

ISED CABid: ES1909

Test Report No:
NIE: 67003RRF.008A1

Test Report

USA FCC Part 15.247, 15.209

CANADA RSS-247, RSS-Gen

(*) Identification of item tested	Telematic control unit with wireless technologies, used in automotive industry
(*) Trademark	VW AG
(*) Model and /or type reference	TKCMOD12N00
(*) Derived model not tested	TKCMOD12E00, TKCMOD11000, TKCMOD12C00, TKCMOD12J00, TKCMOD12R00, TKCMOD12T00 and TKCMOD13C00
Other identification of the product	HW version: C2.3 SW version: X152 FCC ID: T8GCONMOD IC: 6434A-CONMOD
(*) Features	GSM, UMTS, LTE, 5G, GNSS, Wi-Fi, BTLE, BT EDR
Manufacturer	HARMAN BECKER AUTOMOTIVE SYSTEMS GMBH BECKER-GOERING-STR. 16 76307 KARLSBAD 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 (Feb. 2017). CANADA RSS-Gen Issue 5 Amendment 2 (Feb. 2021). 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 Martín EMC Consumer & RF Lab. Manager
Date of issue	2022-12-20
Report template No.	FDT08_24 (*) "Data provided by the client"

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Acronyms

Acronym ID	Acronym Description
Detector	Detector used
Equipment	Equipment Type
Freq	Frequency
Freq Rng	Frequency Range
Lvl	Level
Mod	Modulation
Occ Ch BW	Occupied Channel Bandwidth
Operation Band	Operation Band
PSD	Power Spectral Density
Pol	Polarization
Unwanted Freq	Unwanted Emissions Frequency
Unwanted Lvl	Unwanted Emissions Level

Competences and guarantees

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

DEKRA Testing and Certification is a FCC-recognized accredited testing laboratory with appropriate scope of accreditation that 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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General conditions

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2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of DEKRA Testing and Certification S.A.U.
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Uncertainty

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

The total uncertainty of the measurement system for the radiated emissions of EUT from 30 MHz to 1 GHz is:
Measurement uncertainty $\leq \pm 5.35$ dB (with factor $k = 2$).

The total uncertainty of the measurement system for the radiated emissions of EUT from 1 GHz to 17 GHz is:
Measurement uncertainty $\leq \pm 4.32$ dB (with factor $k = 2$).

The total uncertainty of the measurement system for the radiated emissions of EUT from 17 GHz to 26 GHz is:
Measurement uncertainty $\leq \pm 5.51$ dB (with factor $k = 2$).

The total uncertainty of the measurement system for the conducted testing of EUT is:

RF Peak Output Power: Measurement uncertainty $\leq \pm 0.80$ dB

RF Average Output Power: Measurement uncertainty $\leq \pm 0.99$ dB

Power Spectral Density: Measurement uncertainty $\leq \pm 0.99$ dB

6dB Bandwidth: Measurement uncertainty $\leq \pm 2.84$ %

Occupied Channel Bandwidth: Measurement uncertainty $\leq \pm 1.17$ %

Conducted Band-edge spurious emissions: Measurement uncertainty $\leq \pm 1.76$ dB

Data provided by the client

The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested").
2. The sample consists of a telematics control unit with wireless technologies, used in automotive, equipped with one modem, OEM. This unit was designed for automotive usage and contains the following features: GSM, UMTS, LTE, 5G, GNSS, WiFi (a, b, g, n, ac), Bluetooth Low Energy (BTLE) and Bluetooth EDR.

HARMAN AUTOMOTIVE DIVISION
HARMAN BECKER AUTOMOTIVE SYSTEMS GMBH
BECKER-GÖRING-STRASSE 16
76307 KARLSBAD, GERMANY



Declaration of similarity

To whom it may concern,

We, **Harman Becker Automotive Systems GmbH**, located in
Becker-Goering-Str. 16; 76307 Karlsbad, Germany

Hereby declare that the following units: TKCMOD12E00, TKCMOD12N00,
TKCMOD11000, TKCMOD12C00, TKCMOD12J00, TKCMOD12R00,
TKCMOD12T00 and TKCMOD13C00

have integrated the same BT/Wifi chipset.

The different naming comes from country specific, features enabled or network
access device type.

Targeted countries	Product Name	Type	NAD-HW	GNSS	Bluetooth	WLAN	NAD Services	CV2X
Rest of the world (offline variant)	TKCMOD11000	V046	EU	x	x			
EU + some other countries	TKCMOD12E00	V037, V042, V043, V044, V049	EU	x	x	x		
Canada/Mexico/USA	TKCMOD12N00	V038, V039, V047	NA	x	x	x		
China (without CV2X)	TKCMOD12C00	V105	CN	x	x	x		
Japan	TKCMOD12J00	V045	RW	x	x	x		
Armenia/Belarus/Kazakhstan/Russia/Uzbekistan	TKCMOD12R00	V048	EU	x	x	x		
Turkey	TKCMOD12T00	V040	EU	x	x	x		
China (with CV2X)	TKCMOD13C00	V106	CN	x	x	x	x	x

This declaration is intended to be included in the test reports where applies

Regards

HARMAN AUTOMOTIVE DIVISION
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Becker-Göring-Straße 16
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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.

Id	Control Number	Description	Model	Serial No.	Date of Reception	Application
S/01	67003B_70.1	Telematic control unit	VW	358845890061449	2021-11-30	Element Under Test
S/01	67003B_32.1	BT_WLAN_2-3 - Audi	--	--	2021-09-23	Element Under Test
S/01	67003B_34.1	FAKRA cable 4 on 1 for antenna	--	--	2021-09-23	Element Under Test
S/01	67003B_35.1	Bumper antenna - Audi	--	--	2021-09-23	Element Under Test
S/01	67003B_37.1	BT_WLAN_2-3 - Audi	--	--	2021-09-23	Element Under Test
S/01	67003B_39.1	BT_WLAN_1 - Audi/Porsche	--	--	2021-09-23	Element Under Test
S/01	67003B_41.1	Roof antenna - Audi	--	--	2021-09-23	Element Under Test
S/01	67003B_43.1	FAKRA cable 4 on 1 for antenna	--	--	2021-09-23	Element Under Test
S/01	67003B_44.1	FAKRA cable for antenna	--	--	2021-09-23	Element Under Test
S/01	67003B_66.1	Battery	--	--	2021-11-30	Element Under Test
S/01	67003B_8.1	Harness	--	--	2021-03-09	Auxiliary Element
S/01	67003B_33.1	Metal panel	--	--	2021-09-23	Auxiliary Element
S/01	67003B_36.1	Metal panel	--	--	2021-09-23	Auxiliary Element
S/01	67003B_38.1	Metal panel	--	--	2021-09-23	Auxiliary Element
S/01	67003B_42.1	Metal panel	--	--	2021-09-23	Auxiliary Element
S/02	67003B_70.1	Telematic control unit	VW	358845890061449	2021-11-30	Element Under Test
S/02	67003B_14.1	GNSS antenna	--	--	2021-09-07	Element Under Test
S/02	67003B_15.1	BT_WLAN_3 antenna	--	--	2021-09-07	Element Under Test
S/02	67003B_16.1	LTE_4 antenna	--	--	2021-09-07	Element Under Test
S/02	67003B_17.1	BT_WLAN_2 antenna	--	--	2021-09-07	Element Under Test
S/02	67003B_18.1	BT_WLAN_1 antenna	--	--	2021-09-07	Element Under Test
S/02	67003B_19.1	LTE_3 antenna	--	--	2021-09-07	Element Under Test

Id	Control Number	Description	Model	Serial No.	Date of Reception	Application
S/02	67003B_20.1	BTLE Ant. Combiner (BT_LE_1)	--	--	2021-09-07	Element Under Test
S/02	67003B_21.1	BT_LE_1 antenna	--	--	2021-09-07	Element Under Test
S/02	67003B_22.1	BT_LE_1 antenna	--	--	2021-09-07	Element Under Test
S/02	67003B_23.1	LTE_1 antenna	--	--	2021-09-07	Element Under Test
S/02	67003B_24.1	LTE_2 antenna	--	--	2021-09-07	Element Under Test
S/02	67003B_27.1	ETH (H-MTD) cable	--	--	2021-09-07	Element Under Test
S/02	67003B_66.1	Battery	--	--	2021-11-30	Element Under Test
S/02	67003B_8.1	Harness	--	--	2021-03-09	Auxiliary Element
S/03	67003B_70.1	Telematic control unit	VW	358845890061449	2021-11-30	Element Under Test
S/03	67003B_8.1	Harness	--	--	2021-03-09	Auxiliary Element

Notes referenced to samples during the project:

Id	Type
S/01	Radiated. Configuration #1 (Roof antenna).
S/02	Radiated. Configuration #2 (BT_LE Antenna).
S/03	Conducted. Configuration #1 and Configuration #2.

Test sample description

Ports..... :	Port name and description		Cable			
			Specified max length [m]	Attached during test	Shielded	Coupled to patient ⁽³⁾
	RF connector – code			[]	[X]	[]
	RF connector – code			[X]	[X]	[]
RF connector – code			[X]	[]	[]	
Supplementary information to the ports..... :	.....					
Rated power supply	Voltage and Frequency		Reference poles			
			L1	L2	L3	N	PE
	[X]	DC: 12V car battery (4.8 VDC inside of TCU)				
Rated Power	12V DC					
Clock frequencies..... :	See Block diagram					
Other parameters	See Technical description					
Software version	X152					
Hardware version	C2.3					
Dimensions in cm (W x H x D) .....	.....					
Mounting position	[]	Table top equipment				
	[]	Wall/Ceiling mounted equipment				
	[]	Floor standing equipment				
	[]	Hand-held equipment				
	[X]	Other: automotive telematics control unit				
Modules/parts..... :	Module/parts of test item		Type		Manufacturer	
						
Accessories (not part of the test item)	Description		Type		Manufacturer	
	Cable Harness		.....		.....	
	2G/3G/4G/5G Antenna		.....		Hirschmann / Molex	
	eCall button/LED		.....		.....	
	SOS Loudspeaker		.....		.....	
	Wake-up unit Box		.....		.....	
Documents as provided by the applicant	Description		File name		Issue date	
	Technical Description		.....		.....	

⁽³⁾ Only for Medical Equipment

Identification of the client

HARMAN BECKER AUTOMOTIVE SYSTEMS GMBH
BECKER-GOERING-STR. 16
76307 KARLSBAD GERMANY

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2022-01-18
Date (finish)	2022-02-25

Document history

Report number	Date	Description
67003RRF.008	2022-06-17	First release.
67003RRF.008A1	2022-12-20	First modification: update of typos. This modification test report cancels and replaces the test report 67003RRF.008.

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 semi-anechoic 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 model TKCMOD12N00 comes with two different configurations. Each configuration has different antennas. A summary stating the gains used for the tests is included below:

	Model	Antenna Gain (dBi)	Antenna type	Technology used
Configuration 1	TKCMOD12N00	4.5 dBi	Roof antenna	BTLE
Configuration 2	TKCMOD12N00	1.8 dBi	BT_LE Antenna	BTLE

More detailed information about the different configurations has been provided in the supporting documentation from the manufacturer.

The tests have been performed by the technical personnel: Alfonso Gutiérrez Martínez, José Manuel Jiménez González, Pablo Redondo Reyes and Nicolás Salguero Camarena.

Used instrumentation:

Equipment	Model	Manufacturer	Next Calibration
SHIELDED ROOM	S101	ETS LINDGREN	N.A.
SIGNAL AND SPECTRUM ANALYZER 10Hz-40GHz	FSV40	ROHDE AND SCHWARZ	2023-02-26
OPEN SWITCH UNIT UP TO 40GHz	OSP-B157Wx	ROHDE & SCHWARZ	2024-03-16
POWER SUPPLY DC 40 V / 40 A	NGPE 40/40	ROHDE AND SCHWARZ	N.A.
DIGITAL MULTIMETER	179	FLUKE	2022-10-19
TEMPERATURE AND HUMIDITY PROBE	HWg-STE	HW GROUP	2022-04-13
SOFTWARE	EMC32	ROHDE AND SCHWARZ	N.A.
SEMIANECHOIC ABSORBER LINED CHAMBER II	FACT 3 200 STP	ETS LINDGREN	N.A.
SHIELDED ROOM	S101	ETS LINDGREN	N.A.
SIGNAL AND SPECTRUM ANALYZER 2Hz-50GHz	FSW50	ROHDE AND SCHWARZ	2022-07-06
EMI TEST RECEIVER 9kHz-7GHz	ESR7	ROHDE AND SCHWARZ	2022-12-12
HYBRID BILOG ANTENNA 30MHz-6GHz	3142E	ETS LINDGREN	2023-04-30
HORN ANTENNA 1-18GHz	BBHA 9120 D	SCHWARZBECK MESS-ELEKTRONIK	2022-11-18
HORN ANTENNA 17-40GHz	BBHA 9170	SCHWARZBECK	2023-05-05
PRE-AMPLIFIER G>40dB 10MHz-6GHz	BLNA 0160-01N	BONN ELEKTRONIK	2022-03-09

Equipment	Model	Manufacturer	Next Calibration
PRE-AMPLIFIER G>40dB 1-18 GHz	BLMA 0118-1M	BONN ELEKTRONIK	2022-06-07
PRE-AMPLIFIER G>30dB 17-40GHz	BLMA 1840-4A	BONN ELEKTRONIK	2022-09-08
DC POWER SUPPLY 30V/5A	U8002A	KEYSIGHT TECHNOLOGIES	---

Testing verdicts

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

Summary

Bluetooth Low Energy 5.0 (2M, 1M)

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

Appendix A: Test results. Bluetooth Low Energy 5.0 (2M, 1M)

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 FCC 15.247 (d) / RSS-247 5.5 Band-Edge Emissions Compliance (Transmitter)43

 FCC 15.247 (d) / RSS-247 5.5 Emission Limitations Radiated (Transmitter)50

TEST CONDITIONS

(*) Declared by the Applicant.

POWER SUPPLY (*):

Vnominal:	12 Vdc
Type of Power Supply:	External DC (vehicle battery).

ANTENNAS (*):

Type of Antenna:	Dedicated external antenna.
Maximum Declared Antenna Gain:	
• Configuration #1:	+4.5 dBi
• Configuration #2:	+1.8 dBi

TEST FREQUENCIES (*):

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

MODULATIONS:

- LE 1M. Uncoded data at 1 Mbps and Coded data at 125 kbps and 500 kbps. A preliminary scan determined the 1 Mbps data rate as the worst case.
- LE 2M. 2 Mbps.

CONDUCTED MEASUREMENTS:

The equipment under test was set up in a shielded room and it connected to the TS8997 RF test bench using a low-loss RF cable. The reading of the spectrum analyser is corrected considering 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 1 – 17 GHz Double ridge horn antenna) 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).

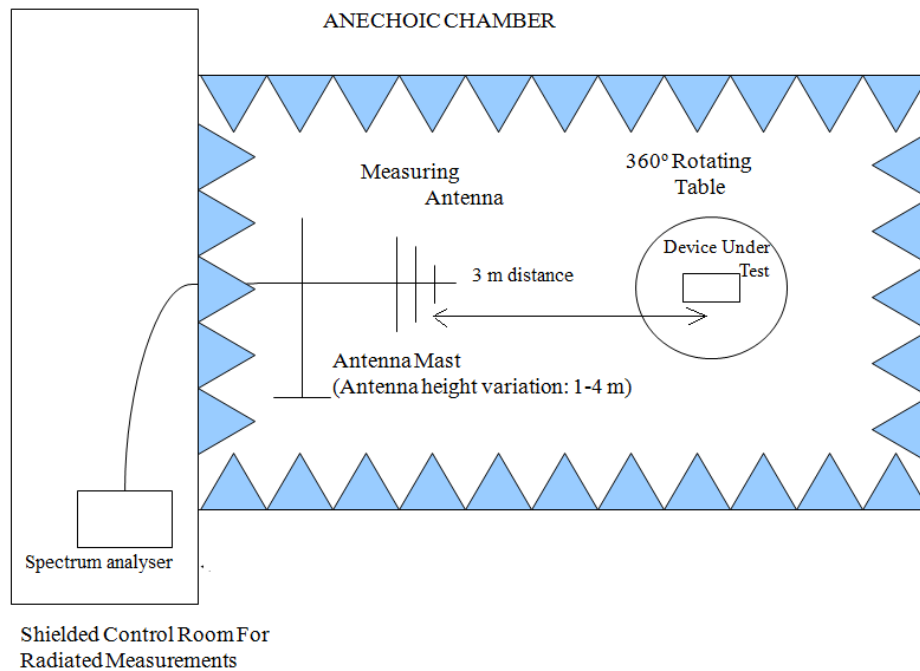
For radiated emissions in the range 17 GHz – 26 GHz performed at a distance closer than the distance specified in standard, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

The equipment under test was set up on a non-conductive platform above the ground plane and its situation and orientation were varied to find the maximum radiated emission. It was also rotated 360° and the antenna height was varied from 1 to 4 meters (up to 18GHz) to find the maximum radiated emission.

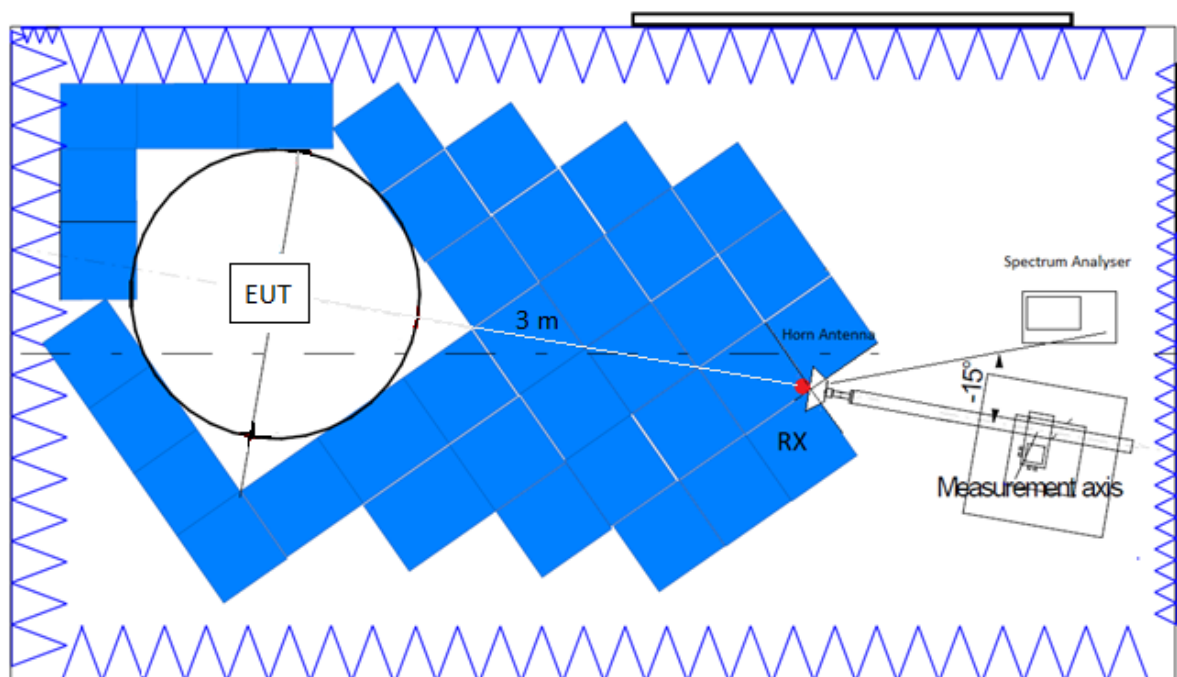
Measurements were made in both horizontal and vertical planes of polarization.

