

SmartAC.com, Inc.

TEST REPORT

SCOPE OF WORK:

47 CFR FCC Part 15.249 – Radio Spectrum report

Model:

SMSHB1A2

REPORT NUMBER

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Radio Spectrum TEST REPORT

Applicant:	SmartAC.com, Inc. 5302 Egbert Street, Houston, TX 77007, United States
Product:	Gateway
Model No.:	SMSHB1A2
FCC ID:	2AVMLSMSHB2
Test Method/ Standard:	47 CFR FCC Part 15.249 & ANSI C63.10 2013
Test By:	Intertek Testing Services Taiwan Ltd., Hsinchu Laboratory No. 11, Lane 275, Ko-Nan 1 Street, Chia-Tung Li, Shiang-Shan District, Hsinchu City, Taiwan



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Revision History

Report No.	Issue Date	Revision Summary
220200196THC-001	Apr. 22, 2022	Same as WPS. After engineer judgment, the AC Power Line Conducted Emission test was considered necessary. The test data in this report are based on Report No.: 200700304TWN-001.

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Summary of Tests

Test	Reference	Results
20dB Bandwidth	15.215(c)	Pass
Radiated Emission test	15.249(c), 15.209	Pass
Emission on the Band Edge	15.249(d)	Pass
Conducted Emission of AC Power	15.207	Pass
Antenna Requirement	15.203	Pass

Note: Please note that the test results with statement of conformity, the decision rules which are based on: Safety Testing: the specification, standard or IEC Guide 115.

Other Testing: the specification, standard and not taking into account the measurement uncertainty.

1. General Information

1.1 Identification of the EUT

Product:	Gateway
Model No.:	SMSHB1A2
Operating Frequency:	2407 MHz ~ 2477 MHz
Channel Number:	8 channels
Frequency of Each Channel:	2407MHz, 2408MHz, 2414MHz, 2425MHz, 2435MHz, 2460MHz, 2469, 2477MHz
Access scheme:	GFSK
Rated Power:	DC 5V from adapter
Power Cord:	N/A
Sample receiving date:	2020/07/23 2022/02/17
Sample condition:	Workable
Test Date(s):	2020/08/03-2020/08/10 2022/03/10

1.2 Adapter information

The EUT will be supplied with a power supply from below list:

No.	Model no.	Specification
Adapter	PG062-0501000UC	I/P: 100-240Vac, 50/60Hz, 0.3A, O/P: 5Vdc, 1000mA

1.3 Antenna description

Antenna Gain	: 2.69 dBi
Antenna Type	: PIFA antenna
Connector Type	: Fixed

1.4 Peripherals equipment

Peripherals	Brand	Model No.	Serial No.	Description of Data Cable
Notebook PC	DELL	Latitude E5420	HXYJBT1	Micro USB shielded cable 1m
Fixture (By client)	N/A	N/A	N/A	N/A
Wireless Router	BUFFALO	WZR-AGL300NH	N/A	RJ45 cable 6m
Micro SD Card	Transcend	Micro SD HC 16G	N/A	N/A
Sensor 1	Misbox	SMCOM1A1	N/A	N/A
Sensor 2	Misbox	SMWAT1A1	N/A	N/A
Sensor 3	Misbox	SMFIL1A1	N/A	N/A

2. Test specifications

2.1 Test standard

The EUT was performed according to the procedures in FCC Part 15 Subpart C Paragraph 15.249 for non-spread spectrum devices.

The test of radiated measurements according to FCC Part15 Section 15.33(a) had been conducted and the field strength of this frequency band were all meet limit requirement, thus we evaluate the EUT pass the specified test.

2.2 Operation mode

The EUT connected to Notebook PC USB port, executing “teraterm” and select different frequency and modulation.

3. 20dB Bandwidth & Occupied Bandwidth test

3.1 Operating environment

Temperature:	27	°C
Relative Humidity:	54	%
Test date:	2020/08/10	

3.2 Test setup & procedure

The 20dB Bandwidth & Occupied Bandwidth was measured using a 50 ohm spectrum analyzer with the resolutions bandwidth set at 100 kHz, the video bandwidth $\geq$ RBW, and the SPAN may equal to approximately 2 to 3 times the 20dB bandwidth. The test was performed at 3 channels (lowest, middle and highest channel). The maximum 20dB modulation bandwidth is in the following Table.

