

TEST REPORT

Application No.: SZEM2102002030CR
Applicant: AJAX SYSTEMS CYPRUS HOLDINGS LTD
Address of Applicant: Ifigeneias, 17, Strovolos, 2007, Nicosia, Cyprus
Manufacturer: AJAX SYSTEMS MANUFACTURING LIMITED LIABILITY COMPANY
Address of Manufacturer: Sklyarenka, 5, Kyiv, 04073, Ukraine
Factory: AJAX SYSTEMS MANUFACTURING LIMITED LIABILITY COMPANY
Address of Factory: Sklyarenka, 5, Kyiv, 04073, Ukraine
Equipment Under Test (EUT):
EUT Name: Security control panel
Model No.: Ajax Hub 2 Plus (9NA/AFA)
Trade Mark: AJAX
FCC ID: 2AX5VHUB2PL
Standard(s) : 47 CFR Part 15, Subpart C 15.247
Date of Receipt: 2021-03-23
Date of Test: 2021-02-24 to 2021-03-25
Date of Issue: 2021-03-29

Test Result:	Pass*
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* In the configuration tested, the EUT complied with the standards specified above.

Keny Xu

Keny Xu
EMC Laboratory Manager



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Revision Record				
Version	Chapter	Date	Modifier	Remark
01		2021-03-29		Original

Authorized for issue by:				
		Edison Li		
		Edison Li/Project Engineer		
		Eric Fu		
		Eric Fu/Reviewer		

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		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)(2)	Pass
20dB Bandwidth		ANSI C63.10 (2013) Section 7.8.7	47 CFR Part 15, Subpart C 15.247(a)(1)	Pass
Carrier Frequencies Separation		ANSI C63.10 (2013) Section 7.8.2	47 CFR Part 15, Subpart C 15.247a(1)	Pass
Hopping Channel Number		ANSI C63.10 (2013) Section 7.8.3	47 CFR Part 15, Subpart C 15.247a(1)(i)	Pass
Dwell Time		ANSI C63.10 (2013) Section 7.8.4	47 CFR Part 15, Subpart C 15.247a(1)(i)	Pass
Conducted Band Edges Measurement		ANSI C63.10 (2013) Section 7.8.6	47 CFR Part 15, Subpart C 15.247(d)	Pass
Conducted Spurious Emissions		ANSI C63.10 (2013) Section 7.8.8	47 CFR Part 15, Subpart C 15.247(d)	Pass
Radiated Spurious Emissions		ANSI C63.10 (2013) Section 6.4,6.5,6.6	47 CFR Part 15, Subpart C 15.205 & 15.209	Pass

Note: Both antennas have the same Tx port, RF conducted is tested under this Tx port;

Emission Part				
Item	Standard	Method	Requirement	Result
Conducted Emissions at AC Power Line (150kHz-30MHz)	47 CFR Part 15, Subpart C 15.247;	ANSI C63.10 (2013) Section 6.2	47 CFR Part 15, Subpart C 15.207 & 15.247	Pass



3 Contents

	Page
1 COVER PAGE	1
2 TEST SUMMARY	3
3 CONTENTS	4
4 GENERAL INFORMATION	6
4.1 DETAILS OF E.U.T.	6
4.2 DESCRIPTION OF SUPPORT UNITS	7
4.3 MEASUREMENT UNCERTAINTY	7
4.4 TEST LOCATION	8
4.5 TEST FACILITY	8
4.6 DEVIATION FROM STANDARDS	8
4.7 ABNORMALITIES FROM STANDARD CONDITIONS	8
5 EQUIPMENT LIST	9
6 RADIO SPECTRUM TECHNICAL REQUIREMENT	12
6.1 ANTENNA REQUIREMENT	12
6.1.1 <i>Test Requirement:</i>	12
6.2 OTHER REQUIREMENTS FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM HOPPING SEQUENCE	13
6.2.1 <i>Test Requirement:</i>	13
7 RADIO SPECTRUM MATTER TEST RESULTS	15
7.1 CONDUCTED PEAK OUTPUT POWER	15
7.1.1 <i>E.U.T. Operation</i>	15
7.1.2 <i>Test Mode Description</i>	15
7.1.3 <i>Test Setup Diagram</i>	16
7.1.4 <i>Measurement Procedure and Data</i>	16
7.2 20dB BANDWIDTH	17
7.2.1 <i>E.U.T. Operation</i>	17
7.2.2 <i>Test Mode Description</i>	17
7.2.3 <i>Test Setup Diagram</i>	17
7.2.4 <i>Measurement Procedure and Data</i>	17
7.3 CARRIER FREQUENCIES SEPARATION	18
7.3.1 <i>E.U.T. Operation</i>	18
7.3.2 <i>Test Mode Description</i>	18
7.3.3 <i>Test Setup Diagram</i>	18
7.3.4 <i>Measurement Procedure and Data</i>	18
7.4 HOPPING CHANNEL NUMBER	19
7.4.1 <i>E.U.T. Operation</i>	19
7.4.2 <i>Test Mode Description</i>	19
7.4.3 <i>Test Setup Diagram</i>	19
7.4.4 <i>Measurement Procedure and Data</i>	19
7.5 DWELL TIME	20
7.5.1 <i>E.U.T. Operation</i>	20



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7.5.2	Test Mode Description	20
7.5.3	Test Setup Diagram	20
7.5.4	Measurement Procedure and Data	20
7.6	CONDUCTED BAND EDGES MEASUREMENT	21
7.6.1	E.U.T. Operation	21
7.6.2	Test Mode Description	21
7.6.3	Test Setup Diagram	22
7.6.4	Measurement Procedure and Data	22
7.7	CONDUCTED SPURIOUS EMISSIONS	23
7.7.1	E.U.T. Operation	23
7.7.2	Test Mode Description	23
7.7.3	Test Setup Diagram	24
7.7.4	Measurement Procedure and Data	24
7.8	RADIATED SPURIOUS EMISSIONS	25
7.8.1	E.U.T. Operation	25
7.8.2	Test Mode Description	25
7.8.3	Test Setup Diagram	26
7.8.4	Measurement Procedure and Data	27
8	EMISSION TEST RESULTS	37
8.1	CONDUCTED EMISSIONS AT AC POWER LINE (150KHZ-30MHZ)	37
8.1.1	E.U.T. Operation	37
8.1.2	Test Mode Description	37
8.1.3	Test Setup Diagram	37
8.1.4	Measurement Procedure and Data	38
9	TEST SETUP PHOTO	41
10	EUT CONSTRUCTIONAL DETAILS (EUT PHOTOS)	41
11	APPENDIX FOR 15.247	42-56



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4 General Information

4.1 Details of E.U.T.

Power supply:	AC 110~240V, 50/60Hz, 0.1A Backup Battery: 3.7V, Rechargeable Li-ion, 3000mAh
Cable(s):	AC cable:142cm unshielded network cable:94cm unshielded
Internal Source:	More than 108MHz
Operation Frequency:	905MHz to 926.5MHz
Spectrum Spread Technology:	Frequency Hopping Spread Spectrum(FHSS)
Modulation Type:	GFSK
Number of Channels:	The number of available frequency hopping channels of this device is 103, only 101 channels are used in normal operation and constantly involved, 2 is reserve in case of jamming.
Antenna Type:	PCB
Antenna Gain:	Antenna1: -5dBi, Antenna2: -6dBi Note: The two antennas can't simultaneous transmission because it's forbidden in firmware.

Channel Lists:

Ch.	Freq. (MHz)	Ch.	Freq. (MHz)	Ch.	Freq. (MHz)	Ch.	Freq. (MHz)	Ch.	Freq. (MHz)
1	916.05	26	921.05	51	915.65	76	910.65	101	915.85
2	916.25	27	921.25	52	915.45	77	910.45	102	905
3	916.45	28	921.45	53	915.25	78	910.25	103	926.5
4	916.65	29	921.65	54	915.05	79	910.05		
5	916.85	30	921.85	55	914.85	80	909.85		
6	917.05	31	922.05	56	914.65	81	909.65		
7	917.25	32	922.25	57	914.45	82	909.45		
8	917.45	33	922.45	58	914.25	83	909.25		
9	917.65	34	922.65	59	914.05	84	909.05		
10	917.85	35	922.85	60	913.85	85	908.85		
11	918.05	36	923.05	61	913.65	86	908.65		
12	918.25	37	923.25	62	913.45	87	908.45		
13	918.45	38	923.45	63	913.25	88	908.25		
14	918.65	39	923.65	64	913.05	89	908.05		
15	918.85	40	923.85	65	912.85	90	907.85		
16	919.05	41	924.05	66	912.65	91	907.65		
17	919.25	42	924.25	67	912.45	92	907.45		
18	919.45	43	924.45	68	912.25	93	907.25		



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19	919.65	44	924.65	69	912.05	94	907.05		
20	919.85	45	924.85	70	911.85	95	906.85		
21	920.05	46	925.05	71	911.65	96	906.65		
22	920.25	47	925.25	72	911.45	97	906.45		
23	920.45	48	925.45	73	911.25	98	906.25		
24	920.65	49	925.65	74	911.05	99	906.05		
25	920.85	50	925.85	75	910.85	100	905.85		

4.2 Description of Support Units

Description	Manufacturer	Model No.	Serial No.
--	--	--	--
The EUT has been tested as an independent unit.			

4.3 Measurement Uncertainty

Test Item	Measurement Uncertainty
Conducted Emissions at AC Power Line (150kHz-30MHz)	± 3.0dB (150kHz to 30MHz)
Conducted Peak Output Power	± 0.75dB
20dB Bandwidth	± 3%
Carrier Frequencies Separation	± 7.25 x 10-8
Hopping Channel Number	± 7.25 x 10-8
Dwell Time	± 0.37%
Conducted Band Edges Measurement	± 0.75dB
Conducted Spurious Emissions	± 0.75dB
Radiated Emissions which fall in the restricted bands	± 4.5dB (Below 1GHz); ± 4.8dB (Above 1GHz)
Radiated Spurious Emissions	± 4.5dB (Below 1GHz); ± 4.8dB (Above 1GHz)

4.4 Test Location

All tests were performed at:

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518057.

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No tests were sub-contracted.

4.5 Test Facility

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

- **A2LA (Certificate No. 3816.01)**

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory is accredited by the American Association for Laboratory Accreditation(A2LA). Certificate No. 3816.01.

- **VCCI**

The 3m Fully-anechoic chamber for above 1GHz, 10m Semi-anechoic chamber for below 1GHz, Shielded Room for Mains Port Conducted Interference Measurement and Telecommunication Port Conducted Interference Measurement of SGS-CSTC Standards Technical Services Co., Ltd. have been registered in accordance with the Regulations for Voluntary Control Measures with Registration No.: G-20026, R-14188, C-12383 and T-11153 respectively.

- **FCC –Designation Number: CN1178**

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory has been recognized as an accredited testing laboratory.

Designation Number: CN1178. Test Firm Registration Number: 406779.

- **Innovation, Science and Economic Development Canada**

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory has been recognized by ISED as an accredited testing laboratory.

CAB identifier: CN0006.

IC#: 4620C.

4.6 Deviation from Standards

None

4.7 Abnormalities from Standard Conditions

None



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5 Equipment List

Conducted Emissions at AC Power Line (150kHz-30MHz)					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
Shielding Room	ZhongYu Electron	GB-88	SEM001-06	2019-06-13	2022-06-12
EMI Test Receiver	Rohde&Schwarz	ESCI	SEM004-02	2021-03-24	2022-03-23
Measurement Software	AUDIX	e3 V8.2014-6-27	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM024-01	2020-07-10	2021-07-09
LISN	Rohde&Schwarz	ENV216	SEM007-01	2020-09-23	2021-09-22
LISN	ETS-LINDGREN	3816/2	SEM007-02	2021-03-24	2022-03-25

RF Conducted Test					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
Shielding Room	SAEMC	MSR733	SEM001-09	2019-06-13	2022-06-12
DC Power Supply	Rohde & Schwarz	NGSM 32/10	SEM011-04	2021-03-23	2022-03-22
Spectrum Analyzer	Rohde & Schwarz	FSU43	SEM004-08	2021-03-24	2022-03-23
Signal Generator	KEYSIGHT	N5173B	SEM006-05	2020-09-23	2021-09-22
Measurement Software	TST	TST PASS V1.0.5	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM031-02	2020-07-10	2021-07-09
Attenuator	Huber+Suhner	6620_SMA-50-1	SEM021-09	2020-05-21	2021-05-20

Radiated Emissions					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
3m Semi-Anechoic Chamber	ETS-LINDGREN	N/A	SEM001-01	2020-07-19	2023-07-18
MXE EMI Receiver	Agilent Technologies	N9038A	SEM004-15	2020-11-02	2021-11-01
BiConiLog Antenna	ETS-LINDGREN	3142C	SEM003-02	2019-05-24	2022-05-23
Pre-Amplifier	Agilent Technologies	8447D	SEM005-01	2020-04-01	2021-03-31
Measurement Software	AUDIX	e3 V8.2014-6-27	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM025-01	2020-07-10	2021-07-09



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Radiated Emissions which fall in the restricted bands					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
3m Semi-Anechoic Chamber	AUDIX	N/A	SEM001-02	2018-03-31	2021-03-30
EXA Signal Analyzer	Agilent Technologies Inc	N9010A	SEM004-12	2020-04-09	2021-04-08
Horn Antenna	Rohde&Schwarz	HF907	SEM003-07	2018-04-13	2021-04-12
Pre-Amplifier	Compliance Directions Systems Inc.	PAP-0126	SEM004-11	2020-09-23	2021-09-22
Measurement Software	AUDIX	e3 V8.2014-6-27	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM026-01	2020-07-10	2021-07-09
Horn Antenna	Schwarzbeck	BBHA 9170	SEM003-15	2020-11-14	2023-11-13
Pre-Amplifier	Compliance Directions Systems Inc.	PAP-2640-50	SEM005-08	2021-03-24	2022-03-23

Radiated Spurious Emissions					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
3m Semi-Anechoic Chamber	AUDIX	N/A	SEM001-02	2018-03-31	2021-03-30
EXA Signal Analyzer	Agilent Technologies Inc	N9010A	SEM004-12	2020-04-09	2021-04-08
Horn Antenna	Rohde&Schwarz	HF907	SEM003-07	2018-04-13	2021-04-12
Pre-Amplifier	Compliance Directions Systems Inc.	PAP-0126	SEM004-11	2020-09-23	2021-09-22
Measurement Software	AUDIX	e3 V8.2014-6-27	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM026-01	2020-07-10	2021-07-09
Horn Antenna	Schwarzbeck	BBHA 9170	SEM003-15	2020-11-14	2023-11-13
Pre-Amplifier	Compliance Directions Systems Inc.	PAP-2640-50	SEM005-08	2021-03-24	2022-03-23



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中国·深圳·科技园中区M-10栋一号厂房 邮编: 518057 t (86-755) 26012053 f (86-755) 26710594 sgs.china@sgs.com

General used equipment					
Equipment	Manufacturer	Model No	Inventory No	Cal Date	Cal Due Date
Humidity/ Temperature Indicator	Shanghai Meteorological Industry Factory	ZJ1-2B	SEM002-04	2020-09-15	2021-09-14
Humidity/ Temperature Indicator	Mingle	N/A	SEM002-08	2020-09-15	2021-09-14
Barometer	Changchun Meteorological Industry Factory	DYM3	SEM002-01	2020-04-07	2021-04-06



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No.1 Workshop, M-10, Middle Section, Science & Technology Park, Shenzhen, China 518057 t (86-755) 26012053 f (86-755) 26710594 www.sgsgroup.com.cn
中国·深圳·科技园中区M-10栋一号厂房 邮编: 518057 t (86-755) 26012053 f (86-755) 26710594 sgs.china@sgs.com

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)

Limit:

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 Antenna1 is -5dBi, Antenna2 is -6dBi.

Antenna location: Refer to Internal photos.



