FCC TEST REPORT

Product Name:	RFID Handheld Scanner
Trade Mark:	BLUEBIRD
Model No.:	RFR900
Add. Model No.:	N/A
Report Number:	2310127258RFC-3
Test Standards:	FCC 47 CFR Part 15 Subpart C
FCC ID:	SS4RFR971
Test Result:	PASS
Date of Issue:	November 1, 2024

Prepared for:

Bluebird Inc.
3F, 115, Irwon-ro, Gangnam-gu, Seoul, Republic of Korea

Prepared by:

Shenzhen UnionTrust Quality and Technology Co., Ltd.
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Prepared by:	David Chen David Chen Senior Project Engineer	Reviewed by:	Henry Lu Team Leader
Approved by:	Robben Chen Robben Chen Assistant Manager	Date:	November 1, 2024

Version

Version No.	Date	Description
V1.0	November 1, 2024	Original

CONTENTS

1. GENERAL INFORMATION

1.1 CLIENT INFORMATION

Applicant:	Bluebird Inc.
Address of Applicant:	3F, 115, Irwon-ro, Gangnam-gu, Seoul, Republic of Korea
Manufacturer:	Bluebird Inc.
Address of Manufacturer:	3F, 115, Irwon-ro, Gangnam-gu, Seoul, Republic of Korea
Factory 1:	Bluebird Inc.
Address of Factory 1:	SSang-young IT Twin tower-B 7~8F), 531, Dunchon-daero, Jungwon-gu, Seongnam-si, Gyeonggi-do, Korea
Factory 2:	DSGLOBAL VINA CO.,LTD
Address of Factory 2:	Lot XN3-1E, Dai An expansion Industrial Zone, Lai Cach town Cam Giang district, HaiDuong province, Vietnam

1.2 EUT INFORMATION

1.2.1 General Description of EUT

Product Name:	RFID Handheld Scanner	
Model No.:	RFR900	
Add. Model No.:	N/A	
Trade Mark:	BLUEBIRD	
DUT Stage:	Identical Prototype	
EUT Supports Function: (Provided by the customer)	2.4 GHz ISM Band:	Bluetooth 5.1
	RFID:	902 MHz to 928 MHz
Software Version:	RFR900-20230920 (Provided by the customer)	
Hardware Version:	Rev 2.1 (Provided by the customer)	
Sample Received Date:	October 12, 2022	
Sample Tested Date:	November 1, 2023 to April 18, 2024	
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

Adapter	
Model No.:	KSA29B0500200D5
Input:	100-240 V~50/60 Hz 0.5A
Output:	5.0 V ⎓ 2.0A
AC Cable:	N/A
DC Cable:	N/A

Battery	
Model No.:	BAT-RFR900_S
Battery Type:	Rechargeable Li-ion Battery Pack
Rated Voltage:	3.6 Vdc
Limited Charge Voltage:	4.2 Vdc
Rated Capacity:	3400 mAh

Cable	
Description:	MicroUSB Plug Cable
Connector:	USB Type-A to MicroUSB
Cable Type:	Shielded without ferrite
Length:	1 Meter

1.3 PRODUCT SPECIFICATION SUBJECTIVE TO THIS STANDARD

Frequency Band:	902 MHz to 928 MHz
Frequency Range:	902.75 MHz to 927.25 MHz
Type of Modulation:	ASK
Number of Channels:	50
Channel Separation:	500 kHz
Channel Bandwidth:	<250 kHz
Antenna Type:	PCB Patch Antenna
Antenna Gain: (Provided by the customer)	2.72 dBi
Maximum Peak Power:	29.31 dBm
Normal Test Voltage:	3.6Vdc and/or 120 Vac

1.4 OTHER INFORMATION

Operation Frequency Each of Channel
f = 902.25 + (0.5*n) MHz, n = 1,…,50
Note: **f** is the operating frequency (MHz); **n** is the operating channel.

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
Hyebrid Full-Touch Handheld Computer	BLUEBIRD	HF550X	HF550XANLCBZ876	BLUEBIRD
RFID Tags	N/A	AZ-H93	4.18	BLUEBIRD

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	±4.6 dB
5	Radiated emission 1GHz-18GHz	±4.4 dB
6	Radiated emission 18GHz-40GHz	±4.6 dB
7	Conducted spurious emissions	± 2.7 dB
8	RF Power, Conducted	± 0.68 dB
9	Occupied Bandwidth	± 1.86 %
10	Radio Frequency	± 6.5 x 10^{-8}
11	Transmission Time	± 0.19 %

2. TEST SUMMARY

FCC 47 CFR Part 15 Subpart C Test Cases			
Test Item	**Test Requirement**	**Test Method**	**Result**
Antenna Requirement	FCC 47 CFR Part 15 Subpart C Section 15.203/15.247(b)(4)	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	PASS
Conducted Peak Output Power	FCC 47 CFR Part 15 Subpart C Section 15.247 (b)(2)	ANSI C63.10-2013 Section 7.8.5	PASS
20 dB Bandwidth	FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1)(i)	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)(i)	ANSI C63.10-2013 Section 7.8.3	PASS
Dwell Time	FCC 47 CFR Part 15 Subpart C Section 15.247 (a)(1)(i)	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
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	27-Oct-2023	26-Oct-2024
☑	Loop Antenna	ETS-LINDGREN	6502	00202525	30-Oct-2023	29-Oct-2024
☑	Broadband Antenna	ETS-LINDGREN	3142E	00201566	30-Oct-2023	29-Oct-2024
☑	6dB Attenuator	Talent	RA6A5-N-18	18103001	30-Oct-2023	29-Oct-2024
☑	Preamplifier	HP	8447F	2805A02960	31-Oct-2023	30-Oct-2024
☑	Double-Ridged Waveguide Horn Antenna (Pre-amplifier)	ETS-LINDGREN	3117-PA	00201541	16-Apr-2023	15-Apr-2024
					01-Apr-2024	31-Mar-2025
☑	Pre-amplifier	ETS-LINDGREN	00118385	00201874	31-Oct-2023	30-Oct-2024
☑	Highpass Filter (1200MHz-18000MHz)	Micro-Tronics	HPM50108	G552	27-Oct-2023	26-Oct-2024
☑	Multi device Controller	ETS-LINDGREN	7006-001	00160105	N/A	N/A
☑	Test Software	Audix	e3	Software Version: 9.160323		

Conducted Emission Test Equipment List						
Used	**Equipment**	**Manufacturer**	**Model No.**	**Serial Number**	**Cal. date**	**Cal. Due date**
☑	Receiver	R&S	ESR7	101181	27-Oct-2023	26-Oct-2024
☑	Pulse Limiter	R&S	ESH3-Z2	0357.8810.54	27-Oct-2023	26-Oct-2024
☑	LISN	R&S	ESH2-Z5	860014/024	27-Oct-2023	26-Oct-2024
☐	LISN	ETS-Lindgren	3816/2SH	00201088	27-Oct-2023	26-Oct-2024
☑	Test Software	EZ-EMC	EZ-CON	Software Version: EMC-CON 3A1.1		

RF Conducted Test Equipment List						
Used	**Equipment**	**Manufacturer**	**Model No.**	**Serial Number**	**Cal. date**	**Cal. Due date**
☑	EXA Spectrum Analyzer	KEYSIGHT	N9020A	MY51286807	27-Oct-2023	26-Oct-2024
☑	USB Wideband Power Sensor	KEYSIGHT	U2021XA	MY55430035	27-Oct-2023	26-Oct-2024

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 (V)	Relative Humidity (%)
NT/NV	+15 to +35	3.6Vdc and/or 120 Vac	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	18.3	43.3	100.5	S202309252169-ZJC10/10	Linson Xie
Conducted Peak Output Power	24.5	51.2	99.5	S202309252169-ZJC09/9	Rain Wang
20 dB Bandwidth					
Carrier Frequencies Separation					
Number of Hopping Channel					
Dwell Time					
Conducted Out of Band Emission					
Radiated Emissions	24.2	55.8	100.0	S202309252169-ZJC10/10 S202403272971-ZJE01/1	Yana Zeng
Band Edge Measurement					

4.2 TEST CHANNELS

Type of Modulation	Tx/Rx Frequency	Test RF Channel Lists		
		Lowest(L)	Middle(M)	Highest(H)
ASK	902.75-927.25 MHz	Channel 1	Channel 25	Channel 50
		902.75 MHz	914.75 MHz	927.25 MHz

4.3 EUT TEST STATUS

Type of Modulation	Tx Function	Description
ASK	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: 28

Test Software (Provided by the customer)
Test software name (apk): BBRFIDCertification

