

RADIO PERFORMANCE TEST REPORT

Test Report No. : OT-237-RWD-048
Reception No. : 2301000279
Applicant : LG Electronics USA, Inc.
Address : 111 Sylvan Avenue, North Building, Englewood Cliffs, New Jersey, 07632, United States
Manufacturer : LG Electronics Inc.
Address : 222 LG-ro, Jinwi-Myeon, Pyeongtaek -Si, Gyeonggi-Do, 451-713, Korea
Type of Equipment : Silverbox RADIO ASM-RECEIVER
FCC ID. : BEJVCUEB-N
Model Name : VCUEB-N
Multiple Model Name : N/A
Serial number : N/A
Total page of Report : 31 pages (including this page)
Date of Incoming : January 31, 2023
Date of issue : July 26, 2023

SUMMARY

The equipment complies with the regulation; **FCC PART 15 SUBPART C Section 15.247**

This test report only contains the result of a single test of the sample supplied for the examination.

It is not a generally valid assessment of the features of the respective products of the mass-production.

This report is not correlated with the "KS Q ISO/IEC 17025 and KOLAS accreditation" of Korean Laboratory Accreditation Scheme.



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Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-237-RWD-048	July 26, 2023	Initial Release	All

1. VERIFICATION OF COMPLIANCE

Applicant : LG Electronics USA, Inc.

Address : 111 Sylvan Avenue, North Building, Englewood Cliffs, New Jersey, 07632, United States

Contact Person : Sung Soo Kim / Director, Regulatory and Environmental Affairs

Telephone No. : +201-266-2215

FCC ID : BEJVCUEB-N

Model Name : VCUEB-N

Brand Name : -

Serial Number : N/A

Date : July 26, 2023

EQUIPMENT CLASS	DTS – DIGITAL TRNSMISSION SYSTEM
E.U.T. DESCRIPTION	Silverbox RADIO ASM-RECEIVER
THIS REPORT CONCERNS	Original Grant
MEASUREMENT PROCEDURES	ANSI C63.10: 2013
TYPE OF EQUIPMENT TESTED	Pre-Production
KIND OF EQUIPMENT AUTHORIZATION REQUESTED	Certification
EQUIPMENT WILL BE OPERATED UNDER FCC RULES PART(S)	FCC PART 15 SUBPART C Section 15.247 KDB 558074 D01 15.247 Meas Guidance v05r02
Modifications on the Equipment to Achieve Compliance	None
Final Test was Conducted On	3 m, Semi Anechoic Chamber

-. The above equipment was tested by ONETECH Corp. for compliance with the requirement set forth in the FCC Rules and Regulations. This said equipment in the configuration described in this report, shows the maximum emission levels emanating from equipment are within the compliance requirements.

2. TEST SUMMARY

2.1 Test items and results

SECTION	TEST ITEMS	RESULTS
15.247 (a) (2)	Minimum 6 dB Bandwidth	Met the Limit / PASS
15.247 (b) (3)	Maximum Peak Conducted Output Power	Met the Limit / PASS
15.247 (d)	100 kHz Bandwidth Outside the Frequency Band	Met the Limit / PASS
15.247 (d)	Radiated Emission which fall in the Restricted Band	Met the Limit / PASS
15.247 (e)	Peak Power Spectral Density	Met the Limit / PASS
15.209	Radiated Emission Limits	Met the Limit / PASS
15.207	Conducted Limits	N/A (See Note)
15.203	Antenna Requirement	Met requirement / PASS

Note: This test is not performed because the EUT is operated by DC Power.

2.2 Additions, deviations, exclusions from standards

No additions, deviations or exclusions have been made from standard.

2.3 Related Submittal(s) / Grant(s)

Original submittal only

2.4 Purpose of the test

To determine whether the equipment under test fulfills the requirements of the regulation stated in FCC PART 15 SUBPART C Section 15.247.

2.5 Test Methodology

Both conducted and radiated testing was performed according to the procedures in ANSI C63.10: 2013. Radiated testing was performed at a distance of 3 m from EUT to the antenna.

2.6 Test Facility

The Onetech Corp. has been designated to perform equipment testing in compliance with ISO/IEC 17025.

The Electromagnetic compatibility measurement facilities are located at 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea.

-. Site Filing:

VCCI (Voluntary Control Council for Interference) – Registration No. R-20122/ C-14617/ G-10666/ T-11842

ISED (Innovation, Science and Economic Development Canada) – Registration No. Site# 3736A-3

KOLAS (Korea Laboratory Accreditation Scheme) - Accreditation NO. KT085

FCC (Federal Communications Commission) - Accreditation No. KR0013

RRA (Radio Research Agency) – Designation No. KR0013

3. GENERAL INFORMATION

3.1 Product Description

The LG Electronics USA, Inc., Model VCUEB-N (referred to as the EUT in this report) is a Silverbox RADIO ASM-RECEIVER. The product specification described herein was obtained from product data sheet or user's manual.

DEVICE TYPE	Silverbox RADIO ASM-RECEIVER		
Temperature Range	-30 °C ~ 85 °C		
OPERATING FREQUENCY	Bluetooth	2 402 MHz ~ 2 480 MHz	
	WLAN 2.4 GHz	2 412 MHz ~ 2 462 MHz (802.11b/g/n(HT20))	
	5 150 MHz ~ 5 250 MHz Band	5 180 MHz ~ 5 240 MHz (802.11a/n(HT20)/ac(VHT20))	
		5 190 MHz ~ 5 230 MHz (802.11n(HT40)/ac(VHT40))	
		5 210 MHz (802.11ac(VHT80))	
	5 725 MHz ~ 5 850 MHz Band	5 745 MHz ~ 5 825 MHz (802.11a/n(HT20)/ac(VHT20))	
		5 755 MHz ~ 5 795 MHz (802.11n(HT40)/ac(VHT40))	
		5 775 MHz (802.11ac(VHT80))	
MODULATION TYPE	Bluetooth	GFSK for 1 Mbps, $\pi/4$ -DQPSK for 2 Mbps, 8-DPSK for 3 Mbps	
	WLAN 2.4 GHz	802.11b: DSSS Modulation(DBPSK/DQPSK/CCK) 802.11g/n(HT20): OFDM Modulation(BPSK/QPSK/16QAM/64QAM)	
	WLAN 5 GHz	802.11a/n(HT20)/n(HT40)/ac(VHT80): OFDM Modulation(BPSK/QPSK/16QAM/64QAM)	
RF OUTPUT POWER	Bluetooth	1 Mbps	0.75 dBm
		2 Mbps	2.78 dBm
		3 Mbps	2.82 dBm
	WLAN 2.4 GHz	10.04 dBm(802.11b)	
		10.49 dBm(802.11g)	
		11.34 dBm(802.11n_HT20)	

