ENSAYOS Nº 51/LE147

Test report No:
NIE: 57478RRF.010

# Partial Test report

## USA FCC Part 22, Part 24, Part 27, Part 90 & Part 15.225, Part 15.209, Part 15.247, Part 15.407 CANADA RSS-210, RSS-130, RSS-132, RSS-133, RSS-139, RSS-199 & RSS-247, RSS-Gen

| | |
|---|---|
| (*) Identification of item tested | Secure Smartphone |
| (*) Trademark | Bittium |
| (*) Model and /or type reference | Tough Mobile 2 |
| Other identification of the product | HW version: 0302<br>SW version: 40.1<br>FCC ID: V27SD-61<br>IC: 3282B-SD61 |
| (*) Features | LTE<br>• 3GPP Rel12<br>• FDD/TDD Cat13/5,<br>• DL 400Mbit/s,<br>• UL 75 Mbit/s<br>UMTS/HSPA<br>• 3GPP rel8, HSPA+,<br>• DL 42 Mbit/s,<br>• UL 5.76 Mbit/s<br>GSM/GPRS/EDGE<br>Complementary Radios<br>• Wi-Fi 802.11 a/b/g/n/ac (2.4 and 5 GHz), 2 x 2 MIMO<br>• BT 5.0<br>• NFC |
| Applicant | BITTIUM WIRELESS OY<br>Ritaharjuntie 1, 90590 Oulu, Finland |
| Test method requested, standard | USA FCC Part 15.225 (10–1–18 Edition): Operation within the band 13.110 -14.010.<br>USA FCC Part 15.407 (10-1-18 Edition): Unlicensed National Information Infrastructure (U-NII) Devices. |

| | |
|---|---|
| | General technical requirements. Band U-NII-3 (5725 MHz – 5850 MHz).<br>USA FCC Part 15.247 10-1-18 Edition: Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz.<br>USA FCC Part 15.209 10-1-18 Edition: Radiated emission limits; general requirements.<br>USA FCC Part 22 (10-1-18 Edition).<br>USA FCC Part 24 (10-1-18 Edition).<br>USA FCC Part 27 (10-1-18 Edition).<br>USA FCC Part 90 (10-1-18 Edition).<br>CANADA RSS-210 Issue 9 (August 2016).<br>CANADA RSS-247 Issue 2 (February 2017).<br>CANADA RSS-Gen Issue 5 (April 2018).<br>CANADA RSS-130 Issue 1, Oct. 2013.<br>CANADA RSS-132 Issue 3, Jan. 2013.<br>CANADA RSS-133 Issue 6, Jan. 2013.<br>CANADA RSS-139 Issue 3, Jul. 2015.<br>CANADA RSS-199 Issue 3, Dec. 2016.<br>-Transmitter out of band radiated emissions with simultaneous transmissions.<br>Guidance for Performing Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid Systems Devices Operating Under Section 15.247 of the FCC Rules. 558074 D01 Meas Guidance v05r02 dated April 2, 2019.<br>Guidance for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices 789033 D02 General U-NII Test Procedures New Rules v02r01 dated Dec 14, 2017.<br>Guidance for Emission Testing of Transmitters with Multiple Outputs in the Same Band 662911 D01 Multiple Transmitter Output v02r01 dated 10/31/2013<br>ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.<br>ANSI C63.26-2015.<br>ANSI/TIA-603-E: 2016. |
| Approved by (name / position & signature) | Jose Carlos Luque<br>RF Lab. Supervisor<br>74841983Y JOSE CARLOS LUQUE (C:A29507456)<br>Firmado digitalmente por 74841983Y JOSE CARLOS LUQUE (C:A29507456)<br>Fecha: 2019.09.11 16:20:25 +02'00' |
| Date of issue | 2019-09-11 |
| Report template No | FDT08_22<br>(*) "Data provided by the client" |

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# Competences and guarantees

DEKRA Testing and Certification S.A.U. 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 a FCC-recognized accredited testing laboratory with appropriate scope of accreditation that include testing performed in this test report.

DEKRA Testing and Certification is an ISED-recognized accredited testing laboratory with appropriate scope of accreditation that include testing performed in this test report.

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

DEKRA Testing and Certification S.A.U. 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 S.A.U. at the time of performance of the test.

DEKRA Testing and Certification S.A.U. 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.

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# General conditions

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2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of DEKRA Testing and Certification S.A.U.
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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 of Tough Mobile 2 consists of a Secure Smartphone targeted for professional use where High Security is required.

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 |
|---|---|---|---|---|
| 57478/032 | Secure Smartphone | Tough Mobile 2 | --- | 2018-11-26 |
| 57478/033 | USB cable | --- | --- | 2018-11-26 |
| 57478/034 | AC/DC power adapter | --- | --- | 2018-11-26 |
| 57478/039 | Headphones | --- | --- | 2018-11-26 |

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

# Test sample description

| | | | | | | |
|---|---|---|---|---|---|---|
| Ports…….. : | Port name and description | | Cable | | | |
| | | | Specified length [m] | Attached during test | Shielded | |
| | - | | | ☐ | ☐ | |
| Supplementary information to the ports…… : | | | | | | |
| Rated power supply .. : | Voltage and Frequency | | Reference poles | | | |
| | | | L1 | L2 | L3 | N | PE |
| | ☐ | AC: | ☐ | ☐ | ☐ | ☐ | ☐ |
| | ☒ | DC: 3.6 – 4.35 Vdc | | | | | |
| Rated Power ..... : | Not provided data. | | | | | | |
| Clock frequencies..... : | Not provided data. | | | | | | |
| Other parameters ..... : | FCC ID: V27SD-61<br><br>IC: 3282B-SD61 | | | | | | |
| Software version ..... : | 40.1 | | | | | | |
| Hardware version ..... : | 0302 | | | | | | |
| Dimensions in cm (W x H x D) ..... : | Not provided data. | | | | | | |
| 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 | |
| | N/A | | | | | |
| Accessories (not part of the test item) ..... : | Description | | Type | | Manufacturer | |
| | N/A | | | | | |
| | N/A | | | | | |

| Documents as provided by the applicant ..... : | Description | File name | Issue date |
|---|---|---|---|
| | - | | |
| | - | | |
| | | | |

## Identification of the client

BITTIUM WIRELESS OY
Ritaharjuntie 1, 90590 Oulu, Finland

## Testing period and place

| | |
|---|---|
| **Test Location** | DEKRA Testing and Certification S.A.U. |
| **Date (start)** | 2019-03-28 |
| **Date (finish)** | 2019-04-09 |

## Document history

| Report number | Date | Description |
|---|---|---|
| 57478RRF.010 | 2019-09-11 | 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 semianechoic 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 % |
| **Air pressure** | Min. = 860 mbar<br>Max. = 1060 mbar |

# Remarks and comments

The tests have been performed by the technical personnel: Miguel Ángel Torres, Nicolás Salguero, Carolina Postigo and José Alberto Aranda.

Used instrumentation:

Radiated Measurements

| | | Last Calibration | Due Calibration |
|---|---|---|---|
| 1. | Semianechoic Absorber Lined Chamber ETS LINDGREN FACT 3 200 STP | N.A. | N.A. |
| 2. | Active Loop Antenna HEWLETT PACKARD 11966A | 2018/06 | 2020/06 |
| 3. | EMI Test Receiver 7 GHz ROHDE AND SCHWARZ ESR7 | 2018/10 | 2020/10 |
| 4. | RF Pre-amplifier 40 dB, 10 MHz-6 GHz BONN ELEKTRONIK BLNA 0160-01N | 2019/02 | 2020/08 |
| 5. | Biconical/Log Antenna ETS LINDGREN 3142E | 2017/09 | 2020/09 |
| 6. | Signal and Spectrum Analyzer ROHDE AND SCHWARZ FSV40 | 2018/02 | 2020/02 |
| 7. | RF Pre-amplifier 30 dB, 1-18GHz BONN ELEKTRONIK BLMA 0118-3A | 2019/04 | 2020/04 |
| 8. | Broadband Horn antenna 1-18 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9120 D | 2018/01 | 2021/01 |
| 9. | RF Pre-amplifier 30 dB, 18 GHz-40 GHz BONN ELEKTRONIK BLMA 1840-1M | 2019/02 | 2021/02 |
| 10. | Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500 | 2019/05 | 2020/05 |

# Testing verdicts

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

# Summary

| FCC PART 15 / FCC PART 22 / FCC PART 24 /FCC PART 27 / FCC PART 90 / RSS-247 / RSS-130 / RSS 132 / RSS 133 / RSS 139 / RSS 199 / RSS-Gen PARAGRAPH | | |
|---|---|---|
| **Requirement – Test case** | **Verdict** | **Remark** |
| FCC 15.209 (a), 15.225 (d), FCC 15.247 (d), FCC 15.407 (b) /<br>RSS-Gen 8.9, RSS-247 5.5, 6.2.1.2, 6.2.2.2, 6.2.3.2 & 6.2.4.2<br>FCC 22.917 / RSS-132 Clause 5.5<br>FCC 24.238 / RSS-133 Clause 6.5<br>FCC 27.53 53 / RSS-139 Clause 6.6. / RSS-130 Clause 4.6. / RSS-199 Clause 4.5<br>FCC 90.543<br>Emission limitations radiated (Transmitter) | P | |
| Supplementary information and remarks:<br>(1) Only co-location radiated spurious emission test was requested | | |

# **Appendix A:** Test results FCC Part 22 / RSS-132

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# TEST CONDITIONS

POWER SUPPLY (V):

V nonimal: 3.8 Vdc.

Type of Power Supply: DC voltage from a rechargeable battery.

ANTENNA:

Type of Antennas: Internal.

**Maximum Declared Gain for NFC:**

Gain: Not Applicable.

**Maximum Declared Gain for 2.4 GHz WLAN:**

CHAIN 0 Antenna Port Gain: -3 dBi

CHAIN 1 Antenna Port Gain: +2.2 dBi

**Maximum Declared Gain for 5 GHz WLAN:**

CHAIN 0 Antenna Port Gain: -1.1 dBi

CHAIN 1 Antenna Port Gain: -1.1 dBi

**Maximum Declared Gain for Cellular:**

| **LOW BANDS (monopole)** | | MIDDLE BANDS (monopole with parasitic resonator) | | HIGH BANDS (loop) | |
|---|---|---|---|---|---|
| B5: LTE WCDMA **GSM850** | **0.9 dBi** | B1: LTE WCDMA | 1.4 dBi | B7: LTE | 2.9 dBi |
| B8: LTE WCDMA GSM900 | -2.5 dBi | B2: LTE WCDMA PCS1900 | 0.1 dBi | B30: LTE | 0.5 dBi |
| B12: LTE | -2.8 dBi | B3: LTE DCS1800 | 0.2 dBi | B38: LTE | 2.1 dBi |
| B13: LTE | -4.4 dBi | B4: LTE WCDMA | 0 dBi | | |
| B14: LTE | -4.7 dBi | B25: LTE | 0.2 dBi | | |
| B17: LTE | -2.8 dBi | B66: LTE | 0.2 dBi | | |
| B20: LTE | 0.8 dBi | | | | |
| B26: LTE | 0.9 dBi | | | | |
| B28: LTE | -2.1 dBi | | | | |

TEST FREQUENCIES - FCC PART 22:

| | CELLULAR 2G | |
|---|---|---|
| Band: | GSM-850 | |
| Frequency Range: | 824 – 849 MHz | |
| Channel Spacing: | 200 KHz | |
| Transmit Channel: | Channel | Channel Frequency (MHz) |
| | Low: 128 | 824.2 MHz |

| | WLAN (IEEE 802.11 anac) / U-NII | |
|---|---|---|
| Mode: | 802.11a: 6, 9, 12, 18, 24, 36, 48 & 54 Mbps (SISO) | |
| Frequency Range: | 5150 MHz to 5725 MHz | |
| Channel Spacing: | 20 MHz | |
| Transmit Channel: | Channel | Channel Frequency (MHz) |
| | Middle: 40 | 5200 |

| | WLAN (IEEE 802.11 bgn2040) / Digital Transmission System (DTS) | |
|---|---|---|
| Mode: | 802.11b: 1, 2, 5.5 & 11 Mbps (SISO) | |
| Channel Spacing: | 20 MHz | |
| Frequency Range: | 2412 MHz to 2472 MHz | |
| Transmit Channel: | Channel | Channel Frequency (MHz) |
| | 1 | 2412 |

| | NFC |
|---|---|
| Mode: | Type B |
| Bitrate: | 106 Kbps |
| Nominal Operating frequency: | 13.56 MHz |

The test set-up was made in accordance to the general provisions of FCC DTS Measurement 558074 D01 DTS Meas Guidance v05 dated 24/08/2018 and FCC Unlicensed National Information Infrastructure (U-NII) Devices 789033 D02 General U-NII Test Procedures New Rules v02r01 dated Dec 14, 2017.

The EUT was tested in the following operating mode:

- Continuous transmission with a modulated carrier at maximum power in all required channels selecting the supported data rates/modulations types.

During transmitter test the EUT was being controlled by the SW tool to operate in a continuous transmit mode on the test channel as required and in each of the different modulation modes.

The following configurations were selected based on preliminary testing that identified those corresponding to the worst cases:

**Transmission modes selected with each radio:**

* CELLULAR 2G: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in GSM-850 band configuration as this channel was found to transmit higher EIRP than all the other 2G channels.

* 5 GHz WLAN: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in 802.11a20 / 6Mbps / SISO (Chain 0) mode configuration as this mode was found to transmit higher EIRP than all the other 5 GHz WLAN modes.

* 2.4 GHz WLAN: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in 802.11b / 1Mbps / SISO (Chain 0) mode configuration as this mode was found to transmit higher EIRP than all the other 2.4 GHz WLAN modes.

* NFC: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in B mode (106 Kbps) because its power is higher than the other modulations and bitrates.

**Simultaneous transmission mode selected:**

**1. CELLULAR 2G, 5 GHz WLAN, 2.4 GHz WLAN and NFC Co-Location**, with the EUT configured to simultaneously transmit four signals at maximum output power, CELLULAR 2G in GSM-850, 5GHz WLAN (Wi-Fi Chain 0) in 802.11a20 / 6 Mbps / SISO, 2.4GHz WLAN (Wi-Fi Chain 0) in 802.11b / 1 Mbps / SISO and NFC (B, 106 Kbps).

# Radiated emissions

SPECIFICATION:

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c) / RSS-Gen):

| Frequency Range (MHz) | Field strength (µV/m) | Field strength (dBµV/m) | Measurement distance (m) |
|---|---|---|---|
| 0.009-0.490 | 2400/F(kHz) | - | 300 |
| 0.490-1.705 | 24000/F(kHz) | - | 30 |
| 1.705 - 30.0 | 30 | - | 30 |
| 30 - 88 | 100 | 40 | 3 |
| 88 - 216 | 150 | 43.5 | 3 |
| 216 - 960 | 200 | 46 | 3 |
| 960 - 25000 | 500 | 54 | 3 |

The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

RSS-247. Attenuation below the general field strength limits specified in RSS-Gen is not required.

**1. 2G GSM-850.** FCC §2.1053 & §22.917 / RSS-132 Clause 5.5.

FCC §22.917:

> (a) Out of band emissions. 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.

RSS-132 Clause 5.5:

> i. In the first 1.0 MHz band immediately outside and adjacent to each of the sub-bands specified in Section 5.1, the power of emissions per any 1% of the occupied bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10p (watts).
>
> ii. After the first 1.0 MHz immediately outside and adjacent to each of the sub-bands, the power of emissions in any 100 kHz bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10 p (watts). If the measurement is performed using 1% of the occupied bandwidth, power integration over 100 kHz is required.

LIMIT:

The spurious signals was measured at 3 meter. The limit of the test is determined by:

| Frequency Range | Detector | Limit (dBµV/m) at 3m |
|---|---|---|
| 30 MHz to 8 GHz | PK | 43 + 10 log (P) dB = -13 dBm -> 82.23 dBµV/m or 74 (*)-> -21.23 dBm |
| 8 GHz to 26 GHz | PK | 74 (*) |
| | AVG | 54 (*) |
| 26 GHz to 40 GHz | PK | 68.23 |

(*) Radiated emissions which fall in the restricted bands, as defined in §15.205(a).

METHOD:

The measurement was performed with the EUT inside an anechoic chamber.

The spectrum was scanned from 9 kHz to at least the 10th harmonic of the highest frequency of the co-located radios till 40 GHz.

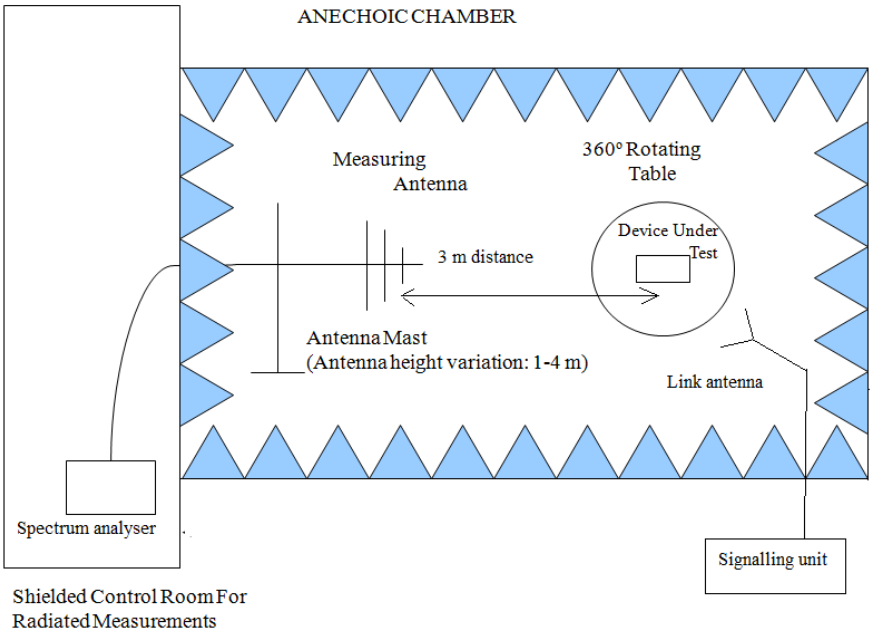
The EUT was placed on a non-conductive stand at a 3 meter distance from the measuring antenna for measurements below 1 GHz and at 1 m distance for measurements above 1 GHz.
Detected emissions were maximized at each frequency by rotating the EUT and adjusting the measuring antenna height and polarization. The maximum meter reading was recorded.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

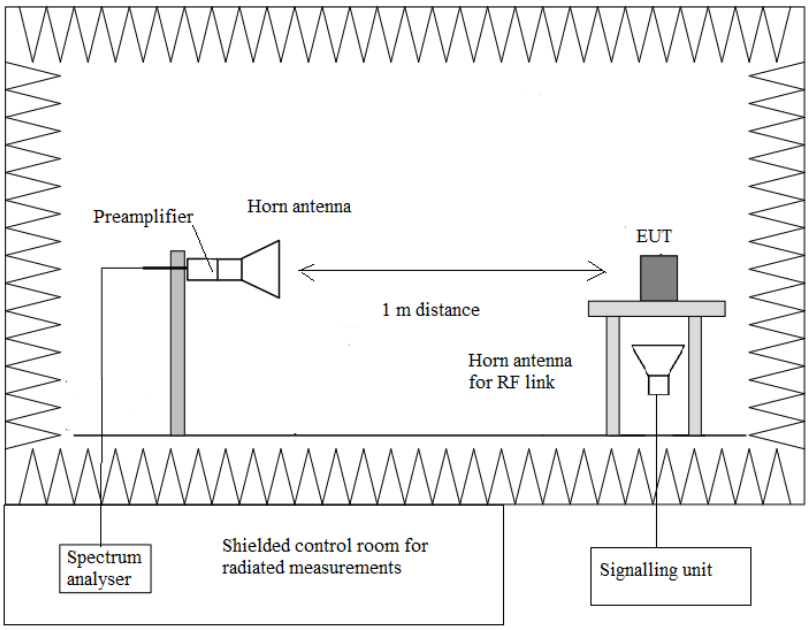
These measurements have been performed in order to check the impact of the Co-Location of all radio interfaces (that can be transmitting simultaneously).

TEST SETUP:

Radiated measurements below 1 GHz.




Radiated measurements above 1 GHz.



RESULTS:

- **Mode 2G GSM-850, 802.11 a20, 802.11 b and NFC B.**

**GPRS & EDGE:**

A preliminary scan determined the GPRS modulation in Channel Low as the worst case.

**Frequency range 9 KHz - 30 MHz**

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

**Frequency range 30 MHz - 1 GHz**

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

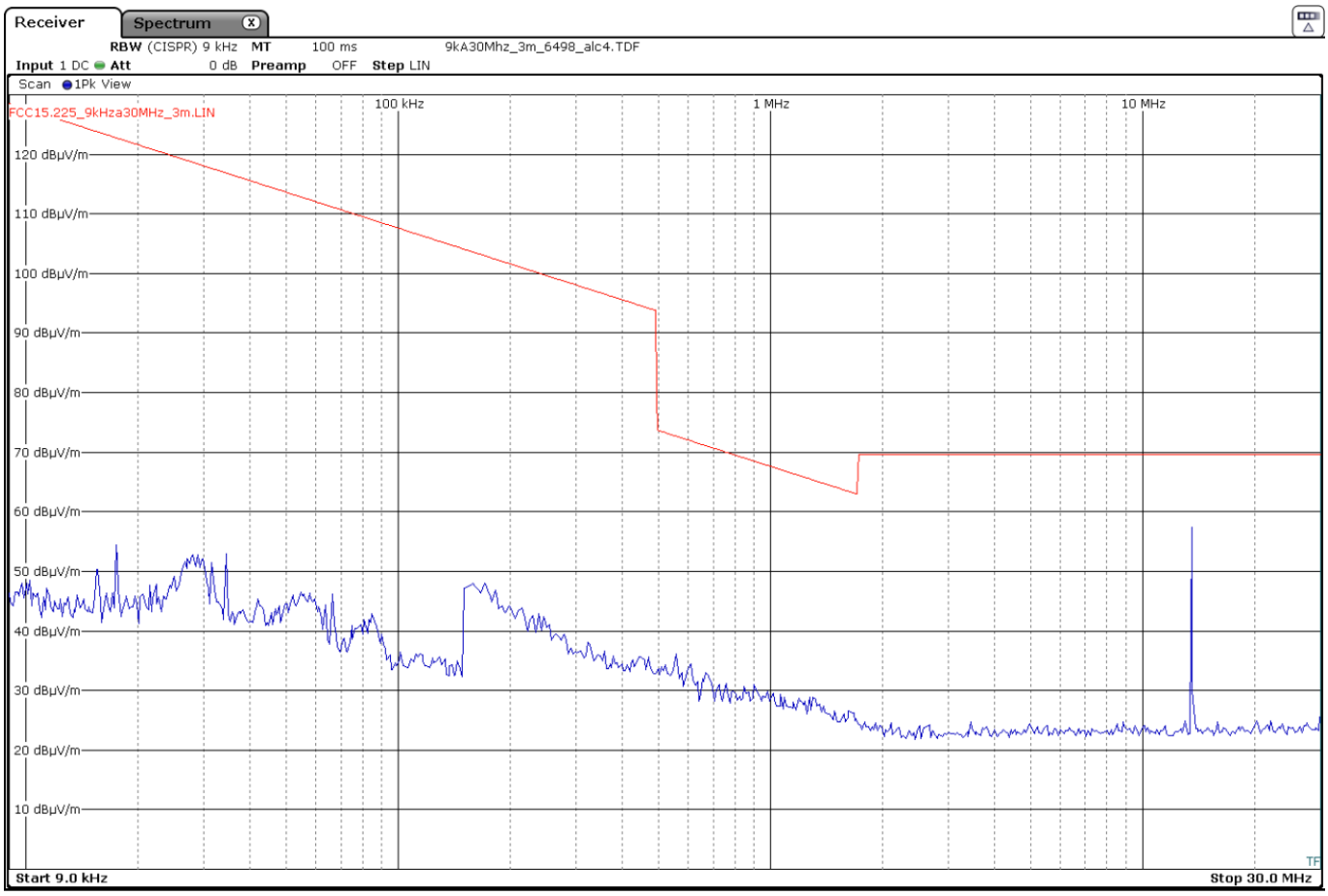
**Frequency range 1 - 40 GHz**

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

| | |
|---|---|
| Measurement uncertainty (dB) | <±3.88 for f < 1GHz<br><±3.70 for f ≥ 1 GHz up to 18 GHz<br><±3.33 for f ≥ 18 GHz up to 20 GHz |

Verdict: PASS

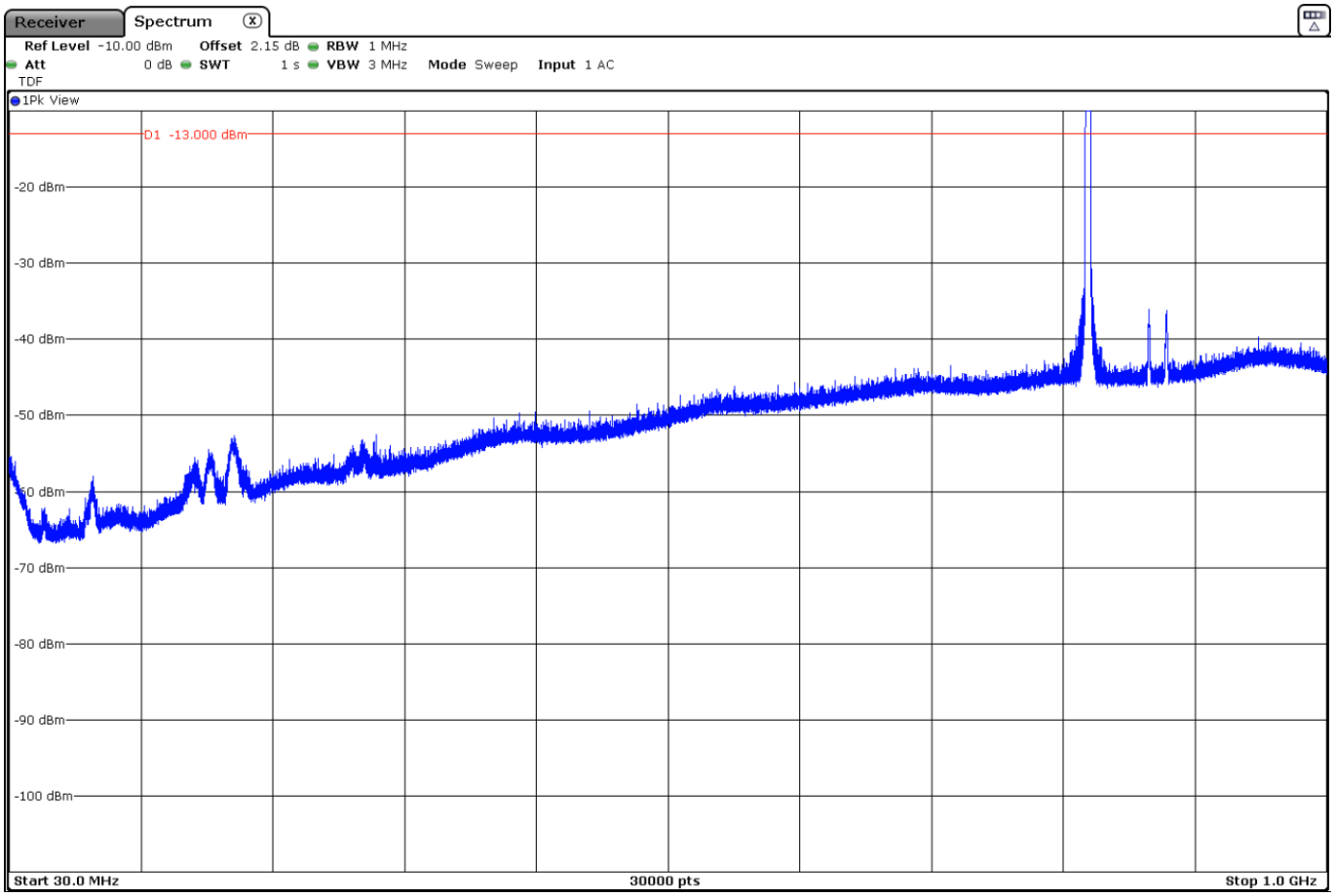
## FREQUENCY RANGE 9 KHz - 30 MHz




The highest peak is the carrier frequency NFC type B (13.56 MHz).

## FREQUENCY RANGE 30 MHz - 1 GHz

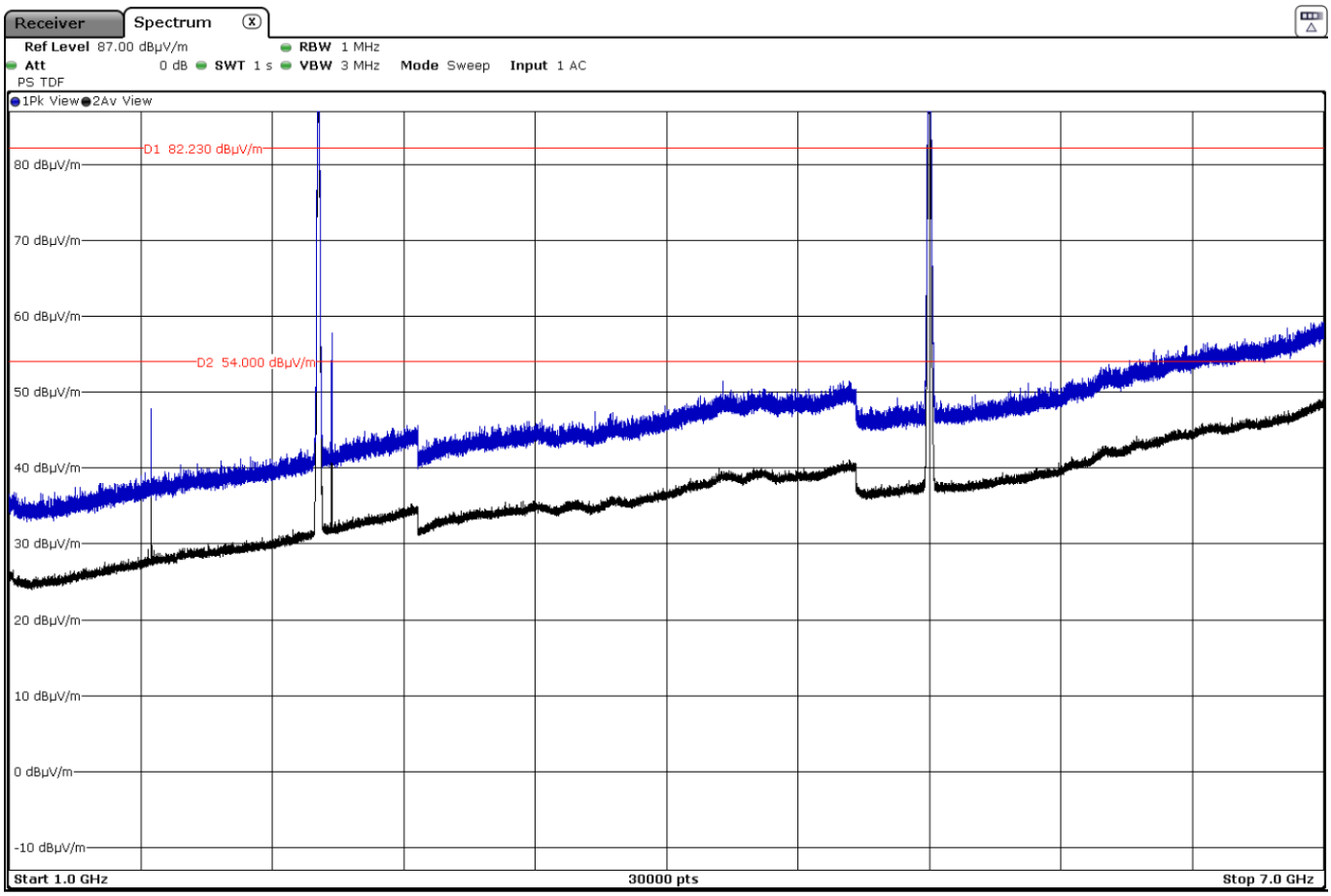
### GPRS MODULATION




The peak above the limit is the carrier frequency 2G GSM-850 (824.2 MHz).

