Prüfbericht-Nr.: *Test report no.:*	**CN2244RH 001**	**Auftrags-Nr.:** *Order no.*:	**244385665**	**Seite 1 von 60** *Page 1 of 60*
Kunden-Referenz-Nr.: *Client reference no.:*	**1288983**	**Auftragsdatum:** *Order date:*	**2022-01-04**	
Auftraggeber: *Client:*	**IKEA of Sweden AB** Box 702, SE-343 81, Älmhult, Sweden			
Prüfgegenstand: *Test item:*	VAPPEBY peanut			
Bezeichnung / Typ-Nr.: *Identification / Type no.:*	E2125 FCC ID: FHO-E2125 IC: 10912A-E2125			
Auftrags-Inhalt: *Order content*:	Complete test			
Prüfgrundlage: *Test specification:*	FCC CFR47 Part 15, Subpart C Section 15.247 RSS-Gen Issue 5, Amendment 2, February 2021 RSS-247 Issue 2, February 2017 ANSI C63.10: 2013			
Wareneingangsdatum: *Date of sample receipt:*	2022-01-24	Refer to photo document		
Prüfmuster-Nr.: *Test sample no:*	A003205571-001			
Prüfzeitraum: *Testing period:*	Refer to test report			
Ort der Prüfung: *Place of testing:*	TÜV Rheinland (Shanghai) Co., Ltd.			
Prüflaboratorium: *Testing laboratory:*	TÜV Rheinland (Shanghai) Co., Ltd.			
Prüfergebnis*: *Test result*:*	Pass			

geprüft von: *tested by:*	X Hongfei Wu Signed by: Hongfei Wu	**genehmigt von:** *authorized by:*	X Elliot Zhang Signed by: Elliot Zhang
Datum: *Date:* 2022-07-07		**Ausstellungsdatum:** *Issue date:* 2022-07-07	
Stellung / *Position:*	PE	**Stellung** / *Position:*	Reviewer

Sonstiges / *Other:* HVIN: E2125

Zustand des Prüfgegenstandes bei Anlieferung: *Condition of the test item at delivery:*	Prüfmuster vollständig und unbeschädigt *Test item complete and undamaged*

* Legende:	P(ass) = entspricht o.g. Prüfgrundlage(n)	F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	N/A = nicht anwendbar	N/T = nicht getestet
* *Legend:*	*P(ass) = passed a.m. test specification(s)*	*F(ail) = failed a.m. test specification(s)*	*N/A = not applicable*	*N/T = not tested*

TEST SUMMARY

5.1.1 ANTENNA REQUIREMENT
RESULT: Pass

5.1.2 20DB & 99% BANDWIDTH
RESULT: Pass

5.1.3 PEAK OUTPUT POWER
RESULT: Pass

5.1.4 FREQUENCY SEPARATION
RESULT: Pass

5.1.5 NUMBER OF HOPPING FREQUENCY
RESULT: Pass

5.1.6 TIME OF OCCUPANCY
RESULT: Pass

5.1.7 CONDUCTED BAND EDGE AND OUT-OF BAND EMISSIONS
RESULT: Pass

5.2.1 CONDUCTED EMISSION
RESULT: Pass

5.3.1 RADIATED BAND-EDGE
RESULT: Pass

5.3.2 RADIATED SPURIOUS EMISSION
RESULT: Pass

Contents

1. General Remarks

1.1 Complementary Materials

Null.

2. Test Sites

2.1 Test Facilities

TÜV Rheinland (Shanghai) Co., Ltd.

Shanghai TUV Rheinland Building No. 177, 178 Lane 777, West Guangzhong Rd, Jing'an District, Shanghai, China

The used test equipment is in accordance with CISPR 16 for measurement of radio interference.

The Federal Communications Commission has reviewed the technical characteristics of the radiated and conducted emission facility, and has found these test facilities to be in compliance with the requirements of section 2.948 of the FCC rules. The description of the test facility is listed under FCC registration number 958801.

The Innovation, Science and Economic Development Canada has reviewed the technical characteristics of the radiated and conducted emission facility, and has found these test facilities to be in compliance. The description of the test facility is listed under chambers filing number 2932F.

2.2 List of Test and Measurement Instruments

Table 1: List of Test and Measurement Equipment

Instrument	Manufacturer	Type No.	Asset No.	Cali. Due Date
3m modified semi-anechoic chamber	Frankonia	SAC3	G1811378	2022-06-27
Bilog antenna	Teseq	CBL 6112D	G1811425	2023-03-10
EMI test receiver	Rohde & Schwarz	ESCI	G1811402	2022-09-01
Spectrum analyser	Rohde & Schwarz	FSV40	G1822702	2023-03-10
Preamplifier	Taiwan EMCI	EMC184045SE	G1825372	2023-05-14
Log periodic antenna	Rohde & Schwarz	HL050	G1811417	2023-03-10
Broadband Horn Antenna	Schwarzbeck	BBHA 9170	9170-305	2023-07-10
Preamplifier	Taiwan EMCI	EMC051845SE	G1825371	2023-05-14
Spectrum Analyzer	Keysight	N9020A	MY54500180	2022-09-07
Thermohygrometer	Testo	608-H1	1241320614	2023-10-12
EMI test receiver	R&S	ESIB26	G1811380	2023-03-06
Artificial main network	R&S	ENV432	G1830003	2022-11-01
EMC measurement software	R&S	EMC32 (Ver 10.20.01)	G1824845	N/A

2.3 Traceability

All measurement equipment calibrations are traceable to NIST or where calibration is performed outside the United States, to equivalent nationally recognized standards organizations.

2.4 Calibration

Equipment requiring calibration is calibrated periodically by the manufacturer or according to manufacturer's specifications. Additionally all equipment is verified for proper performance on a regular basics using in house standards or comparisons.

2.5 Measurement Uncertainty

Table 2: Measurement Uncertainty

Measurement Type	Frequency	Uncertainty
Antenna Port Conducted Emission	< 1GHz	±0.39dB
	> 1GHz	±0.68dB
Conducted Emission	150kHz - 30MHz	±3.39dB
Radiated Emission	9kHz - 30MHz	±2.93dB
	30MHz - 1GHz	±5.34dB
	> 1GHz	±5.40dB

3. General Product Information

3.1 Product Function and Intended Use

The EUT (Equipment Under Test) is a Bluetooth speaker.

For details refer to the User Manual and Circuit Diagram.

3.2 Ratings and System Details

Table 3: Technical Specification of EUT

General Description of EUT	
Product Name:	VAPPEBY peanut
Model No.:	E2125
Operating Voltage:	DC 3.6V (Li-ion Battery) or DC 24V
Technical Specification of Bluetooth Classic	
Frequency Range:	2402 to 2480MHz
Modulation Type:	GFSK, π/4 DQPSK, 8DPSK
Data Rate:	1Mbps(GFSK), 2Mbps(π/4 DQPSK), 3Mbps(8DPSK)
Antenna Type:	PCB Antenna
Antenna Gain:	1.5 dBi (Provided by the Client)

3.3 Independent Operation Modes

Table 4: Independent Operation Modes

Test Mode	Data Rate	Channel
TM1	1-DH5	00
TM2	1-DH5	39
TM3	1-DH5	78
TM4	2-DH5	00
TM5	2-DH5	39
TM6	2-DH5	78
TM7	3-DH5	00
TM8	3-DH5	39
TM9	3-DH5	78
TM10	1-DH1	Hopping
TM11	1-DH3	Hopping
TM12	1-DH5	Hopping
TM13	2-DH1	Hopping
TM14	2-DH3	Hopping
TM15	2-DH5	Hopping
TM16	3-DH1	Hopping
TM17	3-DH3	Hopping
TM18	3-DH5	Hopping
TM19	Normal Operating Mode	

3.4 Noise Generating and Noise Suppressing Parts

Refer to the Circuit Diagram.

3.5 Submitted Documents

- Bill of Material
- Circuit Diagram
- PCB Layout
- Instruction Manual
- Photo Document
- Rating Label

4. Test Set-up and Operation Modes

4.1 Principle of Configuration Selection

The equipment under test (EUT) was configured to measure its maximum power level. The test modes were adapted accordingly in reference to the instructions for use.

4.2 Test Operation and Test Software

Test operation refers to test setup in chapter 5. All testing were performed according to the procedures in ANSI C63.10: 2013.
Test Software used: BT FCC tool, V2.24

Table 5: Power parameter value

Channel Frequency [MHz]	Power Parameter Value
2402	4
2441	4
2480	4

4.3 Special Accessories and Auxiliary Equipment

Table 6: Auxiliary Equipment

No.	Equipment Name	Model Name	Manufacturer
1	Adapter	ICPSW24-19-1	IKEA
2	Adapter	ICPSW24-7-3	IKEA

4.4 Countermeasures to achieve EMC Compliance

Null.

5. Test Results

5.1 Conducted Testing at Antenna Port

5.1.1 Antenna Requirement

RESULT: **Pass**

According to the manufacturer declared, the EUT has one PCB antenna, the directional gain of antenna is 1.5 dBi and the antenna is designed with permanent attachment and no consideration of replacement. Therefore the EUT is considered sufficient to comply with the provision.

