

ISED CABid: ES1909

Test Report No:  
NIE: 71232RRF.002

## Test Report

### USA FCC Part 24

### CANADA IC RSS-133

|                                           |                                                                                                                                                                                      |
|-------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| (*) Identification of item tested         | LTE Cat-M Cellular communication module in SiP packaging                                                                                                                             |
| (*) Trademark                             | Sequans Communications                                                                                                                                                               |
| (*) Model and /or type reference          | SKY66431                                                                                                                                                                             |
| Other identification of the product       | FCC ID: 2AAGM66431<br>IC: 12732A-66431                                                                                                                                               |
| (*) Features                              | LTE-M, 3GPP LTE Release 14<br>HW Version: V1<br>SW Version: LR8.0.6.1-56267                                                                                                          |
| Applicant                                 | SEQUANS COMMUNICATIONS<br>55 Boulevard Charles de Gaulle, 92700 Colombes, France                                                                                                     |
| Test method requested, standard           | USA FCC Part 24 (10-1-21 Edition).<br>CANADA RSS-133 Issue 6, Amendment 1, Jan. 2018.<br>ANSI C63.26: 2015.<br>KDB 971168 D01 Power Meas License Digital Systems v03r01, April 2018. |
| Summary                                   | IN COMPLIANCE                                                                                                                                                                        |
| Approved by (name / position & signature) | Rafael López<br>EMC Consumer & RF Lab. Manager                                                                                                                                       |
| Date of issue                             | 2022-10-25                                                                                                                                                                           |
| Report template No                        | FDT08_24<br>(*) "Data provided by the client"                                                                                                                                        |

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## Competences and guarantees

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DEKRA Testing and Certification is an FCC-recognized accredited testing laboratory with appropriate scope of accreditation that covers the performed tests in this report.

DEKRA Testing and Certification is an ISED-recognized accredited testing laboratory, CABid: ES1909, with the appropriate scope of accreditation that covers the performed tests in this report.

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The results presented in this Test Report apply only to the particular item under test established in this document.

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## General conditions

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1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities
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## Uncertainty

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Uncertainty (factor  $k=2$ ) was calculated according to the DEKRA Testing and Certification S.A.U. internal document PODT000.

## Data provided by the client

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The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested").
2. The sample of the model SKY66431 is a Most compact LTE modem and RF front-end in a single package:
  - Same chipset as GM02S module i.e. SQN3430.
  - Integrated baseband, transceiver, RF front end, RAM memory, crystals and power management.
  - 8.8 x 11.3 x 1.585 (max.) mm BGA package, 0.5 and 1 mm pitch.
  - Compliant to 3GPP Rel-14, upgradeable to 3GPP Rel-15 & 16.
  - Optimized for half-duplex operation (HD-FDD) for LTE-M.

DEKRA Testing and Certification S.A.U. declines any responsibility with respect to the information provided by the client and that may affect the validity of results.

## Usage of samples

Samples undergoing test have been selected by: The client.

- Sample S/01 is composed of the following elements:

| Control No. | Description                                              | Model    | Serial No. | Date of reception |
|-------------|----------------------------------------------------------|----------|------------|-------------------|
| 71232B/004  | LTE Cat-M Cellular communication module in SiP packaging | SKY66431 | 171        | 2022/07/14        |

Auxiliary elements used with the Sample S/01:

| Control No. | Description | Model | Serial No. | Date of reception |
|-------------|-------------|-------|------------|-------------------|
| 71605/014   | SMA Cable   | --    | --         | 2022/04/04        |
| 71605/019   | USB Cable   | --    | --         | 2022/04/04        |

Sample S/01 has undergone the following test(s): The Conducted tests indicated in Appendix A.

- Sample S/02 is composed of the following elements:

| Control No. | Description                                              | Model    | Serial No. | Date of reception |
|-------------|----------------------------------------------------------|----------|------------|-------------------|
| 71232B/004  | LTE Cat-M Cellular communication module in SiP packaging | SKY66431 | 171        | 2022/07/14        |

Auxiliary elements used with the Sample S/02:

| Control No. | Description | Model | Serial No. | Date of reception |
|-------------|-------------|-------|------------|-------------------|
| 71605/019   | USB Cable   | --    | --         | 2022/04/04        |

Sample S/02 has undergone the following test(s): The Radiated tests indicated in Appendix A.

## Test sample description

|                                               |                                                       |                                |                                     |                          |                                   |                          |                          |
|-----------------------------------------------|-------------------------------------------------------|--------------------------------|-------------------------------------|--------------------------|-----------------------------------|--------------------------|--------------------------|
| Ports.....:                                   | Port name and description                             | Cable                          |                                     |                          |                                   |                          |                          |
|                                               |                                                       | Specified max length [m]       | Attached during test                | Shielded                 | Coupled to patient <sup>(3)</sup> |                          |                          |
|                                               | USB                                                   | 2                              | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/>          |                          |                          |
|                                               | -                                                     |                                | <input type="checkbox"/>            | <input type="checkbox"/> | <input type="checkbox"/>          |                          |                          |
| Supplementary information to the ports.....:  |                                                       |                                |                                     |                          |                                   |                          |                          |
| Rated power supply .....                      | Voltage and Frequency                                 |                                | Reference poles                     |                          |                                   |                          |                          |
|                                               |                                                       |                                | L1                                  | L2                       | L3                                | N                        | PE                       |
|                                               | <input type="checkbox"/> AC:                          |                                | <input type="checkbox"/>            | <input type="checkbox"/> | <input type="checkbox"/>          | <input type="checkbox"/> | <input type="checkbox"/> |
|                                               | <input checked="" type="checkbox"/> DC: 3.3V USB port |                                |                                     |                          |                                   |                          |                          |
| Rated Power.....:                             |                                                       |                                |                                     |                          |                                   |                          |                          |
| Clock frequencies.....:                       |                                                       |                                |                                     |                          |                                   |                          |                          |
| Other parameters .....                        |                                                       |                                |                                     |                          |                                   |                          |                          |
| Software version.....: LR8.0.6.1-56267        |                                                       |                                |                                     |                          |                                   |                          |                          |
| Hardware version .....                        |                                                       |                                |                                     |                          |                                   |                          |                          |
| Dimensions in cm (W x H x D) ...:             |                                                       |                                |                                     |                          |                                   |                          |                          |
| Mounting position .....                       | <input checked="" type="checkbox"/>                   | Table top equipment            |                                     |                          |                                   |                          |                          |
|                                               | <input type="checkbox"/>                              | Wall/Ceiling mounted equipment |                                     |                          |                                   |                          |                          |
|                                               | <input type="checkbox"/>                              | Floor standing equipment       |                                     |                          |                                   |                          |                          |
|                                               | <input type="checkbox"/>                              | Hand-held equipment            |                                     |                          |                                   |                          |                          |
|                                               | <input type="checkbox"/>                              | Other:                         |                                     |                          |                                   |                          |                          |
| Modules/parts.....:                           | Module/parts of test item                             |                                | Type                                |                          | Manufacturer                      |                          |                          |
|                                               | NEKTAR-EVK                                            |                                |                                     |                          |                                   |                          |                          |
|                                               | USB Cable                                             |                                |                                     |                          |                                   |                          |                          |
|                                               | External antenna                                      |                                |                                     |                          |                                   |                          |                          |
|                                               | -                                                     |                                |                                     |                          |                                   |                          |                          |
| Accessories (not part of the test item) ..... | Description                                           |                                | Type                                |                          | Manufacturer                      |                          |                          |
|                                               | -                                                     |                                |                                     |                          |                                   |                          |                          |
|                                               | -                                                     |                                |                                     |                          |                                   |                          |                          |
| Documents as provided by the applicant .....  | Description                                           |                                | File name                           |                          | Issue date                        |                          |                          |
|                                               | -                                                     |                                |                                     |                          |                                   |                          |                          |
|                                               | -                                                     |                                |                                     |                          |                                   |                          |                          |

(3) Only for Medical Equipment

## Identification of the client

SEQUANS COMMUNICATIONS  
55 Boulevard Charles de Gaulle, 92700 Colombes, France

## Testing period and place

|               |                                        |
|---------------|----------------------------------------|
| Test Location | DEKRA Testing and Certification S.A.U. |
| Date (start)  | 2022-07-25                             |
| Date (finish) | 2022-09-15                             |

## Document history

| Report number | Date       | Description    |
|---------------|------------|----------------|
| 71232RRF.002  | 2022-10-25 | First release. |

## Environmental conditions

---

In the control chamber, the following limits were not exceeded during the test:

|                          |                              |
|--------------------------|------------------------------|
| <b>Temperature</b>       | Min. = 15 °C<br>Max. = 35 °C |
| <b>Relative humidity</b> | Min. = 20 %<br>Max. = 75 %   |

In the semi-anechoic chamber, the following limits were not exceeded during the test:

|                          |                              |
|--------------------------|------------------------------|
| <b>Temperature</b>       | Min. = 15 °C<br>Max. = 35 °C |
| <b>Relative humidity</b> | Min. = 20 %<br>Max. = 75 %   |

In the chamber for conducted measurements, the following limits were not exceeded during the test:

|                          |                              |
|--------------------------|------------------------------|
| <b>Temperature</b>       | Min. = 15 °C<br>Max. = 35 °C |
| <b>Relative humidity</b> | Min. = 20 %<br>Max. = 75 %   |

## Remarks and comments

The tests have been performed by the technical personnel: Miguel Manuel López, José Manuel Jiménez.

Used instrumentation:

### Conducted Measurements

|                                                                    | Last Calibration | Due Calibration |
|--------------------------------------------------------------------|------------------|-----------------|
| 1. Shielded Room ETS LINDGREN S101                                 | N/A              | N/A             |
| 2. Wideband Radio Communication Tester<br>ROHDE AND SCHWARZ CMW500 | 2021/09          | 2023/09         |
| 3. Signal Analyzer 20 Hz to 8 GHz ROHDE AND<br>SCHWARZ FSQ8        | 2020/10          | 2022/10         |
| 4. Spectrum analyser Rohde & Schwarz FSV40                         | 2021/10          | 2023/10         |
| 5. Climatic chamber HERAEUS VMT 04/35                              | 2022/07          | 2024/07         |
| 6. DC Power Supply Keysight Technologies<br>U8002A                 | N/A              | N/A             |
| 7. Digital multimeter FLUKE 179                                    | 2021/11          | 2022/11         |

### Radiated Measurements

|                                                                            | Last Calibration | Due Calibration |
|----------------------------------------------------------------------------|------------------|-----------------|
| 1. Semianechoic Absorber Lined Chamber ETS<br>LINDGREN FACT 3 200 STP      | N/A              | N/A             |
| 2. Shielded Room ETS LINDGREN S101                                         | N/A              | N/A             |
| 3. Biconical/Log Antenna 30 MHz - 6 GHz ETS<br>LINDGREN 3142E              | 2020/04          | 2023/04         |
| 4. Horn Antenna 1-18 GHz SCHWARZBECK<br>MESS-ELEKTRONIK BBHA 9120 D        | 2019/11          | 2022/11         |
| 5. RF Preamplifier, 40 dB ,1-18 GHz BONN<br>ELEKTRONIK BLMA 0118-1M        | 2022/07          | 2023/07         |
| 6. HORN ANTENNA 18-40GHz SCHWARZBECK<br>BBHA 9170                          | 2020/05          | 2023/05         |
| 7. PRE-AMPLIFIER G>30dB 17-40GHz BONN<br>ELEKTRONIK BLMA 1840-4A           | 09/2021          | 09/2022         |
| 8.. Signal and Spectrum Analyzer 10 Hz - 40 GHz<br>ROHDE AND SCHWARZ FSV40 | 2022/05          | 2024/05         |
| 9. EMI Test Receiver 7 GHz ROHDE AND<br>SCHWARZ ESR7                       | 2021/11          | 2023/11         |
| 10. Wideband Radio Communication Tester<br>ROHDE AND SCHWARZ CMW500        | N/A              | N/A             |
| 11. EMC/RF Test SW ROHDE AND SCHWARZ<br>EMC32                              | N/A              | N/A             |



## Testing verdicts

|                 |     |
|-----------------|-----|
| Not applicable: | N/A |
| Pass:           | P   |
| Fail:           | F   |
| Not measured:   | N/M |

## Summary

| FCC PART 24 / RSS-133                                             |         |        |
|-------------------------------------------------------------------|---------|--------|
| Requirement – Test case                                           | Verdict | Remark |
| FCC 24.232 / RSS-133 6.4: RF Output Power                         | P       |        |
| FCC 2.1047 / RSS-133 6.2: Modulation Characteristics              | P       |        |
| FCC 24.235 / RSS-133 6.3: Frequency Stability                     | P       |        |
| FCC 2.1049 Occupied Bandwidth                                     | P       |        |
| FCC 24.238 / RSS-133 6.5: Spurious Emissions at Antenna Terminals | P       |        |
| FCC 24.238 / RSS-133 6.5: Radiated Emissions                      | P       |        |
| <u>Supplementary information and remarks:</u>                     |         |        |
| None.                                                             |         |        |

## Appendix A: Test results for FCC Part 24 / RSS-133

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## TEST CONDITIONS

(\*): Data provided by the applicant.

### POWER SUPPLY (\*):

Vnormal: 3.3 Vdc (\*)

Vminimum: 2.805 Vdc

Vmaximum: 3.795 Vdc

Type of Power Supply: USB.

### ANTENNA (\*):

Device with external and internal antennas.

After a preliminary scan, the determined worst case for the Radiated tests is the internal antenna.

For the Conducted tests, the gain of the internal antenna is used.

Declared Gain for antennas:

| Middle bands       | Gain (dBi) | Antenna type |
|--------------------|------------|--------------|
| LTE Bands 2 and 25 | +2.4       | Internal     |
|                    | +2.1       | External     |

### TEST FREQUENCIES:

#### LTE Band 2. QPSK AND 16QAM MODULATIONS:

| Channel per Nominal Bandwidth (Frequency, MHz) |                     |                   |                   |                 |                   |                 |
|------------------------------------------------|---------------------|-------------------|-------------------|-----------------|-------------------|-----------------|
|                                                | BW = 1.4 MHz<br>(*) | BW = 3 MHz<br>(*) | BW = 5 MHz        | BW = 10 MHz     | BW = 15 MHz       | BW = 20 MHz     |
| Low                                            | 18607<br>(1850.7)   | 18615<br>(1851.5) | 18625<br>(1852.5) | 18650<br>(1855) | 18675<br>(1857.5) | 18700<br>(1860) |
| Middle                                         | 18900<br>(1880)     | 18900<br>(1880)   | 18900<br>(1880)   | 18900<br>(1880) | 18900<br>(1880)   | 18900<br>(1880) |
| High                                           | 19193<br>(1909.3)   | 19185<br>(1908.5) | 19175<br>(1907.5) | 19150<br>(1905) | 19125<br>(1902.5) | 19100<br>(1900) |

(\*) The EUT does not support the Nominal Bandwidths 1.4 MHz, 3 MHz.

LTE Band 25. QPSK AND 16QAM MODULATIONS:

|        | Channel per Nominal Bandwidth (Frequency, MHz) |                   |                   |                   |                   |                   |
|--------|------------------------------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
|        | BW = 1.4 MHz<br>(*)                            | BW = 3 MHz<br>(*) | BW = 5 MHz        | BW = 10 MHz       | BW = 15 MHz       | BW = 20 MHz       |
| Low    | 26047<br>(1850.7)                              | 26055<br>(1851.5) | 26065<br>(1852.5) | 26090<br>(1855)   | 26115<br>(1857.5) | 26140<br>(1860)   |
| Middle | 26365<br>(1882.5)                              | 26365<br>(1882.5) | 26365<br>(1882.5) | 26365<br>(1882.5) | 26365<br>(1882.5) | 26365<br>(1882.5) |
| High   | 26683<br>(1914.3)                              | 26675<br>(1913.5) | 26665<br>(1912.5) | 26640<br>(1910)   | 26615<br>(1907.5) | 26590<br>(1905)   |

(\*) The EUT does not support the Nominal Bandwidths 1.4 MHz, 3 MHz.

NOTE: Band 2 is completely included in band 25, so the channels of band 25 were tested to give conformity to the assigned block.

## RF Output Power

### SPECIFICATION

FCC §2.1046 and §24.232:

Mobile/portable stations are limited to 2 Watts (33 dBm) Effective Isotropic Radiated Power (E.I.R.P.).  
The peak-to-average ratio (PAR) of the transmission shall not exceed 13 dB.

RSS-133. Clause 6.4:

The peak-to-average power ratio (PAPR) shall not exceed 13 dB for more than 0.1% of the time using a signal corresponding to the highest PAPR during periods of continuous transmission.

### METHOD

The conducted RF output power measurements were made at the RF output terminals of the EUT using the power meter of the Universal Radio Communication tester R&S CMW500, selecting maximum transmission power of the EUT and different modes of modulation.

The maximum equivalent isotropically radiated power (e.i.r.p.) is calculated by adding the declared maximum antenna gain (dBi).

The maximum effective radiated power e.r.p. is calculated from the maximum equivalent isotropically radiated power (e.i.r.p.) by subtracting 2.15 dB:

$$E.R.P. = E.I.R.P. - 2.15 \text{ dB}$$

The peak-to-average power ratio (PAPR) is measured using an attenuator, power splitter and spectrum analyser with a Complementary Cumulative Distribution Function implemented.

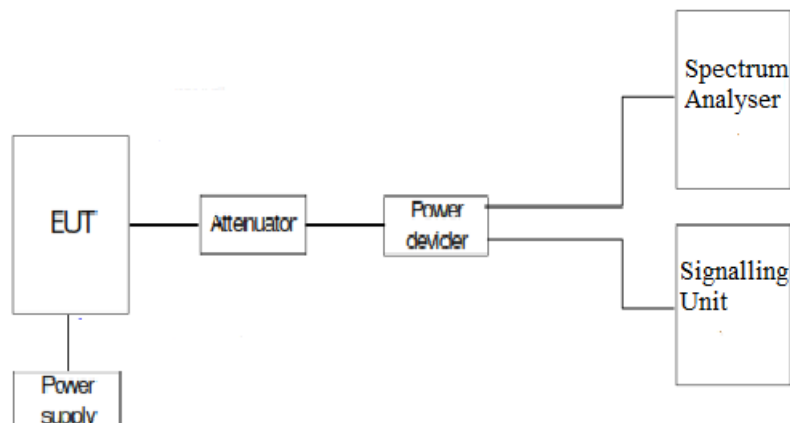
The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation.

### TEST SETUP

#### 1. CONDUCTED AVERAGE POWER:



#### 2. PEAK-TO-AVERAGE POWER RATIO (PAPR):



## RESULTS

### LTE BAND 25:

#### 1. CONDUCTED AVERAGE POWER:

LTE Band 25. QPSK MODULATION. Bandwidth = 5 MHz.

| Channel                                                          | Low    | Middle | High  |
|------------------------------------------------------------------|--------|--------|-------|
| Maximum declared antenna gain (dBi)                              | 2.40   |        |       |
| Measured maximum average power (dBm) at antenna port             | 22.64  | 23.10  | 23.05 |
| Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm) | 25.04  | 25.50  | 25.45 |
| Maximum effective radiated power E.R.P. (dBm)                    | 22.89  | 23.35  | 23.30 |
| PAPR (dB)                                                        | (*)    |        |       |
| Measurement uncertainty (dB)                                     | <±0.66 |        |       |

Average Power Worst Case: Modulation QPSK. RB Size: 1. RB Offset: 0. Narrow Band: 0.

(\*): Preliminary measurements determined 16QAM as the worst-case modulation in terms of PAPR.

