

ISED CABid: ES1909

Test Report No:
NIE: 70048RRF.007

Test Report

USA FCC Part 15.247, 15.209

CANADA RSS-247, RSS-Gen

(*) Identification of item tested	e-bike user interface controller
(*) Trademark	Bosch
(*) Model and /or type reference	BRC 3600
Other identification of the product	HW version: 5.0.2 – NDK Crystal SW version: brc3600_20201223_emc FCC ID: 2AWRC-BRC3600 IC: 26294-BRC3600
(*) Features	Bluetooth Low Energy
Manufacturer	Robert Bosch GmbH – eBike Systems Gerhard-Kindler-Strasse 3 72770 Reutlingen, Germany
Test method requested, standard	USA FCC Part 15.247 (10-1-20 Edition): Operation within the bands 902 - 928 MHz, 2400 -2483.5 MHz, and 5725 - 5850 MHz. USA FCC Part 15.209 (10-1-20 Edition): Radiated emission limits; general requirements. CANADA RSS-247 Issue 2 (February 2017). CANADA RSS-Gen Issue 5 Amendment 1 (March 2019). Guidance for Performing Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid Systems Devices Operating Under Section 15.247 of the FCC Rules. 558074 D01 Meas Guidance v05r02 dated April 2, 2019. ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices.
Summary	IN COMPLIANCE
Approved by (name / position & signature)	Rafael López EMC Consumer & RF Lab. Manager
Date of issue	2021-11-08
Report template No	FDT08_23 (*) "Data provided by the client"



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

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

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Uncertainty

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

Data provided by the client

The following data has been provided by the client:

Identification of item tested	e-bike user interface controller
Trademark (Brand name)	Bosch
Model name	BRC 3600
Detailed description of product:	e-bike user interface controller with BLE

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

Usage of samples

Samples undergoing test have been selected by: the client.

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

Control N°	Description	Model	Serial N°	Date of reception
70048_15.1	Control Unit (Conducted)	BRC 3600	17516-0001-01-368-00-0000	2021-10-15

Auxiliary elements used with S/01:

Control N°	Description	Model	Serial N°	Date of reception
70048_8.1	USB Cable	--	--	2021-10-15
70048_10.1	USB TTL	--	--	2021-10-15

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

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

Control N°	Description	Model	Serial N°	Date of reception
70048_11.1	Power cable	--	--	2021-10-15
70048_23.1	Control Unit (Radiated)	BRC 3600	17517-0003-01-368-00-0000	2021-10-15

Sample S/02 has undergone the test(s): All Radiated tests indicated in Appendix A.

Test sample description

Ports..... :	Port name and description	Cable					
		Specified max length [m]	Attached during test	Shielded	Coupled to patient ⁽³⁾		
	USB service port (USB-C interface for service)		[]	[]	[]		
	System cable connector (Supply+CAN FD) connected to ebike		[X]	[]	[]		
			[]	[]	[]		
			[]	[]	[]		
			[]	[]	[]		
			[]	[]	[]		
	Supplementary information to the ports..... :						
Rated power supply	Voltage and Frequency		Reference poles				
			L1	L2	L3	N	PE
	[]	AC:	[]	[]	[]	[]	[]
	[]	AC:	[]	[]	[]	[]	[]
	[X]	DC: USB port, nom. 5VDC					
	[X]	DC: System cable, nom. 13,5VDC					
Rated Power	System cable: max. 2,7W (13,5V/0,2A) / USB port: max. 2,5W (5V/0,5A)						
Clock frequencies.....	110MHz, 55MHz, 48MHz, 2MHz, 1.1MHz						
Other parameters							
Software version	brc3600_20201223_emc						
Hardware version	HW 5.0.2 – NDK Crystal						
Dimensions in cm (W x H x D)	72,8 x 53,2 x 34,3 mm						
Mounting position	[]	Table top equipment					
	[]	Wall/Ceiling mounted equipment					
	[]	Floor standing equipment					

	[]	Hand-held equipment		
	[X]	Other: Bicycle handlebar		
Modules/parts.....:	Module/parts of test item		Type	Manufacturer
				
				
				
				
Accessories (not part of the test item)	Description		Type	Manufacturer
				
				
				
				
				
				
Documents as provided by the applicant.....:	Description		File name	Issue date
				
				
				
				

⁽³⁾ Only for Medical Equipment

Identification of the client

Bittium Wireless OY
Ritaharjuntie 1, 90590 Oulu, Finland

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2021-10-16
Date (finish)	2021-10-18

Document history

Report number	Date	Description
70048RRF.007	2021-11-08	First release.

Environmental conditions

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

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

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

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

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. = 75 %

Remarks and comments

The tests have been performed by the technical personnel: Jaime Barranquero Gómez, Javier Miguel Nadales Lisbona and Antonio Manuel Sánchez.

Used instrumentation:

Conducted Measurements:

Equipment	Latest Calibration	Next Calibration
Shielded Room ETS LINDGREN S101	N.A.	N.A.
SIGNAL AND SPECTRUM ANALYZER 2Hz-50GHz ROHDE AND SCHWARZ FSW50	2019-10-29	2021-10-29
OPEN SWITCH UNIT UP TO 40GHz Rohde&Schwarz OSP-B157Wx	2021-03-18	2023-03-18
DC POWER SUPPLY 30V/3A 90W GW INSTEK GPS-3030D	N.A.	N.A.
Digital Multimeter Fluke 175	2020-11-04	2021-11-04

Radiated Measurements:

Equipment	Latest Calibration	Next Calibration
Semianechoic Absorber Lined Chamber ALBATROSS P29419	N.A.	N.A.
SHIELDED ROOM ALBATROSS P29419	N.A.	N.A.
ULTRALOG ANTENNA 30MHz-6GHz ROHDE AND SCHWARZ HL562E_UPG	2019-10-15	2022-10-15
HORN ANTENNA 1-18GHz SCHWARZBECK MESS-ELEKTRONIK BBHA 9120D	2019-11-15	2022-11-15
HORN ANTENNA 18-40GHz SCHWARZBECK BBHA 9170	2021-03-19	2024-03-19
PREAMPLIFIER 30dB 500MHz-18GHz SCHWARZBECK BBV 9718 C	2019-11-21	2021-11-21
PRE-AMPLIFIER G>30dB 18-40GHz BONN ELEKTRONIK BLMA 1840-3G	2019-11-21	2021-11-21
EMI TEST RECEIVER 2Hz-44GHz ROHDE AND SCHWARZ ESW44	2019-10-29	2021-10-29

Testing verdicts

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

Summary

Bluetooth Low Energy 5.0 (1M)

Requirement – Test case	FCC PART 15 PARAGRAPH / RSS-247	Verdict	Remark
RSS-247 5.2 (a) / FCC 15.247 (a) (2) 6 dB Bandwidth		Pass	
RSS-247 5.2 (b) / FCC 15.247 (e) Power spectral density		Pass	
RSS-247 5.4 (d) / FCC 15.247 (b) (3) Maximum Peak Conducted output power		Pass	
RSS-247 5.5 / FCC 15.247 (d) Band-edge emissions compliance (Transmitter)		Pass	
RSS-247 5.5 / FCC 15.247 (d) Emission limitations radiated (Transmitter)		Pass	
Occupied Channel Bandwidth 99%		Pass	
<u>Supplementary information and remarks:</u> None.			

Appendix A: Test results. Bluetooth Low Energy 5.0 (1M)

TEST CONDITIONS	12
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FCC 47 CFR PART 15.247 / RSS-247	15
<i>Occupied Channel Bandwidth 99%</i>	15
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<i>RSS-247 5.2 (b) / FCC 15.247 (e) Power spectral density</i>	21
<i>RSS-247 5.4 (d) / FCC 15.247 (b) (3) Maximum Peak Conducted output power</i>	24
<i>RSS-247 5.5 / FCC 15.247 (d) Band-edge emissions compliance (Transmitter)</i>	27
<i>RSS-247 5.5 / FCC 15.247 (d) Emission limitations radiated (Transmitter)</i>	29

TEST CONDITIONS

(*): Data provided by the client.

POWER SUPPLY (*):

Vnominal:	13.5 VDC
Type of Power Supply:	External DC Power supply

ANTENNA (*):

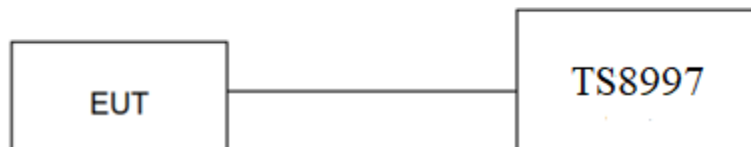
Type of Antenna:	IFA
Maximum Declared Antenna Gain:	3.6 dBi

TEST FREQUENCIES (*):

Low Channel:	2402 MHz
Middle Channel:	2440 MHz
High Channel:	2480 MHz

CONDUCTED MEASUREMENTS:

The equipment under test was set up in a shielded room and it connected to the TS8997 test bench using a low-loss RF cable. The reading of the spectrum analyser is corrected taking into account the cable loss.



RADIATED MEASUREMENTS:

All radiated tests were performed in a semi-anechoic chamber. The measurement antenna (Bilog antenna for the range from 30 MHz to 1000 MHz and Double ridged horn antenna for the range from 1 to 17 GHz) is situated at a distance of 3 m and at a distance of 1 m for the frequency range 17 GHz – 26 GHz (17 GHz – 40 GHz horn antenna).

