



FCC LISTED,
REGISTRATION NUMBER:
720267

ISED LISTED
REGISTRATION NUMBER
4621A-2, 4621A-4

Test report No:
NIE: 56944RRF.002

Test report

USA FCC Part 15.247, 15.209

CANADA RSS-247, RSS-Gen

Radio Frequency Devices. Operation within the bands 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz.

Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSS) and Licence-Exempt Local Area Network (LE-LAN) Devices.

General Requirements and Information for the Certification of Radio Apparatus.

Identification of item tested	27-inch iMAC with Retina 5K display
Trademark	Apple
Model and /or type reference	A2115
Other identification of the product	FCC ID: BCGA2115 IC: 579C-A2115
Features	IEEE 802.11 a/b/g/n/ac radio and Bluetooth radio
Applicant	APPLE INC One Apple Park Way, Cupertino, California 95014, USA
Test method requested, standard	USA FCC Part 15.247 10-1-17 Edition: Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz. USA FCC Part 15.209 10-1-17 Edition: Radiated emission limits; general requirements. CANADA RSS-247 Issue 2 (February 2017). CANADA RSS-Gen Issue 5 (April 2018). 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 v05 dated August 24, 2018. ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.
Summary	IN COMPLIANCE
Approved by (name / position & signature)	A. Llamas p.a. RF Lab. Manager  Firmado digitalmente por FRANCISCO CAÑAS ESCRIBANO Fecha: 2019.03.06 15:43:50 +01'00'

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Competences and guarantees

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

DEKRA Testing and Certification is a laboratory with a measurement facility in compliance with the requirements of Section 2.948 of the FCC rules and has been added to the list of facilities whose measurements data will be accepted in conjunction with applications for Certification under Parts 15 or 18 of the Commission's Rules. Registration Number: 720267.

DEKRA Testing and Certification is a laboratory with a measurement site in compliance with the requirements of RSS 212, Issue 1 (Provisional) and has been added to the list of filed sites of the Canadian Certification and Engineering Bureau. Reference File Number: ISSED 4621A-2 and ISSED 4621A-4.

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

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

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

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

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General conditions

1. This report is only referred to the item that has undergone the test.
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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 and the Accreditation Bodies.

Uncertainty

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

Data provided by the client

iMac desktop computer with IEEE 802.11 a/b/g/n/ac radio and Bluetooth radio.

DEKRA 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
56944/06	iMAC	A2115	C02WW002K1R4	2018-08-16

Auxiliary elements used with the sample S/01

Control N°	Description	Model	Serial N°	Date of reception
56943/03	Keyboard	A1243	---	2018-04-09
56943/05	Power Cable	---	---	2018-04-09
56943/07	Mouse	A1152	---	2018-04-09
56943/09	USB-C to VGA converter	A1620	---	2018-04-09
56943/11	USB to thunderbolt	A1790	---	2018-04-09
56943/13	Earphones	---	---	2018-04-09

1. Sample S/01 has undergone the following test(s):

Emission limitations radiated (Transmitter) indicated in Appendix A. It was determined as the worst case.

Sample S/02 is composed of the following elements:

Control N°	Description	Model	Serial N°	Date of reception
56944/05	iMAC	A2115	C02WW01EKFGK	2018-08-16

Auxiliary elements used with the sample S/02

Control N°	Description	Model	Serial N°	Date of reception
56943/04	Keyboard	A1243	---	2018-04-09
56943/06	Power Cable	---	---	2018-04-09
56943/08	Mouse	A1152	---	2018-04-09
56943/10	USB-C to VGA converter	A1620	---	2018-04-09
56943/12	USB to thunderbolt	A1790	---	2018-04-09
56943/14	Earphones	---	---	2018-04-09

1. Sample S/02 has undergone the following test(s):

Band-edge emissions compliance (Transmitter) indicated in Appendix A. It was determined as the worst case.

Sample S/03 is composed of the following elements:

Control N°	Description	Model	Serial N°	Date of reception
56944/14	iMAC	A2115	C02X300EKFDN	2018-09-03

Auxiliary elements used with the sample S/03

Control N°	Description	Model	Serial N°	Date of reception
56943/04	Keyboard	A1243	---	2018-04-09
56944/13	Power Cable	---	---	2018-04-09
56943/08	Mouse	A1152	---	2018-04-09

1. Sample S/03 has undergone the following test(s):

All conducted tests indicated in Appendix A.

Test sample description

Ports..... :	Port name and description	Cable					
		Specified length [m]	Attached during test	Shielded			
			☐	☐			
			☐	☐			
			☐	☐			
			☐	☐			
			☐	☐			
			☐	☐			
Supplementary information to the ports..... :							
Rated power supply	Voltage and Frequency		Reference poles				
			L1	L2	L3	N	PE
	☒	AC: 120 / 60 Hz	☒	☐	☐	☒	☒
	☐	AC:	☐	☐	☐	☐	☐
	☐	DC:					
☐	DC:						
Rated Power							
Clock frequencies.....							
Other parameters							

Software version	18A334		
Hardware version	EVT		
Dimensions in cm (W x H x D)	65cm wide, 51.65cm high, 20.3cm deep		
Mounting position	☒	Table top equipment	
	☐	Wall/Ceiling mounted equipment	
	☐	Floor standing equipment	
	☐	Hand-held equipment	
	☐	Other:	
Modules/parts.....	Module/parts of test item	Type	Manufacturer
Accessories (not part of the test item)	Description	Type	Manufacturer
	Keyboard	A1243	Apple
	Power Cable	---	Apple
	Mouse	A1152	Apple
	USB-C to VGA conversor	A1620	Apple
	USB to thunderbolt	A1790	Apple
	Earphones	---	Apple
Documents as provided by the applicant.....	Description	File name	Issue date

Copy of marking plate:



Identification of the client

APPLE INC

One Apple Park Way, Cupertino, California 95010, USA

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2018-11-05
Date (finish)	2019-01-14

Document history

Report number	Date	Description
56944RRF.002	2019-03-05	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 %
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 1 Ω

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 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 1 Ω
Normal site attenuation (NSA)	< ±4 dB at 10 m distance between item under test and receiver antenna, (30 MHz to 1000 MHz)
Field homogeneity	More than 75% of illuminated surface is between 0 and 6 dB (26 MHz to 1000 MHz).

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

Temperature	Min. = 15 °C Max. = 35 °C
Relative humidity	Min. = 20 % Max. = 35 %
Air pressure	Min. = 860 mbar Max. = 1060 mbar
Shielding effectiveness	> 100 dB
Electric insulation	> 10 kΩ
Reference resistance to earth	< 1 Ω

Remarks and comments

The tests have been performed by the technical personnel: Jose Carlos Luque, Ignacio Cabra and Jose Alberto Aranda.

Used instrumentation:

Radiated Measurements

		Last Cal. date	Cal. due date
1.	Semianechoic Absorber Lined Chamber ETS FACT3 200STP	N.A.	N.A.
2.	Semianechoic Absorber Lined Chamber ETS FACT3 200STP	N.A.	N.A.
3.	Multi Device Controller EMCO 2090	N.A.	N.A.
4.	Positioning Controller INNCO CO3000	N.A.	N.A.
5.	BiconicalLog antenna ETS LINDGREN 3142E	2017/09	2020/09
6.	BiconicalLog antenna ETS LINDGREN 3142E	2018/07	2021/07
7.	Double-ridge Guide Horn antenna 1-18 GHz SCHWARZBECK BBHA 9120 D	2016/11	2019/11
8.	Double-ridge Guide Horn antenna 1-18 GHz SCHWARZBECK BBHA 9120 D	2018/06	2021/06
9.	Broadband Horn antenna 18-40 GHz SCHWARZBECK BBHA 9170	2017/04	2020/04
10.	Broadband Horn antenna 18-40 GHz SCHWARZBECK BBHA 9170	2018/07	2021/07
11.	EMI Test Receiver R&S ESR7	2018/10	2020/10
12.	EMI Test Receiver R&S ESR7	2018/10	2020/10
13.	Spectrum analyser Rohde & Schwarz FSV40	2018/02	2020/02
14.	Spectrum analyser Rohde & Schwarz FSV40	2017/07	2019/07
15.	RF pre-amplifier 30MHz-6 GHz Bonn Elektronik BLNA 0360-01N	2018/07	2019/07
16.	RF pre-amplifier 10MHz-6 GHz Bonn Elektronik BLNA 0160-01N	2017/09	2019/03
17.	RF pre-amplifier 1-18 GHz Bonn Elektronik BLMA 0118-1M	2018/03	2019/03
18.	RF pre-amplifier 1-18 GHz Bonn Elektronik BLMA 0118-3A	2018/03	2019/03
19.	RF pre-amplifier 18-40 GHz Bonn Elektronik BLMA 1840-1M	2018/03	2019/03
20.	RF pre-amplifier 18-40 GHz NARDA JS44-18004000-33-8P	2018/02	2019/02
21.	RF High Pass Filter 3-18 GHz WAINWRIGHT INSTRUMENTS WHK 3.0/18G-10SS	2017/04	2019/04

22.	RF High Pass Filter 3-18 GHz TEMSTRON ST-3GA2833-HS	2018/09	2019/09
23.	RF Low Pass Filter DC-1GHz WAINWRIGHT INSTRUMENTS WLK1000-6SS	2018/06	2020/06
24.	RF High Pass Filter 18-26.5 GHz MicroWave Circuits H18G26G1	2017/04	2019/04
25.	AC Power Supply Elgar CS-AC35(351SL)	2016/05	2019/05
26.	AC Power Supply California Instruments 5001iM-400	2016/11	2020/11

Conducted Measurements

		Last Cal. date	Cal. due date
1.	Spectrum analyser Rohde & Schwarz FSV40	2017/07	2019/07
2.	AC Power Supply Elgar CS-AC35(351SL)	2016/05	2019/05

Testing verdicts

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

Summary

FCC PART 15 PARAGRAPH / RSS-247			
Requirement – Test case		Verdict	Remark
Part 15.247 (a) (2) / RSS-247 Clause 5.2. (a)	6 dB Bandwidth	P	
Part 15.247 (b) / RSS-247 Clause 5.4. (d)	Maximum output power and antenna gain	P	
Part 15.247 (e) / RSS-247 Clause 5.2. (b)	Power spectral density	P	
Part 15.247 (d) / RSS-247 Clause 5.5. ...	Emission limitations radiated (Transmitter)	P	
Part 15.247 (d) / RSS-247 Clause 5.5. ...	Band-edge emissions compliance (Transmitter)	P	
<u>Supplementary information and remarks:</u> (1) There are two manufacturer of the WiFi/Bluetooth radio modules, manufacturer 1 and manufacturer 2. (2) The WiFi/Bluetooth radio modules have the same mechanical outline (i.e. the same packaging dimension and pin layout), use the same on-board antenna matching circuit, have an identical antenna structure and are built and tested to conform to the same specification and to operate within the same tolerances. (3) Preliminary testing was performed on the two manufacturers to determine the worst case.			

Appendix A: Test results.

TEST CONDITIONS.....	13
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Transmitter Duty Cycle	19
FCC Section 15.247 Subclause (a) (2) / RSS-247 5.2. (a). 6 dB Bandwidth	20
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FCC Section 15.247 Subclause (e) / RSS-247 5.2. (b) Power spectral density	29
FCC Section 15.247 Subclause (d) / RSS-247 5.5. Emission limitations radiated (Transmitter)	33
FCC Section 15.247 Subclause (d) / RSS-247 5.5. Band-edge emissions compliance (Transmitter)	44

TEST CONDITIONS

Power supply (V):

Vnominal = 120 Vac

Type of power supply = AC voltage main supply.

Type of antenna = Internal antenna.

Declared Gain for antenna (maximum) = + 6.56 dBi.

TEST FREQUENCIES:

Lowest channel: 2402 MHz

Middle channel: 2440 MHz

Highest channel: 2480 MHz

The EUT was tested in the following operating mode(s):

- The sample was used to configure the EUT to continuously transmit at maximum power in all required test channels at 1 Mbps bit rate.
- The sample was used to configure the EUT to continuously transmit at maximum power in all required test channels at 2 Mbps bit rate.

CONDUCTED MEASUREMENTS

The equipment under test was set up in a shielded room and connected to the spectrum analyzer using a low loss RF cable. The reading in the spectrum analyzer is corrected taking into account the internal and external RF cable loss.



The AC supply voltage is applied using an external power supply.

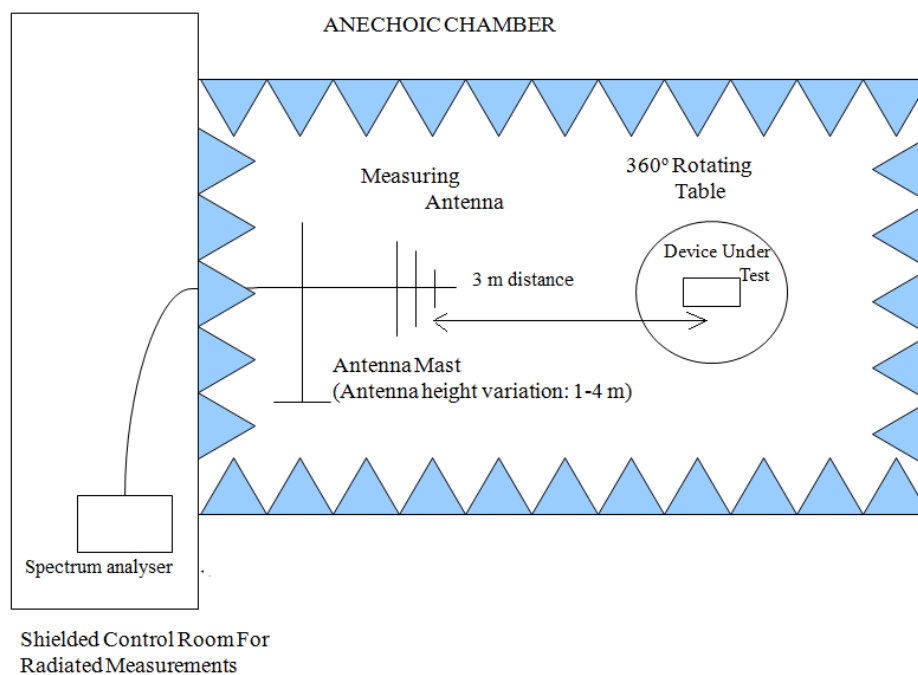
RADIATED MEASUREMENTS

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at a distance of 3 m. The EUT was placed at a height of 80 cm above the reference ground plane in the center of the chamber turntable to perform the measurements below 1GHz and The EUT was placed at a height of 1.5 meters above the test chamber floor in the center of the chamber turntable to perform the measurements above 1GHz. It was also rotated 360° and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

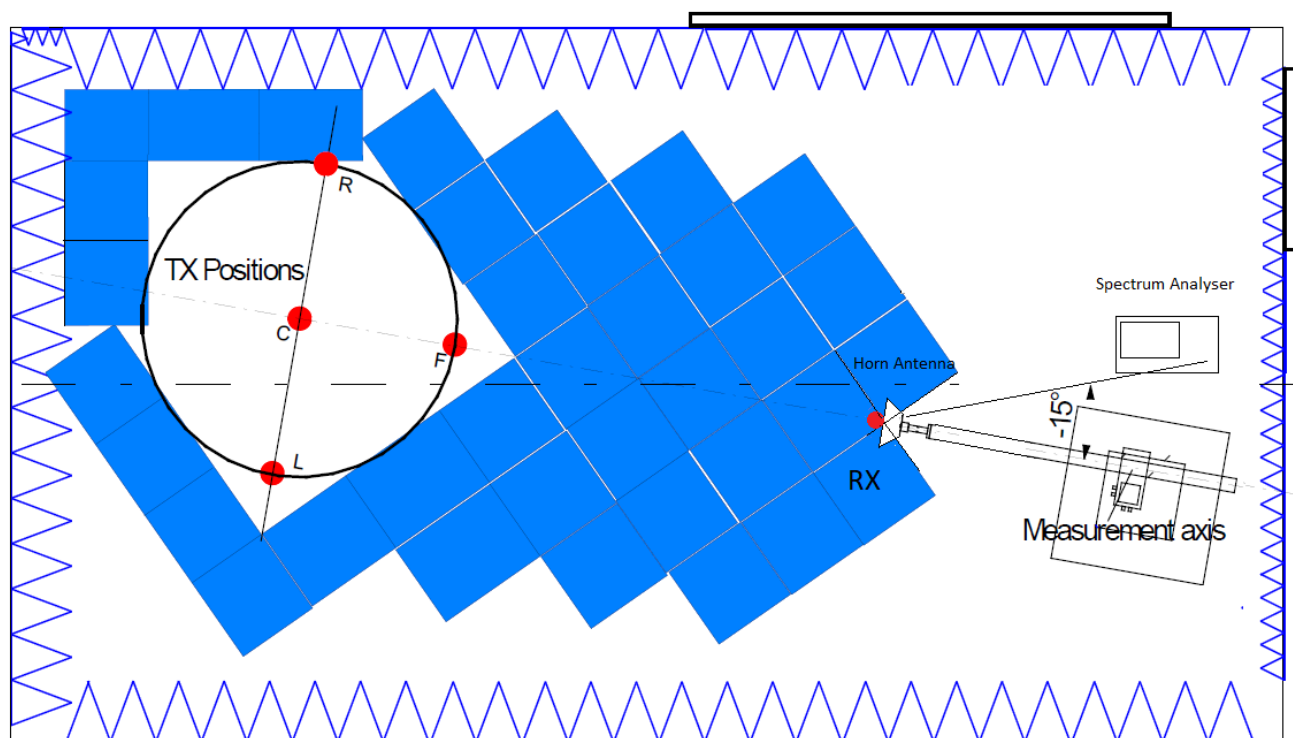
Measurements were made in both horizontal and vertical planes of polarization.

The final measured value, for the given emission, in the tables below incorporates the calibrated antenna factor and cable loss.

Radiated measurements setup $f < 1$ GHz



Radiated measurements setup $f > 1$ GHz



Occupied Bandwidth

RESULTS:

(see next plots).

Mode 1: BTLE BitRate 1Mbps.

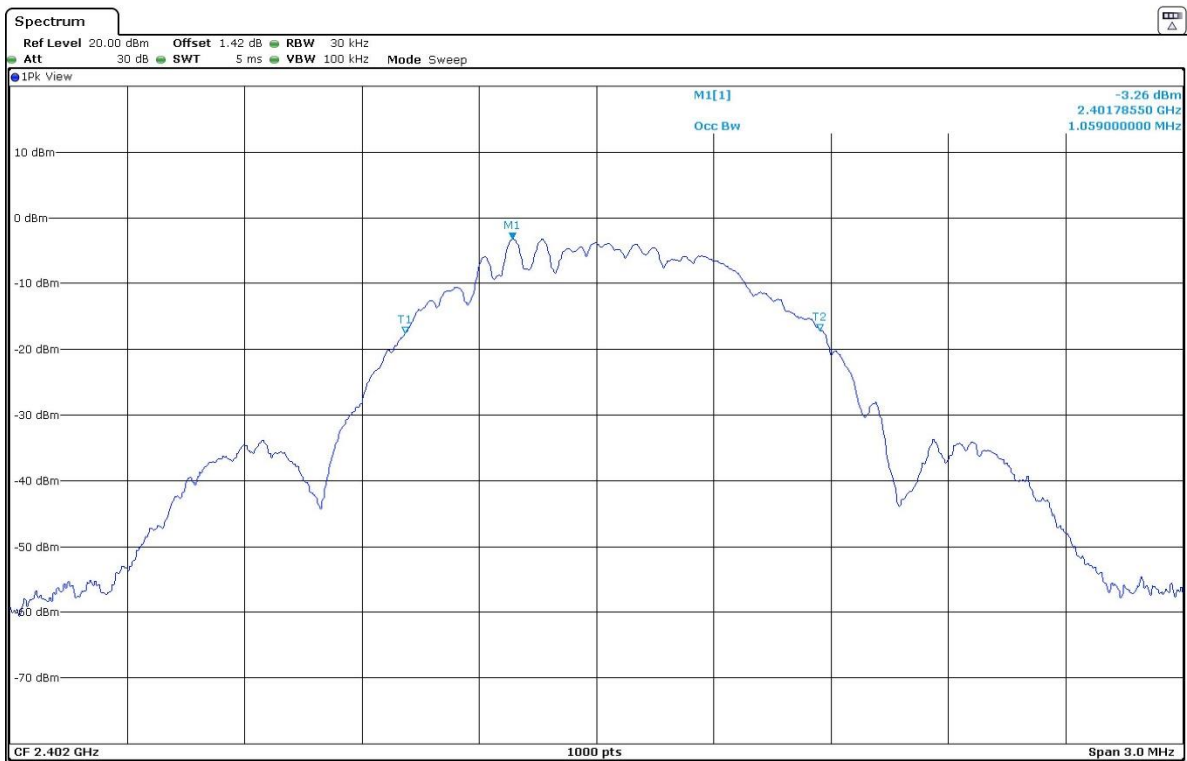
	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
99% bandwidth (MHz)	1.059	1.056	1.068
Measurement uncertainty (kHz)	<± 1.80		

Mode 2: BTLE BitRate 2Mbps.