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.

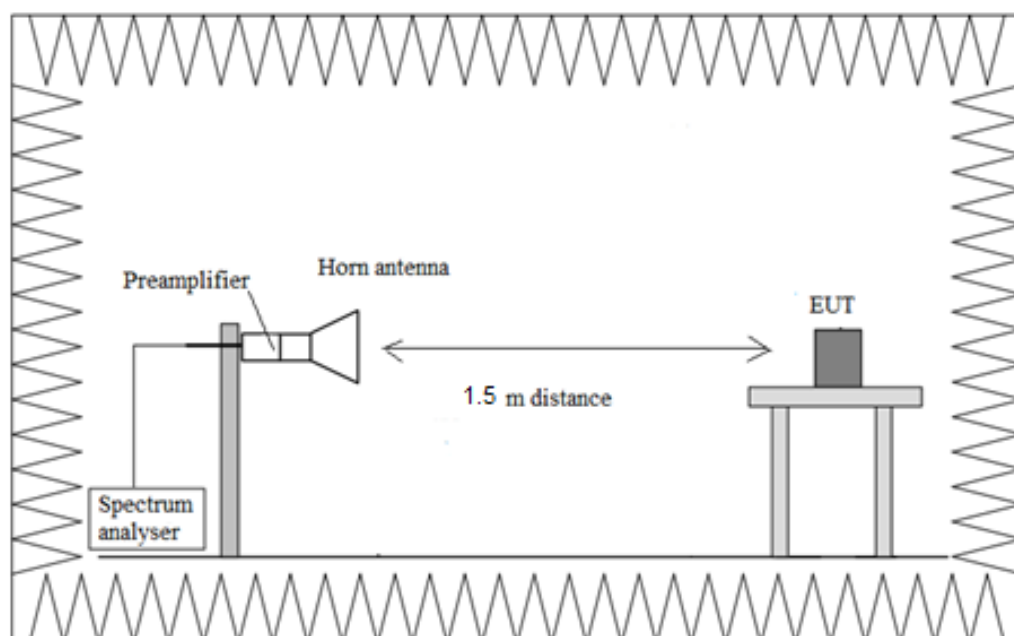
Radiated measurements setup from 30 MHz to 1 GHz:



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

Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

Results

Operation Band (MHz)	Freq (MHz)	Equipment	Occ Ch BW (MHz)
[2400, 2483.5]	2402.00000	Digital Transmission System (DTS)	2.010
	2440.00000		2.010
	2480.00000		2.010

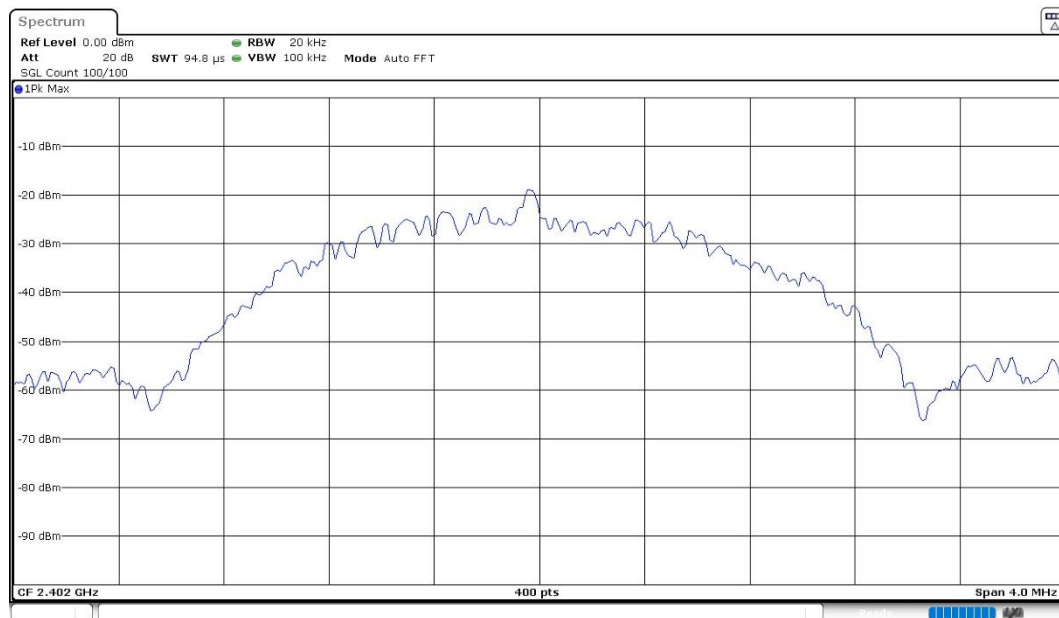
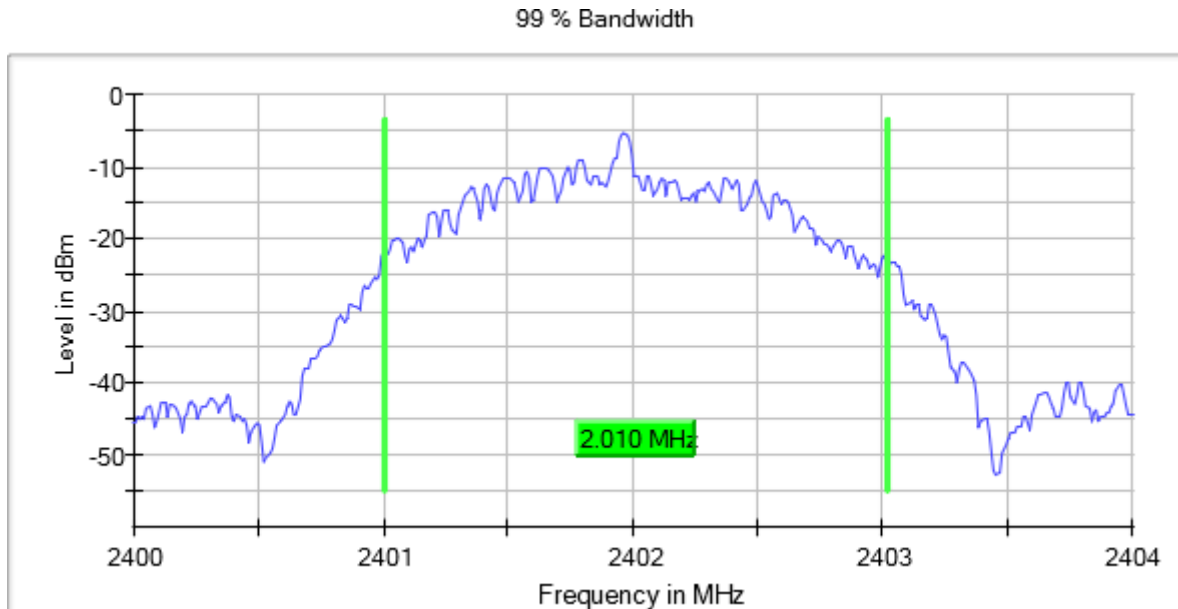
Verdict

Pass

Attachments

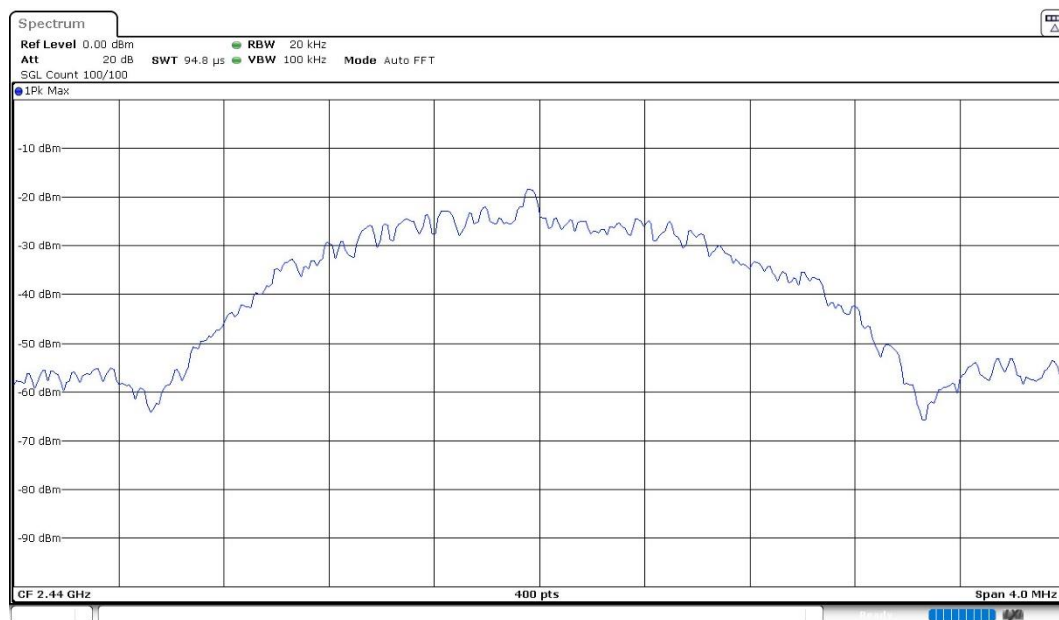
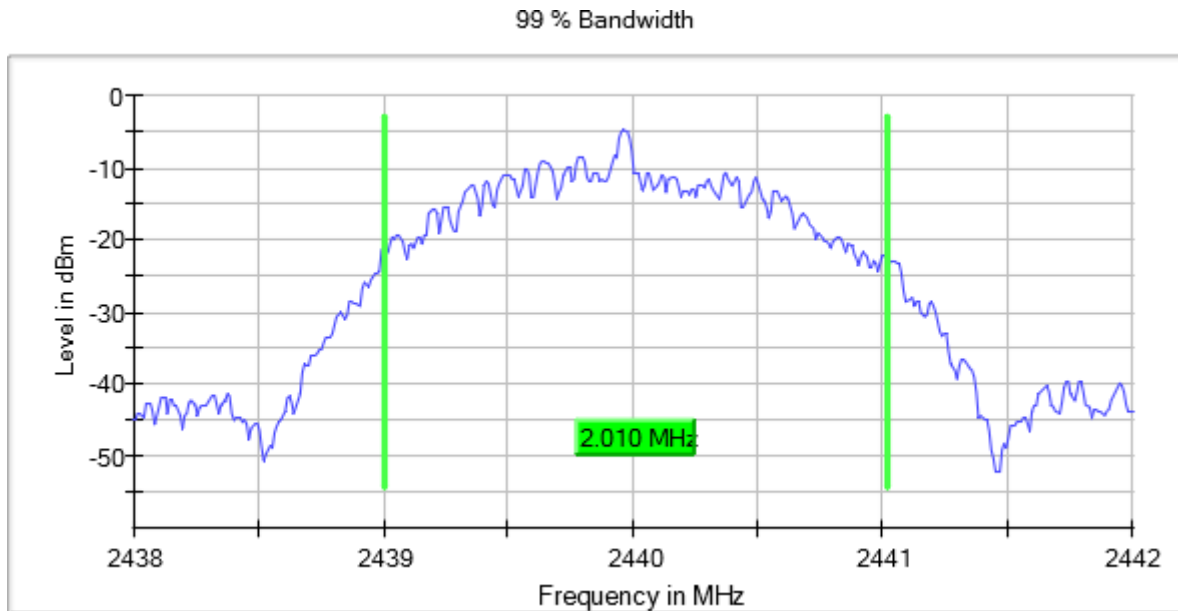
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00000, Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

Plots:



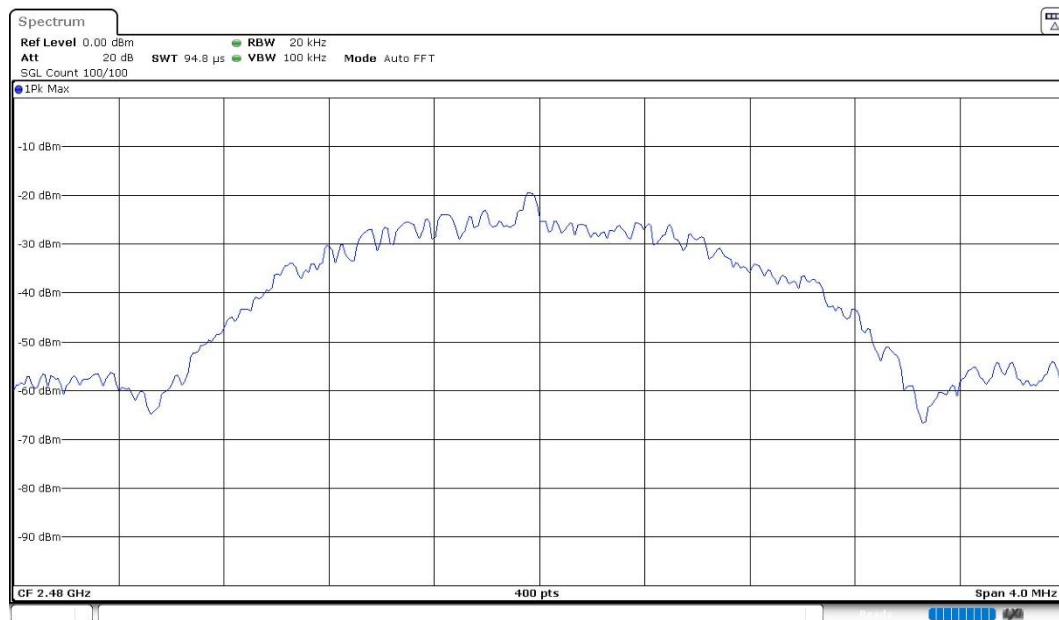
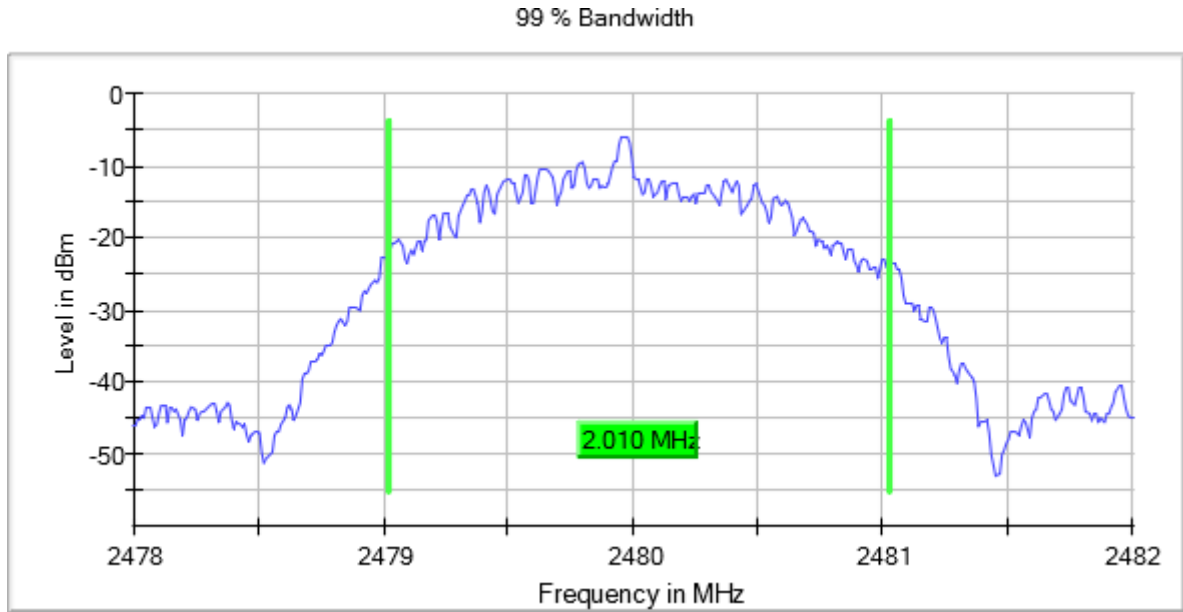
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2440.00000, Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

Plots:



Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00000, Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

Plots:



Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Results

Operation Band (MHz)	Freq (MHz)	Equipment	Occ Ch BW (MHz)
[2400, 2483.5]	2402.00000	Digital Transmission System (DTS)	1.025
	2440.00000		1.025
	2480.00000		1.025

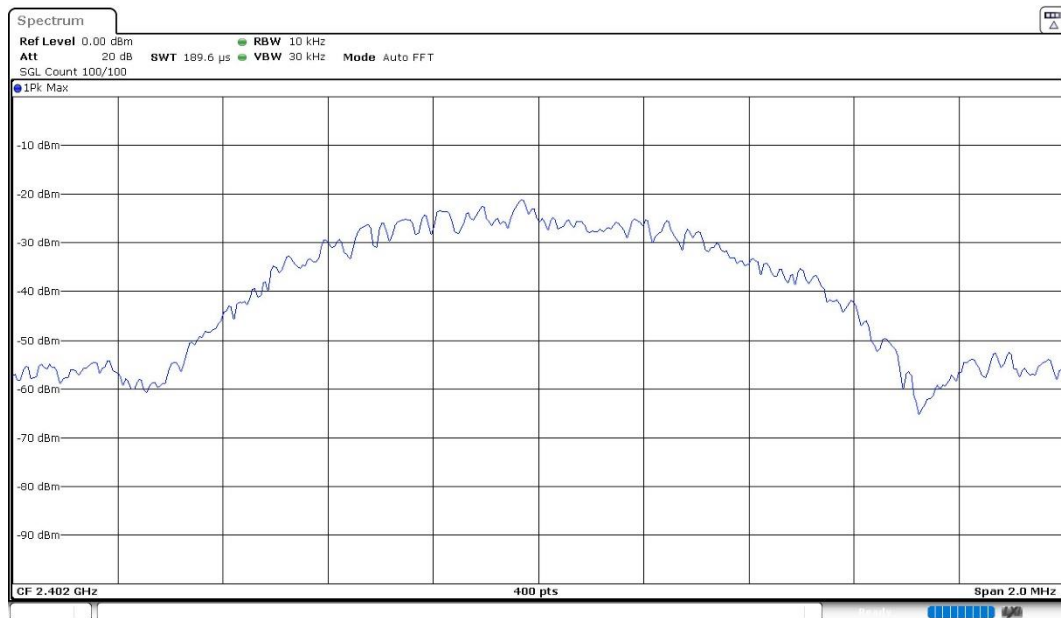
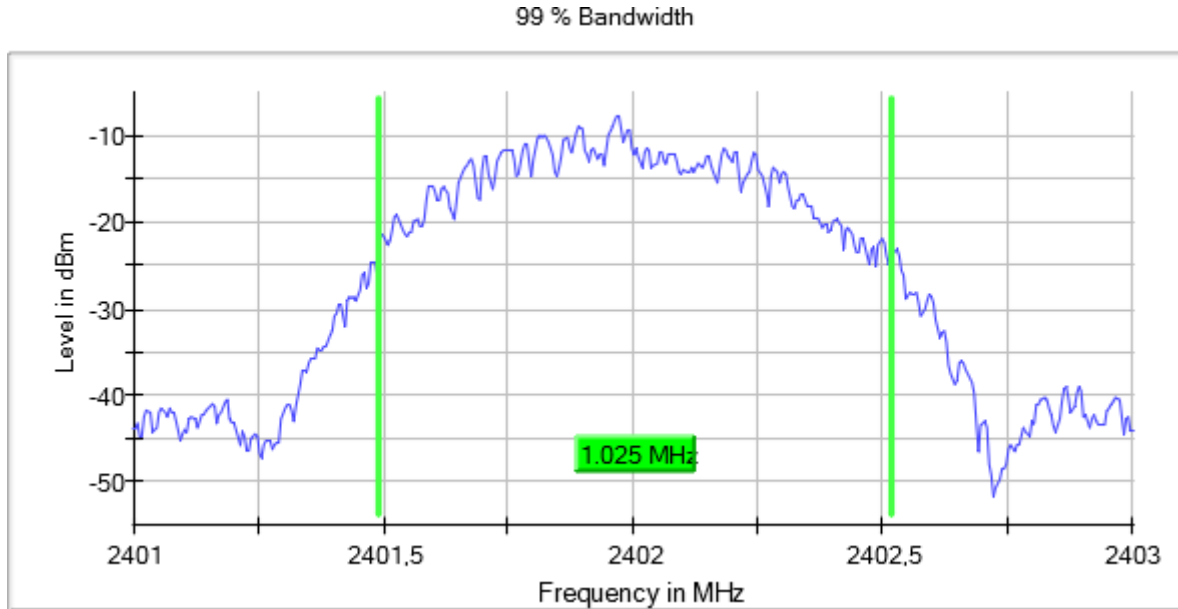
Verdict

