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Gudeng Equipment Co., Ltd.

TEST REPORT

Model:
CT-2112_04

REPORT NUMBER
230100105THC-001

ISSUE DATE
Mar. 31, 2023

PAGES
21

DOCUMENT CONTROL NUMBER
GFT-OP-10h (28-Nov-2018)

Radio Spectrum
TEST REPORT

Applicant:	**Gudeng Equipment Co., Ltd.** **8F-5, No. 2, Sec. 4, Zhongyang Rd., Tucheng Dist., New Taipei City 236041, Taiwan**
Product:	**RFID module**
Model No.:	**CT-2112_04**
FCC ID:	**2A926GD-CT2112**
Test Method/ Standard:	**47 CFR FCC Part 15.209**
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**

Testing Laboratory
0597

Mark Chang
Engineer

Rico Deng
Reviewer

Revision History

Report No.	Issue Date	Revision Summary
230100105THC-001	Mar. 31, 2023	Original report

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Summary of Test Data

Test Requirement	Applicable Rule	Result
Radiated Emission test	15.209	Pass
Conducted Emission test	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:	RFID module
Model No.:	CT-2112_04
Operating Frequency:	134.2 kHz
Rated Power:	DC 24V
Power Cord:	N/A
Sample receiving date:	2023/01/16
Sample condition:	Workable
Test Date(s):	2023/01/30 ~ 2023/03/30

1.2 Antenna description

For Antenna 1 ~ Antenna 4

Antenna Type : Coil antenna
Connector Type : RJ45

2. Test specifications

2.1 Test standard

The EUT was performed according to the requirement in FCC Part 15 Subpart C Section 15.209.

2.2 Operation mode

Power the EUT to test.

The signal is maximized through rotation and placement in the two orthogonal axes.

X axis

Y axis

After verifying three axes, we found the maximum electromagnetic field was occurred at X axis. The final test data was executed under this configuration.

2.3 Peripherals equipment

Peripherals	Brand	Model No.	Serial No.	Data cable
Adaptor (Provide by client)	FSP	FSP120-AAAN3	N/A	N/A