Table 7: Antenna Requirement

FCC 15.203 – Antenna Requirement 1		
Requirement:	No antenna other than that furnished by the responsible party shall be used with the device	
Results:	Antenna type:	PCB antenna
Verdict:	Pass	

FCC 15.204 – Antenna Requirement 2	
Requirement:	An intentional radiator may be operated only with the antenna with which it is authorized. If an antenna is marketed with the intentional radiator, it shall be of a type which is authorized with the intentional radiator.
Results:	Only one PCB antenna can be used
Verdict:	Pass

RSS-Gen 6.4 – External Control	
Requirement:	The device shall not have any external controls accessible to the user that enable it to be adjusted, selected or programmed to operate in violation of the regulatory requirements, including RSS-Gen and the applicable RSSs
Results:	The device does not have any transmitter external controls accessible to the user that can be adjusted and operated in violation of the limits of this standard.
Verdict:	PASS

RSS-Gen 6.8 – Antenna Requirement		
Requirement:	When measurements at the antenna port are used to determine the RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer.	
Results:	a) Antenna Type:	PCB Antenna
	b) Manufacture:	N/A
	c) Model No.:	N/A
	d) Gain with reference to an isotropic radiator:	1.5 dBi
Verdict:	PASS	

5.1.2 20dB & 99% Bandwidth

RESULT: **Pass**

Date of testing	:	2022-01-29
Ambient temperature	:	21.0°C
Relative humidity	:	36.3%
Atmospheric pressure	:	101kPa
Test requirement	:	FCC Part 15.247(a)(1) RSS-247 Issue 2, February 2017, Clause 5.1(a)
Test procedure	:	ANSI C63.10: 2013
Test voltage	:	DC 3.6V
Test modes applied	:	TM1 to TM9

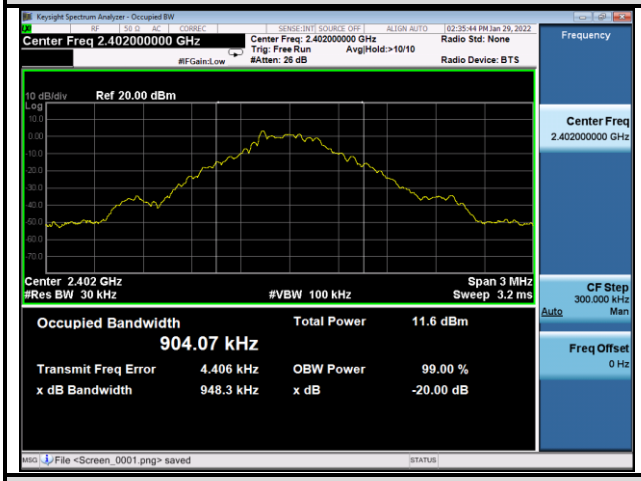
Table 8: 20dB & 99% Bandwidth

Test Mode	Mode	CH.	Freq. [MHz]	20dB Bandwidht [kHz]	99% Bandwidth [kHz]
TM1	1-DH5	00	2402	948.3	904.70
TM2	1-DH5	39	2441	947.1	905.07
TM3	1-DH5	78	2480	946.3	905.34
TM4	2-DH5	00	2402	1284	1178.0
TM5	2-DH5	39	2441	1282	1178.8
TM6	2-DH5	78	2480	1282	1179.7
TM7	3-DH5	00	2402	1248	1161.6
TM8	3-DH5	39	2441	1248	1159.7
TM9	3-DH5	78	2480	1249	1158.6

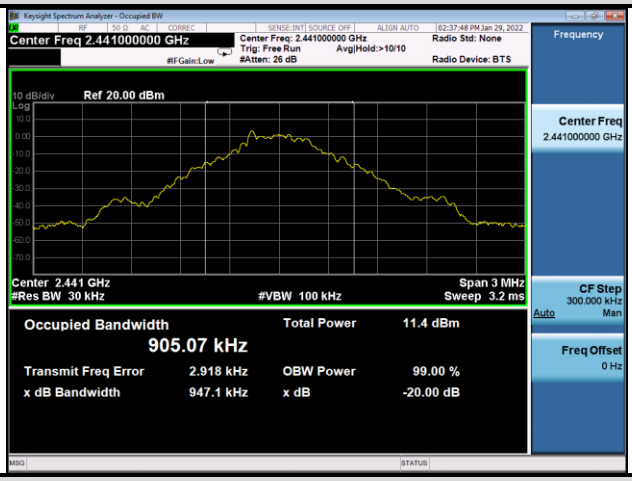
Note:
For frequency hopping systems operating in the 2400 – 2483.5MHz band, no bandwidth limit is specified. The test data is provide for reference.
And according to FCC, when the occupied bandwidth limit is not stated in the applicable FCC or reference measurement method, the transmitted signal band width shall be reported as the 99% emission bandwidth.

