

FREEWINGS DIGITAL TECHNOLOGIES (NINGBO) CO., LTD

TEST REPORT

SCOPE OF WORK

FCC TESTING-100015716

REPORT NUMBER

191127005SZN-001

ISSUE DATE

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FREEWINGS DIGITAL TECHNOLOGIES (NINGBO) CO., LTD

Application
For
Certification

FCC ID: 2AR7X-FW1821SBAR

36`` 2.1 SOUND BAR

Model: 100015716

Brand Name: onn.

2.4GHz Transceiver

Report No.: 191127005SZN-001

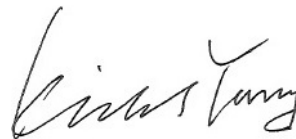
We hereby certify that the sample of the above item is considered to comply with the requirements of FCC Part 15, Subpart C for Intentional Radiator, mention 47 CFR [10-1-18]

Prepared and Checked by:

Approved by:



Leo Li
Project Engineer



Kidd Yang
Technical Supervisor
Date: December 11, 2019

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Intertek Testing Services Shenzhen Ltd. Longhua Branch

101, 201, Building B, No. 308 Wuhe Avenue, Zhangkengjing Community, GuanHu Subdistrict, LongHua District, ShenZhen, P.R. China
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MEASUREMENT/TECHNICAL REPORT

This report concerns (check one:) Original Grant X Class II Change _____

Equipment Type: DXX - Part 15 Low Power Communication Device Transmitter

Deferred grant requested per 47 CFR 0.457(d)(1)(ii)? Yes _____ No X

If yes, defer until: _____
date

Company Name agrees to notify the Commission by: _____
date

of the intended date of announcement of the product so that the grant can be issued on that date.

Transition Rules Request per 15.37? Yes _____ No X

If no, assumed Part 15, Subpart C for intentional radiator – the new 47 CFR [10-1-18 Edition] provision.

Report prepared by:

Leo Li
Intertek Testing Services Shenzhen Ltd. Longhua Branch
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1.0 Summary of Test Result

Applicant: FREEWINGS DIGITAL TECHNOLOGIES (NINGBO) CO., LTD

Applicant Address: 502, WENSHUI ROAD, SHOUNAN SUBDISTRICT, YINZHOU, NINGBO, CHINA

MODEL: 100015716

FCC ID: 2AR7X-FW1821SBAR

Test Specification	Reference	Results
Transmitter Radiated Emission	15.249 &15.209 &15.205	Pass
Conducted Emission	15.207	Pass
Bandedge	15.249 &15.209 &15.205	Pass
20dB Bandwidth	15.215(c)	Pass

Notes: The EUT uses an Integral Antenna which in accordance to Section 15.203 is considered sufficient to comply with the provisions of this section.

2.0 General Description

2.1 Product Description

The equipment under test (EUT) is a 36`` 2.1 SOUND BAR with Bluetooth 4.2 (Single Mode EDR) function operating in 2402-2480MHz. The EUT is powered by AC 120V/60Hz. For more detail information pls. refer to the user manual.

Antenna Type: Integral antenna

Modulation Type: GFSK, $\pi/4$ -DQPSK and 8-DPSK

Antenna Gain: 1dBi Max

Bluetooth Version: 4.2 (Single Mode EDR)

The 36`` 2.1 SOUND BAR, Model: 100015716 has two designing schemes. It would be placed on the market with two different power boards. Partly tests are required to both designing schemes after evaluation, but only worst-case data is shown in the report.

Power board	Model number	Manufacturer
Power board 1	MTRO-48W200240	Li Lun
Power board 2	AW048WR-2000240	A-Win

For electronic filing, the brief circuit description is saved with filename: descri.pdf.

2.2 Related Submittal(s) Grants

This is an application for certification of a transceiver for the 36`` 2.1 SOUND BAR which has Bluetooth function.

For other functions were reported in the SDOC report: 191120066SZN-001.

2.3 Test Methodology

Both AC mains line-conducted and radiated emission measurements were performed according to the procedures in ANSI C63.10 (2013). Radiated emission measurement was performed in Semi-anechoic chamber and conducted emission measurement was performed in shield room. For radiated emission measurement, preliminary scans were performed in the semi-anechoic chamber only to determine the worst-case modes. All radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the "Justification Section" of this Application. All other measurements were made in accordance with the procedures in part 2 of CFR 47.

2.4 Test Facility

The Semi-Anechoic chamber and shield room used to collect the radiated data and conducted data are **Intertek Testing Services Shenzhen Ltd. Longhua Branch** and located at 101, 201, Building B, No. 308 Wuhe Avenue, Zhangkengjing Community, GuanHu Subdistrict, LongHua District, ShenZhen, P.R. China. This test facility and site measurement data have been fully placed on file with the FCC (Registration Number: CN1188).

3.0 System Test Configuration

3.1 Justification

The system was configured for testing in a typical fashion (as a customer would normally use it), and in the confines as outlined in ANSI C63.10 (2013).

The EUT was powered by AC 120V/60Hz during the test, only the worst data was reported in this report. Both designing schemes of power boards were tested, only the worst data was reported in this report.

All packets DH1, DH3 & DH5 mode in modulation type GFSK, $\pi/4$ -DQPSK and 8-DPSK were tested and only the worst data was reported in this report.

For maximizing emissions below 30 MHz, the EUT was rotated through 360°, the centre of the loop antenna was placed 1 meter above the ground, and the antenna polarization was changed. For maximizing emissions, the EUT was rotated through 360°, the antenna height was varied from 1 meter to 4 meters above the ground plane, and the antenna polarization was changed. This step by step procedure for maximizing emissions led to the data reported in Section 4.

The rear of unit was flushed with the rear of the table.

The equipment under test (EUT) was configured for testing in a typical fashion (as a customer would normally use it). The EUT was placed on a turn table, which enabled the engineer to maximize emissions through its placement in the three orthogonal axes.

3.2 EUT Exercising Software

The EUT exercise program (provided by client) used during testing was designed to exercise the various system components in a manner similar to a typical use.

Test Software: AppoTech RF Control Kit V4.2.9

3.3 Special Accessories

Aux cable (shielded, 1.83m)

3.4 Equipment Modification

Any modifications installed previous to testing by FREEWINGS DIGITAL TECHNOLOGIES (NINGBO) CO., LTD will be incorporated in each production model sold / leased in the United States.

No modifications were installed by Intertek Testing Services Shenzhen Ltd. Longhua Branch.

3.5 Measurement Uncertainty

When determining the test conclusion, the Measurement Uncertainty of test has been considered.

3.6 Support Equipment List and Description

Description	Manufacturer	Remark
Mobile phone (Provided by Intertek)	SAMSUNG	Model: S7
iPod (Provided by Intertek)	Apple	Nano 2
Dummy load 1 (Provided by Intertek)	N/A	100 Ω
Dummy load 2 (Provided by Intertek)	N/A	100 Ω
Aux cable (Provided by applicant)	FREEWINGS DIGITAL TECHNOLOGIES (NINGBO) CO., LTD	shielded, 1.83m
AC cable (Provided by applicant)	FREEWINGS DIGITAL TECHNOLOGIES (NINGBO) CO., LTD	unshielded, 1.45m
Optical cable (Provided by applicant)	FREEWINGS DIGITAL TECHNOLOGIES (NINGBO) CO., LTD	unshielded, 1.83m
Remote control (Provided by applicant)	FREEWINGS DIGITAL TECHNOLOGIES (NINGBO) CO., LTD	Model: 100015716

4.0 Emission Results

Data is included worst-case configuration (the configuration which resulted in the highest emission levels).

4.1 Radiated Test Results

A sample calculation, configuration photographs and data tables of the emissions are included.