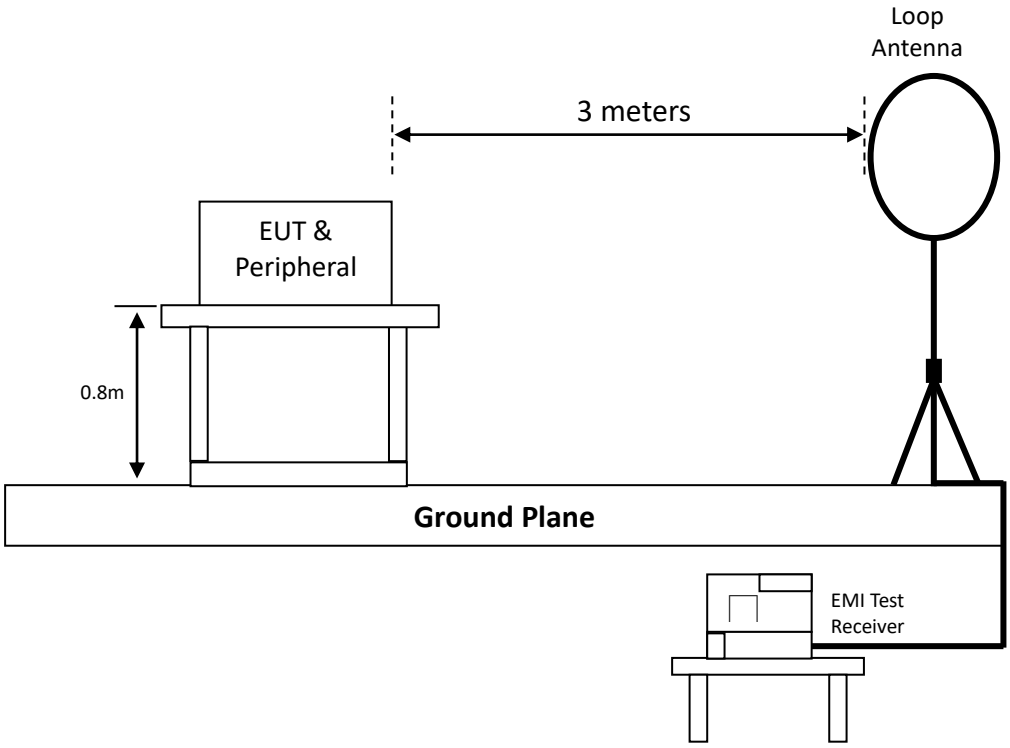
3. Radiated emission test FCC 15.209

3.1 Operating environment

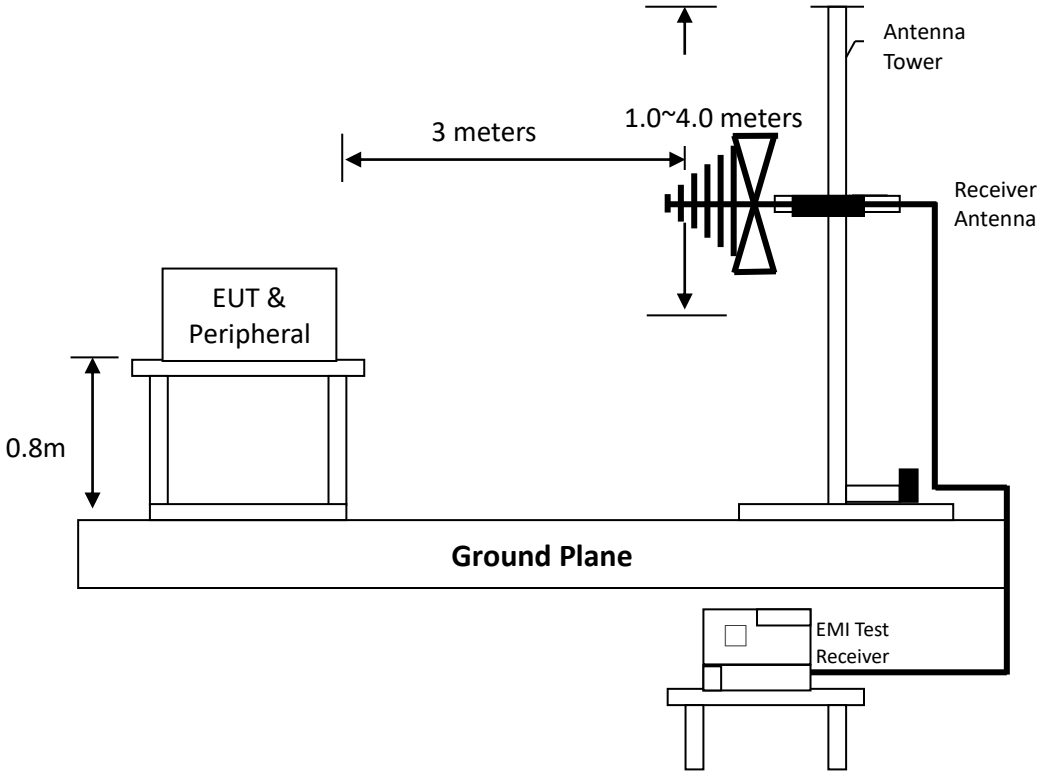
Temperature:	24	℃
Relative Humidity:	54	%

3.2 Test setup & procedure

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



Radiated emission below 1GHz using Bilog Antenna



Radiated emissions were invested 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.

3.3 Radiated emission limit

3.3.1 General radiated emission limit

The spurious Emission shall test through the 10th harmonic. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a).

