NVLAP TESTING
NVLAP LAB CODE 600341-0

BACL Bay Area Compliance Labs Corp.

TEST REPORT

Applicant:	**Hebei Huachuang M&C Technology Co., Ltd.**
Address:	**FCC:Building #1, South of Puhui Street, West of Guangsheng East Road, High-tech Park Fengnan Economic Development Zone, Tangshan, Hebei China** **IC: Building #1, South of Puhui Street, West of Guangsheng East Road, High-tech Park, Fengnan Economic Development Zone Tangshan Hebei 063000 China (Peoples Republic Of)**
Product Name:	**Radar Level Transmitter**
FCC ID:	**2BFRQCNHHCCK-XX2024**
IC:	**32302-HBHCCK**
HVIN:	**HCDAR-8H, HCDAR-8X**
FVIN:	**V1.0**
Standard(s):	**47 CFR Part 15, Subpart C(15.256)** **RSS-211, March 2015** **RSS-Gen, Issue 5, February 2021 Amendment 2** **ANSI C63.10-2013**
Report Number:	**2402S46928E-RF-00**
Report Date:	**2024/4/24**

The above device has been tested and found compliant with the requirement of the relative standards by Bay Area Compliance Laboratories Corp. (Dongguan).

Reviewed By: Gavin Xu	**Approved By:** Ivan Cao
Title: RF Engineer	Title: EMC Manager

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
1.0	2402S46928E-RF-00	Original Report	2024/4/24

1. GENERAL INFORMATION

1.1 General Description of Equipment under Test

EUT Name:	Radar Level Transmitter
EUT Model:	HCDAR-8H
Multiple Models:	HCDAR-8X
HVIN:	HCDAR-8H, HCDAR-8X
FVIN:	V1.0
Operation Frequency Range:	76-81 GHz
Modulation Type:	FMCW
Rated Input Voltage:	DC 12-30V
Serial Number:	2JWL-1(Model: HCDAR-8H)
EUT Received Date:	2024/4/17
EUT Received Status:	Good
Note: The multiple models are electrically identical with the test model. Please refer to the declaration letter for more detail, which was provided by manufacturer.	

1.2 Accessory Information

Accessory Description	Manufacturer	Model	Parameters
/	/	/	/

1.3 Antenna Information Detail▲

Antenna Type	input impedance (Ohm)	Antenna Gain	Frequency Range
Integrated	50	27.5 dBi	76-81 GHz
The design of compliance with §15.203:			
☒ Unit uses a permanently attached antenna.			
☐ Unit uses a unique coupling to the intentional radiator.			
☐ Unit was professionally installed, and installer shall be responsible for verifying that the correct antenna is employed with the unit.			

1.4 Equipment Modifications

No modifications are made to the EUT during all test items.

2. SUMMARY OF TEST RESULTS

Standard(s)/Rule(s)	Description of Test	Result
§15.207(a) RSS-Gen Clause 8.8	AC Line Conducted Emissions	Compliant
§15.256(g) RSS-211 Clause 5.2 (b)	EIRP	Compliant
§15.256(h) RSS-211 Clause 5.1 (d)	Radiated Spurious Emissions	Compliant
§15.256(f) RSS-211 Clause 5.1 (a), (b), (c)	Emission Bandwidth and Occupied Bandwidth	Compliant
§15.203 §15.256(i)(B) §15.256(j) RSS-Gen Clause 6.8 RSS-211 Clause 5.2(a) RSS-211 Clause 5.2(c)	Antenna Requirement	Compliant

3. DESCRIPTION OF TEST CONFIGURATION

3.1 EUT Operation Condition

The system was configured for testing in production version with highest transmitter activity (on time), which was provided by the manufacturer. According to 15.31(c) and RSS-211, the device tested at Swept mode for FMCW modulation.

3.2 EUT Exercise Software

No software was used in test.

3.3 Support Equipment List and Details

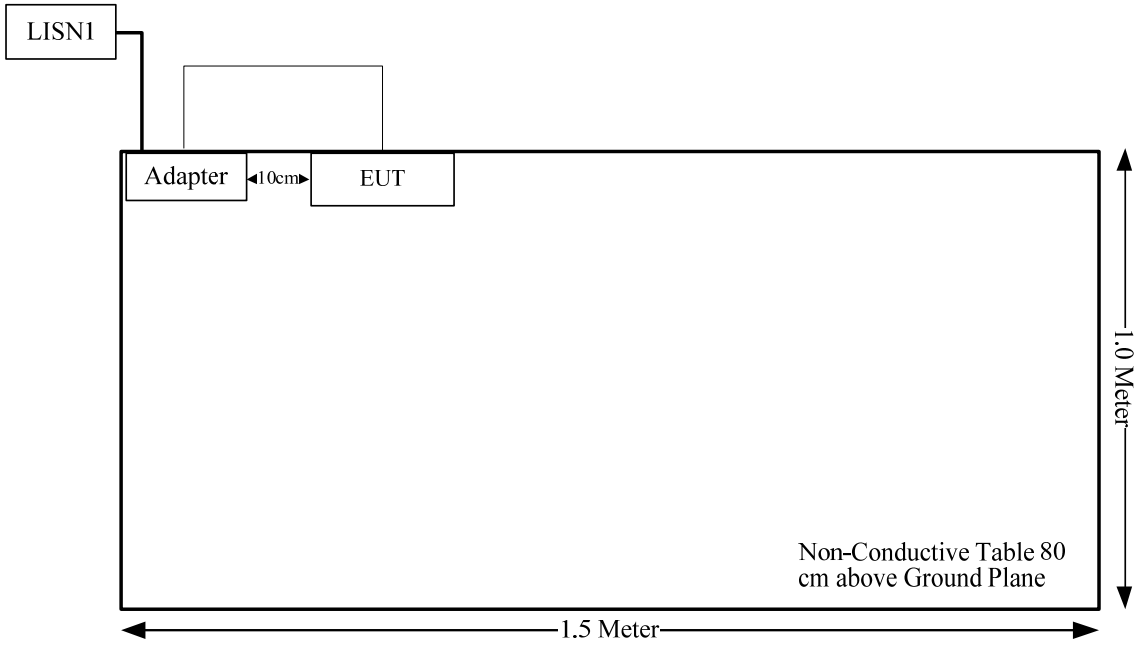
Manufacturer	Description	Model	Serial Number
Simsukian	Adapter	SK05T-2400200Z	20061702000167

3.4 Support Cable List and Details

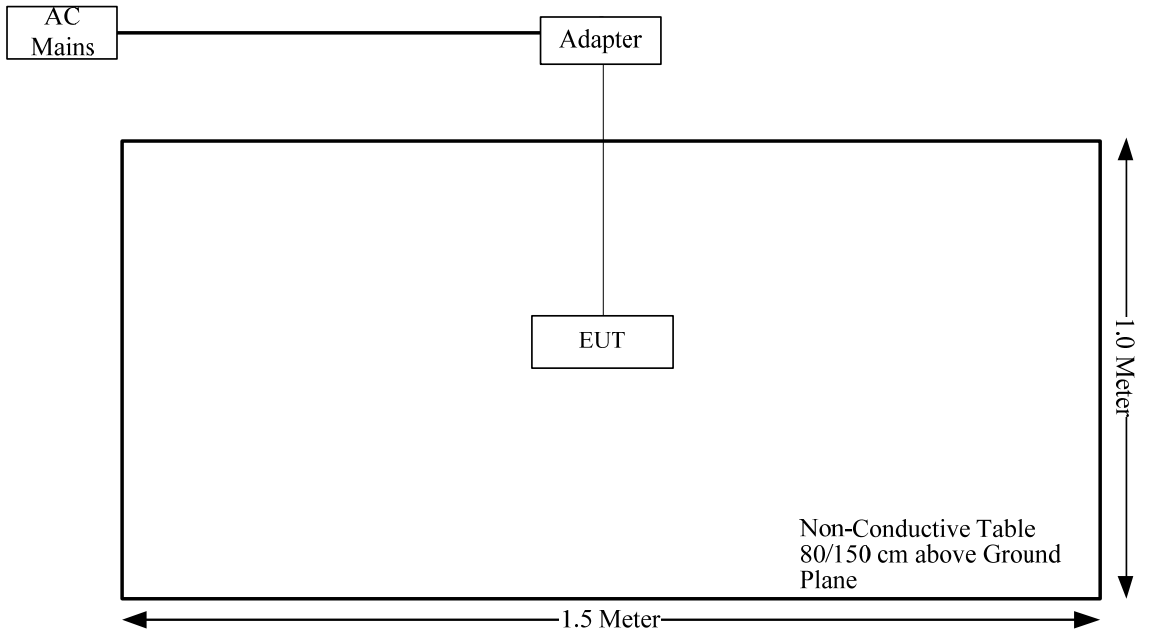
Cable Description	Shielding Type	Ferrite Core	Length (m)	From Port	To
DC Cable	No	No	1.5	Adapter	EUT

3.5 Block Diagram of Test Setup

AC Power Lines Conducted Emission:



Radiated Spurious Emissions:



3.6 Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Dongguan) to collect test data is located on the No.12, Pulong East 1st Road, Tangxia Town, Dongguan, Guangdong, China.

The lab has been recognized as the FCC accredited lab under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No. : 829273, the FCC Designation No. : CN5044.

The lab has been recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements, the CAB identifier: CN0022.

3.7 Measurement Uncertainty

Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty. The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval.

Parameter	Measurement Uncertainty
Occupied Channel Bandwidth	±5 %
Unwanted Emissions, radiated	9kHz~30MHz: 3.3dB, 30MHz~200MHz: 4.55 dB, 200MHz~1GHz: 5.92 dB, 1GHz~6GHz: 4.98 dB, 6GHz~18GHz: 5.89 dB, 18GHz~26.5GHz:5.47 dB, 26.5GHz~40GHz:5.63 dB 40~60G: 4.83dB, 60G~90G: 4.94dB, 90G-140G: 5.46dB, 140G-220G: 6.00dB, 220G-325G: 7.35dB
EIRP	4.94dB
Temperature	±1℃
Humidity	±5%
DC and low frequency voltages	±0.4%
Duty Cycle	1%
AC Power Lines Conducted Emission	3.11 dB (150 kHz to 30 MHz)

4. REQUIREMENTS TEST RESULTS

4.1 AC Line Conducted Emissions

4.1.1 Applicable Standard

FCC§15.207(a).

(a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

	Conducted limit (dBμV)	
Frequency of emission (MHz)	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

(b) The limit shown in paragraph (a) of this section shall not apply to carrier current systems operating as intentional radiators on frequencies below 30 MHz. In lieu thereof, these carrier current systems shall be subject to the following standards:

(1) For carrier current system containing their fundamental emission within the frequency band 535-1705 kHz and intended to be received using a standard AM broadcast receiver: no limit on conducted emissions.