LTE Band 25. 16QAM MODULATION. Bandwidth = 5 MHz.

| Channel                                                          | Low    | Middle | High  |
|------------------------------------------------------------------|--------|--------|-------|
| Maximum declared antenna gain (dBi)                              | 2.40   |        |       |
| Measured maximum average power (dBm) at antenna port             | 22.53  | 22.98  | 22.83 |
| Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm) | 24.93  | 25.38  | 25.23 |
| Maximum effective radiated power E.R.P. (dBm)                    | 22.78  | 23.23  | 23.08 |
| PAPR (dB)                                                        | 6.01   | 6.14   | 7.16  |
| Measurement uncertainty (dB)                                     | <±0.66 |        |       |

Average Power Worst Case: Modulation 16QAM. RB Size: 1. RB Offset: 0. Narrow Band: 0.

PAPR Worst Case Modulation 16QAM. RB Size: 5. RB Offset: 0. Narrow Band: 0.

LTE Band 25. QPSK MODULATION. Bandwidth = 10 MHz.

| Channel                                                          | Low    | Middle | High  |
|------------------------------------------------------------------|--------|--------|-------|
| Maximum declared antenna gain (dBi)                              | 2.40   |        |       |
| Measured maximum average power (dBm) at antenna port             | 22.59  | 23.11  | 22.96 |
| Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm) | 24.99  | 25.51  | 25.36 |
| Maximum effective radiated power E.R.P. (dBm)                    | 22.84  | 23.36  | 23.21 |
| PAPR (dB)                                                        | (*)    |        |       |
| Measurement uncertainty (dB)                                     | <±0.66 |        |       |

Average Power Worst Case: Modulation QPSK. RB Size: 1. RB Offset: 0. Narrow Band: 0.

(\*): Preliminary measurements determined 16QAM as the worst-case modulation in terms of PAPR.

LTE Band 25. 16QAM MODULATION. Bandwidth = 10 MHz.

| Channel                                                          | Low    | Middle | High  |
|------------------------------------------------------------------|--------|--------|-------|
| Maximum declared antenna gain (dBi)                              | 2.40   |        |       |
| Measured maximum average power (dBm) at antenna port             | 22.49  | 23.05  | 22.84 |
| Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm) | 24.89  | 25.45  | 25.24 |
| Maximum effective radiated power E.R.P. (dBm)                    | 22.74  | 23.30  | 23.09 |
| PAPR (dB)                                                        | 5.85   | 6.06   | 5.79  |
| Measurement uncertainty (dB)                                     | <±0.66 |        |       |

Average Power Worst Case: Modulation 16QAM. RB Size: 1. RB Offset: 0. Narrow Band: 0.

PAPR Worst Case: Modulation 16QAM. RB Size: 5. RB Offset: 0. Narrow Band: 0.



LTE Band 25. QPSK MODULATION. Bandwidth = 15 MHz.

| Channel                                                          | Low    | Middle | High  |
|------------------------------------------------------------------|--------|--------|-------|
| Maximum declared antenna gain (dBi)                              | 2.40   |        |       |
| Measured maximum average power (dBm) at antenna port             | 22.81  | 23.21  | 23.16 |
| Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm) | 25.21  | 25.61  | 25.56 |
| Maximum effective radiated power E.R.P. (dBm)                    | 23.06  | 23.46  | 23.41 |
| PAPR (dB)                                                        | 3.85   | 4.84   | 4.57  |
| Measurement uncertainty (dB)                                     | <±0.66 |        |       |

Average Power Worst Case: Modulation QPSK. RB Size: 6. RB Offset: 0. Narrow Band: 0.

PAPR Worst Case: Modulation QPSK. RB Size: 1. RB Offset: 0. Narrow Band: 0.

LTE Band 25. 16QAM MODULATION. Bandwidth = 15 MHz.

| Channel                                                          | Low    | Middle | High  |
|------------------------------------------------------------------|--------|--------|-------|
| Maximum declared antenna gain (dBi)                              | 2.40   |        |       |
| Measured maximum average power (dBm) at antenna port             | 22.67  | 23.04  | 22.96 |
| Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm) | 25.07  | 25.44  | 25.36 |
| Maximum effective radiated power E.R.P. (dBm)                    | 22.92  | 23.29  | 23.21 |
| PAPR (dB)                                                        | (*)    |        |       |
| Measurement uncertainty (dB)                                     | <±0.66 |        |       |

Average Power Worst Case: Modulation 16QAM. RB Size: 5. RB Offset: 0. Narrow Band: 0.

(\*): Preliminary measurements determined QPSK as the worst-case modulation in terms of PAPR.

LTE Band 25. QPSK MODULATION. Bandwidth = 20 MHz.

| Channel                                                          | Low    | Middle | High  |
|------------------------------------------------------------------|--------|--------|-------|
| Maximum declared antenna gain (dBi)                              | 2.40   |        |       |
| Measured maximum average power (dBm) at antenna port             | 23.19  | 23.26  | 23.73 |
| Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm) | 25.59  | 25.66  | 26.13 |
| Maximum effective radiated power E.R.P. (dBm)                    | 23.44  | 23.51  | 23.98 |
| PAPR (dB)                                                        | (*)    |        |       |
| Measurement uncertainty (dB)                                     | <±0.66 |        |       |

Average Power Worst Case: Modulation QPSK. RB Size: 6. RB Offset: 0. Narrow Band: 0.

(\*): Preliminary measurements determined 16QAM as the worst-case modulation in terms of PAPR.

LTE Band 25. 16QAM MODULATION. Bandwidth = 20 MHz.

| Channel                                                          | Low    | Middle | High  |
|------------------------------------------------------------------|--------|--------|-------|
| Maximum declared antenna gain (dBi)                              | 2.40   |        |       |
| Measured maximum average power (dBm) at antenna port             | 23.08  | 23.04  | 23.60 |
| Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm) | 25.48  | 25.44  | 26.00 |
| Maximum effective radiated power E.R.P. (dBm)                    | 23.33  | 23.29  | 23.85 |
| PAPR (dB)                                                        | 5.02   | 5.06   | 2.72  |
| Measurement uncertainty (dB)                                     | <±0.66 |        |       |

Average Power Worst Case: Modulation 16QAM. RB Size: 5. RB Offset: 0. Narrow Band: 0.

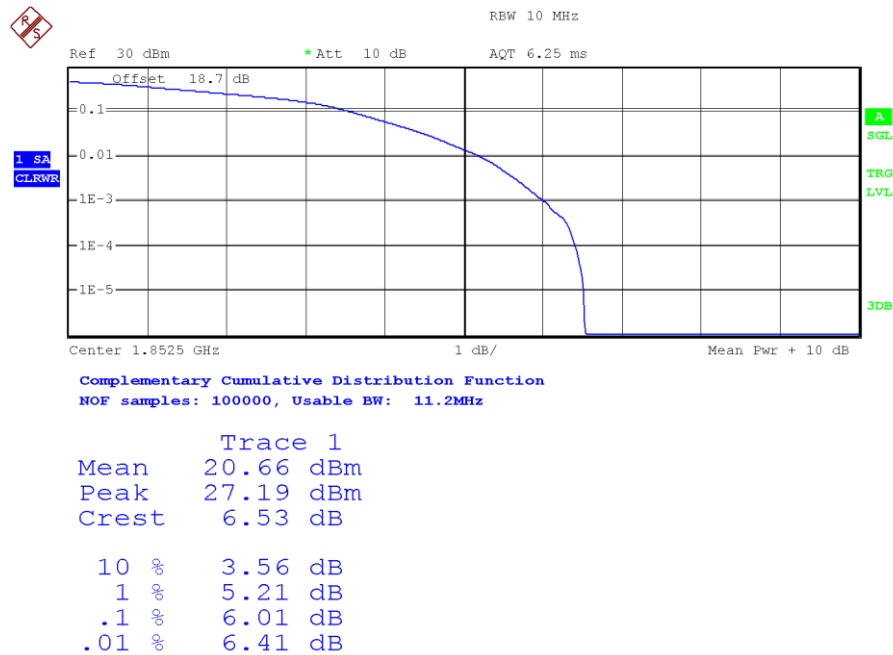
Worst case PAPR: Modulation 16QAM. RB Size: 5. RB Offset: 0. Narrow Band: 0.

2. PEAK-TO-AVERAGE POWER RATIO (PAPR):

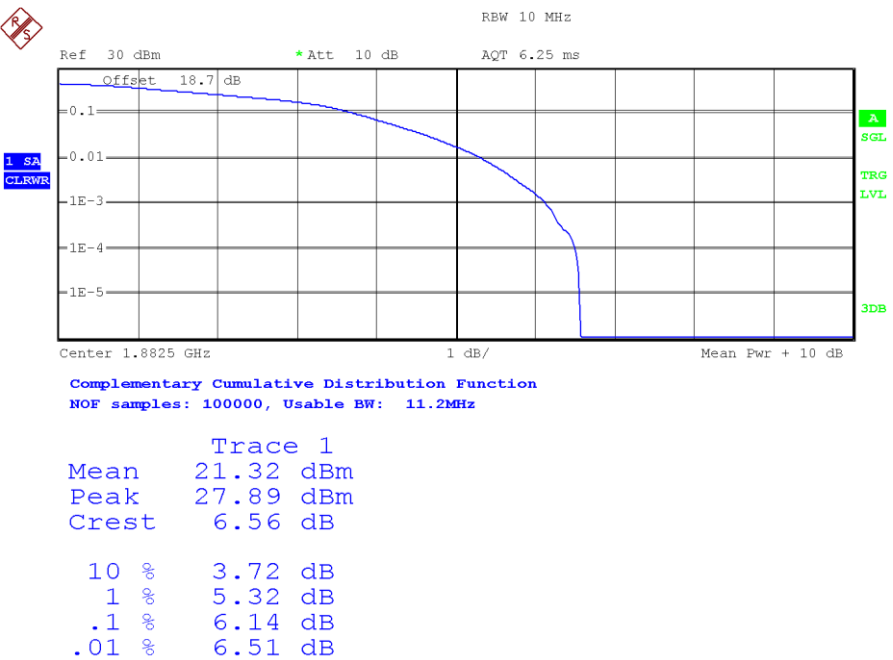
The next results are for the worst-case configuration.

LTE Band 25. Bandwidth = 5 MHz. Modulation 16 QAM. RB Size: 5. RB Offset: 0. Narrow Band: 0.

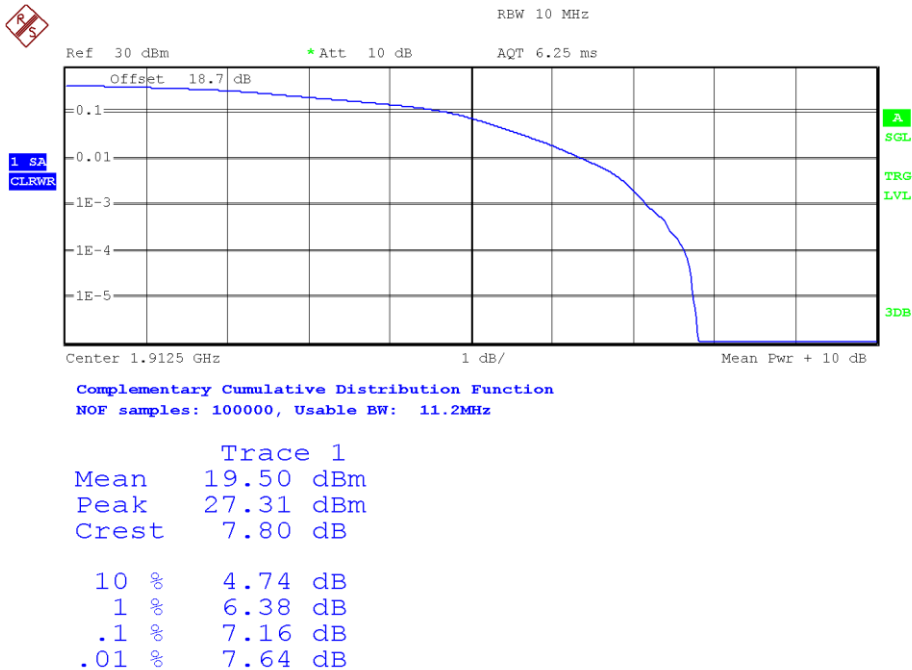
Low Channel:



Middle Channel:



High Channel:



| Channel                      | Measured maximum average power (dBm) at antenna port | Maximum declared antenna gain (dBi) | Maximum equivalent isotropically radiated power (E.I.R.P.) (dBm) | Maximum effective radiated power E.R.P. (dBm) | PAPR (dB) |
|------------------------------|------------------------------------------------------|-------------------------------------|------------------------------------------------------------------|-----------------------------------------------|-----------|
| Low                          | 23.19                                                | 2.40                                | 25.59                                                            | 23.44                                         | 6.01      |
| Middle                       | 23.26                                                |                                     | 25.66                                                            | 23.51                                         | 6.14      |
| High                         | 23.73                                                |                                     | 26.13                                                            | 23.98                                         | 7.16      |
| Measurement uncertainty (dB) | <±0.66                                               |                                     |                                                                  |                                               |           |

Verdict: PASS

## Frequency Stability

### SPECIFICATION

FCC §2.1055 and §24.235. The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block.

RSS-133, Clause 6.3. The carrier frequency shall not depart from the reference frequency in excess of  $\pm 2.5$  ppm for mobile stations.

### METHOD

The frequency tolerance measurements over temperature variations were made over the temperature range of  $-30^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$ . The EUT was placed inside a climatic chamber and the temperature was raised hourly in  $10^{\circ}\text{C}$  steps from  $-30^{\circ}\text{C}$  up to  $+50^{\circ}\text{C}$ .

The supply voltage was varied between 85% and 115% of nominal voltage.

The EUT was set in "Radio Resource Control (RRC) mode" on the middle channel using the Universal Radio Communication tester R&S CMW500 and the maximum frequency error was measured using the built-in calibrated frequency meter.

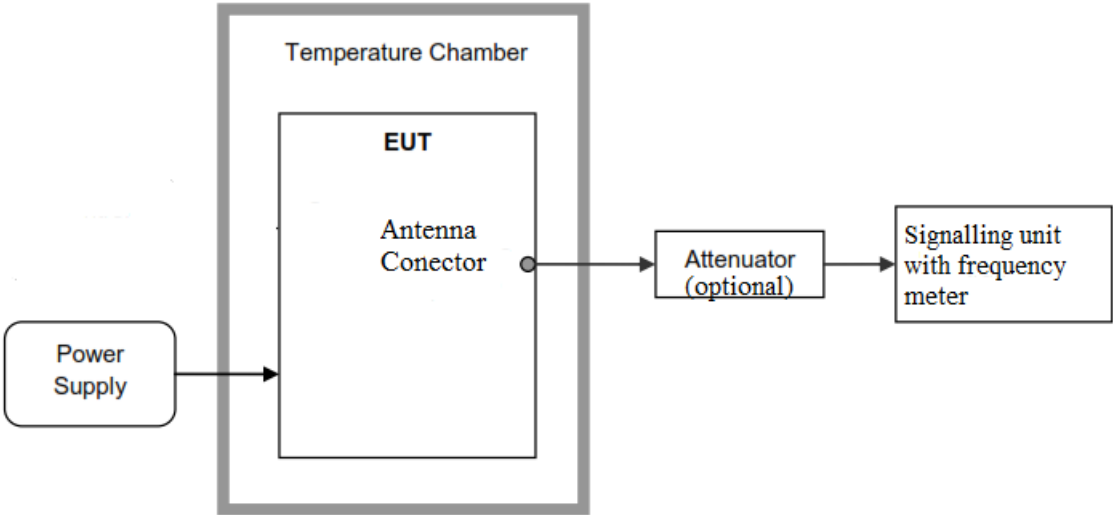
The worst case LTE mode for conducted power was used for the test.

In order to check that the frequency stability is sufficient such that the fundamental emissions stay within the authorized bands of operation, a reference point is established at the applicable unwanted emissions limit using a RBW equal to the RBW required by the unwanted emissions specification of the applicable regulatory standard. These reference points measured using the lowest and highest channels of operation are identified as fL and fH respectively. The worst-case frequency offset determined in the above methods is added or subtracted from the values of fL and fH to check that the resulting frequencies remain within the band.

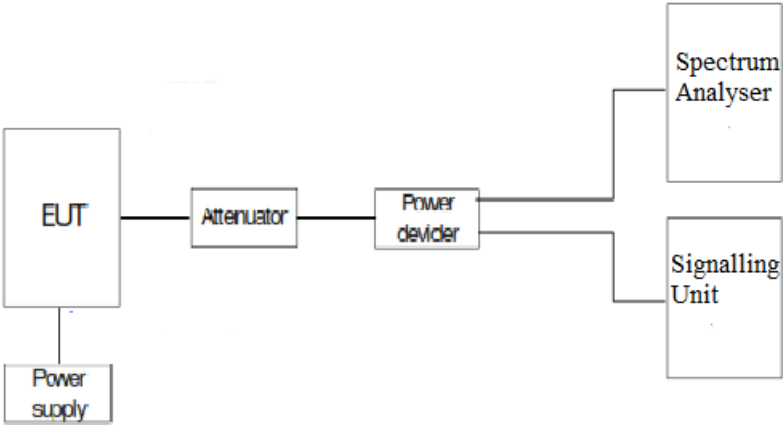
The reference point measurements were made at the RF output terminals of the EUT using an attenuator, power splitter and spectrum analyser. The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation.

TEST SETUP

Frequency tolerance:



Reference points  $f_L$  and  $f_H$ :



## RESULTS

### LTE Band 25:

#### 1. FREQUENCY TOLERANCE:

- Frequency stability over temperature variations.

| Temperature (°C) | Frequency Error (Hz) | Frequency Error (ppm) |
|------------------|----------------------|-----------------------|
| +50              | -20.68               | -0.010985392          |
| +40              | -21.17               | -0.011245684          |
| +30              | -22.82               | -0.012122178          |
| +20              | -20.34               | -0.010804781          |
| +10              | -24.38               | -0.012950863          |
| 0                | -23.46               | -0.012462151          |
| -10              | -16.07               | -0.008536521          |
| -20              | -19.85               | -0.010544489          |
| -30              | -15.71               | -0.008345286          |

- Frequency stability over voltage variations.

| Supply voltage | Voltage (V) | Frequency Error (Hz) | Frequency Error (ppm) |
|----------------|-------------|----------------------|-----------------------|
| Vmax           | 3.795       | -31.32               | -0.016637450          |
| Vmin           | 2.805       | -18.57               | -0.009864542          |

#### 2. REFERENCE FREQUENCY POINTS $f_L$ AND $f_H$ :

The worst-case frequency offsets added or subtracted per band and bandwidth:

QPSK. Nominal Bandwidth 5 MHz.

|             |             |
|-------------|-------------|
| $f_L$ (MHz) | 1850.092330 |
| $f_H$ (MHz) | 1915.019000 |

The reference frequency points  $f_L$  and  $f_H$  stay within the authorized blocks for the band above.

Measurement uncertainty (Hz):  $<\pm 223.94$

Verdict: PASS

## Modulation Characteristics

### SPECIFICATION

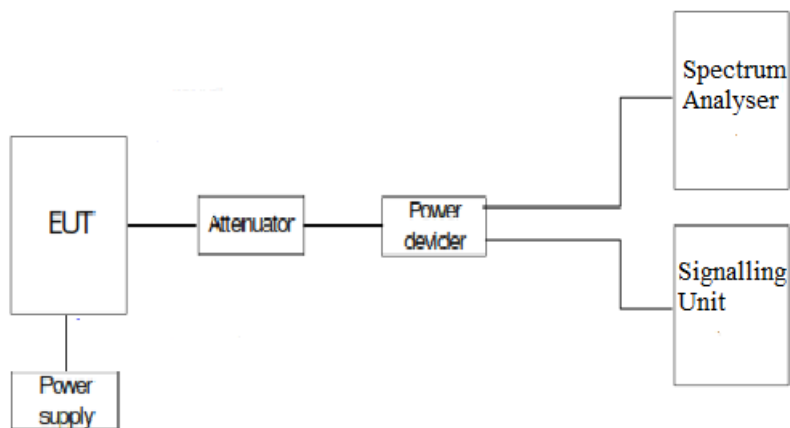
FCC §2.1047.