3.3 Measured data of modulated bandwidth test results

Single TX

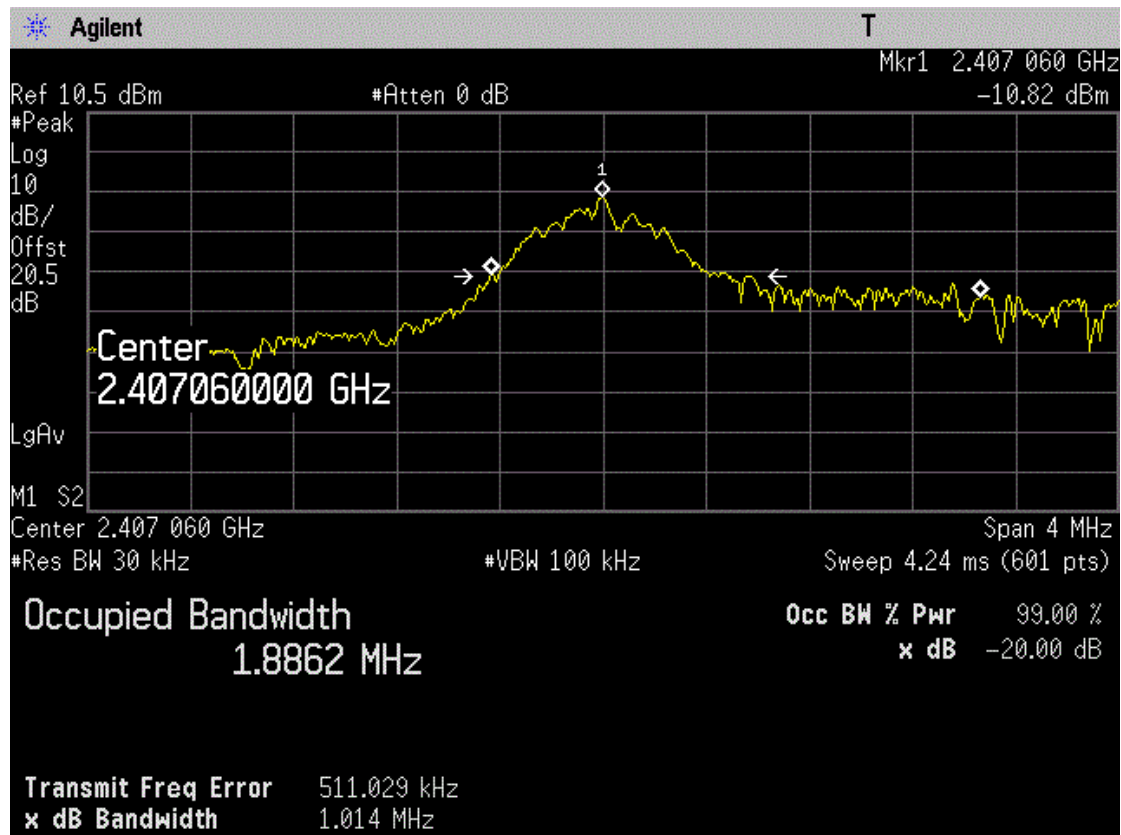
Mode	Channel	Frequency (MHz)	20dB Bandwidth (MHz)
GFSK	Low	2407	1.014
	Mid	2435	0.923
	High	2477	0.870

Please see the plot below.

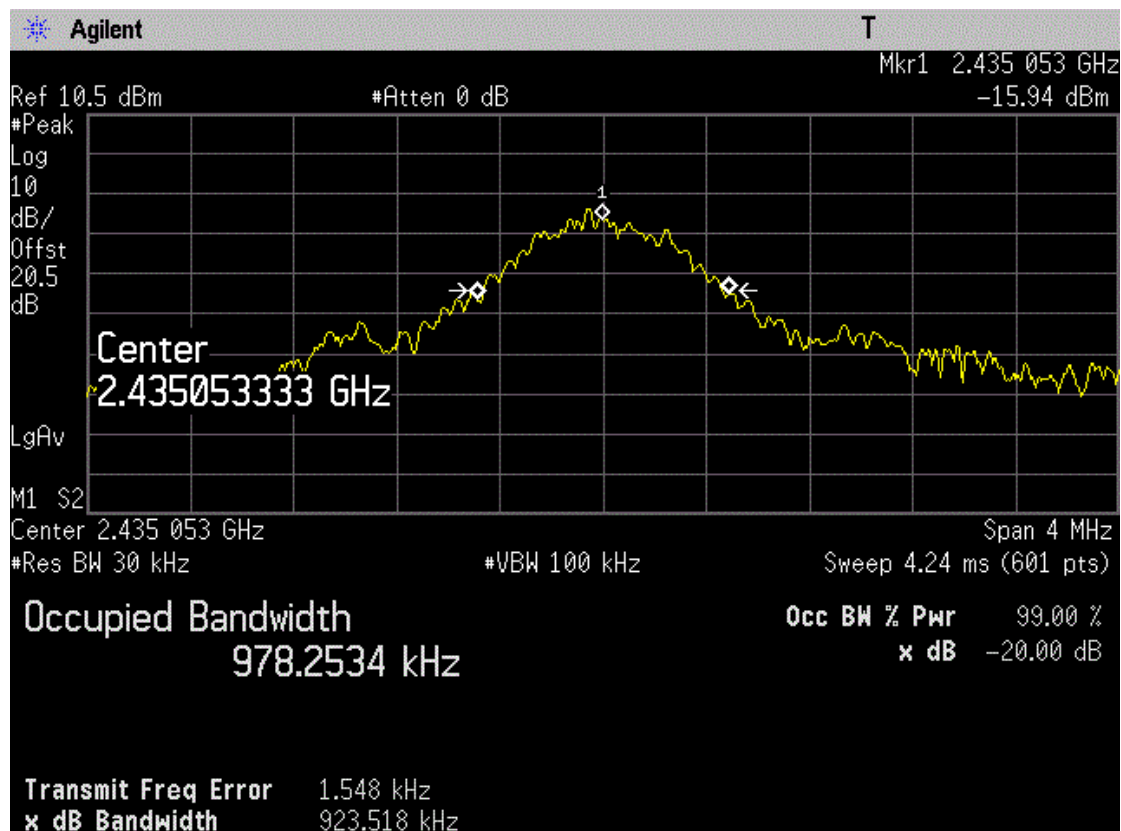
Single TX

Mode	Channel	Frequency (MHz)	Occupied Channel Bandwidth (MHz)
GFSK	Low	2407	1.886
	Mid	2435	0.978
	High	2477	0.995

