

RF TEST REPORT

Report number		RAPA21-O-025
Applicant	Name	IOT WARE Co., Ltd
	Logo	N/A
	Address	#1303-1, Gasan Hansin IT Tower 2cha, 47, Digital-ro 9-gil, Geumcheno-gu, Seoul, Korea
Manufacturer	Name	IOT WARE Co., Ltd
	Address	#1303-1, Gasan Hansin IT Tower 2cha, 47, Digital-ro 9-gil, Geumcheno-gu, Seoul, Korea
Type of equipment		RFID reader
Basic model name		RFID reader
Multi model name		I9-2000N
Serial number		U9-2000N
FCC ID		2A2RE-I9-2000N
Test duration		September 3, 2021 to September 10, 2021
Date of issue		September 10, 2021
Total page		32 Pages (including this page)

SUMMARY

The equipment complies with the regulation; FCC Part 15 Subpart C Section 15.247

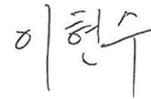
This test report only contains the result of a single test of the sample supplied for the examination. It is not a general valid assessment of the features of the respective products of the mass-production.

September 10, 2021

September 10, 2021



Tested by MinGu Ji
Tester



Reviewed by Hyun Soo Lee
Executive Managing Director

Test Report Version History

Version	Date	Reason for revision
1.0	September 10, 2021	Original Document

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1. Description of EUT

1.1 Applicant

- Company name : IOT WARE Co., Ltd
- Address : #1303-1, Gasan Hansin IT Tower 2cha, 47, Digital-ro 9-gil, Geumcheno-gu, Seoul, Korea
- Contact person : Rack Eon Koo / Header of research center / rekoo@iotware.net
- Phone/Fax : +82-2-866-1150 / +82-2-866-0512

1.2 Manufacturer

- Company name : IOT WARE Co., Ltd
- Address : 76, Hanam-daero, Hanam-si, Gyeonggi-do, Republic of Korea
- Phone/Fax : +82-2-866-1150 / +82-2-866-0512

1.3 Basic description

- Product name : RFID reader
- Basic model name : I9-2000N
- Alternative model name : U9-2000N

1.4 General description

- EQUIPMENT CLASS : DSS – SPREAD SPECTRUM TRANSMITTER
- Frequency Range : 911.3 MHz ~ 925.7 MHz
- Output Power : 29.8 dBm
- Modulation Type : ASK
- Number of Channel : 73
- Antenna Type : Patch Antenna
- Antenna Gain : 2.45 dBi
- Power Supply : DC 12.0 V

Channel List

Number	Freq(MHz)	Number	Freq(MHz)	Number	Freq(MHz)
1	911.3	26	916.3	51	921.3
2	911.5	27	916.5	52	921.5
3	911.7	28	916.7	53	921.7
4	911.9	29	916.9	54	921.9
5	912.1	30	917.1	55	922.1
6	912.3	31	917.3	56	922.3
7	912.5	32	917.5	57	922.5
8	912.7	33	917.7	58	922.7
9	912.9	34	917.9	59	922.9
10	913.1	35	918.1	60	923.1
11	913.3	36	918.3	61	923.3
12	913.5	37	918.5	62	923.5
13	913.7	38	918.7	63	923.7
14	913.9	39	918.9	64	923.9
15	914.1	40	919.1	65	924.1
16	914.3	41	919.3	66	924.3
17	914.5	42	919.5	67	924.5
18	914.7	43	919.7	68	924.7
19	914.9	44	919.9	69	924.9
20	915.1	45	920.1	70	925.1
21	915.3	46	920.3	71	925.3
22	915.5	47	920.5	72	925.5
23	915.7	48	920.7	73	925.7
24	915.9	49	920.9		
25	916.1	50	921.1		

1.5 Alternative type(s)/model(s)

The Following Lists Consist to of the added model and their differences.

Model name	Differences	Tested
I9-2000N	Basic Model	<input checked="" type="checkbox"/>
U9-2000N	It is the same as the I9-2000N model, only the model name is added.	<input type="checkbox"/>

2. General information of test

2.1 Test standards and results

Applied Standards : FCC Part 15 Subpart C		
Section	Description of Test	Result
15.247 (a) (1)	Carrier Frequency Separation	Pass
15.247 (a) (1) (iii)	Minimum Number of Hopping Channels	Pass
	Average Time of Occupancy	Pass
15.247 (d)	100 kHz Bandwidth Outside the Frequency Band	Pass
	Radiated Emission which fall in the Restricted Band	Pass
15.247 (b) (1)	Maximum Peak Conducted Output Power	Pass
15.207	Conducted Limits	N/A
15.209	Radiated Emission Limits, General Requirement	Pass
15.203	Antenna Requirement	Pass

2.2 Description of EUT during the test

During the test, keep the EUT in continuously transmitting mode.

There was no mechanical or circuitry modification to improve RF and spurious characteristic, and any RF and spurious suppression device(s) was not added against the device tested.

The EUT was moved throughout the X, Y, and Z axis and worst case data was recorded in this report.

2.3 Test configuration

• Type of peripheral equipment used

Model	Manufacturer	Description	Connected to
I9-2000N	IOT WARE Co., Ltd	USB	EUT
6560b	HP	Notebook	EUT
PPP12D-S	Delta Electronics Ltd.	Power Adapter	Notebook
B05-24-12	Daygreen	DC IN	EUT

2.4 Test Facility

- FCC Registration No: 931589
- IC Company address code: 9355B
- RRA Designation Number: KR0027

• Place of Test

Anyang Test Site(RF Test Room)

#101 & B104 Anyang Megavalley, 268, Hagui-ro, Dongan-gu, Anyang-si, Gyeonggi-do, 14056, Korea

2.5 PRELIMINARY TEST

2.5.1 AC Power line Conducted Emissions Tests

Not tested as it is a DC power supply and is not intended for use in vehicles.

2.5.2 General Radiated Emissions Tests

During Preliminary Tests, the following operating modes were investigated

Operation Mode	The Worse operating condition (Please check one only)
Transmitting mode.	X

2.5.3 Special conditions for testing

This product uses 4 antenna ports, but does not support MIMO mode operation and operates in sequential SISO mode.

Antenna Port	Conducted Power (dBm)
1	31.1
2	30.8
3	30.7
4	30.9

As a result of the test for each port, port 1 was the worst, so the wired test was conducted with port 1.

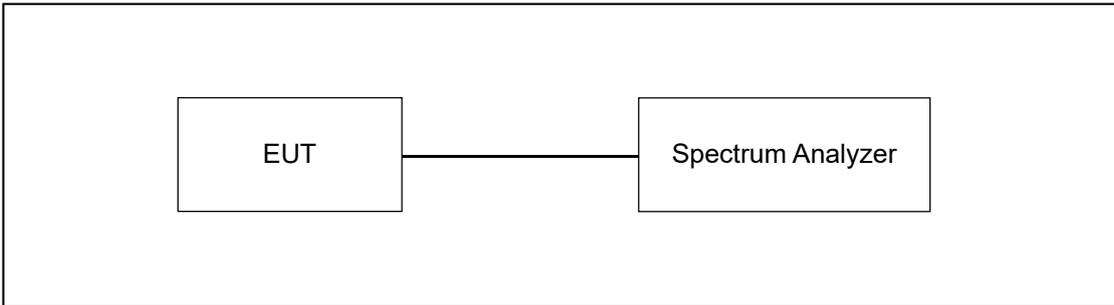
3. Measurement data

3.1 Minimum 20 dB Bandwidth

3.1.1 Requirement

- FCC Part15 subpart C Section 15.247

3.1.2 Test Procedure



The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 100 kHz, and peak detection was used. The 20 dB bandwidth is defined as the total spectrum over which the power is higher than the peak power minus 20 dB.

3.1.3 Test environment

- 24 °C, 48 % R.H.