RSS-133. Clause 6.2. Equipment certified under this standard shall use digital modulation.

### METHOD

For LTE the EUT operates with QPSK and 16QAM modulation modes in which the information is digitised and coded into a bit stream. The RF transmission is multiplexed using *Orthogonal Frequency Division Multiplexing (OFDM)* using different possible arrangement of subcarriers (Resource Blocks RB).

### TEST SETUP



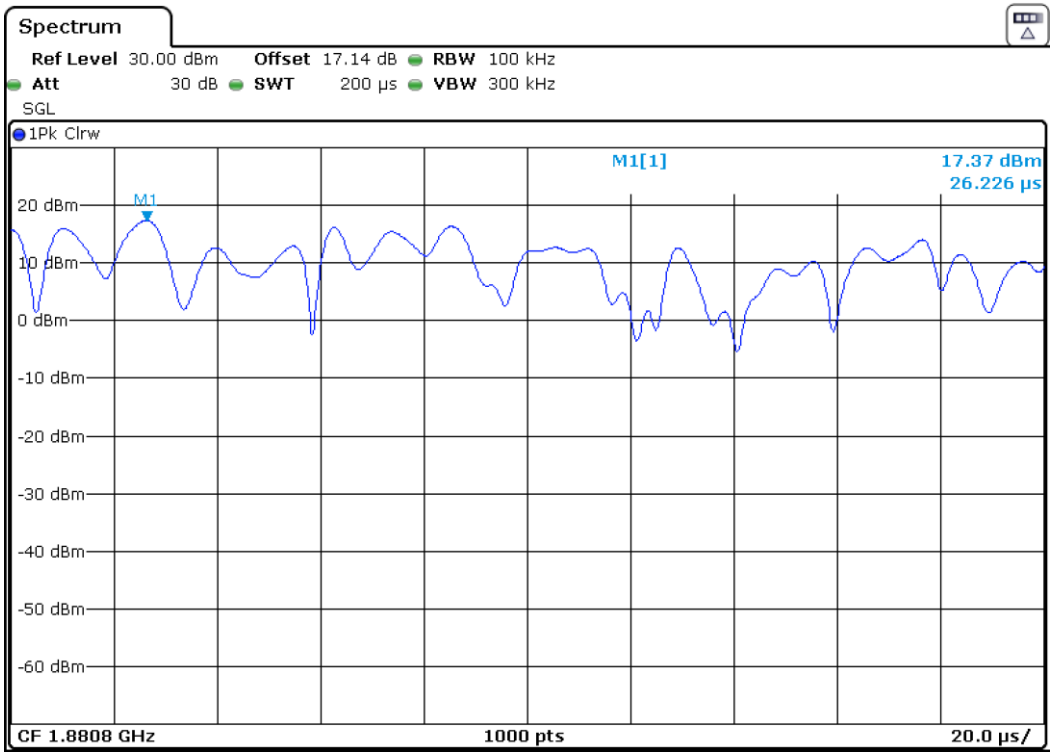


RESULTS

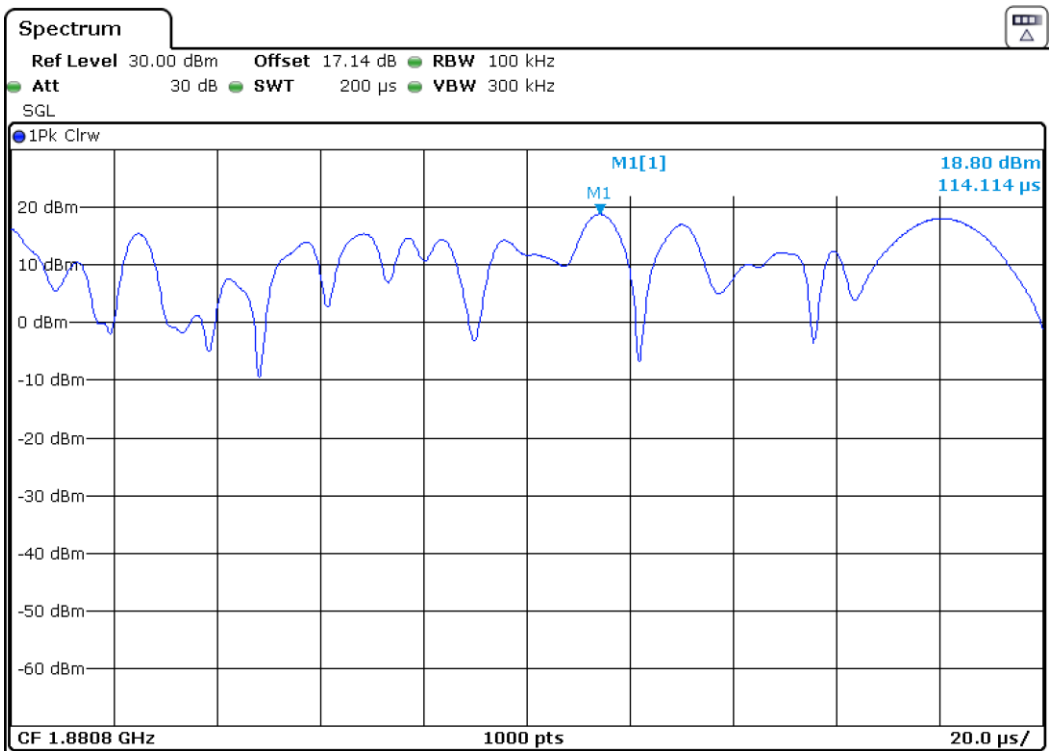
The following plots show the modulation schemes in the EUT.

LTE Band 25:

QPSK. Nominal Bandwidth 5 MHz.



16QAM. Nominal Bandwidth 5 MHz.



## Occupied Bandwidth

### SPECIFICATION

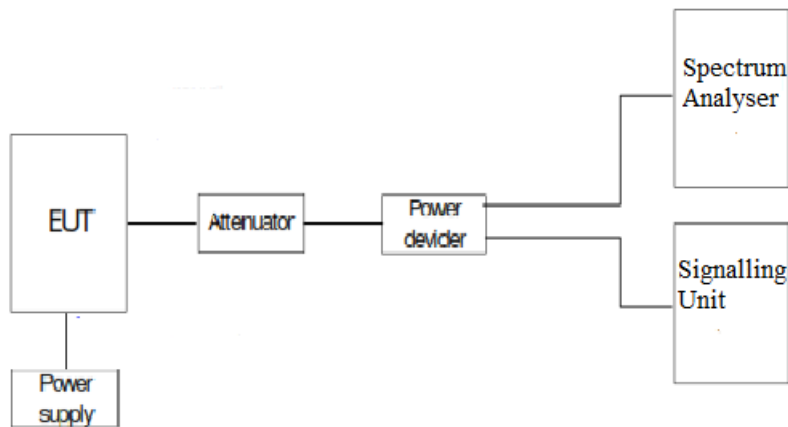
FCC §2.1049. Measurements required: Occupied bandwidth.

RSS-Gen, Clause 6.7.

### METHOD

The occupied bandwidth measurement was performed at the output terminals of the EUT using an attenuator, power splitter and spectrum analyser. The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation. The 99% occupied bandwidth and the -26 dBc bandwidth were measured directly using the built-in bandwidth measuring option of spectrum analyser.

### TEST SETUP



### RESULTS:

The worst case of occupied bandwidth corresponds to all Resource Blocks (RB) offset 0 regardless of either the Narrow band position or the Nominal Bandwidth selected.

#### **LTE Band 25:**

QPSK. Nominal Bandwidth 5 MHz, RB Size 6, RB Offset 0, Narrowband 0 Position 1.

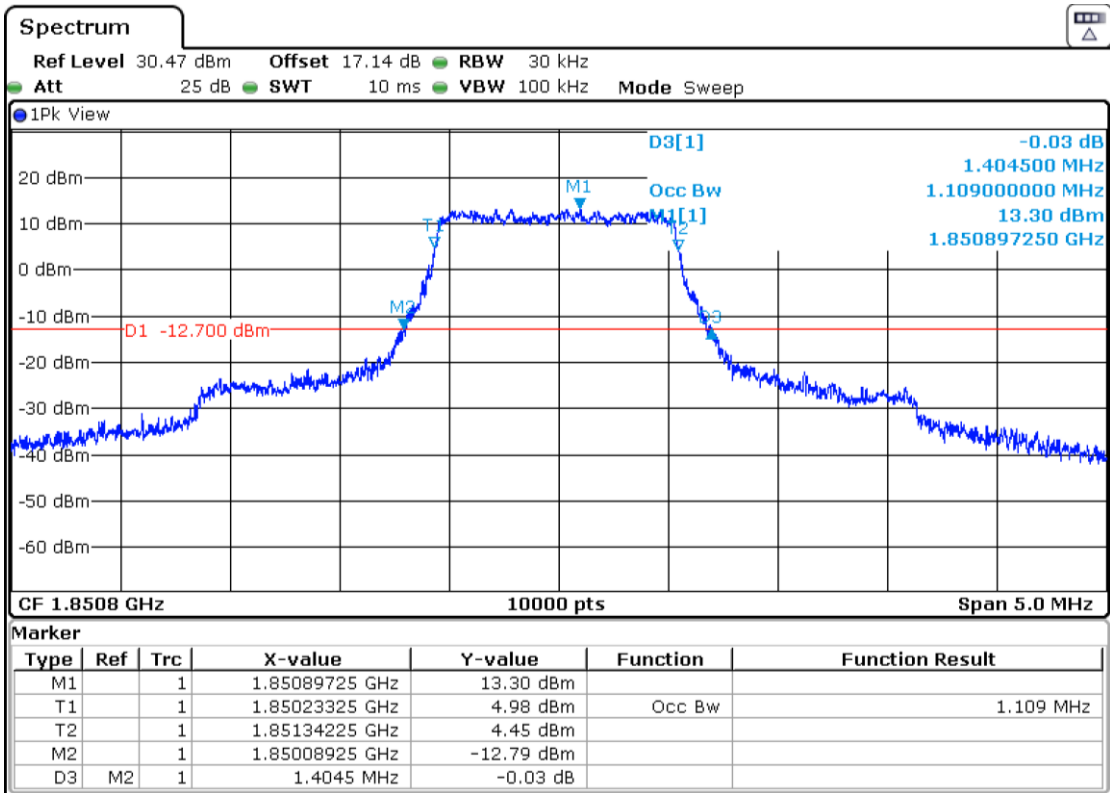
| Channel                       | Low      | Middle   | High     |
|-------------------------------|----------|----------|----------|
| 99% Occupied Bandwidth (MHz)  | 1.109000 | 1.106500 | 1.112500 |
| -26 dBc Bandwidth (MHz)       | 1.404500 | 1.395000 | 1.420000 |
| Measurement uncertainty (kHz) | <±3.75   |          |          |

16QAM. Nominal Bandwidth 5 MHz, RB Size 5, RB Offset 0, Narrowband 0 Position 1.

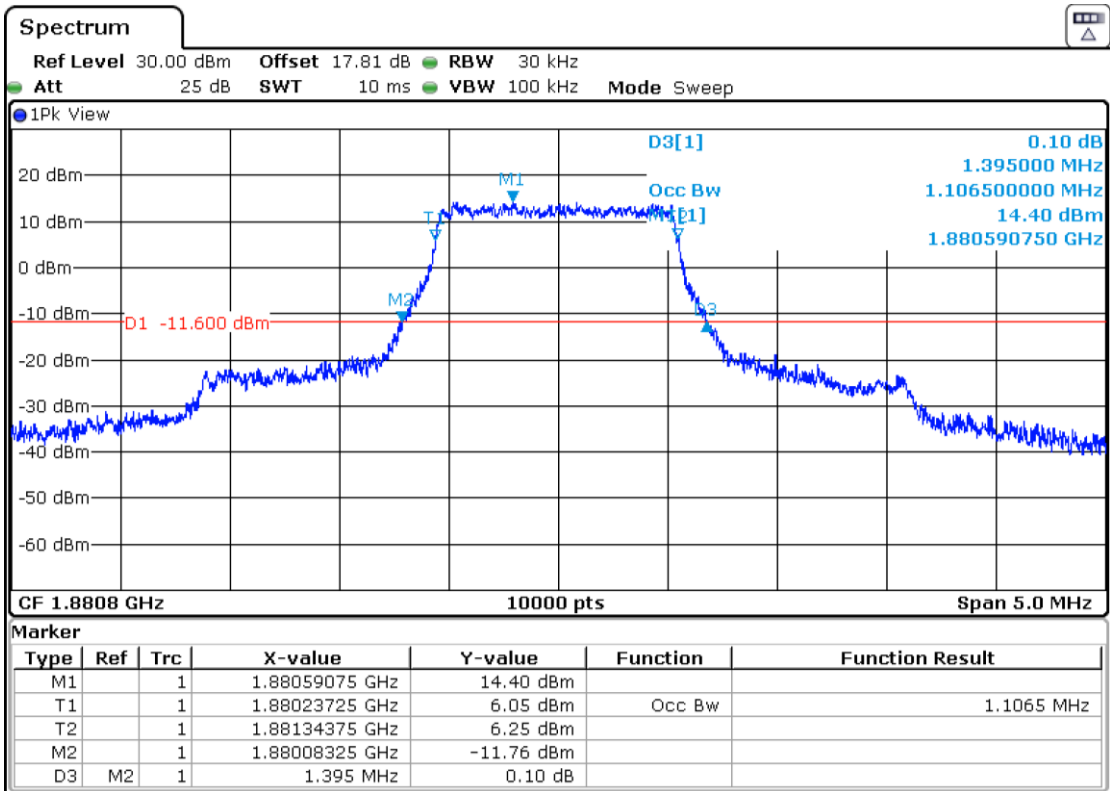
| Channel                       | Low      | Middle   | High     |
|-------------------------------|----------|----------|----------|
| 99% Occupied Bandwidth (MHz)  | 0.953500 | 0.944000 | 0.955000 |
| -26 dBc Bandwidth (MHz)       | 1.358500 | 1.346000 | 1.365500 |
| Measurement uncertainty (kHz) | <±3.75   |          |          |

QPSK. Nominal Bandwidth 5 MHz, RB Size 6, RB Offset 0. Narrowband 0. Position 1.

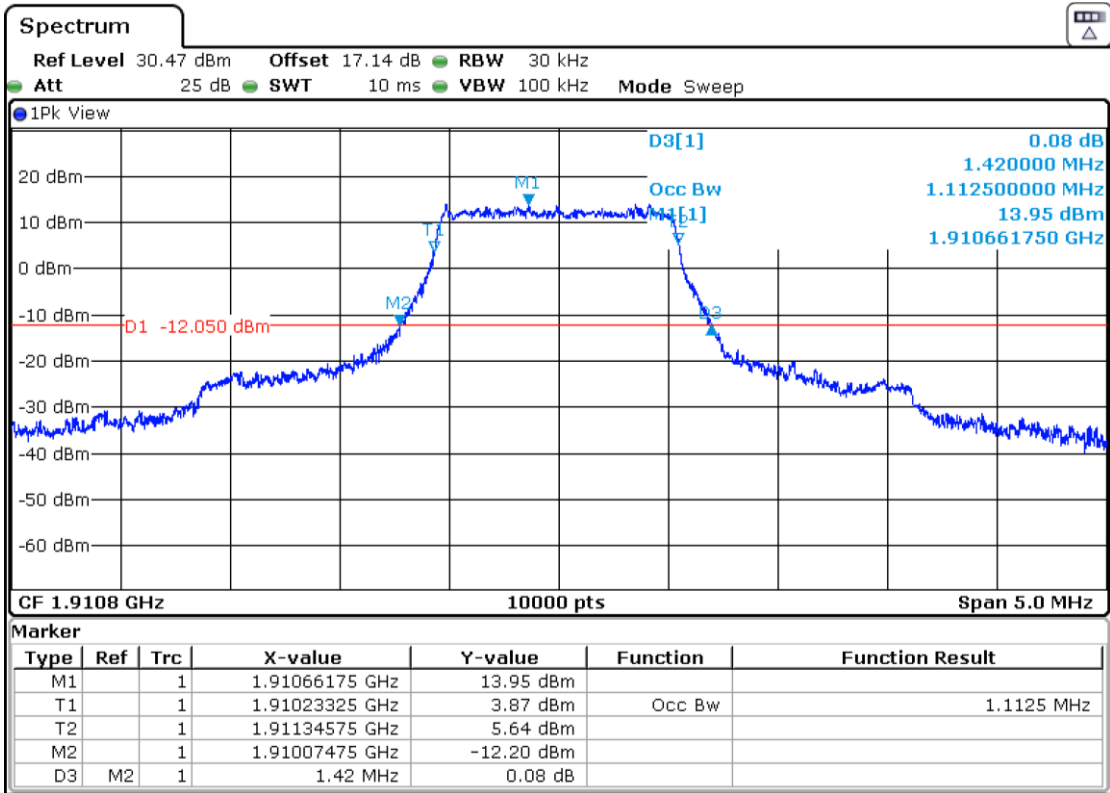
Low Channel:



Middle Channel:

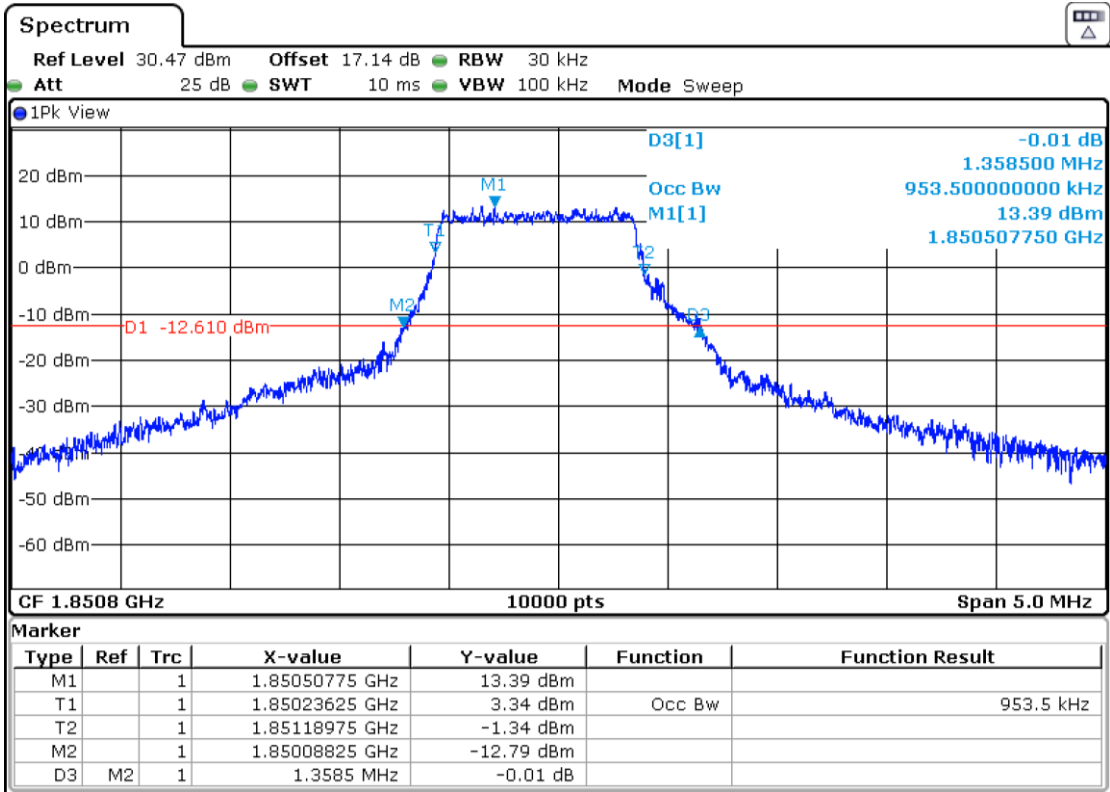


High Channel:

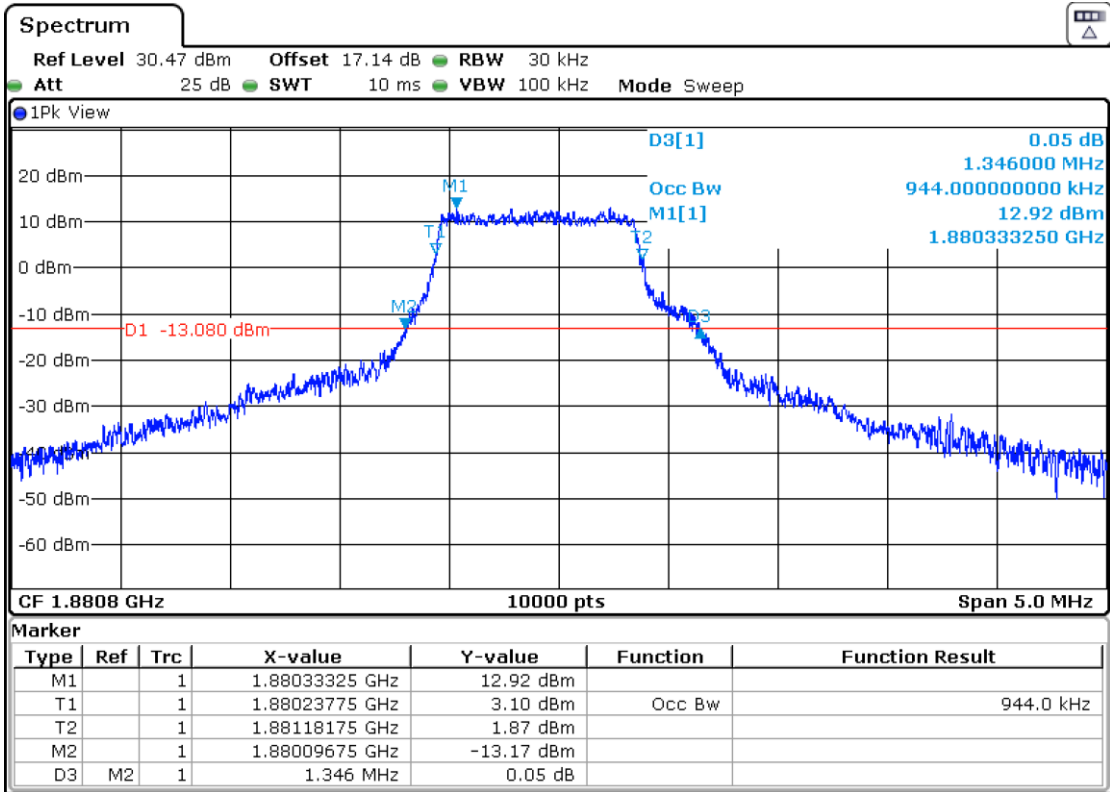


16QAM. Nominal Bandwidth 5 MHz, RB Size 5, RB Offset 0. Narrowband 0. Position 1.

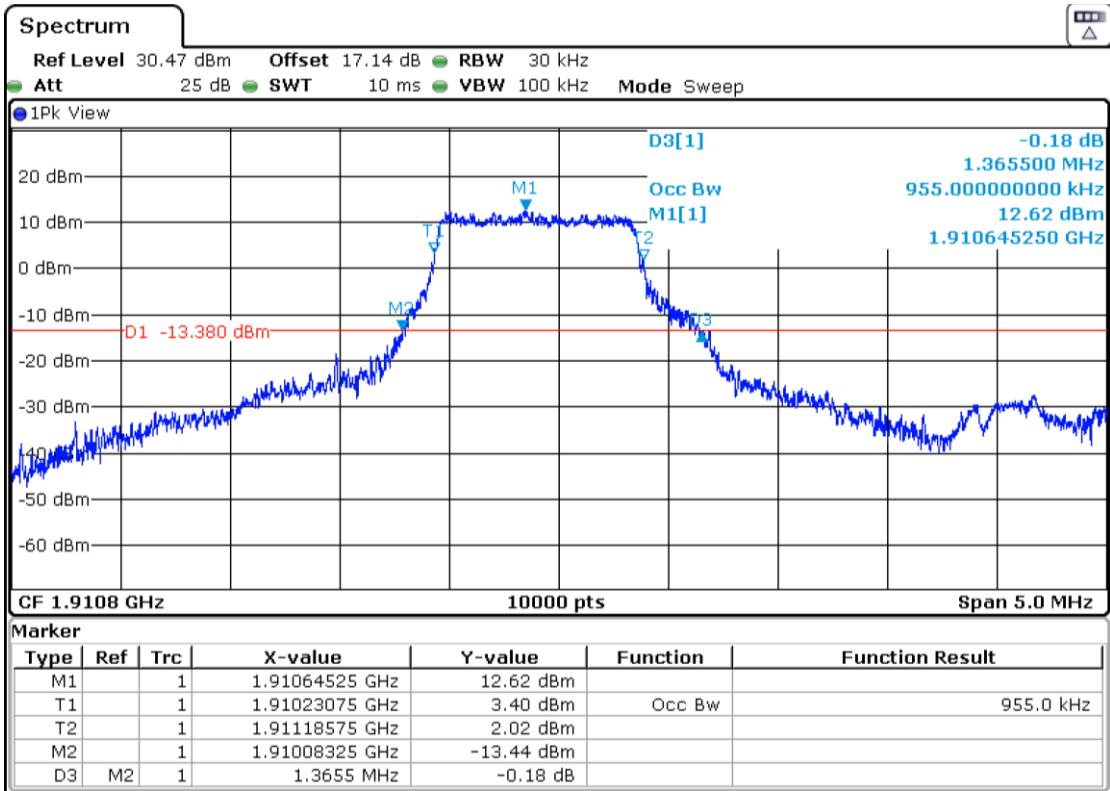
Low Channel:



Middle Channel:



High Channel:



## Spurious Emissions at Antenna Terminals

### SPECIFICATION

FCC §2.1051 and §24.238. RSS-133, Clause 6.5.

The power of emissions shall be attenuated below the transmitter power (P) by a factor of at least  $43 + 10 \log (P)$  dB. P in watts.

Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater.

At  $P_o$  transmitting power, the specified minimum attenuation becomes  $43 + 10 \log (P_o)$ , and the level in dBm relative to  $P_o$  becomes:

$$P_o \text{ (dBm)} - [43 + 10 \log (P_o \text{ in mW}) - 30] = -13 \text{ dBm}$$

### METHOD

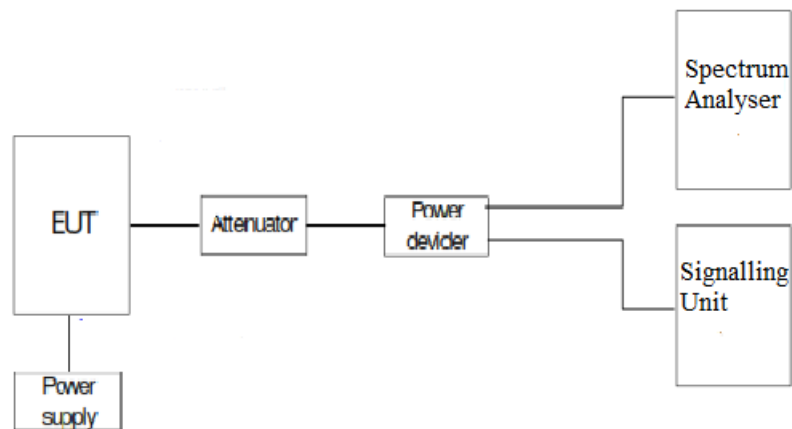
The EUT RF output connector was connected to a spectrum analyser and to the Universal Radio Communication tester R&S CMW500 (selecting maximum transmission power of the EUT and different modes of modulation) using a 50-Ohm attenuator and a power divider.

The spectrum was investigated from 9 kHz to 20 GHz.

The reading of the spectrum analyser is corrected with the attenuation loss of connection between output terminal of EUT and input of the spectrum analyser.

The configuration of Resource Blocks and modulation which is the worst case for conducted power was used.

### TEST SETUP



## RESULTS:

**LTE Band 25:** QPSK. Nominal Bandwidth 20 MHz. RB Size 6, RB Offset 0. Narrowband 0, Position 1.

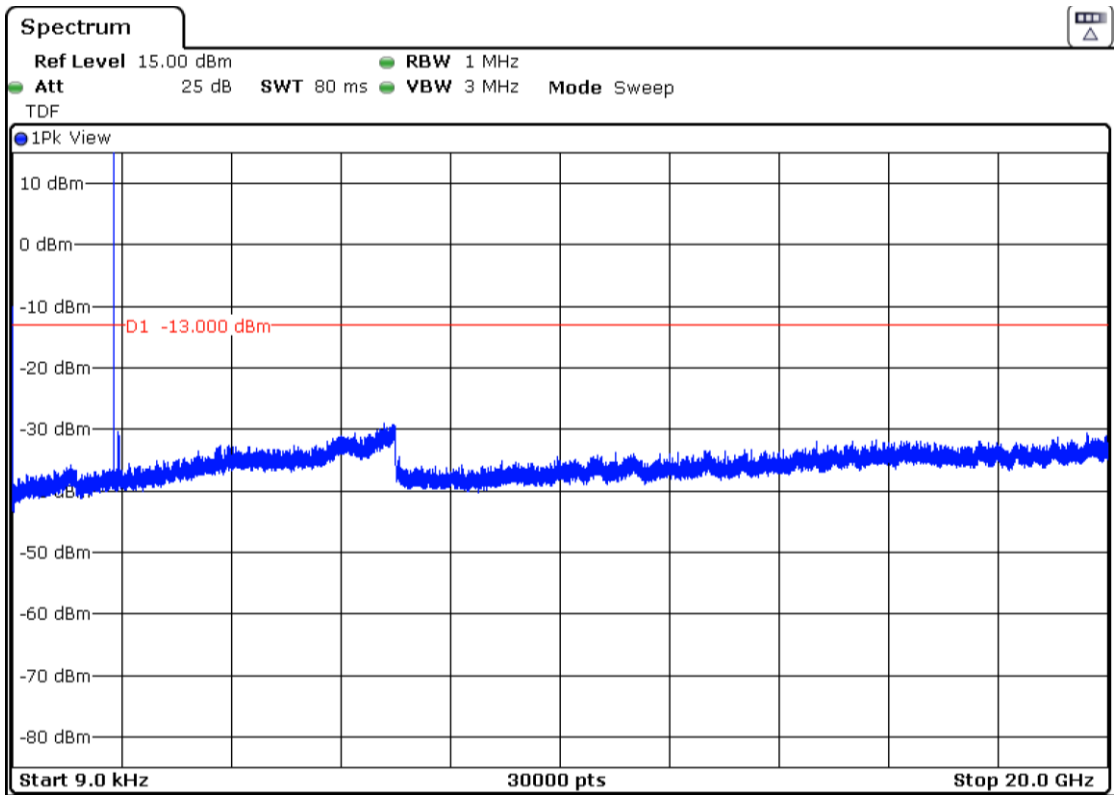
- Low Channel: No spurious frequencies at less than 20 dB below the limit.
- Middle Channel: No spurious frequencies at less than 20 dB below the limit.
- High Channel: No spurious frequencies at less than 20 dB below the limit.

Measurement uncertainty (dB):  $<\pm 2.76$

Verdict: PASS

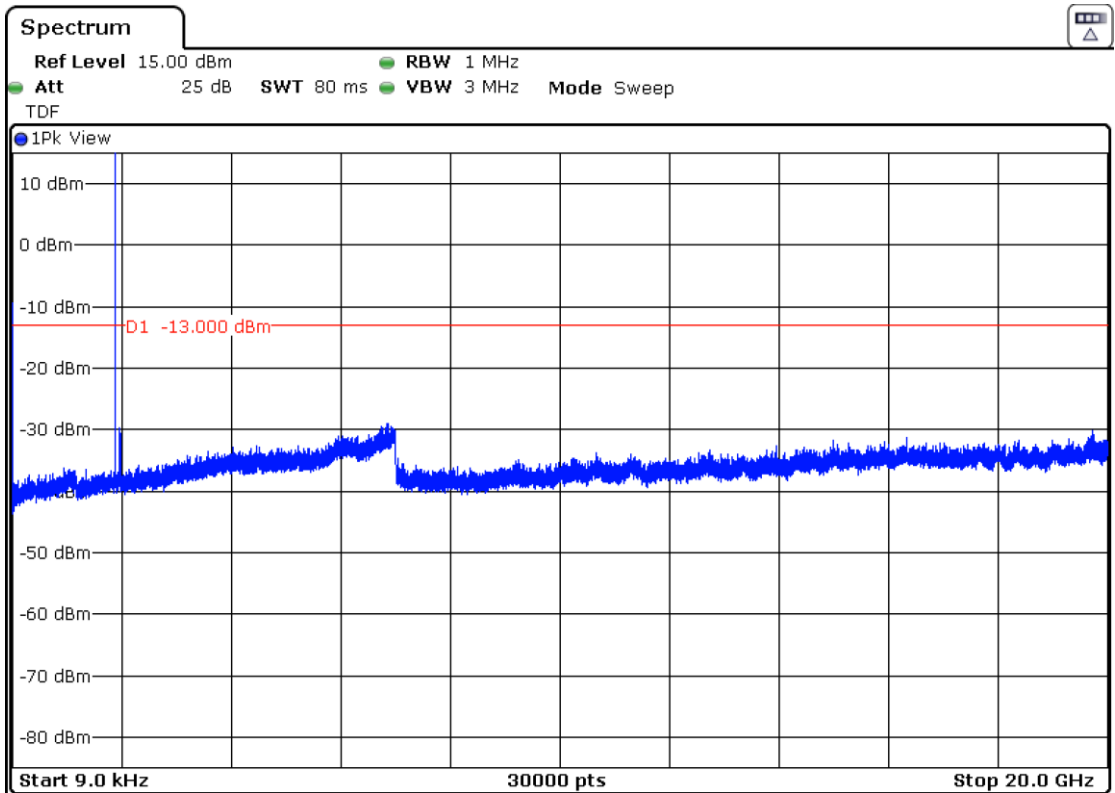
QPSK. Nominal Bandwidth 20 MHz. RB Size 6, RB Offset 0. Narrowband 0, Position 1.

Low Channel:



The peak above the limit is the carrier frequency.

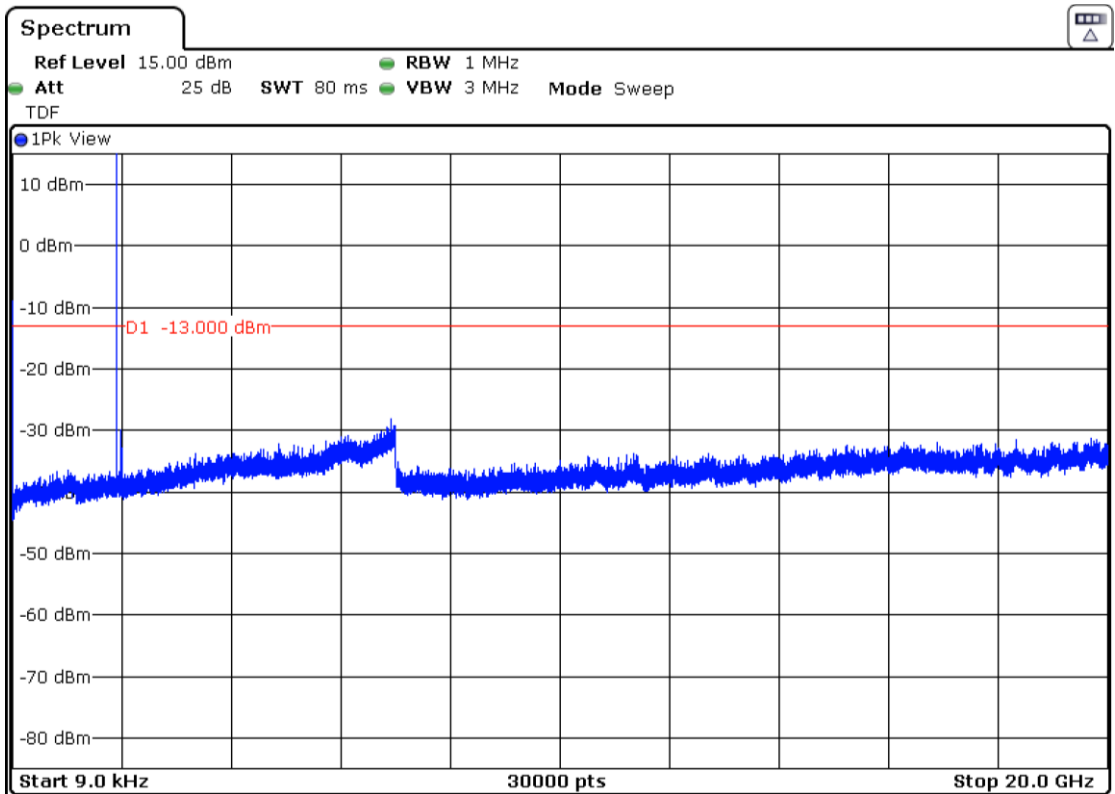
Middle Channel:



The peak above the limit is the carrier frequency.



High Channel:



The peak above the limit is the carrier frequency.

## Spurious Emissions at Antenna Terminals at Block Edges

### SPECIFICATION

FCC §2.1051 and §24.238. RSS-133 Clause 6.5.

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.

At  $P_o$  transmitting power, the specified minimum attenuation becomes  $43 + 10 \log(P_o)$ , and the level in dBm relative to  $P_o$  becomes:

$$P_o \text{ (dBm)} - [43 + 10 \log(P_o \text{ in mW}) - 30] = -13 \text{ dBm}$$

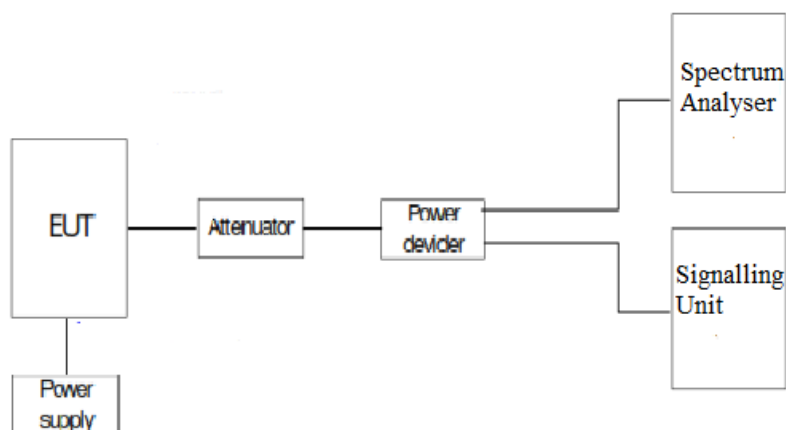
### METHOD

The EUT RF output connector was connected to a spectrum analyser and to the Universal Radio Communication tester R&S CMW500 (selecting maximum transmission power of the EUT and different modes of modulation) using a 50-Ohm attenuator and a power splitter.

The reading of the spectrum analyser is corrected with the attenuation loss of connection between output terminal of EUT and input of the spectrum analyser.

As stated in FCC part 24.238 / RSS-133 Clause 6.5, in the 1 MHz bands immediately outside and adjacent to the frequency block or band a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed.

### TEST SETUP



## RESULTS:

### LTE Band 25:

Preliminary measurements determined QPSK as the worst-case modulation in terms of band edge results. The next results are for this worst-case configuration.