4.1.1 Field Strength Calculation

The field strength is calculated by adding the reading on the Spectrum Analyzer to the factors associated with preamplifiers (if any), antennas, cables, pulse desensitization and average factors (when specified limit is in average and measurements are made with peak detectors). A sample calculation is included below.

$$FS = RA + AF + CF - AG + PD + AV$$

Where

- FS = Field Strength in dB μ V/m
- RA = Receiver Amplitude (including preamplifier) in dB μ V
- CF = Cable Attenuation Factor in dB
- AF = Antenna Factor in dB
- AG = Amplifier Gain in dB
- PD = Pulse Desensitization in dB
- AV = Average Factor in -dB

In the radiated emission table which follows, the reading shown on the data table may reflect the preamplifier gain. An example of the calculations, where the reading does not reflect the preamplifier gain, follows:

$$FS = RA + AF + CF - AG + PD + AV$$

Assume a receiver reading of 62.0 dB μ V is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted. The pulse desensitization factor of the spectrum analyzer was 0 dB, and the resultant average factor was -10 dB. The net field strength for comparison to the appropriate emission limit is 32 dB μ V/m. This value in dB μ V/m was converted to its corresponding level in μ V/m.

$$RA = 62.0 \text{ dB}\mu\text{V}$$

$$AF = 7.4 \text{ dB}$$

$$CF = 1.6 \text{ dB}$$

$$AG = 29.0 \text{ dB}$$

$$PD = 0 \text{ dB}$$

$$AV = -10 \text{ dB}$$

$$FS = 62 + 7.4 + 1.6 - 29 + 0 = 42 \text{ dB}\mu\text{V/m}$$

$$\text{Level in } \mu\text{V/m} = \text{Common Antilogarithm } [(42 \text{ dB}\mu\text{V/m})/20] = 125.9 \mu\text{V/m}$$

4.1.2 Radiated Emission Configuration Photograph

For electronic filing, the worst case radiated emission configuration photograph is saved with filename: radiated photos. pdf.

4.1.3 Radiated Emissions

The data on the following page lists the significant emission frequencies, the limit and the margin of compliance. Numbers with a minus sign are below the limit.

Worst Case Radiated Emission
at
42.175733 MHz

Judgement: Passed by 3.2 dB

TEST PERSONNEL:

Sign on file

Leo Li, Project Engineer
Typed/Printed Name

4 December 2019
Date

Applicant: FREEWINGS DIGITAL TECHNOLOGIES (NINGBO) CO., LTD

Date of Test: 4 December 2019

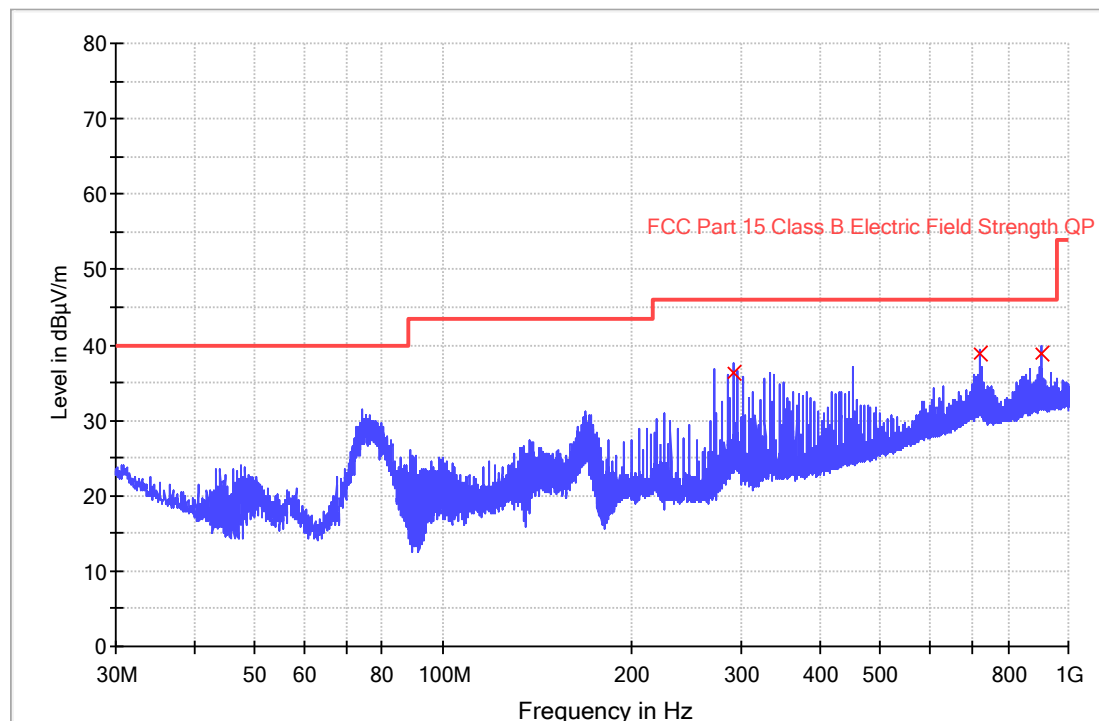
Model: 100015716

Worst Case Operating Mode:

BT Link

Power board: Li Lun

ANT Polarity: Horizontal



Frequency (MHz)	QuasiPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBμV/m)
290.800667	36.3	1000.0	120.000	0.0	H	16.3	9.7	46.0
722.838667	38.8	1000.0	120.000	0.0	H	26.0	7.2	46.0
903.549667	38.8	1000.0	120.000	0.0	H	27.6	7.2	46.0

Remark:

1. Corr. = Antenna Factor (dB/m) + Cable Loss (dB)
2. QuasiPeak (dBμV/m) = Corr. (dB/m) + Read Level (dBμV)
3. Margin (dB) = Limit Line(dBμV/m) – Level (dBμV/m)

Applicant: FREEWINGS DIGITAL TECHNOLOGIES (NINGBO) CO., LTD

Date of Test: 4 December 2019

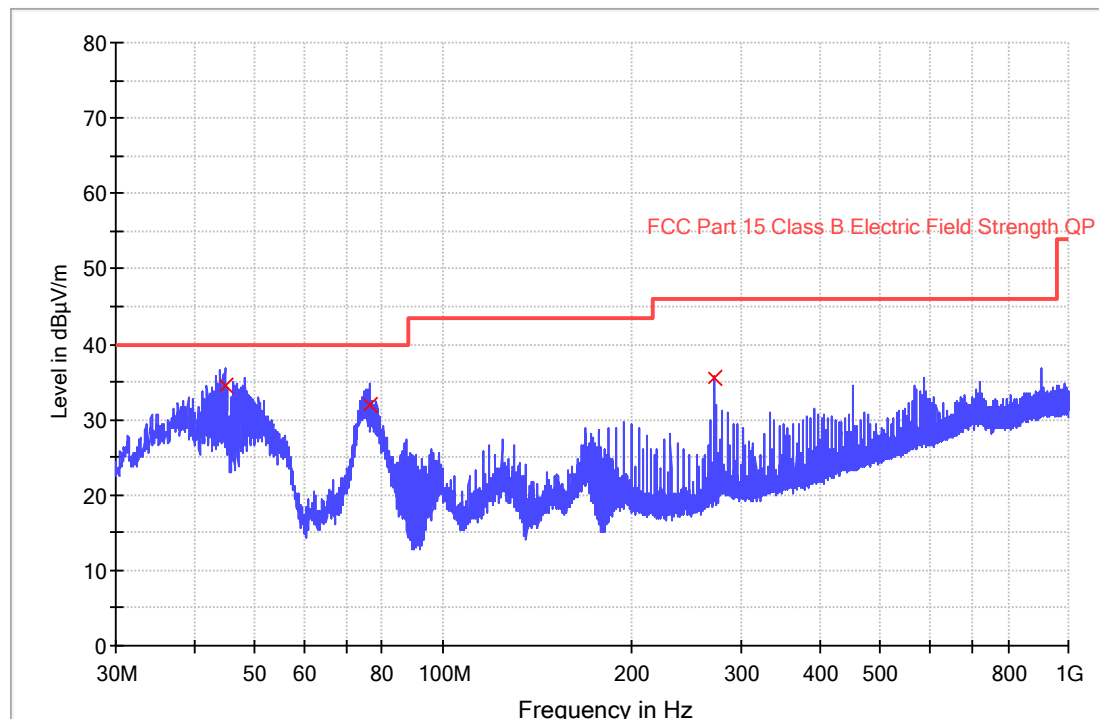
Model: 100015716

Worst Case Operating Mode:

BT Link

Power board: Li Lun

ANT Polarity: Vertical



Frequency (MHz)	QuasiPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBμV/m)
44.808667	34.6	1000.0	120.000	0.0	V	10.9	5.4	40.0
76.236667	31.9	1000.0	120.000	0.0	V	9.1	8.1	40.0
271.045000	35.6	1000.0	120.000	0.0	V	15.5	10.4	46.0

Remark:

1. Corr. = Antenna Factor (dB/m) + Cable Loss (dB)
2. QuasiPeak (dBμV/m) = Corr. (dB/m) + Read Level (dBμV)
3. Margin (dB) = Limit Line (dBμV/m) – Level (dBμV/m)

Applicant: FREEWINGS DIGITAL TECHNOLOGIES (NINGBO) CO., LTD

Date of Test: 4 December 2019

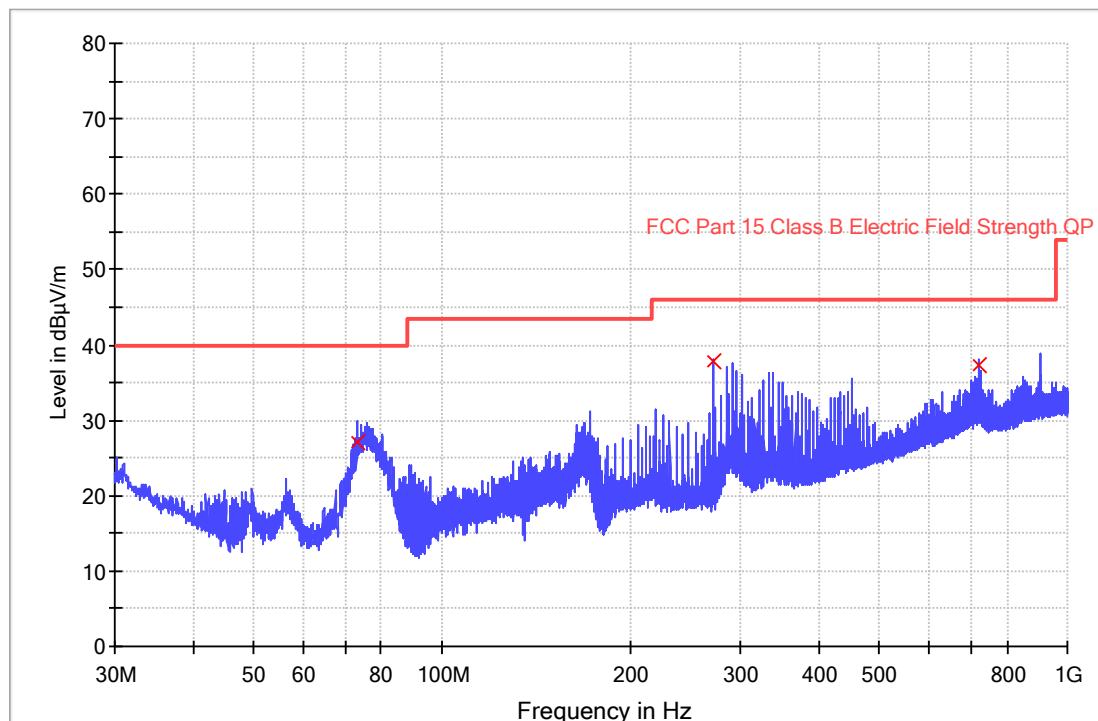
Model: 100015716

Worst Case Operating Mode:

BT Link

Power board: A-Win

ANT Polarity: Horizontal



Frequency (MHz)	QuasiPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBμV/m)
73.197333	27.0	1000.0	120.000	0.0	H	9.0	13.0	40.0
271.045000	37.8	1000.0	120.000	0.0	H	15.5	8.2	46.0
722.838667	37.4	1000.0	120.000	0.0	H	26.0	8.6	46.0

Remark:

1. Corr. = Antenna Factor (dB/m) + Cable Loss (dB)
2. QuasiPeak (dBμV/m) = Corr. (dB/m) + Read Level (dBμV)
3. Margin (dB) = Limit Line(dBμV/m) – Level (dBμV/m)

Applicant: FREEWINGS DIGITAL TECHNOLOGIES (NINGBO) CO., LTD

Date of Test: 4 December 2019

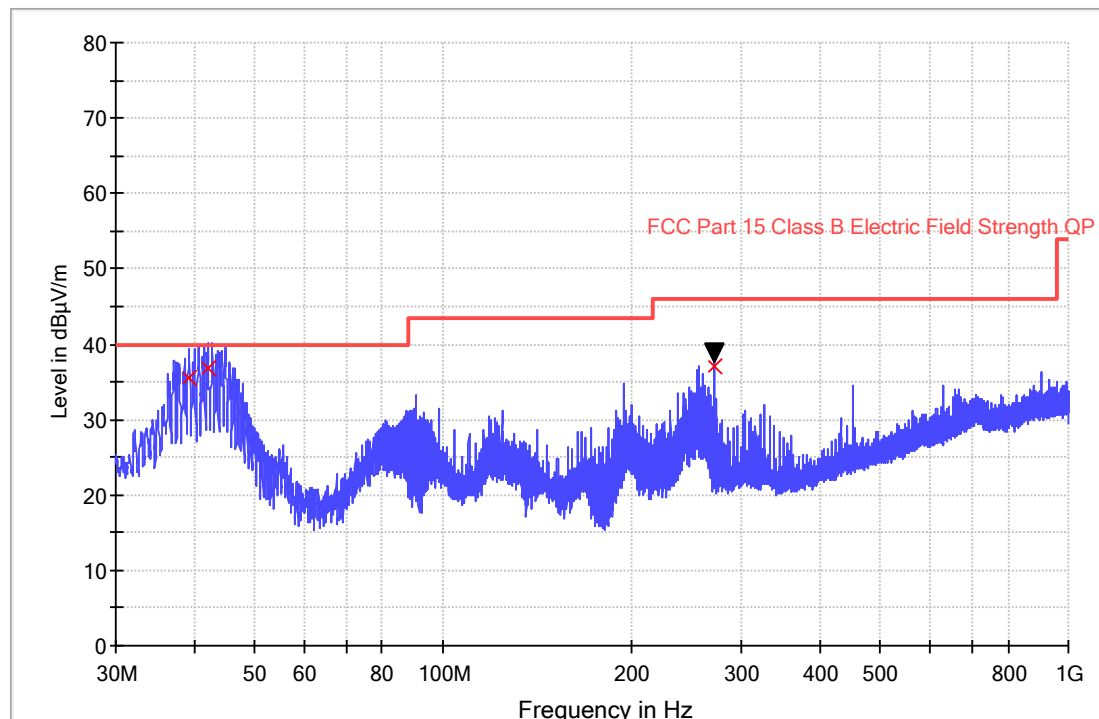
Model: 100015716

Worst Case Operating Mode:

BT Link

Power board: A-Win

ANT Polarity: Vertical



Frequency (MHz)	QuasiPeak (dBμV/m)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Polarization	Corr. (dB)	Margin - QPK (dB)	Limit - QPK (dBμV/m)
39.344333	35.5	1000.0	120.000	0.0	V	13.9	4.5	40.0
42.175733	36.8	1000.0	120.000	0.0	V	12.4	3.2	40.0
271.045000	37.0	1000.0	120.000	0.0	V	15.5	9.0	46.0

Remark:

1. Corr. = Antenna Factor (dB/m) + Cable Loss (dB)
2. QuasiPeak (dBμV/m) = Corr. (dB/m) + Read Level (dBμV)
3. Margin (dB) = Limit Line(dBμV/m) – Level (dBμV/m)

4.1.4 Transmitter Spurious Emissions (Radiated)

Worst Case Radiated Emission
at
2399.942 MHz

For electronic filing, the worst case radiated emission configuration photograph is saved with filename: radiated photos. pdf.

The data on the following page lists the significant emission frequencies, the limit and the margin of compliance. Numbers with a minus sign are below the limit.

Judgement: Passed by 15.54 dB

TEST PERSONNEL:

Sign on file

Leo Li, Project Engineer
Typed/Printed Name

4 December 2019
Date

Applicant: FREEWINGS DIGITAL TECHNOLOGIES (NINGBO) CO., LTD

Date of Test: 4 December 2019

Model: 100015716

Worst Case Operating Mode:

Transmitting

Table 1

Radiated Emissions

(2402MHz)

Polarization	Frequency (MHz)	Reading (dBμV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBμV/m)	Peak Limit at 3m (dBμV/m)	Margin (dB)
Horizontal	2402.000	102.3	36.7	28.1	93.7	114.0	-20.3
Horizontal	4804.000	51.9	36.7	35.5	50.7	74.0	-23.3
Horizontal	7206.000	55.7	36.1	36.5	56.1	74.0	-17.9

Polarization	Frequency (MHz)	Reading (dBμV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Average Factor (-dB)	Net at 3m (dBμV/m)	Average Limit at 3m (dBμV/m)	Margin (dB)
Horizontal	2402.000	102.3	36.7	28.1	22.5	71.2	94.0	-22.8
Horizontal	4804.000	51.9	36.7	35.5	22.5	28.2	54.0	-25.8
Horizontal	7206.000	55.7	36.1	36.5	22.5	33.6	54.0	-20.4

Notes: 1. Peak detector is used for the emission measurement.

2. All measurements were made at 3 meter. Harmonic emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other harmonic emissions than those reported were detected at a test distance of 0.3-meter.

3. Negative value in the margin column shows emission below limit.

4. Horn antenna is used for the emission over 1000MHz.

Test Engineer: Leo Li

Applicant: FREEWINGS DIGITAL TECHNOLOGIES (NINGBO) CO., LTD

Date of Test: 4 December 2019

Model: 100015716

Worst Case Operating Mode:

Transmitting

Table 2

Radiated Emissions

(2441MHz)

Polarization	Frequency (MHz)	Reading (dBμV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBμV/m)	Peak Limit at 3m (dBμV/m)	Margin (dB)
Horizontal	2441.000	103.0	36.7	28.1	94.4	114.0	-19.6
Horizontal	4882.000	51.4	36.7	35.5	50.2	74.0	-23.8
Horizontal	7323.000	53.5	36.1	37.2	54.6	74.0	-19.4

Polarization	Frequency (MHz)	Reading (dBμV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Average Factor (-dB)	Net at 3m (dBμV/m)	Average Limit at 3m (dBμV/m)	Margin (dB)
Horizontal	2441.000	103.0	36.7	28.1	22.5	71.9	94.0	-22.1
Horizontal	4882.000	51.4	36.7	35.5	22.5	27.7	54.0	-26.3
Horizontal	7323.000	53.5	36.1	37.2	22.5	32.1	54.0	-21.9

Notes: 1. Peak detector is used for the emission measurement.

2. All measurements were made at 3 meter. Harmonic emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other harmonic emissions than those reported were detected at a test distance of 0.3-meter.

3. Negative value in the margin column shows emission below limit.

4. Horn antenna is used for the emission over 1000MHz.

Test Engineer: Leo Li

Applicant: FREEWINGS DIGITAL TECHNOLOGIES (NINGBO) CO., LTD

Date of Test: 4 December 2019

Model: 100015716

Worst Case Operating Mode:

Transmitting

Table 3

Radiated Emissions

(2480MHz)

Polarization	Frequency (MHz)	Reading (dBμV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBμV/m)	Peak Limit at 3m (dBμV/m)	Margin (dB)
Horizontal	2480.000	100.9	36.7	28.1	92.3	114.0	-21.7
Horizontal	4960.000	51.2	36.7	35.5	50.0	74.0	-24.0
Horizontal	7440.000	53.9	36.1	37.2	55.0	74.0	-19.0

Polarization	Frequency (MHz)	Reading (dBμV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Average Factor (-dB)	Net at 3m (dBμV/m)	Average Limit at 3m (dBμV/m)	Margin (dB)
Horizontal	2480.000	100.9	36.7	28.1	22.5	69.8	94.0	-24.2
Horizontal	4960.000	51.2	36.7	35.5	22.5	27.5	54.0	-26.5
Horizontal	7440.000	53.9	36.1	37.2	22.5	32.5	54.0	-21.5

Notes: 1. Peak detector is used for the emission measurement.

2. All measurements were made at 3 meter. Harmonic emissions not detected at the 3-meter distance were measured at 0.3-meter and an inverse proportional extrapolation was performed to compare the signal level to the 3-meter limit. No other harmonic emissions than those reported were detected at a test distance of 0.3-meter.

3. Negative value in the margin column shows emission below limit.

4. Horn antenna is used for the emission over 1000MHz.

Test Engineer: Leo Li

4.2 Conducted Emission Configuration Photograph

For electronic filing, the worst case radiated emission configuration photographs are saved with filename: conducted photos.pdf.

4.2.1 Conducted Emission

Worst Case Conducted Configuration
at
0.354MHz

Judgement: Passed by 4.1dB margin

TEST PERSONNEL:

Sign on file

Leo Li, Project Engineer
Typed/Printed Name

10 December 2019
Date

Applicant: FREEWINGS DIGITAL TECHNOLOGIES (NINGBO) CO., LTD

Date of Test: 10 December 2019

Model: 100015716

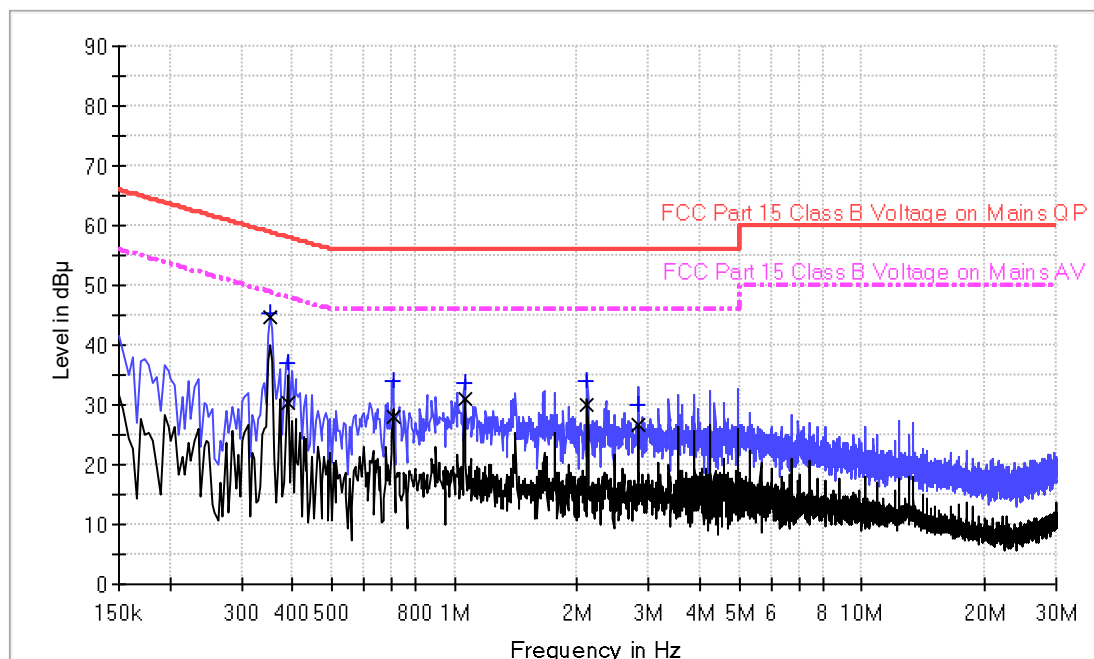
Worst Case Operating Mode: BT Link

Power board: Li Lun

Phase: Live

Graphic / Data Table

Conducted Emissions Pursuant to FCC 15.207: Emissions Requirement



Limit and Margin QP

Frequency (MHz)	QuasiPeak (dBuV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.354000	45.3	9.000	L1	9.7	13.6	58.9
0.390000	37.0	9.000	L1	9.7	21.1	58.1
0.706000	34.0	9.000	L1	9.7	22.0	56.0
1.058000	33.5	9.000	L1	9.7	22.5	56.0
2.118000	33.9	9.000	L1	9.7	22.1	56.0
2.826000	30.0	9.000	L1	9.8	26.0	56.0

Limit and Margin AV

Frequency (MHz)	Average (dBuV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.354000	44.8	9.000	L1	9.7	4.1	48.9
0.390000	30.4	9.000	L1	9.7	17.7	48.1
0.706000	28.0	9.000	L1	9.7	18.0	46.0
1.058000	31.1	9.000	L1	9.7	14.9	46.0
2.118000	30.0	9.000	L1	9.7	16.0	46.0
2.826000	26.7	9.000	L1	9.8	19.3	46.0

Remark:

1. Corr. Factor (dB) = LISN Factor (dB) + Cable Loss (dB)

2. Margin (dB) = Limit (dBuV) – Level (dBuV)

Applicant: FREEWINGS DIGITAL TECHNOLOGIES (NINGBO) CO., LTD

Date of Test: 10 December 2019

Model: 100015716

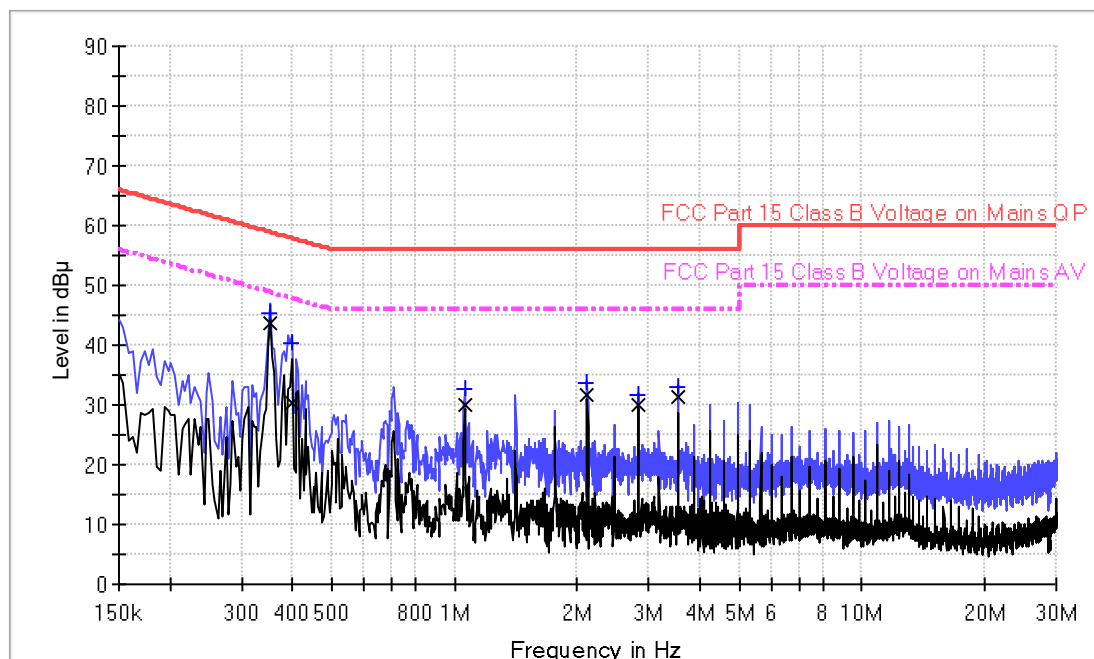
Worst Case Operating Mode: BT Link

Power board: Li Lun

Phase: Neutral

Graphic / Data Table

Conducted Emissions Pursuant to FCC 15.207: Emissions Requirement



Limit and Margin QP

Frequency (MHz)	QuasiPeak (dBuV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.354000	45.3	9.000	N	9.7	13.6	58.9
0.398000	40.5	9.000	N	9.7	17.4	57.9
1.058000	32.8	9.000	N	9.7	23.2	56.0
2.118000	33.8	9.000	N	9.8	22.2	56.0
2.822000	31.7	9.000	N	9.8	24.3	56.0
3.530000	33.1	9.000	N	9.8	22.9	56.0

Limit and Margin AV

Frequency (MHz)	Average (dBuV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.354000	43.8	9.000	N	9.7	5.1	48.9
0.398000	30.4	9.000	N	9.7	17.5	47.9
1.058000	30.1	9.000	N	9.7	15.9	46.0
2.118000	31.8	9.000	N	9.8	14.2	46.0
2.822000	30.1	9.000	N	9.8	15.9	46.0
3.530000	31.2	9.000	N	9.8	14.8	46.0

Remark:

1. Corr. Factor (dB) = LISN Factor (dB) + Cable Loss (dB)
2. Margin (dB) = Limit (dBuV) – Level (dBuV)

Applicant: FREEWINGS DIGITAL TECHNOLOGIES (NINGBO) CO., LTD

Date of Test: 10 December 2019

Model: 100015716

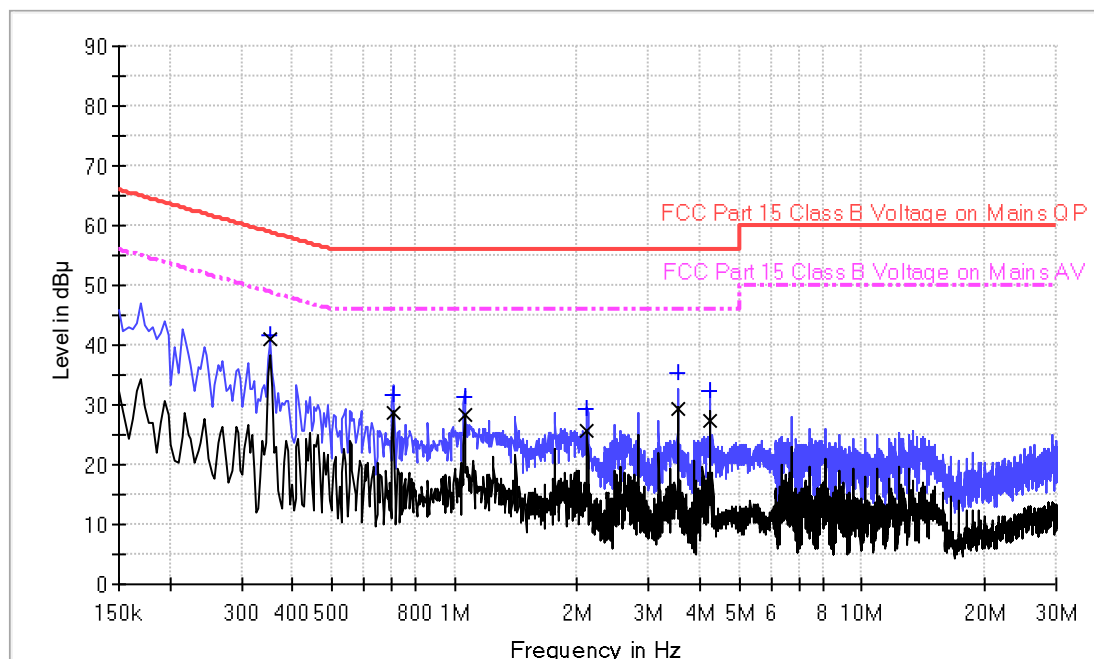
Worst Case Operating Mode: BT Link

Power board: A-Win

Phase: Live

Graphic / Data Table

Conducted Emissions Pursuant to FCC 15.207: Emissions Requirement



Limit and Margin QP

Frequency (MHz)	QuasiPeak (dBuV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.354000	41.7	9.000	L1	9.7	17.2	58.9
0.706000	31.8	9.000	L1	9.7	24.2	56.0
1.058000	31.2	9.000	L1	9.7	24.8	56.0
2.118000	29.4	9.000	L1	9.7	26.6	56.0
3.530000	35.5	9.000	L1	9.8	20.5	56.0
4.234000	32.2	9.000	L1	9.8	23.8	56.0

Limit and Margin AV

Frequency (MHz)	Average (dBuV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.354000	40.9	9.000	L1	9.7	8.0	48.9
0.706000	28.6	9.000	L1	9.7	17.4	46.0
1.058000	28.4	9.000	L1	9.7	17.6	46.0
2.118000	25.7	9.000	L1	9.7	20.3	46.0
3.530000	29.4	9.000	L1	9.8	16.6	46.0
4.234000	27.2	9.000	L1	9.8	18.8	46.0

Remark:

1. Corr. Factor (dB) = LISN Factor (dB) + Cable Loss (dB)

2. Margin (dB) = Limit (dBuV) – Level (dBuV)

Applicant: FREEWINGS DIGITAL TECHNOLOGIES (NINGBO) CO., LTD

Date of Test: 10 December 2019

Model: 100015716

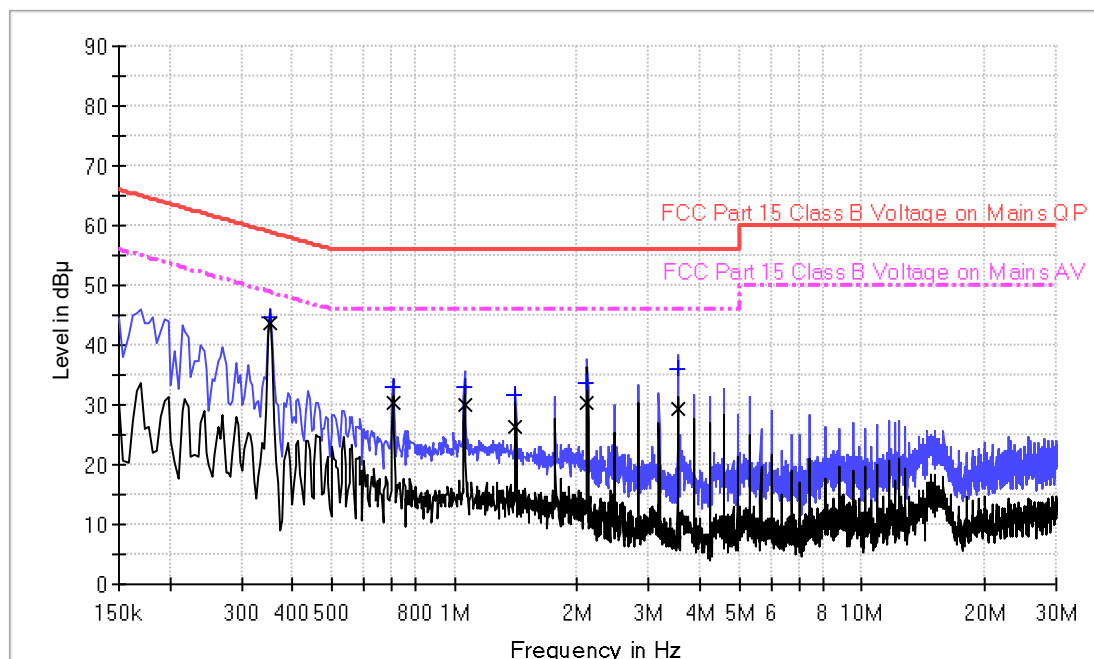
Worst Case Operating Mode: BT Link

Power board: A-Win

Phase: Neutral

Graphic / Data Table

Conducted Emissions Pursuant to FCC 15.207: Emissions Requirement



Limit and Margin QP

Frequency (MHz)	QuasiPeak (dBuV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.354000	44.6	9.000	N	9.7	14.3	58.9
0.706000	33.0	9.000	N	9.7	23.0	56.0
1.058000	33.1	9.000	N	9.7	22.9	56.0
1.414000	31.5	9.000	N	9.7	24.5	56.0
2.118000	33.7	9.000	N	9.8	22.3	56.0
3.530000	36.1	9.000	N	9.8	19.9	56.0

Limit and Margin AV

Frequency (MHz)	Average (dBuV)	Bandwidth (kHz)	Line	Corr. (dB)	Margin (dB)	Limit (dBuV)
0.354000	43.8	9.000	N	9.7	5.1	48.9
0.706000	30.3	9.000	N	9.7	15.7	46.0
1.058000	30.0	9.000	N	9.7	16.0	46.0
1.414000	26.3	9.000	N	9.7	19.7	46.0
2.118000	30.4	9.000	N	9.8	15.6	46.0
3.530000	29.2	9.000	N	9.8	16.8	46.0

Remark:

1. Corr. Factor (dB) = LISN Factor (dB) + Cable Loss (dB)
2. Margin (dB) = Limit (dBuV) – Level (dBuV)

5.0 Equipment Photographs

For electronic filing, the photographs of the tested EUT are saved with filename: external photos.pdf & internal photos.pdf.

6.0 Product Labelling

For electronic filing, the FCC ID label artwork and the label location are saved with filename: label.pdf.

7.0 Technical Specifications

For electronic filing, the block diagram and schematics of the tested EUT are saved with filename: block.pdf and circuit.pdf respectively.

8.0 Instruction Manual

For electronic filing, a preliminary copy of the Instruction Manual is saved with filename: manual.pdf.

This manual will be provided to the end-user with each unit sold/leased in the United States.

9.0 Miscellaneous Information

This miscellaneous information includes details of the measured bandedge, 20dB Bandwidth, the test procedure and calculation of factor such as pulse desensitization.

9.1 Bandedge Plot

The test plots are attached as below. From the below plots, the field strength of any emissions outside of the specified frequency band are attenuated to the general radiated emission limits in section 15.209. It fulfils the requirement of 15.249(d).

Peak Measurement

Bandedge compliance is determined by applying marker-delta method, i.e (Bandedge Plot).

(i) **Lowest frequency channel (2402MHz):**

Peak Resultant field strength = Fundamental emissions (peak value) – delta from the bandedge plot

$$\begin{aligned} &= 93.7 \text{ dB}\mu\text{v/m} - 35.24 \text{ dB} \\ &= 58.46 \text{ dB}\mu\text{v/m} \end{aligned}$$

Average Resultant field strength = Fundamental emissions (average value) – delta from the bandedge plot

$$\begin{aligned} &= 71.2 \text{ dB}\mu\text{v/m} - 35.24 \text{ dB} \\ &= 35.96 \text{ dB}\mu\text{v/m} \end{aligned}$$

(ii) **Highest frequency channel (2480MHz):**

Peak Resultant field strength = Fundamental emissions (peak value) – delta from the bandedge plot

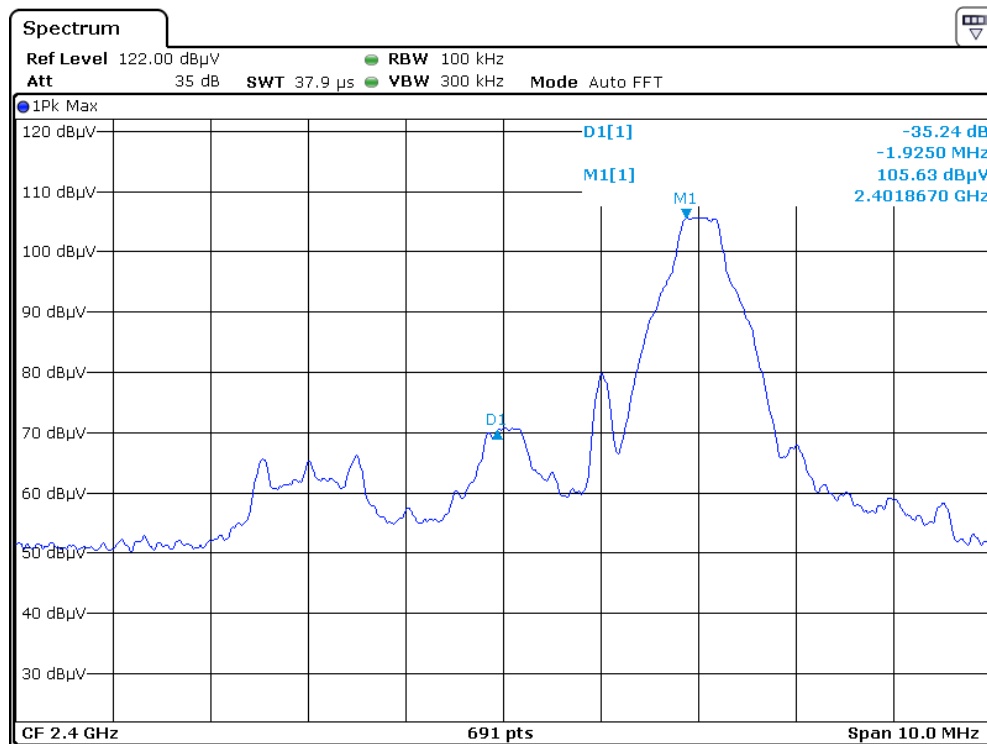
$$\begin{aligned} &= 92.3 \text{ dB}\mu\text{v/m} - 44.51 \text{ dB} \\ &= 47.79 \text{ dB}\mu\text{v/m} \end{aligned}$$

Average Resultant field strength = Fundamental emissions (average value) – delta from the bandedge plot

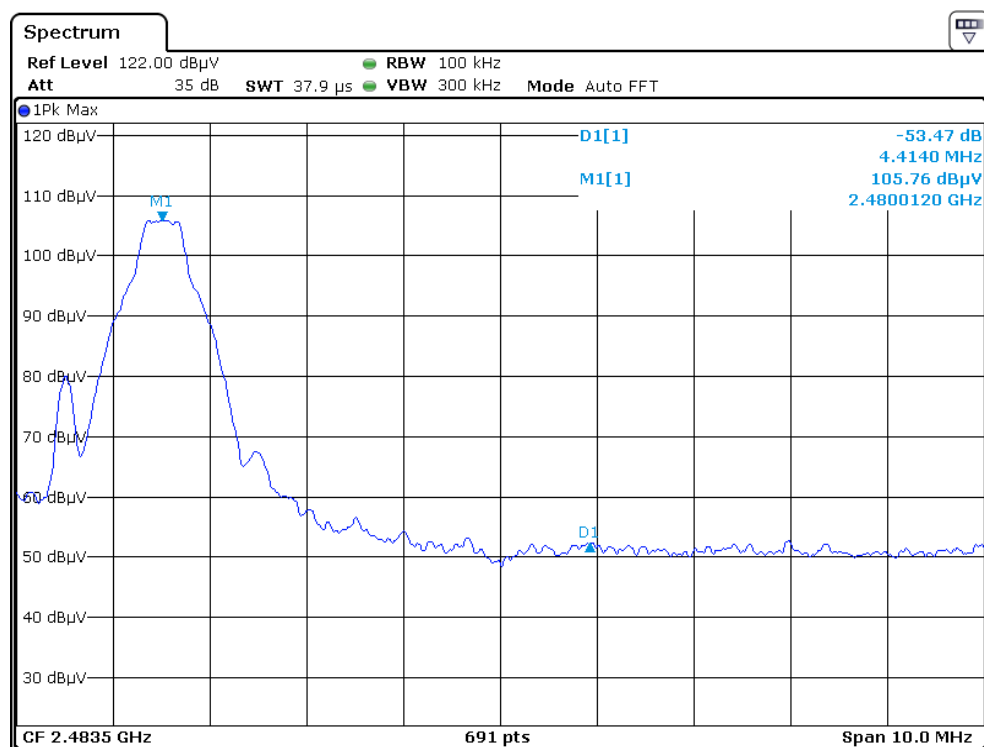
$$\begin{aligned} &= 69.8 \text{ dB}\mu\text{v/m} - 44.51 \text{ dB} \\ &= 25.29 \text{ dB}\mu\text{v/m} \end{aligned}$$

The resultant field strength meets the general radiated emission limit in section 15.209, which does not exceed 74dB μ v/m (Peak Limit) and 54dB μ v/m (Average Limit).

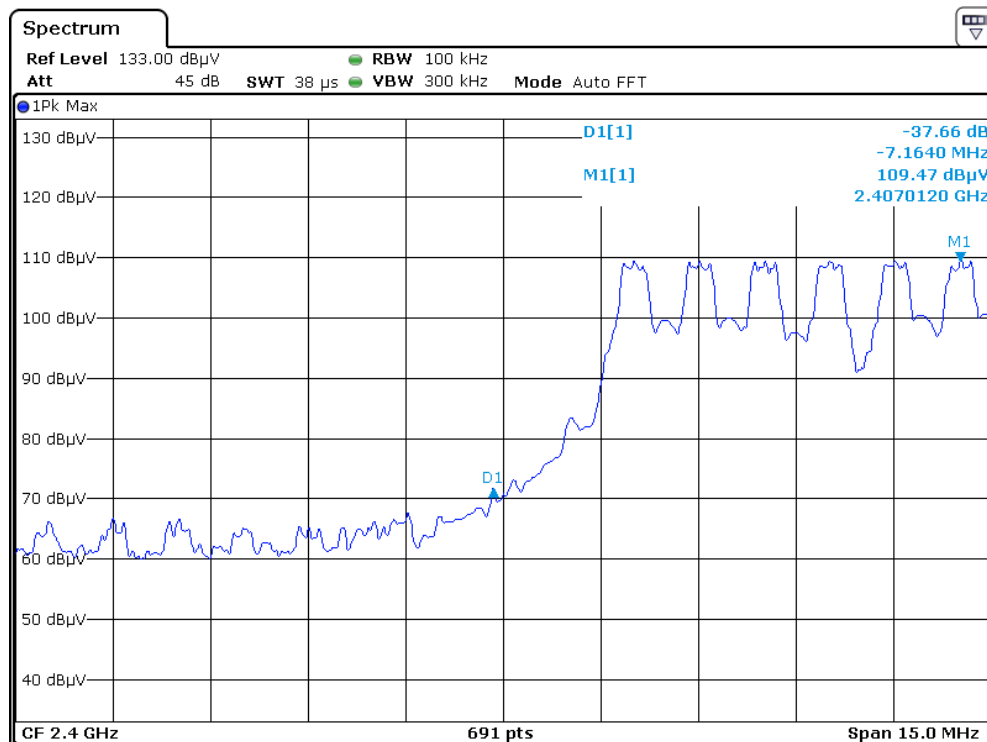
Hopping function off
Lowest frequency Channel



