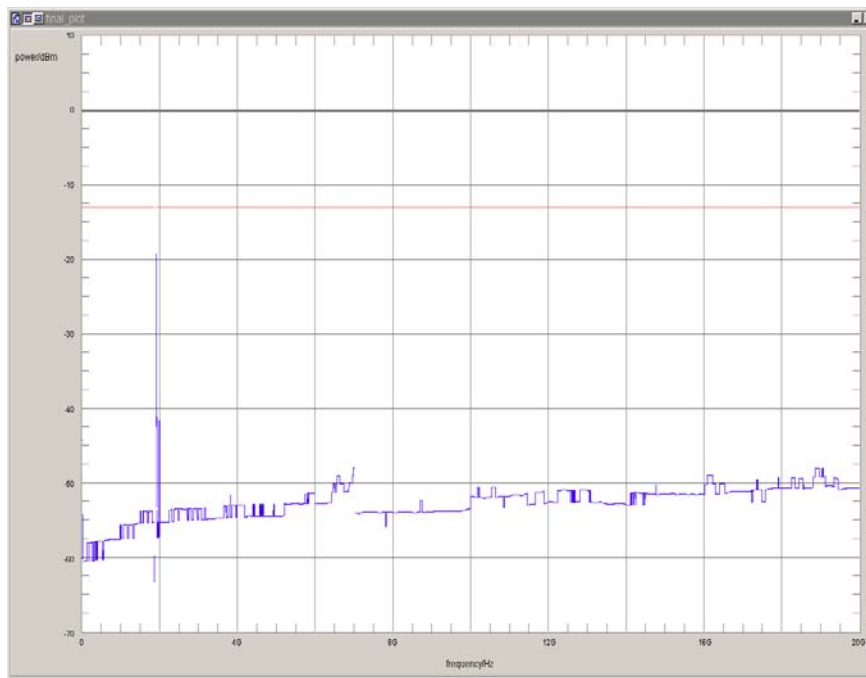
Date: 4 SEP 2014 21:39:39

### 7.3 Spurious emissions at antenna terminals §2.1051, §24.238

Channel 19175, CBW 5 MHz, RB/Offset 1/0, Modulation QPSK

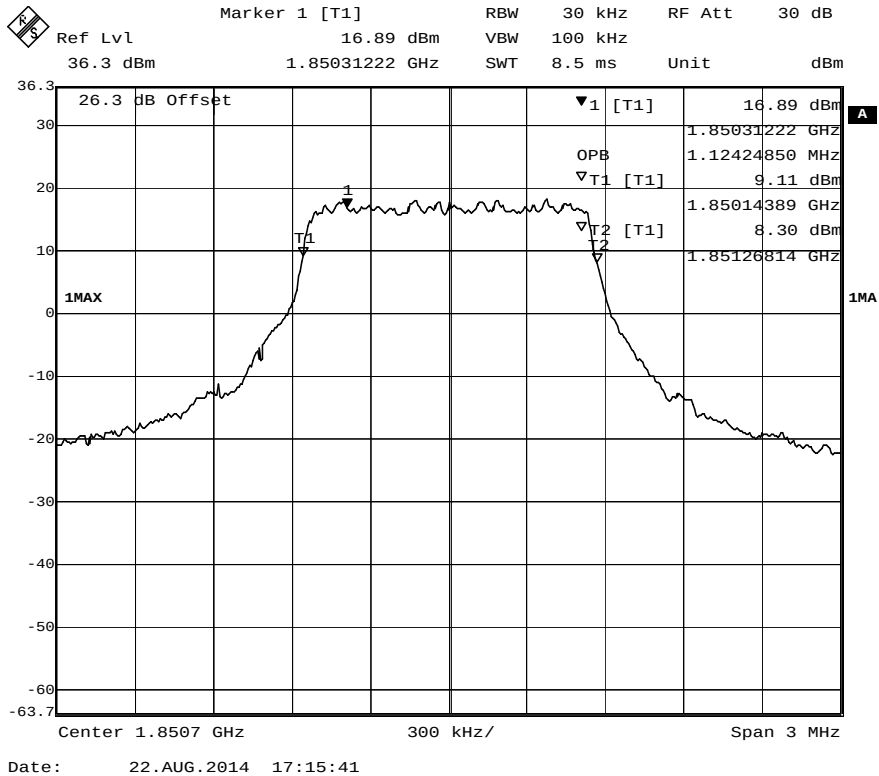