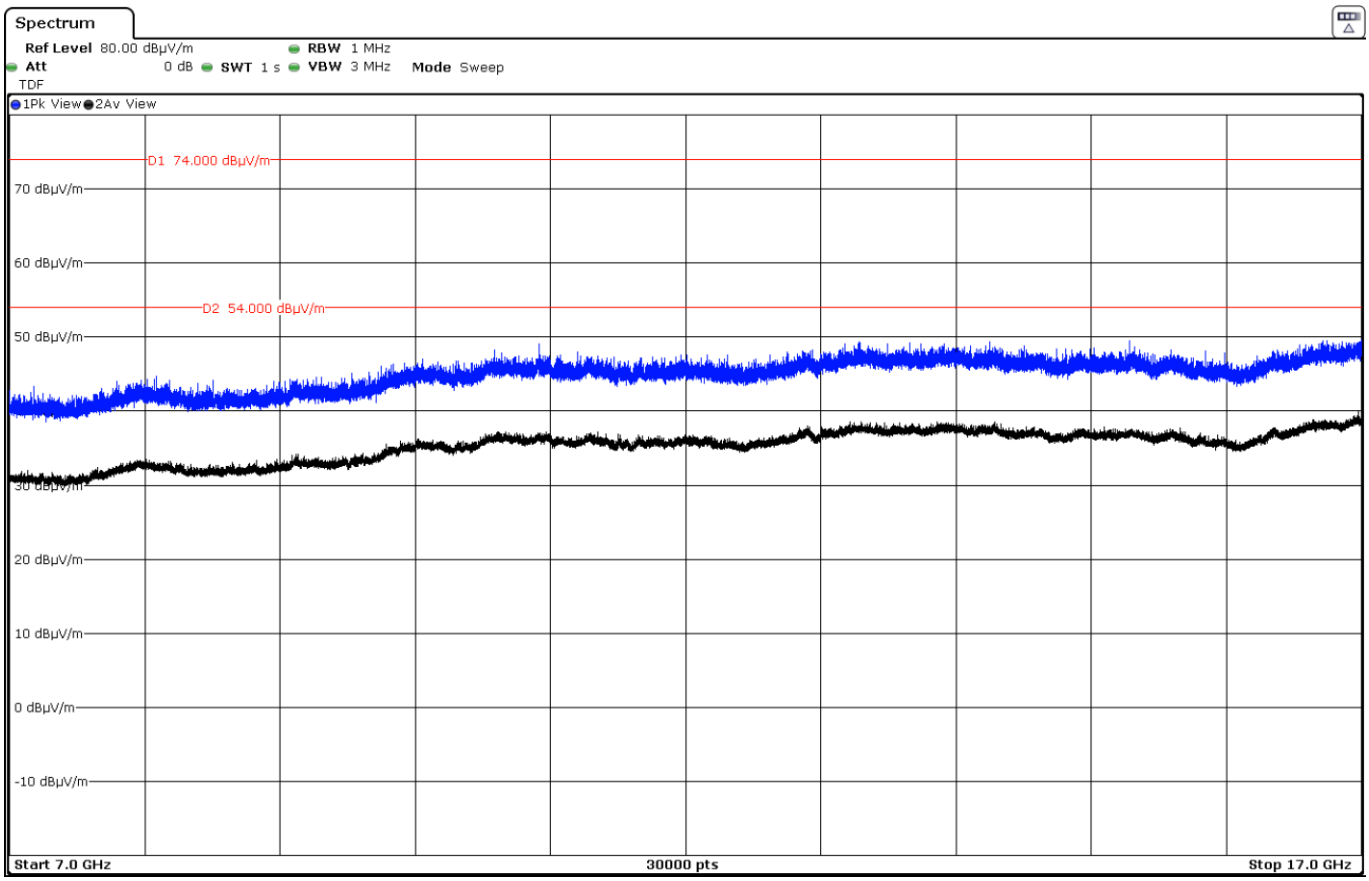
## FREQUENCY RANGE 1 - 7 GHz

### GPRS MODULATION

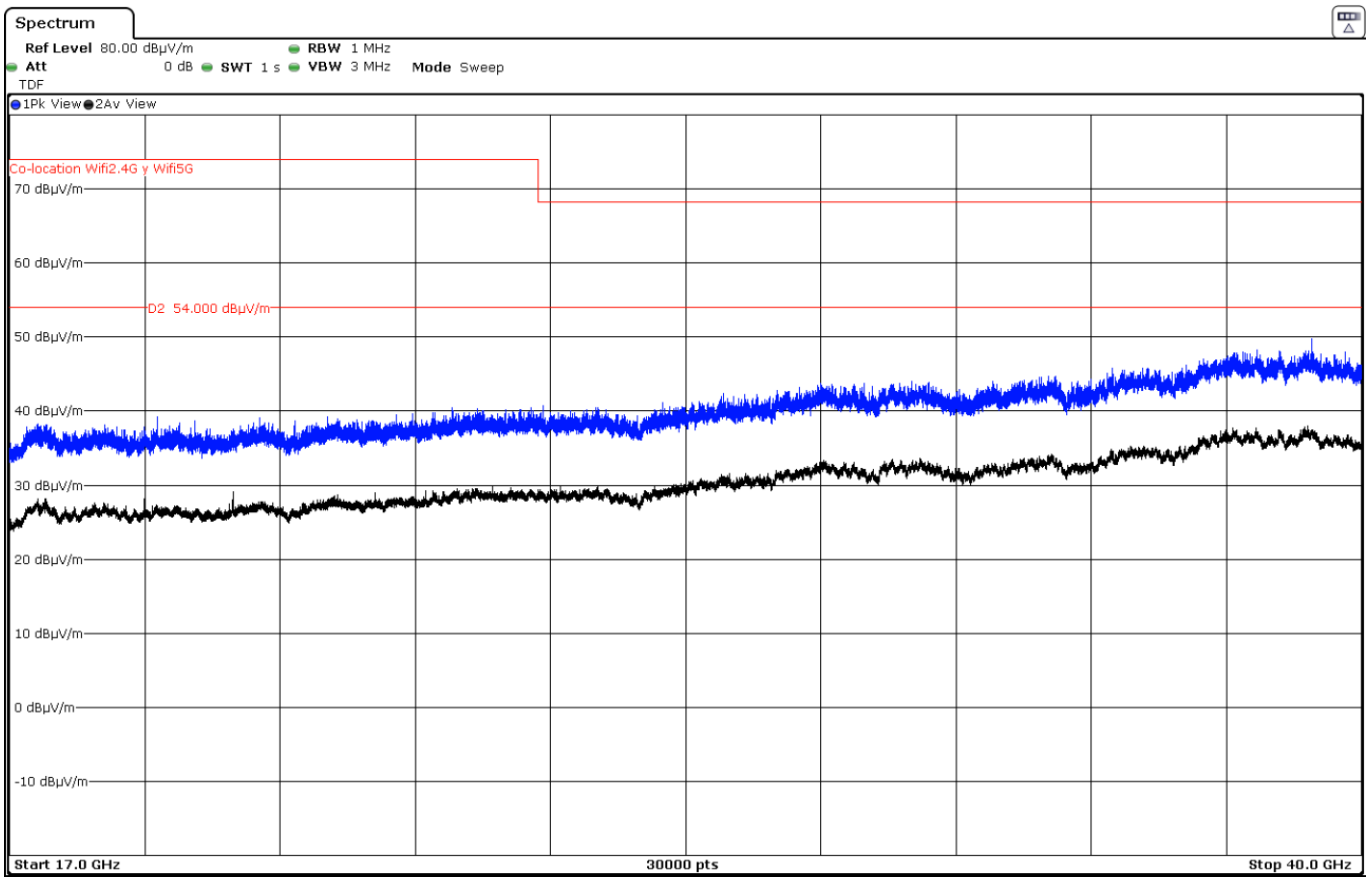



The peaks above the limit are the 802.11 b (2412 MHz) and the 802.11 a20 (5200 MHz) carrier frequencies.

## FREQUENCY RANGE 7 – 17 GHz



## FREQUENCY RANGE 17 - 40 GHz



# **Appendix B:** Test results FCC Part 24 / RSS-133

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# TEST CONDITIONS

POWER SUPPLY (V):

V nonimal: 3.8 Vdc.

Type of Power Supply: DC voltage from a rechargeable battery.

ANTENNA:

Type of Antennas: Internal.

**Maximum Declared Gain for NFC:**

Gain: Not Applicable.

**Maximum Declared Gain for 2.4 GHz WLAN:**

CHAIN 0 Antenna Port Gain : -3 dBi

CHAIN 1 Antenna Port Gain : +2.2 dBi

**Maximum Declared Gain for 5 GHz WLAN:**

CHAIN 0 Antenna Port Gain : -1.1 dBi

CHAIN 1 Antenna Port Gain : -1.1 dBi

**Maximum Declared Gain for Cellular:**

| LOW BANDS (monopole) | | MIDDLE BANDS (monopole with parasitic resonator) | | HIGH BANDS (loop) | |
|---|---|---|---|---|---|
| B5: LTE WCDMA GSM850 | 0.9 dBi | B1: LTE WCDMA | 1.4 dBi | B7: LTE | 2.9 dBi |
| B8: LTE WCDMA GSM900 | -2.5 dBi | B2: LTE WCDMA **PCS1900** | **0.1 dBi** | B30: LTE | 0.5 dBi |
| B12: LTE | -2.8 dBi | B3: LTE DCS1800 | 0.2 dBi | B38: LTE | 2.1 dBi |
| B13: LTE | -4.4 dBi | B4: LTE WCDMA | 0 dBi | | |
| B14: LTE | -4.7 dBi | B25: LTE | 0.2 dBi | | |
| B17: LTE | -2.8 dBi | B66: LTE | 0.2 dBi | | |
| B20: LTE | 0.8 dBi | | | | |
| B26: LTE | 0.9 dBi | | | | |
| B28: LTE | -2.1 dBi | | | | |

TEST FREQUENCIES - FCC PART 24:

| | CELLULAR 2G | |
|---|---|---|
| Band: | PCS-1900 | |
| Frequency Range: | 1850 – 1910 MHz | |
| Channel Spacing: | 200 KHz | |
| Transmit Channel: | Channel | Channel Frequency (MHz) |
| | Low: 512 | 1850.2 MHz |

| | WLAN (IEEE 802.11 anac) / U-NII | |
|---|---|---|
| Mode: | 802.11a: 6, 9, 12, 18, 24, 36, 48 & 54 Mbps (SISO) | |
| Frequency Range: | 5150 MHz to 5725 MHz | |
| Channel Spacing: | 20 MHz | |
| Transmit Channel: | Channel | Channel Frequency (MHz) |
| | Middle: 40 | 5200 |

| | WLAN (IEEE 802.11 bgn2040) / Digital Transmission System (DTS) | |
|---|---|---|
| Mode: | 802.11b: 1, 2, 5.5 & 11 Mbps (SISO) | |
| Channel Spacing: | 20 MHz | |
| Frequency Range: | 2412 MHz to 2472 MHz | |
| Transmit Channel: | Channel | Channel Frequency (MHz) |
| | 1 | 2412 |

| | NFC |
|---|---|
| Mode: | Type B |
| Bitrate: | 106 Kbps |
| Nominal Operating frequency: | 13.56 MHz |

The test set-up was made in accordance to the general provisions of FCC DTS Measurement 558074 D01 DTS Meas Guidance v05 dated 24/08/2018 and FCC Unlicensed National Information Infrastructure (U-NII) Devices 789033 D02 General U-NII Test Procedures New Rules v02r01 dated Dec 14, 2017.

The EUT was tested in the following operating mode:

- Continuous transmission with a modulated carrier at maximum power in all required channels selecting the supported data rates/modulations types.

During transmitter test the EUT was being controlled by the SW tool to operate in a continuous transmit mode on the test channel as required and in each of the different modulation modes.

The following configurations were selected based on preliminary testing that identified those corresponding to the worst cases:

**Transmission modes selected with each radio:**

* CELLULAR 2G: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in PCS-1900 band configuration as this channel was found to transmit higher EIRP than all the other 2G channels.

* 5 GHz WLAN: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in 802.11a20 / 6Mbps / SISO (Chain 0) mode configuration as this mode was found to transmit higher EIRP than all the other 5 GHz WLAN modes.

* 2.4 GHz WLAN: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in 802.11b / 1Mbps / SISO (Chain 0) mode configuration as this mode was found to transmit higher EIRP than all the other 2.4 GHz WLAN modes.

* NFC: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in B mode (106 Kbps) because its power is higher than the other modulations and bitrates.

**Simultaneous transmission mode selected:**

**1. CELLULAR 2G, 5 GHz WLAN, 2.4 GHz WLAN and NFC Co-Location**, with the EUT configured to simultaneously transmit four signals at maximum output power, CELLULAR 2G in PCS-1900, 5GHz WLAN (Wi-Fi Chain 0) in 802.11a20 / 6 Mbps / SISO, 2.4GHz WLAN (Wi-Fi Chain 0) in 802.11b / 1 Mbps / SISO and NFC (B, 106 Kbps).

# Radiated emissions

SPECIFICATION:

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c) / RSS-Gen):

| Frequency Range (MHz) | Field strength (µV/m) | Field strength (dBµV/m) | Measurement distance (m) |
|---|---|---|---|
| 0.009-0.490 | 2400/F(kHz) | - | 300 |
| 0.490-1.705 | 24000/F(kHz) | - | 30 |
| 1.705 - 30.0 | 30 | - | 30 |
| 30 - 88 | 100 | 40 | 3 |
| 88 - 216 | 150 | 43.5 | 3 |
| 216 - 960 | 200 | 46 | 3 |
| 960 - 25000 | 500 | 54 | 3 |

The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

**1. 2G PCS-1900.** FCC §2.1053 & §24.238 / RSS-133 Clause 6.5.

FCC §24.238:

(a) Out of band emissions. 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.

RSS-133 Clause 6.5:

i. In the 1.0 MHz bands immediately outside and adjacent to the equipment's operating frequency block, the emission power per any 1% of the emission bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10p(watts).

ii. After the first 1.0 MHz, the emission power in any 1 MHz bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10p(watts). If the measurement is performed using 1% of the emission bandwidth, power integration over 1.0 MHz is required.

LIMIT:

The spurious signals was measured at 3 meter. The limit of the test is determined by:

| Frequency Range | Detector | Limit (dBµV/m) at 3m |
|---|---|---|
| 30 MHz to 20 GHz | PK | 43 + 10 log (P) dB = -13 dBm -> 82.23 dBµV/m or 74 (*)-> -21.23 dBm |
| 20 GHz to 26 GHz | PK | 74 (*) |
| | AVG | 54 (*) |
| 26 GHz to 40 GHz | PK | 68.23 |

(*) Radiated emissions which fall in the restricted bands, as defined in §15.205(a).

METHOD:

The measurement was performed with the EUT inside an anechoic chamber.

The spectrum was scanned from 9 kHz to at least the 10th harmonic of the highest frequency of the co-located radios till 40 GHz.

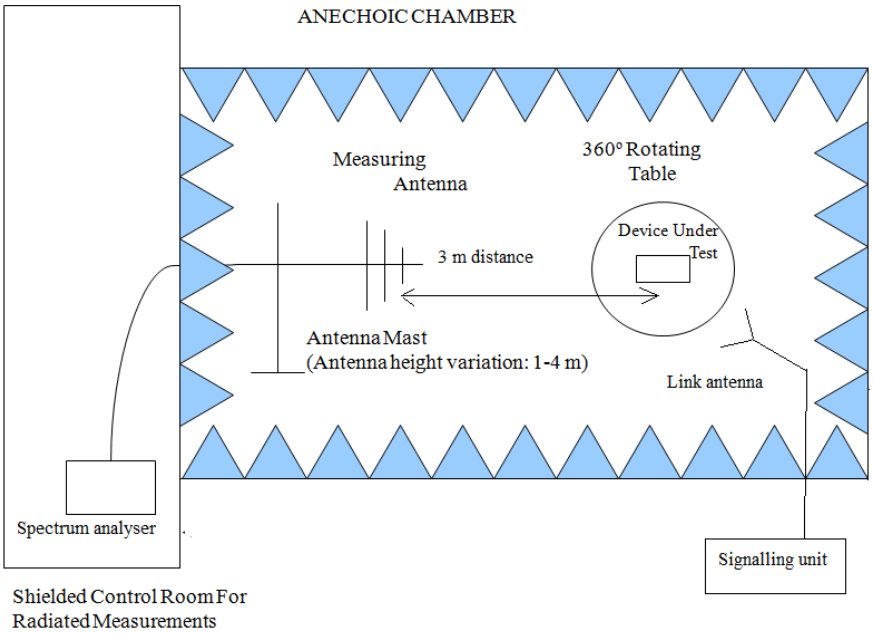
The EUT was placed on a non-conductive stand at a 3 meter distance from the measuring antenna for measurements below 1 GHz and at 1 m distance for measurements above 1 GHz.
Detected emissions were maximized at each frequency by rotating the EUT and adjusting the measuring antenna height and polarization. The maximum meter reading was recorded.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

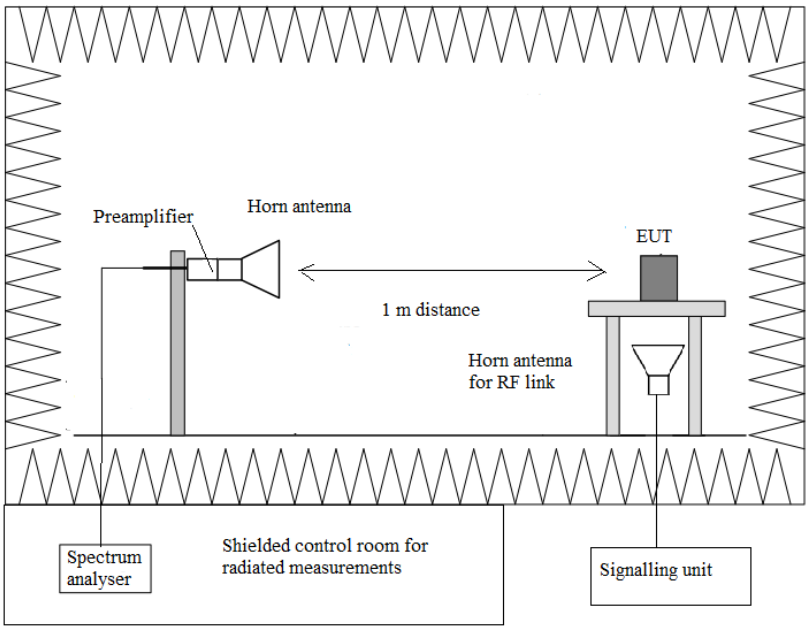
These measurements have been performed in order to check the impact of the Co-Location of all radio interfaces (that can be transmitting simultaneously).

TEST SETUP:

Radiated measurements below 1 GHz.




Radiated measurements above 1 GHz.



RESULTS:

- **Mode 2G PCS-1900, 802.11 a20, 802.11 b and NFC B.**

**GPRS & EDGE:**

A preliminary scan determined the GPRS modulation in Channel Low as the worst case.

**Frequency range 9 KHz - 30 MHz**

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

**Frequency range 30 MHz - 1 GHz**

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

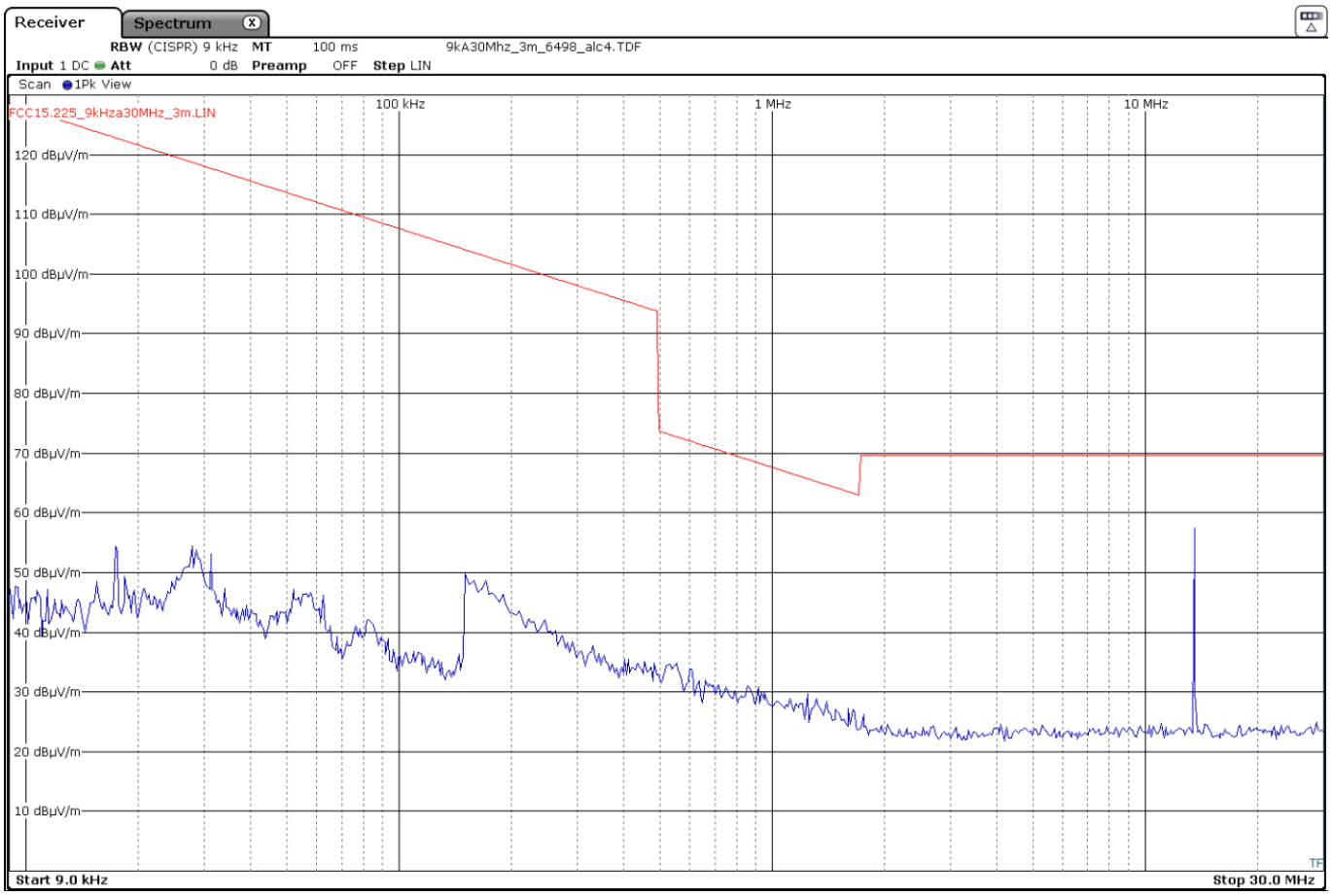
**Frequency range 1 - 40 GHz**

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

| | |
|---|---|
| Measurement uncertainty (dB) | <±3.88 for f < 1GHz<br><±3.70 for f ≥ 1 GHz up to 18 GHz<br><±3.33 for f ≥ 18 GHz up to 20 GHz |

Verdict: PASS

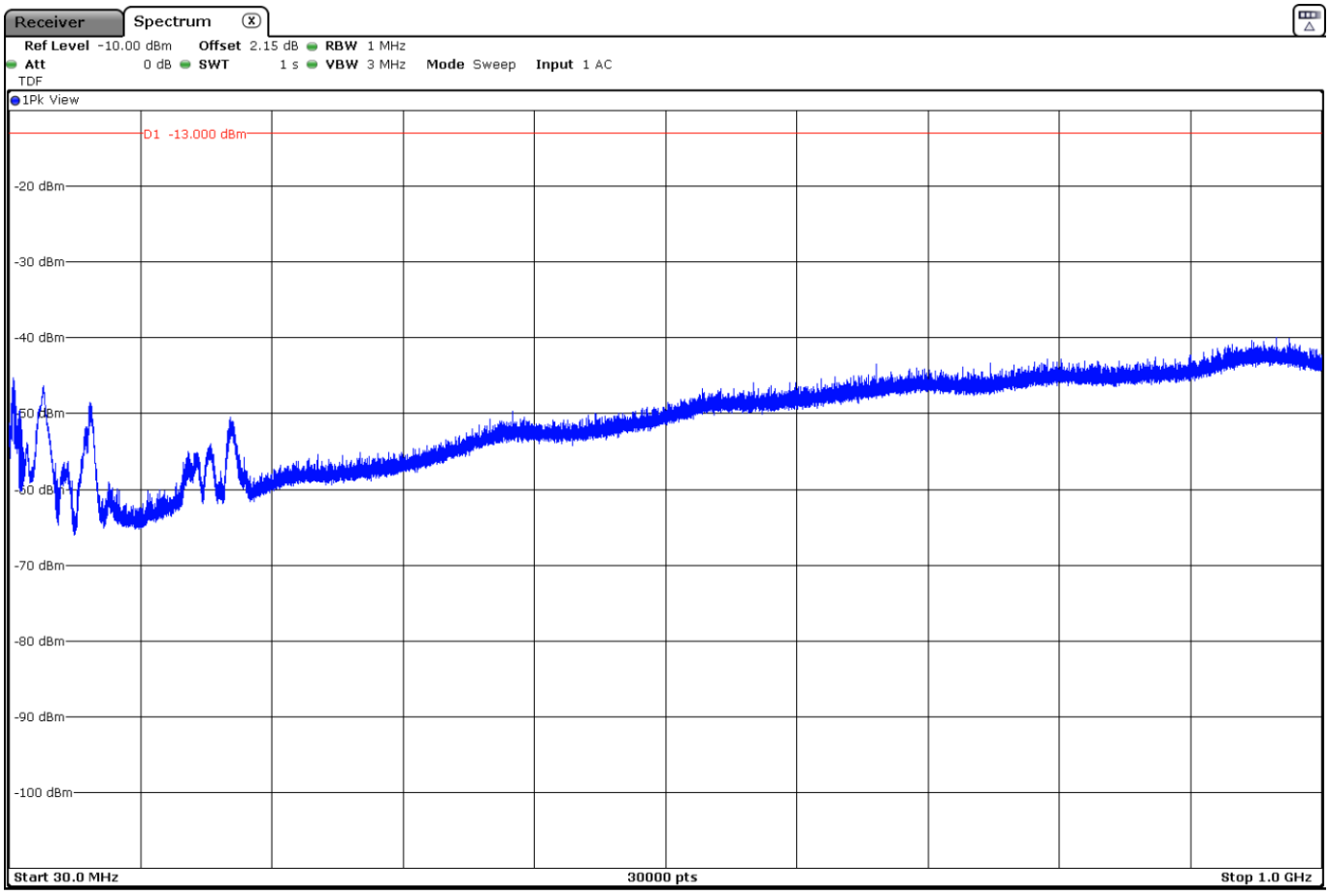
## FREQUENCY RANGE 9 KHz - 30 MHz




The highest peak is the carrier frequency NFC type B (13.56 MHz).

