

# TEST REPORT

EMI Test for FCC Certification of SLEEPade Model

APPLICANT

BrainU Co., Ltd.

REPORT NO.

HCT-EM-2307-FC004

DATE OF ISSUE

July 17, 2023

Tested by  
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<b>TEST REPORT</b> EMI Test for FCC Certification	<b>REPORT NO.</b> HCT-EM-2307-FC004
	<b>DATE OF ISSUE</b> July 17, 2023
	<b>FCC ID.</b> 2BBOF-SLEEPADE

<b>Applicant</b>	BrainU Co., Ltd. 3F, 7, Yatap-ro 105beon-gil, Bundang-gu, Seongnam-si, Gyeonggi-do, Republic of Korea
<b>Product Name</b>	Sleep Monitoring System
<b>Model Name</b>	SLEEPade
<b>Date of Test</b>	June 28, 2023 to July 04, 2023
<b>Test Standard Used</b>	FCC CFR 47 PART 15 Subpart B Class B ANSI C63.4-2014
<b>Test Results</b>	Refer to the present document
<b>Manufacturer</b>	BrainU Co., Ltd.

The result shown in this test report refer only to the sample(s) tested unless otherwise stated.

This test results were applied only to the test methods required by the standard.

## REVISION HISTORY

The revision history for this test report is shown in table.

Revision No.	Date of Issue	Description
0	July 17, 2023	Initial Release

The above Test Report is not related to the accredited test result by (KS Q) ISO/IEC 17025 and KOLAS(Korea Laboratory Accreditation Scheme), which signed the ILAC-MRA.

If this report is required to confirmation of authenticity, please contact to [www.hct.co.kr](http://www.hct.co.kr)

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## 1. GENERAL INFORMATION

### 1.1 Description of EUT

FCC ID	2BBOF-SLEEPADE
Product Name	Sleep Monitoring System
Model Name	SLEEPade
Frequency Range	Bluetooth: 2 402 MHz to 2 480 MHz
Power Rated	DC 3.7 V
Manufacturer	BrainU Co., Ltd.

### 1.2 Tested System Details

All equipment descriptions used in the tested system (including inserted cards) are:

Device Type	Model Name	Serial Number	Manufacturer
Sleep Monitoring System	SLEEPade	-	BrainU Co., Ltd.
AC/DC Adaptor*	GTM46101-1306-0 9 USB	-	GlobTek, Inc.
Notebook PC	HP ProBook 6560b	5CB2095MKD	HP
Notebook PC Adapter	Series PPP009L-E	-	Lite-ON Technology Co., Ltd.
Signal Channel EEG Test Unit	SEEG 100	WEE1001-220006	Whale Teq Co., Ltd
EEG Breakout Box	EBOX100	WEB1001-210020	Whale Teq Co., Ltd
Smart phone	LM-G710EM	806KPSL0132278	LG Electronics Inc.

[\*] Input: AC 100 to 240 V, 50/60 Hz, 0.3 A

Output: DC 5.1 V, 2.54 A

## 1.3 Cable Description

## Charging Mode

Product Name	Port	Power Cord Shielded (Y/N)	I/O Cable Shielded (Y/N)	Length (m)
EUT	C-type USB	Y	N	0.8

"(D)" data cable and "(P)" power cable.

## Normal Mode

Product Name	Port	Power Cord Shielded (Y/N)	I/O Cable Shielded (Y/N)	Length (m)
EUT	Zig (3 line)	N	N	0.2
EEG Breakout Box	15PIN	N	N	-
Signal Channel	USB	N	Y	1.8
EEG Test Unit	Ground	N	N	1.5
Notebook PC	Power	Y	N	1.8

"(D)" data cable and "(P)" power cable.