Pass

Attachments

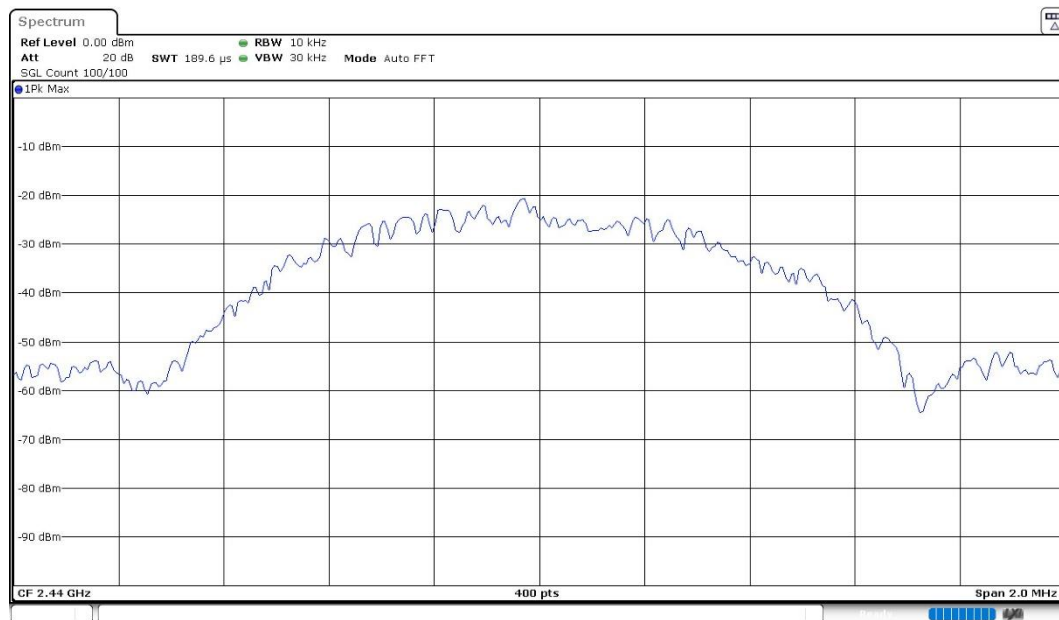
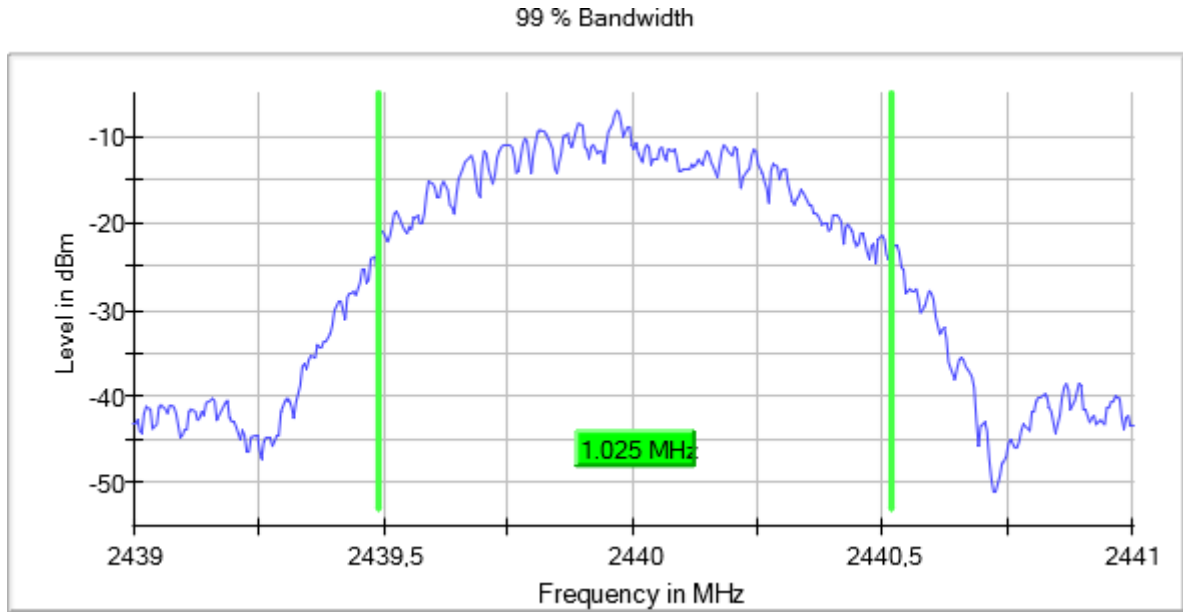
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00000, Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:



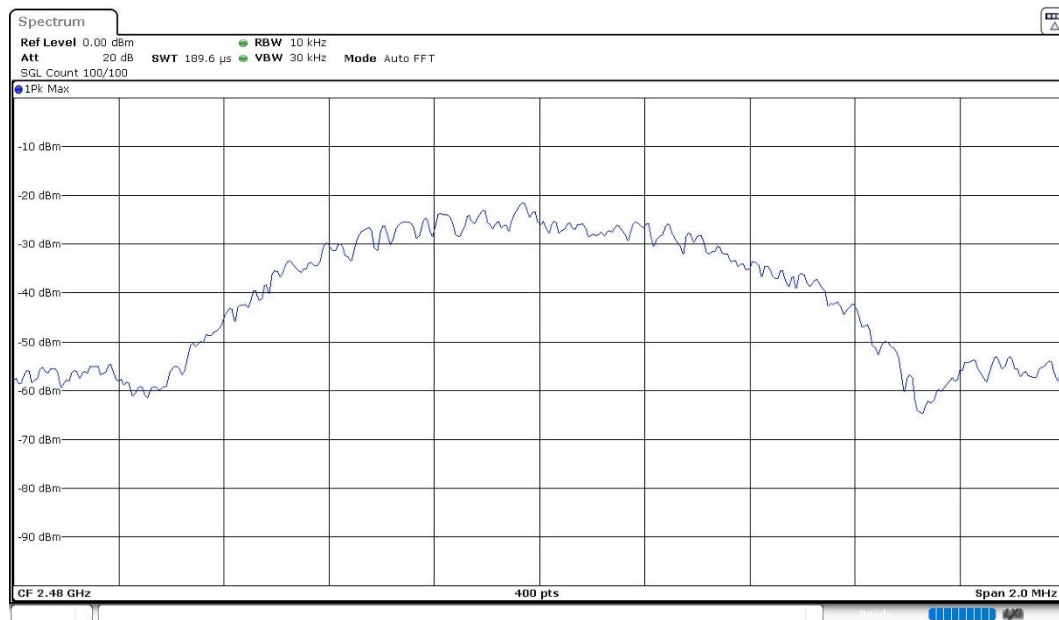
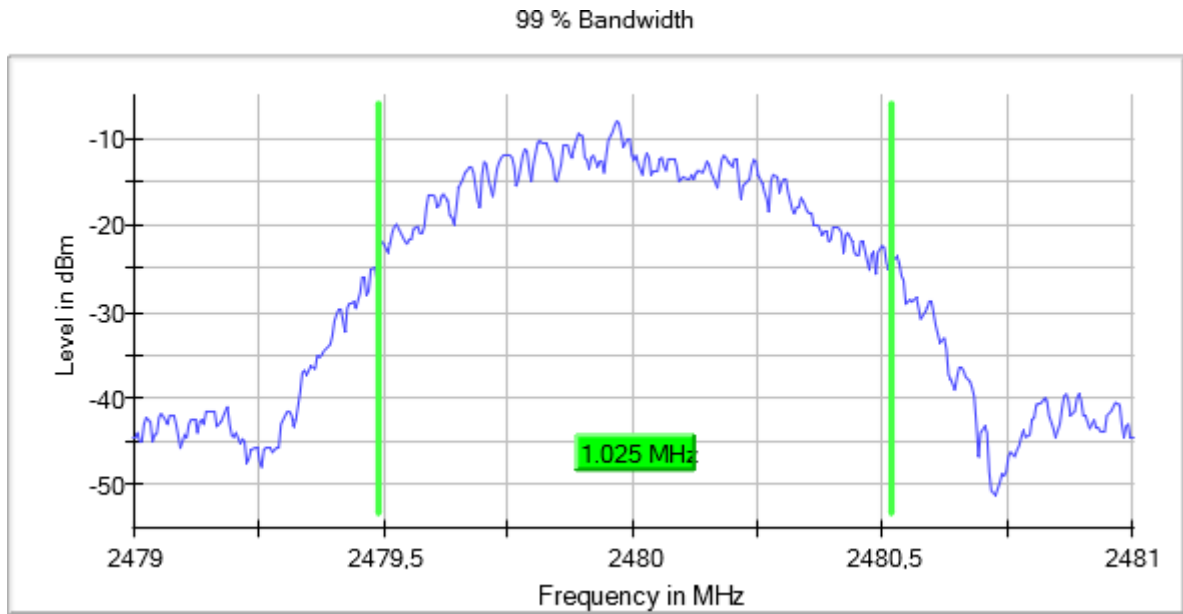
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2440.00000, Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:



Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00000, Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:



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

Limits

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

Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

Results

Freq (MHz)	6dB Bandwidth (MHz)
2402.00000	1.27
2440.00000	1.23
2480.00000	1.23

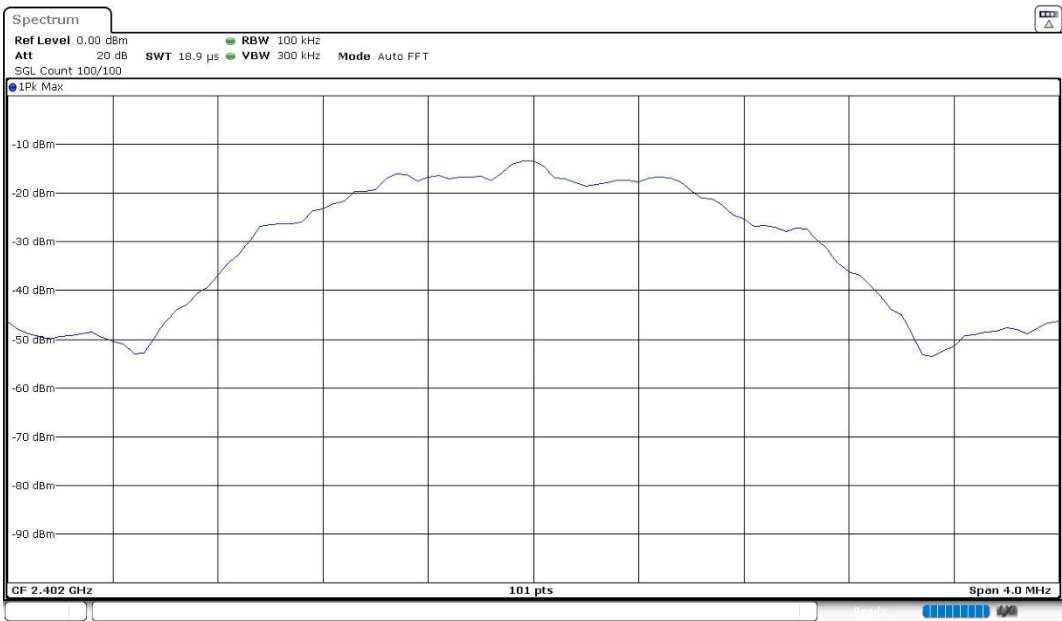
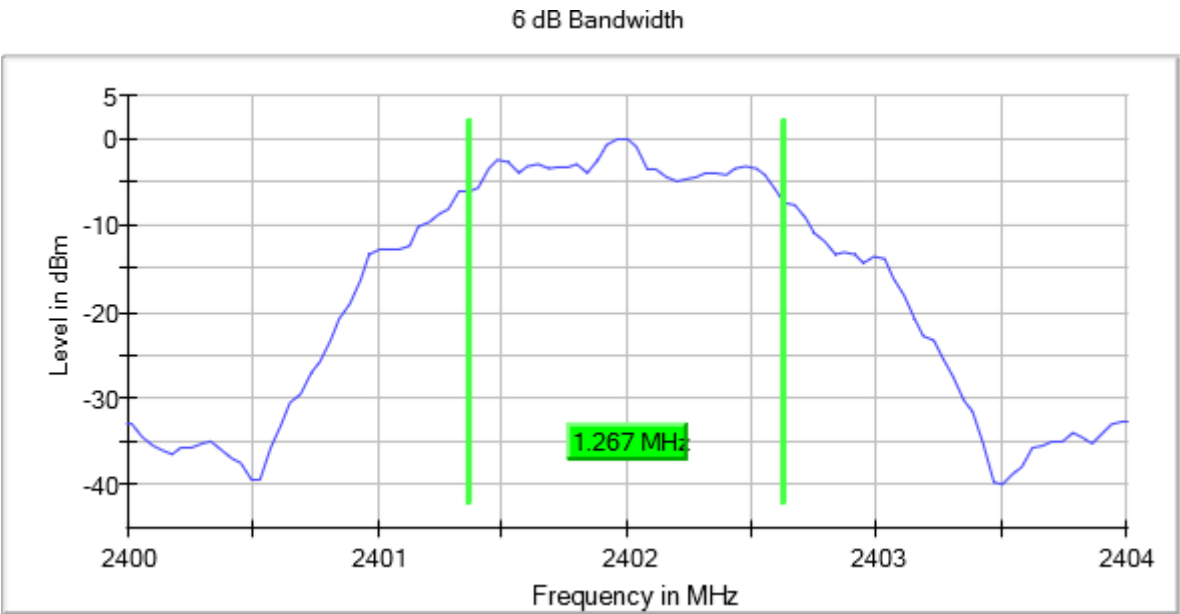
Verdict

Pass

Attachments

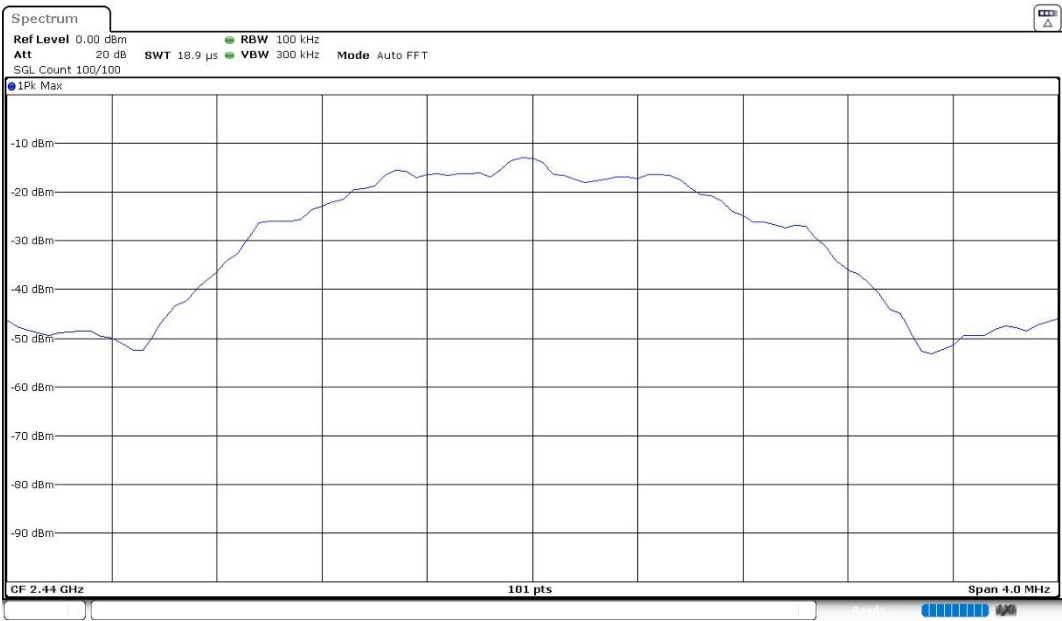
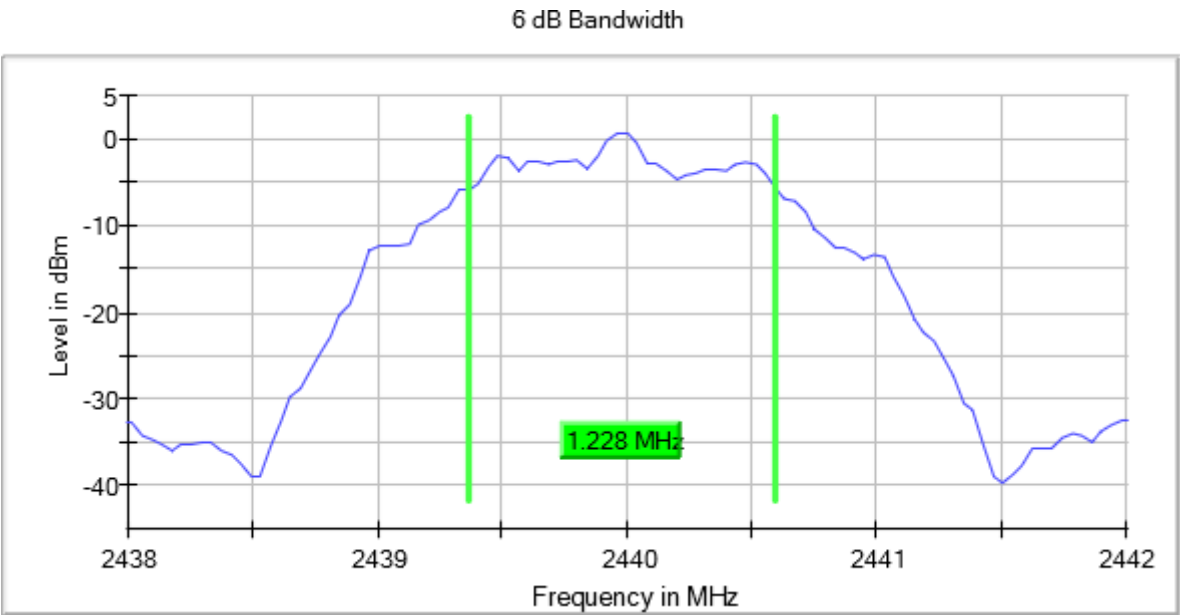
Frequency (MHz) = 2402.00000, Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