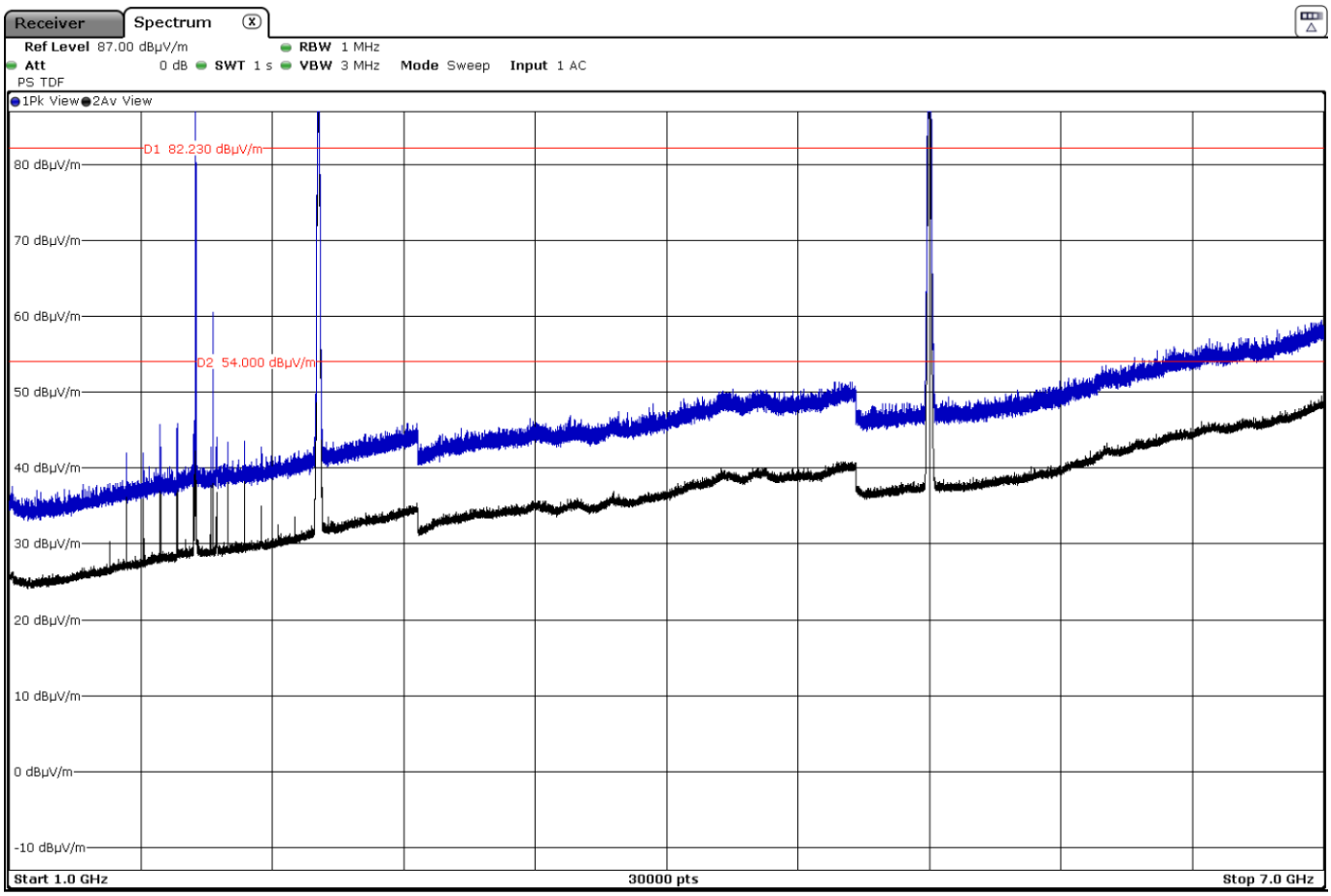
## FREQUENCY RANGE 30 MHz - 1 GHz

### GPRS MODULATION



## FREQUENCY RANGE 1 - 7 GHz

### GPRS MODULATION



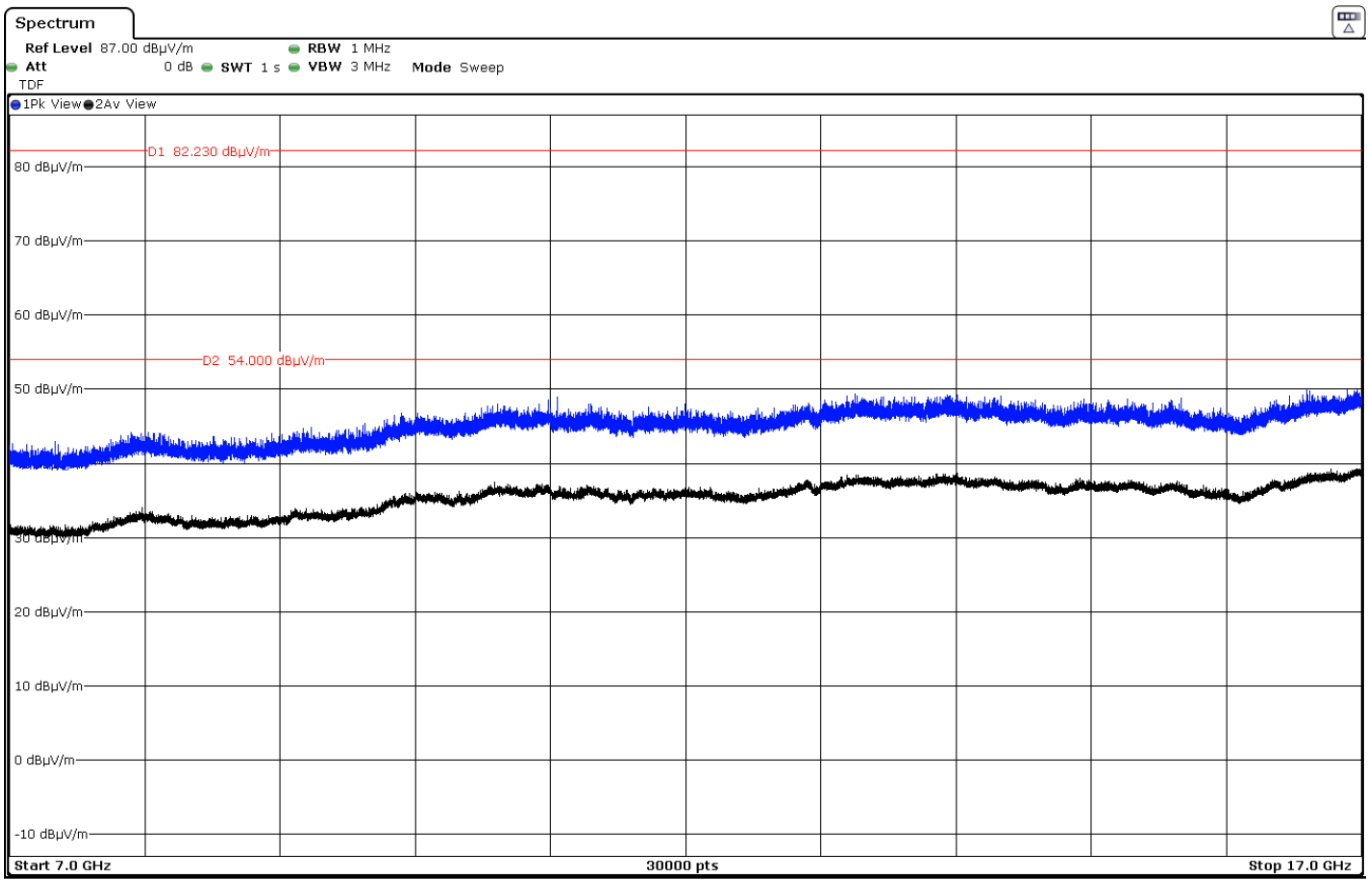

The peaks above the limit are the carrier frequencies:

2G PCS-1900 (1850.2 MHz).

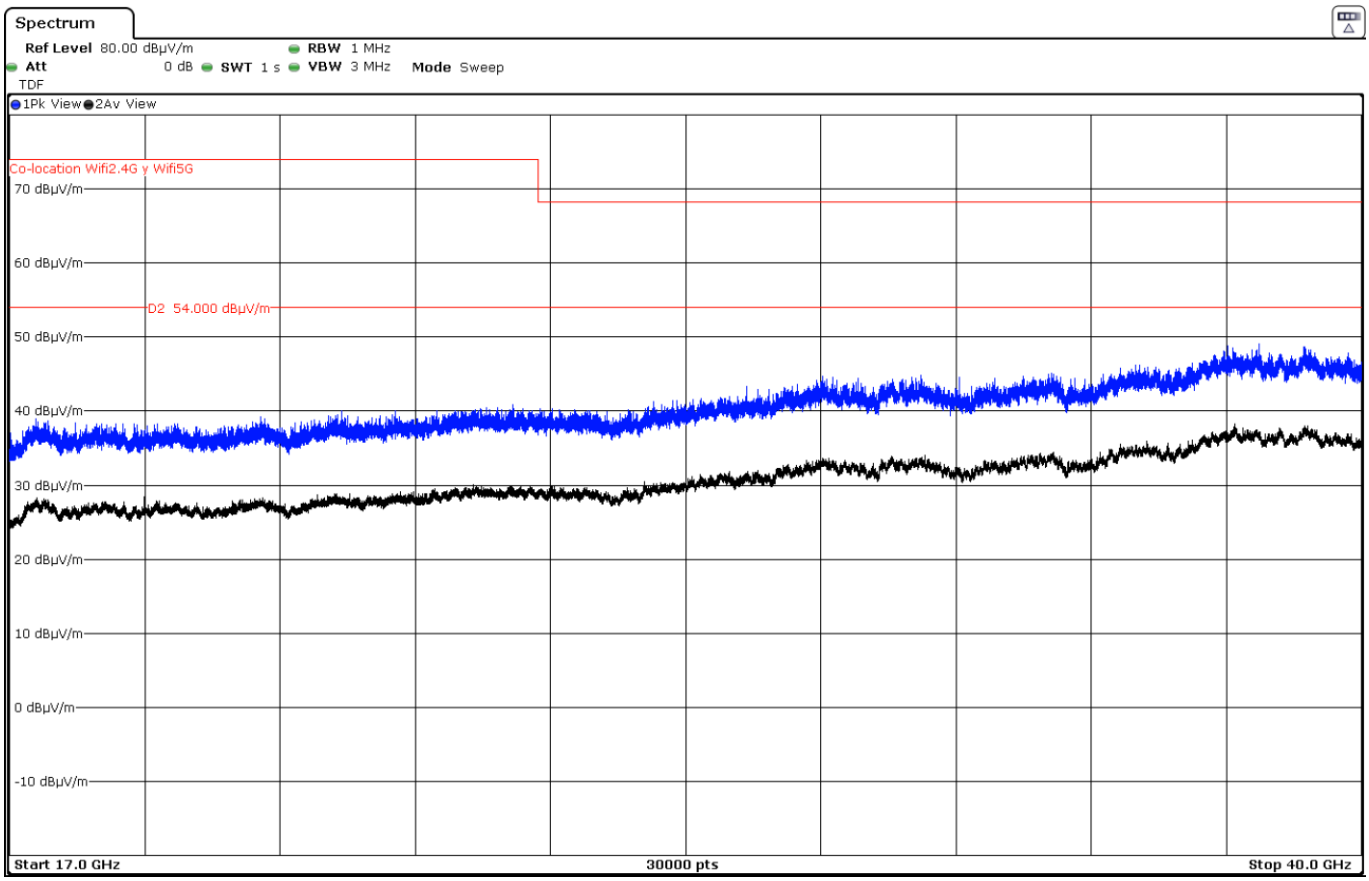
802.11 b (2412 MHz).

802.11 a20 (5200 MHz).

## FREQUENCY RANGE 7 – 17 GHz



## FREQUENCY RANGE 17 - 40 GHz



# **Appendix C:** Test results FCC Part 27 / RSS-139, RSS-130, RSS-199

# INDEX

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# TEST CONDITIONS

POWER SUPPLY (V):

V nonimal: 3.8 Vdc.

Type of Power Supply: DC voltage from a rechargeable battery.

ANTENNA:

Type of Antennas: Internal.

**Maximum Declared Gain for NFC:**

Gain: Not Applicable.

**Maximum Declared Gain for 2.4 GHz WLAN:**

CHAIN 0 Antenna Port Gain : -3 dBi

CHAIN 1 Antenna Port Gain : +2.2 dBi

**Maximum Declared Gain for 5 GHz WLAN:**

CHAIN 0 Antenna Port Gain : -1.1 dBi

CHAIN 1 Antenna Port Gain : -1.1 dBi

**Maximum Declared Gain for Cellular:**

| LOW BANDS (monopole) | | MIDDLE BANDS (monopole with parasitic resonator) | | HIGH BANDS (loop) | |
|---|---|---|---|---|---|
| B5: LTE WCDMA GSM850 | 0.9 dBi | B1: LTE WCDMA | 1.4 dBi | **B7: LTE** | **2.9 dBi** |
| B8: LTE WCDMA GSM900 | -2.5 dBi | B2: LTE WCDMA PCS1900 | 0.1 dBi | **B30: LTE** | **0.5 dBi** |
| **B12: LTE** | **-2.8 dBi** | B3: LTE DCS1800 | 0.2 dBi | **B38: LTE** | **2.1 dBi** |
| **B13: LTE** | **-4.4 dBi** | B4: LTE WCDMA | 0 dBi | | |
| B14: LTE | -4.7 dBi | B25: LTE | 0.2 dBi | | |
| B17: LTE | -2.8 dBi | **B66: LTE** | **0.2 dBi** | | |
| B20: LTE | 0.8 dBi | | | | |
| B26: LTE | 0.9 dBi | | | | |
| B28: LTE | -2.1 dBi | | | | |

TEST FREQUENCIES - FCC PART 27:

| | | |
|---|---|---|
| | CELLULAR LTE (Bands 66, 12, 13, 30, 7, 38) | |
| Band: | LTE 66 | |
| Frequency Range: | 1710 – 1780 MHz | |
| Channel Spacing: | 15 KHz | |
| Transmit Channel: | Channel | Channel Frequency (MHz) |
| | Low: 131987 | 1711.5 MHz<br>(BW 3MHz, RB Size 1, RB Offset 7, QPSK) |
| | | |
| Band: | LTE 12 | |
| Frequency Range: | 699 – 716 MHz | |
| Channel Spacing: | 15 KHz | |
| Transmit Channel: | Channel | Channel Frequency (MHz) |
| | Low: 23095 | 707.5 MHz<br>(BW 3 MHz, RB Size 1, RB Offset 7, QPSK) |
| | | |
| Band: | LTE 13 | |
| Frequency Range: | 777 – 787 MHz | |
| Channel Spacing: | 15 KHz | |
| Transmit Channel: | Channel | Channel Frequency (MHz) |
| | Middle: 23230 | 782 MHz<br>(BW 10 MHz, RB Size 1, RB Offset 49, QPSK) |
| | | |
| Band: | LTE 30 | |
| Frequency Range: | 2305 – 2315 MHz | |
| Channel Spacing: | 15 KHz | |
| Transmit Channel: | Channel | Channel Frequency (MHz) |
| | Middle: 27710 | 2310 MHz<br>(BW 5 MHz, , RB Size 1, RB Offset 0, QPSK) |
| | | |
| Band: | LTE 7 | |
| Frequency Range: | 2500 – 2570 MHz | |
| Channel Spacing: | 15 KHz | |
| Transmit Channel: | Channel | Channel Frequency (MHz) |
| | Middle: 21100 | 2535 MHz<br>(BW 15 MHz, RB Size 1, RB Offset 74, QPSK) |

| | | |
|---|---|---|
| Band: | LTE 38 | |
| Frequency Range: | 2570 – 2620 MHz | |
| Channel Spacing: | 15 KHz | |
| Transmit Channel: | Channel | Channel Frequency (MHz) |
| | Middle: 38000 | 2595 MHz<br>(BW 5 MHz, RB Size 1, RB Offset 12, 16QAM) |

| | | |
|---|---|---|
| | WLAN (IEEE 802.11 anac) / U-NII | |
| Mode: | 802.11a: 6, 9, 12, 18, 24, 36, 48 & 54 Mbps (SISO) | |
| Frequency Range: | 5150 MHz to 5725 MHz | |
| Channel Spacing: | 20 MHz | |
| Transmit Channel: | Channel | Channel Frequency (MHz) |
| | Middle: 40 | 5200 |

| | | |
|---|---|---|
| | WLAN (IEEE 802.11 bgn2040) / Digital Transmission System (DTS) | |
| Mode: | 802.11b: 1, 2, 5.5 & 11 Mbps (SISO) | |
| Channel Spacing: | 20 MHz | |
| Frequency Range: | 2412 MHz to 2472 MHz | |
| Transmit Channel: | Channel | Channel Frequency (MHz) |
| | 1 | 2412 |

| | |
|---|---|
| | NFC |
| Mode: | Type B |
| Bitrate: | 106 Kbps |
| Nominal Operating frequency: | 13.56 MHz |

The test set-up was made in accordance to the general provisions of FCC DTS Measurement 558074 D01 DTS Meas Guidance v05 dated 24/08/2018 and FCC Unlicensed National Information Infrastructure (U-NII) Devices 789033 D02 General U-NII Test Procedures New Rules v02r01 dated Dec 14, 2017.

The EUT was tested in the following operating mode:

- Continuous transmission with a modulated carrier at maximum power in all required channels selecting the supported data rates/modulations types.

During transmitter test the EUT was being controlled by the SW tool to operate in a continuous transmit mode on the test channel as required and in each of the different modulation modes.

The following configurations were selected based on preliminary testing that identified those corresponding to the worst cases:

**Transmission modes selected with each radio:**

* CELLULAR LTE: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in LTE bands 66, 12, 13, 30, 7, 38 configuration as these channels were found to transmit higher EIRP than all the other LTE channels.

* 5 GHz WLAN: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in 802.11a20 / 6Mbps / SISO (Chain 0) mode configuration as this mode was found to transmit higher EIRP than all the other 5 GHz WLAN modes.

* 2.4 GHz WLAN: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in 802.11b / 1Mbps / SISO (Chain 0) mode configuration as this mode was found to transmit higher EIRP than all the other 2.4 GHz WLAN modes.

* NFC: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in B mode (106 Kbps) because its power is higher than the other modulations and bitrates.

**Simultaneous transmission modes selected:**

**1. CELLULAR LTE, 5 GHz WLAN, 2.4 GHz WLAN and NFC Co-Location**, with the EUT configured to simultaneously transmit four signals at maximum output power, CELLULAR LTE in band 66, 5GHz WLAN (Wi-Fi Chain 0) in 802.11a20 / 6 Mbps / SISO, 2.4GHz WLAN (Wi-Fi Chain 0) in 802.11b / 1 Mbps / SISO and NFC (B, 106 Kbps).

**2. CELLULAR LTE, 5 GHz WLAN, 2.4 GHz WLAN and NFC Co-Location**, with the EUT configured to simultaneously transmit four signals at maximum output power, CELLULAR LTE in band 12, 5GHz WLAN (Wi-Fi Chain 0) in 802.11a20 / 6 Mbps / SISO, 2.4GHz WLAN (Wi-Fi Chain 0) in 802.11b / 1 Mbps / SISO and NFC (B, 106 Kbps).

**3. CELLULAR LTE, 5 GHz WLAN, 2.4 GHz WLAN and NFC Co-Location**, with the EUT configured to simultaneously transmit four signals at maximum output power, CELLULAR LTE in band 13, 5GHz WLAN (Wi-Fi Chain 0) in 802.11a20 / 6 Mbps / SISO, 2.4GHz WLAN (Wi-Fi Chain 0) in 802.11b / 1 Mbps / SISO and NFC (B, 106 Kbps).

**4. CELLULAR LTE, 5 GHz WLAN, 2.4 GHz WLAN and NFC Co-Location**, with the EUT configured to simultaneously transmit four signals at maximum output power, CELLULAR LTE in band 30, 5GHz WLAN (Wi-Fi Chain 0) in 802.11a20 / 6 Mbps / SISO, 2.4GHz WLAN (Wi-Fi Chain 0) in 802.11b / 1 Mbps / SISO and NFC (B, 106 Kbps).

**5. CELLULAR LTE, 5 GHz WLAN, 2.4 GHz WLAN and NFC Co-Location**, with the EUT configured to simultaneously transmit four signals at maximum output power, CELLULAR LTE in band 7, 5GHz WLAN (Wi-Fi Chain 0) in 802.11a20 / 6 Mbps / SISO, 2.4GHz WLAN (Wi-Fi Chain 0) in 802.11b / 1 Mbps / SISO and NFC (B, 106 Kbps).

**6. CELLULAR LTE, 5 GHz WLAN, 2.4 GHz WLAN and NFC Co-Location**, with the EUT configured to simultaneously transmit four signals at maximum output power, CELLULAR LTE in band 38, 5GHz WLAN (Wi-Fi Chain 0) in 802.11a20 / 6 Mbps / SISO, 2.4GHz WLAN (Wi-Fi Chain 0) in 802.11b / 1 Mbps / SISO and NFC (B, 106 Kbps).

# Radiated emissions

SPECIFICATION:

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c) / RSS-Gen):

| Frequency Range (MHz) | Field strength (µV/m) | Field strength (dBµV/m) | Measurement distance (m) |
|---|---|---|---|
| 0.009-0.490 | 2400/F(kHz) | - | 300 |
| 0.490-1.705 | 24000/F(kHz) | - | 30 |
| 1.705 - 30.0 | 30 | - | 30 |
| 30 - 88 | 100 | 40 | 3 |
| 88 - 216 | 150 | 43.5 | 3 |
| 216 - 960 | 200 | 46 | 3 |
| 960 - 25000 | 500 | 54 | 3 |

The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

RSS-247. Attenuation below the general field strength limits specified in RSS-Gen is not required.

**1. LTE Band 66.** FCC §2.1053 & §27.53 (h) / RSS-139 Clause 6.6.

FCC §27.53 (h):

> (h) Except as otherwise specified below, for operations in the 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz, and 2180-2200 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least 43 + 10 log10 (P) dB.

RSS-139 Clause 6.6:

> i. In the first 1.0 MHz bands immediately outside and adjacent to the equipment's smallest operating frequency block, which can contain the equipment's occupied bandwidth, the emission power per any 1% of the emission bandwidth shall be attenuated below the transmitter output power P (in dBW) by at least 43 + 10 log10 p (watts) dB.
>
> ii. After the first 1.0 MHz outside the equipment's smallest operating frequency block, which can contain the equipment's occupied bandwidth, the emission power in any 1 MHz bandwidth shall be attenuated below the transmitter output power P (in dBW) by at least 43 + 10 log10 P (watts) dB.

LIMIT:

The spurious signals was measured at 3 meter. The limit of the test is determined by:

| Frequency Range | Detector | Limit (dBµV/m) at 3m |
|---|---|---|
| 30 MHz to 18 GHz | PK | 43 + 10 log (P) dB = -13 dBm -> 82.23 dBµV/m or 74 (*)-> -21.23 dBm |
| 18 GHz to 26 GHz | PK | 74 (*) |
| | AVG | 54 (*) |
| 26 GHz to 40 GHz | PK | 68.23 |

(*) Radiated emissions which fall in the restricted bands, as defined in §15.205(a).

**2. LTE Band 12.** FCC §2.1053 & §27.53 (g) / RSS-130 Clause 4.6.

FCC §27.53 (g):

> (g) For operations in the 600 MHz band and the 698-746 MHz band, the power of any emission outside a 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, by at least 43 + 10 log (P) dB. Compliance with this provision is based on the use of measurement instrumentation employing a resolution bandwidth of 100 kilohertz or greater. However, in the 100 kilohertz bands immediately outside and adjacent to a licensee's frequency block, a resolution bandwidth of at least 30 kHz may be employed.

RSS-130 Issue 1 Clause 4.6.:

> The power of any unwanted emissions in any 100 kHz bandwidth on any frequency outside the frequency range(s) within which the equipment is designed to operate shall be attenuated below the transmitter power, P (dBW), by at least 43 + 10 log10 p (watts), dB. However, in the 100 kHz band immediately outside the equipment's operating frequency range, a resolution bandwidth of 30 kHz may be employed.

LIMIT:

The spurious signals was measured at 3 meter. The limit of the test is determined by:

| Frequency Range | Detector | Limit (dBµV/m) at 3m |
|---|---|---|
| 30 MHz to 8 GHz | PK | 43 + 10 log (P) dB = -13 dBm -> 82.23 dBµV/m or 74 (*)-> -21.23 dBm |
| 8 GHz to 26 GHz | PK | 74 (*) |
| | AVG | 54 (*) |
| 26 GHz to 40 GHz | PK | 68.23 |

(*) Radiated emissions which fall in the restricted bands, as defined in §15.205(a).

**3. LTE Band 13**. FCC §2.1053 & §27.53 (c) (2) (4) & (f) / RSS-130 Clause 4.6.

FCC §27.53 (c) (2) (4) & (f):

(c) (2) On any frequency outside the 776-788 MHz band, the power of any emission shall be attenuated outside the band below the transmitter power (P) by at least 43 + 10 log (P) dB.

(c) (4) On all frequencies between 763-775 MHz and 793-805 MHz, by a factor not less than 65 + 10 log (P) dB in a 6.25 kHz band segment, for mobile and portable stations.

(f) For operations in the 746-758 MHz, 775-788 MHz, and 805-806 MHz bands, emissions in the band 1559-1610 MHz shall be limited to −70 dBW (-40 dBm)/MHz equivalent isotropically radiated power (EIRP) for wideband signals, and −80 dBW (-50 dBm) 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-130 Issue 1 Clause 4.6.1:

4.6.1. The power of any unwanted emissions in any 100 kHz bandwidth on any frequency outside the frequency range(s) within which the equipment is designed to operate shall be attenuated below the transmitter power, P (dBW), by at least 43 + 10 log10 p (watts), dB. However, in the 100 kHz band immediately outside the equipment's operating frequency range, a resolution bandwidth of 30 kHz may be employed.

LIMIT:

The spurious signals was measured at 3 meter. The limit of the test is determined by:

| Frequency Range | Detector | Limit (dBµV/m) at 3m |
|---|---|---|
| 30 MHz to 8 GHz | PK | 43 + 10 log (P) dB = -13 dBm -> 82.23 dBµV/m or 74 (*)-> -21.23 dBm |
| 8 GHz to 26 GHz | PK | 74 (*) |
| | AVG | 54 (*) |
| 26 GHz to 40 GHz | PK | 68.23 |

(*) Radiated emissions which fall in the restricted bands, as defined in §15.205(a).

**4. LTE Band 30**. FCC §2.1053 & §27.53 (a) (4)

FCC §27.53 (a) (4)

(a) For operations in the 2305-2320 MHz band and the 2345-2360 MHz band, the power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power P (with averaging performed only during periods of transmission) within the licensed band(s) of operation, in watts, by the following amounts:

(4) For mobile and portable stations operating in the 2305-2315 MHz and 2350-2360 MHz bands:

(i) By a factor of not less than: 43 + 10 log (P) dB on all frequencies between 2305 and 2320 MHz and on all frequencies between 2345 and 2360 MHz that are outside the licensed band(s) of operation, not less than 55 + 10 log (P) dB on all frequencies between 2320 and 2324 MHz and on all frequencies between 2341 and 2345 MHz, not less than 61 + 10 log (P) dB on all frequencies between 2324 and 2328 MHz and on all frequencies between 2337 and 2341 MHz, and not less than 67 + 10 log (P) dB on all frequencies between 2328 and 2337 MHz;

(ii) By a factor of not less than 43 + 10 log (P) dB on all frequencies between 2300 and 2305 MHz, 55 + 10 log (P) dB on all frequencies between 2296 and 2300 MHz, 61 + 10 log (P) dB on all frequencies between 2292 and 2296 MHz, 67 + 10 log (P) dB on all frequencies between 2288 and 2292 MHz, and 70 + 10 log (P) dB below 2288 MHz;

(iii) By a factor of not less than 43 + 10 log (P) dB on all frequencies between 2360 and 2365 MHz, and not less than 70 + 10 log (P) dB above 2365 MHz.

LIMIT:

The spurious signals was measured at 3 meter. The limit of the test is determined by:

| Frequency Range | Detector | Limit (dBµV/m) at 3m |
|---|---|---|
| 30 MHz to 1 GHz | PK | 43 + 10 log (P) dB = -40 dBm -> 55.23 dBµV/m or 74 (*)-> -21.23 dBm |
| 1 GHz to 26 GHz | PK | 74 (*) |
| | AVG | 54 (*) |
| 26 GHz to 40 GHz | PK | 68.23 |

(*) Radiated emissions which fall in the restricted bands, as defined in §15.205(a).

**5. LTE Band 7**. FCC §2.1053 & §27.53 (m) (4) / RSS-199 Clause 4.5.

FCC §27.53 (m) (4)

(m) For BRS and EBS stations, the power of any emissions outside the licensee's frequency bands of operation shall be attenuated below the transmitter power (P) measured in watts in accordance with the standards below. If a licensee has multiple contiguous channels, out-of-band emissions shall be measured from the upper and lower edges of the contiguous channels.

(4) For mobile digital stations, the attenuation factor shall be not less than 40 + 10 log (P) dB on all frequencies between the channel edge and 5 megahertz from the channel edge, 43 + 10 log (P) dB on all frequencies between 5 megahertz and X megahertz from the channel edge, and 55 + 10 log (P) dB on all frequencies more than X megahertz from the channel edge, where X is the greater of 6 megahertz or the actual emission bandwidth as defined in paragraph (m)(6) of this section. In addition, the attenuation factor shall not be less that 43 + 10 log (P) dB on all frequencies between 2490.5 MHz and 2496 MHz and 55 + 10 log (P) dB at or below 2490.5 MHz. Mobile Satellite Service licensees operating on frequencies below 2495 MHz may also submit a documented interference complaint against BRS licensees operating on channel BRS Channel 1 on the same terms and conditions as adjacent channel BRS or EBS licensees.

RSS-199 Clause 4.5.

4.5. In the 1 MHz band immediately outside and adjacent to the channel edge, the unwanted emission power shall be measured with a resolution bandwidth of at least 1% of the occupied bandwidth for base station and fixed subscriber equipment, and 2% for mobile subscriber equipment. Beyond the 1 MHz band, a resolution bandwidth of 1 MHz shall be used. A narrower resolution bandwidth can be used, provided that the measured power is integrated over the full required measurement bandwidth of 1 MHz, or 1% or 2% of the occupied bandwidth, as applicable.

Equipment shall comply with the following unwanted emission limits:

(b) for mobile subscriber equipment, the power of any unwanted emissions measured as above shall be attenuated (in dB) below the transmitter power, P (dBW), by at least:

40 + 10 log10 p from the channel edges to 5 MHz away

43 + 10 log10 p between 5 MHz and X MHz from the channel edges, and

55 + 10 log10 p at X MHz and beyond from the channel edges

In addition, the attenuation shall not be less than 43 + 10 log10 p on all frequencies between 2490.5 MHz and 2496 MHz, and 55 + 10 log10 p at or below 2490.5 MHz.

In (b), p is the transmitter power measured in watts and X is 6 MHz or the equipment occupied bandwidth, whichever is greater.

LIMIT:

The spurious signals was measured at 3 meter. The limit of the test is determined by:

| Frequency Range | Detector | Limit (dBµV/m) at 3m |
|---|---|---|
| 30 MHz to 1 GHz | PK | 43 + 10 log (P) dB = -25 dBm -> 70.23 dBµV/m |
| 1 GHz to 26 GHz | PK | 74 (*) |
| | AVG | 54 (*) |
| 26 GHz to 40 GHz | PK | 68.23 |

(*) Radiated emissions which fall in the restricted bands, as defined in §15.205(a).

**6. LTE Band 38**. FCC §2.1053 & §27.53 (m) (4) / RSS-199 Clause 4.5.

FCC §27.53 (m) (4)

(m) For BRS and EBS stations, the power of any emissions outside the licensee's frequency bands of operation shall be attenuated below the transmitter power (P) measured in watts in accordance with the standards below. If a licensee has multiple contiguous channels, out-of-band emissions shall be measured from the upper and lower edges of the contiguous channels.

(4) For mobile digital stations, the attenuation factor shall be not less than 40 + 10 log (P) dB on all frequencies between the channel edge and 5 megahertz from the channel edge, 43 + 10 log (P) dB on all frequencies between 5 megahertz and X megahertz from the channel edge, and 55 + 10 log (P) dB on all frequencies more than X megahertz from the channel edge, where X is the greater of 6 megahertz or the actual emission bandwidth as defined in paragraph (m)(6) of this section. In addition, the attenuation factor shall not be less that 43 + 10 log (P) dB on all frequencies between 2490.5 MHz and 2496 MHz and 55 + 10 log (P) dB at or below 2490.5 MHz. Mobile Satellite Service licensees operating on frequencies below 2495 MHz may also submit a documented interference complaint against BRS licensees operating on channel BRS Channel 1 on the same terms and conditions as adjacent channel BRS or EBS licensees.

RSS-199 Clause 4.5.

4.5. In the 1 MHz band immediately outside and adjacent to the channel edge, the unwanted emission power shall be measured with a resolution bandwidth of at least 1% of the occupied bandwidth for base station and fixed subscriber equipment, and 2% for mobile subscriber equipment. Beyond the 1 MHz band, a resolution bandwidth of 1 MHz shall be used. A narrower resolution bandwidth can be used, provided that the measured power is integrated over the full required measurement bandwidth of 1 MHz, or 1% or 2% of the occupied bandwidth, as applicable.

Equipment shall comply with the following unwanted emission limits:

(b) for mobile subscriber equipment, the power of any unwanted emissions measured as above shall be attenuated (in dB) below the transmitter power, P (dBW), by at least:

40 + 10 log10 p from the channel edges to 5 MHz away

43 + 10 log10 p between 5 MHz and X MHz from the channel edges, and

55 + 10 log10 p at X MHz and beyond from the channel edges

In addition, the attenuation shall not be less than 43 + 10 log10 p on all frequencies between 2490.5 MHz and 2496 MHz, and 55 + 10 log10 p at or below 2490.5 MHz.

In (b), p is the transmitter power measured in watts and X is 6 MHz or the equipment occupied bandwidth, whichever is greater.

