DEKRA Testing and Certification, S.A.U.
Parque Tecnológico de Andalucía,
c/ Severo Ochoa nº 2 · 29590 Campanillas · Málaga · España
C.I.F. A29 507 456

Test report No:

NIE: 63721RRF.002A1

Partial Test report

USA FCC Part 22, Part 24, Part 27, Part 15.209, Part 15.247, Part 15.407, Part 15.31(h)
CANADA RSS-130, RSS-132, RSS-133, RSS-139, RSS-199, RSS-247, RSS-Gen

(*) Identification of item tested	A gateway device collecting data from sensors connected to the same Wirepas protocol mesh network as itself. The data is delivered from the device via cellular connection to a data center / cloud.
(*) Trademark	Thingsee Gateway Global
(*) Model and /or type reference	MTXG
Other identification of the product	FCC ID: 2AEU3TSGWGBL IC: 20236-TSGWGBL HW version: 0201 SW version: 2020.01.20.1
(*) Features	Passing sensor data to the internet. LED indicates operation mode. Device has a power button. Bluetooth, GPRS; EGPRS; LTE M1 band 2, 3, 4, 5, 8, 12, 13, 20, 26, 28; LTE NB1 band 2, 3, 4, 5, 8, 12, 13, 20, 26, 28
Applicant	HALTIAN PRODUCTS OY Yrttipellontie 1 D, 90230 Oulu, Finland
Test method requested, standard	USA FCC Part 15.407 (10-1-18 Edition): Unlicensed National Information Infrastructure (U-NII) Devices. General technical requirements. Band U-NII-3 (5725 MHz – 5850 MHz). USA FCC Part 15.247 (10-1-18 Edition): Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz. USA FCC Part 15.209 (10-1-18 Edition): Radiated emission limits; general requirements. USA FCC Part 22 (10-1-18 Edition). USA FCC Part 24 (10-1-18 Edition). USA FCC Part 27 (10-1-18 Edition). CANADA RSS-210 Issue 9 (August 2016). CANADA RSS-247 Issue 2 (February 2017). CANADA RSS-Gen Issue 5 (April 2018). CANADA RSS-130 Issue 1, Oct. 2013. CANADA RSS-132 Issue 3, Jan. 2013.

	CANADA RSS-133 Issue 6, Jan. 2013. CANADA RSS-139 Issue 3, Jul. 2015. CANADA RSS-199 Issue 3, Dec. 2016. -Transmitter out of band radiated emissions with simultaneous transmissions. 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. Guidance for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices 789033 D02 General U-NII Test Procedures New Rules v02r01 dated Dec 14, 2017. 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)	Jose Carlos Luque RF Lab. Supervisor 74841983Y JOSE CARLOS LUQUE (C:A29507456) Firmado digitalmente por 74841983Y JOSE CARLOS LUQUE (C:A29507456) Fecha: 2020.04.03 07:17:24 +02'00'
Date of issue	2020-04-03
Report template No	FDT08_22 (*) “Data provided by the client”

Index

Competences and guarantees 4
General conditions 4
Uncertainty 4
Data provided by the client 4
Usage of samples 5
Test sample description 5
Identification of the client 6
Testing period and place 6
Document history 6
Environmental conditions 6
Remarks and comments 8
Testing verdicts 9
Summary 9
Appendix A: Test results FCC Part 22 / RSS-132 10
Appendix B: Test results FCC Part 24 / RSS-133 29
Appendix C: Test results FCC Part 27 / RSS-139, RSS-130, RSS-199 47

Competences and guarantees

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

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

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

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

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

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

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

IMPORTANT: No parts of this report may be reproduced or quoted out of context, in any form or by any means, except in full, without the previous written permission of DEKRA Testing and Certification S.A.U.

General conditions

1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of DEKRA Testing and Certification S.A.U.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of DEKRA Testing and Certification S.A.U. and the Accreditation Bodies.

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 MTXG is used as a gateway device collecting data from sensors connected to the same Wirepas protocol mesh network as itself. The data is delivered from MTXG via Cat M1/2G/NB-Io1 cellular connection to a data center / cloud.

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

Usage of samples

Samples undergoing test have been selected by: The client.

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

Control Nº	Description	Model	Serial Nº	Date of reception
63721/003	Gateway	MTXG	--	2020/01/24
63721/008	AC/DC Adapter	SYS1561-1105	--	2020/01/24

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

Test sample description

Ports……:	Port name and description	Cable			
		Specified max length [m]	Attached during test	Shielded	Coupled to patient(3)
	micro USB power supply		☒	☐	☐
Supplementary information to the ports…… :	-				
Rated power supply .....:	Voltage and Frequency				
	☒	DC: USB power supply Sunny SYS1561-1105 (micro USB) rc			
Rated Power .....:	2,5W				
Clock frequencies.....:	32768Hz, 25MHz, 32MHz				
Other parameters .....:	-				
Software version .....:	2020.01.20.1				
Hardware version .....:	HW 01				
Dimensions in cm (W x H x D) ....:	105,8 x 62,9 x 16,2				
Mounting position .....:	☒	Wall/Ceiling mounted equipment			
Modules/parts.....:	Module/parts of test item		Type	Manufacturer	
	-				
Accessories (not part of the test item) .....:	Description		Type	Manufacturer	
	-				

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

Identification of the client

HALTIAN PRODUCTS OY

Yrttipellontie 1 D, 90230 Oulu, Finland

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2020-01-27
Date (finish)	2020-01-30

Document history

Report number	Date	Description
63721RRF.002	2020-03-17	First release
63721RRF.002A1	2020-04-03	First modification: correction of IC on front page. This modification of test report cancels and replaces the test report 63721RRF.002

Environmental conditions

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

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

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

Temperature	Min. = 15 ºC Max. = 35 ºC
Relative humidity	Min. = 20 % Max. = 75 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar

Remarks and comments

The tests have been performed by the technical personnel: Nicolás Salguero, Cristina Calle, Miguel Ángel Torres and Verónica García.

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.	Multi-device Controller EMCO 2090	N.A.	N.A.
4.	Multi-device Controller FRANKONIA FC-06	N.A.	N.A.
5.	AC Power Supply 135/270 V, 5/10/20/40 A ELGAR CS-AC35(351SL)	2019/09	2022/09
6.	Digital Multimeter FLUKE 179	2019/06	2020/06
7.	Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500	2019/05	2020/05
8.	Broadband Horn antenna 0.8-18 GHz ROHDE AND SCHWARZ R&S HF907	2017/02	2020/02
9.	EMI Test Receiver 7 GHz ROHDE AND SCHWARZ ESR7	2019/10	2021/10
10.	Biconical/Log Antenna 30 MHz - 6 GHz ETS LINDGREN 3142E	2017/04	2020/04
11.	High Pass Filter 3 - 18 GHz TEMSTRON /TEMWELL ST-3GA2833-HS	2019/10	2020/10
12.	Spectrum Analyzer ROHDE AND SCHWARZ FSW50	2018/02	2020/02
13.	RF Pre-amplifier, 40 dB ,1-18 GHz BONN ELEKTRONIK BLMA 0118-1M	2019/04	2020/04
14.	Low Noise Amplifier G>30dB, 18 - 40 GHz BONN ELEKTRONIK BLMA 1840-1M	2018/02	2020/02
15.	Broadband Horn antenna 1-18 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9120 D	2019/11	2022/11
16.	Broadband Horn Antenna 18 - 40 GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9170	2018/07	2021/07
17.	Wideband Radio Communication Tester ROHDE AND SCHWARZ CMW500	2019/02	2020/02
18.	Antenna Mast ETS LINDGREN 2175 MiniMast	N.A.	N.A.
19.	Field Probe Positioner MATURO FPP 2.3-M	N.A.	N.A.
20.	Low Pass Filter DC - 1 GHz TEMSTRON /TEMWELL ST-1GA3250-LS	2019/10	2020/10
21.	RF Pre-amplifier, G>38dB 30MHz-6GHz BONN ELEKTRONIK BLNA 0360-01N	2019/09	2020/09

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 / RSS-247 / RSS-130 / RSS 132 / RSS 133 / RSS 139 / RSS 199 / RSS-Gen PARAGRAPH		
Requirement – Test case	**Verdict**	**Remark**
FCC 15.209 (a), FCC 15.247 (d), FCC 15.407 (b), FCC 15.31(h) / RSS-Gen 8.9, RSS-247 5.5, 6.2.1.2, 6.2.2.2, 6.2.3.2 & 6.2.4.2 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 / RSS-199 4.5 Emission limitations radiated (Transmitter)	P	(1)
Supplementary information and remarks: (1) Only Co-location radiated spurious emission test was requested.		

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

INDEX

TEST CONDITIONS 12
Radiated emissions 14

TEST CONDITIONS

POWER SUPPLY (V):

V nonimal: 5 Vdc

Type of Power Supply: USB.

ANTENNA:

Type of Bluetooth LE Antenna: Internal (IFA)

Maximum Declared Gain for Bluetooth LE: +3 dBi

Maximum Declared Gain for CELLULAR:

LOW Bands	GAIN	ANTENNA TYPE
2G Band 850 MHz	-0.5 dBi	Internal (SMD)
LTE Cat-M1 Band 5	-0.5 dBi	Internal (SMD)
LTE NB-IoT Band 5	-0.5 dBi	Internal (SMD)

TEST FREQUENCIES - FCC PART 22:

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

	CELLULAR 2G	
Band:	GSM-850	
Frequency Range:	824 – 849 MHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	Middle: 190	836.6 MHz

	CELLULAR LTE Cat-M1 (Band 5) & LTE NB-IoT (Band 5)	
Band:	LTE Cat-M1 Band 5	
Frequency Range:	824 – 849 MHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	Middle: 20525	836.5 MHz (BW 1.4 MHz, RB Size 1, RB Offset 0, QPSK)
Band:	LTE NB-IoT Band 5	
Frequency Range:	824 – 849 MHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	Middle: 20525	836.5 MHz (BW tone 15 kHz, Offset 0, QPSK)

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

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

The EUT was tested in the following operating mode:

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

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

Transmission modes selected with each radio (based on preliminary testing that identified those corresponding to the worst cases)**:**

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

* CELLULAR LTE Cat-M1: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in LTE Cat-M1 Band 5 configuration as this channel was found to transmit higher EIRP than all the other LTE Cat-M1 channels.

* CELLULAR LTE NB-IoT: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in LTE NB-IoT Band 5 configuration as this channel was found to transmit higher EIRP than all the other LTE NB-IoT channels.

* BLUETOOTH: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in Bluetooth Low Energy (GFSK) mode configuration as this mode.

Simultaneous transmission modes selected:

1. CELLULAR 2G, BLUETOOTH Co-Location, with the EUT configured to simultaneously transmit two signals at maximum output power, CELLULAR 2G in GSM-850, Bluetooth Low Energy / GFSK.

2. CELLULAR LTE Cat-M1, BLUETOOTH Co-Location, with the EUT configured to simultaneously transmit two signals at maximum output power, CELLULAR LTE Cat-M1 in Band 5, Bluetooth Low Energy / GFSK.

3. CELLULAR LTE NB-IoT, BLUETOOTH Co-Location, with the EUT configured to simultaneously transmit two signals at maximum output power, CELLULAR LTE NB-IoT in Band 5, Bluetooth Low Energy / 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
960 - 25000	500	54	3

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

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

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

2G Band GSM-850, LTE Cat-M1 Band 5, LTE NB-IoT Band 5. FCC §2.1053 & §22.917 / RSS-132 Clause 5.5.:

FCC §22.917:

(a) Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

RSS-132 Clause 5.5:

i. In the first 1.0 MHz band immediately outside and adjacent to each of the sub-bands specified in Section 5.1, the power of emissions per any 1% of the occupied bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10p (watts).

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

METHOD:

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

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

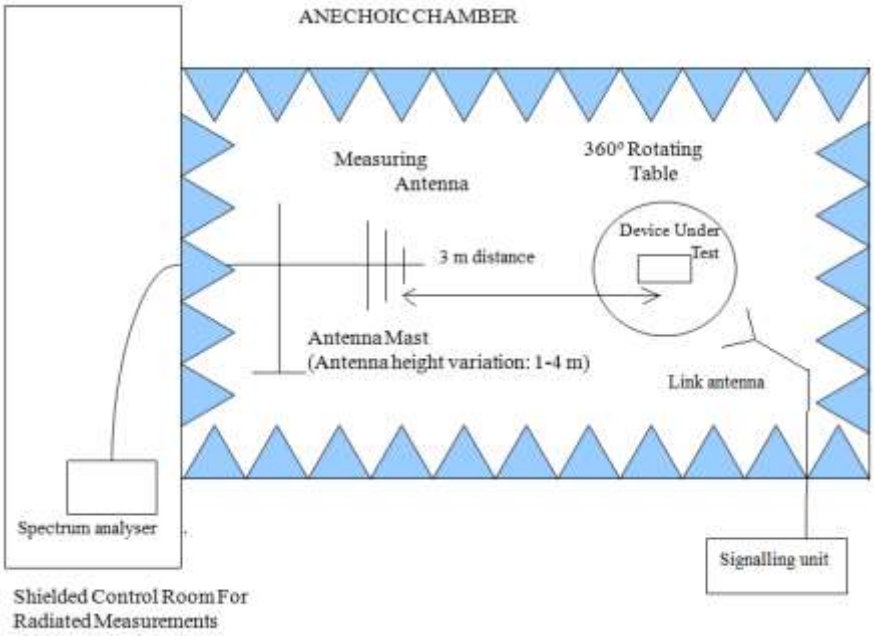
The EUT was placed on a non-conductive stand at a 3 meter distance from the measuring antenna for measurements below 1 GHz and at 1 m distance for measurements above 1 GHz.
Detected emissions were maximized at each frequency by rotating the EUT and adjusting the measuring antenna height and polarization.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

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

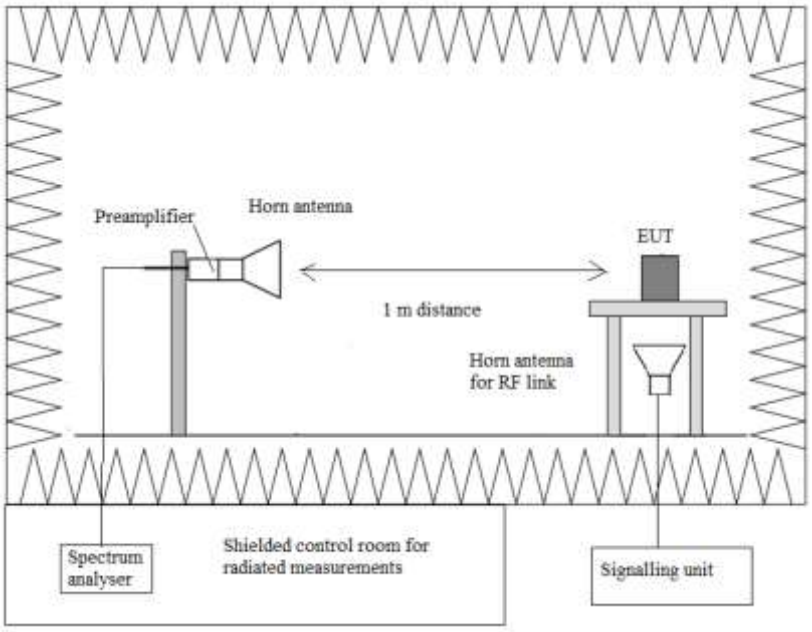
These measurements have been performed in order to check the impact of the Co-Location of all radio interfaces (that can be transmitting simultaneously).

TEST SETUP:

Radiated measurements below 1 GHz.



Radiated measurements above 1 GHz.



RESULTS:

- **Mode 2G Band GSM-850, Bluetooth Low Energy:**

GPRS & EDGE:
A preliminary scan determined the GPRS modulation in the Middle Channel as the worst case.

2G Band GSM-850:	GPRS, Middle Channel (836.6 MHz).
Bluetooth Low Energy:	GFSK, 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 8 GHz	PK	43 + 10 log (P) dB = -13 dBm -> 82.23 dBµV/m OR -21.23 dBm -> 74 dBµV/m (*)
8 GHz to 26 GHz	PK	74 dBµV/m (**)
	AVG	54 dBµV/m (*) (**)

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

(**) Radiated emissions which fall in the non-restricted bands.

Frequency range 30 MHz - 1 GHz

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

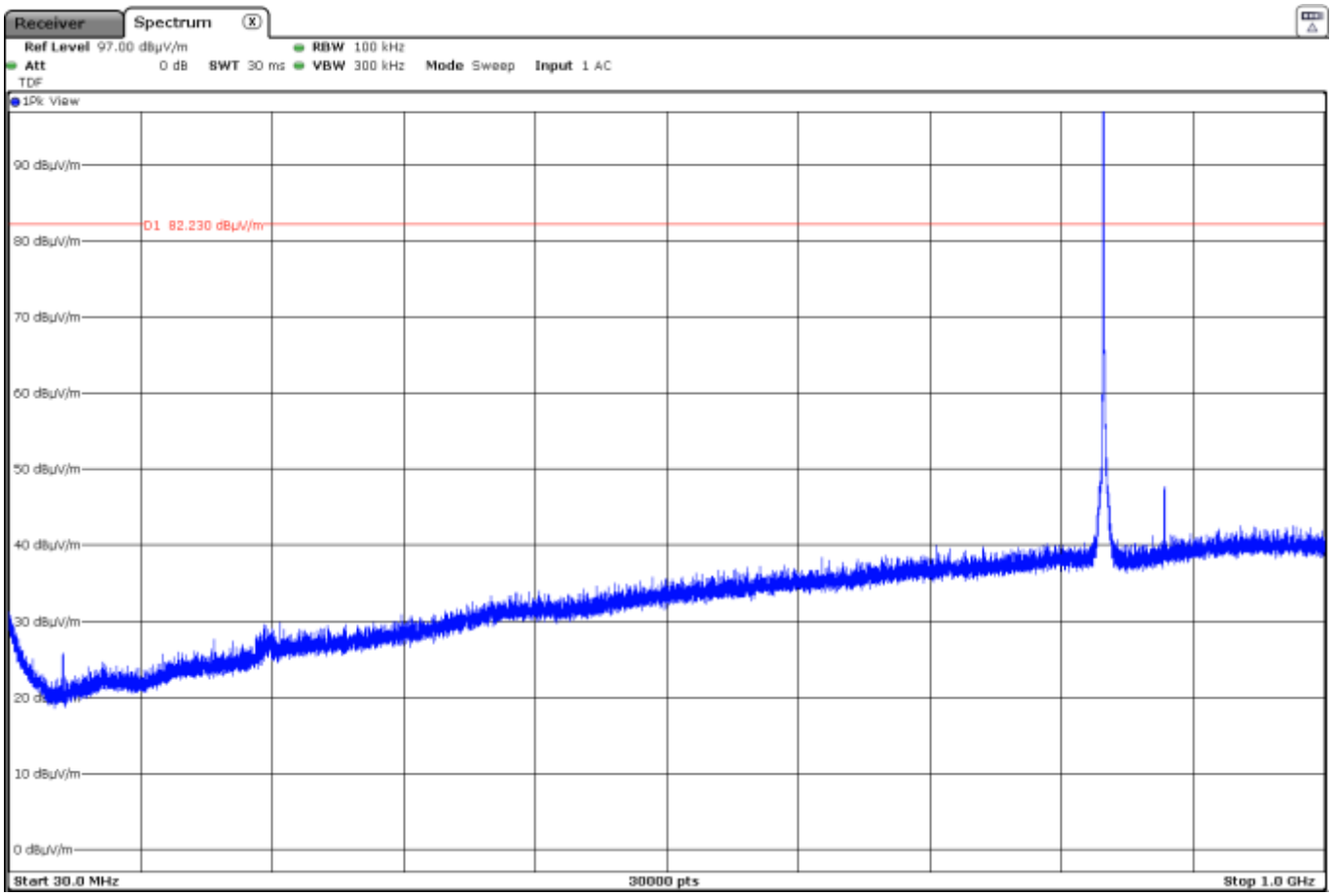
Frequency range 1 - 26 GHz

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

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

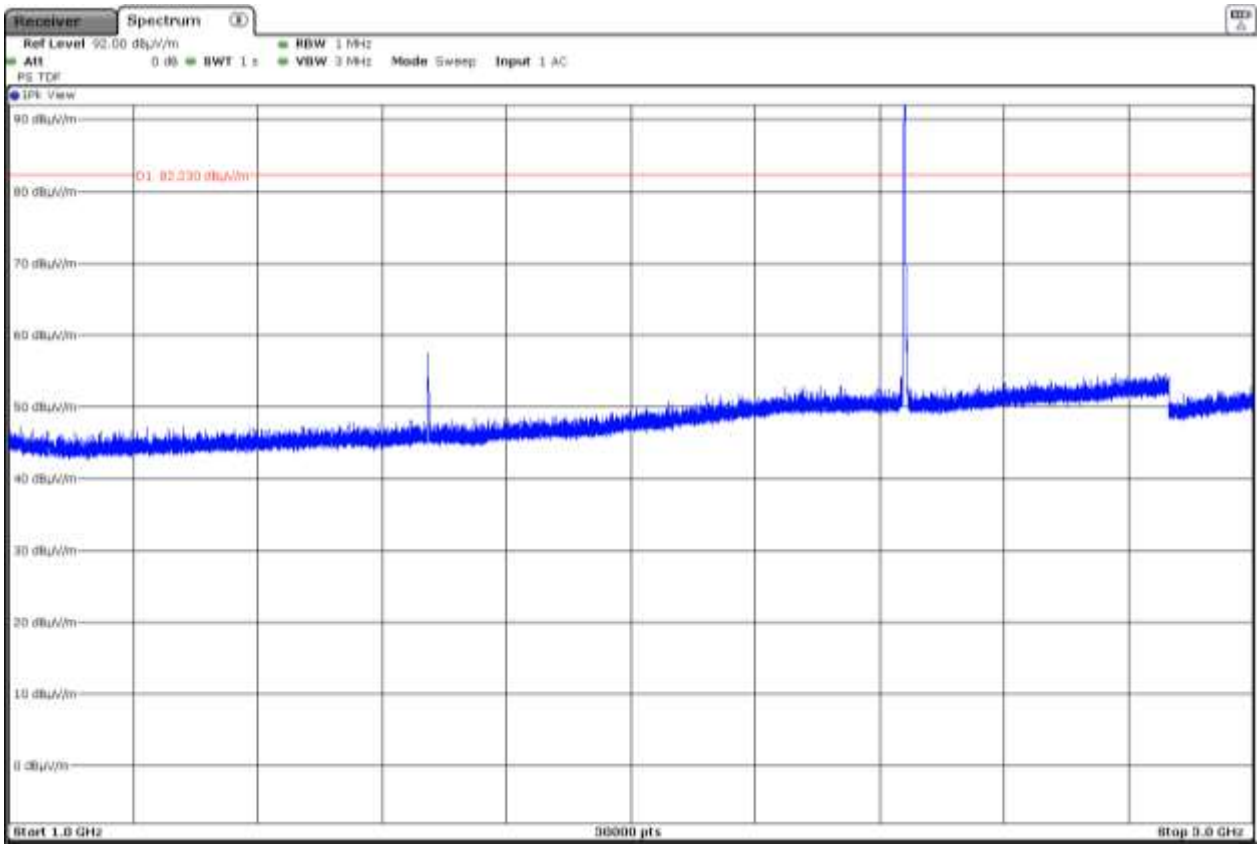
Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz



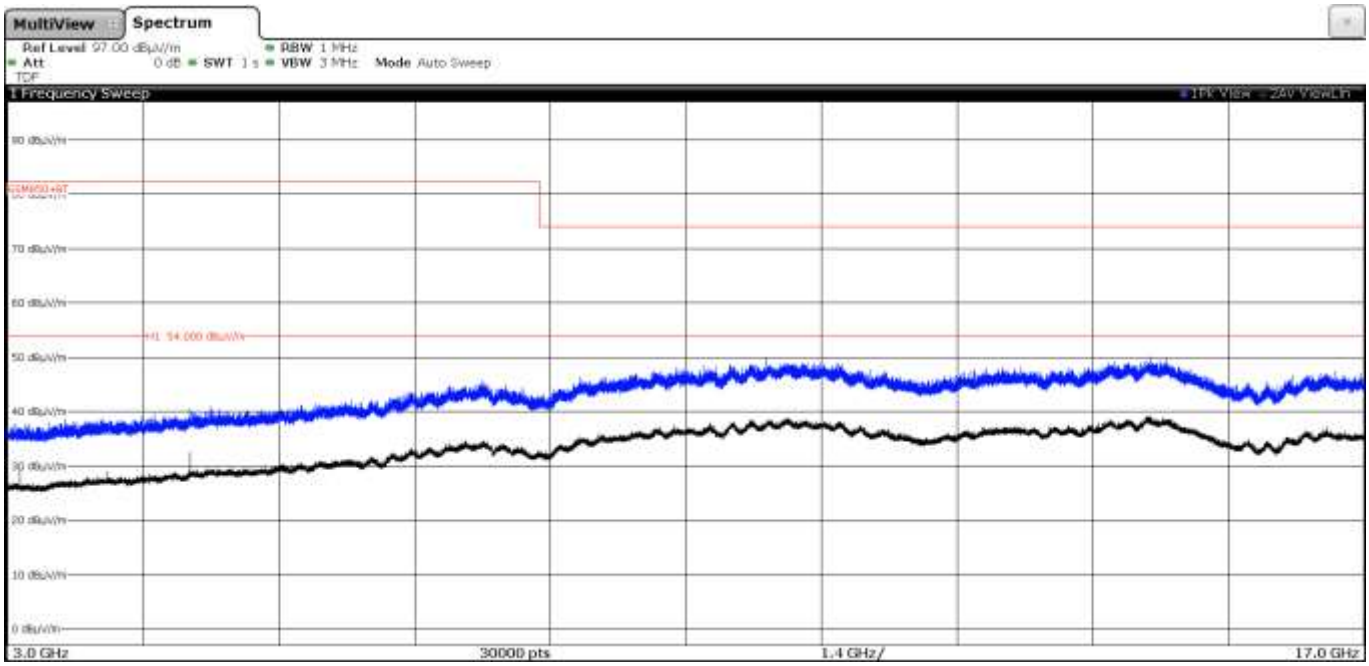
The peak above the limit is the Carrier frequency of the 2G Band GSM-850 (836.6 MHz). The other peak is the Downlink Carrier frequency 2G Band GSM-850 (881.6 MHz).

