TEST REPORT

Product Name	:	SX1262 868/915M LoRaWAN/GNSS HAT
Brand Name	:	N/A
Model	:	SX1262 868/915M LoRaWAN/GNSS HAT
Series Model	:	SX1262 868/915M LoRaWAN HAT, Core1262-HF, Core1262-LF Pico-LoRa-SX1262-868M, Pico-LoRa-SX1262-915M, SX1262-LoRa-DTU-HF, SX1262-LoRa-DTU-HF-Kit, SX1262 868M LoRa HAT, SX1262 915M LoRa HAT
FCC ID	:	2BHC7-WAVESHARE2502
Applicant	:	**Shenzhen waveshare Electronics Co.,Ltd.**
Address	:	202 2F, World Trade Plaza Funan Community Futian Street, Futian District, Shenzhen
Manufacturer	:	**Shenzhen waveshare Electronics Co.,Ltd.**
Address	:	202 2F, World Trade Plaza Funan Community Futian Street, Futian District, Shenzhen
Standard(s)	:	FCC CFR Title 47 Part 15 Subpart C Section 15.247
Date of Receipt	:	Jan. 09, 2025
Date of Test	:	Jan. 10, 2025~ Jan. 16, 2025
Issued Date	:	Jan. 17, 2025

Issued By: **Guangdong Asia Hongke Test Technology Limited**

B1/F, Building 11, Junfeng Industrial Park, Chongqing Road, Heping Community, Fuhai Street, Bao'an District, Shenzhen, Guangdong, China

Tel.: +86 0755-230967639 Fax.: +86 0755-230967639

Reviewed by: Leon Yi
Leon.yi

Approved by: Sean She
Sean She

Report Revise Record

Report Version	Issued Date	Notes
M1	Jan. 17, 2025	Initial Release

Contents

1 TEST SUMMARY

1.1 Test Standards

The tests were performed according to following standards:

FCC Rules Part 15.247: Frequency Hopping, Direct Spread Spectrum and Hybrid Systems that are in operation within the bands of 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz

ANSI C63.10: 2013: American National Standard for Testing Unlicensed Wireless Devices

KDB558074 D01 15.247 Meas Guidance v05r02: Guidance for Compliance Measurements on Digital Transmission System, Frequency Hopping Spreda Spectrum System, and Hybrid System Devices Operating Under Section 15.247 of the FCC Rules

1.2 Test Summary

Test Item	Section in 47 CFR	Result
Maximum Conducted Output Power	§15.247(b)	Pass
Power Spectral Density	§15.247(b)	Pass
20dB Bandwidth	§15.247(a)	Pass
Frequency Separation	§15.247(a)	Pass
Number Of Hopping Frequency	§15.247(a)	Pass
Time Of Occupancy (Dwell Time)	§15.247(a)	Pass
Conducted Spurious Emissions and Band Edges Emissions	§15.205, §15.247(d)	Pass
Radiated Spurious Emissions	§15.209, §15.247(d)	Pass
Emissions at Restricted Band	§15.205	Pass
AC Mains Conducted Emissions	§15.207(a)	Pass
Antenna Requirements	§15.203	Pass

1.3 Test Facility

Test Laboratory:
Guangdong Asia Hongke Test Technology Limited
B1/F, Building 11, Junfeng Industrial Park, Chongqing Road, Heping Community, Fuhai Street, Bao'an District, Shenzhen, Guangdong, China

The test facility is recognized, certified or accredited by the following organizations:
FCC-Registration No.: 251906 Designation Number: CN1376
Guangdong Asia Hongke Test Technology Limited has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files.

IC —Registration No.: 31737 CAB identifier: CN0165
The 3m Semi-anechoic chamber of Guangdong Asia Hongke Test Technology Limited has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No.: 31737

A2LA-Lab Cert. No.: 7133.01
Guangdong Asia Hongke Test Technology Limited has been accredited by A2LA for technical competence in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025: 2017 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the identified field of testing.

1.4 Measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report according to CISPR 16 - 4 “Specification for radio disturbance and immunity measuring apparatus and methods – Part 4: Uncertainty in EMC Measurements” and is documented in the Guangdong Asia Hongke Test Technology Limited’s quality system according to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.
Hereafter the best measurement capability for Asia Hongke laboratory is reported:

Test	Measurement Uncertainty	Notes
Power Line Conducted Emission	9KHz~30MHz ±1.20 dB	(1)
Radiated Emission	9KHz~30MHz ±3.10dB	(1)
Radiated Emission	30MHz~1GHz ±3.75dB	(1)
Radiated Emission	1GHz~18GHz ±3.88 dB	(1)
Radiated Emission	18GHz-40GHz ±3.88dB	(1)
RF power, conducted	30MHz~6GHz ±0.16dB	(1)
RF power density, conducted	±0.24dB	(1)
Spurious emissions, conducted	±0.21dB	(1)
Temperature	±1℃	(1)
Humidity	±3%	(1)
DC and low frequency voltages	±1.5%	(1)
Time	±2%	(1)
Duty cycle	±2%	(1)
Bandwidth	±1.5 x10^{-6}	(1)

The report uncertainty of measurement y ± U, where expended uncertainty U is based on a standard uncertainty Multiplied by a coverage factor of k=2 , providing a level of confidence of approximately 95%.

2 GENGENERAL INFORMATION

2.1 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Normal Temperature:	25°C
Relative Humidity:	55 %
Air Pressure:	101 kPa

2.2 General Description of EUT

Product Name:	SX1262 868/915M LoRaWAN/GNSS HAT
Model:	SX1262 868/915M LoRaWAN/GNSS HAT
Serial Model:	SX1262 868/915M LoRaWAN HAT, Core1262-HF, Core1262-LF Pico-LoRa-SX1262-868M, Pico-LoRa-SX1262-915M, SX1262-LoRa-DTU-HF, SX1262-LoRa-DTU-HF-Kit, SX1262 868M LoRa HAT, SX1262 915M LoRa HAT
Power Rating:	Input: DC 5V/3A
Hardware Version:	N/A
Software Version:	N/A
Sample(s) Status:	AiTDG-250109017-1(Normal sample) AiTDG-250109017-2(Engineer sample)
Lora 125KHz(Hybrid):	
Operation frequency:	902.3MHz~914.9MHz
Modulation:	LoRa
Channel number:	64
Channel separation:	200KHz
Antenna type:	External antenna
Antenna gain:	2.0 dBi
Remark: The above DUT's information was declared by manufacturer. For more detailed features description, please refer to the manufacturer's specifications or the User's Manual.	

2.3 Description of Test Modes and Test Frequency

The Applicant provides communication tools software to control the EUT for staying in continuous transmitting (Duty Cycle more than 98%) and receiving mode for testing.There are 64 channels provided to the EUT and Channel 00/32/63 were selected to test.

Operation Frequency List:

Channel	Frequency (MHz)
00	**902.3**
01	902.5
⋮	⋮
31	908.5
32	**908.7**
30	908.9
⋮	⋮
62	914.7
63	**914.9**

Note: The line display in grey were the channel selected for testing

Exploratory testing was performed under each mode combination test channel; only the final measurement of the worst combination was made and recorded in this report.

Test case	**Exploratory measurement**			**Final measurement Recorded In Report**		
	Mode	**Date rate**	**Channel**	**Mode**	**Date rate**	**Channel**
Frequency Separation	Lora	Lora DR0 Lora DR1 Lora DR2 Lora DR3	☒ Lowest ☒ Middle ☒ Highest	Lora	Lora DR0	☒ Middle
Number Of Hopping Frequency	Lora	Lora DR0 Lora DR1 Lora DR2 Lora DR3	☒ Full	Lora	Lora DR0	☒ Full
Time of Occupancy (dwell time)	Lora	Lora DR0 Lora DR1 Lora DR2 Lora DR3	☒ Lowest ☒ Middle ☒ Highest	Lora	Lora DR0	☒ Middle
20dB bandwidth	Lora	Lora DR0 Lora DR1 Lora DR2 Lora DR3	☒ Lowest ☒ Middle ☒ Highest	Lora	Lora DR0	☒ Lowest ☒ Middle ☒ Highest
Maximum Conducted Output Power	Lora	Lora DR0 Lora DR1 Lora DR2 Lora DR3	☒ Lowest ☒ Middle ☒ Highest	Lora	Lora DR0	☒ Lowest ☒ Middle ☒ Highest
Conducted Band edge	Lora	Lora DR0 Lora DR1 Lora DR2 Lora DR3	☒ Lowest ☒ Highest	Lora	Lora DR0	☒ Lowest ☒ Highest
Conducted Spurious Emissions	Lora	Lora DR0 Lora DR1 Lora DR2 Lora DR3	☒ Lowest ☒ Middle ☒ Highest	Lora	Lora DR0	☒ Lowest ☒ Middle ☒ Highest
Radiated Spurious Emissions Above 1GHz	Lora	Lora DR0 Lora DR1 Lora DR2 Lora DR3	☒ Lowest ☒ Middle ☒ Highest	Lora	Lora DR0	☒ Lowest ☒ Middle ☒ Highest
Radiated Spurious Emissions Below 1GHz	Lora	Lora DR0 Lora DR1 Lora DR2 Lora DR3	☒ Lowest ☒ Middle ☒ Highest	Lora	Lora DR0	☒ Lowest ☒ Highest

&Radiated Band edge						
Conducted Emissions 9KHz-30 MHz	Lora	Lora DR0 Lora DR1 Lora DR2 Lora DR3	☒ Lowest ☒ Middle ☒ Highest	Lora	Lora DR0	☒ Middle

Note: DR means DateRate refer to LoRaWAN Specification as below:

DataRate	Configuration	Indicative physical bit rate [bit/sec]
0	LoRa: SF10 / 125 kHz	980
1	LoRa: SF9 / 125 kHz	1760
2	LoRa: SF8 / 125 kHz	3125
3	LoRa: SF7 / 125 kHz	5470
4	LoRa: SF8 / 500 kHz	12500

Power setting during the test:

During testing, Channel & Power Controlling Software provided by the customer was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the customer and is going to be fixed on the firmware of the final end product.

Power Parameters:

Test Software Version	CMD command		
Channel	Low	Middle	High
Lora	default	default	default

2.4 Special Accessories

Follow auxiliary equipment(s) test with EUT that provided by the manufacturer or laboratory is listed as follow:

Description	Manufacturer	Model	Serial No.	Provided by	Other
Adapter	/	BI18-050300-I	/	Manufacturer	/
/	/	/	/	/	/

2.5 Equipment List for the Test

No	Test Equipment	Manufacturer	Model No	Serial No	Cal. Date	Cal. Due Date
1	EMI Measuring Receiver	R&S	ESR	101160	2024.09.25	2025.09.24
2	Spectrum Analyzer	R&S	FSV40	101470	2024.09.23	2025.09.22
3	Low Noise Pre Amplifier	SCHWARZBECK	BBV 9745	00282	2024.09.25	2025.09.24
4	Low Noise Pre Amplifier	CESHENG	CSKJLNA231016A	CSKJLNA231016A	2024.09.25	2025.09.24
5	Passive Loop	ETS	6512	00165355	2024.08.29	2027.08.28
6	TRILOG Super Broadband test Antenna	SCHWARZBECK	VULB9168	01434	2024.08.29	2027.08.28
7	Broadband Horn Antenna	Schwarzbeck	BBHA 9120D	452	2024.08.29	2027.08.28
8	Horn Antenna 15-40GHz	SCHWARZBECK	BBHA9170	BBHA9170367	2024.08.28	2027.08.27
9	6dB Attenuator	JFW	50FPE-006	4360846-949-1	2024.09.24	2025.09.23

10	EMI Test Receiver	R&S	ESPI	100771	2024.09.25	2025.09.24
11	LISN	R&S	NNLK 8129	8130179	2024.09.24	2025.09.23
12	LISN	R&S	ESH3-Z5	892785/016	2024.09.23	2025.09.22
13	Pulse Limiter	R&S	ESH3-Z2	102789	2024.09.24	2025.09.23
14	RF Automatic Test system	TST	TSTPASS	21033016	2024.09.25	2025.09.24
15	Vector Signal Generator	Agilent	N5182A	MY50143009	2024.09.25	2025.09.24
16	Analog signal generator	Agilent	E8257	MY51554256	2024.09.25	2025.09.24
17	Spectrum Analyzer	Agilent	N9020A	MY51289843	2024.09.25	2025.09.24
18	Spectrum Analyzer	Agilent	N9020A	MY53421570	2024.09.25	2025.09.24
19	Power Sensor	Agilent	8481A	MY41097697	2024.09.25	2025.09.24
20	Wideband Radio communication tester	R&S	CMW500	1201.0002K50	2024.09.24	2025.09.23
21	DC power supply	ZHAOXIN	RXN-305D-2	28070002559	N/A	N/A
22	RE Software	EZ	EZ-EMC_RE	Ver.AIT-03A	N/A	N/A
23	CE Software	EZ	EZ-EMC_CE	Ver.AIT-03A	N/A	N/A
24	RF Software	TST	TSTPASS	Version 2.0	N/A	N/A
25	RF Software	cesheng	WCS-WCN	Version 2024.6.20	N/A	N/A
26	temporary antenna connector(Note)	NTS	R001	N/A	N/A	N/A
Note: The temporary antenna connector is soldered on the PCB board in order to perform conducted tests and this temporary antenna connector is listed in the equipment list.						

