



RF Test Report

Issued Date: Jul. 09, 2021

Applicant : Enlighten Company Limited
Product Type : Wireless LoRaWAN Sensor
Trade Name : Enligten, ChinoINT
Model Number : EL-WSX-923, AECIHWSNE2xx
FCC ID : 2AZMI-EL-WSX-923
EUT Rated Voltage : DC 3.6V
Test Voltage : DC 3.6V
Applicable Standard : FCC 47 CFR PART 15 SUBPART C
ANSI C63.10:2013
Receive Date : Apr. 15, 2021
Test Period : May 19 ~ Jul. 09, 2021

Issue by

A Test Lab Techno Corp.
101-104, 1F, A building, Safflower ridge industrial area,
Taoyuan street, Nanshan district, Shenzhen
Tel : +86-755-23987770 / Fax : +86-755-26637771
<http://www.atl-lab.com.tw/e-index.htm>



Certificate #3464.02

American Association for Laboratory Accreditation number: 3464.02
Test Firm MRA designation number: CN1168

Note:

1. The test results are valid only for samples provided by customers and under the test conditions described in this report.
2. This report shall not be reproduced except in full, without the written approval of A Test Lab Technology Corporation.
3. The relevant information is provided by customers in this test report. According to the correctness, appropriateness or completeness of the information provided by the customer, if there is any doubt or error in the information which affects the validity of the test results, the laboratory does not take the responsibility.

Approved By

:

Louis Shen

Reviewed By

:

Joyce Feng

(Manager)

(Louis Shen)

(Testing Engineer)

(Joyce Feng)



Revision History

Rev.	Issue Date	Revisions
00	Jul. 09, 2021	Initial Issue

TABLE OF CONTENTS

1	General Information	4
1.1.	Summary of Test Result.....	4
1.2.	Measurement Uncertainty	4
2	EUT Description.....	5
3	Test Methodology	6
3.1.	Mode of Operation	6
3.2.	EUT Test Step	7
3.3.	Configuration of Test System Details	7
3.4.	Test Instruments	8
3.5.	Test Site Environment.....	8
4	Measurement Procedure.....	9
4.1.	20 dB bandwidth	9
4.2.	Radiated Emissions Measurement	10
4.3.	Antenna Requirement.....	14
5	Test Results	15
	Annex A. 20dB bandwidth	15
	Annex B. Radiated Emissions Measurement	17

1 General Information

1.1. Summary of Test Result

Standard	Item	Results	Remark
15.215(c)	20 dB bandwidth	PASS	----
15.209&15.249(a)	Transmitter Radiated Emissions	PASS	----
15.249(d)	Bandedge	PASS	----
15.203	Antenna Requirement	PASS	----
CFR 47 Part 15.231(2010) / ANSI C63.10:2013			

Standard	Description
CFR47, Part 15, Subpart C	Intentional Radiators
ANSI C63. 10: 2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

Decision Rule

- ☒ Uncertainty is not included.
- ☐ Uncertainty is included.

1.2. Measurement Uncertainty

Test Item	Frequency Range	Uncertainty (dB)
Radiated Emission	9KHz ~ 30MHz	1.5
	30 MHz ~ 1000 MHz	1.7
	1000 MHz ~ 18000 MHz	5.7
	18000 MHz ~ 26500 MHz	5.5
	26500 MHz ~ 40000 MHz	4.8
RF Bandwidth	4.96 %	

2 EUT Description

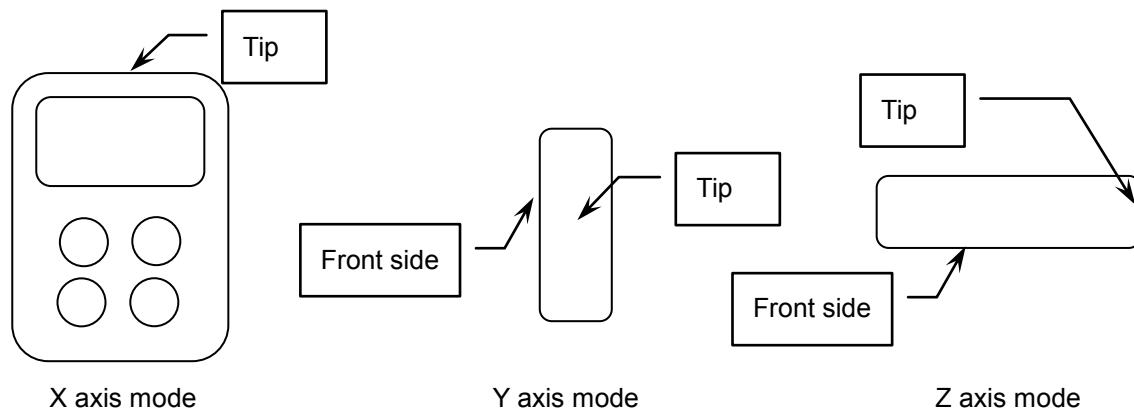
Applicant	Enlighten Company Limited Rm 12, 12/F, Blk A, Profit Industrial Building, No.1-15 Kwai Fung Crescent, Kwai Chung, N.T. Hong Kong
Manufacturer	Enlighten Company Limited Rm 12, 12/F, Blk A, Profit Industrial Building, No.1-15 Kwai Fung Crescent, Kwai Chung, N.T. Hong Kong
Product Type	Wireless LoRaWAN Sensor
Trade Name	Enligten, ChinoINT
Model Number	EL-WSX-923, AECIHWSNE2xx
Model Difference Description	Due to market demand, the models differ from each other in brand, the PCB layout, circuit, and schematic design are the same.
Test Model	EL-WSX-923
FCC ID	2AZMI-EL-WSX-923
Frequency Range	923.200 MHz
Modulation Type	CSS, FSK
Number of Channels	1 Channel
Antenna Type	Wire antenna
Antenna Gain	2.5 dBi
Operate Temp. Range	5~40 °C

3 Test Methodology

3.1. Mode of Operation

Test Mode	Note
Mode 1: Transmitter Mode	EUT works in normal mode
Mode 2: Continuous TX Mode	The manufacturer burn the firmware version in EUT in advance control the EUT to TX continuously, without test software and related power level setting parameter.

Then, the above highest fundamental level mode of the configuration of the EUT and antenna was chosen for all final test items. By preliminary testing and verifying three axis (X, Y and Z) position of EUT transmitted status, it was found that "Z axis" position was the worst, then the final test was executed the worst condition and test data were recorded in this report.