## 1.4 Noise Suppression Parts on Cable (I/O Cable)

## Charging Mode

Product Name	Port	Ferrite Bead (Y/N)	Location	Metal Hood (Y/N)	Location
EUT	C-type USB	N	N	Y	Both

## Normal Mode

Product Name	Port	Ferrite Bead (Y/N)	Location	Metal Hood (Y/N)	Location
EUT	Zig (3 line)	N	N	Y	Both
EEG Breakout Box	15PIN	N	N	N	-
Signal Channel	USB	Y	Both	Y	Both
EEG Test Unit	Ground	N	N	Y	Both
Notebook PC	Power	N	N	Y	Both

## 1.5 Test Facility

Test site is located at 74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, Korea.

Those measurement facilities are constructed in conformance with the requirements of ANSI C63.4-2014.

The Normalized site attenuations (30 MHz to 1 GHz) and Site validation (1 GHz to 18 GHz) were performed in accordance with the standard in ANSI C63.4-2014 and ANSI C63.4a-2017

Our laboratories are accredited and designated in accordance with the provisions of Radio Waves ACT and International Standard ISO/IEC 17025:2017. (National Radio Research Agency, CABID No. KR0032)

## 1.6 Calibration of Measuring Instrument

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturers recommendations for utilizing calibration equipment, which is traceable to recognized national standards. Especially, all antenna for measurement is calibrated in accordance with the requirements of C63.5:2017

## 1.7 Measurement Uncertainty

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.4-2014. All measurement uncertainty values are shown with a coverage factor of  $k = 2$  to indicate a 95 % level of confidence. The measurement data shown herein meets or exceeds the  $U_{CISPR}$  measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Parameter	Test Site	Expanded Uncertainty
Conducted Emission	EMI Shield Room	2.0 dB
Radiated Emission (30 MHz to 1 GHz)	3 m Semi Anechoic Chamber #1	5.9 dB
Radiated Emission (1 GHz to 18 GHz)	3 m Semi Anechoic Chamber #1	4.8 dB

## 2. DESCRIPTION OF TESTING

### 2.1 Measurement of Conducted Emission

The test procedure was in accordance with ANSI C63.4-2014, Clause 7.3

- a. The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN).
  - If the EUT is connected to the PC through USB, the AC power-line adapter of the PC is directly connected to a line impedance stabilization network (LISN).
  - Other support units were connected to the power mains through another LISN. The two LISNs provide 50 Ohm/ 50uH of coupling impedance for the measuring instrument.
- b. Both conducted lines are measured in Quasi-Peak and Average mode, including the worst-case data points for each tested configuration.
- c. The frequency range from 150 kHz to 30 MHz was searched.

#### Conducted Emission Limits

Frequency (MHz)	Resolution Bandwidth (kHz)	Class A		Class B	
		Quasi-Peak (dB $\mu$ V)	Average (dB $\mu$ V)	Quasi-Peak (dB $\mu$ V)	Average (dB $\mu$ V)
0.15 to 0.5	9	79	66	66 to 56*	56 to 46*
0.5 to 5	9	73	60	56	46
5 to 30	9	73	60	60	50

NOTE. Decreases with the logarithm of the frequency.

## 2.2 Measurement of Radiated Emission

The test procedure was in accordance with ANSI C63.4-2014, Clause 8.3

- a. The EUT was placed on the top of a turn table 0.8 meters above the ground at a semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 m away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The antenna height is varied from 1 m to 4 m 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.
- d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 m to 4 m and the turn table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to Quasi-Peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.
- f. The test-receiver system was set to Peak and Average detect function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz.
- g. Place the measurement antenna away from each area of the EUT determined to be a source of emissions at the specified measurement distance, while keeping the measurement antenna aimed at the source of emissions at each frequency of significant emissions, with polarization oriented for maximum response.  
(1 GHz to 40 GHz)

### Radiated Emission Limits

Frequency (MHz)	Class A			Class B		
	Antenna Distance (m)	Field Strength ( $\mu$ V/m)	Quasi-Peak (dB $\mu$ V/m)	Antenna Distance (m)	Field Strength ( $\mu$ V/m)	Quasi-Peak (dB $\mu$ V/m)
30 to 88	10	90	39.0	3	100	40.0
88 to 216	10	150	43.5	3	150	43.5
216 to 960	10	210	46.4	3	200	46.0
Above 960	10	300	49.5	3	500	54.0
Frequency (MHz)	Antenna Distance (m)		Class A		Class B	
			Peak (dB $\mu$ V/m)	Average (dB $\mu$ V/m)	Peak (dB $\mu$ V/m)	Average (dB $\mu$ V/m)
Above 1 000	3		80	60	74	54

