**DEKRA Testing and Certification, S.A.U.**
Parque Tecnológico de Andalucía,
c/ Severo Ochoa nº 2 · 29590 Campanillas · Málaga · España
C.I.F. A29507456

Test Report No:
75461RRF.004

# Test Report
## USA FCC Part 90
## CANADA RSS-140

| | |
|---|---|
| (*) Identification of item tested | LTE Cat 1bis module |
| (*) Trademark | Sequans Communications |
| (*) Model and /or type reference | GC02S1-NA2 |
| Other identification of the product | FCC ID: 2AAGMGC02SA<br>IC: 12732A-GC02SA |
| (*) Features | 4G LTE module<br>HW version: Rev1<br>SW version: LR9.0.1.1-59215 |
| Applicant | SEQUANS COMMUNICATIONS<br>55 Boulevard Charles de Gaulle, 92700 Colombes, France |
| Test method requested, standard | USA FCC Part 90 (10-1-21 Edition).<br>CANADA RSS-140 Issue 1, April 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) | José Manuel Gómez Galván<br>EMC Consumer & RF<br>Lab. Manager<br>Firmado digitalmente por 53680346W JOSE MANUEL GOMEZ (C:A29507456) Fecha: 2023.11.09 15:09:21 +01'00' |
| Date of issue | 2023-11-08 |
| Report template No | FDT08_24<br>(*) "Data provided by the client" |

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# Competences and guarantees

DEKRA Testing and Certification is a testing laboratory accredited by the National Accreditation Body (ENAC - Entidad Nacional de Acreditación) to perform the tests indicated in the Certificate No. 51/LE 147.

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

In order to assure the traceability to other national and international laboratories, DEKRA Testing and Certification has a calibration and maintenance program for its measurement equipment.

DEKRA Testing and Certification guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and it is based on the knowledge and technical facilities available at DEKRA Testing and Certification at the time of performance of the test.

DEKRA Testing and Certification is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

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

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# Uncertainty

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

# Data provided by the client

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 model is GC02S1-NA2. The Calliope 2 GC02S1 modules are based on Sequans's second-generation Calliope 2 silicon and delivers optimized 4G LTE Cat 1 connectivity for IoT, M2M and consumer devices such as wearables and hearables that require voice support and speed higher than 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 |
|---|---|---|---|---|
| 75461B/005 * | LTE Cat 1bis module | GC02S1-NA2 | C2E230509001024 | 21-07-2023 |
| 75461B/008 | Antenna Cable | - | - | 21-07-2023 |
| 75461B/004 ** | LTE Cat 1bis module | GC02S1-NA2 | C2E230509001008 | 21-07-2023 |

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

* : Used in the conducted tests, but the PAPR and Spurious Emissions at Antenna Terminals tests.

**: Used in the PAPR and Spurious Emissions at Antenna Terminals tests.

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

| Control Nº | Description | Model | Serial Nº | Date of reception |
|---|---|---|---|---|
| 75461B/004 | LTE Cat 1bis module | GC02S1-NA2 | C2E230509001008 | 21-07-2023 |
| 75461B/001 | Antenna | OmniLOG 90200 | 20200100252 | 21-07-2023 |
| 75461B/012 | Antenna Cable | - | - | 21-07-2023 |

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(3) | |
| | USB | | | ☒ | ☐ | ☐ | |
| Supplementary information to the ports……: | - | | | | | | |
| Rated power supply ..... : | Voltage and Frequency | | Reference poles | | | | |
| | | | L1 | L2 | L3 | N | PE |
| | ☐ | AC: | ☐ | ☐ | ☐ | ☐ | ☐ |
| | ☒ | DC: 3.2 to 5.5 V | | | | | |
| Rated Power..... : | - | | | | | | |
| Clock frequencies..... : | - | | | | | | |
| Other parameters ..... : | - | | | | | | |
| Software version..... : | LR9.0.1.1-59215 | | | | | | |
| Hardware version ..... : | Rev1 | | | | | | |

| | | | | |
|---|---|---|---|---|
| Dimensions in cm (W x H x D) ... : | 21 x 1.8 x 19.5 mm | | | |
| Mounting position ..... : | ☒ | Table top equipment | | |
| | ☐ | Wall/Ceiling mounted equipment | | |
| | ☐ | Floor standing equipment | | |
| | ☐ | Hand-held equipment | | |
| | ☐ | Other: | | |
| Modules/parts..... : | Module/parts of test item | | Type | Manufacturer |
| | - | | - | - |
| Accessories (not part of the test item) ..... : | Description | | Type | Manufacturer |
| | USB Cables | | USB | - |
| | Antennas | | Antenna | - |
| 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)** | 2023-08-16 |
| **Date (finish)** | 2023-09-13 |

## Document history

| Report number | Date | Description |
|---|---|---|
| 75461RRF.004 | 2023-11-08 | First release. |

## Environmental conditions

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

| | |
|---|---|
| **Temperature** | Min. = 15 ºC<br>Max. = 35 ºC |
| **Relative humidity** | Min. = 20 %<br>Max. = 75 % |

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

| | |
|---|---|
| **Temperature** | Min. = 15 ºC<br>Max. = 35 ºC |
| **Relative humidity** | Min. = 20 %<br>Max. = 75 % |

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

| | |
|---|---|
| **Temperature** | Min. = 15 ºC<br>Max. = 35 ºC |
| **Relative humidity** | Min. = 20 %<br>Max. = 75 % |

# Remarks and comments

The tests have been performed by the technical personnel: Fernando Chito, Pablo Redondo, Carmen Vázquez, Ireneo Bibang, Antonio Maireles, Rafael Fernández.

Used instrumentation:

| Control No. | Equipment | Model | Manufacturer | Next Calibration |
|---|---|---|---|---|
| 6794 | Shielded Room | S101 | ETS LINDGREN | N/A |
| 8002 | TEMPERATURE CHAMBER MK56 BINDER | MK 56 | BINDER | 2024-04 |
| 6157 | Signal and Spectrum Analyzer 10 Hz - 40 GHz | FSV40 | ROHDE AND SCHWARZ | 2023-10 |
| 9229 | Wideband Radio Communication Tester | CMW500 | ROHDE AND SCHWARZ | 2024-06 |
| 6254 | Attenuator 6 dB 2W DC-26.5 GHz | TWSMAG2 | TECHNIWAVE | 2024-03 |
| 2214 | Power Divider DC-25 GHz | 5333-104 | PICOSECOND PULSE LABS | 2023-12 |
| 7798 | EMC/RF MEASUREMENT SOFTWARE | WMS32 | ROHDE AND SCHWARZ | N/A |
| 6791 | SEMIANECHOIC ABSORBER LINED | FACT 3 200 STP | ETS LINDGREN | N/A |
| 6792 | SHIELDED ROOM | S101 | ETS LINDGREN | N/A |
| 6143 | Biconical/Log Antenna 30 MHz - 6 GHz | 3142E | ETS LINDGREN | 2023-10 |
| 7763 | HORN ANTENNA 1-18GHz | BBHA 9120 D | SCHWARZBECK | 2026-01 |
| 7817 | EMI TEST RECEIVER 2Hz-44GHz | ESW44 | ROHDE AND SCHWARZ | 2023-12 |
| 3783 | PRE-AMPLIFIER G>30dB 1GHz-18GHz | BLMA 0118-3A | BONN ELEKTRONIK | 2023-12 |
| 6144 | RF Preamplifier 40 dB, 10 MHz - 6 GHz | BLNA 0160-01N | BONN ELEKTRONIK | 2024-07 |
| 9227 | Wideband Radio Communication Tester | CMW500 | ROHDE AND SCHWARZ | 2024-07 |
| 7760 | Digital Multimeter | 175 | FLUKE | 2023-11 |
| 4848 | SOFTWARE FOR EMC/RF TESTING | EMC32 | ROHDE AND SCHWARZ | N/A |

# Testing verdicts

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

# Summary

## LTE Cat 1bis Band 14.

| FCC PART 90 / RSS-140 PARAGRAPH | | |
|---|---|---|
| **Requirement – Test case** | **Verdict** | **Remark** |
| FCC 90.542 (a) (7) / RSS-140 Clause 4.3: Transmitter output power: RF output power | P | |
| FCC 2.1047 / RSS-140 Clause 4.1: Modulation characteristics | P | |
| FCC 90.213 / RSS-140 Clause 4.2: Frequency stability | P | |
| FCC 2.1049 / RSS-Gen Clause 6.7: Occupied bandwidth (or 99% emission bandwidth) | P | |
| FCC 90.691 / RSS-140 Clause 4.4: Spurious emissions at antenna terminals | P | |
| FCC 90.691 / RSS-140 Clause 4.4: Spurious emissions at antenna terminals (Emission mask requirements for EA-based systems) | P | |
| FCC 90.691 / RSS-140 Clause 4.4: Radiated emissions | P | |
| Supplementary information and remarks:<br>None. | | |

# Appendix A: Test results for FCC 90 / RSS-140: LTE Cat 1bis Band 14

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# TEST CONDITIONS

(*): Declared by the Applicant.

POWER SUPPLY (*):

Vnominal: 3.2 Vdc
Vminimum: 3.8 Vdc
Vmaximum: 5.5 Vdc

Type of Power Supply: DC External.

ANTENNA (*):

| Bands | Gain (dBi) | Type |
|---|---|---|
| LTE Cat 1bis Band 14 | +2 | External (OmniLOG 90200) |
| LTE Cat 1bis Band 14 | +1.1 dBi | Internal (FR01-S4-210) |

Note: Pre-scan determines that external antenna is the worst case in terms of radiated spurious emissions.

TEST FREQUENCIES:

LTE Cat 1bis Band 14. QPSK and 16QAM:

| | Channel (Frequency, MHz) | |
|---|---|---|
| | BW=5 MHz | BW=10 MHz |
| Low | 23305 (790.5) | N/A |
| Middle | N/A | 23330 (793) |
| High | 23355 (795.5) | N/A |

# RF Output Power

***Limits***

**1. LTE Cat 1bis Band 14:**

* FCC § 90.542 (a) (7):

(a) The following power limits apply to the 763-768 / 793-798 MHz band:

(7) Portable stations (hand-held devices) transmitting in the 763-768 MHz band and the 793-798 MHz band are limited to 3 watts ERP.

* RSS-140 Clause 4.3: The equivalent radiated power (e.r.p.) for control and mobile equipment shall not exceed 30 W. The e.r.p. for portable equipment including handheld devices shall not exceed 3 W.

Fixed and base station equipment shall comply with the e.r.p. limits in SRSP-540.

In addition, the peak to average power ratio (PAPR) of the equipment shall not exceed 13 dB for more than 0.1% of the time, using a signal that corresponds 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).

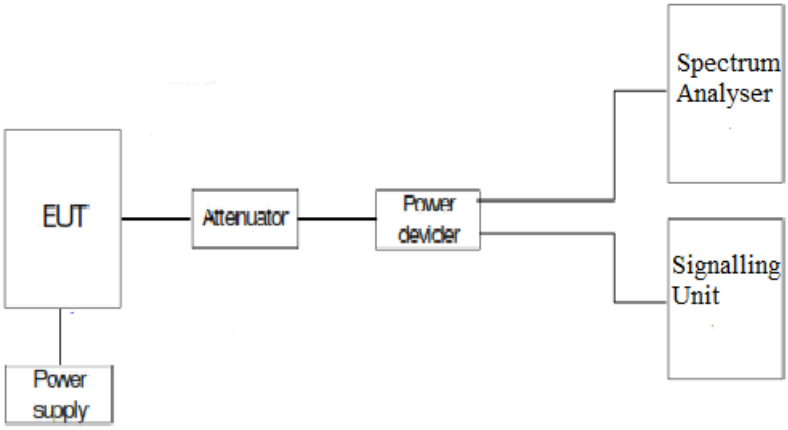
The maximum effective radiated power e.r.p. is calculated from the maximum equivalent isotropically radiated power (e.i.r.p.) by subtracting 2.15 dB:

E.R.P. = E.I.R.P. - 2.15 dB

***Test Setup***

1. CONDUCTED AVERAGE POWER:

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



***Results***

## 1. CONDUCTED AVERAGE POWER:

Measurements required on one frequency near top channel and one frequency near bottom channel, according to FCC § 15.31 (m).

LTE Cat 1bis Band 14:

Worst-case of RF Power is BW=5 MHz, Low Channel, QPSK, RB Size=1, RB Offset=0.

| BANDWIDTH (MHz) | CHANNEL | FREQUENCY (MHz) | MODULATION | RB SIZE | RB OFFSET | AVERAGE POWER (dBm) |
|---|---|---|---|---|---|---|
| | Low 23305 | 790.5 | QPSK | 1 | 0 | 23.07 |
| | | | | 1 | 12 | 22.98 |
| | | | | 1 | 24 | 22.52 |
| | | | | 12 | 0 | 21.95 |
| | | | | 12 | 6 | 21.9 |
| | | | | 12 | 11 | 21.83 |
| | | | | 25 | 0 | 21.87 |
| | | | 16-QAM | 1 | 0 | 22.1 |
| | | | | 1 | 12 | 22.03 |
| | | | | 1 | 24 | 21.62 |
| | | | | 12 | 0 | 20.89 |
| | | | | 12 | 6 | 20.82 |
| | | | | 12 | 11 | 20.74 |
| | | | | 25 | 0 | 20.78 |
| | High 23355 | 795.5 | QPSK | 1 | 0 | 22.66 |
| | | | | 1 | 12 | 22.55 |
| | | | | 1 | 24 | 22.56 |
| | | | | 12 | 0 | 21.45 |
| | | | | 12 | 6 | 21.33 |
| | | | | 12 | 11 | 21.41 |
| | | | | 25 | 0 | 21.34 |
| | | | 16-QAM | 1 | 0 | 21.61 |
| | | | | 1 | 12 | 21.5 |
| | | | | 1 | 24 | 21.53 |
| | | | | 12 | 0 | 20.37 |
| | | | | 12 | 6 | 20.27 |
| | | | | 12 | 11 | 20.35 |
| | | | | 25 | 0 | 20.36 |

BW=5 MHz. QPSK:

| MAX POWER | QPSK COND. POWER AVG (dBm) | ANTENNA GAIN (dBi) | RAD. POWER AVG EIRP(dBm) | RAD. POWER AVG ERP(dBm) |
|---|---|---|---|---|
| LOW | 23.07 | 2 | 25.07 | 22.92 |
| HIGH | 22.66 | 2 | 24.66 | 22.51 |
| MAX: | 23.07 | | 25.07 | 22.92 |

BW=5 MHz. 16QAM:

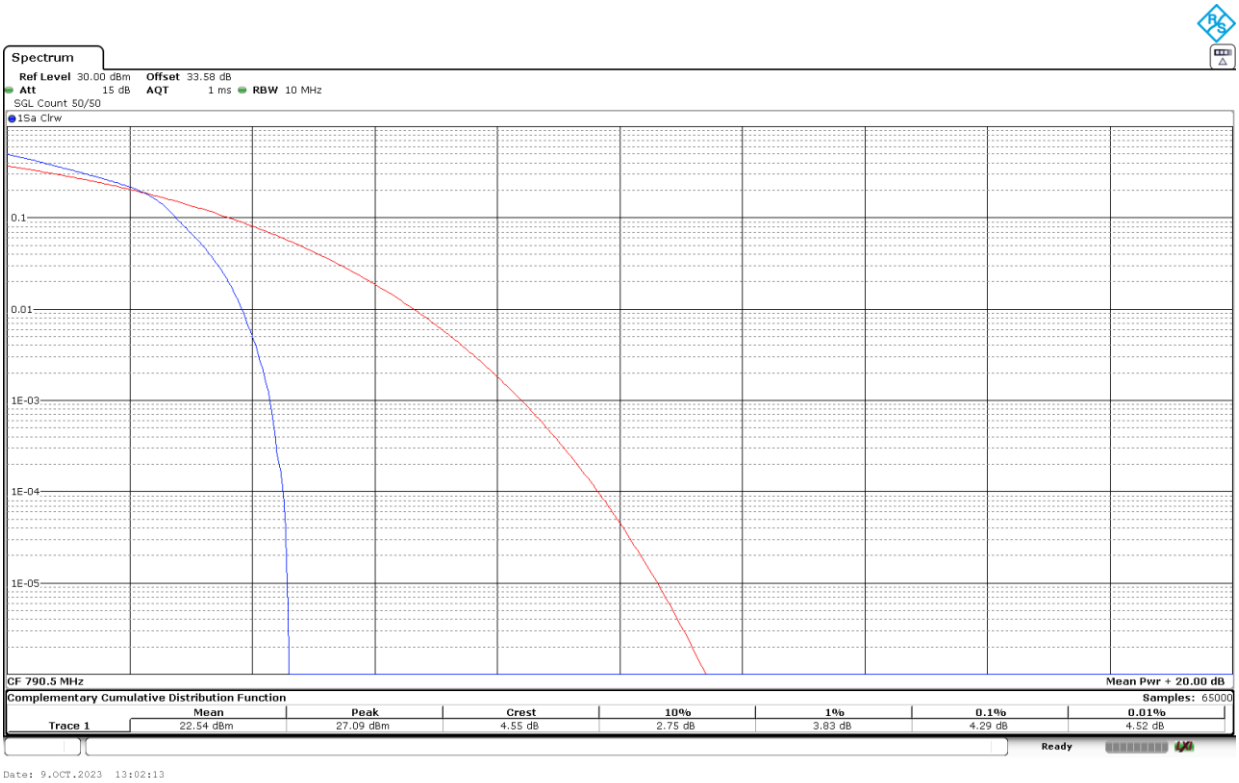
| MAX POWER | 16QAM COND. POWER AVG (dBm) | ANTENNA GAIN (dBi) | RAD. POWER AVG EIRP(dBm) | RAD. POWER AVG ERP(dBm) |
|---|---|---|---|---|
| LOW | 22.1 | 2 | 24.1 | 21.95 |
| HIGH | 21.61 | 2 | 23.61 | 21.46 |
| MAX: | 22.1 | | 24.1 | 21.95 |

