TEST REPORT

Product Name:	OPENDOTS ONE
Trade Mark:	SHOKZ
Model No.:	SHOKZ E310
Report Number:	25041017230RFC-2
Test Standards:	FCC 47 CFR Part 15 Subpart C
FCC ID:	2BCD6-E310
Test Result:	PASS
Date of Issue:	April 17, 2025

Prepared for:

SHOKZ (SINGAPORE) PTE. LTD.
11 NORTH BUONA VISTA DRIVE #16-09 THE METROPOLIS, SINGAPORE 138589, Singapore

Prepared by:

Shenzhen UnionTrust Quality and Technology Co., Ltd.
16/F, Block A, Building 6th, Baoneng Science and Technology Park, Longhua Street, Longhua District, Shenzhen, China
TEL: +86-755-2823 0888
FAX: +86-755-2823 0886

Prepared by: David Chen — David Chen, Senior Project Engineer

Reviewed by: Henry Lu — Henry Lu, Team Leader

Approved by: Kevin Liang, Assistant Manager

Date: April 17, 2025

Version

Version No.	Date	Description
V1.0	April 17, 2025	Original

CONTENTS

1. GENERAL INFORMATION

1.1 CLIENT INFORMATION

Applicant:	SHOKZ (SINGAPORE) PTE. LTD.
Address of Applicant:	11 NORTH BUONA VISTA DRIVE #16-09 THE METROPOLIS, SINGAPORE 138589, Singapore
Manufacturer:	SHOKZ (SINGAPORE) PTE. LTD.
Address of Manufacturer:	11 NORTH BUONA VISTA DRIVE #16-09 THE METROPOLIS, SINGAPORE 138589, Singapore

1.2 EUT INFORMATION

1.2.1 General Description of EUT

Product Name:	OPENDOTS ONE	
Model No.:	SHOKZ E310	
Trade Mark:	SHOKZ	
DUT Stage:	Identical Prototype	
EUT Supports Function: (Provided by the customer)	2.4 GHz ISM Band:	Bluetooth V5.4
Software Version:	THK_EU_B_09 (Provided by the Client)	
Hardware Version:	THK604J (Provided by the Client)	
Sample Received Date:	December 24, 2024	
Sample Tested Date:	December 24, 2024 to February 10, 2025	

Remark:
The above EUT's information was provided by customer. Please refer to the specifications or user's manual for more detailed description.

1.2.2 Description of Accessories

None.

1.3 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD

Frequency Band:	2400 MHz to 2483.5 MHz
Frequency Range:	2402 MHz to 2480 MHz
Bluetooth Version:	Bluetooth BR + EDR
Modulation Technique:	Frequency Hopping Spread Spectrum (FHSS)
Type of Modulation:	GFSK, π/4DQPSK, 8DPSK
Number of Channels:	79
Channel Separation:	1 MHz
Hopping Channel Type:	Adaptive Frequency Hopping Systems
Antenna Type: (Provided by the customer)	Integral Antenna
Antenna Gain: (Provided by the customer)	-3.07 dBi
Maximum Peak Power:	15.04 dBm
Normal Test Voltage:	Internal battery operated 3.85 Vdc

1.4 OTHER INFORMATION

Operation Frequency Each of Channel	
f = 2402 + k MHz, k = 0,…,78	
Note:	
f	is the operating frequency (MHz);
k	is the operating channel.

Modulation Configure			
Modulation	**Packet**	**Packet Type**	**Packet Size**
GFSK	1-DH1	4	27
	1-DH3	11	183
	1-DH5	15	339
π/4 DQPSK	2-DH1	20	54
	2-DH3	26	367
	2-DH5	30	679
8DPSK	3-DH1	24	83
	3-DH3	27	552
	3-DH5	31	1021

1.5 DESCRIPTION OF SUPPORT UNITS

The EUT has been tested with associated equipment below.

1) Support Equipment

Description	Manufacturer	Model No.	Serial Number	Supplied by
Notebook	DELL	Latitude 3400	N/A	UnionTrust
Mouse	DELL	MS111	N/A	UnionTrust

2) Support Cable

Cable No.	Description	Connector	Length	Supplied by
1	Antenna Cable	SMA	0.3 Meter	UnionTrust

1.6 TEST LOCATION

Shenzhen UnionTrust Quality and Technology Co., Ltd.

Address: 16/F, Block A, Building 6th, Baoneng Science and Technology Park, Longhua Street, Longhua District, Shenzhen, China
Telephone: +86 (0) 755 2823 0888
Fax: +86 (0) 755 2823 0886

1.7 TEST FACILITY

The test facility is recognized, certified, or accredited by the following organizations:

CNAS-Lab Code: L9069
The measuring equipment utilized to perform the tests documented in this report has been calibrated once a year or in accordance with the manufacturer's recommendations, and is traceable under the ISO/IEC 17025 to international or national standards. Equipment has been calibrated by accredited calibration laboratories.

A2LA-Lab Certificate No.: 4312.01
Shenzhen UnionTrust Quality and Technology Co., Ltd. has been accredited by A2LA for technical competence in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the identified field of testing.

ISED Wireless Device Testing Laboratories
CAB identifier: CN0032

FCC Accredited Lab.
Designation Number: CN1194
Test Firm Registration Number: 259480

1.8 DEVIATION FROM STANDARDS

None.

1.9 ABNORMALITIES FROM STANDARD CONDITIONS

None.

1.10 OTHER INFORMATION REQUESTED BY THE CUSTOMER

None.

1.11 MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the Product as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

No.	Item	Measurement Uncertainty
1	Conducted emission 9kHz-150kHz	±3.2 dB
2	Conducted emission 150kHz-30MHz	±2.7 dB
3	Radiated emission 9kHz-30MHz	± 4.7 dB
4	Radiated emission 30MHz-1GHz	± 4.9 dB
5	Radiated emission 1GHz-18GHz	± 4.8 dB
6	Radiated emission 18GHz-26GHz	± 5.1 dB
7	Radiated emission 26GHz-40GHz	± 5.1 dB
8	Conducted spurious emissions	± 2.7 dB
9	RF Power, Conducted	± 0.68 dB
10	Occupied Bandwidth	± 1.86 %
11	Radio Frequency	2.4 GHz: ± 6.5 x 10^{-8}
12	Transmission Time	± 0.19 %

2. TEST SUMMARY

Test Cases			
Test Item	**Test Requirement**	**Test Method**	**Result**
Antenna Requirement	FCC 47 CFR Part 15 Subpart C Section 15.203/15.247 (b)	N/A	PASS
AC Power Line Conducted Emission	FCC 47 CFR Part 15 Subpart C Section 15.207	ANSI C63.10-2013 Section 6.2	N/A Note 1, 2
Conducted Peak Output Power	FCC 47 CFR Part 15 Subpart C Section 15.247 (b)(1)	ANSI C63.10-2013 Section 7.8.5	PASS
20 dB Bandwidth	FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1)	ANSI C63.10-2013 Section 6.9.2	PASS
Carrier Frequencies Separation	FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1)	ANSI C63.10-2013 Section 7.8.2	PASS
Number of Hopping Channel	FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1)(iii)	ANSI C63.10-2013 Section 7.8.3	PASS
Dwell Time	FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1)	ANSI C63.10-2013 Section 7.8.4	PASS
Conducted Out of Band Emission	FCC 47 CFR Part 15 Subpart C Section 15.247(d)	ANSI C63.10-2013 Section 6.10.4 & Section 7.8.8	PASS
Radiated Emissions	FCC 47 CFR Part 15 Subpart C Section 15.205/15.209	ANSI C63.10-2013 Section 6.3 & 6.5 & 6.6	PASS
Band Edge Measurement	FCC 47 CFR Part 15 Subpart C Section 15.205/15.209	ANSI C63.10-2013 Section 6.10.5	PASS

Note:
1. N/A: In this whole report not applicable.
2. Place EUT into the charging case, they will turn off automatically, so the Bluetooth does not work.

Disclaimer and Explanations:
The declared of product specification and data (e.g., antenna gain, RF specification, etc) for EUT presented in the report are provided by the customer, and the customer takes all the responsibilities for the accuracy of product specification.

3. EQUIPMENT LIST

Radiated Emission Test Equipment List						
Used	**Equipment**	**Manufacturer**	**Model No.**	**Serial Number**	**Cal. date**	**Cal. Due date**
☑	3m SAC	ETS-LINDGREN	3M	Euroshiedpn-CT001270-1317	11-Nov-2023	10-Nov-2026
☑	Receiver	R&S	ESIB26	100114	25-Oct-2024	24-Oct-2025
☑	Loop Antenna	ETS-LINDGREN	6502	00202525	28-Oct-2024	27-Oct-2025
☑	Broadband Antenna	ETS-LINDGREN	3142E	00201566	29-Oct-2024	28-Oct-2025
☑	6dB Attenuator	Talent	RA6A5-N-18	18103001	29-Oct-2024	28-Oct-2025
☑	Preamplifier	HP	8447F	2805A02960	25-Oct-2024	24-Oct-2025
☑	Double-Ridged Waveguide Horn Antenna (Pre-amplifier)	ETS-LINDGREN	3117-PA	00201541	01-Apr-2024	31-Mar-2025
☑	Pre-amplifier	ETS-LINDGREN	00118385	00201874	01-Apr-2024	31-Mar-2025
☑	Double-Ridged Waveguide Horn Antenna (Pre-amplifier)	ETS-LINDGREN	3116C-PA	00202652	28-Oct-2024	27-Oct-2025
☑	Pre-amplifier	ETS-LINDGREN	00118384	00202652	28-Oct-2024	27-Oct-2025
☑	Multi device Controller	ETS-LINDGREN	7006-001	00160105	N/A	N/A
☑	Test Software	Audix	e3	Software Version: 9.160323		

