

ISED CABid: ES1909

Test Report No:
NIE: 67871RRF.003A1

Partial Test Report

USA FCC 24, 27, 15.519, 15.521, 15.209

CANADA RSS-130, RSS-133, RSS-139, RSS-220,
RSS-Gen

(*) Identification of item tested	Mobile UWB anchor
(*) Trademark	Romware
(*) Model and /or type reference	M-Anchor 100
Other identification of the product	HW version: W4 SW version: 1.2.1 FCC ID: 2AVTBRWM1W5 IC: 27593-RWM1W5
(*) Features	LTE Cat M1, Cat NB2, UWB
Applicant	Rombit Meir 30, 2000 Antwerpen, Belgium
Test method requested, standard	USA FCC Part 24 (10-1-20 Edition): Personal Communications Services. USA FCC Part 27 (10-1-20 Edition): Miscellaneous Wireless Communications Services. USA FCC Part 15.519 (10-1-20 Edition): Technical requirements for hand held UWB systems. USA FCC Part 15.521 (10-1-20 Edition): Technical requirements applicable to all UWB devices. USA FCC Part 15.209 (10-1-20 Edition): Radiated emission limits; general requirements. CANADA RSS-130 Issue 2, Feb 2019. CANADA RSS-133 Issue 6 amendment 1, Jan. 2018. CANADA RSS-139 Issue 3, Jul. 2015. CANADA RSS-220 Issue 1 amendment 1, July 2018. CANADA RSS-Gen Issue 5 amendment 2, Apr. 2018. ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices. ANSI C63.26-2015.
Approved by (name / position & signature)	José de la Plaza Fernández EMC Lab Director
Date of issue	2022-03-04
Report template No	FDT08_23 (*) "Data provided by the client"

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Competences and guarantees

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

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

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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 the model M-Anchor 100 is a connected UWB anchor, to be installed on industrial vehicles such as forklifts or reach-stackers.

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 N°	Description	Model	Serial N°	Reception
67871/041	Mobile UWB anchor	M-Anchor 100	--	2021/09/10
67871/022	Antenna	--	--	2021/05/04
67871/014	GPS Antenna	--	--	2021/05/04

Auxiliary elements used with the Sample S/01:

Control N°	Description	Model	Serial N°	Reception
67871/017	Power Cable DC	--	--	2021/05/04

Sample S/01 has undergone: The tests indicated in the Appendix A for the Co-Location mode LTE Cat NB2 Band 2 + UWB and the tests indicated in the Appendix B for the Co-Location mode LTE Cat NB2 Band 13 + UWB.

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

Control N°	Description	Model	Serial N°	Reception
67871/040	Mobile UWB anchor	M-Anchor 100	--	2021/09/10
67871/022	Antenna	--	--	2021/05/04
67871/014	GPS Antenna	--	--	2021/05/04

Auxiliary elements used with the Sample S/01:

Control N°	Description	Model	Serial N°	Reception
67871/017	Power Cable DC	--	--	2021/05/04

Sample S/02 has undergone: The tests indicated in the Appendix B for the Co-Location mode LTE Cat M1 Band 4 + UWB and the Co-Location mode LTE Cat M1 Band 12 + UWB.

Test sample description

Ports..... :	Port name and description	Cable			
		Specified max length [m]	Attached during test	Shielded	Coupled to patient ⁽³⁾
	Power	5	☒	☒	☐
	CAN	5	☒	☒	☐
	GPS	5	☒	☒	☐
	LTE	5	☒	☒	☐
Supplementary information to the ports..... :	-				
Rated power supply	Voltage and Frequency				
	☒	DC: 6V-24V			
Rated Power..... :	-				
Clock frequencies..... :	-				
Other parameters	-				
Software version..... :	1.2.1				
Hardware version	W4				
Dimensions in cm (W x H x D) ... :	11 x 17 x 4 cm				
Mounting position	☐	Table top equipment			
	☐	Wall/Ceiling mounted equipment			
	☐	Floor standing equipment			
	☐	Hand-held equipment			
	☒	Other: Mounted to an industrial vehicle			
Modules/parts..... :	Module/parts of test item		Type	Manufacturer	
	-				
	-				
	-				
	-				
Accessories (not part of the test item)	Description		Type	Manufacturer	
	LTE antenna (SMA connection)				
	GPS antenna (SMA connection)				
	-				
	-				
	-				
	-				
Documents as provided by the applicant	Description		File name	Issue date	
	-				
	-				
	-				
	-				

⁽³⁾ Only for Medical Equipment

Identification of the client

Rombit
Meir 30, 2000 Antwerpen, Belgium

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2020-09-13
Date (finish)	2020-09-14

Document history

Report number	Date	Description
67871RRF.003	2021-12-16	First release.
67871RRF.003A1	2022-03-04	First modification: typo correction on IC number.. This modification test report cancels and replaces the test report 67678RRF.003

Environmental conditions

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

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %

In the semianechoic chamber, the following limits were not exceeded during the test.

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 75 %

Remarks and comments

The tests have been performed by the technical personnel: Nicolás Salguero, Javier Miguel Nadales.

Used instrumentation:

Radiated Measurements:

		Last Calibration	Due Calibration
1.	Semianechoic Absorber Lined Chamber ETS LINDGREN FACT 3 200 STP	N/A	N/A
2.	Shielded Room ETS LINDGREN S101	N/A	N/A
3.	Biconical/Log Antenna 30MHz - 6 GHz ETS LINDGREN 3142E	2020/10	2023/10
4.	Horn Antenna 1-18 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9120 D	2020/08	2023/08
5.	Horn Antenna 1-18 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9120 D	2019/11	2022/11
6.	Horn Antenna 18-40 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9170	2020/05	2023/05
7.	RF Preamplifier G>30dB, 1-18GHz BONN ELEKTRONIK BLMA 0118-3A	2020/10	2021/10
8.	RF Preamplifier, 40 dB ,1-18 GHz BONN ELEKTRONIK BLMA 0118-1M	2021/06	2022/06
9.	Low Noise Amplifier G>30dB, 18 - 40 GHz BONN ELEKTRONIK BLMA 1840-3G	2019/11	2021/11
10.	Signal and Spectrum Analyzer 10 Hz - 40 GHz ROHDE AND SCHWARZ FSV40	2019/10	2021/10
11.	EMI Test Receiver 7 GHz ROHDE AND SCHWARZ ESR7	2019/10	2021/10
12.	Spectrum Analyzer ROHDE AND SCHWARZ FSW50	2020/07	2022/07
13.	Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500	N/A	N/A
14.	DC Power Supply 30V/5A KEYSIGHT TECHNOLOGIES U8002A	N/A	N/A
15.	Digital Multimeter, FLUKE 175	2020/11	2021/11

Testing verdicts

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

Summary

FCC PARTS 15, 24, 27 / RSS-130, RSS-133, RSS-139, RSS-Gen PARAGRAPH			
Requirement – Test case		Verdict	Remark
FCC 15.31 (h), 15.209 (a) / RSS-Gen 8.9		P	(1)
Emission Limitations Radiated (Transmitter)			
FCC 24.238 / RSS-133 6.5			
FCC 27.53 / RSS-130 4.7, RSS-139 6.6			
FCC 15.519 (c),(d), 15.521 (c) / RSS-220 5.3.1. (c),(d),(e), Annex. Sect.4 (m)			
<u>Supplementary information and remarks:</u>			
(1) Co-Location radiated spurious emission test.			

Appendix A: Test results FCC 24 / RSS-133

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TEST CONDITIONS

(*) Declared by the Applicant

POWER SUPPLY (*):

Vnominal: 24 Vdc
Type of Power Supply: External DC (vehicle battery).

ANTENNA (*):

UWB:

Type of Antenna: Integral (on board ceramic antenna).
Maximum Declared Gain: +6 dBi

CELLULAR:

MIDDLE Band	Maximum Declared Antenna Gain	Type of Antenna
LTE Cat NB2 Band 2	+6 dBi	External

TEST FREQUENCIES:

CELLULAR LTE Cat NB2 (Band 2)		
Band:	LTE Cat NB2 Band 2	
Mode:	Pi/2-BPSK	
Frequency Range:	1850 – 1910 MHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	High: 19198	1909.8 MHz (Tone Number 1, Tone Channel BW 15 kHz, TBS 0, Tone Offset 0)

UWB		
Mode:	UWB	
Transmit Channel:	Channel	Channel Frequency (MHz)
	2	3993.6

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.

Selected Transmission Modes for each Radio:

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

* Cellular LTE Cat NB2: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in LTE Cat NB2 Band 2 on the high channel. This channel was found to transmit higher Radiated Spurious Emission than all the other LTE Cat NB2 channels.

* UWB: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in UWB / Channel 2 and UWB mode configuration.

TESTED SIMULTANEOUS TRANSMISSION MODES:

* **Co-Location mode LTE Cat NB2 Band 2, UWB**, with the EUT configured to simultaneously transmit two signals at maximum output power, Cellular LTE Cat NB2 Band 2 / High Channel and UWB / Channel 2.

Emission Limitations Radiated

SPECIFICATION:

1. LTE Cat NB2 Band 2. 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 $43 + 10 \log_{10}(P)$ (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 $43 + 10 \log_{10}(P)$ (watts). If the measurement is performed using 1% of the emission bandwidth, power integration over 1.0 MHz is required.

LTE Cat NB2 Band 2 MEASUREMENT LIMIT:

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

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

2. UWB. The radiated emissions at or below 960 MHz shall not exceed the emission levels in §15.209:

Frequency Range (MHz)	Field strength ($\mu\text{V/m}$)	Field strength ($\text{dB}\mu\text{V/m}$)	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
Above 960	500	54	3

* §15.519 (c): The radiated emissions at or below 960 MHz from a device operating under the provisions of this section shall not exceed the emission levels in § 15.209. The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz:

Frequency Range (MHz)	EIRP (dBm)
960-1610	-75.3
1610-1990	-63.3
1990-3100	-61.3
3100-10600	-41.3
Above 10600	-61.3

* §15.519 (d): In addition to the radiated emission limits specified in the table above, UWB transmitters shall not exceed the following average limits when measured using a resolution bandwidth of no less than 1 kHz:

Frequency Range (MHz)	EIRP (dBm)
1164-1240	-85.3
1559-1610	-85.3

* §15.521 (c): Emissions from digital circuitry used to enable the operation of the UWB transmitter shall comply with the limits in §15.209, rather than the limits specified above for EIRP, provided it can be clearly demonstrated that those emissions from the UWB device are due solely to emissions from digital circuitry contained within the transmitter and that the emissions are not intended to be radiated from the transmitter's antenna.

* RSS-220 5.3.1. (c): Radiated emissions at or below 960 MHz from a device shall not exceed the limits. Measurements of radiated emissions at and below 960 MHz are to be made using a CISPR quasi-peak detector. CISPR measurement bandwidth specifications are to be used.

Frequency Range (MHz)	Field strength (µV/m)	Measurement distance (m)	E.i.r.p (dBmW)
0.009-0.490	2400/F(kHz)	300	10 log (17.28 / F ²) (F in KHz)
0.490-1.705	24000/F(kHz)	30	10 log (17.28 / F ²) (F in KHz)
1.705 - 30.0	30	30	-45.7
30 - 88	100	3	-55.2
88 - 216	150	3	-51.7
216 - 960	200	3	-49.2

Note: The emission limits for the bands 9-90 kHz and 110-490 kHz are based on measurements employing an average emissions detector.

* RSS-220 5.3.1. (d): Radiated emissions above 960 MHz from a device shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz.

Frequency Range (MHz)	EIRP (dBm) in a RBW of 1 MHz
960-1610	-75.3
1610-4750	-70.0
4750-10600	-41.3
Above 10600	-61.3

* RSS-220 5.3.1. (e): In addition to the radiated emission limits specified in the table above, radiated emissions shall not exceed the following average limits when measured using a resolution bandwidth greater than or equal to 1 kHz. The measurements shall demonstrate compliance with the stated limits at whatever resolution bandwidth is used.

Frequency Range (MHz)	EIRP (dBm)
1164-1240	-85.3
1559-1610	-85.3

* RSS-220 Annex. Section 4 (m): Emissions from digital circuitry (used only to enable the operation of the UWB transmitter and that does not control additional functions or capabilities) shall comply with the average and peak power limits applicable to the UWB transmitter. If it can be clearly demonstrated that an emission from a UWB transmitter is due solely to emissions from digital circuitry contained within the transmitter, and that the emission is not intended to be radiated from the transmitter's antenna, the limits for emissions from digital circuitry prescribed in RSS-Gen apply to that emission rather than the UWB limits.

