



TEST REPORT

Product Name: LoRa Module
FCC ID: 2ATPO-RA03SCH
Trademark:  
Model Number: Ra-03SCH
Prepared For: Shenzhen Ai-Thinker Technology Co., Ltd
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Sample Received Date: Oct. 21, 2024
Sample tested Date: Oct. 21, 2024 to Oct. 31, 2024
Issue Date: Oct. 31, 2024
Report No.: CTB24102113001RF01
Test Standards: FCC CFR Title 47 Part 15 Subpart C Section 15.247
ANSI C63.10:2013
Test Results: PASS
Remark: This is LoRa radio test report.

Compiled by:

Reviewed by:

Approved by:

Zhou kui

Arron Liu



Zhou Kui

Arron Liu

Bin Mei / Director

Note: If there is any objection to the inspection results in this report, please submit a written report to the company within 15 days from the date of receiving the report. The test report is effective only with both signature and specialized stamp. This result(s) shown in this report refer only to the sample(s) tested. Without written approval of Shenzhen CTB Testing Technology Co., Ltd. this report can't be reproduced except in full. The tested sample(s) and the sample information are provided by the client. "*" indicates the testing items were fulfilled by subcontracted lab. "#" indicates the items are not in CNAS accreditation scope.

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(Note: N/A means not applicable)



1. **VERSION**

Report No.	Issue Date	Description	Approved
CTB24102113001RF01	Oct. 31, 2024	Original	Valid

2. TEST SUMMARY

The Product has been tested according to the following specifications:

Test Item	Test Requirement	Test method	Result
AC Power Line Conducted Emission	47 CFR Part 15 Subpart C Section 15.207	ANSI C63.10-2013	PASS
Radiated Spurious emissions	47 CFR Part 15 Subpart C Section 15.205/15.209	ANSI C63.10-2013	PASS
Band edge and RF Conducted Spurious Emissions	47 CFR Part 15 Subpart C Section 15.247(d)/15.205(a)	ANSI C63.10-2013	PASS
Conducted Peak Output Power	47 CFR Part 15 Subpart C Section 15.247 (b)(3)	ANSI C63.10-2013	PASS
Bandwidth	47 CFR Part 15 Subpart C Section 15.247 (a)(2)	ANSI C63.10-2013	PASS
Power Spectral Density	47 CFR Part 15 Subpart C Section 15.247 (e)	ANSI C63.10-2013/ KDB 558074 D01v05r02	PASS
Antenna Requirement	47 CFR Part 15 Subpart C Section 15.203/15.247 (b)	/	PASS

Remark:

Test according to ANSI C63.10-2013.

3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the Product as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Item	Uncertainty
Occupancy bandwidth	54.3kHz
Conducted output power Above 1G	0.9dB
Conducted output power below 1G	0.9dB
Power Spectral Density , Conduction	0.9dB
Conduction spurious emissions	2.0dB
Out of band emission	2.0dB
3m chamber Radiated spurious emission(9K-30MHz)	4.8dB
3m chamber Radiated spurious emission(30MHz-1GHz)	4.6dB
3m chamber Radiated spurious emission(1GHz-18GHz)	5.1dB
3m chamber Radiated spurious emission(18GHz-40GHz)	3.4dB
humidity uncertainty	5.5%
Temperature uncertainty	0.63°C
frequency	1×10 ⁻⁷
Conducted Emission (150KHz-30MHz)	3.2 dB
Radiated Emission(30MHz ~ 1000MHz)	4.8 dB
Radiated Emission(1GHz ~6GHz)	4.9 dB

4. PRODUCT INFORMATION AND TEST SETUP

4.1 Product Information

Model(s):	Ra-03SCH
Model Description:	N/A
Hardware Version:	V1.0
Software Version:	V1.0
Operation Frequency:	902.000066-927.900000MHz
Max. RF output power:	21.578dBm
Type of Modulation:	LoRa
Antenna installation:	Glue rod antenna
Antenna Gain:	0.94dBi
Ratings:	DC 3.3V powering from PC

4.2 Test Setup Configuration

See test photographs attached in EUT TEST SETUP PHOTOGRAPHS for the actual connections between Product and support equipment.

4.3 Support Equipment

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Note
1	Laptop	DELL	Vostro 5490	N/A	AE

Notes:

1. All the equipment/cables were placed in the worst-case configuration to maximize the emission during the test.
2. Grounding was established in accordance with the manufacturer's requirements and conditions for the intended use.

4.4 Channel List

Frequency (MHz)	Frequency (MHz)	Frequency (MHz)	Frequency (MHz)	Frequency (MHz)	Frequency (MHz)
902.000066	905.824176	910.411980	915.382360	919.206235	923.794648
902.000100	905.824200	910.411992	915.382361	919.206246	923.794671
902.000134	905.824224	910.412004	915.382362	919.970589	923.794694
902.000168	905.824248	910.412016	915.382363	919.970602	923.794717
902.000202	905.824272	910.412028	915.382364	919.970615	923.794740
902.000236	905.824296	910.412040	915.382365	919.970628	923.794763
902.000270	905.824320	910.412052	915.382366	919.970641	923.794786
902.000304	905.824344	910.412064	915.382367	919.970654	923.794809
902.000338	905.824368	910.412076	915.382368	919.970667	923.794832
902.000372	906.588278	910.412088	915.382369	919.970680	923.794855
902.000406	906.588300	910.412100	915.382370	919.970693	923.794878
902.000440	906.588322	910.412112	915.382371	919.970706	924.558825
902.000474	906.588344	910.412124	915.382372	919.970719	924.558850
902.000508	906.588366	910.412136	915.382373	919.970732	924.558875
902.000542	906.588388	910.412148	915.382374	919.970745	924.558900
902.000576	906.588410	910.412160	915.382375	919.970758	924.558925
902.000610	906.588432	910.412172	915.382376	919.970771	924.558950
902.000644	906.588454	910.412184	915.382377	919.970784	924.558975
902.000678	906.588476	911.176490	915.382378	919.970797	924.559000
902.000712	906.588498	911.176500	915.382379	919.970810	924.559025
902.000746	906.588520	911.176510	915.382380	919.970823	924.559050
902.000780	906.588542	911.176520	915.382381	919.970836	924.559075
902.000814	906.588564	911.176530	915.382382	919.970849	924.559100
902.000848	906.588586	911.176540	915.382383	919.970862	924.559125
902.000882	906.588608	911.176550	915.382384	919.970875	924.559150
902.000916	906.588630	911.176560	915.382385	919.970888	924.559175
902.000950	906.588652	911.176570	915.382386	919.970901	924.559200
902.000984	906.588674	911.176580	916.147059	919.970914	924.559225
902.001018	906.588696	911.176590	916.147062	919.970927	924.559250
902.001052	906.588718	911.176600	916.147065	919.970940	924.559275
902.001086	906.588740	911.176610	916.147068	919.970953	924.559300
902.001120	906.588762	911.176620	916.147071	919.970966	924.559325
902.001154	906.588784	911.176630	916.147074	919.970979	924.559350
902.001188	906.588806	911.176640	916.147077	919.970992	924.559375
902.764768	906.588828	911.176650	916.147080	919.971005	924.559400
902.764800	906.588850	911.176660	916.147083	919.971018	924.559425
902.764832	906.588872	911.176670	916.147086	920.735295	924.559450
902.764864	906.588894	911.176680	916.147089	920.735310	924.559475
902.764896	906.588916	911.176690	916.147092	920.735325	924.559500
902.764928	906.588938	911.176700	916.147095	920.735340	924.559525
902.764960	906.588960	911.176710	916.147098	920.735355	924.559550
902.764992	906.588982	911.176720	916.147101	920.735370	924.559575
902.765024	906.589004	911.176730	916.147104	920.735385	924.559600
902.765056	907.352980	911.176740	916.147107	920.735400	924.559625

902.765088	907.353000	911.176750	916.147110	920.735415	924.559650
902.765120	907.353020	911.176760	916.147113	920.735430	925.323531
902.765152	907.353040	911.176770	916.147116	920.735445	925.323558
902.765184	907.353060	911.176780	916.147119	920.735460	925.323585
902.765216	907.353080	911.176790	916.147122	920.735475	925.323612
902.765248	907.353100	911.176800	916.147125	920.735490	925.323639
902.765280	907.353120	911.176810	916.147128	920.735505	925.323666
902.765312	907.353140	911.176820	916.147131	920.735520	925.323693
902.765344	907.353160	911.941192	916.147134	920.735535	925.323720
902.765376	907.353180	911.941200	916.147137	920.735550	925.323747
902.765408	907.353200	911.941208	916.147140	920.735565	925.323774
902.765440	907.353220	911.941216	916.147143	920.735580	925.323801
902.765472	907.353240	911.941224	916.147146	920.735595	925.323828
902.765504	907.353260	911.941232	916.147149	920.735610	925.323855
902.765536	907.353280	911.941240	916.147152	920.735625	925.323882
902.765568	907.353300	911.941248	916.147155	920.735640	925.323909
902.765600	907.353320	911.941256	916.147158	920.735655	925.323936
902.765632	907.353340	911.941264	916.911765	920.735670	925.323963
902.765664	907.353360	911.941272	916.911770	920.735685	925.323990
902.765696	907.353380	911.941280	916.911775	920.735700	925.324017
902.765728	907.353400	911.941288	916.911780	920.735715	925.324044
902.765760	907.353420	911.941296	916.911785	920.735730	925.324071
902.765792	907.353440	911.941304	916.911790	920.735745	925.324098
902.765824	907.353460	911.941312	916.911795	920.735760	925.324125
903.529470	907.353480	911.941320	916.911800	920.735775	925.324152
903.529500	907.353500	911.941328	916.911805	920.735790	925.324179
903.529530	907.353520	911.941336	916.911810	921.500001	925.324206
903.529560	907.353540	911.941344	916.911815	921.500018	925.324233
903.529590	907.353560	911.941352	916.911820	921.500035	925.324260
903.529620	907.353580	911.941360	916.911825	921.500052	925.324287
903.529650	907.353600	911.941368	916.911830	921.500069	925.324314
903.529680	907.353620	911.941376	916.911835	921.500086	925.324341
903.529710	907.353640	911.941384	916.911840	921.500103	925.324368
903.529740	908.117682	911.941392	916.911845	921.500120	925.324395
903.529770	908.117700	911.941400	916.911850	921.500137	925.324422
903.529800	908.117718	911.941408	916.911855	921.500154	926.088237
903.529830	908.117736	911.941416	916.911860	921.500171	926.088266
903.529860	908.117754	911.941424	916.911865	921.500188	926.088295
903.529890	908.117772	911.941432	916.911870	921.500205	926.088324
903.529920	908.117790	911.941440	916.911875	921.500222	926.088353
903.529950	908.117808	911.941448	916.911880	921.500239	926.088382
903.529980	908.117826	911.941456	916.911885	921.500256	926.088411
903.530010	908.117844	912.705894	916.911890	921.500273	926.088440
903.530040	908.117862	912.705900	916.911895	921.500290	926.088469
903.530070	908.117880	912.705906	916.911900	921.500307	926.088498
903.530100	908.117898	912.705912	916.911905	921.500324	926.088527
903.530130	908.117916	912.705918	916.911910	921.500341	926.088556
903.530160	908.117934	912.705924	916.911915	921.500358	926.088585
903.530190	908.117952	912.705930	916.911920	921.500375	926.088614

