Radio Test Report

Report No.: STS2307086W03

Issued for

FrSky Electronic Co., Ltd.

F-4, Building C, Zhongxiu Technology Park, No.3 Yuanxi Road, Wuxi, 214125, Jiangsu, China

Product Name:	Wireless digital signal module
Brand Name:	FRSKY
Model Name:	TD PRO Module
Series Model(s):	N/A
FCC ID:	XYFTDPROMDL
Test Standards:	FCC Part15.247

TEST REPORT

Applicant's Name ..... :	FrSky Electronic Co., Ltd.
Address..... :	F-4, Building C, Zhongxiu Technology Park, No.3 Yuanxi Road, Wuxi, 214125, Jiangsu, China
Manufacturer's Name ..... :	FrSky Electronic Co., Ltd.
Address..... :	F-4, Building C, Zhongxiu Technology Park, No.3 Yuanxi Road, Wuxi, 214125, Jiangsu, China

Product Description

Product Name ..... :	Wireless digital signal module
Brand Name..... :	FRSKY
Model Name..... :	TD PRO Module
Series Model(s) ..... :	N/A
Test Standards..... :	FCC Part15.247
Test Procedure..... :	ANSI C63.10-2013

This device described above has been tested by STS, the test results show that the equipment under test (EUT) is in compliance with the FCC requirements. And it is applicable only to the tested sample identified in the report.
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Date of Test..... :

Date of receipt of test item ..... :	20 July 2023
Date (s) of performance of tests :	20 July 2023 ~ 19 Sep. 2023
Date of Issue ..... :	19 Sep. 2023
Test Result ..... :	Pass

Testing Engineer : Aaron Bu

(Aaron Bu)

Technical Manager : Sean She

(Sean she)

Authorized Signatory : Chris Chen

(Chris Chen)

SHENZHEN STS TEST SERVICES CO.,LTD. TESTING APPROVAL

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Revision History

Rev.	Issue Date	Report No.	Effect Page	Contents
00	19 Sep. 2023	STS2307086W03	ALL	Initial Issue

1. SUMMARY OF TEST RESULTS

Test procedures according to the technical standards:
KDB 558074 D01 15.247 Meas Guidance v05r02.

FCC Part 15.247, Subpart C			
Standard Section	Test Item	Judgment	Remark
15.207	Conducted Emission	PASS	--
15.247(a)(1)	Hopping Channel Separation	PASS	--
15.247(b)(2)	Output Power	PASS	--
15.209	Radiated Spurious Emission	PASS	--
15.247(d)	Conducted Spurious & Band Edge Emission	PASS	--
15.247(a)(1)(i) & KDB 558074 D01 10(b)(4)	Number of Hopping Frequency	PASS	--
15.247 (f)	Power Spectral Density	PASS	--
15.247(a)(1)(i) & (f)	Dwell Time	PASS	--
15.247(a)(1)(i)	Bandwidth	PASS	--
15.205	Restricted bands of operation	PASS	--
Part 15.247(d)/part 15.209(a)	Band Edge Emission	PASS	--
15.203	Antenna Requirement	PASS	--

NOTE:

(1) 'N/A' denotes test is not applicable in this Test Report.

(2) All tests are according to ANSI C63.10-2013.

1.1 TEST FACTORY

SHENZHEN STS TEST SERVICES CO., LTD
Add. : A 1/F, Building B, Zhuoke Science Park, No.190 Chongqing Road, HepingShequ, Fuyong Sub-District, Bao'an District, Shenzhen, Guang Dong, China
FCC test Firm Registration Number: 625569
IC test Firm Registration Number: 12108A
A2LA Certificate No.: 4338.01

1.2 MEASUREMENT UNCERTAINTY

The reported uncertainty of measurement **y** ±**U**, where expended uncertainty **U** is based on a standard uncertainty multiplied by a coverage factor of **k=2**, providing a level of confidence of approximately **95** %.

No.	Item	Uncertainty
1	RF output power, conducted	±1.197dB
2	Unwanted Emissions, conducted	±2.896dB
3	All emissions, radiated 9K-30MHz	±3.84dB
4	All emissions, radiated 30M-1GHz	±3.94dB
5	All emissions, radiated 1G-6GHz	±4.59dB
6	All emissions, radiated>6G	±5.22dB
7	Conducted Emission (9KHz-150KHz)	±2.14dB
8	Conducted Emission (150KHz-30MHz)	±2.54dB
9	Occupied Channel Bandwidth	±3.5%
10	Dwell time	±3.2%
11	Power Spectral Density, Conducted	±1.25 dB

2. GENERAL INFORMATION

2.1 GENERAL DESCRIPTION OF THE EUT

<table>
<tr><td>Product Name</td><td>Wireless digital signal module</td></tr>
<tr><td>Brand Name</td><td>FRSKY</td></tr>
<tr><td>Model Name</td><td>TD PRO Module</td></tr>
<tr><td>Series Model(s)</td><td>N/A</td></tr>
<tr><td>Model Difference</td><td>N/A</td></tr>
<tr><td>Product Description</td><td>The EUT is a Wireless digital signal module
<table>
<tr><td>Operation Frequency:</td><td>Hybrid system: 902~928MHz</td></tr>
<tr><td>Modulation Type:</td><td>LoRa</td></tr>
<tr><td>Number Of Channels:</td><td>CH 45(44 Hopping and 1 No-hopping)</td></tr>
<tr><td>Antenna Designation:</td><td>Please refer to the Note 3.</td></tr>
<tr><td>Antenna Gain (dBi)</td><td>1.8dBi</td></tr>
</table></td></tr>
<tr><td>Channel List</td><td>Please refer to the Note 4.</td></tr>
<tr><td>Rating</td><td>Input: DC 7.4V</td></tr>
<tr><td>Hardware version number</td><td>Rev0.3</td></tr>
<tr><td>Software version number</td><td>1.0.8</td></tr>
<tr><td>Connecting I/O Port(s)</td><td>Please refer to the Note 1.</td></tr>
</table>

Note:

1. For a more detailed features description, please refer to the manufacturer’s specifications or the User Manual.
2.

Test Channel List					
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
01	903	24	914.5	45	927

3. Table for Filed Antenna

Ant.	Brand	Model Name	Antenna Type	Connector	Gain (dBi)	NOTE
1	FRSKY	TD PRO Module	Single-band	N/A	1.8dBi	ANT

Note: The antenna information refer the manufacturer provide report, applicable only to the tested sample identified in the report.

4.

Channel List							
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
01	903	13	909	25	915	37	921
02	903.5	14	909.5	26	915.5	38	921.5
03	904	15	910	27	916	39	922
04	904.5	16	910.5	28	916.5	40	922.5
05	905	17	911	29	917	41	923
06	905.5	18	911.5	30	917.5	42	923.5
07	906	19	912	31	918	43	924
08	906.5	20	912.5	32	918.5	44	924.5
09	907	21	913	33	919	45	927
10	907.5	22	913.5	34	919.5	/	/
11	908	23	914	35	920	/	/
12	908.5	24	914.5	36	920.5	/	/

2.2 DESCRIPTION OF THE TEST MODES

To investigate the maximum EMI emission characteristics generates from EUT, the test system was pre-scanning tested base on the consideration of following EUT operation mode or test configuration mode which possible have effect on EMI emission level. Each of these EUT operation mode(s) or test configuration mode(s) mentioned above was evaluated respectively.

Worst Mode	Description	Data/Modulation
Mode 1	TX CH01	LoRa
Mode 2	TX CH24	LoRa
Mode 3	TX CH45	LoRa

Note:

(1) The measurements are performed at all Bit Rate of Transmitter, the worst data was reported.

(2) We tested for all available U.S. voltage and frequencies (For 120V, 50/60Hz and 240V, 50/60Hz) for which the device is capable of operation, and the worst case of 120V/ 60Hz is shown in the report.

(3) The battery is fully-charged during the radiated and RF conducted test.

For AC Conducted Emission

Test Case	
AC Conducted Emission	Mode 4: Keeping TX

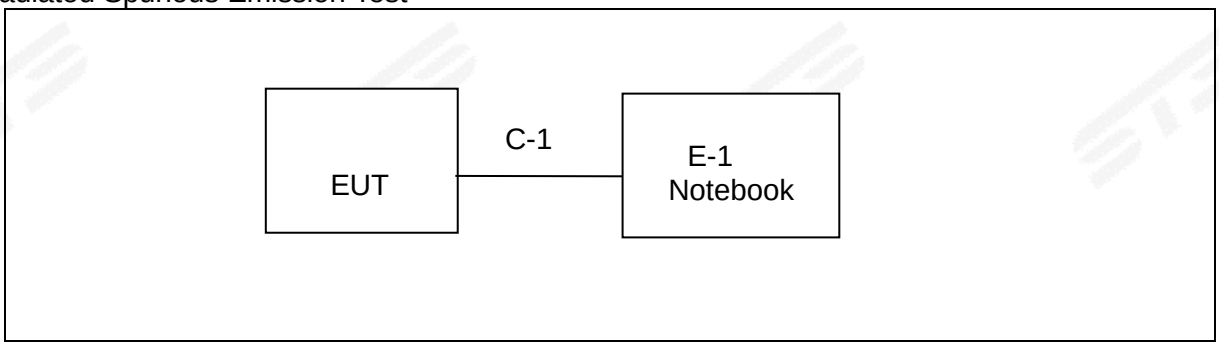
2.3 TEST SOFTWARE AND POWER LEVEL

During testing channel & power controlling software provided by the customer was used to control the operating channel as well as the output power level.

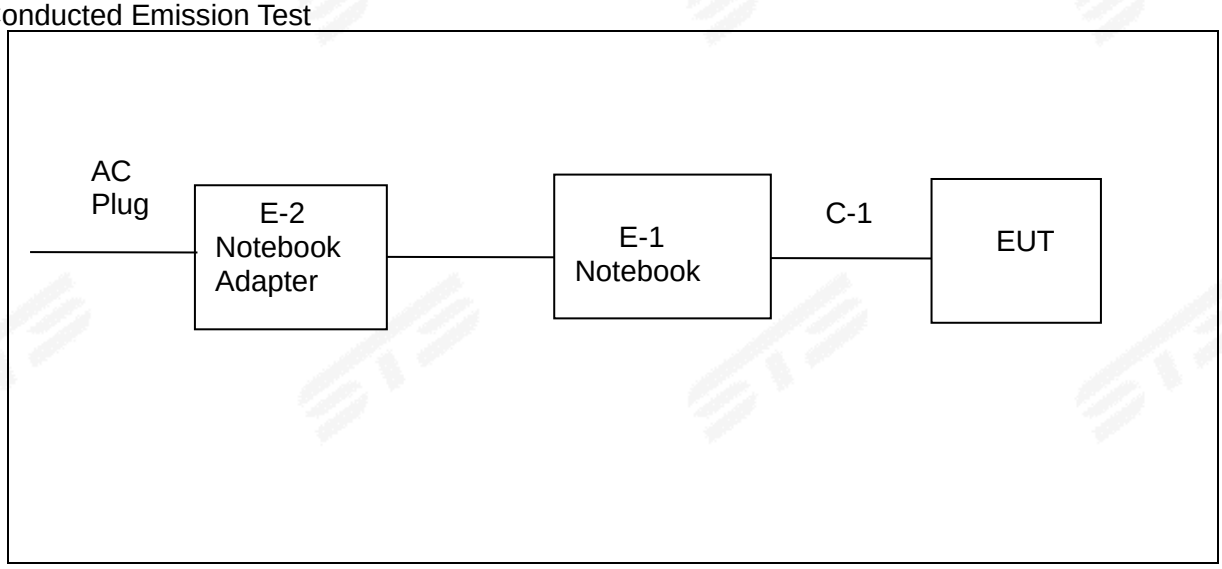
RF Function	Type	Mode Or Modulation type	ANT Gain(dBi)	Power Class	Software For Testing
Other SRD	900M	LoRa	1.8	Default	The EUT has signal transmission when it is powered on

2.4 BLOCK DIAGRAM SHOWING THE CONFIGURATION OF SYSTEM TESTED

Radiated Spurious Emission Test



Conducted Emission Test



2.5 DESCRIPTION OF NECESSARY ACCESSORIES AND SUPPORT UNITS

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

Necessary accessories

Item	Equipment	Mfr/Brand	Model/Type No.	Length	Note
N/A	N/A	N/A	N/A	N/A	N/A

Support units

Item	Equipment	Mfr/Brand	Model/Type No.	Length	Note
E-1	Notebook	LENOVO	Think Pad E470	N/A	N/A
E-2	Notebook Adapter	LENOVO	ADLX45DLC3A	N/A	N/A
C-1	USB Cable	N/A	N/A	150cm	NO

Note:

(1) For detachable type I/O cable should be specified the length in cm in『Length』column.

(2) “YES” is means “with core”; “NO” is means “without core”.

2.6 EQUIPMENTS LIST

RF Radiation Test Equipment					
Kind of Equipment	Manufacturer	Type No.	Serial No.	Last Calibration	Calibrated Until
Temperature & Humidity	SW-108	SuWei	N/A	2023.03.03	2024.03.02
Pre-Amplifier (0.1M-3GHz)	EM	EM330	060665	2023.02.28	2024.02.27
Pre-Amplifier (1G-18GHz)	SKET	LNPA-01018G-45	SK2018080901	2022.09.29	2023.09.28
18GHz-40GHz Filter	XINGBO	XBLBQ-GTA44	22062003-1	2023.03.06	2024.03.05
Pre-mplifier (18G-40G)	SKET	LNPA_1840-50	SK2018101801	2023.03.06	2024.03.05
Positioning Controller	MF	MF-7802	MF-780208587	N/A	N/A
Signal Analyzer	R&S	FSV 40-N	101823	2022.09.29	2023.09.28
Switch Control Box	N/A	N/A	N/A	N/A	N/A
Filter Box	BALUN Technology	SU319E	BL-SZ1530051	N/A	N/A
Active loop Antenna	ZHINAN	ZN30900C	16035	2023.02.28	2024.02.27
Bilog Antenna	TESEQ	CBL6111D	34678	2022.09.30	2024.09.29
Horn Antenna	SCHWARZBECK	BBHA 9120D	02014	2021.10.11	2023.10.10
Horn Antenna	A-INFOMW	LB-180400-KF	J211020657	2021.09.28	2023.09.27
Antenna Mast	MF	MFA-440H	N/A	N/A	N/A
Turn Table	MF	SC100_1	60531	N/A	N/A
AC Power Source	APC	KDF-11010G	F214050035	N/A	N/A
DC Power Supply	Zhaoxin	RXN 605D	20R605D11010081	N/A	N/A
Test SW	EZ-EMC	Ver.STSLAB-03A1 RE			
Conduction Test equipment					
Kind of Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until
Test Receiver	R&S	ESCI	101427	2022.09.29	2023.09.28
LISN	R&S	ENV216	101242	2022.09.28	2023.09.27
LISN	EMCO	3810/2NM	23625	2022.09.28	2023.09.27
Temperature & Humidity	HH660	Mieo	N/A	2022.09.30	2023.09.29
Test SW	EZ-EMC	Ver.STSLAB-03A1 CE			
RF Connected Test					
Kind of Equipment	Manufacturer	Type No.	Serial No.	Last calibration	Calibrated until
Signal Analyzer	Agilent	N9020A	MY51510623	2023.03.01	2024.02.28
Switch control box	MW	MW100-RFCB	N/A	N/A	N/A
Temperature & Humidity	HH660	Mieo	N/A	2022.09.30	2023.09.29
Test SW	MW	MTS 8310_2.0.0.0			

3. EMC EMISSION TEST

3.1 CONDUCTED EMISSION MEASUREMENT

3.1.1 POWER LINE CONDUCTED EMISSION LIMITS

The radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table.