RF OUTPUT POWER	5 150 MHz ~ 5 250 MHz Band (UNII I)	Internal Antenna	14.87 dBm(802.11a) 15.79 dBm(802.11n_HT20) 15.06 dBm(802.11n_HT40) 11.28 dBm(802.11ac_VHT80)	
		External Antenna	8.16 dBm(802.11a) 9.13 dBm(802.11n_HT20) 8.03 dBm(802.11n_HT40) 4.37 dBm(802.11ac_VHT80)	
	5 725 MHz ~ 5 850 MHz Band (UNII 3)	Internal Antenna	15.10 dBm(802.11a) 16.11 dBm(802.11n_HT20) 14.73 dBm(802.11n_HT40) 10.98 dBm(802.11ac_VHT80)	
		External Antenna	8.20 dBm(802.11a) 9.16 dBm(802.11n_HT20) 7.77 dBm(802.11n_HT40) 4.08 dBm(802.11ac_VHT80)	
ANTENNA TYPE	Bluetooth	PCB Antenna		
	WLAN 2.4 GHz	PCB Antenna		
	WLAN 5 GHz	Internal Antenna	PCB Antenna	
		External Antenna	PCB Antenna	
ANTENNA GAIN	Bluetooth	0.89 dBi		
	WLAN 2.4 GHz	2.18 dBi		
	5 150 MHz ~ 5 250 MHz Band	Internal Antenna	0.63 dBi	
		External Antenna	2.37 dBi	
	5 725 MHz ~ 5 850 MHz Band	Internal Antenna	-1.04 dBi	
		External Antenna	3.61 dBi	
List of each Osc. or crystal Freq.(Freq. >= 1 MHz)		20 MHz, 24 MHz, 25 MHz, 27 MHz, 40 MHz, 55.46667 MHz		

3.2 Alternative type(s)/model(s); also covered by this test report.

-. None

4. EUT MODIFICATIONS

-. None

5. SYSTEM TEST CONFIGURATION

5.1 Justification

This device was configured for testing in a typical way as a normal customer is supposed to be used. During the test, the following components were installed inside of the EUT.

DEVICE TYPE	MANUFACTURER	MODEL/PART NUMBER	FCC ID
Main Board	N/A	N/A	N/A
Module	N/A	N/A	N/A
Antenna	N/A	N/A	N/A

5.2 Peripheral equipment

Defined as equipment needed for correct operation of the EUT, but not considered as tested:

Model	Manufacturer	Description	Connected to
VCUEB-N	LG Electronics Inc.	Silverbox RADIO ASM-RECEIVER (EUT)	-
GP-4303D	LG Precision Co.,Ltd	DC Power Supply (DC 30 V 3 A)	-
Ideapad320	LENOVO	NoteBook	EUT

5.3 Mode of operation during the test

For the testing, software used to control the EUT for staying in continuous transmitting is programmed.

For final testing, the EUT was set at 2 412 MHz, 2 437 MHz, and 2 462 MHz to get a maximum emission levels from the EUT. The EUT was moved throughout the XY, XZ, and YZ planes and the worst case is “XY” axis, but the worst data was recorded in this report.

- . Channel List (WLAN 2.4 GHz)

Channel	Frequency[MHz]	Channel	Frequency[MHz]	Channel	Frequency[MHz]
1	2 412.00	6	2 437.00	11	2 462.00
2	2 417.00	7	2 442.00		
3	2 422.00	8	2 447.00		
4	2 427.00	9	2 452.00		
5	2 432.00	10	2 457.00		

- Duty Cycle

Band	TEST Mode	Data Rate	On Time (ms)	Total Time (ms)	Duty Cycle (%)	Duty Cycle Factor (dB)
WLAN 2.4 GHz	802.11 b	1	0.008 62	0.008 64	99.87	0.01
		2	0.004 41	0.004 42	99.72	0.01
		5.5	0.001 73	0.001 74	99.35	0.03
		11	0.000 96	0.000 97	98.84	0.05
	802.11 g	6	0.001 43	0.001 45	98.82	0.05
		9	0.000 96	0.000 98	98.26	0.08
		12	0.000 73	0.000 75	97.69	0.10
		18	0.000 49	0.000 51	96.62	0.15
		24	0.000 38	0.000 39	95.67	0.19
		36	0.000 26	0.000 27	93.71	0.28
		48	0.000 20	0.000 22	92.16	0.35
		54	0.000 18	0.000 20	91.28	0.40
	802.11 n(HT20)	MCS0	0.001 34	0.001 36	98.75	0.05
		MCS1	0.000 69	0.000 71	97.56	0.11
		MCS2	0.000 47	0.000 49	96.49	0.16
		MCS3	0.000 36	0.000 38	95.53	0.20
		MCS4	0.000 26	0.000 27	93.76	0.28
		MCS5	0.000 20	0.000 22	92.09	0.36
		MCS6	0.000 18	0.000 20	91.53	0.38
		MCS7	0.000 17	0.000 19	90.72	0.42

Note – Duty Cycle : (Tx On Time / (Tx On Time + Tx Off Time)) * 100

Correction Factor : 10 * Log(1 / (Duty Cycle / 100))

5.4 Configuration of Test System

Line Conducted Test: It is not need to test this requirement, because the EUT shall be operated by DC Power.

Radiated Emission Test: Preliminary radiated emissions test were conducted using the procedure in ANSI C63.10: 2013 to determine the worse operating conditions. Final radiated emission tests were conducted at 3 meter Semi Anechoic Chamber.

The turntable was rotated through 360 degrees and the EUT was tested by positioned three orthogonal planes to obtain the highest reading on the field strength meter. Once maximum reading was determined, the search antenna was raised and lowered in both vertical and horizontal polarization.

5.5 Antenna Requirement

For intentional device, according to section 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 Construction:

The PCB Antenna is located on the main board of EUT and the PCB antenna is connected to the outside of the EUT by a special connector type, so no consideration of replacement by the user.

6. PRELIMINARY TEST

6.1 AC Power line Conducted Emissions Tests

During Preliminary Test, the following operating mode was investigated.

Operation Mode	The Worse operating condition (Please check one only)
It is not need to test this requirement, because the power of the EUT is supplied by DC Power.	

6.2 General Radiated Emissions Tests

During Preliminary Test, the following operating mode was investigated.

Operation Mode	The Worse operating condition (Please check one only)
Transmitting Mode	X

7. MINIMUM 6 dB BANDWIDTH

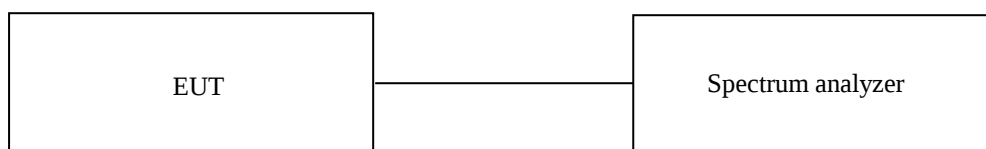
7.1 Operating environment

Temperature : 24 °C

Relative humidity : 52 % R.H.

7.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 200 kHz, and peak detection was used. The 6 dB bandwidth is defined as the total spectrum over which the power is higher than the peak power minus 6 dB.



