FCC PART 15.247

TEST REPORT

For

Altenergy Power System Inc.

Building 2, No. 522, Yatai Road, Jiaxing, China 314050

FCC ID: 2AFGR-ECUR2

Report Type:	**Product Name:**
Original Report	Energy Communication Unit

Report Number:	RSHA240325001-00C
Report Date:	2024-05-10
Reviewed By:	Jenny Yang
Approved By:	Kyle Xu
Prepared By:	Bay Area Compliance Laboratories Corp. (Kunshan) No.248, Chenghu Road, Development Zone, Yushan, Kunshan, Suzhou, Jiangsu, China Tel: +86-512-86175000 Fax: +86-512-88934268 www.baclcorp.com.cn

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REPORT REVISION HISTORY

Number of Revisions	Report No.	Version	Issue Date	Description
0	RSHA240325001-00C	R1V1	2024-05-10	Initial Release

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Applicant:	Altenergy Power System Inc.
Tested Model:	ECU-R
Series Model:	ECU-B
Product Name:	Energy Communication Unit
Power Supply:	DC 5V
Maximum peak Output Power:	6.43dBm
RF Function:	Zigbee
Operating Band/Frequency:	2405~2480MHz
Channel Number:	16
Channel Separation:	5MHz
Modulation Type	OQPSK
Antenna Type:	Omni Antenna
★Maximum Antenna Gain:	2.47 dBi

Note:
1. The antenna gain was provided by the applicant.
2. Model difference: ECU-R, ECU-B have the only difference on model name.

All measurement and test data in this report was gathered from production sample serial number: RSHA240325001-1 (Assigned by the BACL (Kuanshan). The EUT supplied by the applicant was received on 2024-03-25.)

Objective

This report is prepared for *Altenergy Power System Inc.* in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commission's rules.

The tests were performed in order to determine Compliant with FCC Part 15, Subpart C, and section 15.203, 15.205, 15.207, 15.209 and 15.247 rules.

Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliant Testing of Unlicensed Wireless Devices and FCC 558074 D01 15.247 Meas Guidance v05r02.

Measurement Uncertainty

Item		Uncertainty
AC Power Lines Conducted Emissions		3.19 dB
RF conducted test with spectrum		0.9dB
RF Output Power with Power meter		0.5dB
Radiated emission	9 kHz~150 kHz	3.8dB
	150 kHz~30 MHz	3.4dB
	30MHz~1GHz	6.11dB
	1GHz~6GHz	4.45dB
	6GHz~18GHz	5.23dB
	18GHz~40GHz	5.65dB
Occupied Bandwidth		0.5kHz
Temperature		1.0℃
Humidity		6%

Test Facility

The Test site used by Bay Area Compliant Laboratories Corp. (Kunshan) to collect test data is located on the No.248, Chenghu Road, Development Zone, Yushan, Kunshan, Suzhou, Jiangsu, China.

Bay Area Compliance Laboratories Corp. (Kunshan) is accredited in accordance with ISO/IEC 17025:2017 by NVLAP (Lab code: 600338-0), and the lab has been recognized as the FCC accredited lab under the KDB 974614 D01, the FCC Designation No.: CN5055.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

Channel	Frequency (MHz)	Channel	Frequency (MHz)
11	2405	21	2455
12	2410	22	2460
13	2415	23	2465
14	2420	24	2470
15	2425	25	2475
16	2430	26	2480
17	2435	/	/
18	2440	/	/
19	2445	/	/
20	2450	/	/

EUT was tested with Channel 11, 18 and 26.

Equipment Modifications

No modification was made to the EUT tested.

EUT Exercise Software

RF test tool: Smart Studio 7

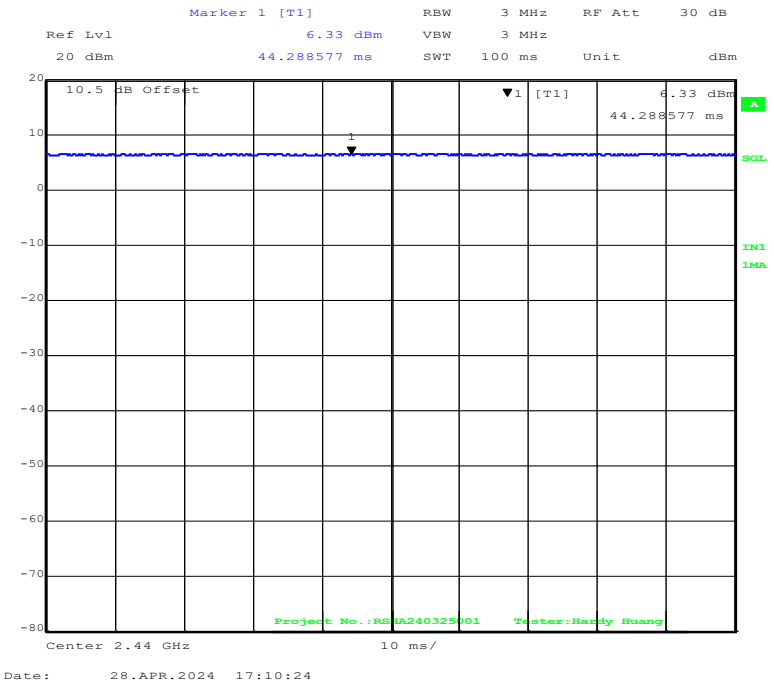
Pre-scan with all the data rates, and the worst case was performed as below:

Channel	Frequency(MHz)	★Power Level
Low	2405	Default
Middle	2440	Default
High	2480	Default

Note: The power level setting was declared by the applicant.

Duty Cycle:

Middle Channel: 2440MHz



Mode	Duty Cycle(%)	Ton(ms)	Ton+off(ms)	10log(1/x)
Zigbee	100	100	100	0

Note: “x” means the Duty Cycle.

Support Equipment List and Details

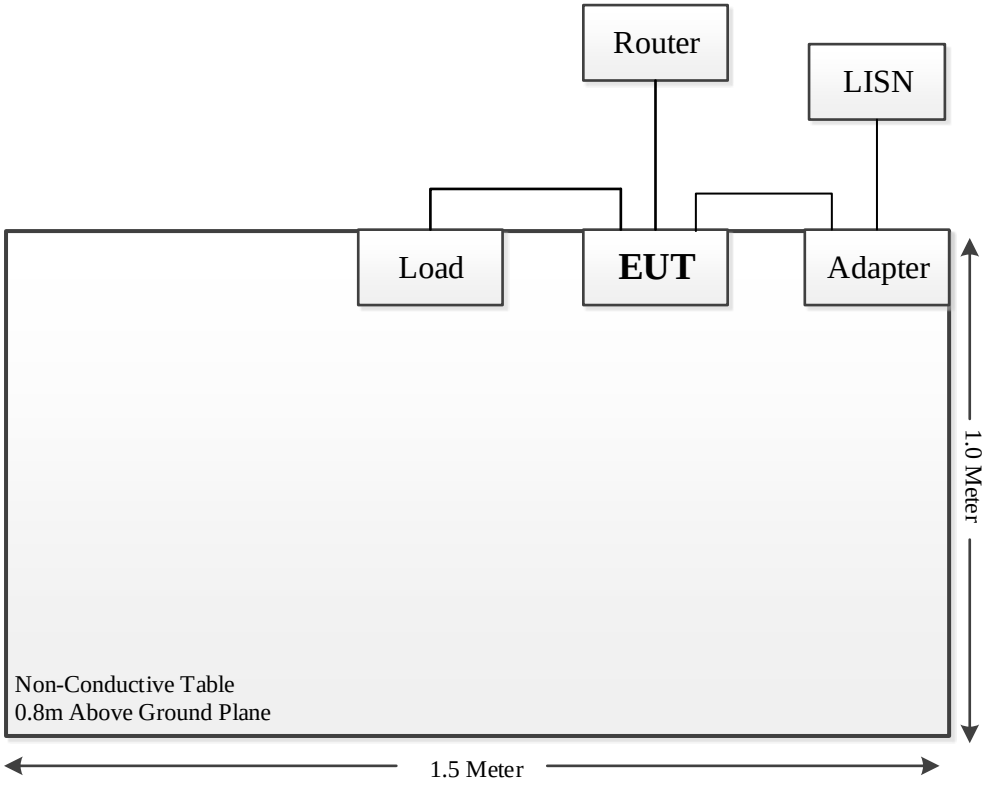
Manufacturer	Description	Model	Serial Number
/	Load	/	/
TP-LINK	Router	TL-XDR3010	12373X0002080
SIMSUKIRN	Adapter	SK02T-0500200U	22090601001172

External I/O Cable

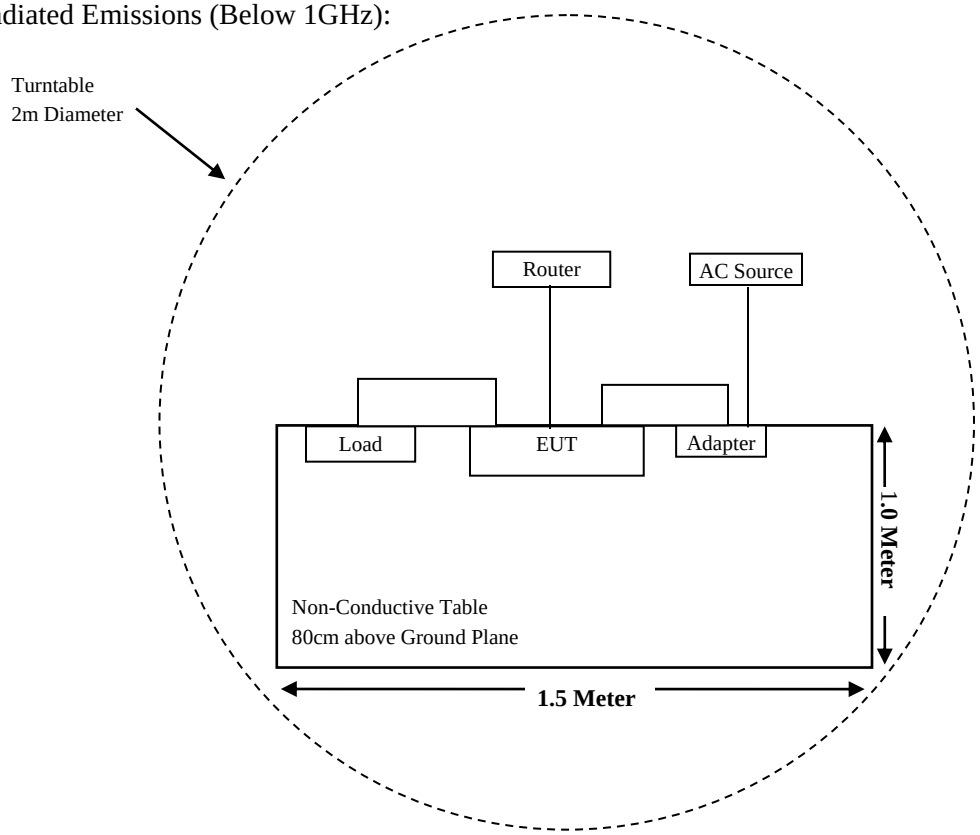
Cable Description	Length (m)	From Port	To Port
Power Cable 1	1.5	AC Source	Adapter
Power Cable 2	1.5	Adapter	EUT
RJ45 Cable	8.0	Router	EUT
USB Cable	0.2	EUT	Load