4.4 TEST SETUP

4.4.1 For Radiated Emissions test setup

Figure 1. Below 30MHz

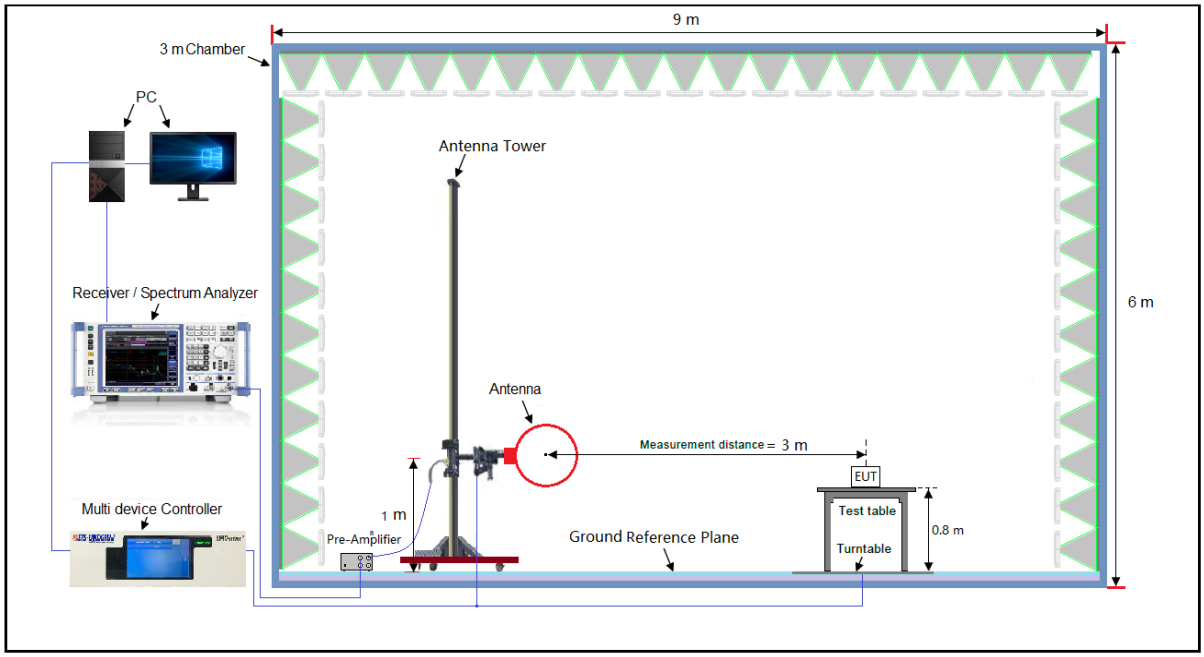


Figure 2. 30MHz to 1GHz

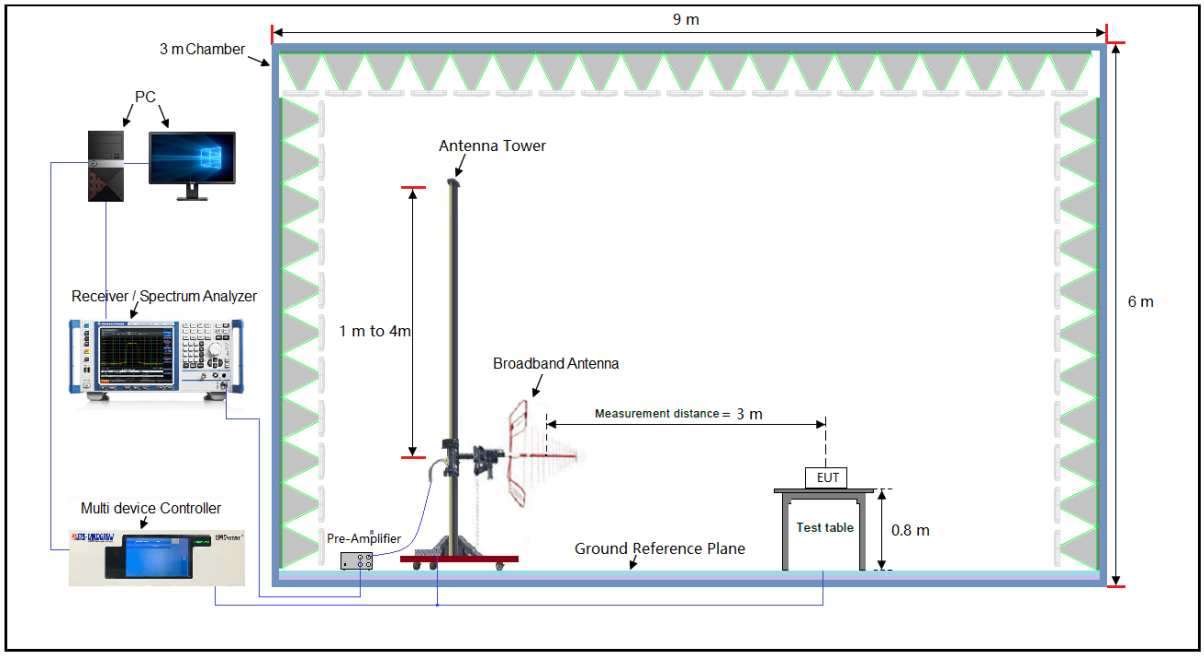
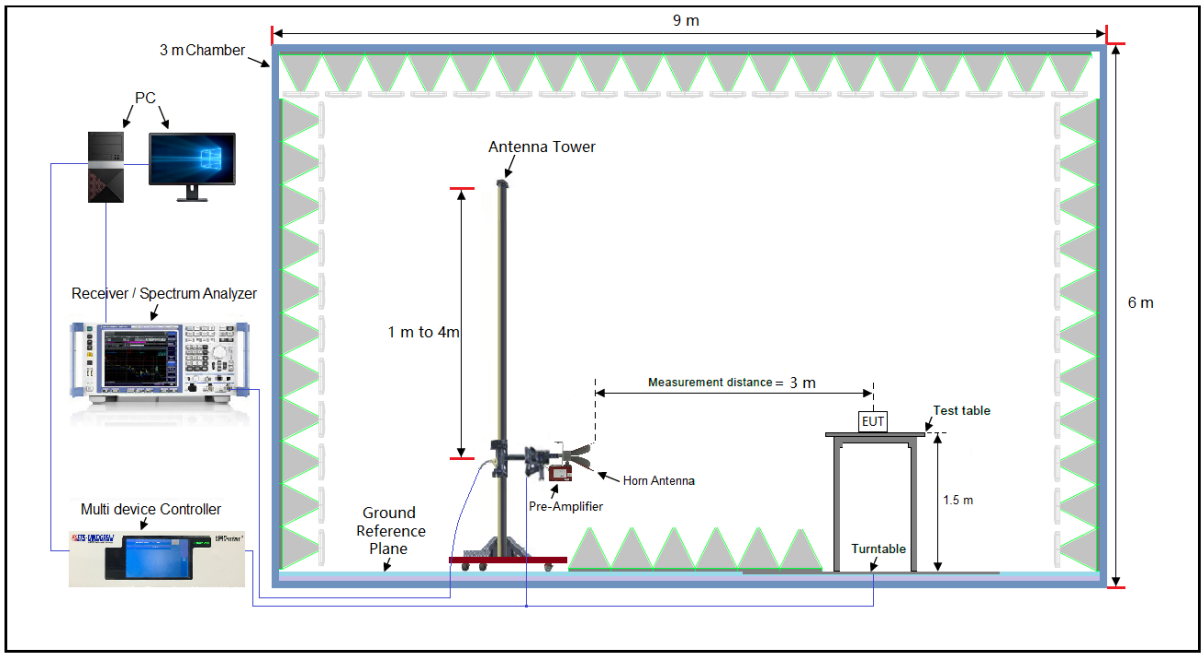
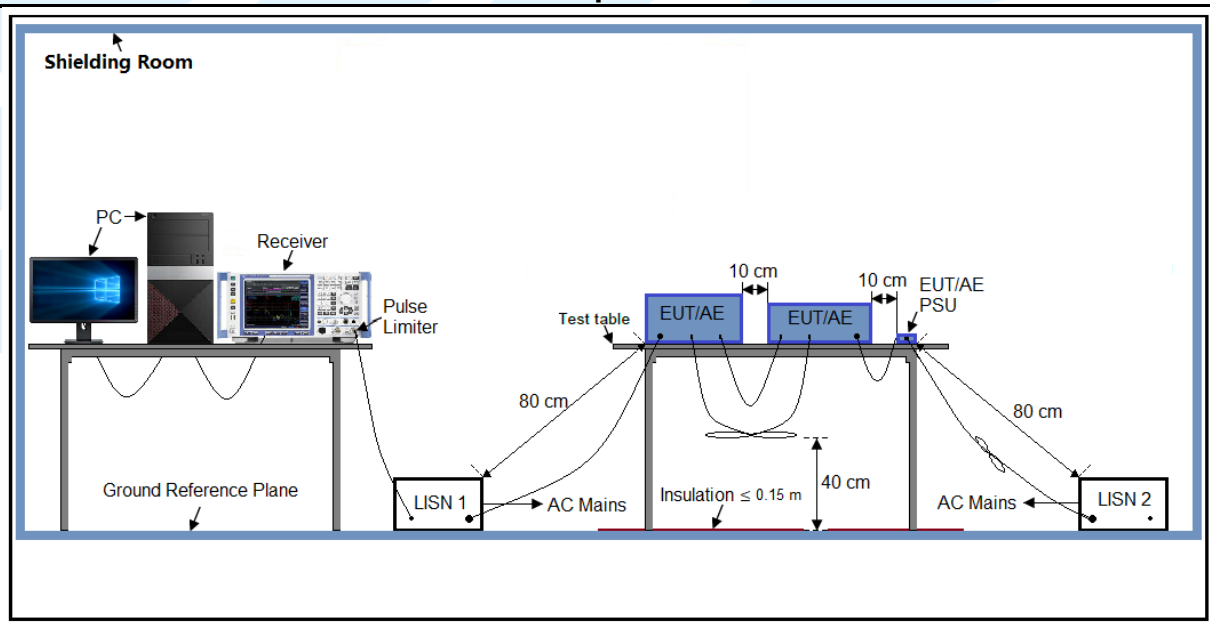


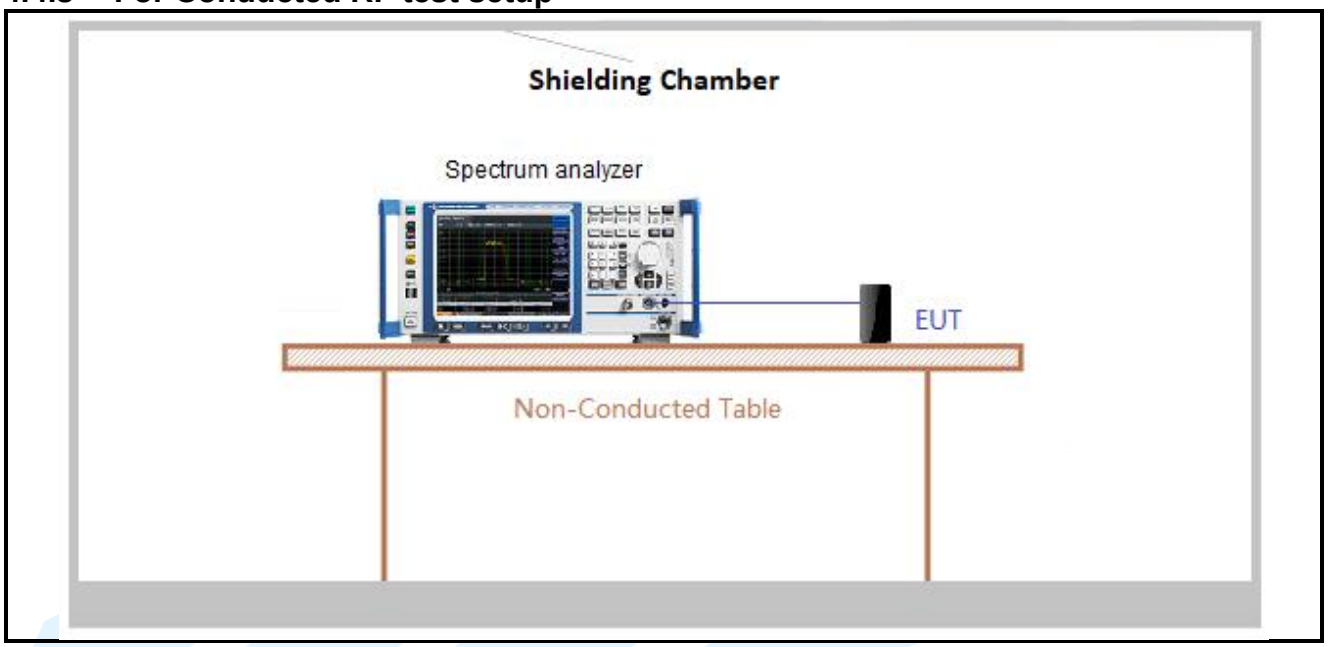
Figure 3. Above 1GHz



4.4.2 For Conducted Emissions test setup



4.4.3 For Conducted RF test setup



4.5 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. It was powered by a 3.6V battery. 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.

4.6 DUTY CYCLE

Test Procedure: ANSI C63.10-2013 Clause 11.6.