7.3 Test Date

February 01, 2023 ~ March 06, 2023

7.4 Test data for 802.11b WLAN Mode

-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412.00	10.14	0.50	9.64
Middle	2 437.00	10.19	0.50	9.69
High	2 462.00	10.19	0.50	9.69

Remark. Margin = Measured Value - Limit

7.5 Test data for 802.11g WLAN Mode

-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412.00	16.38	0.50	15.88
Middle	2 437.00	16.38	0.50	15.88
High	2 462.00	16.38	0.50	15.88

Remark. Margin = Measured Value - Limit

7.6 Test data for 802.11n_HT20 WLAN Mode

-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (MHz)	LIMIT (MHz)	Margin (MHz)
Low	2 412.00	17.58	0.50	17.08
Middle	2 437.00	17.58	0.50	17.08
High	2 462.00	17.58	0.50	17.08

Remark. Margin = Measured Value - Limit

8. MAXIMUM PEAK OUTPUT POWER (Radiated output power (E.I.R.P))

8.1 Operating environment

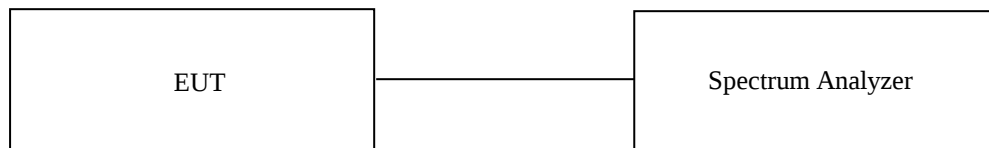
Temperature : 24 °C

Relative humidity : 45 % R.H.

8.2 Test set-up for conducted measurement

The antenna output of the EUT was connected to the spectrum analyzer.

The resolution bandwidth is set to 1 MHz, the video bandwidth is set to 3 times the resolution bandwidth.



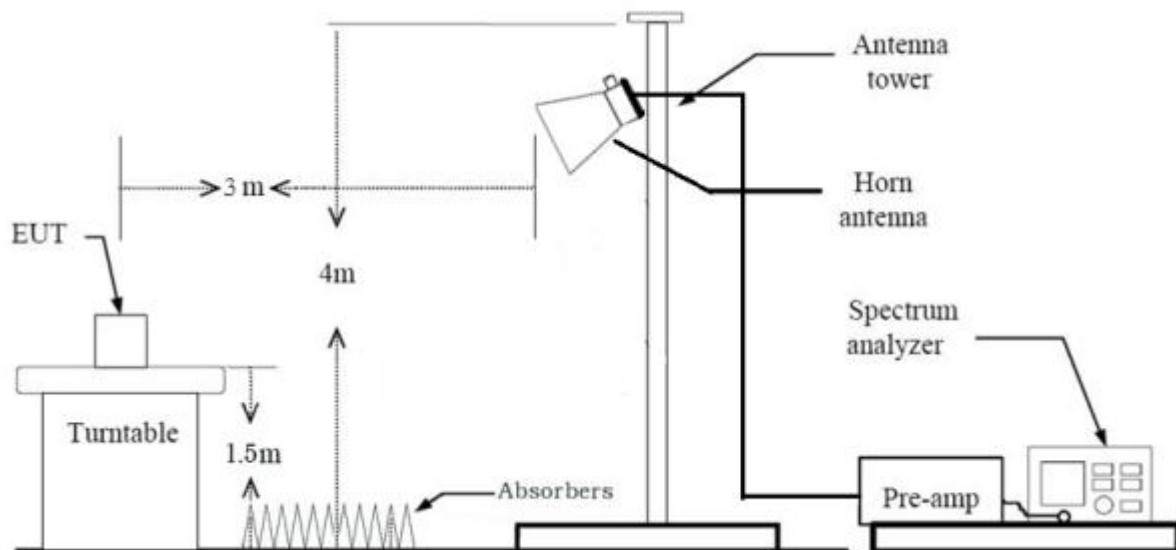
8.3 Test set-up for radiated measurement

The radiated emissions measurements were performed on the 3 m semi anechoic chamber. The EUT was placed on turntable approximately 1.5 m above the ground plane.

The frequency spectrum from 30 MHz to 26.5 GHz was scanned and maximum emission levels at each frequency recorded. The system was rotated 360°, and the antenna was varied in the height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for horizontal and vertical polarization of the receiving antenna.

- Test Configuration

Above 1 GHz



8.4 Test Date

June 19, 2023 ~ July 05, 2023

8.5 Test data for 802.11b

Frequency (MHz)	Ant. Pol. (H/V)	Ant. Height (m)	Angle (°)	OBW (MHz)	Measured (dBuV)	C.F (dB)	Result (dBuV/m)	E.I.R.P (dBm)	Ant Gain (dBi)	Conducted Power (dBm)	Limit (dBm)
2 412.00	V	1.7	175	13.39	74.91	31.88	106.79	11.53	2.18	9.35	30.00
2 442.00	V	1.7	175	13.39	75.41	32.07	107.48	12.22	2.18	10.04	30.00
2 462.00	V	1.7	175	13.39	74.07	32.05	106.12	10.86	2.18	8.68	30.00

8.6 Test data for 802.11g

Frequency (MHz)	Ant. Pol. (H/V)	Ant. Height (m)	Angle (°)	OBW (MHz)	Measured (dBuV)	C.F (dB)	Result (dBuV/m)	E.I.R.P (dBm)	Ant Gain (dBi)	Conducted Power (dBm)	Limit (dBm)
2 412.00	V	1.7	175	16.38	75.01	31.88	106.89	11.63	2.18	9.45	30.00
2 442.00	V	1.7	175	16.38	75.86	32.07	107.93	12.67	2.18	10.49	30.00
2 462.00	V	1.7	175	16.43	74.23	32.05	106.28	11.02	2.18	8.84	30.00

8.7 Test data for 802.11n (HT20)

Frequency (MHz)	Ant. Pol. (H/V)	Ant. Height (m)	Angle (°)	OBW (MHz)	Measured (dBuV)	C.F (dB)	Result (dBuV/m)	E.I.R.P (dBm)	Ant Gain (dBi)	Conducted Power (dBm)	Limit (dBm)
2 412.00	V	1.7	175	17.48	75.03	31.88	106.91	11.65	2.18	9.47	30.00
2 442.00	V	1.7	175	17.53	76.71	32.07	108.78	13.52	2.18	11.34	30.00
2 462.00	V	1.7	175	17.53	74.28	32.05	106.33	11.07	2.18	8.89	30.00

9. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

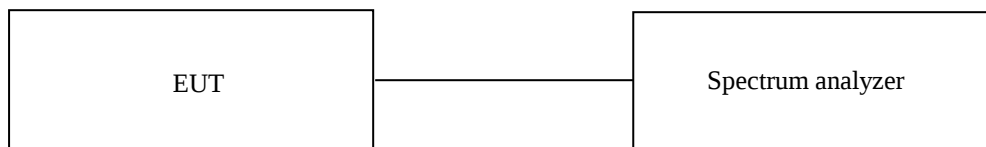
9.1 Operating environment

Temperature : 24 °C

Relative humidity : 52 % R.H.

9.2 Test set-up for conducted measurement

The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 100 kHz and video bandwidth is set to 300 kHz, and peak detection was used.



9.3 Test set-up for radiated measurement

The radiated emissions measurements were performed on the 3 m semi anechoic chamber. The EUT was placed on turntable approximately 1.5 m above the ground plane.

The frequency spectrum from 30 MHz to 26.5 GHz was scanned and maximum emission levels at each frequency recorded. The system was rotated 360°, and the antenna was varied in the height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for horizontal and vertical polarization of the receiving antenna.