Occupied Channel Bandwidth & 20dB Bandwidth @ Ch Low mode

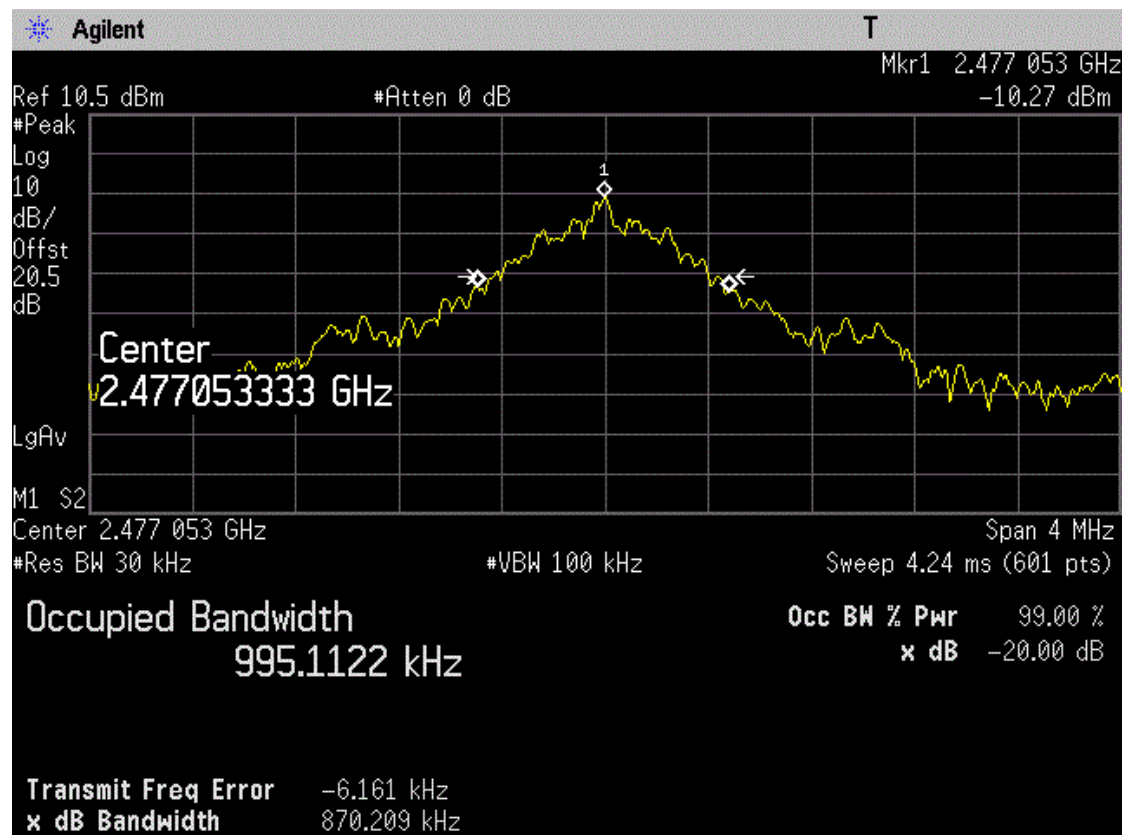


Occupied Channel Bandwidth & 20dB Bandwidth @ Ch Mid mode



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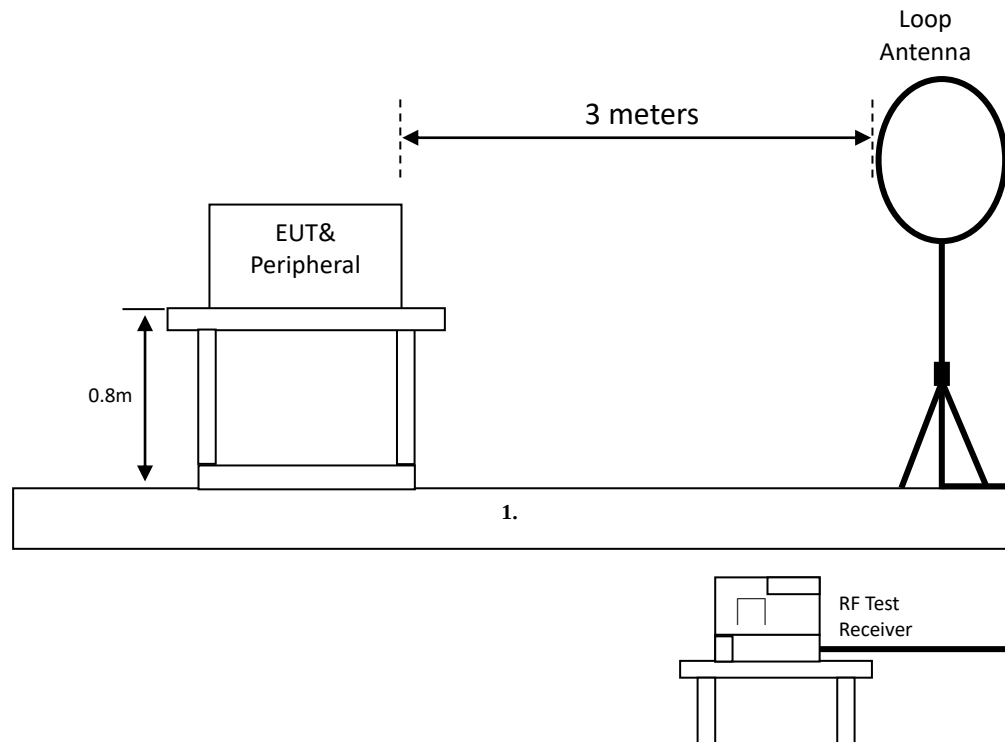
Occupied Channel Bandwidth & 20dB Bandwidth @ Ch High mode