Figure 1: 20dB & 99% Bandwidth

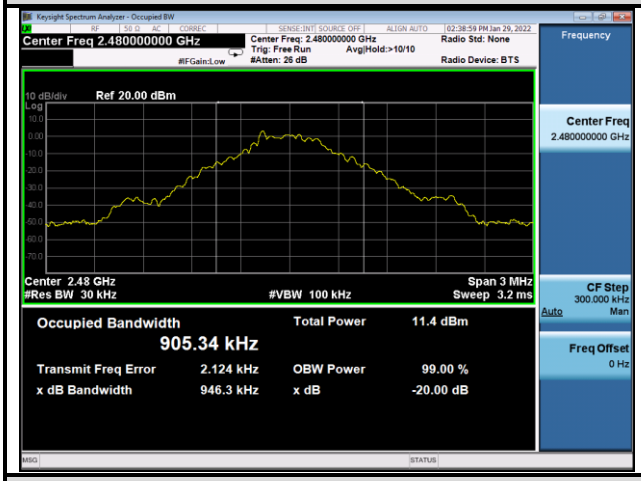
TM1



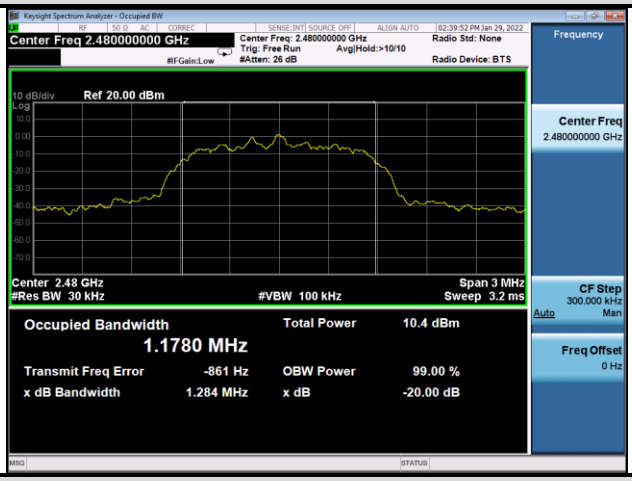
TM2



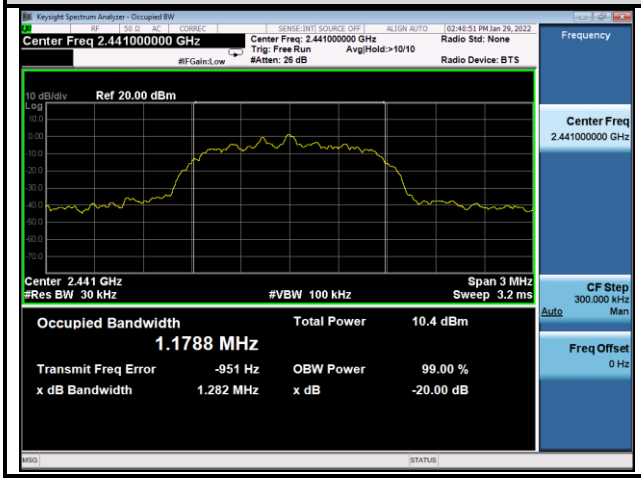
TM3



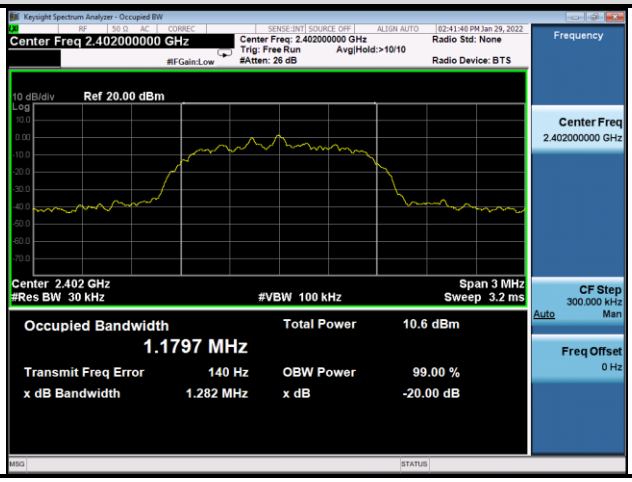
TM4

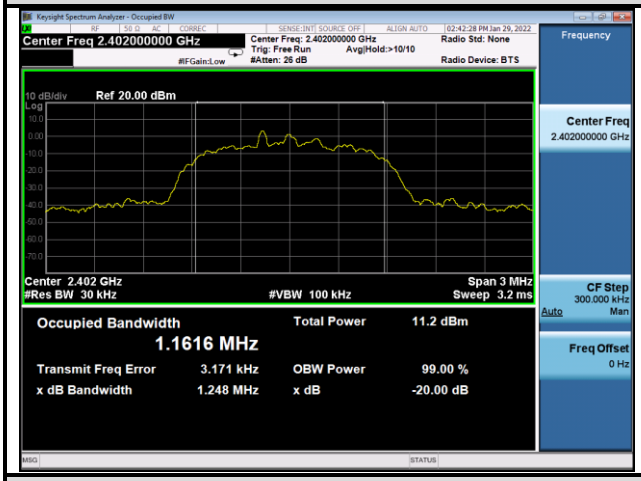
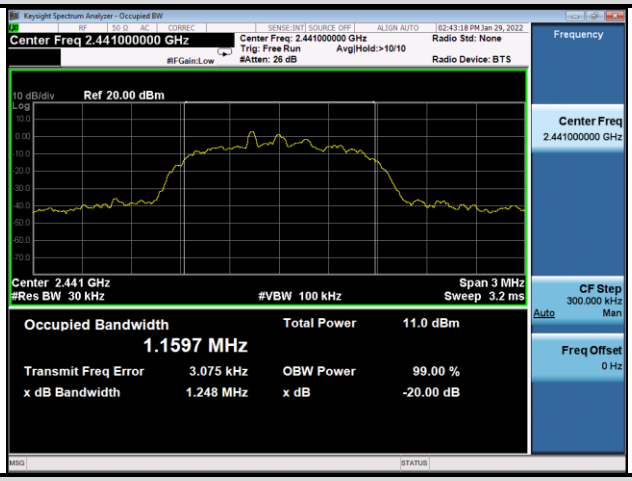


TM5



TM6



TM7	TM8
	
TM9	
	

Center Freq 2.402000000 GHz
Ref 20.00 dBm
Center 2.402 GHz
#Res BW 30 kHz
#VBW 100 kHz
Span 3 MHz
Sweep 3.2 ms
Occupied Bandwidth
1.1616 MHz
Total Power 11.2 dBm
Transmit Freq Error 3.171 kHz
OBW Power 99.00 %
x dB Bandwidth 1.248 MHz
x dB -20.00 dB
Center Freq 2.441000000 GHz
Center 2.441 GHz
Occupied Bandwidth
1.1597 MHz
Total Power 11.0 dBm
Transmit Freq Error 3.075 kHz
OBW Power 99.00 %
x dB Bandwidth 1.248 MHz
x dB -20.00 dB
Center Freq 2.480000000 GHz
Center 2.48 GHz
Occupied Bandwidth
1.1586 MHz
Total Power 10.9 dBm
Transmit Freq Error 2.937 kHz
OBW Power 99.00 %
x dB Bandwidth 1.249 MHz
x dB -20.00 dB

5.1.3 Peak Output Power

RESULT: **Pass**

Date of testing	:	2022-01-29
Ambient temperature	:	21.0°C
Relative humidity	:	36.3%
Atmospheric pressure	:	101kPa
Test requirement	:	FCC Part 15.247(b)(1) RSS-247 Issue 2, February 2017, Clause 5.4(b)
Test procedure	:	ANSI C63.10: 2013
Test voltage	:	DC 3.6V
Test modes applied	:	TM1 to TM9

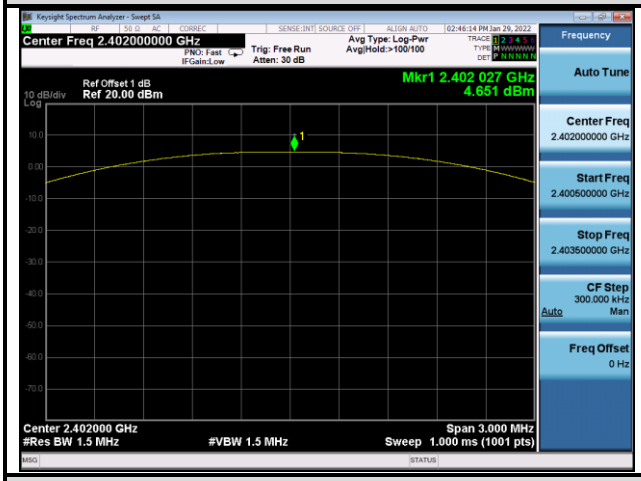
Table 9: Peak Output Power

Test Mode	Antenna Gain [dBi]	CH.	Freq. [MHz]	Maximum Peak Conducted Output Power [dBm]	Peak Conducted Output Power Limit [dBm]	Maximum EIRP [dBm]	EIRP Limit [dBm]
TM1	1.5	00	2402	4.651	30	6.151	36
TM2		39	2441	4.495	30	5.995	36
TM3		78	2480	4.455	30	5.955	36
TM4		00	2402	5.156	30	6.656	36
TM5		39	2441	4.976	30	6.476	36
TM6		78	2480	4.909	30	6.409	36
TM7		00	2402	5.730	30	7.230	36
TM8		39	2441	5.556	30	7.056	36
TM9		78	2480	5.501	30	7.001	36

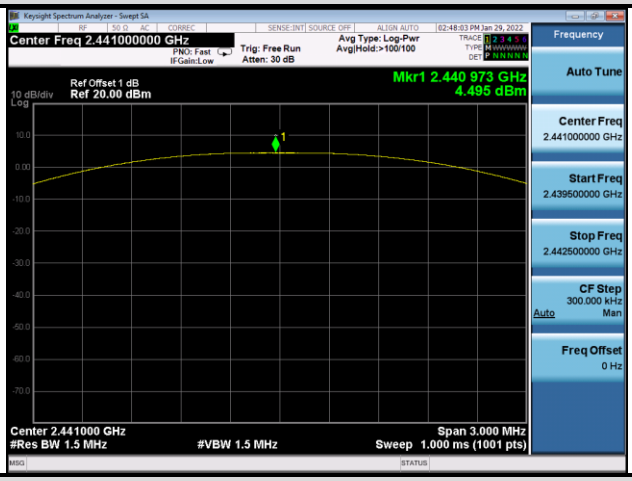
Note:
EIRP=Peak Conducted Output Power + Antenna Gain
The cable loss=1dB was provided by the client, and was factored in the result Peak Conducted Output Power