9.4 Test Date

February 01, 2023 ~ March 06, 2023

9.5 Test data for conducted emission

For Test data for conducted emission, Please refer to the Annex

9.6 Test data for radiated emission

9.6.1 Radiated Emission which fall in the Restricted Band

9.6.1.1 Test data for 802.11b WLAN Mode

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode
- Video bandwidth : 3 MHz for Peak and Average Mode
- Measurement distance : 3 m
- Duty Cycle : 99.87 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	AMP Gain (dB)	ATT (dB)	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel											
2 356.21	53.24	Peak	H	27.34	5.74	44.96	5.77	-	47.13	74.00	26.87
2 376.28	41.35	Average	H	27.46	5.92	44.95	5.77	0.01	35.56	54.00	18.44
2 377.30	52.97	Peak	V	27.46	5.92	44.95	5.77	-	47.17	74.00	26.83
2 386.58	42.36	Average	V	27.52	5.92	44.95	5.77	0.01	36.63	54.00	17.37
Test Data for High Channel											
2 490.91	53.24	Peak	H	27.54	5.89	44.90	5.77	-	47.54	74.00	26.46
2 490.00	42.13	Average	H	27.54	5.90	44.90	5.77	0.01	36.45	54.00	17.55
2 490.57	53.63	Peak	V	27.54	5.89	44.90	5.77	-	47.93	74.00	26.07
2 488.48	42.02	Average	V	27.55	5.90	44.90	5.77	0.01	36.35	54.00	17.65

Remark: "H": Horizontal, "V": Vertical

Margin (dB) = Limits (dBμV/m) - Total Level (dBμV/m)

Total Level = Reading + Antenna Factor + Cable Loss - Amp Gain + ATT + Duty Factor

9.6.1.2 Test data for 802.11g WLAN Mode

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode
- Video bandwidth : 3 MHz for Peak and Average Mode
- Measurement distance : 3 m
- Duty Cycle : 98.82 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	AMP Gain (dB)	ATT (dB)	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel											
2 389.84	68.59	Peak	H	27.54	5.92	44.94	5.77	-	62.88	74.00	11.12
2 389.43	48.78	Average	H	27.54	5.92	44.94	5.77	0.05	43.12	54.00	10.88
2 390.04	71.02	Peak	V	27.54	5.92	44.94	5.77	-	65.31	74.00	8.69
2 389.23	48.53	Average	V	27.54	5.92	44.94	5.77	0.05	42.87	54.00	11.13
Test Data for High Channel											
2 483.70	65.97	Peak	H	27.57	5.90	44.91	5.77	-	60.30	74.00	13.70
2 484.07	48.48	Average	H	27.56	5.90	44.91	5.77	0.05	42.85	54.00	11.15
2 484.38	65.07	Peak	V	27.56	5.90	44.91	5.77	-	59.39	74.00	14.61
2 483.51	47.71	Average	V	27.57	5.90	44.91	5.77	0.05	42.09	54.00	11.91

Remark: "H": Horizontal, "V": Vertical

Margin (dB) = Limits (dBμV/m) - Total Level (dBμV/m)

Total Level = Reading + Antenna Factor + Cable Loss - Amp Gain + ATT + Duty Factor

9.6.1.3 Test data for 802.11n_HT20 WLAN Mode

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode
- Video bandwidth : 3 MHz for Peak and Average Mode
- Measurement distance : 3 m
- Duty Cycle : 98.75 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	AMP Gain (dB)	ATT (dB)	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel											
2 390.04	72.30	Peak	H	27.54	5.92	44.94	5.77	-	66.59	74.00	7.41
2 389.43	49.03	Average	H	27.54	5.92	44.94	5.77	0.05	43.37	54.00	10.63
2 388.82	71.45	Peak	V	27.53	5.92	44.94	5.77	-	65.73	74.00	8.27
2 390.04	51.38	Average	V	27.54	5.92	44.94	5.77	0.05	45.72	54.00	8.28
Test Data for High Channel											
2 483.70	71.27	Peak	H	27.57	5.90	44.91	5.77	-	65.60	74.00	8.40
2 483.51	48.56	Average	H	27.57	5.90	44.91	5.77	0.05	42.94	54.00	11.06
2 484.99	69.01	Peak	V	27.56	5.90	44.91	5.77	-	63.33	74.00	10.67
2 483.58	48.21	Average	V	27.57	5.90	44.91	5.77	0.05	42.59	54.00	11.41

Remark: "H": Horizontal, "V": Vertical

Margin (dB) = Limits (dBμV/m) - Total Level (dBμV/m)

Total Level = Reading + Antenna Factor + Cable Loss - Amp Gain + ATT + Duty Factor

9.6.2 Spurious & Harmonic Radiated Emission

9.6.2.1 Test data for 802.11b WLAN Mode

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode for the emissions fall in restricted band,
1 MHz and RMS Detector for Average Mode for the emissions fall in restricted band
100 kHz for Peak Mode for the emissions outside restricted band
- Video bandwidth : 3 MHz for Peak and Average Mode
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Duty Cycle : 99.87 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	AMP Gain (dB)	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
4 823.25	50.10	Peak	H	31.30	9.07	44.66	-	45.81	74.00	28.19
4 802.52	37.96	Average	H	31.30	9.07	44.66	0.01	33.68	54.00	20.32
4 806.87	50.08	Peak	V	31.30	9.07	44.66	-	45.79	74.00	28.21
4 824.30	37.88	Average	V	31.30	9.07	44.66	0.01	33.60	54.00	20.40
Test Data for Middle Channel										
4 867.36	49.67	Peak	H	31.30	9.07	44.68	-	45.36	74.00	28.64
4 884.34	37.87	Average	H	31.30	9.07	44.68	0.01	33.57	54.00	20.43
4 868.60	49.83	Peak	V	31.30	9.07	44.68	-	45.52	74.00	28.48
4 881.49	38.14	Average	V	31.30	9.07	44.68	0.01	33.84	54.00	20.16
Test Data for High Channel										
4 937.99	50.06	Peak	H	31.30	9.07	44.69	-	45.74	74.00	28.26
4 944.93	38.02	Average	H	31.30	9.07	44.69	0.01	33.71	54.00	20.29
4 899.57	49.92	Peak	V	31.30	9.07	44.69	-	45.60	74.00	28.40
4 948.48	38.14	Average	V	31.30	9.07	44.69	0.01	33.83	54.00	20.17

Remark: "H": Horizontal, "V": Vertical

$$\text{Margin (dB)} = \text{Limits (dBμV/m)} - \text{Total Level (dBμV/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amp Gain} + \text{Duty Factor}$$

9.6.2.2 Test data for 802.11g WLAN Mode

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode for the emissions fall in restricted band,
1 MHz and RMS Detector for Average Mode for the emissions fall in restricted band
100 kHz for Peak Mode for the emissions outside restricted band
- Video bandwidth : 3 MHz for Peak and Average Mode
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Duty Cycle : 98.82 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	AMP Gain (dB)	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
4 846.68	49.89	Peak	H	31.30	9.07	44.66	-	45.60	74.00	28.40
4 799.33	37.76	Average	H	31.30	9.07	44.66	0.05	33.52	54.00	20.48
4 802.77	49.95	Peak	V	31.30	9.07	44.66	-	45.66	74.00	28.34
4 822.95	38.07	Average	V	31.30	9.07	44.66	0.05	33.83	54.00	20.17
Test Data for Middle Channel										
4 851.87	49.67	Peak	H	31.30	9.07	44.68	-	45.36	74.00	28.64
4 881.74	37.84	Average	H	31.30	9.07	44.68	0.05	33.58	54.00	20.42
4 865.56	50.23	Peak	V	31.30	9.07	44.68	-	45.92	74.00	28.08
4 878.90	37.81	Average	V	31.30	9.07	44.68	0.05	33.55	54.00	20.45
Test Data for High Channel										
4 945.78	50.35	Peak	H	31.30	9.07	44.69	-	46.03	74.00	27.97
4 948.77	37.80	Average	H	31.30	9.07	44.69	0.05	33.53	54.00	20.47
4 938.19	50.13	Peak	V	31.30	9.07	44.69	-	45.81	74.00	28.19
4 947.53	38.19	Average	V	31.30	9.07	44.69	0.05	33.92	54.00	20.08