(2) For all other carrier current systems: 1000 μV within the frequency band 535-1705 kHz, as measured using a 50 μH/50 ohms LISN.

(3) Carrier current systems operating below 30 MHz are also subject to the radiated emission limits in §15.205, §15.209, §15.221, §15.223, or §15.227, as appropriate.

(c) Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. Devices that include, or make provisions for, the use of battery chargers which permit operating while charging, AC adapters or battery eliminators or that connect to the AC power lines indirectly, obtainig their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

RSS-Gen Clause 8.8

Unless stated otherwise in the applicable RSS, for radio apparatus that are designed to be connected to the public utility AC power network, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the range 150 kHz to 30 MHz shall not exceed the limits in table 4, as measured using a 50 μH / 50 Ω line impedance stabilization network. This requirement applies for the radio frequency voltage measured between each power line and the ground terminal of each AC power-line mains cable of the EUT.
For an EUT that connects to the AC power lines indirectly, through another device, the requirement for compliance with the limits in table 4 shall apply at the terminals of the AC power-line mains cable of a representative support device, while it provides power to the EUT. The lower limit applies at the boundary between the frequency ranges. The device used to power the EUT shall be representative of typical applications.

Table 4 – AC power-line conducted emissions limits

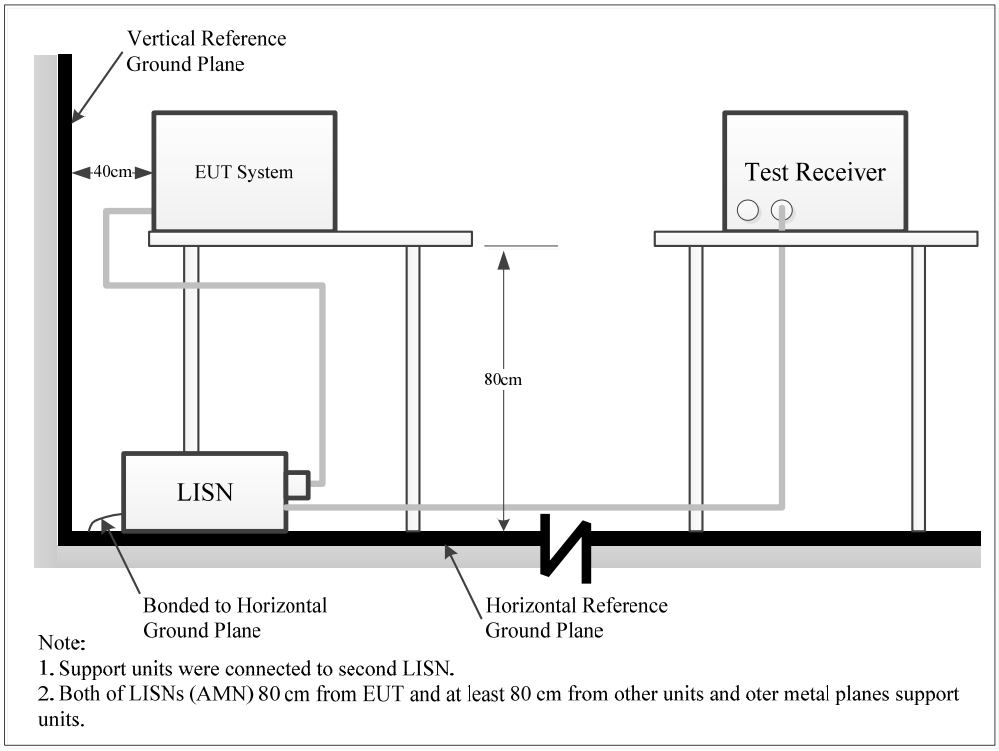
Frequency (MHz)	Conducted limit (dBμV)	
	Quasi-peak	Average
0.15 - 0.5	66 to 56[1]	56 to 46[1]
0.5 – 5	56	46
5 – 30	60	50

Note 1: The level decreases linearly with the logarithm of the frequency.

For an EUT with a permanent or detachable antenna operating between 150 kHz and 30 MHz, the AC power-line conducted emissions must be measured using the following configurations:
(a) Perform the AC power-line conducted emissions test with the antenna connected to determine compliance with the limits of table 4 outside the transmitter's fundamental emission band.

(b) Retest with a dummy load instead of the antenna to determine compliance with the limits of table 4 within the transmitter's fundamental emission band. For a detachable antenna, remove the antenna and connect a suitable dummy load to the antenna connector. For a permanent antenna, remove the antenna and terminate the RF output with a dummy load or network that simulates the antenna in the fundamental frequency band.

4.1.2 EUT Setup



Note:
1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at least 80 cm from other units and oter metal planes support units.

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.207, RSS-Gen limits.

The spacing between the peripherals was 10 cm.

The adapter or EUT was connected to the main LISN with a 120 V/60 Hz AC power source.

3.1.3 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

4.1.4 Test Procedure

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

The frequency and amplitude of the six highest ac power-line conducted emissions relative to the limit, measured over all the current-carrying conductors of the EUT power cords, and the operating frequency or frequency to which the EUT is tuned (if appropriate), should be reported, unless such emissions are more than 20 dB below the limit. AC power-line conducted emissions measurements are to be separately carried out only on each of the phase ("hot") line(s) and (if used) on the neutral line(s), but not on the ground [protective earth] line(s). If less than six emission frequencies are within 20 dB of the limit, then the noise level of the measuring instrument at representative frequencies should be reported. The specific conductor of the power-line cord for each of the reported emissions should be identified. Measure the six highest emissions with respect to the limit on each current-carrying conductor of each power cord associated with the EUT (but not the power cords of associated or peripheral equipment that are part of the test configuration). Then, report the six highest emissions with respect to the limit from among all the measurements identifying the frequency and specific current-carrying conductor identified with the emission. The six highest emissions should be reported for each of the current-carrying conductors, or the six highest emissions may be reported over all the current-carrying conductors.

4.1.5 Corrected Amplitude & Margin Calculation

The basic equation is as follows:

Result = Reading + Factor
Factor = attenuation caused by cable loss + voltage division factor of AMN

The "**Margin**" column of the following data tables indicates the degree of compliance within the applicable limit. The equation for margin calculation is as follows:

Margin = Limit – Result

4.1.6 Test Data

Serial Number:	2JWL-1	Test Date:	2024/4/23
Test Site:	CE	Test Mode:	Swept
Tester:	Wright Lai	Test Result:	Pass

Environmental Conditions:					
Temperature: (℃)	25.2	Relative Humidity: (%)	70	ATM Pressure: (kPa)	100

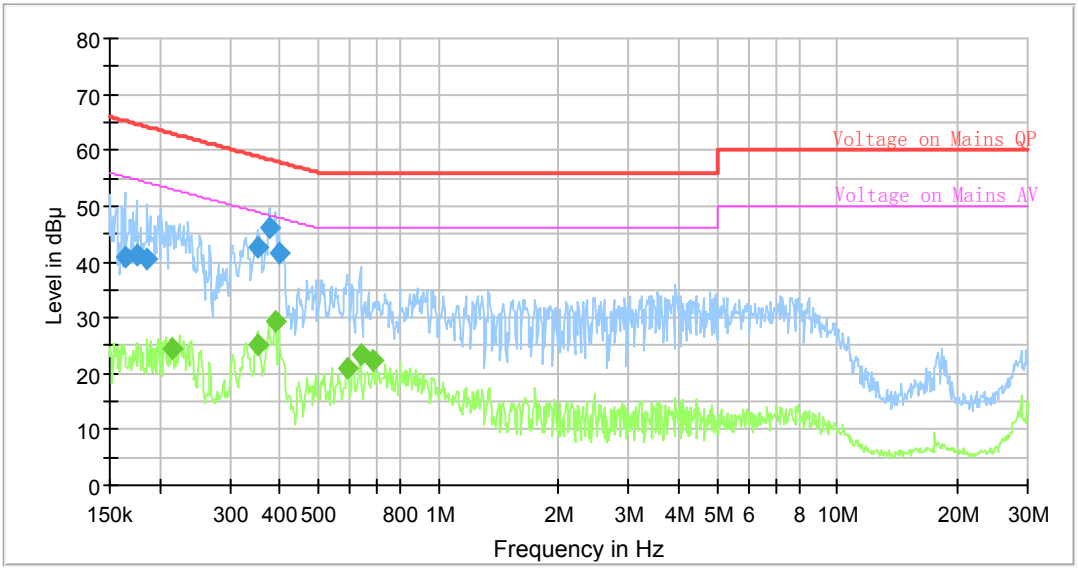
Test Equipment List and Details:

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	LISN	ENV216	101614	2023/10/18	2024/10/17
MICRO-COAX	Coaxial Cable	C-NJNJ-50	C-0200-01	2023/9/5	2024/9/4
R&S	EMI Test Receiver	ESCI	100035	2023/8/18	2024/8/17
R&S	Test Software	EMC32	V9.10.00	N/A	N/A

** Statement of Traceability: Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).*

Test Data:

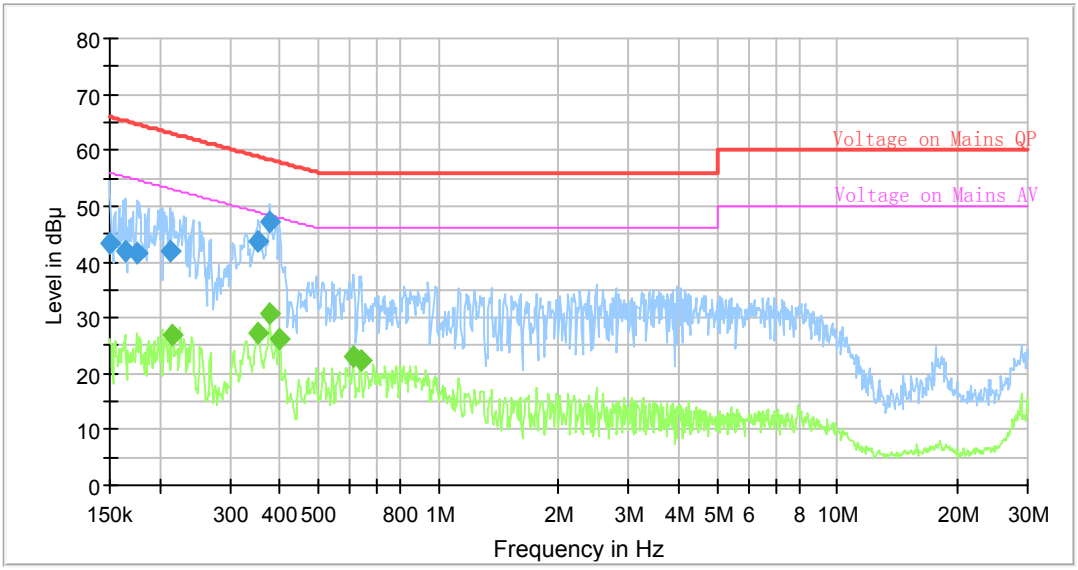
Project No:	2402S46928E-RF
Test Engineer:	Wright Lai
Test Date:	2024-4-23
Port:	L
Test Mode:	Swept
Power Source:	AC 120V/60Hz