FREQUENCY RANGE 1 - 3 GHz

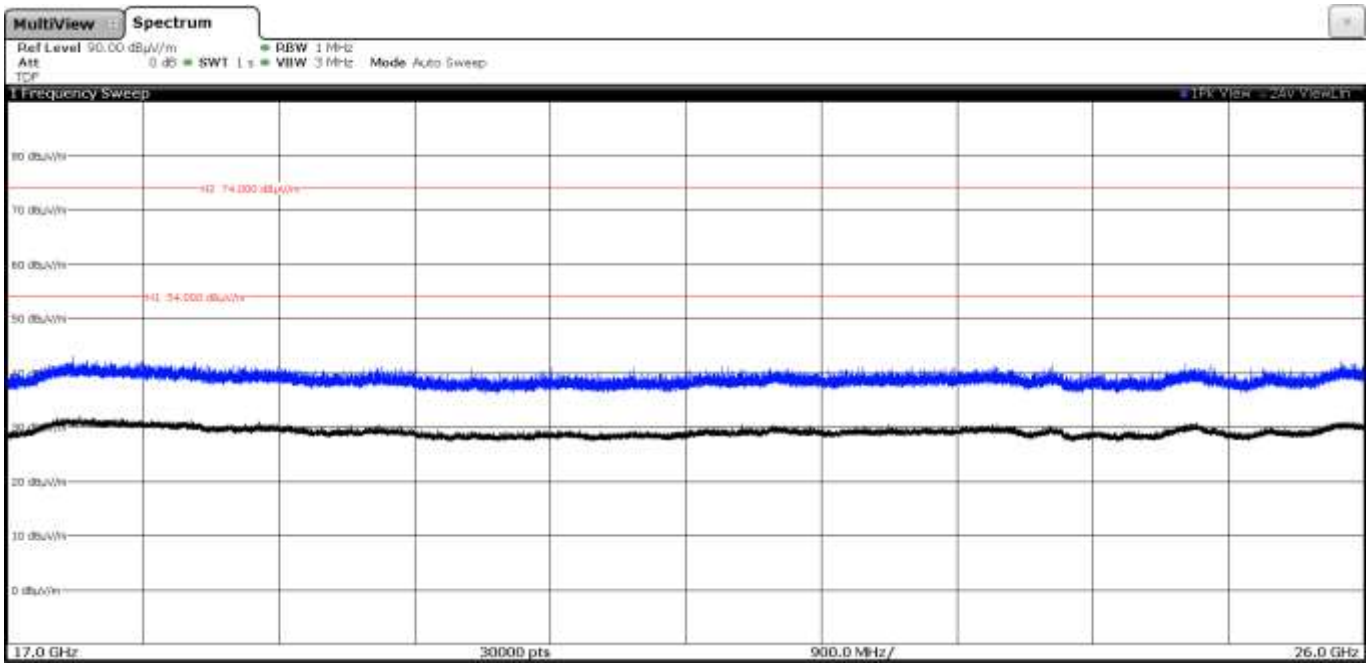


The peak above the limit is the Carrier frequency of the Bluetooth Low Energy.

FREQUENCY RANGE 3 – 17 GHz



FREQUENCY RANGE 17 - 26 GHz



- **Mode LTE Cat-M1 Band 5, Bluetooth Low Energy:**

QPSK and 16QAM Modulations:
A preliminary scan determined the QPSK modulation, BW=1.4 MHz, RB=1, Offset=0 as the worst case.

LTE Cat-M1 Band 5:	QPSK, Middle Channel (836.5 MHz).
Bluetooth Low Energy:	GFSK, 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 8 GHz	PK	43 + 10 log (P) dB = -13 dBm -> 82.23 dBµV/m OR -21.23 dBm -> 74 dBµV/m (*)
8 GHz to 26 GHz	PK	74 dBµV/m (**)
	AVG	54 dBµV/m (*) (**)

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

(**) Radiated emissions which fall in the non-restricted bands.

Frequency range 30 MHz - 1 GHz

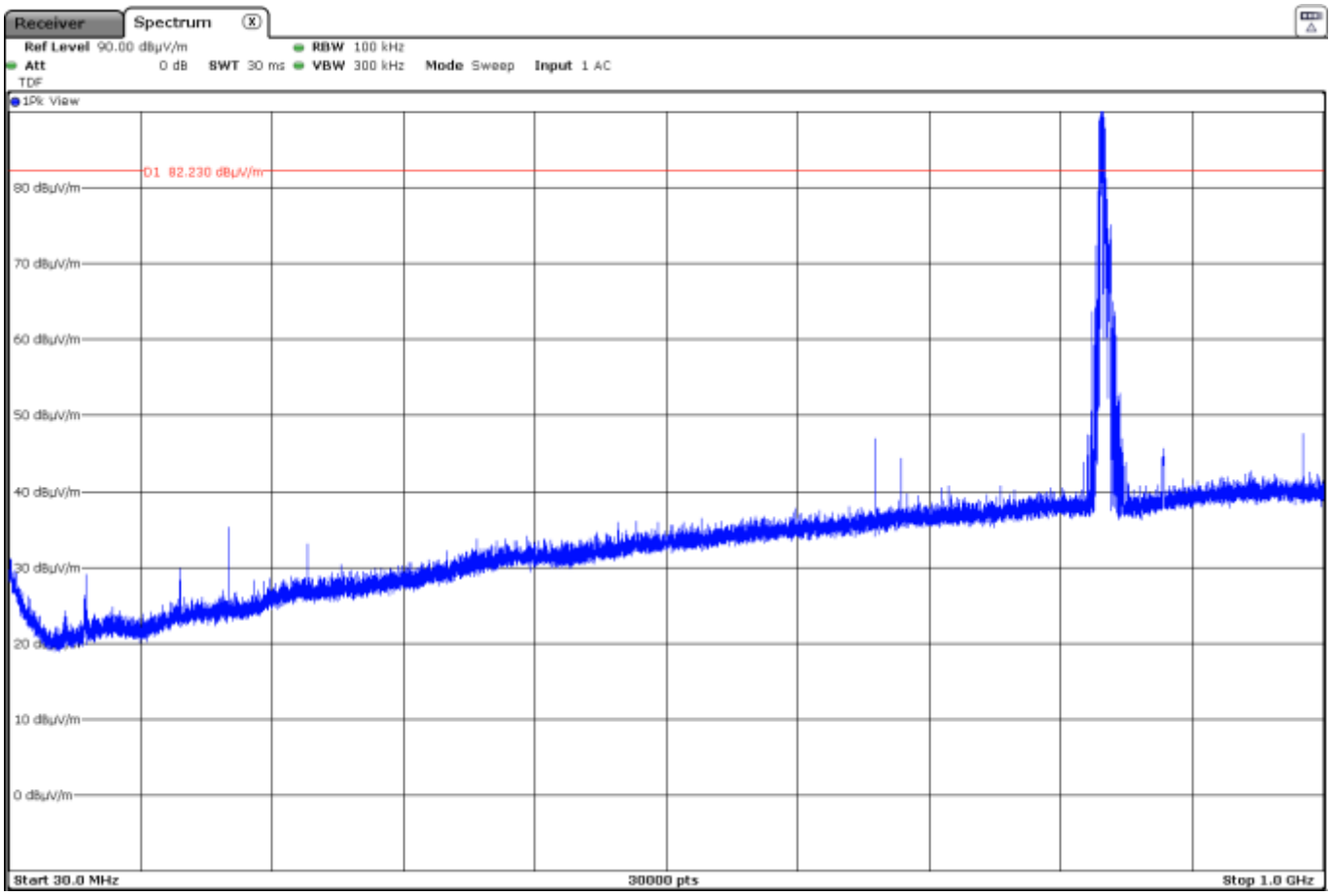
No spurious frequencies detected at less than 20 dB below the limit.

Frequency range 1 - 26 GHz

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

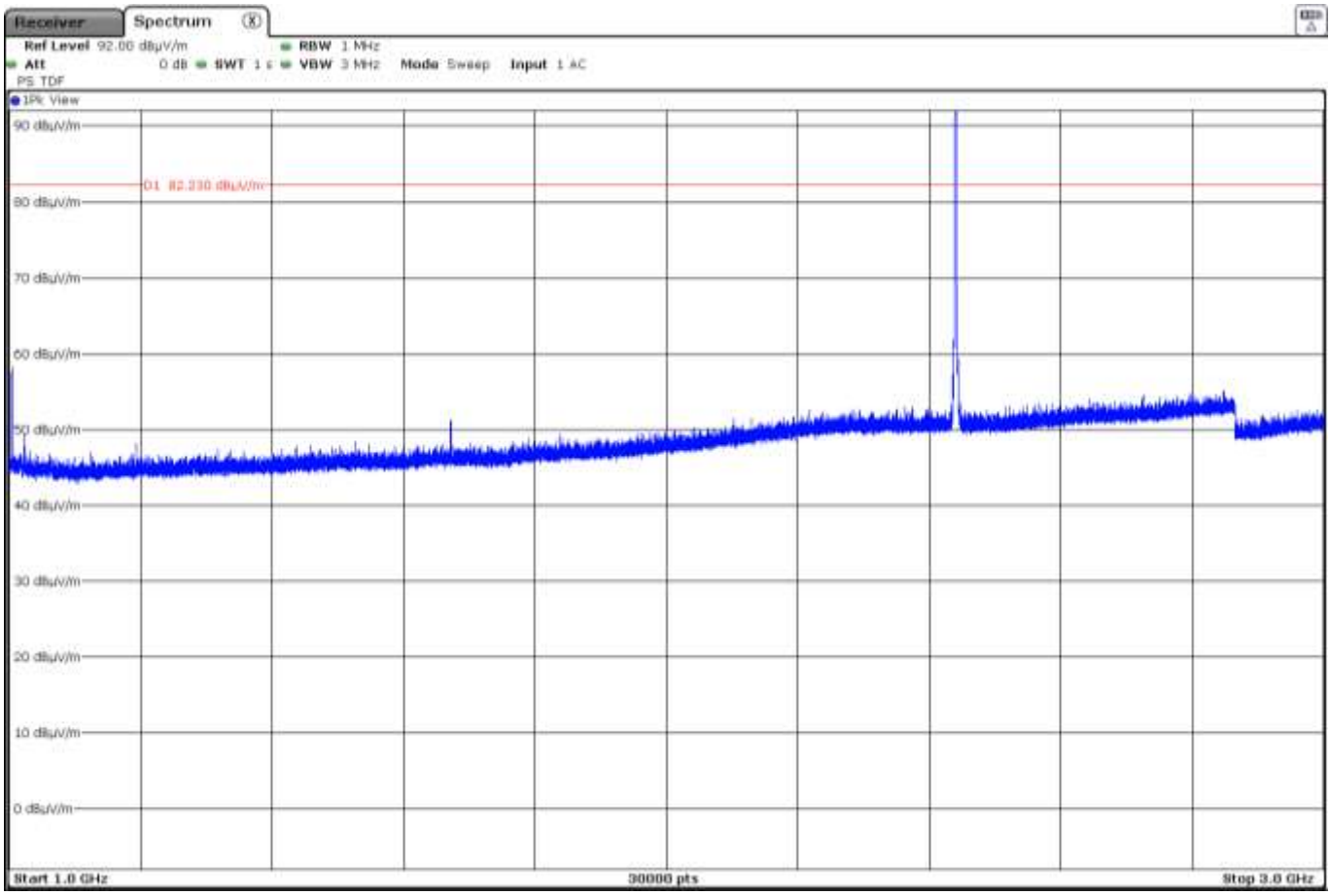
Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz



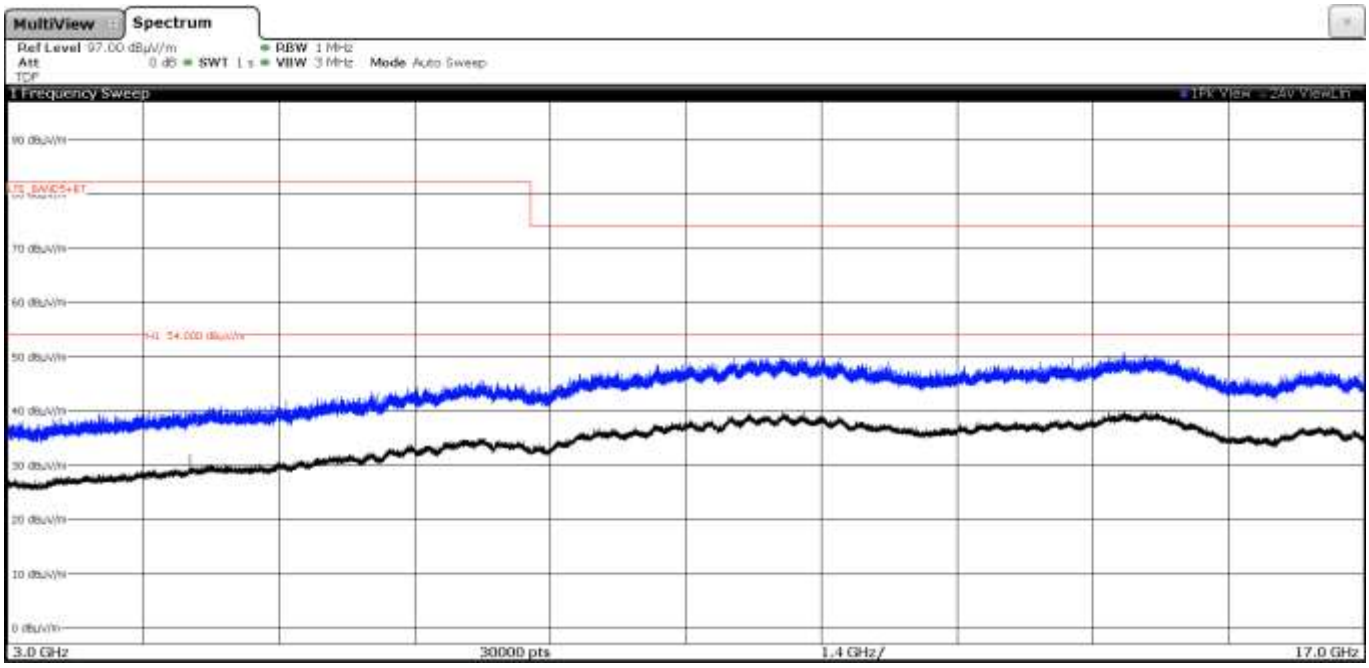
The peak above the limit is the Carrier frequency of the LTE Cat-M1 Band 5 (836.5 MHz).

FREQUENCY RANGE 1 - 3 GHz

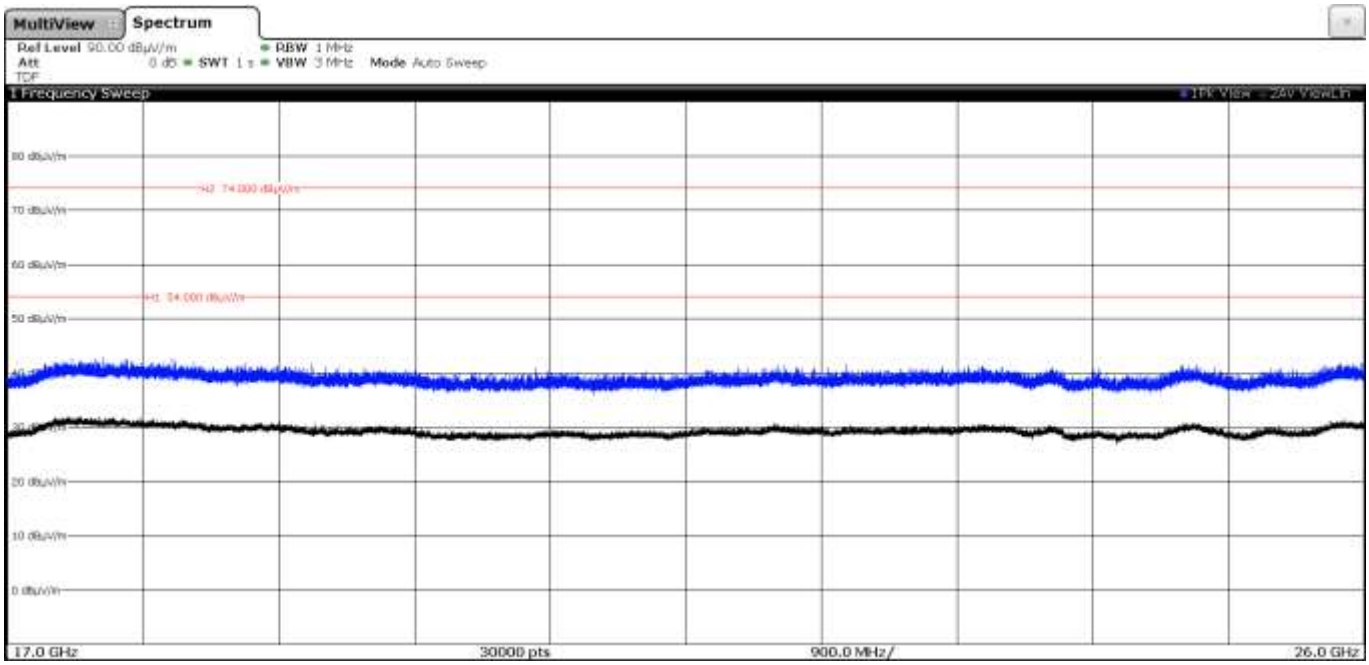


The peak above the limit is the Carrier frequency of the Bluetooth Low Energy.

FREQUENCY RANGE 3 – 17 GHz



FREQUENCY RANGE 17 - 26 GHz



- **Mode LTE NB-IoT Band 5, Bluetooth Low Energy:**

QPSK and 16QAM Modulations:
A preliminary scan determined the QPSK modulation, BW tone=15 kHz, Offset=0 as the worst case.

LTE NB-IoT Band 5:	QPSK, Middle Channel (836.5 MHz).
Bluetooth Low Energy:	GFSK, 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 8 GHz	PK	43 + 10 log (P) dB = -13 dBm -> 82.23 dBµV/m OR -21.23 dBm -> 74 dBµV/m (*)
8 GHz to 26 GHz	PK	74 dBµV/m (**)
	AVG	54 dBµV/m (*) (**)

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

(**) Radiated emissions which fall in the non-restricted bands.

Frequency range 30 MHz - 1 GHz

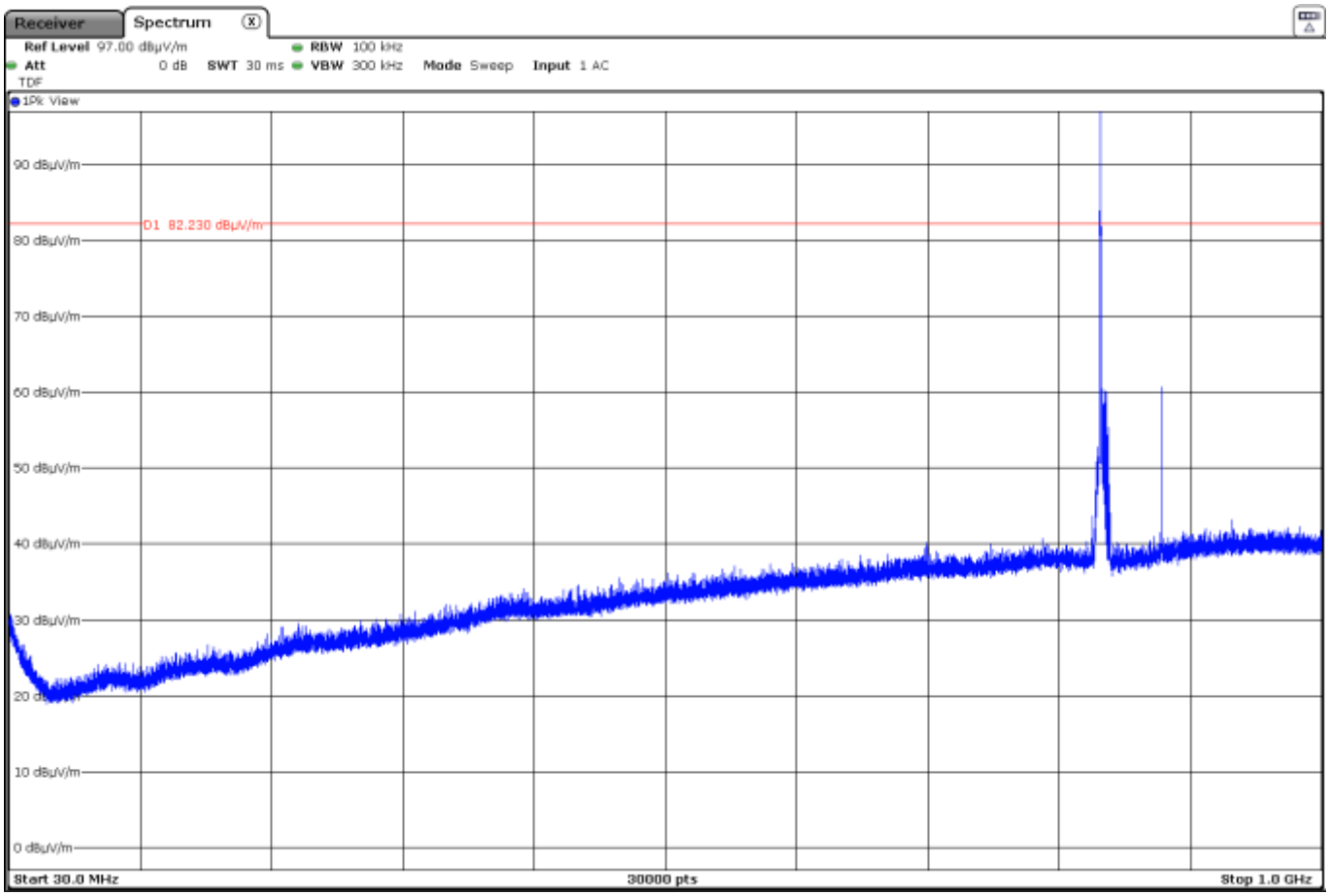
No spurious frequencies detected at less than 20 dB below the limit.