### 2.2.1 Frequency Range of Radiated Measurements

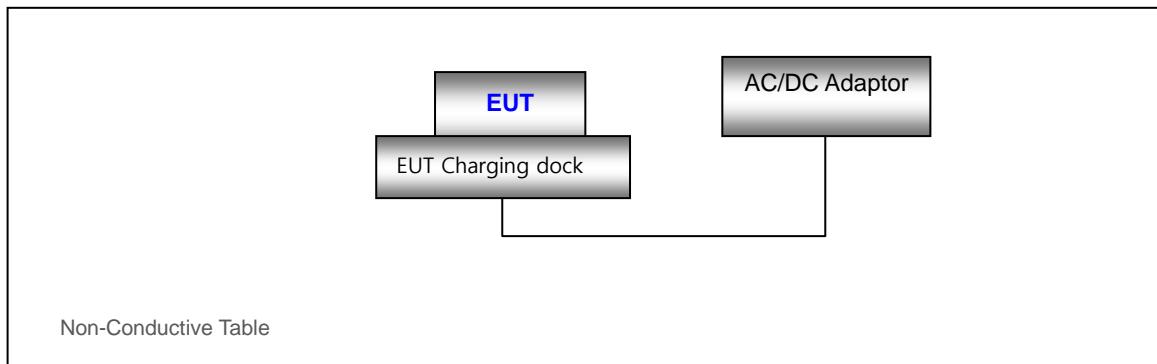
An unintentional radiator, including a digital device, the spectrum shall be investigated from the lowest radio frequency signal generated or used in the device, without going below the lowest frequency for which a Radiated Emission limit is specified, up to the frequency shown in the following table

Highest frequency generated or used in the device or on which the device operates or tunes (MHz)	Upper frequency of measurement range (MHz)
Below 1.705	30
1.705 to 108	1 000
108 to 500	2 000
500 to 1 000	5 000
Above 1 000	5th harmonic of the highest frequency or 40 GHz, whichever is lower