Frequency (MHz)	Field Strength (μV/m)	Field Strength (dBμV/m)	Measurement Distance
0.009-0.490	2400/F(KHz)	20 log (uV/m)	300
0.490-1.705	2400/F(KHz)	20 log (uV/m)	30
1.705-30	30	29.5	30
30-88	100	40	3
88-216	150	43.5	3
216-960	200	46	3
Above 960	500	54	3

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

3.4 Radiated emission test data FCC 15.209

3.4.1 Measurement results: Fundamental emission

For ANT1 port

Antenna Polarization	Frequency (MHz)	Spectrum Analyzer Detector	Correction Factor (dB/m)	Reading @3m (dBμV)	Extrapolation Factor (dB/m)	Corrected Reading (dBμV/m)	Limit @ 300 m (dBμV/m)	Margin (dB)
Perpendicular	0.134	PK	18.06	85.30	80	23.36	25.06	-1.70
Parallel	0.134	PK	18.06	80.70	80	18.76	25.06	-6.30
Ground-parallel	0.134	PK	18.06	70.10	80	8.16	25.06	-16.90

For ANT2 port

Antenna Polarization	Frequency (MHz)	Spectrum Analyzer Detector	Correction Factor (dB/m)	Reading @3m (dBμV)	Extrapolation Factor (dB/m)	Corrected Reading (dBμV/m)	Limit @ 300 m (dBμV/m)	Margin (dB)
Perpendicular	0.134	PK	18.06	85.11	80	23.17	25.06	-1.89
Parallel	0.134	PK	18.06	80.00	80	18.06	25.06	-7.00
Ground-parallel	0.134	PK	18.06	70.40	80	8.46	25.06	-16.60

For ANT3 port

Antenna Polarization	Frequency (MHz)	Spectrum Analyzer Detector	Correction Factor (dB/m)	Reading @3m (dBμV)	Extrapolation Factor (dB/m)	Corrected Reading (dBμV/m)	Limit @ 300 m (dBμV/m)	Margin (dB)
Perpendicular	0.134	PK	18.06	84.80	80	22.86	25.06	-2.20
Parallel	0.134	PK	18.06	80.24	80	18.30	25.06	-6.76
Ground-parallel	0.134	PK	18.06	70.50	80	8.56	25.06	-16.50

For ANT4 port

Antenna Polarization	Frequency (MHz)	Spectrum Analyzer Detector	Correction Factor (dB/m)	Reading @3m (dBμV)	Extrapolation Factor (dB/m)	Corrected Reading (dBμV/m)	Limit @ 300 m (dBμV/m)	Margin (dB)
Perpendicular	0.134	PK	18.06	84.10	80	22.16	25.06	-2.90
Parallel	0.134	PK	18.06	80.50	80	18.56	25.06	-6.50
Ground-parallel	0.134	PK	18.06	70.25	80	8.31	25.06	-16.75

Remark: (1) Correction Factor = Antenna Factor + Cable Loss

(2) Corrected Reading = Correction Factor + Reading - Extrapolation Factor

(3) Extrapolation Factor for frequency below 0.49MHz is 40*log(300/3) = 80 dB; Above 0.49MHz is 40*log(30/3) = 40 dB

(4) PK emission level meets for limit, so there is no requirement for QP/AV Detector