Channel 19175, CBW 5 MHz, RB/Offset 1/0, Modulation 16QAM

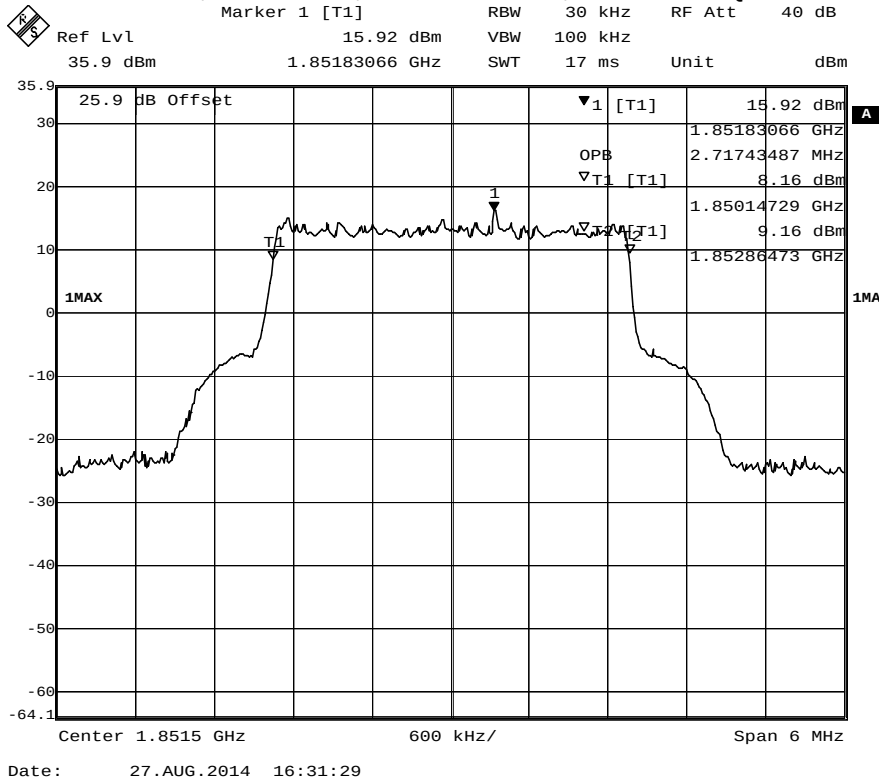


### 7.4 Emission and Occupied Bandwidth §2.1049, §24.238

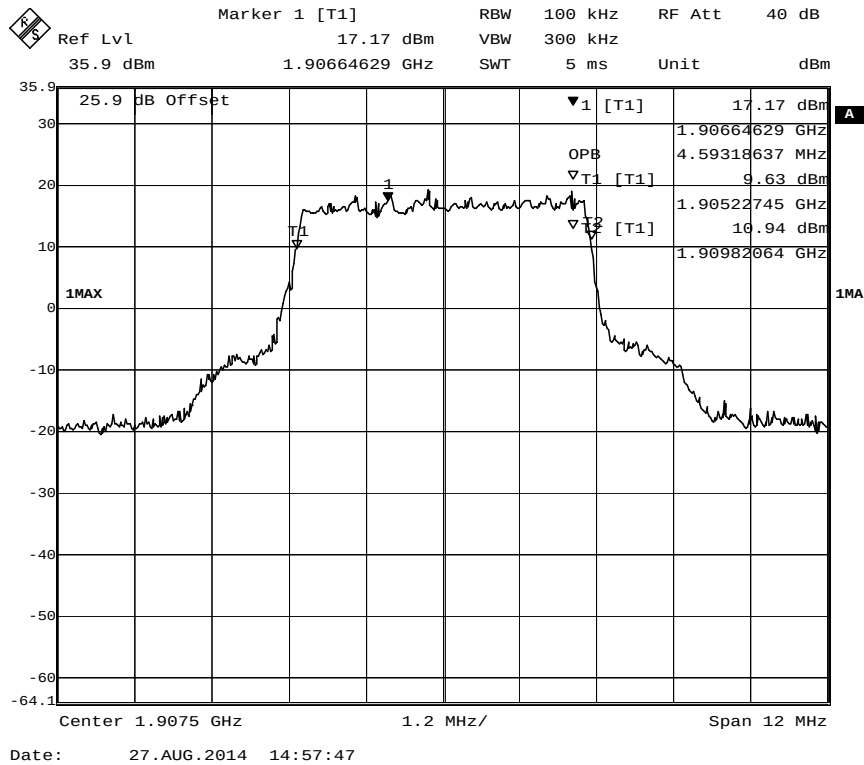
Channel 18607, CBW 1.4MHz, RB/Offset 6/0, Modulation QPSK