3.1.4 Test results

Frequency [MHz]		Measured Value [kHz]	Limit [kHz]	Result
Low	911.3	111.0	500	PASS
Middle	918.5	107.0	500	
High	925.7	100.0	500	

3.1.5 Test Plots



Low Channel



Middle Channel



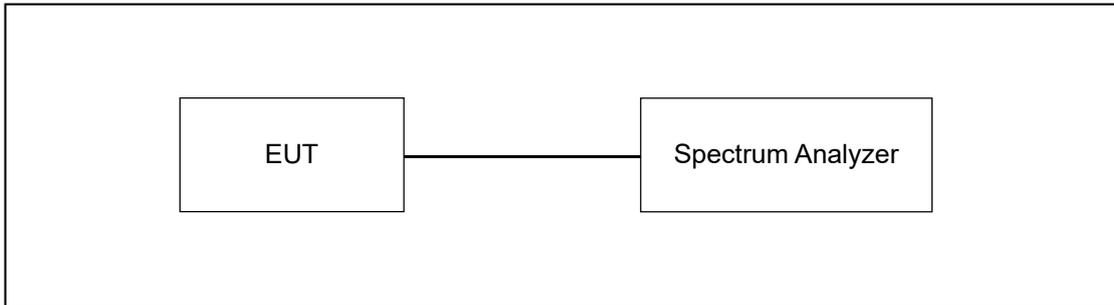
High Channel

3.2 Hopping Frequency Separation

3.2.1 Requirement

- FCC Part15 subpart C Section 15.247

3.2.2 Test Procedure



The antenna output of the EUT was connected to the spectrum analyzer. The frequency span is set to 5 MHz. The analyzer is set to peak hold then a pseudo-random hopping sequence of the transmitter is captured. The mark delta function was used to measure the frequency separation between two adjacent hopping channels.

3.2.3 Test environment

- 24 °C, 48 % R.H.

3.2.4 Test results

Frequency [MHz]	Measured Value [kHz]	Limit [dBm]	Result
918.50	200.0	Minimum of 25 kHz or the 20 dB Bandwidth	PASS

3.2.5 Test Plots

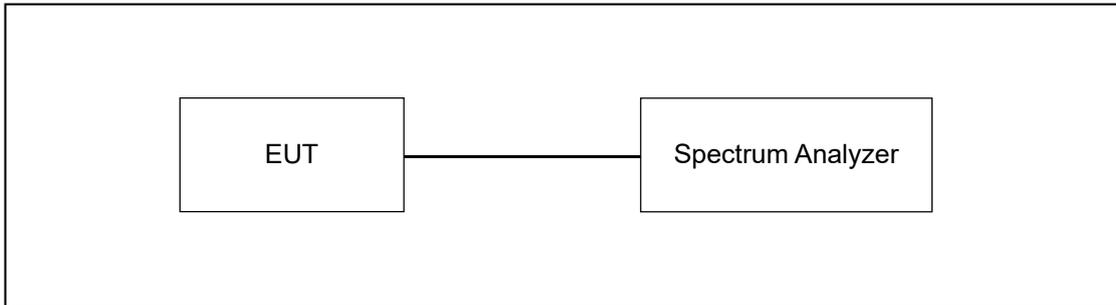


3.3 Number Of Hopping Channels

3.3.1 Requirement

- FCC Part15 subpart C Section 15.247

3.3.2 Test Procedure



The antenna output of the EUT was connected to the spectrum analyzer. The frequency span is set to frequency band of operation and the resolution bandwidth is set to 100 kHz. The analyzer is set to peak hold and then complete pseudo-random hopping sequence of the transmitter is captured..

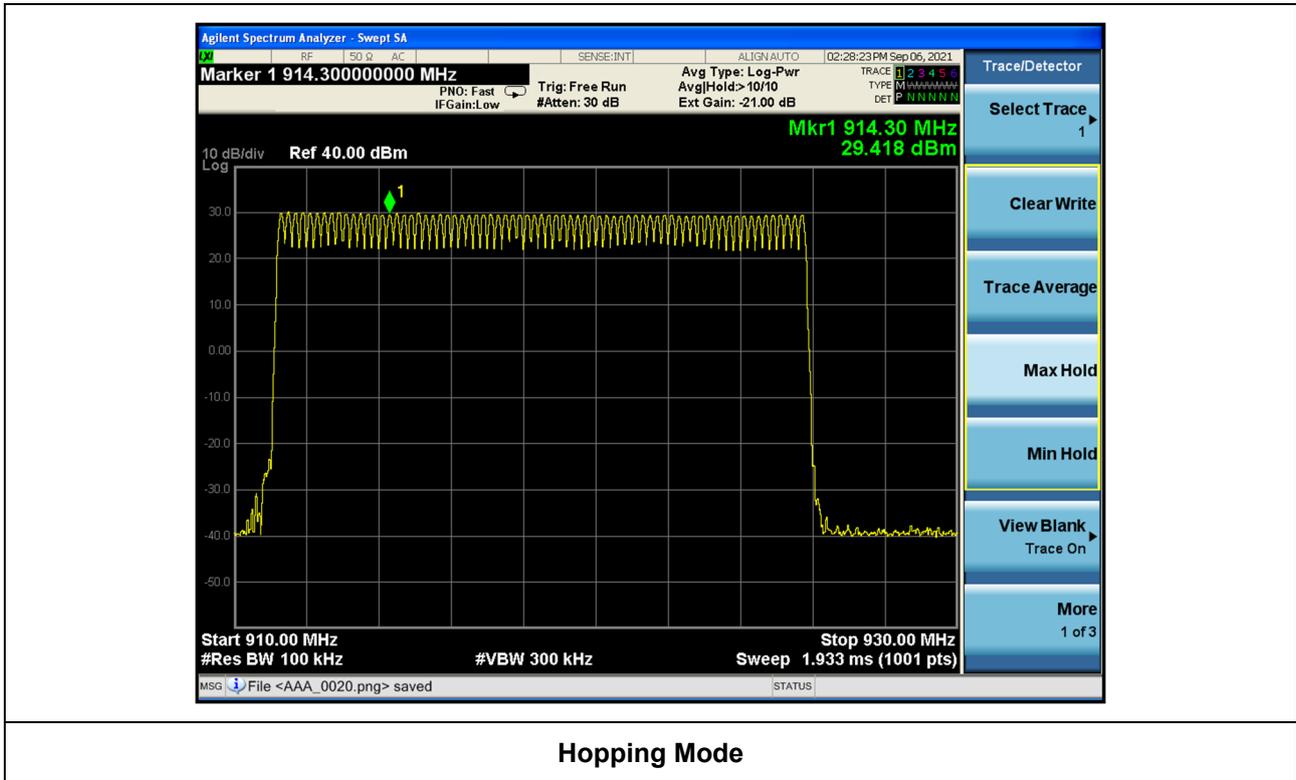
3.3.3 Test environment

- 24 °C, 48 % R.H.

3.3.4 Test results

Frequency [MHz]	Measured Value [Number]	Limit [dBm]	Result
902 ~ 928	73	≥ 50	PASS

3.2.5 Test Plots



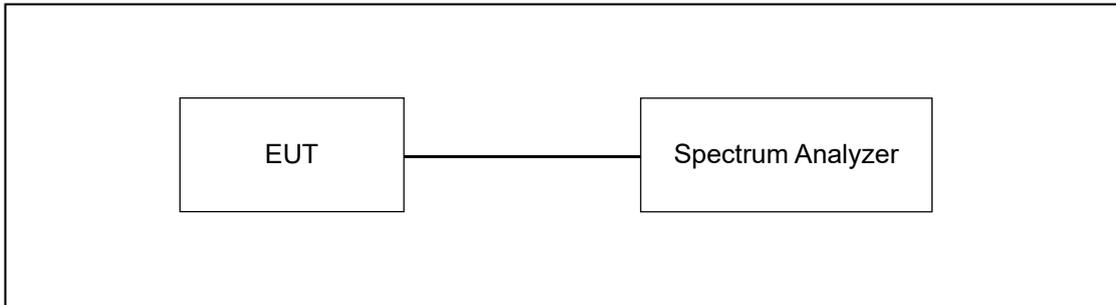
Hopping Mode

3.3 Time Of Occupancy

3.3.1 Requirement

- FCC Part15 subpart C Section 15.247

3.3.2 Test Procedure



The antenna output of the EUT was connected to the spectrum analyzer. The transmitter is set to operate in its normal frequency hopping mode. The center frequency of the spectrum analyzer is set to one of hopping channels near the center of the operating band and span is set to zero Hz. The sweep time is set to display one complete pulse. The mark delta function is used to measure the duration of the pulses.