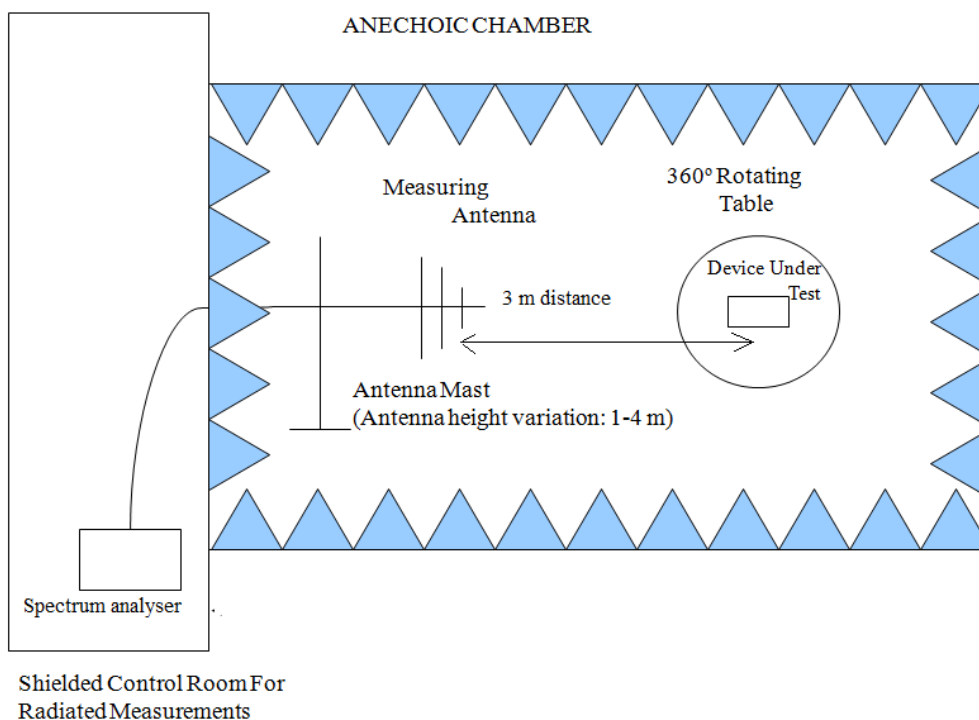
For radiated emissions in the range 17 GHz – 26 GHz performed at a distance closer than the distance specified in standard, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

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 360° and the antenna height (Bilog antenna and Double ridged horn antenna) was varied from 1 to 4 meters to find the maximum radiated emission.

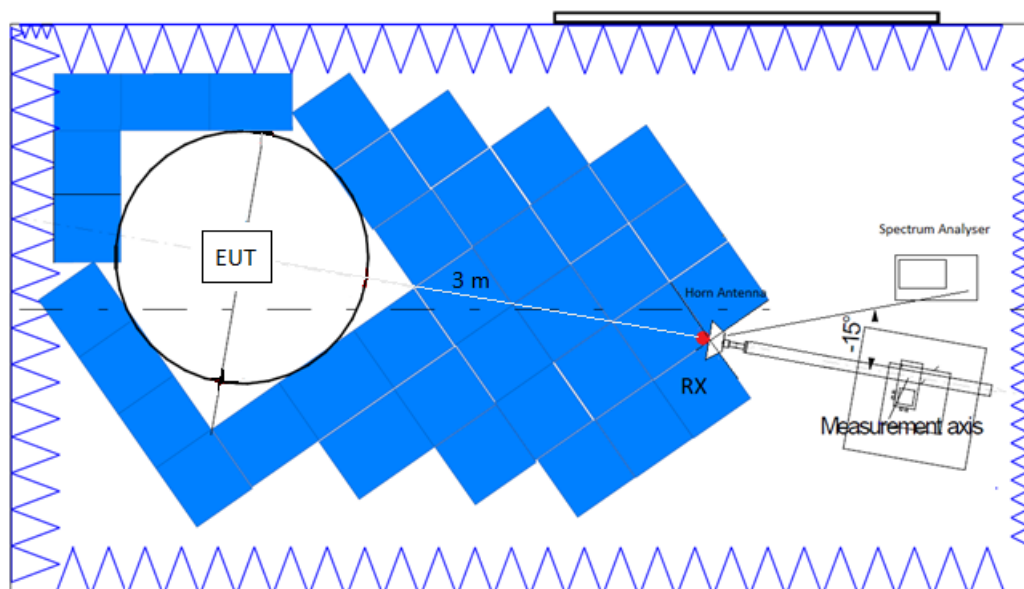
Measurements were made in both horizontal and vertical planes of polarization.

A resolution bandwidth/video bandwidth of 100 kHz / 300 kHz was used for frequencies below 1 GHz and 1 MHz / 3 MHz for frequencies above 1 GHz.

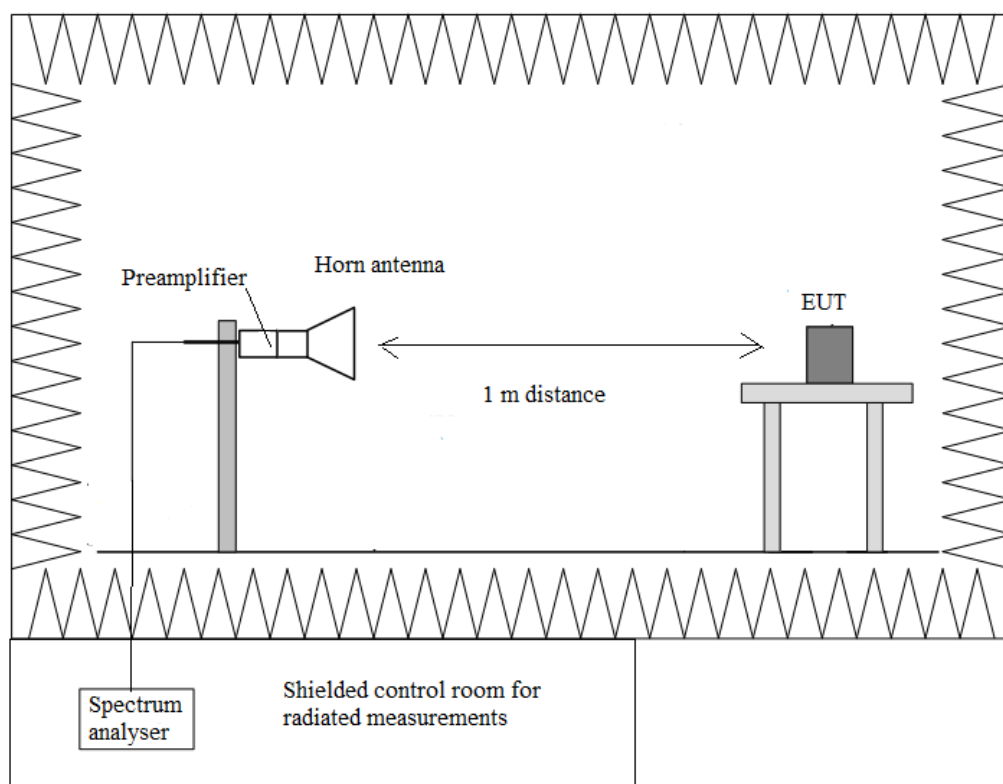
Radiated measurements setup from 30 MHz to 1 GHz:



Radiated measurements setup from 1 GHz to 17 GHz:



Radiated measurements setup $f > 17$ GHz:



TEST CASES DETAILS

FCC 47 CFR Part 15.247 / RSS-247 Occupied Channel Bandwidth 99%

Results

Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Operation Band (MHz)	Freq (MHz)	Equipment	Occupied Channel BW (MHz)
[2400, 2483.5]	2402.00	Digital Transmission System (DTS)	1.060000
	2440.00		1.060000
	2480.00		1.070000