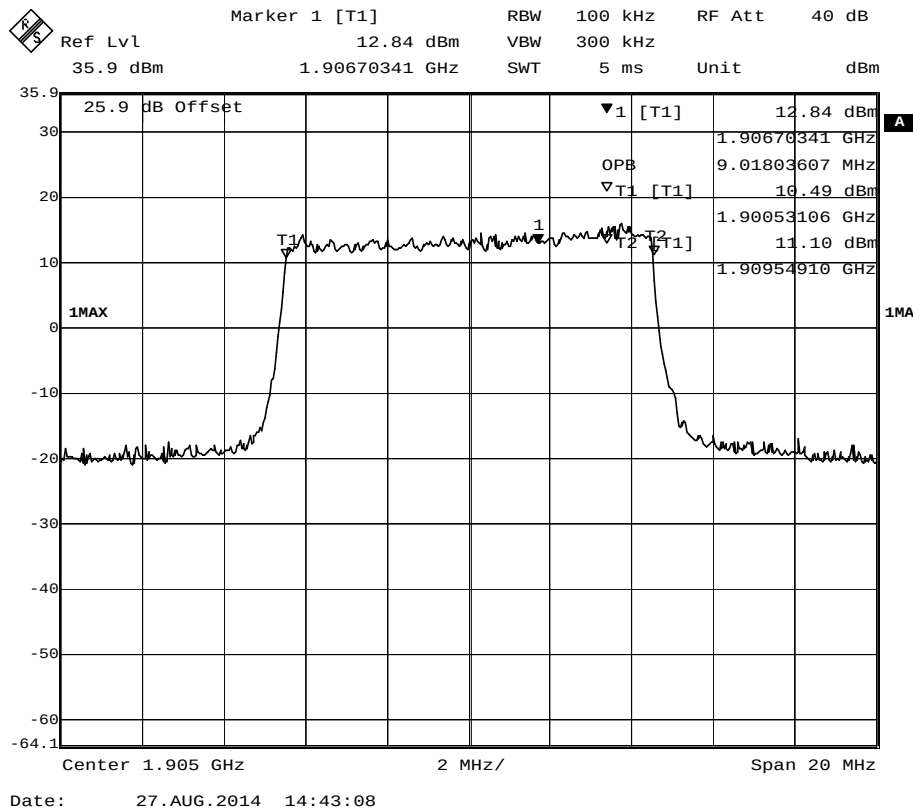
Channel 18615, CBW 3MHz, RB/Offset 15/0, Modulation QPSK



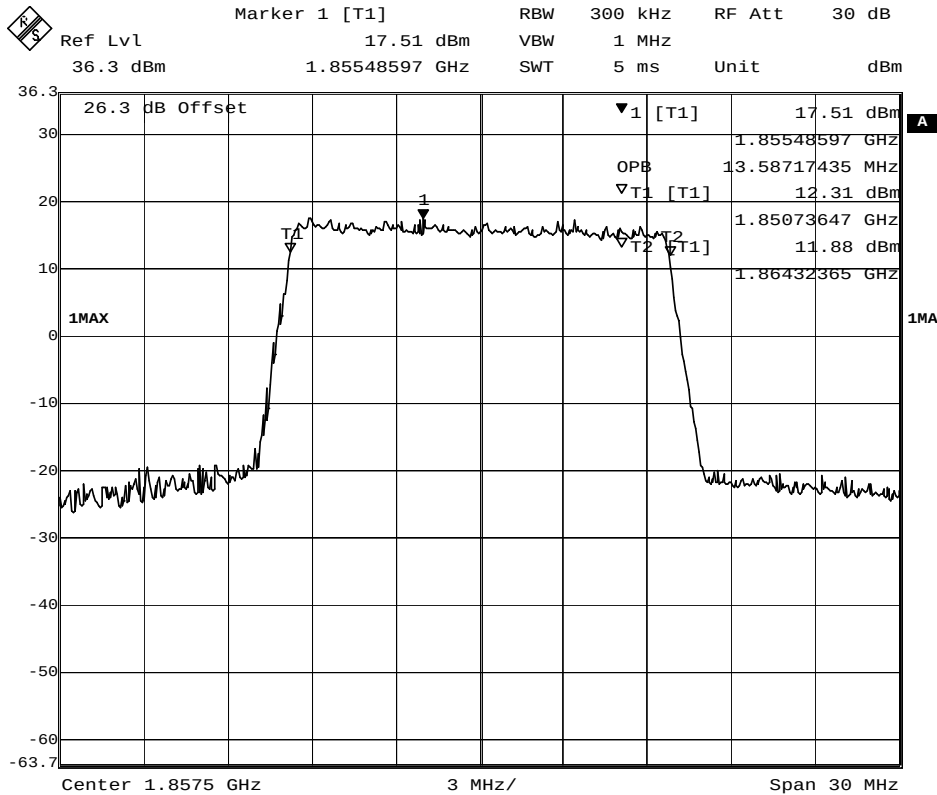
Channel 19175, CBW 5MHz, RB/Offset 25/0, Modulation QPSK