3.4.2 Measurement results: Frequencies equal to 9kHz - 30MHz

For ANT1 port

Antenna Polarization	Frequency (MHz)	Detector	Correction Factor (dB/m)	Reading @3m (dBµV)	Extrapolation Factor (dB/m)	Corrected Reading (dBµV/m)	Limit (dBµV/m)	Margin (dB)
Perpendicular	0.399	PK	18.71	38.91	80.00	-22.38	15.58	-37.96
Perpendicular	0.669	PK	18.90	25.94	40.00	4.84	31.10	-26.26
Perpendicular	0.939	PK	19.07	27.97	40.00	7.04	28.15	-21.11
Perpendicular	1.209	PK	19.10	25.83	40.00	4.93	25.96	-21.03
Perpendicular	1.479	PK	19.10	22.60	40.00	1.70	24.20	-22.50
Perpendicular	1.958	PK	19.10	18.66	40.00	-2.24	29.54	-31.78
Parallel	0.399	PK	18.71	33.77	80.00	-27.52	15.58	-43.10
Parallel	0.669	PK	18.90	21.80	40.00	0.70	31.10	-30.40
Parallel	0.939	PK	19.07	23.49	40.00	2.56	28.15	-25.59
Parallel	1.209	PK	19.10	22.58	40.00	1.68	25.96	-24.28
Parallel	1.479	PK	19.10	19.38	40.00	-1.52	24.20	-25.72
Parallel	1.958	PK	19.10	18.20	40.00	-2.70	29.54	-32.24
Ground-parallel	0.399	PK	18.71	25.60	80.00	-35.69	15.58	-51.27
Ground-parallel	1.209	PK	19.10	19.57	40.00	-1.33	25.96	-27.29
Ground-parallel	2.018	PK	19.10	18.80	40.00	-2.10	29.54	-31.64
Ground-parallel	2.318	PK	19.09	14.57	40.00	-6.34	29.54	-35.88
Ground-parallel	2.828	PK	19.10	15.75	40.00	-5.15	29.54	-34.69
Ground-parallel	3.878	PK	19.32	14.04	40.00	-6.64	29.54	-36.18

Remark: (1) Correction Factor = Antenna Factor + Cable Loss

(2) Corrected Reading = Correction Factor + Reading - Extrapolation Factor

(3) Extrapolation Factor for frequency below 0.49MHz is 40*log(300/3) = 80 dB; Above 0.49MHz is 40*log(30/3) = 40 dB

(4) PK emission level meets for limit, so there is no requirement for QP/AV Detector

For ANT2 port

Antenna Polarization	Frequency (MHz)	Detector	Correction Factor (dB/m)	Reading @3m (dBµV)	Extrapolation Factor (dB/m)	Corrected Reading (dBµV/m)	Limit (dBµV/m)	Margin (dB)
Perpendicular	0.399	PK	18.71	39.61	80.00	-21.68	15.58	-37.26
Perpendicular	0.669	PK	18.90	26.52	40.00	5.42	31.10	-25.68
Perpendicular	0.939	PK	19.07	27.95	40.00	7.02	28.15	-21.13
Perpendicular	1.209	PK	19.10	26.70	40.00	5.80	25.96	-20.16
Perpendicular	1.479	PK	19.10	22.83	40.00	1.93	24.20	-22.27
Perpendicular	1.928	PK	19.09	18.45	40.00	-2.46	29.54	-32.00
Parallel	0.399	PK	18.71	33.50	80.00	-27.79	15.58	-43.37
Parallel	0.669	PK	18.90	22.74	40.00	1.64	31.10	-29.46
Parallel	0.939	PK	19.07	23.59	40.00	2.66	28.15	-25.49
Parallel	1.209	PK	19.10	22.69	40.00	1.79	25.96	-24.17
Parallel	1.329	PK	19.10	19.43	40.00	-1.47	25.13	-26.60
Parallel	1.958	PK	19.10	20.30	40.00	-0.60	29.54	-30.14
Ground-parallel	0.399	PK	18.71	26.40	80.00	-34.89	15.58	-50.47
Ground-parallel	1.209	PK	19.10	19.68	40.00	-1.22	25.96	-27.18
Ground-parallel	1.898	PK	19.10	20.10	40.00	-0.80	29.54	-30.34
Ground-parallel	3.158	PK	19.13	14.74	40.00	-6.13	29.54	-35.67
Ground-parallel	4.238	PK	19.40	13.59	40.00	-7.01	29.54	-36.55
Ground-parallel	6.427	PK	20.00	12.07	40.00	-7.93	29.54	-37.47

Remark: (1) Correction Factor = Antenna Factor + Cable Loss

(2) Corrected Reading = Correction Factor + Reading - Extrapolation Factor

(3) Extrapolation Factor for frequency below 0.49MHz is 40*log(300/3) = 80 dB; Above 0.49MHz is 40*log(30/3) = 40 dB