Figure 2: Peak Output Power, TM1 to TM9

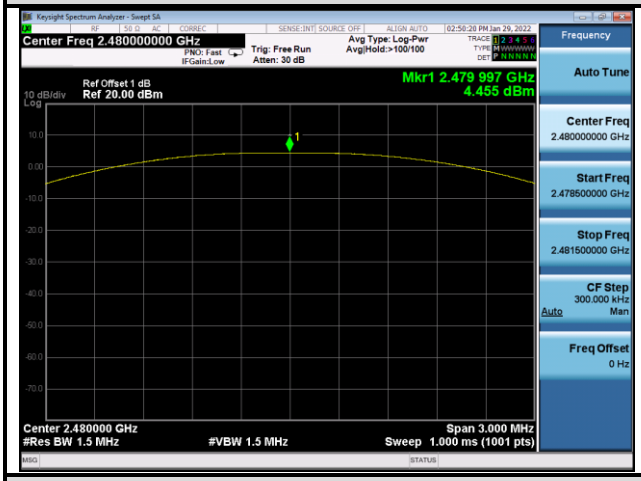
TM1



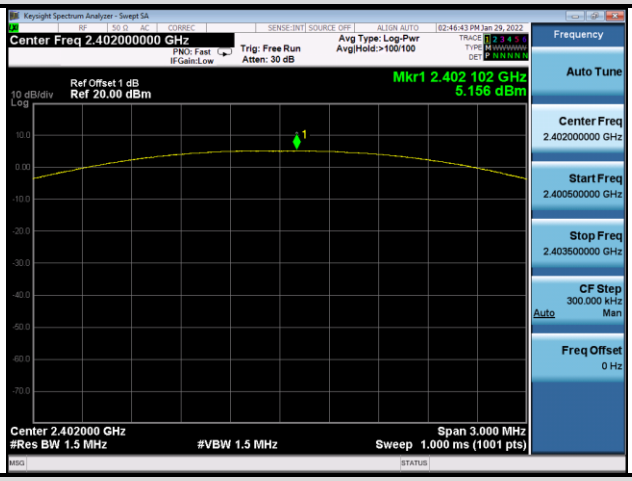
TM2



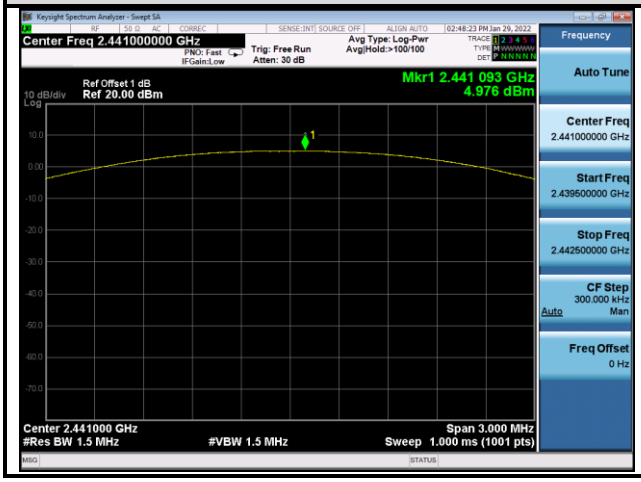
TM3



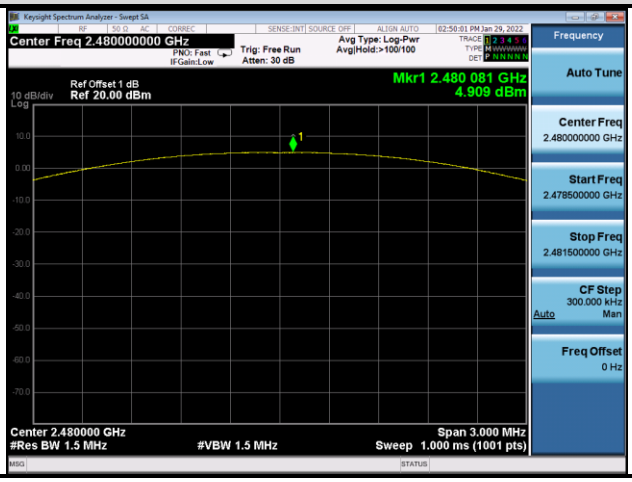
TM4

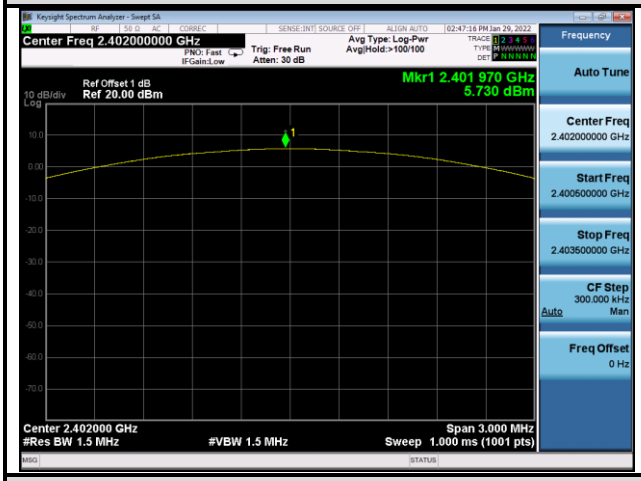
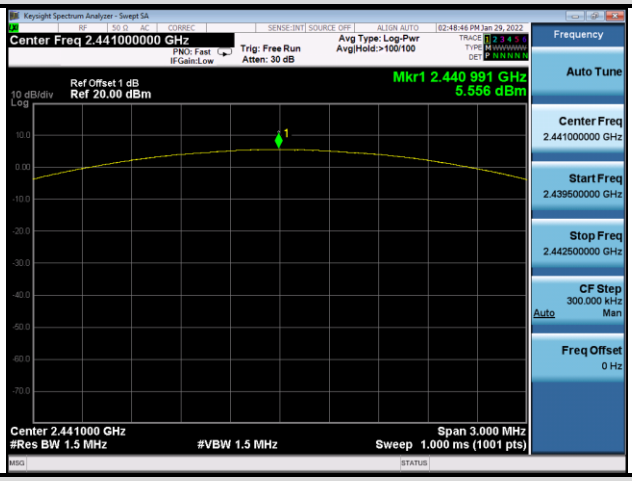
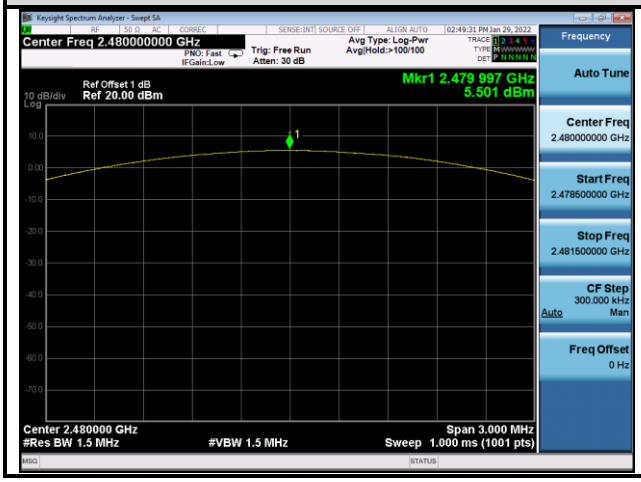


TM5



TM6



TM7	TM8
	
TM9	
	

Center Freq 2.402000000 GHz
Trig: Free Run
Atten: 30 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
Ref Offset 1 dB
10 dB/div
Ref 20.00 dBm
Mkr1 2.401 970 GHz
5.730 dBm
Center 2.402000 GHz
#Res BW 1.5 MHz
#VBW 1.5 MHz
Span 3.000 MHz
Sweep 1.000 ms (1001 pts)
Frequency
Auto Tune
Center Freq
2.402000000 GHz
Start Freq
2.400500000 GHz
Stop Freq
2.403500000 GHz
CF Step
300.000 kHz
Auto
Man
Freq Offset
0 Hz

Center Freq 2.441000000 GHz
Trig: Free Run
Atten: 30 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
Ref Offset 1 dB
10 dB/div
Ref 20.00 dBm
Mkr1 2.440 991 GHz
5.556 dBm
Center 2.441000 GHz
#Res BW 1.5 MHz
#VBW 1.5 MHz
Span 3.000 MHz
Sweep 1.000 ms (1001 pts)
Frequency
Auto Tune
Center Freq
2.441000000 GHz
Start Freq
2.439500000 GHz
Stop Freq
2.442500000 GHz
CF Step
300.000 kHz
Auto
Man
Freq Offset
0 Hz

Center Freq 2.480000000 GHz
Trig: Free Run
Atten: 30 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
Ref Offset 1 dB
10 dB/div
Ref 20.00 dBm
Mkr1 2.479 997 GHz
5.501 dBm
Center 2.480000 GHz
#Res BW 1.5 MHz
#VBW 1.5 MHz
Span 3.000 MHz
Sweep 1.000 ms (1001 pts)
Frequency
Auto Tune
Center Freq
2.480000000 GHz
Start Freq
2.478500000 GHz
Stop Freq
2.481500000 GHz
CF Step
300.000 kHz
Auto
Man
Freq Offset
0 Hz

