TEST REPORT

Reference No.	:	WTF23D07163720W002
FCC ID	:	2AW4Z-SRADIO
Applicant	:	Spirit System
Address	:	K Olsine 28, 73514 Orlova-Lutyne Czech Republic
Manufacturer	:	Spirit System
Address	:	K Olsine 28, 73514 Orlova-Lutyne Czech Republic
Product	:	Spirit WAVE
Model(s)	:	Spirit WAVE
Standards	:	FCC 47CFR Part 15.247
Date of Receipt sample	:	2023-08-30
Date of Test	:	2023-09-15 to 2024-10-28
Date of Issue	:	2024-11-13
Test Result	:	**Pass**

Remarks:
The results shown in this test report refer only to the sample(s) tested, this test report cannot be reproduced, except in full, without prior written permission of the company. The report would be invalid without specific stamp of test institute and the signatures of compiler and approver.

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Compiled by:

James Cheng / Project Engineer

Approved by:

Deval Qin / Designated Reviewer

2 Contents

3 Revision History

Test Report No.	Date of Receipt Sample	Date of Test	Date of Issue	Purpose	Comment	Approved
WTF23D07163720W002	2023-08-30	2023-09-15 to 2024-10-28	2024-11-13	Original	-	Valid

4 General Information

4.1 General Description of E.U.T.

Product:	Spirit WAVE
Model(s):	Spirit WAVE
Model Description:	N/A
Test Sample No.:	1-1/1
Bluetooth Version:	5.0
Hardware Version:	1.0
Software Version:	1.0.11

4.2 Details of E.U.T.

Operation Frequency:	2402~2480MHz
Max. RF output power:	4.7dBm
Type of Modulation:	GFSK
Antenna installation:	ProAnt 2.4G + 5G Niche antenna
Antenna Gain:	3.5dBi

Note:

#: The antenna gain is provided by the applicant, and the applicant should be responsible for its authenticity, WALTEK lab has not verified the authenticity of its information.

Ratings:	Input: DC 5V
Battery:	DC 3.8V, 6900mAh, 26.2Wh

4.3 Channel List

Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)	Channel No.	Frequency (MHz)
0	2402	1	2404	2	2406	3	2408
4	2410	5	2412	6	2414	7	2416
8	2418	9	2420	10	2422	11	2424
12	2426	13	2428	14	2430	15	2432
16	2434	17	2436	18	2438	19	2440
20	2442	21	2444	22	2446	23	2448
24	2450	25	2452	26	2454	27	2456
28	2458	29	2460	30	2462	31	2464
32	2466	33	2468	34	2470	35	2472
36	2474	37	2476	38	2478	39	2480

4.4 Test Facility

The test facility has a test site registered with the following organizations:

ISED CAB identifier: CN0013. Test Firm Registration No.: 7760A.

Waltek Testing Group Co., Ltd. Has been registered and fully described in a report filed with the Industry Canada. The acceptance letter from the Industry Canada is maintained in our files. Registration number 7760A, October 15, 2016.

FCC Designation No.: CN1201. Test Firm Registration No.: 523476.

Waltek Testing Group Co., Ltd. EMC Laboratory `has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Registration number 523476, September 10, 2019.

4.5 Subcontracted

Whether parts of tests for the product have been subcontracted to other labs:

☐ Yes ☒ No

If Yes, list the related test items and lab information:

Test Lab: N/A

Lab address: N/A

Test items: N/A

4.6 Abnormalities from Standard Conditions

None.

4.7 Test Mode

Tests Carried Out Under FCC part 15.247

Test Items	Mode	Data Rate	Channel	TX/RX
Maximum Peak Output Power	BT BLE	1 Mbps	0/19/39	TX
Power Spectral Density	BT BLE	1 Mbps	0/19/39	TX
6dB Bandwidth	BT BLE	1 Mbps	0/19/39	TX
Band Edge	BT BLE	1 Mbps	0/19/39	TX
Transmitter Spurious Emissions	BT BLE	1 Mbps	0/19/39	TX

Note: Parameters set by test software during channel & power tests, the software provided by the applicant was used to set the operating channels as well as the maximum output power level. The RF output power set is the power expected by the manufacturer and is going to be fixed on the firmware of the final product.