RF Conducted Test Equipment List						
Used	**Equipment**	**Manufacturer**	**Model No.**	**Serial Number**	**Cal. date**	**Cal. Due date**
☑	EXA Signal Analyzer	KEYSIGHT	N9010B	MY62060155	29-Mar-2024	28-Mar-2025
☑	USB Wideband Power Sensor	KEYSIGHT	U2021XA	MY55430035	25-Oct-2024	24-Oct-2025

4. TEST CONFIGURATION

4.1 ENVIRONMENTAL CONDITIONS FOR TESTING

4.1.1 Normal or Extreme Test Conditions

Environment Parameter	Selected Values During Tests		
Test Condition	Ambient		
	Temperature (°C)	Voltage	Relative Humidity (%)
NT/NV	+15 to +35	3.85V Battery	20 to 75
Remark: 1) NV: Normal Voltage; NT: Normal Temperature			

4.1.2 Record of Normal Environment and Test Sample

Test Item	Temp. (°C)	Relative Humidity (%)	Pressure (kPa)	Sample No.	Tested by
AC Power Line Conducted Emission	N/A	N/A	N/A	N/A	N/A
Conducted Peak Output Power	20.4	47.1	100.7	S202504115729-ZJA08/9	Allen Zhou
20 dB Bandwidth					
Carrier Frequencies Separation					
Number of Hopping Channel					
Dwell Time					
Conducted Out of Band Emission					
Radiated Emissions	23.5	45.4	100.7	S202504115729-ZJA09/9	Fire Huo
Band Edge Measurement					

4.2 TEST CHANNELS

Mode	Tx/Rx Frequency	Test RF Channel Lists		
		Lowest(L)	Middle(M)	Highest(H)
GFSK (DH1, DH3, DH5)	2402 MHz to 2480 MHz	Channel 0	Channel 39	Channel 78
		2402 MHz	2441 MHz	2480 MHz
π/4DQPSK (DH1, DH3, DH5)	2402 MHz to 2480 MHz	Channel 0	Channel 39	Channel 78
		2402 MHz	2441 MHz	2480 MHz
8DPSK (DH1, DH3, DH5)	2402 MHz to 2480 MHz	Channel 0	Channel 39	Channel 78
		2402 MHz	2441 MHz	2480 MHz

4.3 EUT TEST STATUS

Type of Modulation	Tx Function	Description
GFSK/π/4DQPSK/ 8DPSK	1Tx	1. Keep the EUT in continuously transmitting with Modulation test single 2. Keep the EUT in continuously transmitting with Modulation test Hopping Frequency.

Power Setting (Provided by the customer)
Power Setting: 3

Test Software (Provided by the customer)
Non Signaling Test Tool(20240507 tmp_for2402and2480)

4.4 PRE-SCAN

4.4.1 Worst-case data packets

Type of Modulation	Worst-case data rates
GFSK	1-DH5
π/4DQPSK	2-DH5
8DPSK	3-DH5

4.4.2 Tested channel detail

Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data packets and antenna ports (if EUT with antenna diversity architecture). Following channel(s) was (were) selected for the final test as listed below.

Type of Modulation	**GFSK**			**π/4DQPSK**			**8DPSK**		
Data Packets	1-DH 1	1-DH 3	1-DH 5	2-DH 1	2-DH 3	2-DH 5	3-DH 1	3-DH 3	3-DH 5
Available Channel	0 to 78								
Test Item	**Test channel and choose of data packets**								
Conducted Peak Output Power	Channel 0 & 39 & 78								
	☐	☐	☒	☐	☐	☐	☐	☐	☒
20 dB Bandwidth	Channel 0 & 39 & 78								
	☐	☐	☒	☐	☐	☐	☐	☐	☒
Carrier Frequencies Separation	Frequency Hopping Channel 0 to 78								
	☐	☐	☒	☐	☐	☐	☐	☐	☒
Number of Hopping Channel	Frequency Hopping Channel 0 to 78								
	☐	☐	☒	☐	☐	☐	☐	☐	☒
Dwell Time	Channel 39								
	☒	☒	☒	☐	☐	☐	☒	☒	☒
Conducted Out of Band Emission	Channel 0 & 39 & 78								
	☐	☐	☒	☐	☐	☐	☐	☐	☒
Radiated Emissions	Channel 0 & 39 & 78								
	☐	☐	☒	☐	☐	☐	☐	☐	☐
Band Edge Measurements (Radiated)	Channel 0 & 78								
	☐	☐	☒	☐	☐	☐	☐	☐	☐

Remark:

1. The mark "☒" means is chosen for testing;
2. The mark "☐" means is not chosen for testing.

4.5 TEST SETUP

4.5.1 For Radiated Emissions test setup

Figure 1. Below 30MHz

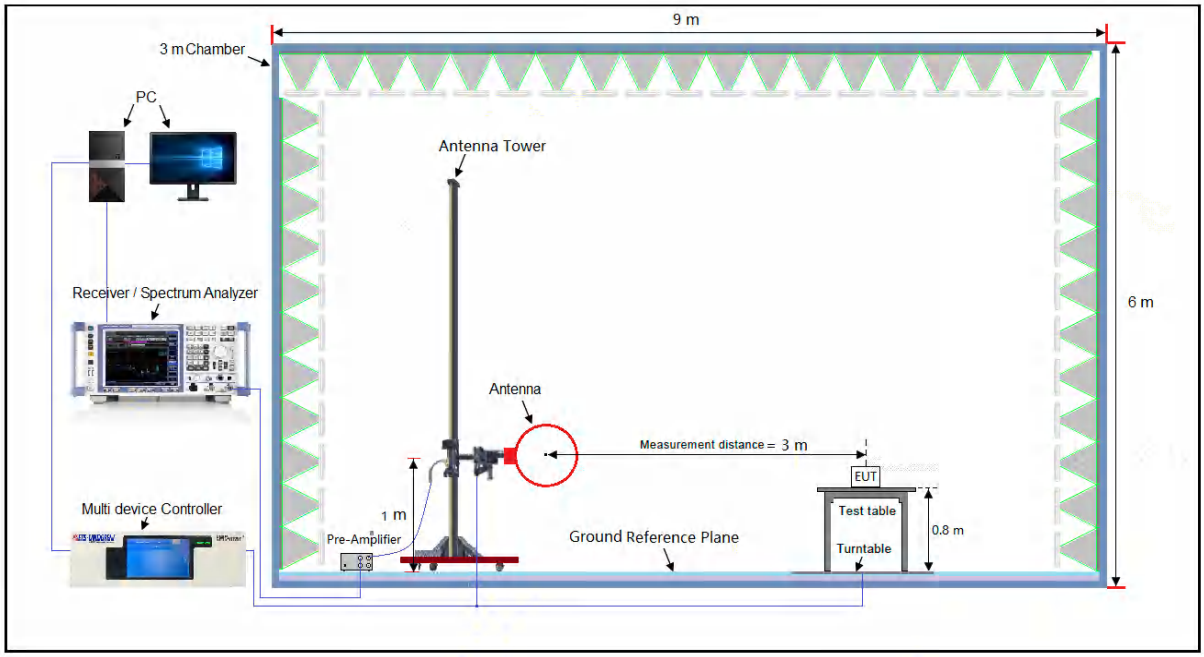


Figure 2. 30MHz to 1GHz

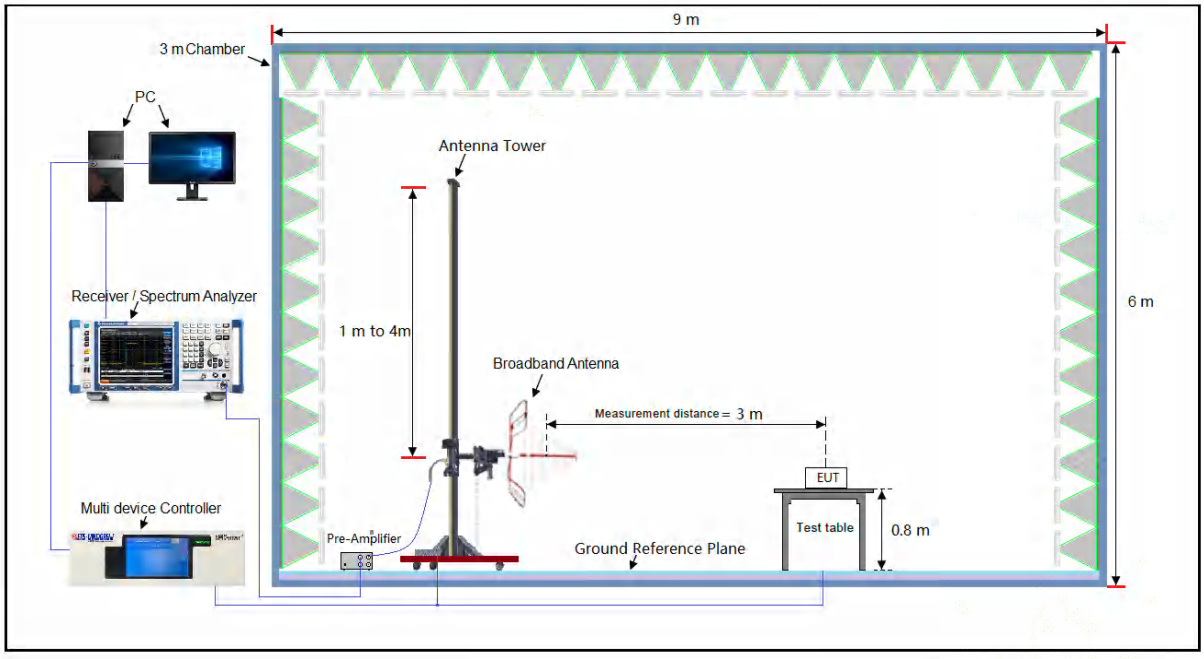
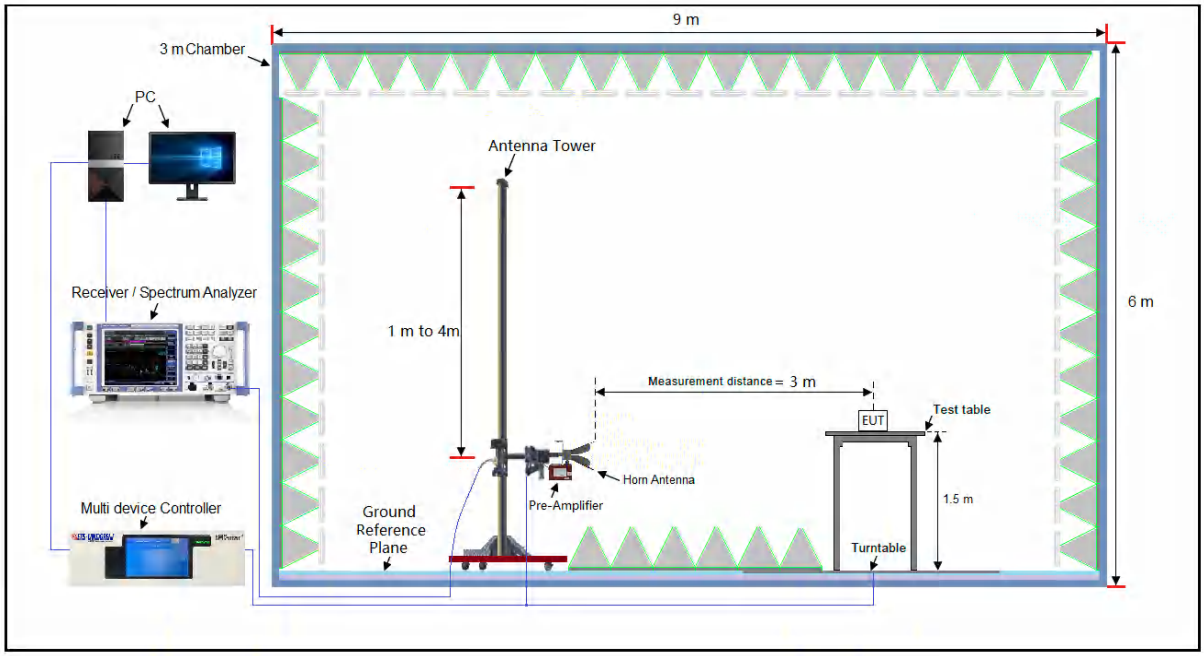
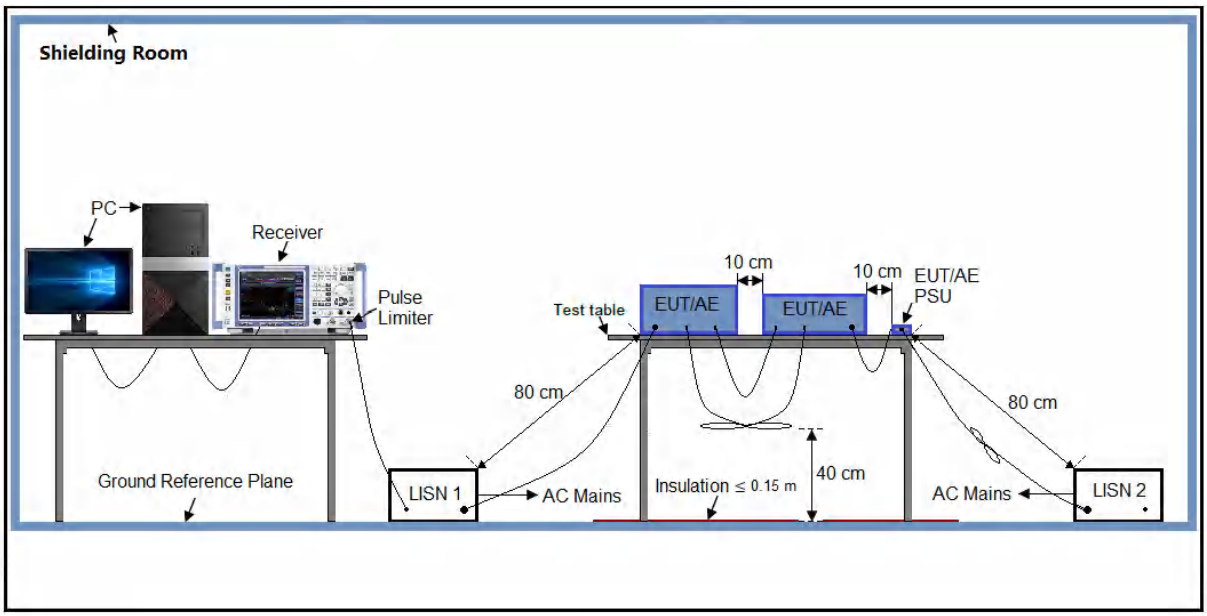


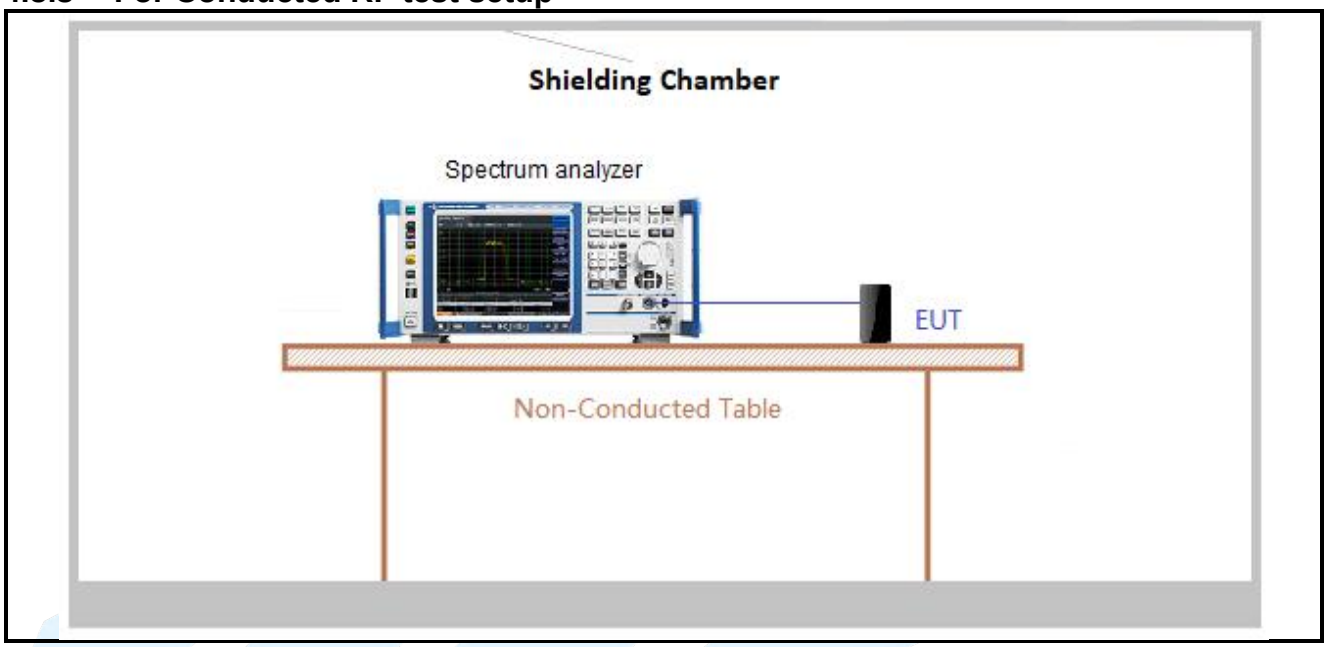
Figure 3. Above 1GHz



4.5.2 For Conducted Emissions test setup



4.5.3 For Conducted RF test setup



4.6 SYSTEM TEST CONFIGURATION

For emissions testing, the equipment under test (EUT) setup to transmit continuously to simplify the measurement methodology. Care was taken to ensure proper power supply voltages during testing. During testing, radiated emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario. Only the worst case data were recorded in this test report.

The signal is maximized through rotation and placement in the three orthogonal axes. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters. Radiated emissions are taken at three meters unless the signal level is too low for measurement at that distance. If necessary, a pre-amplifier is used and/or the test is conducted at a closer distance. Therefore, all final radiated testing was performed with the EUT in orientation.

All readings are extrapolated back to the equivalent three meter reading using inverse scaling with distance. Analyzer resolution is 100 kHz or greater for frequencies below 1000 MHz. The resolution is 1 MHz or greater for frequencies above 1000 MHz. The spurious emissions more than 20 dB below the permissible value are not reported.

Radiated emission measurement were performed from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

5. RADIO TECHNICAL REQUIREMENTS SPECIFICATION

5.1 REFERENCE DOCUMENTS FOR TESTING

No.	Identity	Document Title
1	FCC 47 CFR Part 2	Frequency allocations and radio treaty matters; general rules and regulations
2	FCC 47 CFR Part 15	Radio Frequency Devices
3	ANSI C63.10-2013	American National Standard for Testing Unlicesed Wireless Devices
4	KDB 558074 D01 15.247 Meas Guidance v05r02	Guidance for compliance measurements on Digital Transmission Systems, Frequency Hopping Spread Spectrum system, and Hybrid system devices operating under Section 15.247 of the FCC rules

5.2 ANTENNA REQUIREMENT

Standard Requirement
15.203 requirement: 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, 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. **15.247(b) (4) requirement:** The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.
EUT Antenna:
Antenna in the interior of the equipment and no consideration of replacement. The gain of the antenna is -3.07 dBi.