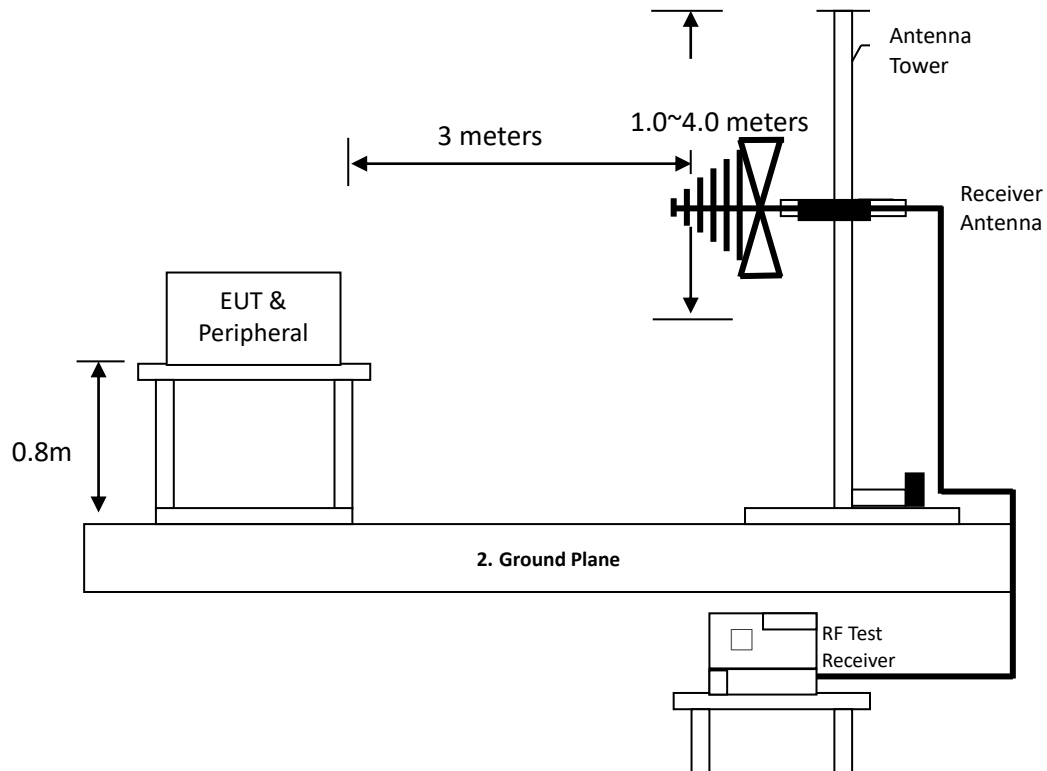
4. Radiated emission test FCC 15.249 (C)

4.1 Test setup & procedure

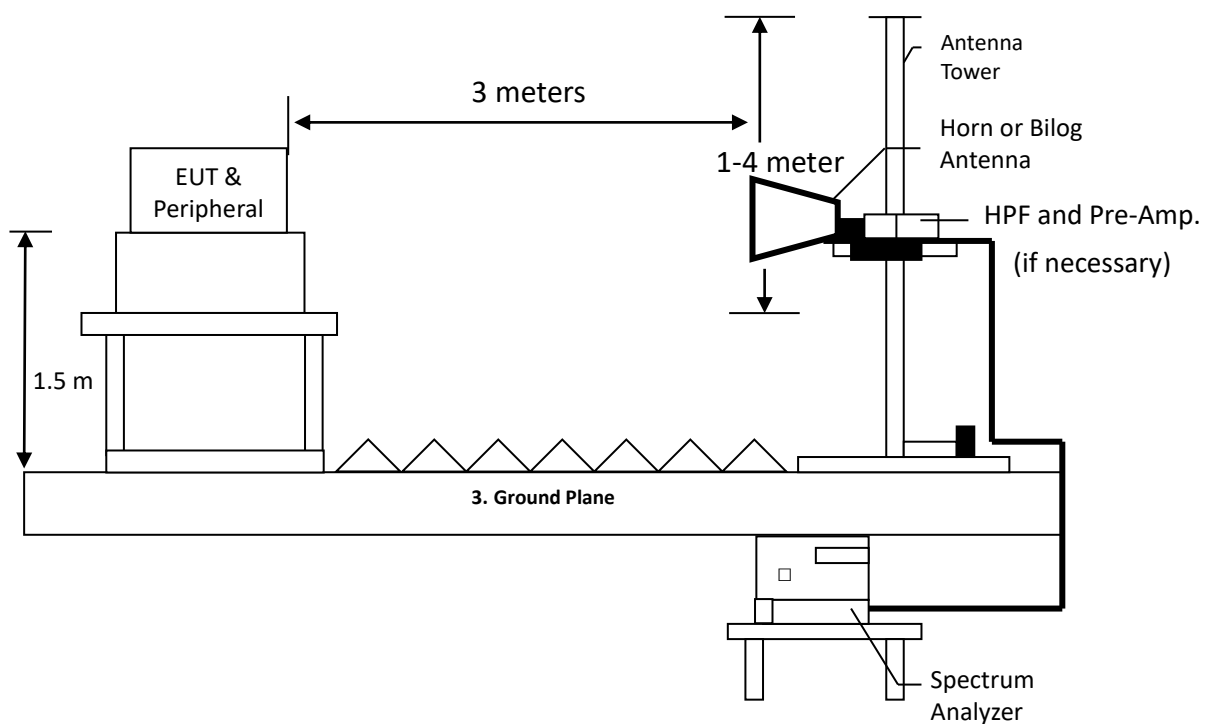
Radiated emission from 9kHz to 30MHz uses Loop Antenna:



Radiated emission below 1GHz using Bilog Antenna



Radiated emission above 1GHz using Horn Antenna



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Radiated emissions were investigated cover the frequency range from 30MHz to 1000MHz using a receiver RBW of 120kHz record QP reading, and the frequency over 1GHz using a spectrum analyzer RBW of 1MHz and 10Hz VBW record Average reading. (15.209 paragraph), the Peak reading (1 MHz RBW/ 3 MHz VBW) recorded also on the report.

The EUT for testing is arranged on a turntable. If some peripherals apply to the EUT, the peripherals will be connected to EUT and the whole system. During the test, all cables were arranged to produce worst-case emissions. The signal is maximized through rotation. The height of antenna and polarization is changing constantly for exploring for maximum signal level. The height of antenna can be up to 4 meters and down to 1 meter.

The measurement for radiated emission will be done at the distance of three meters unless the signal level is too low to measure at that distance. In the case of the reading under noise floor, a pre-amplifier is used and/or the test is conducted at a closer distance. And then all readings are extrapolated back to the equivalent three meter reading using inverse scaling with distance.

4.2 Emission limit

4.2.1 Fundamental and harmonics emission limits

Frequency (MHz)	Field Strength of Fundamental		Field Strength of Harmonics	
	(mV/m@3m)	(dBuV/m@3m)	(uV/m@3m)	(dBuV/m@3m)
2400-2483.5	50	94	500	54

4.2.2 General radiated emission limits

Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50dB below the level of the fundamental or to the general radiated emission limits in paragraph 15.209, whichever is the lesser attenuation.