LIMIT:

The spurious signals was measured at 3 meter. The limit of the test is determined by:

| Frequency Range | Detector | Limit (dBµV/m) at 3m |
|---|---|---|
| 30 MHz to 1 GHz | PK | 43 + 10 log (P) dB = -25 dBm -> 70.23 dBµV/m |
| 1 GHz to 26 GHz | PK | 74 (*) |
| | AVG | 54 (*) |
| 26 GHz to 40 GHz | PK | 68.23 |

(*) Radiated emissions which fall in the restricted bands, as defined in §15.205(a).

METHOD:

The measurement was performed with the EUT inside an anechoic chamber.

The spectrum was scanned from 9 kHz to at least the 10th harmonic of the highest frequency of the co-located radios till 40 GHz.

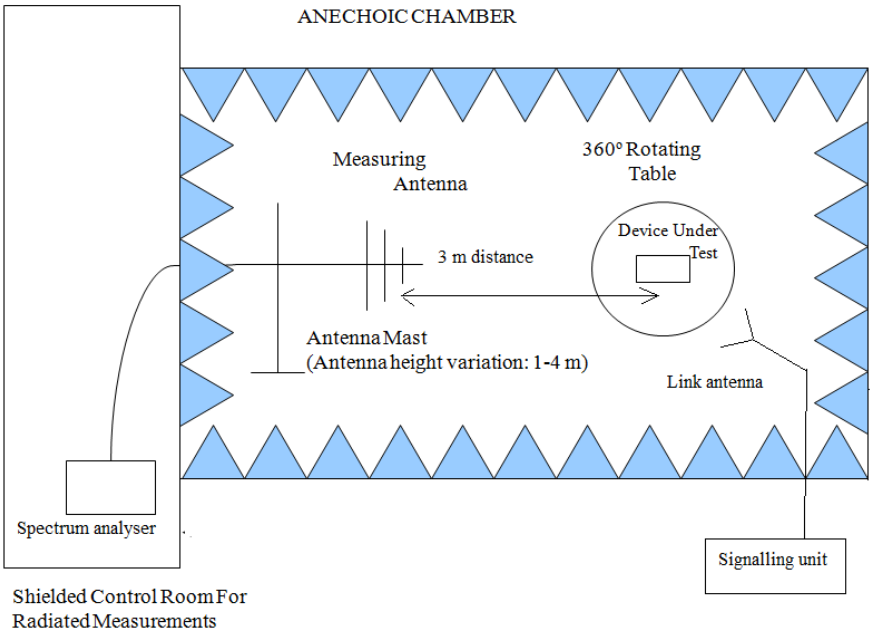
The EUT was placed on a non-conductive stand at a 3 meter distance from the measuring antenna for measurements below 1 GHz and at 1 m distance for measurements above 1 GHz.
Detected emissions were maximized at each frequency by rotating the EUT and adjusting the measuring antenna height and polarization. The maximum meter reading was recorded.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

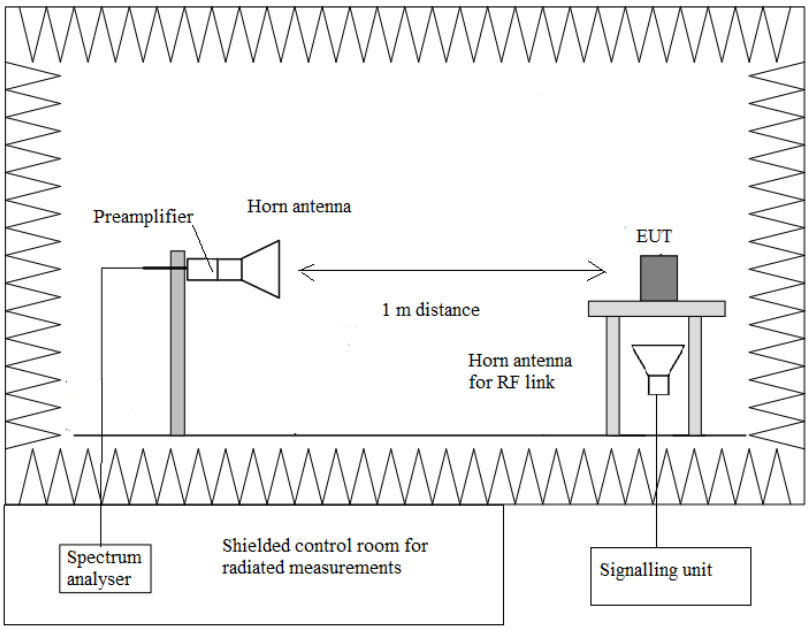
These measurements have been performed in order to check the impact of the Co-Location of all radio interfaces (that can be transmitting simultaneously).

TEST SETUP:

Radiated measurements below 1 GHz.




Radiated measurements above 1 GHz.



RESULTS:

- **1. Mode LTE Band 66, 802.11 a20, 802.11 b and NFC B.**

**QPSK & 16QAM**

A preliminary scan determined the QPSK modulation Channel Low as the worst case.

**Frequency range 9 KHz - 30 MHz**

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

**Frequency range 30 MHz - 1 GHz**

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

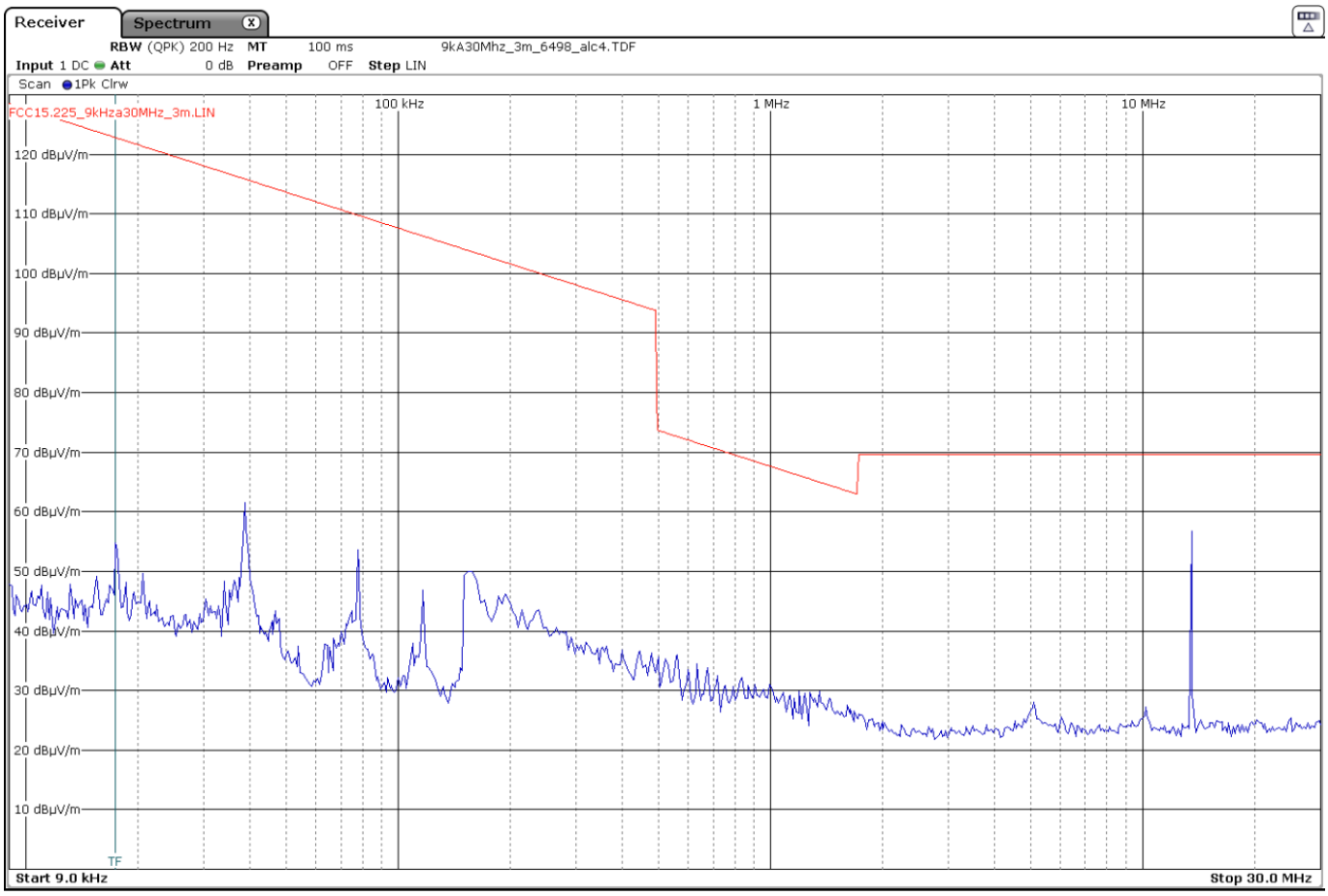
**Frequency range 1 - 40 GHz**

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

| | |
|---|---|
| Measurement uncertainty (dB) | <±3.88 for f < 1GHz<br><±3.70 for f ≥ 1 GHz up to 18 GHz<br><±3.33 for f ≥ 18 GHz up to 20 GHz |

Verdict: PASS

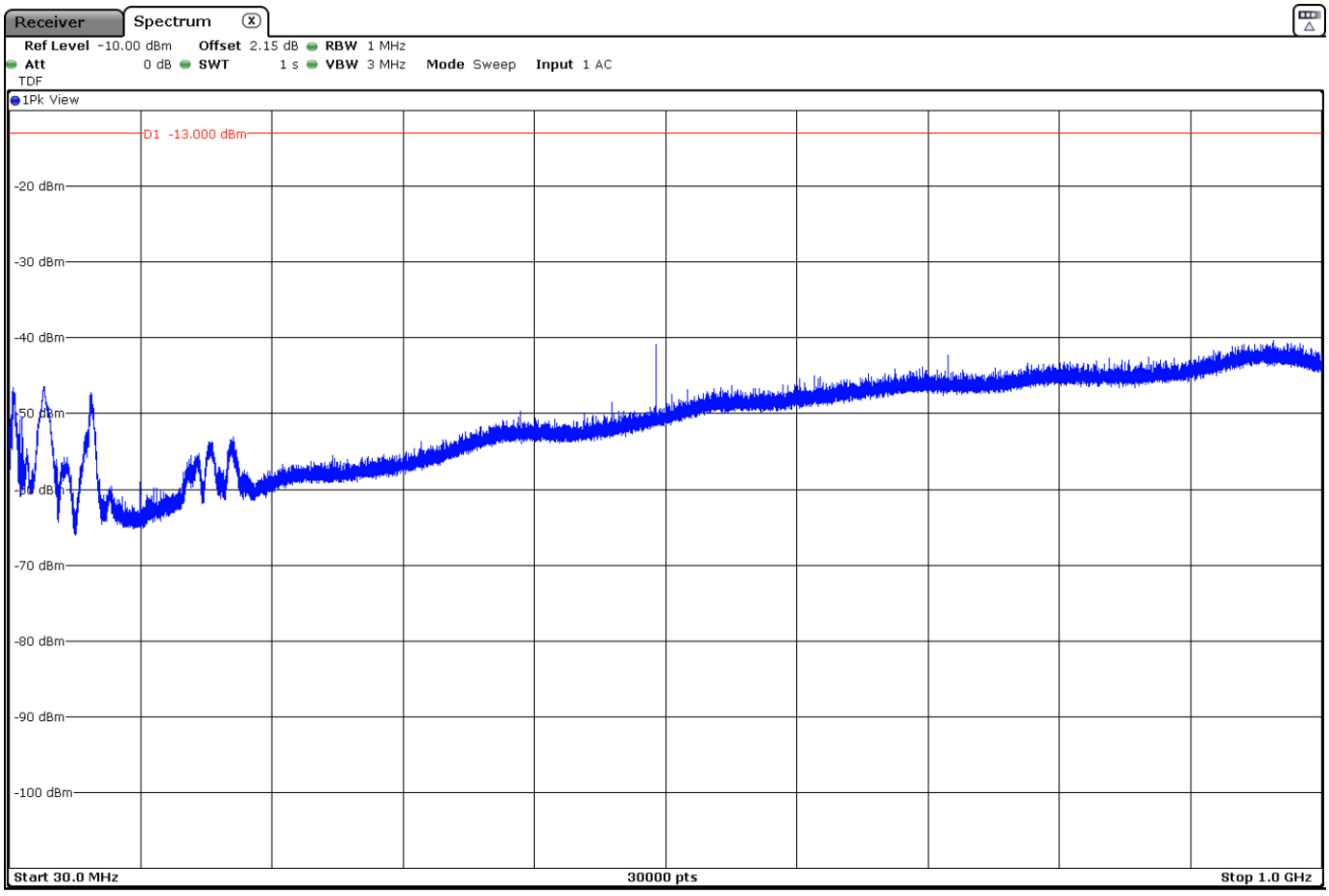
## FREQUENCY RANGE 9 KHz - 30 MHz




The highest peak is the carrier frequency NFC type B (13.56 MHz).

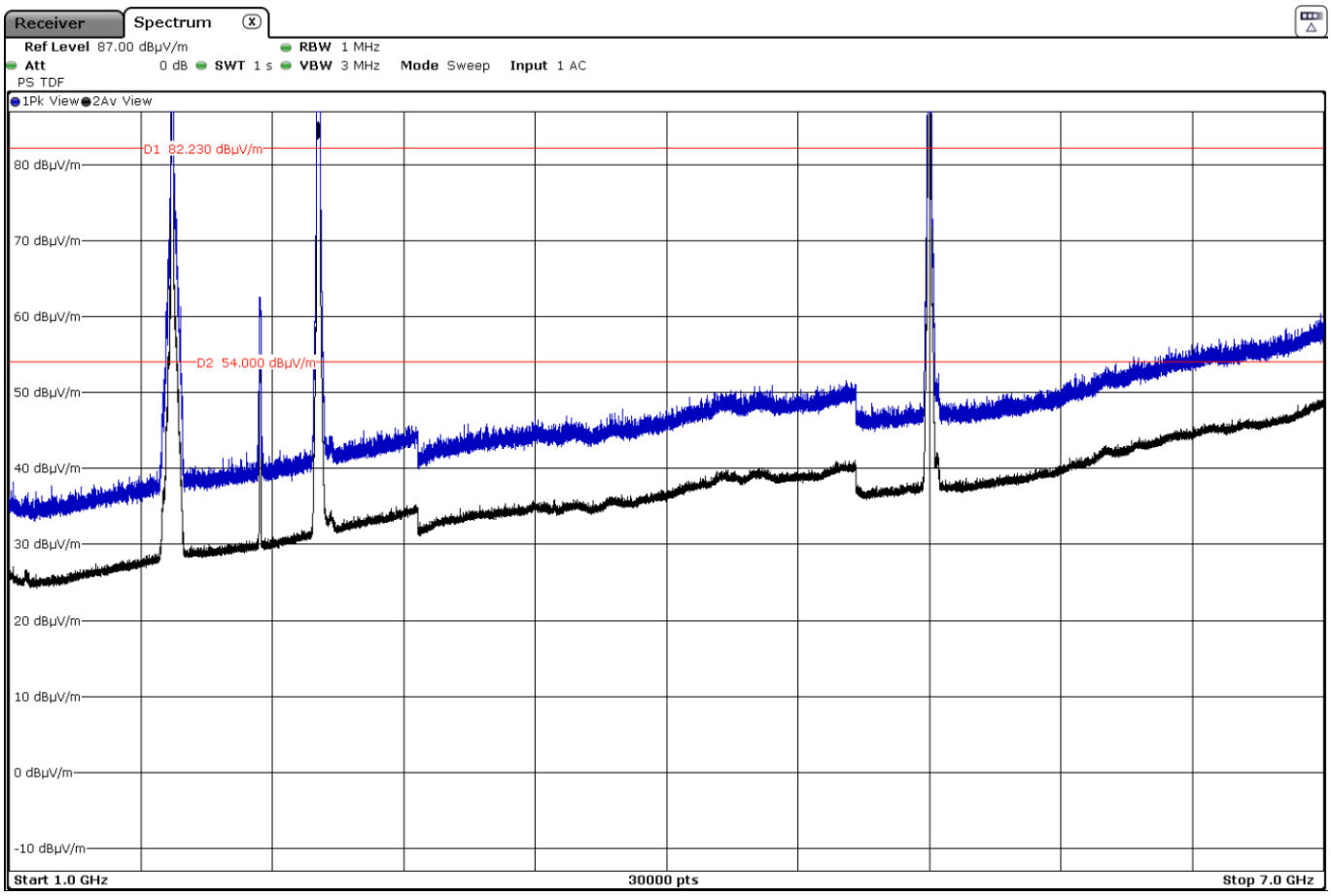
## FREQUENCY RANGE 30 MHz - 1 GHz

### QPSK MODULATION



## FREQUENCY RANGE 1 - 7 GHz

### QPSK MODULATION




The peaks above the limit are the carrier frequencies:

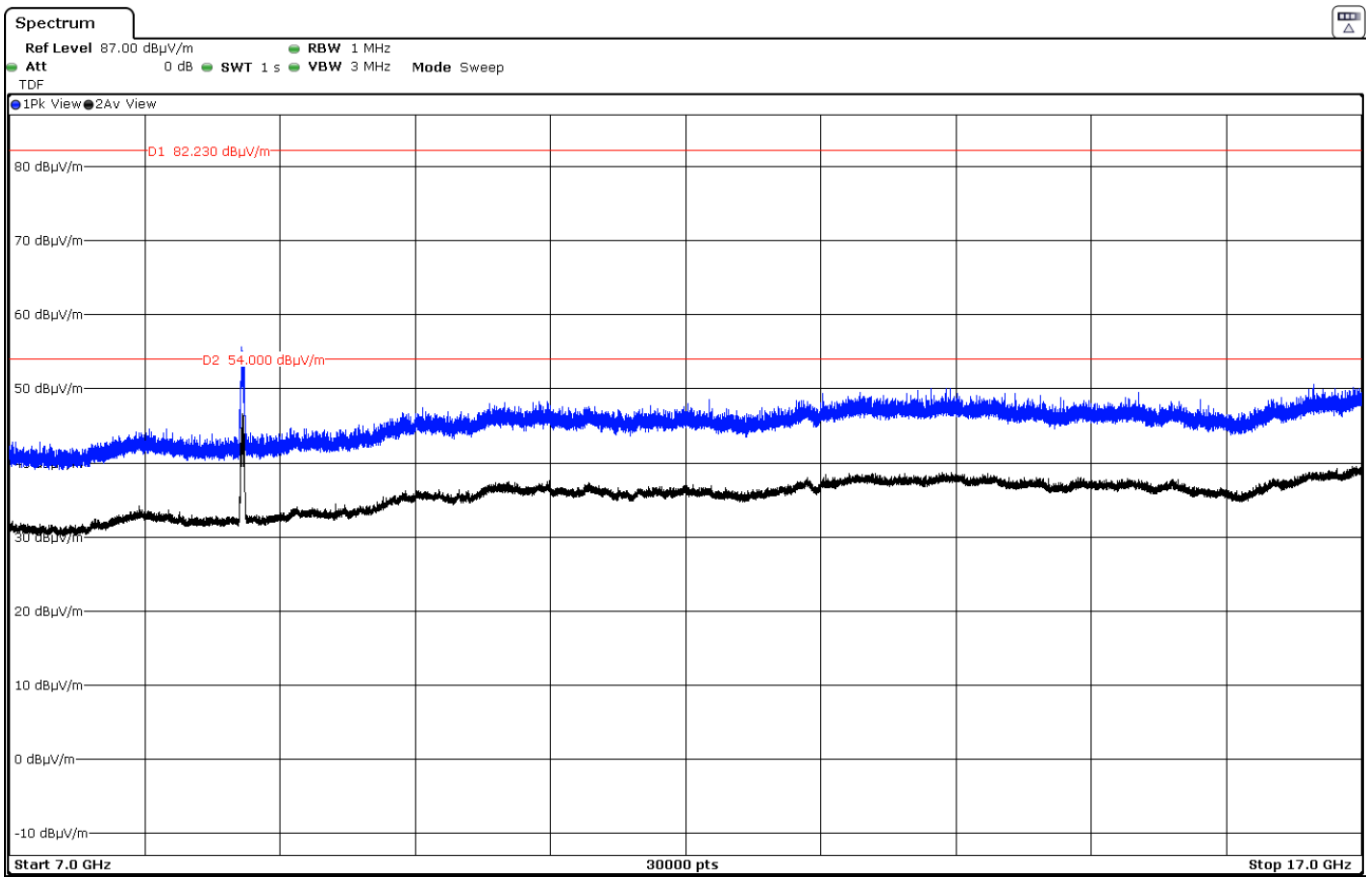
LTE Band 66 (1711.5 MHz).

802.11 b (2412 MHz).

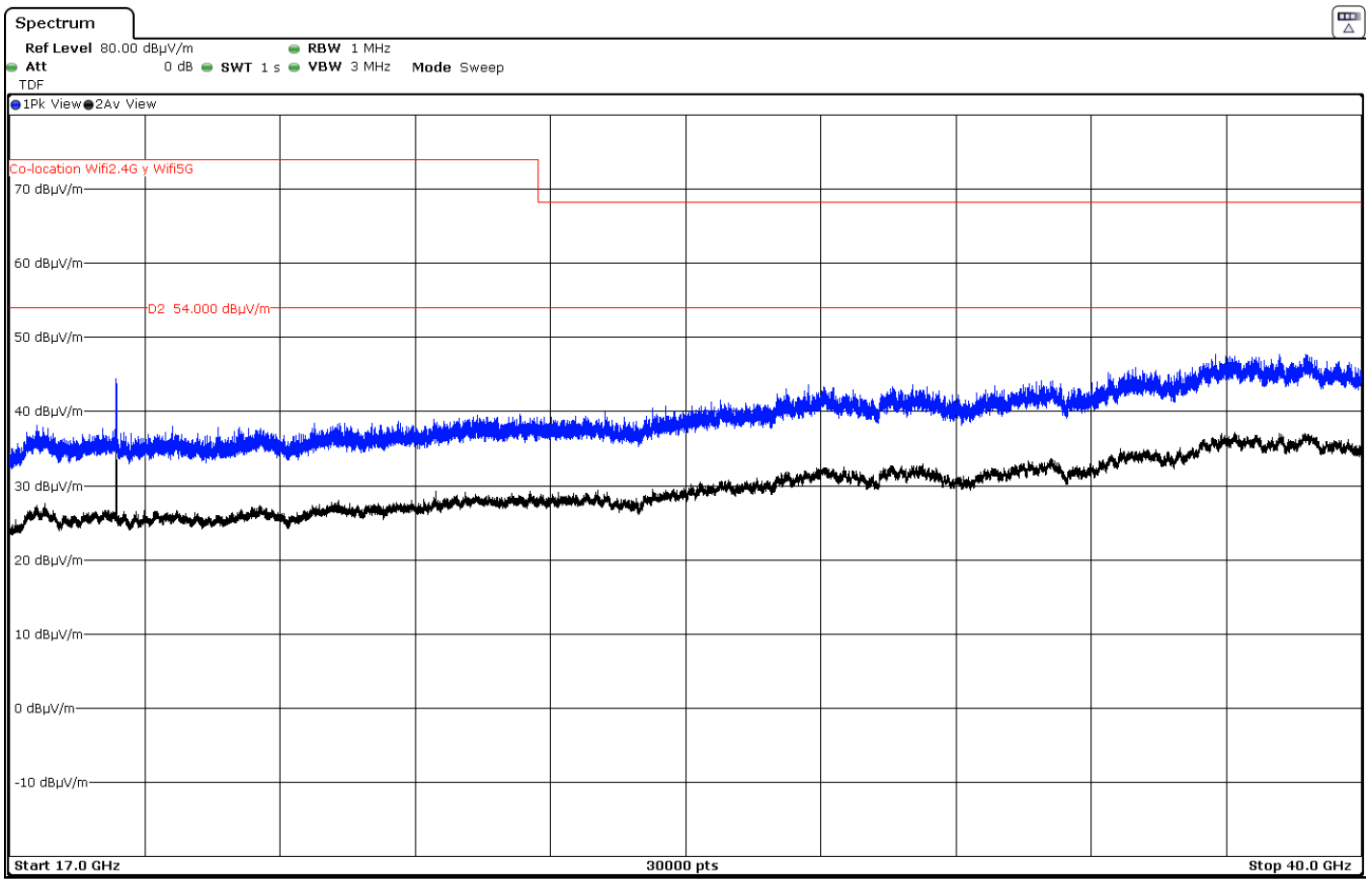
802.11 a20 (5200 MHz).

The peak at 2111.5 MHz corresponds to the downlink signal.

## FREQUENCY RANGE 7 – 17 GHz



## FREQUENCY RANGE 17 - 40 GHz



- **2. Mode LTE Band 12, 802.11 a20, 802.11 b and NFC B.**

**QPSK & 16QAM**

A preliminary scan determined the QPSK modulation Channel Middle as the worst case.

**Frequency range 9 KHz - 30 MHz**

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

**Frequency range 30 MHz - 1 GHz**

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

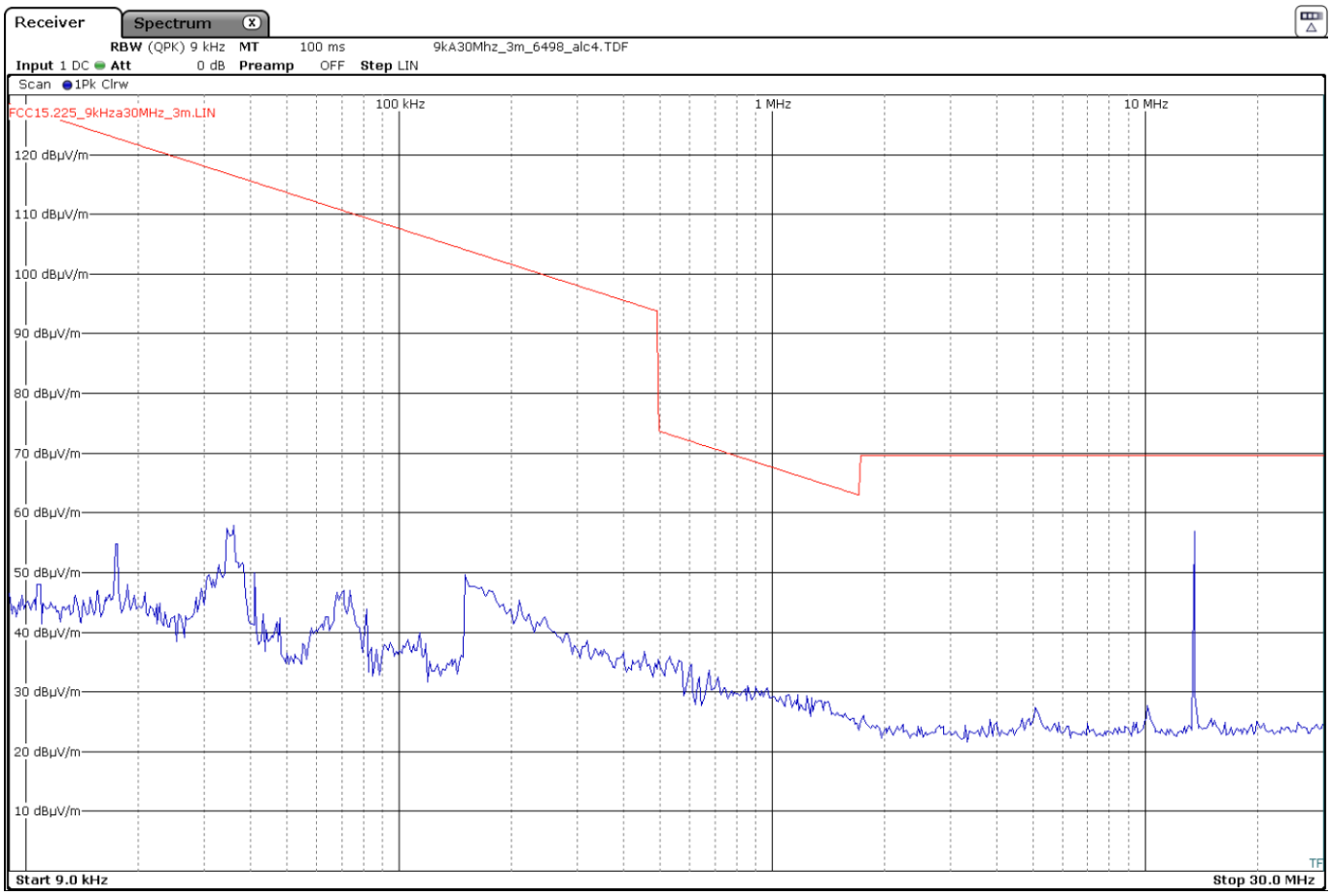
**Frequency range 1 - 40 GHz**

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

| | |
|---|---|
| Measurement uncertainty (dB) | <±3.88 for f < 1GHz<br><±3.70 for f ≥ 1 GHz up to 18 GHz<br><±3.33 for f ≥ 18 GHz up to 20 GHz |

Verdict: PASS

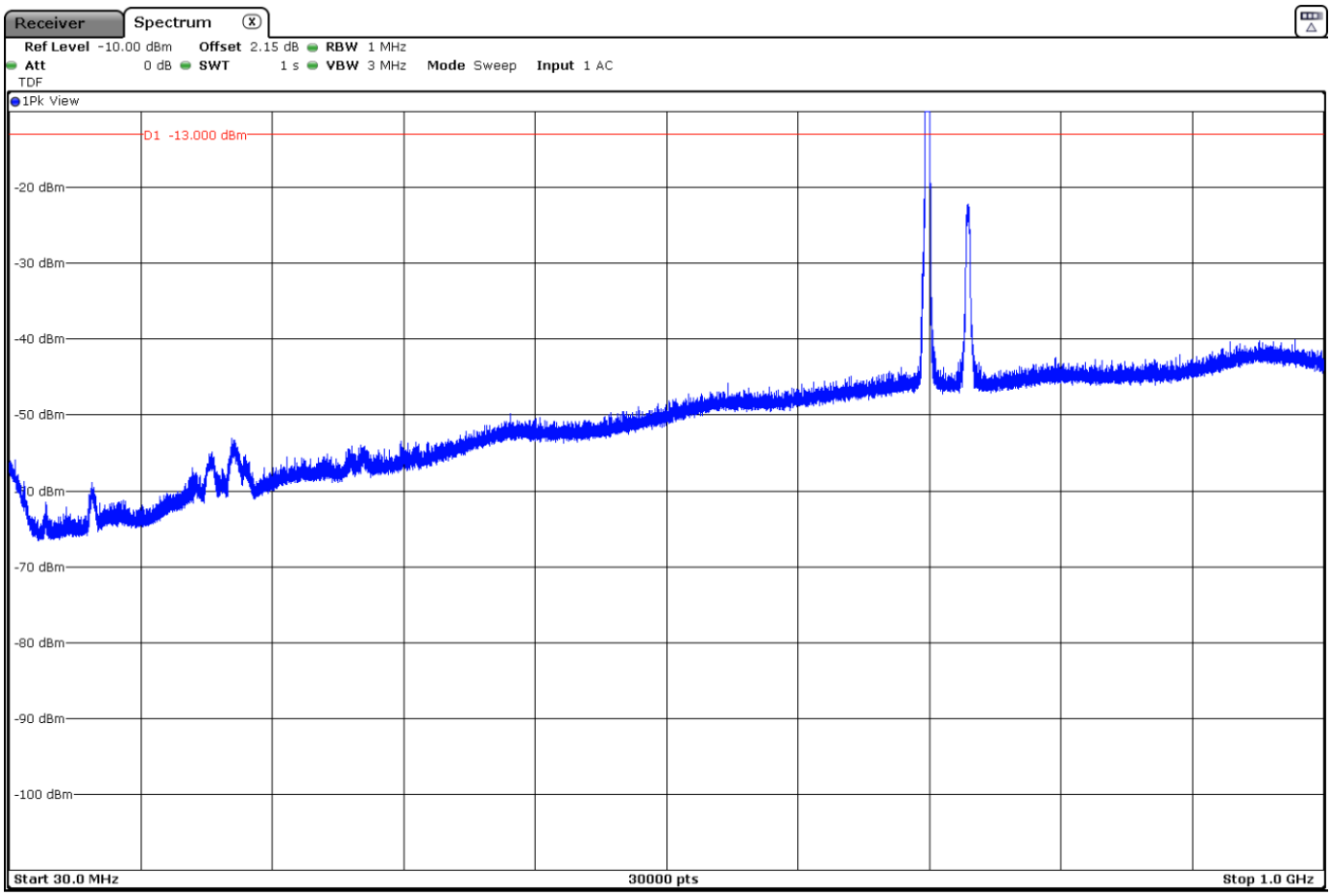
## FREQUENCY RANGE 9 KHz - 30 MHz




The highest peak is the carrier frequency NFC type B (13.56 MHz).

