

ISED CABid: ES1909

Test Report No:
NIE: 70542RRF.007

Test Report

USA FCC Part 15.247, 15.209

CANADA RSS-247, RSS-Gen

(*) Identification of item tested	Wireless hearing instrument
(*) Trademark	ReSound, Beltone, Interton, GN Hearing, Jabra
(*) Model and /or type reference	CAIR1R
Other identification of the product	HW version: See sample list SW version: See sample list FCC ID: X26CAIR1R IC: 6941C-CAIR1R
(*) Features	Audio amplification, proprietary 2.4 GHz wireless Functionality (Proximity), Bluetooth 5.0, 10.667 MHz wireless magnetic induction functionality and WPT at 135.59 kHz
Manufacturer	GN HEARING A/S Lautrupbjerg 7, 2750 Ballerup, Denmark
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 2 (February 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	2022-06-17
Report template No.	FDT08_24 (*) "Data provided by the client"

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Acronyms

Acronym ID	Acronym Description
Emission Bandwidth	6dB Emission Bandwidth
Equipment	Equipment Type
Freq	Frequency
Freq Rng	Frequency Range
Lvl	Level
Mod	Modulation
Occ Ch BW	Occupied Channel Bandwidth
Operation Band	Operation Band
Peak Power	Maximum Peak Conducted Output Power
Pol	Polarization
PSD	Power Spectral Density (Conducted at Antenna Port)
Unwanted Freq	Unwanted Emissions Frequency
Unwanted Lvl	Unwanted Emissions Level

Competences and guarantees

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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.

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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 Wireless hearing aid instrument, model CAIR1R.
3. Testing performed with the information provided in 0437250[B]_RADIO_TEST_PLAN_CAIR1R document.

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	67124D_39.1	Wireless hearing instrument	CAIR1R	3108030122	2021-09-30	Element Under Test
S/02	70542C_144.1	Wireless hearing instrument	CAIR1R	3112200074	2022-02-03	Element Under Test
S/03	70542C_257.1	Wireless hearing instrument	CAIR1R	3112200145	2022-06-06	Element Under Test
S/04	70542C_253.1	Wireless hearing instrument	CAIR1R	3112200090	2022-06-15	Element Under Test

Samples have been used for the following test(s):

Id	Type
S/01	Conducted. HW: PCBA,CAM.CUST,R,MFI,V1.A,C6 SW: Dooku2 v.9.53.1
S/02	Radiated. HW:PCBA,CAM.CUST,R,MFI,V1.B,C6 SW: Dooku2 v.9.58.1
S/03	Conducted power spot-check. HW: PCBA,CAM.CUST,R,MFI,V1.B,C6 SW: Dooku2 v.9.75.2 A small new copper tracing is added on board to supply directly from VBAT a specific point in the circuit, and the value of the capacitor C24 is changed from 4.7uF to 33uF. Critical partial spot-check tests have been performed on this sample to check that the RF behavior is similar as in previous samples.
S/04	Radiated spurious emissions spot-check. HW:PCBA,CAM.CUST,R,MFI,V1.B,C6 SW: Dooku2 v.9.75.2 A small new copper tracing is added on board to supply directly from VBAT a specific point in the circuit, and the value of the capacitor C24 is changed from 4.7uF to 33uF. Critical partial spot-check tests have been performed on this sample to check that the RF behavior is similar as in previous samples.

Test sample description

Ports..... :	Port name and description		Cable				
			Specified max length [m]	Attached during test	Shielded	Coupled to patient ⁽³⁾	
			[]	[]	[]		
Supplementary information to the ports..... :							
Rated power supply	Voltage and Frequency		Reference poles				
			L1	L2	L3	N	PE
	[]	AC:	[]	[]	[]	[]	[]
	[]	AC:	[]	[]	[]	[]	[]
	[X]	DC: Internal rechargeable battery					
[]	DC:						
Rated Power	3.8 V						
Clock frequencies..... :	2.48 GHz, 10.667 MHz and 135.59 kHz						
Other parameters							
Software version	See sample list						
Hardware version	See sample list						
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: Placed in the ear					
Modules/parts..... :	Module/parts of test item		Type		Manufacturer		
							
							
Accessories (not part of the test item)	Description		Type		Manufacturer		
	Computer		Certified according to IEC 60950-1, IEC 62368-1 or equivalent standard				
							
Documents as provided by the applicant	Description		File name		Issue date		
							

⁽³⁾ Only for Medical Equipment

Identification of the client

GN HEARING A/S
Lautrupbjerg 7, 2750 Ballerup, Denmark

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2021-10-15
Date (finish)	2022-06-15

Document history

Report number	Date	Description
70542RRF.007	2022-06-17	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 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 tests were performed by the technical personnel: José Manuel Jiménez and Nicolás Salguero.

Used instrumentation:

Equipment	Model	Manufacturer	Next Calibration
SEMIANECHOIC ABSORBER LINED CHAMBER III	SAC-3	Frankonia	N.A.
SHIELDED ROOM	--	FRANKONIA	N.A.
EMI TEST RECEIVER 2Hz-44GHz	ESW44	ROHDE AND SCHWARZ	2023-09-21
HYBRID BILOG ANTENNA 30MHz-6GHz	3142E	ETS LINDGREN	2024-09-15
HORN ANTENNA 1-18GHz	BBHA 9120 D	SCHWARZBECK MESS- ELEKTRONIK	2024-07-13
HORN ANTENNA 18-40GHz	BBHA 9170	SCHWARZBECK	2023-05-05
PRE-AMPLIFIER G>40dB 10MHz-6GHz	BLNA 0160-01N	BONN ELEKTRONIK	2022-10-27
PREAMPLIFIER 30dB 500MHz-18GHz	BBV 9718 C	SCHWARZBECK	2023-03-17
PRE-AMPLIFIER G>30dB 17-40GHz	BLMA 1840-4A	BONN ELEKTRONIK	2022-09-08
SIGNAL AND SPECTRUM ANALYZER 10Hz-40GHz	FSV40	ROHDE AND SCHWARZ	2023-02-26
OPEN SWITCH UNIT UP TO 7.5 GHz	OSP-B157W8 PLUS	ROHDE & SCHWARZ	2023-08-20
EMC/RF MEASUREMENT SOFTWARE	EMC32	ROHDE AND SCHWARZ	N.A.

Testing verdicts

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

Summary

1. 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	(1)
FCC 15.247 (b) / RSS-247 5.4 (d)	Maximum output power and antenna gain	P	(1)
FCC 15.247 (d) / RSS-247 5.5	Band-edge emissions compliance (Transmitter)	P	(1)
FCC 15.247 (e) / RSS-247 5.2 (b)	Power spectral density	P	(1)
FCC 15.247 (d) / RSS-247 5.5	Emission limitations radiated (Transmitter)	P	(1)
Supplementary information and remarks:			
(1) Critical partial spot-check tests have been performed on HW modified samples to check that the RF behavior is similar as in previous samples.			

2. Proprietary protocol 2.4 GHz

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	(1)
FCC 15.247 (b) / RSS-247 5.4 (d)	Maximum output power and antenna gain	P	(1)
FCC 15.247 (d) / RSS-247 5.5	Band-edge emissions compliance (Transmitter)	P	(1)
FCC 15.247 (e) / RSS-247 5.2 (b)	Power spectral density	P	(1)
FCC 15.247 (d) / RSS-247 5.5	Emission limitations radiated (Transmitter)	P	(1)
Supplementary information and remarks:			
Critical partial spot-check tests have been performed on HW modified samples to check that the RF behavior is similar as in previous samples.			

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

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FCC 47 CFR PART 15.247 / RSS-247	15
Occupied Bandwidth	15
FCC 15.247 (a)(2) / RSS-247 5.2 (a) 6 dB Bandwidth	22
FCC 15.247 (b) / RSS-247 5.4 (d) Maximum Output Power and Antenna Gain	29
FCC 15.247 (d) / RSS-247 5.5 Band-Edge Emissions Compliance (Transmitter)	37
FCC 15.247 (e) / RSS-247 5.2 (b) Power Spectral Density	30
RSS-247 5.5 / FCC 15.247 (d) Emission limitations radiated (Transmitter)	45

TEST CONDITIONS

(*): Data provided by the client.

POWER SUPPLY (*):

Vnominal:	3.8 Vdc
Type of Power Supply:	Internal Li-ion battery

ANTENNA (*):

Type of Antenna:	Integral antenna
Maximum Declared Antenna Gain:	-8.62 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 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 – 18 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).

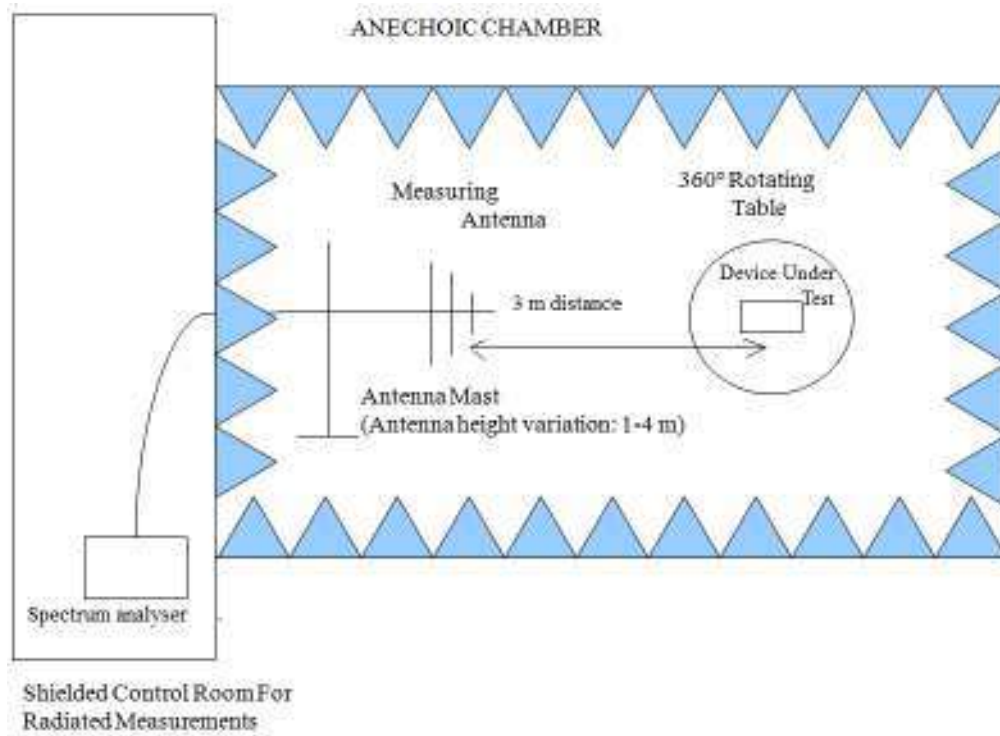
For radiated emissions in the range 17 GHz – 26 GHz performed at a distance closer than the distance specified in standard, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

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 17GHz) to find the maximum radiated emission.

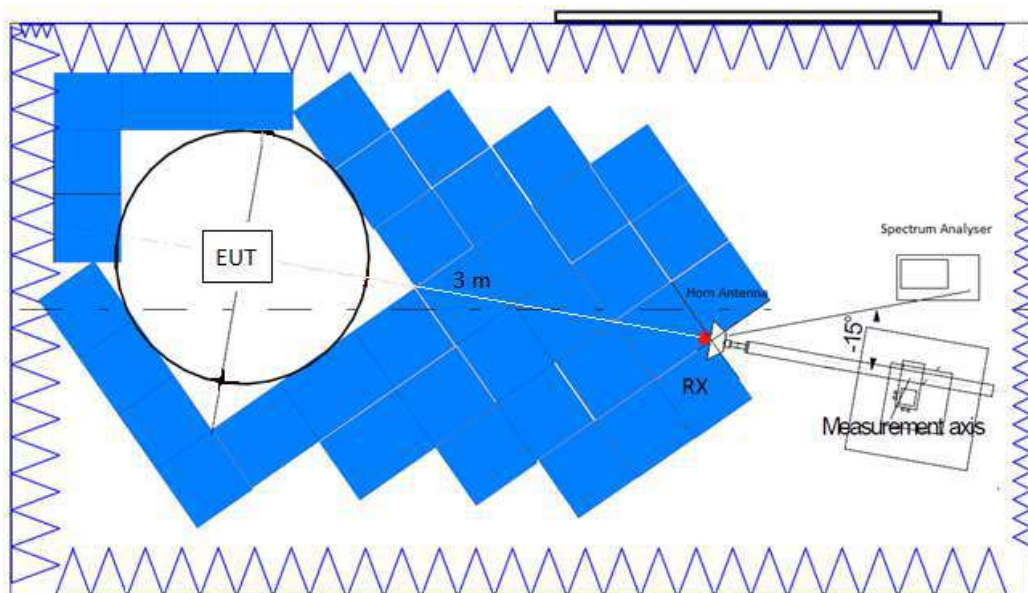
Measurements were made in both horizontal and vertical planes of polarization.

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.

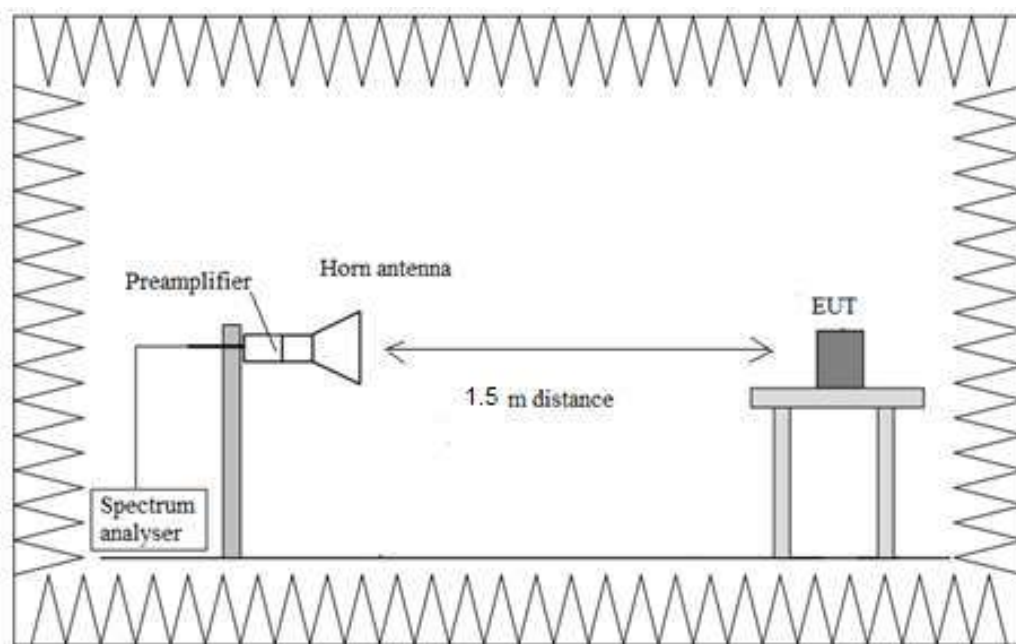
Radiated measurements setup from 30 MHz to 1 GHz:



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 Bandwidth

Results

Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

Freq (MHz)	Equipment	Occ Ch BW (MHz)
2402.00000	Digital Transmission System (DTS)	2.030
2440.00000		2.030
2480.00000		2.010

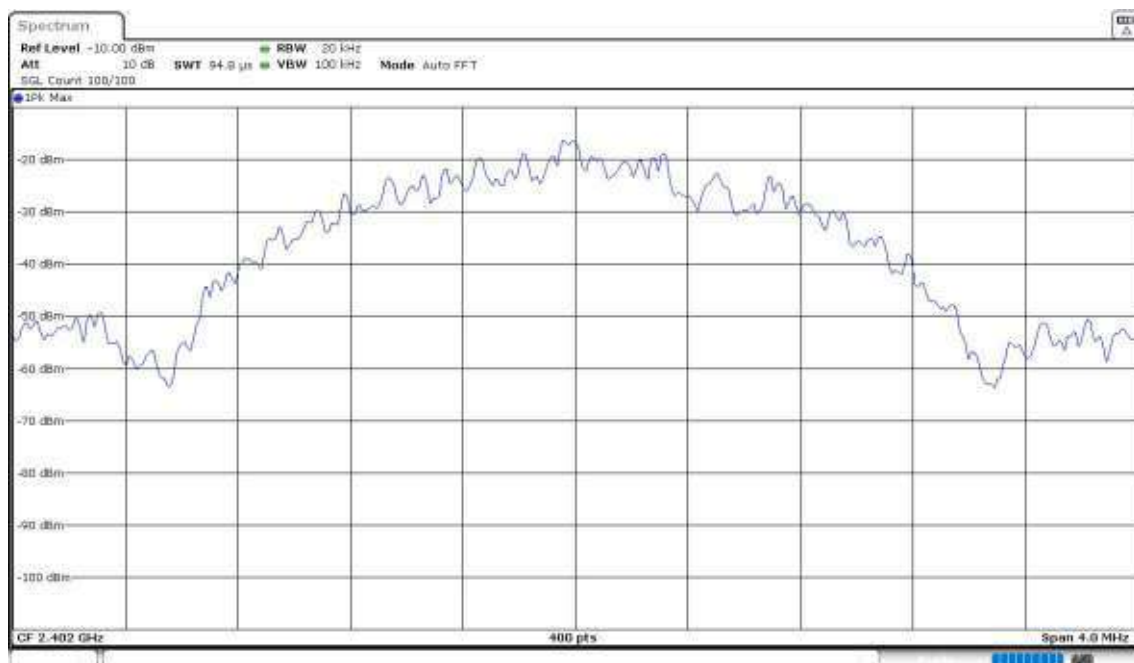
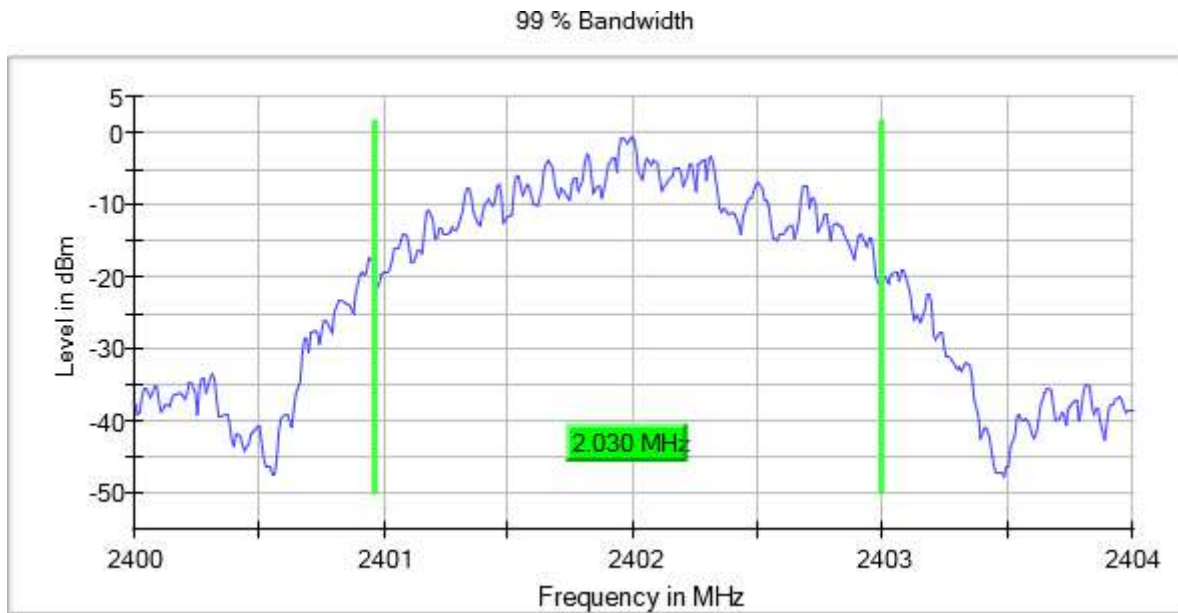
Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Freq (MHz)	Equipment	Occ Ch BW (MHz)
2402.00000	Digital Transmission System (DTS)	1.045
2440.00000		1.045
2480.00000		1.050

Attachments

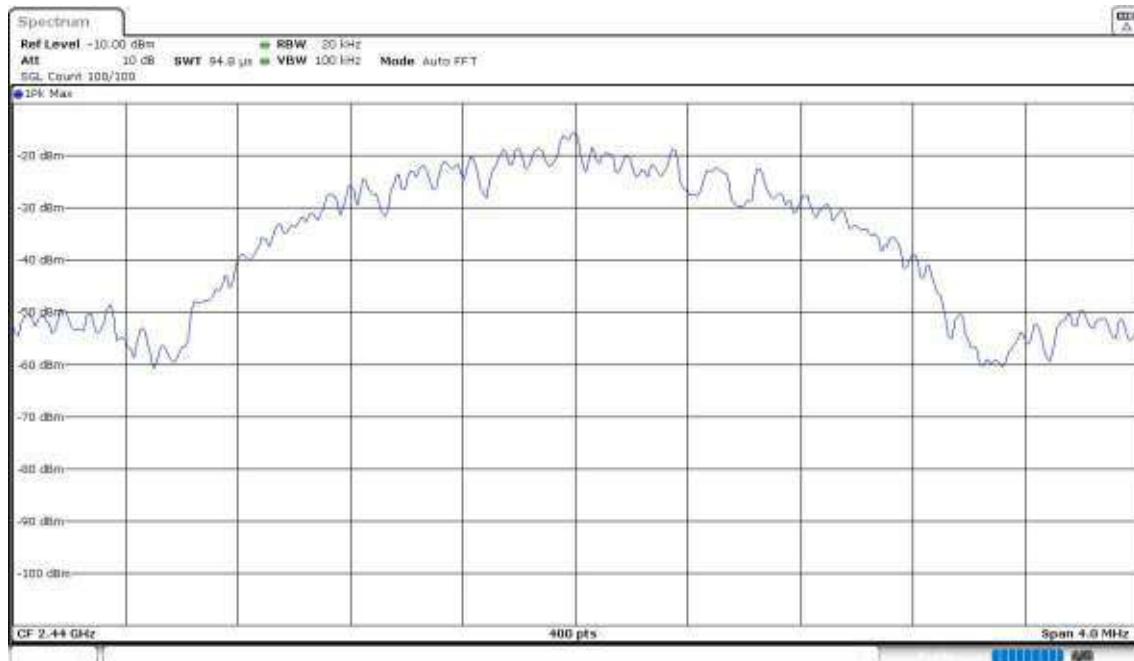
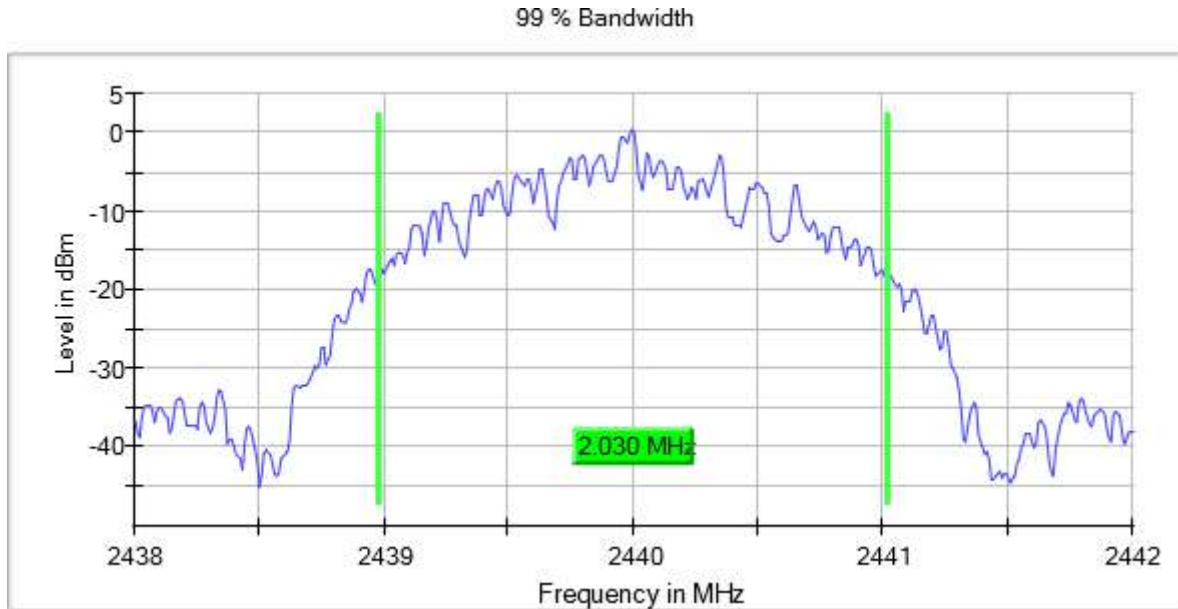
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00000, Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

Plots:



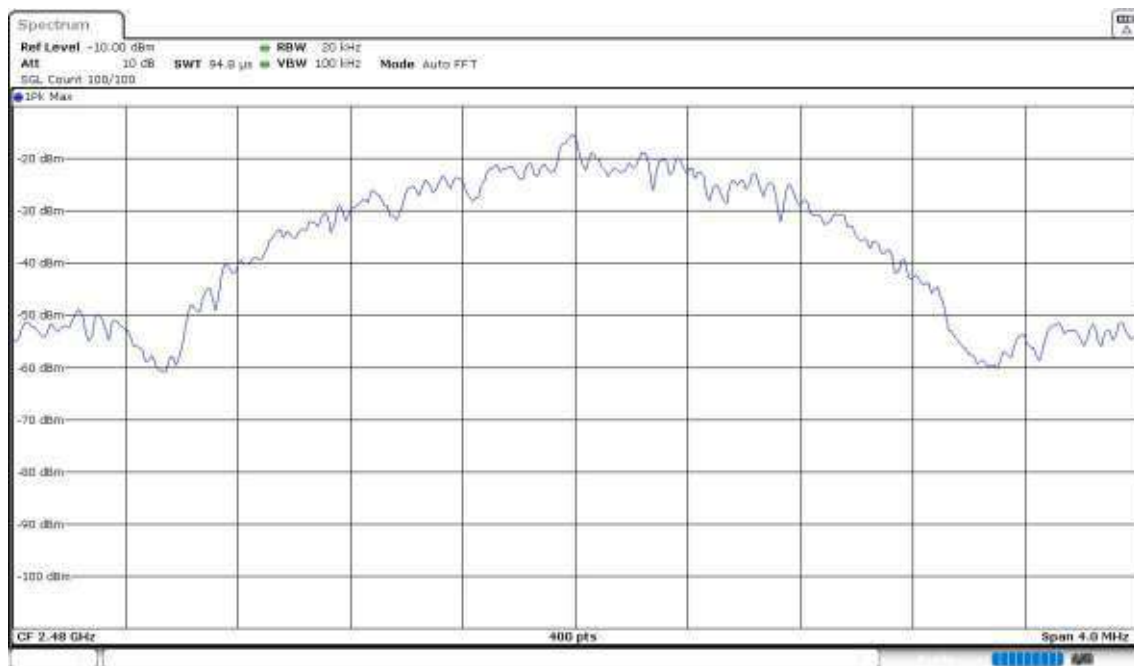
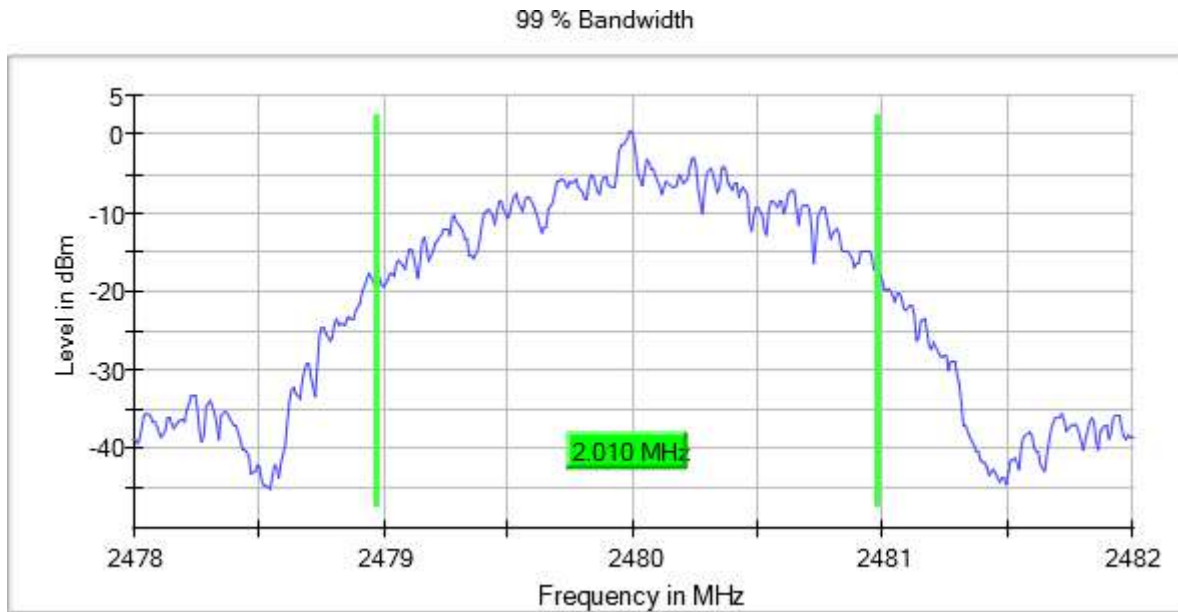
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2440.00000, Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

Plots:



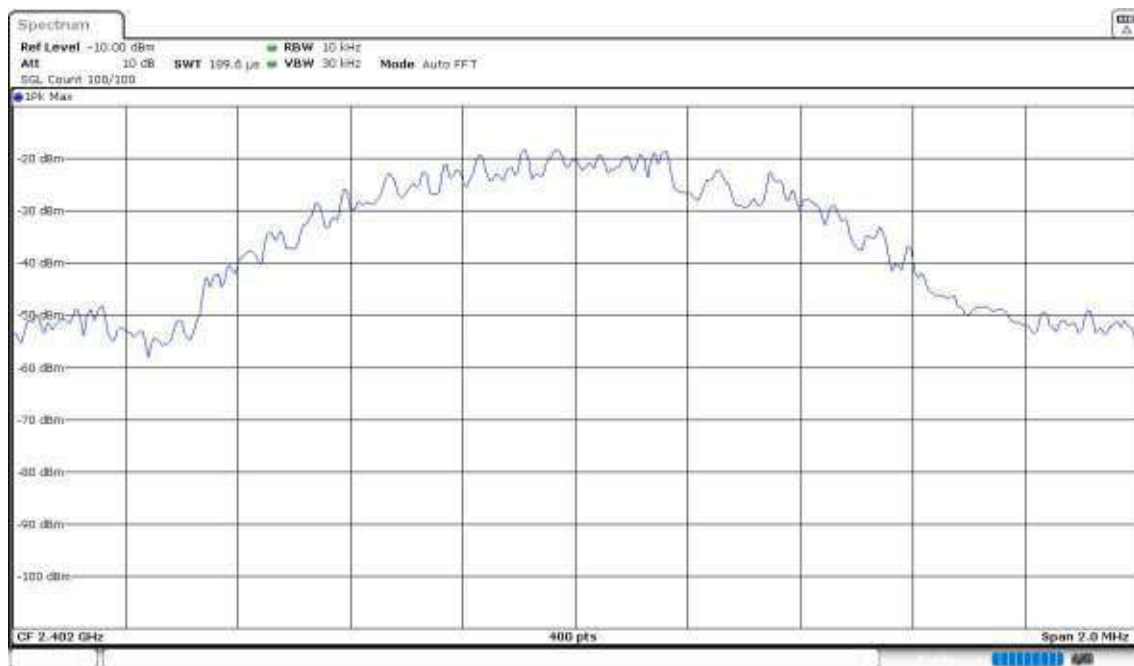
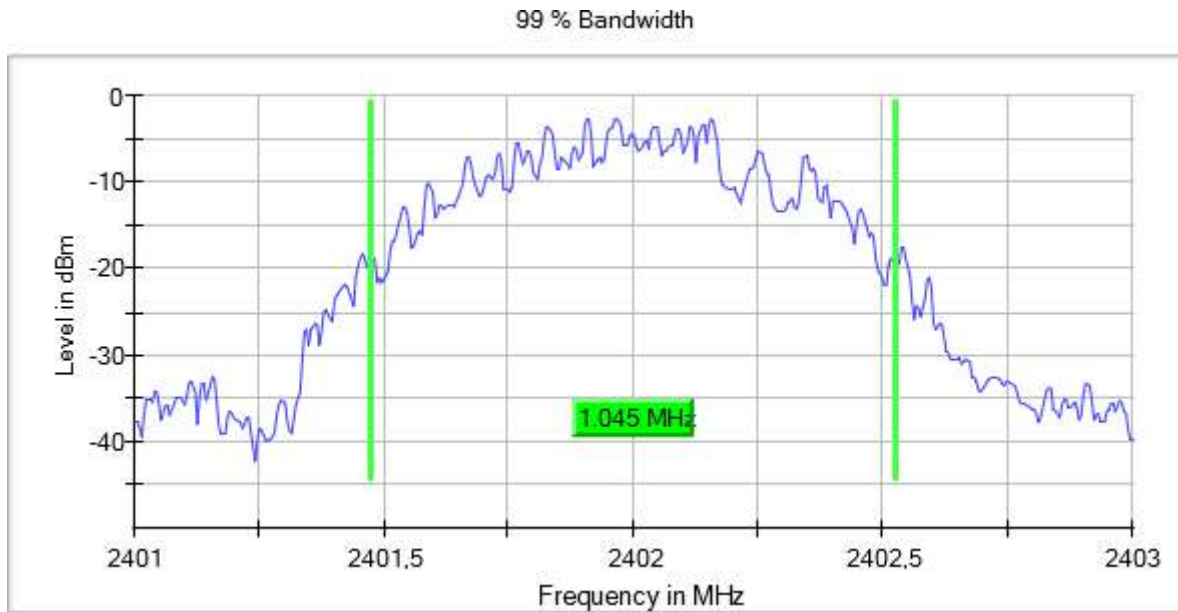
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00000, Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