Frequency range 1 - 26 GHz

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

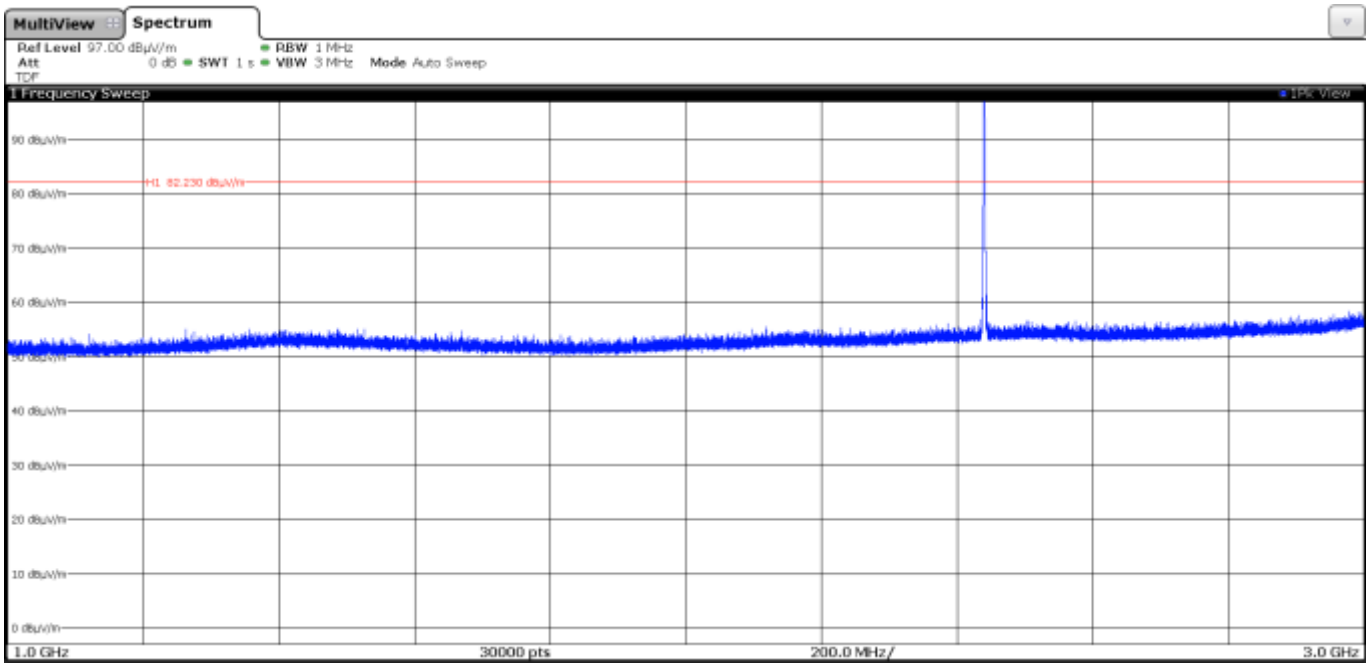
Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz



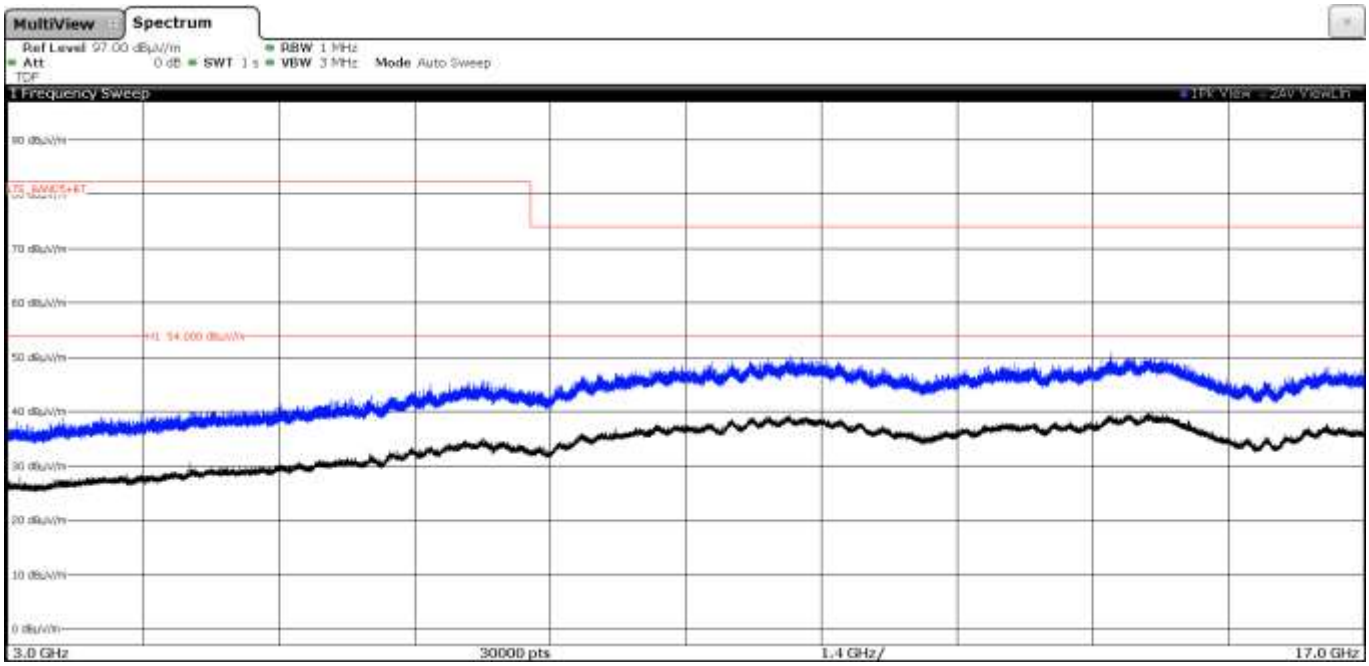
The peak above the limit is the Carrier frequency of the LTE NB-IoT Band 5 (836.5 MHz). The other peak is the Downlink Carrier frequency 2G Band GSM-850 (881.5 MHz).

FREQUENCY RANGE 1 - 3 GHz

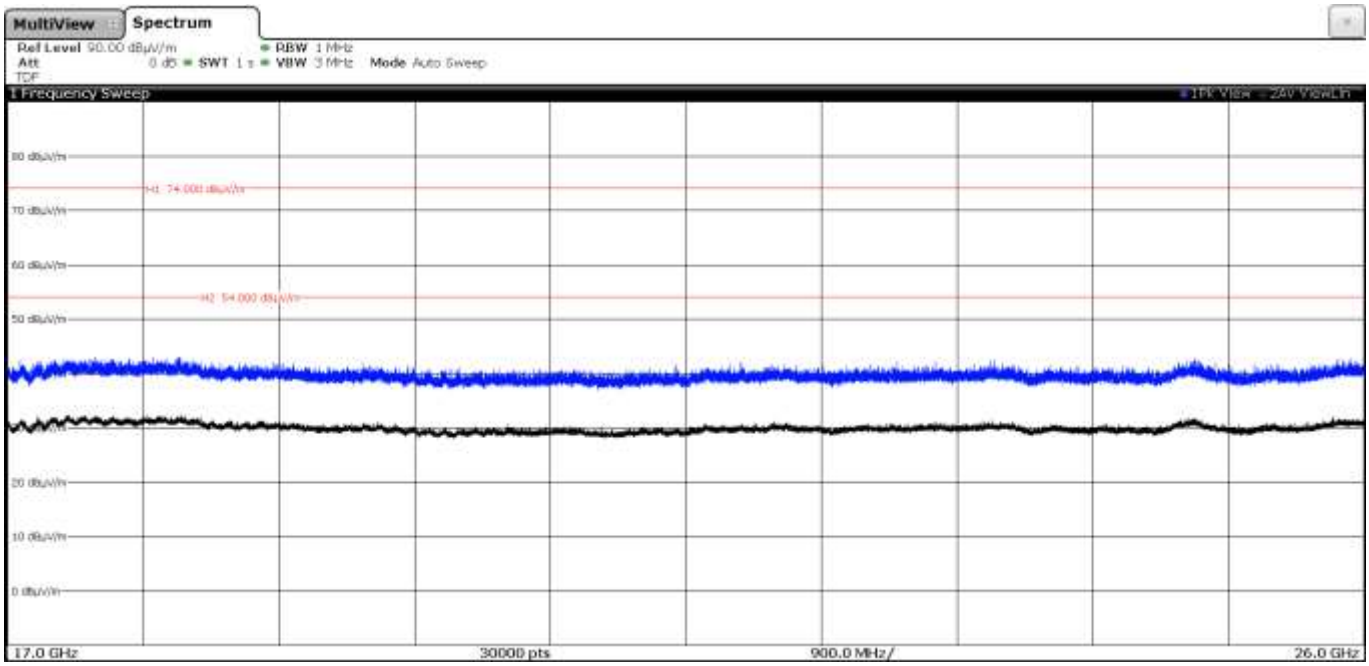


The peak above the limit on the right is the Carrier frequency of the Bluetooth Low Energy.

FREQUENCY RANGE 3 – 17 GHz



FREQUENCY RANGE 17 - 26 GHz



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

INDEX

TEST CONDITIONS 31
Radiated emissions 34

TEST CONDITIONS

POWER SUPPLY (V):

V nonimal: 5 Vdc

Type of Power Supply: USB.

ANTENNA:

Type of Bluetooth LE Antenna: Internal (IFA)

Maximum Declared Gain for Bluetooth LE: +3 dBi

Maximum Declared Gain for CELLULAR:

MIDDLE Bands	GAIN	ANTENNA TYPE
2G Band 1900 MHz	+4 dBi	Internal (SMD)
LTE Cat-M1 Band 2	+4 dBi	Internal (SMD)
LTE NB-IoT Band 2	+4 dBi	Internal (SMD)

TEST FREQUENCIES - FCC PART 24:

	CELLULAR 2G	
Band:	PCS-1900	
Frequency Range:	1850 – 1910 MHz	
Channel Spacing:	200 kHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	Middle: 661	1880 MHz

	CELLULAR LTE Cat-M1 (Band 2) & LTE NB-IoT (Band 2)	
Band:	LTE Cat-M1 Band 2	
Frequency Range:	1850 – 1910 MHz	
Channel Spacing:	200 kHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	Middle: 18900	1880 MHz (BW 1.4 MHz, RB Size 1, RB Offset 0, QPSK)
Band:	LTE NB-IoT Band 2	
Frequency Range:	1850 – 1910 MHz	
Channel Spacing:	200 kHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	Middle: 18900	1880 MHz (BW tone 15 kHz, Offset 6, QPSK)

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

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

The EUT was tested in the following operating mode:

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

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

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

Transmission modes selected with each radio:

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

* CELLULAR LTE Cat-M1: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in LTE Cat-M1 Band 2 configuration as this channel was found to transmit higher EIRP than all the other LTE Cat-M1 channels.

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

* BLUETOOTH: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in Bluetooth Low Energy (GFSK) mode configuration as this mode.

Simultaneous transmission modes selected:

1. CELLULAR 2G, BLUETOOTH Co-Location, with the EUT configured to simultaneously transmit two signals at maximum output power, CELLULAR 2G in PCS-1900, BLUETOOTH.

2. CELLULAR LTE Cat-M1, BLUETOOTH Co-Location, with the EUT configured to simultaneously transmit two signals at maximum output power, CELLULAR LTE Cat-M1 in Band 2, Bluetooth Low Energy / GFSK.

3. CELLULAR LTE NB-IoT, BLUETOOTH Co-Location, with the EUT configured to simultaneously transmit two signals at maximum output power, CELLULAR LTE NB-IoT in Band 2 Bluetooth Low Energy / 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
960 - 25000	500	54	3

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

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

2G PCS-1900, LTE Cat-M1 Band 2, LTE NB-IoT 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 log10p(watts).
>
> ii. After the first 1.0 MHz, the emission power in any 1 MHz bandwidth shall be attenuated (in dB) below the transmitter output power P (dBW) by at least 43 + 10 log10p(watts). If the measurement is performed using 1% of the emission bandwidth, power integration over 1.0 MHz is required.

METHOD:

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

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

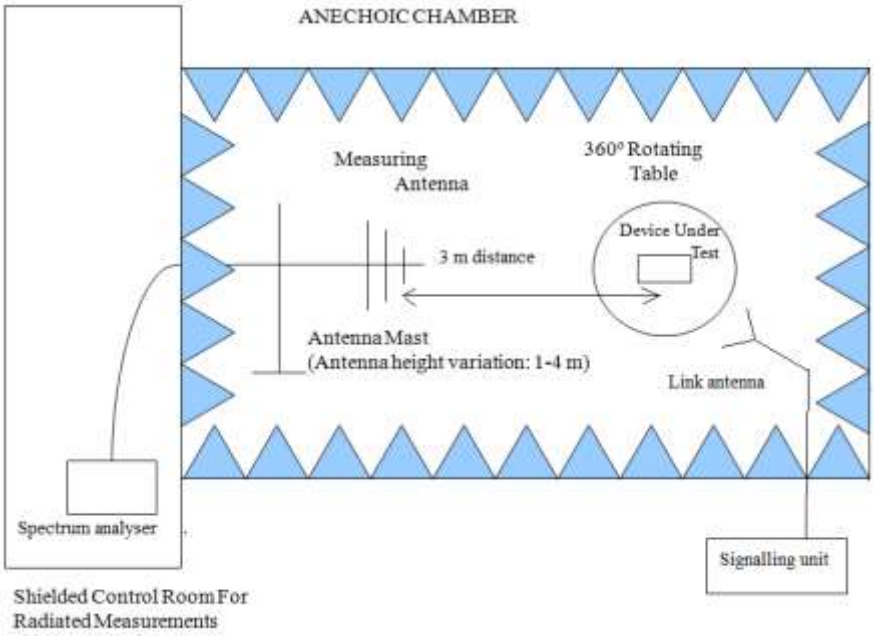
The EUT was placed on a non-conductive stand at a 3 meter distance from the measuring antenna for measurements below 1 GHz and at 1 m distance for measurements above 1 GHz.
Detected emissions were maximized at each frequency by rotating the EUT and adjusting the measuring antenna height and polarization.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

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

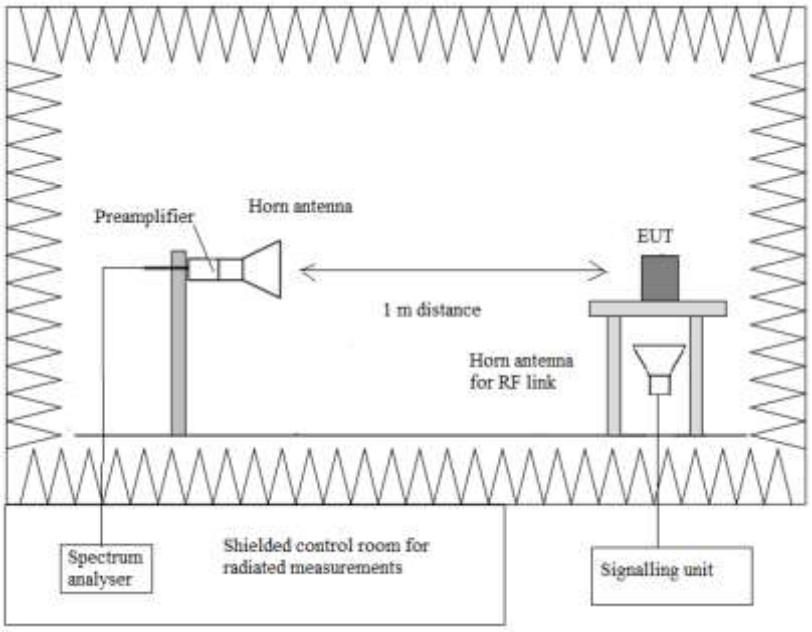
These measurements have been performed in order to check the impact of the Co-Location of all radio interfaces (that can be transmitting simultaneously).

TEST SETUP:

Radiated measurements below 1 GHz.



Radiated measurements above 1 GHz.



RESULTS:

- **Mode 2G Band PCS-1900, Bluetooth Low Energy:**

GPRS & EDGE:
A preliminary scan determined the GPRS modulation in the Middle Channel as the worst case.

2G Band PCS-1900:	GPRS, Middle Channel (1880 MHz).
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 20 GHz	PK	43 + 10 log (P) dB = -13 dBm -> 82.23 dBµV/m OR -21.23 dBm -> 74 dBµV/m (*)
20 GHz to 26 GHz	PK	74 dBµV/m (*) (**)
30 MHz to 26 GHz	AVG	54 dBµV/m (*) (**)

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

(**) Radiated emissions which fall in the non-restricted bands.

Frequency range 30 MHz - 1 GHz

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

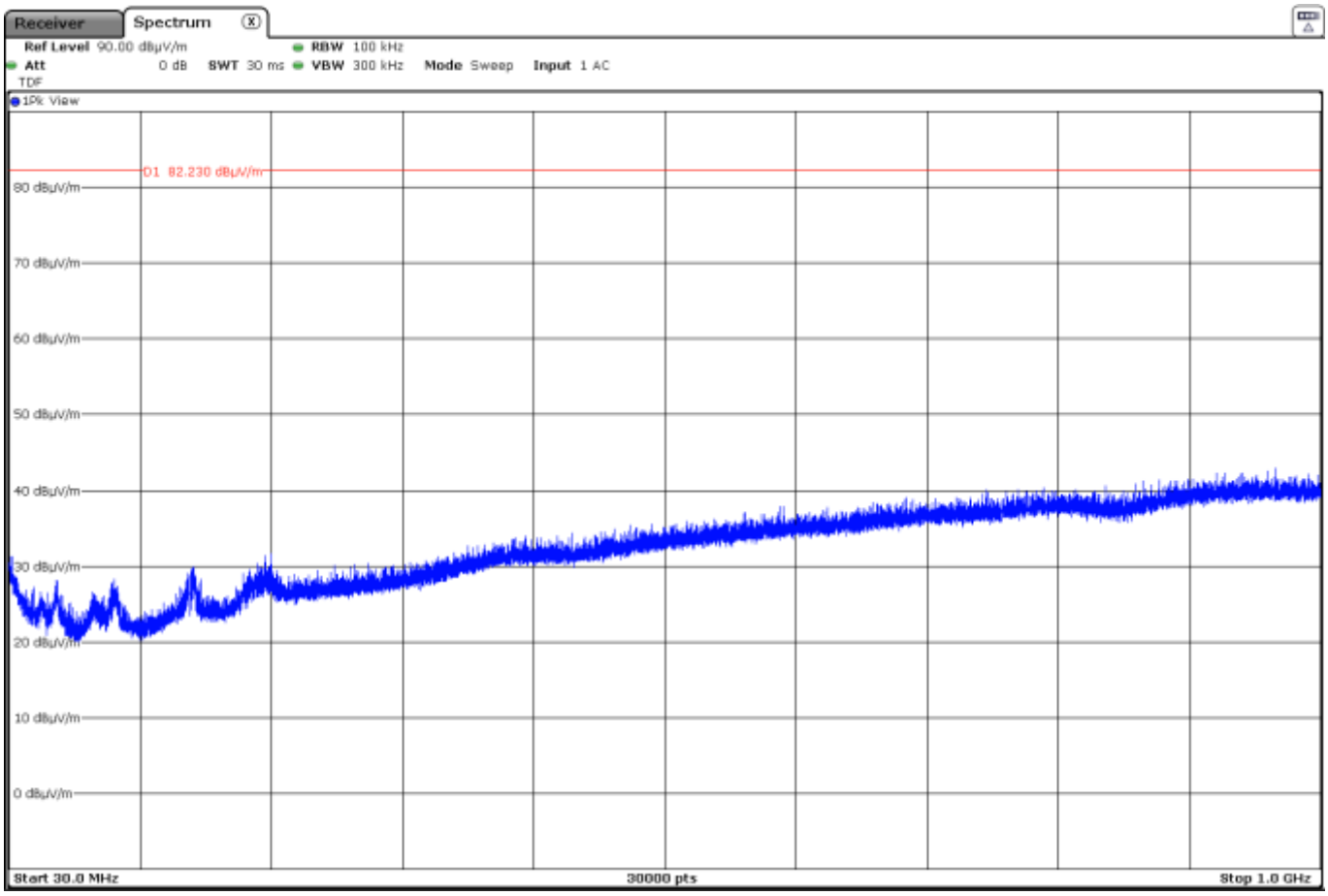
Frequency range 1 – 26 GHz

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

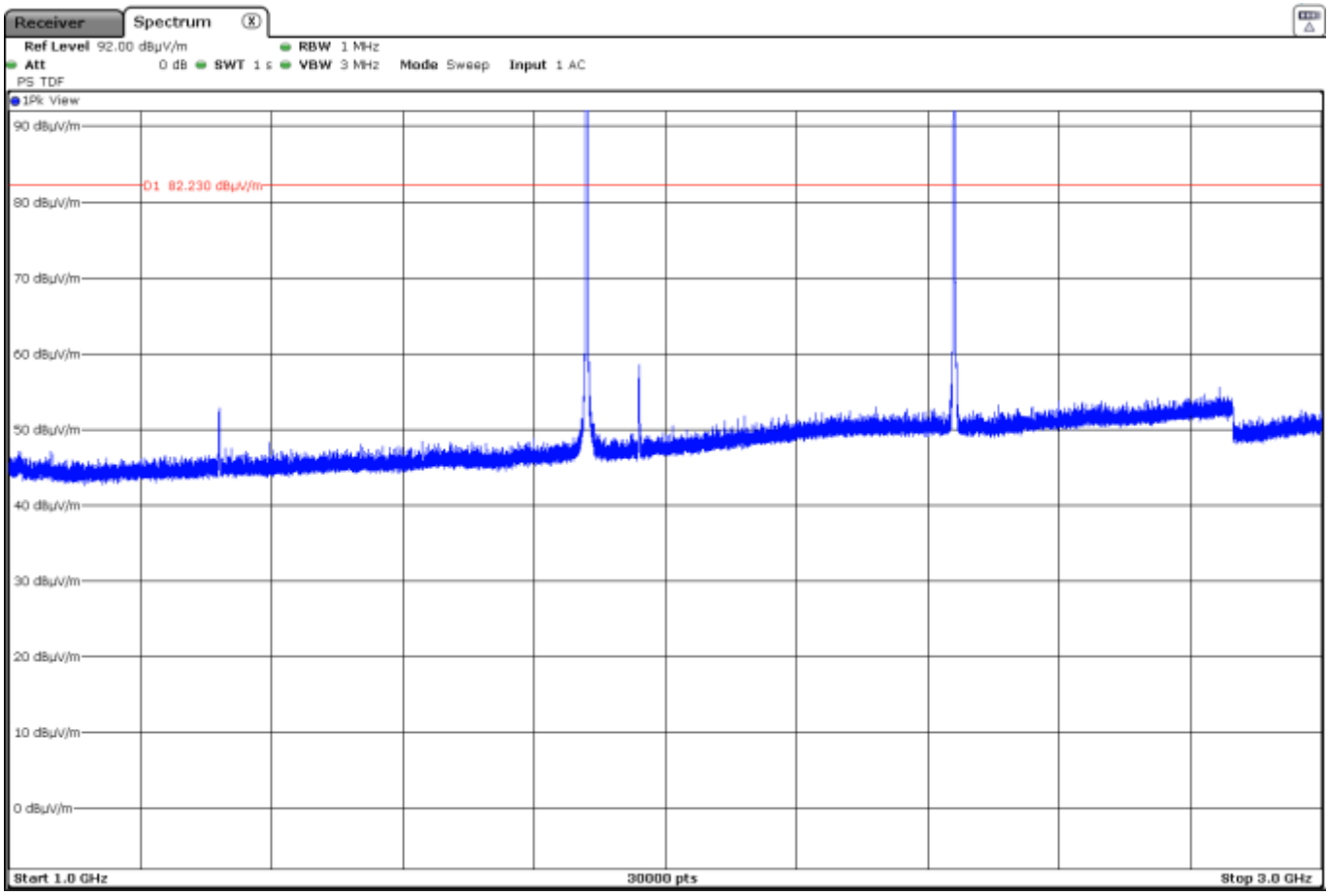
Measurement uncertainty (dB)	<±3.88 for f < 1GHz <±3.70 for f ≥ 1 GHz up to 18 GHz <±3.33 for f ≥ 18 GHz up to 20 GHz

Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz



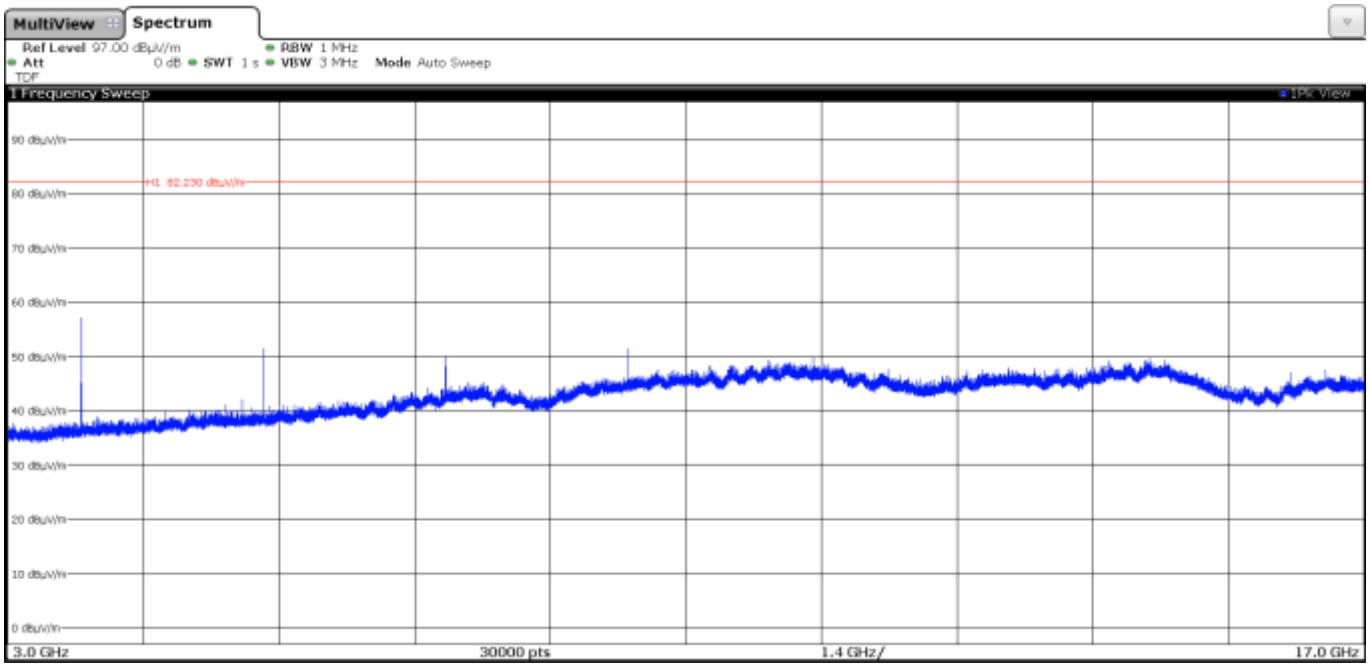
FREQUENCY RANGE 1 – 3 GHz



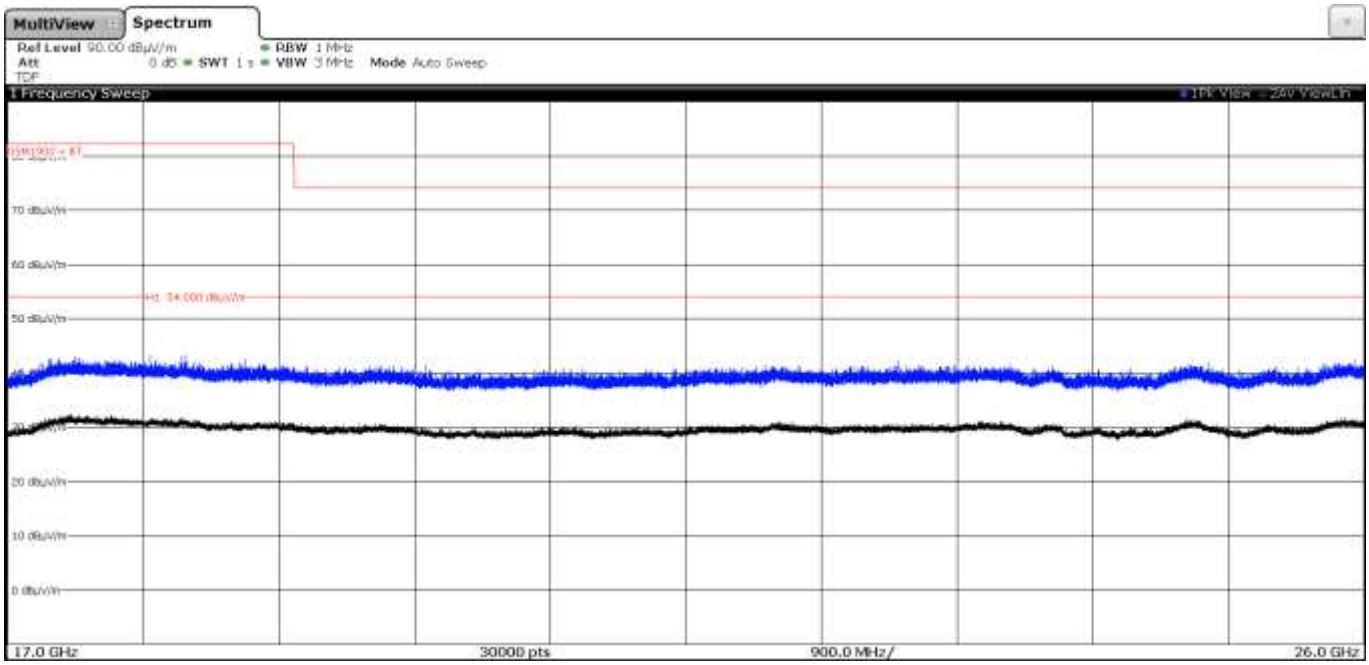
The peak above the limit on the left is the Carrier frequency 2G Band PCS-1900 (1880 MHz).

