

FCC Radio Test Report

FCC ID: 2BCGWS500D

This report concerns: **Class II Permissive Change**

The worst cases of conducted and radiated emissions below 1GHz have been re-evaluated by sample of FCC ID: 2BCGWS500D, model name: HS220-2. It is found that the new data are the worse, so the test data are reissue from the FCC ID: 2AXJ4S500D, model name: Tapo S500D. Model difference(s):

- a. Changed the model name as HS220-2. (HS220-2 consists of two original model Tapo S500D and an outer frame, functions and circuits are independent.)
- b. Changed the product and brand name.
- c. Changed the information of manufacturer from TP-Link Corporation Limited to TP-LINK CORPORATION PTE.LTD..
- d. Changed the shell (Merge two identical products onto one board).

Report No. : eLab-FCCP-1-2310G046A
Equipment : Kasa Smart Wi-Fi Light Switch Dimmer
Model Name : HS220-2
Brand Name : tp-link
Applicant : TP-LINK CORPORATION PTE.LTD.
Address : 7 Temasek Boulevard #29-03 Suntec Tower One, Singapore 038987
Manufacturer : TP-LINK CORPORATION PTE.LTD.
Address : 7 Temasek Boulevard #29-03 Suntec Tower One, Singapore 038987

Radio Function : WLAN 2.4 GHz

FCC Rule Part(s) : FCC CFR Title 47, Part 15, Subpart C (15.247)
Measurement : ANSI C63.10-2013
Procedure(s)

Date of Receipt : 2023/11/13
Date of Test : 2023/11/15 ~ 2023/11/16
Issued Date : 2024/02/23

The above equipment has been tested and found in compliance with the requirement of the above standards by eLab Inc.

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Declaration

eLab represents to the client that testing is done in accordance with standard procedures as applicable and that test instruments used has been calibrated with standards traceable to international standard(s) and/or national standard(s).

eLab's reports apply only to the specific samples tested under conditions. It is manufacture's responsibility to ensure that additional production units of this model are manufactured with the identical electrical and mechanical components. **eLab** shall have no liability for any declarations, inferences or generalizations drawn by the client or others from **eLab** issued reports.

This report is the confidential property of the client. As a mutual protection to the clients, the public and ourselves, the test report shall not be reproduced, except in full, without our written approval.

eLab's laboratory quality assurance procedures are in compliance with the **ISO/IEC 17025** requirements, and accredited by the conformity assessment authorities listed in this test report.

eLab is not responsible for the sampling stage, so the results only apply to the sample as received.

The information, data and test plan are provided by manufacturer which may affect the validity of results, so it is manufacturer's responsibility to ensure that the apparatus meets the essential requirements of applied standards and in all the possible configurations as representative of its intended use.

Limitation

For the use of the authority's logo is limited unless the Test Standard(s)/Scope(s)/Item(s) mentioned in this test report is (are) included in the conformity assessment authorities acceptance respective.

Please note that the measurement uncertainty is provided for informational purpose only and are not use in determining the Pass/Fail results.

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REPORT ISSUED HISTORY

Report No.	Version	Description	Issued Date	Note
eLab-FCCP-1-2310G046A	R00	Original Report.	2024/01/31	Invalid
eLab-FCCP-1-2310G046A	R01	1. Updated the model difference(s). 2. Added the test data of conducted and radiated emissions below 1GHz.	2024/02/23	Valid

1. SUMMARY OF TEST RESULTS

Test procedures according to the technical standard(s):

Standard(s) Section	Description	Result	Remark
15.207	AC Power Line Conducted Emissions	PASS	-----
15.205(a)	Radiated Emissions	PASS	-----

Note:

- (1) "N/A" denotes test is not applicable in this test report.
- (2) The test records and results please refer to the test report number: FCC022022-05625RF1, issued date is Oct. 28, 2022, and issued by:
Test Laboratory: Beijing TIRT Technology Service Co.,Ltd Shenzhen
Address: 101, 3 # Factory Building, Gongjin Electronics, Shatin Community, Kengzi Street, Pingshan District, Shenzhen City, China

Which was accredited by A2LA, accreditation number is 6049.01, with the scopes of cited standards in this test report.

This report is only valid conjunction with the above referenced test report.

1.1 TEST FACILITY

The test facilities used to collect the test data in this report:

No.64, Ln. 169, Sec. 2, Datong Rd., Xizhi Dist., New Taipei City 221, Taiwan

The test sites and facilities are covered under FCC RN 681248 and DN: TW4045.

C01 CB01 TR01

1.2 MEASUREMENT UNCERTAINTY

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor (k=2))

The BTL measurement uncertainty as below table:

A. AC power line conducted emissions test:

Test Site	Method	Measurement Frequency Range	U (dB)
C01	CISPR	150 kHz ~ 30MHz	3.44

B. Radiated emissions test:

Test Site	Measurement Frequency Range	U,(dB)
CB01	0.03 GHz ~ 0.2 GHz	4.01
	0.2 GHz ~ 1 GHz	4.64

Note: Unless specifically mentioned, the uncertainty of measurement has not been taken into account to declare the compliance or non-compliance to the specification.

