



Test report No:
NIE: 64195RRF.006

Partial Test Report

USA FCC 15.31(h), 22, 24, 27, 90, 15.209, 15.247,
15.231

CANADA RSS-130, RSS-132, RSS-133, RSS-139,
RSS-247, RSS-Gen, RSS-210

(*) Identification of item tested	Telematics Control Unit for trucks with TPMS support, GSM, BLE, LF Transmitter and GNSS receiver
(*) Trademark	LDL Technology
(*) Model and /or type reference	19239
Other identification of the product	HW version: 319-158-2090 SW version: 414069191013 FCC ID: T4519239 IC: 6450A-19239 Cell module FCC ID: RI7ME910C1WW Cell module IC: 5131A-ME910C1WW IMEI TAC: 35308109
(*) Features	Bluetooth LE, RF 434, GSM/LTE, GNSS receiver
Applicant	LDL TECHNOLOGY Parc Technologique du Canal, 3 rue Giotto, 31520, Ramonville-Saint-Agne, FRANCE
Test method requested, standard	USA FCC Part 15.31(h) (10-1-19 Edition): Measurement standard. USA FCC Part 22 (10-1-19 Edition): Public Mobile Services. USA FCC Part 24 (10-1-19 Edition): Personal Communications Services. USA FCC Part 27 (10-1-19 Edition): Miscellaneous Wireless Communications Services. USA FCC Part 90 (10-1-19 Edition): Private Land Mobile Radio Services. USA FCC Part 15.209 (10-1-19 Edition): Radiated emission limits; general requirements. USA FCC Part 15.247 (10-1-19 Edition): Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz. USA FCC Part 15.231 (10-1-19 Edition): Periodic operation in the band 40.66-40.70 MHz and above 70 MHz. CANADA RSS-130 Issue 2, Feb 2019. CANADA RSS-132 Issue 3, Jan. 2013.

	CANADA RSS-133 Issue 6 Amendment 1, Jan. 2018. CANADA RSS-139 Issue 3, Jul. 2015. CANADA RSS-Gen Issue 5 (March 2019). CANADA RSS-247 Issue 2 (February 2017). -Transmitter out of band radiated emissions with simultaneous transmissions. CANADA RSS-210 Issue 10 (December 2019). Licence-Exempt Radio Apparatus: Category I Equipment. 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. KDB 971168 D01 Power Meas License Digital Systems v03r01, April. 2018. ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices. ANSI C63.26-2015. ANSI/TIA-603-E: 2016.
Approved by (name / position & signature)	José Carlos Luque RF Lab. Supervisor
Date of issue	2020-09-28
Report template No	FDT08_22 (*) "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.

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General conditions

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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 19239 is a system that aims to offer telematic services and the device acts like gateway, receiving and transmitting data.

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°	Date of reception
64195C/028	Telematics Control Unit	19239	9d99E039	2020-06-01
64195C/020	Harness	--	--	2020-03-25
64195C/013	Metallic mounting bracket	--	--	2020-03-25

Sample S/01 has undergone the test(s): The Radiated tests indicated in the Appendixes A, B, C.

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

Control N°	Description	Model	Serial N°	Date of reception
64195C/005	Telematics Control Unit	19239	--	2020-03-25
64195C/024	Harness	--	--	2020-03-25
64195C/013	Metallic mounting bracket	--	--	2020-03-25

Sample S/02 has undergone the test(s): The Radiated tests indicated in the Appendixes D and E.

Test sample description

Ports..... :	Port name and description	Cable					
		Specified max length [m]	Attached during test	Shielded	Coupled to patient ⁽³⁾		
	Power and data (RS232) test cable	1	☒	☐	☐		
			☐	☐	☐		
			☐	☐	☐		
			☐	☐	☐		
			☐	☐	☐		
			☐	☐	☐		
Supplementary information to the ports..... :							
Rated power supply	Voltage and Frequency		Reference poles				
			L1	L2	L3	N	PE
	☐	AC:	☐	☐	☐	☐	☐
	☐	AC:	☐	☐	☐	☐	☐
	☒	DC: nominal 12V/24V (according to vehicle battery)					
☒	DC: tolerated range: 8 to 32V						
Rated Power	12W						

Clock frequencies.....:	8MHz, 32 MHz, 32.768 KHz, 16 MHz		
Other parameters			
Software version	414069191013		
Hardware version	319-158-2090		
Dimensions in cm (W x H x D)	18 x 6.5 x 13		
Mounting position	☐ Table top equipment ☐ Wall/Ceiling mounted equipment ☐ Floor standing equipment ☐ Hand-held equipment ☒ Other: attached to provided bracket, mounted on vehicle		
Modules/parts.....:	Module/parts of test item	Type	Manufacturer
	TCU 1.2 4G Autolocation	EUT	LDL Technology
	TCU 1.2 Bracket	Metallic mounting bracket	LDL Technology
Accessories (not part of the test item)	Description	Type	Manufacturer
Documents as provided by the applicant	Description	File name	Issue date

⁽³⁾ Only for Medical Equipment

Identification of the client

LDL TECHNOLOGY
Parc Technologique du Canal, 3 rue Giotto, 31520, Ramonville-Saint-Agne, FRANCE

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2020-06-04
Date (finish)	2020-07-27

Document history

Report number	Date	Description
64195RRF.006	2020-09-28	First release.

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: Cristina Calle, Francisco Jesús Olmo and Nicolás Salguero.

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 30 MHz - 6 GHz ETS LINDGREN 3142E	2020/04	2023/04
4. Pre-Amplifier G>40dB 10MHz-6GHz, BONN ELEKTRONIK, BLNA 0160-01N	2020/02	2021/02
5. EMI Test Receiver 7 GHz ROHDE AND SCHWARZ ESR7	2019/10	2021/10
6. Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500	2020/04	2021/04
7. DC Power Supply, 30V/5A KEYSIGHT TECHNOLOGIES U8002A	N.A.	N.A.
8. Digital Multimeter FLUKE 175	2019/10	2020/10
9. Horn antenna 1-18 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9120 D	2019/11	2022/11
10. Broadband Horn Antenna 18 - 40 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9170	2018/07	2021/07
11. RF Pre-amplifier, 40 dB ,1-18 GHz BONN ELEKTRONIK BLMA 0118-1M	2020/05	2021/05
12. Low Noise Amplifier G>30dB, 18 - 40 GHz BONN ELEKTRONIK BLMA 1840-1M	2019/02	2021/02
13. Signal and Spectrum Analyzer 10 Hz - 40 GHz ROHDE AND SCHWARZ FSV40	2019/09	2021/09
14. Spectrum Analyzer ROHDE AND SCHWARZ FSW50	2020/07	2022/07
15. Active Loop Antenna HEWLETT PACKARD 11966A	2020/07	2022/07

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-Gen / RSS-210 PARAGRAPH		
Requirement – Test case	Verdict	Remark
FCC 15.31 (h), 15.209 (a), 15.247 (d) / RSS-Gen 8.9, RSS-247 5.5. FCC 22.917 / RSS-132 5.5 FCC 24.238 / RSS-133 6.5 FCC 27.53 / RSS-139 6.6, RSS-130 4.6 FCC 90.691 FCC 15.231 (e), 15.209 (a) / RSS-Gen 8.9., RSS-210 A.1.2. Emission limitations radiated (Transmitter)	P	(1)
<u>Supplementary information and remarks:</u> (1) Only Co-location radiated spurious emission test was measured.		

Appendix A: Test results FCC 22 & 90, 15.247, 15.209 / RSS-132, RSS-247

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TEST CONDITIONS

POWER SUPPLY (V):

V nominal: 12 Vdc

Type of Power Supply: DC external (car battery).

ANTENNA:

Type of Antennas: Internal (SMD).

Maximum Declared Gain for Bluetooth LE: +2.2 dBi

Maximum Declared Gain for CELLULAR:

LOW Bands	GAIN	ANTENNA TYPE
LTE Band 5	+3.5 dBi	Internal (SMD)
LTE Band 26	+3.5 dBi	Internal (SMD)

TEST FREQUENCIES:

Based on preliminary testing that identified those corresponding to the worst cases (with the highest E.I.R.P.):

	CELLULAR LTE Bands 5, 26	
Band:	LTE Band 5	
Frequency Range:	824 – 849 MHz	
Channel Spacing:	200 KHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	Low: 20425	826.5 MHz
Band:	LTE Band 26	
Frequency Range:	824 – 849 MHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	Middle: 26865	831.5 MHz
Band:	LTE Band 26	
Frequency Range:	814 – 824 MHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	High: 26790	824 MHz

	Bluetooth LE	
Mode:	GFSK	
Channel Spacing:	1 MHz	
Frequency Range:	2400 MHz to 2483.5 MHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	Middle: 17	2440

The test set-up was made in accordance to the general provisions of FCC DTS Measurement 558074 D01 DTS Meas Guidance v05r02 dated April 2, 2019.

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: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in:

Cellular LTE Band 5 / Low Channel configuration.

Cellular LTE Band 26 / range 824-849 MHz (BW=15 MHz) in the Middle Channel configuration.

Cellular LTE Band 26 / range 814-824 MHz in the High Channel configuration.

These channels were found to transmit higher EIRP than all the other LTE channels.

* Bluetooth Low Energy: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in Bluetooth Low Energy / Middle Channel and GFSK mode configuration.

TESTED SIMULTANEOUS TRANSMISSION MODES:

* **Co-location mode LTE Band 5, Bluetooth Low Energy**, with the EUT configured to simultaneously transmit two signals at maximum output power, Cellular LTE Band 5 / Low Channel and Bluetooth Low Energy / Middle Channel and GFSK.

* **Co-location mode LTE Band 26 range 824-849 MHz, Bluetooth Low Energy**, with the EUT configured to simultaneously transmit two signals at maximum output power, Cellular LTE Band 26 range 824-849 MHz / (BW=15 MHz) Middle Channel and Bluetooth Low Energy / Middle Channel and GFSK.

* **Co-location mode LTE Band 26 range 814-824 MHz, Bluetooth Low Energy**, with the EUT configured to simultaneously transmit two signals at maximum output power, Cellular LTE Band 26 range 814-824 MHz / High Channel and Bluetooth Low Energy / Middle Channel and GFSK.

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
Above 960	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 5 and LTE Band 26 (range 824-849 MHz). 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 $43 + 10 \log_{10} p$ (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 $43 + 10 \log_{10} p$ (watts). If the measurement is performed using 1% of the occupied bandwidth, power integration over 100 kHz is required.

2. LTE Band 26 (range 814-824 MHz). FCC §2.1051, §90.691.

FCC §2.1051, §90.691:

Emission mask requirements for EA-based systems.

For any frequency removed from the EA licensee's frequency block greater than 37.5 kHz, the power of any emission shall be attenuated below the transmitter power (P) in watts by at least $43 + 10 \log_{10}(P)$ decibels or 80 decibels, whichever is the lesser attenuation, where f is the frequency removed from the center of the outer channel in the block in kilohertz and where f is greater than 37.5 kHz.

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 26 GHz.

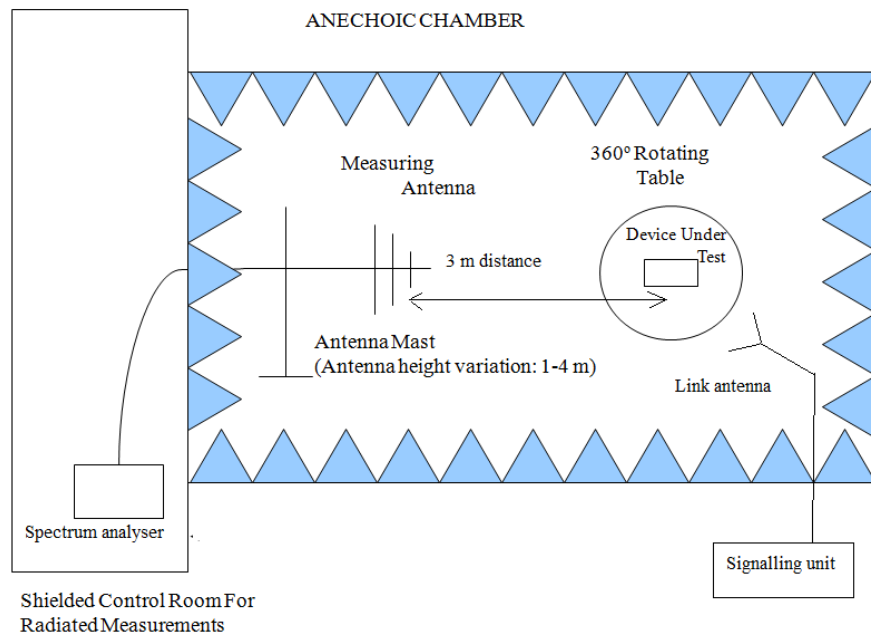
The EUT was placed on a non-conductive stand at a 3 meter distance from the measuring antenna. Detected emissions were maximized at each frequency by rotating the EUT and adjusting the measuring antenna height and polarization. The maximum meter reading was recorded.

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.

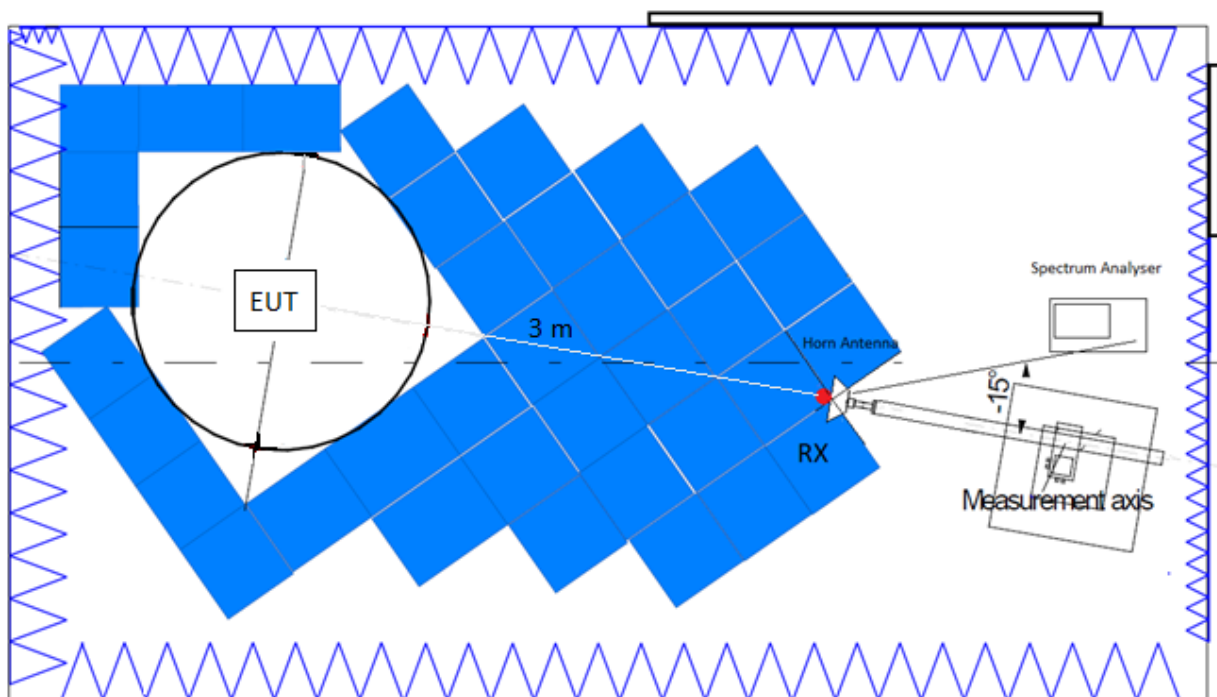
These measurements have been performed in order to check the impact of the Co-Location of all radio interfaces (that can be transmitting simultaneously).

TEST SETUP:

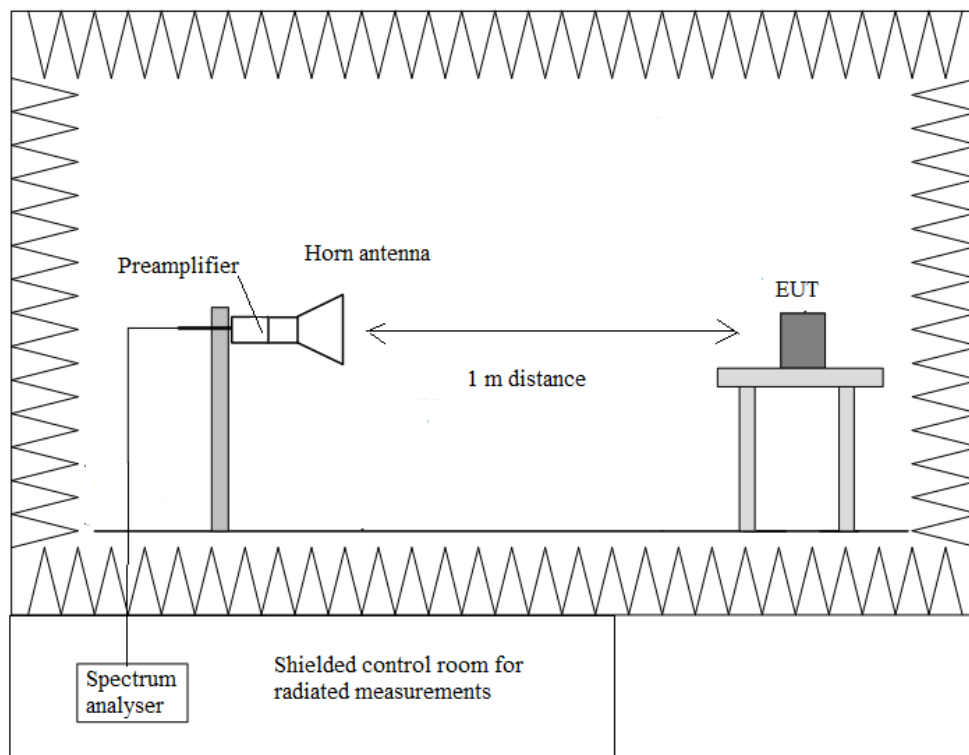
Radiated measurements below 1 GHz.



Radiated measurements setup from 1GHz to 17 GHz:



Radiated measurements setup $f > 17$ GHz:



RESULTS:

• Co-Location mode LTE Band 5, Bluetooth Low Energy:

QPSK & 16QAM:

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

LTE Band 5: BW: 5 MHz. Low Channel (826.5 MHz). RB Size: 1. RB Offset: 0.
Bluetooth Low Energy: Middle Channel (2440 MHz). GFSK.

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

Frequency Range	Detector	Limit at 3m (dBμV/m)
30 MHz to 8.49 GHz	Peak	$43 + 10 \log (P) \text{ dB} = -13 \text{ dBm} \rightarrow 82.23 \text{ dB}\mu\text{V/m}$
8.49 to 26 GHz	Peak	74 dBμV/m (*)
	Average	54 dBμV/m (*)

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

Frequency range 30 MHz - 1 GHz

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

Frequency range 1 - 26 GHz

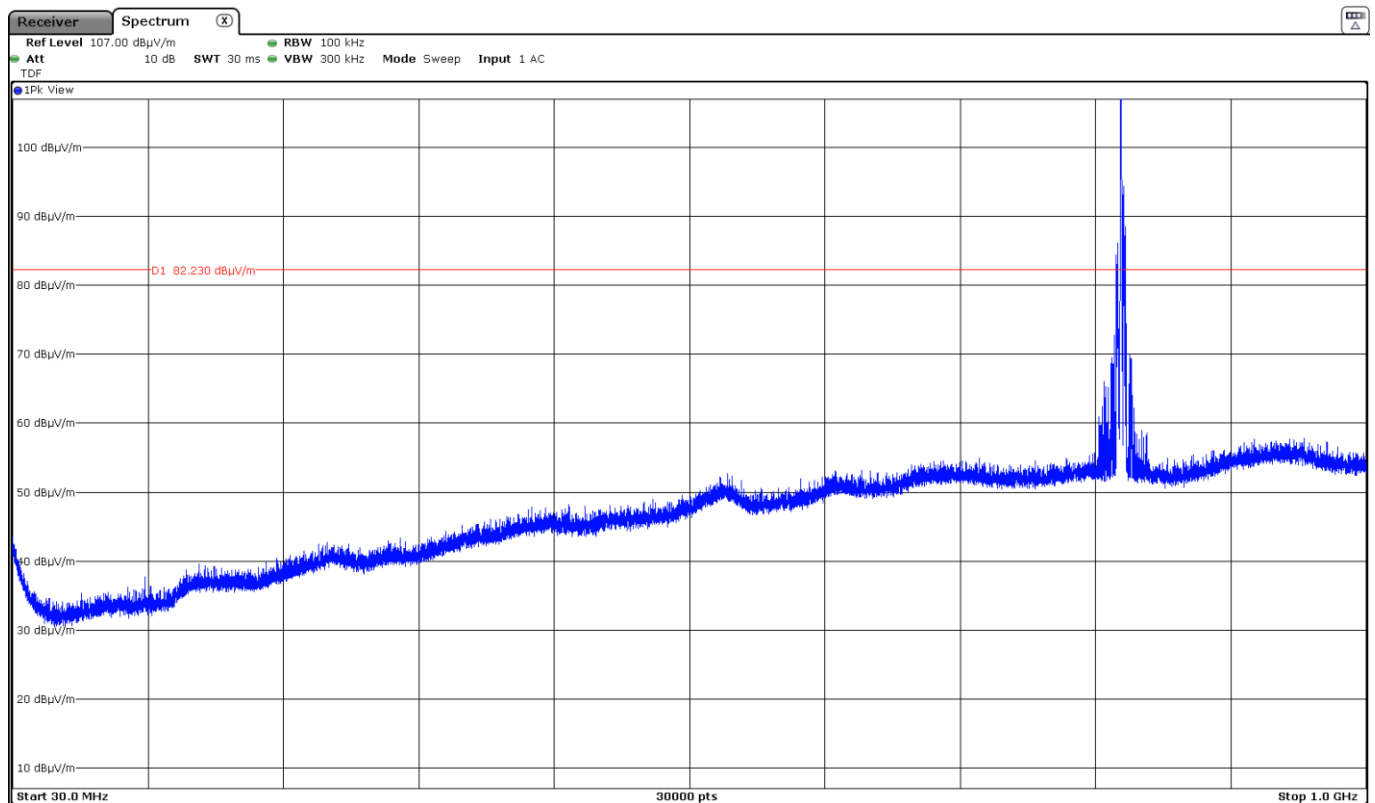
Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (GHz)	Polarization	Detector	E (dBμV/m)
1.64877	H	Peak	65.28

Measurement uncertainty (dB)	<±4.65 for $f < 1 \text{ GHz}$
	<±4.98 for $f \geq 1 \text{ GHz}$ up to 17 GHz
	<±5.08 for $f \geq 17 \text{ GHz}$ up to 26 GHz

