TEST REPORT

Application No.:	HKEM2111001161AT
Applicant:	ECOLAB Inc.
Address of Applicant:	FCC: 1 Ecolab Place, St Paul, Minnesota, United States, 55102 IC: Ecolab Schuman Center-F6, 655 Lone Oak Drive, Eagan, MN United States, 55121
Equipment Under Test (EUT):	
EUT Name:	HHCM NEXA POC Holder
Model No.:	92053075
Trademark:	EcoLab
FCC ID:	Z9O-92053075
IC:	10060A-92053075
HVIN:	92053075
Standard(s) :	47 CFR Part 15 Subpart C, 2020 RSS-247 Issue 2, February 2017 RSS-Gen: Issue 5, Amdt 2021
Date of Receipt:	2021-12-05
Date of Test:	2021-12-06 to 2021-12-20
Date of Issue:	2021-12-28
Test Result:	**Pass***

* In the configuration tested, the EUT complied with the standards specified above.

Law Man Kit
EMC Manager

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Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 30 days only.

Revision Record				
Version	**Chapter**	**Date**	**Modifier**	**Remark**
01		2021-12-28		*Original*

Authorized for issue by:				
		Panny Leung **/Project Engineer**		Date: 2021-12-28
		Law Man Kit **/Reviewer**		Date: 2021-12-28

2 Test Summary

Radio Spectrum Technical Requirement				
Item	**Standard**	**Method**	**Requirement**	**Result**
Antenna Requirement	47 CFR Part 15, Subpart C 15.247	N/A	47 CFR Part 15, Subpart C 15.203 & 15.247(b)(4)	Pass
Other requirements Frequency Hopping Spread Spectrum System Hopping Sequence	47 CFR Part 15, Subpart C 15.247	N/A	47 CFR Part 15, Subpart C 15.247(a)(1),(g),(h)	Pass

Radio Spectrum Matter Part				
Item	**Standard**	**Method**	**Requirement**	**Result**
Conducted Peak Output Power	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 7.8.5	47 CFR Part 15, Subpart C 15.247(b)(1)	Pass
20dB Bandwidth	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 7.8.7	47 CFR Part 15, Subpart C 15.247(a)(1)	Pass
Carrier Frequencies Separation	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 7.8.2	47 CFR Part 15, Subpart C 15.247a(1)	Pass
Hopping Channel Number	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 7.8.3	47 CFR Part 15, Subpart C 15.247a(1)(iii)	Pass
Dwell Time	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 7.8.4	47 CFR Part 15, Subpart C 15.247a(1)(iii)	Pass
Conducted Band Edges Measurement	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 7.8.6	47 CFR Part 15, Subpart C 15.247(d)	Pass
Conducted Spurious Emissions	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 7.8.8	47 CFR Part 15, Subpart C 15.247(d)	Pass
Radiated Emissions which fall in the restricted bands	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 6.10.5	47 CFR Part 15, Subpart C 15.205 & 15.209	Pass
Radiated Spurious Emissions	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 6.4,6.5,6.6	47 CFR Part 15, Subpart C 15.205 & 15.209	Pass

Radio Spectrum Technical Requirement				
Item	**Standard**	**Method**	**Requirement**	**Result**
Antenna Requirement	RSS-247 Issue 2, February 2017	N/A	RSS-Gen Section 6.8	Pass
Pseudorandom Frequency Hopping Sequence	RSS-247 Issue 2, February 2017	N/A	RSS-247 Section 5.1(a)	Pass

Radio Spectrum Matter Part				
Item	**Standard**	**Method**	**Requirement**	**Result**
99% Bandwidth	RSS-247 Issue 2, February 2017	ANSI C63.10 (2013) Section 6.9.3	RSS-Gen Section 6.7	Pass
Conducted Peak Output Power	RSS-247 Issue 2, February 2017	ANSI C63.10 (2013) Section 7.8.5	RSS-247 Section 5.4(b)	Pass
20dB Bandwidth	RSS-247 Issue 2, February 2017	ANSI C63.10 (2013) Section 6.9.2	RSS-247 Section 5.1(a)	Pass
Carrier Frequencies Separation	RSS-247 Issue 2, February 2017	ANSI C63.10 (2013) Section 7.8.2	RSS-247 Section 5.1(b)	Pass
Hopping Channel Number	RSS-247 Issue 2, February 2017	ANSI C63.10 (2013) Section 7.8.3	RSS-247 Section 5.1(d)	Pass
Dwell Time	RSS-247 Issue 2, February 2017	ANSI C63.10 (2013) Section 7.8.4	RSS-247 Section 5.1(d)	Pass
Conducted Band Edges Measurement	RSS-247 Issue 2, February 2017	ANSI C63.10 (2013) Section7.8.6	RSS-247 Section 5.5	Pass
Conducted Spurious Emissions	RSS-247 Issue 2, February 2017	ANSI C63.10 (2013) Section 7.8.8	RSS-247 Section 5.5	Pass
Radiated Emissions which fall in the restricted bands	RSS-247 Issue 2, February 2017	ANSI C63.10 (2013) Section 6.10.5	Section 3.3 & RSS-Gen Section 8.10	Pass
Radiated Spurious Emissions	RSS-247 Issue 2, February 2017	ANSI C63.10 (2013) Section 6.4&6.5&6.6	Section 3.3 & RSS-Gen Section 8.9	Pass
Frequency stability	RSS-247 Issue 2, February 2017	RSS-Gen Section 6.11	RSS-Gen Section 8.11	Pass

Note: Frequency stability requested in RSS GEN Section 8.1.1 has been complied since the result of band edge can demonstrate.

Declaration of EUT Family Grouping:

None.

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4 General Information

4.1 Details of E.U.T.

Power supply:	DC 3.0V ('AA' size battery x2)
Test voltage:	DC 3.0V
Antenna Gain:	-1dBi
Antenna Type:	Ceramic Chip Antenna
Modulation Type:	GFSK
Number of Channels:	50
Operation Frequency:	913.75MHz to 916.30MHz
Spectrum Spread Technology:	Frequency Hopping Spread Spectrum(FHSS)
Series number:	A1
Hardware Version:	Rev.A
Software Version:	V1.01
	Remark: Power level setting was not adjustable and fixed default through SW Version.

EUT channels and frequencies list:

Channel Number	Frequency (MHz)	Channel Index
1	913.75	20
2	913.80	7
3	913.85	1
4	913.90	48
5	913.95	11
6	914.00	44
7	914.05	14
8	914.10	38
9	914.15	50
10	914.20	2
11	914.25	12
12	914.30	36
13	914.35	31
14	914.40	39
15	914.45	9
16	914.50	6
17	914.55	33
18	914.60	13
19	914.65	16
20	914.70	5
21	914.75	Reserved
22	914.80	49
23	914.85	10
24	914.90	23
25	914.95	8
26	915.00	25

Channel Number	Frequency (MHz)	Channel Index
27	915.05	34
28	915.10	3
29	915.15	35
30	915.20	32
31	915.25	Reserved
32	915.30	17
33	915.35	42
34	915.40	15
35	915.45	47
36	915.50	29
37	915.55	37
38	915.60	40
39	915.65	26
40	915.70	22
41	915.75	28
42	915.80	46
43	915.85	18
44	915.90	41
45	915.95	27
46	916.00	30
47	916.05	24
48	916.10	43
49	916.15	21
50	916.20	4
51	916.25	19
52	916.30	45

Remark: 1. Test frequencies are the lowest channel: 913.75 MHz, and highest channel:916.30 MHz

4.2 Description of Support Units

The EUT has been tested as an independent unit.

4.3 Measurement Uncertainty

RF

No.	Item	Measurement Uncertainty
1	Radio Frequency	± 7.25 x 10^{-8}
2	Duty cycle	± 0.37%
3	Occupied Bandwidth	± 3%
4	RF conducted power (30MHz-40GHz)	1.5dB
5	RF power density	1.5dB
6	Conducted Spurious emissions	1.5dB
7	RF Radiated power & Radiated Spurious emission test	4.4dB (30MHz-1GHz)
		4.7dB (1GHz-6GHz)
		4.7dB (6GHz-18GHz)
		5.7dB (18GHz-40GHz)
8	Temperature test	± 1°C
9	Humidity test	± 3%
10	Supply voltages	± 1.5%
11	Time	± 3%

Remark:

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors in calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report according to TR-100028-01 “Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics; Part 1” and TR-100028-02 “Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics; Part 2” and is documented in the test lab quality system according to ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

4.4 Test Location

All tests were performed at:

SGS Hong Kong Limited

Unit 2 and 3, G/F, Block A, Po Lung Centre,

11 Wang Chiu Road, Kowloon Bay, Kowloon, Hong Kong

Tel: +852 2305 2570 Fax: +852 2756 4480

No tests were sub-contracted.

4.5 Test Facility

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

- **HOKLAS (Lab Code: 009)**

SGS Hong Kong Limited has been accepted by HKAS Executive, on the recommendation of the Accreditation Advisory Board, as a HOKLAS Accredited Laboratory, this laboratory meets the requirements of ISO/IEC 17025:2017 and it has been accredited for performing specific test as listed in the scope of accreditation within the test category of Electrical and Electronic Products.

- **IAS Accreditation (Lab Code: TL-817)**

SGS Hong Kong Limited has met the requirements of AC89, IAS Accreditation Criteria for Testing Laboratories, and has demonstrated compliance with ISO/IEC Standard 17025:2017, General requirements for the competence of testing and calibration laboratories. This organization is accredited to provide the services specified in the scope of accreditation maintained on the IAS website (www.iasonline.org).

The report must not be used by the client to claim product certification, approval, or endorsement by IAS, NIST, or any agency of the Federal Government.

- **FCC Recognized Accredited Test Firm(CAB Registration No.: 514599)**

SGS Hong Kong Limited has been accredited and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Designation Number: HK0015, Test Firm Registration Number: 514599.

- **Industry Canada (Site Registration No.: 26103; CAB Identifier No.: HK0015)**

SGS Hong Kong Limited has been recognized by Department of Innovation, Science and Economic Development (ISED) Canada as a wireless testing laboratory. The acceptance letter from the ISED is maintained in our files. CAB Identifier No: HK0015, Site Registration Number: 26103.

4.6 Deviation from Standards

None

4.7 Abnormalities from Standard Conditions

None

5 Equipment List

20dB Bandwidth, Conducted Peak Output Power, Hopping Channel Number, Carrier Frequencies Separation, Dwell Time, Conducted Band Edges Measurement, Conducted Spurious Emissions					
Equipment	**Manufacturer**	**Model No**	**Inventory No**	**Cal Date**	**Cal Due Date**
SMBV100A VECTOR SIGNAL GENERATOR	Rohde & Schwarz	SMBV100A	E234	2021/08/17	2022/08/16
FSV40 SIGNAL ANALYZER 40GHz	Rohde & Schwarz	FSV40	E235	2021/08/17	2022/08/16
SMB100A SIGNAL GENERATOR	Rohde & Schwarz	SMB100A	E236	2021/08/17	2022/08/16
Wireless Conn. Tester (CMW)	Rohde & Schwarz	CMW270	E240	2021/08/20	2022/08/19
OSP	Rohde & Schwarz	OSP-B157W8	E242	2021/04/20	2022/04/19
Cable	Rohde & Schwarz	J12J103539-00-2	E239	2021/09/17	2022/09/16
WMS32 Test software	Rohde & Schwarz	N/A	Version 11	N/A	N/A

Radiated Spurious Emissions (30MHz-1GHz)					
Equipment	**Manufacturer**	**Model No**	**Inventory No**	**Cal Date**	**Cal Due Date**
3m Semi-Anechoic Chamber	ChamPro	N/A	E229	2021/08/09	2022/08/08
Coaxial Cable	SGS	N/A	E167	2021/07/15	2022/07/14
EMI Test Receiver 9kHz to 7GHz	Rohde & Schwarz	ESR7 / 102298	E314	2021/04/26	2022/04/25
TRILOG Super Broadb. Test Antenna, (25) 30-1000 MHz	Schwarzbeck	9168-1110	E311	2020/02/13	2022/02/12
EMC32 Test software	Rohde & Schwarz	Version 10	N/A	N/A	N/A
Boresight Mast Controller	ChamPro	AM-BS-4500-E	E237	N/A	N/A
Turntable with Controller	ChamPro	EM1000	E238	N/A	N/A