Block Diagram of Test Setup

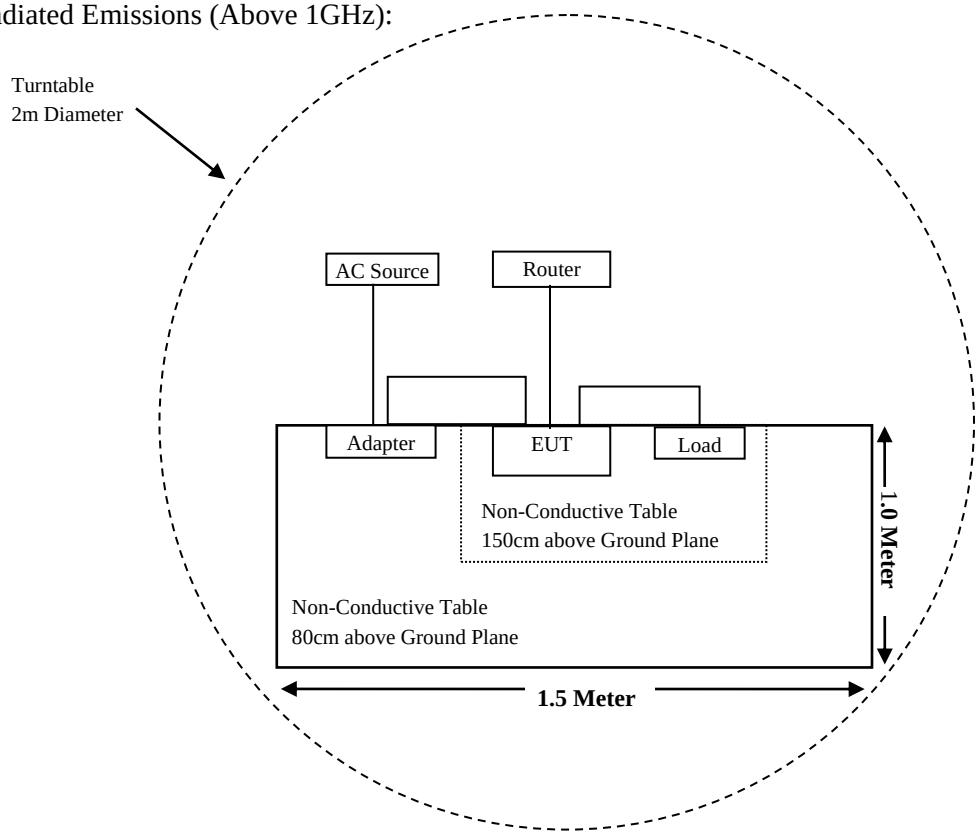
For Conducted Emissions:



For Radiated Emissions (Below 1GHz):



For Radiated Emissions (Above 1GHz):



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§1.1310 & §2.1091	Maximum Permissible Exposure (MPE)	Compliant
§15.203	Antenna Requirement	Compliant
§15.207 (a)	AC Line Conducted Emissions	Compliant
§15.205, §15.209, §15.247(d)	Spurious Emissions	Compliant
§15.247 (a)(2)	6 dB Emission Bandwidth	Compliant
§15.247(b)(3)	Maximum Conducted Output Power	Compliant
§15.247(d)	Band Edge	Compliant
§15.247(e)	Power Spectral Density	Compliant

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiated Emission Test (Chamber 1#)					
Rohde & Schwarz	EMI Test Receiver	ESCI	100195	2023-05-23	2024-05-22
Sunol Sciences	Hybrid Antenna	JB3	A090314-1	2023-11-11	2024-11-10
ETS-LINDGREN	Loop Antenna	6512	108100	2023-11-09	2024-11-08
Narda	6dB Attenuator	773-6	10690812-2-1	2023-11-11	2024-11-10
Sonoma Instrument	Amplifier	310N	171205	2023-05-23	2024-05-22
MICRO-COAX	Coaxial Cable	Cable-8	008	2023-05-23	2024-05-22
MICRO-COAX	Coaxial Cable	Cable-9	009	2023-05-23	2024-05-22
MICRO-COAX	Coaxial Cable	Cable-10	010	2023-05-23	2024-05-22
Rohde & Schwarz	Test Software	EMC32	100361	N/A	N/A
Radiated Emission Test (Chamber 2#)					
Rohde & Schwarz	EMI Test Receiver	ESU40	100207	2023-05-19	2024-05-18
ETS-LINDGREN	Horn Antenna	3115	9207-3900	2023-06-27	2024-06-26
ETS-LINDGREN	Horn Antenna	3116	2516	2023-12-08	2024-12-07
A.H.Systems, inc	Amplifier	PAM-0118P（2641-1）	512	2023-05-23	2024-05-22
EM Electronics Corporation	Amplifier	EM18G40G	060726	2023-05-23	2024-05-22
MICRO-TRONICS	Band Reject Filter	BRM50702	G024	2023-05-23	2024-05-22
Narda	Attenuator	20dB	020	2023-05-23	2024-05-22
Rohde & Schwarz	Auto Test Software	EMC32	100361	N/A	N/A
MICRO-COAX	Coaxial Cable	Cable-6	006	2023-05-23	2024-05-22
MICRO-COAX	Coaxial Cable	Cable-11	011	2023-05-23	2024-05-22
MICRO-COAX	Coaxial Cable	Cable-12	012	2023-05-23	2024-05-22
MICRO-COAX	Coaxial Cable	Cable-13	013	2023-05-23	2024-05-22
RF Conducted Test					
Rohde & schwarz	EMI Test Receiver	ESIB26	100146	2023-05-23	2024-05-22
Narda	Attenuator	10dB	010	2023-05-23	2024-05-22
XHFDZ	RG316 Coaxial Cable	SMA-316	XHF-1175	Each time	N/A

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Conducted Emission Test					
Rohde & Schwarz	EMI Test Receiver	ESR	101746	2023-05-23	2024-05-22
Rohde & Schwarz	LISN	ENV216	101115	2023-05-23	2024-05-22
Audix	Test Software	e3	V9	N/A	N/A
Rohde & Schwarz	Pulse Limiter	ESH3-Z2	0357.8810.54	2023-05-23	2024-05-22
MICRO-COAX	Coaxial Cable	Cable-15	015	2023-05-23	2024-05-22

Statement of Traceability: Bay Area Compliant Laboratories Corp. (Kunshan) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

FCC §1.1310& §2.1091 – AXIMUM PERMISSIBLE EXPOSURE (MPE)

Standard

According to subpart §2.1091 and subpart §1.1310, systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

Limits for Maximum Permissible Exposure (MPE) (§1.1310, §2.1091)

(B) Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	**Electric Field Strength (V/m)**	**Magnetic Field Strength (A/m)**	**Power Density (mW/cm^2)**	**Averaging Time (minutes)**
0.3-1.34	614	1.63	*(100)	30
1.34-30	824/f	2.19/f	*($180/f^2$)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/1500	30
1500-100,000	/	/	1.0	30

f = frequency in MHz; * = Plane-wave equivalent power density;

According to §1.1310 and §2.1091 RF exposure is calculated.

Calculated Formulary:

Predication of MPE limit at a given distance
$S = PG/4\pi R^2$ = power density (in appropriate units, e.g. mW/cm^2);
P = power input to the antenna (in appropriate units, e.g., mW);
G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain;
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm);

For simultaneously transmit system, the calculated power density should comply with:

$$\sum_i \frac{S_i}{S_{Limit,i}} \leq 1$$

Calculation data

Mode	Frequency Range (MHz)	Antenna Gain		Tune-up Output Power		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)	MPE Ratio
		(dBi)	(numeric)	(dBm)	(mW)				
802.11b	2412~2462	2.47	1.77	18.5	70.79	20	0.0249	1.0	0.0249
802.11g		2.47	1.77	18.0	63.10	20	0.0222	1.0	0.0222
802.11n-HT20		2.47	1.77	18.0	63.10	20	0.0222	1.0	0.0222
802.11n-HT40	2422~2452	2.47	1.77	18.0	63.10	20	0.0222	1.0	0.0222
Zigbee	2405~2480	2.47	1.77	7.0	5.01	20	0.0018	1.0	0.0018

Note: For the above tune up power were declared by the manufacturer.

Wi-Fi and Zigbee can transmit simultaneously, The worst condition is 802.11b of Wi-Fi & Zigbee, as below:

$$\sum_i \frac{S_i}{S_{Limit,i}} = 0.0249/1.00+0.0018/1.0=0.0249+0.0018=0.0267 < 1.0$$

Result: The device meet FCC MPE at 20 cm distance.

FCC §15.203 - ANTENNA REQUIREMENT

Applicable Standard

According to § 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. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the user of a standard antenna jack or electrical connector is prohibited. The structure and application of the EUT were analyzed to determine Compliant with section §15.203 of the rules. §15.203 state that the subject device must meet the following criteria:

a. Antenna must be permanently attached to the unit.
b. Antenna must use a unique type of connector to attach to the EUT.
c. Unit must be professionally installed, and installer shall be responsible for verifying that the correct antenna is employed with the unit.

And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Antenna Connector Construction

The EUT has an Omni antenna and the antenna gain is 2.47 dBi, which use a unique type of connector to attach to the EUT. Fulfill the requirement of this section. Please refer to the EUT photos.