Test Results

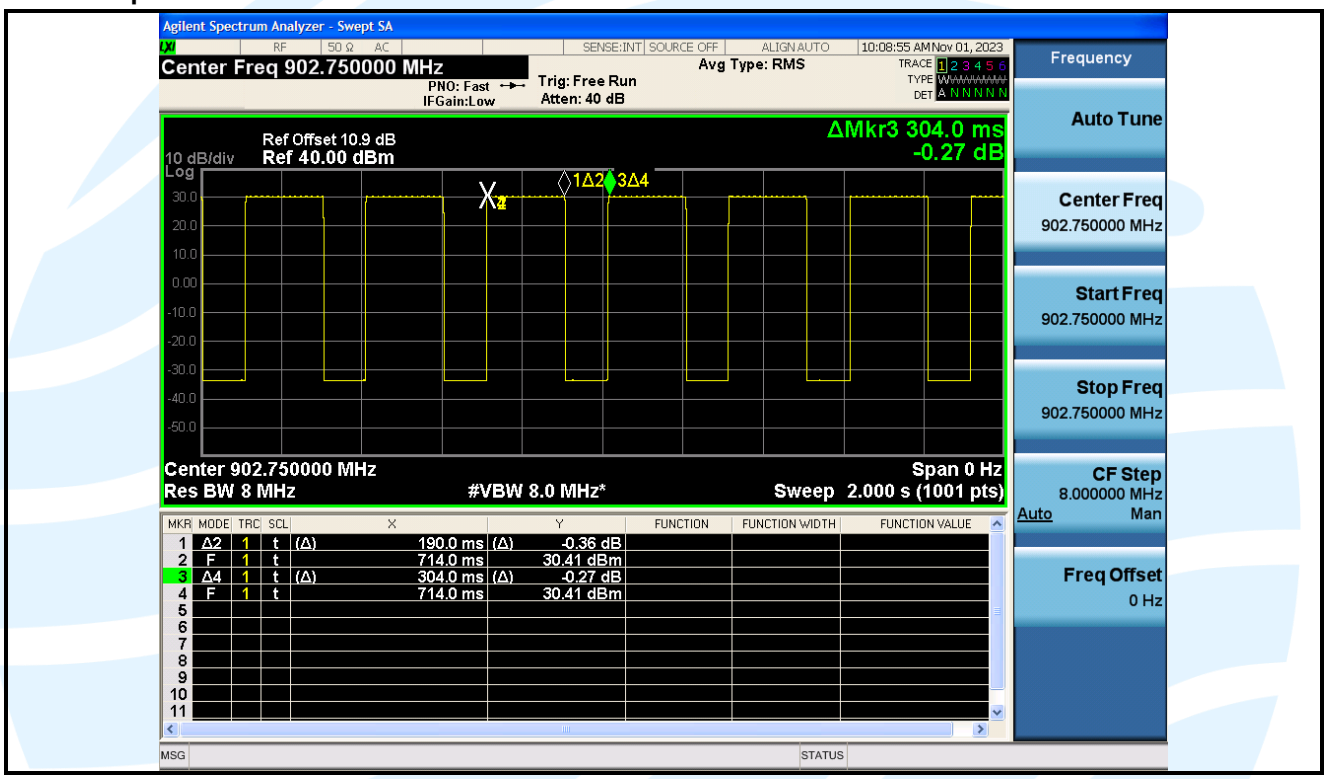
Modulation	On Time (msec)	Period (msec)	Duty Cycle (linear)	Duty Cycle (%)	Duty Cycle Factor (dB)	1/T Minimum VBW (kHz)
ASK	190.0	304.0	0.63	62.50	2.04	0.01

Remark:

1) Duty cycle= On Time/ Period;

2) Duty Cycle factor = 10 * log(1/ Duty cycle)

The test plots as follows



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 2.72 dBi.

5.3 CONDUCTED PEAK OUTPUT POWER

Test Requirement: FCC 47 CFR Part 15 Subpart C Section15.247 (b)(2)

Test Method: ANSI C63.10-2013 Section 7.8.5

Limit: For frequency hopping systems operating in the 902–928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

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.

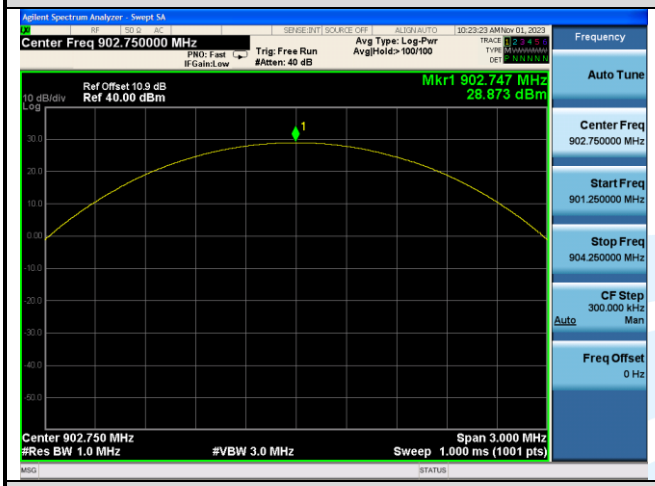
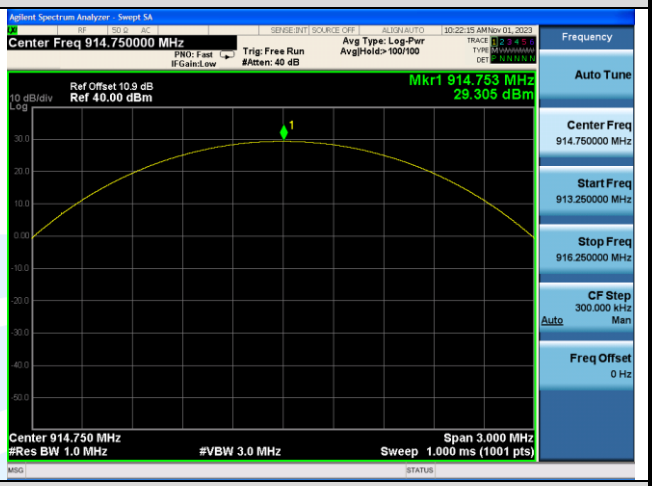
Instruments Used: Refer to section 3 for details

Test Results: Pass

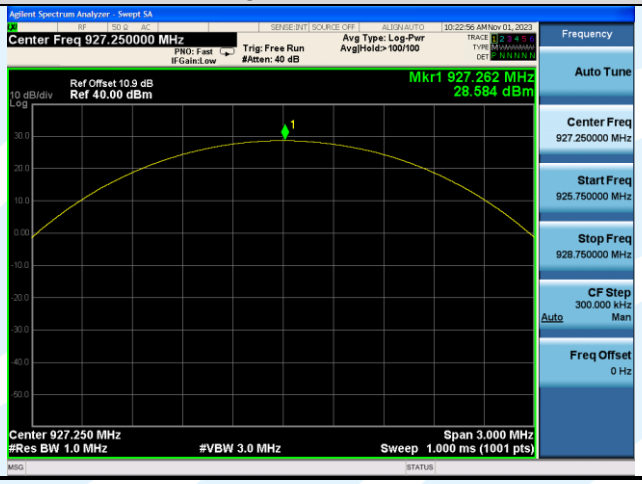
Modulation	Channel	Max. Peak Power		Peak Power Limit	Max. Avg. Power	Result
		(dBm)	(W)	(dBm)	(dBm)	
ASK	1	28.87	0.7714	≤ 30	26.37	Pass
	25	**29.31**	0.8521	≤ 30	**26.66**	Pass
	50	28.58	0.7218	≤ 30	26.15	Pass

Note: The antenna gain of 2.72 dBi less than 6dBi maximum permission antenna gain value based on 1 W (30dBm) peak output power limit.

The test plots as follows:

Lowest Channel	Middle Channel
	

Highest Channel



5.4 20 DB BANDWIDTH

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

Test Method: ANSI C63.10-2013 Section 6.9.2

Limit: For frequency hopping systems operating in the 902–928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

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.

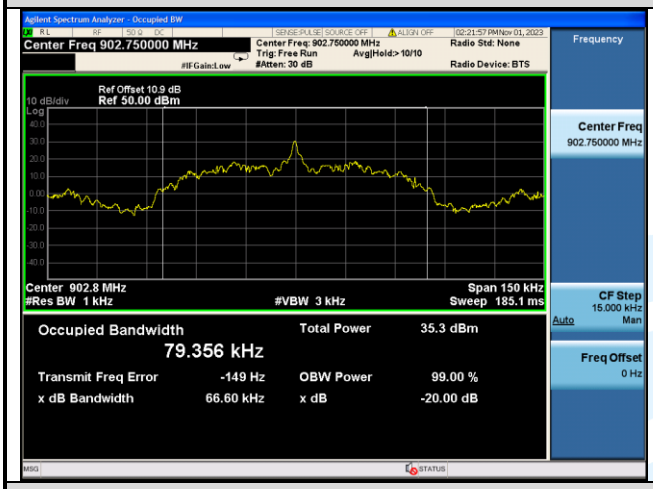
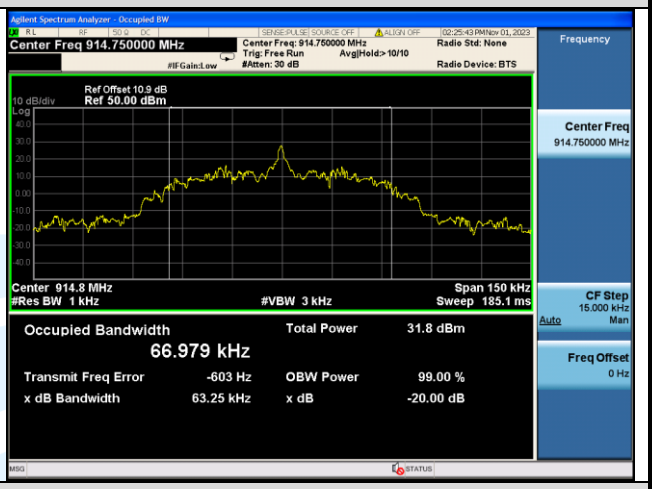
Test Setup: Refer to section 4.5.3 for details.

Instruments Used: Refer to section 3 for details

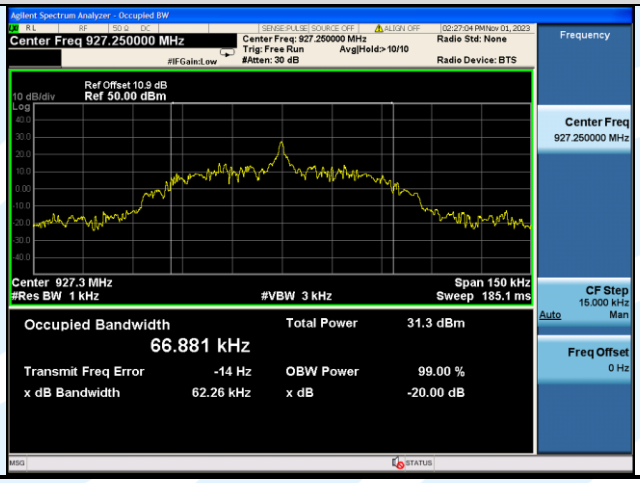
Test Results: Pass

Channel	20 dB Bandwidth (kHz)	20 dB BW Limit (kHz)	Result	99% Bandwidth (kHz)
1	66.60	≤ 250 kHz	Pass	79.356
25	63.25	≤ 250 kHz	Pass	66.979
50	62.26	≤ 250 kHz	Pass	66.881

The test plots as follows:

Lowest Channel	Middle Channel
	

Highest Channel



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 shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

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.