6.2 Other requirements Frequency Hopping Spread Spectrum System Hopping Sequence

6.2.1 Test Requirement:

47 CFR Part 15, Subpart C 15.247(a)(1),(g),(h)

Limit:

Standard Requirement:

The system shall hop to channel frequencies that are selected at the system hopping rate from a Pseudorandom ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

Compliance for section 15.247(a)(1):

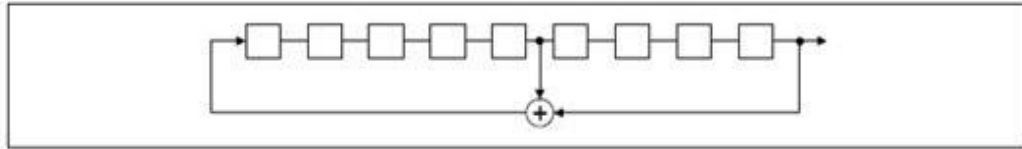
According to Technical Specification, the pseudorandom sequence may be generated in a nine-stage shift register whose 5th and 9th stage outputs are added in a modulo-two addition stage. And the result is fed back to the input of the first stage. The sequence begins with the first ONE of 9 consecutive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

- > Number of shift register stages: 9
- > Length of pseudo-random sequence: $2^9 - 1 = 511$ bits
- > Longest sequence of zeros: 8 (non-inverted signal)

Linear Feedback Shift Register for Generation of the PRBS sequence

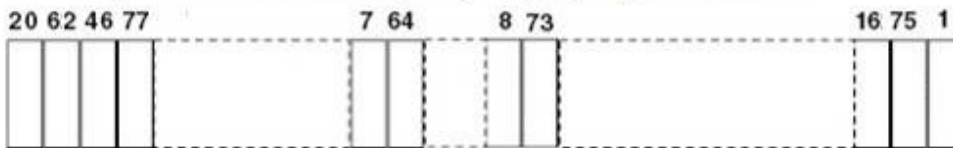
An example of Pseudorandom Frequency Hopping Sequence as follow:





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.

Compliance for section 15.247(g):

According to Technical Specification, the system transmits the packet with the pseudorandom hopping frequency with a continuous data and the short burst transmission from the Bluetooth system is also transmitted under the frequency hopping system with the pseudorandom hopping frequency system.

Compliance for section 15.247(h):

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 Conducted Peak Output Power

Test Requirement 47 CFR Part 15, Subpart C 15.247(b)(2)
Test Method: ANSI C63.10 (2013) Section 7.8.5
Limit:

Frequency range(MHz)	Output power of the intentional radiator(watt)
902-928	1 for ≥ 50 hopping channels
	0.25 for $25 \leq$ hopping channels < 50
	1 for digital modulation
2400-2483.5	1 for ≥ 75 non-overlapping hopping channels
	0.125 for all other frequency hopping systems
	1 for digital modulation
5725-5850	1 for frequency hopping systems and digital modulation

7.1.1 E.U.T. Operation

Operating Environment:

Temperature: 25 °C

Humidity: 54 % RH

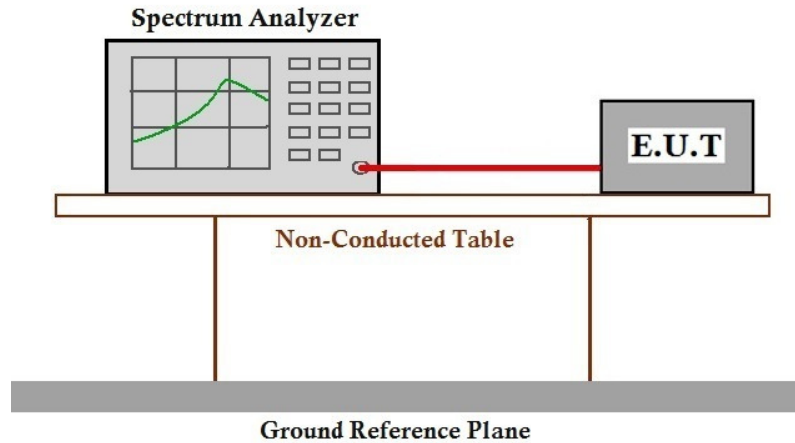
Atmospheric Pressure: 1010 mbar

7.1.2 Test Mode Description

Pre-scan / Final test	Mode Code	Description
Pre-scan	07	TX_non-Hop mode_Keep the EUT in continuously transmitting mode with GFSK modulation.
Final test	08	Charge + TX_non-Hop mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation.



7.1.3 Test Setup Diagram



7.1.4 Measurement Procedure and Data

Please Refer To Appendix For Details



7.2 20dB Bandwidth

Test Requirement 47 CFR Part 15, Subpart C 15.247(a)(1)
Test Method: ANSI C63.10 (2013) Section 7.8.7
Limit:

20 dB bandwidth	hopping frequencies
<250KHz	≥50
≥250KHz	≥25

7.2.1 E.U.T. Operation

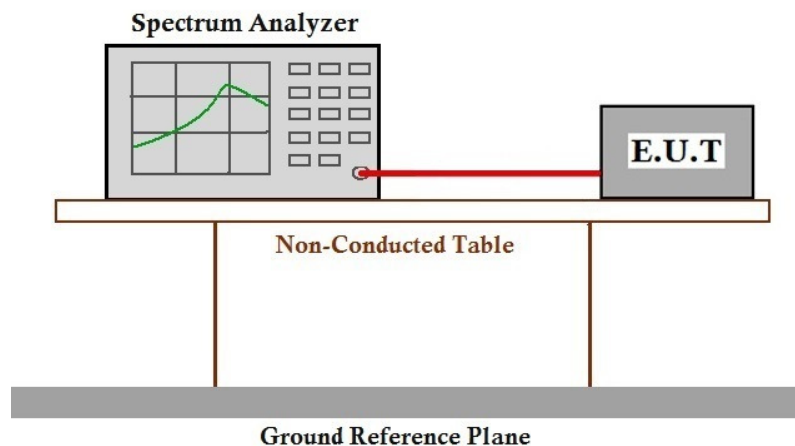
Operating Environment:

Temperature: 25 °C Humidity: 54 % RH Atmospheric Pressure: 1010 mbar

7.2.2 Test Mode Description

Pre-scan / Final test	Mode Code	Description
Pre-scan	07	TX_non-Hop mode_Keep the EUT in continuously transmitting mode with GFSK modulation.
Final test	08	Charge + TX_non-Hop mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation.

7.2.3 Test Setup Diagram



7.2.4 Measurement Procedure and Data

Please Refer To Appendix For Details

7.3 Carrier Frequencies Separation

Test Requirement 47 CFR Part 15, Subpart C 15.247a(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.

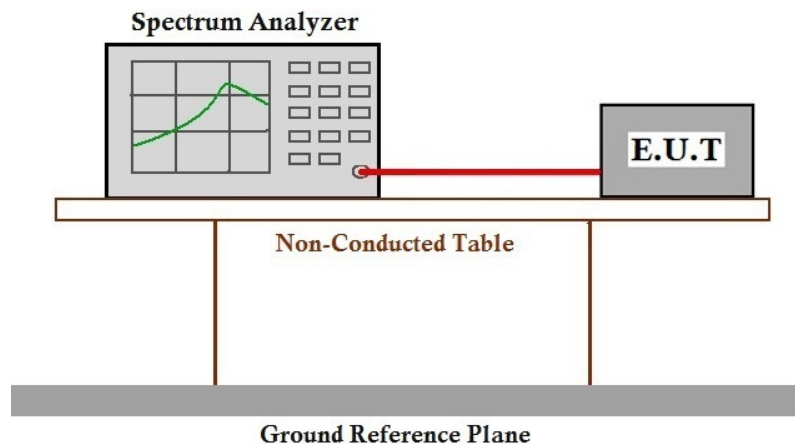
7.3.1 E.U.T. Operation

Operating Environment:
 Temperature: 25 °C Humidity: 54 % RH Atmospheric Pressure: 1010 mbar

7.3.2 Test Mode Description

Pre-scan / Final test	Mode Code	Description
Final test	09	TX_Hop mode_Keep the EUT in frequency hopping mode with GFSK modulation.

7.3.3 Test Setup Diagram



7.3.4 Measurement Procedure and Data

Please Refer To Appendix For Details

7.4 Hopping Channel Number

Test Requirement 47 CFR Part 15, Subpart C 15.247a(1)(i)
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

7.4.1 E.U.T. Operation

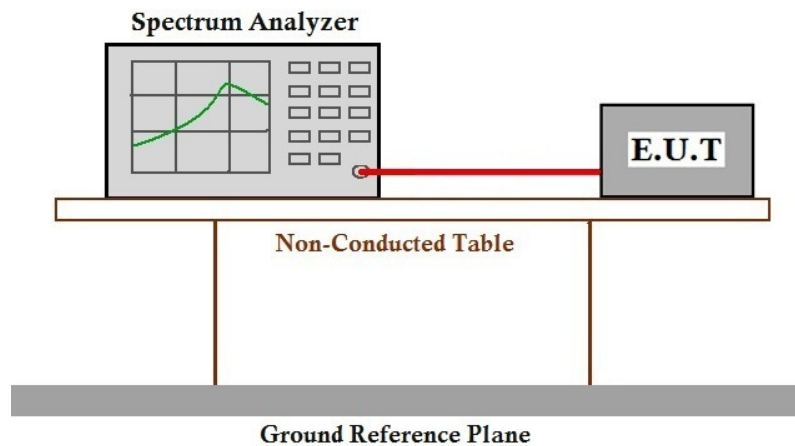
Operating Environment:

Temperature: 25 °C Humidity: 54 % RH Atmospheric Pressure: 1010 mbar

7.4.2 Test Mode Description

Pre-scan / Final test	Mode Code	Description
Final test	09	TX_Hop mode_Keep the EUT in frequency hopping mode with GFSK modulation.

7.4.3 Test Setup Diagram



7.4.4 Measurement Procedure and Data

Please Refer To Appendix For Details

7.5 Dwell Time

Test Requirement 47 CFR Part 15, Subpart C 15.247a(1)(i)
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

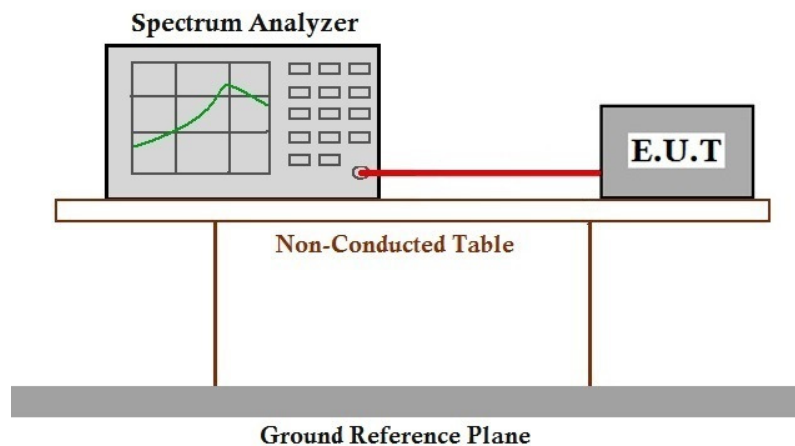
7.5.1 E.U.T. Operation

Operating Environment:
Temperature: 25 °C Humidity: 54 % RH Atmospheric Pressure: 1010 mbar

7.5.2 Test Mode Description

Pre-scan / Final test	Mode Code	Description
Final test	09	TX_Hop mode_Keep the EUT in frequency hopping mode with GFSK modulation.

7.5.3 Test Setup Diagram



7.5.4 Measurement Procedure and Data

Please Refer To Appendix For Details

7.6 Conducted Band Edges Measurement

Test Requirement	47 CFR Part 15, Subpart C 15.247(d)
Test Method:	ANSI C63.10 (2013) Section 7.8.6
Limit:	In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator 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 the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. 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)).

7.6.1 E.U.T. Operation

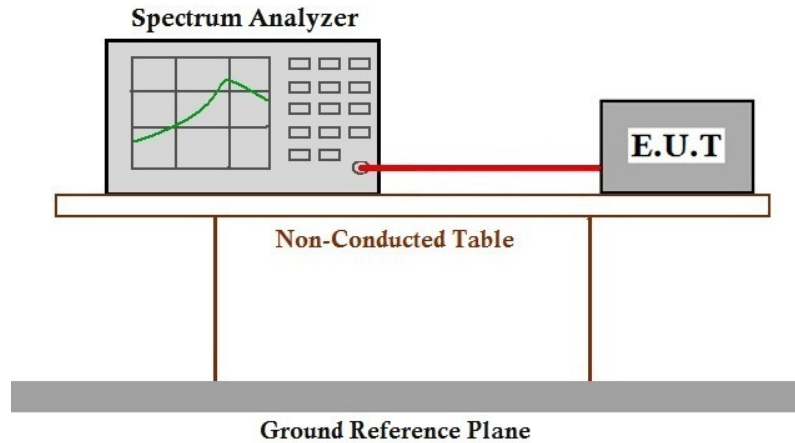
Operating Environment:							
Temperature:	25	°C	Humidity:	54 % RH	Atmospheric Pressure:	1010	mbar

7.6.2 Test Mode Description

Pre-scan / Final test	Mode Code	Description
Pre-scan	07	TX_non-Hop mode_Keep the EUT in continuously transmitting mode with GFSK modulation.
Final test	08	Charge + TX_non-Hop mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation.
Final test	09	TX_Hop mode_Keep the EUT in frequency hopping mode with GFSK modulation.



7.6.3 Test Setup Diagram



7.6.4 Measurement Procedure and Data

Please Refer To Appendix For Details



7.7 Conducted Spurious Emissions

Test Requirement	47 CFR Part 15, Subpart C 15.247(d)
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 intentional radiator is operating, the radio frequency power that is produced by the intentional radiator 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 the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. 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)).

7.7.1 E.U.T. Operation

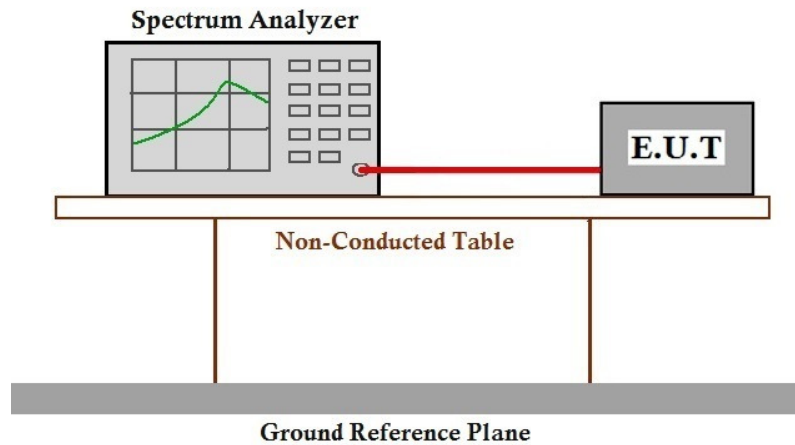
Operating Environment:							
Temperature:	25	°C	Humidity:	54 % RH	Atmospheric Pressure:	1010	mbar

7.7.2 Test Mode Description

Pre-scan / Final test	Mode Code	Description
Pre-scan	07	TX_non-Hop mode_Keep the EUT in continuously transmitting mode with GFSK modulation.
Final test	08	Charge + TX_non-Hop mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation.



7.7.3 Test Setup Diagram



7.7.4 Measurement Procedure and Data

Please Refer To Appendix For Details



7.8 Radiated Spurious Emissions

Test Requirement 47 CFR Part 15, Subpart C 15.205 & 15.209
Test Method: ANSI C63.10 (2013) Section 6.4,6.5,6.6
Measurement Distance: 3m
Limit:

Frequency(MHz)	Field strength(microvolts/meter)	Measurement distance(meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Remark: The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90kHz, 110-490kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector, 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.

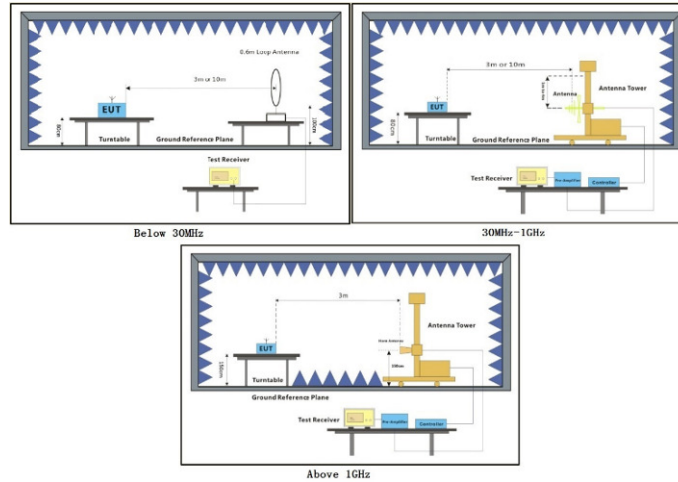
7.8.1 E.U.T. Operation

Operating Environment:
Temperature: 25 °C Humidity: 54 % RH Atmospheric Pressure: 1010 mbar

7.8.2 Test Mode Description

Pre-scan / Final test	Mode Code	Description
Pre-scan	07	TX_non-Hop mode_Keep the EUT in continuously transmitting mode with GFSK modulation.
Final test	08	Charge + TX_non-Hop mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation.