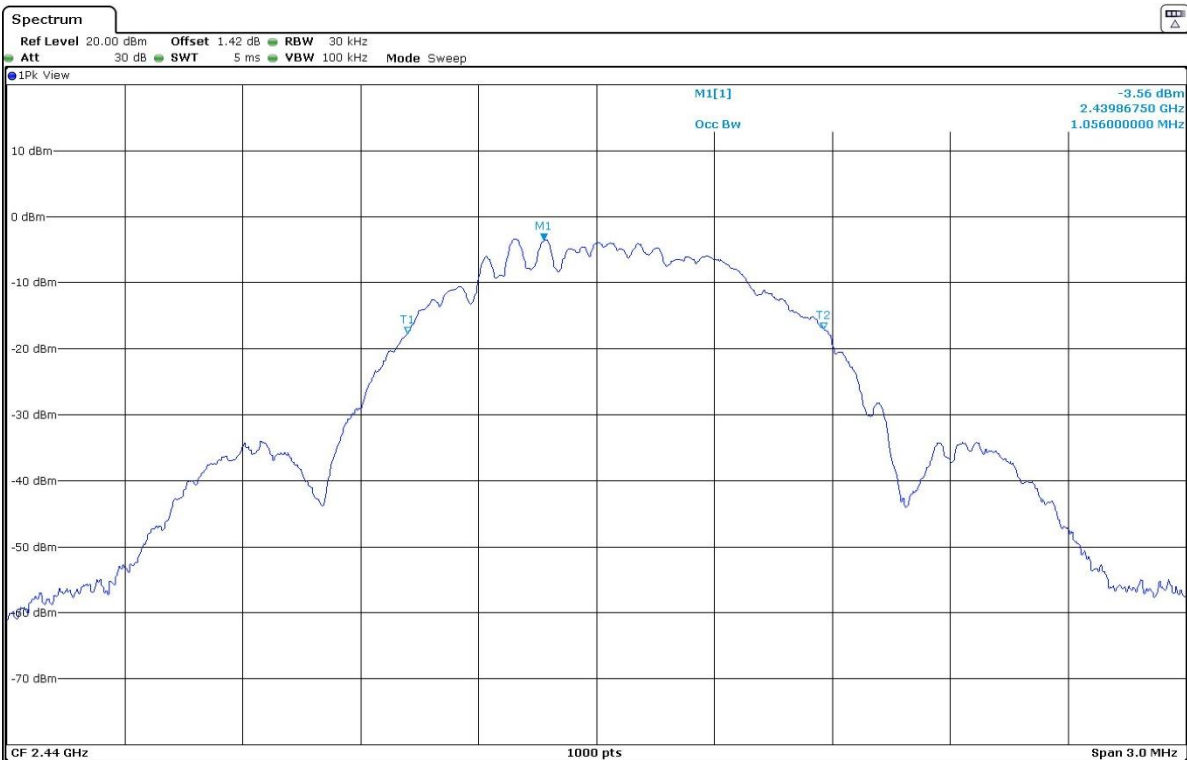
	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
99% bandwidth (MHz)	2.045	2.049	2.045
Measurement uncertainty (kHz)	<± 1.80		

Mode 1: BTLE BitRate 1Mbps.

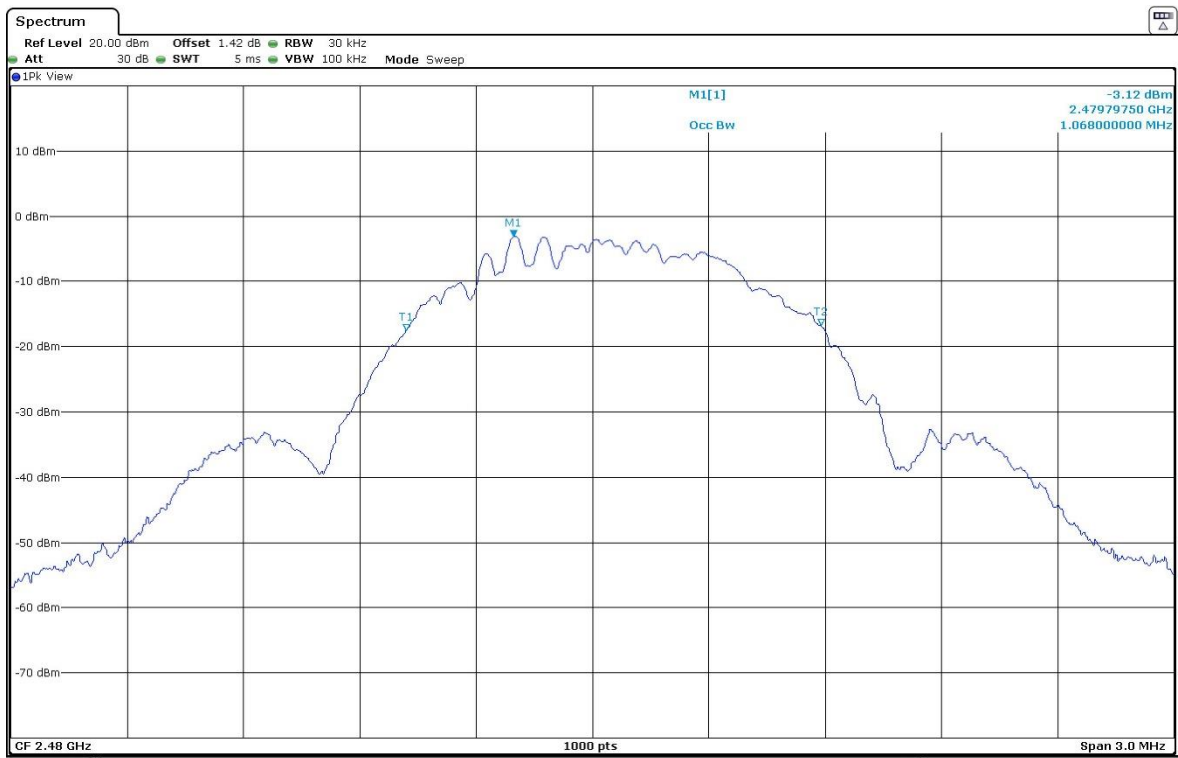
Lowest Channel



Middle Channel

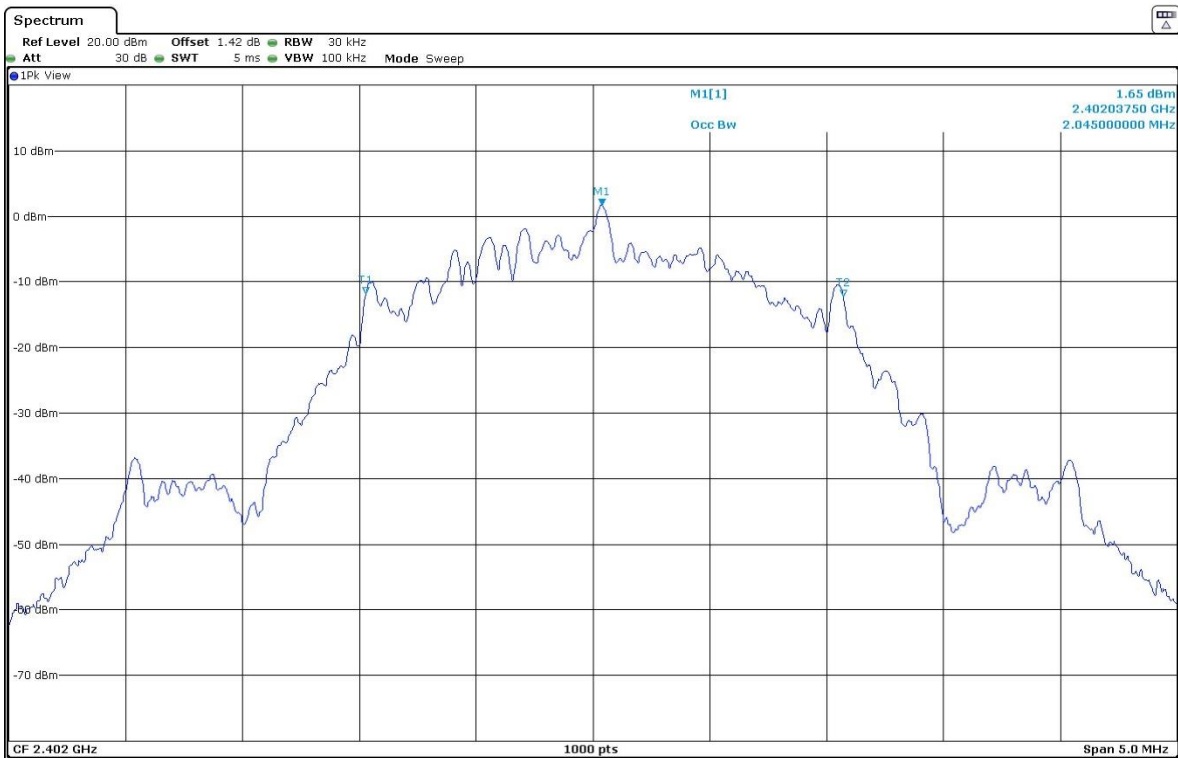


Highest channel

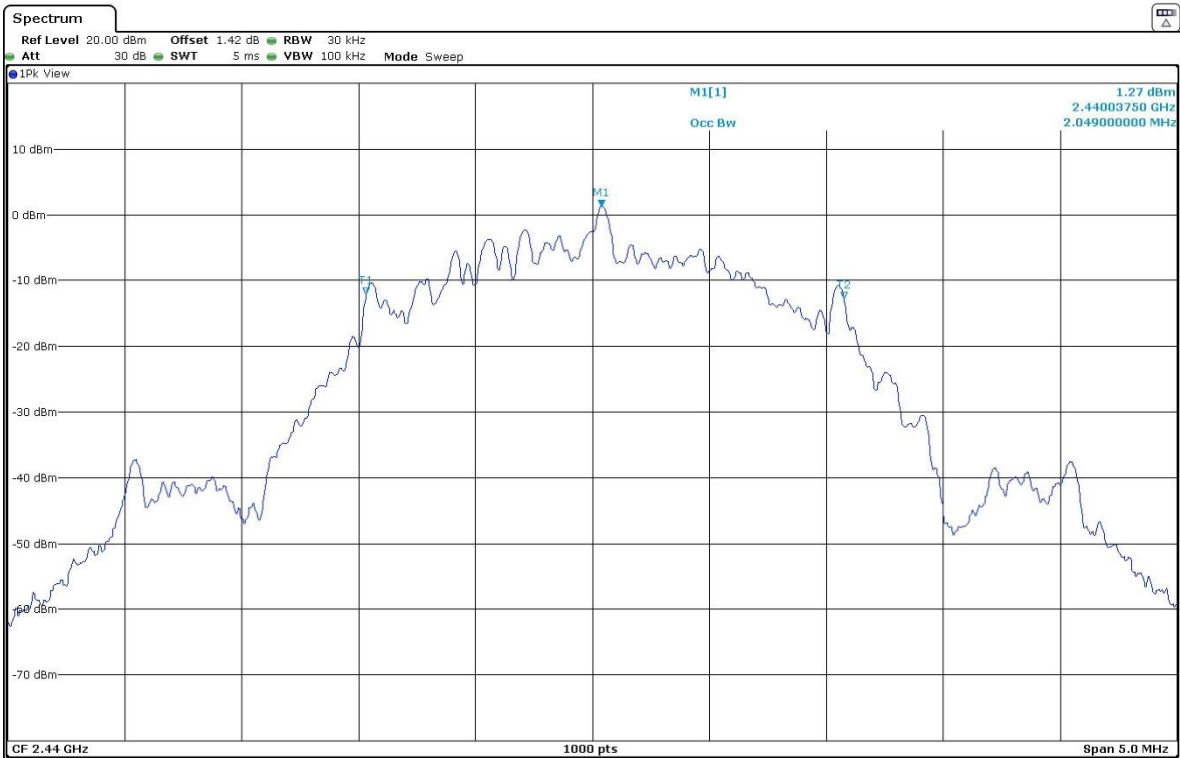


Mode 2: BTLE BitRate 2Mbps.

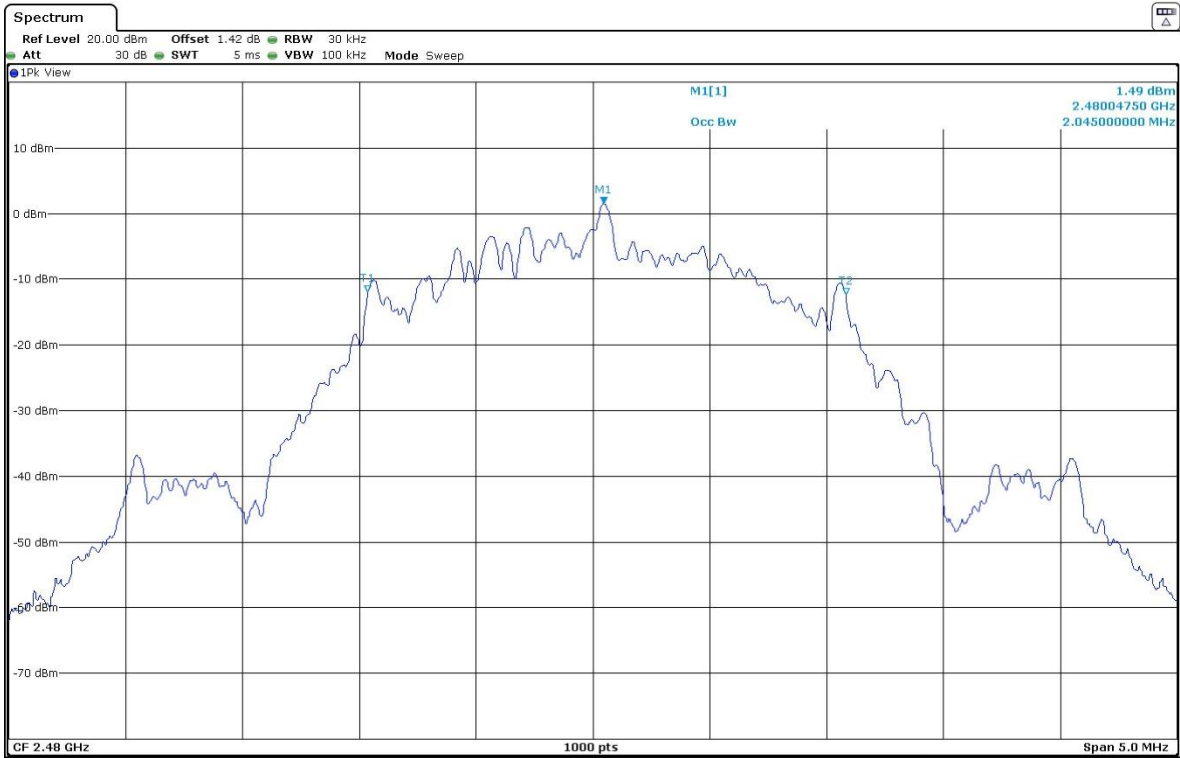
Lowest Channel



Middle Channel



Highest channel



Transmitter Duty Cycle

RESULTS:

Mode 1: BTLE BitRate 1Mbps

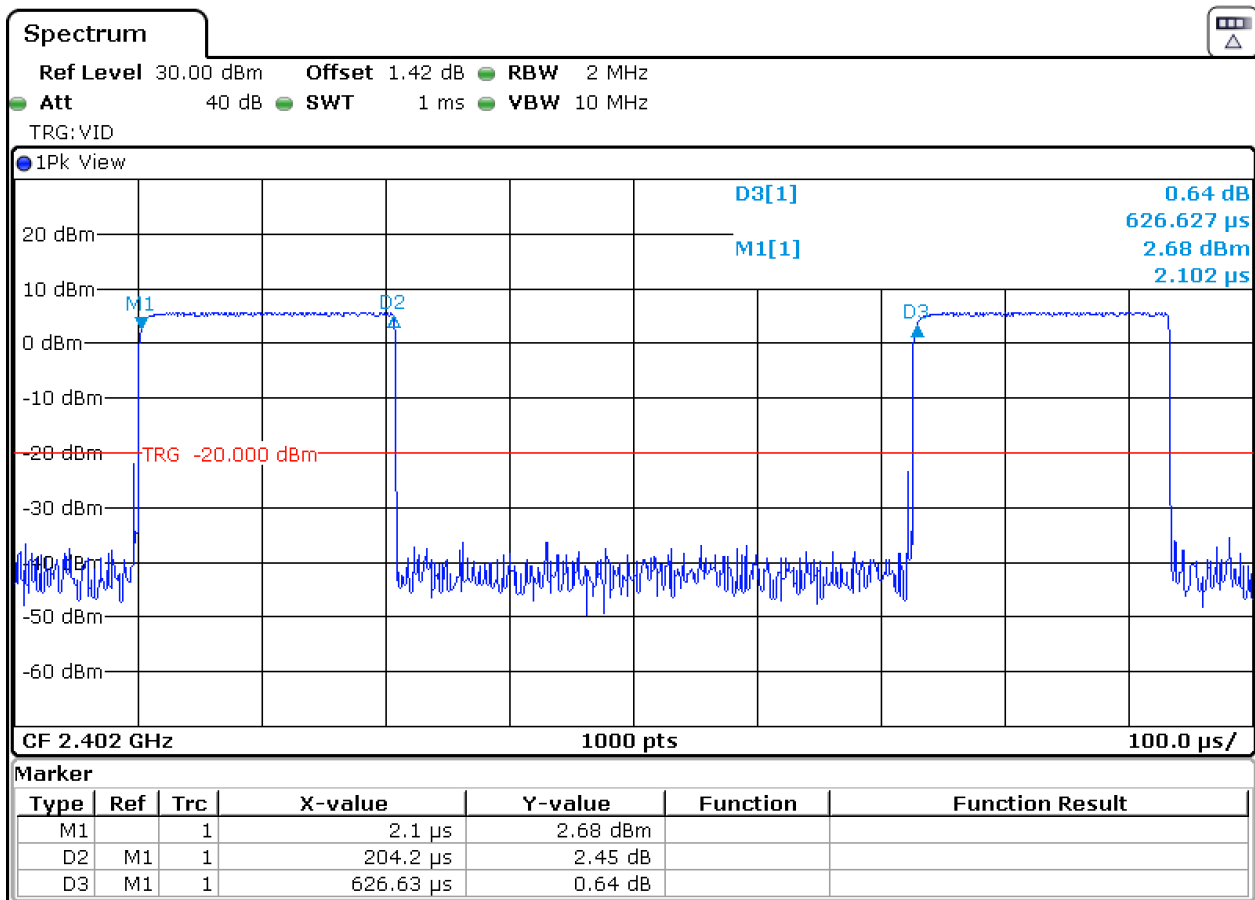
The equipment transmits continuously in this mode with a duty cycle > 98 %.

Mode 2: BTLE BitRate 2Mbps.