Frequency MHz	15.209 Limits (dB μ V/m@3m)
30-88	40
88-216	43.5
216-960	46
Above 960	54

Remark:

1. In the above table, the tighter limit applies at the band edges.
2. Distance refers to the distance in meters between the measuring instrument antenna and the closed point of any part of the device or system

4.3 Radiated spurious emission test data

4.3.1 Measurement results: frequency range from 9 kHz to 30 MHz

The emissions are more than 20 dB below the limit, the value has no need to be reported.

4.3.2 Measurement results: frequencies from 30 MHz to 1 GHz

Temperature:	26	°C
Relative Humidity:	59	%
Test date:	2020/08/03	

The test was performed continuously transmitting mode. The worst case occurred at TX middle channel (2435MHz).

Antenna Polarity (H/V)	Frequency (MHz)	Spectrum Analyzer Detector	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)
Vertical	37.76	QP	20.16	16.36	36.52	40.00	-3.48
Vertical	295.78	QP	22.32	6.89	29.21	46.00	-16.79
Vertical	540.22	QP	28.10	11.11	39.21	46.00	-6.79
Vertical	553.80	QP	28.38	9.25	37.62	46.00	-8.38
Vertical	749.74	QP	32.03	3.18	35.21	46.00	-10.79
Vertical	804.06	QP	32.52	11.35	43.87	46.00	-2.13

Remark: Corr. Factor = Antenna Factor + Cable Loss

Antenna Polarity (H/V)	Frequency (MHz)	Spectrum Analyzer Detector	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)
Horizontal	291.90	QP	22.23	9.52	31.74	46.00	-14.26
Horizontal	544.10	QP	28.18	11.07	39.24	46.00	-6.76
Horizontal	567.38	QP	28.69	10.91	39.60	46.00	-6.40
Horizontal	701.24	QP	30.95	7.00	37.94	46.00	-8.06
Horizontal	749.74	QP	32.03	6.70	38.73	46.00	-7.27
Horizontal	804.06	QP	32.52	12.38	44.90	46.00	-1.10

Remark: Corr. Factor = Antenna Factor + Cable Loss

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4.3.3 Measurement results: frequency from 1GHz to 25GHz

Temperature:	27	°C
Relative Humidity:	58	%
Test date:	2020/08/07	

Mode	Frequency (MHz)	Spectrum Analyzer Detector	Antenna Polarity (H/V)	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)
Ch_Low	4814	PK	V	6.95	52.4	59.35	74.00	-14.65
	4814	AV	V	---	---	38.27	54.00	-15.73
	7221	PK	V	13.69	36.12	49.81	74.00	-24.19
	4814	PK	H	6.95	51.45	58.39	74.00	-15.61
	4814	AV	H	---	---	37.31	54.00	-16.69
	7221	PK	H	13.69	35.73	49.42	74.00	-24.58
Ch_Mid	4870	PK	V	7.09	53.46	60.56	74.00	-13.44
	4870	AV	V	---	---	39.48	54.00	-14.52
	7305	PK	V	14	38.06	52.06	74.00	-21.94
	4870	PK	H	7.09	54.17	61.27	74.00	-12.73
	4870	AV	H	---	---	40.19	54.00	-13.81
	7305	PK	H	14	37.01	51.01	74.00	-22.99
Ch_High	4954	PK	V	7.32	54.41	61.73	74.00	-12.27
	4954	AV	V	---	---	40.65	54.00	-13.35
	7431	PK	V	14.47	36.91	51.38	74.00	-22.62
	4954	PK	H	7.32	53.77	61.09	74.00	-12.91
	4954	AV	H	---	---	40.01	54.00	-13.99
	7431	PK	H	14.47	35.14	49.61	74.00	-24.39

Remark: Correction Factor = Antenna Factor + Cable Loss + High Pass Filter Loss - Pre_Amplifier Gain

Note: AV Corrected Reading = PK Corrected Reading + Duty cycle correction factor(-21.08)

4.3.4 Measurement results: Fundamental

Temperature:	27	°C
Relative Humidity:	58	%
Test date:	2020/08/07	

Mode	Frequency (MHz)	Spectrum Analyzer Detector	Antenna Polarity (H/V)	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)
Ch low	2407	PK	V	34.59	56.19	88.18	114.00	-25.82
	2407	AV	V	--	--	67.10	94.00	-26.90
	2407	PK	H	34.59	64.04	92.56	114.00	-21.44
	2407	AV	H	--	--	71.48	94.00	-22.52
Ch mid	2435	PK	V	34.74	57.26	88.52	114.00	-25.48
	2435	AV	V	--	--	67.44	94.00	-26.56
	2435	PK	H	34.74	64.40	93.42	114.00	-20.58
	2435	AV	H	--	--	72.34	94.00	-21.66
Ch high	2477	PK	V	34.89	56.37	85.48	114.00	-28.52
	2477	AV	V	--	--	64.40	94.00	-29.60
	2477	PK	H	34.89	62.83	91.42	114.00	-22.58
	2477	AV	H	--	--	70.34	94.00	-23.66

Remark: Correction Factor = Antenna Factor + Cable Loss

Note: AV Corrected Reading = PK Corrected Reading + Duty cycle correction factor(-21.08)

