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Epicore Biosystems Inc.
TEST REPORT

SCOPE OF WORK
EMC TESTING – CONNECTED HYDRATION

REPORT NUMBER
105353929LEX-003

ISSUE DATE
5/18/2023

PAGES
38

DOCUMENT CONTROL NUMBER
Non-Specific EMC Report Shell Rev. December 2017

EMC TEST REPORT

(FULL COMPLIANCE)

Report Number: 105353929LEX-003
Project Number: G105353929

Report Issue Date: 5/18/2023

Model(s) Tested: Connected Hydration
ASY-0215

Standards: Title 47 CFR Part 15.247
RSS-247 Issue 2
RSS-Gen Issue 5

Tested by:
Intertek Testing Services NA, Inc.
731 Enterprise Dr.
Lexington, KY 40510
USA

Client:
Epicore Biosystems Inc.
810 Memorial Drive Suite 100
Cambridge, MA 02139
USA

Report prepared by

David Perry, Engineer

Report reviewed by

Brian Lackey, Team Leader

Table of Contents

1 Introduction and Conclusion

The tests indicated in section 2.0 were performed on the product constructed as described in section 4.0. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test Method, a list of the actual Test Equipment Used, documentation Photos, Results and raw Data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded the product tested **complies** with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

2 Test Summary

Section	Test full name	Result
6	Radiated Spurious Emissions (FCC Part 15.247(d), RSS-247 Issue 2 § 5.5)	Pass
7	Conducted Spurious Emissions (FCC Part 15.247(d), RSS-247 Issue 2 § 5.5)	Pass
8	Output Power (FCC Part 15.247(b)(3), RSS-247 Issue 2 § 5.4(d))	Pass
9	Occupied Bandwidth (FCC Part 15.247, RSS-247 Issue 2 § 5.2(a))	Pass
10	Power Spectral Density (FCC Part 15.247(e), RSS-247 Issue 2 § 5.2(b))	Pass
11	Antenna Requirement (FCC Part 15.203, RSS-Gen Issue 5 § 6.8)	Pass

3 Client Information

This product was tested at the request of the following:

Client Information	
Client Name:	Epicore Biosystems Inc.
Address:	810 Memorial Drive Suite 100 Cambridge, MA 02139 USA
Contact:	Stephen Lee
Email:	stever@epicorebiosystems.com
Manufacturer Information	
Manufacturer Name:	Epicore Biosystems Inc.
Manufacturer Address:	810 Memorial Drive Suite 100 Cambridge, MA 02139 USA

4 Description of Equipment under Test and Variant Models

Equipment Under Test	
Product Name	Connected Hydration
Model Numbers	ASY-0215
Serial Number	SN105, SN143
Receive Date	3/31/2023
Test Start Date	4/3/2023
Test End Date	4/6/2023
Device Received Condition	Good
Test Sample Type	Production
Rated Voltage	3.2V
Software Used By EUT	Conn Hydration RF Test Firmware
Frequency Band(s)	2402, 2440, 2480 MHz
Modulation Type(s)	Constant modulation, PRBS9
Test Channel(s)	2402, 2440, 2480 MHz
Maximum Antenna Gain (dBi)	-1.0[1]
Description of Equipment Under Test (provided by client)	
Wearable sweat sensor.	

[1] Antenna gain not measured; values used are from § 4.1 Antenna Specifications, a client provided document

4.1 Antenna Specifications

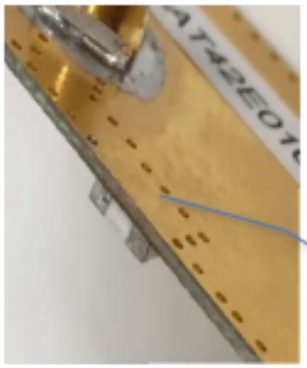
High Frequency Ceramic Solutions

2.4 GHz SMD, Above Metal, Low Profile Mini Chip Antenna **P/N 2450AT42E010B**

This antenna will generally have a metal layer directly underneath for proper operation, exceptions may apply.

Detail Specification: 10/28/2021 Page 1 of 9

General Specifications		
Part Number	2450AT42E010B	
Frequency (MHz)	2400 - 2480	
Return Loss (dB)	EVB1*	EVB2*
	2.7 min.	3.5 min.
Peak Gain (dBi typ.)	-1.0 (YZ-V)	-1.0 (YZ-V)
Average Gain (dBi typ.)	-3.5 (YZ-V)	-5.0 (YZ-V)
Impedance (Ω)	50	
Power Capacity (W)	2 max. (CW)	
Reel Quantity (pcs./reel)	2,000	
Operating Temp	-40 to +85°C	
Recommended Storage Conditions and Period for unused Product on T&R	+5 to +35°C Humidity 45 - 75% RH 18 months max.	



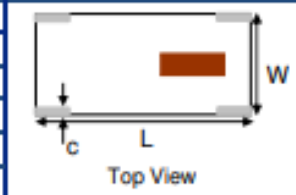
*Evaluation boards 1 and 2 are meant to demonstrate the difference in performance achievable with different substrate thicknesses.

This antenna was designed in mind for small coin cell, wearable, IoT, 2.4 BLE, 802.11, ISM, Zigbee, etc. applications in close-range networks where metal or a battery/display covers the entire length or side of the PCB or encasement must be present directly under the antenna and there's no room for usual/typical antenna metal clearance.

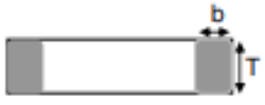
Part Number Explanation				
P/N Suffix	Packing Style	Bulk (loose pcs.)	Suffix = S	E.g. 2450AT42E010BS
		T & R	Suffix = E	E.g. 2450AT42E010BE
	Evaluation Board 1	2450AT42E010B-EB1SMA (comes with 1 female SMA connector)		
	Evaluation Board 2	2450AT42E010B-EB2SMA (comes with 1 female SMA connector)		

Mechanical Specifications

	In	mm
L	0.197 ± 0.008	5.00 ± 0.20
W	0.079 ± 0.008	2.00 ± 0.20
T	0.059 ± 0.008	1.50 ± 0.20
a	0.020 ± 0.008	0.50 ± 0.20
b	0.059 ± 0.008	1.50 ± 0.20
C	0.012 max	0.30 max



Top View

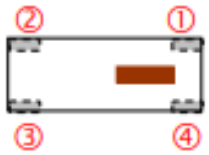


Side View

Bottom View

Terminal Configuration

1	Feeding Point
2	NC[1]
3	GND
4	GND



[1]Make sure to have Pin 2 soldered to its PCB land pad but **not** connected to GND or input, it must be NC (or floating).

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JOHANSON TECHNOLOGY

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Ver. 5.1

5 System Setup and Method

5.1 Method:

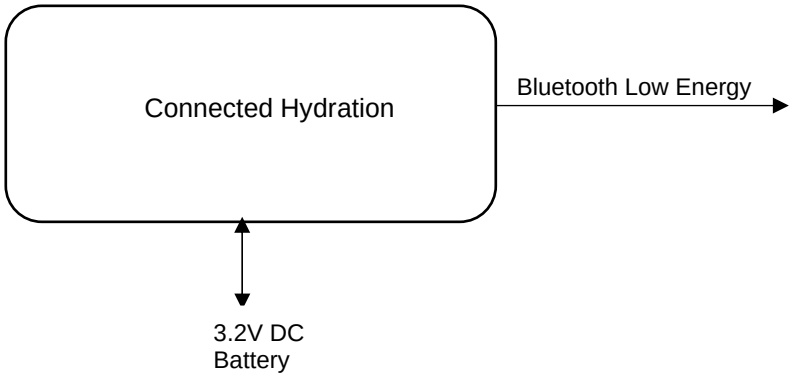
Configuration as required by ANSI C63.10:2013

No.	Descriptions of EUT Exercising
1	Transmitting a Bluetooth Low Energy (BLE) signal or low, middle, or high channel

Cables					
Qty	Description	Length (m)	Shielding	Ferrites	Termination
-	-	-	-	-	-

Support Equipment			
Description	Manufacturer	Model Number	Serial Number
-	-	-	-

5.2 EUT Block Diagram:



6 Transmitter Spurious Emissions & Band Edge

6.1 Test Limits

FCC Part 15.247(d):

> In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

RSS-247 Issue 2 § 5.5:

> In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

6.2 Test Method

Tests are performed in accordance with ANSI C63.10:2013 § 11.12.1 Radiated emission measurements.

6.3 Test Equipment Used

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
EMI Test Receiver	8285	Rohde & Schwarz	EW44	12/23/2022	12/23/2023
Bilog Antenna (30MHz-1GHz)	7085	SunAR	JB6	3/7/2023	3/7/2024
Horn Antenna (1-18GHz)	3780	ETS	3117	8/19/2022	8/19/2023
Horn Antenna (18-40GHz)	3779	ETS	3116c	8/29/2022	8/29/2023
System Controller	4096	ETS Lindgren	2090	Verify at Time of Use	Verify at Time of Use
System Controller	3957	Sunol Sciences	SC99V	Verify at Time of Use	Verify at Time of Use
Preamplifier	3918	Rohde & Schwarz	TS-PR18	1/10/2023	1/10/2024
Coaxial Cable	3074			1/10/2023	1/10/2024
Coaxial Cable	2588			1/10/2023	1/10/2024
Coaxial Cable	2593			1/10/2023	1/10/2024
Coaxial Cable	8185			1/10/2023	1/10/2024
Coaxial Cable	8188			1/10/2023	1/10/2024
Preamplifier	3919	Rohde & Schwarz	TS-PR3	1/10/2023	1/10/2024
Coaxial Cable	3172			1/10/2023	1/10/2024
Coaxial Cable	2590			1/10/2023	1/10/2024
Coaxial Cable	8186			1/10/2023	1/10/2024
Coaxial Cable	8187			1/10/2023	1/10/2024
Preamplifier (18-40GHz)	3921	Rohde & Schwarz	TS-PR40	1/12/2023	1/12/2024
Coaxial Cable	7020	Rohde & Schwarz	TS-PR40	1/12/2023	1/12/2024
Coaxial Cable	7021	Rohde & Schwarz	TS-PR40	1/12/2023	1/12/2024

6.4 Software Utilized

Name	Manufacturer	Version
EMC32	Rohde & Schwarz	Version 10.60.20

6.5 Test Results

The sample tested was found to be **compliant**. The data presented represents the worst-case emissions with the device positioned in three orthogonal positions.

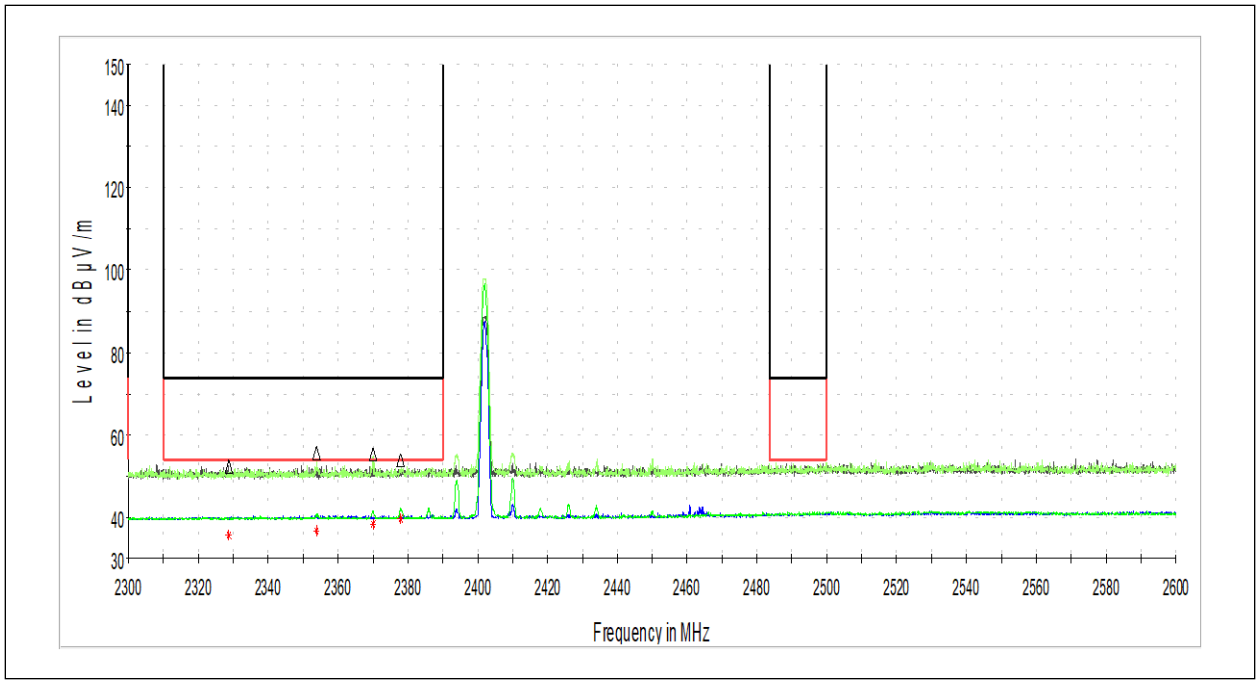
6.6 Test Conditions

Test Personnel:	David Perry	Test Date:	4/3/2023
Supervising/Reviewing Engineer: (Where Applicable)	Brian Lackey	Limit Applied:	FCC Part 15.209 in Restricted Bands from FCC Part 15.205
Product Standard:	FCC Part 15.247 RSS-247 Issue 2	Ambient Temperature:	22.0C
Input Voltage:	3.2V DC	Relative Humidity:	23.5%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	990.8mbar