1.3 TEST ENVIRONMENT CONDITIONS

Test Item	Temperature	Humidity	Test Voltage	Tested By
AC Power Line Conducted Emissions	25°C	45%	AC 120V/60Hz	Hunter Chiang
Radiated Emissions-30MHz to 1000MHz	25°C	60%	AC 120V/60Hz	Hunter Chiang

2. GENERAL INFORMATION

2.1 GENERAL DESCRIPTION OF EUT

Equipment	Kasa Smart Wi-Fi Light Switch Dimmer
Brand Name	tp-link
Test Model	HS220-2
Series Model	N/A
Model Difference(s)	N/A
Power Source	AC Mains.
Power Rating	AC 120V/60Hz
Operation Frequency	2412 MHz ~ 2462 MHz
Modulation Type	IEEE 802.11b: DSSS IEEE 802.11g: OFDM IEEE 802.11n: OFDM
Bit Rate of Transmitter	IEEE 802.11b: 11/5.5/2/1 Mbps IEEE 802.11g: 54/48/36/24/18/12/9/6 Mbps IEEE 802.11n: up to 72.2 Mbps
Maximum Peak Output Power	IEEE 802.11g: 21.68 dBm (0.147 W)

Note:

- For a more detailed features description, please refer to the manufacturer's specifications or the user's manual.

2. Channel List:

CH01 - CH11 for IEEE 802.11b, IEEE 802.11g, IEEE 802.11n(HT20)							
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
01	2412	04	2427	07	2442	10	2457
02	2417	05	2432	08	2447	11	2462
03	2422	06	2437	09	2452		

3. Antenna Specification:

Ant.	Brand	P/N	Antenna Type	Connector	Gain (dBi)
1	tp-link	6035500079	PIFA	N/A	2.98

Note: The antenna gain is provided by the manufacturer.

2.2 DESCRIPTION OF TEST MODES

The test system was pre-tested based on the consideration of all possible combinations of EUT operation mode.

Pretest Mode	Description
Mode 1	TX B Mode Channel 01/06/11
Mode 2	TX G Mode Channel 01/06/11
Mode 3	TX N(HT20) Mode Channel 01/06/11
Mode 4	TX B Mode Channel 01

Following mode(s) was (were) found to be the worst case(s) and selected for the final test.

AC power line conducted emissions test	
Final Test Mode	Description
Mode 4	TX B Mode Channel 01

Radiated emissions test - Below 1GHz	
Final Test Mode	Description
Mode 4	TX B Mode Channel 01

NOTE:

- (1) All the bit rate of transmitter have been tested and found the lowest rate is found to be the worst case and recorded.
- (2) For AC power line conducted emissions and radiated emission below 1 GHz test, the TX B Mode Channel 01 is found to be the worst case and recorded.

2.3 PARAMETERS OF TEST SOFTWARE

Test Software Version	UI_mptool.exe		
	2412	2437	2462
Frequency (MHz)			
IEEE 802.11b	84	84	84
IEEE 802.11g	116	116	110
IEEE 802.11n(HT20)	112	112	106

2.3.1 DUTY CYCLE

If duty cycle is $\geq 98\%$, duty factor is not required.
 If duty cycle is $< 98\%$, duty factor shall be considered.
 The output power = measured power + duty factor.

Test Mode	Antenna	Channel	Transmission Duration [ms]	Transmission Period [ms]	Duty Cycle [%]	Duty factor
11B	Ant1	2437	12.41	12.54	98.96	0.045
11G	Ant1	2437	2.06	2.19	94.06	0.266
11N20SISO	Ant1	2437	1.92	2.05	93.66	0.284

NOTE:

For IEEE 802.11b:

For radiated emissions frequency above 1 GHz, the resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 10Hz.

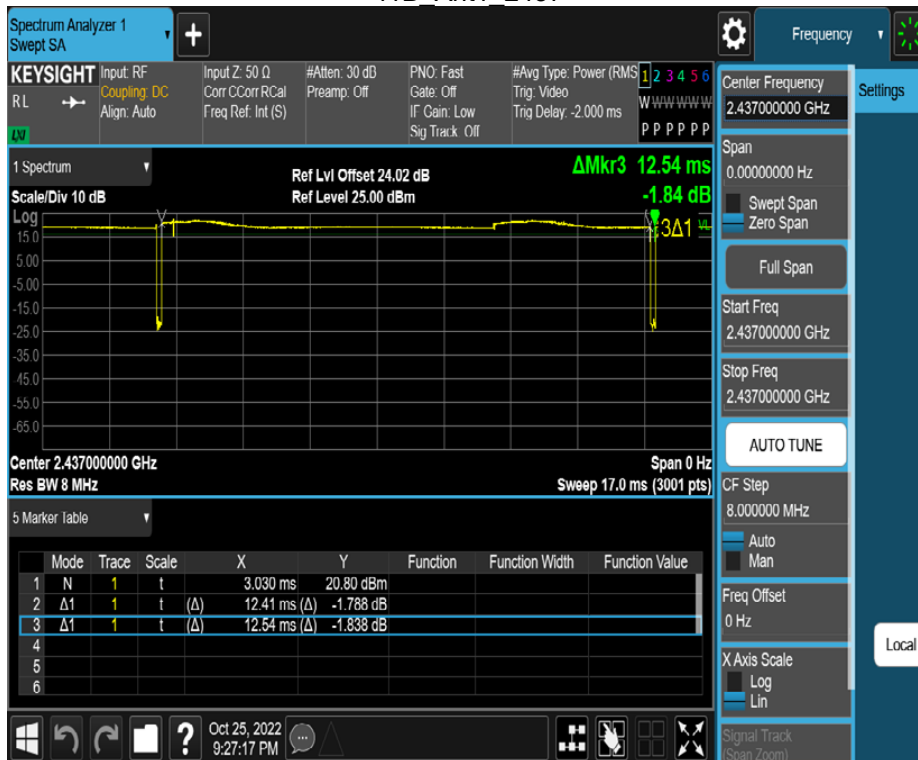
For IEEE 802.11g:

For radiated emissions frequency above 1 GHz, the resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 485Hz.