3.3.3 Test environment

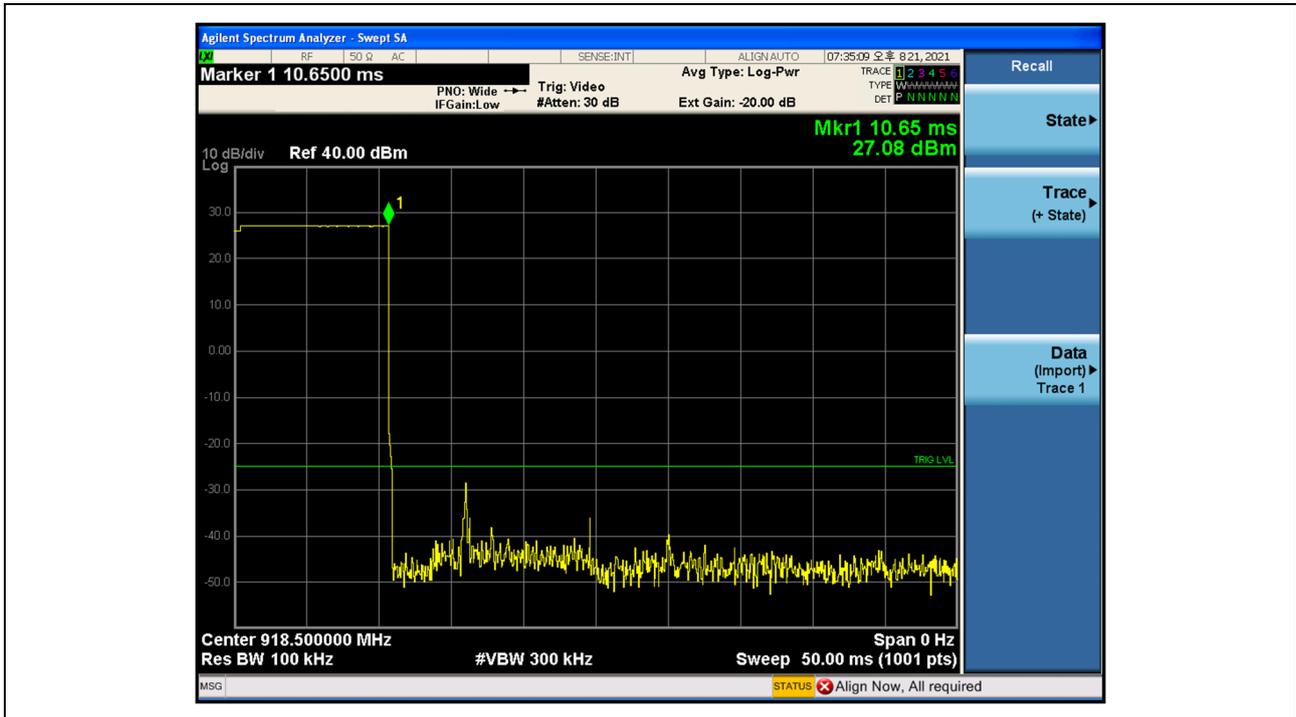
- 24 °C, 48 % R.H.

3.3.4 Test results

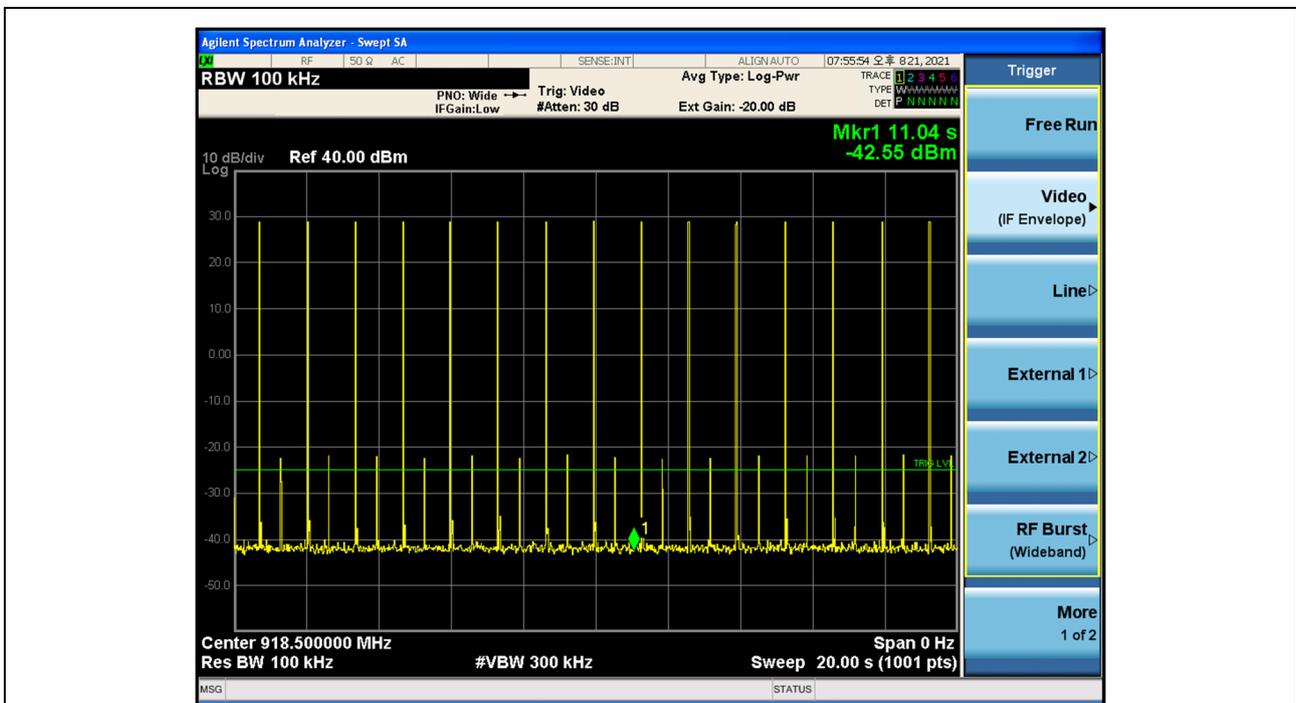
Frequency Range (MHz)	Pulse Time (ms)	Number of Pulse in 20 seconds	Average Occupancy Time (ms)	Limit (ms)
918.5	10.65	15	159.75	400

* Average Occupancy Time = Pulse Time * Number of Pulse in 20 seconds

3.2.5 Test Plots



Pulse Time



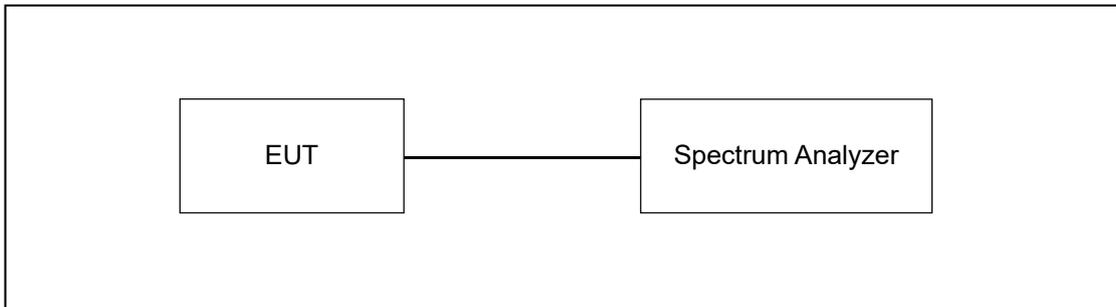
Number of Transmissions during a 20 second period

3.3 Maximum Peak Output Power

3.3.1 Requirement

- FCC Part15 subpart C Section 15.247

3.3.2 Test Procedure



The maximum peak output power was measured with the spectrum analyzer connected to the antenna output of the EUT. The EUT was operating in transmit mode at the appropriate center frequency.