5 Test Summary

Test Items	Test Requirement	Result
Radiated Spurious Emissions	15.247(d) 15.205(a) 15.209(a)	PASS
Conducted Spurious Emissions	15.247(d)	PASS*
Conducted Emissions	15.207(a)	PASS
6dB Bandwidth	15.247(a)(2)	PASS*
Maximum Peak Output Power	15.247(b)(3),(4)	PASS*
Power Spectral Density	15.247(e)	PASS*
Band Edge	15.247(d)	PASS*
Antenna Requirement	15.203	PASS
Maximum Permissible Exposure (Exposure of Humans to RF Fields)	1.1307(b)(1)	PASS
*: The test result refer to the report UL-RPT-RP13337971-1216A V3.0, which FCC ID is 2ABCB-RPIRM0. The date of modular grant is 11/03/2020.		

6 Equipment Used during Test

6.1 Equipments List

Item	Equipment	Manufacturer	Model No.	Serial No.	Last Cal. Date	Calibration Due Date
Conducted Emissions 1#						
1	EMI Test Receiver	R&S	ESCI	100947	2023-07-27 2024-07-18	2024-07-18 2025-07-17
2	LISN	R&S	ENV216	100115	2023-07-27 2024-07-18	2024-07-18 2025-07-17
3	Cable	Top	TYPE16(3.5M)	-	2023-07-27 2024-07-18	2024-07-18 2025-07-17
3m Semi-anechoic Chamber for Radiation Emissions 1#						
1	Spectrum Analyzer	R&S	FSP30	100091	2023-04-24 2024-04-22	2024-04-23 2025-04-21
2	Amplifier	Agilent	8447D	2944A10178	2023-07-27 2024-07-18	2024-07-18 2025-07-17
3	Tri-log Broadband Antenna	SCHWARZBECK	VULB9163	336	2023-08-07 2024-07-21	2024-07-21 2025-07-20
4	Coaxial Cable	Top	TYPE16(13M)	-	2023-04-24 2024-04-22	2024-04-23 2025-04-21
5	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9120D	667	2023-01-24 2024-01-23	2024-01-23 2025-01-22
6	Broad-band Horn Antenna	SCHWARZBECK	BBHA 9170	335	2023-07-27 2024-07-18	2024-07-18 2025-07-17
7	Broadband Preamplifier	COMPLIANCE	PAP-1G18	2004	2023-07-27 2024-07-18	2024-07-18 2025-07-17
8	Coaxial Cable	Top	ZT26-NJ-NJ-8M/FA	-	2023-04-24 2024-04-22	2024-04-23 2025-04-21
9	Microwave Amplifier	SCHWARZBECK	BBV 9721	100472	2023-07-27 2024-07-18	2024-07-18 2025-07-17
10	Coaxial Cable	Top	ZT40-2.92J-2.92J-2.0M	17100919	2023-04-24 2024-04-22	2024-04-23 2025-04-21
3m Semi-anechoic Chamber for Radiation Emissions 2#						
1	Test Receiver	R&S	ESCI	101296	2023-04-24 2024-04-22	2024-04-23 2025-04-21
2	Trilog Broadband Antenna	SCHWARZBECK	VULB9160	9160-3325	2022-11-05 2023-11-04	2023-11-04 2024-11-03
3	Active Loop Antenna	Com-Power	AL-130R	10160007	2024-04-27	2025-04-26
4	Amplifier	ANRITSU	MH648A	M43381	2023-04-24 2024-04-22	2024-04-23 2025-04-21
5	Cable	HUBER+SUHNER	CBL2	525178	2023-04-24 2024-04-22	2024-04-23 2025-04-21

Test Software:

Test Item	Software name	Software version
Conduction disturbance Radiated Emission(3m)	EZ-EMC	EZ-EMC(RA-03A1-1)

6.2 Description of Support Units

Equipment	Manufacturer	Model No.	Series No.
/	/	/	/

6.3 Measurement Uncertainty

Parameter	Uncertainty
Conducted Emission	± 3.64 dB(AC mains 150KHz~30MHz)
Radiated Spurious Emissions	± 5.08 dB (Bilog antenna 30M~1000MHz)
	± 5.47 dB (Horn antenna 1000M~25000MHz)
Radio Frequency	± 1 x 10^{-7}Hz
RF Power	± 0.42 dB
RF Power Density	± 0.7dB
Conducted Spurious Emissions	± 2.76 dB (9kHz~26500MHz)
Confidence interval：95%. Confidence factor:k=2	

6.4 Test Equipment Calibration

All the test equipments used are valid and calibrated by CEPREI Certification Body that address is No.110 Dongguan Zhuang RD. Guangzhou, P.R. China.