Low Block Edge. Narrowband = 0.

| LTE QPSK MODULATION:                                                     | RB=1.<br>Offset = 0.<br>BW = 5 MHz | RB=1.<br>Offset = 0.<br>BW = 10 MHz | RB=1.<br>Offset = 0.<br>BW = 15 MHz | RB=1.<br>Offset = 0.<br>BW = 20 MHz |
|--------------------------------------------------------------------------|------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
| Maximum measured level at <u>Lowest Block Edge</u> at antenna port (dBm) | -24.12                             | -33.29                              | -37.26                              | -37.78                              |

| LTE QPSK MODULATION:                                                     | RB = All.<br>Offset = 0.<br>BW = 5 MHz | RB = All.<br>Offset = 0.<br>BW = 10 MHz | RB = All.<br>Offset = 0.<br>BW = 15 MHz | RB = All.<br>Offset = 0.<br>BW = 20 MHz |
|--------------------------------------------------------------------------|----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|
| Maximum measured level at <u>Lowest Block Edge</u> at antenna port (dBm) | -26.94                                 | -26.55                                  | -25.04                                  | -33.76                                  |

High Block Edge. Narrowband = Max.

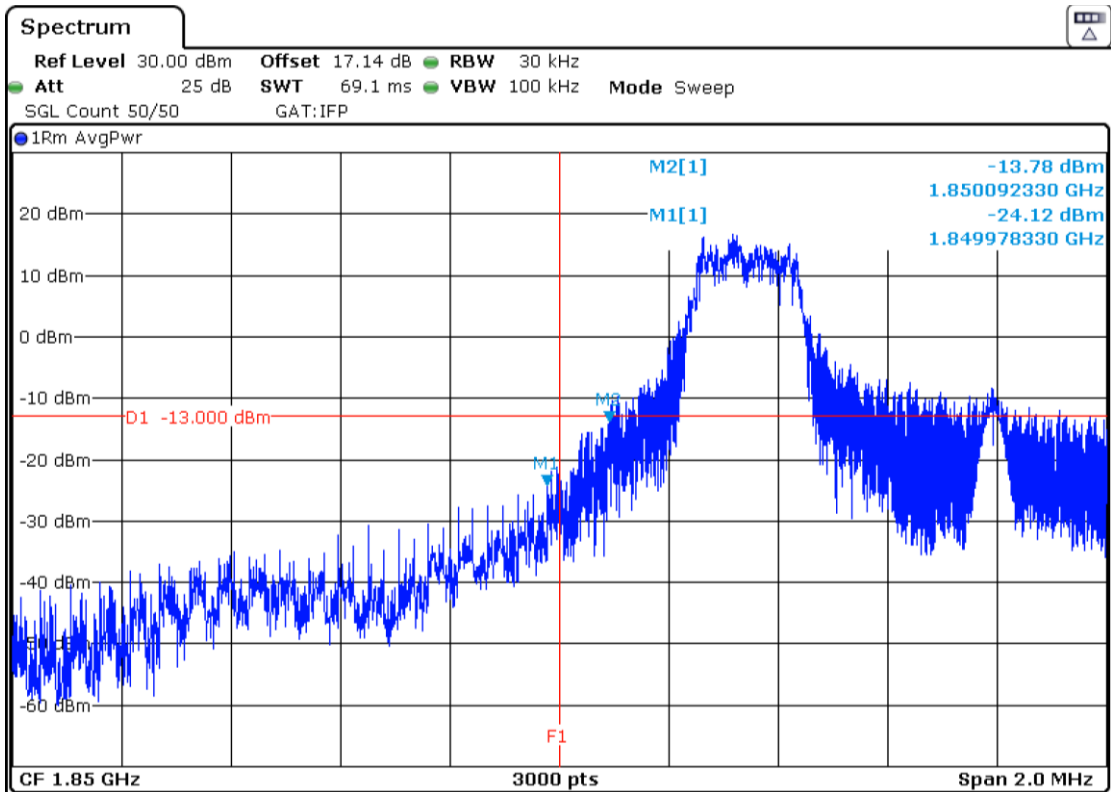
| LTE QPSK MODULATION:                                                      | RB=1.<br>Offset=Max.<br>BW = 5 MHz | RB=1.<br>Offset=Max.<br>BW = 10 MHz | RB=1.<br>Offset=Max.<br>BW = 15 MHz | RB=1.<br>Offset=Max.<br>BW = 20 MHz |
|---------------------------------------------------------------------------|------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
| Maximum measured level at <u>Highest Block Edge</u> at antenna port (dBm) | -24.01                             | -30.49                              | -36.47                              | -43.89                              |

| LTE QPSK MODULATION:                                                      | RB = All.<br>Offset = 0.<br>BW = 5 MHz | RB = All.<br>Offset = 0.<br>BW = 10 MHz | RB = All.<br>Offset = 0.<br>BW = 15 MHz | RB = All.<br>Offset = 0.<br>BW = 20 MHz |
|---------------------------------------------------------------------------|----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|
| Maximum measured level at <u>Highest Block Edge</u> at antenna port (dBm) | -26.02                                 | -27.22                                  | -26.07                                  | -36.87                                  |

Measurement uncertainty (dB):  $\leq \pm 2.76$

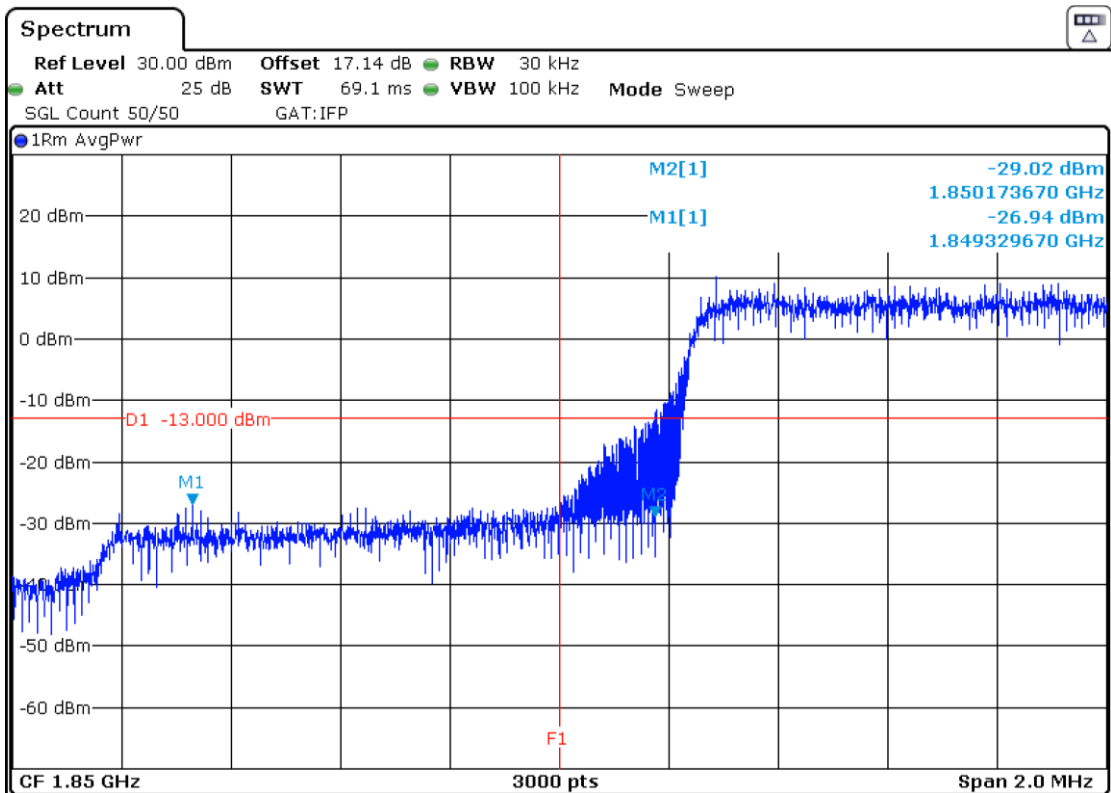
Verdict: PASS

LTE Band 25. QPSK MODULATION. BW=5 MHz. RB=1. Offset=0. Narrowband=0. Low Block Edge:



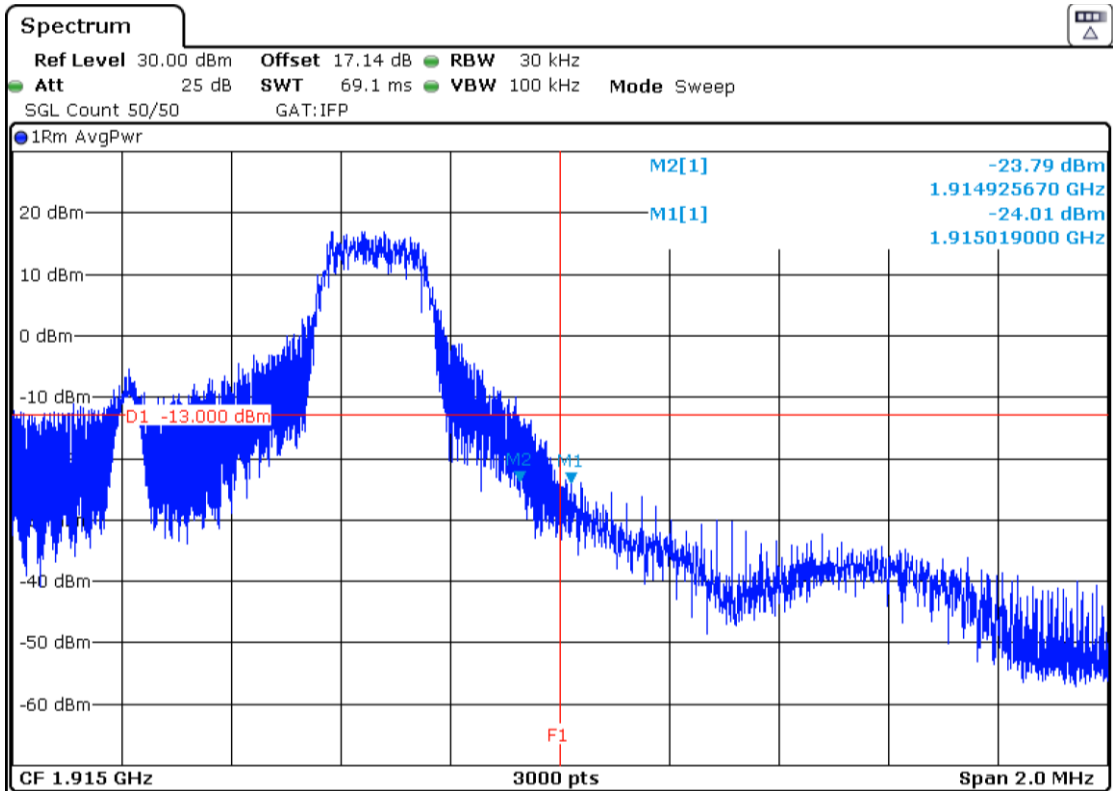
The equipment transmits at the maximum output power

LTE Band 25. QPSK MODULATION. BW=5 MHz. RB=All. Offset=0. Narrowband=0. Low Block Edge:



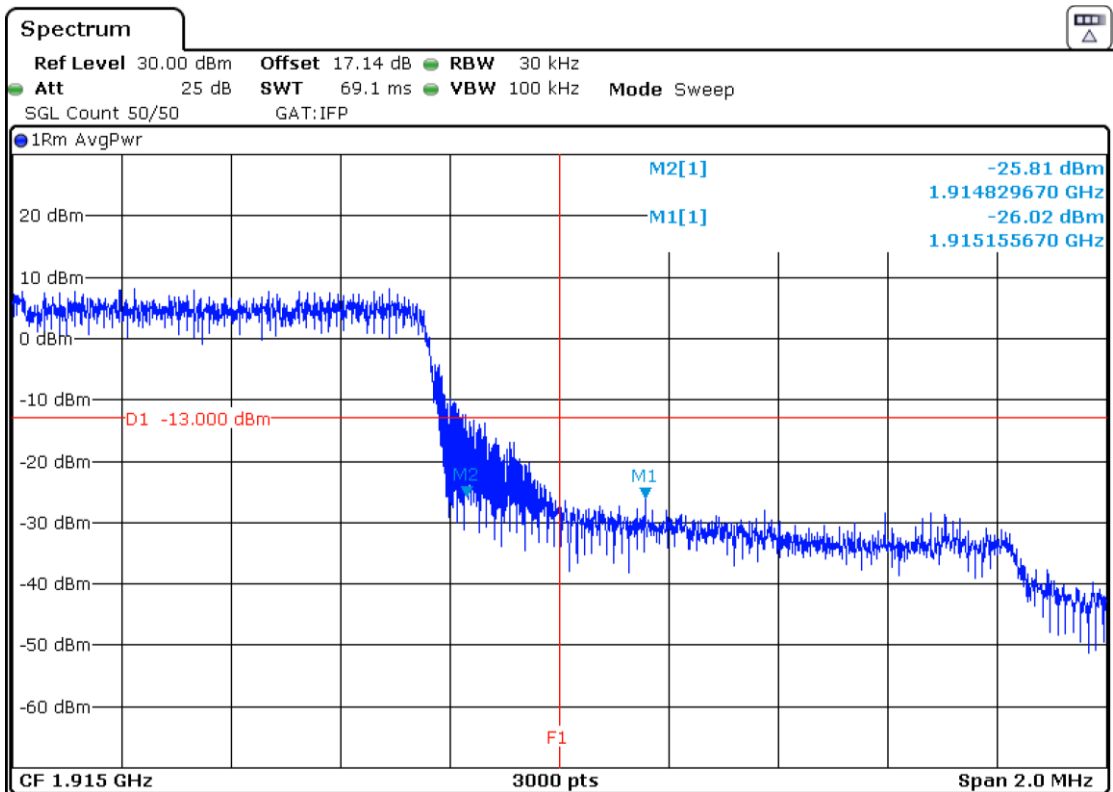
The equipment transmits at the maximum output power

LTE Band 25. QPSK MODULATION. BW=5 MHz. RB=1. Offset=Max. Narrowband=3. Highest Block Edge:



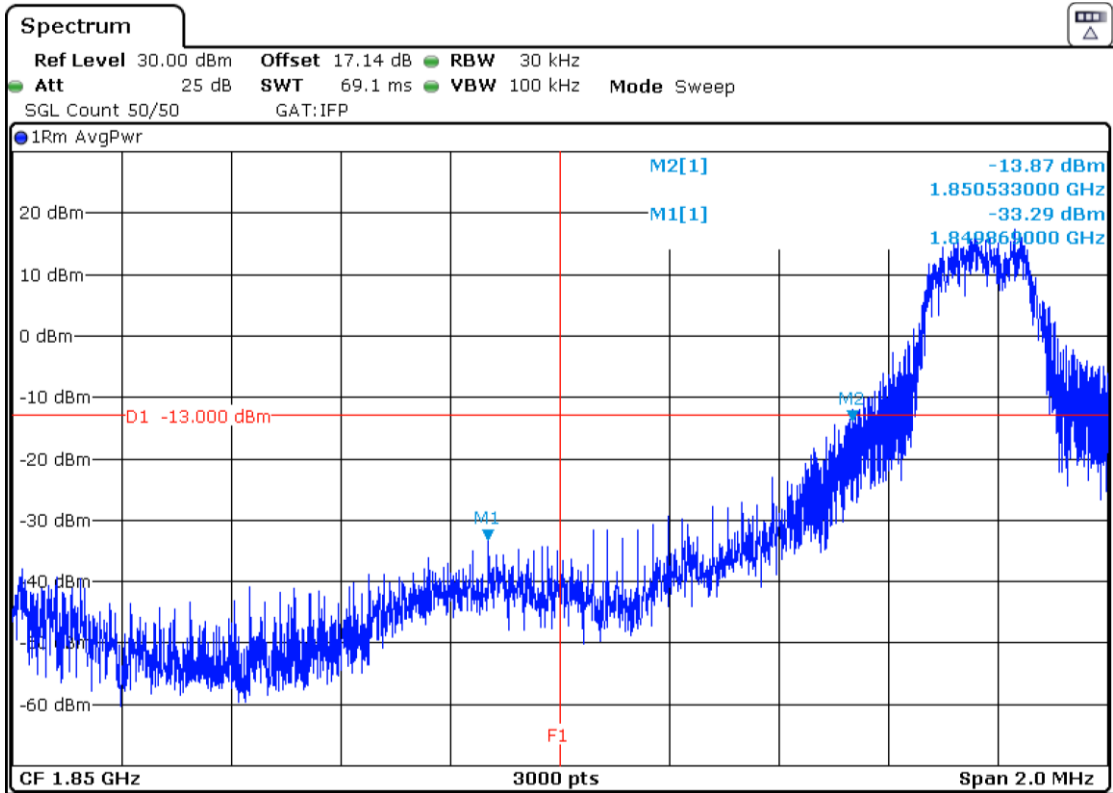
The equipment transmits at the maximum output power

LTE Band 25. QPSK MODULATION. BW=5 MHz. RB=All. Offset=0. Narrowband=3. Highest Block Edge:



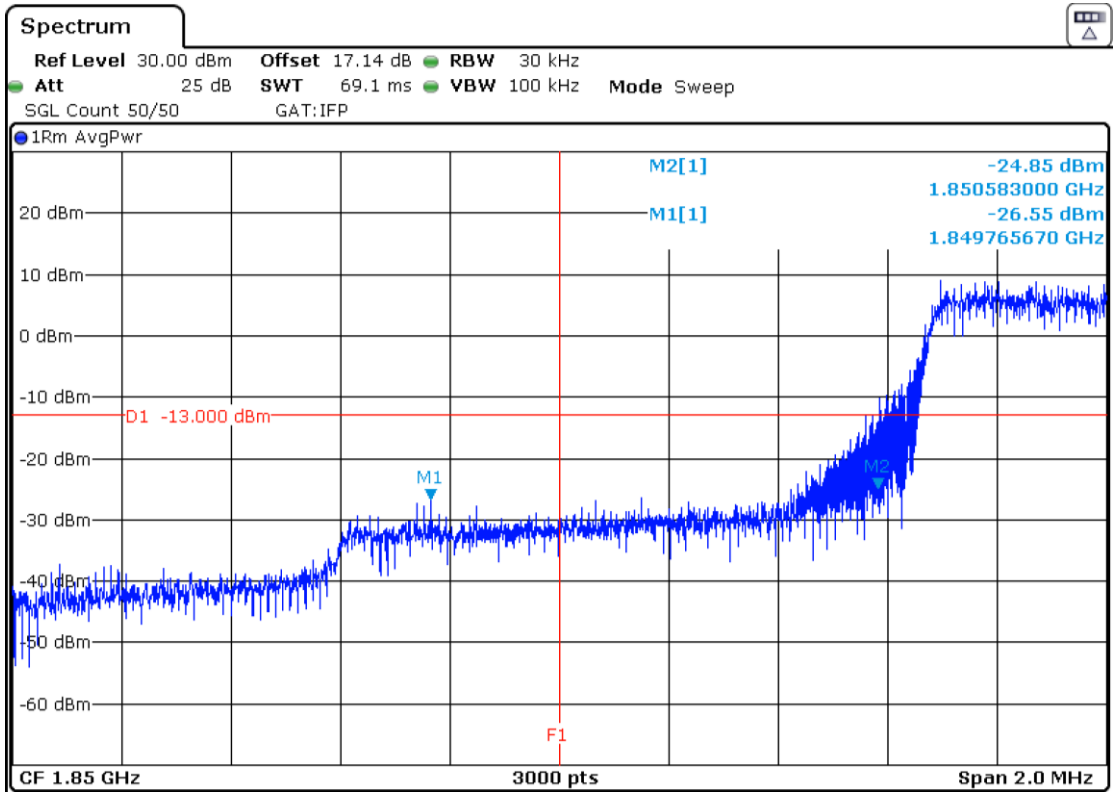
The equipment transmits at the maximum output power