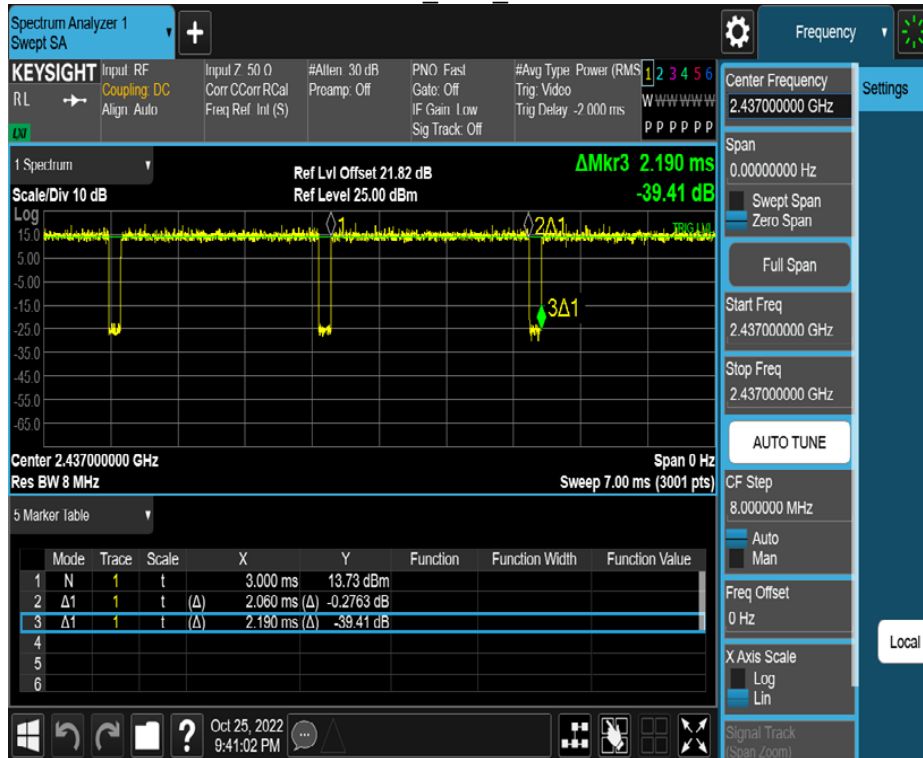
For IEEE 802.11n(HT20):

For radiated emissions frequency above 1 GHz, the resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 521Hz.