Final_Result

Frequency (MHz)	QuasiPeak (dB µ V)	Average (dB µ V)	Limit (dB µ V)	Margin (dB)	Bandwidth (kHz)	Line	Corr. (dB)
0.163273	40.96	---	65.30	24.34	9.000	L1	10.8
0.175081	41.38	---	64.72	23.34	9.000	L1	10.8
0.185880	40.35	---	64.22	23.87	9.000	L1	10.8
0.214807	---	24.29	53.02	28.73	9.000	L1	10.8
0.351956	42.63	---	58.92	16.29	9.000	L1	10.8
0.353715	---	25.18	48.87	23.69	9.000	L1	10.8
0.377409	46.06	---	58.34	12.28	9.000	L1	10.8
0.390819	---	29.26	48.05	18.79	9.000	L1	10.8
0.398694	41.63	---	57.88	16.25	9.000	L1	10.8
0.591232	---	20.99	46.00	25.01	9.000	L1	10.8
0.637161	---	23.25	46.00	22.75	9.000	L1	10.8
0.686657	---	22.42	46.00	23.58	9.000	L1	10.9

Project No:	2402S46928E-RF
Test Engineer:	Wright Lai
Test Date:	2024-4-23
Port:	N
Test Mode:	Swept
Power Source:	AC 120V/60Hz



Final_Result

Frequency (MHz)	QuasiPeak (dB µ V)	Average (dB µ V)	Limit (dB µ V)	Margin (dB)	Bandwidth (kHz)	Line	Corr. (dB)
0.150750	43.40	---	65.96	22.56	9.000	N	10.9
0.164910	41.87	---	65.21	23.34	9.000	N	10.9
0.175956	41.57	---	64.67	23.10	9.000	N	10.9
0.212675	41.95	---	63.10	21.15	9.000	N	10.8
0.215881	---	26.86	52.98	26.12	9.000	N	10.8
0.353715	---	27.23	48.87	21.64	9.000	N	10.8
0.353715	43.82	---	58.87	15.05	9.000	N	10.8
0.377409	---	30.68	48.34	17.66	9.000	N	10.8
0.377409	47.00	---	58.34	11.34	9.000	N	10.8
0.400687	---	26.23	47.84	21.61	9.000	N	10.8
0.612239	---	22.94	46.00	23.06	9.000	N	10.7
0.637161	---	22.44	46.00	23.56	9.000	N	10.7

4.2 EIRP

4.2.1 Applicable Standard

FCC §15.256(g)

Fundamental emissions limits.

(1) All emission limits provided in this section are expressed in terms of Equivalent Isotropic Radiated Power (EIRP).
(2) The EIRP level is to be determined from the maximum measured power within a specified bandwidth.
(i) The EIRP in 1 MHz is computed from the maximum power level measured within any 1-MHz bandwidth using a power averaging detector;
(ii) The EIRP in 50 MHz is computed from the maximum power level measured with a peak detector in a 50-MHz bandwidth centered on the frequency at which the maximum average power level is realized and this 50 MHz bandwidth must be contained within the authorized operating bandwidth. For a RBW less than 50 MHz, the peak EIRP limit (in dBm) is reduced by 20 log(RBW/50) dB where RBW is the resolution bandwidth in megahertz. The RBW shall not be lower than 1 MHz or greater than 50 MHz. The video bandwidth of the measurement instrument shall not be less than the RBW. If the RBW is greater than 3 MHz, the application for certification filed shall contain a detailed description of the test procedure, calibration of the test setup, and the instrumentation employed in the testing.
(3) The EIRP limits for LPR operations in the bands authorized by this rule section are provided in Table 1. The emission limits in Table 1 are based on boresight measurements (*i.e.*, measurements performed within the main beam of an LPR antenna).

Table 1—LPR EIRP Emission Limits

Frequency band of operation (GHz)	Average emission limit (EIRP in dBm measured in 1 MHz)	Peak emission limit (EIRP in dBm measured in 50 MHz)
5.925–7.250	−33	7
24.05–29.00	−14	26
75–85	−3	34

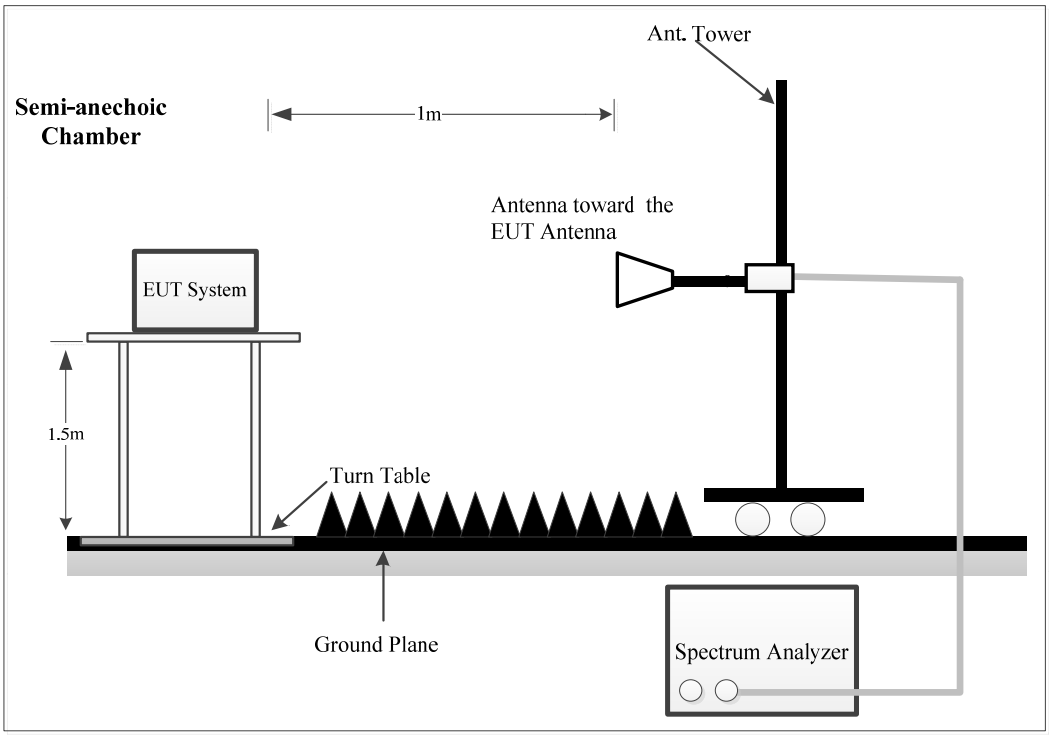
RSS-211, Clause 5.2 (b)
For average emission limits, LPR devices shall not exceed the limits provided in Table 1 measured in a 1 MHz measurement bandwidth with an average detector. For peak emission limits, LPR devices shall not exceed the limits provided in Table 1 measured in a 50 MHz measurement bandwidth with a peak detector.

Table 1: EIRP Emission Limits for LPR Devices

Frequency Band (GHz)	Average Emission Limit (EIRP in dBm/MHz) as Measured Boresight	Peak Emission Limit (EIRP in dBm Measured in 50 MHz) as Measured Boresight
5.65-8.50	-33	+7
24.05-29.00	-14	+26
75-85	-3	+34

Notes: 1. The minimum bandwidth at the -10 dB point is 50 MHz.
2. All emission limits defined herein are based on boresight measurements (*i.e.*, measurements performed within the main beam of an LPR antenna).

4.2.2 EUT Setup



Place the measurement antenna at a measurement distance that is in the far-field of the measurement antenna, in the far-field of the EUT antenna. The EIRP test was performed at 1m distance, which was larger than the minimum test distance, please refer to section 4.3.4 for more detail.

4.2.3 Test Procedure

Refer to ANSI C63.10-2013 Clause 9.10

For radiated measurements:

1) Place the measurement antenna at a measurement distance that is in the far-field of the measurement antenna, in the far-field of the EUT antenna, and meets the measurement distance requirements for final radiated measurements as specified in 9.8.
2) Place the measurement antenna in the main beam of the EUT then maximize the fundamental emission using the procedures of 9.9, noting that multiple peaks can be found at different beam orientations and/or polarizations.
3) Correct the power reading from the spectrum analyzer for any external gain and/or attenuation between the measurement antenna and the spectrum analyzer. This is the power at the output of the measurement antenna
4) Calculate the EIRP from the power at the output of the measurement antenna using Equation (22), and then convert to linear form using Equation (24).
5) Where applicable, calculate conducted output power from the EIRP using Equation (27).

Calculate the EIRP from the measured field strength using equation as follows:

$$EIRP = 21.98 - 20\log(\lambda) + 20\log(d_{Meas}) + P - G$$

$$E = 126.8 - 20\log(\lambda) + P - G$$

=> EIRP (dBm) = E (dBμV/m) + 20log(D) − 104.8

For Peak Measurement:

For FMCW emissions, the procedures in 4.1.5.2.8 and Annex L shall be used.

EIRP (dBm) = E (dBμV/m) + 20log(D) − 104.8+ Chirps Correction Factor

EIRP is the equivalent isotropically radiated power
E is the field strength of the emission at the measurement distance
D is the measurement distance

E (dBμV/m) = Reading(dBμV) + Factor(dB/m)

Note: Factor includes the antenna and mixer factor, which was calibrated together.