903.530220	908.117970	912.705936	916.911925	921.500392	926.088643
903.530250	908.117988	912.705942	916.911930	921.500409	926.088672
903.530280	908.118006	912.705948	917.676471	921.500426	926.088701
903.530310	908.118024	912.705954	917.676478	921.500443	926.088730
903.530340	908.118042	912.705960	917.676485	921.500460	926.088759
903.530370	908.118060	912.705966	917.676492	921.500477	926.088788
903.530400	908.118078	912.705972	917.676499	921.500494	926.088817
903.530430	908.118096	912.705978	917.676506	921.500511	926.088846
903.530460	908.118114	912.705984	917.676513	921.500528	926.088875
904.294172	908.118132	912.705990	917.676520	921.500545	926.088904
904.294200	908.118150	912.705996	917.676527	921.500562	926.088933
904.294228	908.118168	912.706002	917.676534	922.264707	926.088962
904.294256	908.118186	912.706008	917.676541	922.264726	926.088991
904.294284	908.118204	912.706014	917.676548	922.264745	926.089020
904.294312	908.118222	912.706020	917.676555	922.264764	926.089049
904.294340	908.118240	912.706026	917.676562	922.264783	926.089078
904.294368	908.118258	912.706032	917.676569	922.264802	926.089107
904.294396	908.118276	912.706038	917.676576	922.264821	926.089136
904.294424	908.882384	912.706044	917.676583	922.264840	926.089165
904.294452	908.882400	912.706050	917.676590	922.264859	926.089194
904.294480	908.882416	912.706056	917.676597	922.264878	926.852943
904.294508	908.882432	912.706062	917.676604	922.264897	926.852974
904.294536	908.882448	912.706068	917.676611	922.264916	926.853005
904.294564	908.882464	912.706074	917.676618	922.264935	926.853036
904.294592	908.882480	912.706080	917.676625	922.264954	926.853067
904.294620	908.882496	912.706086	917.676632	922.264973	926.853098
904.294648	908.882512	912.706092	917.676639	922.264992	926.853129
904.294676	908.882528	913.470596	917.676646	922.265011	926.853160
904.294704	908.882544	913.470600	917.676653	922.265030	926.853191
904.294732	908.882560	913.470604	917.676660	922.265049	926.853222
904.294760	908.882576	913.470608	917.676667	922.265068	926.853253
904.294788	908.882592	913.470612	917.676674	922.265087	926.853284
904.294816	908.882608	913.470616	917.676681	922.265106	926.853315
904.294844	908.882624	913.470620	917.676688	922.265125	926.853346
904.294872	908.882640	913.470624	917.676695	922.265144	926.853377
904.294900	908.882656	913.470628	917.676702	922.265163	926.853408
904.294928	908.882672	913.470632	918.441177	922.265182	926.853439
904.294956	908.882688	913.470636	918.441186	922.265201	926.853470
904.294984	908.882704	913.470640	918.441195	922.265220	926.853501
904.295012	908.882720	913.470644	918.441204	922.265239	926.853532
904.295040	908.882736	913.470648	918.441213	922.265258	926.853563
904.295068	908.882752	913.470652	918.441222	922.265277	926.853594
904.295096	908.882768	913.470656	918.441231	922.265296	926.853625
905.058874	908.882784	913.470660	918.441240	922.265315	926.853656
905.058900	908.882800	913.470664	918.441249	922.265334	926.853687
905.058926	908.882816	913.470668	918.441258	923.029413	926.853718
905.058952	908.882832	913.470672	918.441267	923.029434	926.853749
905.058978	908.882848	913.470676	918.441276	923.029455	926.853780
905.059004	908.882864	913.470680	918.441285	923.029476	926.853811

905.059030	908.882880	913.470684	918.441294	923.029497	926.853842
905.059056	908.882896	913.470688	918.441303	923.029518	926.853873
905.059082	908.882912	913.470692	918.441312	923.029539	926.853904
905.059108	909.647086	913.470696	918.441321	923.029560	926.853935
905.059134	909.647100	913.470700	918.441330	923.029581	926.853966
905.059160	909.647114	913.470704	918.441339	923.029602	927.617649
905.059186	909.647128	913.470708	918.441348	923.029623	927.617682
905.059212	909.647142	913.470712	918.441357	923.029644	927.617715
905.059238	909.647156	913.470716	918.441366	923.029665	927.617748
905.059264	909.647170	913.470720	918.441375	923.029686	927.617781
905.059290	909.647184	913.470724	918.441384	923.029707	927.617814
905.059316	909.647198	913.470728	918.441393	923.029728	927.617847
905.059342	909.647212	914.235298	918.441402	923.029749	927.617880
905.059368	909.647226	914.235300	918.441411	923.029770	927.617913
905.059394	909.647240	914.235302	918.441420	923.029791	927.617946
905.059420	909.647254	914.235304	918.441429	923.029812	927.617979
905.059446	909.647268	914.235306	918.441438	923.029833	927.618012
905.059472	909.647282	914.235308	918.441447	923.029854	927.618045
905.059498	909.647296	914.235310	918.441456	923.029875	927.618078
905.059524	909.647310	914.235312	918.441465	923.029896	927.618111
905.059550	909.647324	914.235314	918.441474	923.029917	927.618144
905.059576	909.647338	914.235316	919.205883	923.029938	927.618177
905.059602	909.647352	914.235318	919.205894	923.029959	927.618210
905.059628	909.647366	914.235320	919.205905	923.029980	927.618243
905.059654	909.647380	914.235322	919.205916	923.030001	927.618276
905.059680	909.647394	914.235324	919.205927	923.030022	927.618309
905.059706	909.647408	914.235326	919.205938	923.030043	927.618342
905.059732	909.647422	914.235328	919.205949	923.030064	927.618375
905.823576	909.647436	914.235330	919.205960	923.030085	927.618408
905.823600	909.647450	914.235332	919.205971	923.030106	927.618441
905.823624	909.647464	914.235334	919.205982	923.794119	927.618474
905.823648	909.647478	914.235336	919.205993	923.794142	927.618507
905.823672	909.647492	914.235338	919.206004	923.794165	927.618540
905.823696	909.647506	914.235340	919.206015	923.794188	927.618573
905.823720	909.647520	914.235342	919.206026	923.794211	927.618606
905.823744	909.647534	914.235344	919.206037	923.794234	927.618639
905.823768	909.647548	914.235346	919.206048	923.794257	927.618672
905.823792	910.411788	914.235348	919.206059	923.794280	927.618705
905.823816	910.411800	914.235350	919.206070	923.794303	927.618738
905.823840	910.411812	914.235352	919.206081	923.794326	927.900000
905.823864	910.411824	914.235354	919.206092	923.794349	
905.823888	910.411836	914.235356	919.206103	923.794372	
905.823912	910.411848	914.235358	919.206114	923.794395	
905.823936	910.411860	914.235360	919.206125	923.794418	
905.823960	910.411872	914.235362	919.206136	923.794441	
905.823984	910.411884	914.235364	919.206147	923.794464	
905.824008	910.411896	915.382353	919.206158	923.794487	
905.824032	910.411908	915.382354	919.206169	923.794510	
905.824056	910.411920	915.382355	919.206180	923.794533	

905.824080	910.411932	915.382356	919.206191	923.794556	
905.824104	910.411944	915.382357	919.206202	923.794579	
905.824128	910.411956	915.382358	919.206213	923.794602	
905.824152	910.411968	915.382359	919.206224	923.794625	

4.5 Test Mode

All test mode(s) and condition(s) mentioned were considered and evaluated respectively by performing full tests, the worst data were recorded and reported.

Test mode	Low channel	Middle channel	High channel
Transmitting (GFSK)	902.000066MHz	915.382374MHz	927.900000MHz

4.6 Test Environment

Humidity(%):	54
Atmospheric Pressure(kPa):	101
Normal Voltage(DC):	3.3V
Normal Temperature(°C)	23
Low Temperature(°C)	0
High Temperature(°C)	40

5. TEST FACILITY AND TEST INSTRUMENT USED

5.1 Test Facility

All measurement facilities used to collect the measurement data are located at 1&2F., Building A, No. 26, Xinghe Road, Xinqiao, Xinqiao Street, Bao'an District, Shenzhen, Guangdong, China. The site and apparatus are constructed in conformance with the requirements of ANSI C63.4 and CISPR 16-1-1 other equivalent standards.