Verdict

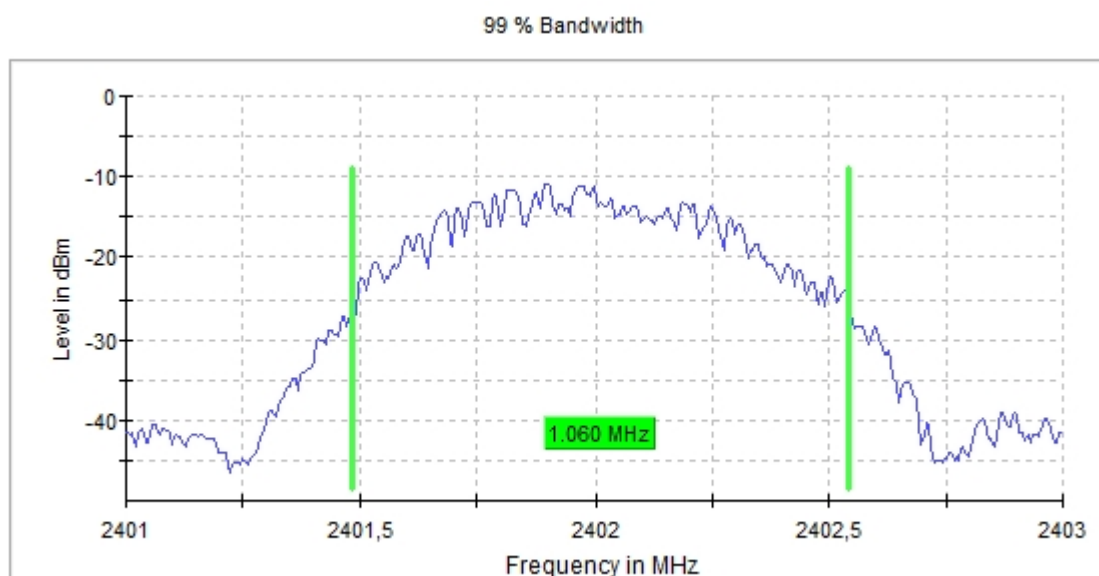
Pass

Uncertainty

< ±1.17 %

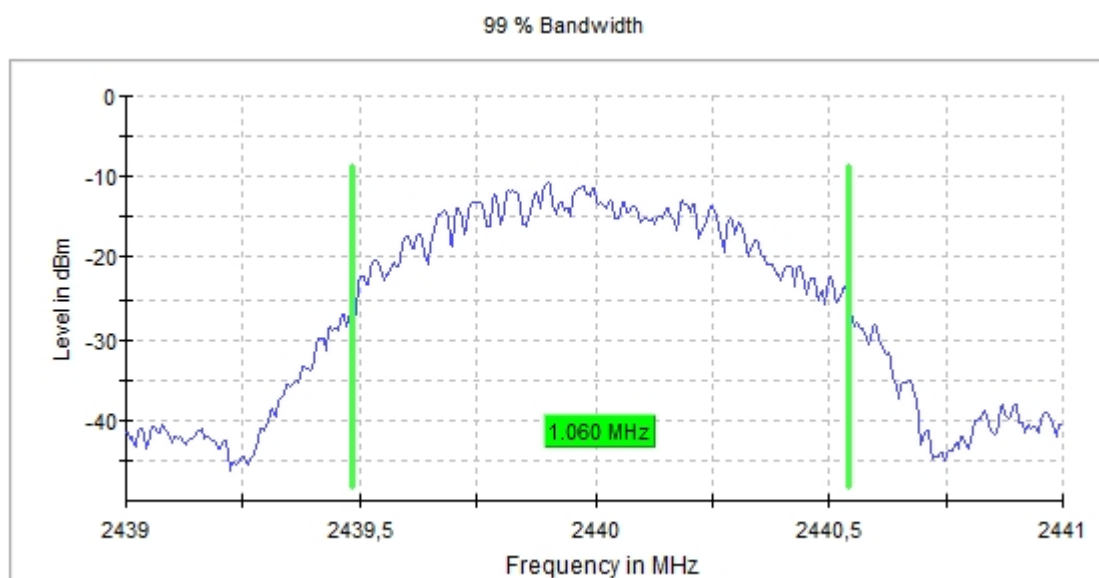
Frequency (MHz) = 2402.00, Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:



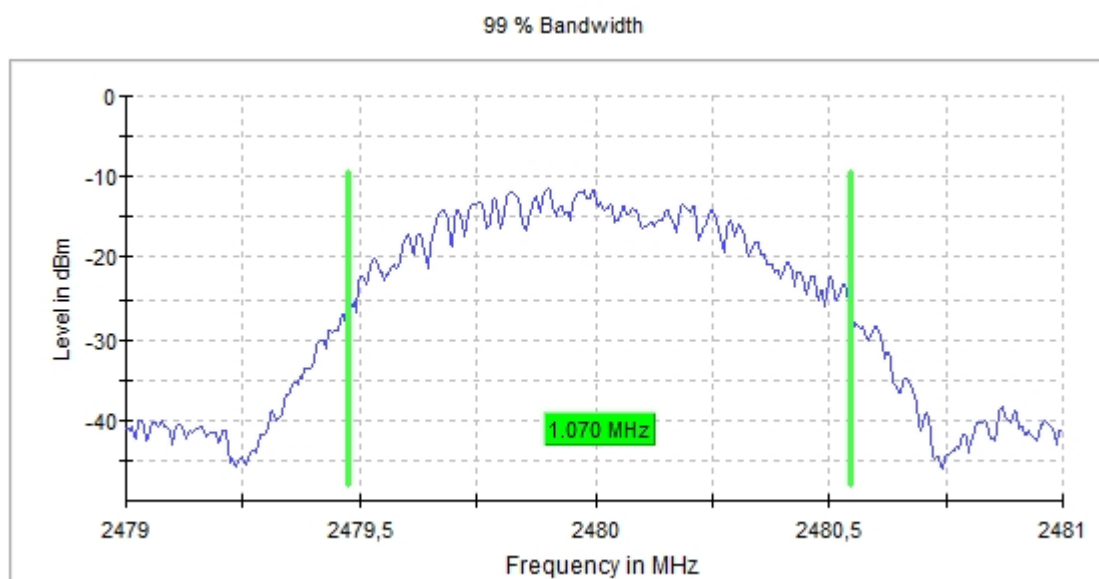
Frequency (MHz) = 2440.00, Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:



Frequency (MHz) = 2480.00, Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:



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

Limits

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

Results

Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Operation Band (MHz)	Freq (MHz)	Equipment	6dB Bandwidth (MHz)
[2400, 2483.5]	2402.00	Digital Transmission System (DTS)	0.732674
	2440.00		0.811882
	2480.00		0.811882

Verdict

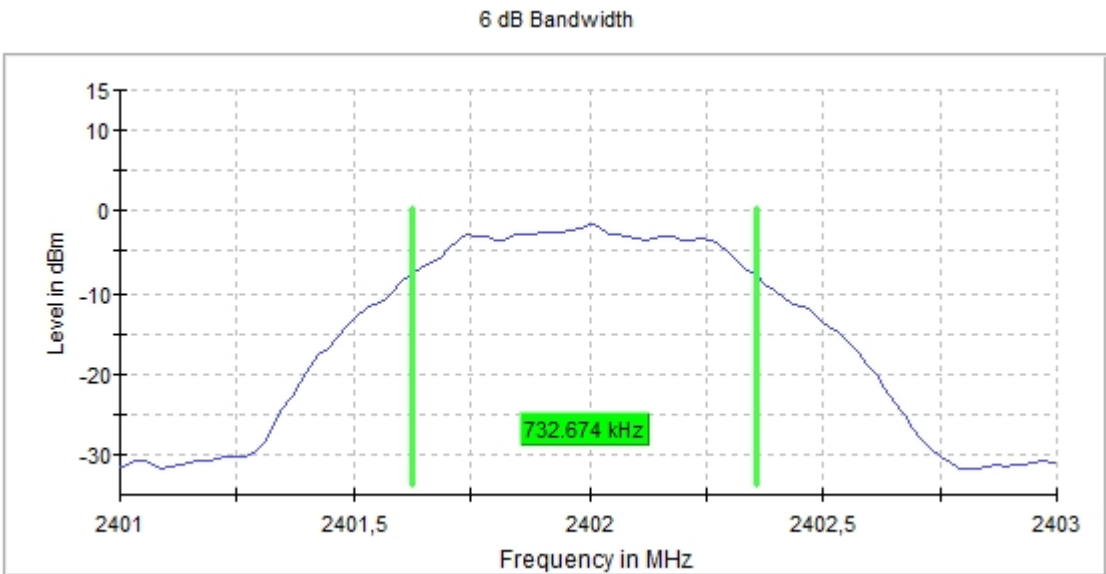
Pass

Uncertainty

< ±2.84 %

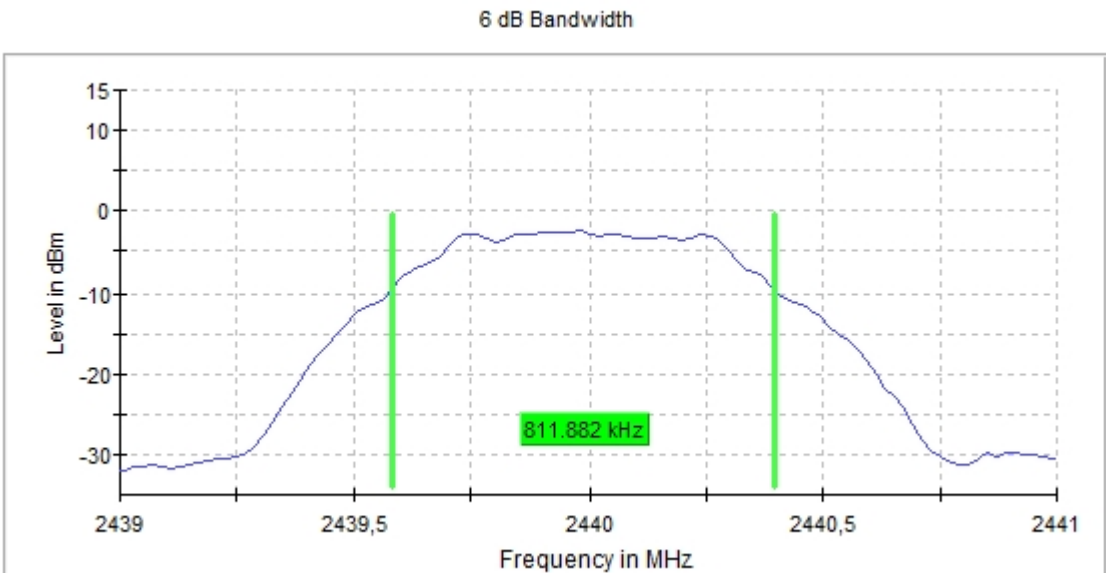
Frequency (MHz) = 2402.00, Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:



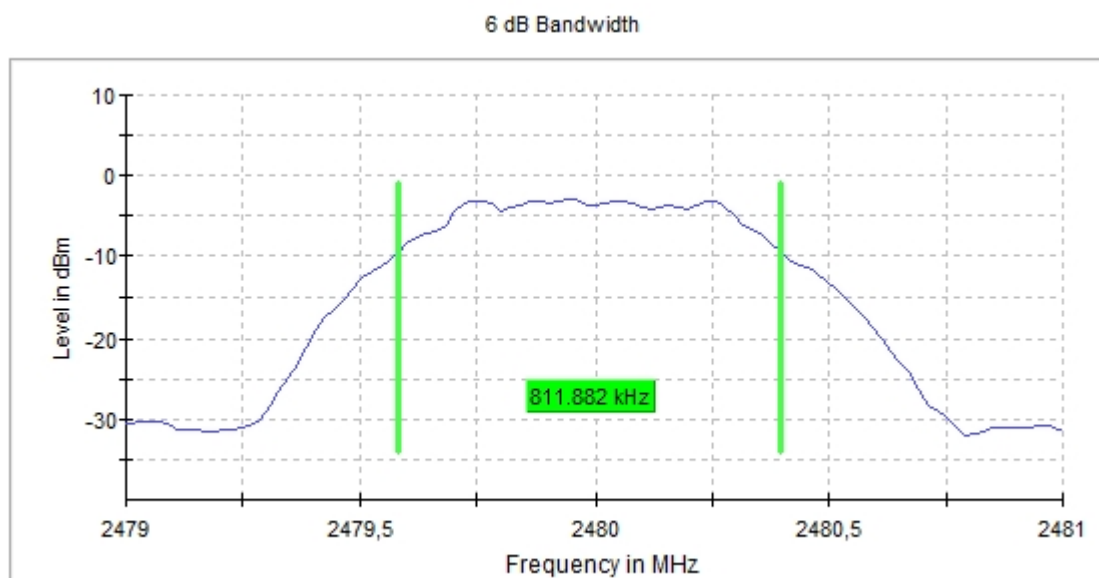
Frequency (MHz) = 2440.00, Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:



Frequency (MHz) = 2480.00, Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:



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

Limits

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 of the fundamental emission was measured according to clause 11.10.2 "Method PKPSD (peak PSD)" of ANSI C63.10-2013.

Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Operation Band (MHz)	Freq (MHz)	Equipment	PSD (dBm)
[2400, 2483.5]	2402.00	Digital Transmission System (DTS)	-10.783000
	2440.00		-10.986000
	2480.00		-11.351000

Verdict

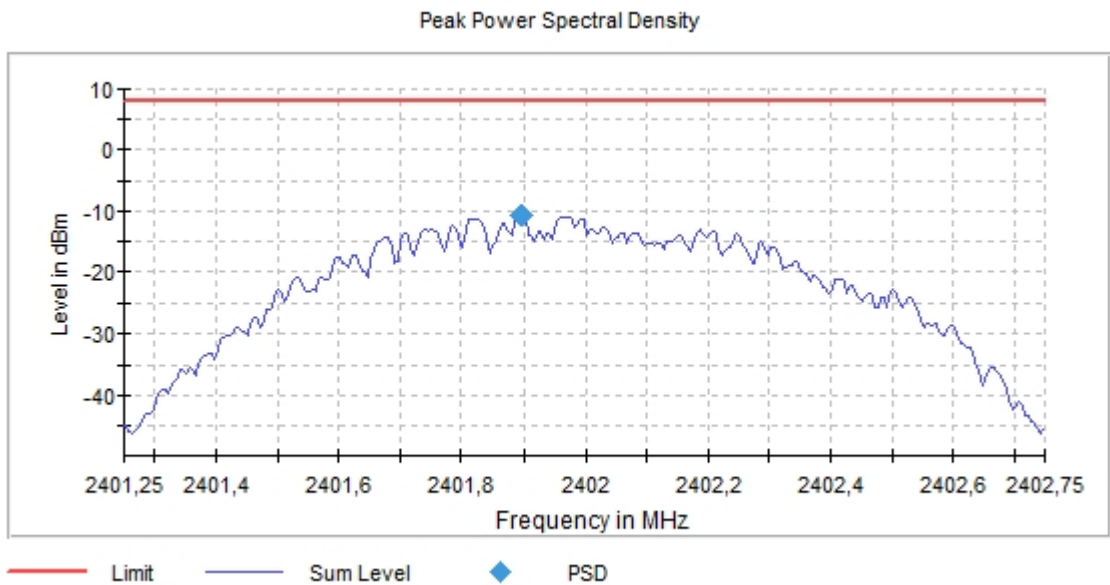
Pass

Uncertainty

< ±0.99 dB

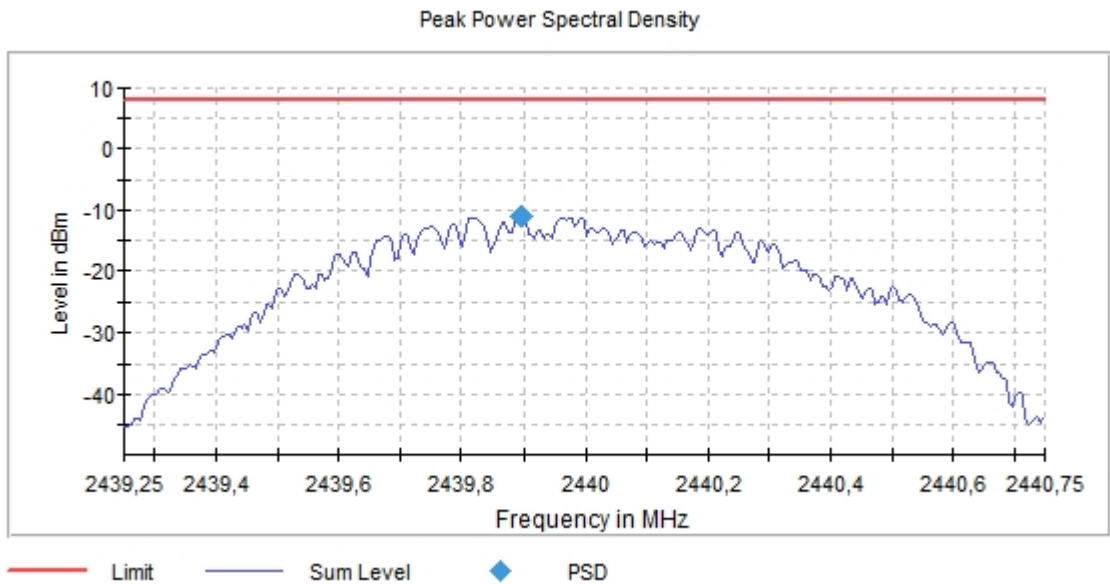
Frequency (MHz) = 2402.00, Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:



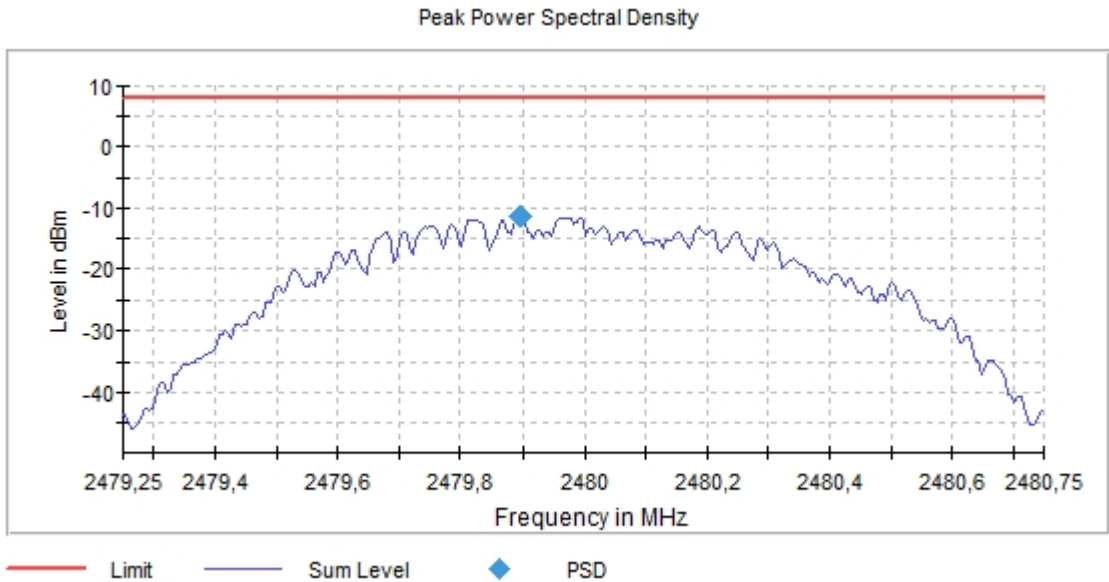
Frequency (MHz) = 2440.00, Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:



Frequency (MHz) = 2480.00, Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:



RSS-247 5.4 (d) / FCC 15.247 (b) (3) Maximum Peak Conducted output power

Limits

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 level of the fundamental emission was measured according to clause 11.9.1.1 "RBW $\geq$ DTS bandwidth" of ANSI C63.10-2013.

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

Maximum Declared Antenna Gain: 3.6 dBi

Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Operation Band (MHz)	Freq (MHz)	Equipment	Maximum Conducted Power (dBm)	Maximum EIRP Power (dBm)
[2400, 2483.5]	2402.00	Digital Transmission System (DTS)	-0.9	2.7
	2440.00		-0.9	2.7
	2480.00		-1.2	2.4