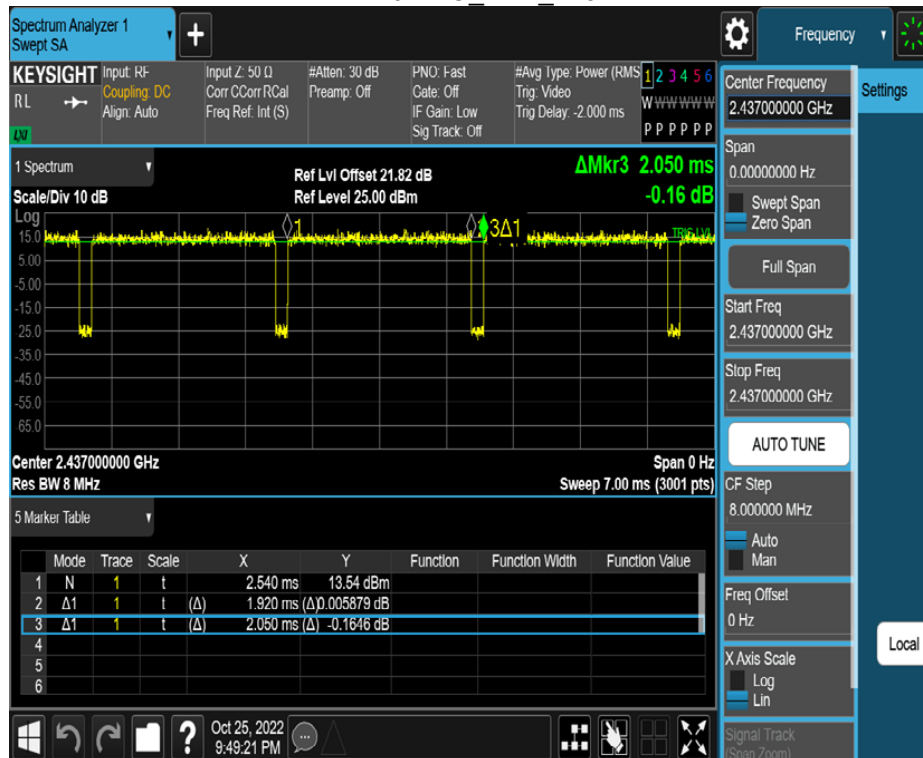
11B Ant1 2437



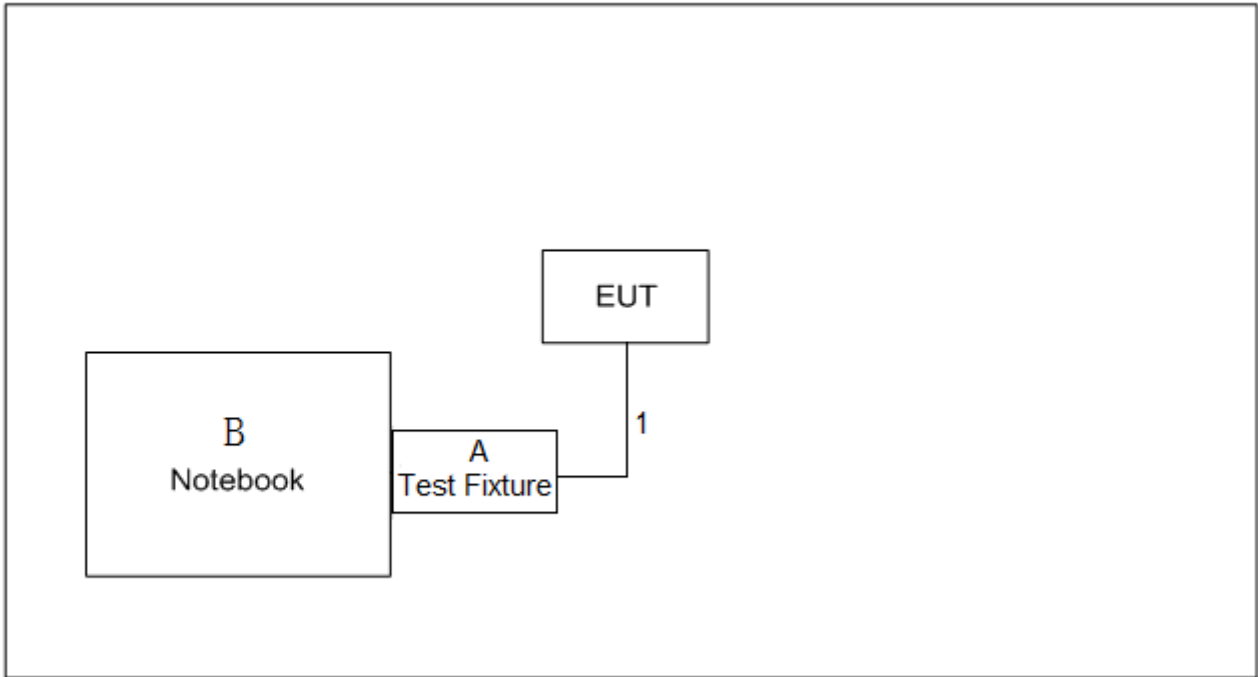
11G Ant1 2437



11N20SISO Ant1 2437



2.4 BLOCK DIAGRAM SHOWING THE CONFIGURATION OF SYSTEM TESTED



2.5 SUPPORT UNITS

Item	Equipment	Brand	Model No.	Series No.
A	Test Fixture	N/A	N/A	N/A
B	Notebook	Dynabook Inc.	TECRA A40-J	41029329H

Item	Cable Type	Shielded Type	Ferrite Core	Length
1	Data Cable	NO	NO	0.2m

3. AC POWER LINE CONDUCTED EMISSIONS

3.1 LIMIT

Frequency (MHz)	Limit (dB μ V)	
	Quasi-peak	Average
0.15 - 0.5	66 - 56 *	56 - 46 *
0.50 - 5.0	56	46
5.0 - 30.0	60	50

NOTE:

- (1) The tighter limit applies at the band edges.
- (2) The limit of " * " marked band means the limitation decreases linearly with the logarithm of the frequency in the range.
- (3) The test result calculated as following:

Measurement Value = Reading Level + Correct Factor
 Correct Factor = Insertion Loss + Cable Loss + Attenuator Factor (if use)
 Margin Level = Measurement Value – Limit Value
 Calculation example:

Reading Level		Correct Factor		Measurement Value
38.22	+	3.45	=	41.67

Measurement Value		Limit Value		Margin Level
41.67	-	60	=	-18.33

The following table is the setting of the receiver.

Receiver Parameter	Setting
Attenuation	10 dB
Start Frequency	0.15 MHz
Stop Frequency	30 MHz
IF Bandwidth	9 KHz

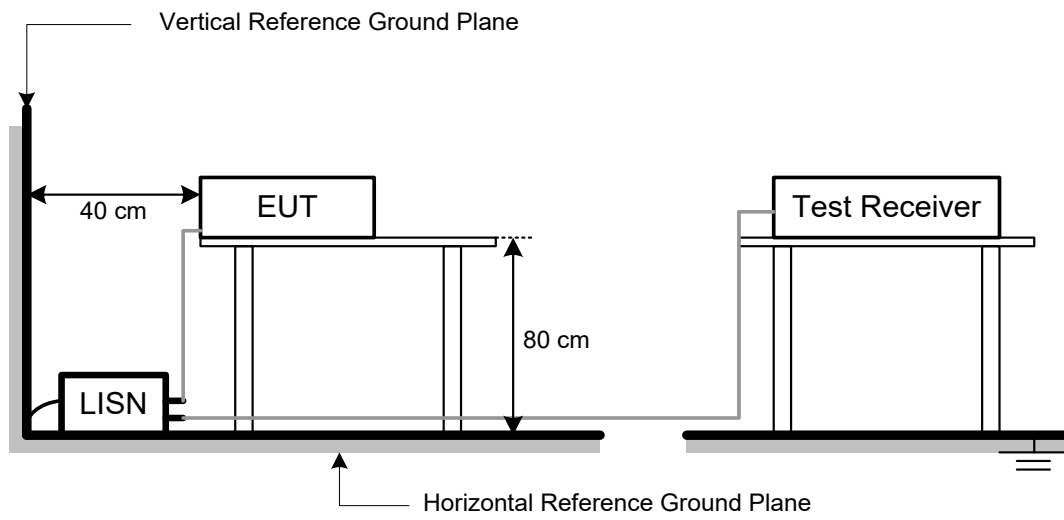
3.2 TEST PROCEDURE

- a. The EUT was placed 0.8 m above the horizontal ground plane with the EUT being connected to the power mains through a line impedance stabilization network (LISN).
 All other support equipment were powered from an additional LISN(s).
 The LISN provides 50 Ohm/50uH of impedance for the measuring instrument.
- b. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle to keep the cable above 40 cm.
- c. Excess I/O cables that are not connected to a peripheral shall be bundled in the center.
 The end of the cable will be terminated, using the correct terminating impedance.
 The overall length shall not exceed 1 m.
- d. The LISN is spaced at least 80 cm from the nearest part of the EUT chassis.
- e. For the actual test configuration, please refer to the related Item - EUT TEST PHOTO.