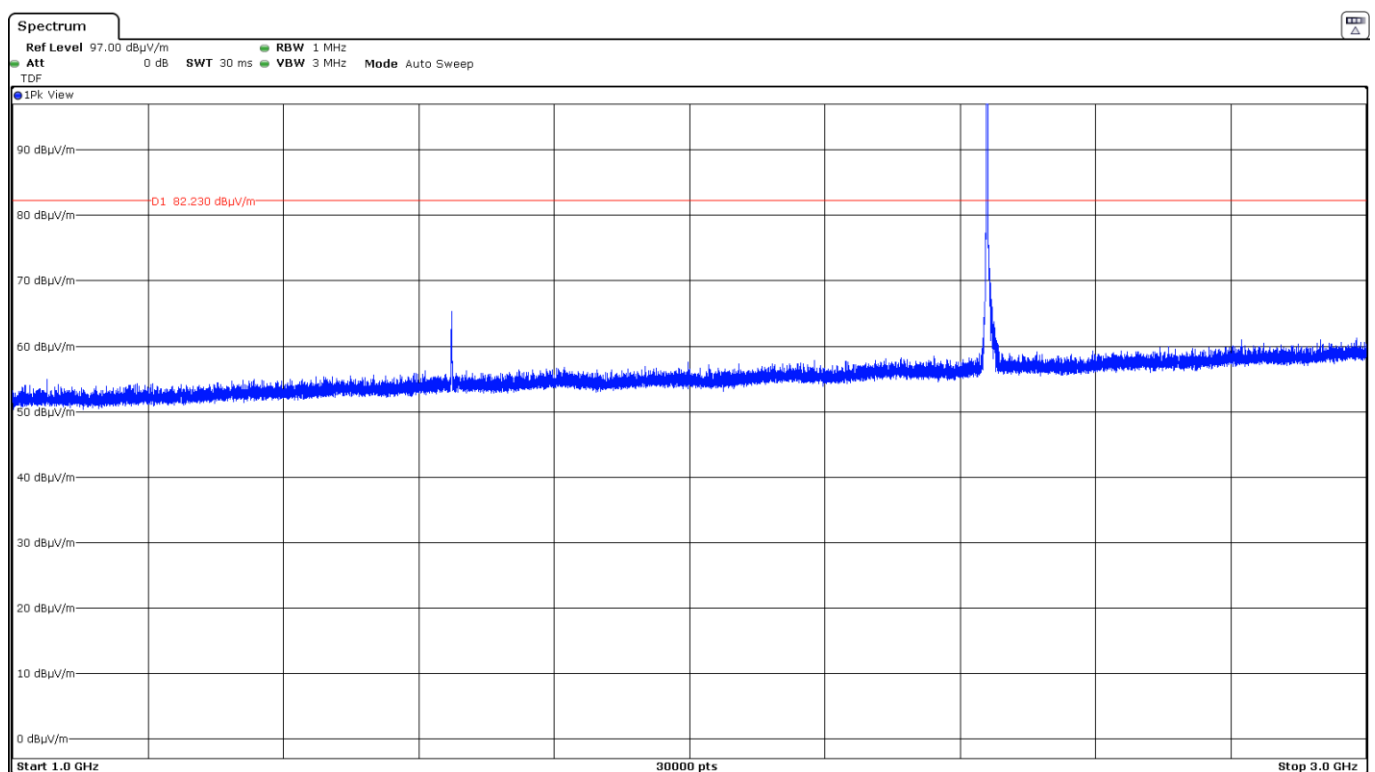
Verdict: PASS

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



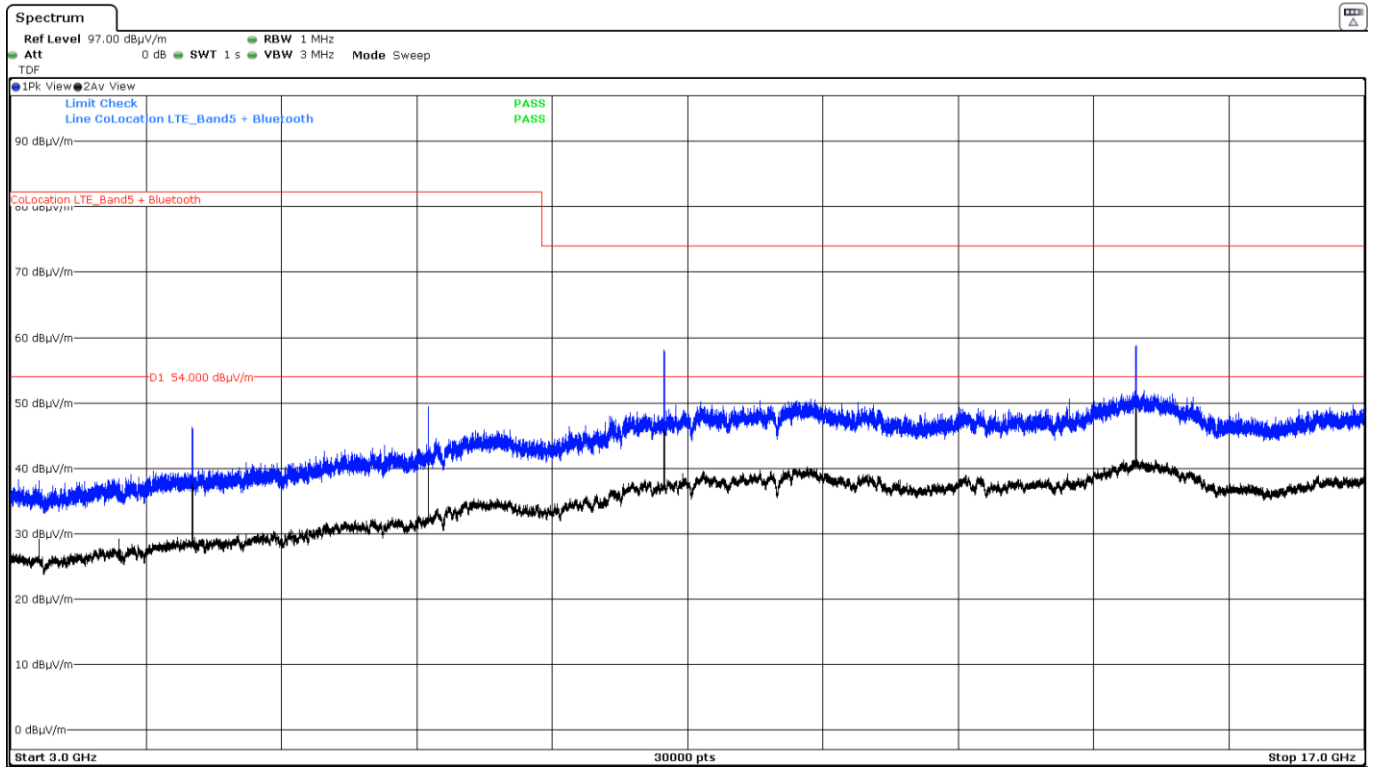
The peak above the limit is the carrier frequency LTE Band 5 (826.5 MHz).

FREQUENCY RANGE 1 - 3 GHz (worst case):

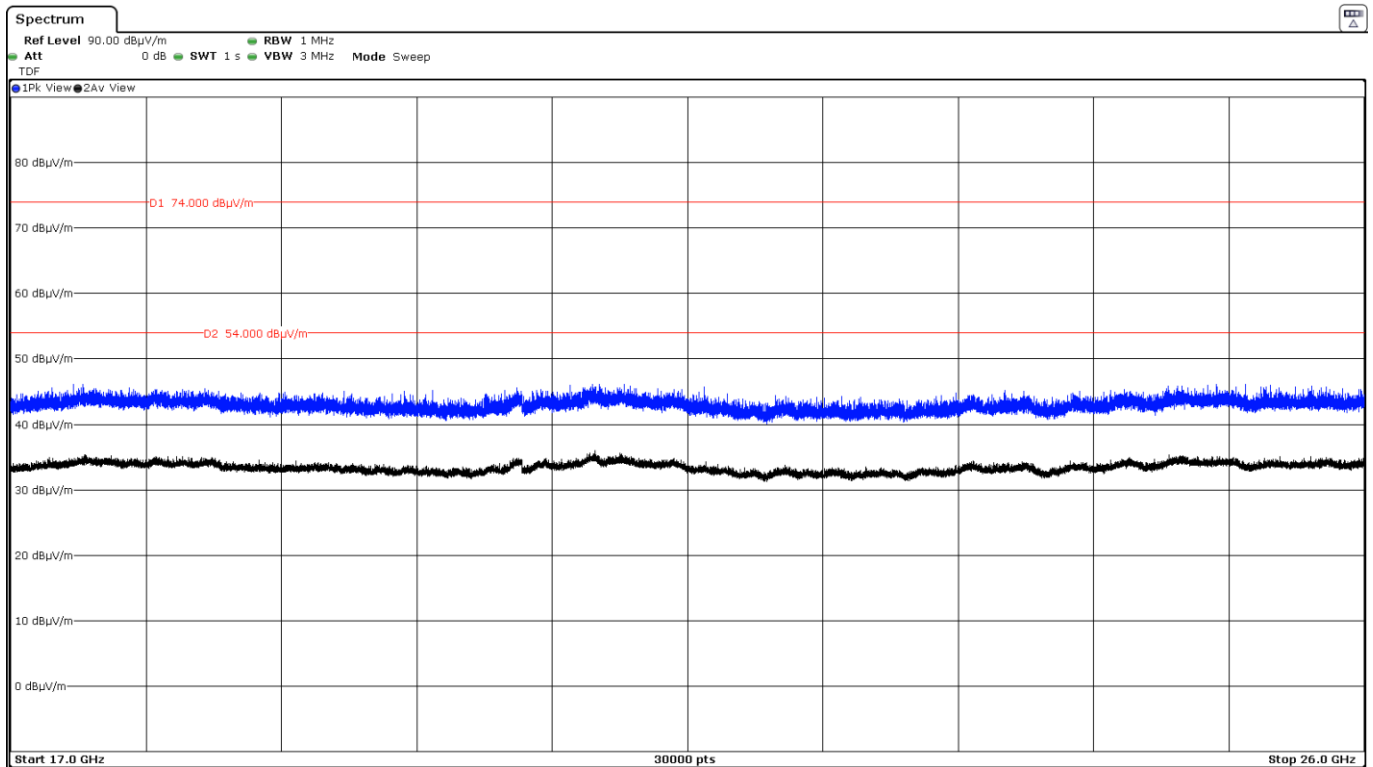


The peak above the limit is the carrier frequency Bluetooth Low Energy (2440 MHz).

FREQUENCY RANGE 3 – 17 GHz (worst case):



FREQUENCY RANGE 17 - 26 GHz (worst case):



- **Co-Location mode LTE Band 26 range 824-849, Bluetooth Low Energy:**

QPSK & 16QAM:

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

LTE Band 26: BW: 15 MHz. Middle Channel (831.5 MHz). RB Size: 1. RB Offset: 0.

Bluetooth Low Energy: Middle Channel (2440 MHz). GFSK.

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

Frequency Range	Detector	Limit at 3m (dBμV/m)
30 MHz to 8.49 GHz	Peak	$43 + 10 \log (P) \text{ dB} = -13 \text{ dBm} \rightarrow 82.23 \text{ dB}\mu\text{V/m}$
8.49 to 26 GHz	Peak	74 dBμV/m (*)
	Average	54 dBμV/m (*)

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

Frequency range 30 MHz - 1 GHz

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

Frequency range 1 - 26 GHz

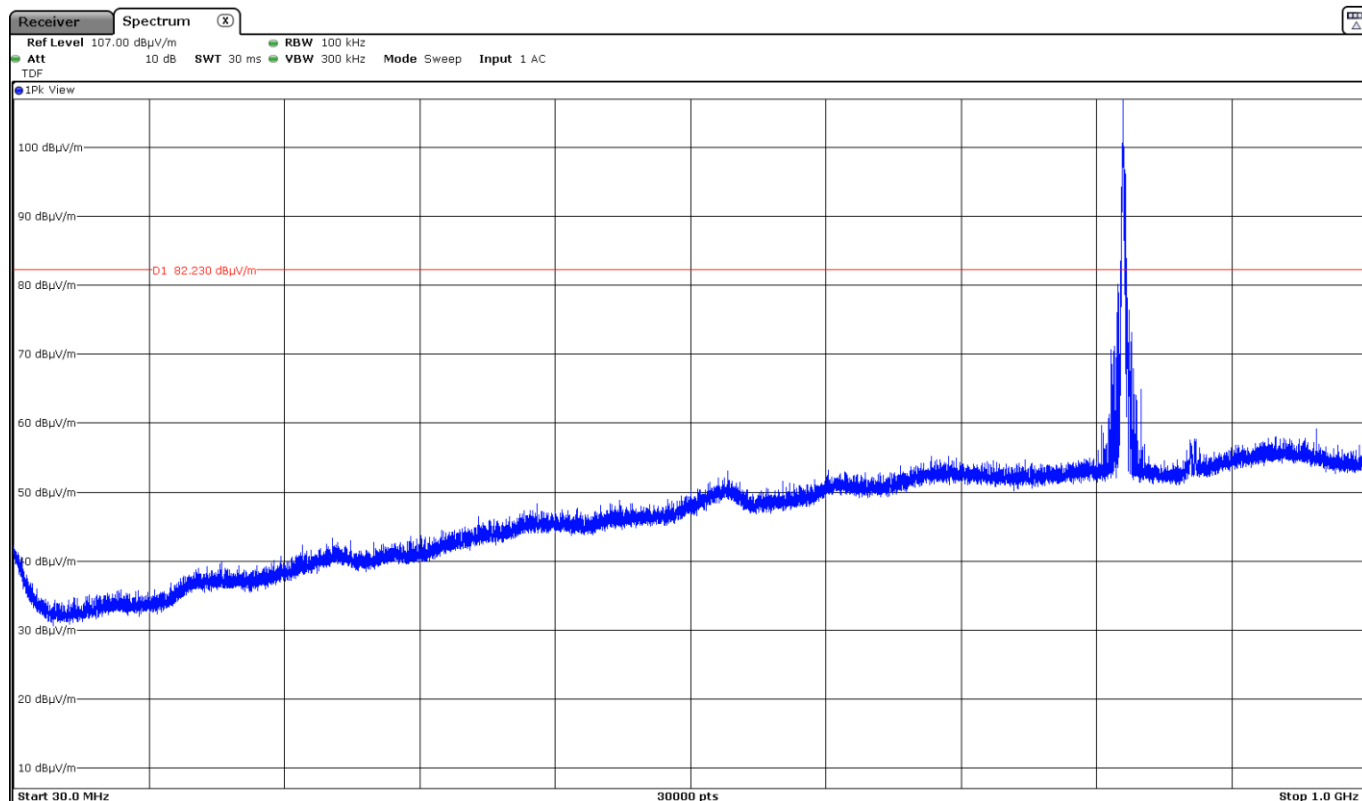
Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (GHz)	Polarization	Detector	E (dBμV/m)
1.64990	H	Peak	65.89

Measurement uncertainty (dB)	$< \pm 4.65$ for $f < 1 \text{ GHz}$ $< \pm 4.98$ for $f \geq 1 \text{ GHz}$ up to 17 GHz $< \pm 5.08$ for $f \geq 17 \text{ GHz}$ up to 26 GHz
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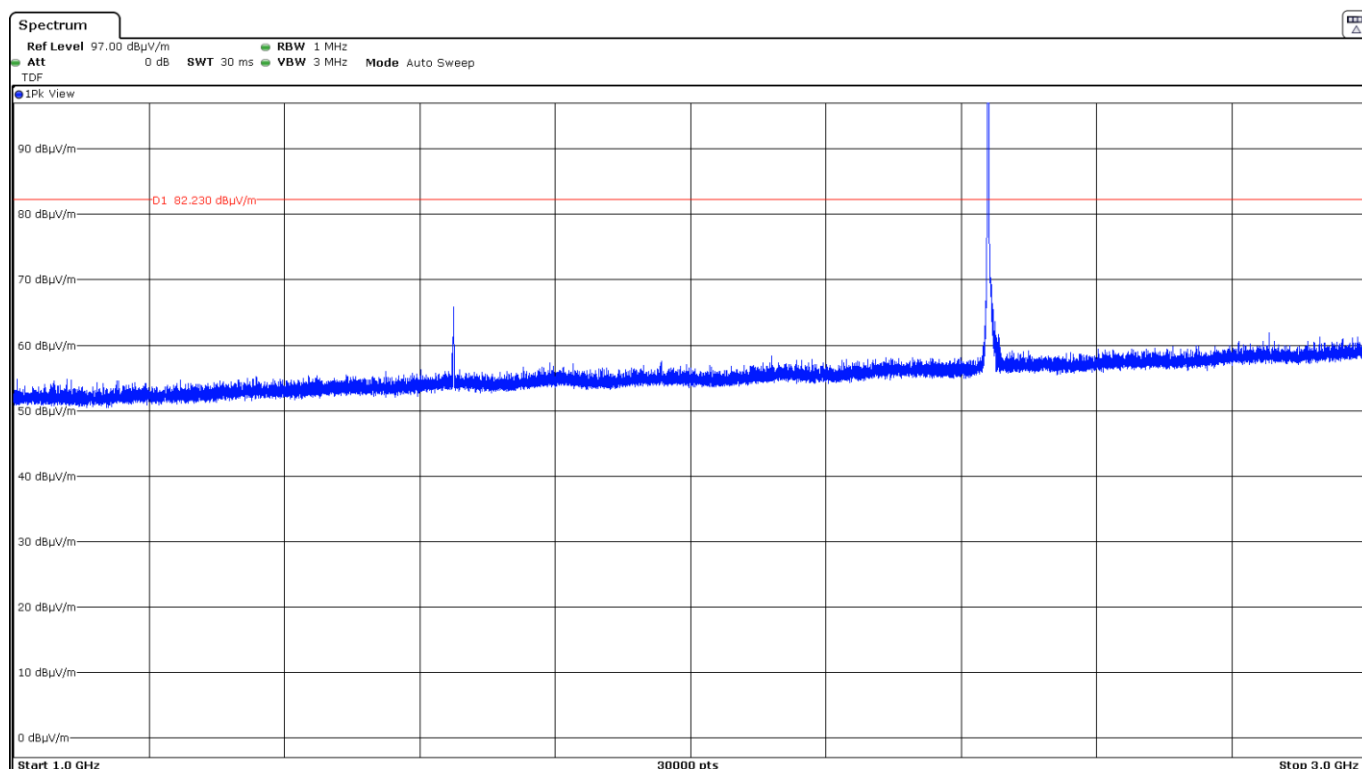
Verdict: PASS

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



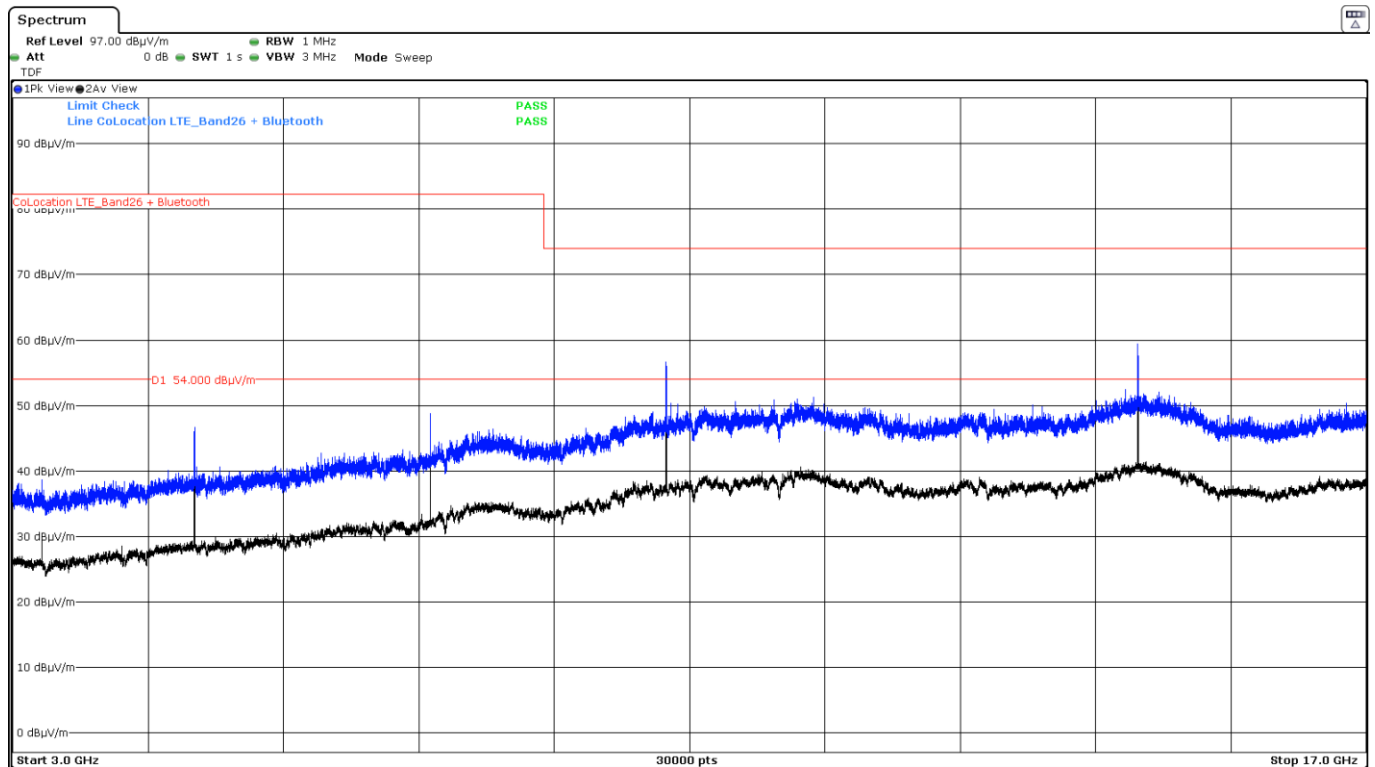
The peak above the limit is the carrier frequency LTE Band 26 range 824-849 MHz (831.5 MHz).

FREQUENCY RANGE 1 - 3 GHz (worst case):

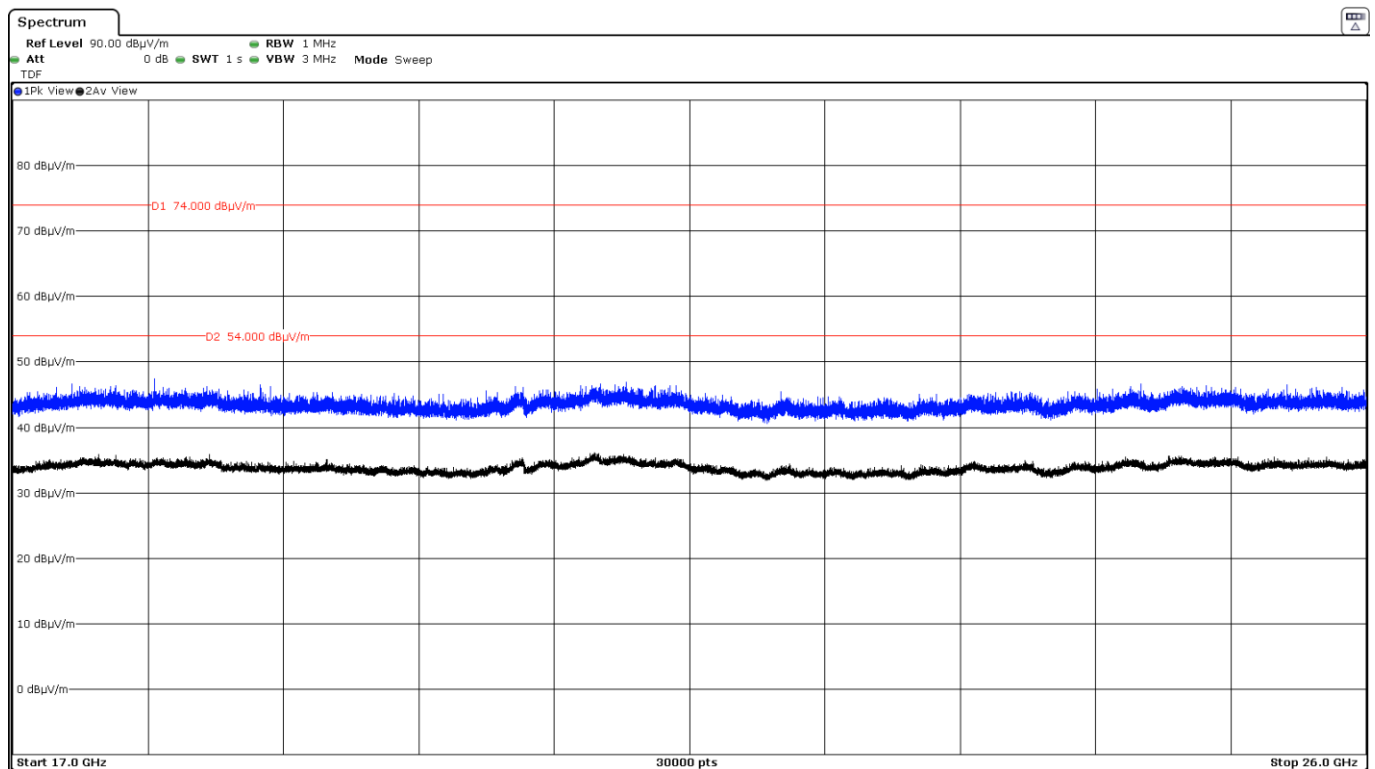


The peak above the limit is the carrier frequency Bluetooth Low Energy (2440 MHz).

FREQUENCY RANGE 3 – 17 GHz (worst case):



FREQUENCY RANGE 17 - 26 GHz (worst case):



- **Co-Location mode LTE Band 26 range 814-824, Bluetooth Low Energy:**

QPSK & 16QAM:

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

LTE Band 26: BW: 1.4 MHz. High Channel (824 MHz). RB Size: 1. RB Offset: 0.
Bluetooth Low Energy: Middle Channel (2440 MHz). GFSK.