5.1.4 Frequency Separation

RESULT: **Pass**

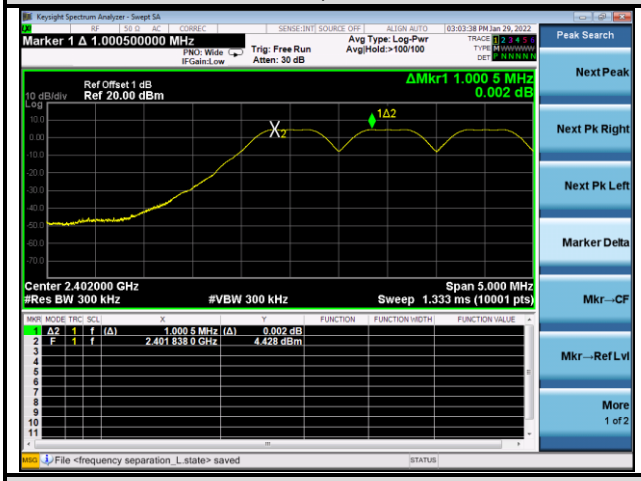
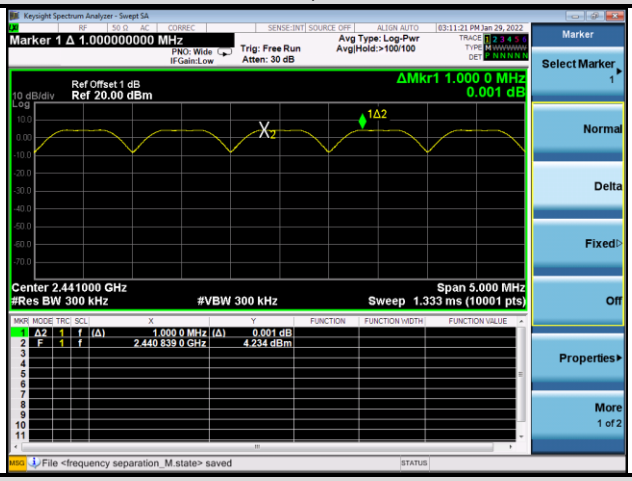
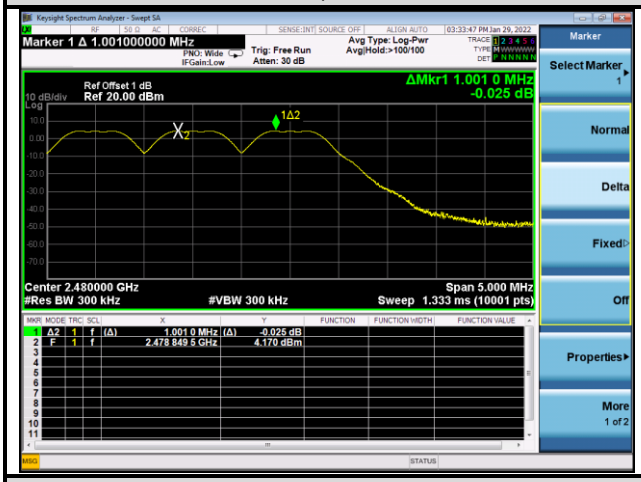
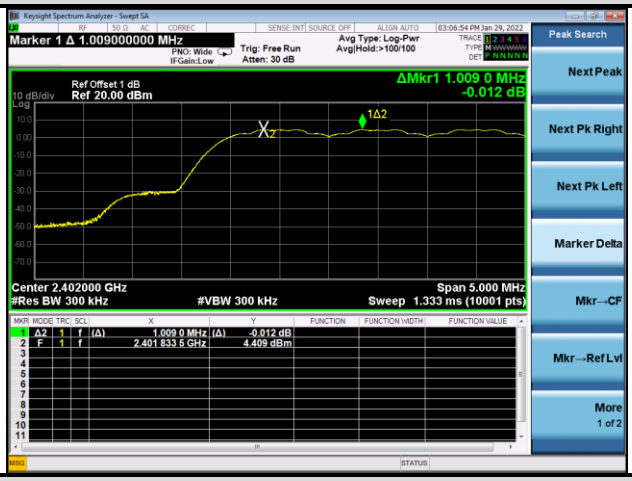
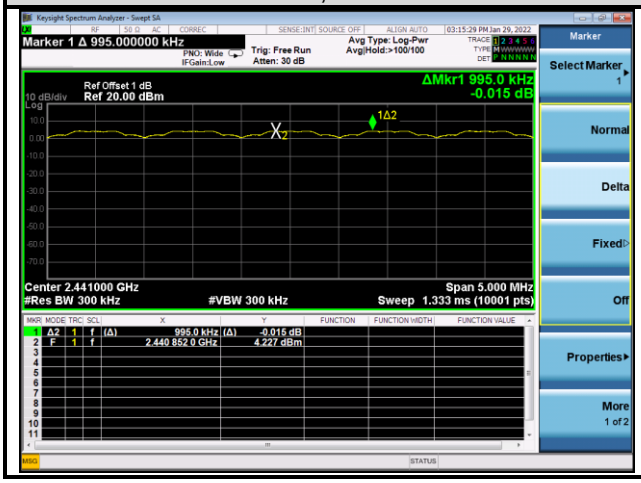
Date of testing	:	2022-01-29
Ambient temperature	:	21.0°C
Relative humidity	:	36.3%
Atmospheric pressure	:	101kPa
Test requirement	:	FCC Part 15.247(a)(1) RSS-247 Issue 2, February 2017, Clause 5.1(b)
Test procedure	:	ANSI C63.10: 2013
Test voltage	:	DC 3.6V
Test modes applied	:	TM12 , TM15, TM18

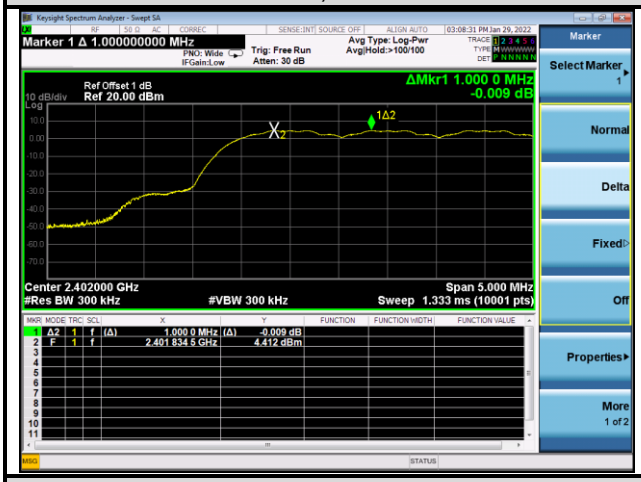
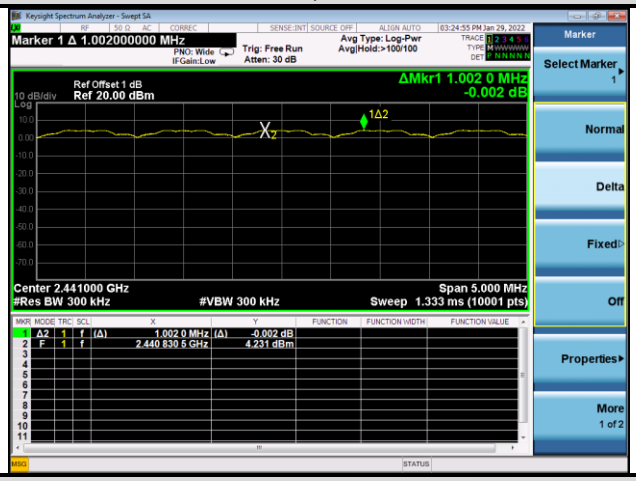
Table 10: Frequency Separation

Test Mode	CH.	Frequency [MHz]	Frequency Separation [kHz]	Limit [kHz]
TM12	00	2402	1005	≥ 632.2
	39	2441	1000	≥ 631.4
	78	2480	1001	≥ 630.9
TM15	00	2402	1009	≥ 856.0
	39	2441	995	≥ 854.7
	78	2480	997	≥ 854.7
TM18	00	2402	1000	≥ 832.0
	39	2441	1002	≥ 832.0
	78	2480	999	≥ 832.7

Note:
Frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater.

Figure 3: Frequency Separation

TM12, CH00	TM12, CH39
	
TM12, TM78	**TM15, CH00**
	
TM15, CH39	**TM15, CH78**
	

TM18, CH00	TM18, CH39
	
TM18, CH78	
	

5.1.5 Number of Hopping Frequency

RESULT: **Pass**

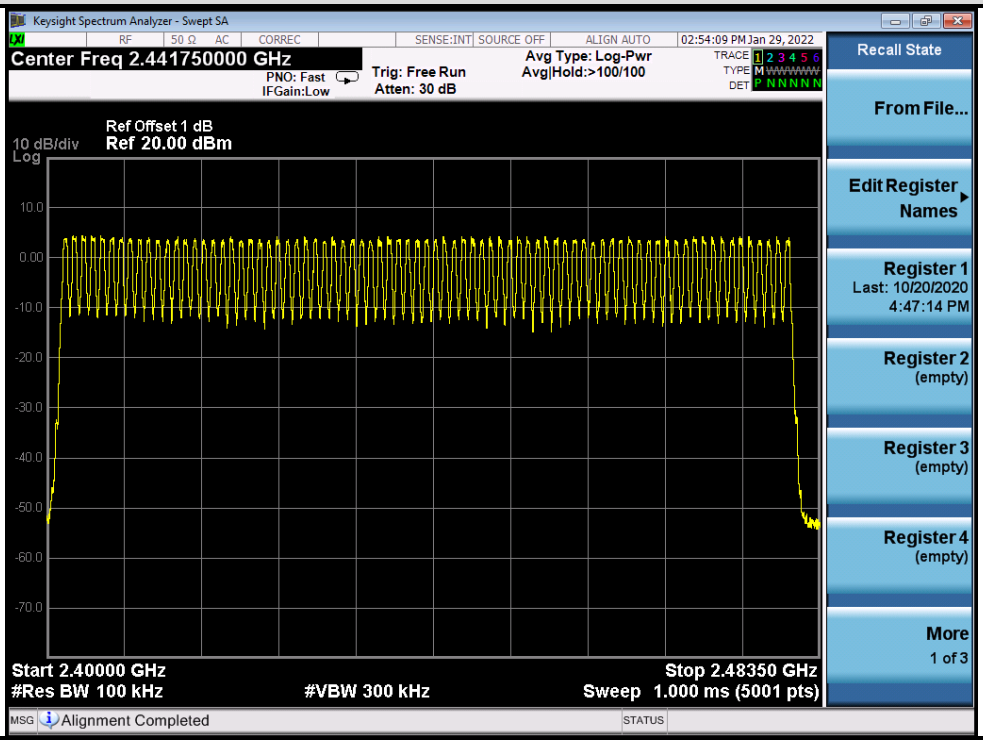
Date of testing	:	2022-01-29
Ambient temperature	:	21.0°C
Relative humidity	:	36.3%
Atmospheric pressure	:	101kPa
Test requirement	:	FCC 15.247(a)(1)(iii) RSS-247 Issue 2, February 2017, Clause 5.1(d)
Test procedure	:	ANSI C63.10: 2013
Test voltage	:	DC 3.6V
Test modes applied	:	TM12, TM15, TM18

