DEKRA Certification, Inc.
405, Glenn Drive Suite 12
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DEKRA

Test Lab
Cert 2764.01

FCC LISTED, REGISTRATION NUMBER: 2764.01

ISED LISTED REGISTRATION NUMBER: 23595-1

Test report No:

NIE: 2125ERM.005A1

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 License-Exempt Local Area Network (LE-LAN) Devices.
General Requirements and Information for the Certification of Radio Apparatus.

Identification of item tested.....:	Wave Plus
Trademark .....:	AIRTHINGS AS
Model and /or type reference .....:	2930
Other identification of the product .....:	FCC ID:2APPT-2930 IC : 23900-2930
Final HW version .....:	---
Final SW version .....:	---
Features.....:	2.4 GHz Wireless Bluetooth with 1Mb and 2Mb
Manufacturer.....:	AIRTHINGS AS Wergelandsveien 7 Oslo Norway 0167
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. CANADA RSS-247 Issue 2 (February 2017). CANADA RSS-Gen Issue 4 (November 2014). Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v04 dated 05/04/2017. ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.
Summary .....:	IN COMPLIANCE
Approved by (name / position & signature) .....:	Domingo Galvez EMC & RF Lab. Manager Digitally signed by Domingo Galvez DN: cn=Domingo Galvez, o=DEKRA, ou=EMC-RF Lab Manager, email=domingo.galvez@dekra.com, c=US Date: 2018.07.21 13:03:08 -04'00'
Date of issue.....:	07/18/2018
Report template No.....:	FDT08_20

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Competences and guarantees

DEKRA Certification Inc. is a testing laboratory accredited by A2LA (The American Association for Laboratory Accreditation), to perform the tests indicated in the Certificate 2764.01.

DEKRA Certification Inc. 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: 2764.01.

DEKRA Certification Inc. 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:23595-1.

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

DEKRA Certification Inc. 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 Certification Inc. at the time of performance of the test.

DEKRA Certification Inc. 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.
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 Certification Inc.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of DEKRA Certification Inc. and the Accreditation Bodies.

Uncertainty

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

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
2125.005	Radon Sensor Prepared for RF Conducted Testing	WAVE PLUS	Prototype: CERT #5	05/07/2018
2125.008	TI Launchpad for UART Communication and with special Firmware.	H51	A6E337862	05/07/2018

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

   All Conducted tests indicated in appendix A.

Sample S/02 is composed of the following elements:

Control Nº	Description	Model	Serial Nº	Date of reception
2125.004	Radon Sensor Prepared for RF Radiated Testing	WAVE PLUS	Prototype: CERT #4	05/07/2018
2125.008	TI Launchpad for UART Communication and with special Firmware.	H51	A6E337862	05/07/2018

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

   All Radiated tests indicated in appendix A.

Test sample description

2.4GHz Wireless Bluetooth with 1Mb and 2 Mb.

Identification of the client

Airthings AS

Wergelandsveien 7 Oslo Norway 0167

Testing period

The performed test started on 05/14/2018 and finished on 05/31/2018.

The tests have been performed at DEKRA Certification, Inc.

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 %

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

In the chamber for conducted measurements, 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

Modifications to the reference test report

It was introduced the following modifications in respect to the test report number 2125ERM.005 related with the same samples, in the next clauses and sub-clauses:

Clauses / Sub-clauses	Modification	Justification
Appendix A/ Test Section 15.247 Subclause (d) / RSS-247 5.5. Emission limitations radiated (Transmitter).	Emission levels were corrected for mid channel in BTLE2Mb tests.	Typo
	Plots for 4.5-5.15 GHz restricted bands were added for BTLE1Mb and BTLE2Mb tests	To provide more detailed data for some emissions closer to the limit

This modification test report cancels and replaces the test report 2125ERM.005.

Remarks and comments

1; The tests have been performed by the technical personnel: Divya Adusumilli, Koji Nishimoto and Victor Acedo Rubio.

2: Used instrumentation:

Conducted Measurements

Test system Rohde & Schwarz TS 8997:

No.	Description	Last Cal. Date	Cal. Due date
1.	Signal analyzer Rohde & Schwarz FSV40	2017/03	2019/03
2.	Switch unit Rohde & Schwarz with power detector OSP120 / OSP-B157	2017/03	2019/03
3.	RF generator Rohde & Schwarz SMB100A	2017/04	2019/04
4.	RF generator Rohde & Schwarz SMBV100A	2018/01	2019/01
5.	Climatic chamber Espec	2017/12	2018/12

Radiated Measurements

No.	Description	Last Cal. date	Cal. due date
1.	Semi anechoic Absorber Lined Chamber Frankonia SAC 3 plus “L”	N/A	N/A
2.	BiconicalLog antenna ETS LINDGREN 3142E	2017/03	2020/03
3.	Double-ridge Waveguide Horn antenna 1-18 GHz	2017/03	2019/03
4.	Spectrum analyzer Rohde & Schwarz FSV40	2017/03	2019/03
5.	Double Ridge Horn Antenna 10 – 40 GHz	2016/12	2018/12
6.	RF pre-amplifier 30 MHz-6 GHz Bonn Elektronik BLMA 0360-01N	2017/05	2019/05
7.	RF pre-amplifier 1-18 GHz Bonn Elektronik BLMA 0118-2A	2017/05	2019/05
8.	RF Pre-amplifier 18-40 GHz Bonn Elektronik BLMA1840-1M	2017/05	2019/05
9.	Rohde & Schwarz EMC32 software	N/A	N/A

Testing verdicts

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

1. BTLE

FCC PART 15 PARAGRAPH / RSS-247		VERDICT			
		NA	P	F	NM
Section 15.247 Subclause (a) (2) / RSS-247 5.2. (a)	6 dB Bandwidth		P		
Section 15.247 Subclause (b) / RSS-247 5.4. (d)	Maximum output power and antenna gain		P		
Section 15.247 Subclause (d) / RSS-247 5.5.	Emission limitations conducted (Transmitter)		P		
Section 15.247 Subclause (d) / RSS-247 5.5.	Band-edge emissions compliance (Transmitter)		P		
Section 15.247 Subclause (e) / RSS-247 5.2. (b)	Power spectral density		P		
Section 15.247 Subclause (d) / RSS-247 5.5.	Emission limitations radiated (Transmitter)		P		

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TEST CONDITIONS

Power supply (V):

$V_{nominal}$ = 3 Vdc

Type of power supply = DC voltage from internal battery.

Type of antenna = Integral antenna

Declared Gain for antenna (maximum) = +3.3 dBi

Temperature (ºC):

T_n = +15 to +35

T_{min} = 4 (*)

T_{max} = +40 (*)

The subscript n indicates normal test conditions.

The subscripts min and max indicates extreme test conditions (minimum and maximum respectively).

(*): Declared by applicant.

TEST FREQUENCIES:

Lowest channel: 2402 MHz

Middle channel: 2440 MHz

Highest channel: 2480 MHz

CONDUCTED MEASUREMENTS

The equipment under test was set up in a shielded room and it is directly connected to the Test System TS8997.

RADIATED MEASUREMENTS

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna is situated at a distance of 3 m for the frequency range 30 MHz-1000 MHz (30 MHz-1000 MHz Bilog antenna) and at a distance of 1m for the frequency range 1 GHz-25 GHz (1 GHz-18 GHz Double ridge horn antenna and 18 GHz-40 GHz horn antenna).

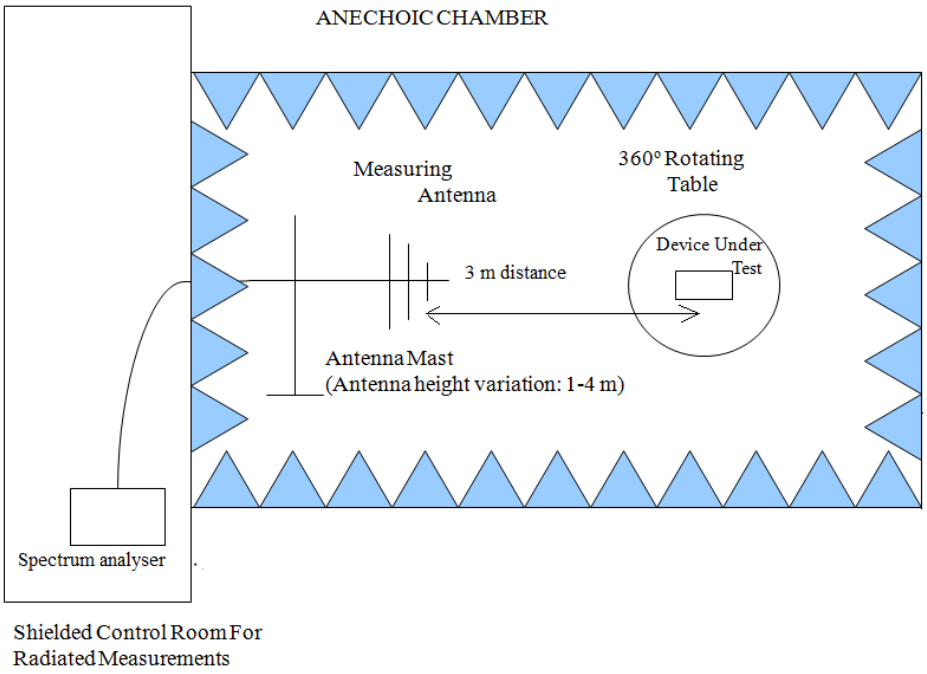
For radiated emissions in the range 1 GHz-25 GHz that is performed at a distance closer than the specified distance, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive platform above the ground plane and the situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission.

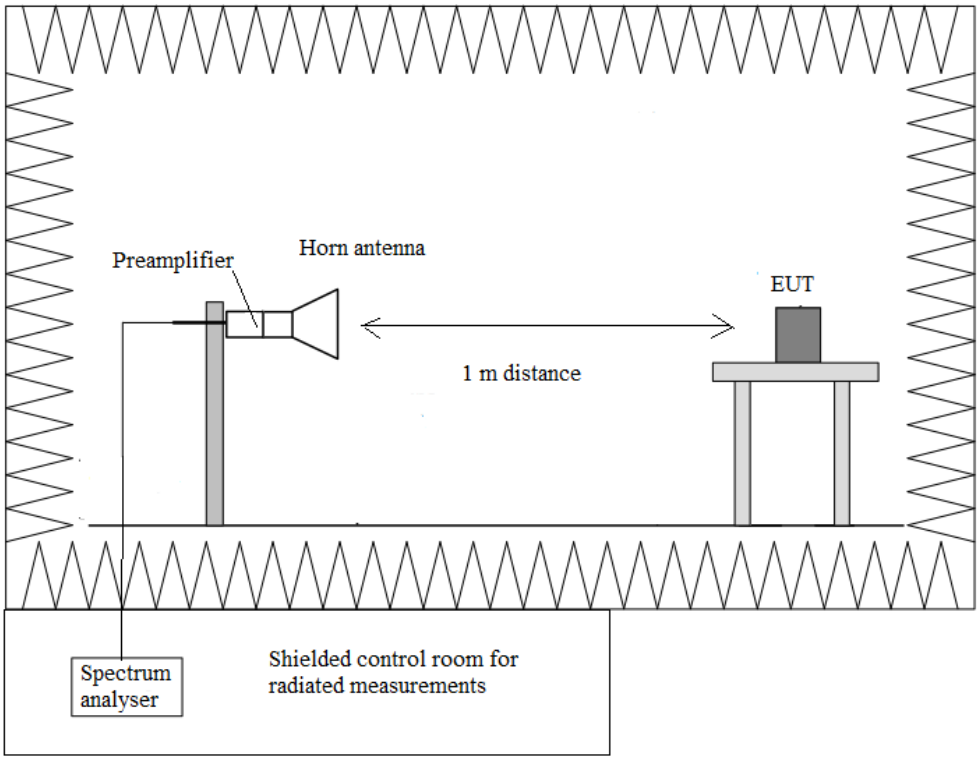
Measurements were made in both horizontal and vertical planes of polarization.

The test was performed with the equipment transmitting first with only the BTLE radio and repeated with SRD radio transmitting simultaneously to check the impact of the co-location of the other radio interfaces. The results and plots below show the worst results obtained.

Radiated measurements setup f < 1 GHz



Radiated measurements setup f > 1 GHz



Occupied Bandwidth

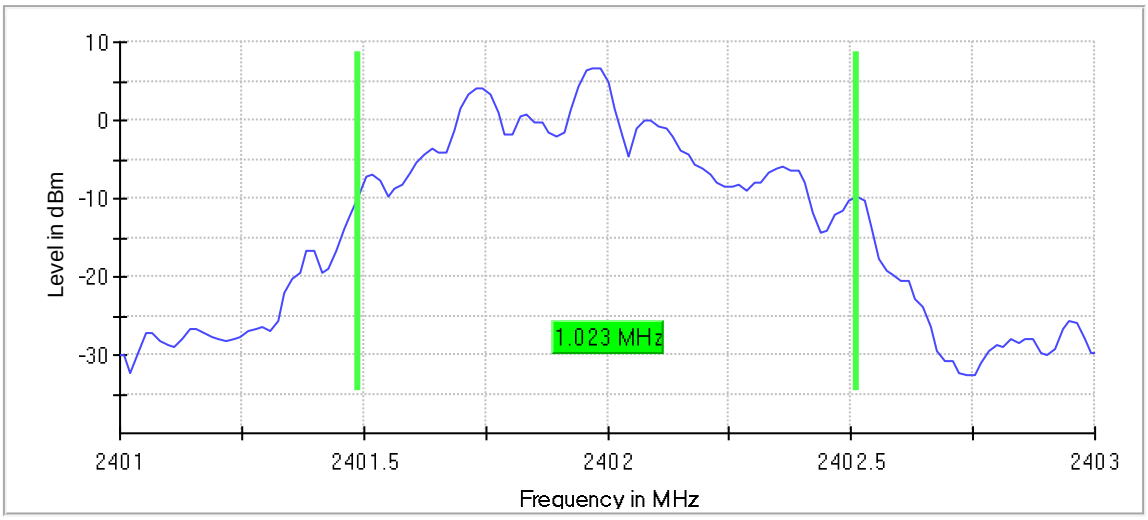
RESULTS

BTLE 1Mb

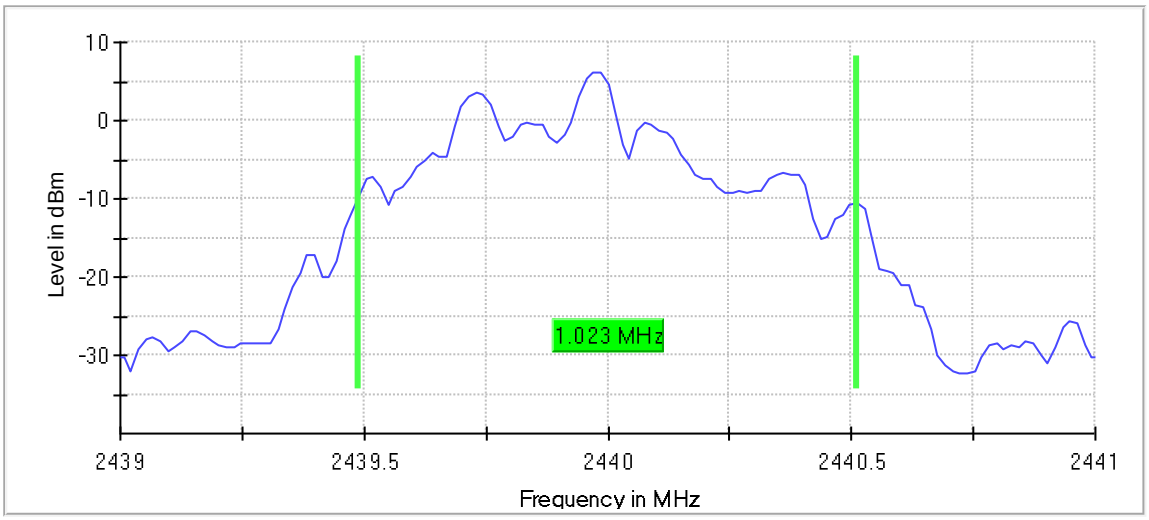
(see next plots).

	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
20 dB bandwidth (MHz)	1.098	1.083	1.083
99% bandwidth (MHz)	1.023	1.023	1.023
Measurement uncertainty (kHz)	<± 8.33		

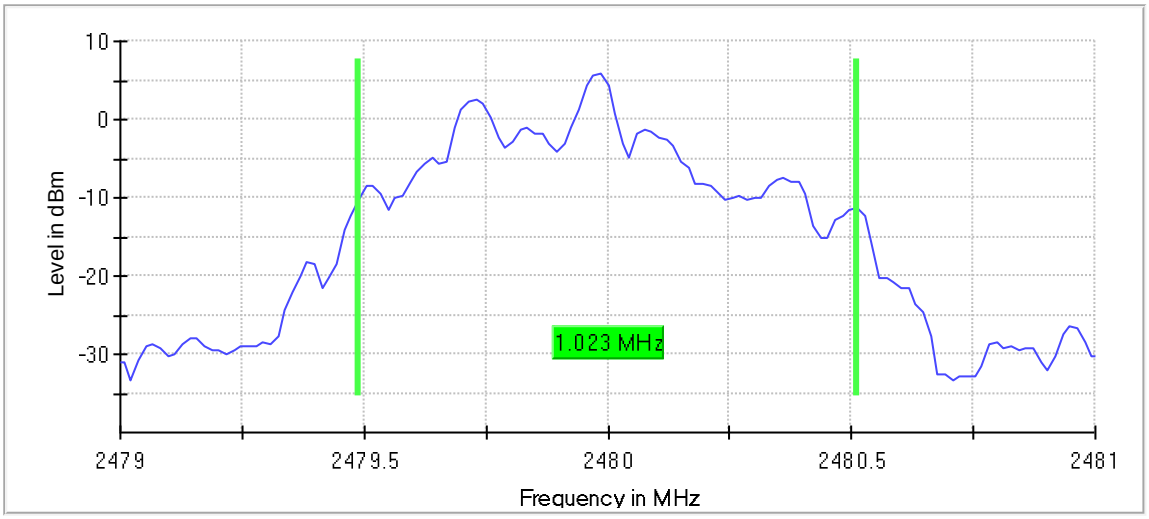
Lowest Channel (99% Bandwidth)



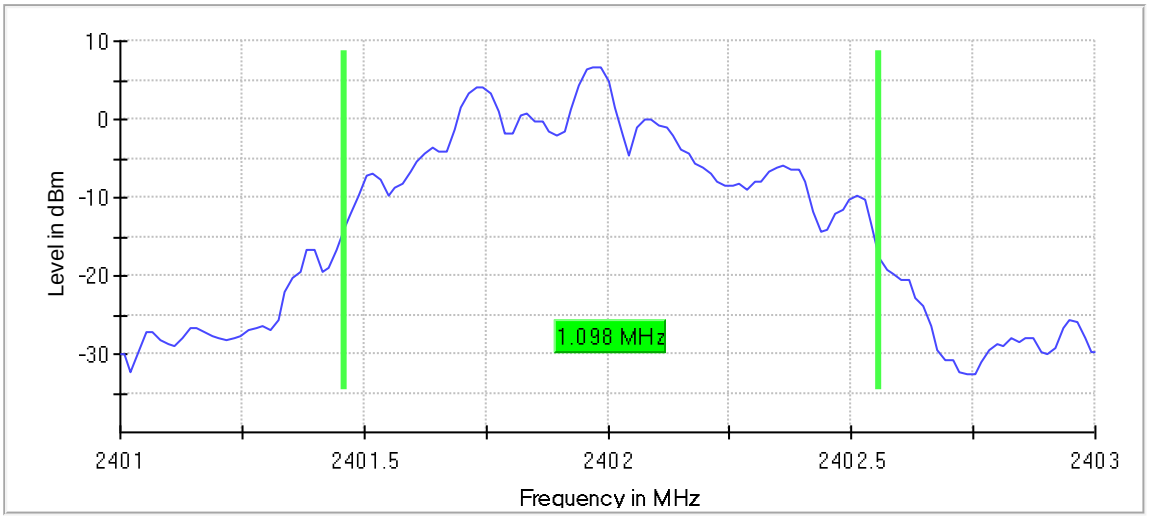
Middle Channel (99% Bandwidth)



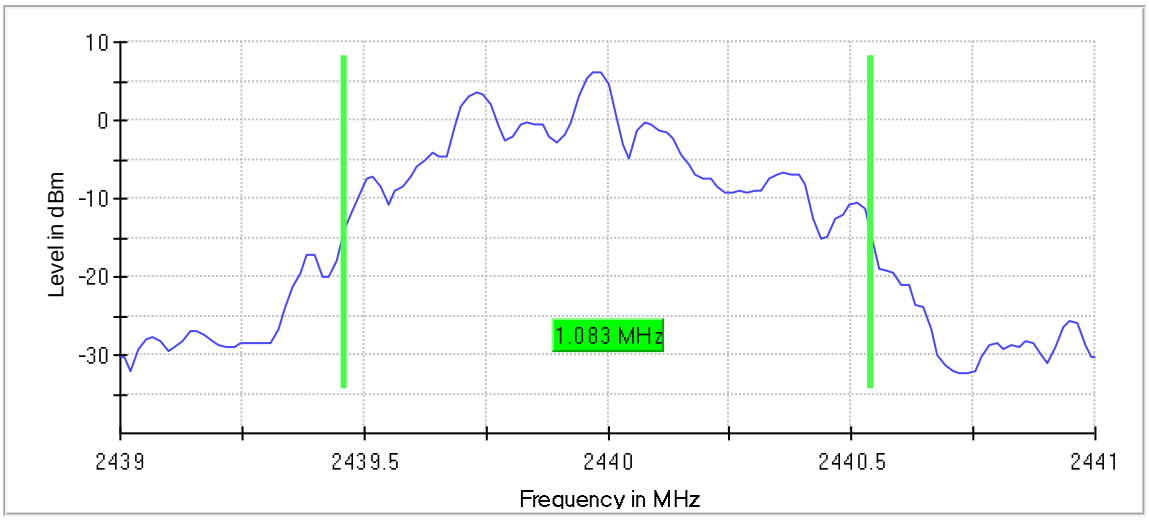
Highest channel (99% Bandwidth)



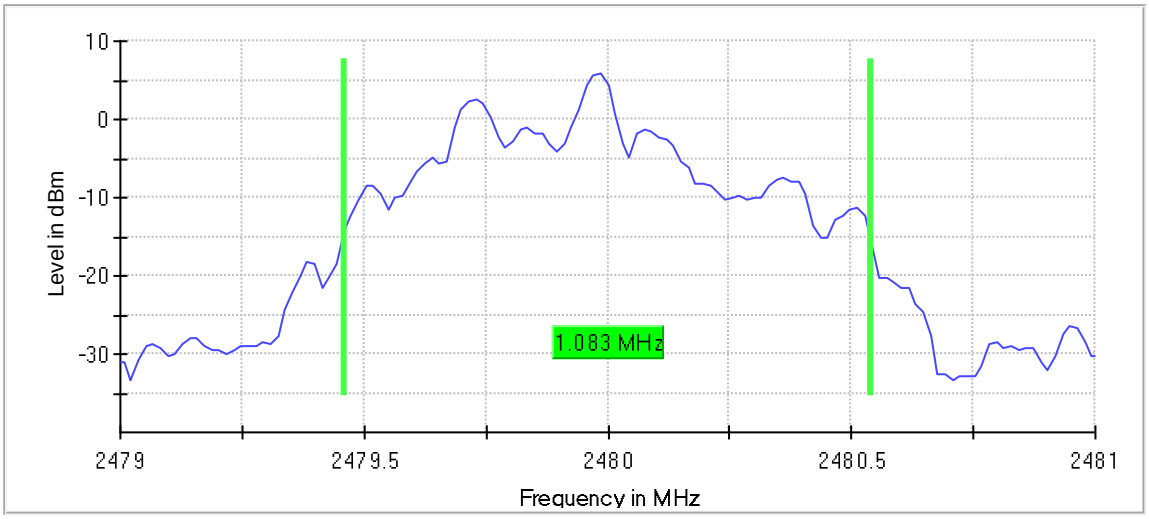
Lowest Channel (20dB Bandwidth)



Middle Channel (20dB Bandwidth)



Highest channel (20dB Bandwidth)



Measurement

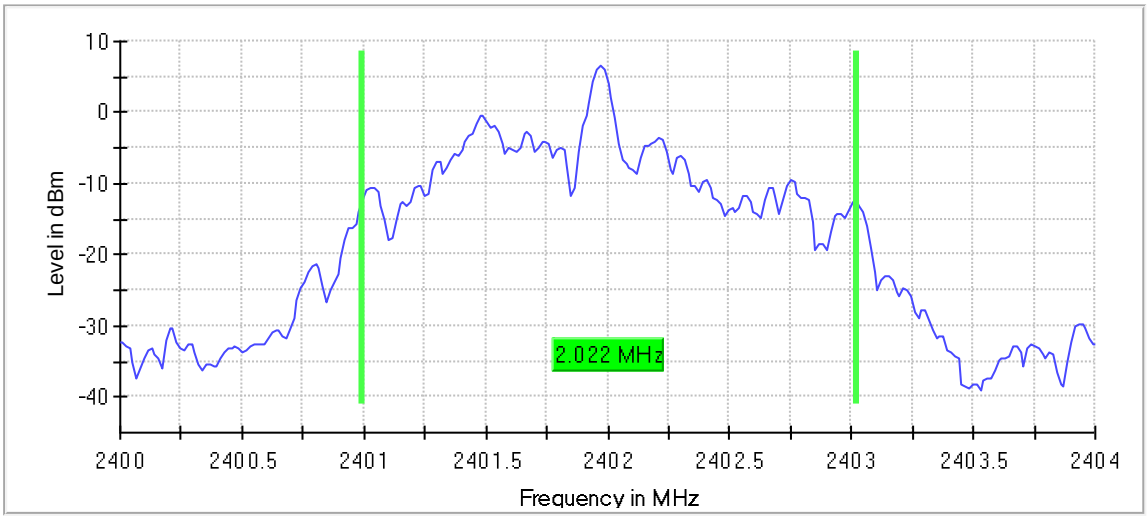
Setting	Instrument Value	Instrument Value	Instrument Value
Start Frequency	2.40100 GHz	2.43900 GHz	2.47900 GHz
Stop Frequency	2.40300 GHz	2.44100 GHz	2.48100 GHz
Span	2.000 MHz	2.000 MHz	2.000 MHz
RBW	30.000 kHz	30.000 kHz	30.000 kHz
VBW	100.000 kHz	100.000 kHz	100.000 kHz
Sweep Points	133	133	133
Sweep time	63.123 µs	63.123 µs	63.123 µs
Reference Level	10.000 dBm	10.000 dBm	10.000 dBm
Attenuation	25.000 dB	25.000 dB	25.000 dB
Detector	MaxPeak	MaxPeak	MaxPeak
Sweep Count	100	100	100
Filter	3 dB	3 dB	3 dB
Trace Mode	Max Hold	Max Hold	Max Hold
Sweep type	FFT	FFT	FFT
Preamp	off	off	off
Stable mode	Trace	Trace	Trace
Stable value	0.50 dB	0.50 dB	0.50 dB
Run	8 / max. 150	8 / max. 150	7 / max. 150
Stable	5 / 5	5 / 5	5 / 5
Max Stable Difference	0.02 dB	0.45 dB	0.32 dB

BTLE 2Mb

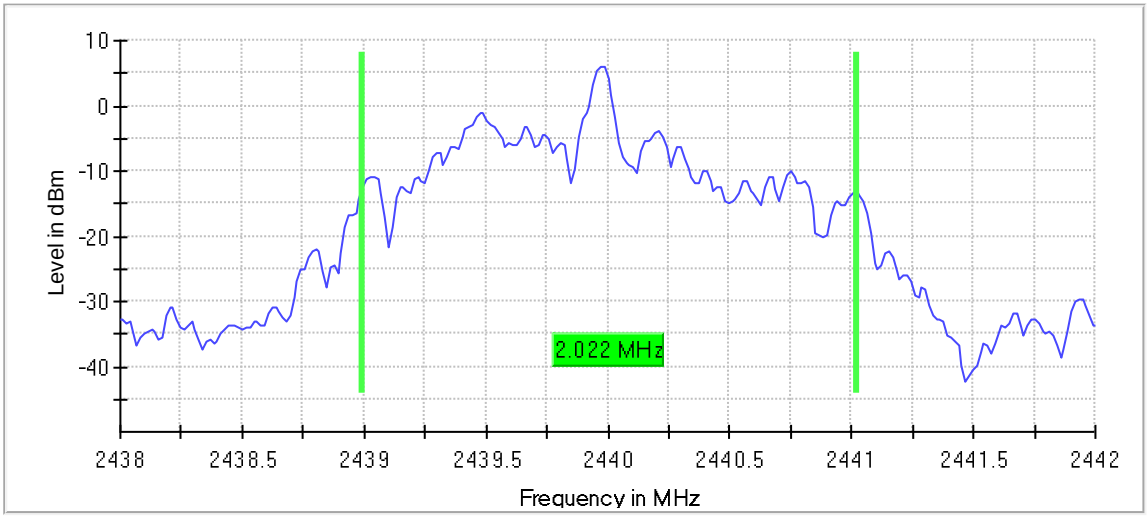
(see next plots).