Remark: "H": Horizontal, "V": Vertical

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amp Gain} + \text{Duty Factor}$$

9.6.2.3 Test data for 802.11n_HT20 WLAN Mode

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode for the emissions fall in restricted band,
1 MHz and RMS Detector for Average Mode for the emissions fall in restricted band
100 kHz for Peak Mode for the emissions outside restricted band
- Video bandwidth : 3 MHz for Peak and Average Mode
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Duty Cycle : 98.75 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	AMP Gain (dB)	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
4 809.02	49.95	Peak	H	31.30	9.07	44.66	-	45.66	74.00	28.34
4 801.02	37.67	Average	H	31.30	9.07	44.66	0.05	33.43	54.00	20.57
4 829.69	49.70	Peak	V	31.30	9.07	44.66	-	45.41	74.00	28.59
4 799.82	38.59	Average	V	31.30	9.07	44.66	0.05	34.35	54.00	19.65
Test Data for Middle Channel										
4 882.89	50.30	Peak	H	31.30	9.07	44.68	-	45.99	74.00	28.01
4 880.19	37.90	Average	H	31.30	9.07	44.68	0.05	33.64	54.00	20.36
4 895.93	50.73	Peak	V	31.30	9.07	44.68	-	46.42	74.00	27.58
4 879.59	38.08	Average	V	31.30	9.07	44.68	0.05	33.82	54.00	20.18
Test Data for High Channel										
4 947.93	50.01	Peak	H	31.30	9.07	44.69	-	45.69	74.00	28.31
4 947.28	37.85	Average	H	31.30	9.07	44.69	0.05	33.58	54.00	20.42
4 932.64	49.90	Peak	V	31.30	9.07	44.69	-	45.58	74.00	28.42
4 945.38	38.13	Average	V	31.30	9.07	44.69	0.05	33.86	54.00	20.14

Remark: "H": Horizontal, "V": Vertical

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} - \text{Amp Gain} + \text{Duty Factor}$$

10. PEAK POWER SPECTRAL DENSITY (Radiated power spectral density)

10.1 Operating environment

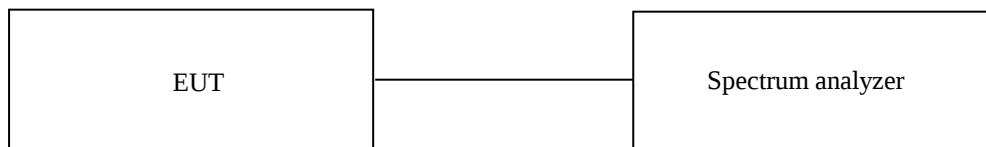
Temperature : 24 °C

Relative humidity : 45 % R.H.

10.2 Test set-up for conducted measurement

The antenna output of the EUT was connected to the spectrum analyzer.

The resolution bandwidth is set to $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$, the video bandwidth is set to 3 times the resolution bandwidth.



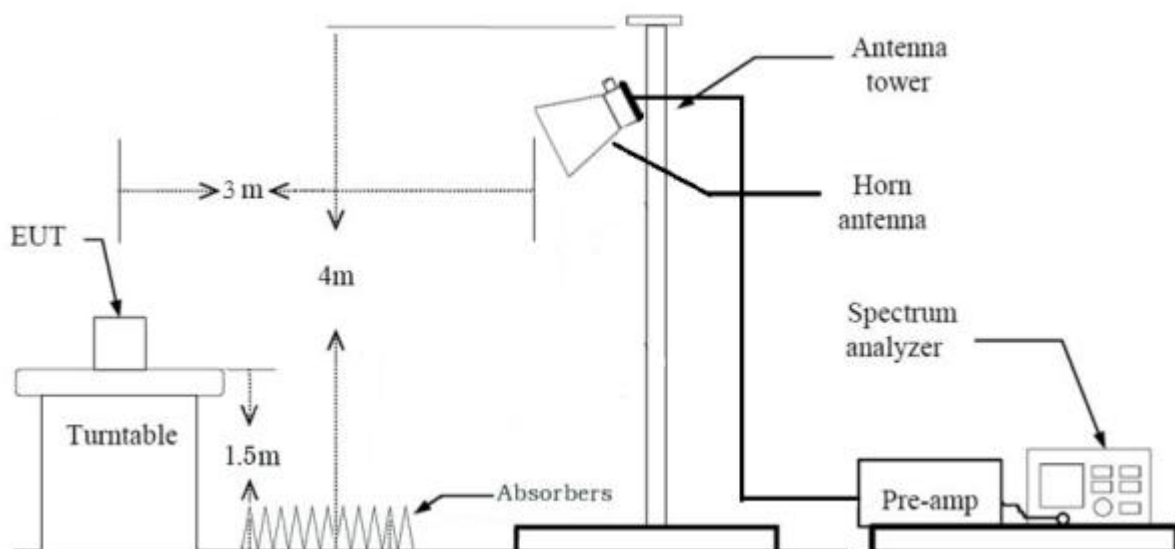
10.3 Test set-up for radiated measurement

The radiated emissions measurements were performed on the 3 m semi anechoic chamber. The EUT was placed on turntable approximately 1.5 m above the ground plane.

The frequency spectrum from 30 MHz to 26.5 GHz was scanned and maximum emission levels at each frequency recorded. The system was rotated 360°, and the antenna was varied in the height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for horizontal and vertical polarization of the receiving antenna.

- Test Configuration

Above 1 GHz



10.4 Test Date

June 19, 2023 ~ July 05, 2023

10.5 Test data

Mode	Frequency (MHz)	Ant. Pol. (H/V)	Ant. Height (m)	Angle (°)	Measured (dBuV)	C.F (dB)	Result (dBuV/m)	E.I.R.P Density (dBm)	Ant Gain (dBi)	PSD (dBm)	Limit (dBm)
802.11b	2 412.00	V	1.7	175	40.02	31.88	71.90	-23.36	2.18	-25.54	8.00
	2 442.00	V	1.7	175	39.85	32.07	71.92	-23.34	2.18	-25.52	8.00
	2 462.00	V	1.7	175	40.07	32.05	72.12	-23.14	2.18	-25.32	8.00
802.11g	2 412.00	V	1.7	175	38.66	31.88	70.54	-24.72	2.18	-26.90	8.00
	2 442.00	V	1.7	175	39.26	32.07	71.33	-23.93	2.18	-26.11	8.00
	2 462.00	V	1.7	175	39.95	32.05	72.00	-23.26	2.18	-25.44	8.00
802.11n (HT20)	2 412.00	V	1.7	175	38.46	31.88	70.34	-24.92	2.18	-27.10	8.00
	2 442.00	V	1.7	175	39.12	32.07	71.19	-24.07	2.18	-26.25	8.00
	2 462.00	V	1.7	175	39.73	32.05	71.78	-23.48	2.18	-25.66	8.00

11. RADIATED EMISSION TEST

11.1 Operating environment

Temperature : 24 °C

Relative humidity : 52 % R.H.