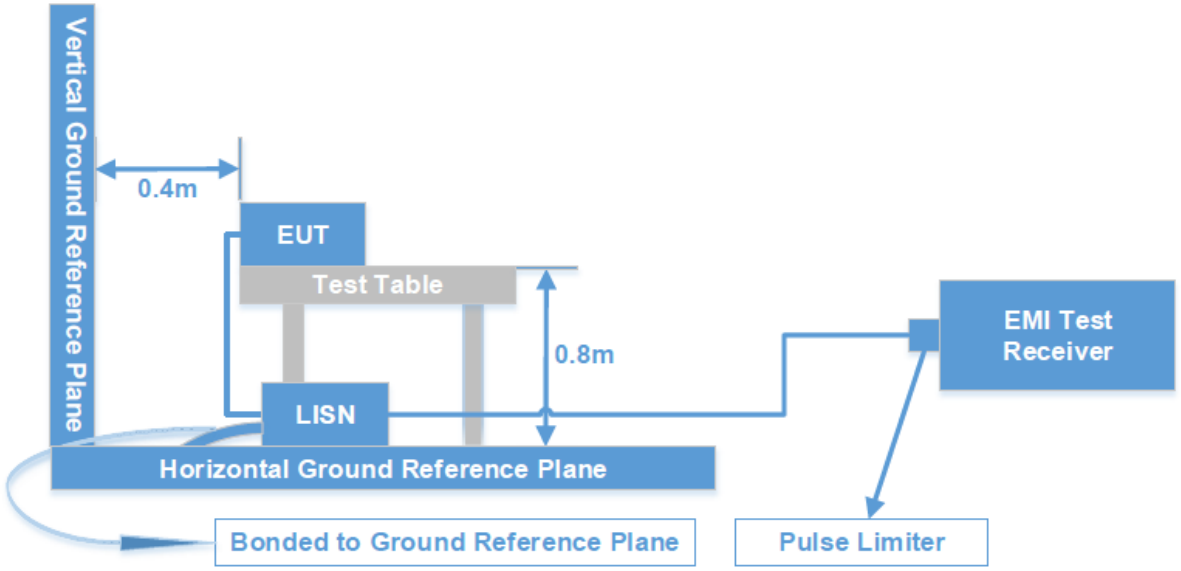
Result: Compliant.

FCC §15.207 (a) - AC LINE CONDUCTED EMISSIONS

Applicable Standard

FCC §15.207(a)

EUT Setup



The measurement procedure of EUT setup is according with ANSI C63.10-2013. The related limit was specified in FCC Part 15.207.

The spacing between the peripherals was 10 cm.

EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz.

During the conducted emission test, the EMI test receiver was set with the following configurations:

Frequency Range	IF B/W
150 kHz – 30 MHz	9 kHz

Test Procedure

ANSI C63.10-2013 clause 6.2

During the conducted emission test, the adapter was connected to the outlet of the LISN.

Maximizing procedure was performed on the six (6) highest emissions of the EUT.
If the maximum peak value of the emissions is below the average limit, the QP value and average value measurement will not need to be performed and only record the maximum peak measured value to meet the requirements.

Factor & Over Limit Calculation

The Factor is calculated by adding LISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

Factor (dB) = LISN VDF (dB) + Cable Loss (dB) + Transient Limiter Attenuation (dB)

The "**Over Limit**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, an Over Limit of 7 dB means the emission is 7 dB above the limit. The equation for Over Limit calculation is as follows:

Over Limit (dB) = Read level (dBμV) + Factor (dB) - Limit (dBμV)

Test Results Summary

According to the recorded data in following table, the EUT complied with the FCC Part 15.207.

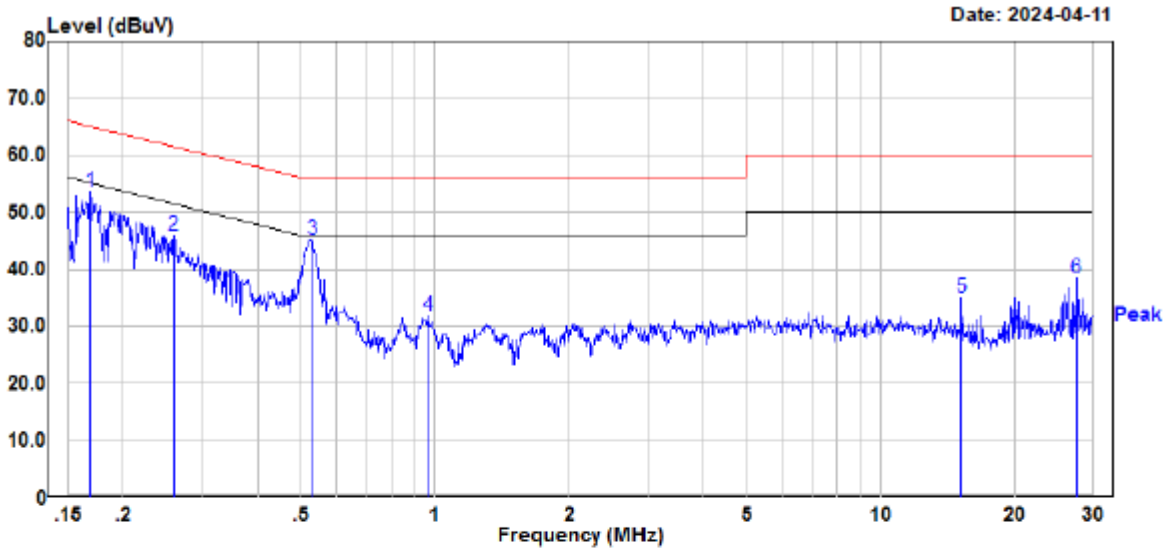
Test Data

Environmental Conditions & Test Information

Temperature:	19.6 ℃
Relative Humidity:	62 %
ATM Pressure:	101.8 kPa
Test Date:	2024-04-11
Test Engineer:	Frank Liu

EUT operation mode: Transmitting in maximum output power mode Low channel

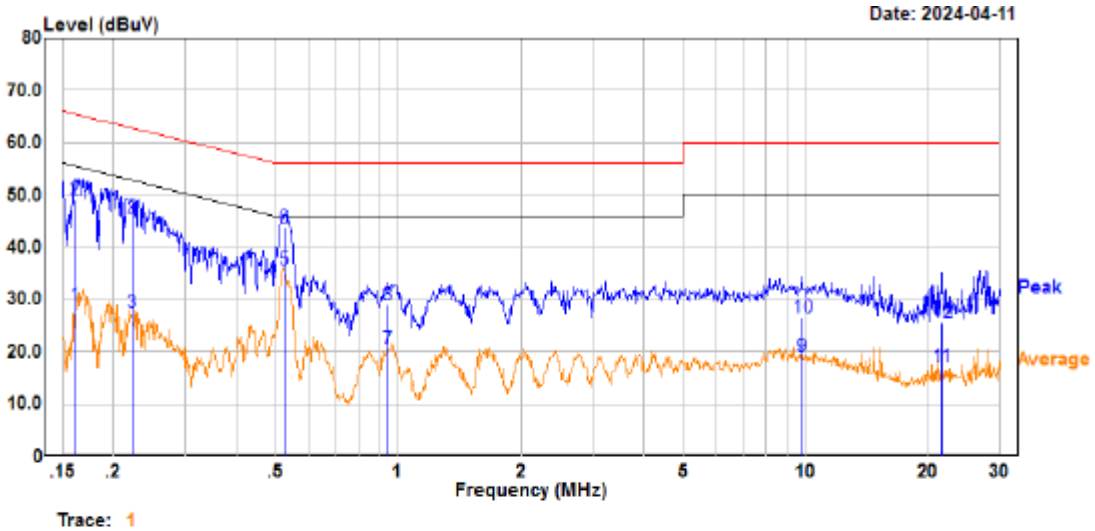
AC 120V/60 Hz, Line




```
Site                : CE
Condition           : limit\FCC PART 15C
                    : DET:Peak
Project             : RSHA240325001
Model               : ECU-R
Phase               : L
Voltage             : 120V/60Hz
Mode                : Zigbee
Test Equipment      : ENV216,ESR
Temperature         : 19.6℃
Humidity            : 62%
Atmospheric pressure: 101.8kPa
Test Engineer       : Frank Liu
```

	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dBuV	dBuV	dB	
1	0.168	33.73	20.01	53.74	65.05	-11.31	Peak
2	0.260	25.85	20.04	45.89	61.45	-15.56	Peak
3	0.529	25.36	19.97	45.33	56.00	-10.67	Peak
4	0.963	12.17	19.64	31.81	56.00	-24.19	Peak
5	15.155	15.36	19.63	34.99	60.00	-25.01	Peak
6	27.426	18.42	19.98	38.40	60.00	-21.60	Peak

AC 120V/60 Hz, Neutral




```
Site                  : CE
Condition             : limit\FCC PART 15C
                      : DET:Peak
Project               : RSHA240325001
Model                 : ECU-R
Phase                 : N
Voltage               : 120V/60Hz
Mode                  : Zigbee
Test Equipment        : ENV216,ESR
Temperature           : 19.6℃
Humidity              : 62%
Atmospheric pressure: 101.8kPa
Test Engineer         : Frank Liu
```

	Freq	Read Level	Factor	Level	Limit Line	Over Limit	Remark
	MHz	dBuV	dB	dBuV	dBuV	dB	
1	0.161	8.90	20.00	28.90	55.42	-26.52	Average
2	0.161	29.00	20.00	49.00	65.42	-16.42	QP
3	0.221	7.60	20.04	27.64	52.77	-25.13	Average
4	0.221	24.90	20.04	44.94	62.77	-17.83	QP
5	0.524	15.70	19.97	35.67	46.00	-10.33	Average
6	0.524	23.80	19.97	43.77	56.00	-12.23	QP
7	0.939	1.00	19.66	20.66	46.00	-25.34	Average
8	0.939	9.40	19.66	29.06	56.00	-26.94	QP
9	9.774	-0.70	19.88	19.18	50.00	-30.82	Average
10	9.774	6.60	19.88	26.48	60.00	-33.52	QP
11	21.590	-2.70	19.83	17.13	50.00	-32.87	Average
12	21.590	5.70	19.83	25.53	60.00	-34.47	QP

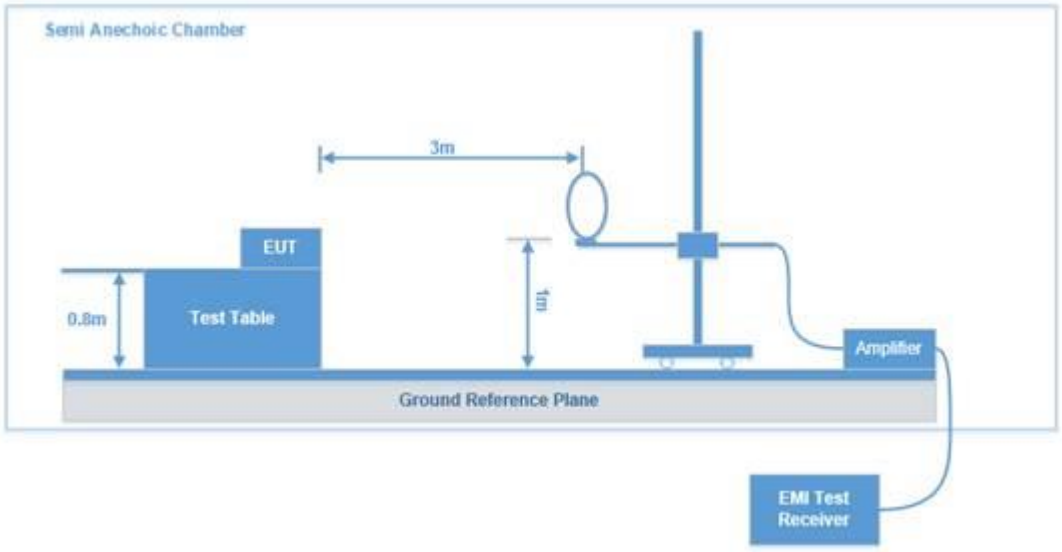
FCC §15.209, §15.205 & §15.247(d) - SPURIOUS EMISSIONS