3 TEST CONDITIONS AND RESULTS

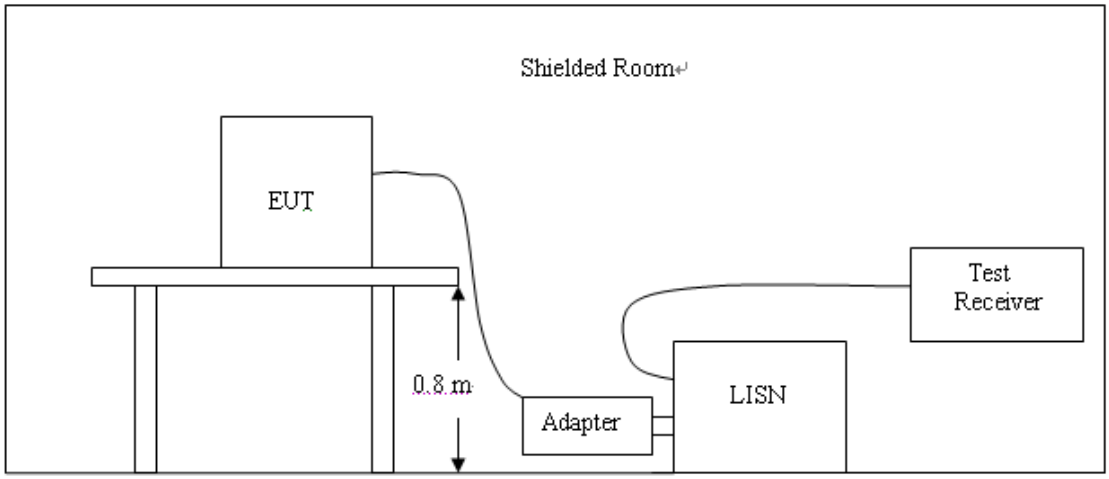
3.1 Conducted Emissions Test

LIMIT

Frequency range (MHz)	Limit (dBuV)	
	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.

TEST CONFIGURATION



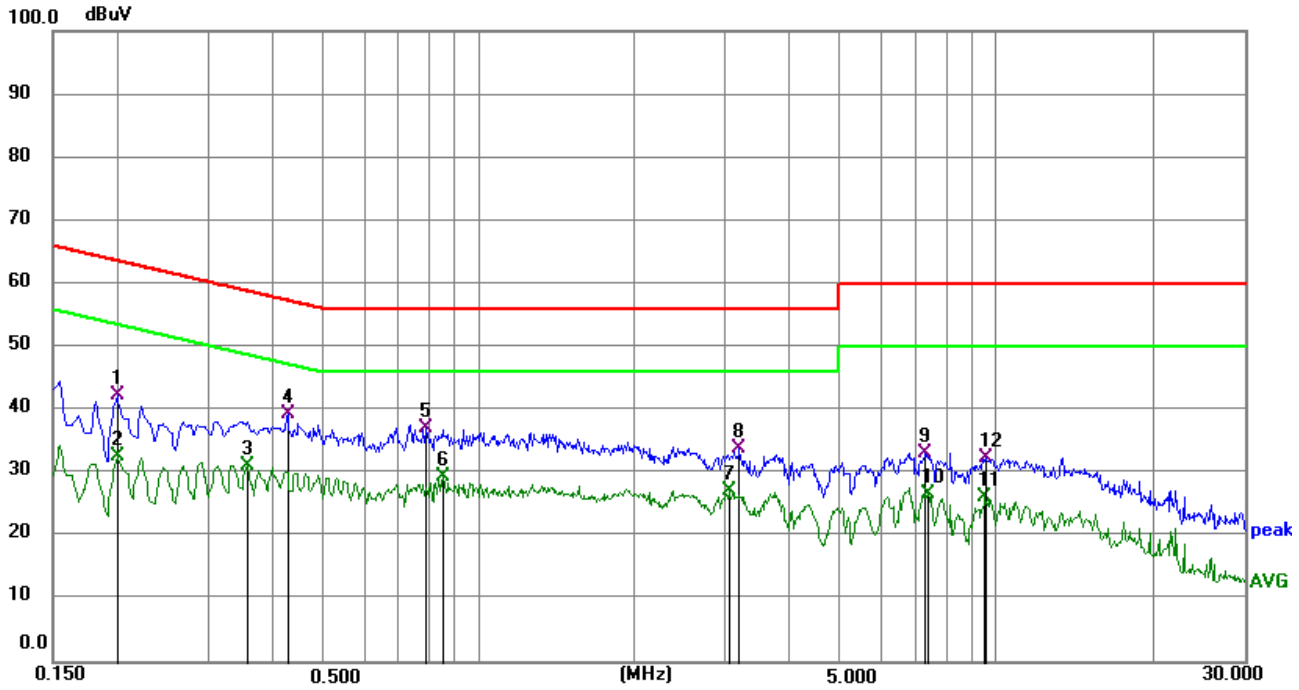
TEST PROCEDURE

1. The equipment was set up as per the test configuration to simulate typical actual usage per the user's manual. The EUT is a tabletop system; a wooden table with a height of 0.8 meters is used and is placed on the ground plane as per ANSI C63.10:2013.
2. Support equipment, if needed, was placed as per ANSI C63.10:2013.
3. All I/O cables were positioned to simulate typical actual usage as per ANSI C63.10:2013.
4. The adapter received AC120V/60Hz power through a Line Impedance Stabilization Network (LISN) which supplied power source and was grounded to the ground plane.
5. All support equipments received AC power from a second LISN, if any.
6. The EUT test program was started. Emissions were measured on each current carrying line of the EUT using a spectrum Analyzer / Receiver connected to the LISN powering the EUT. The LISN has two monitoring points: Line 1 (Hot Side) and Line 2 (Neutral Side). Two scans were taken: one with Line 1 connected to Analyzer / Receiver and Line 2 connected to a 50 ohm load; the second scan had Line 1 connected to a 50 ohm load and Line 2 connected to the Analyzer / Receiver.
7. Analyzer / Receiver scanned from 150 KHz to 30MHz for emissions in each of the test modes.
8. During the above scans, the emissions were maximized by cable manipulation.

TEST RESULTS

Remark: Both 120 VAC, 50/60 Hz and 240 VAC, 50/60 Hz power supply have been tested, only the worst result of 120 VAC, 60 Hz was reported as below:

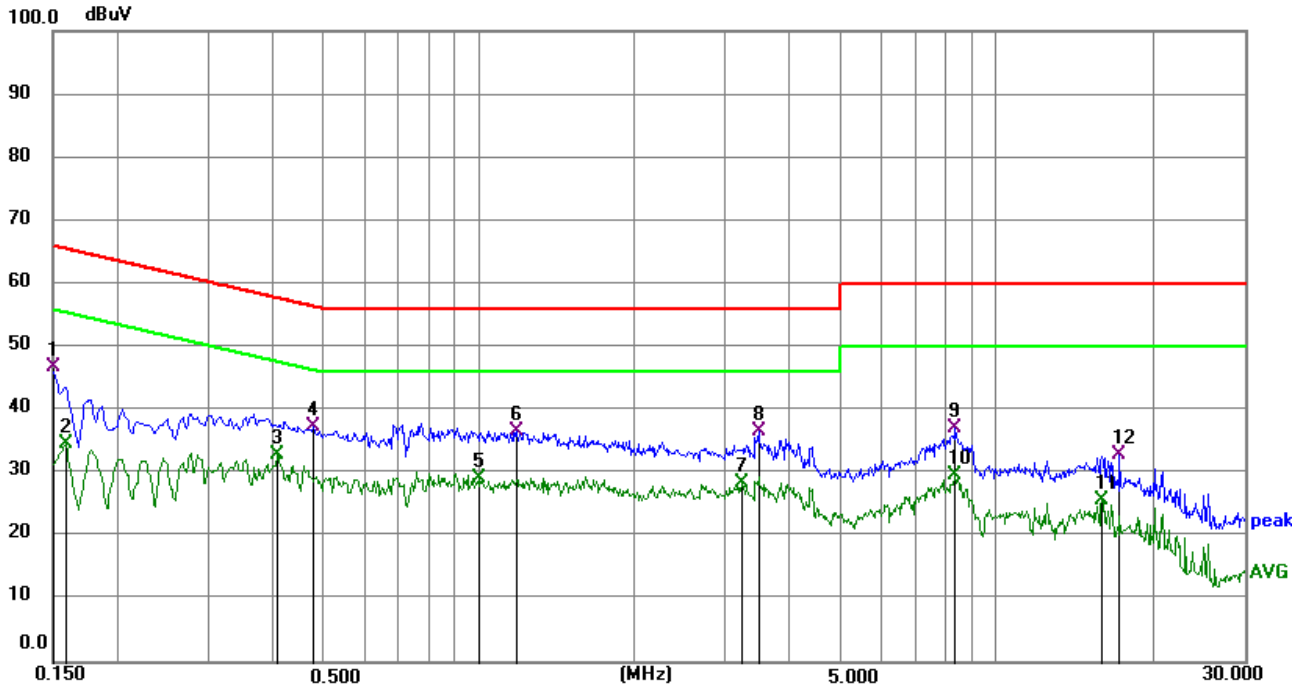
Test Mode	Lora	Line:	L



Remark: Correct Factor = Insertion loss of LISN + Cable loss + Insertion loss of Pulse Limiter;
Measurement Result = Reading Level +Correct Factor;
Margin = Measurement Result- Limit

No.	Frequency (MHz)	Reading (dBuV)	Correct (dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Remark
1	0.1995	31.49	10.70	42.19	63.63	-21.44	QP
2	0.1995	21.98	10.70	32.68	53.63	-20.95	AVG
3	0.3570	20.54	10.69	31.23	48.80	-17.57	AVG
4	0.4245	28.55	10.69	39.24	57.36	-18.12	QP
5	0.7890	26.46	10.67	37.13	56.00	-18.87	QP
6	0.8565	18.84	10.66	29.50	46.00	-16.50	AVG
7	3.0345	16.29	10.79	27.08	46.00	-18.92	AVG
8	3.1740	22.97	10.80	33.77	56.00	-22.23	QP
9	7.2870	22.19	11.05	33.24	60.00	-26.76	QP
10	7.3365	15.56	11.05	26.61	50.00	-23.39	AVG
11	9.4920	15.30	10.96	26.26	50.00	-23.74	AVG
12	9.5370	21.32	10.96	32.28	60.00	-27.72	QP

Test Mode	Lora	Line:	N



Remark: Correct Factor = Insertion loss of LISN + Cable loss + Insertion loss of Pulse Limiter;
Measurement Result = Reading Level +Correct Factor;
Margin = Measurement Result- Limit

No.	Frequency (MHz)	Reading (dBuV)	Correct (dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Remark
1	0.1500	34.98	11.84	46.82	66.00	-19.18	QP
2	0.1590	23.88	10.78	34.66	55.52	-20.86	AVG
3	0.4061	22.14	10.69	32.83	47.73	-14.90	AVG
4	0.4785	26.72	10.69	37.41	56.37	-18.96	QP
5	1.0005	18.61	10.64	29.25	46.00	-16.75	AVG
6	1.1805	25.86	10.66	36.52	56.00	-19.48	QP
7	3.2100	17.56	10.80	28.36	46.00	-17.64	AVG
8	3.4710	25.52	10.96	36.48	56.00	-19.52	QP
9	8.2905	26.08	11.04	37.12	60.00	-22.88	QP
10	8.2905	18.61	11.04	29.65	50.00	-20.35	AVG
11	15.9405	14.29	11.50	25.79	50.00	-24.21	AVG
12	17.2500	21.42	11.56	32.98	60.00	-27.02	QP

3.2 Radiated Emissions and Band Edge

Limit

For intentional device, according to § 15.209(a), the general requirement of field strength of radiated emission out of authorized band shall not exceed the following table at a 3 meters measurement distance.

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)

For intentional device, according to RSS-Gen section 8.9, the general requirement of field strength of radiated emission out of authorized band shall not exceed the following table at a 3 meters measurement distance.