## FREQUENCY RANGE 30 MHz - 1 GHz

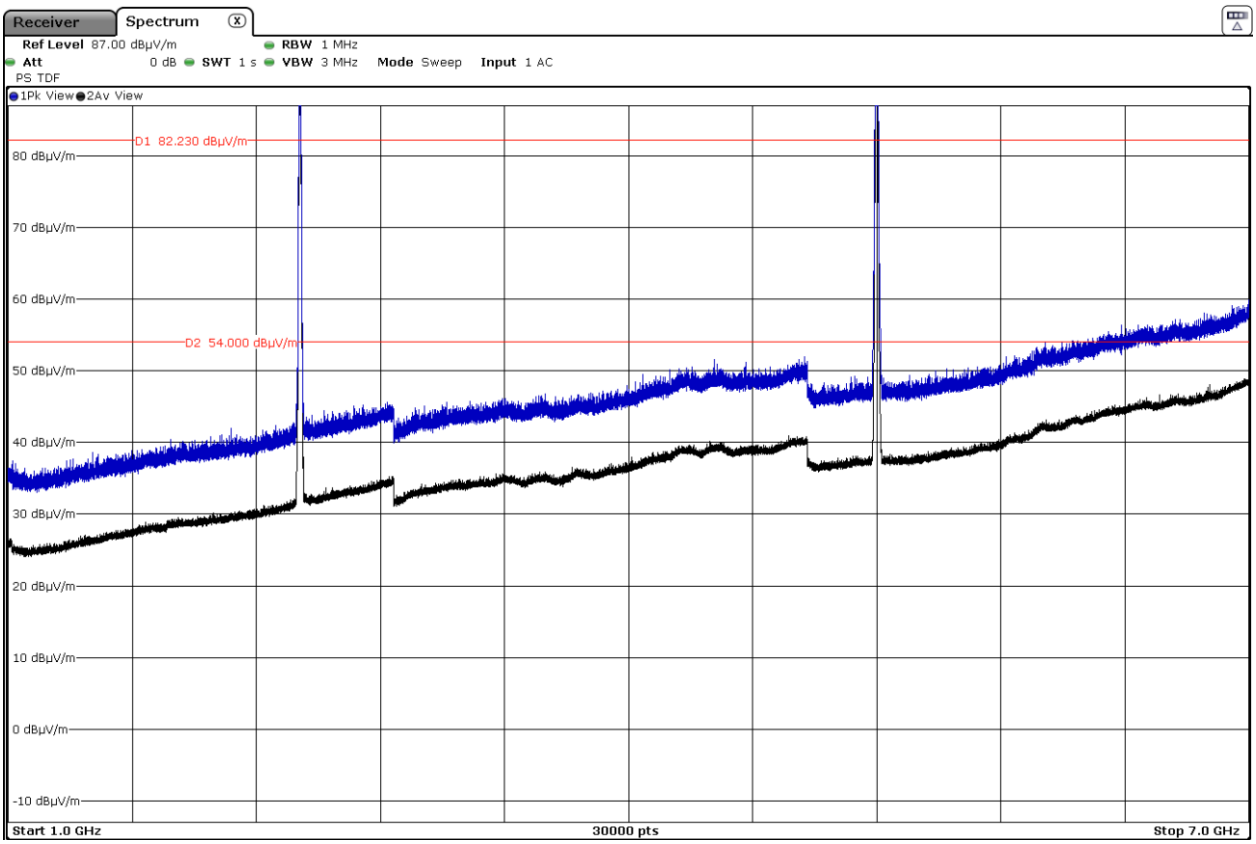
## QPSK MODULATION




The peak above the limit is the carrier frequency LTE Band 12 (707.5 MHz). The peak at 737.5 MHz corresponds to the downlink signal.

## FREQUENCY RANGE 1 - 7 GHz

### QPSK MODULATION

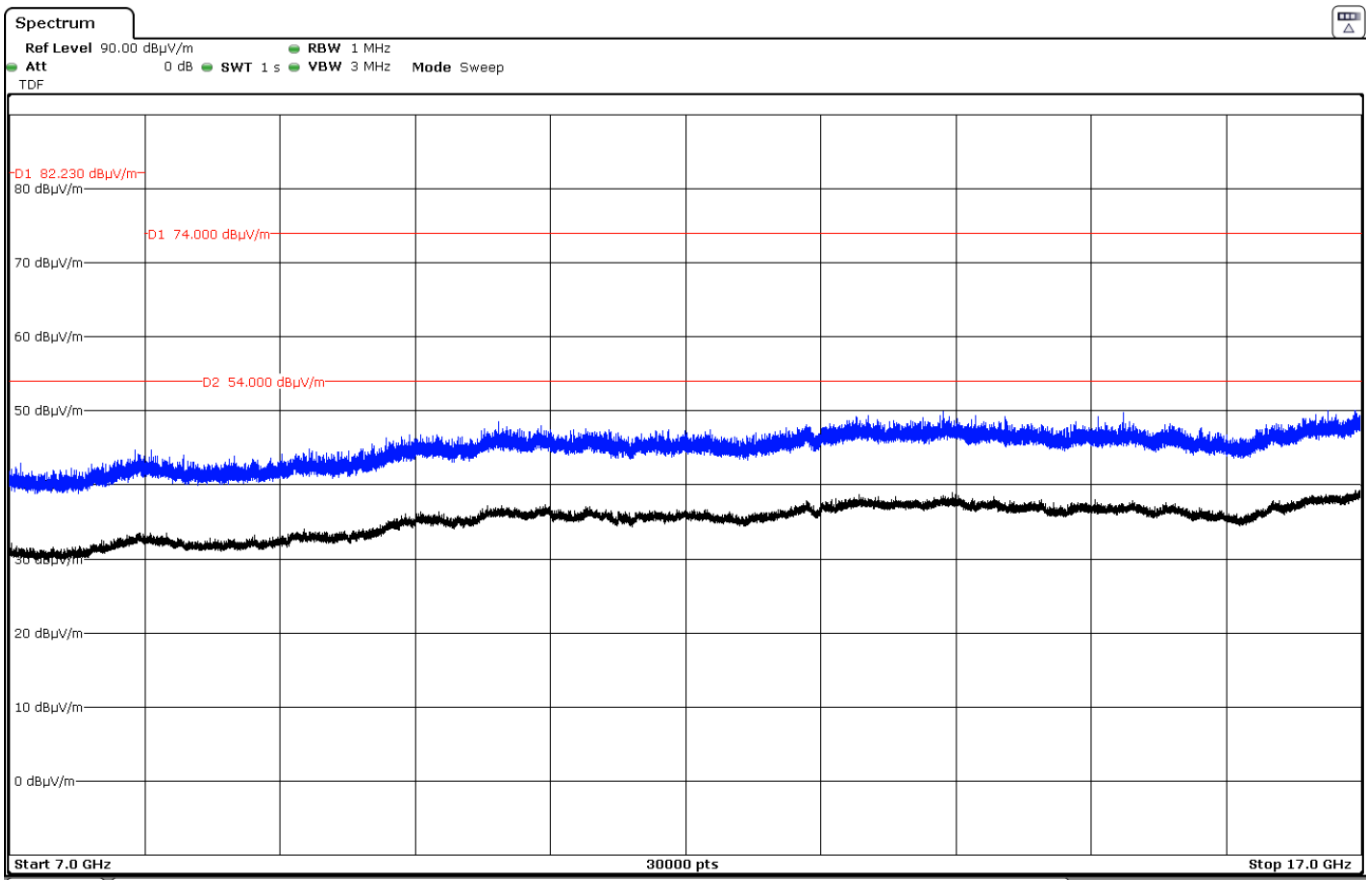



The peaks above the limit are the carrier frequencies:

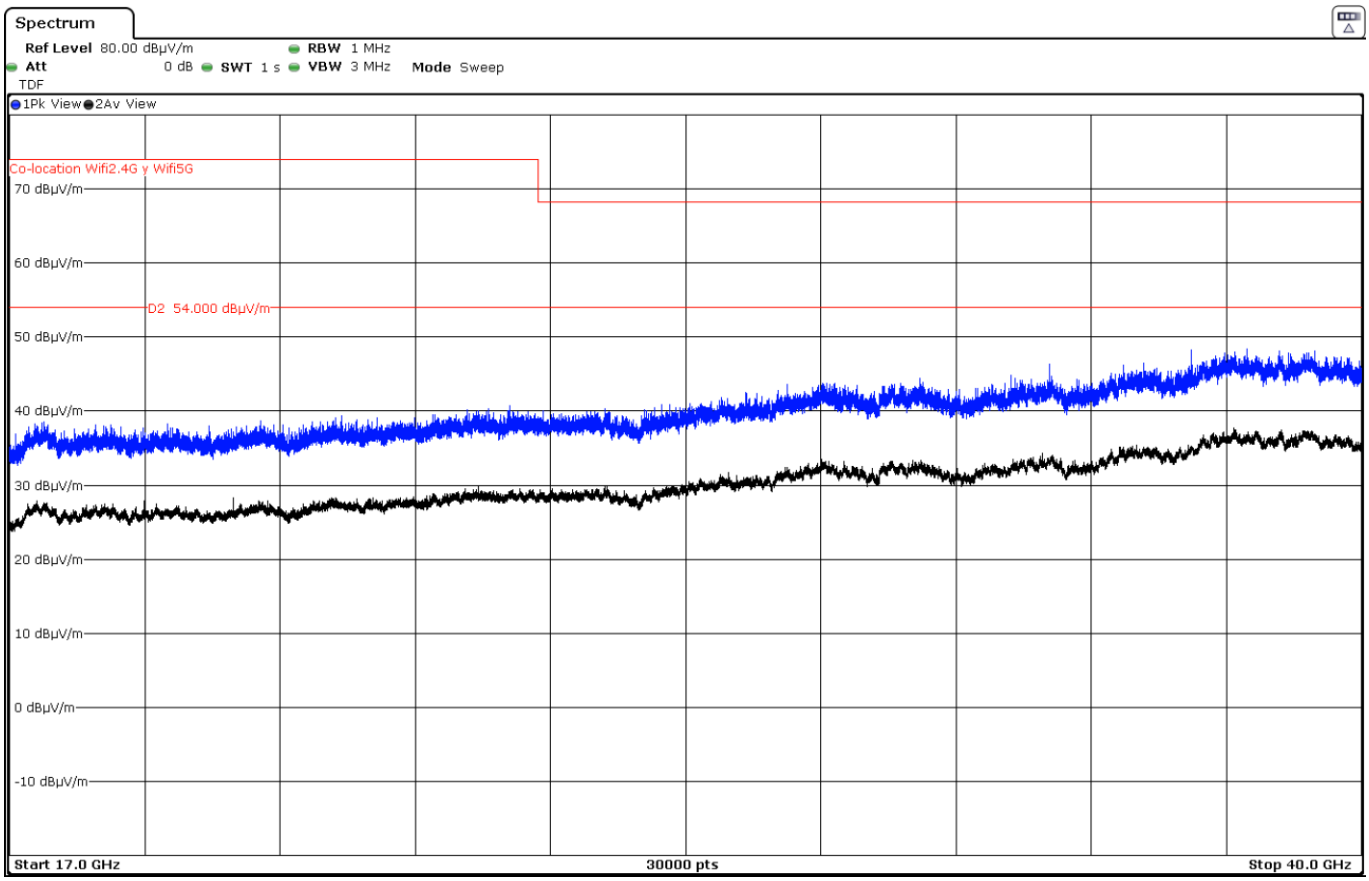
802.11 b (2412 MHz).

802.11 a20 (5200 MHz).

## FREQUENCY RANGE 7 – 17 GHz



## FREQUENCY RANGE 17 - 40 GHz



- **3. Mode LTE Band 13, 802.11 a20, 802.11 b and NFC B.**

**QPSK & 16QAM**

A preliminary scan determined the QPSK modulation Channel Middle as the worst case.

**Frequency range 9 KHz - 30 MHz**

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

**Frequency range 30 MHz - 1 GHz**

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

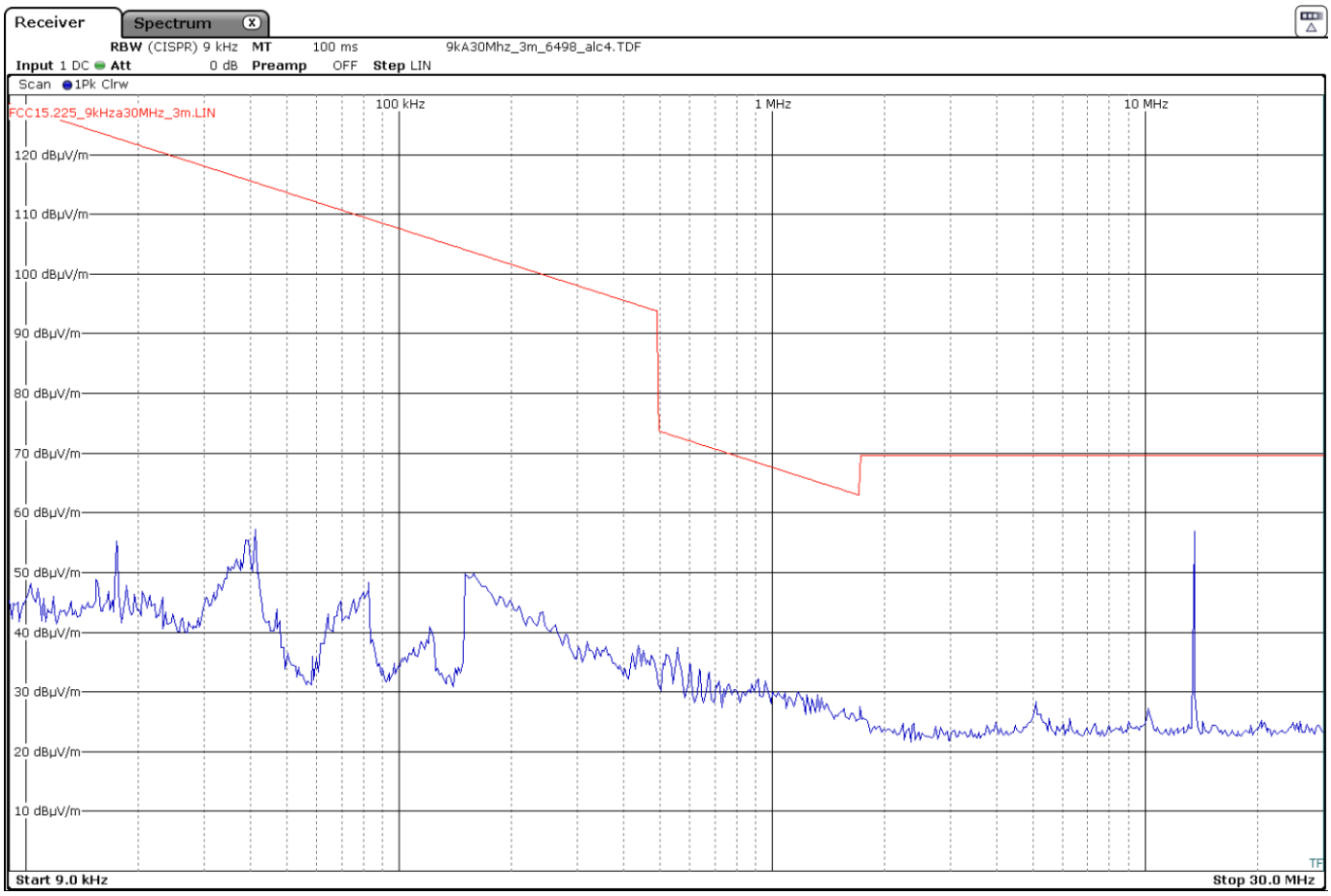
**Frequency range 1 - 40 GHz**

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

| | |
|---|---|
| Measurement uncertainty (dB) | <±3.88 for f < 1GHz<br><±3.70 for f ≥ 1 GHz up to 18 GHz<br><±3.33 for f ≥ 18 GHz up to 20 GHz |

Verdict: PASS

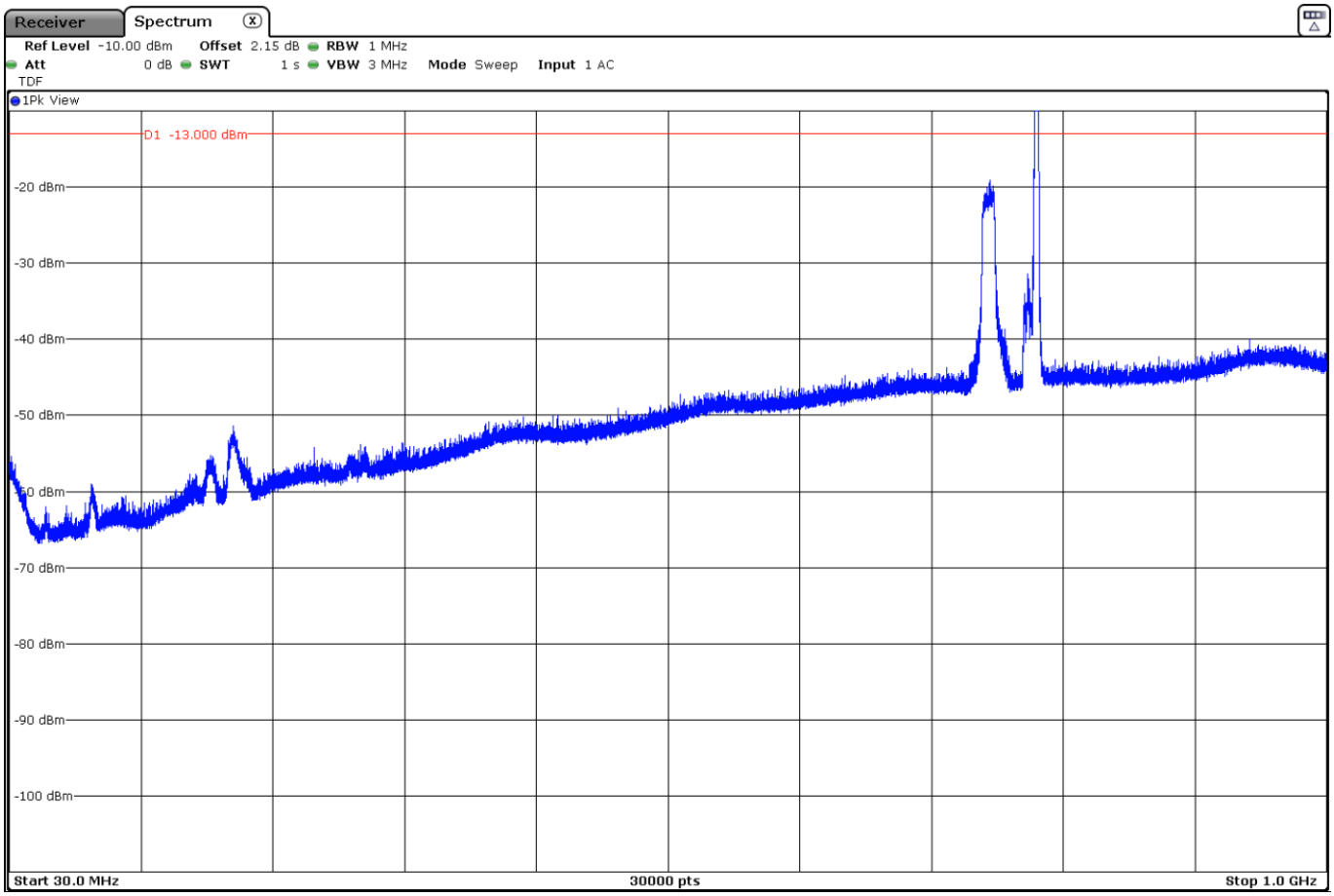
## FREQUENCY RANGE 9 KHz - 30 MHz




The highest peak is the carrier frequency NFC type B (13.56 MHz).

## FREQUENCY RANGE 30 MHz - 1 GHz

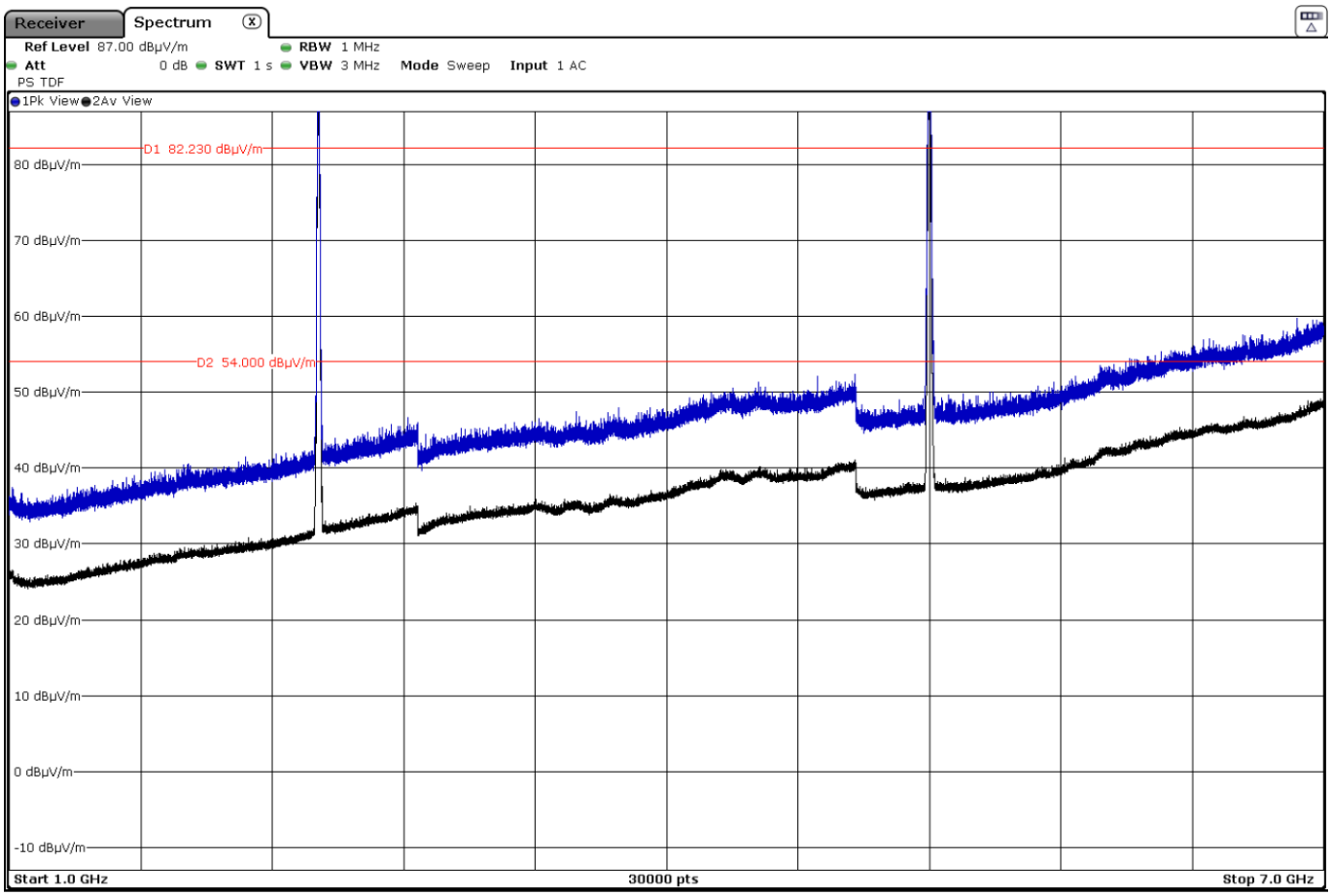
### QPSK MODULATION




The peak above the limit is the carrier frequency LTE Band 13 (782 MHz). The peak at 751 MHz corresponds to the downlink signal.

## FREQUENCY RANGE 1 - 7 GHz

### QPSK MODULATION

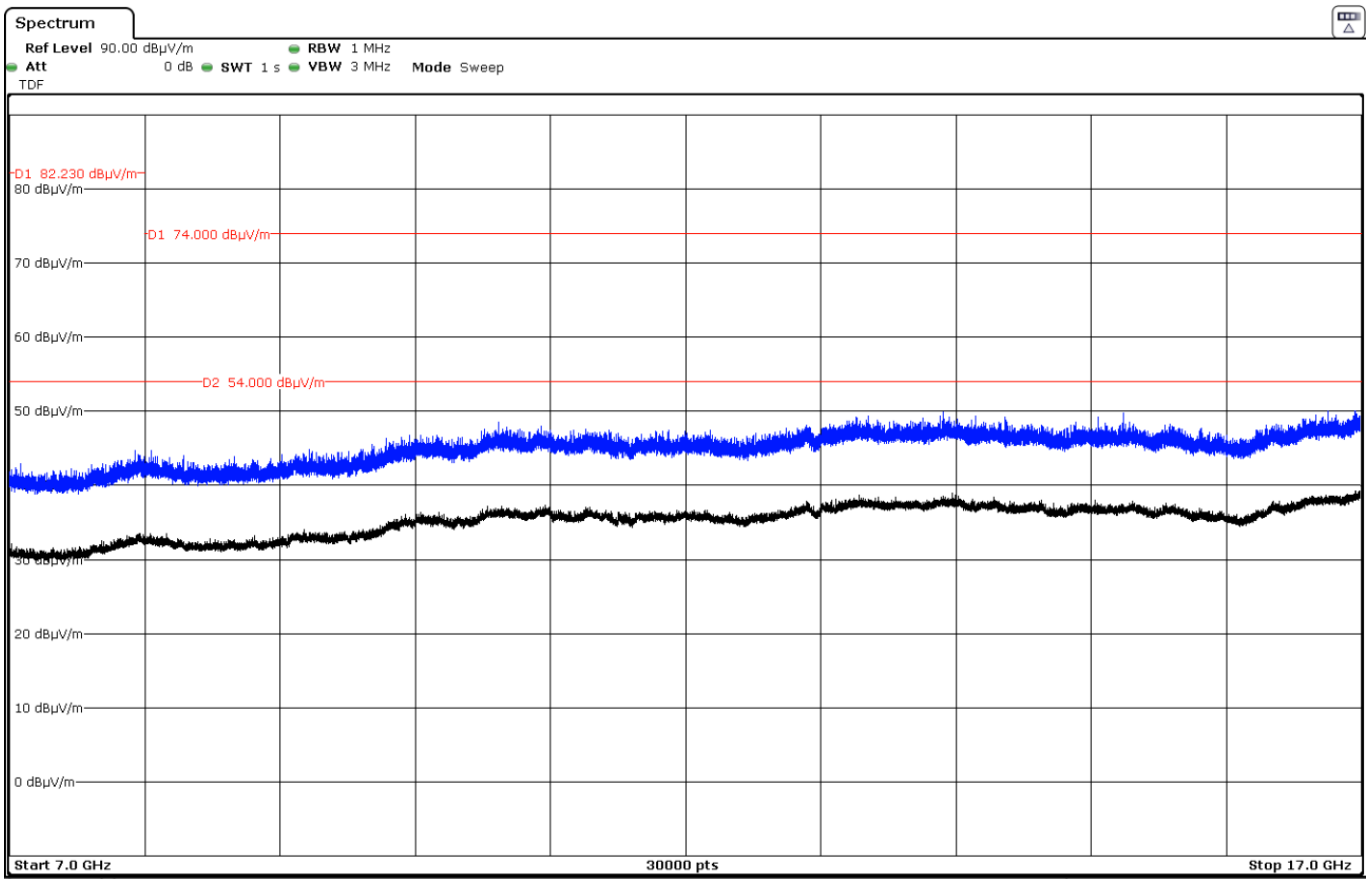



The peaks above the limit are the carrier frequencies:

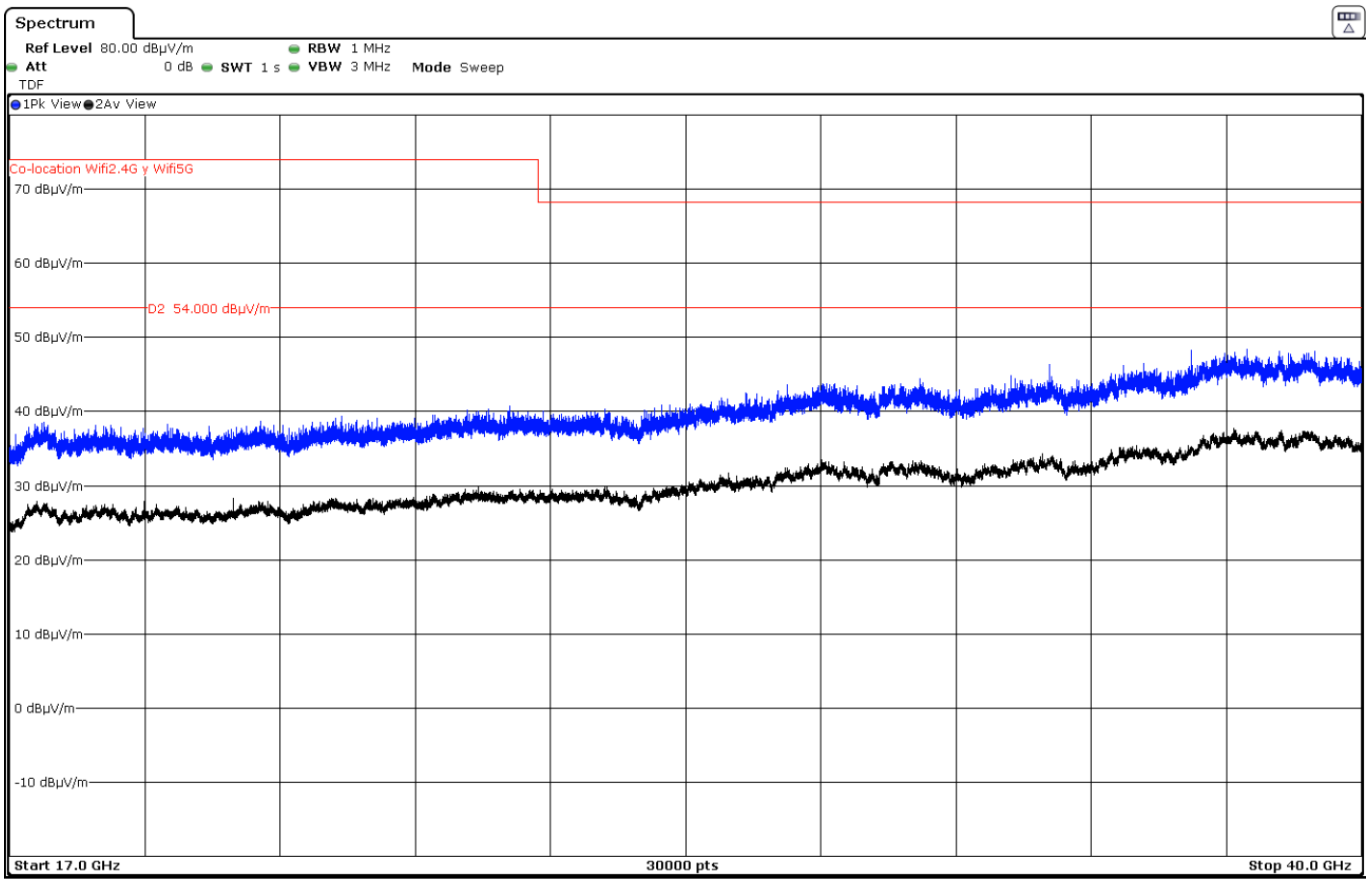
802.11 b (2412 MHz).