5.3 CONDUCTED PEAK OUTPUT POWER

Test Requirement: FCC 47 CFR Part 15 Subpart C Section15.247 (b)(1)

Test Method: ANSI C63.10-2013 Section 7.8.5

Limit: For FHSs operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1.0 W if the hopset uses 75 or more hopping channels; the maximum peak conducted output power shall not exceed 0.125 W if the hopset uses less than 75 hopping channels. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

Alternatively, 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, provided the systems operate with an output power no greater than 125 mW.

Test Procedure: Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.

a) Use the following spectrum analyzer settings:
   1) Span: Approximately 5 x 20 dB bandwidth, centered on a hopping channel.
   2) RBW > 20 dB bandwidth of the emission being measured.
   3) VBW ≥ RBW.
   4) Sweep: Auto.
   5) Detector function: Peak.
   6) Trace: Max hold.

b) Allow trace to stabilize.
c) Use the marker-to-peak function to set the marker to the peak of the emission.
d) The indicated level is the peak output power, after any corrections for external attenuators and cables.
e) A plot of the test results and setup description shall be included in the test report.

Test Setup: Refer to section 4.5.3 for details.

Instruments Used: Refer to section 3 for details

Test Results: Pass

Modulation	Frequency	Max. Peak Power		Peak Power Limit	Max. Avg. Power	Result
	(MHz)	(dBm)	(mW)	(dBm)	(dBm)	
GFSK	2402	14.88	30.76	20.97	13.89	Pass
	2441	14.88	30.76	20.97	13.85	Pass
	2480	14.53	28.38	20.97	13.46	Pass
8DPSK	2402	14.87	30.69	20.97	11.21	Pass
	2441	15.04	31.92	20.97	11.28	Pass
	2480	14.46	27.93	20.97	10.94	Pass

Note: The antenna gain of -3.07 dBi less than 6dBi maximum permission antenna gain value based on 125 mW peak output power limit.

5.4 20 DB BANDWIDTH

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1)

Test Method: ANSI C63.10-2013 Section 6.9.2
RSS-Gen section 6.7

Limit: None; for reporting purposes only.

Test Procedure: Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
Use the following spectrum analyzer settings:

a) Span = approximately 2 to 5 times the OBW, centered on a hopping channel.
b) RBW = 1% to 5% of the OBW.
c) VBW ≥ 3 x RBW
d) Sweep = auto;
e) Detector function = peak
f) Trace = max hold
g) All the trace to stabilize, use the marker-to-peak function to set the marker to the peak of the emission, use the marker-delta function to measure and record the 20dB down bandwidth of the emission.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.5.3 for details.

Instruments Used: Refer to section 3 for details

Test Results:

Test Mode	Antenna	Channel	20db EBW [MHz]	Limit[MHz]	Verdict
DH5	Ant1	2402	1.002	---	---
		2441	0.954	---	---
		2480	0.966	---	---
3DH5	Ant1	2402	1.161	---	---
		2441	1.230	---	---
		2480	1.242	---	---

DH5_Ant1_2402 MHz

DH5_Ant1_2441 MHz

DH5_Ant1_2480 MHz

3DH5_Ant1_2402 MHz

3DH5_Ant1_2441 MHz

3DH5_Ant1_2480 MHz


5.5 CARRIER FREQUENCIES SEPARATION

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1)

Test Method: ANSI C63.10-2013 Section 7.8.2

Limit: 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.
Alternatively, 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, provided the systems operate with an output power no greater than 125 mW.

Test Procedure: Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
Use the following spectrum analyzer settings:

a) Span: Wide enough to capture the peaks of two adjacent channels.
b) RBW: Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
c) Video (or average) bandwidth (VBW) ≥ RBW.
d) Sweep: Auto.
e) Detector function: Peak.
f) Trace: Max hold.
g) Allow the trace to stabilize.
h) Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.5.3 for details.

Instruments Used: Refer to section 3 for details

Test Results:

Test Mode	Antenna	Channel	Result[MHz]	Limit[MHz]	Verdict
DH5	Ant1	Hop	1.004	≥1.002	PASS
3DH5	Ant1	Hop	1.298	≥1.242	PASS

DH5_Ant1_Hop

3DH5_Ant1_Hop


5.6 NUMBER OF HOPPING CHANNEL

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.247(b)(1)

Test Method: ANSI C63.10-2013 Section 7.8.3

Limit: Frequency hopping systems in the 2400 – 2483.5 MHz band shall use at least 15 non-overlapping channels.

Test Procedure: Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
Use the following spectrum analyzer settings:

a) Span: The frequency band of operation. Depending on the number of channels the device supports, it may be necessary to divide the frequency range of operation across multiple spans, to allow the individual channels to be clearly seen.
b) RBW < 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
c) VBW ≥ RBW.
d) Sweep: Auto.
e) Detector function: Peak.
f) Trace: Max hold.
g) Allow the trace to stabilize.

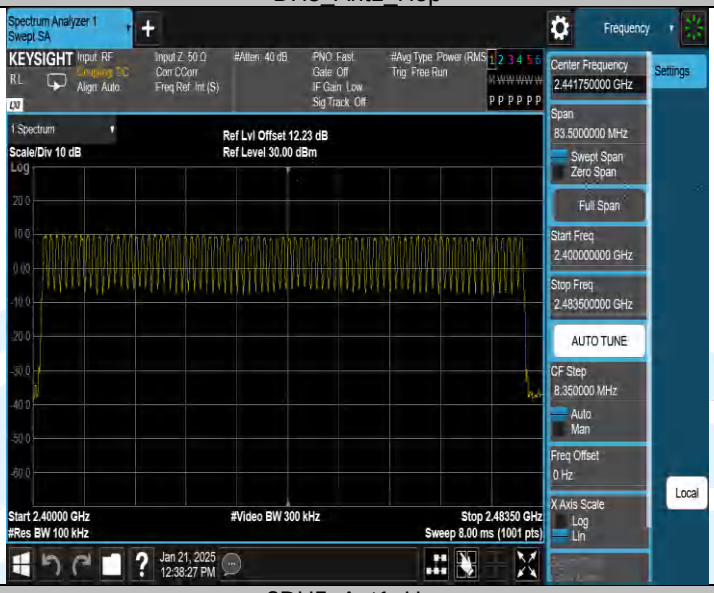
Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.5.3 for details.

Instruments Used: Refer to section 3 for details

Test Results:

Test Mode	Antenna	Channel	Result [Num]	Limit [Num]	Verdict
DH5	Ant1	Hop	79	≥15	PASS
3DH5	Ant1	Hop	79	≥15	PASS

DH5_Ant1_Hop

3DH5_Ant1_Hop


5.7 DWELL TIME

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.247(a)(1)

Test Method: ANSI C63.10-2013 Section 7.8.4

Limit: Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

Test Procedure: Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
Use the following spectrum analyzer settings:

a) Span = zero span, centered on a hopping channel
b) RBW shall be ≤ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel.
c) Sweep = As necessary to capture the entire dwell time per hopping channel; where possible use a video trigger and trigger delay so that the transmitted signal starts a little to the right of the start of the plot. The trigger level might need slight adjustment to prevent triggering when the system hops on an adjacent channel; a second plot might be needed with a longer sweep time to show two successive hops on a channel.
d) Detector function = peak
e) Trace = max hold
f) Use the marker-delta function to determine the dwell time

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.5.3 for details.

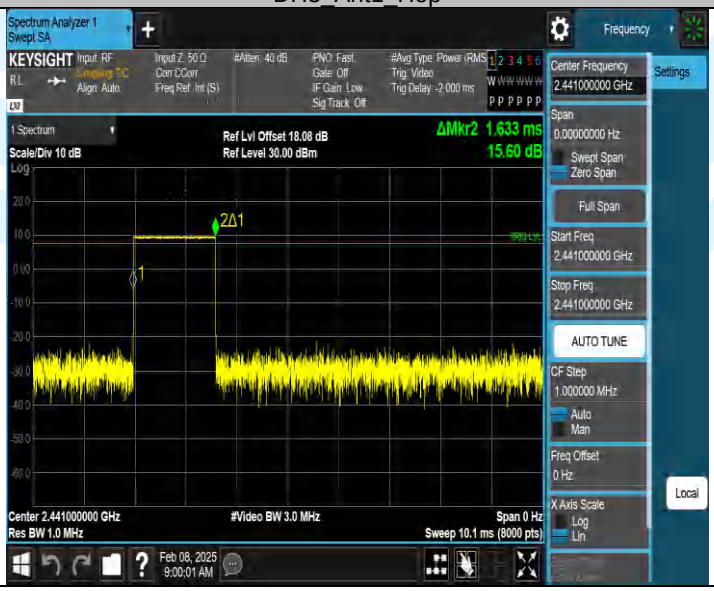
Instruments Used: Refer to section 3 for details

Test Results:

Test Mode	Antenna	Channel	Burst Width [ms]	Total Hops [Num]	Result[s]	Limit[s]	Verdict
DH1	Ant1	Hop	0.377	155	0.058	≤0.4	PASS
DH3	Ant1	Hop	1.633	112	0.183	≤0.4	PASS
DH5	Ant1	Hop	2.880	74	0.213	≤0.4	PASS
3DH1	Ant1	Hop	0.388	158	0.061	≤0.4	PASS
3DH3	Ant1	Hop	1.637	106	0.174	≤0.4	PASS
3DH5	Ant1	Hop	2.887	78	0.225	≤0.4	PASS