Applicable Standard

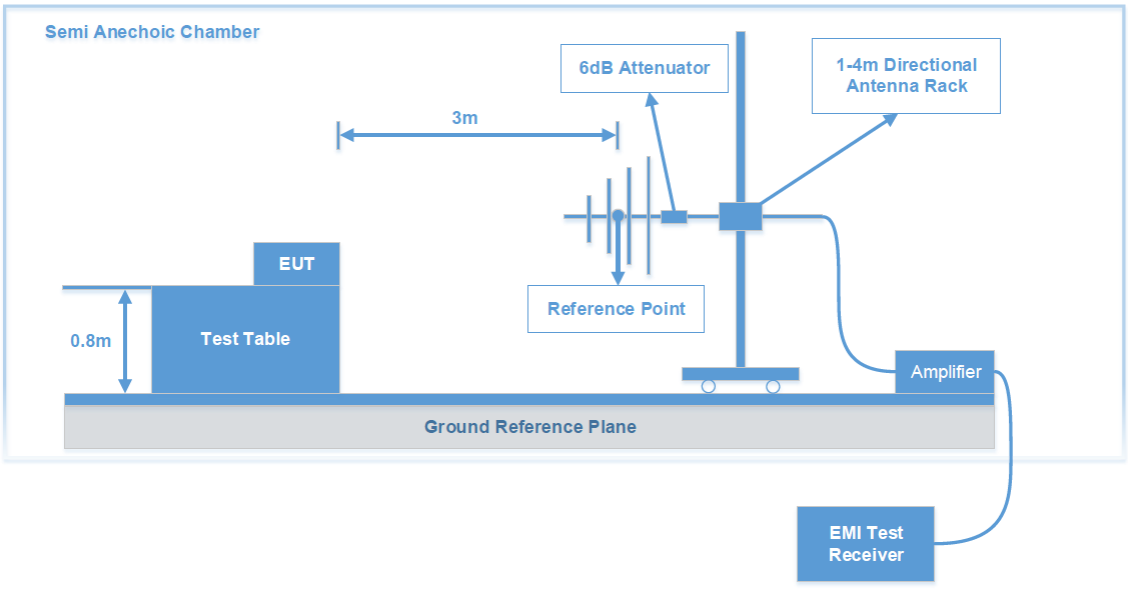
FCC §15.247 (d); §15.209; §15.205;

EUT Setup

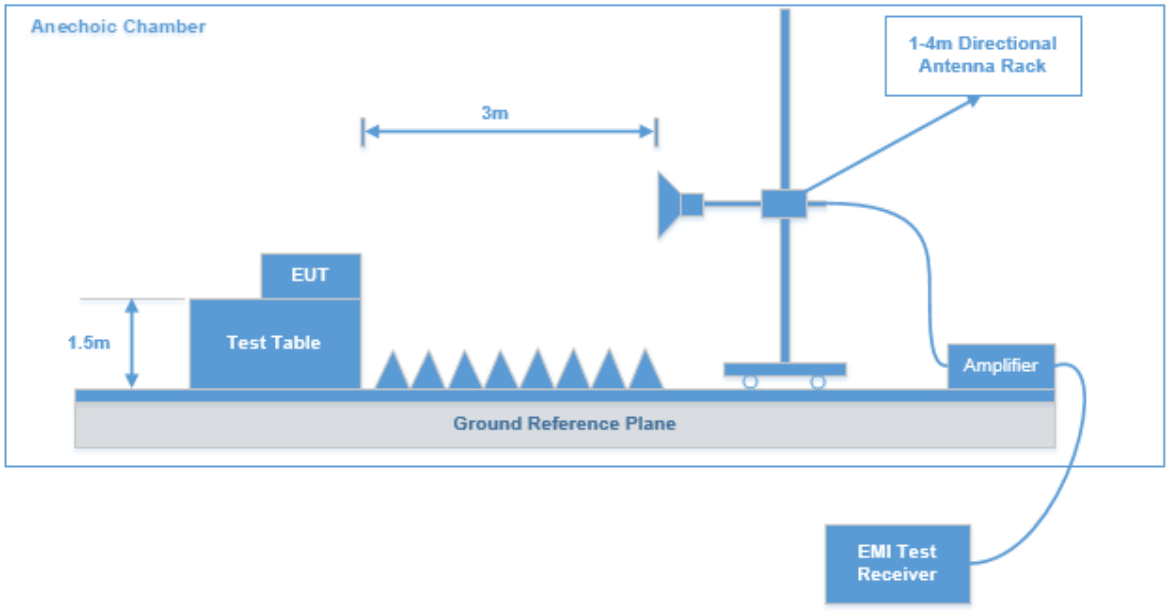
9 kHz - 30 MHz:



30 MHz - 1 GHz:



1 GHz -25 GHz:



The radiated emission tests were performed in the 3 meters test site, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209, and FCC 15.247 limits.

EMI Test Receiver Setup

The system was investigated from 9 kHz to 25 GHz.

During the radiated emission test, the EMI test receiver setup was set with the following configurations:

Frequency Range	RBW	VBW	IF B/W	Detector
9 kHz – 150 kHz	200 Hz	1 kHz	200 Hz	QP/Average
150 kHz – 30 MHz	9 kHz	30 kHz	9 kHz	QP/ Average
30 MHz – 1000 MHz	100 kHz	300 kHz	/	Peak
	/	/	120 kHz	QP
Above 1GHz	1MHz	3 MHz	/	Peak
	1MHz	3 MHz	/	Average

Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

Data was recorded in Quasi-peak detection mode for frequency range of 9 kHz-1 GHz, peak and Average detection mode for frequencies above 1 GHz.

For 9 kHz-30MHz test, the lowest height of the magnetic antenna shall be 1 m above the ground and three antenna orientations (parallel, perpendicular, and ground-parallel) shall be measured.

Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain from the Meter Reading. The basic equation is as follows:

Corrected Amplitude (dBμV/m) = Meter Reading (dBμV) + Antenna Factor (dB/m) + Cable Loss (dB) - Amplifier Gain (dB)

Note: The QuasiPeak (dBμV/m), MaxPeak (dBμV/m), Average (dBμV/m) which shown in the data table are all Corrected Amplitude.

The "**Margin**" column of the following data tables indicates the degree of Compliant with the applicable limit. For example, a margin of 7dB means the emission is 7dB below the limit. The equation for margin calculation is as follows:

Margin (dB) = Limit (dBμV/m) - Corrected Amplitude (dBμV/m)

Test Results Summary

According to the recorded data in following table, the EUT is compliant with the FCC Title 47, Part 15, Subpart C, section 15.205, 15.209 and 15.247.

Test Data

Environmental Conditions & Test Information

Frequency Range:	Below 1 GHz	Above 1 GHz
Temperature:	17.7 ℃	20.0~22.5 ℃
Relative Humidity:	54 %	42~53 %
ATM Pressure:	102.2 kPa	102.0~102.5 kPa
Test Date:	2024-04-10	2024-04-28 to 2024-04-29
Test Engineer:	Leah Li	Peter Wang

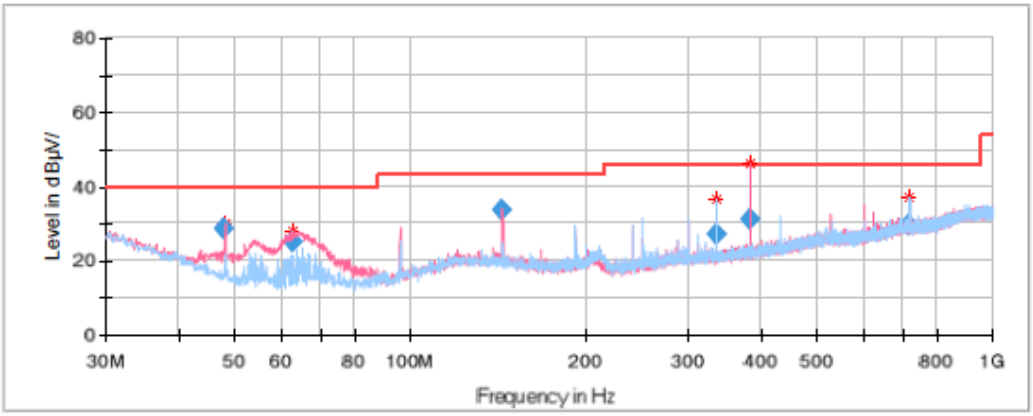
EUT operation mode: Transmitting

After pre-scan in the X, Y and Z axes of orientation, the worst case is below:
***9 kHz-30 MHz**:(Transmitting in maximum output power channel)*
The amplitude of spurious emissions attenuated more than 20 dB below the limit was not be recorded.

30 MHz - 1 GHz:
low channel: 2405MHz

Common Information

Project No:	RSHA240325001
EUT Model:	ECU-R
Test Mode:	Zigbee
Standard:	Part 15.247&Part 15.209&Part 15.205
Test Equipment:	ESCI、JB3、310N
Temperature:	17.7℃
Humidity:	54%
Barometric Pressure:	102.2kPa
Test Engineer:	Leah Li
Test Date:	2024/4/10



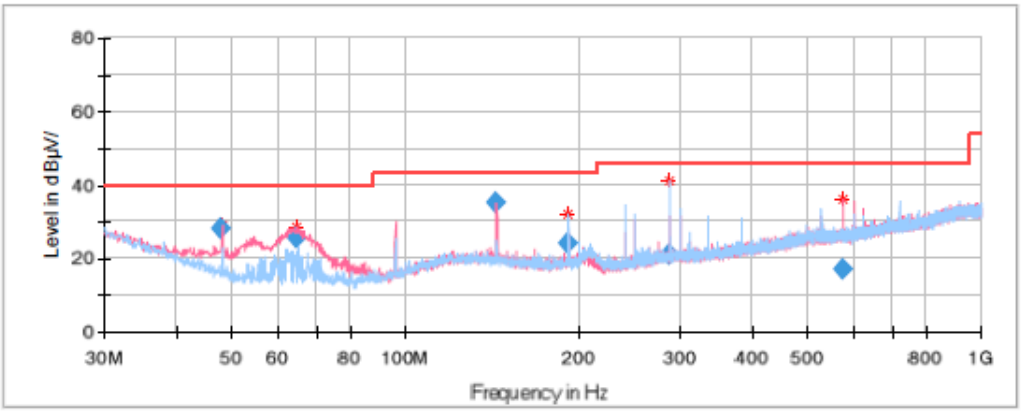
Final_Result

Frequency (MHz)	QuasiPeak (dBµ V/m)	Limit (dBµ V/m)	Margin (dB)	Pol	Corr. (dB/m)
47.940000	28.82	40.00	11.18	V	-15.6
62.610000	25.19	40.00	14.81	V	-17.2
143.970000	33.83	43.50	9.67	V	-11.7
336.030000	27.29	46.00	18.71	H	-10.1
383.920000	31.05	46.00	14.95	V	-9.0
719.910000	29.74	46.00	16.26	H	-2.2