METHOD:

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

The spectrum was scanned from 30 MHz to at least the 10th harmonic of the highest frequency of the co-located radios till 40 GHz.

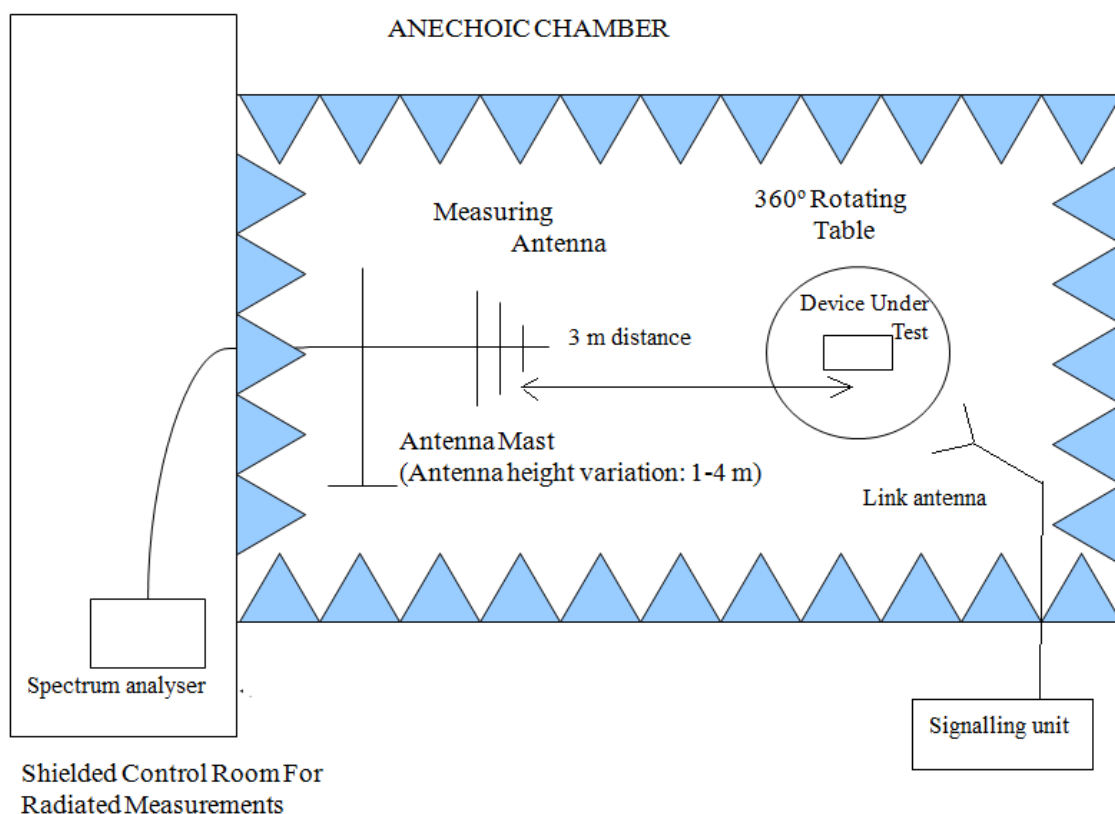
The measurement antenna is situated at a distance of 3 m for the frequency range 30 MHz-1000 MHz (30 MHz-1000 MHz Bilog Antenna) and at a distance of 1 m for the frequency range 1 GHz-40 GHz (1 GHz-17 GHz Double Ridge Horn Antenna and 17 GHz-40 GHz Horn Antenna).

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.

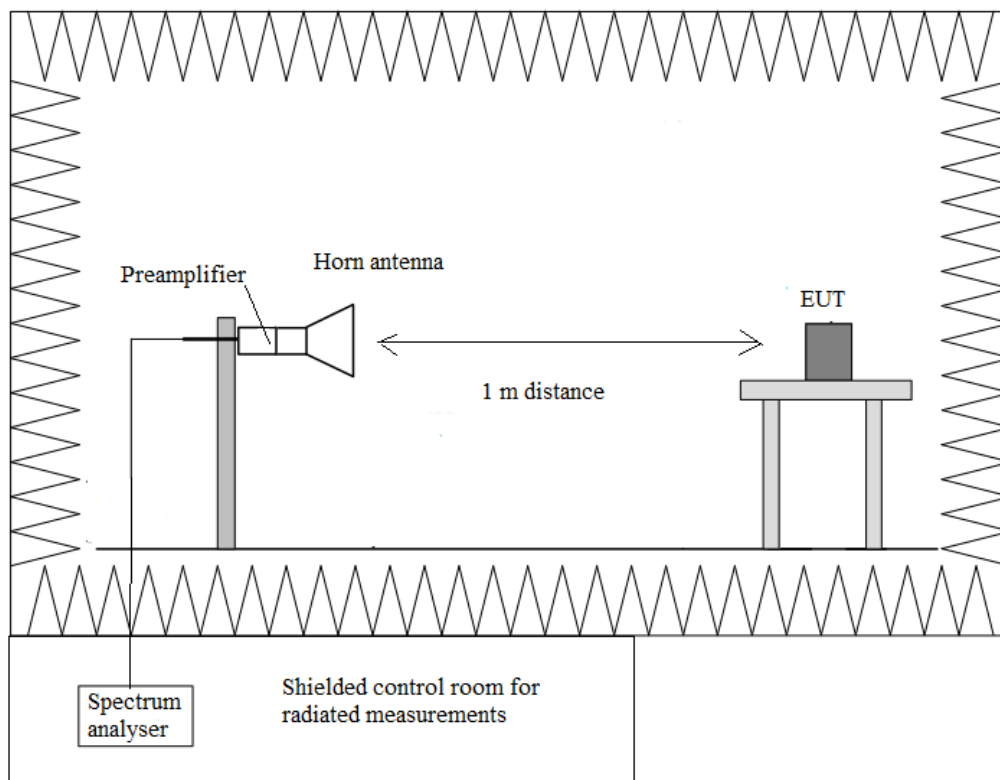
These measurements have been performed in order to check the impact of the Co-Location of all radio interfaces (that can be transmitting simultaneously).

TEST SETUP:

Radiated measurements below 1 GHz.



Radiated measurements setup $f > 1$ GHz:



RESULTS:

• Co-Location mode LTE Cat NB2 Band 2, UWB:

A preliminary scan determined as the worst-case:

LTE Cat NB2 Band 2: Pi/2-BPSK modulation, High Channel (1909.8 MHz). Tone Number 1, Tone Channel Bandwidth 15 kHz, TBS 0, Tone Offset 0.

UWB: Channel 2 (3993.6 MHz).

LIMIT: The spurious frequencies were measured at 3 meter. The limit of the test is determined by:

Frequency Range	Detector	Limit at 3m (dBm)
30 MHz to 19.1 GHz	Peak	$43 + 10 \log (P) \text{ dB} = -13 \text{ dBm}$
19.1 GHz to 40 GHz	RMS	-61.3 dBm

Frequency range 30 MHz - 1 GHz:

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

Frequency range 1 - 19.1 GHz:

Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (GHz)	E.I.R.P. (dBm)	Polarization	Detector
5.72925	-29.31	H	Peak
7.63875	-28	V	Peak

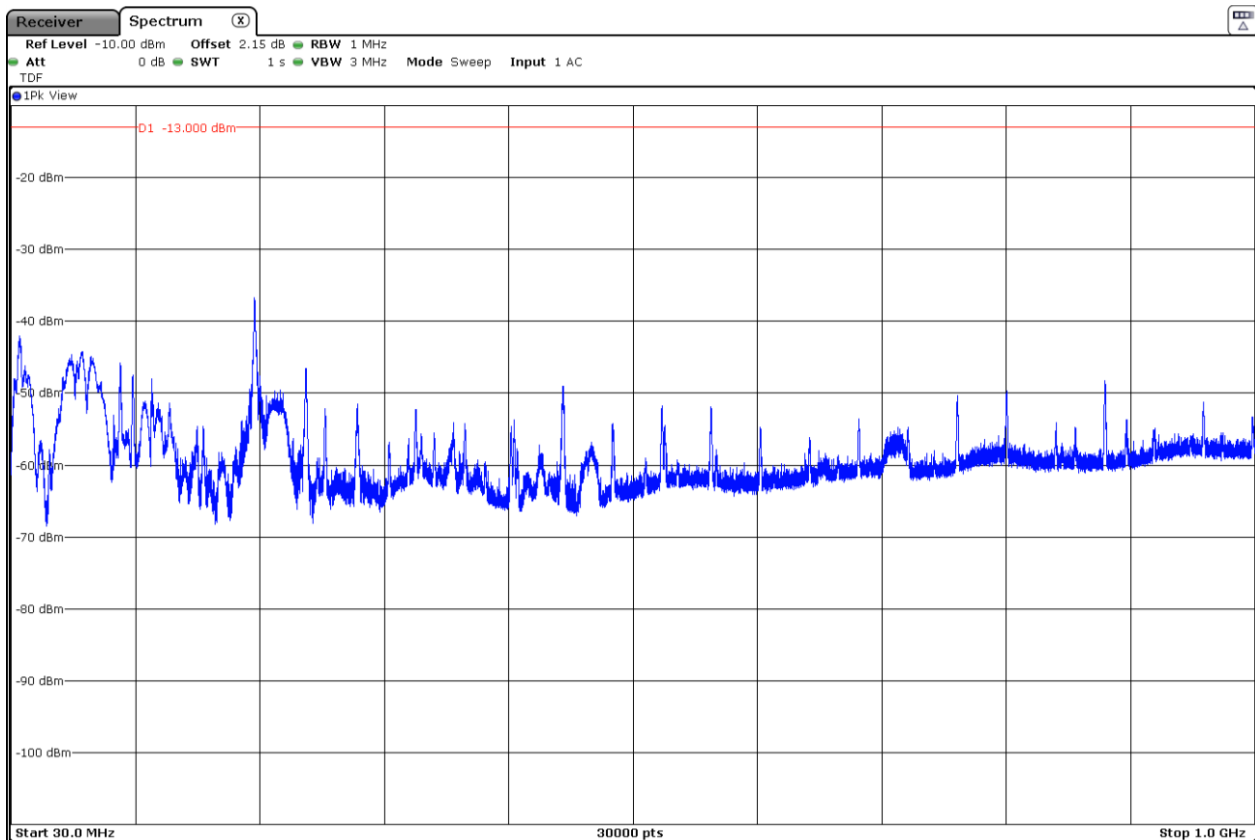
Frequency range 19.1 - 40 GHz:

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

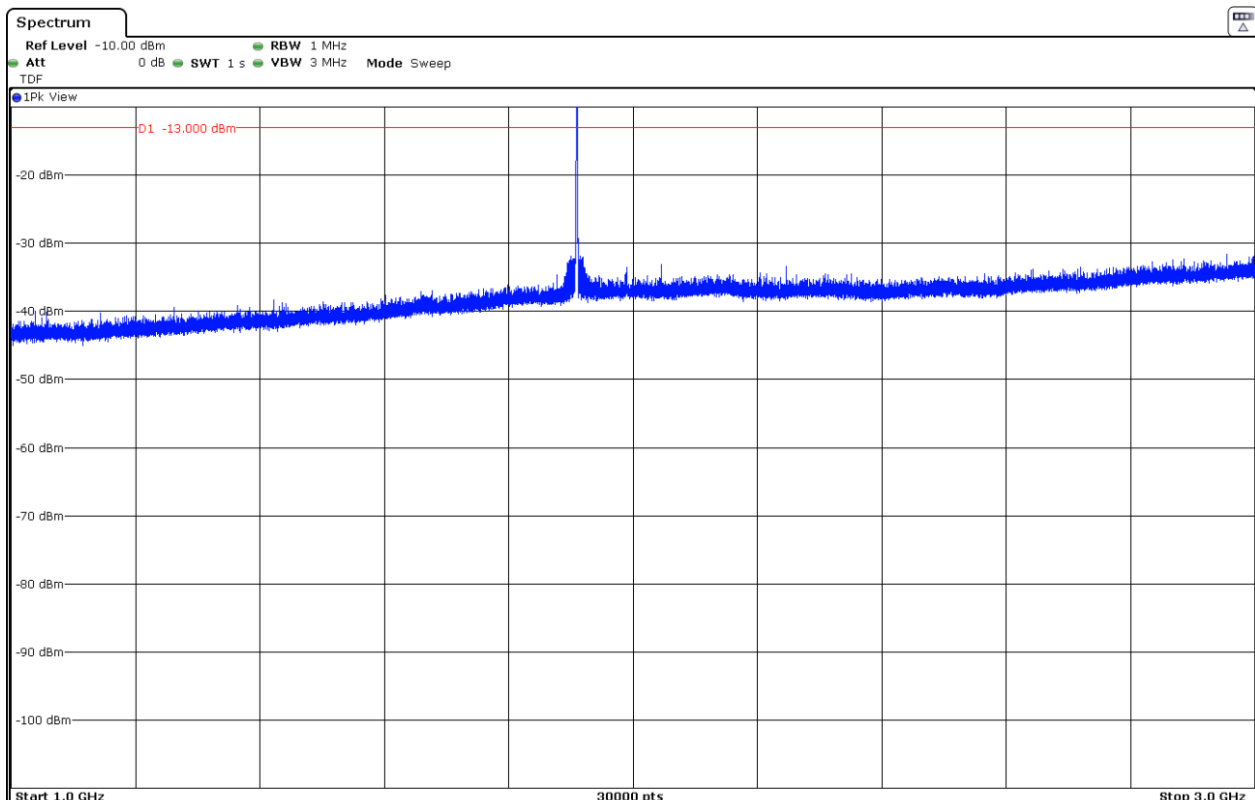
Measurement Uncertainty (dB)	$< \pm 5.08$ for $f < 1 \text{ GHz}$
	$< \pm 5.13$ for $f \geq 1 \text{ GHz}$ up to 17 GHz
	$< \pm 5.08$ for $f \geq 17 \text{ GHz}$ up to 26.5 GHz
	$< \pm 5.33$ for $f \geq 26.5 \text{ GHz}$ up to 40 GHz