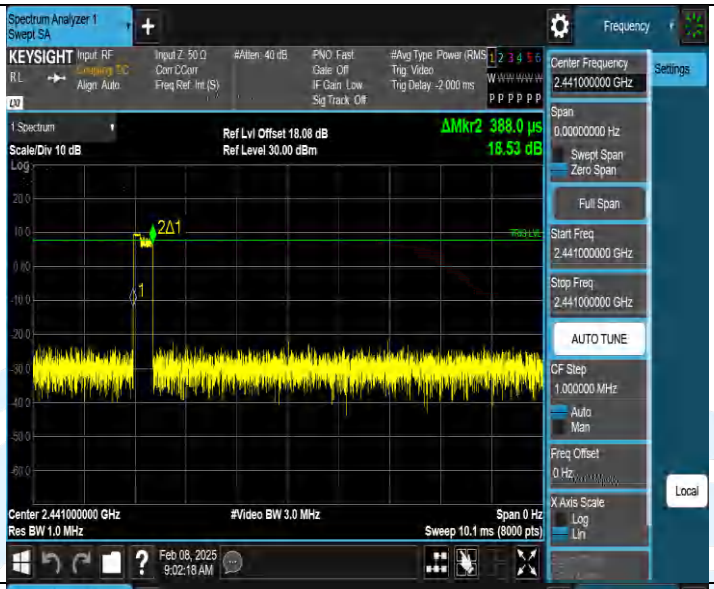
DH1_Ant1_Hop

DH3_Ant1_Hop



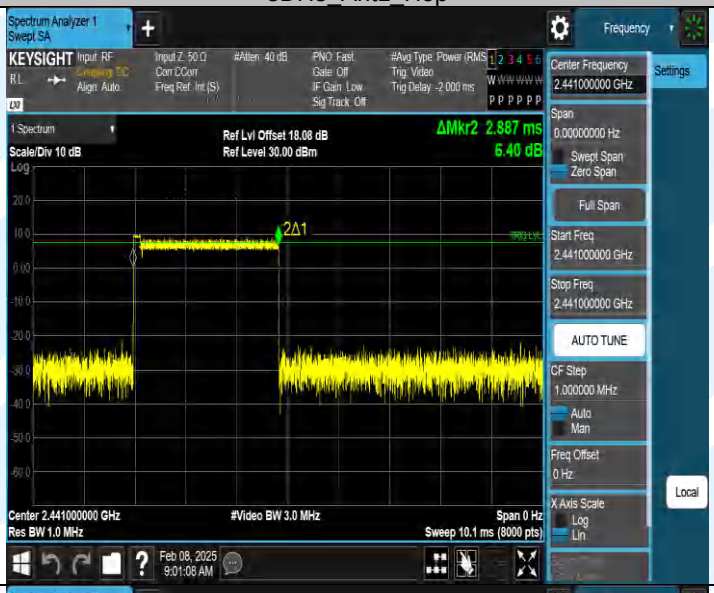
DH5_Ant1_Hop

3DH1_Ant1_Hop



3DH3_Ant1_Hop

3DH5_Ant1_Hop



5.8 CONDUCTED OUT OF BAND EMISSION

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.247(d)

Test Method: ANSI C63.10-2013 Section 6.10.4 & Section 7.8.8

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

Test Procedure: Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
Use the following spectrum analyzer settings:

Step 1: Measurement Procedure REF

a) Set instrument center frequency to 2400 MHz or 2483.5 MHz.
b) Wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products that fall outside of the authorized band of operation.
c) Set the RBW = 100 kHz.
d) Set the VBW ≥ 3 x RBW.
e) Detector = peak.
f) Sweep time = auto couple.
g) Sweep points ≥ 2 x Span/RBW
h) Trace mode = max hold.
i) Allow the trace to stabilize.
j) Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge. Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the in-band emission.

Step 2: Measurement Procedure OOBE

a) Set RBW = 100 kHz.
b) Set VBW ≥ 300 kHz.
c) Detector = peak.
d) Sweep = auto couple.
e) Trace Mode = max hold.
f) Allow trace to fully stabilize.
g) Use the peak marker function to determine the maximum amplitude level.

Note: The cable loss and attenuator loss were offset into measure device as an amplitude offset.

Test Setup: Refer to section 4.5.3 for details.

Instruments Used: Refer to section 3 for details

Test Mode: Hopping Frequencies Transmitter mode

Test Results:

Band Edge

Test Mode	Antenna	Ch Name	Channel	Ref Level [dBm]	Result [dBm]	Limit [dBm]	Verdict
DH5	Ant1	Low	2402	9.67	-43.27	≤-10.33	PASS
		High	2480	8.90	-44.28	≤-11.10	PASS
3DH5	Ant1	Low	2402	9.03	-42.84	≤-10.97	PASS
		High	2480	8.79	-40.80	≤-11.21	PASS
DH5	Ant1	Hopping	2402	9.53	-43.34	≤-10.47	PASS
		Hopping	2480	7.97	-43.56	≤-12.03	PASS
3DH5	Ant1	Hopping	2402	2.99	-45.05	≤-17.01	PASS
		Hopping	2480	4.22	-43.21	≤-15.78	PASS

DH5_Ant1_Low_2402 MHz

DH5_Ant1_High_2480 MHz

3DH5_Ant1_Low_2402 MHz

3DH5_Ant1_High_2480 MHz

DH5_Ant1_Hopping_2402 MHz


DH5_Ant1_Hopping_2480 MHz

3DH5_Ant1_Hopping_2402 MHz

3DH5_Ant1_Hopping_2480 MHz

Conducted Spurious Emission

Test Mode	Antenna	Channel	Freq Range [MHz]	Ref Level [dBm]	Result [dBm]	Limit [dBm]	Verdict
DH5	Ant1	2402	Reference	11.20	11.20	---	PASS
			30~1000	11.20	-41.02	≤-8.8	PASS
			1000~26500	11.20	-33.36	≤-8.8	PASS
		2441	Reference	11.78	11.78	---	PASS
			30~1000	11.78	-41.37	≤-8.22	PASS
			1000~26500	11.78	-33	≤-8.22	PASS
		2480	Reference	10.64	10.64	---	PASS
			30~1000	10.64	-41.3	≤-9.36	PASS
			1000~26500	10.64	-33.58	≤-9.36	PASS
3DH5	Ant1	2402	Reference	9.15	9.15	---	PASS
			30~1000	9.15	-40.56	≤-10.85	PASS
			1000~26500	9.15	-32.6	≤-10.85	PASS
		2441	Reference	6.68	6.68	---	PASS
			30~1000	6.68	-40.05	≤-13.32	PASS
			1000~26500	6.68	-32.59	≤-13.32	PASS
		2480	Reference	8.32	8.32	---	PASS
			30~1000	8.32	-40.79	≤-11.68	PASS
			1000~26500	8.32	-33.13	≤-11.68	PASS