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

Frequency Range	Detector	Limit at 3m (dBμV/m)
30 MHz to 8.24 GHz	Peak	$43 + 10 \log (P) \text{ dB} = -13 \text{ dBm} \rightarrow 82.23 \text{ dB}\mu\text{V/m}$
8.24 to 26 GHz	Peak	74 dBμV/m (*)
	Average	54 dBμV/m (*)

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

Frequency range 30 MHz - 1 GHz

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

Frequency range 1 - 26 GHz

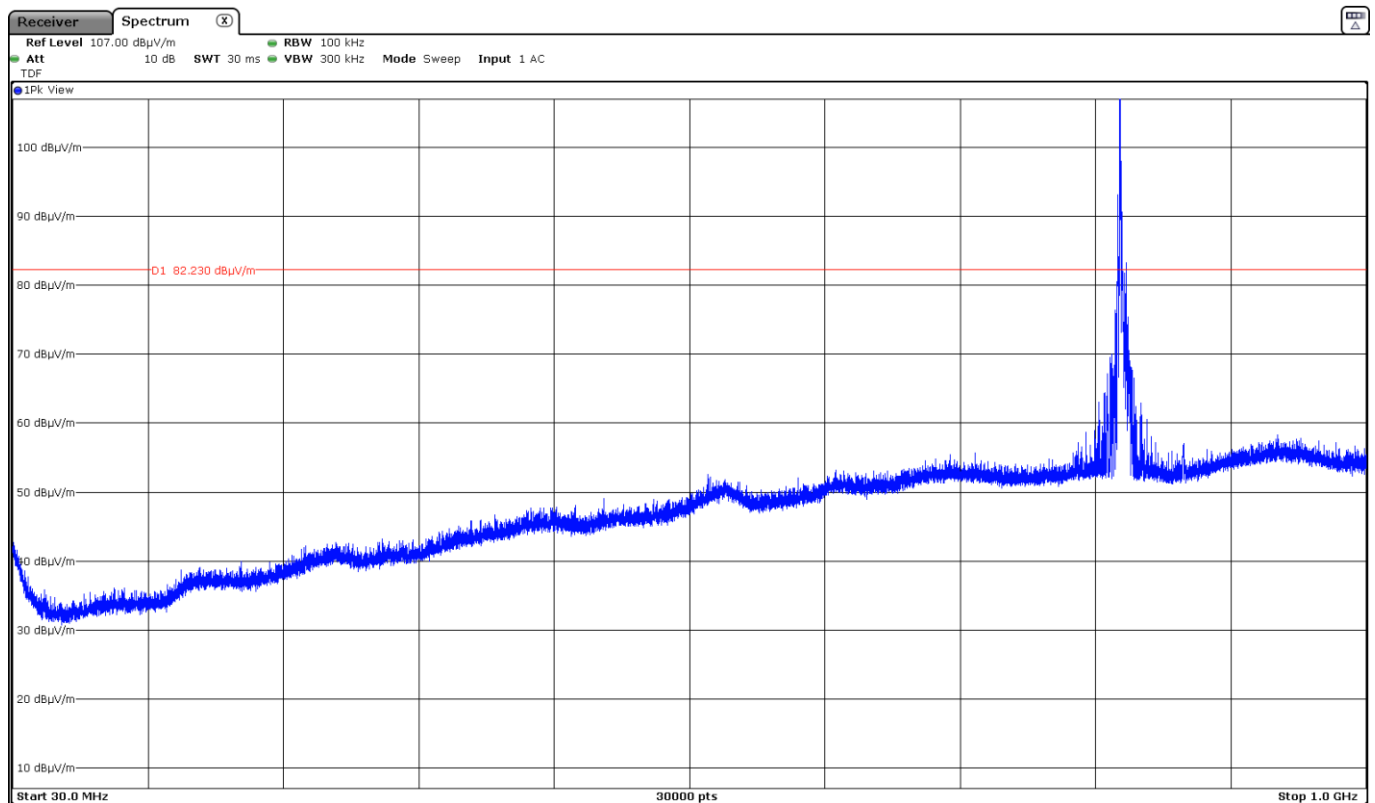
Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (GHz)	Polarization	Detector	E (dBμV/m)
1.64703	H	Peak	65.88

Measurement uncertainty (dB)	$< \pm 4.65$ for $f < 1 \text{ GHz}$ $< \pm 4.98$ for $f \geq 1 \text{ GHz}$ up to 17 GHz $< \pm 5.08$ for $f \geq 17 \text{ GHz}$ up to 26 GHz
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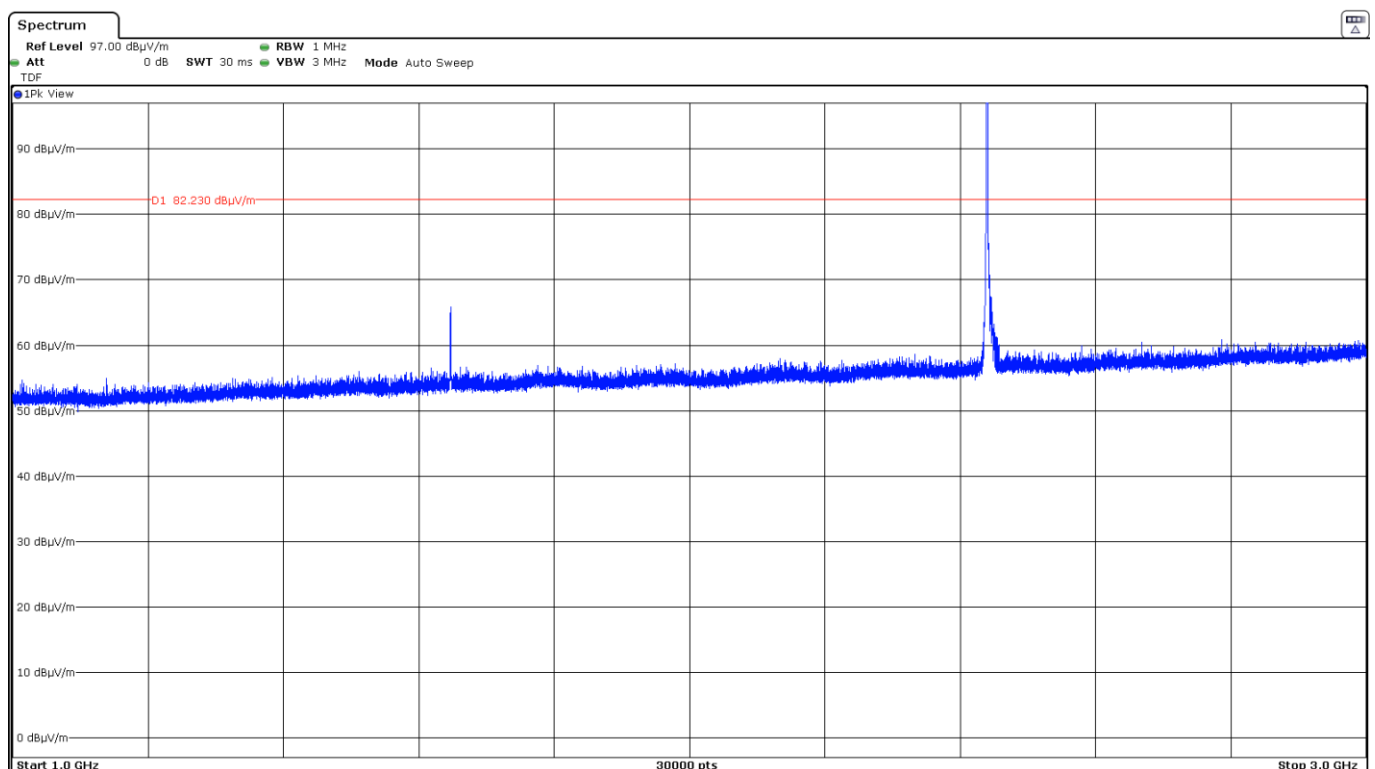
Verdict: PASS

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



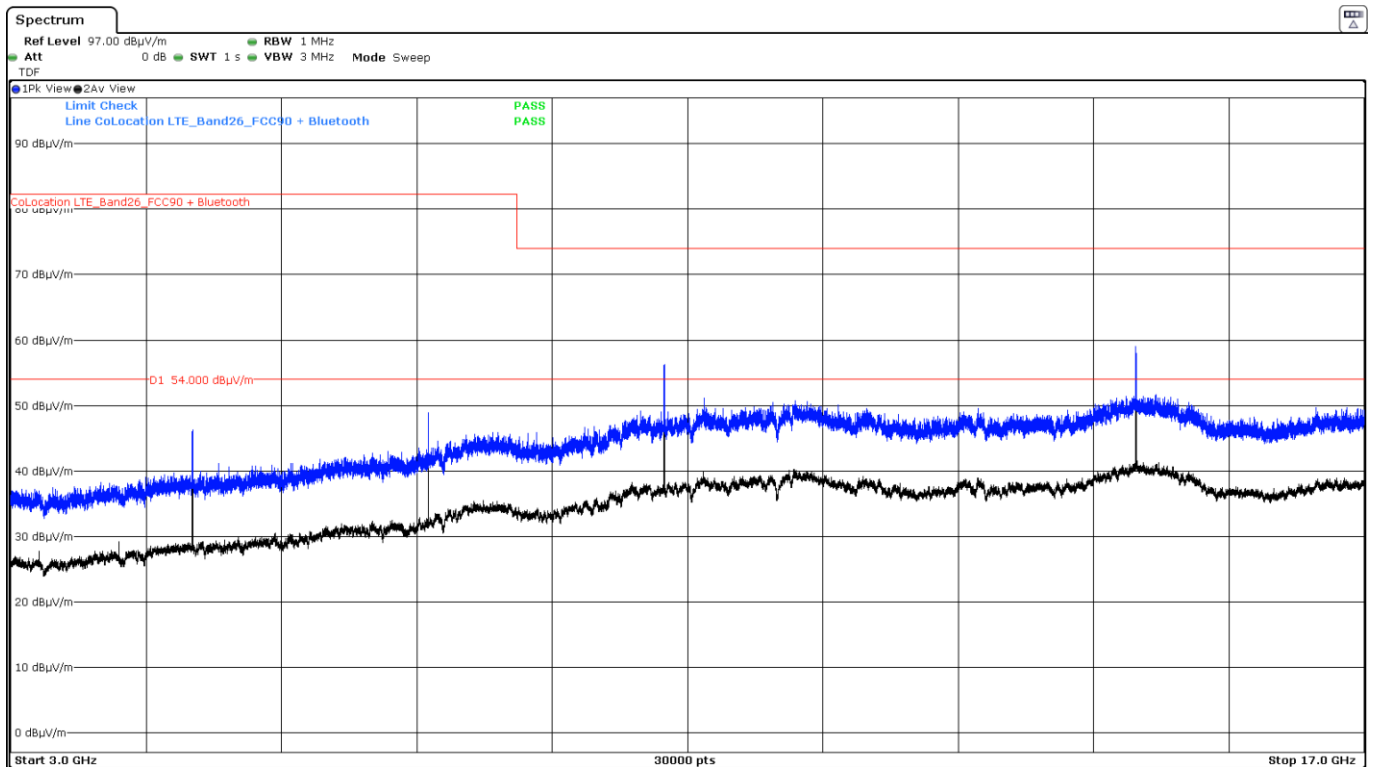
The peak above the limit is the carrier frequency LTE Band 26 range 814-824 MHz (824 MHz).

FREQUENCY RANGE 1 - 3 GHz (worst case):

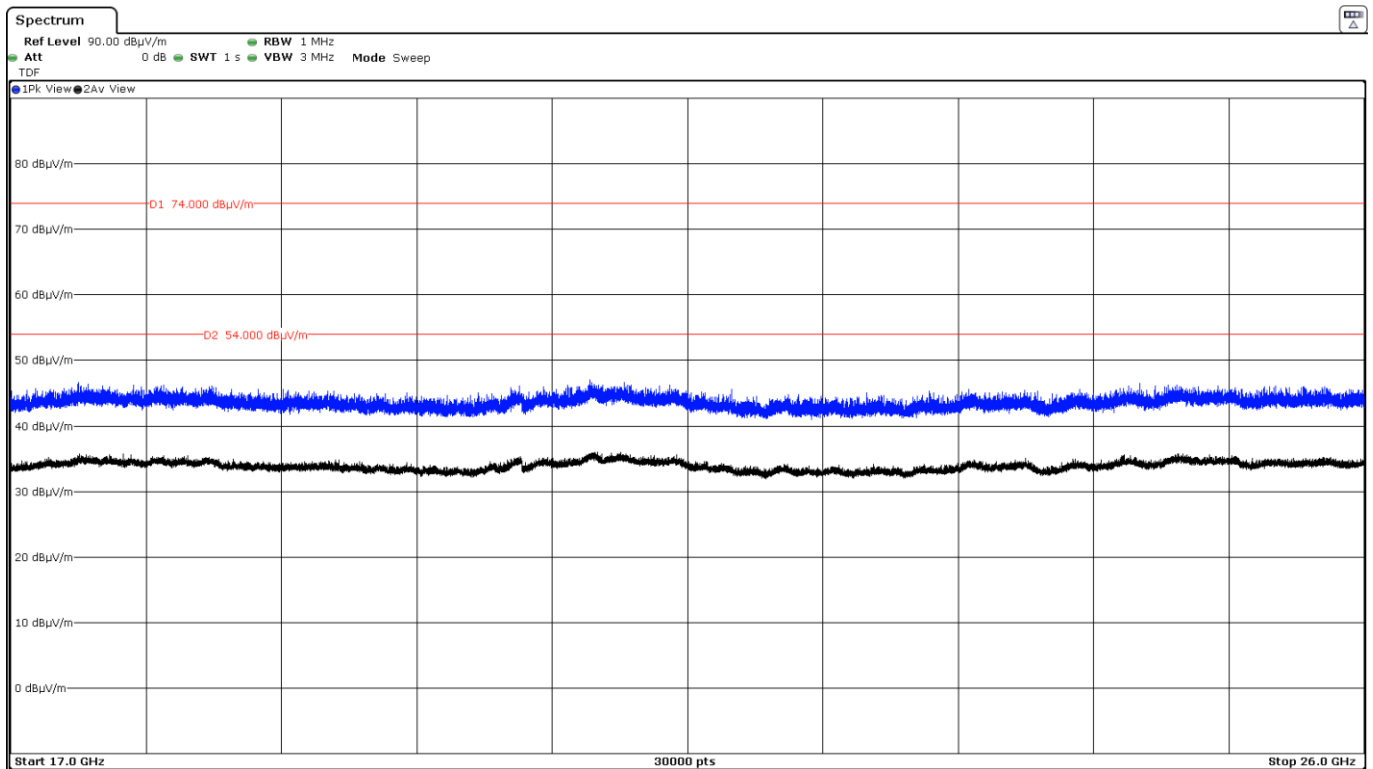


The peak above the limit is the carrier frequency Bluetooth Low Energy (2440 MHz).

FREQUENCY RANGE 3 – 17 GHz (worst case):



FREQUENCY RANGE 17 - 26 GHz (worst case):



Appendix B: Test results FCC 24, 15.247, 15.209 / RSS-133, RSS-247

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TEST CONDITIONS

POWER SUPPLY (V):

V nominal: 12 Vdc
Type of Power Supply: External power supply (Car Battery).

ANTENNA:

Type of Antennas: Internal (SMD).
Maximum Declared Gain for Bluetooth LE: +2.2 dBi
Maximum Declared Gain for CELLULAR:

MIDDLE Bands	GAIN	ANTENNA TYPE
LTE Band 2	+3.5 dBi	Internal (SMD)

TEST FREQUENCIES:

	CELLULAR LTE Band 2	
Band:	LTE Band 2	
Frequency Range:	1850 – 1910 MHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	High: 19125	1902.5

	Bluetooth LE	
Mode:	GFSK	
Channel Spacing:	1 MHz	
Frequency Range:	2400 MHz to 2483.5 MHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	Middle: 17	2440

The test set-up was made in accordance to the general provisions of FCC DTS Measurement 558074 D01 DTS Meas Guidance v05r02 dated April 2, 2019.

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: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in: Cellular LTE Band 2 / High Channel configuration.
This channel was found to transmit higher EIRP than all the other LTE channels.

* Bluetooth Low Energy: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in Bluetooth Low Energy / Middle Channel and GFSK mode configuration.

TESTED SIMULTANEOUS TRANSMISSION MODES:

* **Co-location mode LTE Band 2, Bluetooth Low Energy**, with the EUT configured to simultaneously transmit two signals at maximum output power, Cellular LTE Band 2 / High Channel and Bluetooth Low Energy / Middle Channel and GFSK.

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
Above 960	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 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.

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 26 GHz.

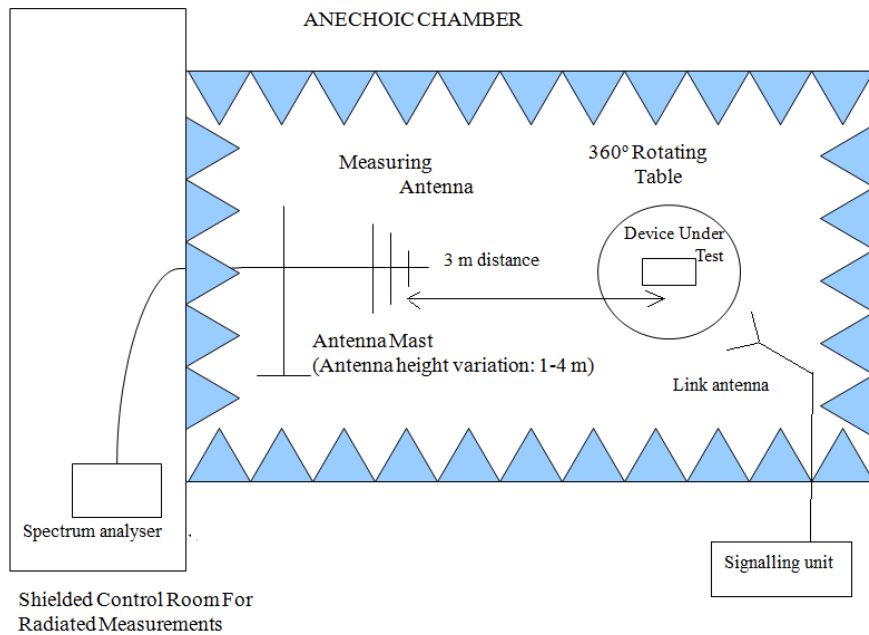
The EUT was placed on a non-conductive stand at a 3 meter distance from the measuring antenna. Detected emissions were maximized at each frequency by rotating the EUT and adjusting the measuring antenna height and polarization. The maximum meter reading was recorded.

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.

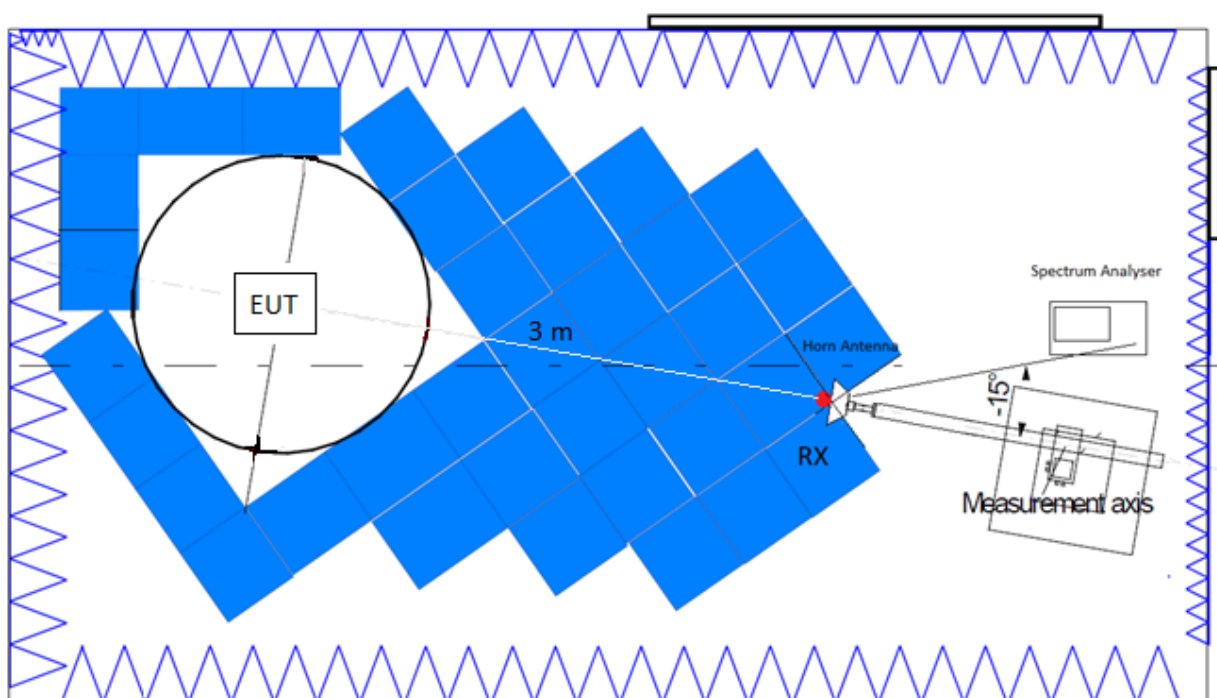
These measurements have been performed in order to check the impact of the Co-Location of all radio interfaces (that can be transmitting simultaneously).

TEST SETUP:

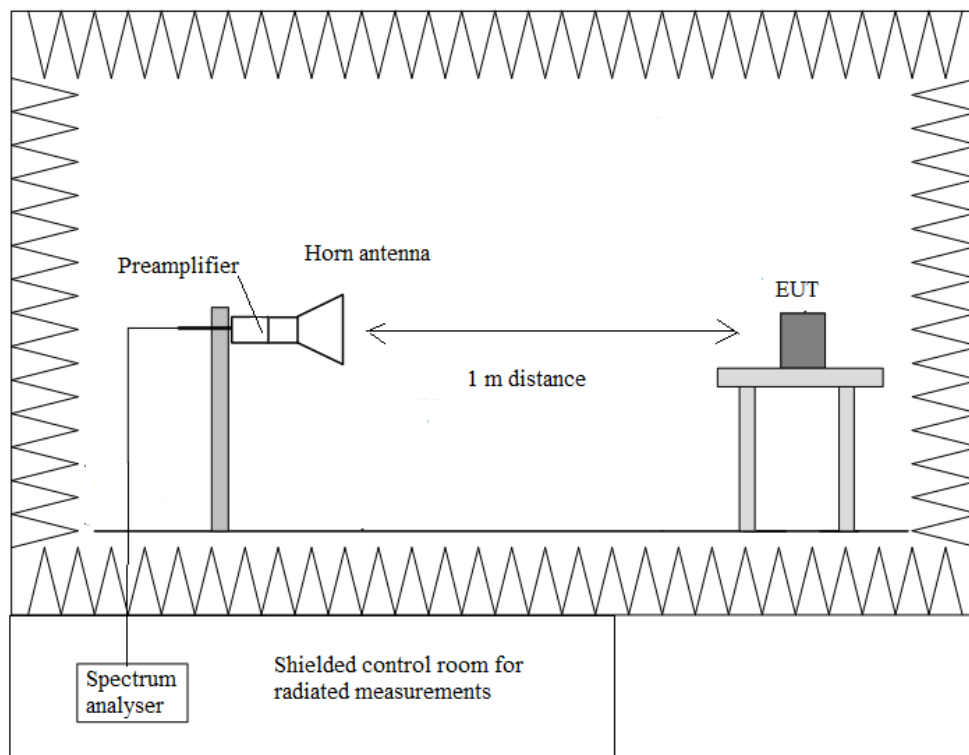
Radiated measurements below 1 GHz.



Radiated measurements setup from 1GHz to 17 GHz:



Radiated measurements setup $f > 17$ GHz:



RESULTS:

• Co-Location mode LTE Band 2, Bluetooth Low Energy:

QPSK & 16QAM:

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

LTE Band 2: BW: 15 MHz. High Channel (1902.5 MHz). RB Size: 1. RB Offset: 0.
Bluetooth Low Energy: Middle Channel (2440 MHz).