7.8.3 Test Setup Diagram



7.8.4 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.

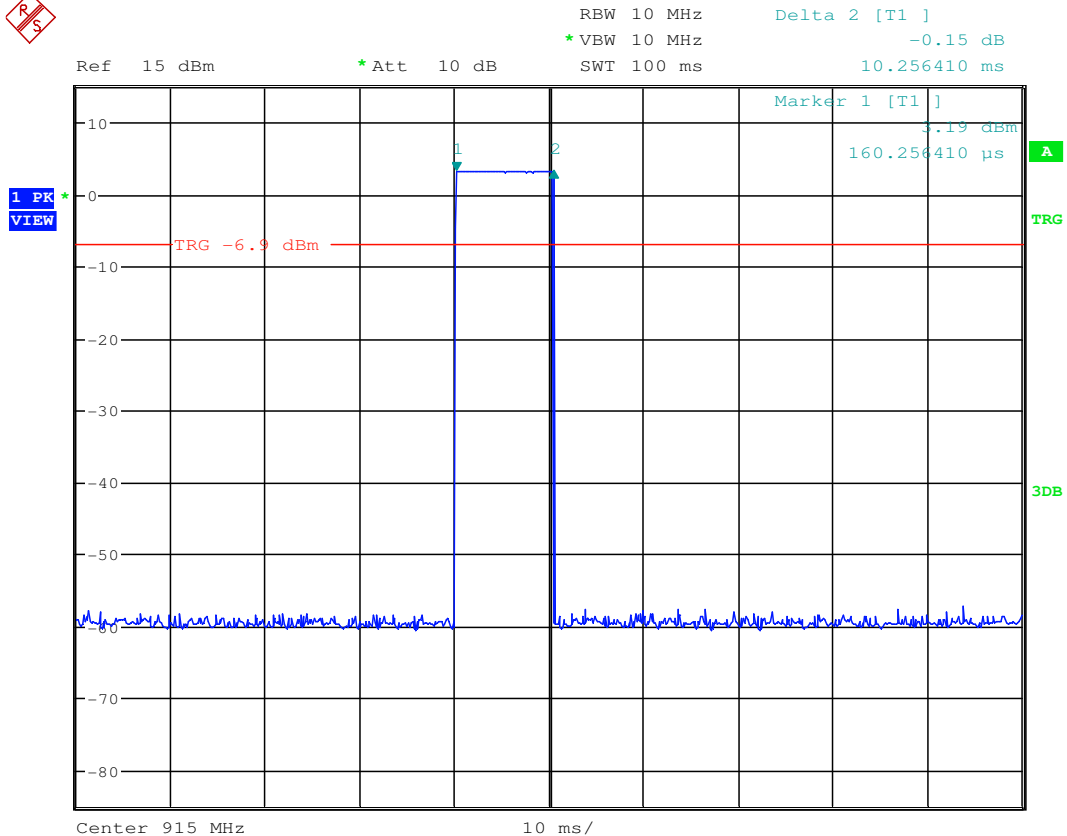
Remark:

1. Level= Read Level+ Cable Loss+ Antenna Factor- Preamp Factor
2. Scan from 9kHz to 30MHz, the disturbance 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.
3. The disturbance below 1GHz was very low and the harmonics were the highest point could be found when testing, so only the above harmonics had been displayed.
4. Pretest the EUT at Jeweller antenna1 and Jeweller antenna2, found the Jeweller antenna1 which is worst case for FHSS mode, So, Only the worst test data is recorded in the report.



Duty Cycle:

On time(ms)	T(ms)	Duty Cycle(%)	Duty Factor
10.25641	100	0.1025641	-19.78



Note:

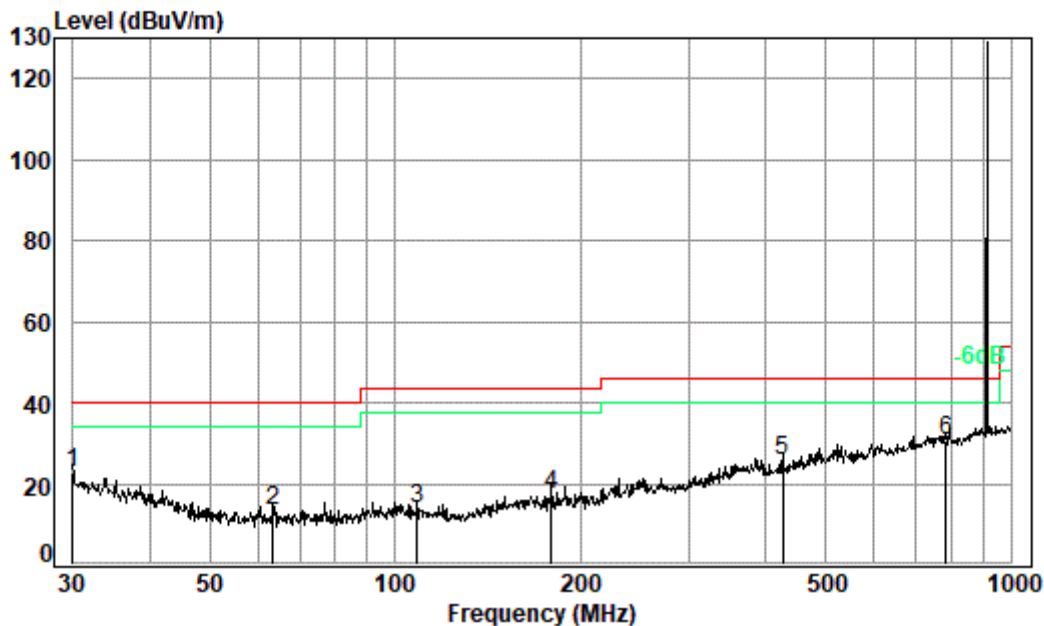
Average Level=Peak Level + Duty Factor

Duty Factor=20*log(Duty Cycle)

Duty Cycle=On Time/T



Test Mode: 08; Polarity: Horizontal; Modulation: GFSK; Channel: Low



Condition: 3m HORIZONTAL

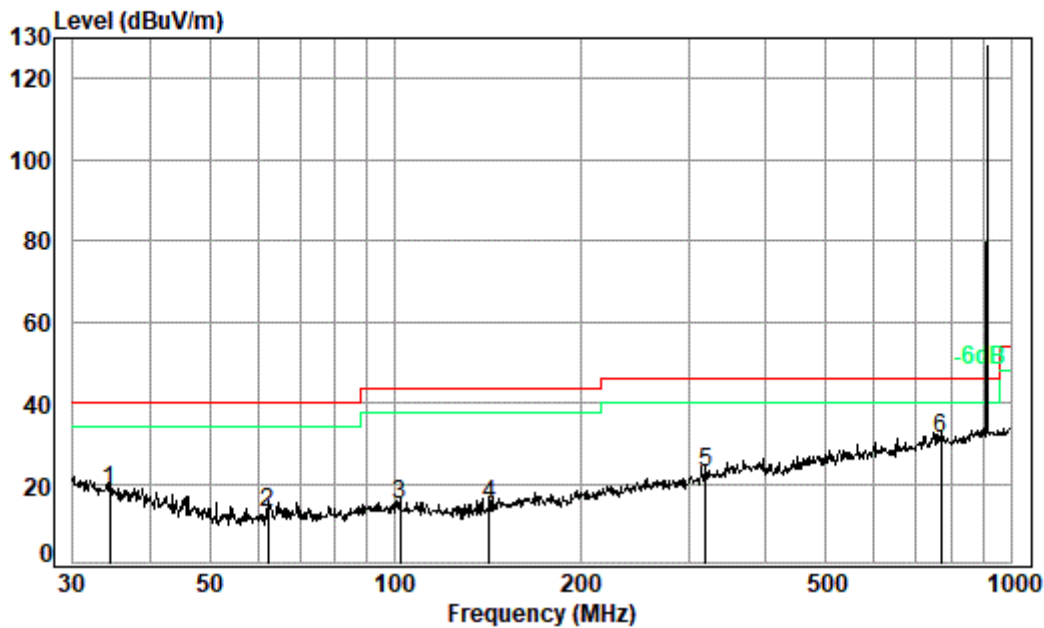
Job No. : 02030CR

Test Mode: 08

	Freq	Cable	Ant	Preamp	Read	Limit	Over	
	MHz	Loss	Factor	Factor	Level	Level	Line	Limit Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB
1	30.00	0.60	23.00	27.74	26.77	22.63	40.00	-17.37 QP
2	63.31	0.80	12.80	27.66	27.22	13.16	40.00	-26.84 QP
3	108.65	1.11	13.74	27.55	26.70	14.00	43.50	-29.50 QP
4	179.39	1.18	15.41	27.22	27.80	17.17	43.50	-26.33 QP
5	426.52	2.36	22.13	27.51	28.54	25.52	46.00	-20.48 QP
6 pp	785.09	3.24	28.00	27.76	26.97	30.45	46.00	-15.55 QP



Test Mode: 08; Polarity: Vertical; Modulation: GFSK; Channel: Low



Condition: 3m VERTICAL

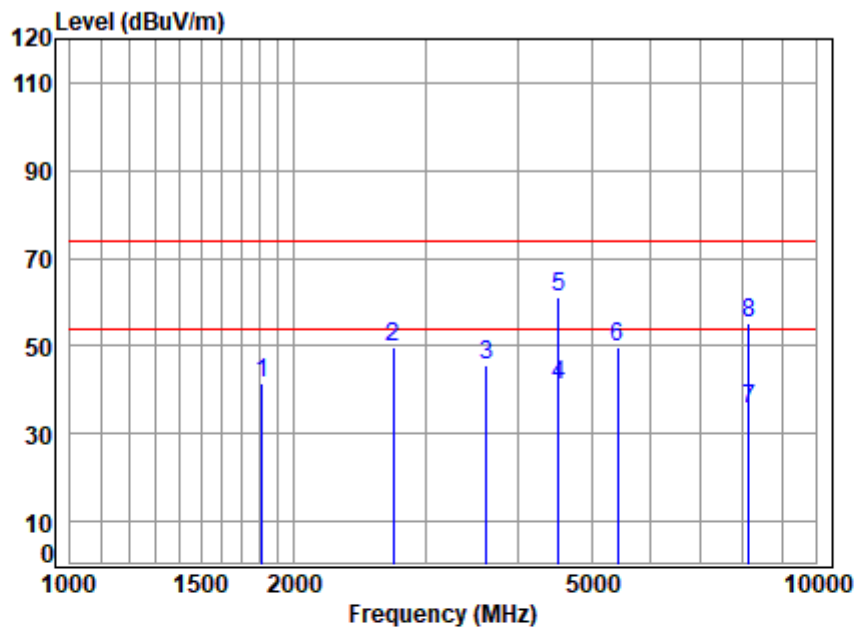
Job No. : 02030CR

Test Mode: 08

	Freq	Cable	Ant	Preamp	Read	Limit	Over	
	MHz	Loss	Factor	Factor	Level	Line	Limit	Remark
		dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB
1	34.40	0.65	20.66	27.72	24.68	18.27	40.00	-21.73 QP
2	62.21	0.80	12.97	27.66	26.57	12.68	40.00	-27.32 QP
3	102.00	1.10	13.94	27.60	27.61	15.05	43.50	-28.45 QP
4	142.32	1.15	13.71	27.37	27.39	14.88	43.50	-28.62 QP
5	319.94	2.07	19.80	26.99	27.82	22.70	46.00	-23.30 QP
6 pp	771.45	3.19	28.02	27.78	27.52	30.95	46.00	-15.05 QP



Test Mode: 08; Polarity: Horizontal; Modulation:GFSK; Channel:Low

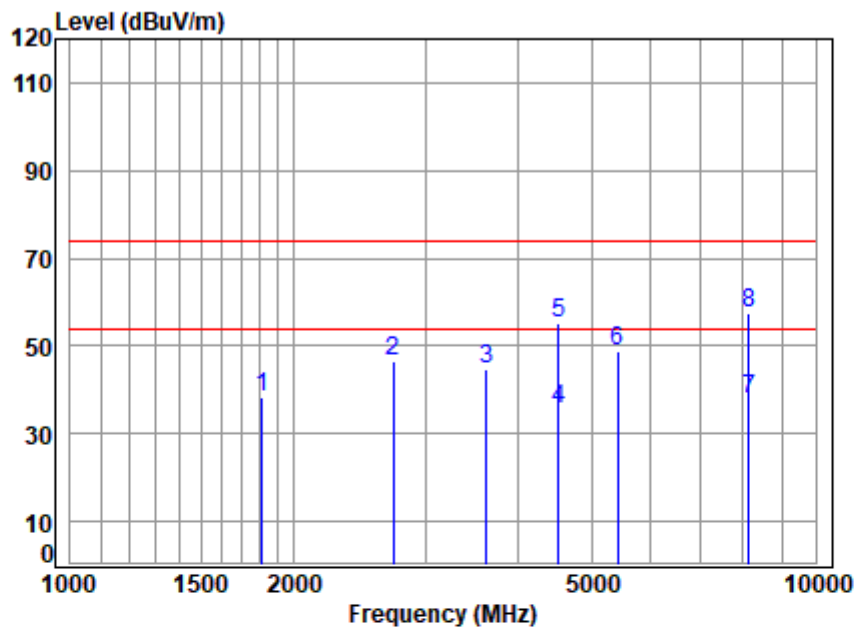


Site : chamber
Condition: 3m HORIZONTAL
Job No : 02030CR/02031CR
Mode : 905MHz TX SE
Note :

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1	1808.551	3.51	27.10	40.11	50.81	41.31	74.00	-32.69	Peak
2	2715.000	4.68	29.71	40.58	55.81	49.62	74.00	-24.38	Peak
3	3620.000	5.71	31.95	41.16	49.26	45.76	74.00	-28.24	Peak
4	4525.000	6.78	33.63	41.89	42.66	41.18	54.00	-12.82	Average
5	4525.000	6.78	33.63	41.89	62.44	60.96	74.00	-13.04	Peak
6	5430.000	8.05	34.54	42.34	49.66	49.91	74.00	-24.09	Peak
7	8145.000	9.63	36.79	40.49	29.55	35.48	54.00	-18.52	Average
8	8145.000	9.63	36.79	40.49	49.33	55.26	74.00	-18.74	Peak



Test Mode: 08; Polarity: Vertical; Modulation:GFSK; Channel:Low

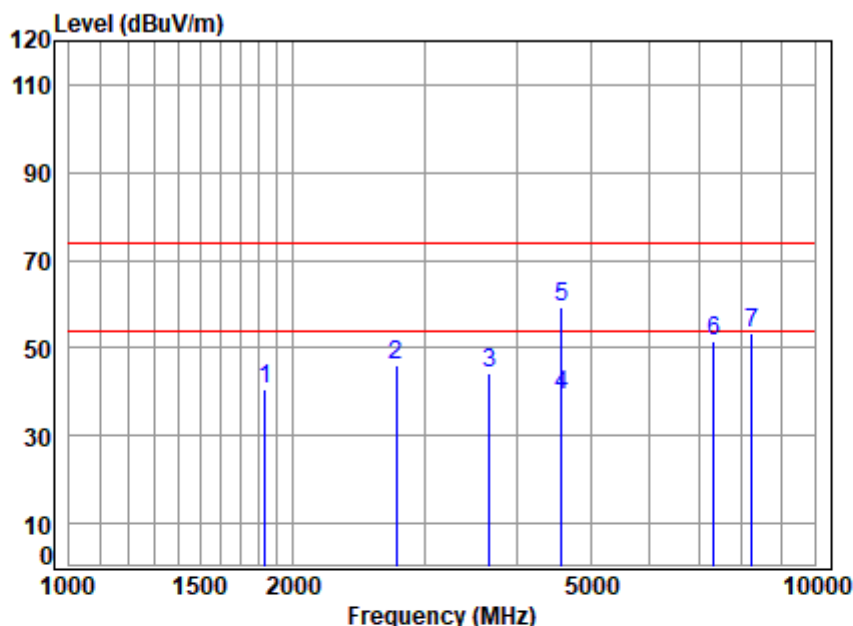


Site : chamber
Condition: 3m VERTICAL
Job No : 02030CR/02031CR
Mode : 905MHz TX SE
Note :