Plots:



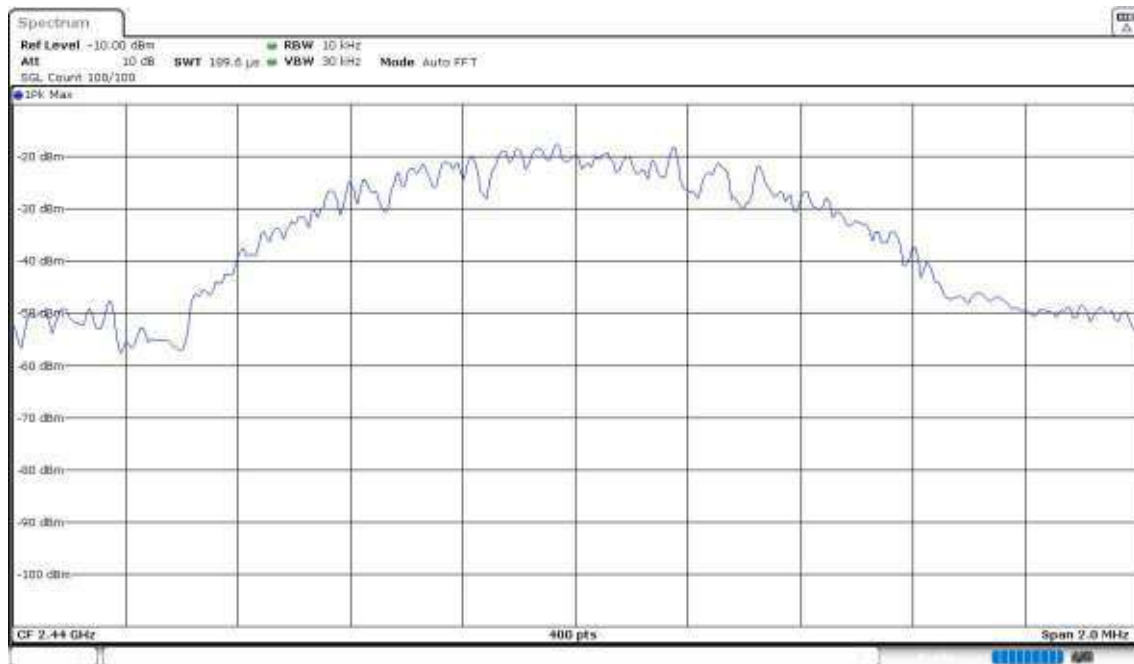
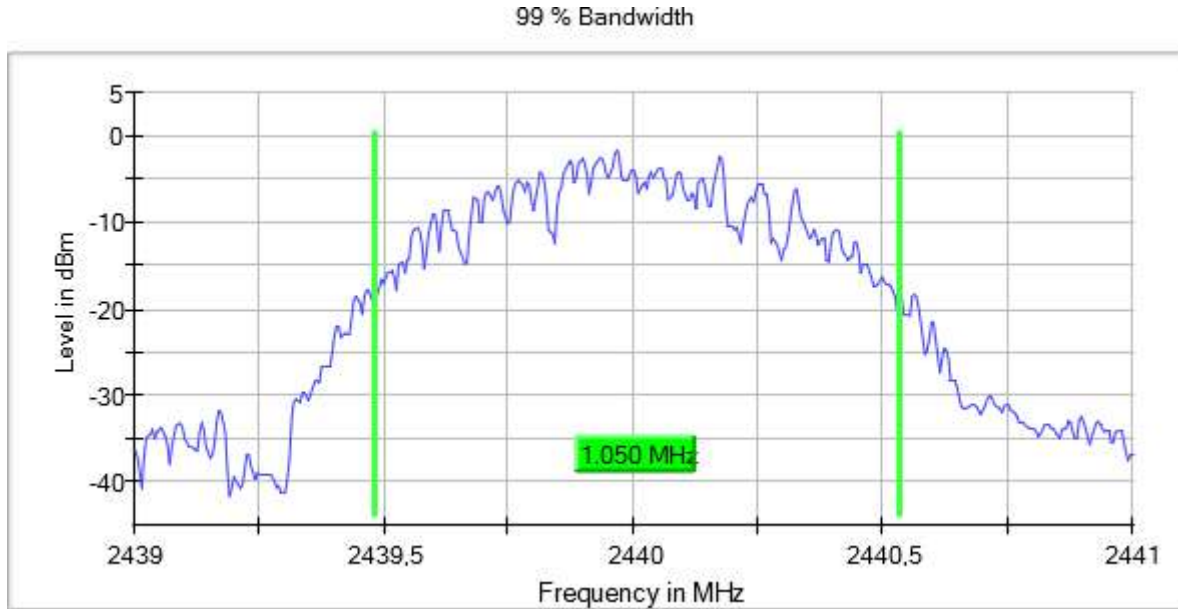
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00000, Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:



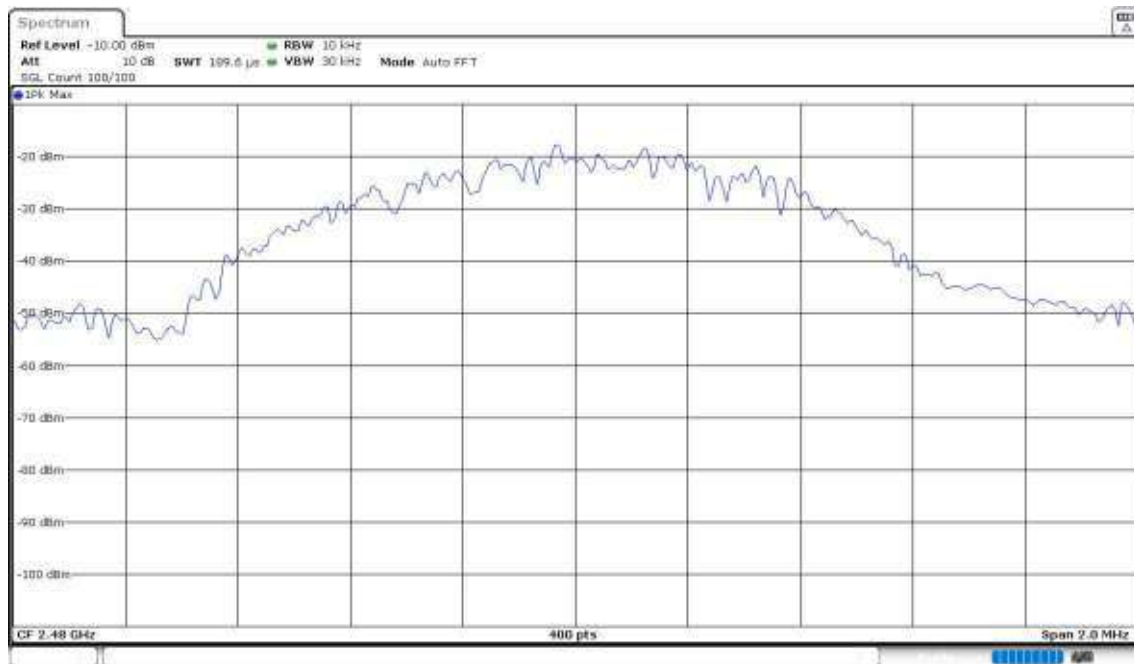
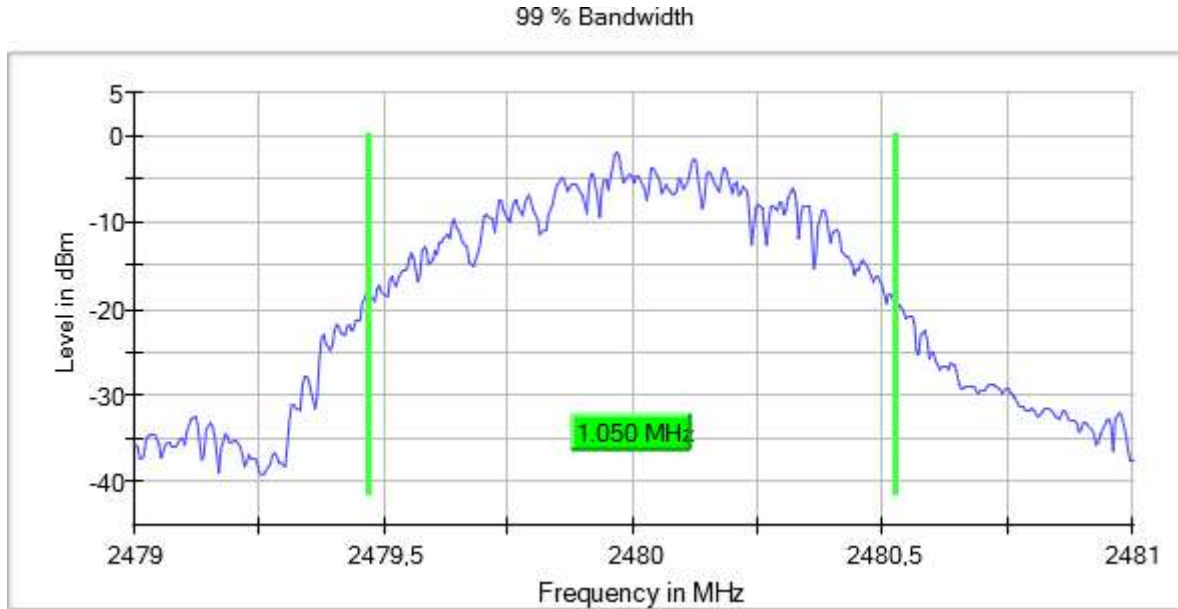
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2440.00000, Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

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.

Results

Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

Freq (MHz)	Emission Bandwidth (MHz)
2402.00000	1.15
2440.00000	1.19
2480.00000	0.79

Verdict

Pass

Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Freq (MHz)	Emission Bandwidth (MHz)
2402.00000	0.69
2440.00000	0.69
2480.00000	0.67

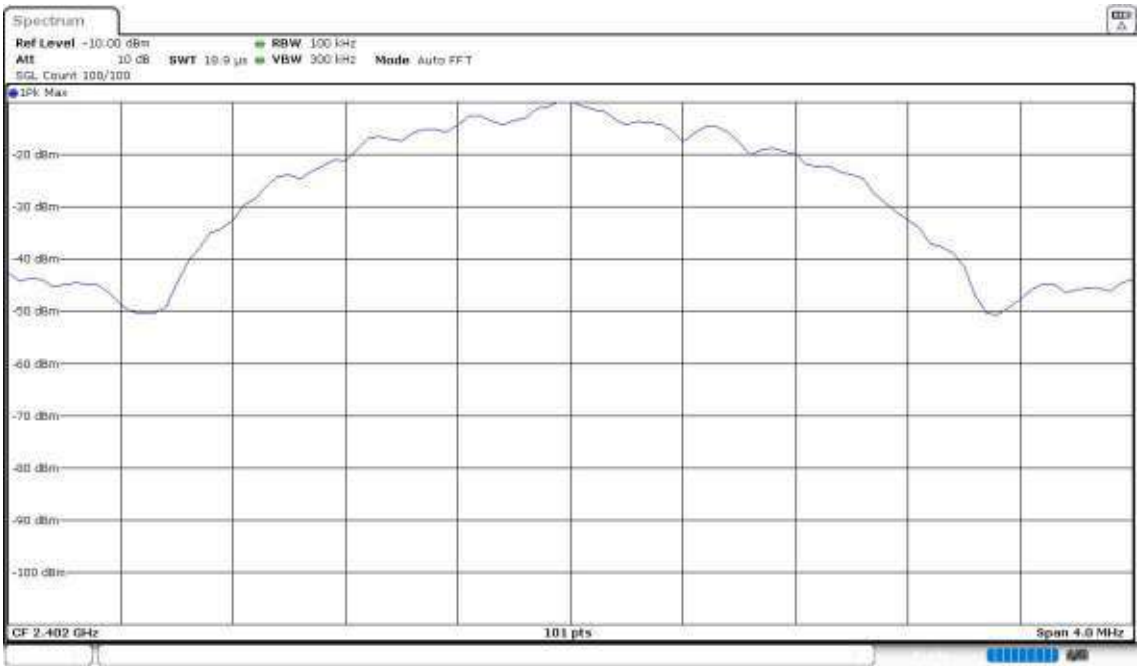
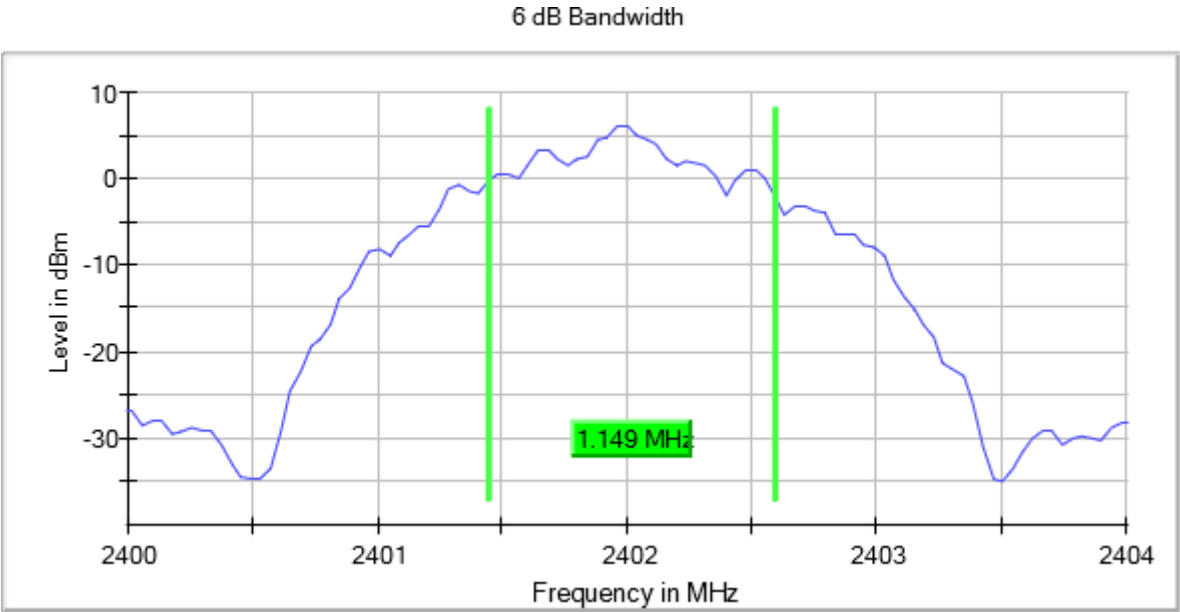
Verdict

Pass

Attachments

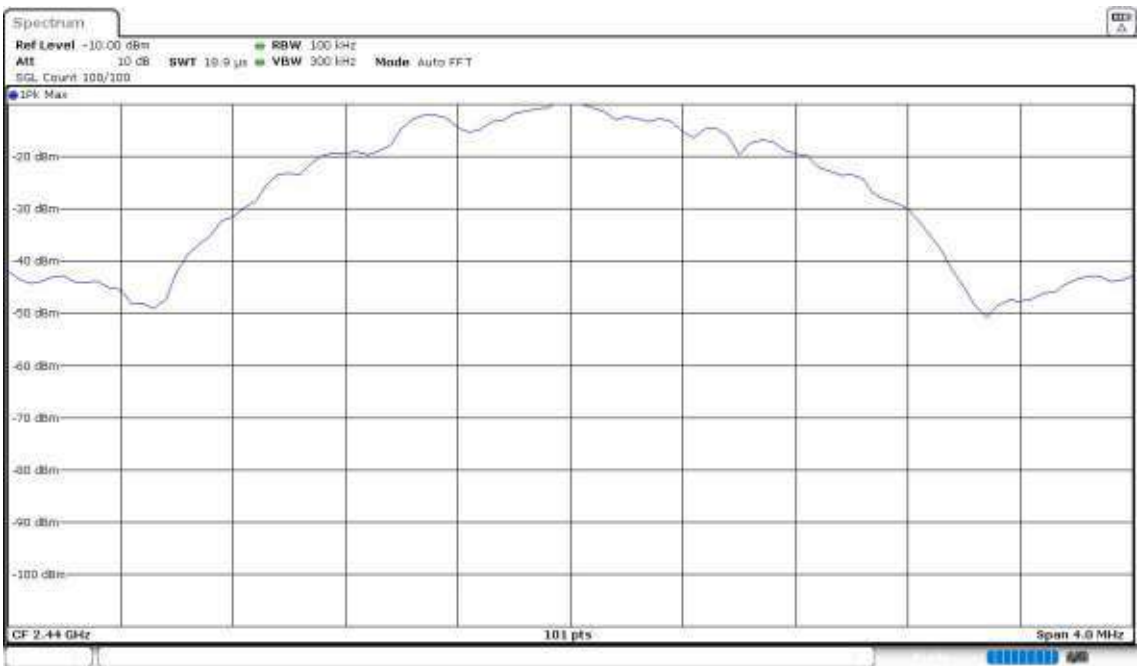
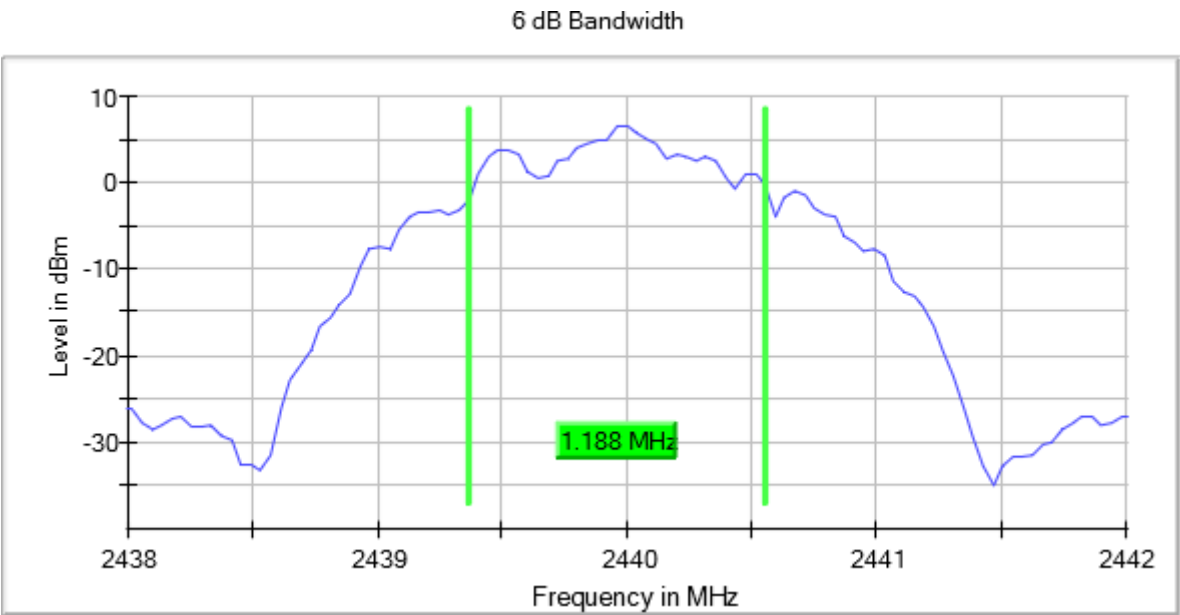
Frequency (MHz) = 2402.00000, Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

Plots:



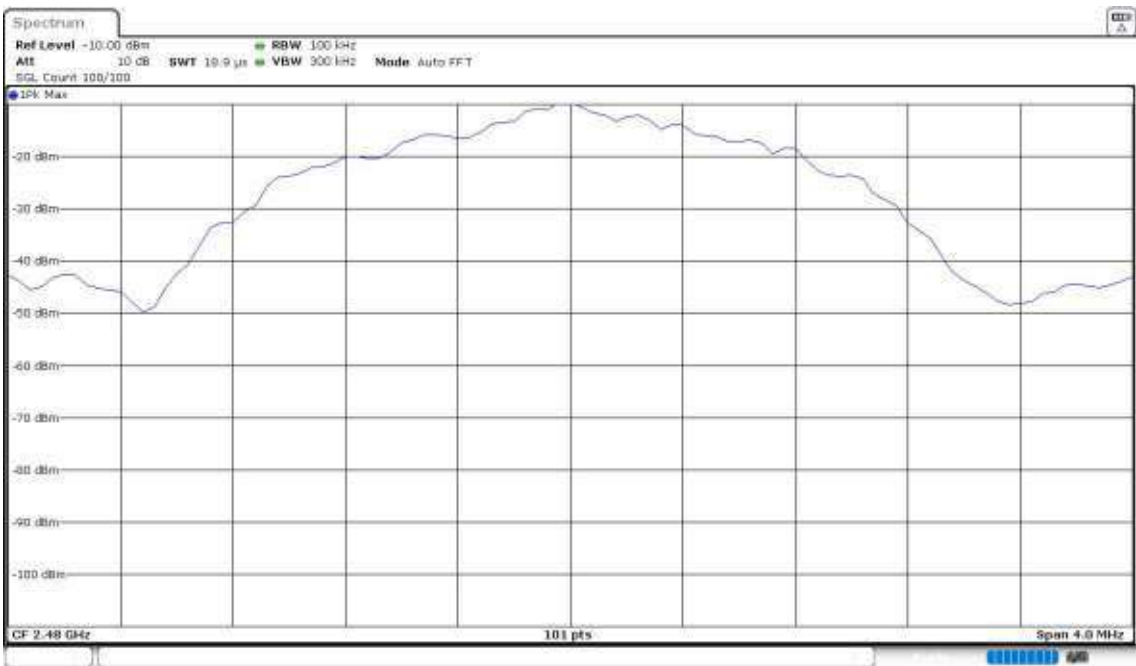
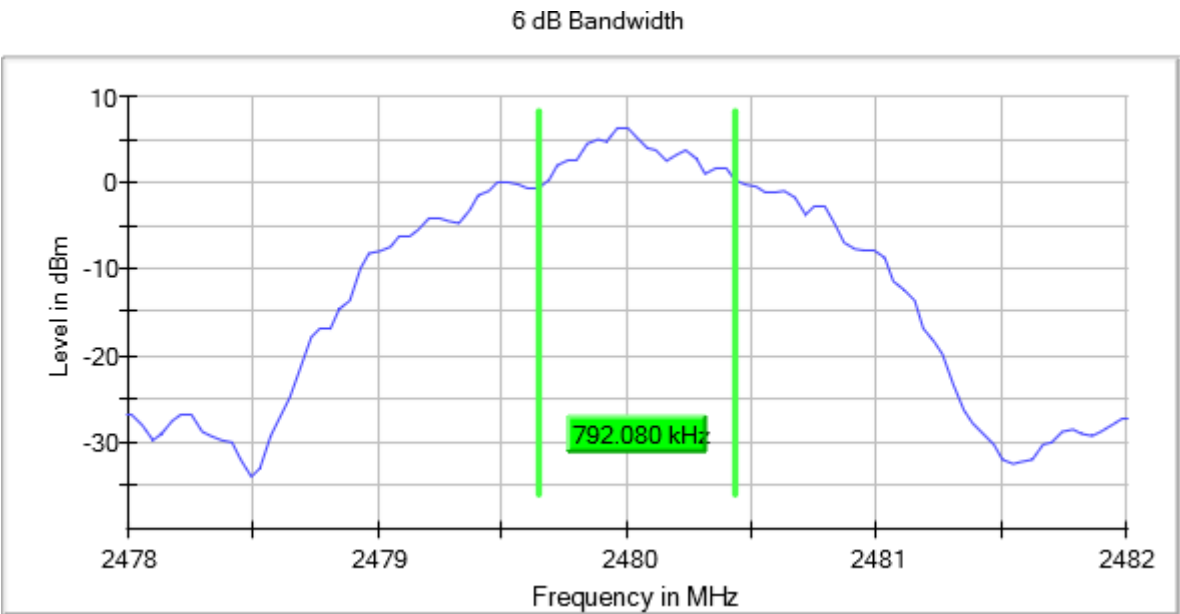
Frequency (MHz) = 2440.00000, Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

Plots:



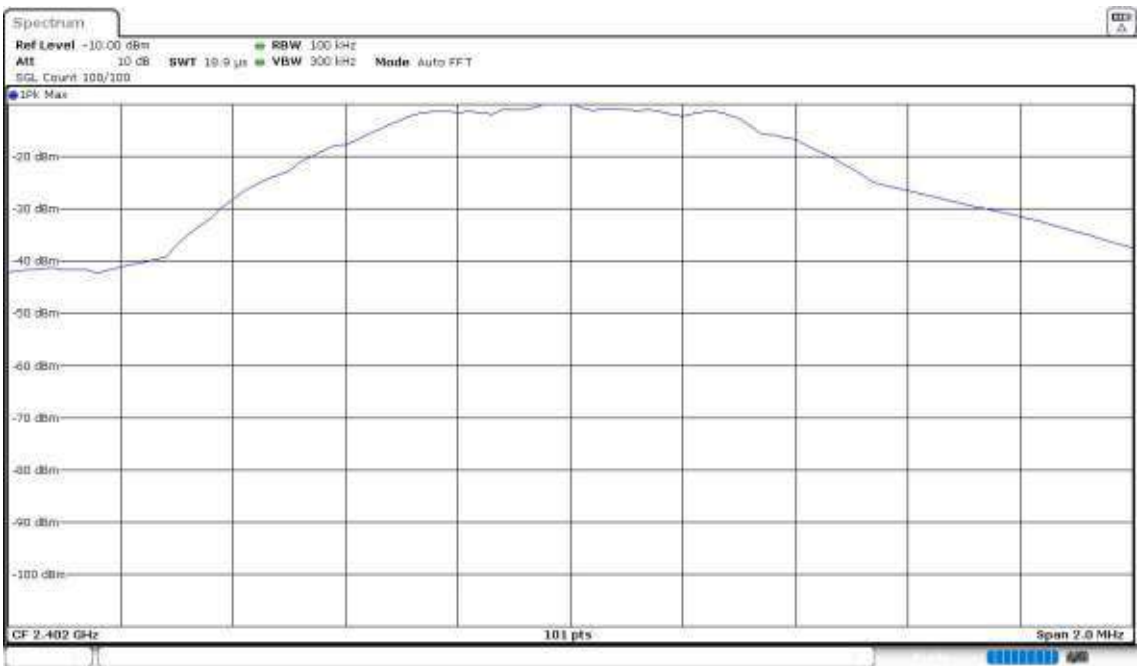
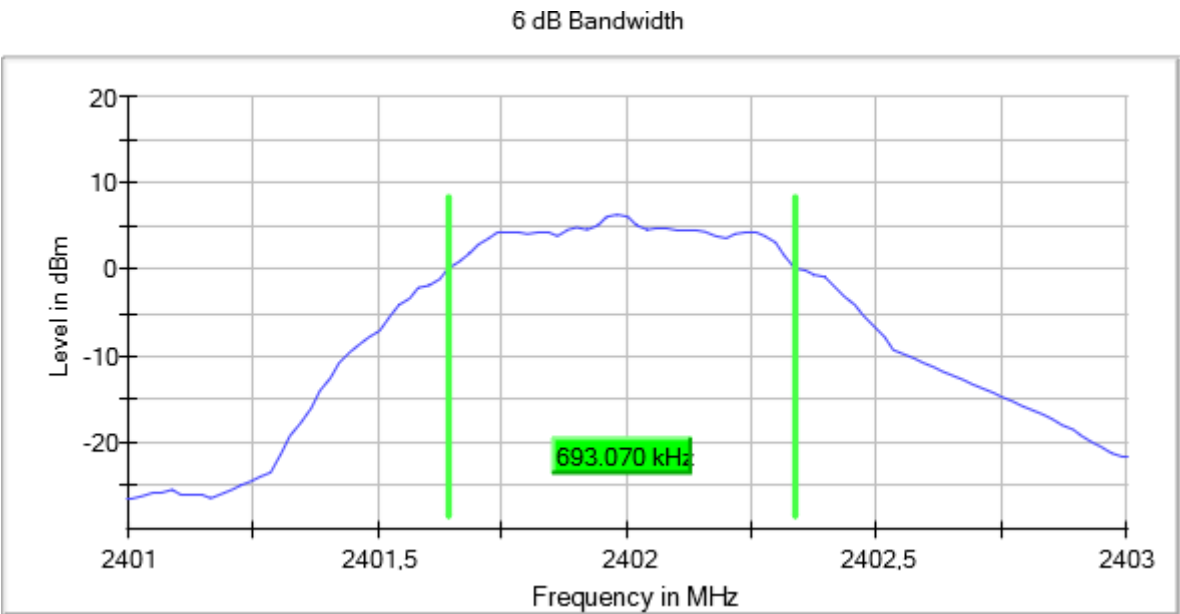
Frequency (MHz) = 2480.00000, Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

Plots:



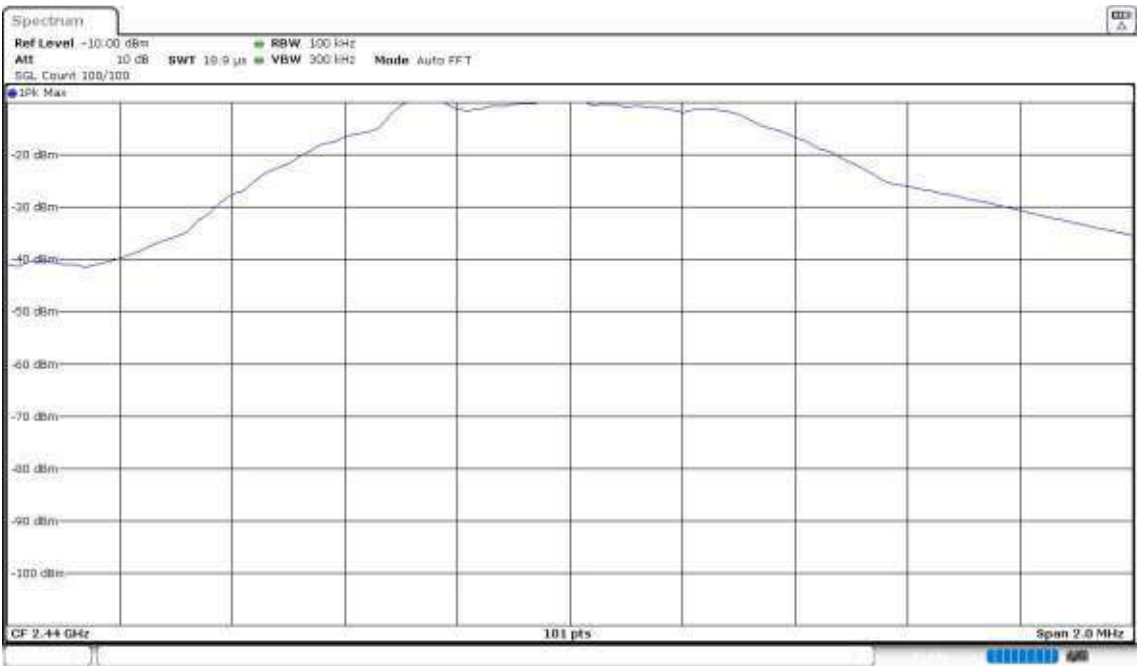
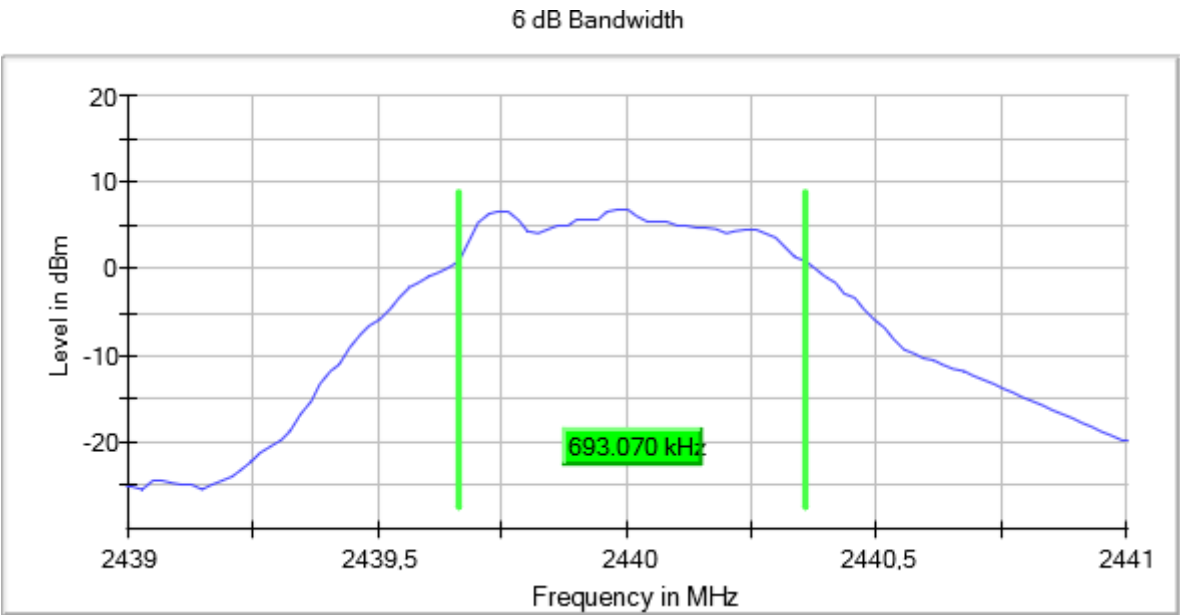
Frequency (MHz) = 2402.00000, Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:



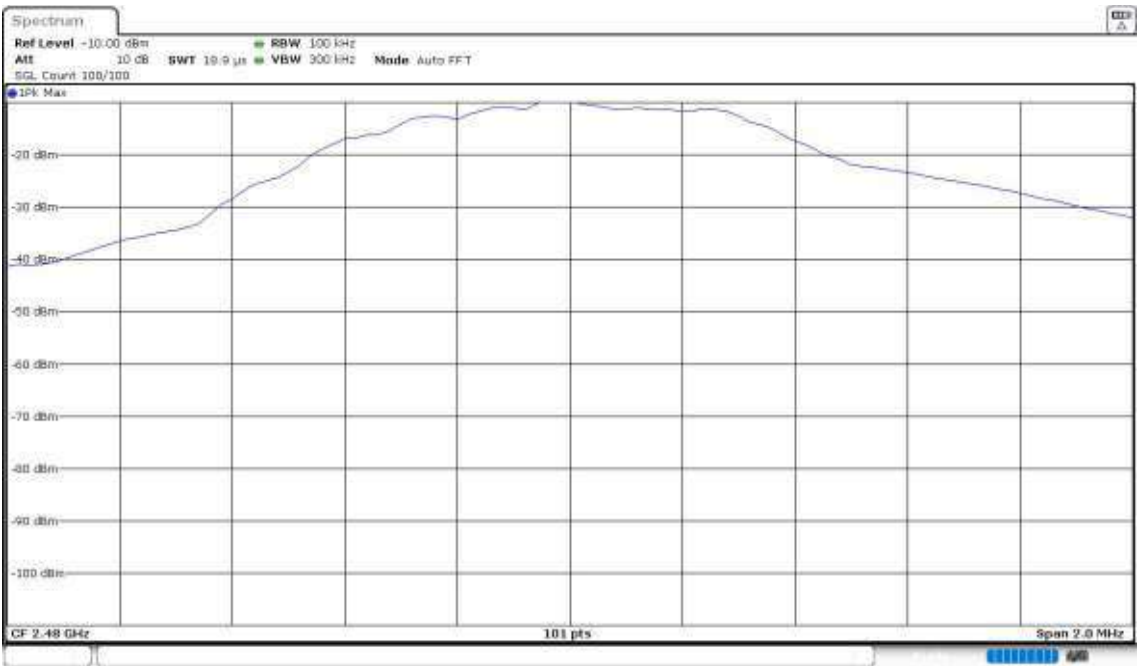
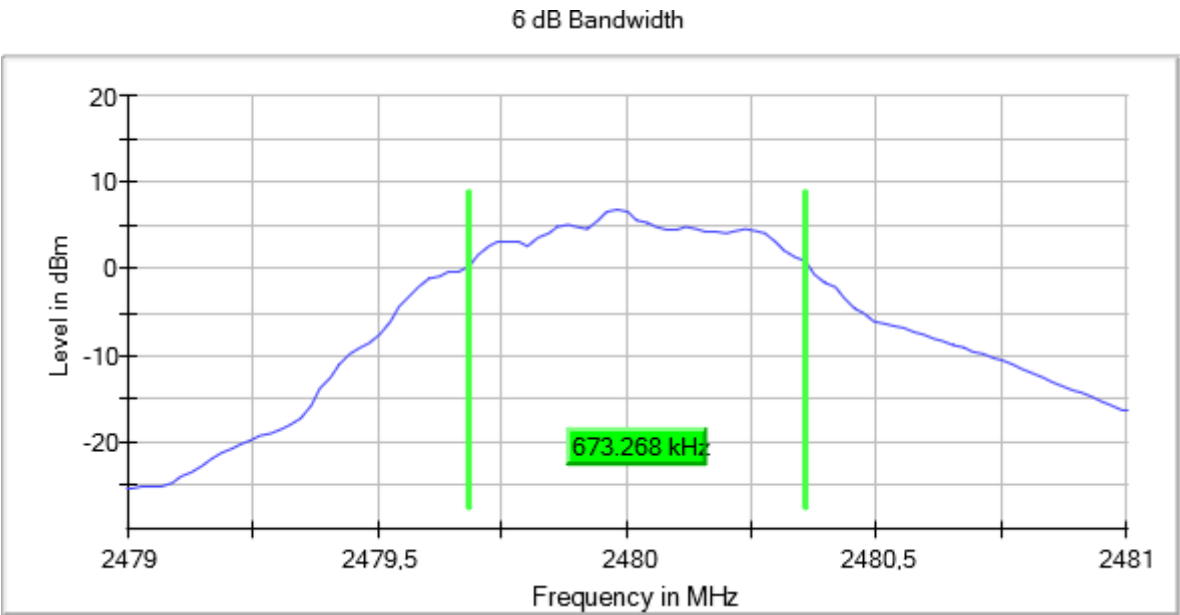
Frequency (MHz) = 2440.00000, Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:



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.

Maximum Declared Antenna Gain: -8.62 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.

Operation Band: [2400, 2483.5]

Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

Freq (MHz)	Equipment	Peak Power (dBm)	Peak Power E.I.R.P (dBm)
2402.00000	Digital Transmission System (DTS)	6.1	-2.5
2440.00000		6.6	-2.0
2480.00000		6.4	-2.2

Verdict

Pass

Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Freq (MHz)	Equipment	Peak Power (dBm)	Peak Power E.I.R.P (dBm)
2402.00000	Digital Transmission System (DTS)	6.5	-2.1
2440.00000		7.0	-1.6
2480.00000		6.8	-1.8

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)

Freq (MHz)	PSD (dBm)
2402.00000	-3.52
2440.00000	-3.77
2480.00000	-4.10

Verdict

Pass

Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Freq (MHz)	PSD (dBm)
2402.00000	-2.15
2440.00000	-1.65
2480.00000	-1.73

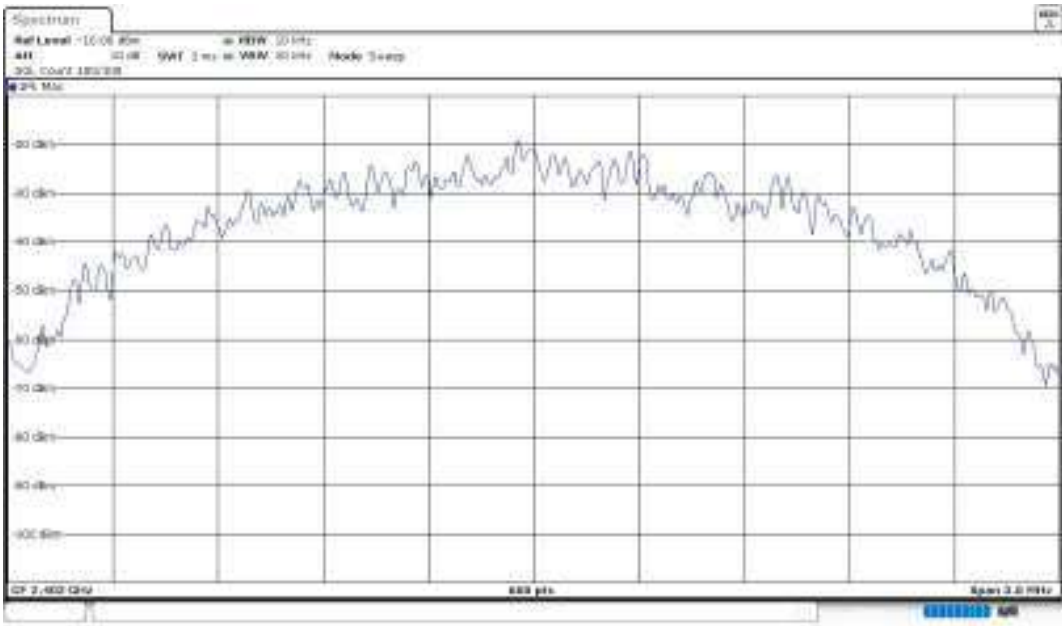
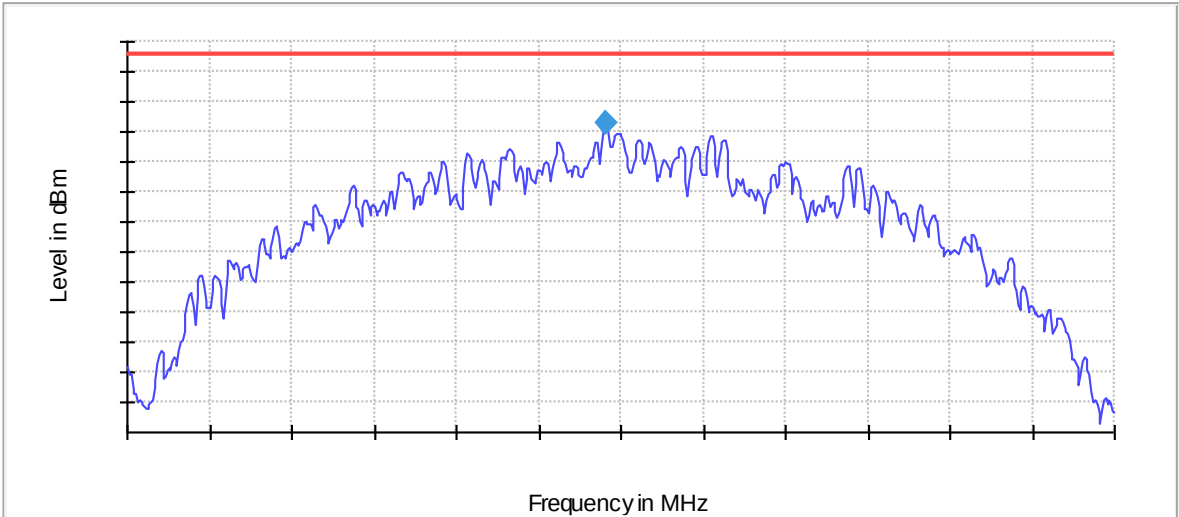
Verdict

Pass

Attachments

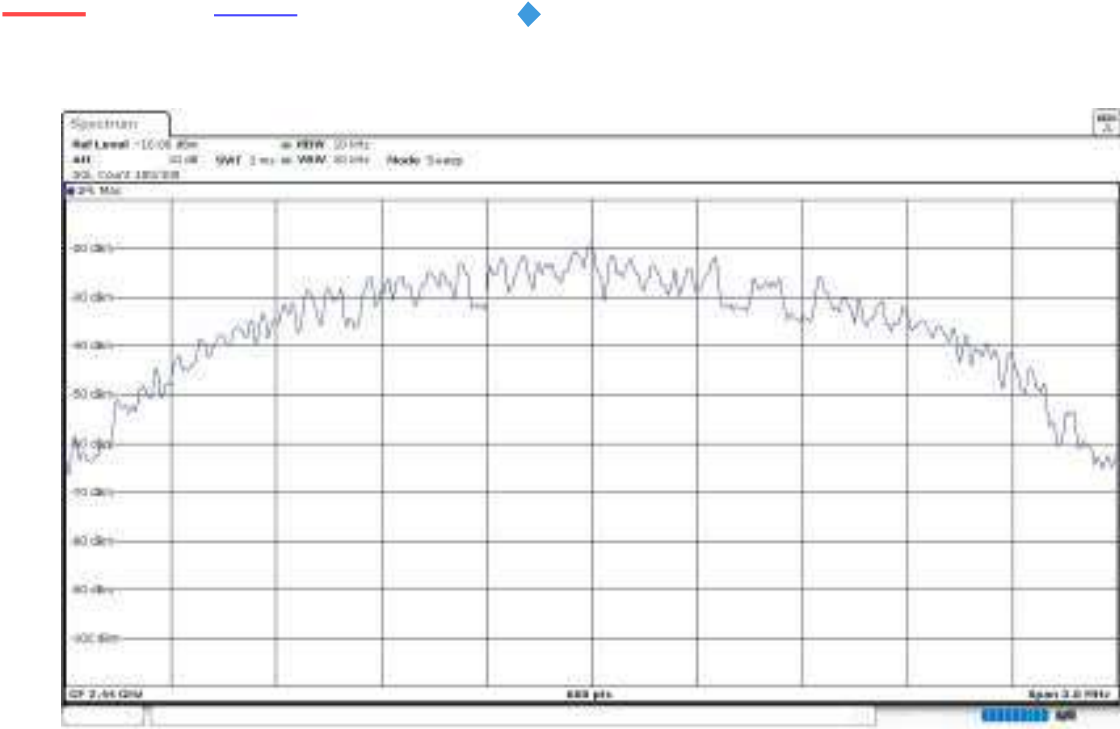
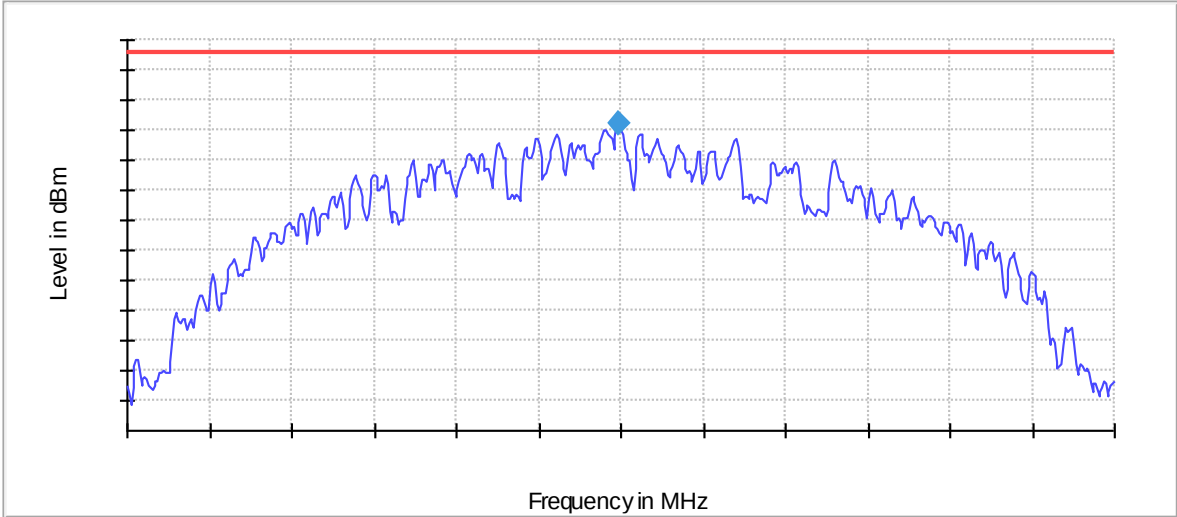
Frequency (MHz) = 2402.00000, Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

Plots:



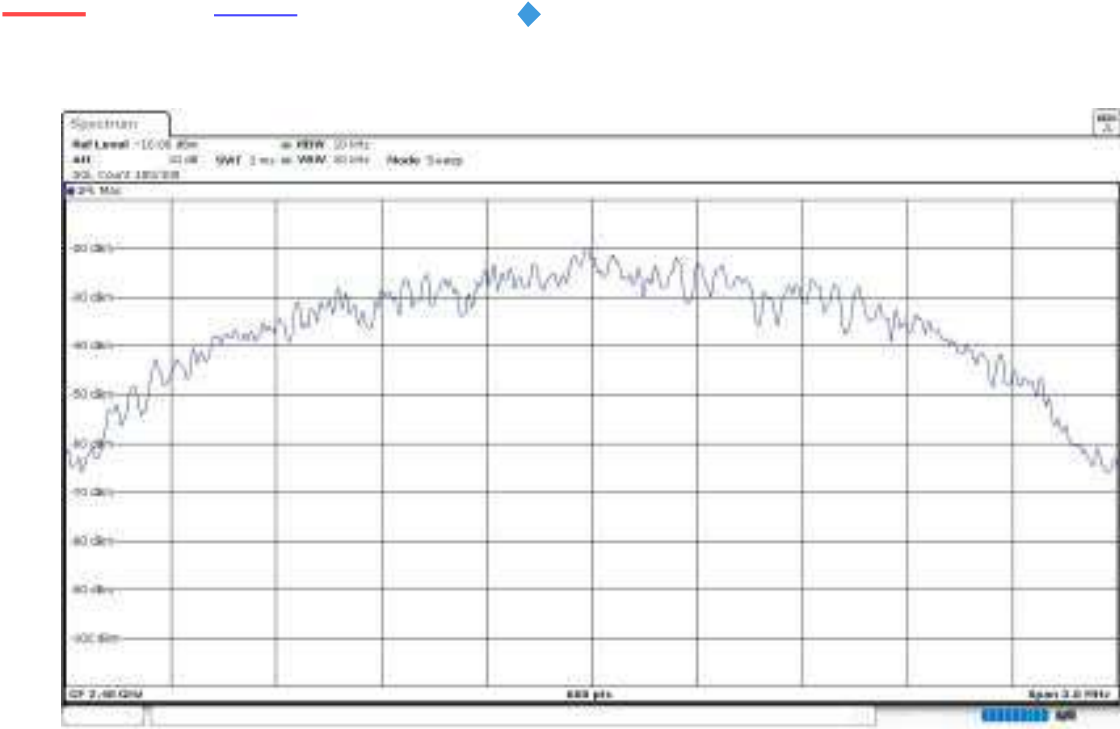
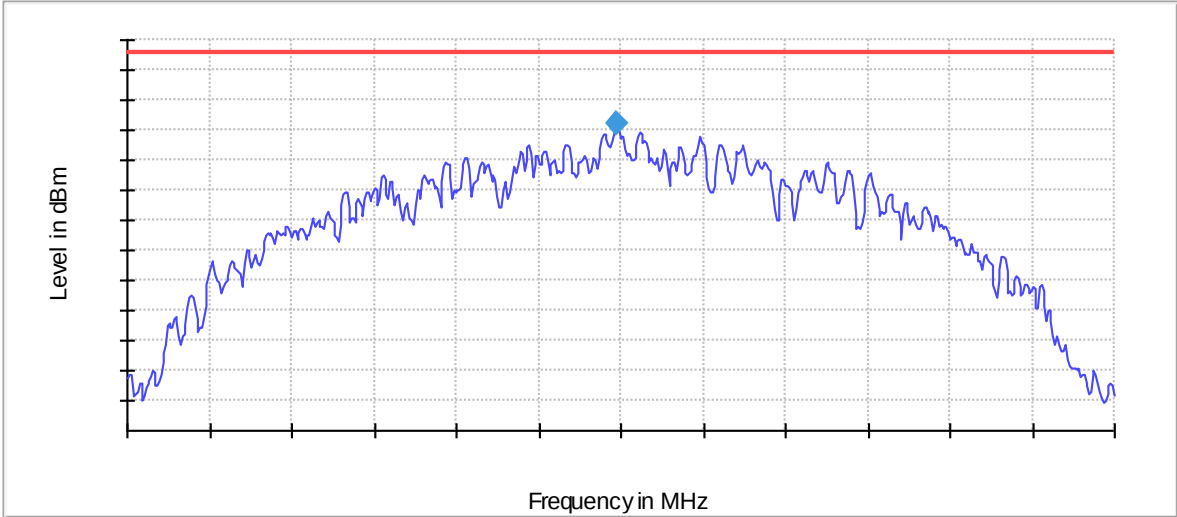
Frequency (MHz) = 2440.00000, Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

Plots:



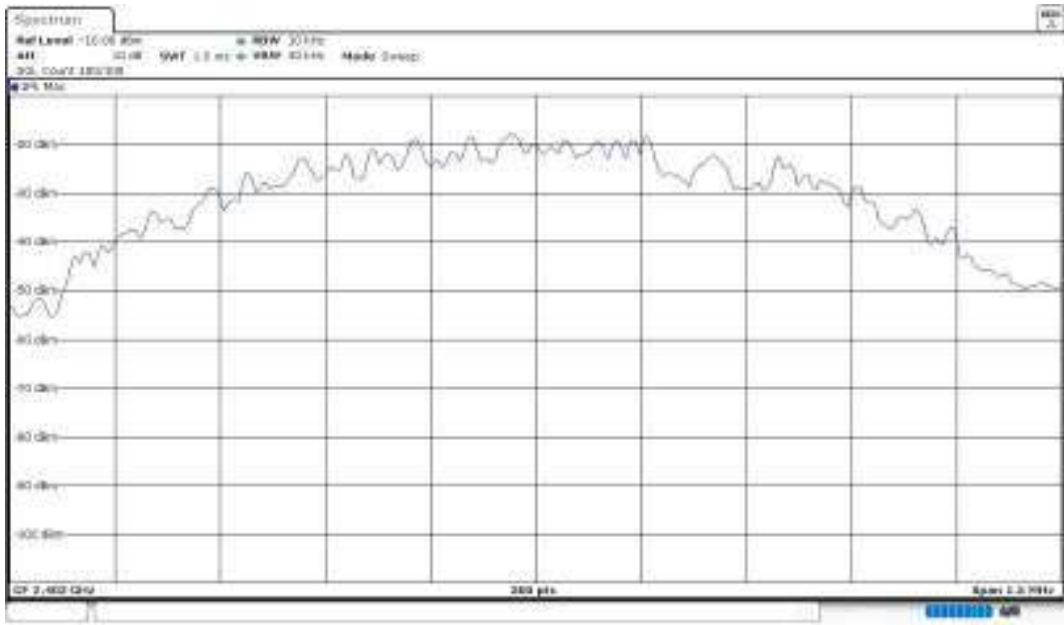
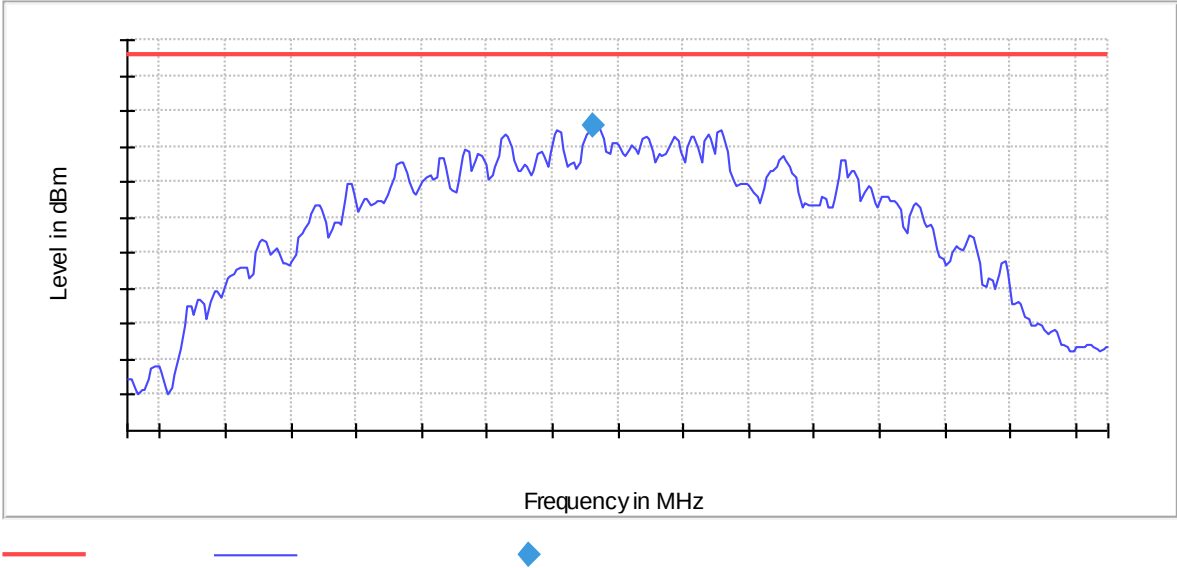
Frequency (MHz) = 2480.00000, Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

Plots:



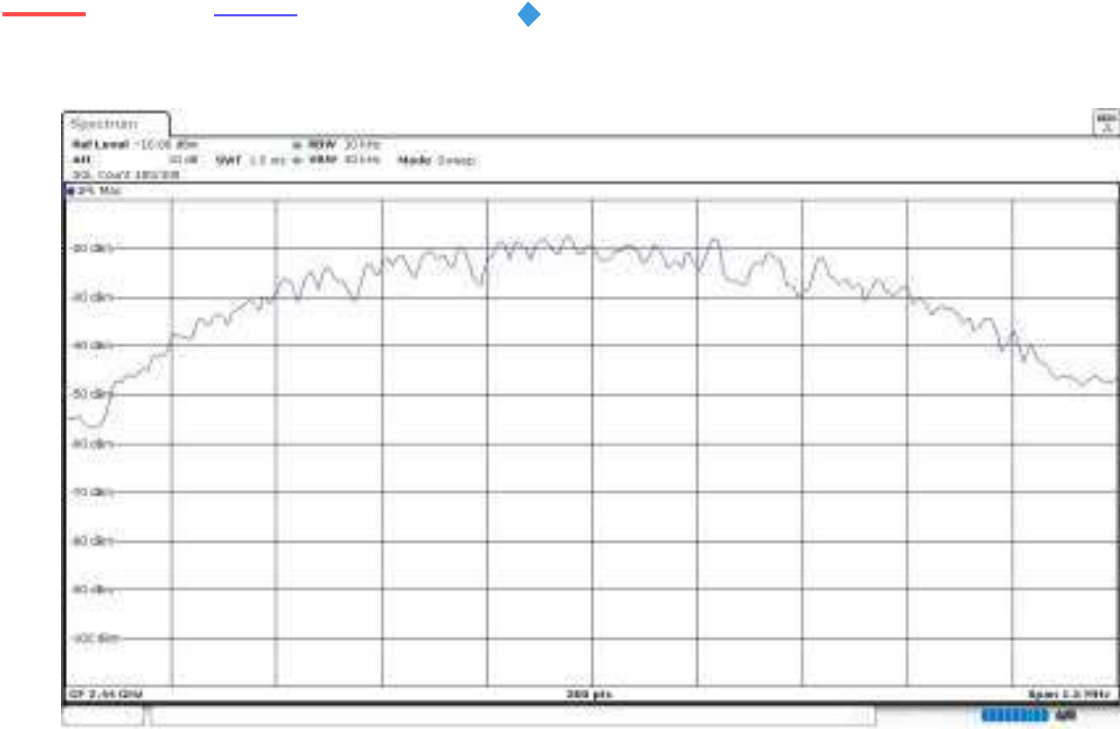
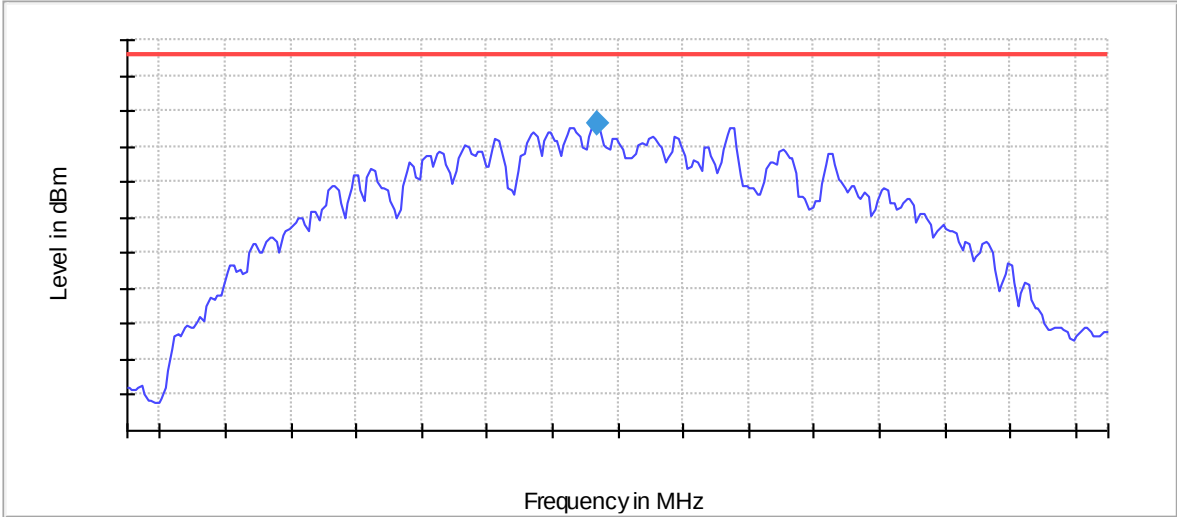
Frequency (MHz) = 2402.00000, Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:



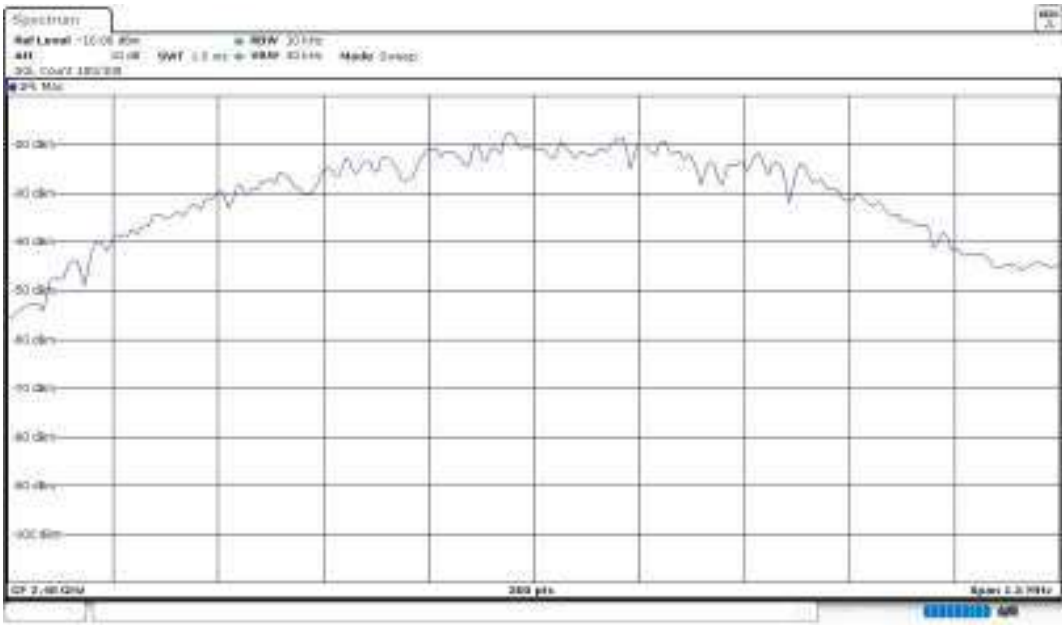
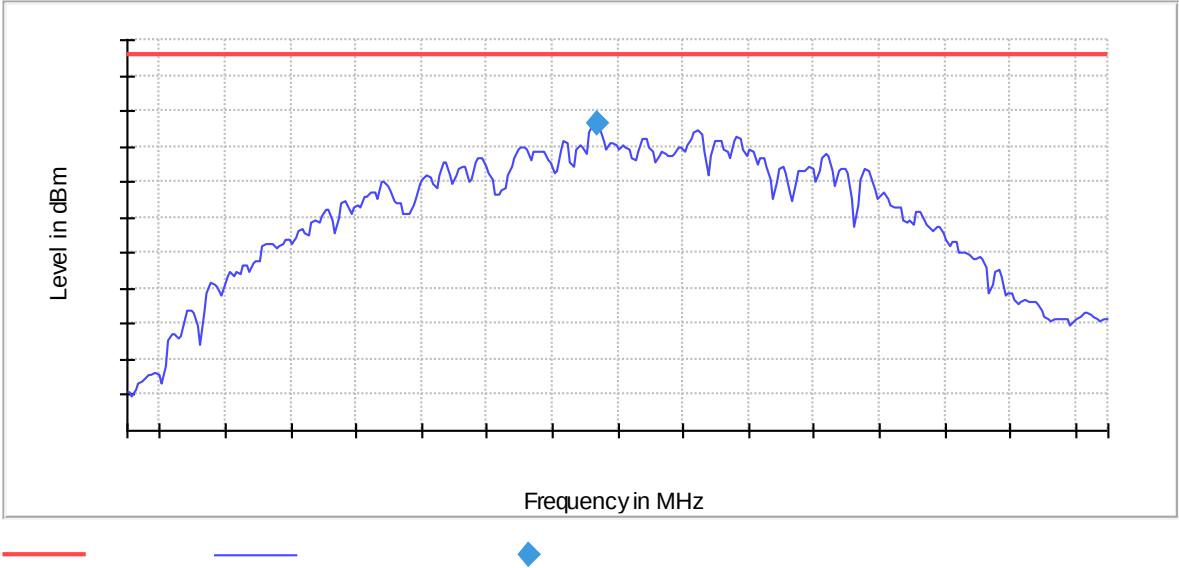
Frequency (MHz) = 2440.00000, Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:



Frequency (MHz) = 2480.00000, 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

Operation Band: [2400, 2483.5]

Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

Verdict

Pass

Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

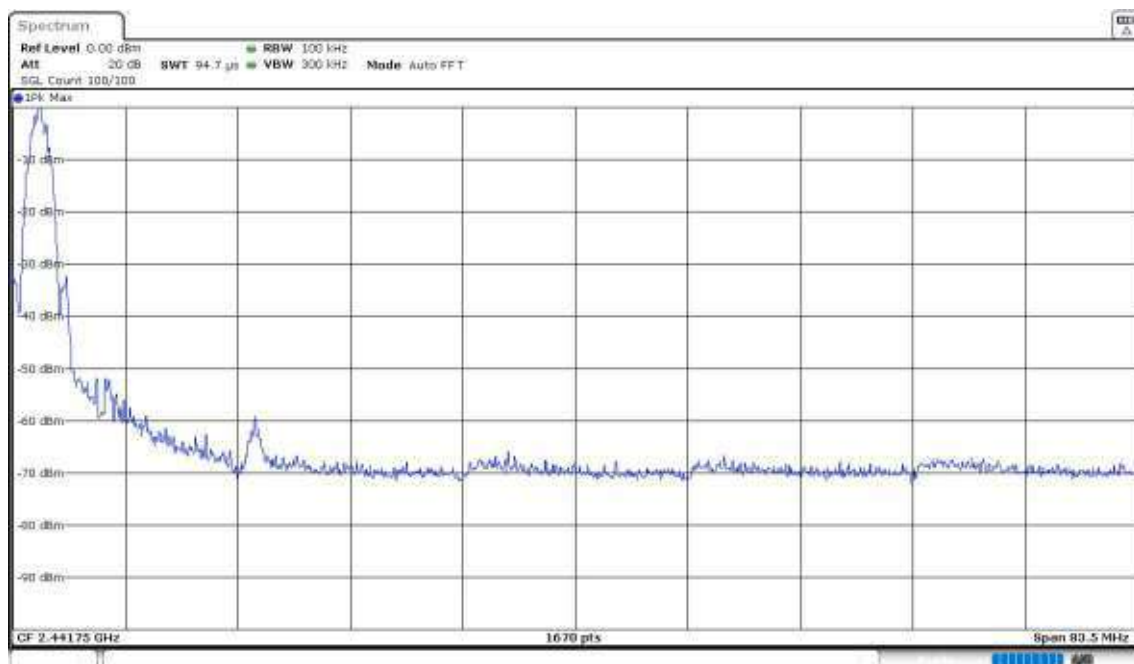
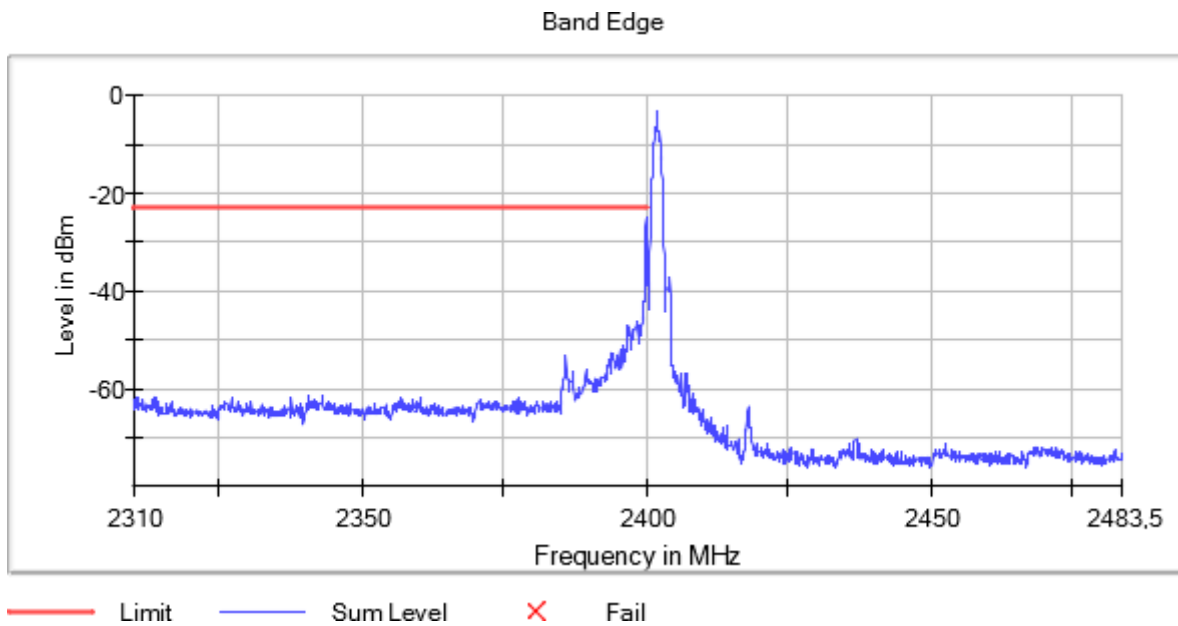
Verdict

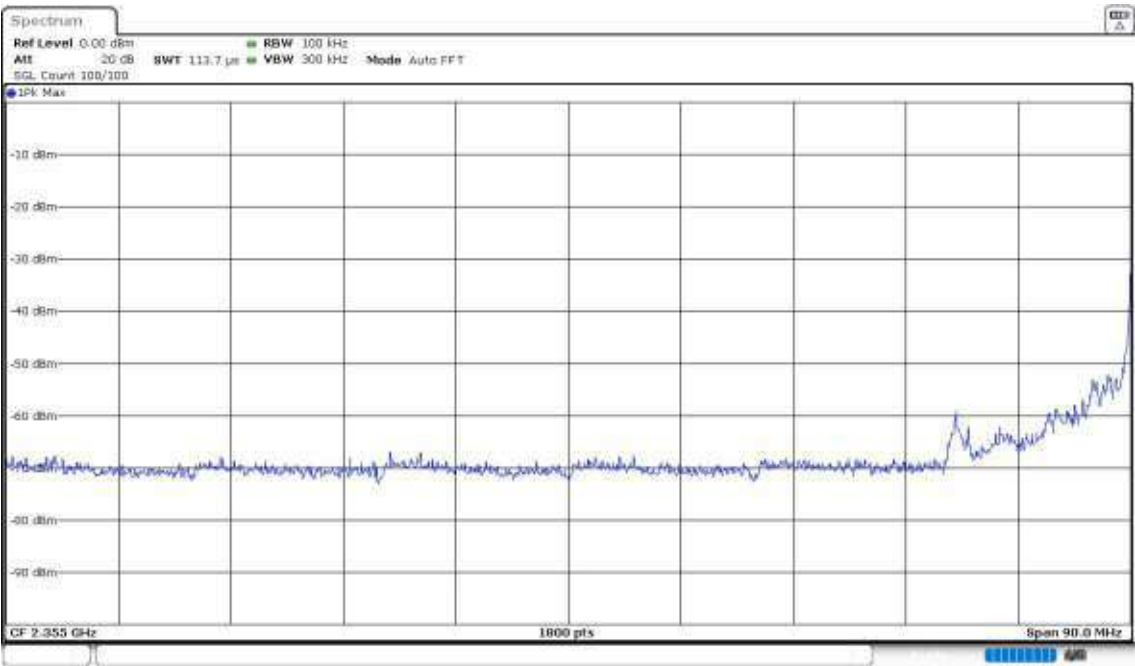
Pass

Attachments

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

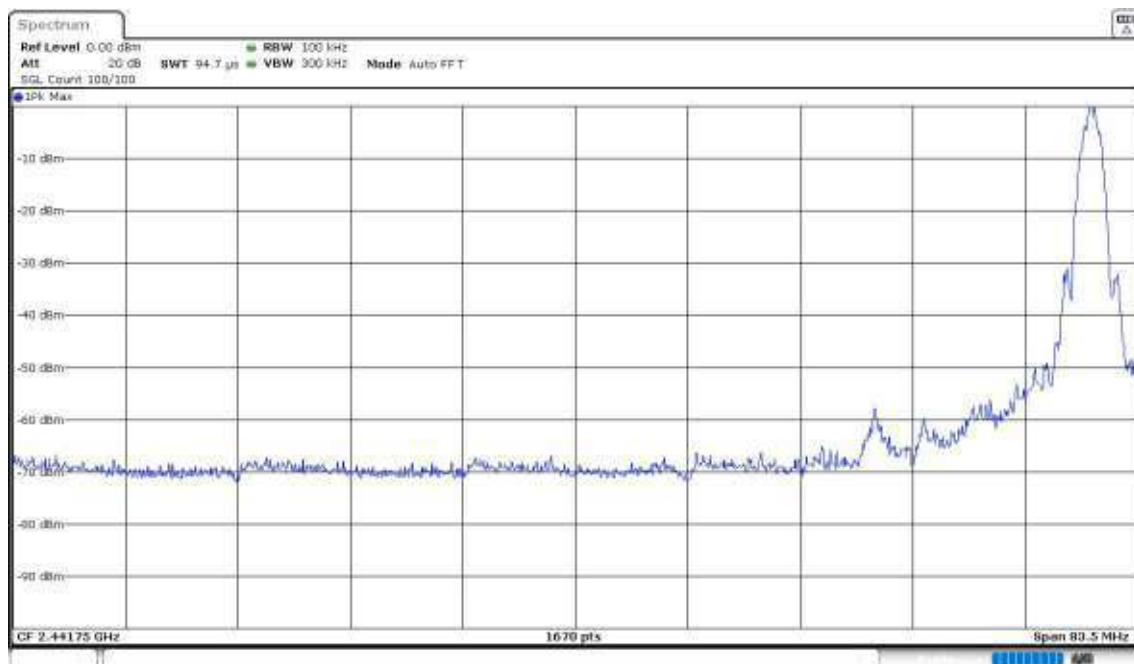
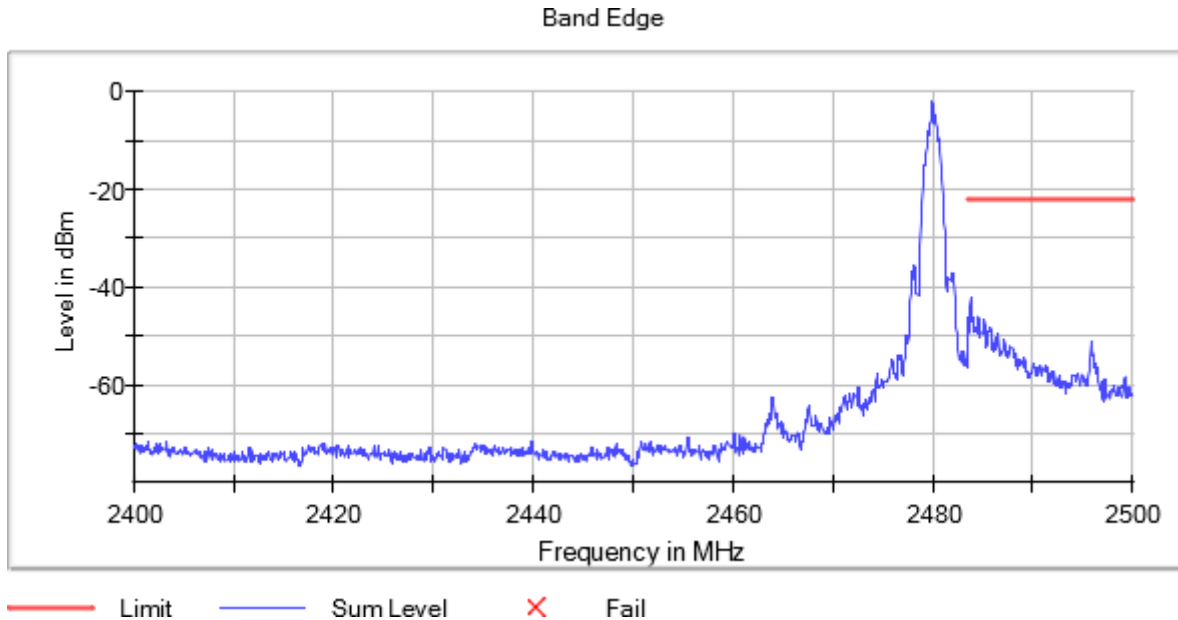
Plots:

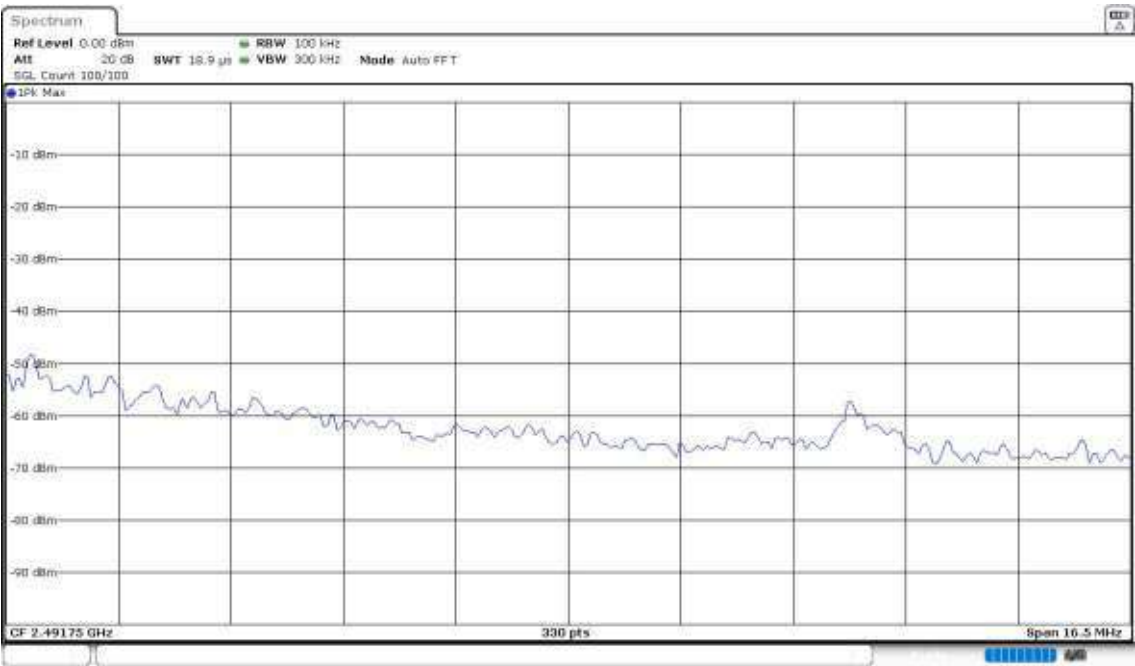




Operation Band (MHz) = [2400, 2483.5], Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

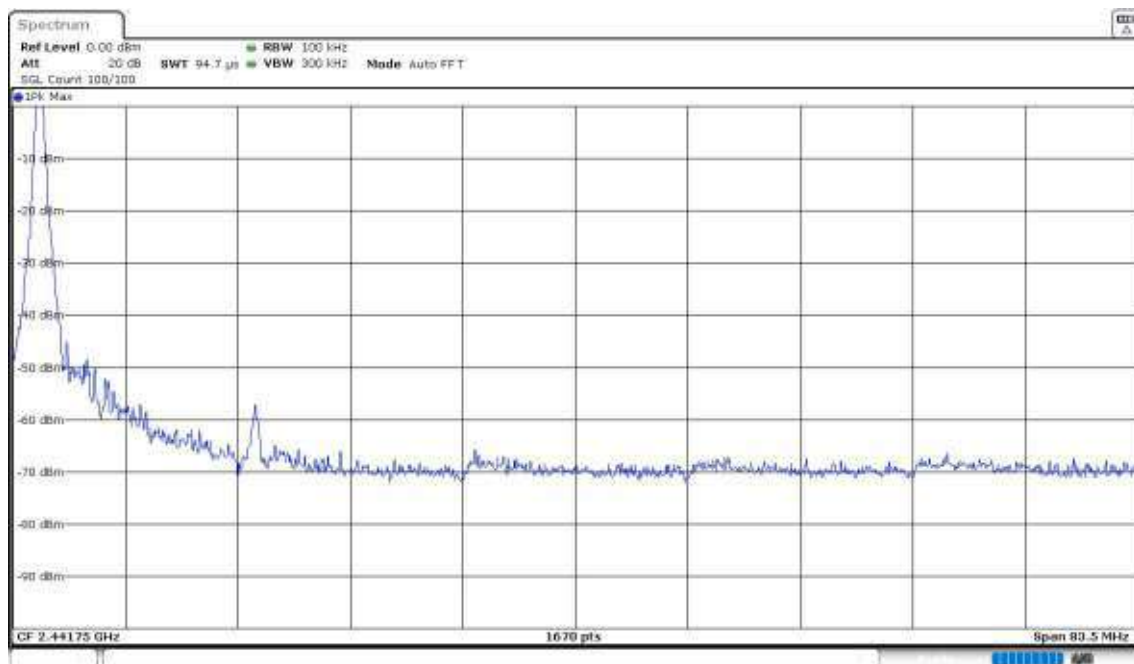
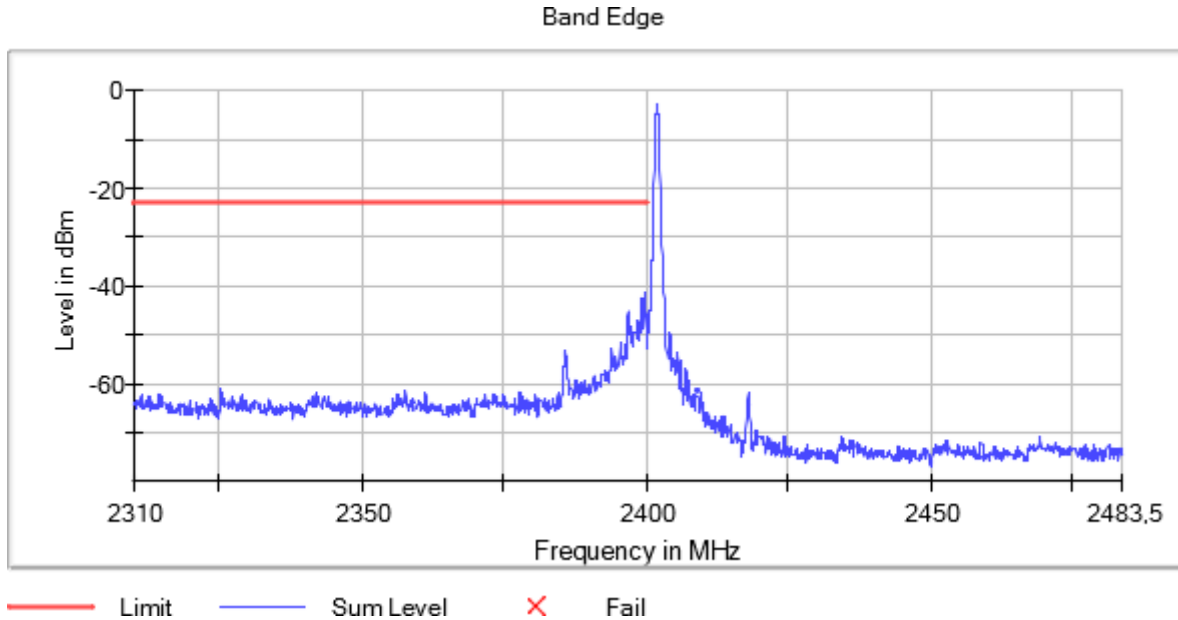
Plots:

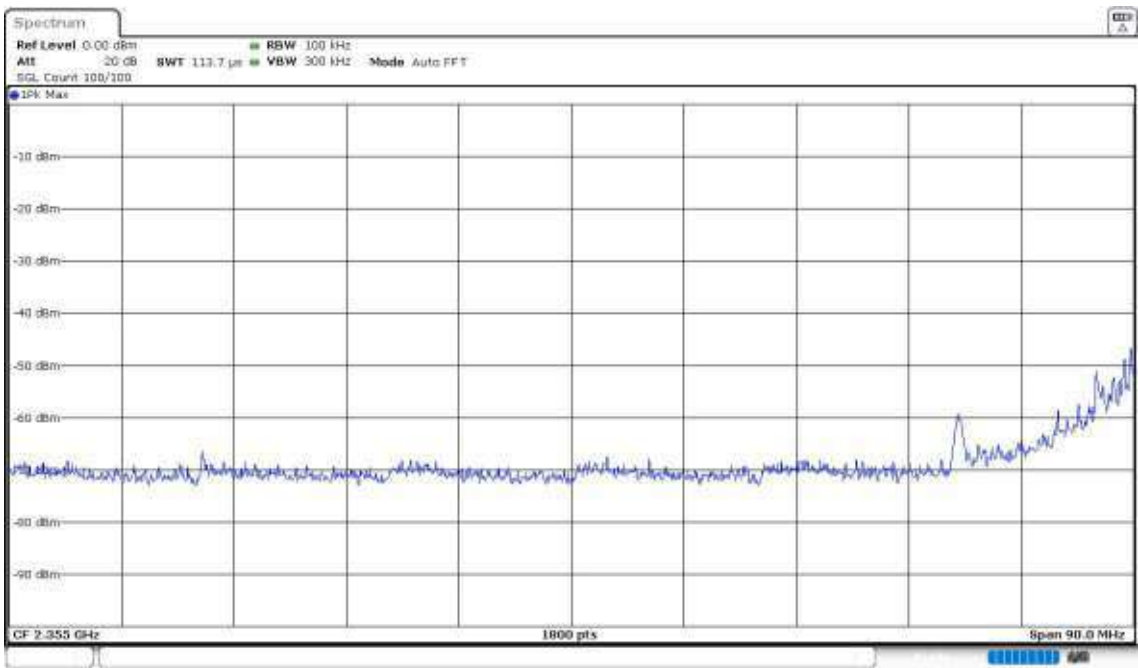




Operation Band (MHz) = [2400, 2483.5], Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

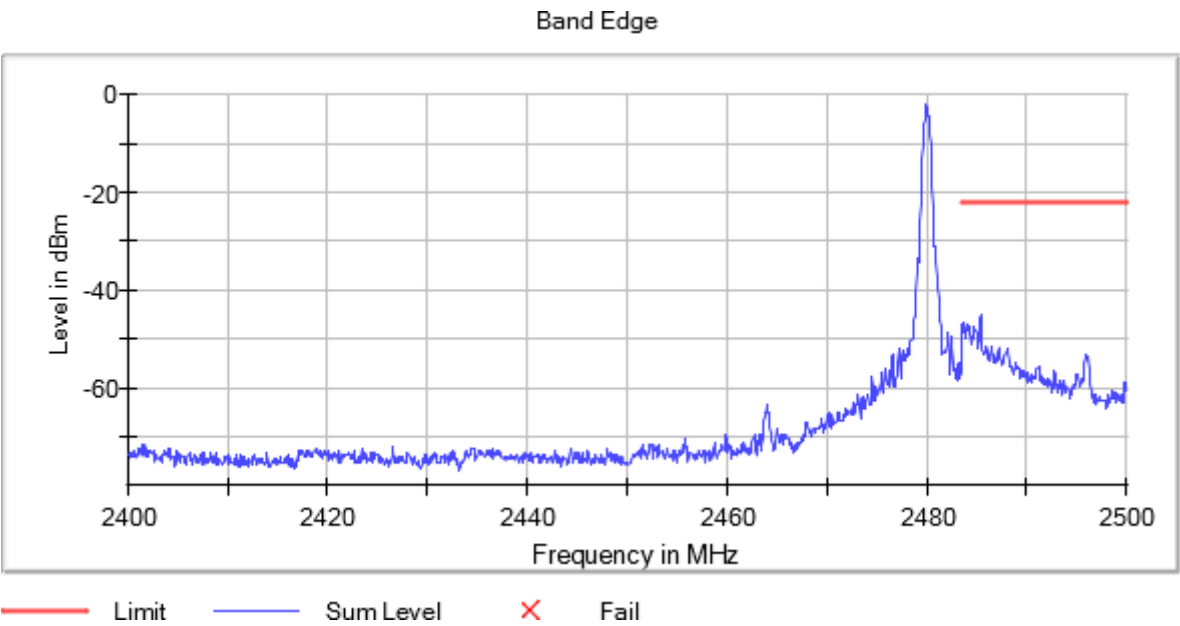
Plots:

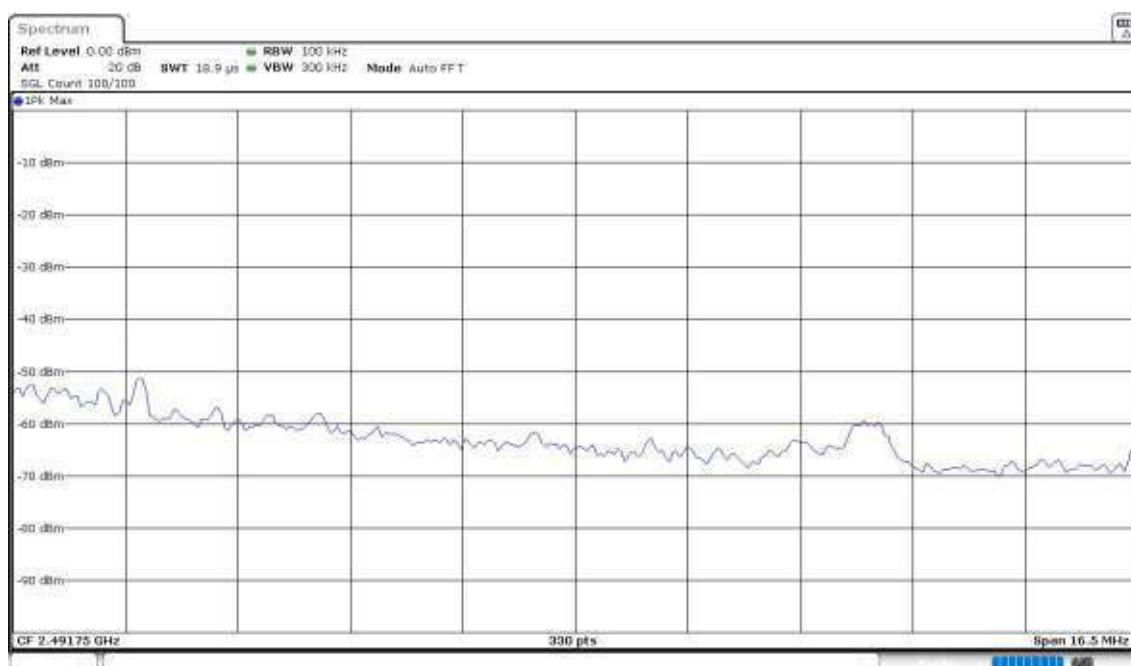
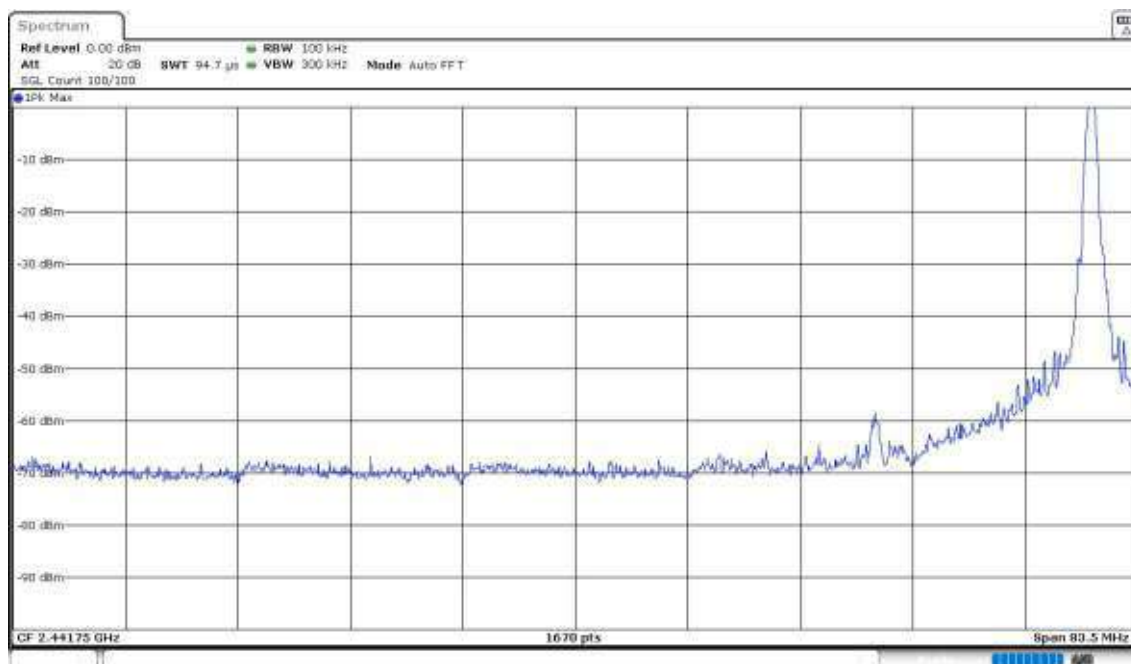




Operation Band (MHz) = [2400, 2483.5], Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Plots:





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	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.