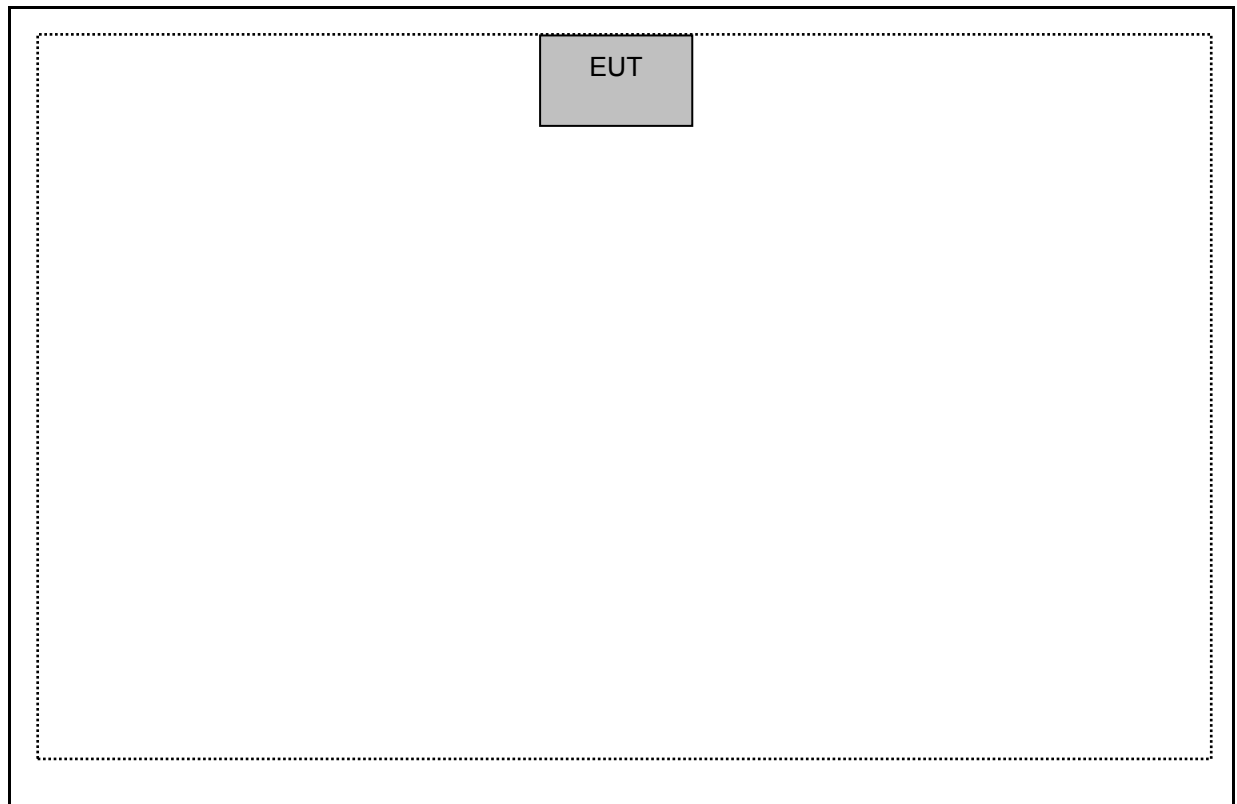


3.2. EUT Test Step

1.	Setup the EUT and simulators as shown on 4.1 and 4.2.
----	---

Measurement Software			
No.	Description	Software	Version
1	Radiated Emission	EZ EMC	ATL-03A1-1

3.3. Configuration of Test System Details



3.4. Test Instruments

For Radiated Emissions

Test Period: May 19 ~ Jul. 09, 2021

Equipment	Manufacturer	Model Number	Serial Number	Cal. Date	Remark
Preamplifier (10 kHz~3 GHz)	EMCI	EMC001330	980300	09/01/2020	1 year
Preamplifier (0.1 GHz~26.5 GHz)	EMCI	EMC012645SE	980318	09/01/2020	1 year
Bilog Antenna (30 MHz~1.4 GHz)	Schwarzbeck	VULB 9168	672	10/17/2020	1 year
Horn Antenna (1 GHz~18 GHz)	ETS	3117	00204949	10/17/2020	1 year
Horn Antenna (18 GHz~26.5 GHz)	ETS	3160-09	00202549	10/17/2020	1 year
Receiver (3 Hz~26.5 GHz)	Keysight	N9038A	MY51210179	09/01/2020	1 year
Spectrum Analyzer (3 Hz~43 GHz)	Keysight	N9030A	MY55410268	09/01/2020	1 year
Cable (30 MHz~1 GHz)	EMCI	N/A	1066LFC	09/01/2020	1 year
Cable (1 GHz~18 GHz)	EMCI	N/A	160719	09/01/2020	1 year
Cable (1 GHz~18 GHz)	EMCI	N/A	160324	09/01/2020	1 year
Cable (1 GHz~18 GHz)	EMCI	N/A	160322	09/01/2020	1 year
Loop Antenna	EMCI	LPA600	272	09/01/2020	1 year
Test Site	OuHeng	MFAC3M	RE-026	02/23/2021	1 year

For Conducted

Test Period: May 19, 2021

Equipment	Manufacturer	Model Number	Serial Number	Cal. Date	Remark
Spectrum Analyzer (10 Hz~26.5 GHz)	Agilent	N9020A	MY53420615	09/01/2020	1 year
Spectrum Analyzer (9 KHz~26.5 GHz)	Agilent	E4445A	MY46181814	09/01/2020	1 year
Test Site	ATL	RF	RF	N.C.R.	-----

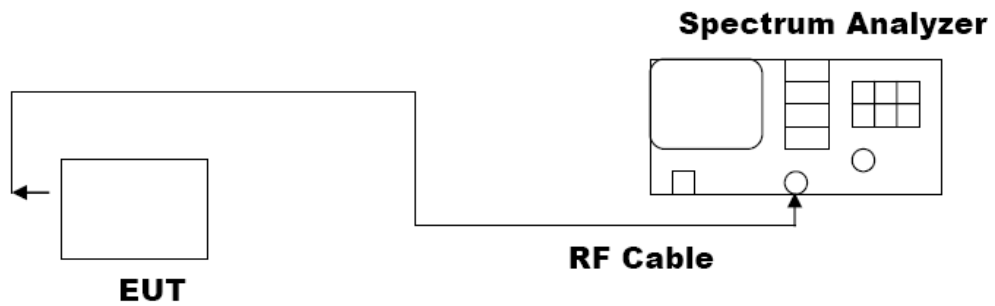
3.5. Test Site Environment

Items	Required (IEC 60068-1)	Actual
Temperature (°C)	15-35	26
Humidity (%RH)	25-75	60
Barometric pressure (mbar)	860-1060	990

4 Measurement Procedure

4.1. 20 dB bandwidth

- Setup



4.2. Radiated Emissions Measurement

■ Limit

According to FCC Part 15.249(a) requirement:

In addition to the provisions of §15.205, the field strength of emissions from intentional radiator operated under this section shall not exceed the following:

Fundamental emission limits

Frequency range	Field Strength of Fundamental
(MHz)	(dBμV/m@3 m)
923.200	94

Harmonics emission limits

Fundamental frequency	Field strength of fundamental (millivolts/meter)	Field strength of harmonics (microvolts/meter)
902-928 MHz	50	500
2400-2483.5 MHz	50	500
5725-5875 MHz	50	500
24.0-24.25 GHz	250	2500