Verdict: PASS

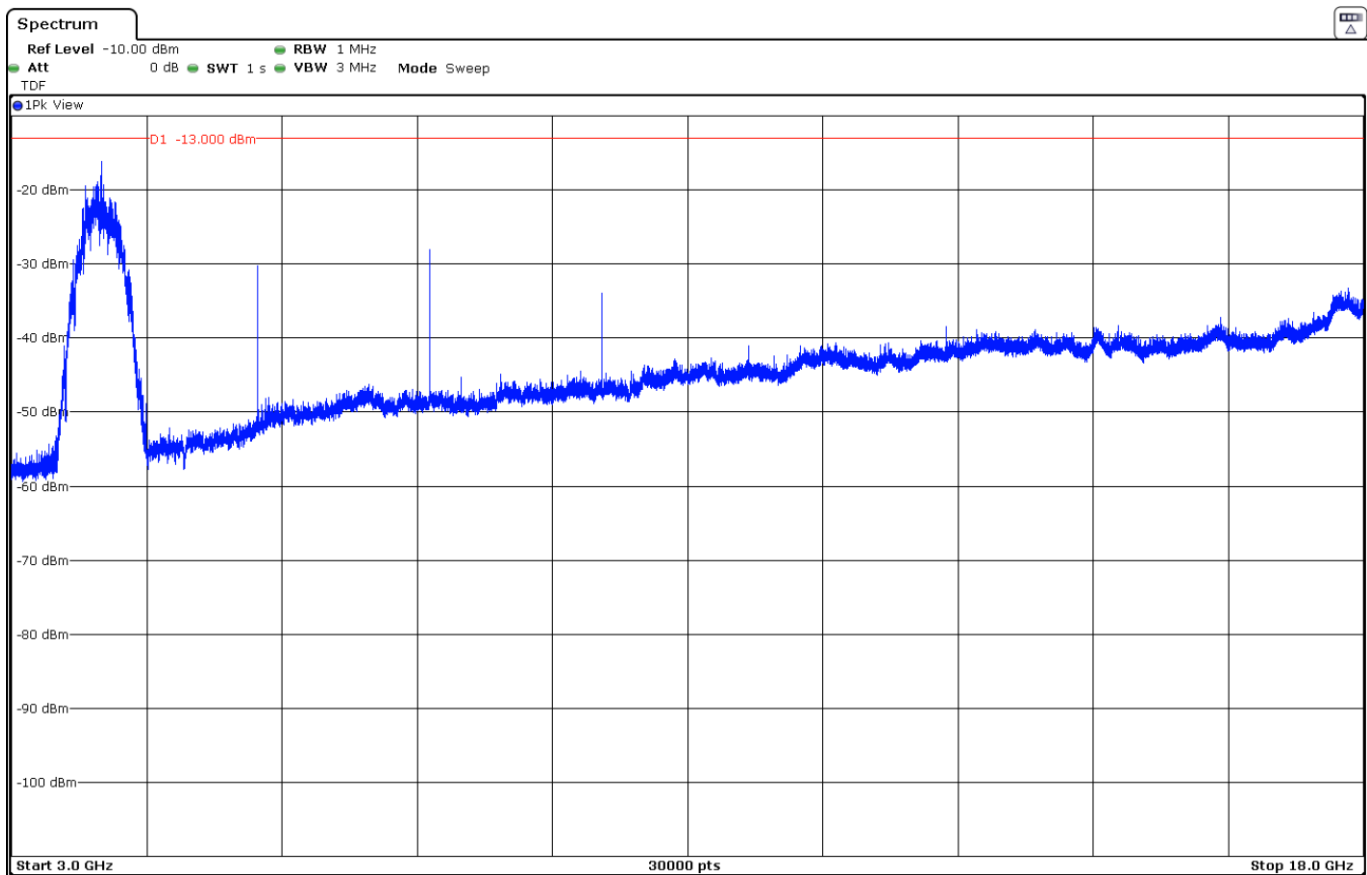
FREQUENCY RANGE 30 MHz - 1 GHz (worst-case):



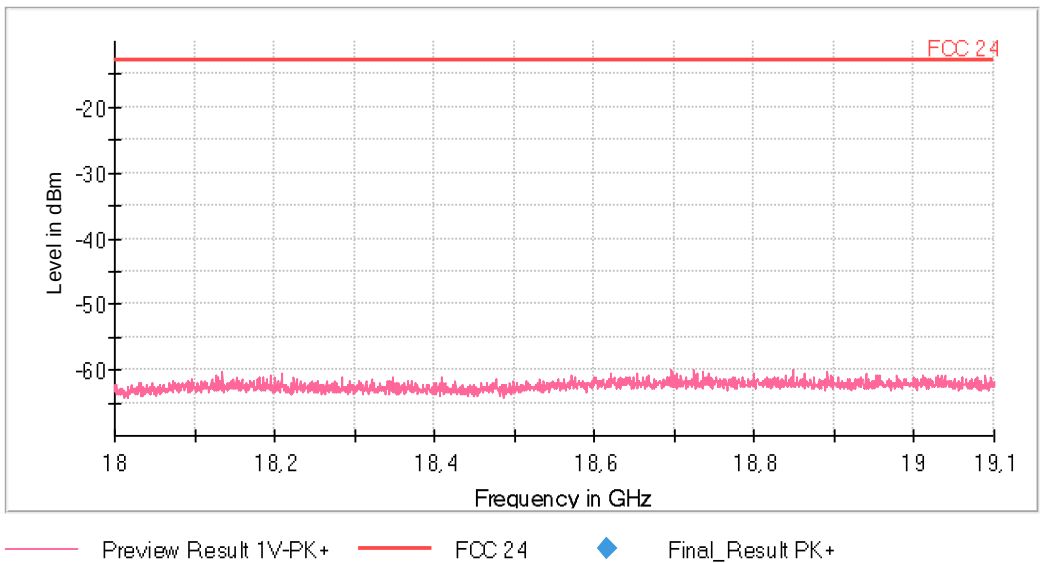
FREQUENCY RANGE 1 - 19.1 GHz (worst-case):



The peak above the limit is the carrier frequency LTE Cat NB2 Band 2 (1909.8 MHz).

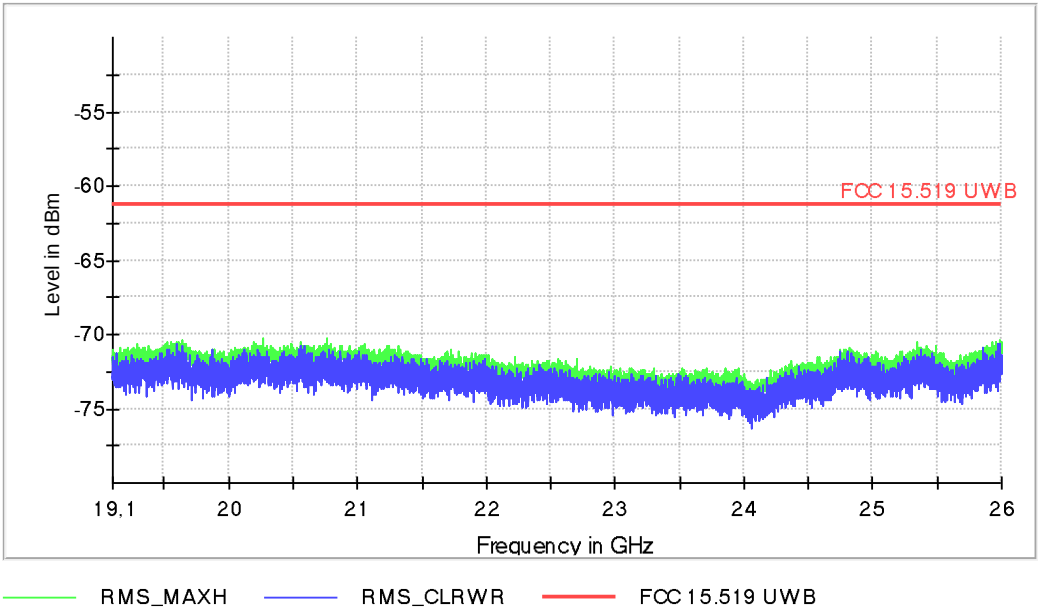


The wideband peak near the limit on the left is the carrier frequency UWB (3993.6 MHz).

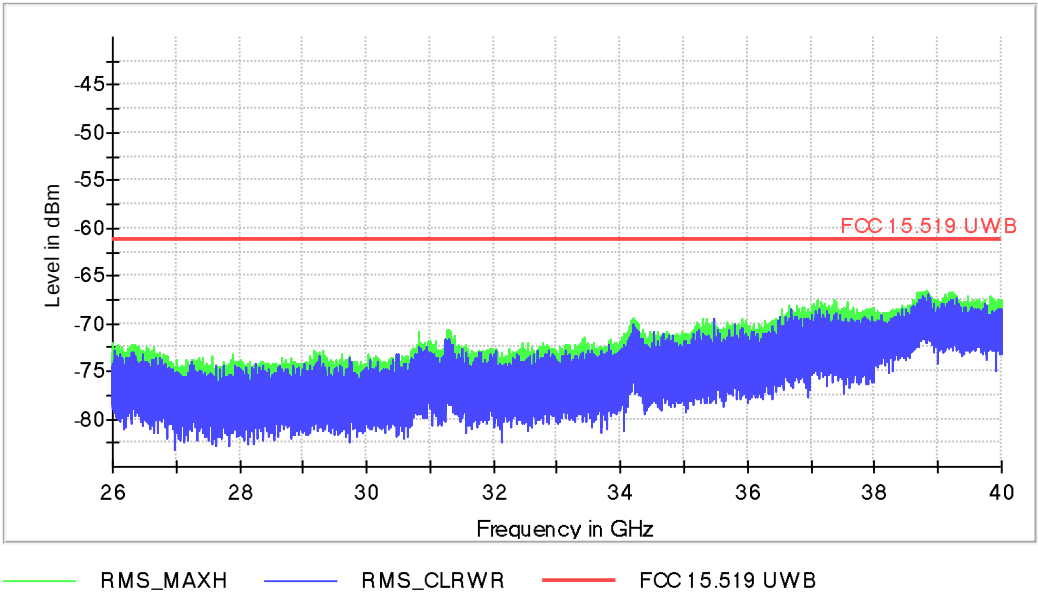


FREQUENCY RANGE 19.1 - 40 GHz (worst-case):

FCC 15.519_17GHz-26GHz



FCC 15.519_26GHz-40GHz



Appendix B: Test results FCC 27 / RSS-130, RSS-139

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TEST CONDITIONS

(*) Declared by the Applicant

POWER SUPPLY (*):

Vnominal: 24 Vdc
Type of Power Supply: External DC (vehicle battery).