Middle channel: 2440MHz

Common Information

Project No:	RSHA240325001
EUT Model:	ECU-R
Test Mode:	Zigbee
Standard:	Part 15.247&Part 15.209&Part 15.205
Test Equipment:	ESCI、JB3、310N
Temperature:	17.7℃
Humidity:	54%
Barometric Pressure:	102.2kPa
Test Engineer:	Leah Li
Test Date:	2024/4/10



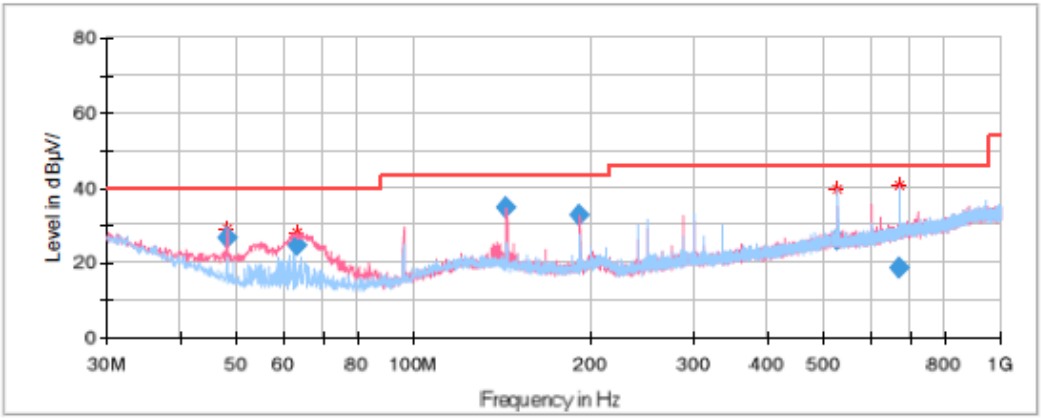
Final_Result

Frequency (MHz)	QuasiPeak (dBµ V/m)	Limit (dBµ V/m)	Margin (dB)	Pol	Corr. (dB/m)
47.940000	28.13	40.00	11.87	V	-15.6
64.430000	25.66	40.00	14.34	V	-17.2
143.970000	34.97	43.50	8.53	V	-11.7
191.990000	24.33	43.50	19.17	H	-12.8
288.020000	20.93	46.00	25.07	H	-11.0
575.980000	17.13	46.00	28.87	V	-5.0

High channel: 2480MHz

Common Information

Project No:	RSHA240325001
EUT Model:	ECU-R
Test Mode:	Zigbee
Standard:	Part 15.247&Part 15.209&Part 15.205
Test Equipment:	ESCI、JB3、310N
Temperature:	17.7℃
Humidity:	54%
Barometric Pressure:	102.2kPa
Test Engineer:	Leah Li
Test Date:	2024/4/10



Final_Result

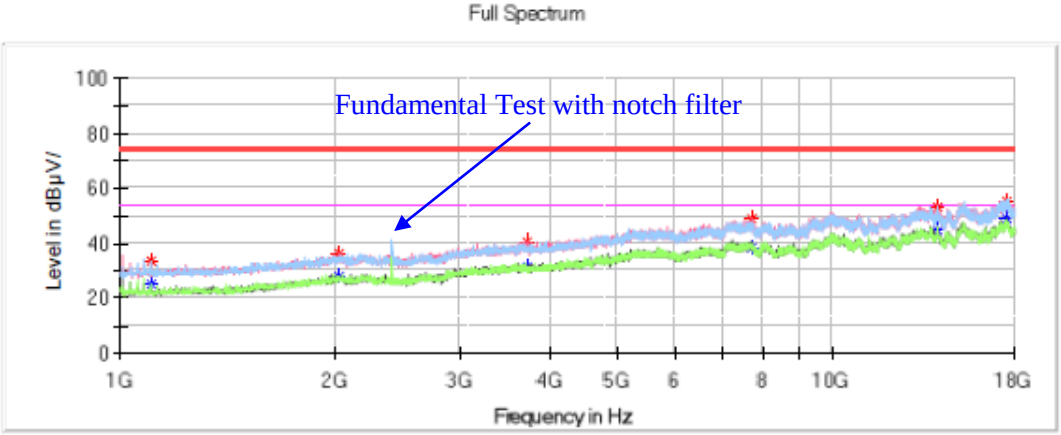
Frequency (MHz)	QuasiPeak (dBµ V/m)	Limit (dBµ V/m)	Margin (dB)	Pol	Corr. (dB/m)
48.060000	26.83	40.00	13.17	V	-15.6
63.460000	24.66	40.00	15.34	V	-17.2
143.970000	34.72	43.50	8.78	V	-11.7
191.990000	32.55	43.50	10.95	V	-12.8
527.850000	26.19	46.00	19.81	H	-5.5
672.010000	18.66	46.00	27.34	V	-3.1

1 GHz - 18 GHz:

Low Channel: 2405 MHz

Common Information

Project No.:	RSHA240325001
Test Mode:	ZigBee
Standard:	Part 15.247&Part 15.209&Part 15.205
Test Engineer:	Peter Wang



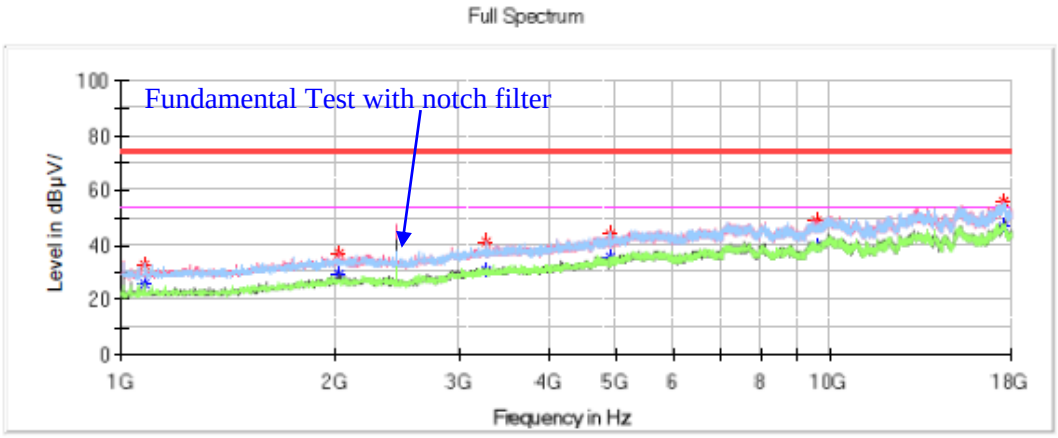
Critical_Freqs

Frequency (MHz)	MaxPeak (dB µ V/m)	Average (dB µ V/m)	Limit (dB µ V/m)	Margin (dB)	Pol	Corr. (dB/m)
1102.000000	33.84	---	74.00	40.16	H	-15.2
1102.000000	---	25.14	54.00	28.86	H	-15.2
2026.800000	36.62	---	74.00	37.38	H	-10.5
2026.800000	---	27.74	54.00	26.26	H	-10.5
3713.200000	40.29	---	74.00	33.71	V	-5.7
3713.200000	---	31.35	54.00	22.65	V	-5.7
7713.300000	49.00	---	74.00	25.00	V	4.0
7713.300000	---	38.74	54.00	15.26	V	4.0
14001.600000	---	44.58	54.00	9.42	H	10.5
14001.600000	52.88	---	74.00	21.12	H	10.5
17541.000000	55.42	---	74.00	18.58	H	13.4
17541.000000	---	48.65	54.00	5.35	H	13.4

Middle Channel: 2440 MHz

Common Information

Project No.:	RSHA240325001
Test Mode:	ZigBee
Standard:	Part 15.247&Part 15.209&Part 15.205
Test Engineer:	Peter Wang



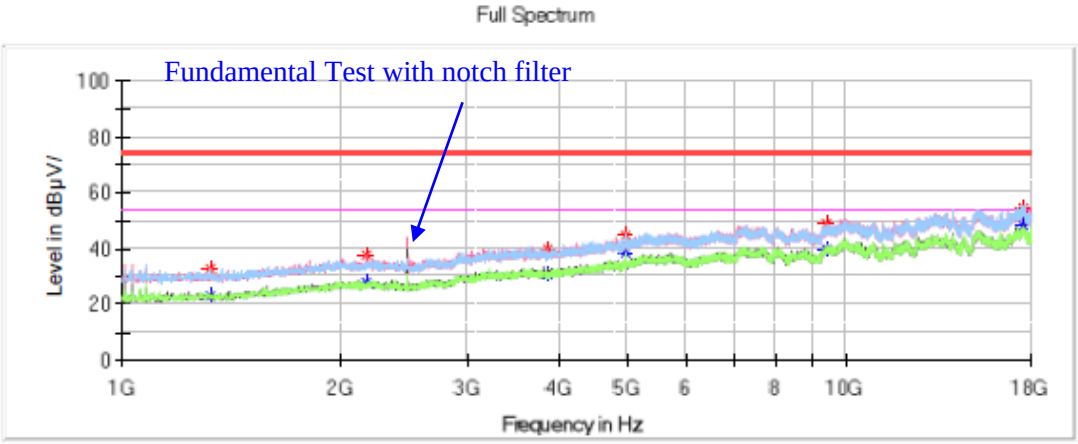
Critical_Freqs

Frequency (MHz)	MaxPeak (dB µ V/m)	Average (dB µ V/m)	Limit (dB µ V/m)	Margin (dB)	Pol	Corr. (dB/m)
1078.200000	32.64	---	74.00	41.36	V	-15.3
1078.200000	---	26.03	54.00	27.97	V	-15.3
2031.900000	36.75	---	74.00	37.25	V	-10.5
2031.900000	---	29.19	54.00	24.81	V	-10.5
3279.700000	---	30.62	54.00	23.38	H	-7.0
3279.700000	40.95	---	74.00	33.05	H	-7.0
4881.100000	44.39	---	74.00	29.61	V	-1.8
4881.100000	---	35.76	54.00	18.24	V	-1.8
9547.600000	---	39.86	54.00	14.14	V	6.4
9547.600000	48.71	---	74.00	25.29	V	6.4
17549.500000	---	46.54	54.00	7.46	H	13.4
17549.500000	55.84	---	74.00	18.16	H	13.4