7 Conducted Emission

Test Requirement: 47CFR FCC Part15 Subpart C §15.207

Test Method: ANSI C63.10:2013

Test Result: PASS

Frequency Range: 150kHz to 30MHz

Limit:

Frequency (MHz)	Conducted Limit (dBμV)	
	Quasi-peak	Average
0.15 to 0.5	66 to 56*	56 to 46*
0.5 to 5.0	5	46
5.0 to 30	60	50
*Decreases with the logarithm of the frequency.		

7.1 E.U.T. Operation

Operating Environment:

Temperature: 25.9 °C

Humidity: 51.6 % RH

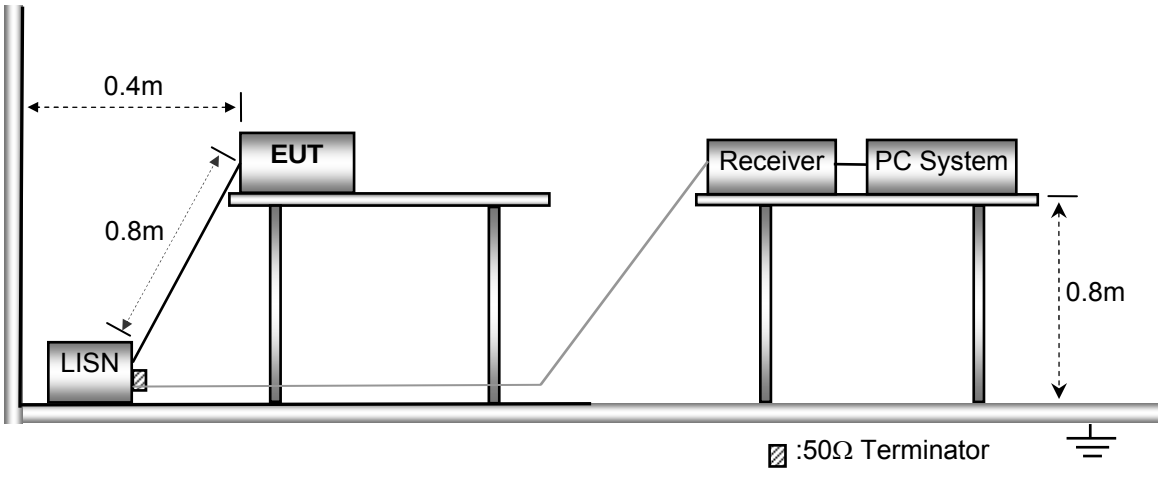
Atmospheric Pressure: 101.3kPa

EUT Operation:

The test was performed in Transmitting mode, the worst test data were shown in the report.

7.2 EUT Setup

The conducted emission tests were performed using the setup accordance with the ANSI C63.10:2013.