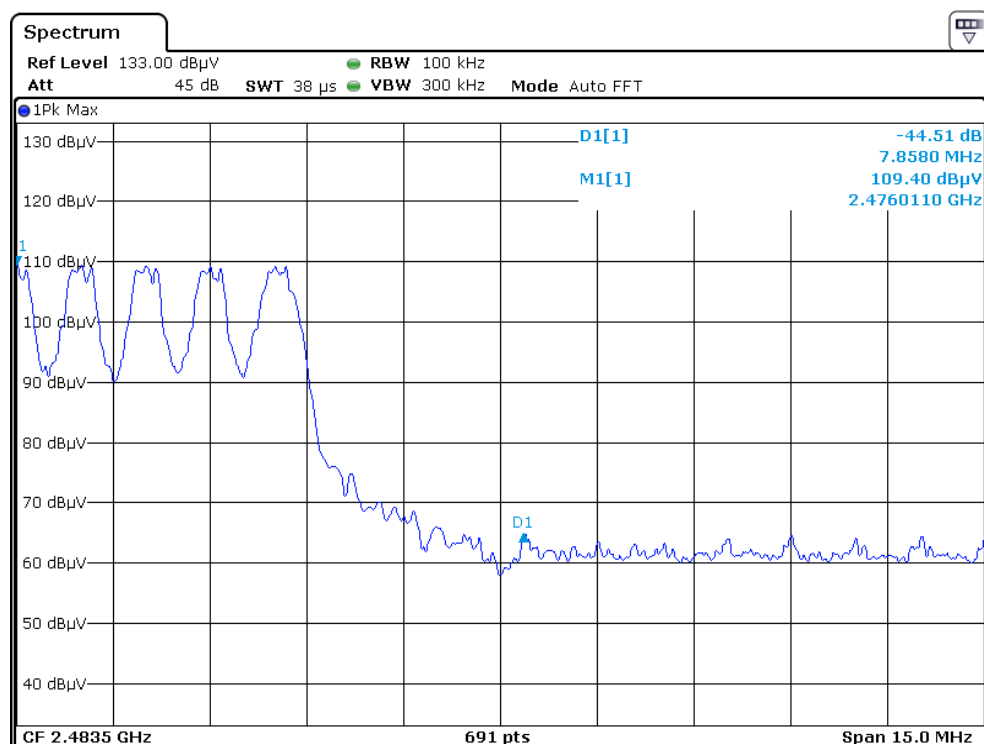
Highest frequency Channel



Hopping function on Lowest frequency Channel

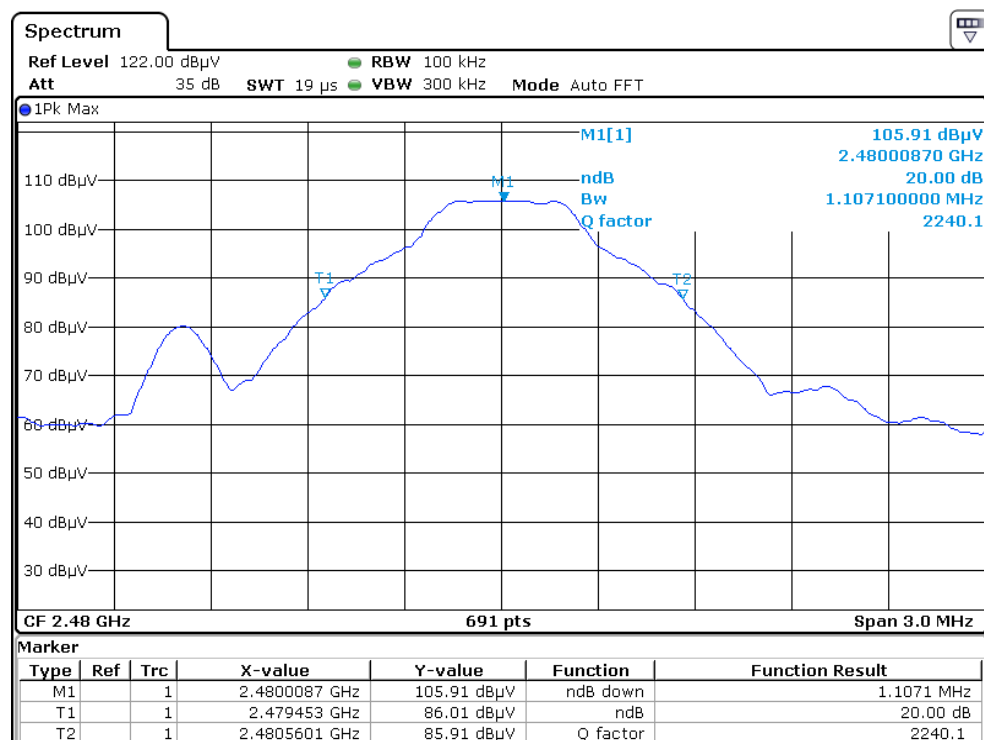
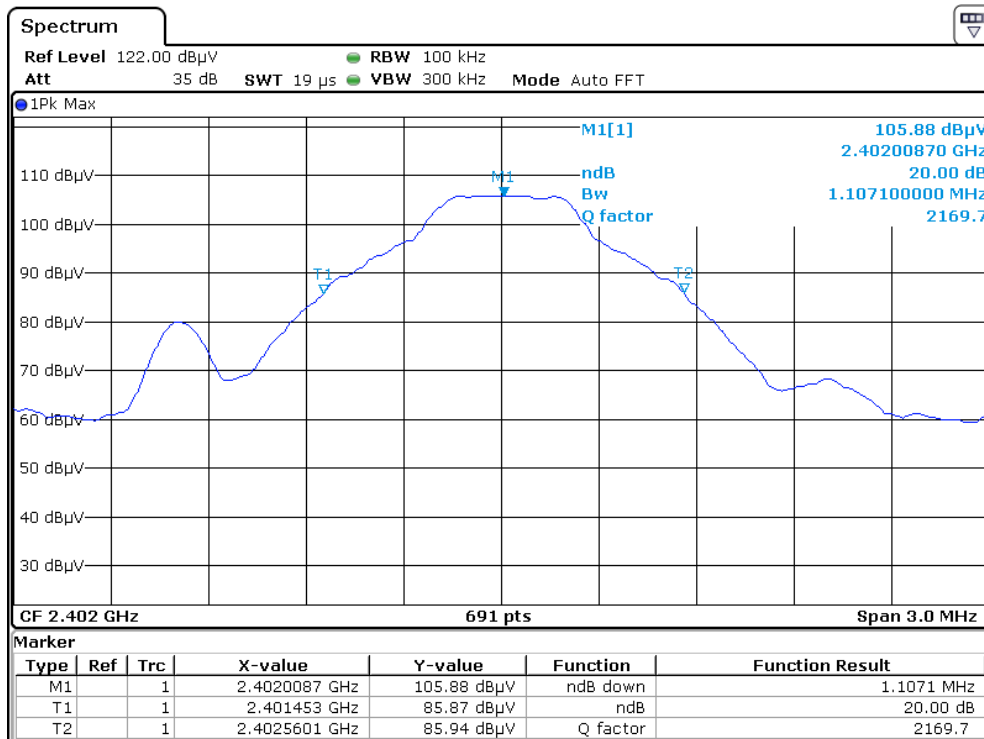


Highest frequency Channel



9.2 20dB bandwidth

Pursuant to FCC part 15 Section 15.215(c), the 20dB bandwidth of the emission was contained within the frequency band designated (mentioned as above) which the EUT operated. The effects, if any, from frequency sweeping, frequency hopping, other modulation techniques and frequency stability over excepted variations in temperature and supply voltage were considered. The test plots are reported as below.



9.3 Discussion of Pulse Desensitization

Pulse desensitivity is not applicable for this device. The effective period (T_{eff}) is approximately $625\mu s$ for Bluetooth. With a resolution bandwidth (3dB) of 1MHz, so the pulse desensitivity factor is 0dB.

9.4 Calculation of Average Factor

Based on the Bluetooth Specification Version 4.2 (without BLE) and worst case AFH mode, transmitter ON time is independent of packet type (DH1, DH3 and DH5) and packet length, the AFH mode Duty cycle connection factor as below:

Channel hop rate = 800 hops/second (AFH Mode)

Adjusted channel hop rate for DH5 mode = 133.33 hops/second

Time per channel hop = $1 / 133.33 \text{ hops/second} = 7.5 \text{ ms}$

Time to cycle through all channels = $7.5 \times 20 \text{ channels} = 150 \text{ ms}$

Number of times transmitter hits on one channel = $100 \text{ ms} / 150 \text{ ms} = 1 \text{ time(s)}$

Worst case dwell time = 7.5 ms

Duty cycle connection factor = $20\log_{10} (7.5\text{ms} / 100\text{ms}) = -22.5 \text{ dB}$

9.5 Emissions Test Procedures

The following is a description of the test procedure used by Intertek Testing Services in the measurements of transmitters operating under Part 15, Subpart C rules.

The test set-up and procedures described below are designed to meet the requirements of ANSI C63.10 - 2013.

The transmitting equipment under test (EUT) is placed on a styrene turntable which is four feet in diameter and approximately 0.8 meter up to 1GHz and 1.5 meter above 1GHz in height above the ground plane. During the radiated emissions test, the turntable is rotated and any cables leaving the EUT are manipulated to find the configuration resulting in maximum emissions. The EUT is adjust through all three orthogonal axes to obtain maximum emission levels. The antenna height and polarization are varied during the testing to search for maximum signal levels.

Detector function for radiated emissions is in peak mode. Average readings, when required, are taken by measuring the duty cycle of the equipment under test and subtracting the corresponding amount in dB from the measured peak readings. A detailed description for the calculation of the average factor can be found in section 9.4.

The frequency range scanned is from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or 40 GHz, whichever is lower.

Detector function for conducted emissions is in QP & AV mode and IFBW setting is 9 kHz from the frequency band 150 kHz to 30MHz.

9.5 Emissions Test Procedures (cont'd)

The EUT is warmed up for 15 minutes prior to the test.

AC power to the unit is varied from 85% to 115% nominal and variation in the fundamental emission field strength is recorded. If battery powered, a new, fully charged battery is used.

Conducted measurements are made as described in ANSI C63.10 - 2013.

The IF bandwidth used for measurement of radiated signal strength was 10 kHz for emission below 30 MHz and 120 kHz for emission from 30 MHz to 1000 MHz. Where pulsed transmissions of short enough pulse duration warrant, a greater bandwidth is selected according to the recommendations of Hewlett Packard Application Note 150-2. Above 1000 MHz, a resolution bandwidth of 1 MHz is used (RBW 3MHz used for fundamental emission).

Transmitter measurements are normally conducted at a measurement distance of three meters. However, to assure low enough noise floor in the restricted bands and above 1 GHz, signals are acquired at a distance of one meter or less. All measurements are extrapolated to three meters using inverse scaling, but those measurements taken at a closer distance are so marked.

10.0 Test Equipment List

Equipment No.	Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Due Date
SZ061-12	Biconilog Antenna	ETS	3142E	00166158	14-Sep-2018	14-Sep-2020
SZ061-06	Active Loop Antenna	Electro-Metrics	EM-6876	217	24-May-2019	24-May-2020
SZ061-08	Horn Antenna	ETS	3115	00092346	7-Sep-2019	7-Sep-2021
SZ061-07	Pyramidal Horn Antenna	ETS	3160-09	00083067	13-Aug-2019	13-Aug-2021
SZ056-03	Spectrum Analyzer	R&S	FSP30	101148	28-May-2019	28-May-2020
SZ185-01	EMI Receiver	R & S	ESCI	100547	4-Jan-2019	4-Jan-2020
SZ181-04	Preamplifier	Agilent	8449B	3008A02474	15-Jan-2019	15-Jan-2020
SZ188-01	Anechoic Chamber	ETS	RFD-F/A-100	4102	15-Dec-2018	15-Dec-2020
SZ062-02	RF Cable	RADIAL	RG 213U	--	19-Jun-2019	19-Dec-2019
SZ062-05	RF Cable	RADIAL	0.04-26.5GHz	--	14-Aug-2019	14-Aug-2020
SZ062-12	RF Cable	RADIAL	0.04-26.5GHz	--	14-Aug-2019	14-Aug-2020
SZ067-04	Notch Filter	Micro-Tronics	BRM5070 2-02	--	28-May-2019	28-May-2020
SZ185-02	EMI Test Receiver	R&S	ESCI	100692	29-Oct-2019	29-Oct-2020
SZ187-02	Two-Line V-Network	R&S	ENV216	100073	28-May-2019	28-May-2020
SZ188-03	Shielding Room	ETS	RFD-100	4100	16-Jan-2017	16-Jan-2020
SZ062-16	RF Cable	HUBER+SUHNER	CBL2-BN-1m	110127-2231000	30-Oct-2019	30-Oct-2020

***** End of Report*****