(4) PK emission level meets for limit, so there is no requirement for QP/AV Detector

For ANT3 port

Antenna Polarization	Frequency (MHz)	Detector	Correction Factor (dB/m)	Reading @3m (dBµV)	Extrapolation Factor (dB/m)	Corrected Reading (dBµV/m)	Limit (dBµV/m)	Margin (dB)
Perpendicular	0.399	PK	18.71	39.15	80.00	-22.14	15.58	-37.72
Perpendicular	0.669	PK	18.90	25.75	40.00	4.65	31.10	-26.45
Perpendicular	0.939	PK	19.07	27.68	40.00	6.75	28.15	-21.40
Perpendicular	1.209	PK	19.10	26.30	40.00	5.40	25.96	-20.56
Perpendicular	1.479	PK	19.10	22.10	40.00	1.20	24.20	-23.00
Perpendicular	1.958	PK	19.10	18.05	40.00	-2.85	29.54	-32.39
Parallel	0.399	PK	18.71	34.20	80.00	-27.09	15.58	-42.67
Parallel	0.699	PK	18.92	20.88	40.00	-0.20	30.71	-30.91
Parallel	0.939	PK	19.07	23.99	40.00	3.06	28.15	-25.09
Parallel	1.209	PK	19.10	22.90	40.00	2.00	25.96	-23.96
Parallel	1.479	PK	19.10	18.56	40.00	-2.34	24.20	-26.54
Parallel	1.928	PK	19.09	17.43	40.00	-3.48	29.54	-33.02
Ground-parallel	0.399	PK	18.71	26.83	80.00	-34.46	15.58	-50.04
Ground-parallel	0.609	PK	18.86	21.49	40.00	0.35	31.91	-31.56
Ground-parallel	0.939	PK	19.07	18.86	40.00	-2.07	28.15	-30.22
Ground-parallel	1.239	PK	19.10	19.68	40.00	-1.22	25.74	-26.96
Ground-parallel	1.898	PK	19.10	18.98	40.00	-1.92	29.54	-31.46
Ground-parallel	2.648	PK	19.10	15.20	40.00	-5.70	29.54	-35.24

Remark: (1) Correction Factor = Antenna Factor + Cable Loss

(2) Corrected Reading = Correction Factor + Reading - Extrapolation Factor

(3) Extrapolation Factor for frequency below 0.49MHz is 40*log(300/3) = 80 dB; Above 0.49MHz is 40*log(30/3) = 40 dB

(4) PK emission level meets for limit, so there is no requirement for QP/AV Detector

For ANT4 port

Antenna Polarization	Frequency (MHz)	Detector	Correction Factor (dB/m)	Reading @3m (dBµV)	Extrapolation Factor (dB/m)	Corrected Reading (dBµV/m)	Limit (dBµV/m)	Margin (dB)
Perpendicular	0.399	PK	18.71	38.99	80.00	-22.30	15.58	-37.88
Perpendicular	0.669	PK	18.90	25.70	40.00	4.60	31.10	-26.50
Perpendicular	0.939	PK	19.07	26.94	40.00	6.01	28.15	-22.14
Perpendicular	1.209	PK	19.10	24.93	40.00	4.03	25.96	-21.93
Perpendicular	1.479	PK	19.10	20.65	40.00	-0.25	24.20	-24.45
Perpendicular	1.928	PK	19.09	19.11	40.00	-1.80	29.54	-31.34
Parallel	0.399	PK	18.71	33.90	80.00	-27.39	15.58	-42.97
Parallel	0.669	PK	18.90	20.63	40.00	-0.47	31.10	-31.57
Parallel	0.939	PK	19.07	22.69	40.00	1.76	28.15	-26.39
Parallel	1.209	PK	19.10	23.10	40.00	2.20	25.96	-23.76
Parallel	1.479	PK	19.10	20.41	40.00	-0.49	24.20	-24.69
Parallel	1.838	PK	19.10	18.38	40.00	-2.52	29.54	-32.06
Ground-parallel	0.399	PK	18.71	25.67	80.00	-35.62	15.58	-51.20
Ground-parallel	1.299	PK	19.10	19.69	40.00	-1.21	25.33	-26.54
Ground-parallel	1.868	PK	19.10	20.81	40.00	-0.09	29.54	-29.63
Ground-parallel	2.618	PK	19.10	15.40	40.00	-5.50	29.54	-35.04
Ground-parallel	3.428	PK	19.21	14.84	40.00	-5.95	29.54	-35.49
Ground-parallel	6.427	PK	20.00	12.90	40.00	-7.10	29.54	-36.64