Deviations, Additions, or Exclusions: None

6.7 Test Data: Radiated Band Edge

6.7.1 2402 MHz



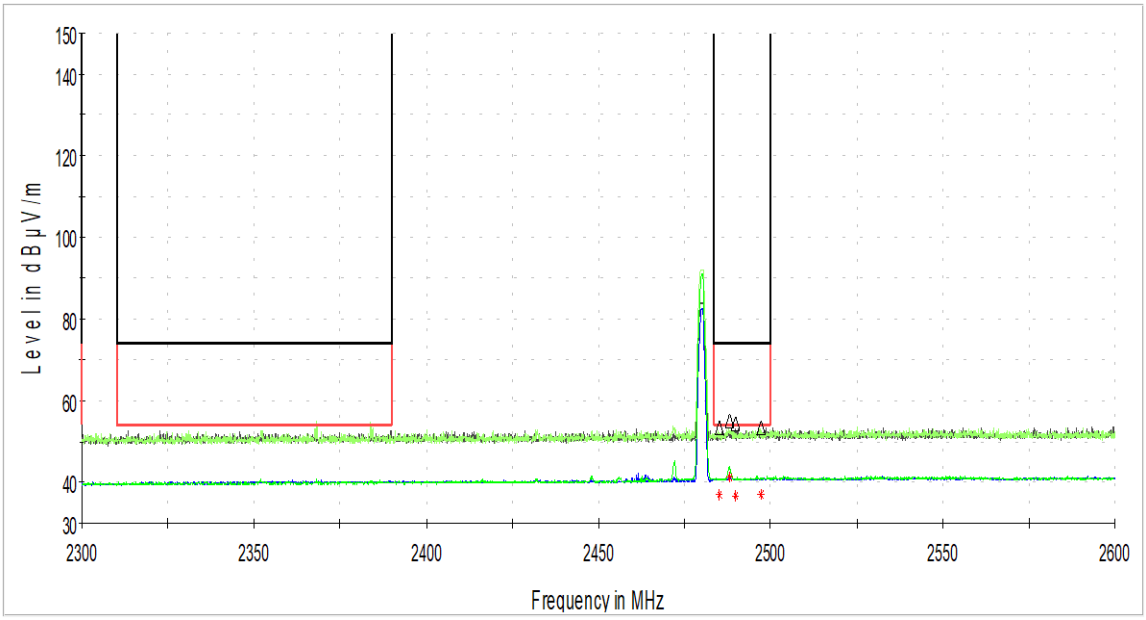
Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2328.730769	52.32	73.98	21.66	1000.000	121.0	V	228.0	38.3
2353.826923	55.58	73.98	18.40	1000.000	344.0	H	346.0	38.3
2369.980769	55.34	73.98	18.64	1000.000	305.0	H	0.0	38.2
2377.942308	54.09	73.98	19.89	1000.000	340.0	H	0.0	38.3

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2328.730769	35.67	53.98	18.31	1000.000	121.0	V	228.0	38.3
2353.826923	36.72	53.98	17.26	1000.000	344.0	H	346.0	38.3
2369.980769	38.29	53.98	15.69	1000.000	305.0	H	0.0	38.2
2377.942308	39.55	53.98	14.43	1000.000	340.0	H	0.0	38.3

Test Personnel:	David Perry	Test Date:	4/3/2023
Supervising/Reviewing Engineer: (Where Applicable)	Brian Lackey	Limit Applied:	FCC Part 15.209 in Restricted Bands from FCC Part 15.205
Product Standard:	FCC Part 15.247 RSS-247 Issue 2	Ambient Temperature:	22.0C
Input Voltage:	3.2V DC	Relative Humidity:	23.5%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	990.8mbar

Deviations, Additions, or Exclusions: None

6.7.2 2480 MHz



Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2485.076923	53.40	73.98	20.58	1000.000	283.0	H	171.0	39.0
2488.019231	54.96	73.98	19.02	1000.000	395.0	H	0.0	39.1
2489.750000	54.40	73.98	19.58	1000.000	390.0	V	328.0	39.1
2497.192308	53.51	73.98	20.47	1000.000	256.0	H	238.0	39.2

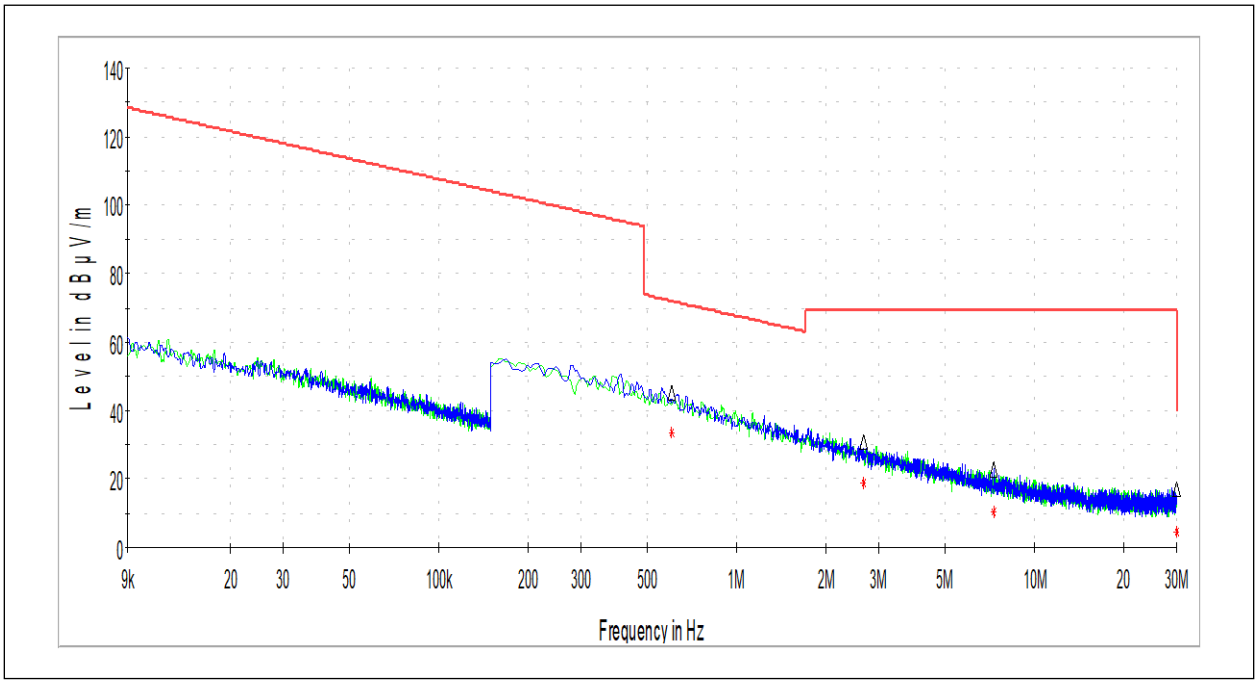
Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2485.076923	36.84	53.98	17.14	1000.000	283.0	H	171.0	39.0
2488.019231	40.99	53.98	12.99	1000.000	395.0	H	0.0	39.1
2489.750000	36.79	53.98	17.19	1000.000	390.0	V	328.0	39.1
2497.192308	36.98	53.98	17.00	1000.000	256.0	H	238.0	39.2

Test Personnel:	David Perry	Test Date:	4/3/2023
Supervising/Reviewing Engineer: (Where Applicable)	Brian Lackey	Limit Applied:	FCC Part 15.209 in Restricted Bands from FCC Part 15.205
Product Standard:	FCC Part 15.247 RSS-247 Issue 2	Ambient Temperature:	22.0C
Input Voltage:	3.2V DC	Relative Humidity:	23.5%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	990.8mbar

Deviations, Additions, or Exclusions: None

6.8 Test Data: Radiated Spurious Emissions

6.8.1 BLE 9KHz-30MHz:



Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Azimuth (deg)	Corr. (dB/m)
0.606530	45.05	91.95	46.9	9.000	203.0	11.7
2.669691	31.01	89.5	58.49	9.000	34.0	11.3
7.283272	22.78	89.5	66.72	9.000	128.0	10.8
30.000000	16.82	89.5	72.68	9.000	194.0	8.1

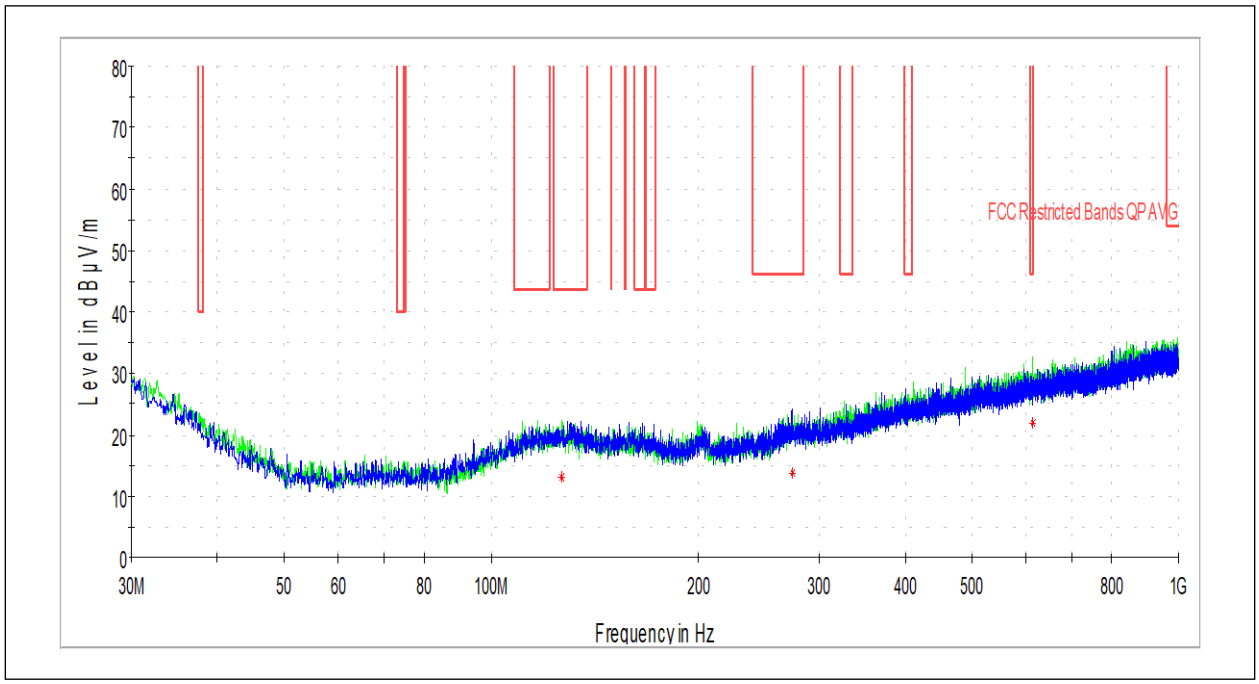
Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Azimuth (deg)	Corr. (dB/m)
0.606530	33.60	71.95	38.35	9.000	203.0	11.7
2.669691	18.95	69.50	50.55	9.000	34.0	11.3
7.283272	10.28	69.50	59.22	9.000	128.0	10.8
30.000000	4.47	69.50	35.53	9.000	194.0	8.1

Test Personnel:	David Perry	Test Date:	4/3/2023
Supervising/Reviewing Engineer: (Where Applicable)	Brian Lackey	Limit Applied:	FCC Part 15.209 in Restricted Bands from FCC Part 15.205
Product Standard:	FCC Part 15.247 RSS-247 Issue 2	Ambient Temperature:	22.0C
Input Voltage:	3.2V DC	Relative Humidity:	23.5%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	990.8mbar

Deviations, Additions, or Exclusions: Measurements with a max peak detector showed compliance with the quasi-peak limit and thereby the device is deemed to comply.

Note: Testing represents worst case of low, middle, and high channels.

6.8.2 BLE 2402MHz, 30MHz-1GHz:

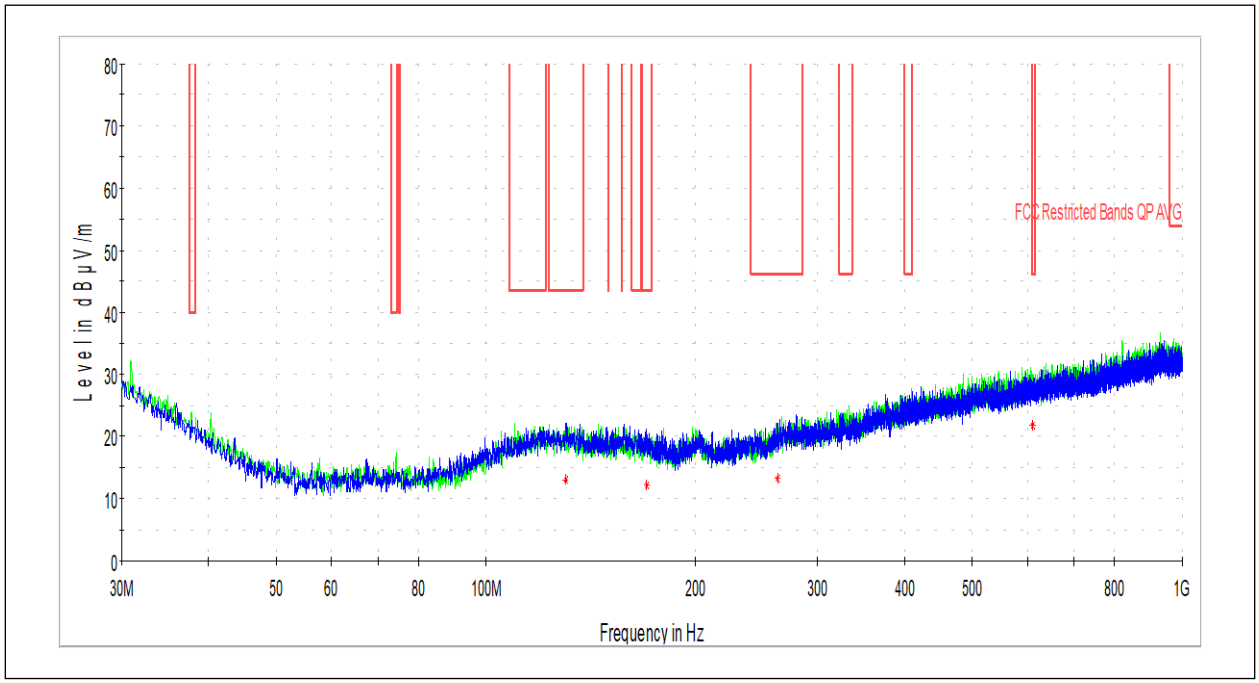


Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
126.838333	13.20	43.52	30.32	120.000	185.0	H	58.0	20.9
274.116667	13.86	46.02	32.16	120.000	250.0	V	151.0	21.4
613.886111	21.99	46.02	24.03	120.000	95.0	H	47.0	28.6