NOTE:

- (1) In the results, each reading is marked as Peak, QP or AVG per the detector used.
 BW=9 kHz (6 dB Bandwidth)
- (2) All readings are Peak unless otherwise stated QP or AVG in column of Note. Both the QP and the AVG readings must be less than the limit for compliance.

3.3 TEST SETUP



3.4 TEST RESULTS

Please refer to the APPENDIX A.

4. RADIATED EMISSIONS

4.1 LIMIT

In case the emission fall within the restricted band specified on 15.205, then the 15.209 limit in the table below has to be followed.

LIMITS OF RADIATED EMISSIONS MEASUREMENT (30 MHz to 1000 MHz)

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
30~88	100	3
88~216	150	3
216~960	200	3
960~1000	500	3

NOTE:

- (1) The limit for radiated test was performed according to FCC CFR Title 47, Part 15, Subpart C.
- (2) The tighter limit applies at the band edges.
- (3) Emission level (dBuV/m)=20log Emission level (uV/m).
- (4) The test result calculated as following:

Measurement Value = Reading Level + Correct Factor

Correct Factor = Antenna Factor + Cable Loss - Amplifier Gain(if use)

Margin Level = Measurement Value - Limit Value

Calculation example:

Reading Level		Correct Factor		Measurement Value
19.11	+	2.11	=	21.22

Measurement Value		Limit Value		Margin Level
21.22	-	54	=	-32.78

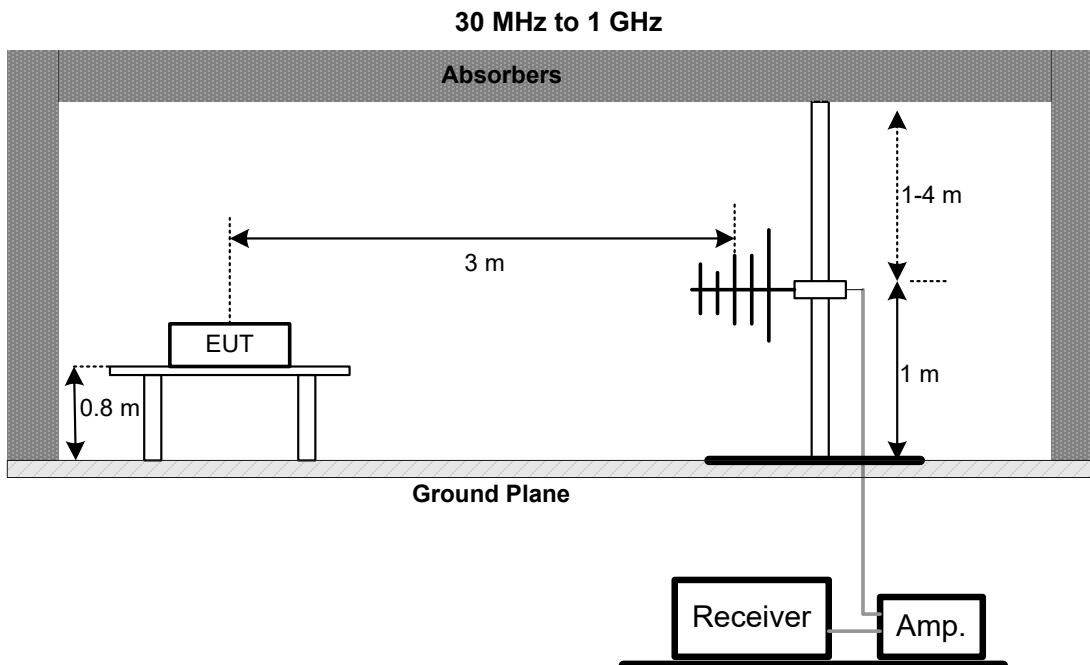
Spectrum Parameter	Setting
Attenuation	Auto
Start Frequency	1000 MHz
Stop Frequency	10th carrier harmonic
RBW / VBW (Emission in restricted band)	1MHz / 3MHz for Peak, 1MHz / 1/T for Average

Spectrum Parameter	Setting
Attenuation	Auto
Start ~ Stop Frequency	9KHz~90KHz for PK/AVG detector
Start ~ Stop Frequency	90KHz~110KHz for QP detector
Start ~ Stop Frequency	110KHz~490KHz for PK/AVG detector
Start ~ Stop Frequency	490KHz~30MHz for QP detector
Start ~ Stop Frequency	30MHz~1000MHz for QP detector

4.2 TEST PROCEDURE

- The measuring distance of 3 m shall be used for measurements. The EUT was placed on the top of a rotating table 0.8 meter above the ground at a 3 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.(below 1GHz).
- The height of the equipment or of the substitution antenna shall be 0.8 m or 1.5 m, the height of the test antenna shall vary between 1 m to 4 m. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights find the maximum reading (used Bore sight function).
- The initial step in collecting radiated emission data is a receiver peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured.
- All readings are Peak unless otherwise stated QP in column of Note. Peak denotes that the Peak reading compliance with the QP Limits and then QP Mode measurement didn't perform. (below 1GHz)
- For the actual test configuration, please refer to the related Item – EUT TEST PHOTO.