Channel 19150, CBW 10MHz, RB/Offset 50/0, Modulation QPSK

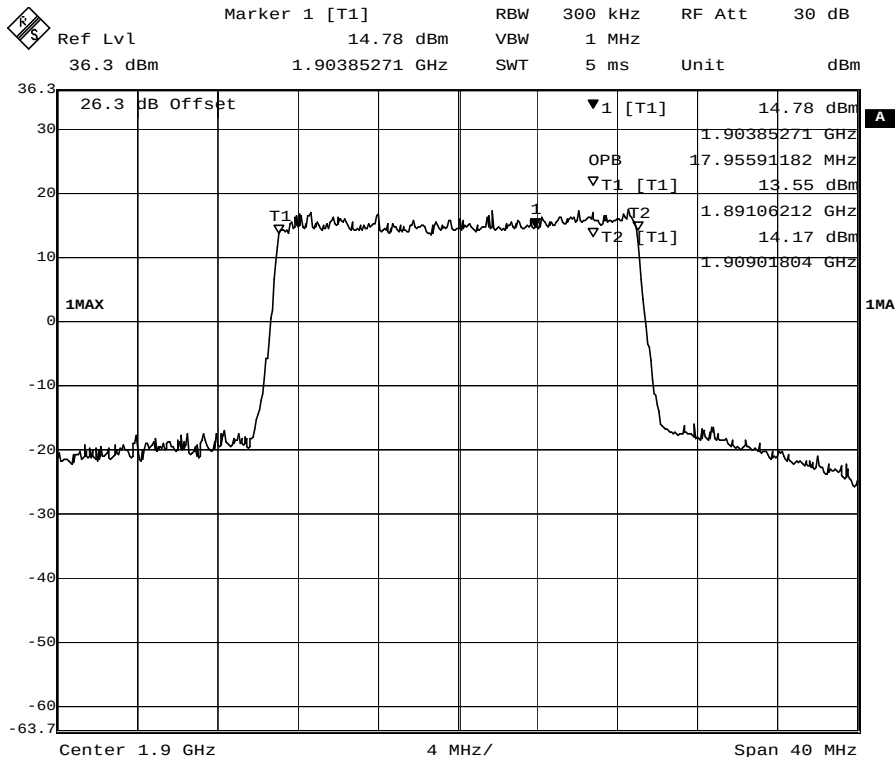


Channel 18675, CBW 15MHz, RB/Offset 75/0, Modulation QPSK



Date: 22.AUG.2014 17:26:19

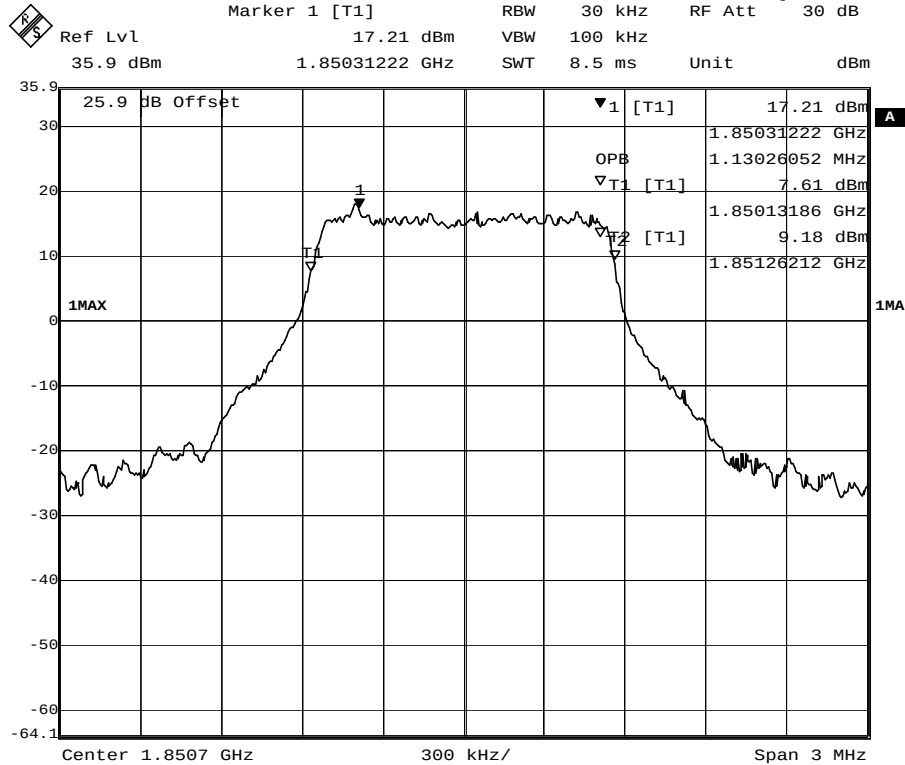
Channel 19100, CBW 20MHz, RB/Offset 100/0, Modulation QPSK