Test Personnel:	David Perry	Test Date:	4/3/2023
Supervising/Reviewing Engineer: (Where Applicable)	Brian Lackey	Limit Applied:	FCC Part 15.209 in Restricted Bands from FCC Part 15.205
Product Standard:	FCC Part 15.247 RSS-247 Issue 2	Ambient Temperature:	22.0C
Input Voltage:	3.2V DC	Relative Humidity:	23.5%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	990.8mbar

Deviations, Additions, or Exclusions: None

6.8.3 BLE 2440MHz, 30MHz-1GHz:

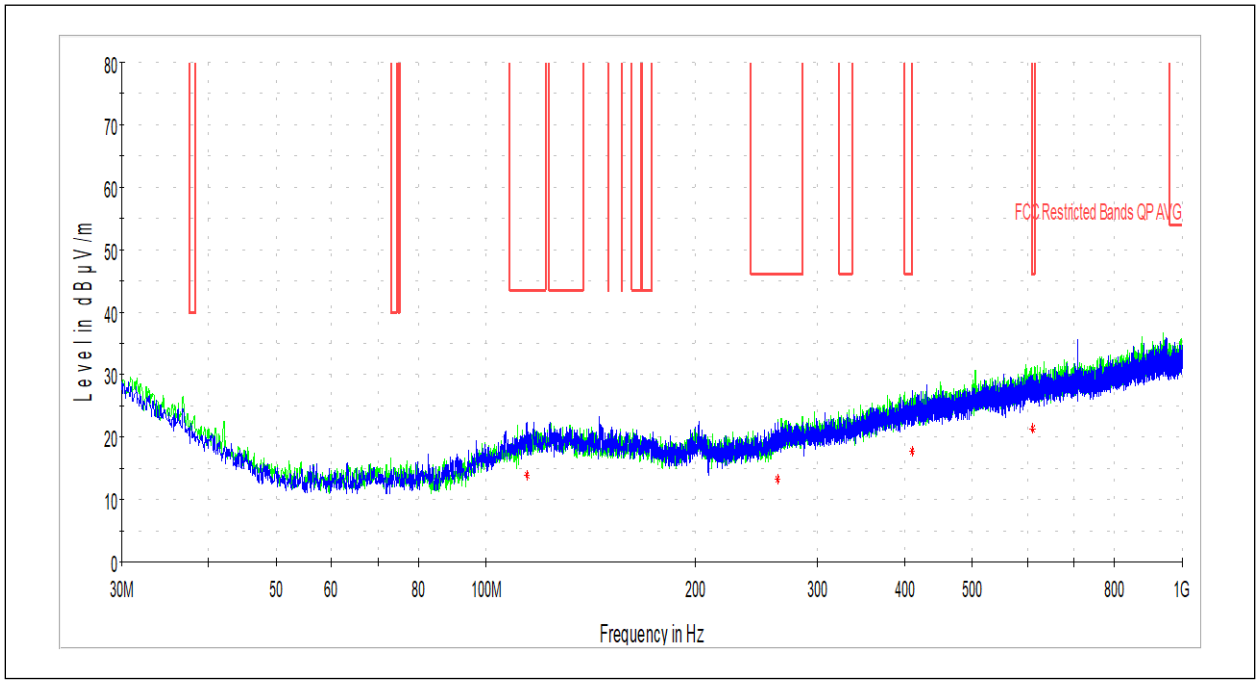


Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
130.341111	13.11	43.52	30.41	120.000	321.0	V	278.0	21.0
170.057222	12.10	43.52	31.42	120.000	323.0	V	111.0	19.8
262.261111	13.12	46.02	32.90	120.000	388.0	H	171.0	20.9
610.221667	21.79	46.02	24.23	120.000	400.0	H	210.0	28.6

Test Personnel:	David Perry	Test Date:	4/3/2023
Supervising/Reviewing Engineer: (Where Applicable)	Brian Lackey	Limit Applied:	FCC Part 15.209 in Restricted Bands from FCC Part 15.205
Product Standard:	FCC Part 15.247 RSS-247 Issue 2	Ambient Temperature:	22.0C
Input Voltage:	3.2V DC	Relative Humidity:	23.5%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	990.8mbar

Deviations, Additions, or Exclusions: None

6.8.4 BLE 2480MHz, 30MHz-1GHz:

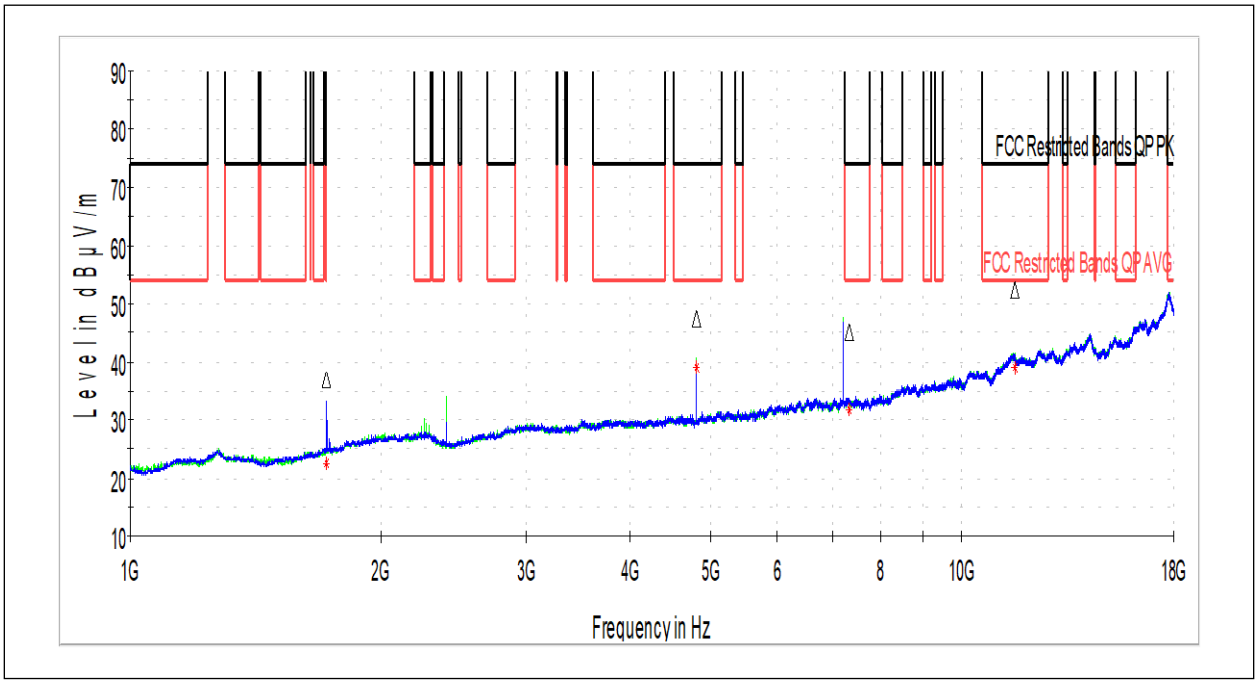


Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
114.497778	13.85	43.52	29.67	120.000	376.0	V	129.0	20.4
262.638333	13.14	46.02	32.88	120.000	282.0	H	191.0	20.9
409.647222	17.79	46.02	28.23	120.000	207.0	V	304.0	24.3
610.545000	21.30	46.02	24.72	120.000	147.0	V	223.0	28.0

Test Personnel:	David Perry	Test Date:	4/3/2023
Supervising/Reviewing Engineer: (Where Applicable)	Brian Lackey	Limit Applied:	FCC Part 15.209 in Restricted Bands from FCC Part 15.205
Product Standard:	FCC Part 15.247 RSS-247 Issue 2	Ambient Temperature:	22.0C
Input Voltage:	3.2V DC	Relative Humidity:	23.5%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	990.8mbar

Deviations, Additions, or Exclusions: None

6.8.5 BLE 2402MHz 1GHz-18GHz:



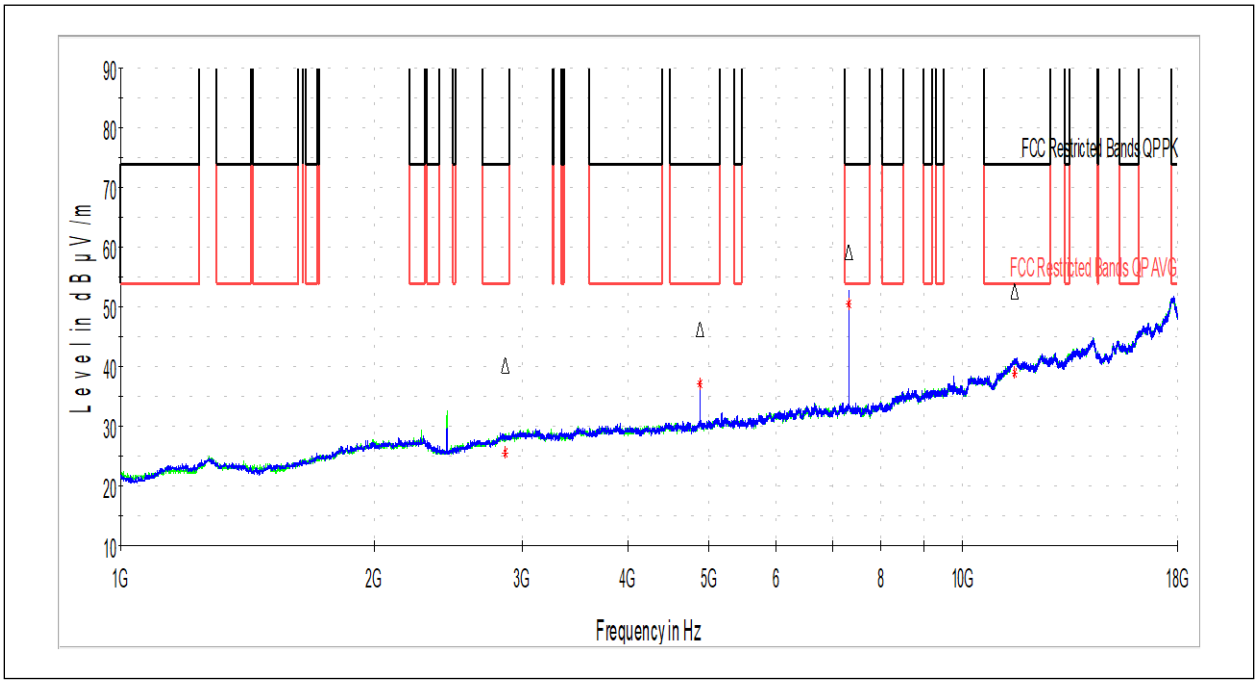
Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1722.000000	36.98	73.98	37.00	1000.000	109.0	V	93.0	1.7
4804.000000	47.28	73.98	26.70	1000.000	281.0	H	225.0	10.4
7329.500000	44.95	73.98	29.03	1000.000	126.0	H	140.0	14.6
11607.500000	52.39	73.98	21.59	1000.000	109.0	H	34.0	20.9

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1722.000000	22.46	53.98	31.52	1000.000	109.0	V	93.0	1.7
4804.000000	39.01	53.98	14.97	1000.000	281.0	H	225.0	10.4
7329.500000	31.66	53.98	22.32	1000.000	126.0	H	140.0	14.6
11607.500000	39.12	53.98	14.86	1000.000	109.0	H	34.0	20.9

Test Personnel:	David Perry	Test Date:	4/3/2023
Supervising/Reviewing Engineer: (Where Applicable)	Brian Lackey	Limit Applied:	FCC Part 15.209 in Restricted Bands from FCC Part 15.205
Product Standard:	FCC Part 15.247 RSS-247 Issue 2	Ambient Temperature:	22.0C
Input Voltage:	3.2V DC	Relative Humidity:	23.5%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	990.8mbar

Deviations, Additions, or Exclusions: None

6.8.6 BLE 2440MHz 1GHz-18GHz:



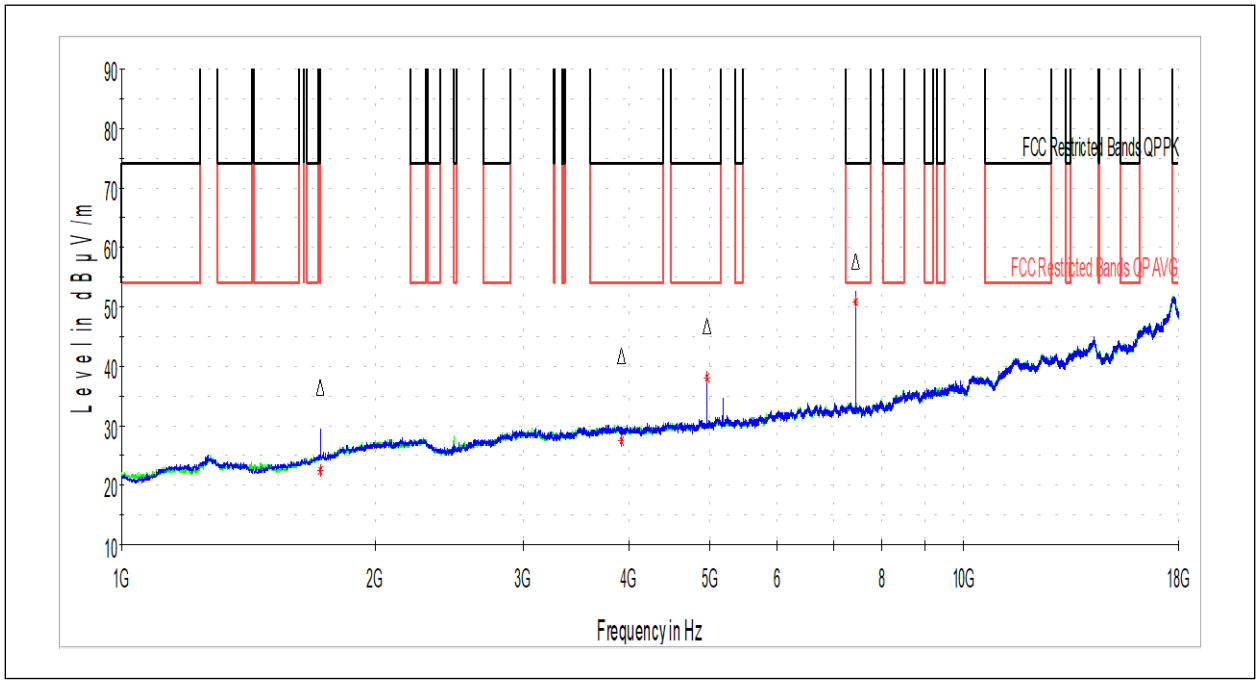
Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2860.500000	40.30	73.98	33.68	1000.000	100.0	H	151.0	6.4
4880.000000	46.32	73.98	27.66	1000.000	308.0	V	55.0	10.3
7321.000000	59.22	73.98	14.76	1000.000	388.0	H	303.0	14.4
11520.500000	52.55	73.98	21.43	1000.000	100.0	H	33.0	20.6