FREQUENCY (MHz)	Conducted Emissionlimit (dBuV)	
	Quasi-peak	Average
0.15 -0.5	66 - 56 *	56 - 46 *
0.50 -5.0	56.00	46.00
5.0 -30.0	60.00	50.00

Note:

(1) The tighter limit applies at the band edges.

(2) The limit of " * " marked band means the limitation decreases linearly with the logarithm of the frequency in the range.

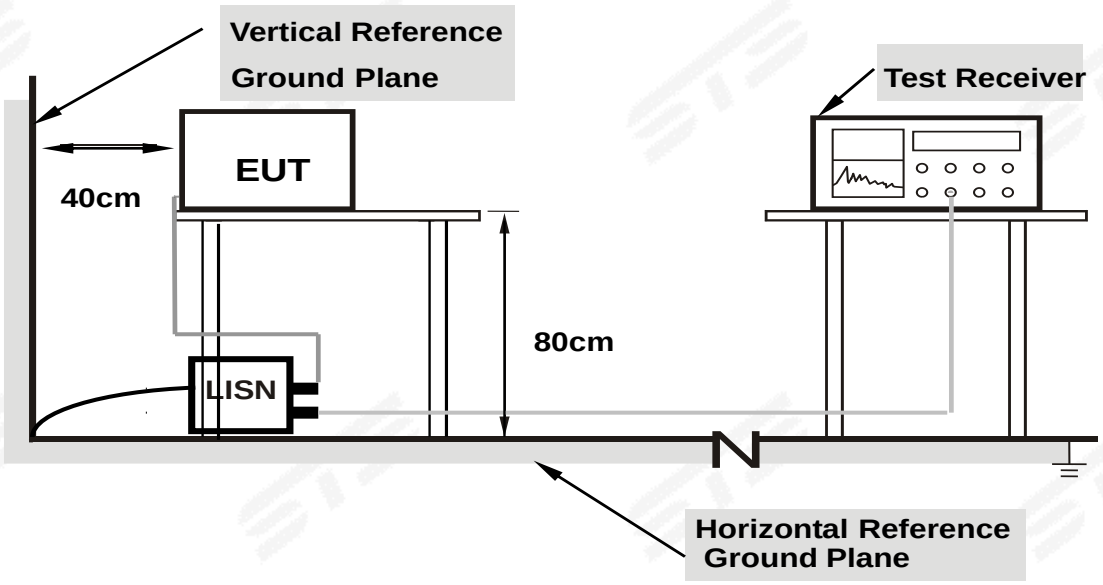
The following table is the setting of the receiver

Receiver Parameters	**Setting**
Attenuation	10 dB
Start Frequency	0.15 MHz
Stop Frequency	30 MHz
IF Bandwidth	9 kHz

3.1.2 TEST PROCEDURE

a. The EUT is 0.8 m from the horizontal ground plane and 0.4 m from the vertical ground plane with EUT being connected to the power mains through a line impedance stabilization network (LISN). All other support equipments are powered from additional LISN(s). The LISN provides 50 Ohm/ 50uH of coupling impedance for the measuring instrument.
b. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 to 40 cm long.
c. I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.
d. LISN is at least 80 cm from the nearest part of EUT chassis.
e. For the actual test configuration, please refer to the related Item –EUT Test Photos.

3.1.3 TEST SETUP



Note: 1. Support units were connected to second LISN.

2. Both of LISNs (AMN) are 80 cm from EUT and at least 80 cm from other units and other metal planes support units.

3.1.4 EUT OPERATING CONDITIONS

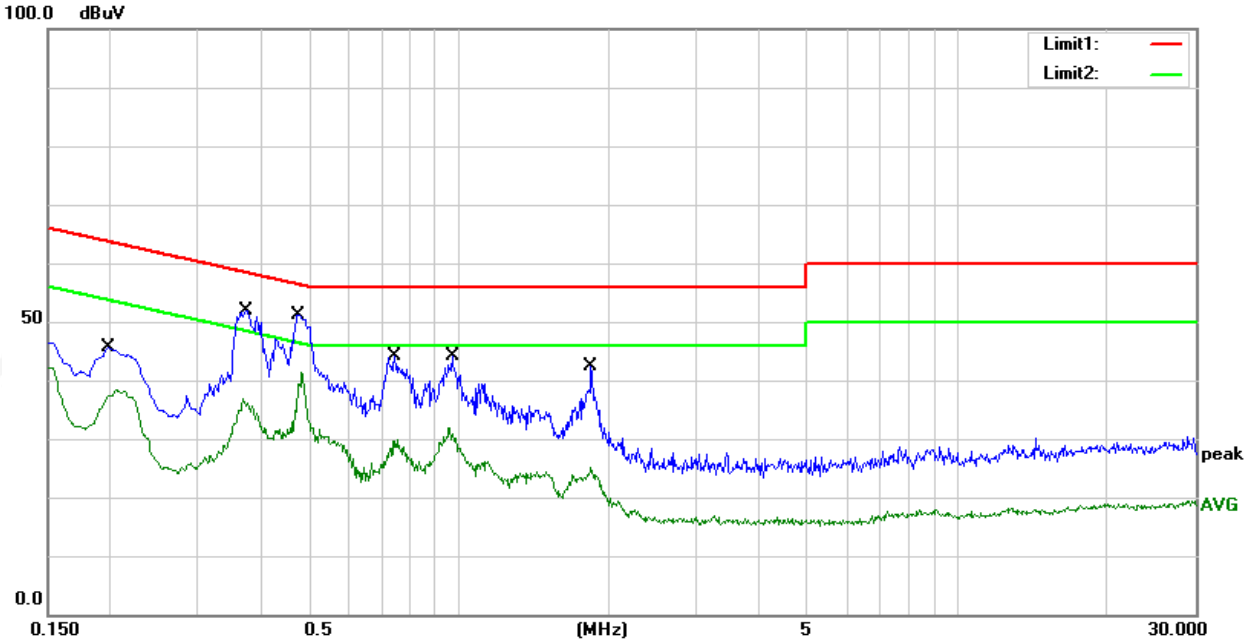
The EUT was configured for testing in a typical fashion (as a customer would normally use it). The EUT has been programmed to continuously transmit during test. This operating condition was tested and used to collect the included data.

3.1.5 TEST RESULT

Temperature:	26.5(C)	Relative Humidity:	59%RH
Test Voltage:	AC 120V/60Hz	Phase:	L
Test Mode:	Mode 4		

No.	Frequency (MHz)	Reading (dBuV)	Correct Factor(dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Remark
1	0.1980	25.32	20.40	45.72	63.69	-17.97	QP
2	0.1980	18.01	20.40	38.41	53.69	-15.28	AVG
3	0.3740	31.36	20.63	51.99	58.41	-6.42	QP
4	0.3740	16.14	20.63	36.77	48.41	-11.64	AVG
5	0.4780	30.66	20.51	51.17	56.37	-5.20	QP
6	0.4780	20.95	20.51	41.46	46.37	-4.91	AVG
7	0.7460	23.71	20.36	44.07	56.00	-11.93	QP
8	0.7460	9.52	20.36	29.88	46.00	-16.12	AVG
9	0.9700	23.77	20.31	44.08	56.00	-11.92	QP
10	0.9700	11.55	20.31	31.86	46.00	-14.14	AVG
11	1.8460	21.98	20.38	42.36	56.00	-13.64	QP
12	1.8460	4.72	20.38	25.10	46.00	-20.90	AVG

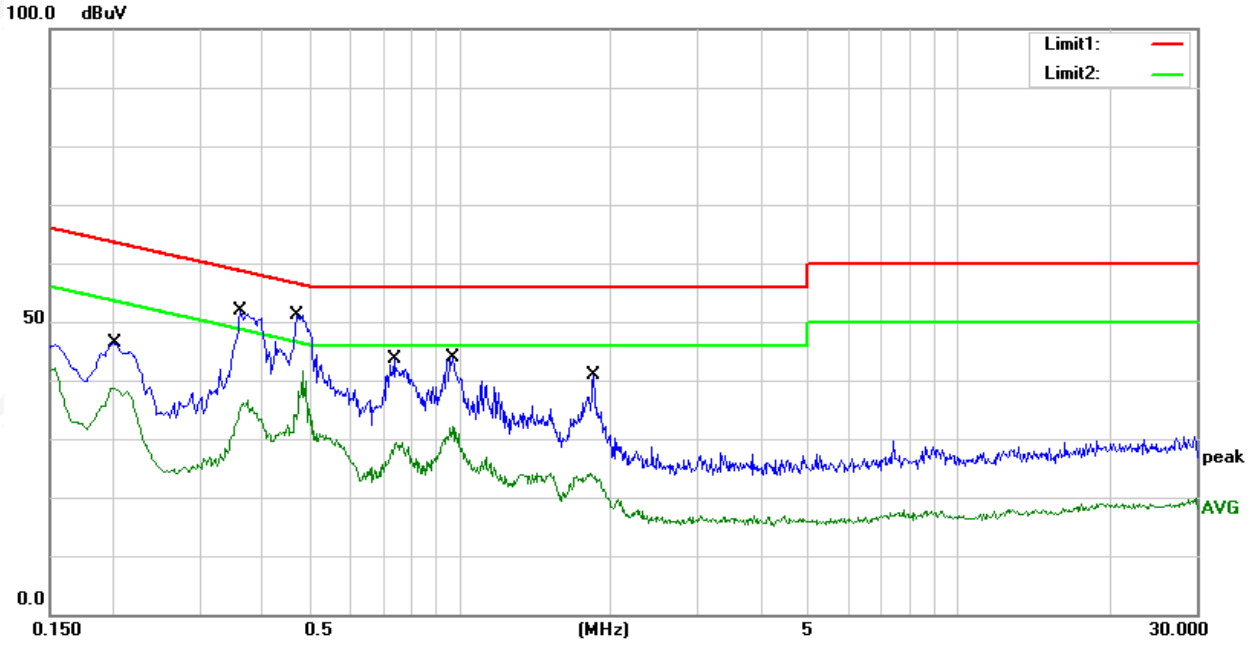
Remark:
1. All readings are Quasi-Peak and Average values
2. Margin = Result (Result =Reading + Factor)–Limit
3. Factor=LISN factor+Cable loss+Limiter (10dB)



Temperature:	26.5(C)	Relative Humidity:	59%RH
Test Voltage:	AC 120V/60Hz	Phase:	N
Test Mode:	Mode 4		

No.	Frequency (MHz)	Reading (dBuV)	Correct Factor(dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Remark
1	0.2020	26.06	20.41	46.47	63.53	-17.06	QP
2	0.2020	18.23	20.41	38.64	53.53	-14.89	AVG
3	0.3620	31.15	20.65	51.80	58.68	-6.88	QP
4	0.3620	15.99	20.65	36.64	48.68	-12.04	AVG
5	0.4700	30.68	20.51	51.19	56.51	-5.32	QP
6	0.4700	21.00	20.51	41.51	46.51	-5.00	AVG
7	0.7380	23.20	20.36	43.56	56.00	-12.44	QP
8	0.7380	8.98	20.36	29.34	46.00	-16.66	AVG
9	0.9660	23.47	20.31	43.78	56.00	-12.22	QP
10	0.9660	11.78	20.31	32.09	46.00	-13.91	AVG
11	1.8500	20.50	20.38	40.88	56.00	-15.12	QP
12	1.8500	3.62	20.38	24.00	46.00	-22.00	AVG

Remark:
1. All readings are Quasi-Peak and Average values
2. Margin = Result (Result =Reading + Factor)–Limit
3. Factor=LISN factor+Cable loss+Limiter (10dB)



3.2 RADIATED EMISSION MEASUREMENT

3.2.1 RADIATED EMISSION LIMITS

In any 100 kHz bandwidth outside the operating frequency band. In case the emission fall within the Restricted band specified on Part15.205 (a)&209(a) limit in the table and according to ANSI C63.10-2013 below has to be followed.

LIMITS OF RADIATED EMISSION MEASUREMENT (0.009MHz - 1000MHz)

Frequencies (MHz)	Field Strength (micorvolts/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

LIMITS OF RADIATED EMISSION MEASUREMENT (1GHz-25 GHz)

FREQUENCY (MHz)	(dBuV/m) (at 3M)	
	PEAK	AVERAGE
Above 1000	74	54

Notes:

(1) The limit for radiated test was performed according to FCC PART 15C.

(2) The tighter limit applies at the band edges.

(3) Emission level (dBuV/m)=20log Emission level (uV/m).

LIMITS OF RESTRICTED FREQUENCY BANDS

FREQUENCY (MHz)	FREQUENCY (MHz)	FREQUENCY (MHz)	FREQUENCY (GHz)
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
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	2690-2900	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	Above 38.6
13.36-13.41			

For Radiated Emission

Spectrum Parameter	Setting
Attenuation	Auto
Detector	Peak/QP/AV
Start Frequency	9 KHz/150KHz(Peak/QP/AV)
Stop Frequency	150KHz/30MHz(Peak/QP/AV)
RB / VB (emission in restricted band)	200Hz (From 9kHz to 0.15MHz)/ 9KHz (From 0.15MHz to 30MHz); 200Hz (From 9kHz to 0.15MHz)/ 9KHz (From 0.15MHz to 30MHz)

Spectrum Parameter	Setting
Attenuation	Auto
Detector	Peak/QP
Start Frequency	30 MHz(Peak/QP)
Stop Frequency	1000 MHz (Peak/QP)
RB / VB (emission in restricted band)	120 KHz / 300 KHz

Spectrum Parameter	Setting
Attenuation	Auto
Detector	Peak/AV
Start Frequency	1000 MHz(Peak/AV)
Stop Frequency	10th carrier hamonic(Peak/AV)
RB / VB (emission in restricted band)	1 MHz / 3 MHz(Peak) 1 MHz/1/T MHz(AVG)

For Restricted band

Spectrum Parameter	Setting
Detector	Peak/AV
Start/Stop Frequency	Lower Band Edge: 2310 to 2410 MHz Upper Band Edge: 2476 to 2500 MHz
RB / VB	1 MHz / 3 MHz(Peak) 1 MHz/1/T MHz(AVG)

Receiver Parameter	Setting
Attenuation	Auto
Start ~ Stop Frequency	9kHz~90kHz / RB 200Hz for PK & AV
Start ~ Stop Frequency	90kHz~110kHz / RB 200Hz for QP
Start ~ Stop Frequency	110kHz~490kHz / RB 200Hz for PK & AV
Start ~ Stop Frequency	490kHz~30MHz / RB 9kHz for QP
Start ~ Stop Frequency	30MHz~1000MHz / RB 120kHz for QP

3.2.2 TEST PROCEDURE

a. The measuring distance at 3 m shall be used for measurements at frequency 0.009MHz up to 1GHz, and above 1GHz.
b. The EUT was placed on the top of a rotating table 0.8 m (above 1GHz is 1.5 m) above the ground at a 3 m anechoic chamber test site. The table was rotated 360 degree to determine the position of the highest radiation.
c. The height of the equipment shall be 0.8 m (above 1GHz is 1.5 m); the height of the test antenna shall vary between 1 m to 4 m. Horizontal and vertical polarization of the antenna are set to make the measurement.
d. The initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and QuasiPeak detector mode will be re-measured.
e. If the Peak Mode measured value is compliance with and lower than Quasi Peak Mode Limit, the EUT shall be deemed to meet QP Limits and no additional QP Mode measurement was performed.
f. For the actual test configuration, please refer to the related Item –EUT Test Photos.