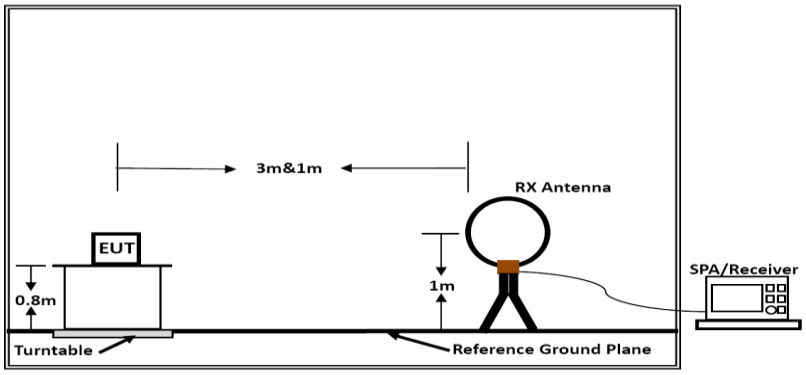
In addition, radiated emissions which fall in the restricted bands, as defined in RSS-Gen section 8.10, must also comply with the radiated emission limits specified in RSS-Gen section 8.9

Radiated emission limits

Frequency (MHz)	Distance (Meters)	Radiated (dBμV/m)	Radiated (μV/m)
0.009-0.49	3	20log(2400/F(KHz))+40log(300/3)	2400/F(KHz)
0.49-1.705	3	20log(24000/F(KHz))+ 40log(30/3)	24000/F(KHz)
1.705-30	3	20log(30)+ 40log(30/3)	30
30-88	3	40.0	100
88-216	3	43.5	150
216-960	3	46.0	200
Above 960	3	54.0	500

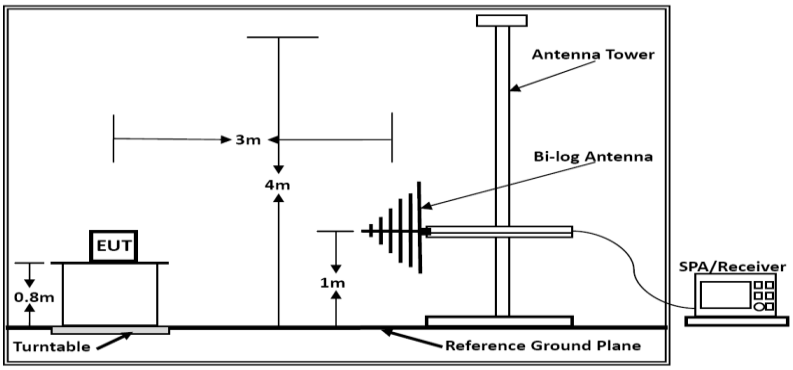
TEST CONFIGURATION

(A) Radiated Emission Test Set-Up, Frequency Below 30MHz



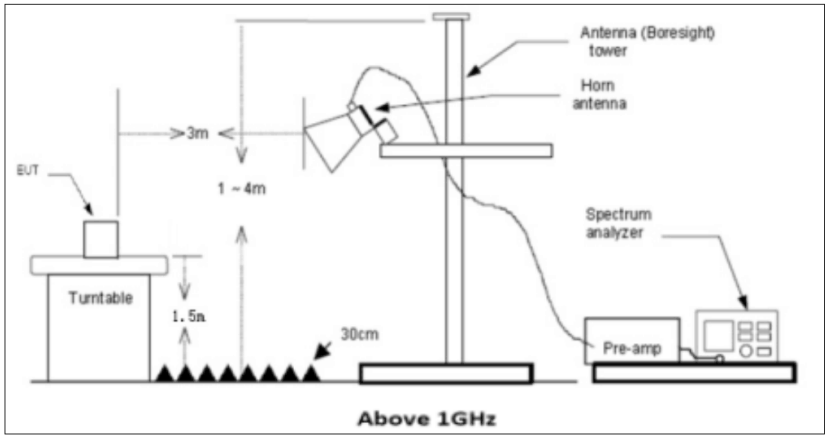
Below 30MHz

(B) Radiated Emission Test Set-Up, Frequency below 1000MHz



Below 1GHz

(C) Radiated Emission Test Set-Up, Frequency above 1000MHz



Test Procedure

1. Below 1GHz measurement the EUT is placed on a turntable which is 0.8m above ground plane, and above 1GHz measurement EUT was placed on a low permittivity and low loss tangent turn table which is 1.5m above ground plane.
2. Maximum procedure was performed by raising the receiving antenna from 1m to 4m and rotating the turn table from 0℃ to 360℃ to acquire the highest emissions from EUT
3. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
4. Repeat above procedures until all frequency measurements have been completed.
5. Radiated emission test frequency band from 9KHz to 10GHz.
6. The distance between test antenna and EUT as following table states:

Test Frequency range	Test Antenna Type	Test Distance
9KHz-30MHz	Active Loop Antenna	3
30MHz-1GHz	Bilog Antenna	3
1GHz-18GHz	Horn Antenna	3

7. Setting test receiver/spectrum as following table states:

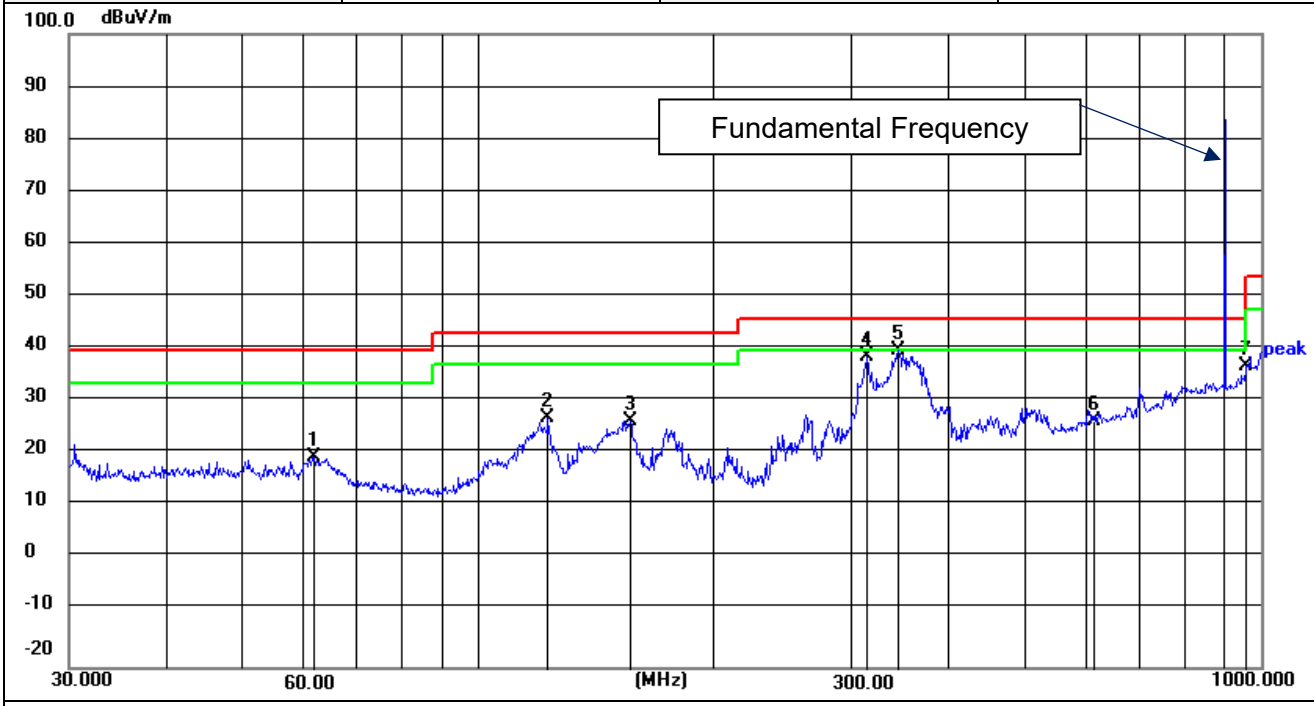
Test Frequency range	Test Receiver/Spectrum Setting	Detector
9KHz-150KHz	RBW=200Hz/VBW=3KHz,Sweep time=Auto	QP
150KHz-30MHz	RBW=9KHz/VBW=100KHz,Sweep time=Auto	QP
30MHz-1GHz	RBW=120KHz/VBW=1000KHz,Sweep time=Auto	QP
Above 1GHz	Peak Value: RBW=1MHz/VBW=3MHz, Sweep time=Auto Average Value: RBW=1MHz/VBW=10Hz, Sweep time=Auto	Peak

TEST RESULTS

Remark: Radiated emission test from 9 KHz to 10th harmonic of fundamental was verified, and The emission levels from 9kHz to 30MHz are attenuated 20dB below the limit and not recorded in report.

For 30MHz-1GHz

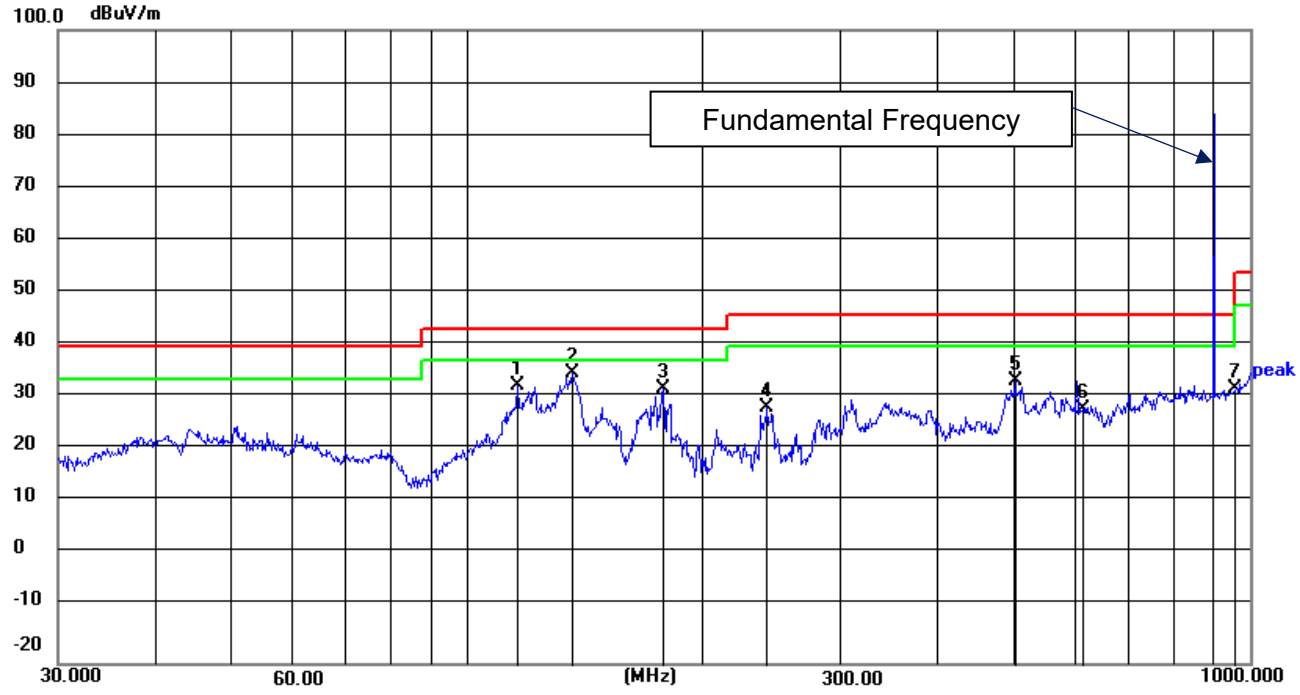
Test Frequency:	902.3	Polarization:	Horizontal



Remark:
Emission Level = Reading + Factor;
Factor = Antenna Factor + Cable Loss – Pre-amplifier;
Margin= Emission Level - Limit.

No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Det.
1	61.7780	37.40	-17.54	19.86	40.00	-20.14	QP
2	122.8340	45.72	-18.20	27.52	43.50	-15.98	QP
3	156.4577	43.45	-16.53	26.92	43.50	-16.58	QP
4	314.3764	55.58	-16.53	39.05	46.00	-6.95	QP
5	344.3855	55.98	-15.87	40.11	46.00	-5.89	QP
6	614.0000	36.32	-9.41	26.91	46.00	-19.09	QP
7	960.0000	40.53	-3.47	37.06	46.00	-8.94	QP

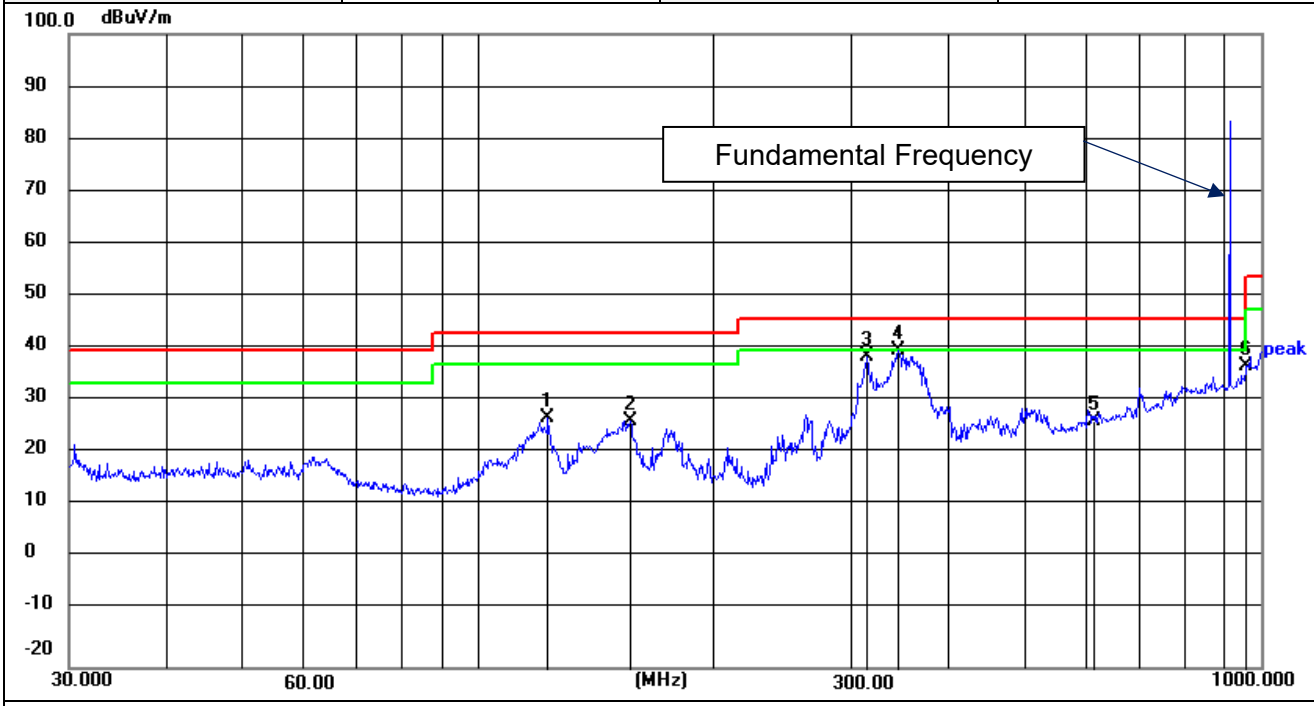
Test Frequency:	902.3	Polarization:	Vertical



Remark:
Emission Level = Reading + Factor;
Factor = Antenna Factor + Cable Loss – Pre-amplifier;
Margin= Emission Level - Limit.