High Channel: 2480 MHz

Common Information

Project No.:	RSHA240325001
Test Mode:	ZigBee
Standard:	Part 15.247&Part 15.209&Part 15.205
Test Engineer:	Peter Wang



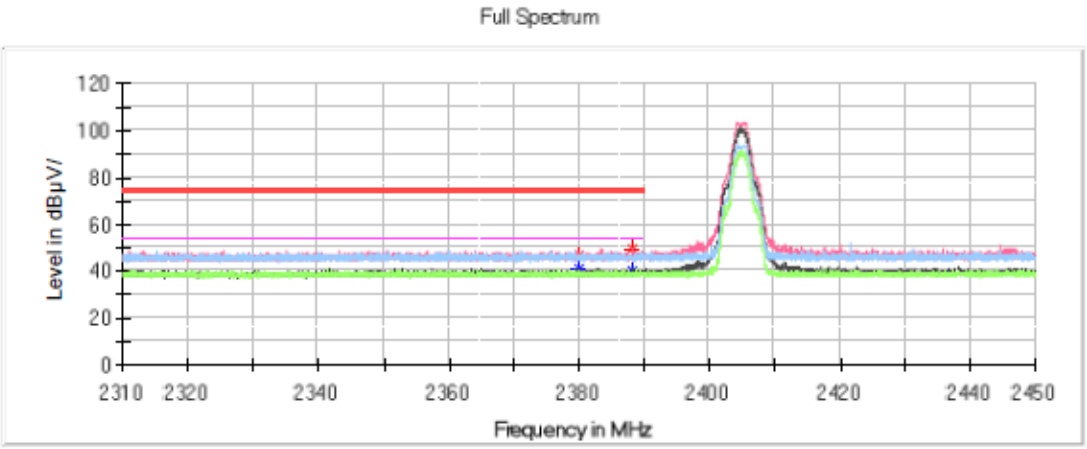
Critical_Freqs

Frequency (MHz)	MaxPeak (dB µ V/m)	Average (dB µ V/m)	Limit (dB µ V/m)	Margin (dB)	Pol	Corr. (dB/m)
1319.600000	32.54	---	74.00	41.46	V	-14.5
1319.600000	---	22.91	54.00	31.09	V	-14.5
2173.000000	37.95	---	74.00	36.05	V	-10.3
2173.000000	---	28.01	54.00	25.99	V	-10.3
3867.900000	40.16	---	74.00	33.84	H	-5.3
3867.900000	---	31.05	54.00	22.95	H	-5.3
4959.300000	44.89	---	74.00	29.11	H	-1.4
4959.300000	---	38.79	54.00	15.21	H	-1.4
9404.800000	---	39.52	54.00	14.48	V	5.7
9404.800000	48.95	---	74.00	25.05	V	5.7
17607.300000	54.45	---	74.00	19.55	V	13.2
17607.300000	---	47.90	54.00	6.10	V	13.2

Band edge:

Common Information

Project No.:	RSHA240325001
Test Mode:	ZigBee
Standard:	Part 15.247&Part 15.209&Part 15.205
Test Engineer:	Peter Wang

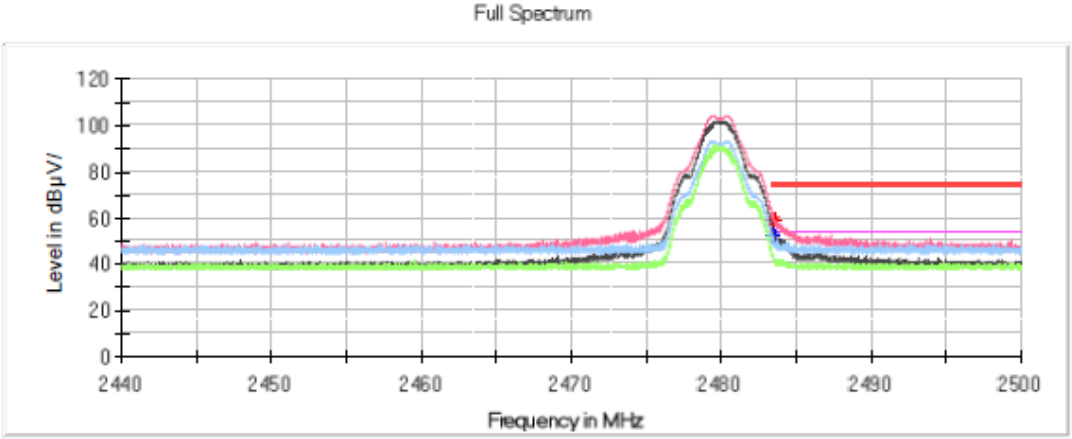


Critical_Freqs

Frequency (MHz)	MaxPeak (dB µ V/m)	Average (dB µ V/m)	Limit (dB µ V/m)	Margin (dB)	Pol	Corr. (dB/m)
2380.028000	---	41.22	54.00	12.78	V	0.0
2380.028000	47.03	---	74.00	26.97	V	0.0
2388.162000	---	39.93	54.00	14.07	V	0.1
2388.162000	49.40	---	74.00	24.60	V	0.1

Common Information

Project No.:	RSHA240325001
Test Mode:	ZigBee
Standard:	Part 15.247&Part 15.209&Part 15.205
Test Engineer:	Peter Wang



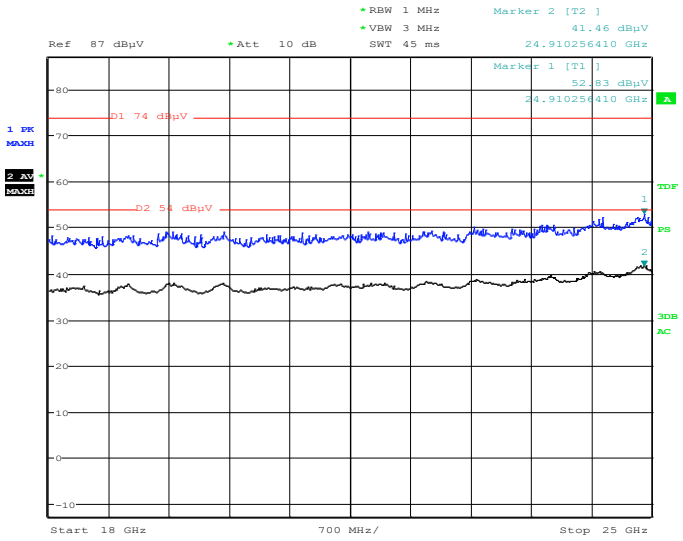
Critical_Freqs

Frequency (MHz)	MaxPeak (dB µ V/m)	Average (dB µ V/m)	Limit (dB µ V/m)	Margin (dB)	Pol	Corr. (dB/m)
2483.512000	58.43	---	74.00	15.57	V	0.2
2483.512000	---	51.80	54.00	2.20	V	0.2
2483.530000	59.02	---	74.00	14.98	V	0.2
2483.530000	---	50.98	54.00	3.02	V	0.2

18 GHz - 25 GHz:

*(Pre-scan with low channel, middle channel and high channel of operation in the X,Y and Z axes of orientation, the worst case **high channel of operation in X-axis of orientation** was recorded)*

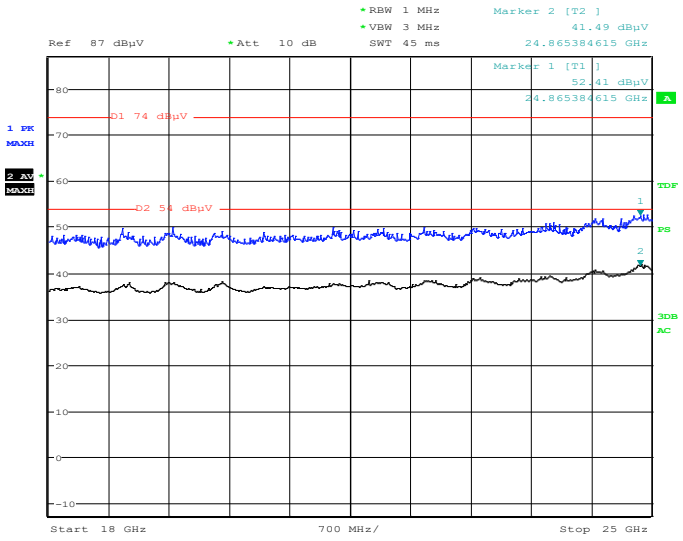
Horizontal



Project No.RSHA240325001 Tester: Peter Wang

Date: 29.APR.2024 22:24:47

Vertical



Project No.RSHA240325001 Tester: Peter Wang

Date: 29.APR.2024 22:45:44

Note: The test distance is 3m. The limit is 74dBµV/m(Peak) and 54dBµV/m(Average).

FCC §15.247(a) (2) - 6 dB EMISSION BANDWIDTH

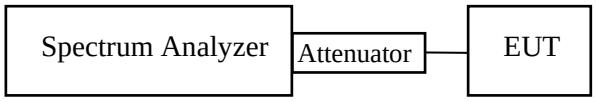
Applicable Standard

Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

Test Procedure

According to ANSI C63.10-2013 sub-clause 11.8.1

1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW) ≥ 3 x RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.



Test Data

Environmental Conditions & Test Information

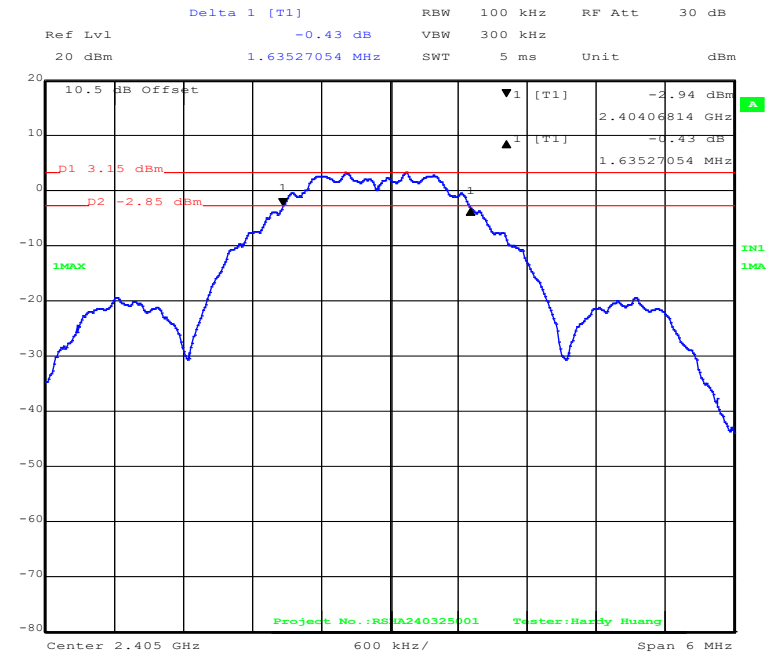
Temperature:	22 ℃
Relative Humidity:	41 %
ATM Pressure:	102.5 kPa
Test Date:	2024-04-28
Test Engineer:	Jenny Yang

Test Result: Compliant.