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

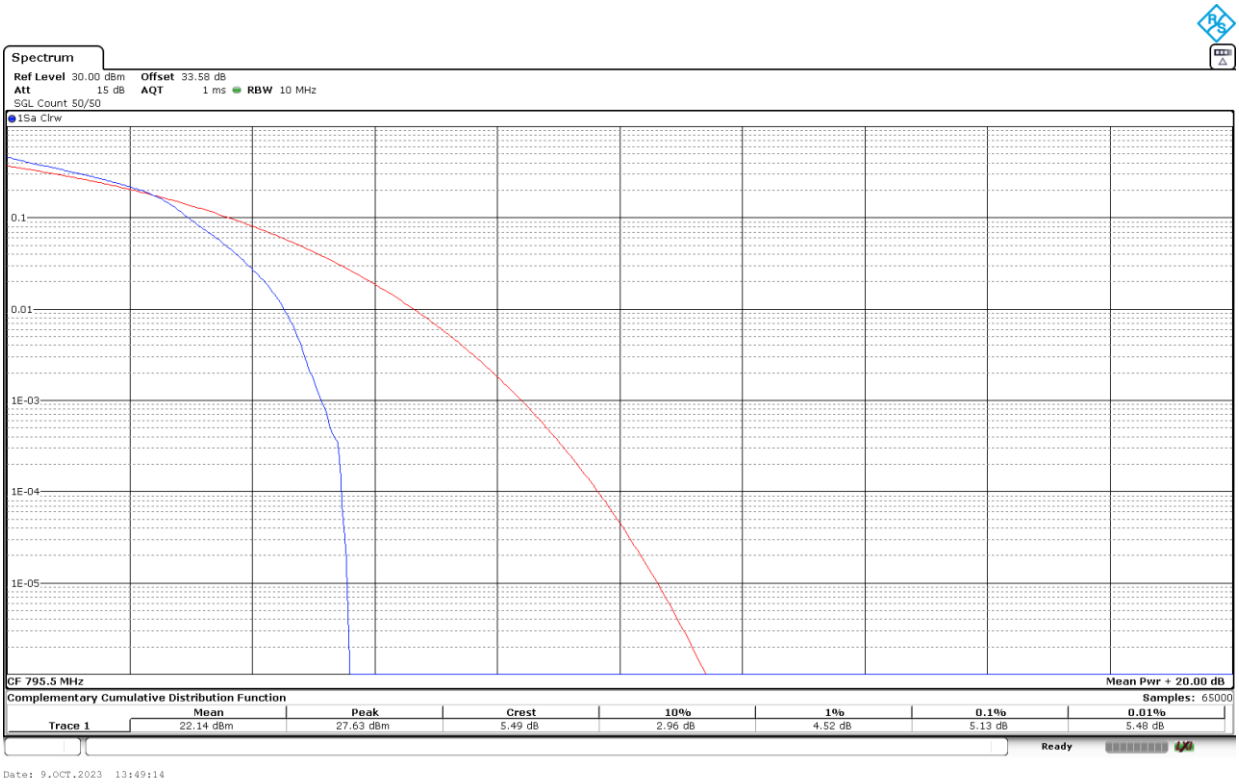
LTE Cat 1bis Band 14:

Preliminary measurements determined the worst case of PAPR is BW=5 MHz, High Channel, 16QAM, RB Size=12, RB Offset=0.

Low Channel:




High Channel:



| 16QAM | Low | High |
|---|---|---|
| PAPR (dB) | 4.29 | 5.13 |

Measurement uncertainty (dB) <±1.11

***Verdict***

Pass

# Frequency Stability

***Limits***

**1. LTE Cat 1bis Band 14:**

* FCC § 2.1055:

(a) The frequency stability shall be measured with variation of ambient temperature as follows:

(1) From -30° to +50° centigrade for all equipment except that specified in paragraphs (a) (2) and (3) of this section.

(b) Frequency measurements shall be made at the extremes of the specified temperature range and at intervals of not more than 10° centigrade through the range. A period of time sufficient to stabilize all of the components of the oscillator circuit at each temperature level shall be allowed prior to frequency measurement. The short term transient effects on the frequency of the transmitter due to keying (except for broadcast transmitters) and any heating element cycling normally occurring at each ambient temperature level also shall be shown. Only the portion or portions of the transmitter containing the frequency determining and stabilizing circuitry need be subjected to the temperature variation test.

(c) 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.

* RSS-140 Clause 4.2:

The frequency stability shall be sufficient to ensure that the occupied bandwidth stays within the operating frequency block when tested at the temperature and supply voltage variations specified in RSS-Gen.

***Method***

The frequency tolerance measurements over temperature variations were made over the temperature range of –30ºC to +50ºC. The EUT was placed inside a climatic chamber and the temperature was raised hourly in 10ºC steps from –30ºC up to +50ºC.
The supply voltage was varied between 85% and 115% of nominal voltage.

The EUT was set in “Radio Resource Control (RRC) mode” in 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.

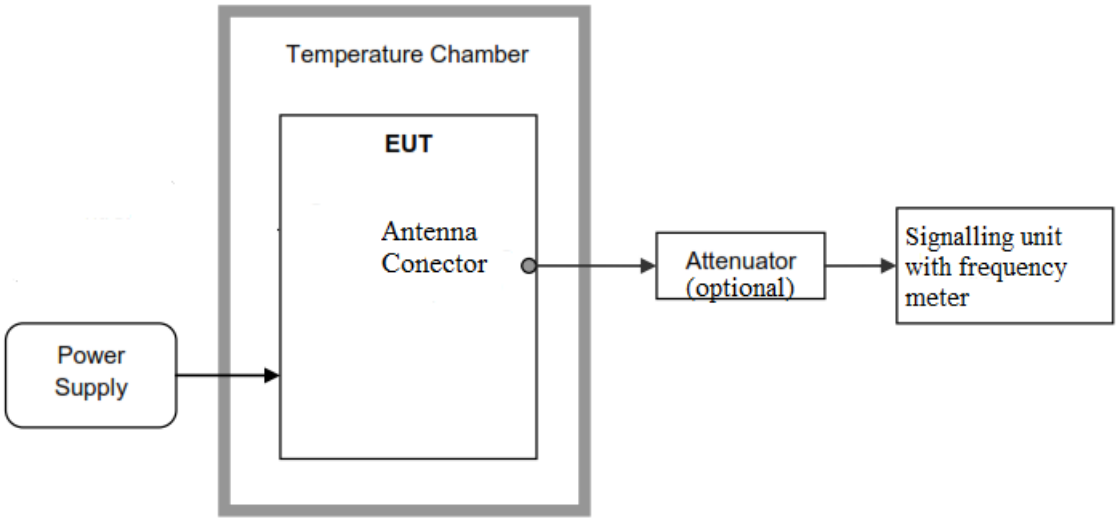
In order to check that the frequency stability is sufficient such that the fundamental emissions stay within the authorized bands of operation, a reference point is established at the applicable unwanted emissions limit using a RBW equal to the RBW required by the unwanted emissions specification of the applicable regulatory standard. These reference points measured using the Low and High channel 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.

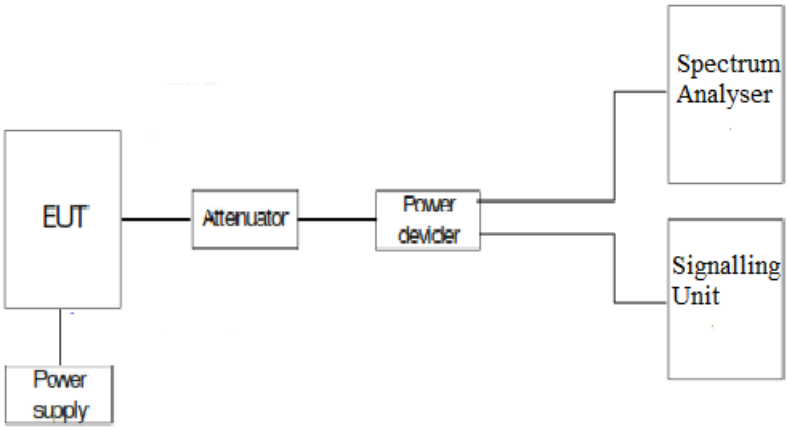
The reference point measurements were made at the RF output terminals of the EUT using an attenuator. power splitter and spectrum analyser. The EUT was controlled via the Universal Radio Communication tester R&S CMW500 selecting maximum transmission power of the EUT and different modes of modulation.

***Test Setup***

1. Frequency Tolerance:




2. Reference Frequency Points fL and fH:



***Results***

**LTE Cat 1bis Band 14:**

The worst case modulation in terms of Frequency Stability is BW=10 MHz, QPSK, RB Size=1, RB Offset=0.

**1. Frequency Tolerance:**

- **Frequency Stability over Temperature Variations:**

| Temperature (ºC) | Frequency Error (Hz) | Frequency Error (ppm) |
|---|---|---|
| +85 | 1,44 | 0,001815889 |
| +80 | 5,49 | 0,006923077 |
| +70 | 2,23 | 0,002812106 |
| +60 | 2,92 | 0,003682219 |
| +50 | 4.62 | 0.005825977 |
| +40 | 2.75 | 0.003467844 |
| +30 | 2.26 | 0.002849937 |
| +20 | 4.09 | 0.005157629 |
| +10 | 3.46 | 0.004363178 |
| 0 | 5.31 | 0.006696091 |
| -10 | 3.45 | 0.004350567 |
| -20 | 3.36 | 0.004237074 |
| -30 | 5.96 | 0.007515763 |

- **Frequency Stability over Voltage Variations.**

| Battery Supply voltage | Voltage (V) | Frequency Error (Hz) | Frequency Error (ppm) |
|---|---|---|---|
| Vmax | 5.5 | 6.17 | 0.00778058 |
| Vmin (*) | 3.2 | 5.29 | 0.00667087 |

**2. Reference Frequency Points fL and fH:**

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

| | |
|---|---|
| *f*L (MHz) | 788.0114 |
| *f*H (MHz) | 797.9663 |

The reference frequency points fL and fH stay within the authorized blocks for all the band above.

Measurement uncertainty (Hz) <± 249.55

***Results***

PASS

# Modulation Characteristics

***Limits***

**1. LTE Cat 1bis Band 14:**

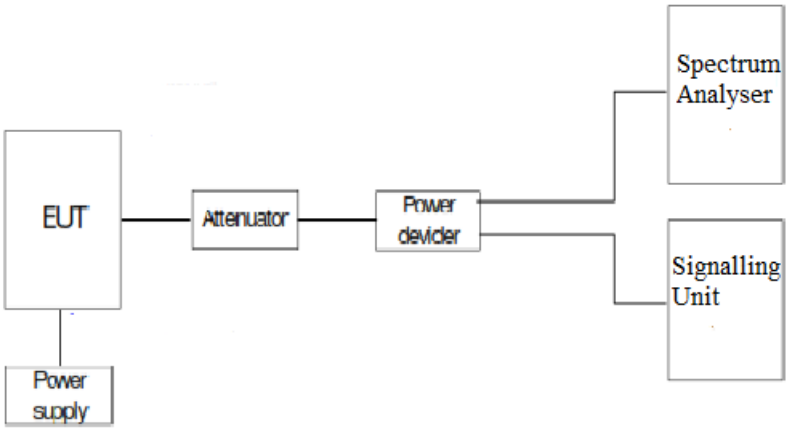
* FCC § 2.1047: Measurements required: Modulation characteristics.

* RSS-140 Clause 4.1: Equipment shall employ digital modulation techniques.

***Method***

For LTE the EUT operates with QPSK and 16QAM 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).

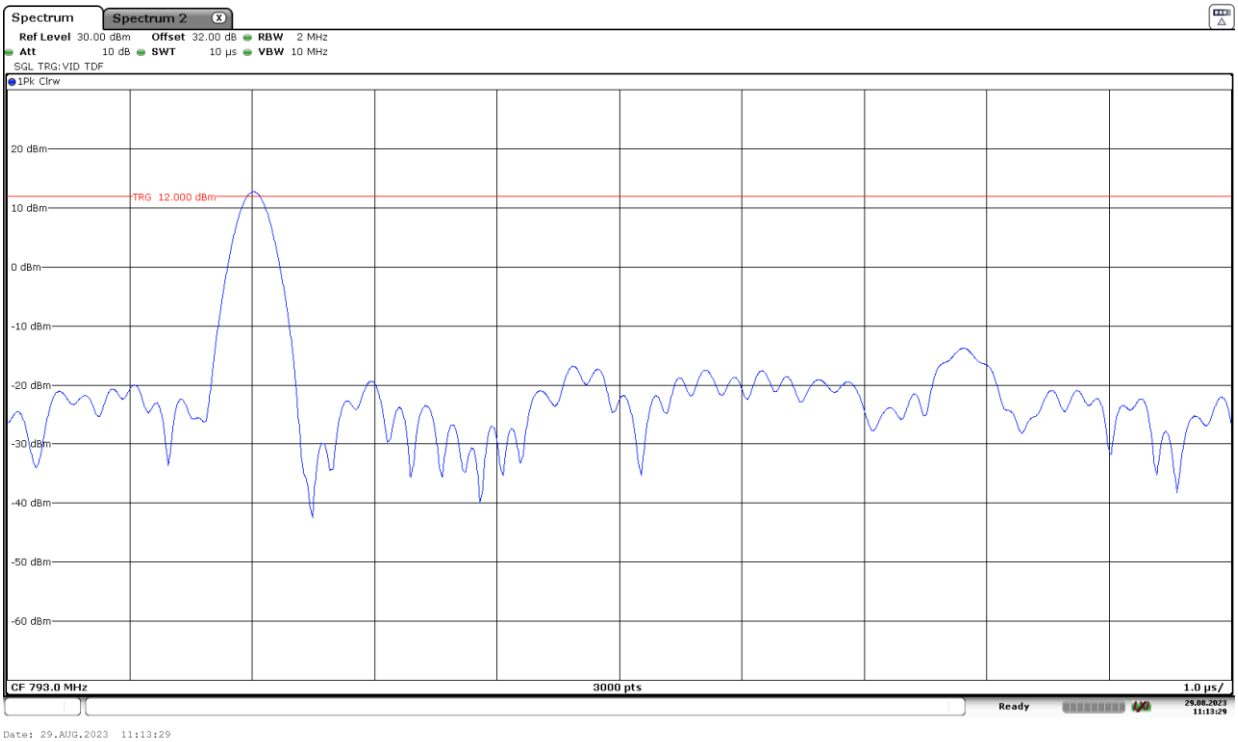
***Test Setup***



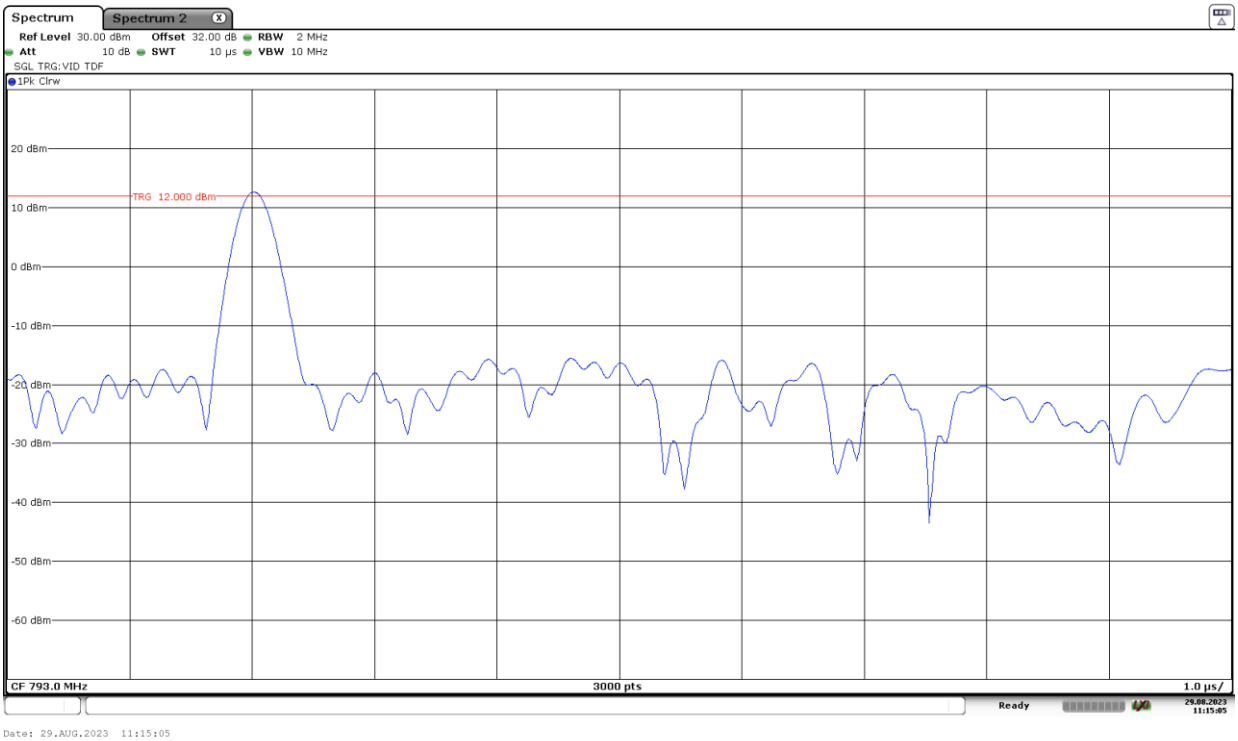
### *Results*

The following plots show the modulation schemes in the EUT.

**LTE Cat 1bis Band 14**: BW=10 MHz. QPSK.




**LTE Cat 1bis Band 14**: BW=10 MHz. 16QAM.



# Occupied Bandwidth

***Limits***

**1. LTE Cat 1bis Band 14:**

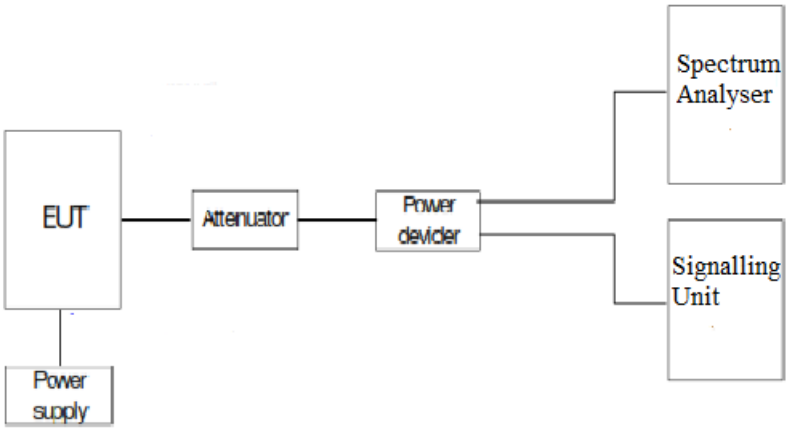
* FCC § 2.1049. Measurements required: Occupied bandwidth.