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
2860.500000	25.63	53.98	28.35	1000.000	100.0	H	151.0	6.4
4880.000000	37.10	53.98	16.88	1000.000	308.0	V	55.0	10.3
7321.000000	50.63	53.98	3.35	1000.000	388.0	H	303.0	14.4
11520.500000	39.06	53.98	14.92	1000.000	100.0	H	33.0	20.6

Test Personnel:	David Perry	Test Date:	4/3/2023
Supervising/Reviewing Engineer: (Where Applicable)	Brian Lackey	Limit Applied:	FCC Part 15.209 in Restricted Bands from FCC Part 15.205
Product Standard:	FCC Part 15.247 RSS-247 Issue 2	Ambient Temperature:	22.0C
Input Voltage:	3.2V DC	Relative Humidity:	23.5%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	990.8mbar

Deviations, Additions, or Exclusions: None

6.8.7 BLE 2480MHz 1GHz-18GHz:



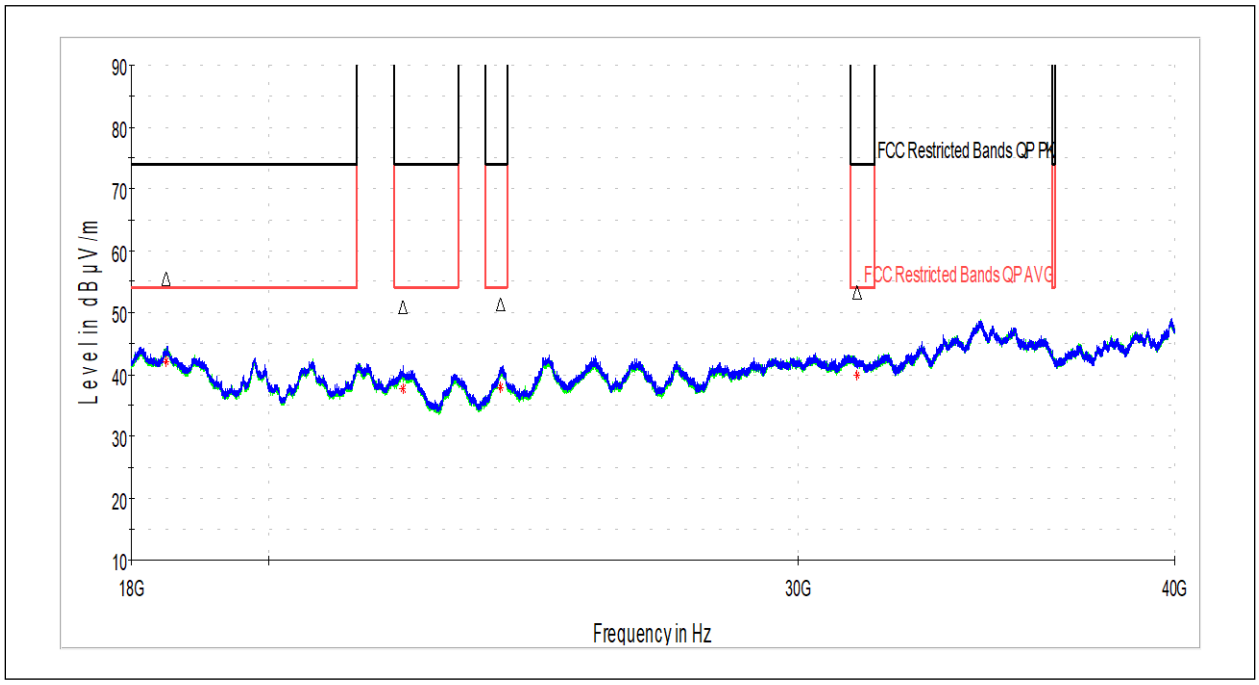
Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1722.000000	36.40	73.98	37.58	1000.000	100.0	V	339.0	1.7
3921.000000	41.82	73.98	32.16	1000.000	100.0	V	318.0	9.1
4960.000000	46.76	73.98	27.22	1000.000	296.0	H	316.0	10.2
7439.500000	57.71	73.98	16.27	1000.000	100.0	V	169.0	13.9

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1722.000000	22.46	53.98	31.52	1000.000	100.0	V	339.0	1.7
3921.000000	27.49	53.98	26.49	1000.000	100.0	V	318.0	9.1
4960.000000	38.19	53.98	15.79	1000.000	296.0	H	316.0	10.2
7439.500000	50.78	53.98	3.20	1000.000	100.0	V	169.0	13.9

Test Personnel:	David Perry	Test Date:	4/3/2023
Supervising/Reviewing Engineer: (Where Applicable)	Brian Lackey	Limit Applied:	FCC Part 15.209 in Restricted Bands from FCC Part 15.205
Product Standard:	FCC Part 15.247 RSS-247 Issue 2	Ambient Temperature:	22.0C
Input Voltage:	3.2V DC	Relative Humidity:	23.5%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	990.8mbar

Deviations, Additions, or Exclusions: None

6.8.8 Spurious Emissions, 18GHz-40GHz:



Frequency (MHz)	MaxPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18487.500000	55.55	73.98	18.43	1000.000	125.0	H	349.0	25.4
22163.500000	50.84	73.98	23.14	1000.000	350.0	V	349.0	9.7
23883.000000	51.23	73.98	22.75	1000.000	215.0	V	195.0	7.7
31366.000000	53.23	73.98	20.75	1000.000	345.0	V	260.0	12.9

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18487.500000	42.03	53.98	11.95	1000.000	125.0	H	349.0	25.4
22163.500000	37.70	53.98	16.28	1000.000	350.0	V	349.0	9.7
23883.000000	37.82	53.98	16.16	1000.000	215.0	V	195.0	7.7
31366.000000	39.83	53.98	14.15	1000.000	345.0	V	260.0	12.9

Test Personnel:	David Perry	Test Date:	4/4/2023
Supervising/Reviewing Engineer: (Where Applicable)	Brian Lackey	Limit Applied:	FCC Part 15.209 in Restricted Bands from FCC Part 15.205
Product Standard:	FCC Part 15.247 RSS-247 Issue 2	Ambient Temperature:	23.6C
Input Voltage:	3.4V DC	Relative Humidity:	41.3%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	991.1mbar

Deviations, Additions, or Exclusions: None

Note: Testing represents worst case of low, middle, and high channels.

7 Conducted Spurious Emissions

7.1 Test Limits

FCC Part 15.247(d):

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

RSS-247 Issue 2 § 5.5:

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

7.2 Test Method

Tests are performed in accordance with ANSI C63.10:2013 § 11.11 Emissions in nonrestricted frequency bands.

7.3 Test Equipment Used

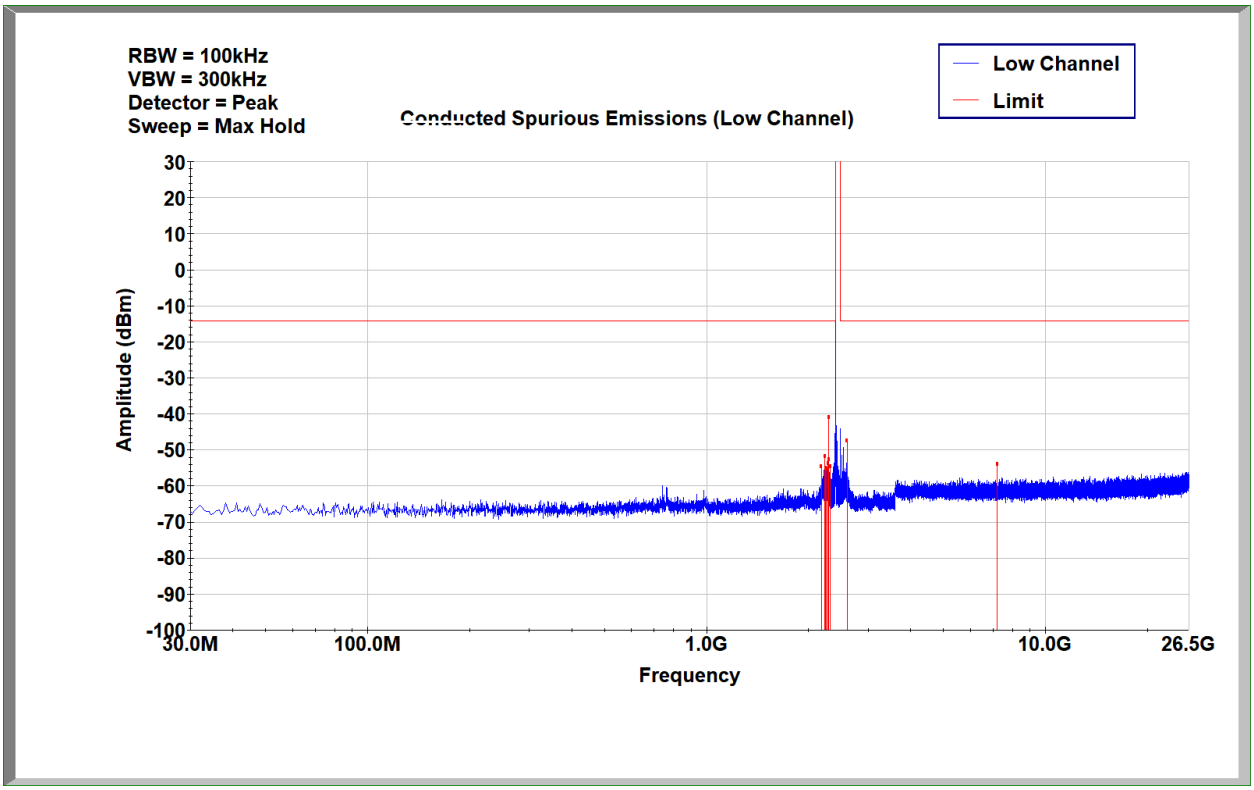
Description	Asset	Manufacturer	Model	Cal Date	Cal Due
EMI Test Receiver	3900	Rohde & Schwarz	ESU40	10/3/2022	10/3/2023

7.4 Test Results

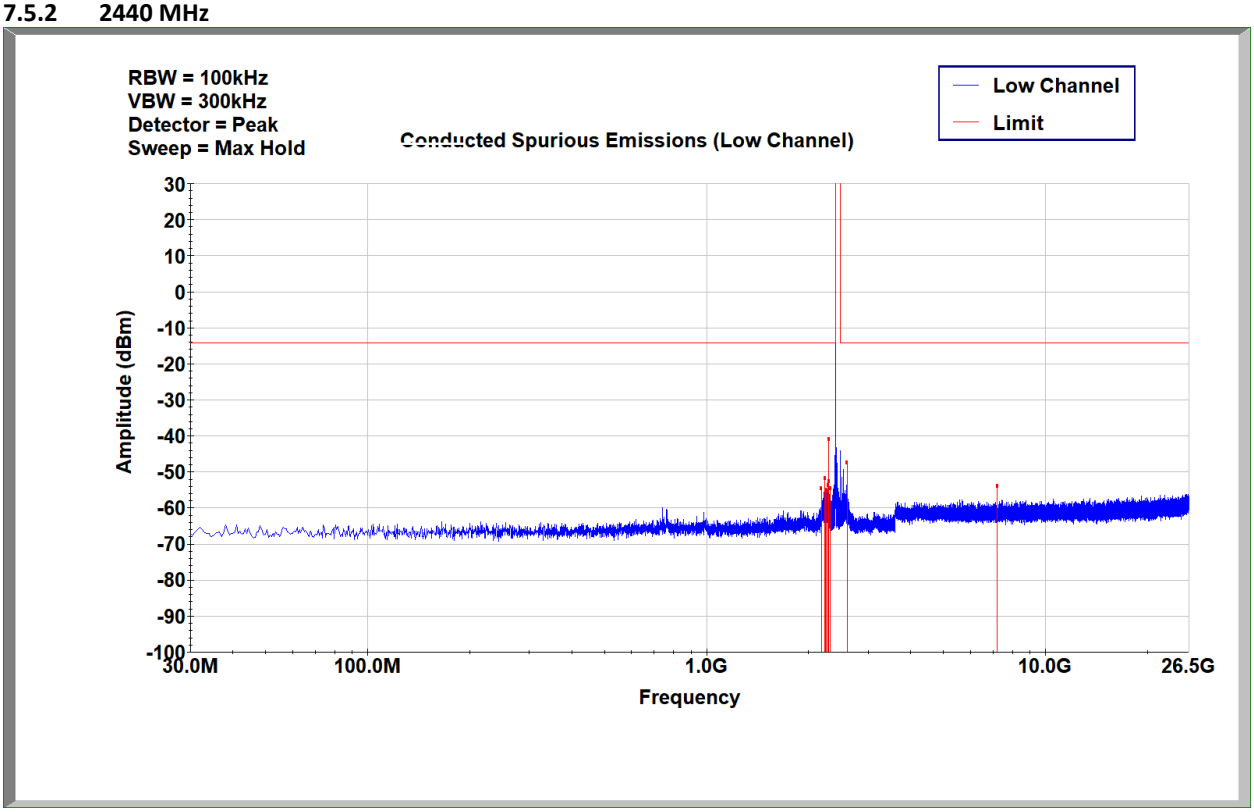
The device was found to be **compliant**. All spurious emissions were found to be attenuated more than 20dB below the level of the fundamental.