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB		dB/m	dB	dBuV	dBuV/m	dBuV/m	dB
1	1810.000	3.51	27.10	40.11	47.71	38.21	74.00	-35.79	Peak
2	2715.000	4.68	29.71	40.58	52.73	46.54	74.00	-27.46	Peak
3	3620.000	5.71	31.95	41.16	48.30	44.80	74.00	-29.20	Peak
4	4525.000	6.78	33.63	41.89	37.01	35.53	54.00	-18.47	Average
5	4525.000	6.78	33.63	41.89	56.79	55.31	74.00	-18.69	Peak
6	5430.000	8.05	34.54	42.34	48.68	48.93	74.00	-25.07	Peak
7	8145.000	9.63	36.79	40.49	31.84	37.77	54.00	-16.23	Average
8	8145.000	9.63	36.79	40.49	51.62	57.55	74.00	-16.45	Peak



Test Mode: 08; Polarity: Horizontal; Modulation:GFSK; Channel:Middle

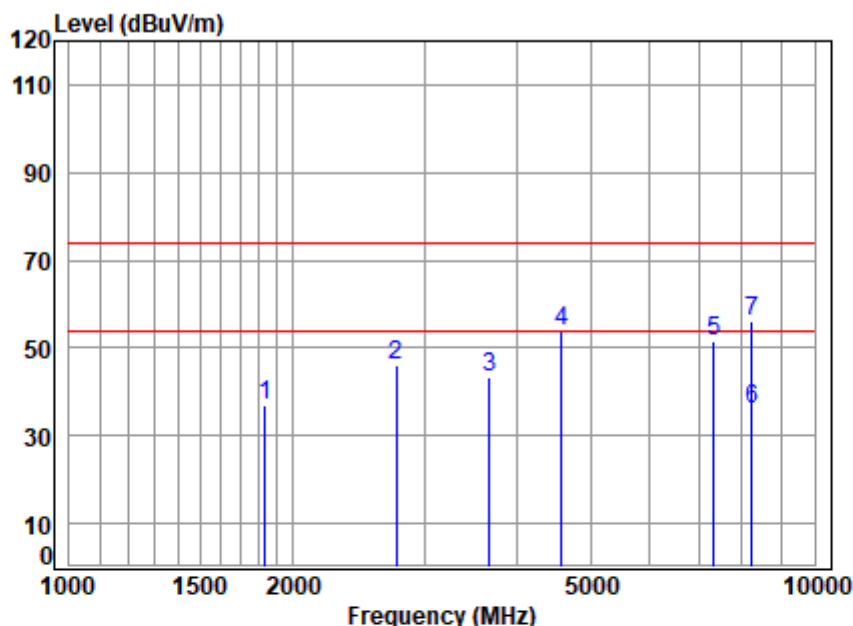


Site : chamber
Condition: 3m HORIZONTAL
Job No : 02030CR/02031CR
Mode : 915.85MHz TX SE
Note :

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1	1831.700	3.53	27.18	40.12	50.00	40.59	74.00	-33.41	Peak
2	2747.550	4.70	29.85	40.59	52.31	46.27	74.00	-27.73	Peak
3	3663.400	5.78	32.04	41.18	47.68	44.32	74.00	-29.68	Peak
4	4579.250	6.84	33.69	41.94	40.84	39.43	54.00	-14.57	Average
5	4579.250	6.84	33.69	41.94	60.62	59.21	74.00	-14.79	Peak
6	7326.800	8.85	36.16	41.39	48.08	51.70	74.00	-22.30	Peak
7	8242.650	9.76	36.85	40.29	47.02	53.34	74.00	-20.66	Peak



Test Mode: 08; Polarity: Vertical; Modulation: GFSK; Channel: Middle

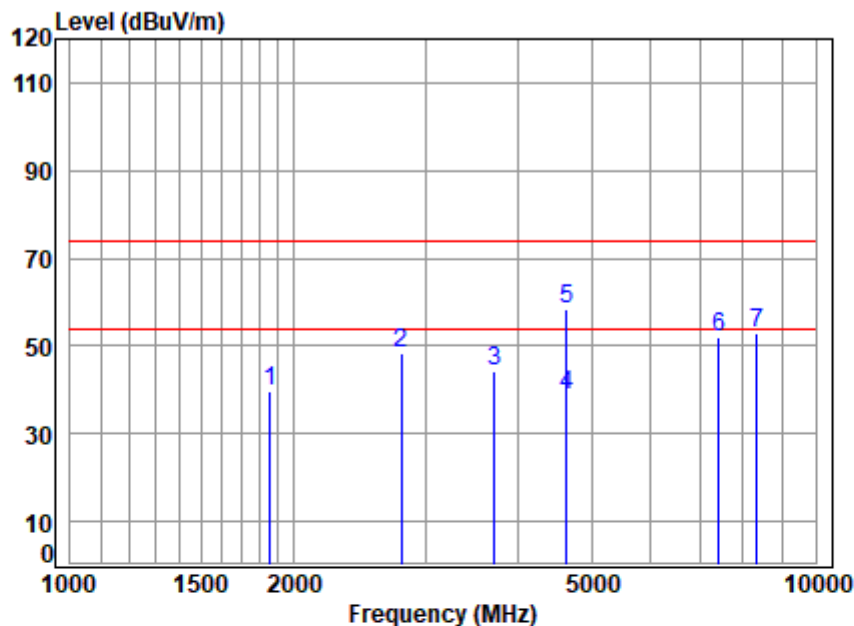


Site : chamber
Condition: 3m VERTICAL
Job No : 02030CR/02031CR
Mode : 915.85MHz TX SE
Note :

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1	1831.700	3.53	27.18	40.12	46.50	37.09	74.00	-36.91	Peak
2	2747.550	4.70	29.85	40.59	52.05	46.01	74.00	-27.99	Peak
3	3663.400	5.78	32.04	41.18	46.64	43.28	74.00	-30.72	Peak
4	4579.250	6.84	33.69	41.94	55.08	53.67	74.00	-20.33	Peak
5	7326.800	8.85	36.16	41.39	47.87	51.49	74.00	-22.51	Peak
6	8242.650	9.76	36.85	40.29	29.87	36.19	54.00	-17.81	Average
7	8242.650	9.76	36.85	40.29	49.65	55.97	74.00	-18.03	Peak



Test Mode: 08; Polarity: Horizontal; Modulation:GFSK; Channel:High

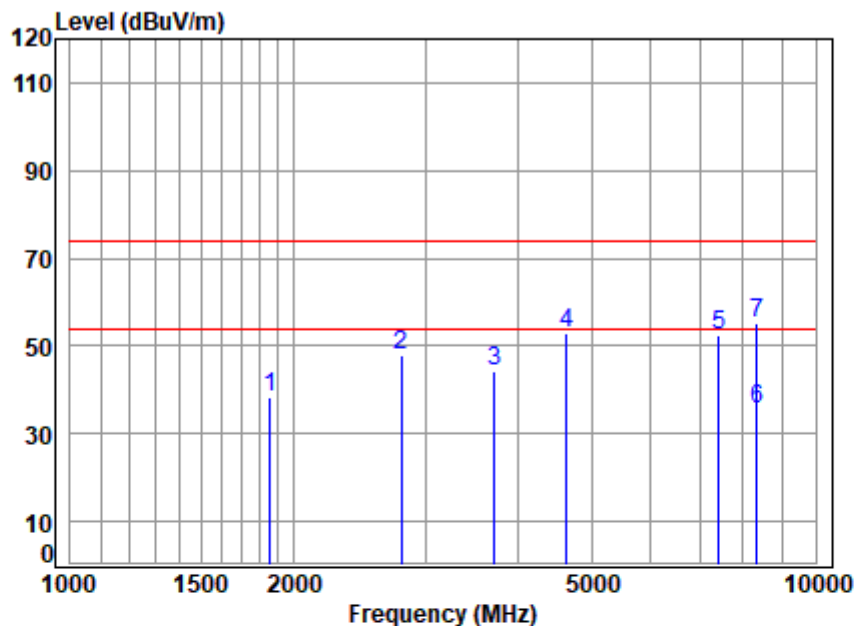


Site : chamber
Condition: 3m HORIZONTAL
Job No : 02030CR/02031CR
Mode : 926.5MHz TX SE
Note :

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1	1853.000	3.54	27.26	40.13	49.21	39.88	74.00	-34.12	Peak
2	2779.500	4.72	29.99	40.61	54.13	48.23	74.00	-25.77	Peak
3	3706.000	5.84	32.12	41.21	47.44	44.19	74.00	-29.81	Peak
4	4632.500	6.90	33.76	41.99	39.99	38.66	54.00	-15.34	Average
5	4632.500	6.90	33.76	41.99	59.77	58.44	74.00	-15.56	Peak
6	7412.000	8.93	36.23	41.32	48.13	51.97	74.00	-22.03	Peak
7	8338.500	9.89	36.91	40.10	46.12	52.82	74.00	-21.18	Peak



Test Mode: 08; Polarity: Vertical; Modulation: GFSK; Channel: High



Site : chamber
Condition: 3m VERTICAL
Job No : 02030CR/02031CR
Mode : 926.5MHz TX SE
Note :

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1	1853.000	3.54	27.26	40.13	47.45	38.12	74.00	-35.88	Peak
2	2782.060	4.72	29.99	40.61	53.81	47.91	74.00	-26.09	Peak
3	3706.000	5.84	32.12	41.21	47.69	44.44	74.00	-29.56	Peak
4	4626.946	6.90	33.76	41.99	54.40	53.07	74.00	-20.93	Peak
5	7412.000	8.93	36.23	41.32	48.48	52.32	74.00	-21.68	Peak
6	8338.500	9.89	36.91	40.10	28.94	35.64	54.00	-18.36	Average
7	8338.500	9.89	36.91	40.10	48.72	55.42	74.00	-18.58	Peak



8 Emission Test Results

8.1 Conducted Emissions at AC Power Line (150kHz-30MHz)

Test Requirement: 47 CFR Part 15, Subpart C 15.247 & 15.207

Test Method: ANSI C63.10 (2013) Section 6.2

Limit:

Frequency of emission(MHz)	Conducted limit(dBμV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

Detector: Peak for pre-scan (9kHz resolution bandwidth) 0.15M to 30MHz

8.1.1 E.U.T. Operation

Operating Environment:

Temperature: 25 °C

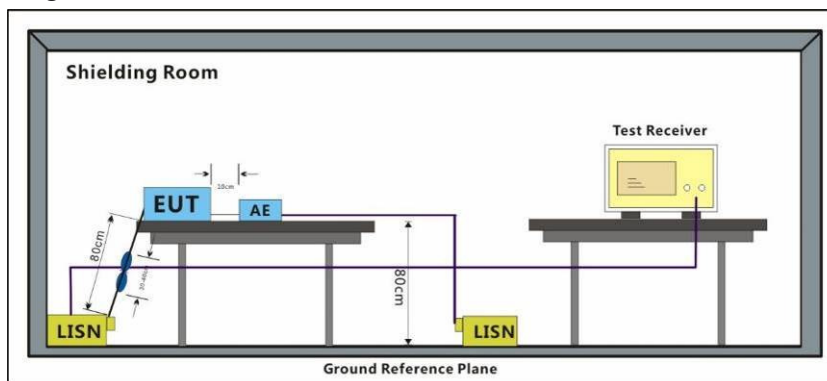
Humidity: 54 % RH

Atmospheric Pressure: 1010 mbar

8.1.2 Test Mode Description

Pre-scan / Final test	Mode Code	Description
Final test	08	Charge + TX_non-Hop mode_Keep the EUT in charging and continuously transmitting mode with GFSK modulation.

8.1.3 Test Setup Diagram



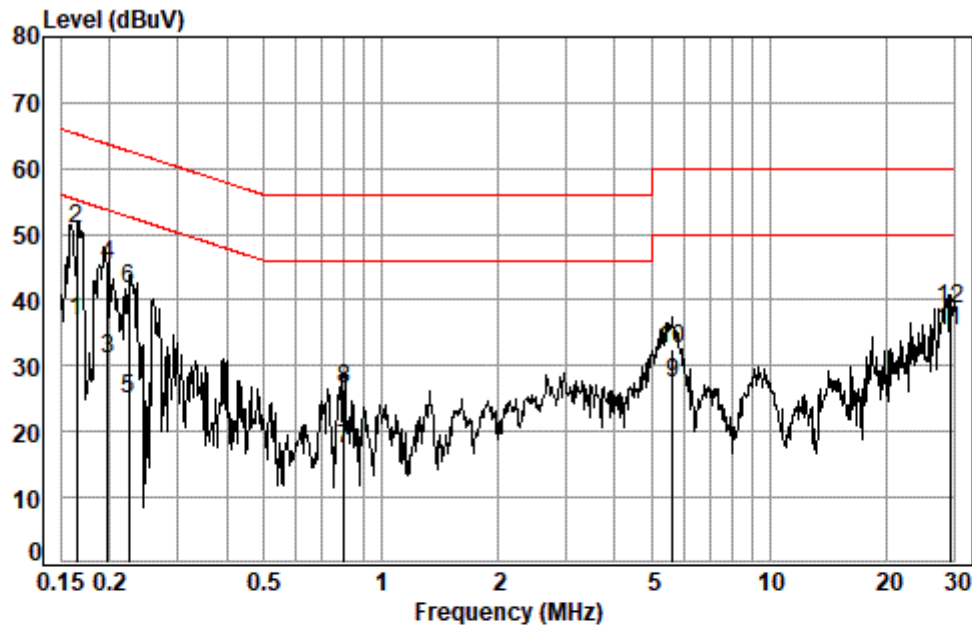
8.1.4 Measurement Procedure and Data

- 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 50ohm/50μH + 5ohm 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.

Remark: LISN=Read Level+ Cable Loss+ LISN Factor



Test Mode: 08; Line: Live Line

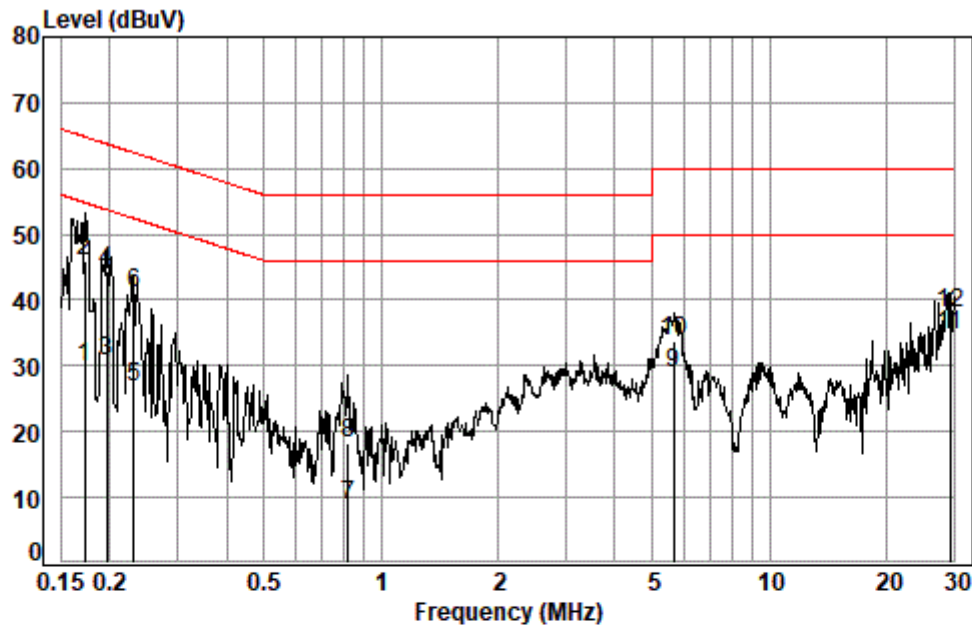


Site : Shielding Room
Condition: Line
Job No. : 02030CR
Test mode: 08

	Freq	Cable Loss	LISN Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB	dBuV	dBuV	dBuV	dB	
1	0.1650	0.03	9.63	27.07	36.73	55.21	-18.48	Average
2	0.1650	0.03	9.63	41.18	50.84	65.21	-14.37	QP
3	0.1976	0.04	9.64	21.37	31.05	53.71	-22.66	Average
4	0.1976	0.04	9.64	35.49	45.17	63.71	-18.54	QP
5	0.2244	0.04	9.65	15.13	24.82	52.66	-27.84	Average
6	0.2244	0.04	9.65	32.07	41.76	62.66	-20.90	QP
7	0.8045	0.09	9.68	7.52	17.29	46.00	-28.71	Average
8	0.8045	0.09	9.68	16.73	26.50	56.00	-29.50	QP
9	5.6234	0.16	9.79	17.47	27.42	50.00	-22.58	Average
10	5.6234	0.16	9.79	22.50	32.45	60.00	-27.55	QP
11	29.2387	0.21	10.01	25.03	35.25	50.00	-14.75	Average
12	29.2387	0.21	10.01	28.50	38.72	60.00	-21.28	QP