The transmitter duty cycle is measured using a spectrum analyser in time domain and calculated:

Duty cycle correction: $10 \log (1 / (\text{Pulse duration} / \text{Period}))$

Pulse duration (µs)	Period (µs)	Duty Cycle correction (dB)
204.2	626.63	4.8



FCC Section 15.247 Subclause (a) (2) / RSS-247 5.2. (a). 6 dB Bandwidth

SPECIFICATION

The minimum 6 dB bandwidth shall be at least 500 kHz.

RESULTS:

6 dB Bandwidth (see next plots).

Mode 1: BTLE BitRate 1Mbps.

	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
6 dB Spectrum bandwidth (kHz)	728	728	734
Measurement uncertainty (kHz)	<±1.80		

Mode 2: BTLE BitRate 2Mbps.

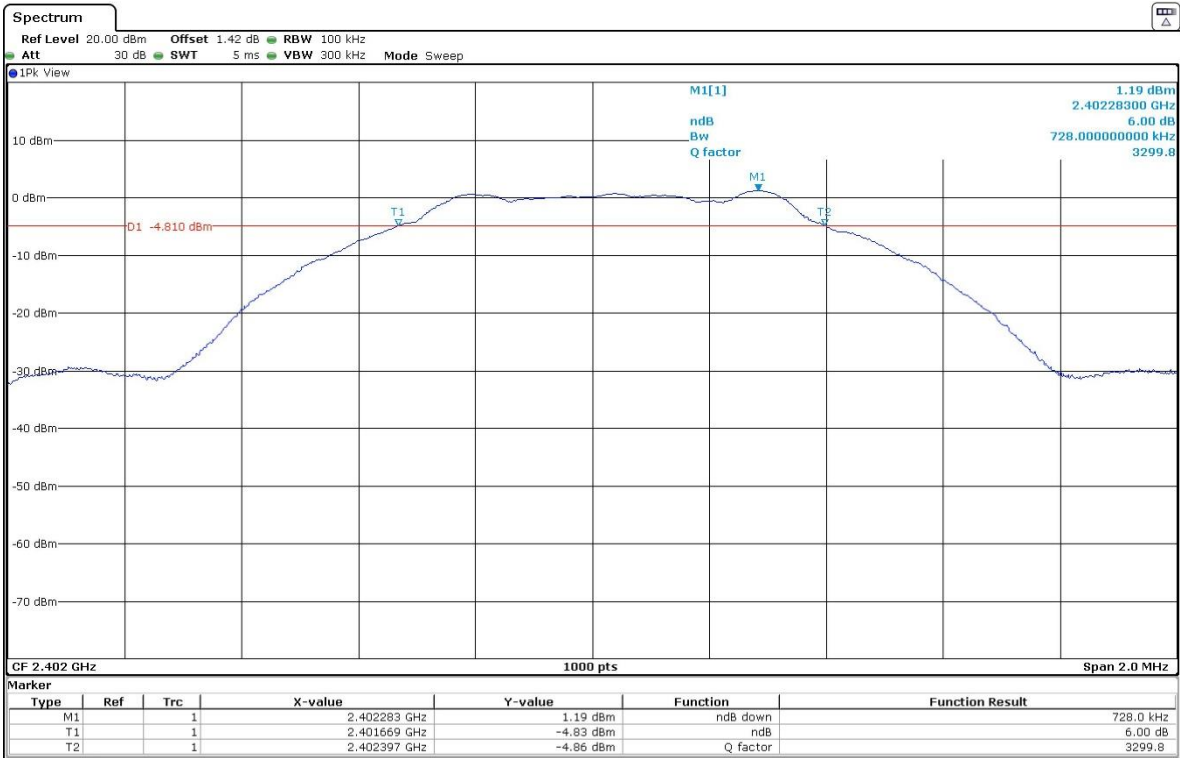
	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
6 dB Spectrum bandwidth (kHz)	1120	1120	1120
Measurement uncertainty (kHz)	<±1.80		

Verdict: PASS

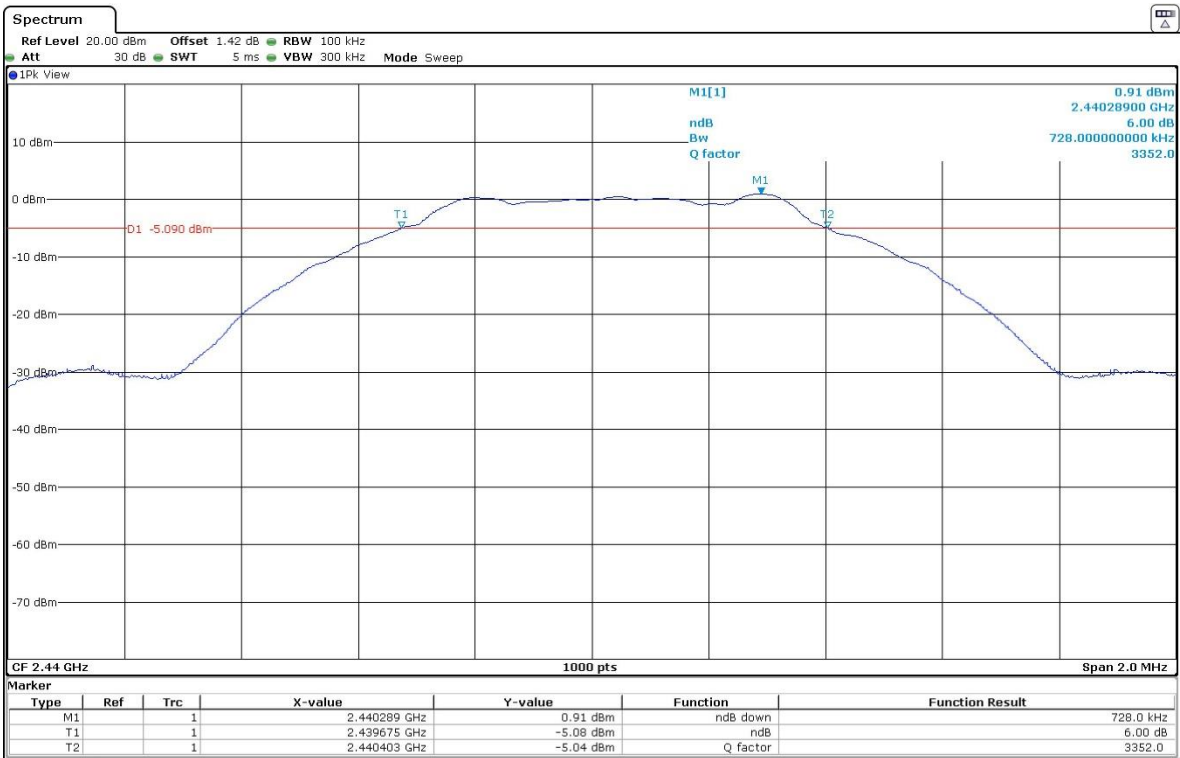
6 dB BANDWIDTH.

Mode 1: BTLE BitRate 1Mbps.

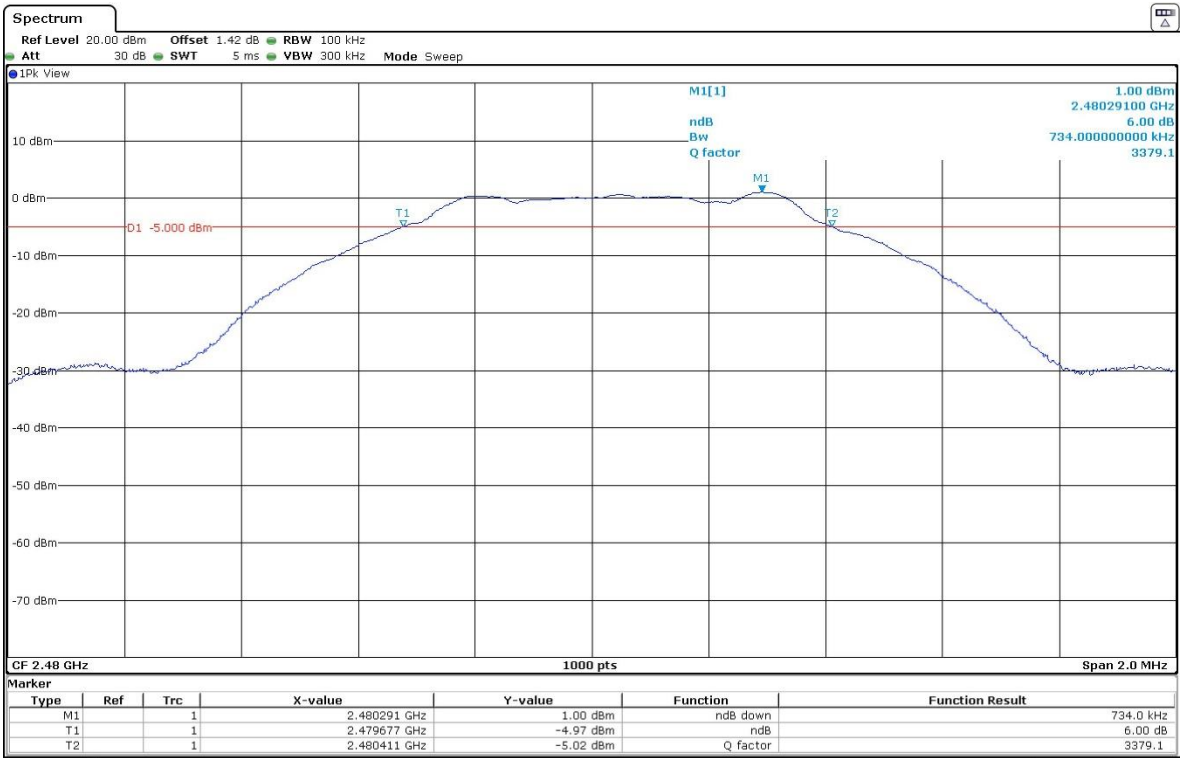
Lowest Channel



Middle Channel

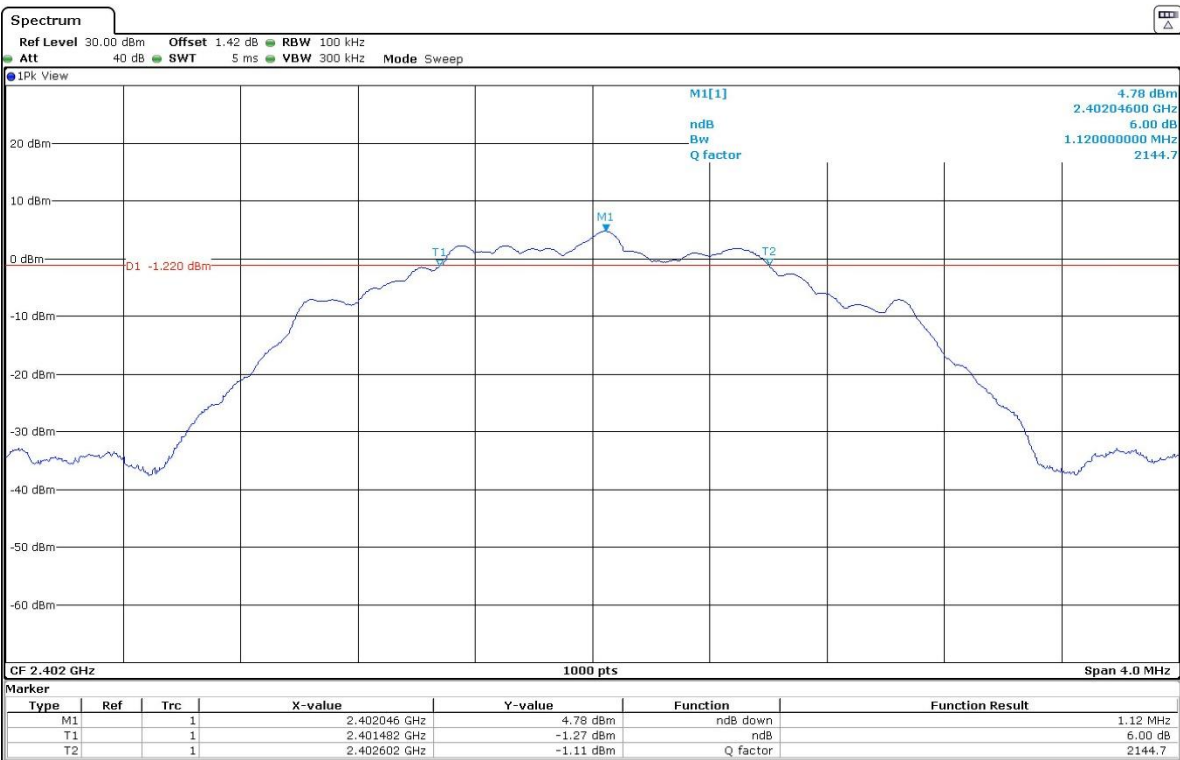


Highest Channel

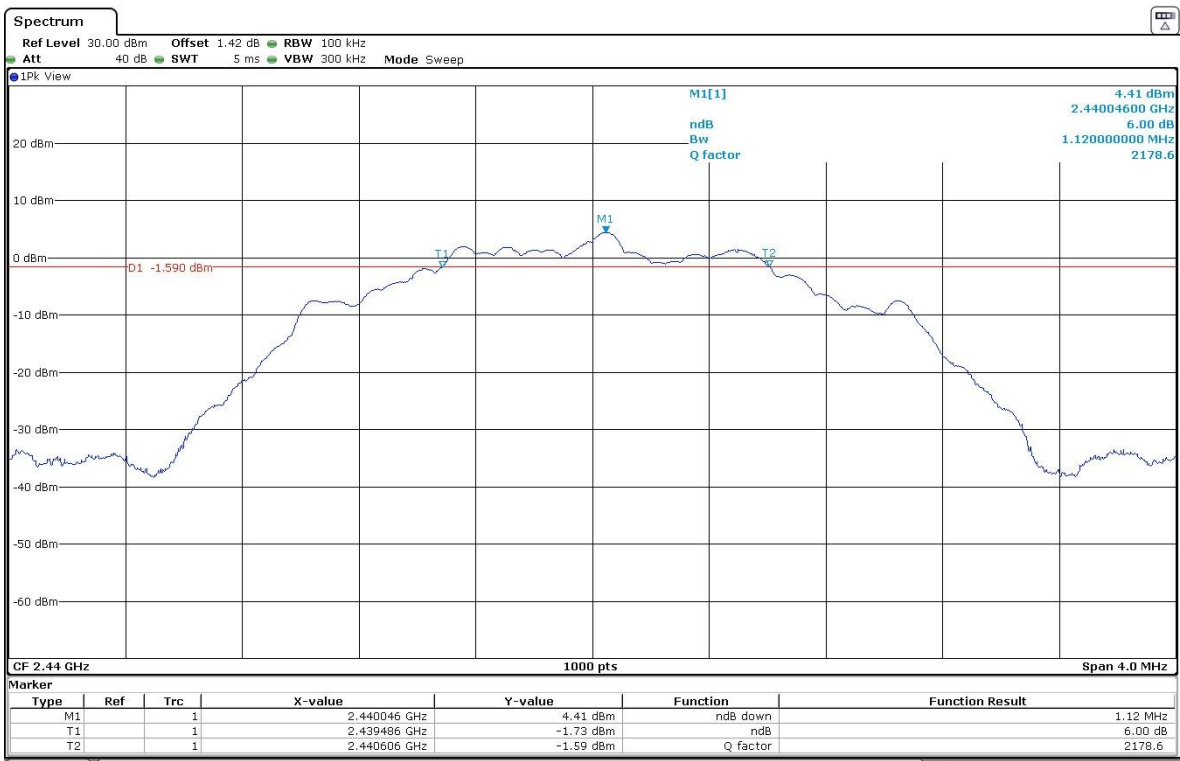


Mode 2: BTLE BitRate 2Mbps.

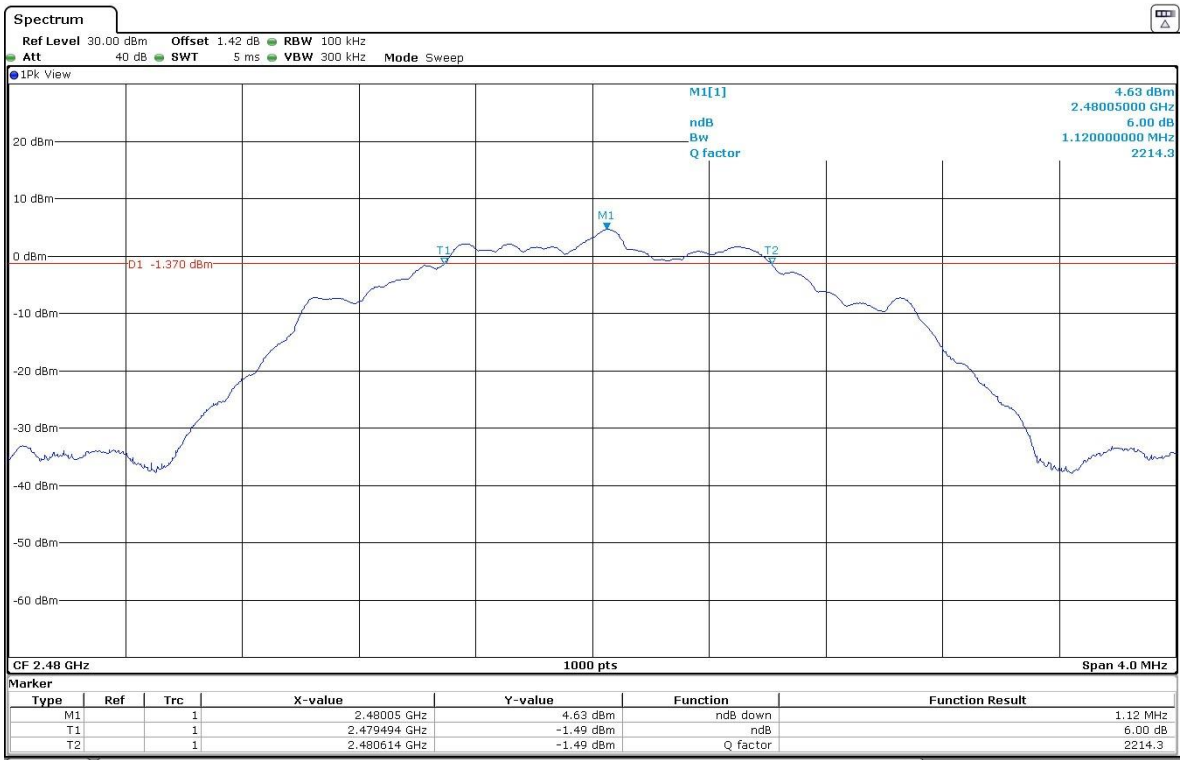
Lowest Channel



Middle Channel



Highest Channel



FCC Section 15.247 Subclause (b) / RSS-247 5.4. (d). Maximum output power and antenna gain

SPECIFICATION

For systems using digital modulation in the 2400-2483.5 MHz band: 1 watt (30 dBm).

The e.i.r.p. shall not exceed 4 W (36 dBm) (RSS-247).

RESULTS:

The maximum peak conducted output power was measured according to the method specified in the 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 v05 dated August 24, 2018.

MAXIMUM OUTPUT POWER. See next plots.

Declared Gain for antenna RF port (maximum) = +6.56 dBi.

The EIRP power (dBm) is calculated by adding the declared maximum antenna gain to the measured conducted power.

As declared in the 15.247 (b) (4), the conducted output power is reduced by the amount in dB that the directional gain of the antenna exceeds 6dB. The applicable output power limit shall be calculated as follows:

$$P_{Out} = P_{Limit} - (G_{Tx} - 6)$$

Mode 1: BTLE BitRate 1Mbps.

	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
Maximum conducted peak power (dBm)	2.16	1.87	2.04
Conducted Peak Power Limit (dBm)	30	30	30
Corrected Limit (dBm)	29.44	29.44	29.44
Margin (dB)	27.28	27.57	27.40
Measurement uncertainty (dB)	<±1.20		

	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
Maximum conducted peak power (dBm)	2.16	1.87	2.04
Maximum EIRP power (dBm)	8.72	8.43	8.60
EIRP power Limit (dBm)	36	36	36
Margin (dB)	27.28	27.57	27.40
Measurement uncertainty (dB)	<±1.20		

Mode 2: BTLE BitRate 2Mbps.