Results

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

Operation Band: [2400, 2483.5]

Modulation: BTLE 5.0 (GFSK 2 Mbit/s)

Freq (MHz)	Freq Rng (GHz)	Unwanted Freq (MHz)	Unwanted Lvl (dBµV/m)	Pol	Detector
2480.00000	[1, 3]	2484.090000	59.02	H	PK
			52.43		AVG
2402.00000	[3, 17]	4804.740000	47.66	V	PK
2440.00000	[3, 17]	4878.800000	53.44	H	PK
2480.00000	[3, 17]	4958.880000	53.29	H	PK

Verdict

Pass

Modulation: BTLE 5.0 (GFSK 1 Mbit/s)

Freq (MHz)	Freq Rng (GHz)	Unwanted Freq (MHz)	Unwanted Lvl (dBμV/m)	Pol	Detector
2480.00000	[1, 3]	2484.092300	59.02	V	PK
			50.28		AVG
2402.00000	[3, 17]	4804.320000	47.16	H	PK
2440.00000	[3, 17]	4879.780000	51.88	V	PK
2480.00000	[3, 17]	4960.420000	55.04	V	PK
			47.46	V	AVG

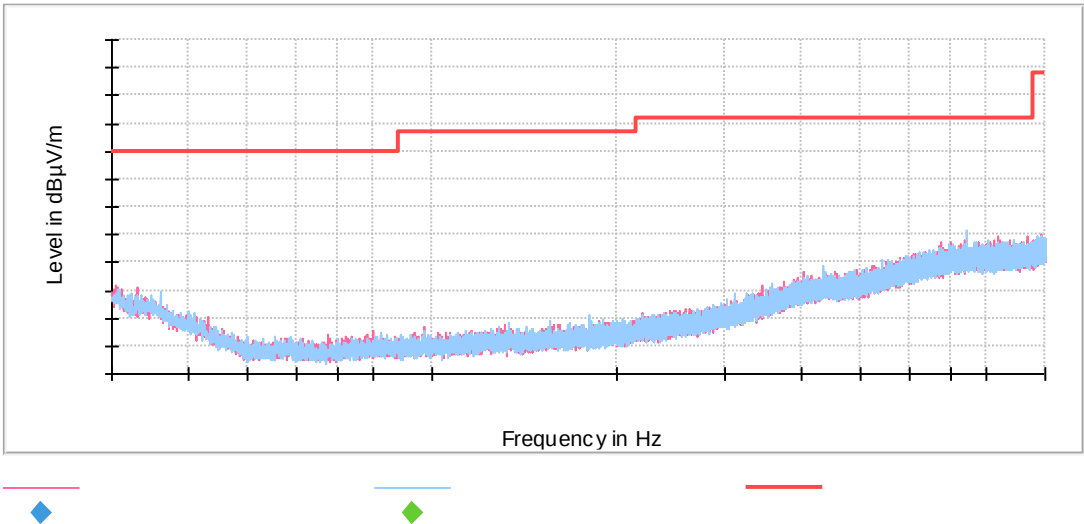
Verdict

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]

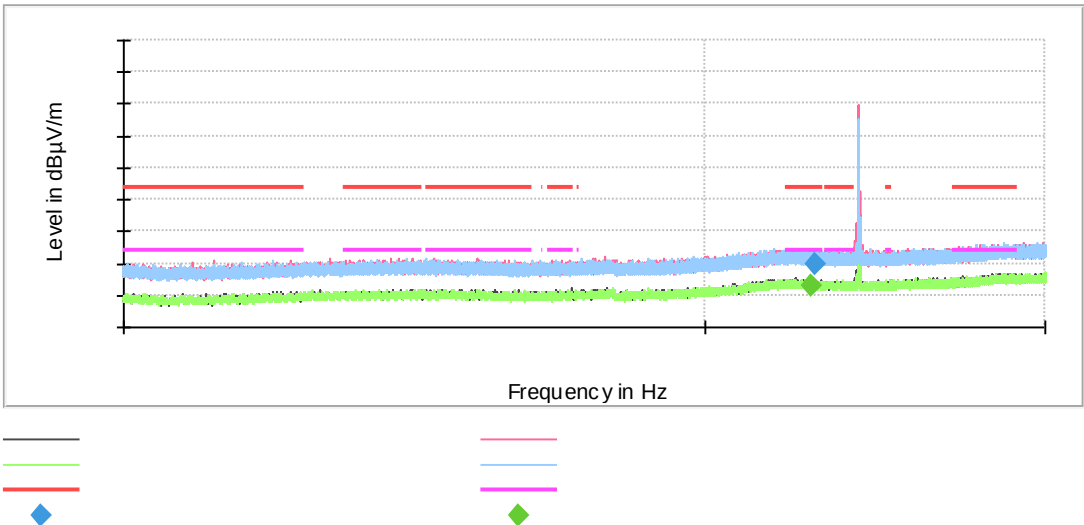
Plots:

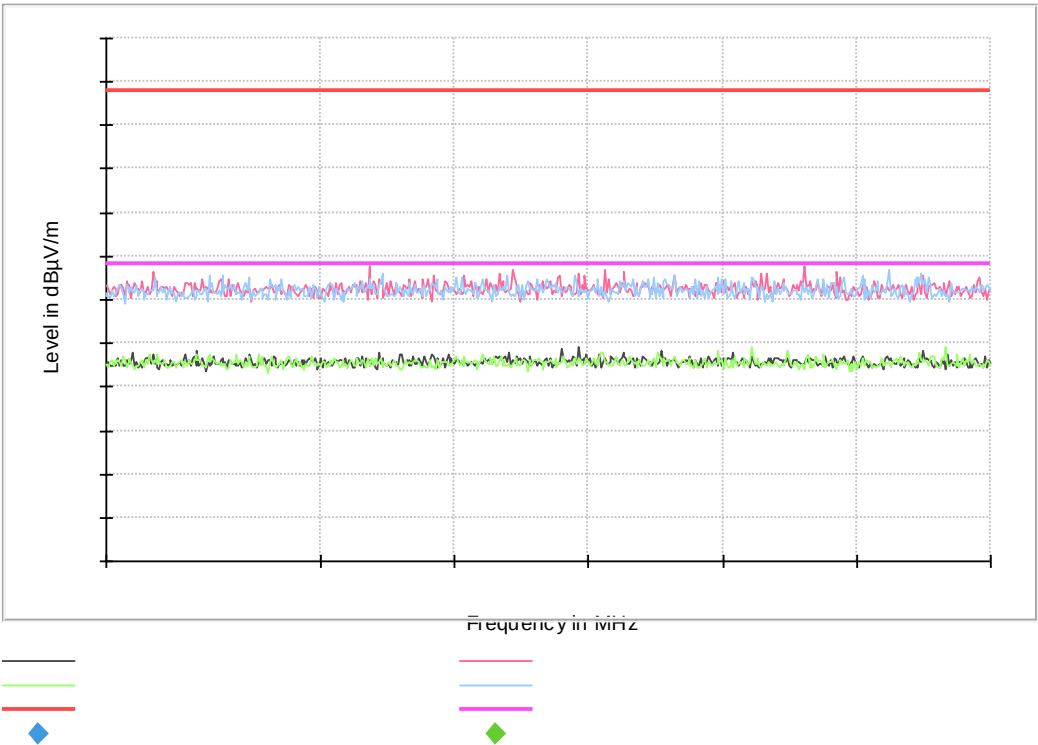
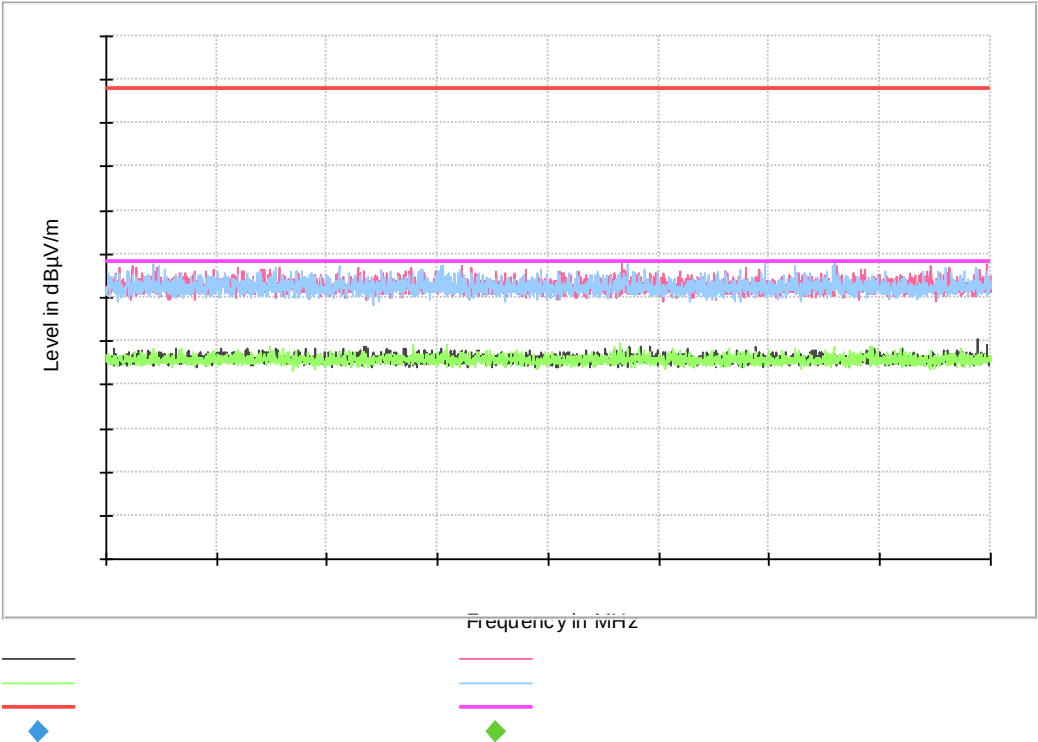


This plot is valid for Low, Middle and High Channels.

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]

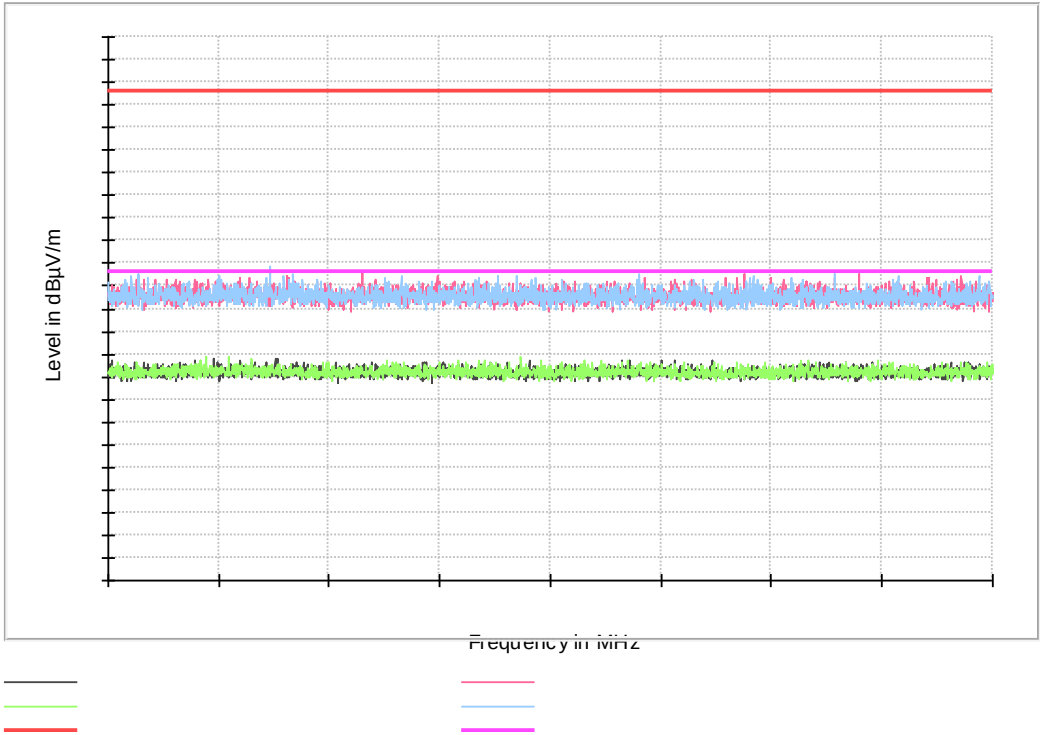
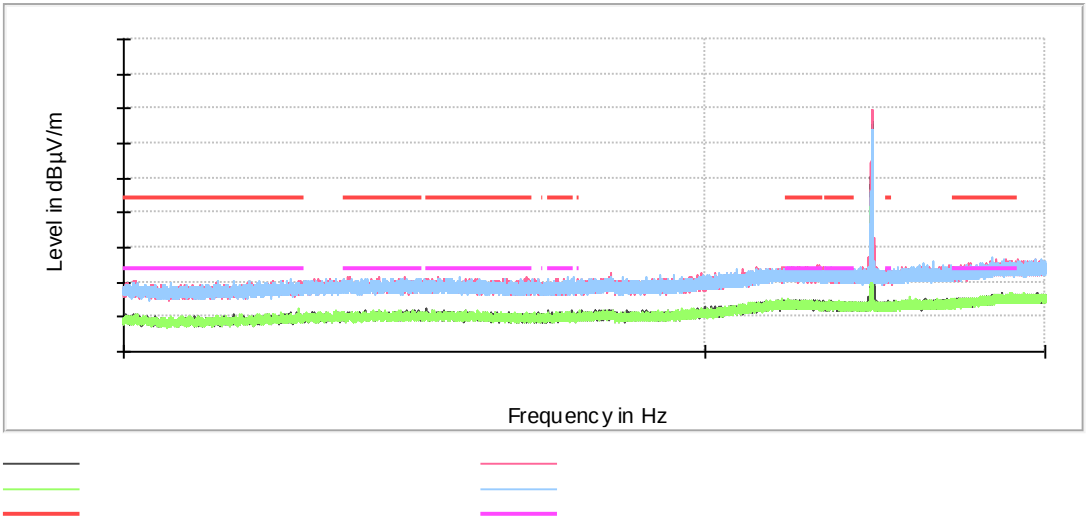
Plots:

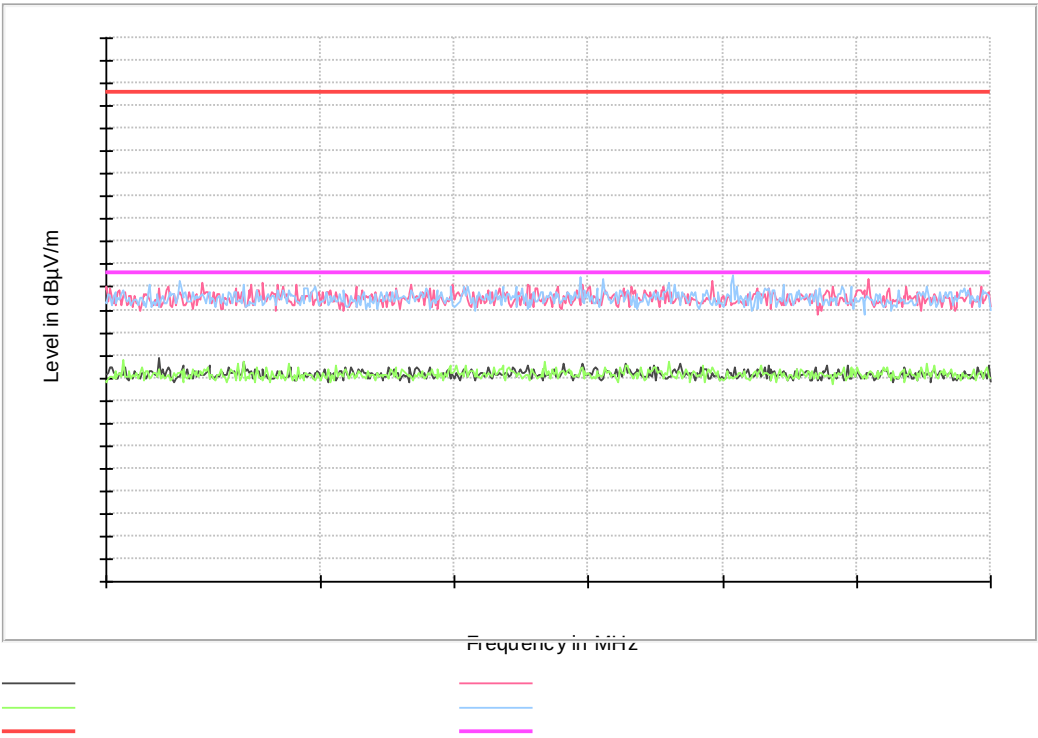




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2440.00000, Equipment Type: Digital
Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 2 Mbit/s), Frequency Range (GHz) = [1, 3]

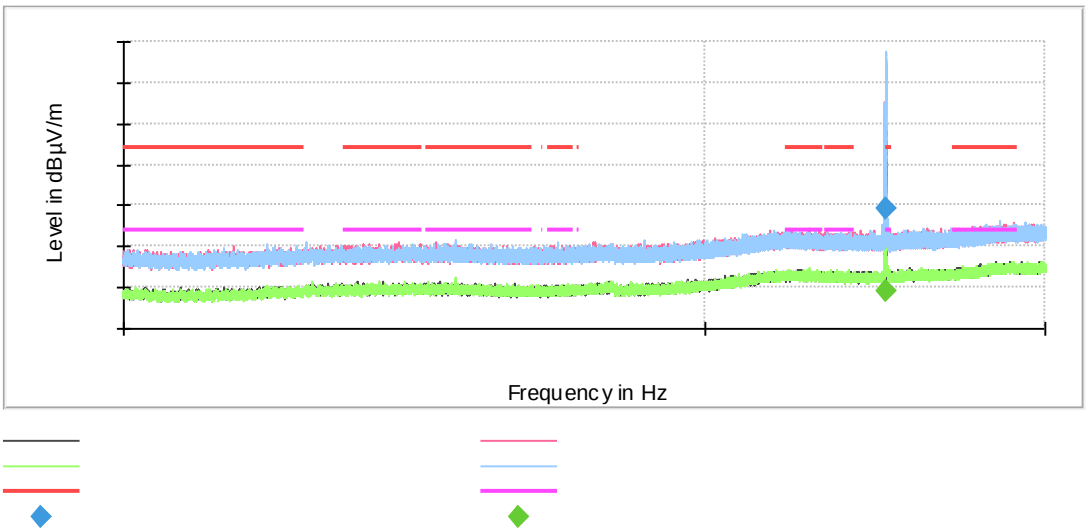
Plots:

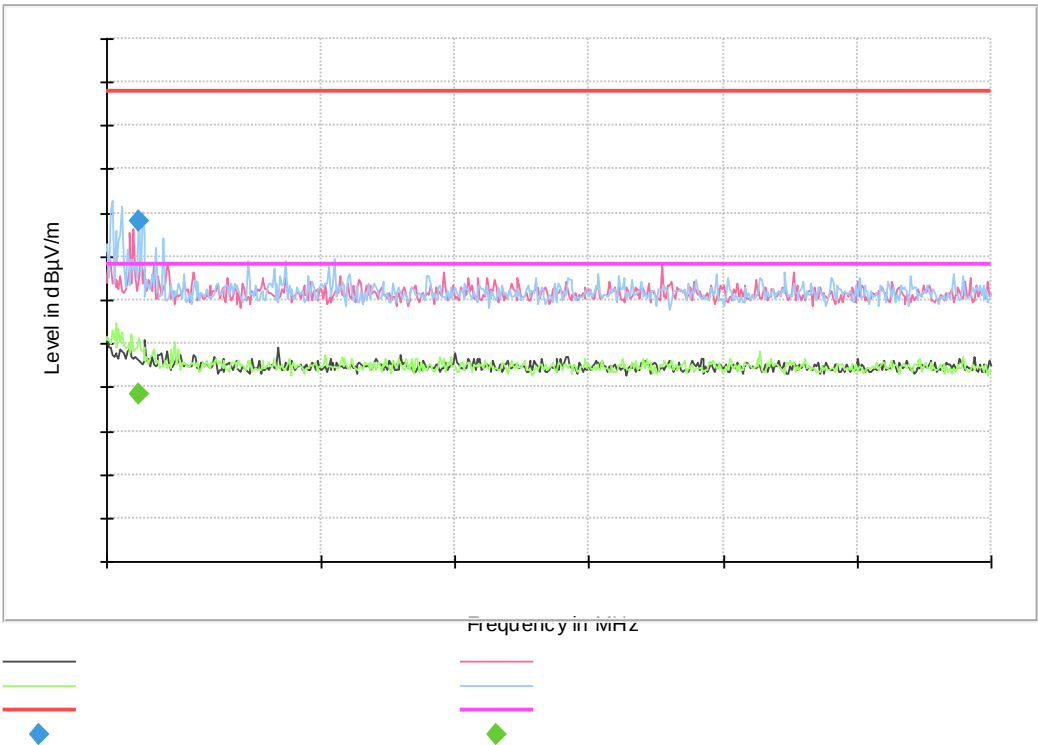
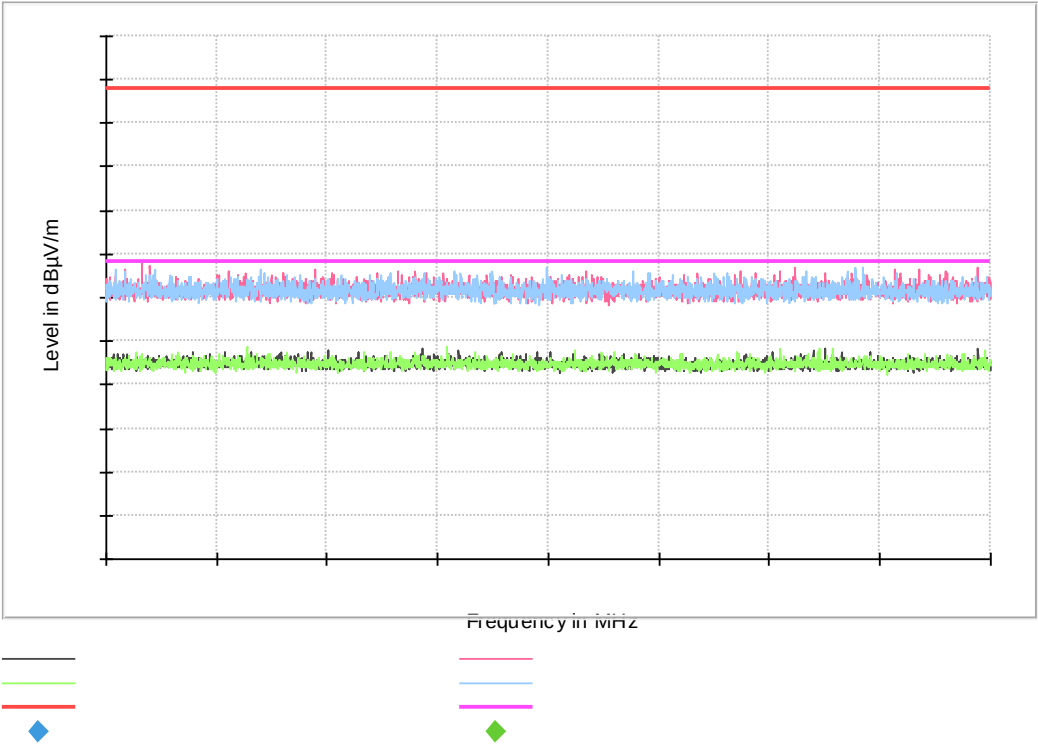




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00000, Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 2 Mbit/s), Frequency Range (GHz) = [1, 3]

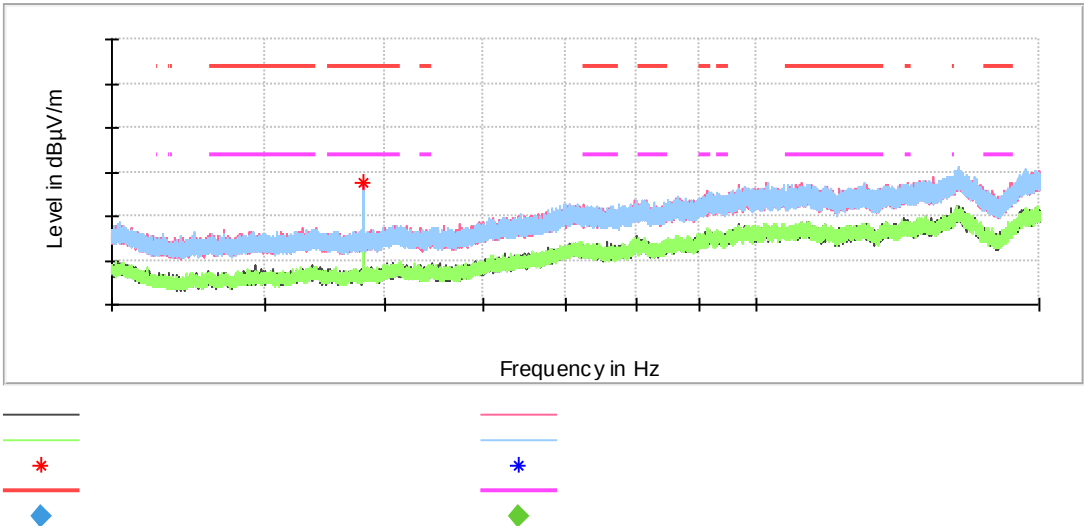
Plots:





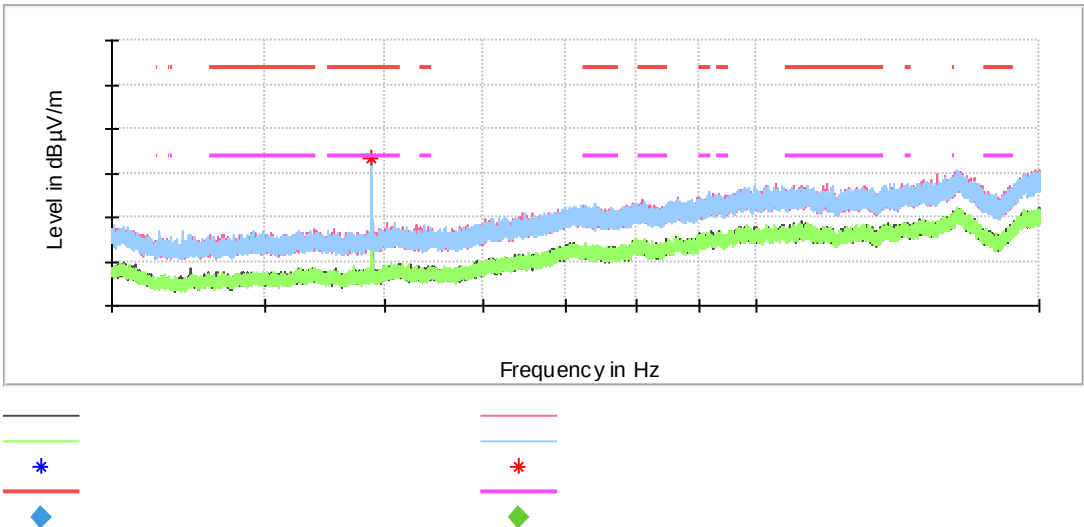
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00000, Equipment Type: Digital
Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 2 Mbit/s), Frequency Range (GHz) = [3, 17]

Plots:



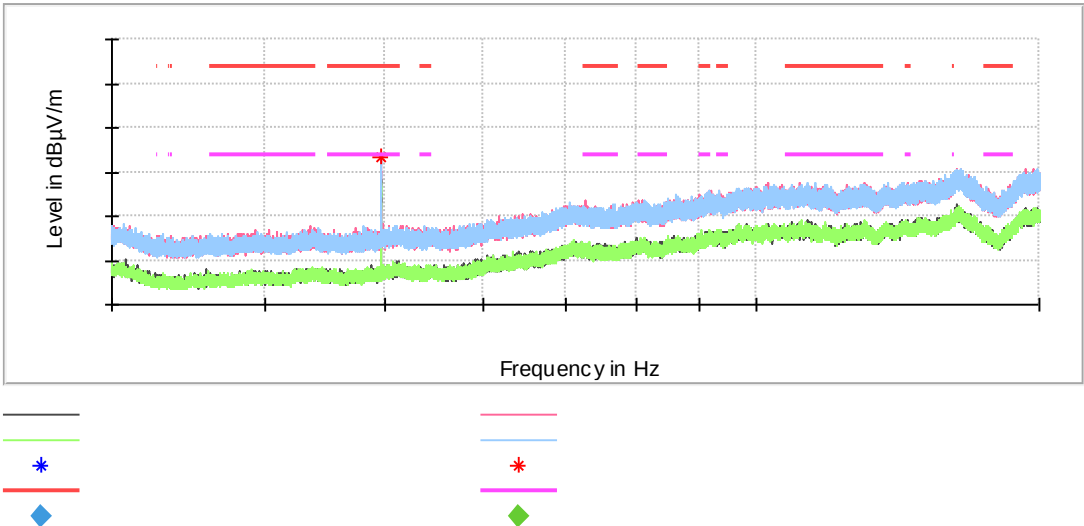
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2440.00000, Equipment Type: Digital
Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 2 Mbit/s), Frequency Range (GHz) = [3, 17]

Plots:



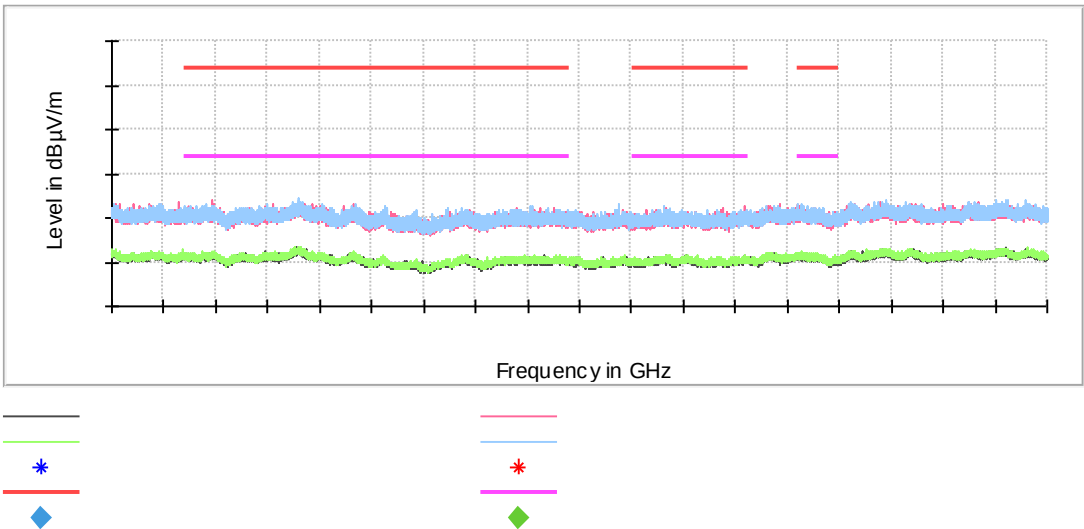
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00000, Equipment Type: Digital
Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 2 Mbit/s), Frequency Range (GHz) = [3, 17]

Plots:



Operation Band (MHz) = [2400, 2483.5], Equipment Type: Digital Transmission System (DTS), Modulation:
BTLE 5.0 (GFSK 2 Mbit/s), Frequency Range (GHz) = [17, 26]

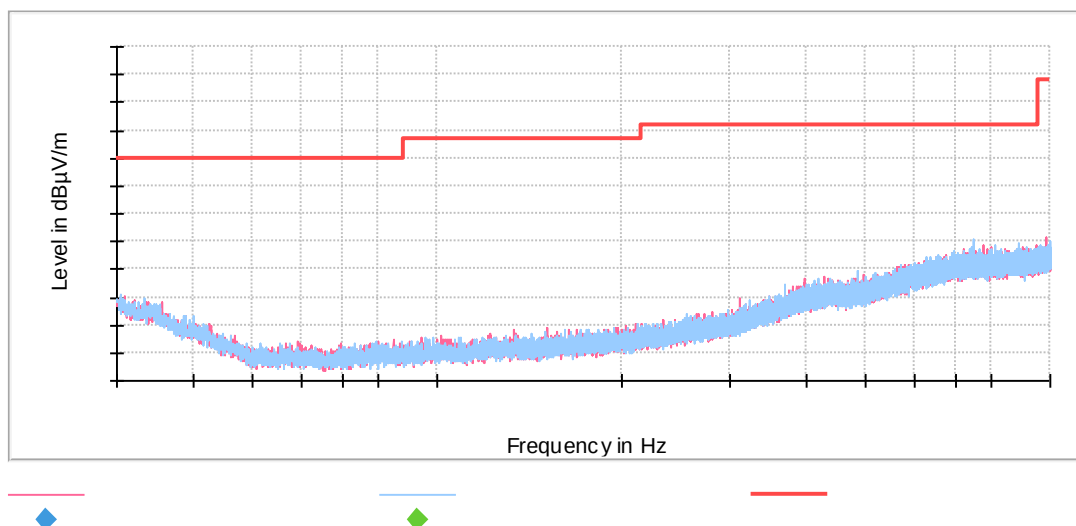
Plots:



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

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

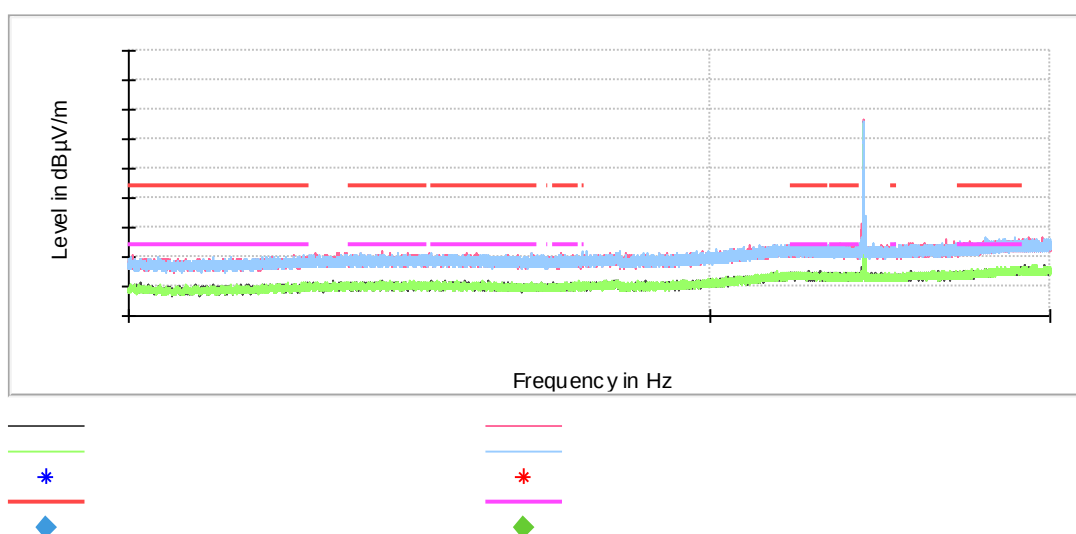
Plots:

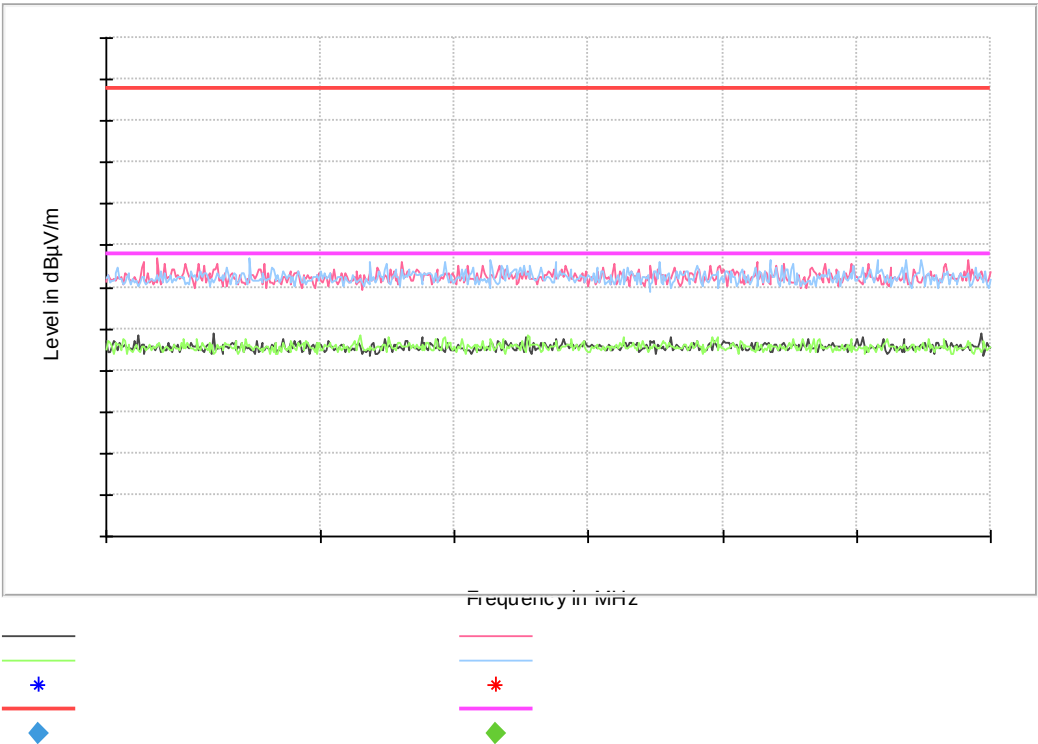
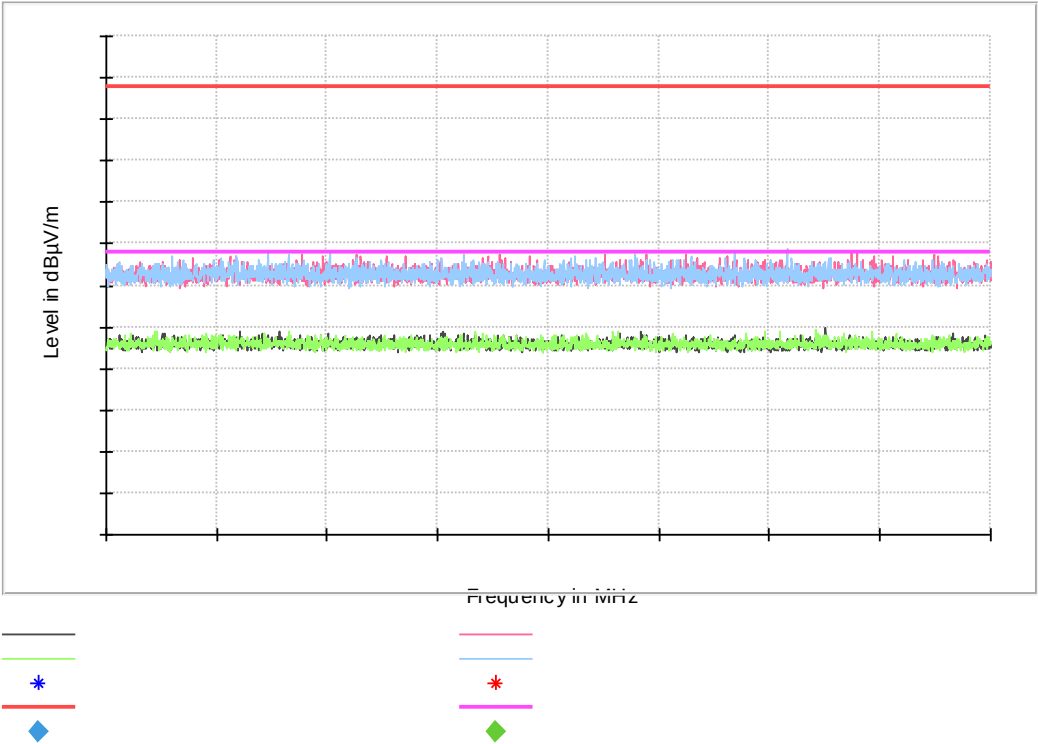


This plot is valid for Low, Middle and High Channels.