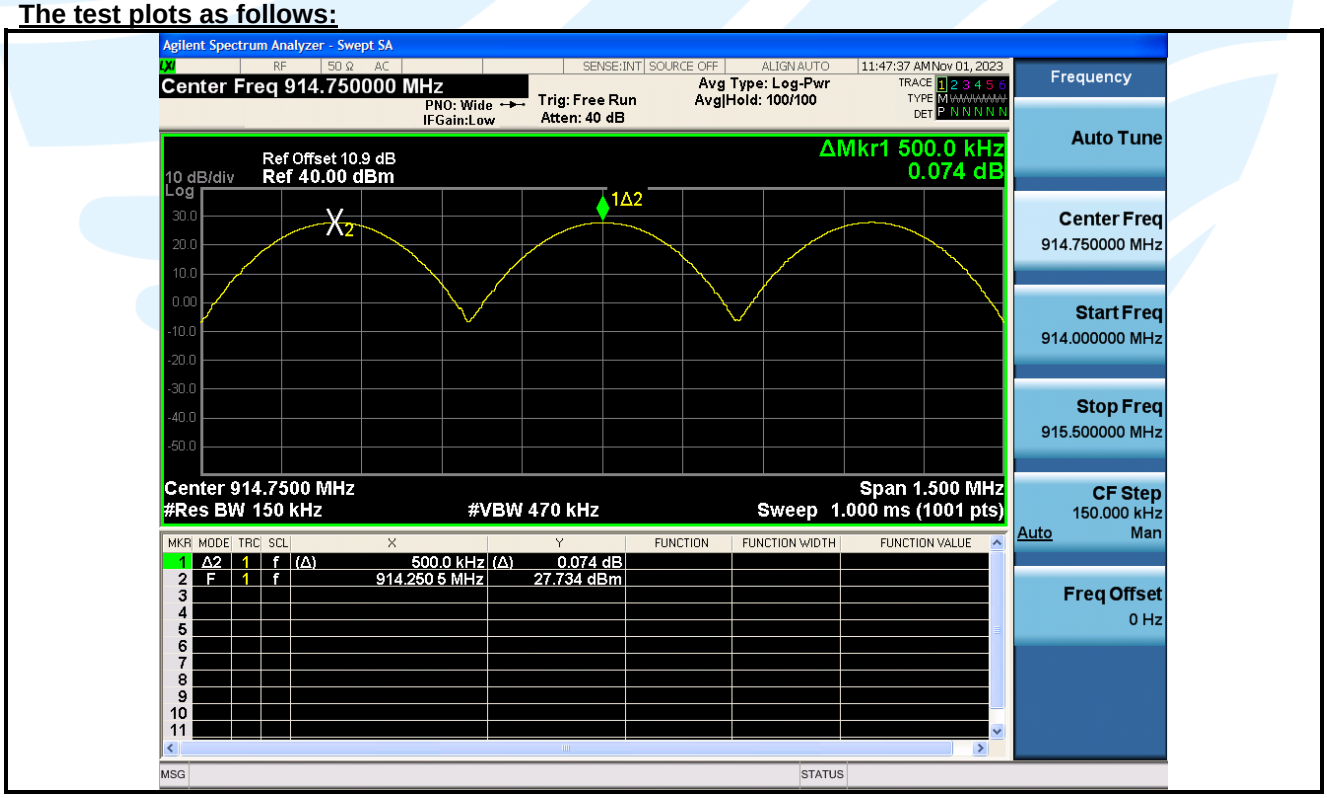
Test Setup: Refer to section 4.5.3 for details.

Instruments Used: Refer to section 3 for details

Test Results: Pass

Type of Modulation	Adjacent Channel Separation (kHz)	Minimum Limit	Result
ASK	500.0	≥ MAX { 25 kHz, BW_{20dB} }	Pass

The test plots as follows:



5.6 NUMBER OF HOPPING CHANNEL

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

Test Method: ANSI C63.10-2013 Section 7.8.3

Limit: For frequency hopping systems operating in the 902–928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

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.

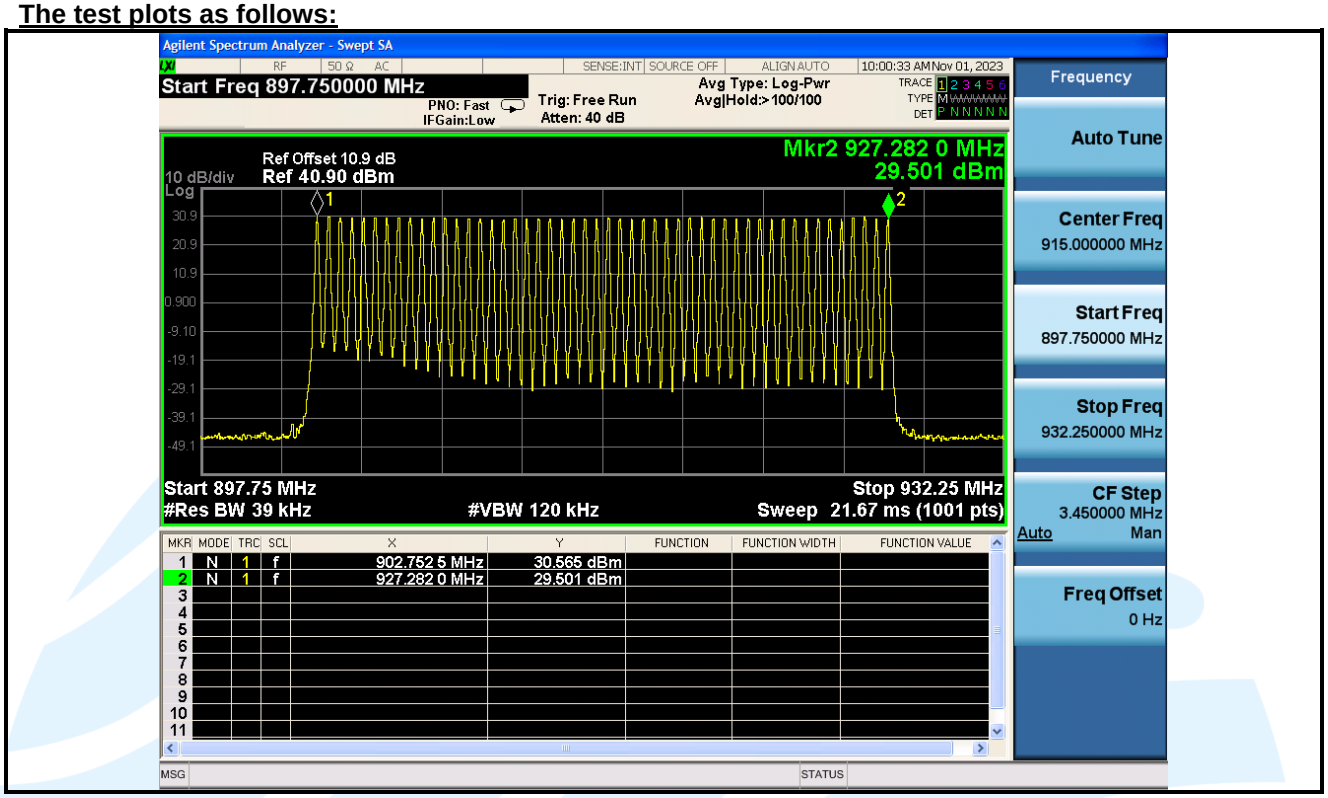
Test Setup: Refer to section 4.5.3 for details.

Instruments Used: Refer to section 3 for details

Test Results: Pass

Type of Modulation	Number of Hopping Channel	Limit	Result
ASK	50	≥ 50	Pass

The test plots as follows:



5.7 DWELL TIME

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

Test Method: ANSI C63.10-2013 Section 7.8.4

Limit: For frequency hopping systems operating in the 902–928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

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.

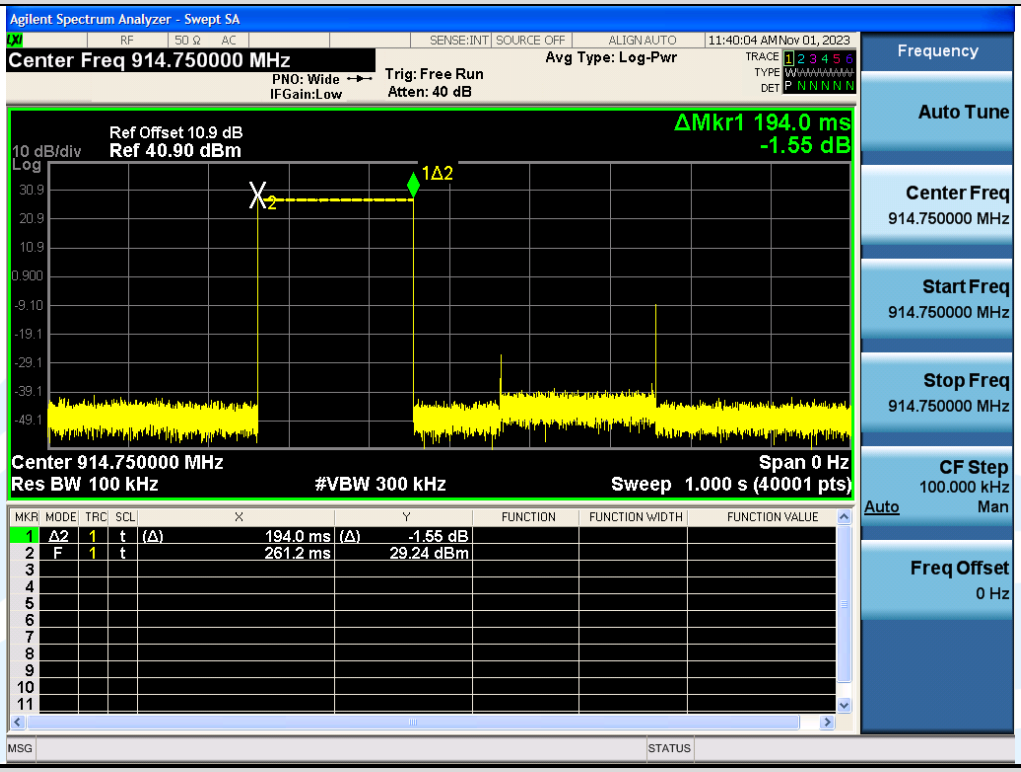
Instruments Used: Refer to section 3 for details