Remark: (1) Correction Factor = Antenna Factor + Cable Loss

(2) Corrected Reading = Correction Factor + Reading - Extrapolation Factor

(3) Extrapolation Factor for frequency below 0.49MHz is 40*log(300/3) = 80 dB; Above 0.49MHz is 40*log(30/3) = 40 dB

(4) PK emission level meets for limit, so there is no requirement for QP/AV Detector

3.4.3 Measurement results: Frequencies equal to 30MHz - 1GHz

Antenna Polarity	Frequency (MHz)	Spectrum Analyzer Detector	Correction Factor (dB/m)	Reading (dBµV)	Corrected Reading (dBµV/m)	Limit @ 3 m (dBµV/m)	Margin (dB)
Horizontal	159.98	PK	20.00	23.00	43.00	43.50	-0.50
Horizontal	244.37	PK	19.97	21.62	41.59	46.00	-4.41
Horizontal	752.65	PK	29.67	12.51	42.18	46.00	-3.82
Horizontal	816.67	PK	31.14	12.91	44.05	46.00	-1.95
Horizontal	880.69	PK	32.12	11.10	43.22	46.00	-2.78
Horizontal	914.64	PK	32.78	10.73	43.51	46.00	-2.49

Antenna Polarity	Frequency (MHz)	Spectrum Analyzer Detector	Correction Factor (dB/m)	Reading (dBµV)	Corrected Reading (dBµV/m)	Limit @ 3 m (dBµV/m)	Margin (dB)
Vertical	79.47	PK	13.52	18.79	32.31	40.00	-7.69
Vertical	127.97	PK	23.02	10.20	33.22	43.50	-10.28
Vertical	159.98	PK	20.00	18.10	38.10	43.50	-5.40
Vertical	246.31	PK	20.06	17.00	37.06	46.00	-8.94
Vertical	416.06	PK	25.29	16.20	41.49	46.00	-4.51
Vertical	732.28	PK	29.41	10.73	40.14	46.00	-5.86

Remark: (1) Correction Factor = Antenna Factor + Cable Loss
(2) PK emission level meets for limit, so there is no requirement for QP/AV Dete

4. Conducted emission FCC 15.207

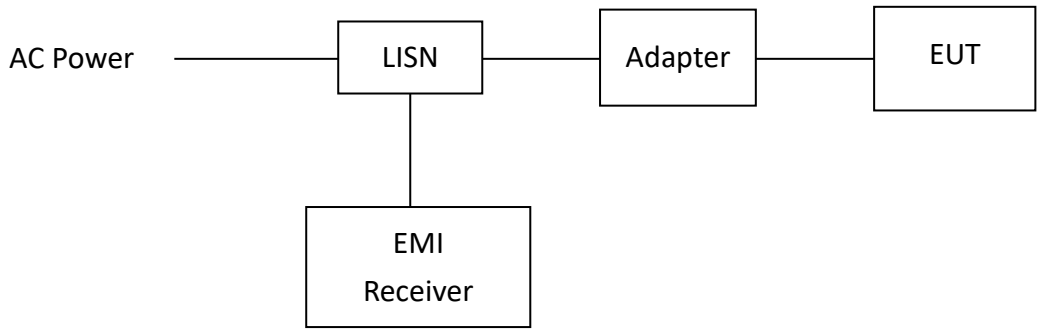
4.1 Measuring instrument setting

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

4.2 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.