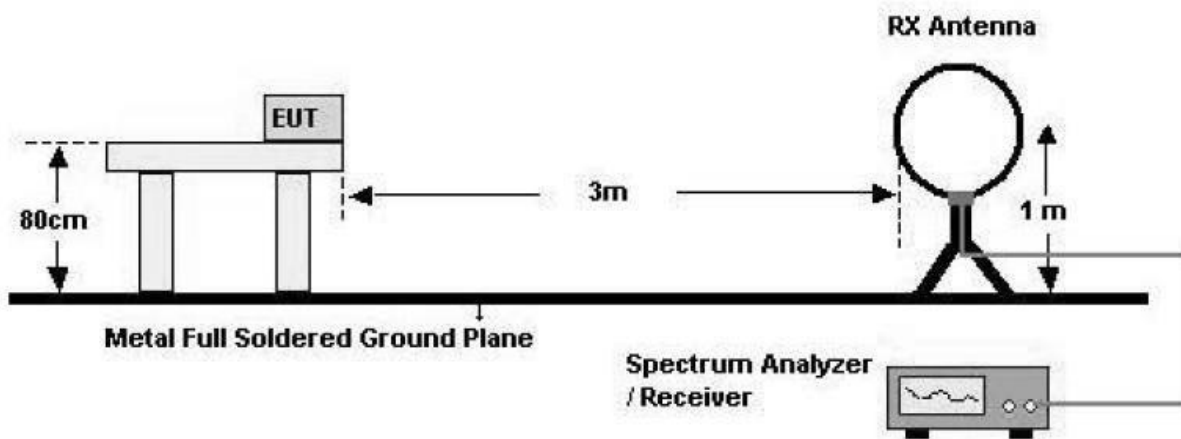
11.2 Test set-up

The radiated emissions measurements were on the 3 m semi anechoic chamber. The EUT and other support equipment were placed on a non-conductive turntable above the ground plane. The interconnecting cables from outside test site were inserted into ferrite clamps at the point where the cables reach the turntable.

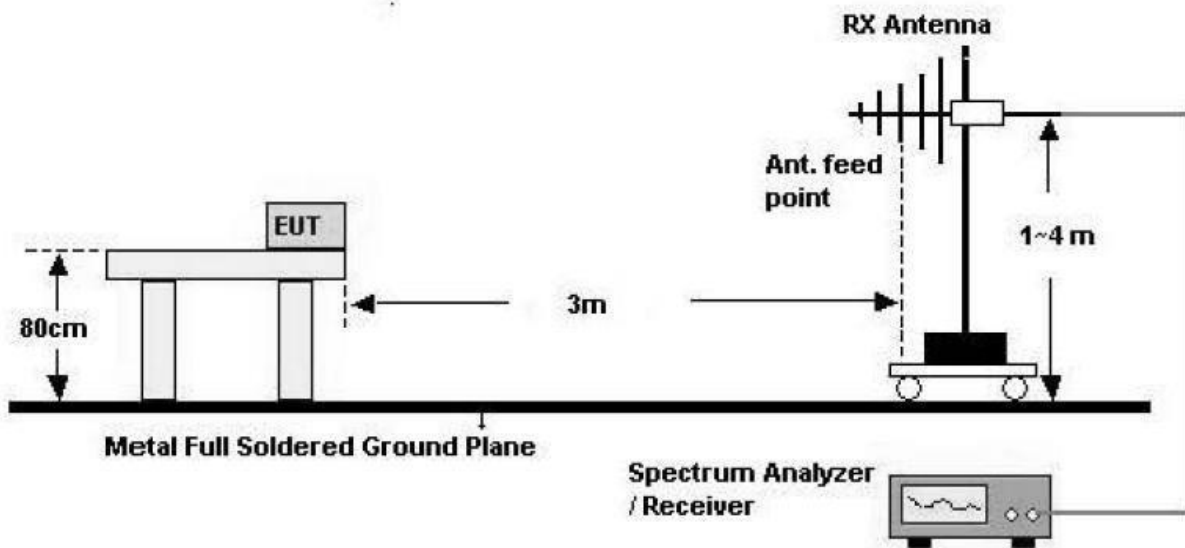
The frequency spectrum from 30 MHz to 26.5 GHz was scanned and emission levels maximized at each frequency recorded. The system was rotated 360°, and the antenna was varied in height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for both horizontal and vertical polarization of the receiving antenna.