ANTENNA (*):

UWB:
Type of Antenna: Integral (on board ceramic antenna).
Maximum Declared Gain: +6 dBi

CELLULAR:

MIDDLE Band	Maximum Declared Antenna Gain	Type of Antenna
LTE Cat NB2 Band 13	+6 dBi	External

LOW Band	Maximum Declared Antenna Gain	Type of Antenna
LTE Cat M1 Band 4	+6 dBi	External
LTE Cat M1 Band 12	+6 dBi	External

TEST FREQUENCIES:

CELLULAR LTE Cat NB2 (Band 13)		
Band:	LTE Cat NB2 Band 13	
Mode:	Pi/2-BPSK	
Transmit Channel:	Channel	Channel Frequency (MHz)
	Middle: 23230	782 MHz (Tone Number 1, Tone Channel BW 3.75 kHz, TBS 0, Tone Offset 0)

CELLULAR LTE Cat M1 (Bands 4, 12)		
Band:	LTE Cat M1 Band 4	
Frequency Range:	1710 – 1755 MHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	Middle: 20175	1732.5 MHz (QPSK , BW 20 MHz, RB Size 1, RB Offset 0, NB 0)
Band:	LTE Cat M1 Band 12	
Frequency Range:	699 – 716 MHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	Low: 23095	707.5 MHz (QPSK, BW 10 MHz, RB Size 1, RB Offset 0, NB 0)

	UWB	
Mode:	UWB	
Transmit Channel:	Channel	Channel Frequency (MHz)
	2	3993.6

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

Selected Transmission Modes for each Radio:

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

* Cellular LTE Cat NB2 Band 13: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in LTE Cat NB2 Band 13 on the middle channel. This channel was found to transmit higher Radiated Spurious Emission than all the other LTE Cat NB2 channels.

* Cellular LTE Cat M1 Band 4: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in Cellular LTE Cat M1 Band 4 on the middle channel as this channel was found to transmit higher Radiated Spurious Emission than all the other channels.

* Cellular LTE Cat M1 Band 12: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in Cellular LTE Cat M1 Band 12 on the low channel as this channel was found to transmit higher Radiated Spurious Emission than all the other channels.

* UWB: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in UWB / Channel 2 and UWB mode configuration.

TESTED SIMULTANEOUS TRANSMISSION MODES:

* **Co-Location mode LTE Cat NB2 Band 13, UWB**, with the EUT configured to simultaneously transmit two signals at maximum output power, Cellular LTE Cat NB2 Band 13 / Middle Channel and UWB / Channel 2.

* **Co-Location mode LTE Cat M1 Band 4, UWB**, with the EUT configured to simultaneously transmit two signals at maximum output power, Cellular LTE Cat M1 Band 4 / Middle Channel and UWB / Channel 2.

* **Co-Location mode LTE Cat M1 Band 12, UWB**, with the EUT configured to simultaneously transmit two signals at maximum output power, Cellular LTE Cat M1 Band 12 / Low Channel and UWB / Channel 2.

Emission Limitations Radiated

SPECIFICATION:

1. LTE Cat NB2 Band 13. FCC §2.1053 & §27.53 (c) (2) (4) & (f) / RSS-130 Issue 2 Clause 4.7.1. & 4.7.2.

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 2 Clause 4.7.1 and 4.7.2:

4.7.1. 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 $43 + 10 \log_{10} p$ (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.

4.7.2. In addition to the limit outlined in section 4.7.1 above, equipment operating in the frequency bands 746-756 MHz and 777-787 MHz shall also comply with the following restrictions:

a. the power of any unwanted emissions in any 6.25 kHz bandwidth for all frequencies between 763-775 MHz and 793-806 MHz shall be attenuated below the transmitter power, P (dBW), by at least:

i. $76 + 10 \log_{10} p$ (watts), dB, for base and fixed equipment and

ii. $65 + 10 \log_{10} p$ (watts), dB, for mobile and portable equipment

b. the e.i.r.p. in the band 1559-1610 MHz shall not exceed -70 dBW (-40 dBm) /MHz for wideband signal and -80 dBW (-50 dBm) for discrete emission with bandwidth less than 700 Hz.

2. LTE Cat M1 Band 4. FCC §2.1053 & §27.53 (h) / RSS-139 Issue 3 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 MHz, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least $43 + 10 \log_{10} (P)$ 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 $43 + 10 \log_{10} p$ (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 $43 + 10 \log_{10} P$ (watts) dB.

LTE Cat M1 Band 4 MEASUREMENT LIMIT:

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

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

3. LTE Cat M1 Band 12. FCC §2.1053 & §27.53 (g) / RSS-130 Issue 2 Clause 4.7.1. & 4.7.2.

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 2 Clause 4.7.1 and 4.7.2:

4.7.1. 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 $43 + 10 \log_{10} p$ (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.

4.7.2. In addition to the limit outlined in section 4.7.1 above, equipment operating in the frequency bands 746-756 MHz and 777-787 MHz shall also comply with the following restrictions:

a. the power of any unwanted emissions in any 6.25 kHz bandwidth for all frequencies between 763-775 MHz and 793-806 MHz shall be attenuated below the transmitter power, P (dBW), by at least:

- i. $76 + 10 \log_{10} p$ (watts), dB, for base and fixed equipment and
- ii. $65 + 10 \log_{10} p$ (watts), dB, for mobile and portable equipment

b. the e.i.r.p. in the band 1559-1610 MHz shall not exceed -70 dBW/MHz for wideband signal and -80 dBW for discrete emission with bandwidth less than 700 Hz.

4. UWB. The radiated emissions at or below 960 MHz shall not exceed the emission levels in §15.209:

Frequency Range (MHz)	Field strength ($\mu\text{V/m}$)	Field strength ($\text{dB}\mu\text{V/m}$)	Measurement distance (m)
0.009-0.490	$2400/F(\text{kHz})$	-	300
0.490-1.705	$24000/F(\text{kHz})$	-	30
1.705 - 30.0	30	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
Above 960	500	54	3

* §15.519 (c): The radiated emissions at or below 960 MHz from a device operating under the provisions of this section shall not exceed the emission levels in § 15.209. The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz:

Frequency Range (MHz)	EIRP (dBm)
960-1610	-75.3
1610-1990	-63.3
1990-3100	-61.3
3100-10600	-41.3
Above 10600	-61.3

* §15.519 (d): In addition to the radiated emission limits specified in the table above, UWB transmitters shall not exceed the following average limits when measured using a resolution bandwidth of no less than 1 kHz:

Frequency Range (MHz)	EIRP (dBm)
1164-1240	-85.3
1559-1610	-85.3

* §15.521 (c): Emissions from digital circuitry used to enable the operation of the UWB transmitter shall comply with the limits in §15.209, rather than the limits specified above for EIRP, provided it can be clearly demonstrated that those emissions from the UWB device are due solely to emissions from digital circuitry contained within the transmitter and that the emissions are not intended to be radiated from the transmitter's antenna.

* RSS-220 5.3.1. (c): Radiated emissions at or below 960 MHz from a device shall not exceed the limits. Measurements of radiated emissions at and below 960 MHz are to be made using a CISPR quasi-peak detector. CISPR measurement bandwidth specifications are to be used.

Frequency Range (MHz)	Field strength (µV/m)	Measurement distance (m)	E.i.r.p (dBmW)
0.009-0.490	2400/F(kHz)	300	10 log (17.28 / F ²) (F in KHz)
0.490-1.705	24000/F(kHz)	30	10 log (17.28 / F ²) (F in KHz)
1.705 - 30.0	30	30	-45.7
30 - 88	100	3	-55.2
88 - 216	150	3	-51.7
216 - 960	200	3	-49.2

Note: The emission limits for the bands 9-90 kHz and 110-490 kHz are based on measurements employing an average emissions detector.

* RSS-220 5.3.1. (d): Radiated emissions above 960 MHz from a device shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz.

Frequency Range (MHz)	EIRP (dBm) in a RBW of 1 MHz
960-1610	-75.3
1610-4750	-70.0
4750-10600	-41.3
Above 10600	-61.3

* RSS-220 5.3.1. (e): In addition to the radiated emission limits specified in the table above, radiated emissions shall not exceed the following average limits when measured using a resolution bandwidth greater than or equal to 1 kHz. The measurements shall demonstrate compliance with the stated limits at whatever resolution bandwidth is used.

Frequency Range (MHz)	EIRP (dBm)
1164-1240	-85.3
1559-1610	-85.3

* RSS-220 Annex. Section 4 (m): Emissions from digital circuitry (used only to enable the operation of the UWB transmitter and that does not control additional functions or capabilities) shall comply with the average and peak power limits applicable to the UWB transmitter. If it can be clearly demonstrated that an emission from a UWB transmitter is due solely to emissions from digital circuitry contained within the transmitter, and that the emission is not intended to be radiated from the transmitter's antenna, the limits for emissions from digital circuitry prescribed in RSS-Gen apply to that emission rather than the UWB limits.

METHOD:

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

The spectrum was scanned from 30 MHz to at least the 10th harmonic of the highest frequency of the co-located radios till 40 GHz.

The measurement antenna is situated at a distance of 3 m for the frequency range 30 MHz-1000 MHz (30 MHz-1000 MHz Bilog Antenna) and at a distance of 1 m for the frequency range 1 GHz-40 GHz (1 GHz-17 GHz Double Ridge Horn Antenna and 17 GHz-40 GHz Horn Antenna).

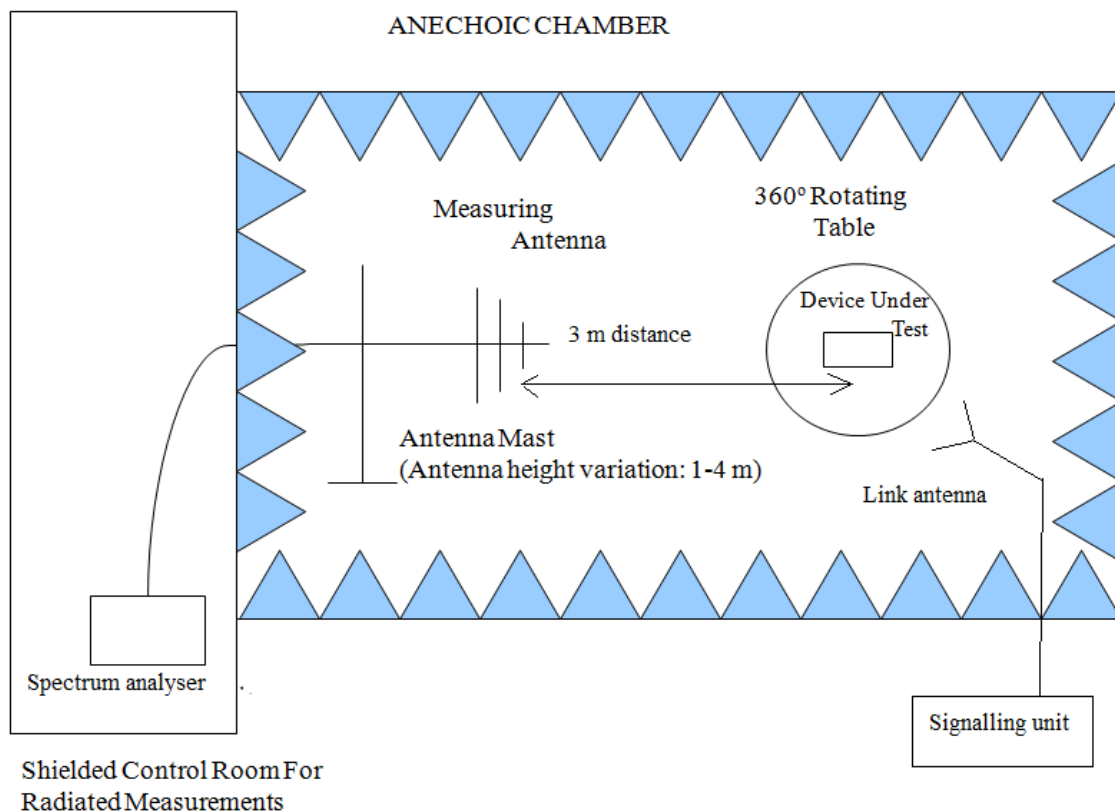
Detected emissions were maximized at each frequency by rotating the EUT and adjusting the measuring antenna height and polarization. The maximum meter reading was recorded.

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.