	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
Maximum conducted peak power (dBm)	2.05	1.81	1.91
Conducted Peak Power Limit (dBm)	30	30	30
Corrected Limit (dBm)	29.44	29.44	29.44
Margin (dB)	27.39	27.63	27.53
Measurement uncertainty (dB)	<±1.20		

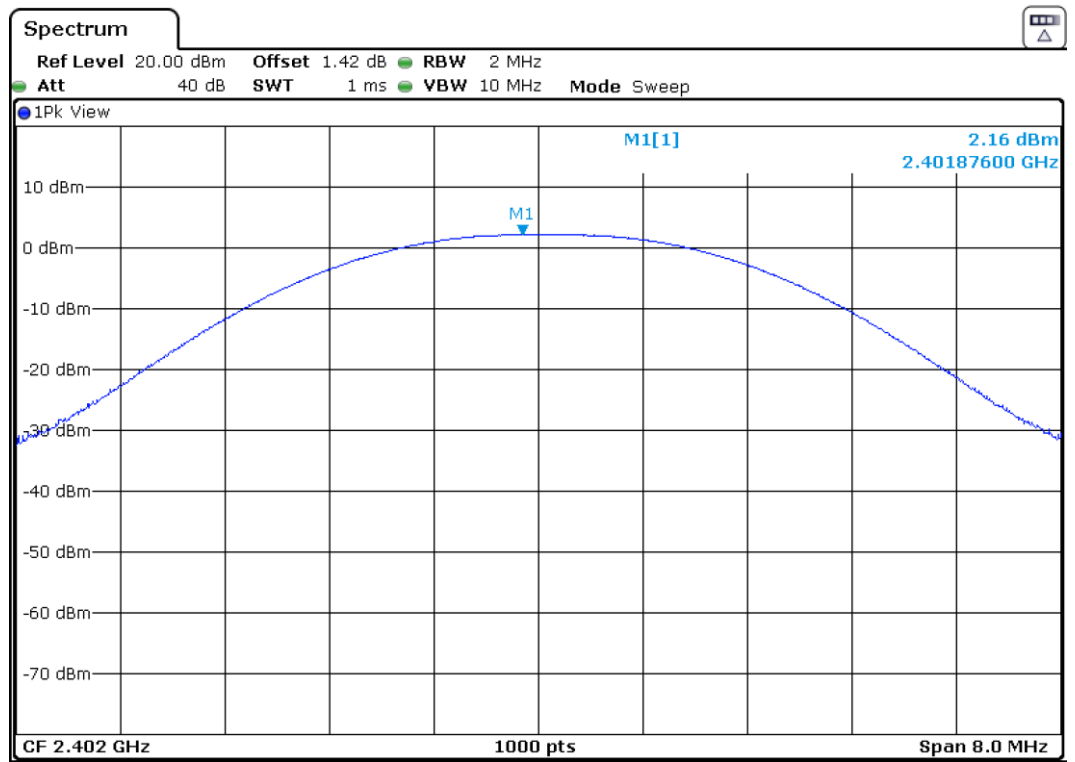
	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
Maximum conducted peak power (dBm)	2.05	1.81	1.91
Maximum EIRP power (dBm)	8.61	8.37	8.47
EIRP power Limit (dBm)	36	36	36
Margin (dB)	27.39	27.63	27.53
Measurement uncertainty (dB)	<±1.20		

Verdict: PASS

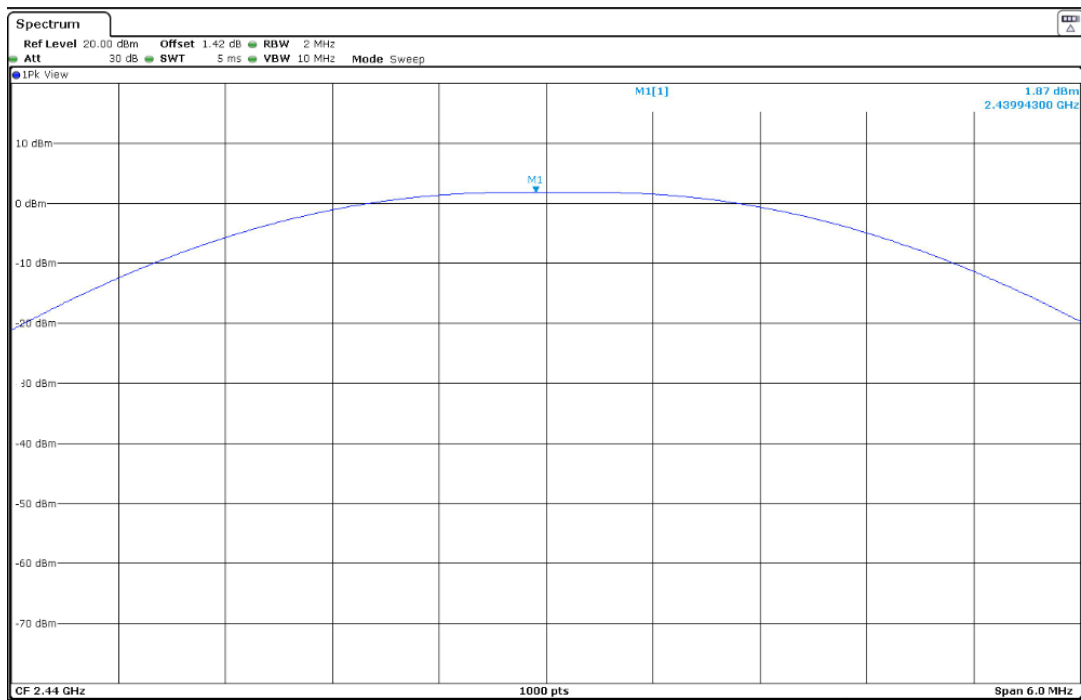
CONDUCTED PEAK POWER.

Mode 1: BTLE BitRate 1Mbps.

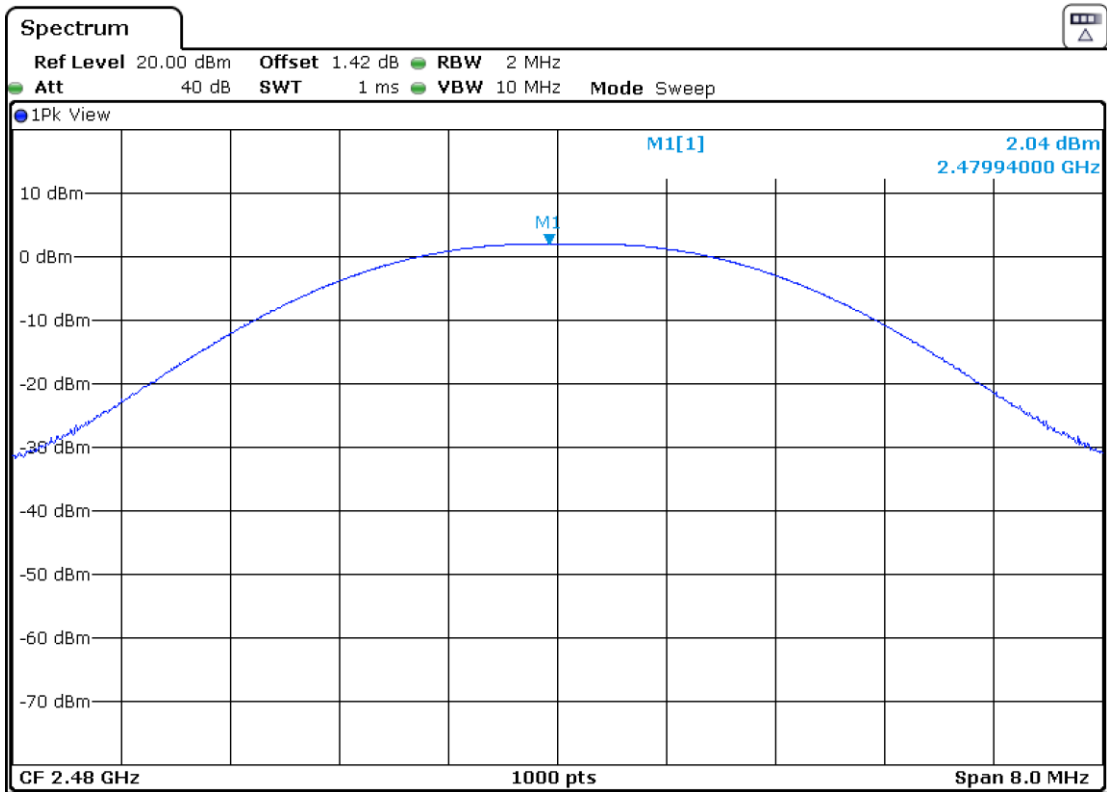
Lowest frequency



Middle frequency

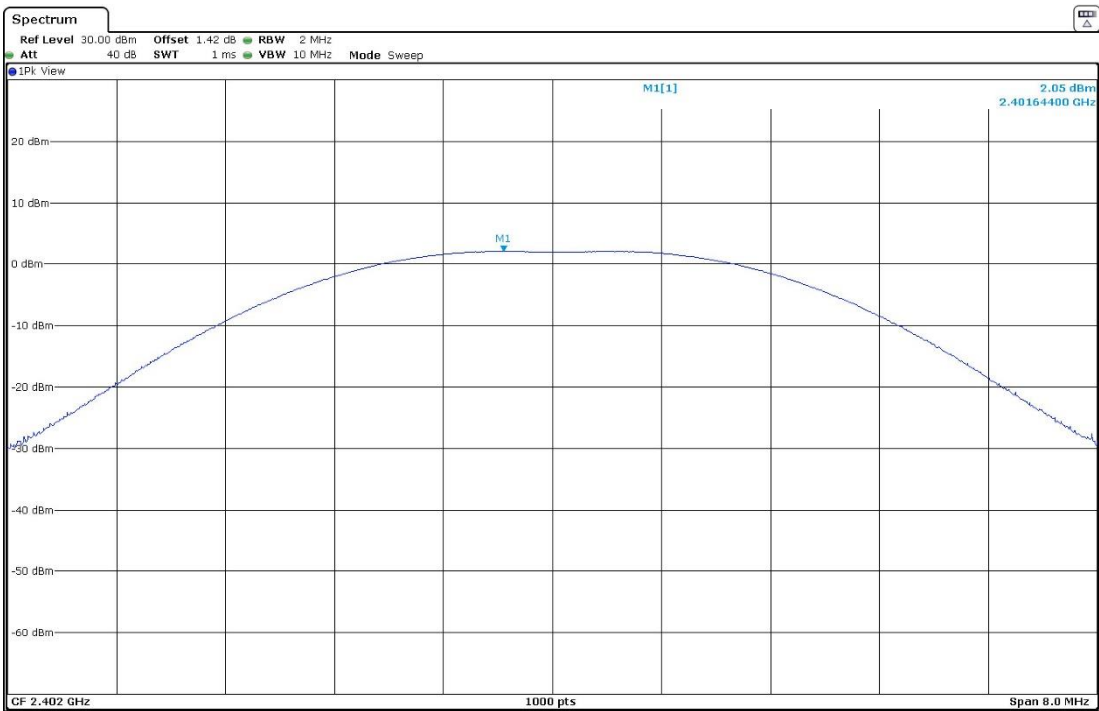


Highest frequency

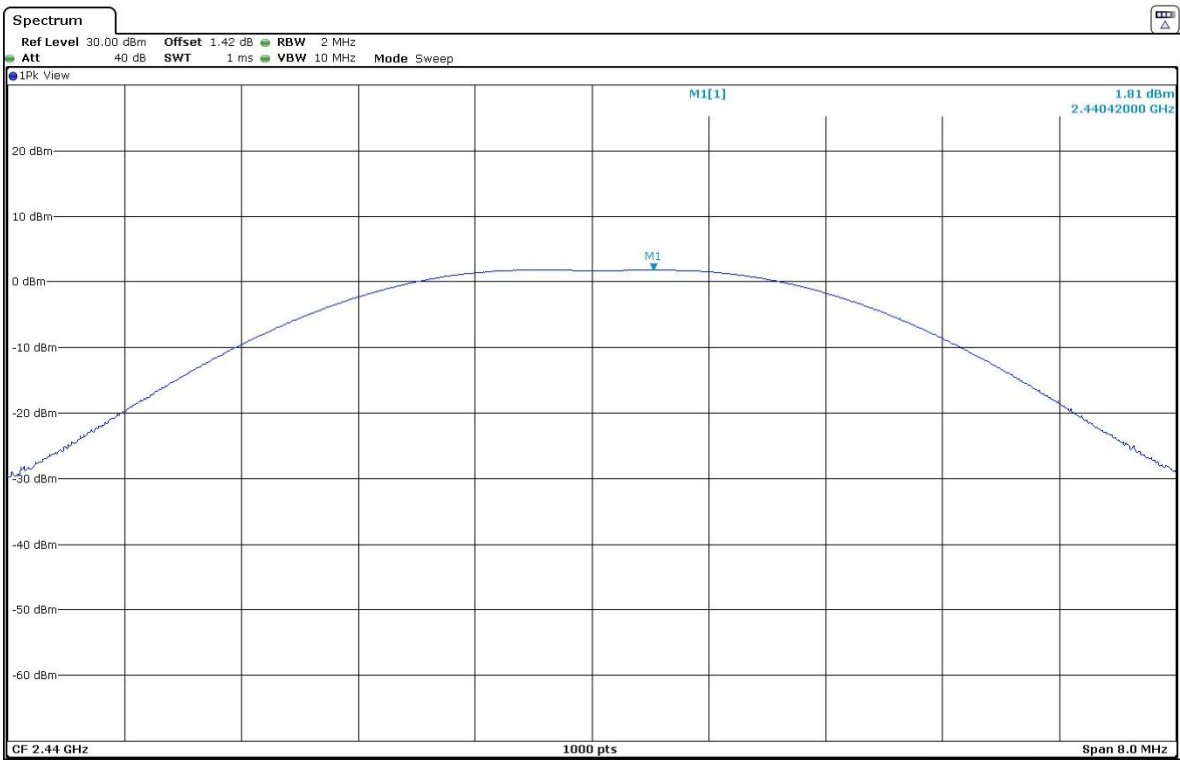


Mode 2: BTLE BitRate 2Mbps.

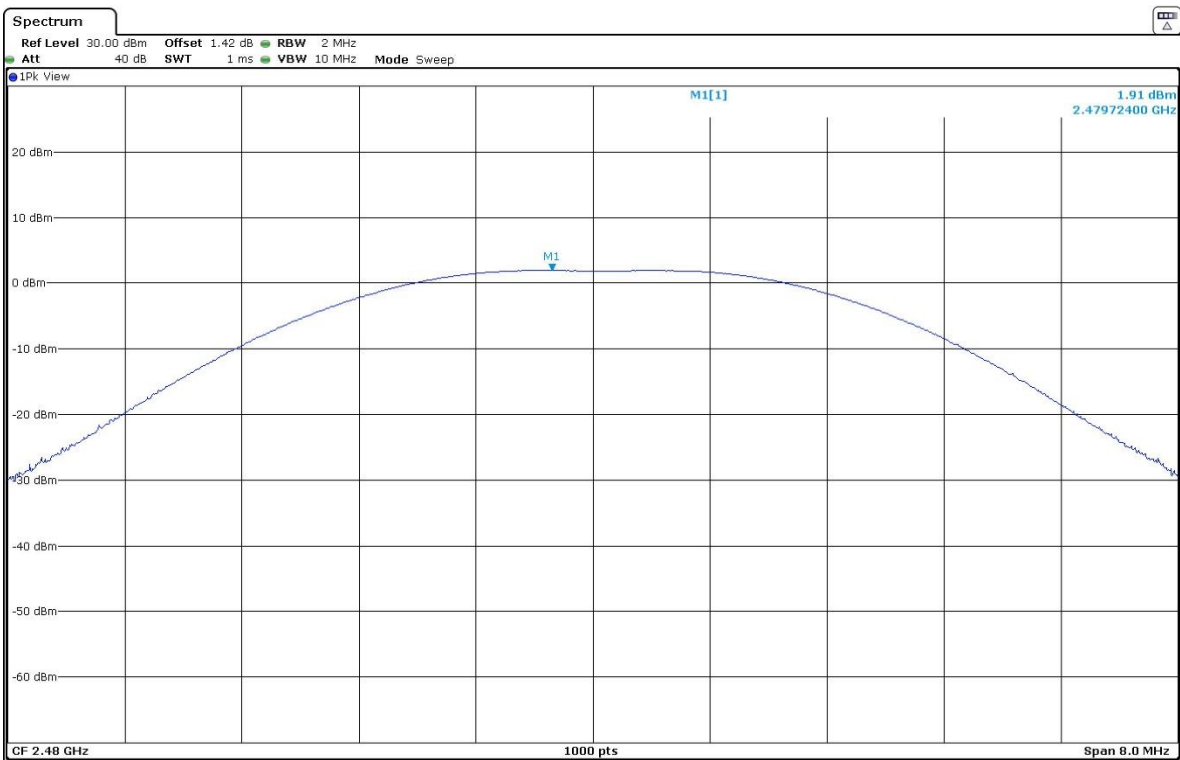
Lowest frequency



Middle frequency



Highest frequency



FCC Section 15.247 Subclause (e) / RSS-247 5.2. (b) Power spectral density

SPECIFICATION

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

RESULTS:

The maximum power spectral density level in the fundamental emission was measured using the method PKPSD (Peak PSD) according to the 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 v05 dated August 24, 2018.

Power spectral density (see next plots).

Mode 1: BTLE BitRate 1Mbps.

	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
Power spectral density (dBm)	1.27	0.92	1.03
Measurement uncertainty (dB)	<±0.78		

Mode 2: BTLE BitRate 2Mbps.