Test Mode: 08; Line: Neutral Line



Site : Shielding Room
Condition: Neutral
Job No. : 02030CR
Test mode: 08

	Freq	Cable Loss	LISN Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB	dBuV	dBuV	dBuV	dB	
1	0.1722	0.03	9.63	20.05	29.71	54.86	-25.15	Average
2	0.1722	0.03	9.63	36.29	45.95	64.86	-18.91	QP
3	0.1965	0.04	9.63	21.09	30.76	53.76	-23.00	Average
4	0.1965	0.04	9.63	34.83	44.50	63.76	-19.26	QP
5	0.2304	0.04	9.64	17.20	26.88	52.44	-25.56	Average
6	0.2304	0.04	9.64	31.40	41.08	62.44	-21.36	QP
7	0.8217	0.09	9.67	-0.99	8.77	46.00	-37.23	Average
8	0.8217	0.09	9.67	8.40	18.16	56.00	-37.84	QP
9	5.6532	0.16	9.79	18.88	28.83	50.00	-21.17	Average
10	5.6532	0.16	9.79	23.71	33.66	60.00	-26.34	QP
11	29.2387	0.21	10.10	24.41	34.72	50.00	-15.28	Average
12	29.2387	0.21	10.10	27.64	37.95	60.00	-22.05	QP



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SGS-CSTC Standards Technical Services Co., Ltd.
Shenzhen Branch

No.1 Workshop, M-10, Middle Section, Science & Technology Park, Shenzhen, China 518057 t (86-755) 26012053 f (86-755) 26710594 www.sgs.com.cn
中国·深圳·科技园中区M-10栋一号厂房 邮编: 518057 t (86-755) 26012053 f (86-755) 26710594 sgs.china@sgs.com

9 Test Setup Photo

Refer to Setup Photos

10 EUT Constructional Details (EUT Photos)

Refer to external and internal photos for SZEM2102002030CR



11 Appendix for 15.247

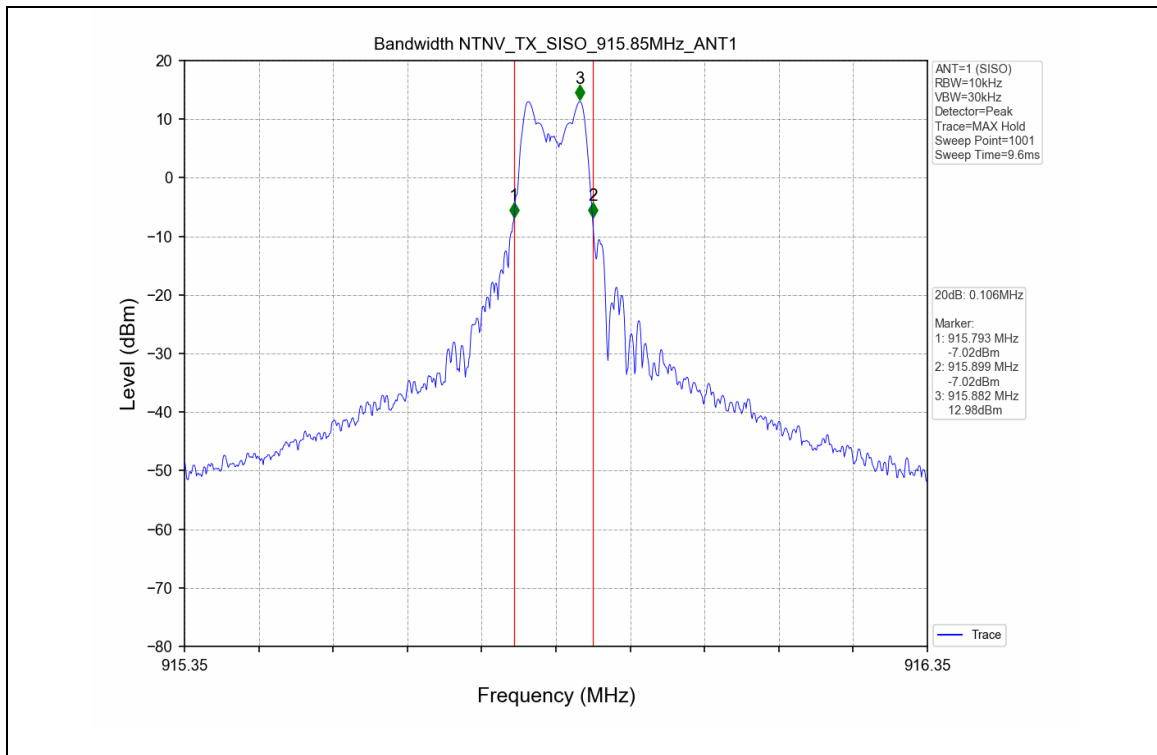
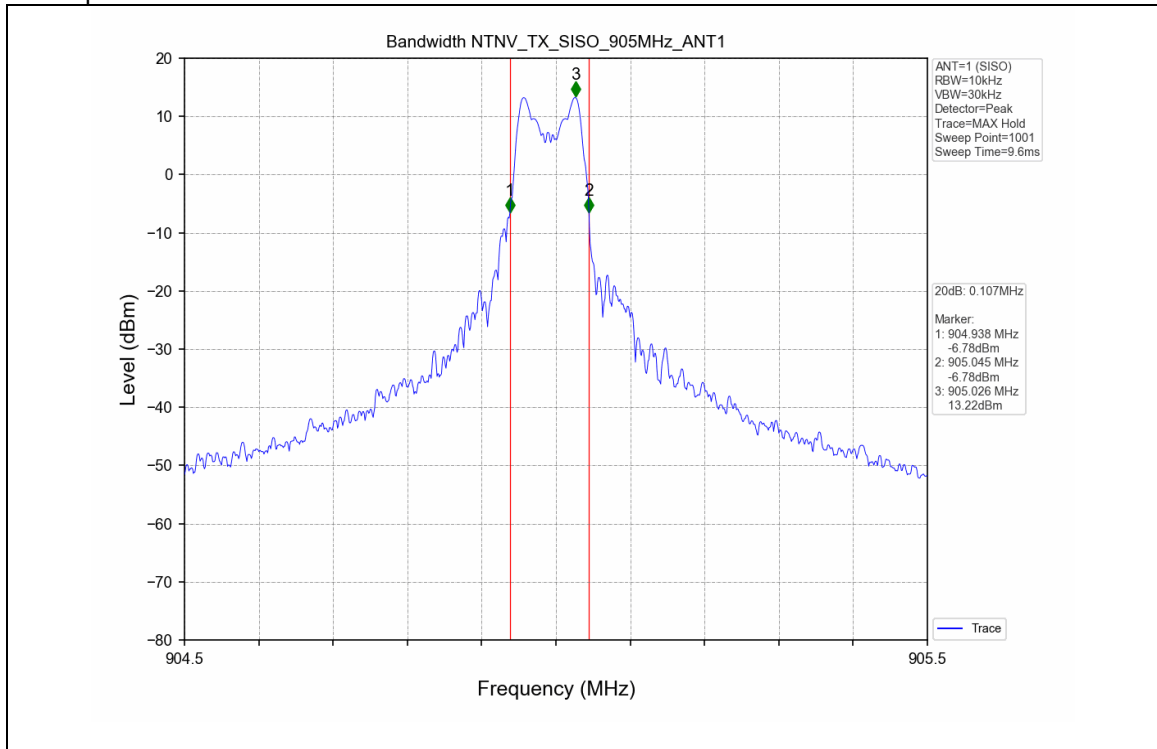
1. Bandwidth

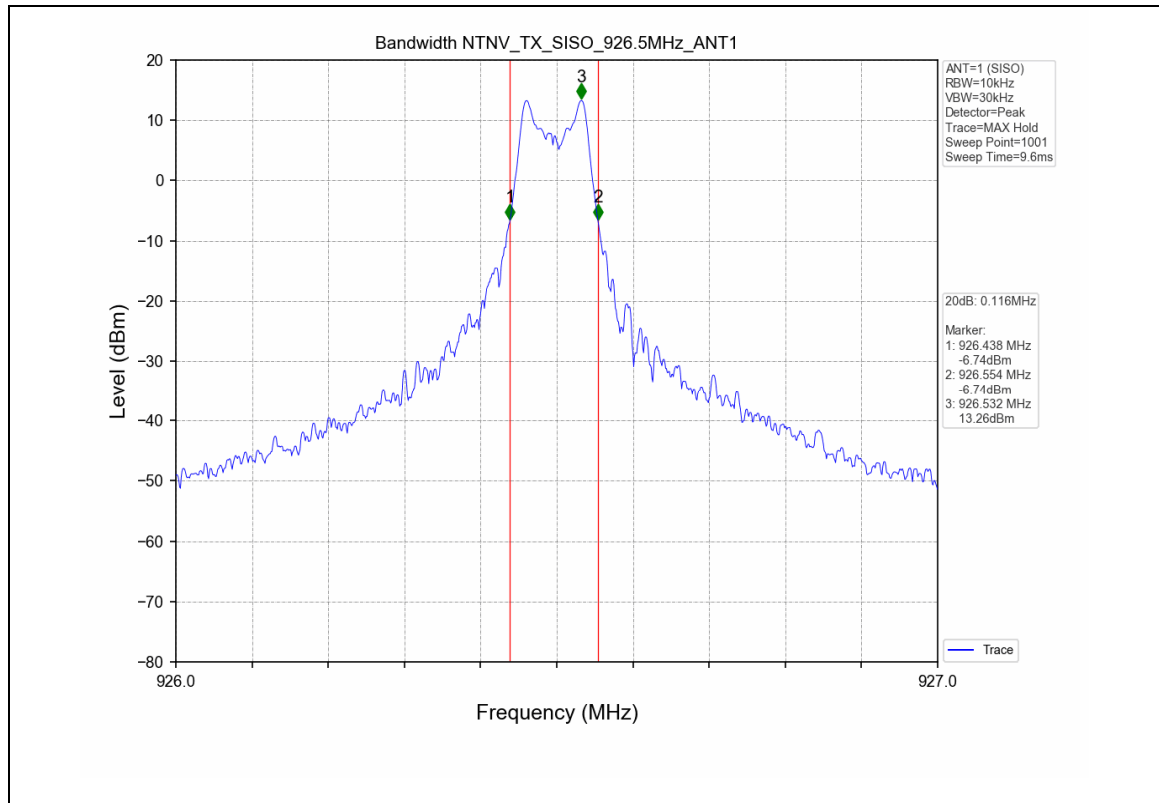
1.1 Test Result

Test Mode	Frequency (MHz)	TX Type	ANT No.	20dB Bandwidth	Limit (KHz)	Verdict
				Test Result (MHz)		
TX	905	SISO	1	0.107	≤250	PASS
	915.85	SISO	1	0.106	≤250	PASS
	926.5	SISO	1	0.116	≤250	PASS

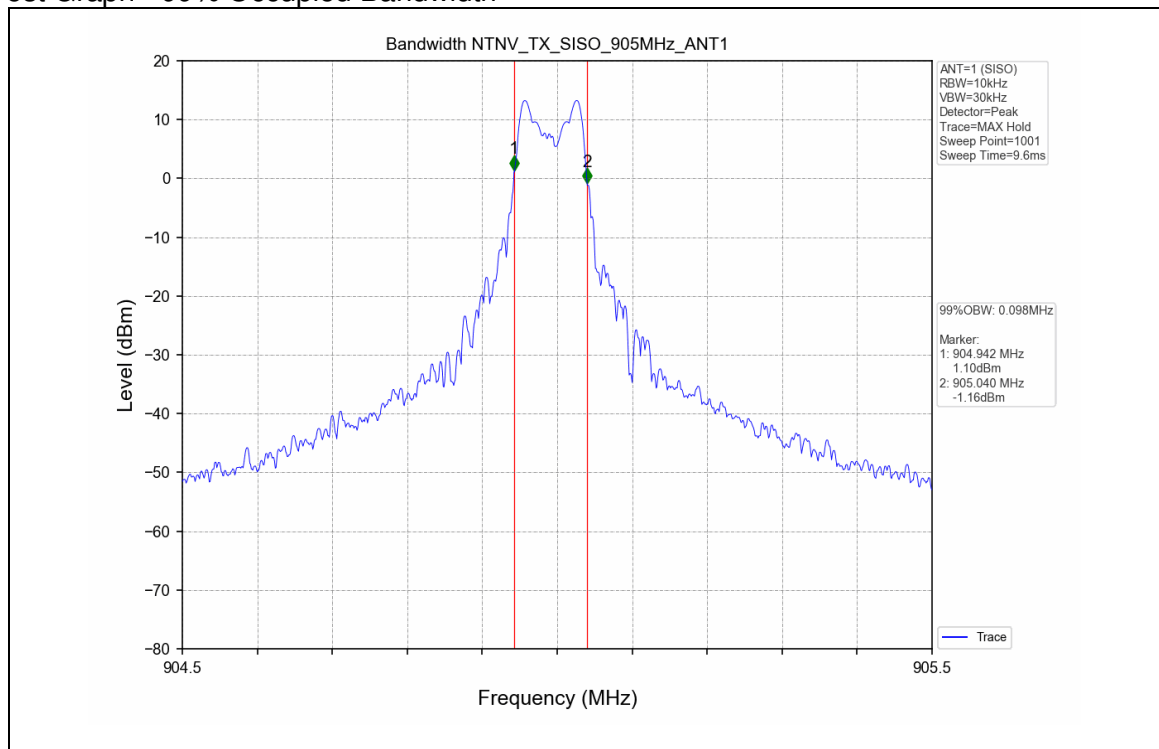
Test Mode	Frequency (MHz)	TX Type	ANT No.	99% Occupied Bandwidth	
				Test Result (MHz)	
TX	905	SISO	1	0.098	Only for Report Use
	915.85	SISO	1	0.096	Only for Report Use
	926.5	SISO	1	0.103	Only for Report Use