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

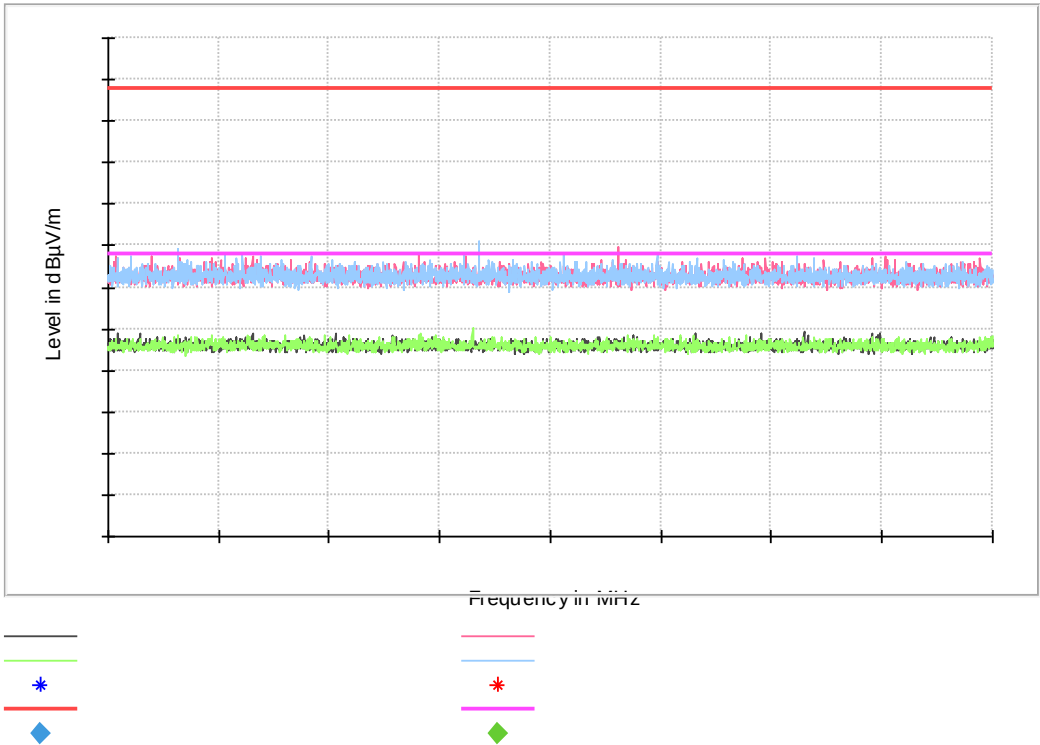
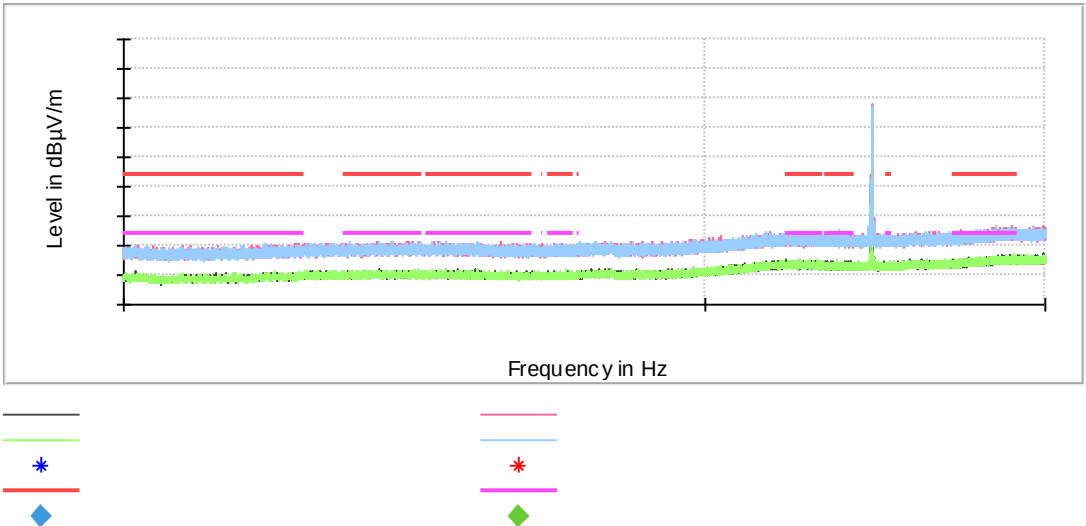
Plots:

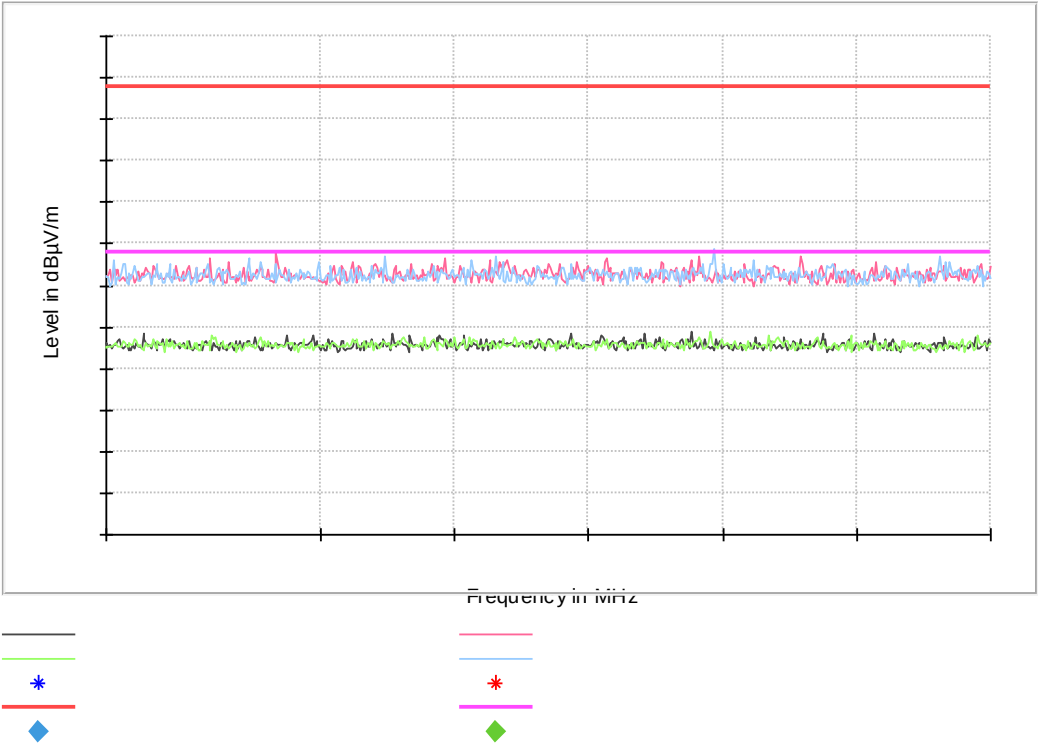




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2440.00000, Equipment Type: Digital
Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 1 Mbit/s), Frequency Range (GHz) = [1, 3]

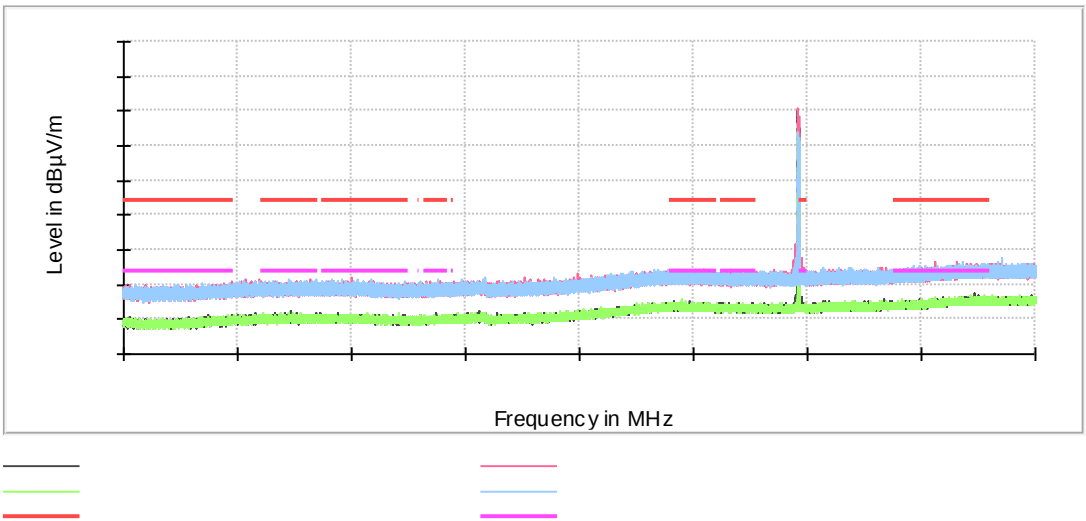
Plots:

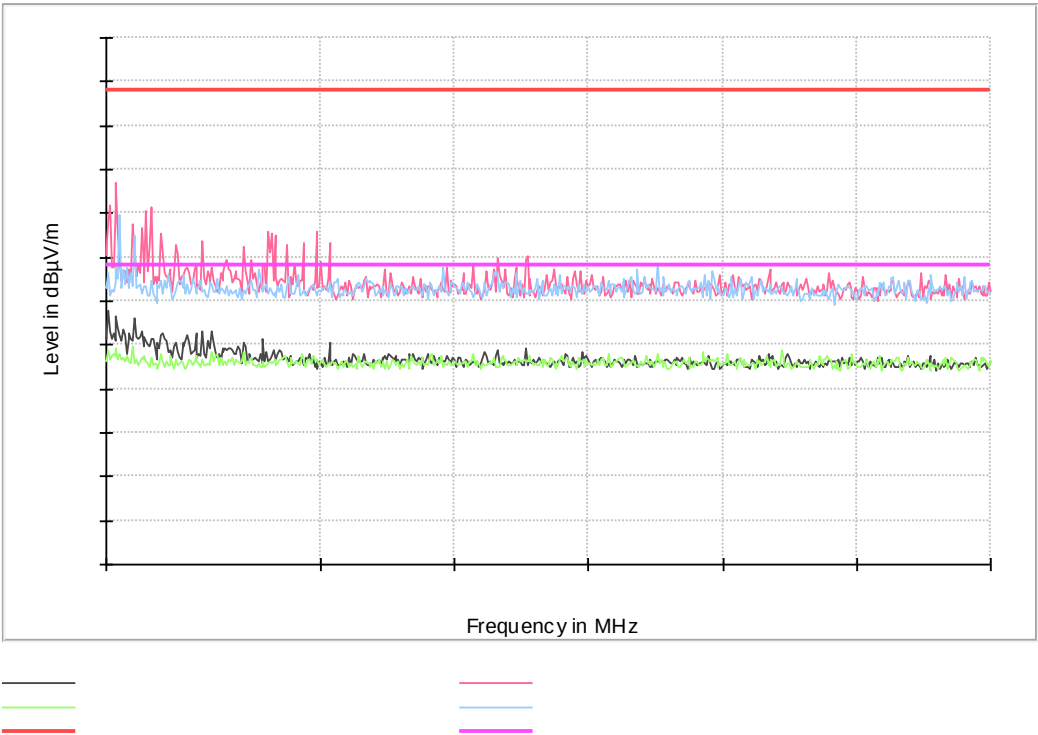
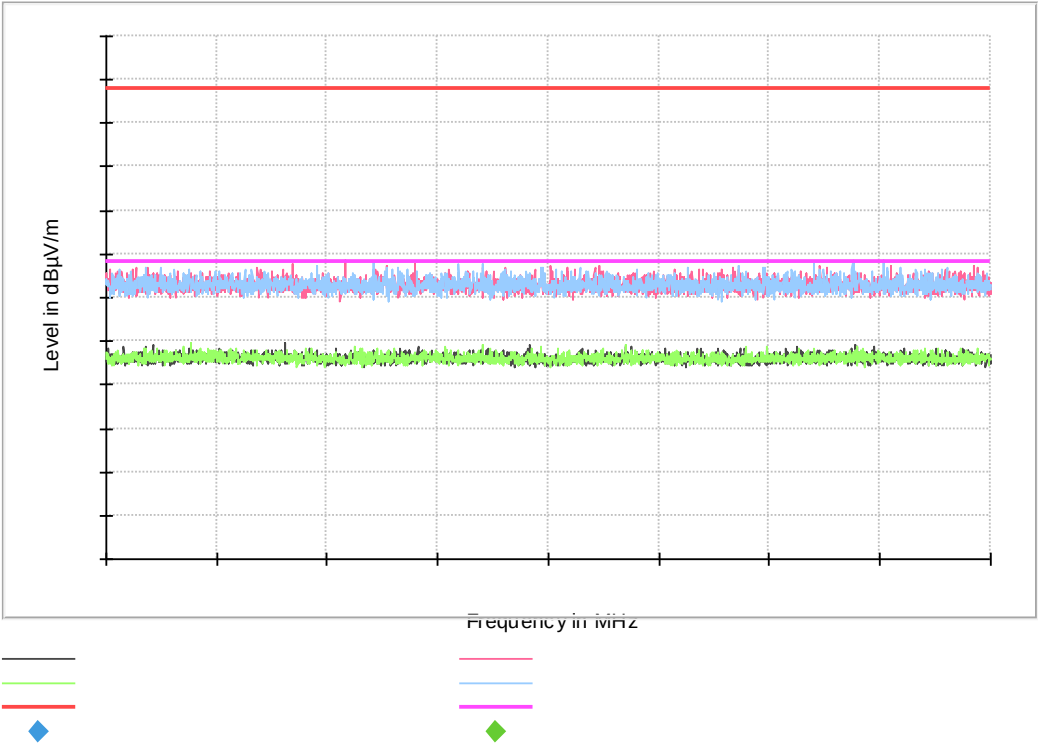




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00000, Equipment Type: Digital Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 1 Mbit/s), Frequency Range (GHz) = [1, 3]

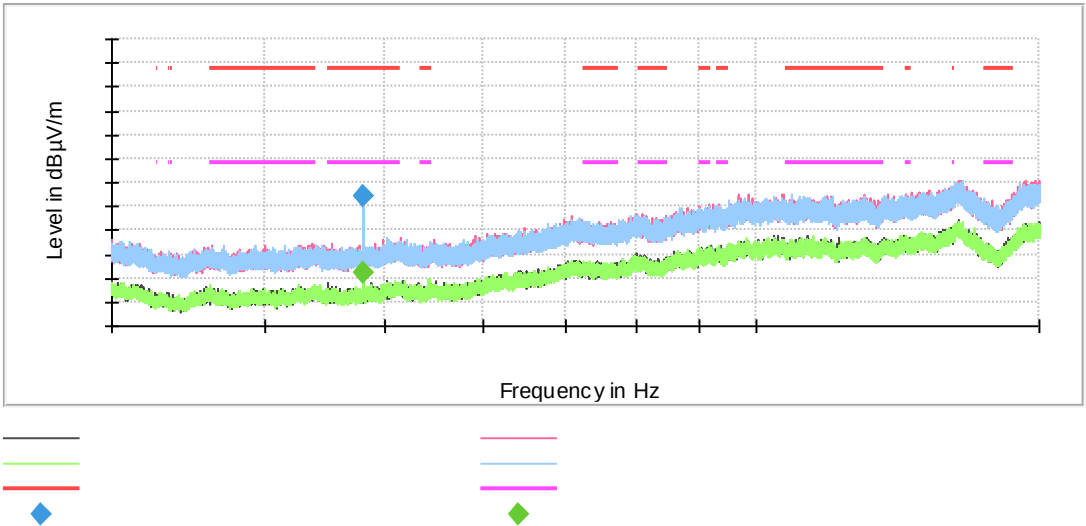
Plots:





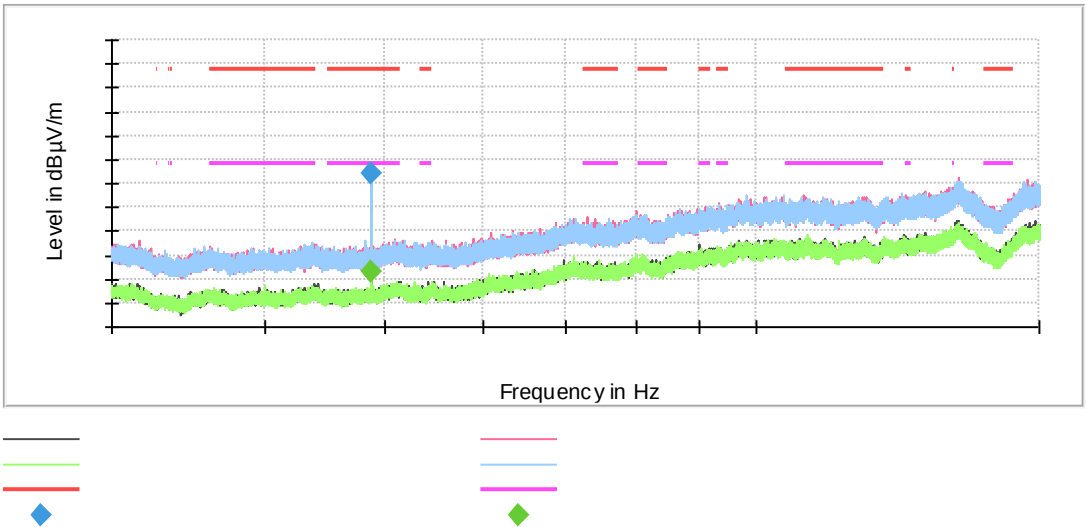
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00000, Equipment Type: Digital
Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 1 Mbit/s), Frequency Range (GHz) = [3, 17]

Plots:



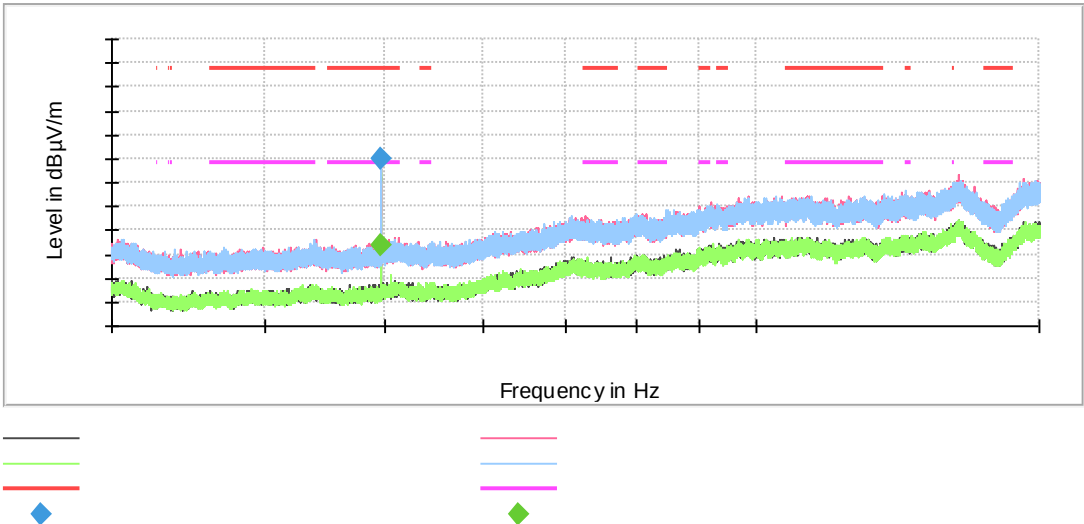
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2440.00000, Equipment Type: Digital
Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 1 Mbit/s), Frequency Range (GHz) = [3, 17]

Plots:



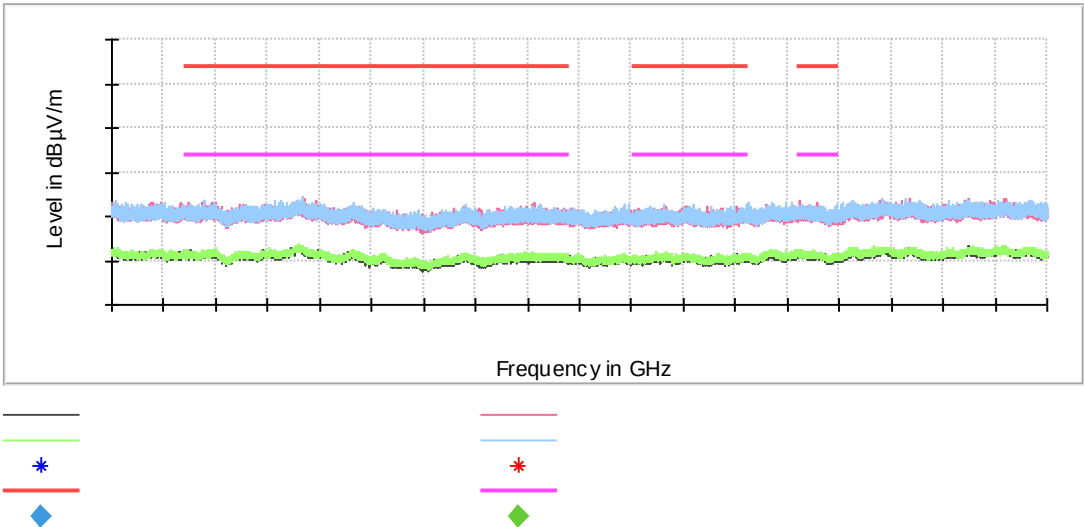
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00000, Equipment Type: Digital
Transmission System (DTS), Modulation: BTLE 5.0 (GFSK 1 Mbit/s), Frequency Range (GHz) = [3, 17]

Plots:



Operation Band (MHz) = [2400, 2483.5], Equipment Type: Digital Transmission System (DTS), Modulation:
BTLE 5.0 (GFSK 1 Mbit/s), Frequency Range (GHz) = [17, 26]

Plots:



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

Appendix B: Test results. Proprietary Protocol 2.4 GHz

TEST CONDITIONS	12
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TEST CONDITIONS

(*): Data provided by the client.

POWER SUPPLY (*):

Vnominal:	3.8 Vdc
Type of Power Supply:	Internal Li-ion battery

ANTENNA (*):

Type of Antenna:	Integral antenna
Maximum Declared Antenna Gain:	-8.62 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 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 – 18 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).

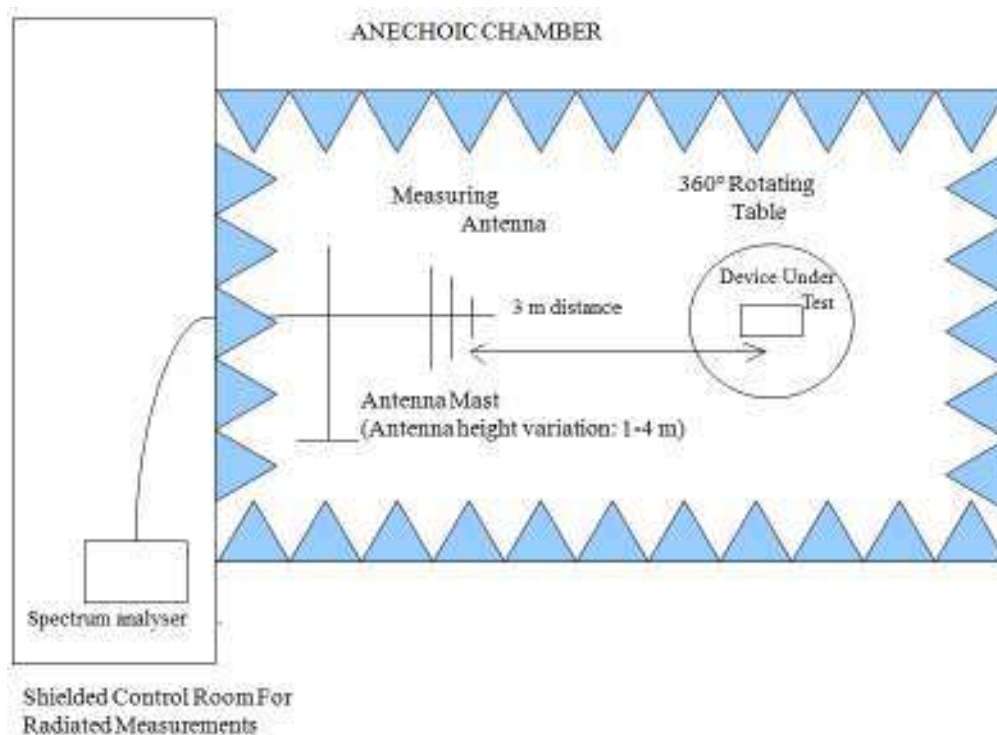
For radiated emissions in the range 17 GHz – 26 GHz performed at a distance closer than the distance specified in standard, an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

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 17GHz) to find the maximum radiated emission.

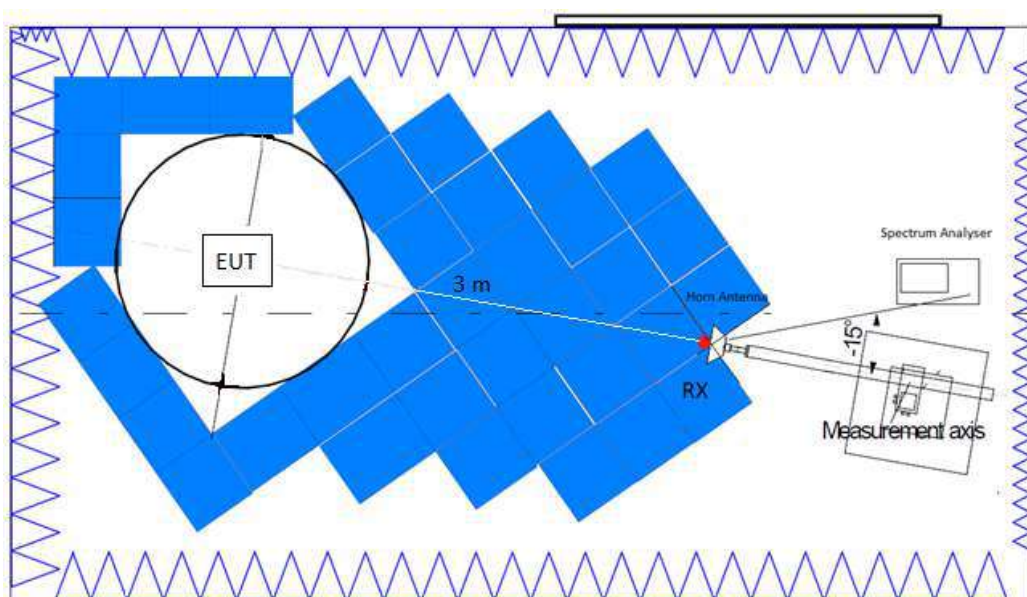
Measurements were made in both horizontal and vertical planes of polarization.

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.