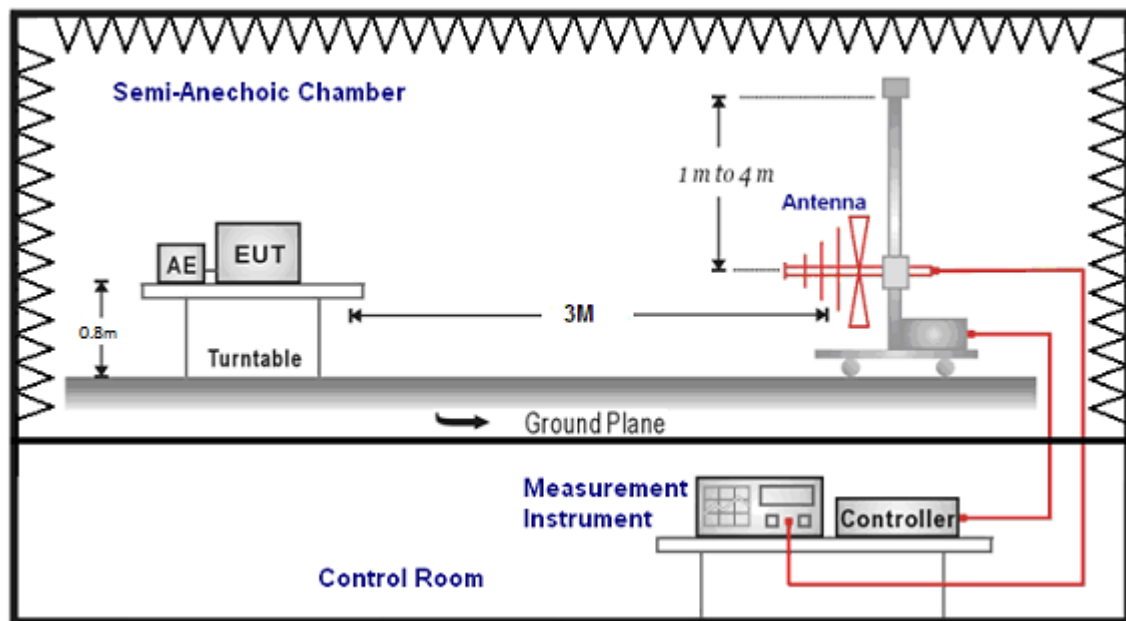
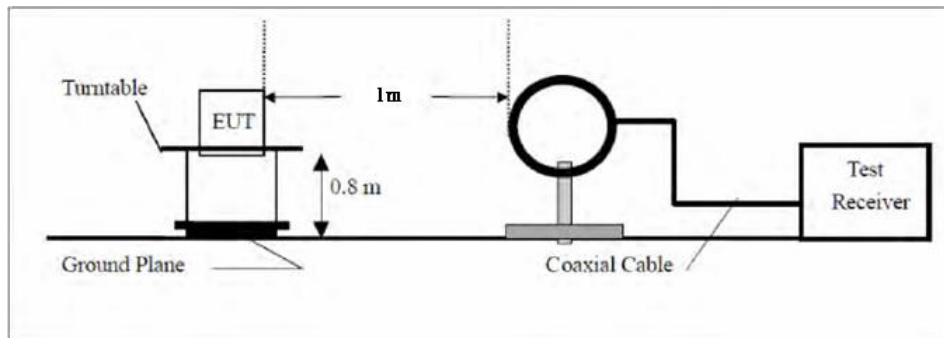
General Radiated emission Limit

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

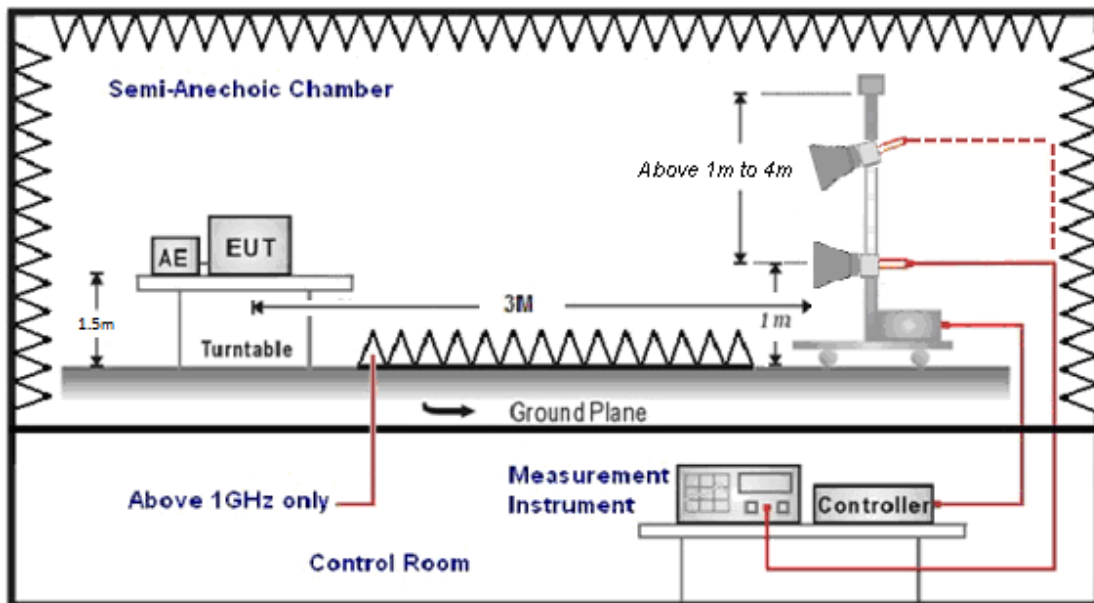
Remark: 1. The measurement distance in meters, which that between form closest point of EUT to instrument antenna.

■ Setup

Below 1 GHz



Above 1 GHz



■ Test Procedure

Final radiation measurements were made on a three-meter, Semi Anechoic Chamber. The EUT system was placed on a nonconductive turntable which is 0.8 or 1.5 meters height, top surface 1.0 x 1.5 meter. The spectrum was examined from 250 MHz to 2.5 GHz in order to cover the whole spectrum below 10th harmonic which could generate from the EUT. During the test, EUT was set to transmit continuously & Measurements spectrum range from 30 MHz to 26.5 GHz is investigated.

For measurements below 1 GHz the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak. For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, and then the video bandwidth is set to 3 MHz for peak measurements and 10 Hz for average measurements.

A nonconductive material surrounded the EUT to supporting the EUT for standing on three orthogonal planes. At each condition, the EUT was rotated 360 degrees, and the antenna was raised and lowered from one to four meters to find the maximum emission levels. Measurements were taken using both horizontal and vertical antenna polarization.

SCHWARZBECK MESS-ELEKTRONIK Biconilog Antenna at 3 Meter and the SCHWARZBECK Double Ridged Guide Antenna was used in frequencies 1 – 26.5 GHz at a distance of 1 meter. All test results were extrapolated to equivalent signal at 3 meters utilizing an inverse linear distance extrapolation Factor (20 dB/decade).

For testing above 1 GHz, the emission level of the EUT in peak mode was 20 dB lower than average limit (that means the emission level in peak mode also complies with the limit in average mode), then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.

Appropriate preamplifiers were used for improving sensitivity and precautions were taken to avoid overloading or desensitizing the spectrum analyzer. No post – detector video filters were used in the test.

The spectrum analyzer's 6 dB bandwidth was set to 1 MHz, and the analyzer was operated in the peak detection mode, for frequencies both below and up 1 GHz. The average levels were obtained by subtracting the duty cycle correction factor from the peak readings.

The following procedures were used to convert the emission levels measured in decibels referenced to 1 microvolt (dBuV) into field intensity in micro volts per meter (uV/m).

The actual field intensity in decibels referenced to 1 microvolt in to field intensity in micro volts per meter (dBuV/m).