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

FREQUENCY RANGE 3 – 17 GHz



FREQUENCY RANGE 17 - 26 GHz



- **Mode LTE Cat-M1 Band 2, Bluetooth Low Energy:**

QPSK and 16QAM Modulations:
A preliminary scan determined the QPSK modulation, BW=1.4 MHz, RB=1, Offset=0 as the worst case.

LTE Cat-M1 Band 2:	QPSK, Middle Channel (1880 MHz).
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 20 GHz	PK	43 + 10 log (P) dB = -13 dBm -> 82.23 dBµV/m OR -21.23 dBm -> 74 dBµV/m (*)
20 GHz to 26 GHz	PK	74 dBµV/m (*) (**)
30 MHz to 26 GHz	AVG	54 dBµV/m (*) (**)

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

(**) Radiated emissions which fall in the non-restricted bands.

Frequency range 30 MHz - 1 GHz

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

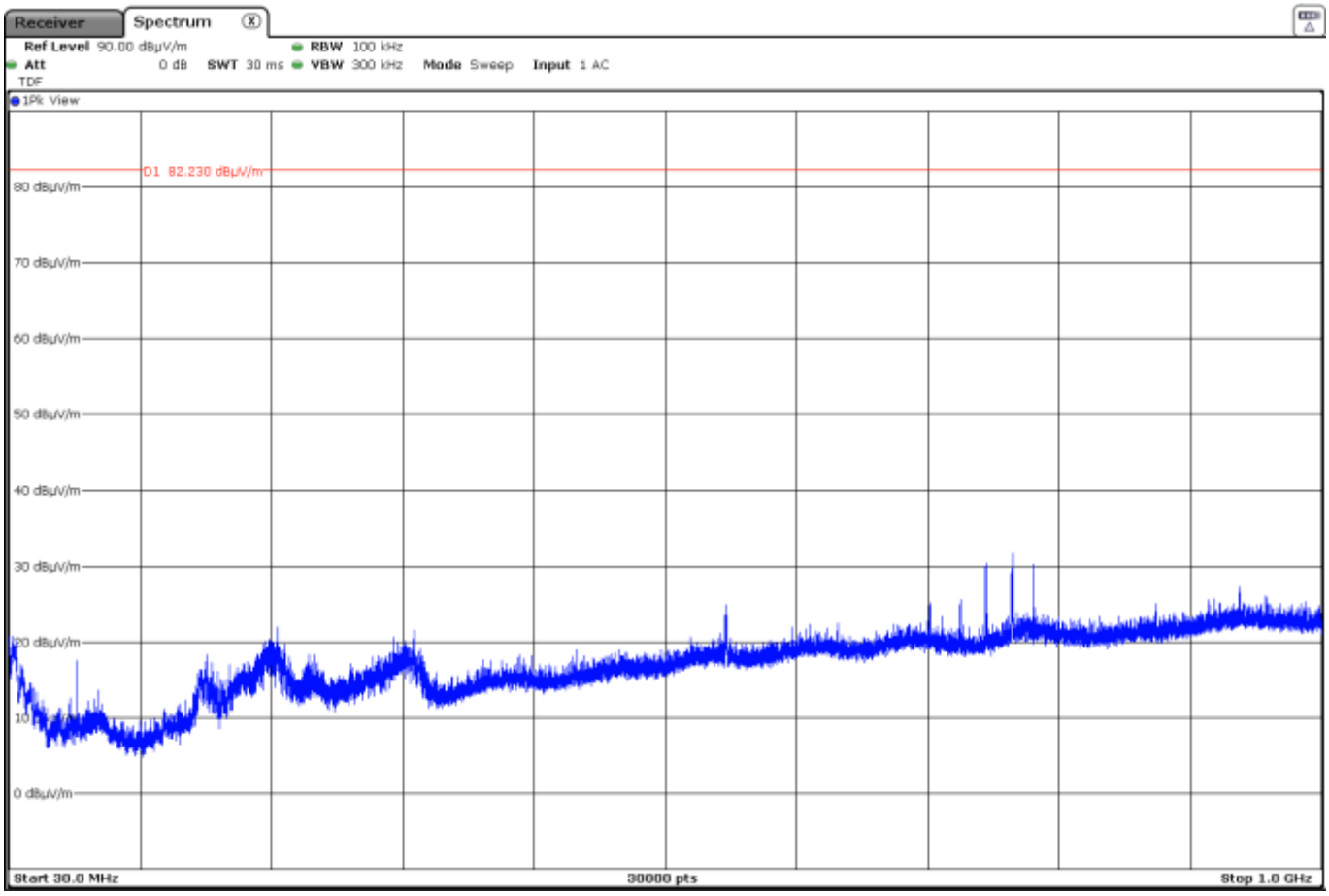
Frequency range 1 - 26 GHz

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

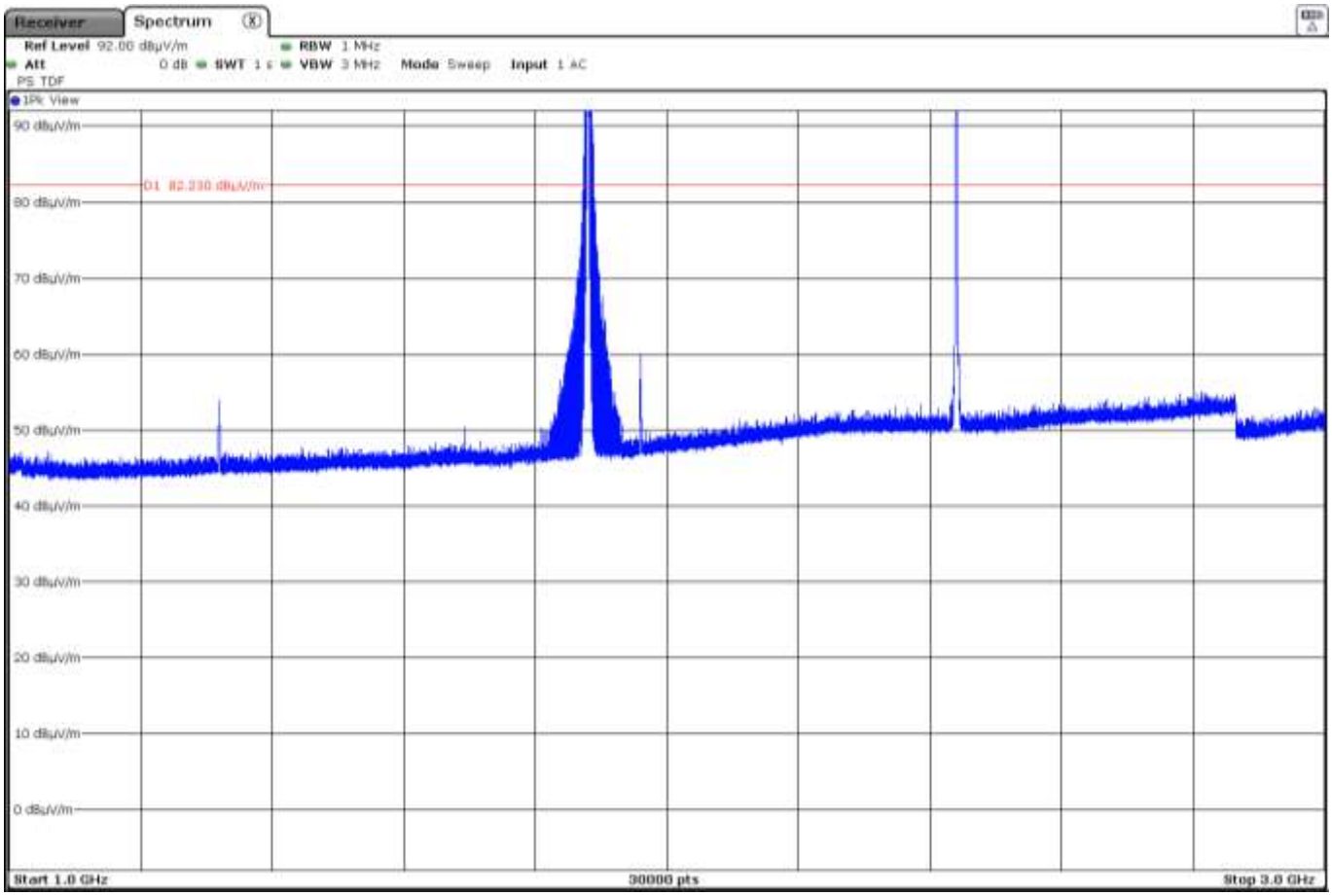
Measurement uncertainty (dB)	<±3.88 for f < 1GHz <±3.70 for f ≥ 1 GHz up to 18 GHz <±3.33 for f ≥ 18 GHz up to 20 GHz

Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz



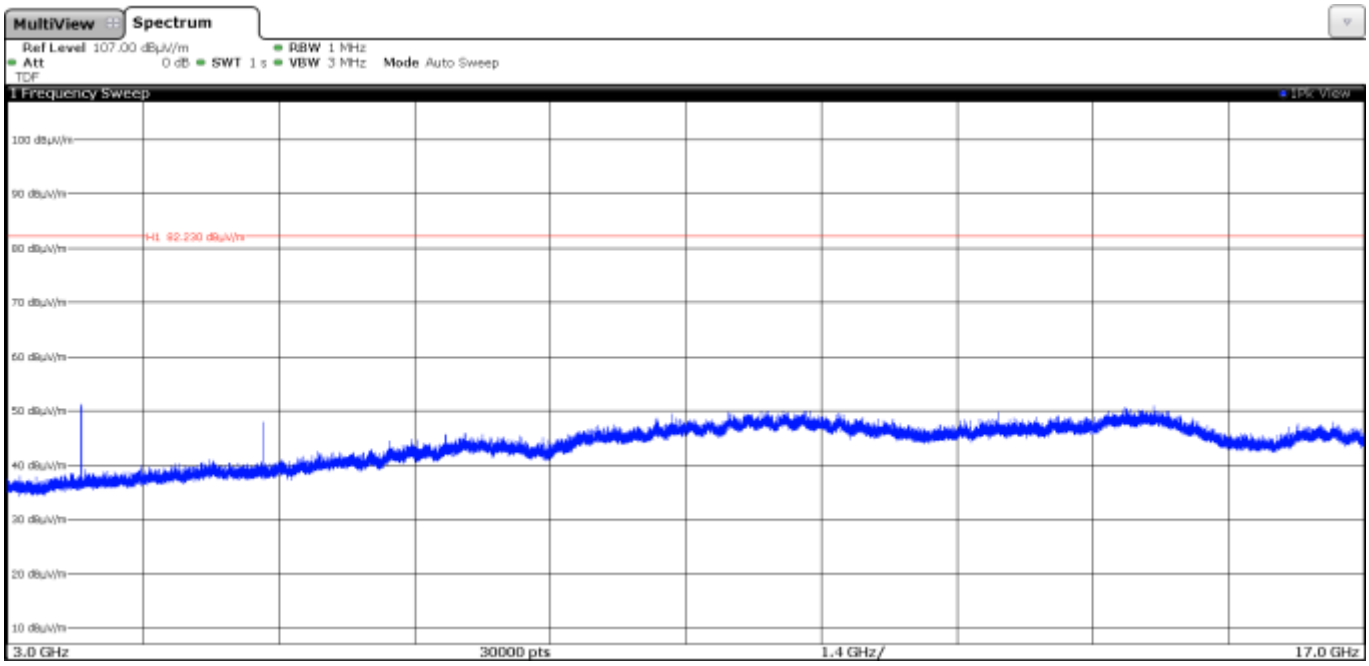
FREQUENCY RANGE 1 – 3 GHz



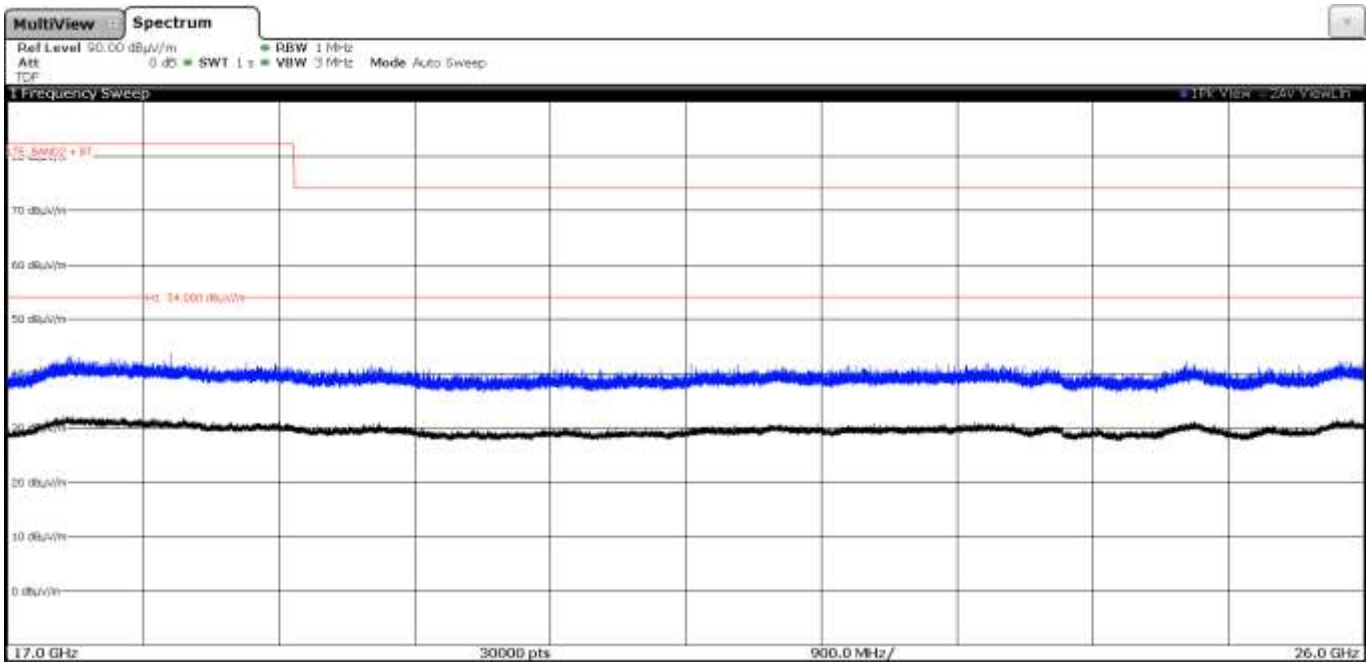
The peak above the limit on the left is the Carrier frequency LTE Cat-M1 Band 2 (1880 MHz).

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

FREQUENCY RANGE 3 – 17 GHz



FREQUENCY RANGE 17 - 26 GHz



- **Mode LTE NB-IoT Band 2, Bluetooth Low Energy:**

QPSK and 16QAM Modulations:
A preliminary scan determined the QPSK modulation, BW tone=15 kHz, Offset=6 as the worst case.

LTE NB-IoT Band 2:	QPSK, Middle Channel (1880 MHz).
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 20 GHz	PK	43 + 10 log (P) dB = -13 dBm -> 82.23 dBµV/m OR -21.23 dBm -> 74 dBµV/m (*)
20 GHz to 26 GHz	PK	74 dBµV/m (*) (**)
30 MHz to 26 GHz	AVG	54 dBµV/m (*) (**)

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

(**) Radiated emissions which fall in the non-restricted bands.

Frequency range 30 MHz - 1 GHz

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

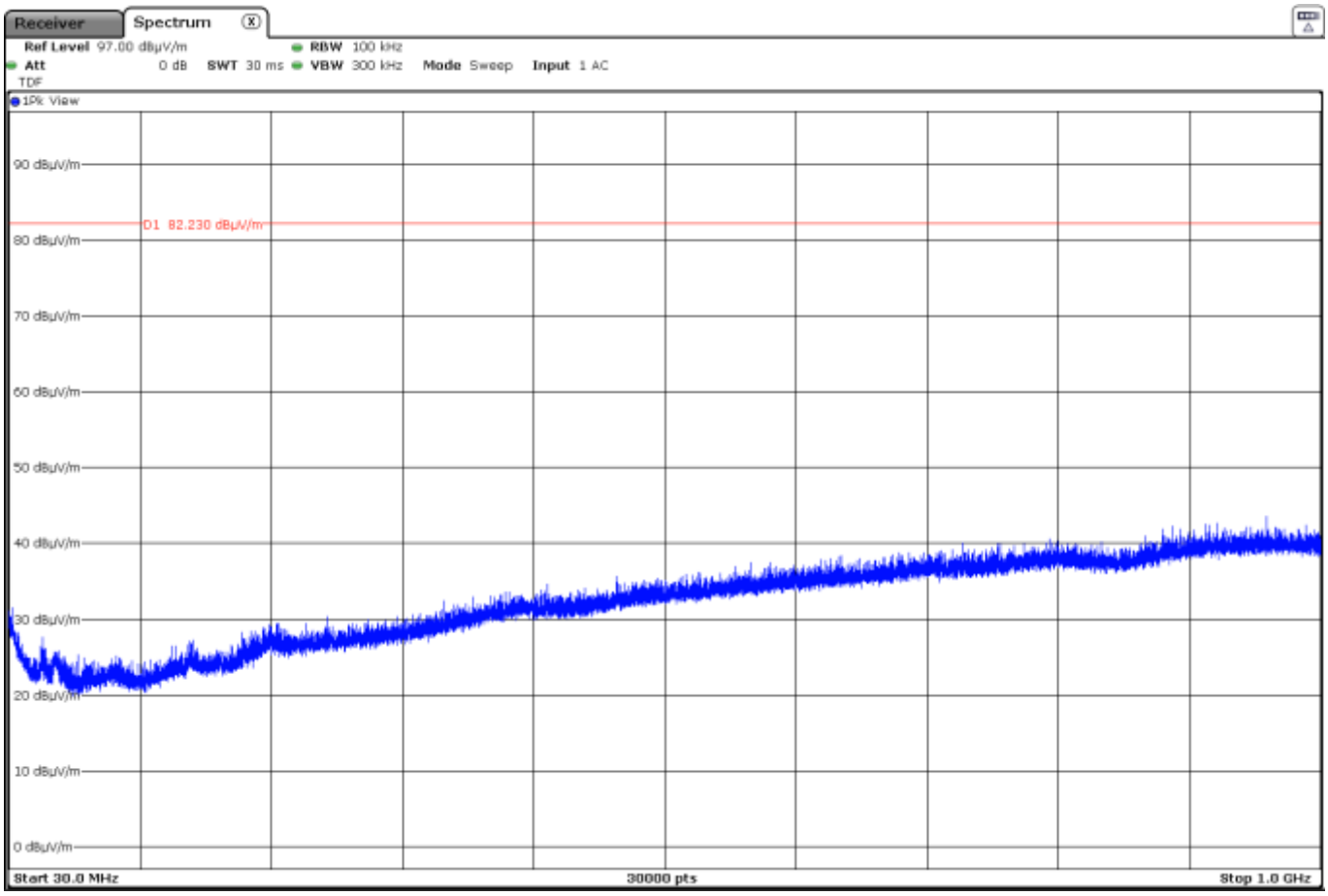
Frequency range 1 - 26 GHz

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

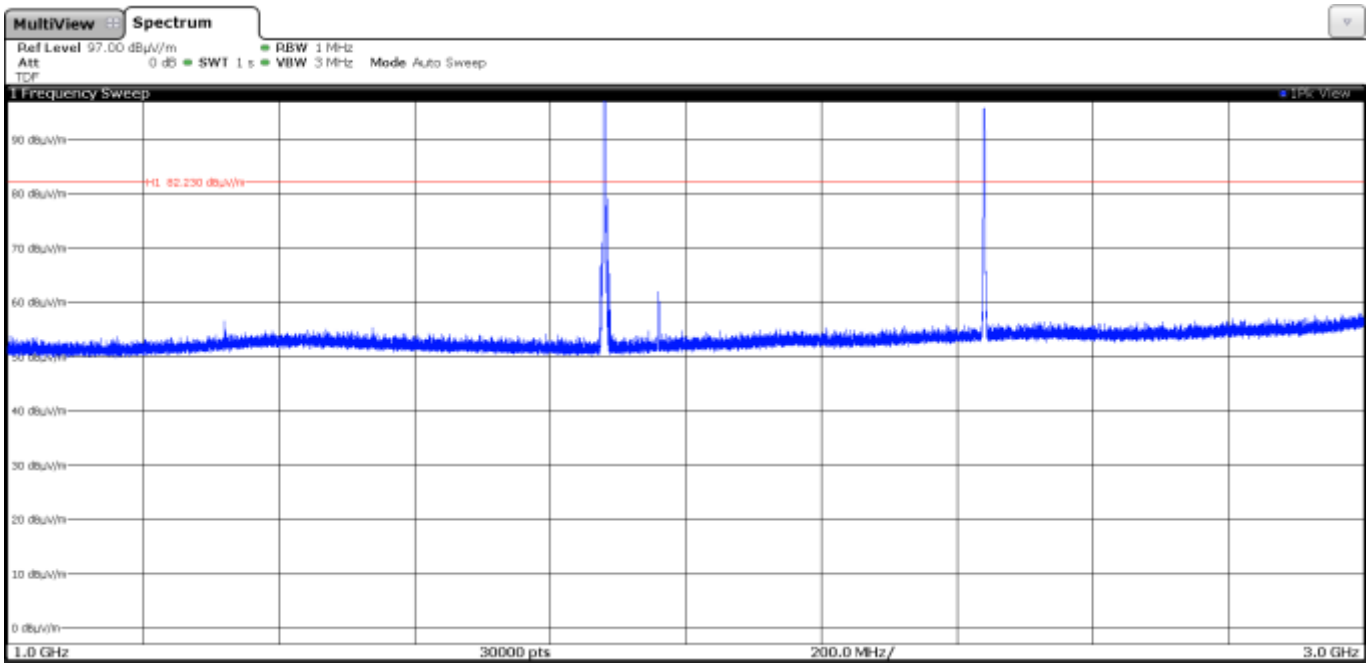
Measurement uncertainty (dB)	<±3.88 for f < 1GHz <±3.70 for f ≥ 1 GHz up to 18 GHz <±3.33 for f ≥ 18 GHz up to 20 GHz

Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz



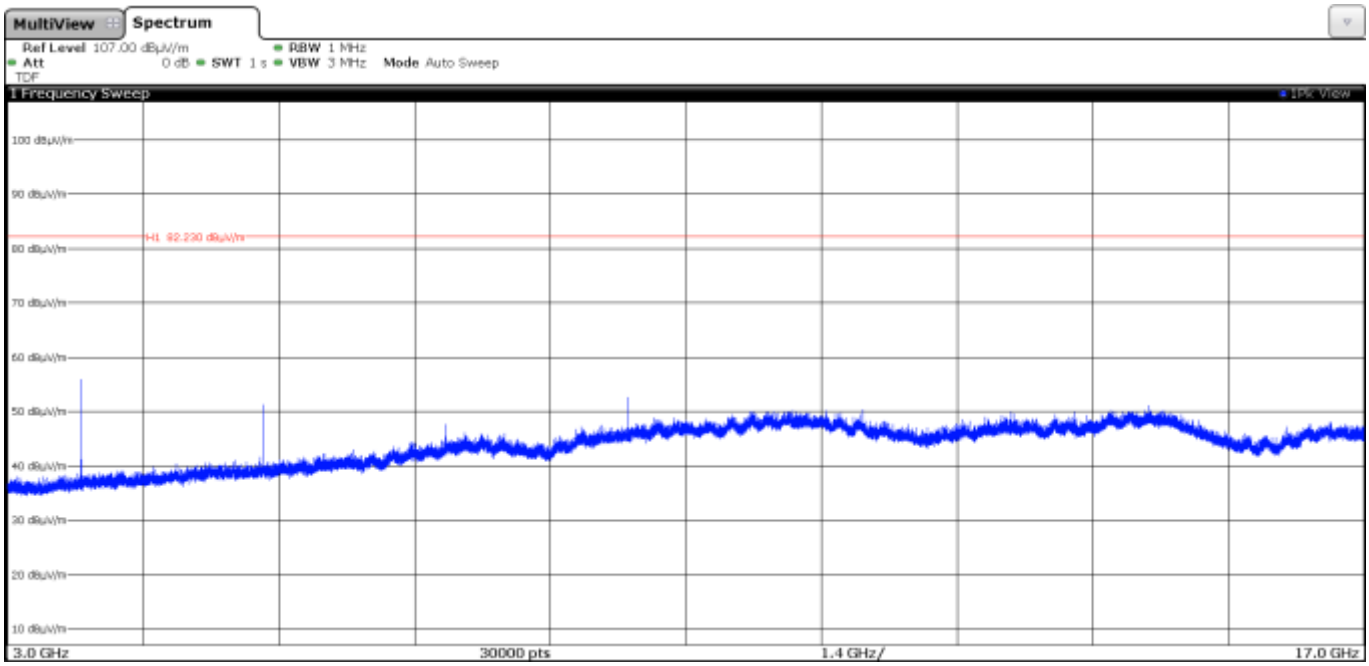
FREQUENCY RANGE 1 – 3 GHz



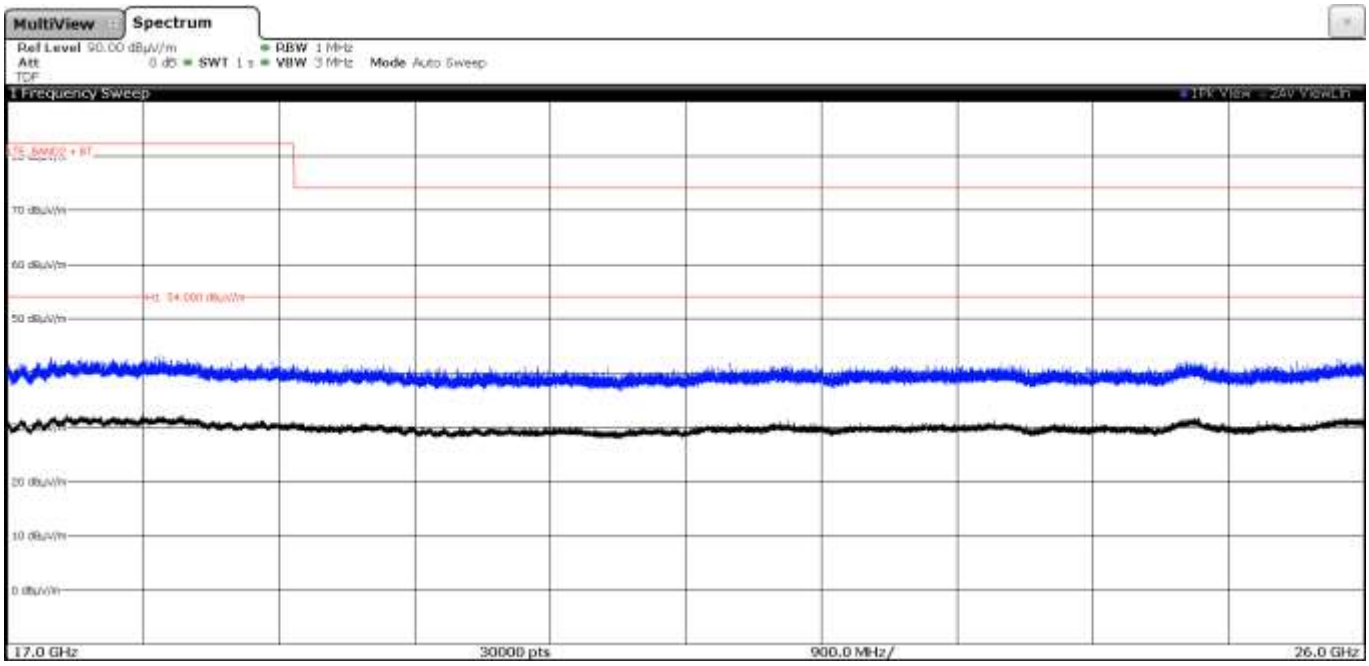
The peak above the limit on the left is the Carrier frequency LTE NB-IoT Band 2 (1880 MHz).

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

FREQUENCY RANGE 3 – 17 GHz



FREQUENCY RANGE 17 - 26 GHz



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

INDEX

TEST CONDITIONS 49
Radiated emissions 53

TEST CONDITIONS

POWER SUPPLY (V):

V nonimal: 5 Vdc

Type of Power Supply: USB.

ANTENNA:

Type of Bluetooth LE Antenna: Internal (IFA)

Maximum Declared Gain for Bluetooth LE: +3 dBi

Maximum Declared Gain for CELLULAR:

HIGH Bands	GAIN	ANTENNA TYPE
LTE Cat-M1 Band 4	+5 dBi	Internal (SMD)
LTE NB-IoT Band 4	+5 dBi	Internal (SMD)
LTE Cat-M1 Band 12	-1.7 dBi	Internal (SMD)
LTE NB-IoT Band 12	-1.7 dBi	Internal (SMD)
LTE Cat-M1 Band 13	-0.5 dBi	Internal (SMD)
LTE NB-IoT Band 13	-0.5 dBi	Internal (SMD)

TEST FREQUENCIES - FCC PART 27:

	CELLULAR LTE Cat-M1 (Bands 4, 12, 13) & LTE NB-IoT (Bands 4, 12, 13)	
Band:	LTE Cat-M1 Band 4	
Frequency Range:	1710 – 1755 MHz	
Channel Spacing:	200 kHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	Middle: 20175	1732.5 MHz (BW 1.4 MHz, RB Size 1, RB Offset 0, QPSK)
Band:	LTE NB-IoT Band 4	
Frequency Range:	1710 – 1755 MHz	
Channel Spacing:	200 kHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	Middle: 20175	1732.5 MHz (BW tone 15 kHz, Offset 6, QPSK)

Band:	LTE Cat-M1 Band 12	
Frequency Range:	699 – 716 MHz	
Channel Spacing:	200 kHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	Low: 23095	707.5 MHz (BW 1.4 MHz, RB Size 1, RB Offset 7, QPSK)
Band:	LTE NB-IoT Band 12	
Frequency Range:	699 – 716 MHz	
Channel Spacing:	200 kHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	Low: 23095	707.5 MHz (BW tone 15 kHz, Offset 9, QPSK)
Band:	LTE Cat-M1 Band 13	
Frequency Range:	777 – 787 MHz	
Channel Spacing:	200 kHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	Low: 23230	782 MHz (BW 5 MHz, RB Size 1, RB Offset 0, QPSK)
Band:	LTE NB-IoT Band 13	
Frequency Range:	777 – 787 MHz	
Channel Spacing:	200 kHz	
Transmit Channel:	Channel	Channel Frequency (MHz)
	Low: 23230	782 MHz (BW tone 15 kHz, Offset 6, QPSK)

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

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

The EUT was tested in the following operating mode:

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

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

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

Transmission modes selected with each radio:

* CELLULAR LTE Cat-M1: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in LTE Cat-M1 Bands 4, 12, 13 configuration as this channel was found to transmit higher EIRP than all the other LTE Cat-M1 channels.

* CELLULAR LTE NB-IoT: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in LTE NB-IoT Bands 4, 12, 13 configuration as this channel was found to transmit higher EIRP than all the other LTE NB-IoT channels.

* BLUETOOTH: Transmitter radiated spurious emissions tests were performed with the EUT transmitting in Bluetooth Low Energy (GFSK) mode configuration.

Simultaneous transmission modes selected:

1. CELLULAR LTE Cat-M1, BLUETOOTH Co-Location, with the EUT configured to simultaneously transmit two signals at maximum output power, CELLULAR LTE Cat-M1 in Band 4, Bluetooth Low Energy / GFSK.

2. CELLULAR LTE NB-IoT, BLUETOOTH Co-Location, with the EUT configured to simultaneously transmit two signals at maximum output power, CELLULAR LTE NB-IoT in Band 4 Bluetooth Low Energy / GFSK.

3. CELLULAR LTE Cat-M1, BLUETOOTH Co-Location, with the EUT configured to simultaneously transmit two signals at maximum output power, CELLULAR LTE Cat-M1 in Band 12, Bluetooth Low Energy / GFSK.

4. CELLULAR LTE NB-IoT, BLUETOOTH Co-Location, with the EUT configured to simultaneously transmit two signals at maximum output power, CELLULAR LTE NB-IoT in Band 12, Bluetooth Low Energy / GFSK.

5. CELLULAR LTE Cat-M1, BLUETOOTH Co-Location, with the EUT configured to simultaneously transmit two signals at maximum output power, CELLULAR LTE Cat-M1 in Band 13, Bluetooth Low Energy / GFSK.

6. CELLULAR LTE NB-IoT, BLUETOOTH Co-Location, with the EUT configured to simultaneously transmit two signals at maximum output power, CELLULAR LTE NB-IoT in Band 13, Bluetooth Low Energy / 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
960 - 25000	500	54	3

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

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

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

LTE Cat-M1 Band 4, LTE NB-IoT 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 bands, the power of any emission outside a licensee's frequency block shall be attenuated below the transmitter power (P) in watts by at least 43 + 10 log10 (P) dB.

RSS-139 Clause 6.6:

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

LTE Band 4 MEASUREMENT LIMIT:

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

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

LTE Cat-M1 Band 12, LTE NB-IoT Band 12. FCC §2.1053 & §27.53 (g) / RSS-130 Clause 4.6.

FCC §27.53 (g):

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

RSS-130 Issue 1 Clause 4.6.:

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

LTE Band 12 MEASUREMENT LIMIT:

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

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

LTE Cat-M1 Band 13, LTE NB-IoT Band 13. FCC §2.1053 & §27.53 (c) (2) (4) & (f) / RSS-130 Issue 1 Clause 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 Clause 4.6.1:

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

LTE Band 13 MEASUREMENT LIMIT:

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

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

METHOD:

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

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

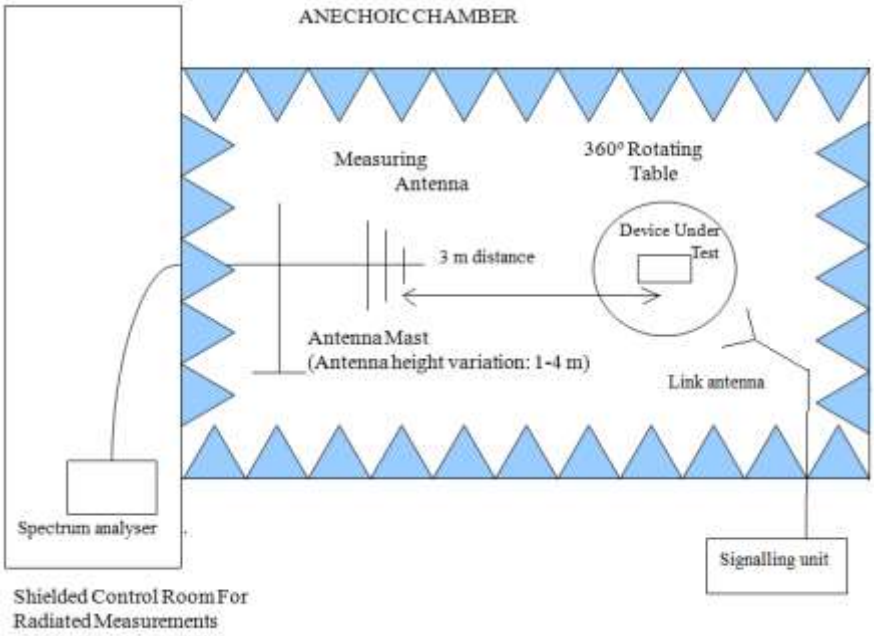
The EUT was placed on a non-conductive stand at a 3 meter distance from the measuring antenna for measurements below 1 GHz and at 1 m distance for measurements above 1 GHz.
Detected emissions were maximized at each frequency by rotating the EUT and adjusting the measuring antenna height and polarization.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

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

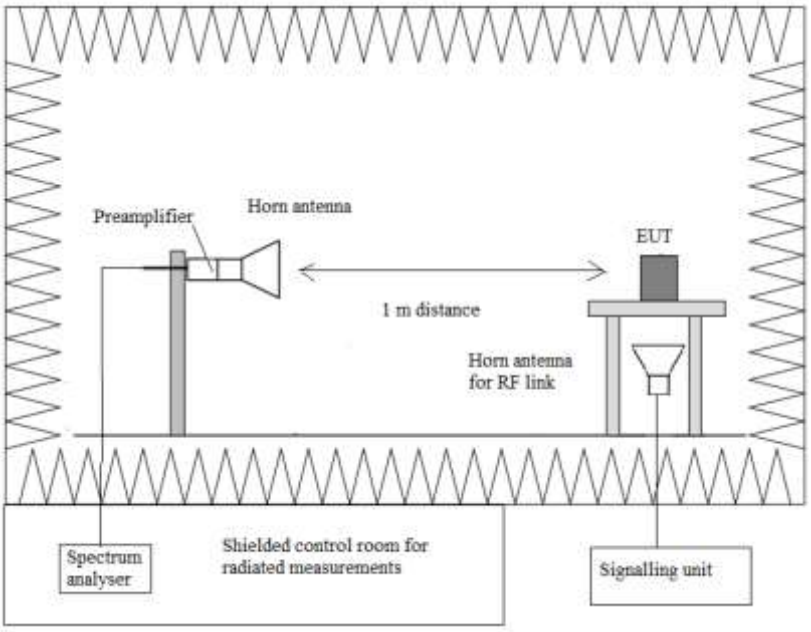
These measurements have been performed in order to check the impact of the Co-Location of all radio interfaces (that can be transmitting simultaneously).

TEST SETUP:

Radiated measurements below 1 GHz.



Radiated measurements above 1 GHz.



RESULTS:

- **Mode LTE Cat-M1 Band 4, Bluetooth.**

QPSK & 16QAM
A preliminary scan determined the QPSK modulation in the Middle Channel as the worst case.

LTE Cat-M1 Band 4:	QPSK, Middle Channel (1732.5 MHz).
Bluetooth Low Energy:	GFSK, 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 20 GHz	PK	43 + 10 log (P) dB = -13 dBm -> 82.23 dBµV/m OR -21.23 dBm -> 74 dBµV/m (*)
20 GHz to 26 GHz	PK	74 dBµV/m (*) (**)
30 MHz to 26 GHz	AVG	54 dBµV/m (*) (**)

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

(**) Radiated emissions which fall in the non-restricted bands.

Frequency range 30 MHz - 1 GHz

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

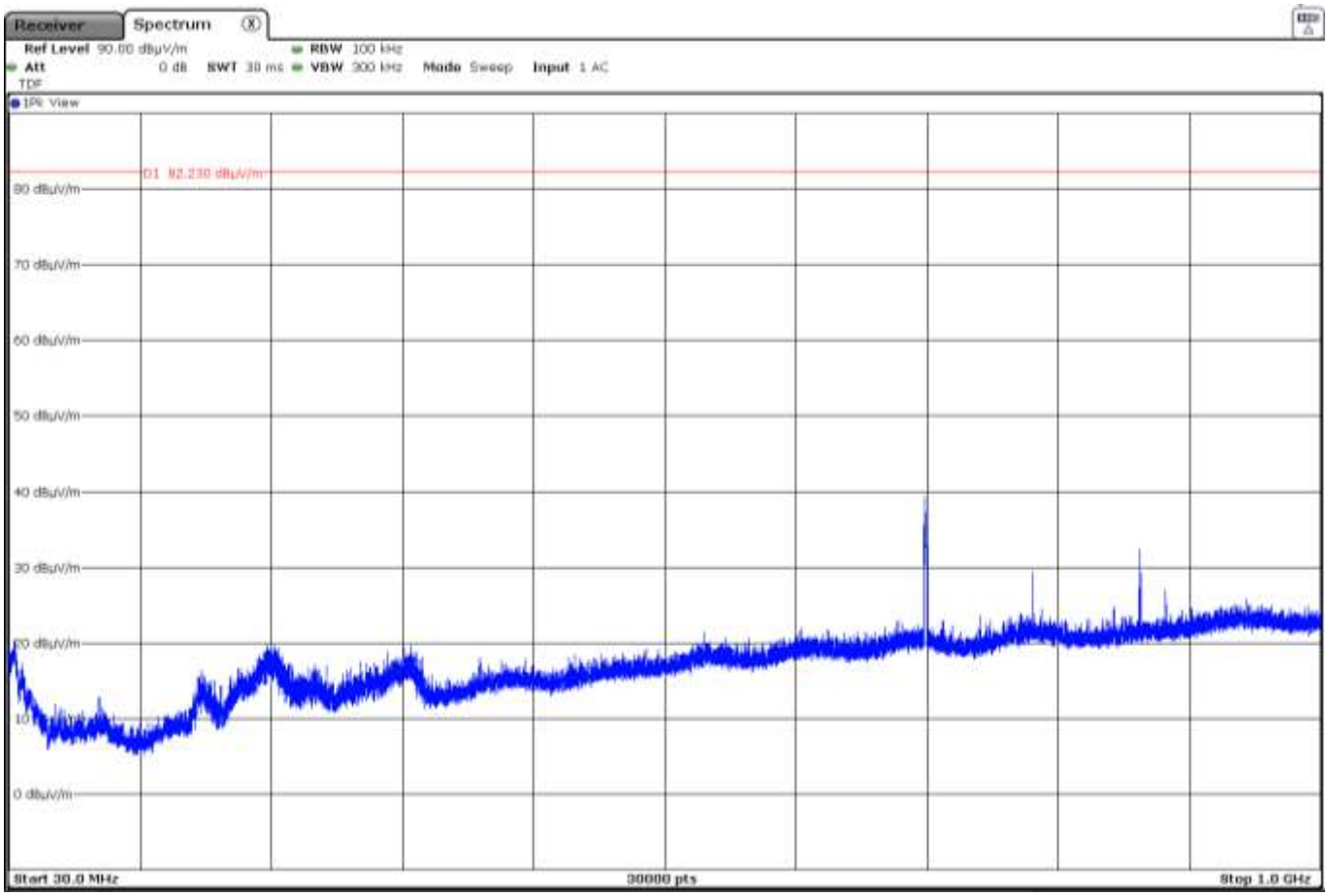
Frequency range 1 - 26 GHz

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

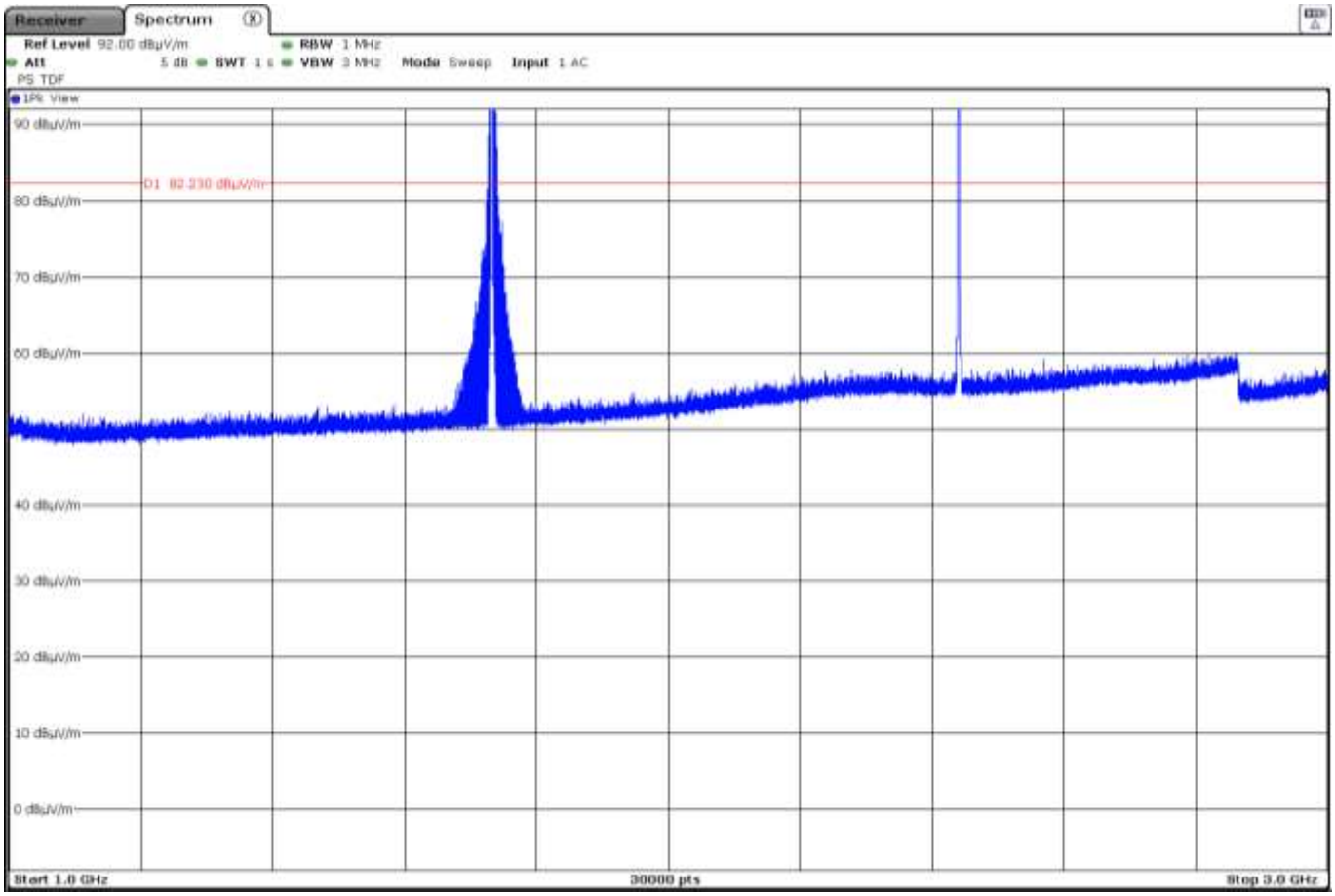
Measurement uncertainty (dB)	<±3.88 for f < 1GHz <±3.70 for f ≥ 1 GHz up to 18 GHz <±3.33 for f ≥ 18 GHz up to 40 GHz

Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz



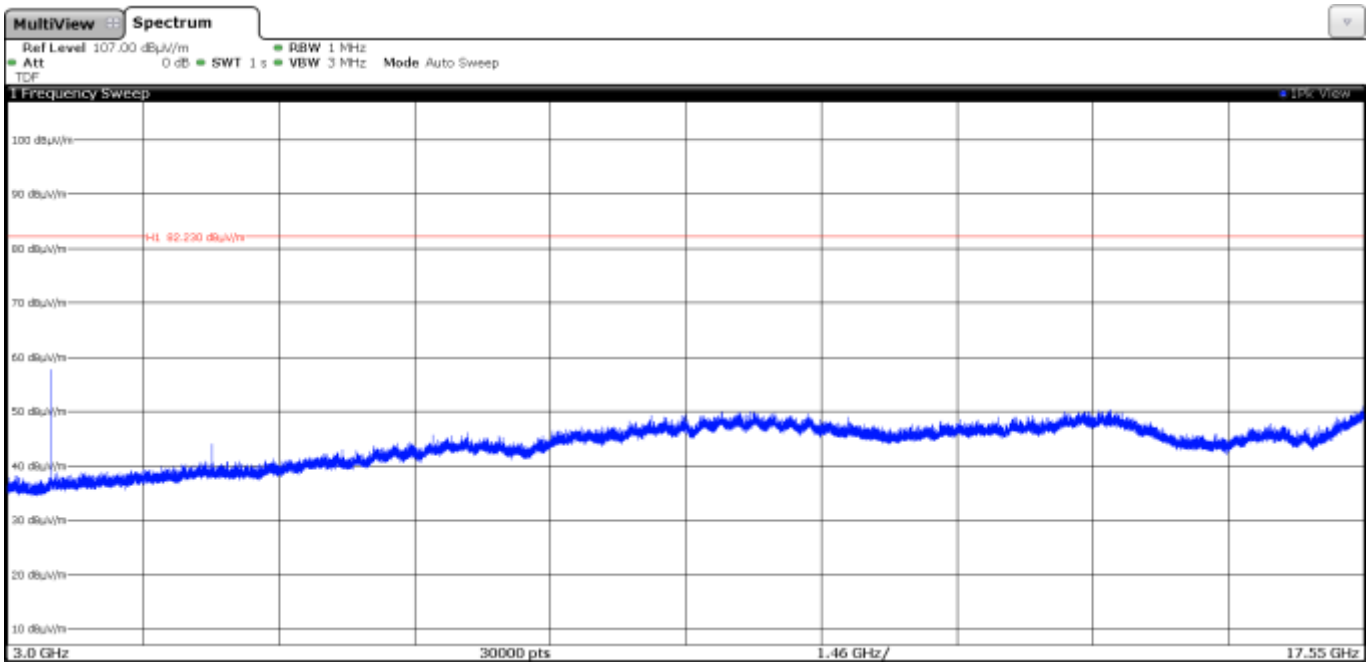
FREQUENCY RANGE 1 – 3 GHz



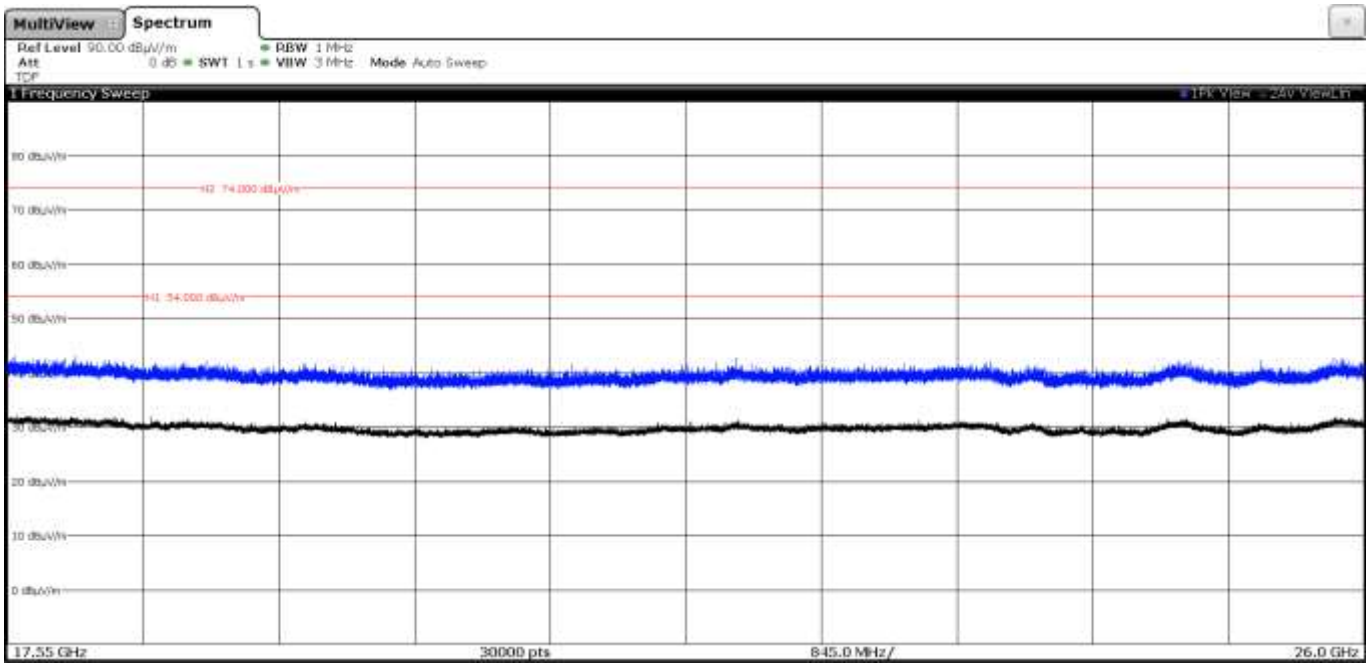
The peak above the limit on the left is the Carrier frequency LTE Cat-M1 Band 4 (1732.5 MHz).

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

FREQUENCY RANGE 3 – 17.55 GHz



FREQUENCY RANGE 17.55 - 26 GHz



- **Mode LTE NB-IoT Band 4, Bluetooth.**

QPSK & 16QAM
A preliminary scan determined the QPSK modulation in the Middle Channel as the worst case.

LTE NB-IoT Band 4:	QPSK, Middle Channel (1732.5 MHz).
Bluetooth Low Energy:	GFSK, 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 20 GHz	PK	43 + 10 log (P) dB = -13 dBm -> 82.23 dBµV/m OR -21.23 dBm -> 74 dBµV/m (*)
20 GHz to 26 GHz	PK	74 dBµV/m (*) (**)
30 MHz to 26 GHz	AVG	54 dBµV/m (*) (**)

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

(**) Radiated emissions which fall in the non-restricted bands.

Frequency range 30 MHz - 1 GHz

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

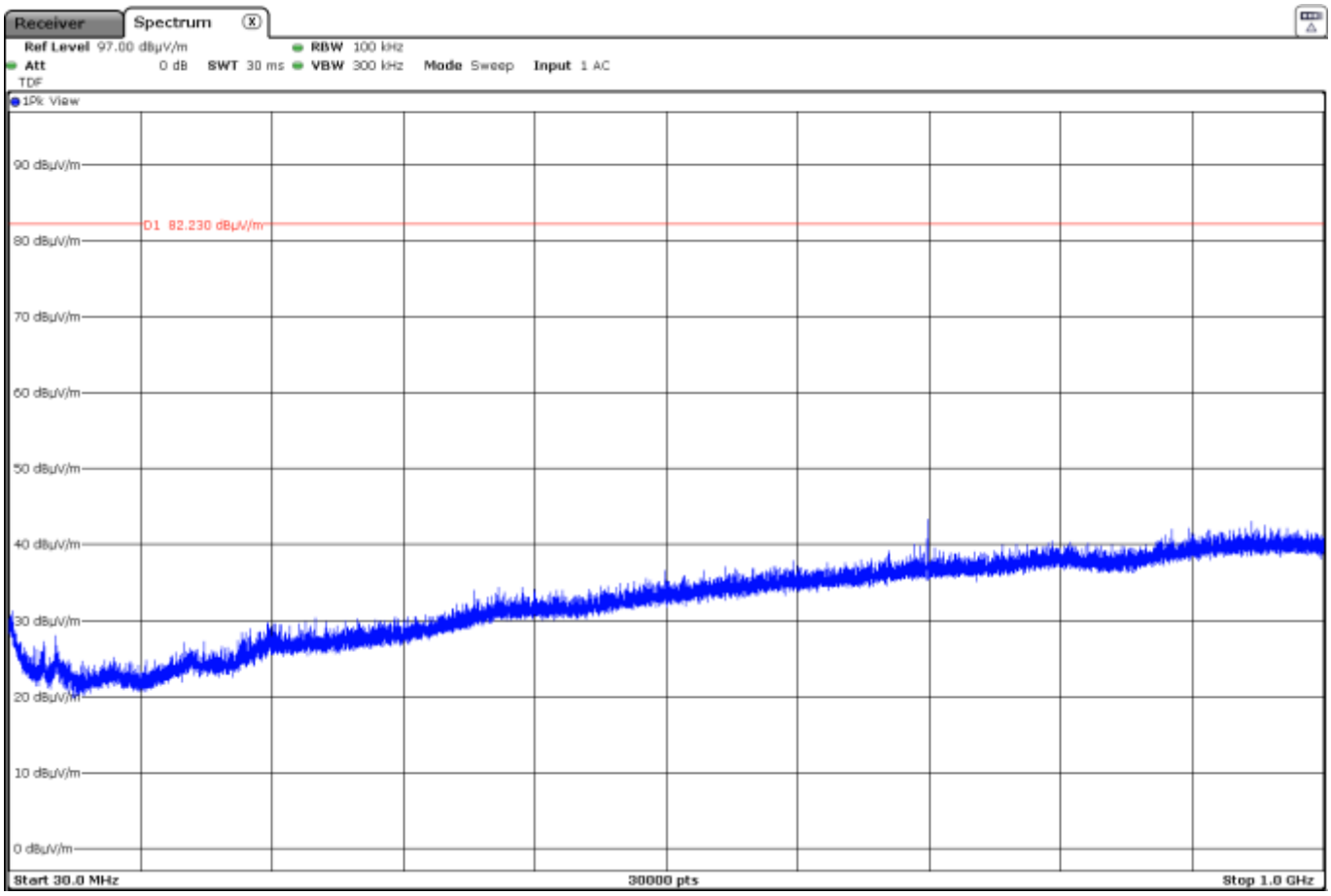
Frequency range 1 - 26 GHz

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

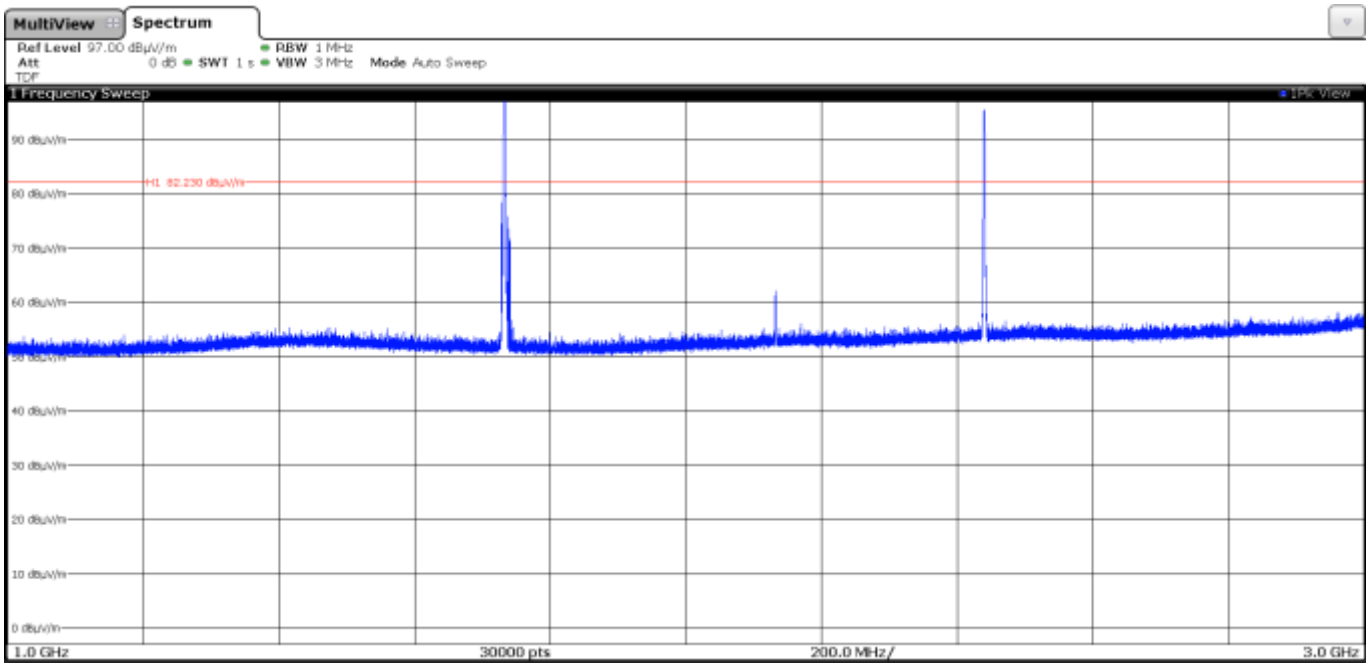
Measurement uncertainty (dB)	<±3.88 for f < 1GHz <±3.70 for f ≥ 1 GHz up to 18 GHz <±3.33 for f ≥ 18 GHz up to 40 GHz

Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz



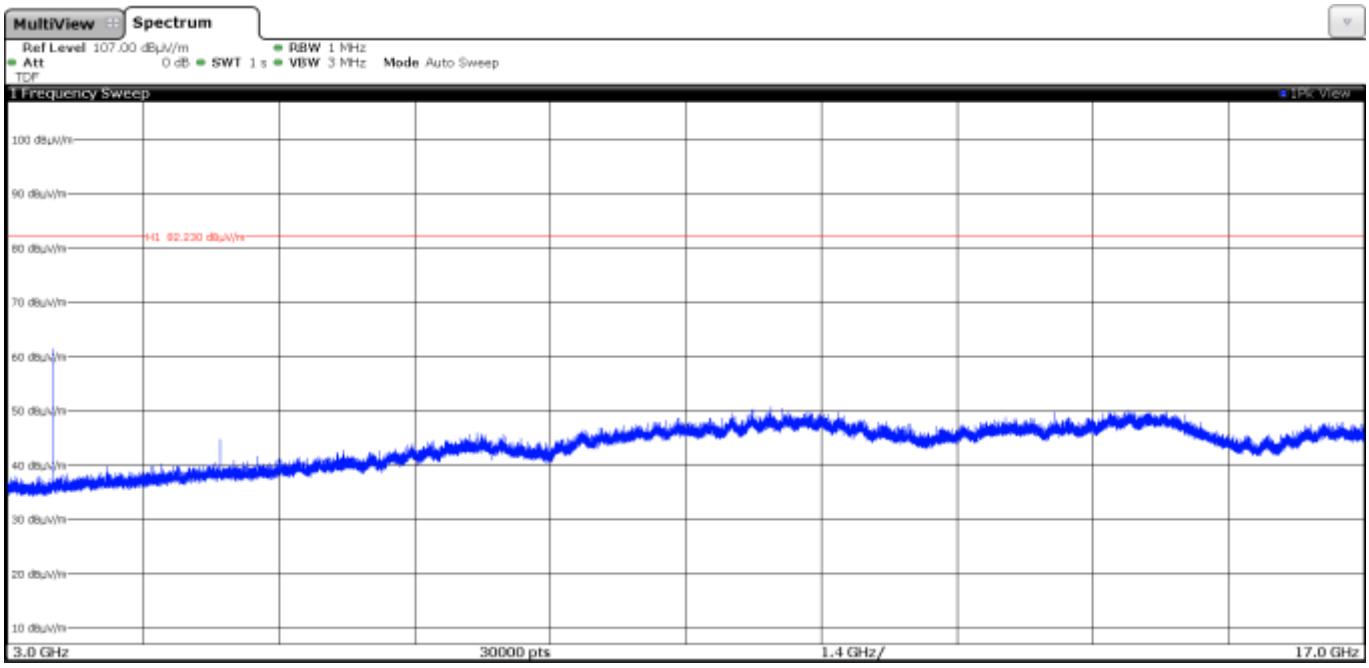
FREQUENCY RANGE 1 – 3 GHz



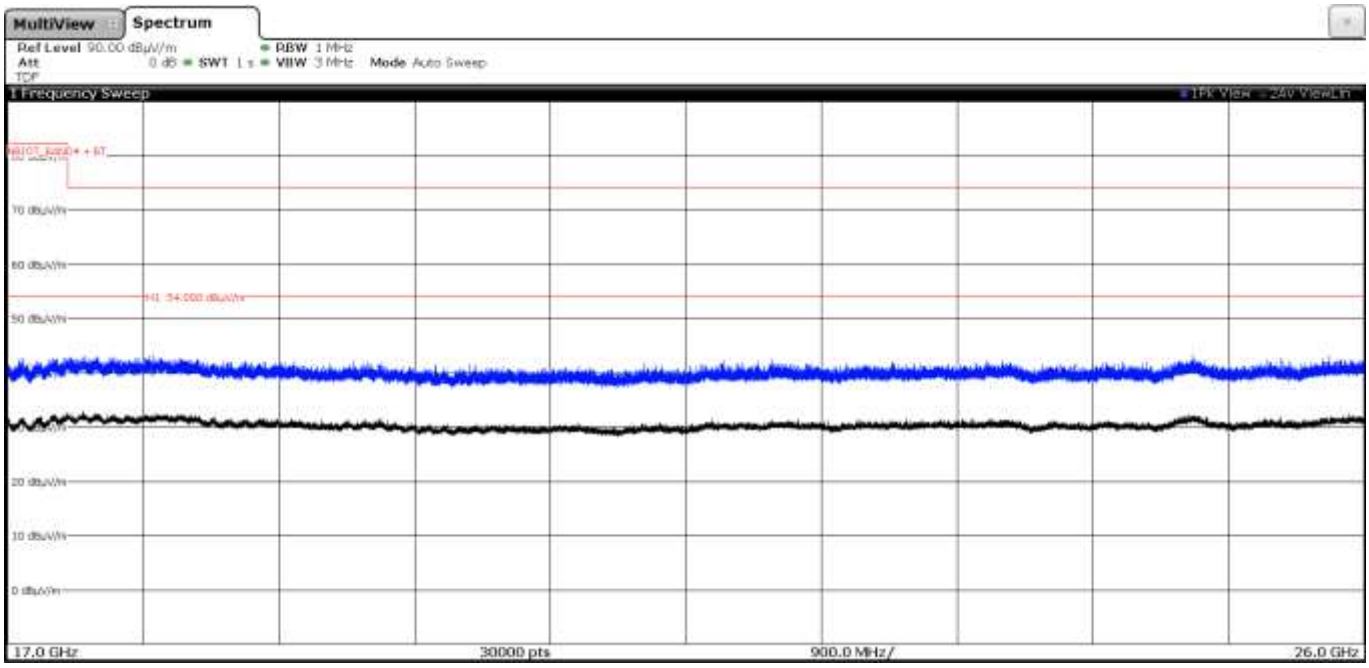
The peak above the limit on the left is the Carrier frequency LTE NB-IoT Band 4 (1732.5 MHz).

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

FREQUENCY RANGE 3 – 17 GHz



FREQUENCY RANGE 17 - 26 GHz



- **Mode LTE Cat-M1 Band 12, Bluetooth.**

QPSK & 16QAM:
A preliminary scan determined the QPSK modulation in the Middle Channel as the worst case.

LTE Cat-M1 Band 12:	QPSK, Middle Channel (707.5 MHz).
Bluetooth Low Energy:	GFSK, 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 8 GHz	PK	43 + 10 log (P) dB = -13 dBm -> 82.23 dBµV/m OR -21.23 dBm -> 74 dBµV/m (*)
8 GHz to 26 GHz	PK	74 dBµV/m (*) (**)
30 MHz to 26 GHz	AVG	54 dBµV/m (*) (**)

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

(**) Radiated emissions which fall in the non-restricted bands.

Frequency range 30 MHz - 1 GHz

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

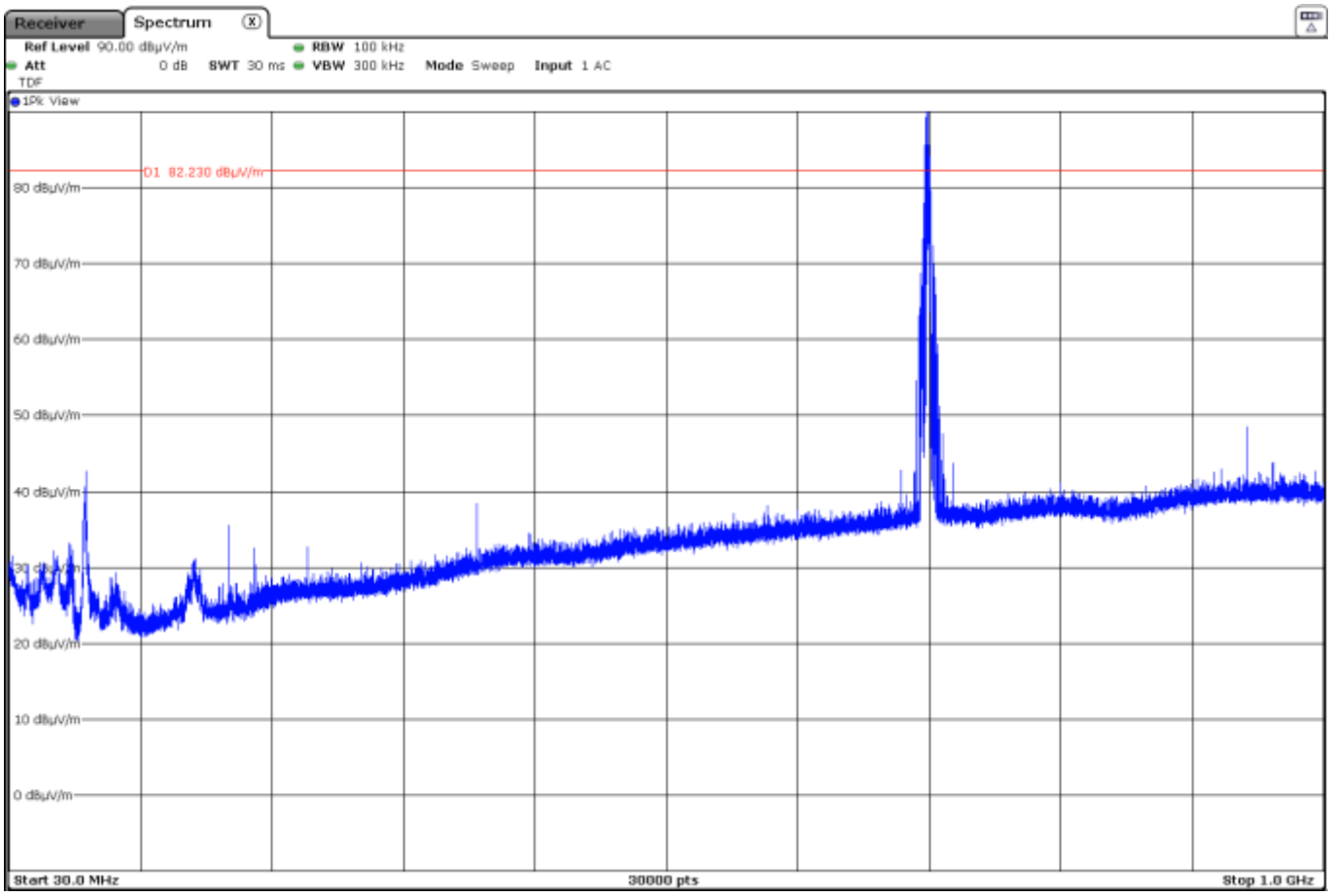
Frequency range 1 - 26 GHz

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

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

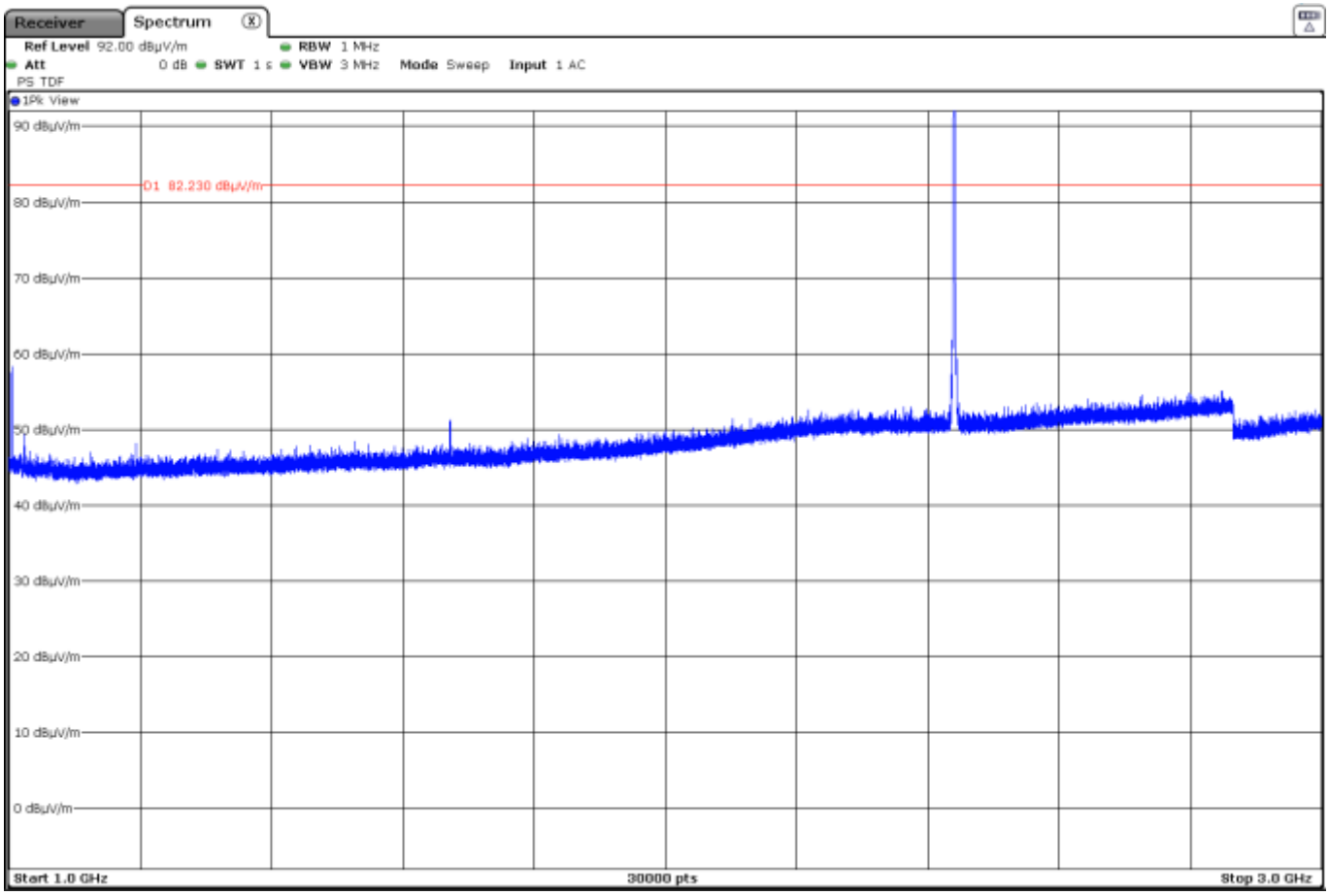
Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz



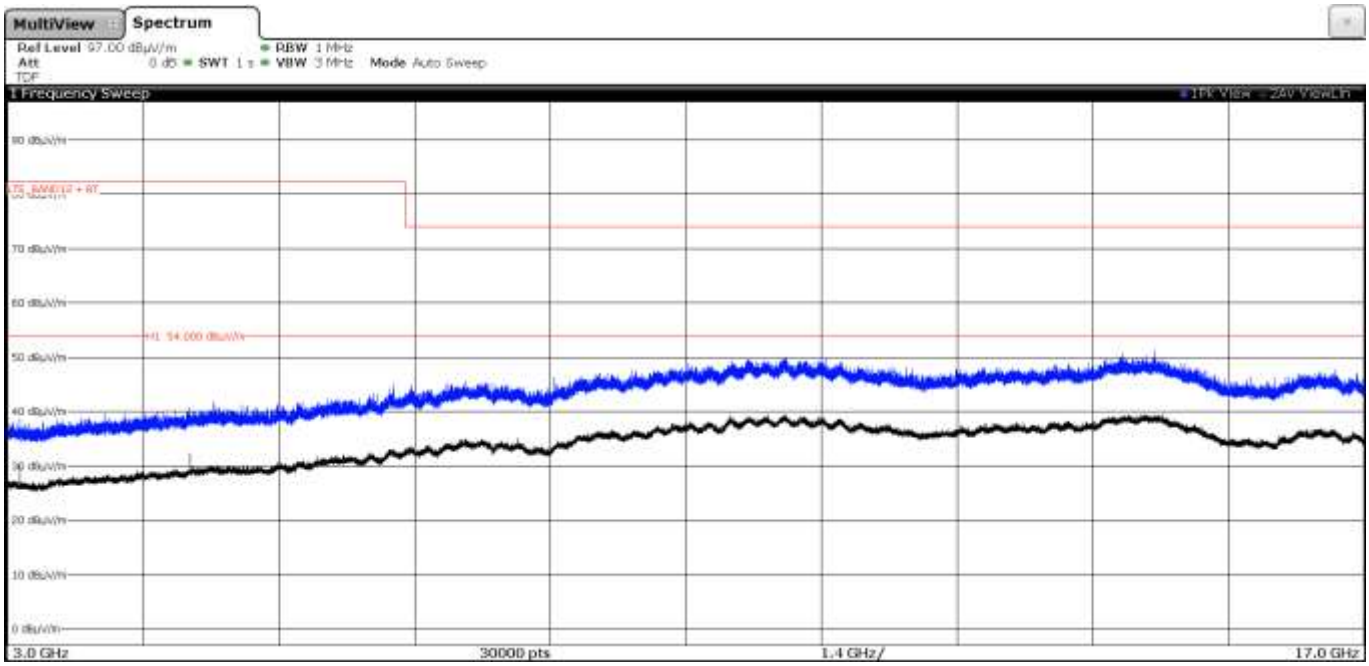
The peak above the limit is the Carrier frequency LTE Cat-M1 Band 12 (707.5 MHz)

FREQUENCY RANGE 1 – 3 GHz

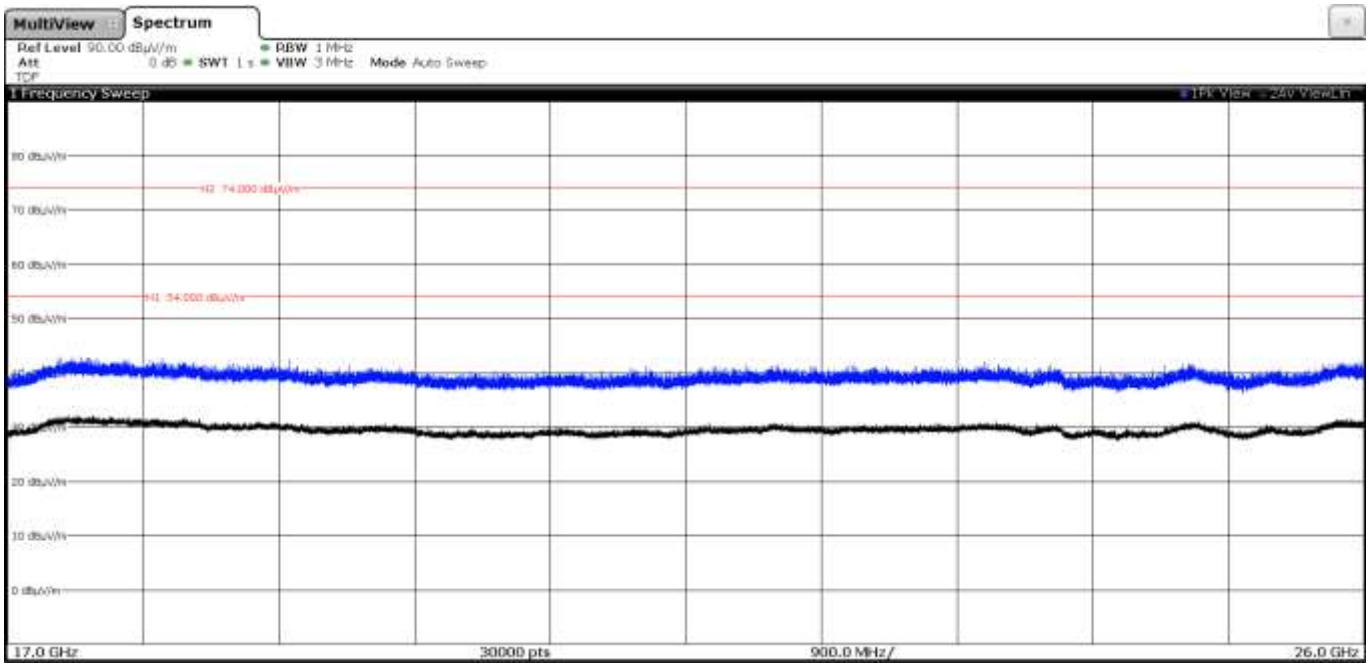


The peak above the limit is the Carrier frequency Bluetooth Low Energy (2440 MHz).

FREQUENCY RANGE 3 – 17 GHz



FREQUENCY RANGE 17 - 26 GHz



- **Mode LTE NB-IoT Band 12, Bluetooth.**

QPSK & 16QAM:
A preliminary scan determined the QPSK modulation in the Middle Channel as the worst case.

LTE NB-IoT Band 12:	QPSK, Middle Channel (707.5 MHz).
Bluetooth Low Energy:	GFSK, 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 8 GHz	PK	43 + 10 log (P) dB = -13 dBm -> 82.23 dBµV/m OR -21.23 dBm -> 74 dBµV/m (*)
8 GHz to 26 GHz	PK	74 dBµV/m (*) (**)
30 MHz to 26 GHz	AVG	54 dBµV/m (*) (**)

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

(**) Radiated emissions which fall in the non-restricted bands.

Frequency range 30 MHz - 1 GHz

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

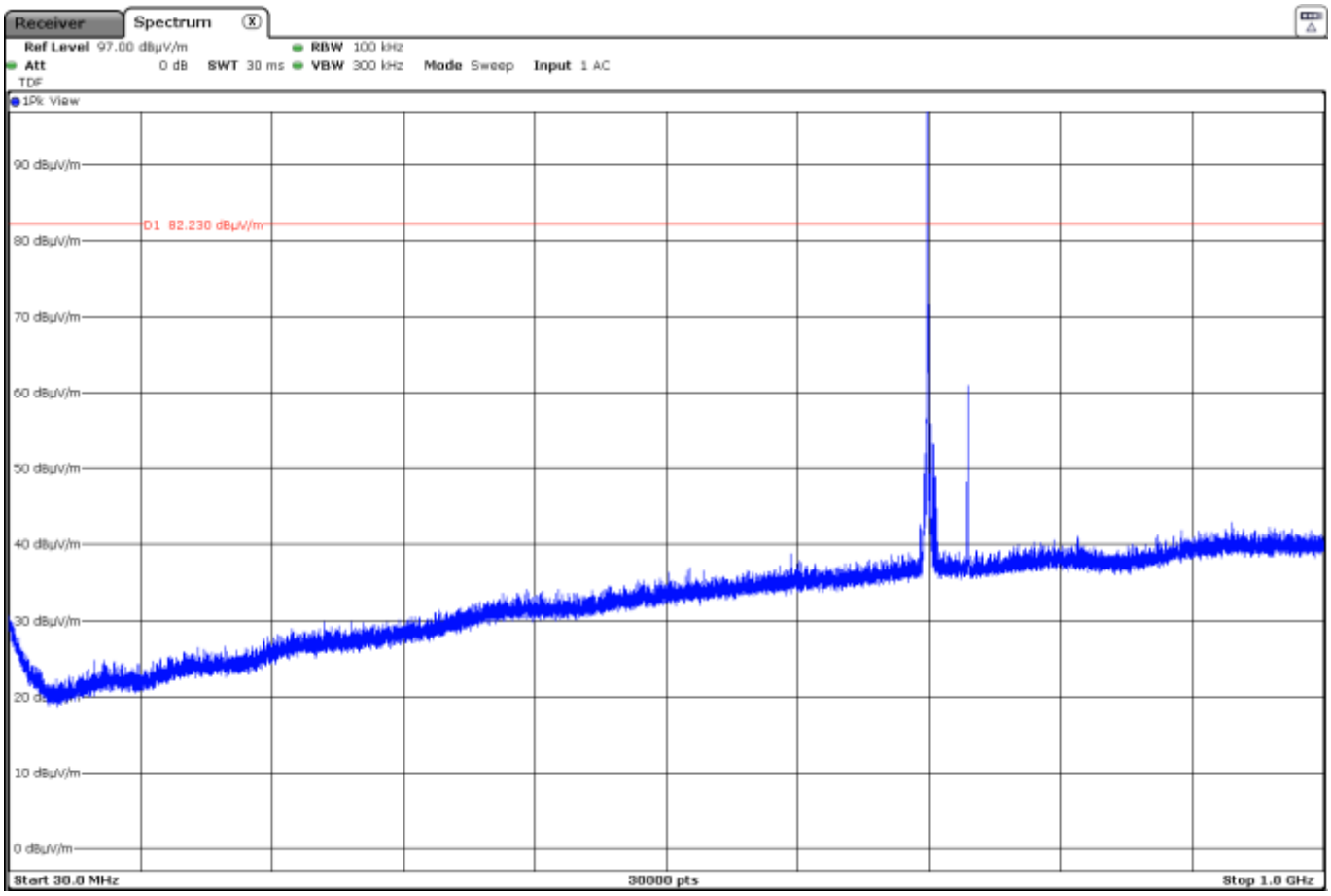
Frequency range 1 - 26 GHz

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

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

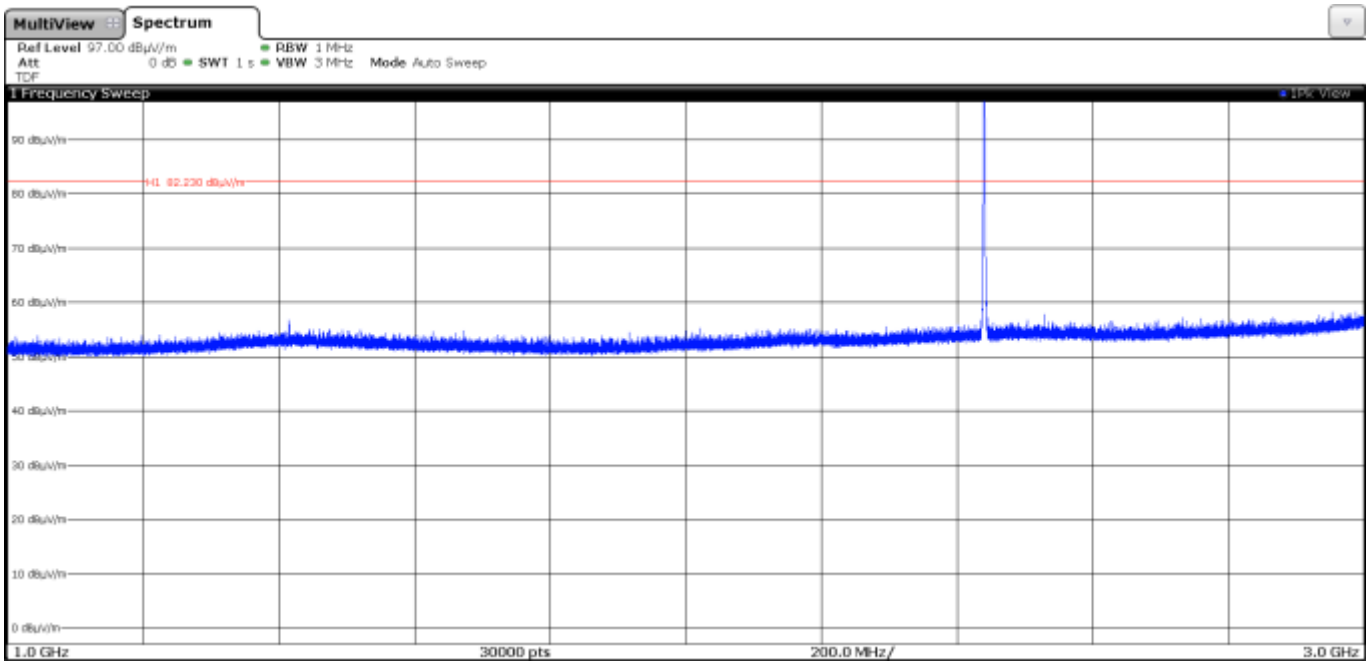
Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz



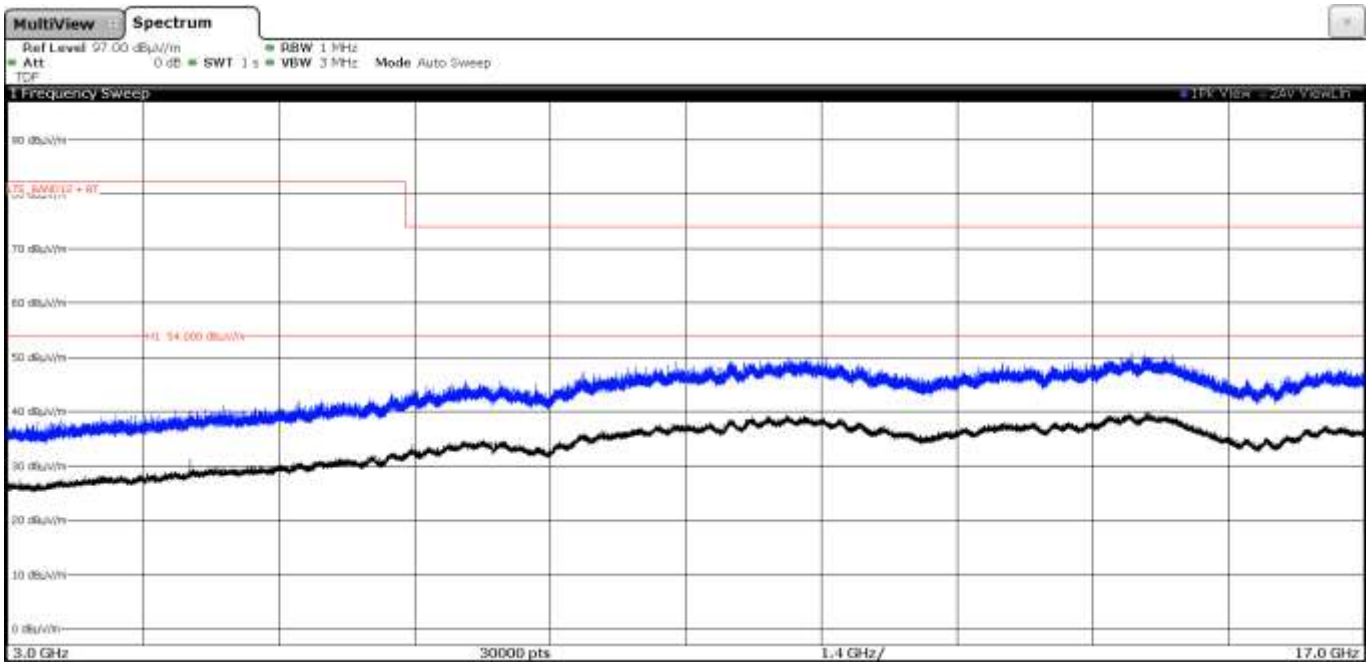
The peak above the limit is the Carrier frequency LTE NB-IoT Band 12 (707.5 MHz)

FREQUENCY RANGE 1 – 3 GHz

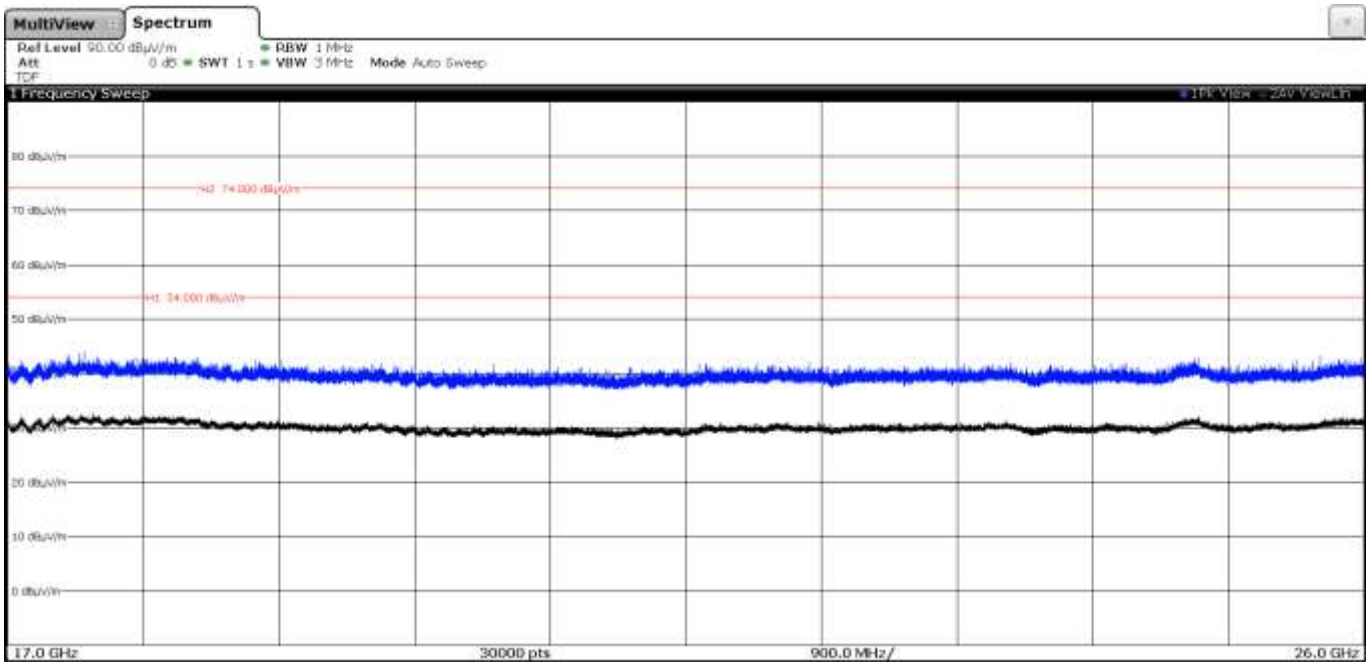


The peak above the limit is the Carrier frequency Bluetooth Low Energy (2440 MHz).

FREQUENCY RANGE 3 – 17 GHz



FREQUENCY RANGE 17 - 26 GHz



- **Mode LTE Cat-M1 Band 13, Bluetooth.**

QPSK & 16QAM:
A preliminary scan determined the QPSK modulation in the Middle Channel as the worst case.

LTE Cat-M1 Band 13:	QPSK, Middle Channel (782 MHz).
Bluetooth Low Energy:	GFSK, 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 8 GHz	PK	43 + 10 log (P) dB = -13 dBm -> 82.23 dBµV/m OR -21.23 dBm -> 74 dBµV/m (*)
8 GHz to 26 GHz	PK	74 dBµV/m (*) (**)
30 MHz to 26 GHz	AVG	54 dBµV/m (*) (**)

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

(**) Radiated emissions which fall in the non-restricted bands.