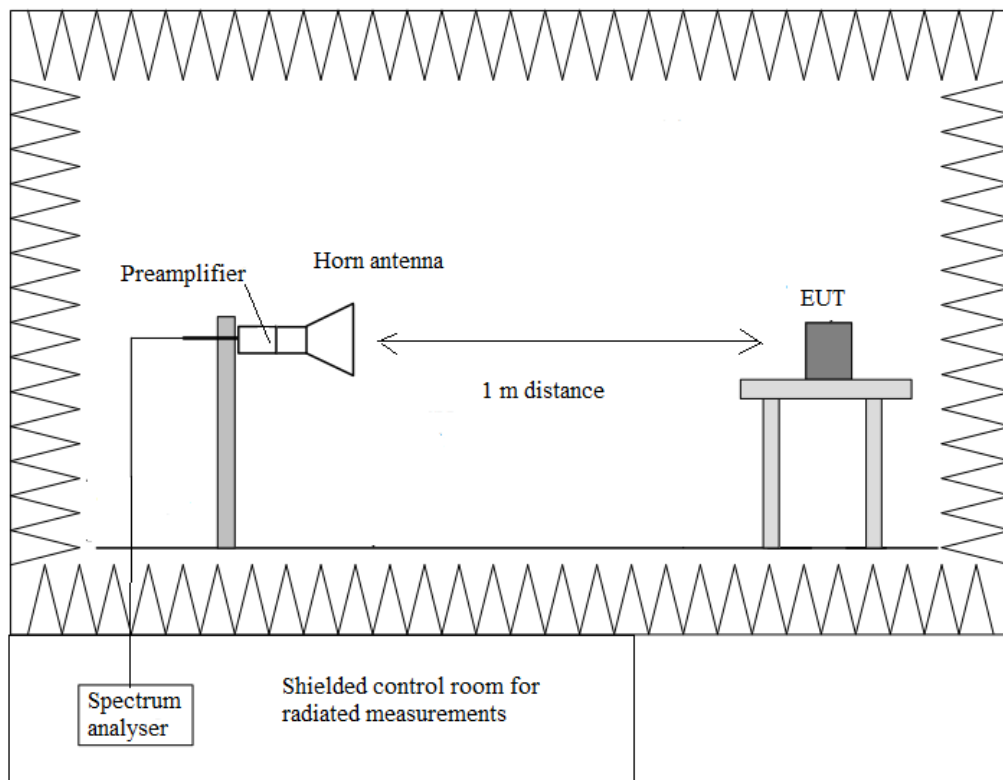
These measurements have been performed in order to check the impact of the Co-Location of all radio interfaces (that can be transmitting simultaneously).

TEST SETUP:

Radiated measurements below 1 GHz.



Radiated measurements setup above 1GHz:



RESULTS:

• Co-Location mode LTE Cat NB2 Band 13, UWB.

A preliminary scan determined as the worst-case:

LTE Cat NB2 Band 13: Pi/2-BPSK, Tone Number 1, Tone Channel BW 3.75 kHz, TBS 0, Tone Offset 0.
UWB: Channel 2 (3993.6 MHz).

LIMIT: The spurious frequencies were measured at 3 meter. The limit of the test is determined by:

Frequency Range	Detector	Limit at 3m (dBm)
30 MHz to 7.87 GHz	Peak	$43 + 10 \log (P) \text{ dB} = -13 \text{ dBm}$
1.559-1.610 GHz	RMS	-40 dBm
7.87 GHz to 10.6 GHz	RMS	-41.3 dBm
10.6 GHz to 40 GHz	RMS	-61.3 dBm

Frequency range 30 MHz - 1 GHz:

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

Frequency range 1 - 8 GHz:

Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (GHz)	E.I.R.P. (dBm)	Polarization	Detector
1.5637456	-42.29	V	RMS
2.3457500	-31.45	H	Peak

Frequency range 8 - 40 GHz:

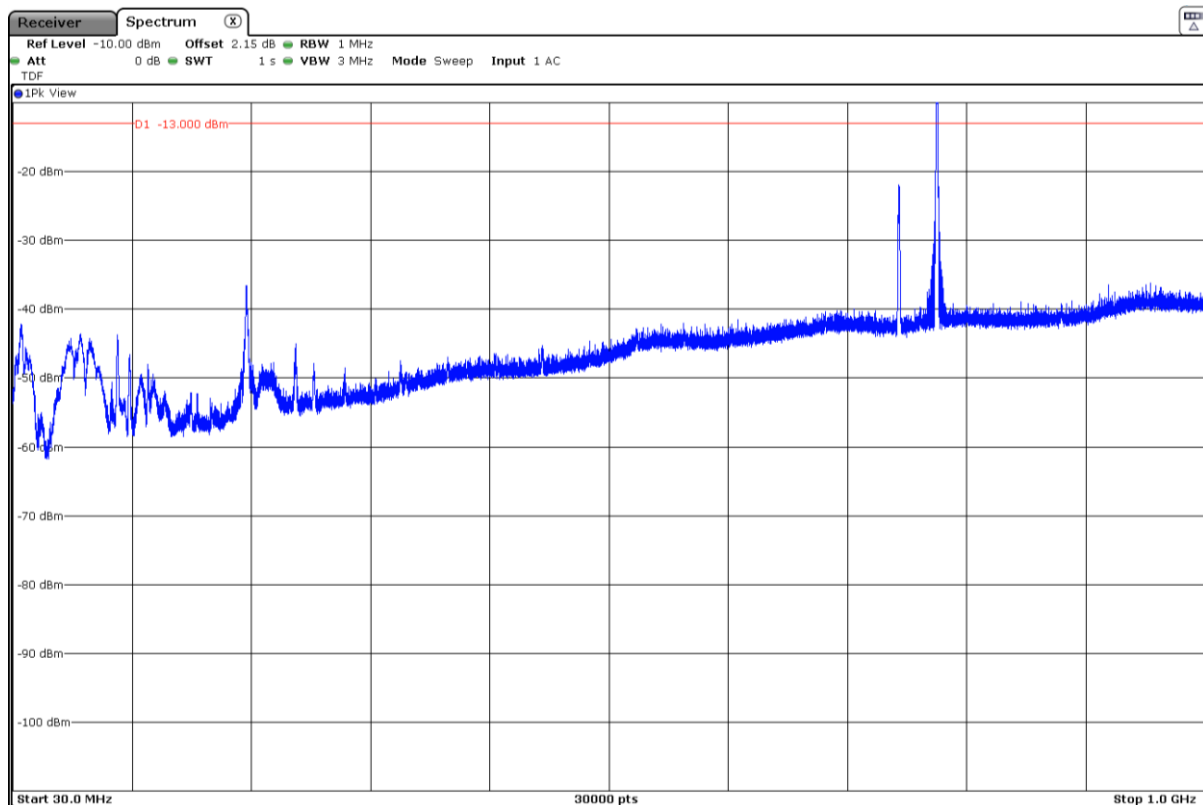
No spurious frequencies at less than 20 dB below the limit.

Measurement Uncertainty (dB)

- <±5.08 for $f < 1 \text{ GHz}$
- <±5.13 for $f \geq 1 \text{ GHz}$ up to 17 GHz
- <±5.08 for $f \geq 17 \text{ GHz}$ up to 26.5 GHz
- <±5.33 for $f \geq 26.5 \text{ GHz}$ up to 40 GHz

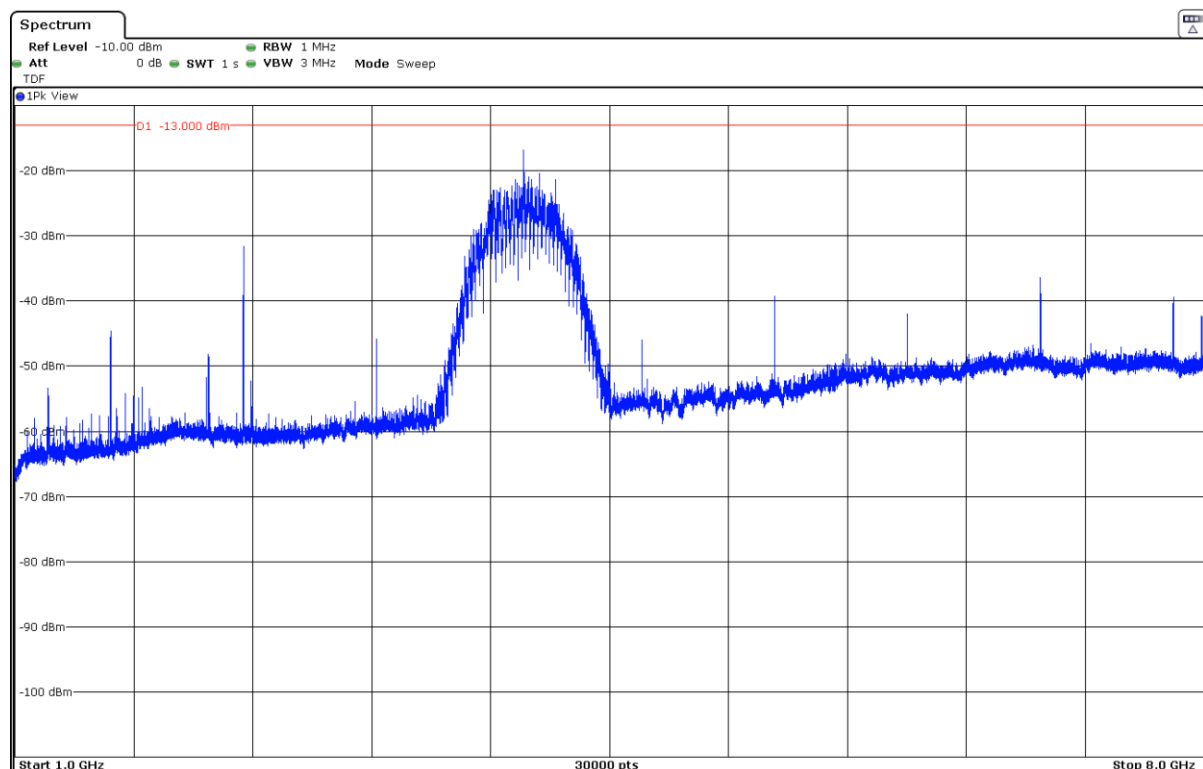
Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz (worst-case):



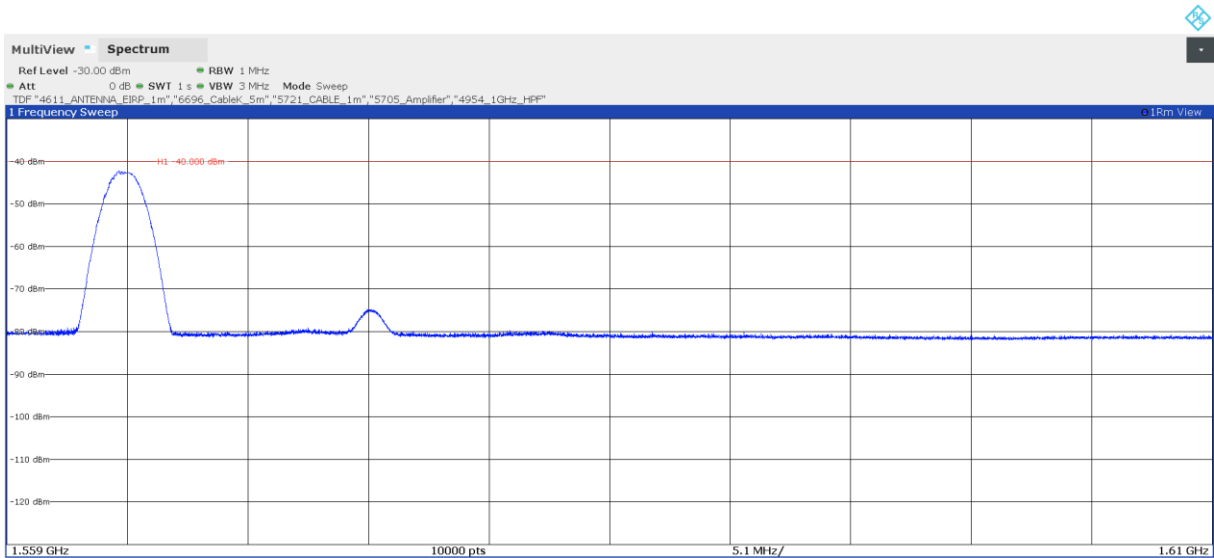
The peak above the limit is the carrier frequency LTE Cat NB2 Band 13 (782 MHz). The other peak near the limit is the carrier frequency downlink.