	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
20 dB bandwidth (MHz)	2.067	2.067	2.082
99% bandwidth (MHz)	2.022	2.022	2.022
Measurement uncertainty (kHz)	<± 8.33		

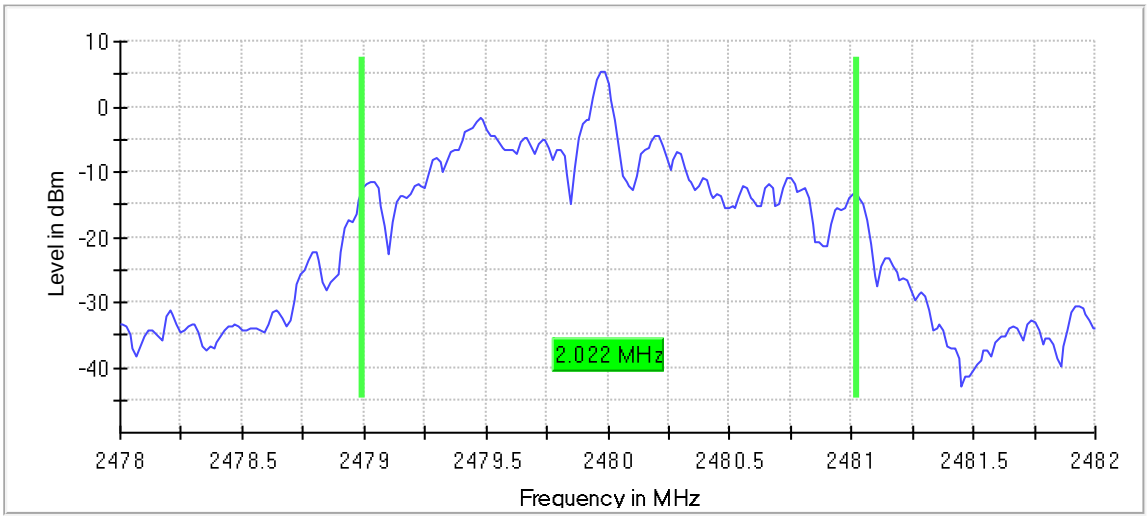
Lowest Channel (99% Bandwidth)



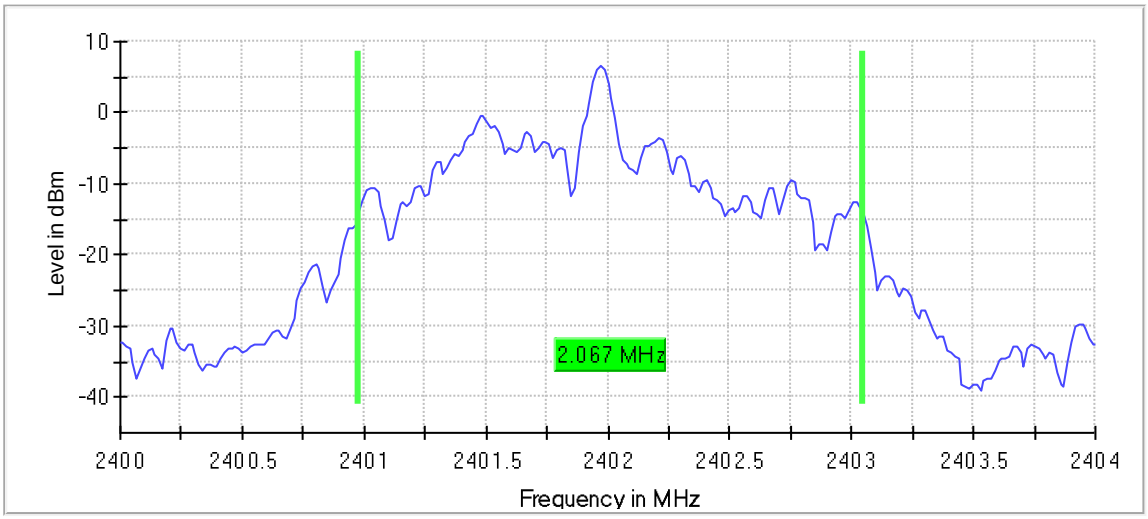
Middle Channel (99% Bandwidth)



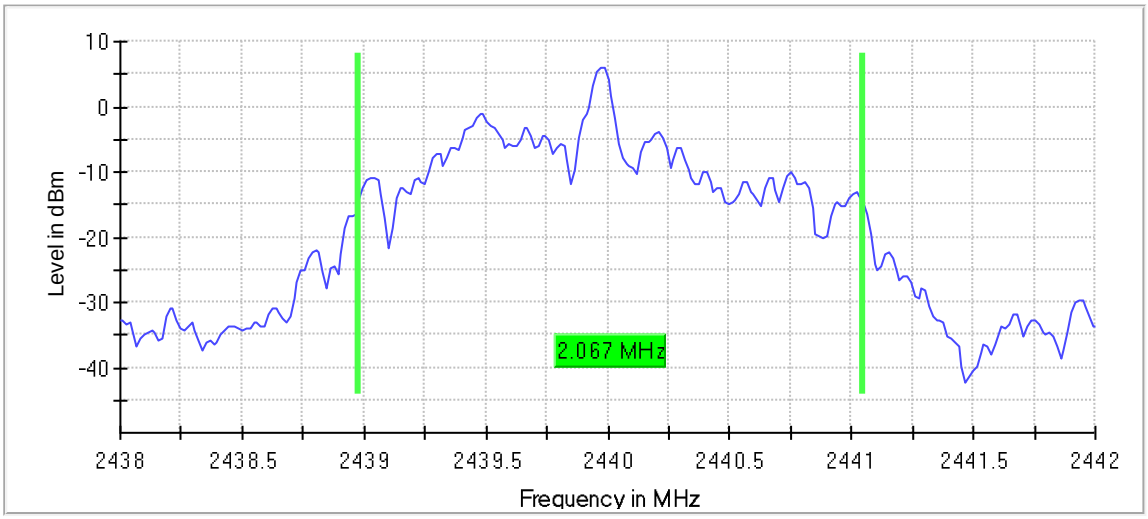
Highest channel (99% Bandwidth)



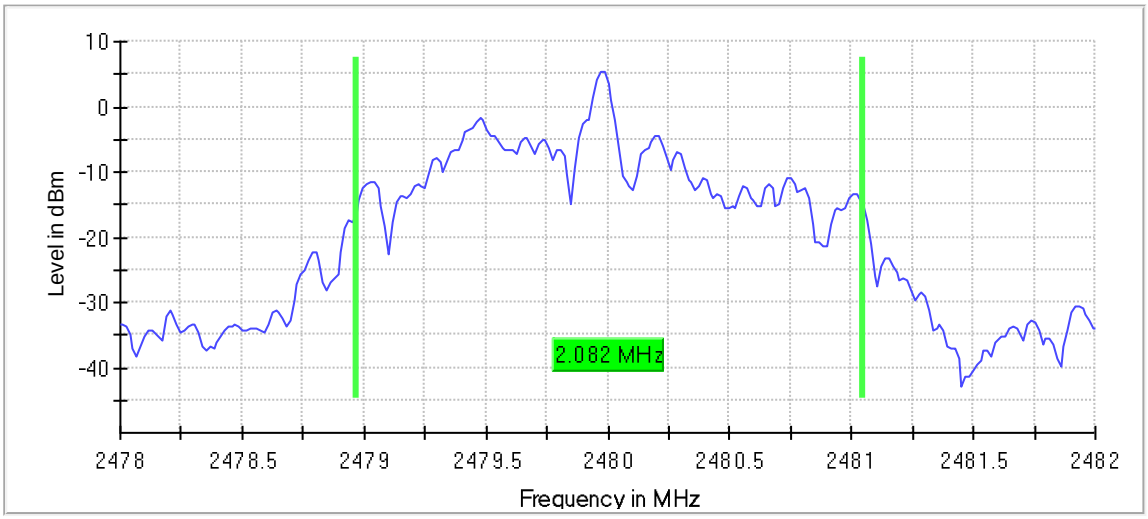
Lowest Channel (20dB Bandwidth)



Middle Channel (20dB Bandwidth)



Highest channel (20dB Bandwidth)



Measurement

Setting	Instrument Value	Instrument Value	Instrument Value
Start Frequency	2.40000 GHz	2.43800 GHz	2.47800 GHz
Stop Frequency	2.40400 GHz	2.44200 GHz	2.48200 GHz
Span	4.000 MHz	4.000 MHz	4.000 MHz
RBW	30.000 kHz	30.000 kHz	30.000 kHz
VBW	100.000 kHz	100.000 kHz	100.000 kHz
Sweep Points	267	267	267
Sweep time	63.230 µs	63.230 µs	63.230 µs
Reference Level	10.000 dBm	10.000 dBm	10.000 dBm
Attenuation	25.000 dB	25.000 dB	25.000 dB
Detector	MaxPeak	MaxPeak	MaxPeak
Sweep Count	100	100	100
Filter	3 dB	3 dB	3 dB
Trace Mode	Max Hold	Max Hold	Max Hold
Sweep type	FFT	FFT	FFT
Preamp	off	off	off
Stable mode	Trace	Trace	Trace
Stable value	0.50 dB	0.50 dB	0.50 dB
Run	8 / max. 150	8 / max. 150	16 / max. 150
Stable	5 / 5	5 / 5	5 / 5
Max Stable Difference	0.18 dB	0.28 dB	0.00 dB

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

BTLE 1Mb

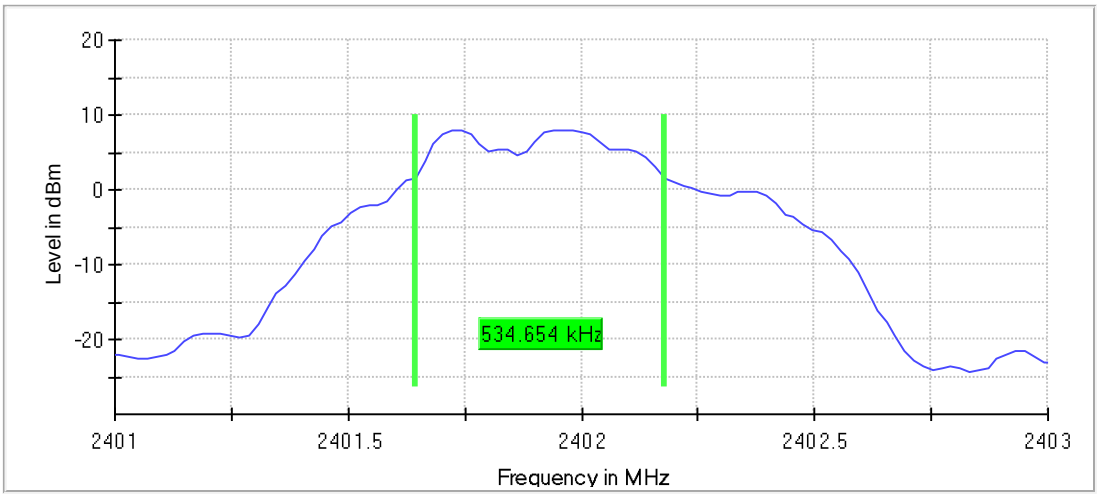
6 dB Bandwidth (see next plots).

	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
6 dB Spectrum bandwidth (kHz)	534.654	534.654	554.456
Measurement uncertainty (kHz)	<±20.0		

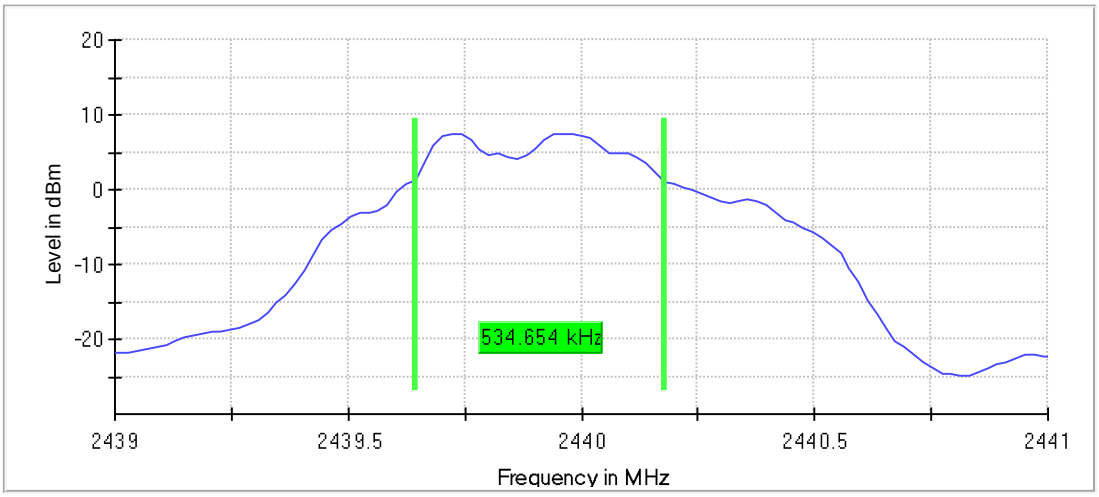
Verdict: PASS

6 dB BANDWIDTH.

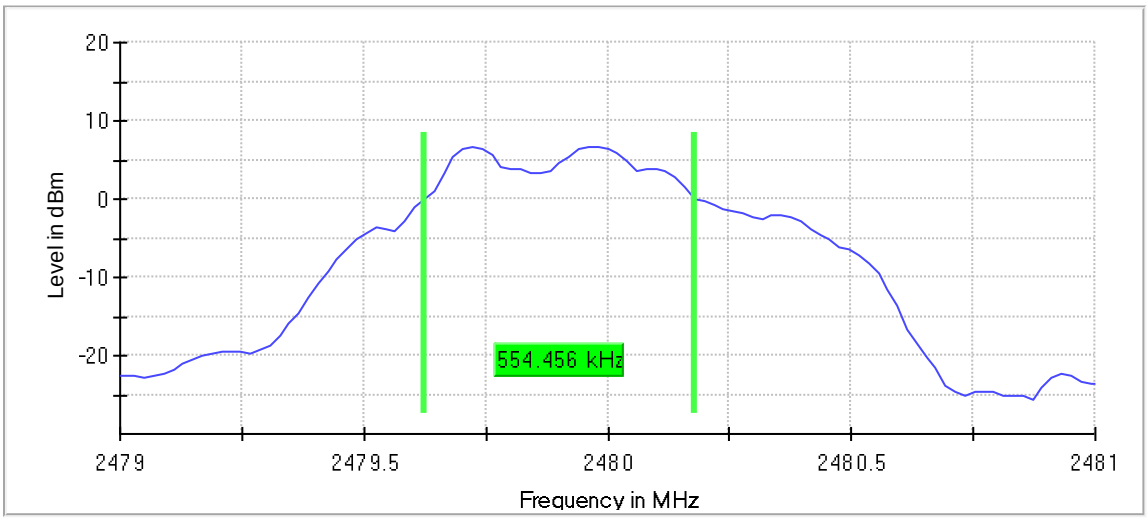
Lowest Channel



Middle Channel



Highest Channel



Measurement

Setting	Instrument Value	Instrument Value	Instrument Value
Start Frequency	2.40100 GHz	2.43900 GHz	2.47900 GHz
Stop Frequency	2.40300 GHz	2.44100 GHz	2.48100 GHz
Span	2.000 MHz	2.000 MHz	2.000 MHz
RBW	100.000 kHz	100.000 kHz	100.000 kHz
VBW	300.000 kHz	300.000 kHz	300.000 kHz
Sweep Points	101	101	101
Sweep time	18.938 µs	18.938 µs	18.938 µs
Reference Level	10.000 dBm	10.000 dBm	10.000 dBm
Attenuation	25.000 dB	25.000 dB	25.000 dB
Detector	MaxPeak	MaxPeak	MaxPeak
Sweep Count	100	100	100
Filter	3 dB	3 dB	3 dB
Trace Mode	Max Hold	Max Hold	Max Hold
Sweep type	FFT	FFT	FFT
Preamp	off	off	off
Stable mode	Trace	Trace	Trace
Stable value	0.50 dB	0.50 dB	0.50 dB
Run	8 / max. 150	9 / max. 150	8 / max. 150
Stable	5 / 5	5 / 5	5 / 5
Max Stable Difference	0.06 dB	0.24 dB	0.11 dB

BTLE 2Mb

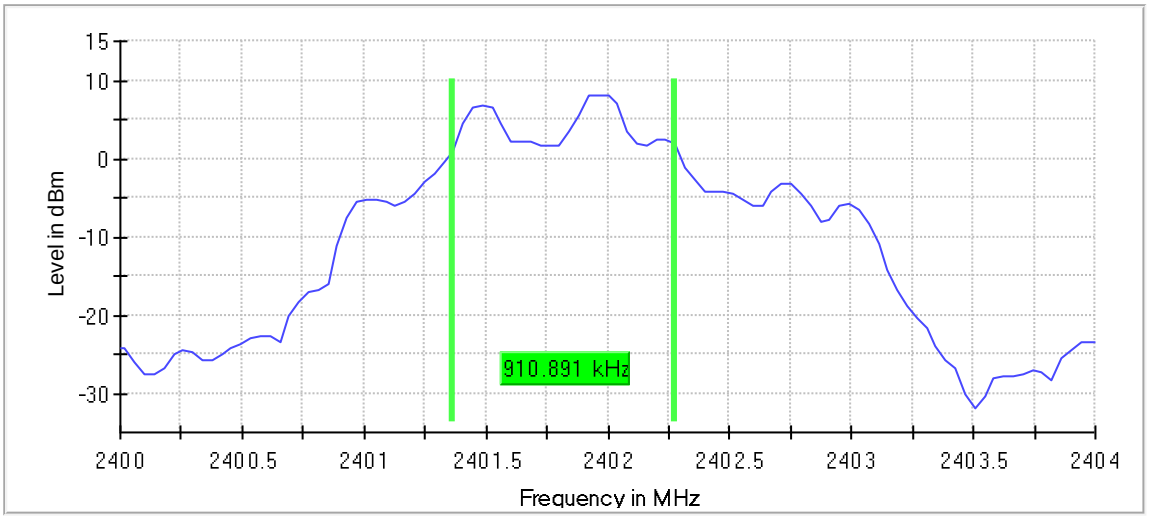
6 dB Bandwidth (see next plots).

	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
6 dB Spectrum bandwidth (kHz)	910.891	910.891	950.495
Measurement uncertainty (kHz)	<±20.0		

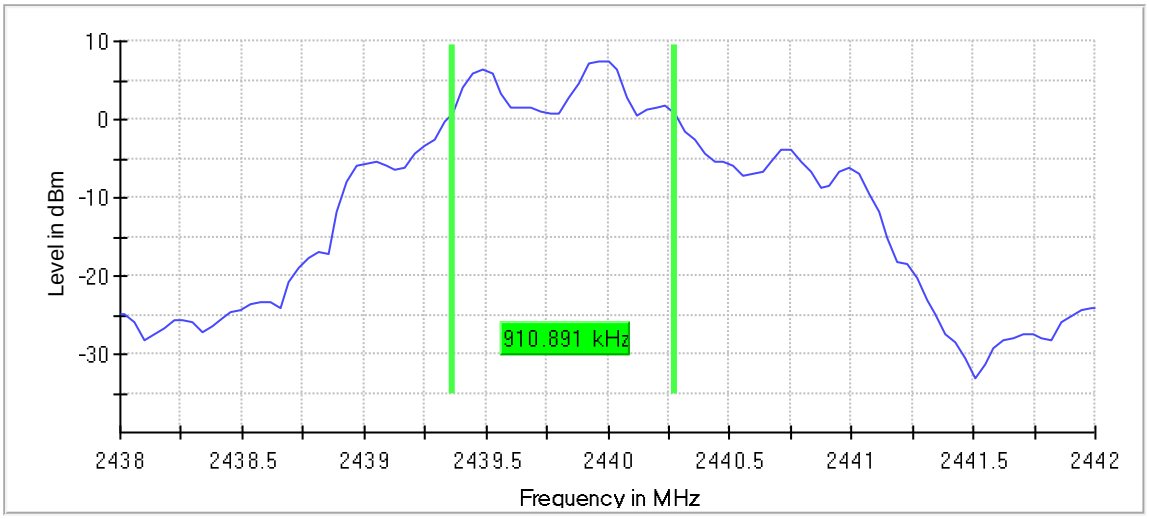
Verdict: PASS

6 dB BANDWIDTH.

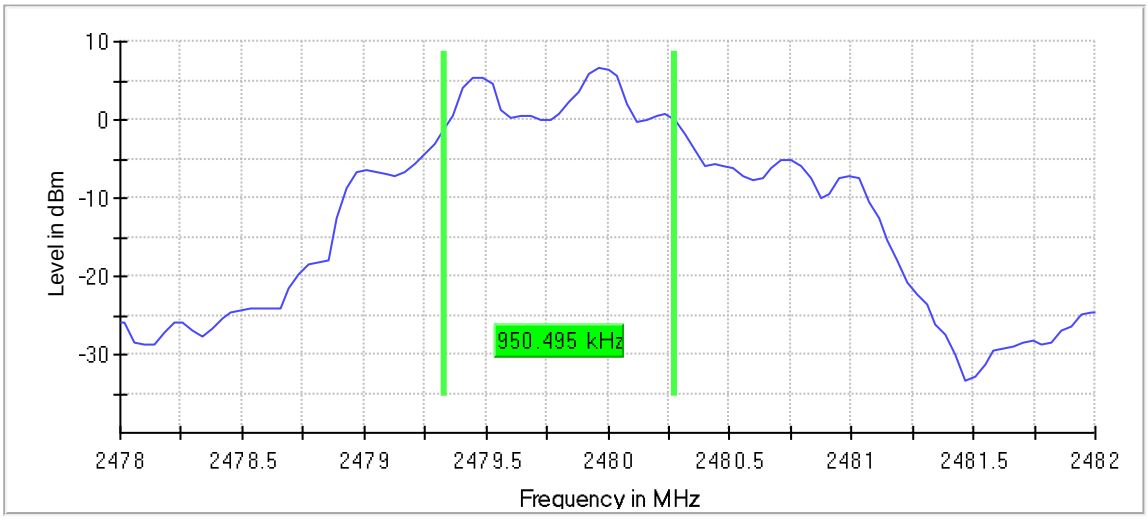
Lowest Channel



Middle Channel



Highest Channel



Measurement

Setting	Instrument Value	Instrument Value	Instrument Value
Start Frequency	2.40000 GHz	2.43800 GHz	2.47800 GHz
Stop Frequency	2.40400 GHz	2.44200 GHz	2.48200 GHz
Span	4.000 MHz	4.000 MHz	4.000 MHz
RBW	100.000 kHz	100.000 kHz	100.000 kHz
VBW	300.000 kHz	300.000 kHz	300.000 kHz
Sweep Points	101	101	101
Sweep time	18.938 µs	18.938 µs	18.938 µs
Reference Level	10.000 dBm	10.000 dBm	10.000 dBm
Attenuation	25.000 dB	25.000 dB	25.000 dB
Detector	MaxPeak	MaxPeak	MaxPeak
Sweep Count	100	100	100
Filter	3 dB	3 dB	3 dB
Trace Mode	Max Hold	Max Hold	Max Hold
Sweep type	FFT	FFT	FFT
Preamp	off	off	off
Stable mode	Trace	Trace	Trace
Stable value	0.50 dB	0.50 dB	0.50 dB
Run	17 / max. 150	10 / max. 150	7 / max. 150
Stable	5 / 5	5 / 5	5 / 5
Max Stable Difference	0.00 dB	0.45 dB	0.00 dB

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) (Canada).

RESULTS

The maximum peak conducted output power was measured using the method according to point 9.1.1. of Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v04 dated 05/04/2017.

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

Maximum declared antenna gain: +3.3 dBi.

BTLE 1Mb

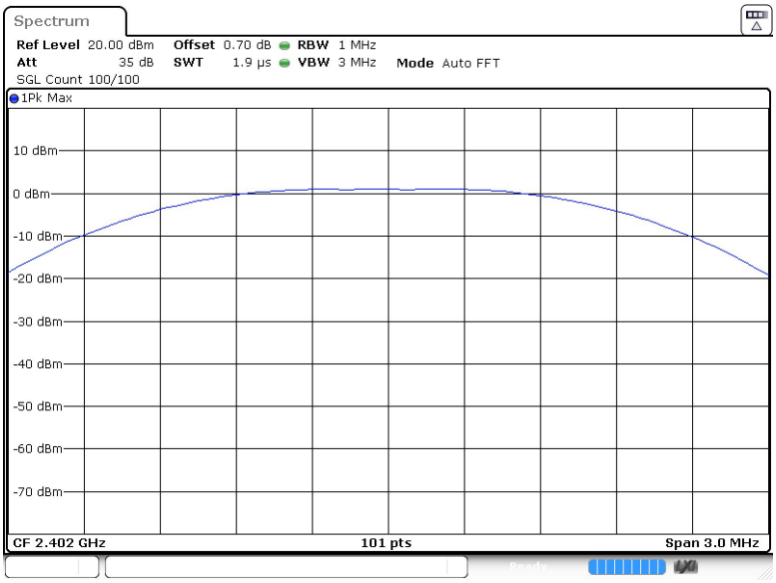
	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
Maximum Conducted Power (dBm)	3.2	3.1	1.6
Maximum EIRP power (dBm)	6.5	6.4	4.9
Measurement uncertainty (dB)	<±0.78		

The maximum directional gain of the antenna is less than 6 dBi and therefore the maximum output power is not required to be reduced from the stated values.

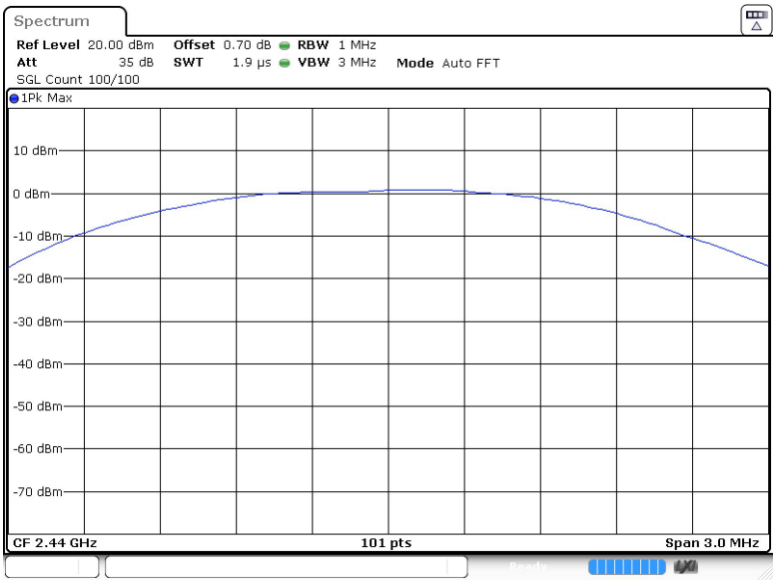
Verdict: PASS

MAXIMUM CONDUCTED POWER

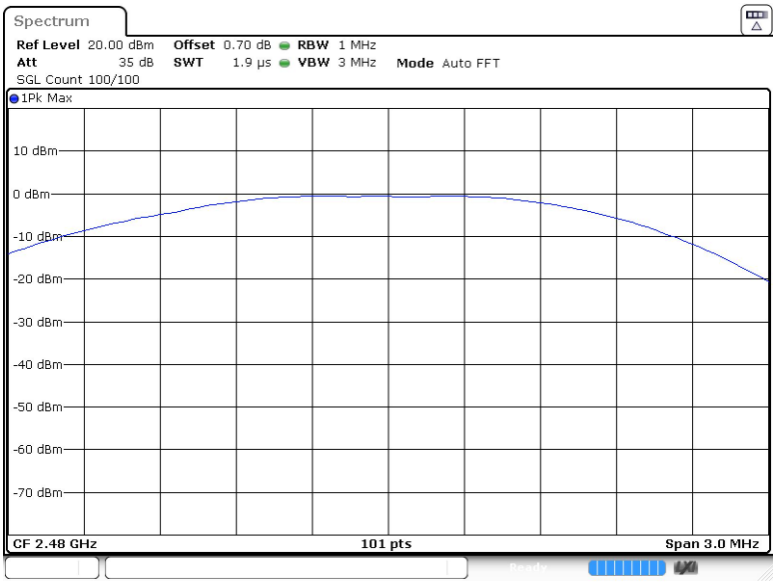
Low Frequency



Middle frequency



Highest frequency



BTLE 2Mb

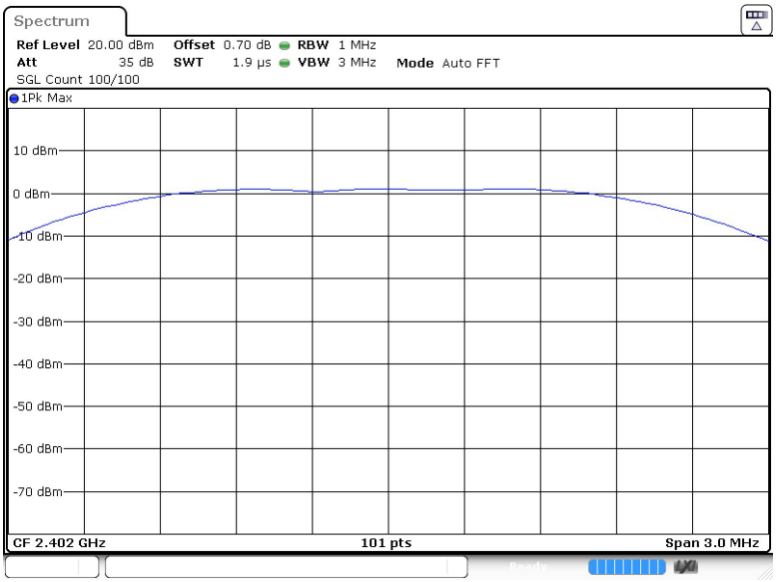
	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
Maximum Conducted Power (dBm)	3.2	2.6	2.1
Maximum EIRP power (dBm)	6.5	5.9	5.4
Measurement uncertainty (dB)	<±0.78		

The maximum directional gain of the antenna is less than 6 dBi and therefore the maximum output power is not required to be reduced from the stated values.

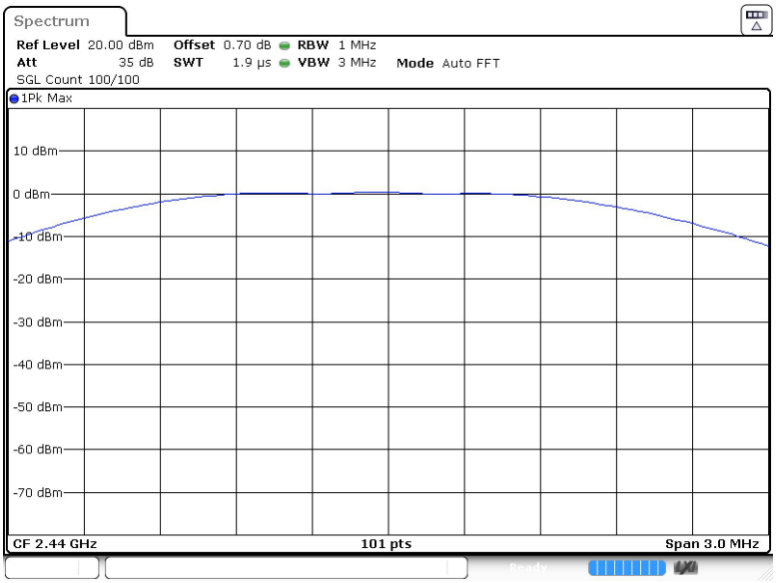
Verdict: PASS

MAXIMUM CONDUCTED POWER.

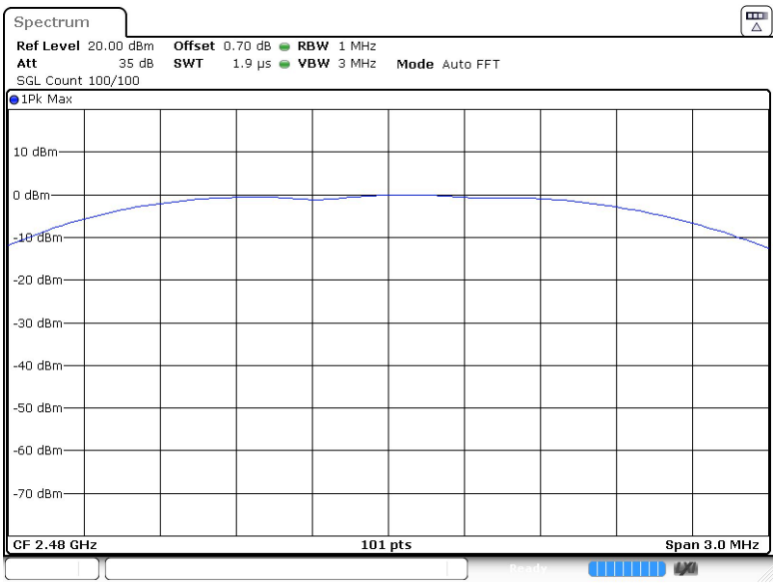
Lowest frequency



Middle frequency



Highest frequency



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

SPECIFICATION

In any 100 kHz bandwidth outside the frequency band in which the 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. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required shall be 30 dB instead of 20 dB.

RESULTS:

BTLE 1Mb

Reference Level Measurement

	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
Reference Level Measurement (dBm)	3.074	2.382	1.485
Measurement uncertainty (dB)	<±0.78		

Lowest frequency 2402 MHz:

Frequency (GHz)	Emission limitations conducted (dBm)	Limit (dBm)
2380.750000	-66.6	-16.9
2383.750000	-65.3	-16.9
2390.250000	-61.6	-16.9
2392.750000	-59.7	-16.9
2398.750000	-48.5	-16.9
2399.750000	-43.9	-16.9
4804.750000	-49.8	-16.9

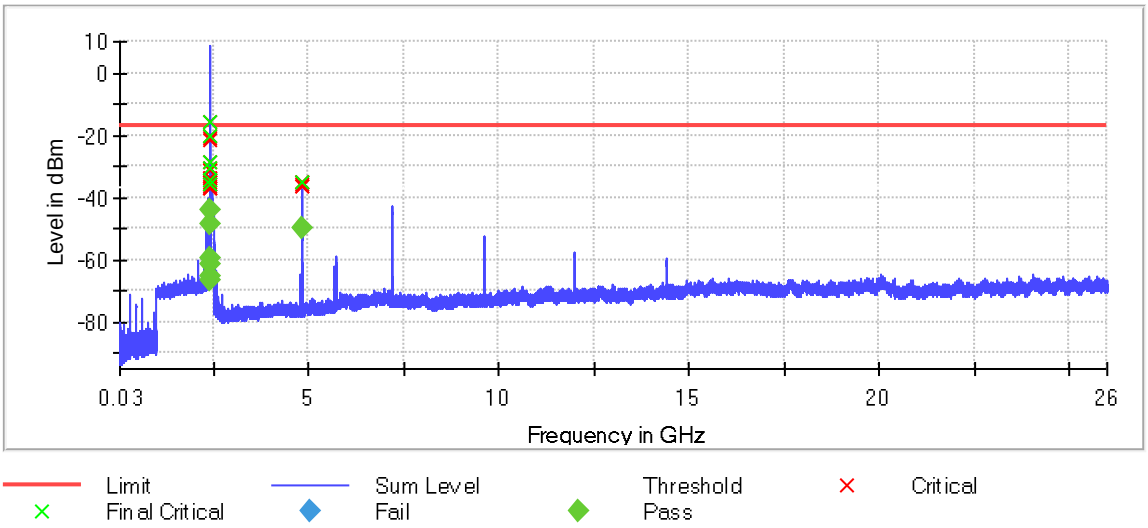
Middle frequency 2440 MHz:

Frequency (GHz)	Emission limitations conducted (dBm)	Limit (dBm)
4880.750000	-50.6	-17.6

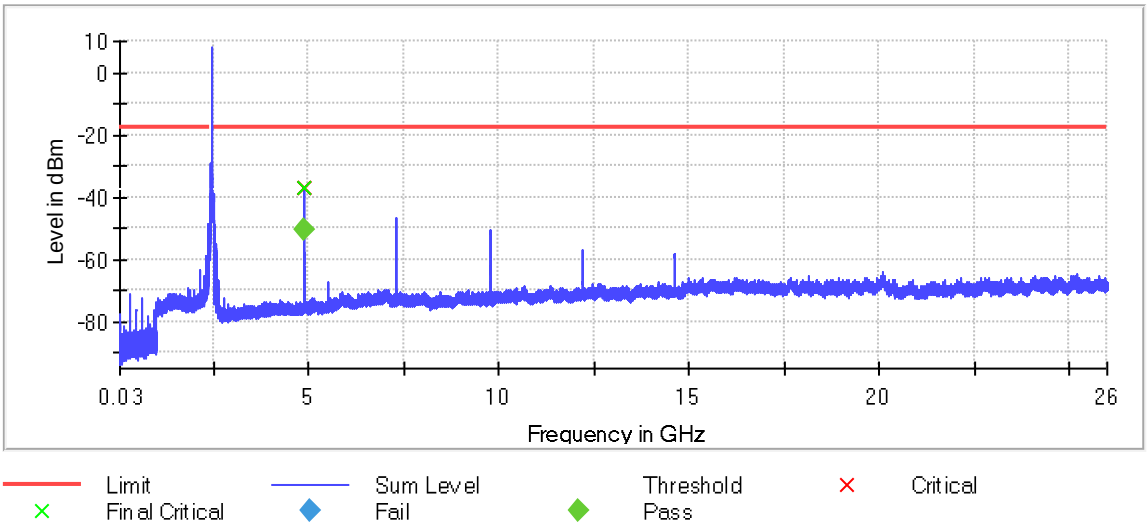
Highest frequency 2480 MHz:

Frequency (GHz)	Emission limitations conducted (dBm)	Limit (dBm)
2483.750000	-53.0	-18.5
2485.750000	-57.1	-18.5
2486.750000	-58.7	-18.5
2491.250000	-63.1	-18.5
2494.250000	-64.8	-18.5
2497.750000	-67.3	-18.5
4960.750000	-53.3	-18.5

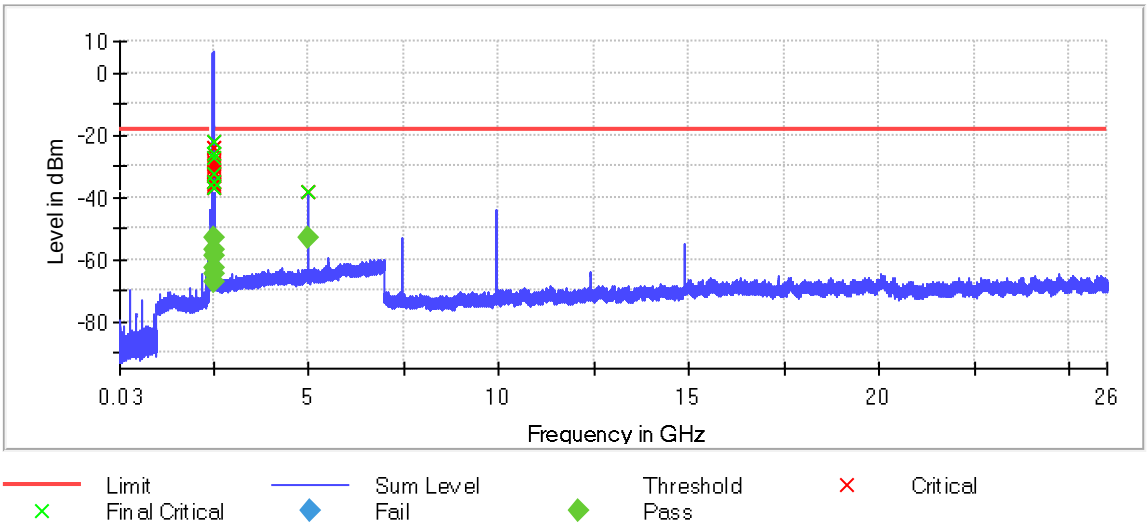
Lowest frequency 2402 MHz:



Middle frequency 2440 MHz:



Highest frequency 2480 MHz:



Measurement 1

Setting	Instrument Value
Start Frequency	30.000 MHz
Stop Frequency	1.000 GHz
RBW	100.000 kHz
VBW	300.000 kHz
Sweep Points	19400
Sweep time	1.061 ms
Reference Level	-30.000 dBm
Attenuation	0.000 dB
Detector	MaxPeak
Sweep Count	30
Filter	3 dB
Trace Mode	Max Hold
Sweep type	FFT
Preamp	off
Stable mode	Trace
Stable value	0.50 dB
Run	10 / max. 150
Stable	3 / 3
Max Stable Difference	0.22 dB

Measurement 2

Setting	Instrument Value	Instrument Value	Instrument Value	Instrument Value	Instrument Value
Start Frequency	1.000 GHz	2.4000 GHz	2.4835 GHz	7.000 GHz	18.000 GHz
Stop Frequency	2.400 GHz	2.4835 GHz	7.000 GHz	18.000 GHz	26.000 GHz
RBW	1.000 MHz	1.000 MHz	1.000 MHz	1.000 MHz	1.000 MHz
VBW	3.000 MHz	3.000 MHz	3.000 MHz	3.000 MHz	3.000 MHz
Sweep Points	2800	167	9033	22000	16000
Sweep time	2.800 ms	11.4 µs	9.000 ms	44.000 ms	32.000 ms
Reference Level	-20.000 dBm	10.000 dBm	-30.000 dBm	-30.000 dBm	-30.000 dBm
Attenuation	10.000 dB	25.000 dB	0.000 dB	0.000 dB	0.000 dB
Detector	MaxPeak	MaxPeak	MaxPeak	MaxPeak	MaxPeak
Sweep Count	30	30	30	30	30
Filter	3 dB	3 dB	3 dB	3 dB	3 dB
Trace Mode	Max Hold	Max Hold	Max Hold	Max Hold	Max Hold
Sweep type	Sweep	Sweep	Sweep	Sweep	Sweep
Preamp	off	off	off	off	off
Stable mode	Trace	Trace	Trace	Trace	Trace
Stable value	0.50 dB	0.50 dB	0.50 dB	0.50 dB	0.50 dB
Run	7 / max. 150	7/ max. 150	7 / max. 150	7 / max. 150	7 / max. 150
Stable	3 / 3	3 / 3	3 / 3	3 / 3	3 / 3
Max Stable Difference	0.00 dB	0.00 dB	0.00 dB	0.00 dB	0.00 dB

BTLE 2Mb

Reference Level Measurement

	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
Reference Level Measurement (dBm)	3.080	2.397	1.537
Measurement uncertainty (dB)	<±0.78		

Lowest frequency 2402 MHz:

Frequency (GHz)	Emission limitations conducted (dBm)	Limit (dBm)
2384.250000	-65.1	-16.9
2387.250000	-63.4	-16.9
2389.250000	-62.1	-16.9
2391.250000	-60.7	-16.9
2394.250000	-58.0	-16.9
2399.750000	-38.4	-16.9
4803.250000	-49.1	-16.9

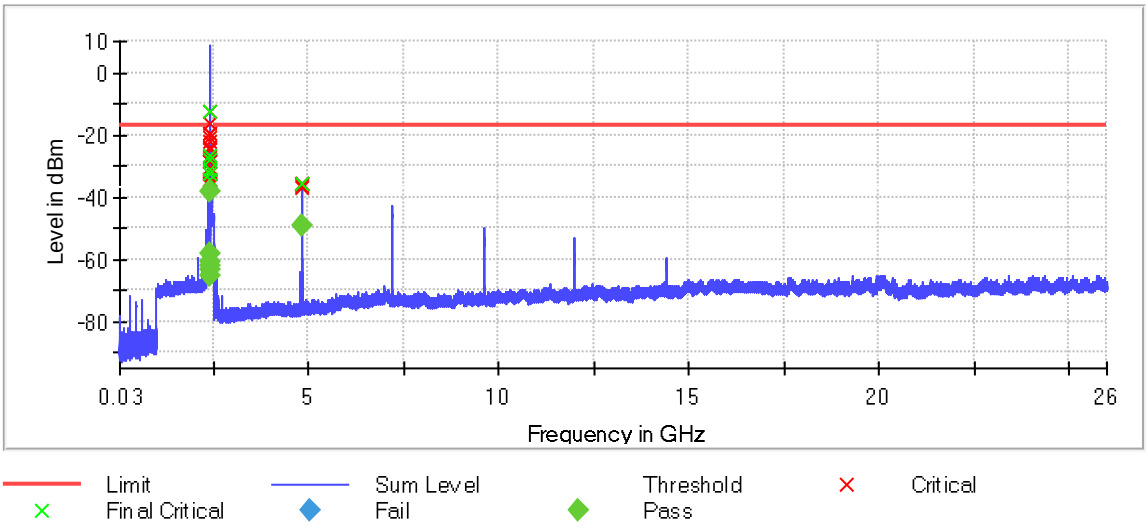
Middle frequency 2440 MHz:

Frequency (GHz)	Emission limitations conducted (dBm)	Limit (dBm)
4879.250000	-50.0	-17.6

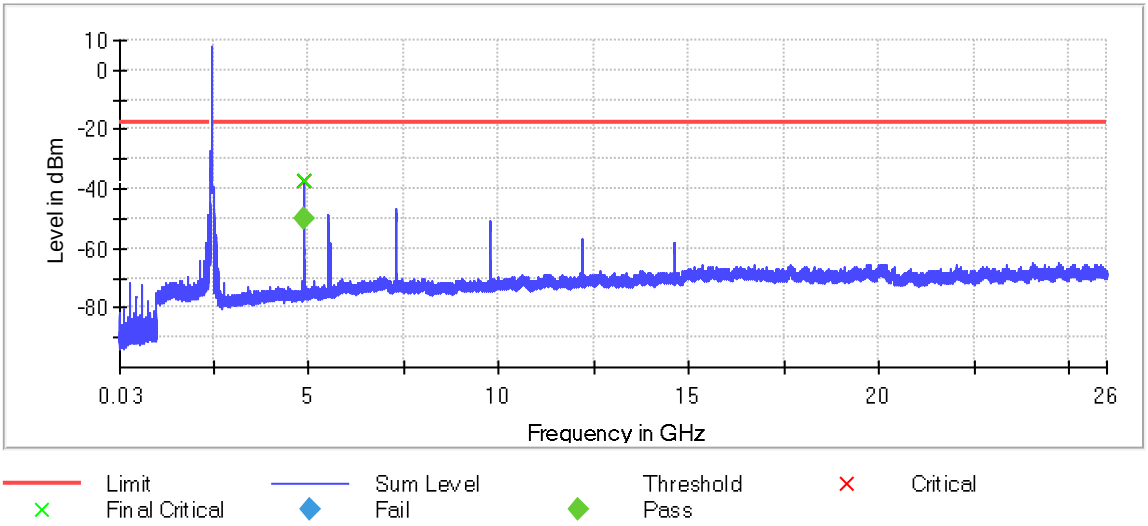
Highest frequency 2480 MHz:

Frequency (GHz)	Emission limitations conducted (dBm)	Limit (dBm)
2483.750000	-53.3	-18.5
2486.250000	-58.3	-18.5
2489.750000	-62.1	-18.5
2492.750000	-64.1	-18.5
2494.250000	-65.1	-18.5
2496.250000	-66.5	-18.5
2497.750000	-67.4	-18.5
2499.750000	-68.6	-18.5

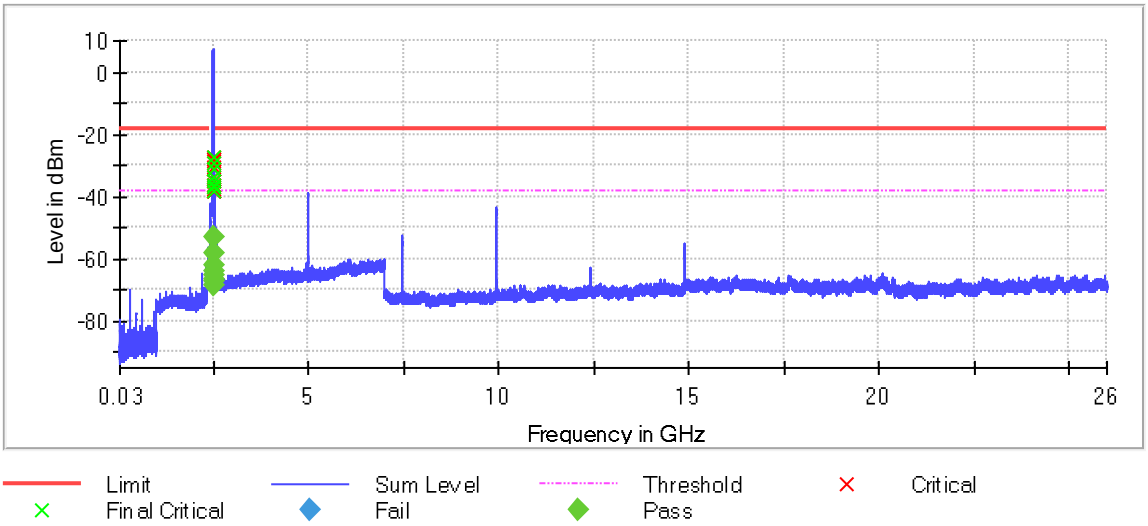
Lowest frequency 2402 MHz:



Middle frequency 2440 MHz:



Highest frequency 2480 MHz:



Measurement 1

Setting	Instrument Value
Start Frequency	30.000 MHz
Stop Frequency	1.000 GHz
RBW	100.000 kHz
VBW	300.000 kHz
Sweep Points	19400
Sweep time	1.061 ms
Reference Level	-30.000 dBm
Attenuation	0.000 dB
Detector	MaxPeak
Sweep Count	30
Filter	3 dB
Trace Mode	Max Hold
Sweep type	FFT
Preamp	off
Stable mode	Trace
Stable value	0.50 dB
Run	11 / max. 150
Stable	3 / 3
Max Stable Difference	0.08 dB

Measurement 2

Setting	Instrument Value	Instrument Value	Instrument Value	Instrument Value	Instrument Value
Start Frequency	1.000 GHz	2.4000 GHz	2.4835 GHz	7.000 GHz	18.000 GHz
Stop Frequency	2.400 GHz	2.4835 GHz	7.000 GHz	18.000 GHz	26.000 GHz
RBW	1.000 MHz	1.000 MHz	1.000 MHz	1.000 MHz	1.000 MHz
VBW	3.000 MHz	3.000 MHz	3.000 MHz	3.000 MHz	3.000 MHz
Sweep Points	2800	167	9033	22000	16000
Sweep time	2.800 ms	11.4 µs	9.000 ms	44.000 ms	32.000 ms
Reference Level	-20.000 dBm	10.000 dBm	-30.000 dBm	-30.000 dBm	-30.000 dBm
Attenuation	10.000 dB	25.000 dB	0.000 dB	0.000 dB	0.000 dB
Detector	MaxPeak	MaxPeak	MaxPeak	MaxPeak	MaxPeak
Sweep Count	30	30	30	30	30
Filter	3 dB	3 dB	3 dB	3 dB	3 dB
Trace Mode	Max Hold	Max Hold	Max Hold	Max Hold	Max Hold
Sweep type	Sweep	Sweep	Sweep	Sweep	Sweep
Preamp	off	off	off	off	off
Stable mode	Trace	Trace	Trace	Trace	Trace
Stable value	0.50 dB	0.50 dB	0.50 dB	0.50 dB	0.50 dB
Run	19 / max. 150	19 / max. 150	19 / max. 150	19 / max. 150	19 / max. 150
Stable	3 / 3	3 / 3	3 / 3	3 / 3	3 / 3
Max Stable Difference	0.00 dB	0.00 dB	0.00 dB	0.00 dB	0.00 dB

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

SPECIFICATION

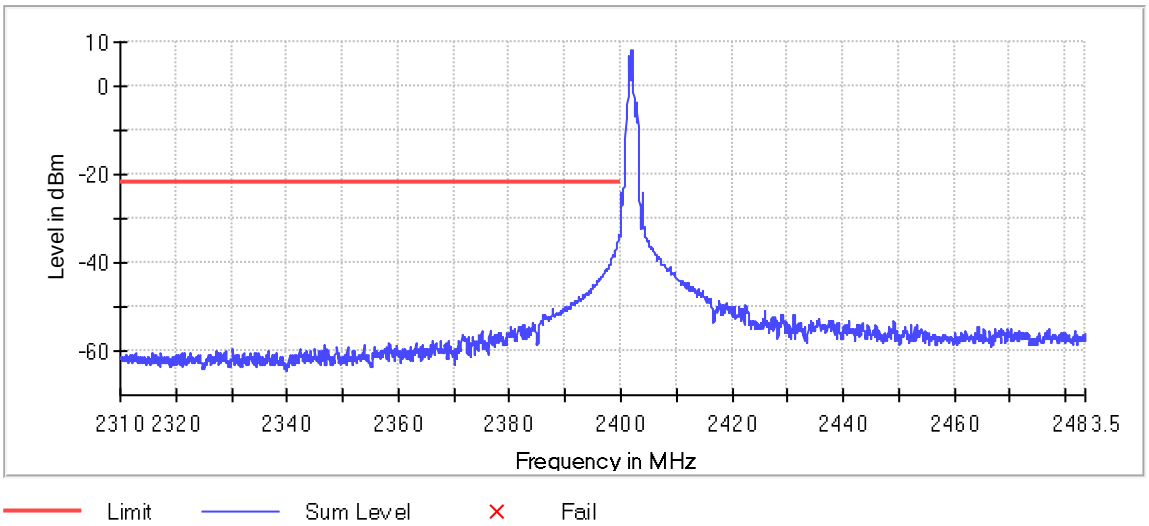
In any 100 kHz bandwidth outside the frequency band in which the digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required shall be 30 dB instead of 20 dB.

RESULTS:

BTLE 1Mb

1. LOW FREQUENCY SECTION. CONDUCTED.

See next plot.

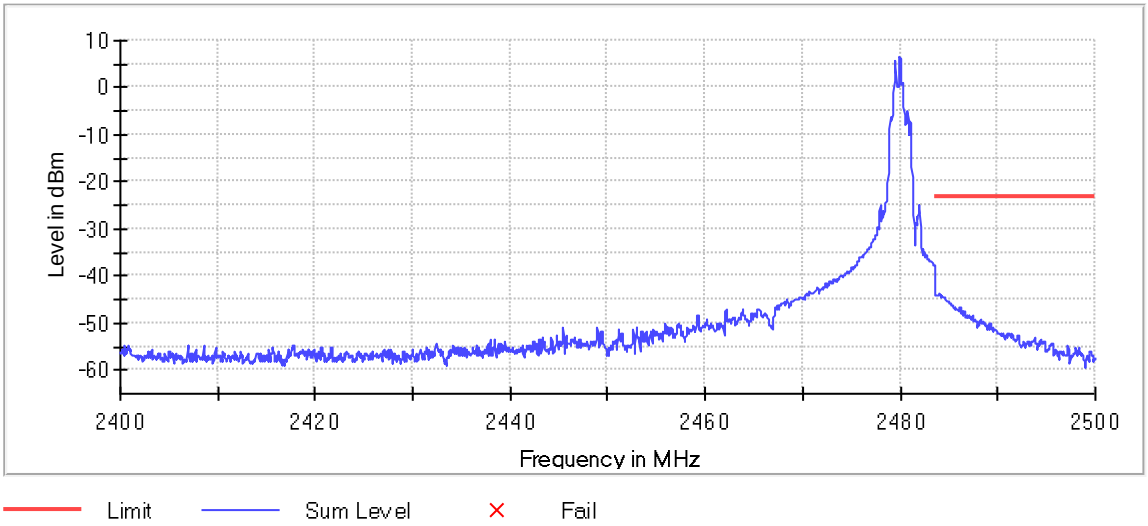


Measurement

Setting	Instrument Value	Instrument Value
Start Frequency	2.31000 GHz	2.40000 GHz
Stop Frequency	2.40000 GHz	2.48350 GHz
Span	90.000 MHz	83.500 MHz
RBW	100.000 kHz	100.000 kHz
VBW	300.000 kHz	300.000 kHz
Sweep Points	1800	1670
Sweep time	113.672 µs	94.727 µs
Reference Level	10.000 dBm	10.000 dBm
Attenuation	25.000 dB	25.000 dB
Detector	MaxPeak	MaxPeak
Sweep Count	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweep type	FFT	FFT
Preamp	off	off
Stable mode	Trace	Trace
Stable value	0.50 dB	0.50 dB
Run	8 / max. 150	6 / max. 150
Stable	3 / 3	3 / 3
Max Stable Difference	0.00 dB	0.49 dB

2. HIGH FREQUENCY SECTION. CONDUCTED.

See next plot.



Measurement

Setting	Instrument Value	Instrument Value
Start Frequency	**2.40000 GHz**	**2.48350 GHz**
Stop Frequency	**2.48350 GHz**	**2.50000 GHz**
Span	**83.500 MHz**	**16.500 MHz**
RBW	**100.000 kHz**	**100.000 kHz**
VBW	**300.000 kHz**	**300.000 kHz**
Sweep Points	**1670**	**330**
Sweep time	**94.727 µs**	**18.945 µs**
Reference Level	**10.000 dBm**	**10.000 dBm**
Attenuation	**25.000 dB**	**25.000 dB**
Detector	**MaxPeak**	**MaxPeak**
Sweep Count	**100**	**100**
Filter	**3 dB**	**3 dB**
Trace Mode	**Max Hold**	**Max Hold**
Sweep type	**FFT**	**FFT**
Preamp	**off**	**off**
Stable mode	**Trace**	**Trace**
Stable value	**0.50 dB**	**0.50 dB**
Run	**9 / max. 150**	**4 / max. 150**
Stable	**3 / 3**	**3 / 3**
Max Stable Difference	**0.17 dB**	**0.00 dB**

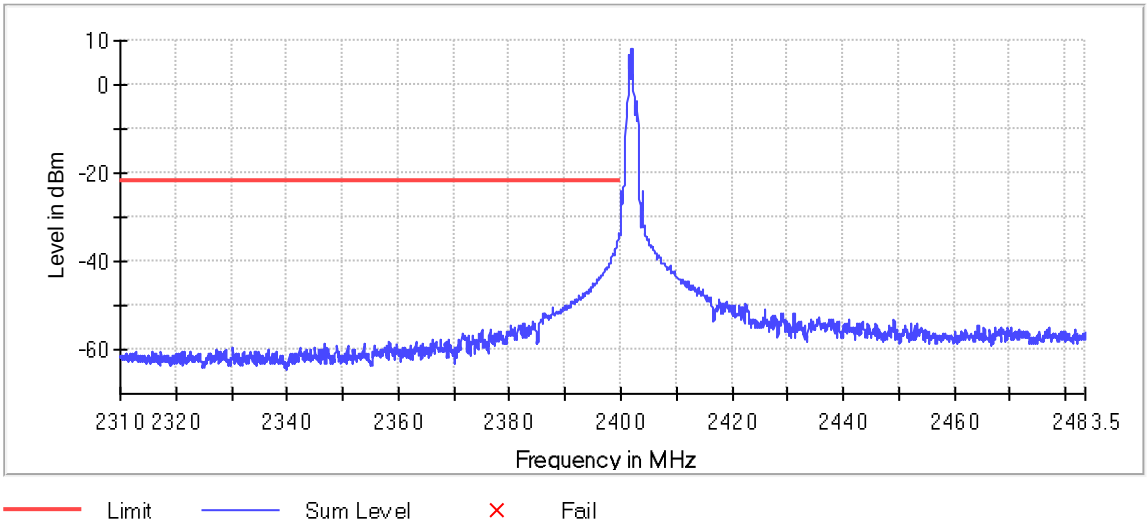
Measurement uncertainty (dB)	< ±2.03

Verdict: PASS

BTLE 2Mb

1. LOW FREQUENCY SECTION. CONDUCTED.

See next plot.

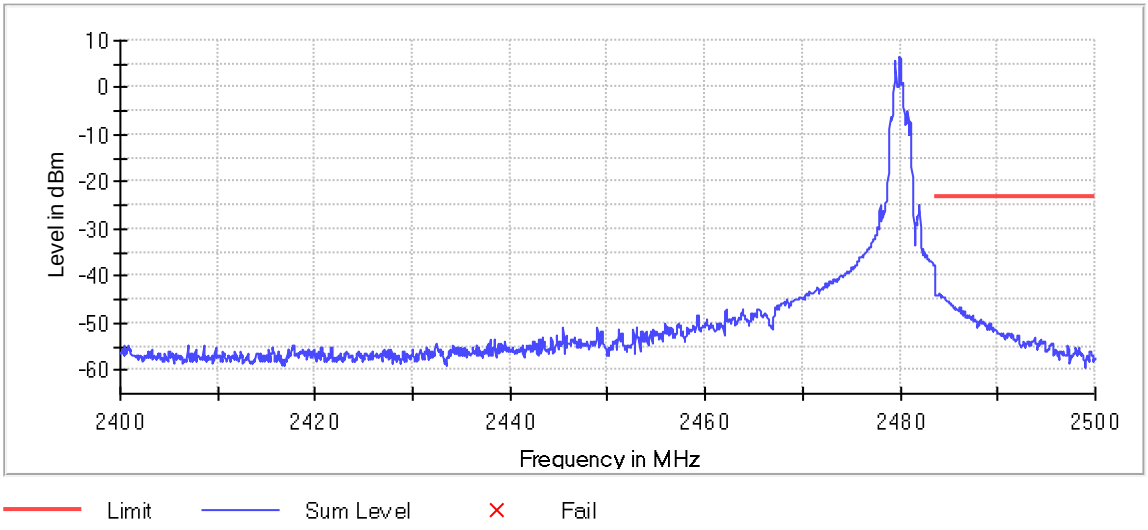


Measurement

Setting	Instrument Value	Instrument Value
Start Frequency	**2.31000 GHz**	**2.40000 GHz**
Stop Frequency	**2.40000 GHz**	**2.48350 GHz**
Span	**90.000 MHz**	**83.500 MHz**
RBW	**100.000 kHz**	**100.000 kHz**
VBW	**300.000 kHz**	**300.000 kHz**
Sweep Points	**1800**	**1670**
Sweep time	**113.672 µs**	**94.727 µs**
Reference Level	**10.000 dBm**	**10.000 dBm**
Attenuation	**25.000 dB**	**25.000 dB**
Detector	**MaxPeak**	**MaxPeak**
Sweep Count	**100**	**100**
Filter	**3 dB**	**3 dB**
Trace Mode	**Max Hold**	**Max Hold**
Sweep type	**FFT**	**FFT**
Preamp	**off**	**off**
Stable mode	**Trace**	**Trace**
Stable value	**0.50 dB**	**0.50 dB**
Run	**8 / max. 150**	**6 / max. 150**
Stable	**3 / 3**	**3 / 3**
Max Stable Difference	**0.00 dB**	**0.49 dB**

2. HIGH FREQUENCY SECTION. CONDUCTED.

See next plot.



Measurement

Setting	Instrument Value	Instrument Value
Start Frequency	**2.40000 GHz**	**2.48350 GHz**
Stop Frequency	**2.48350 GHz**	**2.50000 GHz**
Span	**83.500 MHz**	**16.500 MHz**
RBW	**100.000 kHz**	**100.000 kHz**
VBW	**300.000 kHz**	**300.000 kHz**
Sweep Points	**1670**	**330**
Sweep time	**94.727 µs**	**18.945 µs**
Reference Level	**10.000 dBm**	**10.000 dBm**
Attenuation	**25.000 dB**	**25.000 dB**
Detector	**MaxPeak**	**MaxPeak**
Sweep Count	**100**	**100**
Filter	**3 dB**	**3 dB**
Trace Mode	**Max Hold**	**Max Hold**
Sweep type	**FFT**	**FFT**
Preamp	**off**	**off**
Stable mode	**Trace**	**Trace**
Stable value	**0.50 dB**	**0.50 dB**
Run	**9 / max. 150**	**4 / max. 150**
Stable	**3 / 3**	**3 / 3**
Max Stable Difference	**0.17 dB**	**0.00 dB**

Measurement uncertainty (dB)	< ±2.03

Verdict: PASS

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 point 10.2. of Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 558074 D01 DTS Meas Guidance v04 dated 05/04/2017.

Power spectral density (see next plots).

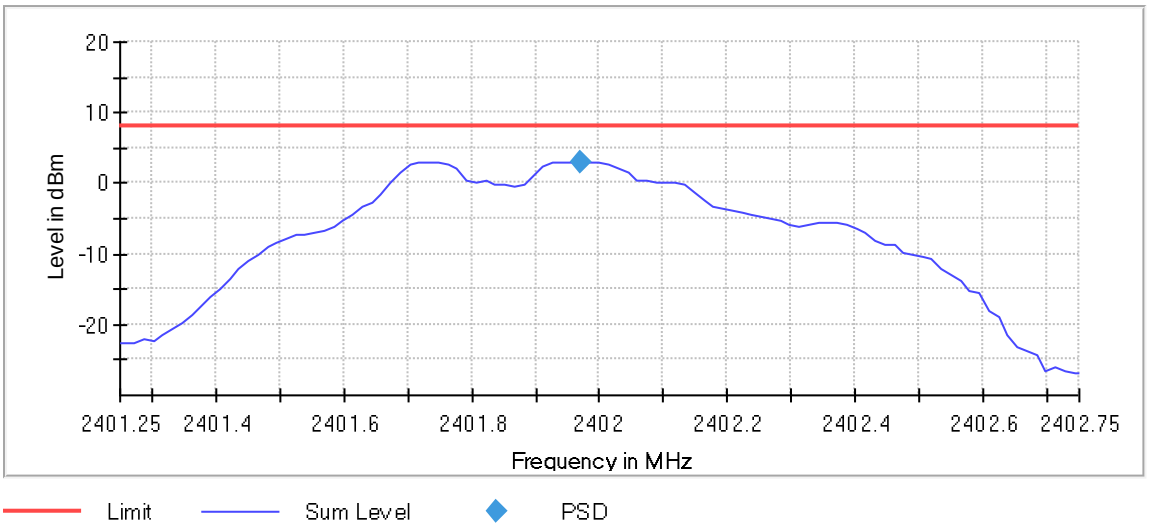
BTLE 1Mb

	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
Power spectral density (dBm)	3.074	2.382	1.485
Measurement uncertainty (dB)	<±0.78		

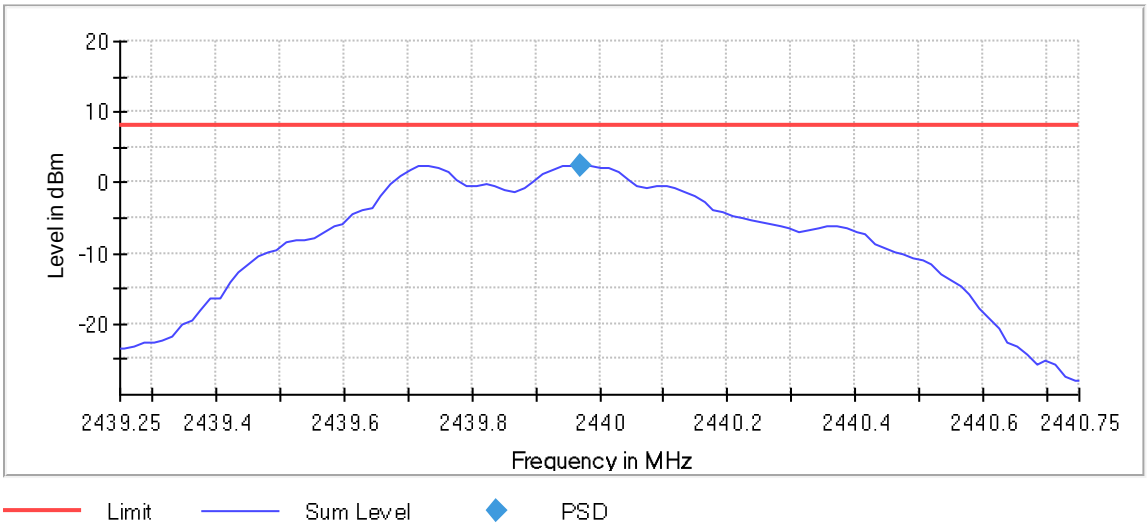
Verdict: PASS

POWER SPECTRAL DENSITY

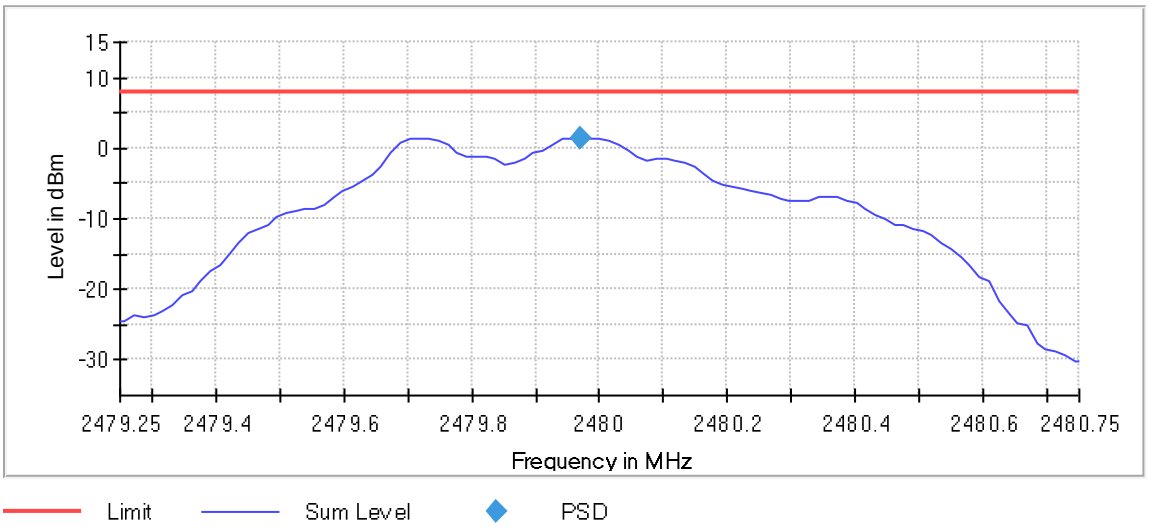
Lowest Channel



Middle Channel



Highest Channel



Measurement

Setting	Instrument Value	Instrument Value	Instrument Value
Start Frequency	2.40118 GHz	2.43918 GHz	2.47918 GHz
Stop Frequency	2.40283 GHz	2.44083 GHz	2.48083 GHz
Span	1.50 MHz	1.500 MHz	1.500 MHz
RBW	100.000 kHz	100.000 kHz	100.000 kHz
VBW	300.000 kHz	300.000 kHz	300.000 kHz
Sweep Points	101	101	101
Sweep time	1.000 ms	1.000 ms	1.000 ms
Reference Level	5.000 dBm	5.000 dBm	5.000 dBm
Attenuation	20.000 dB	20.000 dB	20.000 dB
Detector	MaxPeak	MaxPeak	MaxPeak
Sweep Count	100	100	100
Filter	3 dB	3 dB	3 dB
Trace Mode	Max Hold	Max Hold	Max Hold
Sweep type	Sweep	Sweep	Sweep
Preamp	off	off	off
Stable mode	Trace	Trace	Trace
Stable value	0.50 dB	0.50 dB	0.50 dB
Run	5 / max. 150	4 / max. 150	5 / max. 150
Stable	2 / 2	2 / 2	2 / 2
Max Stable Difference	0.33 dB	0.49 dB	0.22 dB

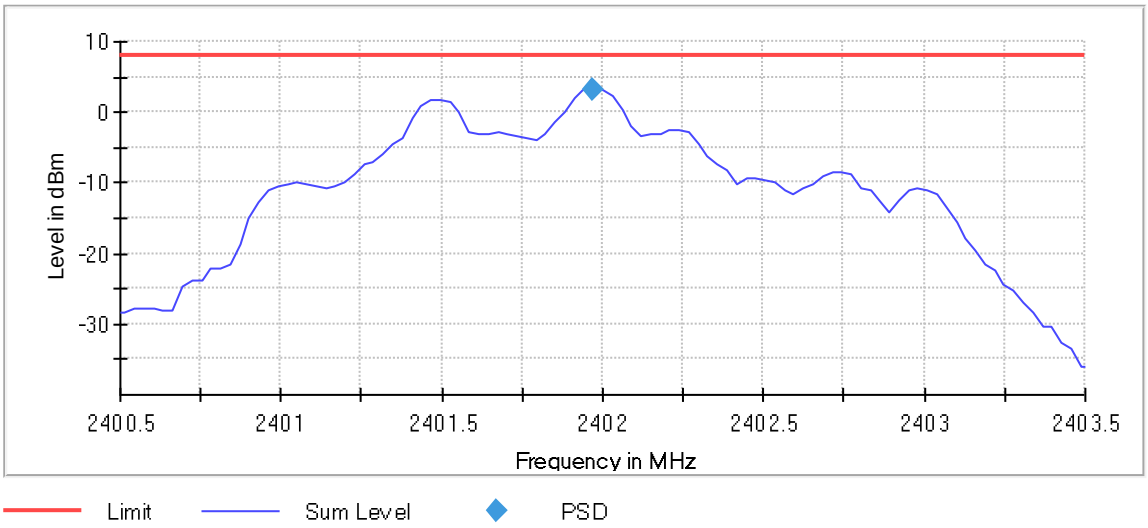
BTLE 2Mb

	Lowest frequency 2402 MHz	Middle frequency 2440 MHz	Highest frequency 2480 MHz
Power spectral density (dBm)	3.080	2.397	1.537
Measurement uncertainty (dB)	<±0.78		

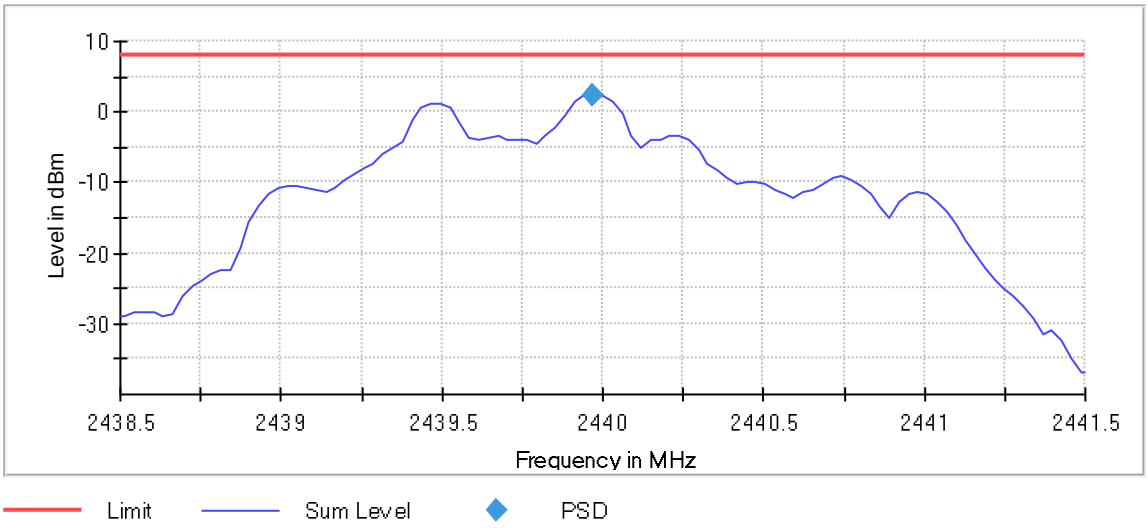
Verdict: PASS

POWER SPECTRAL DENSITY

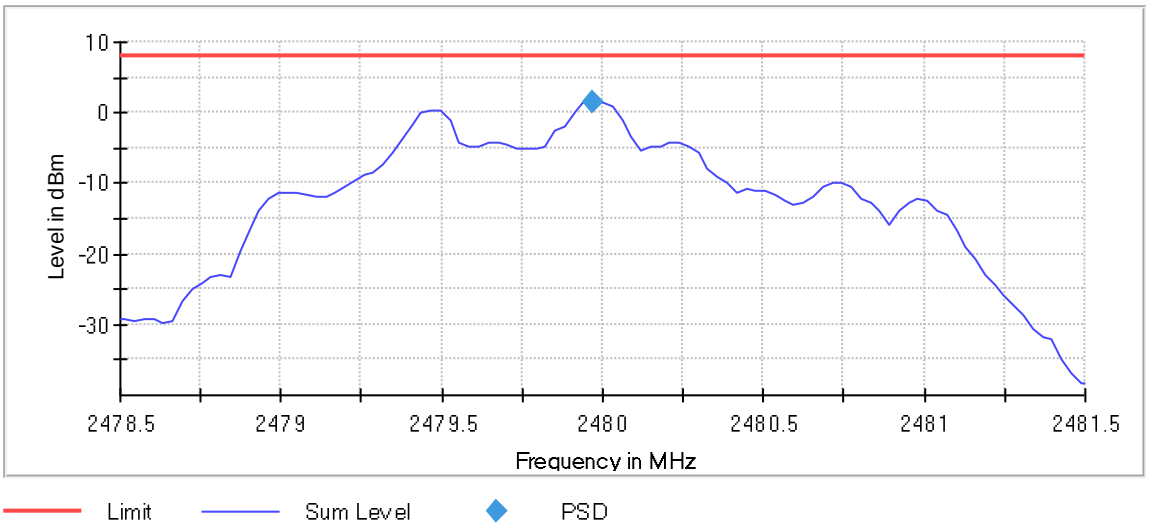
Lowest Channel



Middle Channel



Highest Channel



Measurement

Setting	Instrument Value	Instrument Value	Instrument Value
Start Frequency	2.40050 GHz	2.43850 GHz	2.47850 GHz
Stop Frequency	2.40350 GHz	2.44150 GHz	2.48150 GHz
Span	3.000 MHz	3.000 MHz	3.000 MHz
RBW	100.000 kHz	100.000 kHz	100.000 kHz
VBW	300.000 kHz	300.000 kHz	300.000 kHz
Sweep Points	101	101	101
Sweep time	1.000 ms	1.000 ms	1.000 ms
Reference Level	5.000 dBm	5.000 dBm	5.000 dBm
Attenuation	20.000 dB	20.000 dB	20.000 dB
Detector	MaxPeak	MaxPeak	MaxPeak
Sweep Count	100	100	100
Filter	3 dB	3 dB	3 dB
Trace Mode	Max Hold	Max Hold	Max Hold
Sweep type	Sweep	Sweep	Sweep
Preamp	off	off	off
Stable mode	Trace	Trace	Trace
Stable value	0.50 dB	0.50 dB	0.50 dB
Run	5 / max. 150	6 / max. 150	5 / max. 150
Stable	2 / 2	2 / 2	2 / 2
Max Stable Difference	0.28 dB	0.06 dB	0.06 dB

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

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.

RESULTS:

BTLE 1Mb

The situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º 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-1000 MHz and at distance of 1m for the frequency range 1 GHz-25 GHz.

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.

The spurious signals detected do not depend on the operating channel.

No radiated spurious signals were detected at less than 20 dB respect to the limit for the lowest, middle and highest operating channels.

Frequency range 1 GHz-25 GHz

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

Here, No Spurious Signals were detected in the restricted bands 2.31-2.39 GHz, 2.4835-2.5 GHz, and 4.5-5.15 GHz (see plots for the worst polarization shown below).

Spurious signals with peak levels above the average limit (54 dBµV/m at 3 m) are measured with average detector for checking compliance with the average limit.

1. CHANNEL: LOWEST (2402 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
4.80403	H	Peak	47.40	± 4.87
		Average	44.00	± 4.87
4.80347	V	Peak	47.90	± 4.87
		Average	43.80	± 4.87

2. CHANNEL: MIDDLE (2440 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
4.88053	H	Peak	50.30	± 4.87
		Average	44.70	± 4.87
4.87940	V	Peak	48.10	± 4.87
		Average	45.90	± 4.87

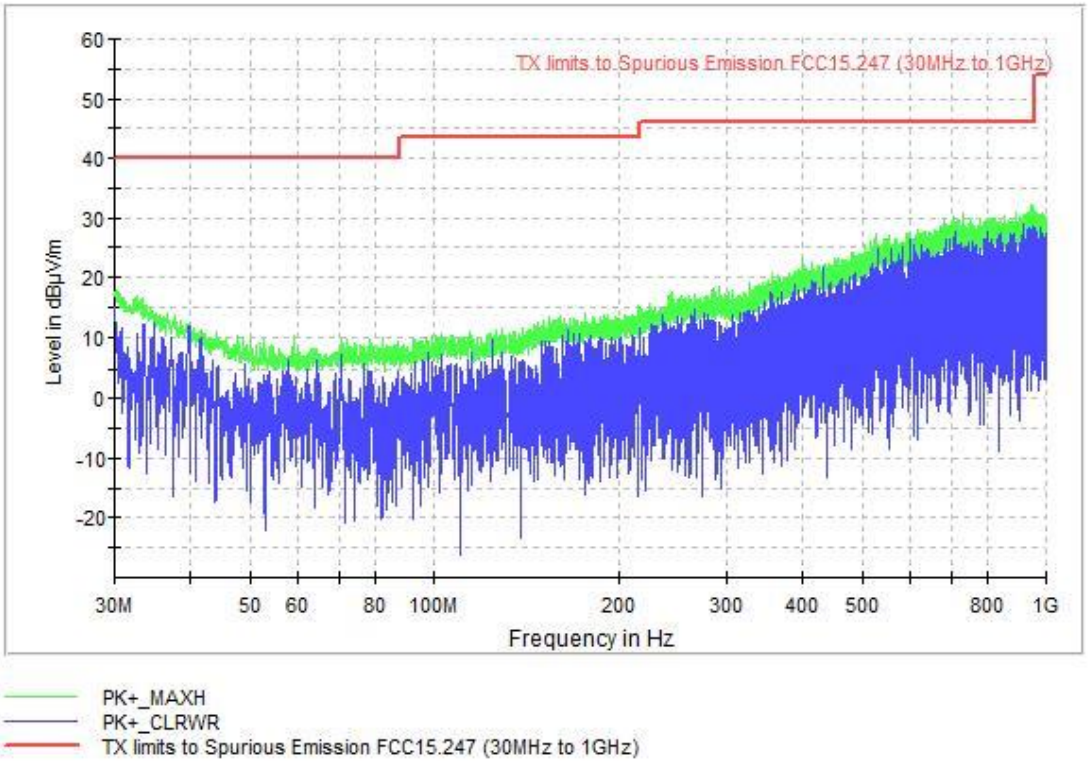
3. CHANNEL: HIGHEST (2480 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
4.96043	H	Peak	50.30	± 4.87
		Average	49.00	± 4.87
4.95930	V	Peak	47.10	± 4.87
		Average	42.60	± 4.87
		Average	47.90	± 4.87

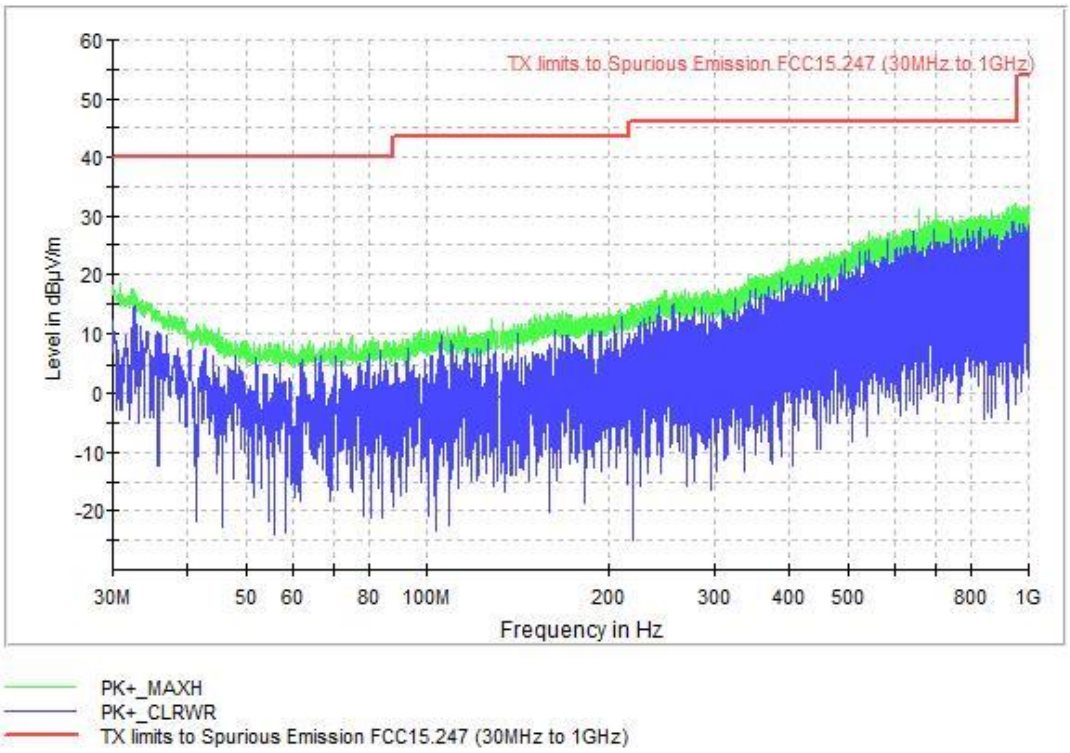
Verdict: PASS

FREQUENCY RANGE 30 MHz-1000 MHz

CHANNEL: Lowest (2402 MHz)

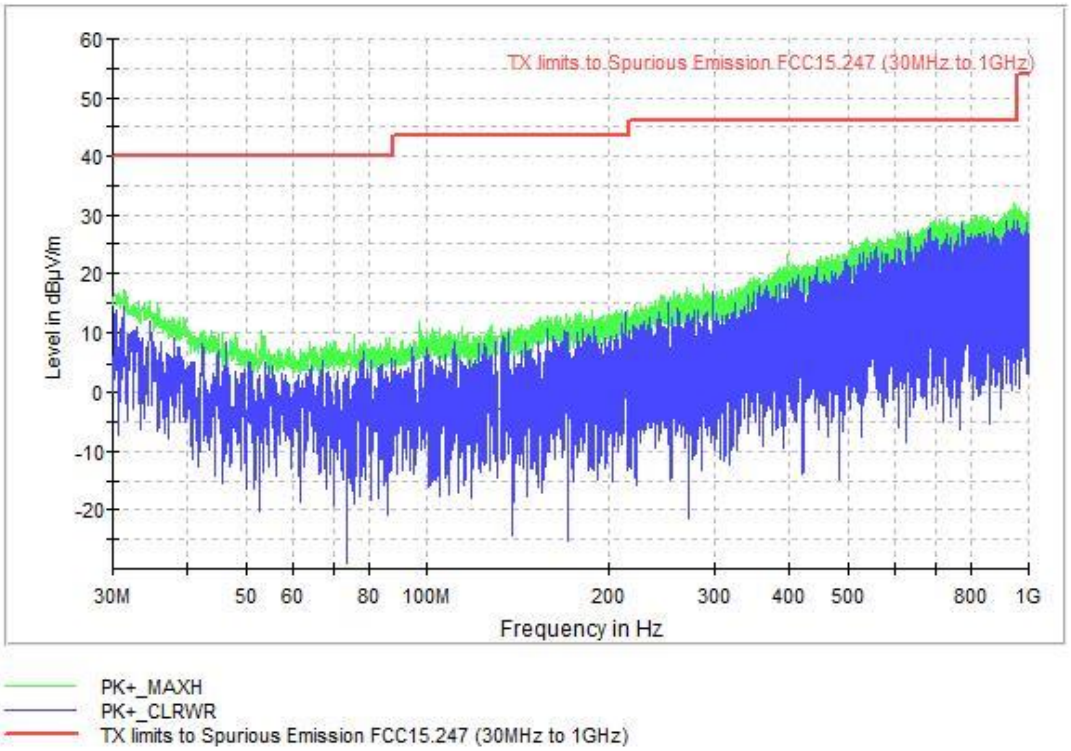


30MHz_1GHz_CH Low HP

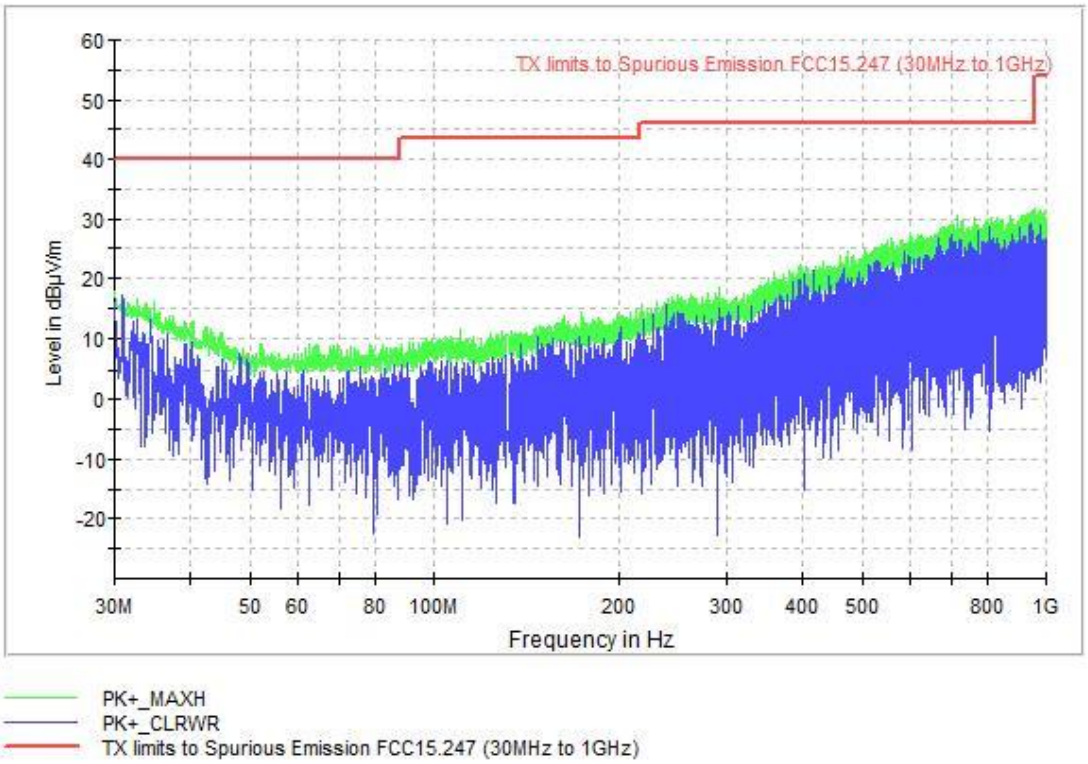


30MHz_1GHz_CH Low VP

CHANNEL: Middle (2440 MHz)

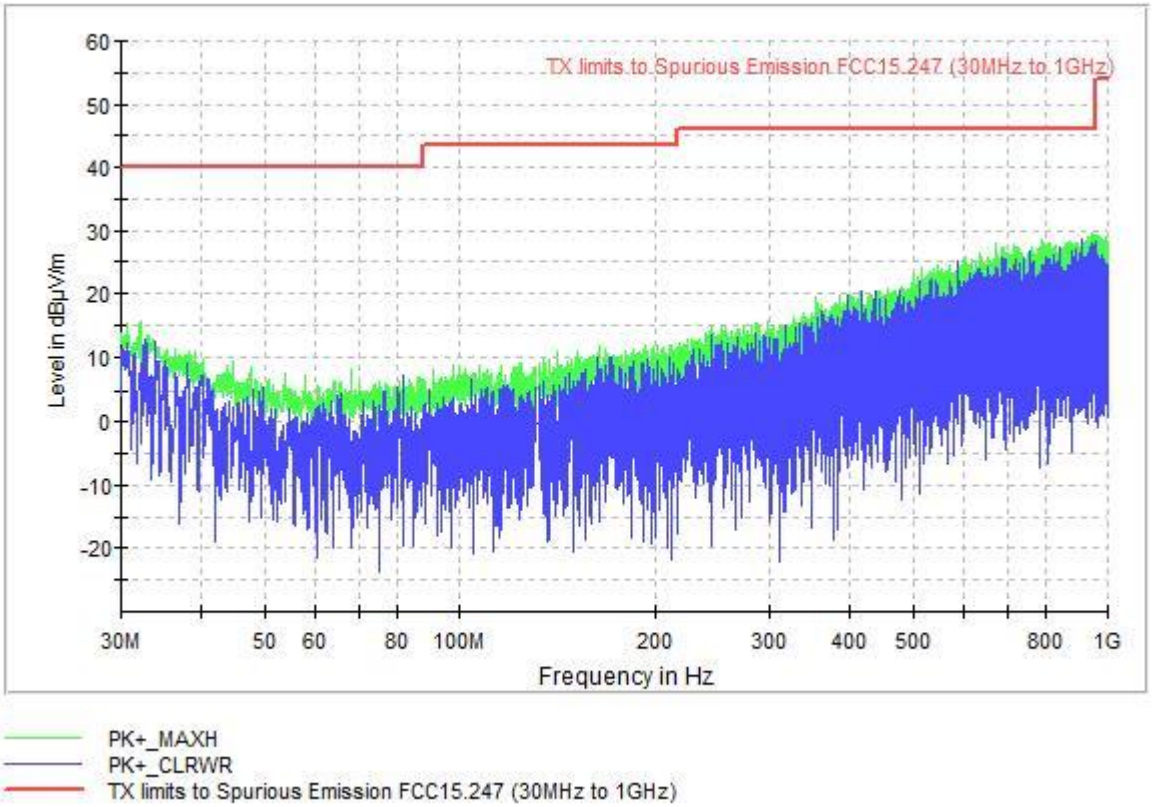


30MHz_1GHz_CH Mid HP

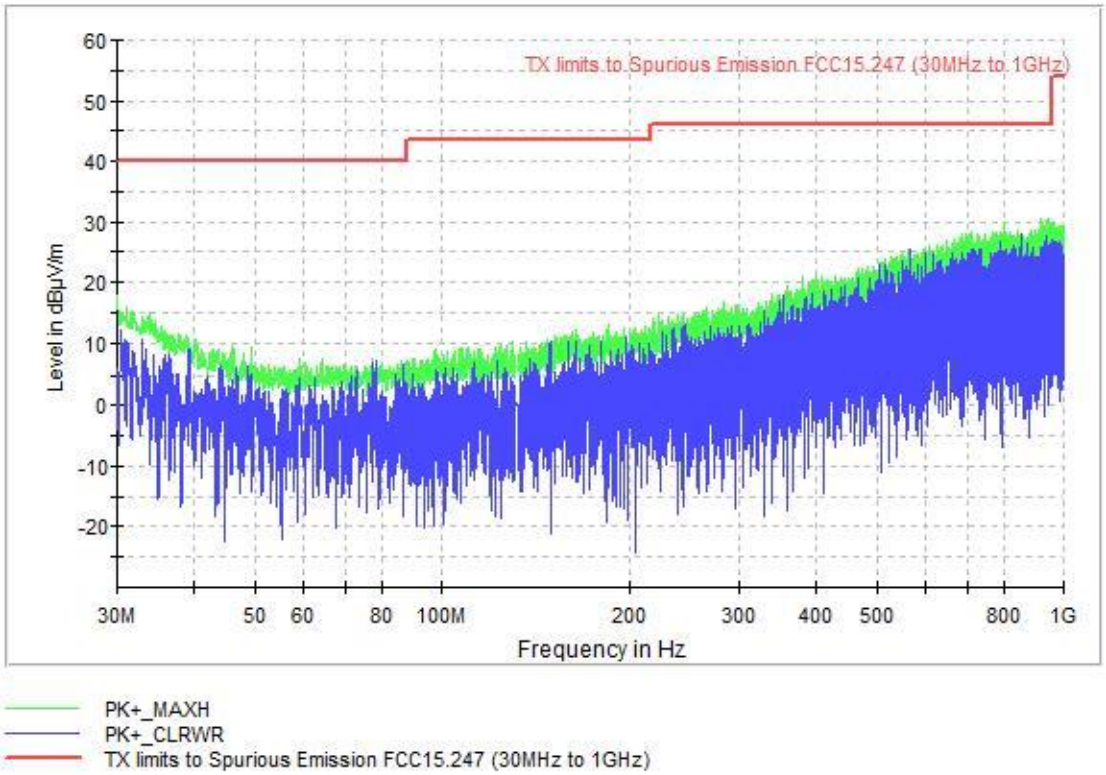


30MHz_1GHz_CH Mid VP

CHANNEL: Highest (2480 MHz)



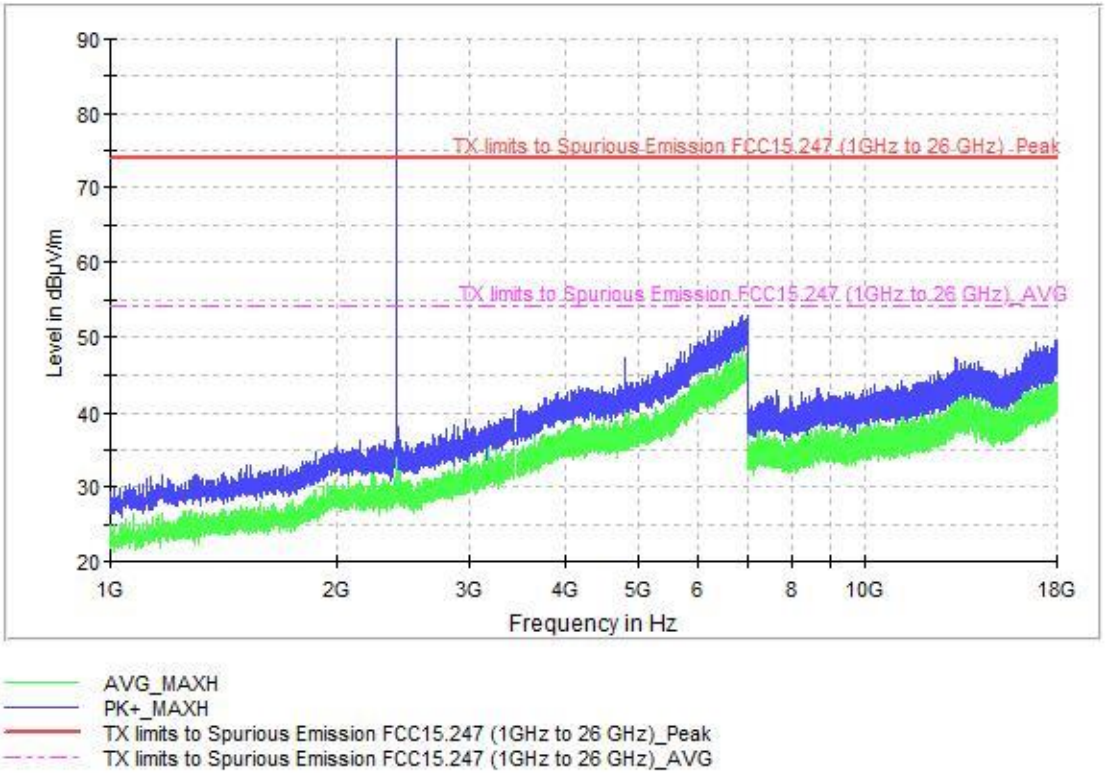
30MHz_1GHz_CH High HP



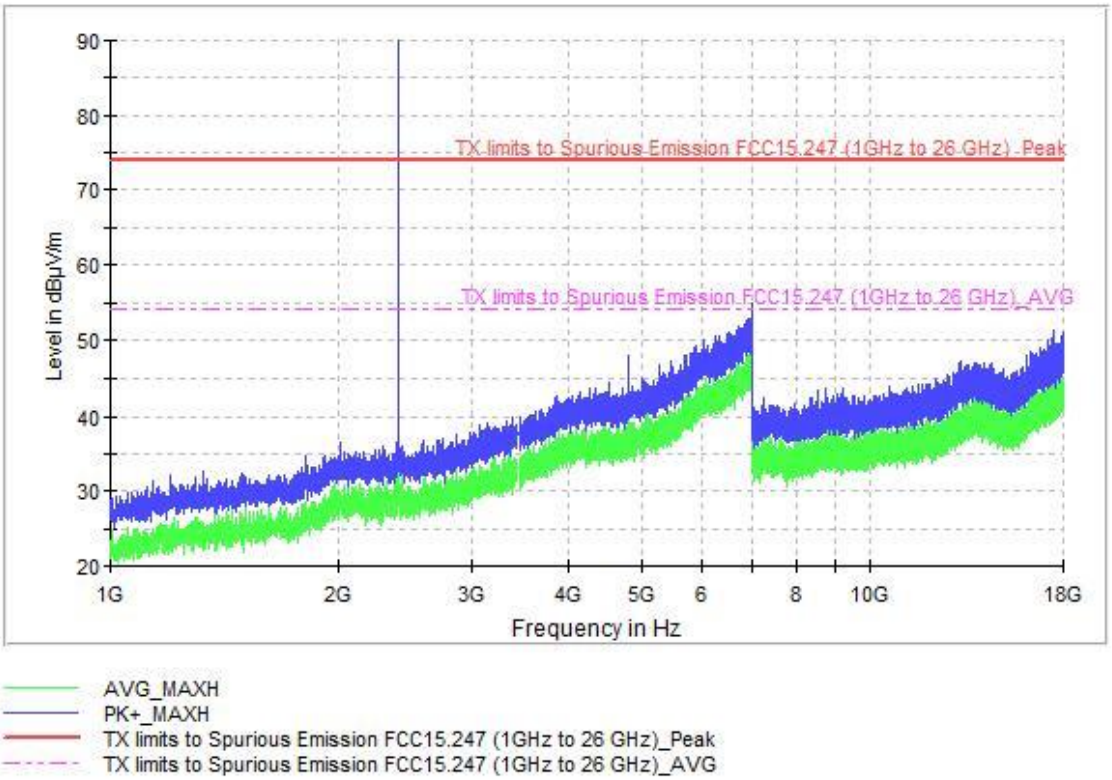
30MHz_1GHz_CH High VP

FREQUENCY RANGE 1 GHz to 18 GHz

CHANNEL: Lowest (2402 MHz)

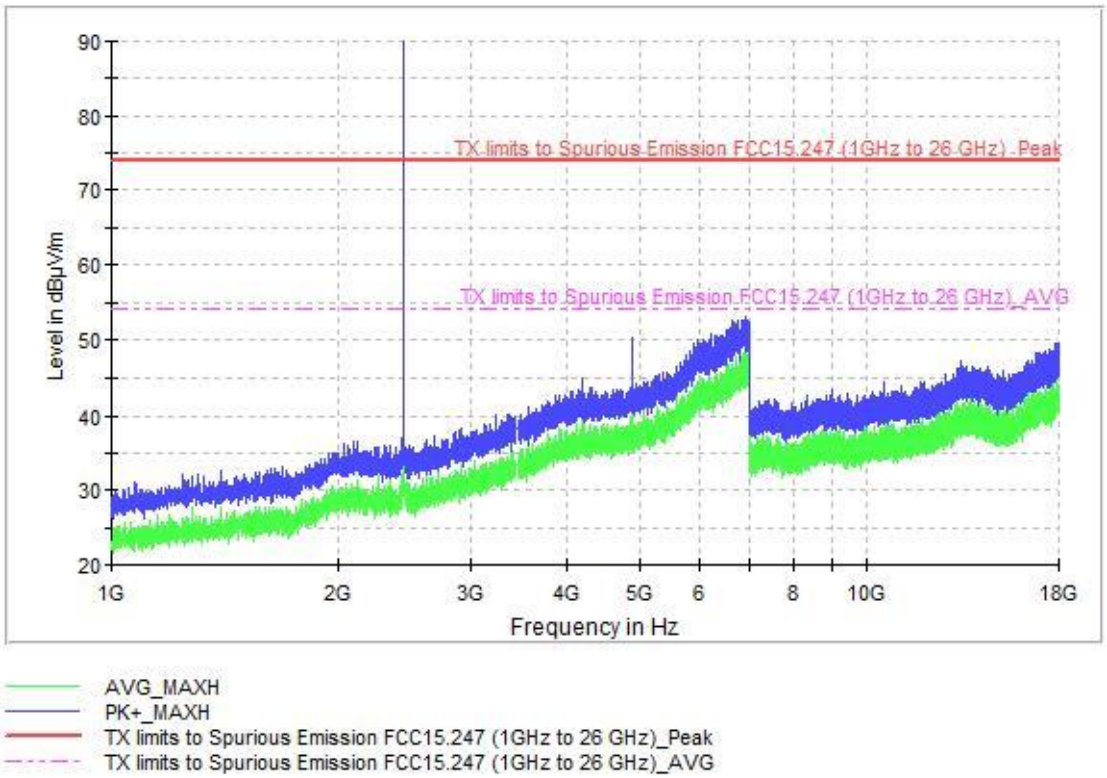


1GHz_18GHz_ HP_CH Low

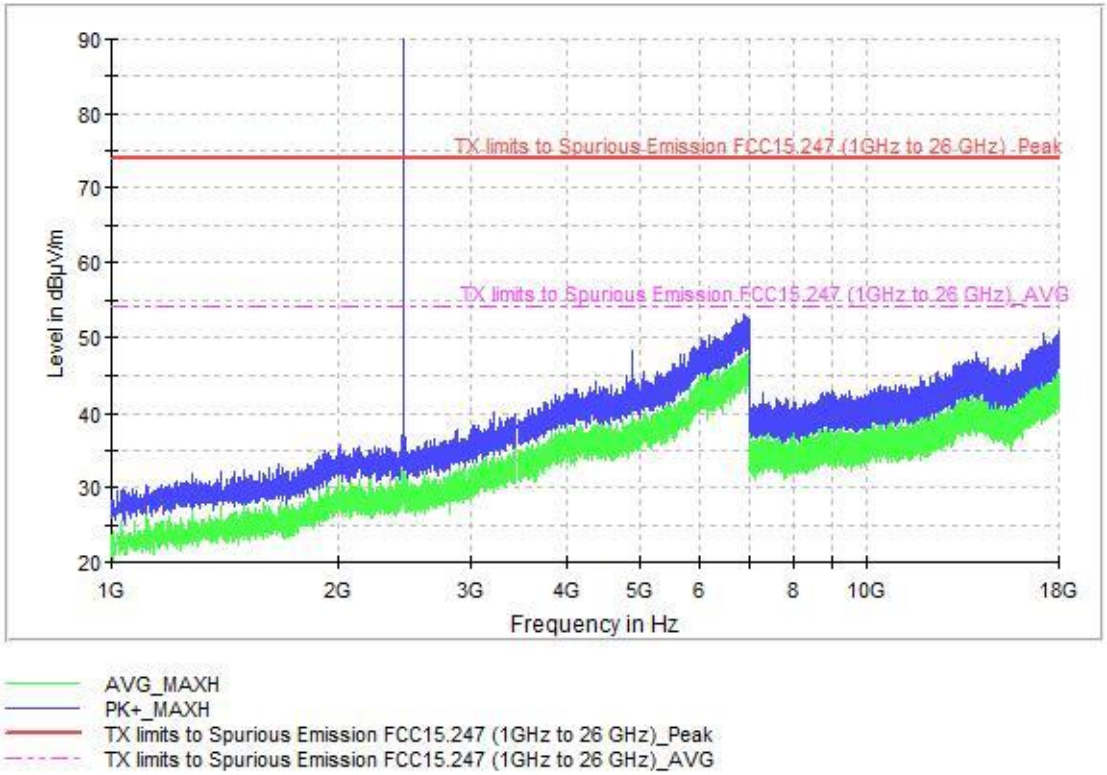


1GHz_18GHz_VP_CH Low

CHANNEL: Middle (2440 MHz)

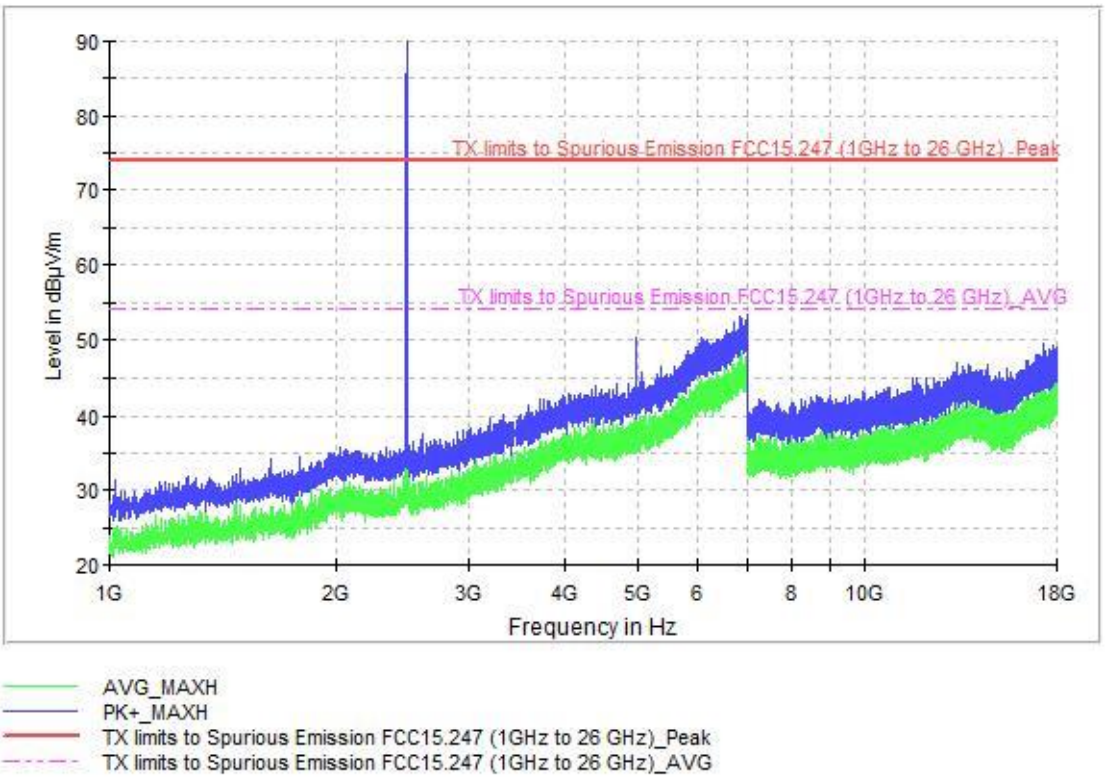


1GHz_18GHz_HP_CH Mid

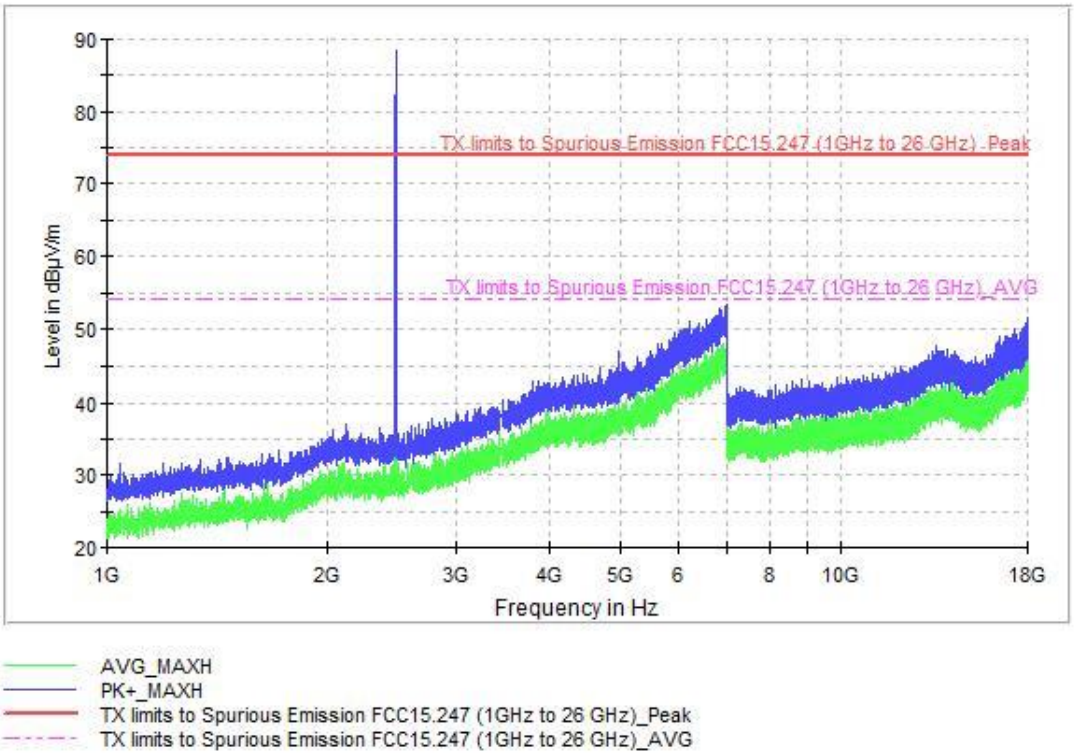


1GHz_18GHz_VP_CH Mid

CHANNEL: Highest (2480 MHz)



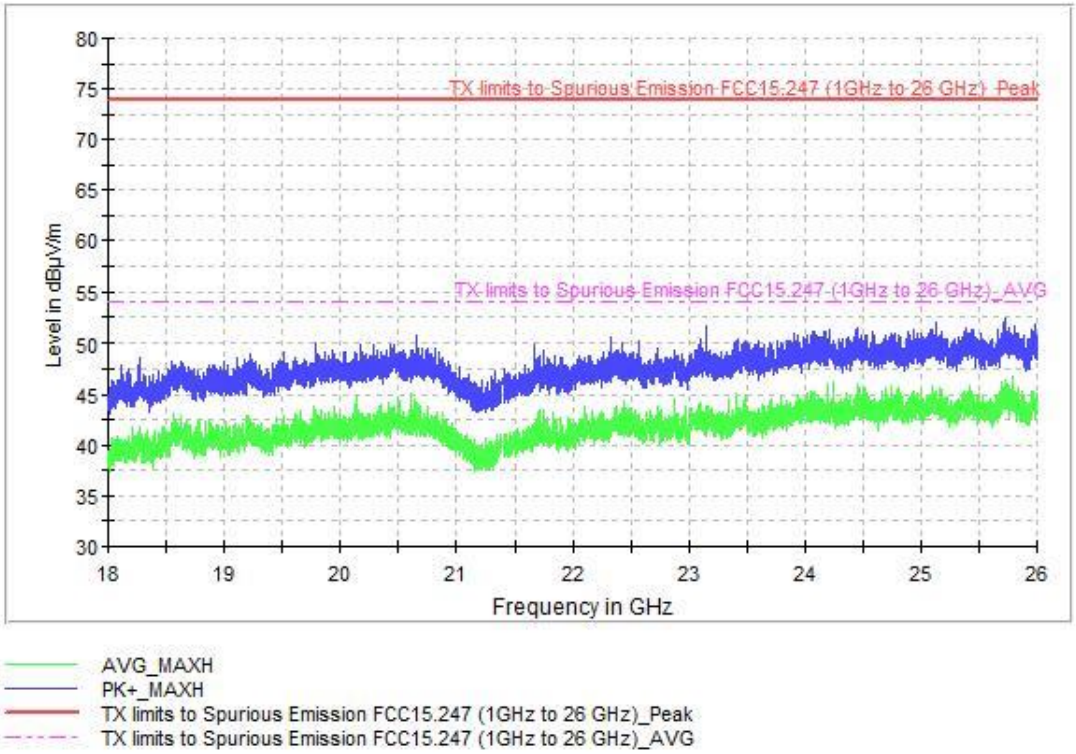
1GHz_18GHz_HP_CH High



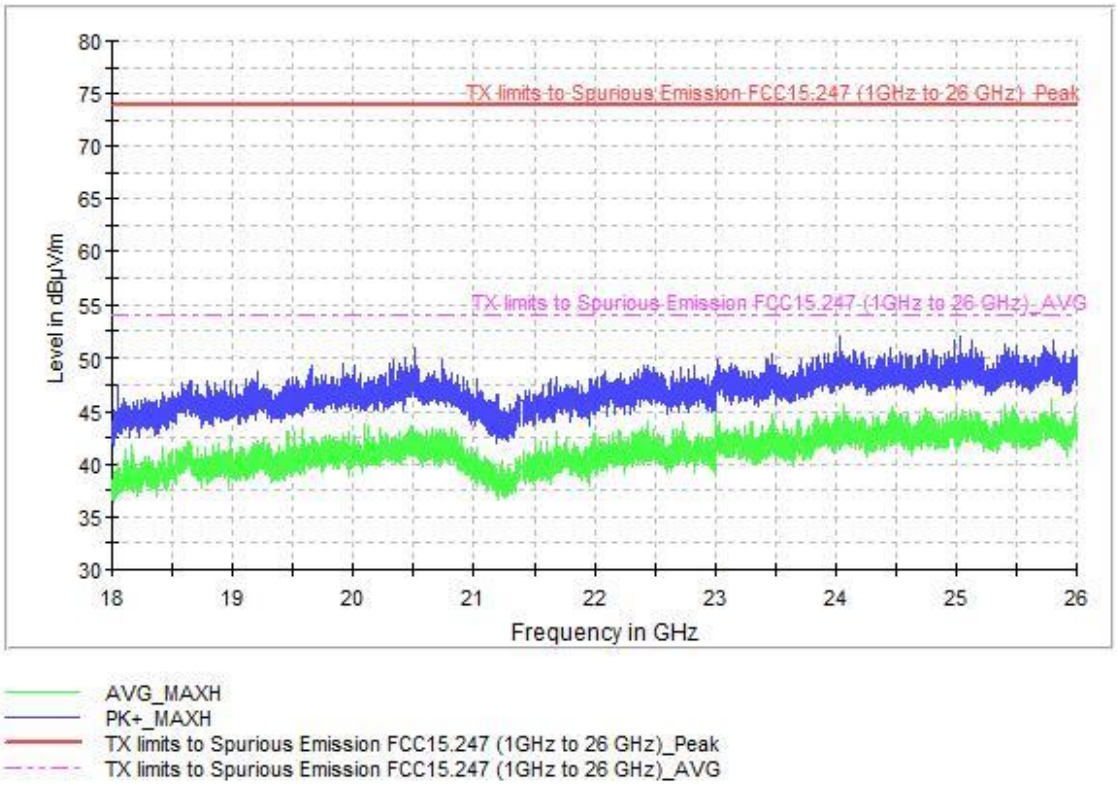
1GHz_18GHz_VP_CH High

FREQUENCY RANGE 18 GHz to 26 GHz

CHANNEL: Lowest (2402 MHz)

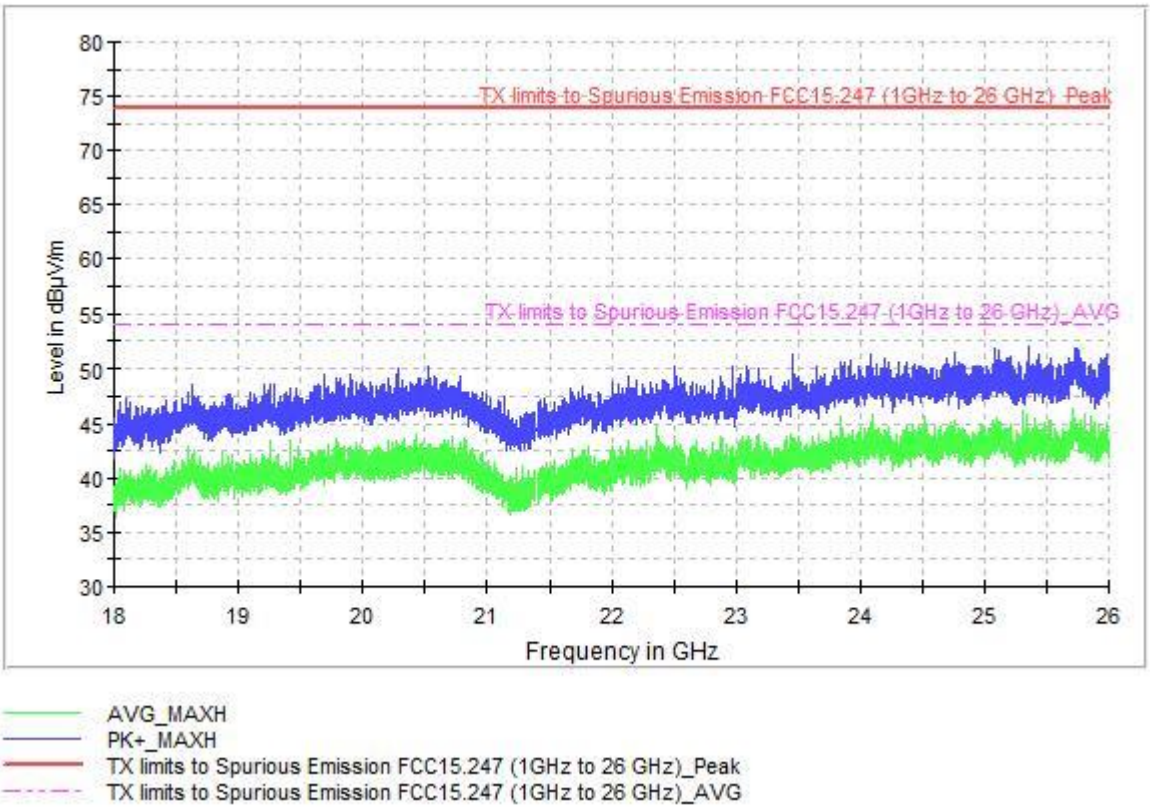


18GHz_26GHz_HP_CH Low

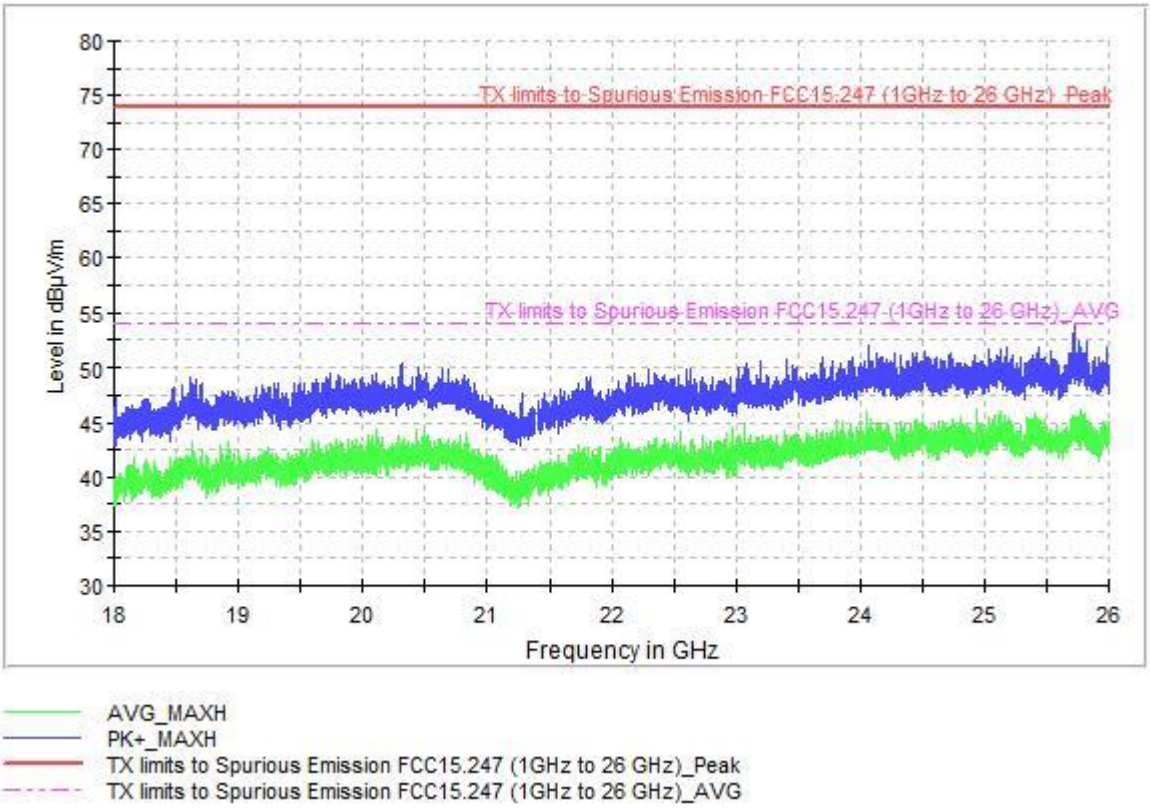


18GHz_26GHz_VP_CH Low

CHANNEL: Middle (2440 MHz)

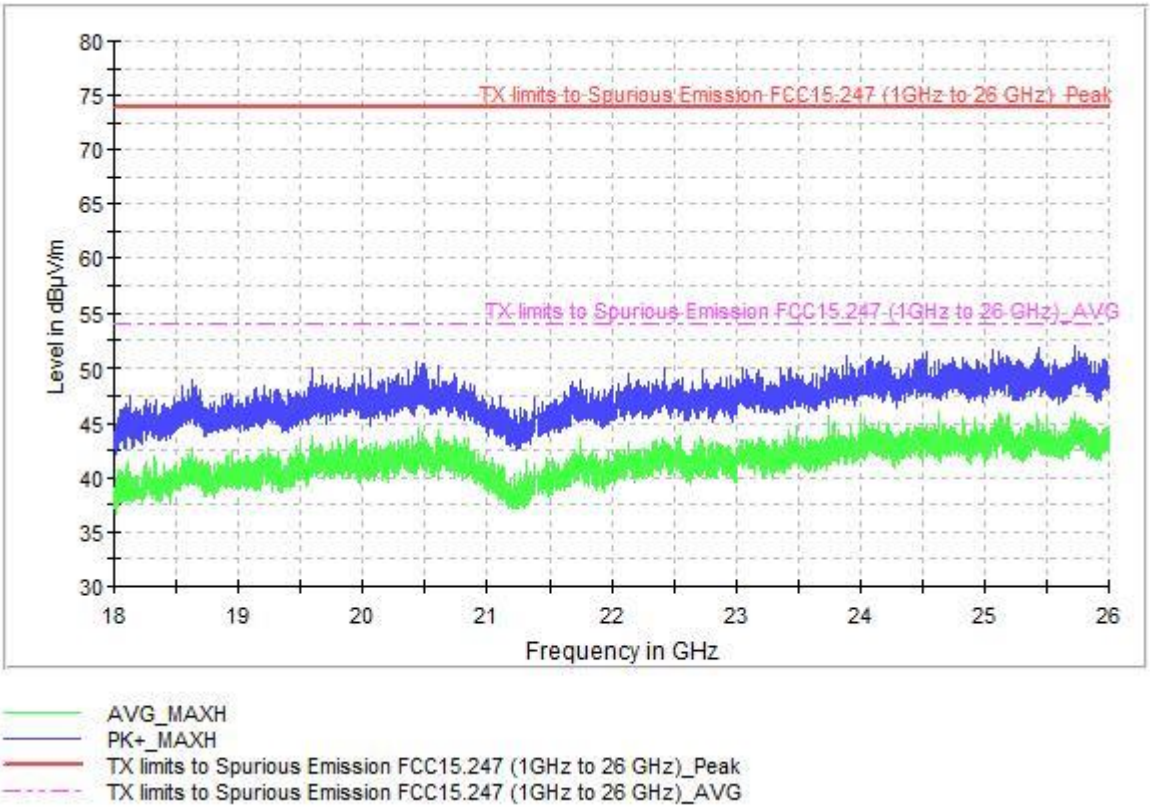


18GHz_26GHz_HP_CH Mid

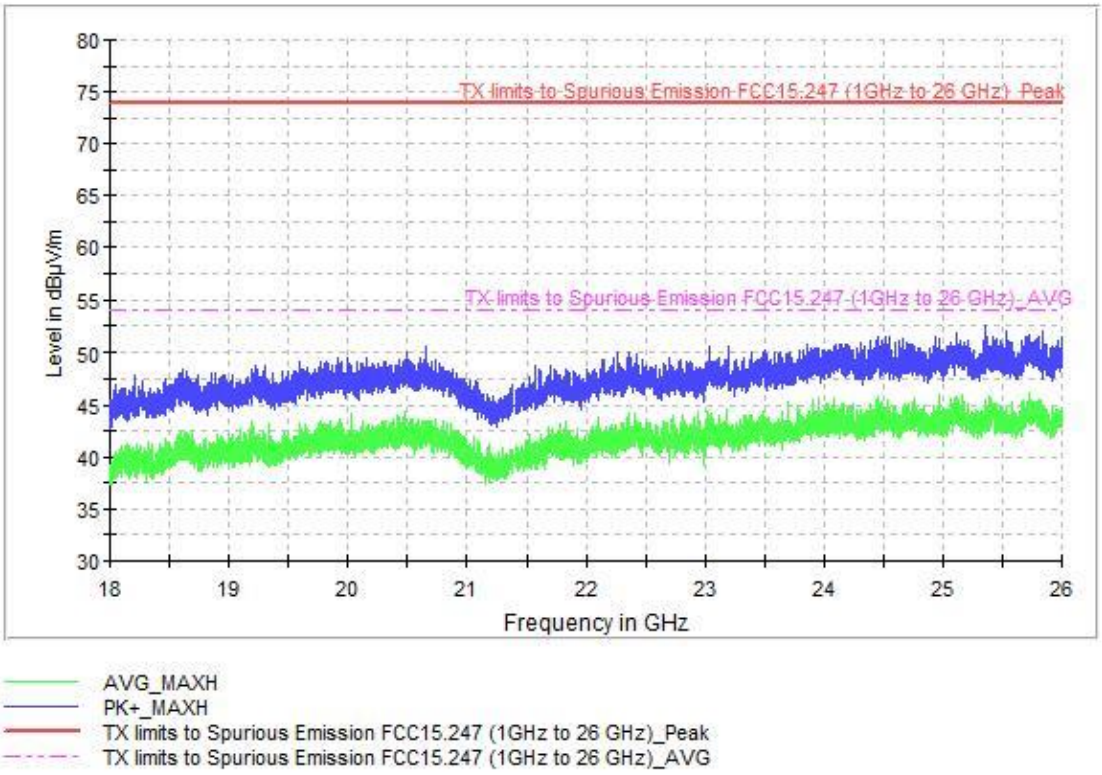


18GHz_26GHz_VP_CH Mid

CHANNEL: Highest (2480 MHz)