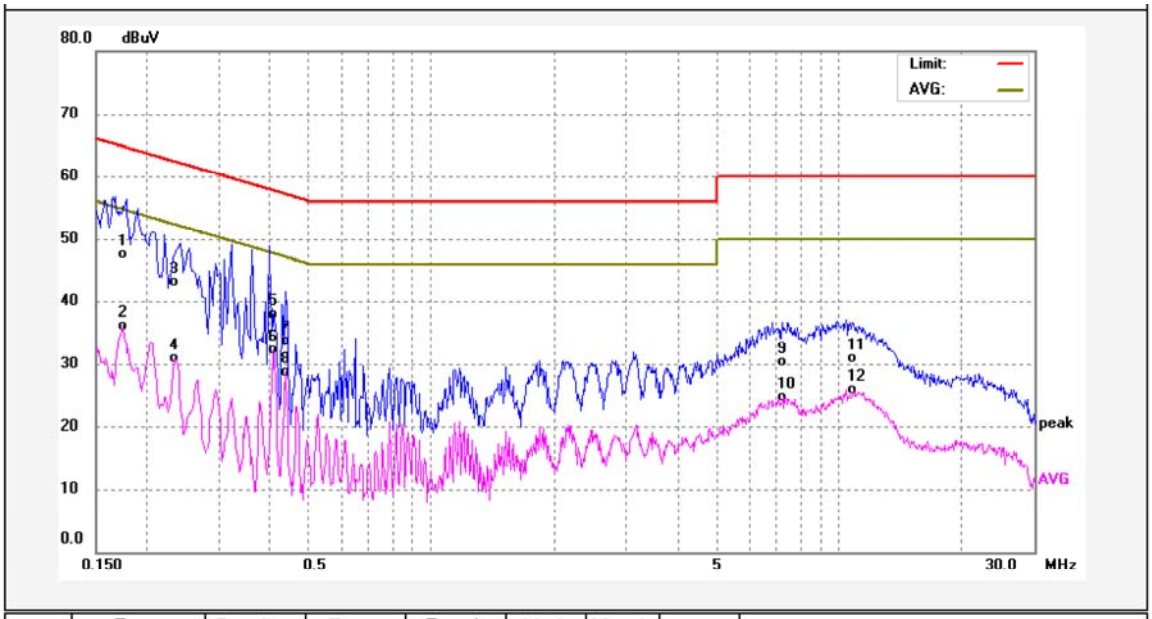
7.3 Measurement Description

The maximised peak emissions from the EUT was scanned and measured for both the Live and Neutral Lines. Quasi-peak & average measurements were performed if peak emissions were within 6dB of the average limit line.

7.4 Conducted Emission Test Result

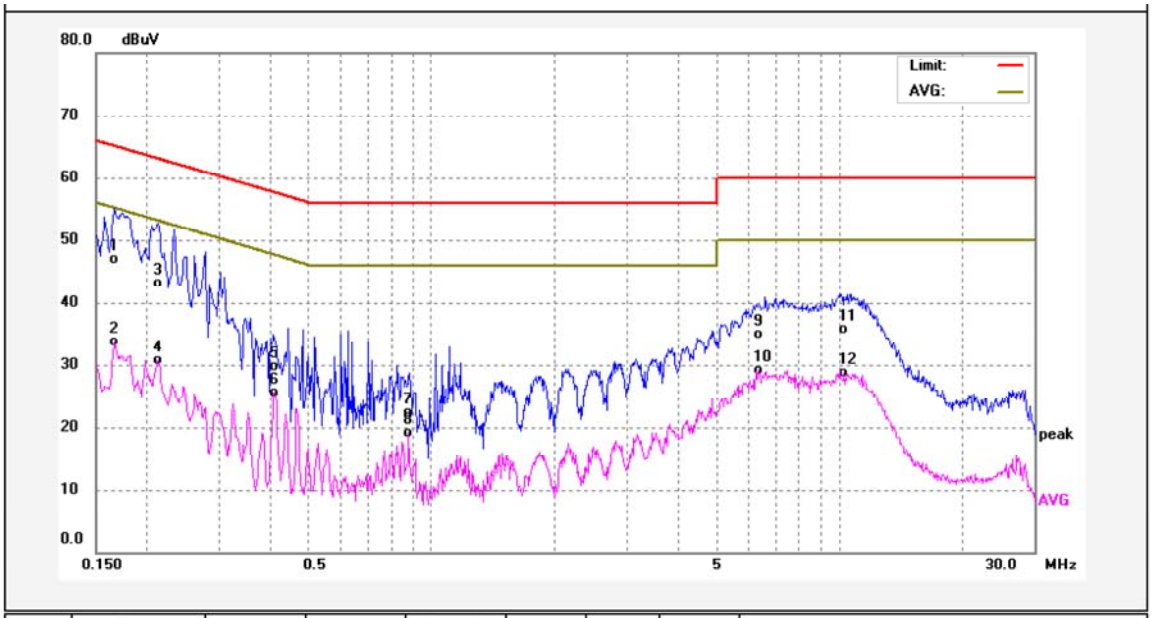
Remark: only the worst data (High channel mode) were reported

Live line:



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit dBuV	Margin (dB)	Detector	Remark
1	0.1737	36.63	10.92	47.55	64.78	-17.23	QP	
2	0.1737	25.28	10.92	36.20	54.78	-18.58	AVG	
3	0.2340	32.08	10.94	43.02	62.30	-19.28	QP	
4	0.2340	19.89	10.94	30.83	52.30	-21.47	AVG	
5	0.4097	26.87	10.98	37.85	57.65	-19.80	QP	
6	0.4097	21.23	10.98	32.21	47.65	-15.44	AVG	
7	0.4380	22.65	10.98	33.63	57.10	-23.47	QP	
8	0.4380	17.72	10.98	28.70	47.10	-18.40	AVG	
9	7.2858	18.98	11.38	30.36	60.00	-29.64	QP	
10	7.2858	13.24	11.38	24.62	50.00	-25.38	AVG	
11	10.7939	19.36	11.50	30.86	60.00	-29.14	QP	
12	10.7939	14.49	11.50	25.99	50.00	-24.01	AVG	