Verdict

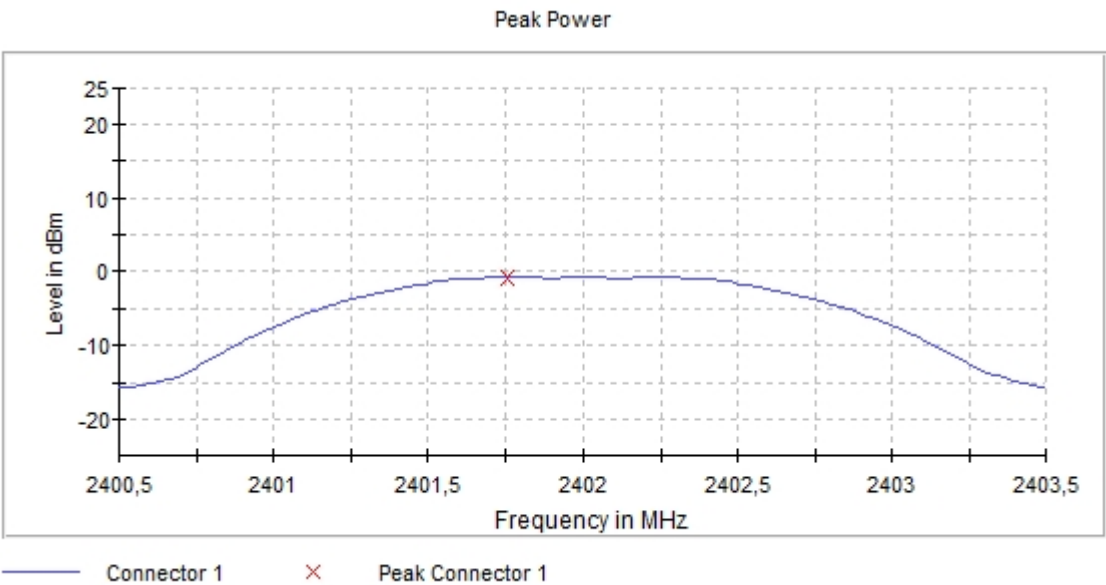
Pass

Uncertainty

< ± 0.80 dB

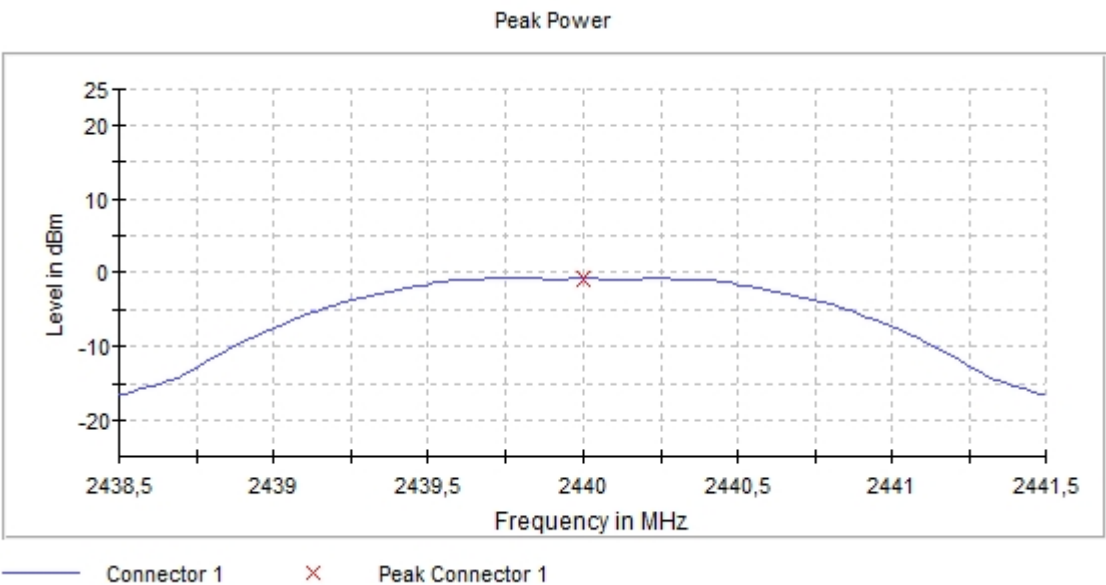
Frequency (MHz) = 2402.00, Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:



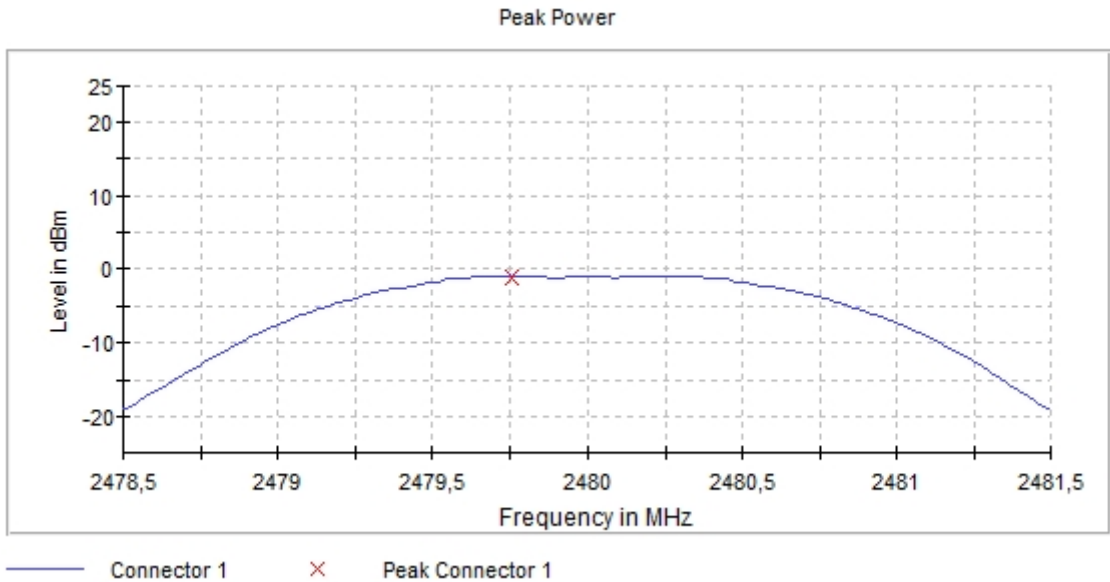
Frequency (MHz) = 2440.00, Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:



Frequency (MHz) = 2480.00, Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:



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

Limits

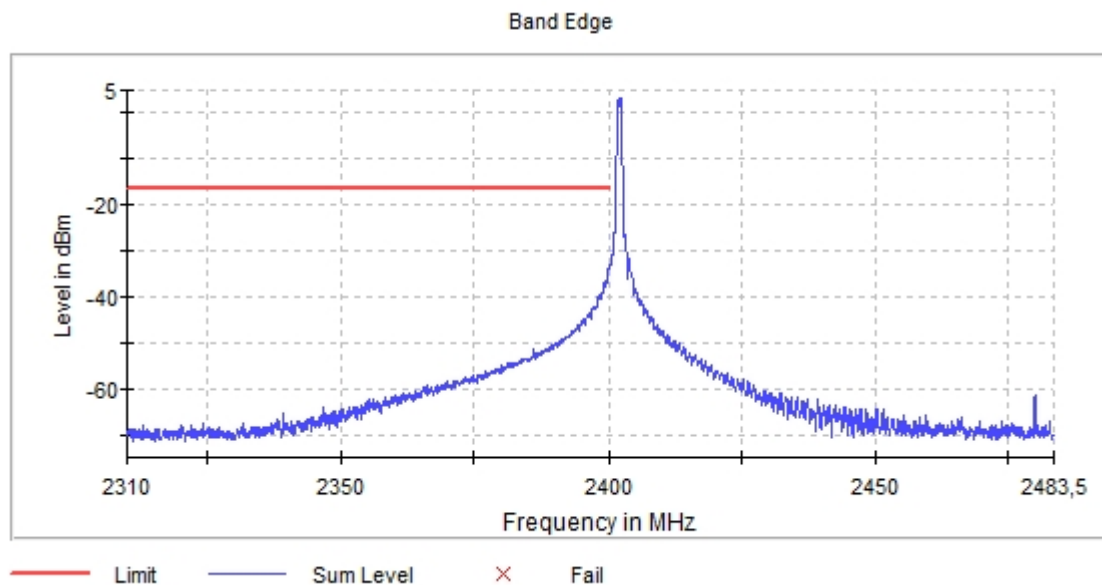
In any 100 kHz bandwidths outside the frequency band in which the intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, 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, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

Results

Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

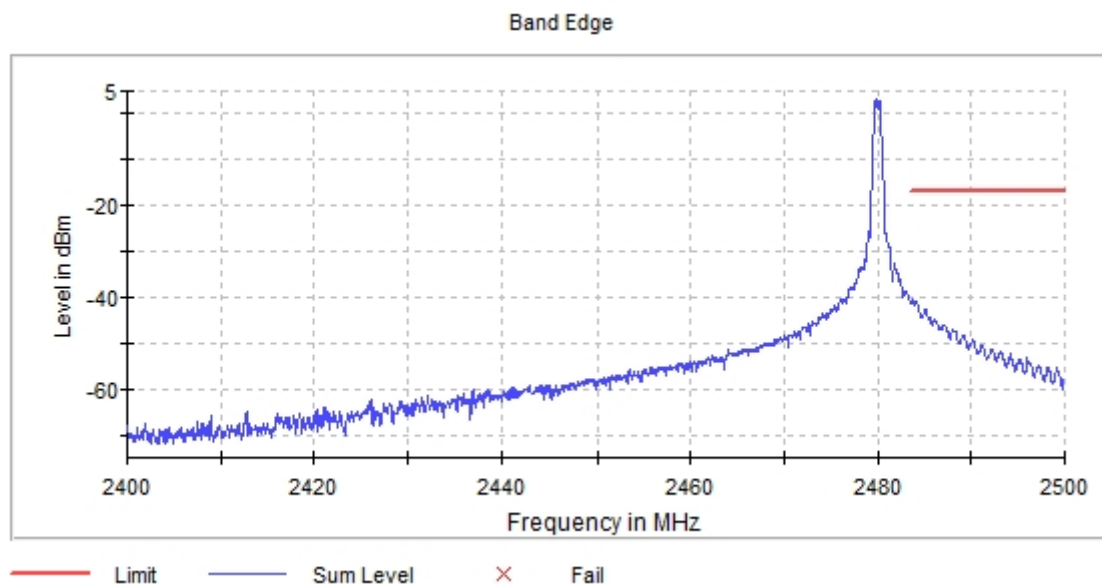
Frequency (MHz) = 2402.00, Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:



Frequency (MHz) = 2480.00, Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:



Verdict

Pass

Uncertainty

< ±1.76 dB

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

Limits

Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)/RSS-Gen):

Frequency Range (MHz)	Field strength (µV/m)	Field strength (dBµV/m)	Measurement distance (m)
0.009 - 0.490	2400/F(kHz)	-	300
0.490 - 1.705	24000/F(kHz)	-	30
1.705 - 30.0	30	-	30
30 - 88	100	40	3
88 - 216	150	43.5	3
216 - 960	200	46	3
Above 960	500	54	3

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

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

RSS-247:

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

Results

The situation and orientation of the EUT were 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.

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

Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Frequency range 30 MHz – 1 GHz:

Spurious frequencies do not depend on the operating channel.

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

Frequency range 1 GHz – 26 GHz:

The results in the next tables show the maximum measured levels in the 1 – 26 GHz range including the restricted bands 2.31 – 2.39 GHz and 2.4835 – 2.5 GHz.