- Test Configuration

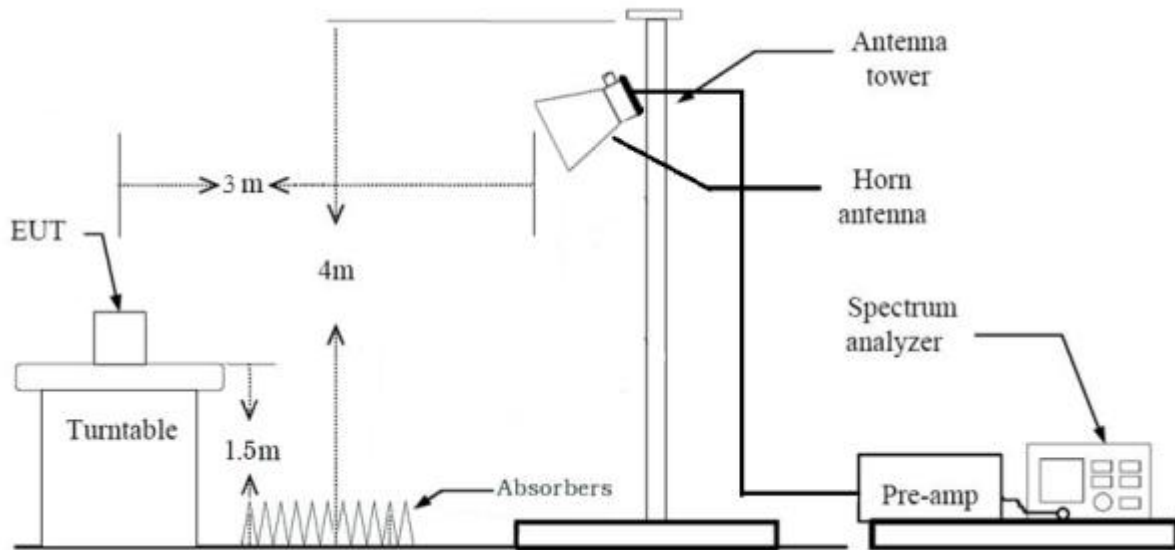
1. Below 30 MHz



2. 30 MHz - 1 GHz



3. Above 1 GHz



11.3 Test Date

February 01, 2023 ~ March 06, 2023

11.4 Test data for 30 MHz ~ 1 000 MHz

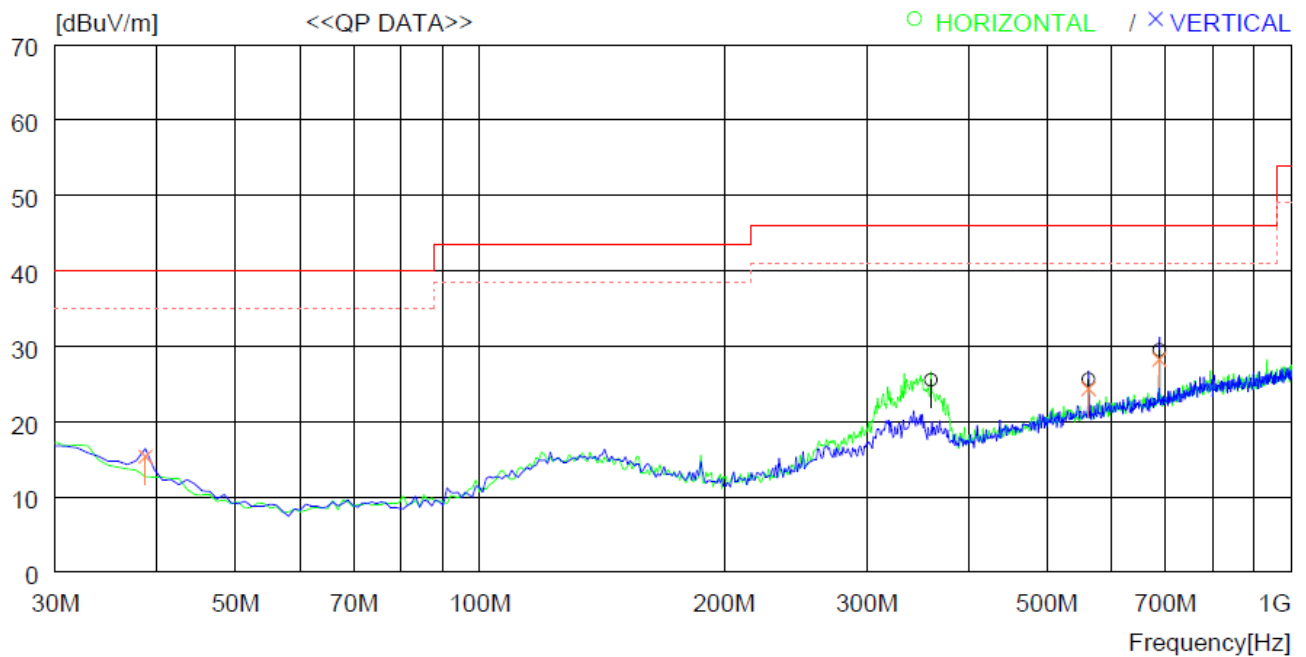
11.4.1 Test data for WLAN 2.4 GHz_External Antenna

Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.247

Result : PASSED

EUT : Silverbox RADIO ASM-RECEIVER

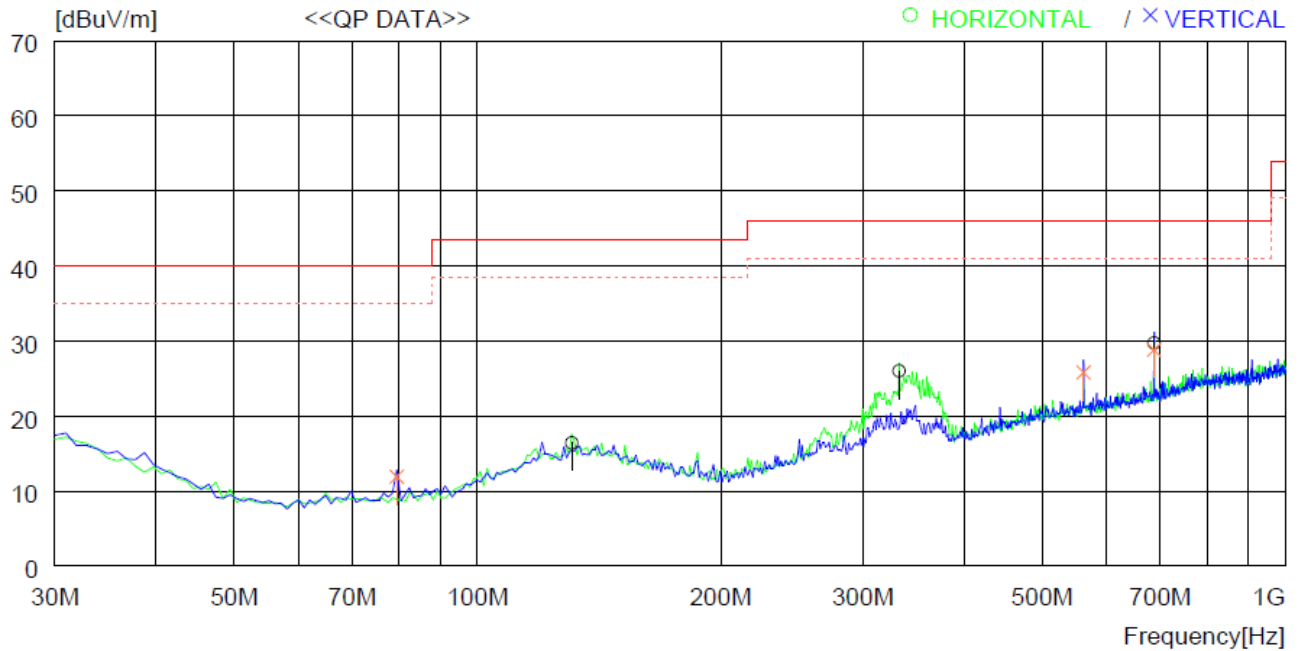
Detector : CISPR Quasi-Peak (6 dB Bandwidth: 120 kHz)



No.	FREQ	READING	ANT	LOSS	GAIN	RESULT	LIMIT	MARGIN	ANTENNA	TABLE
	[MHz]	QP	FACTOR	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[cm]	[DEG]
----- Horizontal -----										
1	359.800	35.1	20.0	2.4	32.0	25.5	46.0	20.5	100	145
2	562.529	31.0	23.7	3.1	32.2	25.6	46.0	20.4	400	86
3	687.655	33.2	25.2	3.4	32.3	29.5	46.0	16.5	400	0
----- Vertical -----										
4	38.730	29.0	17.6	0.8	32.1	15.3	40.0	24.7	100	72
5	562.529	29.7	23.7	3.1	32.2	24.3	46.0	21.7	100	0
6	687.655	31.9	25.2	3.4	32.3	28.2	46.0	17.8	100	0