Radiated Spurious Emissions (above 1GHz)					
Equipment	**Manufacturer**	**Model No**	**Inventory No**	**Cal Date**	**Cal Due Date**
3m Semi-Anechoic Chamber	ChamPro	N/A	E229	2021/08/09	2022/08/08
Coaxial Cable	SGS	N/A	E167	2021/07/15	2022/07/14
EMI Test Receiver 9kHz to 7GHz	Rohde & Schwarz	ESR7 / 102298	E314	2021/04/26	2022/04/25
TRILOG Super Broadb. Test Antenna, (25) 30-1000 MHz	Schwarzbeck	9168-1110	E311	2020/02/13	2022/02/12
Signal and Spectrum Analyzer 2Hz - 26.5GHz	Rohde & Schwarz	FSW26	E296	2021/09/17	2022/09/16
Spectrum Analyzer 9kHz - 30GHz	Rohde & Schwarz	FSP30	E204	2020/03/11	2022/03/10
Horn Antenna 1 - 18GHz	Schwarzbeck	BBHA9120D	E211	2020/01/29	2022/01/28
Horn Antenna 15 - 40GHz	Schwarzbeck	BBHA9170	E212	2020/01/29	2022/01/28
Preamplifier 33dB, 1 - 18GHz	Schwarzbeck	BBV9718	E214	2019/04/24	2022/04/23
Preamplifier 33dB, 18 - 26.5GHz	Schwarzbeck	BBV9719	E215	2020/09/21	2022/09/20
Broadband Coaxial Preamplifier typ. 30 dB, 18-40GHz	Schwarzbeck	BBV 9721	E266	2021/09/17	2022/09/16
Band Reject Filter 2.4 -2.5GHz	MICRO-TRONICS	BRM50702	E324	2021/09/17	2022/09/16
RF cable SMA to SMA 10000mm	HUBER+SUHNER	SF104-26.5/2*11SMA 45	E207-1	2021/09/17	2022/09/16
Boresight Mast Controller	ChamPro	AM-BS-4500-E	E237	N/A	N/A
Turntable with Controller	ChamPro	EM1000	E238	N/A	N/A

General used equipment					
Equipment	**Manufacturer**	**Model No**	**Inventory No**	**Cal Date**	**Cal Due Date**
Digital temperature & humidity data logger	SATO	SK-L200TH II	E232	2021/08/16	2022/08/15
Electronic Digital Thermometer with Hygrometer	nil	2074/2075	E159	2021/08/16	2022/08/15
Barometer with digital thermometer	SATO	7612-00	E218	2021/03/29	2022/03/28
Conditional Chamber	Zhong Zhi Testing Instruments	CZ-E-608D	E216	2021/08/17	2022/08/16

6 Radio Spectrum Technical Requirement

6.1 Antenna Requirement

6.1.1 Test Requirement:

47 CFR Part 15, Subpart C 15.203 & 15.247(b)(4)

RSS-Gen Section 6.8

6.1.2 Conclusion

Standard 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:

The antenna is integrated on the main PCB and no consideration of replacement. The best case gain of the antenna is -1dBi.

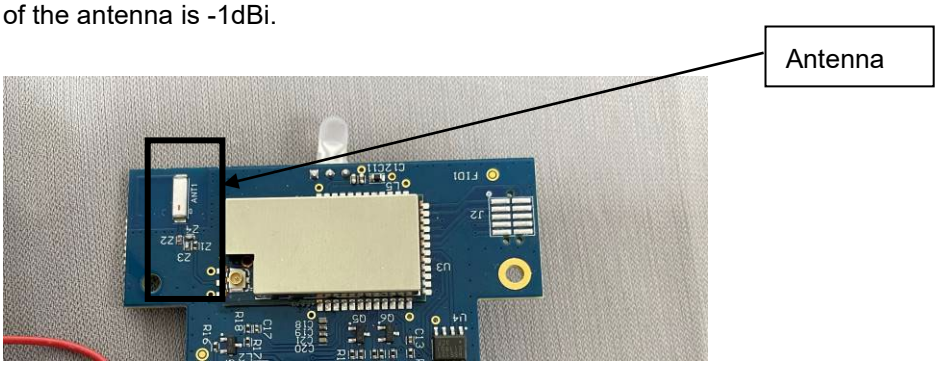


Photo of antenna refer to Appendix – Internal photo.

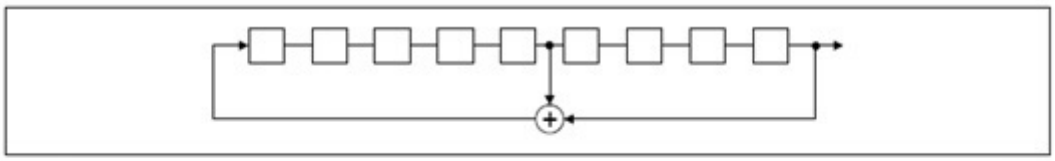
6.2 Pseudorandom Frequency Hopping Sequence

6.2.1 Test Requirement:

FCC Part 15 Subpart C Section 15.247(a)(1)

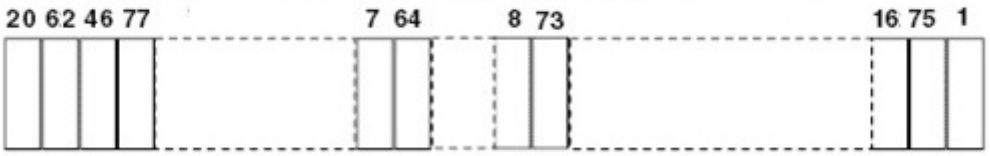
RSS-247 Section 5.1(a)

6.2.2 Test Setup Diagram



Linear Feedback Shift Register for Generation of the PRBS sequence

An example of Pseudorandom Frequency Hopping Sequence as follow:



6.2.3 Conclusion

Standard Requirement:

The pseudorandom sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first ONE of 9 consecutive ONEs; i.e. the shift register is initialized with nine ones.

- Number of shift register stages: 9
- Length of pseudo-random sequence: 29 -1 = 511 bits
- Longest sequence of zeros: 8 (non-inverted signal)

Linear Feedback Shift Register for Generation of the PRBS sequence

An example of Pseudorandom Frequency Hopping Sequence as follow:

Each frequency used equally on the average by each transmitter.

According to Technical Specification, the receivers are designed to have input and IF bandwidths that match the hopping channel bandwidths of any transmitters and shift frequencies in synchronization with the transmitted signals.

According to Technical specification, the system incorporates with an adaptive system to detect other user within the spectrum band so that it individually and independently to avoid hopping on the occupied channels.

The system is designed not have the ability to coordinated with other FHSS System in an effort to avoid the simultaneous occupancy of individual hopping frequencies by multiple transmitter.

7 Radio Spectrum Matter Test Results

7.1 99% Bandwidth

Test Requirement RSS-Gen Section 6.7

Test Method: ANSI C63.10 (2013) Section 6.9.3

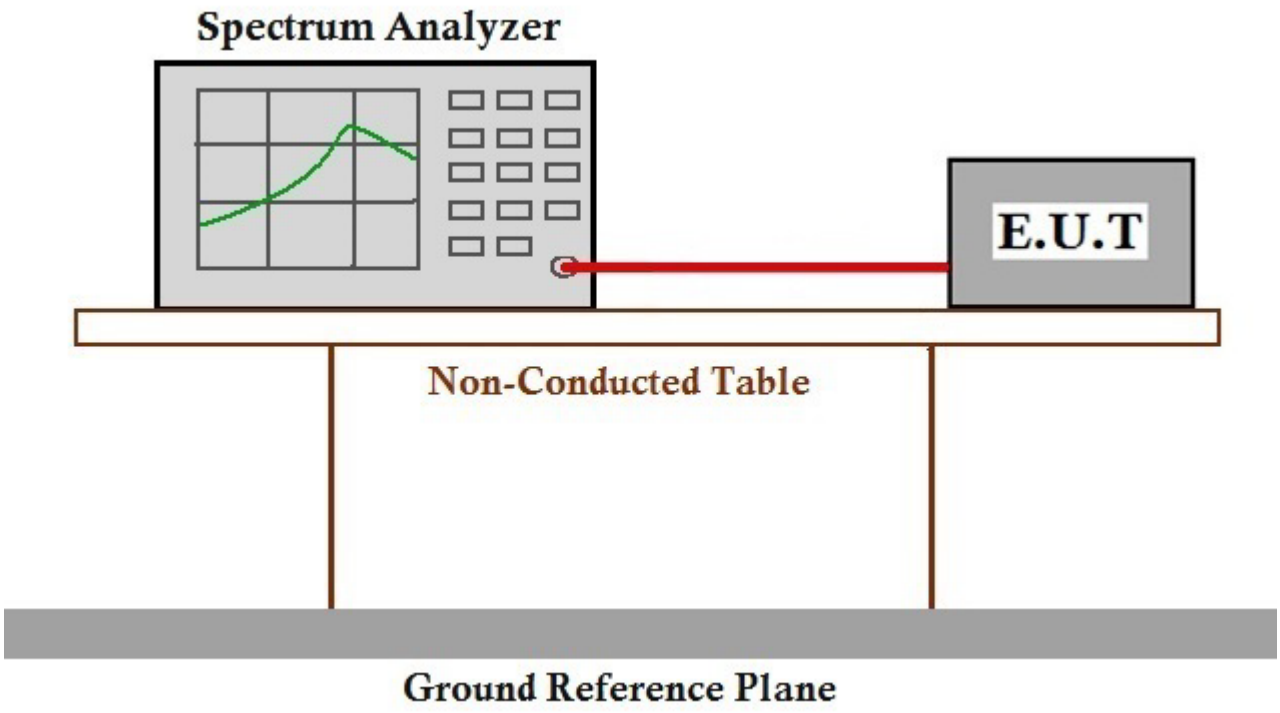
7.1.1 E.U.T. Operation

Operating Environment:

Temperature: 20.0 °C Humidity: 48.0 % RH :

Test mode b: TX_non-Hop mode_Keep the EUT in continuously transmitting mode with modulation. All modes have been tested and only the data of worst case is recorded in the report.

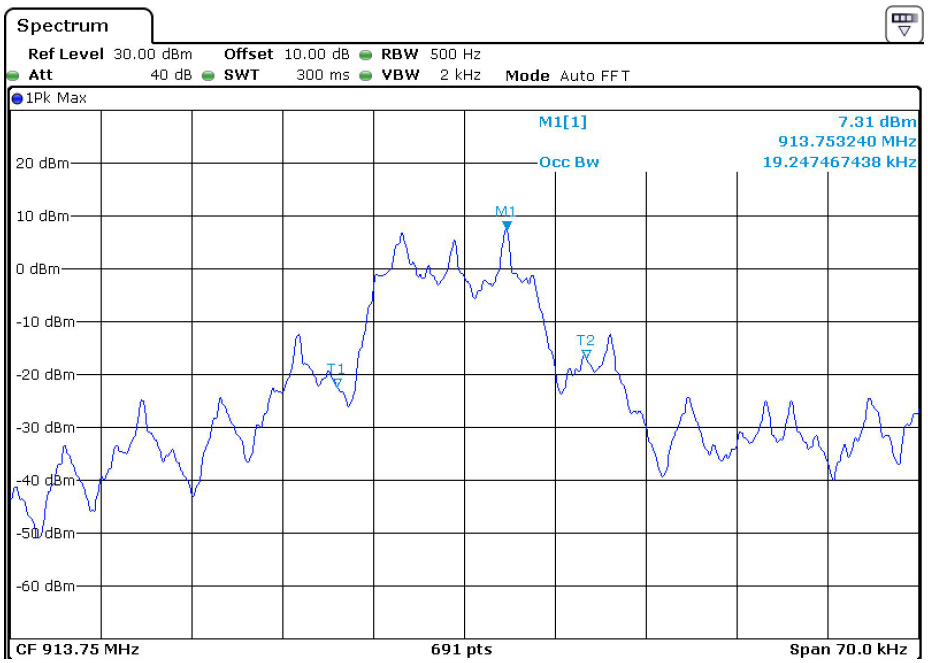
7.1.2 Test Setup Diagram

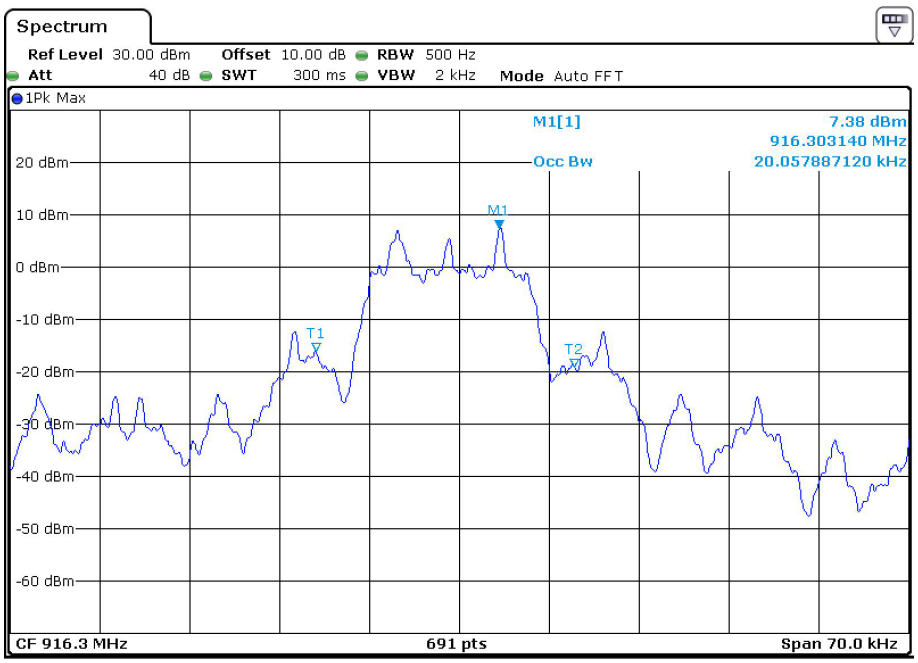


7.1.3 Measurement Procedure and Data

DUT Frequency (MHz)	Bandwidth (kHz)	Limit (MHz)	Result
913.75	19.2	---	PASS
916.30	20.1	---	PASS