* RSS-Gen Clause 6.7: The occupied bandwidth or the “99% emission bandwidth” is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

***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***

**LTE Bands**: The worst case of Occupied Bandwidth corresponds to Resource Blocks (RB) Size all, regardless the nominal bandwidth selected.

**LTE Cat 1bis Band 14:**

LTE Cat 1bis Band 14. BW=5 MHz. QPSK. RB Size=Max.

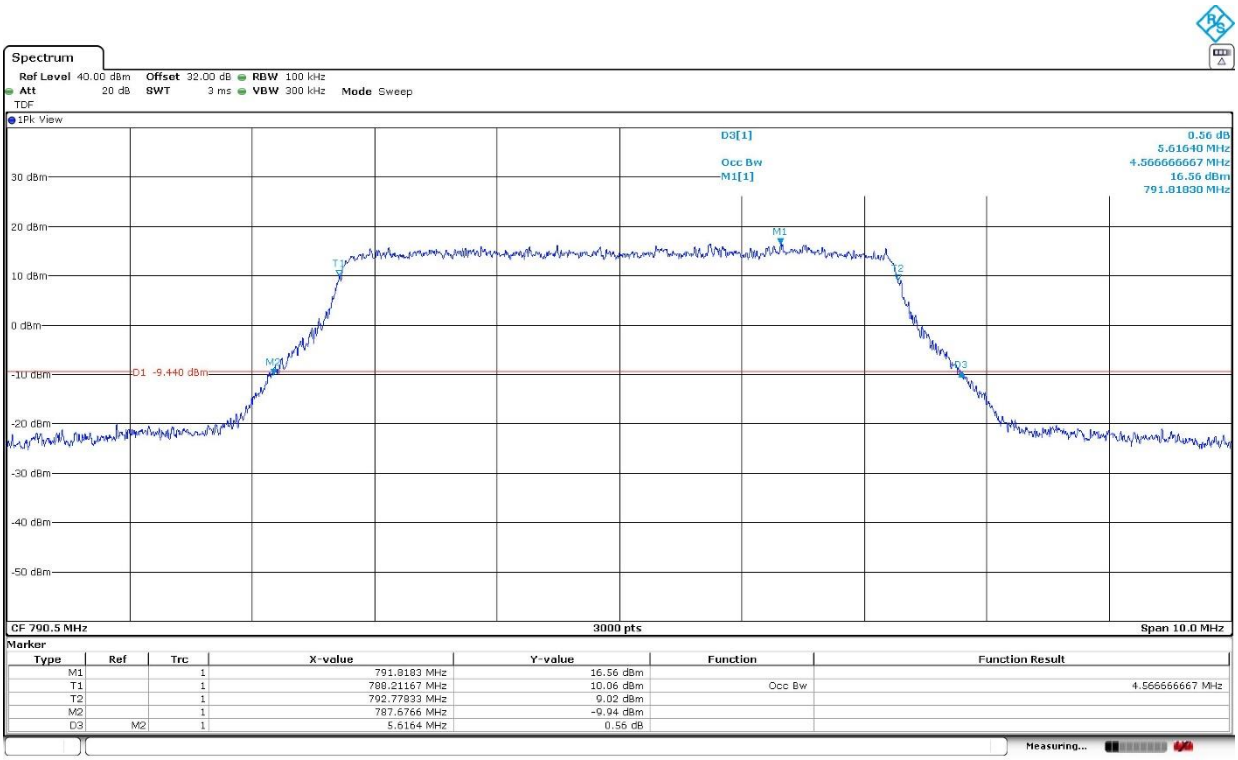
| | Low Channel | High Channel |
|---|---|---|
| 99% Occupied Bandwidth (MHz) | 4.567 | 4.560 |
| -26 dBc Bandwidth (MHz) | 5.616 | 5.621 |
| Measurement uncertainty (kHz) | <±4.67 | |

LTE Cat 1bis Band 14. BW=5 MHz. 16QAM. RB Size = Max.

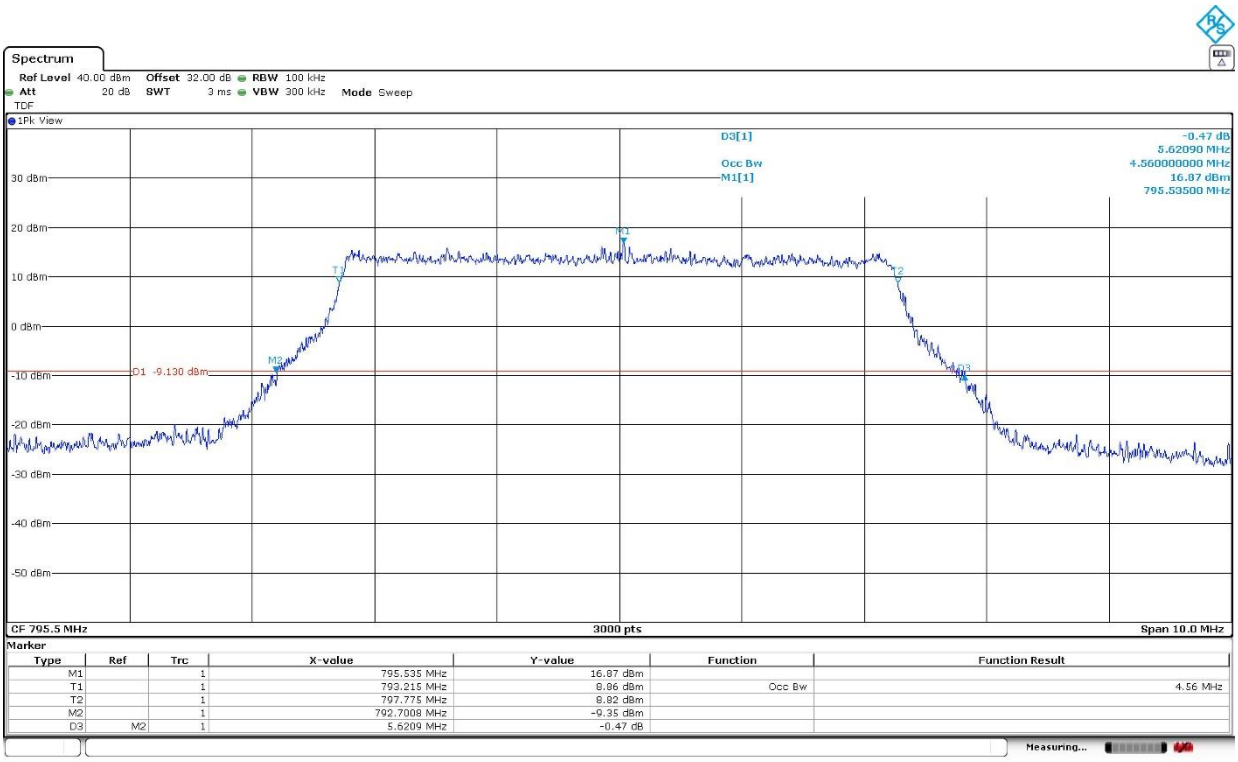
| | Low Channel | High Channel |
|---|---|---|
| 99% Occupied Bandwidth (MHz) | 4.547 | 4.733 |
| -26 dBc Bandwidth (MHz) | 5.625 | 5.710 |
| Measurement uncertainty (kHz) | <±4.67 | |

LTE Cat 1bis Band 14. BW = 5 MHz. QPSK.

Low Channel:

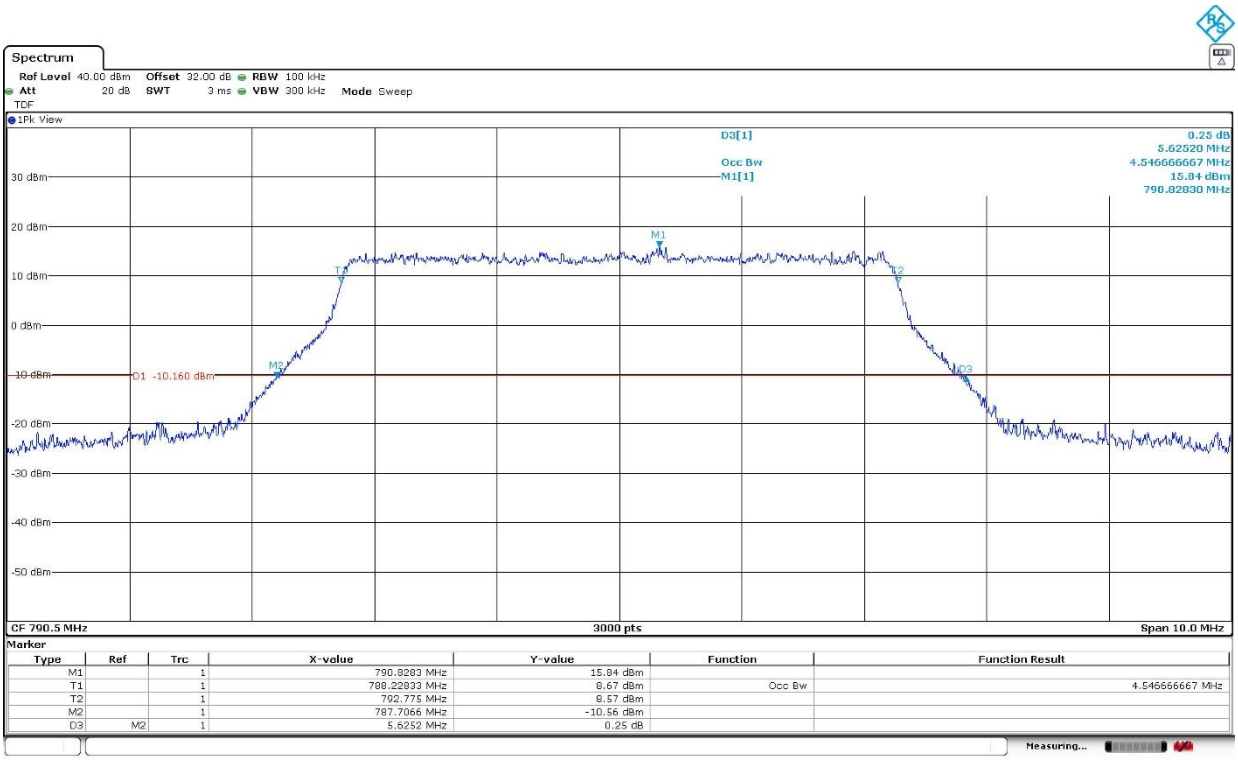



High Channel:

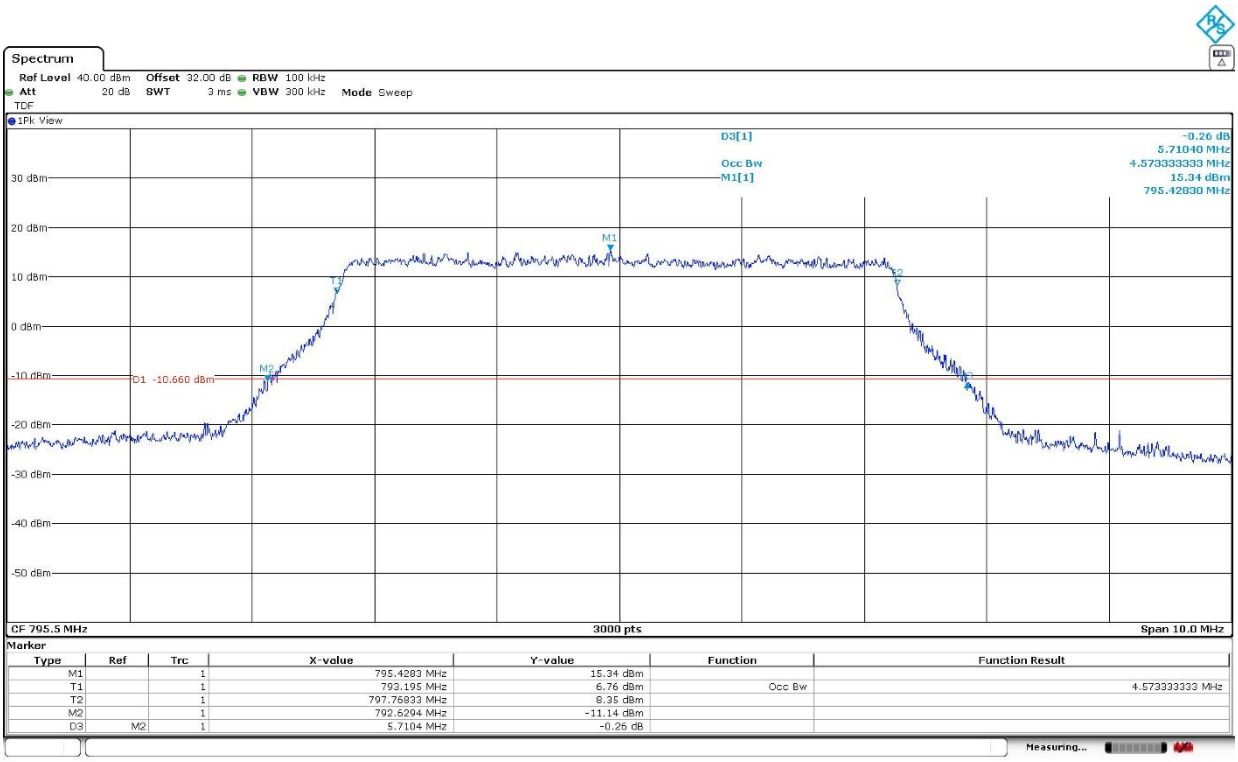


LTE Cat 1bis Band 14. BW = 5 MHz. 16QAM.

Low Channel:




High Channel:



LTE Cat 1bis Band 14. BW=10 MHz. QPSK. RB Size=Max.

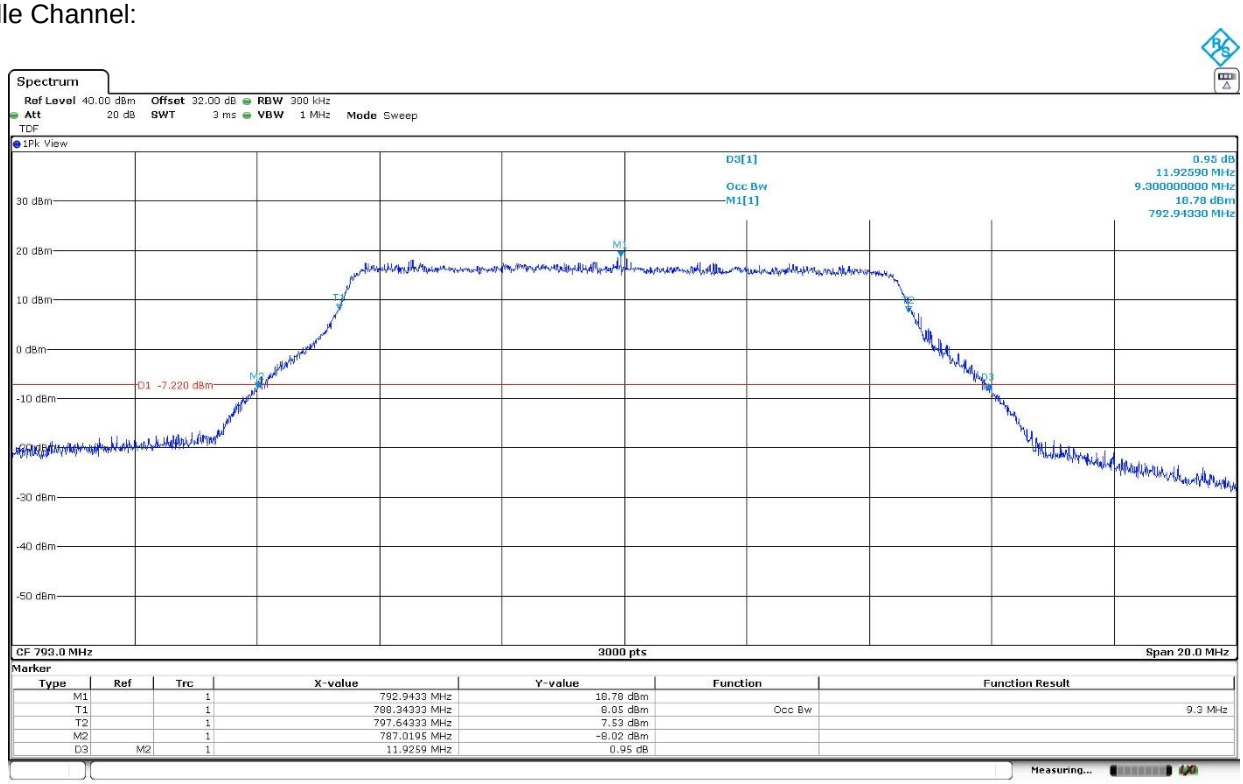
| | Low Channel |
|---|---|
| 99% Occupied Bandwidth (MHz) | 9.300 |
| -26 dBc Bandwidth (MHz) | 11.926 |
| Measurement uncertainty (kHz) | <±4.67 |

LTE Cat 1bis Band 14. BW=10 MHz. 16QAM. RB Size = Max.

| | Low Channel |
|---|---|
| 99% Occupied Bandwidth (MHz) | 4.620 |
| -26 dBc Bandwidth (MHz) | 6.612 |
| Measurement uncertainty (kHz) | <±4.67 |

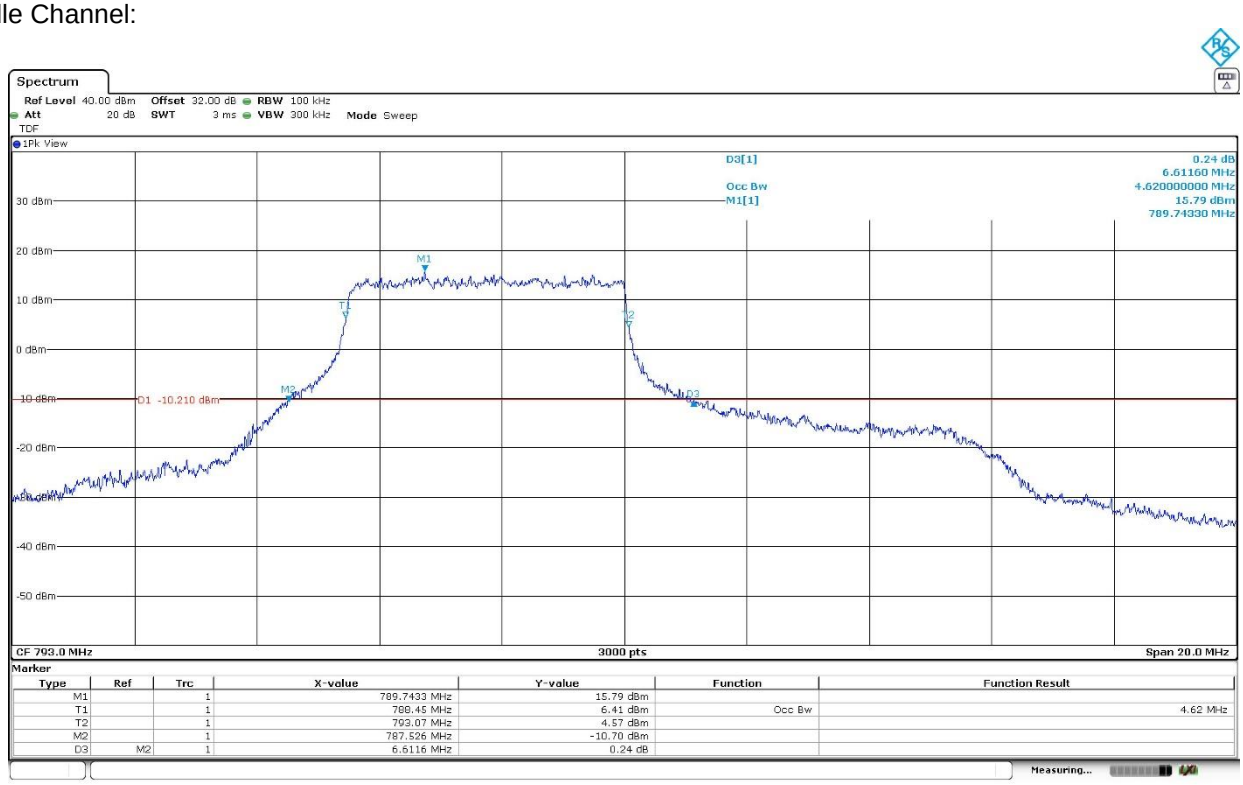
LTE Cat 1bis Band 14. BW = 10 MHz. QPSK.