LTE Band 25. QPSK MODULATION. BW=10 MHz. RB=1. Offset=0. Narrowband=0. Low Block Edge:



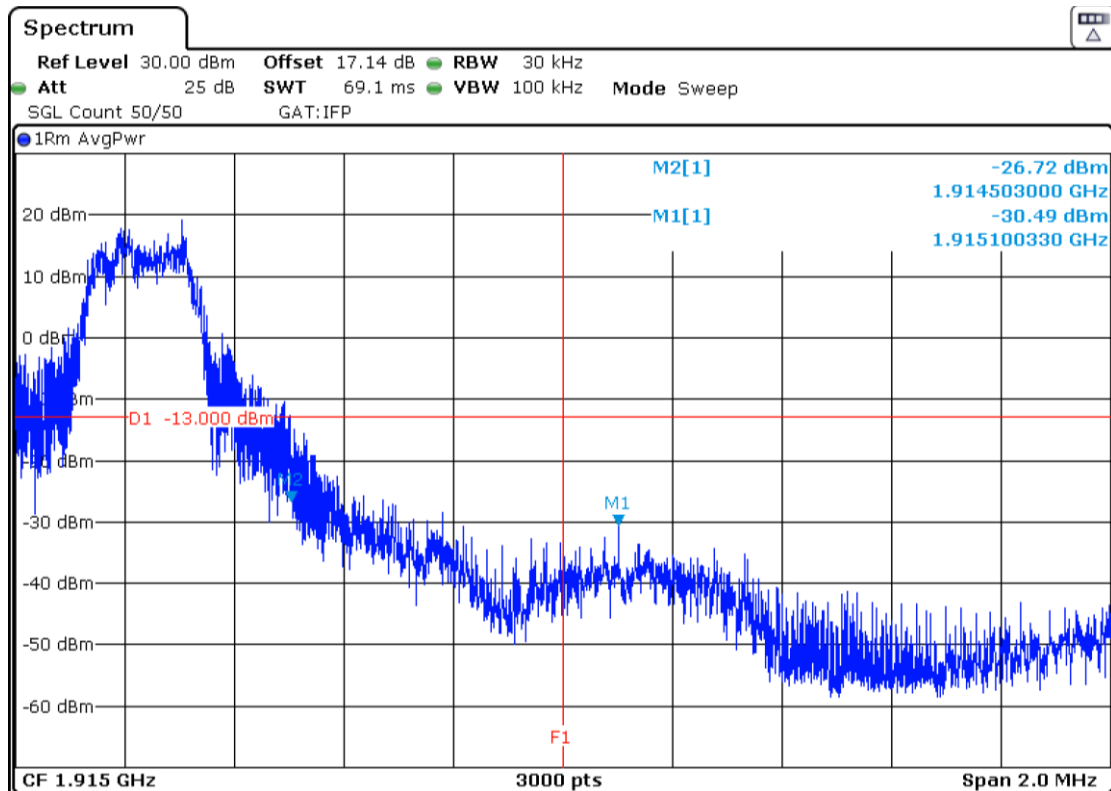
The equipment transmits at the maximum output power

LTE Band 25. QPSK MODULATION. BW=10 MHz. RB=All. Offset=0. Narrowband=0. Low Block Edge:



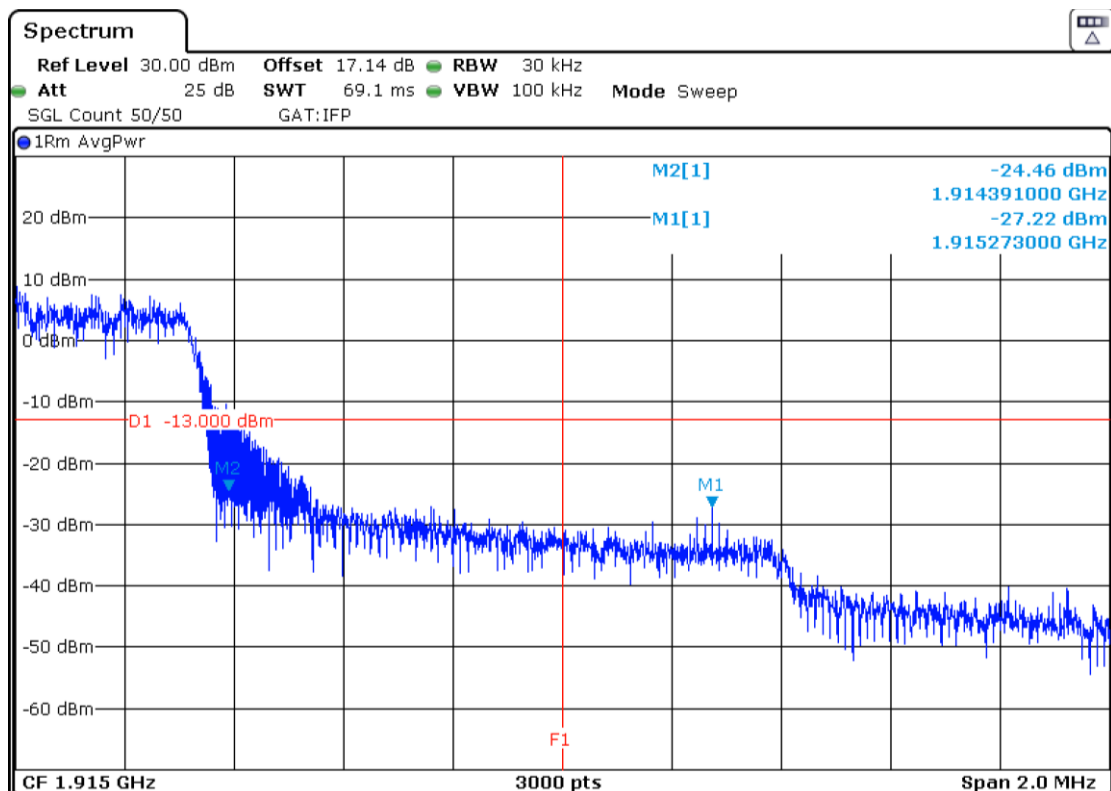
The equipment transmits at the maximum output power

LTE Band 25. QPSK MODULATION. BW=10 MHz. RB=1. Offset=Max. Narrowband=7. High Block Edge:



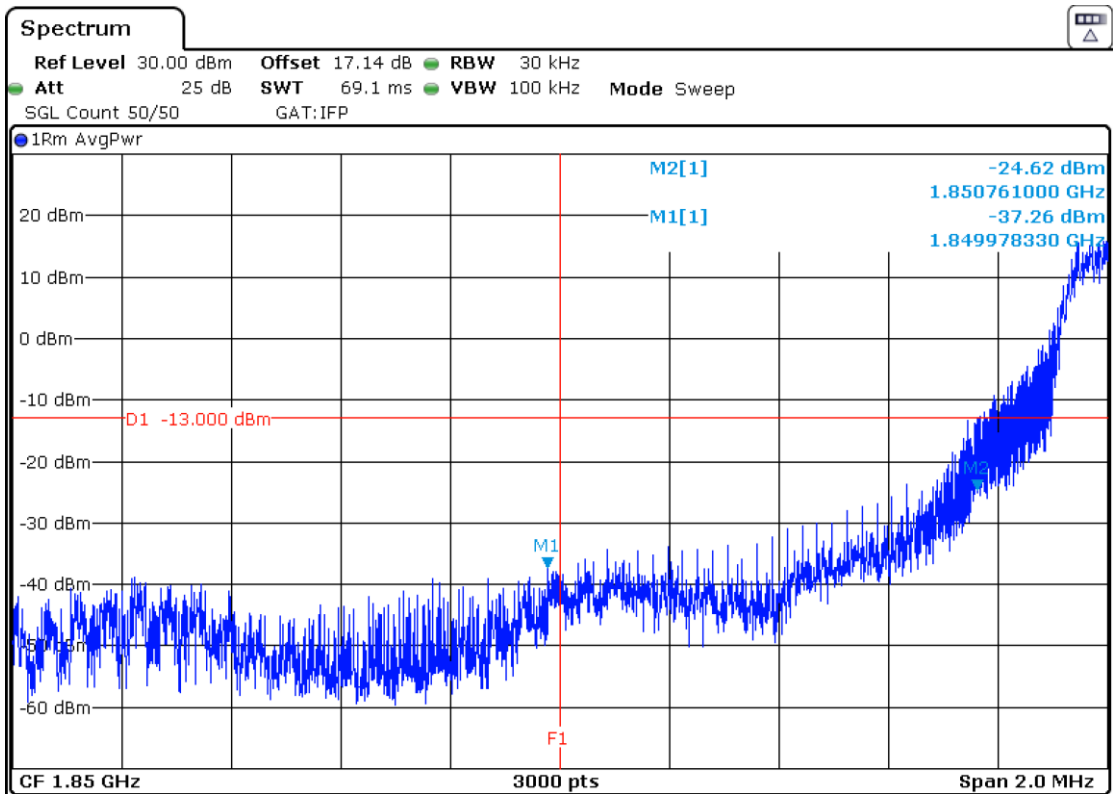
The equipment transmits at the maximum output power

LTE Band 25. QPSK MODULATION. BW=10 MHz. RB=All. Offset=0. Narrowband=7. High Block Edge:



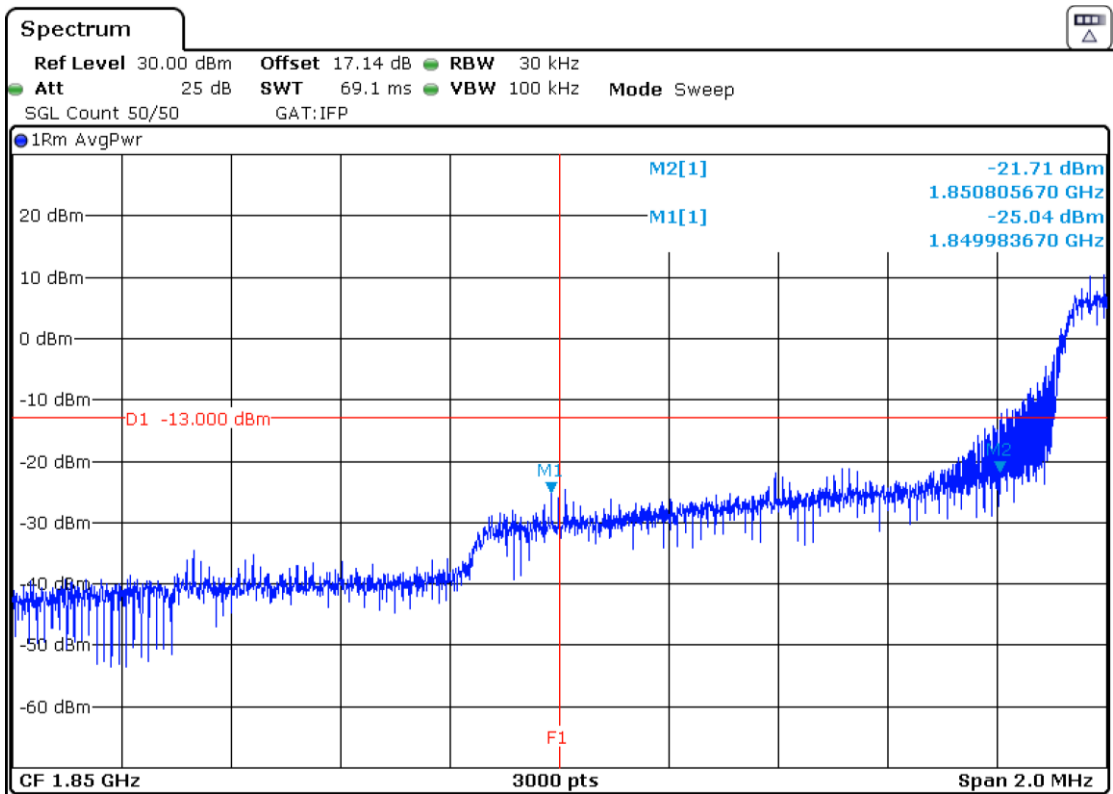
The equipment transmits at the maximum output power

LTE Band 25. QPSK MODULATION. BW=15 MHz. RB=1. Offset=0. Narrowband=0. Low Block Edge:



The equipment transmits at the maximum output power

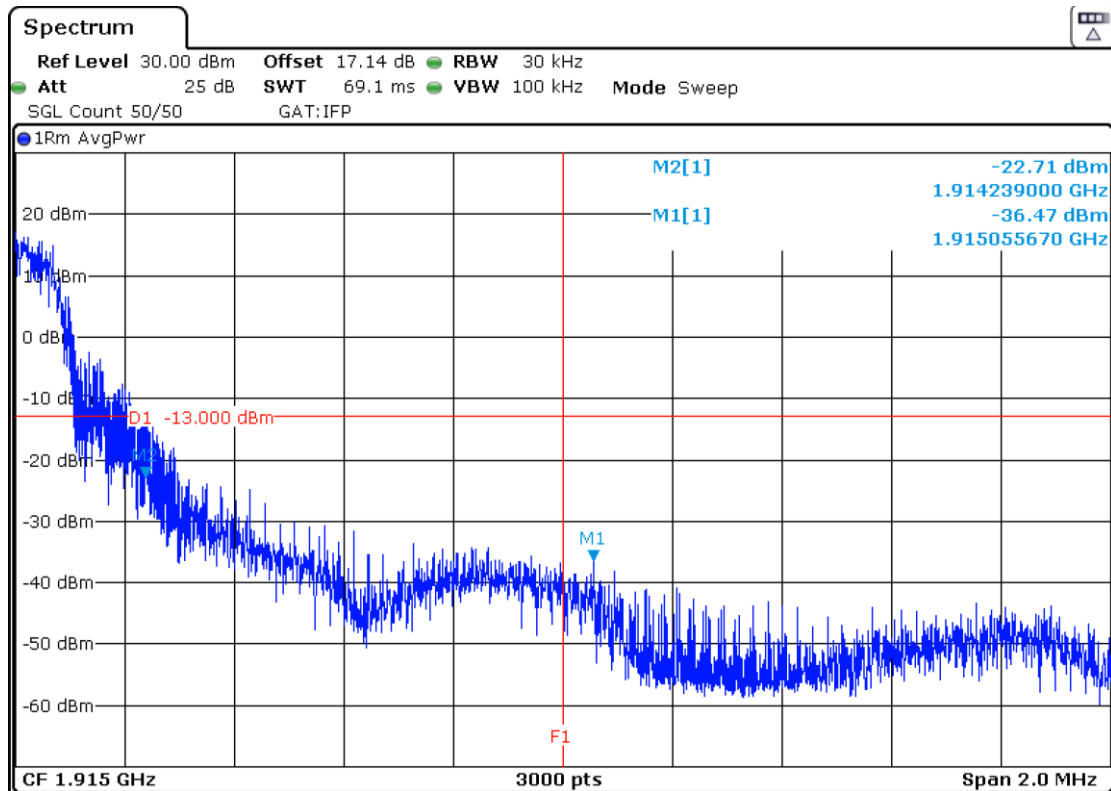
LTE Band 25. QPSK MODULATION. BW=15 MHz. RB=All. Offset=0. Narrowband=0. Low Block Edge:



The equipment transmits at the maximum output power

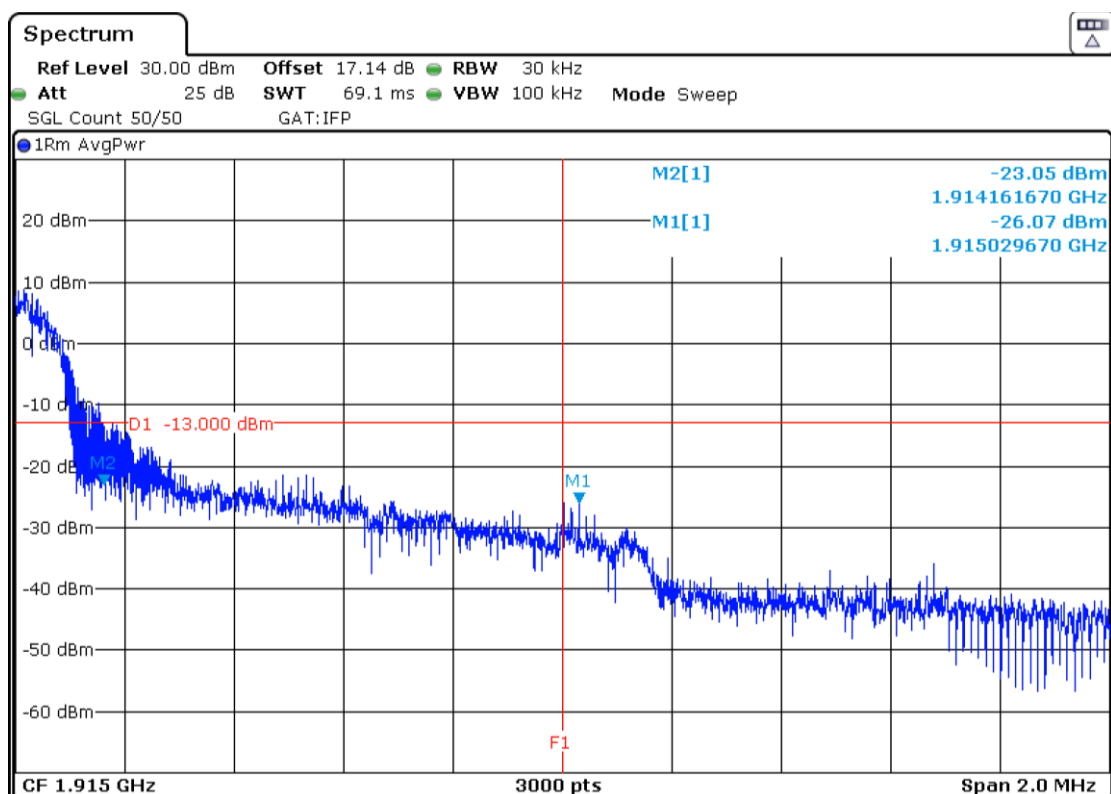


LTE Band 25. QPSK MODULATION. BW=15 MHz. RB=1. Offset=Max. Narrowband=11. High Block Edge:



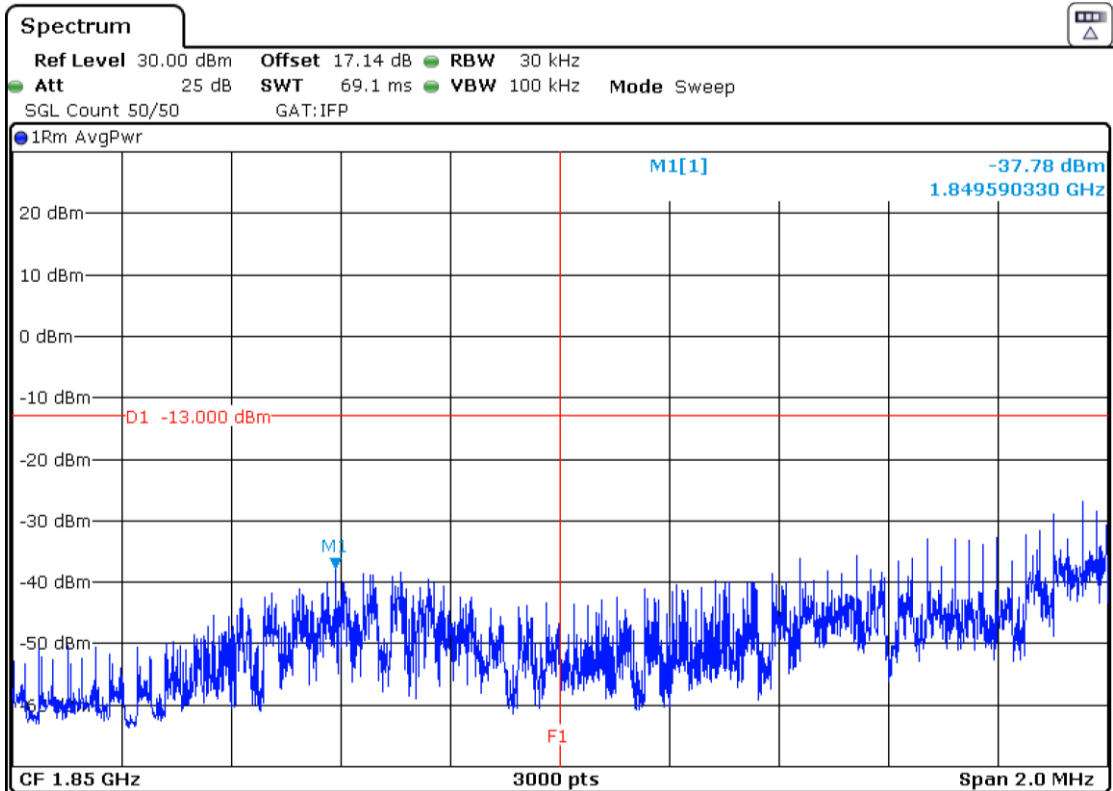
The equipment transmits at the maximum output power