Plots:



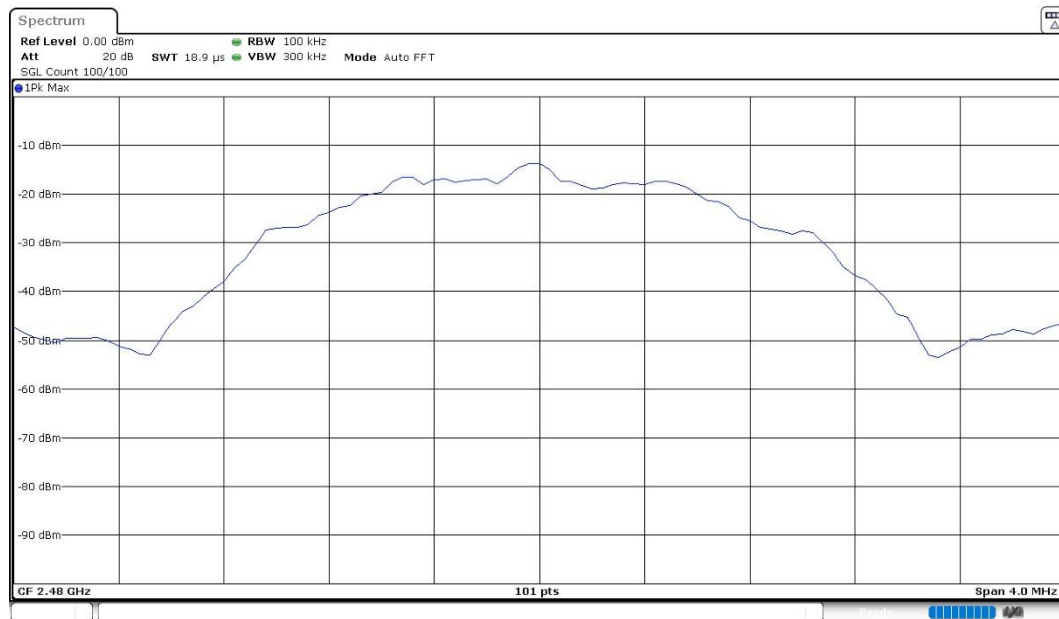
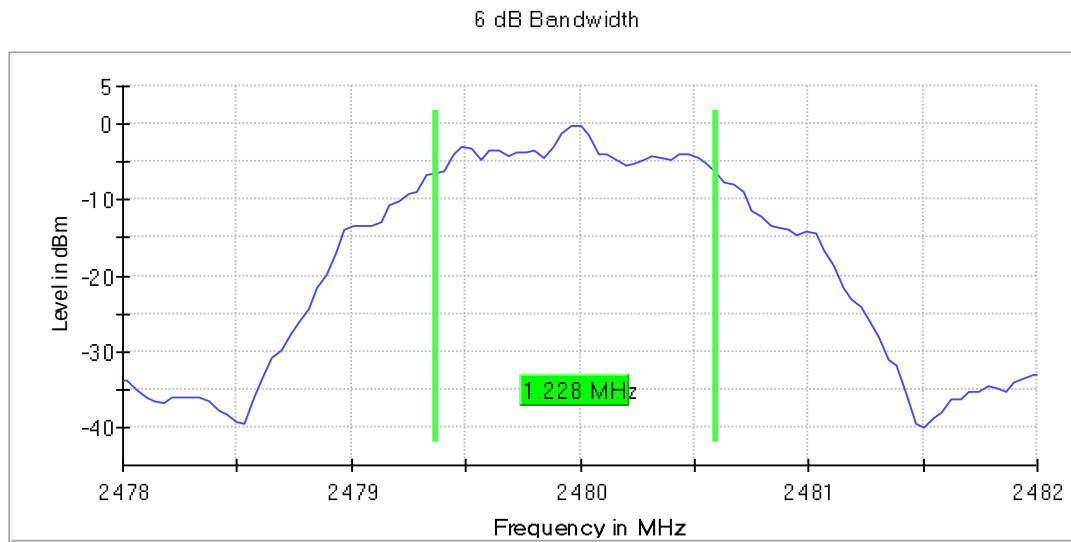
Frequency (MHz) = 2440.00000, Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

Plots:



Frequency (MHz) = 2480.00000, Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

Plots:



Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Results

Freq (MHz)	6dB Bandwidth (MHz)
2402.00000	0.73
2440.00000	0.73
2480.00000	0.71

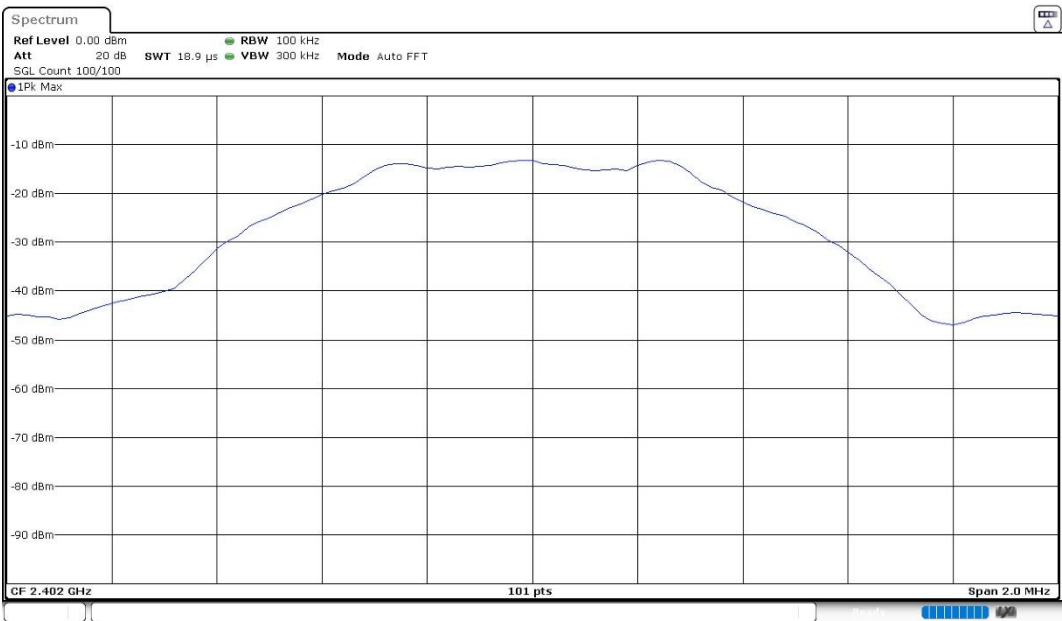
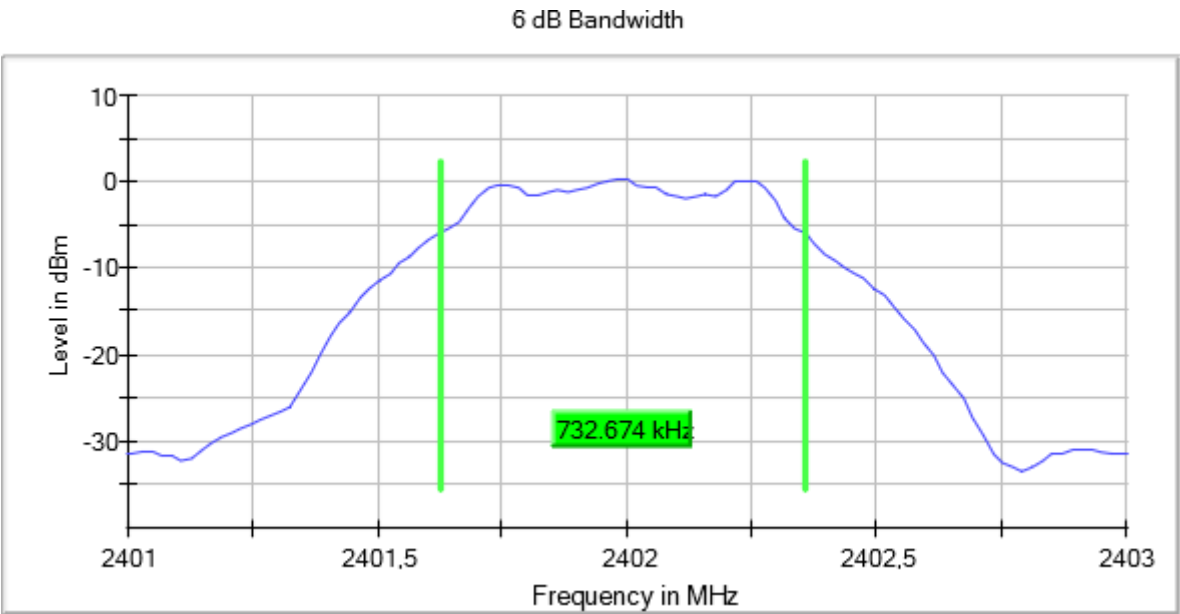
Verdict

Pass

Attachments

Frequency (MHz) = 2402.00000, Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

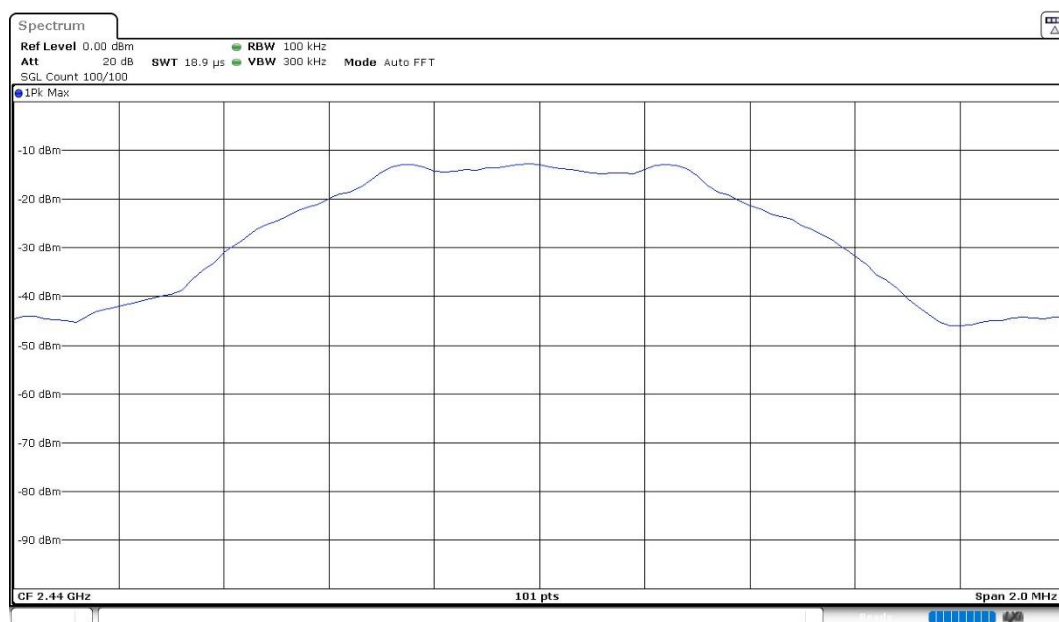
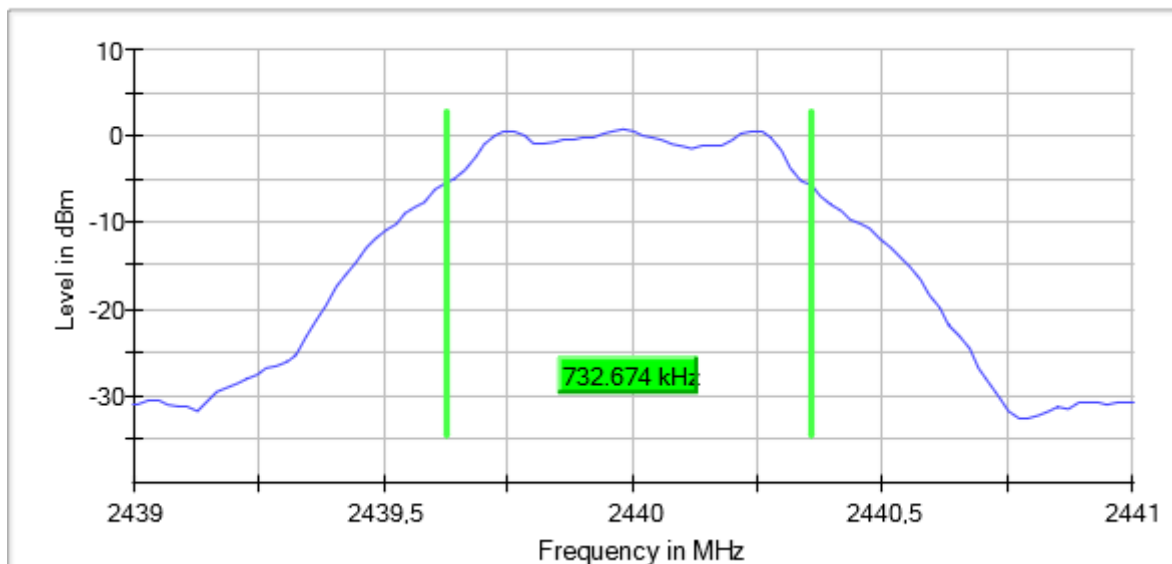
Plots:



Frequency (MHz) = 2440.00000, Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

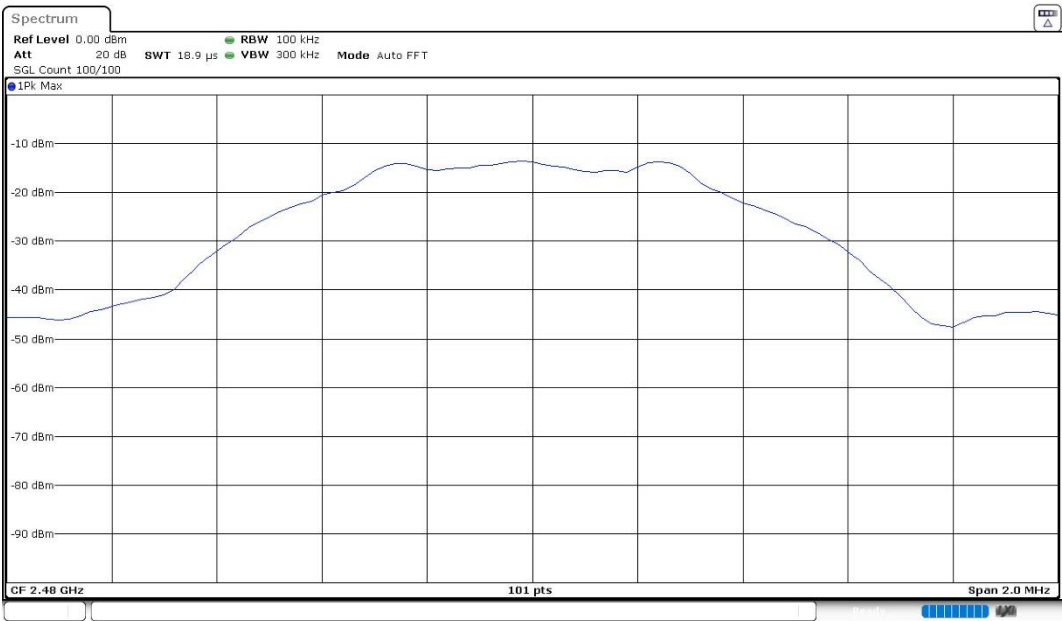
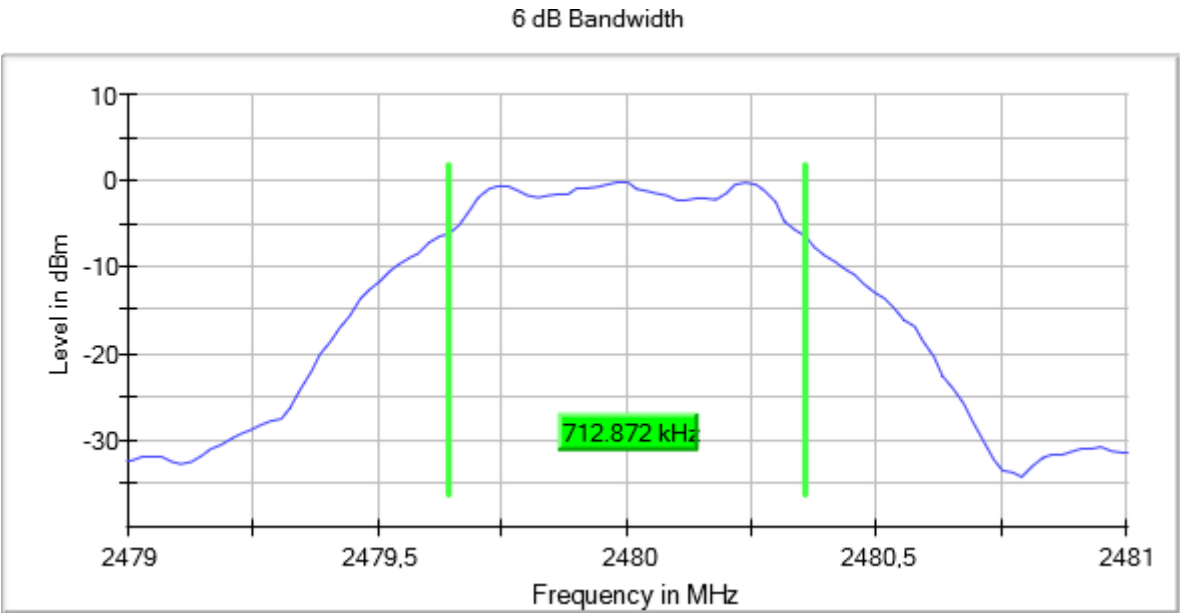
Plots:

6 dB Bandwidth



Frequency (MHz) = 2480.00000, Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:



FCC 15.247 (b) / RSS-247 5.4 (d) Maximum Output Power and Antenna Gain

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.

- Configuration 1**

Maximum Declared Antenna Gain: +4.5 dBi

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.

Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
Maximum Conducted Power (dBm)	0.97	1.46	0.63
Maximum EIRP Power (dBm)	5.47	5.96	5.13

Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
Maximum Conducted Power (dBm)	1.00	1.48	0.63
Maximum EIRP Power (dBm)	5.50	5.98	5.13

Verdict

Pass

- **Configuration 2**

Maximum Declared Antenna Gain: +1.8 dBi

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.

Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
Maximum Conducted Power (dBm)	0.97	1.46	0.63
Maximum EIRP Power (dBm)	2.77	3.26	2.43

Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

	Low Channel 2402 MHz	Middle Channel 2440 MHz	High Channel 2480 MHz
Maximum Conducted Power (dBm)	1.00	1.48	0.63
Maximum EIRP Power (dBm)	2.80	3.28	2.43

Verdict

Pass

FCC 15.247 (e) / RSS-247 5.2 (b) 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 2 Mbit/s)

Operation Band (MHz)	Freq (MHz)	Measured Freq (MHz)	Equipment	PSD (dBm)
[2400, 2483.5]	2402.00000	2401.9525	Digital Transmission System (DTS)	-9.51
	2440.00000	2439.9525		-9.03
	2480.00000	2479.9525		-10.01

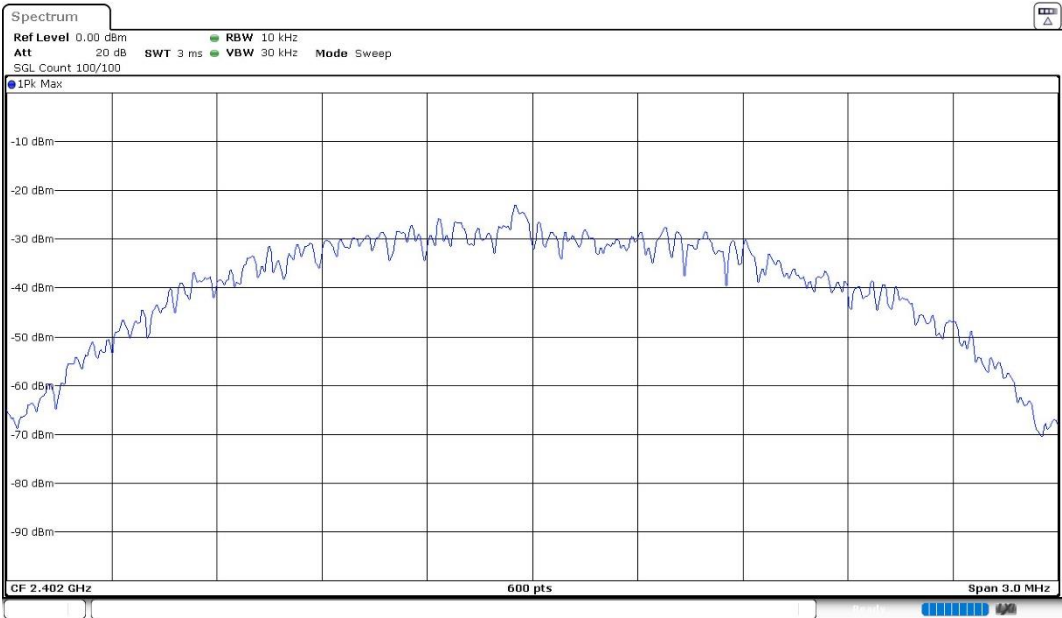
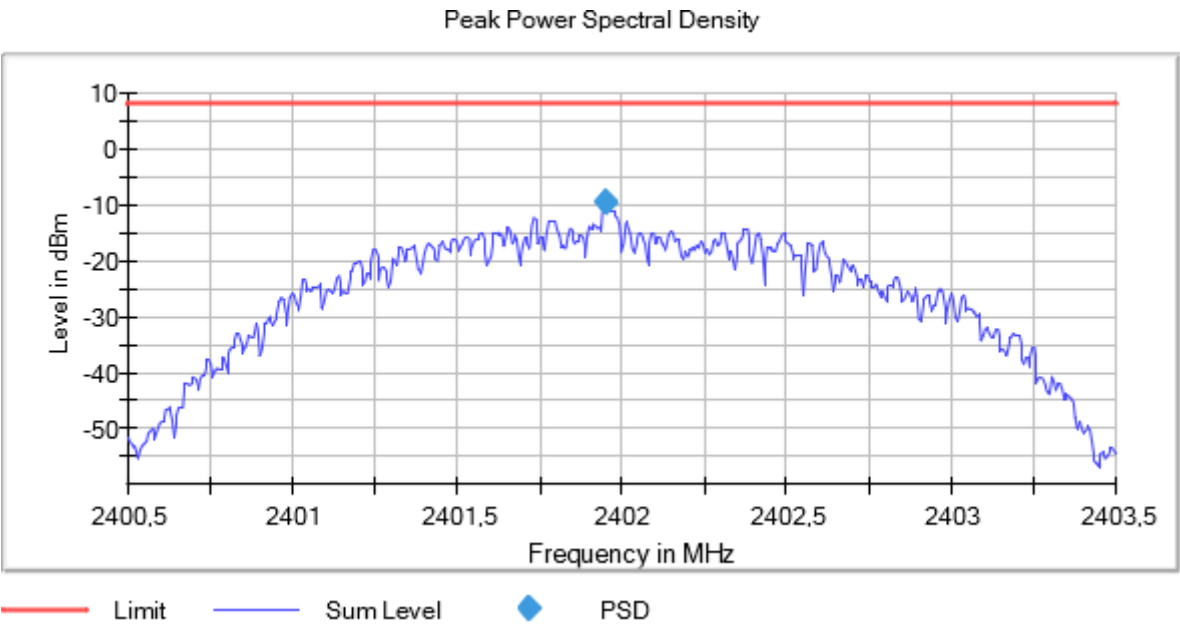
Verdict

Pass

Attachments

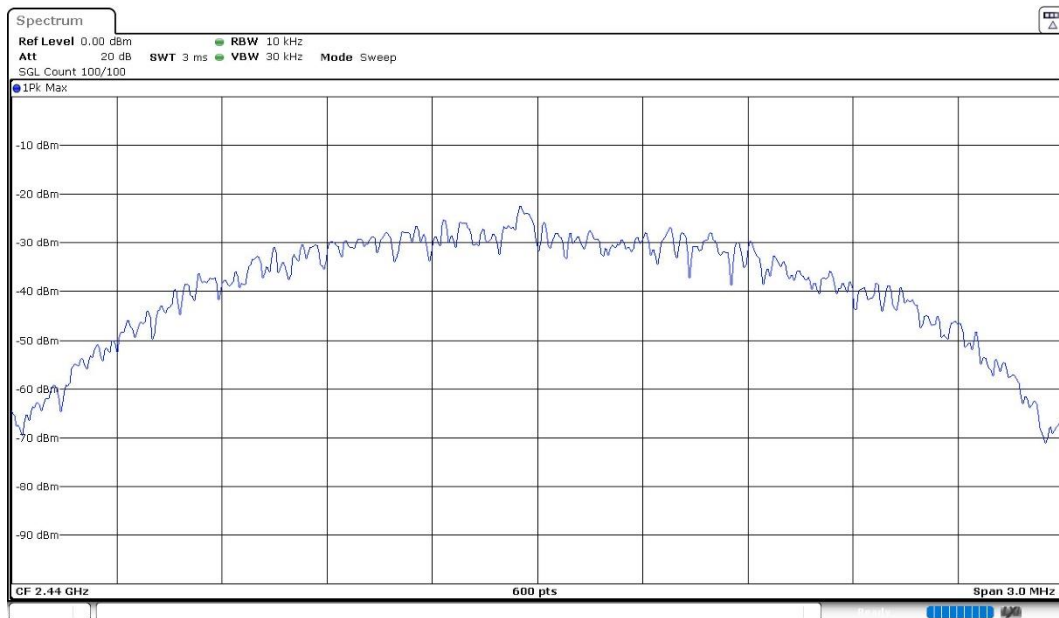
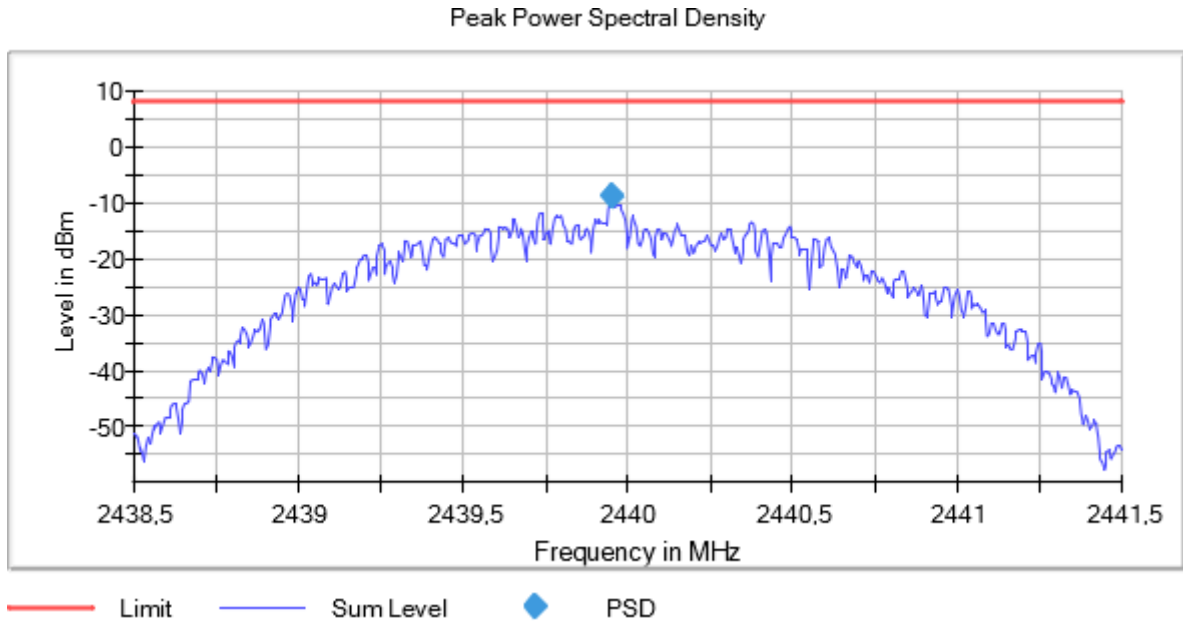
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00000, Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

Plots:



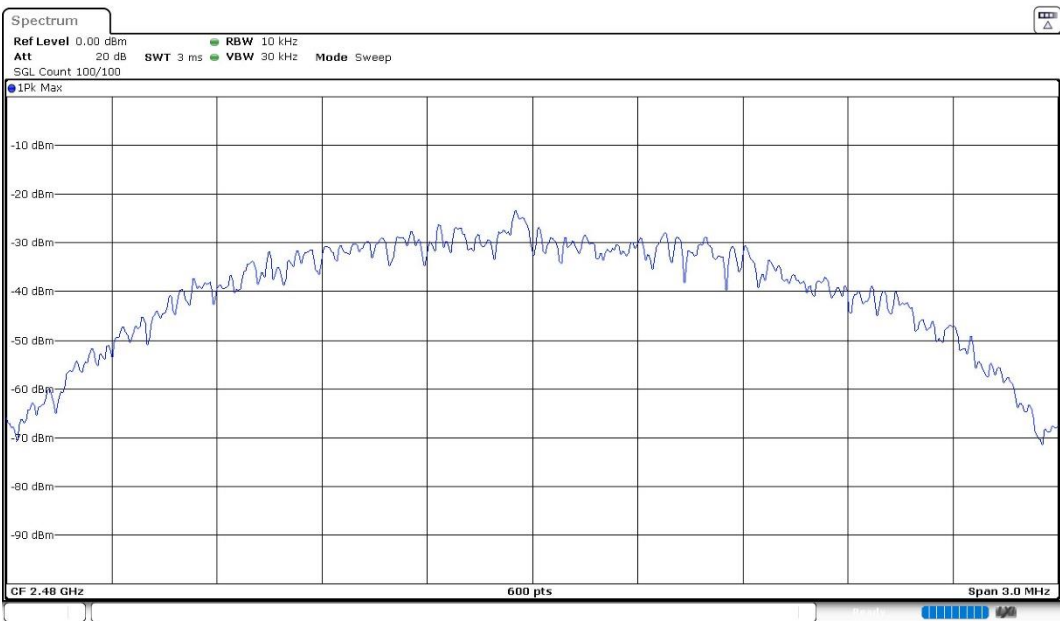
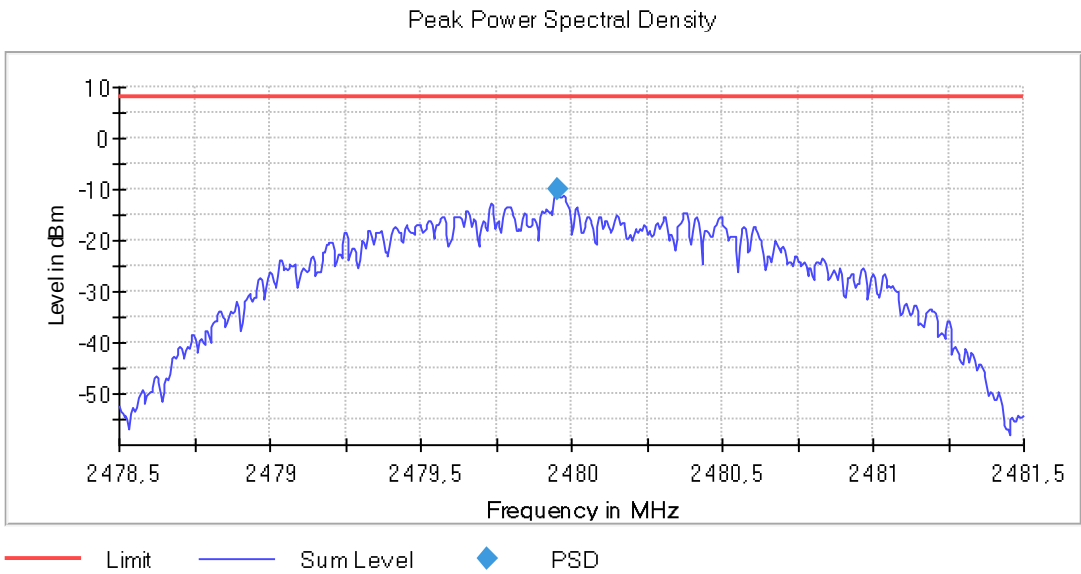
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2440.00000, Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

Plots:



Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00000, Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

Plots:



Results

Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Operation Band (MHz)	Freq (MHz)	Measured Freq (MHz)	Equipment	PSD (dBm)
[2400, 2483.5]	2402.00000	2401.9675	Digital Transmission System (DTS)	-7.48
	2440.00000	2439.9675		-6.83
	2480.00000	2479.9675		-7.82

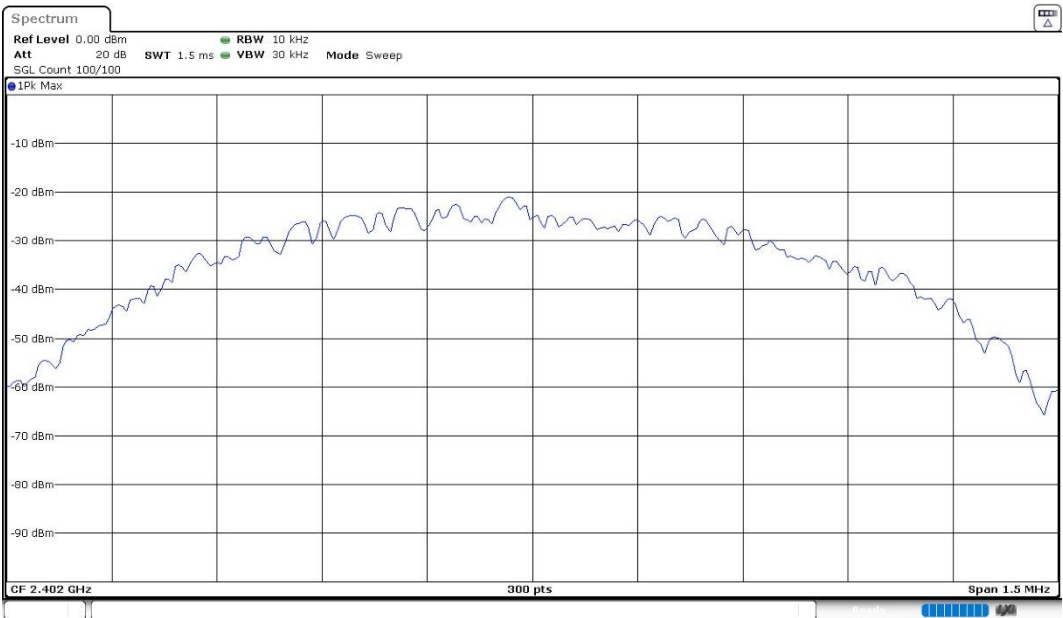
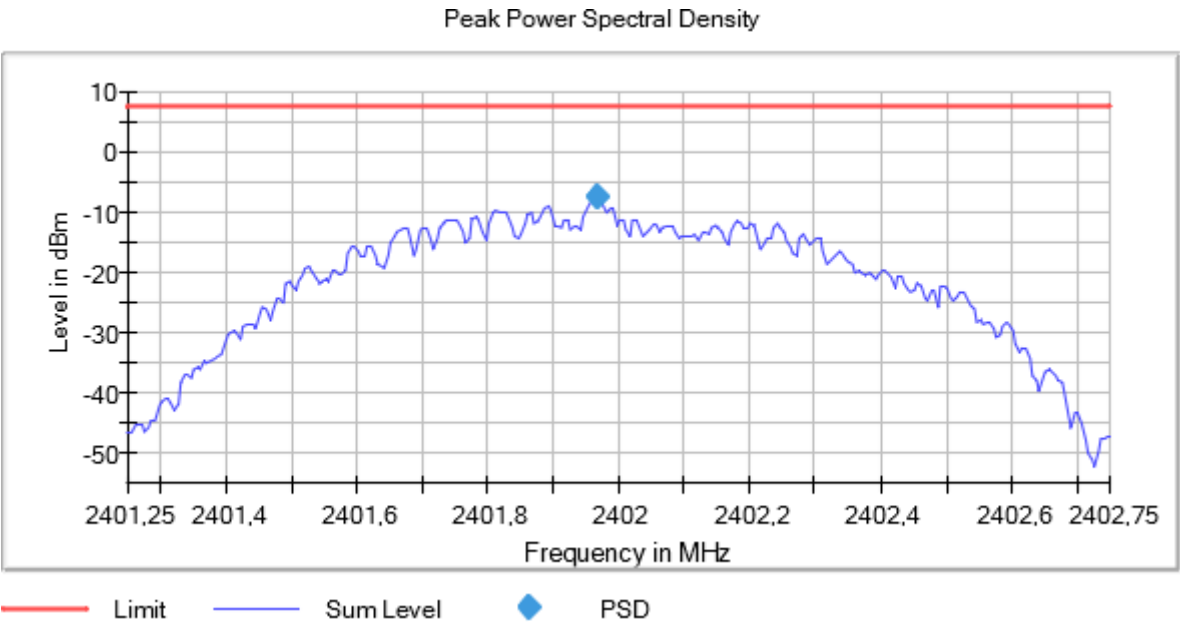
Verdict