Middle Channel:




LTE Cat 1bis Band 14. BW = 10 MHz. 16QAM.

Middle Channel:



# Spurious emissions at antenna terminals

***Limits***

**1. LTE Cat 1bis Band 14:**

* FCC § 90.543 (e) (2) (3) & (5):

Transmitters operating in 758-768 MHz and 788-798 MHz bands must meet the emission limitations in (e) of this section.

(e) For operations in the 758-768 MHz and the 788-798 MHz bands, the power of any emission outside the licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, in accordance with the following:

(1) On all frequencies between 769-775 MHz and 799-805 MHz, by a factor not less than 76 + 10 log (P) dB in a 6.25 kHz band segment, for base and fixed stations.

(2) On all frequencies between 769-775 MHz and 799-805 MHz, by a factor not less than 65 + 10 log (P) dB in a 6.25 kHz band segment, for mobile and portable stations.

(3) On any frequency between 775-788 MHz, above 805 MHz, and below 758 MHz, by at least 43 + 10 log (P) dB.

(4) Compliance with the provisions of paragraphs (e)(1) and (2) of this section is based on the use of measurement instrumentation such that the reading taken with any resolution bandwidth setting should be adjusted to indicate spectral energy in a 6.25 kHz segment.

(5) Compliance with the provisions of paragraph (e)(3) of this section is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. However, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of 30 kHz may be employed.

* RSS-140 Clause 4.4:

The power of any unwanted emission outside the band 788-798 MHz shall be attenuated below the Transmitter output power P in dBW as follows, where p is the transmitter output power in watts:

a. For any frequency between 769-775 MHz and 799-806 MHz:
   i. 76 + 10 log (p), dB in a 6.25 kHz band for fixed and base station equipment
   ii. 65 + 10 log (p), dB in a 6.25 kHz band for mobile and portable/hand-held equipment
b. For any frequency between 775-788 MHz, above 806 MHz, and below 758 MHz: 43 + 10 log (p), dB in a bandwidth of 100 kHz or greater. However, in the 100 kHz bands immediately outside and adjacent to the frequency bands 758-768 MHz and 788-798 MHz, a resolution bandwidth of 30 kHz may be employed.

***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 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.

Measurement Limit:

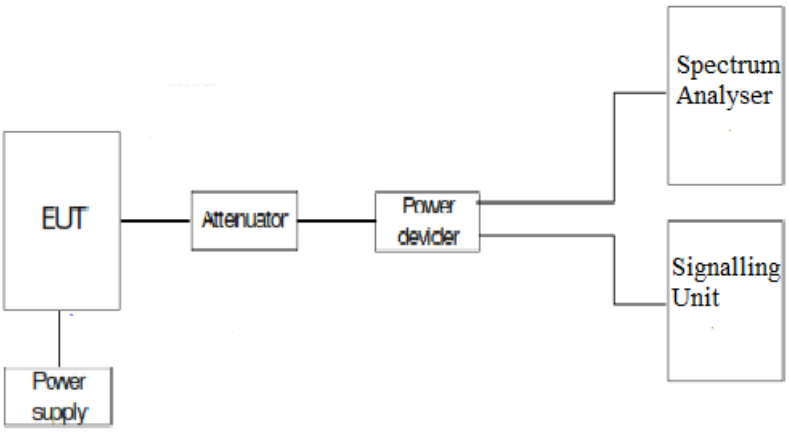
According to specification, the power of emissions shall be attenuated below the transmitter power (P) by a factor not less 65 + 10 log (P) dB in a 6.25 kHz band segment. P in watts.
At Po transmitting power, the specified minimum attenuation becomes 65 + 10log (Po), and the level in dBm relative Po becomes:

Po (dBm) - [65 + 10 log (Po in mwatts) - 30] = - 35 dBm

According to specification, 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.
At Po transmitting power, the specified minimum attenuation becomes 43+10log (Po), and the level in dBm relative Po becomes:

Po (dBm) - [43 + 10 log (Po in mwatts) - 30] = - 13 dBm

***Test Setup***



***Results***

Test performed on the worst-case modulation, RB Size and RB Offset for each LTE band.

**LTE Cat 1bis Band 14**: BW=5 MHz. QPSK. RB Size=1. RB Offset=0.

**Frequency range 9 KHz - 8 GHz:**

- Low Channel: No spurious frequencies detected at less than 20 dB below the limit. (Peak detector).

- High Channel: Spurious frequencies detected at less than 20 dB below the limit: (Peak detector, but the range 799-806 MHz measured with Average detector).

| Frequency (MHz) | Emission limitations conducted (dBm) |
|---|---|
| 799.83895 | -46 |
| 801.09888 | -53.4 |
| 802.03205 | -39.97 |

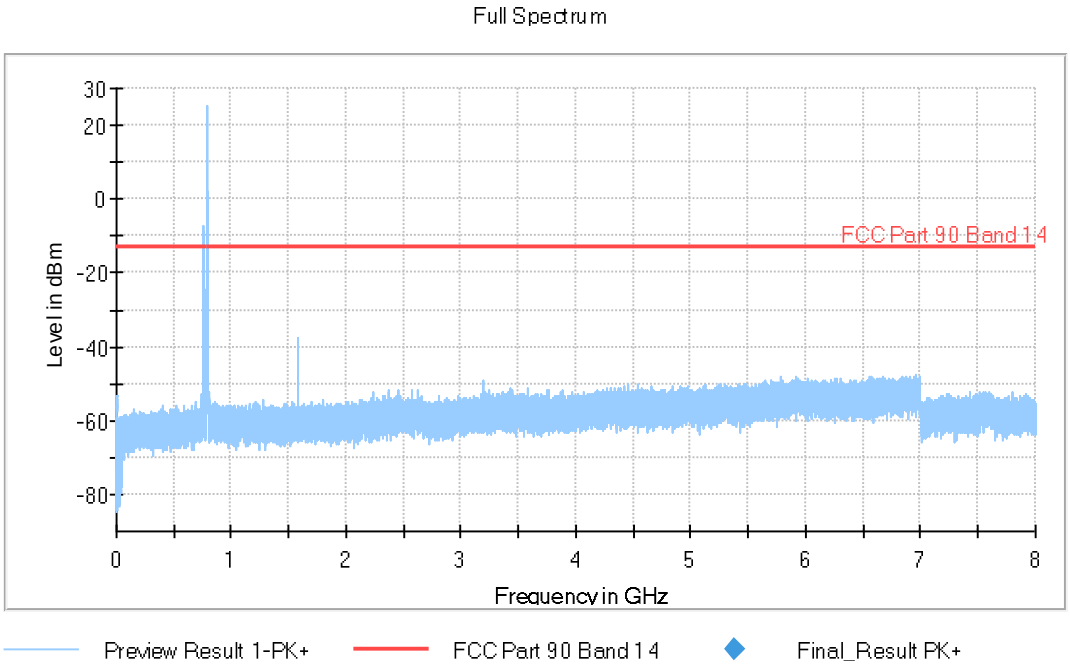
***Verdict***

PASS

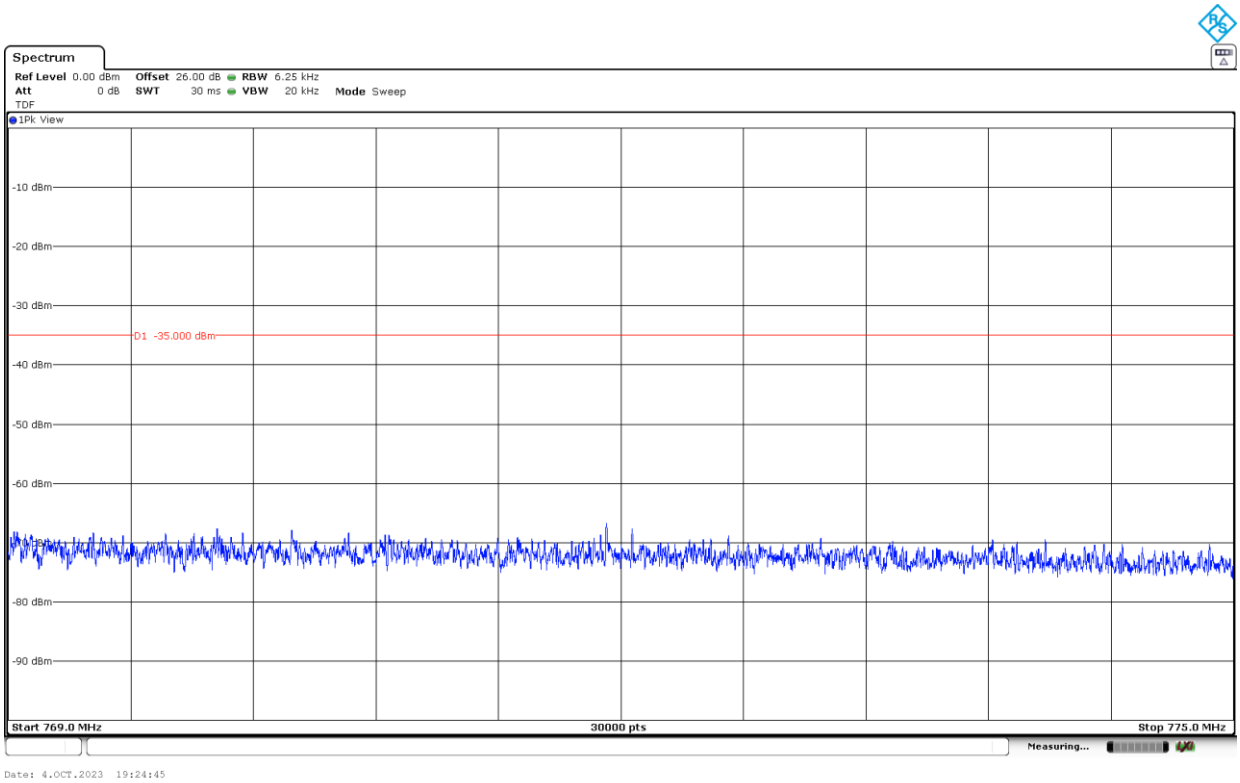
| Subrange | Step Size | Detectors | Bandwidth | Sweep Time | Preamp |
|---|---|---|---|---|---|
| Receiver: [FSV 40] | | | | | |
| 9 kHz - 150 kHz | 14.1 Hz | PK+ | 300 Hz | Coupled | 0 dB |
| 150 kHz - 30 MHz | 932.812 Hz | PK+ | 10 kHz | Coupled | 0 dB |
| 30 MHz - 1 GHz | 30.312 kHz | PK+ | 100 kHz | Coupled | 0 dB |
| 1 GHz - 10 GHz | 281.25 kHz | PK+ | 1 MHz | Coupled | 0 dB |

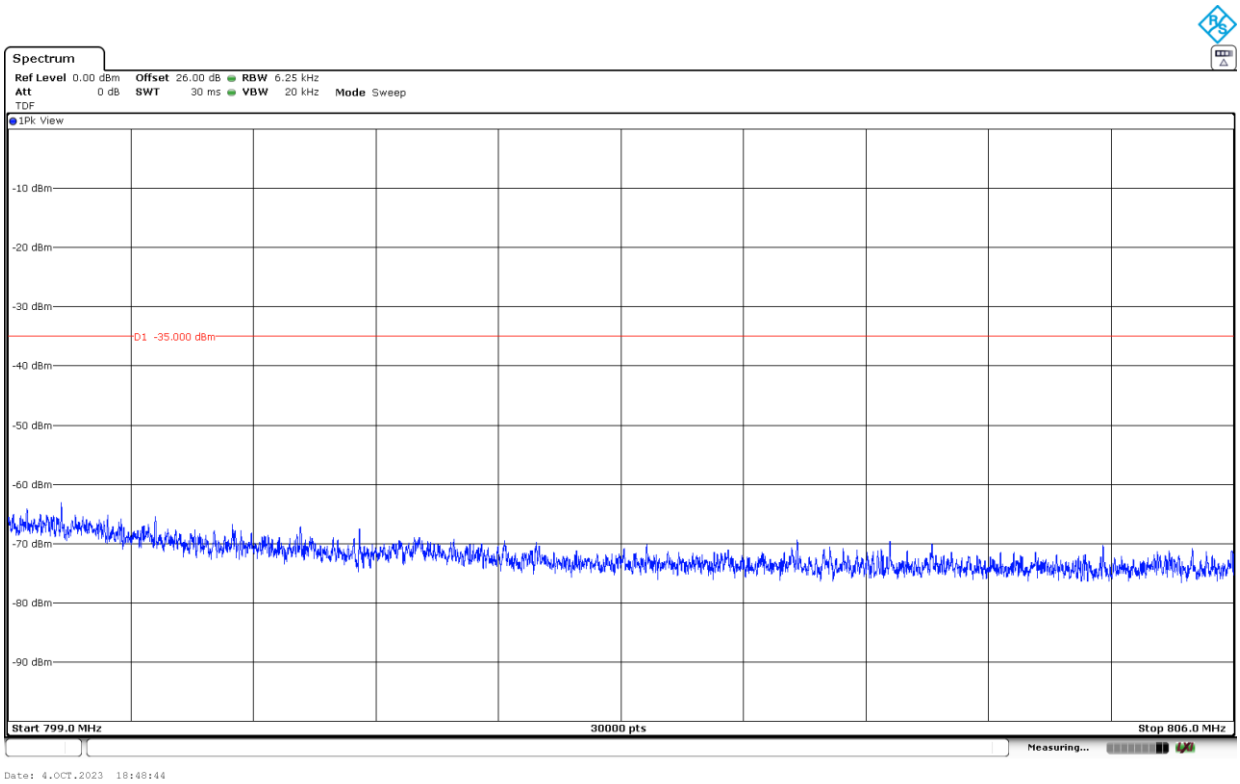
**LTE Cat 1bis Band 14**: BW=5 MHz. QPSK. RB Size=1. RB Offset=0.

Low Channel:

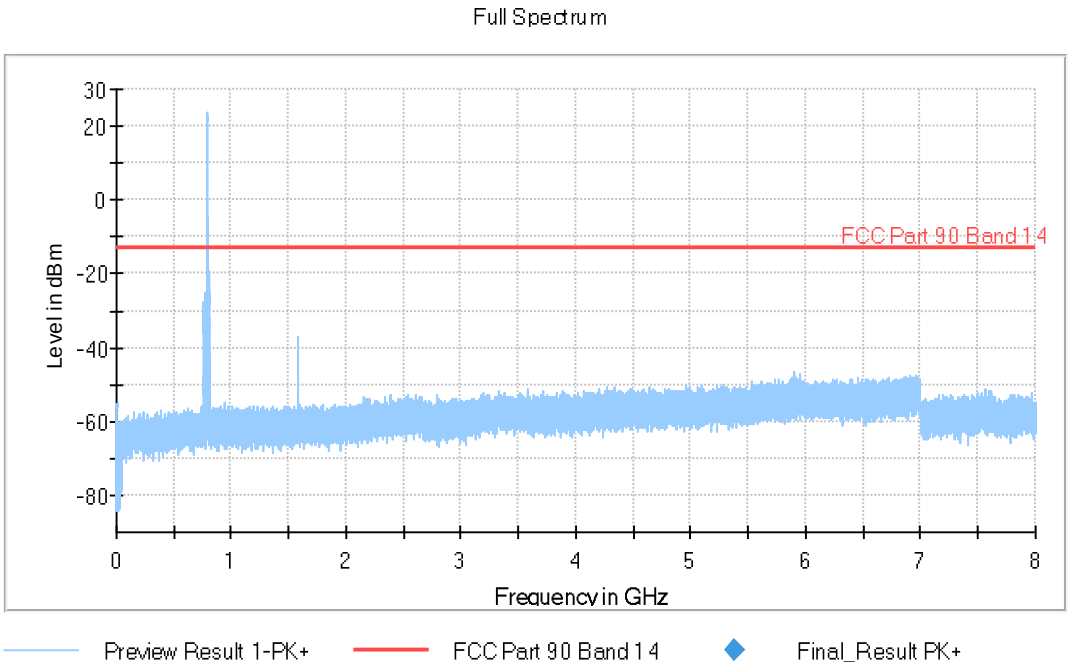



The peak above the limit is the carrier frequency.