Note:

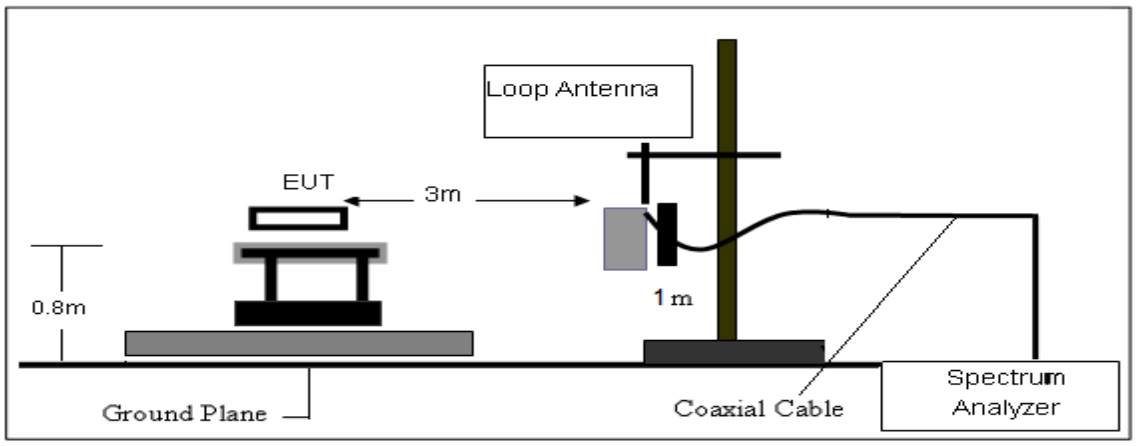
Both horizontal and vertical antenna polarities were tested and performed pretest to three orthogonal axis. The worst case emissions were reported.

3.2.3 DEVIATION FROM TEST STANDARD

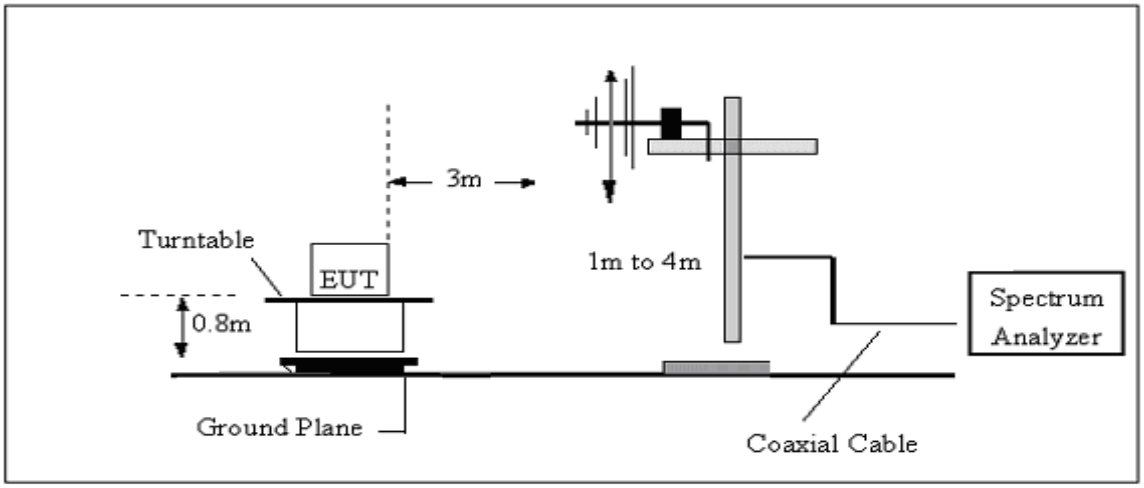
No deviation.

3.2.4 TESTSETUP

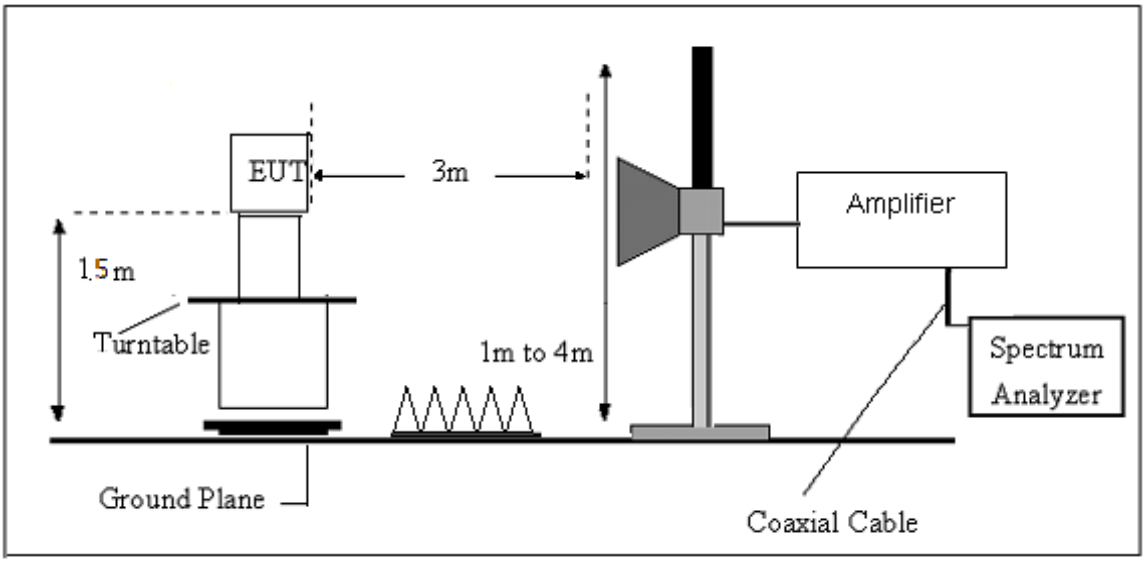
(A) Radiated Emission Test-Up Frequency Below 30MHz



(B) Radiated Emission Test-Up Frequency 30MHz~1GHz



(C) Radiated Emission Test-Up Frequency Above 1GHz



3.2.5 EUT OPERATING CONDITIONS

Please refer to section 3.1.4 of this report.

3.2.6 FIELD STRENGTH CALCULATION

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CL - AG

Where

FS = Field Strength

CL = Cable Attenuation Factor (Cable Loss)

RA = Reading Amplitude

AG = Amplifier Gain

AF = Antenna Factor

For example

Frequency	FS	RA	AF	CL	AG	Factor
(MHz)	(dBμV/m)	(dBμV/m)	(dB)	(dB)	(dB)	(dB)
300	40	58.1	12.2	1.6	31.9	-18.1

Factor=AF+CL-AG

3.2.7 TEST RESULTS

(9KHz-30MHz)

Temperature:	23.1(C)	Relative Humidity:	60%RH
Test Voltage:	DC 7.4V	Test Mode:	TX Mode

Freq.	Reading	Limit	Margin	State	Test Result
(MHz)	(dBuV/m)	(dBuV/m)	(dB)	P/F	
--	--	--	--	--	PASS
--	--	--	--	--	PASS

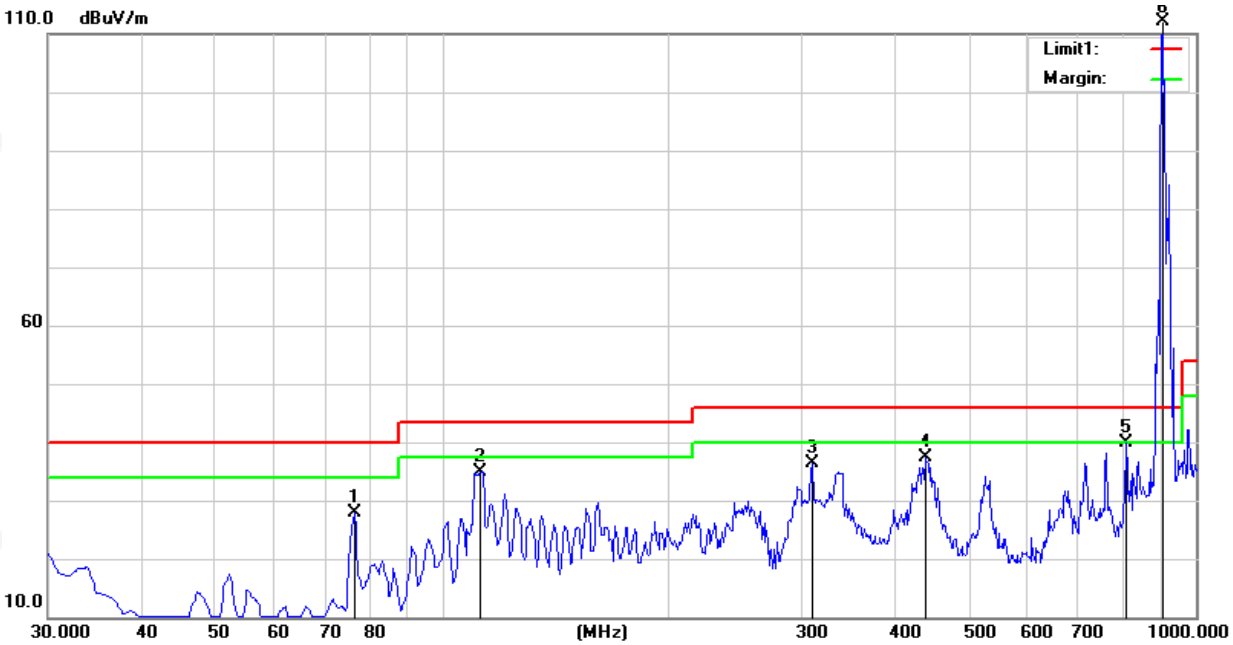
Note:
The amplitude of spurious emissions which are attenuated by more than 20dB below the permissible value has no need to be reported.
Distance extrapolation factor =40 log (specific distance/test distance)(dB);
Limit line = specific limits (dBuv) + distance extrapolation factor.

(30MHz-1000MHz)

Temperature:	23.1(C)	Relative Humidity:	60%RH
Test Voltage:	DC 7.4V	Phase:	Horizontal
Test Mode:	Mode 1/2/3(Mode 1 worst mode)		
Description:	903MHz		

No.	Frequency (MHz)	Reading (dBuV)	Correct Factor(dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	76.5600	51.58	-23.61	27.97	40.00	-12.03	peak
2	112.4500	53.69	-18.82	34.87	43.50	-8.63	peak
3	310.3300	50.76	-14.45	36.31	46.00	-9.69	peak
4	438.3700	47.53	-10.10	37.43	46.00	-8.57	peak
5	809.8800	41.99	-2.00	39.99	46.00	-6.01	peak
6	903.9700	112.49	-0.34	112.15	N/A	N/A	fundamental

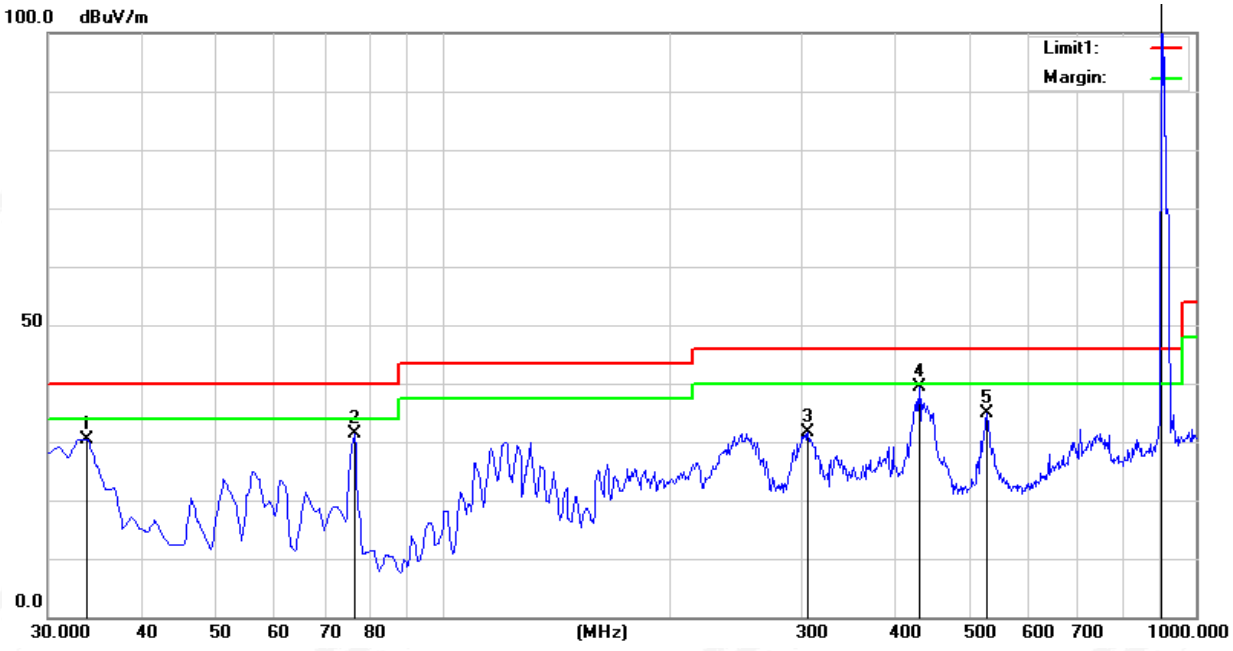
Remark:
1. Margin = Result (Result =Reading + Factor)–Limit
2. Factor= Antenna factor+Cable attenuation factor(cable loss)-Amplifier gain



Temperature:	23.1(C)	Relative Humidity:	60%RH
Test Voltage:	DC 7.4V	Phase:	Vertical
Test Mode:	Mode 1/2/3(Mode 3 worst mode)		
Description:	903MHz		