No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Det.
1	116.1321	51.58	-18.81	32.77	43.50	-10.73	QP
2	136.4598	52.69	-17.46	35.23	43.50	-8.27	QP
3	178.1327	50.21	-18.03	32.18	43.50	-11.32	QP
4	241.6763	47.32	-18.82	28.50	46.00	-17.50	QP
5	501.1790	45.97	-12.50	33.47	46.00	-12.53	QP
6	614.0000	37.53	-9.41	28.12	46.00	-17.88	QP
7	960.0000	35.49	-3.47	32.02	46.00	-13.98	QP

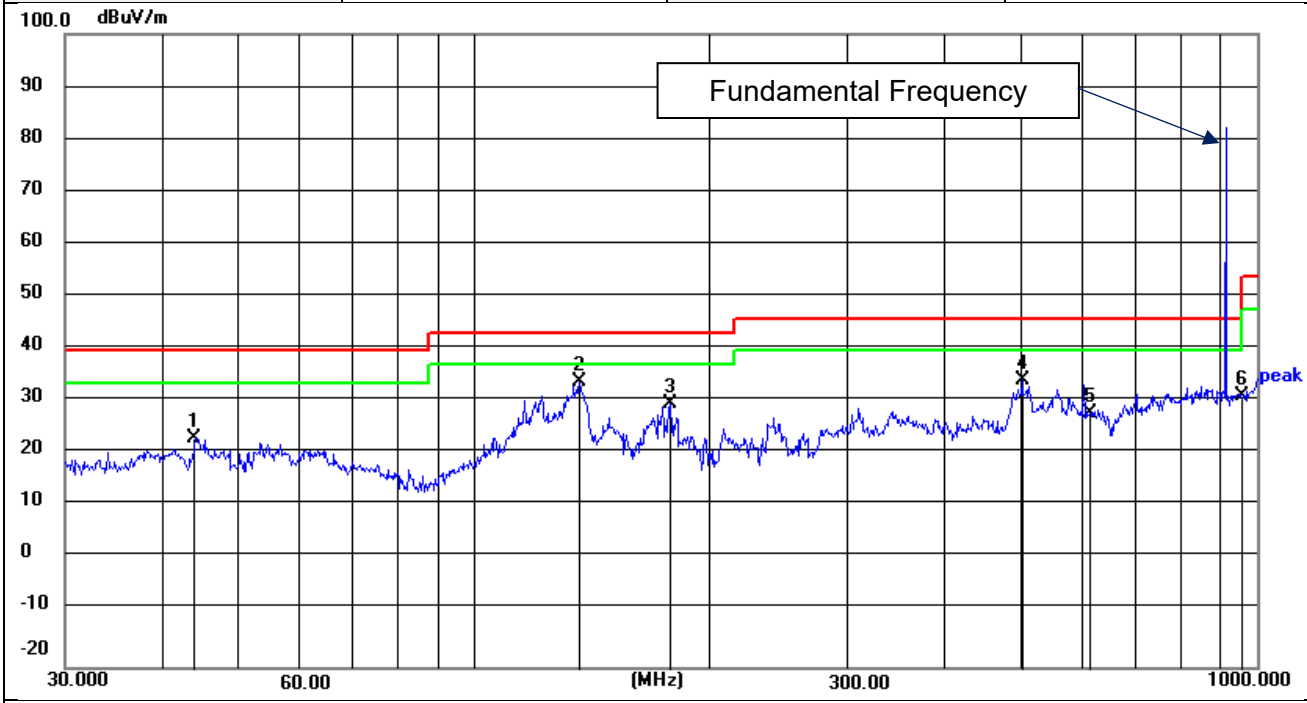
Test Frequency:	914.9	Polarization:	Horizontal



Remark:
Emission Level = Reading + Factor;
Factor = Antenna Factor + Cable Loss – Pre-amplifier;
Margin= Emission Level - Limit.

No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Det.
1	122.8340	45.72	-18.20	27.52	43.50	-15.98	QP
2	156.4576	43.45	-16.53	26.92	43.50	-16.58	QP
3	314.3763	55.58	-16.53	39.05	46.00	-6.95	QP
4	344.3854	55.97	-15.86	40.11	46.00	-5.89	QP
5	614.0000	36.32	-9.41	26.91	46.00	-19.09	QP
6	960.0000	40.53	-3.47	37.06	46.00	-8.94	QP

Test Frequency:	914.9	Polarization:	Vertical



Remark:
Emission Level = Reading + Factor;
Factor = Antenna Factor + Cable Loss – Pre-amplifier;
Margin= Emission Level - Limit.

No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Det.
1	44.1200	40.17	-16.67	23.50	40.00	-16.50	QP
2	136.4598	51.69	-17.46	34.23	43.50	-9.27	QP
3	178.1325	48.21	-18.03	30.18	43.50	-13.32	QP
4	501.1790	46.97	-12.50	34.47	46.00	-11.53	QP
5	614.0000	37.53	-9.41	28.12	46.00	-17.88	QP
6	960.0000	34.99	-3.47	31.52	46.00	-14.48	QP

For 1GHz to 10GHz

Above 1GHz

Frequency(MHz):		902.3		Polarity:	Horizontal	
Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB/m)	(dBμV/m)	(dBμV/m)	(dB)	
1804.35	74.39	-16.74	57.65	74	-16.35	PEAK
1804.35	66.63	-16.74	49.89	54	-4.11	AVG
2707.50	64.08	-13.03	51.05	74	-22.95	PEAK
--	--	--	--	--	--	AVG

Frequency(MHz):		902.3		Polarity:	VERTICAL	
Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB/m)	(dBμV/m)	(dBμV/m)	(dB)	
1804.35	74.87	-16.74	58.13	74	-15.87	PEAK
1804.35	66.69	-16.74	49.95	54	-4.05	AVG
2707.50	64.76	-13.03	51.73	74	-22.27	PEAK
--	--	--	--	--	--	AVG

Frequency(MHz):		908.7		Polarity:	Horizontal	
Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB/m)	(dBμV/m)	(dBμV/m)	(dB)	
1818.75	74.18	-16.58	57.60	74	-16.40	PEAK
1818.75	66.44	-16.58	49.86	54	-4.14	AVG
2726.30	67.09	-12.78	54.31	74	-19.69	PEAK
2726.30	58.51	-12.78	45.73	54	-8.27	AVG

Frequency(MHz):		908.7		Polarity:	VERTICAL	
Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB/m)	(dBμV/m)	(dBμV/m)	(dB)	
1818.75	74.35	-16.58	57.77	74	-16.23	PEAK
1818.75	66.96	-16.58	50.38	54	-3.62	AVG
2726.30	68.17	-12.78	55.39	74	-18.61	PEAK
2726.30	57.99	-12.78	45.21	54	-8.79	AVG

Frequency(MHz):		914.9		Polarity:	Horizontal	
Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB/m)	(dBμV/m)	(dBμV/m)	(dB)	
1829.40	47.02	-16.47	59.69	74	-14.31	PEAK
1829.40	66.81	-16.47	50.34	54	-3.66	AVG
2745.00	46.47	-12.53	54.83	74	-19.17	PEAK
2745.00	58.41	-12.53	45.88	54	-8.12	AVG

Frequency(MHz):		914.9		Polarity:	VERTICAL	
Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB/m)	(dBμV/m)	(dBμV/m)	(dB)	
1829.40	45.63	-16.47	60.59	74	-13.41	PEAK
1829.40	65.38	-16.47	48.91	54	-5.09	AVG
2745.00	45.02	-12.53	55.59	74	-18.41	PEAK
2745.00	56.31	-12.53	43.78	54	-10.22	AVG

REMARKS:

1. Emission level (dBuV/m) = Reading (dBuV)+ Factor (dB/m)
2. Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)-Pre-amplifier Factor
3. Margin value = Emission level- Limit value.
4. -- Mean the PK detector measured value is below average limit.
5. Other emission levels are attenuated 20dB below the limit and not recorded in report.
6. RBW1MHz VBW3MHz Peak detector is for PK value; RBW 1MHz VBW10Hz Peak detector is for AV value.

3.3 Maximum Peak Conducted Output Power

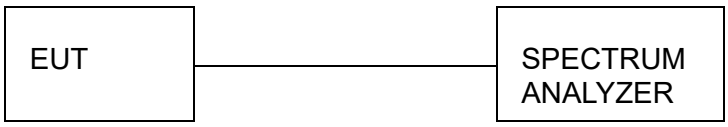
Limit

The maximum peak conducted output power shall not exceed 1.0 W, and the e.i.r.p. shall not exceed 4 W.

Test Procedure

Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the SPECTRUM ANALYZER

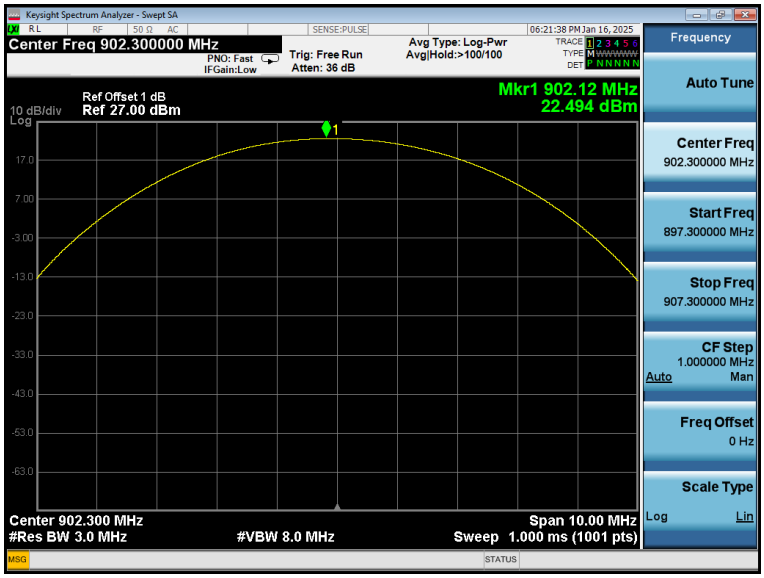
Test Configuration



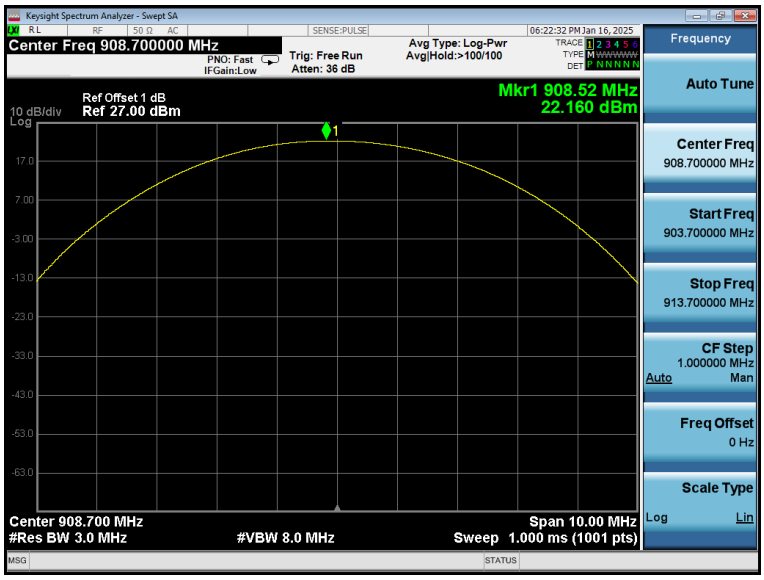
Test Results

Channel	Output power (dBm)	Limit (dBm)	Result
00	22.494	30.00	Pass
32	22.160		
63	21.848		