DH5_Ant1_2402 MHz_0~Reference

DH5_Ant1_2402 MHz_30~1000 MHz

DH5_Ant1_2402 MHz_1000~26500 MHz

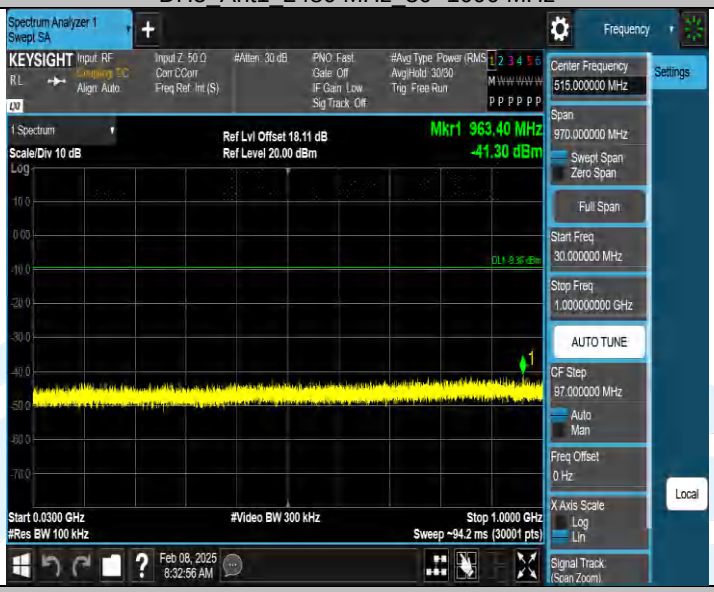
DH5_Ant1_2441 MHz_0~Reference

DH5_Ant1_2441 MHz_30~1000 MHz

DH5_Ant1_2441 MHz_1000~26500 MHz

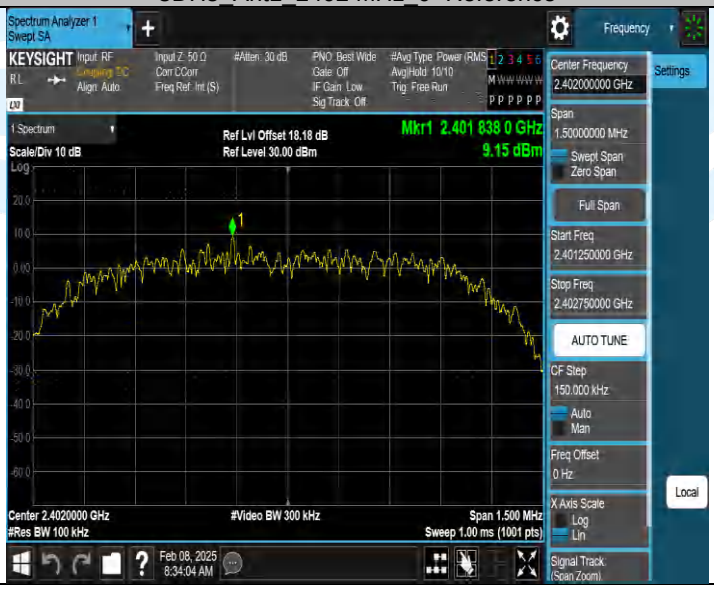
DH5_Ant1_2480 MHz_0~Reference

DH5_Ant1_2480 MHz_30~1000 MHz



DH5_Ant1_2480 MHz_1000~26500 MHz

3DH5_Ant1_2402 MHz_0~Reference

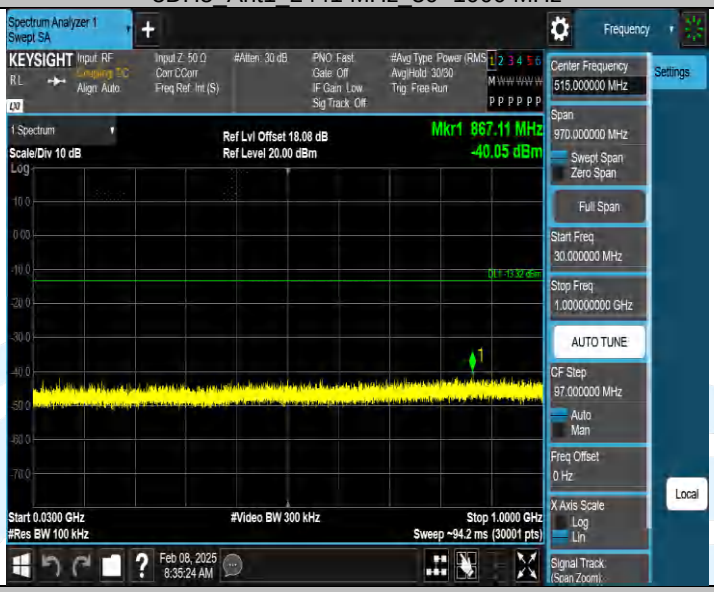


3DH5_Ant1_2402 MHz_30~1000 MHz

3DH5_Ant1_2402 MHz_1000~26500 MHz

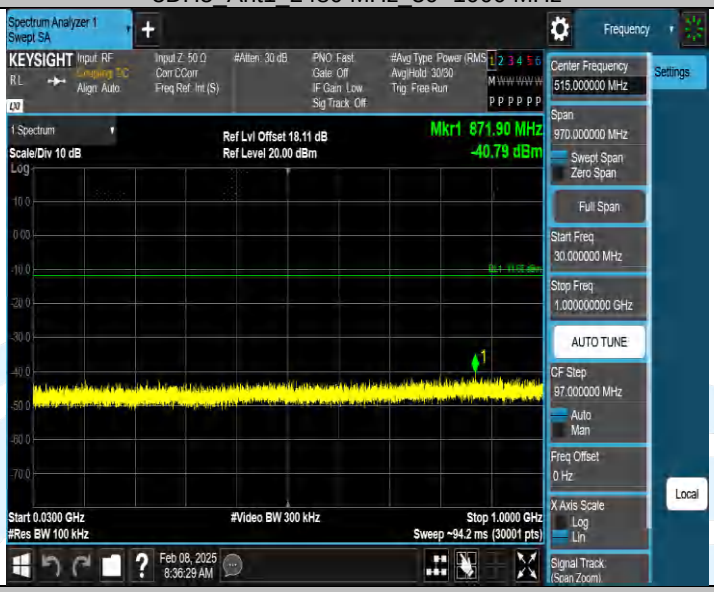
3DH5_Ant1_2441 MHz_0~Reference

3DH5_Ant1_2441 MHz_30~1000 MHz



3DH5_Ant1_2441 MHz_1000~26500 MHz

3DH5_Ant1_2480 MHz_0~Reference

3DH5_Ant1_2480 MHz_30~1000 MHz

3DH5_Ant1_2480 MHz_1000~26500 MHz


5.9 RADIATED SPURIOUS EMISSIONS

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.205/15.209

Test Method: ANSI C63.10-2013 Section 6.3 & 6.5 & 6.6

Receiver Setup:

Frequency	RBW
0.009 MHz-0.150 MHz	200/300 kHz
0.150 MHz -30 MHz	9/10 kHz
30 MHz-1 GHz	100/120 kHz
Above 1 GHz	1 MHz

Limits:

Spurious Emissions

Frequency	Field strength (microvolt/meter)	Limit (dBμV/m)	Remark	Measurement distance (m)
0.009 MHz-0.490 MHz	2400/F(kHz)	--	--	300
0.490 MHz-1.705 MHz	24000/F(kHz)	--	--	30
1.705 MHz-30 MHz	30	--	--	30
30 MHz-88 MHz	100	40.0	Quasi-peak	3
88 MHz-216 MHz	150	43.5	Quasi-peak	3
216 MHz-960 MHz	200	46.0	Quasi-peak	3
960MHz-1GHz	500	54.0	Quasi-peak	3
Above 1 GHz	500	54.0	Average	3

Remark:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).
3. For frequencies above 1000 MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20 dB under any condition of modulation.

Test Setup: Refer to section 4.5.1 for details.

Test Procedures:

1. From 30 MHz to 1GHz test procedure as below:

1) The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic camber. The table was rotated 360 degrees to determine the position of the highest radiation.
2) The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
3) The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4) For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rota table table was turned from 0 degrees to 360 degrees to find the maximum reading.
5) The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
6) If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

2. Above 1GHz test procedure as below:

1) Different between above is the test site, change from Semi- Anechoic Chamber to fully Anechoic Chamber and change form table 0.8 meter to 1.5 meter (Above 18GHz the distance is 1 meter and table is 1.5 meter).

2) Test the EUT in the lowest channel, middle channel, the Highest channel
3) The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the Y axis positioning which it is worse case.
4) Repeat above procedures until all frequencies measured was complete.

Equipment Used: Refer to section 3 for details.

Test Result: Pass

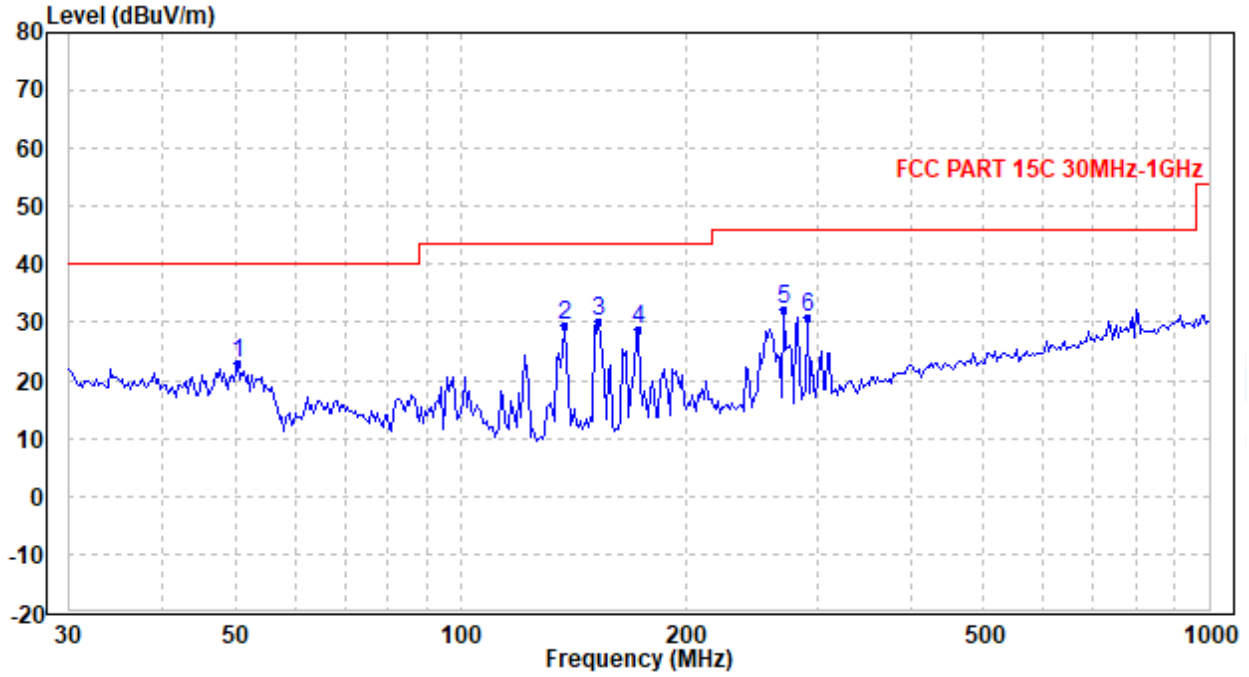
The worst measurement data as follows:

Radiated Emission Test Data (9 kHz ~ 30 MHz):
The amplitude of spurious emissions attenuated more than 20 dB below the permissible value is not required to be report.