7.5 Test Data

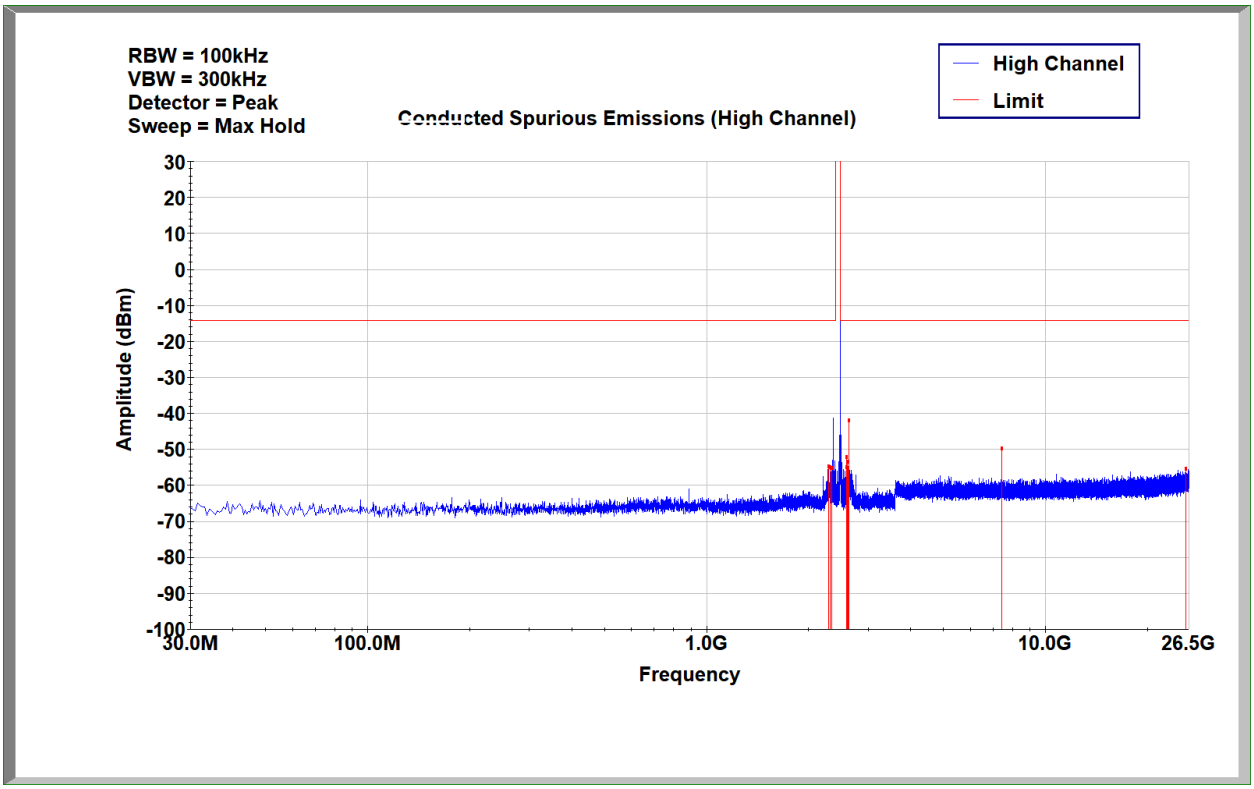
7.5.1 2402 MHz



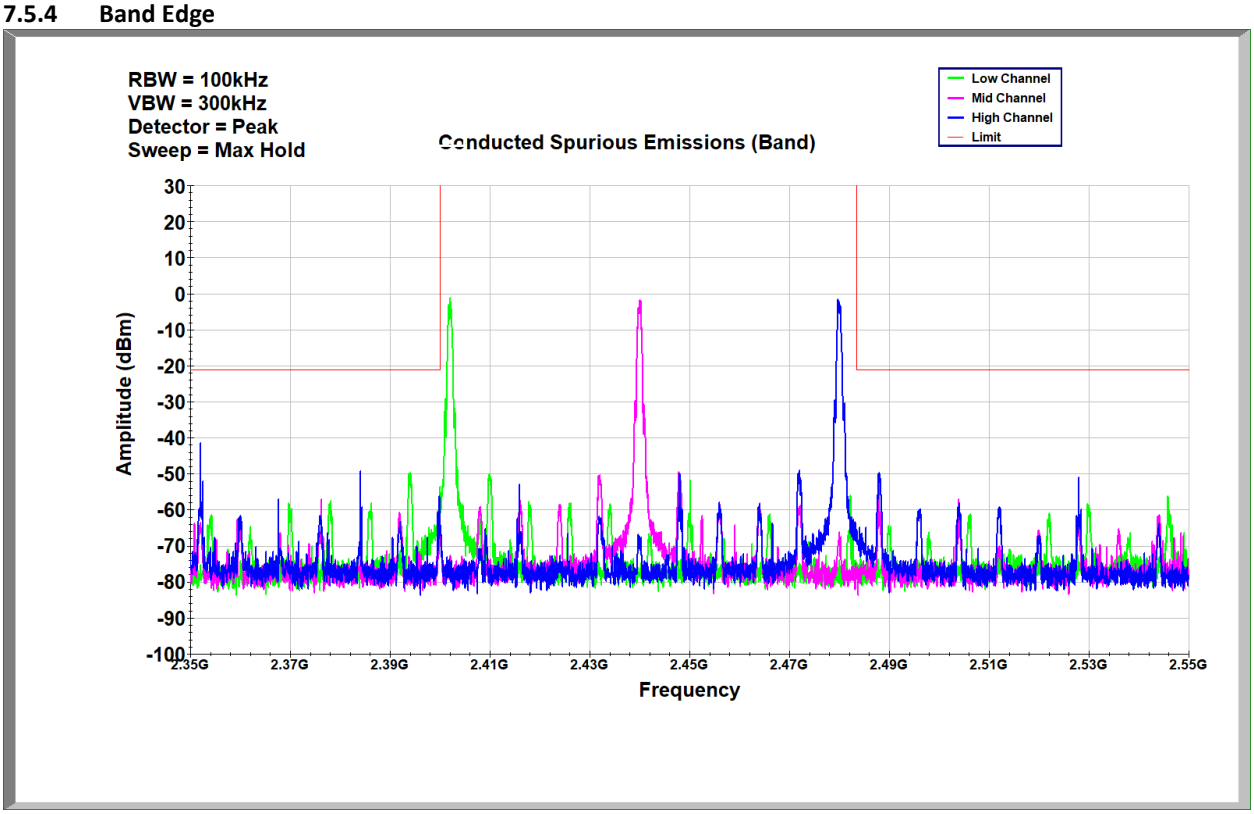
7.5.2 2440 MHz



7.5.3 2480 MHz



7.5.4 Band Edge



8 Output Power

8.1 Test Limits

FCC Part 15.247(b)(3):

For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

RSS-247 Issue 2 § 5.4(d):

For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power. The maximum conducted output power is the total transmit power delivered to all antennas and antenna elements, averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or transmitting at a reduced power level. If multiple modes of operation are implemented, the maximum conducted output power is the highest total transmit power occurring in any mode.

8.2 Test Method

Tests are performed in accordance with ANSI C63.10:2013 § 11.9.1.1

8.3 Test Equipment Used

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
EMI Test Receiver	3900	Rohde & Schwarz	ESU40	10/3/2022	10/3/2023

8.4 Test Results

The device was found to be **compliant**. The peak output power was less than 1W and the EIRP was less than 4W.

8.5 Test Conditions

Test Personnel:	David Perry	Test Date:	4/3/2023
Supervising/Reviewing Engineer: (Where Applicable)	Brian Lackey	Limit Applied:	From FCC Part 15.247(b)(3), RSS-247 Issue 2 § 5.4(d)
Product Standard:	FCC Part 15.247 RSS-247 Issue 2	Ambient Temperature:	22.0C
Input Voltage:	3.2V DC	Relative Humidity:	23.5%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	990.8mbar

Deviations, Additions, or Exclusions: None

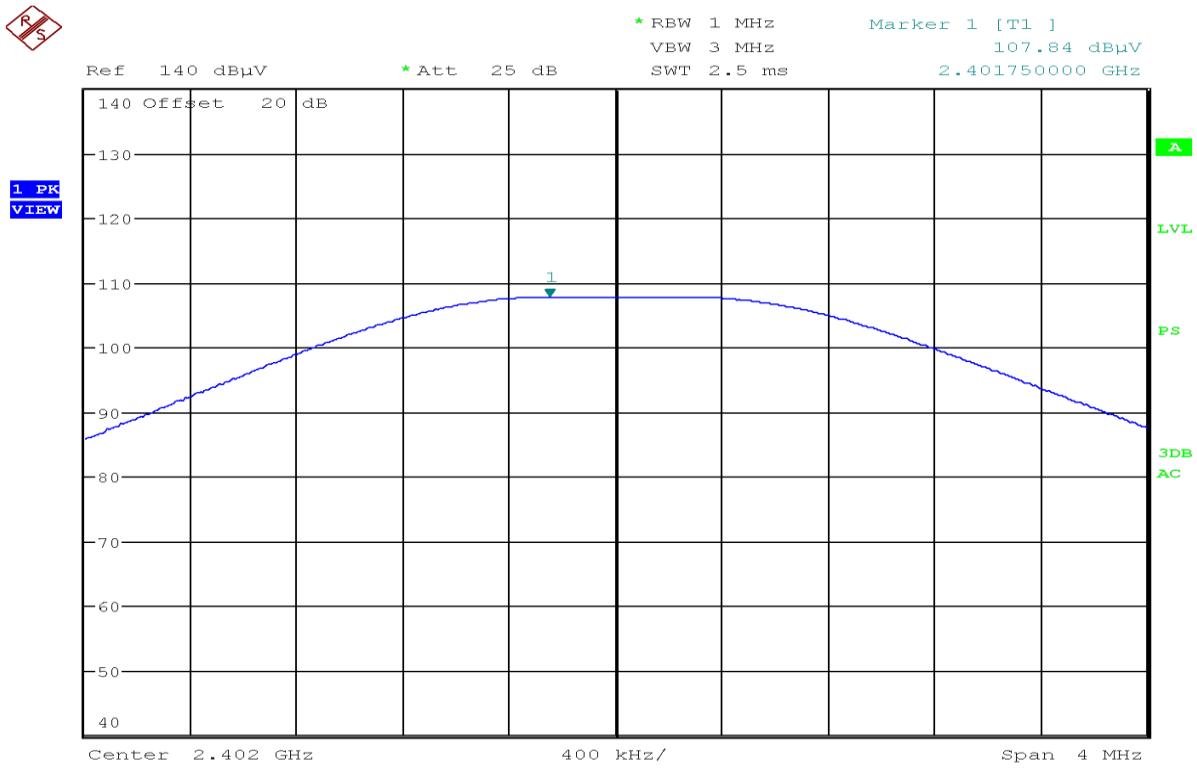
8.6 Test Data

Frequency (MHz)	Max Peak (dBµV)	Conducted Power (dBm)	Conducted Power Limit (dBm)	Max Antenna Gain[2] (dBi)	EIRP (dBm)	EIRP Limit (dBm)
2402	107.64	0.7	30	-1	-0.3	36.02
2440	107.21	0.2	30	-1	-0.8	36.02
2480	106.72	-0.3	30	-1	-1.3	36.02

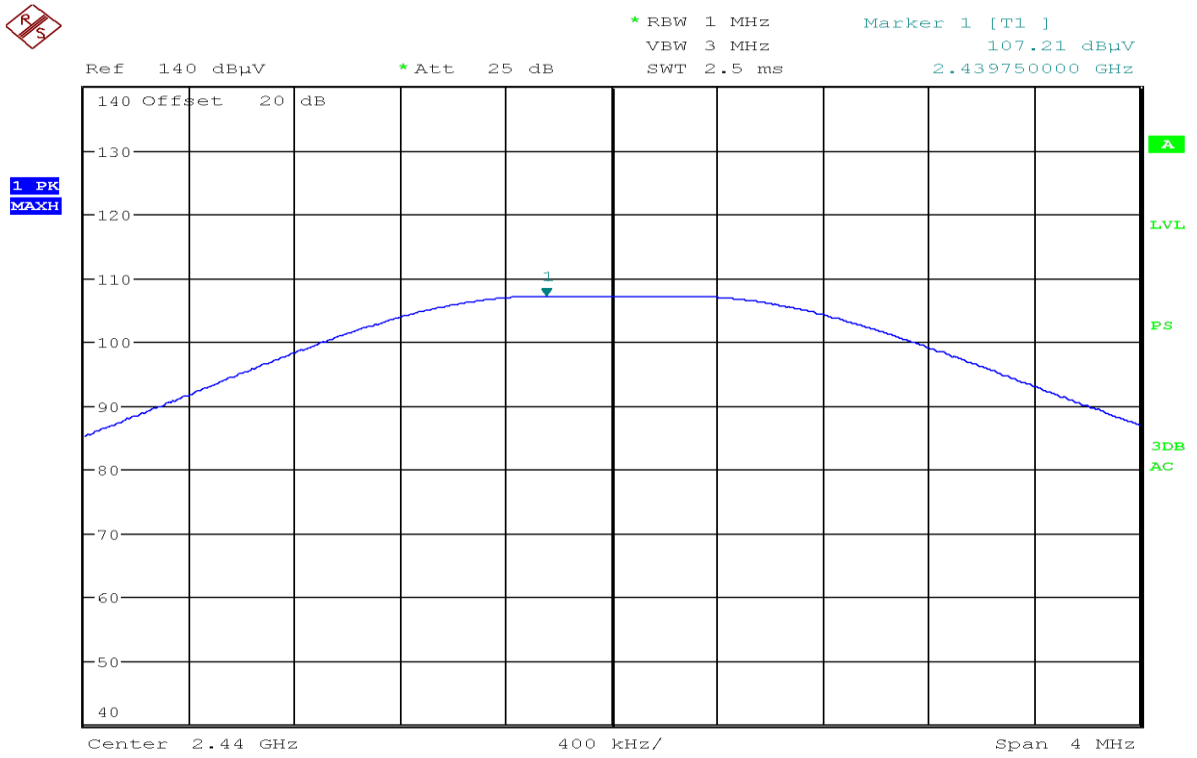
[2] Antenna gain not measured; values used are from § 4.1 Antenna Specifications, a client provided document