Test Results: Pass

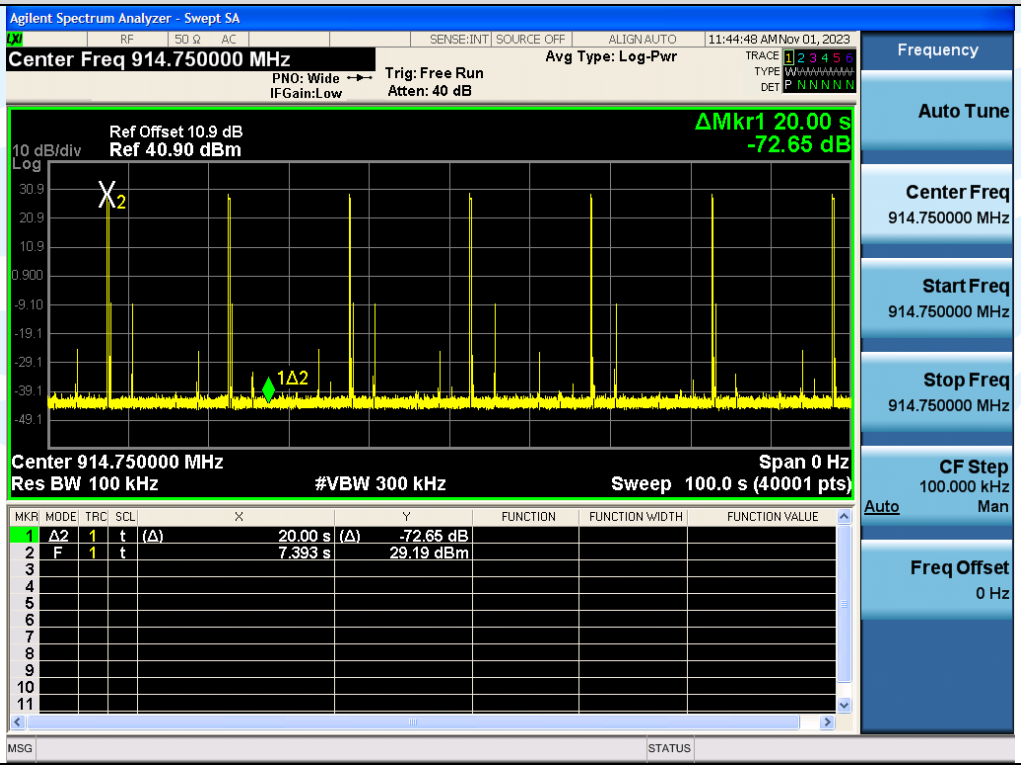
Modulation	Test Channel	Pulse Width (ms)	Number of Pulses in 20 seconds	Dwell Time (ms)	Limit (ms)
ASK	25	194.0	2	388.0	≤ 400

The test plots as follows:

Pulse Width



Number of Pulses in 20 Seconds



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.

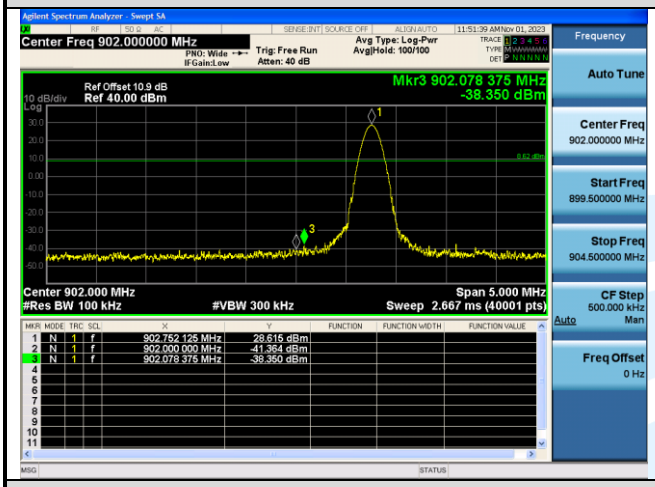
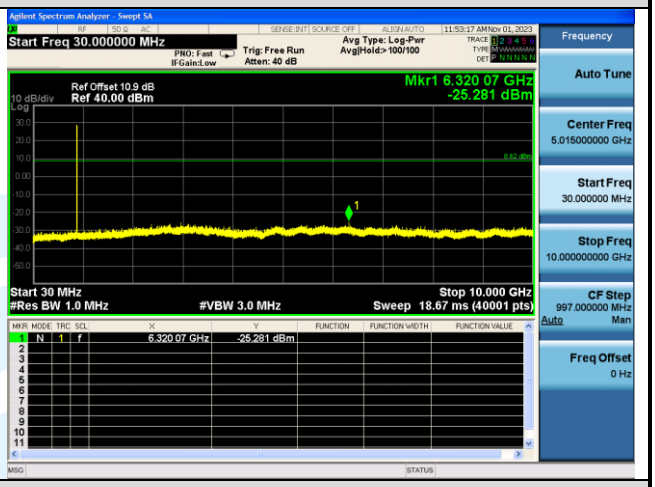
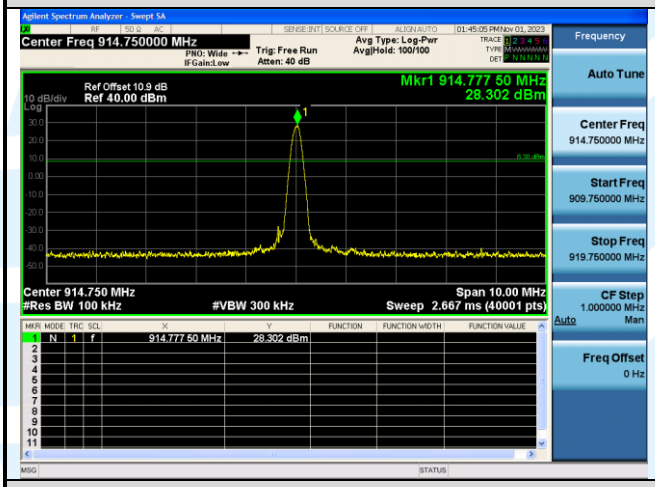
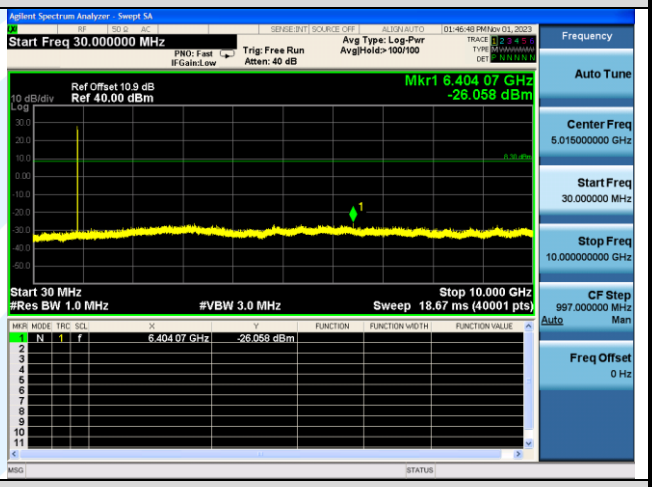
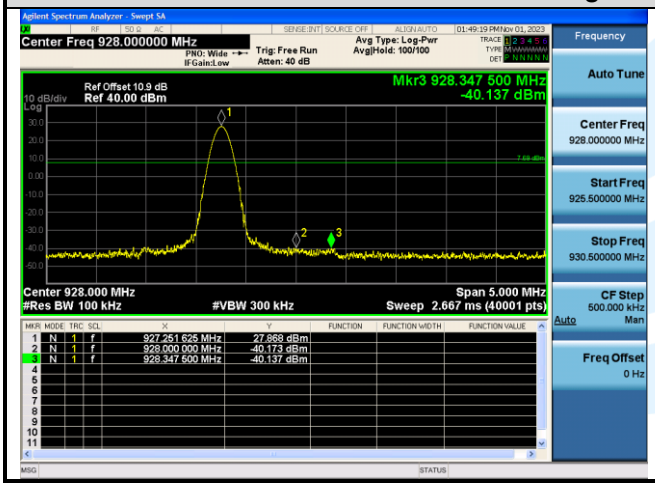
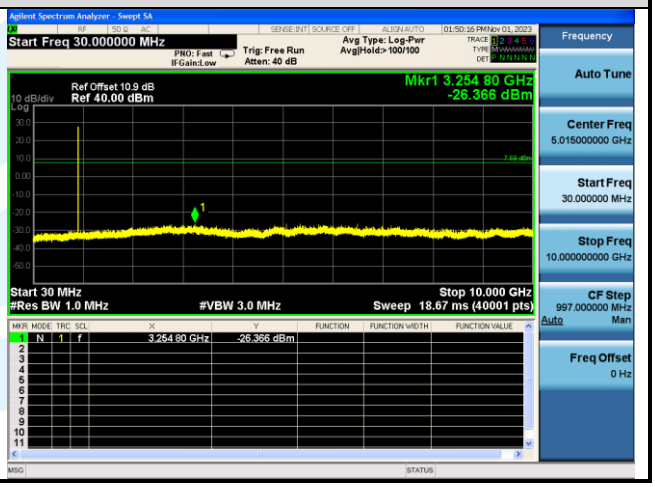
Test Setup: Refer to section 4.5.3 for details.

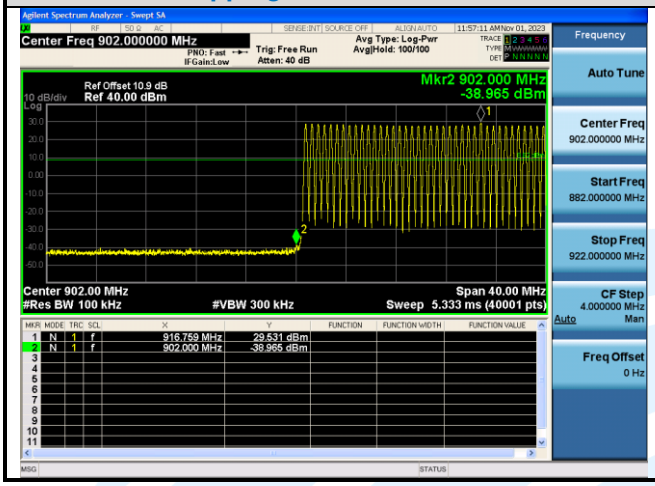
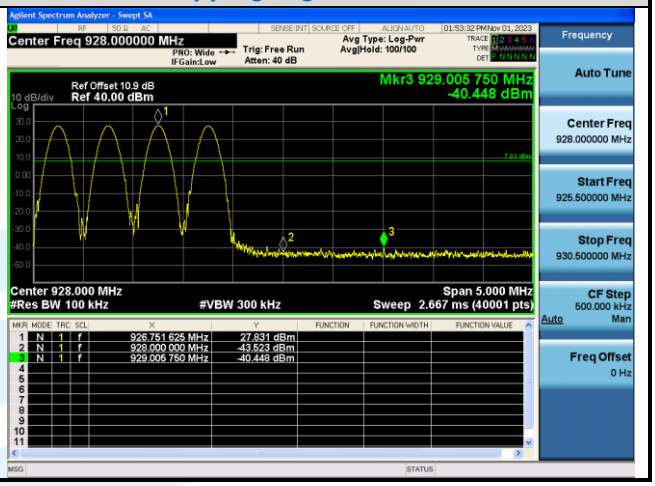
Instruments Used: Refer to section 3 for details