Test plots:





7.2 Conducted Peak Output Power

Test Requirement 47 CFR Part 15 Subpart C 15.247:2019(b)(1) & 15.247(b)(3), RSS-247 Section 5.4(b)

Test Method: ANSI C63.10 (2013) Section 7.8.5

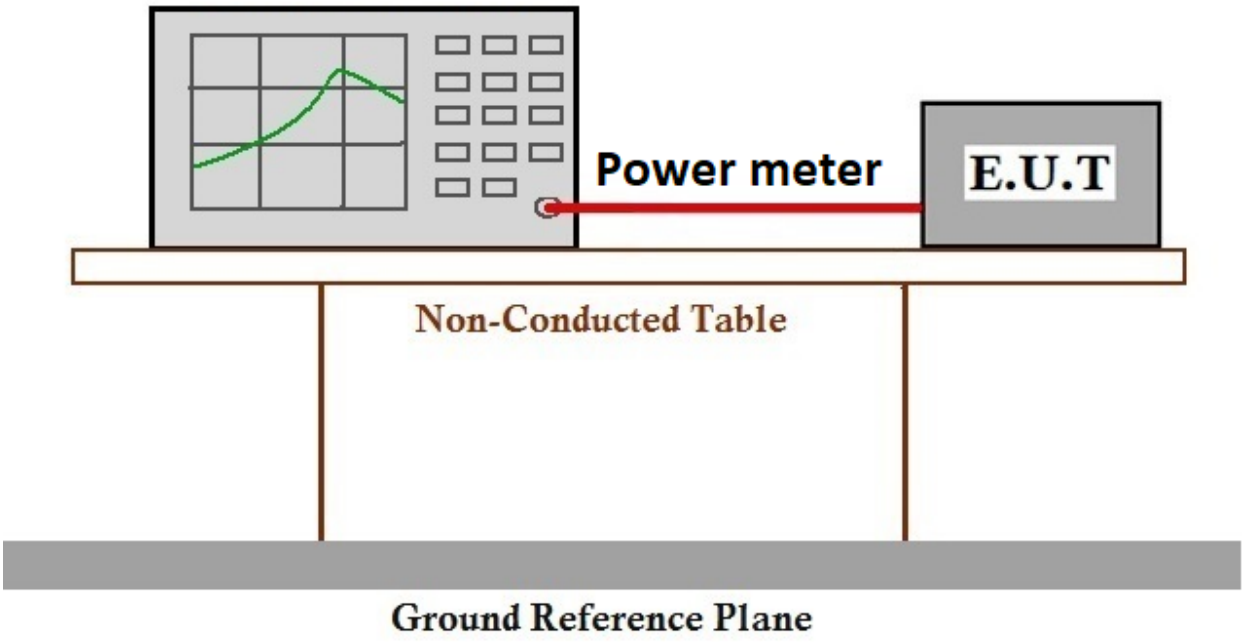
7.2.1 E.U.T. Operation

Operating Environment:

Temperature: 20.0 °C Humidity: 48.0 % RH :

Test mode a: TX_Hop mode_Keep the EUT in frequency hopping mode with modulation. All modes have been tested and only the data of worst case is recorded in the report.

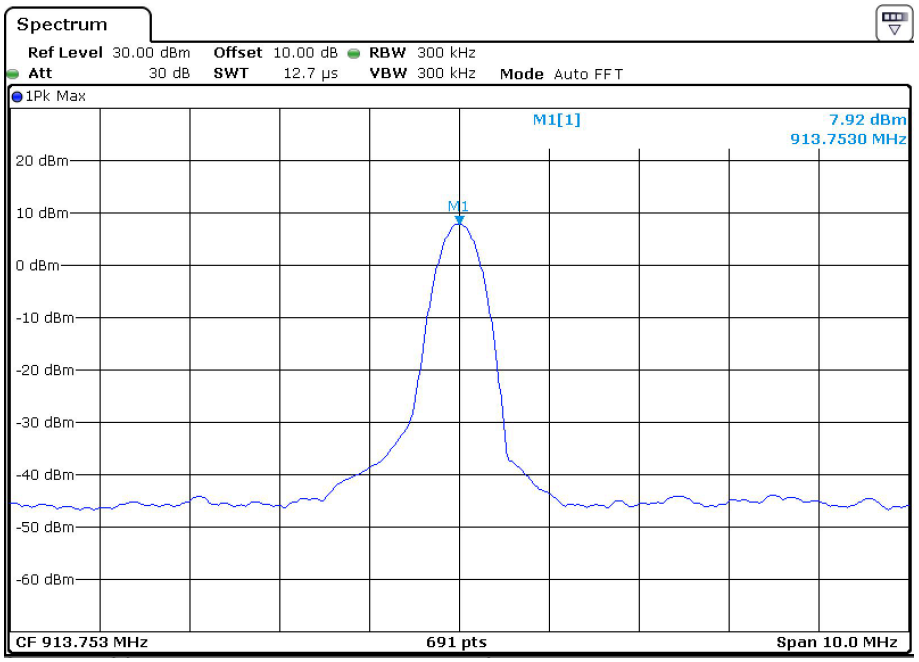
7.2.2 Test Setup Diagram

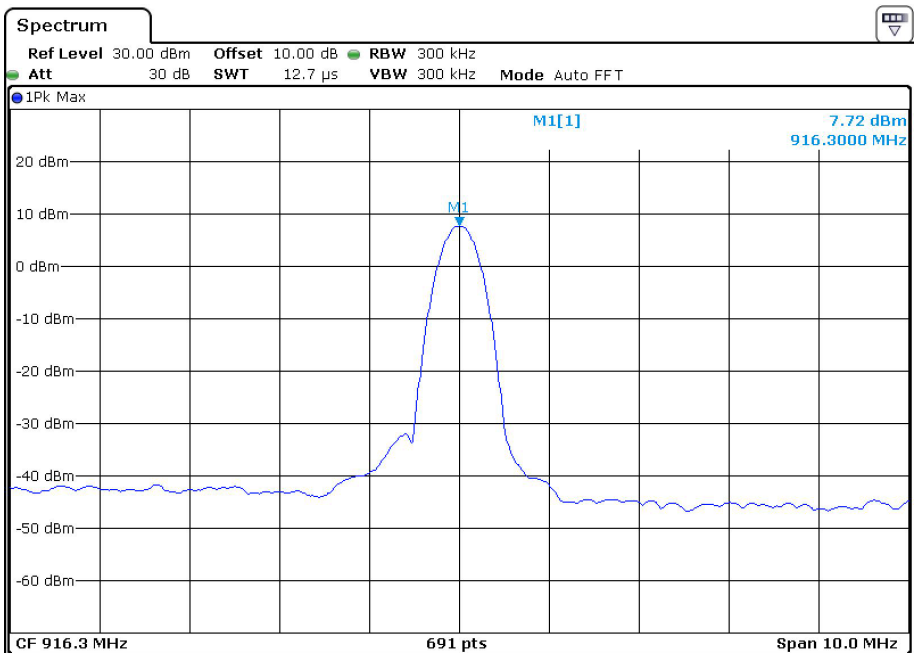


7.2.3 Measurement Procedure and Data

DUT Frequency (MHz)	Peak Power (dBm)	Limit Max (dBm)	Result
913.75	7.9	30.0	PASS
916.30	7.7	30.0	PASS

Test plots:





7.3 20dB Bandwidth

Test Requirement 47 CFR Part 15 Subpart C 15.215, RSS-247 Section 5.1(a)

Test Method: ANSI C63.10 (2013) Section 6.9.2

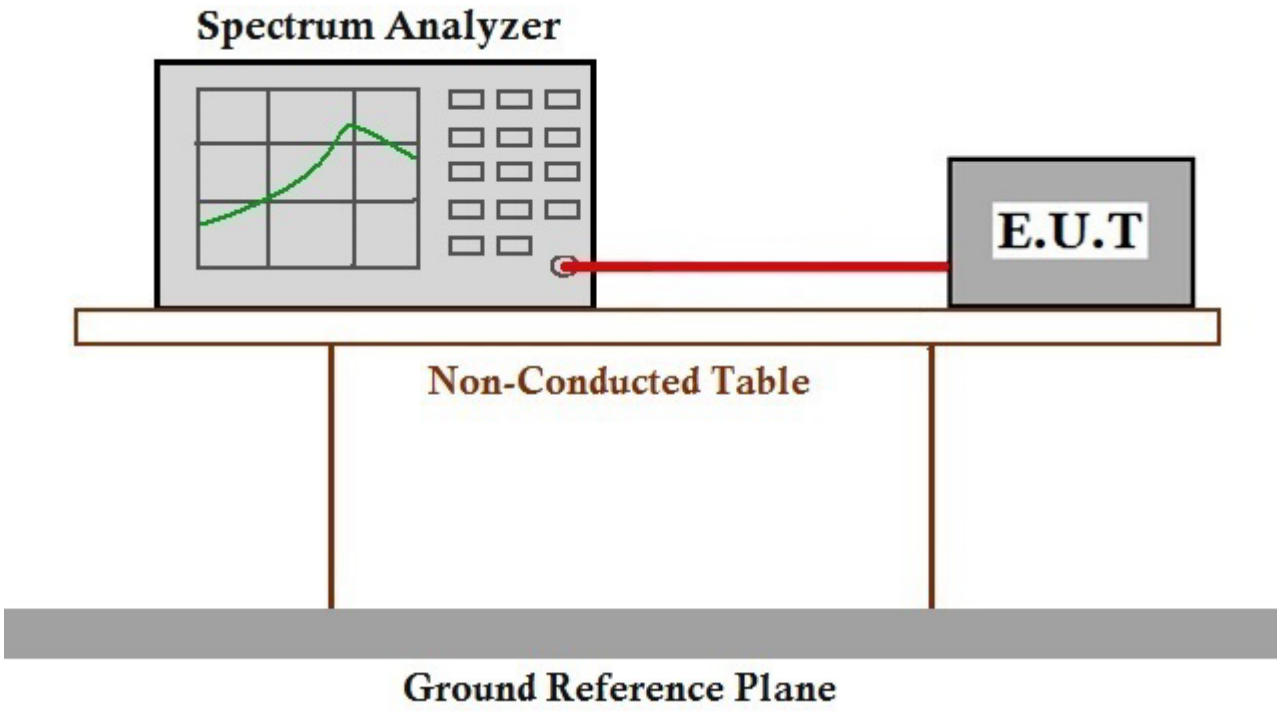
7.3.1 E.U.T. Operation

Operating Environment:

Temperature: 20.0 °C Humidity: 48.0 % RH :

Test mode b: TX_non-Hop mode_Keep the EUT in continuously transmitting mode with modulation. All modes have been tested and only the data of worst case is recorded in the report.