8.7 Spectrum Plots

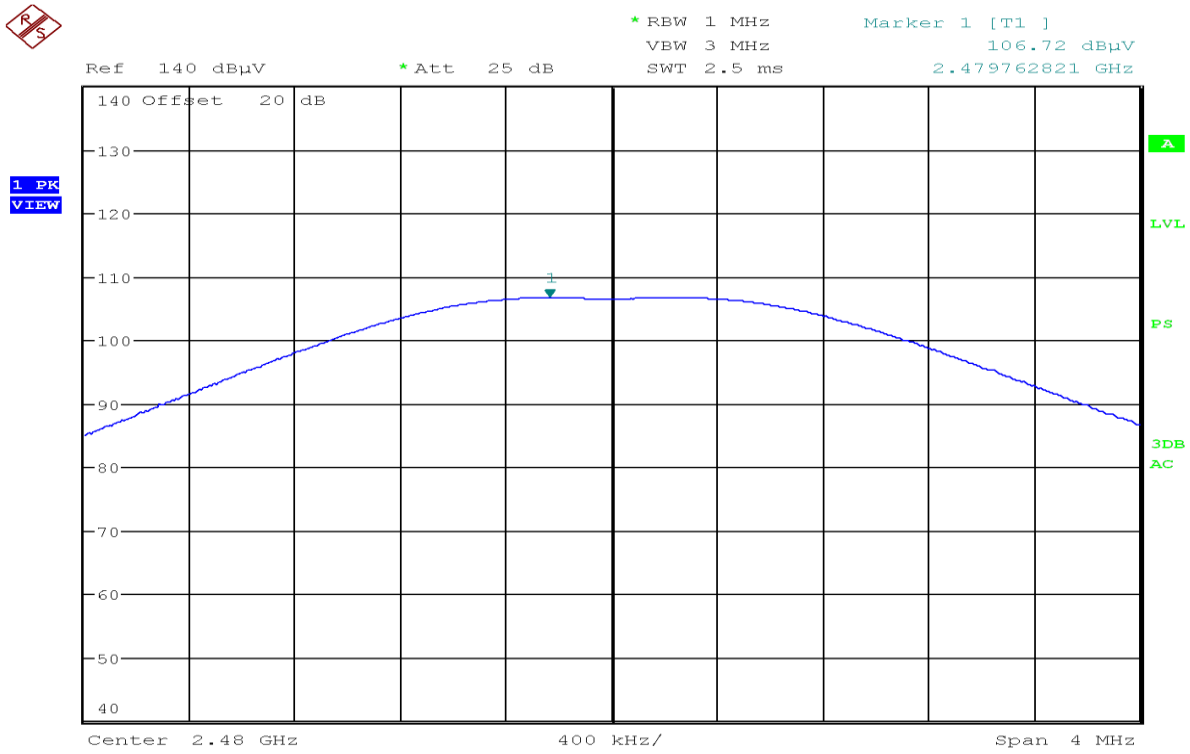
8.7.1 2402 MHz



8.7.1 2440 MHz



8.7.2 2480 MHz


* RBW 1 MHz
VBW 3 MHz
SWT 2.5 ms
Marker 1 [T1]
106.72 dBµV
2.479762821 GHz
Ref 140 dBµV
* Att 25 dB
140 Offset 20 dB
130
120
110
100
90
80
70
60
50
40
1 PK
VIEW
A
LVL
PS
3DB
AC
Center 2.48 GHz
400 kHz/
Span 4 MHz

9 Occupied Bandwidth

9.1 Test Limits

FCC Part 15.247(a)(2):

Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

RSS-247 Issue 2 § 5.2(a):

The minimum 6 dB bandwidth shall be 500 kHz.

9.2 Test Method

Tests are performed in accordance with ANSI C63.10:2013 § 11.8.1.

9.3 Test Equipment Used

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
EMI Test Receiver	3900	Rohde & Schwarz	ESU40	10/3/2022	10/3/2023

9.4 Test Results

The device was found to be **compliant**. The 6dB bandwidth was at least 500kHz.

9.5 Test Conditions

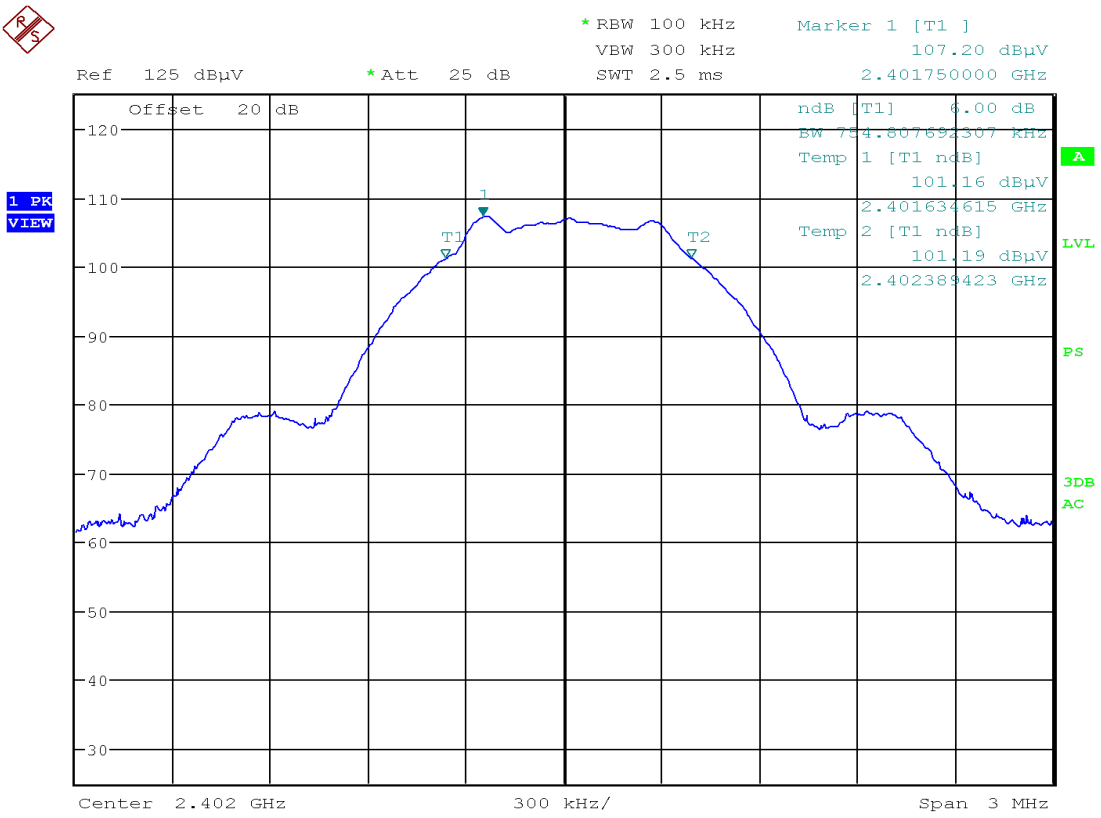
Test Personnel:	David Perry	Test Date:	4/4/2023
Supervising/Reviewing Engineer: (Where Applicable)	Brian Lackey	Limit Applied:	From FCC Part 15.247(a)(2), RSS-247 Issue 2 § 5.2(a)
Product Standard:	FCC Part 15.247 RSS-247 Issue 2	Ambient Temperature:	22.0C
Input Voltage:	3.2V DC	Relative Humidity:	23.5%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	990.8mbar

Deviations, Additions, or Exclusions: None

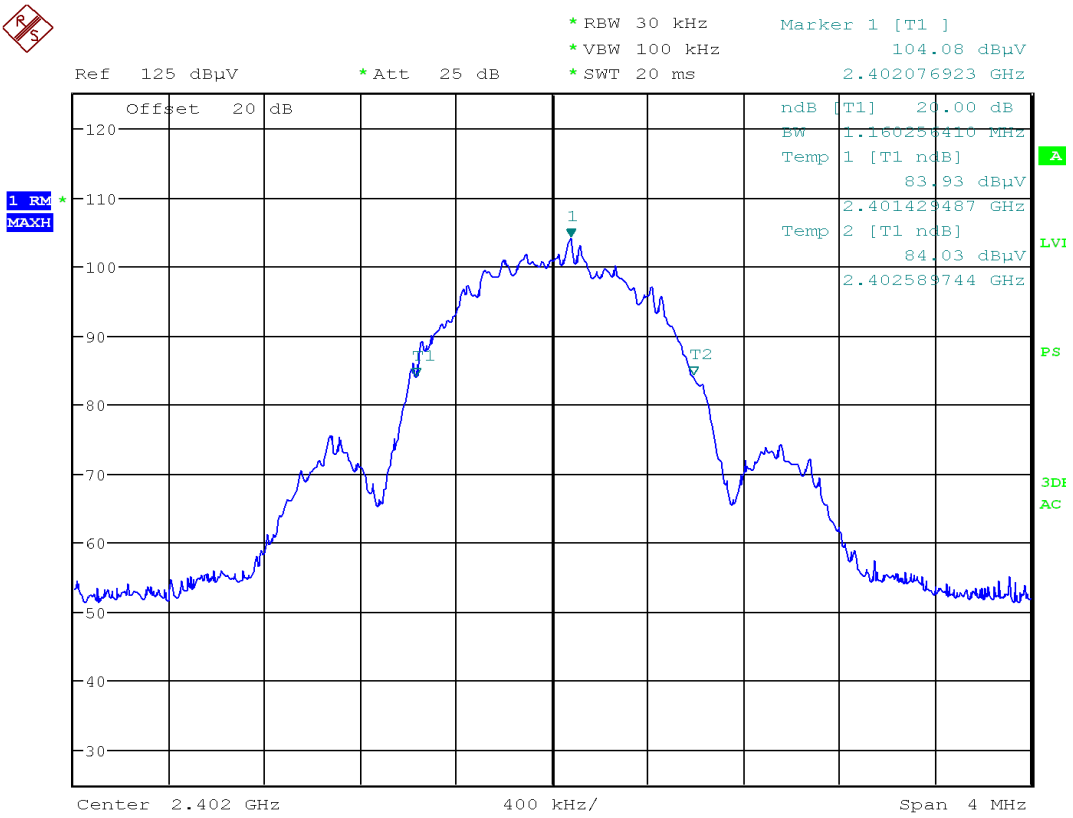
9.6 Test Data

Frequency (MHz)	6dB BW (kHz)	20dB BW (kHz)	99% BW (kHz)
2402	754.81	1160	1083
2440	721.15	1166	1083
2480	730.77	1185	1096