Neutral line:



No.	Freq. (MHz)	Reading (dBuV)	Factor (dB)	Result (dBuV)	Limit dBuV	Margin (dB)	Detector	Remark
1	0.1660	35.90	10.95	46.85	65.15	-18.30	QP	
2	0.1660	22.76	10.95	33.71	55.15	-21.44	AVG	
3	0.2127	32.06	10.96	43.02	63.10	-20.08	QP	
4	0.2127	19.80	10.96	30.76	53.10	-22.34	AVG	
5	0.4102	18.64	10.99	29.63	57.64	-28.01	QP	
6	0.4102	14.57	10.99	25.56	47.64	-22.08	AVG	
7	0.8780	11.19	11.17	22.36	56.00	-33.64	QP	
8	0.8780	7.87	11.17	19.04	46.00	-26.96	AVG	
9	6.3418	23.54	11.32	34.86	60.00	-25.14	QP	
10	6.3418	17.87	11.32	29.19	50.00	-20.81	AVG	
11	10.2499	24.30	11.49	35.79	60.00	-24.21	QP	
12	10.2499	17.23	11.49	28.72	50.00	-21.28	AVG	

8 Radiated Emissions

Test Requirement: FCC 47CFR Part 15 Section 15.209 & 15.247

Test Method: ANSI C63.10:2013

Test Result: PASS

Measurement Distance: 3m

Limit:

Frequency (MHz)	Field Strength		Field Strength Limit at 3m Measurement Dist	
	uV/m	Distance (m)	uV/m	dBuV/m
0.009 ~ 0.490	2400/F(kHz)	300	10000 * 2400/F(kHz)	$20\log^{(2400/F(kHz))} + 80$
0.490 ~ 1.705	24000/F(kHz)	30	100 * 24000/F(kHz)	$20\log^{(24000/F(kHz))} + 40$
1.705 ~ 30	30	30	100 * 30	$20\log^{(30)} + 40$
30 ~ 88	100	3	100	$20\log^{(100)}$
88 ~ 216	150	3	150	$20\log^{(150)}$
216 ~ 960	200	3	200	$20\log^{(200)}$
Above 960	500	3	500	$20\log^{(500)}$

8.1 EUT Operation

Operating Environment**:**

Temperature: 25.9 °C

Humidity: 59.6 % RH

Atmospheric Pressure: 101.1kPa

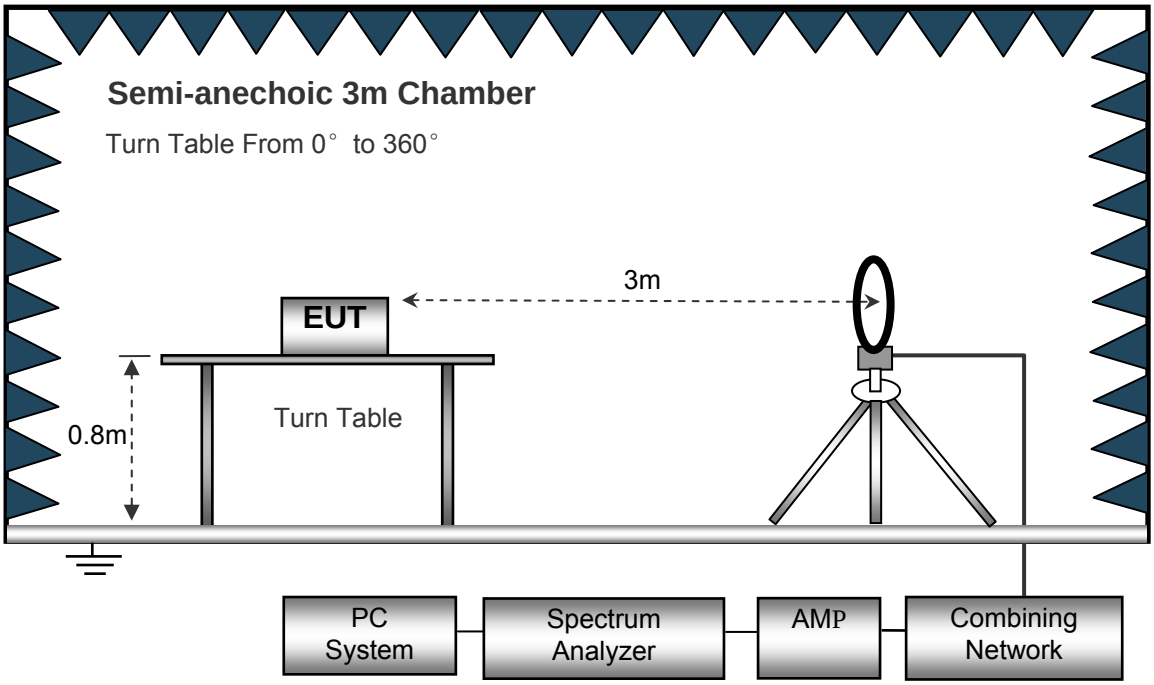
EUT Operation:

The test was performed in transmitting mode, the test data were shown in the report.

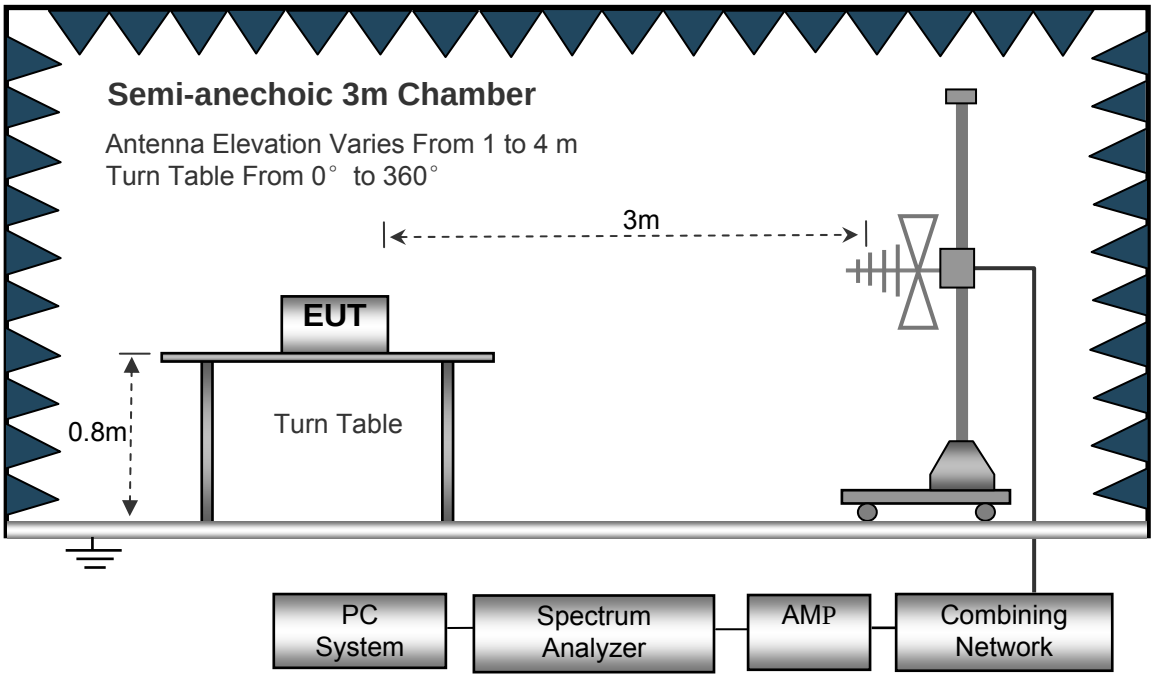
8.2 Test Setup

The radiated emission tests were performed in the 3m Semi- Anechoic Chamber test site, using the setup accordance with the ANSI C63.10.