Spurious frequencies with peak levels above the average limit (54 dB μ V/m at 3 m) are measured with average detector to check compliance with the average limit.

- Low Channel:

Spurious frequency (GHz)	Emission Level (dB μ V/m)	Polarization	Detector
2.3889	60.60	H	Peak
	40.23		Average
4.8040	53.25	V	Peak

- Middle Channel:

Spurious frequency (GHz)	Emission Level (dB μ V/m)	Polarization	Detector
4.8790	47.63	V	Peak

- High Channel:

Spurious frequency (GHz)	Emission Level (dB μ V/m)	Polarization	Detector
2.3829	53.52	V	Peak
	40.16		Average
4.9605	49.98	V	Peak

Verdict

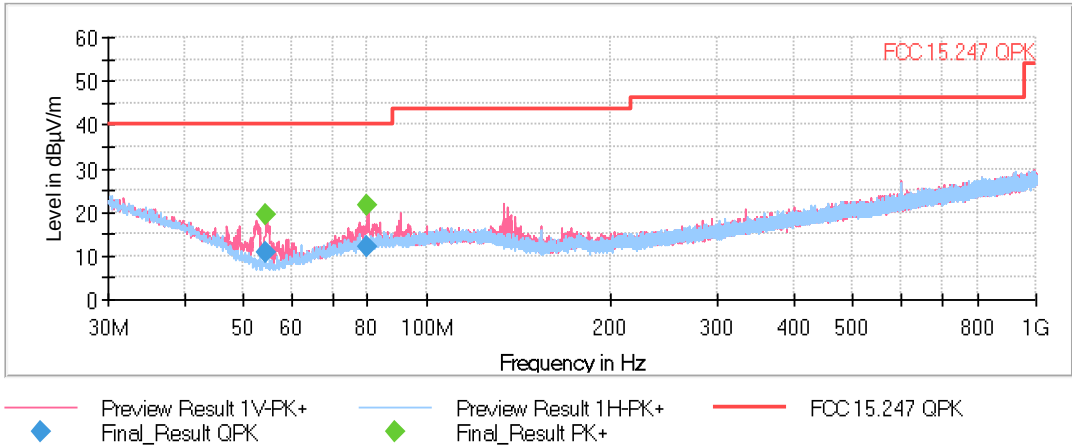
Pass

Uncertainty

Measurement Uncertainty:	< ± 5.15 dB,	30MHz < f < 1 GHz
	< ± 4.01 dB,	1GHz < f < 3 GHz
	< ± 4.28 dB,	3 GHz < f < 17 GHz
	< ± 4.89 dB,	17 GHz < f < 26 GHz

Modulation: BTLE 5.0 (GFSK 1 Mbit/s), Frequency Range (GHz) = [0.03, 1]

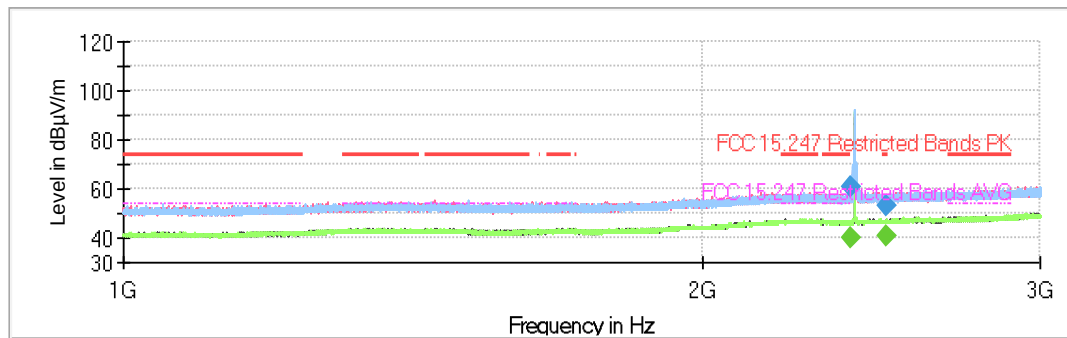
Plots:



This plot is valid for the Low, Middle and High Channels.

Frequency (MHz) = 2402.00, Modulation: BTLE 5.0 (GFSK 1 Mbit/s), Frequency Range (GHz) = [1, 3]

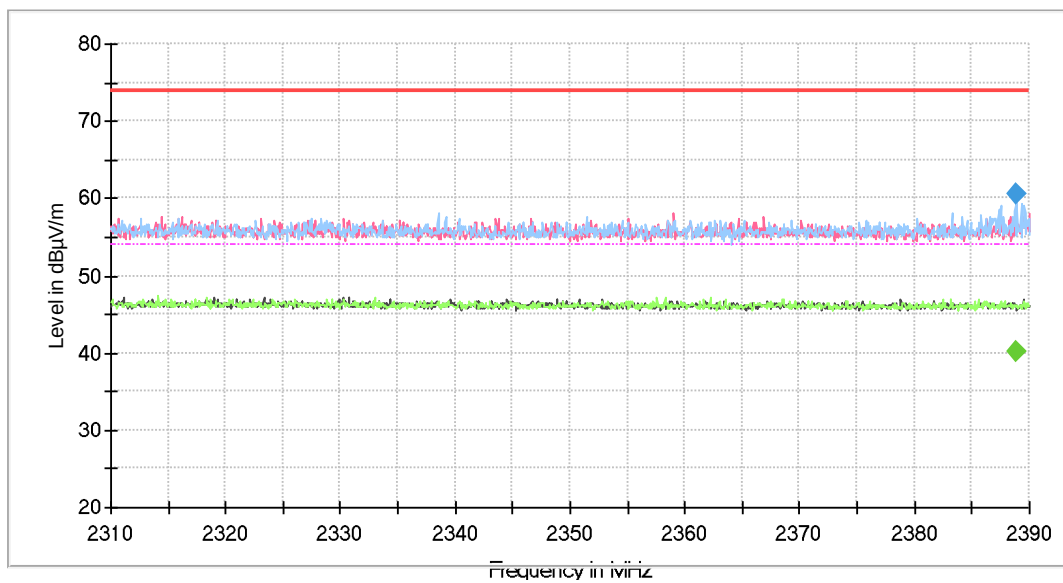
Plots:



Preview Result 2V-AVG
Preview Result 2H-AVG
FCC 15.247 Restricted Bands PK
Final_Result PK+

Preview Result 1V-PK+
Preview Result 1H-PK+
FCC 15.247 Restricted Bands AVG
Final_Result AVG

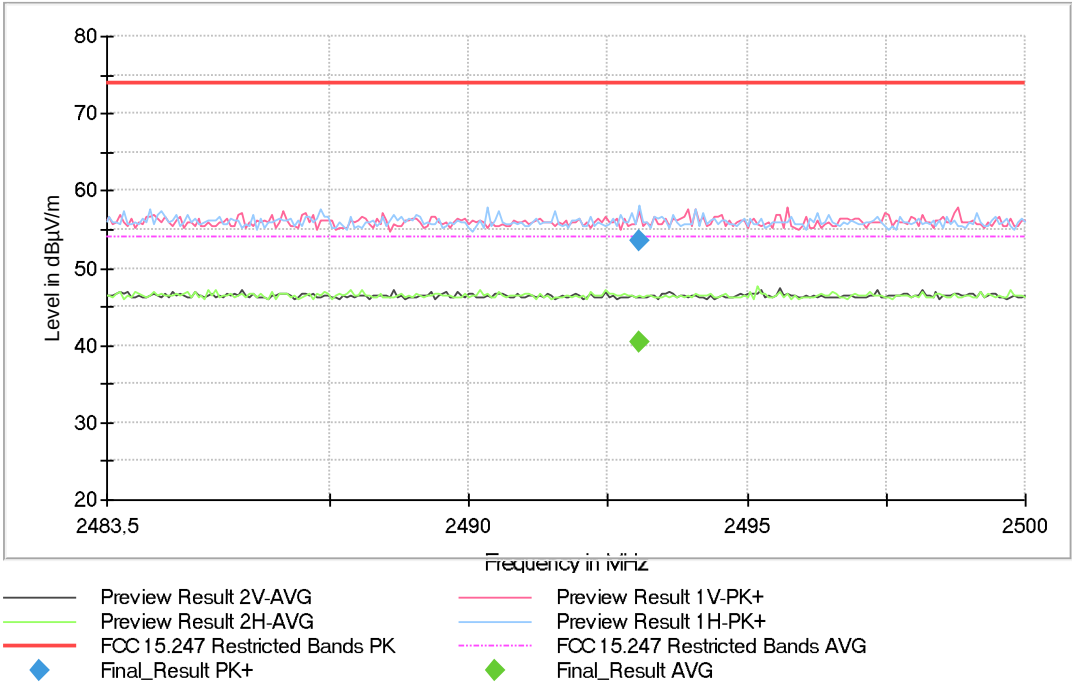
Full Spectrum



Preview Result 2V-AVG
Preview Result 2H-AVG
FCC 15.247 Restricted Bands PK
Final_Result PK+

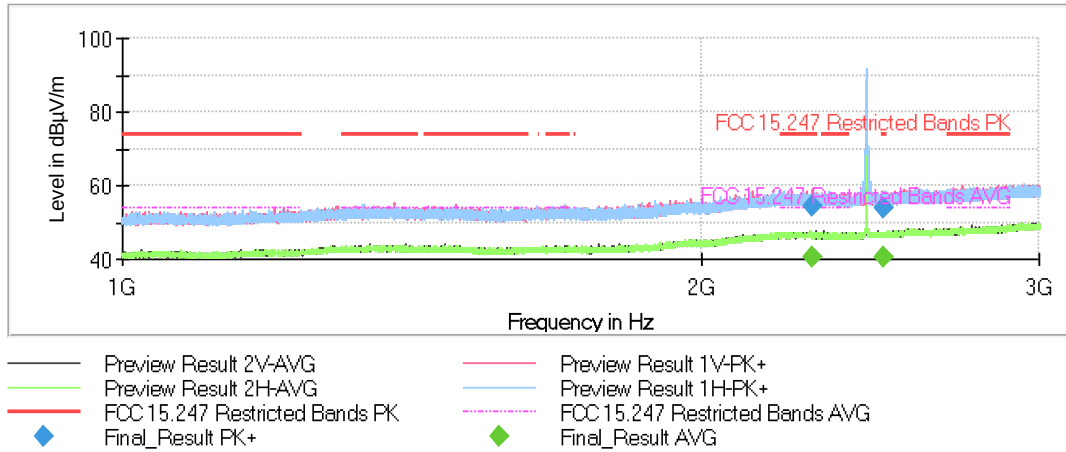
Preview Result 1V-PK+
Preview Result 1H-PK+
FCC 15.247 Restricted Bands AVG
Final_Result AVG