Date: 22.AUG.2014 17:35:26

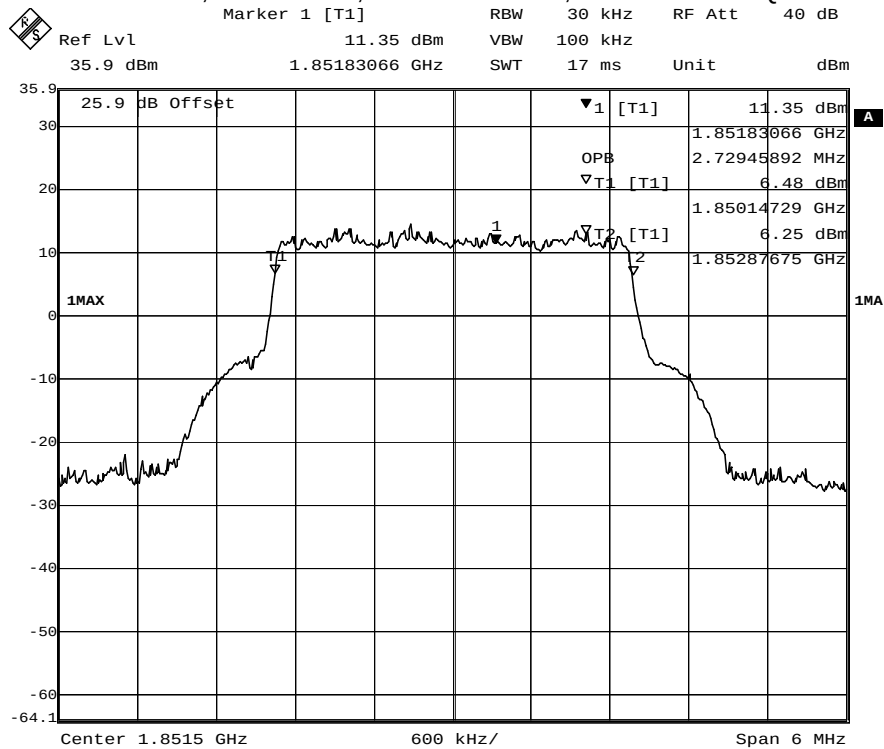


Channel 18607, CBW 1.4MHz, RB/Offset 6/0, Modulation 16QAM



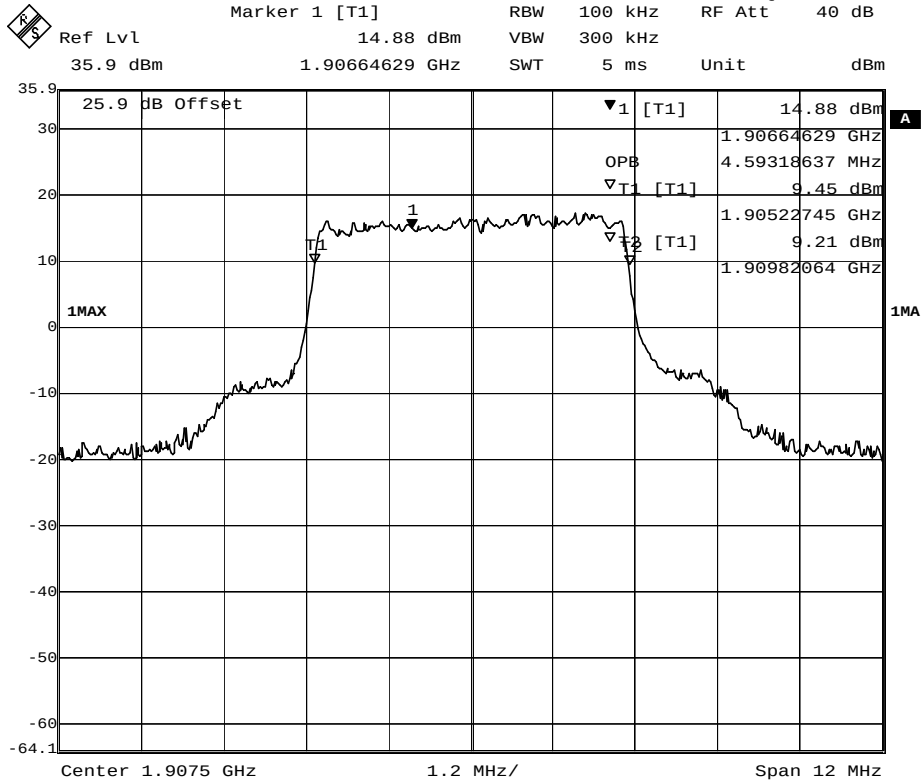
Date: 22.AUG.2014 17:11:47

Channel 18615, CBW 3MHz, RB/Offset 15/0, Modulation 16QAM



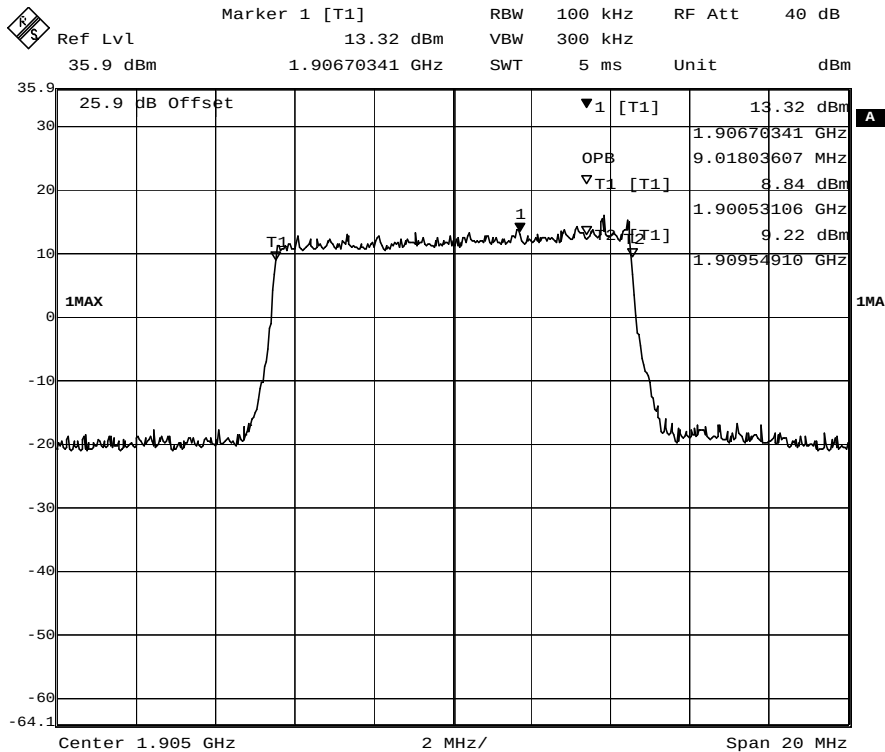
Date: 27.AUG.2014 16:33:44

Channel 19175, CBW 5MHz, RB/Offset 25/0, Modulation 16QAM



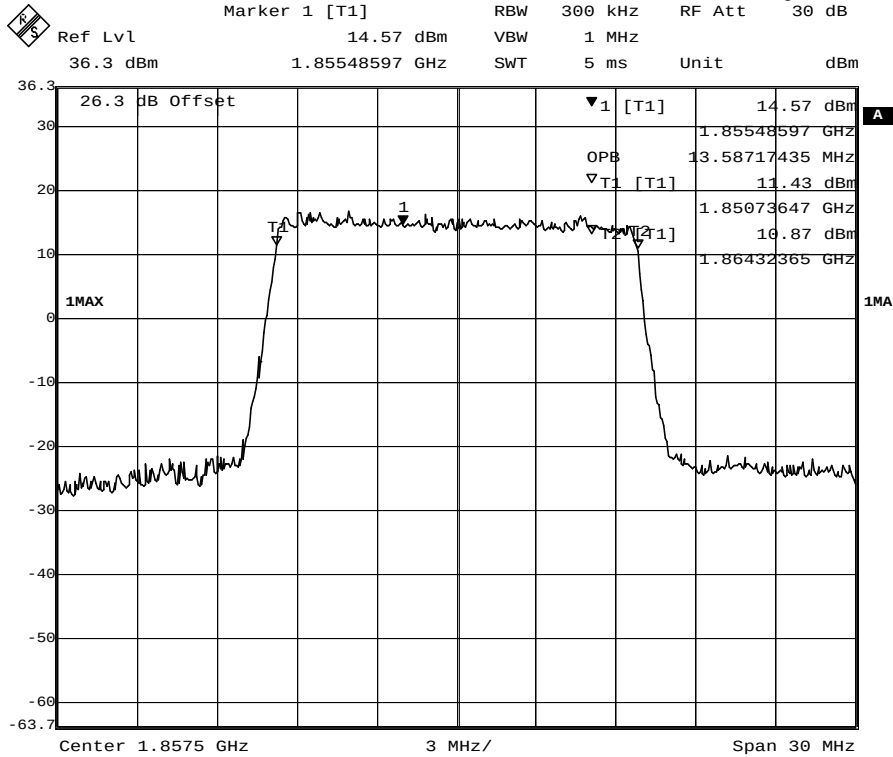
Date: 27.AUG.2014 15:01:44

Channel 19150, CBW 10MHz, RB/Offset 50/0, Modulation 16QAM