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

Frequency Range	Detector	Limit at 3m (dBµV/m)
30 MHz to 19.1 GHz	Peak	$43 + 10 \log (P) \text{ dB} = -13 \text{ dBm} \rightarrow 82.23 \text{ dBµV/m}$
19.1 GHz to 26 GHz	Peak	74 dBµV/m (*)
	Average	54 dBµV/m (*)

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

Frequency range 30 MHz - 1 GHz

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

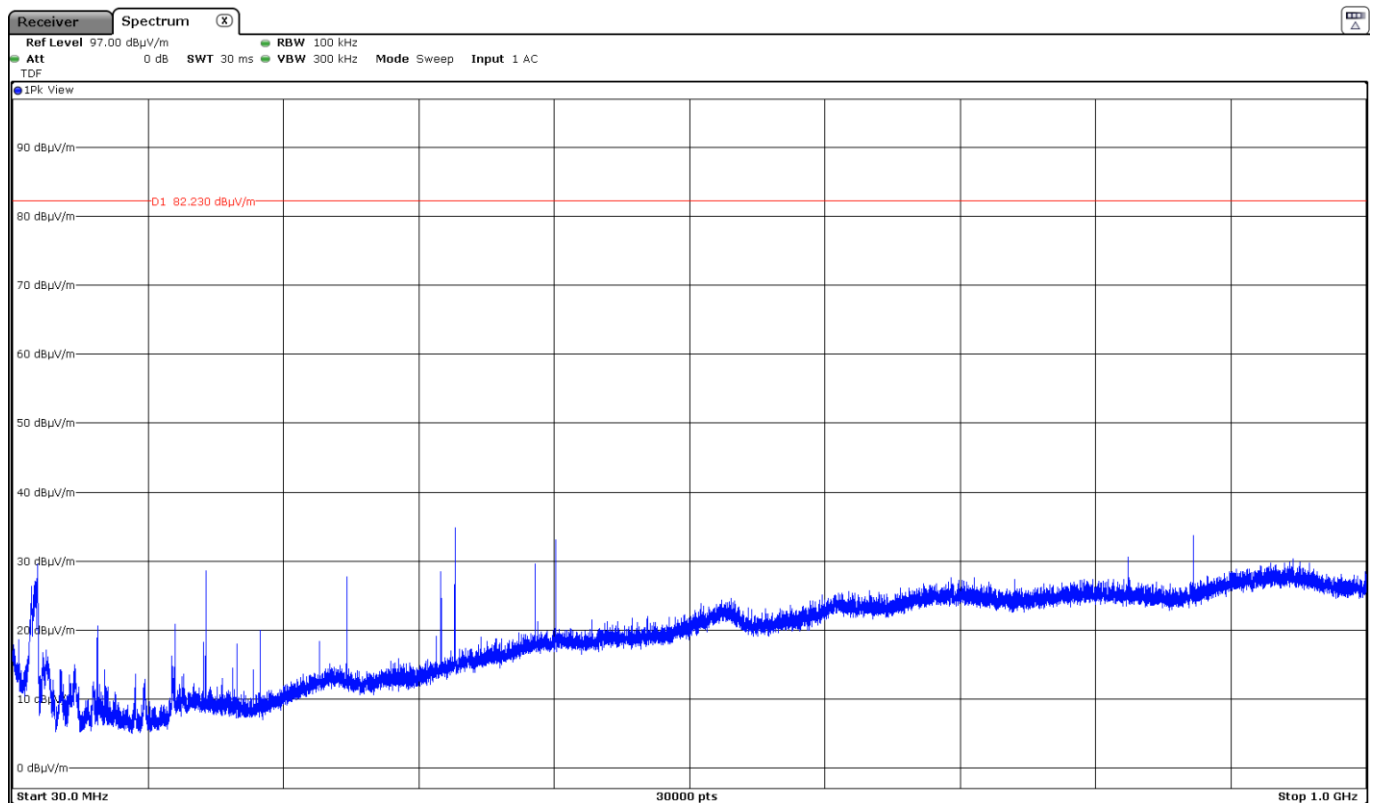
Frequency range 1 – 26 GHz

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

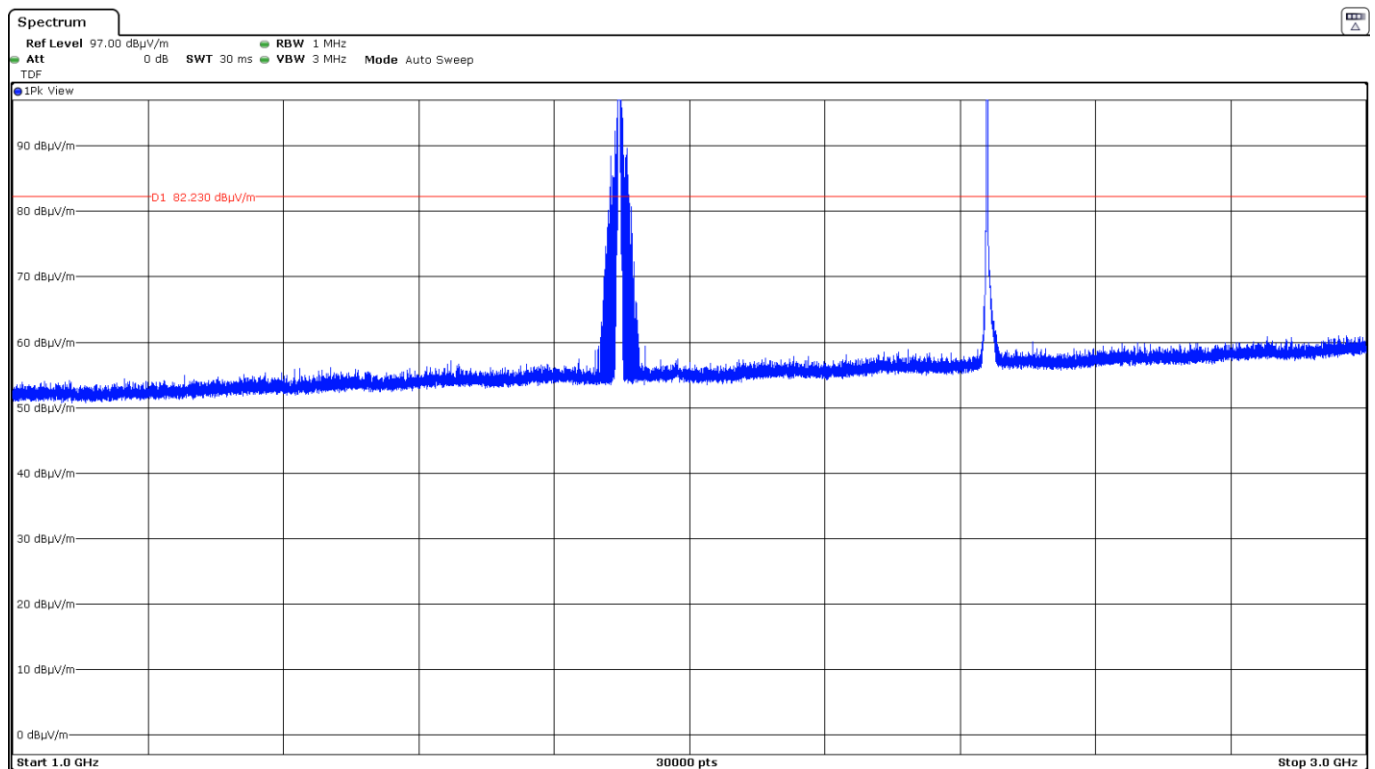
Measurement uncertainty (dB)	$<\pm 4.65$ for $f < 1 \text{ GHz}$ $<\pm 4.98$ for $f \geq 1 \text{ GHz}$ up to 17 GHz $<\pm 5.08$ for $f \geq 17 \text{ GHz}$ up to 26 GHz
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Verdict: PASS

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



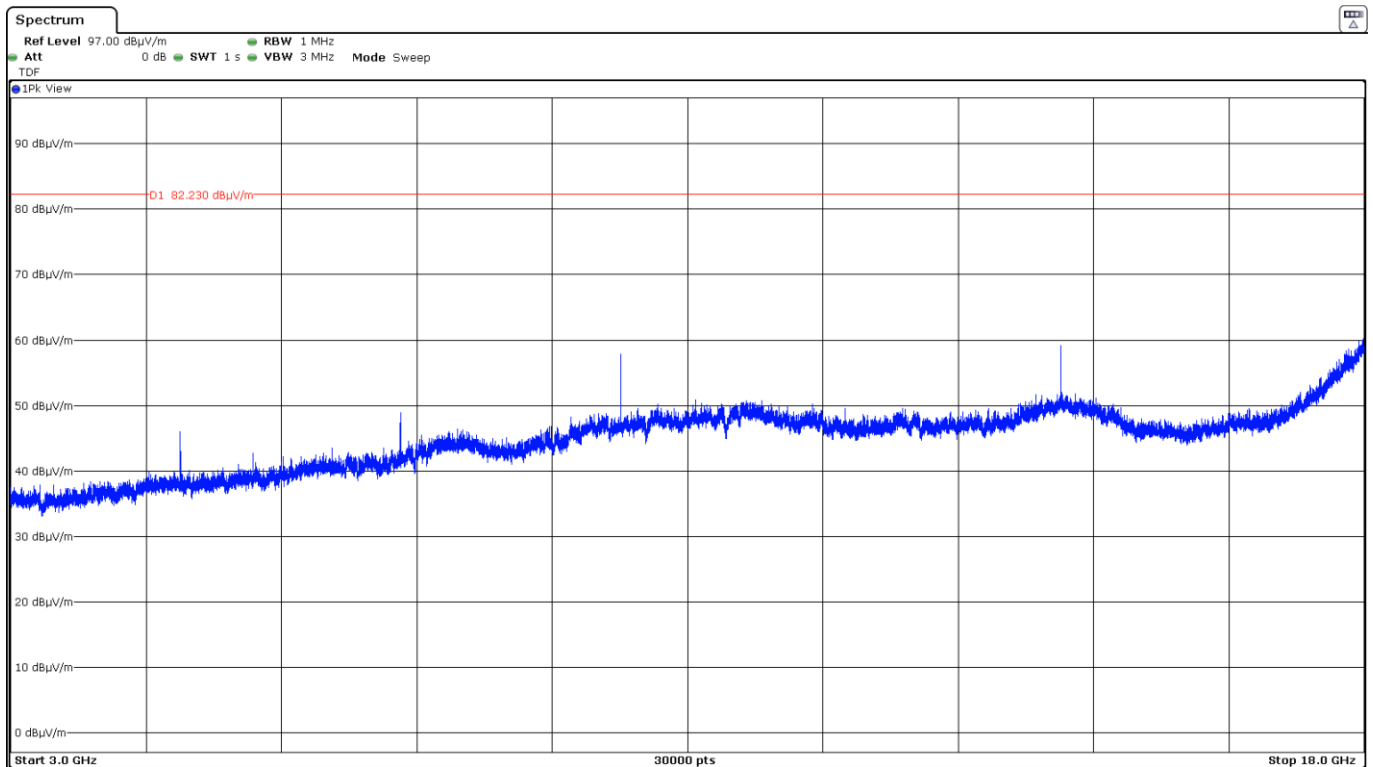
FREQUENCY RANGE 1 – 3 GHz (worst case):



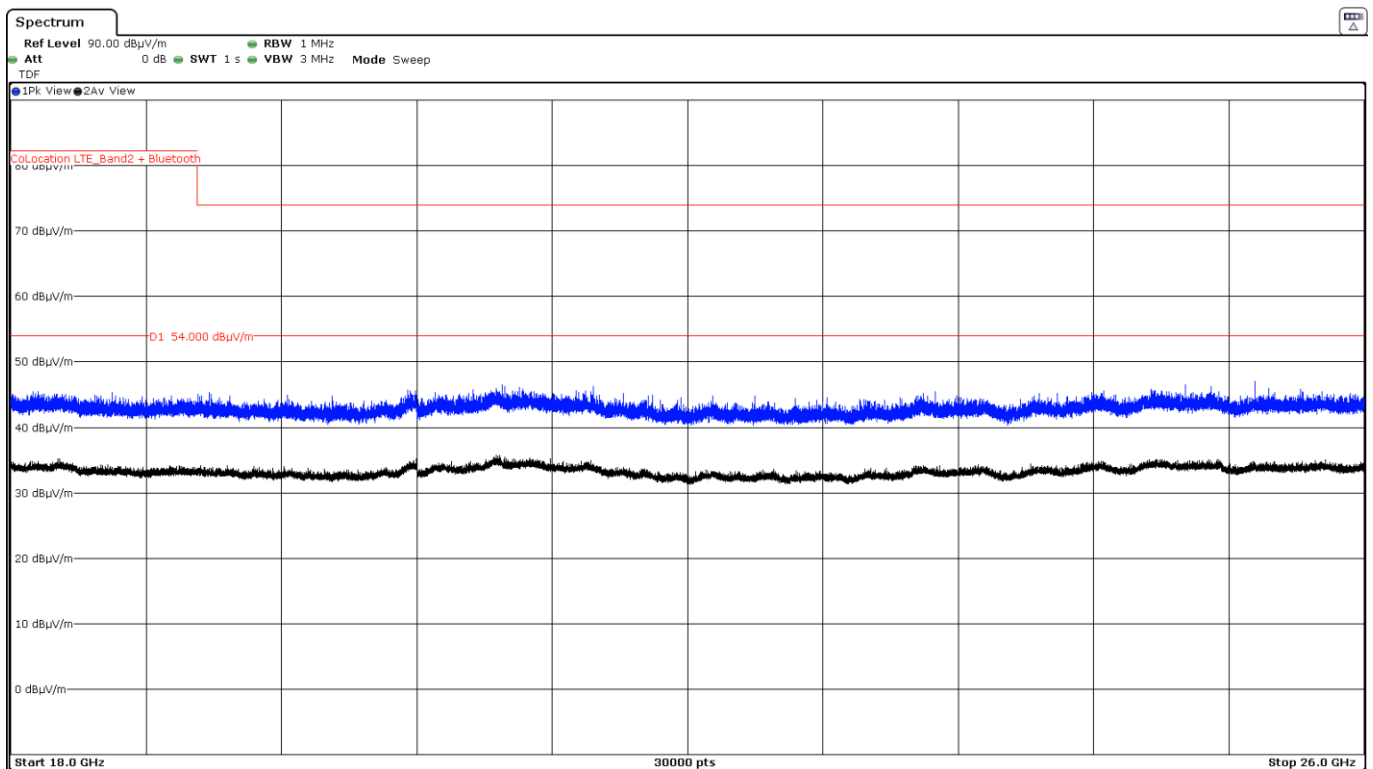
The peak above the limit on the left is the carrier frequency LTE Band 2 (1902.5 MHz).

The peak above the limit on the right is the carrier frequency Bluetooth Low Energy (2440 MHz).

FREQUENCY RANGE 3 – 18 GHz (worst case):



FREQUENCY RANGE 18 - 26 GHz (worst case):



Appendix C: Test results FCC 27, 15.247, 15.209 / RSS-139, RSS-130, RSS-247

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TEST CONDITIONS

POWER SUPPLY (V):

V nominal: 12 Vdc
Type of Power Supply: DC External (car battery).

ANTENNA:

Type of Antennas: Internal (SMD).
Maximum Declared Gain for Bluetooth LE: +2.2 dBi
Maximum Declared Gain for CELLULAR:

MIDDLE Band	GAIN	ANTENNA TYPE
LTE Band 4 (1732.5 MHz)	+3.5 dBi	Internal (SMD)

LOW Band	GAIN	ANTENNA TYPE
LTE Band 12 (707.5 MHz)	+3.5 dBi	Internal (SMD)
LTE Band 13 (782 MHz)	+3.5 dBi	Internal (SMD)

TEST FREQUENCIES:

	CELLULAR LTE Bands 4, 12, 13.	
Band:	LTE Band 4	
Frequency Range:	1710 – 1755 MHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	Low: 19957	1710.7
Band:	LTE Band 12	
Frequency Range:	699 – 716 MHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	High: 23173	715.3
Band:	LTE Band 13	
Frequency Range:	777 – 787 MHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	Middle: 23230	782

	Bluetooth LE	
Mode:	GFSK	
Channel Spacing:	1 MHz	
Frequency Range:	2400 MHz to 2483.5 MHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	Middle: 17	2440

The test set-up was made in accordance to the general provisions of FCC DTS Measurement 558074 D01 DTS Meas Guidance v05r02 dated April 2, 2019.

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: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in Cellular LTE Band 4 / Low Channel as this channel was found to transmit higher EIRP than all the other channels.

* Cellular LTE: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in Cellular LTE Band 12 / High Channel as this channel was found to transmit higher EIRP than all the other channels.

* Cellular LTE: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in Cellular LTE Band 13 / Middle Channel as this channel was found to transmit higher EIRP than all the other channels.

* Bluetooth Low Energy: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in Bluetooth Low Energy / Middle Channel and GFSK mode configuration.

TESTED SIMULTANEOUS TRANSMISSION MODES:

* **Co-location mode LTE Band 4, Bluetooth Low Energy**, with the EUT configured to simultaneously transmit two signals at maximum output power, Cellular LTE Band 4 / Low Channel and Bluetooth Low Energy / Middle Channel and GFSK.

* **Co-location mode LTE Band 12, Bluetooth Low Energy**, with the EUT configured to simultaneously transmit two signals at maximum output power, Cellular LTE Band 12 / High Channel and Bluetooth Low Energy / Middle Channel and GFSK.

* **Co-location mode LTE Band 13, Bluetooth Low Energy**, with the EUT configured to simultaneously transmit two signals at maximum output power, Cellular LTE Band 13 / Middle Channel and Bluetooth Low Energy / Middle Channel and GFSK.

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
Above 960	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 4. FCC §2.1053 & §27.53 (h) / RSS-139 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 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.

2. LTE Band 12. FCC §2.1053 & §27.53 (g) / RSS-130 Issue 1 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 $43 + 10 \log_{10} p$ (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.

3. LTE Band 13. FCC §2.1053 & §27.53 (c) (2) (4) & (f) / RSS-130 Issue 1, 4.6.1.

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

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 26 GHz.

The EUT was placed on a non-conductive stand at a 3 meter distance from the measuring antenna.

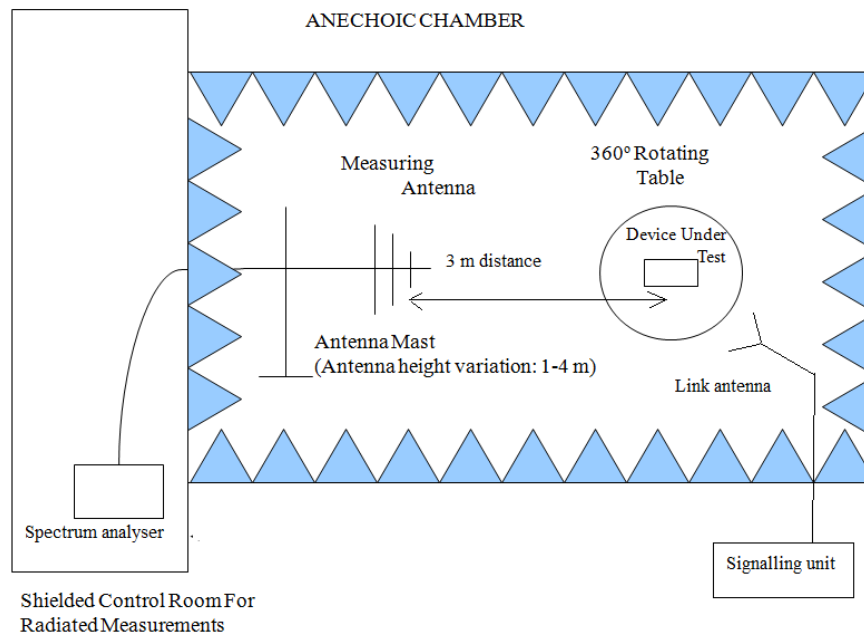
Detected emissions were maximized at each frequency by rotating the EUT and adjusting the measuring antenna height and polarization. The maximum meter reading was recorded.

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.

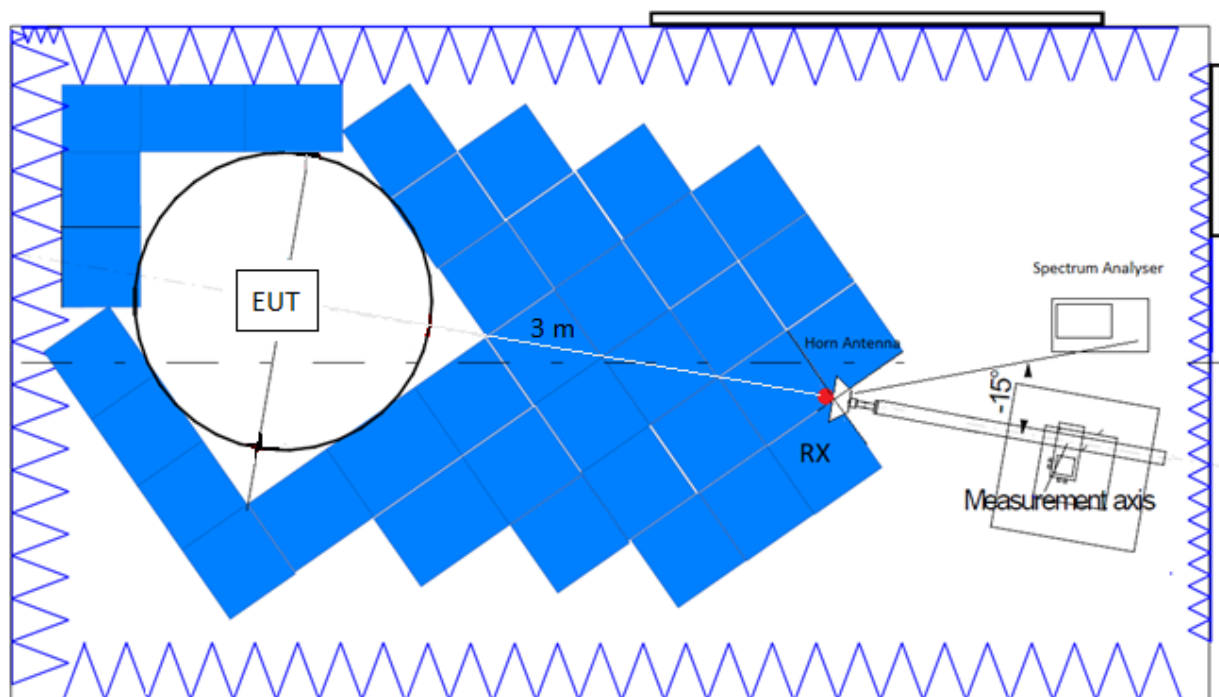
These measurements have been performed in order to check the impact of the Co-Location of all radio interfaces (that can be transmitting simultaneously).

TEST SETUP:

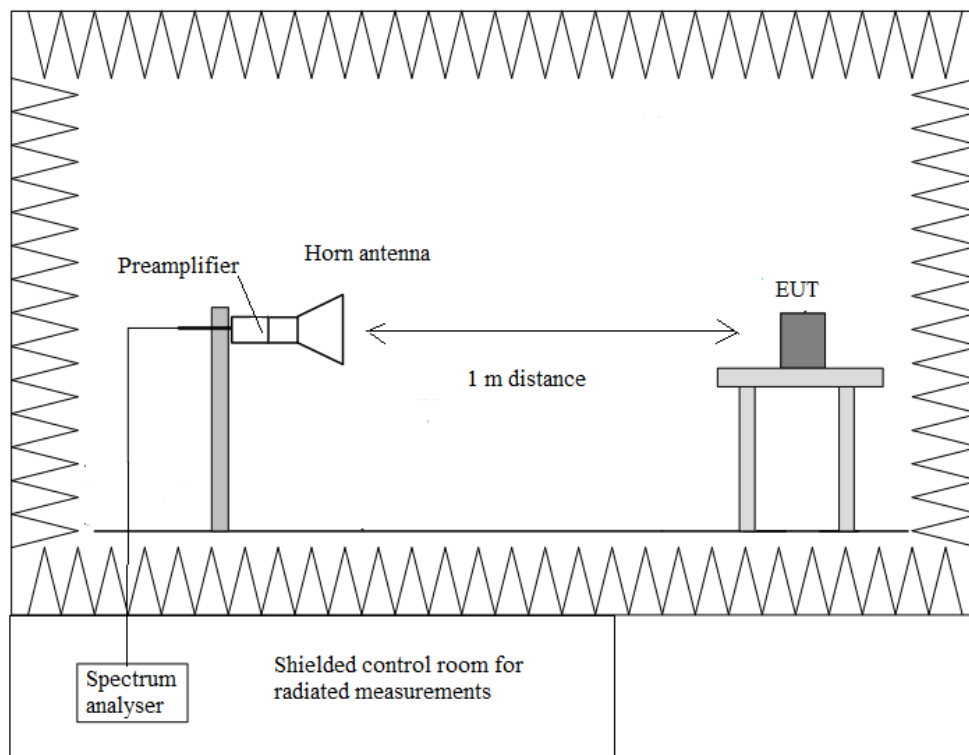
Radiated measurements below 1 GHz.