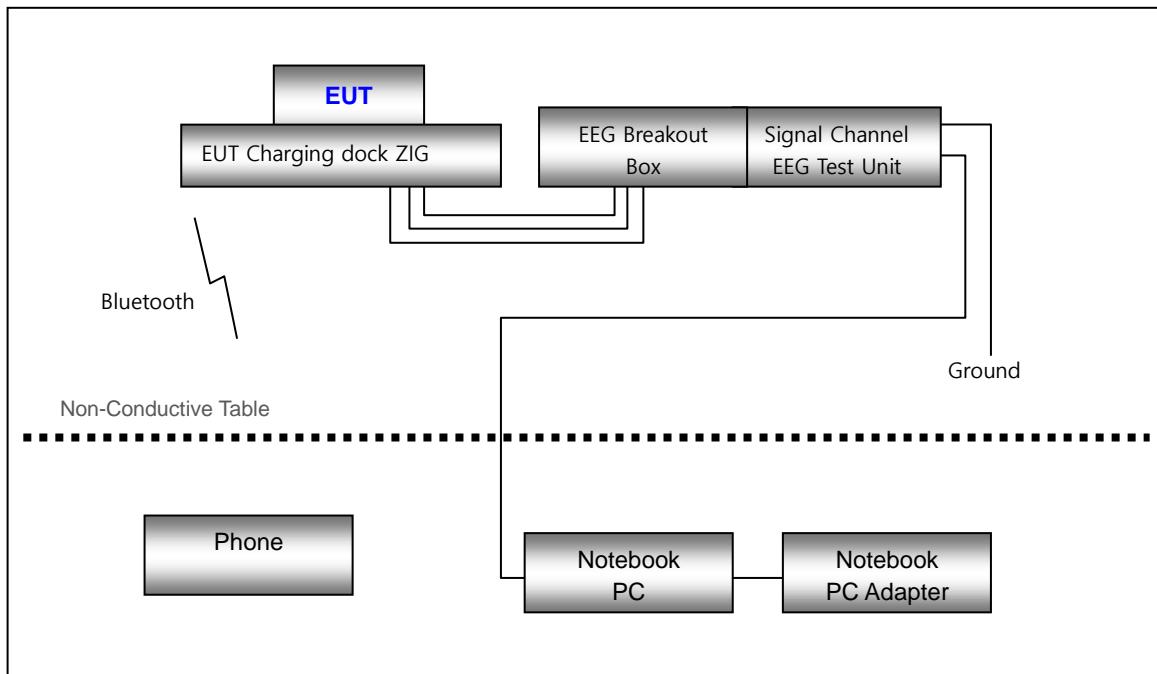
### 2.3 Configuration of Tested System

After connecting the EUT to the Notebook PC, test using the program provided by the manufacturer.

#### Charging Mode



#### Normal Mode



### 3. OPERATION OF THE EUT

During preliminary test and final tests, the following operating mode was investigated.

It was tested the following operating mode, after connecting all peripheral devices.

#### **Charging Mode:**

The EUT tested in charging mode.

#### **Normal Mode:**

After connecting the peripheral devices, apply the 5 kHz signal using the program provided by the manufacturer, and test the Bluetooth signal sent from the EUT while checking the signal using the phone.

## 4. MEASURING INSTRUMENTS

Type	Model Name	Manufacturer	Serial Number	Calibration Cycle	Next Calibration Date
<b>Conducted emission</b>					
<input checked="" type="checkbox"/>	EMI Test Receiver	ESR7	Rohde & Schwarz	101910	1 year
<input checked="" type="checkbox"/>	LISN	ENV216	Rohde & Schwarz	102245	1 year
<input checked="" type="checkbox"/>	Software	EMC32	Rohde & Schwarz	-	-
<b>Radiated emission below 1 GHz</b>					
<input checked="" type="checkbox"/>	EMI test receiver	Rohde & Schwarz	ESU40	100524	1 year
<input checked="" type="checkbox"/>	Bilog Antenna	VULB 9168	SCHWARZBECK	255	2 year
<input checked="" type="checkbox"/>	Antenna master	MA4640-XP-ET	INNCO SYSTEM	-	N/A
<input checked="" type="checkbox"/>	Antenna master controller	CO3000	INNCO SYSTEM	CO3000/870 /35990515/L	N/A
<input checked="" type="checkbox"/>	Turn Table	1060	INNCO SYSTEM	-	N/A
<input checked="" type="checkbox"/>	Turn Table controller	CO2000	INNCO SYSTEM	CO2000/095 /7590304/L	N/A
<b>Radiated emission above 1 GHz</b>					
<input checked="" type="checkbox"/>	EMI test receiver	Rohde & Schwarz	ESU40	100524	1 year
<input checked="" type="checkbox"/>	Horn Antenna	BBHA 9120D	Schwarzbeck	01836	1 year
<input checked="" type="checkbox"/>	Power Amplifier	TK-PA18H	TESTEK	170034-L	1 year
<input type="checkbox"/>	Horn Antenna	BBHA 9170	Schwarzbeck	BBHA 9170 #786	1 year
<input type="checkbox"/>	Power Amplifier	TK-PA1840H	TESTEK	170030-L	1 year
<input checked="" type="checkbox"/>	Antenna master	MA4640-XP-ET	INNCO SYSTEM	-	N/A
<input checked="" type="checkbox"/>	Antenna master controller	CO3000	INNCO SYSTEM	CO3000/870/ 35990515/L	N/A
<input checked="" type="checkbox"/>	Turn Table	1060	INNCO SYSTEM	-	N/A
<input checked="" type="checkbox"/>	Turn Table controller	CO2000	INNCO SYSTEM	CO2000/095/ 7590304/L	N/A
<input checked="" type="checkbox"/>	Software	EMC32	Rohde & Schwarz	-	-