4.2.4 Test Result

Serial Number:	2JWL-1	Test Date:	2024/4/20
Test Site:	Chamber B	Test Mode:	Transmitting
Tester:	Bill Yang	Test Result:	Pass

Environmental Conditions:					
Temperature: (℃)	25.1	Relative Humidity: (%)	53	ATM Pressure: (kPa)	100.4

Test Equipment List and Details:

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
OML	Waveguide Mixer	WR12/M12HWD	E60120-1	2023/2/16	2026/2/15
OML	Horn Antenna	M12RH	E60120-2	2023/2/27	2026/2/26
R&S	Spectrum Analyzer	FSV40	101944	2023/10/18	2024/10/17
Resenberger	Coaxial Cable	LU7-022-1000	0031	2024/3/1	2025/2/28

** Statement of Traceability: Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).*

Test Data:

Peak EIRP:

Frequency (GHz)	Reading (dBμV)	Detector	Polar (H/V)	Factor (dB/m)	E-Field@1m (dBμV/m)	Chirps Correction Factor (dB)	EIRP (dBm/MHz)	Limit (dBm)
78.24	62.35	PK	V	43.65	106	0.18	1.38	9.56

Refer to Application Note 1EF107-1E Rohde &Schwarz Peak and Mean Power measurements on wideband FMCW radar signals. The chirps correction factor was calculated using the formula:

$$CF_{chirp} = 5 * \log\left(1 + K * \left(\frac{Span}{t * RBW^2}\right)^2\right)$$

K = a correction factor for the settling process of the gaussian shaped filter (0.1947)
t = the length of the chirp,

Peak EIRP limit (in dBm) is reduced by 20 log(RBW/50) dB where RBW is the resolution bandwidth in megahertz

EIRP Limit= 34+20*log(3/50)=9.56 dBm/MHz

Average EIRP:

Frequency (GHz)	Reading (dBμV)	Detector	Polar (H/V)	Factor (dB/m)	E-Field@1m (dBμV/m)	EIRP (dBm)	Limit (dBm)
78.24	48.65	AV	V	43.65	92.3	-12.5	-3

The maximum fundamental emission power (EIRP) was measured using a power averaging (rms) detector with a 1 MHz resolution bandwidth (RBW) and integrated over the full 99% occupied bandwidth (OBW).

Chirps Correction Factor Calculation:

Chirp Time▲ (μs)	Span (MHz)	RBW (MHz)	CF_{chirp} (dB)
430	2553	3	0.18

4.3 Radiated Emissions

4.3.1 Applicable Standard

FCC §15.256(h)

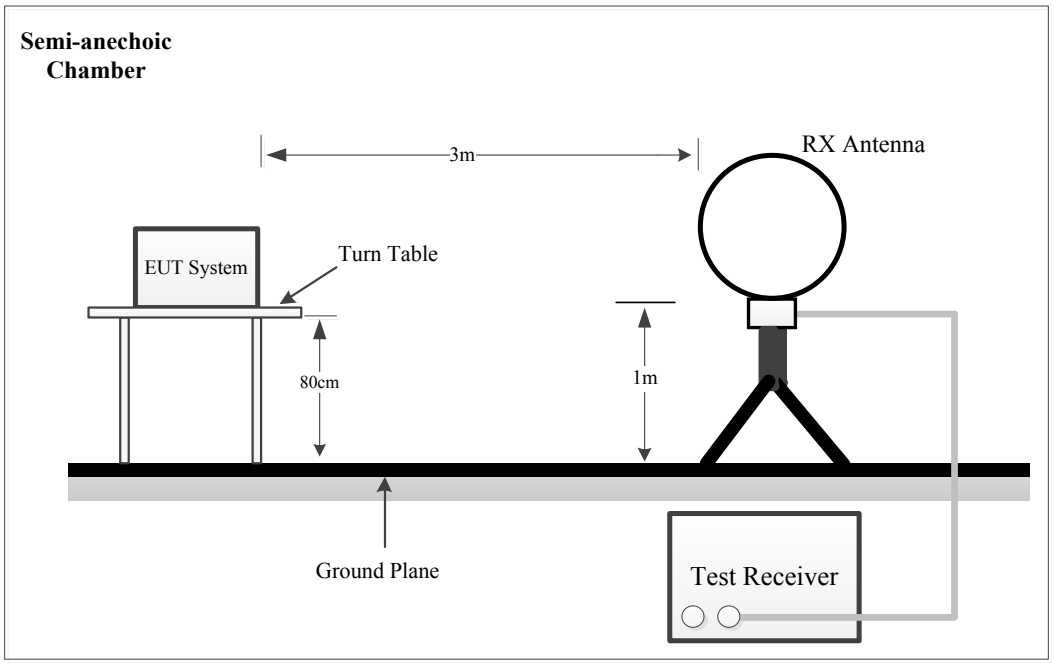
Unwanted emissions limits. Unwanted emissions from LPR devices shall not exceed the general emission limit in § 15.209 of this chapter.

RSS-211, Clause 5.1 (d)

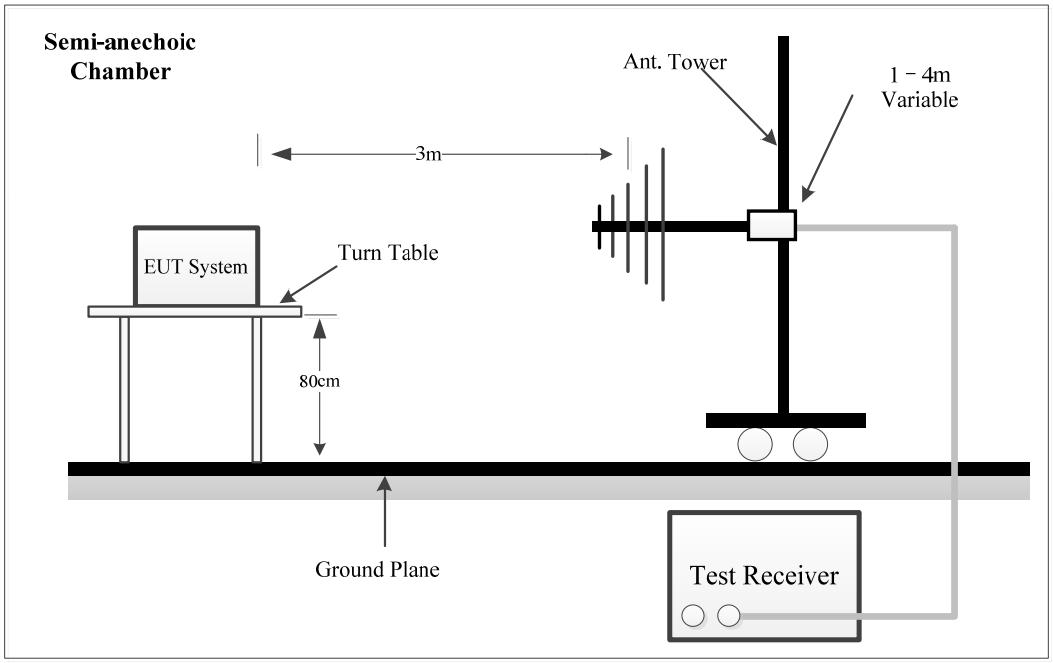
Unwanted emissions shall not exceed the general field strength limits set out in RSS-Gen.

4.3.2 EUT Setup

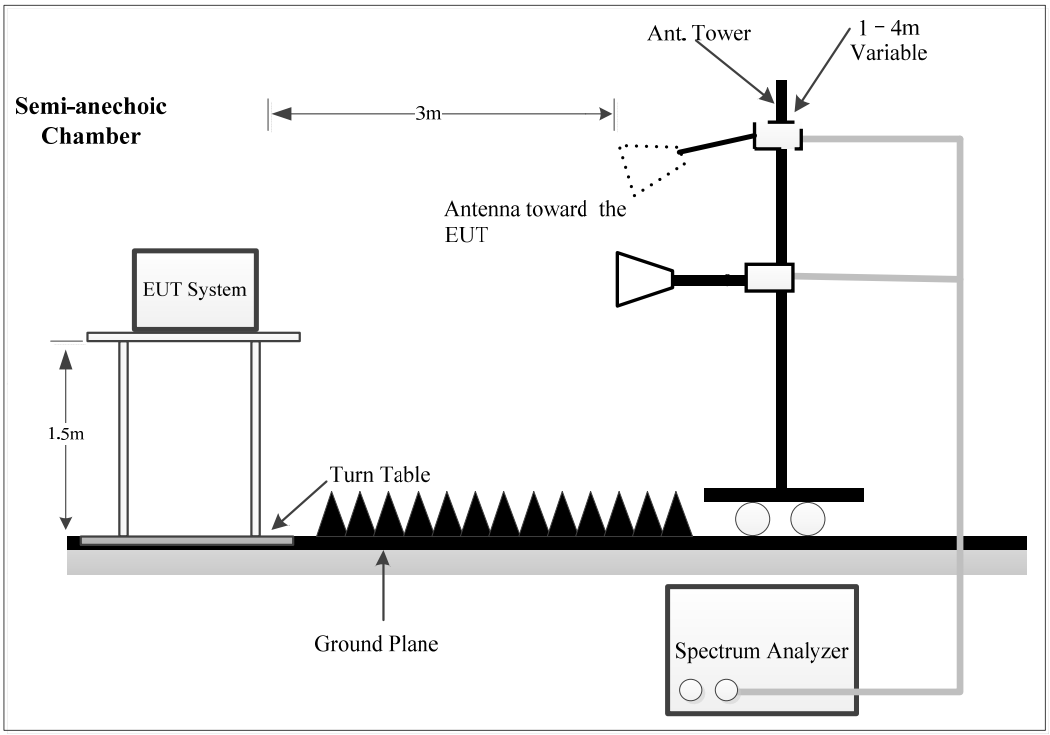
9kHz-30MHz:



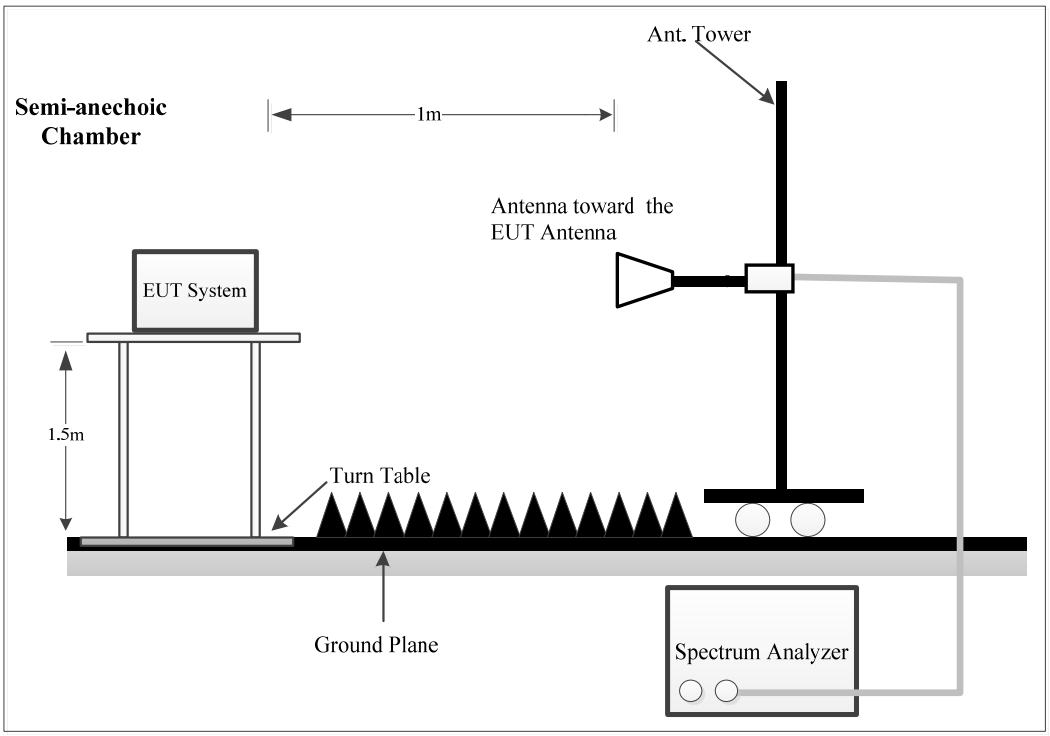
30MHz~1GHz:



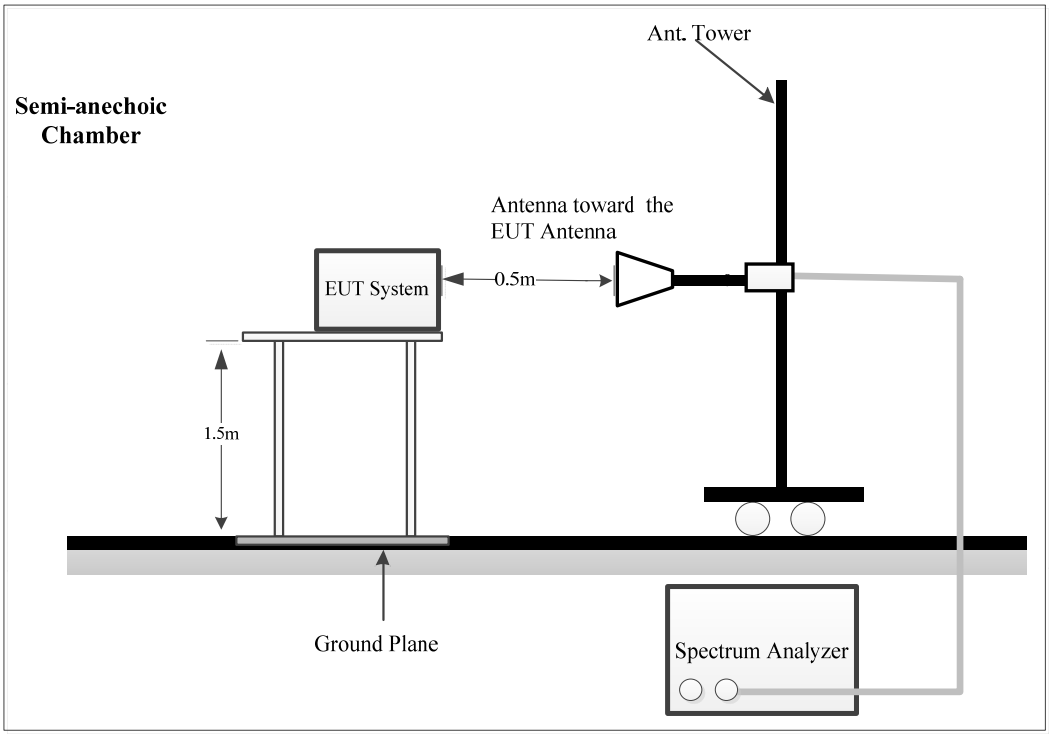
1~40 GHz:



40~90 GHz:



90~200 GHz:



Above 40GHz:

The antenna is scanned around the entire perimeter surface of the EUT, in both horizontal and vertical polarizations, at the distance of 1.0 m from 40 GHz to 90 GHz, and 0.5 m from 90 GHz to 200 GHz.

4.3.3 EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 200 GHz.

During the radiated emission test, the EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Measurement
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	/	/	120 kHz	QP
	100 kHz	300 kHz	/	PK
1-40 GHz	1MHz	3 MHz	/	PK
	1MHz	10 Hz	/	Average
Above 40 GHz	1MHz	3 MHz	/	Average

Note: Data was recorded in Quasi-peak detection mode for frequency range of 9 kHz-30MHz except 9 – 90 kHz, 110 – 490 kHz, employing an average detector.

FCC §15.256(I)(5)

The provisions in § 15.35(b) and (c) of this part that require emissions to be averaged over a 100 millisecond period and that limits the peak power to 20 dB above the average limit do not apply to devices operating under paragraphs (a) through (l) of this section.

4.3.4 Test Procedure

A Maximizing procedure was performed to ensure that the highest emissions from the EUT were actually measured in all of the Test Arrangements of the EUT and Local Support Equipment.

All emissions under the average limit and under the noise floor have not recorded in the report.

For above 40GHz:

External harmonic mixers are utilized. The antenna is scanned around the entire perimeter surface of the EUT, in both horizontal and vertical polarizations. The Mixers and it`s RF cables is compose a system for calibration, the conversion factor was added into the test Spectrum Analyzer in testing.

The far-field boundary is given in ANSI C63.10-2013:

$$R_m = 2D^2 / \lambda$$

Where:

D is the largest dimension of the antenna aperture in m and

λ is the free-space wavelength in m at the frequency of measurement.

The minimum test distance for the frequency range 40GHz-231GHz determine as below:

Model	Frequency Range (GHz)	Largest Dimension of the Horn Antenna (mm)	Minimum Test Distance R_m (m)
M19RH	40-60	46.3	0.57
M12RH	60-90	30.02	0.36
M08RH	90-140	19.7	0.23
M05RH	140-220	12.5	0.15
M03RH	220-325	8.36	0.10

Note: the test distances used were 1.0 m from 40 GHz to 90 GHz, and 0.5 m from 90 GHz to 231GHz, it can be seen that the EUT was always in the Far-field of the Receive Antenna during all Radiated Emissions Tests.

4.3.5 Corrected Amplitude & Margin Calculation

The basic equation is as follows:

For 9kHz~40GHz:
The basic equation is as follows:

Result = Reading + Factor

Factor = Antenna Factor + Cable Loss- Amplifier Gain

Note: the antenna JB3 was calibrated with 6dB Attenuator, the antenna factor includes the insertion loss of the Attenuator.

The "**Margin**" column of the following data tables indicates the degree of compliance within the applicable limit. The equation for margin calculation is as follows:

Margin = Limit – Result

4.3.6 Test Data

Serial Number:	2JWL-1	Test Date:	2024/4/17~2024/4/19
Test Site:	Chamber 10, Chamber B	Test Mode:	Transmitting
Tester:	Bill Yang	Test Result:	Pass

Environmental Conditions:					
Temperature: (℃)	25.1	Relative Humidity: (%)	50~53	ATM Pressure: (kPa)	100.1~100.4

Test Equipment List and Details:

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
9kHz~1000MHz					
EMCO	Passive Loop Antenna	6512	9706-1206	2023/10/21	2024/10/20
Sunol Sciences	Hybrid Antenna	JB3	A060611-3	2024/1/12	2027/1/11
Wilson	Attenuator	859936	F-08-EM014	2023/7/1	2024/6/30
Unknown	Coaxial Cable	C-NJNJ-50	C-0075-01	2023/7/1	2024/6/30
Unknown	Coaxial Cable	C-NJNJ-50	C-0400-01	2023/7/1	2024/6/30
Unknown	Coaxial Cable	C-NJNJ-50	C-1400-01	2023/7/1	2024/6/30
Sonoma	Amplifier	310N	372193	2023/7/1	2024/6/30
R&S	EMI Test Receiver	ESR3	102453	2023/8/18	2024/8/17
Audix	Test Software	E3	191218 (V9)	N/A	N/A
Above 1GHz					
ETS-Lindgren	Horn Antenna	3115	000 527 35	2023/9/7	2026/9/6
Ducommun Technologies	Horn Antenna	ARH-4223-02	1007726-02 1304	2023/2/22	2026/2/21
Ducommun Technologies	Horn Antenna	ARH-2823-02	1007726-01 1302	2023/2/22	2026/2/21
Xinhang Macrowave	Coaxial Cable	XH750A-N/J-SMA/J-10M	20231117004 #0001	2023/11/17	2024/11/16
Xinhang Macrowave	Coaxial Cable	XH360A-2.92/J-2.92/J-6M-A	20231208001 #0001	2023/12/11	2024/12/10
AH	Preamplifier	PAM-0118P	469	2023/8/19	2024/8/18
AH	Preamplifier	PAM-1840VH	191	2023/9/7	2024/9/6
R&S	Spectrum Analyzer	FSV40	101944	2023/10/18	2024/10/17
Audix	Test Software	E3	191218 (V9)	N/A	N/A
OML	Waveguide Mixer	WR19/M19HWD	U60313-1	2023/2/16	2026/2/15
OML	Horn Antenna	M19RH	11648-01	2023/2/27	2026/2/26
OML	Waveguide Mixer	WR12/M12HWD	E60120-1	2023/2/16	2026/2/15
OML	Horn Antenna	M12RH	E60120-2	2023/2/27	2026/2/26
OML	Waveguide Mixer	WR08/M08HWD	F60313-1	2023/2/16	2026/2/15
OML	Horn Antenna	M08RH	F60313-2	2023/2/27	2026/2/26
OML	Waveguide Mixer	WR05/M05HWD	G60106-1	2023/2/16	2026/2/15
OML	Horn Antenna	M05RH	G60106-2	2023/2/27	2026/2/26

Resenberger	Coaxial Cable	LU7-022-1000	0031	2024/3/1	2025/2/28

** Statement of Traceability: Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).*

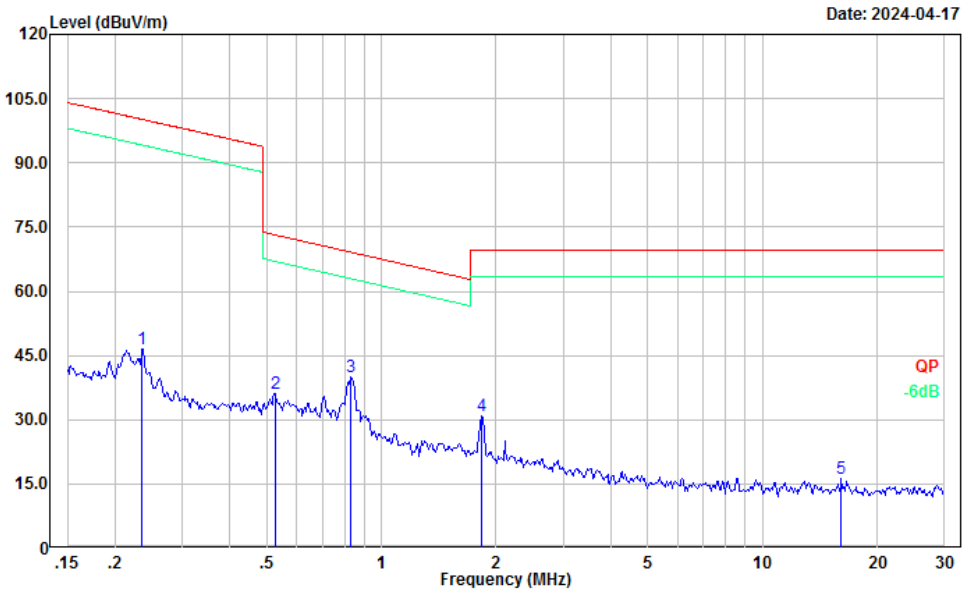
Test Data:

Please refer to the below table and plots.