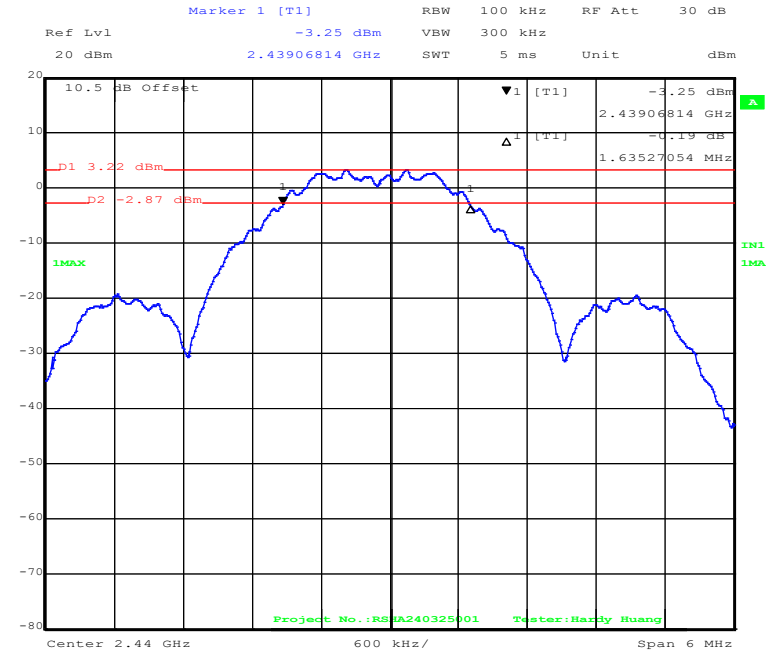
EUT operation mode: Transmitting

Channel	Frequency (MHz)	6 dB Emission Bandwidth (MHz)	Limit (MHz)
Low	2405	1.635	≥0.5
Middle	2440	1.635	≥0.5
High	2480	1.635	≥0.5

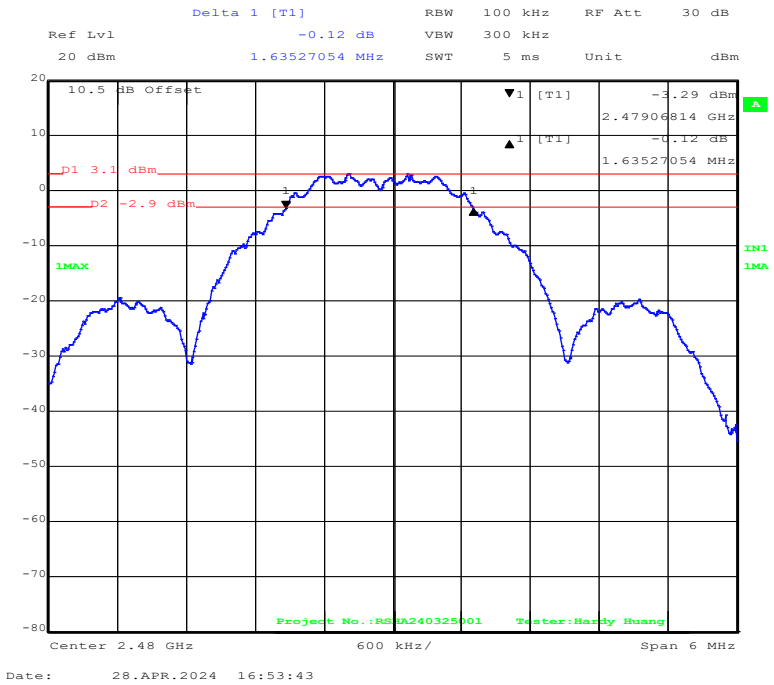
Low Channel



Middle Channel



High Channel



FCC §15.247(b) (3) - MAXIMUM CONDUCTED OUTPUT POWER

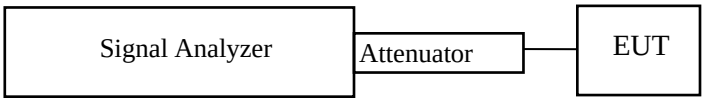
Applicable Standard

According to FCC §15.247(b) (3), for systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, Compliant with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

Test Procedure

According to ANSI C63.10-2013 sub-clause 11.9.1.3

1. Set the RBW ≥ DTS bandwidth.
2. Set VBW ≥ 3 x RBW.
3. Set span ≥ 3 x RBW
4. Sweep time = auto couple.
5. Detector = peak.
6. Trace mode = max hold.
7. Allow trace to fully stabilize.
8. Use peak marker function to determine the peak amplitude level.



Test Data

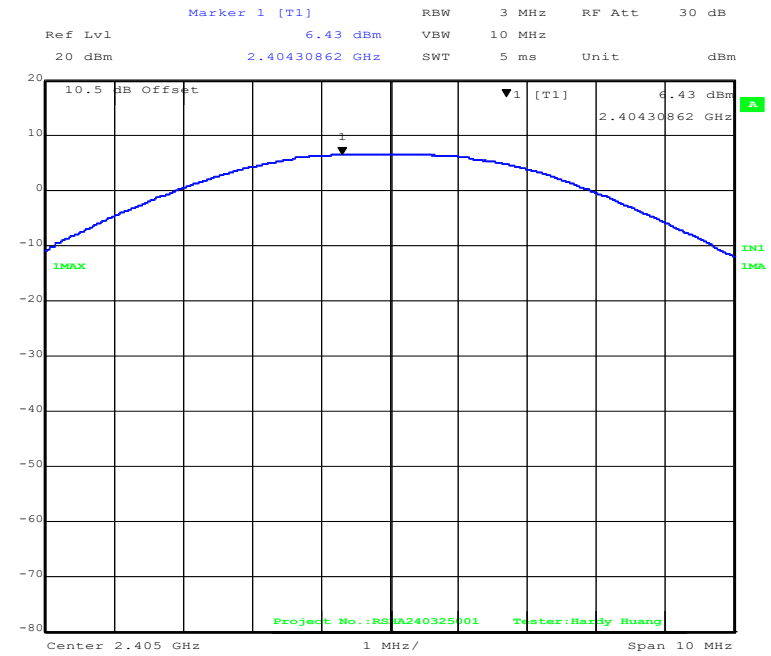
Environmental Conditions & Test Information

Temperature:	22 ℃
Relative Humidity:	41 %
ATM Pressure:	102.5 kPa
Test Date:	2024-04-28
Test Engineer:	Jenny Yang

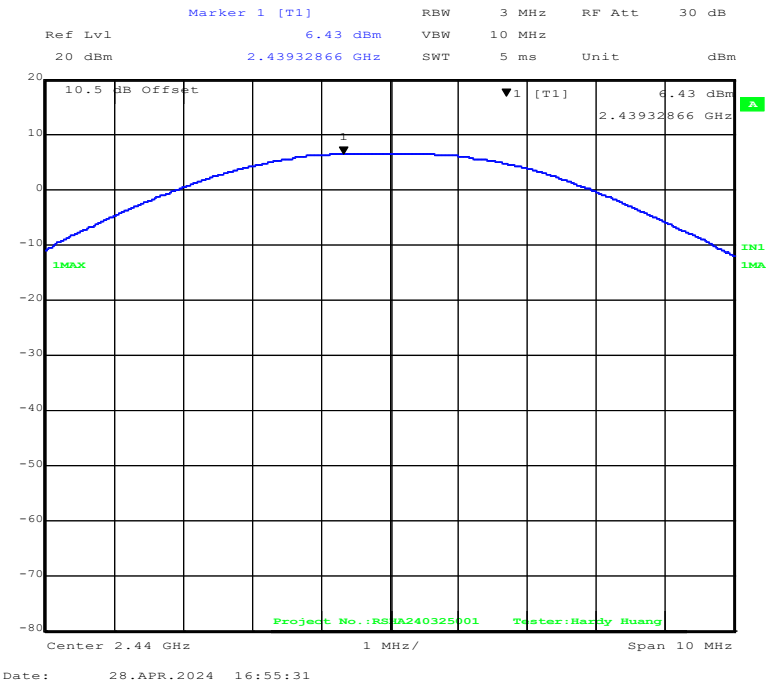
EUT operation mode: Transmitting

Channel	Frequency (MHz)	Max Conducted Peak Output Power (dBm)	Limit (dBm)	Result
Low	2405	6.43	30	Pass
Middle	2440	6.43	30	Pass
High	2480	6.43	30	Pass

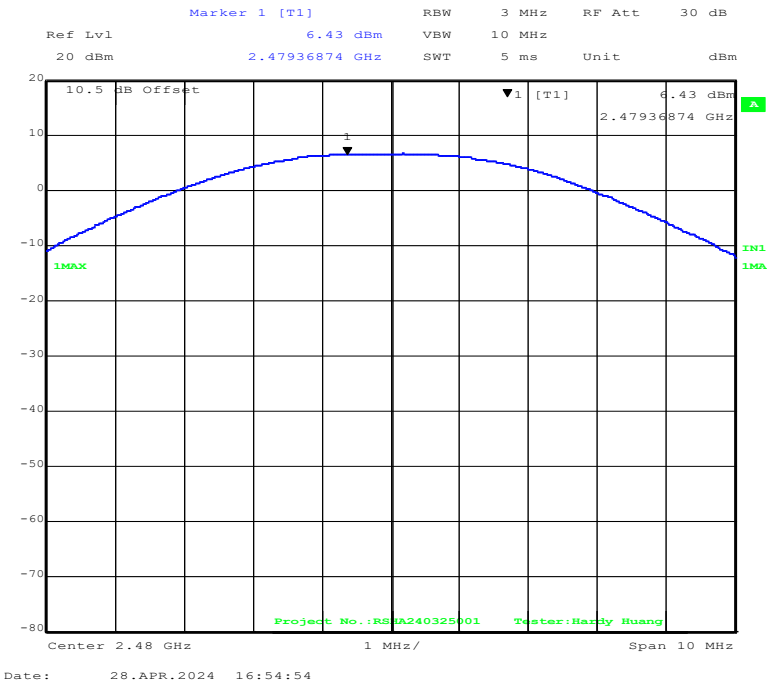
Low Channel



Middle Channel



High Channel



FCC §15.247(d) - BAND EDGE

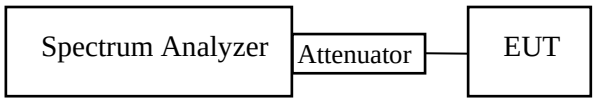
Applicable Standard

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates Compliant with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. 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) (see §15.205(c)).