The actual field intensity in referenced to 1 microvolt per meter (dBuV/m) is determined by algebraically adding the measured reading in dBuV, the antenna factor (dB), and cable loss (dB) and Subtracting the gain of preamplifier (dB) is auto calculate in spectrum analyzer.

$$(1) \text{ Amplitude (dBuV/m) = FI (dBuV) + AF (dBuV) + CL (dBuV) - Gain (dB)}$$

FI= Reading of the field intensity.

AF= Antenna factor.

CL= Cable loss.

P.S Amplitude is auto calculate in spectrum analyzer.

$$(2) \text{ Actual Amplitude (dBuV/m) = Amplitude (dBuV) - Dis(dB)}$$

The FCC specified emission limits were calculated according the EUT operating frequency and by following linear interpolation equations:

(a) For fundamental frequency : Transmitter Output < +30 dBm

(b) For spurious frequency : Spurious emission limits = fundamental emission limit /10

Data of measurement within this frequency range without mark in the table above means the reading of emissions are attenuated more than 20 dB below the permissible limits or the field strength is too small to be measured.

■ Calculation of Average Factor

The output field strengths of specification in accordance with the FCC rules specify measurements with an average detector. During the test, a spectrum analyzer incorporating a peak detector was used. Therefore, a reduction factor can be applied to the resultant peak signal level and compared to the limit for measurement instrumentation incorporating an average detector.

Please see the diagrams below.

(*) When the field strength (or envelope power) is not constant or when it is in pulses, and an averaging detector is specified to be used, the value of field strength or power over one complete pulse train, excluding blanking intervals, shall be averaged as long as the pulse train does not exceed 0.1 seconds. In cases where the pulse train exceeds 0.1 seconds, the average value (of field strength or output power) shall be determined during a 0.1 second interval during which the field strength or power is at its maximum value.



4.3. Antenna Requirement

- **Limit**

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.

- **Antenna Connector Construction**

See section 2 – antenna information.



5 Test Results

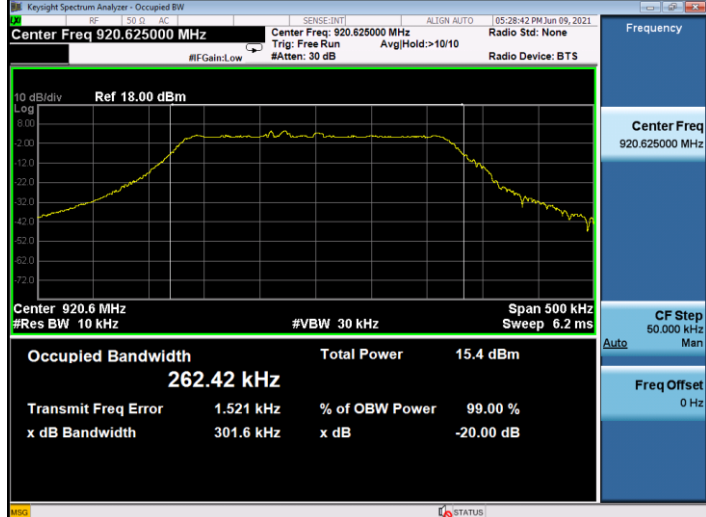
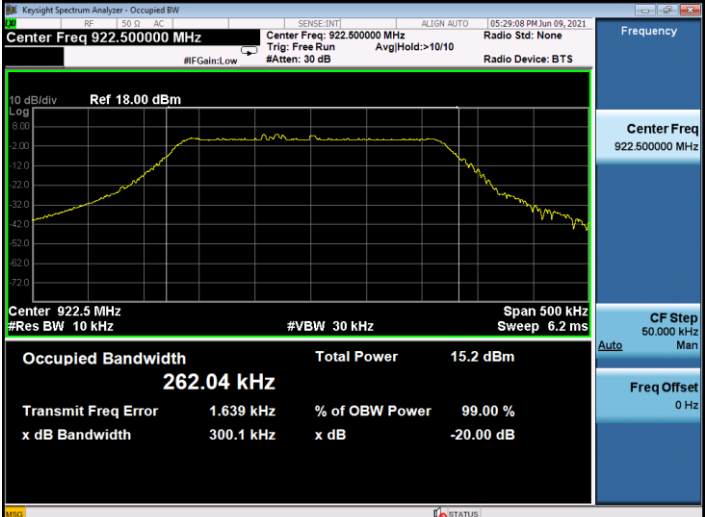
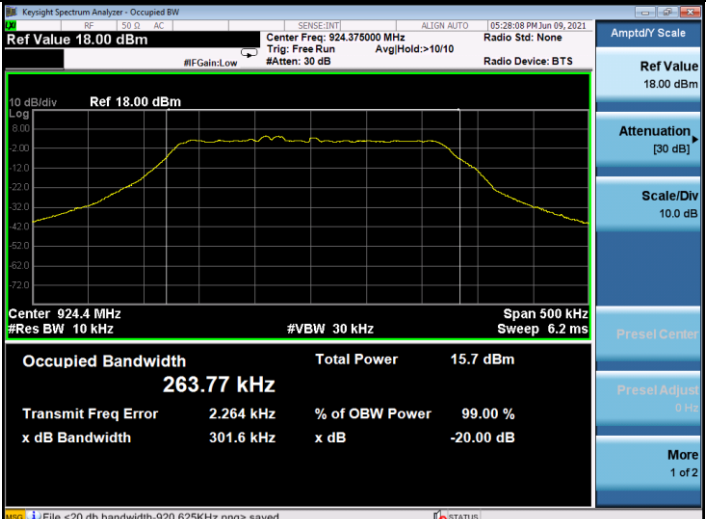
Annex A. 20dB bandwidth

Test Mode	Frequency (MHz)	Measurement Results (KHz)
Mode 2	920.625	301.6
	922.500	300.1
	924.375	301.6