After pre-scan in the X, Y and Z axes of orientation, the worst case is below:

1) 9kHz~30MHz

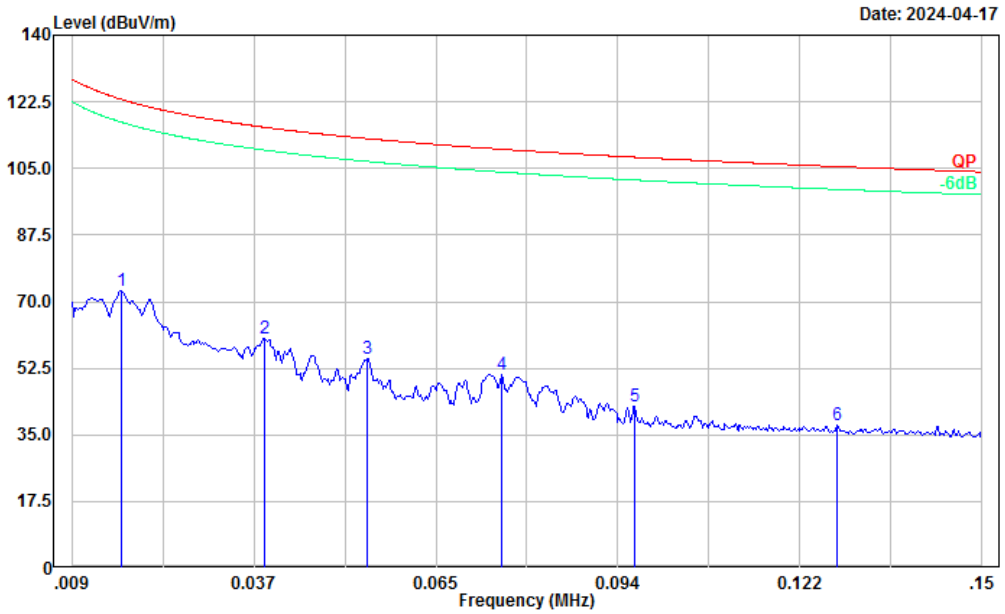
Project No.: 2402S46928E-RF Serial No.: 2JWL-1
Polarization: Parallel Tester: Bill Yang
Test Mode: Transmitting
Note:



No.	Frequency (MHz)	Reading (dBµV)	Factor (dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
1	0.24	578.18	-531.60	46.58	100.15	53.57	Peak
2	0.53	567.66	-531.61	36.05	73.13	37.08	Peak
3	0.83	571.66	-531.56	40.10	69.11	29.01	Peak
4	1.83	562.44	-531.49	30.95	69.54	38.59	Peak
5	16.11	547.34	-531.13	16.21	69.54	53.33	Peak

Project No.: 2402S46928E-RF
Polarization: Vertical
Test Mode: Transmitting
Note:

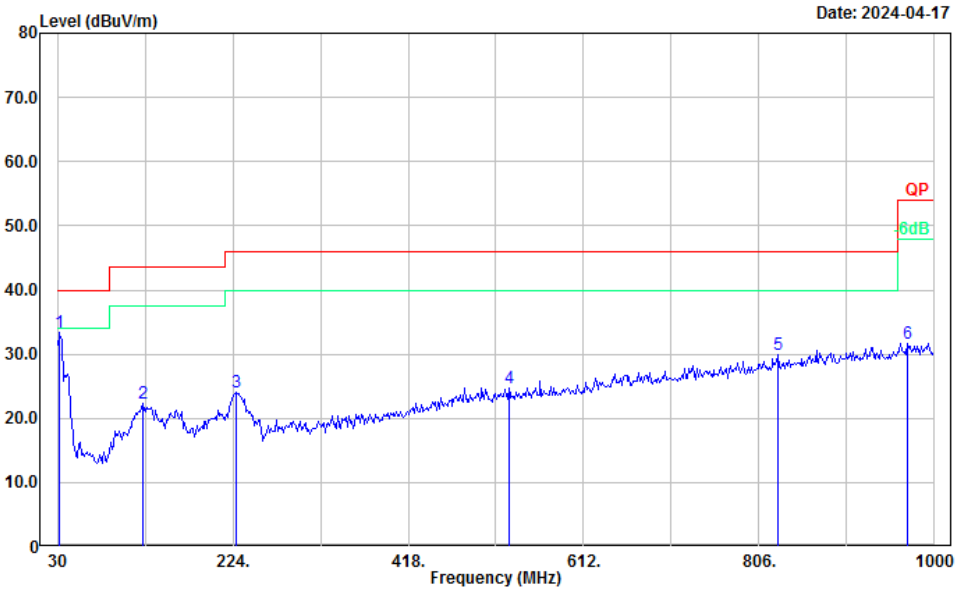
Serial No.: 2JWL-1
Tester: Bill Yang



No.	Frequency (MHz)	Reading (dBµV)	Factor (dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
1	0.02	22.75	50.00	72.75	123.12	50.37	Peak
2	0.04	15.27	45.07	60.34	115.82	55.48	Peak
3	0.05	12.72	42.32	55.04	112.83	57.79	Peak
4	0.08	12.11	38.77	50.88	110.03	59.15	Peak
5	0.10	7.20	35.17	42.37	107.94	65.57	Peak
6	0.13	4.50	32.99	37.49	105.49	68.00	Peak

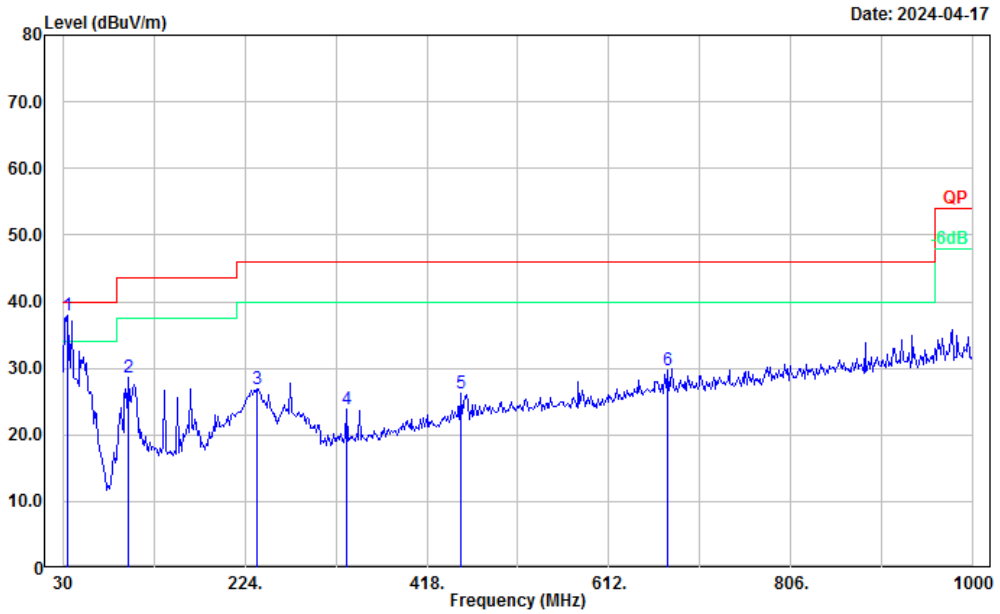
2) 30MHz-1GHz

Project No.: 2402S46928E-RF Serial No.: 2JWL-1
Polarization: Horizontal Tester: Bill Yang
Test Mode: Transmitting
Note:



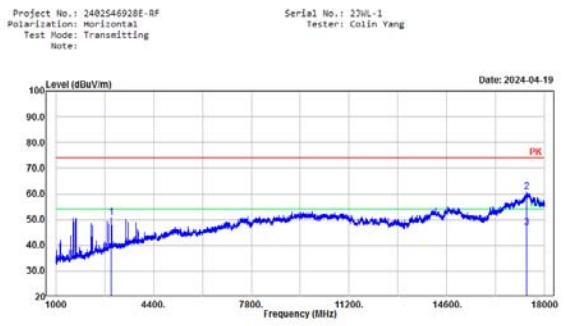
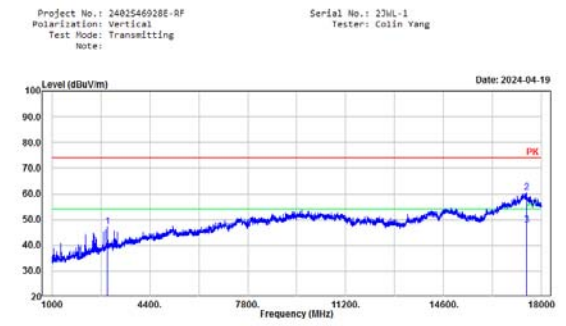
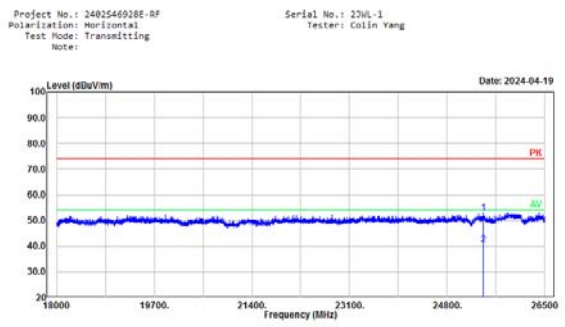
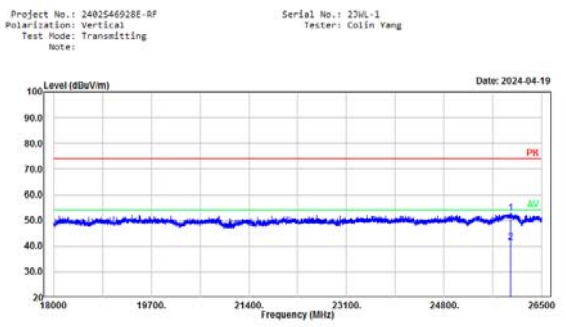
No.	Frequency (MHz)	Reading (dBµV)	Factor (dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
1	32.81	38.27	-4.95	33.32	40.00	6.68	Peak
2	124.19	32.21	-9.95	22.26	43.50	21.24	Peak
3	228.22	34.87	-10.86	24.01	46.00	21.99	Peak
4	529.06	28.24	-3.45	24.79	46.00	21.21	Peak
5	827.09	28.06	1.83	29.89	46.00	16.11	Peak
6	970.48	26.74	4.83	31.57	54.00	22.43	Peak