No.	Frequency (MHz)	Reading (dBuV)	Correct Factor(dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	33.8800	45.30	-14.80	30.50	40.00	-9.50	peak
2	76.5600	55.06	-23.61	31.45	40.00	-8.55	peak
3	306.4500	46.23	-14.58	31.65	46.00	-14.35	peak
4	429.6400	49.48	-10.14	39.34	46.00	-6.66	peak
5	528.5800	42.43	-7.51	34.92	46.00	-11.08	peak
6	903.0000	113.49	-0.37	113.12	N/A	N/A	fundamental

Remark:
1. Margin = Result (Result =Reading + Factor)–Limit
2. Factor= Antenna factor+Cable attenuation factor(cable loss)-Amplifier gain



(1GHz~25GHz) Spurious emission Requirements

Frequency	Meter Reading	Amplifier	Loss	Antenna Factor	Corrected Factor	Emission Level	Limits	Margin	Detector	Comment
(MHz)	(dBμV)	(dB)	(dB)	(dB/m)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	Type	
903 MHz										
1227.36	61.81	44.70	6.70	28.20	-9.80	52.01	74.00	-21.99	PK	Vertical
1227.36	51.55	44.70	6.70	28.20	-9.80	41.75	54.00	-12.25	AV	Vertical
1227.36	61.10	44.70	6.70	28.20	-9.80	51.30	74.00	-22.70	PK	Horizontal
1227.36	50.93	44.70	6.70	28.20	-9.80	41.13	54.00	-12.87	AV	Horizontal
1806.14	59.46	44.20	9.04	31.60	-3.56	55.90	74.00	-18.10	PK	Vertical
1806.14	49.30	44.20	9.04	31.60	-3.56	45.74	54.00	-8.26	AV	Vertical
1806.14	58.38	44.20	9.04	31.60	-3.56	54.82	74.00	-19.18	PK	Horizontal
1806.14	50.22	44.20	9.04	31.60	-3.56	46.66	54.00	-7.34	AV	Horizontal
2014.87	49.40	44.20	9.86	32.00	-2.34	47.05	74.00	-26.95	PK	Vertical
2014.87	39.45	44.20	9.86	32.00	-2.34	37.11	54.00	-16.89	AV	Vertical
2014.93	47.29	44.20	9.86	32.00	-2.34	44.95	74.00	-29.05	PK	Horizontal
2014.93	38.51	44.20	9.86	32.00	-2.34	36.16	54.00	-17.84	AV	Horizontal
2708.98	54.88	43.50	11.40	35.50	3.40	58.28	74.00	-15.72	PK	Vertical
2708.98	44.34	43.50	11.40	35.50	3.40	47.74	54.00	-6.26	AV	Vertical
2708.98	53.99	43.50	11.40	35.50	3.40	57.39	74.00	-16.61	PK	Horizontal
2708.98	44.08	43.50	11.40	35.50	3.40	47.48	54.00	-6.52	AV	Horizontal
914.5 MHz										
1222.98	61.55	44.70	6.70	28.20	-9.80	51.75	74.00	-22.25	PK	Vertical
1222.98	51.26	44.70	6.70	28.20	-9.80	41.46	54.00	-12.54	AV	Vertical
1223.04	62.16	44.70	6.70	28.20	-9.80	52.36	74.00	-21.64	PK	Horizontal
1223.04	49.88	44.70	6.70	28.20	-9.80	40.08	54.00	-13.92	AV	Horizontal
1829.01	59.59	44.20	9.04	31.60	-3.56	56.03	74.00	-17.97	PK	Vertical
1829.01	49.54	44.20	9.04	31.60	-3.56	45.98	54.00	-8.02	AV	Vertical
1828.99	59.44	44.20	9.04	31.60	-3.56	55.88	74.00	-18.12	PK	Horizontal
1828.99	50.19	44.20	9.04	31.60	-3.56	46.63	54.00	-7.37	AV	Horizontal
2007.82	48.75	44.20	9.86	32.00	-2.34	46.41	74.00	-27.59	PK	Vertical
2007.82	39.69	44.20	9.86	32.00	-2.34	37.35	54.00	-16.65	AV	Vertical
2007.79	47.48	44.20	9.86	32.00	-2.34	45.14	74.00	-28.86	PK	Horizontal
2007.79	39.52	44.20	9.86	32.00	-2.34	37.18	54.00	-16.82	AV	Horizontal
2743.72	54.34	43.50	11.40	35.50	3.40	57.74	74.00	-16.26	PK	Vertical
2743.72	43.84	43.50	11.40	35.50	3.40	47.24	54.00	-6.76	AV	Vertical
2743.69	54.18	43.50	11.40	35.50	3.40	57.58	74.00	-16.42	PK	Horizontal
2743.69	44.49	43.50	11.40	35.50	3.40	47.89	54.00	-6.11	AV	Horizontal
927 MHz										
1259.97	60.88	44.70	6.70	28.20	-9.80	51.08	74.00	-22.92	PK	Vertical
1259.97	49.90	44.70	6.70	28.20	-9.80	40.10	54.00	-13.90	AV	Vertical
1260.00	61.48	44.70	6.70	28.20	-9.80	51.68	74.00	-22.32	PK	Horizontal
1260.00	50.31	44.70	6.70	28.20	-9.80	40.51	54.00	-13.49	AV	Horizontal
1854.17	59.15	44.20	9.04	31.60	-3.56	55.59	74.00	-18.41	PK	Vertical
1854.17	49.26	44.20	9.04	31.60	-3.56	45.70	54.00	-8.30	AV	Vertical
1854.12	59.07	44.20	9.04	31.60	-3.56	55.51	74.00	-18.49	PK	Horizontal
1854.12	50.60	44.20	9.04	31.60	-3.56	47.04	54.00	-6.96	AV	Horizontal
2068.44	48.00	44.20	9.86	32.00	-2.34	45.66	74.00	-28.34	PK	Vertical
2068.44	39.23	44.20	9.86	32.00	-2.34	36.89	54.00	-17.11	AV	Vertical
2068.50	48.41	44.20	9.86	32.00	-2.34	46.06	74.00	-27.94	PK	Horizontal
2068.50	38.29	44.20	9.86	32.00	-2.34	35.94	54.00	-18.06	AV	Horizontal
2780.98	54.16	43.50	11.40	35.50	3.40	57.56	74.00	-16.44	PK	Vertical
2780.98	44.66	43.50	11.40	35.50	3.40	48.06	54.00	-5.94	AV	Vertical
2780.89	54.16	43.50	11.40	35.50	3.40	57.56	74.00	-16.44	PK	Horizontal
2780.89	43.55	43.50	11.40	35.50	3.40	46.95	54.00	-7.05	AV	Horizontal

Note:

1) Factor = Antenna Factor + Cable Loss – Pre-amplifier.
   Emission Level = Reading + Factor
2) The frequency emission of peak points that did not show above the forms are at least 20dB below the limit, the frequency emission is mainly from the environment noise.

Restricted band Requirements

Note: The main frequency is too far away from the restricted band and does not require testing.

4. CONDUCTED SPURIOUS & BAND EDGE EMISSION

4.1 LIMIT

According to FCC section 15.247(d), in any 100kHz 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 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

4.2 TEST PROCEDURE

Spectrum Parameter	Setting
Detector	Peak
Start/Stop Frequency	30 MHz to 10th carrier harmonic
RB / VB (emission in restricted band)	100 KHz/300 KHz
Trace-Mode:	Max hold

For Band edge

Spectrum Parameter	Setting
Detector	Peak
Start/Stop Frequency	Lower Band Edge Upper Band Edge
RB / VB (emission in restricted band)	100 KHz/300 KHz
Trace-Mode:	Max hold

4.3 TEST SETUP

The EUT which is powered by the Battery, is connected to the Spectrum Analyzer; the RF load attached to the EUT antenna terminal is 50 Ohm; the path loss as the factor is calibrated to correct the reading. Make the measurement with the spectrum analyzer's resolution bandwidth(RBW) = 100 kHz. In order to make an accurate measurement, set the span greater than RBW.

4.4 EUT OPERATION CONDITIONS

Please refer to section 3.1.4 of this report.

4.5 TEST RESULTS

Note: The test data please refer to APPENDIX 1.

5. NUMBER OF HOPPING CHANNEL

5.1 LIMIT

FCC Part 15.247, Subpart C & KDB 558074 D01				
Section	Test Item	Limit	FrequencyRange (MHz)	Result
KDB 558074 Section 10(b)(4)	Number of Hopping Channel	No limit	902-928	PASS

Spectrum Parameters	Setting
Attenuation	Auto
Span Frequency	> Operating FrequencyRange
RB	To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20 dB bandwidth, whichever is smaller.
VB	⩾ RBW.
Detector	Peak
Trace	Max Hold
Sweep Time	Auto

5.2 TEST PROCEDURE

a. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram below.

5.3 TEST SETUP

5.4 EUT OPERATION CONDITIONS

Please refer to section 3.1.4 of this report.

5.5 TEST RESULTS

Note: The test data please refer to APPENDIX 1.

6. AVERAGE TIME OF OCCUPANCY

6.1 LIMIT

FCC Part 15.247, Subpart C				
Section	Test Item	Limit	FrequencyRange (MHz)	Result
15.247 (f)	Average Time of Occupancy	Average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4	902-928	PASS

6.2 TEST PROCEDURE

a. The transmitter output (antenna port) was connected to the spectrum analyzer.
b. Set RBW =1MHz/VBW =3MHz.
c. Use a video trigger with the trigger level set to enable triggering only on full pulses.
d. Sweep Time is more than once pulse time.
e. Set the center frequency on any frequency would be measure and set the frequency span to zero span.
f. Measure the maximum time duration of one single pulse.

6.3 TEST SETUP

6.4 EUT OPERATION CONDITIONS

Please refer to section 3.1.4 of this report.

6.5 TEST RESULTS

Note: The test data please refer to APPENDIX 1.

7. HOPPING CHANNEL SEPARATION MEASUREMEN

7.1 LIMIT

15.247(a)(1): 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.

Spectrum Parameter	Setting
Attenuation	Auto
Span Frequency	Wide enough to capture the peaks of two adjacent channels.
RB	Approximately 30% of the channel spacing
VB	≥ RBW
Detector	Peak
Trace	Max Hold
Sweep Time	Auto

7.2 TEST PROCEDURE

a. The transmitter output (antenna port) was connected to the spectrum analyser in peak hold mode.

7.3 TEST SETUP

7.4 EUT OPERATION CONDITIONS

The EUT was programmed to be in continuously transmitting mode.

7.5 TEST RESULTS

Note: The test data please refer to APPENDIX 1.

8. BANDWIDTH TEST

8.1 LIMIT

FCC Part15 15.247, Subpart C & KDB 558074 D01				
Section	Test Item	Limit (MHz)	FrequencyRange (MHz)	Result
KDB 558074 Section 10(b)(3)	20dB Bandwidth	902-928	902-928	pass
	6dB Bandwidth			

Spectrum Parameter	Setting
Attenuation	Auto
Span Frequency	> Measurement Bandwidth or Channel Separation
RB	DSS: 1% to 5% of the OBW / DTS: 100kHz
VB	≥ RBW
Detector	Peak
Trace	Max Hold
Sweep Time	Auto

8.2 TEST PROCEDURE

a. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram below.

8.3 TEST SETUP

8.4 EUT OPERATION CONDITIONS

Please refer to section 3.1.4 of this report.

8.5 TEST RESULTS

Note: The test data please refer to APPENDIX 1.

9. OUTPUT POWER TEST

9.1 LIMIT

FCC Part 15.247, Subpart C				
Section	Test Item	Limit	Frequency Range (MHz)	Result
15.247 (b)	Output Power	1 W	902-928	PASS

9.2 TEST PROCEDURE

DSS:

This is an RF-conducted test to evaluate maximum peak output power. Use a direct connection between the antenna port of the unlicensed wireless device and the spectrum analyzer, through suitable attenuation. The hopping shall be disabled for this test:

a) Use the following spectrum analyzer settings:
1) Span: Approximately five times the 20 dB bandwidth, centered on a hopping channel.
2) RBW > 20 dB bandwidth of the emission being measured.
3) VBW ≥ RBW.
4) Sweep: Auto.
5) Detector function: Peak.
6) Trace: Max hold.
b) Allow trace to stabilize.
c) Use the marker-to-peak function to set the marker to the peak of the emission.
d) The indicated level is the peak output power, after any corrections for external attenuators and cables.
e) A plot of the test results and setup description shall be included in the test report.
NOTE—A peak responding power meter may be used, where the power meter and sensor system video bandwidth is greater than the occupied bandwidth of the unlicensed wireless device, rather than a spectrum analyzer.

PKPM1 Peak power meter method:

The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DSS bandwidth and shall use a fast-responding diode detector.

DTS:

One of the following procedures may be used to determine the maximum peak conducted output power of a DTS EUT.

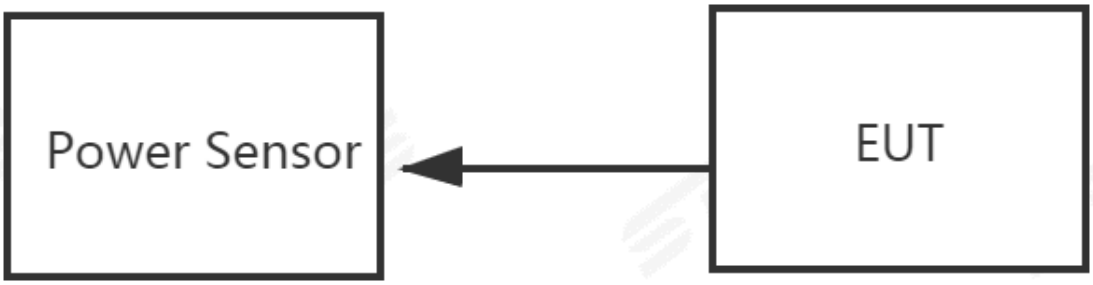
RBW ⩾ DTS bandwidth

The following procedure shall be used when an instrument with a resolution bandwidth that is greater than the DTS bandwidth is available to perform the measurement:

a) Set the RBW ⩾ DTS bandwidth.
b) Set VBW ⩾ [3 × RBW].
c) Set span ⩾ [3 × RBW].
d) Sweep time = auto couple.
e) Detector = peak.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use peak marker function to determine the peak amplitude level.

Integrated band power method:
The following procedure can be used when the maximum available RBW of the instrument is less than the
DTS bandwidth:
a) Set the RBW = 1 MHz.
b) Set the VBW ≥ [3 × RBW].
c) Set the span ≥ [1.5 × DTS bandwidth].
d) Detector = peak.
e) Sweep time = auto couple.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use the instrument's band/channel power measurement function with the band limits set equal to the DTS bandwidth edges (for some instruments, this may require a manual override to select the peak detector). If the instrument does not have a band power function, then sum the spectrum levels (in linear power units) at intervals equal to the RBW extending across the DTS channel bandwidth.
PKPM1 Peak power meter method:
The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall use a fast-responding diode detector.