Radiated measurements setup from 1GHz to 17 GHz:



Radiated measurements setup $f > 17$ GHz:



RESULTS:

- Co-Location mode LTE Band 4, Bluetooth Low Energy.**

QPSK and 16QAM:

A preliminary scan determined QPSK modulation as the worst case.

LTE Band 4: BW: 1.4 MHz. Low Channel (1710.7 MHz). RB Size: 1. RB Offset: 0.
Bluetooth Low Energy: Middle Channel (2440 MHz).

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

Frequency Range	Detector	Limit at 3m (dBμV/m)
30 MHz to 17.55 GHz	Peak	$43 + 10 \log (P) \text{ dB} = -13 \text{ dBm} \rightarrow 82.23 \text{ dB}\mu\text{V/m}$
17.55 GHz to 26 GHz	Peak	74 dBμV/m (*)
	Average	54 dBμV/m (*)

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

Frequency range 30 MHz - 1 GHz

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

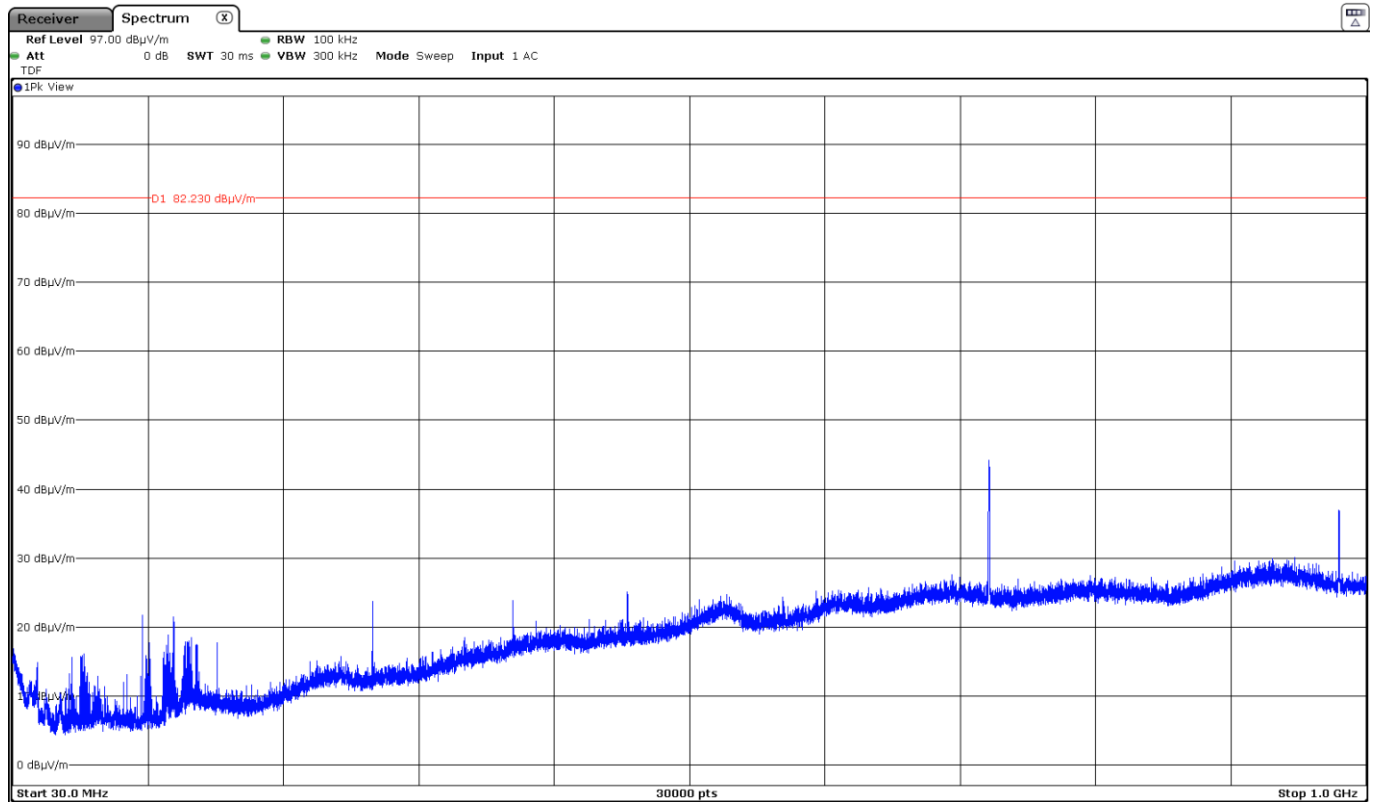
Frequency range 1 - 26 GHz

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

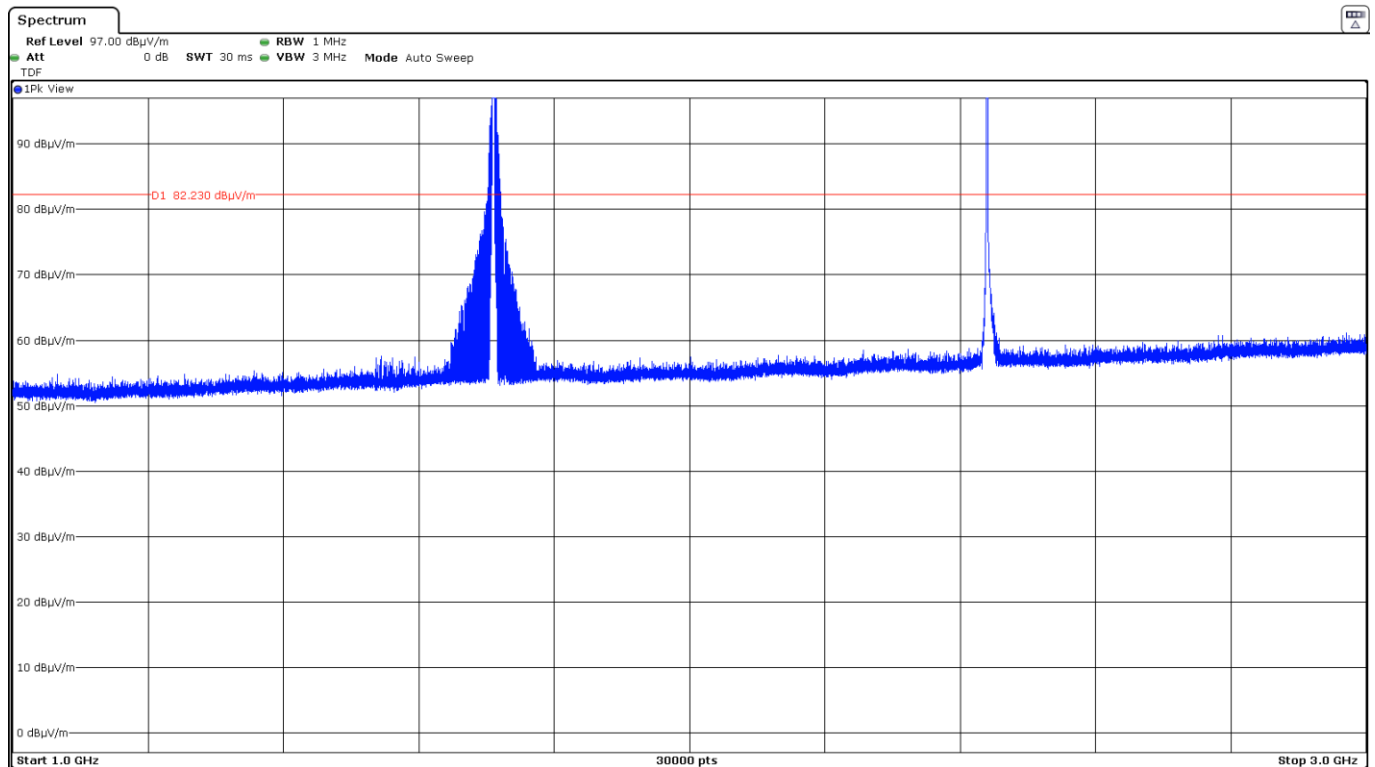
Measurement uncertainty (dB)	$\leq \pm 4.65$ for $f < 1 \text{ GHz}$ $\leq \pm 4.98$ for $f \geq 1 \text{ GHz}$ up to 17 GHz $\leq \pm 5.08$ for $f \geq 17 \text{ GHz}$ up to 26 GHz
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Verdict: PASS

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

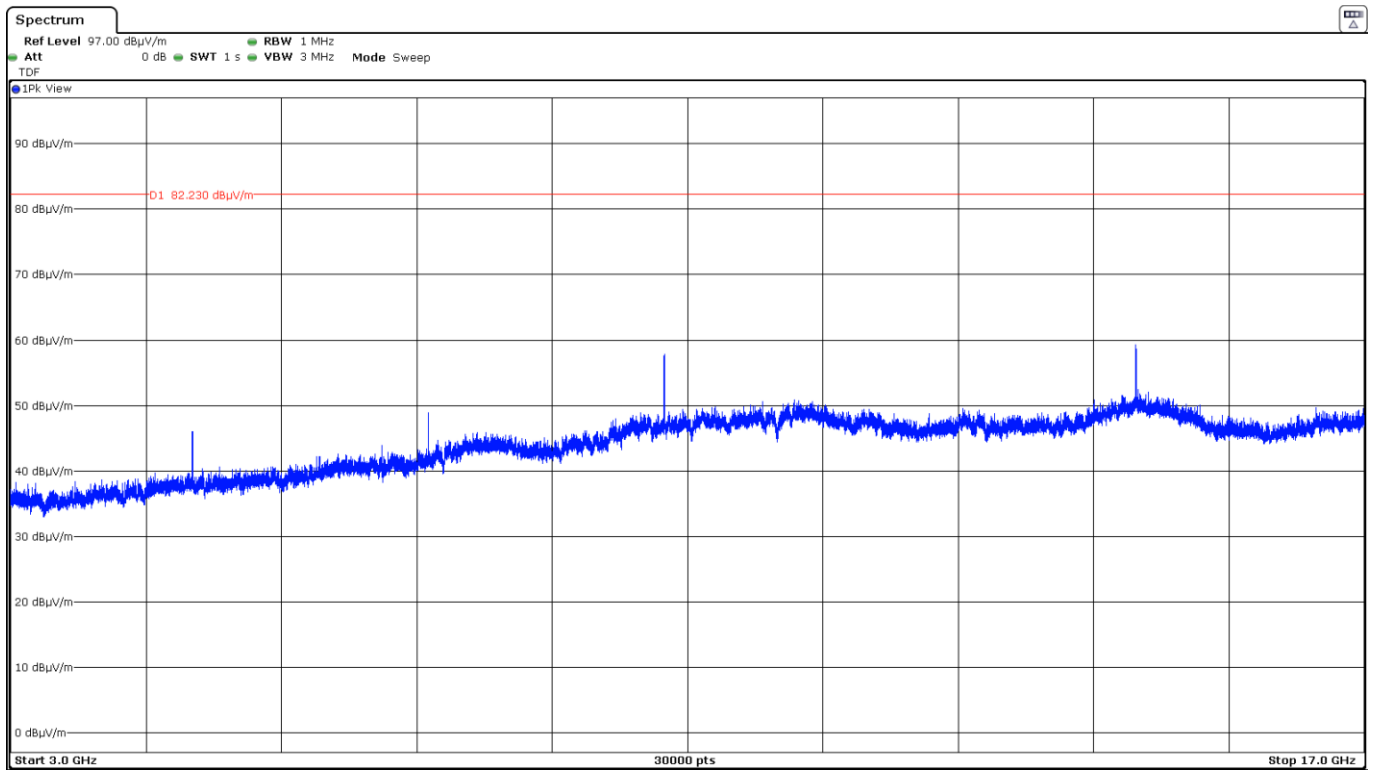


FREQUENCY RANGE 1 - 3 GHz (worst case):

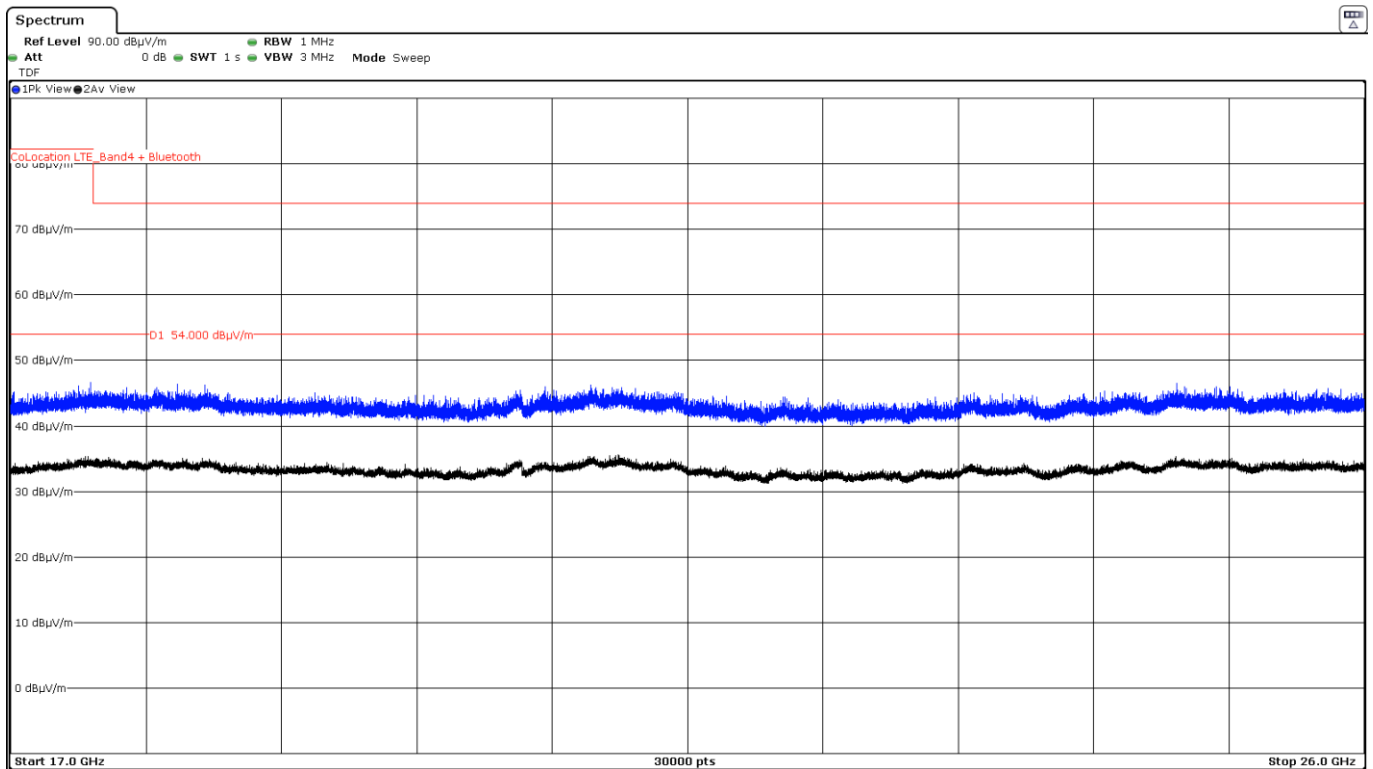


The peak above the limit on the left is the carrier frequency LTE Band 4 (1710.7 MHz)
The peak above the limit on the right is the carrier frequency Bluetooth Low Energy (2440 MHz).

FREQUENCY RANGE 3 - 17 GHz (worst case):



FREQUENCY RANGE 17 - 26 GHz (worst case):



- **Co-Location mode LTE Band 12, Bluetooth Low Energy.**

QPSK & 16QAM:

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

LTE Band 12: BW: 1.4 MHz. High Channel (715.3 MHz). RB Size: 1. RB Offset: 0.
Bluetooth Low Energy: Middle Channel (2440 MHz).

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

Frequency Range	Detector	Limit at 3m (dBμV/m)
30 MHz to 7.16 GHz	Peak	$43 + 10 \log (P) \text{ dB} = -13 \text{ dBm} \rightarrow 82.23 \text{ dB}\mu\text{V/m}$
7.16 to 26 GHz	Peak	74 dBμV/m (*)
	Average	54 dBμV/m (*)

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

Frequency range 30 MHz - 1 GHz

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

Frequency range 1 - 26 GHz

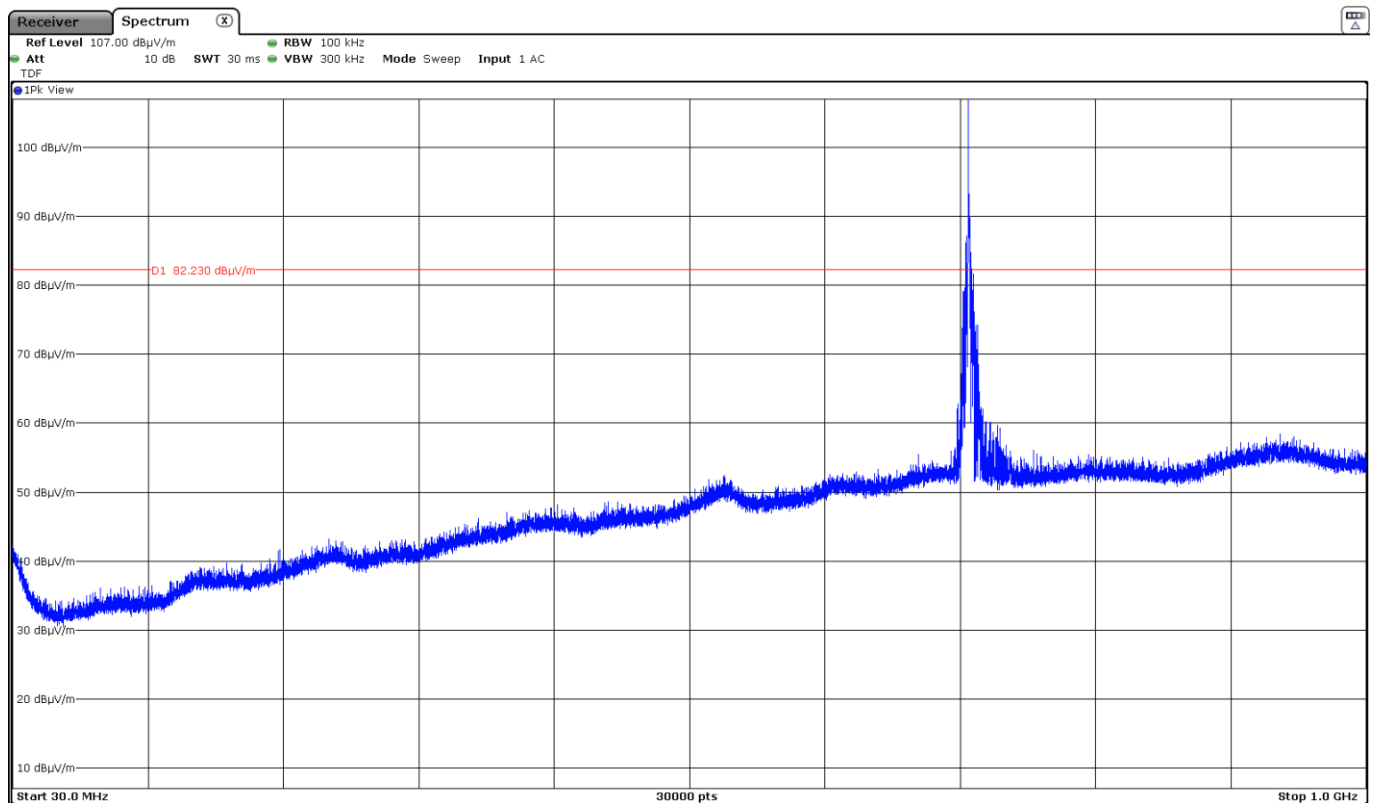
Spurious frequencies closest to the limit:

Spurious frequency (GHz)	Polarization	Detector	E (dBμV/m)
1.42963	H	Peak	67.61
7.31923	V	Peak	48.81

Measurement uncertainty (dB)	$< \pm 4.65$ for $f < 1 \text{ GHz}$ $< \pm 4.98$ for $f \geq 1 \text{ GHz}$ up to 17 GHz $< \pm 5.08$ for $f \geq 17 \text{ GHz}$ up to 26 GHz
------------------------------	---

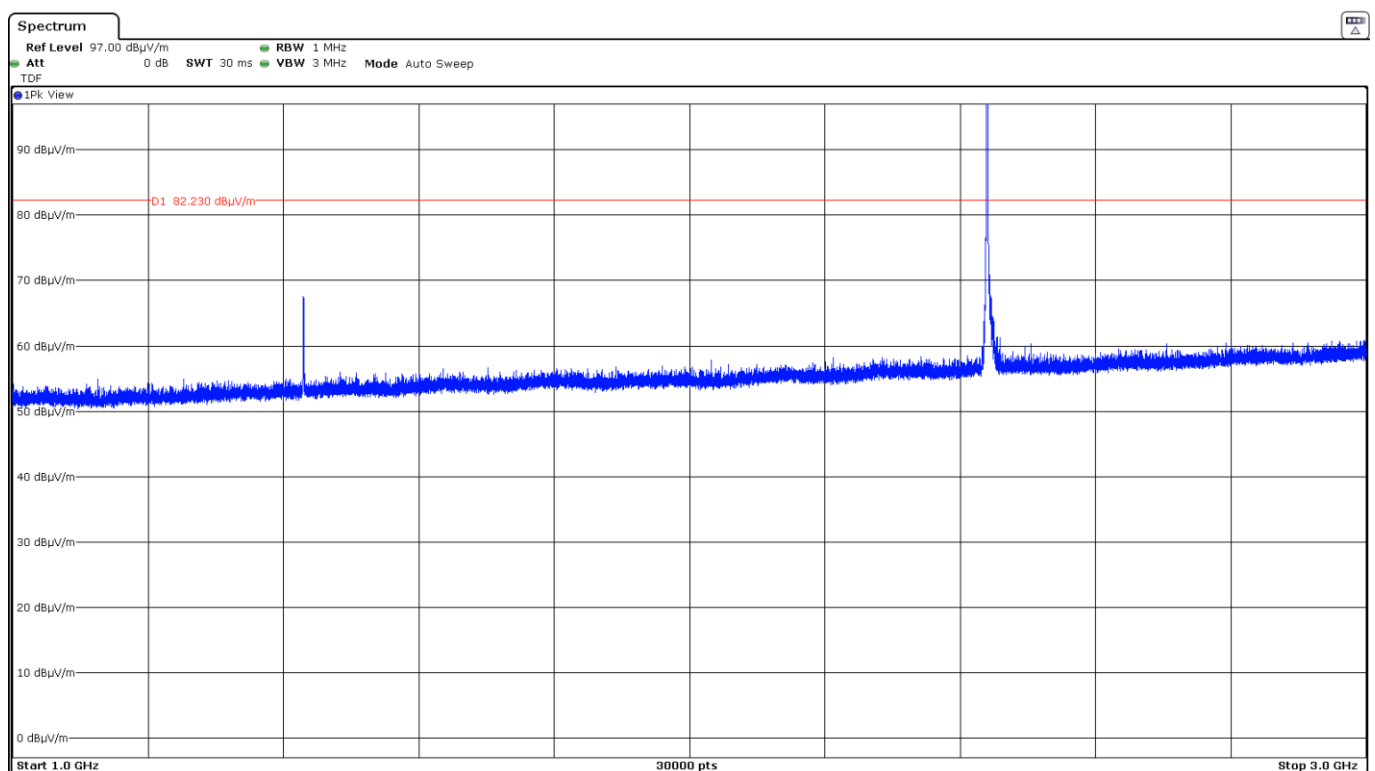
Verdict: PASS

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



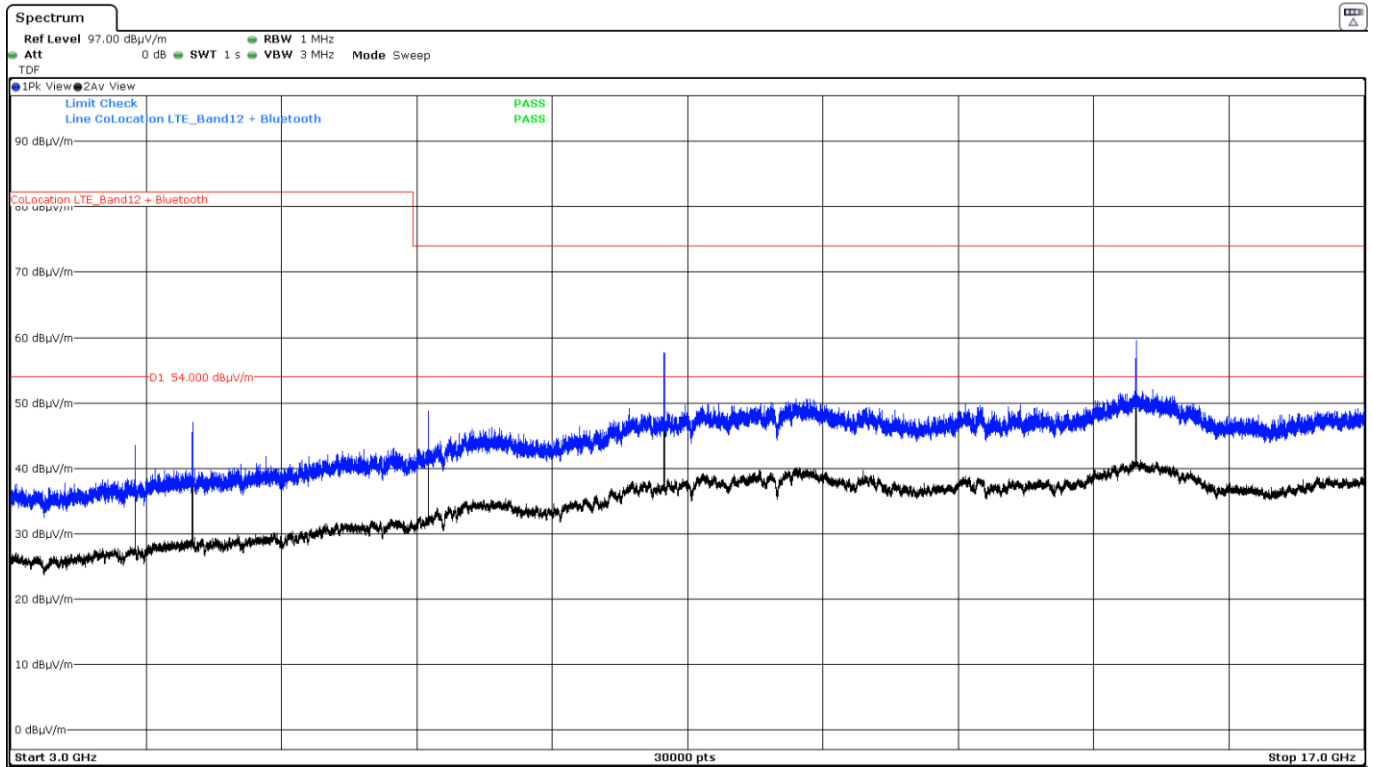
The peak above the limit is the carrier frequency LTE Band 12 (715.3 MHz)