Test Graphs

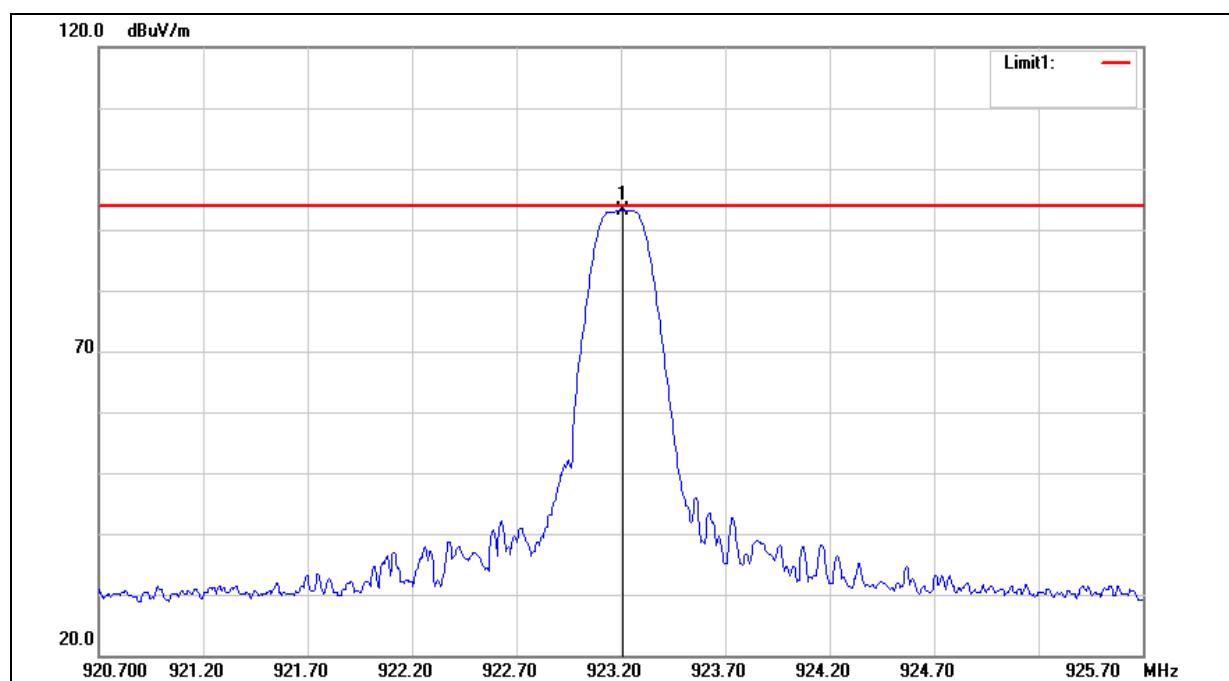
Mode 2: Continuous TX mode

920.625 MHz	 Key parameters from the 920.625 MHz screenshot: - Center Freq: 920.625000 MHz - Span: 500 kHz - Occupied Bandwidth: 262.42 kHz - Total Power: 15.4 dBm - Transmit Freq Error: 1.521 kHz % of OBW Power: 99.00 % - x dB Bandwidth: 301.6 kHz - x dB: -20.00 dB
922.500 MHz	 Key parameters from the 922.500 MHz screenshot: - Center Freq: 922.500000 MHz - Span: 500 kHz - Occupied Bandwidth: 262.04 kHz - Total Power: 15.2 dBm - Transmit Freq Error: 1.639 kHz % of OBW Power: 99.00 % - x dB Bandwidth: 300.1 kHz - x dB: -20.00 dB
924.375 MHz	 Key parameters from the 924.375 MHz screenshot: - Center Freq: 924.375000 MHz - Span: 500 kHz - Occupied Bandwidth: 263.77 kHz - Total Power: 15.7 dBm - Transmit Freq Error: 2.264 kHz % of OBW Power: 99.00 % - x dB Bandwidth: 301.6 kHz - x dB: -20.00 dB

Annex B. Radiated Emissions Measurement

Fundamental Frequency Test Results

Standard:	FCC Part 15. 249(a)	Test Distance:	3 m
Test item:	Fundamental	Power:	DC 3.6V
Test Mode:	Mode 2	Temp.(°C)/Hum.(%RH):	26(°C)/60 %RH
Ant.Polar.:	Horizontal		

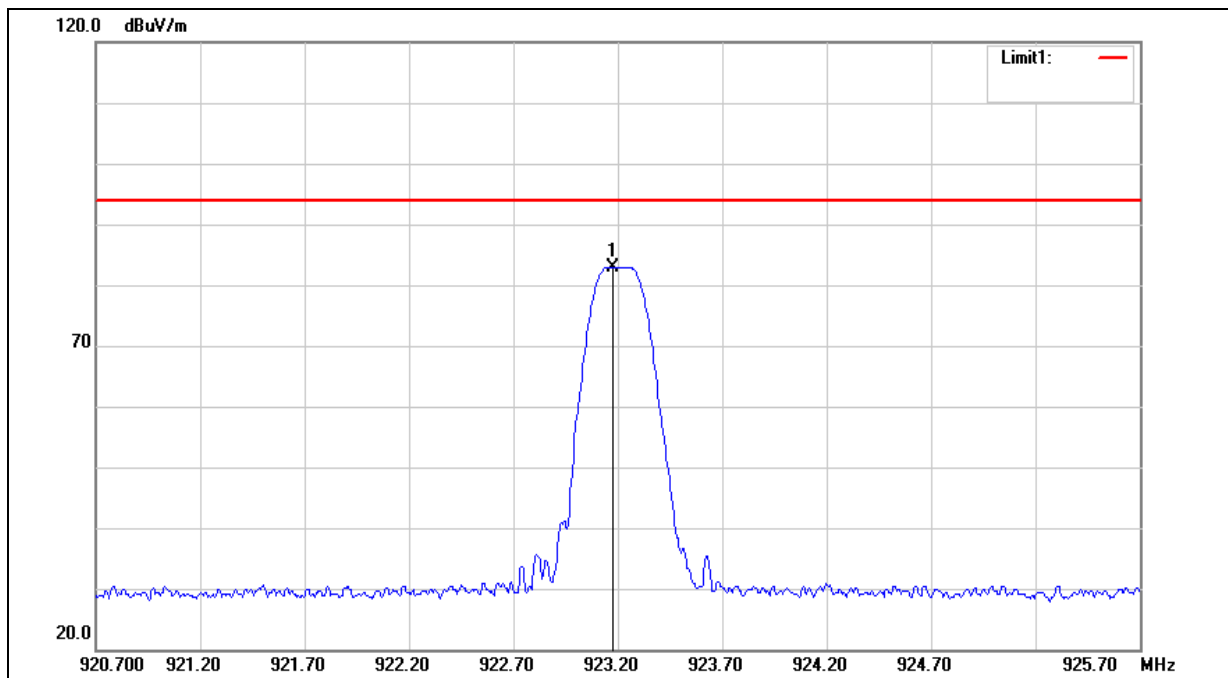


No.	Frequency (MHz)	Reading (dBuV)	Correct Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	923.2100	91.87	1.24	93.11	94.00	-0.89	QP

Note: 1. Result (dBuV) = Correction factor (dB) + Reading(dBuV).

2. Correction factor (dB/m) = Antenna Factor (dB/m) + Cable loss (dB) – Pre-Amplifier gain (dB).

Standard:	FCC Part 15.249(a)	Test Distance:	3 m
Test item:	Fundamental	Power:	DC 3.6 V
Test Mode:	Mode 2	Temp.(°C)/Hum.(%RH):	26(°C)/60 %RH
Ant.Polar.:	Vertical		



No.	Frequency (MHz)	Reading (dBuV)	Correct Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	923.1800	81.65	1.24	82.89	94.00	-11.11	QP

Note: 1. Result (dBuV) = Correction factor (dB) + Reading(dBuV).

2. Correction factor (dB/m) = Antenna Factor (dB/m) + Cable loss (dB) – Pre-Amplifier gain (dB).

Below 1 GHz

9KHz ~30MHz

H/V	Frequency	Reading	Correct	Result	Limit	Margin	Degree
	(MHz)	(dBuV)	Factor(dB/m)	(dBuV/m)	(dBuV/m)	(dB)	(°)
H	0.0785	-58.89	36.80	-22.09	29.70	-51.79	QP
H	0.2347	-35.74	26.12	-9.62	20.19	-29.81	QP
H	0.7288	-41.12	17.89	-23.23	30.35	-53.58	QP
H	2.4382	-43.86	14.09	-29.77	29.54	-59.31	QP
H	5.2274	-44.03	13.01	-31.02	29.54	-60.56	QP
H	8.0166	-41.59	12.34	-29.25	29.54	-58.79	QP
V	0.0494	-49.68	41.46	-8.22	33.73	-41.95	QP
V	0.1310	-18.40	31.56	13.16	25.25	-12.09	QP
V	0.2945	-36.78	24.50	-12.28	18.22	-30.50	QP
V	0.6468	-41.25	18.74	-22.51	31.38	-53.89	QP
V	2.2282	-43.51	14.20	-29.31	29.54	-58.85	QP
V	5.5873	-41.27	12.93	-28.34	29.54	-57.88	QP

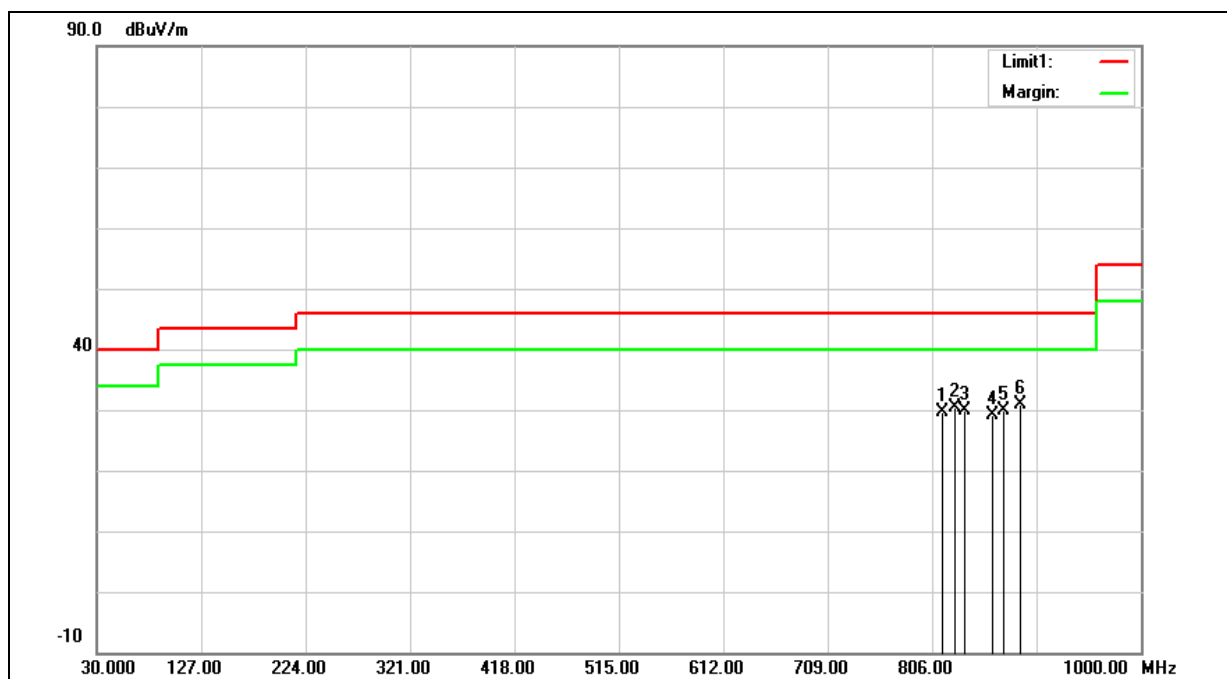
Note:1. Result (dBuV) = Correction factor (dB) + Reading(dBuV).

Example: -22.09=36.80-58.89

2. Correction factor (dB/m) = Antenna Factor (dB/m) + Cable loss (dB) – Pre-Amplifier gain (dB).

30MHz ~ 1GHz

Standard:	FCC Part 15.209	Test Distance:	3 m
Test item:	Harmonic	Power:	DC 3.6 V
Test Mode:	Mode 1	Temp.(°C)/Hum.(%RH):	26(°C)/60 %RH
Description:	Horizontal		



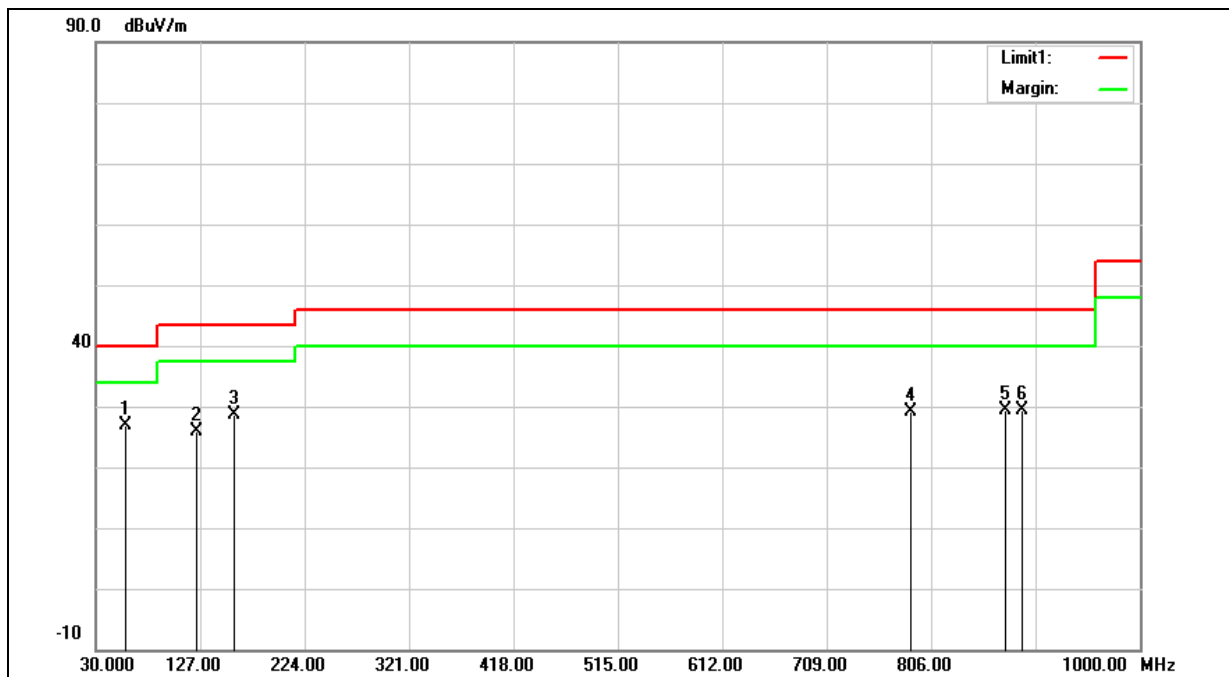
No.	Frequency (MHz)	Reading (dBuV)	Correct Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	815.7000	29.12	0.43	29.55	46.00	-16.45	QP
2	827.3400	29.85	0.51	30.36	46.00	-15.64	QP
3	836.0700	29.20	0.58	29.78	46.00	-16.22	QP
4	862.2600	28.36	0.75	29.11	46.00	-16.89	QP
5	872.9300	29.11	0.83	29.94	46.00	-16.06	QP
6	888.4500	29.86	0.94	30.80	46.00	-15.20	QP

Note: 1. Result (dBuV) = Correction factor (dB) + Reading(dBuV).