Full Spectrum

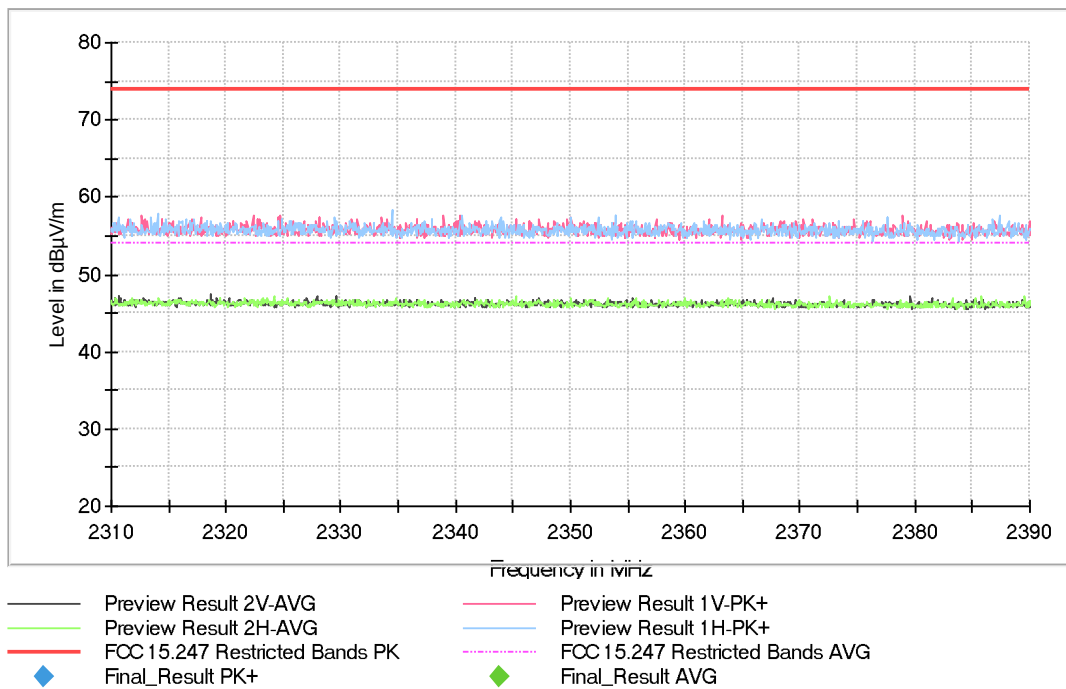


Frequency (MHz) = 2440.00, Modulation: BTLE 5.0 (GFSK 1 Mbit/s), Frequency Range (GHz) = [1, 3]

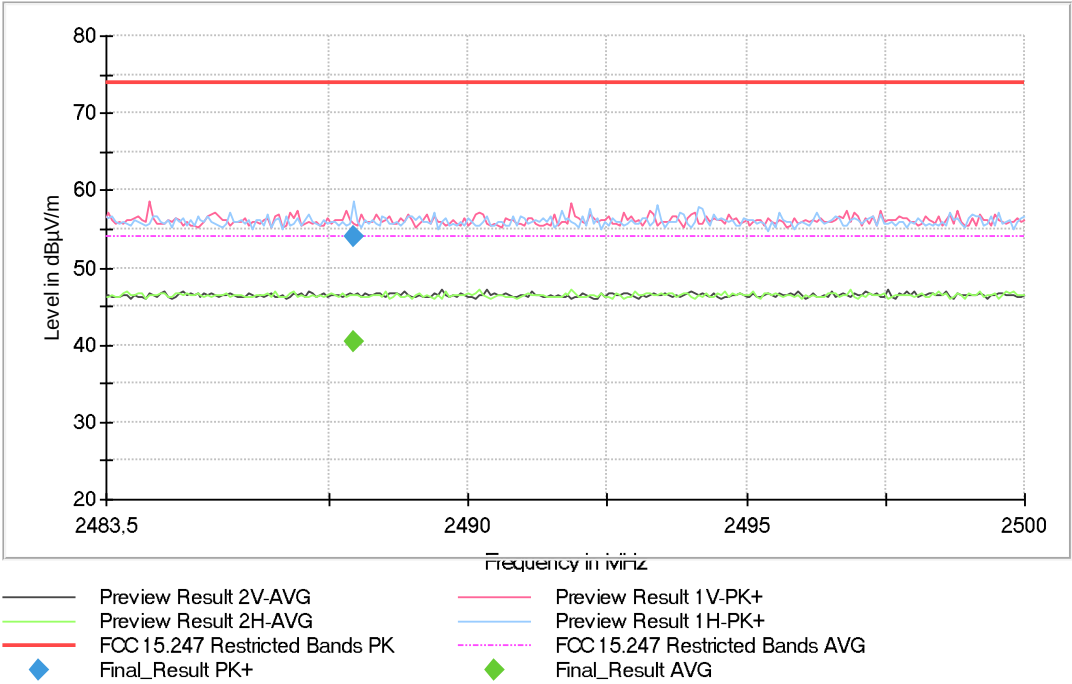
Plots:



Full Spectrum

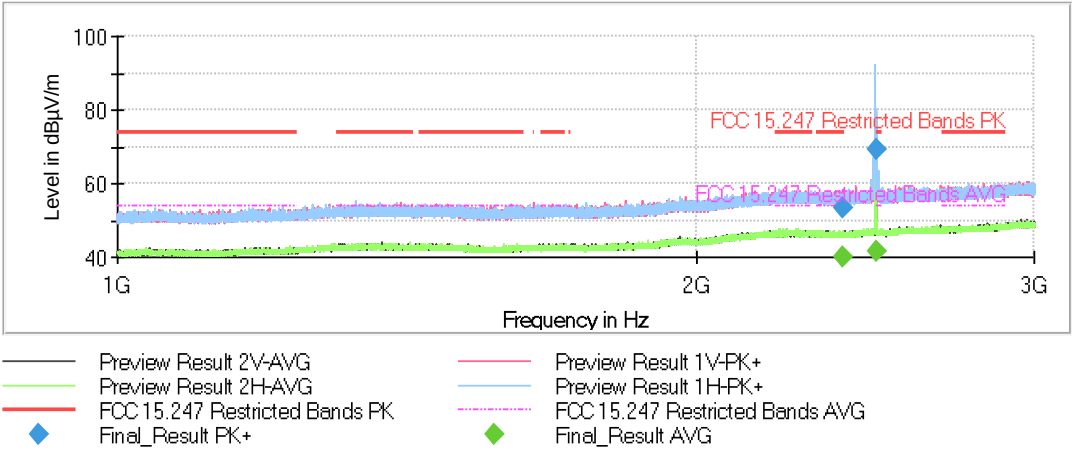


Full Spectrum

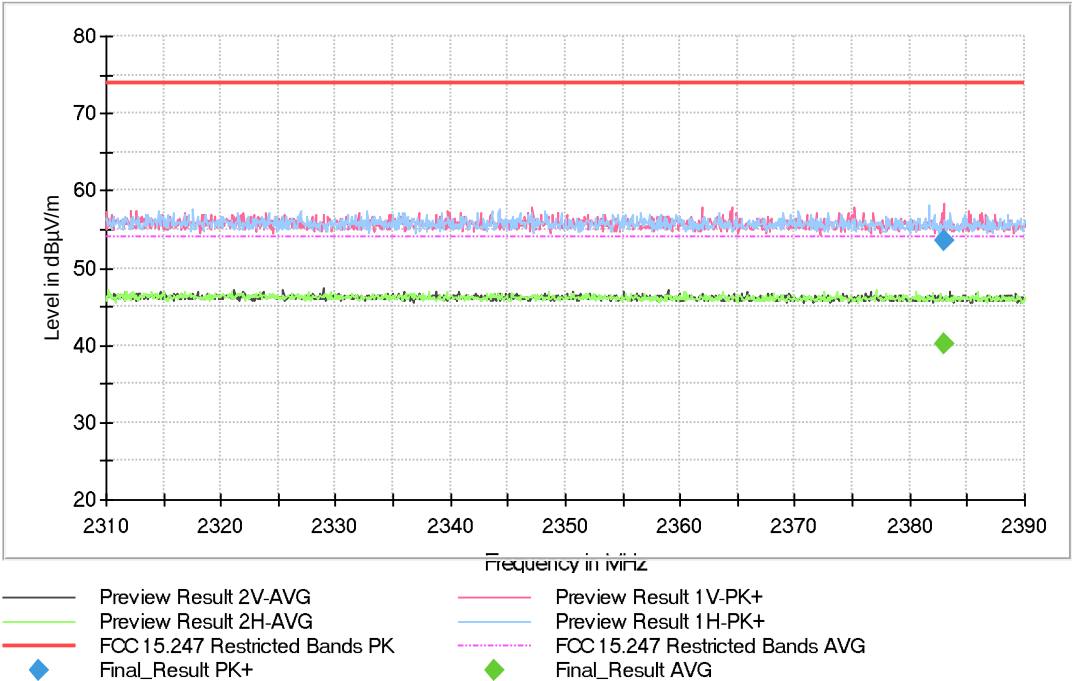


Frequency (MHz) = 2480.00, Modulation: BTLE 5.0 (GFSK 1 Mbit/s), Frequency Range (GHz) = [1, 3]