5. Radiated emission on the band edge FCC 15.249(d)

5.1 Operating environment

Temperature:	27	°C
Relative Humidity:	58	%
Test date:	2020/08/07	

5.2 Radiated emission on the band edge test data

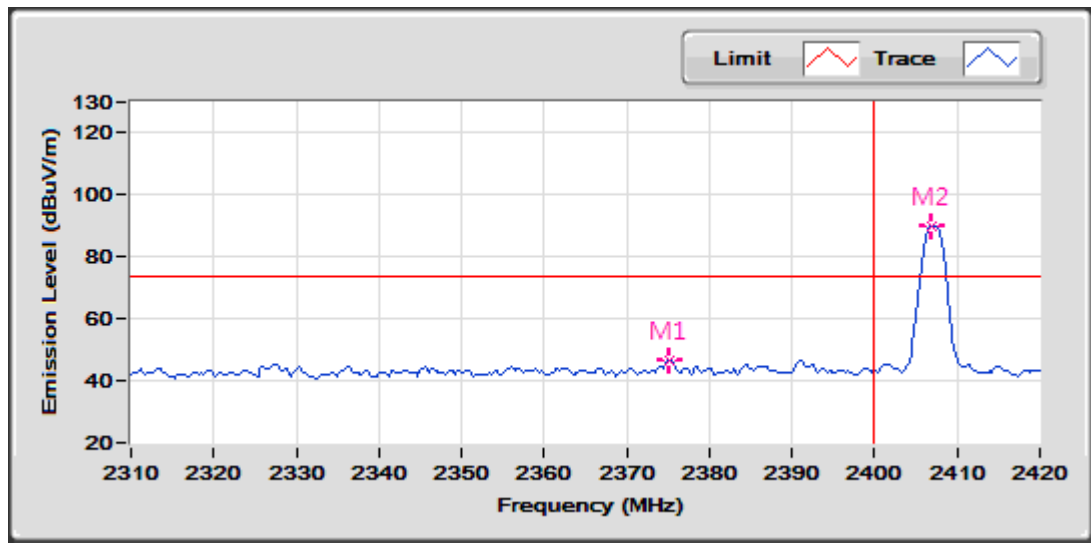
Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

Mode	Frequency (MHz)	Spectrum Analyzer Detector	Ant. Pol. (H/V)	Correction Factor (dB/m)	Reading (dBμV)	Corrected Reading (dBμV/m)	Limit @ 3 m (dBμV/m)	Margin (dB)	Restricted band (MHz)
GFSK	2375.12	PK	H	34.45	12.30	46.75	74	-27.25	≤2400
	2375.12	AV	H	---	---	25.67	54	-28.33	
	2483.50	PK	H	34.92	16.95	51.87	74	-22.13	≥2483.5
	2483.50	AV	H	---	---	30.79	54	-23.21	

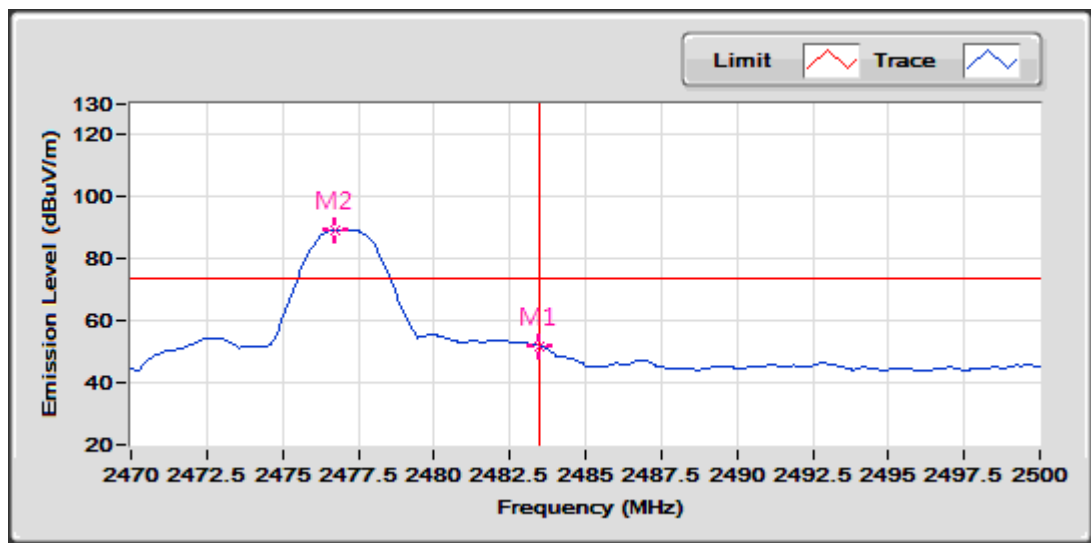
Remark: Correction Factor = Antenna Factor + Cable Loss

Note: AV Corrected Reading = PK Corrected Reading + Duty cycle correction factor(-21.08)

Restricted Band Bandedge @ 2.4G Mode Ch low PK



Restricted Band Bandedge @ 2.4G Mode Ch high PK



6. AC Power Line Conducted Emission

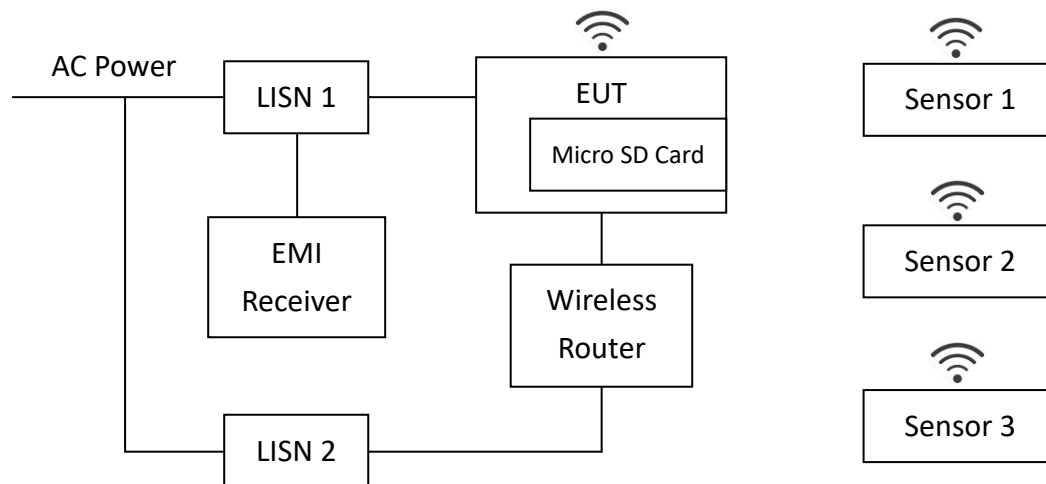
6.1 Measuring instrument setting

Receiver Function	Setting
Detector	QP
Start frequency	0.15MHz
Stop frequency	30MHz
IF bandwidth	9 kHz
Attenuation	10dB