FREQUENCY RANGE 1 – 3 GHz (worst case):

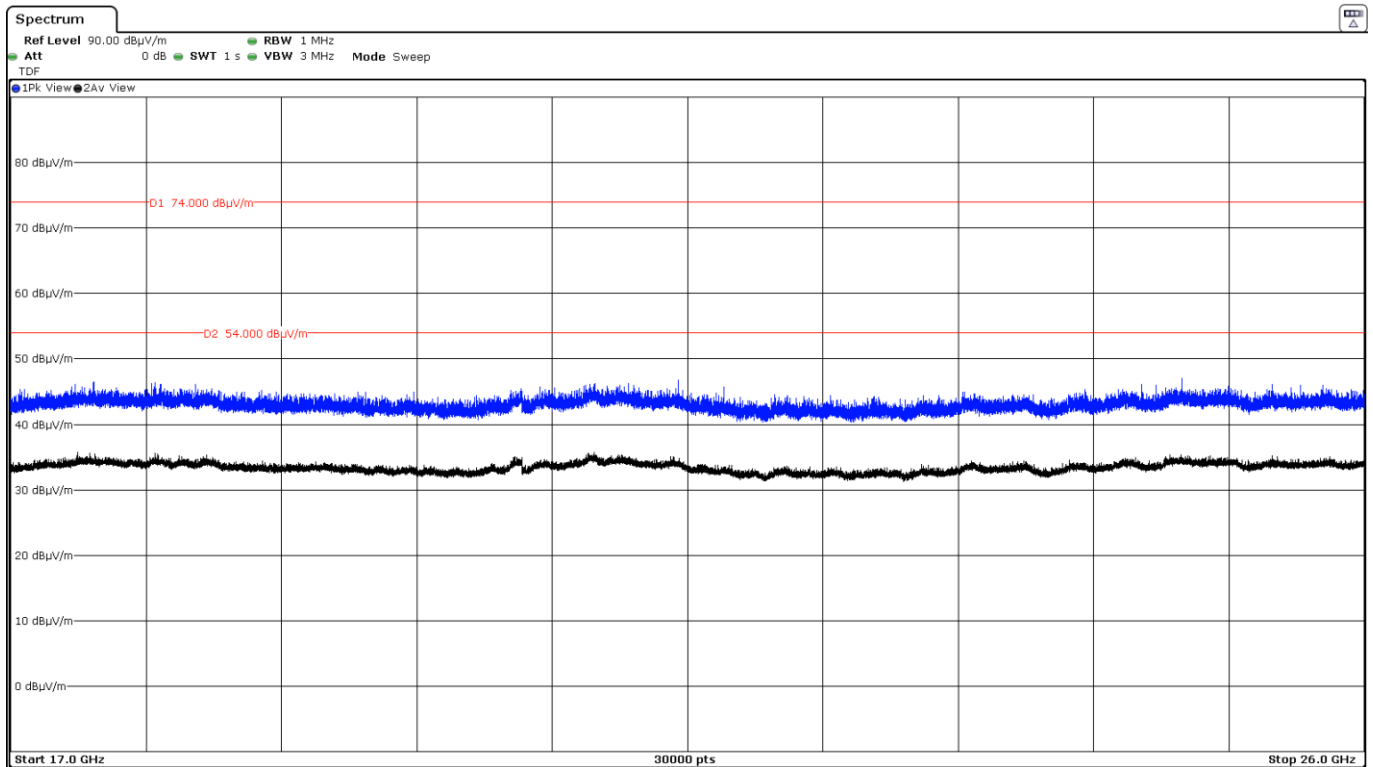


The peak above the limit is the carrier frequency Bluetooth Low Energy (2440 MHz).

FREQUENCY RANGE 3 – 17 GHz (worst case):



FREQUENCY RANGE 17 - 26 GHz (worst case):



- **Co-Location mode LTE Band 13, Bluetooth Low Energy.**

QPSK & 16QAM:

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

LTE Band 13: BW: 5 MHz. Middle Channel (782 MHz). RB Size: 1. RB Offset: 0.
Bluetooth Low Energy: Middle Channel (2440 MHz). GFSK.

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

Frequency Range	Detector	Limit at 3m (dBμV/m)
30 MHz to 7.87 GHz	Peak	$43 + 10 \log (P) \text{ dB} = -13 \text{ dBm} \rightarrow 82.23 \text{ dB}\mu\text{V/m}$
7.87 to 26 GHz	Peak	74 dBμV/m (*)
	Average	54 dBμV/m (*)

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

Frequency range 30 MHz - 1 GHz

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

Frequency range 1 - 26 GHz

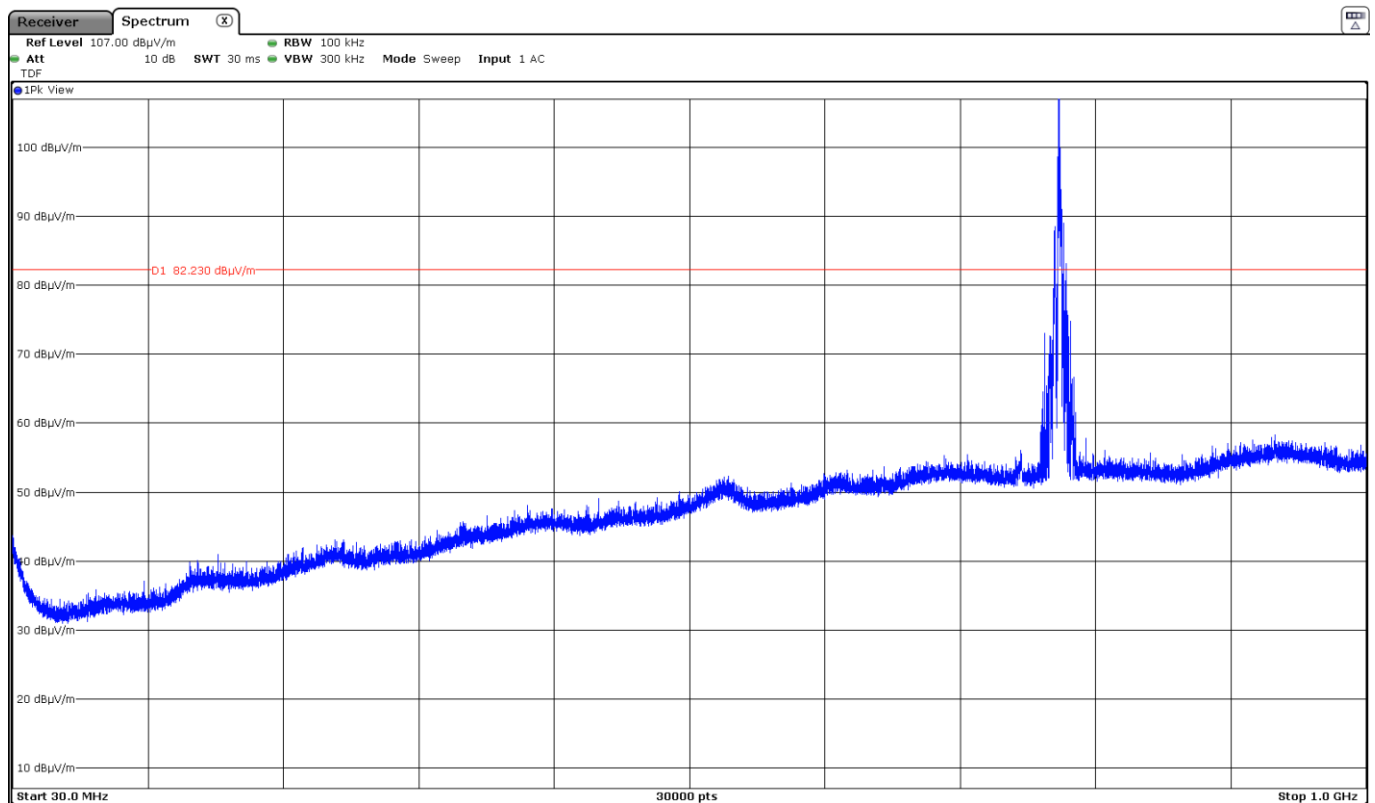
Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (GHz)	Polarization	Detector	E (dBμV/m)
1.55970	H	Peak	67.70

Measurement uncertainty (dB)	$< \pm 4.65$ for $f < 1 \text{ GHz}$ $< \pm 4.98$ for $f \geq 1 \text{ GHz}$ up to 17 GHz $< \pm 5.08$ for $f \geq 17 \text{ GHz}$ up to 26 GHz
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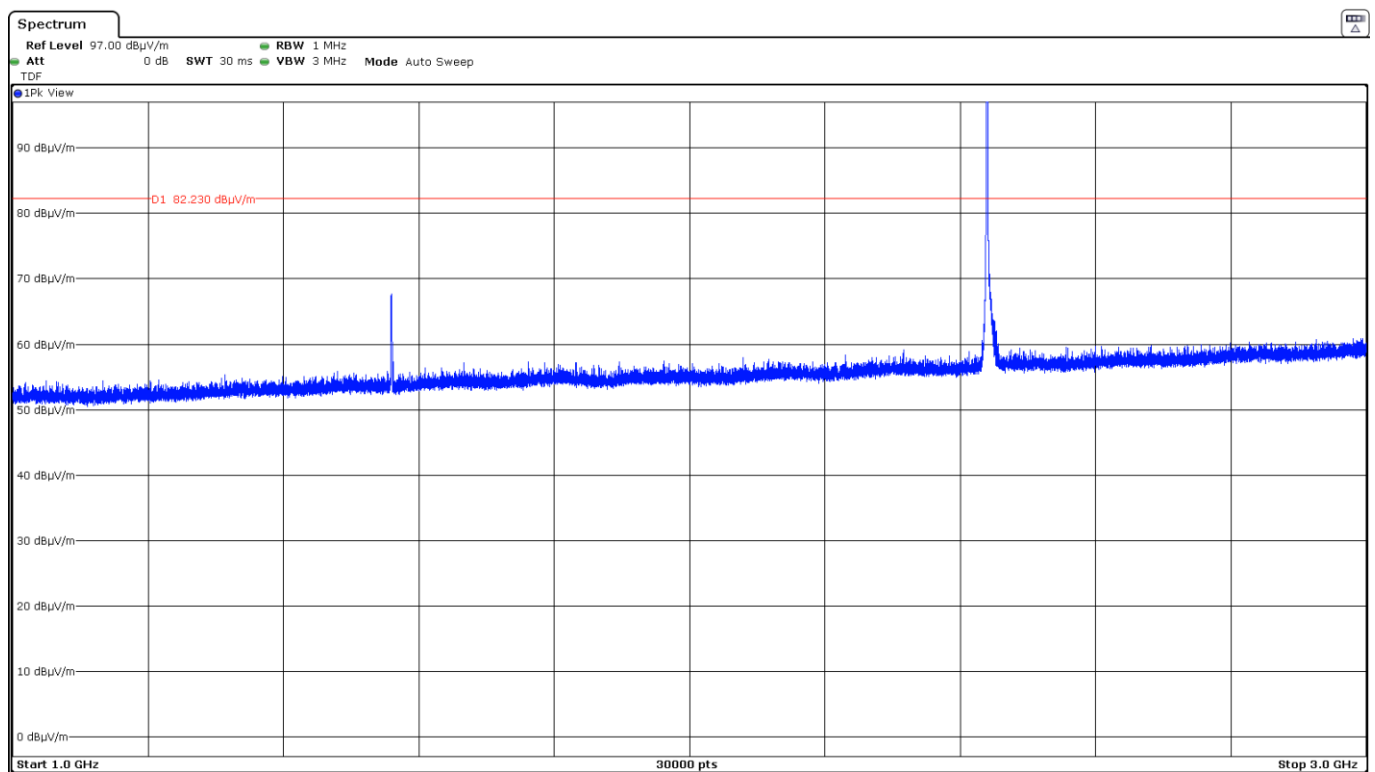
Verdict: PASS

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



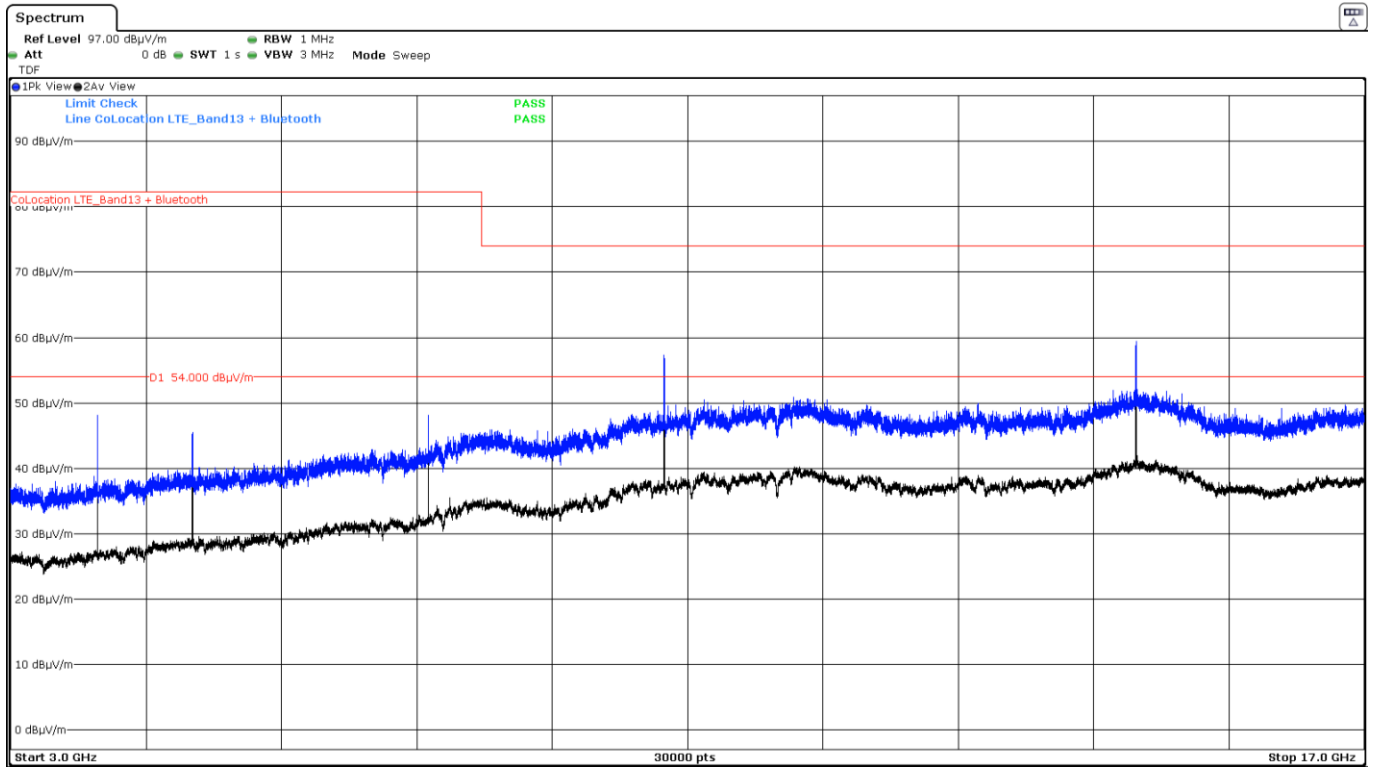
The peak above the limit is the carrier frequency LTE Band 13 (782 MHz)

FREQUENCY RANGE 1 – 3 GHz (worst case):

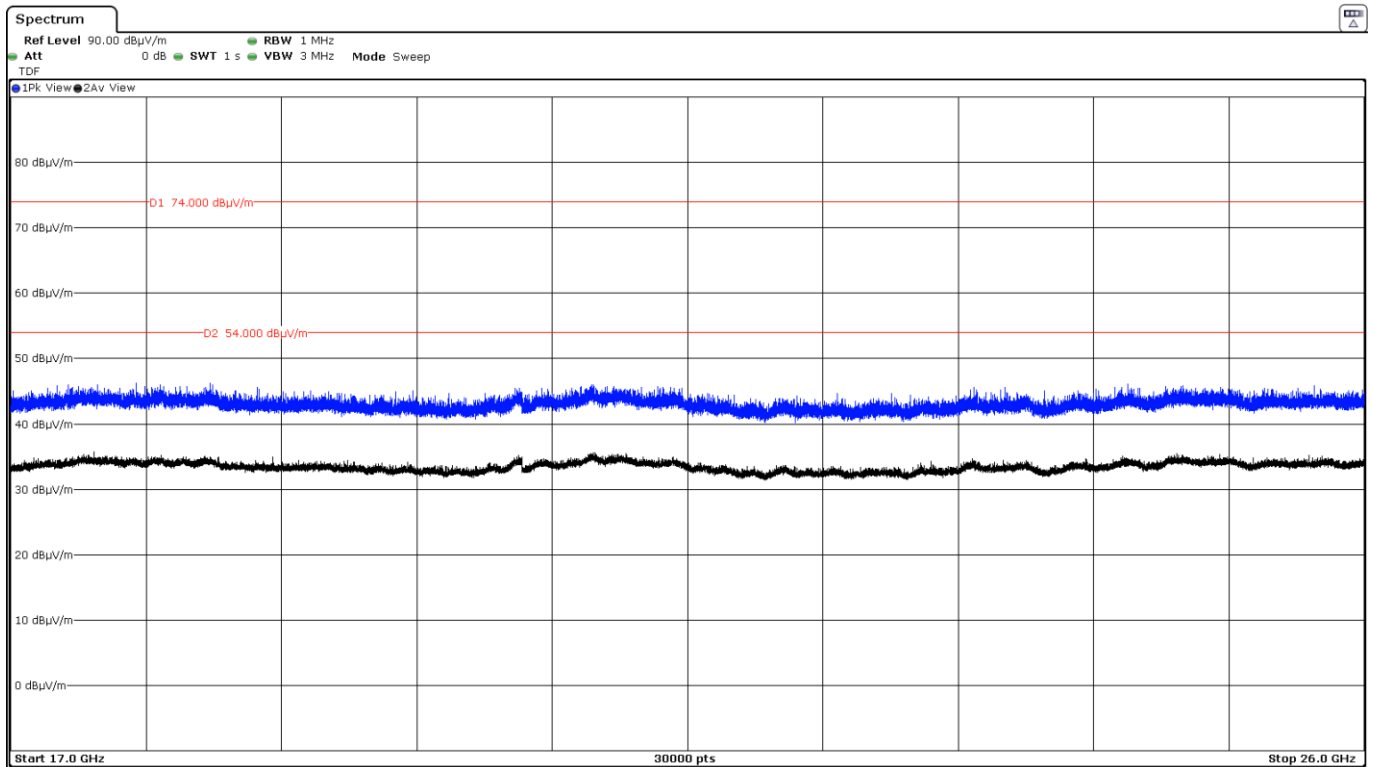


The peak above the limit is the carrier frequency Bluetooth Low Energy (2440 MHz).

FREQUENCY RANGE 3 – 17 GHz (worst case):



FREQUENCY RANGE 17 - 26 GHz (worst case):



Appendix D: Test results FCC 15.247, 15.209 / RSS-247, RSS-Gen

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TEST CONDITIONS

POWER SUPPLY (V):

V nominal: 12 Vdc
Type of Power Supply: DC External (car battery).

ANTENNA:

Type of Antenna for Bluetooth: Internal (SMD).
Maximum Declared Gain for Bluetooth LE: +2.2 dBi

Type of Antenna for SRD 125 kHz: Integral (Embedded LC resonant Ferrite).

TEST FREQUENCIES:

	Bluetooth LE	
Mode:	GFSK	
Channel Spacing:	1 MHz	
Frequency Range:	2400 MHz to 2483.5 MHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	Low: 37	2402

	SRD 125 kHz / ASK	
Mode:	Single Channel	
Channel Spacing:	Not Applicable	
Frequency Range:	125 kHz	
Transmit Channel:	Channel	Channel Frequency (kHz)
	Single: 1	125

The test set-up was made in accordance to the general provisions of FCC DTS Measurement 558074 D01 DTS Meas Guidance v05r02 dated April 2, 2019.

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:

* Bluetooth Low Energy: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in Bluetooth Low Energy / Low Channel and GFSK mode configuration.

* SRD 125 kHz: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in the single channel configuration supported by this radio.

TESTED SIMULTANEOUS TRANSMISSION MODES:

* **Co-location mode Bluetooth Low Energy, SRD 125 kHz**, with the EUT configured to simultaneously transmit two signals at maximum output power, Bluetooth Low Energy / Low Channel and GFSK, and SRD 125 kHz / Single Channel and ASK.

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 ($\mu\text{V/m}$)	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

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.

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 26 GHz.

The EUT was placed on a non-conductive stand at a 3 meter distance from the measuring antenna.

For radiated emissions in the range 9 kHz to 30 MHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 40 dB per decade is used to normalize the measured data for determining compliance.

In the range between 9 kHz and 30 MHz the measurements were made in the three different orientation planes of the loop antenna to determine the maximum received field.