802.11 a20 (5200 MHz).

## FREQUENCY RANGE 7 – 17 GHz



## FREQUENCY RANGE 17 - 40 GHz



- **4. Mode LTE Band 30, 802.11 a20, 802.11 b and NFC B.**

**QPSK & 16QAM**

A preliminary scan determined the QPSK modulation Channel Middle as the worst case.

**Frequency range 9 KHz - 30 MHz**

The spurious emissions below 1 GHz do not depend on either the operating channel or the modulation mode selected in the EUT.

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

**Frequency range 30 MHz - 1 GHz**

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

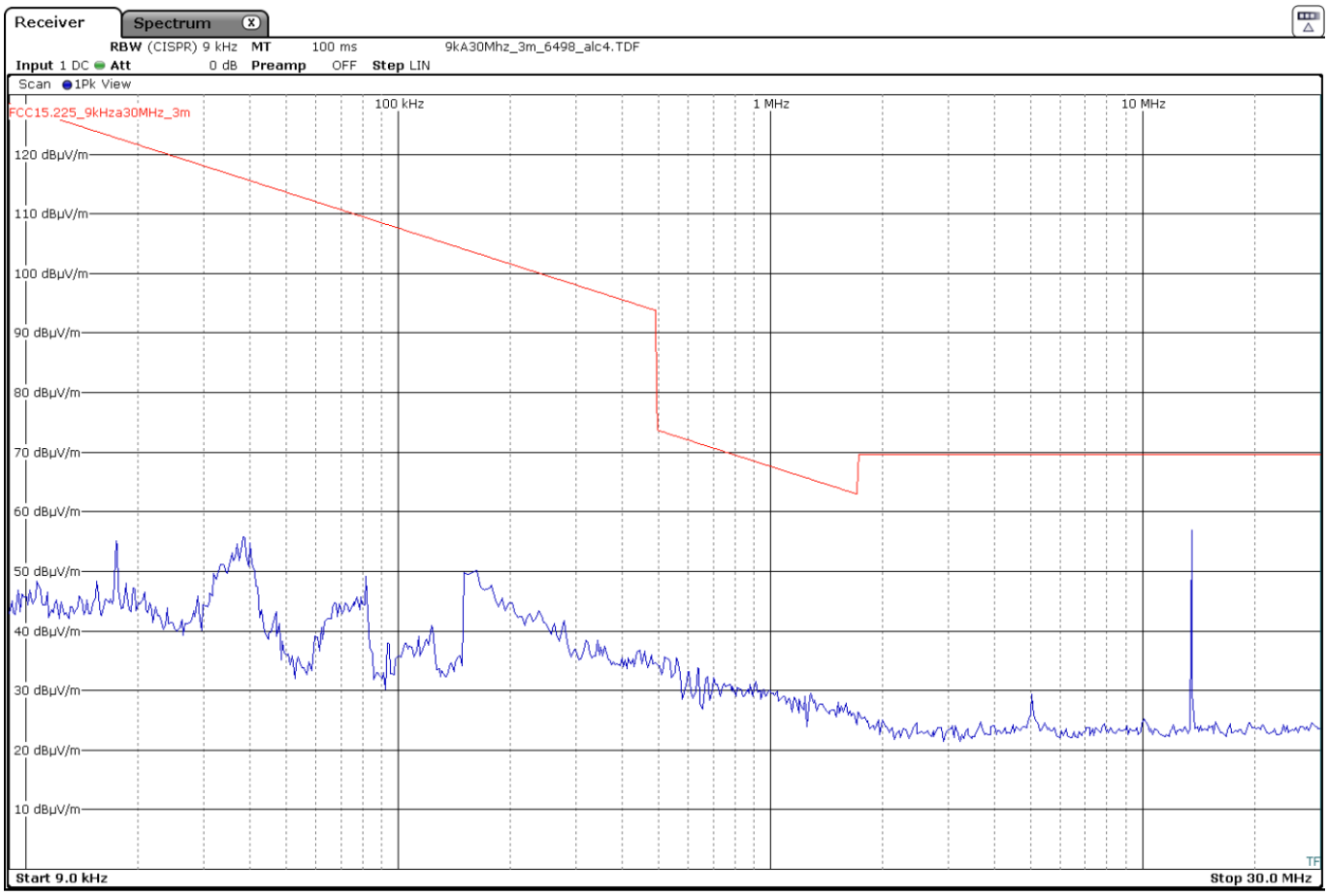
**Frequency range 1 - 40 GHz**

| Spurious frequency (GHz) | Detector | Emission Level (dBµV/m) | Polarization |
|---|---|---|---|
| 6.9251 | Peak | 61.18 | V |
| | Average | 51.26 | |
| 9.2335 | Peak | 47.94 | V |
| 11.5415 | Peak | 50.38 | V |
| 18.4624 | Peak | 61.51 | V |
| | Average | 50.56 | |

| | |
|---|---|
| Measurement uncertainty (dB) | <±3.88 for f < 1GHz<br><±3.70 for f ≥ 1 GHz up to 18 GHz<br><±3.33 for f ≥ 18 GHz up to 40 GHz |

Verdict: PASS

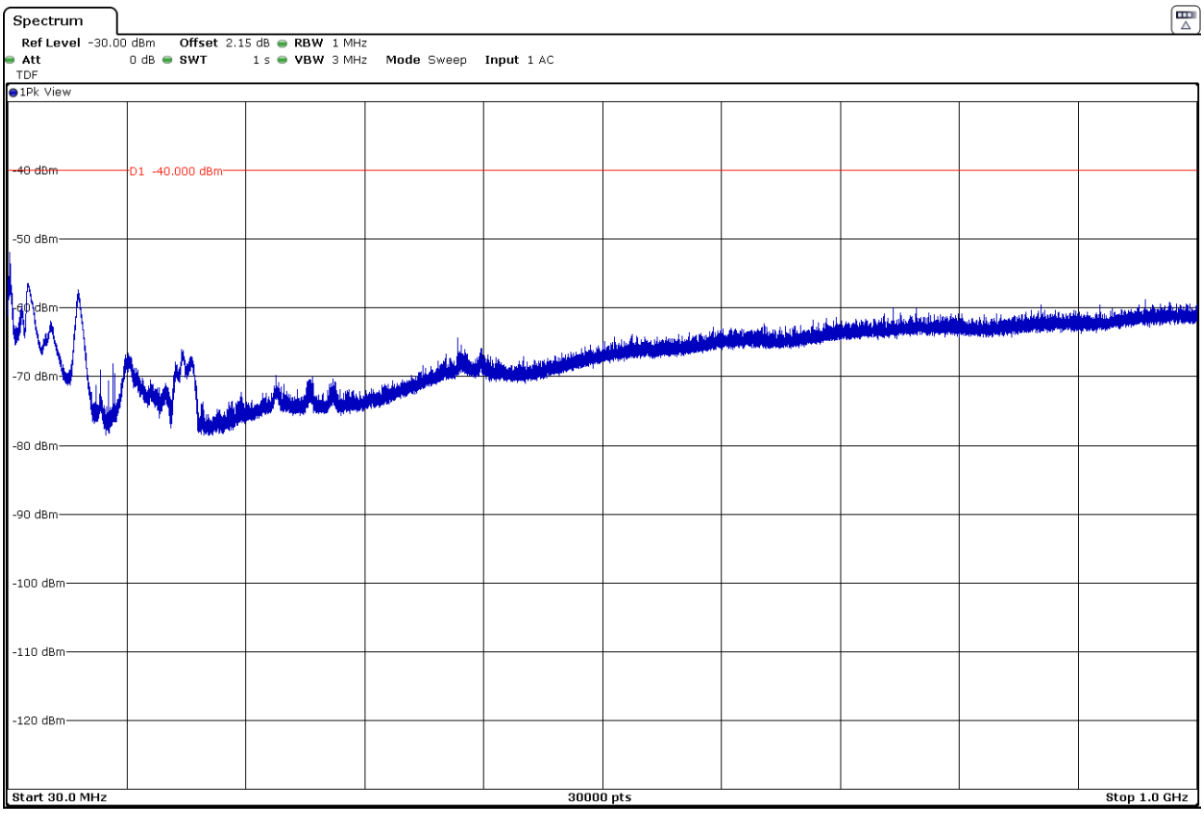
## FREQUENCY RANGE 9 KHz - 30 MHz




The highest peak is the carrier frequency NFC type B (13.56 MHz).

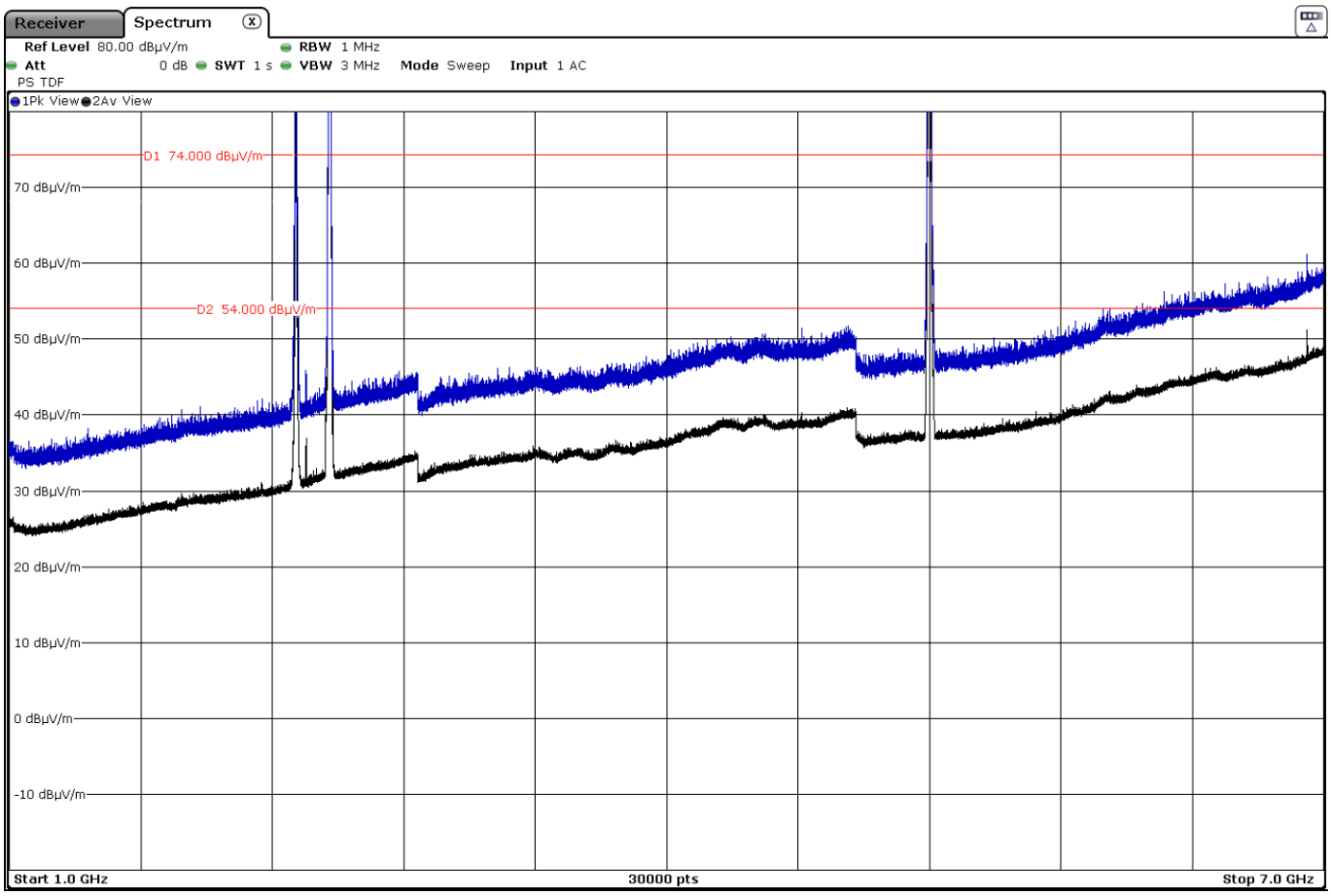
## FREQUENCY RANGE 30 MHz - 1 GHz

### QPSK MODULATION



## FREQUENCY RANGE 1 - 7 GHz

### QPSK MODULATION




The peaks above the limit are the carrier frequencies:

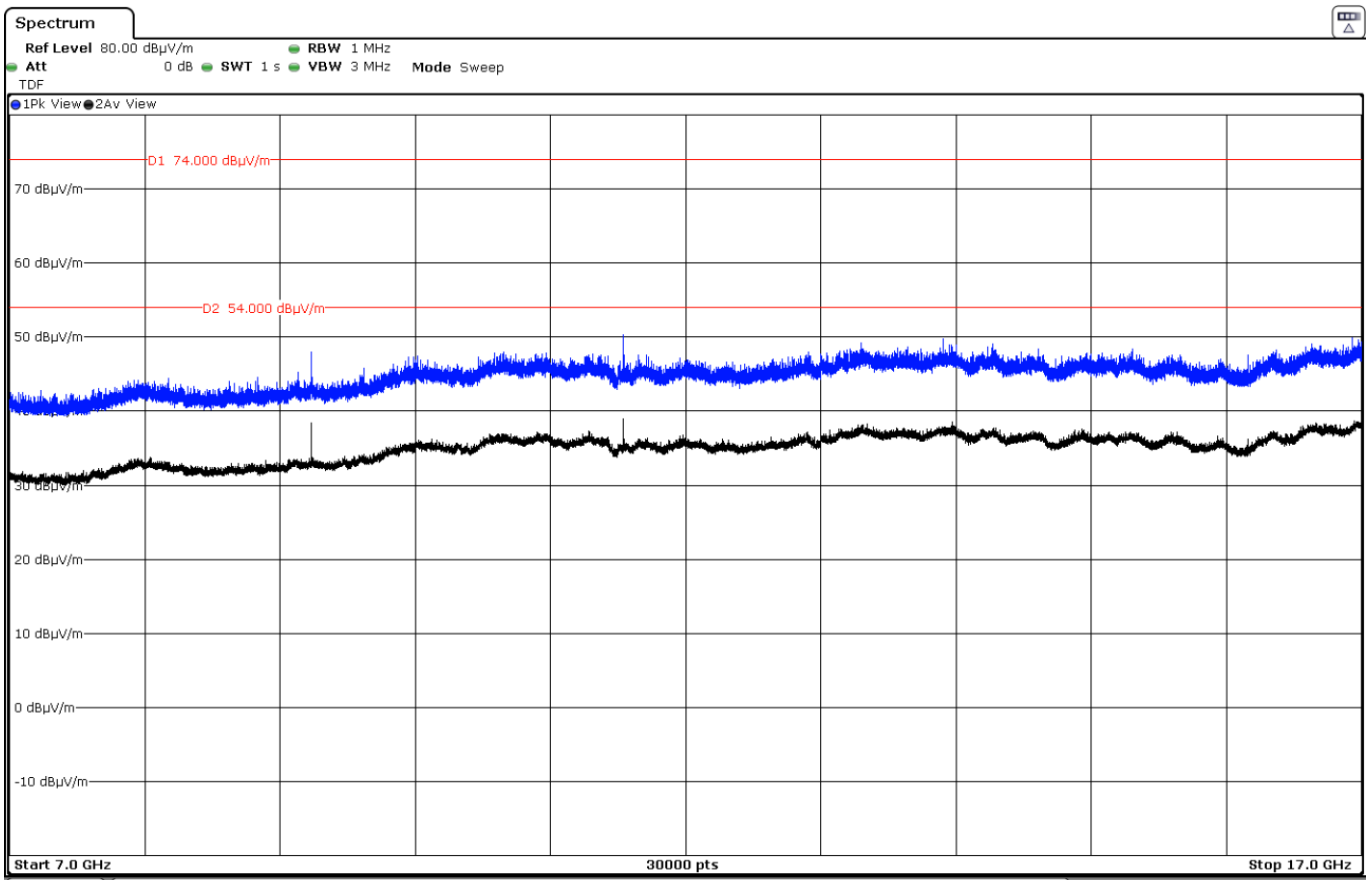
LTE Band 30 (2310 MHz)

802.11 b (2412 MHz).

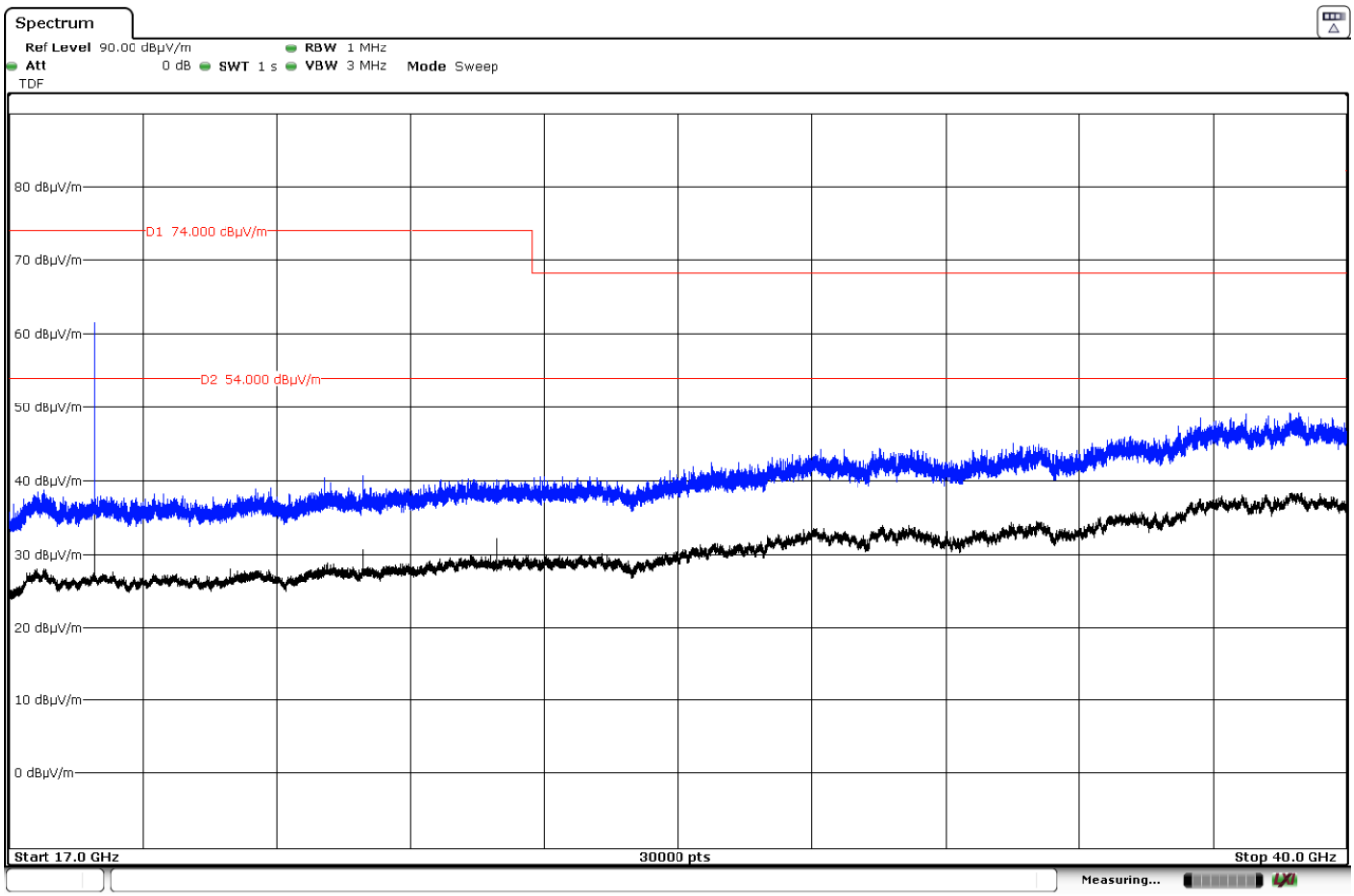
802.11 a20 (5200 MHz).

The peak at 2355 MHz corresponds to the downlink signal.

## FREQUENCY RANGE 7 – 17 GHz



## FREQUENCY RANGE 17 - 40 GHz



- **5. Mode LTE Band 7, 802.11 a20, 802.11 b and NFC B.**

**QPSK & 16QAM**

A preliminary scan determined the QPSK modulation Channel Middle as the worst case.

**Frequency range 9 KHz - 30 MHz**

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

**Frequency range 30 MHz - 1 GHz**

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

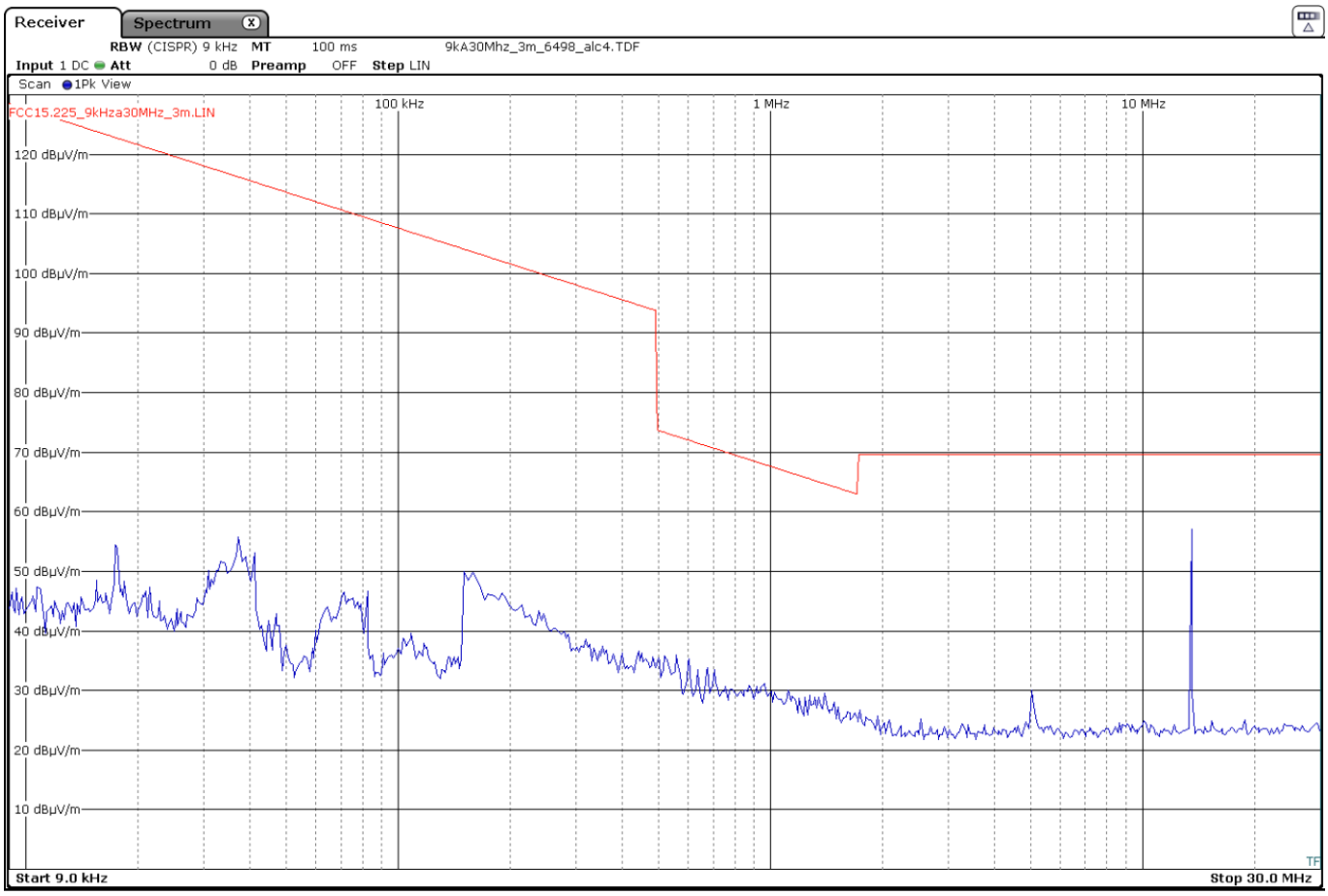
**Frequency range 1 - 40 GHz**

| Spurious frequency (GHz) | Detector | Emission Level (dBµV/m) | Polarization |
|---|---|---|---|
| 7.6005 | Peak | 53.72 | V |
| 12.6658 | Peak | 50.09 | V |
| 15.2002 | Peak | 50.41 | V |
| 17.7916 | Peak | 45.94 | V |
| | Average | 40.53 | |
| 22.8746 | Peak | 45.08 | V |

| | |
|---|---|
| Measurement uncertainty (dB) | <±3.88 for f < 1GHz<br><±3.70 for f ≥ 1 GHz up to 18 GHz<br><±3.33 for f ≥ 18 GHz up to 40 GHz |

Verdict: PASS

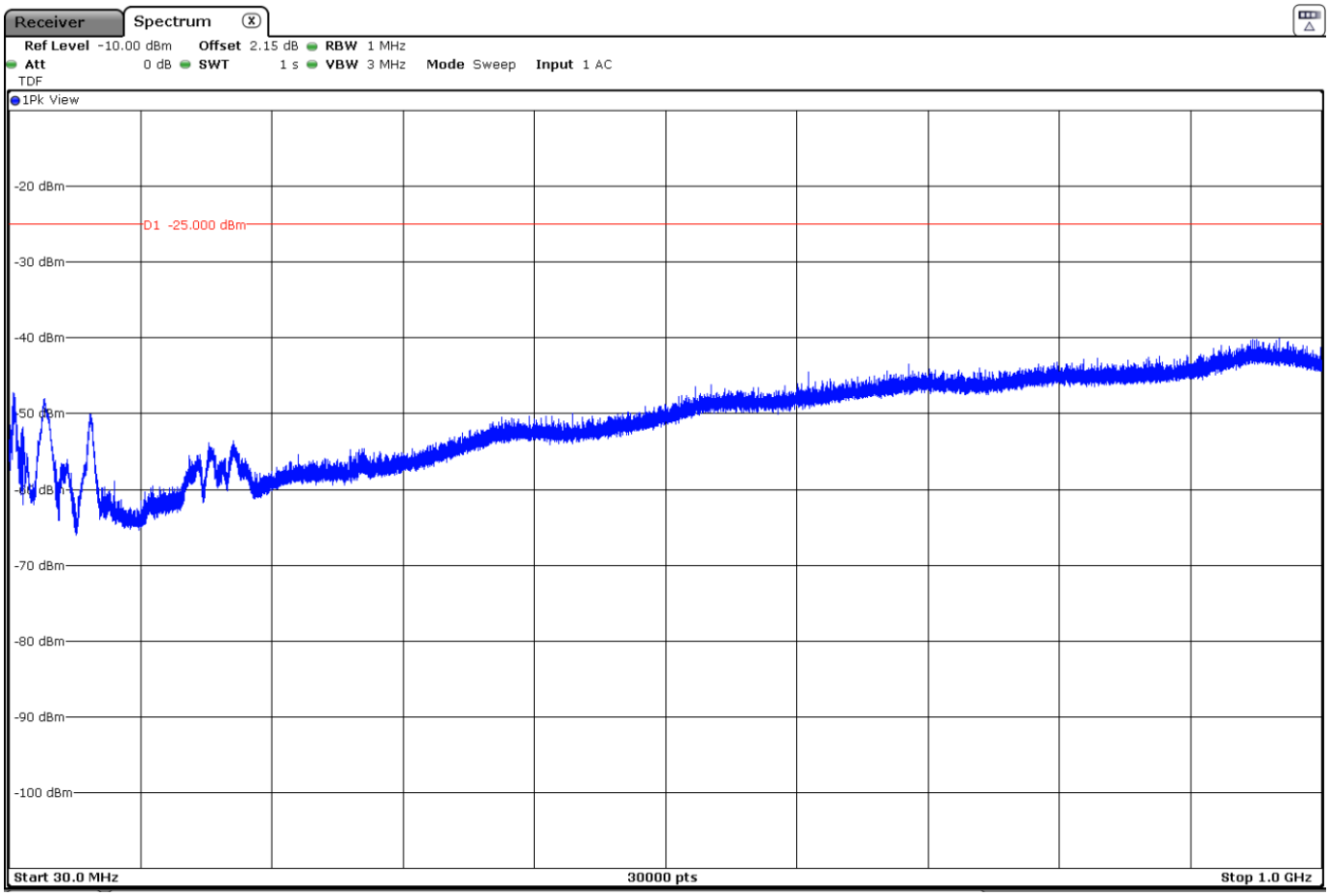
## FREQUENCY RANGE 9 KHz - 30 MHz




The highest peak is the carrier frequency NFC type B (13.56 MHz).