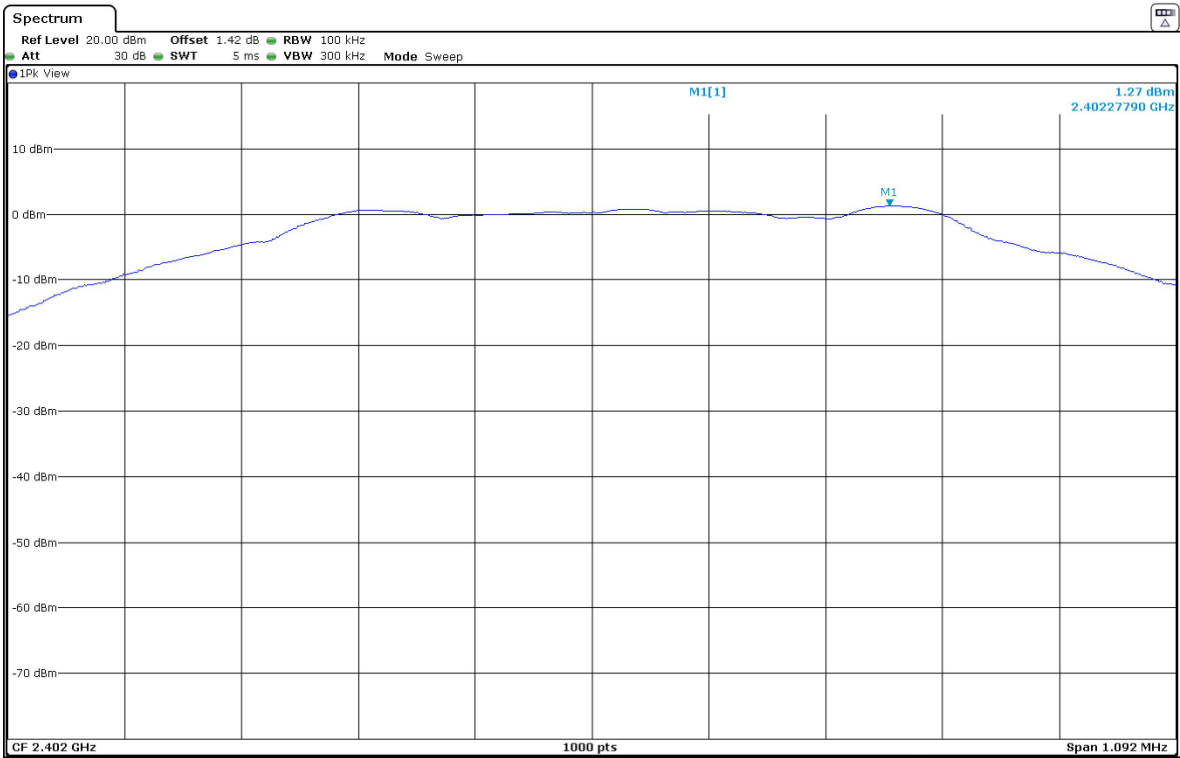
	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
Power spectral density (dBm)	0.85	0.62	0.37
Measurement uncertainty (dB)	<±0.78		

Verdict: PASS

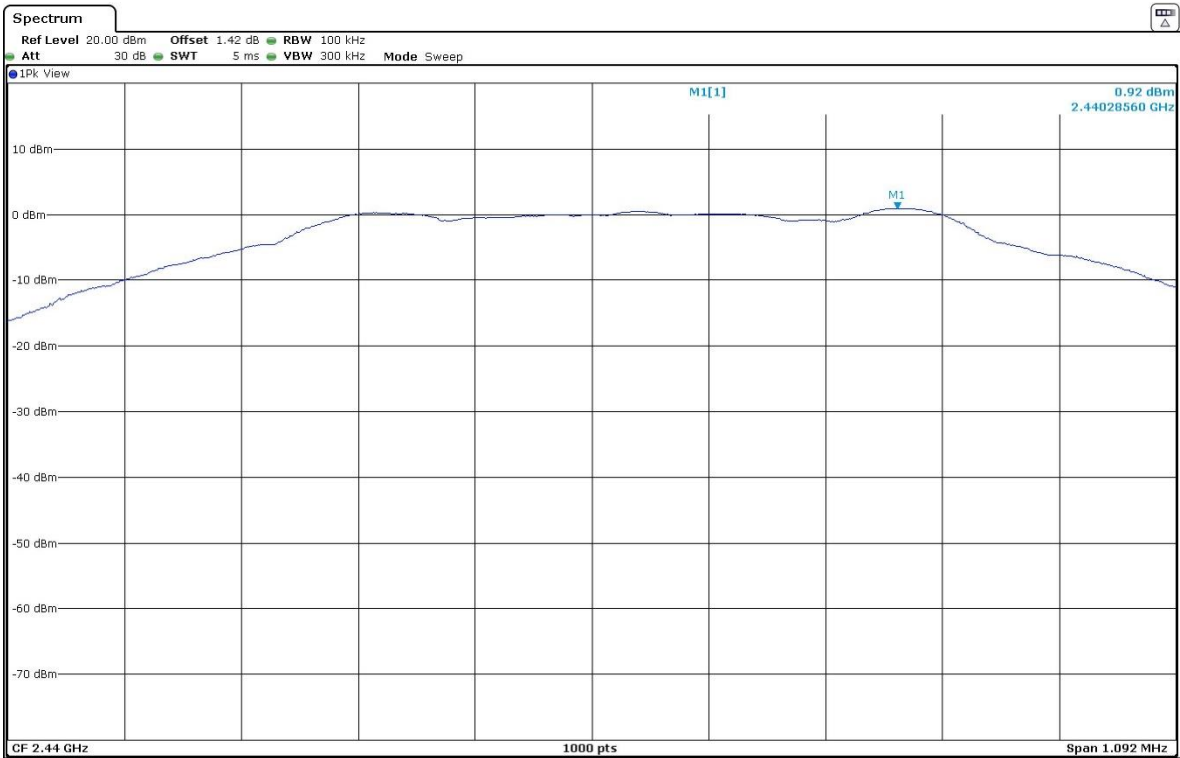
POWER SPECTRAL DENSITY

Mode 1: BTLE BitRate 1Mbps

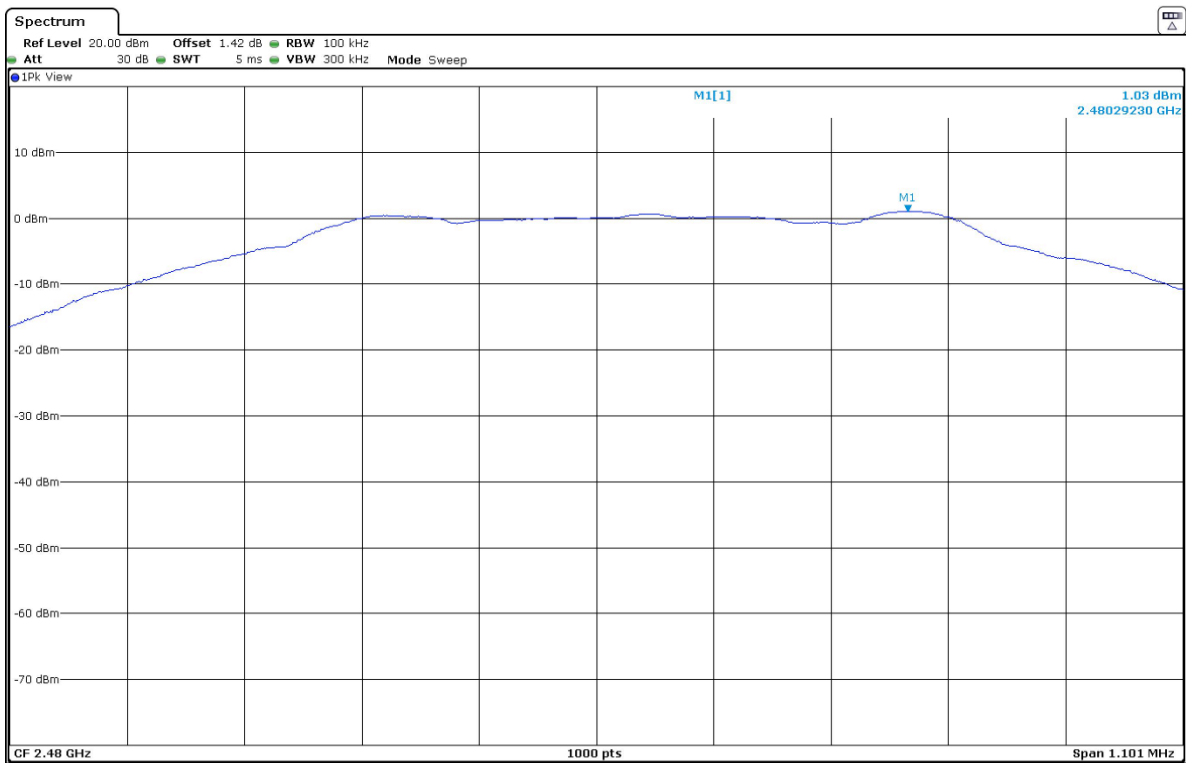
Lowest Channel



Middle Channel

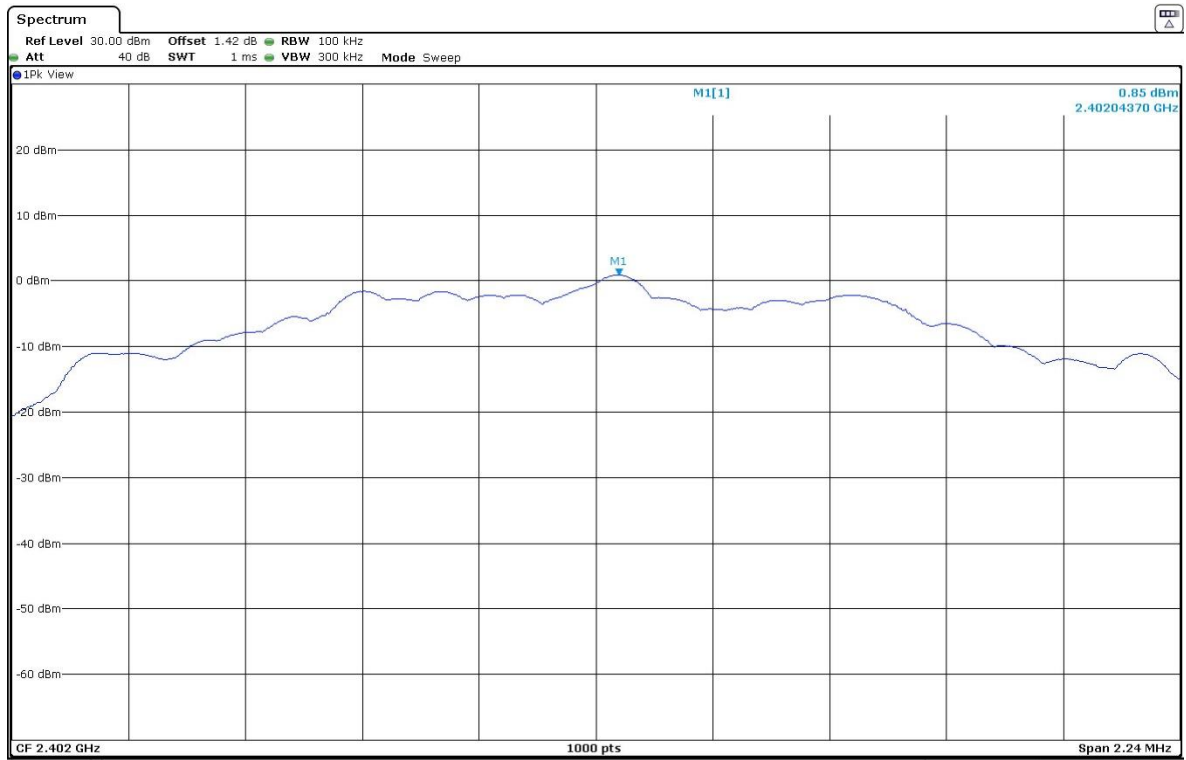


Highest Channel

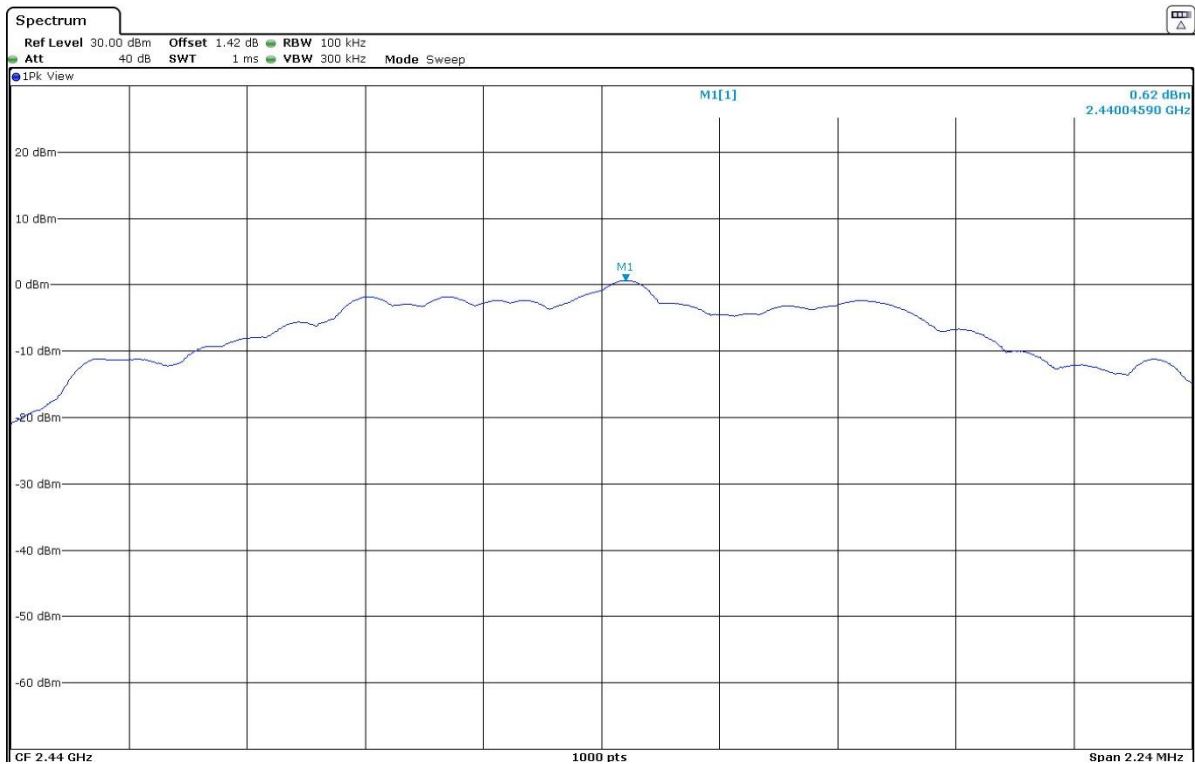


Mode 2: BTLE BitRate 2Mbps

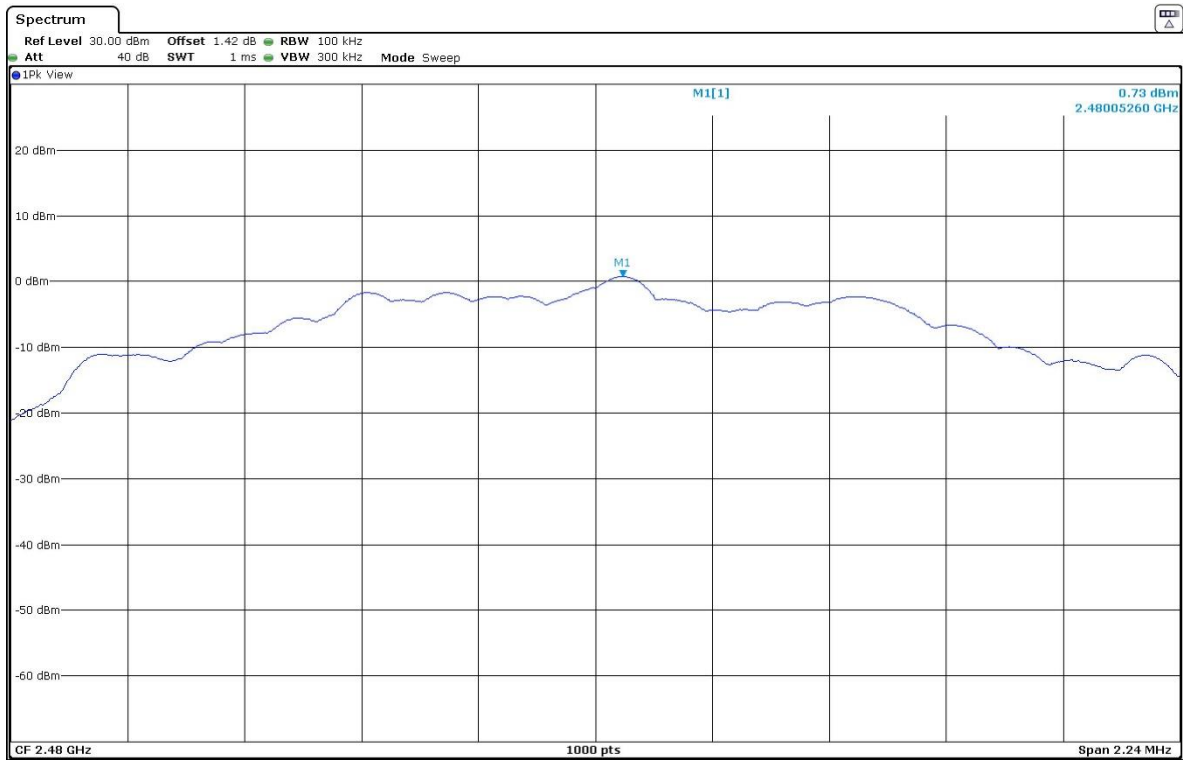
Lowest Channel



Middle Channel



Highest Channel



FCC Section 15.247 Subclause (d) / RSS-247 5.5. Emission limitations radiated (Transmitter)

SPECIFICATION

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required.

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.

RESULTS:

The situation and orientation was varied to find the maximum radiated emission. It was also rotated 360° and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

Measurements were made in both horizontal and vertical planes of polarization.

All tests were performed in a semi-anechoic chamber at a distance of 3 m for the frequency range 30 MHz-25GHz.

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.

Frequency range 30 MHz-1000 MHz.

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

Spurious levels operating (radiated) closest to limit.

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Measurement Uncertainty (dB)
39.781	Vertical	Quasi-Peak	26.6	40	13.4	± 3.88
133.709	Vertical	Quasi-Peak	26.8	43.5	16.7	± 3.88
143.991	Vertical	Quasi-Peak	36.3	43.5	7.2	± 3.88
240.021	Vertical	Quasi-Peak	30.8	46	15.2	± 3.88
720.042	Vertical	Quasi-Peak	28.0	46	18.0	± 3.88

Frequency range 1 GHz-25 GHz

The results in the next tables show the maximum measured levels in the 1-25 GHz frequency range.

Mode 1: BTLE BitRate 1Mbps

Lowest Channel (2402 MHz)

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Measurement Uncertainty (dB)
3401.55	Vertical	Peak	47.13	74	26.9	± 3.05
3407.62		Average	45.56	54	8.4	± 3.05

Middle Channel (2440 MHz)

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Measurement Uncertainty (dB)
3394.55	Vertical	Peak	47.68	74	26.3	± 3.05
		Average	45.12	54	8.9	± 3.05

Highest Channel (2480 MHz)

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Measurement Uncertainty (dB)
3393.15	Vertical	Peak	47.24	74	26.8	± 3.05
3407.62		Average	44.91	54	9.1	± 3.05

Mode 2: BTLE BitRate 2Mbps

Lowest Channel (2402 MHz)

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Measurement Uncertainty (dB)
3402.02	Vertical	Peak	46.79	74	27.2	± 3.05
		Average	44.22	54	9.8	± 3.05

Middle Channel (2440 MHz)

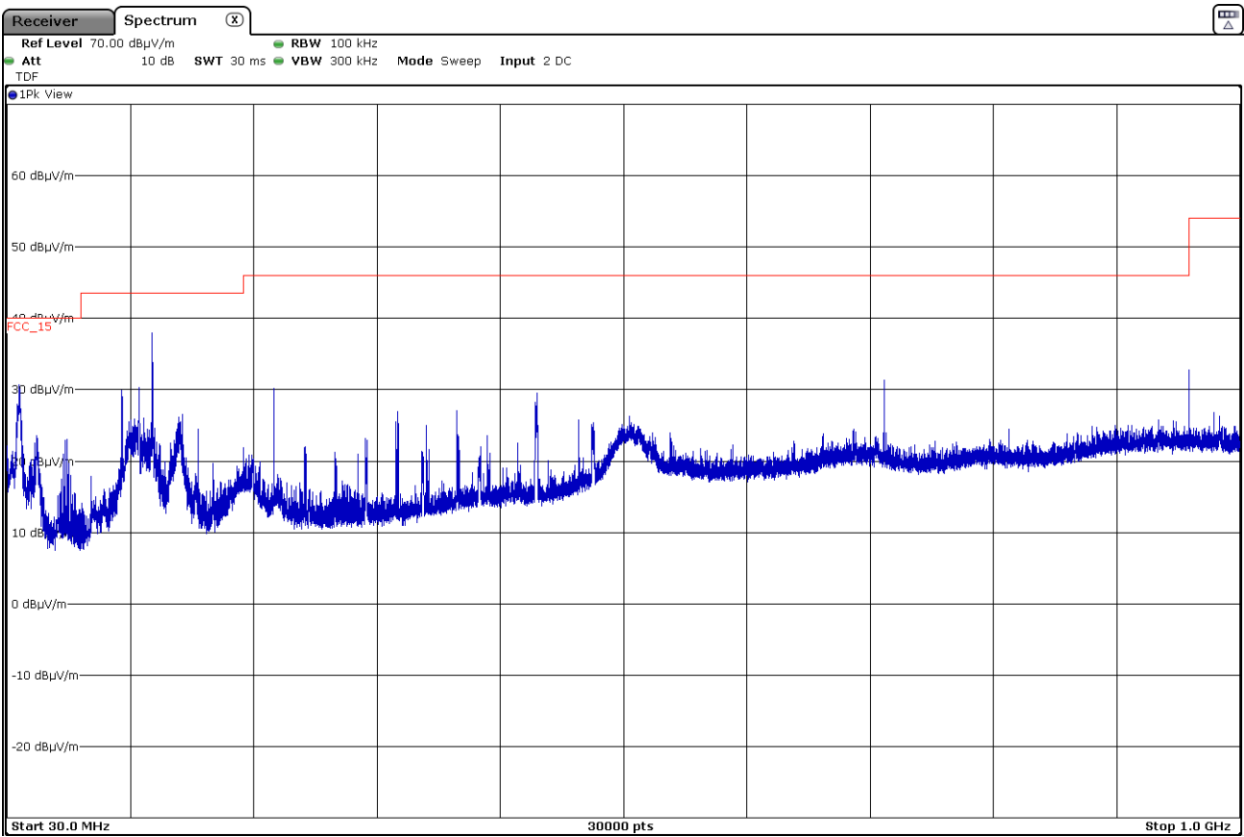
Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Measurement Uncertainty (dB)
3404.35	Vertical	Peak	46.19	74	27.8	± 3.05
		Average	44.34	54	9.7	± 3.05

Highest Channel (2480 MHz)

Spurious frequency (MHz)	Polarization	Detector	Emission Level (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Measurement Uncertainty (dB)
3394.09	Vertical	Peak	46.52	74	27.5	± 3.05
3408.09		Average	43.92	54	10.1	± 3.05

Verdict: PASS

FREQUENCY RANGE 30 MHz-1000 MHz.