Test Mode: Hopping Frequencies Transmitter mode

Test Results: Pass

The test plots as follows:

In-Band Reference Level	Out of Band Emission
Lowest Channel	
	
Middle Channel	
	
Highest Channel	
	

Hopping Lowest Channel	Hopping Highest Channel
	

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

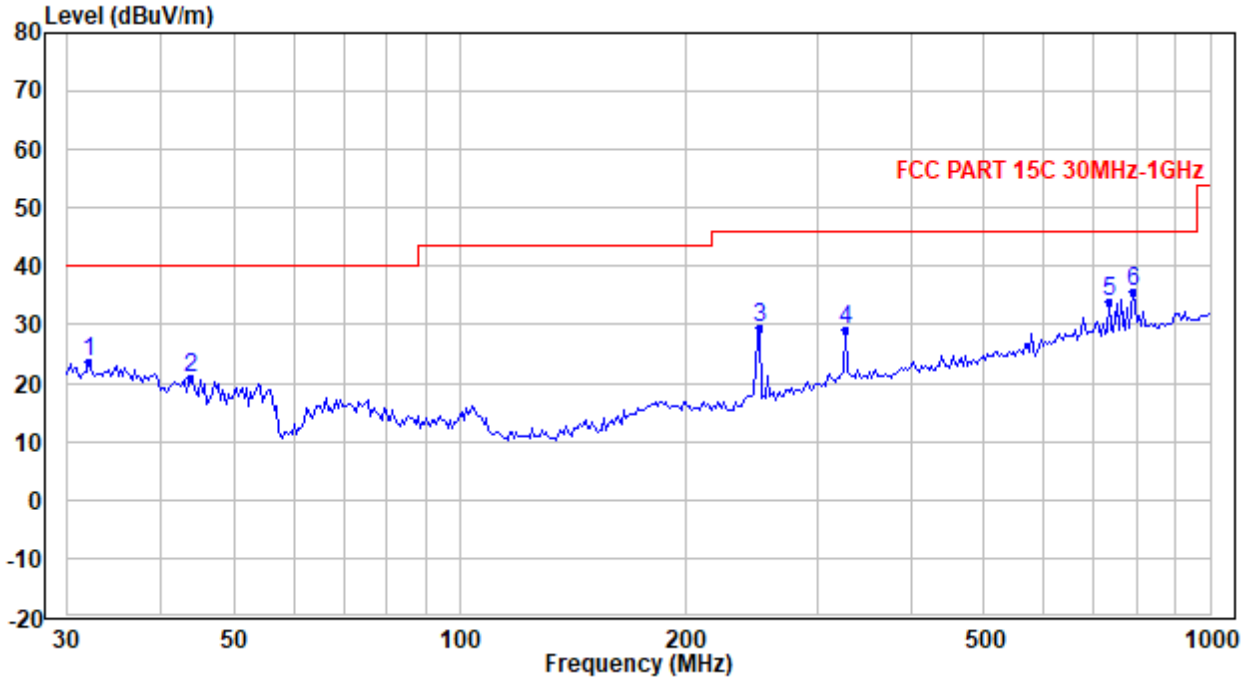
The measurement data as follows:

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):

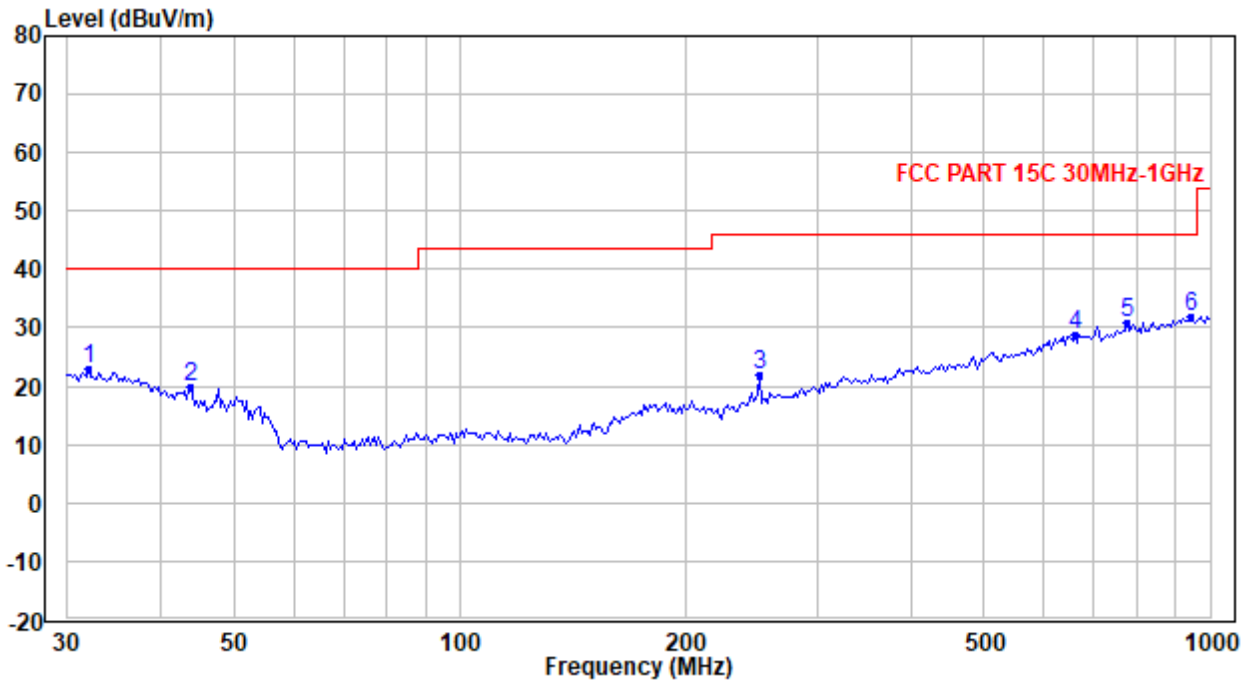
Worst-Case Configuration

Horizontal



No.	Frequency (MHz)	Reading (dBuV)	Correction factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	31.959	28.73	-5.08	23.65	40.00	-16.35	Peak
2	43.845	31.46	-10.49	20.97	40.00	-19.03	Peak
3	250.486	38.11	-8.52	29.59	46.00	-16.41	Peak
4	327.155	34.22	-5.21	29.01	46.00	-16.99	Peak
5	734.037	32.06	2.01	34.07	46.00	-11.93	Peak
6	787.475	32.38	3.35	35.73	46.00	-10.27	Peak

Vertical



No.	Frequency (MHz)	Reading (dBuV)	Correction factor (dB)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1	31.959	28.17	-5.08	23.09	40.00	-16.91	Peak
2	43.845	30.39	-10.49	19.90	40.00	-20.10	Peak
3	250.486	30.44	-8.52	21.92	46.00	-24.08	Peak
4	660.602	27.62	1.18	28.80	46.00	-17.20	Peak
5	776.485	27.80	3.12	30.92	46.00	-15.08	Peak
6	945.334	26.90	4.83	31.73	46.00	-14.27	Peak

Radiated Emission Test Data:								
Lowest Channel:								
No.	**Frequency (MHz)**	**Reading (dBμV)**	**Correction factor (dB/m)**	**Result (dBμV/m)**	**Limit (dBμV/m)**	**Margin (dB)**	**Detector**	**Antenna Polaxis**
1	1805.500	31.93	-10.62	21.31	54.00	-32.69	Average	Horizontal
2	1805.500	43.34	-10.62	32.72	74.00	-41.28	Peak	Horizontal
3	2708.250	26.86	-7.52	19.34	54.00	-34.66	Average	Horizontal
4	2708.250	38.32	-7.52	30.80	74.00	-43.20	Peak	Horizontal
5	6319.250	28.11	0.36	28.47	54.00	-25.53	Average	Horizontal
6	6319.250	46.17	0.36	46.53	74.00	-27.47	Peak	Horizontal
7	7222.000	25.71	1.63	27.34	54.00	-26.66	Average	Horizontal
8	7222.000	38.86	1.63	40.49	74.00	-33.51	Peak	Horizontal
9	1805.500	30.96	-10.62	20.34	54.00	-33.66	Average	Vertical
10	1805.500	42.11	-10.62	31.49	74.00	-42.51	Peak	Vertical
11	2708.250	27.18	-7.52	19.66	54.00	-34.34	Average	Vertical
12	2708.250	38.65	-7.52	31.13	74.00	-42.87	Peak	Vertical
13	6319.250	28.50	0.36	28.86	54.00	-25.14	Average	Vertical
14	6319.250	46.80	0.36	47.16	74.00	-26.84	Peak	Vertical
15	7222.000	25.71	1.63	27.34	54.00	-26.66	Average	Vertical
16	7222.000	39.65	1.63	41.28	74.00	-32.72	Peak	Vertical
Middle Channel:								
1	1829.500	33.66	-10.46	23.20	54.00	-30.80	Average	Horizontal
2	1829.500	45.74	-10.46	35.28	74.00	-38.72	Peak	Horizontal
3	2744.250	30.95	-7.45	23.50	54.00	-30.50	Average	Horizontal
4	2744.250	43.50	-7.45	36.05	74.00	-37.95	Peak	Horizontal
5	5488.500	26.40	-0.30	26.10	54.00	-27.90	Average	Horizontal
6	5488.500	46.67	-0.30	46.37	74.00	-27.63	Peak	Horizontal
7	6403.250	24.89	0.51	25.40	54.00	-28.60	Average	Horizontal
8	6403.250	43.50	0.51	44.01	74.00	-29.99	Peak	Horizontal
9	1829.500	34.18	-10.46	23.72	54.00	-30.28	Average	Vertical
10	1829.500	45.19	-10.46	34.73	74.00	-39.27	Peak	Vertical
11	2744.250	31.27	-7.45	23.82	54.00	-30.18	Average	Vertical
12	2744.250	44.34	-7.45	36.89	74.00	-37.11	Peak	Vertical
13	5488.500	27.20	-0.30	26.90	54.00	-27.10	Average	Vertical
14	5488.500	46.12	-0.30	45.82	74.00	-28.18	Peak	Vertical
15	6403.250	24.29	0.51	24.80	54.00	-29.20	Average	Vertical
16	6403.250	42.42	0.51	42.93	74.00	-31.07	Peak	Vertical

No.	Frequency (MHz)	Reading (dBμV)	Correction factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector	Antenna Polaxis
Highest Channel:								
1	1854.500	33.73	-10.30	23.43	54.00	-30.57	Average	Horizontal
2	1854.500	45.73	-10.30	35.43	74.00	-38.57	Peak	Horizontal
3	2781.750	31.38	-7.40	23.98	54.00	-30.02	Average	Horizontal
4	2781.750	42.35	-7.40	34.95	74.00	-39.05	Peak	Horizontal
5	5563.500	27.45	-0.31	27.14	54.00	-26.86	Average	Horizontal
6	5563.500	46.33	-0.31	46.02	74.00	-27.98	Peak	Horizontal
7	6490.750	27.49	0.67	28.16	54.00	-25.84	Average	Horizontal
8	6490.750	43.84	0.67	44.51	74.00	-29.49	Peak	Horizontal
9	1854.500	33.82	-10.30	23.52	54.00	-30.48	Average	Vertical
10	1854.500	45.57	-10.30	35.27	74.00	-38.73	Peak	Vertical
11	2781.750	31.65	-7.40	24.25	54.00	-29.75	Average	Vertical
12	2781.750	42.66	-7.40	35.26	74.00	-38.74	Peak	Vertical
13	5563.500	28.72	-0.31	28.41	54.00	-25.59	Average	Vertical
14	5563.500	47.28	-0.31	46.97	74.00	-27.03	Peak	Vertical
15	6490.750	28.30	0.67	28.97	54.00	-25.03	Average	Vertical
16	6490.750	46.12	0.67	46.79	74.00	-27.21	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 902 MHz and 928 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) = 100 kHz, video bandwidth (VBW) = 300 kHz for peak levels and RBW = 120 kHz and VBW =300 kHz).