6.2 Test Procedure

Step 1	Configure the EUT according to ANSI C63.10:2013. The EUT or host of EHT has to be placed 0.4 meter far from the conducting wall of the shielding room and at least 80 centimeters from any other grounded conducting surface.
Step 2	Connect EUT or host of EUT to the power mains through a line impedance stabilization network.
Step 3	All the companion devices are connected to the other LISN. The LISN should provide 50Uh/50ohms coupling impedance.
Step 4	The frequency range from 150 kHz to 30MHz was searched.
Step 5	Set the test-receiver system to peak detector and specified bandwidth with maximum hold mode.
Step 6	The measurement has to be done between each power line and ground at the power terminal.

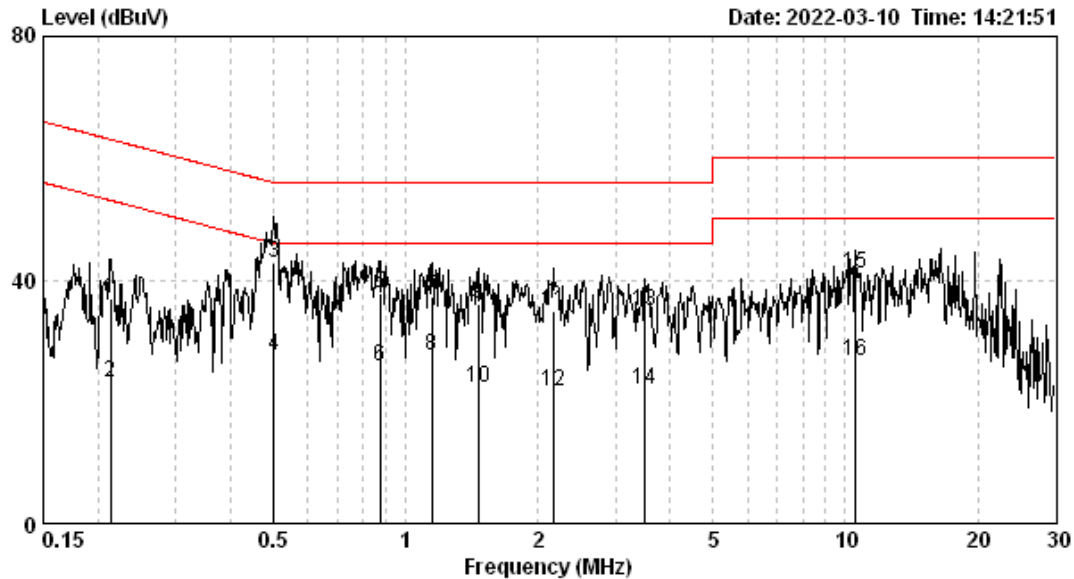
6.3 Test Diagram



6.4 Limit

Frequency (MHz)	Conducted Limit (dBuV)	
	Q.P.	Ave.
0.15~0.50	66 – 56	56 – 46
0.50~5.00	56	46
5.00~30.0	60	50

6.5 Test Results

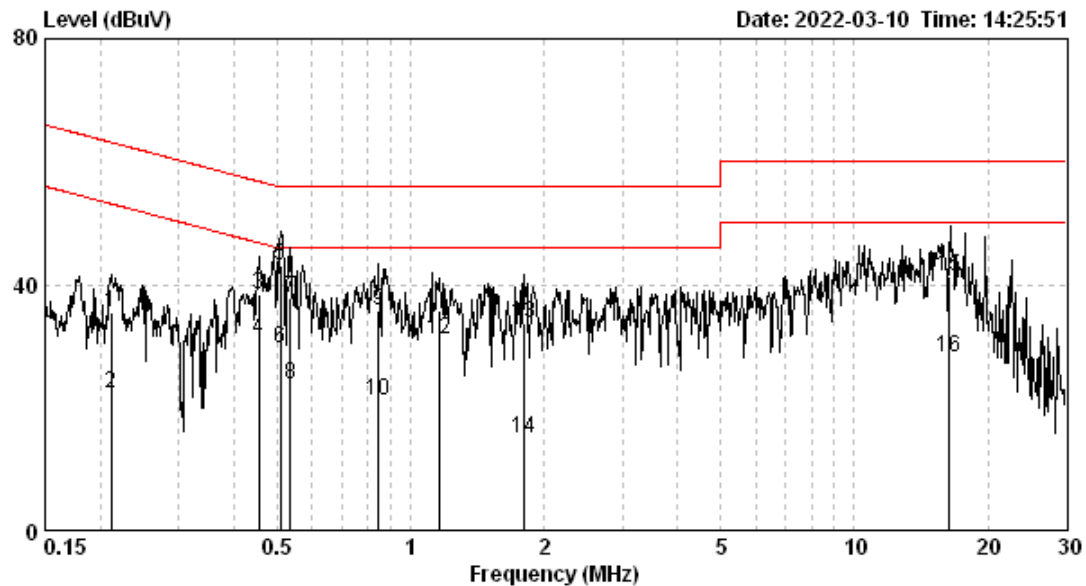


Test voltage : 120Vac, 60Hz
Temp. / R.H. : 23 °C / 56 %RH
Atmospheric pressure : 1007 hPa