4.3 TEST SETUP



4.4 EUT OPERATION CONDITIONS

The EUT was programmed to be in continuously transmitting mode.

4.5 TEST RESULTS - 30 MHZ TO 1000 MHZ

Please refer to the APPENDIX B.

5. MEASUREMENT INSTRUMENTS LIST

AC Power Line Conducted Emissions						
Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated Date	Calibrated Until
1	TWO-LINE V-NETWORK	R&S	ENV216	101051	2023/7/15	2024/7/20
2	Test Cable	EMCI	EMCRG58-BM-B M-9000	210501	2022/12/15	2023/12/14
3	MXE EMI Receiver	Agilent	N9038A	MY54130009	2023/06/26	2024/06/25
4	Measurement Software	EZ	EZ EMC (Version NB-03A1-01)	N/A	N/A	N/A

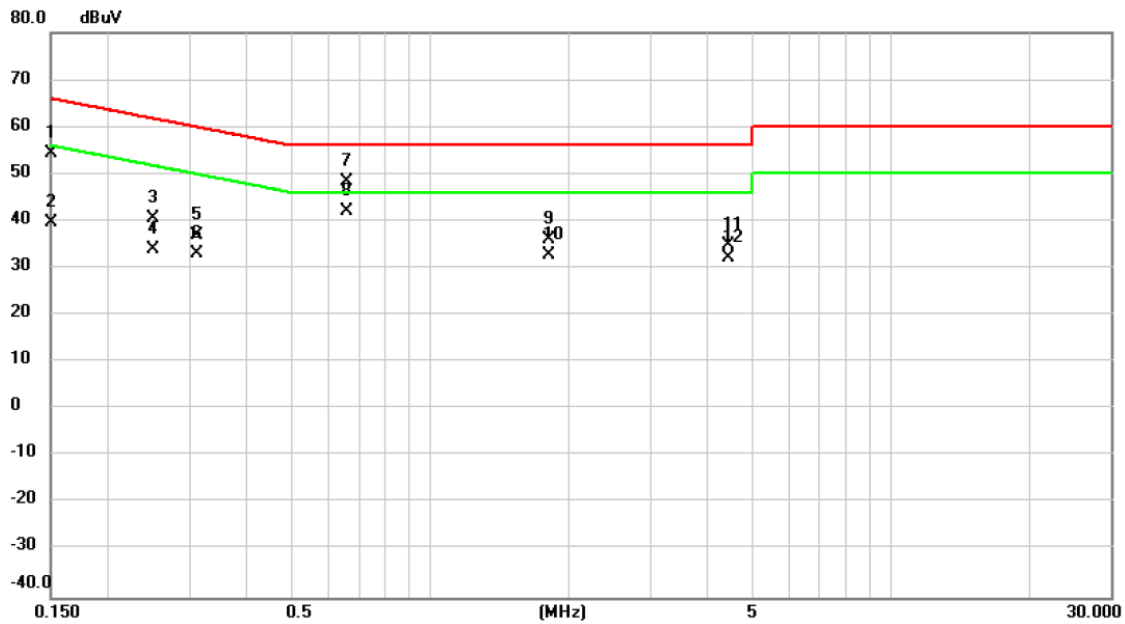
Radiated Emissions						
Item	Kind of Equipment	Manufacturer	Type No.	Serial No.	Calibrated Date	Calibrated Until
1	Preamplifier	EMCI	EMC051845SE	980779	2022/12/19	2023/12/18
2	Preamplifier	EMCI	EMC184045SE	980512	2022/12/02	2023/12/01
3	Preamplifier	EMCI	EMC001340	980555	2022/12/05	2023/12/04
4	Test Cable	EMCI	EMCCFD400-NM -NM-8000	200343	2023/11/14	2024/11/13
5	Test Cable	EMCI	EMC105-SM-SM-3000	210118	2022/12/08	2023/12/07
6	Test Cable	EMCI	EMC105-SM-SM-7000	210117	2023/11/14	2024/11/13
7	Test Cable	EMCI	EMCCFD400-NM -NM-3300	200348	2023/11/14	2024/11/13
8	EXA Signal Analyzer	keysight	N9010A	MY56480554	2023/9/12	2024/9/11
9	Loop Ant	Electro-Metrics	EMCI-LPA600	274	2023/06/28	2024/06/27
10	Log-bicon Antenna	Schwarzbeck	VULB9168	9168-1207	2023/01/13	2024/01/12
11	6dB Attenuator	EMCI	EMCI-N-6-06	AT-N0690	2023/01/13	2024/01/12
12	Measurement Software	EZ	EZ EMC (Version NB-03A1-01)	N/A	N/A	N/A

Remark: "N/A" denotes no model name, serial no. or calibration specified.

All calibration period of equipment list is one year.