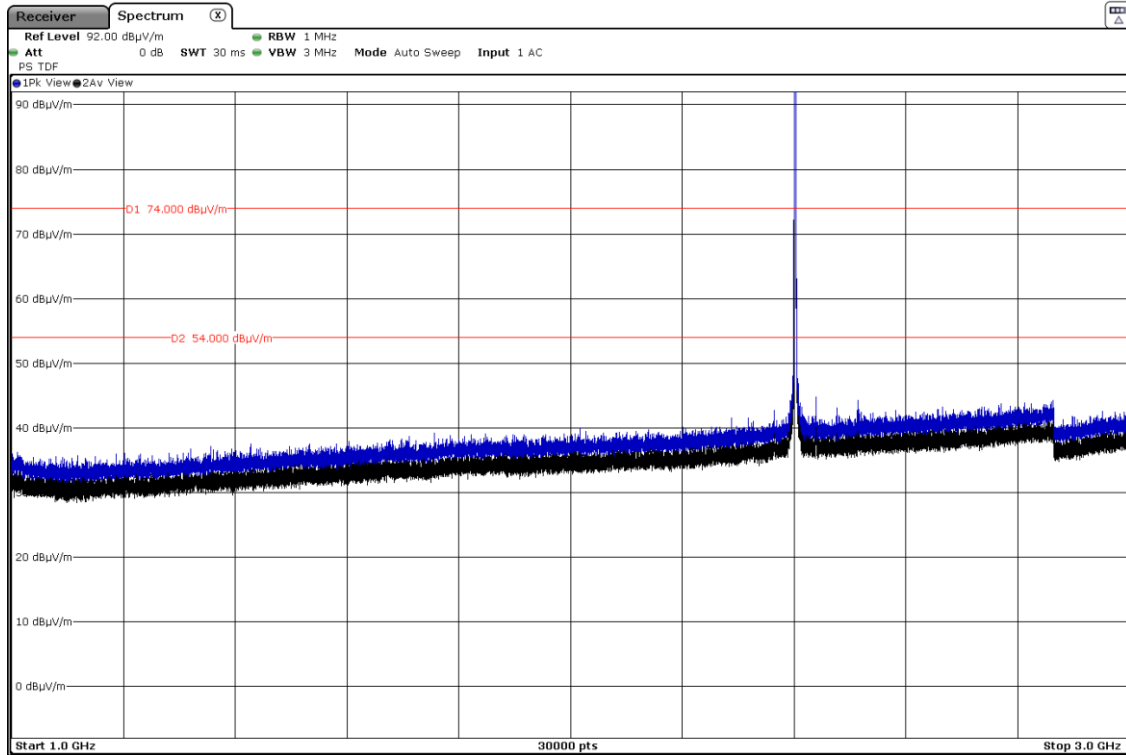


(This plot is valid for all three channels and all modulation modes).

FREQUENCY RANGE 1 GHz to 3 GHz.

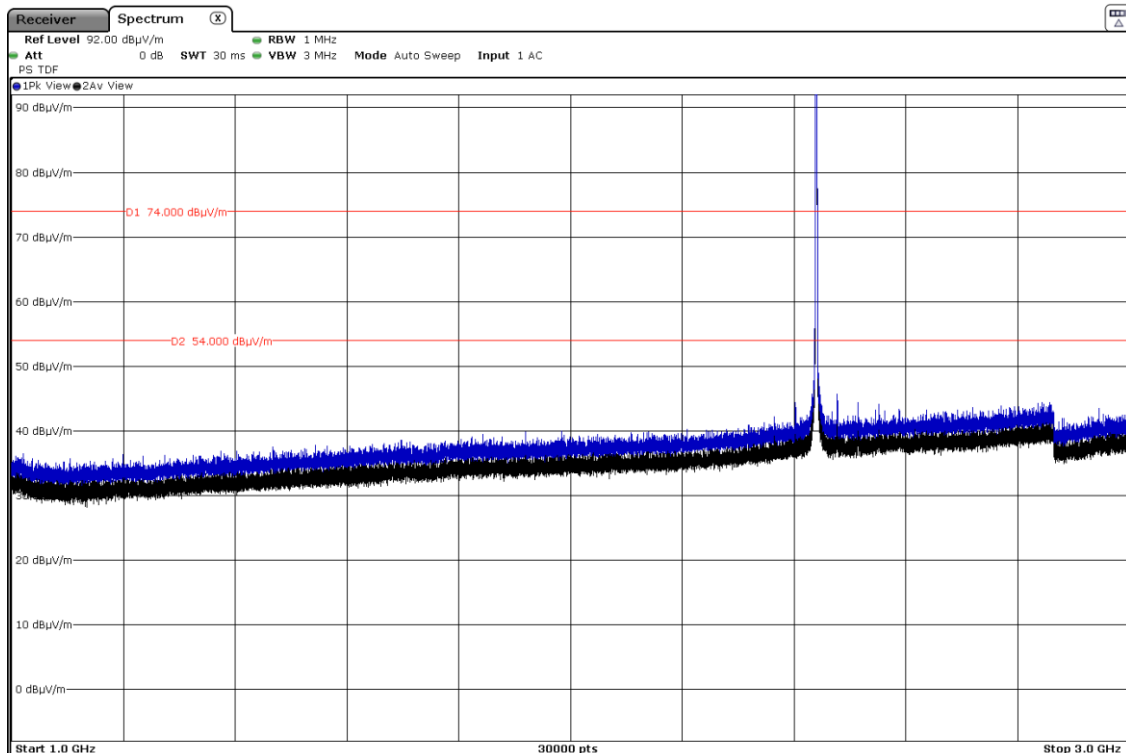
Mode 1: BTLE BitRate 1Mbps

CHANNEL: Lowest (2402 MHz).



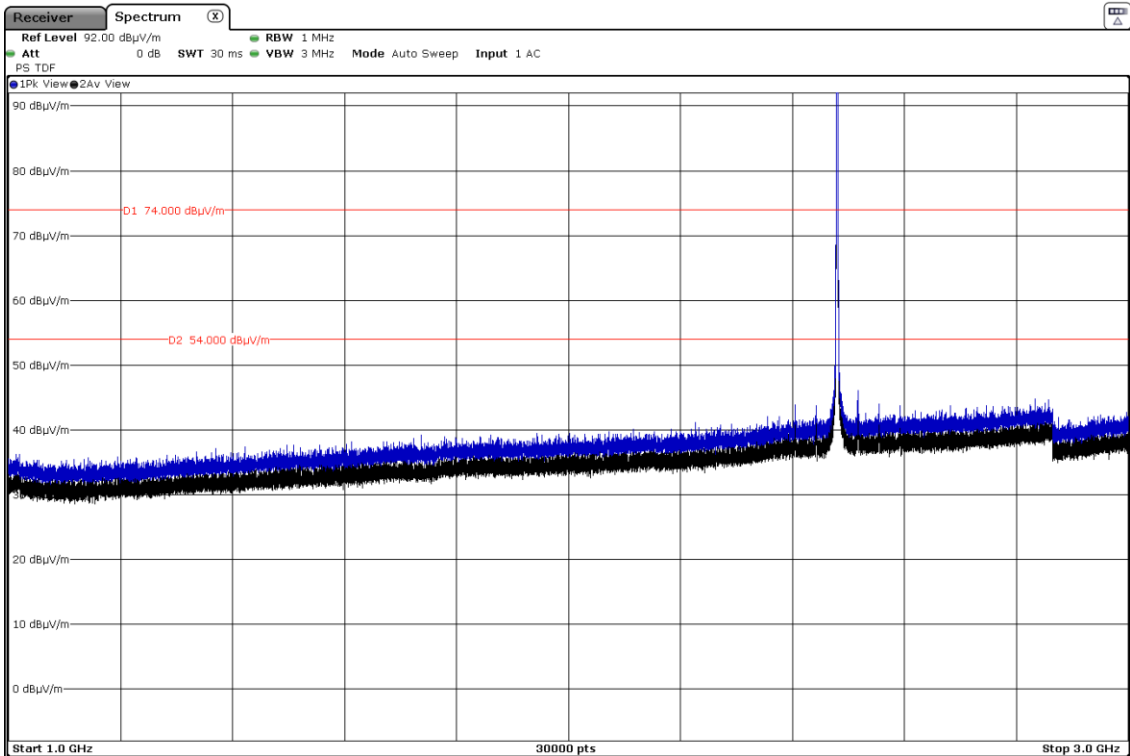
Note: The peak shown in the plot above the limit is the carrier frequency.

CHANNEL: Middle (2440 MHz).



Note: The peak shown in the plot above the limit is the carrier frequency.

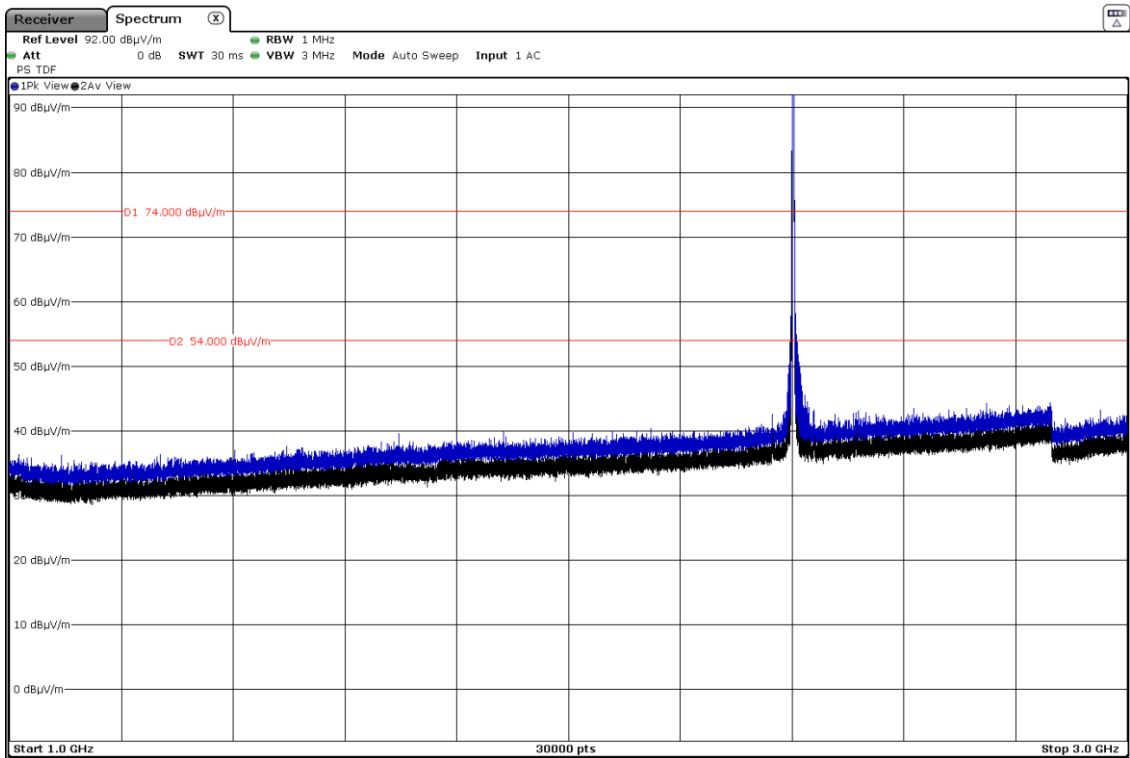
CHANNEL: Highest (2480 MHz).



Note: The peak shown in the plot above the limit is the carrier frequency.

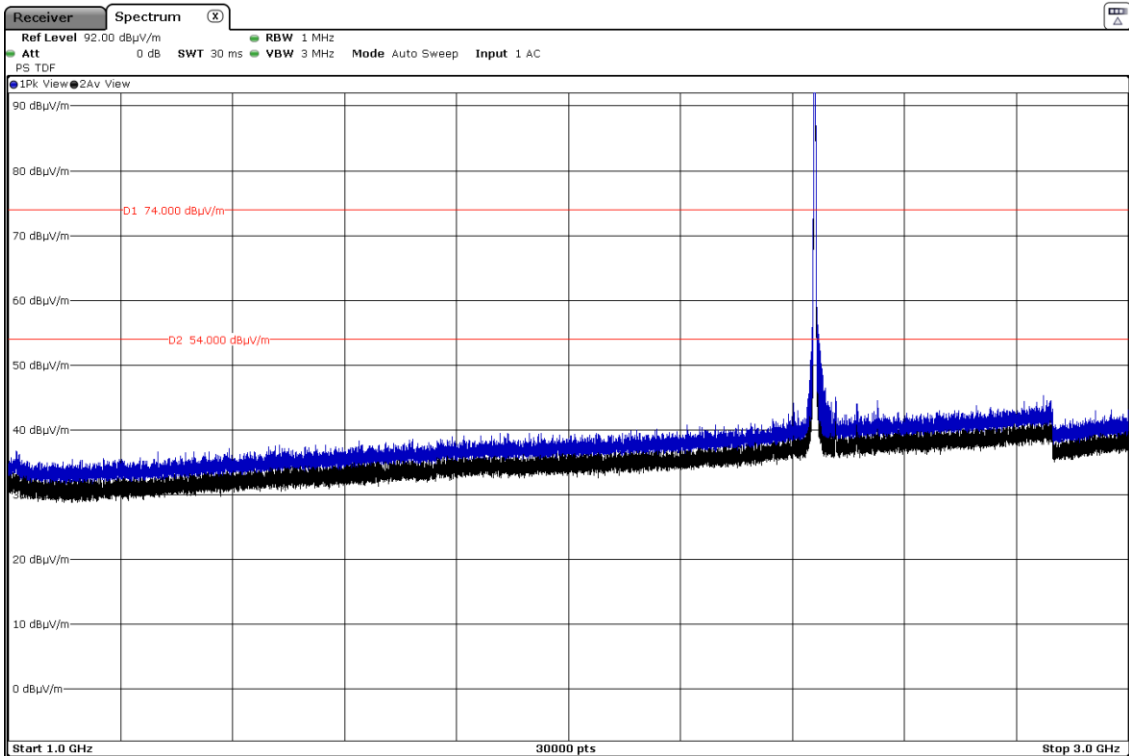
Mode 2: BTLE BitRate 2Mbps

CHANNEL: Lowest (2402 MHz).



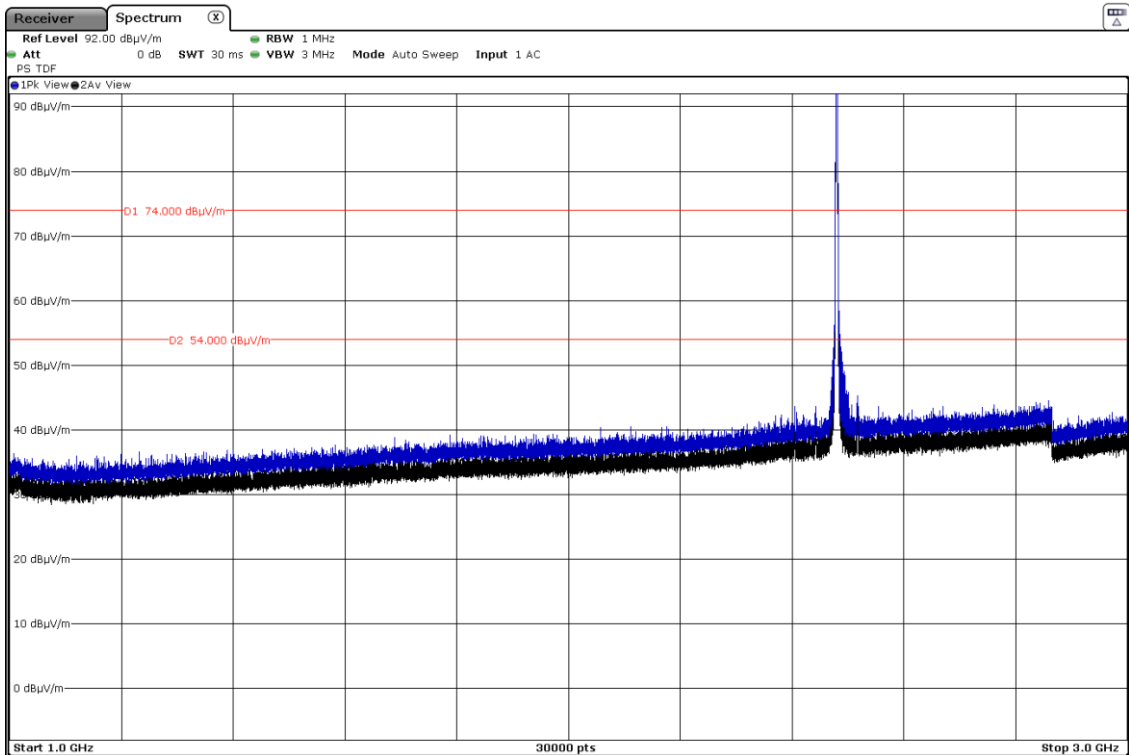
Note: The peak shown in the plot above the limit is the carrier frequency.

CHANNEL: Middle (2440 MHz).



Note: The peak shown in the plot above the limit is the carrier frequency.

CHANNEL: Highest (2480 MHz).