Project No.: 2402S46928E-RF Serial No.: 2JWL-1
Polarization: Vertical Tester: Bill Yang
Test Mode: Transmitting
Note:



No.	Frequency (MHz)	Reading (dBµV)	Factor (dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
1	35.62	44.75	-6.79	37.96	40.00	2.04	QP
2	100.29	41.94	-13.26	28.68	43.50	14.82	Peak
3	236.65	37.87	-10.94	26.93	46.00	19.07	Peak
4	332.25	32.06	-8.17	23.89	46.00	22.11	Peak
5	454.55	30.96	-4.65	26.31	46.00	19.69	Peak
6	673.86	30.51	-0.75	29.76	46.00	16.24	Peak

2) 1GHz-40GHz:

Horizontal	Vertical
	
	

Project No.: 2402S46928E-RF
Polarization: Horizontal
Test Mode: Transmitting
Note:
Serial No.: 23WL-1
Tester: Colin Yang
Date: 2024-04-19
Level (dBuV/m)
Frequency (MHz)

No.	Frequency (MHz)	Reading (dBμV)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
1	2917.60	57.22	-6.45	50.77	74.00	23.23	Peak
2	17377.80	45.82	14.90	60.72	74.00	13.28	Peak
3	17377.80	32.09	14.90	46.99	54.00	7.01	Average

Project No.: 2402S46928E-RF
Polarization: Vertical
Test Mode: Transmitting
Note:
Serial No.: 23WL-1
Tester: Colin Yang
Date: 2024-04-19
Level (dBuV/m)
Frequency (MHz)

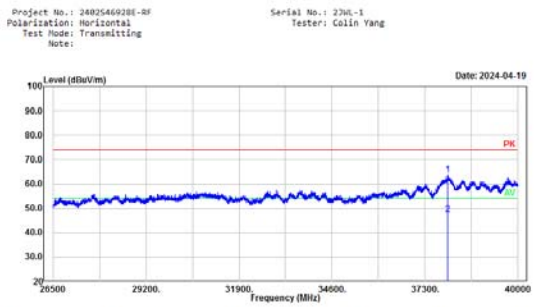
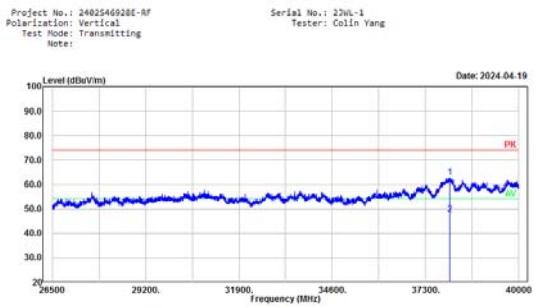
No.	Frequency (MHz)	Reading (dBμV)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
1	2917.60	53.69	-6.45	47.24	74.00	26.76	Peak
2	17476.40	44.88	15.68	60.56	74.00	13.44	Peak
3	17476.40	32.15	15.68	47.83	54.00	6.17	Average

Project No.: 2402S46928E-RF
Polarization: Horizontal
Test Mode: Transmitting
Note:
Serial No.: 23WL-1
Tester: Colin Yang
Date: 2024-04-19
Level (dBuV/m)
Frequency (MHz)

No.	Frequency (MHz)	Reading (dBμV)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
1	25432.40	42.94	9.88	52.82	74.00	21.18	Peak
2	25432.40	30.70	9.88	40.58	54.00	13.42	Average

Project No.: 2402S46928E-RF
Polarization: Vertical
Test Mode: Transmitting
Note:
Serial No.: 23WL-1
Tester: Colin Yang
Date: 2024-04-19
Level (dBuV/m)
Frequency (MHz)

No.	Frequency (MHz)	Reading (dBμV)	Factor (dB/m)	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Detector
1	25952.60	42.23	10.76	52.99	74.00	21.01	Peak
2	25952.60	30.69	10.76	41.45	54.00	12.55	Average

Horizontal	Vertical
	

No.	Frequency (MHz)	Reading (dBµV)	Factor (dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
1	37953.40	46.02	17.71	63.73	74.00	10.27	Peak
2	37953.40	29.77	17.71	47.48	54.00	6.52	Average

No.	Frequency (MHz)	Reading (dBµV)	Factor (dB/m)	Result (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Detector
1	37991.20	45.06	17.89	62.95	74.00	11.05	Peak
2	37991.20	29.74	17.89	47.63	54.00	6.37	Average

3) 40GHz-200GHz:

Frequency (GHz)	Reading (dBμV)	Detector	Polar (H/V)	Factor (dB/m)	Field Strength@3m (dBμV/m)	Limits@3m (dBμV/m)	Margin (dB)
41.320	20.32	AV	H	39.00	49.78	54.00	4.22
42.160	20.65	AV	V	39.13	50.24	54.00	3.76
62.320	18.26	AV	H	42.27	50.99	54.00	3.01
61.570	18.24	AV	V	42.15	50.85	54.00	3.15
91.470	19.65	AV	H	45.29	49.38	54.00	4.62
92.060	20.16	AV	V	45.36	49.96	54.00	4.04
141.320	17.50	AV	H	48.95	50.89	54.00	3.11
142.000	17.55	AV	V	48.98	50.97	54.00	3.03

Note:
Factor = Antenna Factor
Field Strength = Reading + Factor + 20log(d_{Meas}/$d_{SpecLimit}$)
d_{Meas} is the measurement distance, in m
The Specified distance is 3m.

4.4 Emission Bandwidth:

4.4.1 Applicable Standard

FCC §15.256(f)

The fundamental bandwidth of an LPR emission is defined as the width of the signal between two points, one below and one above the center frequency, outside of which all emissions are attenuated by at least 10 dB relative to the maximum transmitter output power when measured in an equivalent resolution bandwidth.
(1) The minimum fundamental emission bandwidth shall be 50 MHz for LPR operation under the provisions of this section.
(2) LPR devices operating under this section must confine their fundamental emission bandwidth within the 5.925–7.250 GHz, 24.05–29.00 GHz, and 75–85 GHz bands under all conditions of operation.

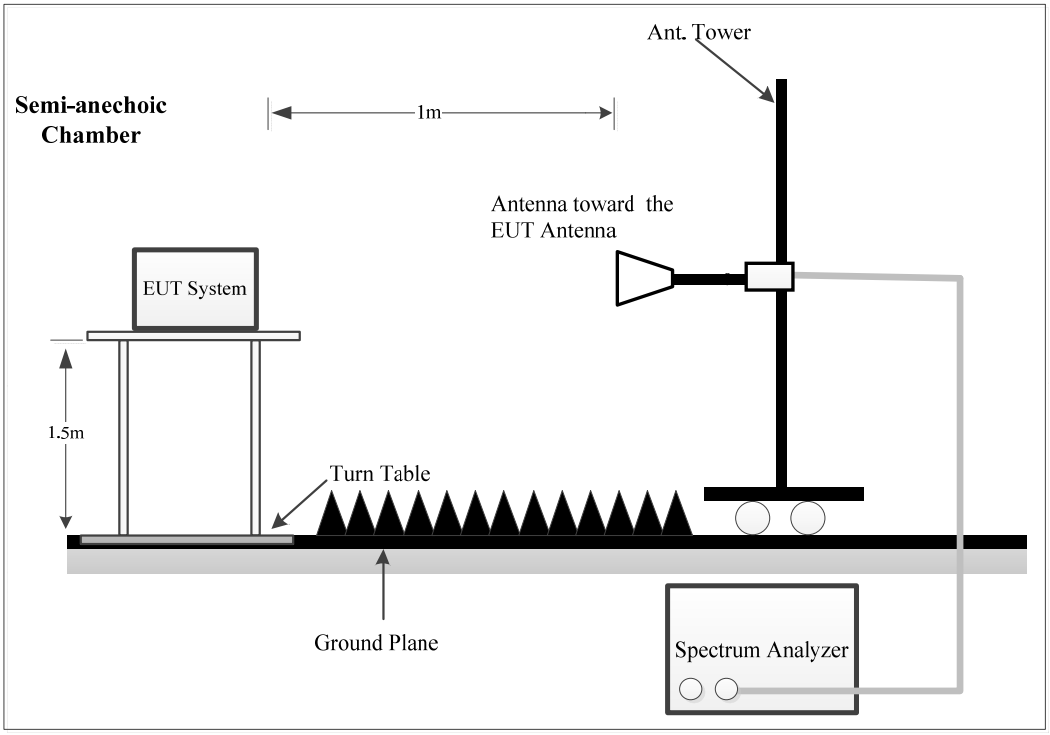
RSS-211, Clause 5.1

(a) The minimum fundamental emission bandwidth shall be 50 MHz.
(b) The fundamental emission bandwidth shall be confined within the designated device operating bands under all conditions.
(c) The sweep, step or hop function is never stopped with the fundamental emission within any restricted band specified in RSS-Gen.

RSS-Gen Clause 6.7

The occupied bandwidth or the "99% emission bandwidth" is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.
In some cases, the "x dB bandwidth" is required, which is defined as the frequency range between two points, one at the lowest frequency below and one at the highest frequency above the carrier frequency, at which the maximum power level of the transmitted emission is attenuated x dB below the maximum in-band power level of the modulated signal, where the two points are on the outskirts of the in-band emission.
The following conditions shall be observed for measuring the occupied bandwidth and x dB bandwidth:
The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.
The detector of the spectrum analyzer shall be set to "Sample". However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or "Max Hold") may be necessary to determine the occupied / x dB bandwidth if the device is not transmitting continuously.
The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / x dB bandwidth and the video bandwidth (VBW) shall not be smaller than three times the RBW value. Video averaging is not permitted.
Note: It may be necessary to repeat the measurement a few times until the RBW and VBW are in compliance with the above requirement.
For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).

4.4.2 EUT Setup



Place the measurement antenna in the main beam of the EUT then maximize the fundamental emission, noting that multiple peaks can be found at different beam orientations and/or polarizations.

4.4.3 Test Procedure

FCC §15.256(I) Measurement procedures

The fundamental emission bandwidth measurement shall be made using a peak detector with a resolution bandwidth of 1 MHz and a video bandwidth of at least 3 MHz.

RSS-211, Clause 4 Measurement Method

The fundamental emission bandwidth measurement shall be made using a peak detector with a resolution bandwidth of 1 MHz and a video bandwidth of at least 3 MHz.