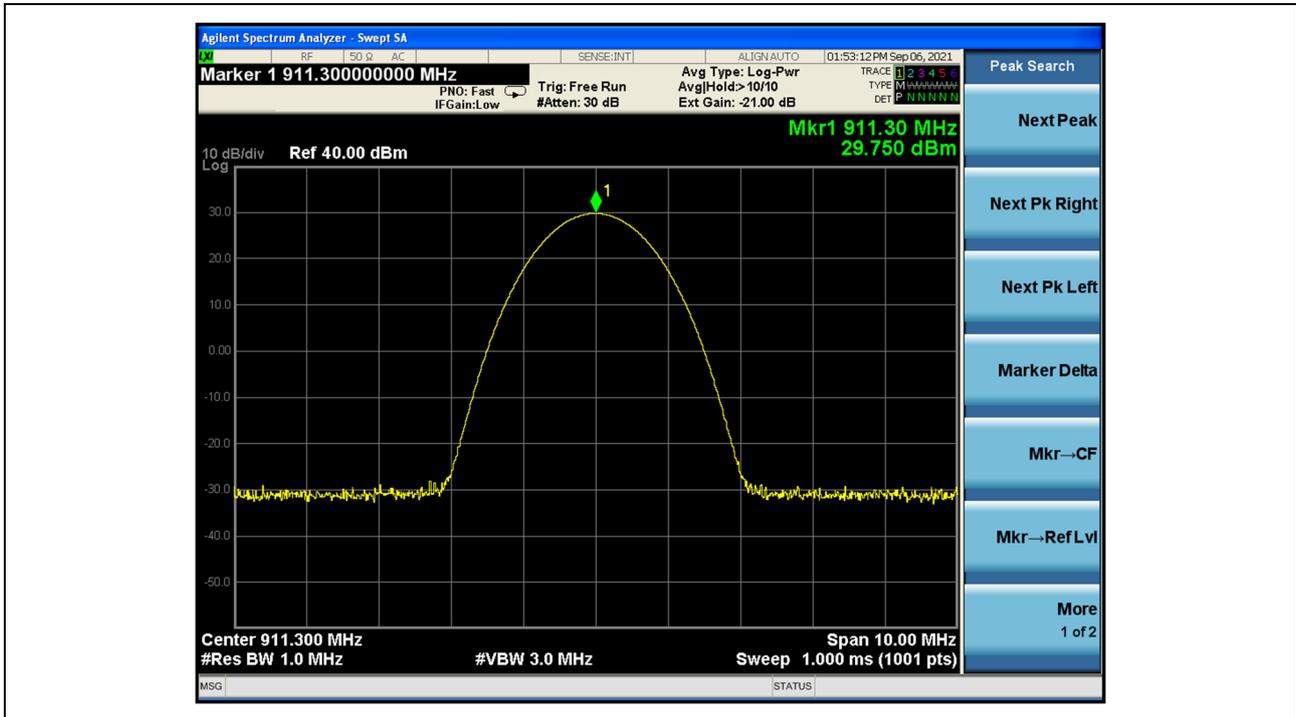
3.3.3 Test environment

- 24 °C, 48 % R.H.

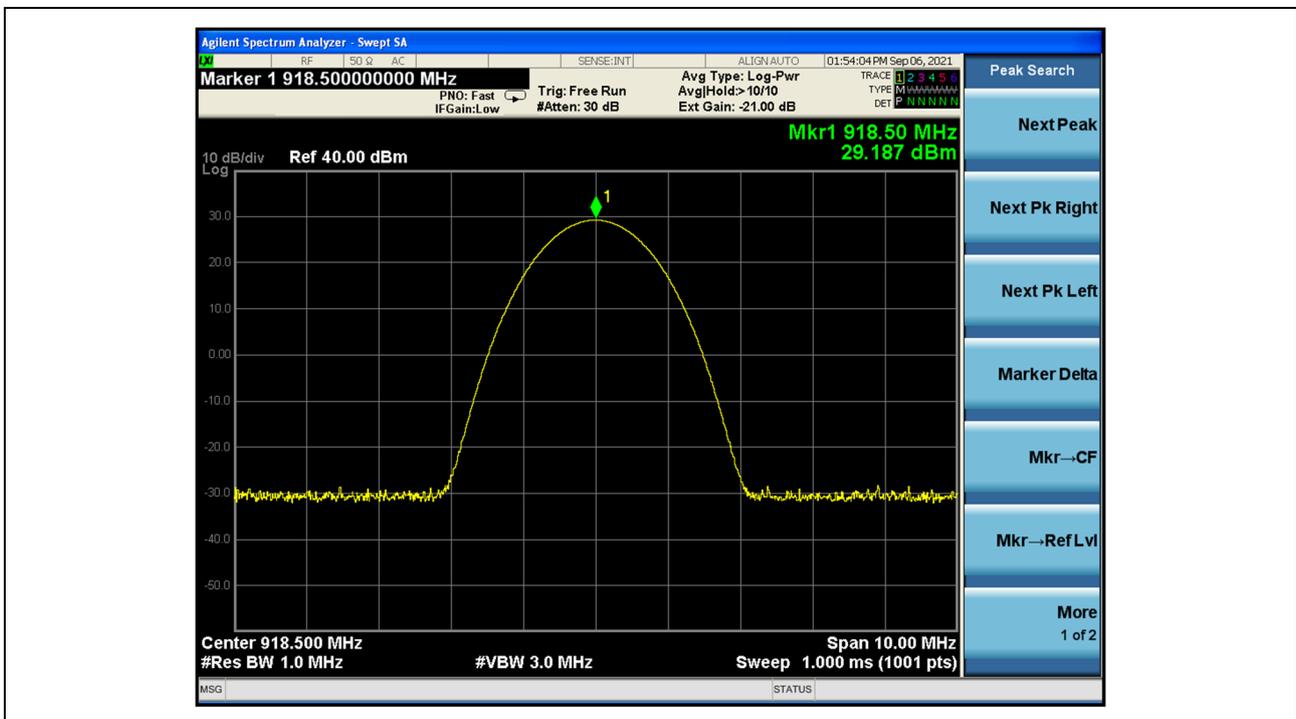
3.3.4 Test results

Frequency [MHz]		Measured Value [dBm]	Limit [dBm]	Result
Low	911.3	29.8	30.0	PASS
Middle	918.5	29.2		PASS
High	925.7	29.1		PASS