Pass

Attachments

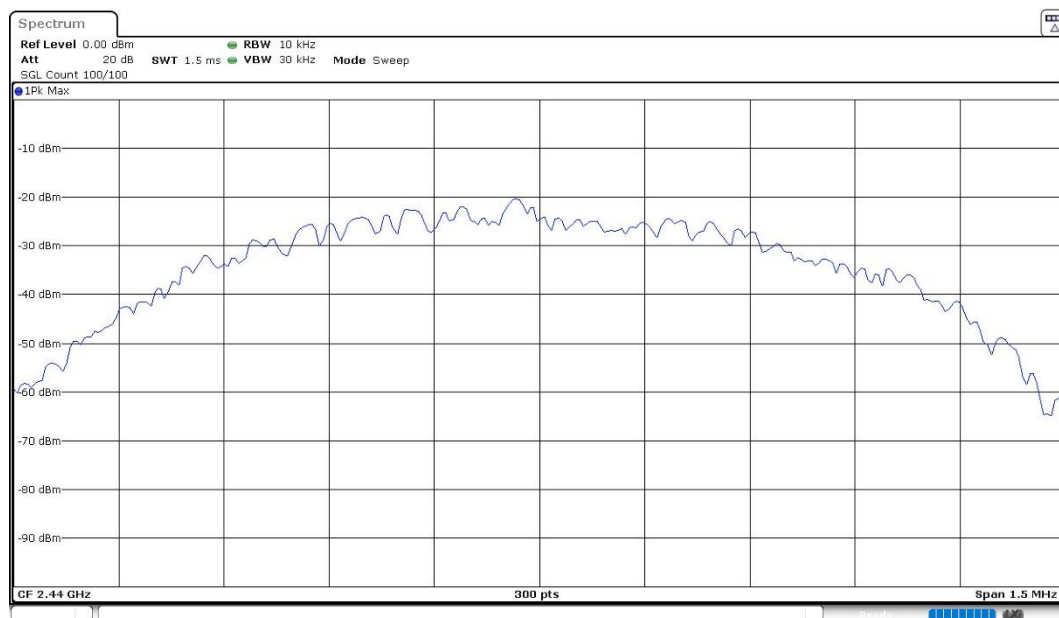
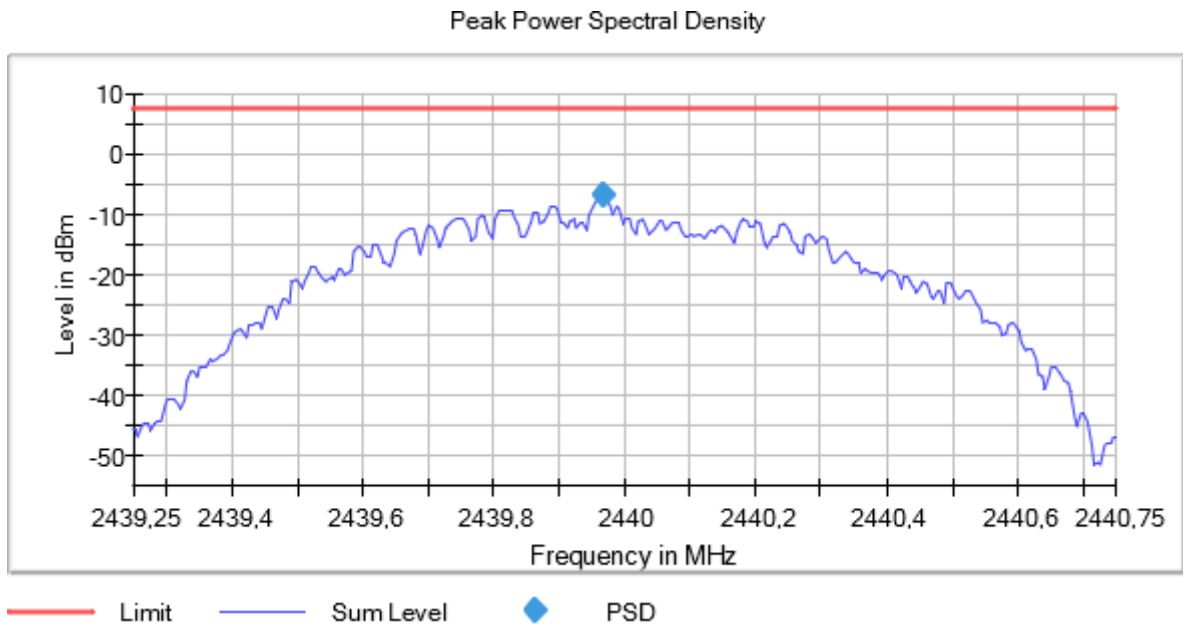
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00000, Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:



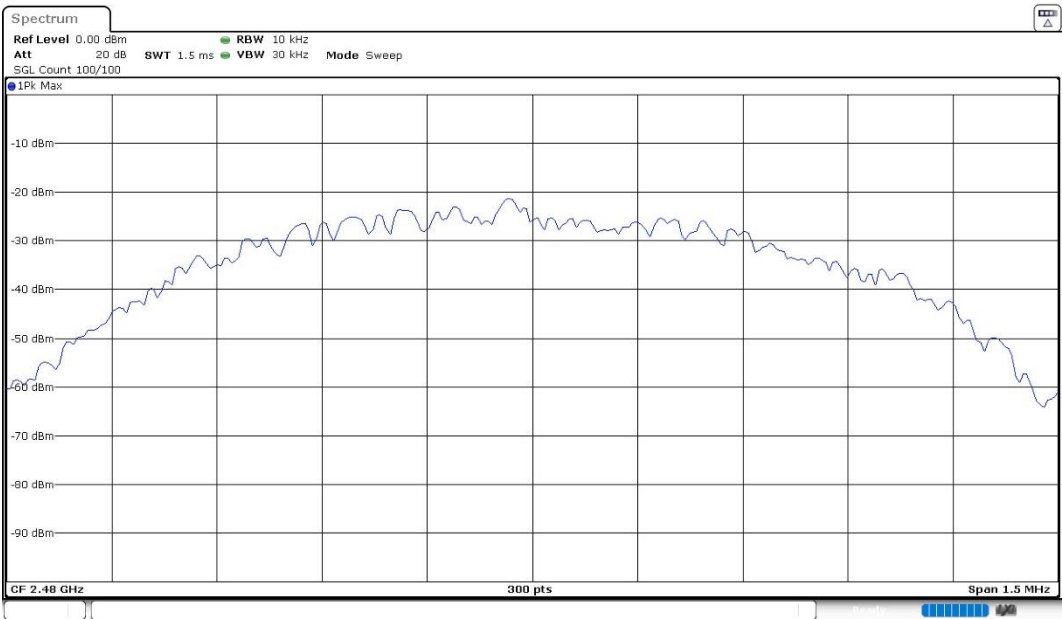
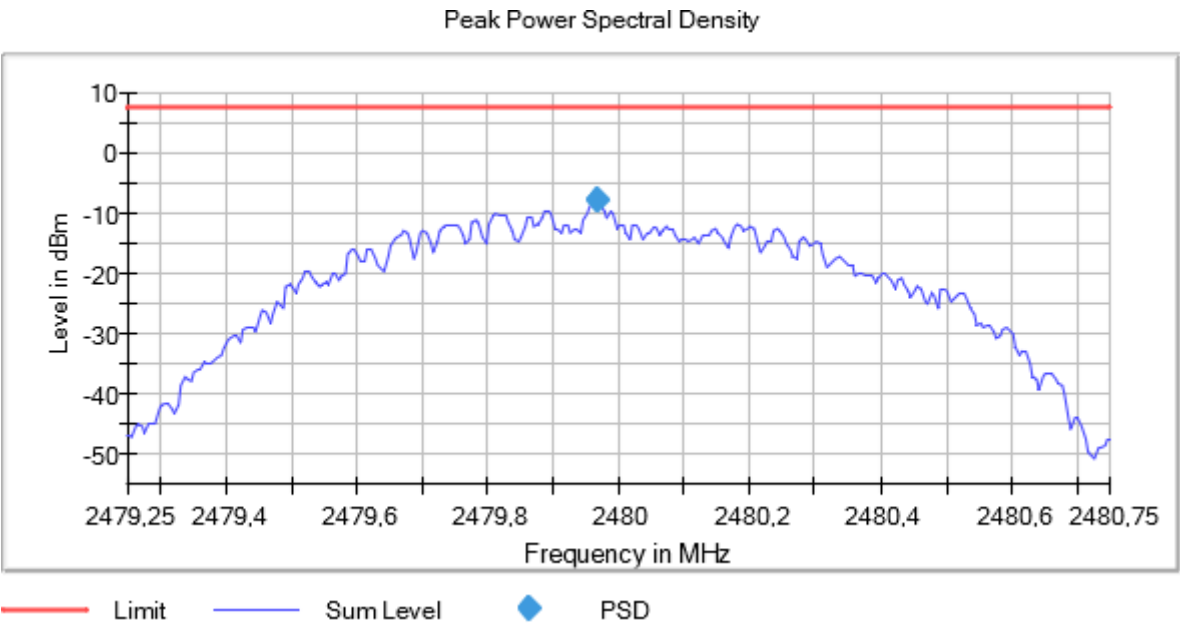
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2440.00000, Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:



Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00000, Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:



FCC 15.247 (d) / RSS-247 5.5 Band-Edge Emissions Compliance (Transmitter)

Limits

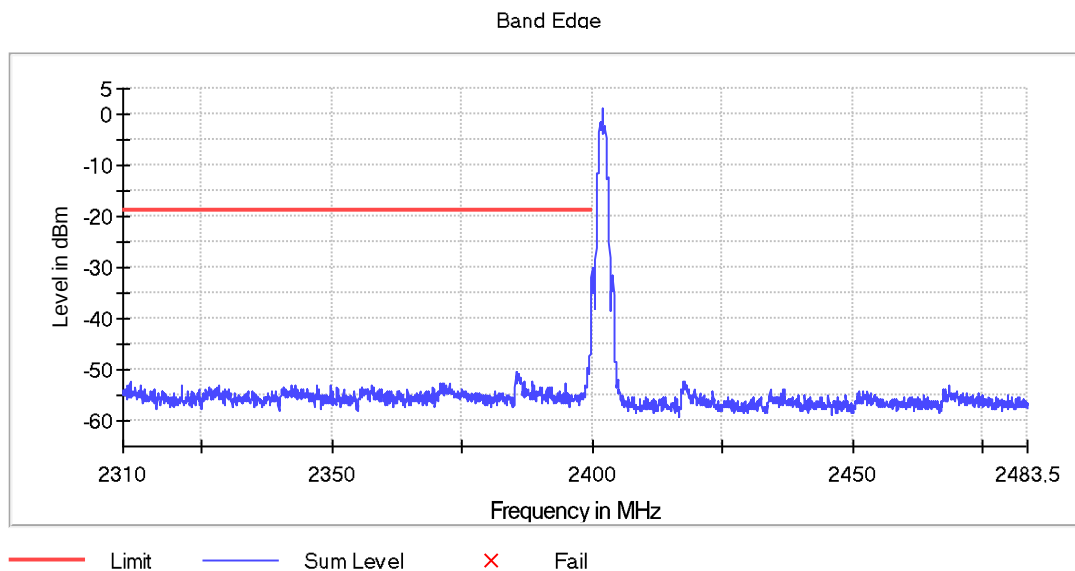
In any 100 kHz bandwidths outside the frequency band in which the intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power,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

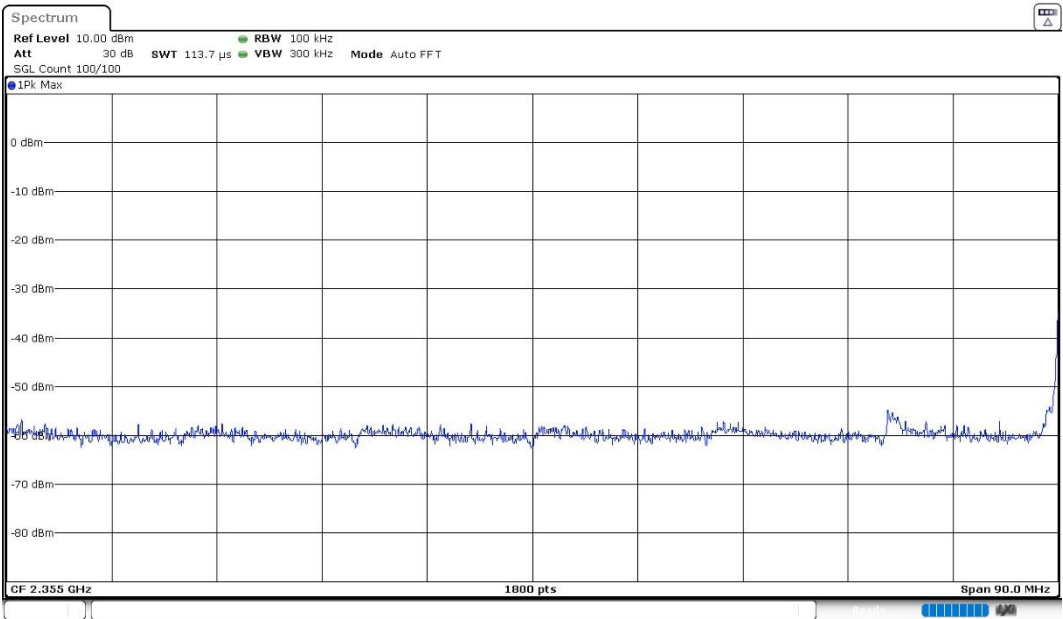
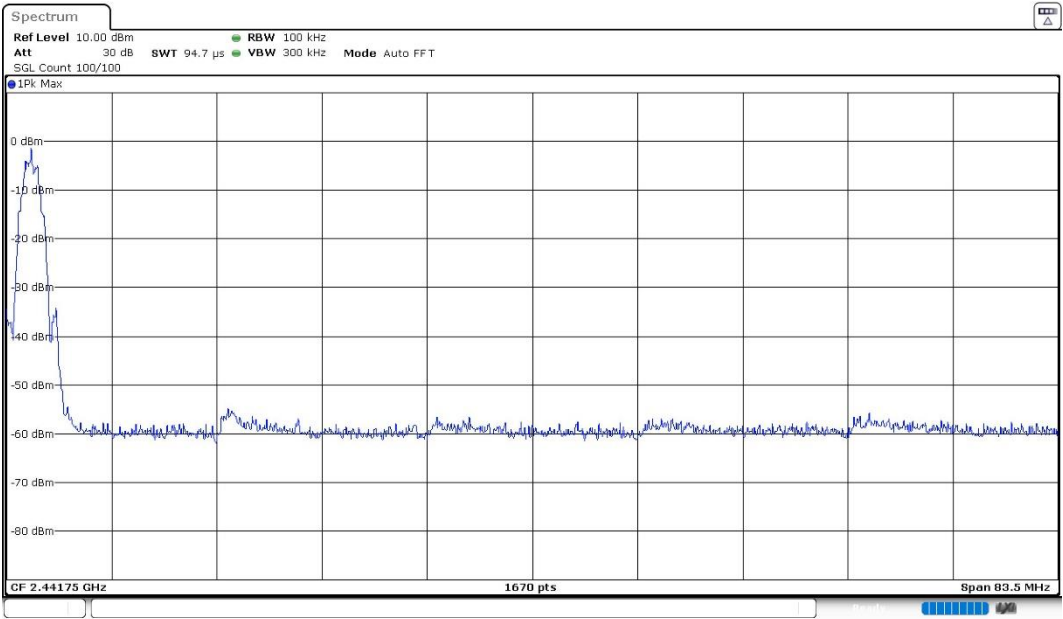
Results

Radiated measurements were used to show compliance with the limits in the restricted bands 2.31-2.39 GHz and 2.4835-2.5 GHz.

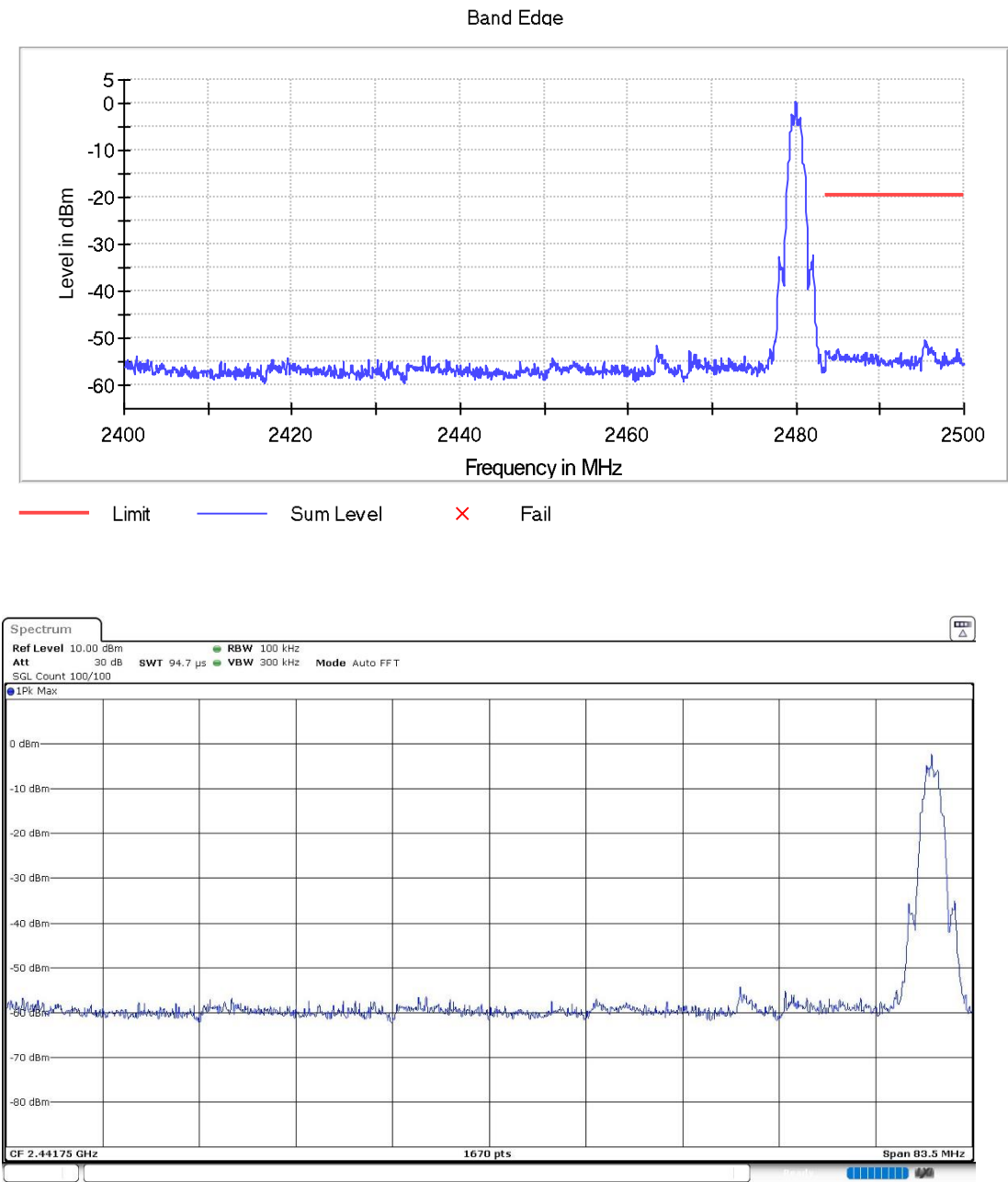
Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