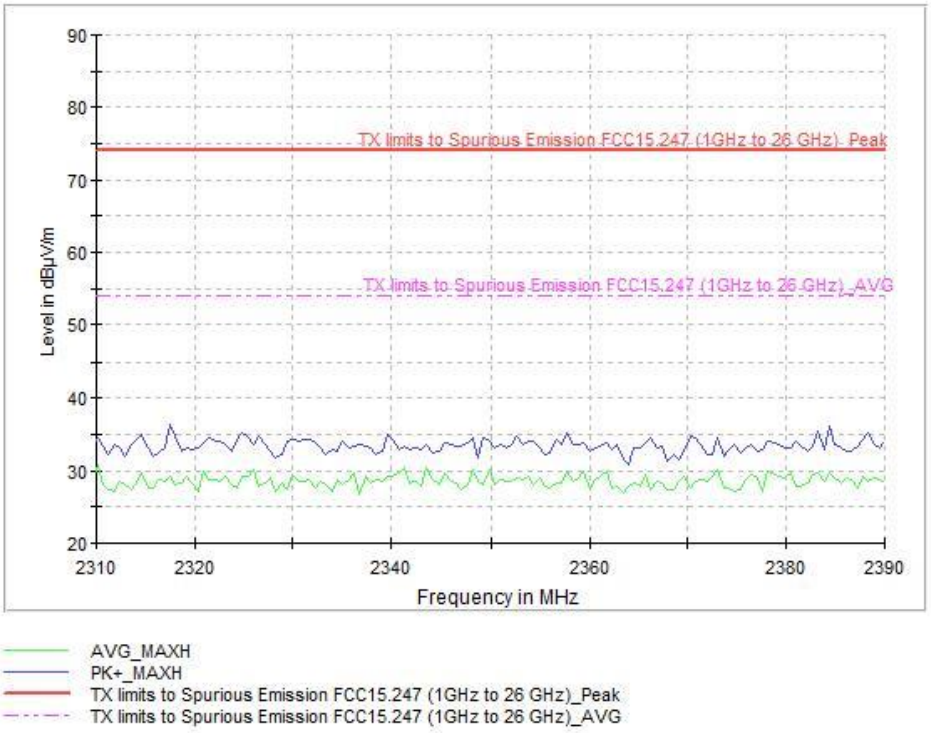
18GHz_26GHz_HP_CH High



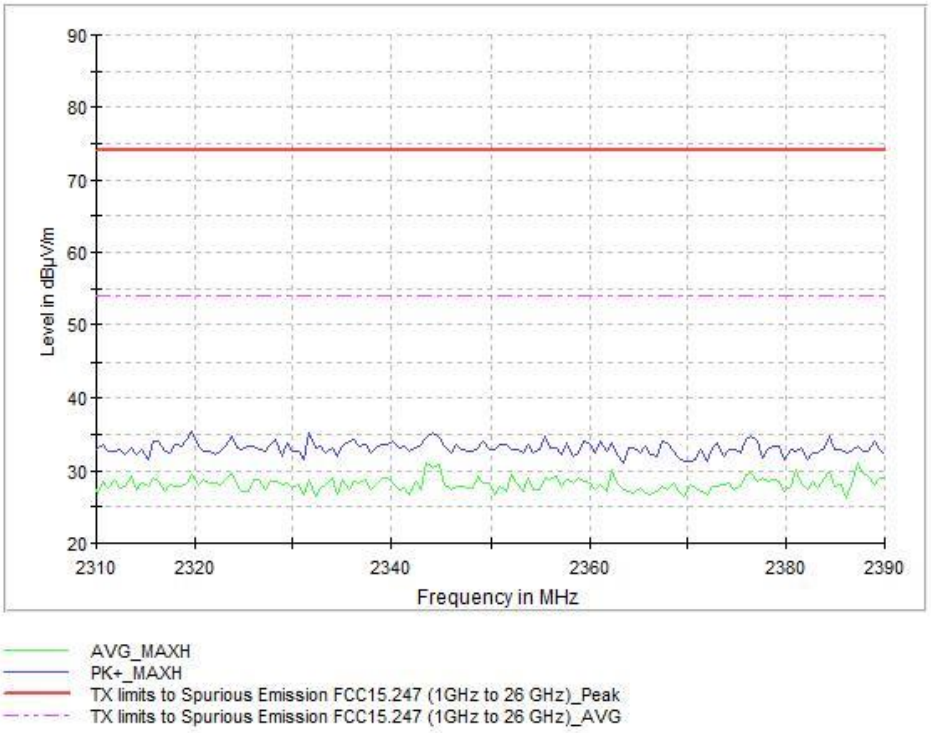
18GHz_26GHz_HP_CH High

FREQUENCY RANGE 2.31 GHz to 2.39 GHz. (RESTRICTED BAND)

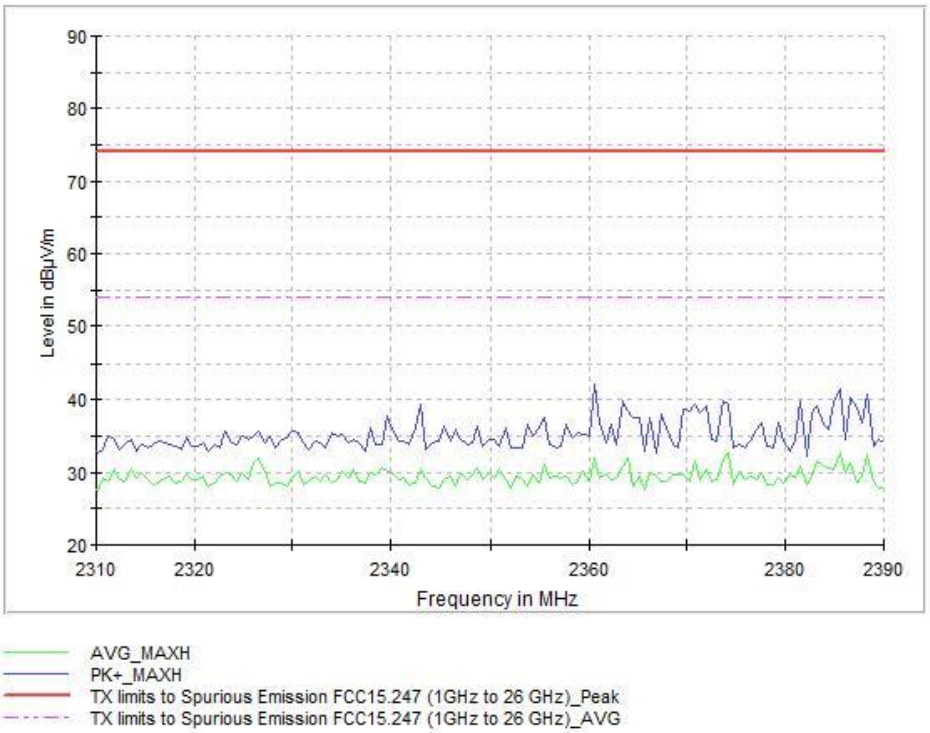
CHANNEL: Lowest (2402 MHz)



CHANNEL: Middle (2440 MHz)

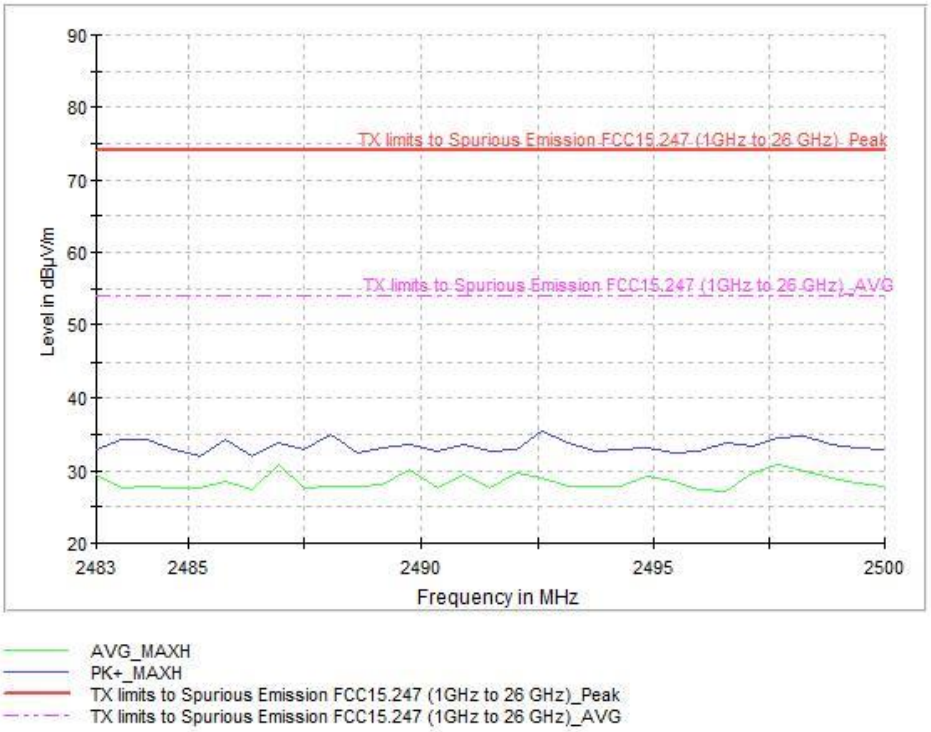


CHANNEL: Highest (2480 MHz)

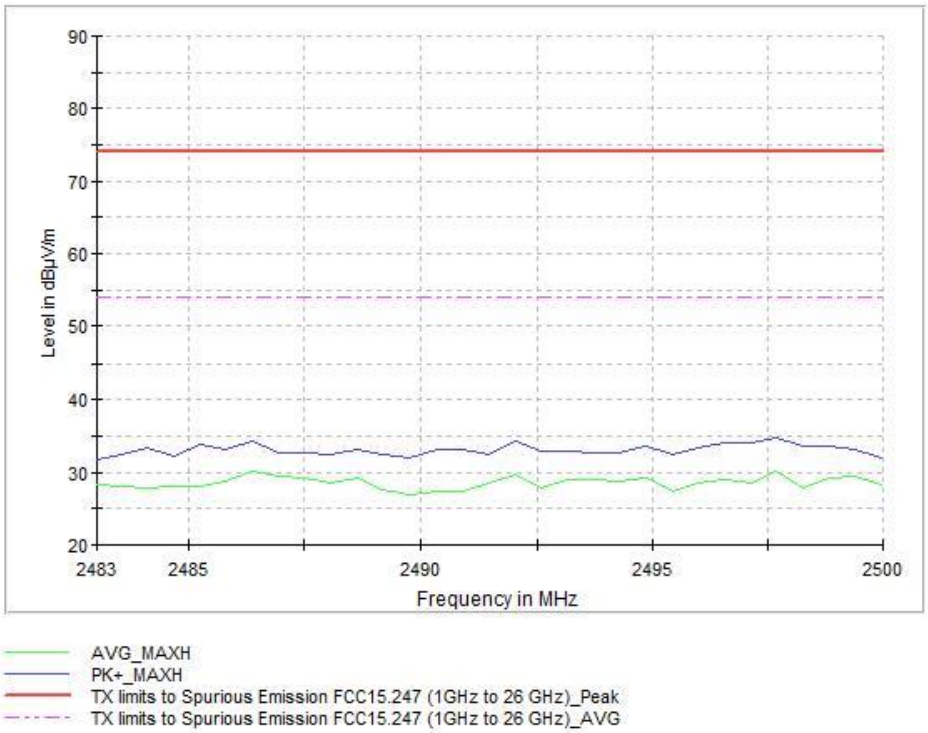


FREQUENCY RANGE 2.4835 GHz to 2.5 GHz. (RESTRICTED BAND)

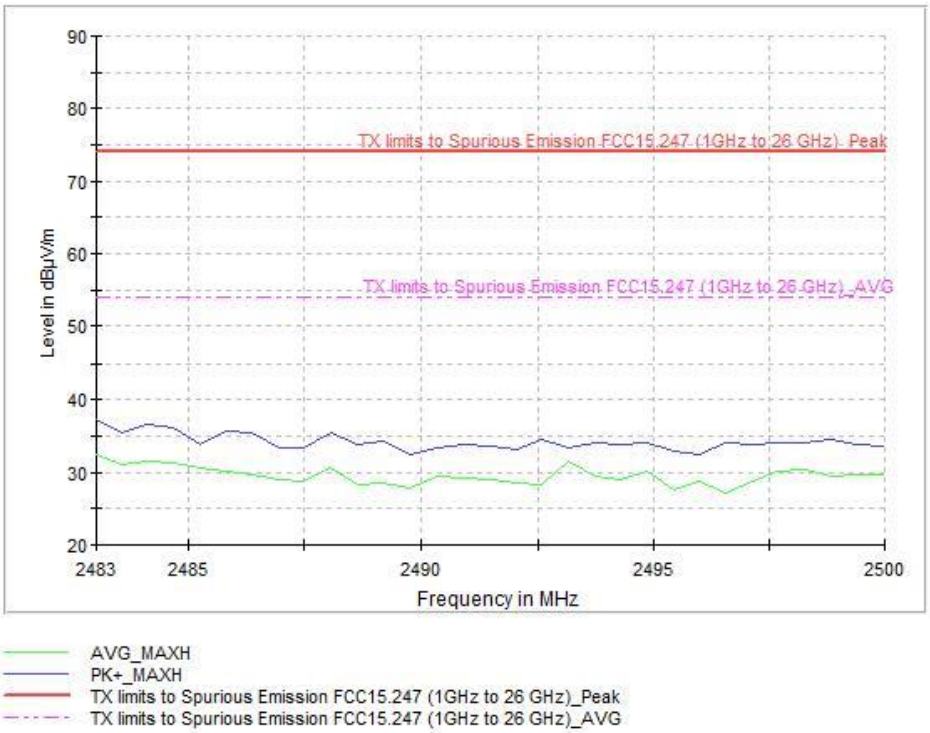
CHANNEL: Lowest (2402 MHz)



CHANNEL: Middle (2440 MHz)

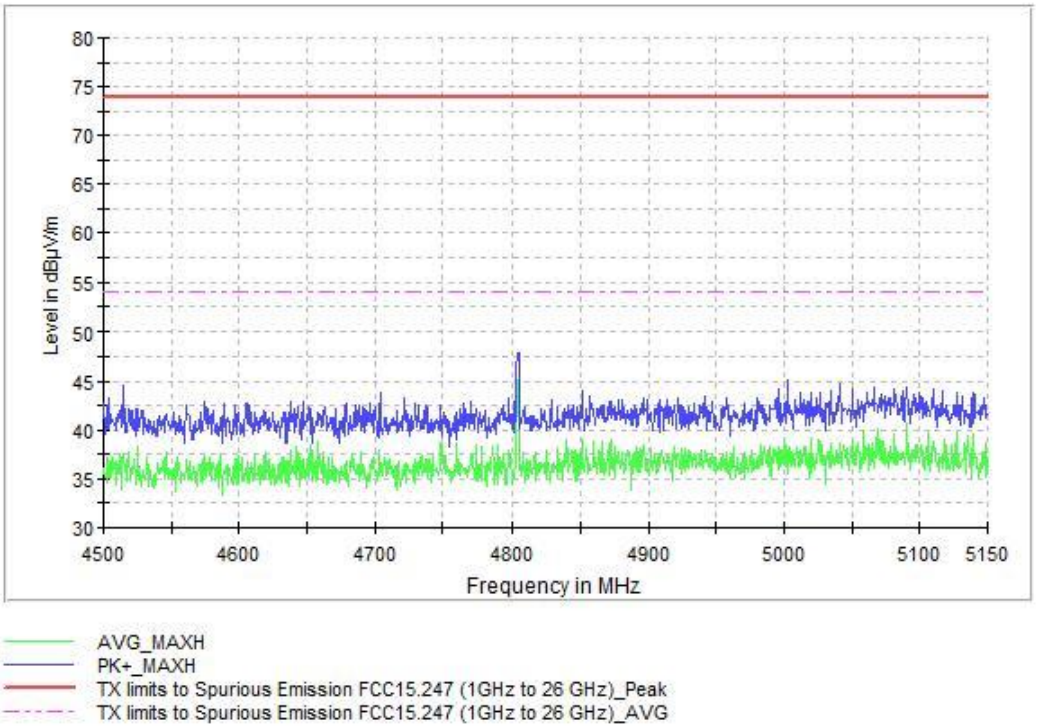


CHANNEL: Highest (2480 MHz)

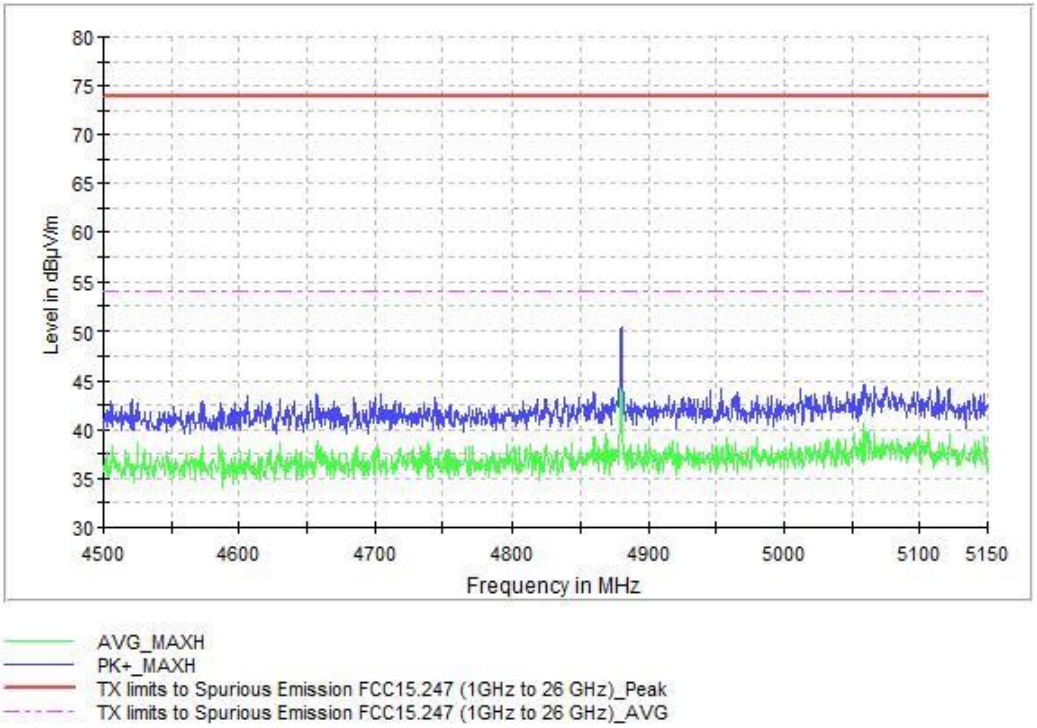


FREQUENCY RANGE 4.5 GHz to 5.15 GHz. (RESTRICTED BAND)

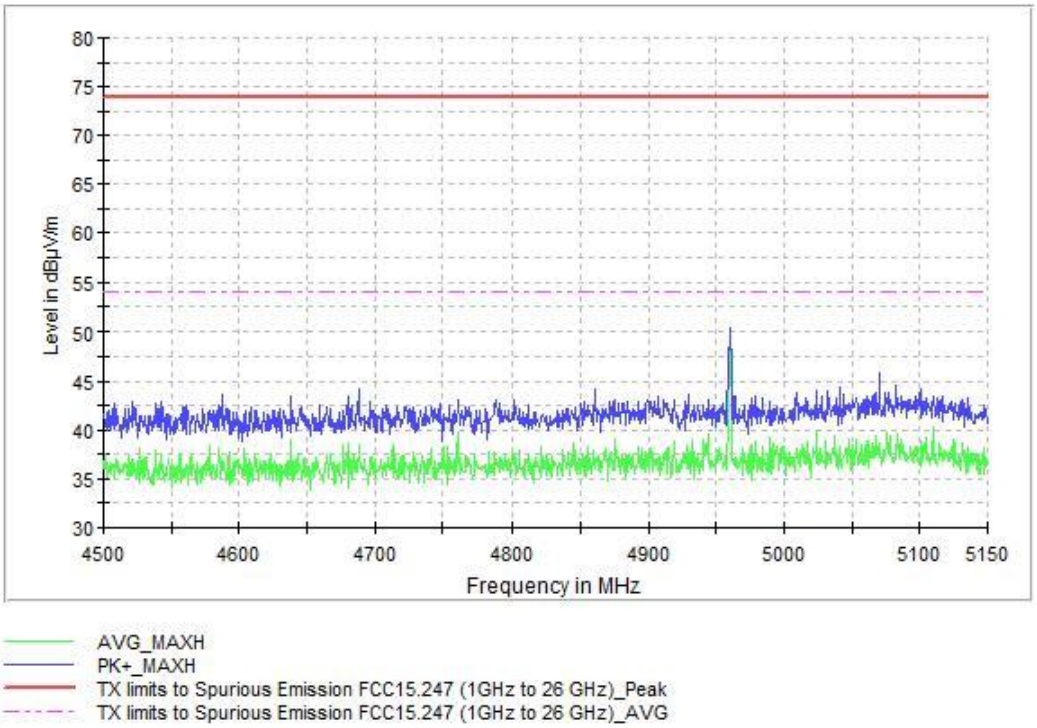
CHANNEL: Lowest (2402 MHz)



CHANNEL: Middle (2440 MHz)



CHANNEL: Highest (2480 MHz)



BTLE 2Mb

The situation and orientation was varied to find the maximum radiated emission. It was also rotated 360º 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-1000 MHz and at distance of 1m for the frequency range 1 GHz-25 GHz.

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.

The spurious signals detected do not depend on the operating channel.

No radiated spurious signals were detected at less than 20 dB respect to the limit for the lowest, middle and highest operating channels.

Frequency range 1 GHz-25 GHz

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

Here, No Spurious signals were detected in the restricted bands 2.31-2.39 GHz, 2.4835-2.5 GHz, and 4.5-5.15 GHz (see plots for the worst polarization shown below).

Spurious signals with peak levels above the average limit (54 dBµV/m at 3 m) are measured with average detector for checking compliance with the average limit.

1. CHANNEL: LOWEST (2402 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
4.80347	H	Peak	53.00	± 4.87
		Average	49.20	± 4.87
4.80290	V	Peak	54.40	± 4.87
		Average	53.90	± 4.87
7.20613	V	Peak	50.20	± 4.87
		Average	48.20	± 4.87
9.60597	V	Peak	46.20	± 4.87
		Average	43.10	± 4.87

2. CHANNEL: MIDDLE (2440 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
4.87883	H	Peak	58.70	± 4.87
		Average	52.40	± 4.87
7.31947	H	Peak	45.00	± 4.87
		Average	41.20	± 4.87
9.76180	H	Peak	45.60	± 4.87
		Average	42.30	± 4.87
4.87997	V	Peak	56.20	± 4.87
		Average	51.50	± 4.87
7.31890	V	Peak	45.70	± 4.87
		Average	42.90	± 4.87
9.76010	V	Peak	50.00	± 4.87
		Average	48.90	± 4.87

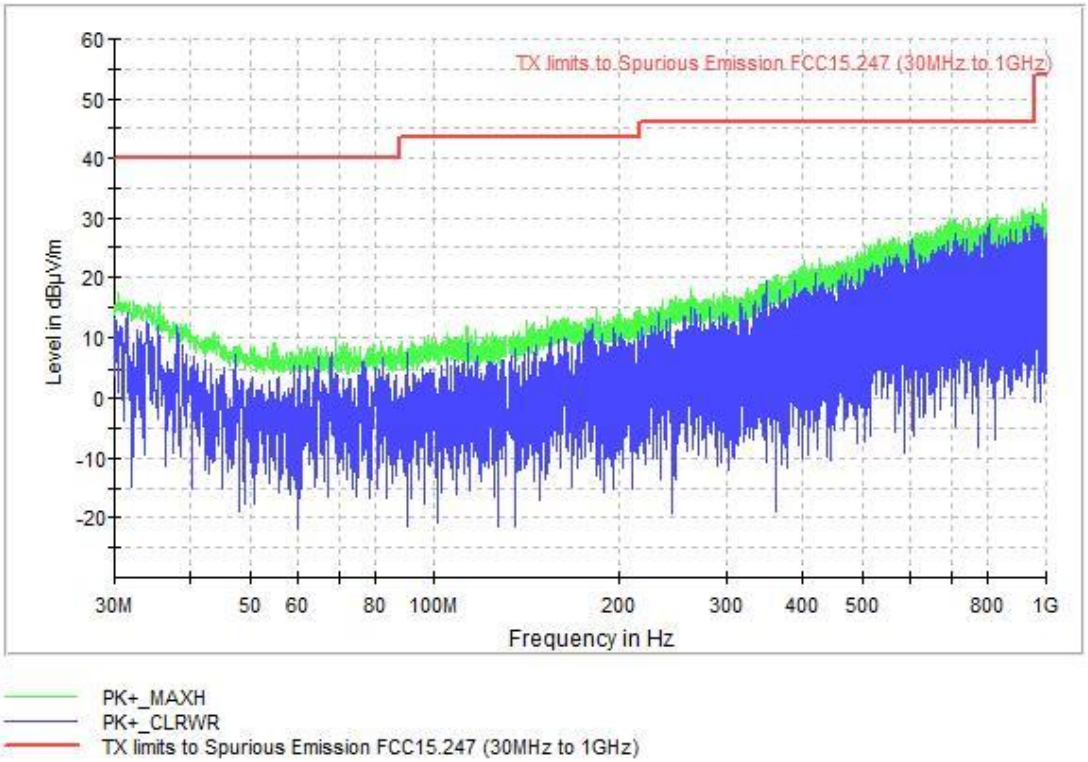
3. CHANNEL: HIGHEST (2480 MHz).

Spurious frequency (GHz)	Polarization	Detector	Emission Level (dBµV/m)	Measurement Uncertainty (dB)
4.9610	H	Peak	59.80	± 4.87
		Average	49.00	± 4.87
7.43903	H	Peak	45.20	± 4.87
		Average	40.60	± 4.87
4.95930	V	Peak	53.60	± 4.87
		Average	51.80	± 4.87
7.43903	V	Peak	47.00	± 4.87
		Average	42.20	± 4.87
9.91990	V	Peak	50.20	± 4.87
		Average	49.60	± 4.87

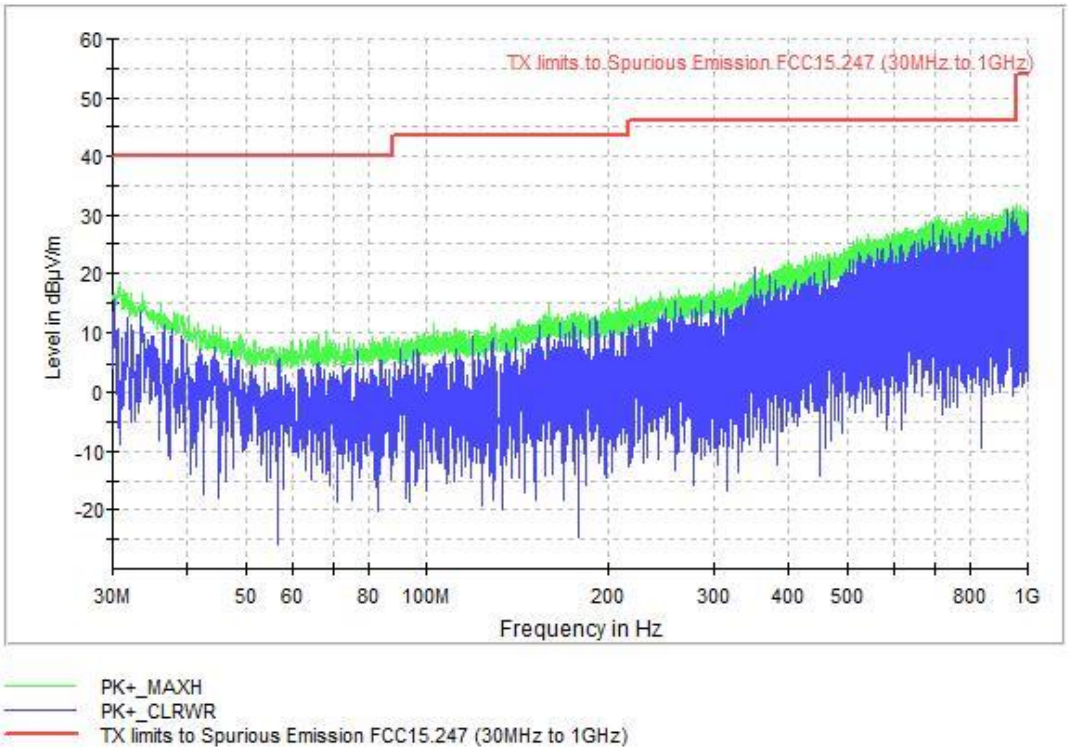
Verdict: PASS

FREQUENCY RANGE 30 MHz-1000 MHz

CHANNEL: Lowest (2402 MHz)