According to ANSI C63.10-2013 Section 6.9.3

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission.
The following procedure shall be used for measuring 99% power bandwidth:
a) The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.
b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW, unless otherwise specified by the applicable requirement.
c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.
d) Step a) through step c) might require iteration to adjust within the specified range.

e) Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.
f) Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth.
g) If the instrument does not have a 99% power bandwidth function, then the trace data points are recovered and directly summed in linear power terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% power bandwidth is the difference between these two frequencies.
h) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

4.4.4 Test Data

Serial Number:	2JWL-1	Test Date:	2024/4/20~2024/4/24
Test Site:	Chamber B	Test Mode:	Swept
Tester:	Bill Yang	Test Result:	N/A

Environmental Conditions:					
Temperature: (℃)	23~25.1	Relative Humidity: (%)	53~63	ATM Pressure: (kPa)	100.2~100.4

Test Equipment List and Details:

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
OML	Waveguide Mixer	WR12/M12HWD	E60120-1	2023/2/16	2026/2/15
OML	Horn Antenna	M12RH	E60120-2	2023/2/27	2026/2/26
R&S	Spectrum Analyzer	FSV40	101944	2023/10/18	2024/10/17
Resenberger	Coaxial Cable	LU7-022-1000	0031	2024/3/1	2025/2/28

** Statement of Traceability: Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).*

Test Data:

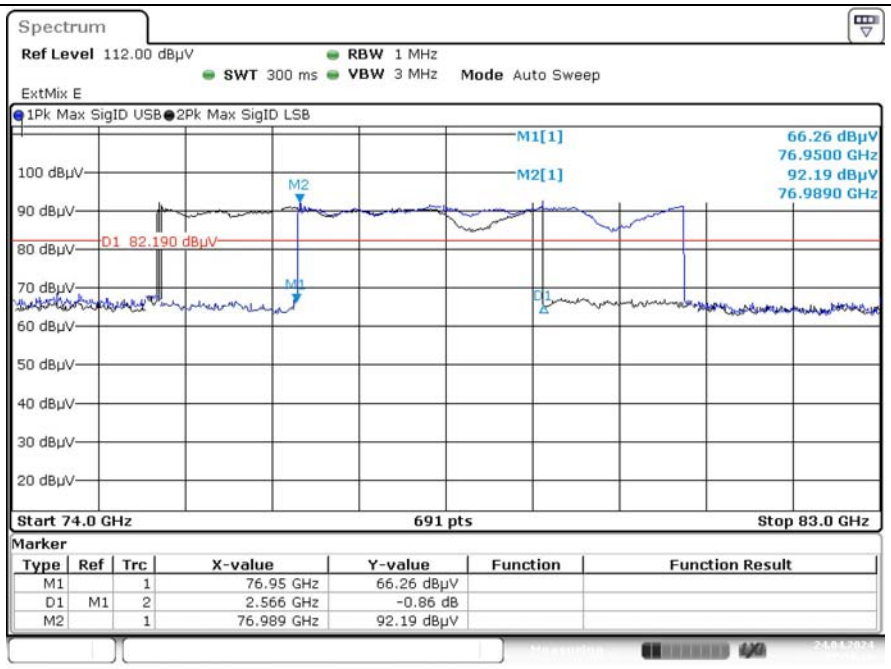
10 dB Emission Bandwidth:

10dB Emission Bandwidth (GHz)	10dB Emission Bandwidth Limit (GHz)	F_L (GHz)	F_L Limit (GHz)	F_H (GHz)	F_H Limit (GHz)
2.566	>0.05	76.95	>75	79.516	<85
$F_H = F_L$ + Bandwidth=76.95+2.566=79.516GHz					

99% Occupied Bandwidth

F_L (GHz)	F_H (GHz)	99% Occupied Bandwidth (GHz)
76.963	79.516	2.553
The 99% power bandwidth is the difference between these 99.5% power frequencies of upper and lower.		

10dB Emission Bandwidth



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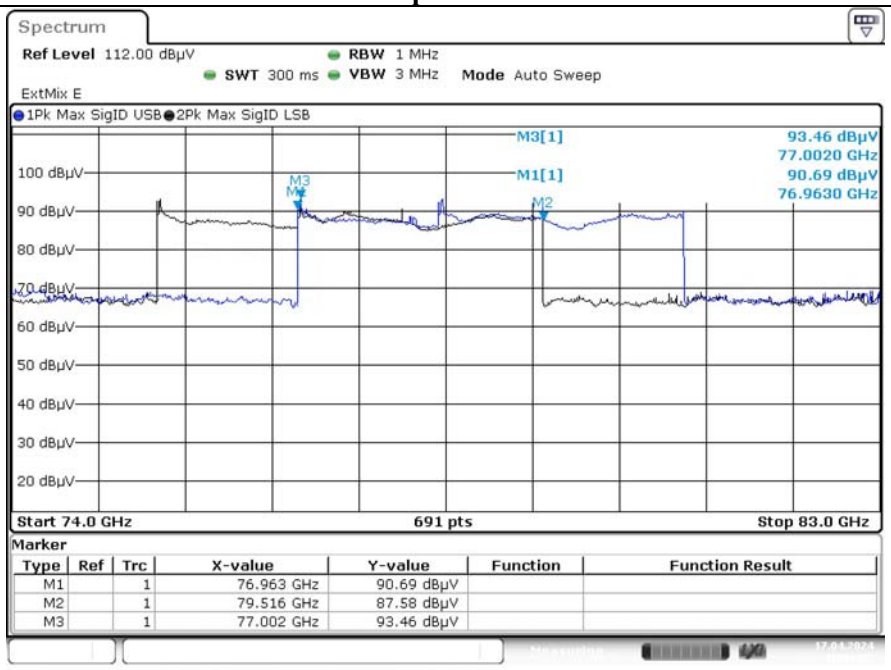
Date: 24.APR.2024 07:58:14

99% Occupied Bandwidth



ProjectNo.:2402S46928E-RF Tester:Bill Yang

Date: 17.APR.2024 18:06:07

4.5 Antenna Requirement

4.5.1 Applicable Standard

FCC §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 use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §§15.211, 15.213, 15.217, 15.219, 15.221, or §15.236. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

FCC §15.256 (i) (B)

LPR devices operating under the provisions of this section within the 75 – 85 GHz band must use an antenna with a -3 dB beamwidth no greater than 8 degrees.

FCC §15.256 (j)

Antenna side lobe gain. LPR devices operating under the provisions of this section must limit the side lobe antenna gain relative to the main beam gain for off-axis angles from the main beam of greater than 60 degrees to the levels provided in Table 2.

Table 2—Antenna Side Lobe Gain Limits

Frequency range (GHz)	Antenna side lobe gain limit relative to main beam gain (dB)
5.925–7.250	–22
24.05–29.00	–27
75–85	–38

RSS-Gen Clause 6.8

The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report (and in the notice to be included in the user manual, provided below).
When measurements at the antenna port are used to determine the RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer.
The test report shall state the RF power, output power setting and spurious emission measurements with each antenna type that is used with the transmitter being tested.
For licence-exempt equipment with detachable antennas, the user manual shall also contain the following notice in a conspicuous location:
This radio transmitter [enter the device's ISED certification number] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Immediately following the above notice, the manufacturer shall provide a list of all antenna types which can be used with the transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna type.

RSS-211 Clause 5.2(a)

For devices operating in open-air environments, the antenna shall have a maximum half-power beamwidth of 12° for the bands 5.65-8.5 GHz and 24.05-29 GHz, and a maximum half-power beamwidth of 8° for the band 75-85 GHz.

RSS-211 Clause 5.2(c)

LPR devices must limit the antenna side lobe gain relative to the main beam gain for off-axis angles from the main beam of greater than 60° for the levels provided in Table 2.

Table 2: Antenna Side Lobe Gain Limits

Frequency Band (GHz)	Antenna Side Lobe Gain Limit Relative to Main Beam Gain (dB)
5.65-8.50	-22
24.05-29.00	-27
75-85	-38

The standard ETSI EN 302 729 contains measurement techniques for the LPR "boresight-axis" method.

4.5.2 Judgment

Compliant. Please refer to the Antenna Information below provided by manufacturer. And antenna report for more detail. ▲

Antenna Type	Antenna Gain (dBi)	Half-power beam angle		antenna side lobe gain (dB)	
		Value	Limit	Value	Limit
Integrated	27.5 dBi	7.5°	8°	-40	-38

APPENDIX A - EUT PHOTOGRAPHS

Please refer to the attachment 2402S46928E-RF-EXP EUT external photographs and 2402S46928E-RF-INP EUT internal photographs.

APPENDIX B - TEST SETUP PHOTOGRAPHS

Please refer to the attachment 2402S46928E-RF-00-TSP test setup photographs.

APPENDIX C - RF EXPOSURE EVALUATION

Maximum Permissible Exposure (MPE)

Applicable Standard

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/f²)	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.

Procedure

Prediction of power density at the distance of the applicable MPE limit
$S = PG/4\pi R^2$ = 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:

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

Measurement Result

For Radar:

Frequency (GHz)	Peak EIRP including Tune-up Tolerance		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
	(dBm)	(mW)			
76-81	2	1.58	20	0.001	1.0

The devices contain a certified BLE module, FCC ID: 2ABN2-BG22A3:

Operation Modes	Frequency (MHz)	Antenna Gain		Conducted output power including Tune-up Tolerance		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
		(dBi)	(numeric)	(dBm)	(mW)			
BLE	2402-2480	-0.02	1.00	5.97	3.95	20.00	0.0008	1.0

The BLE and Radar can transmit simultaneously:

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

$=S_{BLE}/S_{limit-\ BLE}+ S_{Radar}/S_{limit-\ Radar}$

=0.001/1+0.0008/1

=0.0018

< 1.0

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

Exemption Limits For Routine Evaluation-RF Exposure Evaluation

Applicable Standard

According to RSS-102 Clause 2.5.2:

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

• below 20 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);

• at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $4.49/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz;

• at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);

• at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2}\ f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;

• at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

Calculated Data:

For Radar:

Frequency (GHz)	Peak EIRP including Tune-up Tolerance		Exemption limits (mW)
	(dBm)	(mW)	
76-81	2	1.58	5000

Note:The Conducted output power including Tune-up Tolerance provided by manufacturer.

The devices contain a certified BLE module, IC: 23949-BG22A3

Frequency (MHz)	Conducted Output power including Tune-up Tolerance (dBm)	Antenna Gain (dBi)	EIRP		Exemption limits (mW)
			dBm	mW	
2402-2480	5.97	-0.02	5.95	3.94	2676

Result: Compliant, the device is compliance exemption from Routine Evaluation Limits –RF exposure Evaluation.

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