## 5. EMISSION TEST SUMMARY

### 5.1 Conducted Emission

#### 5.1.1 Operating Condition

The test results of conducted emission at mains ports provide the following information:

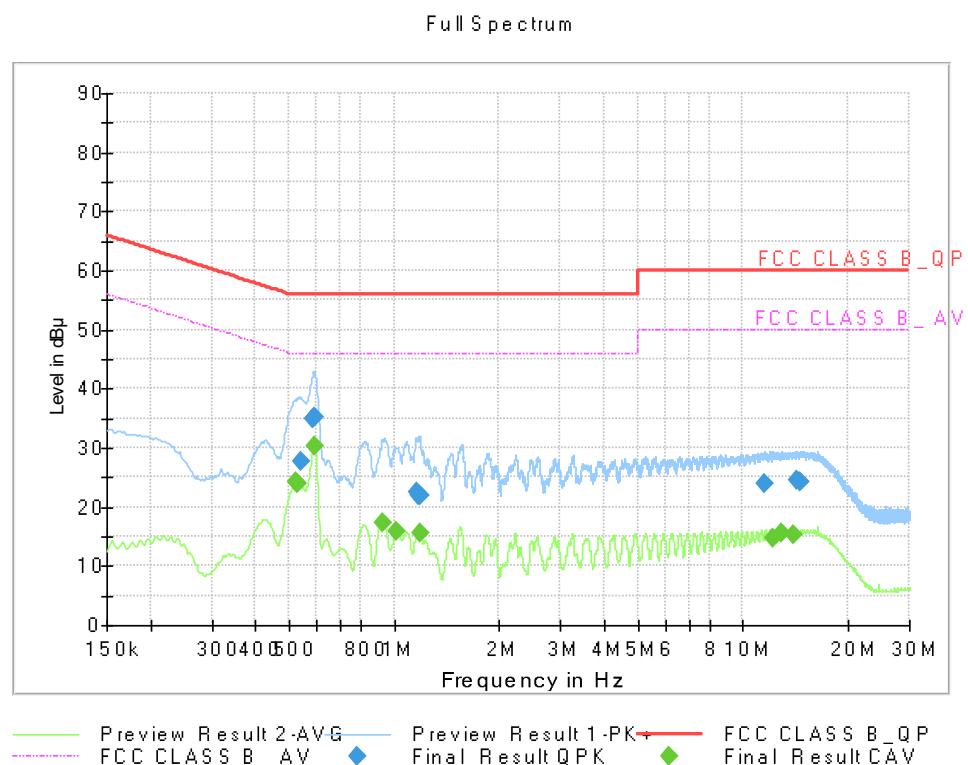
<b>Test Standard Used</b>	FCC CFR 47 PART 15 Subpart B Class B ANSI C63.4-2014
<b>Power Supply</b>	AC 120 V, 60 Hz
<b>Frequency Range</b>	150 kHz to 30 MHz
<b>Detector</b>	Quasi-Peak, CISPR-Average
<b>Bandwidth</b>	9 kHz (6 dB)
<b>Operating Mode</b>	Charging mode
<b>Test Site</b>	EMI Shielded Room
<b>Temperature</b>	min. 24.9 °C / max. 25.9 °C
<b>Relative Humidity</b>	min. 48.2 % / max. 52.6 %
<b>Test Date</b>	June 28, 2023

**Calculation Formula:**

1. Conductor L1 = Hot, Conductor N = Neutral
2. Corr. = LISN Factor + Cable Loss
3. QuasiPeak or CAverage = Receiver Reading + Corr.
4. Margin = Limit – QuasiPeak or CAverage