Example: 29.55=0.43+29.12

2. Correction factor (dB/m) = Antenna Factor (dB/m) + Cable loss (dB) – Pre-Amplifier gain (dB).

Standard:	FCC Part 15.209	Test Distance:	3 m
Test item:	Harmonic	Power:	DC 3.6 V
Test Mode:	Mode 1	Temp.(°C)/Hum.(%RH):	26(°C)/60 %RH
Description:	Vertical		



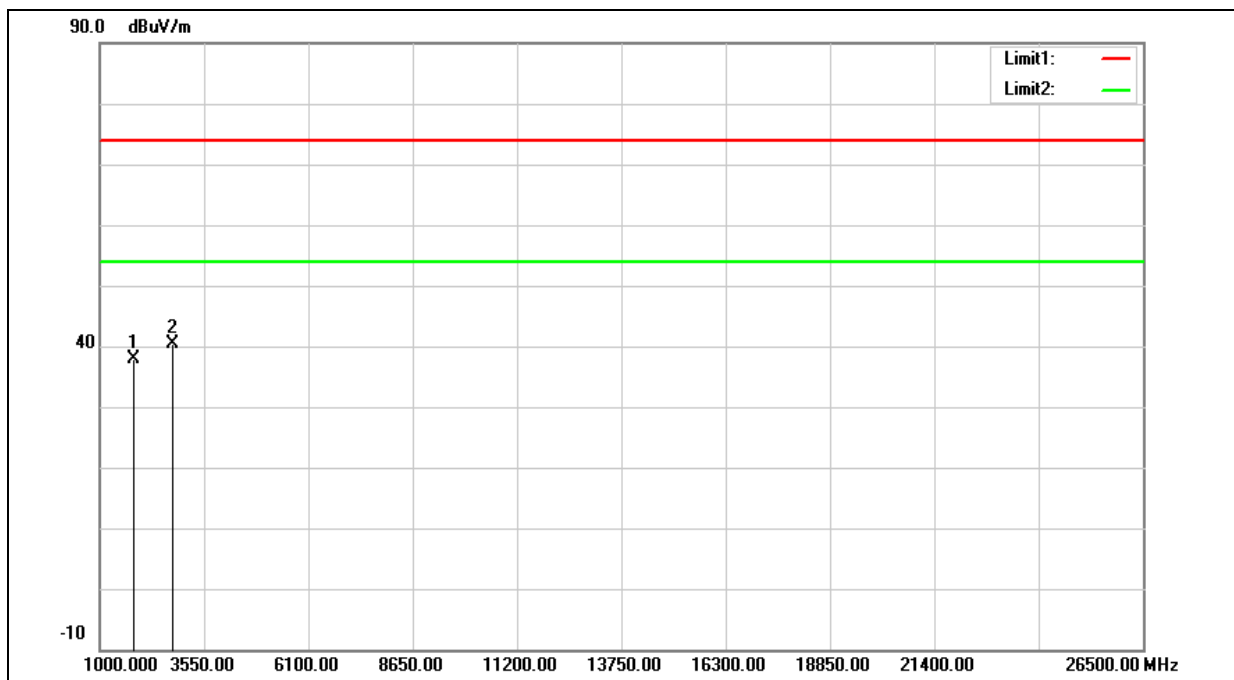
No.	Frequency (MHz)	Reading (dBuV)	Correct Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	58.1300	38.19	-11.31	26.88	40.00	-13.12	QP
2	124.0900	38.67	-12.76	25.91	43.50	-17.59	QP
3	159.0100	39.33	-10.60	28.73	43.50	-14.77	QP
4	786.6000	29.13	0.08	29.21	46.00	-16.79	QP
5	874.8700	28.47	0.84	29.31	46.00	-16.69	QP
6	890.3900	28.47	0.95	29.42	46.00	-16.58	QP

Note:1. Result (dBuV) = Correction factor (dB) + Reading(dBuV).

2. Correction factor (dB/m) = Antenna Factor (dB/m) + Cable loss (dB) – Pre-Amplifier gain (dB).

Above 1 GHz

Standard:	FCC Part 15.209	Test Distance:	3 m
Test item:	Harmonic	Power:	DC 3.6 V
Test Mode:	Mode 1	Temp.(°C)/Hum.(%RH):	26(°C)/60 %RH
Description:	Horizontal		

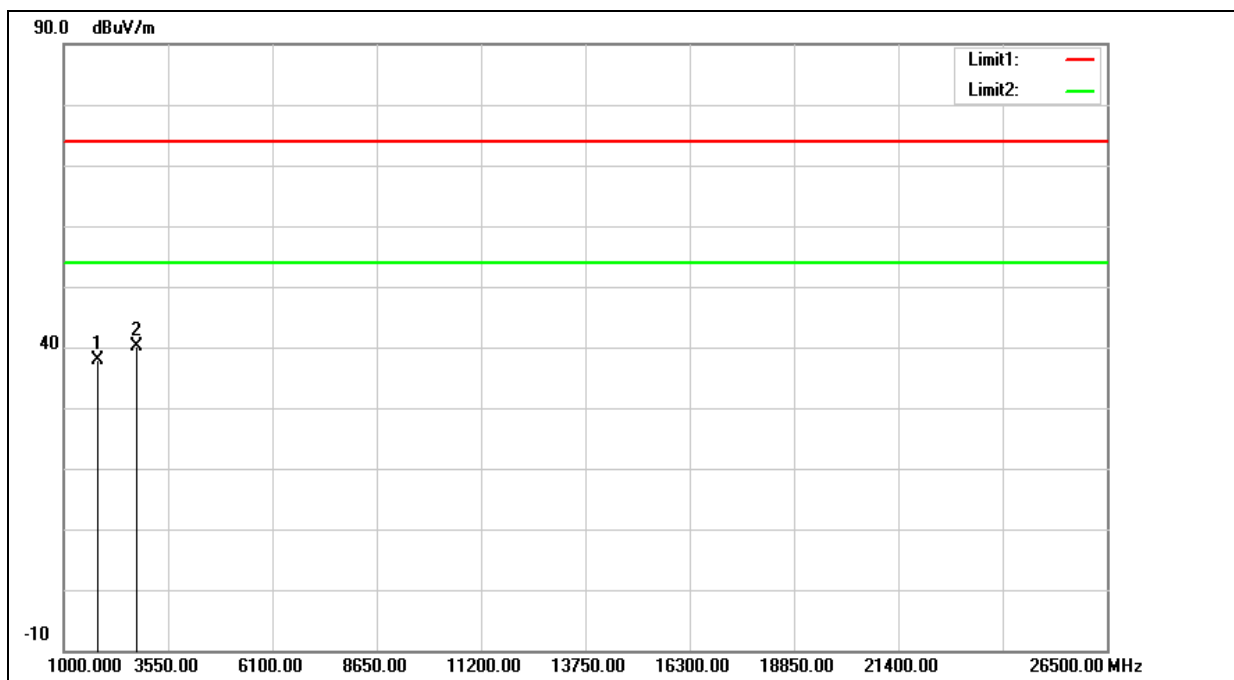


No.	Frequency (MHz)	Reading (dBuV)	Correct Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1846.400	50.91	-12.99	37.92	74.00	-36.08	peak
2	2769.600	49.82	-9.55	40.27	74.00	-33.73	peak

Note: 1. Result (dBuV) = Correction factor (dB) + Reading(dBuV).