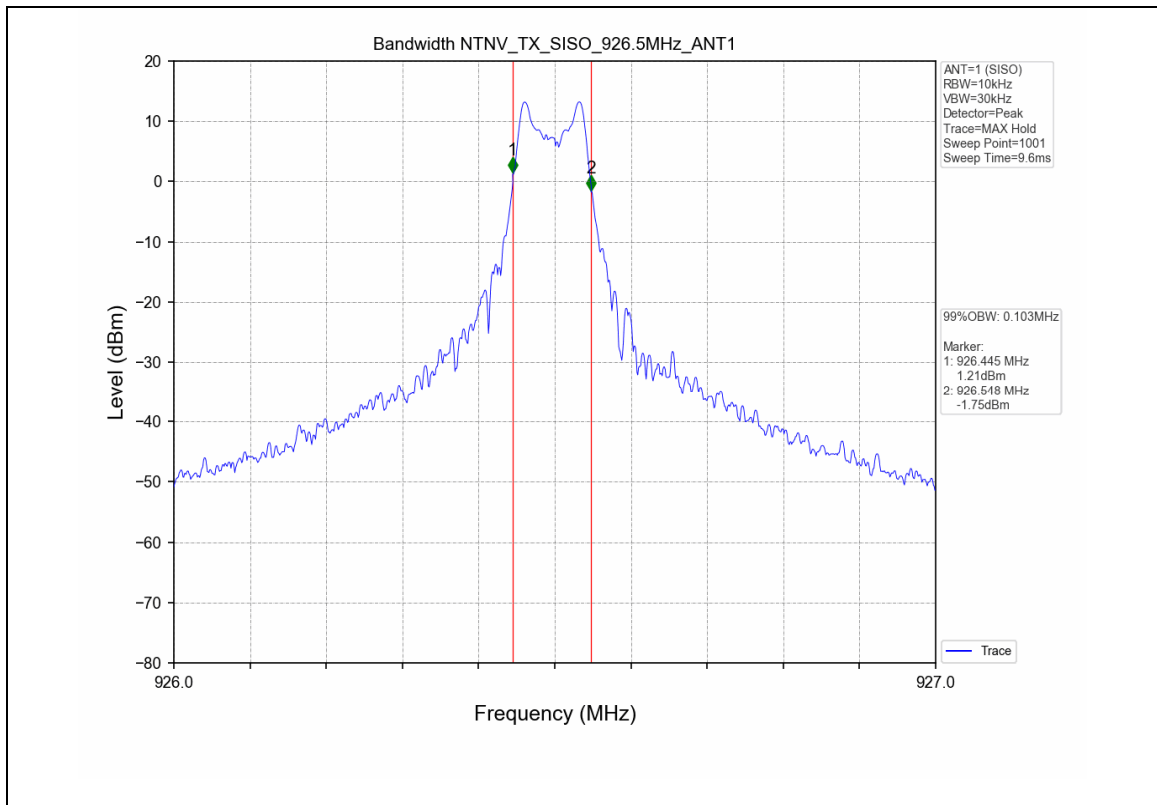
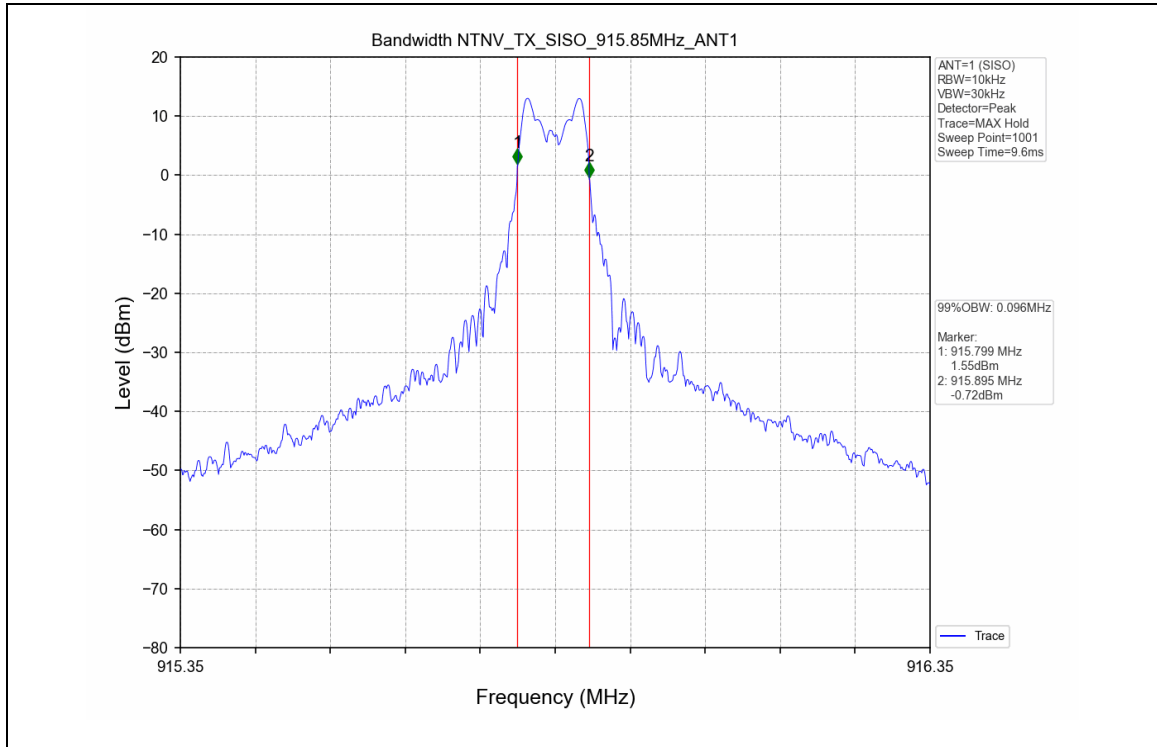
1.2 Test Graph - 20dB Bandwidth





1.3 Test Graph - 99% Occupied Bandwidth



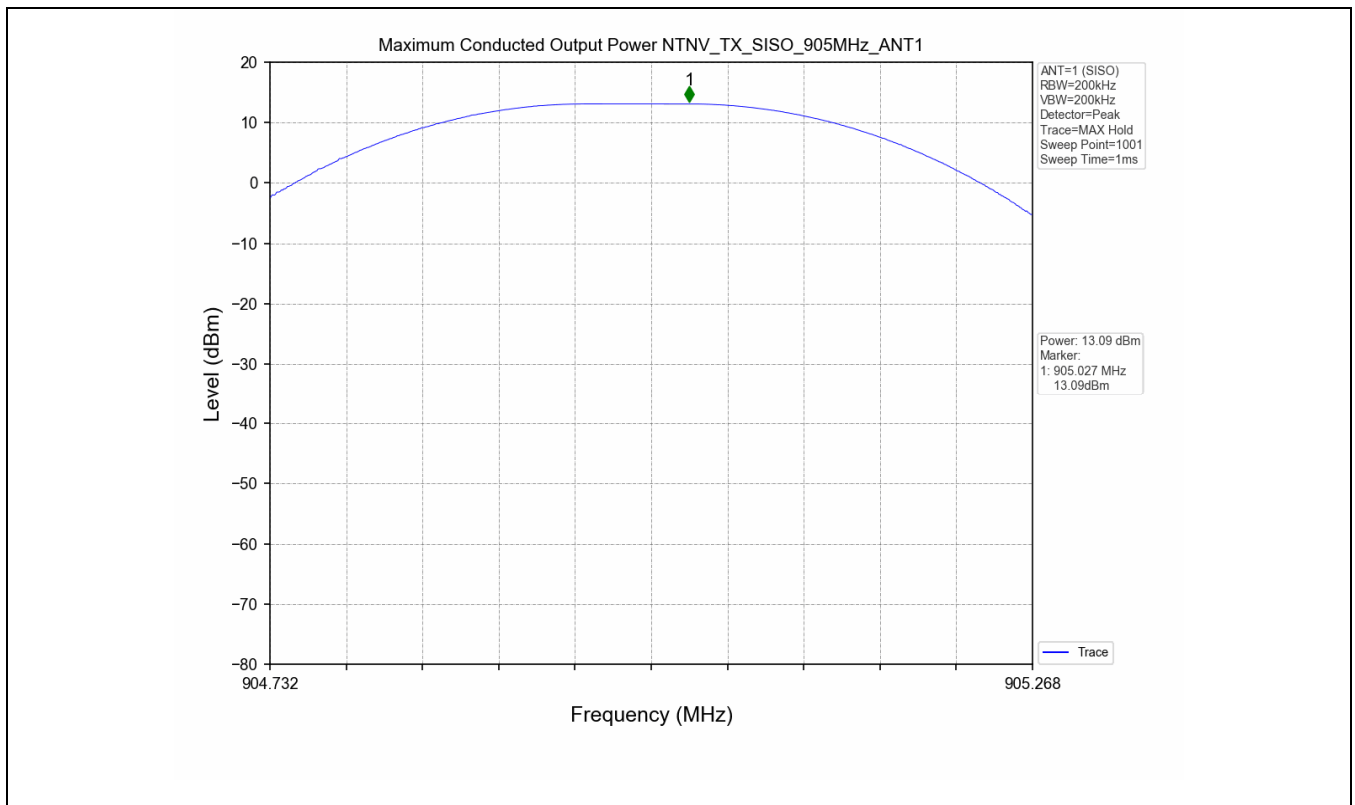


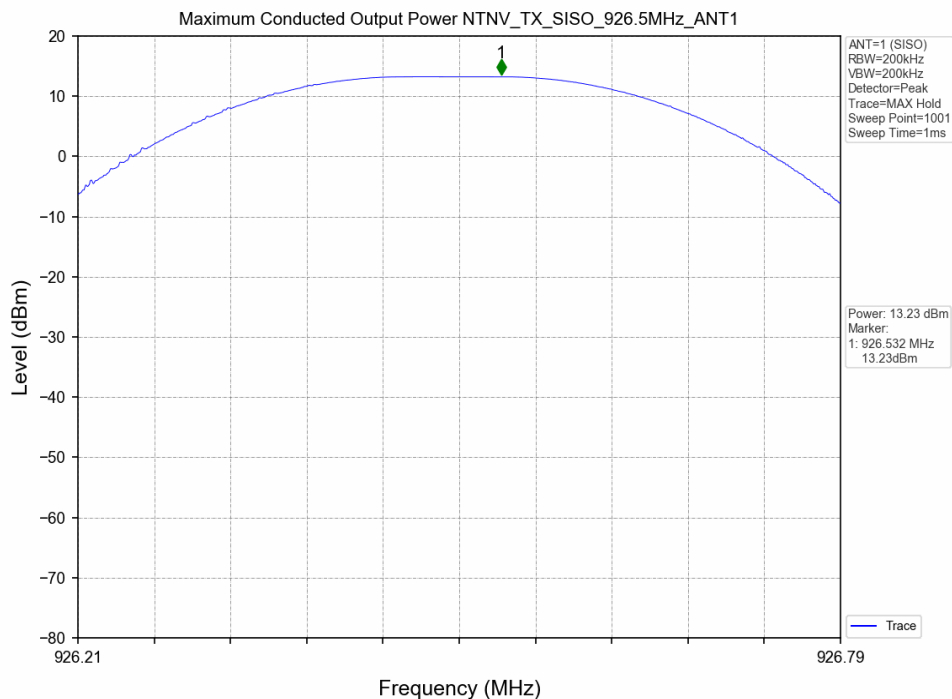
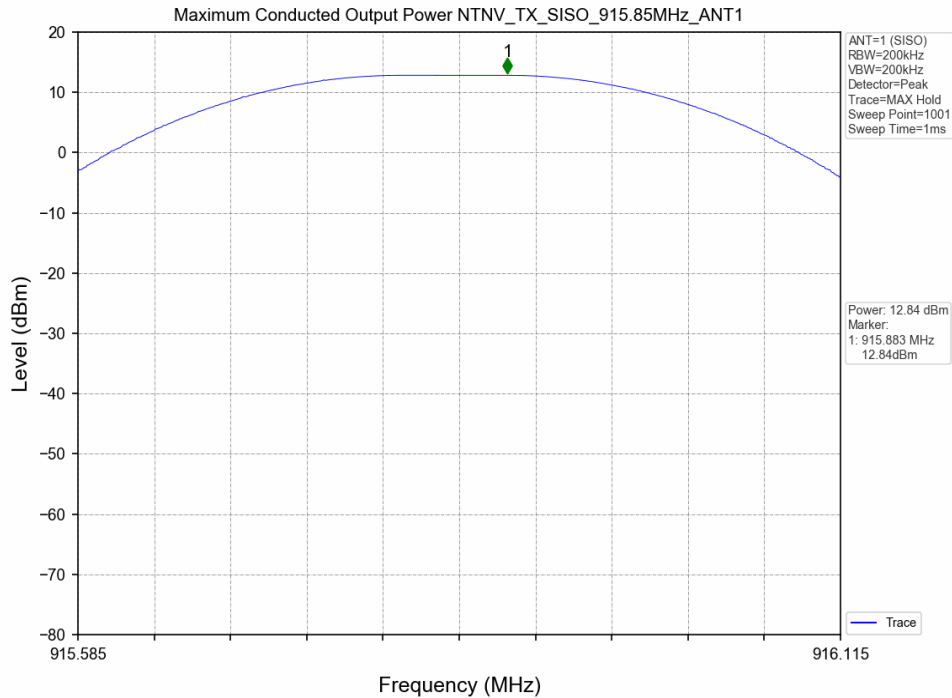
2. Maximum Conducted Output Power

2.1 Test Result

Test Mode	Frequency (MHz)	Tx Type	Measured Peak Output Power (dBm)	Limits (dBm)	Verdict
			Ant 1		
TX	905	SISO	13.09	30	PASS
	915.85	SISO	12.84	30	PASS
	926.5	SISO	13.23	30	PASS

2.2 Test Graph



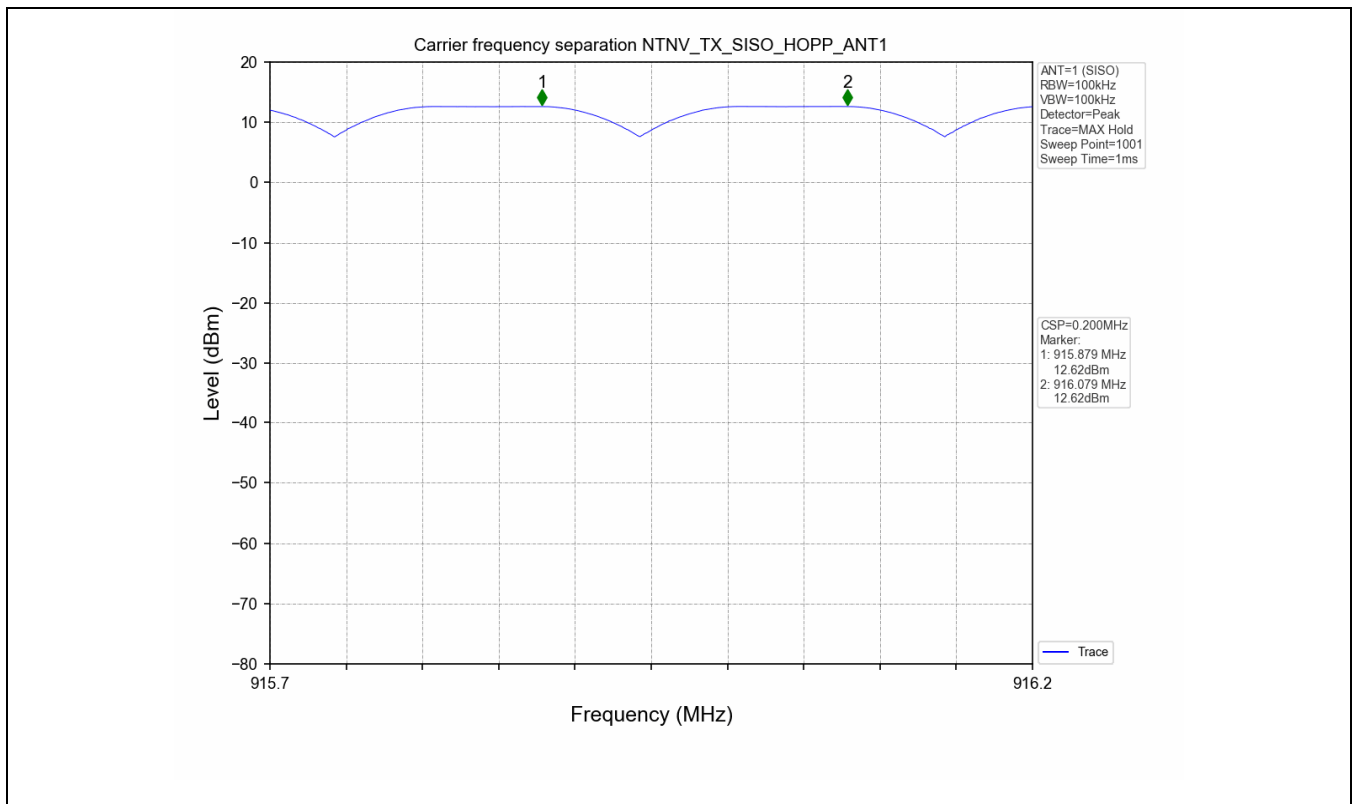


3. Carrier frequency separation

3.1 Test Result

Test Mode	TX Type	ANT No.	Channel Separation (MHz)	Limits (MHz)	Verdict
TX	SISO	1	0.200	≥0.106	PASS

3.2 Test Graph

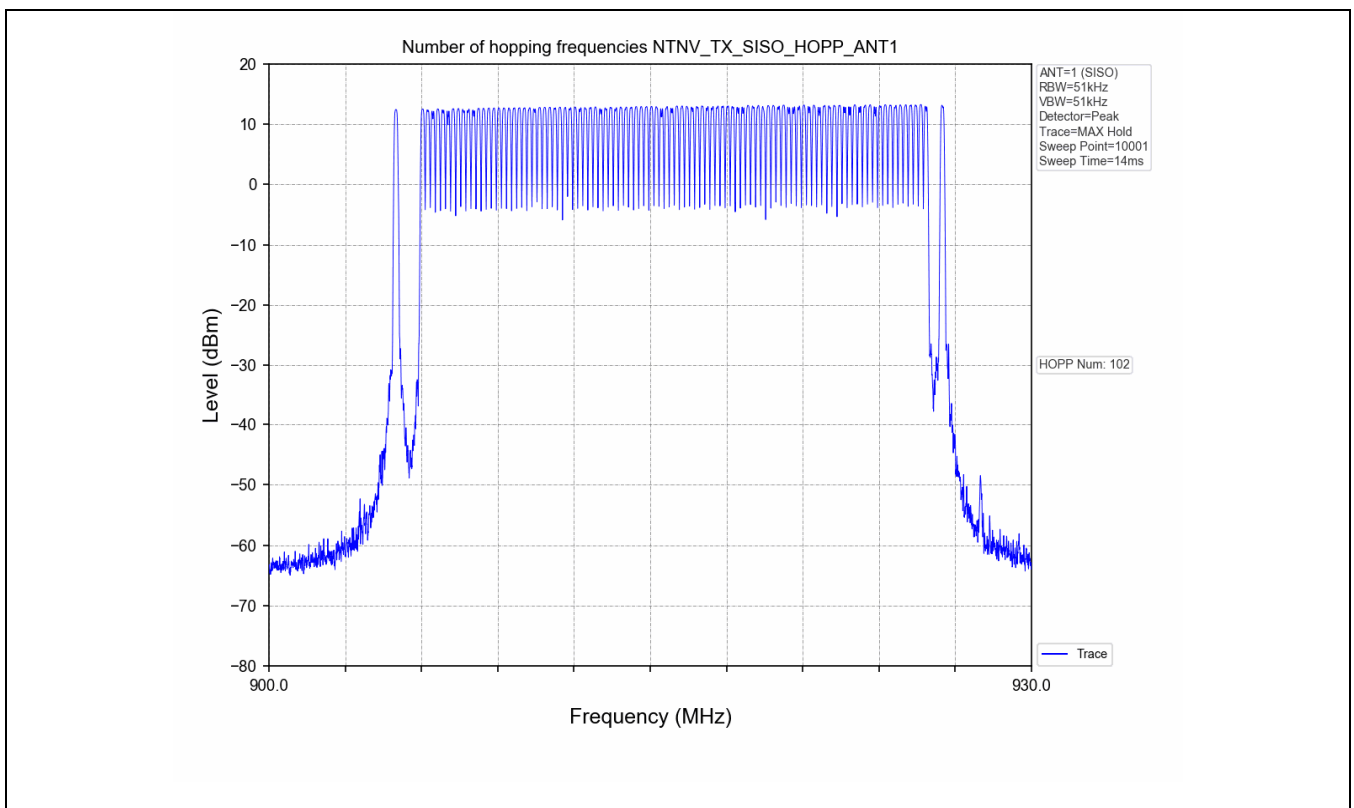


4. Number of hopping frequencies

4.1 Test Result

Test Mode	TX Type	ANT No.	Num of Hopping Frequencies	Limits	Verdict
TX	SISO	1	102	≥50	PASS

4.2 Test Graph



Note: The number of available frequency hopping channels of this device is 103, only 101 channels are used in normal operation and constantly involved, 2 is reserve in case of jamming.