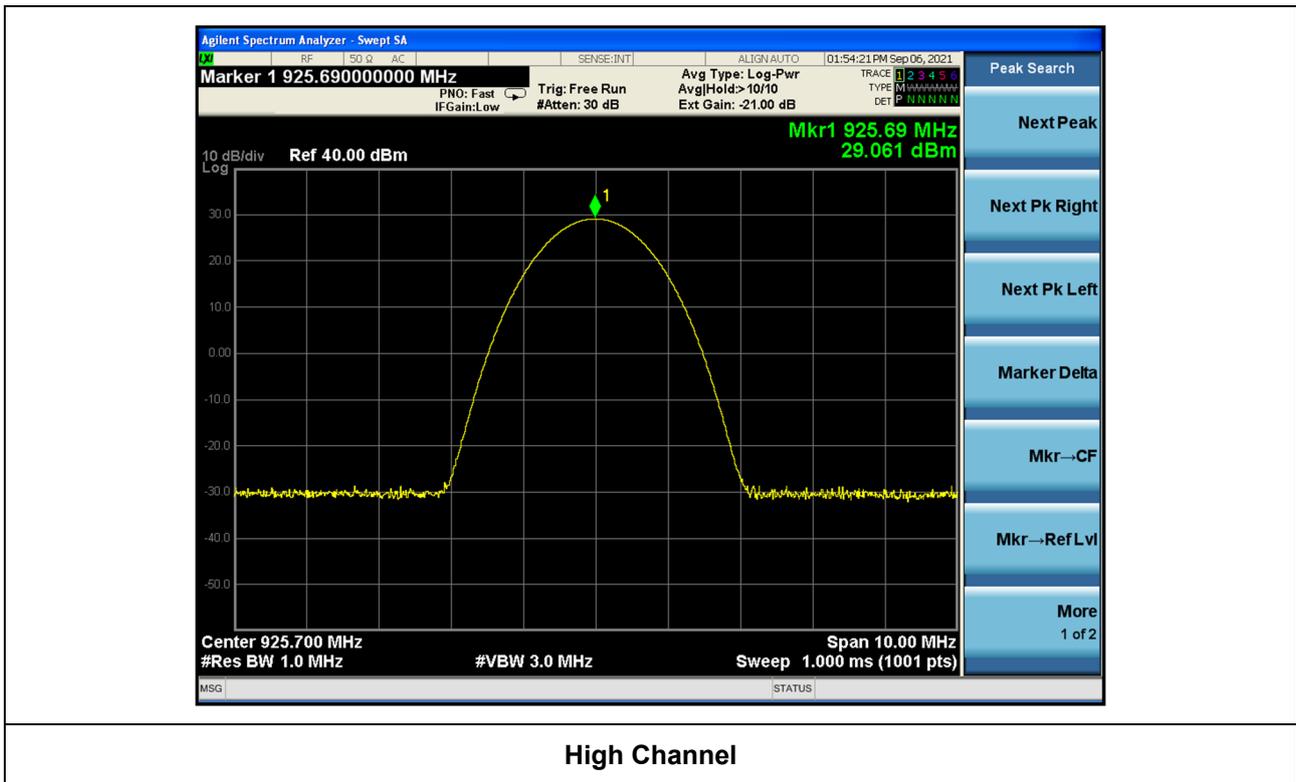
3.2.5 Test Plots



Low Channel



Middle Channel



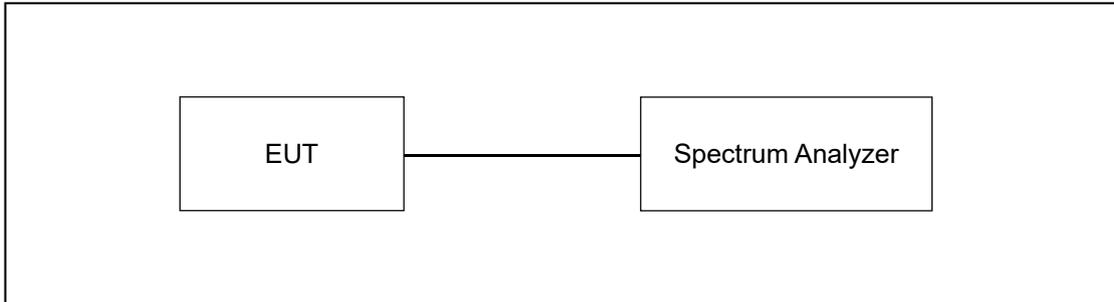
High Channel

3.3 100 kHz Bandwidth Outside the Frequency Band

3.3.1 Requirement

- FCC Part15 subpart C Section 15.247

3.3.2 Test Procedure

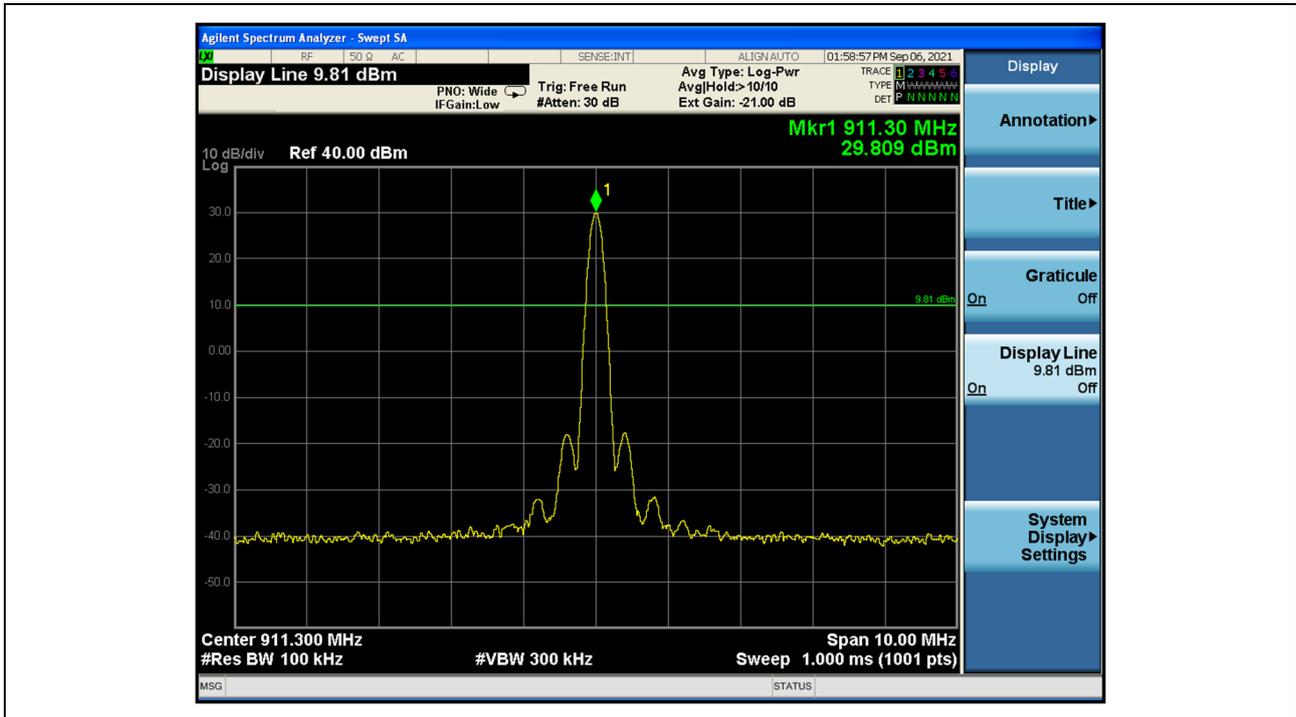


The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth and video bandwidth is set to 100 kHz, and peak detection was used.

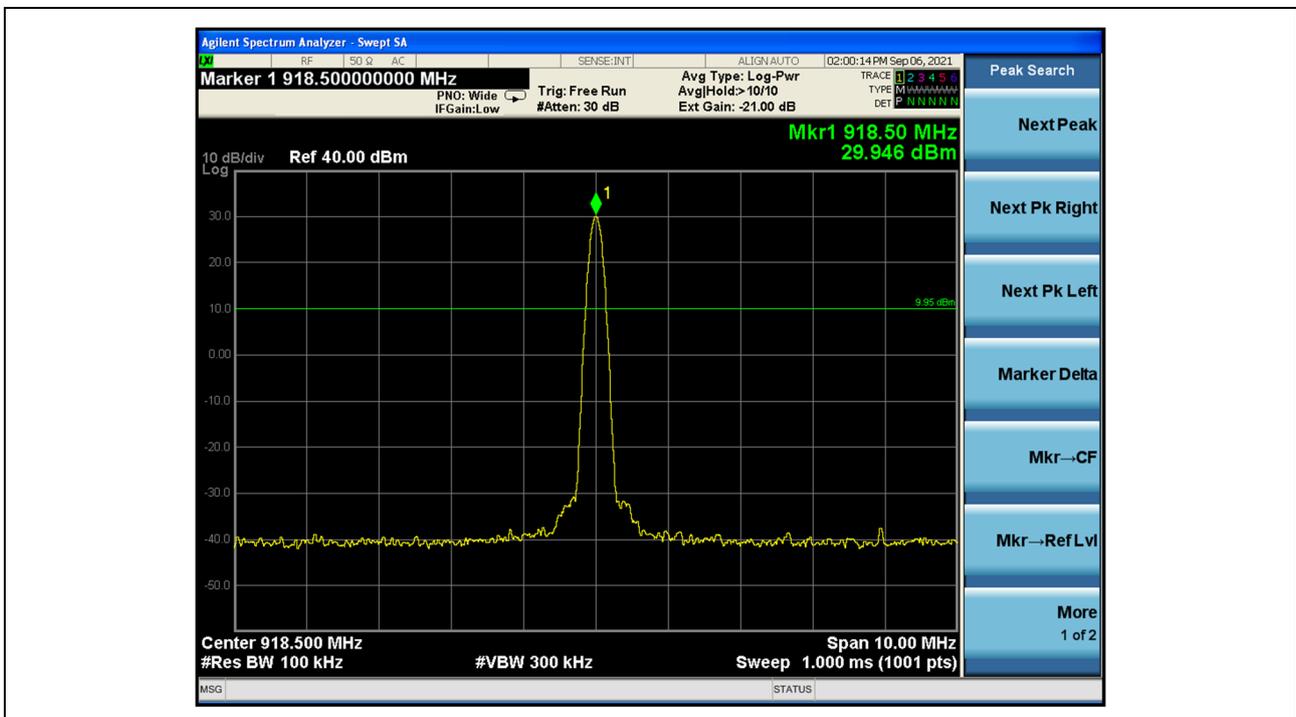
3.3.3 Test environment

- 24 °C, 48 % R.H.