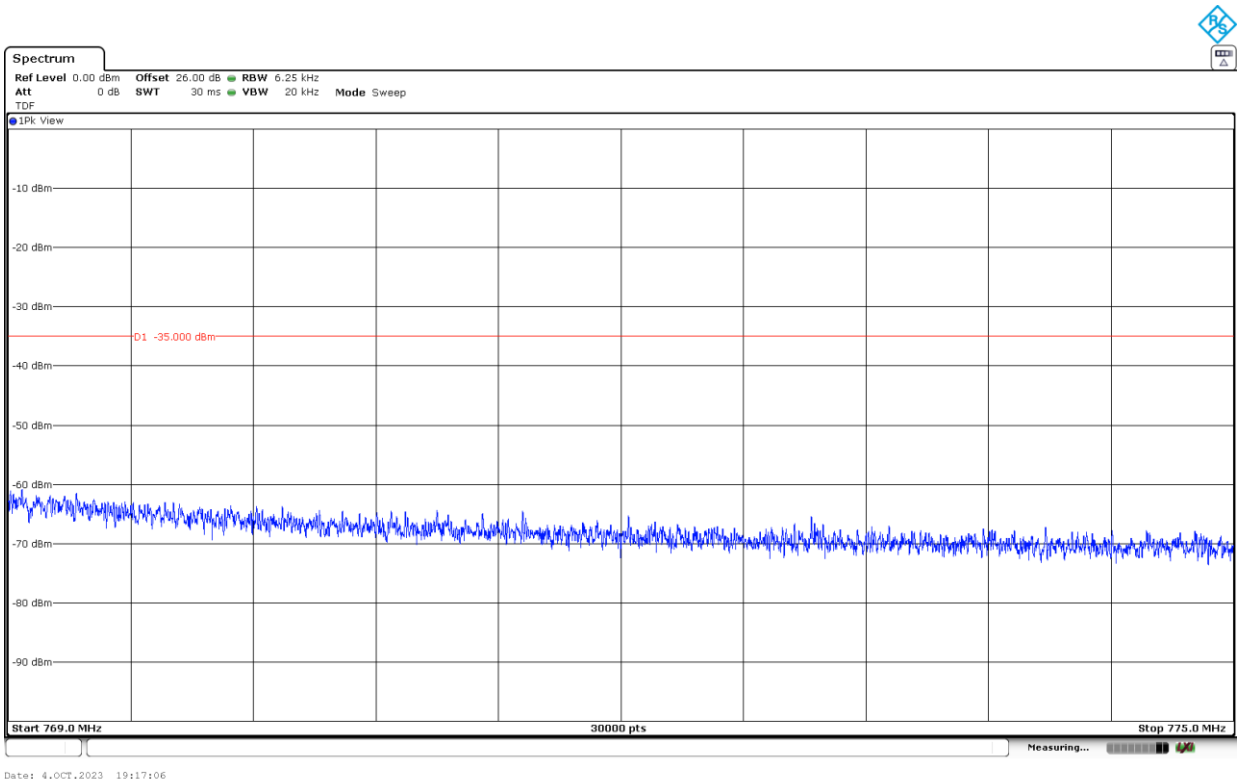

Spectrum
Ref Level 0.00 dBm Offset 26.00 dB RBW 6.25 kHz
Att 0 dB SWT 30 ms VBW 20 kHz Mode Sweep
TDF
1Pk View
-10 dBm
-20 dBm
-30 dBm
D1 -35.000 dBm
-40 dBm
-50 dBm
-60 dBm
-80 dBm
-90 dBm
Start 769.0 MHz
30000 pts
Stop 775.0 MHz
Measuring...
Date: 4.OCT.2023 19:24:45

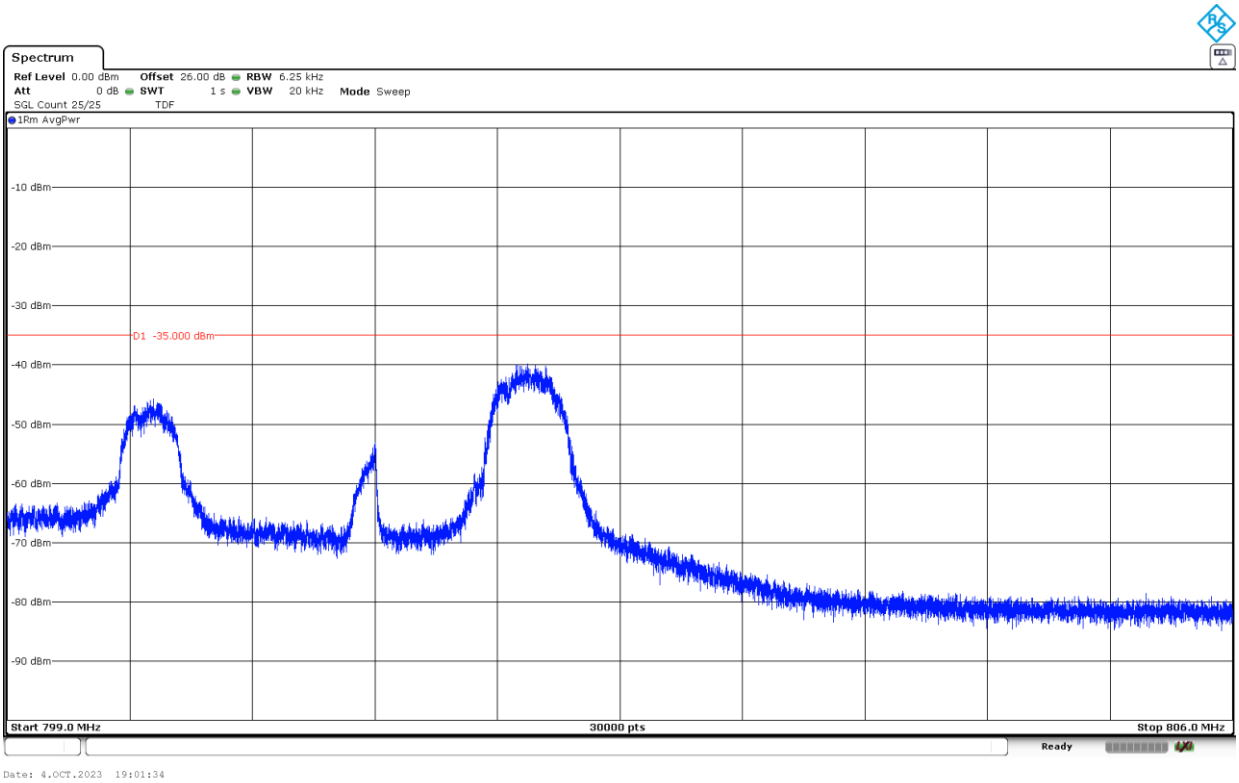

Spectrum
Ref Level 0.00 dBm Offset 26.00 dB RBW 6.25 kHz
Att 0 dB SWT 30 ms VBW 20 kHz Mode Sweep
TDF
1Pk View
-10 dBm
-20 dBm
-30 dBm
D1 -35.000 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
-90 dBm
Start 799.0 MHz
30000 pts
Stop 806.0 MHz
Measuring...
Date: 4.OCT.2023 18:48:44

High Channel:




The peak above the limit is the carrier frequency.




Spectrum
Ref Level 0.00 dBm Offset 26.00 dB RBW 6.25 kHz
Att 0 dB SWT 1 s VBW 20 kHz Mode Sweep
SGL Count 25/25 TDF
1Rm AvgPwr
-10 dBm
-20 dBm
-30 dBm
D1 -35.000 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
-80 dBm
-90 dBm
Start 799.0 MHz
30000 pts
Stop 806.0 MHz
Ready
Date: 4.OCT.2023 19:01:34

# Spurious Emissions at Antenna Terminals at Block Edges

***Limits***

**1. LTE Cat 1bis Band 14:**

* FCC § 90.543 (e) (2) (3) & (5):

Transmitters operating in 758-768 MHz and 788-798 MHz bands must meet the emission limitations in (e) of this section.

(e) For operations in the 758-768 MHz and the 788-798 MHz bands, the power of any emission outside the licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, in accordance with the following:

(1) On all frequencies between 769-775 MHz and 799-805 MHz, by a factor not less than 76 + 10 log (P) dB in a 6.25 kHz band segment, for base and fixed stations.

(2) On all frequencies between 769-775 MHz and 799-805 MHz, by a factor not less than 65 + 10 log (P) dB in a 6.25 kHz band segment, for mobile and portable stations.

(3) On any frequency between 775-788 MHz, above 805 MHz, and below 758 MHz, by at least 43 + 10 log (P) dB.

(4) Compliance with the provisions of paragraphs (e)(1) and (2) of this section is based on the use of measurement instrumentation such that the reading taken with any resolution bandwidth setting should be adjusted to indicate spectral energy in a 6.25 kHz segment.

(5) Compliance with the provisions of paragraph (e)(3) of this section is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. However, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of 30 kHz may be employed.

* RSS-140 Clause 4.4:

The power of any unwanted emission outside the band 788-798 MHz shall be attenuated below the Transmitter output power P in dBW as follows, where p is the transmitter output power in watts:

a. For any frequency between 769-775 MHz and 799-806 MHz:
   i. 76 + 10 log (p), dB in a 6.25 kHz band for fixed and base station equipment
   ii. 65 + 10 log (p), dB in a 6.25 kHz band for mobile and portable/hand-held equipment
b. For any frequency between 775-788 MHz, above 806 MHz, and below 758 MHz: 43 + 10 log (p), dB in a bandwidth of 100 kHz or greater. However, in the 100 kHz bands immediately outside and adjacent to the frequency bands 758-768 MHz and 788-798 MHz, a resolution bandwidth of 30 kHz may be employed.

***Method***

The EUT RF output connector was connected to a spectrum analyzer 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 path loss of the connection between the output terminal of the EUT and the input of the spectrum analyzer.

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

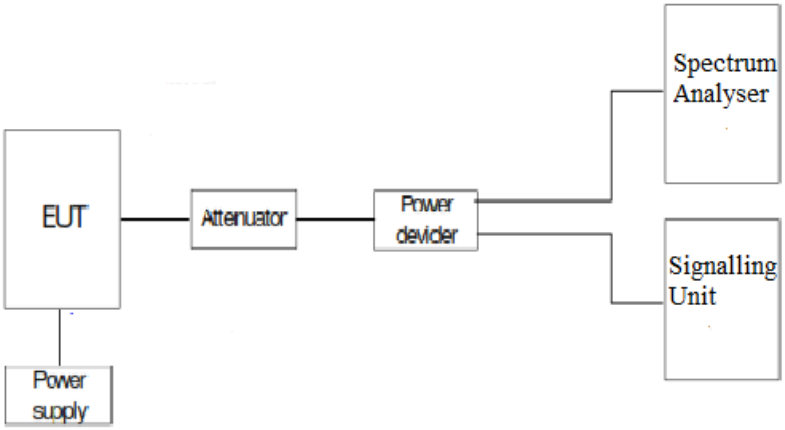
As stated in FCC § 90.543, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of 30 kHz may be employed.
As stated in RSS-140, in the 100 kHz bands immediately outside and adjacent to the frequency bands 758-768 MHz and 788-798 MHz, a resolution bandwidth of 30 kHz may be employed.

Measurement Limit:

At Po transmitting power, the specified minimum attenuation 43 + 10 log10 p (watts) becomes:

Po (dBm) - [43 + 10 log (Po in mwatts) - 30] = -13 dBm

***Test Setup***



***Results***

**LTE Cat 1bis Band 14:**

Preliminary measurements determined the BW=5 MHz, QPSK as the worst case.

| LTE Cat 1bis Band 14. QPSK. | RB=1. Offset=0. BW=5 MHz | RB=1. Offset=0. BW=10 MHz |
|---|---|---|
| Maximum measured level at Low Block Edge at antenna port (dBm) | -13.14 | -14.67 |

| LTE Cat 1bis Band 14. QPSK. | RB=All. Offset=0. BW=5 MHz | RB=All. Offset=0. BW=10 MHz |
|---|---|---|
| Maximum measured level at Low Block Edge at antenna port (dBm) | -19.92 | -24.13 |

| LTE Cat 1bis Band 14. QPSK. | RB=1. Offset=Max. BW=5 MHz | RB=1. Offset=Max. BW=10 MHz |
|---|---|---|
| Maximum measured level at High Block Edge at antenna port (dBm) | -13.37 | -14.78 |

| LTE Cat 1bis Band 14. QPSK. | RB=All. Offset=0. BW=5 MHz | RB=All. Offset=0. BW=10 MHz |
|---|---|---|
| Maximum measured level at High Block Edge at antenna port (dBm) | -20.62 | -24.69 |

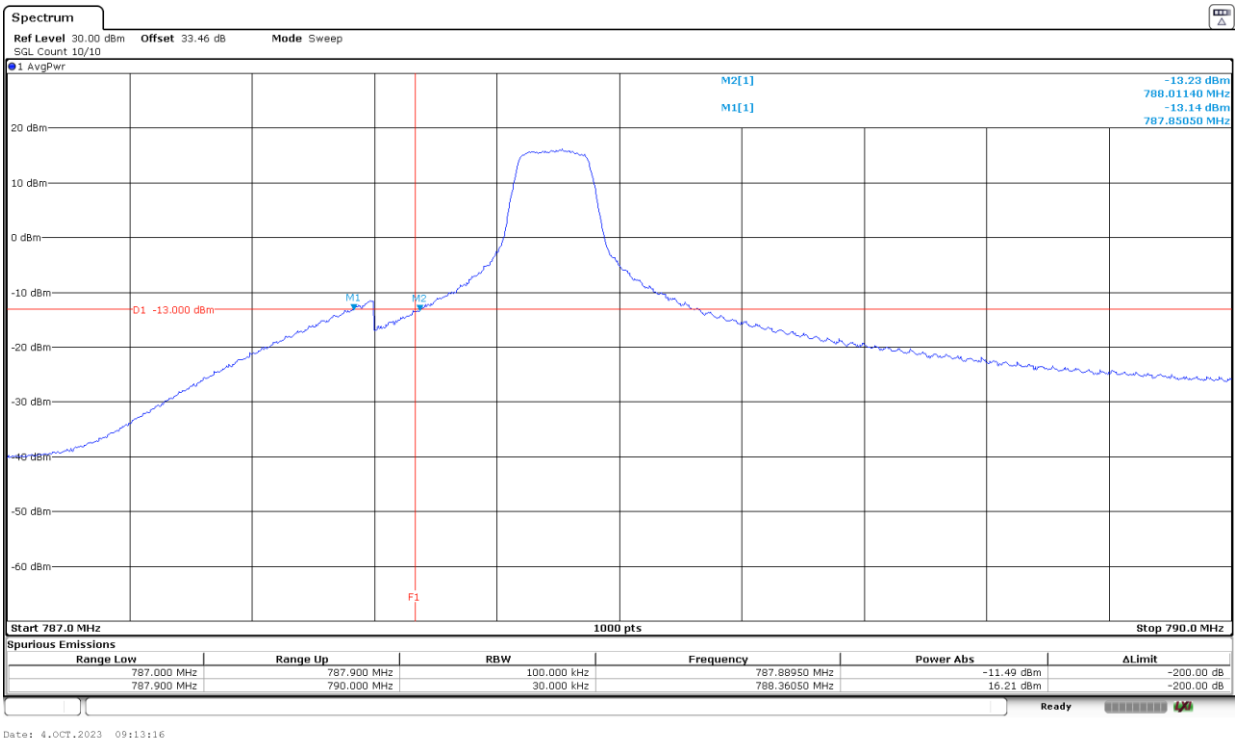
Measurement uncertainty (dB): <±2.76

***Verdict***

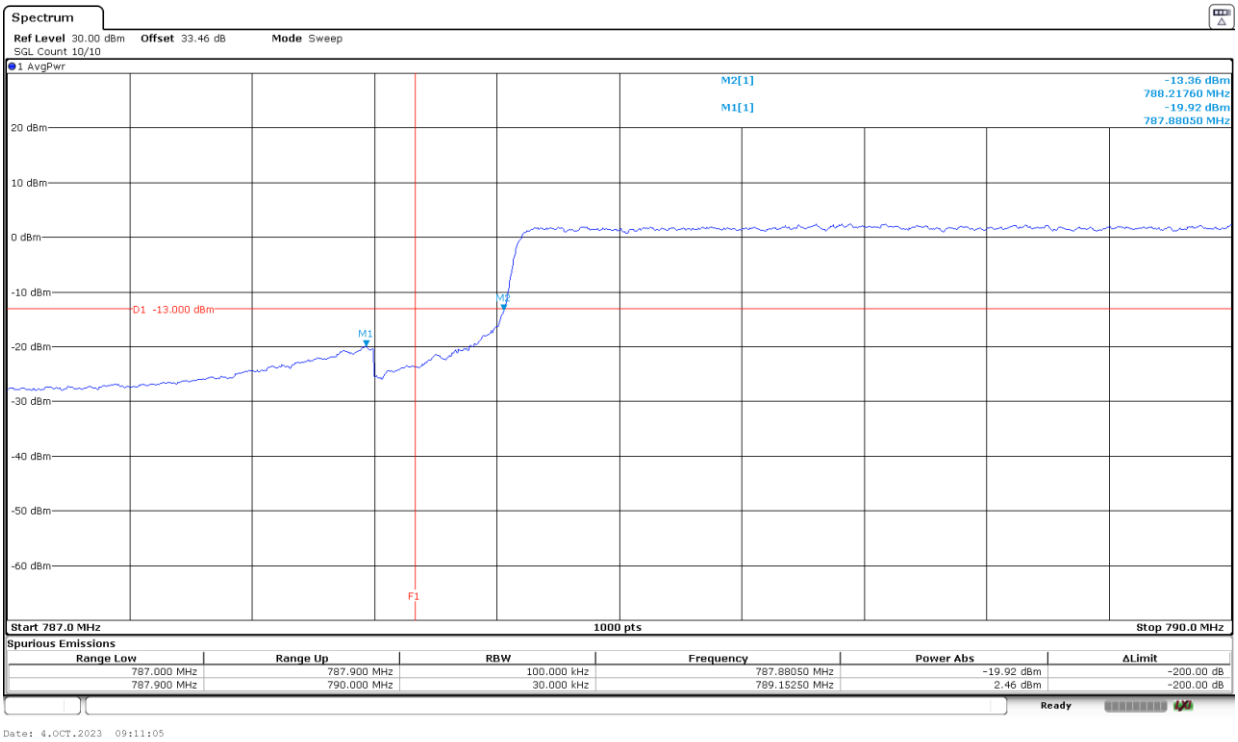
Pass

The plots below are for the worst case configuration specified before.