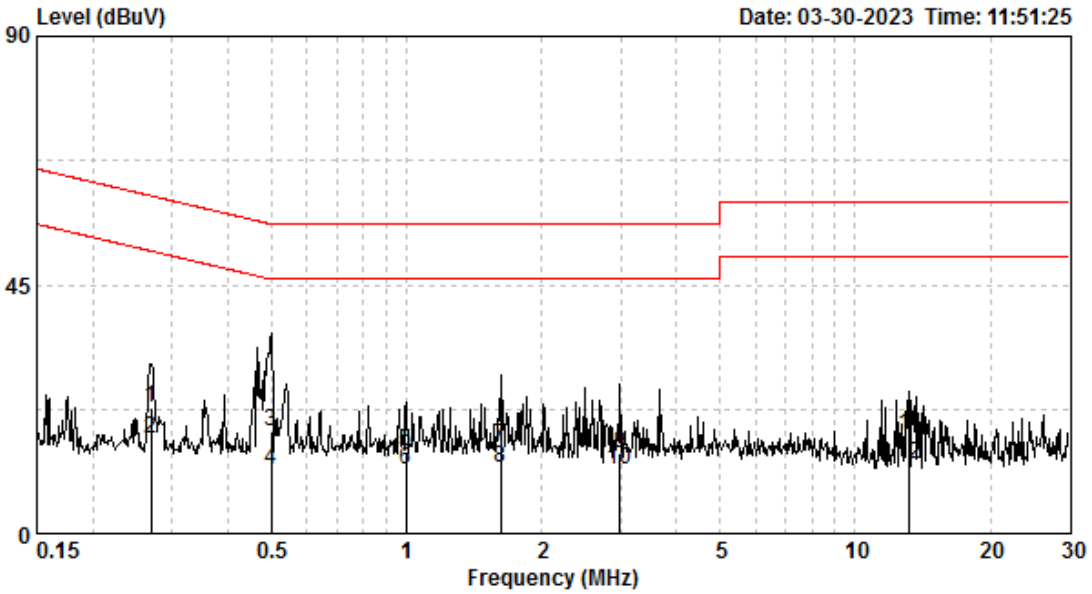
4.3 Test Diagram



4.4 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

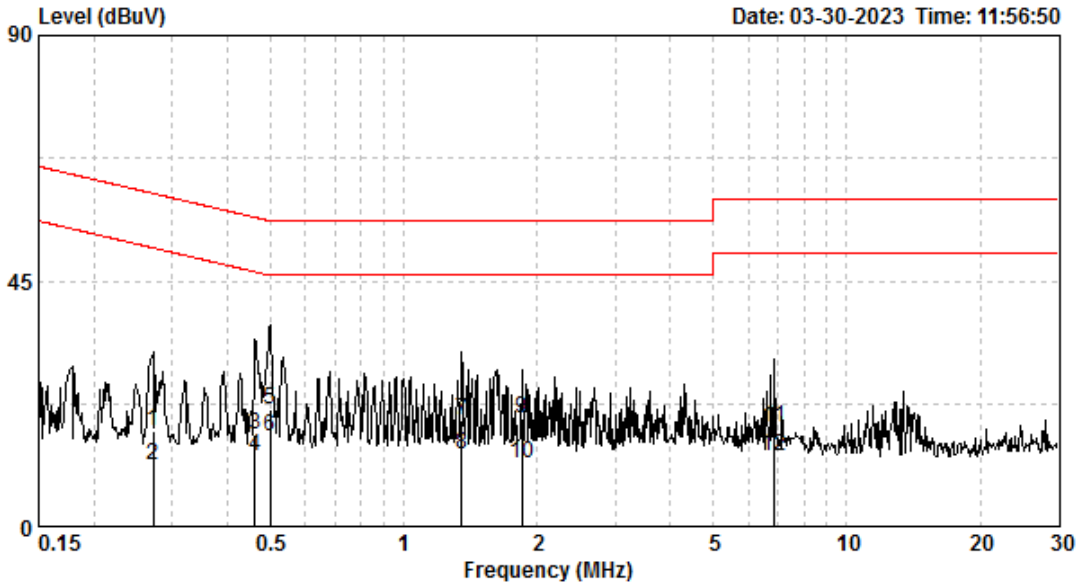
4.5 Test Results



Test voltage :120Vac / 60Hz
Temp \ Relative Humidity:15\ 53
Atmospheric pressure :1008

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	Margin (dB) AV
LINE	0.270	9.61	13.00	22.61	61.12	7.69	17.30	51.12	-38.50	-33.82
LINE	0.499	9.60	9.00	18.60	56.01	1.80	11.40	46.01	-37.41	-34.61
LINE	1.000	9.61	5.14	14.75	56.00	2.09	11.70	46.00	-41.25	-34.30
LINE	1.619	9.64	6.11	15.75	56.00	2.16	11.80	46.00	-40.25	-34.20
LINE	2.993	9.65	5.00	14.65	56.00	2.00	11.65	46.00	-41.35	-34.35
LINE	13.197	9.74	8.00	17.74	60.00	2.86	12.60	50.00	-42.26	-37.40

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 \ Relative Humidity:15\ 53
Atmospheric pressure :1008

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	Margin (dB) AV
NEUTRAL	0.272	9.61	8.00	17.61	61.07	1.69	11.30	51.07	-43.46	-39.77
NEUTRAL	0.461	9.60	7.20	16.80	56.67	3.15	12.75	46.67	-39.87	-33.92
NEUTRAL	0.499	9.60	11.90	21.50	56.01	6.80	16.40	46.01	-34.51	-29.61
NEUTRAL	1.352	9.63	9.87	19.50	56.00	3.47	13.10	46.00	-36.50	-32.90
NEUTRAL	1.848	9.65	10.00	19.65	56.00	1.75	11.40	46.00	-36.35	-34.60