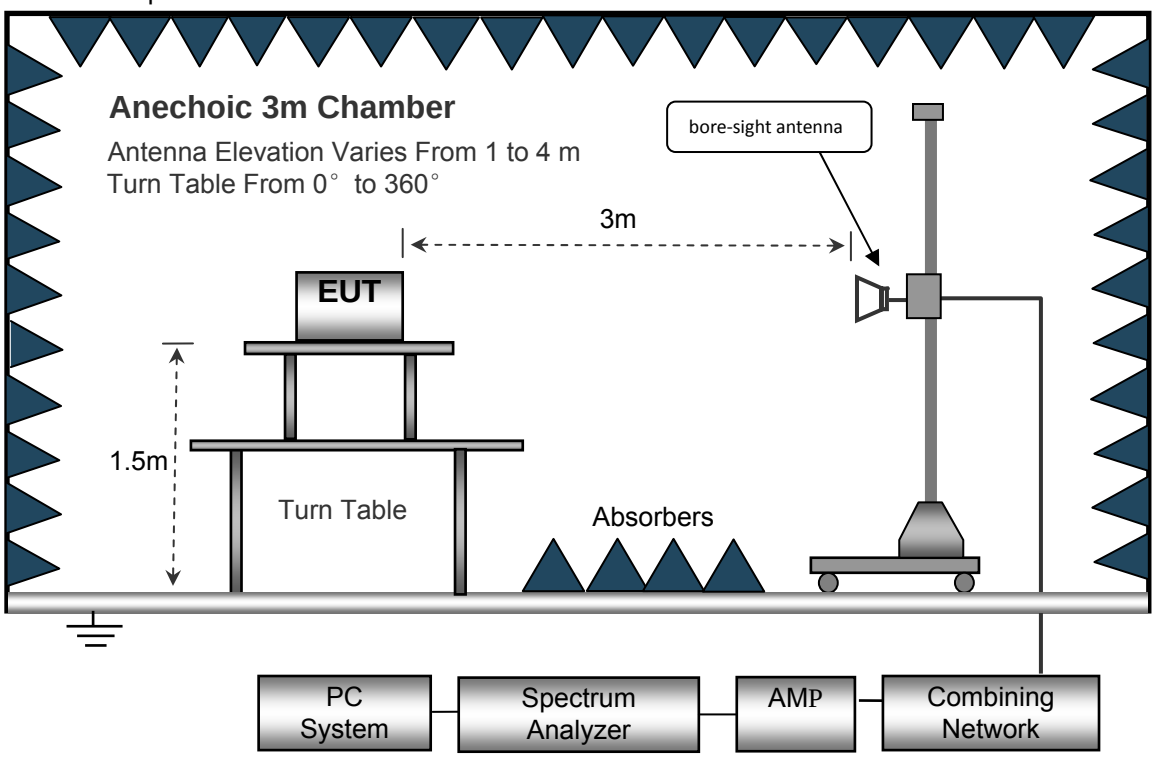
The test setup for emission measurement below 30MHz.



The test setup for emission measurement from 30 MHz to 1 GHz.



The test setup for emission measurement above 1 GHz.



8.3 Spectrum Analyzer Setup

Below 30MHz

Sweep Speed ..... Auto
IF Bandwidth..... 10kHz
Video Bandwidth..... 10kHz
Resolution Bandwidth..... 10kHz

30MHz ~ 1GHz

Sweep Speed ..... Auto
Detector ..... PK
Resolution Bandwidth..... 100kHz
Video Bandwidth..... 300kHz

Above 1GHz

Sweep Speed ..... Auto
Detector ..... PK
Resolution Bandwidth..... 1MHz
Video Bandwidth..... 3MHz
Detector ..... Ave.
Resolution Bandwidth..... 1MHz
Video Bandwidth..... 10Hz

8.4 Test Procedure

1. The EUT is placed on a turntable, which is 0.8m above ground plane for below 1GHz and 1.5m for above 1GHz.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. EUT is set 3m away from the receiving antenna, which is moved from 1m to 4m to find out the maximum emissions.
4. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
5. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
6. Repeat above procedures until the measurements for all frequencies are complete.
7. The radiation measurements are performed in X,Y and Z axis positioning(X denotes lying on the table, Y denotes side stand and Z denotes vertical stand),the worst condition was tested putting the eut in Z axis,so the worst data were shown as follow.
8. A 2.4GHz high –pass filter is used druing radiated emissions above 1GHz measurement.

8.5 Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain from the Amplitude reading. The basic equation is as follows:

Corr. Ampl. = Indicated Reading + Antenna Factor + Cable Factor - Amplifier Gain

The “Margin” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -7dB means the emission is 7dB below the maximum limit for Class B. The equation for margin calculation is as follows:

Margin = Corr. Ampl. – Limit

8.6 Summary of Test Results

Test Frequency: 9kHz~30MHz

The measurements were more than 20 dB below the limit and not reported.