5.2 Test Instrument Used

No.	Equipment	Manufacturer	Type No.	Serial No.	Firmware Version	Calibrated until
1	Spectrum Analyzer	Agilent	N9020A	MY52090073	A.14.16	2025/6/28
2	Power Sensor	Agilent	U2021XA	MY56120032	/	2025/6/28
3	Power Sensor	Agilent	U2021XA	MY56120034	/	2025/6/28
4	Communication test set	R&S	CMW500	108058	V3.5.80	2025/6/28
5	Spectrum Analyzer	KEYSIGHT	N9020A	MY51289897	A.14.16	2025/6/28
6	Signal Generator	Agilent	N5181A	MY50140365	A.01.60	2025/6/28
7	Vector signal generator	Agilent	N5182A	MY47420195	A.01.87	2025/6/28
8	Communication test set	Agilent	E5515C	MY50102567	B.19.07 (E1962B)	2025/6/28
9	2.4 GHz Filter	Shenxiang	MSF2400-24 83.5MS-1154	20181015001	/	2025/6/30
10	5 GHz Filter	Shenxiang	MSF5150-58 50MS-1155	20181015001	/	2025/6/30
11	Filter	Xingbo	XBLBQ-DZA 120	190821-1-1	/	2025/6/30
12	BT&WI-FI Automatic test software	Microwave	MTS8310	Ver. 2.0.0.0	/	/
13	Rohde & Schwarz SFU Broadcast Test System	R&S	SFU	101017	/	2025/6/28
14	Temperature humidity chamber	Hongjing	TH-80CH	DG-15174	/	2025/6/28
15	234G Automatic test software	Microwave	MTS8200	Ver. 2.0.0.0	/	/
16	966 chamber	C.R.T.	966	/	/	2027/6/21
17	Receiver	R&S	ESPI	100362	RF_ATTEN_7 (104489/003)	2025/6/28
18	Amplifier	HP	8447E	2945A02747	/	2025/6/28
19	Amplifier	Agilent	8449B	3008A01838	/	2025/6/28
20	TRILOG Broadband Antenna	Schwarzbeck	VULB 9168	00869	/	2025/6/28
21	Double Ridged Broadband Horn Antenna	Schwarzbeck	BBHA9120D	01911	/	2025/6/28

22	EMI test software	Fala	EZ-EMC	FA-03A2 RE	/	/
23	Loop Antenna	Schwarzbeck	FMZB 1519B	1519B-224	/	2025/6/28
24	loop antenna	ZHINAN	ZN30900A	GTS534	/	/
25	40G Horn antenna	A/H/System	SAS-574	588	/	2025/6/28
26	Amplifier	AEROFLEX	Aeroflex	097	/	2025/6/28
27	Power Metter	KEYSIGHT	N1912AP	N/A	A.05.00	2025/6/28

Continuous disturbance						
No.	Equipment	Manufacturer	Model No.	Serial No.	Firmware version	Calibrated until
1	843 Shield Room	C/ R/ T	843	/	/	2027/6/21
2	AMN	ROHDE&SCHWARZ	ESH3-Z5	831551852	/	2025/6/30
3	Pulse limiter	ROHDE&SCHWARZ	ESH3Z2	357881052	/	2025/6/28
4	EMI TEST RECEIVER	ROHDE&SCHWARZ	ESCI	100428	V4.42.SP3	2025/6/30
5	Coaxial cable	ZDECL	Z302S	18091904	/	2025/6/30
6	ISN	Schwarzbeck	NTFM8158	183	/	2025/6/30
7	Voltage sensor	Schwarzbeck	TK 9420	01189	/	2024/11/16
8	EZ-EMC	Frad	EMC-con3A1.1	/	/	/
9	Current Probe	FCC	F-52B	199453	/	2025/5/27
10	Communication test set	R&S	CMW500	108058	B.19.07 (E1962B)	2025/6/28
11	Communication test set	Agilent	E5515C	MY50102567	V3.5.80	2025/6/28

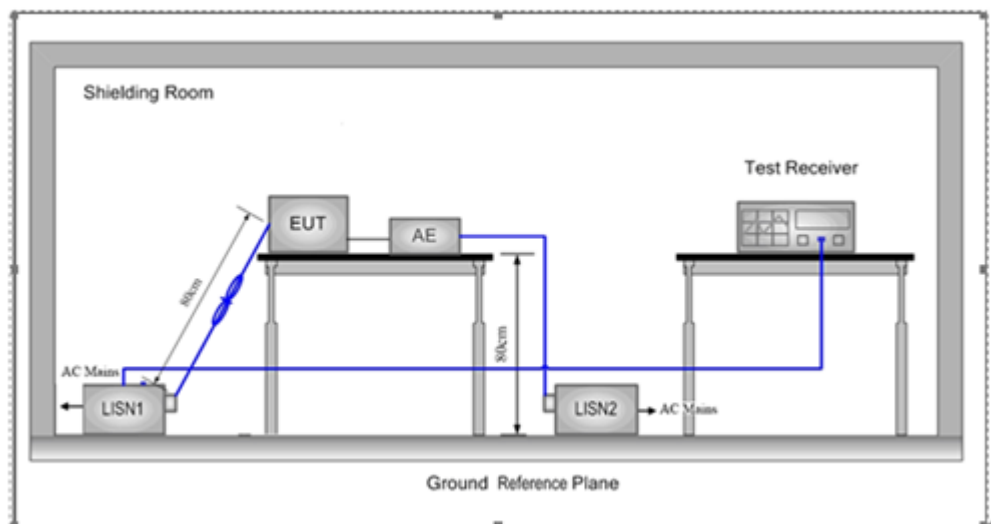
Radiated emission(No.2 Chamber)						
No.	Equipment	Manufacturer	Model No.	Serial No.	Firmware version	Calibrated until
1	966 Chamber	C/ R/ T	966	/	/	2026/11/14
2	Double Ridged Broadband Horn Antenna	Schwarzbeck	BBHA 9120 D	01911	/	2026/7/07
3	Broadband Antenna	Schwarzbeck	VULB 9168	1471	/	2025/7/06
4	Amplifier	Agilent	8449B	3008A01838	/	2025/6/30
5	Preamplifier	Schwarzbeck	BBV 9743 B	00500	/	2025/5/23
6	EMI TEST RECEIVER	R&S	ESCI7	100861	/	2024/11/27
7	Spectrum Analyzer	KEYSIGHT	N9020A	MY51289897	A.14.16	2025/6/28
8	EMI test software	Farad	EZ-EMC	/	Ver. FARAD-3A1+	/
9	Coaxial cable	Rosenberg	8m	/	/	2024/11/27
10	Coaxial cable	Times	2m	/	/	2024/11/27



11	Coaxial cable	Times	2m	/	/	2024/11/27
12	Coaxial cable	Times	1m	/	/	2024/11/27
13	loop antenna	Schwarzbeck	FMZB 1519B	1519B-224	/	2025/6/29
14	Communication test set	R&S	CMW500	108058	B.19.07 (E1962B)	2025/6/28
15	Communication test set	Agilent	E5515C	MY50102567	V3.5.80	2025/6/28

6. AC POWER LINE CONDUCTED EMISSION

6.1 Block Diagram Of Test Setup



6.2 Limit

Table 4 – AC power-line conducted emissions limits

Frequency (MHz)	Conducted limit (dB μ V)	
	Quasi-peak	Average
0.15 - 0.5	66 to 56 ^{Note 1}	56 to 46 ^{Note 1}
0.5 - 5	56	46
5 - 30	60	50

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

* Decreasing linearly with the logarithm of the frequency

6.3 Test procedure

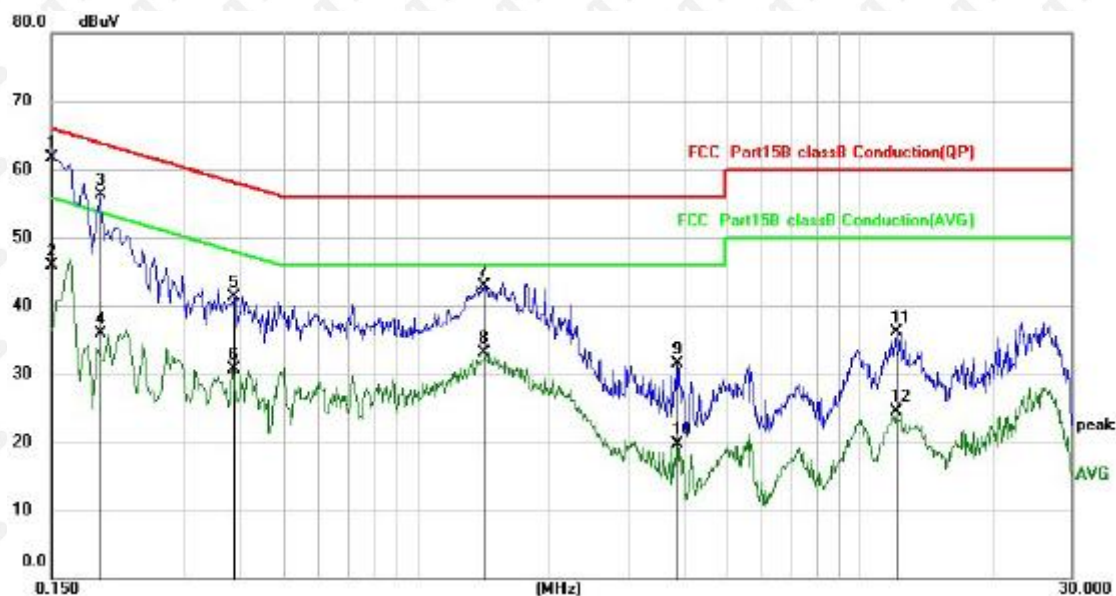
- 1) The mains terminal disturbance voltage test was conducted in a shielded room.
- 2) The EUT was connected to AC power source through a LISN 1 (Line Impedance Stabilization Network) which provides a 50 Ω /50 μ H + 5 Ω linear impedance. The power cables of all other units of the EUT were connected to a second LISN 2, which was bonded to the ground reference plane in the same way as the LISN 1 for the unit being measured. A multiple socket outlet strip was used to connect multiple power cables to a single LISN provided the rating of the LISN was not exceeded.
- 3) The tabletop EUT was placed upon a non-metallic table 0.8m above the ground reference plane. And for floor-standing arrangement, the EUT was placed on the horizontal ground reference plane,
- 4) The test was performed with a vertical ground reference plane. The rear of the EUT shall be 0.4 m from the vertical ground reference plane. The vertical ground reference plane was bonded to the horizontal ground reference plane. The LISN 1 was placed 0.8 m from the boundary of the unit under

test and bonded to a ground reference plane for LISNs mounted on top of the ground reference plane. This distance was between the closest points of the LISN 1 and the EUT. All other units of the EUT and associated equipment was at least 0.8 m from the LISN 2.