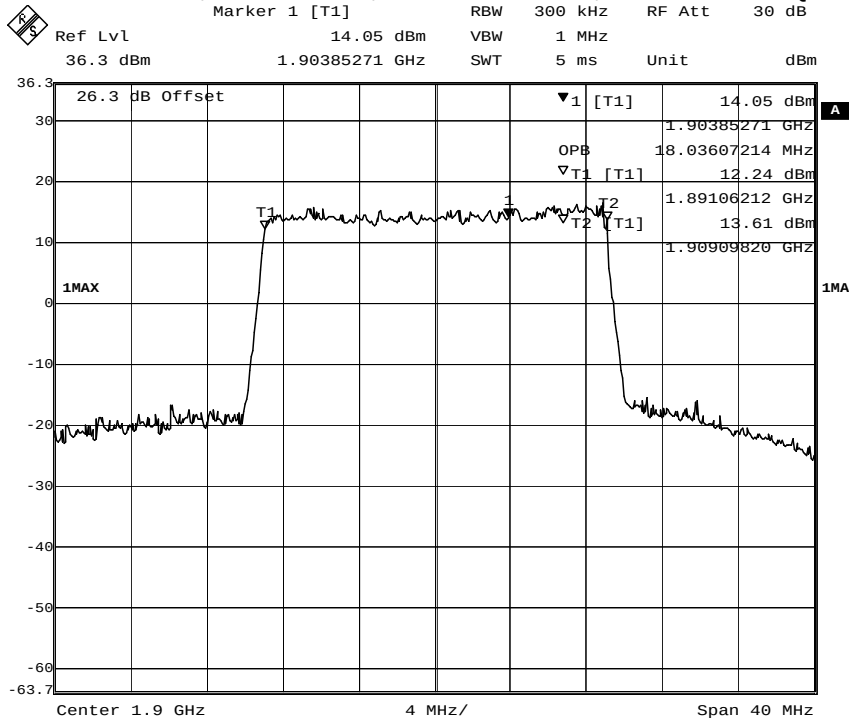
Date: 27.AUG.2014 14:41:03

Channel 18675, CBW 15MHz, RB/Offset 75/0, Modulation 16QAM



Date: 22.AUG.2014 17:27:25

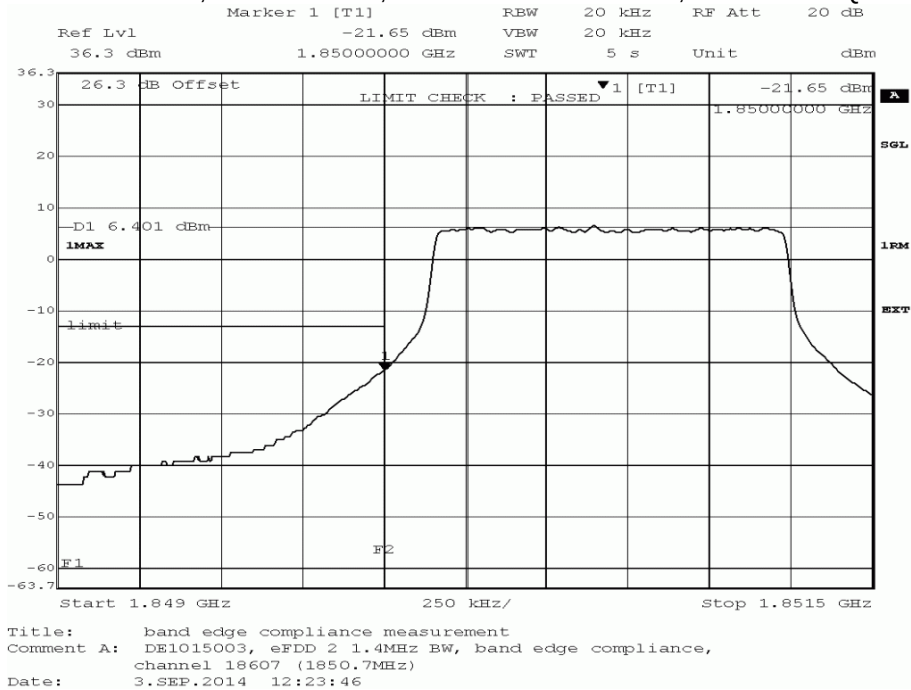
Channel 19100, CBW 20MHz, RB/Offset 100/0, Modulation 16QAM