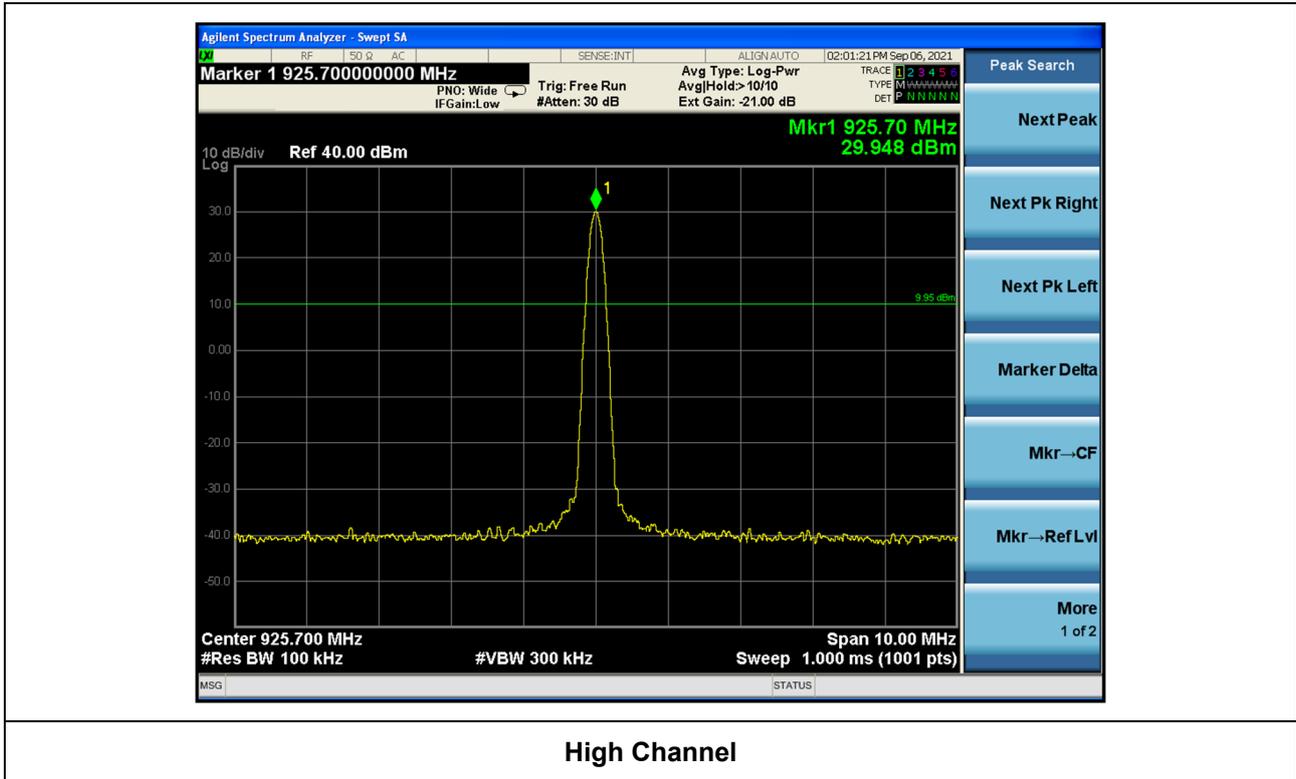
3.3.4 Test Plots



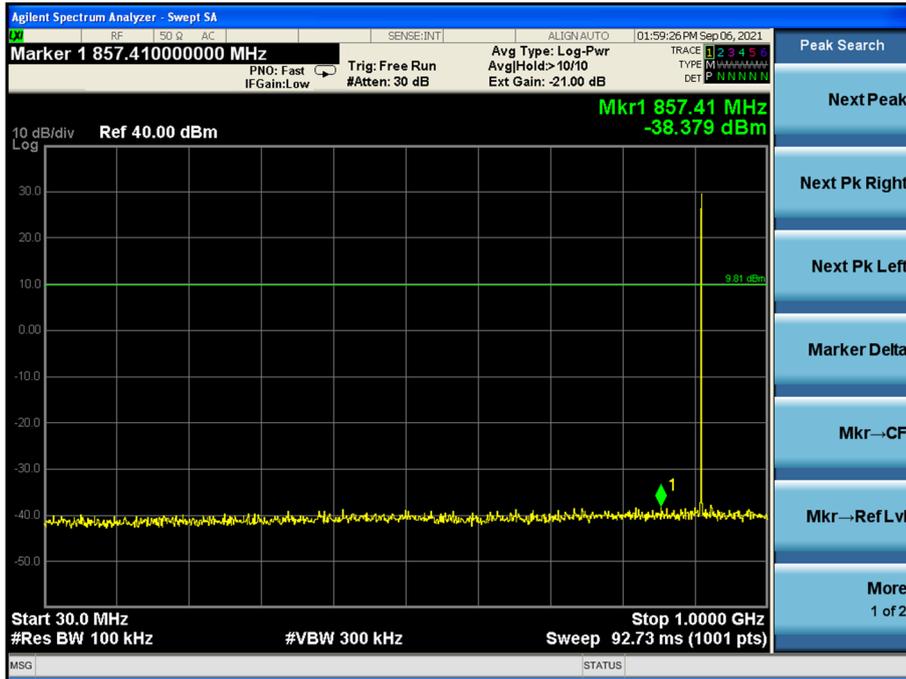
Low Channel



Middle Channel



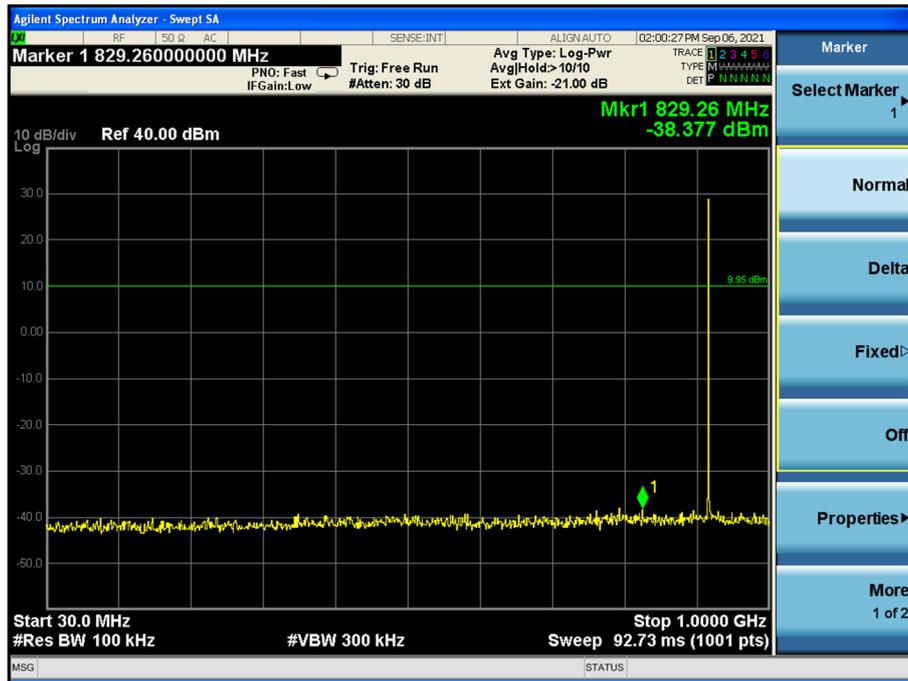
High Channel



Low Channel



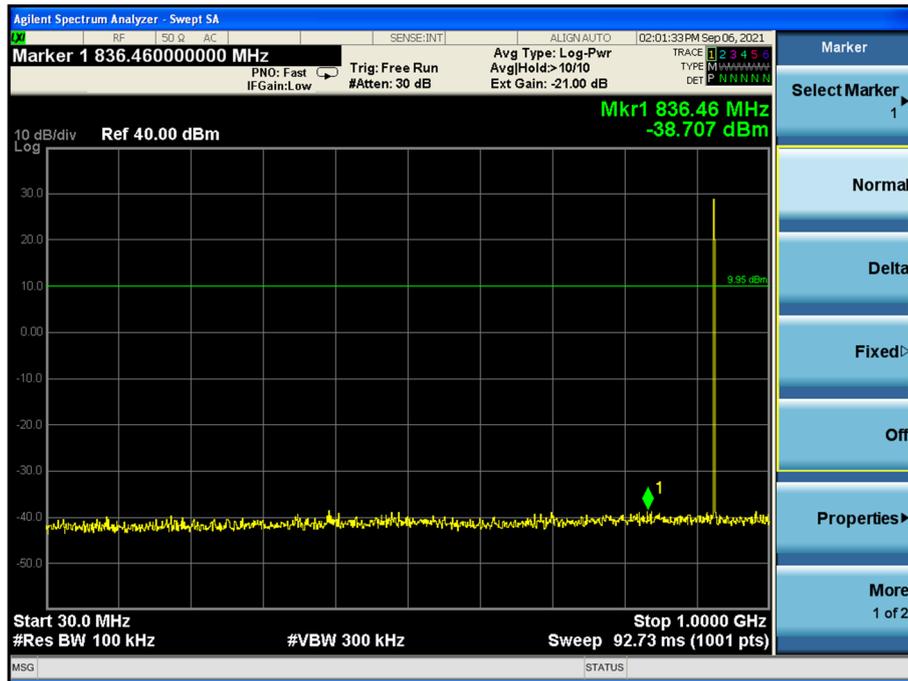
Low Channel



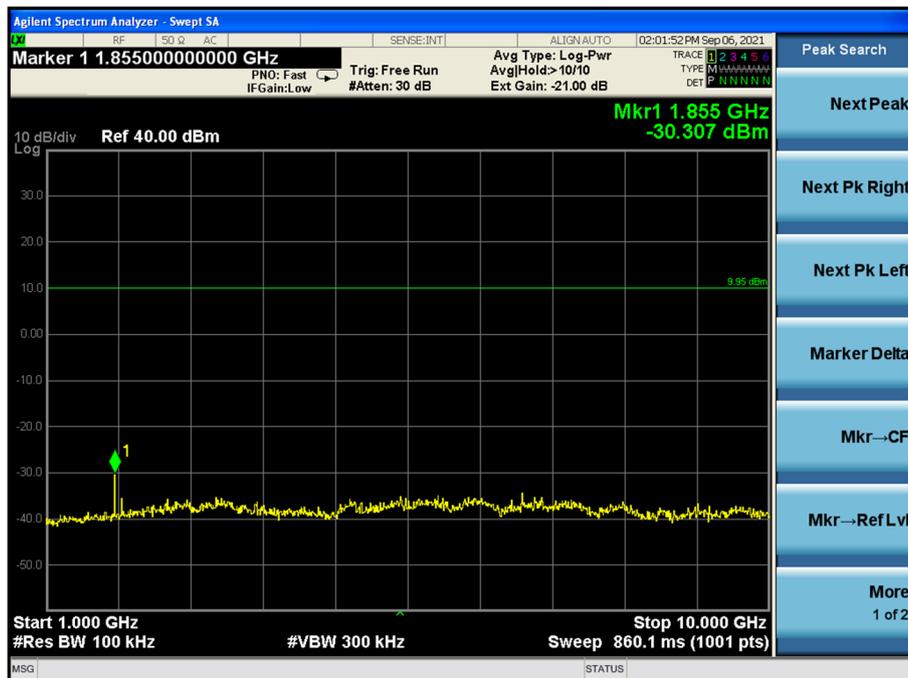
Middle Channel



Middle Channel



High Channel



High Channel

3.4 Radiated Emission

3.4.1 Requirement

- FCC Part15 subpart C Section 15.247

3.4.2 Test Procedure

The radiated emissions measurements were performed on the 3 m anechoic chamber. The EUT was placed on a non-conductive turntable above the ground plane. The frequency spectrum from 30 kHz to 10.0 GHz was scanned and maximum emission levels at each frequency recorded. The system was rotated 360°, and the antenna was varied in the height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for horizontal and vertical polarization of the receiving antenna.

3.4.3 Test environment

- 24 °C, 45 % R.H.

3.4.4 Test results

3.4.4.1 Radiated Emission which fall in the Restricted Band

- Resolution bandwidth : 1 MHz
- Video bandwidth : 3 MHz
- Detector : Peak Mode(Peak), Average Mode(RMS)
- Measurement distance : 3 m
- Operating Condition : Highest Output Power Transmitting Mode(Low Channel and High Channel)
- Result : PASS

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Low Channel									
2733.89	44.24	Peak	H	29.20	10.10	34.90	48.64	74.00	25.36
2733.89	37.54	Average	H				41.94	54.00	12.06
2733.68	36.58	Peak	V				40.98	74.00	33.02
2733.89	27.73	Average	V				32.13	54.00	21.87
Middle Channel									
2755.31	34.90	Peak	H	29.20	10.10	34.90	39.30	74.00	34.70
2755.31	24.55	Average	H				28.95	54.00	25.05
2755.52	38.45	Peak	V				42.85	74.00	31.15
2755.52	30.05	Average	V				34.45	54.00	19.55
High Channel									
2705.12	34.84	Peak	H	29.20	10.10	34.90	39.24	74.00	34.76