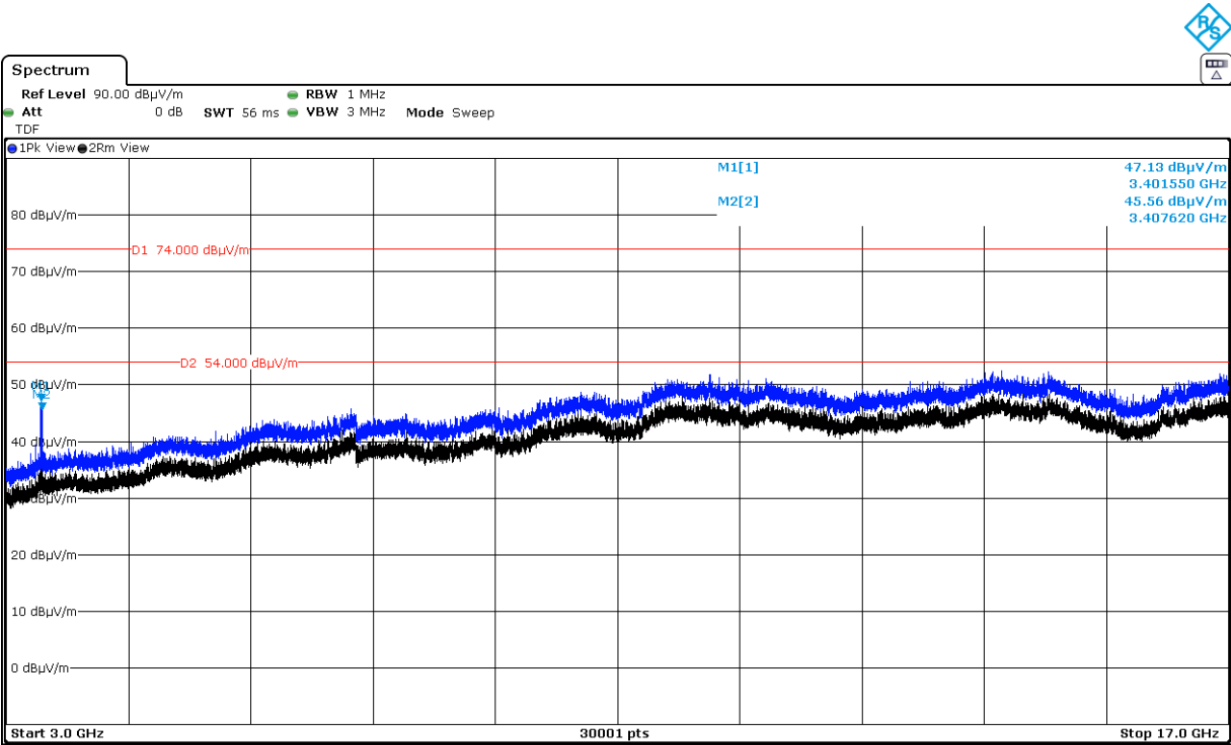


Note: The peak shown in the plot above the limit is the carrier frequency.

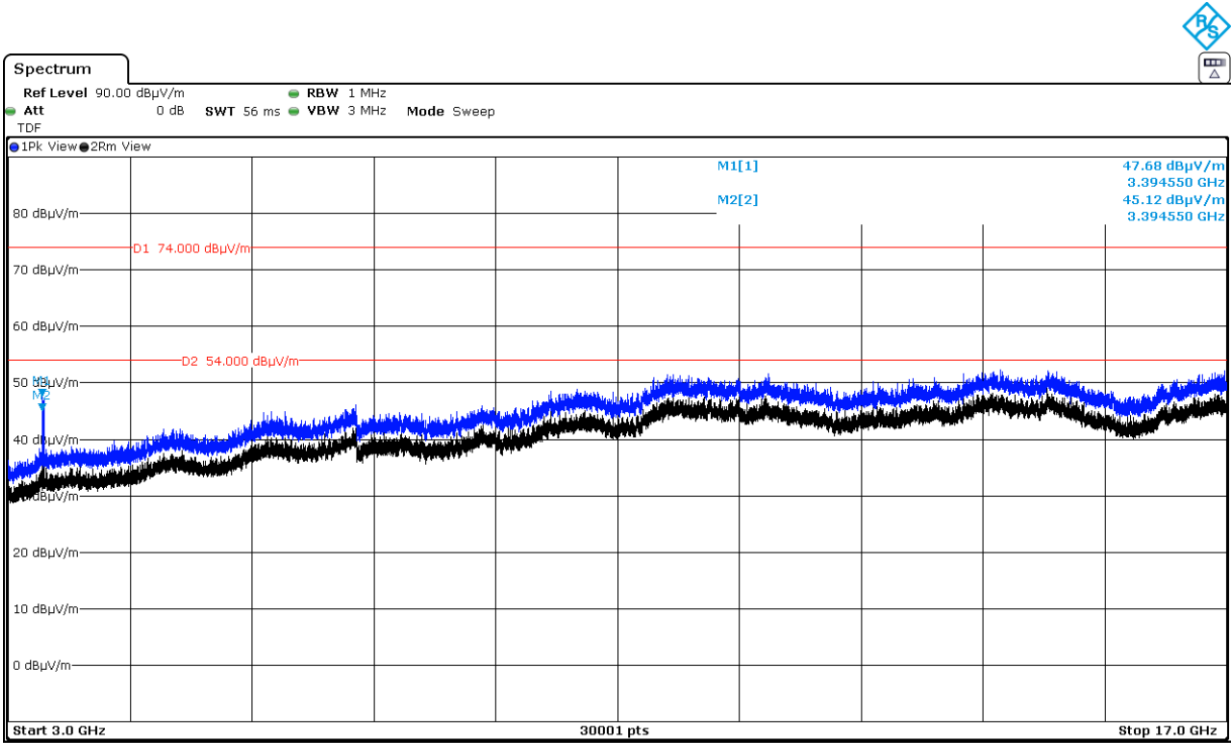
FREQUENCY RANGE 3 GHz to 17 GHz.

Mode 1: BTLE BitRate 1Mbps

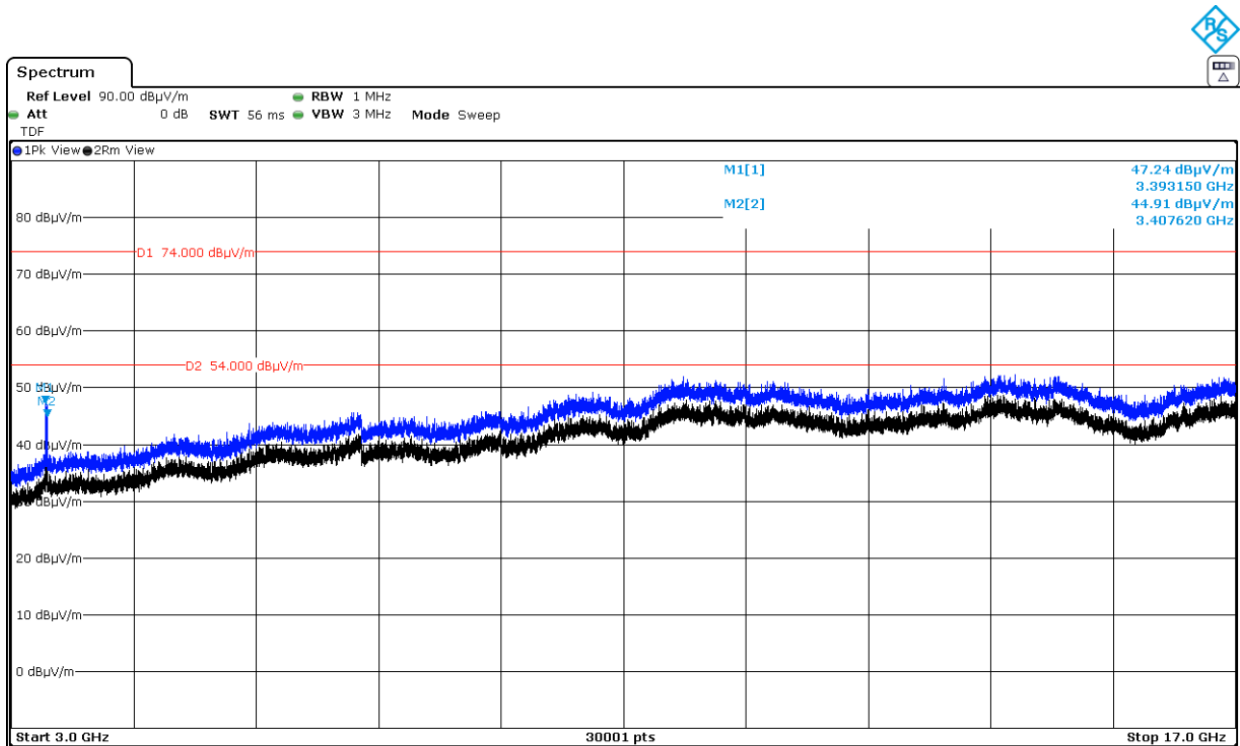
CHANNEL: Lowest (2402 MHz).



CHANNEL: Middle (2440 MHz).

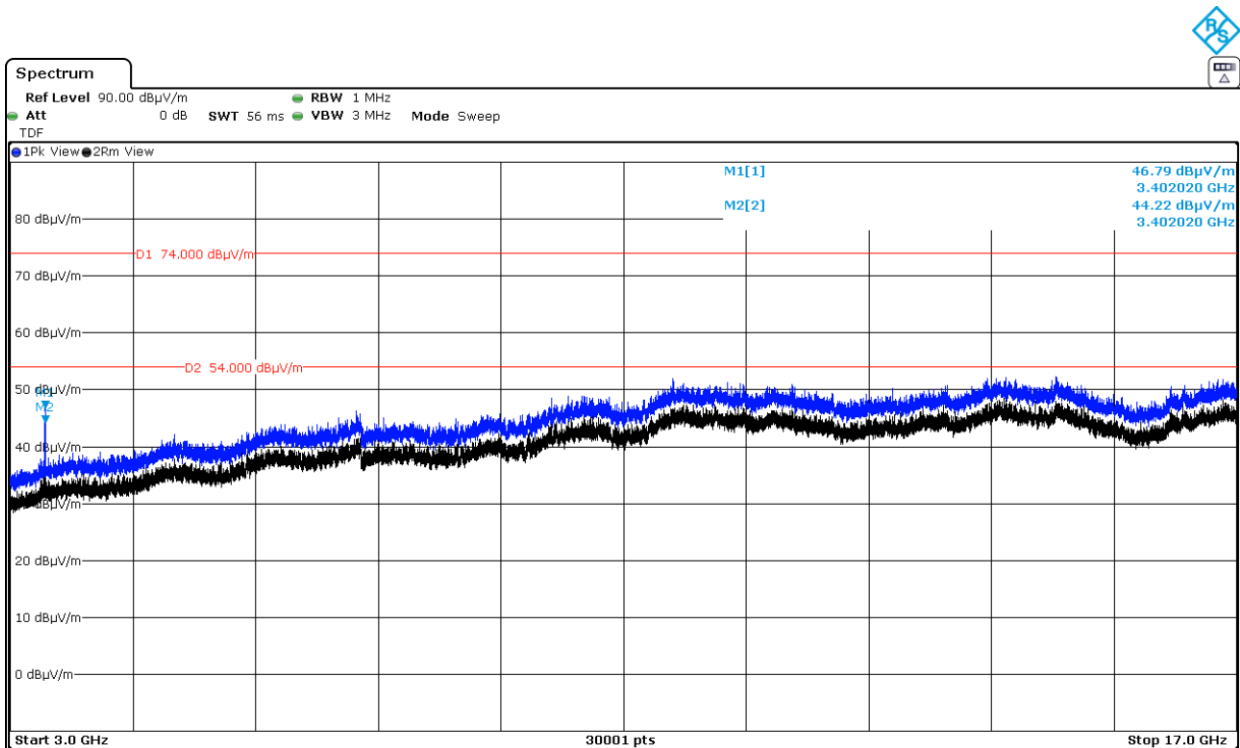


CHANNEL: Highest (2480 MHz).

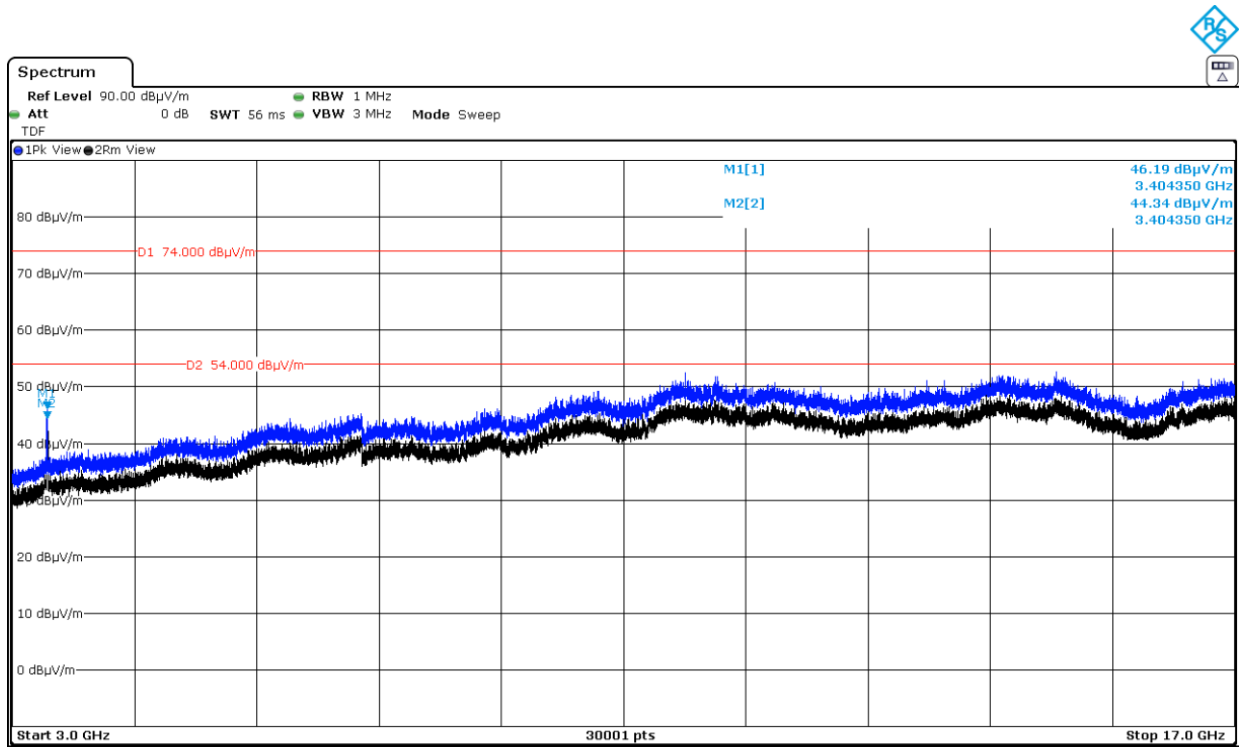


Mode 2: BTLE BitRate 2Mbps

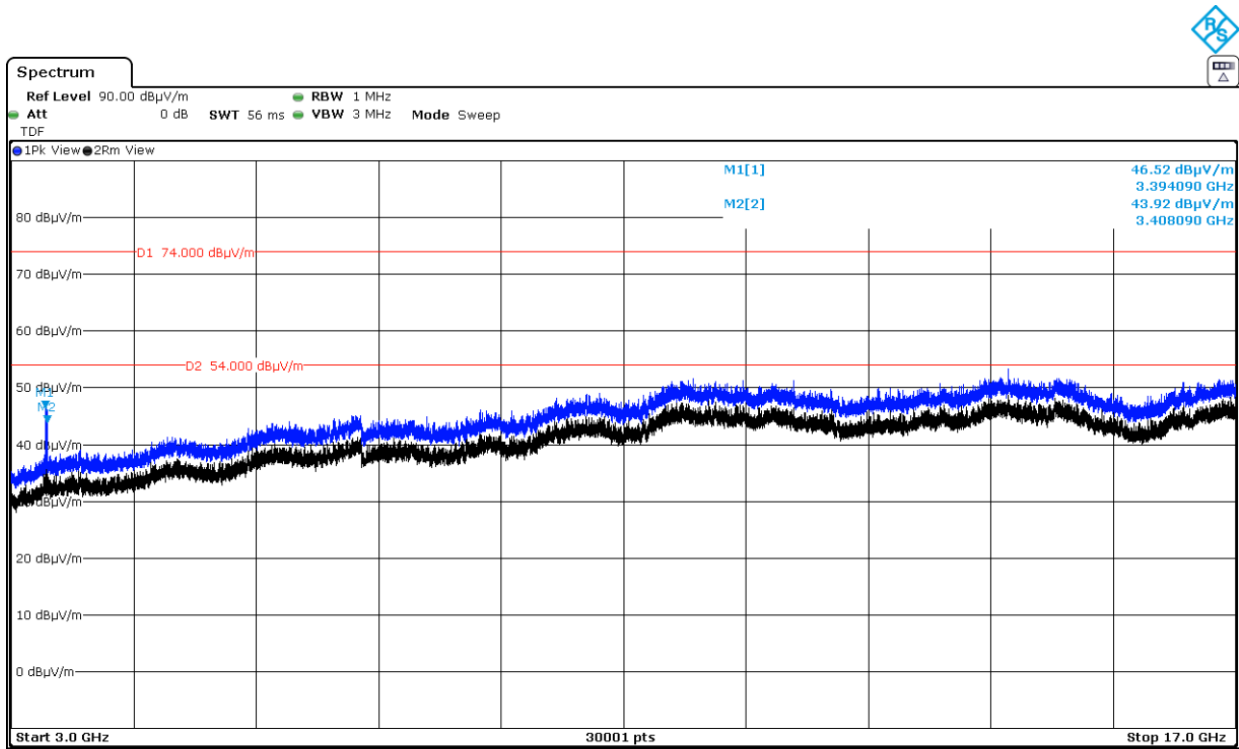
CHANNEL: Lowest (2402 MHz).



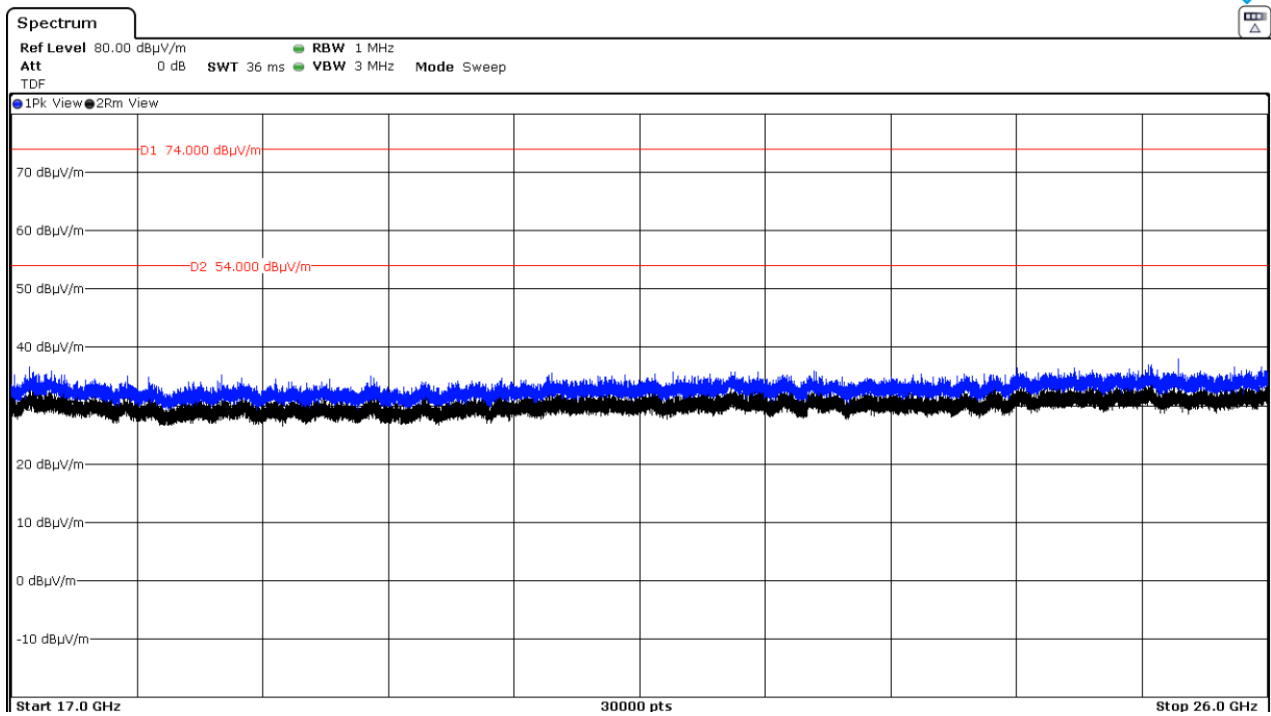
CHANNEL: Middle (2440 MHz).



CHANNEL: Highest (2480 MHz).



FREQUENCY RANGE 17 GHz to 26 GHz.



(This plot is valid for all three channels and all modulation modes).

FCC Section 15.247 Subclause (d) / RSS-247 5.5. Band-edge emissions compliance (Transmitter)

SPECIFICATION

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) / RSS-Gen is not required.