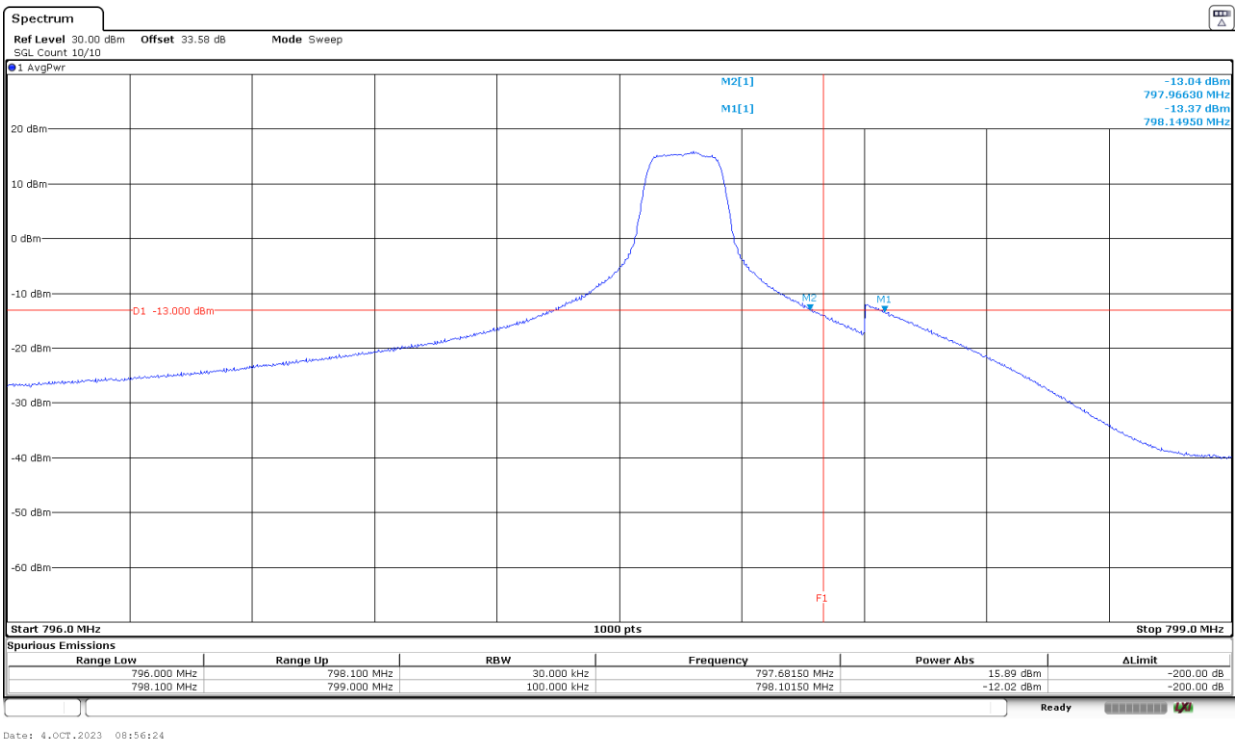
**LTE Cat 1bis Band 14:** BW=5 MHz. QPSK. RB Size=1. RB Offset=0. Low Block Edge:



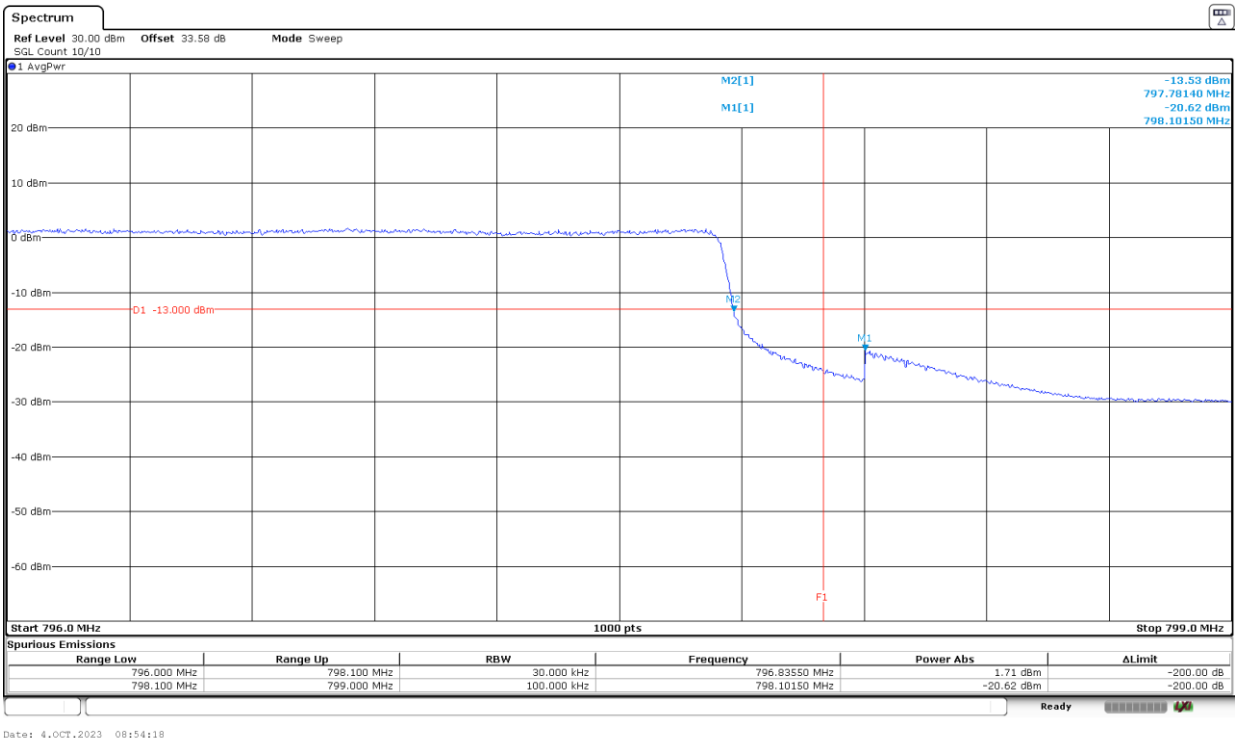

**LTE Cat 1bis Band 14:** BW=5 MHz. QPSK. RB Size=All. RB Offset=0. Low Block Edge:



**LTE Cat 1bis Band 14:** BW=5 MHz. QPSK. RB Size=1. RB Offset=Max. High Block Edge:




**LTE Cat 1bis Band 14:** BW=5 MHz. QPSK. RB Size=All. RB Offset=0. High Block Edge:



# Radiated Emissions

***Limits***

**1. LTE Cat 1bis Band 14:**

* FCC § 90.543 (e) & (f):

Transmitters operating in 758-768 MHz and 788-798 MHz bands must meet the emission limitations in (e) of this section.

(e) For operations in the 758-768 MHz and the 788-798 MHz bands, the power of any emission outside the licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, in accordance with the following:

(1) On all frequencies between 769-775 MHz and 799-805 MHz, by a factor not less than 76 + 10 log (P) dB in a 6.25 kHz band segment, for base and fixed stations.

(2) On all frequencies between 769-775 MHz and 799-805 MHz, by a factor not less than 65 + 10 log (P) dB in a 6.25 kHz band segment, for mobile and portable stations.

(3) On any frequency between 775-788 MHz, above 805 MHz, and below 758 MHz, by at least 43 + 10 log (P) dB.

(4) Compliance with the provisions of paragraphs (e) (1) and (2) of this section is based on the use of measurement instrumentation such that the reading taken with any resolution bandwidth setting should be adjusted to indicate spectral energy in a 6.25 kHz segment.

(5) Compliance with the provisions of paragraph (e) (3) of this section is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kHz or greater. However, in the 100 kHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of 30 kHz may be employed.

(f) For operations in the 758–775 MHz and 788–805 MHz bands, all emissions including harmonics in the band 1559–1610 MHz shall be limited to −70 dBW/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and −80 dBW EIRP for discrete emissions of less than 700 Hz bandwidth. For the purpose of equipment authorization, a transmitter shall be tested with an antenna that is representative of the type that will be used with the equipment in normal operation.

* RSS-140 Clause 4.4:

The power of any unwanted emission outside the bands 758-768 MHz and 788-798 MHz shall be attenuated below the transmitter output power P in dBW as follows, where p is the transmitter output power in watts:

a) For any frequency between 769-775 MHz and 799-806 MHz:
- i) 76 + 10 log (p), dB in a 6.25 kHz band for fixed and base station equipment.
- ii) 65 + 10 log (p), dB in a 6.25 kHz band for mobile and portable/hand-held equipment

b) For any frequency between 775-788 MHz, above 806 MHz, and below 758 MHz:
43 + 10 log (p), dB in a bandwidth of 100 kHz or greater. However, in the 100 kHz bands immediately outside and adjacent to the frequency bands 758-768 MHz and 788-798 MHz, a resolution bandwidth of 30 kHz may be employed.

In addition, the equivalent isotropically radiated power (e.i.r.p.) of all emissions, including harmonics in the band 1559-1610 MHz, shall not exceed −70 dBW/MHz for wideband emissions, and −80 dBW/kHz for discrete emissions of less than 700 Hz bandwidth.

***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 High frequency generated within the equipment.

For radiated emissions measurements performed at frequencies less than or equal to 1 GHz, the EUT was placed on a RF-transparent table or support at a nominal height of 80 cm above the reference ground plane, at a 3 meter distance from the measuring antenna.

For radiated measurements performed at frequencies above 1 GHz, the EUT shall be placed on an RF transparent table or support at a nominal height of 1.5 m above the ground plane, at a 3 meter distance from the measuring antenna.

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.

Measurement limit:

According to specification, 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.
At Po transmitting power, the specified minimum attenuation becomes 43+10log (Po), and the level in dBm relative Po becomes:

Po (dBm) - [43 + 10 log (Po in mwatts) - 30] = - 13 dBm

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:

EIRP (dBm) = E (dBµV/m) + 20 log(D) - 104.8; where D is the measurement distance (in the far field region) in m. D = 3 m

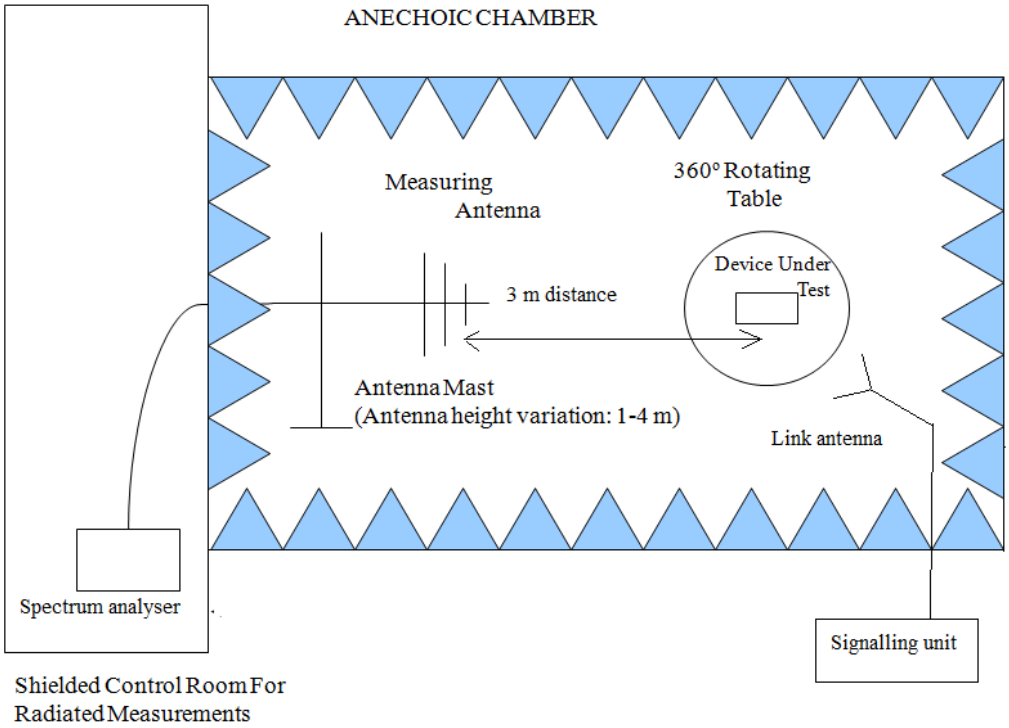
According to specification. the power of emissions shall be attenuated below the transmitter power (P) by a factor not less 65 + 10 log (P) dB in a 6.25 kHz band segment. P in watts.
At Po transmitting power. the specified minimum attenuation becomes 65+10log (Po). and the level in dBm relative Po becomes:

Po (dBm) - [65 + 10 log (Po in mwatts) - 30] = - 35 dBm

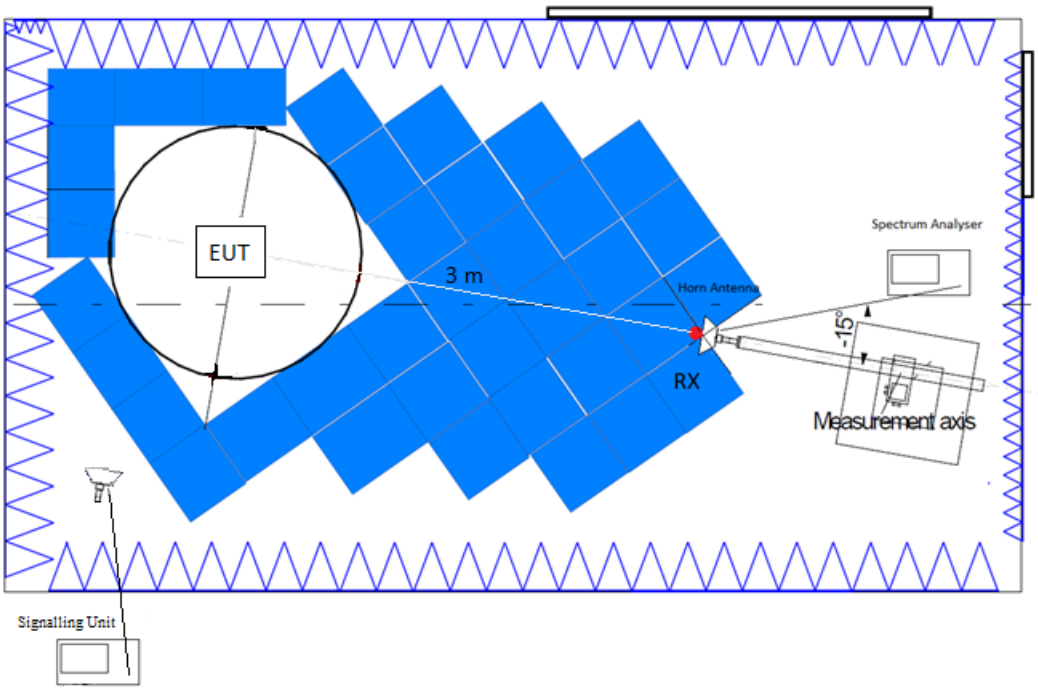
For the LTE Cat 1bis Band 14, a resolution bandwidth / video bandwidth of 100 kHz / 300 kHz was used for frequencies below 1 GHz and 1 MHz / 3 MHz for frequencies above 1 GHz.

### *Test Setup*

Radiated measurements below 1 GHz:




Radiated measurements above 1 GHz:



***Results***

Measurements required on one frequency near top channel and one frequency near bottom channel, according to FCC § 15.31 (m).

**LTE Cat 1bis Band 14:**

A preliminary scan determined the BW=5 MHz, QPSK, RB Size=1, RB Offset=0 as the worst-case. The next results are for this worst-case configuration.