2777.15	24.94	Average	H				29.34	54.00	24.66
2777.15	36.13	Peak	V				40.53	74.00	33.47
2777.15	28.78	Average	V				33.18	54.00	20.82

Note 1. Total = Reading + Ant.Factor + Cable Loss – Amp Gain

3.4.4.2 Spurious & Harmonic Radiated Emission

- Resolution bandwidth : 1 MHz
- Video bandwidth : 3 MHz
- Detector : Peak Mode(Peak), Average Mode(RMS)
- Measurement distance : 3 m
- Frequency range : 1 GHz ~ 10.0 GHz
- Operating Condition : Highest Output Power Transmitting Mode
- Result : PASS

Frequency (MHz)	Reading (dB μ V)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Total (dB μ V/m)	Limits (dB μ V/m)	Margin (dB)
Low Channel									
1822.60	54.28	Peak	H	26.30	7.60	35.60	52.58	74.00	21.42
1822.60	42.53	Average	H				40.83	54.00	13.17
1822.60	58.07	Peak	V				56.37	74.00	17.63
1822.60	53.18	Average	V				51.48	54.00	2.52
Middle Channel									
1837.00	59.37	Peak	H	26.40	7.60	35.50	57.87	74.00	16.13
1837.00	42.47	Average	H				40.97	54.00	13.03
1837.00	53.79	Peak	V				52.29	74.00	21.71
1837.00	47.55	Average	V				46.05	54.00	7.95
High Channel									
1851.40	54.39	Peak	H	26.60	7.60	35.50	53.09	74.00	20.91
1851.40	38.62	Average	H				37.32	54.00	16.68
1851.40	50.05	Peak	V				48.75	74.00	25.25
1851.40	49.20	Average	V				47.90	54.00	6.10

Note 1. Total = Reading + Ant.Factor + Cable Loss – Amp Gain

3.4.4.3 Spurious Radiated Emission

3.4.4.3.1 Test Data for Below 30 MHz for RFID Mode

- Detector : Quasi-Peak (6 dB Bandwidth: 200 Hz, 9 kHz)
- Measurement distance : 3 m
- Frequency range : 9 kHz ~ 30 MHz
- Operating Condition : Highest Output Power Transmitting Mode
- Result : PASS

Frequency (MHz)	Reading (dB μ V)	Ant. Pol. (H/V)	Ant. Factor (dB/m)	Cable Loss	Amp Gain	Emission Level(dB μ V/m)	Limits (dB μ V/m)	Margin (dB)
Emissions observed were 20dB below the limit and thus not reported								