- 5) In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.10:2013 on conducted measurement.
- 6) All modes were tested at AC 120V and 240V, only the worst result of AC 120V 60Hz was reported.
- 7) If a EUT received DC power from the USB Port of Notebook PC, the PC's adapter received AC120V/60Hz power through a Line Impedance Stabilization Network (LISN) which supplied power source and was grounded to the ground plane.

6.4 Test Result

L: Worst case-LORA(low channel)

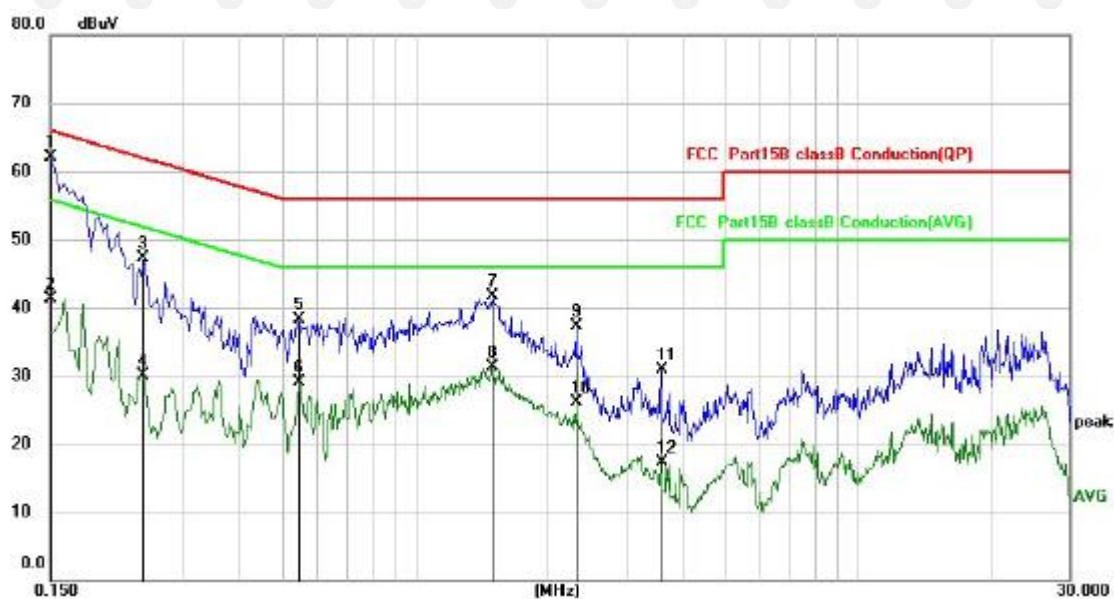


No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV	Limit dBuV	Over dB	Detector
1	*	0.1500	50.87	10.89	61.76	66.00	-4.24	QP
2		0.1500	34.94	10.89	45.83	56.00	-10.17	AVG
3		0.1940	45.57	10.73	56.30	63.86	-7.56	QP
4		0.1940	25.26	10.73	35.99	53.86	-17.87	AVG
5		0.3860	30.81	10.58	41.39	58.15	-16.76	QP
6		0.3860	20.04	10.58	30.62	48.15	-17.53	AVG
7		1.4220	31.71	11.22	42.93	56.00	-13.07	QP
8		1.4220	21.87	11.22	33.09	46.00	-12.91	AVG
9		3.8740	19.58	11.99	31.57	56.00	-24.43	QP
10		3.8740	7.63	11.99	19.62	46.00	-26.38	AVG
11		12.0700	22.89	13.28	36.17	60.00	-23.83	QP
12		12.0700	11.29	13.28	24.57	50.00	-25.43	AVG

Remark:

Factor = Cable loss + LISN factor, Margin = Measurement – Limit

N:



No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV	Limit dBuV	Over dB	Detector
1	*	0.1500	51.14	10.89	62.03	66.00	-3.97	QP
2		0.1500	30.37	10.89	41.26	56.00	-14.74	AVG
3		0.2420	36.65	10.68	47.33	62.03	-14.70	QP
4		0.2420	19.49	10.68	30.17	52.03	-21.86	AVG
5		0.5460	27.75	10.55	38.30	56.00	-17.70	QP
6		0.5460	18.51	10.55	29.06	46.00	-16.94	AVG
7		1.4900	30.43	11.26	41.69	56.00	-14.31	QP
8		1.4900	20.03	11.26	31.29	46.00	-14.71	AVG
9		2.3179	25.69	11.65	37.34	56.00	-18.66	QP
10		2.3179	14.41	11.65	26.06	46.00	-19.94	AVG
11		3.5860	19.07	11.93	31.00	56.00	-25.00	QP
12		3.5860	5.32	11.93	17.25	46.00	-28.75	AVG

Remark:

Factor = Cable loss + LISN factor, Margin = Measurement – Limit

7. RADIATED SPURIOUS EMISSION

7.1 Block Diagram Of Test Setup

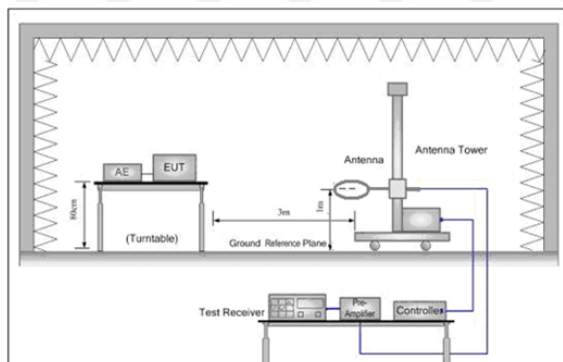


Figure 1. Below 30MHz

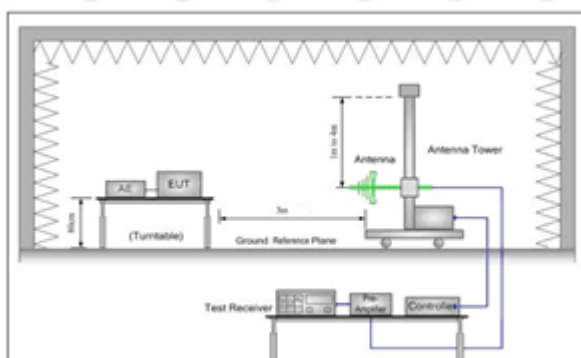
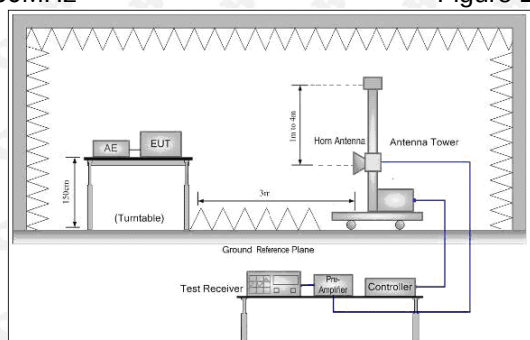


Figure 2. 30MHz to 1GHz



7.2 Limit

Spurious Emissions:

Frequency	Field strength (microvolt/meter)	Limit (dBμV/m)	Remark	Measurement distance (m)
0.009MHz-0.490MHz	2400/F(kHz)	-	-	300
0.490MHz-1.705MHz	24000/F(kHz)	-	-	30
1.705MHz-30MHz	30	-	-	30
30MHz-88MHz	100	40.0	Quasi-peak	3
88MHz-216MHz	150	43.5	Quasi-peak	3
216MHz-960MHz	200	46.0	Quasi-peak	3
960MHz-1GHz	500	54.0	Quasi-peak	3
Above 1GHz	500	54.0	Average	3

Note: 15.35(b), Unless otherwise specified, the limit on peak radio frequency emissions is 20dB above the maximum permitted average emission limit applicable to the equipment under test. This peak limit applies to the total peak emission level radiated by the device.

7.3 Test procedure

Below 1GHz test procedure as below:

- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters (for the test frequency of below 30MHz, the antenna was tuned to heights 1 meter) and the rota table table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

Above 1GHz test procedure as below:

- g. Different between above is the test site, change from Semi- Anechoic Chamber to fully Anechoic Chamber and change form table 0.8 meter to 1.5 meter(Above 18GHz the distance is 1 meter and table is 1.5 meter).
- h. Test the EUT in the lowest channel ,the middle channel ,the Highest channel
- i. Repeat above procedures until all frequencies measured was complete.
- j. Full battery is used during test.

Receiver set:

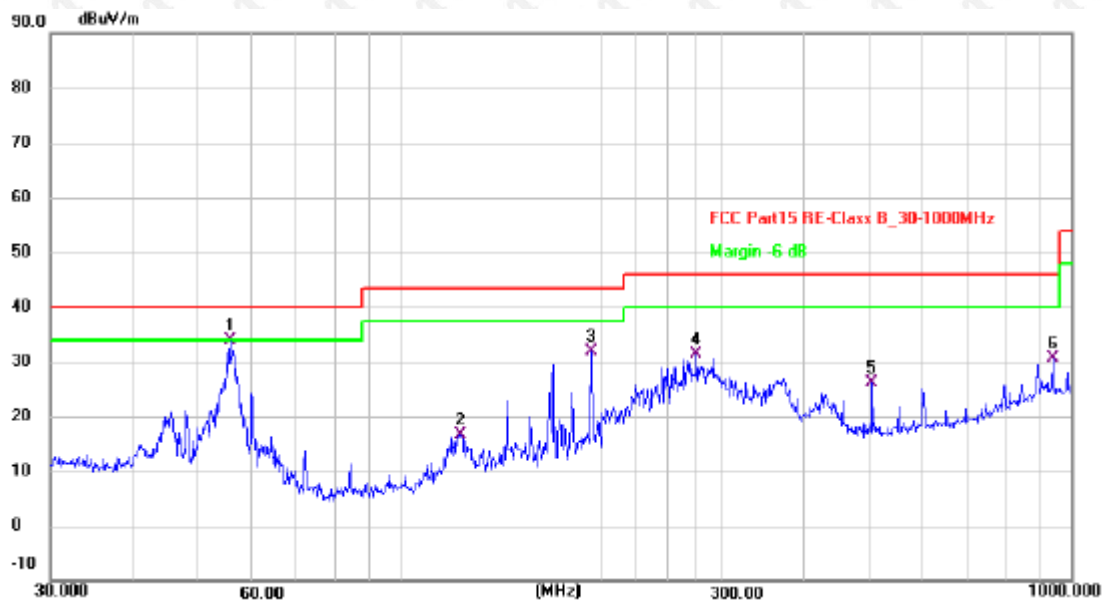
Frequency	Detector	RBW	VBW	Remark
0.009MHz-0.090MHz	Peak	10kHz	30KHz	Peak
0.009MHz-0.090MHz	Average	10kHz	30KHz	Average
0.090MHz-0.110MHz	Quasi-peak	10kHz	30KHz	Quasi-peak
0.110MHz-0.490MHz	Peak	10kHz	30KHz	Peak
0.110MHz-0.490MHz	Average	10kHz	30KHz	Average
0.490MHz -30MHz	Quasi-peak	10kHz	30kHz	Quasi-peak
30MHz-1GHz	Quasi-peak	120 kHz	300KHz	Quasi-peak
Above 1GHz	Peak	1MHz	3MHz	Peak
	Peak	1MHz	10Hz	Average