**- LOW CHANNEL:**

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

Spurious frequencies at less than 20 dB below the limit:

| Spurious frequency (MHz) | E.I.R.P (dBm) | Polarization | Detector |
|---|---|---|---|
| 779.7121 | -25.14 | V | Peak |

**Frequency range 1 - 8 GHz:**

Spurious frequencies at less than 20 dB below the limit:

| Spurious frequency (MHz) | E.I.R.P (dBm) | Polarization | Detector |
|---|---|---|---|
| 1576.6469 | -57.93 | H | Peak |

**- HIGH CHANNEL:**

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

Spurious frequencies at less than 20 dB below the limit:

| Spurious frequency (MHz) | E.I.R.P (dBm) | Polarization | Detector |
|---|---|---|---|
| 784.6896 | -22.41 | V | Peak |
| 802.0135 | -38.65 | V | Peak |
| 799.8085 | -43.69 | V | Peak |
| 801.1015 | -53.1 | V | Peak |

**Frequency range 1 - 8 GHz:**

Spurious frequencies at less than 20 dB below the limit:

| Spurious frequency (MHz) | E.I.R.P (dBm) | Polarization | Detector |
|---|---|---|---|
| 1586.6514 | -58.6 | H | Peak |

Measurement uncertainty (dB): < ±5.35 for f ≥ 30 MHz up to 1 GHz
< ±4.32 for f ≥ 1 GHz up to 8.5 GHz

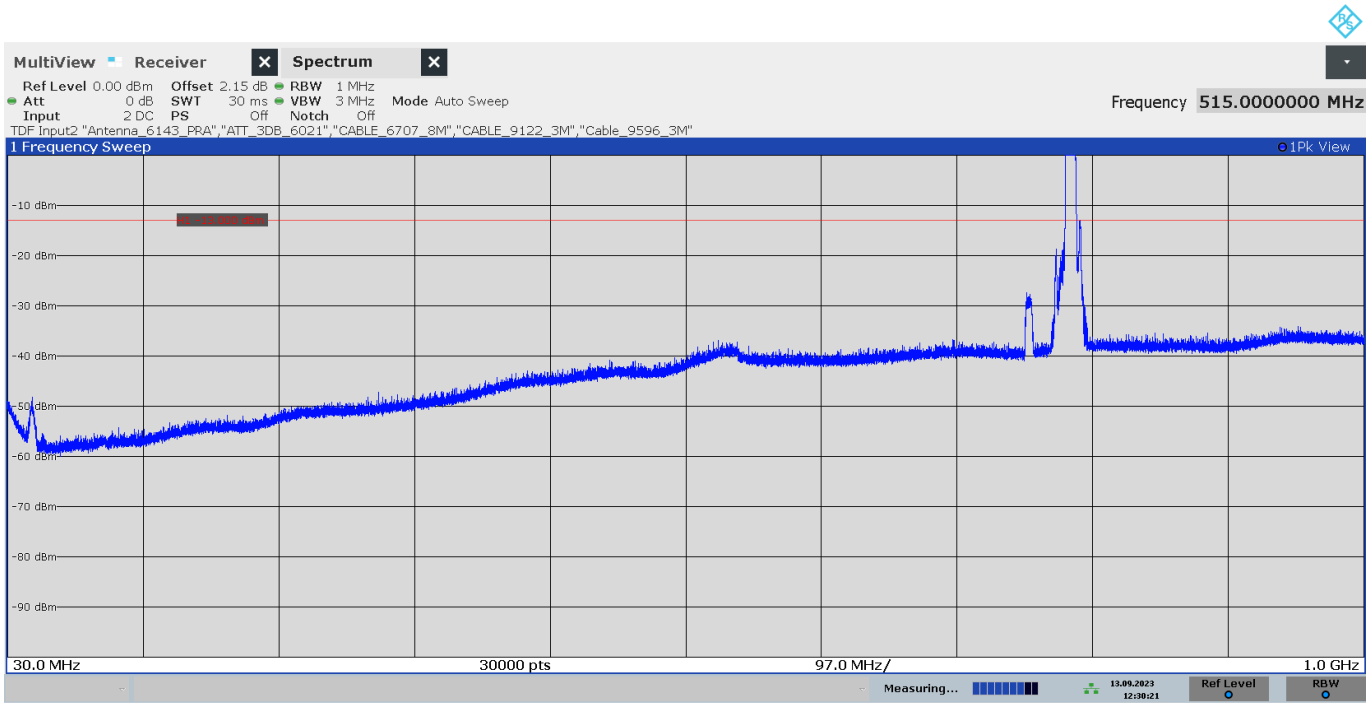
***Verdict***

Pass

## LTE Cat 1bis Band 14:

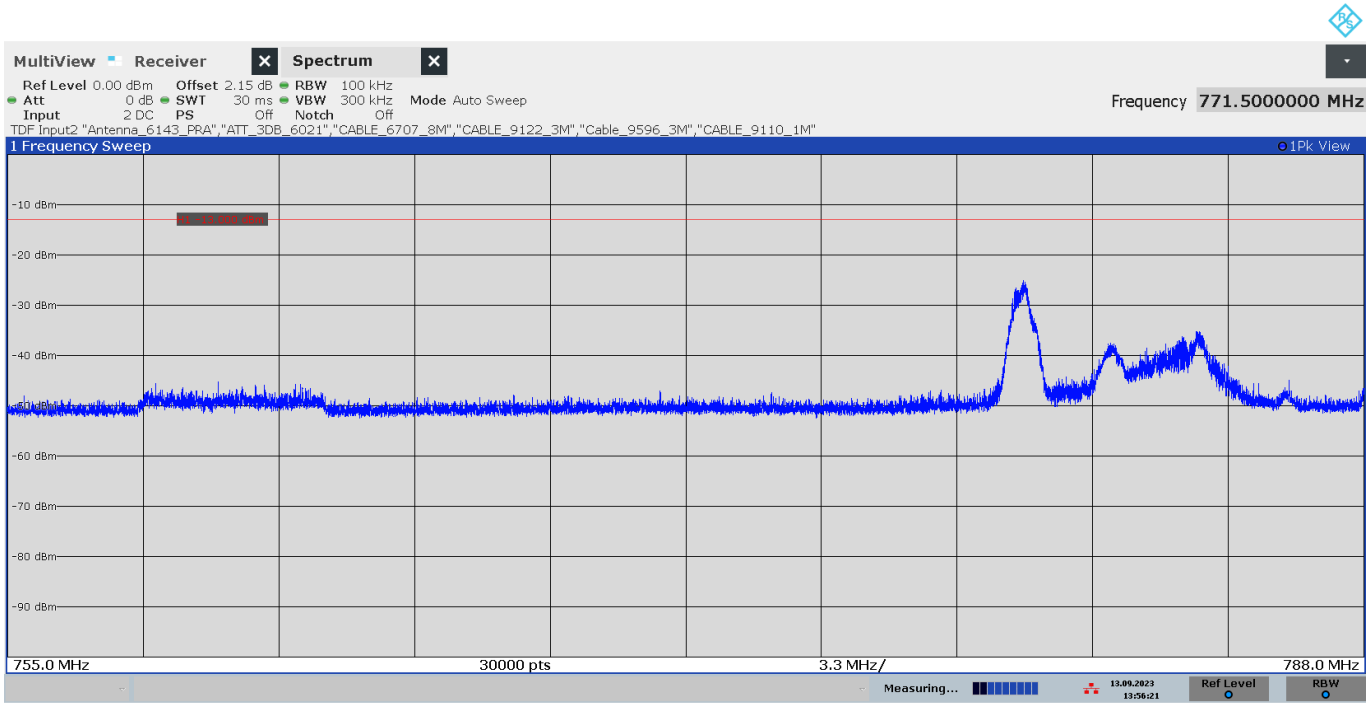
### FREQUENCY RANGE 30 MHz - 1 GHz:

- LOW CHANNEL:

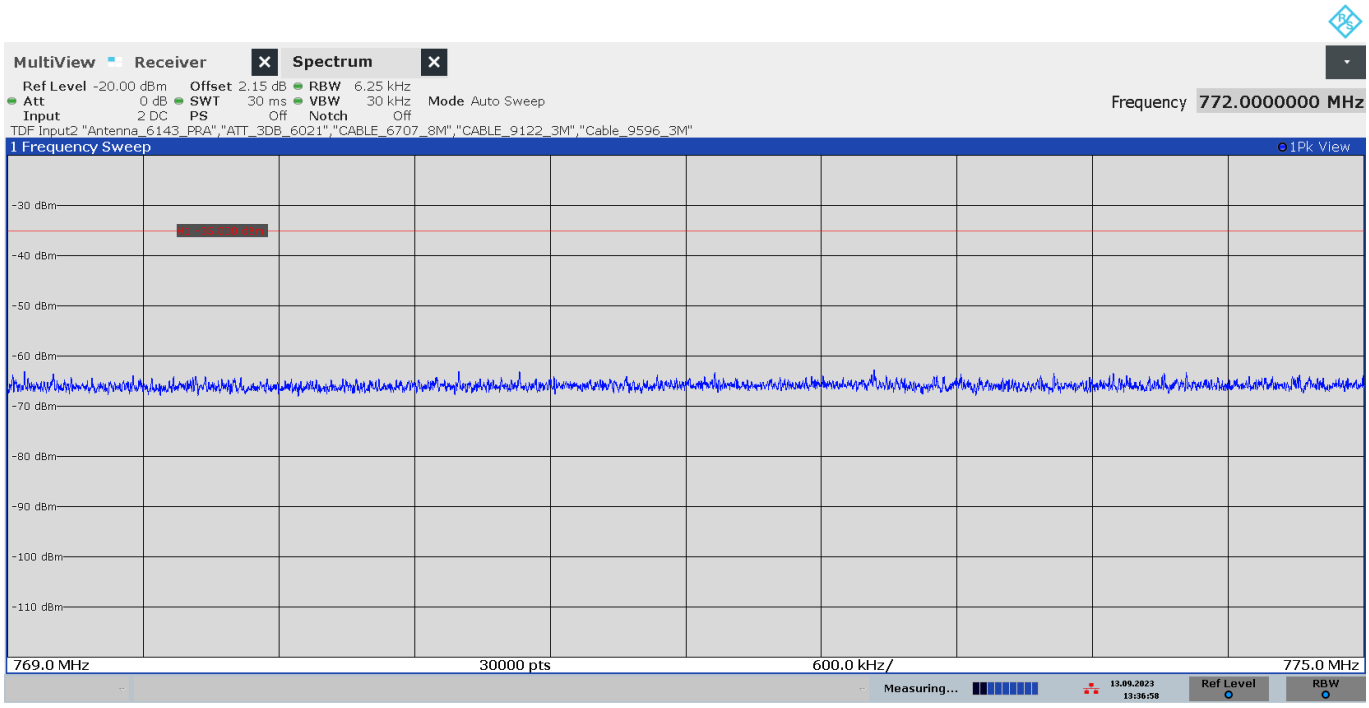



12:30:21 13.09.2023

The peak above the limit is the carrier frequency:
LTE Cat 1bis Band 14, 790.5 MHz




13:56:22 13.09.2023

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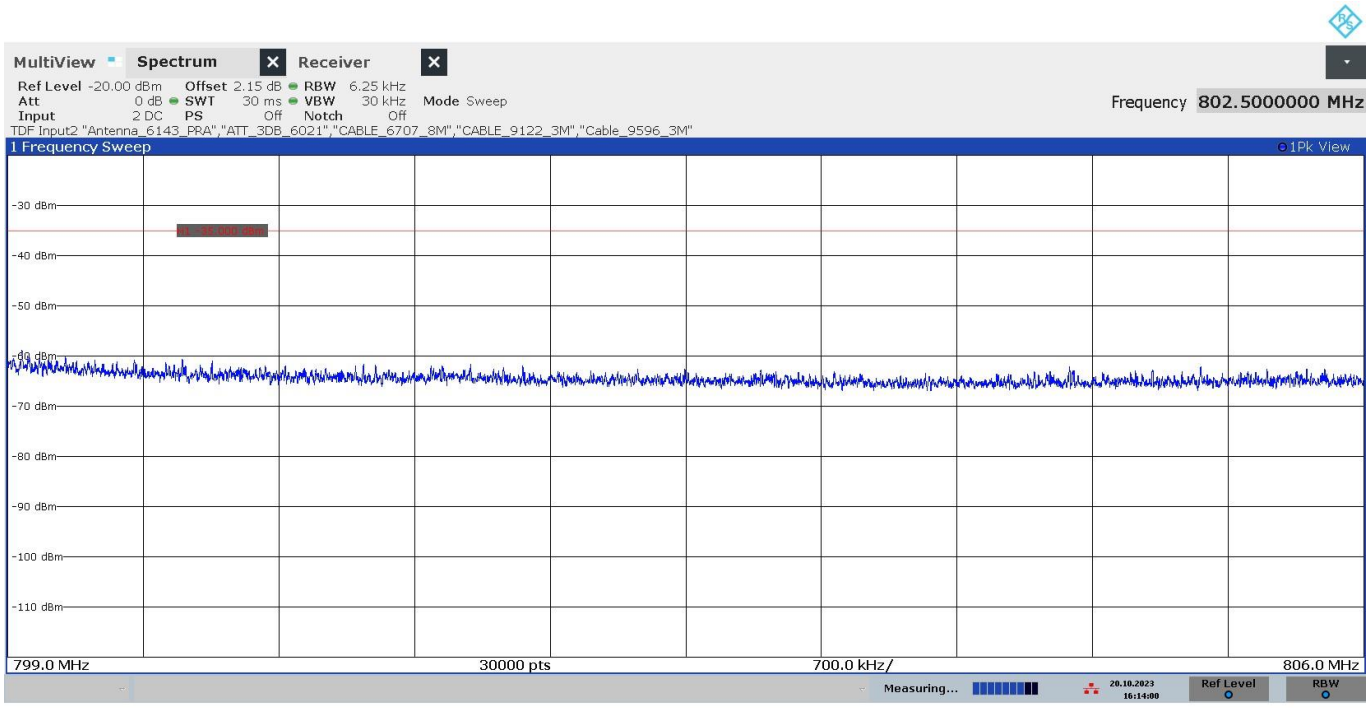
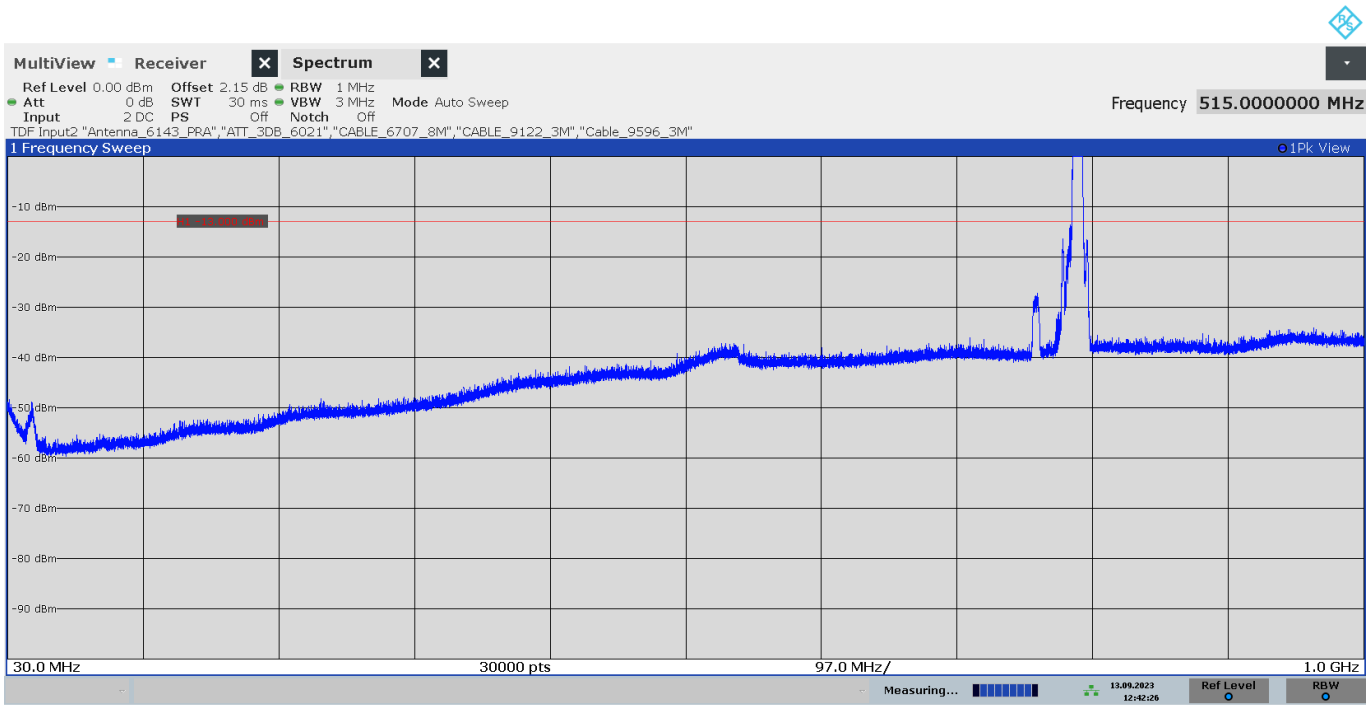


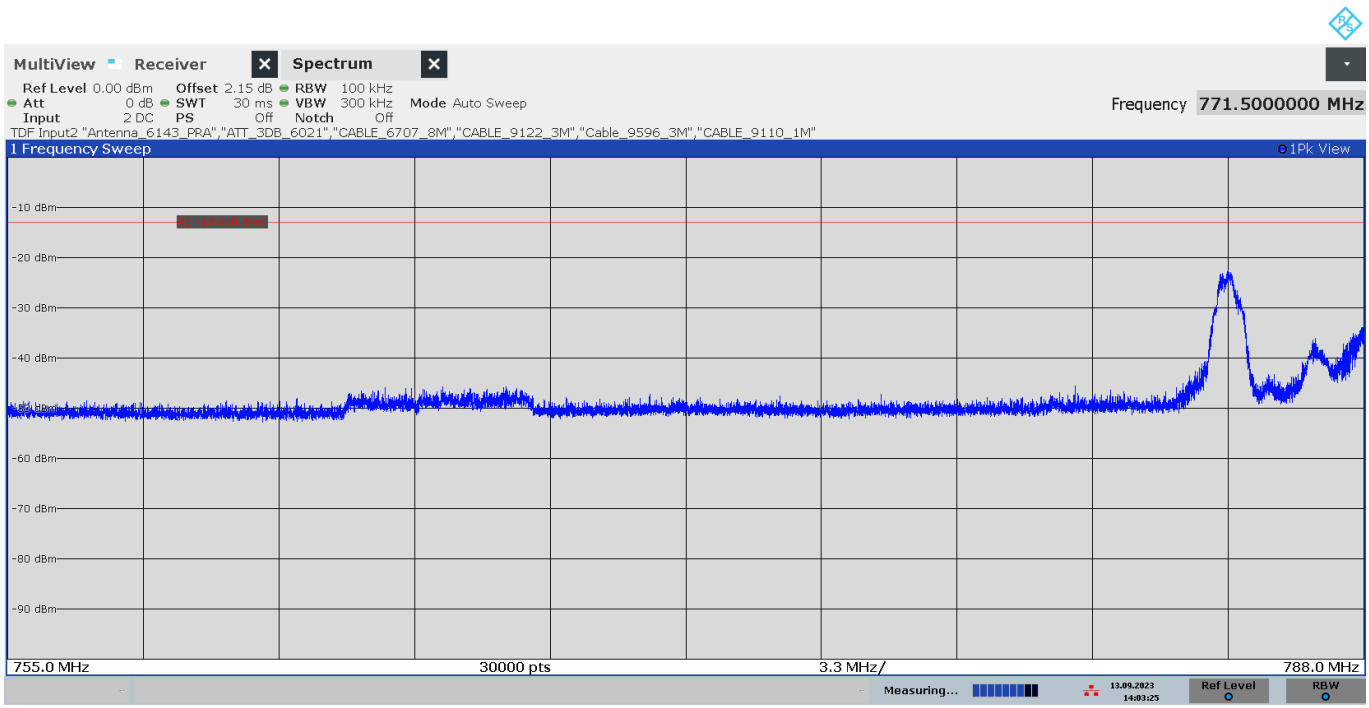

16:14:01 20.10.2023

- HIGH CHANNEL:




12:42:26 13.09.2023

The peak above the limit is the carrier frequency:
LTE Cat 1bis Band 14, 795.5 MHz