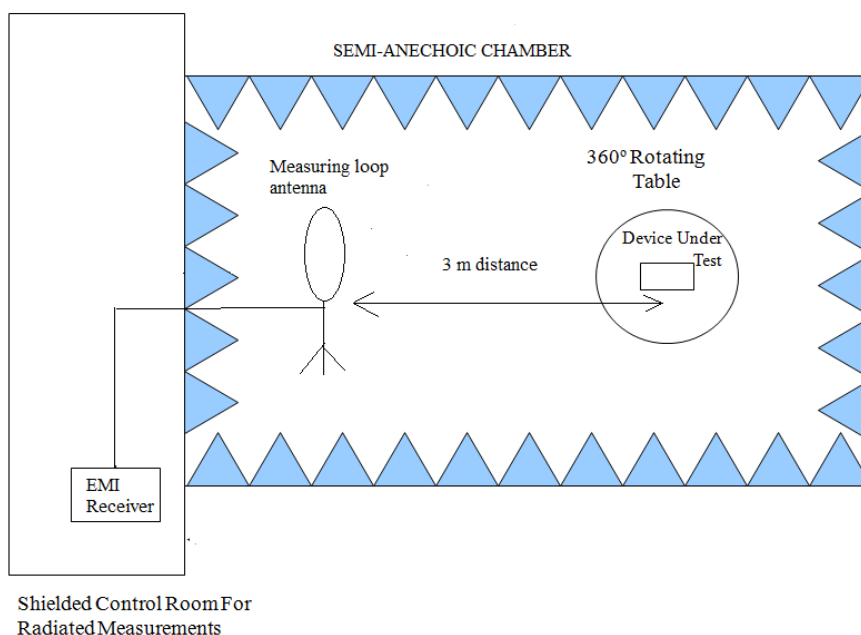
Detected emissions were maximized at each frequency by rotating the EUT and adjusting the measuring antenna height and polarization. The maximum meter reading was recorded.

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.

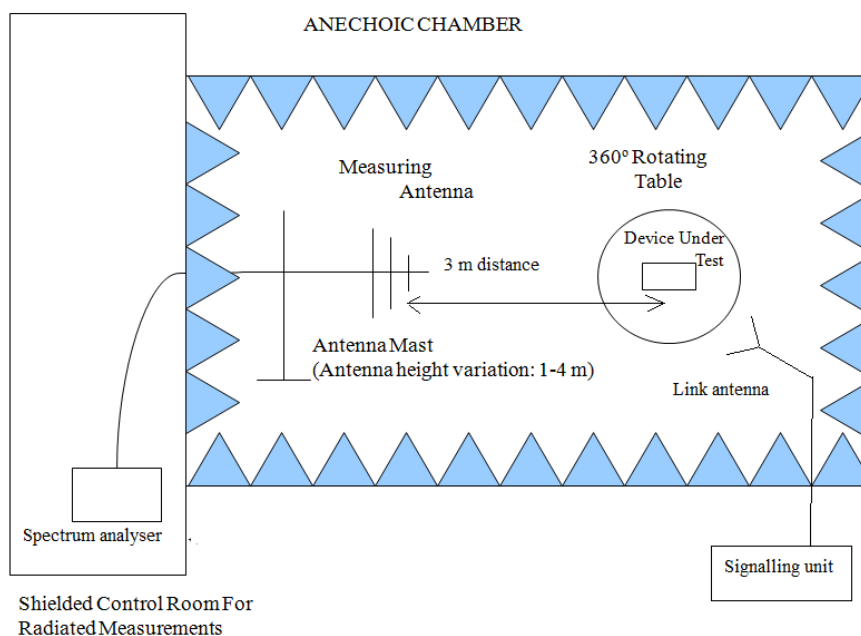
These measurements have been performed in order to check the impact of the Co-Location of all radio interfaces (that can be transmitting simultaneously).

TEST SETUP:

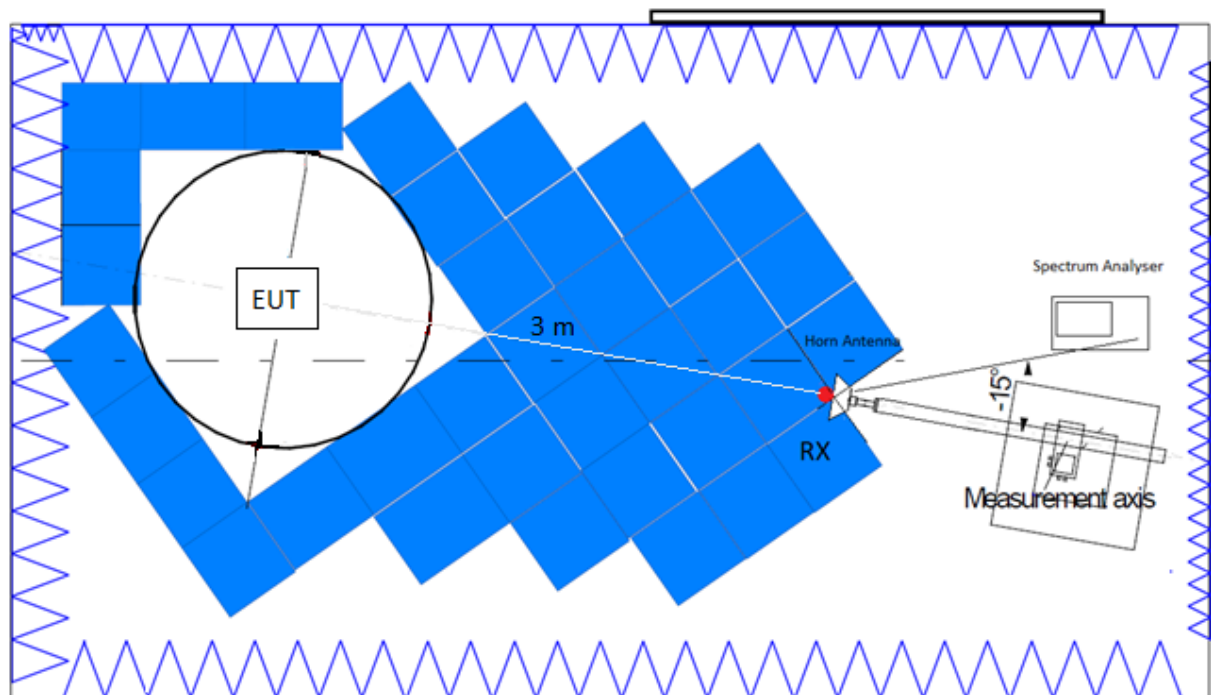
Radiated measurements setup $f < 30$ MHz:



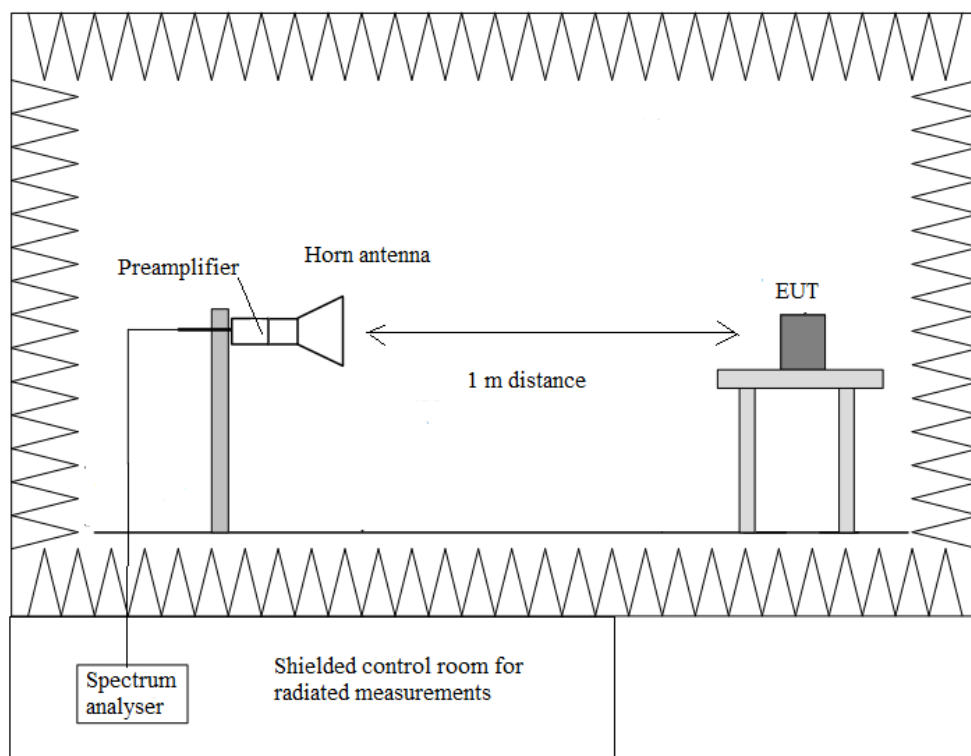
Radiated measurements setup from 30 MHz to 1 GHz.



Radiated measurements setup from 1GHz to 17 GHz:



Radiated measurements setup $f > 17$ GHz:



RESULTS:

- Co-Location mode Bluetooth Low Energy, SRD 125 kHz.**

Bluetooth Low Energy: Low Channel (2402 MHz).
SRD 125 kHz: Single Channel (125 kHz).

Frequency range 9 kHz - 30 MHz

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

Frequency range 30 MHz - 1 GHz

Spurious frequencies detected at less than 20 dB below the limit:

Spurious Frequency (MHz)	Emission Level (dBμV/m)	Polarization	Detector
32.021	21.40	V	Quasi Peak
43.532	24.90	V	Quasi Peak
63.999	24.50	V	Quasi Peak

Frequency range 1 - 26 GHz

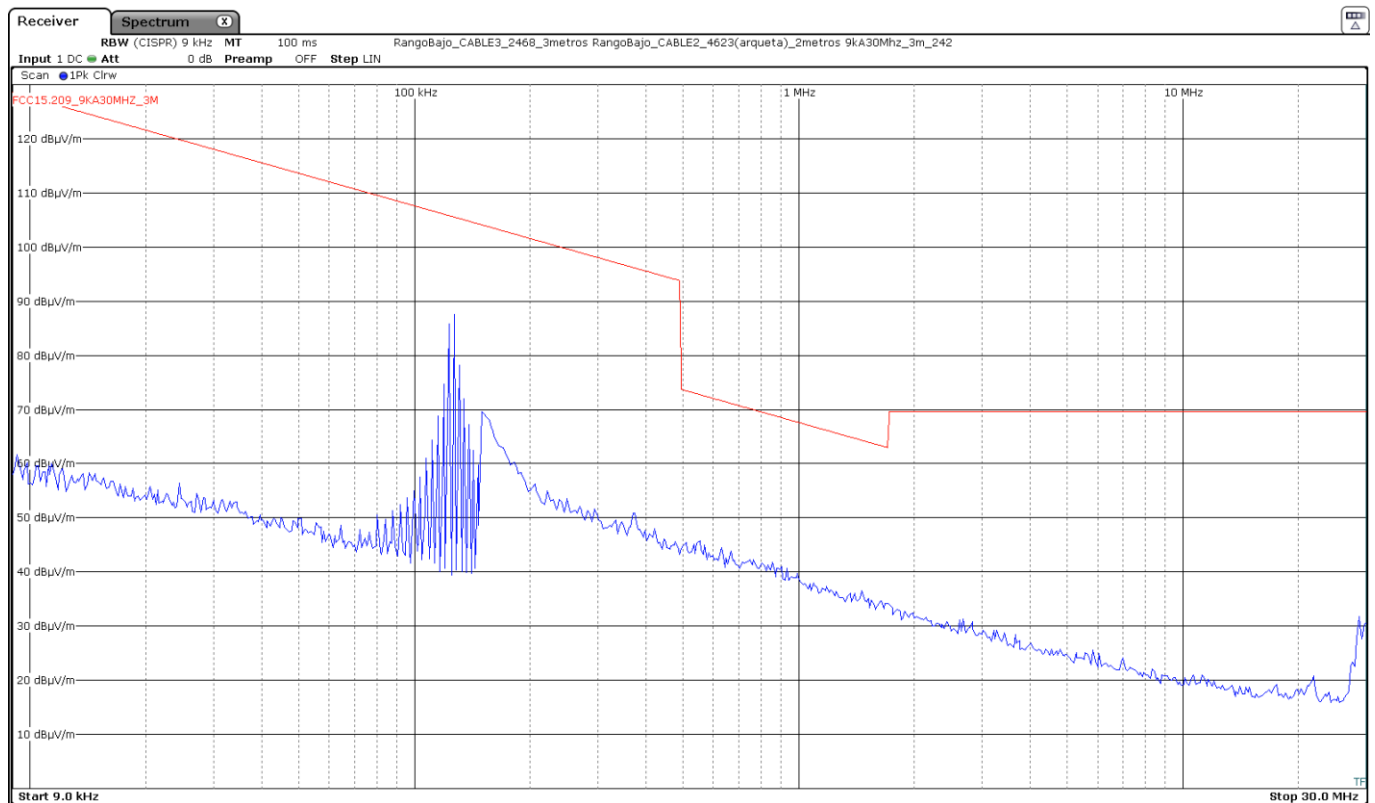
Spurious frequencies detected at less than 20 dB below the limit:

Spurious Frequency (GHz)	Emission Level (dBμV/m)	Polarization	Detector
4.80343	47.23	V	Peak
12.00877	51.54	H	Peak
19.21445	46.36	V	Peak
21.61578	45.46	V	Peak

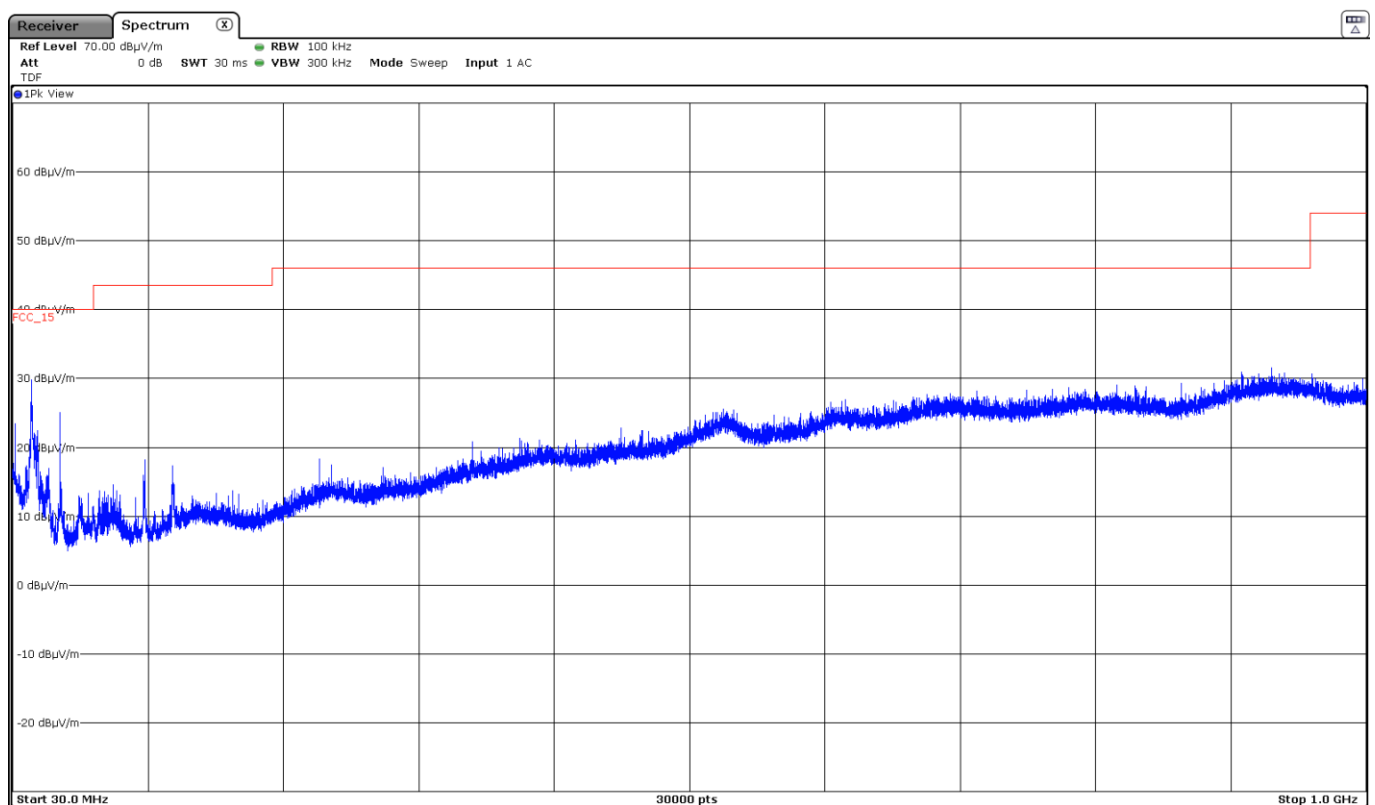
Measurement uncertainty (dB)	$< \pm 4.99$ for $f < 1$ GHz $< \pm 4.98$ for $f \geq 1$ GHz up to 17 GHz $< \pm 5.08$ for $f \geq 17$ GHz up to 26 GHz
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Verdict: PASS

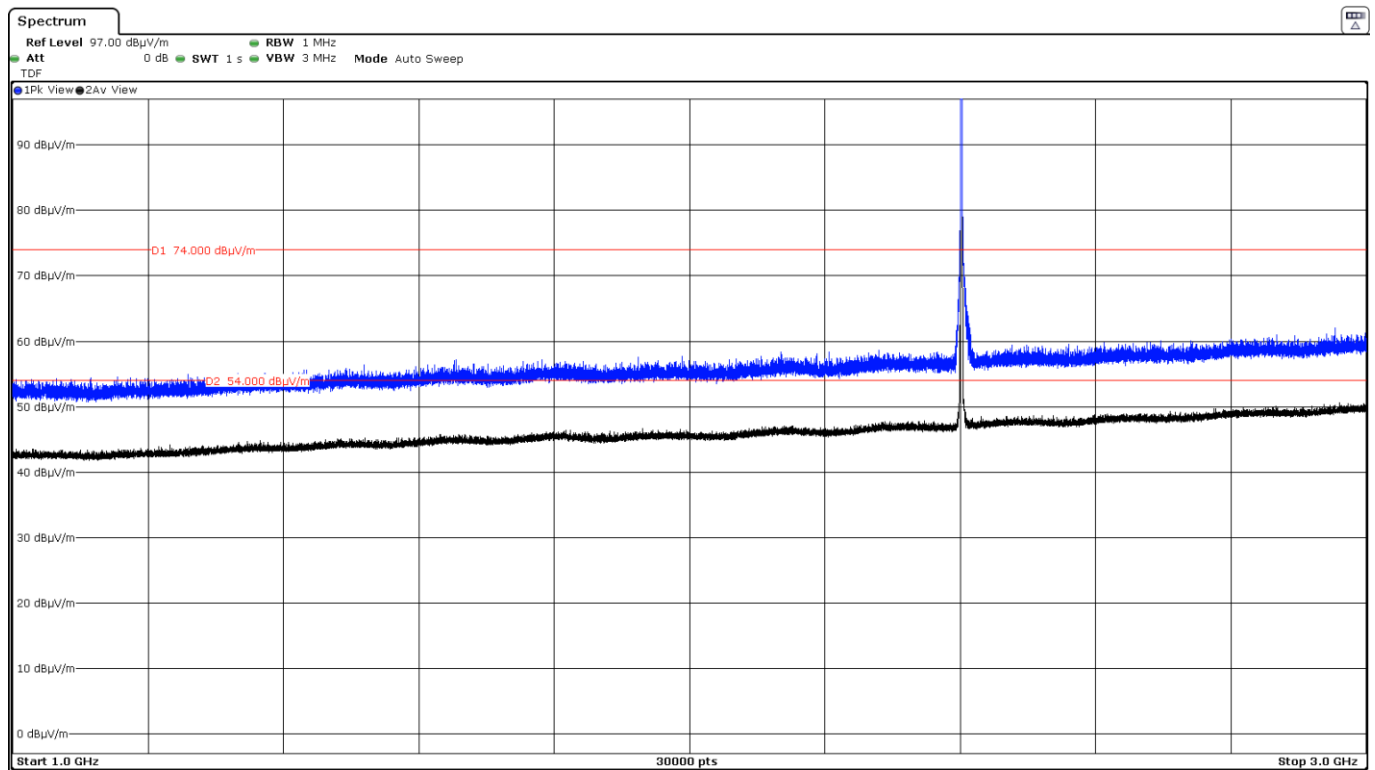
FREQUENCY RANGE 9 kHz - 30 MHz (worst case):



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

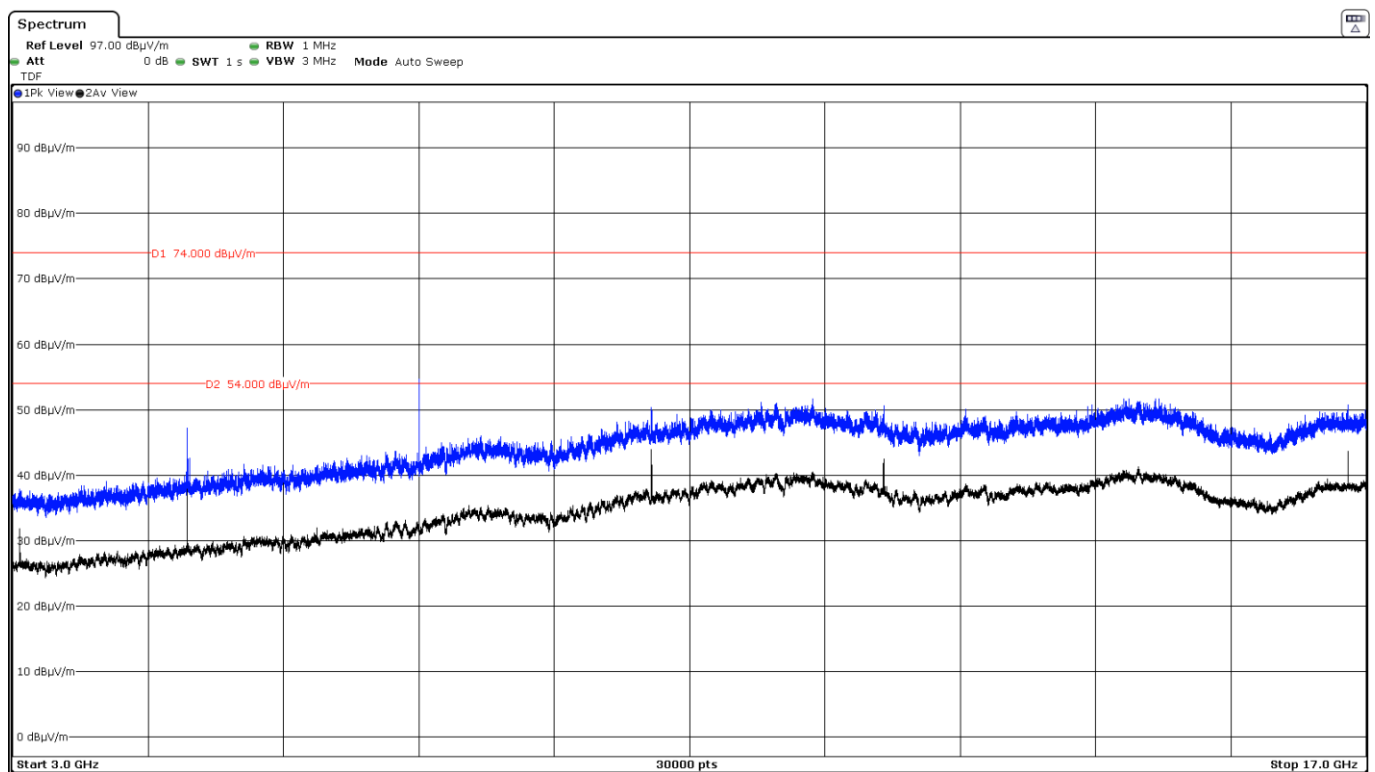


FREQUENCY RANGE 1 - 3 GHz (worst case):

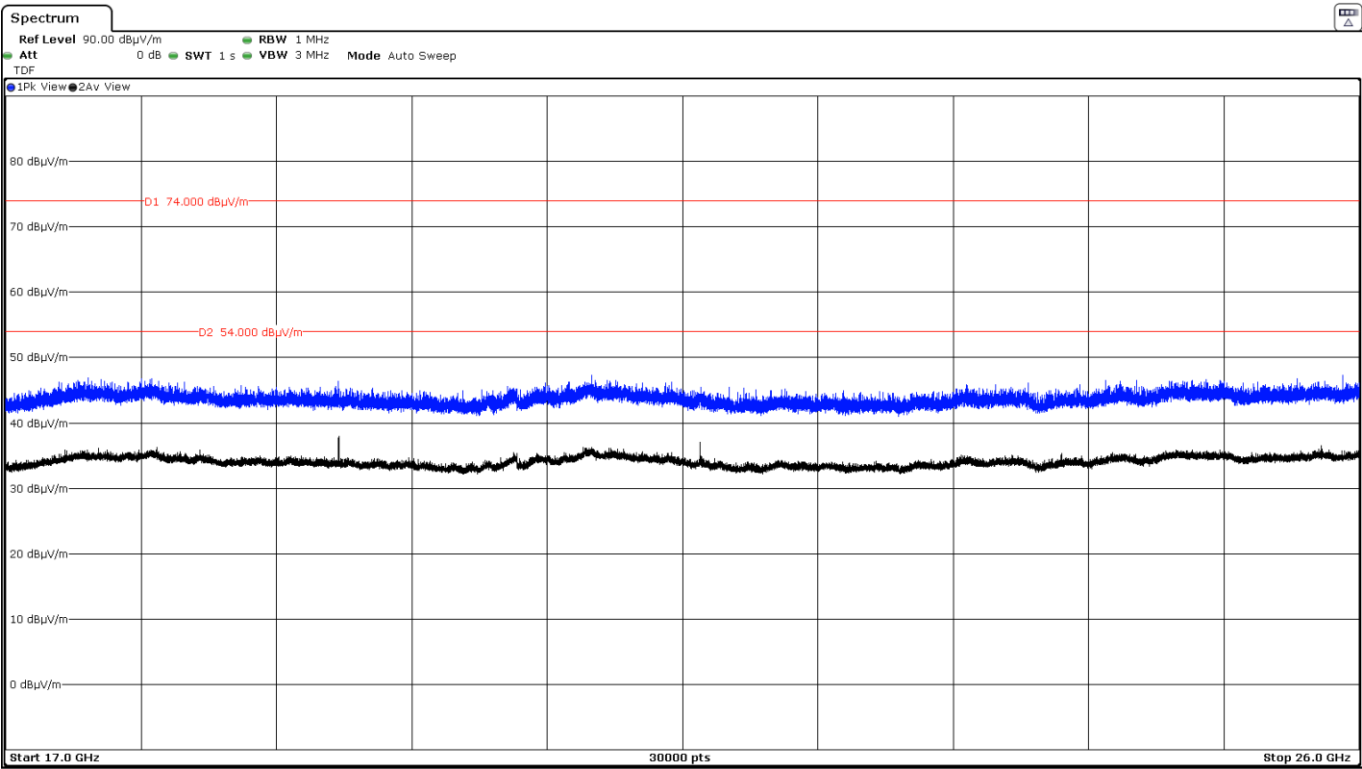


The peak above the limit is the carrier frequency Bluetooth Low Energy (2402 MHz).