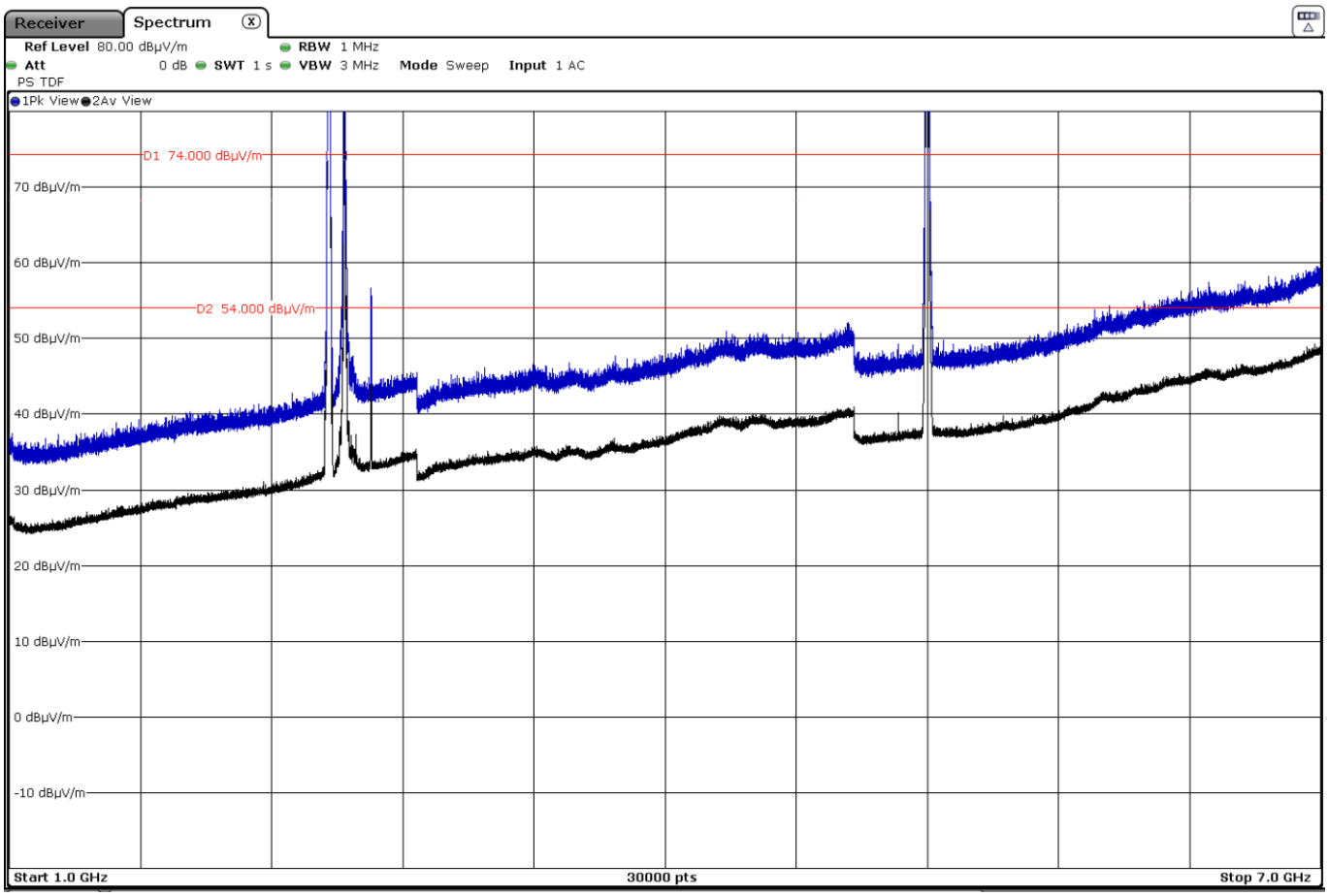
## FREQUENCY RANGE 30 MHz - 1 GHz

### QPSK MODULATION



## FREQUENCY RANGE 1 - 7 GHz

### QPSK MODULATION




The peaks above the limit are the carrier frequencies:

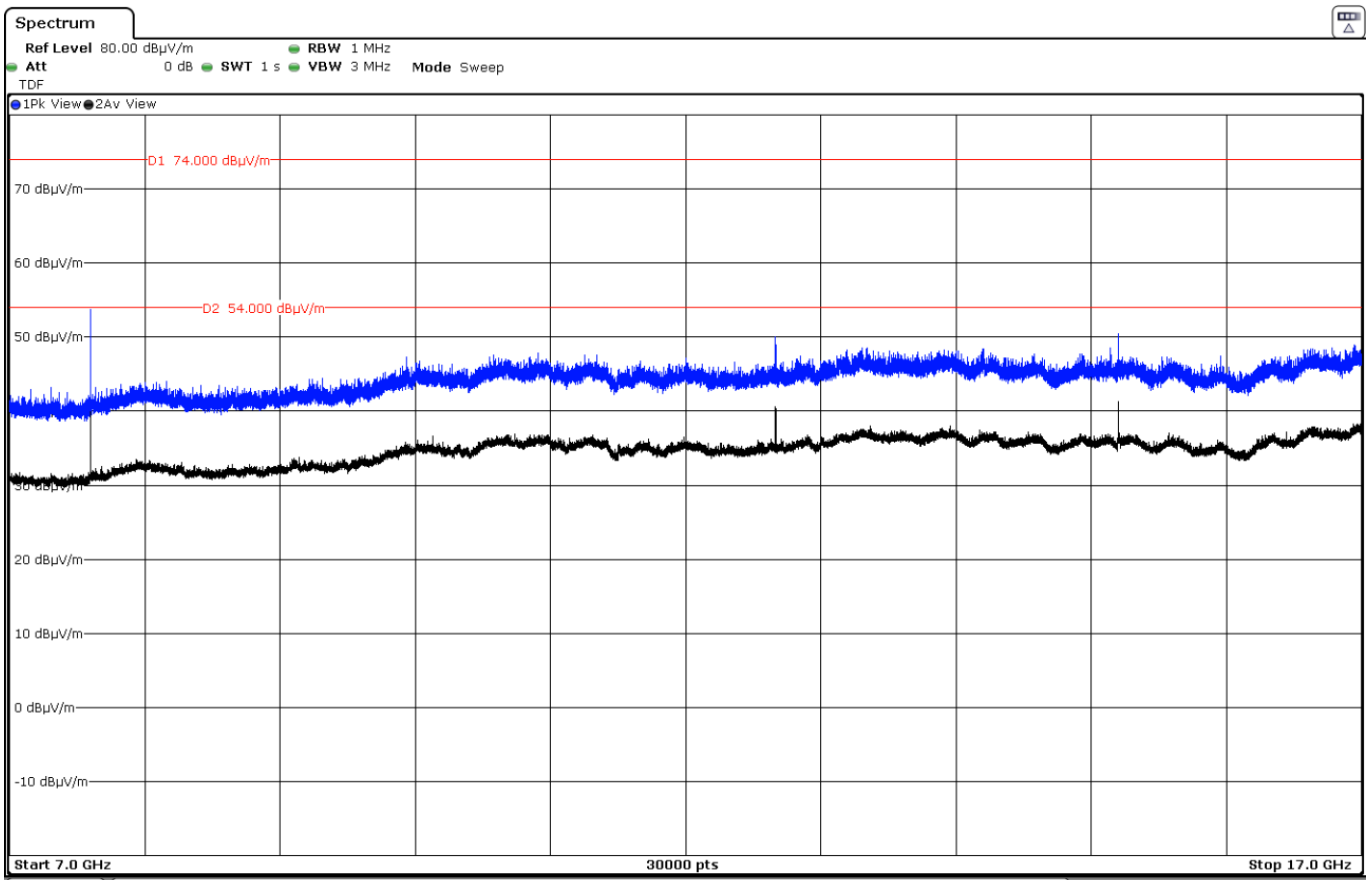
LTE Band 7 (2535 MHz)

802.11 b (2412 MHz)

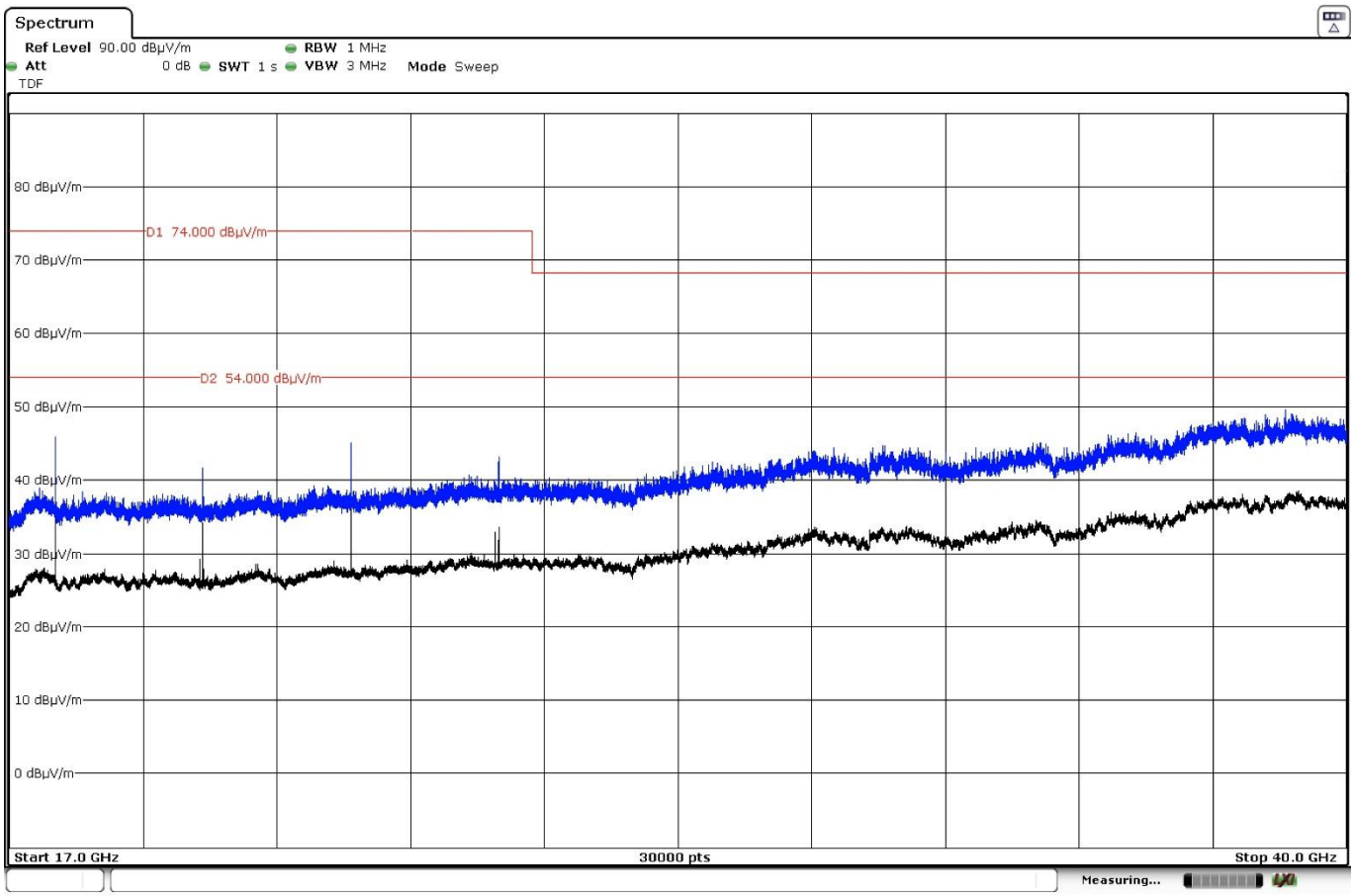
802.11 a20 (5200 MHz)

The peak at 2655 MHz corresponds to the downlink signal.

## FREQUENCY RANGE 7 – 17 GHz



## FREQUENCY RANGE 17 - 40 GHz



- **6. Mode LTE Band 38, 802.11 a20, 802.11 b and NFC B.**

**QPSK & 16QAM**

A preliminary scan determined the QPSK modulation Channel Middle as the worst case.

**Frequency range 9 KHz - 30 MHz**

The spurious emissions below 1 GHz do not depend on either the operating channel or the modulation mode selected in the EUT.

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

**Frequency range 30 MHz - 1 GHz**

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

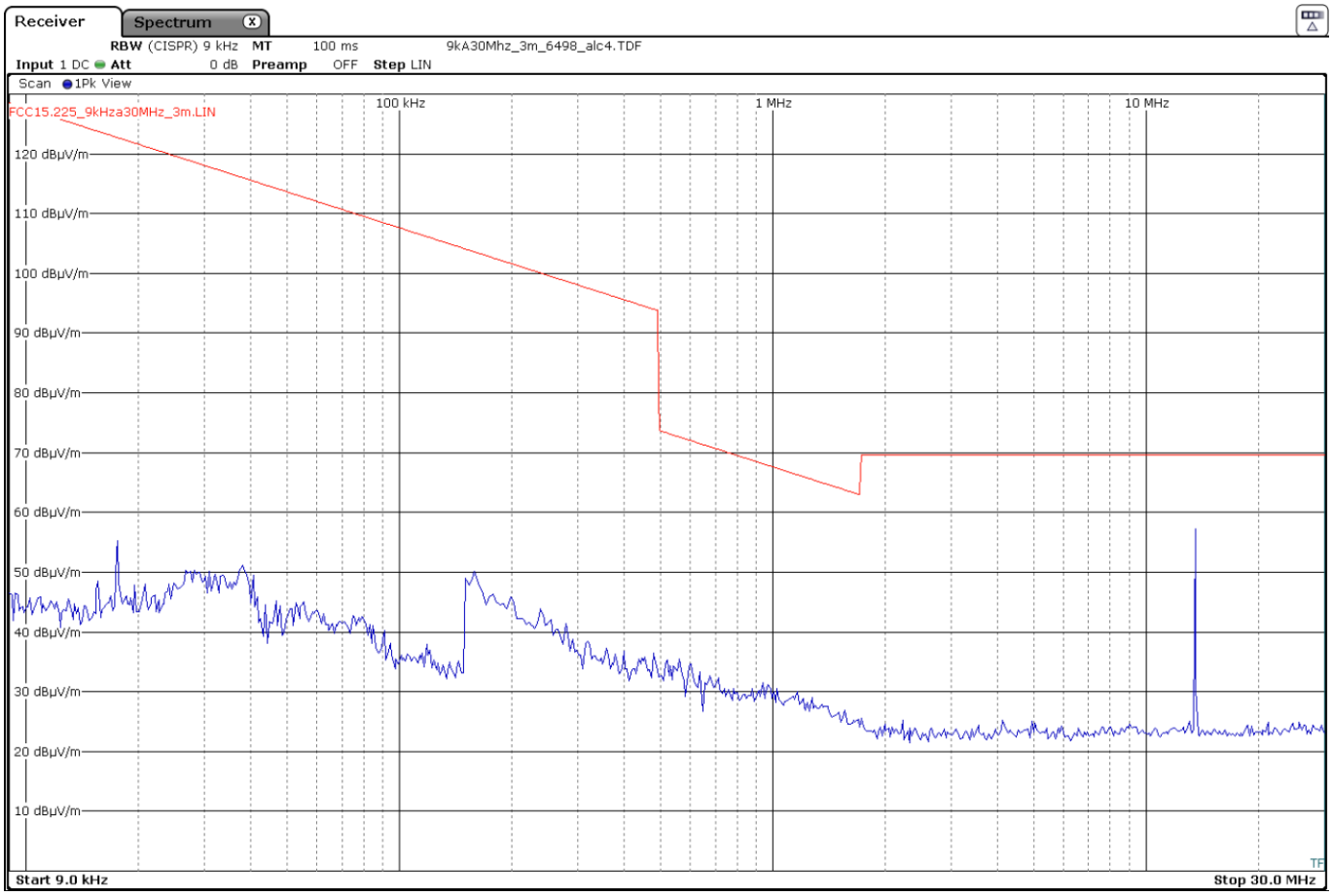
**Frequency range 1 - 40 GHz**

| Spurious frequency (GHz) | Detector | Emission Level (dBµV/m) | Polarization |
|---|---|---|---|
| 7.7983 | Peak | 56.76 | V |
| | Average | 46.3 | |
| 10.3735 | Peak | 51.27 | V |
| 18.16495 | Peak | 59.64 | V |
| | Average | 52.57 | |
| 20.76012 | Peak | 45.79 | V |
| 25.95045 | Peak | 42.06 | V |

| | |
|---|---|
| Measurement uncertainty (dB) | <±3.88 for f < 1GHz<br><±3.70 for f ≥ 1 GHz up to 18 GHz<br><±3.33 for f ≥ 18 GHz up to 40 GHz |

Verdict: PASS

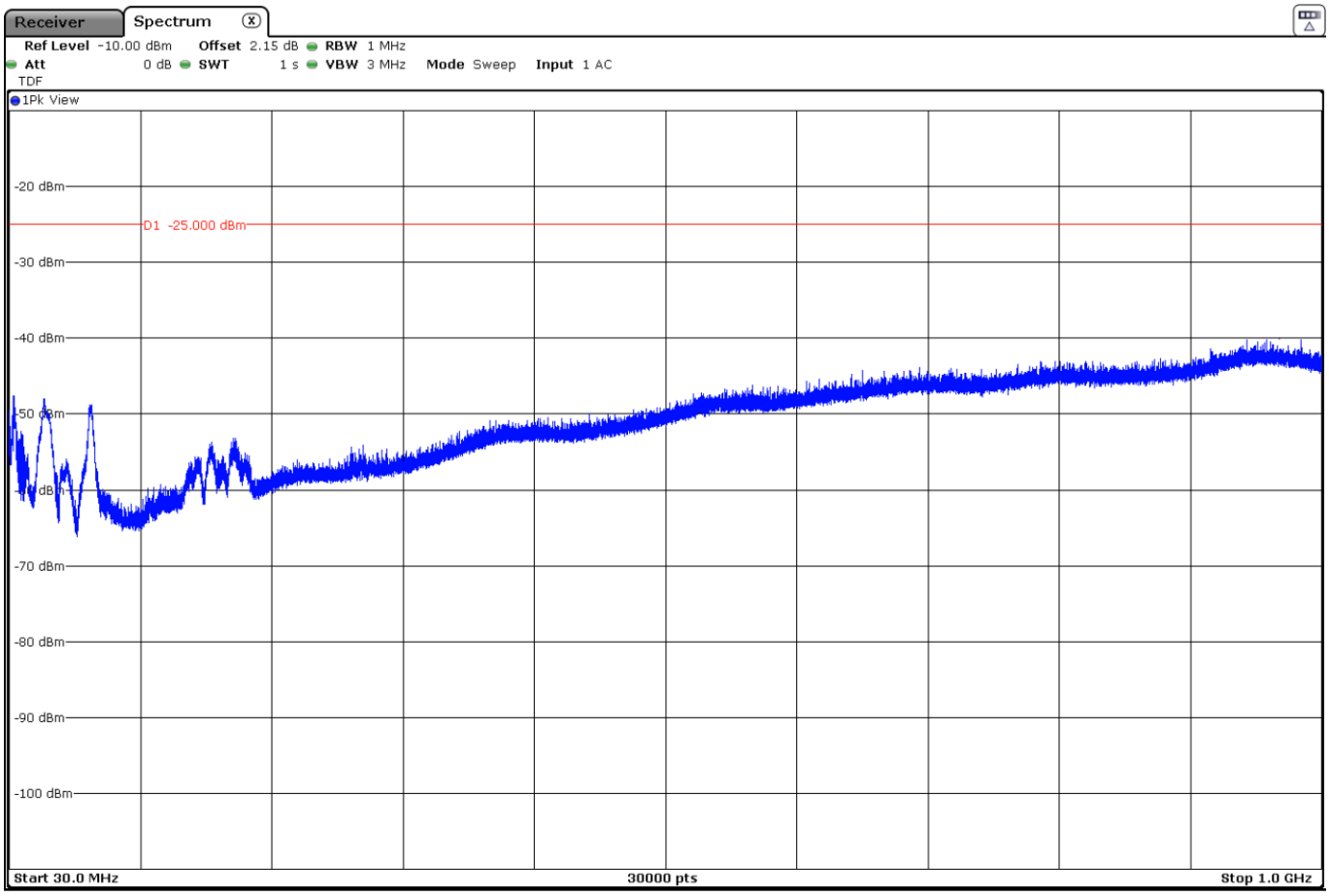
## FREQUENCY RANGE 9 KHz - 30 MHz




The highest peak is the carrier frequency NFC type B (13.56 MHz).

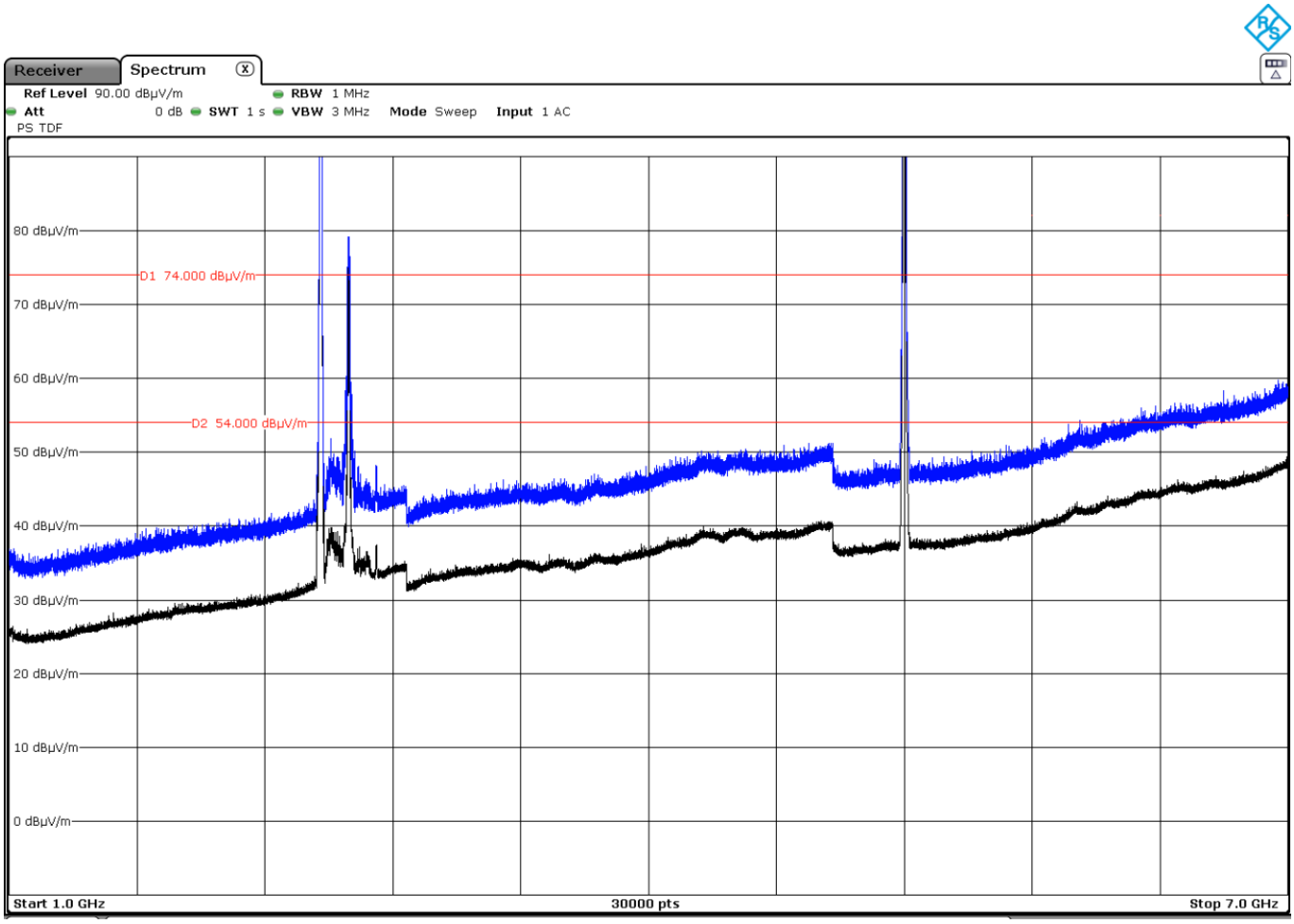
## FREQUENCY RANGE 30 MHz - 1 GHz

### QPSK MODULATION



## FREQUENCY RANGE 1 - 7 GHz

### QPSK MODULATION



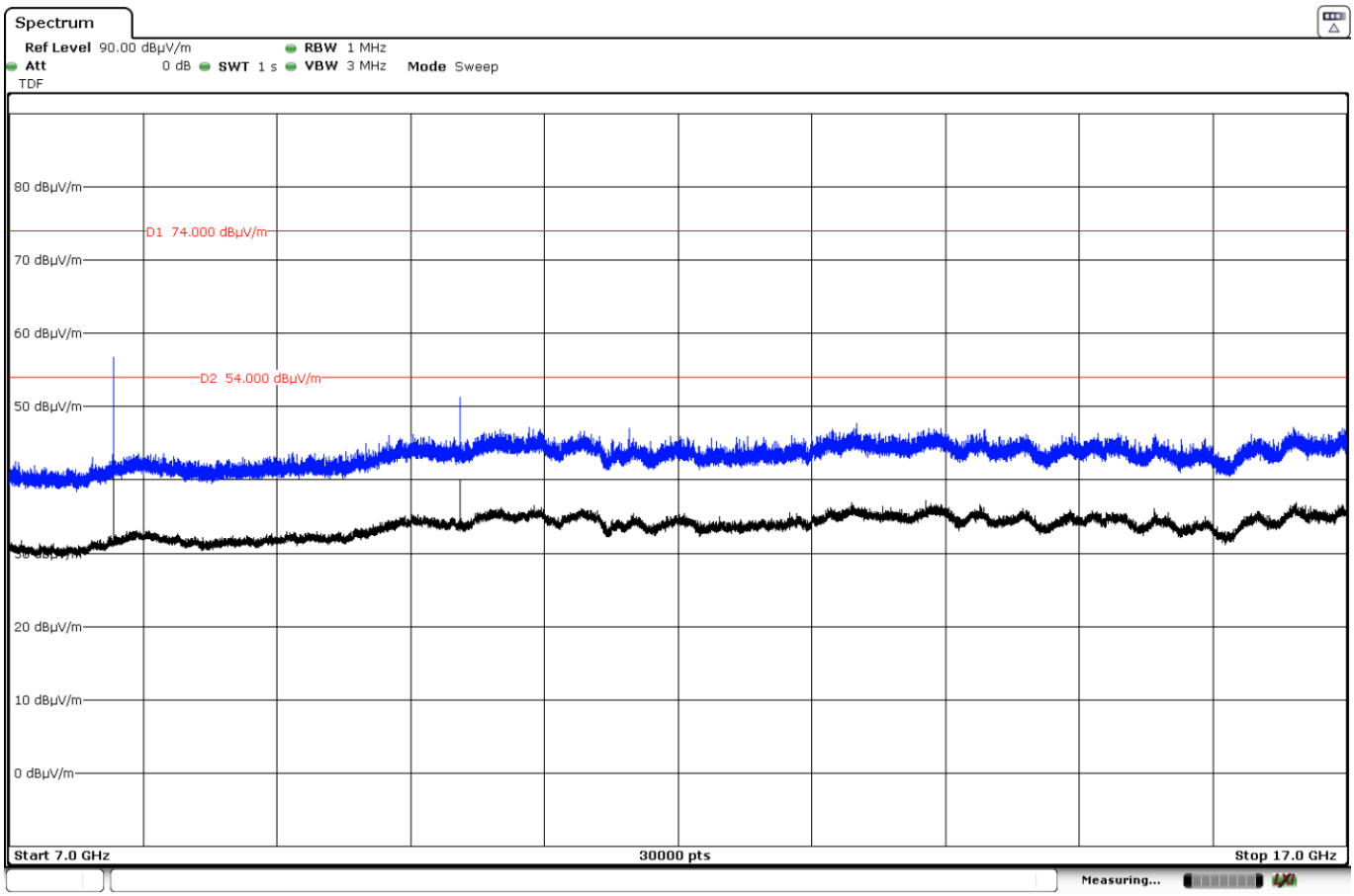

The peaks above the limit are the carrier frequencies:

LTE Band 30 (2595 MHz)

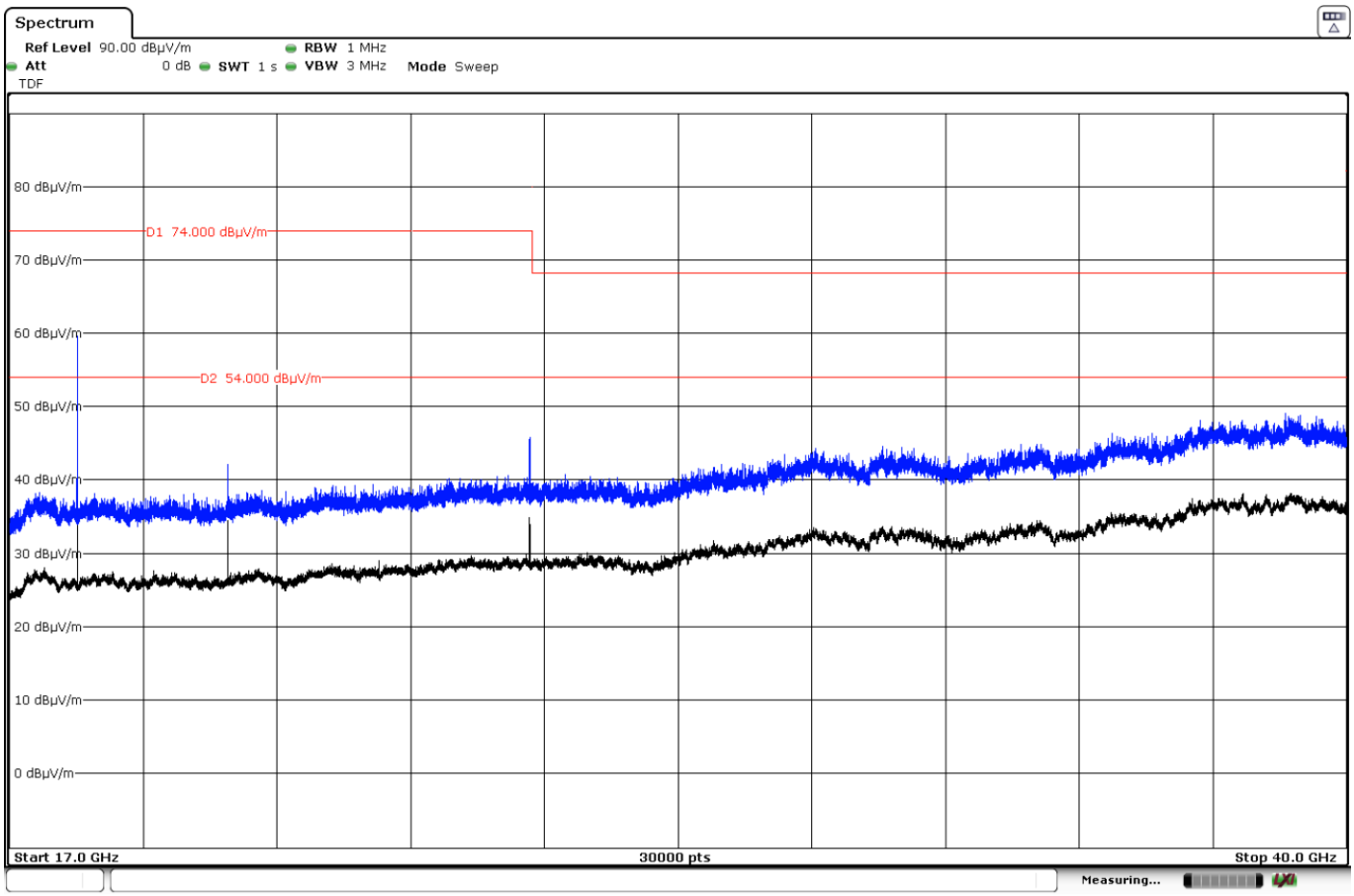
802.11 b (2412 MHz).