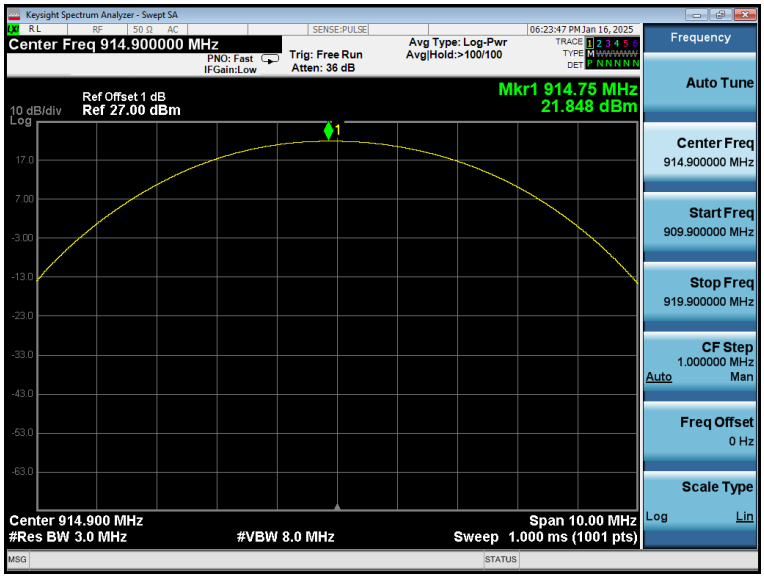
CH00



CH32


Keysight Spectrum Analyzer - Swept SA
Center Freq 908.700000 MHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 36 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
06:22:32 PM Jan 16, 2025
Ref Offset 1 dB
10 dB/div
Log
Ref 27.00 dBm
Mkr1 908.52 MHz
22.160 dBm
Center 908.700 MHz
#Res BW 3.0 MHz
#VBW 8.0 MHz
Span 10.00 MHz
Sweep 1.000 ms (1001 pts)
Frequency
Auto Tune
Center Freq
908.700000 MHz
Start Freq
903.700000 MHz
Stop Freq
913.700000 MHz
CF Step
1.000000 MHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin

CH63


Keysight Spectrum Analyzer - Swept SA
Center Freq 914.900000 MHz
PNO: Fast
IFGain:Low
Trig: Free Run
Atten: 36 dB
Avg Type: Log-Pwr
Avg|Hold:>100/100
06:23:47 PM Jan 16, 2025
Ref Offset 1 dB
10 dB/div
Log
Ref 27.00 dBm
Mkr1 914.75 MHz
21.848 dBm
Center 914.900 MHz
#Res BW 3.0 MHz
#VBW 8.0 MHz
Span 10.00 MHz
Sweep 1.000 ms (1001 pts)
Frequency
Auto Tune
Center Freq
914.900000 MHz
Start Freq
909.900000 MHz
Stop Freq
919.900000 MHz
CF Step
1.000000 MHz
Auto
Man
Freq Offset
0 Hz
Scale Type
Log
Lin

3.4 Power Spectral Density

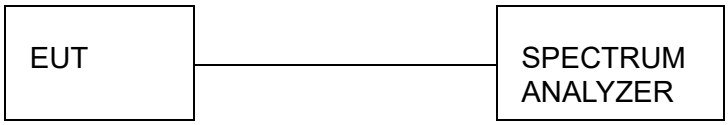
Limit

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.

Test Procedure

1. Use this procedure when the maximum peak conducted output power in the fundamental emission is used to demonstrate compliance.
2. Set the RBW ≥ 3 kHz.
3. Set the VBW ≥ 3× RBW.
4. Set the span to 1.5 times the DTS channel 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 power level.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.
11. The resulting peak PSD level must be 8dBm.

Test Configuration



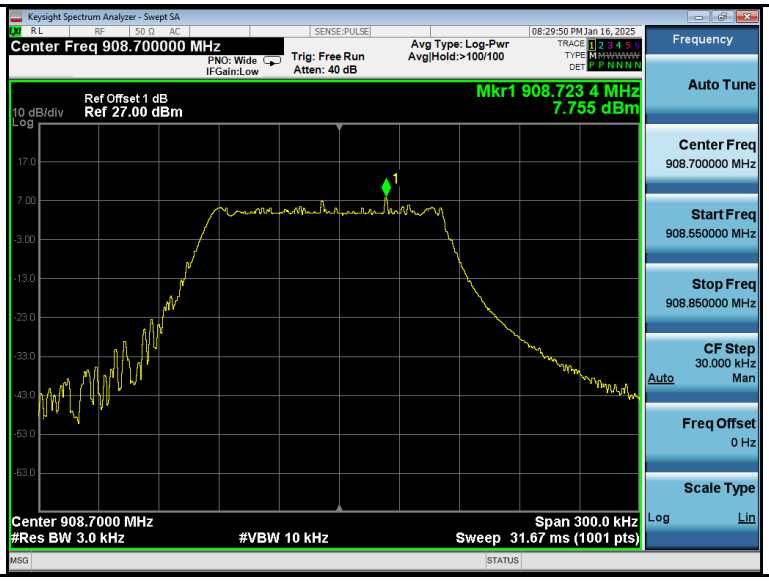
Test Results

Type	Channel	Power Spectral Density (dBm/3KHz)	Limit (dBm/3KHz)	Result
Lora	00	7.576	8.00	Pass
	32	7.755		
	63	6.148		

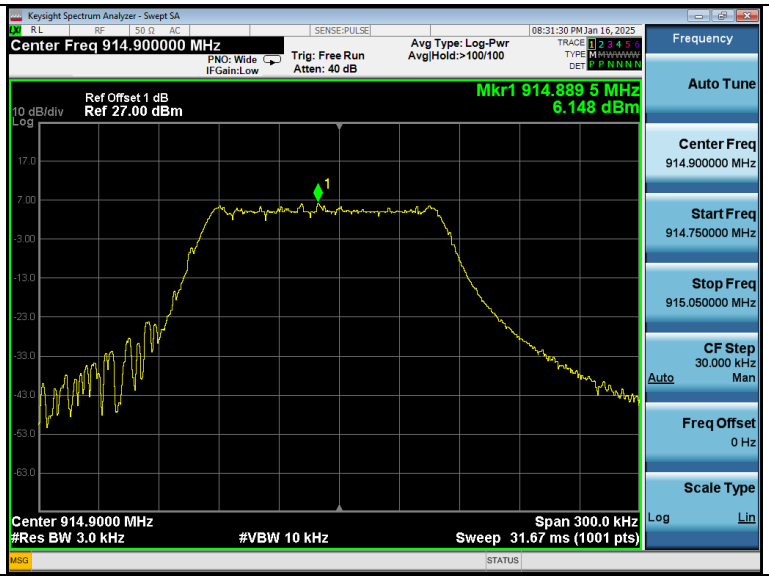
Test plot as follows:

Lora

CH00



CH32



CH63

3.5 20dB and 99% Bandwidth

Limit

For frequency hopping systems operating in the 902-928 MHz band. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Test Procedure

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 30 KHz RBW and 100 KHz VBW.

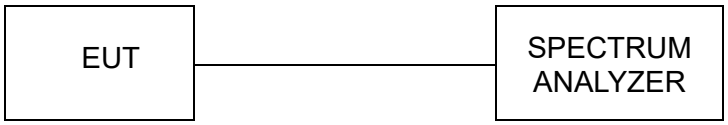
The 20dB bandwidth is defined as the total spectrum the power of which is higher than peak power minus 20dB.

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:

RBW=1% to 5% of the OBW
VBW=approximately 3 X RBW
Detector=Peak
Trace Mode: Max Hold

Use the 99% power bandwidth function of the instrument to measure the Occupied Bandwidth and recoded.

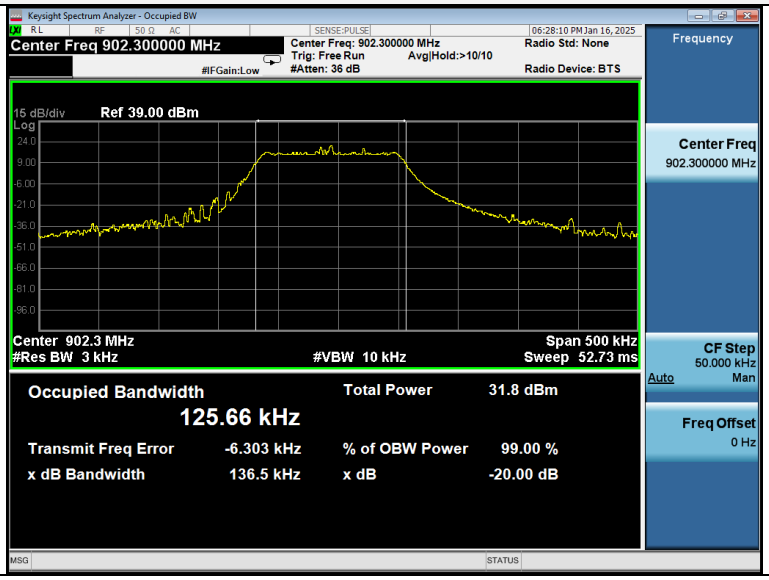
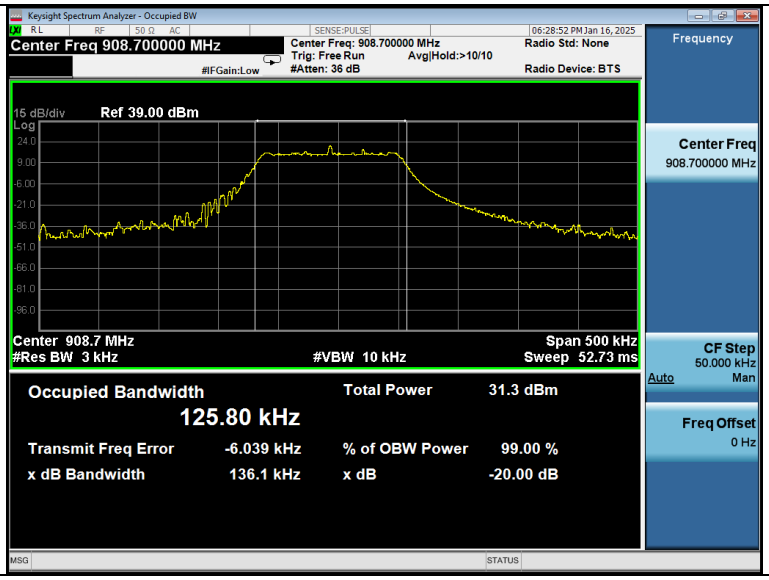
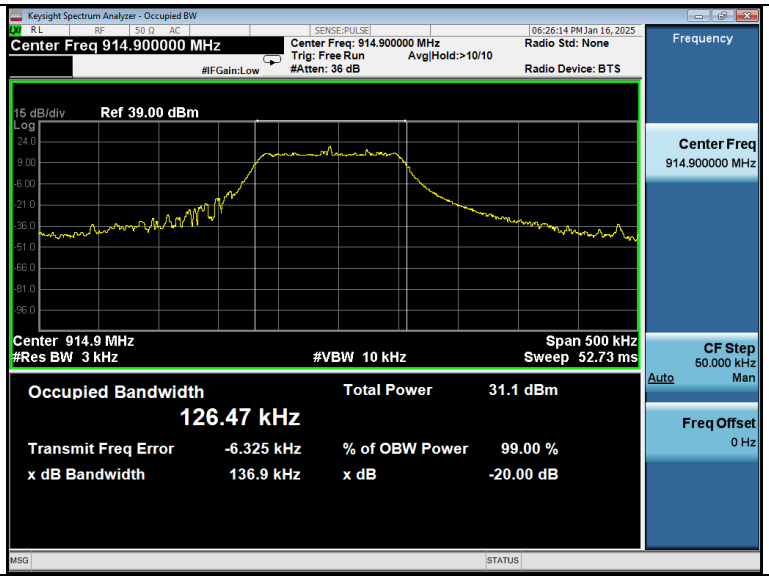
Test Configuration



Test Results

Channel	20dB bandwidth (KHz)	99% OBW(KHz)	Result
CH00	136.5	125.66	Pass
CH32	136.1	125.80	
CH63	136.9	126.47	

Test plot as follows:

Normal Modulation

CH00

CH32

CH63

3.6 Frequency Separation

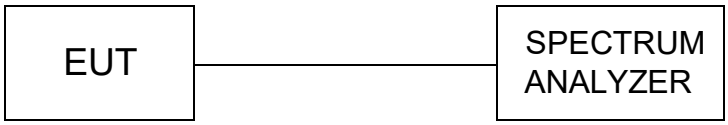
LIMIT

FHSs shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

TEST PROCEDURE

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with100 KHz RBW and 300 KHz VBW.