LTE Band 25. QPSK MODULATION. BW=15 MHz. RB=All. Offset=0. Narrowband=11. High Block Edge:



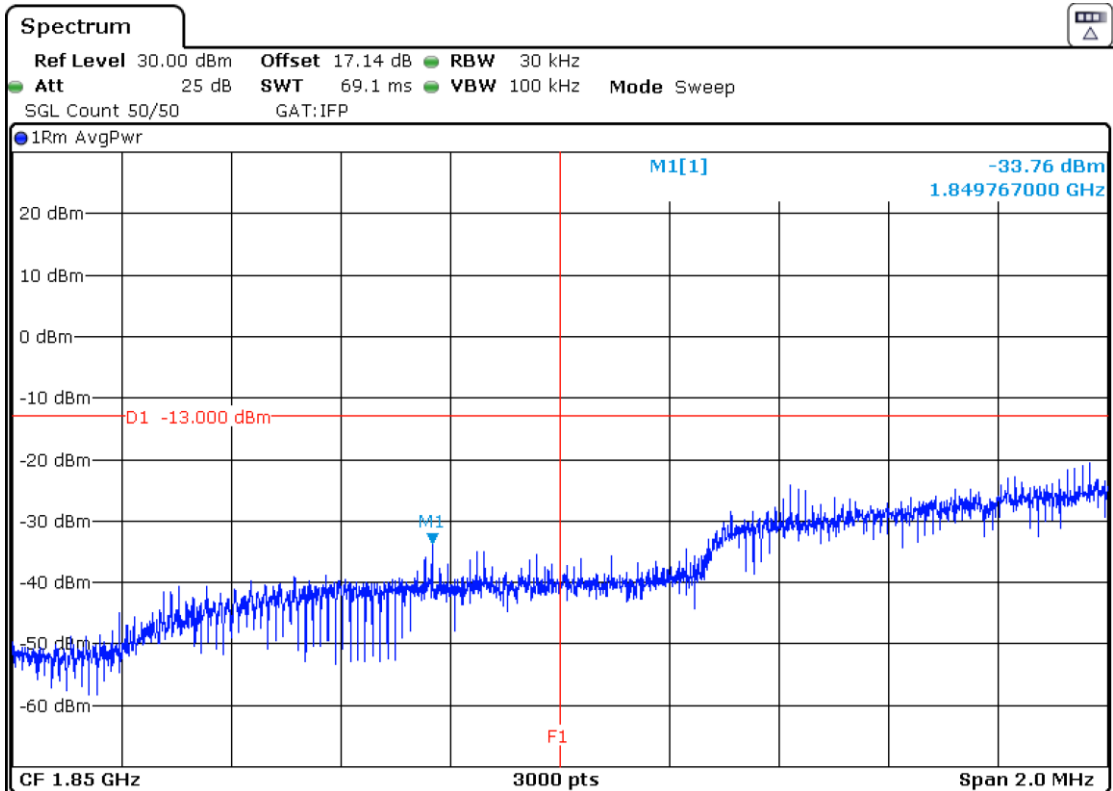
The equipment transmits at the maximum output power

LTE Band 25. QPSK MODULATION. BW=20 MHz. RB=1. Offset=0. Narrowband=0. Low Block Edge:



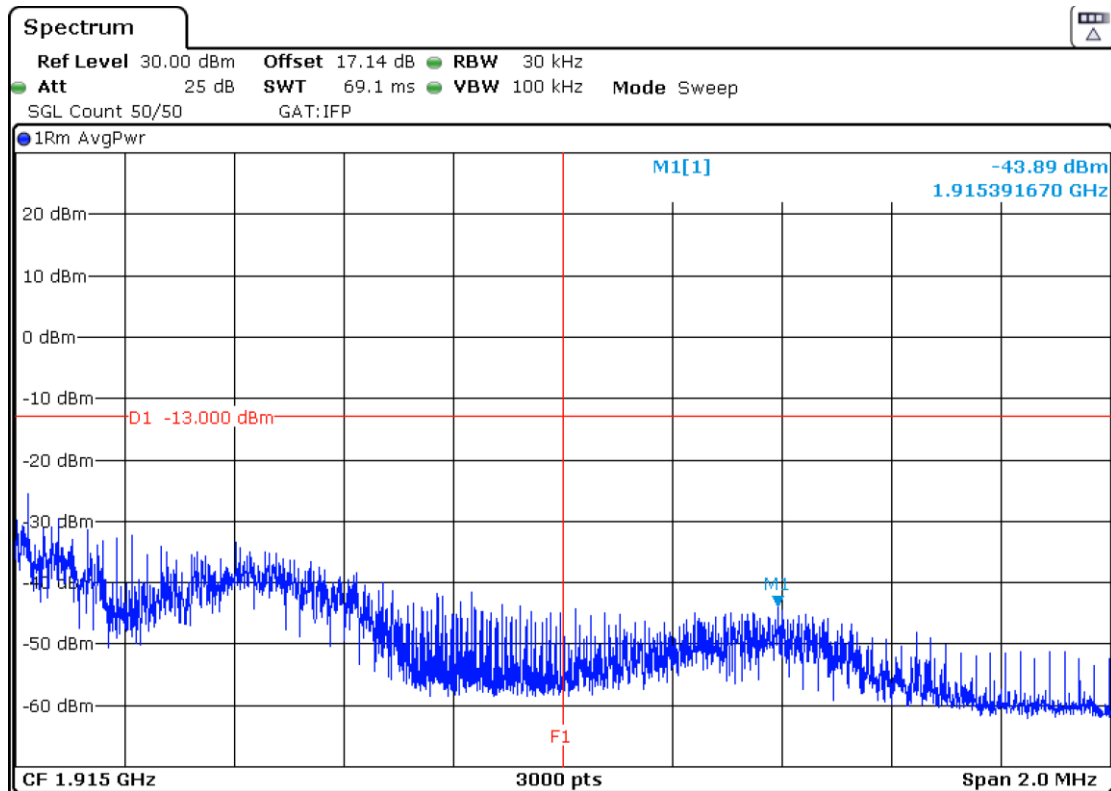
The equipment transmits at the maximum output power

LTE Band 25. QPSK MODULATION. BW=20 MHz. RB=All. Offset=0. Narrowband=0. Low Block Edge:



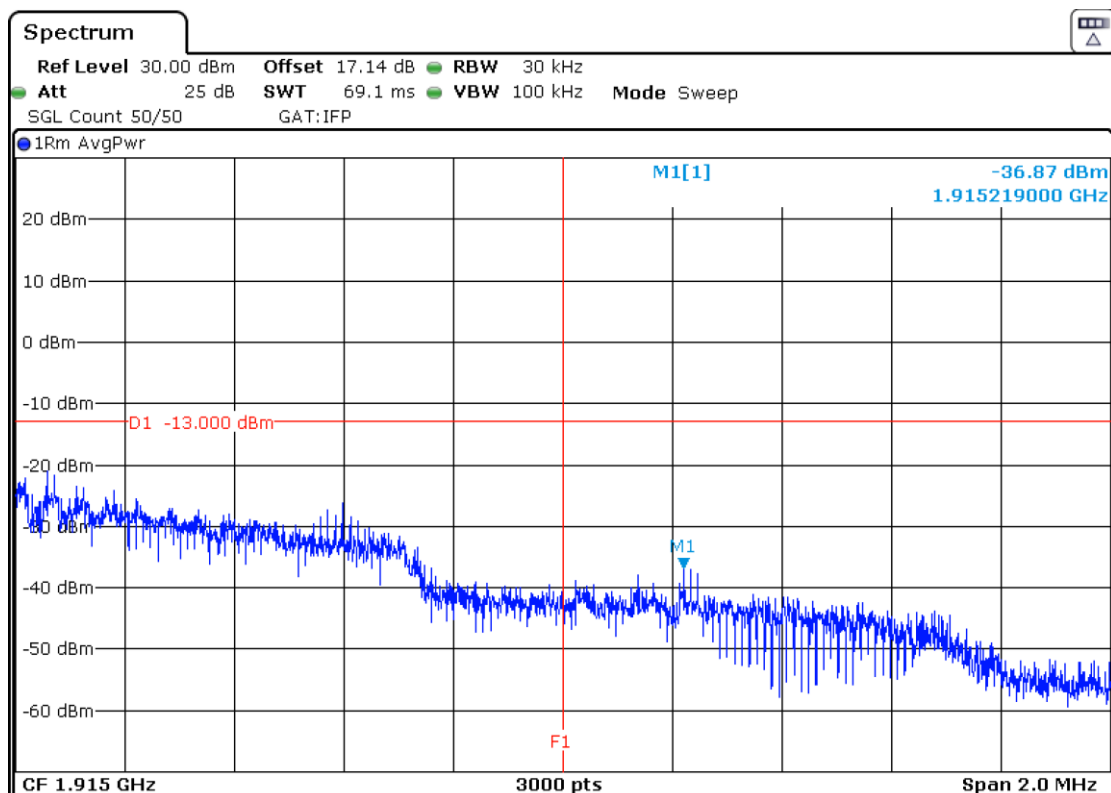
The equipment transmits at the maximum output power

LTE Band 25. QPSK MODULATION. BW=20 MHz. RB=1. Offset=Max. Narrowband=15. High Block Edge:



The equipment transmits at the maximum output power

LTE Band 25. QPSK MODULATION. BW=20 MHz. RB=All. Offset=0. Narrowband=15. High Block Edge:



The equipment transmits at the maximum output power

## Radiated Emissions

### SPECIFICATION

FCC §24.238. RSS-133, Clause 6.5.

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.

Compliance with these rules is based on the use of measurement instrumentation employing a resolution bandwidth of 1 MHz or greater.

At  $P_o$  transmitting power, the specified minimum attenuation becomes  $43 + 10 \log(P_o)$ , and the level in dBm relative to  $P_o$  becomes:

$$P_o \text{ (dBm)} - [43 + 10 \log(P_o \text{ in mW}) - 30] = -13 \text{ dBm}$$

### METHOD

The measurement was performed with the EUT inside an anechoic chamber. The spectrum was scanned from 30 MHz to at least the 10th harmonic of the highest frequency generated within the equipment.

The EUT was placed on a non-conductive stand at a 3-meter distance from the measuring antenna for measurements from 30 MHz up to 18 GHz. Distance is reduced to 1.5m for measurements above 18 GHz.

Detected emissions were maximized at each frequency by rotating the EUT and adjusting the height and polarization of the measuring antenna. The maximum meter reading was recorded.

The maximum field strength (dBμV/m) of each detected emission at less than 20 dB respect to the limit is converted to an equivalent EIRP level (dBm) according to ANSI C63.26 with the formula:

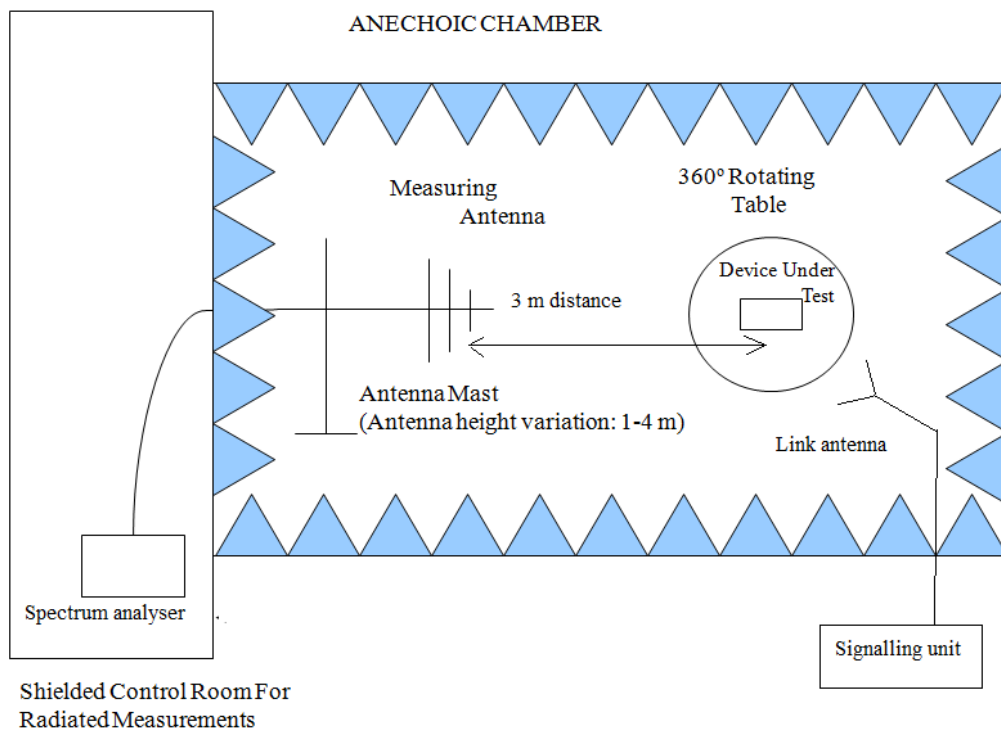
$$\text{EIRP (dBm)} = E(\text{dB}\mu\text{V/m}) + 20 \log(D) - 104.8$$

Where D is the measurement distance (in the far field region) in m.  $D = 3$  m.

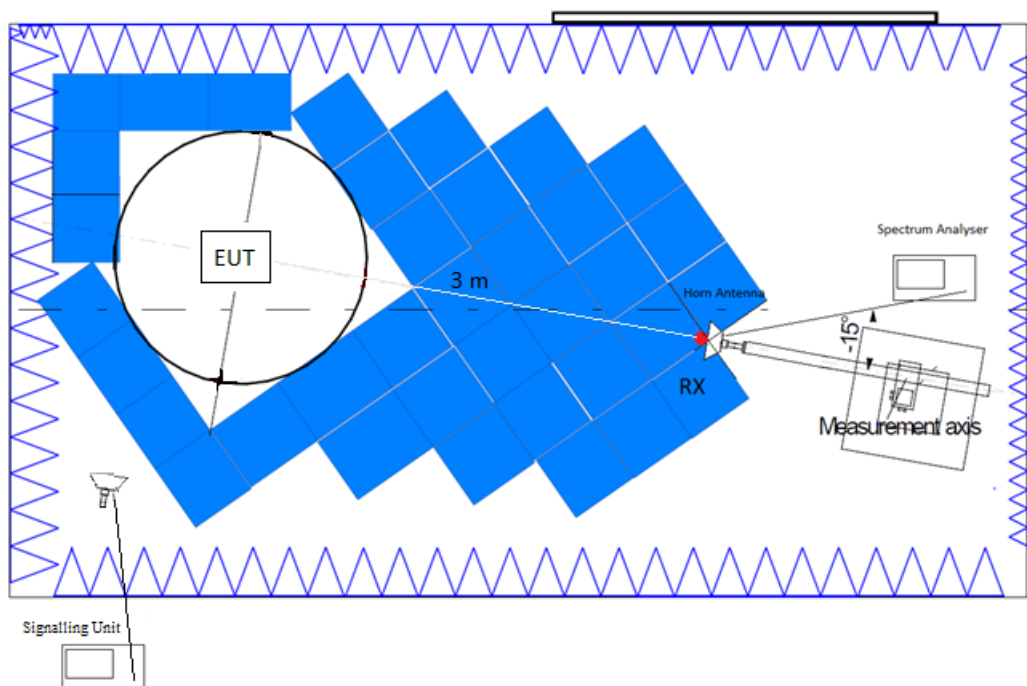
A resolution bandwidth / video bandwidth of 100 kHz / 300 kHz was used for frequencies below 1 GHz and 1 MHz / 3 MHz for frequencies above 1 GHz.

## TEST SETUP

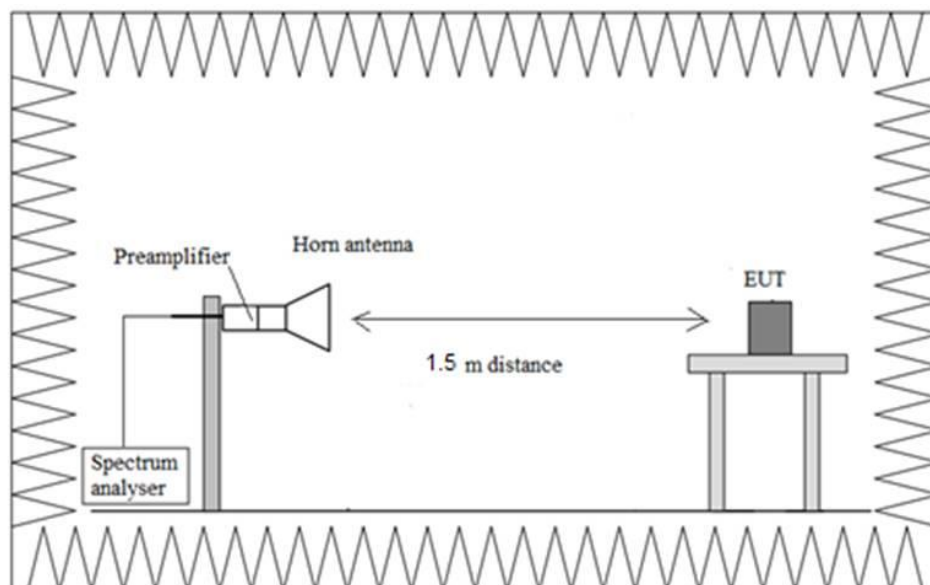
Radiated measurements below 1 GHz.



Radiated measurements between 1 GHz and 18 GHz.



Radiated measurements above 18 GHz.



## RESULTS:

### LTE Band 25:

Preliminary measurements determined QPSK modulation, Nominal Bandwidth of 20 MHz, RB Size 6, RB Offset 0, Narrowband 0 as the worst case in terms of RF Output Power and spurious emissions.

The next results are for this worst-case configuration.

#### - **Low Channel:**

##### **Frequency range 30 MHz – 1 GHz**

No spurious frequencies at less than 20 dB below the limit.

##### **Frequency range 1 GHz – 18 GHz**

Spurious frequencies at less than 20 dB below the limit:

| Spurious Frequency (GHz) | E.I.R.P (dBm) | Polarization | Detector |
|--------------------------|---------------|--------------|----------|
| 5.555780                 | -32.24        | V            | Peak     |

##### **Frequency range 18 GHz – 20 GHz**

No spurious frequencies at less than 20 dB below the limit.

#### - **Middle Channel:**

##### **Frequency range 30 MHz - 1 GHz**

No spurious frequencies at less than 20 dB below the limit.