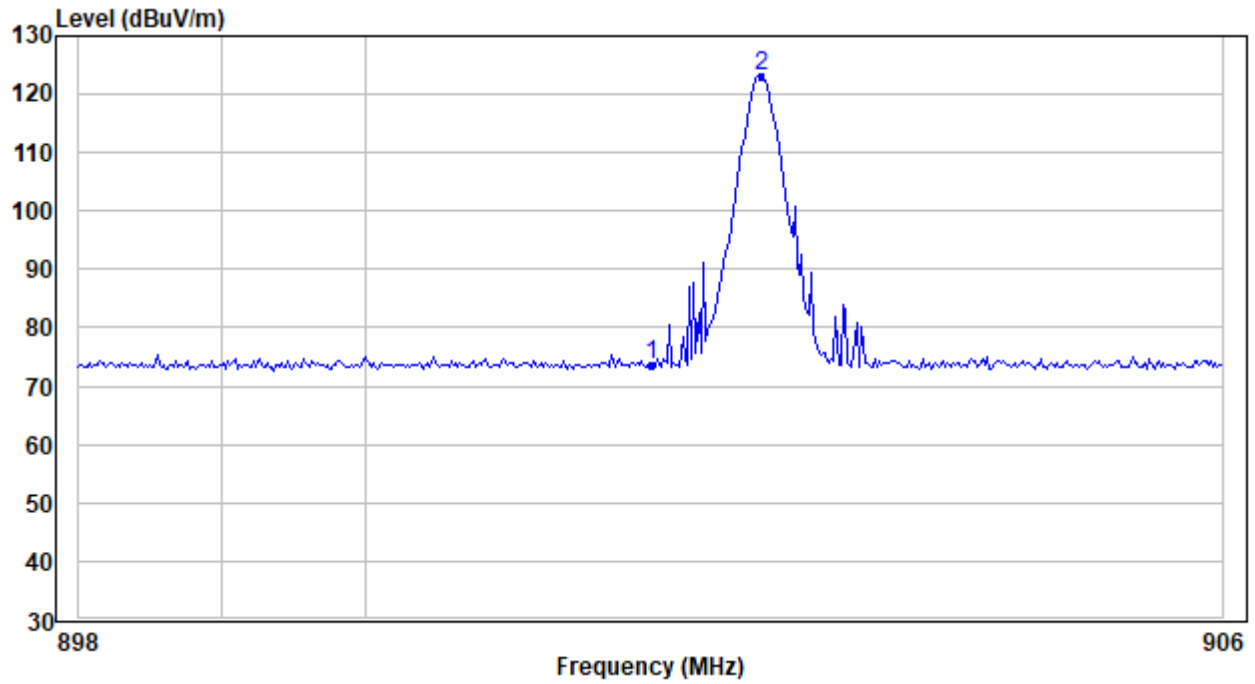
1. Use radiated spurious emission test procedure described in clause 5.10. The transmitter output (antenna port) was connected to the test receiver.
2. Set the QP limit line.
3. Record the fundamental emission and emissions out of the band-edge.
4. Determine band-edge compliance as required.

Equipment Used: Refer to section 3 for details.

Test Result: Pass

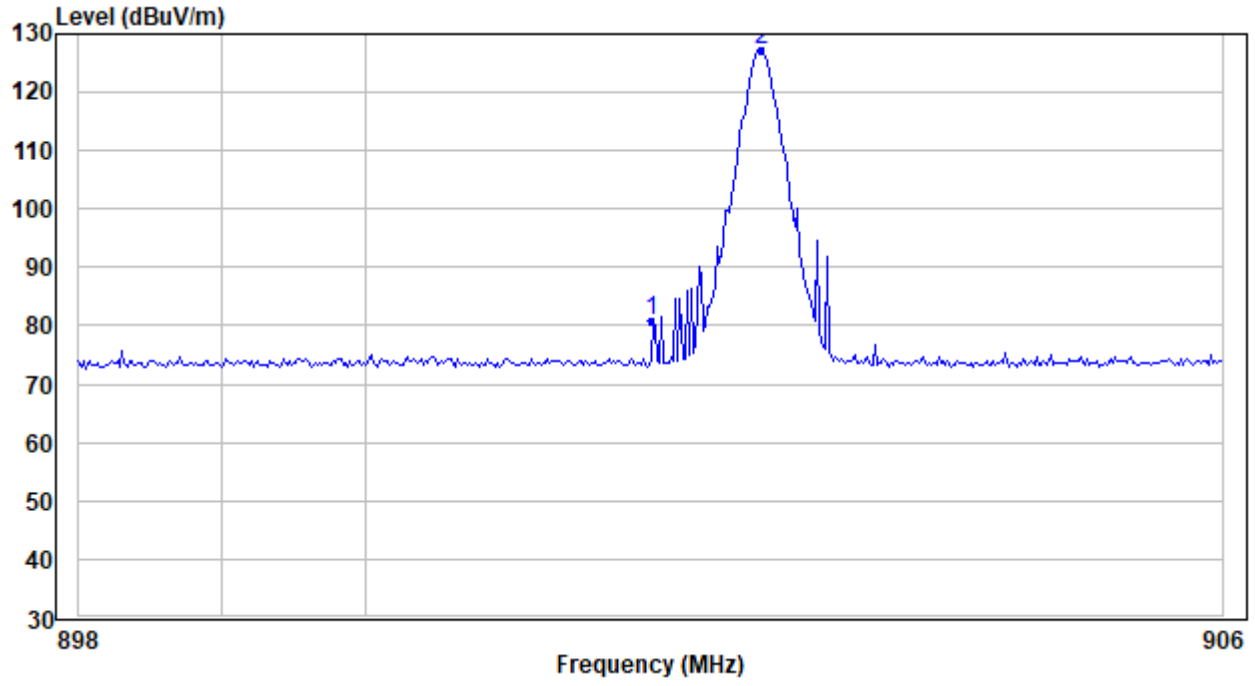
The measurement data as follows:

Test Channel:	Lowest Channel	Ant. Polar. :	Horizontal



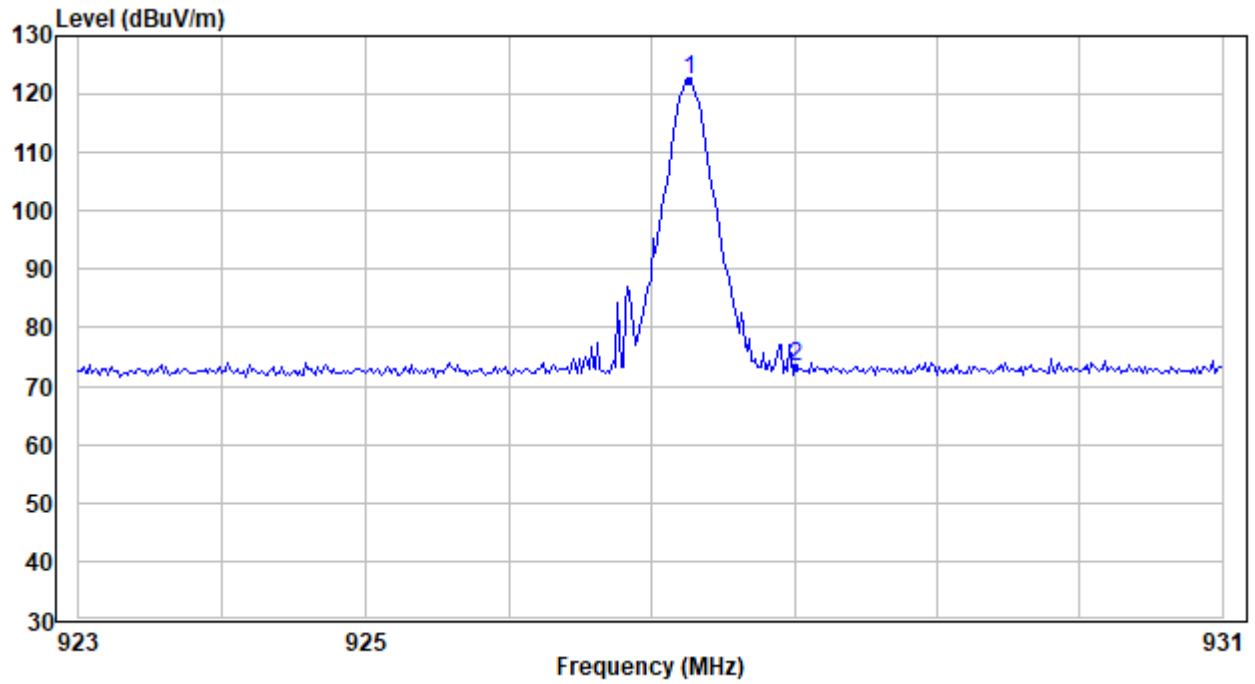
Frequency (MHz)	Peak level (dBuv/m)	Delta (dBc)	Attenuation required (dBc)	Conclusion
902.00	73.57	49.72	20	Pass
902.75	123.29			