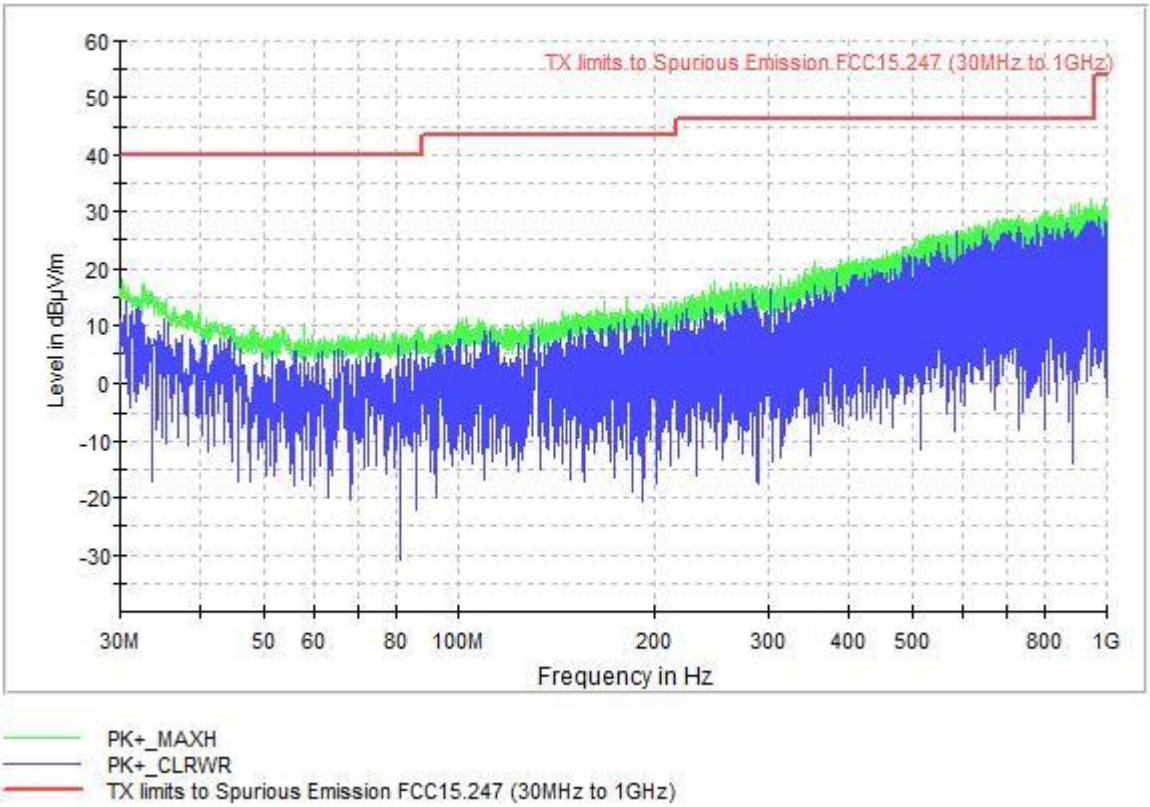


30MHz_1GHz_CH Low HP

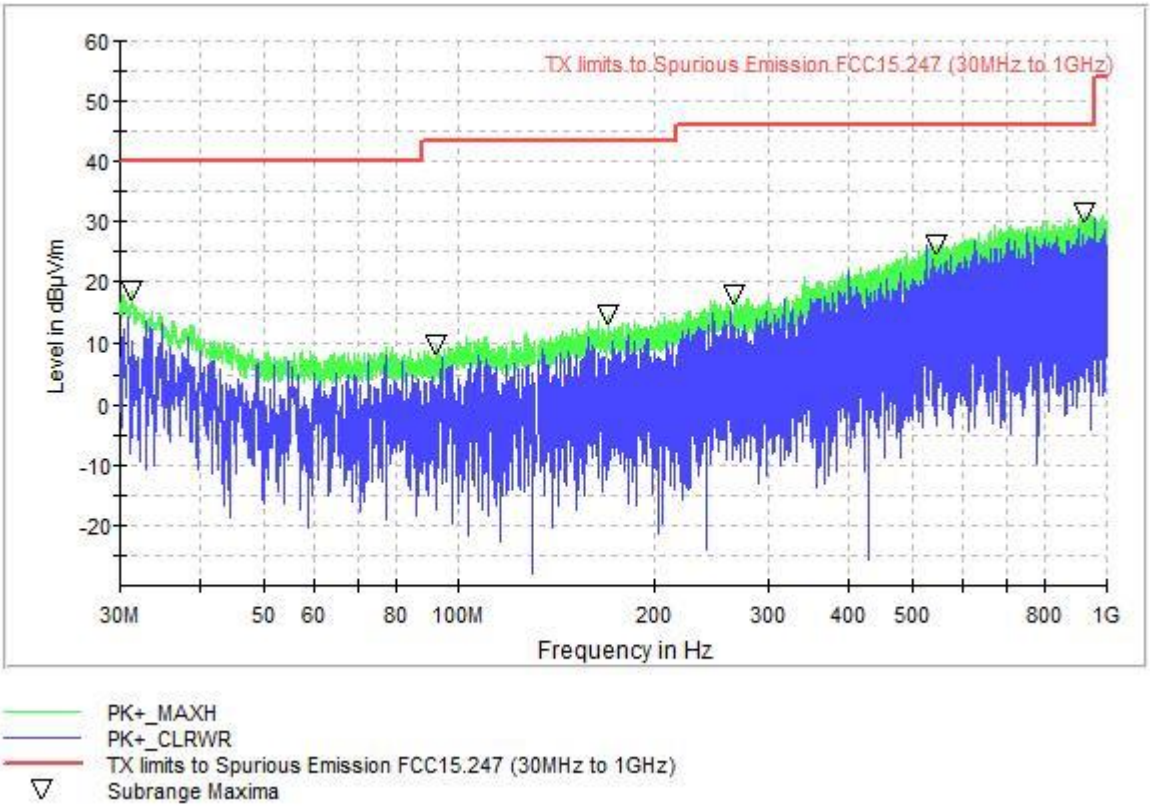


30MHz_1GHz_CH Low VP

CHANNEL: Middle (2440 MHz)

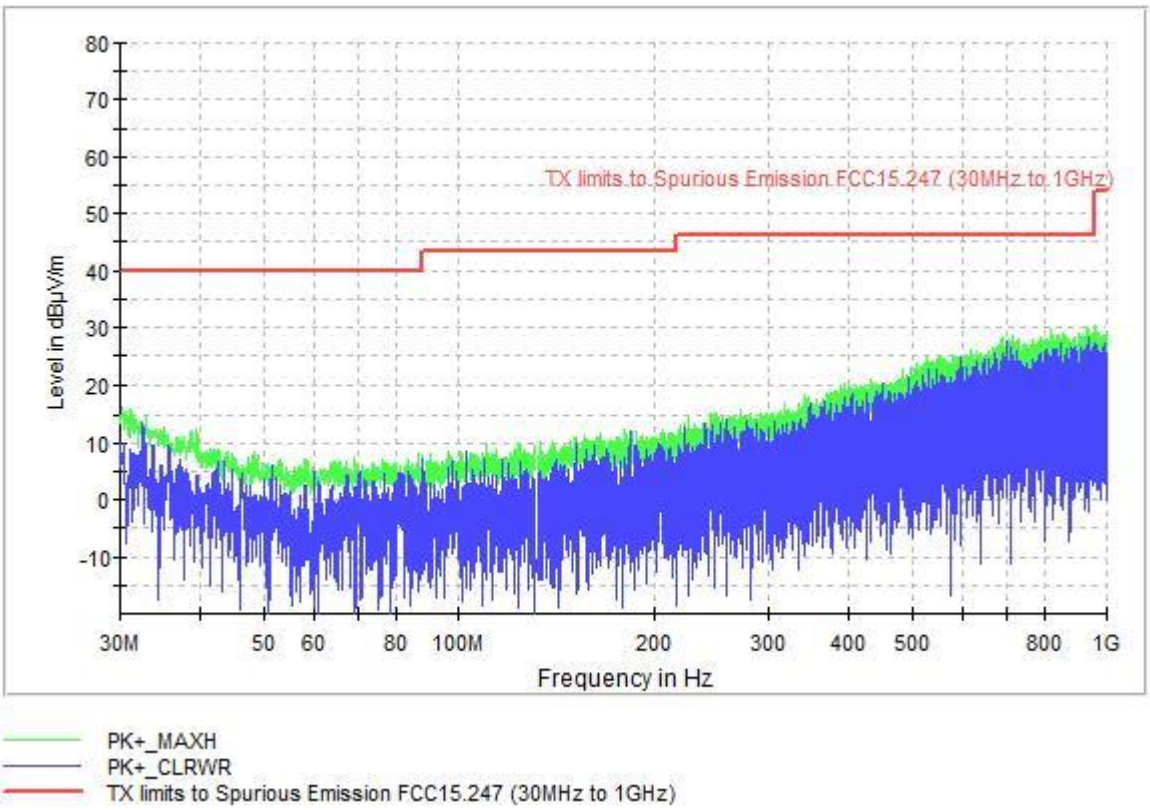


30MHz_1GHz_CH Mid HP

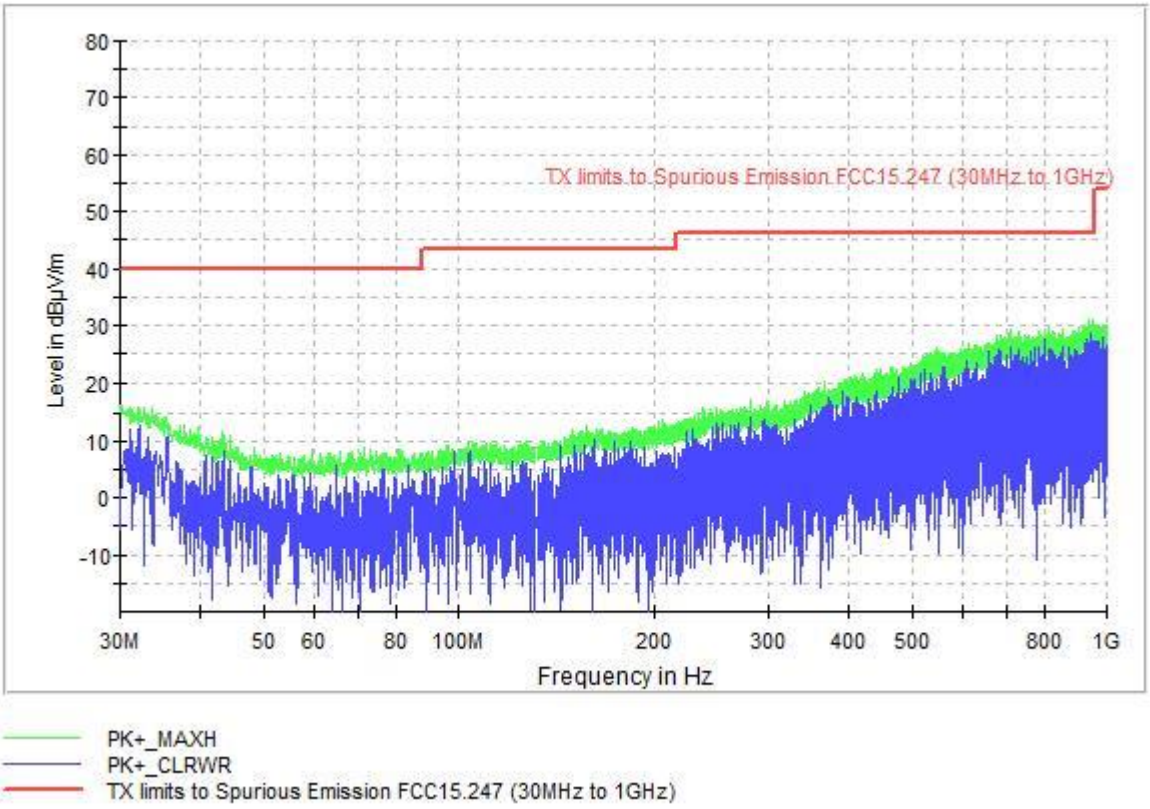


30MHz_1GHz_CH Mid VP

CHANNEL: Highest (2480 MHz)



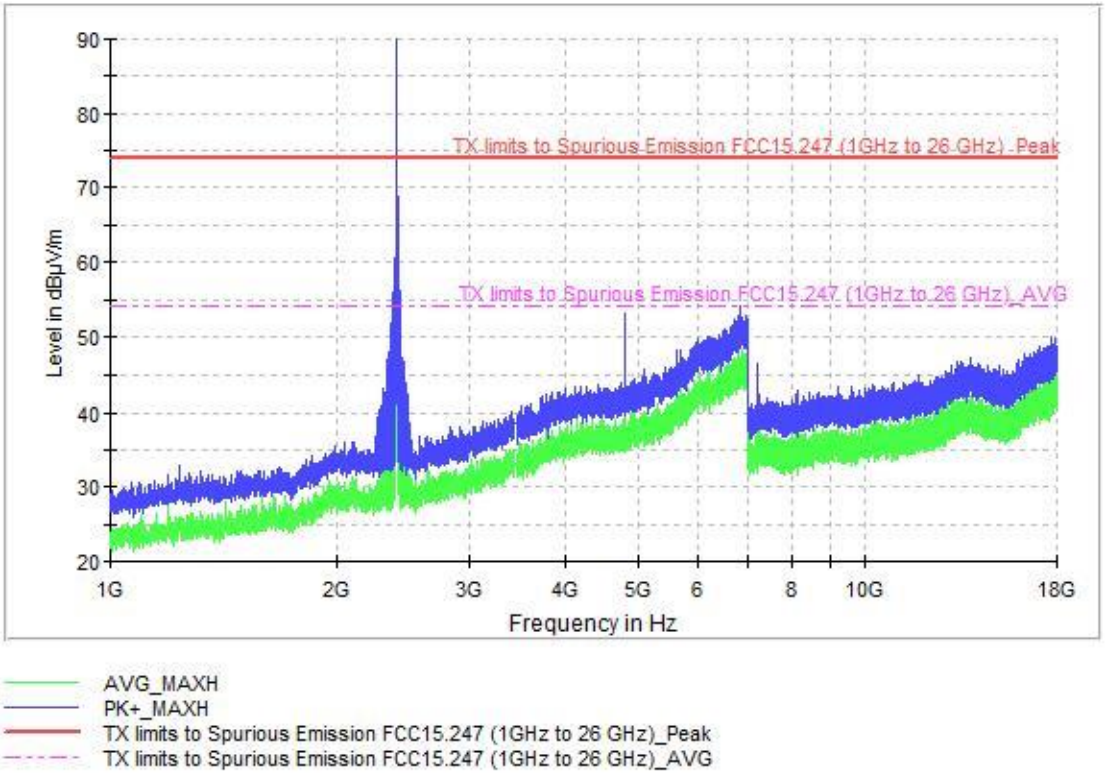
30MHz_1GHz_CH High HP



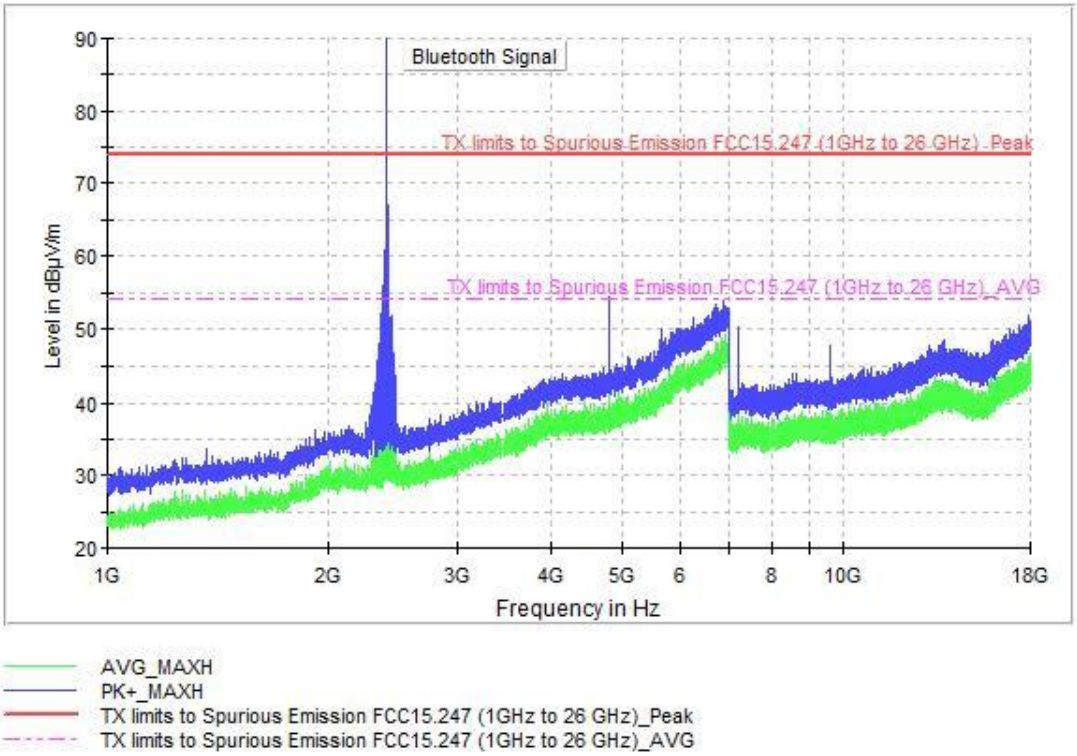
30MHz_1GHz_CH High VP

FREQUENCY RANGE 1 GHz to 18 GHz

CHANNEL: Lowest (2402 MHz)

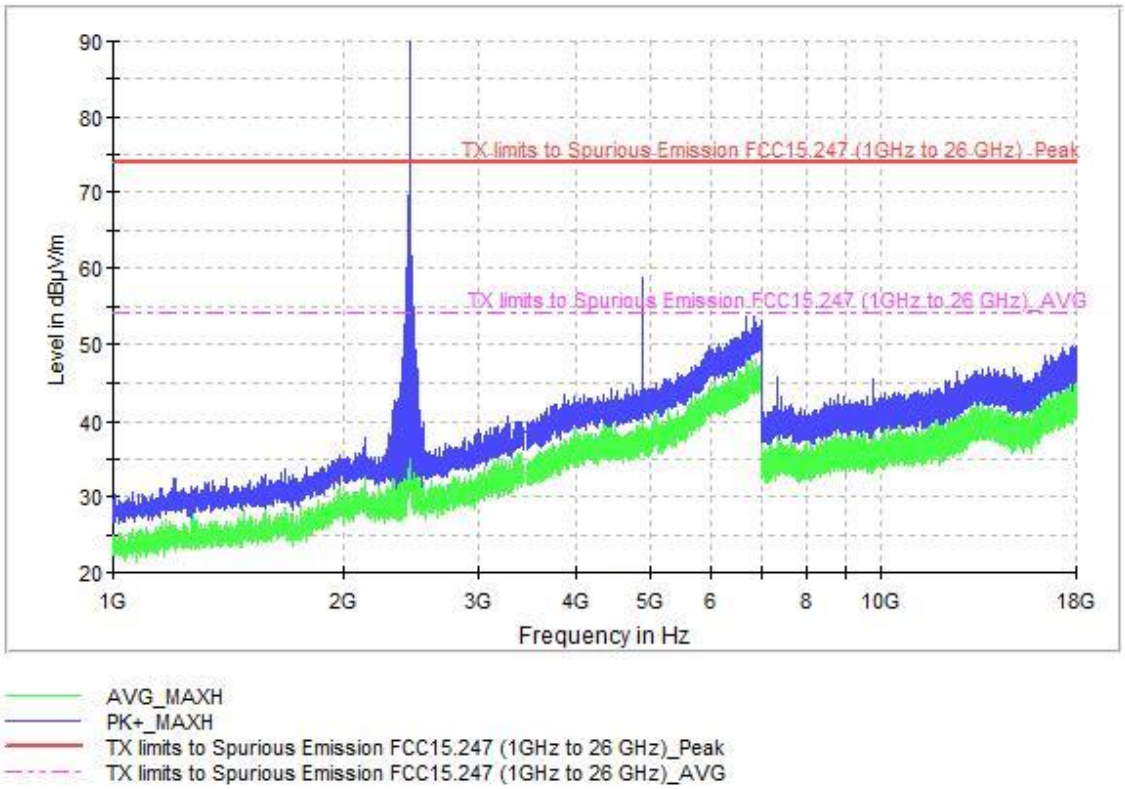


1GHz_18GHz_ HP_CH Low

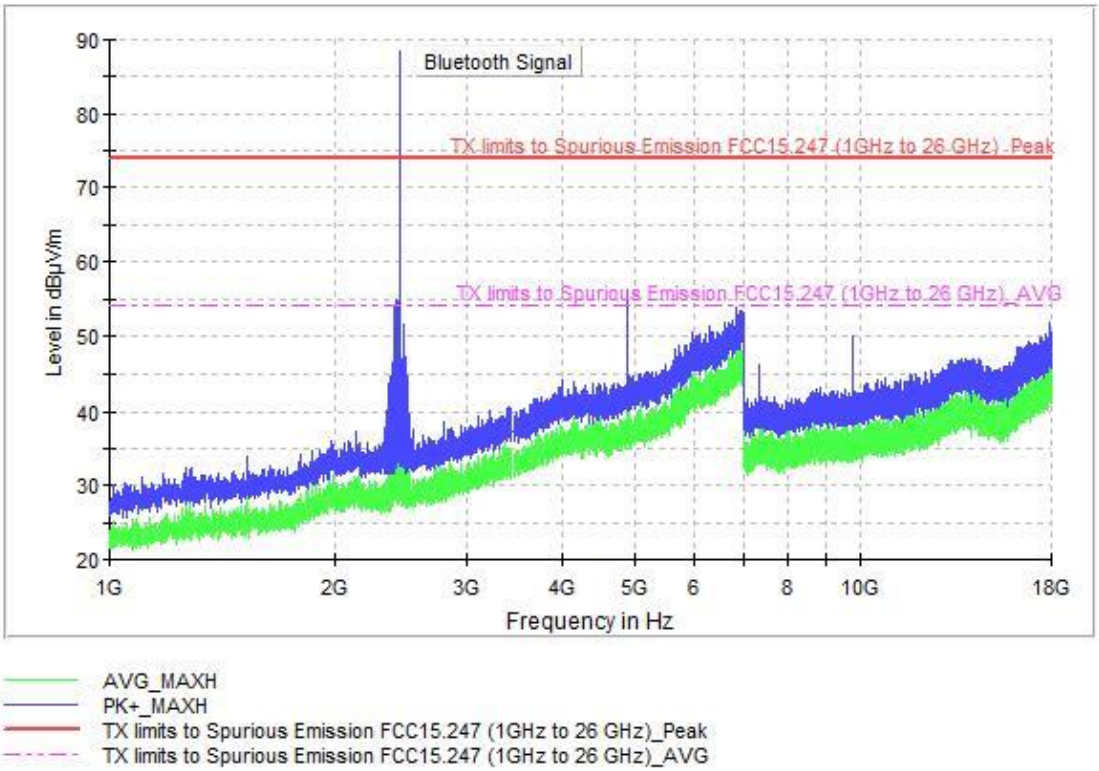


1GHz_18GHz_VP_CH Low

CHANNEL: Middle (2440 MHz)

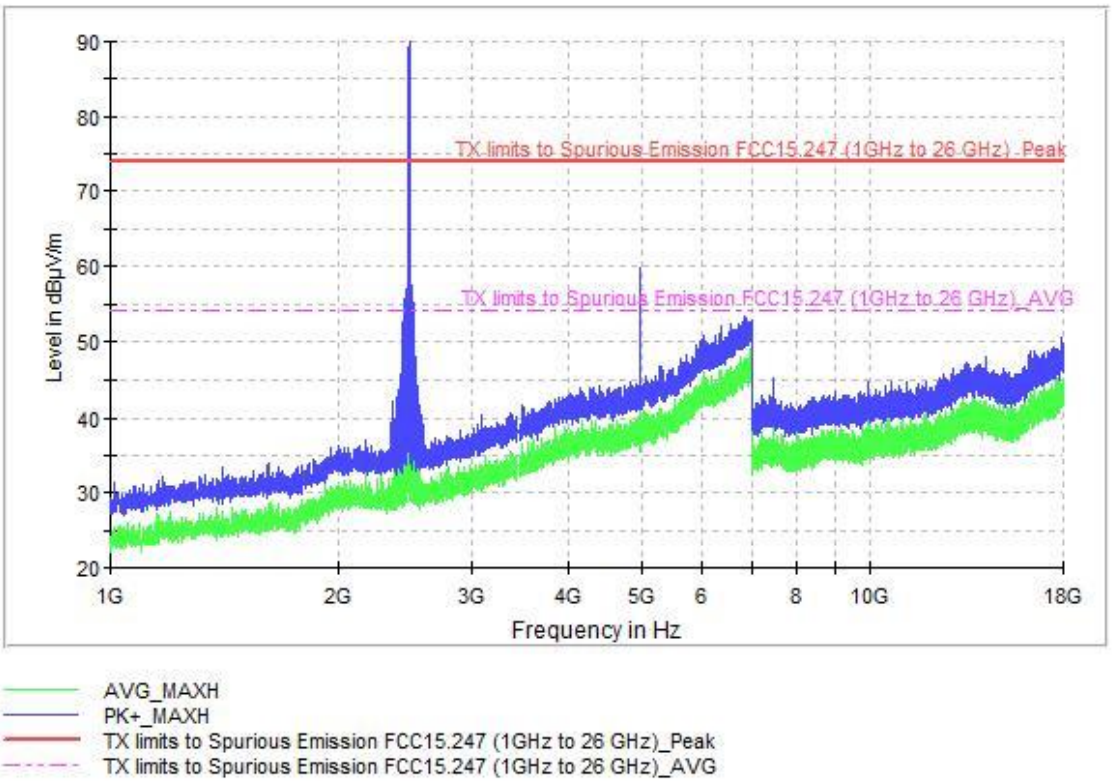


1GHz_18GHz_HP_CH Mid

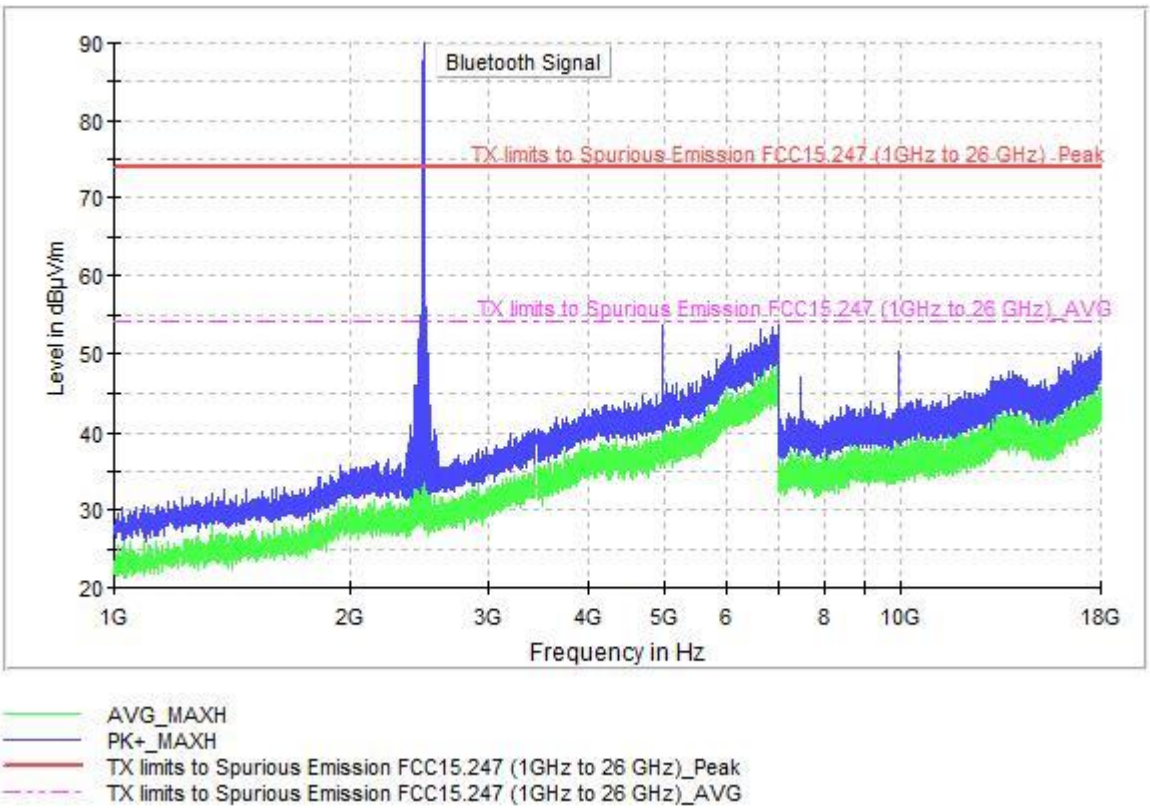


1GHz_18GHz_VP_CH Mid

CHANNEL: Highest (2480 MHz)



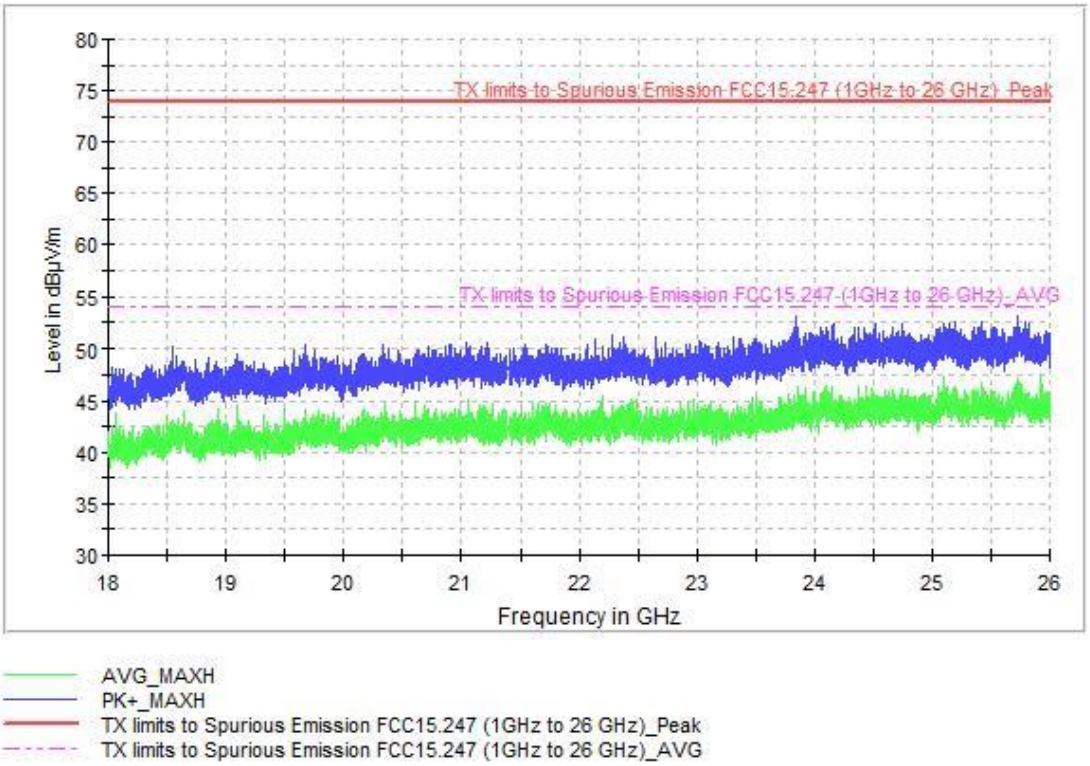
1GHz_18GHz_HP_CH High



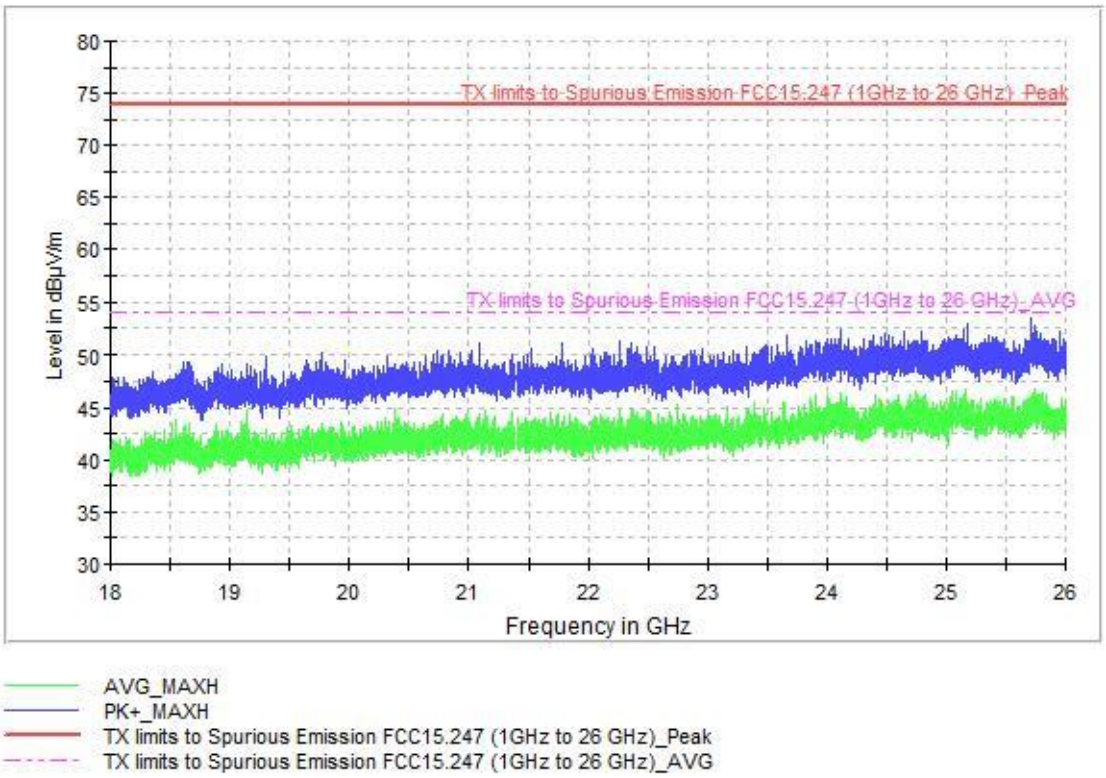
1GHz_18GHz_VP_CH High

FREQUENCY RANGE 18 GHz to 26 GHz

CHANNEL: Lowest (2402 MHz)