FREQUENCY RANGE 3 - 17 GHz (worst case):



FREQUENCY RANGE 17 - 26 GHz (worst case):



Appendix E: Test results FCC 15.247, 15.209, 15.231 / RSS-247, RSS-Gen, RSS-210

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TEST CONDITIONS

POWER SUPPLY (V):

V nominal: 12 Vdc
Type of Power Supply: DC External (car battery).

ANTENNA:

Type of Antenna for Bluetooth: Internal (SMD).
Maximum Declared Gain for Bluetooth LE: +2.2 dBi

Type of Antenna for SRD 433.92 MHz: Internal (helix).

TEST FREQUENCIES:

	Bluetooth LE	
Mode:	GFSK	
Channel Spacing:	1 MHz	
Frequency Range:	2400 MHz to 2483.5 MHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	Low: 37	2402

	SRD 433.92 MHz / FSK	
Mode:	Single Channel	
Channel Spacing:	Not Applicable	
Frequency Range:	433.92 MHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	Single: 1	433.92

The test set-up was made in accordance to the general provisions of FCC DTS Measurement 558074 D01 DTS Meas Guidance v05r02 dated April 2, 2019.

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:

* Bluetooth Low Energy: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in Bluetooth Low Energy / Low Channel and GFSK mode configuration.

* SRD 433.92 MHz: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in the single channel configuration supported by this radio.

TESTED SIMULTANEOUS TRANSMISSION MODES:

* **Co-location mode Bluetooth Low Energy, SRD 433.92 MHz**, with the EUT configured to simultaneously transmit two signals at maximum output power, Bluetooth Low Energy / Low Channel and GFSK, and SRD 433.92 MHz / Single Channel and FSK.

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
Above 960	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.

FCC 15.231 (e), 15.209 (a) / RSS-Gen 8.9., RSS-210 A.1.2. Field strength and Emission limitations radiated (Transmitter).

The field strength of emissions from intentional radiators shall not exceed the following:

Fundamental frequency (MHz)	Field strength of fundamental (µV/m)	Field strength of spurious emission (µV/m)
40.66 – 40.70	1,000	100
70 – 130	500	50
130 - 174	500 to 1,500 **	50 to 150 **
174 - 260	1,500	150
260 - 470	1,500 to 5,000 **	150 to 500 **
Above 470	5,000	500

** : Linear Interpolations: The maximum permitted unwanted emission level is 20 dB below the maximum permitted fundamental level.

Spurious emissions shall be attenuated to the limits shown in the above table or to the general limits shown in Section 15.209 / RSS-Gen, whichever limit permits a higher field strength.

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.

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 26 GHz.

The EUT was placed on a non-conductive stand at a 3 meter distance from the measuring antenna.

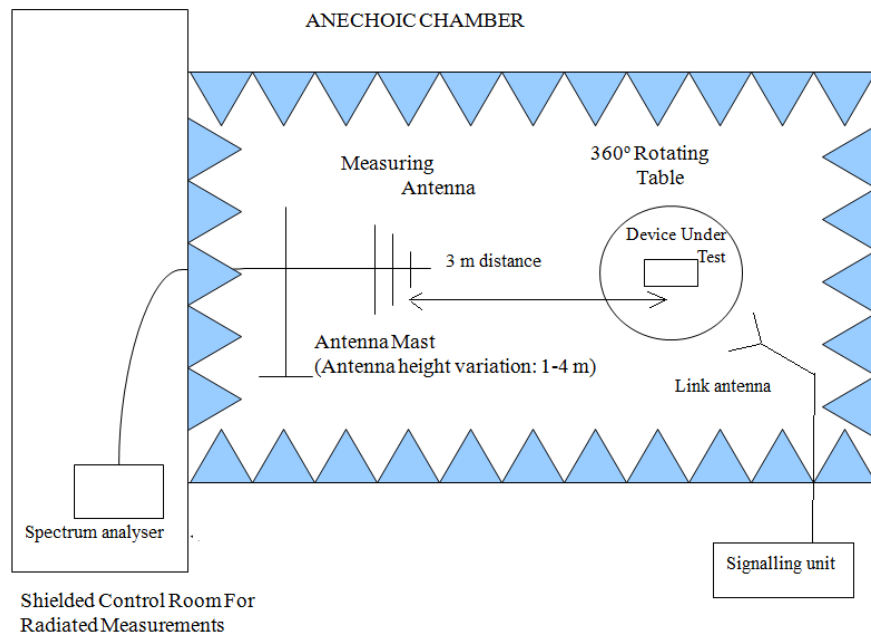
Detected emissions were maximized at each frequency by rotating the EUT and adjusting the measuring antenna height and polarization. The maximum meter reading was recorded.

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.

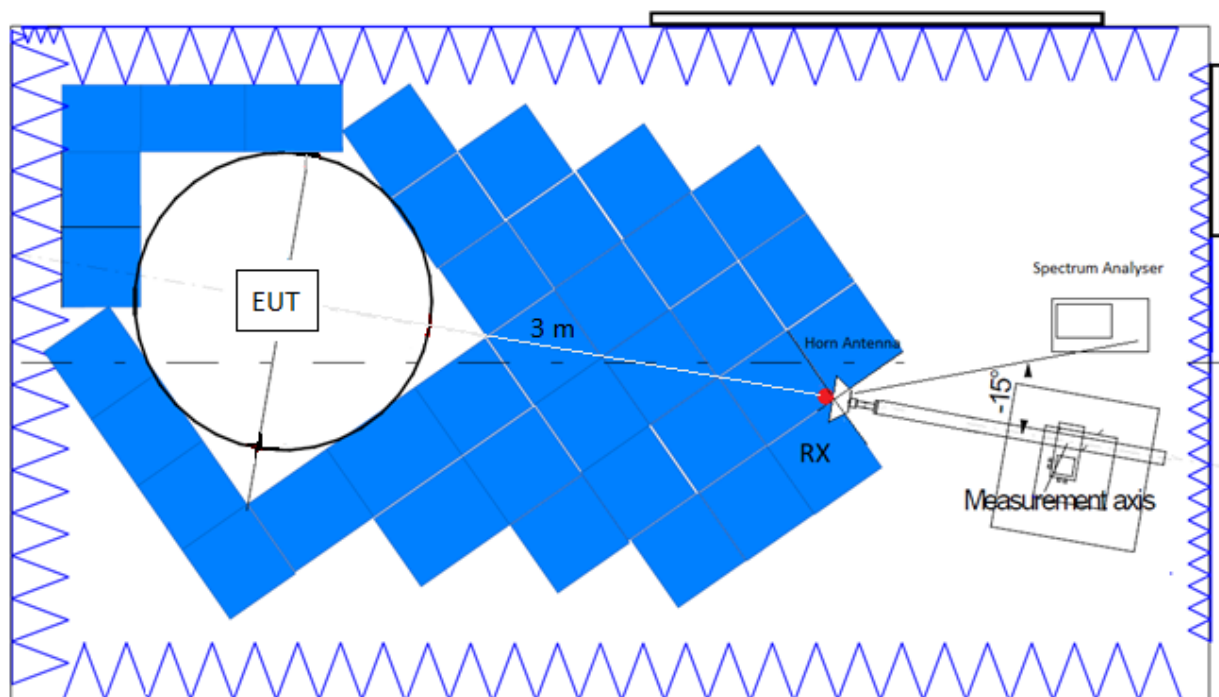
These measurements have been performed in order to check the impact of the Co-Location of all radio interfaces (that can be transmitting simultaneously).

TEST SETUP:

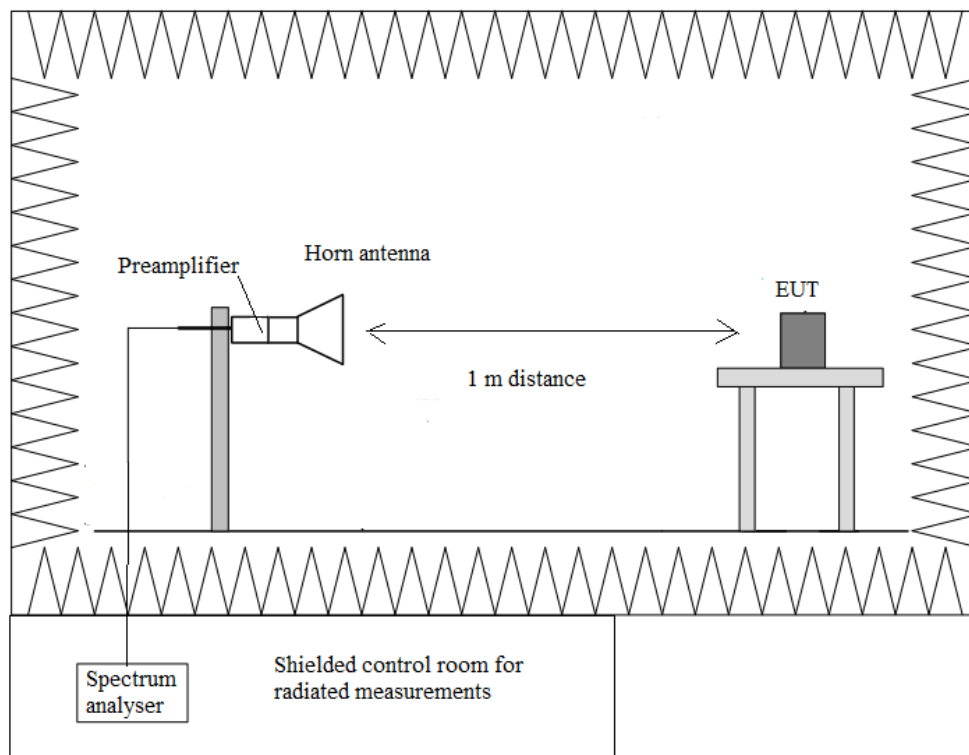
Radiated measurements below 1 GHz.



Radiated measurements setup from 1GHz to 17 GHz:



Radiated measurements setup $f > 17$ GHz:



RESULTS:

- Co-Location mode Bluetooth Low Energy, SRD 433.92 MHz.**

Bluetooth Low Energy: Low Channel (2402 MHz).
SRD 433.92 MHz: Single Channel (433.92 MHz).

Frequency range 30 MHz - 1 GHz

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

Frequency range 1 - 26 GHz

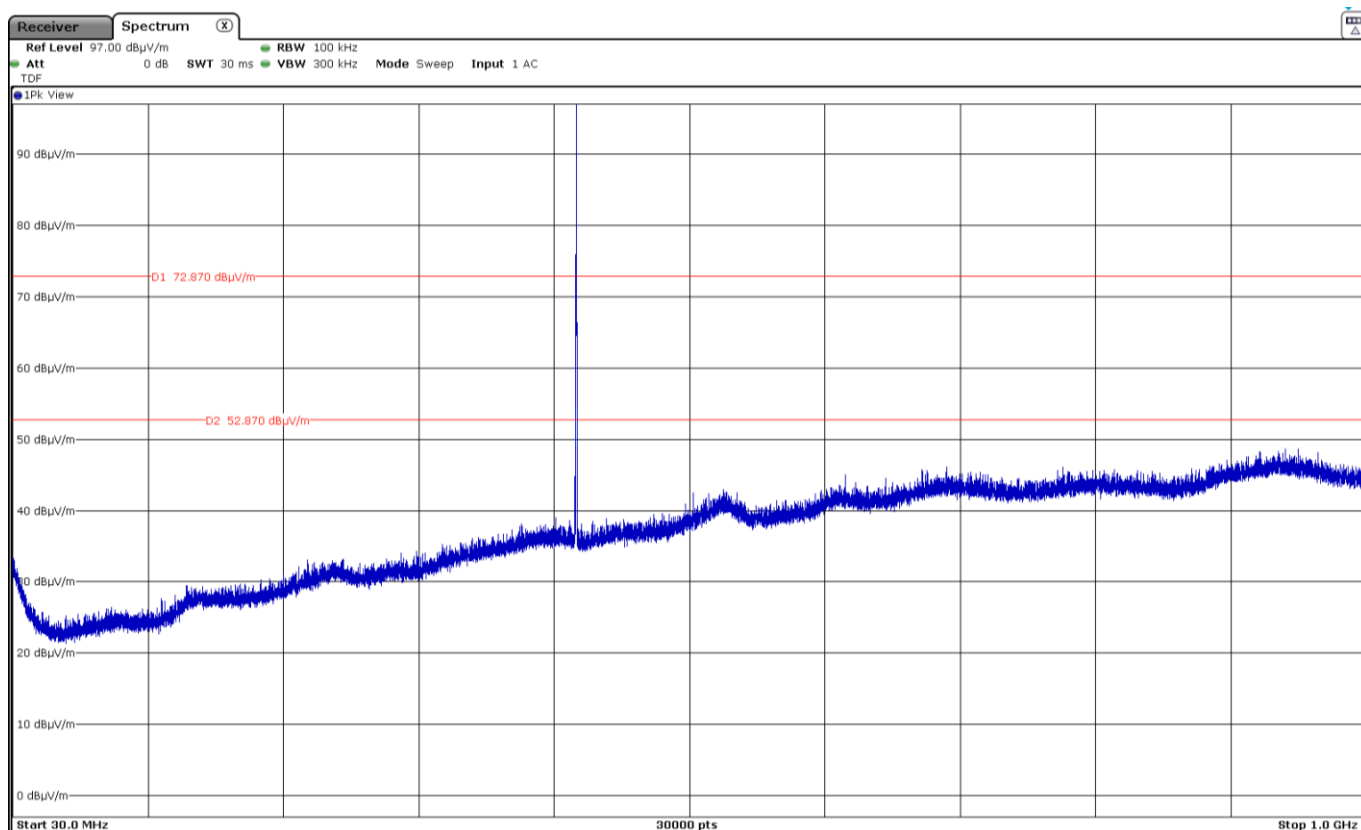
Spurious frequencies detected at less than 20 dB below the limit:

Spurious Frequency (GHz)	Emission Level (dBμV/m)	Duty Cycle Correction (dB)	Corrected Emission Level (dBμV/m)	Polarization	Detector
1.537499	56.01	-	56.01	V	Peak
	47.20	2.06	49.26		Average
4.80390	46.95	-	46.95	V	Peak
12.01110	50.35	-	50.35	H	Peak
19.21385	46.68	-	46.68	V	Peak

Measurement uncertainty (dB)	$\leq \pm 4.99$ for $f < 1$ GHz $\leq \pm 4.98$ for $f \geq 1$ GHz up to 17 GHz $\leq \pm 5.08$ for $f \geq 17$ GHz up to 26 GHz
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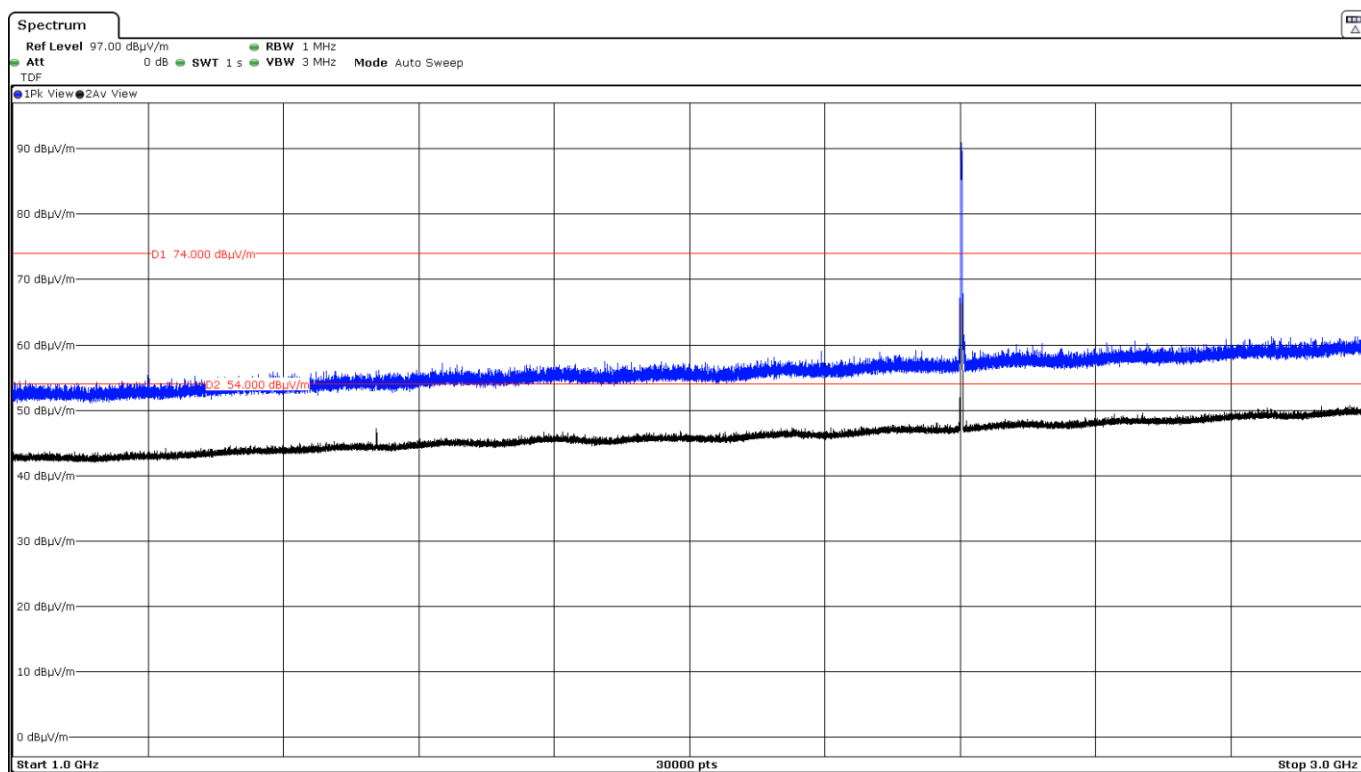
Verdict: PASS

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



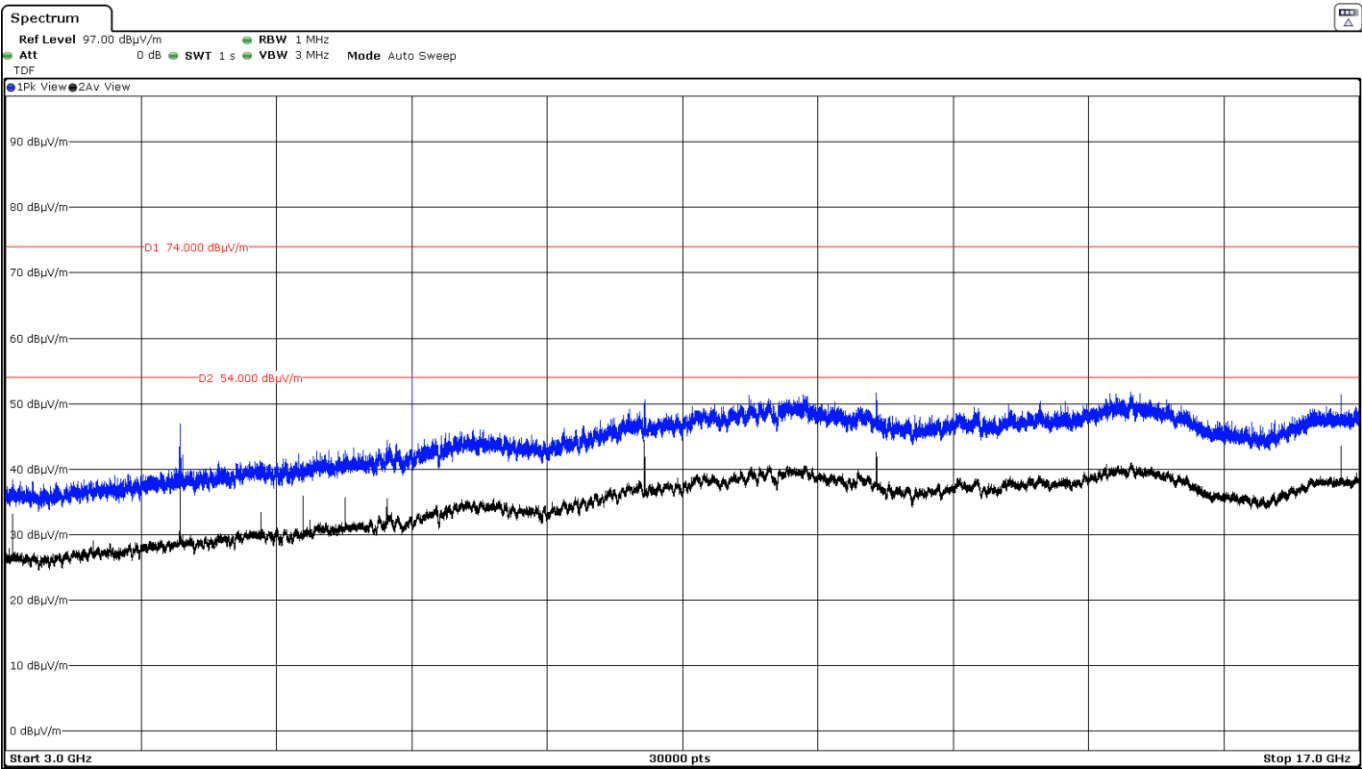
The peak above the limit is the carrier frequency SRD 433.92 MHz.

FREQUENCY RANGE 1 - 3 GHz (worst case):



The peak above the limit is the carrier frequency Bluetooth Low Energy (2402 MHz).

FREQUENCY RANGE 3 - 17 GHz (worst case):



FREQUENCY RANGE 17 - 26 GHz (worst case):