RESULTS:

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.

The lower band edge is adjacent to a non-restricted band. The test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and trace mode was MAX HOLD to maximise the carrier level and out-of-band emissions. A marker was placed on the highest emission level.

The upper band edge is adjacent to a restricted band. The test receiver resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. Peak and average measurements were performed with their respective detectors, sweep time auto and trace mode was MAX HOLD / trace averaging respectively to maximise the carrier level and out-of-band emissions. A marker was placed on the highest emission.

For restricted band (2310 MHz-2390 MHz) the test receiver resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. Peak and average measurements were performed with their respective detectors, sweep time auto couple and trace mode was MAX HOLD / trace averaging respectively.

Results for Mode 1: BTLE BitRate 1Mbps

Results: lower and upper Band Edge

Frequency (MHz)	Polarization	Peak Level (dBuV/m)	Limit (dBuv/m)	Margin (dB)	Measurement uncertainty (dB)	Verdict
2400	Vertical	66.06	91.7*	25.64	<±3.05	PASS
2483.54	Vertical	56.42	74	17.58	<±3.05	PASS

(*): -20 dBc limit.

Frequency (MHz)	Polarization	Average Level (dBuV/m)	Limit (dBuv/m)	Margin (dB)	Measurement uncertainty (dB)	Verdict
2483.54	Vertical	44.20	54	9.80	<±3.05	PASS

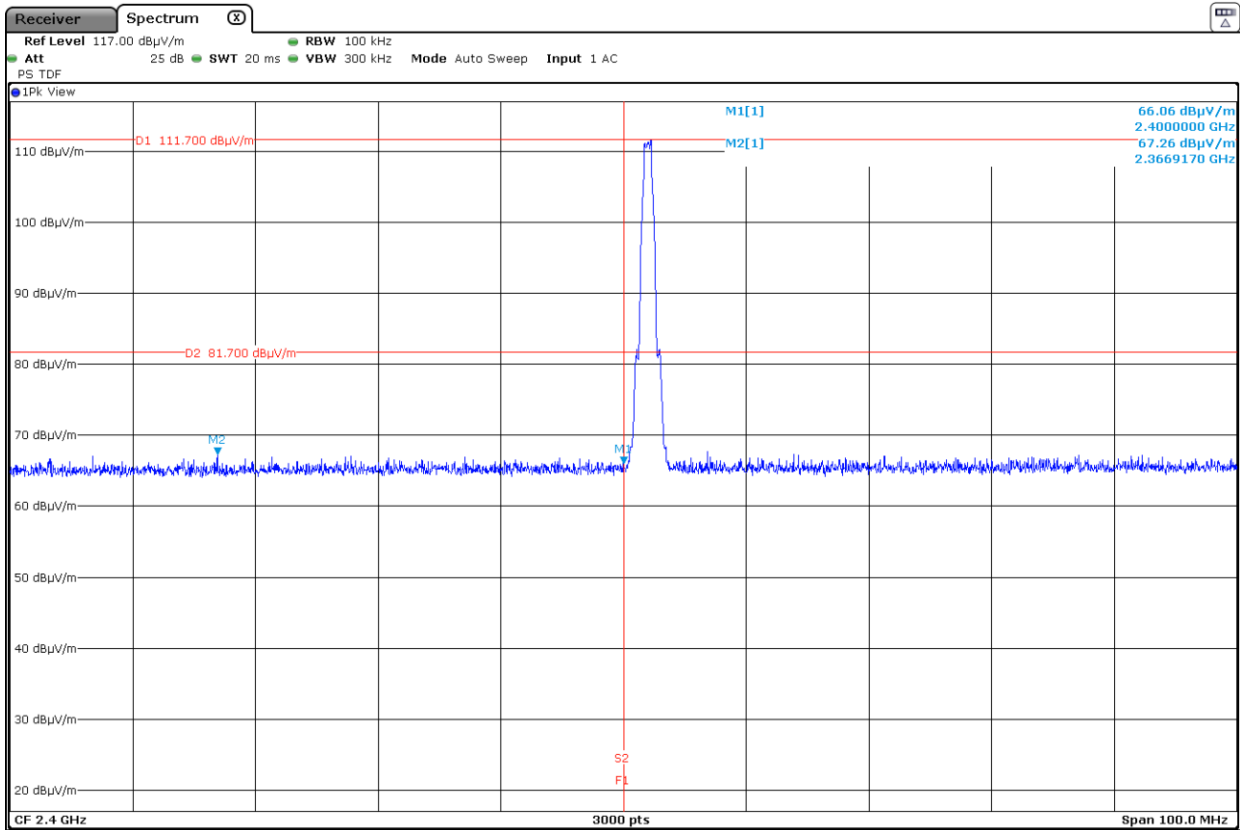
Results: 2310 MHz to 2390 MHz Restricted Band (Peak)

Frequency (MHz)	Polarization	Level (dBuV/m)	Limit (dBuv/m)	Margin (dB)	Measurement uncertainty (dB)	Verdict
2387.747	Vertical	52.83	74.0	21.17	<±3.05	PASS

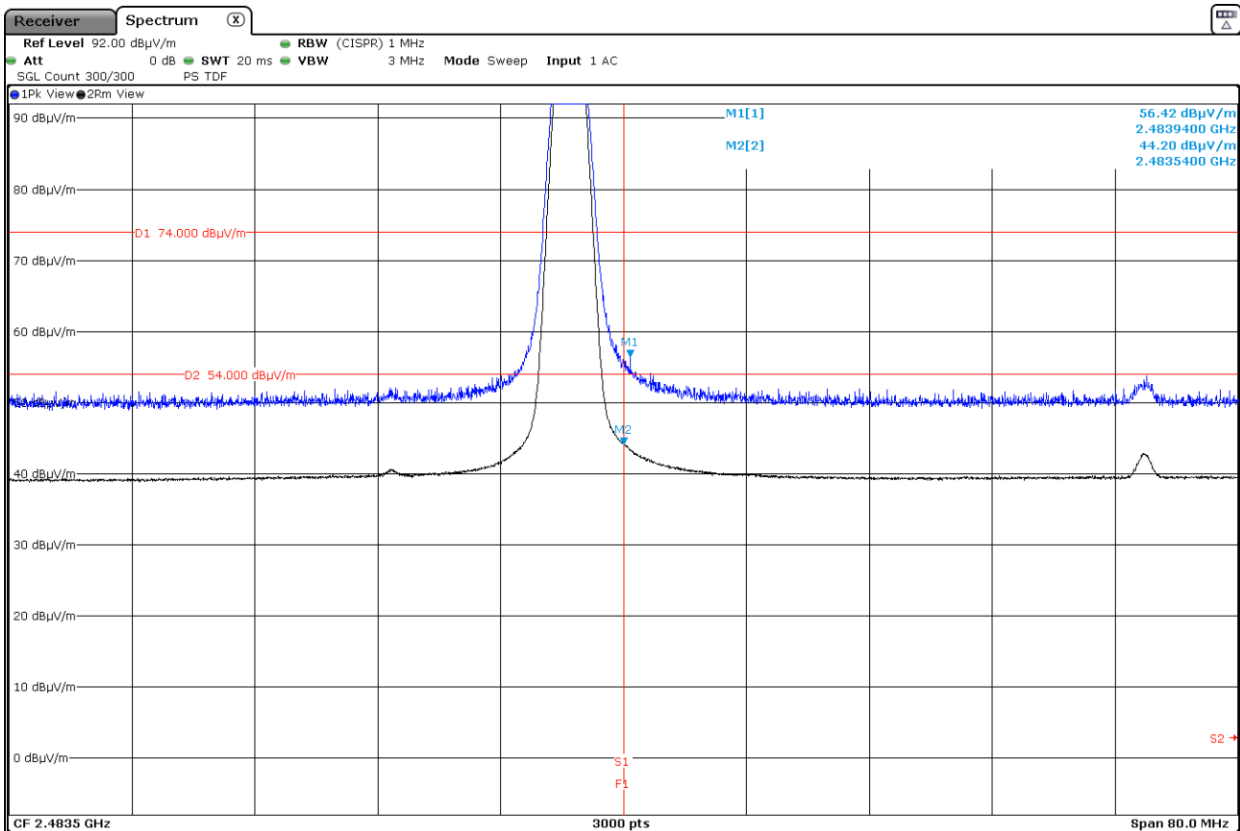
Results: 2310 MHz to 2390 MHz Restricted Band (Average)

Frequency (MHz)	Polarization	Level (dBuV/m)	Limit (dBuv/m)	Margin (dB)	Measurement uncertainty (dB)	Verdict
2364.653	Vertical	41.47	54.0	12.53	<±3.05	PASS

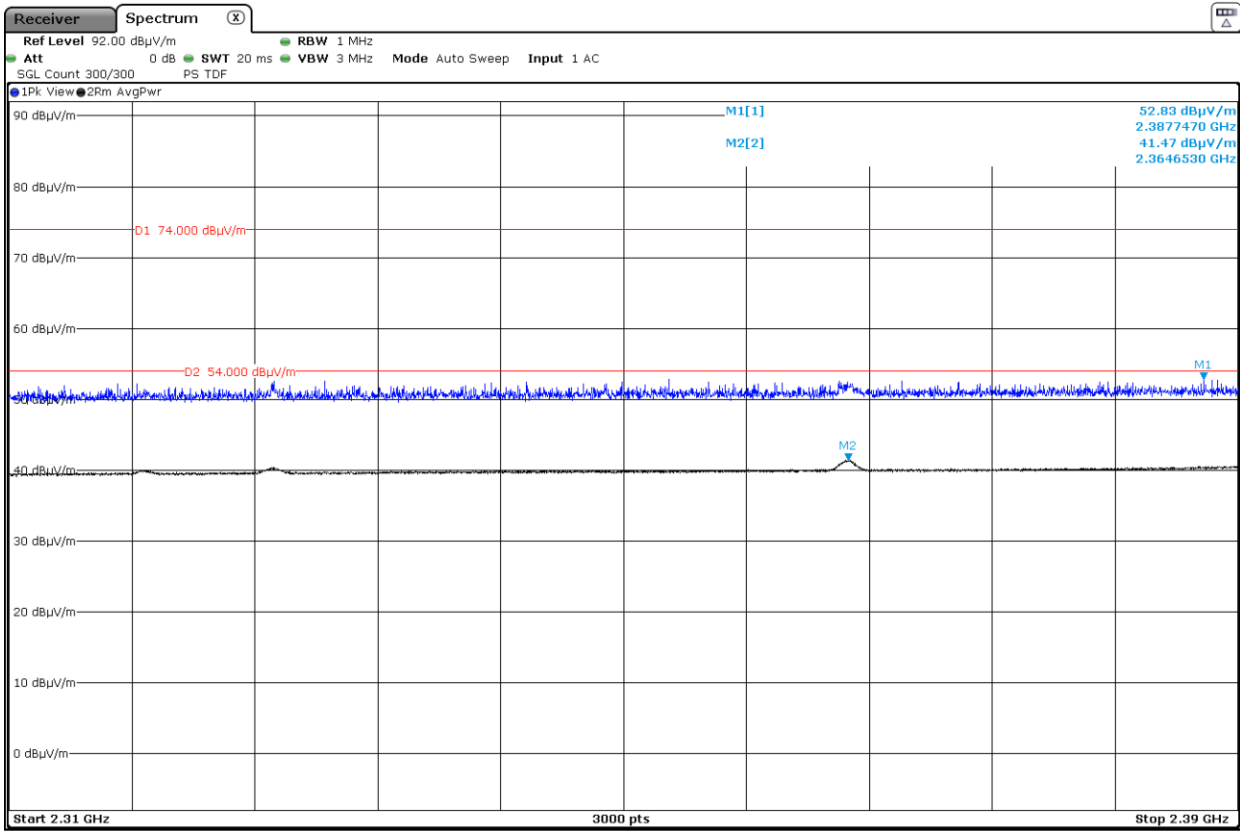
Lower Band Edge



Upper Band Edge



2310 MHz to 2390 MHz Restricted Band



Results for Mode 2: BTLE BitRate 2Mbps

Results: lower and upper Band Edge

Frequency (MHz)	Polarization	Peak Level (dBuV/m)	Limit (dBuv/m)	Margin (dB)	Measurement uncertainty (dB)	Verdict
2399.983	Vertical	78.69	92.09*	13.40	<±3.05	PASS
2483.673	Vertical	61.41	74	12.59	<±3.05	PASS

(*): -20 dBc limit.

Frequency (MHz)	Polarization	Average Level (dBuV/m)	Duty cycle correction (dB)	Corrected Level (dBuv/m)	Limit (dBuv/m)	Margin (dB)	Measurement uncertainty (dB)	Verdict
2483.513	Vertical	46.94	4.8	51.74	54	2.26	<±3.05	PASS

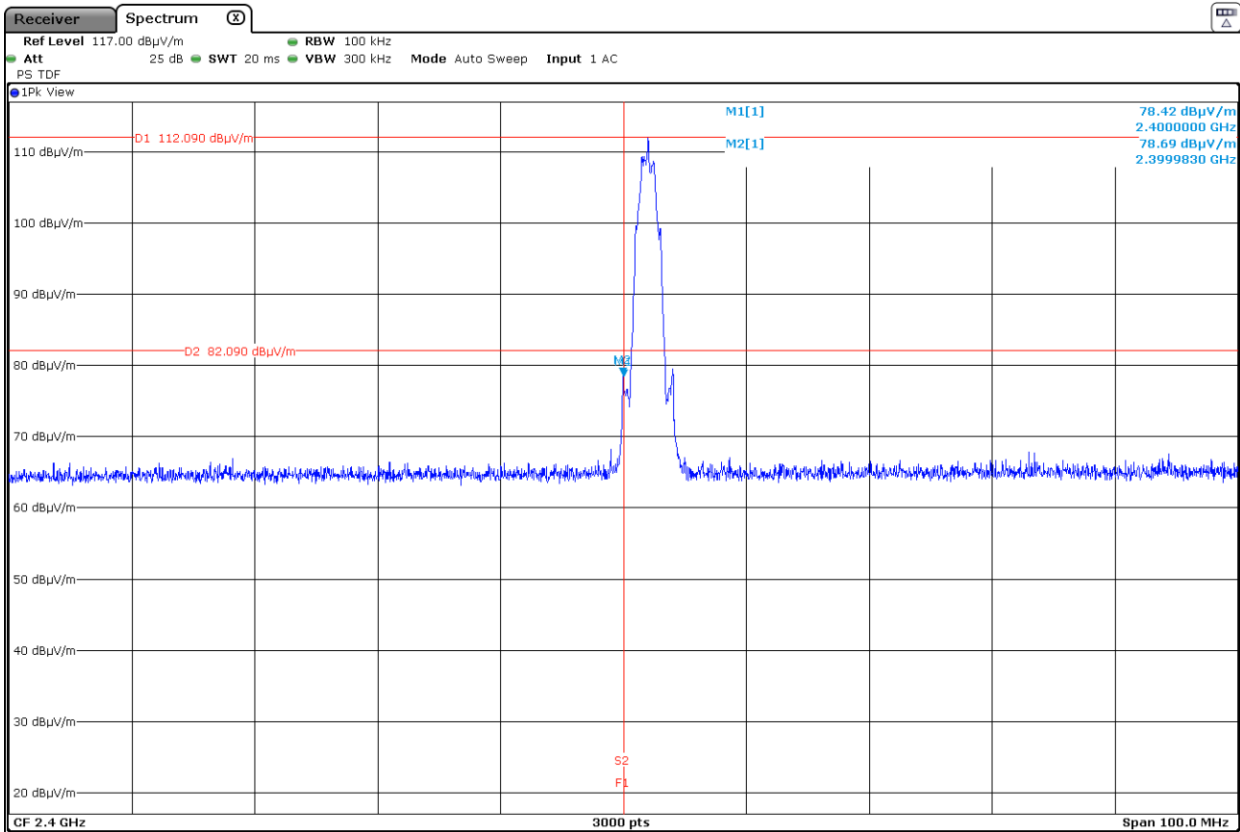
Results: 2310 MHz to 2390 MHz Restricted Band (Peak)

Frequency (MHz)	Polarization	Level (dBuV/m)	Limit (dBuv/m)	Margin (dB)	Measurement uncertainty (dB)	Verdict
2335.48	Vertical	53.33	74.0	20.67	<±3.05	PASS

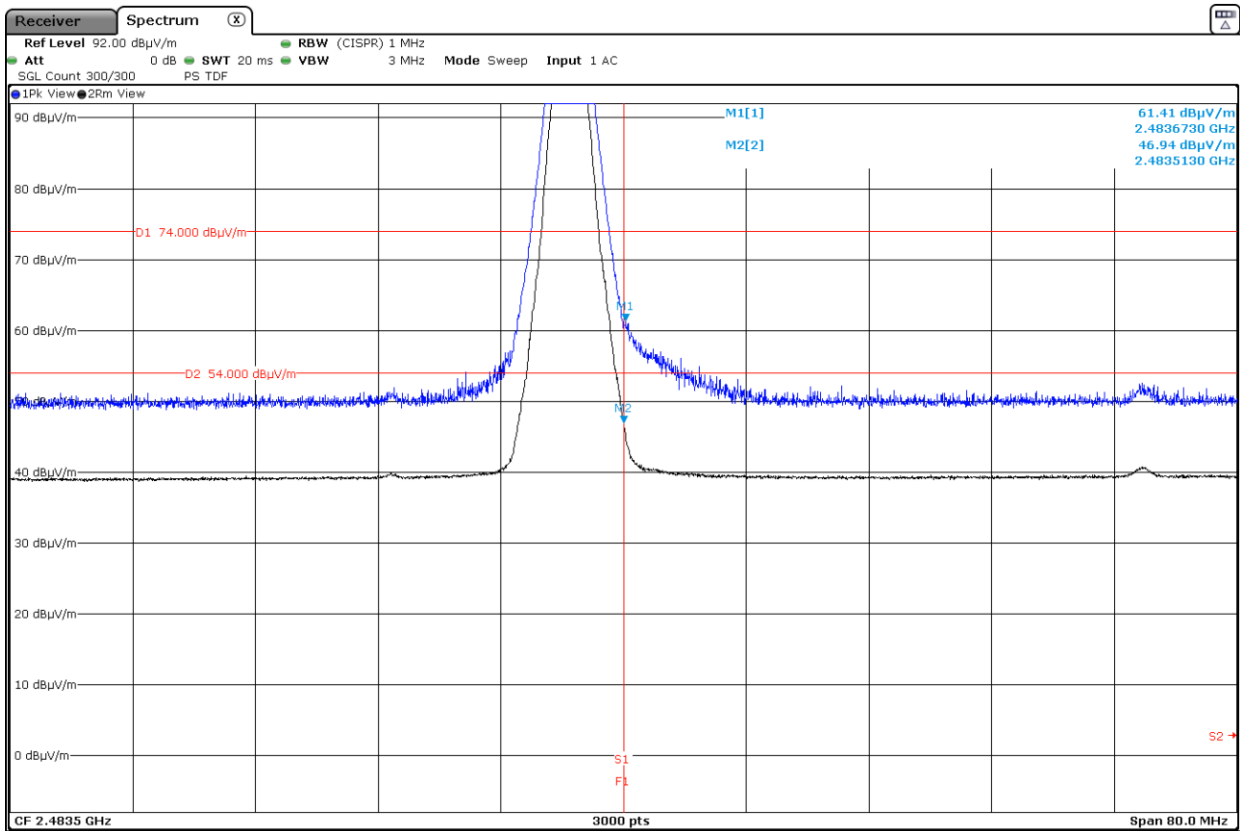
Results: 2310 MHz to 2390 MHz Restricted Band (Average)

Frequency (MHz)	Polarization	Average Level (dBuV/m)	Duty cycle correction (dB)	Corrected Level (dBuv/m)	Limit (dBuv/m)	Margin (dB)	Measurement uncertainty (dB)	Verdict
2364.68	Vertical	40.47	4.8	45.27	54	8.73	<±3.05	PASS

Lower Band Edge



Upper Band Edge



2310 MHz to 2390 MHz Restricted Band