7.4 Test Result

Below 1GHz Test Results:

Antenna polarity: H

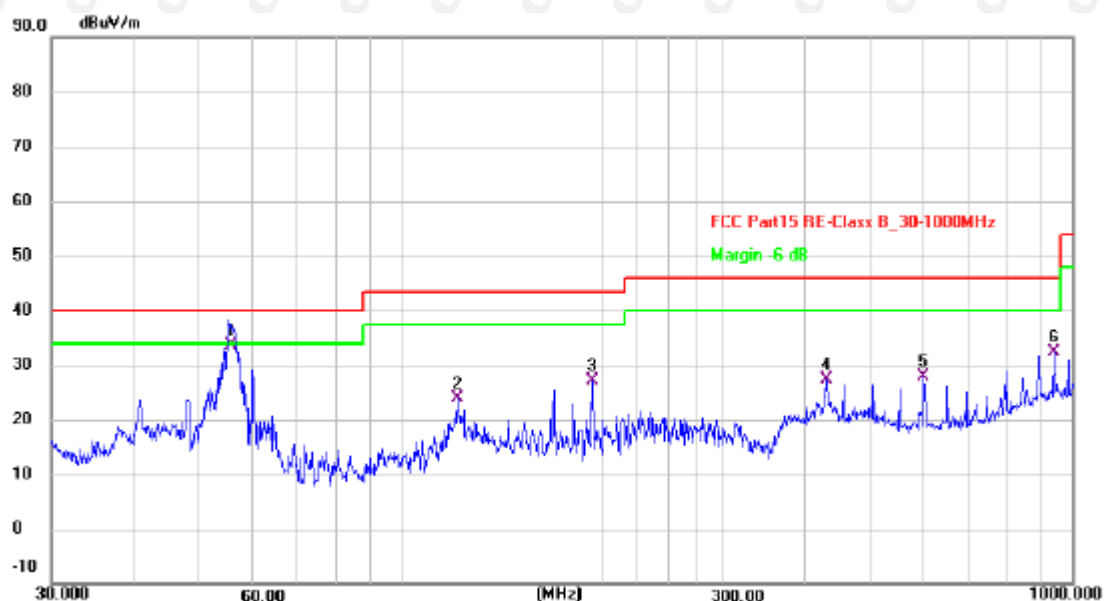
Worst case-LORA(low channel)



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1 *	55.6093	48.51	-14.61	33.90	40.00	-6.10	QP
2	122.8340	32.32	-15.69	16.63	43.50	-26.87	QP
3	192.4185	48.93	-16.98	31.95	43.50	-11.55	QP
4	276.1235	46.35	-15.03	31.32	46.00	-14.68	QP
5	504.7062	35.22	-9.14	26.08	46.00	-19.92	QP
6	938.8326	30.97	-0.45	30.52	46.00	-15.48	QP

Remark: Factor = Cable lose + Antenna factor - Pre-amplifier; Margin = Measurement – Limit

Antenna polarity: V
Worst case-LORA(low channel)



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector
1 *	55.7157	48.20	-14.62	33.58	40.00	-6.42	QP
2	121.1231	39.63	-15.84	23.79	43.50	-19.71	QP
3	192.4185	43.99	-16.98	27.01	43.50	-16.49	QP
4	429.5228	38.74	-11.48	27.26	46.00	-18.74	QP
5	599.3212	34.40	-6.49	27.91	46.00	-18.09	QP
6	938.8326	32.74	-0.45	32.29	46.00	-13.71	QP

Remark: Factor = Cable lose + Antenna factor - Pre-amplifier; Margin = Measurement – Limit

Above 1 GHz Test Results:

CH Low (902.000066MHz)

Horizontal:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
1804.000132	66.66	-5.84	60.82	74	-13.18	peak
1804.000132	54.04	-5.84	48.20	54	-5.80	AVG
2706.000198	59.04	-3.64	55.40	74	-18.60	peak
2706.000198	48.41	-3.64	44.77	54	-9.23	AVG
3608.000264	58.34	-0.95	57.39	74	-16.61	peak
3608.000264	50.09	-0.95	49.14	54	-4.86	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits						

Vertical:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
1804.000132	68.84	-5.84	63.00	74	-11.00	peak
1804.000132	54.22	-5.84	48.38	54	-5.62	AVG
2706.000198	57.72	-3.64	54.08	74	-19.92	peak
2706.000198	49.85	-3.64	46.21	54	-7.79	AVG
3608.000264	58.11	-0.95	57.16	74	-16.84	peak
3608.000264	49.44	-0.95	48.49	54	-5.51	AVG
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits						

CH Middle (915.382374MHz)

Horizontal:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
1830.764748	66.56	-5.71	60.85	74	-13.15	peak
1830.764748	52.24	-5.71	46.53	54	-7.47	AVG
2746.147122	55.83	-3.51	52.32	74	-21.68	peak
2746.147122	45.47	-3.51	41.96	54	-12.04	AVG
3661.529496	57.82	-0.82	57.00	74	-17.00	peak
3661.529496	46.34	-0.82	45.52	54	-8.48	AVG

Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits

Vertical:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
1830.764748	67.98	-5.71	62.27	74	-11.73	peak
1830.764748	53.82	-5.71	48.11	54	-5.89	AVG
2746.147122	55.02	-3.51	51.51	74	-22.49	peak
2746.147122	46.72	-3.51	43.21	54	-10.79	AVG
3661.529496	57.89	-0.82	57.07	74	-16.93	peak
3661.529496	47.25	-0.82	46.43	54	-7.57	AVG

Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits

CH High (927.900000MHz)

Horizontal:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
1855.8	66.46	-5.65	60.81	74	-13.19	peak
1855.8	52.59	-5.65	46.94	54	-7.06	AVG
2783.7	55.03	-3.43	51.60	74	-22.40	peak
2783.7	45.62	-3.43	42.19	54	-11.81	AVG
3711.6	56.96	-0.75	56.21	74	-17.79	peak
3711.6	47.41	-0.75	46.66	54	-7.34	AVG

Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits

Vertical:

Frequency	Meter Reading	Factor	Emission Level	Limits	Margin	Detector Type
(MHz)	(dBμV)	(dB)	(dBμV/m)	(dBμV/m)	(dB)	
1855.8	66.28	-5.65	60.63	74	-13.37	peak
1855.8	55.78	-5.65	50.13	54	-3.87	AVG
2783.7	55.95	-3.43	52.52	74	-21.48	peak
2783.7	46.54	-3.43	43.11	54	-10.89	AVG
3711.6	56.12	-0.75	55.37	74	-18.63	peak
3711.6	46.20	-0.75	45.45	54	-8.55	AVG

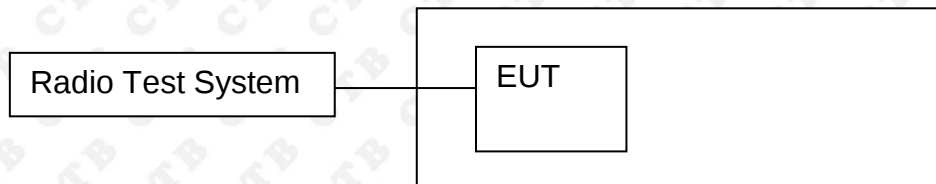
Remark: Factor = Antenna Factor + Cable Loss – Pre-amplifier. Emission level = Reading Result + Factor, Margin = Emission level - Limits

Remark:

- (1). Measuring frequencies from 9kHz to the 25 GHz, The test range is 9K ~10 times the main wave, and other spurious below the limit of 20dB will not be reflected in the report.
- (2). All modes of LORA were test at Low, Middle, and High channel, only the worst result of LORA Low Channel was reported for below 1GHz test.
- (3). For BT above 1GHz test all modes of LORA were test at Low, Middle, and High channel, only the worst result of LORA Low Channel was reported.
- (4). By preliminary testing and verifying three axis (X, Y and Z) position of EUT transmitted status, it was found that "Z axis" position was the worst, and test data recorded in this report.
- (5). Radiated emission test from 9kHz to 10th harmonic of fundamental was verified, and no emission found except system noise floor in 9kHz to 30MHz and not recorded in this report.