Test Frequency: 30MHz ~ 8GHz

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	Limit	Margin
				Height	Polar				
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
GFSK Low Channel 2402MHz									
236.25	39.29	QP	90	1.3	H	-11.88	27.41	46.00	-18.59
236.25	45.17	QP	297	1.1	V	-11.88	33.29	46.00	-12.71
4804.00	50.94	PK	171	1.8	V	-1.06	49.88	74.00	-24.12
4804.00	39.31	Ave	171	1.8	V	-1.06	38.25	54.00	-15.75
7206.00	51.93	PK	238	1.6	H	1.33	53.26	74.00	-20.74
7206.00	38.75	Ave	238	1.6	H	1.33	40.08	54.00	-13.92
2321.47	46.21	PK	251	1.1	V	-13.19	33.02	74.00	-40.98
2321.47	39.40	Ave	251	1.1	V	-13.19	26.21	54.00	-27.79
2370.06	44.00	PK	262	1.3	H	-13.14	30.86	74.00	-43.14
2370.06	37.92	Ave	262	1.3	H	-13.14	24.78	54.00	-29.22
2494.50	42.55	PK	196	1.9	V	-13.08	29.47	74.00	-44.53
2494.50	38.89	Ave	196	1.9	V	-13.08	25.81	54.00	-28.19

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	Limit	Margin
				Height	Polar				
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
GFSK Middle Channel 2440MHz									
236.25	40.12	QP	118	1.0	H	-13.35	26.77	46.00	-19.23
236.25	44.55	QP	53	1.6	V	-13.35	31.20	46.00	-14.80
4880.00	50.62	PK	208	1.5	V	-0.62	50.00	74.00	-24.00
4880.00	40.50	Ave	208	1.5	V	-0.62	39.88	54.00	-14.12
7320.00	52.51	PK	149	1.7	H	2.21	54.72	74.00	-19.28
7320.00	39.05	Ave	149	1.7	H	2.21	41.26	54.00	-12.74
2311.24	46.47	PK	221	1.1	V	-13.19	33.28	74.00	-40.72
2311.24	39.32	Ave	221	1.1	V	-13.19	26.13	54.00	-27.87
2372.57	42.03	PK	251	1.7	H	-13.14	28.89	74.00	-45.11
2372.57	38.97	Ave	251	1.7	H	-13.14	25.83	54.00	-28.17
2495.73	43.83	PK	46	1.3	V	-13.08	30.75	74.00	-43.25
2495.73	37.32	Ave	46	1.3	V	-13.08	24.24	54.00	-29.76

Frequency	Receiver Reading	Detector	Turn table Angle	RX Antenna		Corrected Factor	Corrected Amplitude	Limit	Margin
				Height	Polar				
(MHz)	(dBμV)	(PK/QP/Ave)	Degree	(m)	(H/V)	(dB)	(dBμV/m)	(dBμV/m)	(dB)
GFSK High Channel 2480MHz									
236.25	41.15	QP	167	1.2	H	-13.35	27.80	46.00	-18.20
236.25	45.72	QP	256	1.5	V	-13.35	32.37	46.00	-13.63
4960.00	53.79	PK	356	1.3	V	-0.24	53.55	74.00	-20.45
4960.00	40.59	Ave	356	1.3	V	-0.24	40.35	54.00	-13.65
7440.00	50.21	PK	100	1.7	H	2.84	53.05	74.00	-20.95
7440.00	40.02	Ave	100	1.7	H	2.84	42.86	54.00	-11.14
2336.70	46.34	PK	321	2.0	V	-13.19	33.15	74.00	-40.85
2336.70	38.35	Ave	321	2.0	V	-13.19	25.16	54.00	-28.84
2357.53	43.45	PK	184	1.7	H	-13.14	30.31	74.00	-43.69
2357.53	37.52	Ave	184	1.7	H	-13.14	24.38	54.00	-29.62
2488.43	42.49	PK	116	1.2	V	-13.08	29.41	74.00	-44.59
2488.43	38.13	Ave	116	1.2	V	-13.08	25.05	54.00	-28.95

Test Frequency: 8GHz~25GHz

The measurements were more than 20 dB below the limit and not reported.

9 Antenna Requirement

According to the FCC Part 15 Paragraph 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. This product has a ProAnt 2.4G + 5G Niche antenna fulfil the requirement of this section.

Note: Please refer to EUT photos for more details.

10 RF Exposure

Remark: Please refer to SAR test report: WTF23D07163720W006.

11 Photographs of test setup and EUT.

Note: Please refer to appendix: Appendix-Spirit WAVE-Photos.

======End of Report======