##### **Frequency range 1 GHz – 18 GHz**

Spurious frequencies at less than 20 dB below the limit:

| Spurious Frequency (GHz) | E.I.R.P (dBm) | Polarization | Detector |
|--------------------------|---------------|--------------|----------|
| 5.622810                 | -28.78        | V            | Peak     |

##### **Frequency range 18 GHz – 20 GHz**

No spurious frequencies at less than 20 dB below the limit.

- **High Channel:**

**Frequency range 30 MHz – 1 GHz**

No spurious frequencies at less than 20 dB below the limit.

**Frequency range 1 GHz – 18 GHz**

Spurious frequencies at less than 20 dB below the limit:

| Spurious Frequency (GHz) | E.I.R.P (dBm) | Polarization | Detector |
|--------------------------|---------------|--------------|----------|
| 5.691240                 | -26.13        | V            | Peak     |

**Frequency range 18 GHz – 20 GHz**

No spurious frequencies at less than 20 dB below the limit.

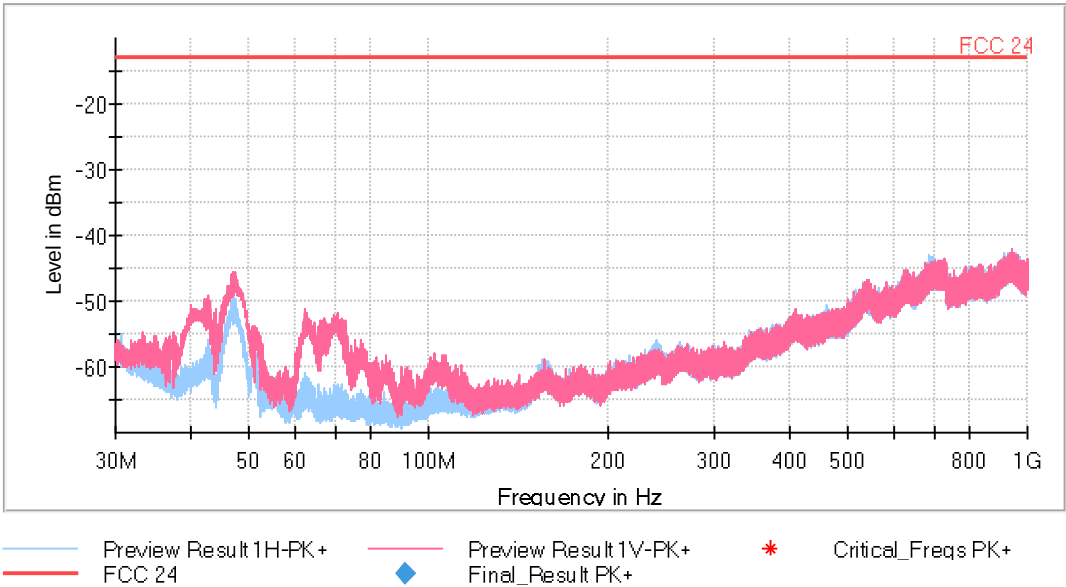
Measurement Uncertainty (dB):  
<± 4.89 for f ≥ 30 MHz up to 1 GHz  
<± 4.11 for f ≥ 1 GHz up to 3 GHz  
<± 5.13 for f ≥ 3 GHz up to 18 GHz  
<± 4.81 for f ≥ 18 GHz up to 20 GHz

Verdict: PASS



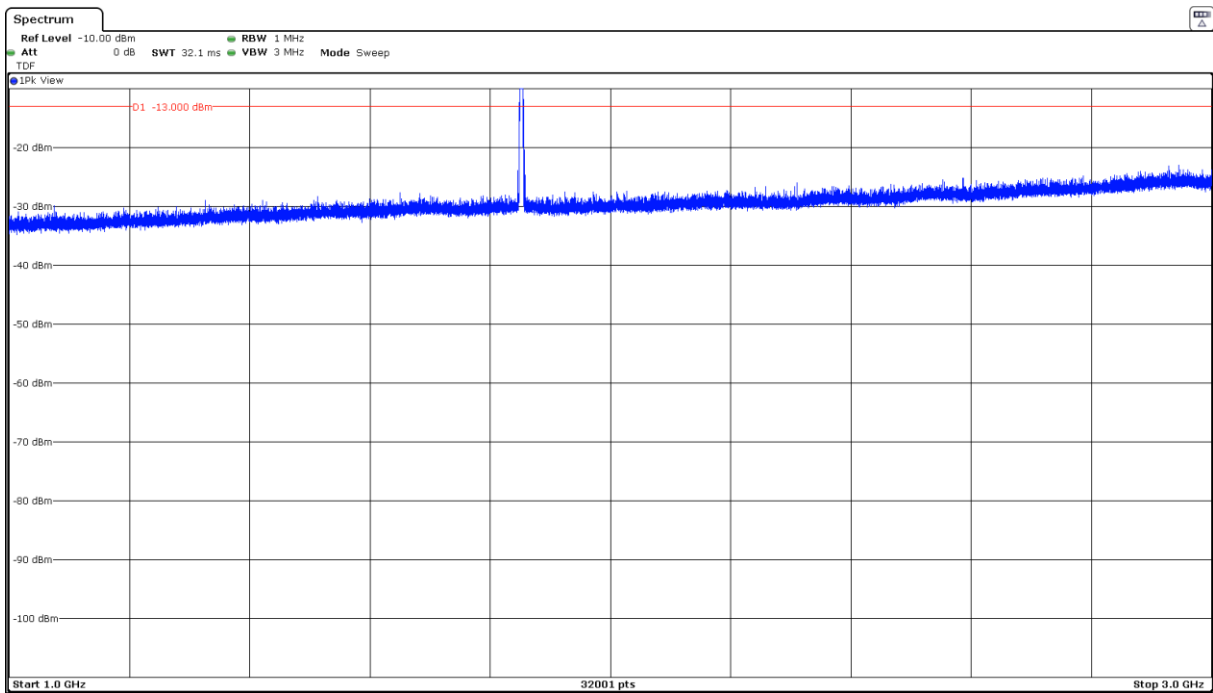
FREQUENCY RANGE 30 MHz –1 GHz

This plot is valid for the Low, Middle and High Channels:



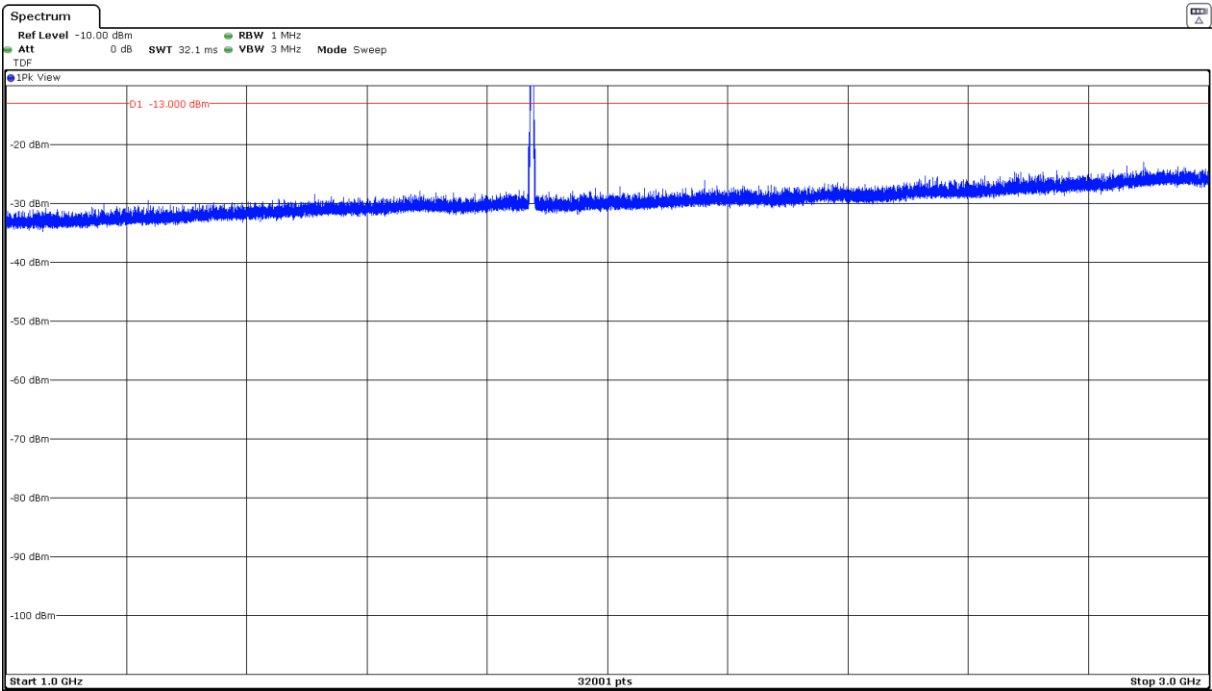
FREQUENCY RANGE 1 GHz – 3 GHz

- Low Channel:



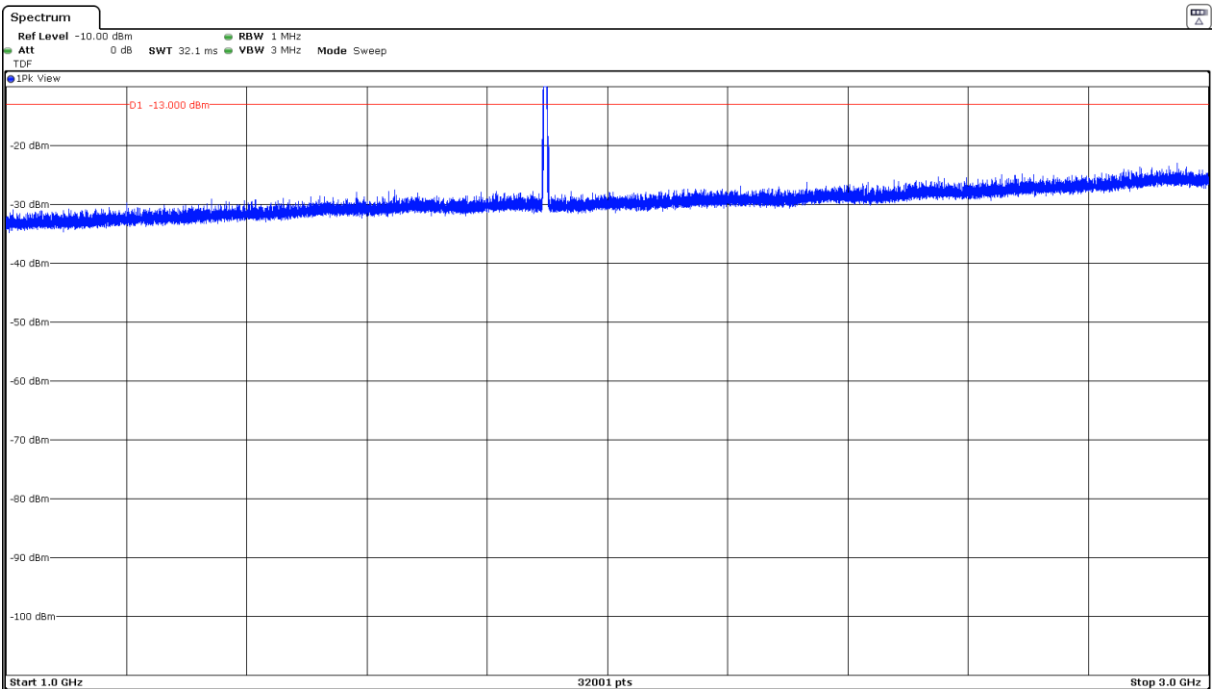
The peak above the limit is the carrier frequency.

- Middle Channel:



The peak above the limit is the carrier frequency.

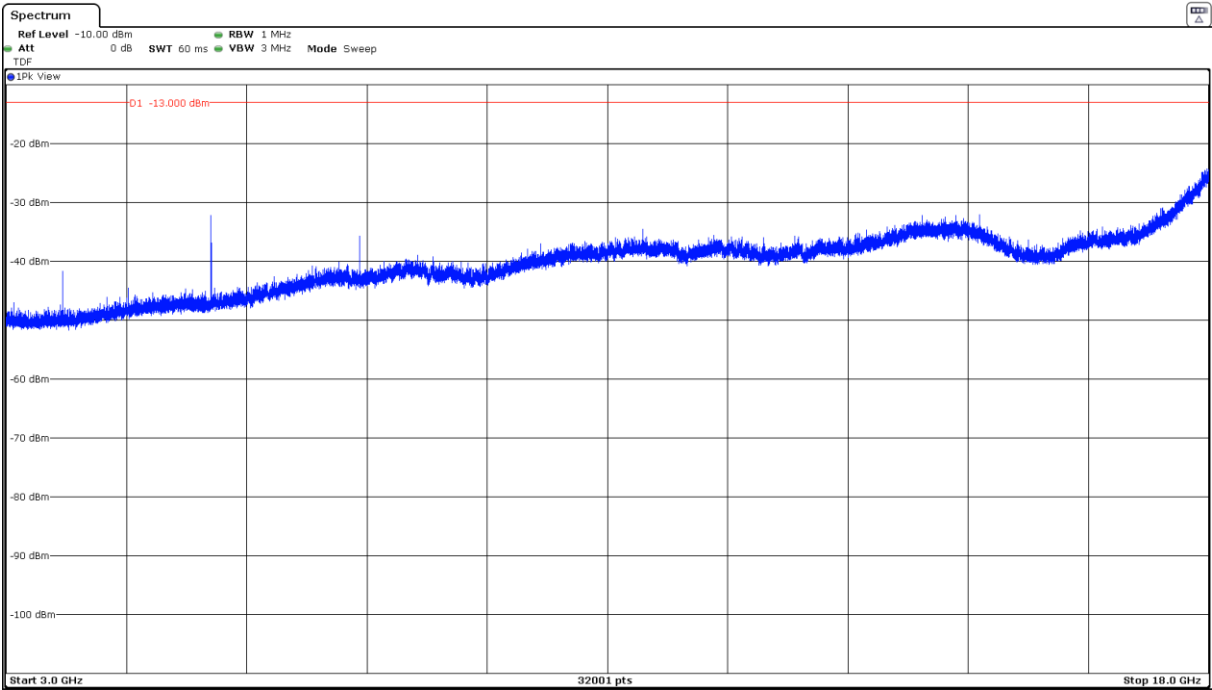
- High Channel:



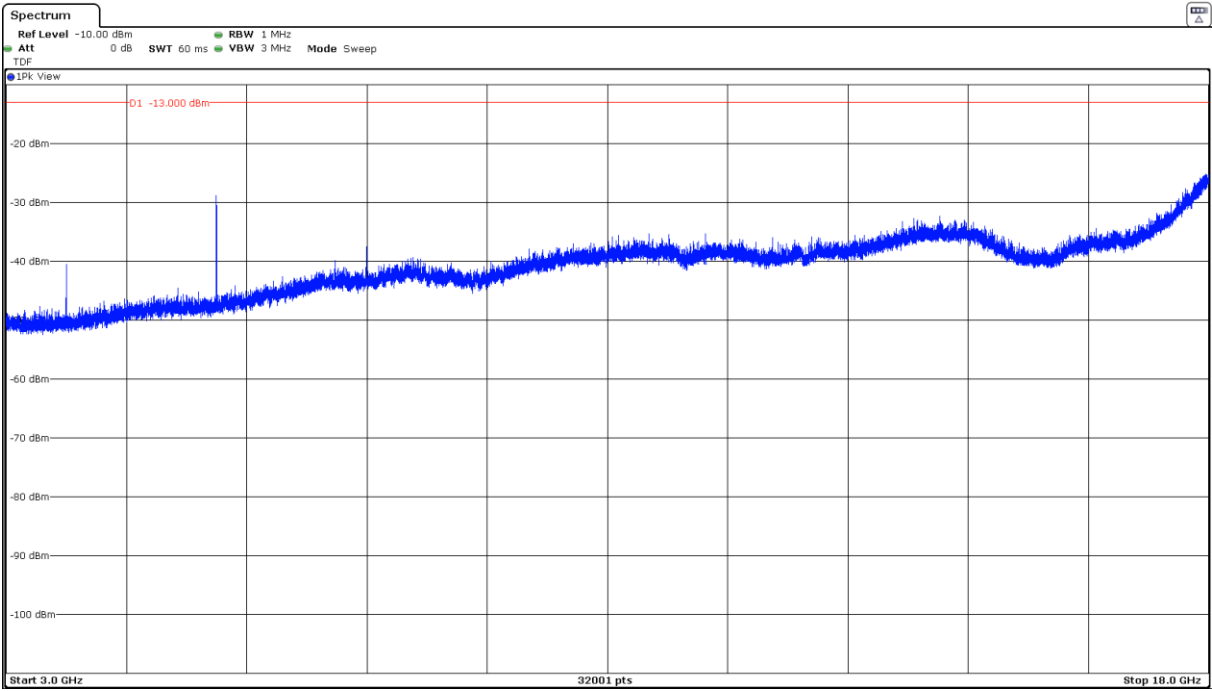
The peak above the limit is the carrier frequency.

FREQUENCY RANGE 3 GHz – 18 GHz

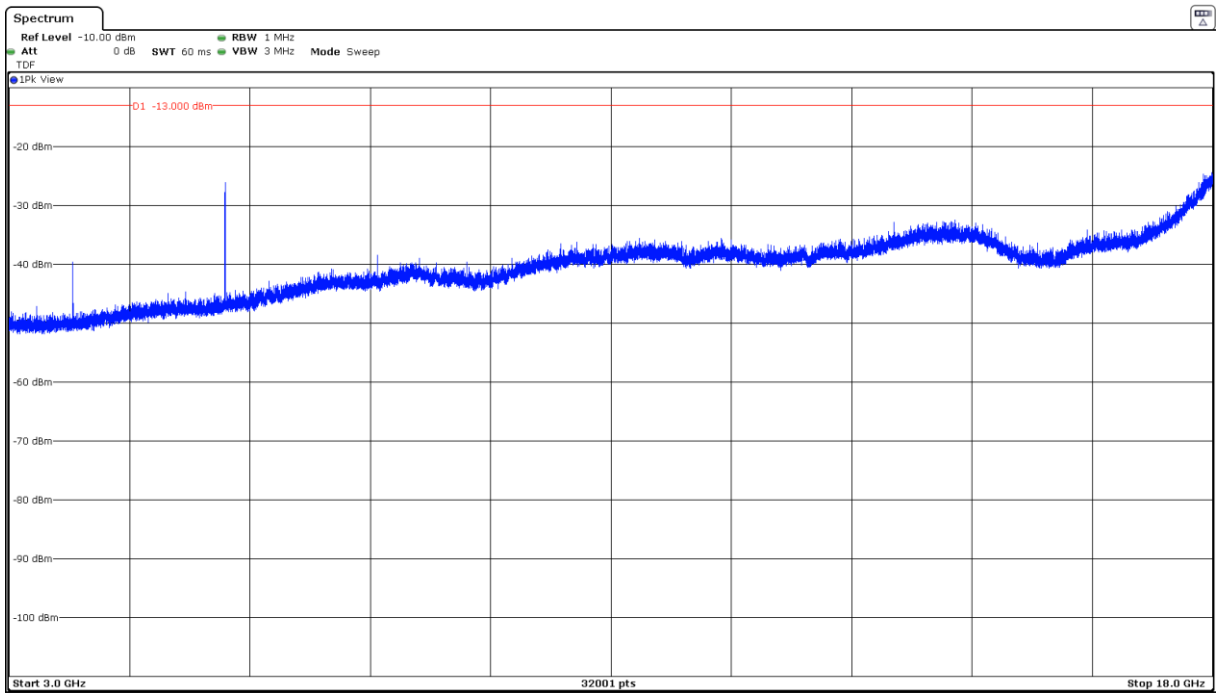
- Low Channel:



- Middle Channel:



- High Channel:



FREQUENCY RANGE 18 GHz – 20 GHz

This plot is valid for the Low, Middle and High Channels:

