



EUROFINS ELECTRICAL TESTING SERVICE (SHENZHEN) Co., LTD.

RADIO TEST - REPORT

FCC Compliance Test Report

Test Report Number: EFGX22060052-IE-01-E01

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1 General Information

1.1 Notes


The results of this test report relate exclusively to the item tested as specified in chapter “Description of test item” and are not transferable to any other test items.

Eurofins Product Testing Service (Shenzhen) Co., Ltd. is not responsible for any generalisations and conclusions drawn from this report. Any modification of the test item can lead to invalidity of test results and this test report may therefore be not applicable to the modified test item.

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Operator:

2022-07-05		Bruce Zheng / Project Engineer	
Date	Eurofins-Lab.	Name / Title	Signature

Technical responsibility for area of testing:

2022-07-05		Tom Tian / Supervisor	
Date	Eurofins-Lab.	Name / Title	Signature

1.2 Testing laboratory

Eurofins Electrical Testing Service (Shenzhen) Co., Ltd.

1st Floor, Building 2, Chungu, Meisheng Huigu Science and Technology Park, No. 83 Dabao Road, Bao'an District, Shenzhen. P.R.China.

Telephone : +86-755-82911867

Fax : +86-755-82910749

The Laboratory has passed the Accreditation by the American Association for Laboratory Accrediation (A2LA). The Accreditation number is 5376.01

The Laboratory has been listed by industry Canada to perform electromagnetic emission measurements, The CAB identifier is CN0088

1.3 Details of approval holder

Name : SOUND AROUND INC.
Address : 1600 63 RD STREET BROOKLYN,NEW YORK
Telephone : N/A
Fax : N/A

1.4 Details of Manufacturer

Name : SOUND AROUND INC.
Address : 1600 63 RD STREET BROOKLYN,NEW YORK
Telephone : N/A
Fax : N/A

1.5 Application details

Date of receipt of application : 2022-06-02
Date of receipt of test item : 2022-06-02
Date of test : 2022-06-02 to 2022-06-07
Date of issue : 2022-07-05

1.6 Test item

Product type : APOLLO Button
Model name : APButton
Brand : SQUATZ
Serial number : N/A
Ratings : 3.0Vdc supplied by a type "CR2032" Battery
Test voltage : 3.0Vdc
FCC ID : 2A5X5-APBUTTON
PMN : APPOLLO Button
Additional information : N/A

RadioTechnical data

Frequency range : 2405MHz
Radio Tech. : N/A
Frequency channel : 1 Channel
Modulation : GFSK
Antenna type : PCB antenna
Antenna gain : 0 dBi

1.7 Test standards

Test Standards	
FCC Part 15 Subpart C 2018 Edition	PART 15 - RADIO FREQUENCY DEVICES Subpart C - Intentional Radiators

Test Method

- 1: ANSI C63.4-2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
- 2: ANSI C63.10-2013, American National Standard for Testing Unlicensed Wireless Devices.

2 Technical test

2.1 Summary of test results

No deviations from the technical specification(s) were ascertained in the course of the tests performed.

or

The deviations as specified were ascertained in the course of the tests performed.

2.2 Test environment

Temperature : 20 ... 25°C
 Relative humidity content : 30 ... 60%
 Air pressure : 100 ... 101kPa

2.3 Measurement uncertainty

The uncertainty is calculated using the methods suggested in the "Guide to the Expression of Uncertainty in Measurement" (GUM) published by ISO.

System Measurement Uncertainty	
Test Items	Extended Uncertainty
Uncertainty for Conducted RF test	RF Power Conducted: 1.16dB Frequency test involved: 1.05×10 ⁻⁷ or 1%
Uncertainty for Radiated Spurious Emission 25MHz-3000MHz	Horizontal: 4.46dB; Vertical: 4.54dB;
Uncertainty for Radiated Spurious Emission 3000MHz-18000MHz	Horizontal: 4.42dB; Vertical: 4.41dB;
Uncertainty for Radiated Spurious Emission 18000MHz-40000MHz	Horizontal: 4.63dB; Vertical: 4.62dB;

2.4 Test mode

The EUT was set at continuously transmitting during the test.

2.5 Test equipment utilized

EQUIPMENT ID	EQUIPMENT NAME	MODEL NO.	CAL. DUE DATE
23-2-13-01	EMI Test Receiver	ESR7	2023-04-04
23-2-13-02	Signal Analyzer	N9020B-544	2023-05-05
23-2-12-01	Active Loop Antenna	FMZB 1519B	2023-04-20
23-2-12-02	TRILOG Broadband Antenna	VULB9168	2023-04-13
23-2-12-03	Horn Antenna	3117	2023-04-13
23-2-12-04	Horn Antenna	BBHA 9170	2023-04-17
23-2-12-05	Universal Antenna Stand	CLSA0110	2023-04-13
23-2-10-01	Preamplifier	BBV9745	2023-04-15
23-2-10-02	Preamplifier	EMC001330	2023-04-15
23-2-10-03	Preamplifier	EMC051845SE	2023-05-06
23-2-10-14	Switch and Control Unit	ERIT-E-JS0806-SF1	N/A

2.6 Auxiliary Equipment Used during Test:

DESCRIPTION	MANUFACTURER	MODEL NO.	S/N
N/A	N/A	N/A	N/A

2.7 Test software information

Test Software Version	N/A		
Modulation	Setting TX Power	TX Pattern	Packet Type
ASK	Default	Default	Default

Remark: The EUT has two buttons with same duty cycle and it was setted to continue transmitting by debug software, therefore we pressed one button to transmitting 2405MHz Fundamental frequency during Testing.

2.8 Customized Configurations

EUT Conf.	Signal Description	Operating Frequency	Duty Cycle
TM1	GFSK	2405MHz	1 %

2.9 Test Environments

Environment Parameter	Temperature	Voltage	Relative Humidity
101.7Kpa	26.5℃	3.0Vdc	68.3%

2.10 Test results

 1st test

 test after modification

 production test

Technical Requirements				
FCC Part 15 Subpart C/ RSS-210 Issue 9/RSS-Gen Issue 5				
Test Condition		Test Result	Verdict	Test Site
§15.207	Conducted emission AC power port	--	N/A	--
§15.231(a)(1)	Automatically Deactivate	Page 11	Pass	Site 1
§15.231(b)(3)	Field strength of fundamental	Page 20	Pass	Site 1
§15.231(b)(3) §15.209 & §15.205	Field strength of spurious emission	Page 22	Pass	Site 1
§15.231(c)	-20dB Bandwidth	Page 13	Pass	Site 1
§15.203	Antenna requirement	See note 1	Pass	--

Remark 1: N/A – Not Applicable.

Note 1: The EUT uses a PCB antenna, the gain: 0 dBi. According to §15.203, it is considered sufficiently to comply with the provisions of this section.

3 Technical Requirement

3.1 Conducted Emission

Test Method:

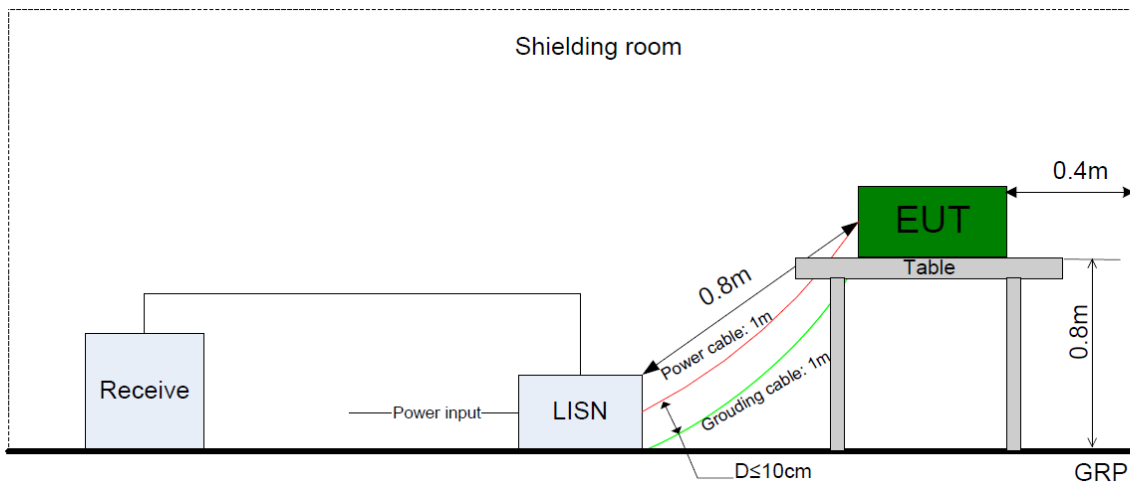
The test method was referred to the subclause 5.2 of ANSI C63.4-2014.

1. The EUT was placed on a table, which is 0.8m above ground plane
2. The power line of the EUT is connected to the AC mains through a Artificial Mains Network (A.M.N.).
3. Maximum procedure was performed to ensure EUT compliance
4. A EMI test receiver is used to test the emissions from both sides of AC line

Test Setup:

The mains cable of the EUT (per AC/DC Adapter) must be connected to LISN. The LISN shall be placed 0.8 m from the boundary of EUT and bonded to a ground reference plane for LISN mounted on top of the ground reference plane. This distance is between the closest points of the LISN and the EUT. All other units of the EUT and associated equipment shall be at least 0.8m from the LISN.

Ground connections, where required for safety purposes, shall be connected to the reference ground point of the LISN and, where not otherwise provided or specified by the manufacturer, shall be of same length as the mains cable and run parallel to the mains connection at a separation distance of not more than 0.1 m.



Limit:

Frequency MHz	QP Limit dB μ V	AV Limit dB μ V
0.150-0.500	66-56*	56-46*
0.500-5	56	46
5-30	60	50

Decreasing linear.

Test Result:

Not Applicable, the EUT was supplied by 3VDC from a type "CR2025" Battery.

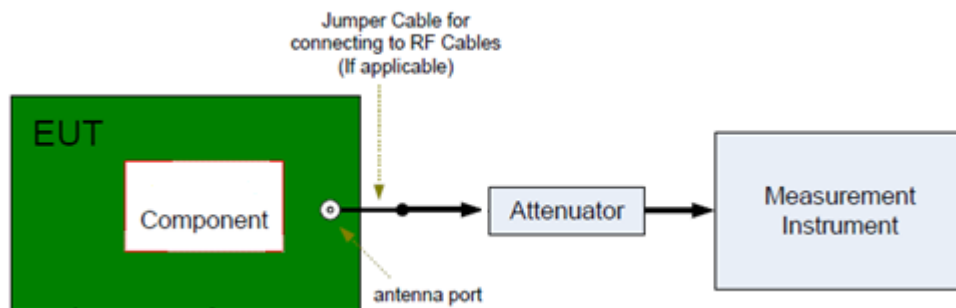
3.2 Automatically Deactivate

Test Method

1. Connect EUT test port to spectrum analyzer.
2. Set the EUT to transmit maximum output power at 2405MHz.
3. RBW=1MHz, VBW \geq 3RBW, Span=0MHz, Sweep = 10s, Detector function = Average, Sweep time = single
4. Remark transmission time and record test plot.

Test Setup:

The component's antenna ports(s) of the EUT are connected to the measurement instrument per an appropriate attenuator. The press a button of the EUT is to emit the specified signals for the purpose of measurements.



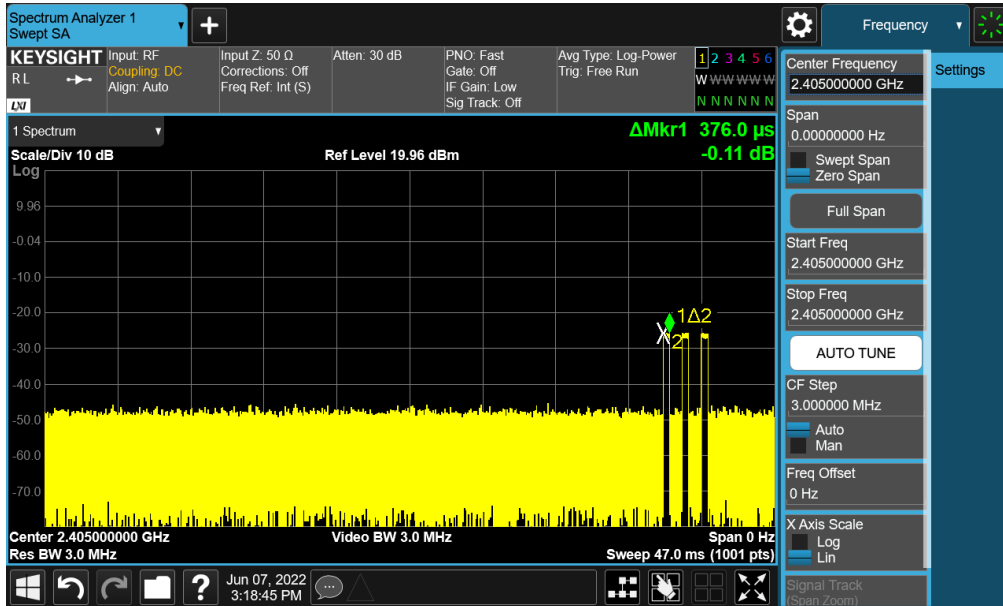
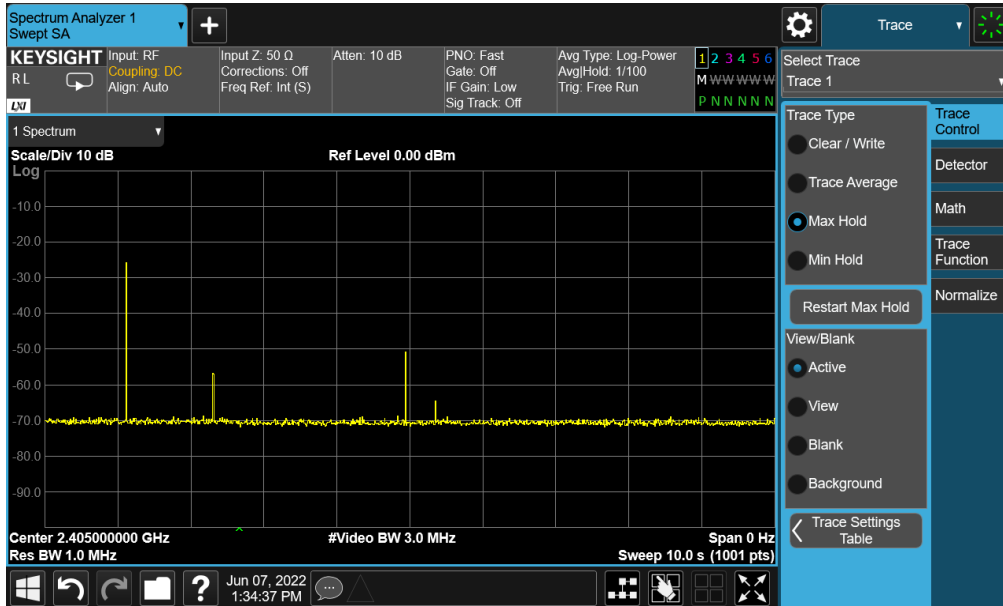
Limits:

According to §15.231 (a) (1), automatically deactivate limit as below:

- (1) A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

Test Data:

Time of Transmitting (ms)	Limit (sec)	Result
1.128	5	Pass



Test Result: Pass

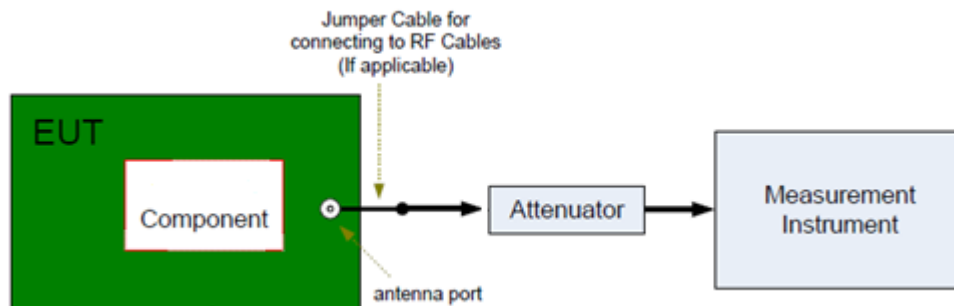
3.3 20dB bandwidth

Test Method:

1. Connect EUT test port to spectrum analyzer.
2. Set the EUT to transmit maximum output power at 2405MHz.
3. Then set the EUT to transmit at high, middle and low frequency separately.
4. Set Span = approximately 1.5 to 5 times the 99% bandwidth.
5. Set RBW \geq 1% to 5% of the 99% bandwidth, VBW \geq RBW.
6. Set Sweep = auto.
7. Set Detector function = Average.
8. Allow the trace to stabilize.
9. Repeat above procedures until all frequencies measured were complete.

Test Setup:

The component's antenna ports(s) of the EUT are connected to the measurement instrument per an appropriate attenuator. The press a button of the EUT is to emit the specified signals for the purpose of measurements.



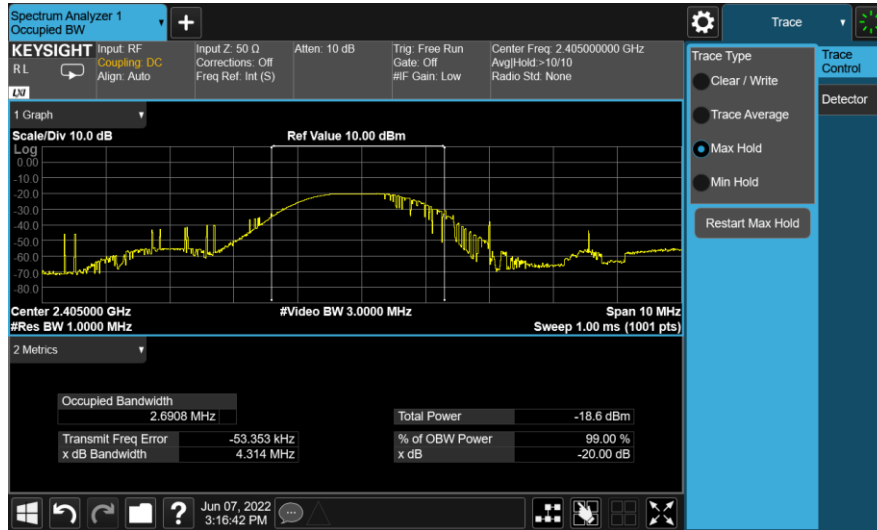
Limit:

According to §15.231 (c), automatically deactivate limit as below:

For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.

Test Result

20dB Bandwidth (KHz)	Limit (KHz)	Result
2690.8	12025	Pass



3.4 Field strength of fundamental , Field strength of spurious emission for transmitter and Restricted bands

Test Method:

- 1: The EUT was placed on a turn table which is 1.5m above ground plane for above 1GHz and 0.8m above ground for below 1GHz at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
- 2: The EUT was set 3 meters away from the interference – receiving antenna, which was mounted on the top of a variable – height antenna tower.
- 3: The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- 4: For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- 5: Use the following spectrum analyzer settings According to C63.10:
For Above 1GHz
Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 1MHz, VBW \geq RBW for peak measurement and VBW = 10Hz for average measurement, Sweep = auto, Detector function = peak, Trace = max hold.
For Below 1GHz
Use the following spectrum analyzer settings:
Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 100 KHz, VBW \geq RBW for peak measurement, Sweep = auto, Detector function = peak, Trace = max hold.
For Below 30MHz
Use the following spectrum analyzer settings:
Span = wide enough to capture the peak level of the in-band emission and all spurious
RBW = 200 Hz, VBW \geq RBW from 9KHz to 0.15MHz, RBW 9KHz VBW \geq RBW from 0.15MHz to 30MHz for peak measurement, Sweep = auto, Detector function = peak, Trace = max hold.

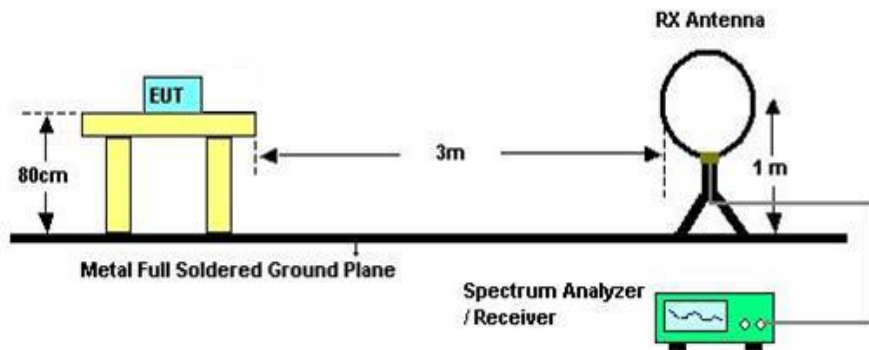
Note:

- 1: The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 KHz for Quasi-peak detection (QP) at frequency below 1GHz.
- 2: The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is 3MHz for peak detection (PK) at frequency above 1GHz.
- 3: The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is 3MHz for RMS Average ((duty cycle < 98%) for Average detection (AV) at frequency above 1GHz, then the measurement results was added to a correction factor (20log(1/duty cycle)).
- 4: The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is 10Hz (duty cycle > 98%) for Average detection (AV) at frequency above 1GHz.

Test Setup:

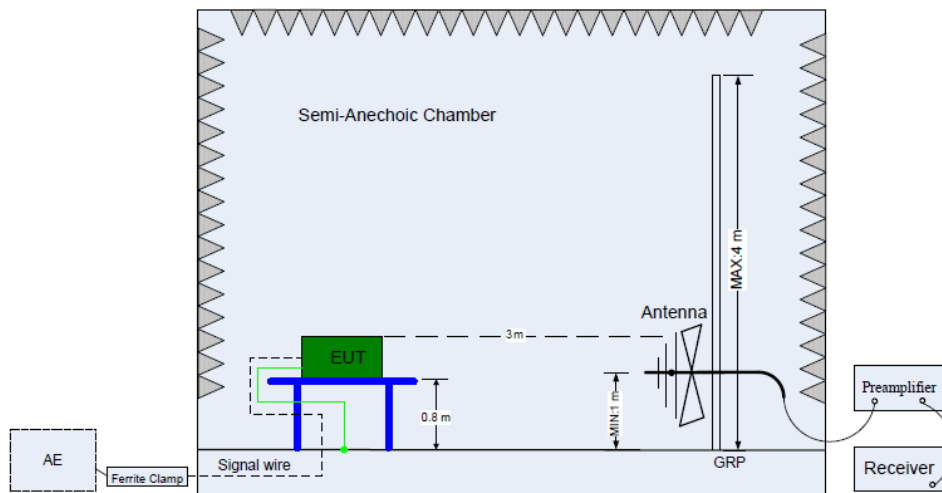
Test Setup 1: Radiated Emission test below 30MHz

The test site semi-anechoic chamber has met the requirement of NSA tolerance 4 dB according to the standards: ANSI C63.4. The test distance is 3m. The setup is according to ANSI C63.4.



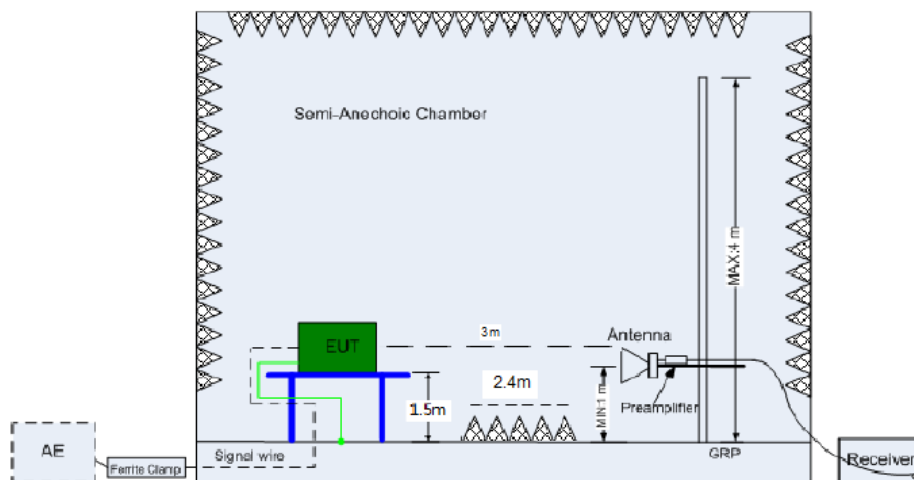
Test Setup 2: Radiated Emission test below 1GHz

The test site semi-anechoic chamber has met the requirement of NSA tolerance 4 dB according to the standards: ANSI C63.4. The test distance is 3m. The setup is according to ANSI C63.4.



Test Setup 3: Radiated Emission test above 1GHz

The test site semi-anechoic chamber has met the requirement of NSA tolerance 4 dB according to the standards: ANSI C63.4. The test distance is 3m. The setup is according to ANSI C63.4.



Limit:

Radiated emissions which fall in the restricted bands, as defined in section 15.205, must comply with the radiated emission limits specified in section 15.209.

§ 15.209

Frequency MHz	Field Strength uV/m	Field Strength dBµV/m	Detector
30-88	100	40	QP
88-216	150	43.5	QP
216-960	200	46	QP
960-1000	500	54	QP
Above 1000	500	54	AV
Above 1000	5000	74	PK

§15.205 Restricted bands of operation

MHz	MHz	MHz	GHz
0.090-0.110	16.42-16.423	399.9-410	4.5-5.15
¹ 0.495-0.505	16.69475-16.69525	608-614	5.35-5.46
2.1735-2.1905	16.80425-16.80475	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	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	(²)
13.36-13.41			

§15.231 (b) In addition to the provisions of §15.205, the field strength of emissions from intentional radiators operated under this section shall not exceed the following:

Fundamental frequency (MHz)	Field strength of fundamental (microvolts/meter)	Field strength of spurious emissions (microvolts/meter)
40.66-40.70	2,250	225
70-130	1,250	125
130-174	¹ 1,250 to 3,750	¹ 125 to 375
174-260	3,750	375
260-470	¹ 3,750 to 12,500	¹ 375 to 1,250
Above 470	12,500	1,250

* Linear interpolation with frequency, f, in MHz:

For 130-174 MHz: Field Strength ($\mu\text{V}/\text{m}$) = $(56.82 \times f) - 6136$

For 260-470 MHz: Field Strength ($\mu\text{V}/\text{m}$) = $(41.67 \times f) - 7083$

Note 1: Frequency bands 225-328.6 MHz and 335.4-399.9 MHz are designated for the exclusive use of the Government of Canada. Manufacturers should be aware of possible harmful interference and degradation of their licence-exempt radio equipment in these frequency bands.

Field Strength of the Fundamental Emissions

The limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit.

Fundamental Average ($\text{dB}\mu\text{V}/\text{m}$) = $81.93\text{dB}\mu\text{V}/\text{m}$ (Average)

Fundamental Peak ($\text{dB}\mu\text{V}/\text{m}$) = $81.93\text{dB}\mu\text{V}/\text{m} + 20 = 101.93\text{dB}\mu\text{V}/\text{m}$

Remark:

- (1) "*" means the emission(s) appear within the restrict bands shall follow the requirement of section 15.205.
- (2) Data of measurement within this frequency range shown "--" in the table above means the reading of emissions are the noise floor or attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.
- (3) Above 1GHz: Corrector factor = Antenna Factor + Cable Loss - Amplifier Gain.
- (4) Below 1GHz: Corrector factor = Antenna Factor + Cable Loss - Amplifier Gain.
- (5) Note: The low frequency, which started from 9 kHz to 30MHz with X/Y/Z axis, was pre-scanned and the result which was 20dB lower than the limit line per 15.31(o) was not reported.

Field Strength of the Fundamental Emissions
PK

Freq. [MHz]	PK Level [dB μ V/m]	Factor [dB]	Limit [dB μ V/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
2405	93.18	-20.1	101.93	-8.75	100	95	Horizontal

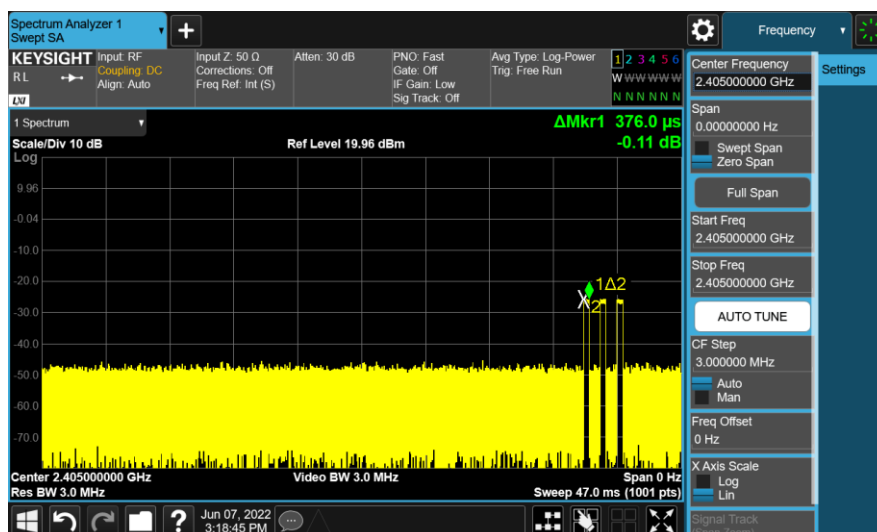
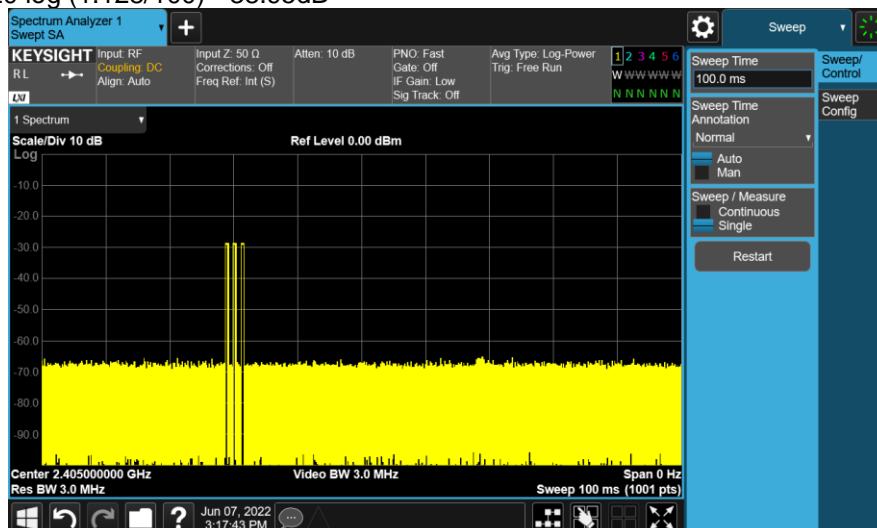
PK with Duty factor (AV)