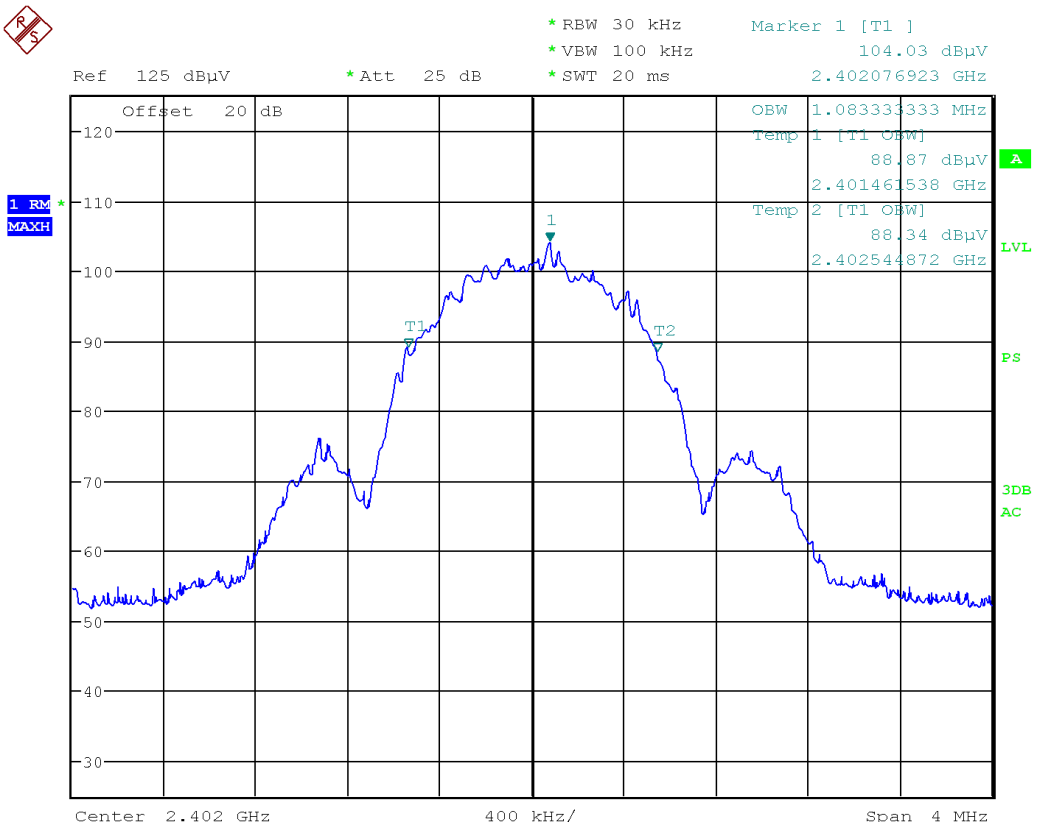
9.6.1 2402MHz 6dB BW



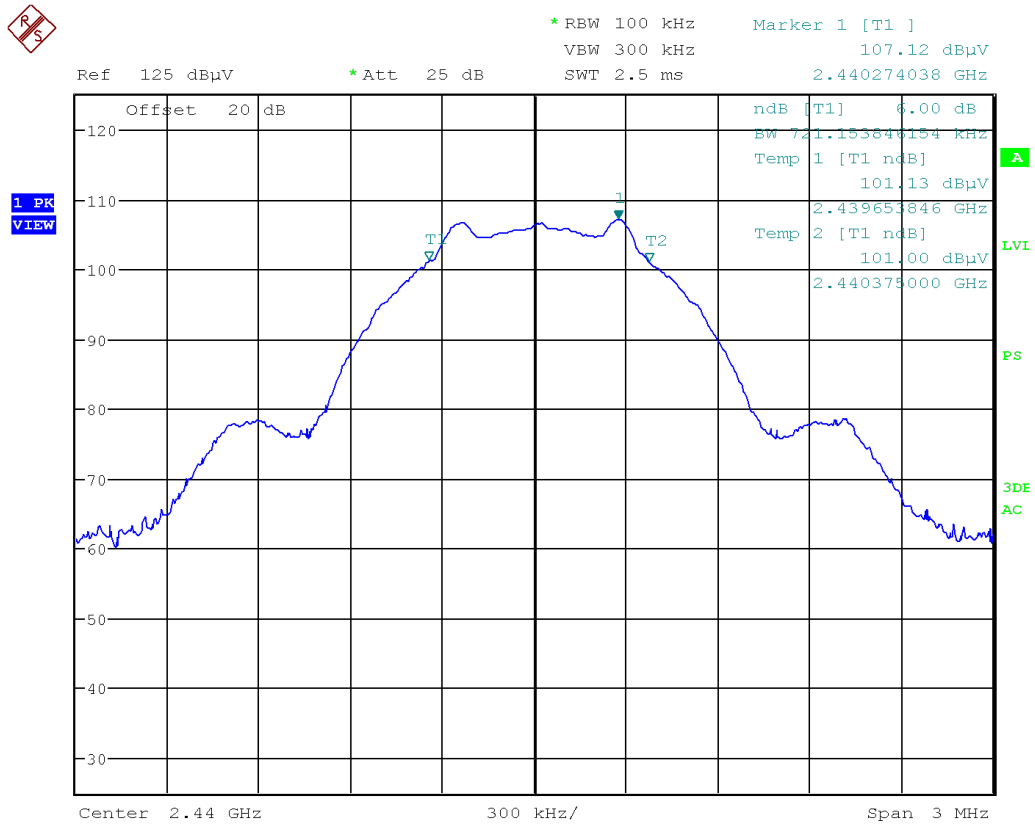
9.6.2 2402MHz 20dB BW



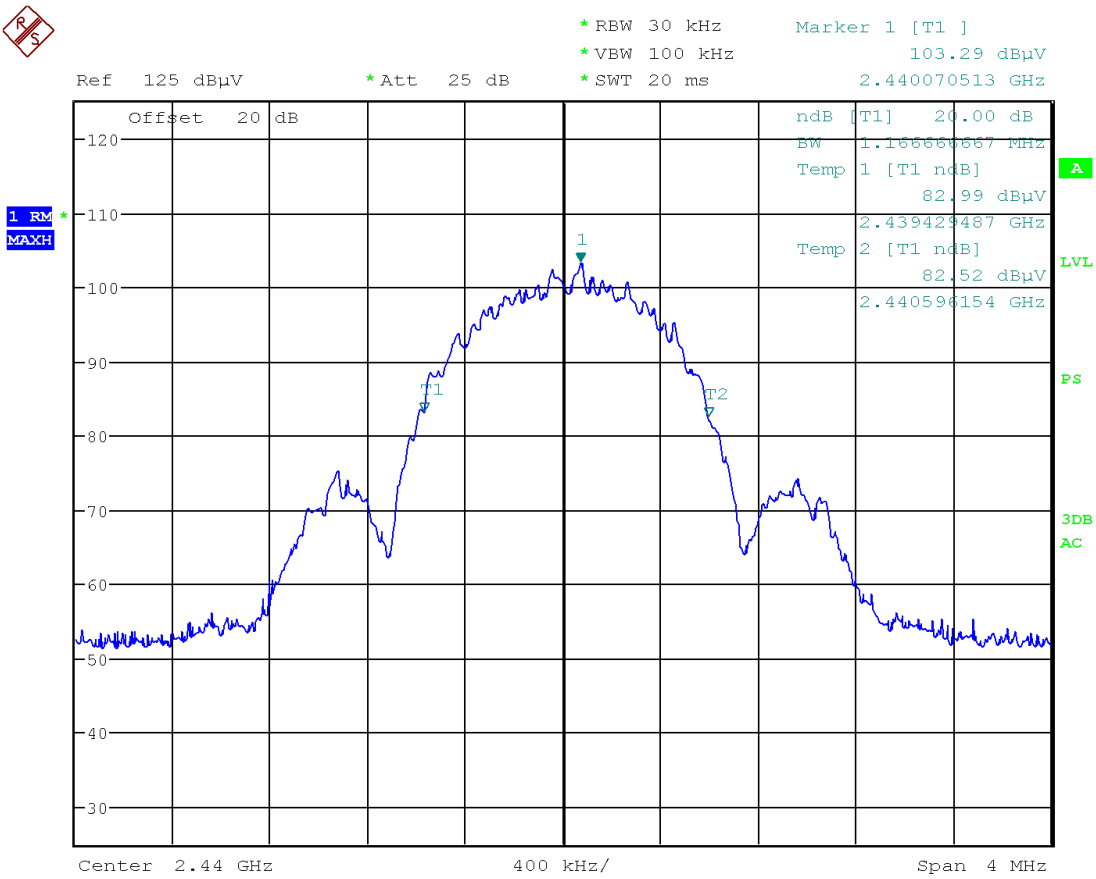
9.6.3 2402MHz 99% BW



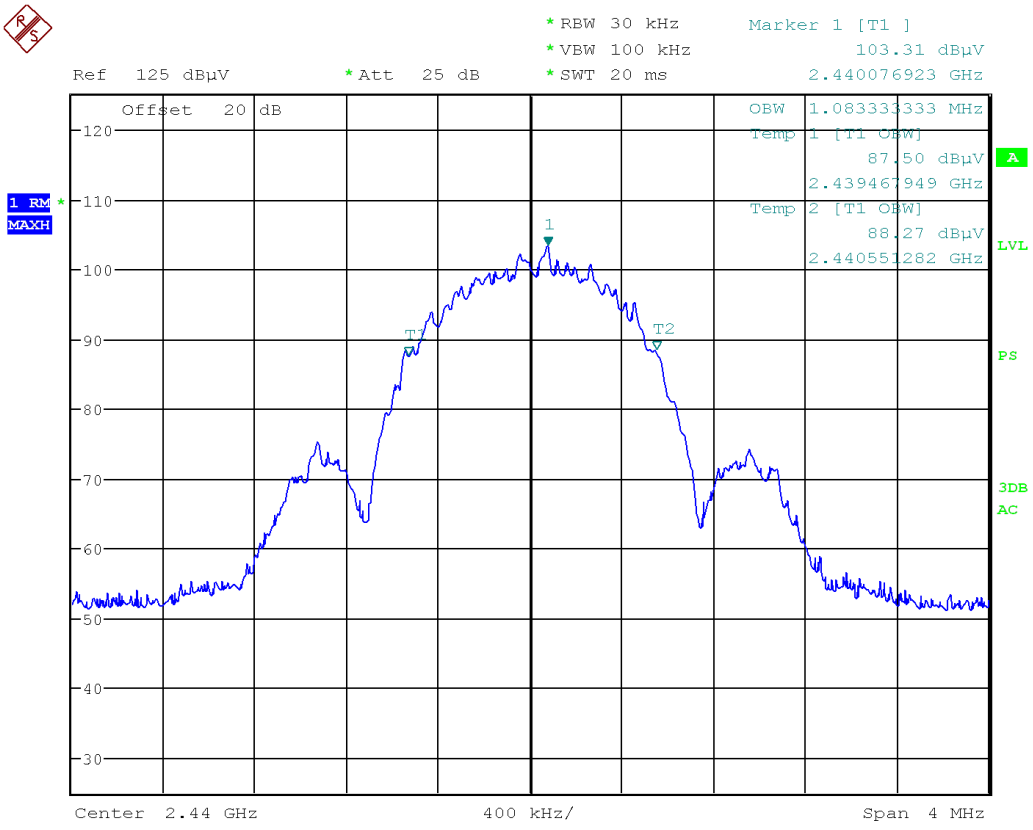
9.6.4 2440MHz 6dB BW



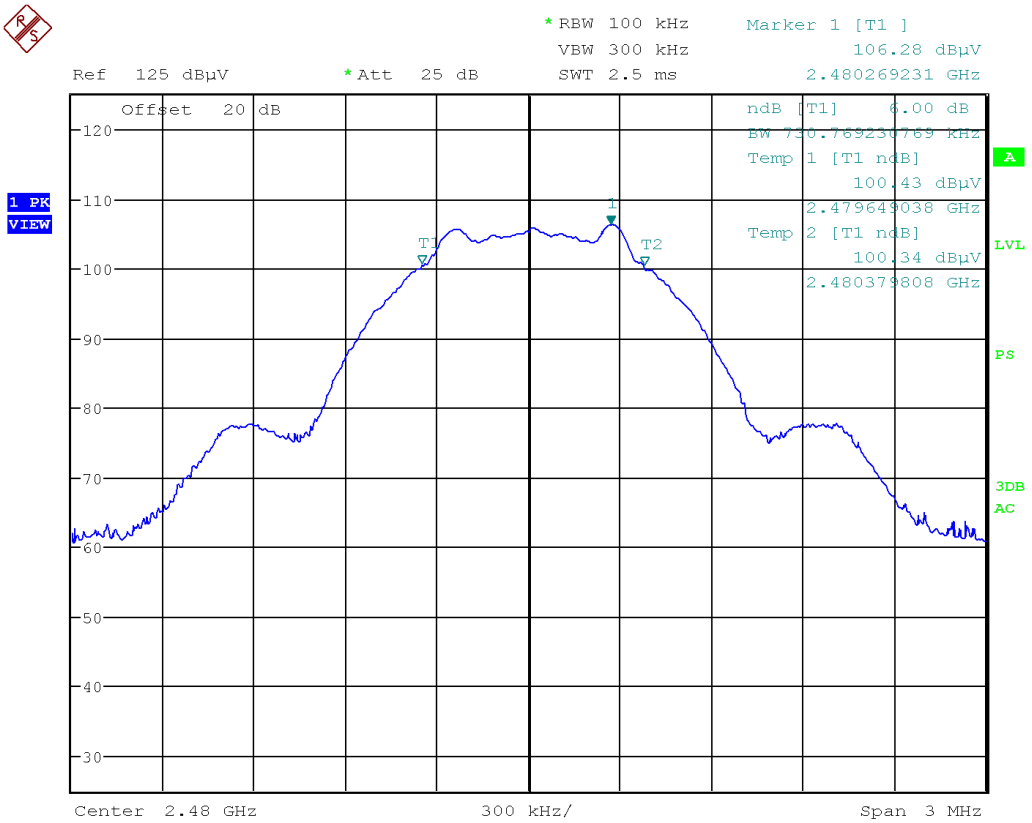
9.6.5 2440MHz 20dB BW



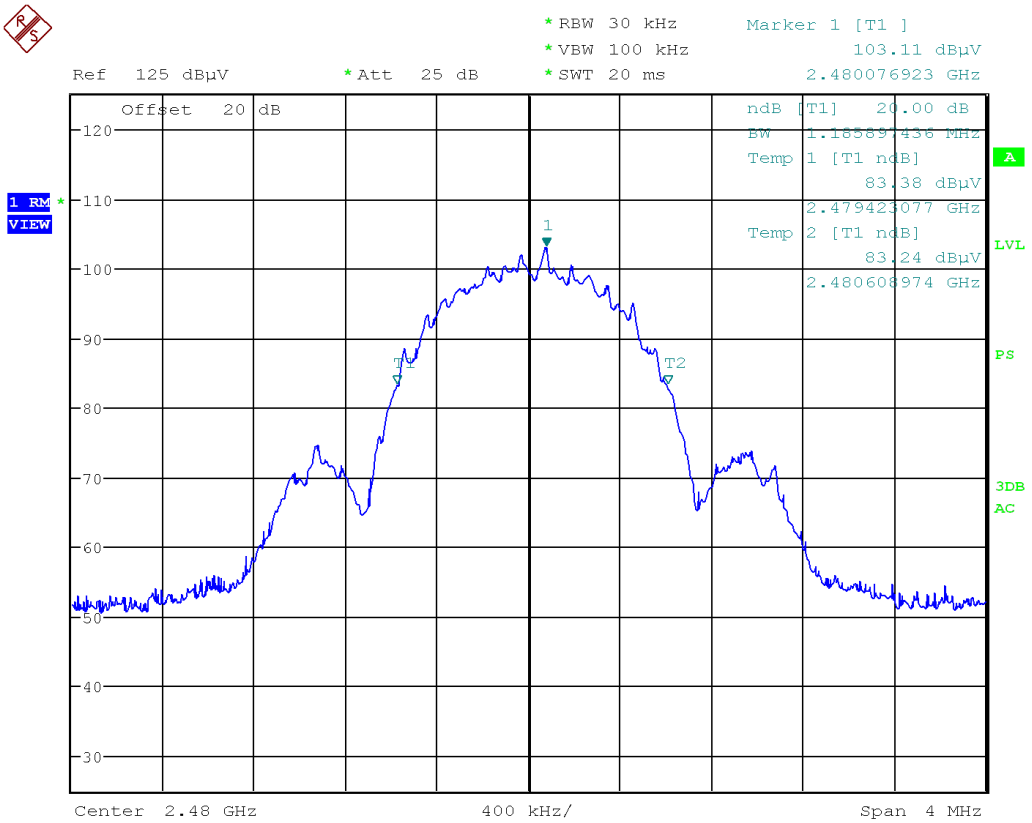
9.6.6 2440MHz 99% BW



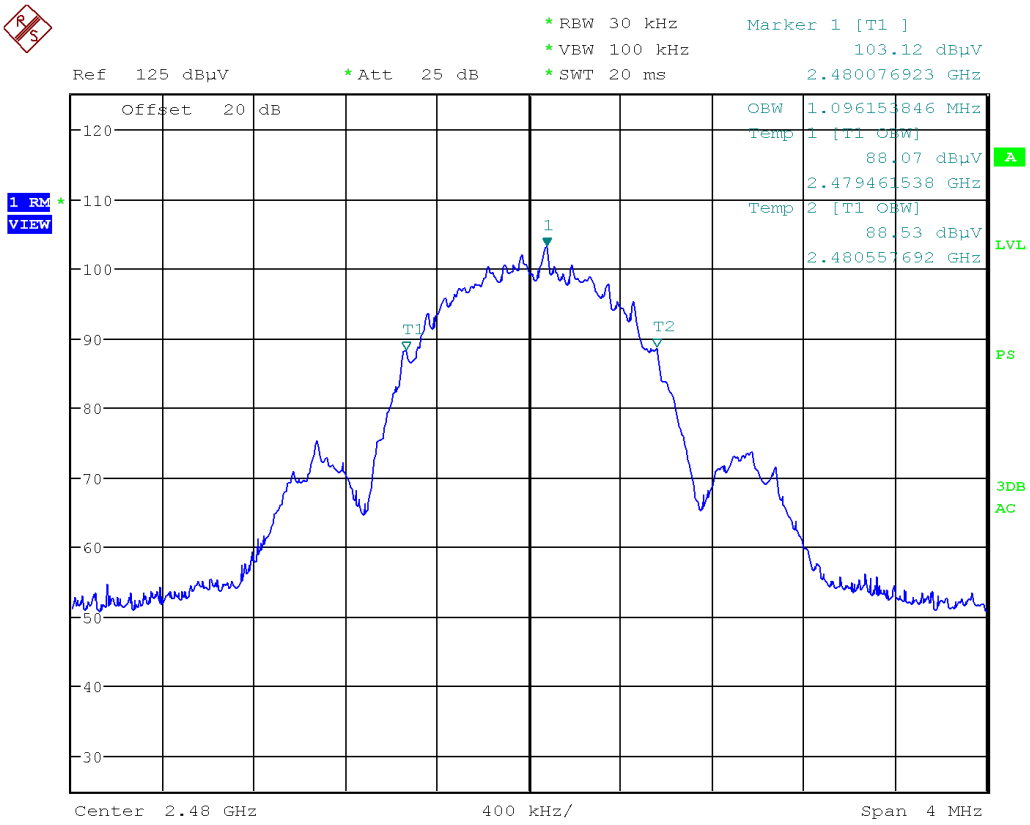
9.6.7 2480MHz 6dB BW



9.6.8 2480MHz 20dB BW



9.6.9 2480MHz 99% BW



10 Power Spectral Density

10.1 Test Limits

FCC Part 15.247(e):

> 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. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

RSS-247 Issue 2 § 5.2(b):

> The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of section 5.4(d), (i.e., the power spectral density shall be determined using the same method as is used to determine the conducted output power).

10.2 Test Method

Tests are performed in accordance with ANSI C63.10:2020 § 11.10.2 Method PKPSD (peak PSD).

10.3 Test Equipment Used

Description	Asset	Manufacturer	Model	Cal Date	Cal Due
EMI Test Receiver	3900	Rohde & Schwarz	ESU40	10/3/2022	10/3/2023

10.4 Test Results

The device was found to be **compliant**. The peak power spectral density was less than 8dBm.

10.5 Test Conditions

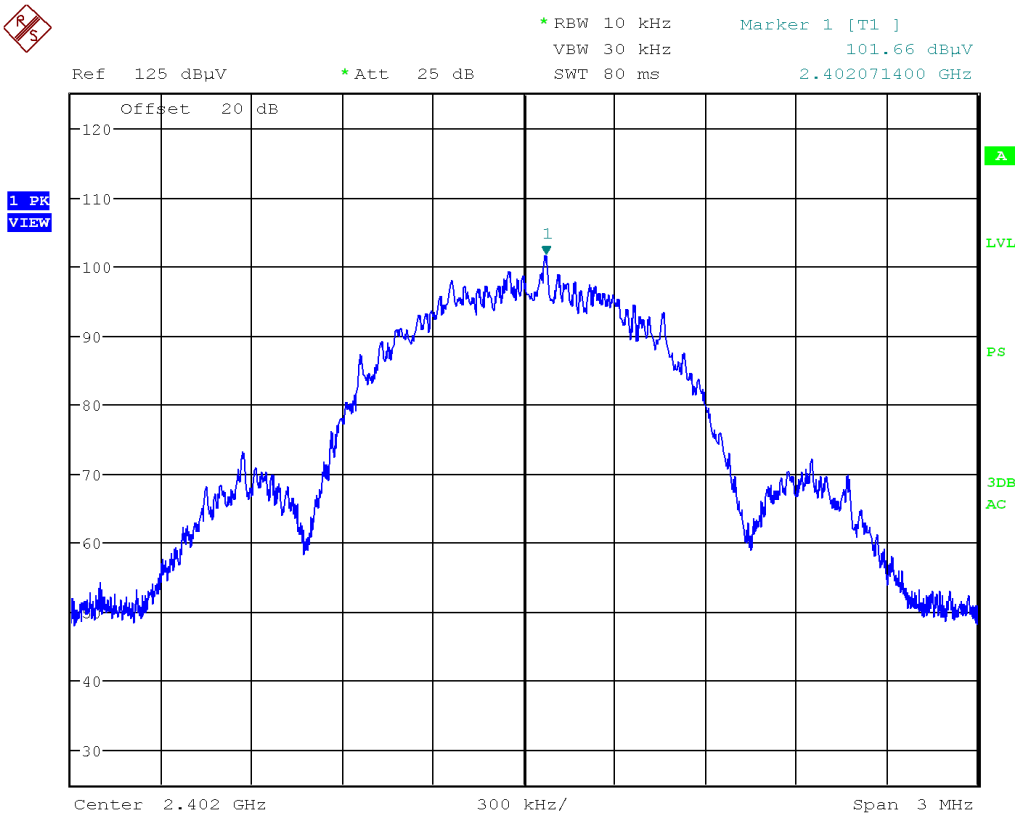
Test Personnel:	David Perry	Test Date:	4/4/2023
Supervising/Reviewing Engineer: (Where Applicable)	Brian Lackey	Limit Applied:	FCC Part 15.209 in Restricted Bands from FCC Part 15.205
Product Standard:	FCC Part 15.247 RSS-247 Issue 2	Ambient Temperature:	22.0C
Input Voltage:	3.2V DC	Relative Humidity:	23.5%
Pretest Verification w / Ambient Signals or BB Source:	Yes	Atmospheric Pressure:	990.8mbar

Deviations, Additions, or Exclusions: None

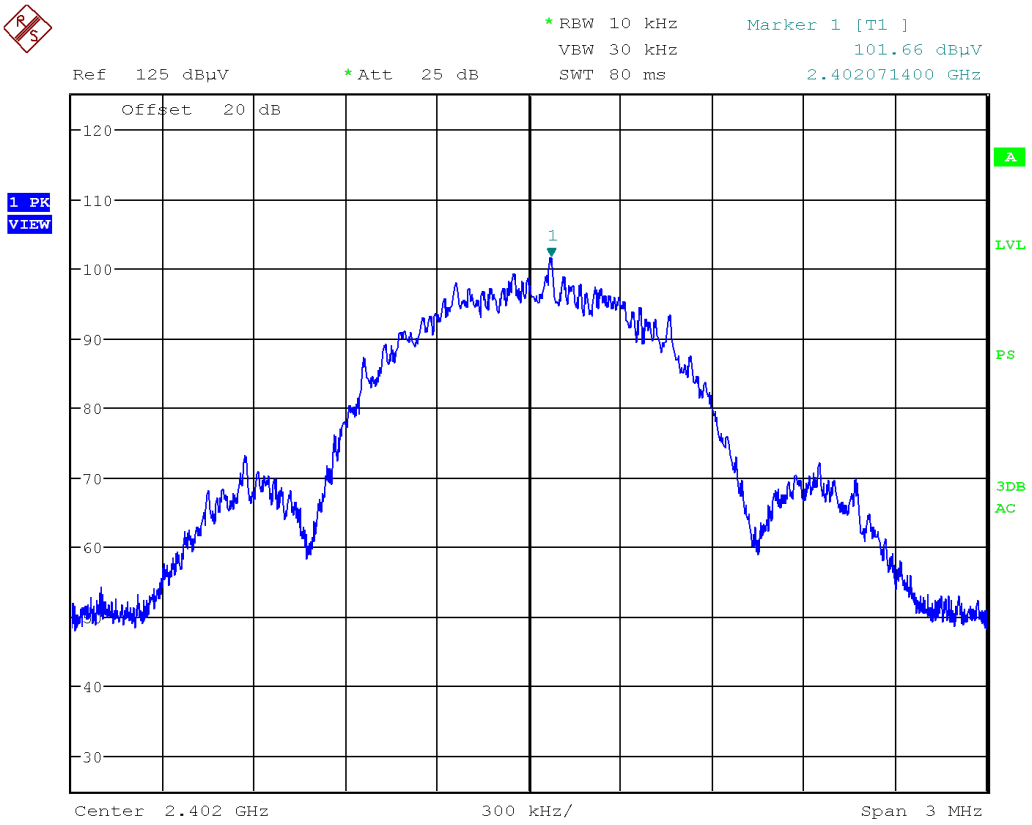
10.6 Test Data

Frequency (MHz)	PPSD (dBµV/10KHz)	PPSD (dBm/10KHz)	Limit (dBm/3KHz)	Result