9.3 TEST SETUP



9.4 EUT OPERATION CONDITIONS

Please refer to section 3.1.4 of this report.

9.5 TEST RESULTS

Note: The test data please refer to APPENDIX 1.

10. POWER SPECTRAL DENSITY TEST

10.1 LIMIT

FCC Part 15.247, Subpart C				
Section	Test Item	Limit	Frequency Range (MHz)	Result
15.247(f)	Power Spectral Density	≤8 dBm (RBW≥3KHz)	902-928	PASS

10.2 TEST PROCEDURE

1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to 1.5 times the DTS channel bandwidth.
3. Set the RBW to: 100 kHz ≥ RBW ≥ 3 kHz.
4. Set the VBW ≥ 3 x RBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

10.3 TEST SETUP

10.4 EUT OPERATION CONDITIONS

Please refer to section 3.4 of this report.

10.5 TEST RESULTS

Note: The test data please refer to APPENDIX 1.

11. ANTENNA REQUIREMENT

11.1 STANDARD REQUIREMENT

15.203 requirement: For intentional device, according to 15.203: an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

11.2 EUT ANTENNA

The EUT antenna is Single-band Antenna. It comply with the standard requirement.

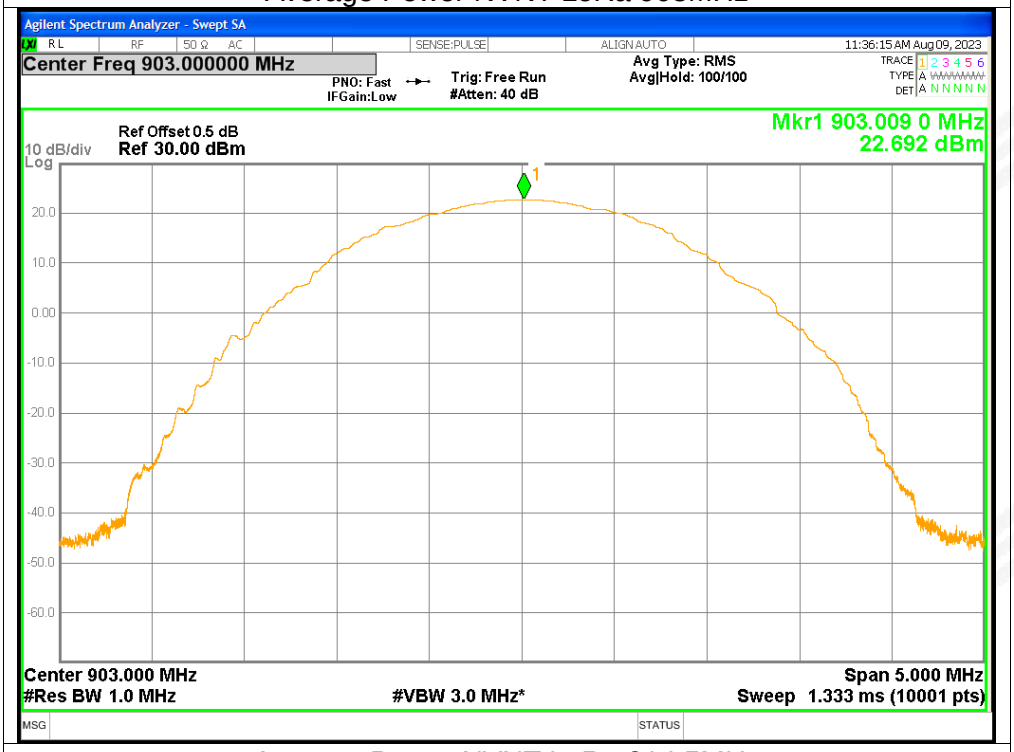
APPENDIX 1-TEST DATA

1. Maximum Average Conducted Output Power

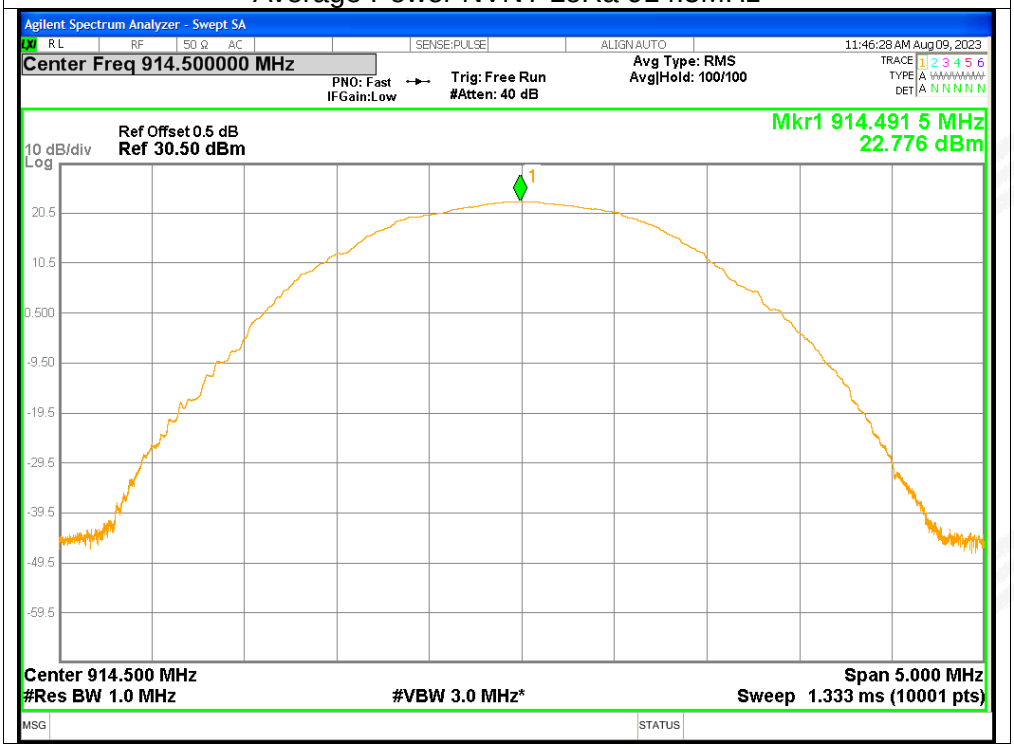
Condition	Mode	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Verdict
NVNT	LoRa	903	22.69	<=30	Pass
NVNT	LoRa	914.5	22.78	<=30	Pass

Condition	Mode	Frequency (MHz)	Conducted Power (dBm)	Duty Factor (dB)	Total Power (dBm)	Limit (dBm)	Verdict
NVNT	LoRa	927	9.03	4.91	13.94	<=30	Pass

Test Graphs
Average Power NVNT LoRa 903MHz

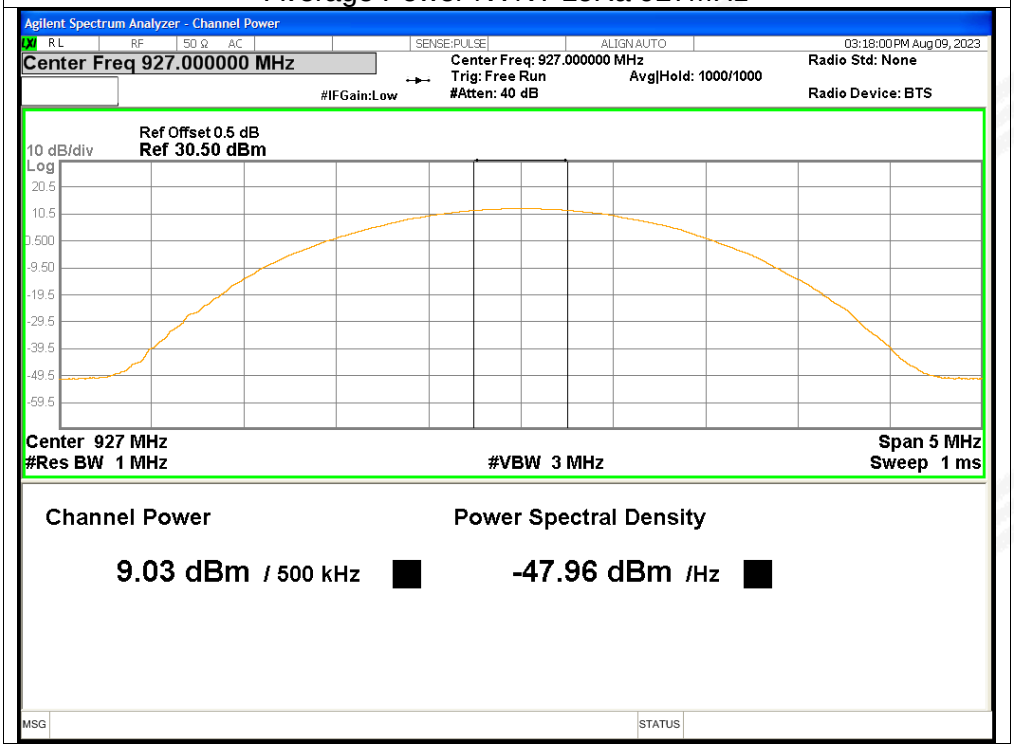


Average Power NVNT LoRa 914.5MHz



Test Graphs

Average Power NVNT LoRa 927MHz



2. Maximum Peak Conducted Output Power

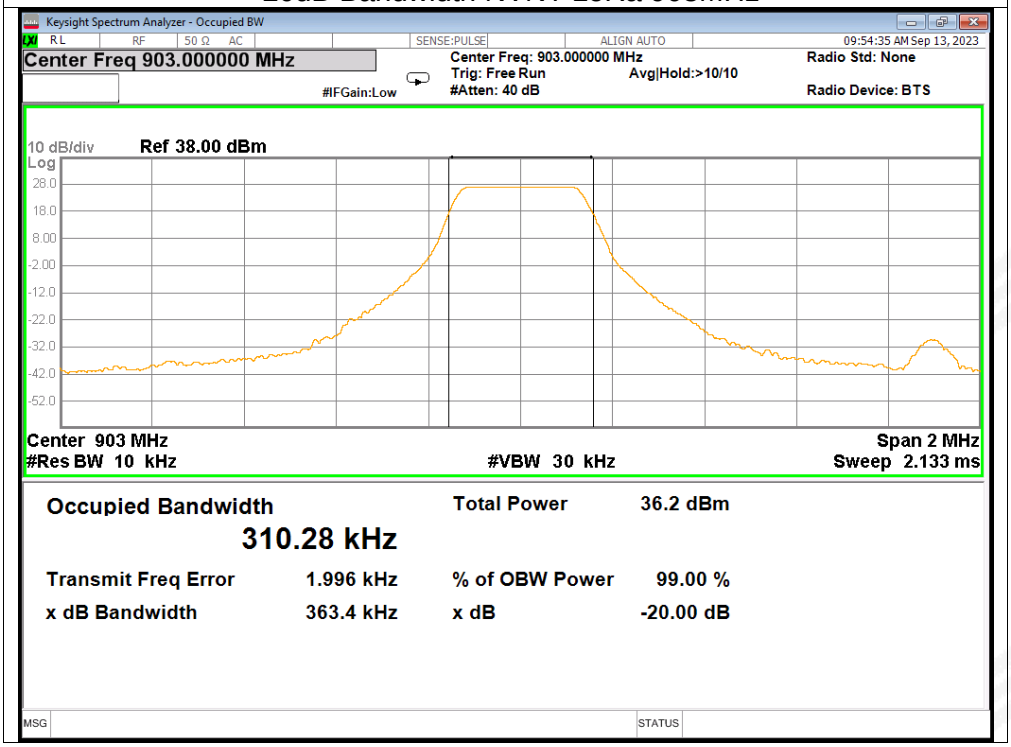
Condition	Mode	Frequency (MHz)	Conducted Power (dBm)	Limit (dBm)	Verdict
NVNT	LoRa	903	28.72	<=30	Pass
NVNT	LoRa	914.5	28.87	<=30	Pass
NVNT	LoRa	927	17.84	<=30	Pass

3. Bandwidth

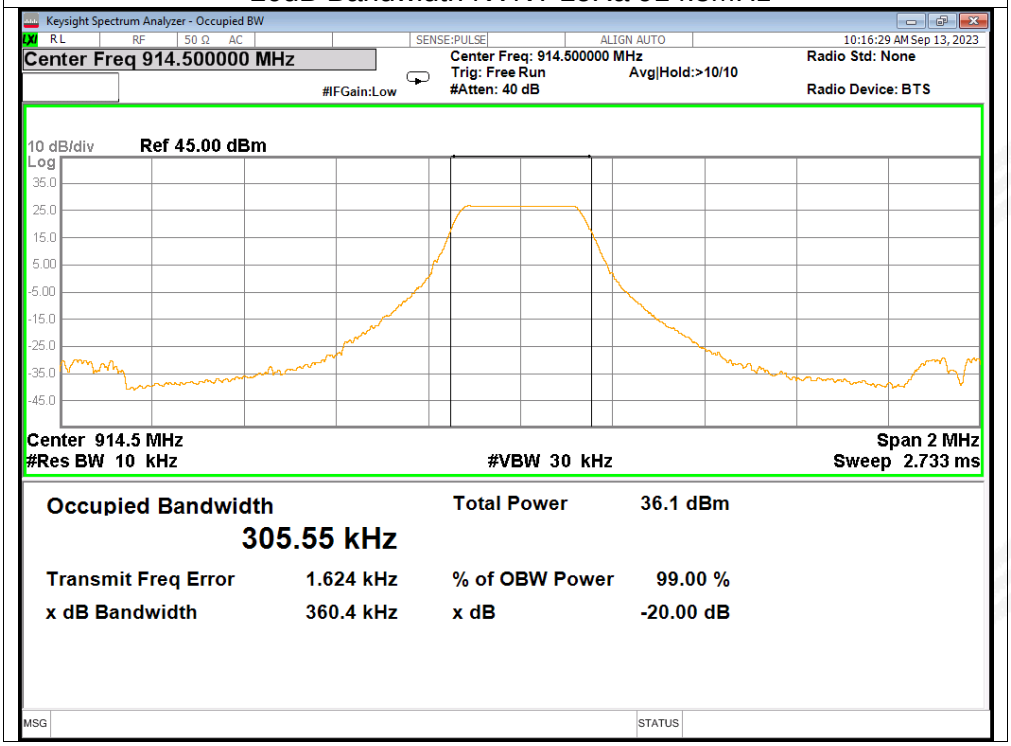
Condition	Mode	Frequency (MHz)	-20 dB Bandwidth (MHz)	Limit (MHz)	Verdict
NVNT	LoRa	903	0.3634	902 -928	Pass
NVNT	LoRa	914.5	0.3604	902 -928	Pass
NVNT	LoRa	927	0.7311	902 -928	Pass