Table 11: Number of Hopping Frequency

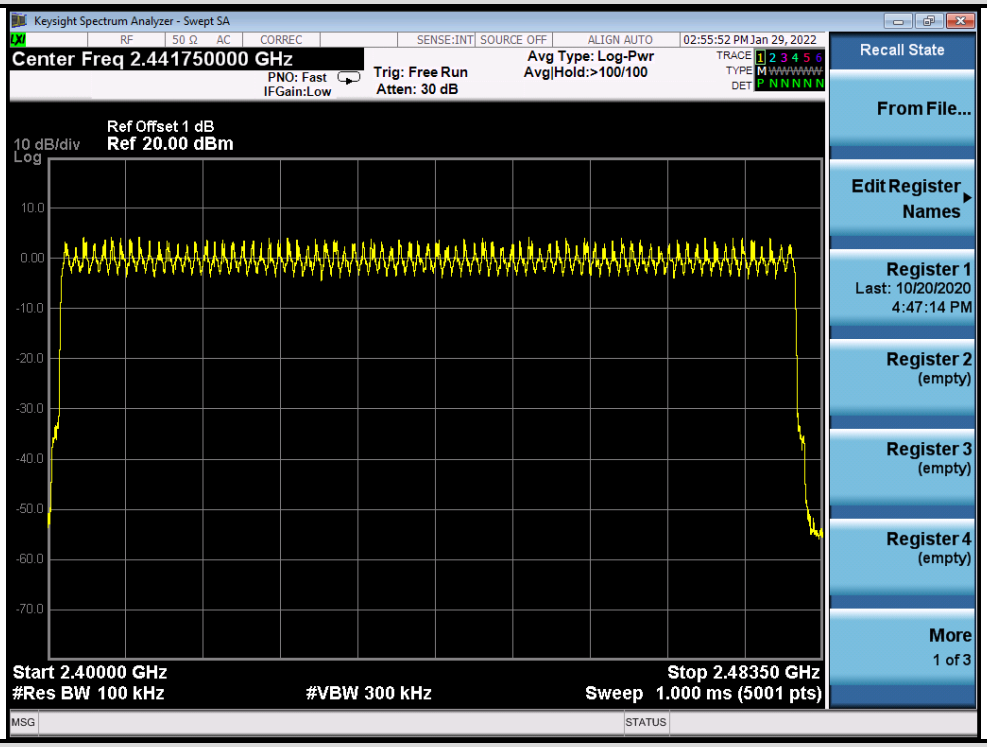
Frequency Range	Test mode	Measured Quantity of Hopping Channel	Limit
2402 to 2480	TM12	79	≥15
	TM15	79	≥15
	TM18	79	≥15

Figure 4: Number of Hopping Frequency

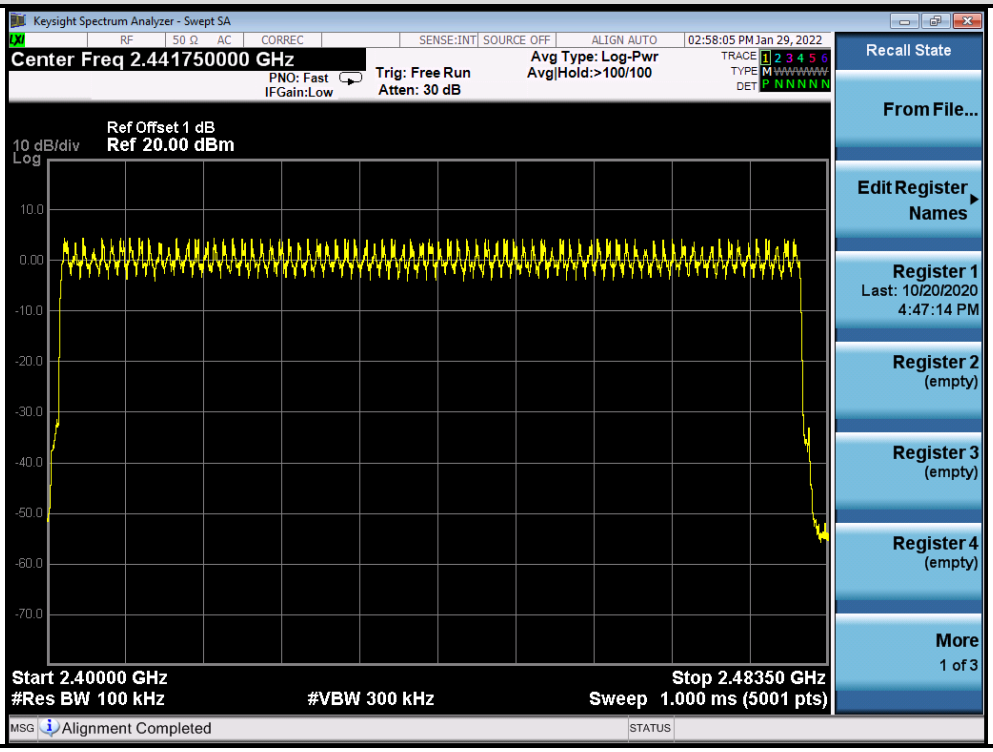
TM12



TM15


Keysight Spectrum Analyzer - Swept SA
Center Freq 2.441750000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 30 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
02:55:52 PM Jan 29, 2022
Ref Offset 1 dB
10 dB/div
Log
Ref 20.00 dBm
Start 2.40000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 2.48350 GHz
Sweep 1.000 ms (5001 pts)
Recall State
From File...
Edit Register Names
Register 1
Last: 10/20/2020 4:47:14 PM
Register 2
(empty)
Register 3
(empty)
Register 4
(empty)
More
1 of 3

TM18


Keysight Spectrum Analyzer - Swept SA
Center Freq 2.441750000 GHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 30 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
02:58:05 PM Jan 29, 2022
Ref Offset 1 dB
10 dB/div
Log
Ref 20.00 dBm
Start 2.40000 GHz
#Res BW 100 kHz
#VBW 300 kHz
Stop 2.48350 GHz
Sweep 1.000 ms (5001 pts)
Alignment Completed
Recall State
From File...
Edit Register Names
Register 1
Last: 10/20/2020 4:47:14 PM
Register 2
(empty)
Register 3
(empty)
Register 4
(empty)
More
1 of 3

5.1.6 Time of Occupancy

RESULT: **Pass**

Date of testing : 2022-01-29
Ambient temperature : 21.0°C
Relative humidity : 36.3%
Atmospheric pressure : 101kPa
Test requirement : FCC 15.247(a)(1)(iii)
RSS-247 Issue 2, February 2017, Clause 5.1(d)
Test procedure : ANSI C63.10: 2013
Test voltage : DC 3.6V
Test modes applied : TM10 to TM18

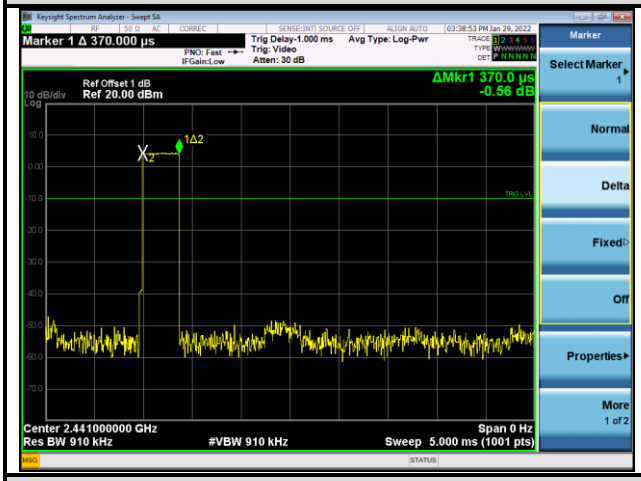
Table 12: Time of Occupancy, TM10 to TM18

Test Mode	Mode	CH.	Frequency [MHz]	Packet Duration [ms]	Hops over Occupancy Time [Hops]	Time of Occupancy [ms]	Limit [ms]
TM10	1-DH1	39	2441	0.370	320	118.40	400
TM11	1-DH3	39	2441	1.620	160	259.20	400
TM12	1-DH5	39	2441	2.870	107	307.09	400
TM13	2-DH1	39	2441	0.375	320	120.00	400
TM14	2-DH3	39	2441	1.630	160	260.80	400
TM15	2-DH5	39	2441	2.880	107	308.16	400
TM16	3-DH1	39	2441	0.380	320	121.60	400
TM17	3-DH3	39	2441	1.630	160	260.80	400
TM18	3-DH5	39	2441	2.880	107	308.16	400

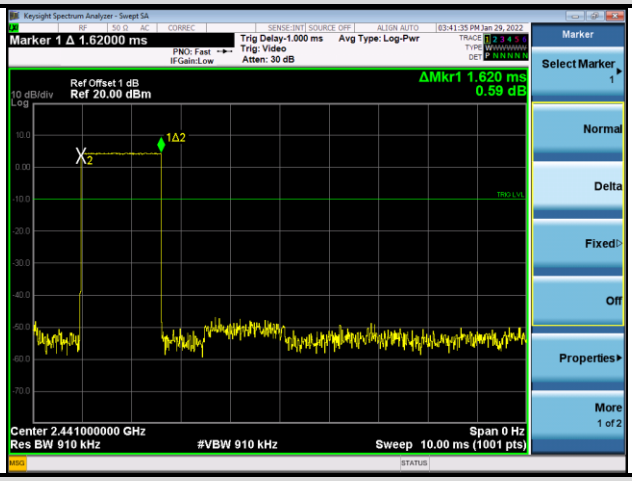
Note:
Time of occupancy = Packet duration * Hops over Occupancy Time.
Hops Over Occupancy Time in 31.6s for DH1 = 1600 / 2 / 79 * 31.6 = 320.
Hops Over Occupancy Time in 31.6s for DH3 = 1600 / 4 / 79 * 31.6 = 160.
Hops Over Occupancy Time in 31.6s for DH5 = 1600 / 6 / 79 * 31.6 = 107.