3.4.4.3.2 Test Data for Above 1 GHz

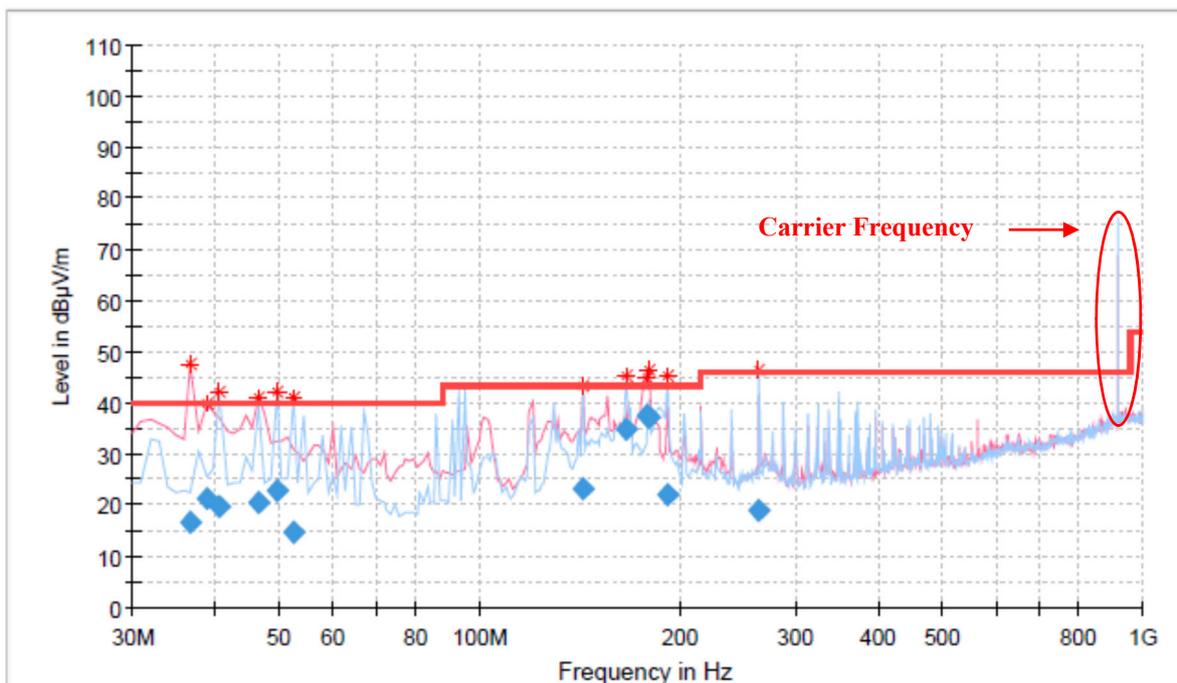
- Detector : Peak, Average (6 dB Bandwidth: 1 MHz)
- Measurement distance : 3 m
- Frequency range : 1 GHz ~ 26.5 GHz
- Operating Condition : Highest Output Power Transmitting Mode
- Result : PASS
- Result : PASS

Frequency (MHz)	Reading (dB μ V)	Ant. Pol. (H/V)	Ant. Factor (dB/m)	Cable Loss	Amp Gain	Emission Level(dB μ V/m)	Limits (dB μ V/m)	Margin (dB)
Emissions observed were 20dB below the limit and thus not reported								

3.4.4.3.3 Test Data for 30 MHz ~ 1000 MHz

- Detector : Quasi-Peak (6 dB Bandwidth: 120 kHz)
- Measurement distance : 3 m
- Frequency range : 30 MHz ~ 1000 MHz
- Operating Condition : Highest Output Power Transmitting Mode
- Result : PASS

RE Test Report



— Preview Result 1V-PK+
* Critical_Freqs PK+
◆ Final_Result QPK
— Preview Result 1H-PK+
— 30 MHz ~ 1 000 MHz_FCC_CLASS B

Final Result

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB)
36.79	16.80	40.00	23.20	15000.0	400.0	V	266.0	-24.4
38.73	21.45	40.00	18.55	15000.0	400.0	V	266.0	-24.2
40.67	19.78	40.00	20.22	15000.0	200.3	H	114.0	-23.9
46.49	20.72	40.00	19.28	15000.0	400.0	V	266.0	-23.8
49.40	22.69	40.00	17.31	15000.0	400.1	H	189.0	-24.2
52.31	14.67	40.00	25.33	15000.0	99.8	H	73.0	-25.0
143.49	23.42	43.50	20.08	15000.0	99.7	V	90.0	-16.8
166.77	34.91	43.50	8.59	15000.0	200.3	H	236.0	-15.9
178.41	37.41	43.50	6.09	15000.0	99.8	V	67.0	-19.4
180.35	37.37	43.50	6.13	15000.0	99.7	V	95.0	-19.5
191.99	22.06	43.50	21.44	15000.0	199.9	H	68.0	-20.9
263.77	18.98	46.00	27.02	15000.0	200.3	H	191.0	-20.0

3.6 Conducted Emission Test

3.6.1 Requirement

- FCC Part15 subpart C Section 15.207

3.6.2 Test Procedure

The EUT was placed on a wooden table, 0.8 m height above the floor. Power was fed to the EUT through a $50 \Omega / 50 \mu\text{H} + 5 \Omega$ Artificial Mains Network (AMN). The ground plane was electrically bonded to the reference ground system and all power lines were filtered from ambient.

3.6.3 Test data

- Not tested as it is a DC power supply and is not intended for use in vehicles.

3.7 Antenna Requirement

3.7.1 Requirement

- FCC Part15 subpart C Section 15.203
- An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

3.7.2 Result

- The antenna of the EUT is a Patch Antenna on the board in the EUT.

4. Test equipment list

Use	Model Number	Manufacturer	Description	Serial Number	Cal. Date.(Interval)
<input checked="" type="checkbox"/>	AMP 20-1000	INFINITECH	BROADBAND PRE-AMP	2013 05 00003	Jan 14, 2021(1Y)
<input checked="" type="checkbox"/>	GP-4303DU	EZ Digital Co.,Ltd.	DC Power Supply	2100196	Jan 14, 2021(1Y)
<input checked="" type="checkbox"/>	DS 2000S	Innco GmbH	Turn Table	N/A	N/A
<input checked="" type="checkbox"/>	MA4000-EP-HS	Innco GmbH	Antenna Mast	N/A	N/A
<input checked="" type="checkbox"/>	MA4640-XP-ET	Innco GmbH	Tilt Antenna Mast	N/A	N/A
<input checked="" type="checkbox"/>	CO3000	Innco GmbH	Controller	N/A	N/A
<input checked="" type="checkbox"/>	CO3000	Innco GmbH	Controller	N/A	N/A
<input checked="" type="checkbox"/>	N9020A	Agilent	Spectrum Analyzer	MY50200260	Jan 14, 2021(1Y)
<input checked="" type="checkbox"/>	6502	EMCO	Loop Antenna	9609-3087	Nov 12, 2019(2Y)
<input checked="" type="checkbox"/>	VULB 9168	SCHWARZBECK	Trilog-Broadband Antenna	9168-735	Nov 19, 2019(2Y)
<input checked="" type="checkbox"/>	8449B	Agilent	Preamplifier	3008A02013	Jan 14, 2021(1Y)
<input checked="" type="checkbox"/>	3115	ETS	Horn Antenna	9402-4229	July 28, 2020(2Y)
<input checked="" type="checkbox"/>	ESCI7	Rohde & Schwarz	EMI Test Receiver	100938	Jan 14, 2021(1Y)
<input type="checkbox"/>	ESH-Z2	Rohde & Schwarz	Pulse Limter	101631	Jan 14, 2021(1Y)
<input type="checkbox"/>	ENV216	Rohde & Schwarz	LISN	101264	July 14, 2021(1Y)
<input type="checkbox"/>	ES-SCAN	Rohde & Schwarz	EMI Software	N/A	N/A
<input checked="" type="checkbox"/>	EMC32	Rohde & Schwarz	EMI Software	N/A	N/A
<input checked="" type="checkbox"/>	FSV	Rohde & Schwarz	Spectrum Analyzer	101673	Jan 14, 2021(1Y)