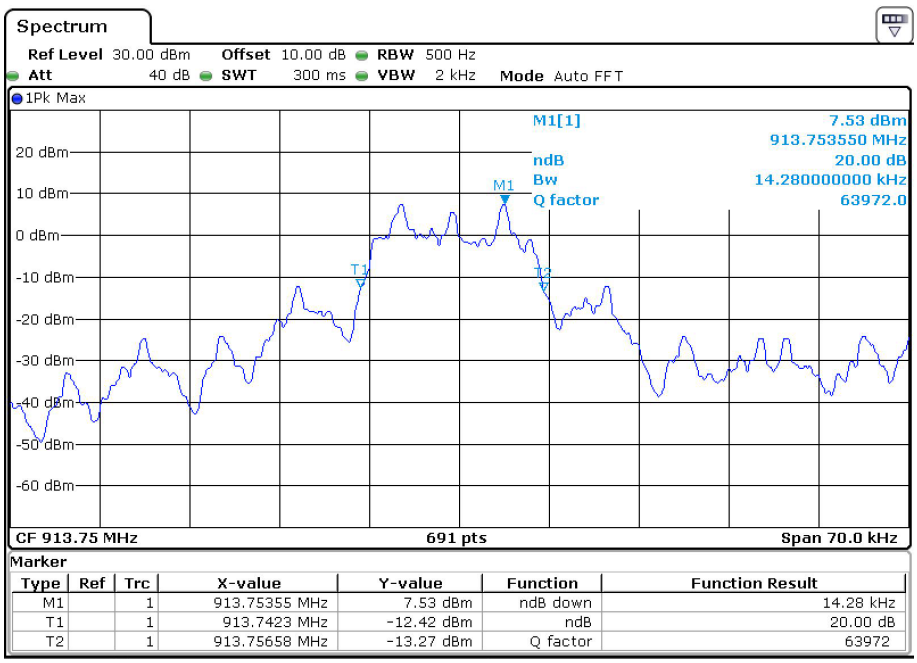
7.3.2 Test Setup Diagram

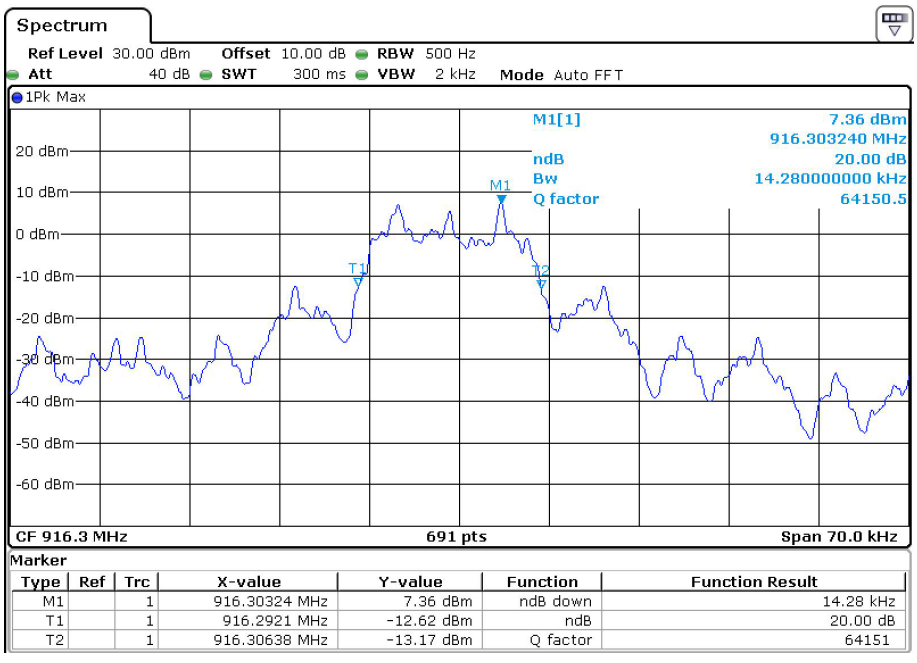


7.3.3 Measurement Procedure and Data

DUT Frequency (MHz)	Bandwidth (kHz)	Limit (MHz)	Result
913.75	14.3	---	PASS
916.30	14.3	---	PASS

Test plots:





7.4 Carrier Frequencies Separation

Test Requirement	47 CFR Part 15 Subpart C 15.247:2019a(1), RSS-247 Section 5.1(b)
Test Method:	ANSI C63.10 (2013) Section 7.8.2
Limit:	A minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

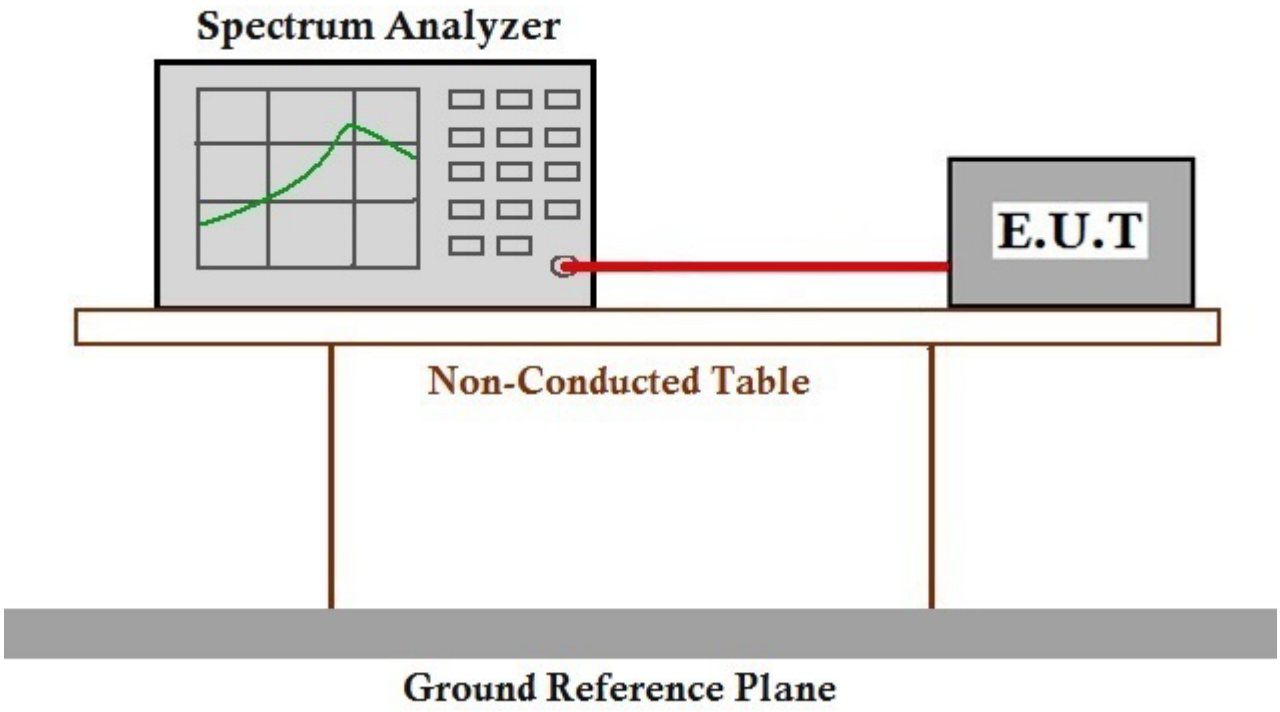
7.4.1 E.U.T. Operation

Operating Environment:

Temperature: 20.0 °C Humidity: 48.0 % RH :

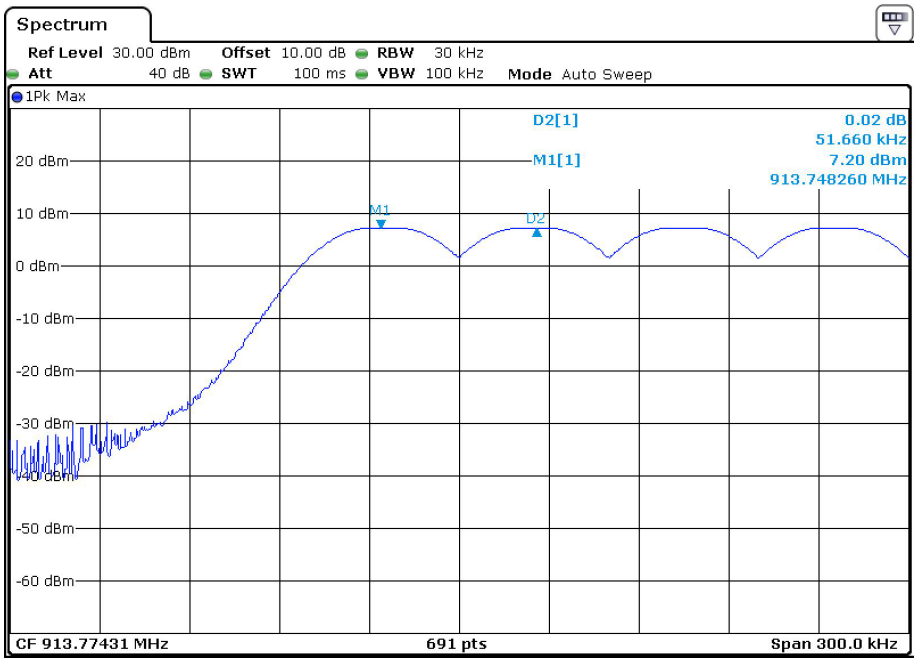
Test mode a: TX_Hop mode_Keep the EUT in frequency hopping mode with modulation. All modes have been tested and only the data of worst case is recorded in the report.

7.4.2 Test Setup Diagram



7.4.3 Measurement Procedure and Data

DUT Frequency (MHz)	Frequency Separation (kHz)	Limit (kHz)	Result
913.74826	51.7	25	PASS



7.5 Hopping Channel Number

Test Requirement 47 CFR Part 15 Subpart C 15.247:2019a(1)(iii), RSS-247 Section 5.1(d)

Test Method: ANSI C63.10 (2013) Section 7.8.3

Limit:

Frequency range(MHz)	Number of hopping channels (minimum)
902-928	50 for 20dB bandwidth <250kHz
	25 for 20dB bandwidth ≥250kHz
2400-2483.5	15
5725-5850	75

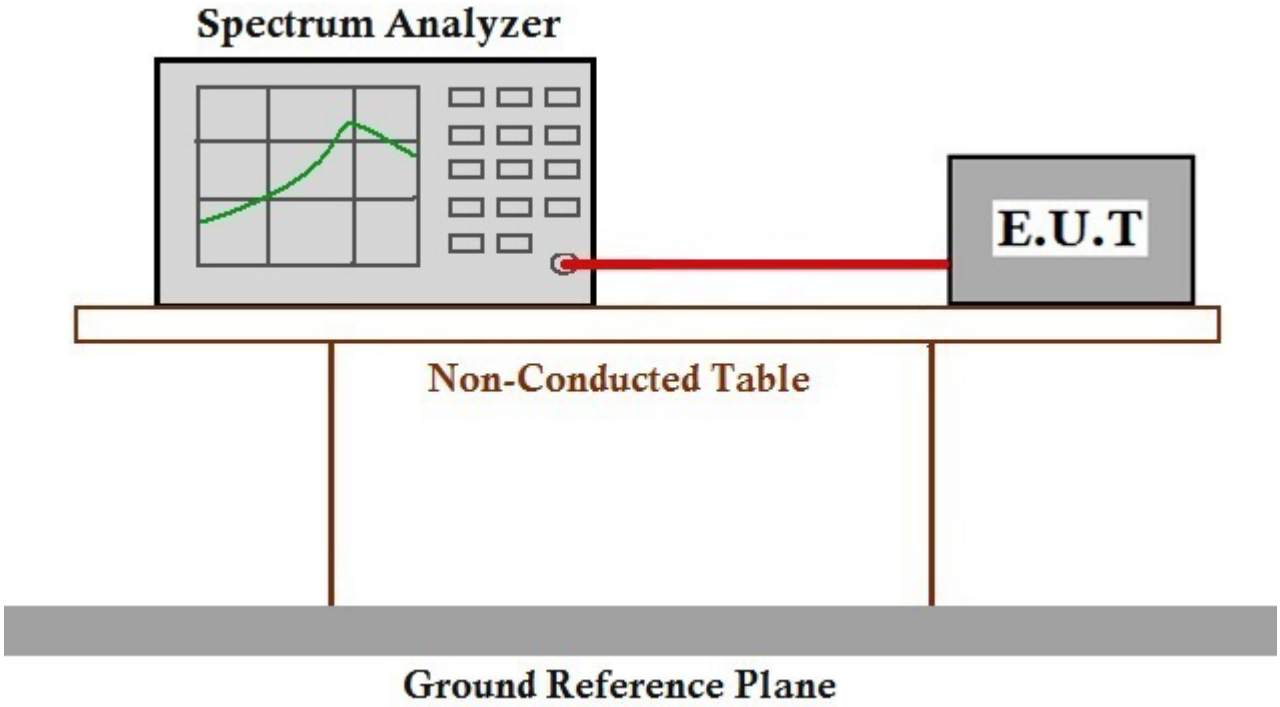
7.5.1 E.U.T. Operation

Operating Environment:

Temperature: 20.0 °C Humidity: 48.0 % RH :

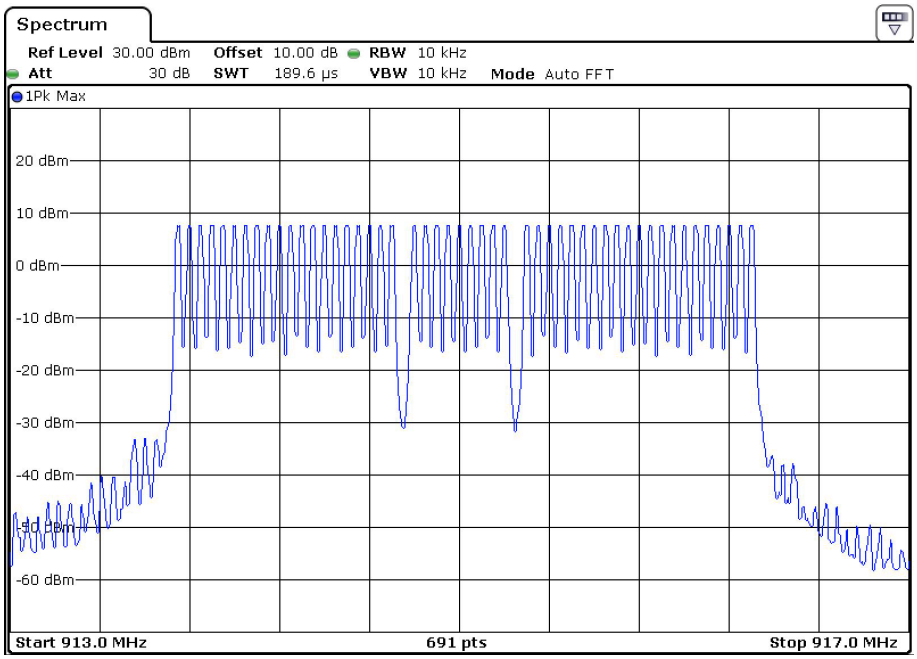
Test mode a: TX_Hop mode_Keep the EUT in frequency hopping mode with modulation. All modes have been tested and only the data of worst case is recorded in the report.

7.5.2 Test Setup Diagram



7.5.3 Measurement Procedure and Data

Channels	Limit Min	Result
50	50	PASS



7.6 Dwell Time

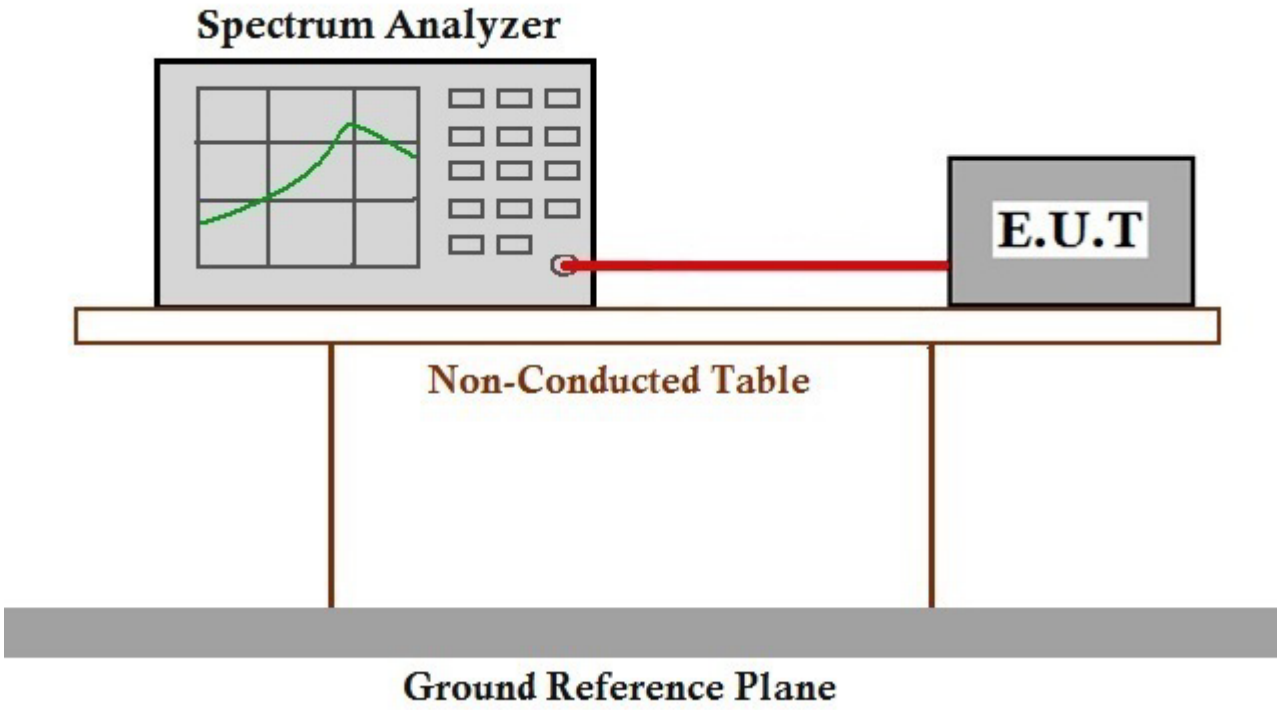
Test Requirement 47 CFR Part 15 Subpart C 15.247:2019a(1)(iii), RSS-247 Section 5.1(d)
Test Method: ANSI C63.10 (2013) Section 7.8.4
Limit:

Frequency(MHz)	Limit
902-928	0.4S within a 20S period(20dB bandwidth<250kHz)
	0.4S within a 10S period(20dB bandwidth≥250kHz)
2400-2483.5	0.4S within a period of 0.4S multiplied by the number of hopping channels
5725-5850	0.4S within a 30S period

7.6.1 E.U.T. Operation

Operating Environment:
Temperature: 20.0 °C Humidity: 48.0 % RH :
Test mode a: TX_Hop mode_Keep the EUT in frequency hopping mode with modulation, 8DPSK modulation. All modes have been tested and only the data of worst case is recorded in the report.

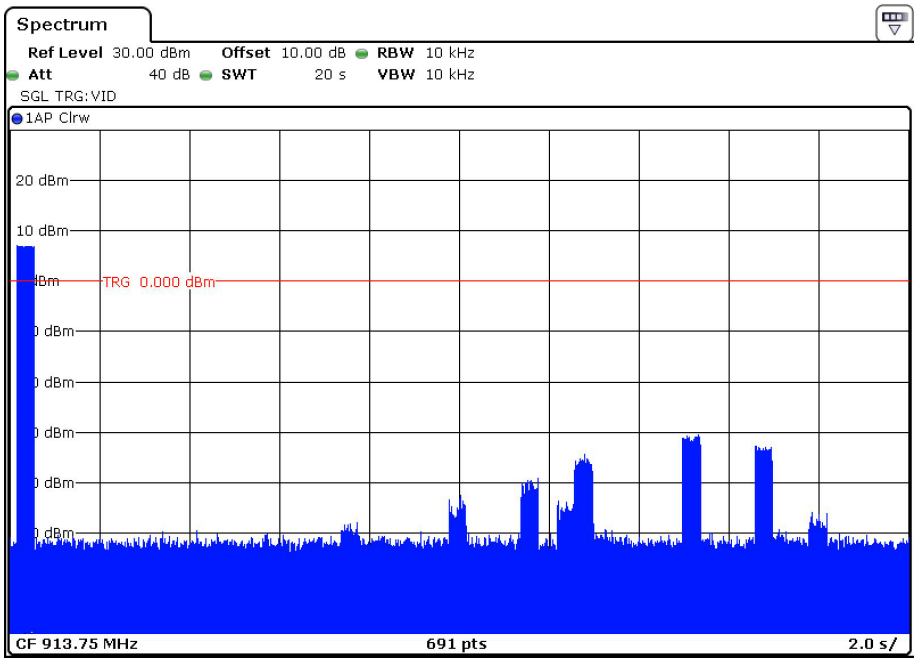
7.6.2 Test Setup Diagram

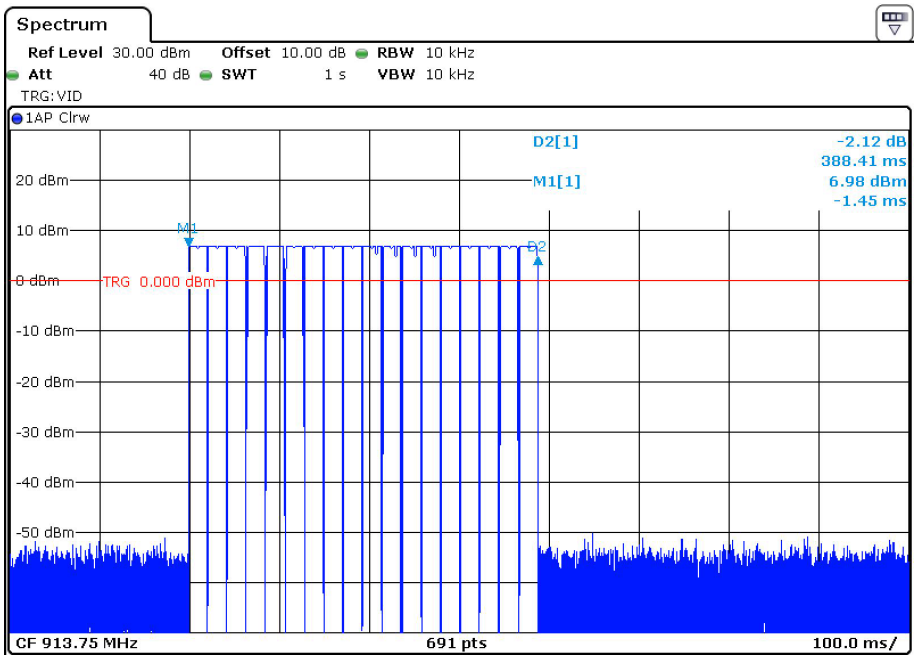


7.6.3 Measurement Procedure and Data

Channel (MHz)	Width of Burst (ms)	Number of Burst (s)	Measurement Time (s)	Dwell Time (ms)	Limit (ms)	Result
913.75	388.41	1	20	388.41	≤400	Pass

*Remark: the channel shown is the worst case.





7.7 Conducted Band Edges Measurement

Test Requirement: 47 CFR Part 15 Subpart C 15.247:2019(d), RSS-247 Section 5.5

Test Method: ANSI C63.10 (2013) Section7.8.6

Limit: In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)

FCC Part15 C Section 15.205 Restricted bands of operation.

(a) Except as shown in paragraph (d) of this section. only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2655 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	
13.36 - 13.41			

RSS-Gen Section 8.10 Restricted bands of operation.

Restricted frequency bands, identified in table 7, are designated primarily for safety-of-life services (distress calling and certain aeronautical activities), certain satellite downlinks, radio astronomy and some government uses. Except where otherwise indicated, the following conditions related to the restricted frequency bands apply:

(a) The transmit frequency, including fundamental components of modulation, of licence-exempt radio

apparatus shall not fall within the restricted frequency bands listed in table 7 except for apparatus compliant with RSS-287, *Emergency Position Indicating Radio Beacons (EPIRB), Emergency Locator Transmitters (ELT), Personal Locator Beacons (PLB), and Maritime Survivor Locator Devices (MSLD)*.
(b) Unwanted emissions that fall into restricted frequency bands listed in table 7 shall comply with the limits specified in table 5 and table 6.
(c) Unwanted emissions that do not fall within the restricted frequency bands listed in table 7 shall comply either with the limits specified in the applicable RSS or with those specified in table 5 and table 6.