Figure 5: Time of Occupancy, TM10 to TM18

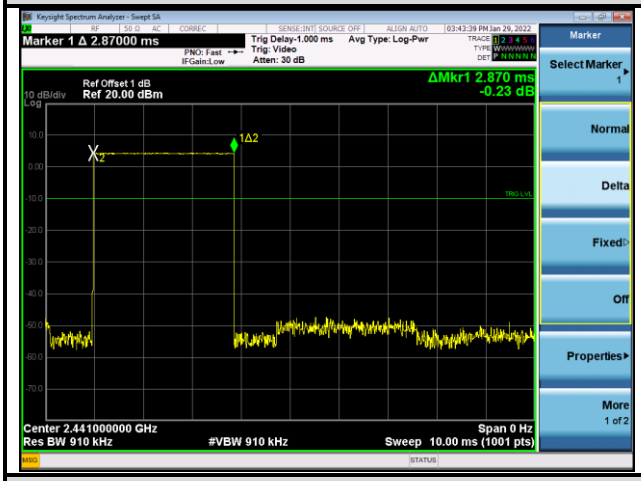
TM10



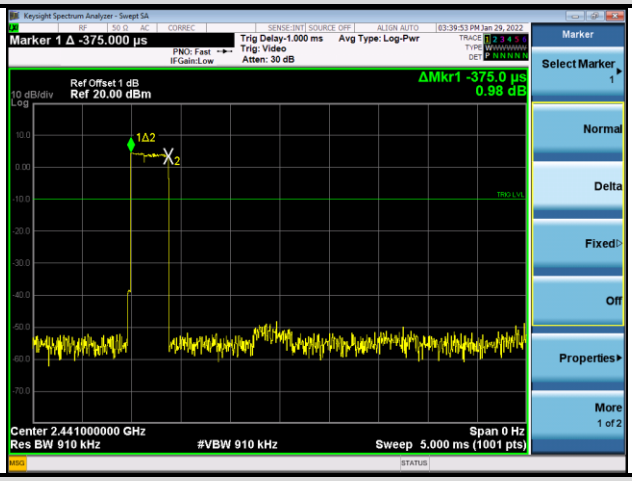
TM11



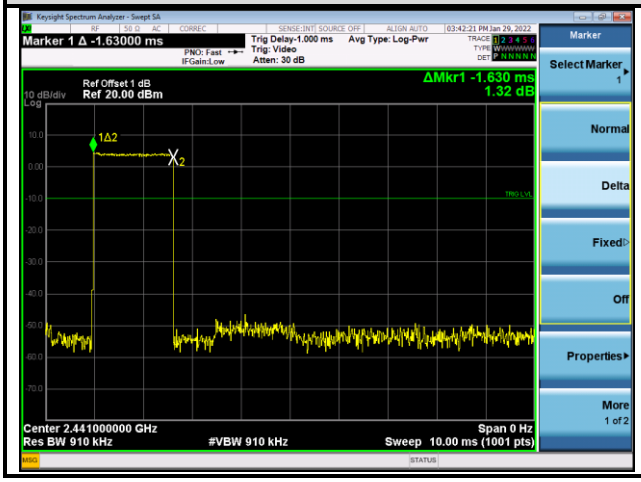
TM12



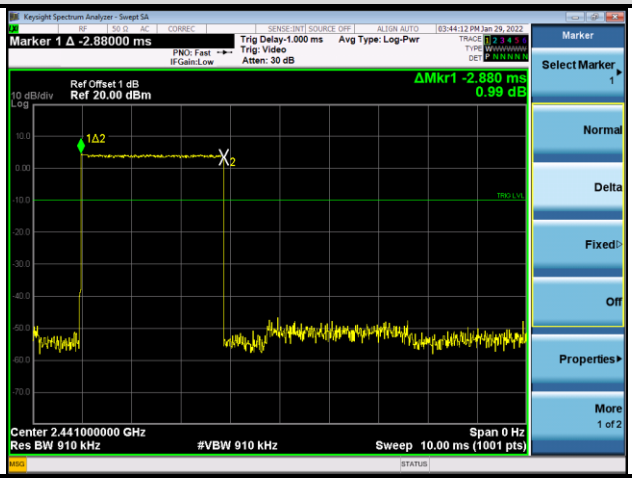
TM13

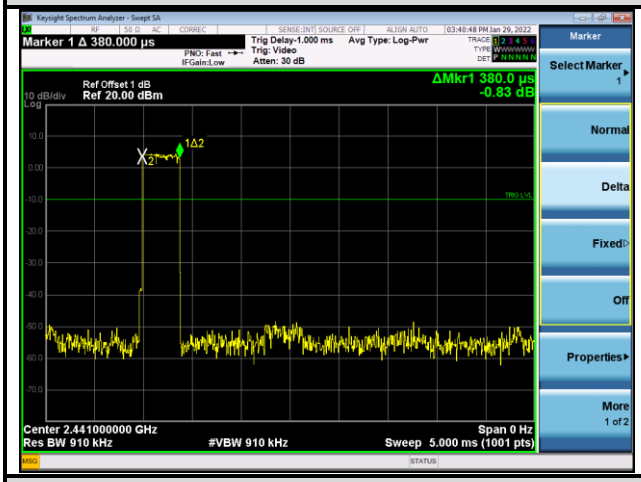
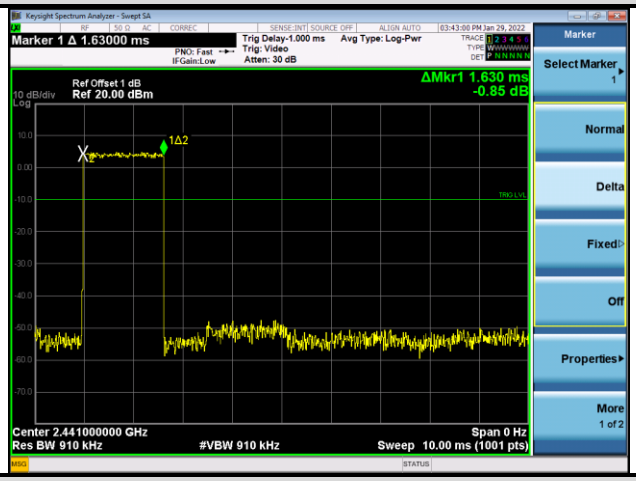
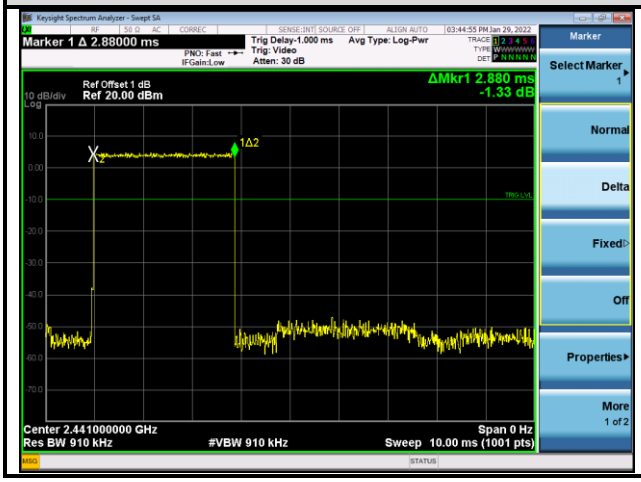


TM14



TM15



TM16	TM17
	
TM18	
	

5.1.7 Conducted Band Edge and out-of Band Emissions

RESULT: **Pass**

Date of testing	:	2022-01-29
Ambient temperature	:	21.0°C
Relative humidity	:	36.3%
Atmospheric pressure	:	101kPa
Test requirement	:	FCC Part 15.247(d) RSS-247 Issue 2, February 2017, Clause 5.5
Test procedure	:	ANSI C63.10: 2013
Test voltage	:	DC 3.6V
Test modes applied	:	TM1 to TM9, TM12, TM15, TM18