APPENDIX A - AC POWER LINE CONDUCTED EMISSIONS

Test Mode	Normal	Tested Date	2023/11/16
Test Frequency	-	Phase	Line

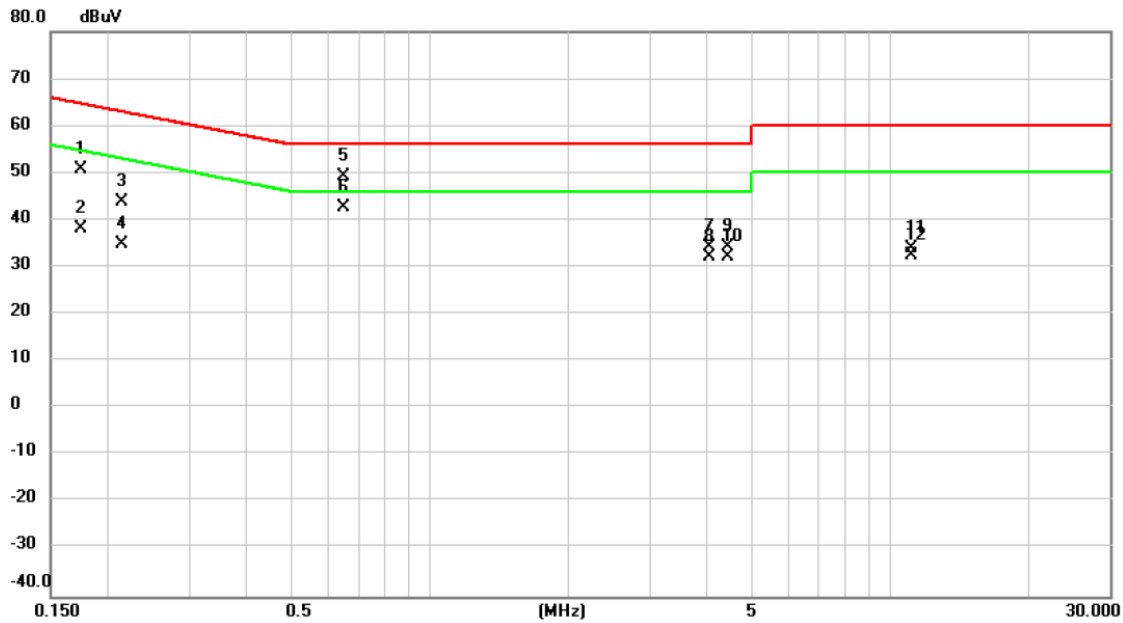


No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Margin		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1500	44.82	9.67	54.49	66.00	-11.51	QP	
2		0.1500	29.96	9.67	39.63	56.00	-16.37	AVG	
3		0.2511	30.82	9.66	40.48	61.72	-21.24	QP	
4		0.2511	24.15	9.66	33.81	51.72	-17.91	AVG	
5		0.3120	27.24	9.65	36.89	59.92	-23.03	QP	
6		0.3120	23.31	9.65	32.96	49.92	-16.96	AVG	
7		0.6575	38.59	9.70	48.29	56.00	-7.71	QP	
8	*	0.6575	32.45	9.70	42.15	46.00	-3.85	AVG	
9		1.8095	26.28	9.77	36.05	56.00	-19.95	QP	
10		1.8095	22.90	9.77	32.67	46.00	-13.33	AVG	
11		4.4240	24.88	9.88	34.76	56.00	-21.24	QP	
12		4.4240	22.38	9.88	32.26	46.00	-13.74	AVG	

REMARKS:

- (1) Measurement Value = Reading Level + Correct Factor.
- (2) Margin Level = Measurement Value - Limit Value.

Test Mode	Normal	Tested Date	2023/11/16
Test Frequency	-	Phase	Neutral



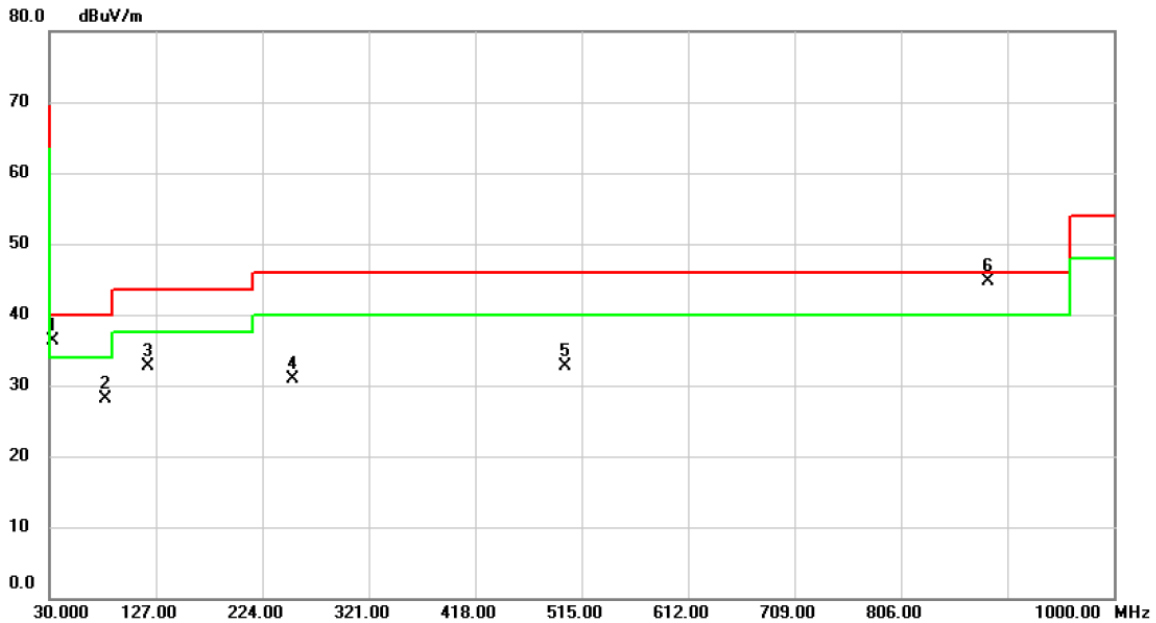
No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Margin		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1741	40.96	9.67	50.63	64.76	-14.13	QP	
2		0.1741	28.52	9.67	38.19	54.76	-16.57	AVG	
3		0.2147	34.34	9.66	44.00	63.02	-19.02	QP	
4		0.2147	25.22	9.66	34.88	53.02	-18.14	AVG	
5		0.6485	39.59	9.70	49.29	56.00	-6.71	QP	
6	*	0.6485	33.03	9.70	42.73	46.00	-3.27	AVG	
7		4.0595	24.25	9.88	34.13	56.00	-21.87	QP	
8		4.0595	22.25	9.88	32.13	46.00	-13.87	AVG	
9		4.4375	24.26	9.88	34.14	56.00	-21.86	QP	
10		4.4375	22.24	9.88	32.12	46.00	-13.88	AVG	
11		11.1250	23.83	10.11	33.94	60.00	-26.06	QP	
12		11.1250	22.24	10.11	32.35	50.00	-17.65	AVG	