Test Graphs

-20dB Bandwidth NVNT LoRa 903MHz

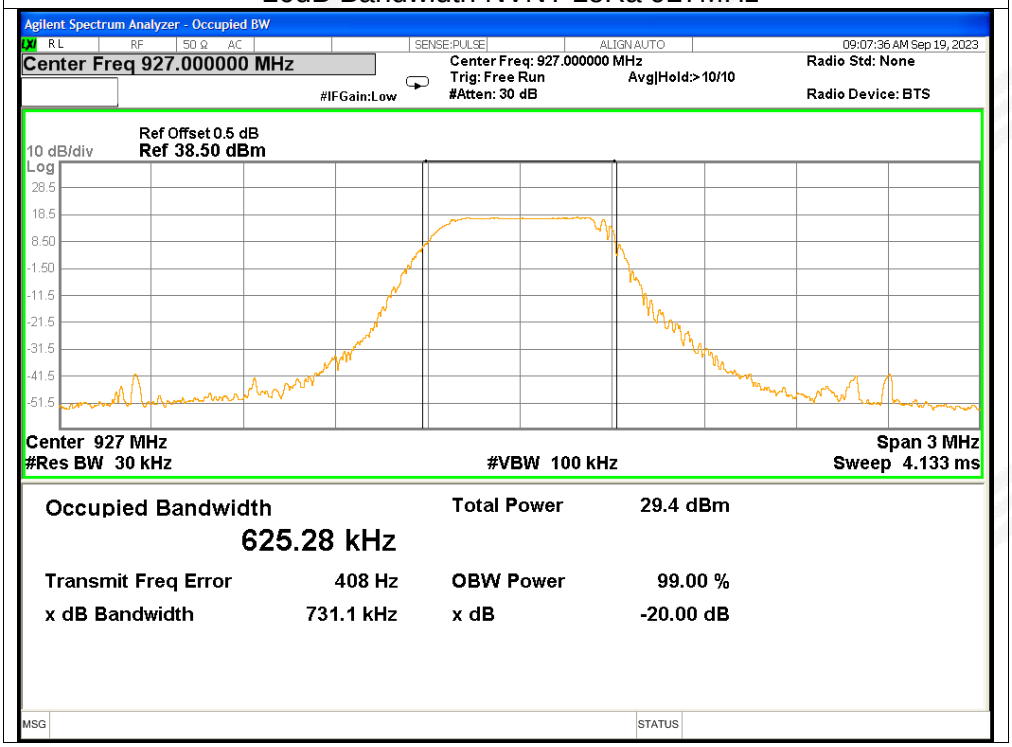


-20dB Bandwidth NVNT LoRa 914.5MHz



Test Graphs

-20dB Bandwidth NVNT LoRa 927MHz

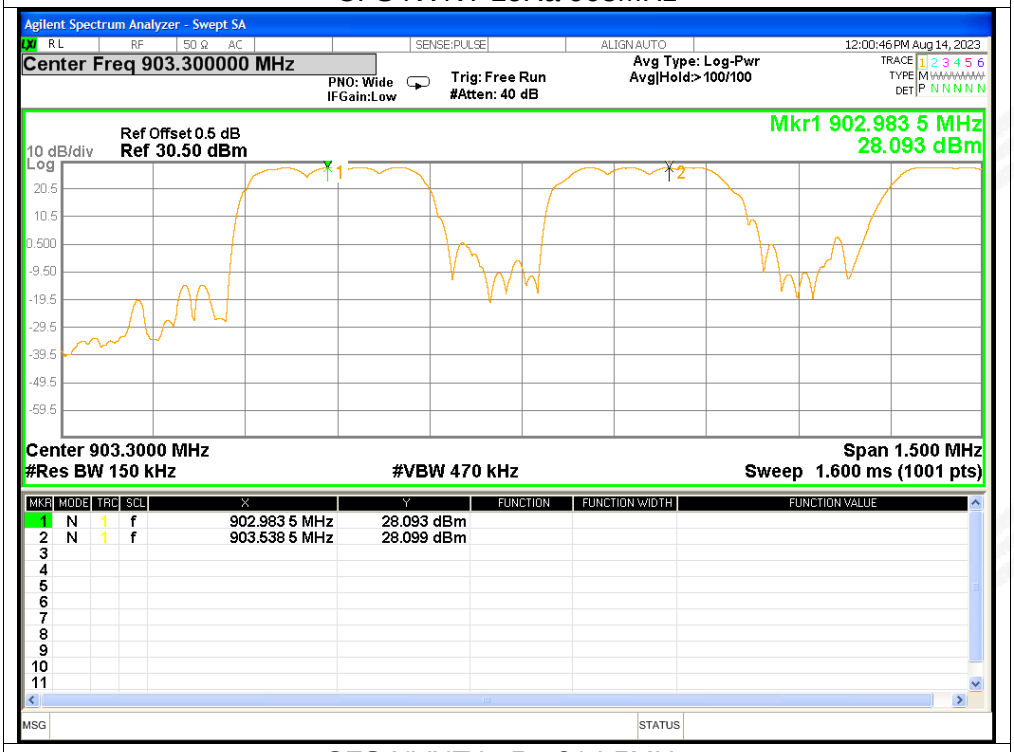


4. Carrier Frequencies Separation

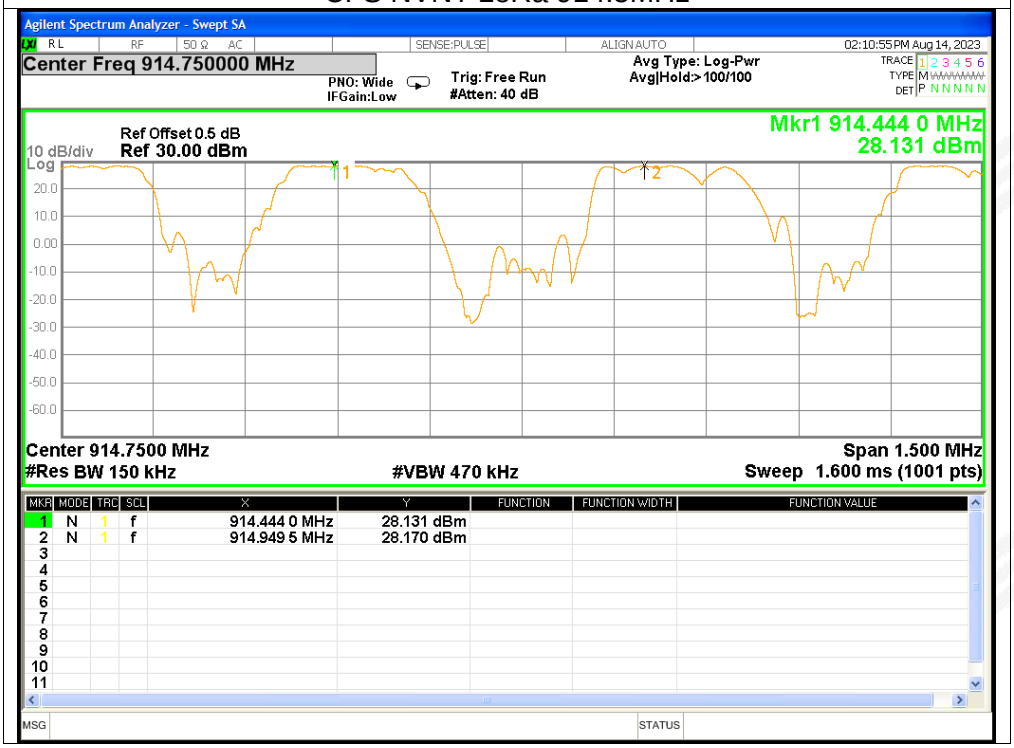
Condition	Mode	Hopping Freq1 (MHz)	Hopping Freq2 (MHz)	HFS (MHz)	Limit (MHz)	Verdict
NVNT	LoRa	902.9835	903.5385	0.555	>=0.3634	Pass
NVNT	LoRa	914.444	914.9495	0.5055	>=0.3604	Pass

Test Graphs

CFS NVNT LoRa 903MHz



CFS NVNT LoRa 914.5MHz

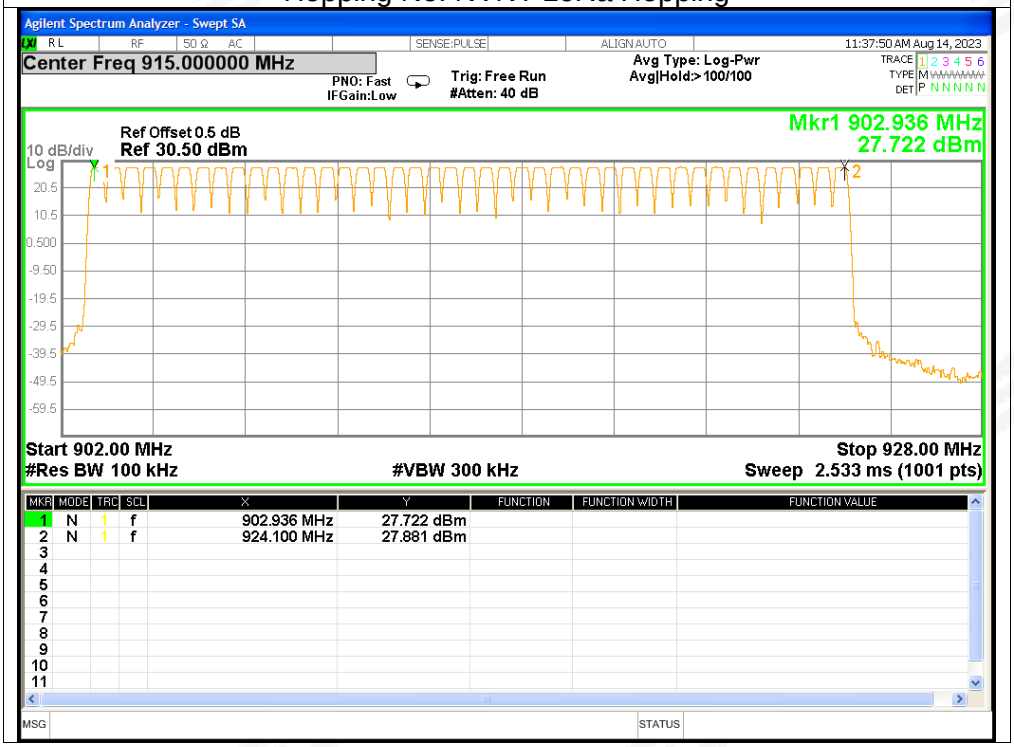


5. Number of Hopping Channel

Condition	Mode	Hopping Number	Limit	Verdict
NVNT	LoRa	44	NA	Pass

Test Graphs

Hopping No. NVNT LoRa Hopping



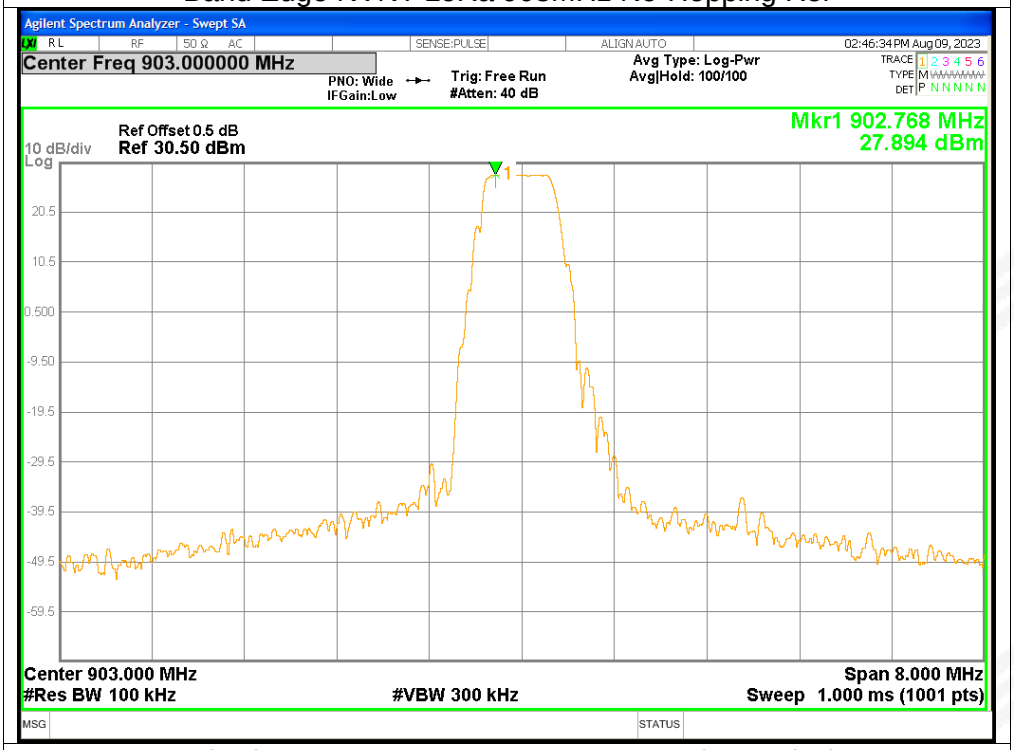
6. Band Edge

Condition	Mode	Frequency (MHz)	Hopping Mode	Max Value (dBc)	Limit (dBc)	Verdict
NVNT	LoRa	903	No-Hopping	-63.56	<=-20	Pass

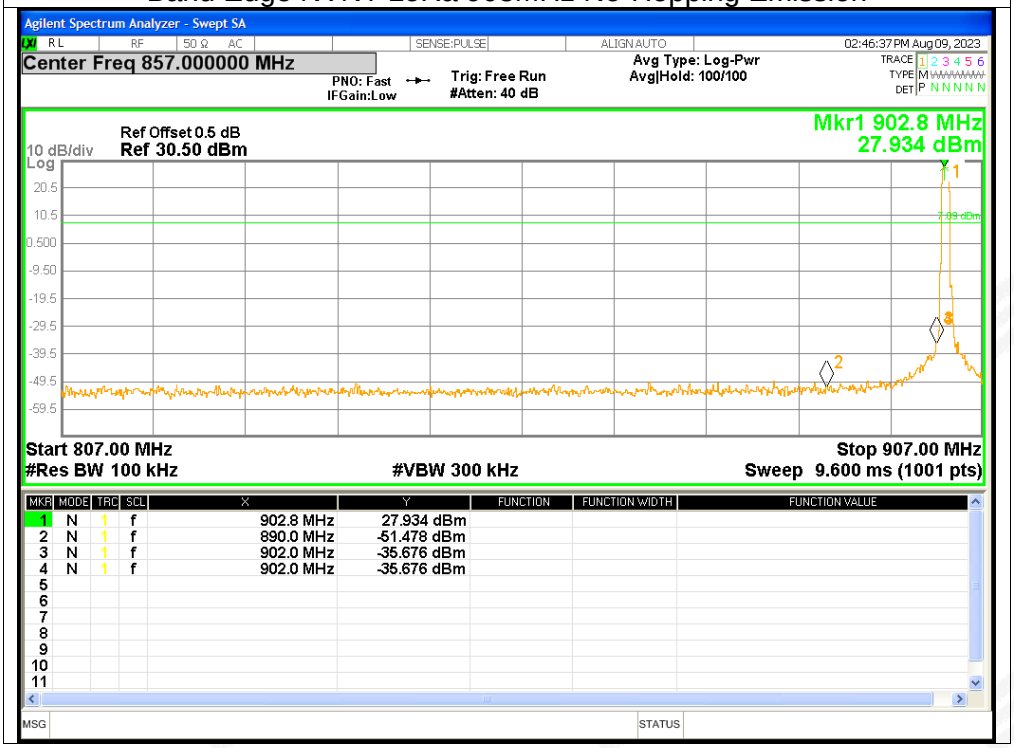
Condition	Mode	Frequency (MHz)	Max Value (dBc)	Limit (dBc)	Verdict
NVNT	LoRa	927	-62.64	<=-20	Pass

Test Graphs

Band Edge NVNT LoRa 903MHz No-Hopping Ref

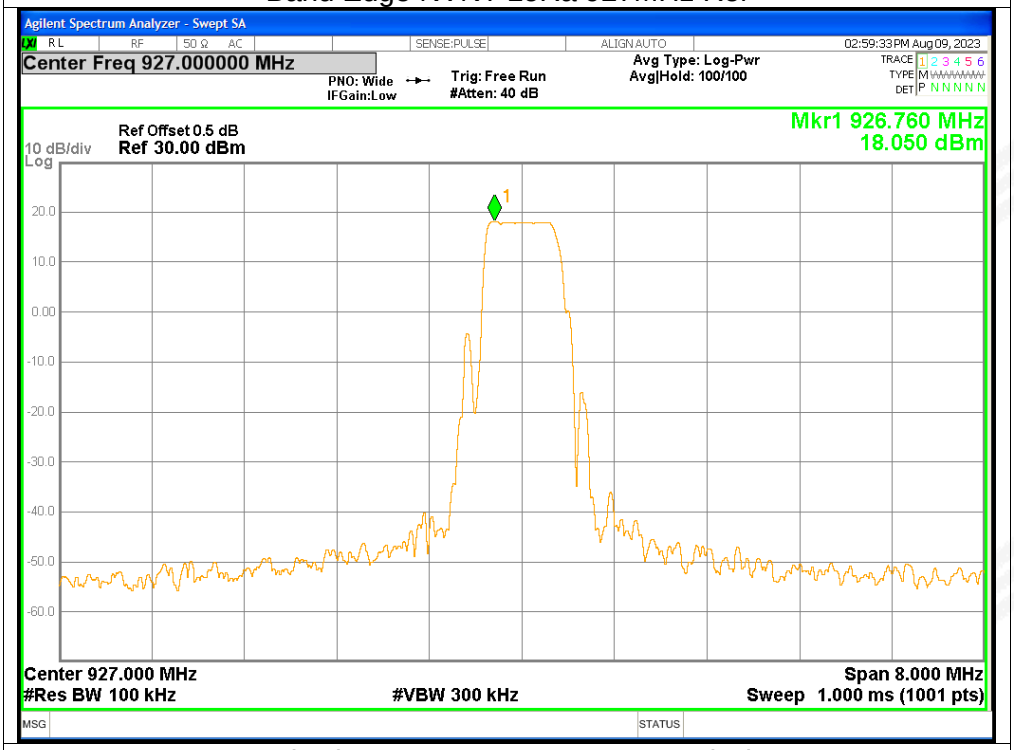


Band Edge NVNT LoRa 903MHz No-Hopping Emission

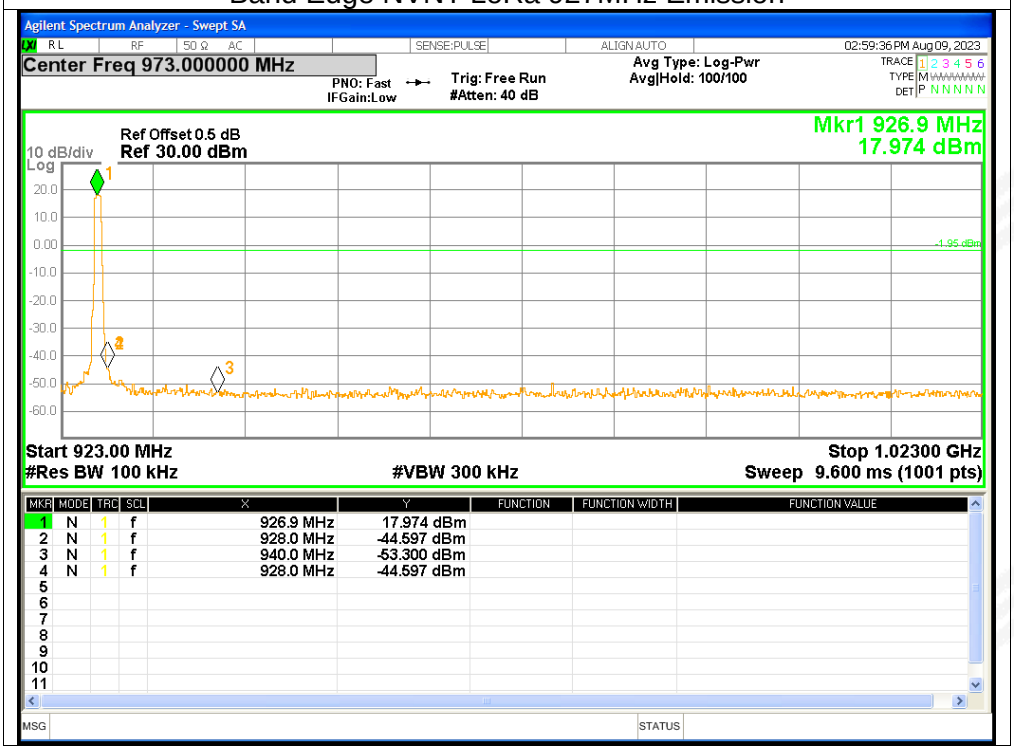


Band Edge NVNT LoRa 924.5MHz No-Hopping Ref

Band Edge NVNT LoRa 927MHz Ref



Band Edge NVNT LoRa 927MHz Emission

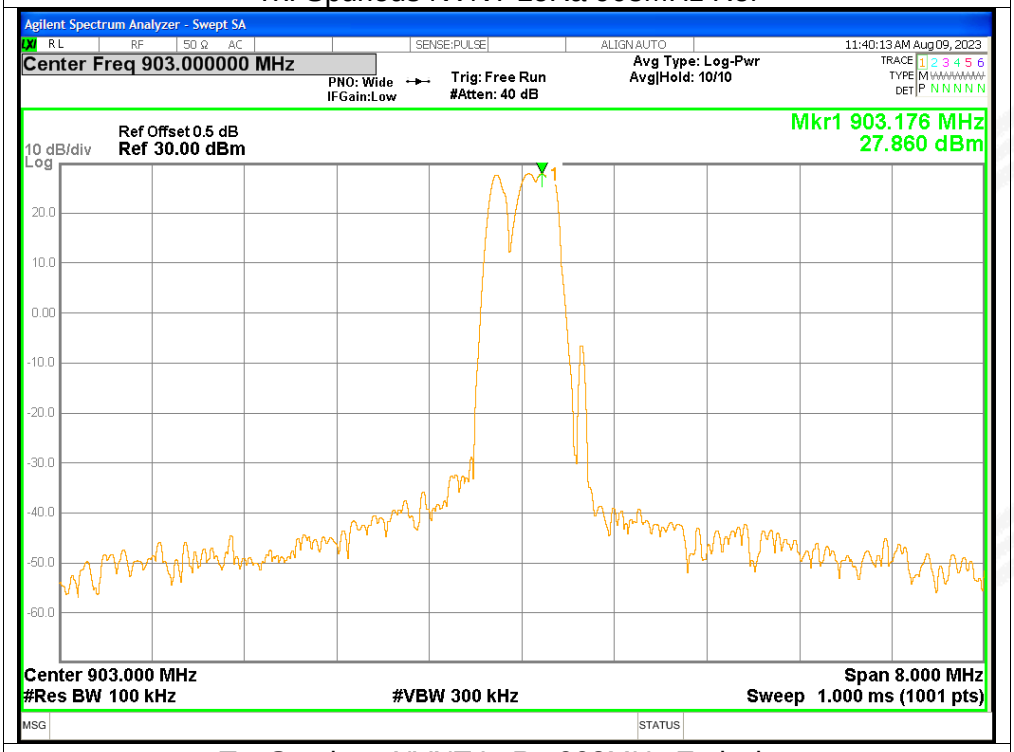


7. Conducted RF Spurious Emission

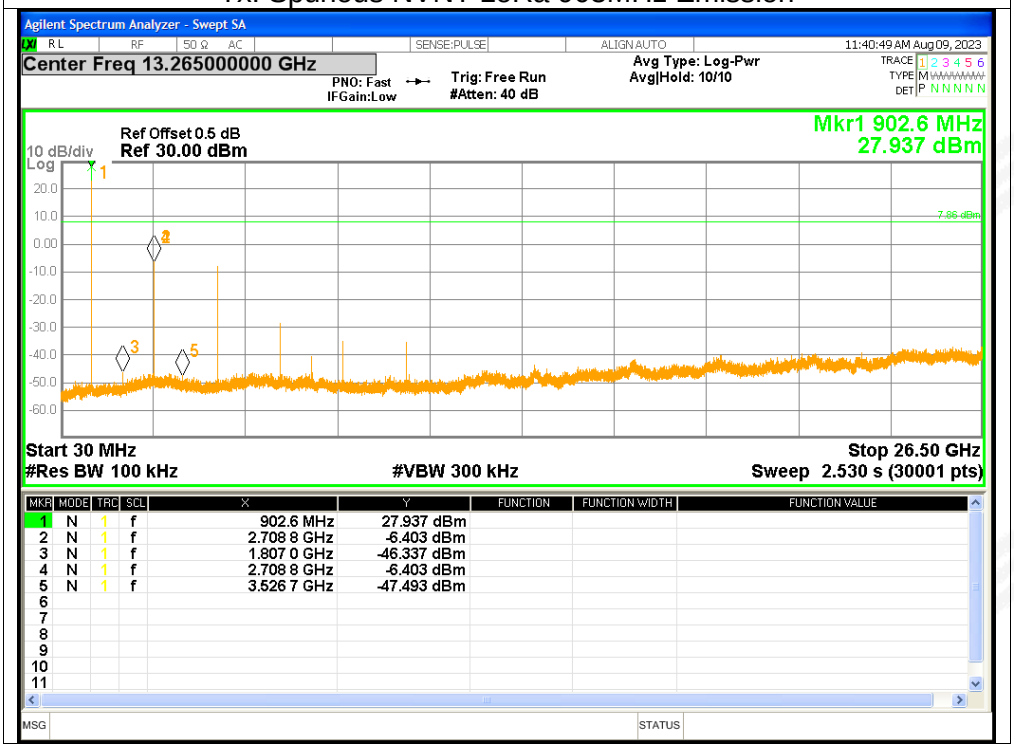
Condition	Mode	Frequency (MHz)	Max Value (dBc)	Limit (dBc)	Verdict
NVNT	LoRa	903	-34.26	<=-20	Pass
NVNT	LoRa	914.5	-63.82	<=-20	Pass
NVNT	LoRa	927	-52.14	<=-20	Pass