2402	101.66	-5.3	8	Pass
2440	101.67	-5.3	8	Pass
2480	100.12	-6.9	8	Pass

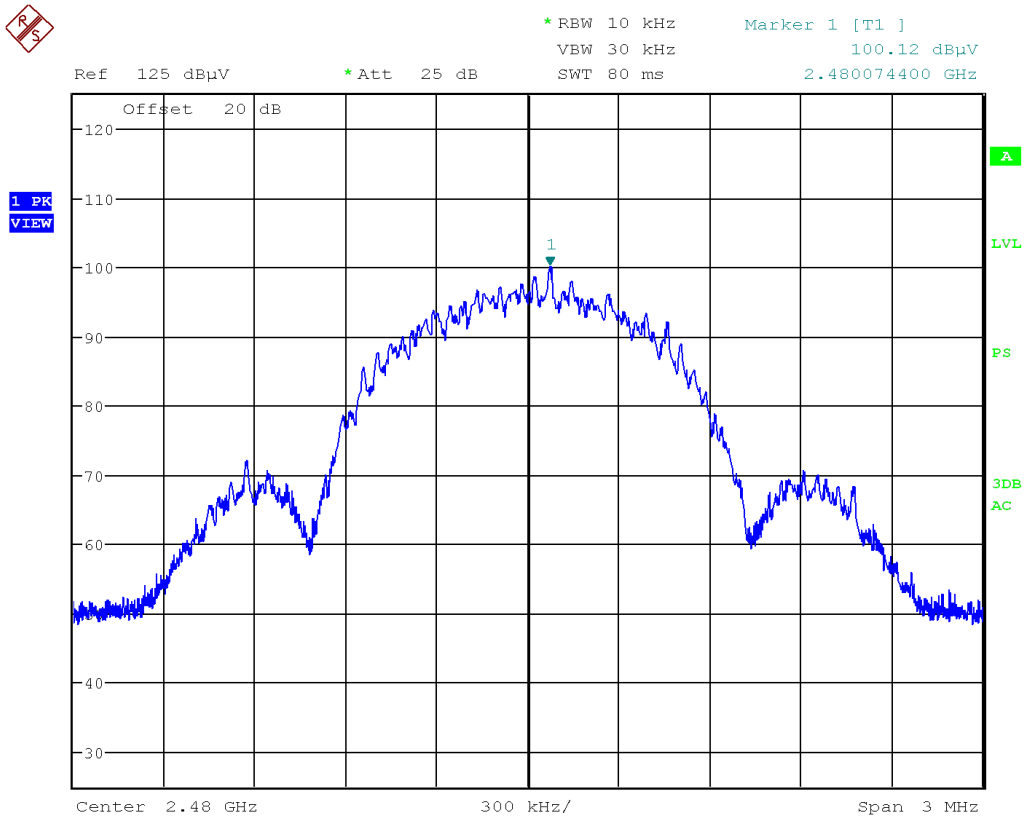
10.6.1 2402MHz PPSD



10.6.2 2440MHz PPSD



10.6.3 2480MHz PPSD



11 Antenna Requirement

11.1 Test Limits

FCC Part 15.203:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §§15.211, 15.213, 15.217, 15.219, 15.221, or §15.236. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

RSS-Gen Issue 5 § 6.8:

The applicant for equipment certification, as per RSP-100, must provide a list of all antenna types that may be used with the licence-exempt transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna.

Licence-exempt transmitters that have received equipment certification may operate with different types of antennas. However, it is not permissible to exceed the maximum equivalent isotropically radiated power (e.i.r.p.) limits specified in the applicable standard (RSS) for the licence-exempt apparatus.

Testing shall be performed using the highest gain antenna of each combination of licence-exempt transmitter and antenna type, with the transmitter output power set at the maximum level. When a measurement at the antenna connector is used to determine RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna manufacturer.

User manuals for transmitters equipped with detachable antennas shall also contain the following notice in a conspicuous location:

This radio transmitter (identify the device by certification number) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Immediately following the above notice, the manufacturer shall provide a list of all antenna types approved for use with the transmitter, indicating the maximum permissible antenna gain (in dBi).

11.2 Test Results

The device was found to be **compliant**. The device has an internal, permanently affixed antenna.

13 Revision History

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	5/18/2023	105353929LEX-003			Original Issue