Freq. [MHz]	PK Level [dB μ V/m]	Factor (dB)	Duty Factor (dB)	Limit [dB μ V/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
2405	93.18	-20.1	-38.95	81.93	27.7	100	95	Horizontal

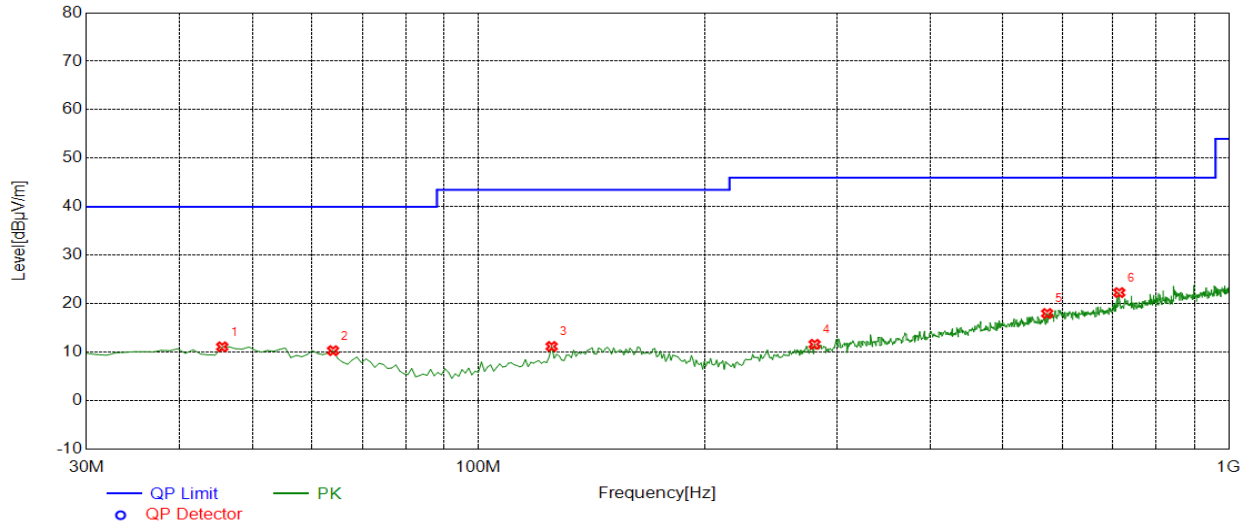
Result of PK=Reading Level +Antenna Factor + Cable Loss - Amplifier Gain.

Result of AV= Reading Level +Antenna Factor + Cable Loss - Amplifier Gain+Duty factor.

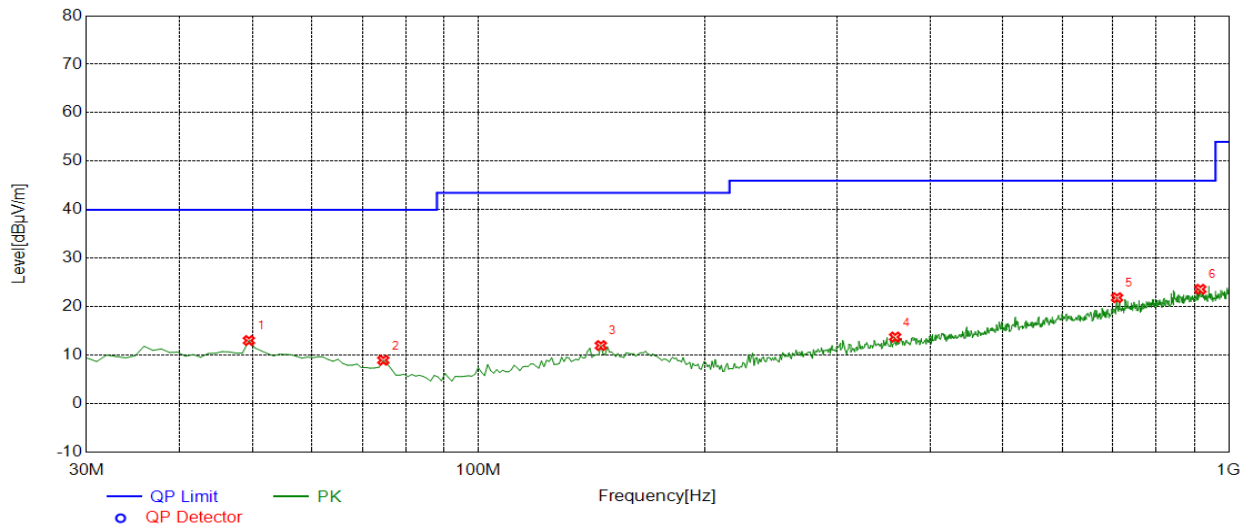
Duty factor= $20 \log(1.128/100)=-38.95\text{dB}$



Field strength of spurious emission for transmitter 30MHz – 1GHz



NO.	Freq. [MHz]	Level [dBμV/m]	Factor [dB/m]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	45.5355	11.11	-15.70	40.00	28.89	100	233	Horizontal
2	63.9840	10.32	-17.25	40.00	29.68	100	17	Horizontal
3	125.155	11.19	-17.99	43.50	32.31	100	73	Horizontal
4	280.510	11.63	-16.29	46.00	34.37	100	27	Horizontal
5	572.772	17.99	-10.45	46.00	28.01	100	109	Horizontal
6	714.534	22.29	-8.21	46.00	23.71	100	56	Horizontal



NO.	Freq. [MHz]	Level [dBµV/m]	Factor [dB/m]	Limit [dBµV/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	49.4194	13.03	-15.64	40.00	26.97	100	218	Vertical
2	74.6647	8.97	-19.51	40.00	31.03	100	18	Vertical
3	145.545	11.99	-16.08	43.50	31.51	100	100	Vertical
4	359.159	13.75	-14.61	46.00	32.25	100	49	Vertical
5	709.679	21.86	-8.31	46.00	24.14	100	37	Vertical
6	916.496	23.60	-5.65	46.00	22.40	100	127	Vertical

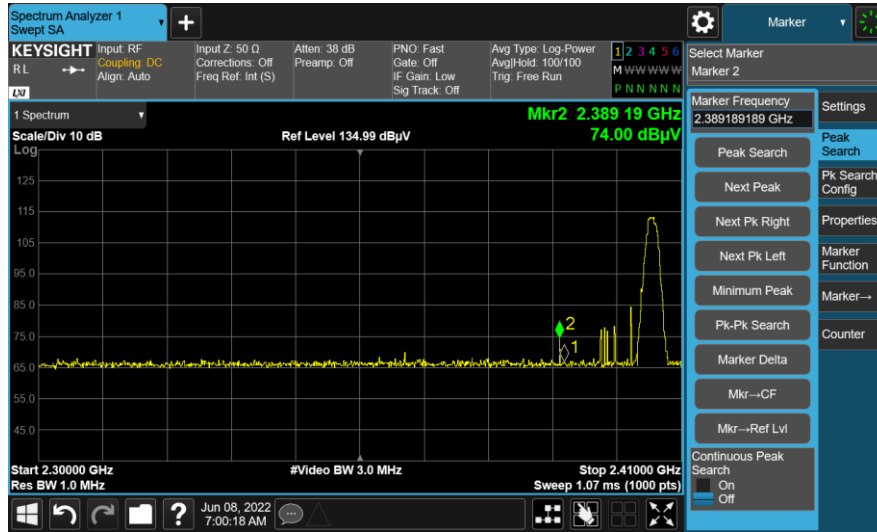
Field strength of spurious emission for transmitter above 1GHz

According to C63.10, if the peak (or quasi-peak) measured value complies with the average limit, it is unnecessary to perform an average measurement, so AV emission value did not show in below table if the peak value complies with average limit.

NO.	Freq. [MHz]	Level [dB μ V/m]	Factor [dB/m]	Limit [dB μ V/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	1567.7135	45.76	-24.26	74.00	28.24	150	321	Horizontal
2	2063.4127	45.92	-20.33	74.00	28.08	150	330	Horizontal
3	4744.6745	46.28	-16.44	74.00	27.72	150	265	Horizontal
4	5589.2589	46.04	-15.18	74.00	27.96	150	134	Horizontal
5	8108.0108	50.81	-11.37	74.00	23.19	150	160	Horizontal
6	9641.1641	50.86	-9.78	74.00	23.14	150	160	Horizontal

NO.	Freq. [MHz]	Level [dB μ V/m]	Factor [dB/m]	Limit [dB μ V/m]	Margin [dB]	Height [cm]	Angle [°]	Polarity
1	1362.4725	41.33	-25.08	74.00	32.67	150	316	Vertical
2	2064.6129	46.04	-20.33	74.00	27.96	150	214	Vertical
3	4209.1209	46.06	-17.31	74.00	27.94	150	330	Vertical
4	4969.6970	47.22	-16.23	74.00	26.78	150	330	Vertical
5	6420.3420	48.43	-13.37	74.00	25.57	150	135	Vertical
6	7339.9340	49.78	-12.76	74.00	24.22	150	42	Vertical

Restricted bands



Freq. [MHz]	PK Level [dBμV/m]	Factor [dB]	Limit [dBμV/m]	Margin [dB]	Height [cm]	Angle [°]
2389.19	53.90	-20.1	74	20.1	100	95

END