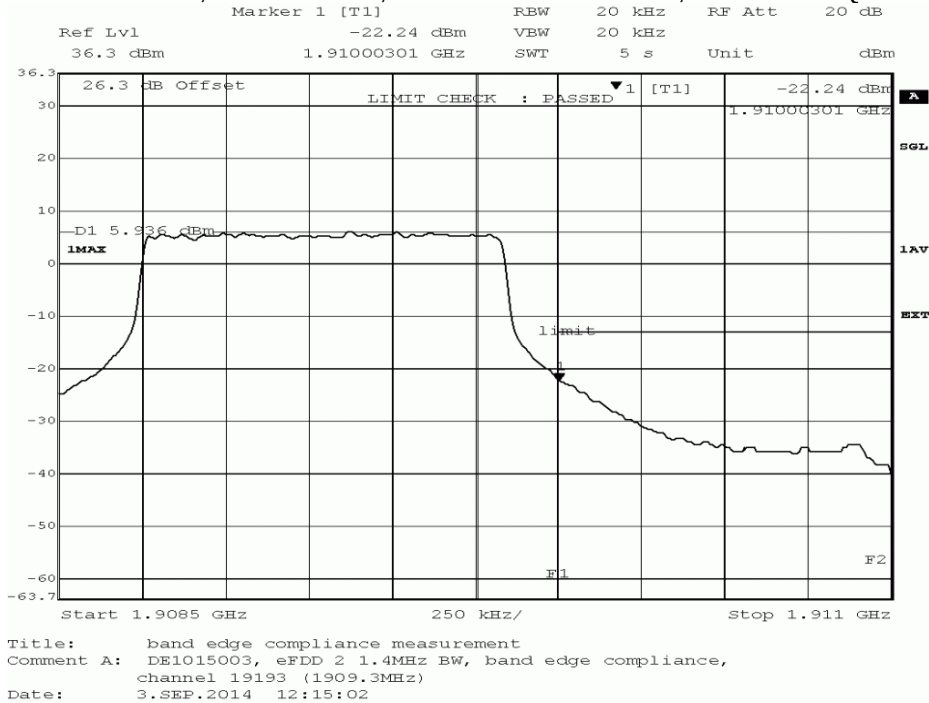
Date: 22.AUG.2014 17:37:41

## 7.5 Band edge compliance §2.1053, §24.238

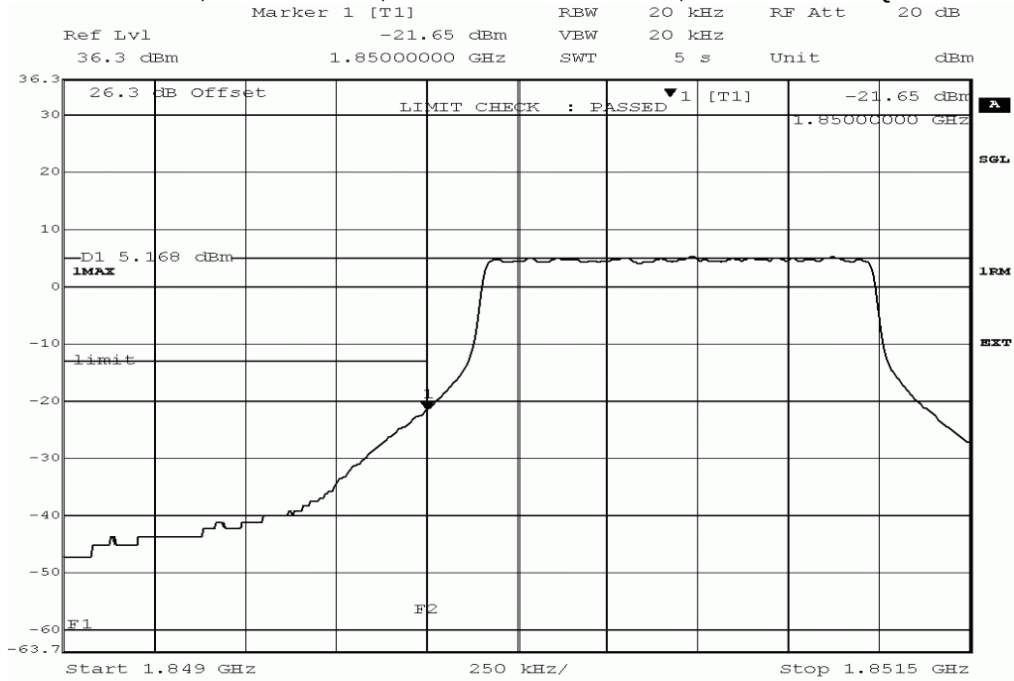
Channel 18607, CBW 1.4MHz, RB/Offset 6/Maximum, Modulation QPSK



Channel 19193, CBW 1.4MHz, RB/Offset 6/Maximum, Modulation QPSK

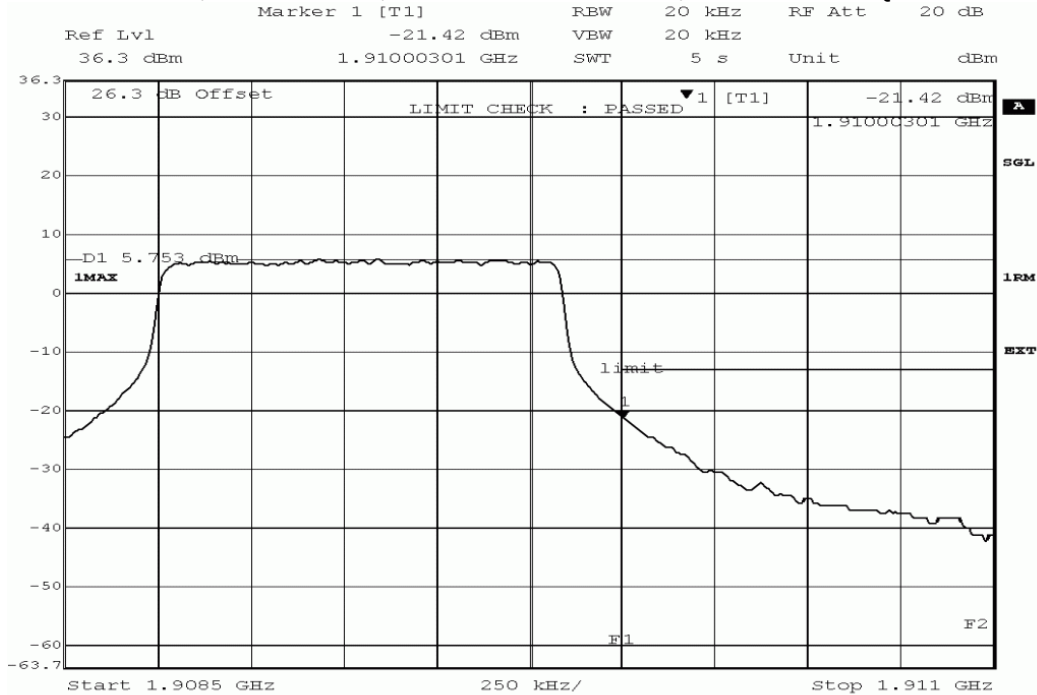


Channel 18607, CBW 1.4MHz, RB/Offset 6/Maximum, Modulation 16QAM



Title: band edge compliance measurement  
Comment A: DE1015003, eFDD 2 1.4MHz BW, band edge compliance,  
channel 18607 (1850.7MHz)  
Date: 3.SEP.2014 12:22:05

Channel 19193, CBW 1.4MHz, RB/Offset 6/Maximum, Modulation 16QAM



Title: band edge compliance measurement  
Comment A: DE1015003, eFDD 2 1.4MHz BW, band edge compliance,  
channel 19193 (1909.3MHz)  
Date: 3.SEP.2014 12:18:17