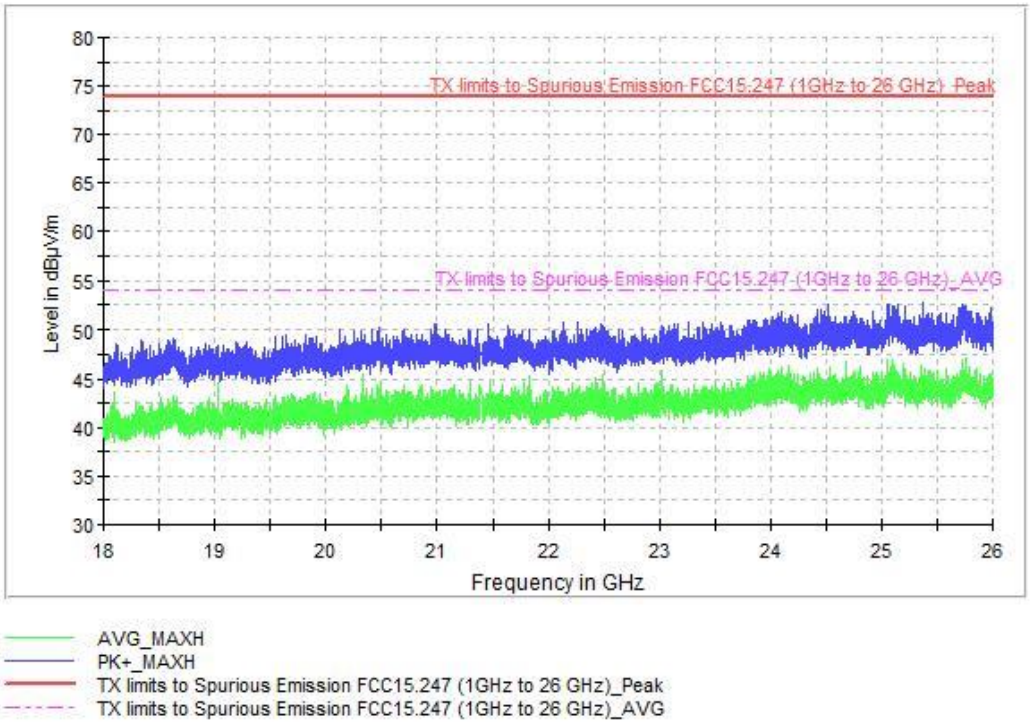


18GHz_26GHz_HP_CH Low

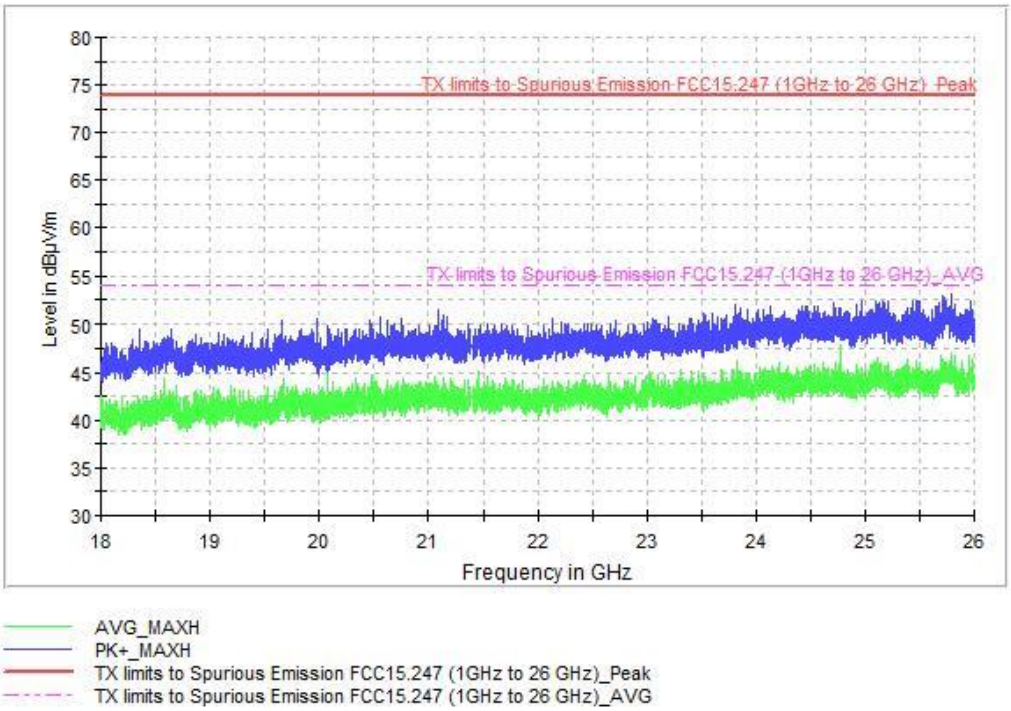


18GHz_26GHz_VP_CH Low

CHANNEL: Middle (2440 MHz)

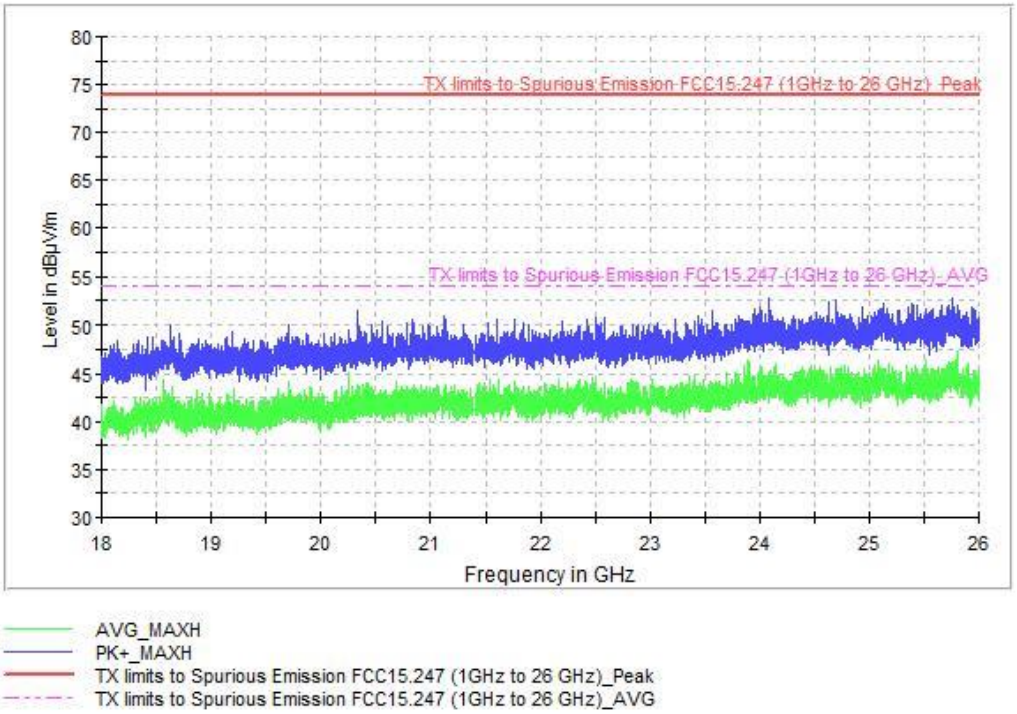


18GHz_26GHz_HP_CH Mid

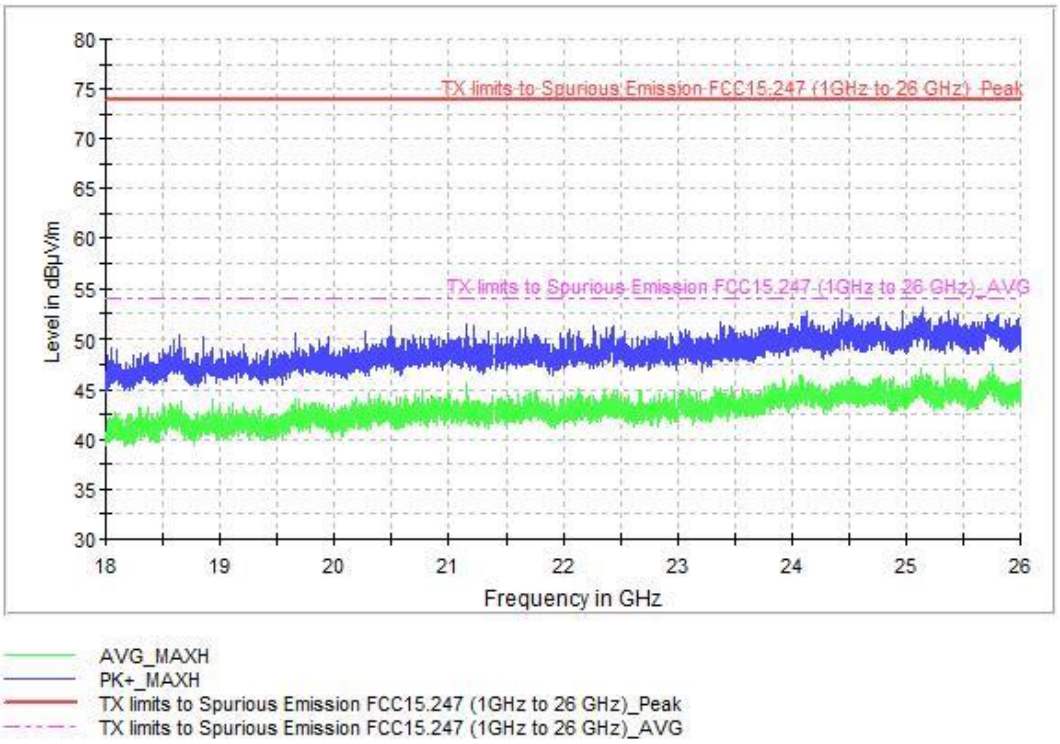


18GHz_26GHz_VP_CH Mid

CHANNEL: Highest (2480 MHz)



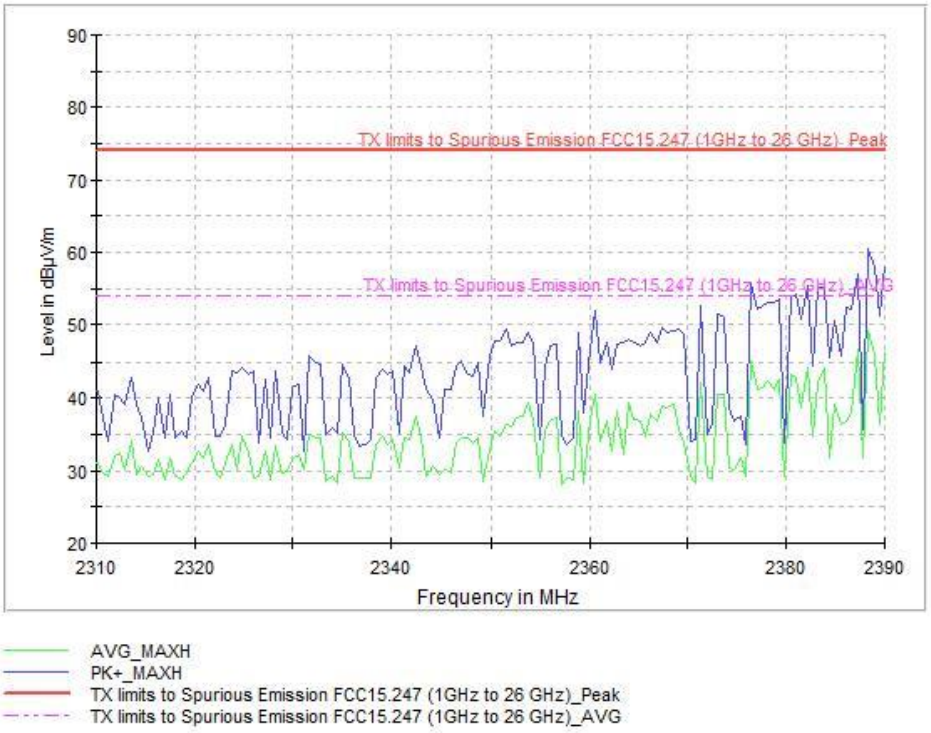
18GHz_26GHz_HP_CH High



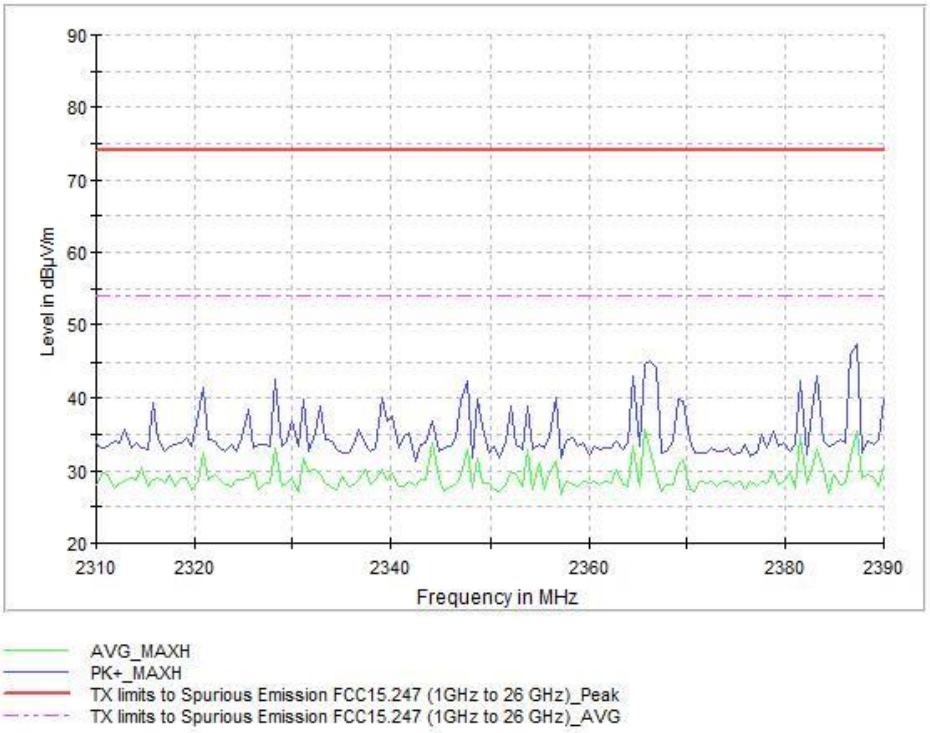
18GHz_26GHz_VP_CH High

FREQUENCY RANGE 2.31 GHz to 2.39 GHz. (RESTRICTED BAND)

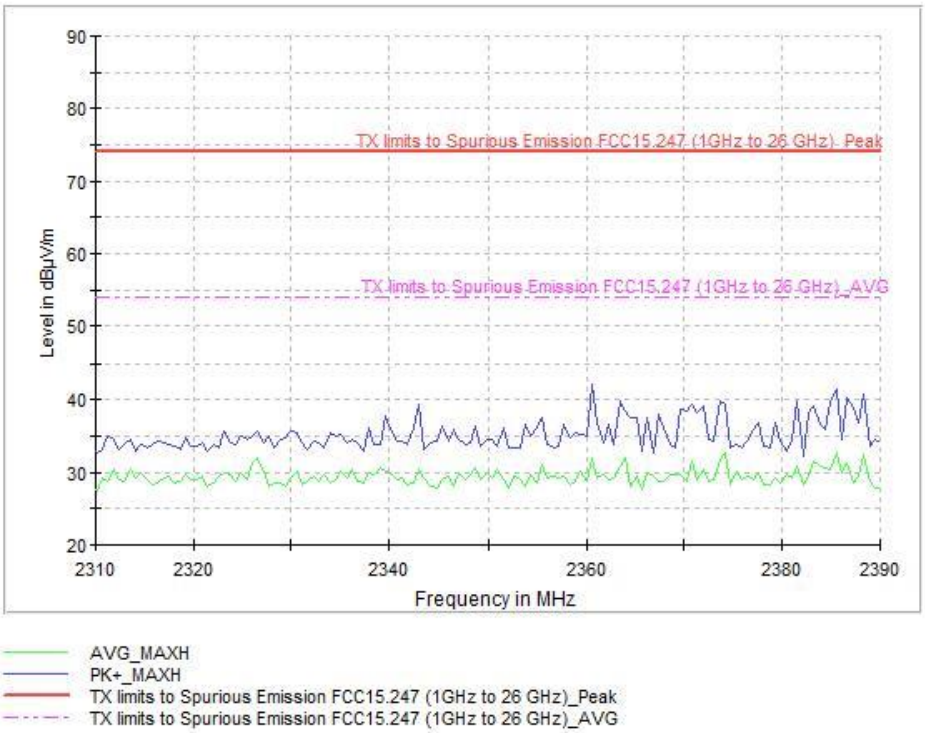
CHANNEL: Lowest (2402 MHz)



CHANNEL: Middle (2440 MHz)

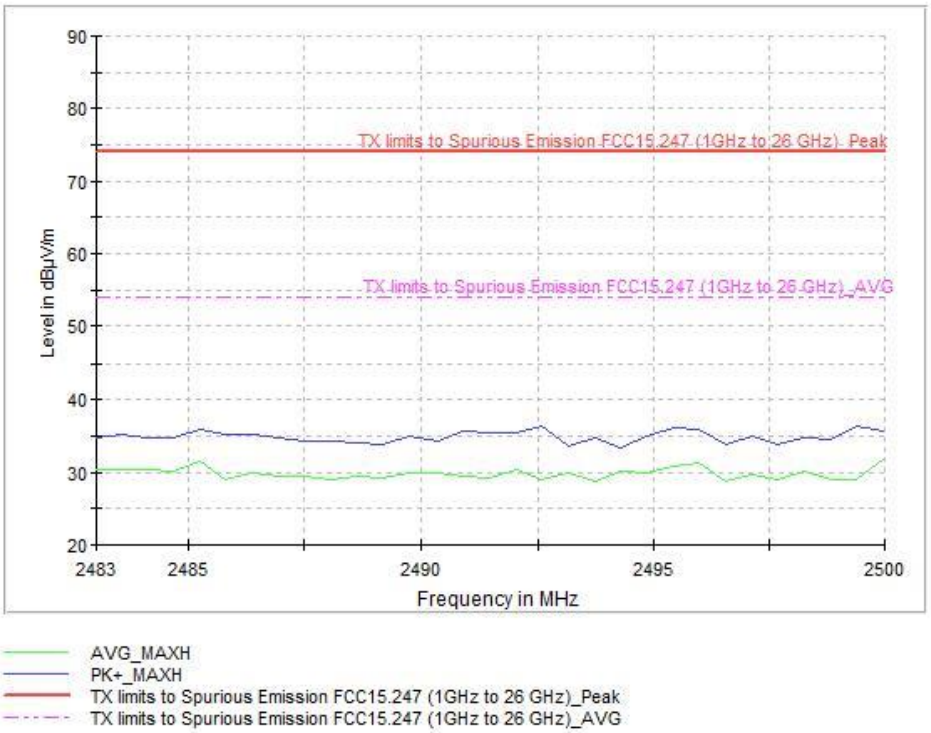


CHANNEL: Highest (2480 MHz)

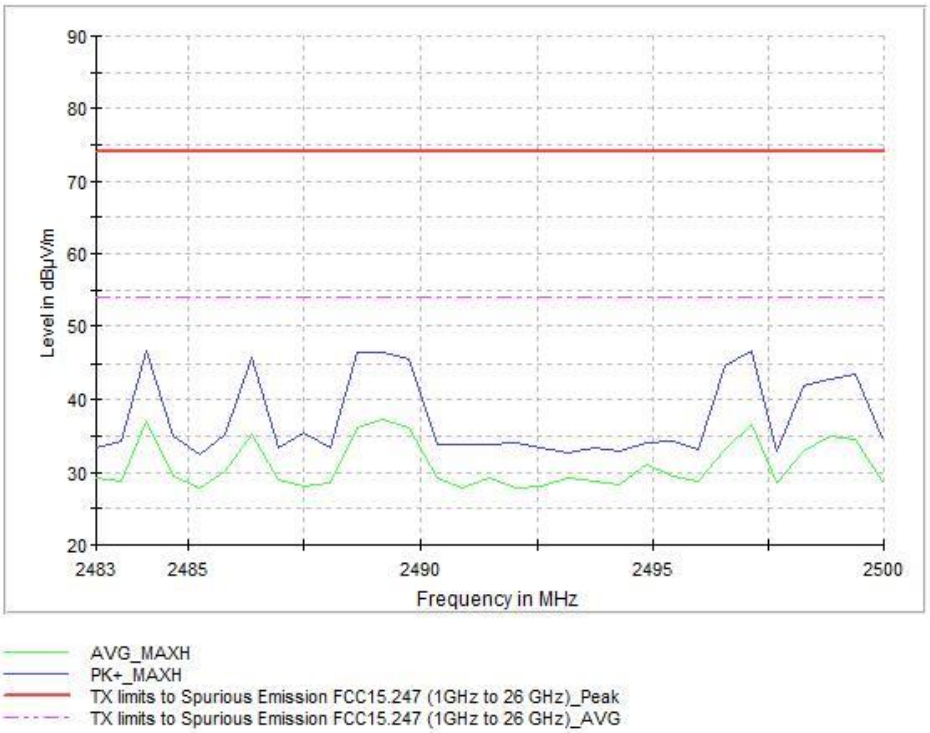


FREQUENCY RANGE 2.4835 GHz to 2.5 GHz. (RESTRICTED BAND)

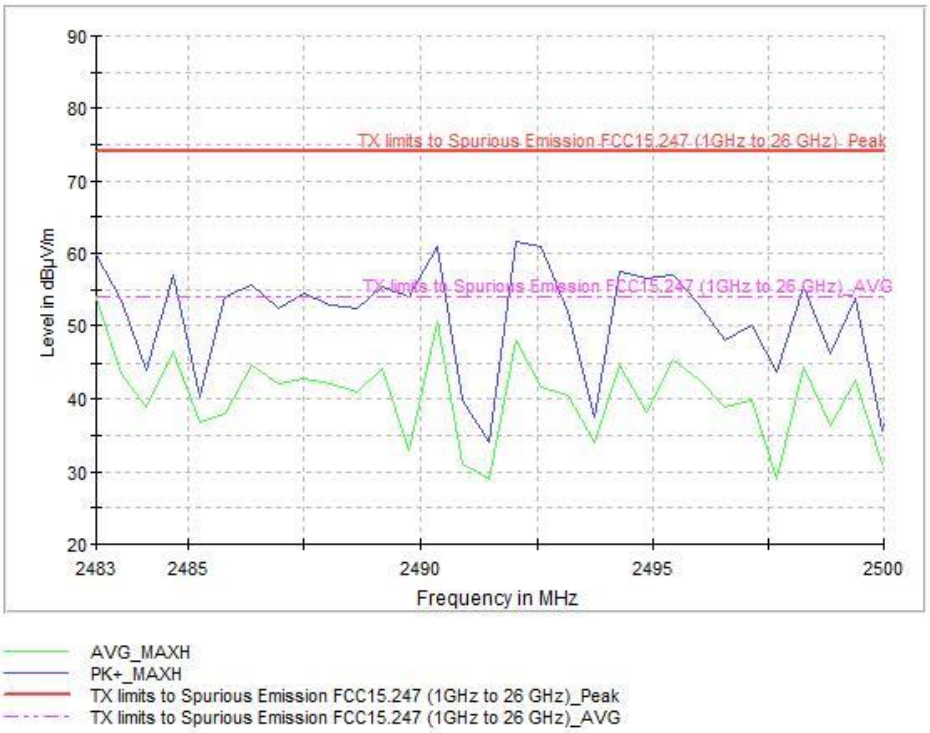
CHANNEL: Lowest (2402 MHz)



CHANNEL: Middle (2440 MHz)

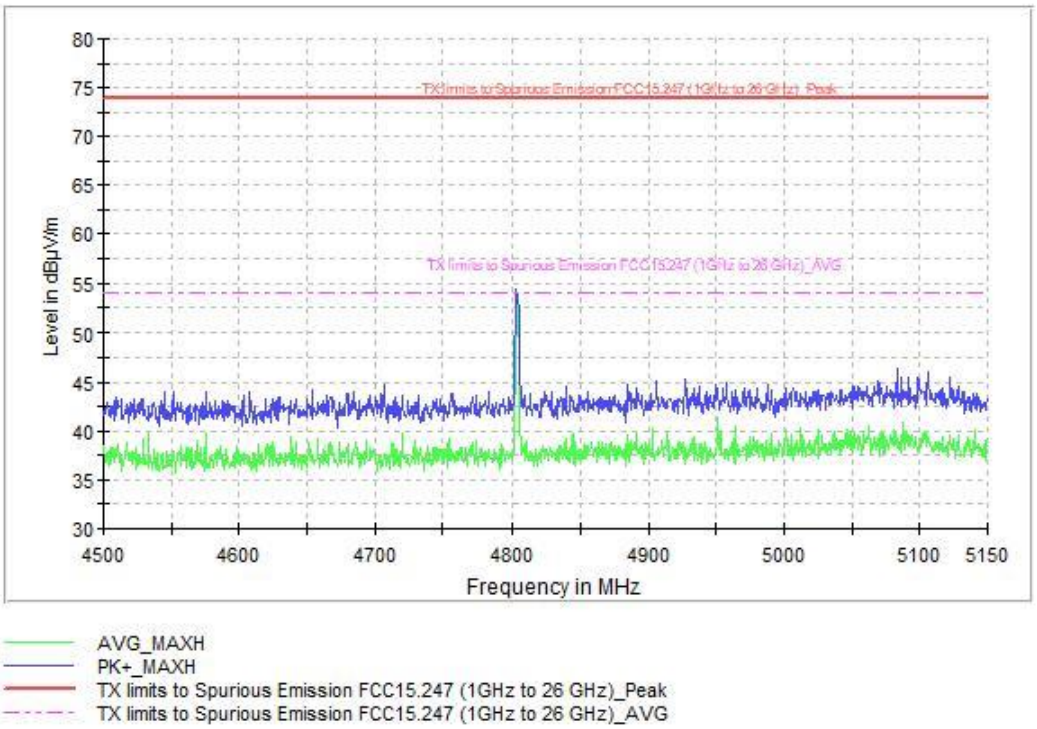


CHANNEL: Highest (2480 MHz)

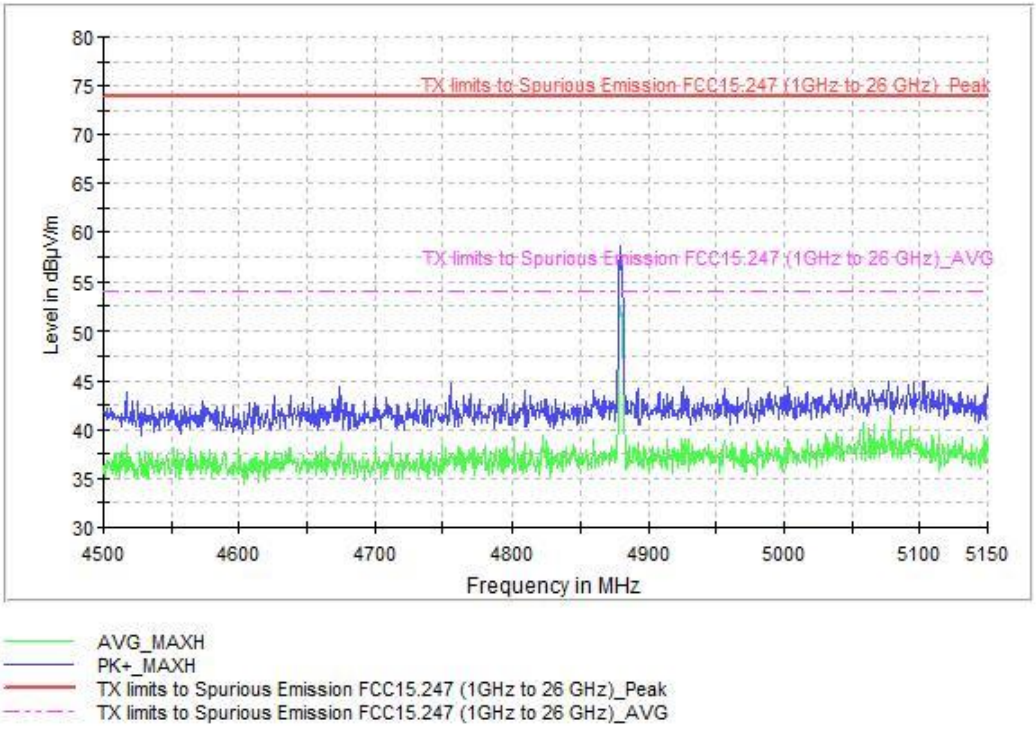
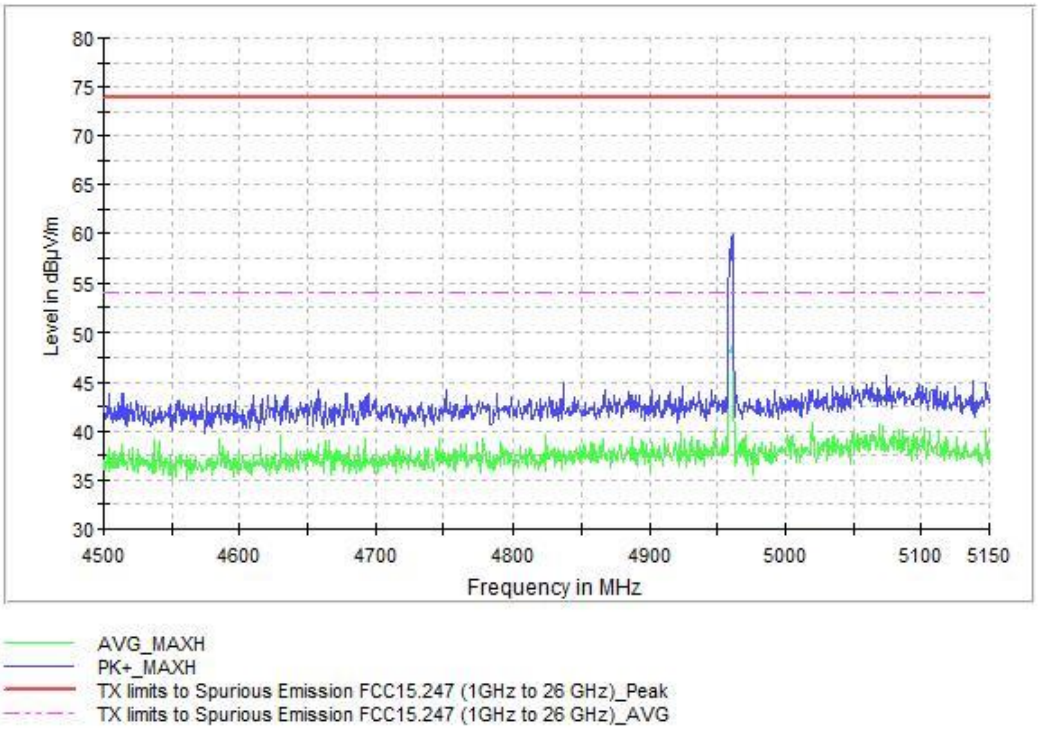


FREQUENCY RANGE 4.5 GHz to 5.15 GHz. (RESTRICTED BAND)

CHANNEL: Lowest (2402 MHz)



CHANNEL: Middle (2440 MHz)



CHANNEL: Highest (2480 MHz)