NEUTRAL	6.878	9.72	8.48	18.20	60.00	3.23	12.95	50.00	-41.80	-37.05

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	ESR7	101822	2022/08/09	2023/08/08
Active Loop Antenna	SCHWARZBECK	FMZB1519	1519-067	2022/04/13	2023/04/12
Bi_log Hybrid Antenna	ETC	MCTD 2786B	BLB17J04019 & JB-5-019	2022/10/04	2023/10/03
966-2(A) Cable	SUHNER	SUCOFLEX 104	295105/4	2022/03/04	2023/03/03
966-2(B) Cable	SUHNER	SUCOFLEX 104P	CB0005	2022/03/04	2023/03/03
966-2_3m Semi-Anechoic Chamber	966_2	CEM-966_2	N/A	2023/01/13	2024/01/12
Test software	Audix	e3	V9	NCR	NCR
EMI Test Receiver	R&S	ESCI	100059	2022/10/24	2023/10/23
LISN	R&S	ENV216	101159	2022/06/07	2023/06/06
CON-1 Cable	EMC Co.	EMCRG1420 -NM-NM-1500	210215	2023/02/21	2024/02/20
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*=2.0.

Item	Uncertainty
Fundamental emission	4.32 dB
Radiated disturbances from 9kHz~30MHz in a semi-anechoic chamber at a distance of 3m	3.70 dB
Vertically polarized radiated disturbances from 30MHz~1GHz in a semi-anechoic chamber at a distance of 3m	5.16 dB
Horizontally polarized radiated disturbances from 30MHz~1GHz in a semi-anechoic chamber at a distance of 3m	5.02 dB
AC Power Line Conducted Emission	3.08 dB