8. BAND EDGE AND RF CONDUCTED SPURIOUS EMISSIONS

8.1 Block Diagram Of Test Setup



8.2 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 conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

8.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum;
2. Set the spectrum analyzer:

Below 30MHz:

RBW = 100kHz, VBW = 300kHz, Sweep = auto

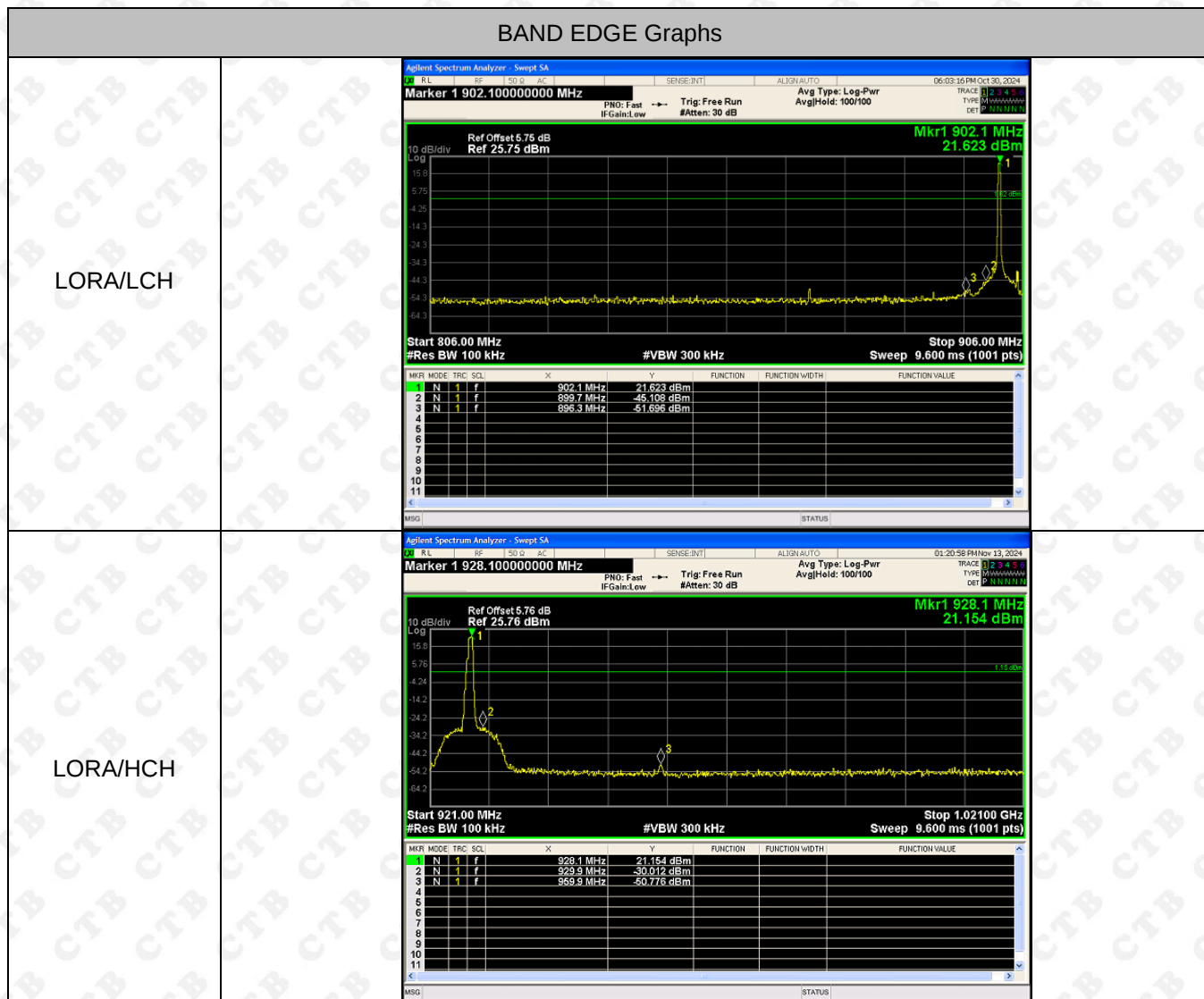
Detector function = peak, Trace = max hold

Above 30MHz:

RBW = 100kHz, VBW = 300kHz, Sweep = auto

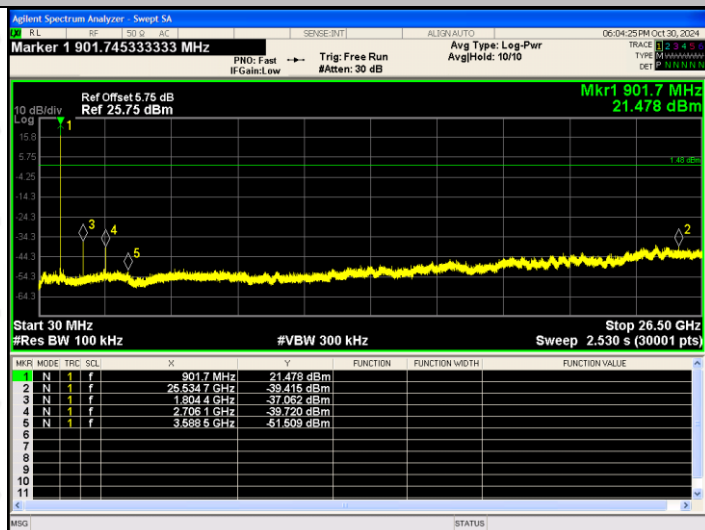
Detector function = peak, Trace = max hold

8.4 Test Result

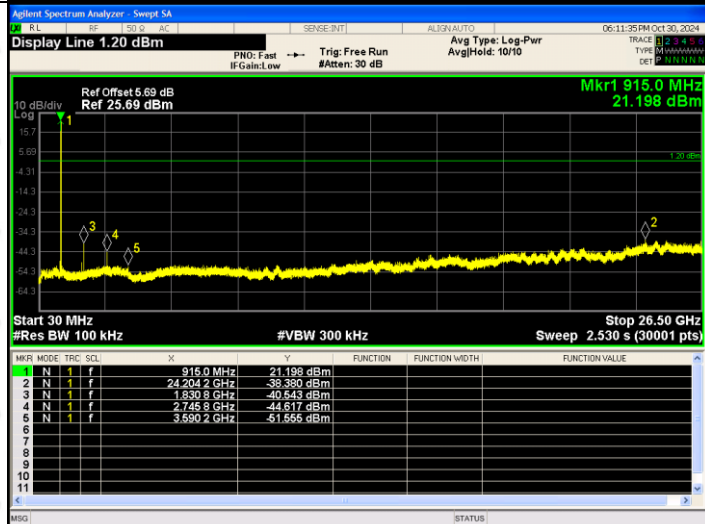


RF Conducted Spurious Emissions Graphs

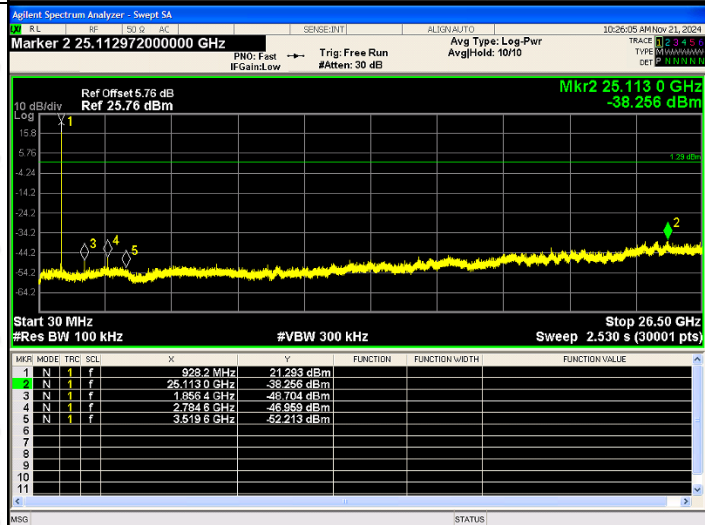
LORA/LCH



LORA/MCH



LORA/HCH



9. COUDUCTED OUTPUT POWER

9.1 Block Diagram Of Test Setup



9.2 Limit

FCC Part15 (15.247) , Subpart C				
Section	Test Item	Limit	Frequency Range (MHz)	Result
15.247(b)(3)	Output Power	1 watt or 30dBm	902-928	PASS

9.3 Test procedure

1. Remove the antenna from the EUT and then connect a low RF cable from the antenna port to the spectrum.
2. Set the spectrum analyzer: RBW = 2MHz. VBW = 6MHz. Channel power measurement. Sweep = auto; Detector Function = peak.
3. Keep the EUT in transmitting at lowest, middle and highest channel individually. Record the max value.

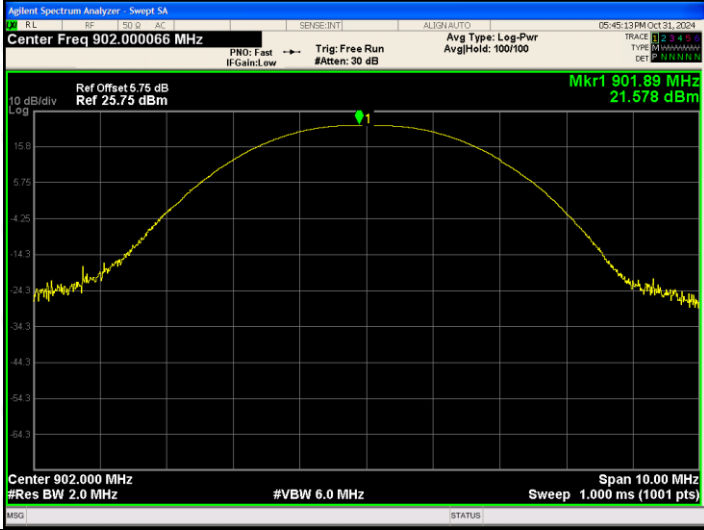
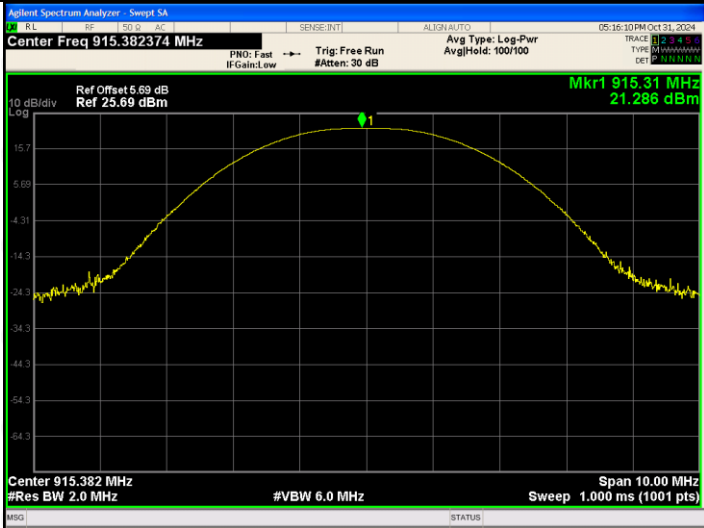
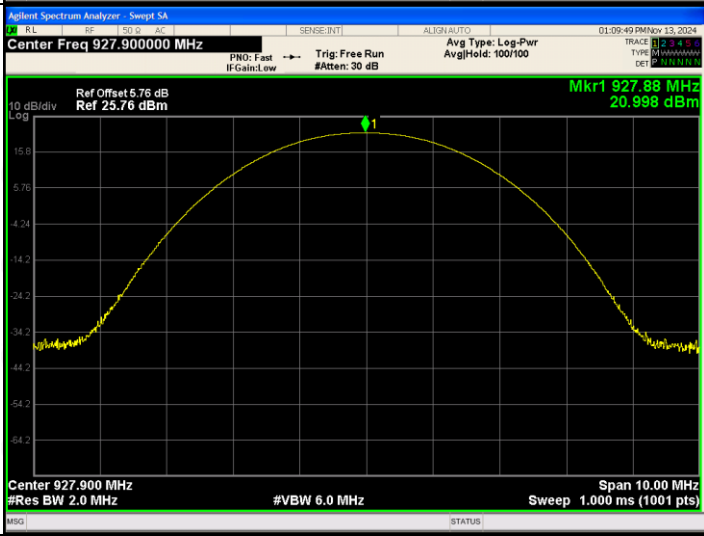
9.4 Test Result