FREQUENCY RANGE 1 - 8 GHz (worst-case):

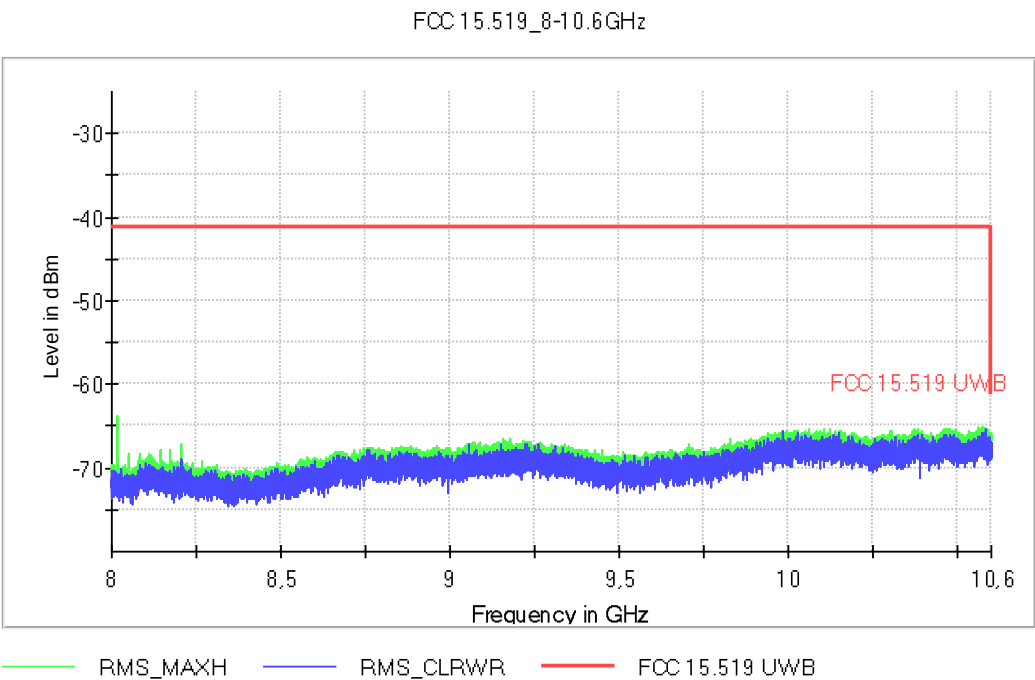


The peak near the limit is the carrier frequency UWB (3993.6 MHz).

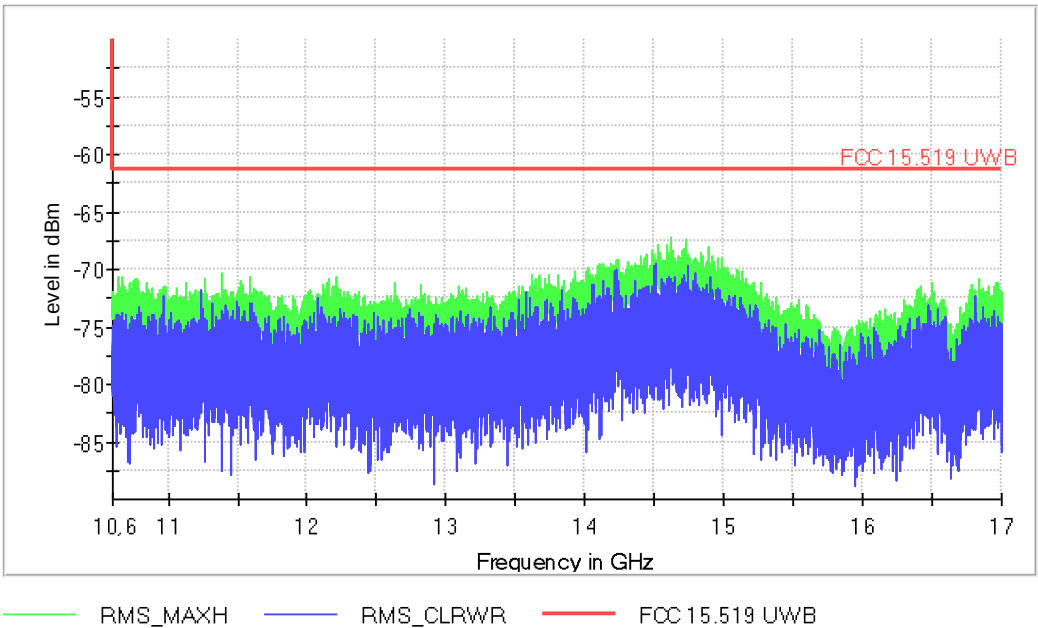
FREQUENCY RANGE 1.559-1.610 GHz:



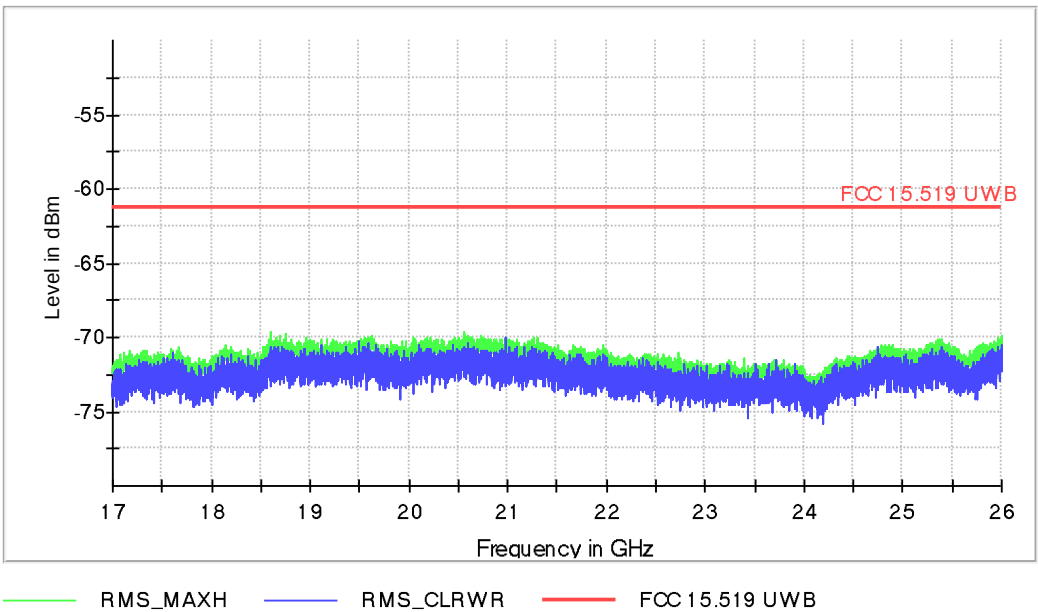
FREQUENCY RANGE 8 - 40 GHz (worst-case):



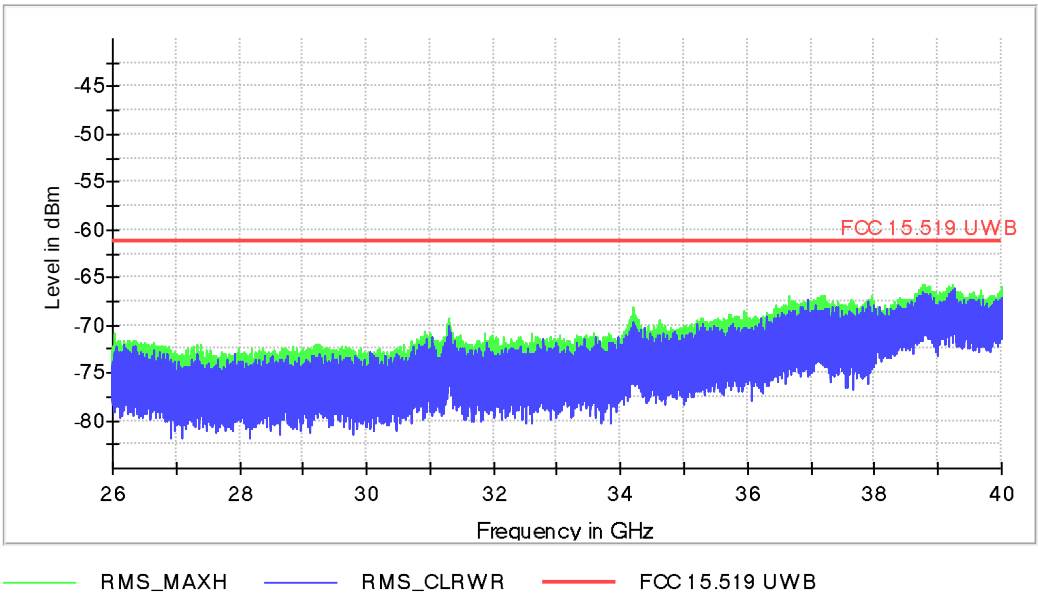
FCC 15.519_10.6-17GHz RBW 100kHz



FCC 15.519_17GHz-26GHz



FCC 15.519_26GHz-40GHz



- **Co-Location mode LTE Cat M1 Band 4, UWB.**

A preliminary scan determined as the worst-case:

LTE Cat M1 Band 4: QPSK modulation, Middle Channel (1732.5 MHz). BW 20 MHz, RB Size 1. RB Offset 0, NB 0.

UWB: Channel 2 (3993.6 MHz).

LIMIT: The spurious frequencies were measured at 3 meter. The limit of the test is determined by:

Frequency Range	Detector	Limit at 3m (dBm)
30 MHz to 17.55 GHz	Peak	$43 + 10 \log (P) \text{ dB} = -13 \text{ dBm}$
17.55 GHz to 40 GHz	RMS	-61.3 dBm

Frequency range 30 MHz - 1 GHz:

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

Frequency range 1 - 18 GHz

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

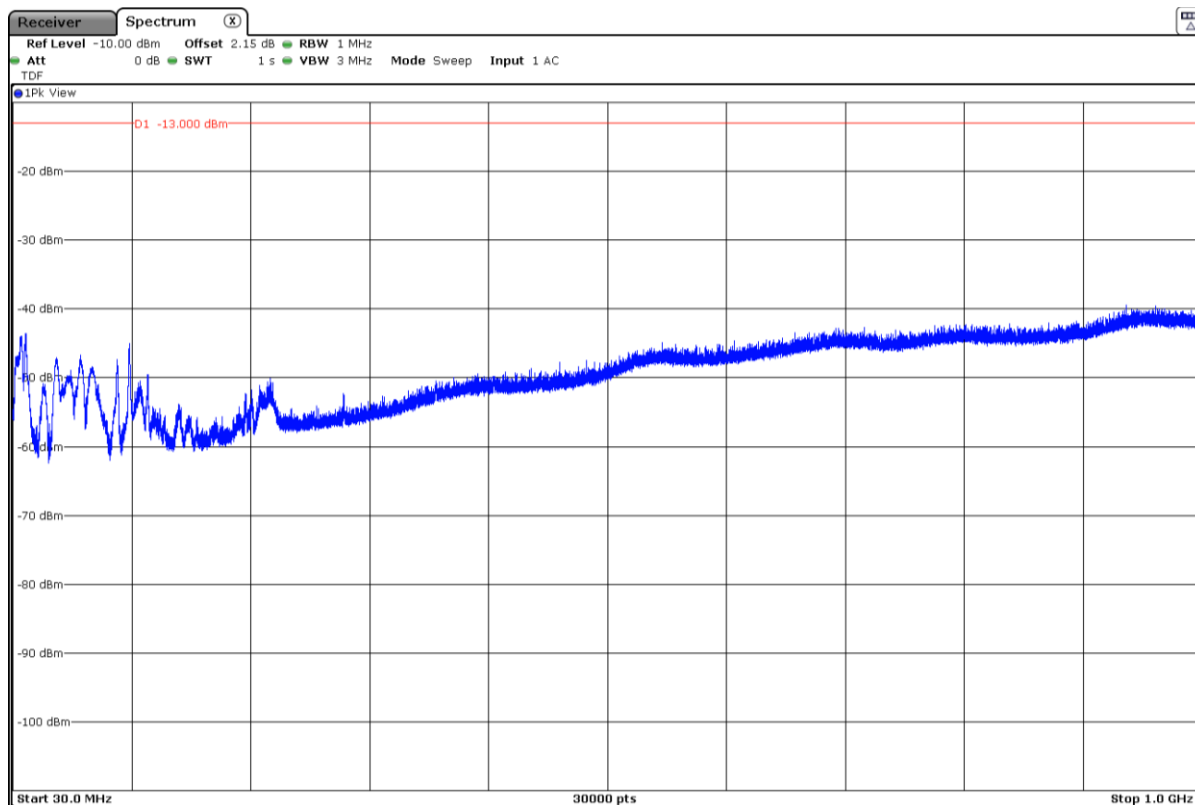
Frequency range 18 - 40 GHz

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

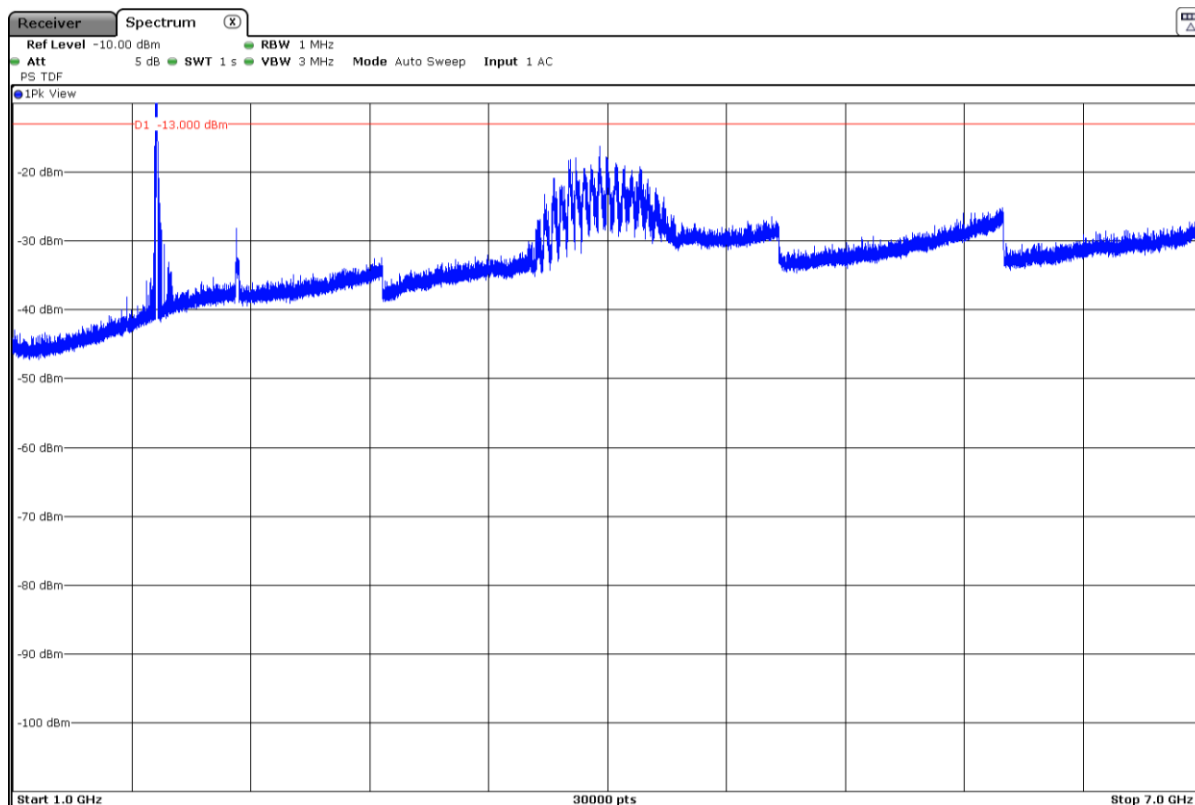
Measurement Uncertainty (dB)	$<\pm 5.08$ for $f < 1 \text{ GHz}$
	$<\pm 5.13$ for $f \geq 1 \text{ GHz}$ up to 17 GHz
	$<\pm 5.08$ for $f \geq 17 \text{ GHz}$ up to 26.5 GHz
	$<\pm 5.33$ for $f \geq 26.5 \text{ GHz}$ up to 40 GHz

Verdict: PASS

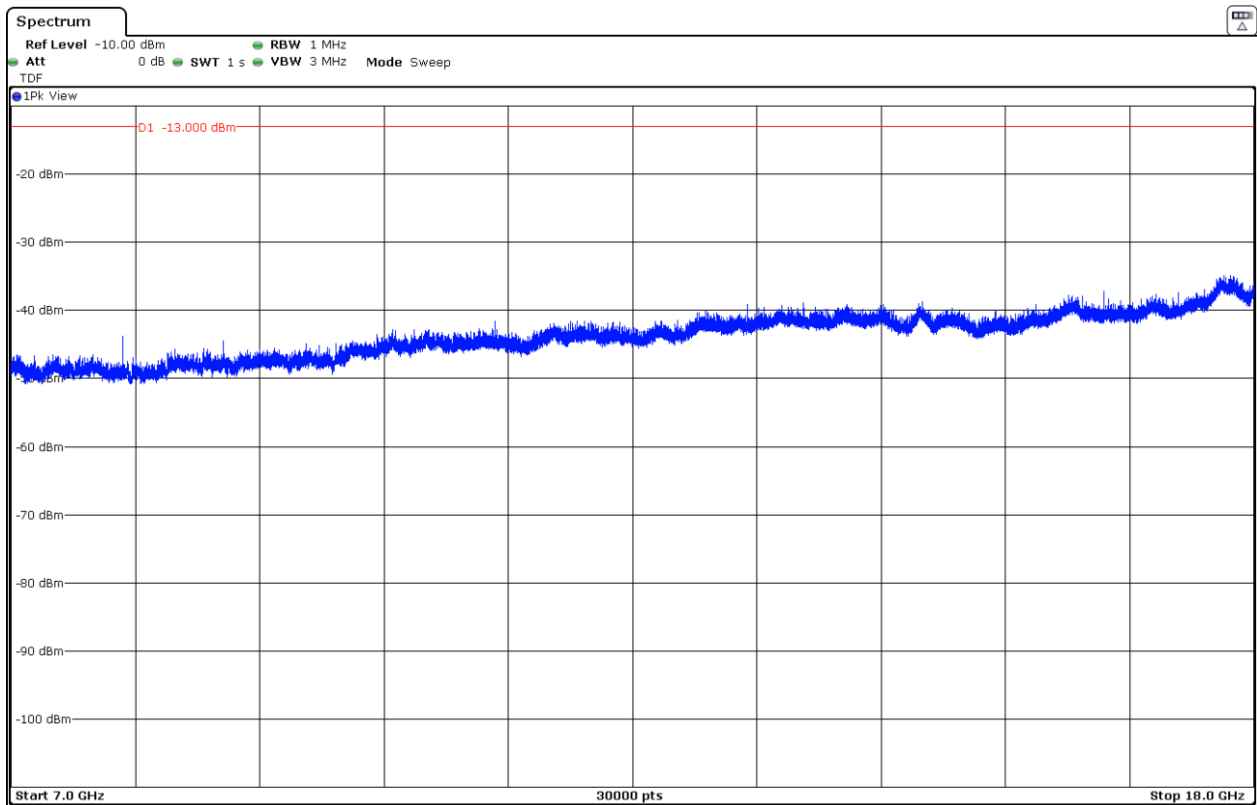
FREQUENCY RANGE 30 MHz - 1 GHz (worst-case):



FREQUENCY RANGE 1 - 18 GHz (worst-case):

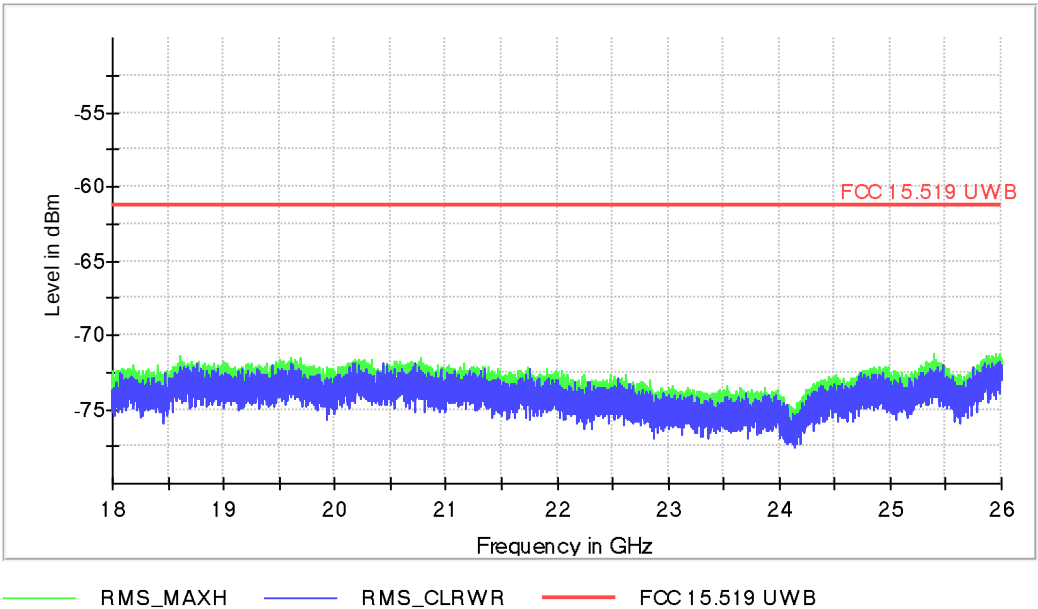


The peak above the limit on the left is the carrier frequency LTE Cat M1 Band 4 (1732.5 MHz). The peak near the limit on the middle is the downlink of LTE Cat M1 Band 4 (1732.5 MHz). The wideband peak near the limit is the carrier frequency UWB.

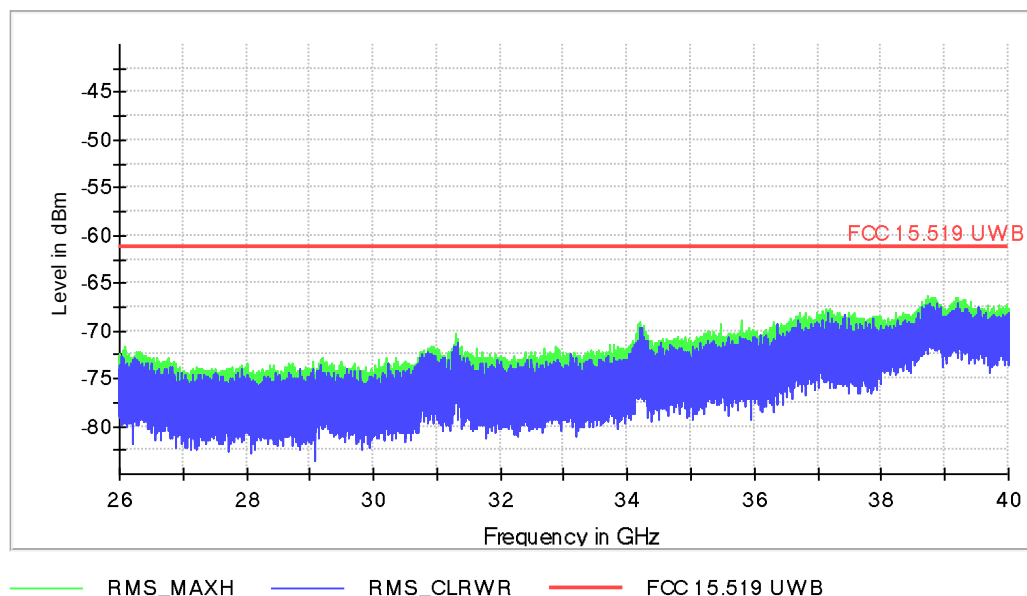


FREQUENCY RANGE 18 - 40 GHz (worst-case):

FCC 15.519_17GHz-26GHz



FCC 15.519_26GHz-40GHz



- **Co-Location mode LTE Cat M1 Band 12, UWB.**

A preliminary scan determined as the worst-case:

LTE Cat M1 Band 12: QPSK modulation, Middle Channel (707.5 MHz). BW 10 MHz, RB Size 1, RB Offset 0, NB 0.

UWB: Channel 2 (3993.6 MHz).