Table 7 – Restricted frequency bands* MHz	**MHz**	**GHz**
0.090 - 0.110	149.9 - 150.05	9.0 - 9.2
0.495 - 0.505	156.52475 - 156.52525	9.3 - 9.5
2.1735 - 2.1905	156.7 - 156.9	10.6 - 12.7
3.020 - 3.026	162.0125 - 167.17	13.25 - 13.4
4.125 - 4.128	167.72 - 173.2	14.47 - 14.5
4.17725 - 4.17775	240 - 285	15.35 - 16.2
4.20725 - 4.20775	322 - 335.4	17.7 - 21.4
5.677 - 5.683	399.9 - 410	22.01 - 23.12
6.215 - 6.218	608 - 614	23.6 - 24.0
6.26775 - 6.26825	960 - 1427	31.2 - 31.8
6.31175 - 6.31225	1435 - 1626.5	36.43 - 36.5
8.291 - 8.294	1645.5 - 1646.5	Above 38.6
8.362 - 8.366	1660 - 1710	* Certain frequency bands listed in table 7 and in bands above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to related devices are set out in the 200 and 300 series of RSSs.
8.37625 - 8.38675	1718.8 - 1722.2	
8.41425 - 8.41475	2200 - 2300	
12.29 - 12.293	2310 - 2390	
12.51975 - 12.52025	2483.5 - 2500	
12.57675 - 12.57725	2655 - 2900	
13.36 - 13.41	3260 - 3267	
16.42 - 16.423	3332 - 3339	
16.69475 - 16.69525	3345.8 - 3358	
16.80425 - 16.80475	3500 - 4400	
25.5 - 25.67	4500 - 5150	
37.5 - 38.25	5350 - 5460	
73 - 74.6	7250 - 7750	
74.8 - 75.2	8025 - 8500	
108 - 138	--	

7.7.1 E.U.T. Operation

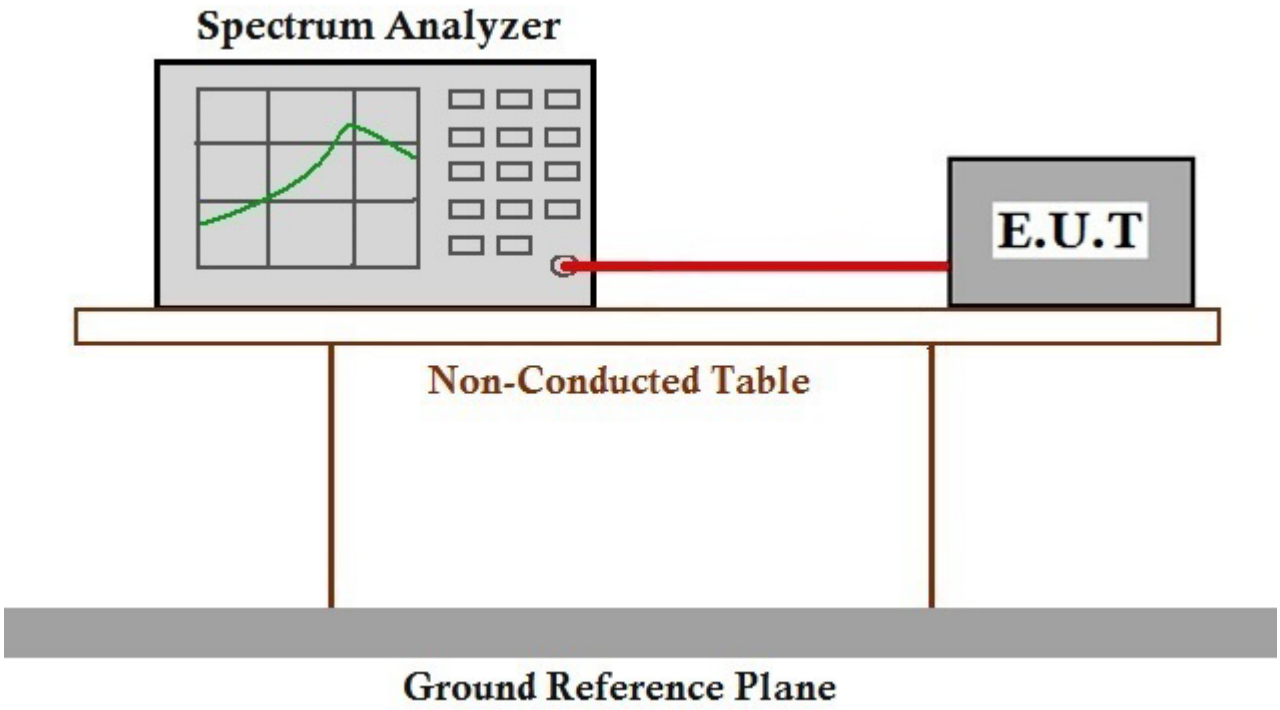
Operating Environment:

Temperature: 20.0 °C Humidity: 48.0 % RH :

Test mode a: TX_Hop mode_Keep the EUT in frequency hopping mode with modulation. All modes have been tested and only the data of worst case is recorded in the report.

b: TX_non-Hop mode_Keep the EUT in continuously transmitting mode with modulation. All modes have been tested and only the data of worst case is recorded in the report.

7.7.2 Test Setup Diagram



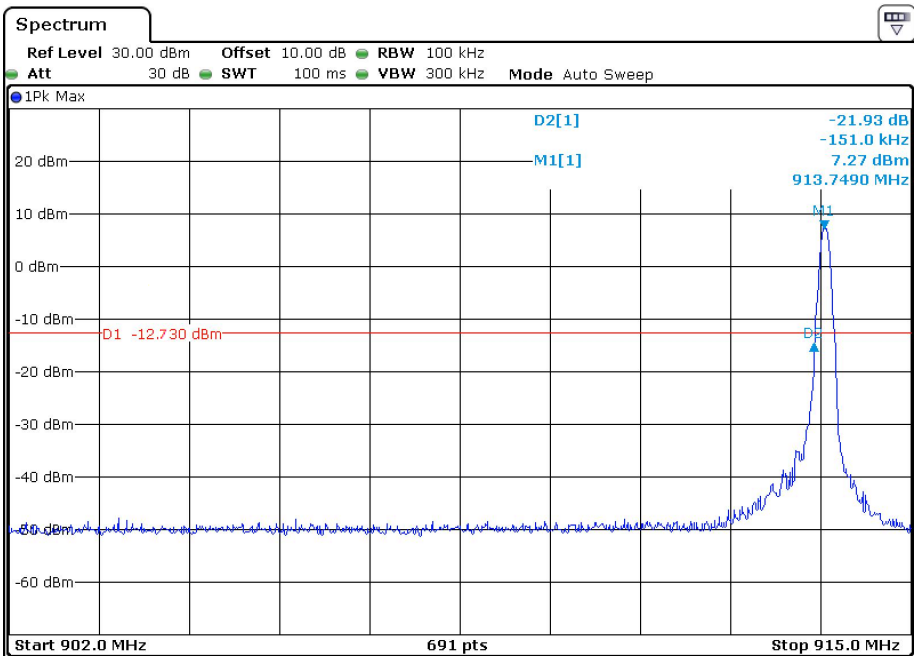
7.7.3 Measurement Procedure and Data

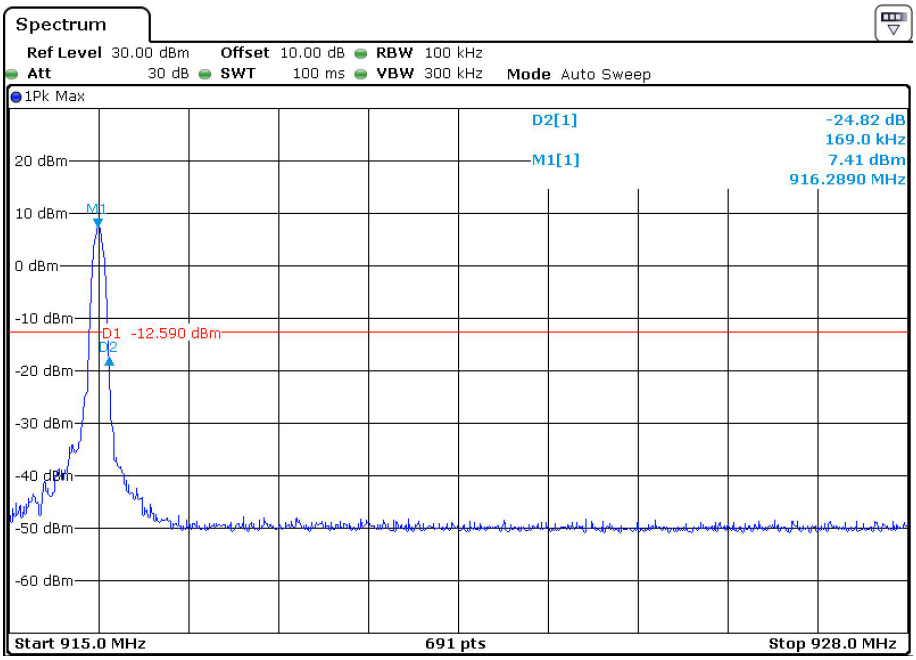
Non-hopping mode

Inband Peak

Frequency (MHz)	Level (dBm)
913.749000	7.27
916.290000	7.41

Remark: Limit = Inband peak – 20dB



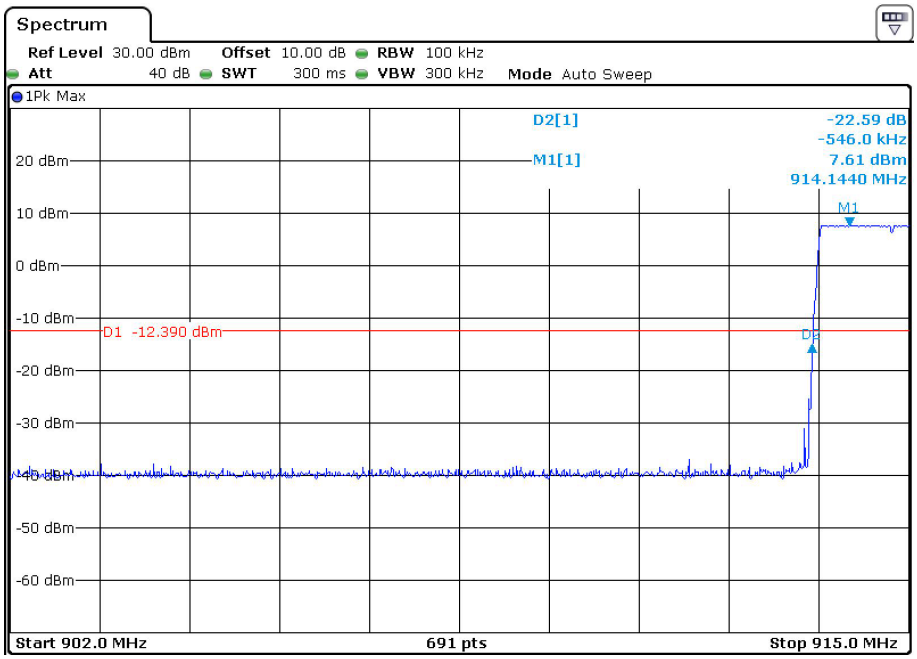


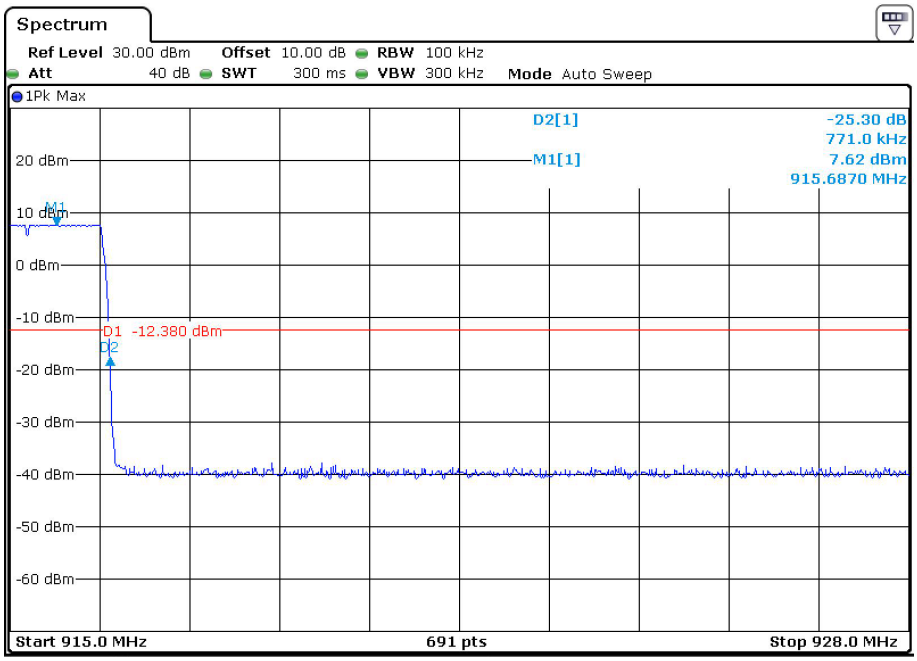
Hopping mode

Inband Peak

Frequency (MHz)	Level (dBm)
914.140	7.61
915.687	7.62

Remark: Limit = Inband peak – 20dB





7.8 Conducted Spurious Emissions

Test Requirement	47 CFR Part 15 Subpart C 15.247:2019(d), RSS-247 Section 5.5
Test Method:	ANSI C63.10 (2013) Section 7.8.8
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