Mode	Channel.	Maximum Output Power [dBm]	Limit[dBm]	Verdict
LORA	LCH	21.578	30	PASS
	MCH	21.286	30	PASS
	HCH	20.998	30	PASS

Duty Cycle

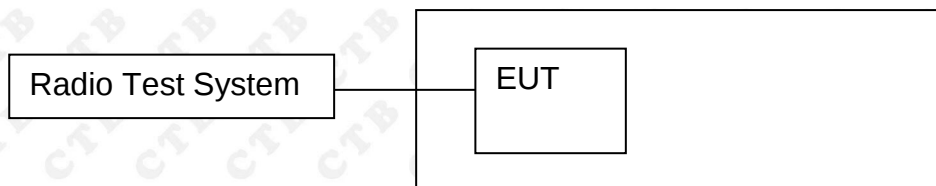
Mode	Channel.	Duty Cycle(%)	Correction Factor (dB)
LORA	LCH	100	0
	MCH	100	0
	HCH	100	0

Test Graph:

LORA Low channel	 Agilent Spectrum Analyzer - Swept SA Center Freq 902.000066 MHz Ref Offset 5.75 dB Ref 25.75 dBm Mkr1 901.89 MHz 21.578 dBm Center 902.000 MHz #Res BW 2.0 MHz #VBW 6.0 MHz Span 10.00 MHz Sweep 1.000 ms (1001 pts)
LORA Mid channel	 Agilent Spectrum Analyzer - Swept SA Center Freq 915.362374 MHz Ref Offset 5.69 dB Ref 25.69 dBm Mkr1 915.31 MHz 21.286 dBm Center 915.382 MHz #Res BW 2.0 MHz #VBW 6.0 MHz Span 10.00 MHz Sweep 1.000 ms (1001 pts)
LORA High channel	 Agilent Spectrum Analyzer - Swept SA Center Freq 927.900000 MHz Ref Offset 5.76 dB Ref 25.76 dBm Mkr1 927.88 MHz 20.998 dBm Center 927.900 MHz #Res BW 2.0 MHz #VBW 6.0 MHz Span 10.00 MHz Sweep 1.000 ms (1001 pts)

10. 6DB OCCUPIED BANDWIDTH

10.1 Block Diagram Of Test Setup



10.2 Limit

FCC Part15 (15.247) , Subpart C				
Section	Test Item	Limit	Frequency Range (MHz)	Result
15.247(a)(2)	Bandwidth	$\geq 500\text{KHz}$ (6dB bandwidth)	902-928	PASS

10.3 Test procedure

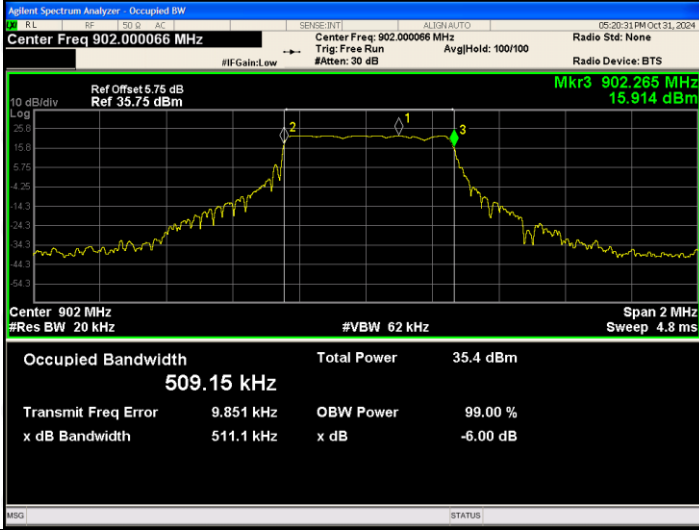
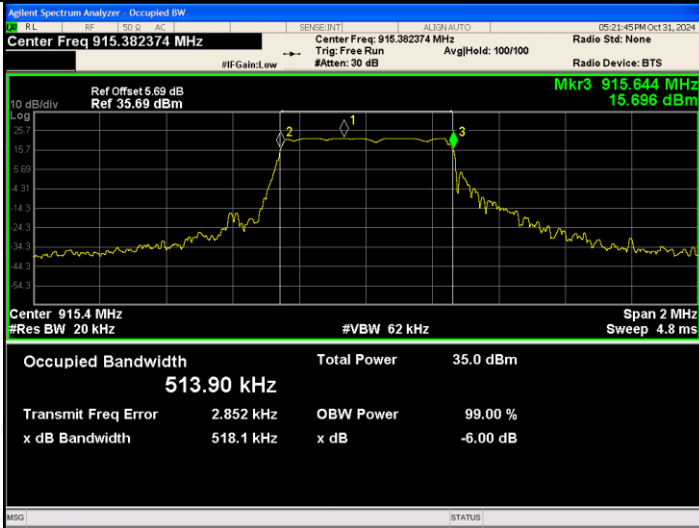
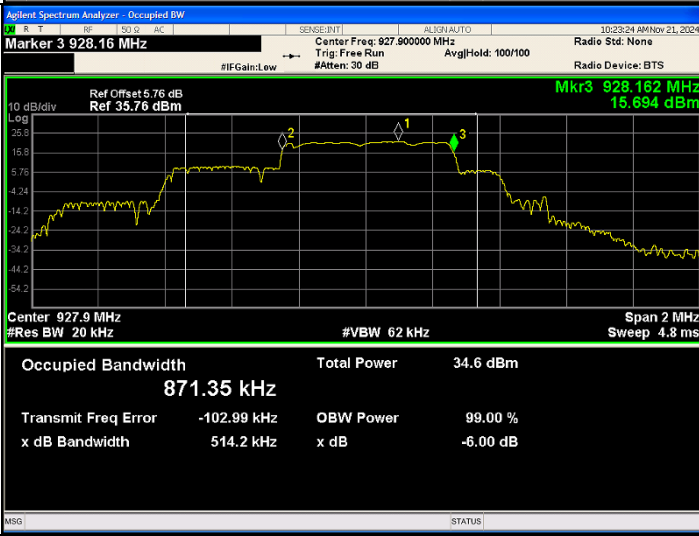
1. Rem1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW) $\geq 3 \times$ RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

10.4 Test Result

Test Mode	Frequency	6dB Bandwidth (MHz)	Limit (KHz)	Result
LORA	Low channel	0.511	≥ 500	PASS
	Mid channel	0.518	≥ 500	PASS
	High channel	0.514	≥ 500	PASS

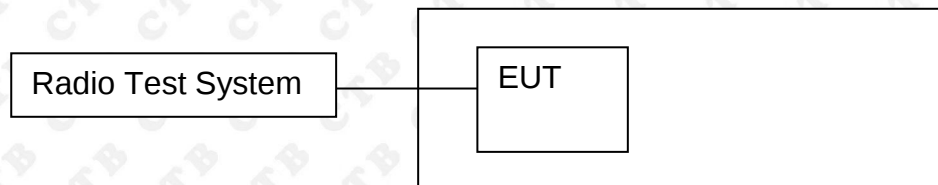
Note: All modes of operation were Pre-scan and the worst-case emissions are reported.

Test Graph:

LORA Low channel		
LORA Mid channel		
LORA High channel		

11. POWER SPECTRAL DENSITY

11.1 Block Diagram Of Test Setup



11.2 Limit

FCC Part15 (15.247) , Subpart C				
Section	Test Item	Limit	Frequency Range (MHz)	Result
15.247	Power Spectral Density	8 dBm (in any 3KHz)	902-928	PASS