5. Time of Occupancy (Dwell Time)

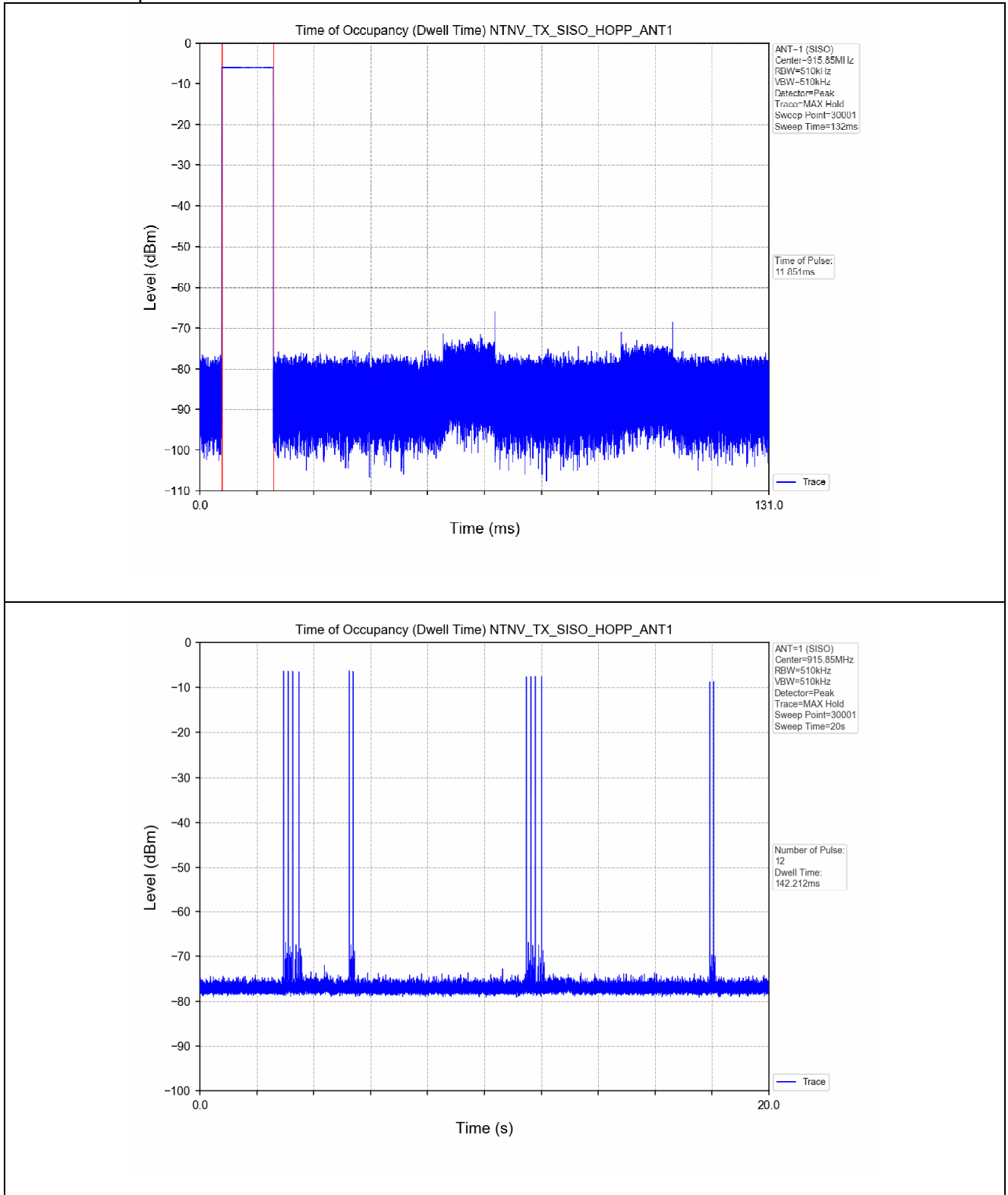
5.1 Test Result

Test Mode	Packet Type	TX Type	ANT No.	Duration of Single Pulse (ms)	Observation Period (s)	Num of Pulse in Observation Period	Dwell Time (ms)	Limits (ms)	Verdict
TX	NoPT	SISO	1	11.851	20	12	142.212	≤400	PASS

Dwell Time (ms)= Duration of Single Pulse (ms)* Num of Pulse in Observation Period



5.2 Test Graph



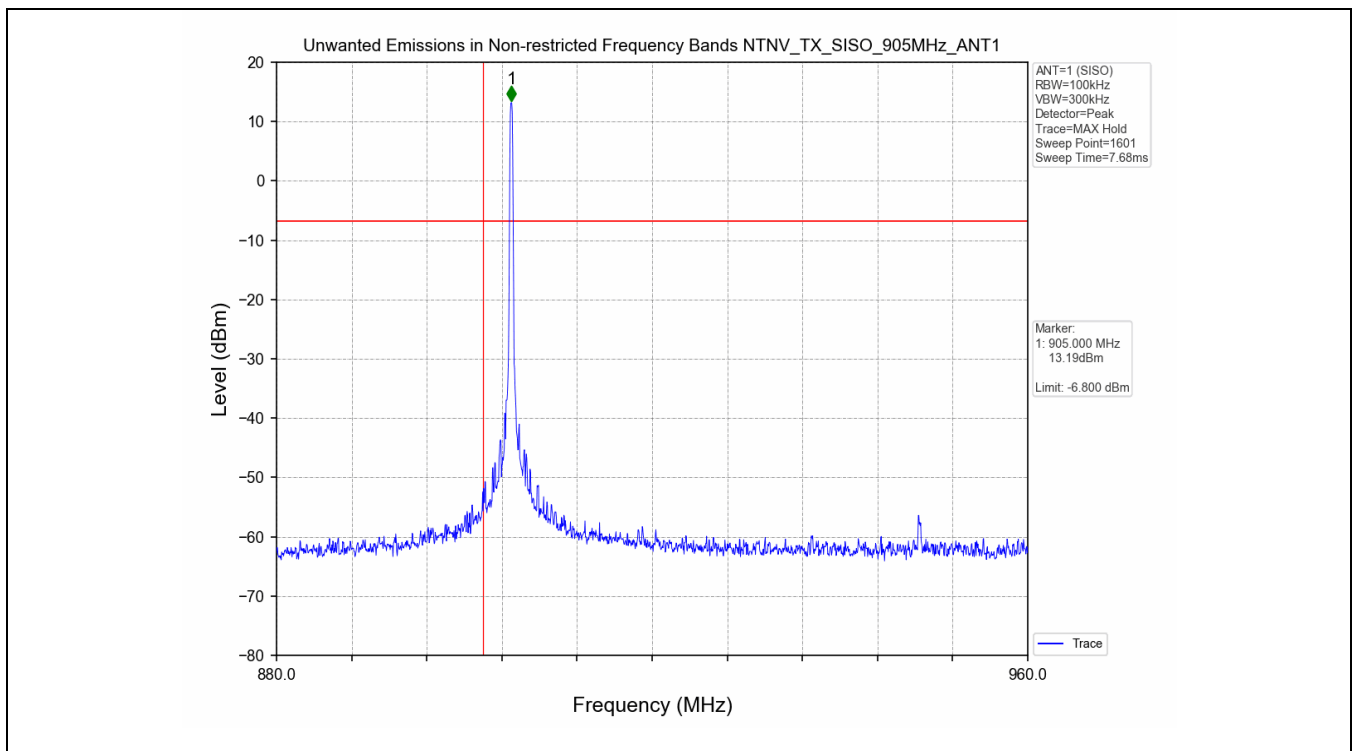
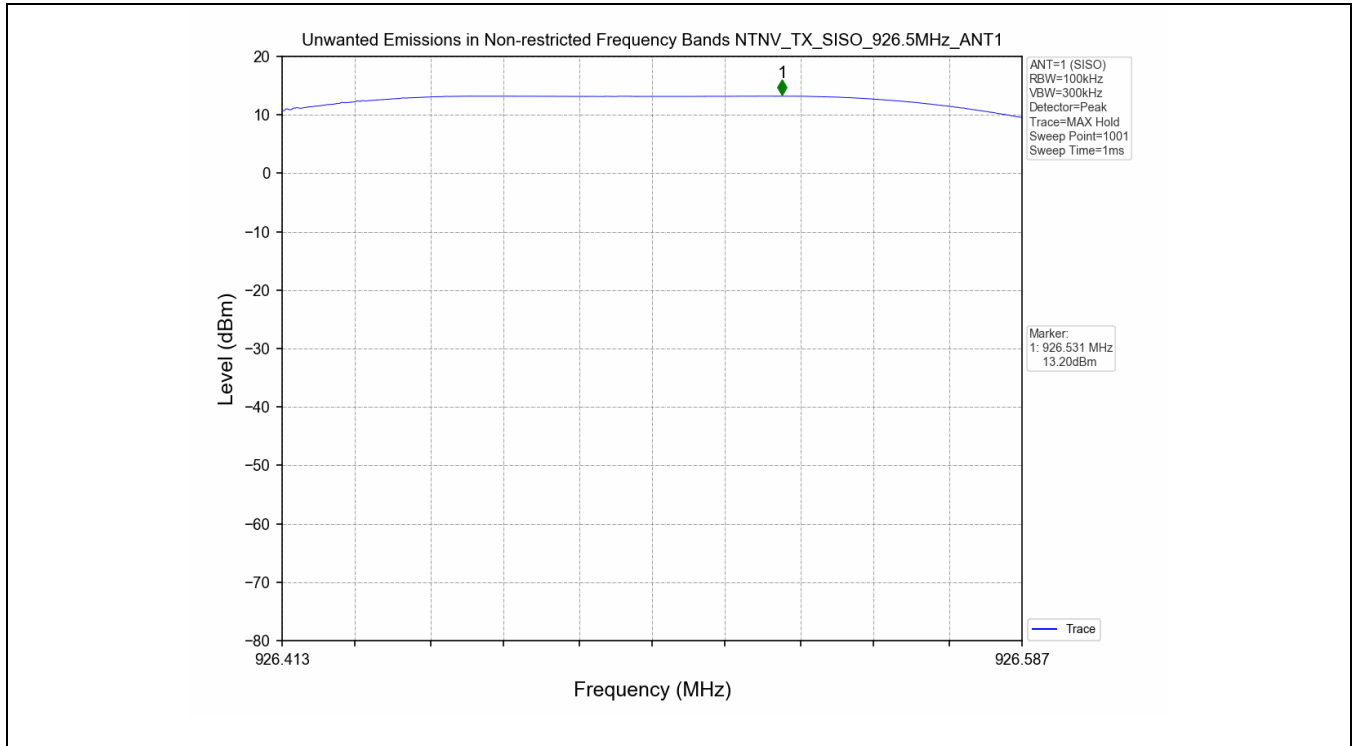
6. Unwanted Emissions in Non-restricted Frequency Bands

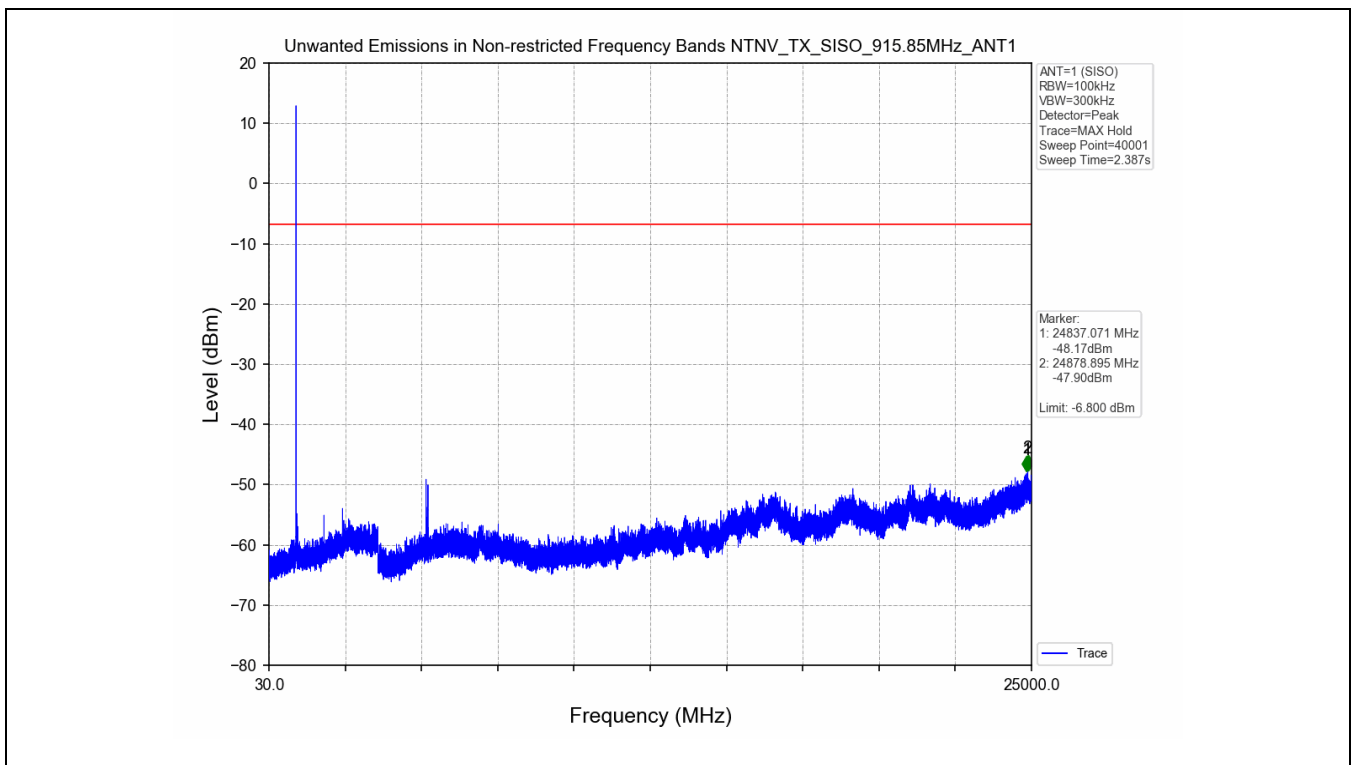
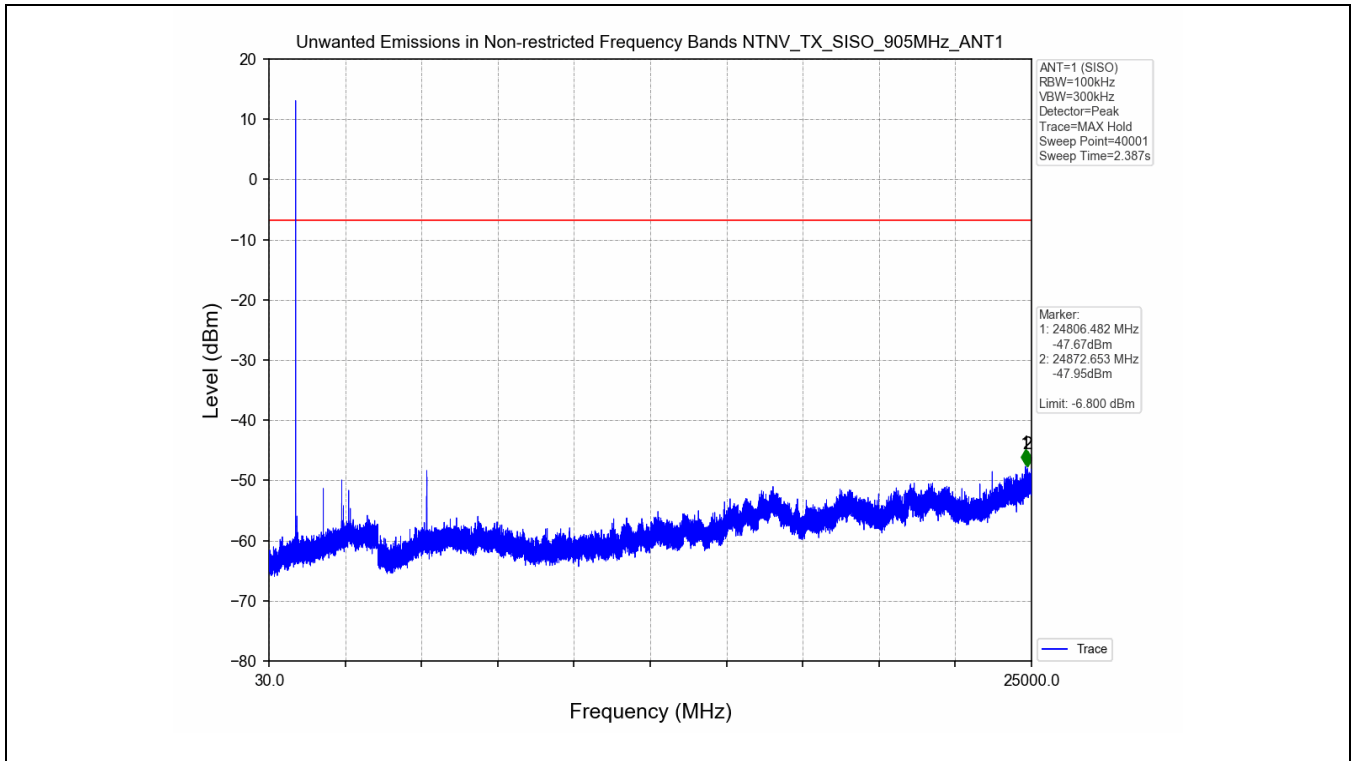
6.1 Test Result