REMARKS:

- (1) Measurement Value = Reading Level + Correct Factor.
 (2) Margin Level = Measurement Value - Limit Value.

APPENDIX B - RADIATED EMISSION - 30 MHZ TO 1000 MHZ

Test Mode	IEEE 802.11b	Test Date	2023/11/15
Test Frequency	2412MHz	Polarization	Vertical
Temp	25°C	Hum.	60%

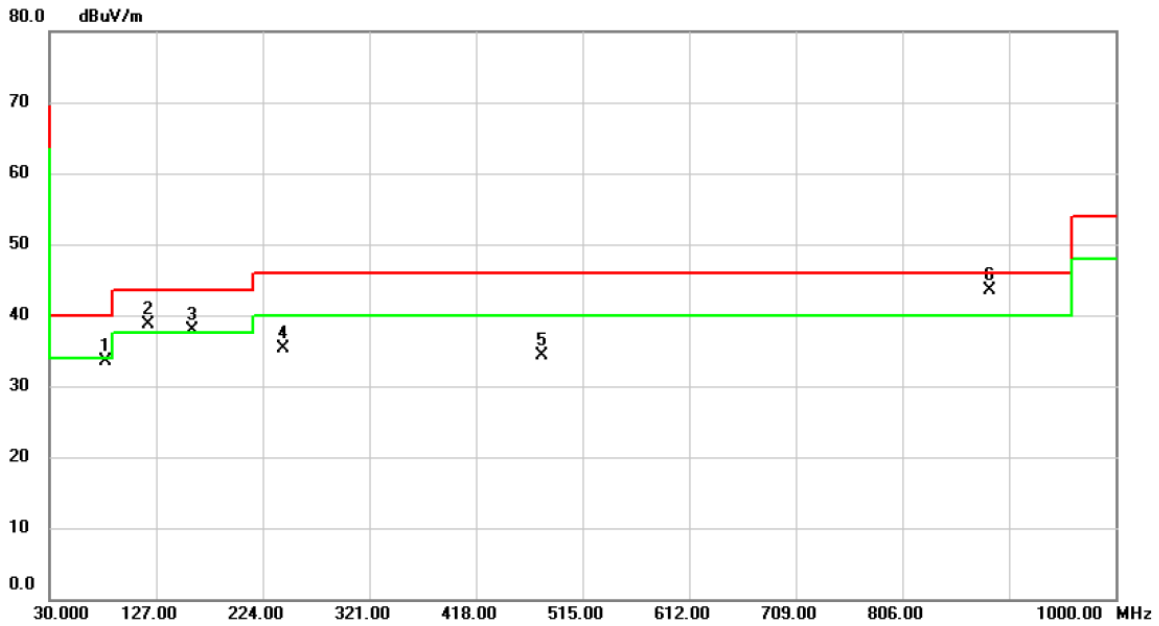


No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dBuV/m	Margin dB	Detector	Antenna Height cm	Table Degree degree	Comment
1		32.9100	49.75	-13.42	36.33	40.00	-3.67	peak	100	43	
2		80.4400	44.45	-16.33	28.12	40.00	-11.88	peak	200	245	
3		120.2100	46.63	-14.02	32.61	43.50	-10.89	peak	100	102	
4		251.1600	42.92	-11.97	30.95	46.00	-15.05	peak	100	237	
5		499.4800	38.10	-5.34	32.76	46.00	-13.24	peak	100	167	
6	*	885.5400	43.42	1.35	44.77	46.00	-1.23	peak	100	163	

REMARKS:

- (1) Measurement Value = Reading Level + Correct Factor.
- (2) Margin Level = Measurement Value - Limit Value.

Test Mode	IEEE 802.11b	Test Date	2023/11/15
Test Frequency	2412MHz	Polarization	Horizontal
Temp	25°C	Hum.	60%



No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dBuV/m	Margin dB	Detector	Antenna Height cm	Table Degree	Comment
1		80.4400	49.93	-16.33	33.60	40.00	-6.40	peak	200	198	
2		120.2100	52.65	-14.02	38.63	43.50	-4.87	peak	200	198	
3		159.9800	49.25	-11.30	37.95	43.50	-5.55	peak	200	175	
4		242.4300	47.59	-12.22	35.37	46.00	-10.63	peak	100	251	
5		478.1400	40.01	-5.72	34.29	46.00	-11.71	peak	100	265	
6	*	885.5400	42.09	1.35	43.44	46.00	-2.56	peak	200	95	

REMARKS:

- (1) Measurement Value = Reading Level + Correct Factor.
- (2) Margin Level = Measurement Value - Limit Value.

End of Test Report