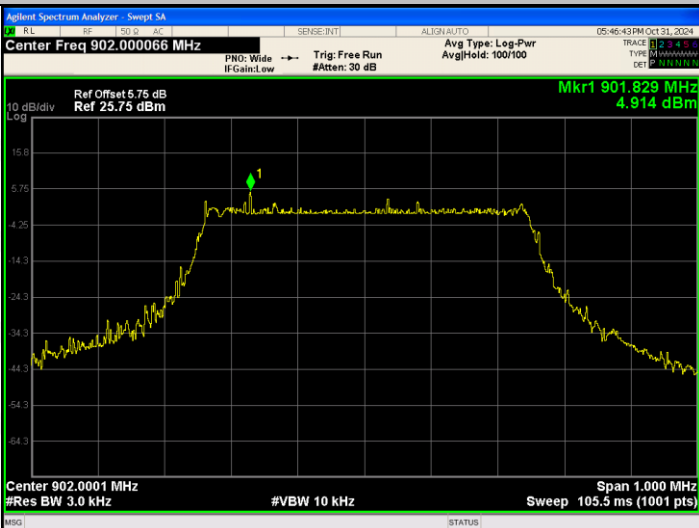
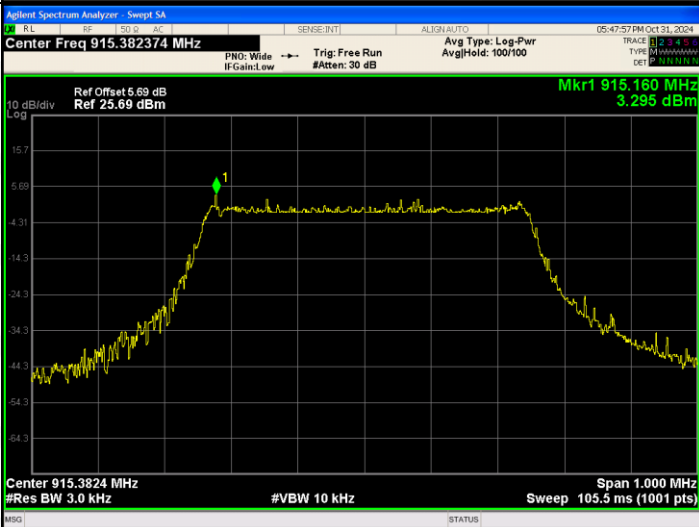
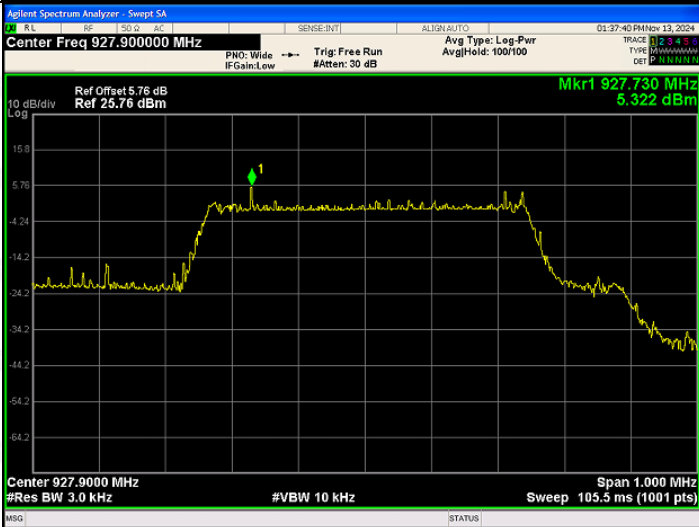
11.3 Test procedure

1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to 1.5 times the DTS bandwidth.
3. Set the RBW to: $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$.
4. Set the VBW $\geq 3 \times \text{RBW}$.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

11.4 Test Result

Mode	Channel.	Power Spectral Density (dBm/3kHz)	Limit(dBm/3kHz)	Verdict
LORA	LCH	4.914	8	PASS
LORA	MCH	3.295	8	PASS
LORA	HCH	4.726	8	PASS

Test Graph

Graphs	
LORA/LCH	 Agilent Spectrum Analyzer - Sweep SA Center Freq 902.000066 MHz Ref Offset 5.75 dB Ref 25.75 dBm Mkr1 901.829 MHz 4.914 dBm Center 902.0001 MHz #Res BW 3.0 kHz #VBW 10 kHz Span 1.000 MHz Sweep 105.5 ms (1001 pts)
LORA/MCH	 Agilent Spectrum Analyzer - Sweep SA Center Freq 915.382374 MHz Ref Offset 5.69 dB Ref 25.69 dBm Mkr1 915.160 MHz 3.295 dBm Center 915.3824 MHz #Res BW 3.0 kHz #VBW 10 kHz Span 1.000 MHz Sweep 105.5 ms (1001 pts)
LORA/HCH	 Agilent Spectrum Analyzer - Sweep SA Center Freq 927.900000 MHz Ref Offset 5.76 dB Ref 25.76 dBm Mkr1 927.730 MHz 5.322 dBm Center 927.9000 MHz #Res BW 3.0 kHz #VBW 10 kHz Span 1.000 MHz Sweep 105.5 ms (1001 pts)

12. ANTENNA REQUIREMENT

15.203 requirement:

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.

15.247(b) (4) requirement:

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.

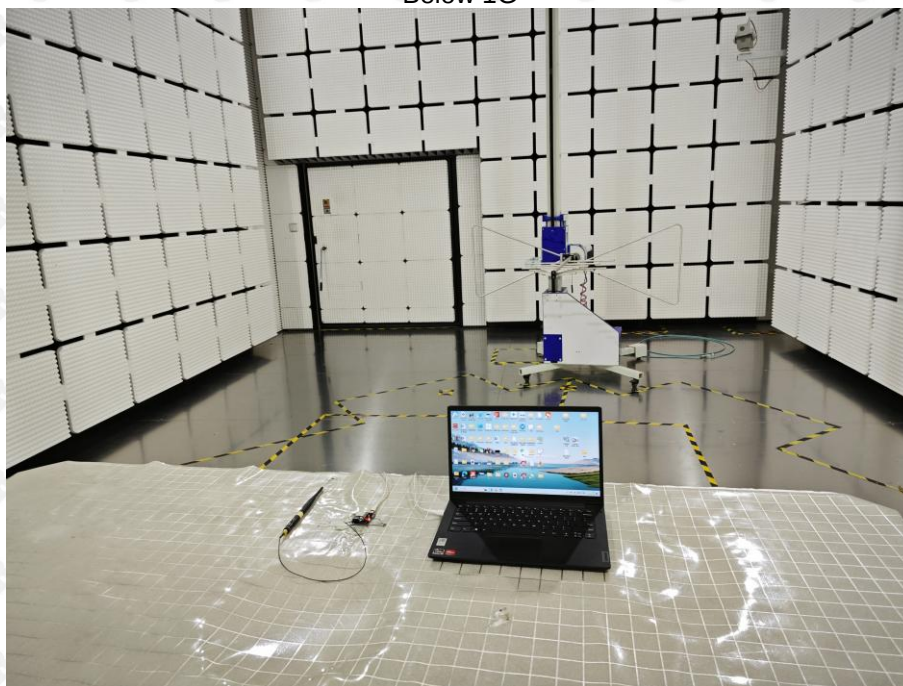
EUT Antenna:

The EUT antenna is Glue rod antenna. The best case gain of the antenna is 0.94dBi.

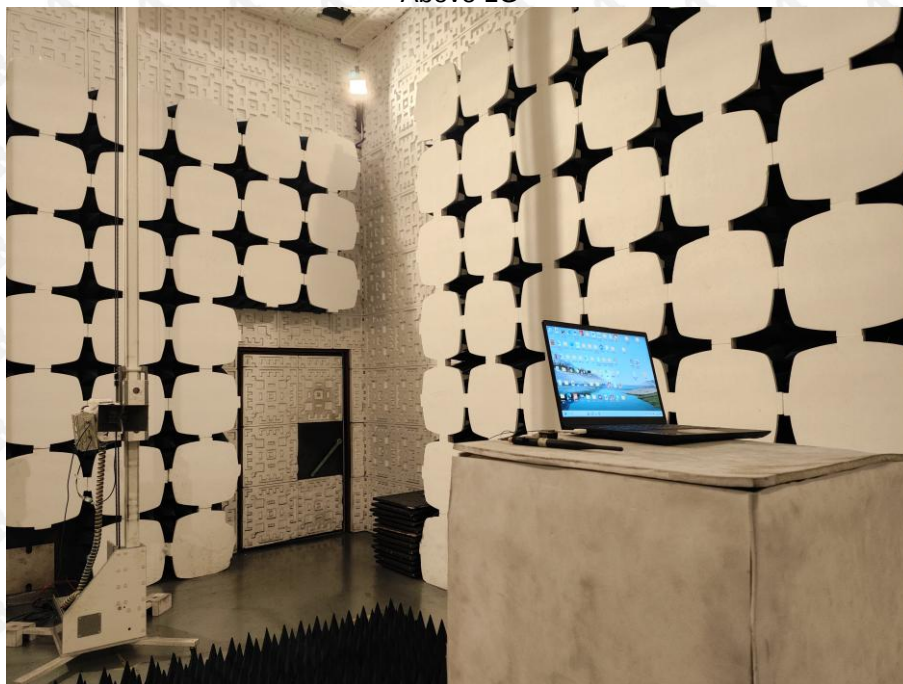
13. EUT TEST SETUP PHOTOGRAPHS

Radiated Emissions

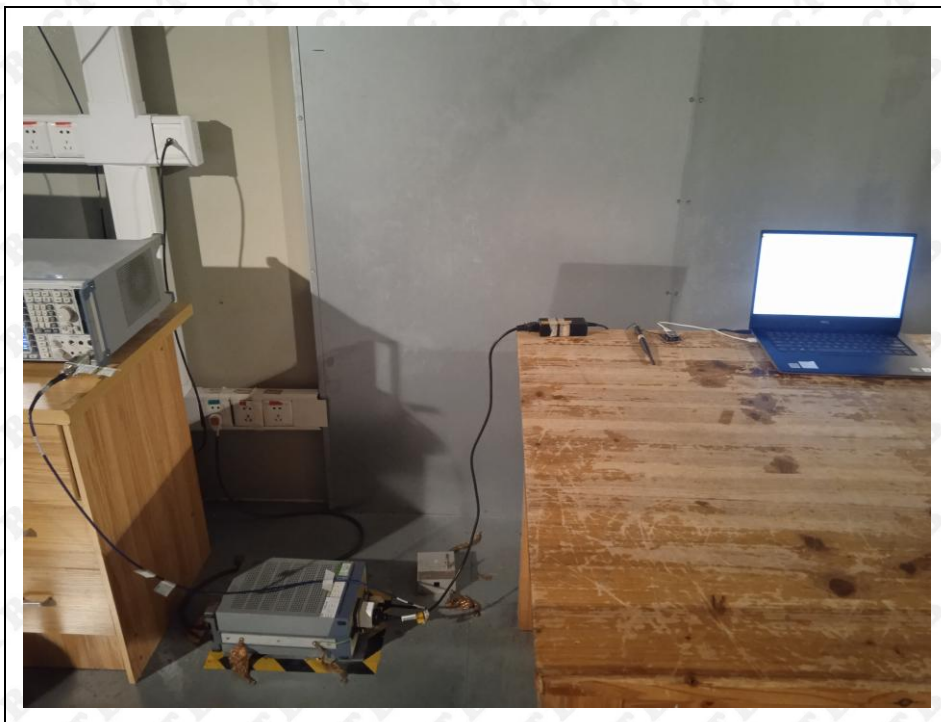
Below 1G



Above 1G



Conducted emission



※※※※※ END OF REPORT ※※※※※