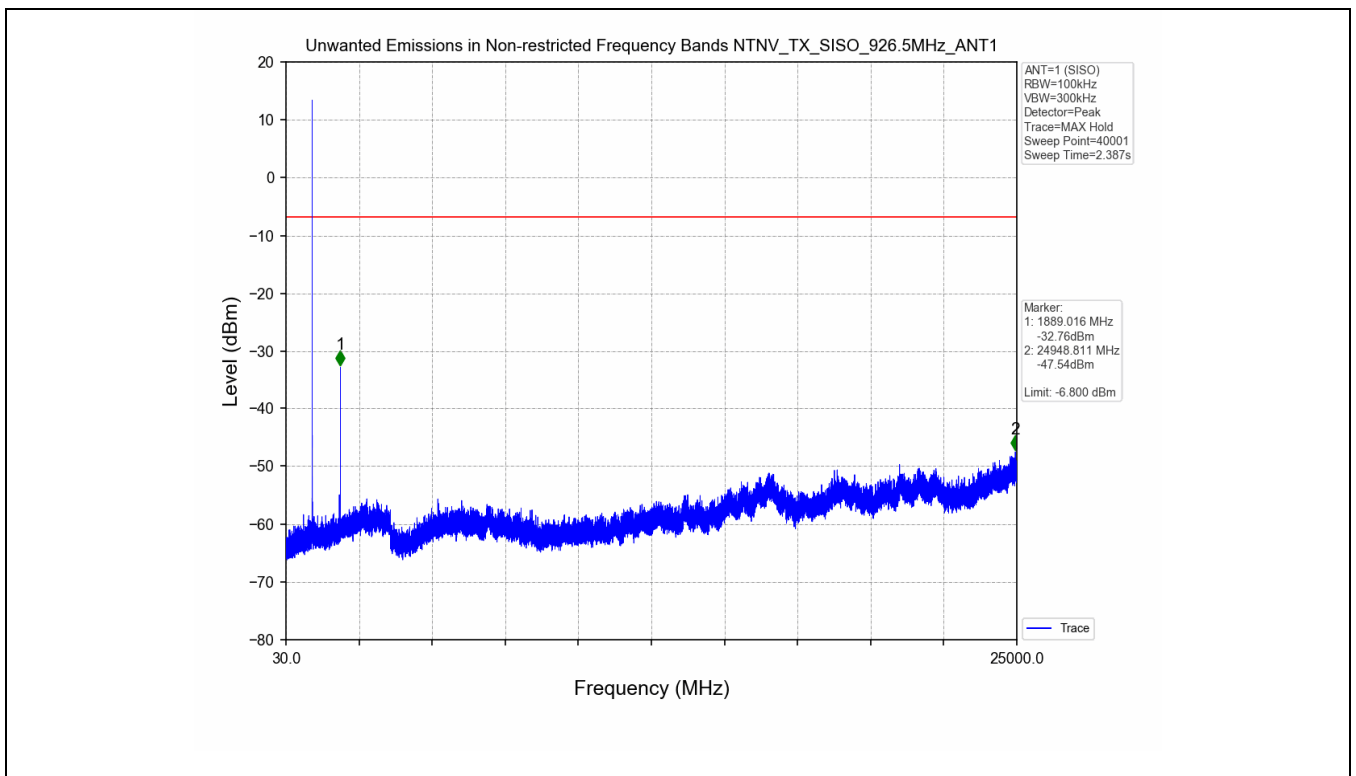
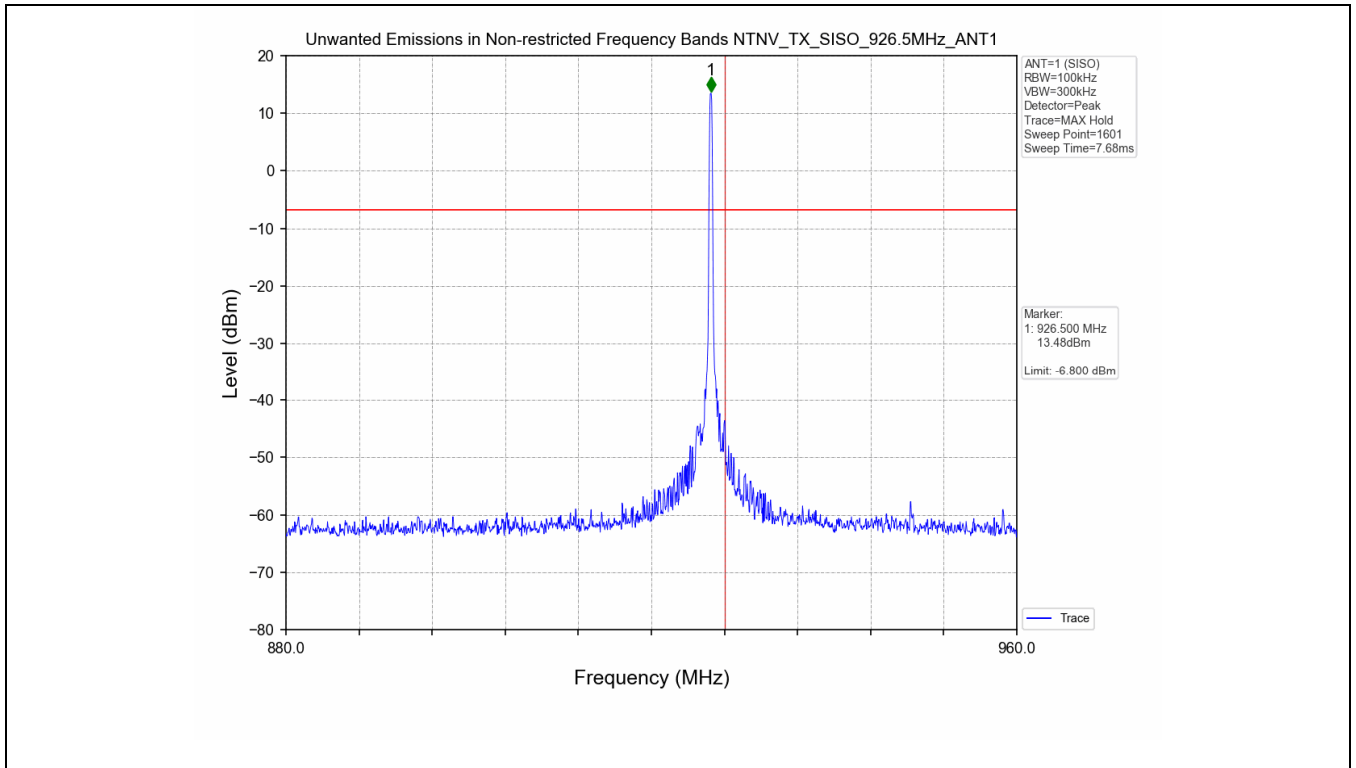
Test Mode	Frequency (MHz)	TX Type	ANT No.	Spurious Conducted Emission (dBm)	Limits (dBm)	Verdict
TX	905	SISO	1	Refer to test graph	-6.80	PASS
	915.85	SISO	1	Refer to test graph	-6.80	PASS
	926.5	SISO	1	Refer to test graph	-6.80	PASS
	Hopping	SISO	1	Refer to test graph	-6.80	PASS

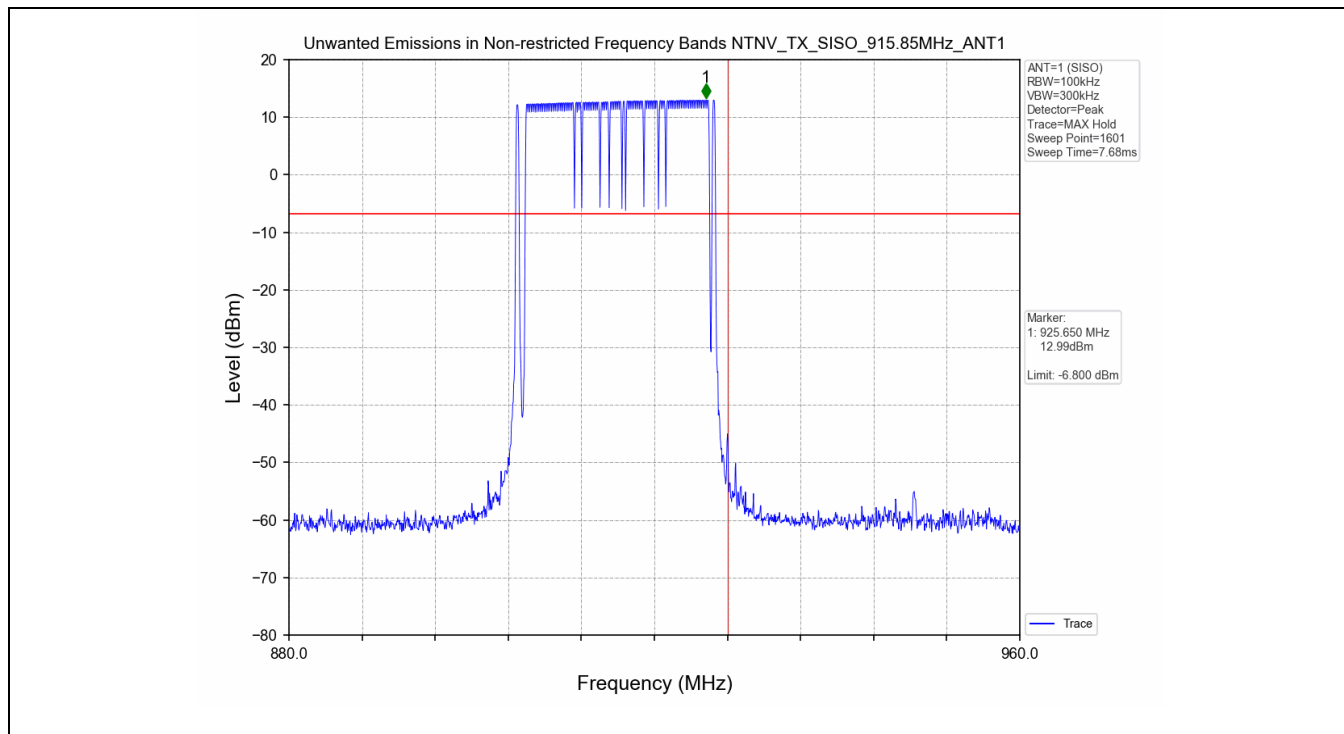
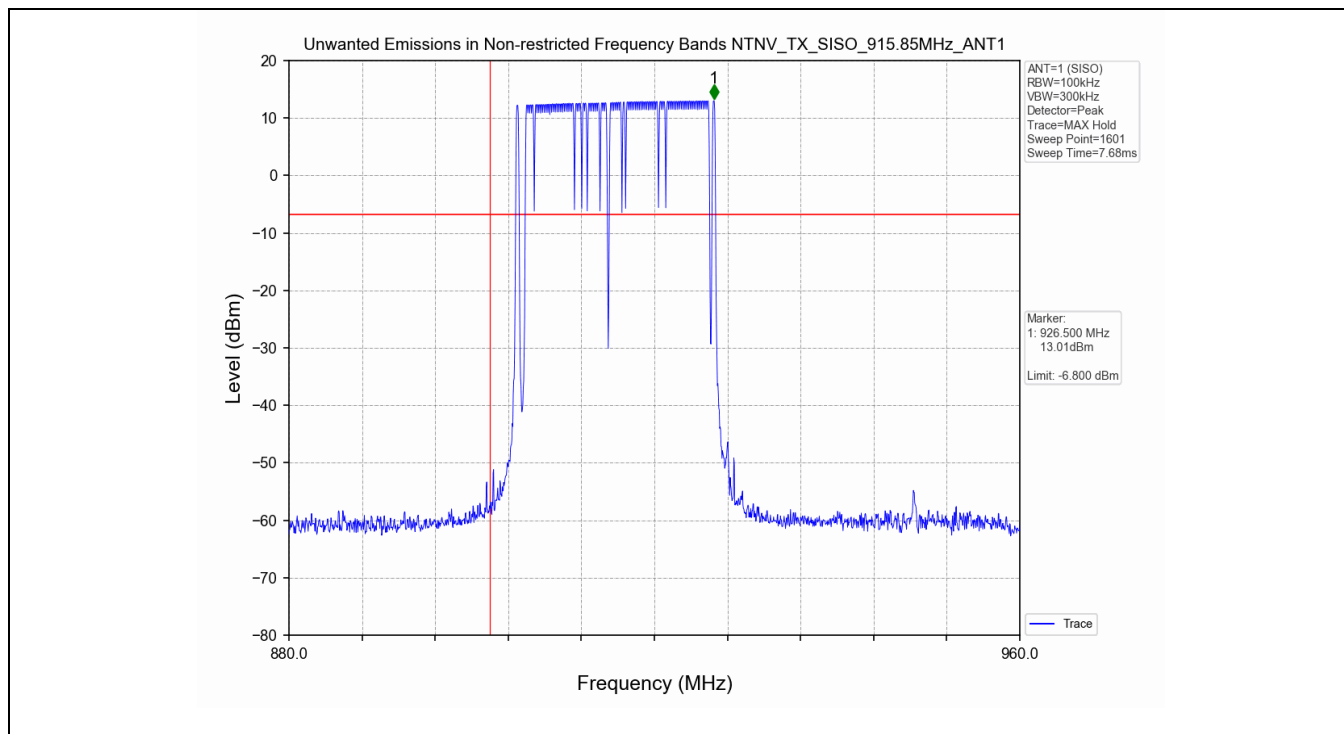


6.2 Test Graph









- End of the Report -