7.8.1 E.U.T. Operation

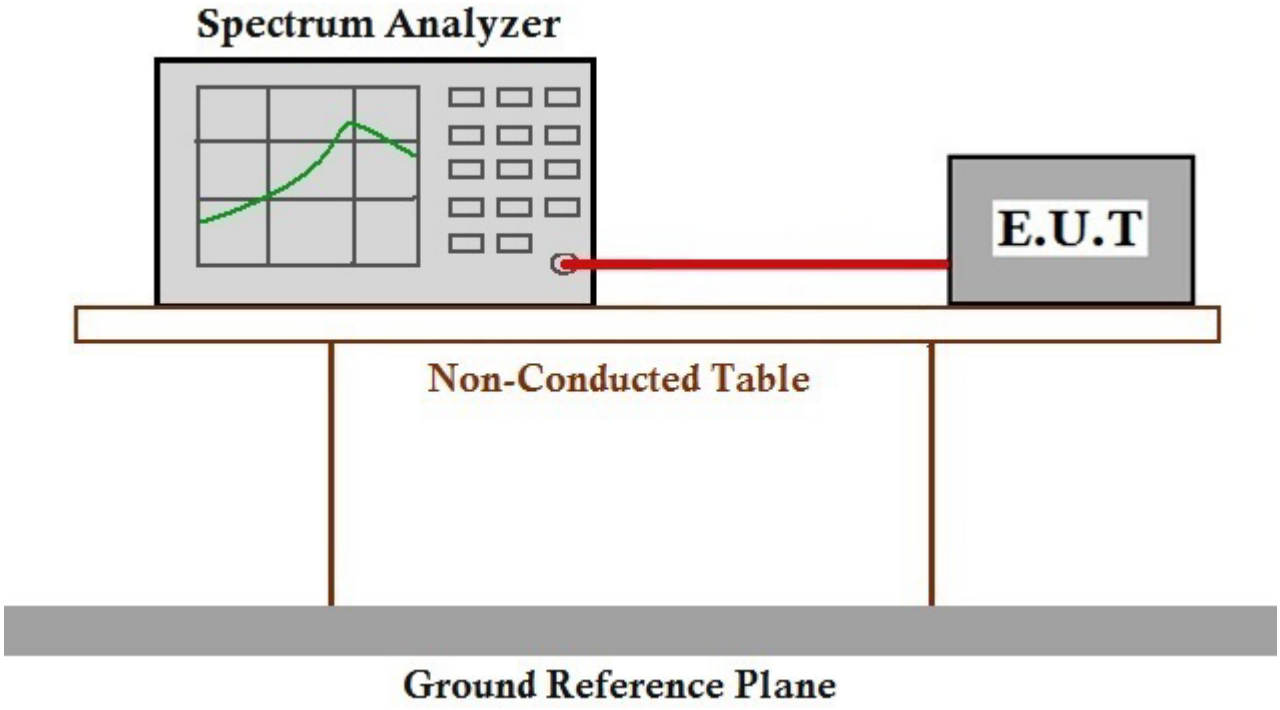
Operating Environment:

Temperature: 20.0 °C Humidity: 48.0 % RH :

Test mode a: TX_Hop mode_Keep the EUT in frequency hopping mode with modulation. All modes have been tested and only the data of worst case is recorded in the report.

b: TX_non-Hop mode_Keep the EUT in continuously transmitting mode with modulation. All modes have been tested and only the data of worst case is recorded in the report.

7.8.2 Test Setup Diagram



7.8.3 Measurement Procedure and Data

The detailed test data see section 9: Appendix

7.9 Radiated Emissions which fall in the restricted bands

Test Requirement 47 CFR Part 15 Subpart C 15.209 & 15.247(d), Section 3.3 & RSS-Gen Section 8.10

Test Method: ANSI C63.10 (2013) Section 6.10.5

Limit:

Table 5 – General field strength limits at frequencies above 30 MHz

Frequency (MHz)	Field strength (μ V/m at 3 m)
30 – 88	100
88 – 216	150
216 – 960	200
Above 960	500

Table 6 – General field strength limits at frequencies below 30 MHz

Frequency	Magnetic field strength (H-Field) (μ A/m)	Measurement distance (m)
9 - 490 kHz 1	6.37/F (F in kHz)	300
490 - 1705 kHz	63.7/F (F in kHz)	30
1.705 - 30 MHz	0.08	30

Note 1: The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector.

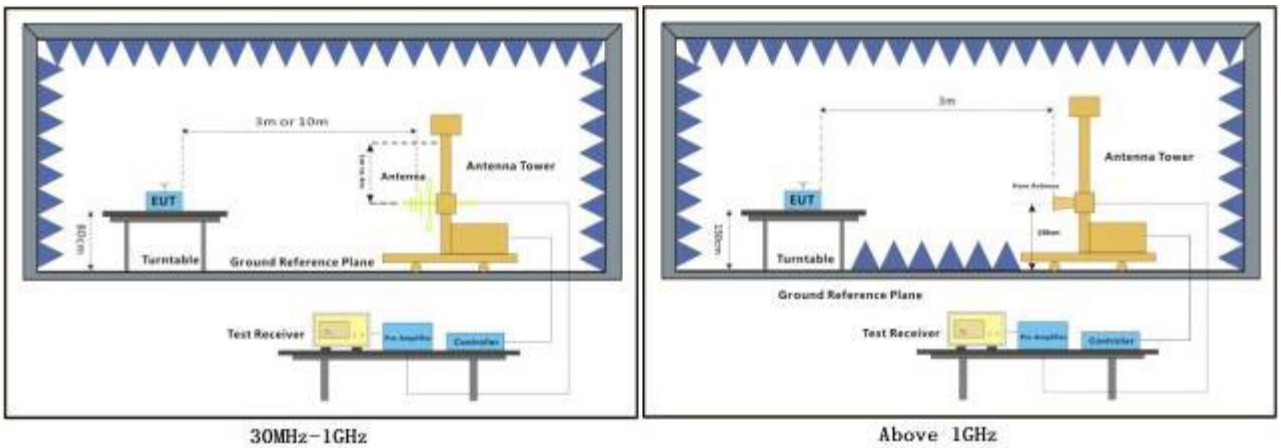
7.9.1 E.U.T. Operation

Operating Environment:

Temperature: 20.0 °C Humidity: 48.0 % RH :

Test mode b: TX_non-Hop mode_Keep the EUT in continuously transmitting mode with modulation. All modes have been tested and only the data of worst case is recorded in the report.

7.9.2 Test Setup Diagram



30MHz-1GHz Above 1GHz

7.9.3 Measurement Procedure and Data

a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.

b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter fully-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.

c. The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

d. 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.

e. 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 rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

f. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

g. 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.

h. Test the EUT in the lowest channel, the middle channel, the Highest channel.

i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case.

j. Repeat above procedures until all frequencies measured was complete.

Remark 1: Level= Read Level+ Cable Loss+ Antenna Factor- Preamp Factor

Remark 2: For frequencies above 1GHz, the field strength limits are based on average limits. 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. For the emissions whose peak level is lower than the average limit, only the peak measurement is shown in the report.

Frequency (MHz)	Antenna Polarization	Emission Level (dBμV/m)		Limit (dBμV/m)		Result
		Peak	Average	Peak	Average	
902.000	H	31.2	/	74.0	54.0	Pass
928.000	H	30.1	/	74.0	54.0	Pass
902.000	V	26.5	/	74.0	54.0	Pass
928.000	V	26.9	/	74.0	54.0	Pass

7.10 Radiated Spurious Emissions

Test Requirement 47 CFR Part 15 Subpart C 15.205 & 15.209, Section 3.3 & RSS-Gen Section 8.9

Test Method: ANSI C63.10 (2013) Section 6.4&6.5&6.6

Limit:

Table 5 – General field strength limits at frequencies above 30 MHz

Frequency (MHz)	Field strength (μ V/m at 3 m)
30 – 88	100
88 – 216	150
216 – 960	200
Above 960	500

Table 6 – General field strength limits at frequencies below 30 MHz

Frequency	Magnetic field strength (H-Field) (μ A/m)	Measurement distance (m)
9 - 490 kHz 1	6.37/F (F in kHz)	300
490 - 1705 kHz	63.7/F (F in kHz)	30
1.705 - 30 MHz	0.08	30

Note 1: The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector.

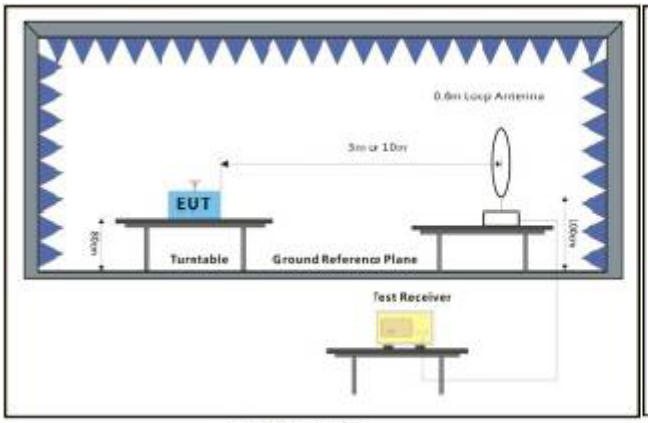
7.10.1 E.U.T. Operation

Operating Environment:

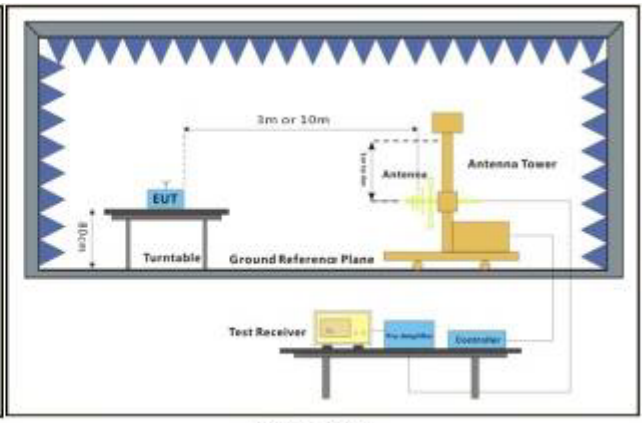
Temperature: 22.2 °C Humidity: 48.6 % RH :

Test mode b: TX_non-Hop mode_Keep the EUT in continuously transmitting mode with modulation. All modes have been tested and only the data of worst case is recorded in the report.

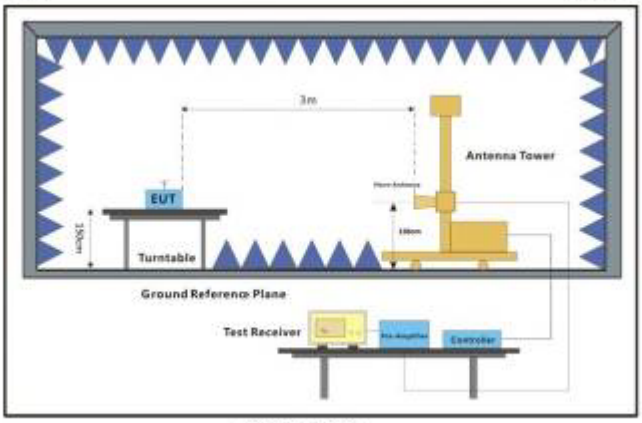
7.10.2 Test Setup Diagram



Below 30MHz



30MHz-1GHz



Above 1GHz

7.10.3 Measurement Procedure and Data

a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.

b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter fully-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.

c. The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

d. 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.

e. 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 rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

f. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

g. 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.

h. Test the EUT in the lowest channel, the middle channel, the Highest channel.

i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case.

j. Repeat above procedures until all frequencies measured was complete.