Phase	Frequency (MHz)	Corr. Factor (dB)	Reading QP (dBuV)	Level QP (dBuV)	Limit QP (dBuV)	Reading AV (dBuV)	Level AV (dBuV)	Limit AV (dBuV)	Margin (dB)	
									QP	AV
LINE	0.214	0.09	36.71	36.80	63.05	22.93	23.02	53.05	-26.25	-30.03
LINE	0.502	0.09	42.57	42.66	56.00	27.49	27.58	46.00	-13.34	-18.42
LINE	0.876	0.12	37.79	37.91	56.00	25.72	25.84	46.00	-18.09	-20.16
LINE	1.147	0.14	37.03	37.17	56.00	27.43	27.57	46.00	-18.83	-18.43
LINE	1.464	0.16	35.79	35.95	56.00	22.02	22.18	46.00	-20.05	-23.82
LINE	2.167	0.19	34.82	35.01	56.00	21.36	21.55	46.00	-20.99	-24.45
LINE	3.509	0.18	34.71	34.89	56.00	21.82	22.00	46.00	-21.11	-24.00
LINE	10.508	0.57	40.48	41.05	60.00	26.03	26.60	50.00	-18.95	-23.40

Remark:

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



Test voltage :120Vac, 60Hz
 Temp./ R.H. :23 °C / 56 %RH
 Atmospheric pressure :1007 hPa

Phase	Frequency (MHz)	Corr. Factor (dB)	Reading QP (dBuV)	Level QP (dBuV)	Limit QP (dBuV)	Reading AV (dBuV)	Level AV (dBuV)	Limit AV (dBuV)	Margin (dB)	
									QP	AV
NEUTRAL	0.212	0.08	35.35	35.43	63.14	22.19	22.27	53.14	-27.71	-30.87
NEUTRAL	0.454	0.08	38.43	38.51	56.80	30.85	30.93	46.80	-18.29	-15.87
NEUTRAL	0.510	0.09	43.12	43.21	56.00	29.41	29.50	46.00	-12.79	-16.50
NEUTRAL	0.535	0.09	37.66	37.75	56.00	23.69	23.78	46.00	-18.25	-22.22
NEUTRAL	0.848	0.11	35.65	35.76	56.00	21.04	21.15	46.00	-20.24	-24.85
NEUTRAL	1.160	0.13	35.70	35.83	56.00	31.03	31.16	46.00	-20.17	-14.84
NEUTRAL	1.810	0.17	33.58	33.75	56.00	14.82	14.99	46.00	-22.25	-31.01
NEUTRAL	16.312	0.61	40.60	41.21	60.00	27.53	28.14	50.00	-18.79	-21.86

Remark:

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

Appendix A: Test equipment list

Test Equipment/ Test site	Brand	Model No.	Serial No.	Calibration Date	Next Calibration Date
EMI Test Receiver	R&S	ESR-7	101232	2020/01/18	2021/01/16
EMI Test Receiver	R&S	ESU40	100381	2020/05/29	2021/05/28
Spectrum Analyzer	R&S	FSP30	100137	2019/08/29	2020/08/27
Signal Analyzer	Agilent	N9030A	MY51380492	2019/08/21	2020/08/19
Active Loop Antenna	SCHWARZBECK MESS-ELEKTRONIC	FMZB1519	1519-067	2020/04/13	2021/04/12
Broadband Antenna	SHWARZBECK	VULB 9168	9168-172	2020/06/02	2021/06/01
Horn Antenna	SCHWARZBECK	BBHA 9170	BBHA9170159	2017/09/04	2020/09/02
Horn Antenna	SHWARZBECK	BBHA 9120 D	9120D-456	2020/01/20	2021/01/18
Power Meter	Anritsu	ML2495A	0844001	2019/10/23	2020/10/21
Power Sensor	Anritsu	MA2411B	0738452	2019/10/23	2020/10/21
Pre-Amplifier	SCHWARZBECK	BBV9718	9718-004	2019/10/16	2020/10/14
Pre-amplifier	EMCI	EMC184045SE	980512	2020/06/01	2021/05/31
966-2(A) Cable	SUHNER	SMA / EX 100	N/A	2019/08/19	2020/08/17
966-2(B) Cable	SUHNER	SUCOFLEX 104P	CB0005	2019/08/19	2020/08/17
RF Cable	EMCI	EMC102-KM-KM-2000	170225	2020/07/13	2021/07/12
RF Cable	SUHNER	SUCOFLEX 102	N/A	2020/04/15	2021/04/14
RF Cable	SUHNER	SUCOFLEX 102	CB0006	2020/04/30	2021/04/29
Hight Pass Filter	Reactel	7HS-3G/18G-S11	N/A	2020/05/27	2021/05/26
966-2_3m Semi-Anechoic Chamber	966_2	CEM-966_2	N/A	2020/02/22	2021/02/20

Test Equipment	Brand	Model No.	Serial No.	Calibration Date	Next Calibration Date
EMI Test Receiver	Rohde & Schwarz	ESCS30	833364/011	2021/05/07	2022/05/06
LISN	R&S	ESH3-Z5	835239/023	2021/09/22	2022/09/21
CON-3 Cable	SUHNER	SUCOFLEX 106	27222 /6	2022/01/12	2023/01/11
Test software	Audix	e3	V4.20040112L	NCR	NCR

Note: No Calibration Required (NCR).

Appendix B: Measurement Uncertainty

This uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level using a coverage factor of $k=2$.

Item	Uncertainty
Vertically polarized radiated disturbances from 30MHz~1GHz in a semi-anechoic chamber at a distance of 3m	4.90 dB
Horizontally polarized radiated disturbances from 30MHz~1GHz in a semi-anechoic chamber at a distance of 3m	4.89 dB
Vertically polarized Radiated disturbances from 1GHz~18GHz in a semi-anechoic chamber at a distance of 3m	4.29 dB
Horizontally polarized Radiated disturbances from 1GHz~18GHz in a semi-anechoic chamber at a distance of 3m	4.29 dB
Vertically polarized Radiated disturbances from 18GHz~26.5GHz in a semi-anechoic chamber at a distance of 1m	2.45 dB
Horizontally polarized Radiated disturbances from 18GHz~26.5GHz in a semi-anechoic chamber at a distance of 1m	2.45 dB
Radiated disturbances from 9kHz~30MHz in a semi-anechoic chamber at a distance of 3m	3.32 dB
Emission on the Band Edge Test	4.29 dB
20dB Bandwidth	7.69 %
AC Power Line Conducted Emission	3.08 dB