## 5.1.2 Measuring Data

Figure 1: Conducted Emission (0.15 to 30) MHz, Charging mode



## Final\_Result\_QPK

Frequency (MHz)	QuasiPeak (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Bandwidth (kHz)	Line (L1/N)	Corr. (dB)
0.5383	27.68	56.00	28.32	9.000	N	9.6
0.5855	34.76	56.00	21.24	9.000	N	9.6
0.5900	35.10	56.00	20.90	9.000	N	9.6
1.1570	22.52	56.00	33.48	9.000	N	9.7
1.1773	22.05	56.00	33.95	9.000	N	9.7
1.1840	21.86	56.00	34.14	9.000	N	9.7
11.4980	23.80	60.00	36.20	9.000	L1	10.1
14.2430	24.51	60.00	35.49	9.000	L1	10.2
14.5220	24.23	60.00	35.77	9.000	L1	10.2

## Final\_Result\_CAV

Frequency (MHz)	CAverage (dB $\mu$ V)	Limit (dB $\mu$ V)	Margin (dB)	Bandwidth (kHz)	Line (L1/N)	Corr. (dB)
0.5225	24.10	46.00	21.90	9.000	L1	9.7
0.5315	24.00	46.00	22.00	9.000	L1	9.7
0.5900	30.43	46.00	15.57	9.000	L1	9.7
0.9253	17.39	46.00	28.61	9.000	L1	9.7
1.0198	15.82	46.00	30.18	9.000	L1	9.7
1.1885	15.54	46.00	30.46	9.000	L1	9.7
12.1910	14.64	50.00	35.36	9.000	L1	10.1
12.9695	15.45	50.00	34.55	9.000	L1	10.1
14.0068	15.38	50.00	34.62	9.000	L1	10.2

## 5.2 Radiated Emission Below 1 GHz

## 5.2.1 Operating Condition

The test results of radiated emission provide the following information:

Used Test Standard	FCC CFR 47 PART 15 Subpart B Class B ANSI C63.4-2014
Power Supply	AC 120 V, 60 Hz
Frequency Range	30 MHz to 1 000 MHz
Detector	Quasi-Peak
Bandwidth	120 kHz (6 dB)
Measurement Distance	3 m
Antenna Height	1 m to 4 m
Operating Mode	Charging mode Normal mode
Test Site	3 m Semi Anechoic Chamber #1
Temperature	min. 24.2 °C, max. 25.7 °C
Relative Humidity	min. 49.5 %, max. 55.2 %
Test Date	July 04, 2023

**Calculation Formula:**

1. POL. H = Horizontal, POL. V = Vertical
2. QuasiPeak = Reading (Receiver Reading) + Corr.
3. Corr. (Correction Factor) = Antenna Factor + Cable Loss
4. Margin = Limit - QuasiPeak

## 5.2.2 Measuring Data

Figure 2: Radiated Emission (30 to 1 000) MHz, Charging mode

Frequency (MHz)	QuasiPeak (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Height (cm)	Polarization (H/V)	Azimuth (deg)	Corr. (dB)
35.2156	16.46	40.00	23.54	299.7	V	0.0	18.9
53.8638	17.33	40.00	22.67	225.0	V	60.0	19.9
58.0690	17.15	40.00	22.85	109.8	V	39.0	19.6
95.9380	12.51	43.50	30.99	321.8	V	41.0	15.0
687.9994	28.59	46.00	17.41	225.1	V	90.0	28.7
931.1917	31.93	46.00	14.07	100.0	H	216.0	32.0

Figure 3: Radiated Emission (30 to 1 000) MHz, Normal mode

Frequency (MHz)	QuasiPeak (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Height (cm)	Polarization (H/V)	Azimuth (deg)	Corr. (dB)
44.6053	23.47	40.00	16.53	100.0	V	119.0	19.7
49.3218	28.61	40.00	11.39	100.0	V	110.0	20.1
54.0238	27.28	40.00	12.72	109.9	V	82.0	19.9
58.6968	20.57	40.00	19.43	125.1	V	95.0	19.6
68.1365	26.64	40.00	13.36	100.0	V	102.0	18.5
72.9100	33.11	40.00	6.90	100.0	V	75.0	17.4

## 5.3 Radiated Emission Above 1 GHz

## 5.3.1 Operating Condition

The test results of radiated emission provide the following information:

Used Test Standard	FCC CFR 47 PART 15 Subpart B Class B ANSI C63.4-2014
Power Supply	AC 120 V, 60 Hz
Detector	Peak, CISPR-Average
Bandwidth	1 MHz
Highest Frequency	2 480 MHz
Tested Frequency Range	1 GHz to 18 GHz
Measurement Distance	3 m
Antenna Height	1 m to 4 m
Operating Mode	Charging mode Normal mode
Test Site	3 m Semi Anechoic Chamber #1
Temperature	min. 24.2 °C, max. 25.7 °C
Relative Humidity	min. 49.1 %, max. 55.2 %
Test Date	July 04, 2023

**Calculation Formula:**

1. POL. H = Horizontal, POL. V = Vertical
2. Peak or CAverage = Reading (Receiver Reading) + Corr.
3. Corr. (Correction Factor) = Antenna Factor + Cable Loss - Amplifier Gain
4. Margin = Limit - Peak or CAverage

## 5.3.2 Measuring Data

Figure 4: Radiated Emission (1 to 18) GHz, Charging mode

Frequency (MHz)	MaxPeak (dB $\mu$ V/m)	CAverage (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Height (cm)	Polarization (H/V)	Azimuth (deg)	Corr. (dB)
2438.5250	---	19.17	54.00	34.83	171.6	V	163.0	-26.3
2438.5250	31.63	---	74.00	42.37	171.6	V	163.0	-26.3
5445.5000	---	24.35	54.00	29.65	184.8	V	355.0	-17.0
5445.5000	36.81	---	74.00	37.19	184.8	V	355.0	-17.0
7298.1300	40.46	---	74.00	33.54	113.5	V	50.0	-11.2
7298.1300	---	28.26	54.00	25.74	113.5	V	50.0	-11.2
9722.3500	43.82	---	74.00	30.18	249.8	H	164.0	-7.4
9722.3500	---	30.96	54.00	23.04	249.8	H	164.0	-7.4
13256.4350	---	32.45	54.00	21.55	123.4	H	256.0	-3.0
13256.4350	44.87	---	74.00	29.13	123.4	H	256.0	-3.0
14632.6950	46.33	---	74.00	27.67	100.0	H	0.0	-0.2
14632.6950	---	33.99	54.00	20.01	100.0	H	0.0	-0.2
17822.8450	53.91	---	74.00	20.09	150.1	V	12.0	8.8
17822.8450	---	41.45	54.00	12.55	150.1	V	12.0	8.8

Figure 5: Radiated Emission (1 to 18) GHz, Normal mode

Frequency (MHz)	MaxPeak (dB $\mu$ V/m)	CAverage (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)	Height (cm)	Polarization (H/V)	Azimuth (deg)	Corr. (dB)
1331.3750	36.83	---	74.00	37.17	168.8	V	80.0	-30.3
1331.3750	---	22.17	54.00	31.83	168.8	V	80.0	-30.3
1597.9350	---	20.71	54.00	33.29	173.8	V	50.0	-29.5
1597.9350	51.03	---	74.00	22.97	173.8	V	50.0	-29.5
1882.1750	---	18.20	54.00	35.80	111.5	V	242.0	-28.7
1882.1750	38.90	---	74.00	35.10	111.5	V	242.0	-28.7
2995.1550	---	26.97	54.00	27.03	157.8	V	238.0	-23.9
2995.1550	43.52	---	74.00	30.48	157.8	V	238.0	-23.9
4997.2750	---	24.21	54.00	29.79	232.5	H	282.0	-17.9
4997.2750	38.20	---	74.00	35.80	232.5	H	282.0	-17.9
5978.7700	45.77	---	74.00	28.23	238.5	V	221.0	-15.5
5978.7700	---	28.65	54.00	25.35	238.5	V	221.0	-15.5



## 6. APPENDIX A. TEST SETUP PHOTO

Please refer to Appendix. A and test setup photo file no. as follows;

File No.	Date of Issue	Description
HCT-EM-2307-FC004-P	July 17, 2023	Initial Release

End of report