Radiated Emission Test Data (30 MHz ~ 1 GHz):

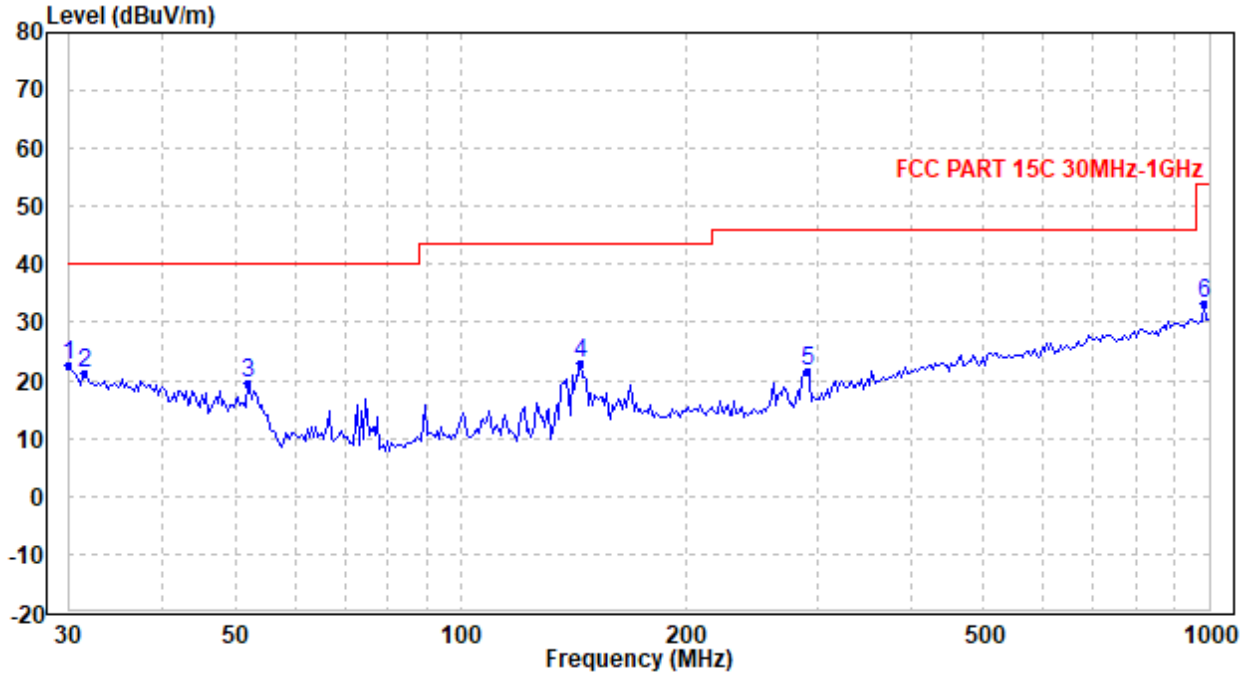
Worst-Case Configuration

Horizontal



No.	Frequency (MHz)	Reading (dBuV)	Correction factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	47.703	36.79	-13.58	23.21	40.00	-16.79	Peak
2	140.777	48.72	-15.42	33.30	43.50	-10.20	Peak
3	143.776	49.59	-15.28	34.31	43.50	-9.19	Peak
4	165.472	43.22	-13.11	30.11	43.50	-13.39	Peak
5	263.115	42.14	-10.22	31.92	46.00	-14.08	Peak
6	282.270	40.52	-9.40	31.12	46.00	-14.88	Peak

Vertical



No.	Frequency (MHz)	Reading (dBuV)	Correction factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	30.000	25.93	-4.53	21.40	40.00	-18.60	Peak
2	38.096	29.02	-7.77	21.25	40.00	-18.75	Peak
3	53.006	33.27	-15.18	18.09	40.00	-21.91	Peak
4	142.769	37.80	-15.29	22.51	43.50	-20.99	Peak
5	868.886	26.59	3.84	30.43	46.00	-15.57	Peak
6	887.398	26.23	4.22	30.45	46.00	-15.55	Peak

Radiated Emission Test Data (Above 1GHz):								
Lowest Channel:								
No.	**Frequency (MHz)**	**Reading (dBμV)**	**Correction factor (dB/m)**	**Result (dBμV/m)**	**Limit (dBμV/m)**	**Margin (dB)**	**Detector**	**Antenna Polaxis**
1	4804.000	35.22	-2.08	33.14	54.00	-20.86	Average	Horizontal
2	4804.000	45.80	-2.08	43.72	74.00	-30.28	Peak	Horizontal
3	7206.000	35.60	1.30	36.90	54.00	-17.10	Average	Horizontal
4	7206.000	52.68	1.30	53.98	74.00	-20.02	Peak	Horizontal
5	4804.000	35.07	-2.08	32.99	54.00	-21.01	Average	Vertical
6	4804.000	53.31	-2.08	51.23	74.00	-22.77	Peak	Vertical
7	7206.000	36.96	1.30	38.26	54.00	-15.74	Average	Vertical
8	7206.000	55.28	1.30	56.58	74.00	-17.42	Peak	Vertical
Middle Channel:								
1	4882.000	34.35	-2.05	32.30	54.00	-21.70	Average	Horizontal
2	4882.000	47.72	-2.05	45.67	74.00	-28.33	Peak	Horizontal
3	7323.000	34.18	1.31	35.49	54.00	-18.51	Average	Horizontal
4	7323.000	52.36	1.31	53.67	74.00	-20.33	Peak	Horizontal
5	4882.000	36.49	-2.05	34.44	54.00	-19.56	Average	Vertical
6	4882.000	54.97	-2.05	52.92	74.00	-21.08	Peak	Vertical
7	7323.000	34.18	1.31	35.49	54.00	-18.51	Average	Vertical
8	7323.000	51.44	1.31	52.75	74.00	-21.25	Peak	Vertical
Highest Channel:								
1	4960.000	34.59	-2.02	32.57	54.00	-21.43	Average	Horizontal
2	4960.000	50.10	-2.02	48.08	74.00	-25.92	Peak	Horizontal
3	7440.000	33.83	1.32	35.15	54.00	-18.85	Average	Horizontal
4	7440.000	47.13	1.32	48.45	74.00	-25.55	Peak	Horizontal
5	4960.000	33.71	-2.02	31.69	54.00	-22.31	Average	Vertical
6	4960.000	50.10	-2.02	48.08	74.00	-25.92	Peak	Vertical
7	7440.000	34.01	1.32	35.33	54.00	-18.67	Average	Vertical
8	7440.000	45.57	1.32	46.89	74.00	-27.11	Peak	Vertical

Remark:

1. Correct Factor = Antenna Factor + Cable Loss - Amplifier Gain, the value was added to Original Receiver Reading by the software automatically.
2. Result = Reading + Correct Factor.
3. Margin = Result – Limit

5.10 BAND EDGE MEASUREMENTS (RADIATED)

Test Requirement: FCC 47 CFR Part 15 Subpart C Section 15.205/15.209

Test Method: ANSI C63.10-2013 Section 6.10.5

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).

Frequency	Limit (dBμV/m @3m)	Remark
30 MHz-88 MHz	40.0	Quasi-peak Value
88 MHz-216 MHz	43.5	Quasi-peak Value
216 MHz-960 MHz	46.0	Quasi-peak Value
960 MHz-1 GHz	54.0	Quasi-peak Value
Above 1 GHz	54.0	Average Value
	74.0	Peak Value

Test Setup: Refer to section 4.5.1 for details.

Test Procedures:

Radiated band edge measurements at 2390 MHz and 2483.5 MHz were made with the unit transmitting in the low end of the channel range and the high end closest to the restricted bands respectively. The emissions were made on the 966 Semi-Chamber. Use (resolution bandwidth (RBW) = 1 MHz, video bandwidth (VBW) = 3 MHz for peak levels and RBW = 1 MHz and VBW = 10 Hz or 1/T for average levels).

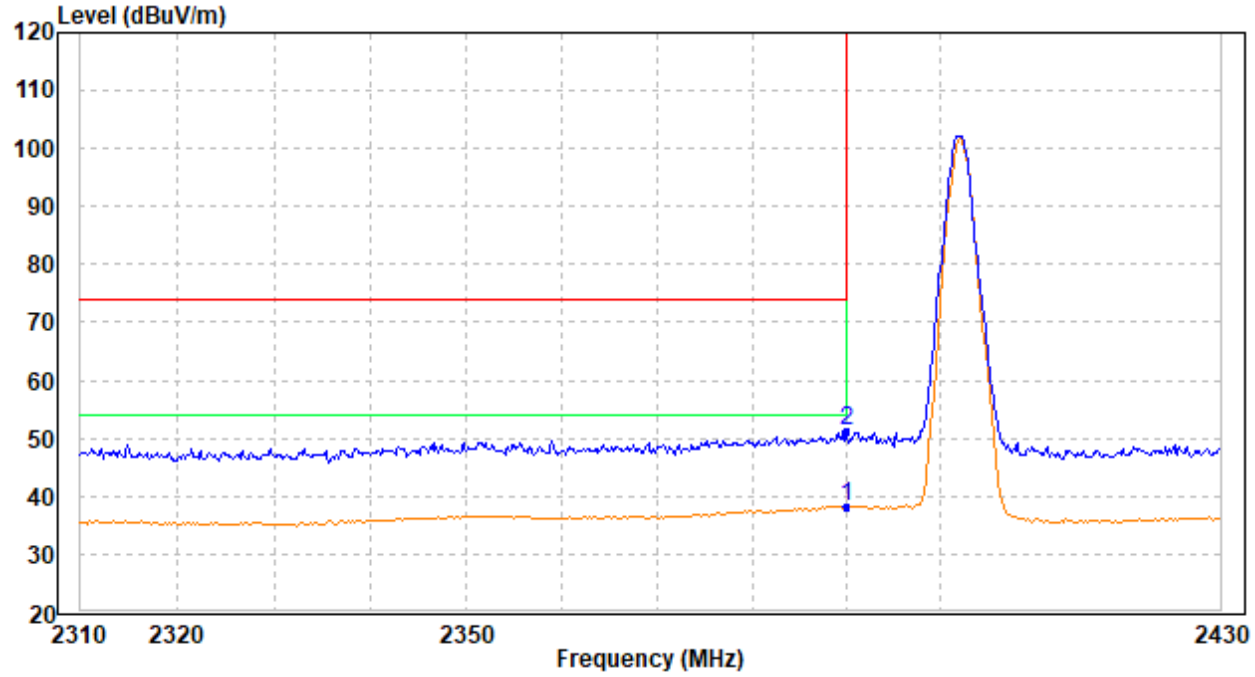
1. Use radiated spurious emission test procedure described in clause 5.10. The transmitter output (antenna port) was connected to the test receiver.
2. Set the PK and AV limit line.
3. Record the fundamental emission and emissions out of the band-edge.
4. Determine band-edge compliance as required.

Equipment Used: Refer to section 3 for details.