Figure 6: Reference Level

TM1

TM2

TM3

TM4

TM5

TM6

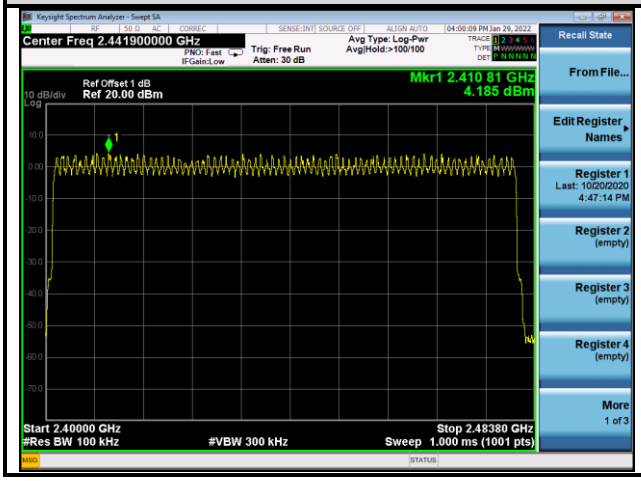
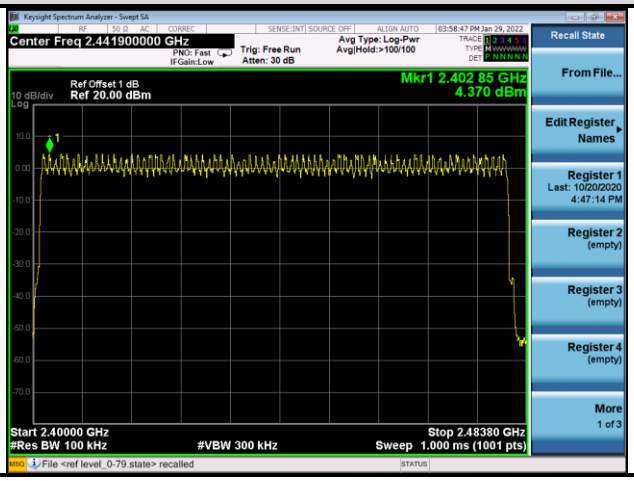
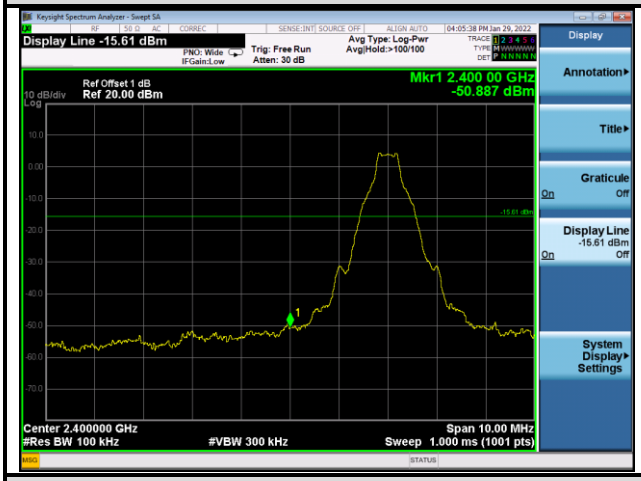
TM7	TM8
	
TM9	**TM12**
	
TM15	**TM18**
	

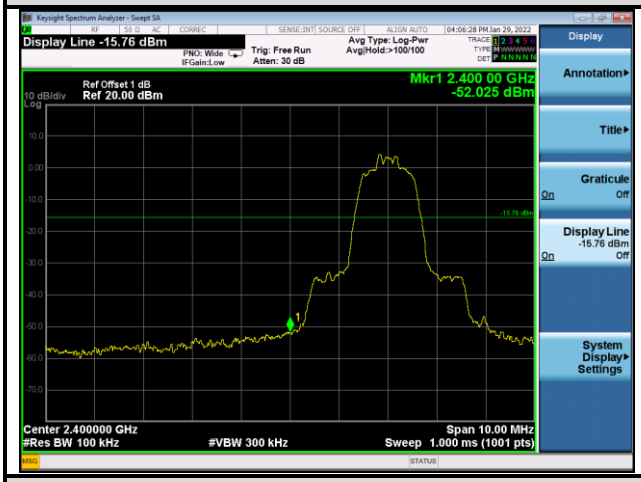
Figure 7: Conducted Band Edge

TM1



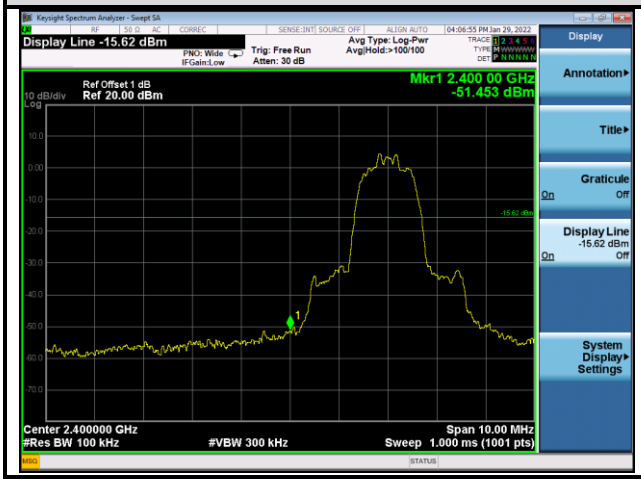
TM3

TM4

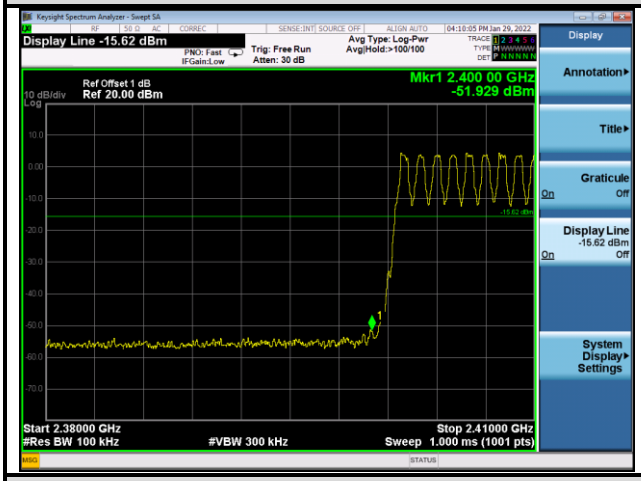
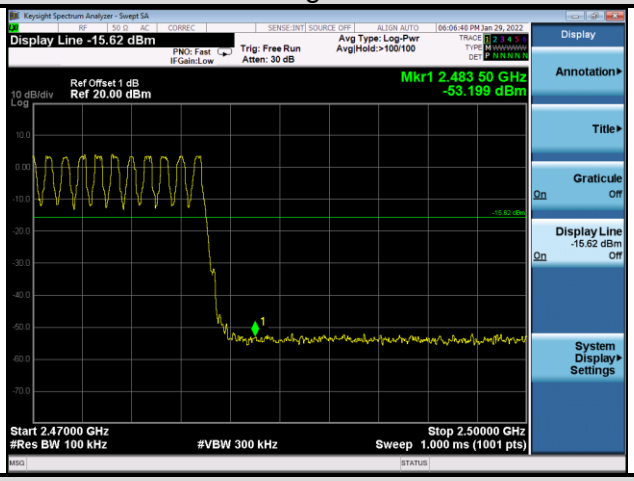
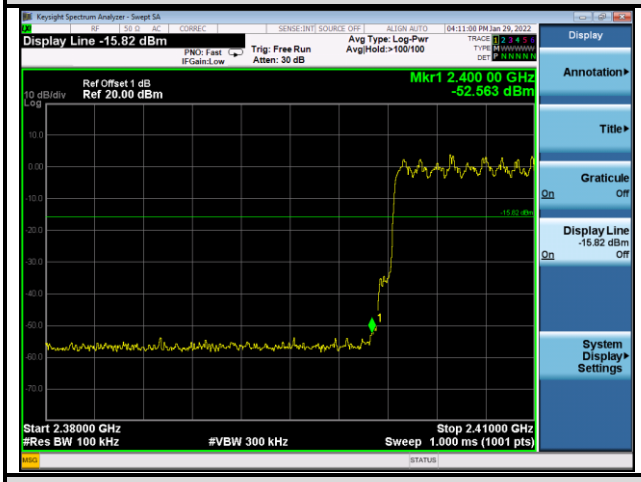
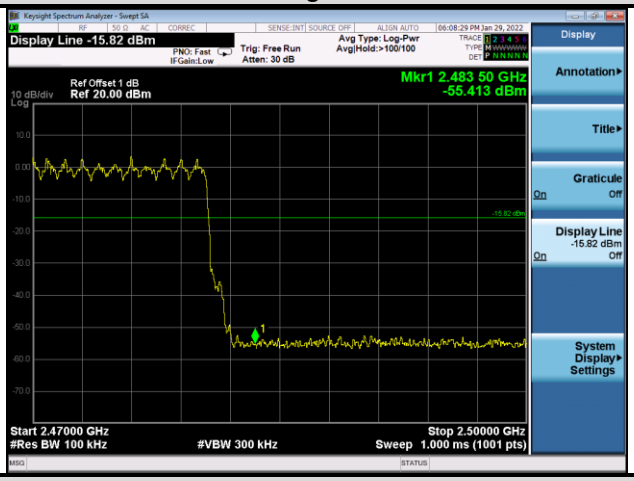


TM6

TM7



TM9

TM12 lower band	TM12 higher band
	
TM15 lower band	**TM15 higher band**
	
TM18 lower band	**TM18 higher band**