Test Channel:	Lowest Channel	Ant. Polar. :	Vertical



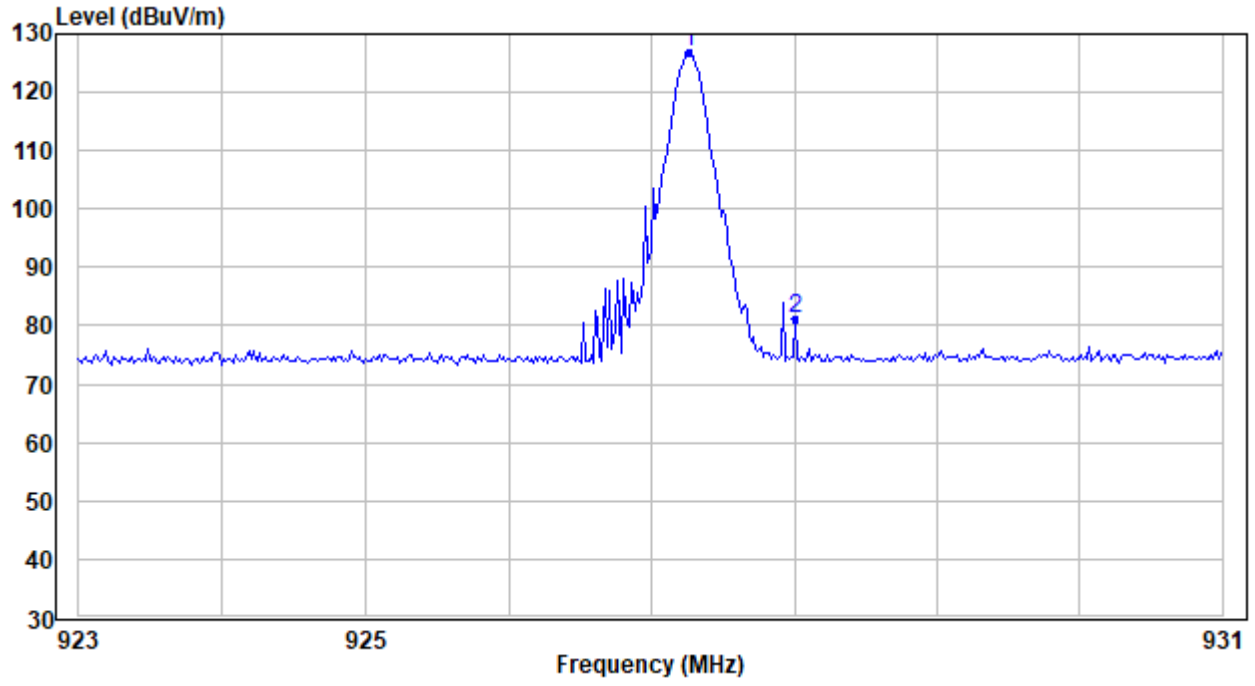
Frequency (MHz)	Peak level (dBuv/m)	Delta (dBc)	Attenuation required (dBc)	Conclusion
902.00	80.85	46.3	20	Pass
902.75	127.15			

Test Channel:	Highest Channel	Ant. Polar. :	Horizontal



Frequency (MHz)	Peak level (dBuv/m)	Delta (dBc)	Attenuation required (dBc)	Conclusion
928.00	73.33	49.17	20	Pass
927.25	122.5			

Test Channel:	Highest Channel	Ant. Polar. :	Vertical



Frequency (MHz)	Peak level (dBuv/m)	Delta (dBc)	Attenuation required (dBc)	Conclusion
928.00	81.12	45.91	20	Pass
927.25	127.03			

5.11 CONDUCTED EMISSION

Test Requirement: 47 CFR Part 15C Section 15.207

Test Method: ANSI C63.10-2013 Section 6.2

Limits:

Frequency range (MHz)	Limits (dB(μV))	
	Quasi-peak	Average
0,15 to 0,50	66 to 56	56 to 46
0,50 to 5	56	46
5 to 30	60	50

Remark:

1. The lower limit shall apply at the transition frequencies.
2. The limit decreases linearly with the logarithm of the frequency in the range 0.15 to 0.50 MHz.

Test Setup: Refer to section 4.5.2 for details.

Test Procedures:

Test frequency range :150KHz-30MHz

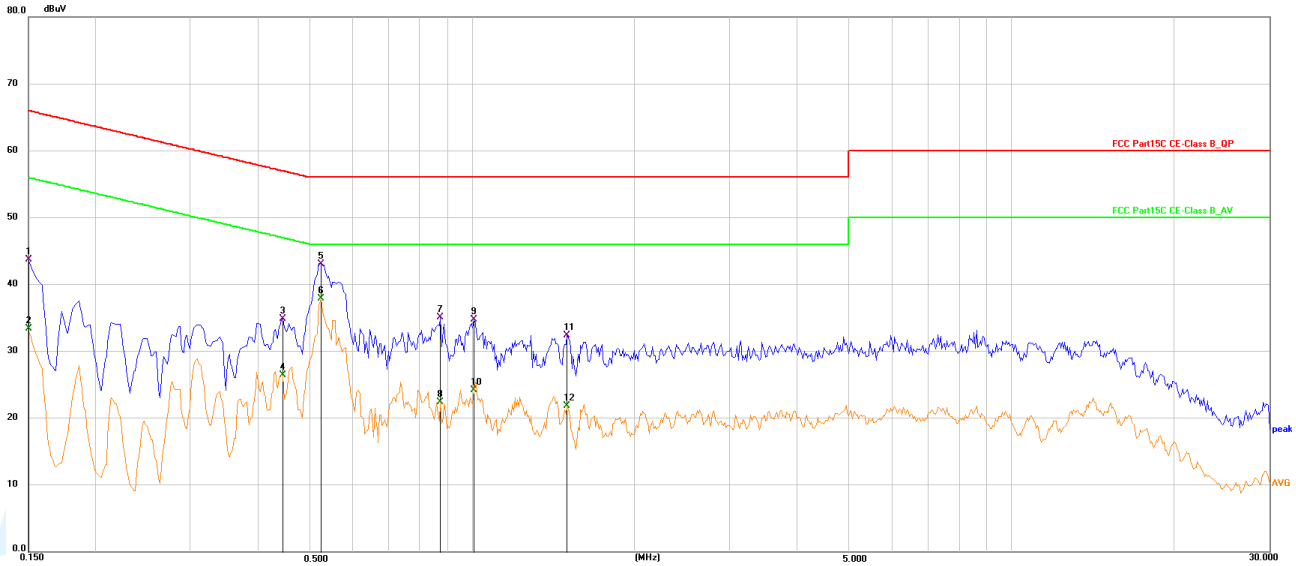
1) The mains terminal disturbance voltage test was conducted in a shielded room.
2) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a 50Ω/50μH + 5Ω linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded.
3) The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane,
4) The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0.4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN 1 was placed 0.8 m from the boundary of the unit under test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane. This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0.8 m from the LISN 2.
5) In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10 on conducted measurement.

Equipment Used: Refer to section 3 for details.

Test Result: Pass

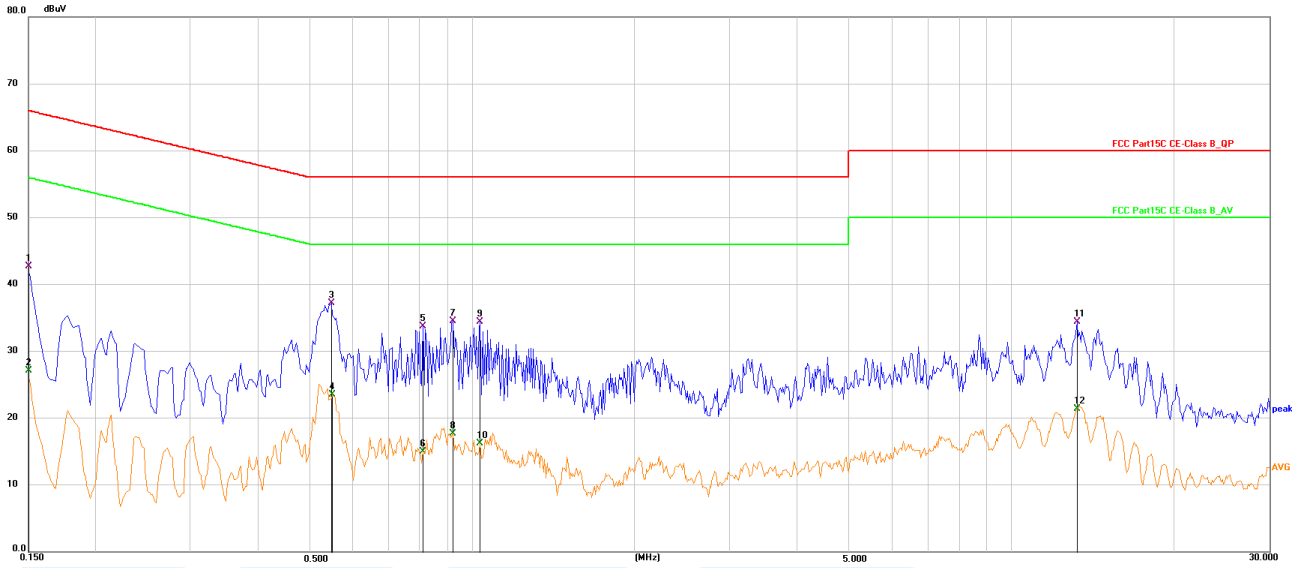
The measurement data as follows:
Quasi Peak and Average:
Mode: RFID

Live Line



No.	Frequency (MHz)	Reading (dBuV)	Correction factor (dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Detector
1	0.1500	33.55	10.20	43.75	66.00	-22.25	QP
2	0.1500	23.20	10.20	33.40	56.00	-22.60	AVG
3	0.4425	24.67	10.15	34.82	57.01	-22.19	QP
4	0.4425	16.25	10.15	26.40	47.01	-20.61	AVG
5	0.5234	32.87	10.19	43.06	56.00	-12.94	QP
6	0.5234	27.63	10.19	37.82	46.00	-8.18	AVG
7	0.8745	24.80	10.28	35.08	56.00	-20.92	QP
8	0.8745	12.15	10.28	22.43	46.00	-23.57	AVG
9	1.0095	24.39	10.35	34.74	56.00	-21.26	QP
10	1.0095	13.81	10.35	24.16	46.00	-21.84	AVG
11	1.4955	22.11	10.28	32.39	56.00	-23.61	QP
12	1.4955	11.58	10.28	21.86	46.00	-24.14	AVG

Neutral Line



No.	Frequency (MHz)	Reading (dBuV)	Correction factor (dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Detector
1	0.1500	32.55	10.19	42.74	66.00	-23.26	QP
2	0.1500	16.92	10.19	27.11	56.00	-28.89	AVG
3	0.5460	26.90	10.27	37.17	56.00	-18.83	QP
4	0.5505	13.21	10.27	23.48	46.00	-22.52	AVG
5	0.8115	23.55	10.22	33.77	56.00	-22.23	QP
6	0.8115	4.71	10.22	14.93	46.00	-31.07	AVG
7	0.9195	24.29	10.18	34.47	56.00	-21.53	QP
8	0.9195	7.51	10.18	17.69	46.00	-28.31	AVG
9	1.0365	24.24	10.16	34.40	56.00	-21.60	QP
10	1.0365	6.01	10.16	16.17	46.00	-29.83	AVG
11	13.2225	23.86	10.56	34.42	60.00	-25.58	QP
12	13.2225	10.79	10.56	21.35	50.00	-28.65	AVG

Remark:

1. Correct Factor = LISN Factor + Cable Loss + Pulse Limiter Factor, the value was added to Original Receiver Reading by the software automatically.
2. Result = Reading + Correct Factor.
3. Margin = Result - Limit
4. An initial pre-scan was performed on the Phase and neutral lines with peak detector. Quasi-Peak and Average measurement were performed at the frequencies with maximized peak emission were detected.
5. All possible modes of operation were investigated, and testing at two nominal voltages of 240V/50Hz and 120V/60Hz, only the worst case emissions reported.

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 ***