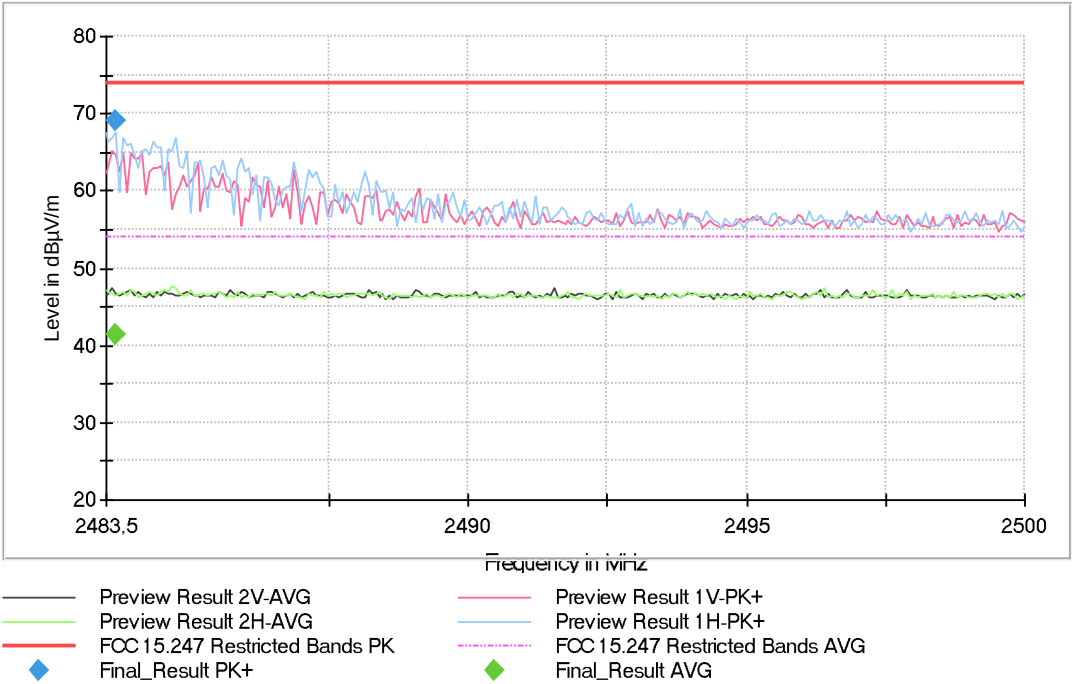
Plots:



Full Spectrum

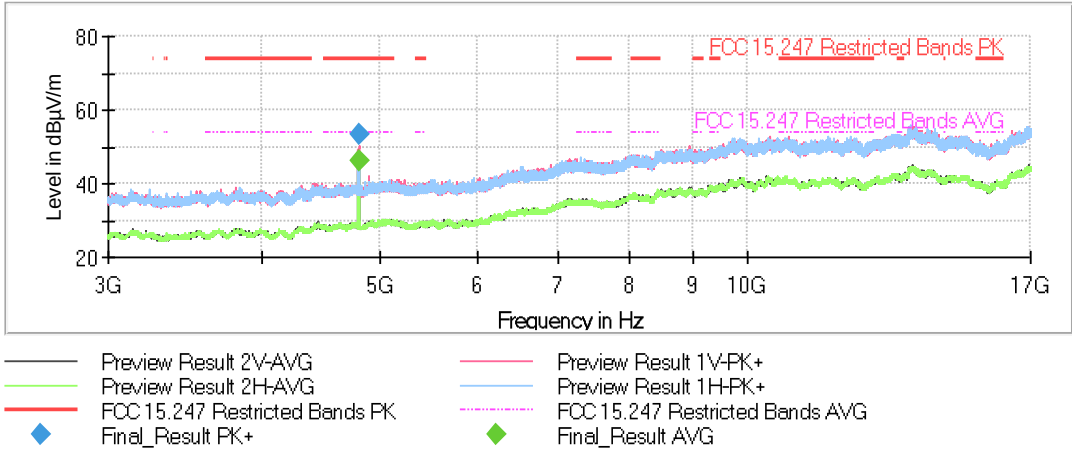


Full Spectrum



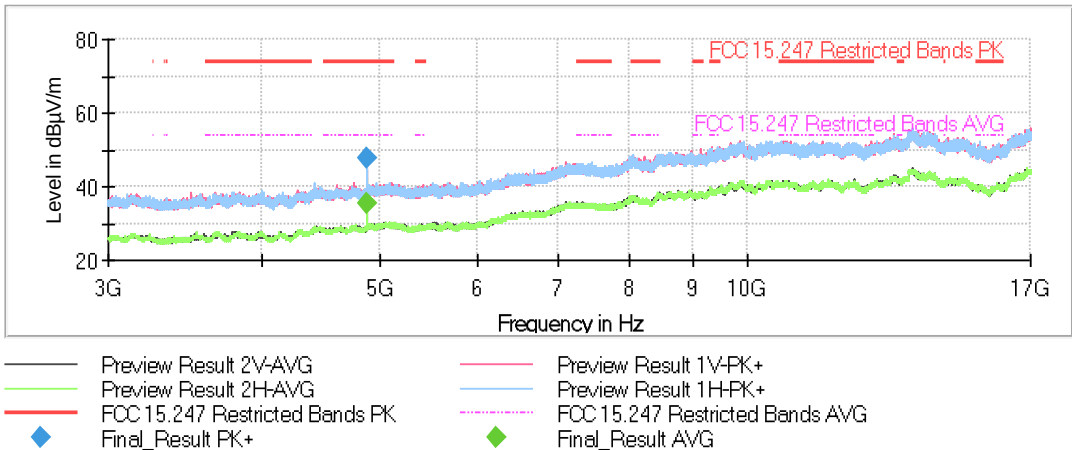
Frequency (MHz) = 2402.00, Modulation: BTLE 5.0 (GFSK 1 Mbit/s), Frequency Range (GHz) = [3, 17]

Plots:



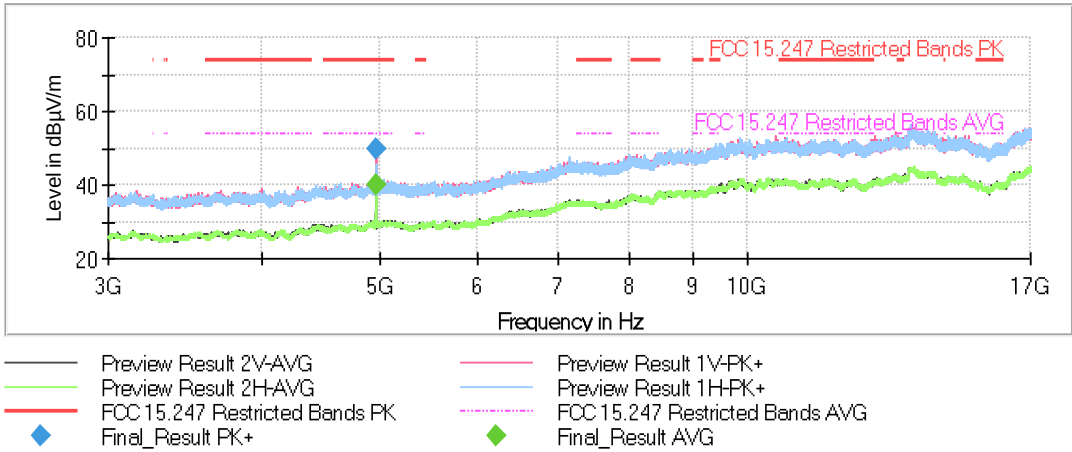
Frequency (MHz) = 2440.00, Modulation: BTLE 5.0 (GFSK 1 Mbit/s), Frequency Range (GHz) = [3, 17]

Plots:



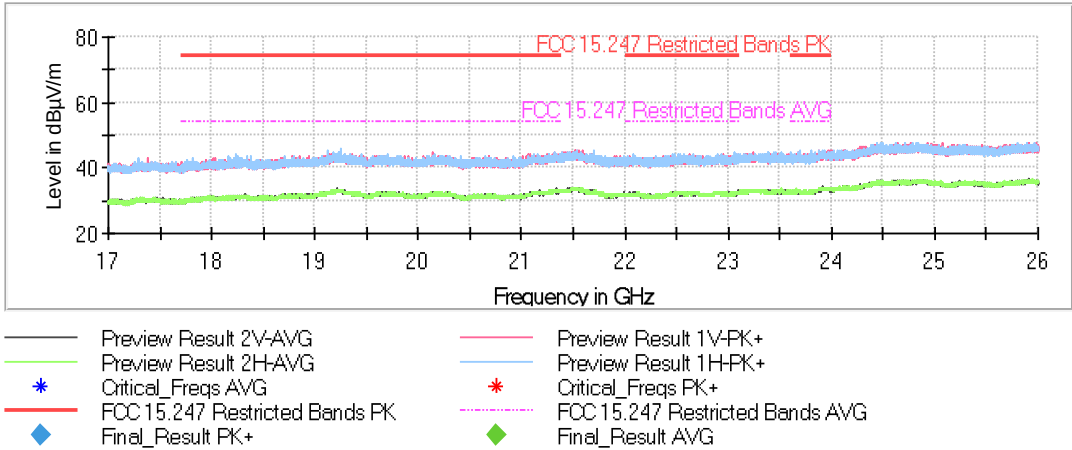
Frequency (MHz) = 2480.00, Modulation: BTLE 5.0 (GFSK 1 Mbit/s), Frequency Range (GHz) = [3, 17]

Plots:



Modulation: BTLE 5.0 (GFSK 1 Mbit/s), Frequency Range (GHz) = [17, 26]

Plots:



This plot is valid for the Low, Middle and High Channels.