Test Procedure

According to ANSI C63.10-2013 sub-clause 6.10.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW to 100 kHz and VBW of spectrum analyzer to 300 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.



Test Data

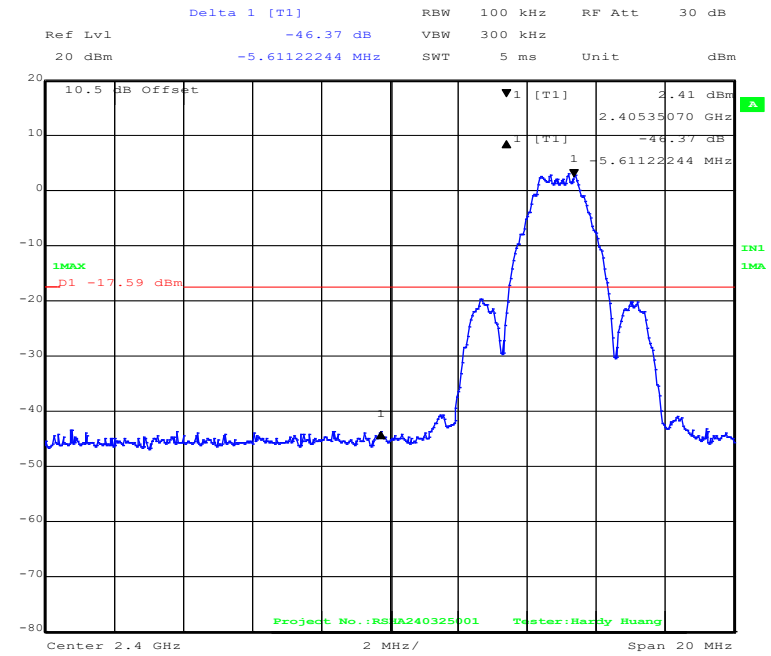
Environmental Conditions & Test Information

Temperature:	22 ℃
Relative Humidity:	41 %
ATM Pressure:	102.5 kPa
Test Date:	2024-04-28
Test Engineer:	Jenny Yang

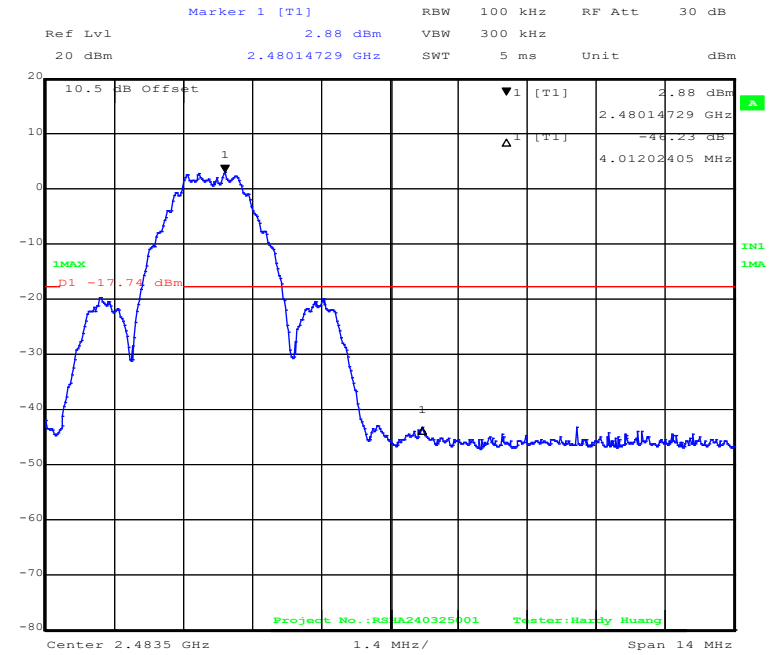
EUT operation mode: Transmitting

Test Result: Compliant.

Left Side



Right Side



FCC §15.247(e) - POWER SPECTRAL DENSITY

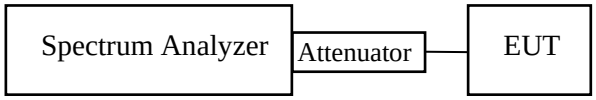
Applicable Standard

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

Test Procedure

According to ANSI C63.10-2013 sub-clause 11.10.2

1. Use this procedure when the maximum peak conducted output power in the fundamental emission is used to demonstrate Compliant.
2. Set the RBW to: 3kHz≤ RBW≤100 kHz.
3. Set the VBW ≥ 3×RBW.
4. Set the span to 1.5 times the DTS bandwidth.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.



Test Data

Environmental Conditions & Test Information

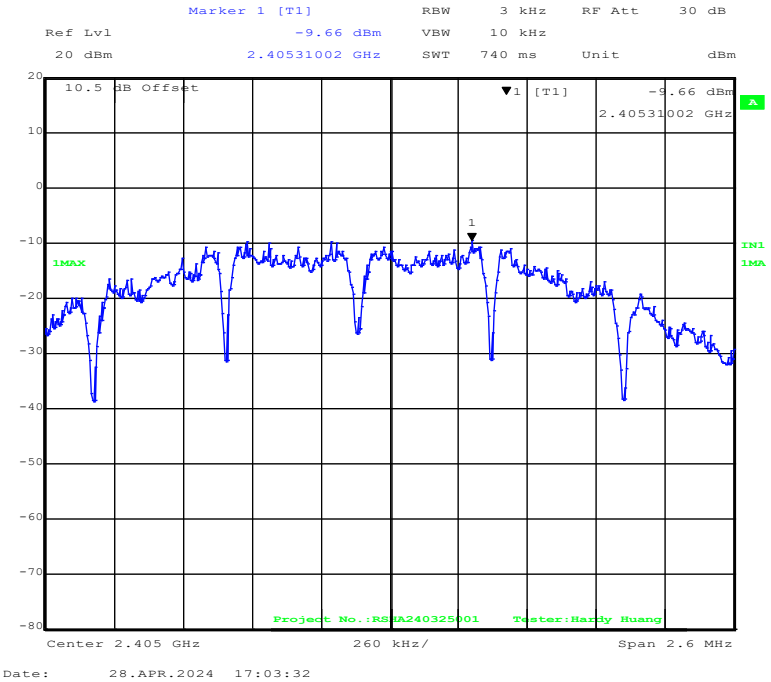
Temperature:	22 ℃
Relative Humidity:	41 %
ATM Pressure:	102.5 kPa
Test Date:	2024-04-28
Test Engineer:	Jenny Yang

EUT operation mode: Transmitting

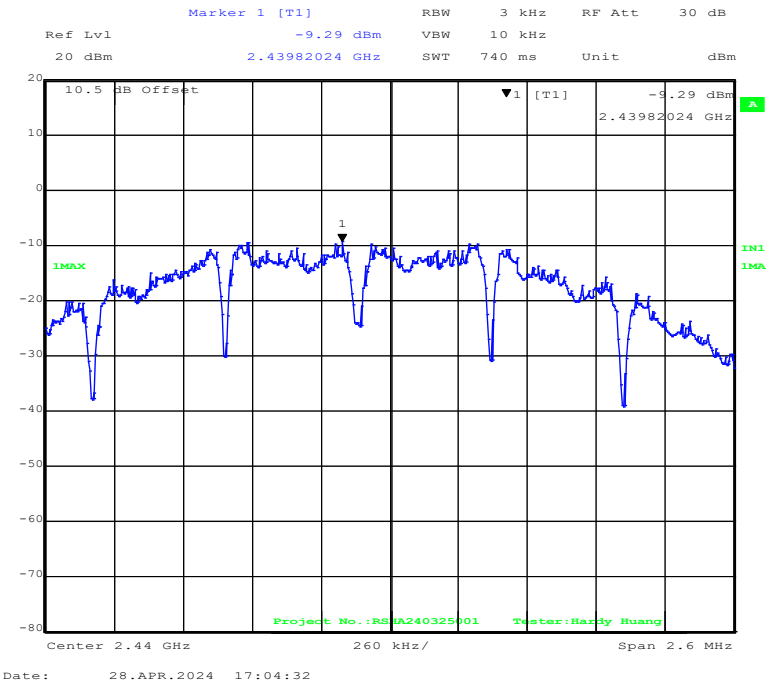
Test Result: Compliant.

Channel	Frequency (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)
Low	2405	-9.66	≤8
Middle	2440	-9.29	≤8
High	2480	-9.51	≤8

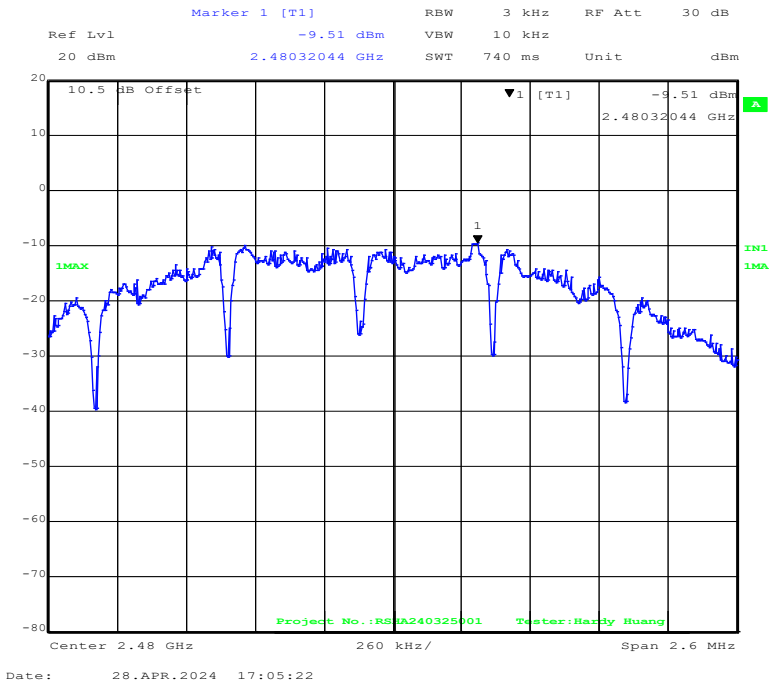
Low Channel



Middle Channel



High Channel



EUT PHOTOGRAPHS

Please refer to the attachment EXHIBIT A - EUT EXTERNAL PHOTOGRAPHS and EXHIBIT B - EUT INTERNAL PHOTOGRAPHS.

TEST SETUP PHOTOGRAPHS

Please refer to the attachment EXHIBIT C - TEST SETUP PHOTOGRAPHS.

Declarations

1. The laboratory is not responsible for the authenticity of any information provided by the applicant. Information from the applicant that may affect test results is marked with "★".

2. The test data was only valid for the test sample(s).

3. This report is valid only with a valid digital signature. The digital signature may be available only under the Adobe software above version 7.0.

4. Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.

5. The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor k=2 with the 95.45% confidence interval.

******* END OF REPORT *******