Frequency range 30 MHz - 1 GHz

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

Frequency range 1 – 26 GHz

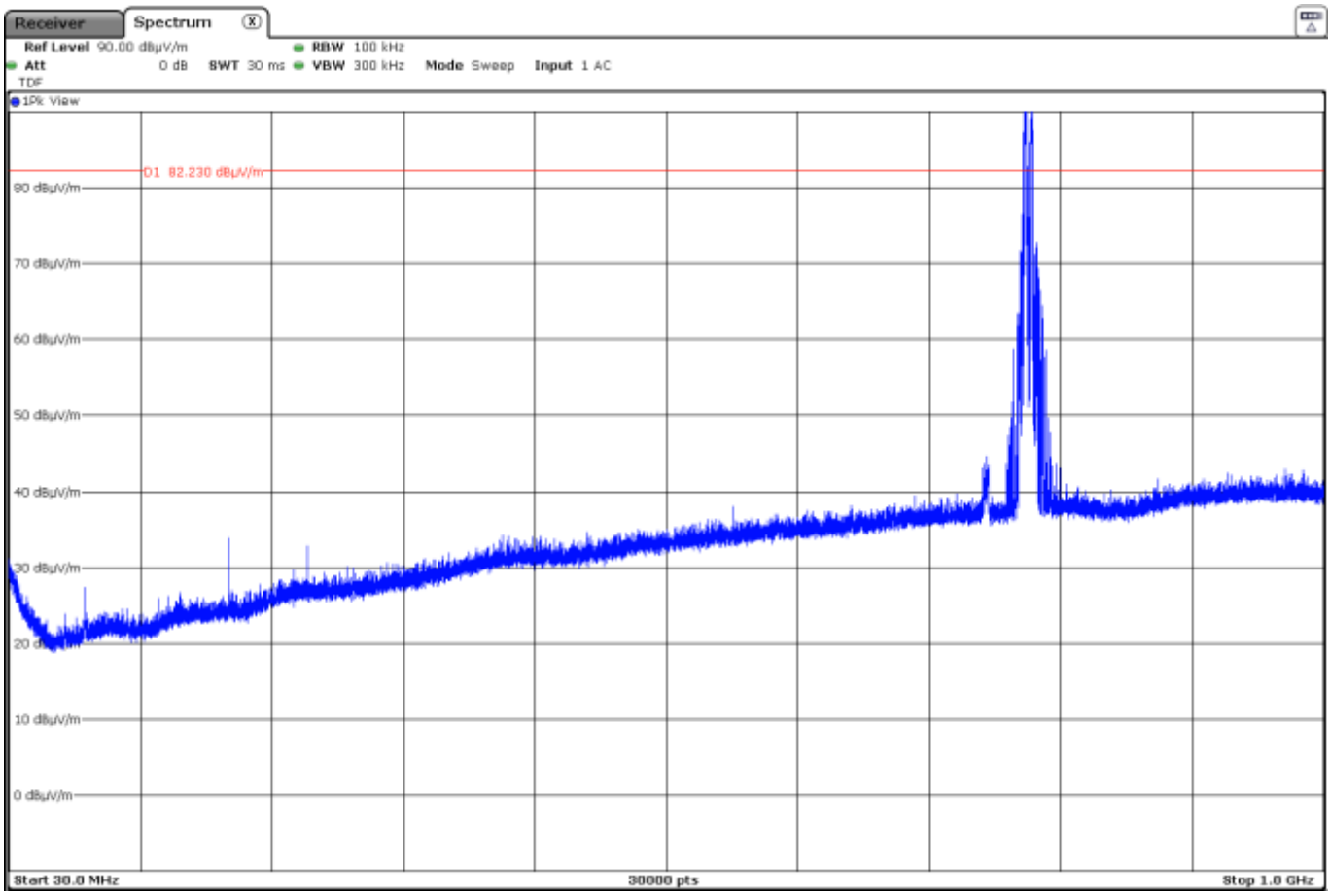
Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (GHz)	Detector	E (dBµV/m)	Polarization	Limit (dBµV/m)	Measurement Uncertainty (dB)
1.559767	Peak	71.33	H	82.23	<±3.70

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

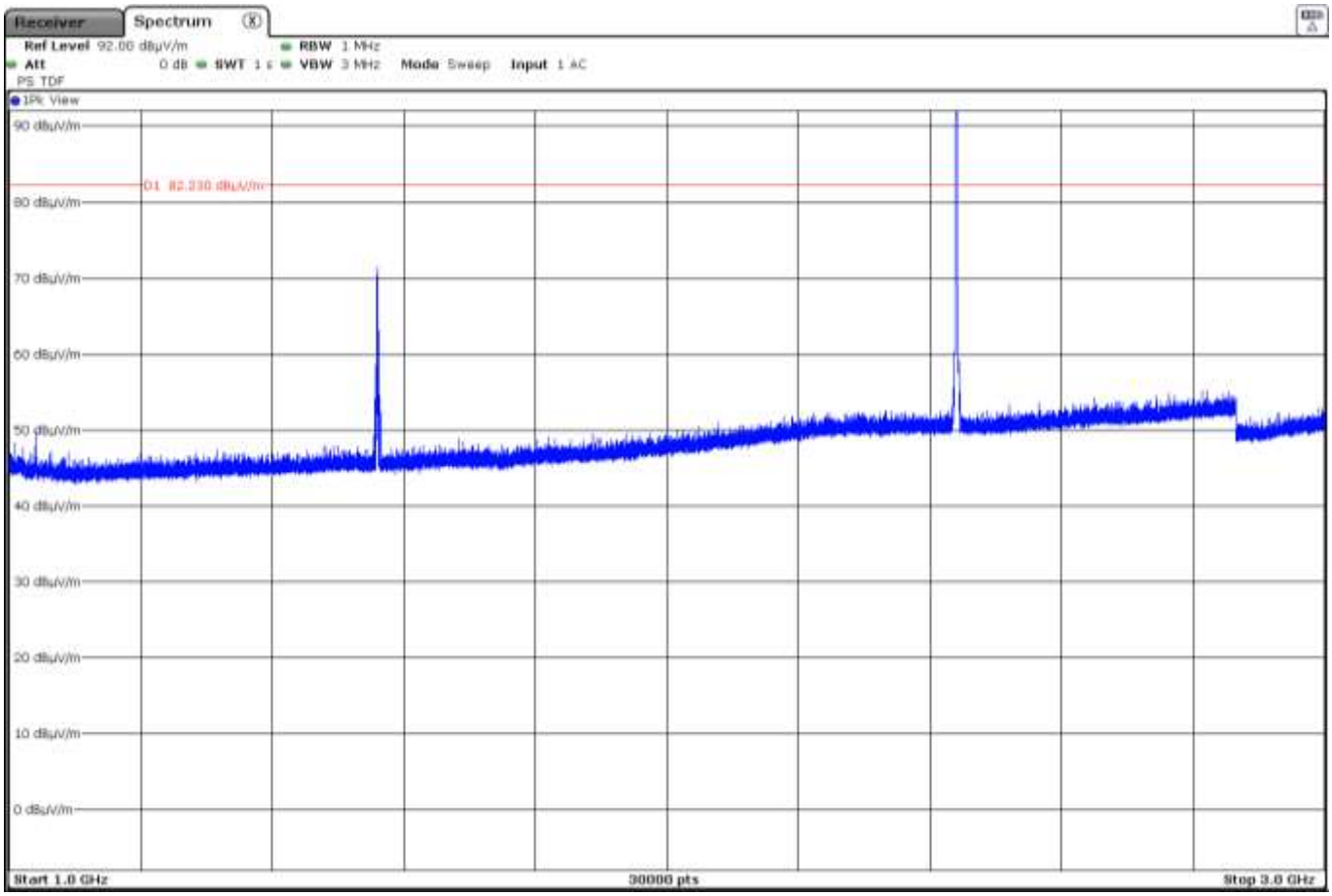
Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz



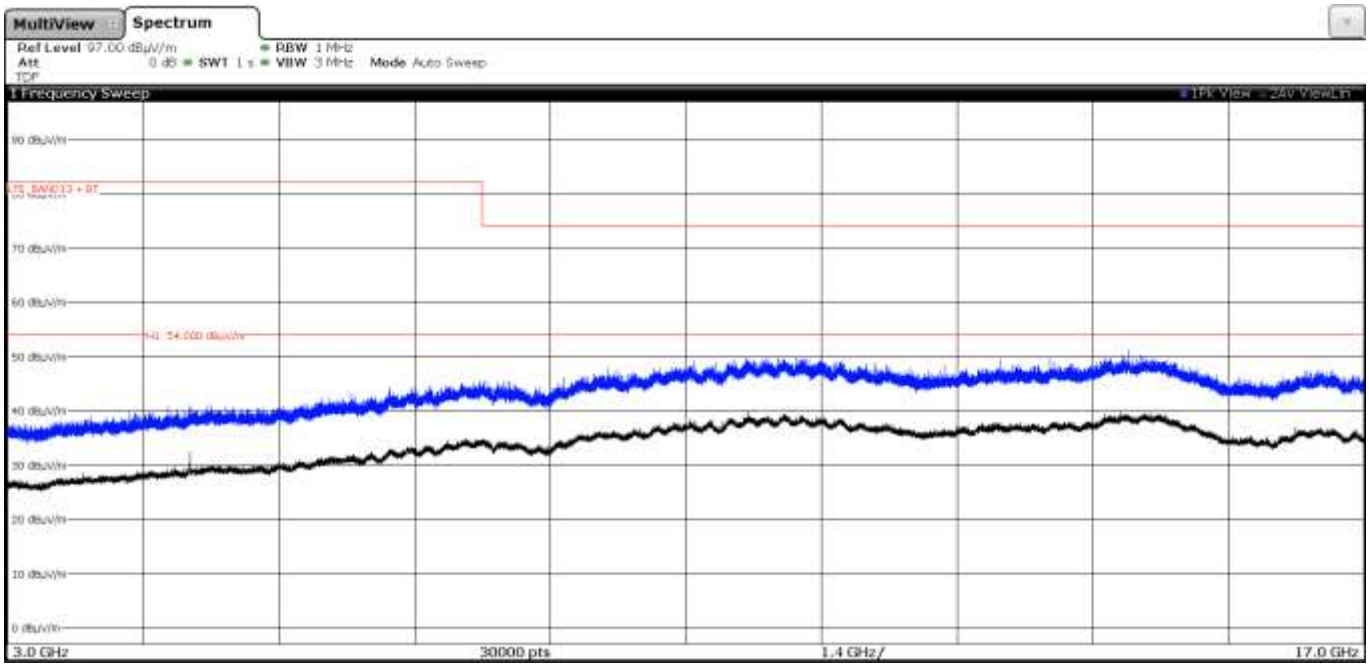
The peak above the limit is the Carrier frequency LTE Cat-M1 Band 13 (782 MHz)

FREQUENCY RANGE 1 – 3 GHz

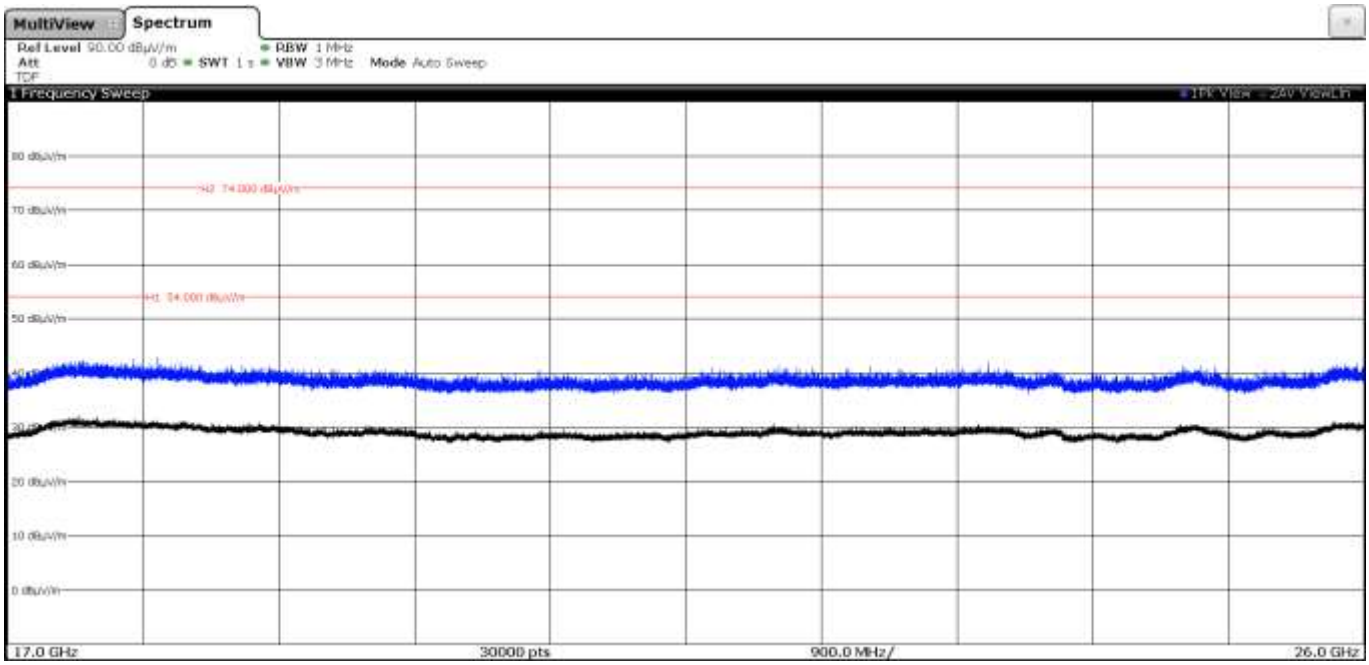


The peak above the limit is the Carrier frequency Bluetooth Low Energy (2440 MHz).

FREQUENCY RANGE 3 – 17 GHz



FREQUENCY RANGE 17 - 26 GHz



- **Mode LTE NB-IoT Band 13, Bluetooth.**

QPSK & 16QAM:
A preliminary scan determined the QPSK modulation in the Middle Channel as the worst case.

LTE NB-IoT Band 13:	QPSK, Middle Channel (782 MHz).
Bluetooth Low Energy:	GFSK, 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 8 GHz	PK	43 + 10 log (P) dB = -13 dBm -> 82.23 dBµV/m OR -21.23 dBm -> 74 dBµV/m (*)
8 GHz to 26 GHz	PK	74 dBµV/m (*) (**)
30 MHz to 26 GHz	AVG	54 dBµV/m (*) (**)

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

(**) Radiated emissions which fall in the non-restricted bands.

Frequency range 30 MHz - 1 GHz

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

Frequency range 1 - 26 GHz

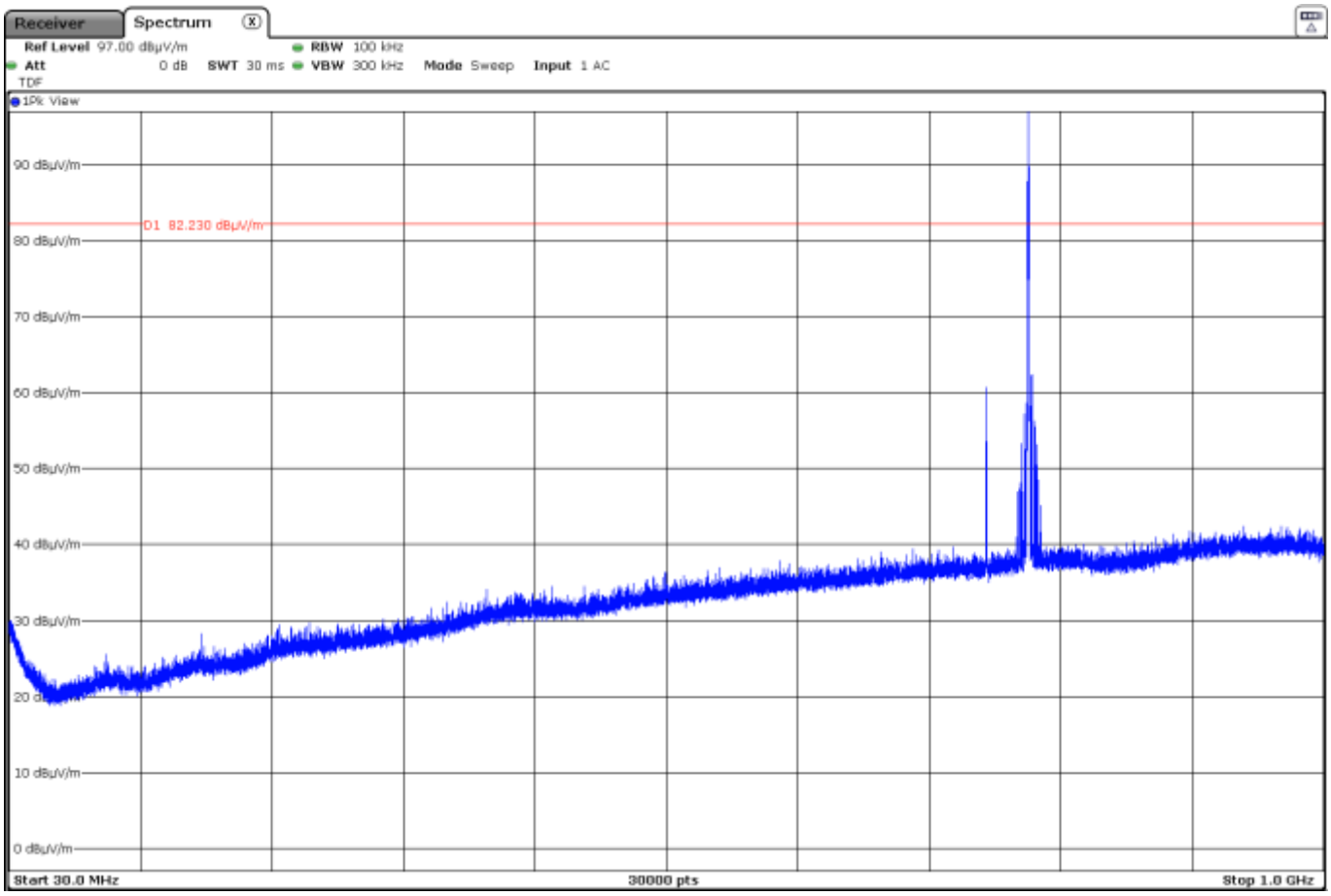
Spurious frequencies at less than 20 dB below the limit:

Spurious frequency (GHz)	Detector	E (dBµV/m)	Polarization	Limit (dBµV/m)	Measurement Uncertainty (dB)
1.563967	Peak	70.69	H	82.23	<±3.70

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

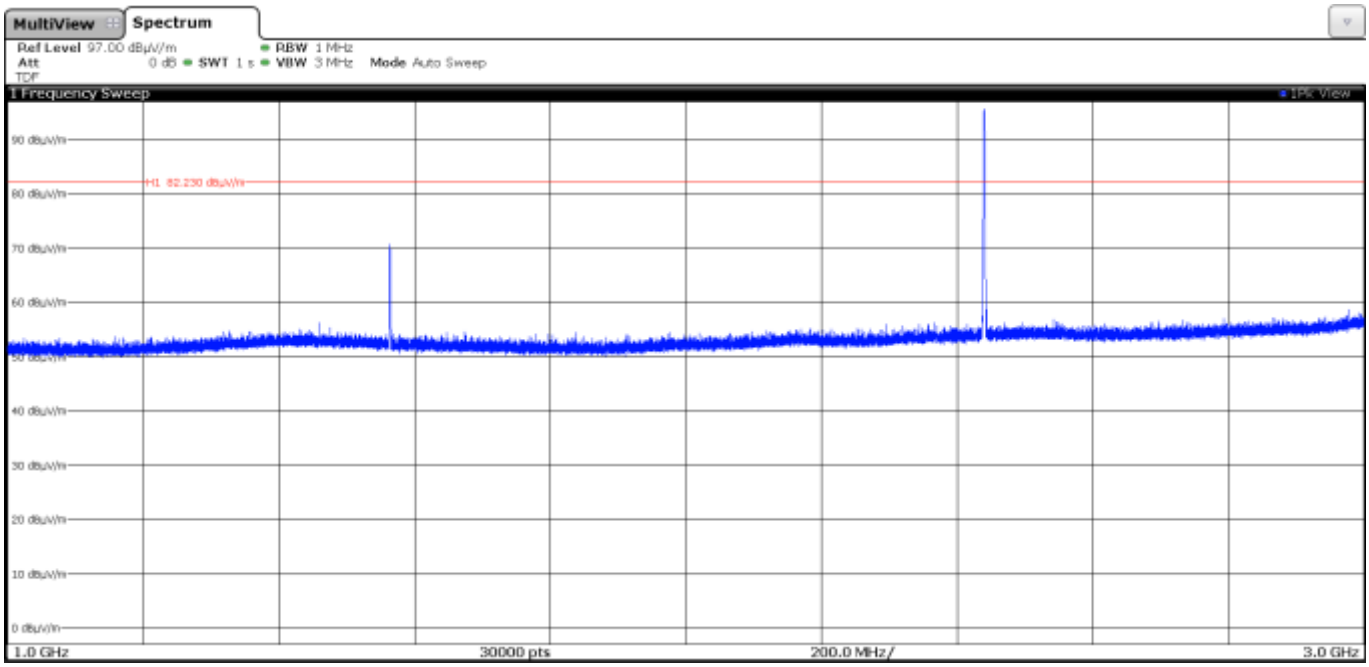
Verdict: PASS

FREQUENCY RANGE 30 MHz - 1 GHz



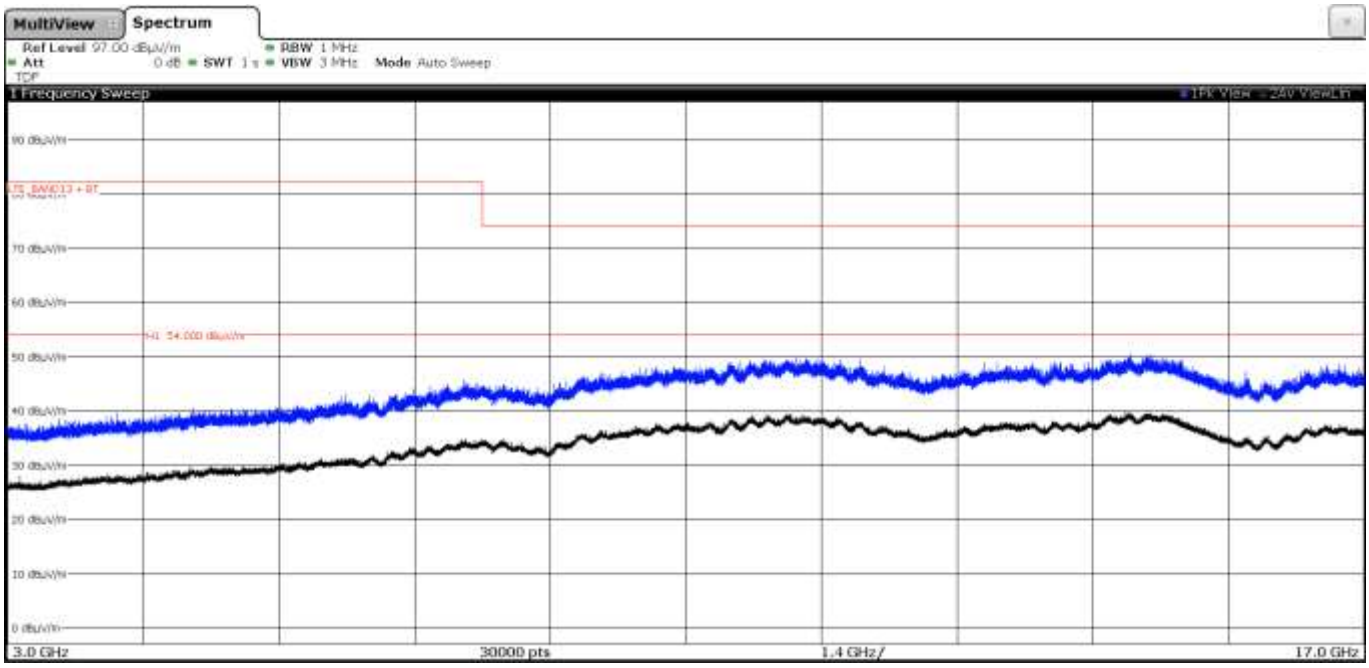
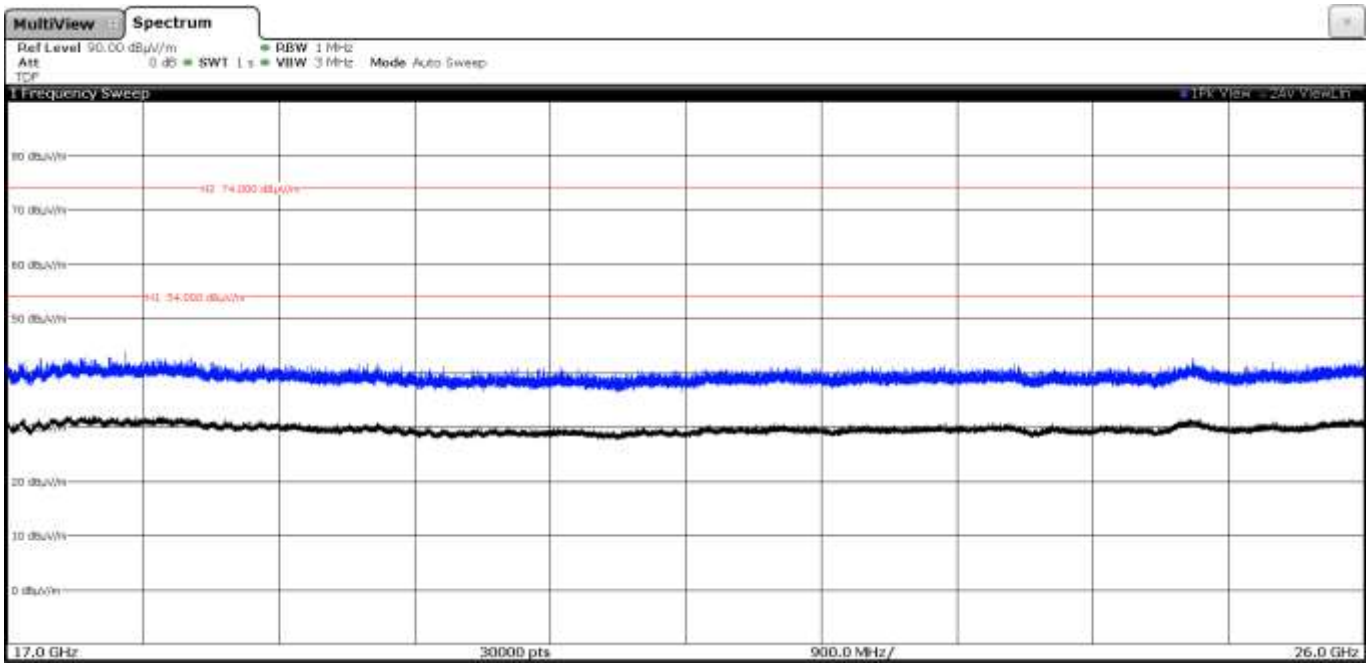
The peak above the limit is the Carrier frequency LTE NB-IoT Band 13 (782 MHz)

FREQUENCY RANGE 1 – 3 GHz



The peak above the limit is the Carrier frequency Bluetooth (2440 MHz).

FREQUENCY RANGE 3 – 17 GHz



FREQUENCY RANGE 17 - 26 GHz