Remark:

1) For emission below 1GHz, through pre-scan found the worst case is the lowest channel. Only the worst case is recorded in the report.

2) The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

Final Test Level =Receiver Reading + Antenna Factor + Cable Factor – Preamplifier Factor

3) Scan from 9kHz to 25GHz, the disturbance above 18GHz and below 30MHz was very low. The points marked on above plots are the highest emissions could be found when testing, so only above points had been displayed. The amplitude of spurious emissions from the radiator which are attenuated more than 20dB below the limit need not be reported.

4) For frequencies above 1GHz, the field strength limits are based on average limits. 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. For the emissions whose peak level is lower than the average limit, only the peak measurement is shown in the report.

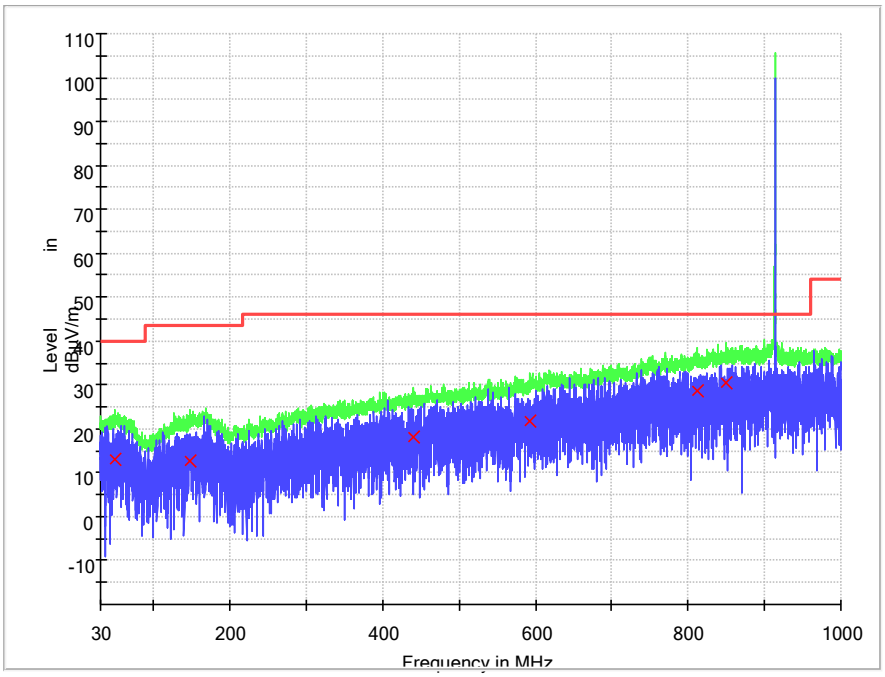
Radiated emission below 1GHz

Channel: Low

Mode: b;

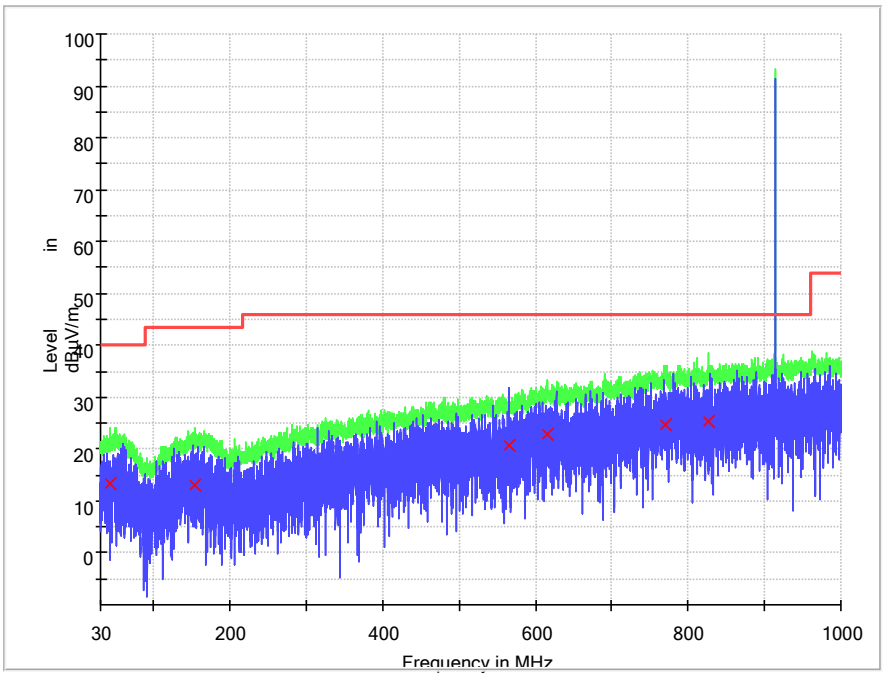
Polarization: Horizontal

Quasi-peak measurement:



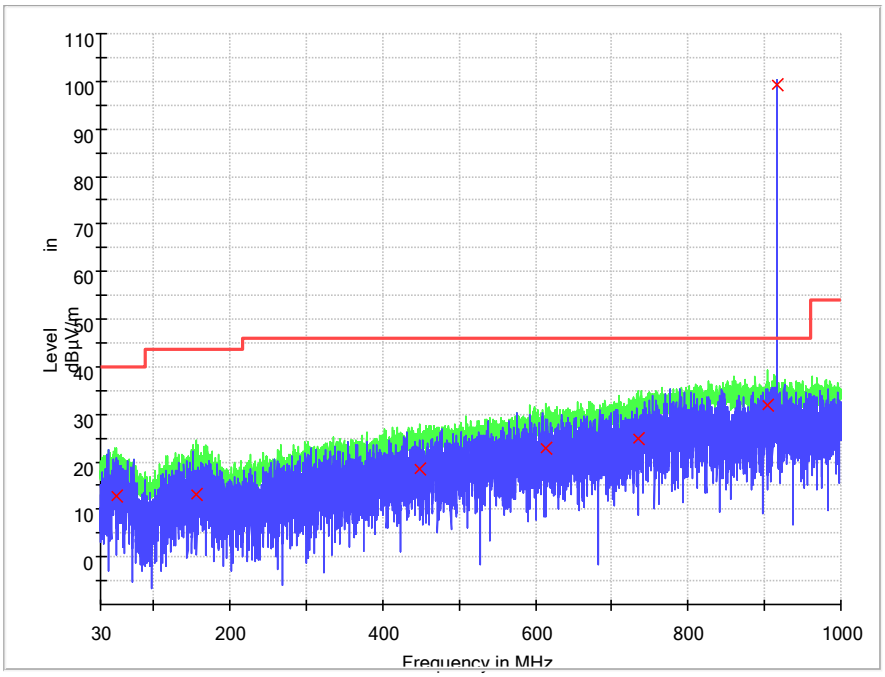
Frequency (MHz)	QuasiPeak (dBµV/m)	Pol.	Corr. (dB/m)	Margin (dB)	Limit (dBµV/m)	Result
48.430000	13.2	H	14.2	26.8	40.0	Pass
146.400000	12.8	H	13.9	30.7	43.5	Pass
440.517857	18.0	H	18.5	28.0	46.0	Pass
592.669286	21.8	H	21.8	24.2	46.0	Pass
811.196429	28.7	H	25.0	17.3	46.0	Pass
849.719286	30.6	H	25.4	15.4	46.0	Pass

Mode: b;
Polarization: Vertical
Quasi-peak measurement:



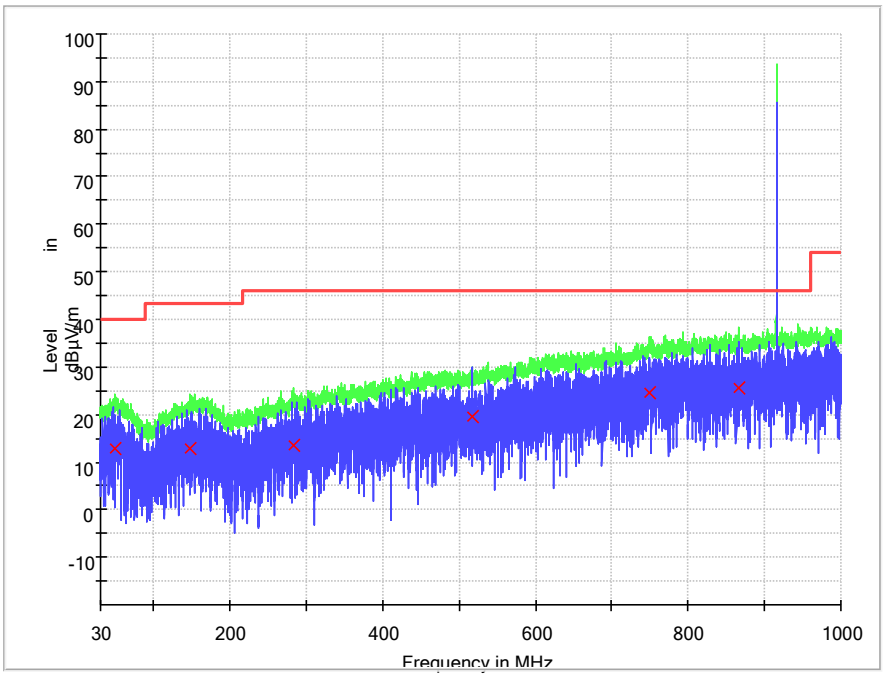
Frequency (MHz)	QuasiPeak (dBµV/m)	Pol.	Corr. (dB/m)	Margin (dB)	Limit (dBµV/m)	Result
42.956429	13.2	V	13.9	26.8	40.0	Pass
153.605714	13.0	V	14.3	30.5	43.5	Pass
564.747143	20.9	V	20.7	25.2	46.0	Pass
615.602857	23.0	V	22.5	23.0	46.0	Pass
769.625000	24.8	V	24.8	21.2	46.0	Pass
826.023571	25.4	V	25.2	20.6	46.0	Pass

Channel: High
Mode: b;
Polarization: Horizontal
Quasi-peak measurement:



Frequency (MHz)	QuasiPeak (dBµV/m)	Pol.	Corr. (dB/m)	Margin (dB)	Limit (dBµV/m)	Result
51.062857	12.8	H	14.2	27.2	40.0	Pass
155.130000	13.2	H	14.4	30.4	43.5	Pass
448.139286	18.4	H	18.7	27.7	46.0	Pass
613.455000	22.8	H	22.5	23.2	46.0	Pass
735.467143	25.0	H	24.2	21.0	46.0	Pass
904.662857	31.9	H	26.1	14.1	46.0	Pass

Mode: b;
Polarization: Vertical
Quasi-peak measurement:



Frequency (MHz)	QuasiPeak (dBµV/m)	Pol.	Corr. (dB/m)	Margin (dB)	Limit (dBµV/m)	Result
49.400000	13.0	V	14.2	27.0	40.0	Pass
146.815714	12.8	V	13.9	30.7	43.5	Pass
283.793571	13.6	V	14.5	32.4	46.0	Pass
516.732143	19.7	V	19.9	26.3	46.0	Pass
750.017143	24.6	V	24.7	21.4	46.0	Pass
865.793571	25.7	V	25.4	20.3	46.0	Pass

Above 1GHz

Channel: Low

Frequency (MHz)	Antenna Polarization	Emission Level (dBμV/m)		Limit (dBμV/m)		Result
		Peak	Average	Peak	Average	
1827.250	H	58.1	52.1	74	54	Pass
2741.500	H	59.8	50.5	74	54	Pass
3655.375	H	62.3	51.9	74	54	Pass
1827.250	V	51.4	49.1	74	54	Pass
2741.500	V	48.6	42.4	74	54	Pass
3655.000	V	65.9	52.1	74	54	Pass

Channel: High

Frequency (MHz)	Antenna Polarization	Emission Level (dBμV/m)		Limit (dBμV/m)		Result
		Peak	Average	Peak	Average	
1832.500	H	55.9	52.6	74	54	Pass
2749.000	H	57.0	52.1	74	54	Pass
6414.000	H	47.7	39.2	74	54	Pass
1832.500	V	50.0	47.3	74	54	Pass
2748.625	V	45.0	33.0	74	54	Pass
7932.000	V	50.4	36.8	74	54	Pass

8 Photographs

Remark: Photos refer to Appendix: External Photo, Internal Photo and setup Photo.

- End of the Report -