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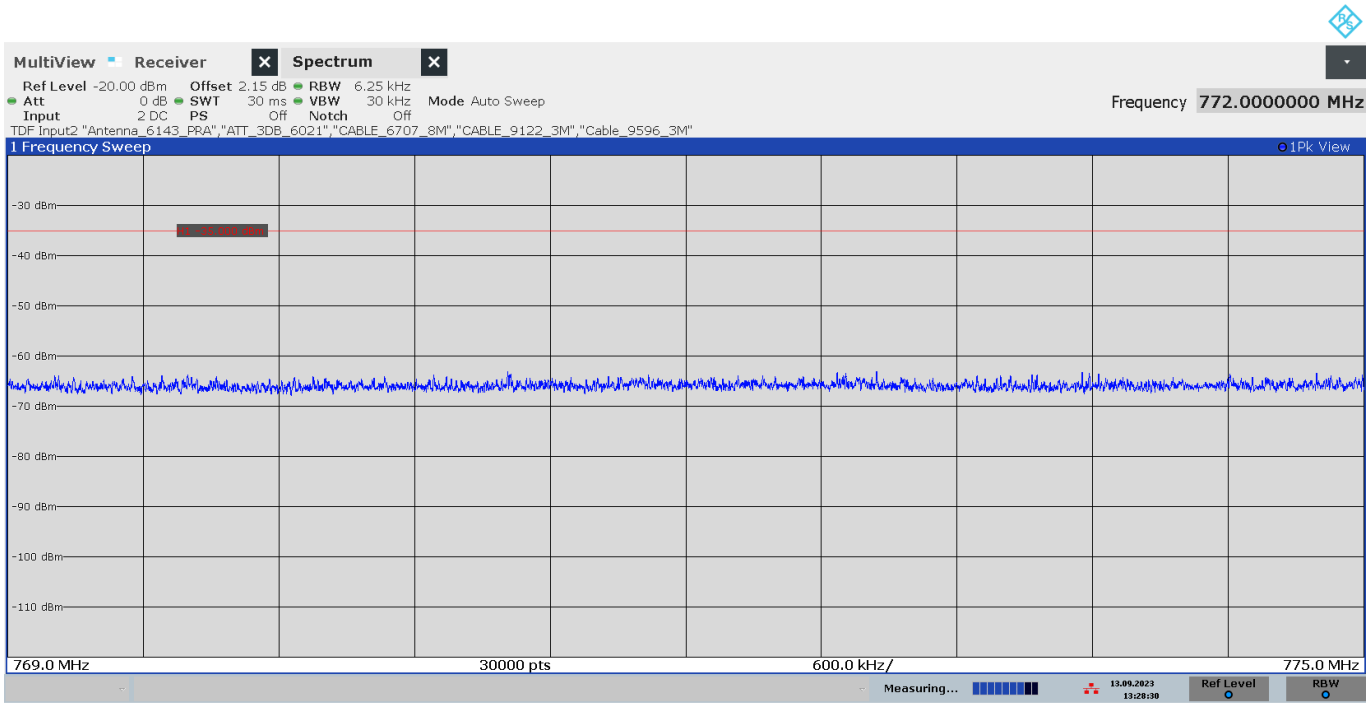


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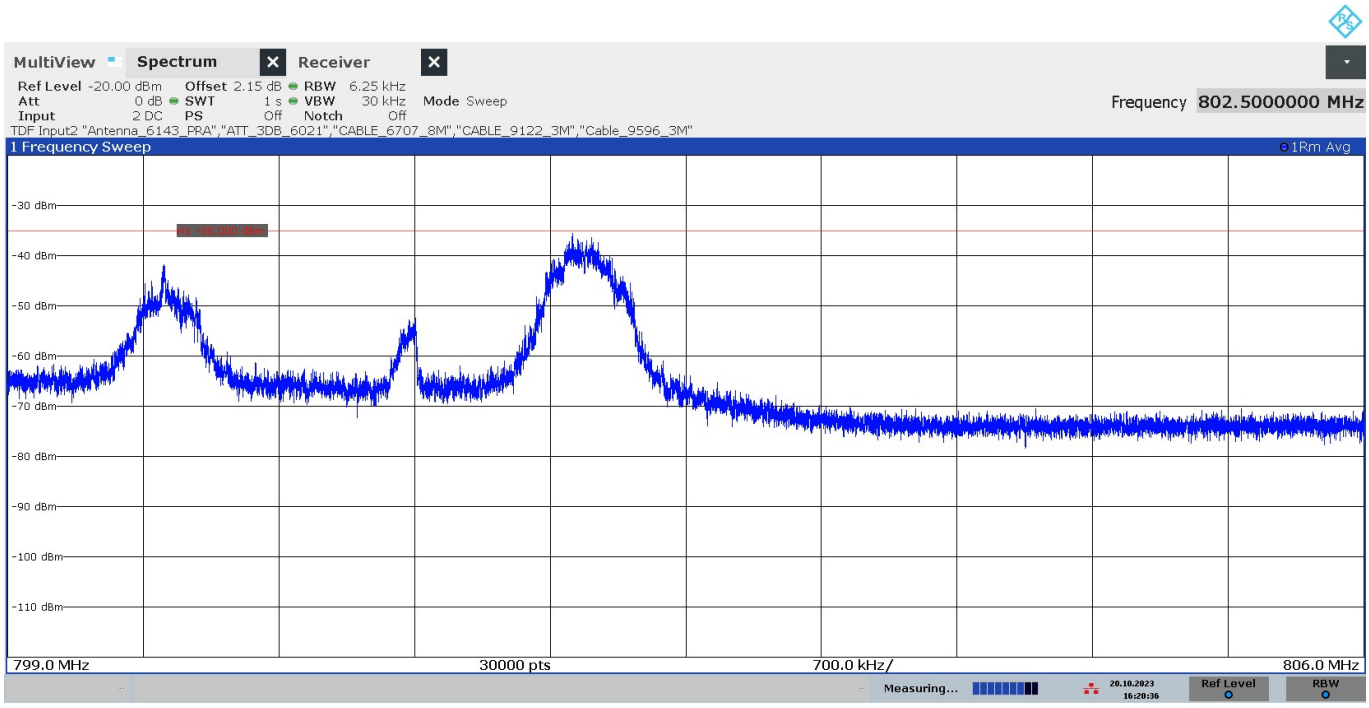
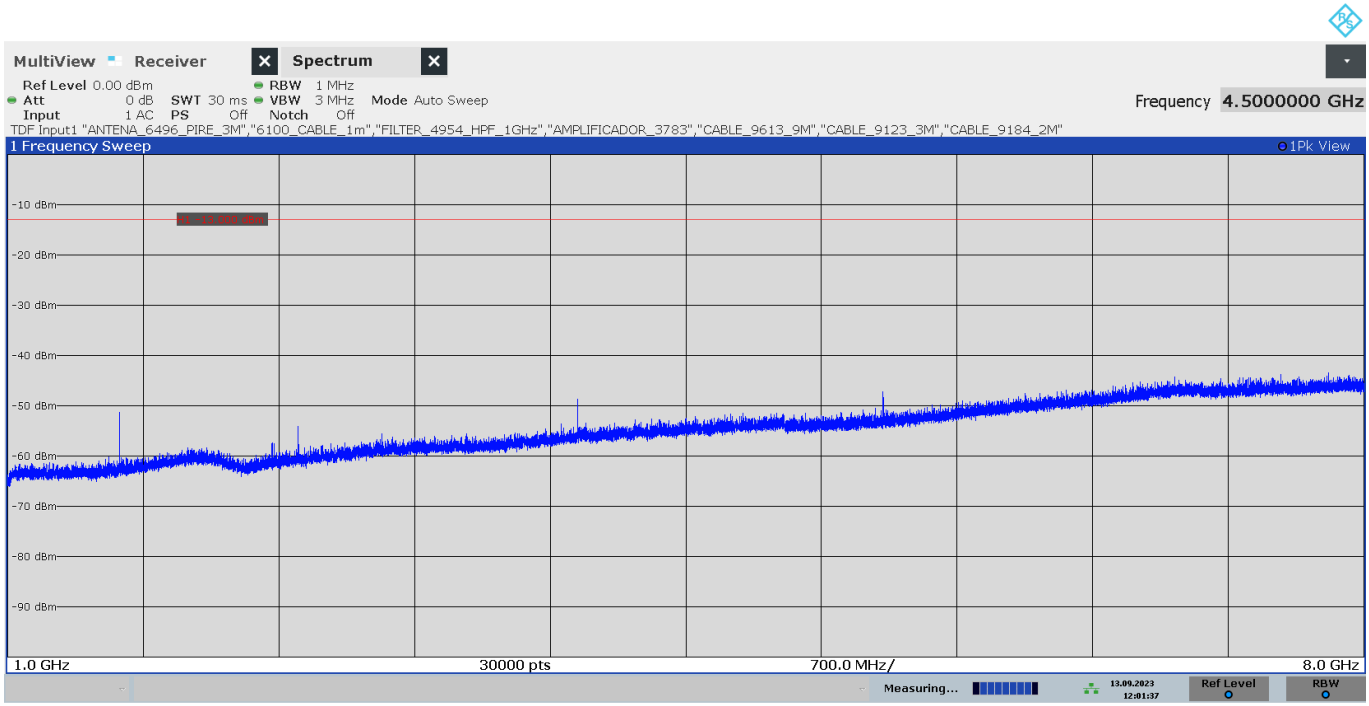



16:20:37 20.10.2023

## FREQUENCY RANGE 1 - 8 GHz:

- LOW CHANNEL:

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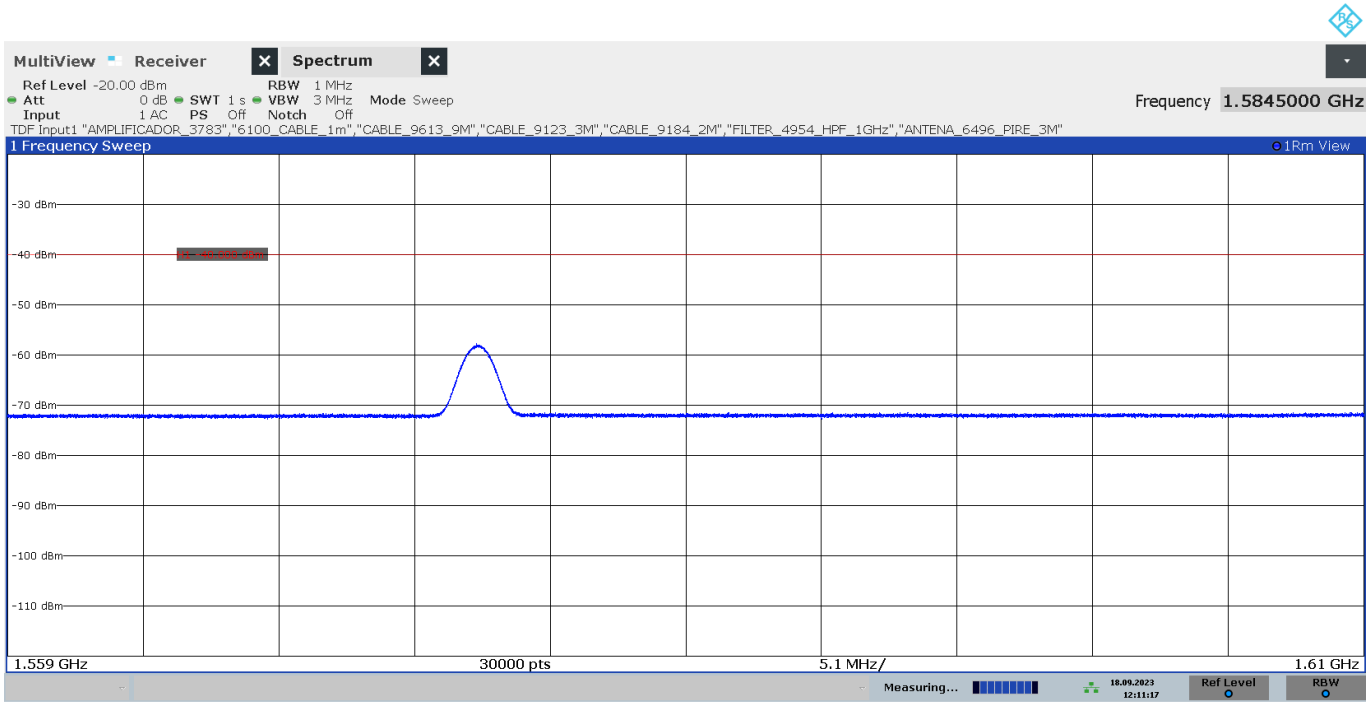


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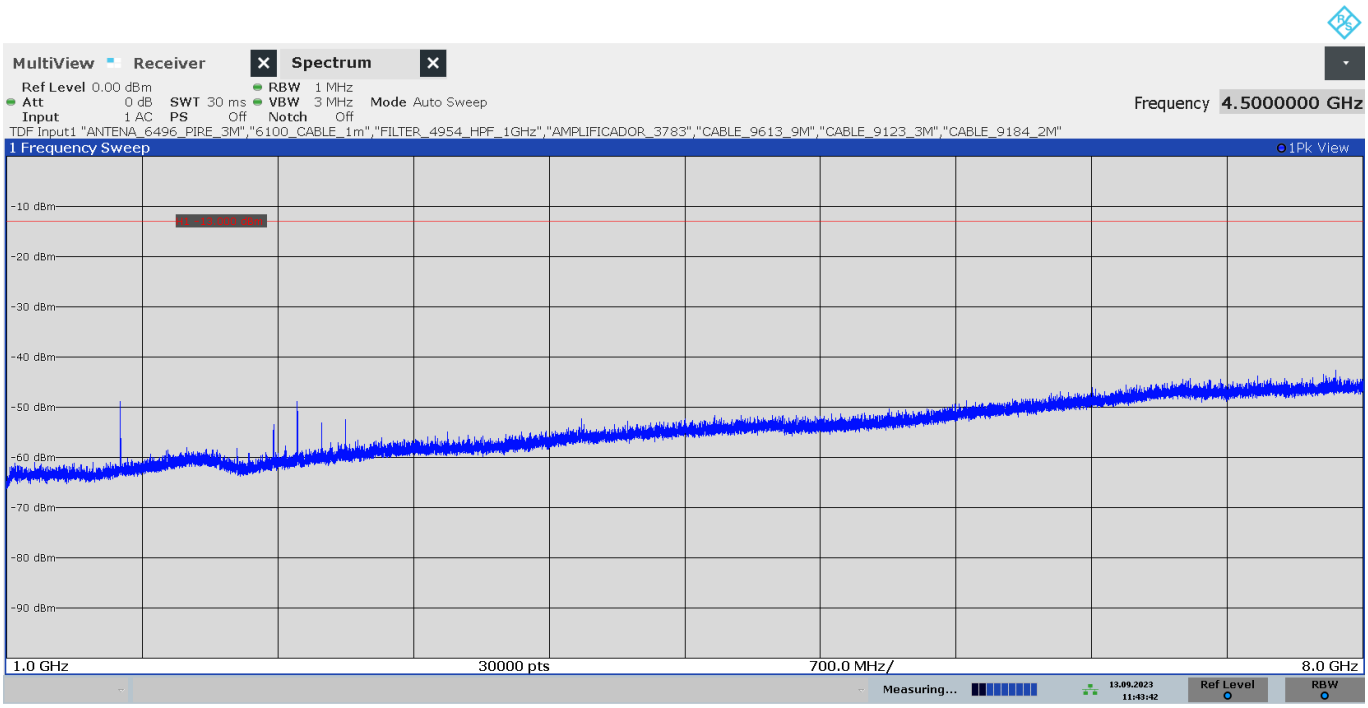
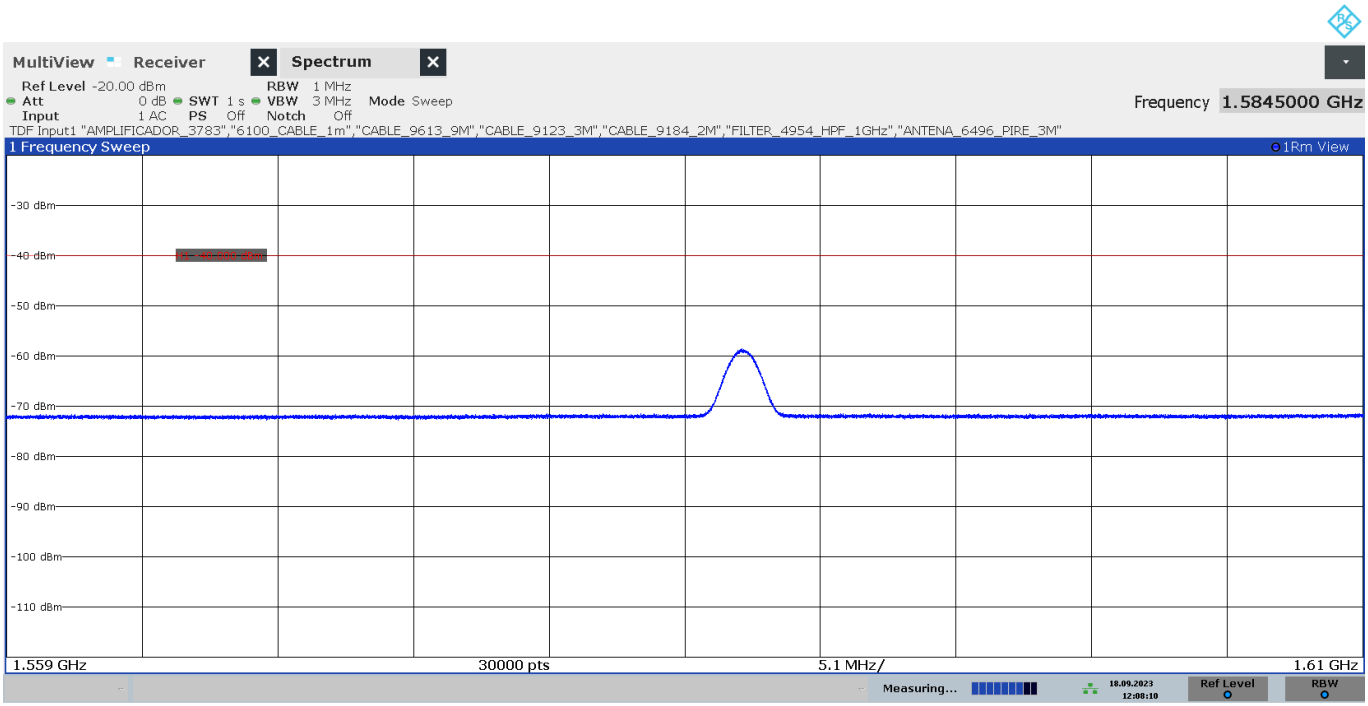
- HIGH CHANNEL:




11:43:42 13.09.2023




12:08:10 18.09.2023