Test Graphs

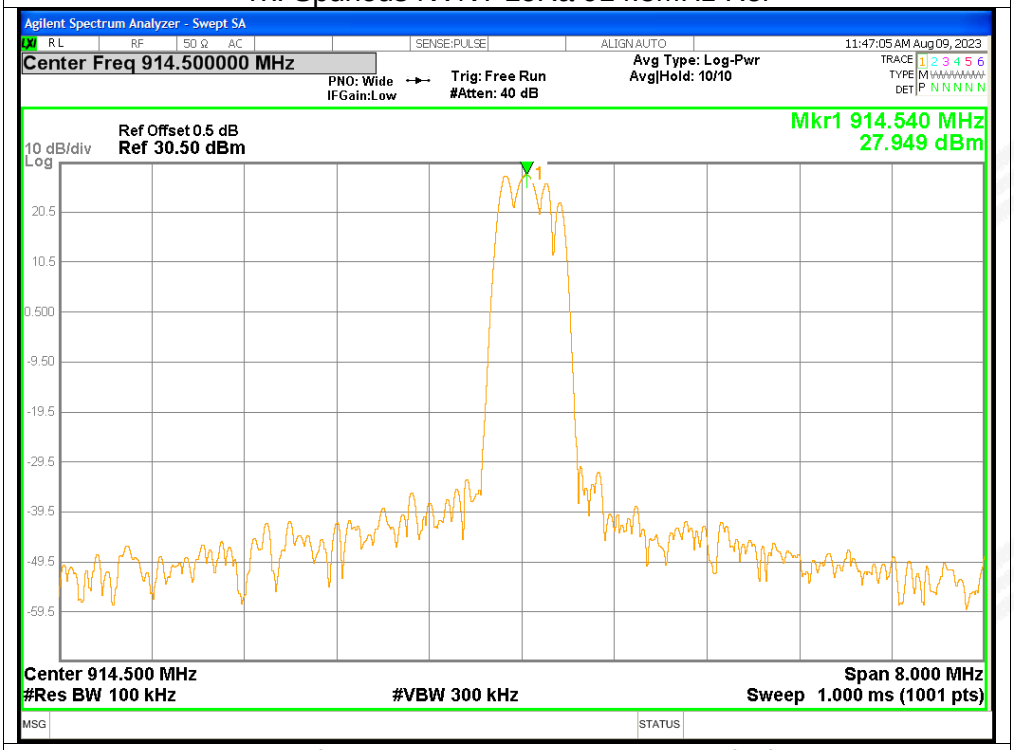
Tx. Spurious NVNT LoRa 903MHz Ref



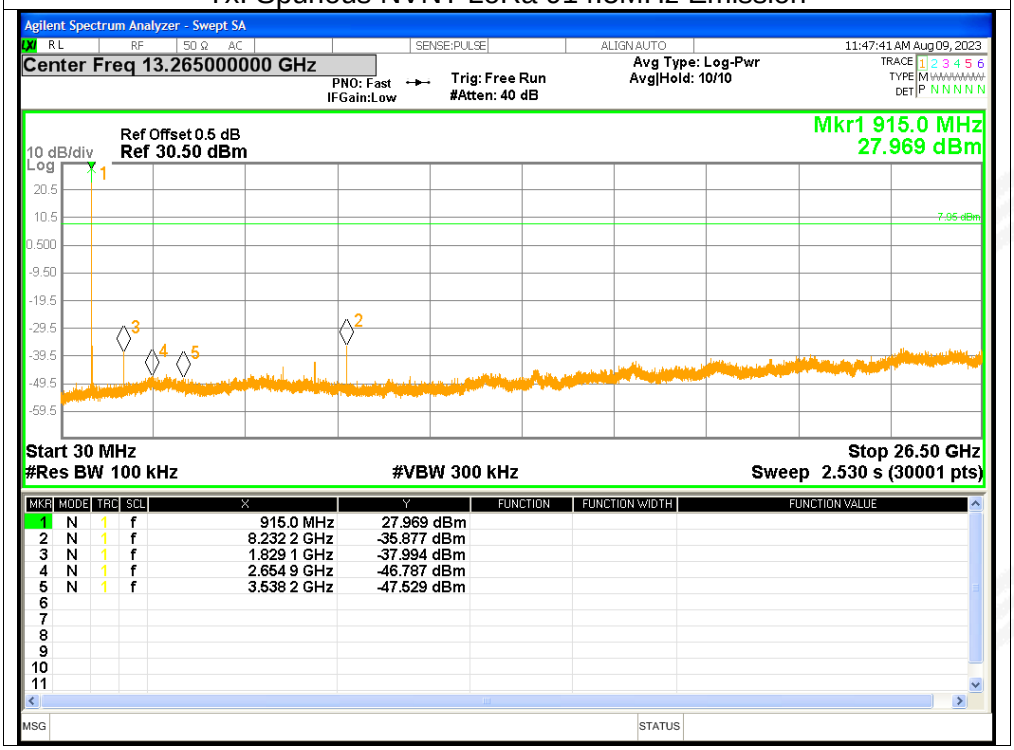
Tx. Spurious NVNT LoRa 903MHz Emission



Tx. Spurious NVNT LoRa 914.5MHz Ref

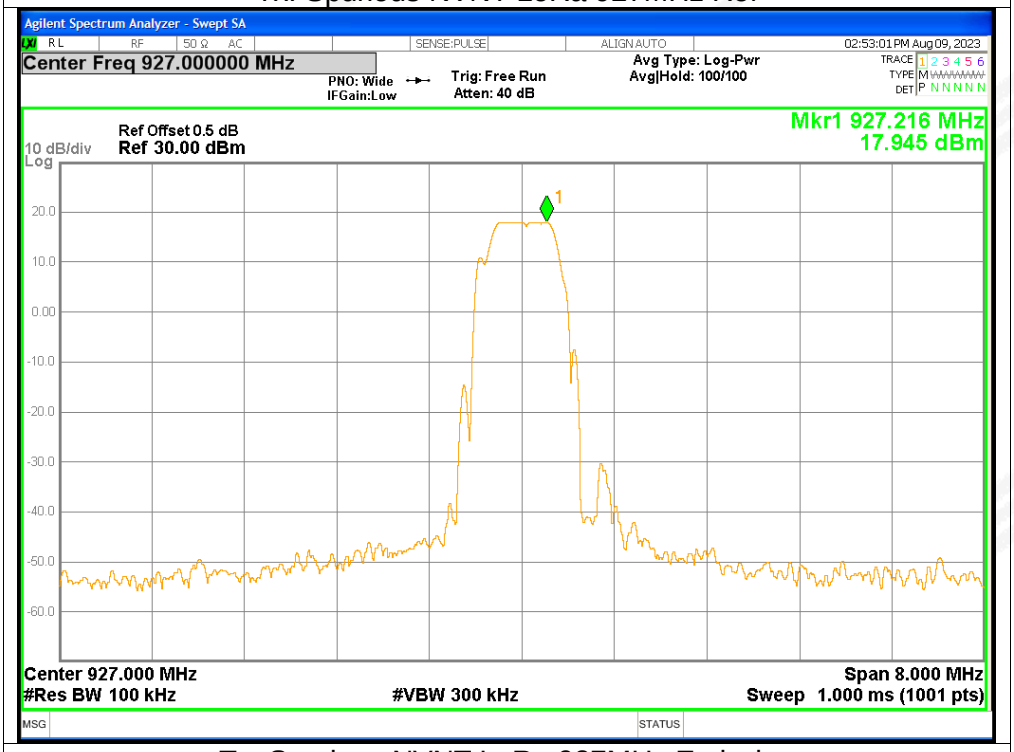


Tx. Spurious NVNT LoRa 914.5MHz Emission

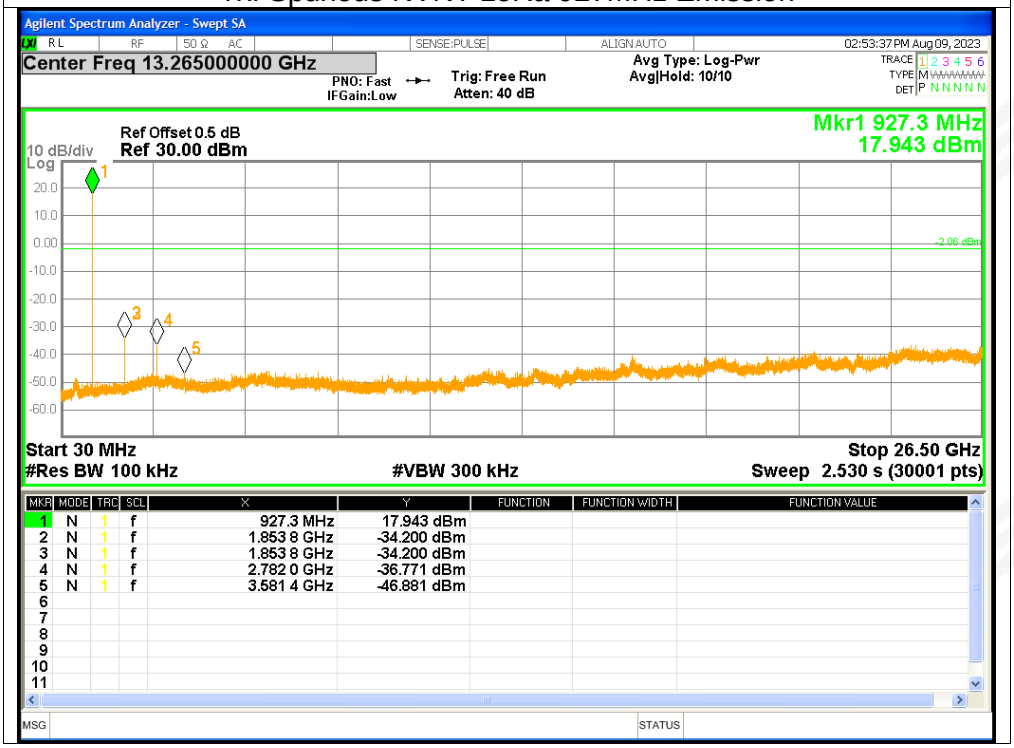


Test Graphs

Tx. Spurious NVNT LoRa 927MHz Ref



Tx. Spurious NVNT LoRa 927MHz Emission



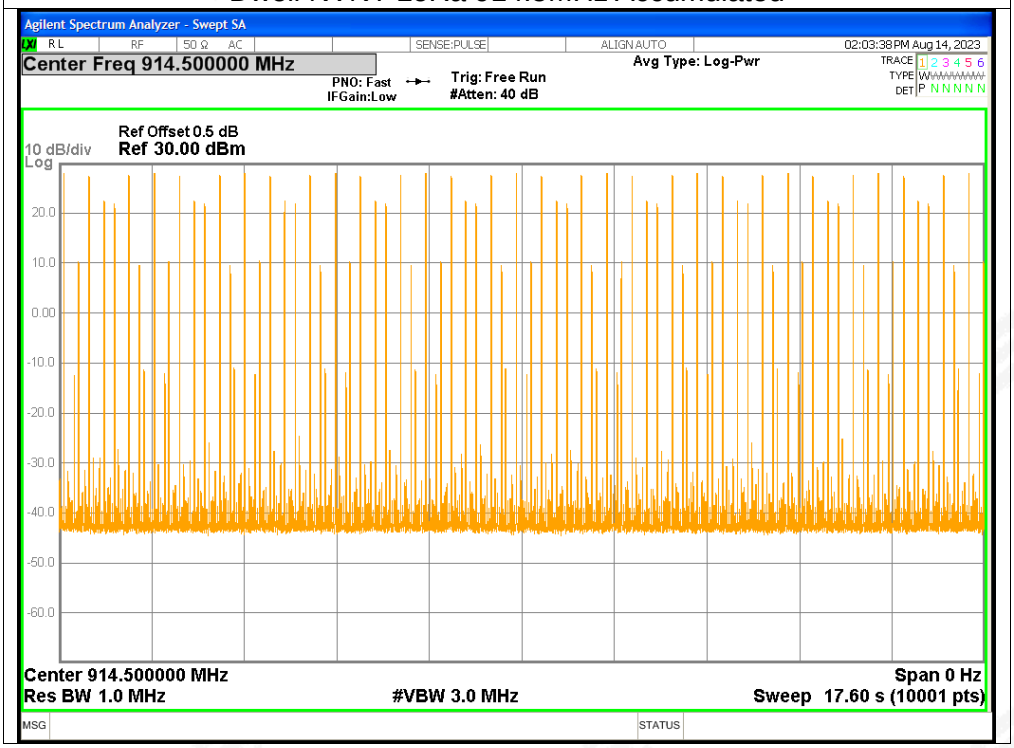
8. Dwell Time

Condition	Mode	Frequency (MHz)	Pulse Time (ms)	Total Dwell Time (ms)	Burst Count	Period Time (ms)	Limit (ms)	Verdict
NVNT	LoRa	914.5	12.89	399.59	31	17600	<=400	Pass

Test Graphs

Dwell NVNT LoRa 914.5MHz One Burst

Dwell NVNT LoRa 914.5MHz Accumulated

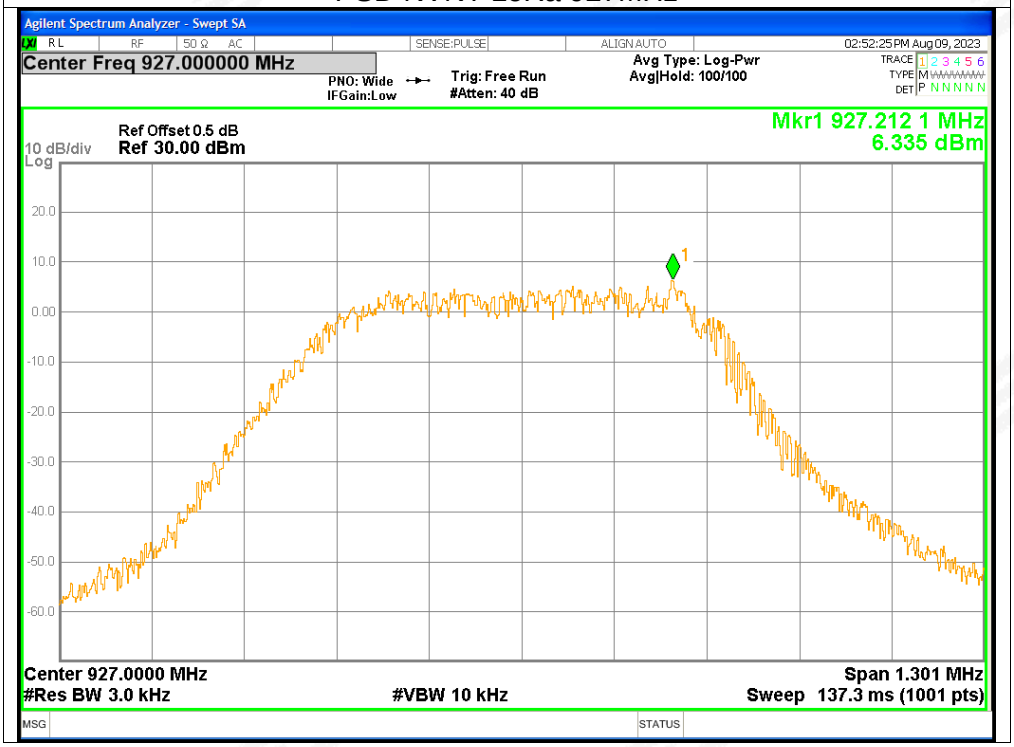


9. Maximum Power Spectral Density Level

Condition	Mode	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Verdict
NVNT	LoRa	927	6.34	<=8	Pass

Test Graphs

PSD NVNT LoRa 927MHz

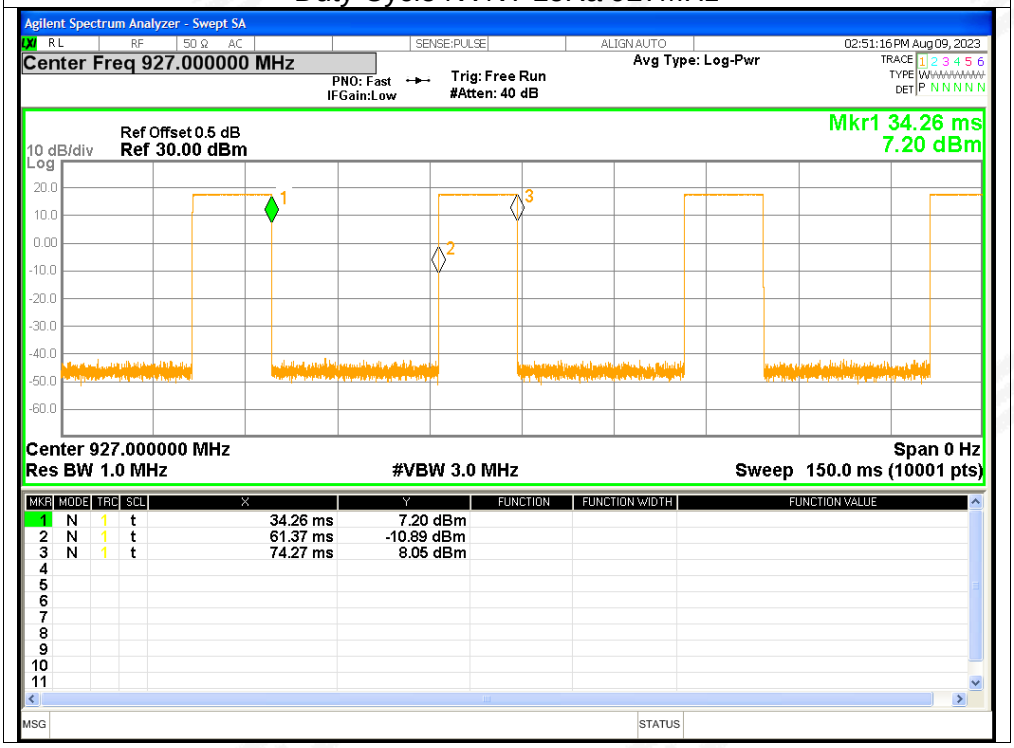


10. Duty Cycle

Condition	Mode	Frequency (MHz)	Duty Cycle (%)	Correction Factor (dB)	1/T (kHz)
NVNT	LoRa	927	32.25	4.91	0.08

Test Graphs

Duty Cycle NVNT LoRa 927MHz



APPENDIX 2-PHOTOS OF TEST SETUP

Note: See test photos in setup photo document for the actual connections between Product and support equipment.

※※※※※END OF THE REPORT※※※※※