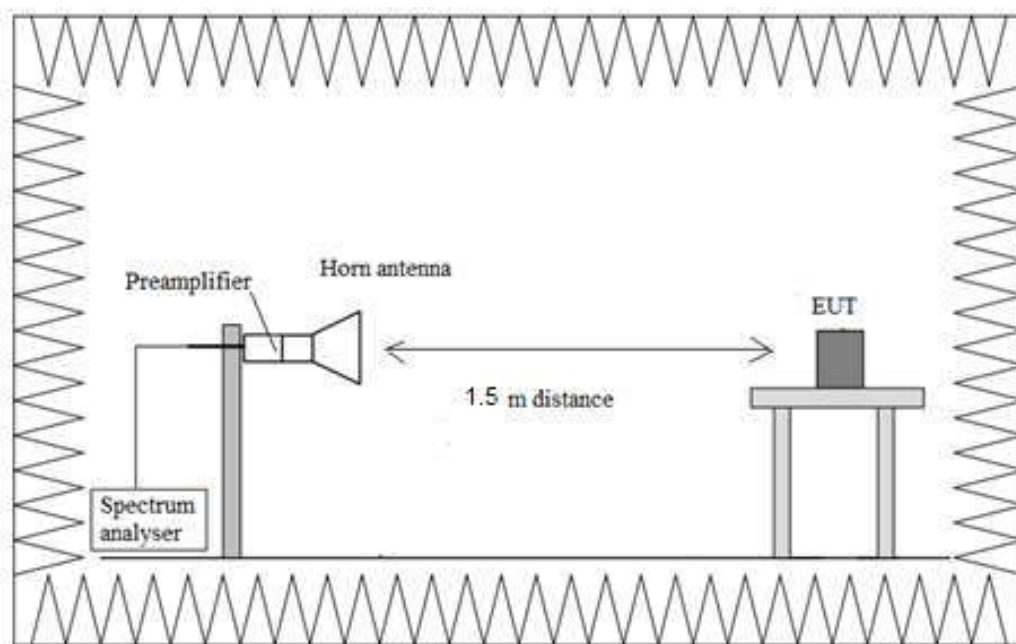
Radiated measurements setup from 30 MHz to 1 GHz:



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 Bandwidth

Results

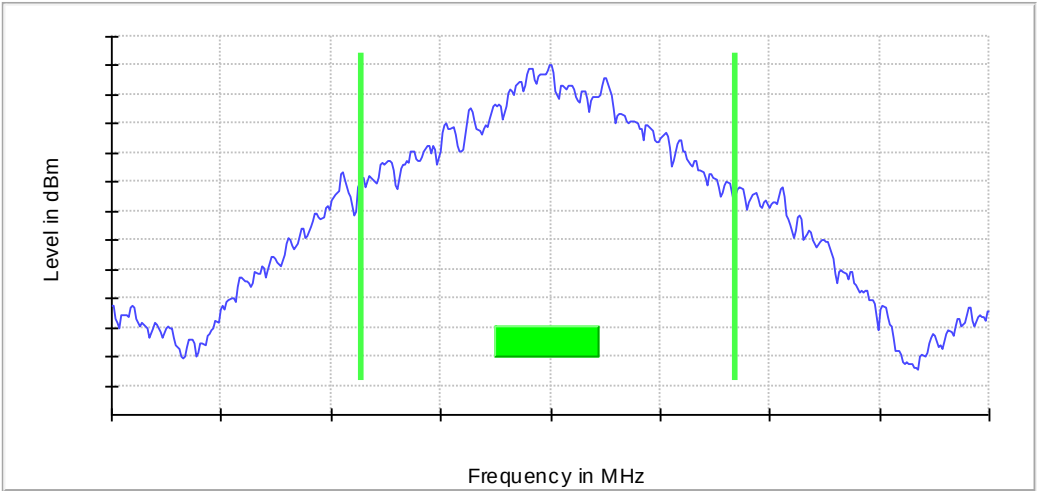
Modulation: Proximity

Freq (MHz)	Equipment	Occ Ch BW (MHz)
2402.00000	Digital Transmission System (DTS)	1.710
2440.00000		1.720
2480.00000		1.720

Attachments

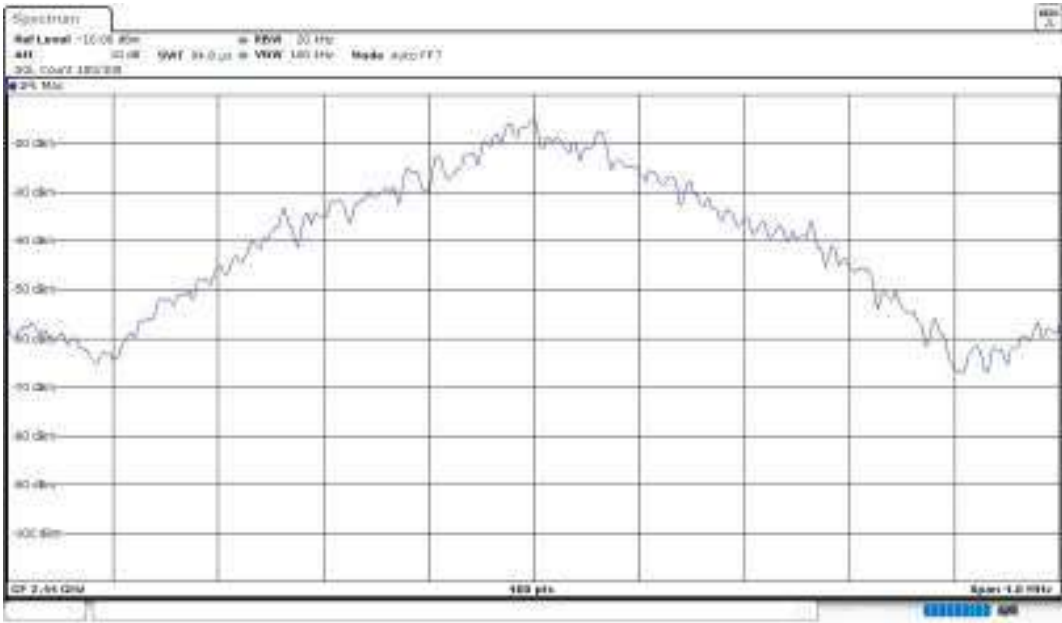
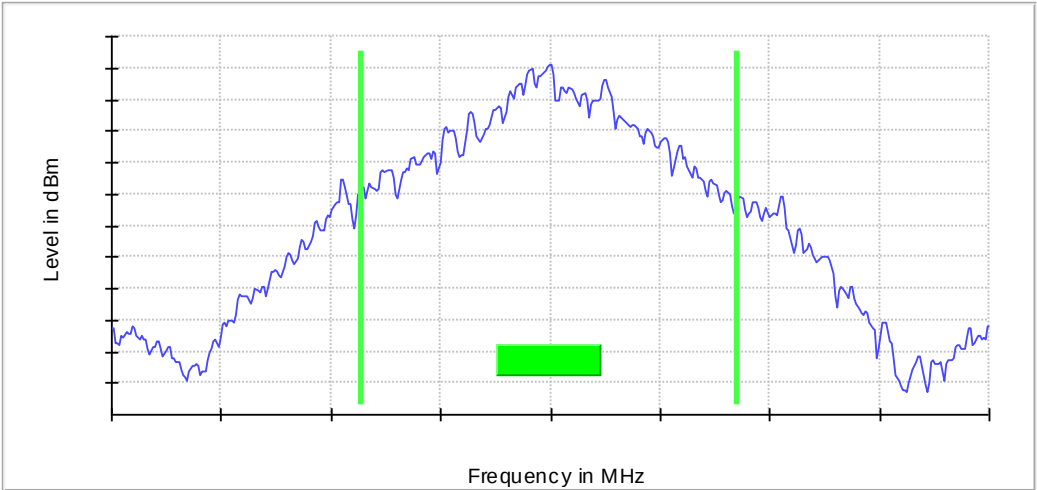
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00000, Equipment Type: Digital Transmission System (DTS), Modulation: Proximity

Plots:



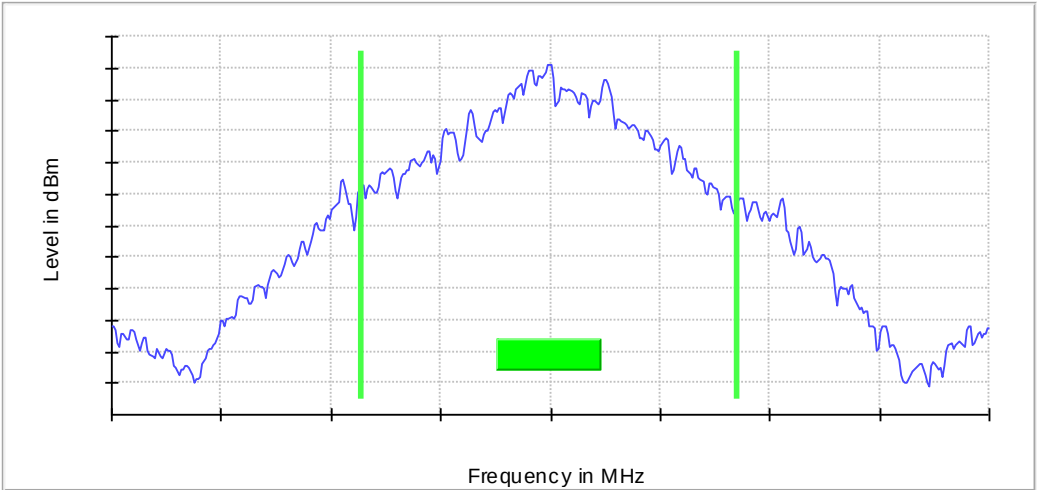
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2440.00000, Equipment Type: Digital Transmission System (DTS), Modulation: Proximity

Plots:



Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00000, Equipment Type: Digital Transmission System (DTS), Modulation: Proximity

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.

Results

Modulation: Proximity

Freq (MHz)	Emission Bandwidth (MHz)
2402.00000	0.71
2440.00000	0.71
2480.00000	0.71

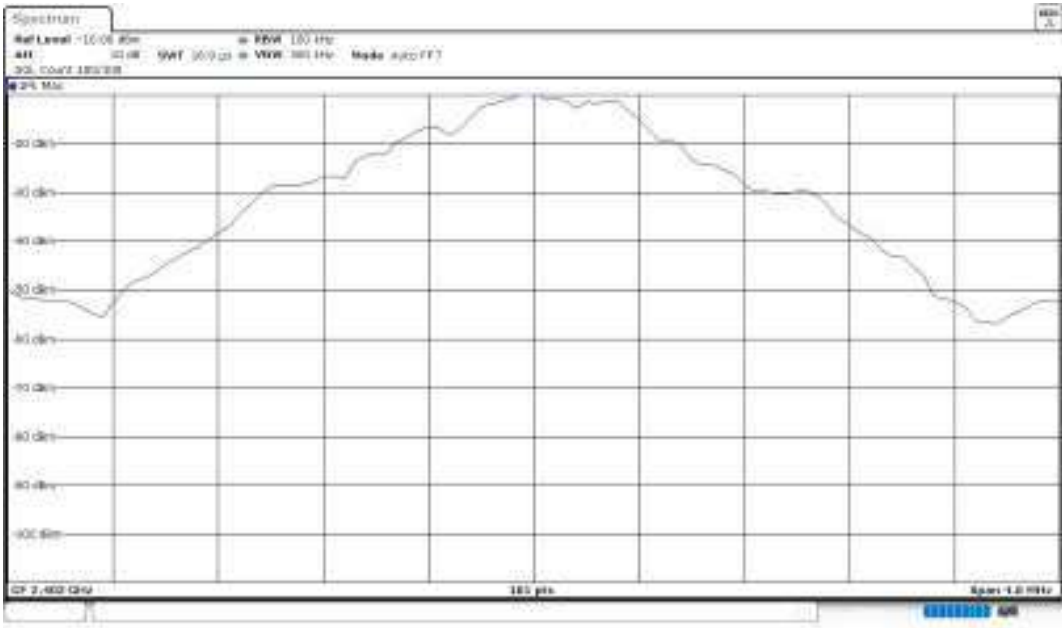
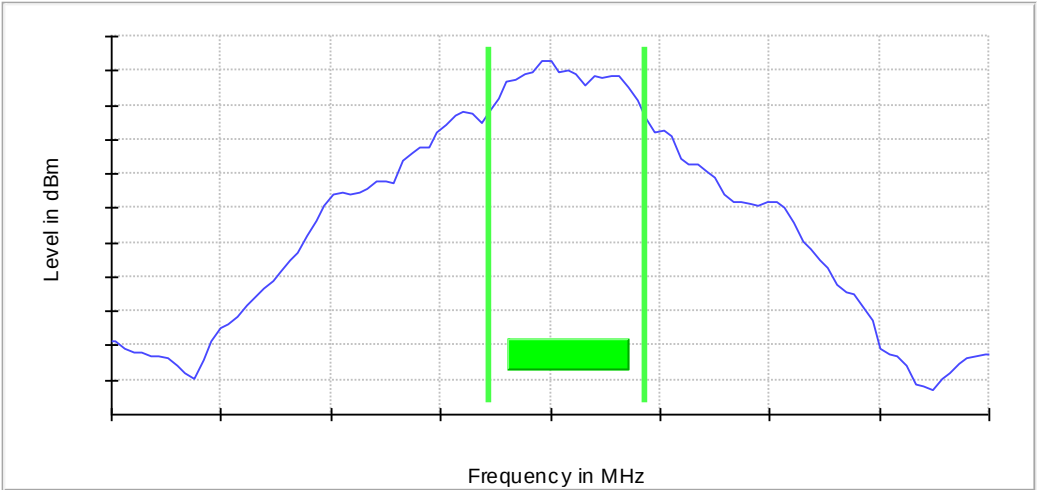
Verdict

Pass

Attachments

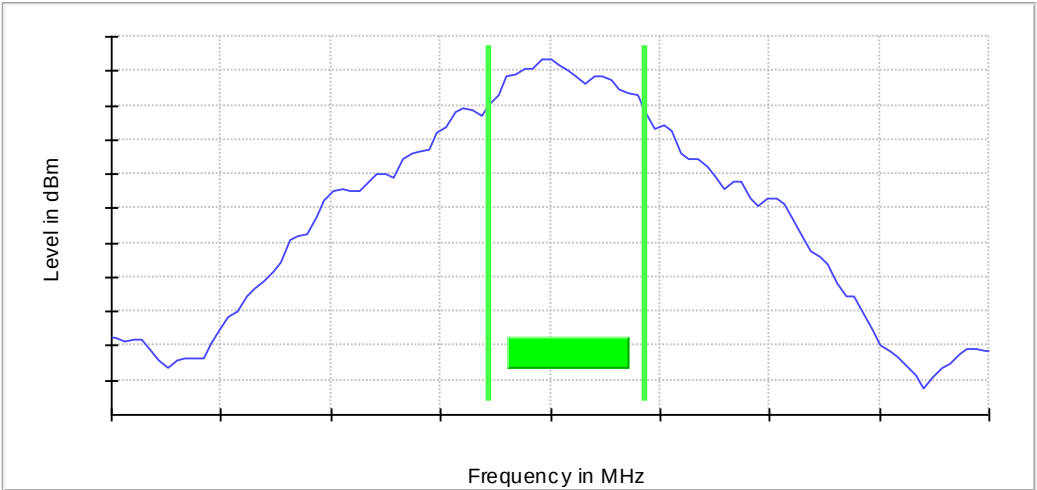
Frequency (MHz) = 2402.00000, Modulation: Proximity

Plots:



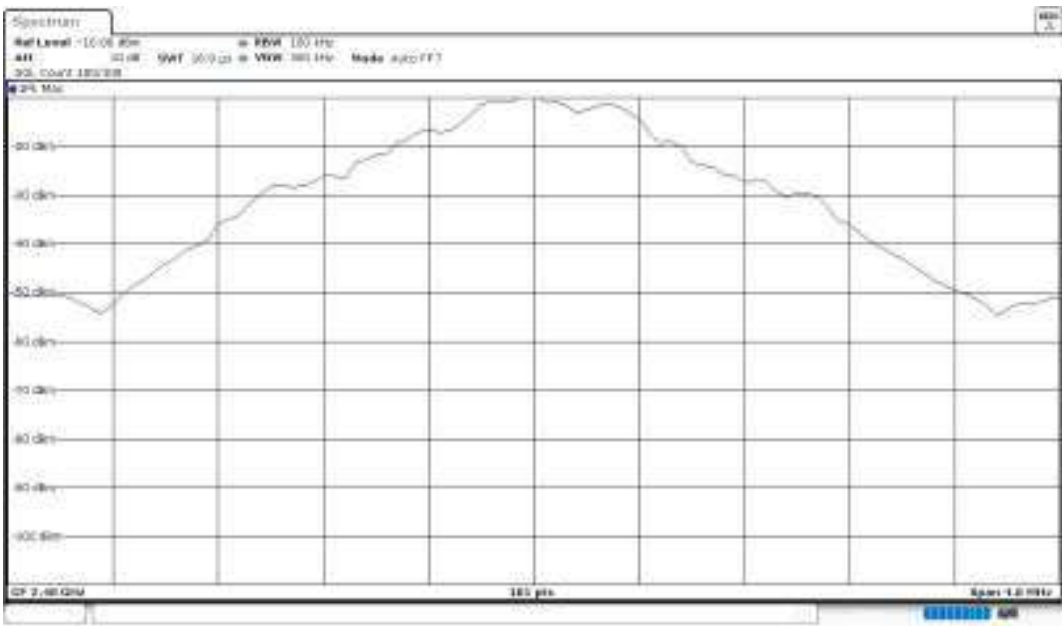
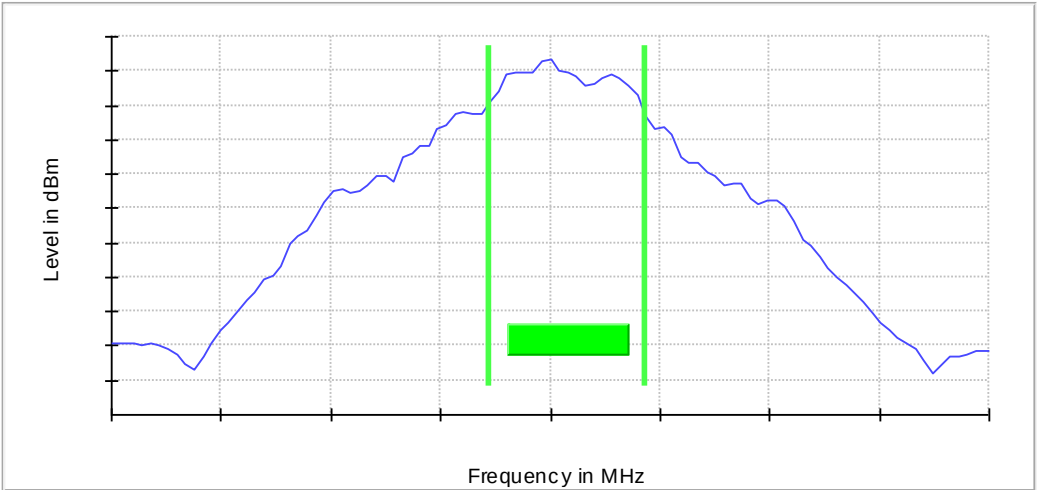
Frequency (MHz) = 2440.00000, Modulation: Proximity

Plots:



Frequency (MHz) = 2480.00000, Modulation: Proximity

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.

Maximum Declared Antenna Gain: -8.62 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.

Operation Band: [2400, 2483.5]

Modulation: Proximity

Freq (MHz)	Equipment	Peak Power (dBm)	Peak Power E.I.R.P (dBm)
2402.00000	Digital Transmission System (DTS)	6.1	-2.5
2440.00000		6.9	-1.7
2480.00000		6.7	-1.9

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: Proximity

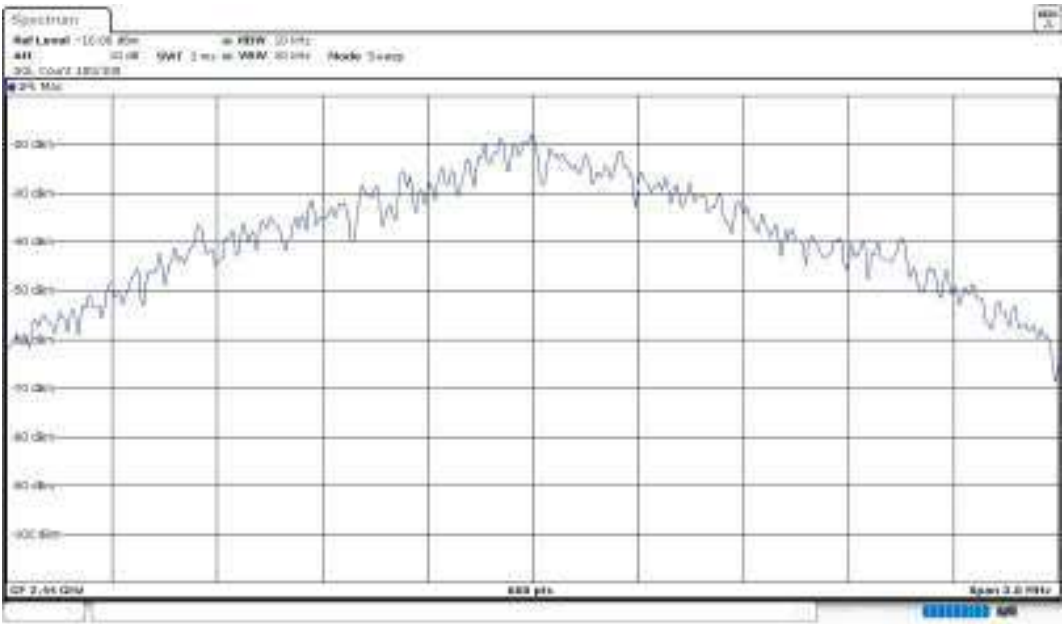
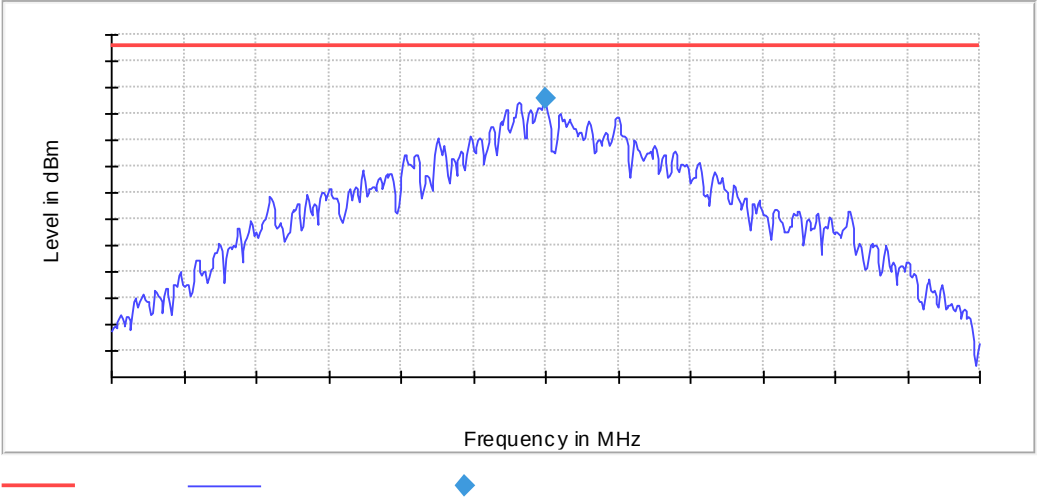
Freq (MHz)	PSD (dBm)
2402.00000	-2.53
2440.00000	-2.26
2480.00000	-2.32

Verdict

Pass

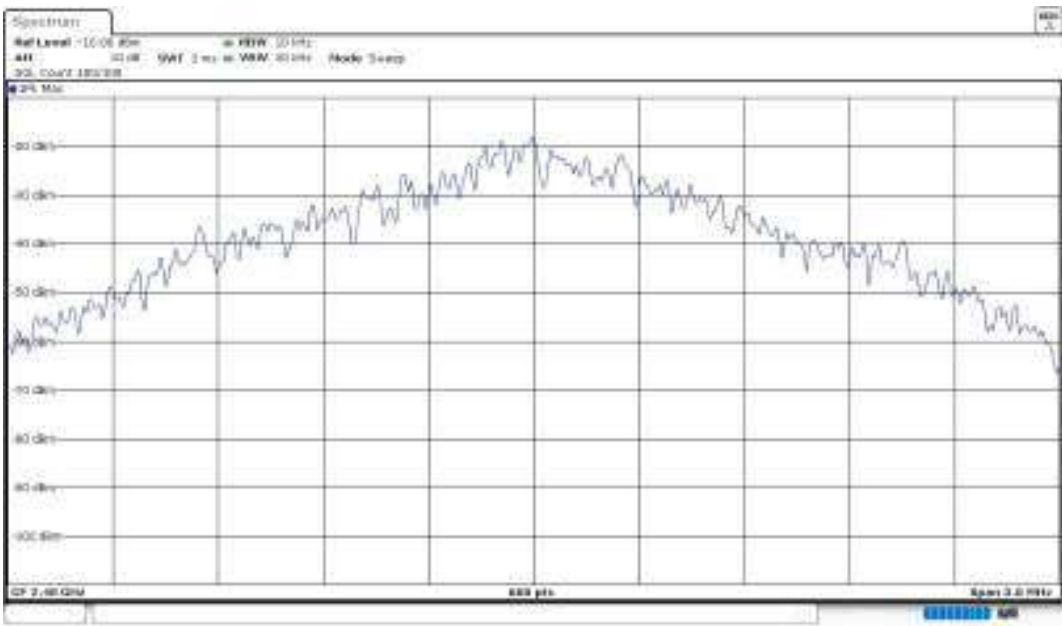
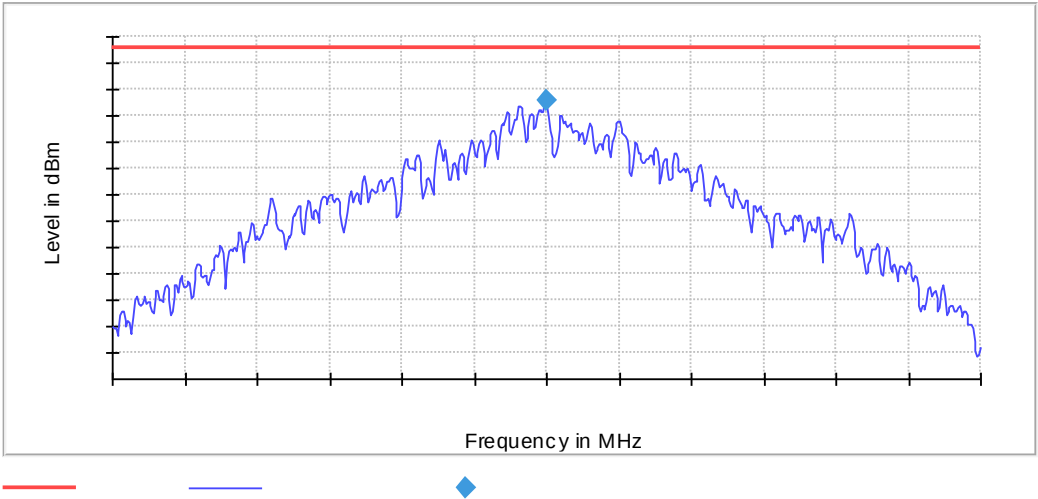
Frequency (MHz) = 2440.00000, Modulation: Proximity

Plots:



Frequency (MHz) = 2480.00000, Modulation: Proximity

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

Operation Band: [2400, 2483.5]

Modulation: Proximity

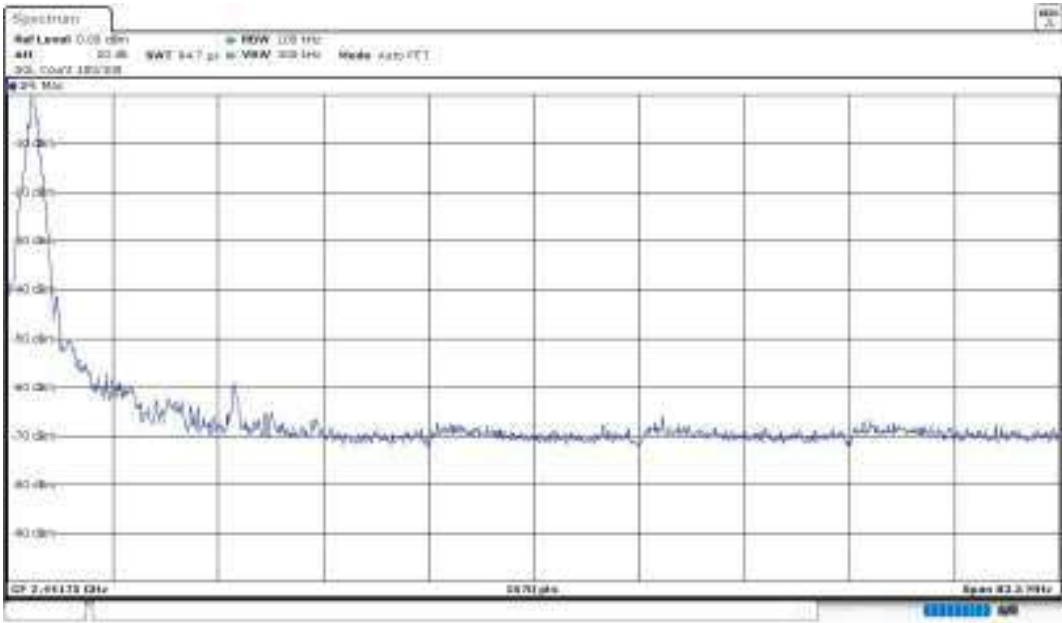
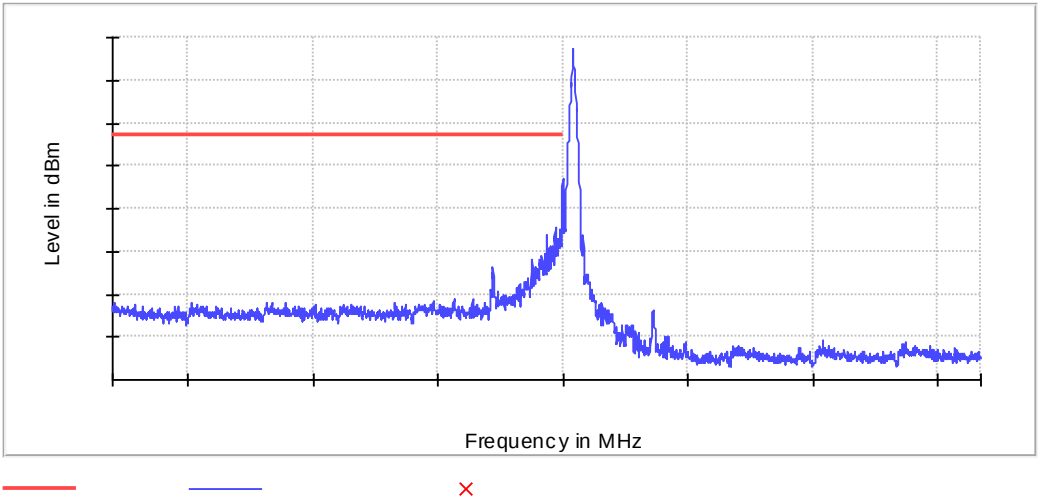
Verdict

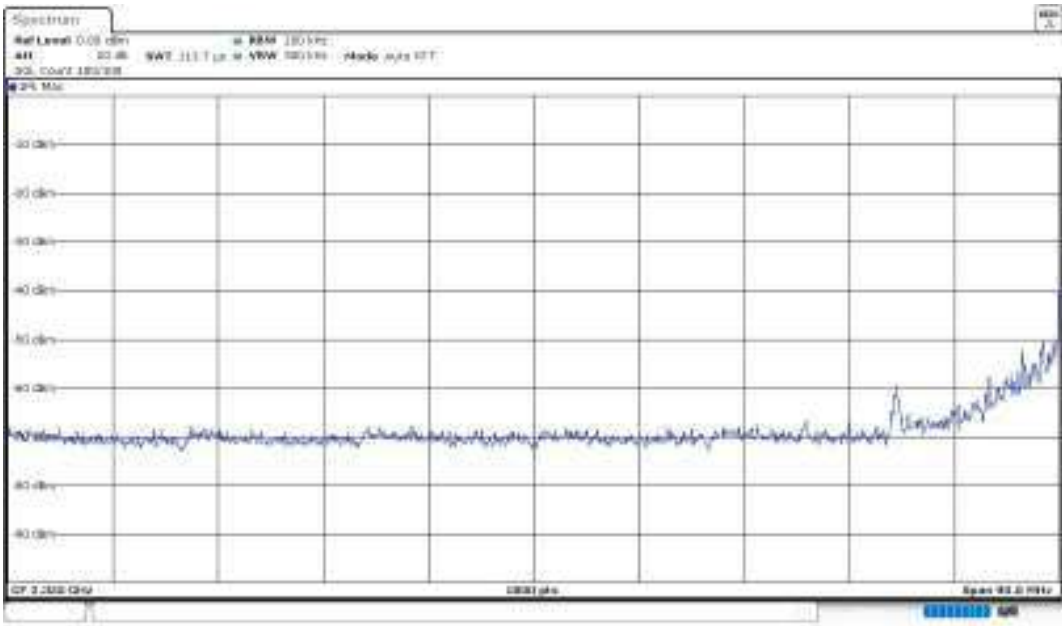
Pass

Attachments

Operation Band (MHz) = [2400, 2483.5], Equipment Type: Digital Transmission System (DTS), Modulation: Proximity

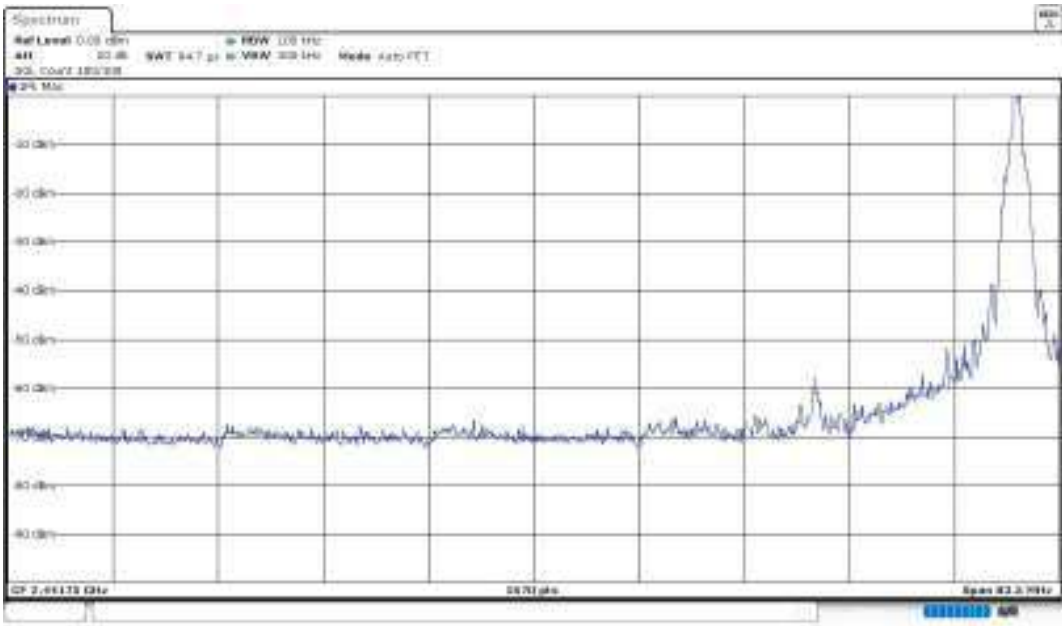
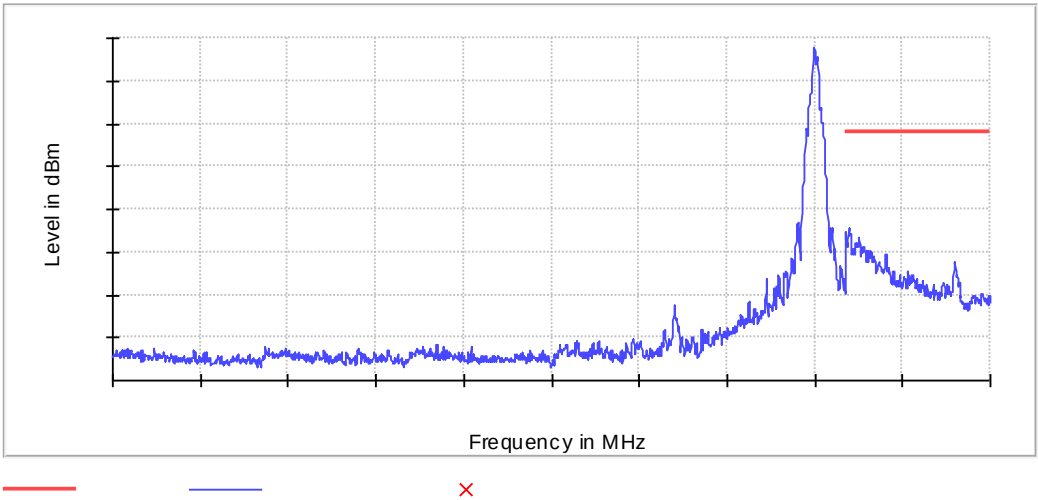
Plots:

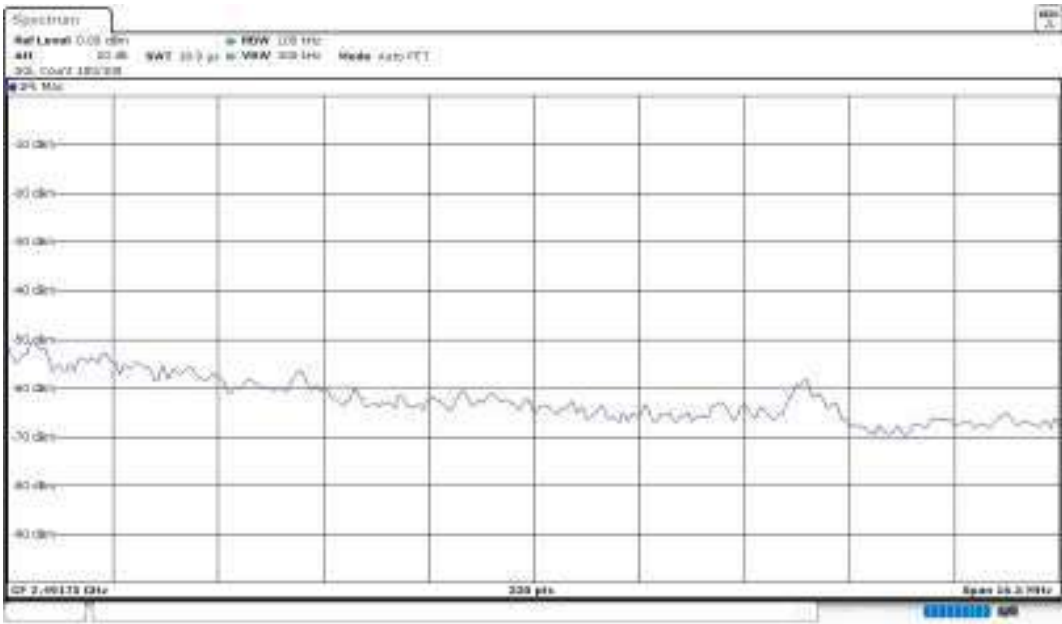




Operation Band (MHz) = [2400, 2483.5], Equipment Type: Digital Transmission System (DTS), Modulation: Proximity

Plots:





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 ($\mu\text{V/m}$)	Field strength ($\text{dB}\mu\text{V/m}$)	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.