11.4.2 Test data for Intermodulation Mode(Bluetooth + WLAN 2.4 GHz)

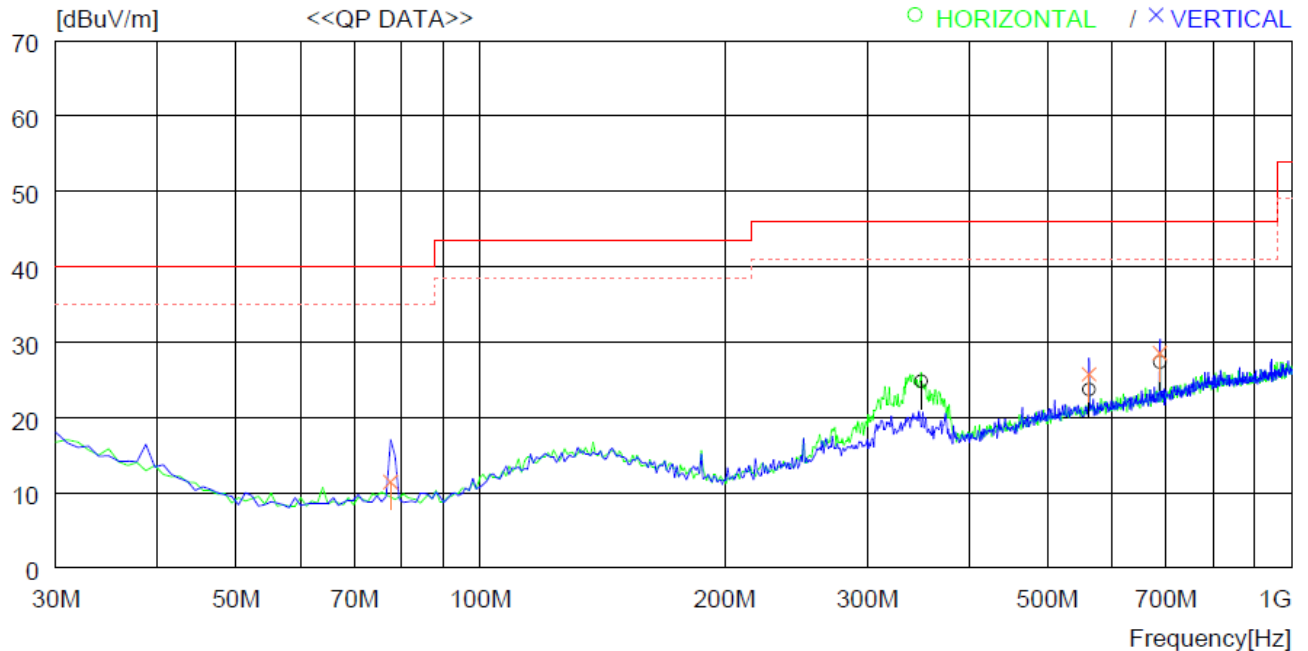
- Resolution bandwidth : 120 kHz
- Frequency range : 30 MHz ~ 1 000 MHz
- Measurement distance : 3 m



No.	FREQ	READING	ANT	LOSS	GAIN	RESULT	LIMIT	MARGIN	ANTENNA	TABLE
	[MHz]	QP	FACTOR	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[cm]	[DEG]
----- Horizontal -----										
1	130.880	28.0	18.9	1.5	32.0	16.4	43.5	27.1	200	0
2	332.640	36.0	19.7	2.3	32.0	26.0	46.0	20.0	100	359
3	687.655	33.4	25.2	3.4	32.3	29.7	46.0	16.3	400	29
----- Vertical -----										
4	79.470	29.6	13.2	1.1	32.0	11.9	40.0	28.1	400	359
5	562.529	31.2	23.7	3.1	32.2	25.8	46.0	20.2	400	2
6	687.655	32.5	25.2	3.4	32.3	28.8	46.0	17.2	100	0

11.4.3 Test data for Intermodulation Mode(WLAN 2.4 GHz + WLAN 5 GHz)

- Resolution bandwidth : 120 kHz
- Frequency range : 30 MHz ~ 1 000 MHz
- Measurement distance : 3 m



No.	FREQ	READING	ANT	LOSS	GAIN	RESULT	LIMIT	MARGIN	ANTENNA	TABLE
	[MHz]	QP	FACTOR	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[cm]	[DEG]
----- Horizontal -----										
1	349.130	34.5	19.9	2.4	32.0	24.8	46.0	21.2	100	359
2	562.529	29.1	23.7	3.1	32.2	23.7	46.0	22.3	400	261
3	687.655	31.0	25.2	3.4	32.3	27.3	46.0	18.7	400	26
----- Vertical -----										
4	77.530	29.1	13.2	1.1	32.0	11.4	40.0	28.6	400	48
5	562.529	31.1	23.7	3.1	32.2	25.7	46.0	20.3	100	166
6	687.655	32.2	25.2	3.4	32.3	28.5	46.0	17.5	100	201

11.5 Test data for Below 30 MHz

- . Resolution bandwidth : 200 Hz (from 9 kHz to 0.15 MHz), 9 kHz (from 0.15 MHz to 30 MHz)
- . Frequency range : 9 kHz ~ 30 MHz
- . Measurement distance : 3 m
- . Operating mode : Transmitting mode

Frequency (MHz)	Reading (dBμV)	Ant. Pol. (H/V)	Ant. Height (m)	Angle (°)	Ant. Factor (dB/m)	Cable Loss	Emission Level(dBμV/m)	Limits (dBμV/m)	Margin (dB)
Emission from the EUT more than 20 dB below the limit in each frequency range.									

11.6 Test data for above 1 GHz

- . Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode
- . Video bandwidth : 3 MHz for Peak and Average Mode
- . Frequency range : 1 GHz ~ 26.5 GHz
- . Measurement distance : 3 m
- . Operating mode : Transmitting mode

Frequency (MHz)	Reading (dBμV)	Ant. Pol. (H/V)	Ant. Height (m)	Angle (°)	Ant. Factor (dB/m)	Cable Loss	Emission Level(dBμV/m)	Limits (dBμV/m)	Margin (dB)
Emission from the EUT more than 20 dB below the limit in each frequency range.									

12. LIST OF TEST EQUIPMENT

Model Number	Manufacturer	Description	Serial Number	Last Cal.(Interval)
FSVA40	Rohde & Schwarz	Signal Analyzer	101598	Apr. 03, 2023 (1Y)
ESU	Rohde & Schwarz	EMI Test Receiver	100261	Mar. 06, 2023 (1Y)
GP-4303D	LG Precision Co.,Ltd	DC POWER SUPPLY	5071069	Jan. 04, 2023 (1Y)
WT-A3882-R10	Microwave	Cavity Band Rejection Filter	WT22040502-1	Apr. 03, 2023 (1Y)
310N	Sonoma Instrument	Pre-Amplifier	392756	Oct. 13, 2022 (1Y)
SCU18	Rohde & Schwarz	Pre-Amplifier	102266	Jul. 14, 2023 (1Y)
SCU40A	Rohde & Schwarz	Signal Conditioning unit	100436	Jan. 18, 2023 (1Y)
QFA1802-26-6-S	Qualwave	6dB Attenuator	225340	Apr. 04, 2023 (1Y)
DT2000-2t	Innco System	Turn Table	N/A	N/A
CO3000	Innco System	Controller	1026/40960617/P	N/A
MA-4640-XPET	Innco System	Antenna Master	MA4640/652/43100318/P	N/A
HLP-2008	TDK	Hybrid Antenna	131316	Mar. 07, 2022 (2Y)
BBHA9120D	Schwarzbeck	Horn Antenna	9120D-1366	Jun. 22, 2023 (1Y)
BBHA9170	Schwarzbeck	Horn Antenna	BBHA9170178	Jan. 04, 2023 (1Y)
FMZB 1513	Schwarzbeck	Loop Antenna	1513-235	Mar. 24, 2022 (2Y)