Test Result: Pass

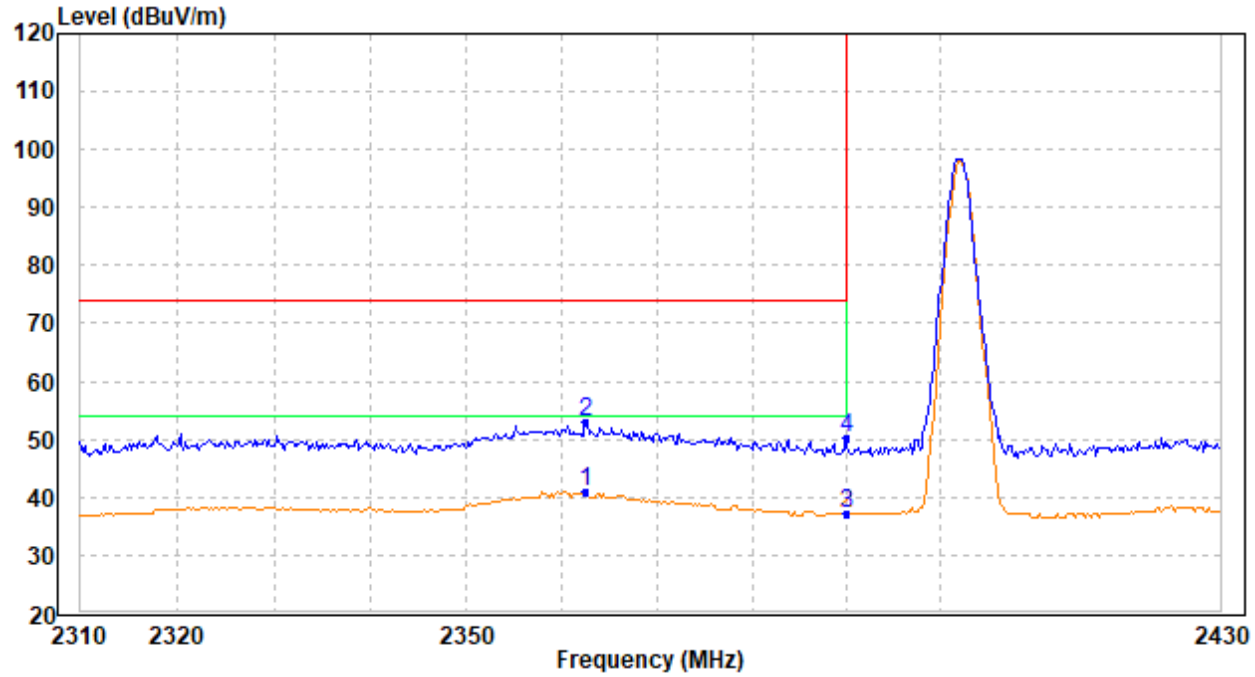
The worst measurement data as follows:

Test Channel:	Lowest Channel	Ant. Polar. :	Horizontal



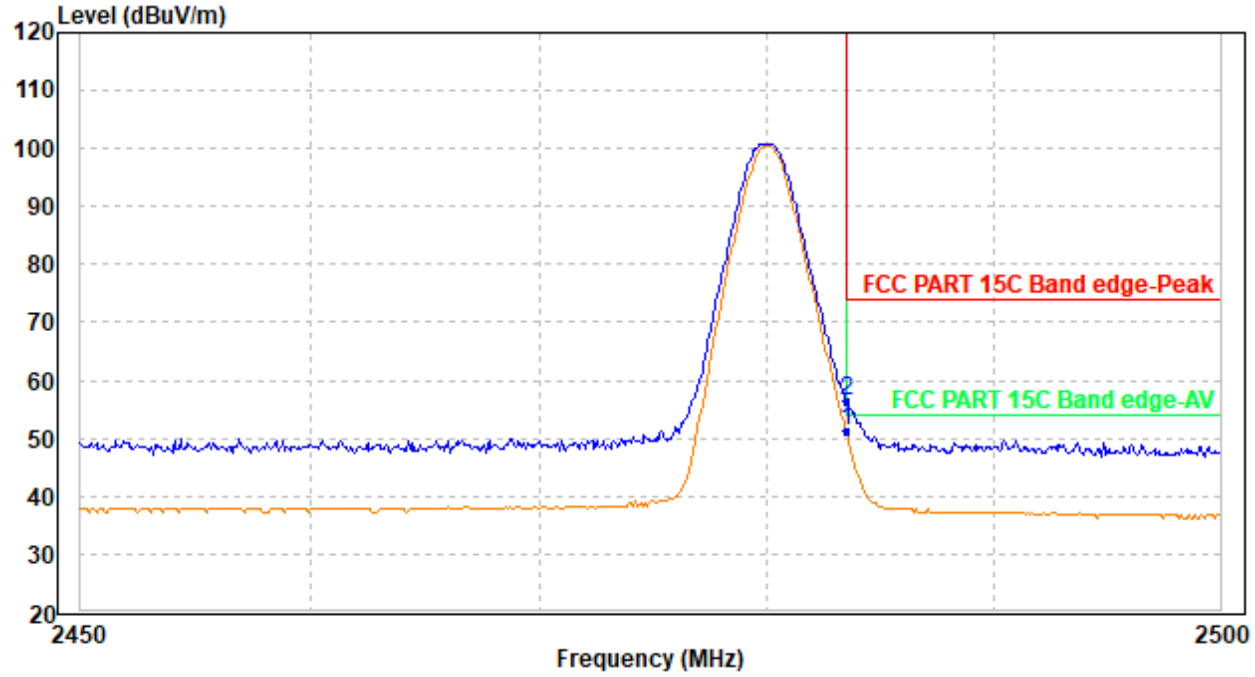
Frequency (MHz)	Peak level (dBuv/m)	Peak Limit (dBuv/m)	AV level (dBuv/m)	AV Limit (dBuv/m)	Conclusion
2390.000	51.30	74.00	38.19	54.00	Pass

Test Channel:	Lowest Channel	Ant. Polar. :	Vertical



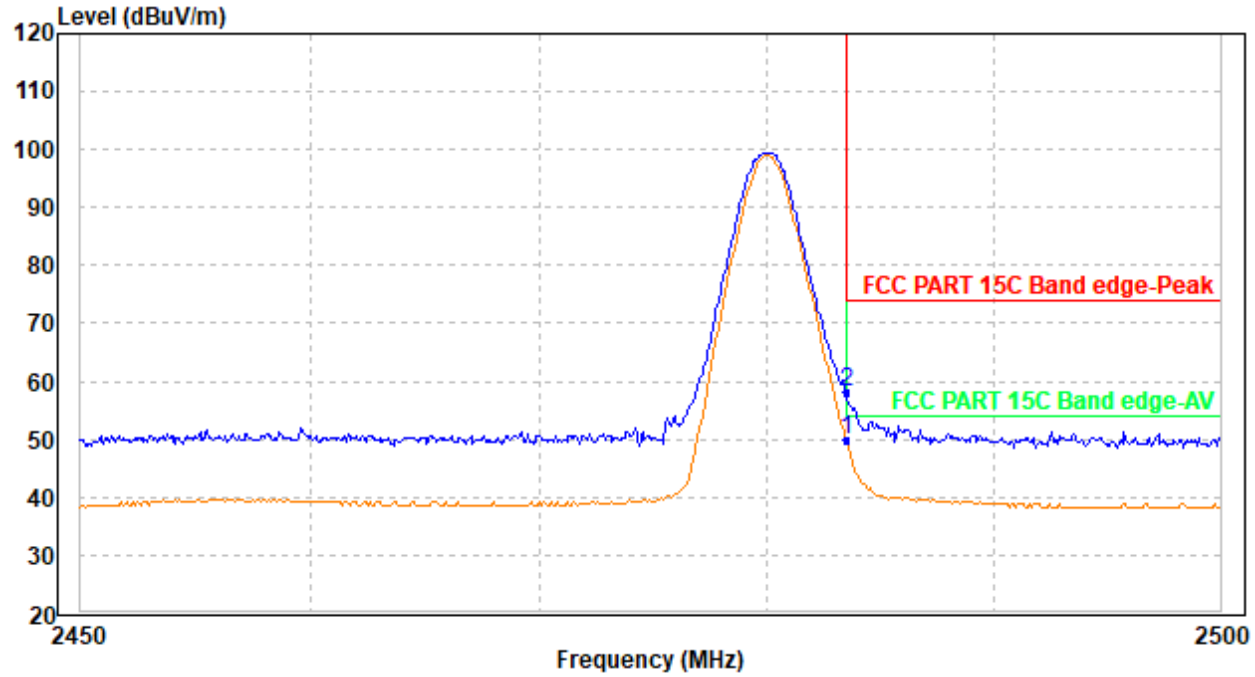
Frequency (MHz)	Peak level (dBuv/m)	Peak Limit (dBuv/m)	AV level (dBuv/m)	AV Limit (dBuv/m)	Conclusion
2390.000	52.92	74.00	40.82	54.00	Pass

Test Channel:	Highest Channel	Ant. Polar. :	Horizontal



Frequency (MHz)	Peak level (dBuv/m)	Pe Limit (dBuv/m)	AV level (dBuv/m)	AV Limit (dBuv/m)	Conclusion
2483.500	56.59	74.00	51.25	54.00	Pass

Test Channel:	Highest Channel	Ant. Polar. :	Vertical



Frequency (MHz)	Peak level (dBuv/m)	Peak Limit (dBuv/m)	AV level (dBuv/m)	AV Limit (dBuv/m)	Conclusion
2483.500	58.10	74.00	49.96	54.00	Pass

APPENDIX 1 PHOTOS OF TEST SETUP

See test photos attached in Appendix 1 for the actual connections between Product and support equipment.

APPENDIX 2 PHOTOS OF EUT CONSTRUCTIONAL DETAILS

Refer to Appendix 2 for EUT external and internal photos.

*** End of Report ***