TEST CONFIGURATION

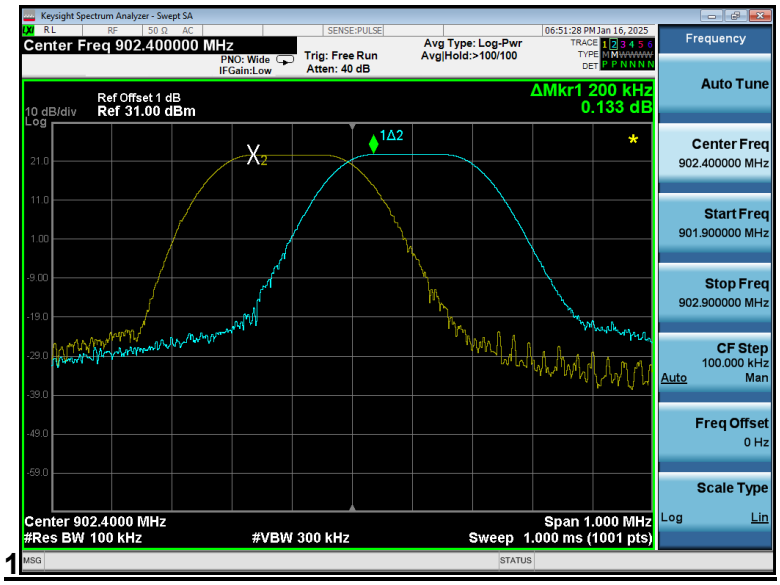


TEST RESULTS

Channel	Channel Separation (MHz)	Limit	Result
CH00	0.200	25KHz or 20dB bandwidth	Pass
CH01			

Note: We have tested all mode at high, middle and low channel, and recorded worst case at low channel

Test plot as follows:



3.7 Number of hopping frequency

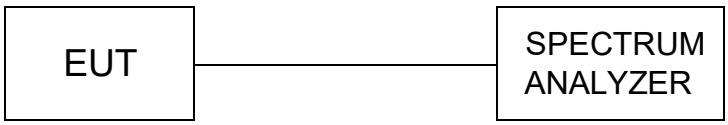
Limit

For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10‑second period.

Test Procedure

The transmitter output was connected to the spectrum analyzer through an attenuator. Set spectrum analyzer start 902MHz to 928MHz.

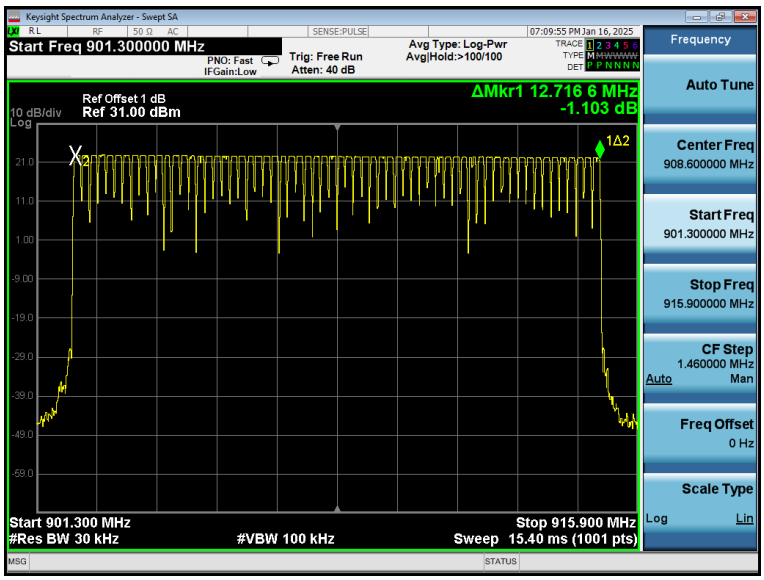
Test Configuration



Test Results

Modulation	Number of Hopping Channel	Limit	Result
FHSS	64	≥50	Pass

Test plot as follows:



3.8 Time of Occupancy (Dwell Time)

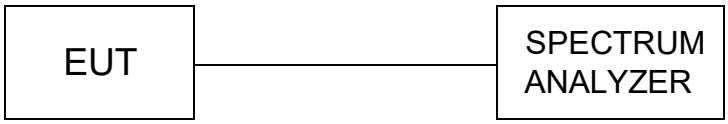
Limit

For FHSs in the band 902-928 MHz: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 20-second period. If the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping channels and the average time of occupancy on any channel shall not be greater than 0.4 seconds within a 10‑second period.

Test Procedure

The transmitter output was connected to the spectrum analyzer through an attenuator. Set center frequency of spectrum analyzer=operating frequency with 1MHz RBW and 1MHz VBW, Span 0Hz.

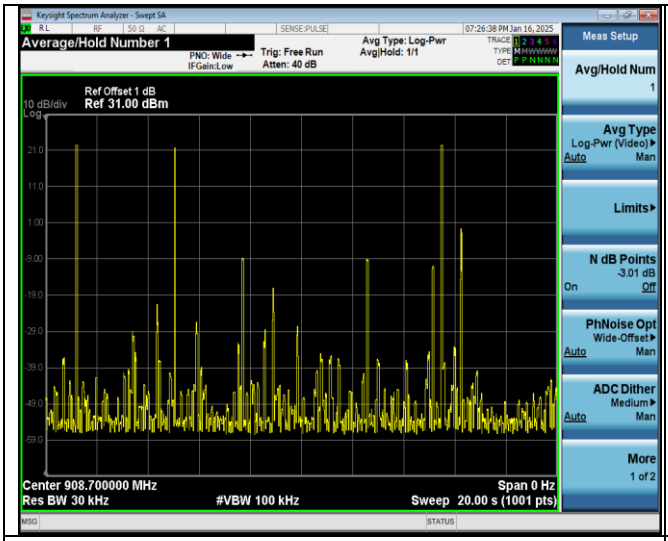
Test Configuration



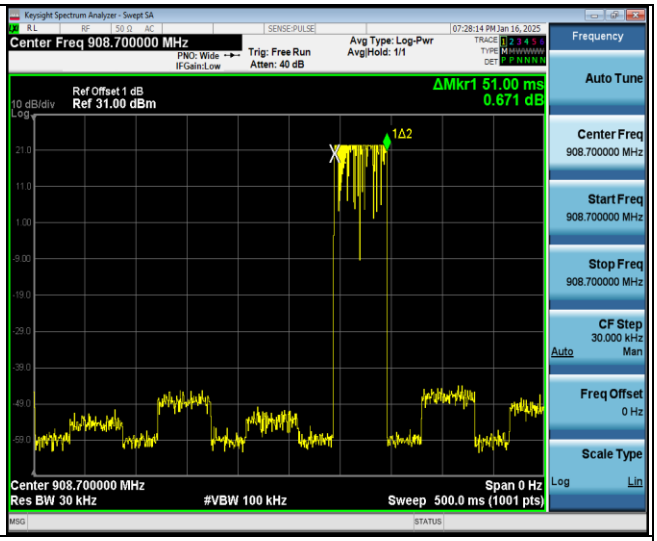
Test Results

In measurement time of 20s, total of 3 transmissions occurred. The duration of one transmission was 51ms.Based on these measurements the transmitter operated 3*51ms=0.153s during the 20s period. The measurement result 0.153s<0.4s, the test result is pass.

Test plot as follows:



Total Busts in 2.00s Observation time



Occupancy Time per burst

3.9 Out-of-band Emissions

Limit

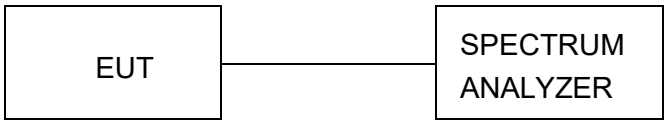
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF con-ducted or a radiated measurement, pro-vided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter com-plies 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 any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

Test Procedure

Connect the transmitter output to spectrum analyzer using a low loss RF cable, and set the spectrum analyzer to RBW=100 kHz, VBW= 300 kHz, peak detector , and max hold. Measurements utilizing these setting are made of the in-band reference level, bandedge and out-of-band emissions.

Test Configuration

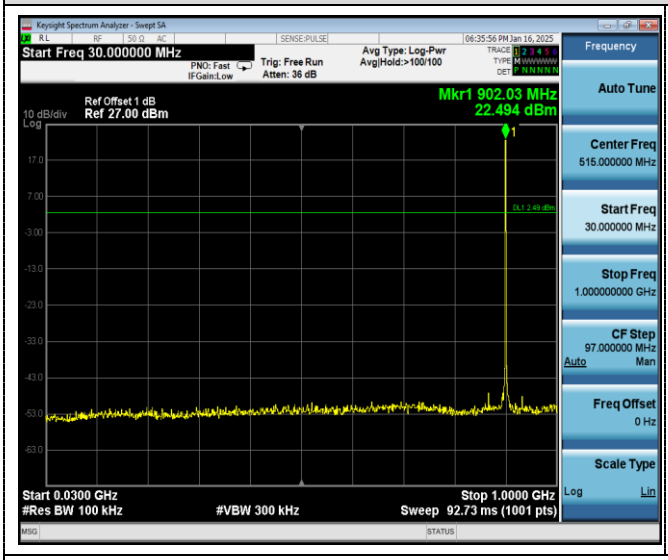


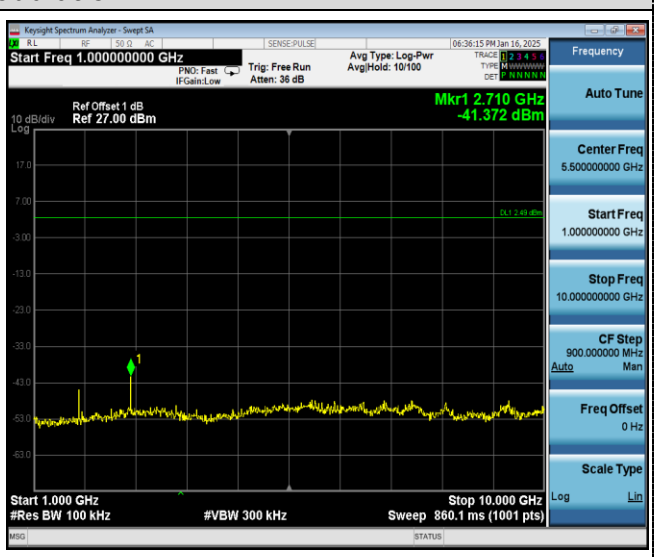
Test Results

Remark: The measurement frequency range is from 30MHz to the 10th harmonic of the fundamental frequency. The lowest, middle and highest channels are tested to verify the spurious emissions and bandage measurement data.

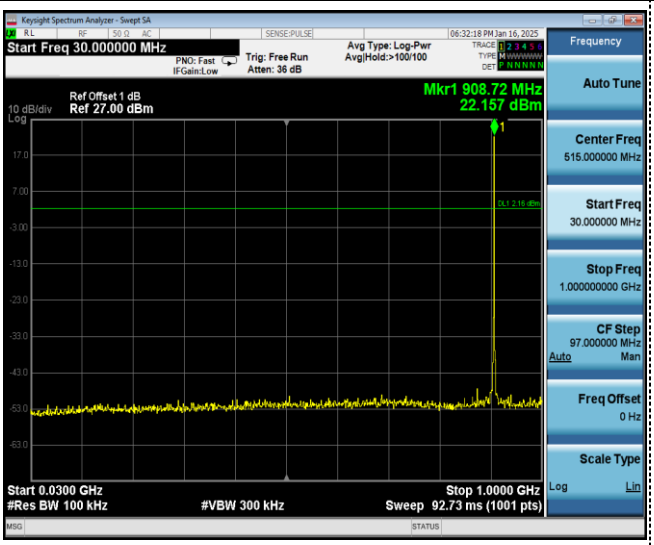
Test plot as follows:

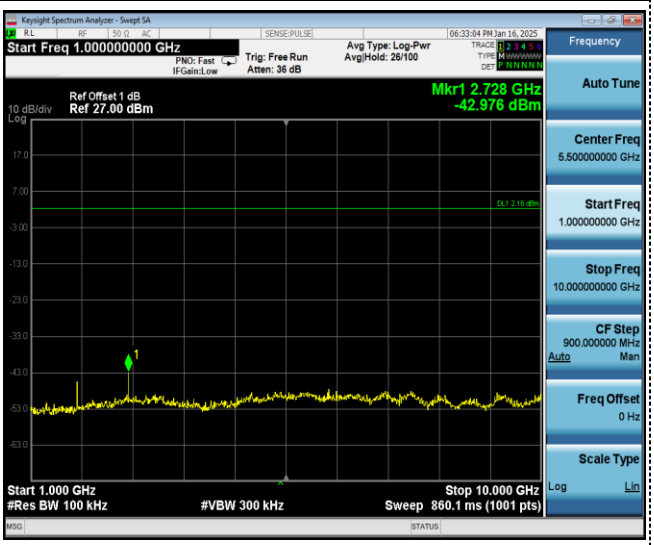
Normal modulation



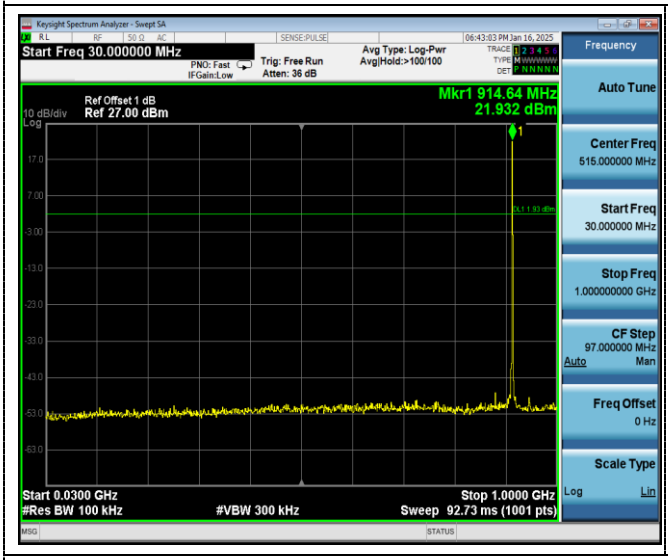


CH00

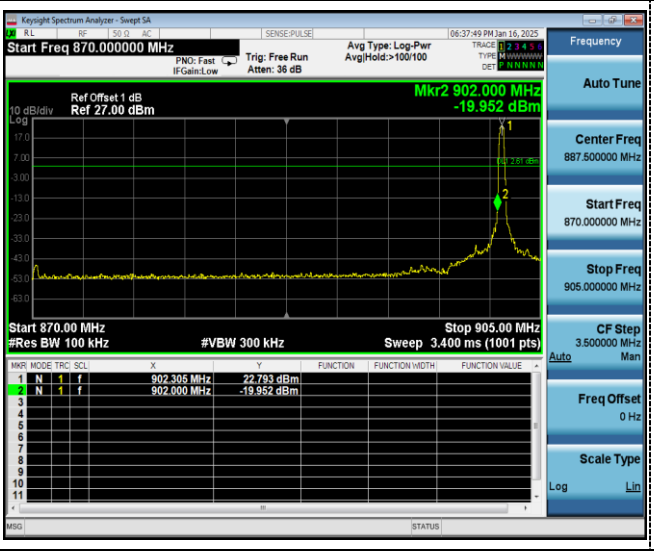




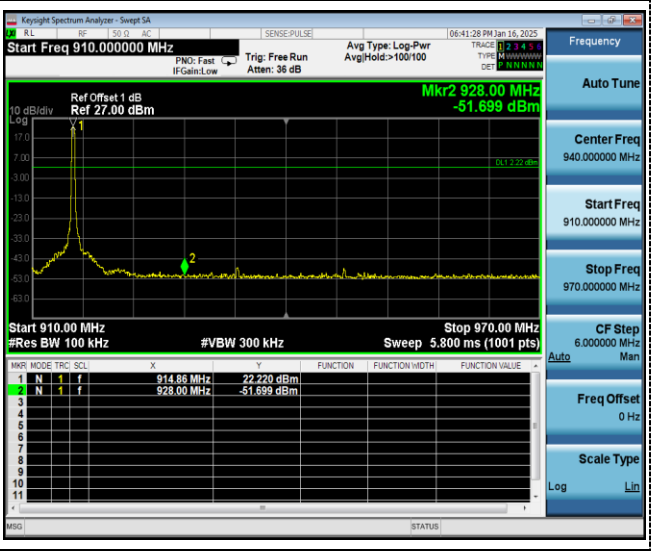
CH32



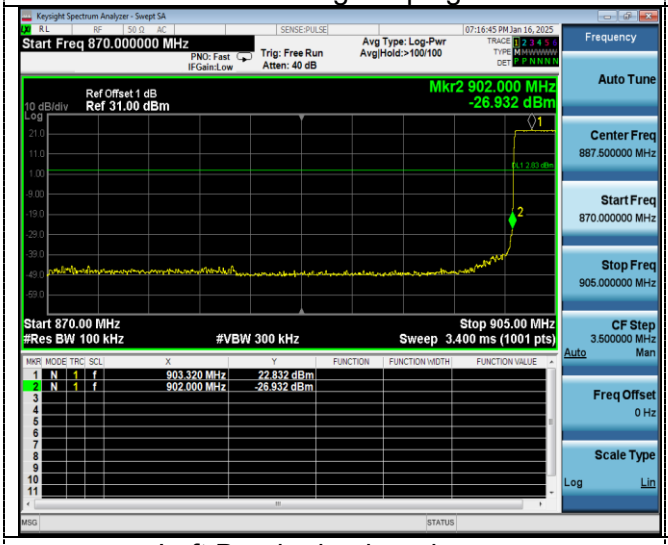
CH63



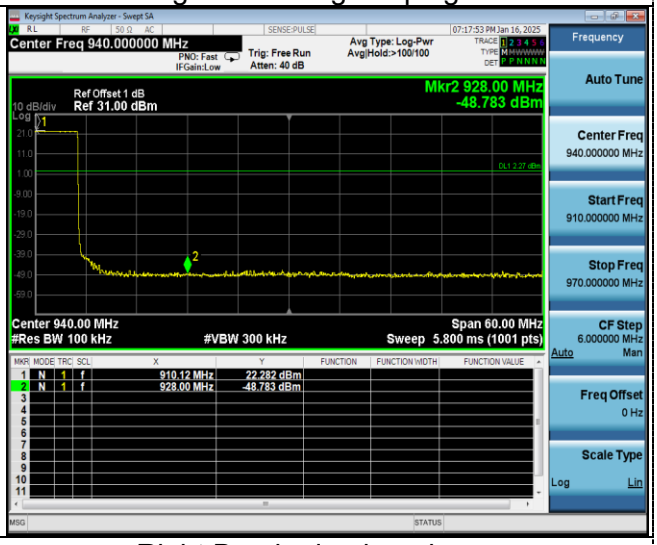
Left Band edge hoping off



Right Band edge hoping off



Left Band edge hopping on



Right Band edge hopping on

3.10 Pseudorandom Frequency Hopping Sequence

TEST APPLICABLE

For 47 CFR Part 15C section 15.247 (a) (1) & RSS 247 requirement:

The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

Test result

The device hops on 64 channel frequencies that are selected in a pseudo random order.

An example of the order is:

{48, 25,53,17, 20, 41, 37, 36, 10, 52,15, 44, 30, 6, 54, 42, 33, 5,55, 8, 28, 56, 1,58, 57, 23, 49, 16, 3, 19, 29, 21,59, 43, 31, 9,60, 18, 27, 22, 45, 61, 13, 0, 2, 32, 11, 14, 62, 46, 12, 24, 4, 7, 38, 47, 35, 40, 50, 34, 39, 26, 51,63}

where Channel 0 is 902.3 MHz and Channel 63 is 914.90 MHz.

The dwell time of each hopping channel is 153ms. Each channel is used equally on average.

3.11 Antenna Requirement

Standard Applicable

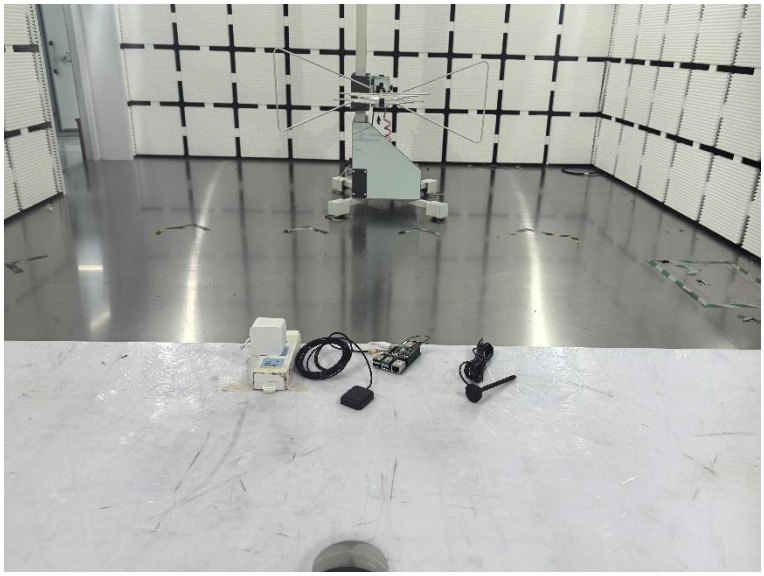
For intentional device, according to FCC 47 CFR Section 15.203:
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, 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

FCC CFR Title 47 Part 15 Subpart C Section 15.247(b) (4):
(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

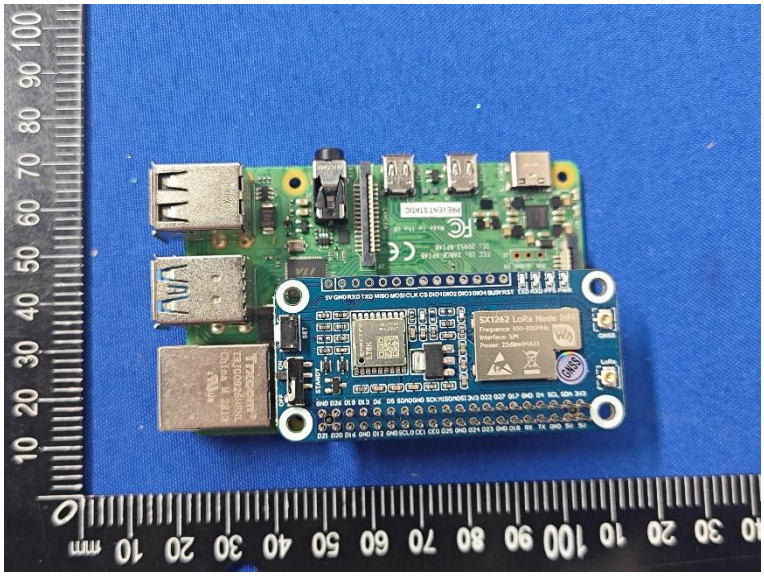
Test Result

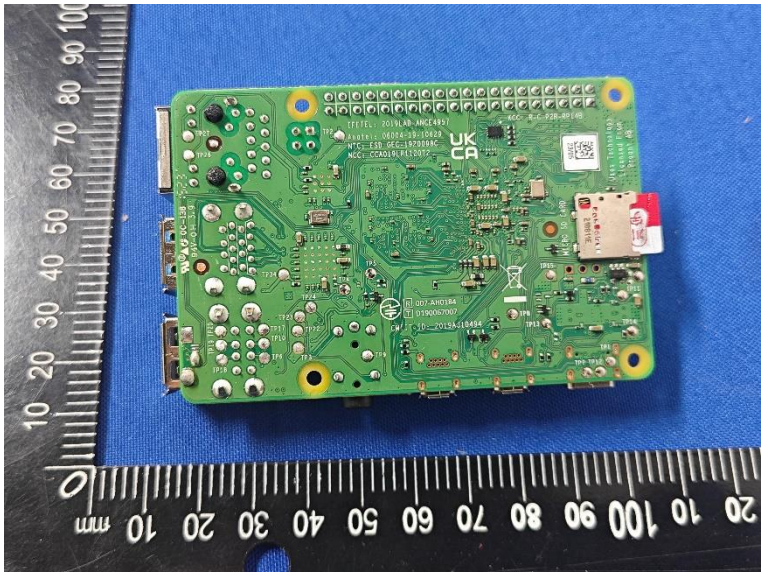
The maximum gain of antenna was 2.0dBi with impedance 50Ω.