LIMIT: The spurious frequencies were measured at 3 meter. The limit of the test is determined by:

Frequency Range	Detector	Limit at 3m (dBm)
30 MHz to 7.16 GHz	Peak	$43 + 10 \log (P) \text{ dB} = -13 \text{ dBm}$
7.16 GHz to 10.6 GHz	RMS	-41.3 dBm
10.6 GHz to 40 GHz	RMS	-61.3 dBm

Frequency range 30 MHz - 1 GHz:

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

Frequency range 1 - 7.16 GHz:

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

Frequency range 7.16 - 40 GHz:

Spurious frequencies at less than 20 dB below the limit:

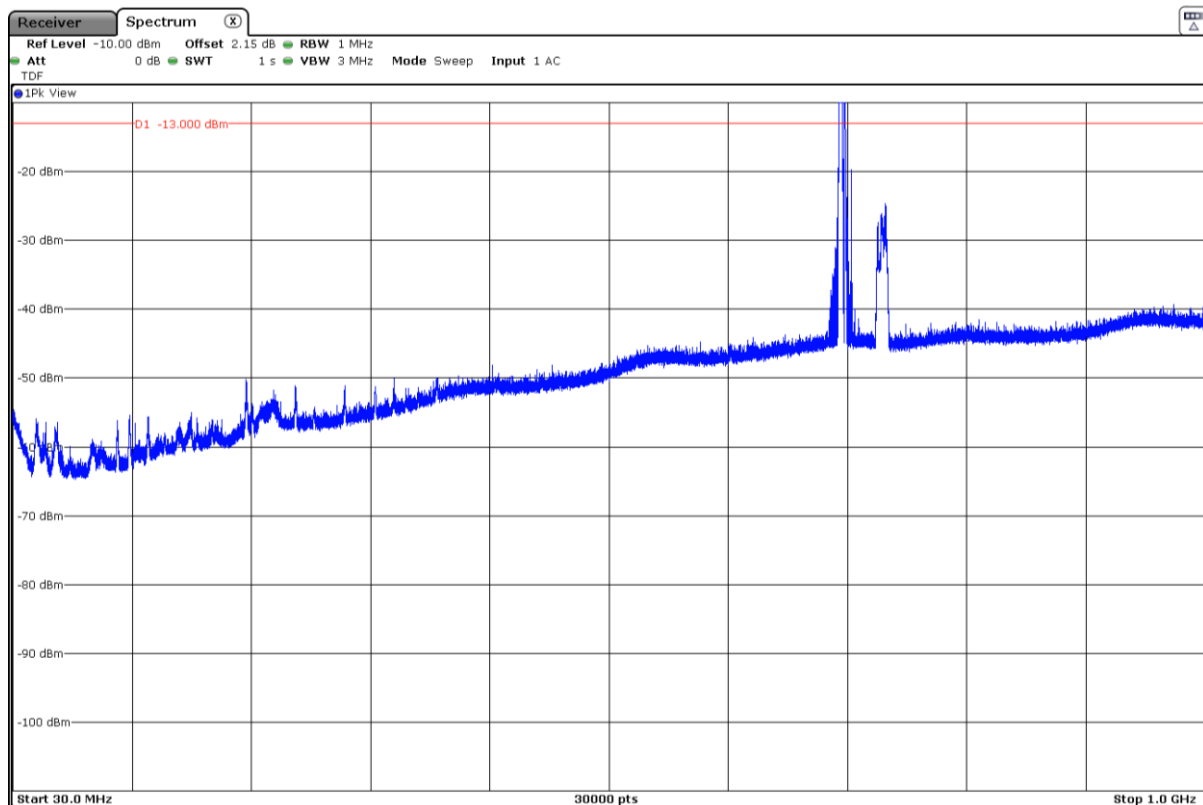
Spurious frequency (GHz)	E.I.R.P. (dBm)	Polarization	Detector
7.98575	-42.48	V	Peak

Measurement Uncertainty (dB)

- <±5.08 for $f < 1 \text{ GHz}$
- <±5.13 for $f \geq 1 \text{ GHz}$ up to 17 GHz
- <±5.08 for $f \geq 17 \text{ GHz}$ up to 26.5 GHz
- <±5.33 for $f \geq 26.5 \text{ GHz}$ up to 40 GHz

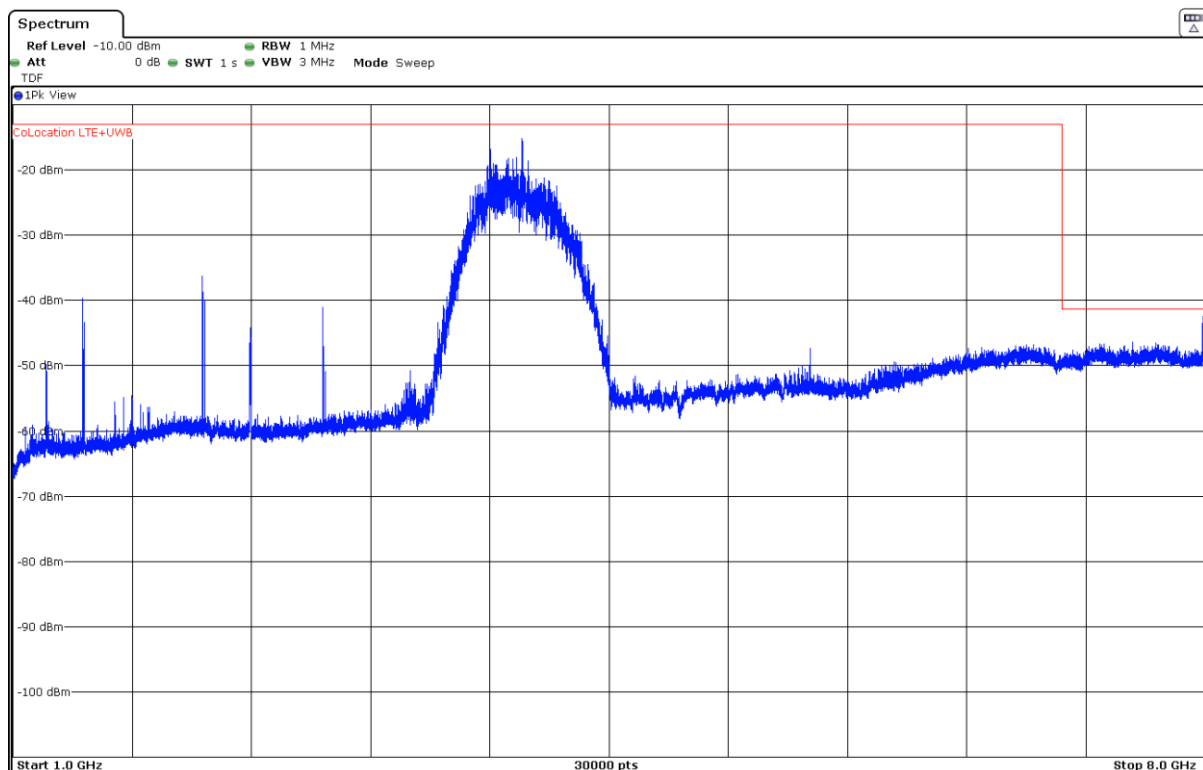
Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz (worst-case):



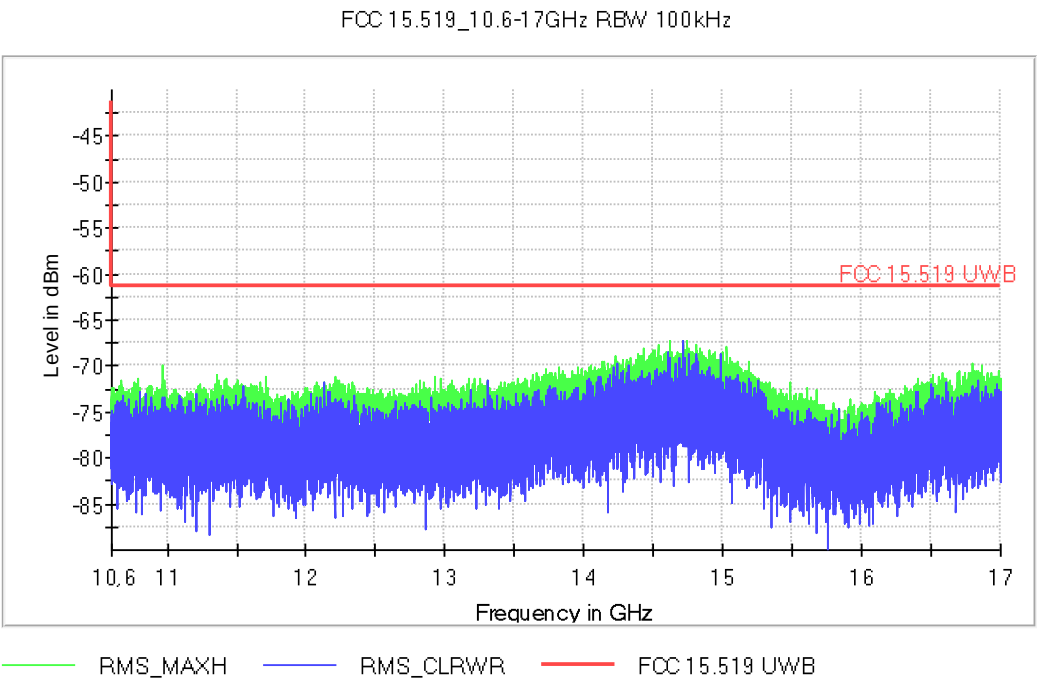
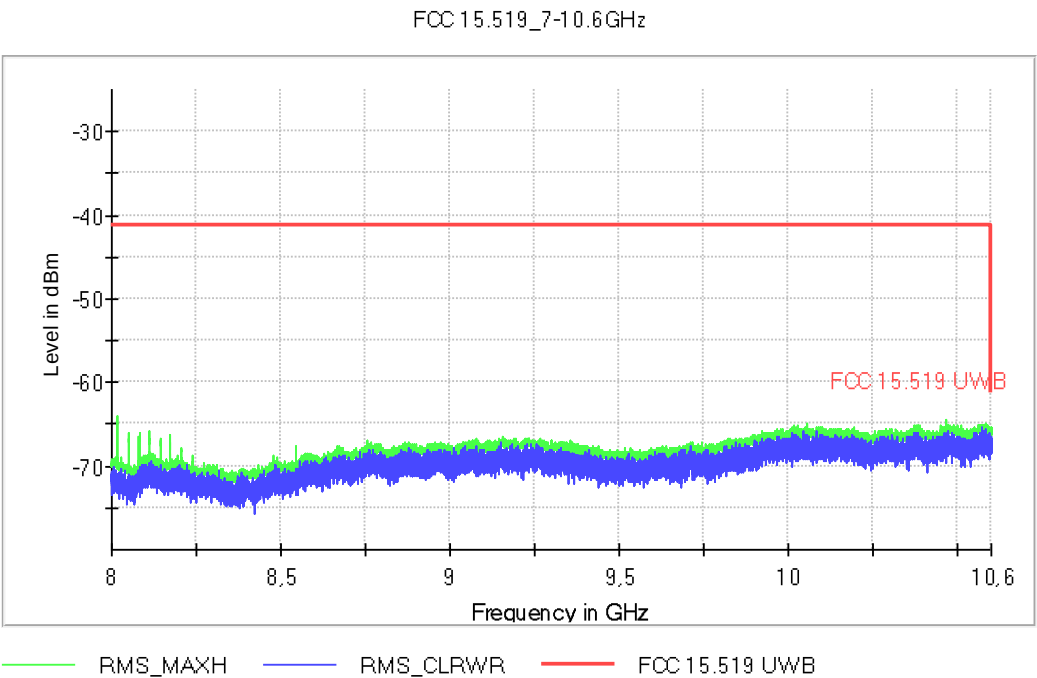
The peak above the limit is the carrier frequency LTE Cat M1 Band 12 (707.5 MHz). The other peak near the limit is the downlink signal of LTE Cat M1 Band12.

FREQUENCY RANGE 1 - 8 GHz (worst-case):

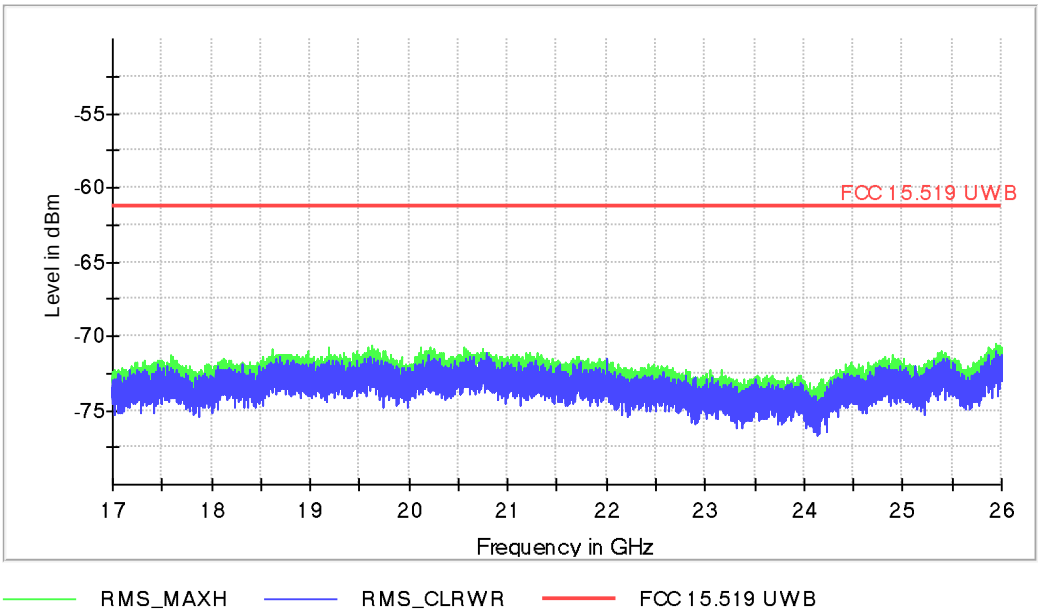


The peak above the limit is the carrier frequency UWB (3993.6 MHz).

FREQUENCY RANGE 8 - 40 GHz (worst-case):



FCC 15.519_17GHz-26GHz



FCC 15.519_26GHz-40GHz