Results

Spurious frequencies with peak levels above the average limit ($54 \text{ dB}\mu\text{V/m}$ at 3 m) are measured with average detector for average compliance checking.

Operation Band: [2400, 2483.5]

Modulation: Proximity

Freq (MHz)	Freq Rng (GHz)	Unwanted Freq (MHz)	Unwanted Lvl ($\text{dB}\mu\text{V/m}$)	Pol	Detector
2402.00000	[3, 17]	4803.900000	46.16	H	PK
2440.00000	[3, 17]	4879.360000	48.54	V	PK
2480.00000	[3, 17]	4959.580000	52.79	V	PK

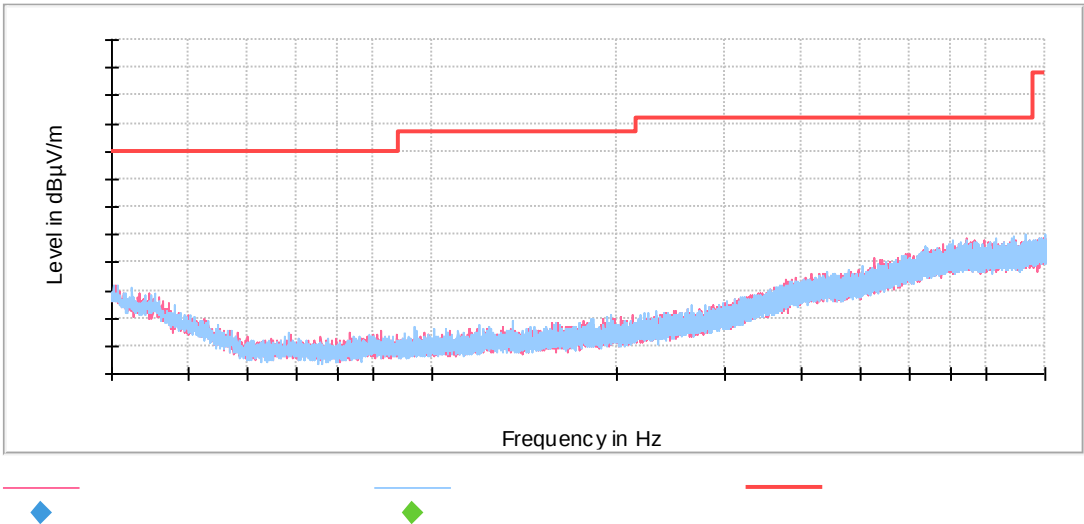
Verdict

Pass

Attachments

Operation Band (MHz) = [2400, 2483.5], Equipment Type: Digital Transmission System (DTS), Modulation: Proximity, Frequency Range (GHz) = [0.03, 1]

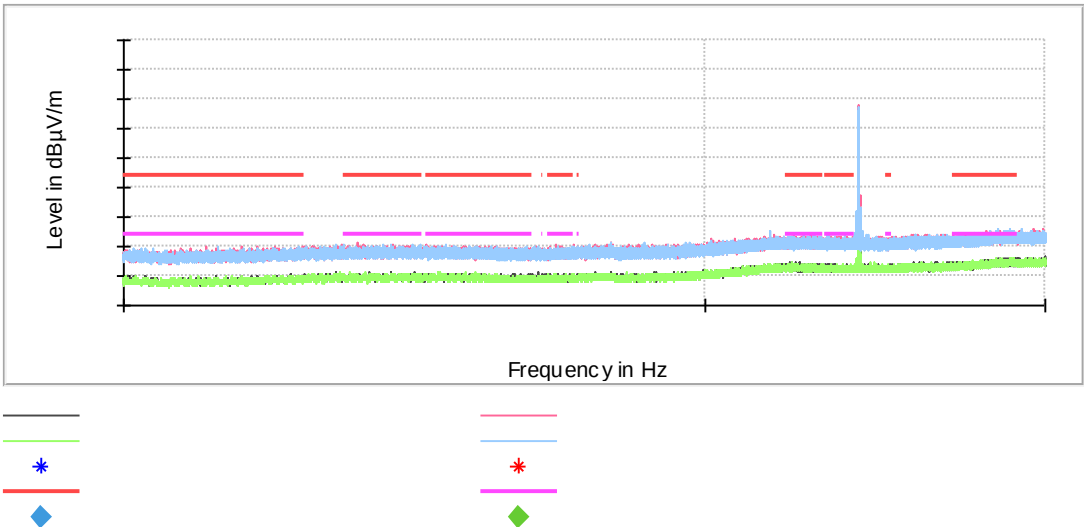
Plots:

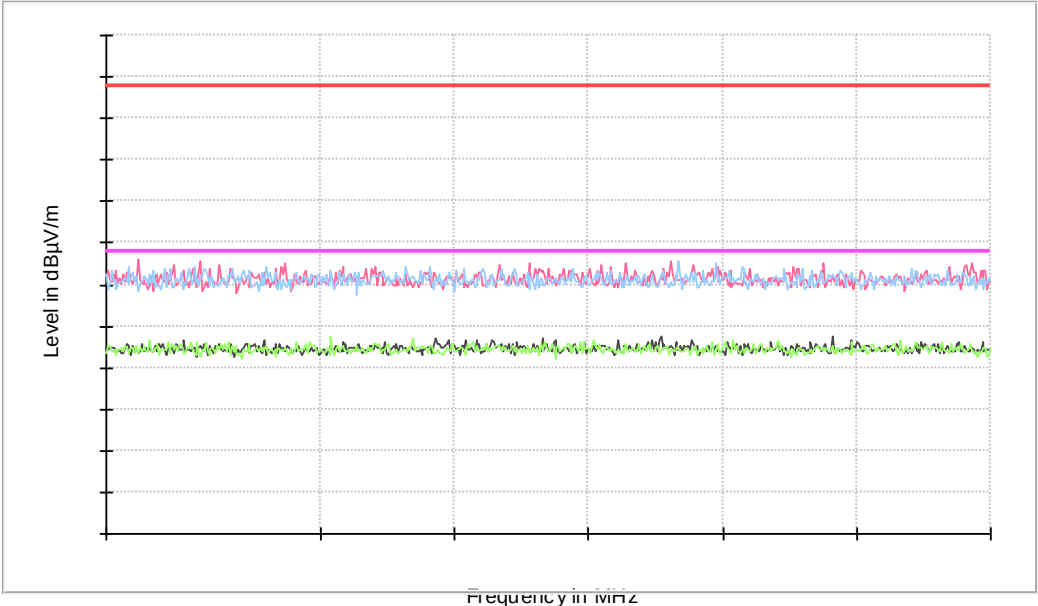
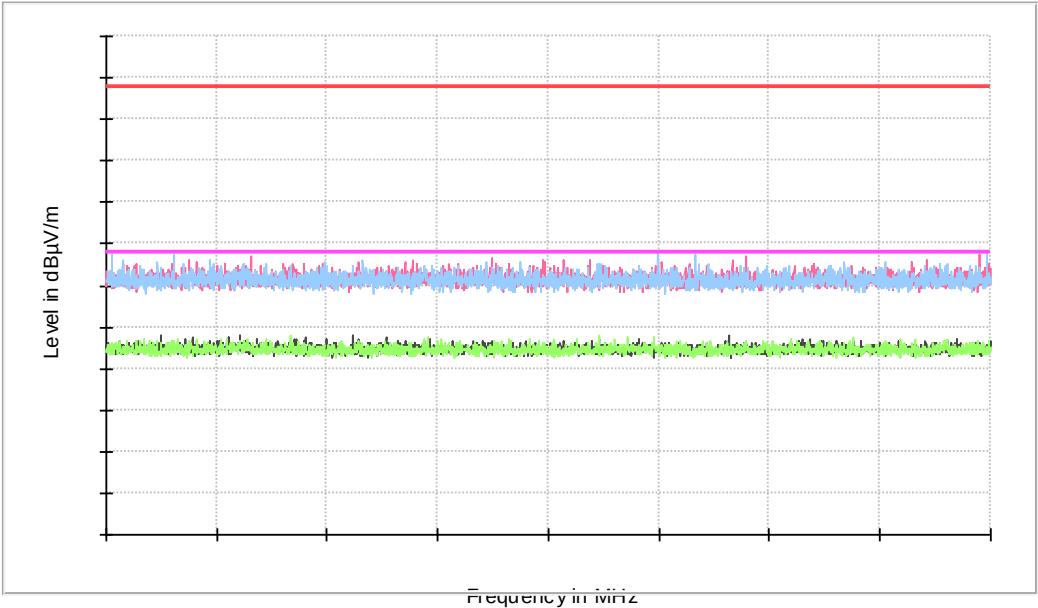


This plot is valid for Low, Middle and High Channels.

Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00000, Equipment Type: Digital Transmission System (DTS), Modulation: Proximity, Frequency Range (GHz) = [1, 3]

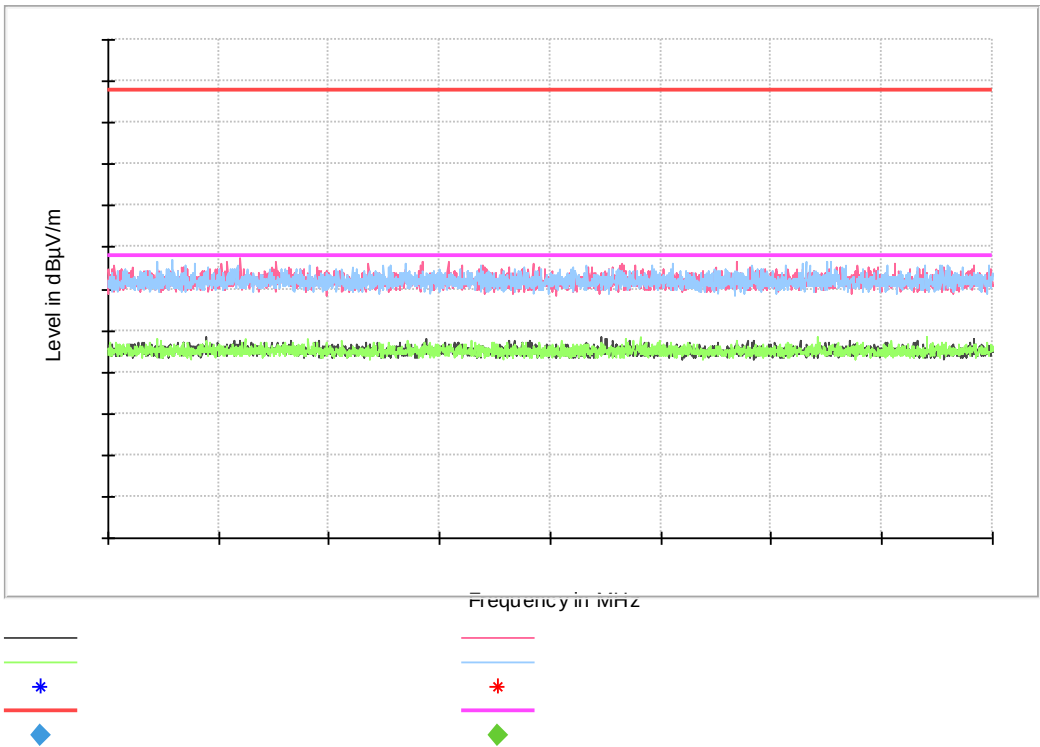
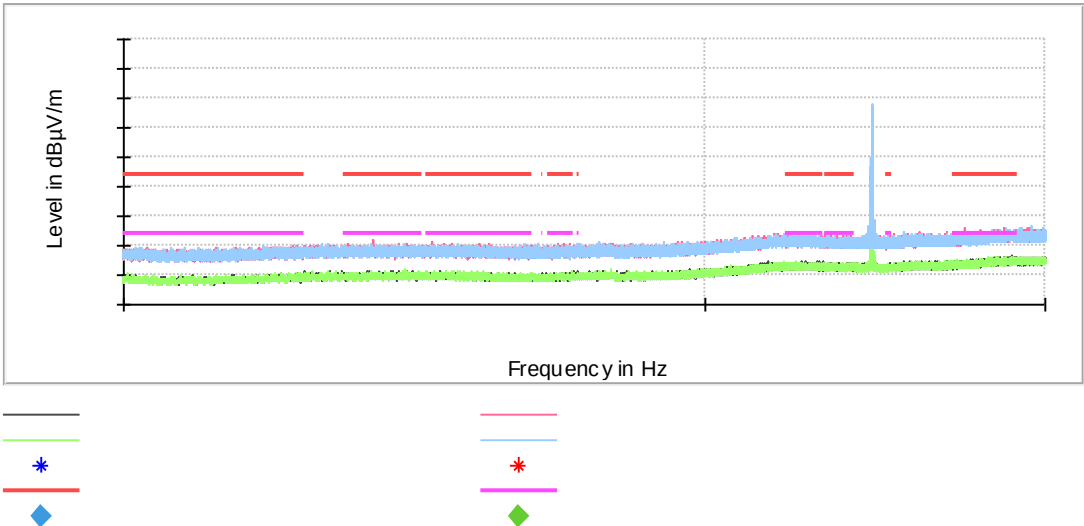
Plots:

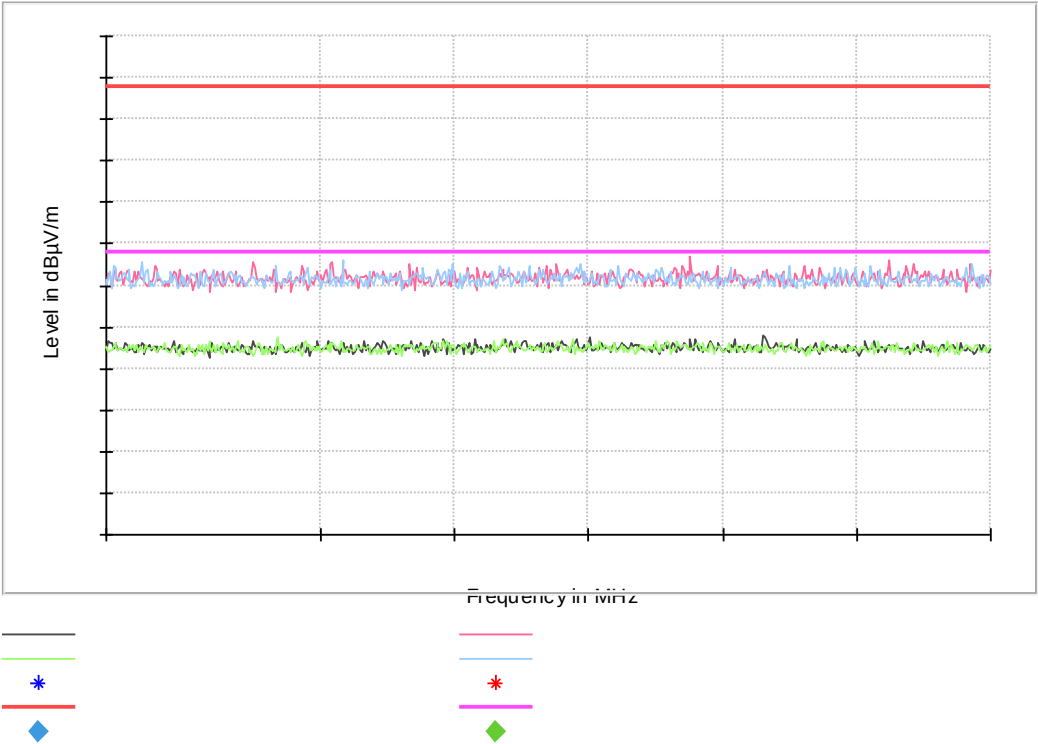




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2440.00000, Equipment Type: Digital
Transmission System (DTS), Modulation: Proximity, Frequency Range (GHz) = [1, 3]

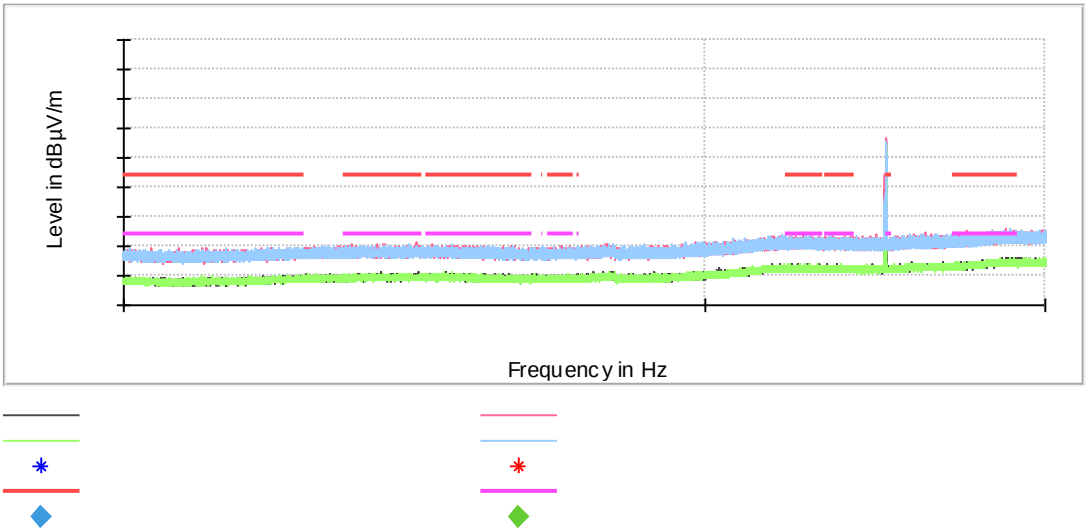
Plots:

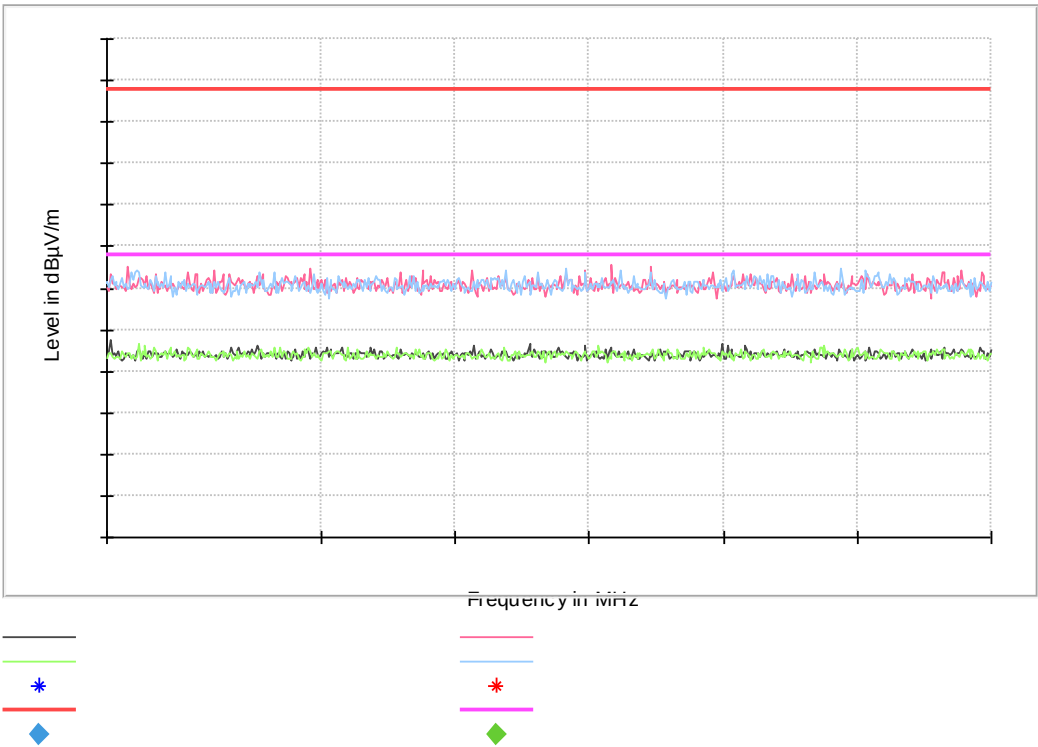
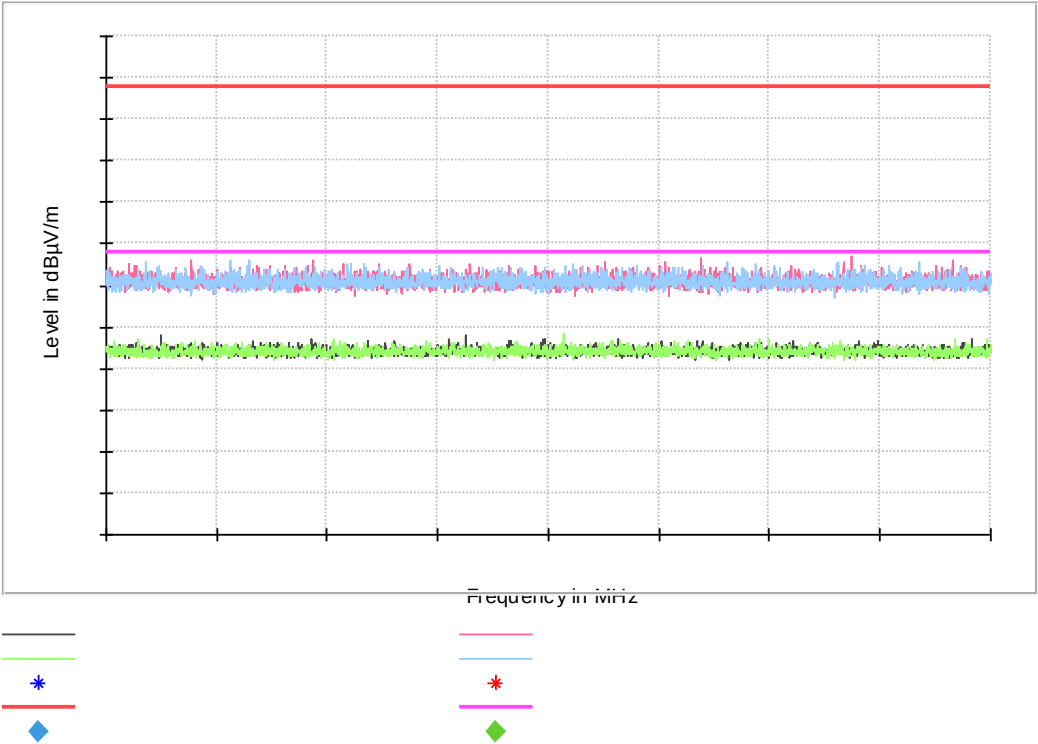




Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00000, Equipment Type: Digital Transmission System (DTS), Modulation: Proximity, Frequency Range (GHz) = [1, 3]

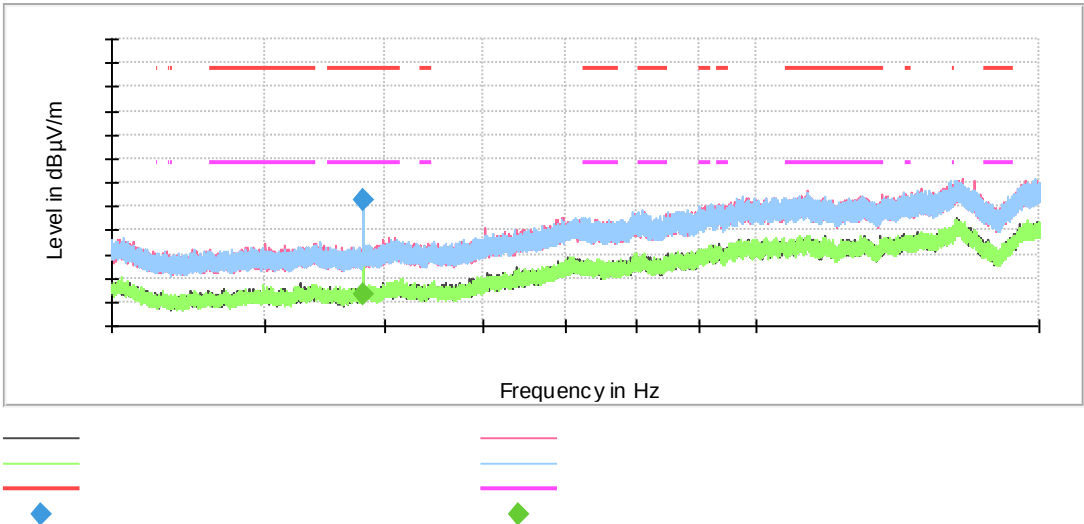
Plots:





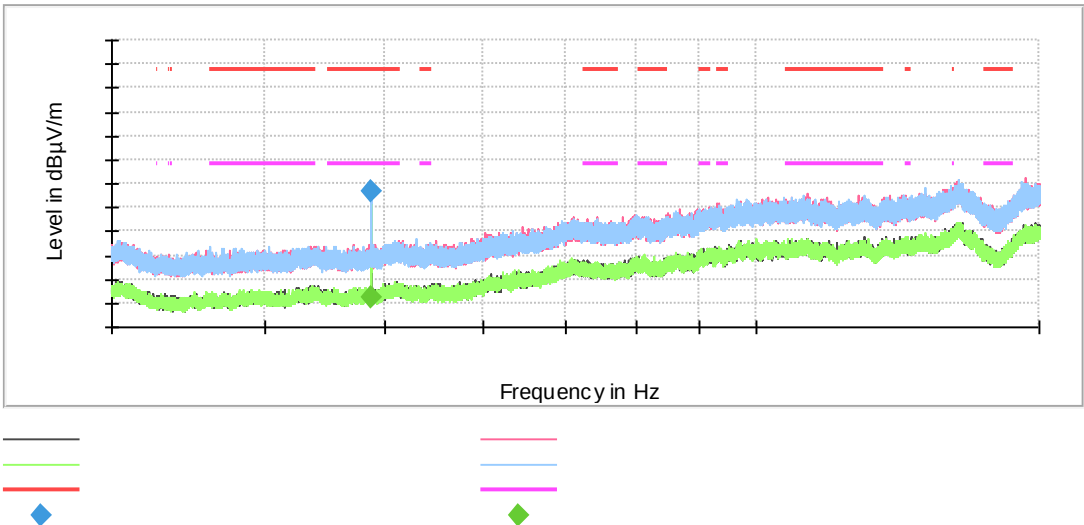
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2402.00000, Equipment Type: Digital
Transmission System (DTS), Modulation: Proximity, Frequency Range (GHz) = [3, 17]

Plots:



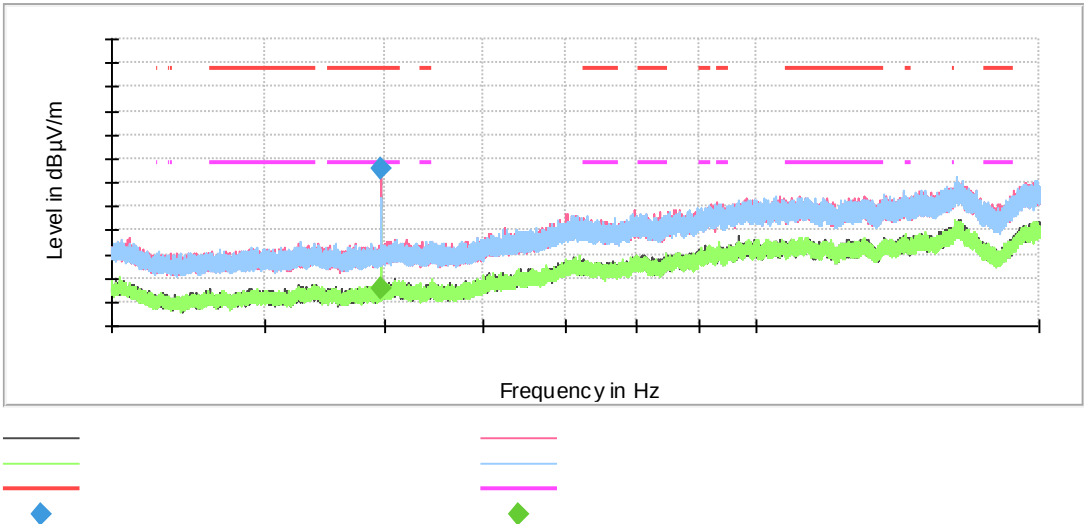
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2440.00000, Equipment Type: Digital
Transmission System (DTS), Modulation: Proximity, Frequency Range (GHz) = [3, 17]

Plots:



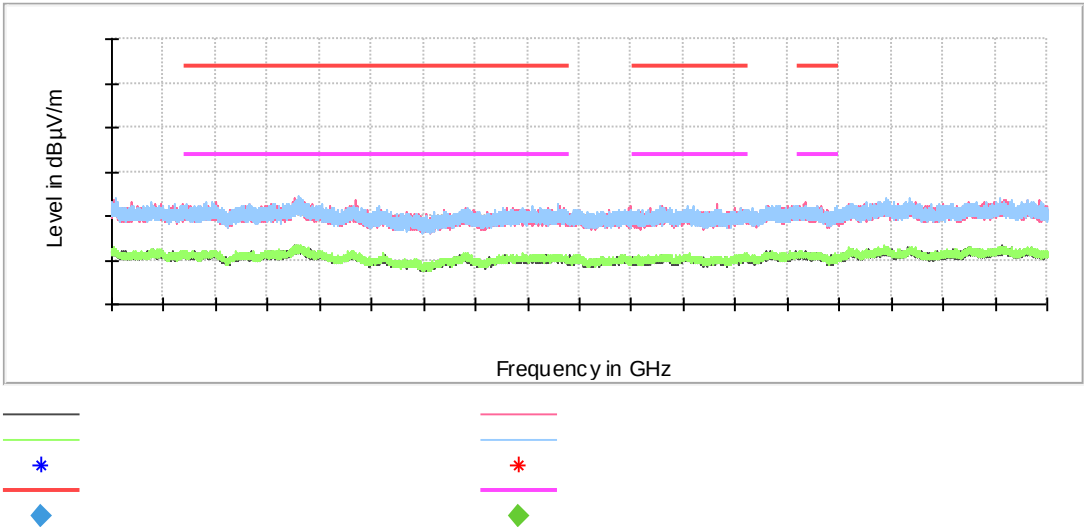
Operation Band (MHz) = [2400, 2483.5], Frequency (MHz) = 2480.00000, Equipment Type: Digital Transmission System (DTS), Modulation: Proximity, Frequency Range (GHz) = [3, 17]

Plots:



Operation Band (MHz) = [2400, 2483.5], Equipment Type: Digital Transmission System (DTS), Modulation: Proximity, Frequency Range (GHz) = [17, 26]

Plots:



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