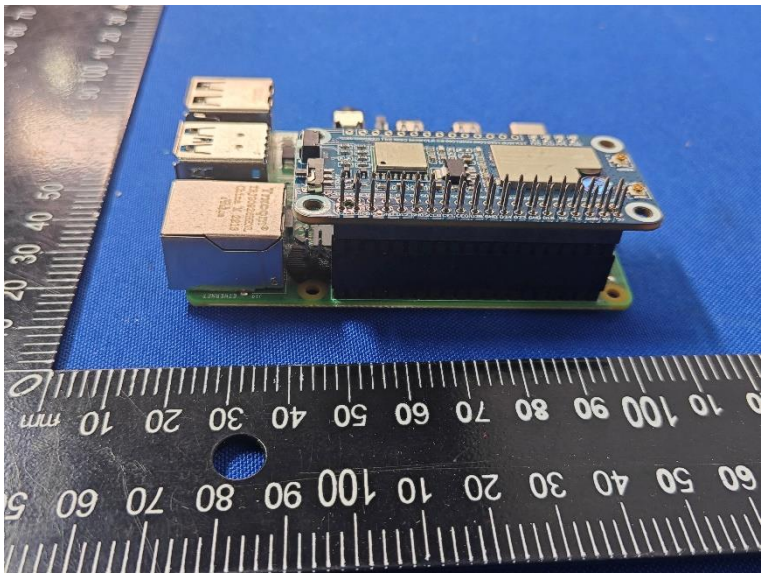
4 Test Setup Photographs of EUT

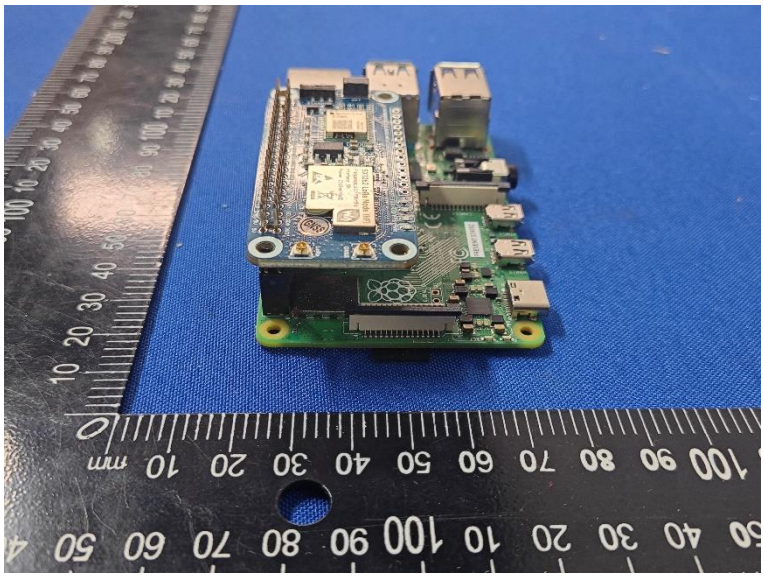


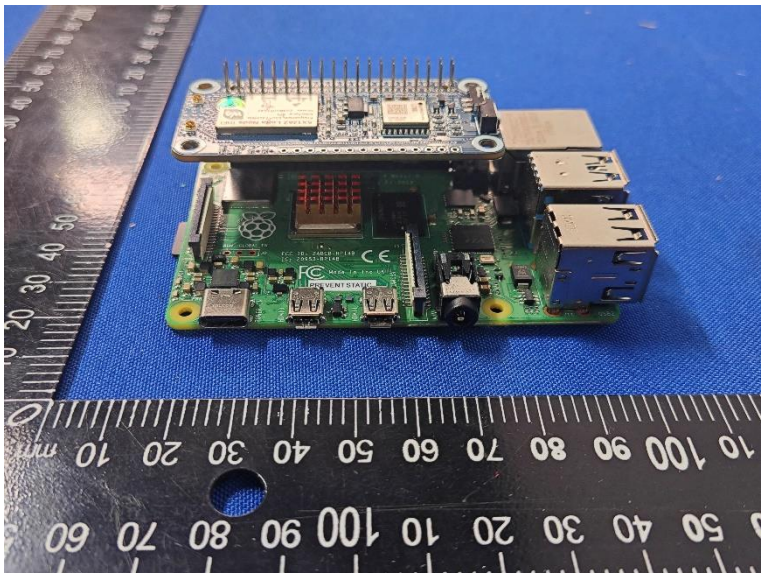
5 External Photographs of EUT

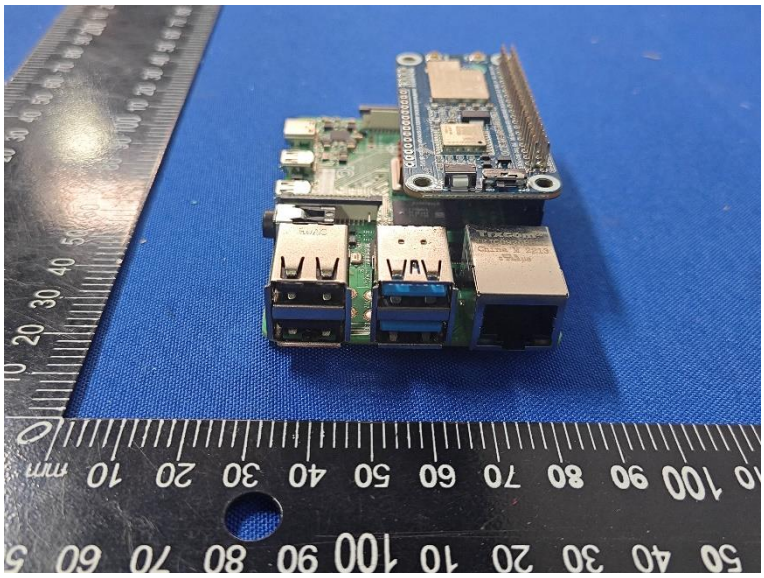




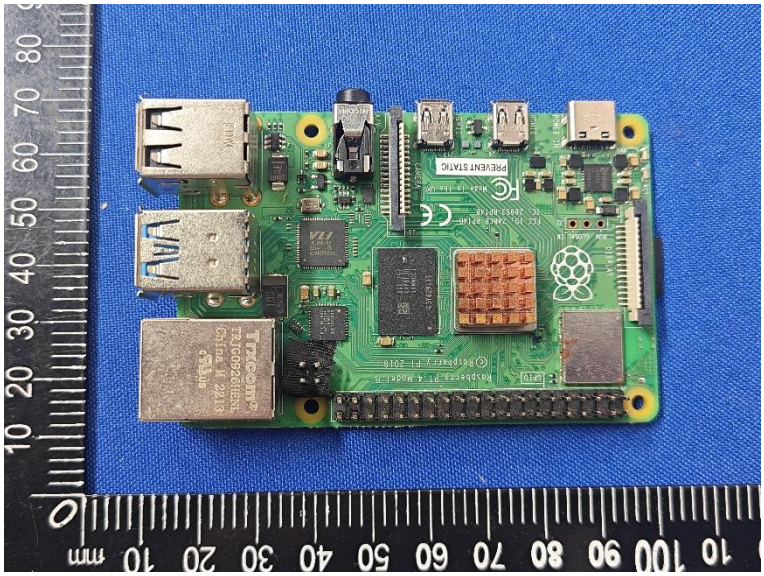


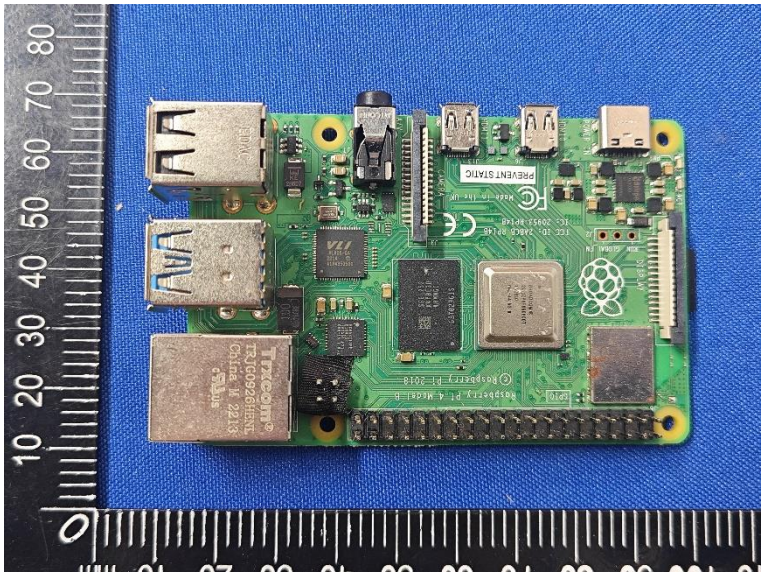


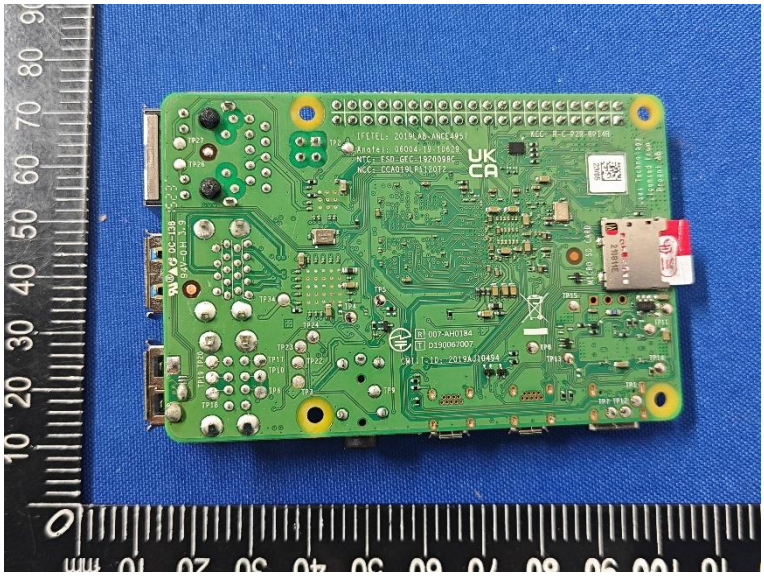


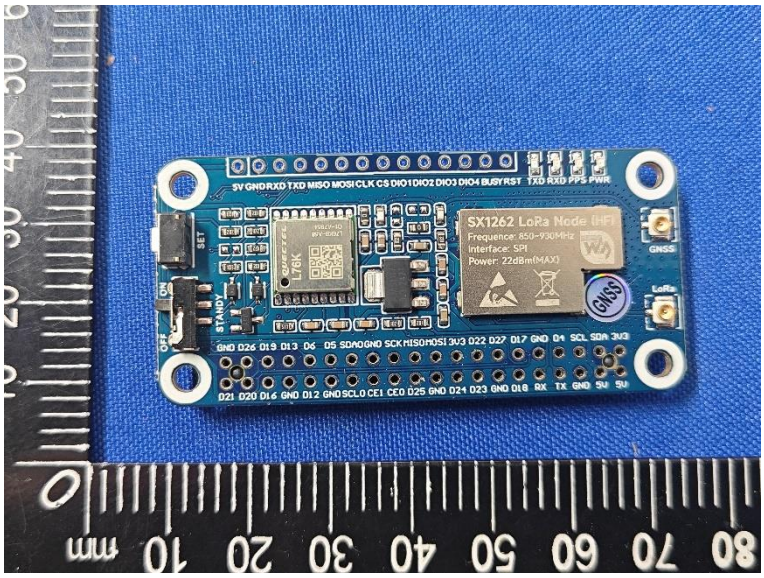


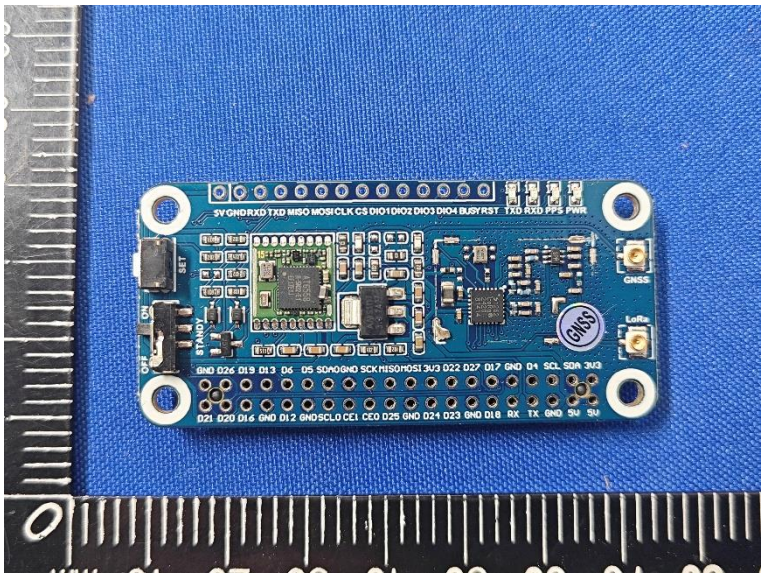
6 Internal Photographs of EUT

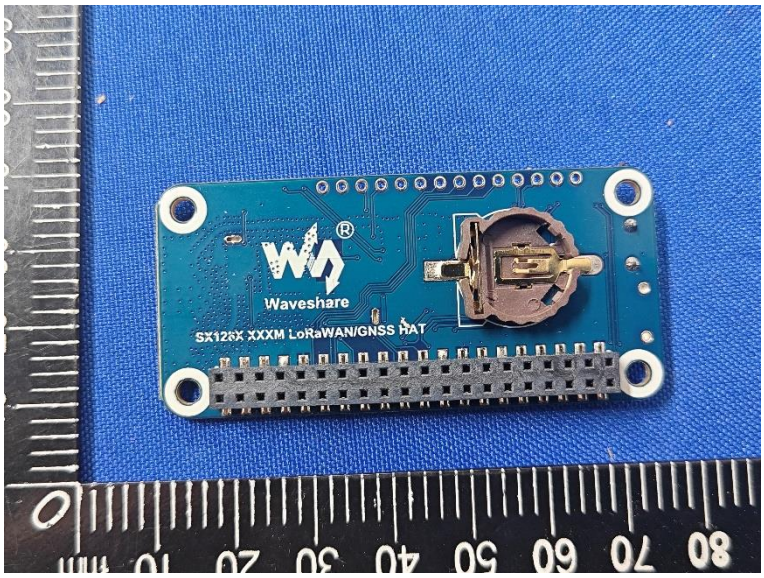












********** End of Report **********