2. Correction factor (dB/m) = Antenna Factor (dB/m) + Cable loss (dB) – Pre-Amplifier gain (dB).

Standard:	FCC Part 15.209	Test Distance:	3 m
Test item:	Harmonic	Power:	DC 3.6 V
Test Mode:	Mode 1	Temp.(°C)/Hum.(%RH):	26(°C)/60 %RH
Description:	Vertical		



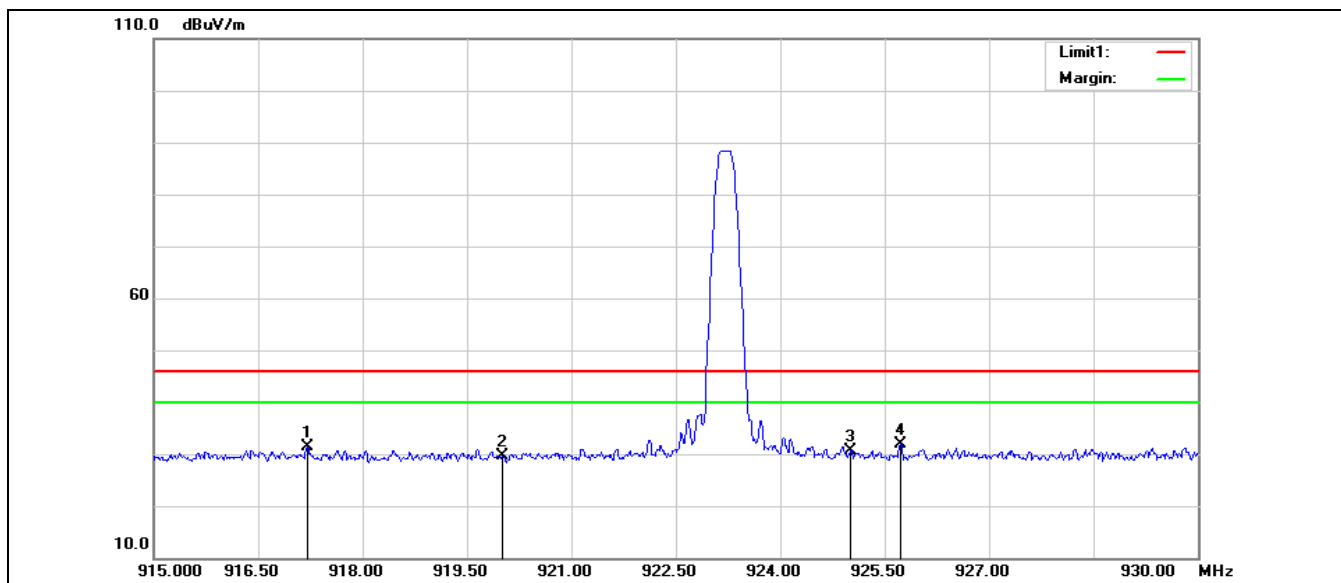
No.	Frequency (MHz)	Reading (dBuV)	Correct Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	1846.400	50.77	-12.99	37.78	74.00	-36.22	peak
2	2769.600	49.69	-9.55	40.14	74.00	-33.86	peak

Note:1. Result (dBuV) = Correction factor (dB) + Reading(dBuV).

2. Correction factor (dB/m) = Antenna Factor (dB/m) + Cable loss (dB) – Pre-Amplifier gain (dB).

Bandedge

Standard:	FCC Part 15.249	Test Distance:	3 m
Test item:	Bandedge	Power:	DC 3.6 V
Test Mode:	Mode 1	Temp.(°C)/Hum.(%RH):	26(°C)/60 %RH
Description:	Horizontal		

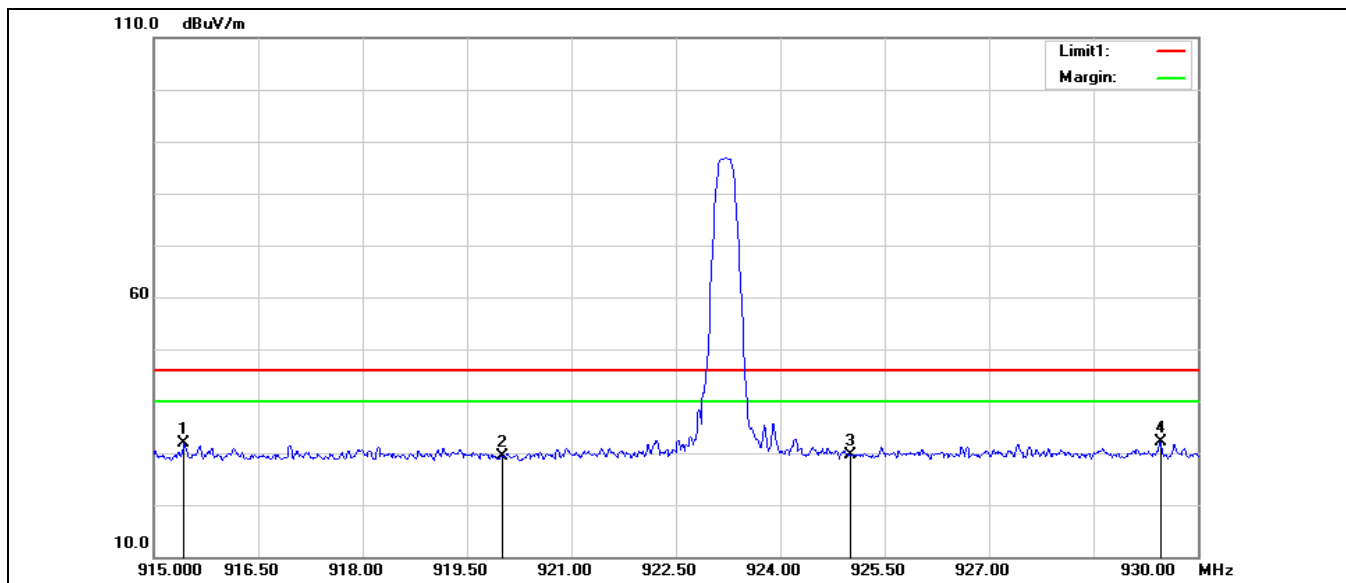


No.	Frequency (MHz)	Reading (dBuV)	Correct Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	917.2050	30.25	1.18	31.43	46.00	-14.57	peak
2	920.0000	28.30	1.21	29.51	46.00	-16.49	peak
3	925.0000	29.42	1.26	30.68	46.00	-15.32	peak
4	925.7250	30.68	1.26	31.94	46.00	-14.06	peak

Note:1. Result (dBuV) = Correction factor (dB) + Reading(dBuV).

2. Correction factor (dB/m) = Antenna Factor (dB/m) + Cable loss (dB) – Pre-Amplifier gain (dB).

Standard:	FCC Part 15.249	Test Distance:	3 m
Test item:	Bandedge	Power:	DC 3.6 V
Test Mode:	Mode 1	Temp.(°C)/Hum.(%RH):	26(°C)/60 %RH
Description:	Vertical		



No.	Frequency (MHz)	Reading (dBuV)	Correct Factor (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
1	915.4350	30.64	1.16	31.80	46.00	-14.20	peak
2	920.0000	28.20	1.21	29.41	46.00	-16.59	peak
3	925.0000	28.44	1.26	29.70	46.00	-16.30	peak
4	929.4600	30.93	1.30	32.23	46.00	-13.77	peak

Note:1. Result (dBuV) = Correction factor (dB) + Reading(dBuV).

2. Correction factor (dB/m) = Antenna Factor (dB/m) + Cable loss (dB) – Pre-Amplifier gain (dB).