802.11 a20 (5200 MHz).

## FREQUENCY RANGE 7 – 17 GHz



## FREQUENCY RANGE 17 - 40 GHz



# **Appendix D:** Test results FCC Part 90

# INDEX

TEST CONDITIONS ..... 89
Radiated emissions ..... 92

# TEST CONDITIONS

POWER SUPPLY (V):

V nonimal: 3.8 Vdc.

Type of Power Supply: DC voltage from a rechargeable battery.

ANTENNA:

Type of Antennas: Internal.

**Maximum Declared Gain for NFC:**

Gain: Not Applicable.

**Maximum Declared Gain for 2.4 GHz WLAN:**

CHAIN 0 Antenna Port Gain : -3 dBi

CHAIN 1 Antenna Port Gain : +2.2 dBi

**Maximum Declared Gain for 5 GHz WLAN:**

CHAIN 0 Antenna Port Gain : -1.1 dBi

CHAIN 1 Antenna Port Gain : -1.1 dBi

**Maximum Declared Gain for Cellular:**

| LOW BANDS (monopole) | | MIDDLE BANDS (monopole with parasitic resonator) | | HIGH BANDS (loop) | |
|---|---|---|---|---|---|
| B5: LTE WCDMA GSM850 | 0.9 dBi | B1: LTE WCDMA | 1.4 dBi | B7: LTE | 2.9 dBi |
| B8: LTE WCDMA GSM900 | -2.5 dBi | B2: LTE WCDMA PCS1900 | 0.1 dBi | B30: LTE | 0.5 dBi |
| B12: LTE | -2.8 dBi | B3: LTE DCS1800 | 0.2 dBi | B38: LTE | 2.1 dBi |
| B13: LTE | -4.4 dBi | B4: LTE WCDMA | 0 dBi | | |
| **B14: LTE** | **-4.7 dBi** | B25: LTE | 0.2 dBi | | |
| B17: LTE | -2.8 dBi | B66: LTE | 0.2 dBi | | |
| B20: LTE | 0.8 dBi | | | | |
| B26: LTE | 0.9 dBi | | | | |
| B28: LTE | -2.1 dBi | | | | |

TEST FREQUENCIES - FCC PART 90:

| | CELLULAR LTE (Band 14) | |
|---|---|---|
| Band: | LTE 14 | |
| Frequency Range: | 788 – 798 MHz | |
| Channel Spacing: | 15 KHz | |
| Transmit Channel: | Channel | Channel Frequency (MHz) |
| | Middle: 23330 | 793 MHz<br>(BW 10 MHz, QPSK 1-49) |

| | WLAN (IEEE 802.11 anac) / U-NII | |
|---|---|---|
| Mode: | 802.11a: 6, 9, 12, 18, 24, 36, 48 & 54 Mbps (SISO) | |
| Frequency Range: | 5150 MHz to 5725 MHz | |
| Channel Spacing: | 20 MHz | |
| Transmit Channel: | Channel | Channel Frequency (MHz) |
| | Middle: 40 | 5200 |

| | WLAN (IEEE 802.11 bgn2040) / Digital Transmission System (DTS) | |
|---|---|---|
| Mode: | 802.11b: 1, 2, 5.5 & 11 Mbps (SISO) | |
| Channel Spacing: | 20 MHz | |
| Frequency Range: | 2412 MHz to 2472 MHz | |
| Transmit Channel: | Channel | Channel Frequency (MHz) |
| | 1 | 2412 |

| | NFC |
|---|---|
| Mode: | Type B |
| Bitrate: | 106 Kbps |
| Nominal Operating frequency: | 13.56 MHz |

The test set-up was made in accordance to the general provisions of FCC DTS Measurement 558074 D01 DTS Meas Guidance v05 dated 24/08/2018 and FCC Unlicensed National Information Infrastructure (U-NII) Devices 789033 D02 General U-NII Test Procedures New Rules v02r01 dated Dec 14, 2017.

The EUT was tested in the following operating mode:

- Continuous transmission with a modulated carrier at maximum power in all required channels selecting the supported data rates/modulations types.

During transmitter test the EUT was being controlled by the SW tool to operate in a continuous transmit mode on the test channel as required and in each of the different modulation modes.

The following configurations were selected based on preliminary testing that identified those corresponding to the worst cases:

**Transmission modes selected with each radio:**

* CELLULAR LTE: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in LTE band 14 configuration as these channels were found to transmit higher EIRP than all the other LTE channels.

* 5 GHz WLAN: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in 802.11a20 / 6Mbps / SISO (Chain 0) mode configuration as this mode was found to transmit higher EIRP than all the other 5 GHz WLAN modes.

* 2.4 GHz WLAN: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in 802.11b / 1Mbps / SISO (Chain 1) mode configuration as this mode was found to transmit higher EIRP than all the other 2.4 GHz WLAN modes.

* NFC: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in B mode (106 Kbps) because its power is higher than the other modulations and bitrates.

**Simultaneous transmission modes selected:**

**1. CELLULAR LTE, 5 GHz WLAN, 2.4 GHz WLAN and NFC Co-Location**, with the EUT configured to simultaneously transmit four signals at maximum output power, CELLULAR LTE in band 14, 5GHz WLAN (Wi-Fi Chain 0) in 802.11a20 / 6 Mbps / SISO, 2.4GHz WLAN (Wi-Fi Chain 0) in 802.11b / 1 Mbps / SISO and NFC (B, 106 Kbps).

# Radiated emissions

SPECIFICATION:

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c) / RSS-Gen):

| Frequency Range (MHz) | Field strength (µV/m) | Field strength (dBµV/m) | Measurement distance (m) |
|---|---|---|---|
| 0.009-0.490 | 2400/F(kHz) | - | 300 |
| 0.490-1.705 | 24000/F(kHz) | - | 30 |
| 1.705 - 30.0 | 30 | - | 30 |
| 30 - 88 | 100 | 40 | 3 |
| 88 - 216 | 150 | 43.5 | 3 |
| 216 - 960 | 200 | 46 | 3 |
| 960 - 25000 | 500 | 54 | 3 |

The emission limits shown in the above table are based on measurements employing CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

For average radiated emission measurements above 1000 MHz, there is also a limit corresponding to 20 dB above the indicated values in the table is specified when measuring with peak detector function.

**1. LTE Band 14**. FCC §2.1051 and FCC §90.543 (e) (2) (3) & (f):

(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:

(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.

(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.

LIMIT:

The spurious signals was measured at 3 meter. The limit of the test is determined by:

| Frequency Range | Detector | Limit (dBµV/m) at 3m |
|---|---|---|
| 30 MHz to 8 GHz | PK | 43 + 10 log (P) dB = -13 dBm -> 82.23 dBµV/m or 74 (*)-> -21.23 dBm |
| 8 GHz to 26 GHz | PK | 74 (*) |
| | AVG | 54 (*) |
| 26 GHz to 40 GHz | PK | 68.23 |

(*) Radiated emissions which fall in the restricted bands, as defined in §15.205(a).

METHOD:

The measurement was performed with the EUT inside an anechoic chamber.

The spectrum was scanned from 9 kHz to at least the 10th harmonic of the highest frequency of the co-located radios till 40 GHz.

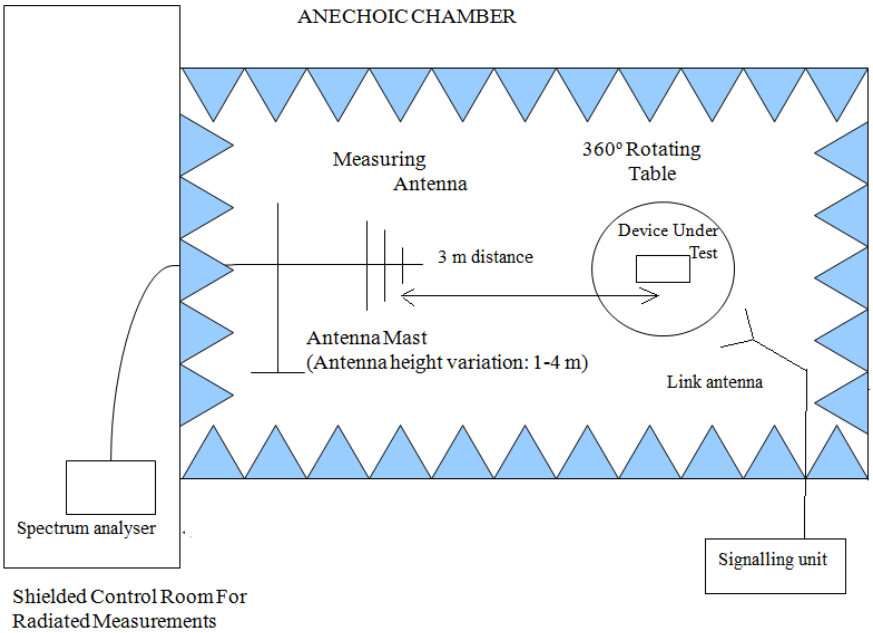
The EUT was placed on a non-conductive stand at a 3 meter distance from the measuring antenna for measurements below 1 GHz and at 1 m distance for measurements above 1 GHz.
Detected emissions were maximized at each frequency by rotating the EUT and adjusting the measuring antenna height and polarization. The maximum meter reading was recorded.

The field strength is calculated by adding correction factor to the measured level from the spectrum analyzer. This correction factor includes antenna factor, cable loss and pre-amplifiers gain.

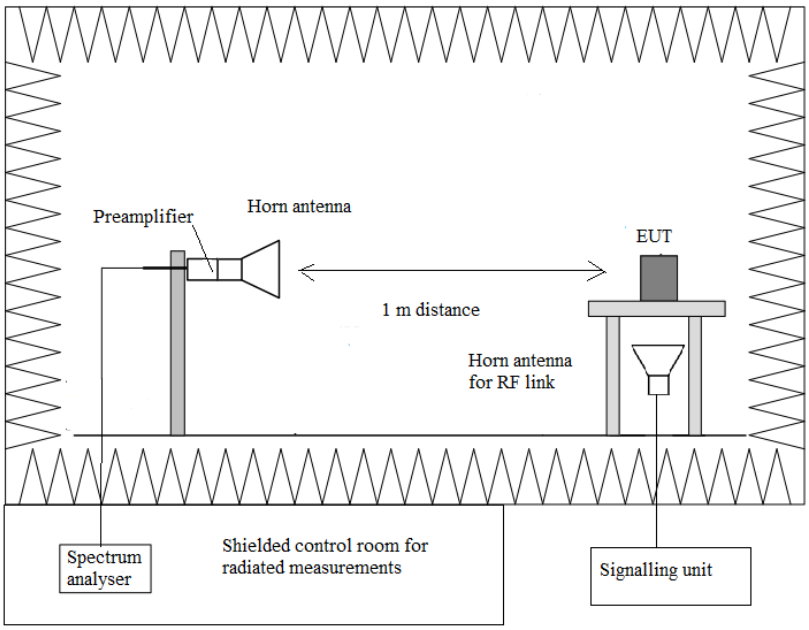
These measurements have been performed in order to check the impact of the Co-Location of all radio interfaces (that can be transmitting simultaneously).

TEST SETUP:

Radiated measurements below 1 GHz.




Radiated measurements above 1 GHz.



RESULTS:

- **1. Mode LTE Band 14, 802.11 a20, 802.11 b and NFC B.**

**QPSK & 16QAM**

A preliminary scan determined the QPSK modulation Channel Middle as the worst case.

**Frequency range 9 KHz - 30 MHz**

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

**Frequency range 30 MHz - 1 GHz**

Spurious frequencies at less than 20 dB below the limit:

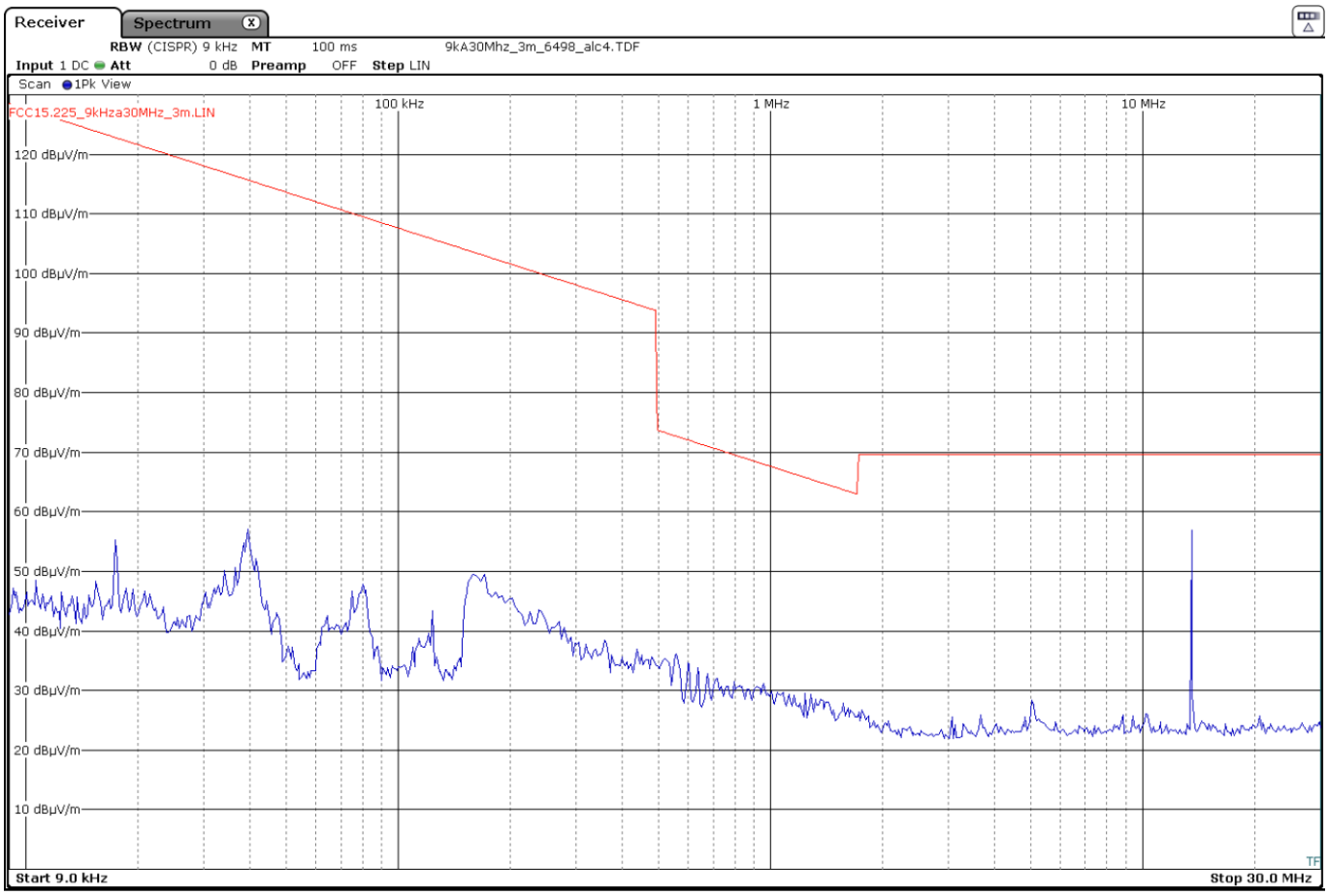
No spurious frequencies at less than 20 dB below the limit.

**Frequency range 1 - 40 GHz**

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

| | |
|---|---|
| Measurement uncertainty (dB) | <±3.88 for f < 1GHz<br><±3.70 for f ≥ 1 GHz up to 18 GHz<br><±3.33 for f ≥ 18 GHz up to 20 GHz |

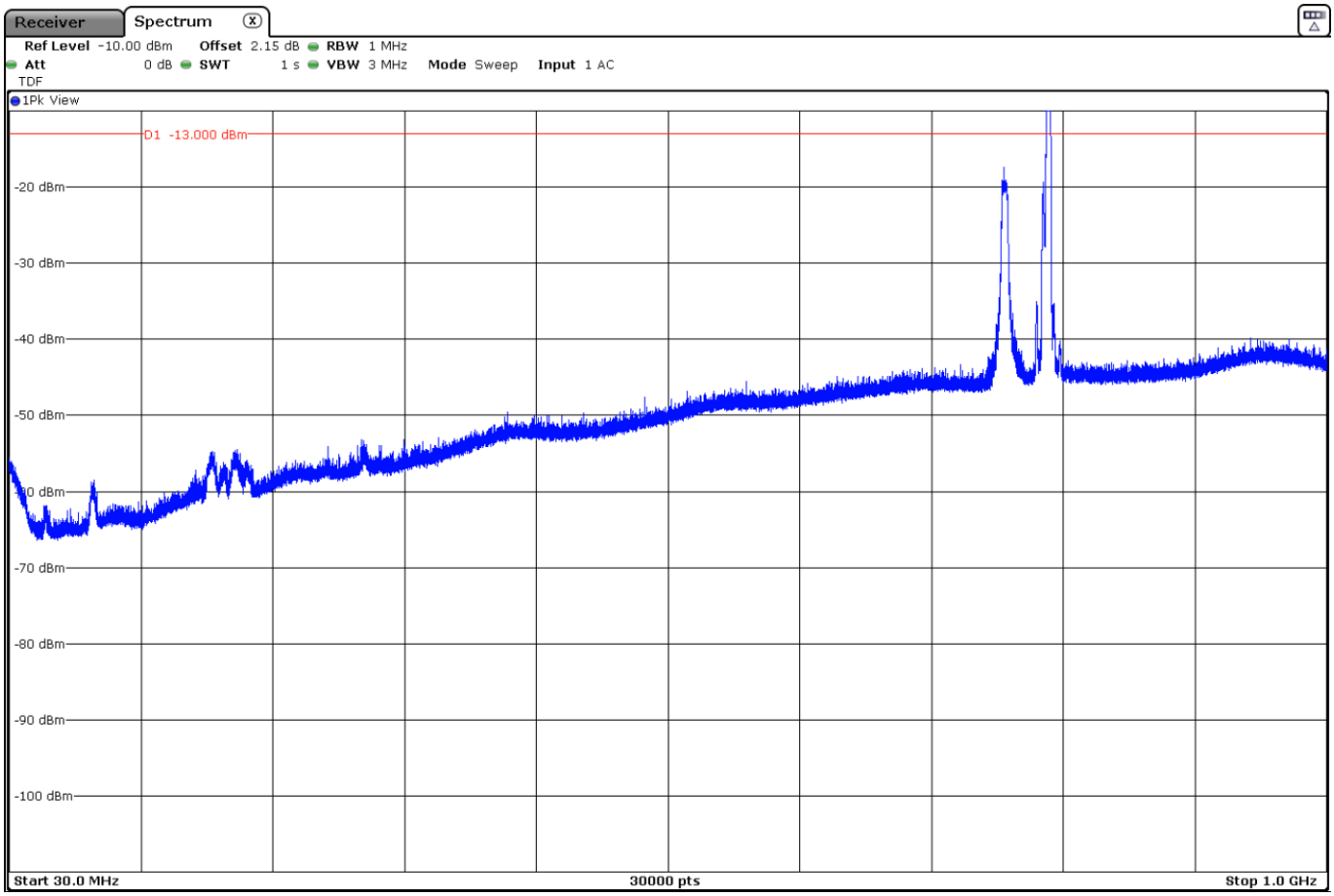
## FREQUENCY RANGE 9 KHz - 30 MHz




The highest peak is the carrier frequency NFC type B (13.56 MHz).

## FREQUENCY RANGE 30 MHz - 1 GHz

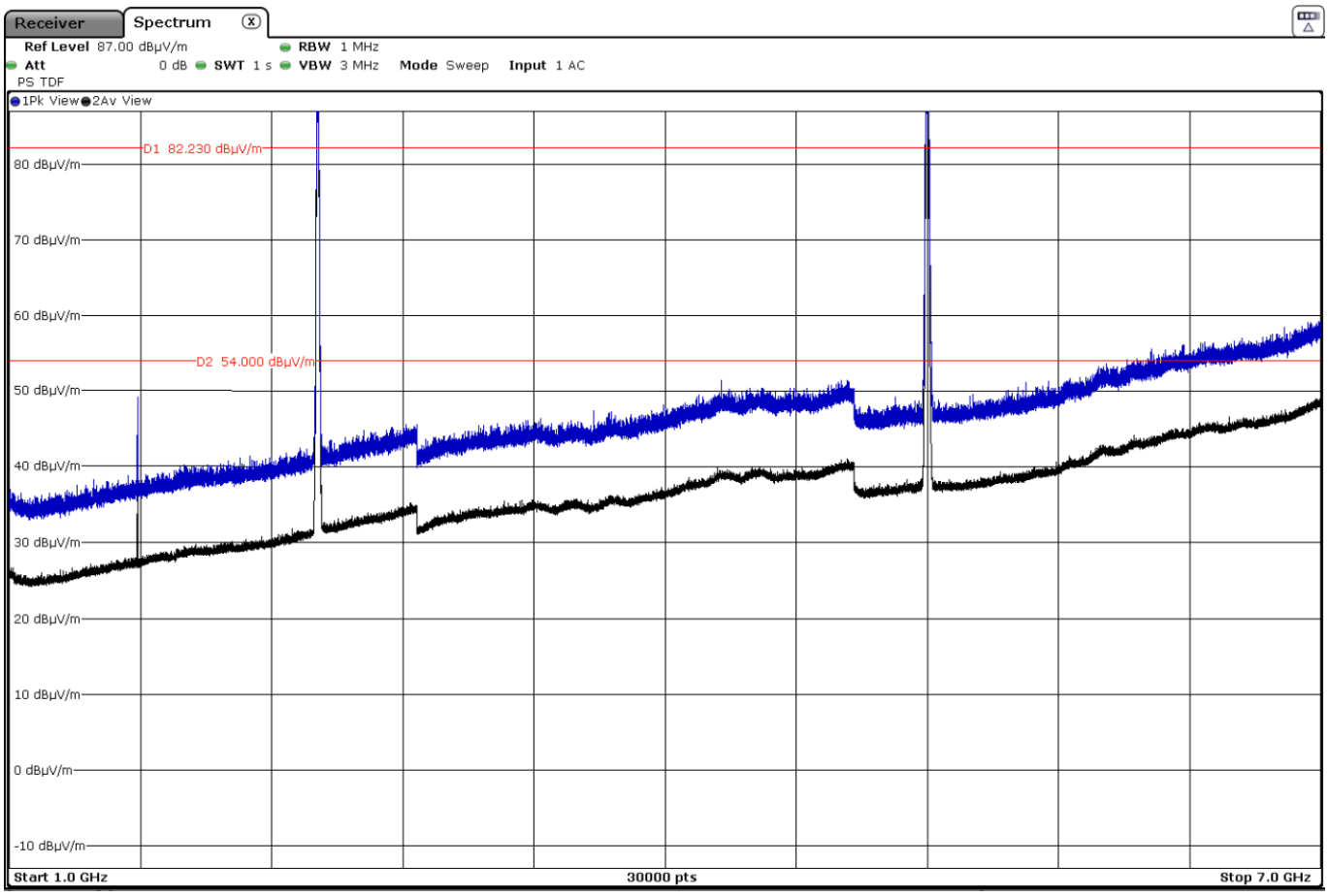
## QPSK MODULATION




The peak above the limit is the carrier frequency LTE Band 14 (793 MHz). The peak at 763 MHz corresponds to the downlink signal.

## FREQUENCY RANGE 1 - 7 GHz

### QPSK MODULATION

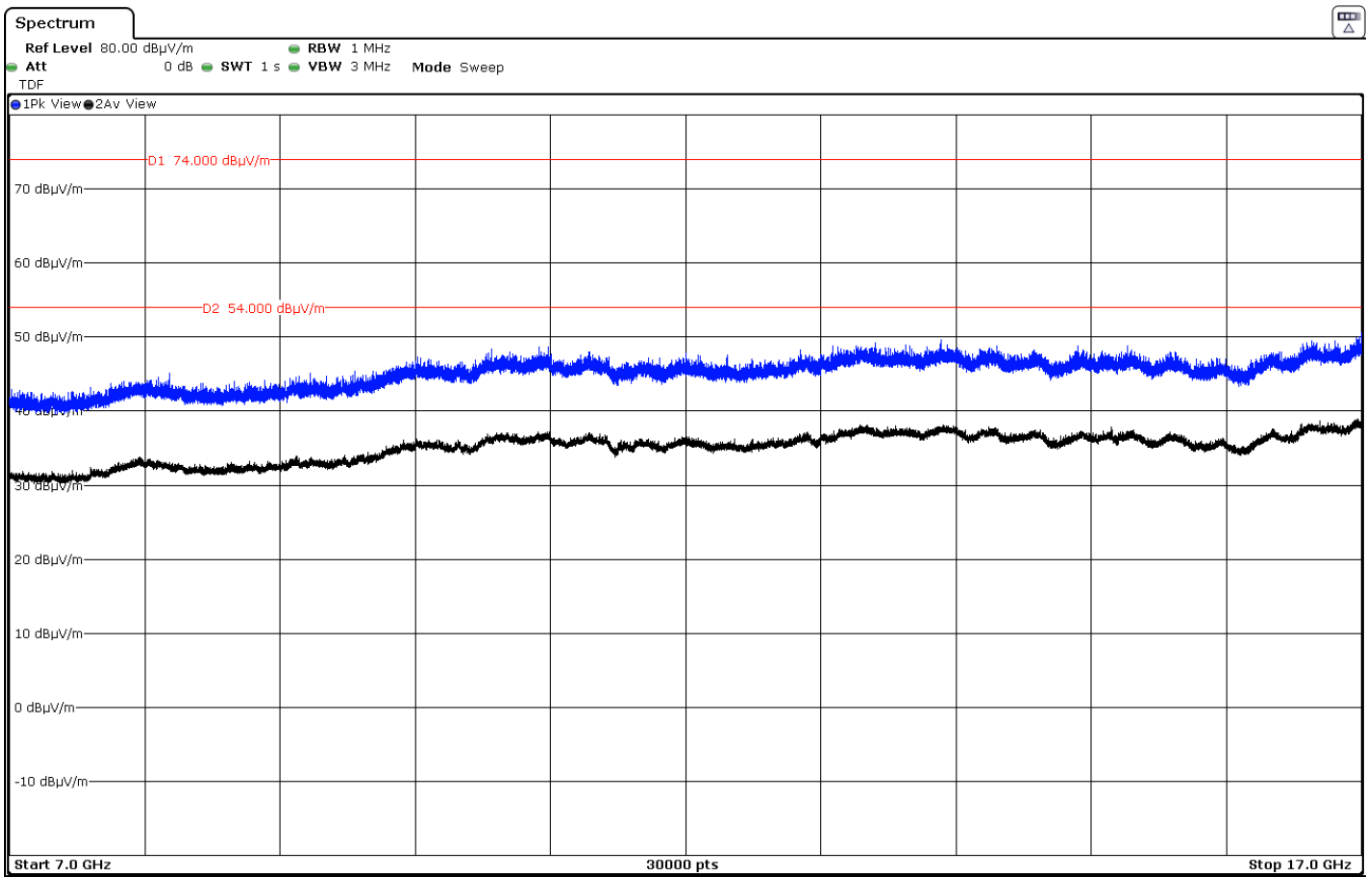
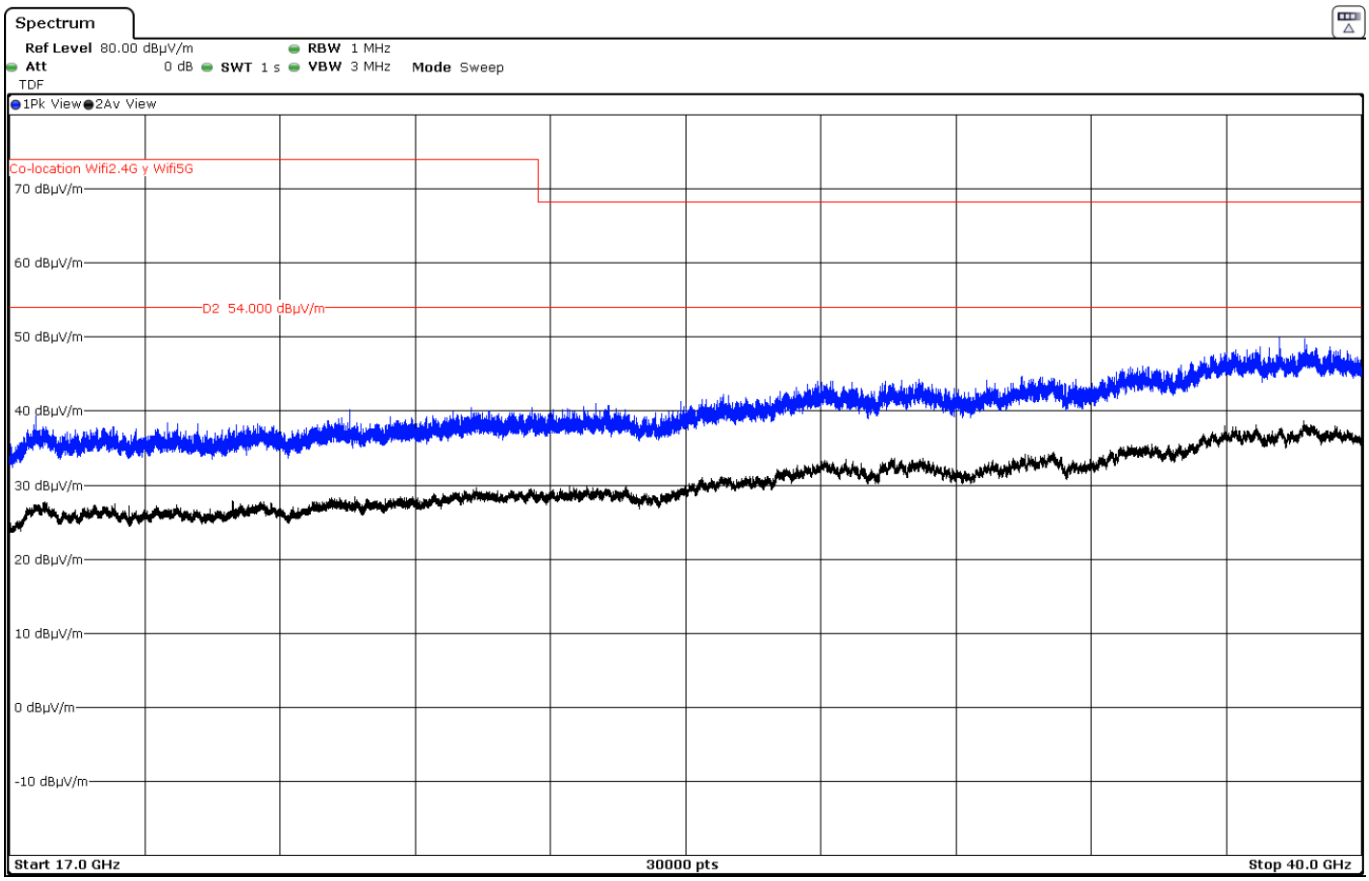



The peaks above the limit are the carrier frequencies:

802.11 b (2412 MHz).

802.11 a20 (5200 MHz).

## FREQUENCY RANGE 7 – 17 GHz



## FREQUENCY RANGE 17 - 40 GHz