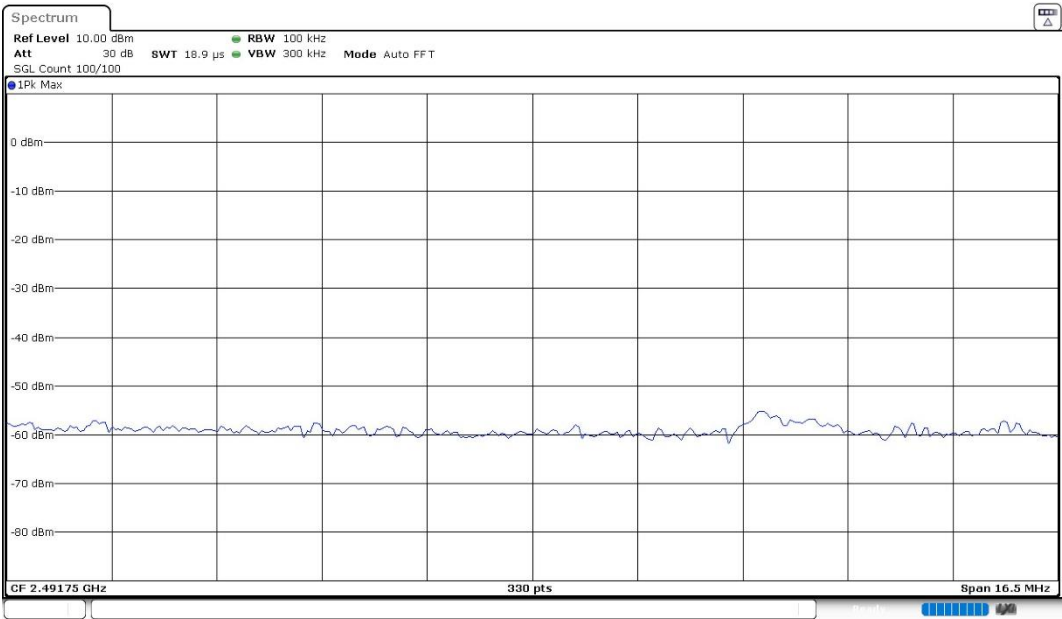
- Low Channel:





- High Channel:





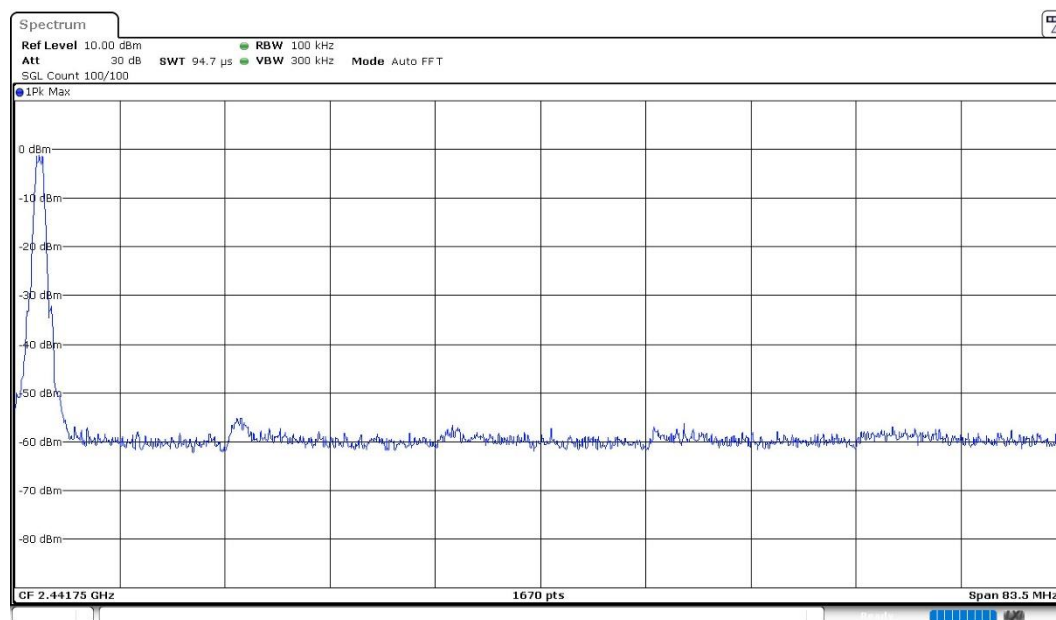
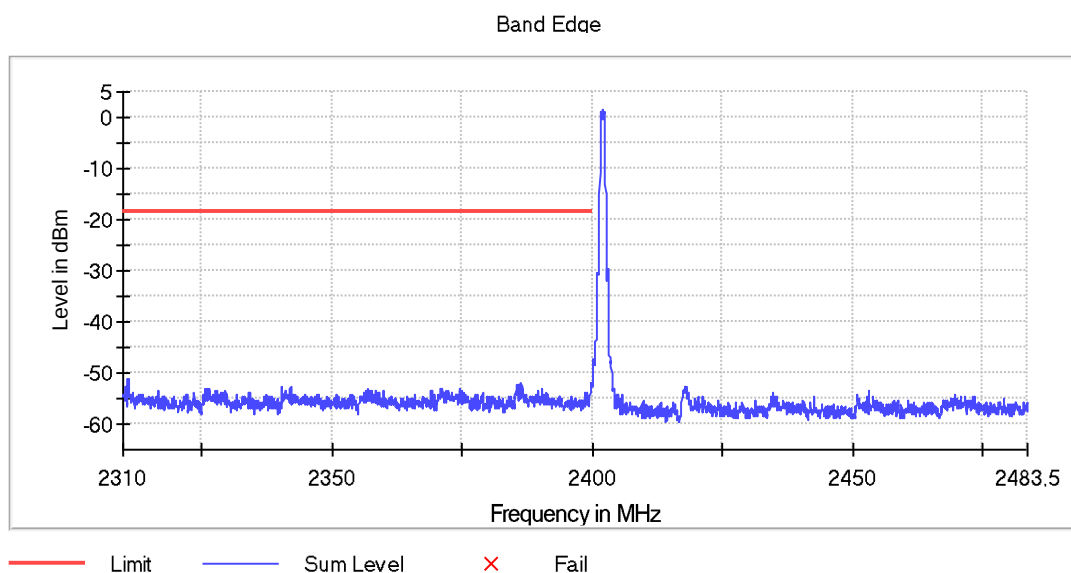
Verdict

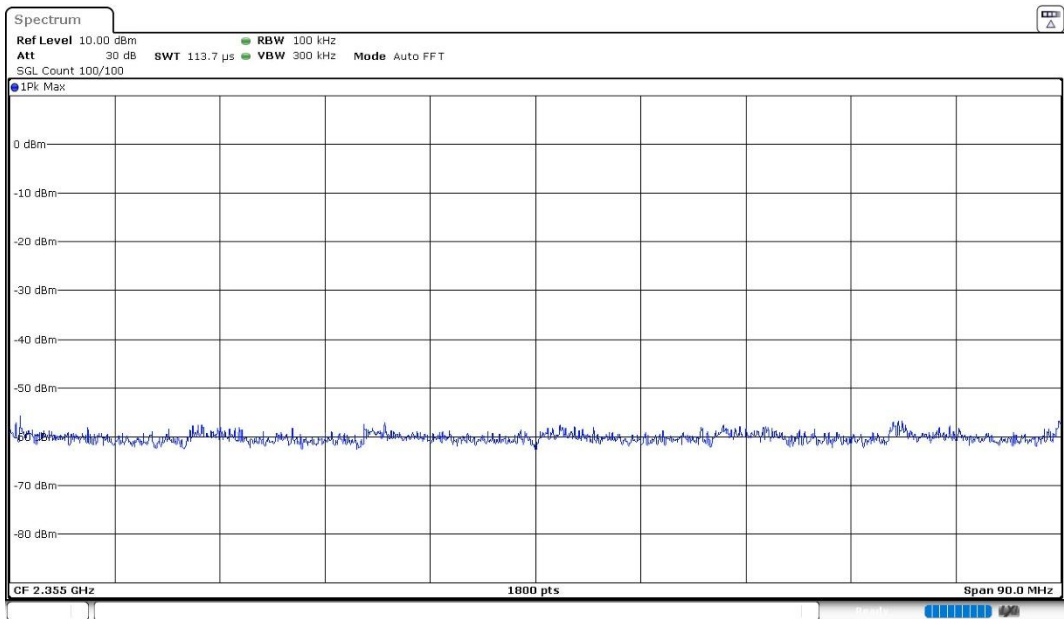
Pass

Results

Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

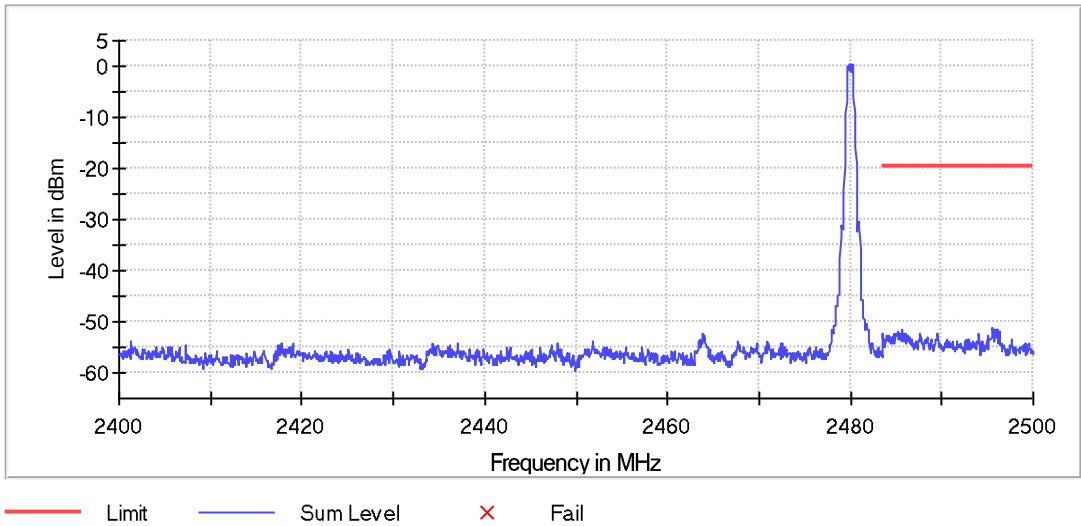
- Low Channel:

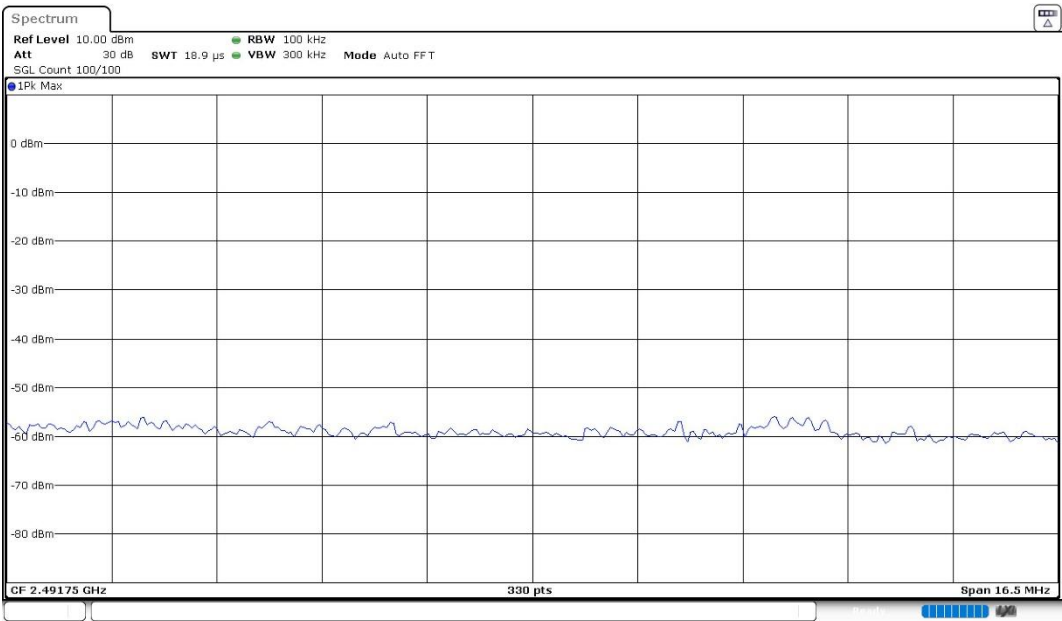
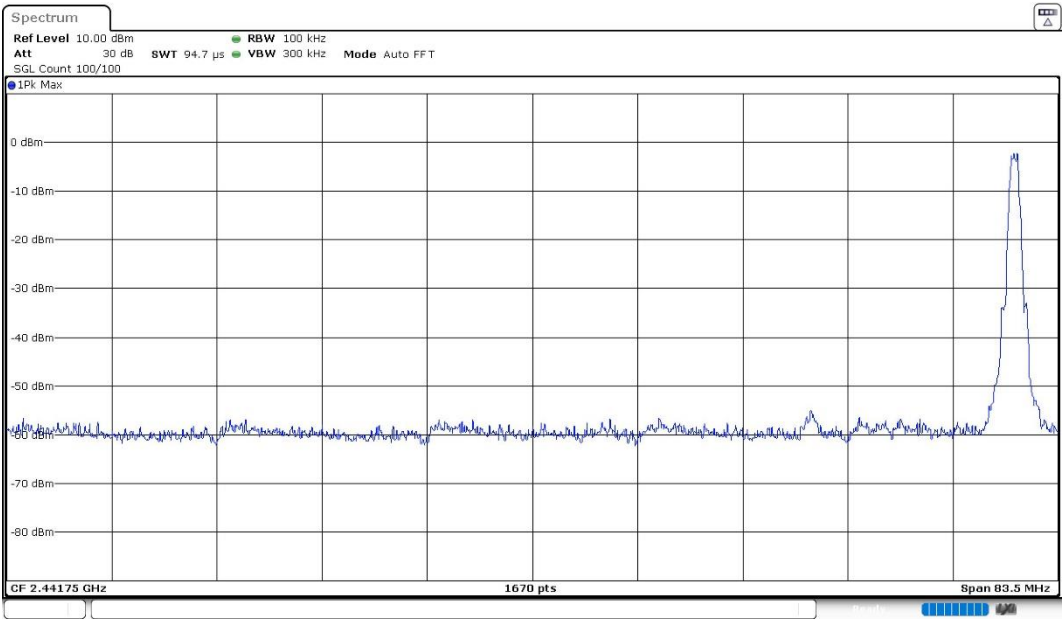




- High Channel:

Band Edge





Verdict

Pass

FCC 15.247 (d) / RSS-247 5.5 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 ($\mu\text{V/m}$)	Field strength (dB $\mu\text{V/m}$)	Measurement distance (m)
0.009 – 0.490	2400/F(kHz)	-	300
0.490 – 1.705	24000/F(kHz)	-	30
1.705 – 30	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 specified when measuring with peak detector function, corresponding to 20 dB above the indicated values in the table.

RSS-247:

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

- Configuration 1**

Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

Results

Frequency range 30 MHz – 1 GHz:

ID	Comments
--	The spurious frequencies detected do not depend on the operating channel.

Freq Rng (GHz)	Unwanted Freq (MHz)	Unwanted Lvl (dB $\mu\text{V/m}$)	Pol	Detector
[0.03, 1]	375.0096	39.42	H	QP
	449.9712	39.37	H	QP
	624.9883	33.61	V	QP

Frequency range 1 GHz – 26 GHz:

ID	Comments
--	The results in the next table 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 for compliance checking with the average limit.

Freq (MHz)	Freq Rng (GHz)	Unwanted Freq (MHz)	Unwanted Lvl (dB μ V/m)	Pol	Detector
2402.00000	[3, 17]	7204.3400 (*)	49.64	V	PK
		9605.7600 (*)	51.80	V	PK
		14414.7600 (*)	53.08	V	PK
2440.00000	[3, 17]	7321.2400	49.84	V	PK
		9758.0800 (*)	52.00	V	PK
		14636.6600 (*)	53.78	V	PK
2480.00000	[3, 17]	7441.5000	50.16	V	PK
		9922.0200 (*)	55.17	V	PK
		14880.2600 (*)	53.44	V	PK

(*) This Spurious Frequency is outside the restricted bands as defined in §15.205(a). The peak spurious level is more than 20 dB below the peak carrier level.

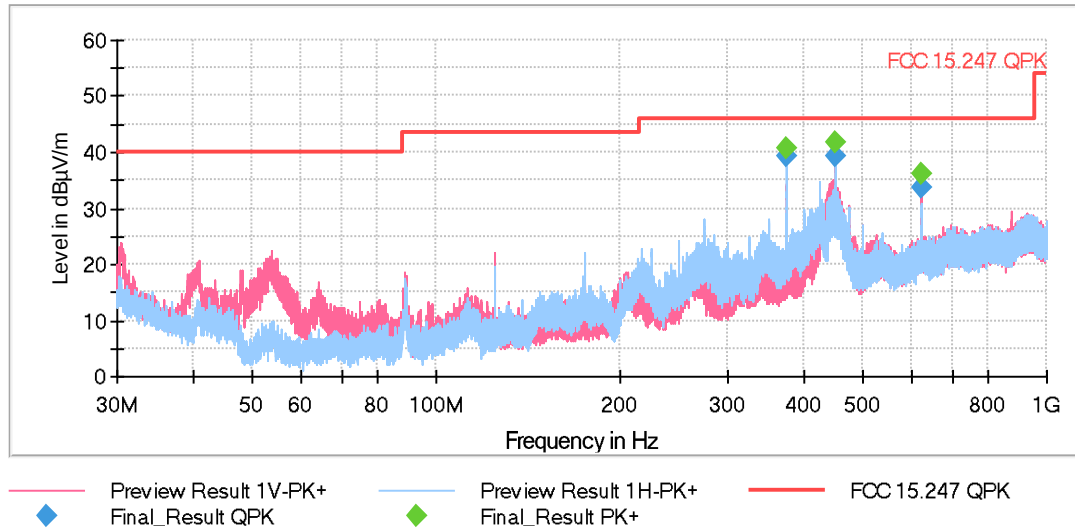
Verdict

Pass

Attachments

Operation Band (MHz) = [2400, 2483.5], Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 2 Mbit/s), Frequency Range (GHz) = [0.03, 1]

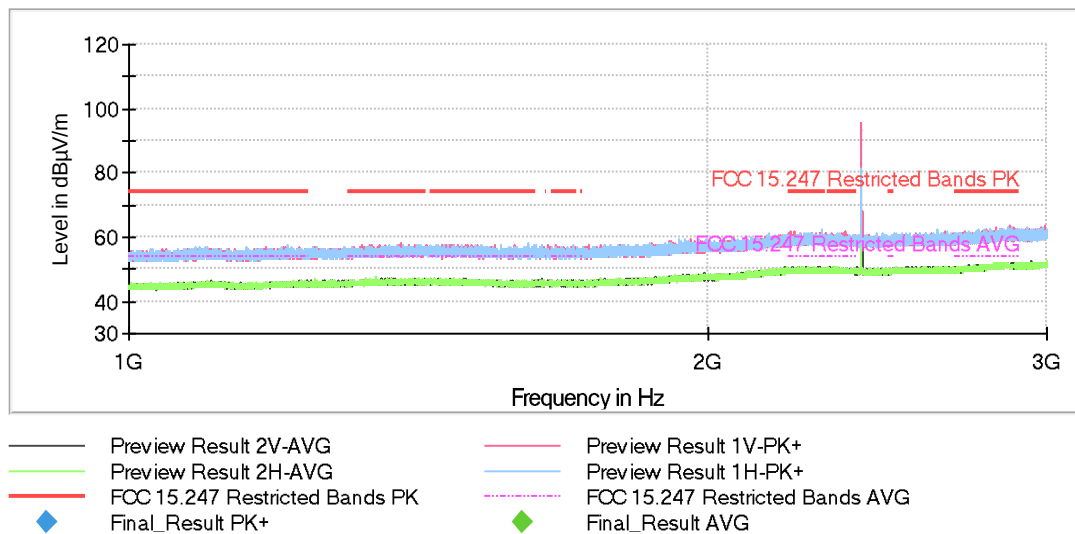
Plots:



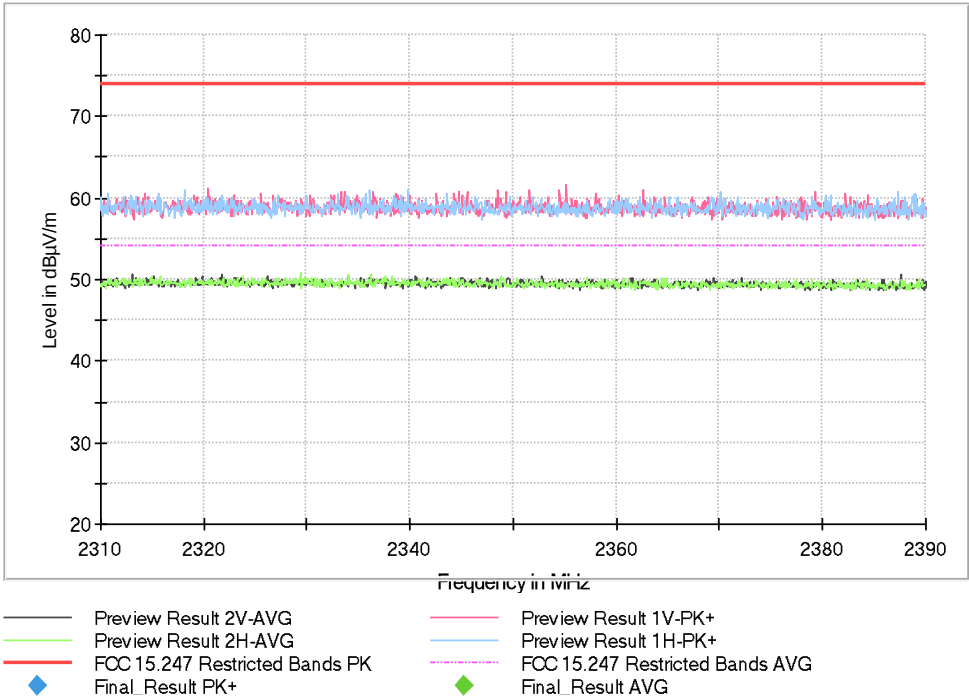
This plot is valid for Low, Middle and High Channels.

Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00000, Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 2 Mbit/s), Frequency Range (GHz) = [1, 3]

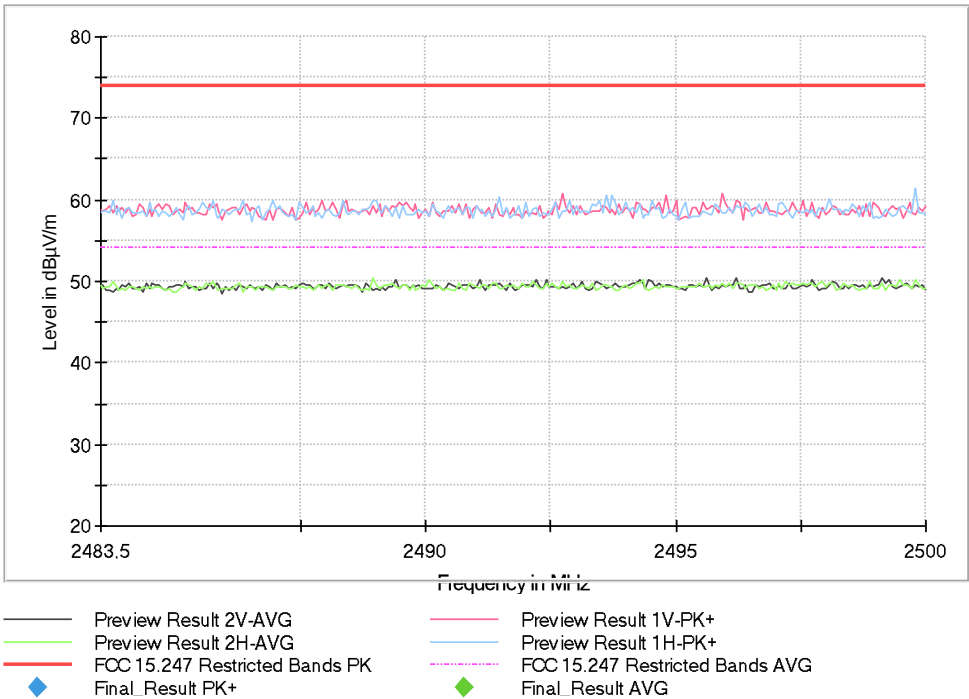
Plots:



Full Spectrum

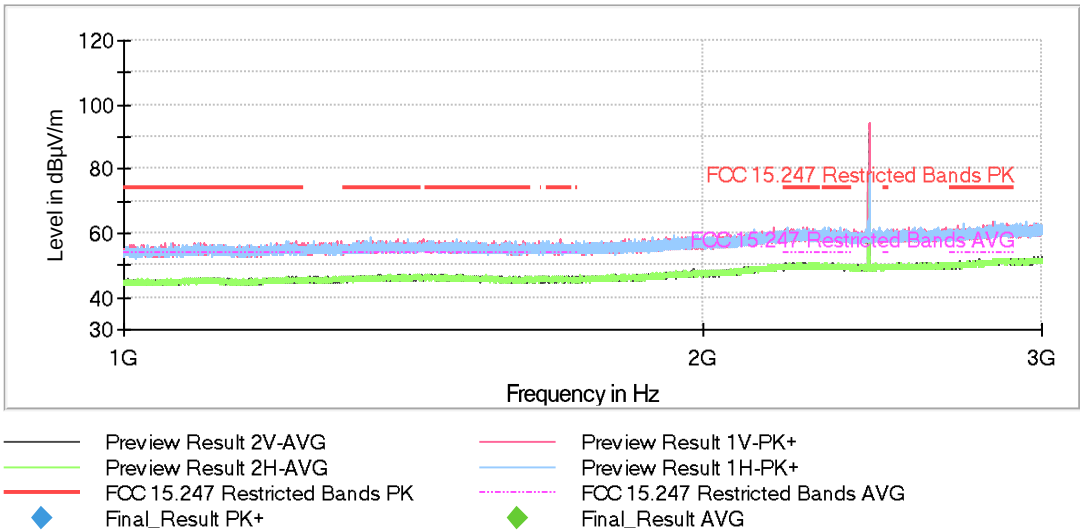


Full Spectrum

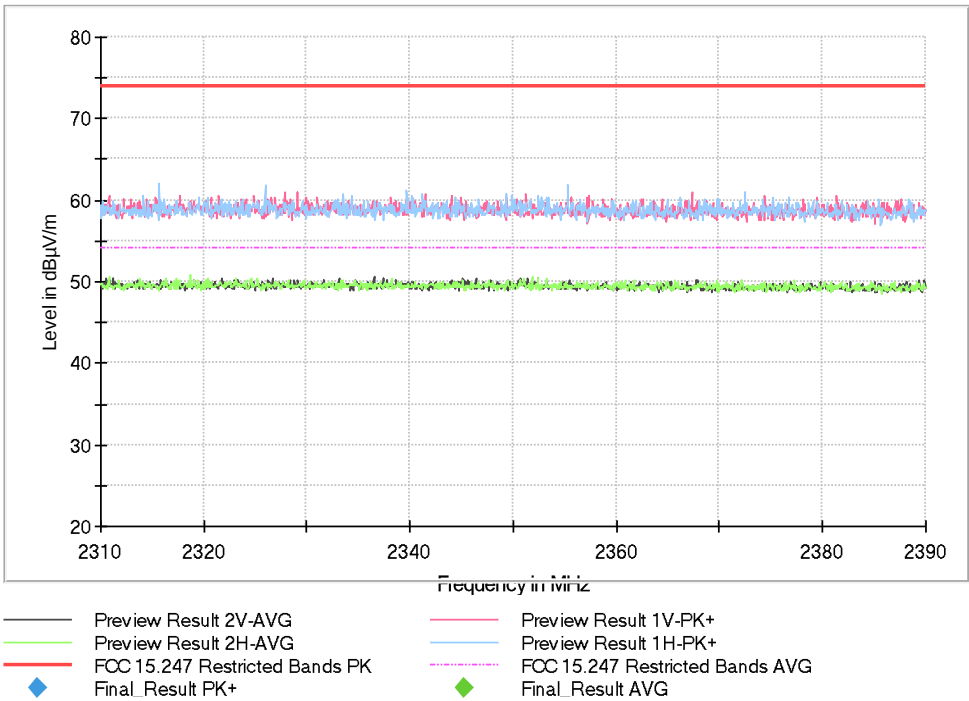


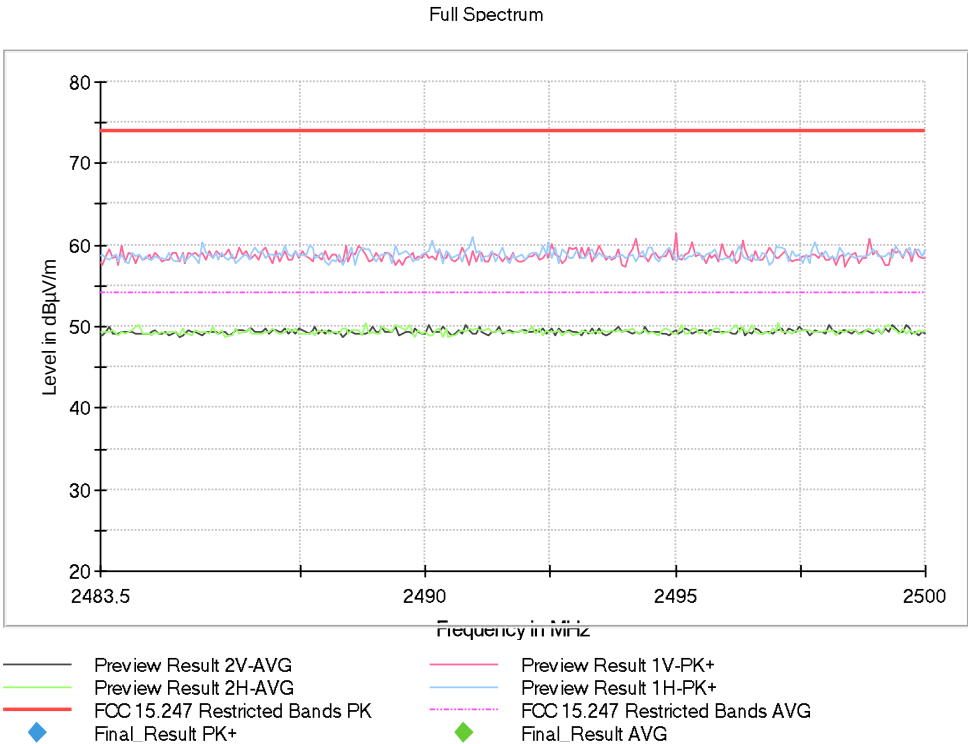
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2440.00000, Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 2 Mbit/s), Frequency Range (GHz) = [1, 3]

Plots:



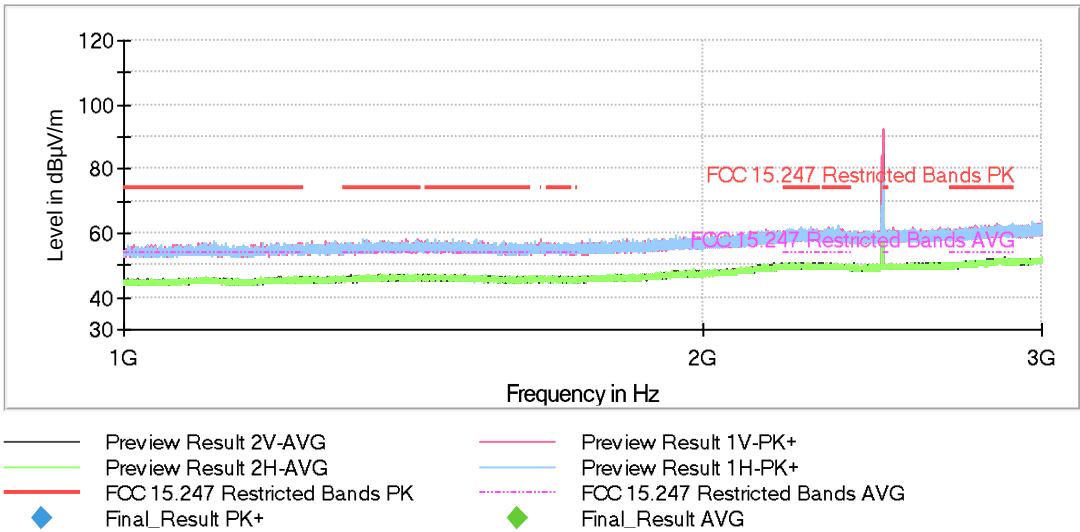
Full Spectrum



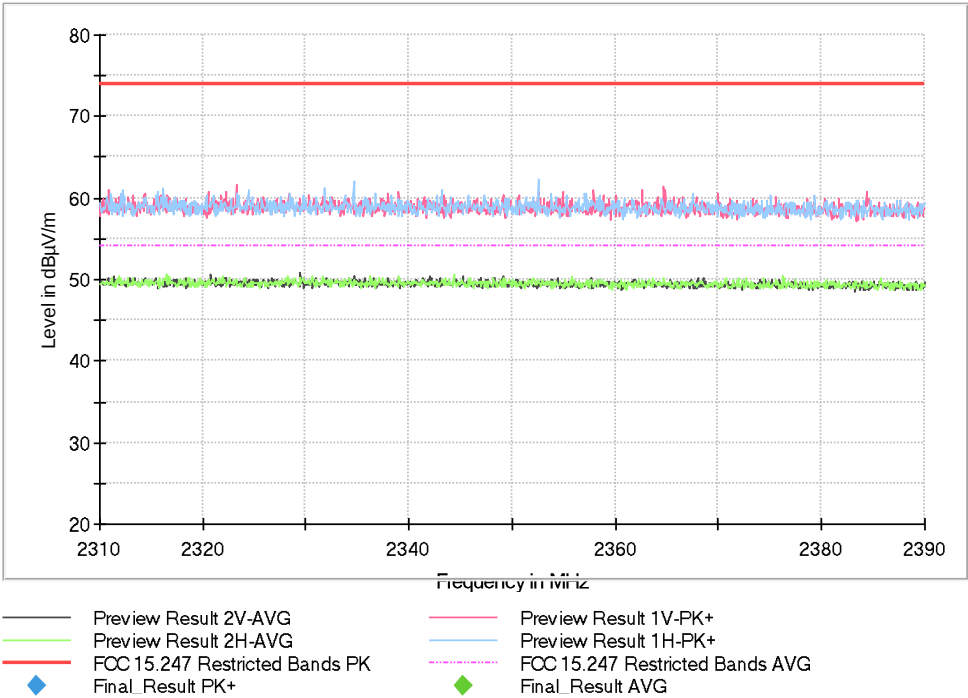


Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00000, Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 2 Mbit/s), Frequency Range (GHz) = [1, 3]

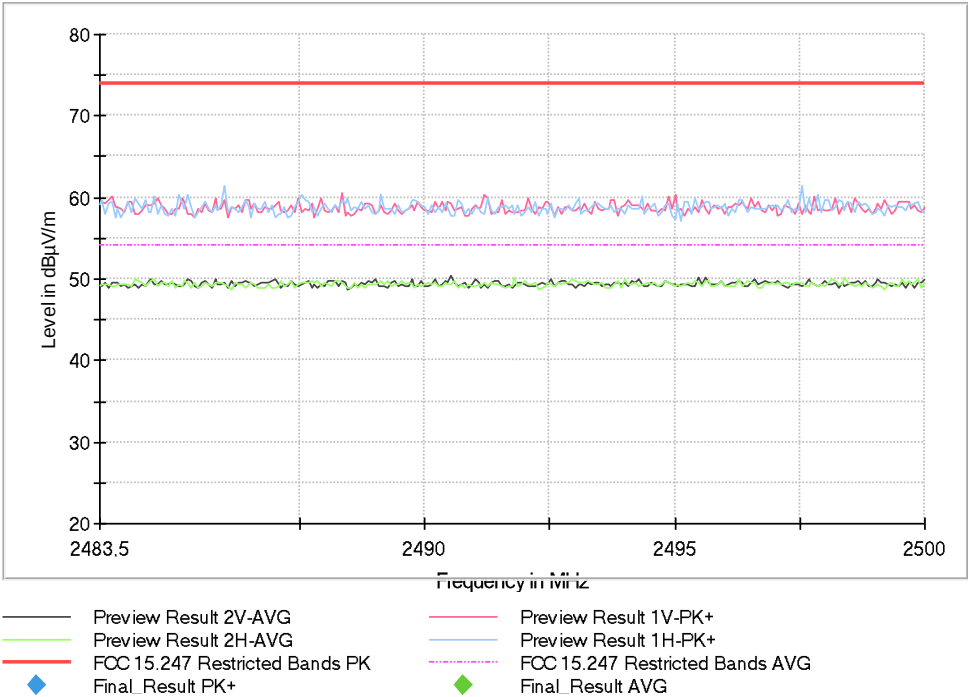
Plots:



Full Spectrum

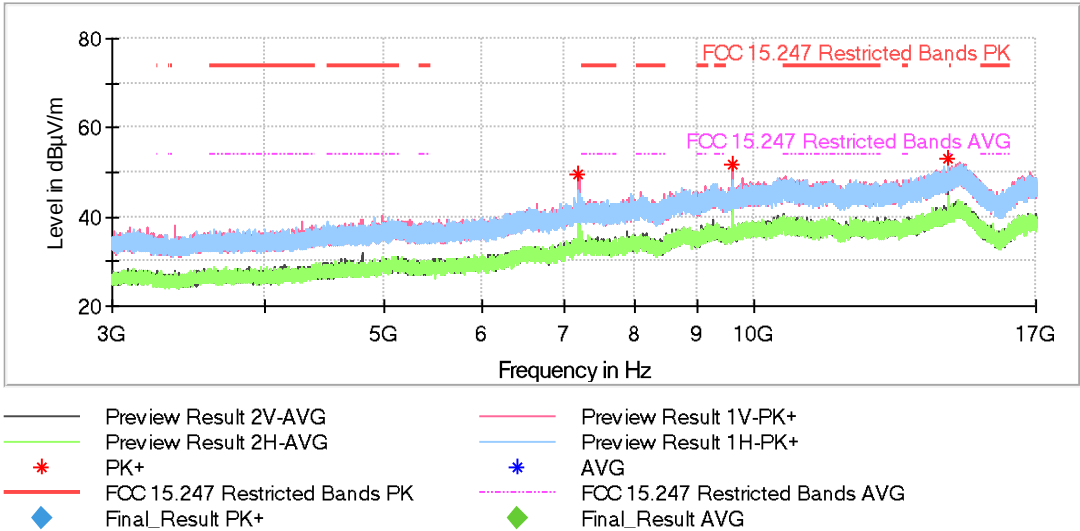


Full Spectrum



Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00000, Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 2 Mbit/s), Frequency Range (GHz) = [3, 17]

Plots:



Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2440.00000, Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 2 Mbit/s), Frequency Range (GHz) = [3, 17]

Plots:

