TEST REPORT

Application No.:	HKEM2107000711AT
Applicant:	Webasto Charging Systems, Inc.
Address of Applicant:	1333 South Mayflower Avenue Monrovia, California 91016, USA
Manufacture:	Webasto Charging Systems, Inc.
Address of Manufacture:	1333 South Mayflower Avenue Monrovia, California 91016, USA
Equipment Under Test (EUT):	
EUT Name:	IPC Communication Board
Model No.:	IPC COMM
FCC ID:	2AZ8SIPC
IC:	27507-IPC
HVIN:	IPC COMM
Standard(s) :	CFR 47 FCC Part 15, Subpart C
	RSS-247 Issue 2: February 2017
	RSS-Gen: Issue 5 April 2018 Amendment 2
Date of Receipt:	2021-06-21
Date of Test:	2021-07-01 to 2021-08-23
Date of Issue:	2021-08-23
Test Result:	Pass*

* In the configuration tested, the EUT complied with the standards specified above.

Law Man Kit
EMC Manager

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Revision Record				
Version	**Chapter**	**Date**	**Modifier**	**Remark**
01		2021-08-23		Original

Authorized for issue by:				
		Yung Yukwah /Project Engineer		Date: 2021-07-26
		Law Man Kit /Reviewer		Date: 2021-07-26

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2 Test Summary

Radio Spectrum Technical Requirement				
Item	**Standard**	**Method**	**Requirement**	**Result**
Antenna Requirement	47 CFR Part 15, Subpart C 15.247	N/A	47 CFR Part 15, Subpart C 15.203 & 15.247(b)(4)	Pass

Radio Spectrum Matter Part				
Item	**Standard**	**Method**	**Requirement**	**Result**
Conducted Disturbance at AC Power Line(150kHz-30MHz)	47 CFR Part 15, Subpart C 15.207	ANSI C63.10: 2013 Section 6.2	47 CFR FCC Part 15, Subpart C 15.207	Pass
Minimum 6dB Bandwidth	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 11.8.1	47 CFR Part 15, Subpart C 15.247a(2)	Pass
Conducted Peak Output Power	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 11.9.2.3	47 CFR Part 15, Subpart C 15.247(b)(3)	Pass
Power Spectrum Density	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 11.10.2	47 CFR Part 15, Subpart C 15.247(e)	Pass
Conducted Band Edges Measurement	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 11.13.3.2	47 CFR Part 15, Subpart C 15.247(d)	Pass
Conducted Spurious Emissions	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 11.11	47 CFR Part 15, Subpart C 15.247(d)	Pass
Radiated Emissions which fall in the restricted bands	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 6.10.5	47 CFR Part 15, Subpart C 15.209 & 15.247(d)	Pass
Radiated Spurious Emissions	47 CFR Part 15, Subpart C 15.247	ANSI C63.10 (2013) Section 6.4,6.5,6.6	47 CFR Part 15, Subpart C 15.209 & 15.247(d)	Pass

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Radio Spectrum Technical Requirement				
Item	**Standard**	**Method**	**Requirement**	**Result**
Antenna Requirement	RSS-Gen: Issue 5 April 2018 Amendment 2	N/A	RSS-Gen Section 6.8	Pass

Radio Spectrum Matter Part				
Item	**Standard**	**Method**	**Requirement**	**Result**
Conducted Emissions at AC Power Line (150kHz-30MHz)	RSS-Gen: Issue 5 April 2018 Amendment 2	ANSI C63.10 (2013) Section 6.2	RSS-Gen Section 8.8	Pass
99% Bandwidth	RSS-Gen: Issue 5 April 2018 Amendment 2	ANSI C63.10 Section 6.9.3	RSS-Gen Section 6.7	Pass
Minimum 6dB Bandwidth	RSS-247 Issue 2, February 2017	ANSI C63.10 (2013) Section 11.8.1	RSS-247 Section 5.2(a)	Pass
Conducted Peak Output Power	RSS-247 Issue 2, February 2017	ANSI C63.10 (2013) Section 11.9.1	RSS-247 Section 5.4(d)	Pass
Power Spectrum Density	RSS-247 Issue 2, February 2017	ANSI C63.10 (2013) Section 11.10.2	RSS-247 Clause 5.2(b)	Pass
Conducted Band Edges Measurement	RSS-247 Issue 2, February 2017	ANSI C63.10 (2013) Section 11.12	RSS-247 Section 5.5	Pass
Spurious Emissions	RSS-247 Issue 2, February 2017	ANSI C63.10 (2013) Section 11.11	RSS-247 Section 5.5	Pass
Radiated Emissions which fall in the restricted bands	RSS-Gen: Issue 5 April 2018 Amendment 2	ANSI C63.10 (2013) Section 6.4&6.5&6.6	RSS-247 Section Section 3.3 & RSS-Gen Section 8.10	Pass
Frequency stability	RSS-247 Issue 2, February 2017	RSS-Gen Section 6.11	RSS-Gen Section 8.11	Pass

Note: Frequency stability requested in RSS GEN Section 8.1.1 has been complied since the result of band edge can demonstrate.

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Abbreviation:

Tx: In this whole report Tx (or tx) means Transmitter.

Rx: In this whole report Rx (or rx) means Receiver.

RF: In this whole report RF means Radiated Frequency.

CH: In this whole report CH means channel.

Volt: In this whole report Volt means Voltage.

Temp: In this whole report Temp means Temperature.

Humid: In this whole report Humid means humidity.

Press: In this whole report Press means Pressure.

N/A: In this whole report not application.

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4 General Information

4.1 Details of E.U.T.

Power supply:	Input: DC 5.0 V, 1 A powered from Micro USB port
Test voltage:	AC 120 V,60Hz
Cable:	99.5 cm unshielded 3-wire USB cable
Antenna Gain:	2 dBi
Antenna Type:	Dipole Antenna
Bluetooth Version:	V5.0
Operation Frequency:	2402MHz to 2480MHz
Number of Channels:	40
Tested Channels:	2402MHz, 2440MHz, 2480MHz
Channel Spacing:	2MHz
Modulation Type:	GFSK
Data rate:	1Mbps
Series number:	IPC COM-001
FVIN:	V1.2
Hardware Version:	DVT1
Software Version:	V1.2
	Remark: Power level setting was not adjustable and fixed default through SW Version.

Frequency List

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	**2402**	15	2430	29	2458
2	2404	16	2432	30	2460
3	2406	17	2434	31	2462
4	2408	18	2436	32	2464
5	2410	19	2438	33	2466
6	2412	**20**	**2440**	34	2468
7	2414	21	2442	35	2470
8	2416	22	2444	36	2472
9	2418	23	2446	37	2474
10	2420	24	2448	38	2476
11	2422	25	2450	39	2478
12	2424	26	2452	**40**	**2480**
13	2426	27	2454		
14	2428	28	2456		

Remark: 1. Testing Channels are highlighted in **bold**.

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4.2 Description of Support Units

The EUT has been tested with corresponding accessories as below:

Supplied by client

Description	Manufacturer	Model No.	SN/Certificate NO
Test Software	Webasto Charging Systems, Inc.	SecureCRT	N/A

Supplied by SGS:

Description	Manufacturer	Model No.	SN/Certificate NO
NoteBook (EMC4)	Dell	P75F	N/A
AC/DC Adapter	SGS	IEC 005	N/A

4.3 Measurement Uncertainty

No.	Item	Measurement Uncertainty
1	Radio Frequency	± 7.25 x 10^{-8}
2	Duty cycle	± 0.37%
3	Occupied Bandwidth	± 3%
4	RF conducted power (30MHz-40GHz)	1.5dB
5	RF power density	1.5dB
6	Conducted Spurious emissions	1.5dB
7	RF Radiated power & Radiated Spurious emission test	4.9dB (30MHz-1GHz)
		4.6dB (1GHz-6GHz)
		4.7dB (6GHz-18GHz)
		5.6dB (18GHz-40GHz)
8	Temperature test	± 1°C
9	Humidity test	± 3%
10	Supply voltages	± 1.5%
11	Time	± 3%

Remark:

The U_{lab} (lab Uncertainty) is less than U_{cispr} (CISPR Uncertainty), so the test results

- compliance is deemed to occur if no measured disturbance level exceeds the disturbance limit;
- non-compliance is deemed to occur if any measured disturbance level exceeds the disturbance limit.

According to decision rule based on Clause 4.2 of CISPR 16-4-2, the EUT complied with the standards specified above.

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4.4 Test Location

All tests were performed at:

SGS Hong Kong Limited

Unit 2 and 3, G/F, Block A, Po Lung Centre,

11 Wang Chiu Road, Kowloon Bay, Kowloon, Hong Kong

Tel: +852 2305 2570 Fax: +852 2756 4480

No tests were sub-contracted.

4.5 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

- **HOKLAS (Lab Code: 009)**

SGS HONG KONGLimited has been accepted by HKAS Executive, on the recommendation of the Accreditation Advisory Board, as a HOKLAS Accredited Laboratory, this laboratory meets the requirements of ISO/IEC 17025:2017 an it has been accredited for performing specific test as listed in the scope of accreditation within the test category of Electrical and Electronic Products.

- **IAS Accreditation (Lab Code: TL-817)**

SGS HONG KONGLimited has met the requirements of AC89, IAS Accreditation Criteria for Testing Laboratories, and has demonstrated compliance with ISO/IEC Standard 17025:2017, General requirements for the competence of testing and calibration laboratories. This organization is accredited to provide the services specified in the scope of accreditation maintained on the IAS website (www.iasonline.org).

The report must not be used by the client to claim product certification, approval, or endorsement by IAS, NIST, or any agency of the Federal Government.

- **FCC Recognized Accredited Test Firm(CAB Registration No.: 514599)**

SGS HONG KONG Limited has been accredited and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files. Designation Number: HK0015, Test Firm Registration Number: 514599.

- **Industry Canada (Site Registration No.: 26103; CAB Identifier No.: HK0015)**

SGS HONG KONG Limited has been recognized by Department of Innovation, Science and Economic Development (ISED) Canada as a wireless testing laboratory. The acceptance letter from the ISED is maintained in our files. CAB Identifier No: HK0015, Site Registration Number: 26103.

4.6 Deviation from Standards

None

4.7 Abnormalities from Standard Conditions

None

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5 Equipment List

Minimum 6dB Bandwidth					
Equipment	**Manufacturer**	**Model No**	**Inventory No**	**Cal Date**	**Cal Due Date**
SMBV100A VECTOR SIGNAL GENERATOR	Rohde & Schwarz	SMBV100A	E234	2020/08/31	2021/08/30
Signal Analyzer	Keysight	N9020A	N/A	2021/05/31	2022/05/30
Wireless Conn. Tester (CMW)	Rohde & Schwarz	CMW270	E240	2020/08/31	2021/08/30
OSP	Rohde & Schwarz	OSP-B157W8	E242	2020/08/31	2021/08/30
Cable	Rohde & Schwarz	J12J103539-00-2	E239	2020/08/31	2021/08/30

99% Bandwidth					
Equipment	**Manufacturer**	**Model No**	**Inventory No**	**Cal Date**	**Cal Due Date**
SMBV100A VECTOR SIGNAL GENERATOR	Rohde & Schwarz	SMBV100A	E234	2020/08/31	2021/08/30
Signal Analyzer	Keysight	N9020A	N/A	2021/05/31	2022/05/30
Wireless Conn. Tester (CMW)	Rohde & Schwarz	CMW270	E240	2020/08/31	2021/08/30
OSP	Rohde & Schwarz	OSP-B157W8	E242	2020/08/31	2021/08/30
Cable	Rohde & Schwarz	J12J103539-00-2	E239	2020/08/31	2021/08/30

Conducted Peak Output Power					
Equipment	**Manufacturer**	**Model No**	**Inventory No**	**Cal Date**	**Cal Due Date**
SMBV100A VECTOR SIGNAL GENERATOR	Rohde & Schwarz	SMBV100A	E234	2020/08/31	2021/08/30
Signal Analyzer	Keysight	N9020A	N/A	2021/05/31	2022/05/30
Wireless Conn. Tester (CMW)	Rohde & Schwarz	CMW270	E240	2020/08/31	2021/08/30
OSP	Rohde & Schwarz	OSP-B157W8	E242	2020/08/31	2021/08/30
Cable	Rohde & Schwarz	J12J103539-00-2	E239	2020/08/31	2021/08/30

Power Spectrum Density					
Equipment	**Manufacturer**	**Model No**	**Inventory No**	**Cal Date**	**Cal Due Date**
SMBV100A VECTOR SIGNAL GENERATOR	Rohde & Schwarz	SMBV100A	E234	2020/08/31	2021/08/30
Signal Analyzer	Keysight	N9020A	N/A	2021/05/31	2022/05/30

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Wireless Conn. Tester (CMW)	Rohde & Schwarz	CMW270	E240	2020/08/31	2021/08/30
OSP	Rohde & Schwarz	OSP-B157W8	E242	2020/08/31	2021/08/30
Cable	Rohde & Schwarz	J12J103539-00-2	E239	2020/08/31	2021/08/30

Conducted Band Edges Measurement					
Equipment	**Manufacturer**	**Model No**	**Inventory No**	**Cal Date**	**Cal Due Date**
SMBV100A VECTOR SIGNAL GENERATOR	Rohde & Schwarz	SMBV100A	E234	2020/08/31	2021/08/30
Signal Analyzer	Keysight	N9020A	N/A	2021/05/31	2022/05/30
Wireless Conn. Tester (CMW)	Rohde & Schwarz	CMW270	E240	2020/08/31	2021/08/30
OSP	Rohde & Schwarz	OSP-B157W8	E242	2020/08/31	2021/08/30
Cable	Rohde & Schwarz	J12J103539-00-2	E239	2020/08/31	2021/08/30

Conducted Emissions at Mains Terminals (150kHz-30MHz)					
Equipment	**Manufacturer**	**Model No**	**Inventory No**	**Cal Date**	**Cal Due Date**
EMI Test Receiver 9kHz to 3.6GHz	Rohde & Schwarz	ESR3 / 102326	E231	2020/08/31	2021/08/30
Artificial Mains Network (LISN)	Schwarzbeck	NSLK 8127 / 8127312	TE10	2021/05/10	2022/05/09
Impulse Limiter	Rohde & Schwarz	ESH-3-Z2 / 357881052	E028	2020/10/23	2021/10/22
EMC32 Test Software	R&S	Version 10	N/A	--	--

Radiated Spurious Emissions (30MHz-1GHz)					
Equipment	**Manufacturer**	**Model No**	**Inventory No**	**Cal Date**	**Cal Due Date**
3m Semi-Anechoic Chamber	ChamPro	N/A	E229	2020/08/09	2021/08/08
				2021/08/08	2022/08/07
Coaxial Cable	SGS	N/A	E167	2020/07/20	2021/07/19
				2021/07/19	2022/07/18
EMI Test Receiver 9kHz to 7GHz	Rohde & Schwarz	ESR7 / 102298	E314	2021/5/18	2022/5/17
TRILOG Super Broadb. Test Antenna, (25) 30-1000MHz	Schwarzbeck	9168-1110	E311	2020/02/13	2022/02/12
Boresight Mast Controller	ChamPro	AM-BS-4500-E	E237	--	--

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Turntable with Controller	ChamPro	EM1000	E238	--	--
EMC32 Test Software	R&S	Version 10	N/A	--	--

Radiated Spurious Emissions (above 1GHz)					
Equipment	**Manufacturer**	**Model No**	**Inventory No**	**Cal Date**	**Cal Due Date**
3m Semi-Anechoic Chamber	ChamPro	N/A	E229	2020/08/09	2021/08/08
Coaxial Cable	SGS	N/A	E167	2020/07/20	2021/07/19
				2021/07/19	2022/07/18
EMI Test Receiver 9kHz to 7GHz	Rohde & Schwarz	ESR7 / 102298	E314	2021/5/18	2022/5/18
Spectrum Analyzer 9kHz - 30GHz	Rohde & Schwarz	FSP30	E204	2021/5/10	2022/5/09
Horn Antenna 1 - 18GHz	Schwarzbeck	BBHA9120D	E211	2020/01/29	2022/01/29
Preamplifier 33dB, 1 - 18GHz	Schwarzbeck	BBV9718	E214	2021/04/12	2022/04/11
Broadband Coaxial Preamplifier typ. 30 dB, 18-40 G	Schwarzbeck	BBV 9721	E266	2020/09/21	2021/09/20
Horn Antenna 15 - 40GHz	Schwarzbeck	BBHA9170	E212	2020/01/29	2022/01/28
Band Reject Filter 2.4-2.5GHz	Wainwright	WRCJV 2400/2500-2100	E206	2021/04/23	2023/04/22
RF cable SMA to SMA 10000mm	HUBER+SUHNER	SF104-26.5/2*11SMA 45	E207-1	2020/09/21	2021/09/20
Boresight Mast Controller	ChamPro	AM-BS-4500-E	E237	--	--
Turntable with Controller	ChamPro	EM1000	E238	--	--
EMC32 Test Software	R&S	Version 10	N/A	--	--

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Conducted Spurious Emissions					
Equipment	**Manufacturer**	**Model No**	**Inventory No**	**Cal Date**	**Cal Due Date**
SMBV100A VECTOR SIGNAL GENERATOR	Rohde & Schwarz	SMBV100A	E234	2020/08/31	2021/08/30
Signal Analyzer	Keysight	N9020A	N/A	2021/05/31	2022/05/30
Wireless Conn. Tester (CMW)	Rohde & Schwarz	CMW270	E240	2020/08/31	2021/08/30
OSP	Rohde & Schwarz	OSP-B157W8	E242	2020/08/31	2021/08/30
Cable	Rohde & Schwarz	J12J103539-00-2	E239	2020/08/31	2021/08/30

General used equipment					
Equipment	**Manufacturer**	**Model No**	**Inventory No**	**Cal Date**	**Cal Due Date**
Digital temperature & humidity data logger	SATO	SK-L200TH II	E232	2020/09/12	2021/09/11
Electronic Digital Thermometer with Hygrometer	nil	2074/2075	E159	2020/09/12	2021/09/11
Barometer with digital thermometer	SATO	7612-00	E218	2021/04/22	2022/04/21
Conditional Chamber	Zhong Zhi Testing Instruments	CZ-E-608D	E216	2020/08/31	2021/08/30

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6 Radio Spectrum Technical Requirement

6.1 Antenna Requirement

6.1.1 Test Requirement:

FCC Part 15 Subpart C Section 15.247 & 15.203

RSS-Gen Section 6.8

6.1.2 Conclusion

Standard 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.

Testing shall be performed using the highest gain antenna of each combination of licence-exempt transmitter and antenna type, with the transmitter output power set at the maximum level. When a measurement at the antenna connector is used to determine RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna manufacturer.

EUT Antenna:

The antenna is Dipole Antenna. The best case gain of the antenna is 2 dBi.

Photo of antenna refer to Appendix – Internal photo.

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7 Radio Spectrum Matter Test Results

7.1 Conducted Emissions at AC Power Line (150kHz-30MHz)

Test Requirement 47 CFR Part 15, Subpart C 15.207, RSS-Gen Section 8.8

Test Method: ANSI C63.10 (2013) Section 6.2

Limit:

Frequency of emission(MHz)	Conducted limit(dBµV)	
	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.		

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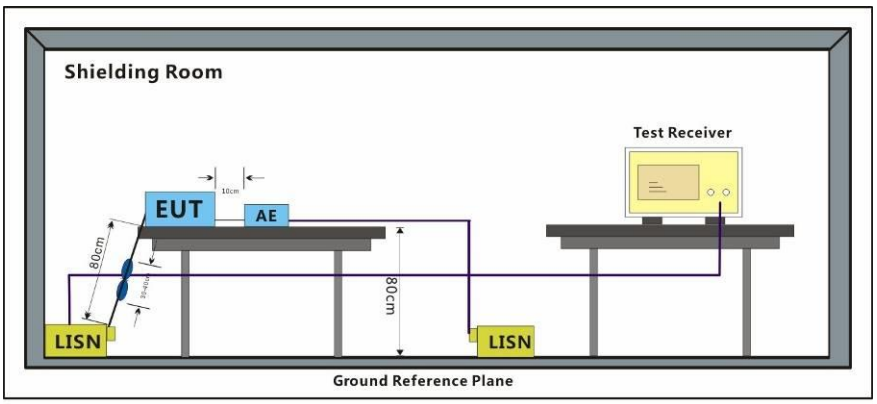
7.1.1 E.U.T. Operation

Operating Environment:

Temperature: 25.7 °C Humidity: 53.2 % RH :

Test mode b : TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation.

7.1.2 Test Setup Diagram



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7.1.3 Measurement Procedure and Data

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 50ohm/50μH + 5ohm 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 on conducted measurement.

Remark:

1. Correction Factor = LISN Factor + Cable Loss.
2. Margin = Limit – Reading
3. Pol = Polarization
4. Corr.: Correction Factor

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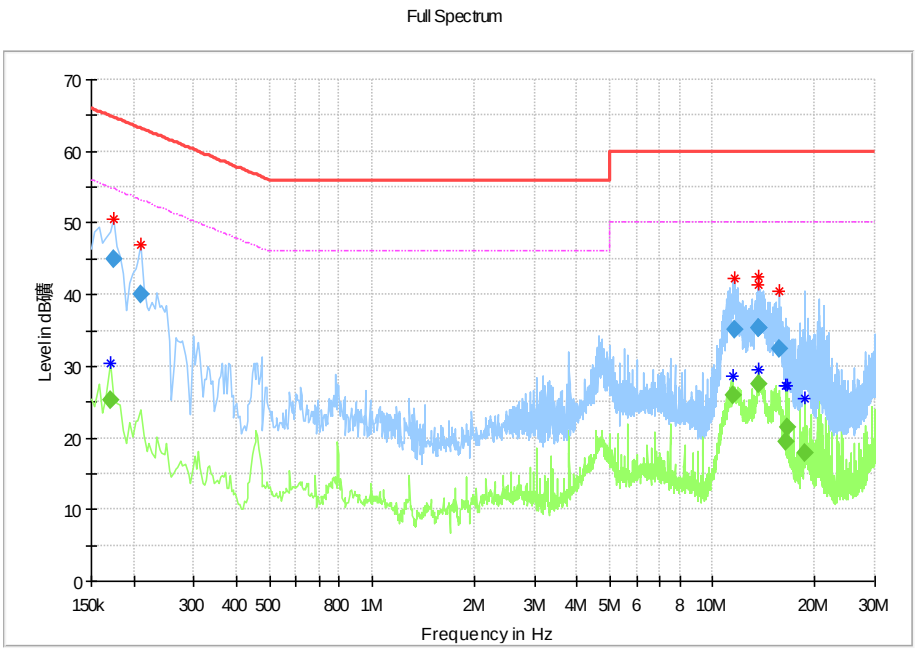
Mode:b;
Line: Live Line



Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Corr. (dB)	Result
0.170000	---	25.38	54.96	29.58	10.1	Pass
0.174000	45.05	---	64.77	19.72	10.1	Pass
0.210000	40.14	---	63.21	23.07	10.1	Pass
11.462000	---	25.93	50.00	24.07	10.7	Pass
11.662000	35.01	---	60.00	24.99	10.7	Pass
13.610000	35.27	---	60.00	24.73	10.9	Pass
13.630000	35.37	---	60.00	24.63	10.9	Pass
13.710000	---	27.51	50.00	22.49	10.9	Pass
15.658000	32.33	---	60.00	27.67	11.0	Pass
16.458000	---	19.49	50.00	30.51	10.9	Pass
16.502000	---	21.39	50.00	28.61	10.9	Pass
18.670000	---	17.79	50.00	32.21	10.8	Pass

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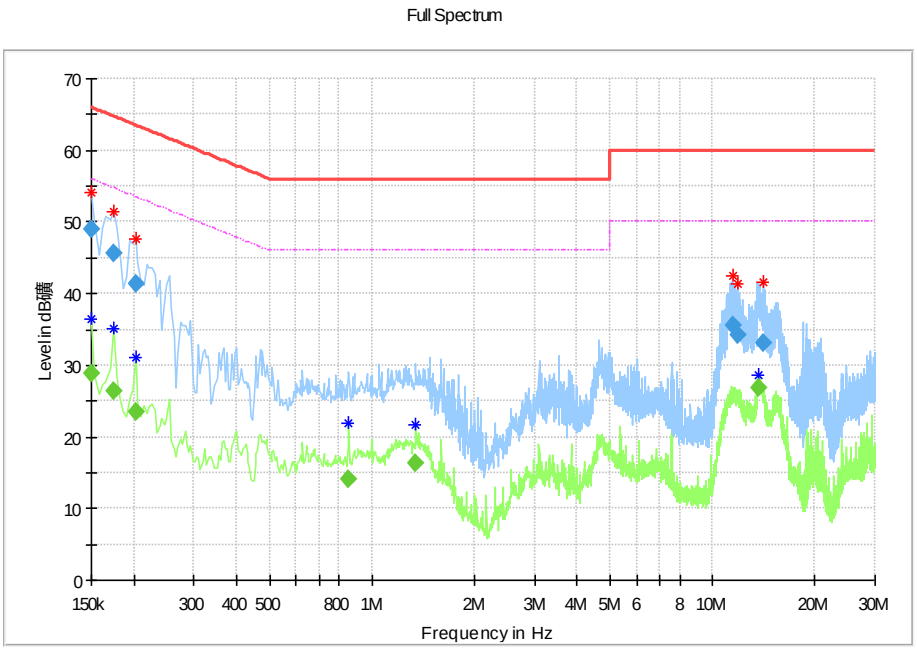
Mode:b;
Line: Neutral Line



Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Corr. (dB)	Result
0.150000	48.99	---	66.00	17.01	10.1	Pass
0.150000	---	28.88	56.00	27.12	10.1	Pass
0.174000	45.53	---	64.77	19.23	10.1	Pass
0.174000	---	26.43	54.77	28.34	10.1	Pass
0.202000	---	23.47	53.53	30.06	10.1	Pass
0.202000	41.31	---	63.53	22.21	10.1	Pass
0.854000	---	14.10	46.00	31.90	10.1	Pass
1.346000	---	16.31	46.00	29.69	10.2	Pass
11.454000	35.50	---	60.00	24.50	10.7	Pass
11.822000	34.12	---	60.00	25.88	10.7	Pass
13.686000	---	26.83	50.00	23.17	10.9	Pass
14.154000	33.12	---	60.00	26.88	11.0	Pass

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7.2 99% Bandwidth

Test Requirement RSS-Gen Section 6.7

Test Method: ANSI C63.10 Section 6.9.3

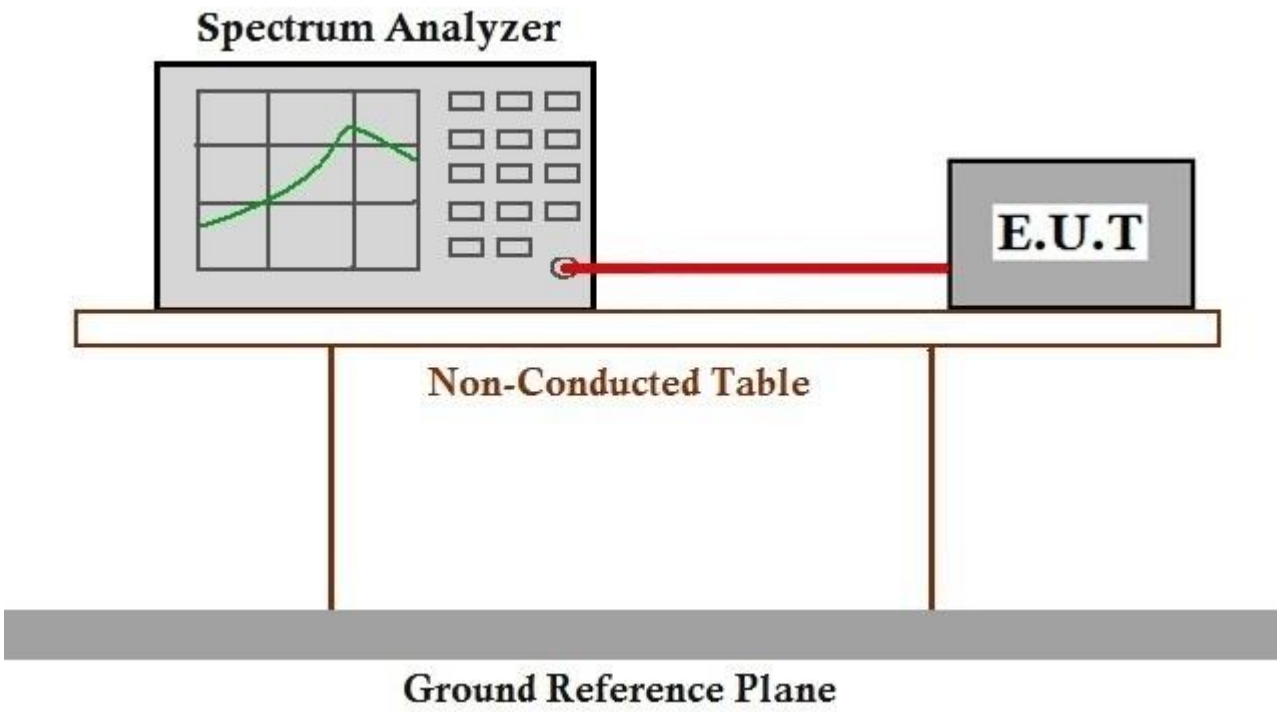
7.2.1 E.U.T. Operation

Operating Environment:

Temperature: 23.5 °C Humidity: 52.2 % RH :

Test mode b : TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation.

7.2.2 Test Setup Diagram



7.2.3 Measurement Procedure and Data

The detailed test data see section 9: Appendix

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7.3 Minimum 6dB Bandwidth

Test Requirement	47 CFR Part 15, Subpart C 15.247a(2)
	RSS-247 Section 5.2(a)
Test Method:	ANSI C63.10 (2013) Section 11.8.1
Limit:	⩾500 kHz

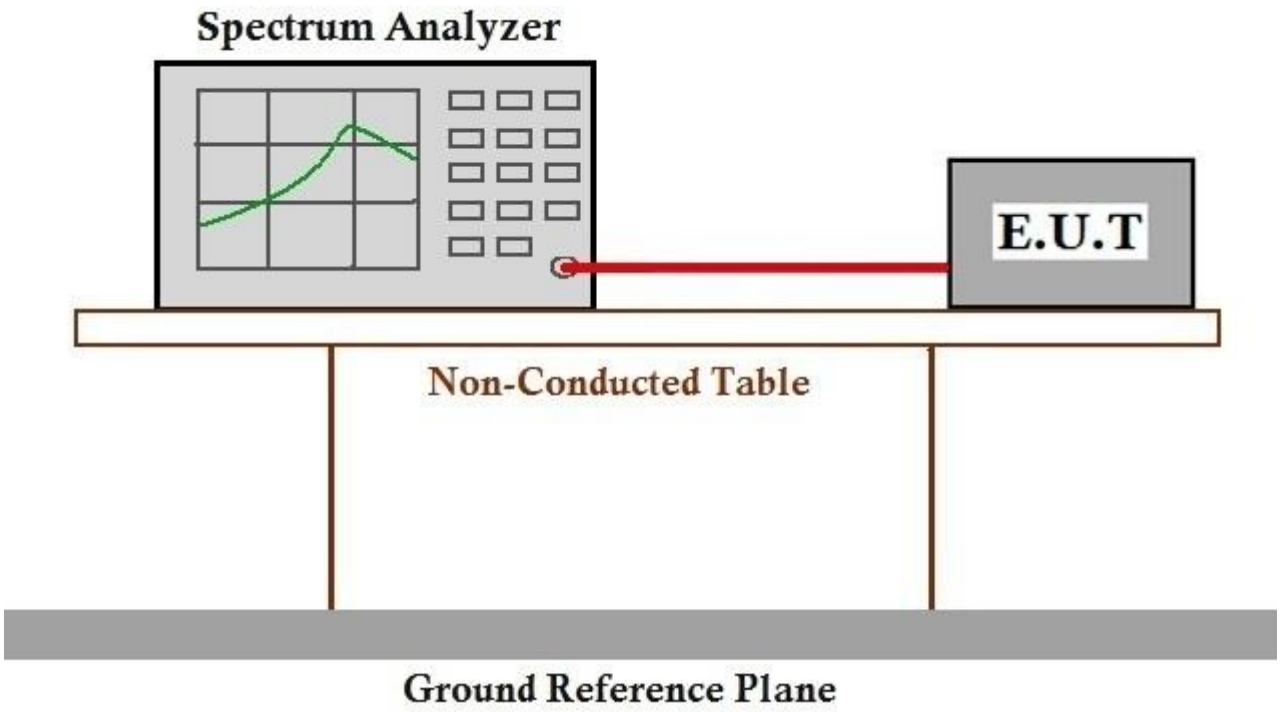
7.3.1 E.U.T. Operation

Operating Environment:

Temperature: 23.5 °C Humidity: 49.1 % RH :

Test mode b : TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation.

7.3.2 Test Setup Diagram



7.3.3 Measurement Procedure and Data

The detailed test data see section 9: Appendix

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7.4 Conducted Peak Output Power

Test Requirement 47 CFR Part 15, Subpart C 15.247(b)(1) & 15.247(b)(3), RSS-247 Section 5.4(b)

Test Method: ANSI C63.10 (2013) Section 11.9.1

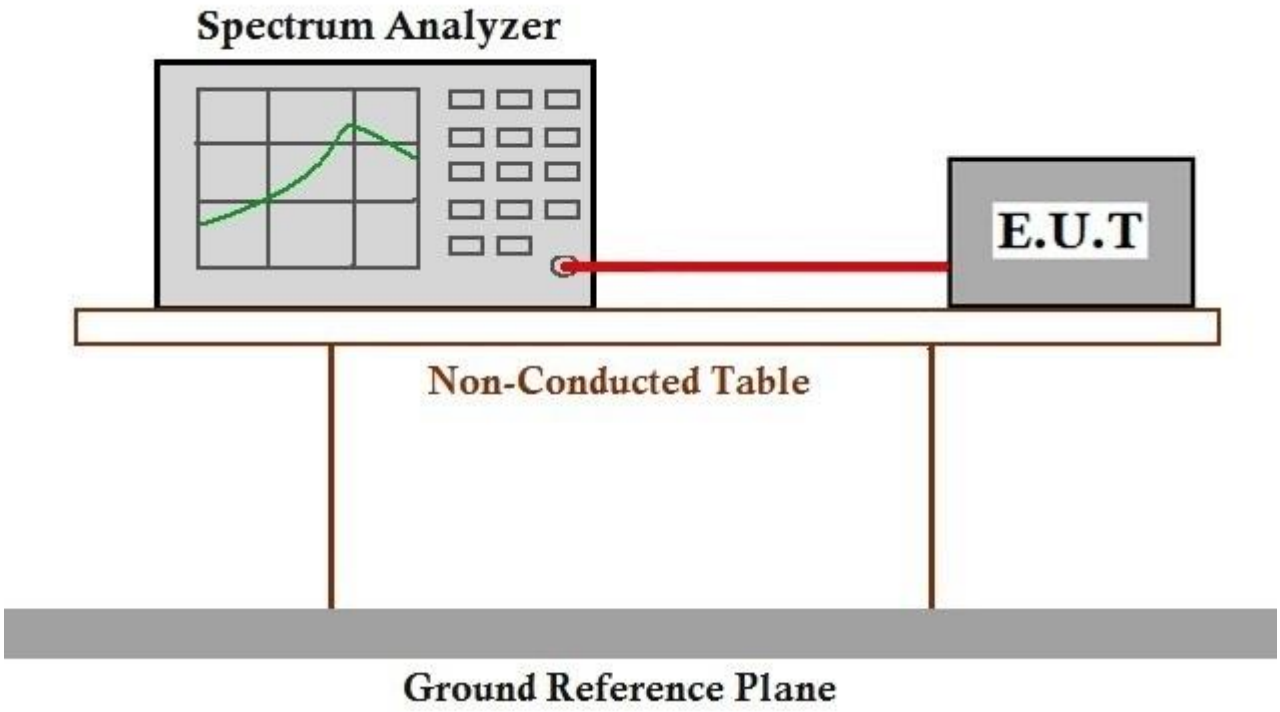
7.4.1 E.U.T. Operation

Operating Environment:

Temperature: 23.5 °C Humidity: 52.2 % RH :

Test mode b : TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation.

7.4.2 Test Setup Diagram



7.4.3 Measurement Procedure and Data

The detailed test data see section 9: Appendix

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7.5 Power Spectrum Density

Test Requirement	47 CFR Part 15, Subpart C 15.247(e), RSS-247 Clause 5.2(b)
Test Method:	ANSI C63.10 (2013) Section 11.10.2
Limit:	≤8dBm in any 3 kHz band during any time interval of continuous transmission

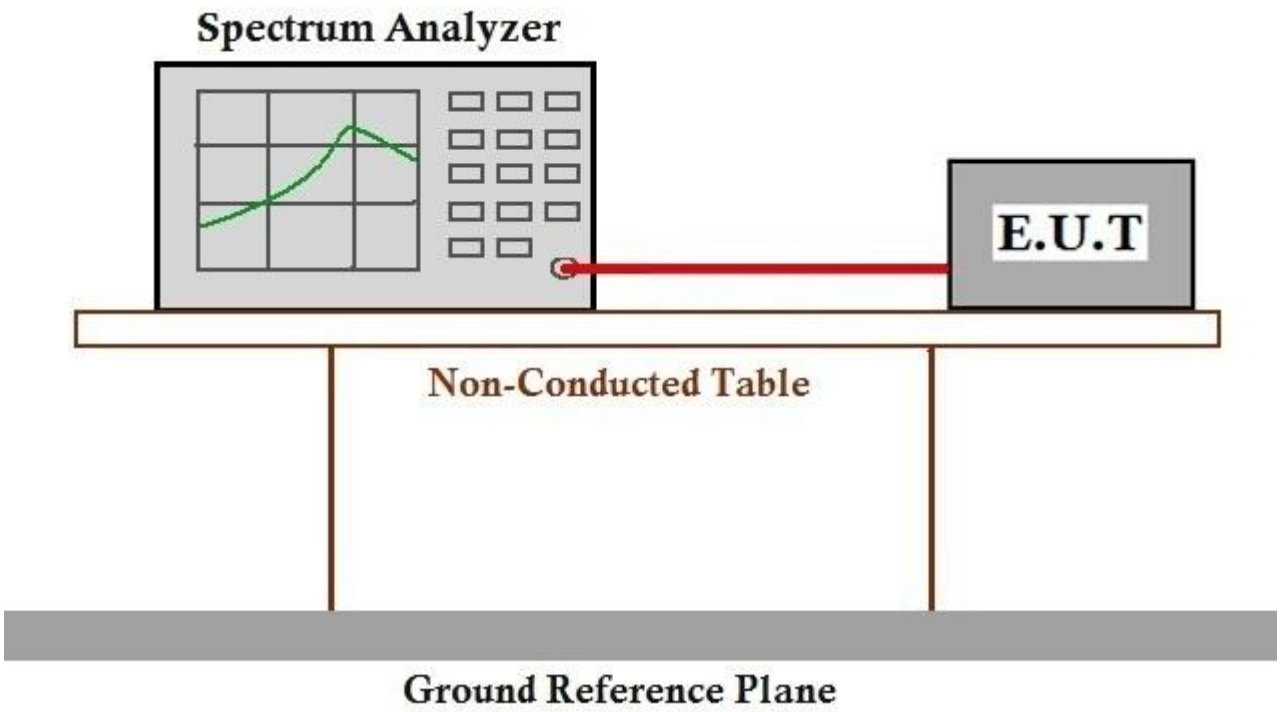
7.5.1 E.U.T. Operation

Operating Environment:

Temperature: 23.5 °C Humidity: 49.1 % RH :

Test mode b : TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation.

7.5.2 Test Setup Diagram



7.5.3 Measurement Procedure and Data

The detailed test data see section 9: Appendix

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7.6 Conducted Band Edges Measurement

Test Requirement	47 CFR Part 15, Subpart C 15.247(d), RSS-247 Section 5.5
Test Method:	ANSI C63.10 (2013) Section7.8.6
Limit:	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(d), 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. 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)

7.6.1 E.U.T. Operation

Operating Environment:

Temperature:	23.5 °C	Humidity:	51.1 % RH	:
Test mode	b : TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation.			

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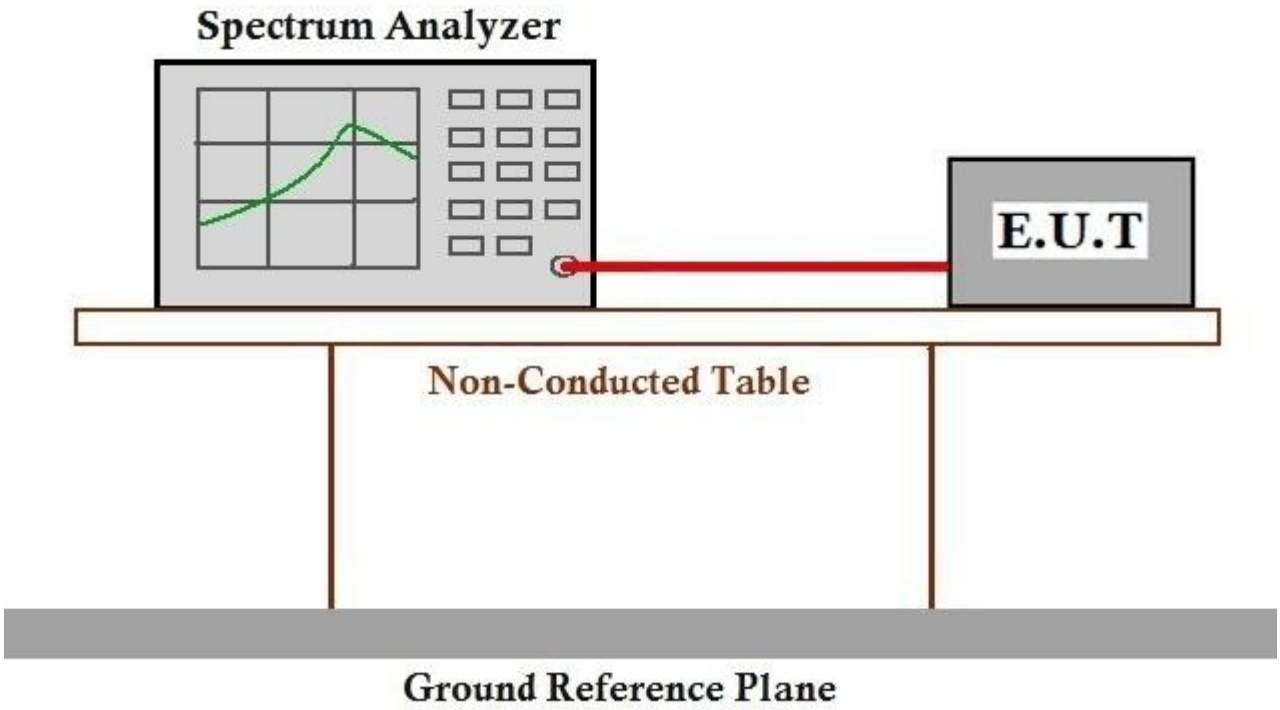
7.6.2 Test Setup Diagram



7.6.3 Measurement Procedure and Data

The detailed test data see section 9: Appendix

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7.7 Conducted Spurious Emissions

Test Requirement: 47 CFR Part 15, Subpart C 15.247(d), RSS-247 Section 5.5

Test Method: ANSI C63.10 (2013) Section 7.8.8

Limit: 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(d), 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.

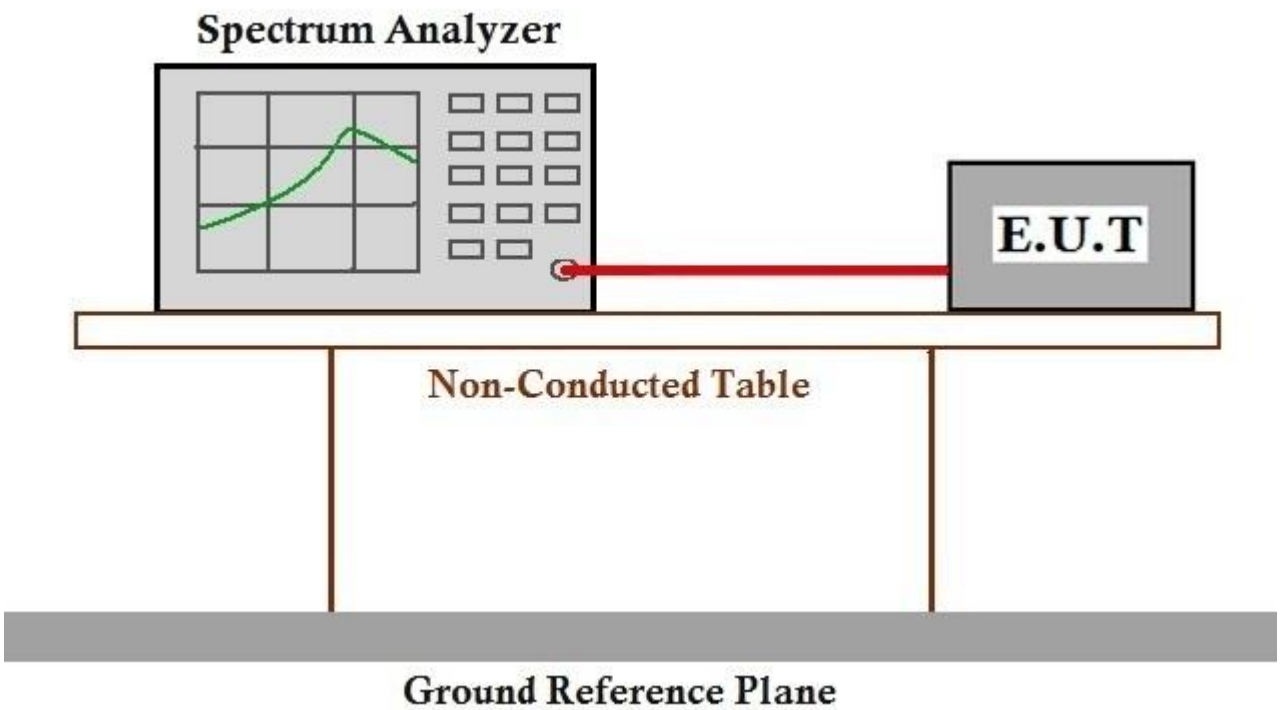
7.7.1 E.U.T. Operation

Operating Environment:

Temperature: 23.5 °C Humidity: 52.2 % RH :

Test mode b : TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation.

7.7.2 Test Setup Diagram



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7.7.3 Measurement Procedure and Data

The detailed test data see section 9: Appendix

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7.8 Radiated Emissions which fall in the restricted bands

Test Requirement: 47 CFR Part 15, Subpart C 15.209 & 15.247(d), Section 3.3 & RSS-Gen Section 8.9

Test Method: ANSI C63.10 (2013) Section 6.10.5

Limit:

FCC:

Frequency(MHz)	Field strength(microvolts/meter)	Measurement distance(meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3
Remark: The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90kHz, 110-490kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.		

IC:

Table 5 – General field strength limits at frequencies above 30 MHz

Frequency (MHz)	Field strength (μ V/m at 3 m)
30 – 88	100
88 – 216	150
216 – 960	200
Above 960	500

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Table 6 – General field strength limits at frequencies below 30 MHz

Frequency	Magnetic field strength (H-Field) (μ A/m)	Measurement distance (m)
9 - 490 kHz 1	6.37/F (F in kHz)	300
490 - 1705 kHz	63.7/F (F in kHz)	30
1.705 - 30 MHz	0.08	30

Note 1: The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector.

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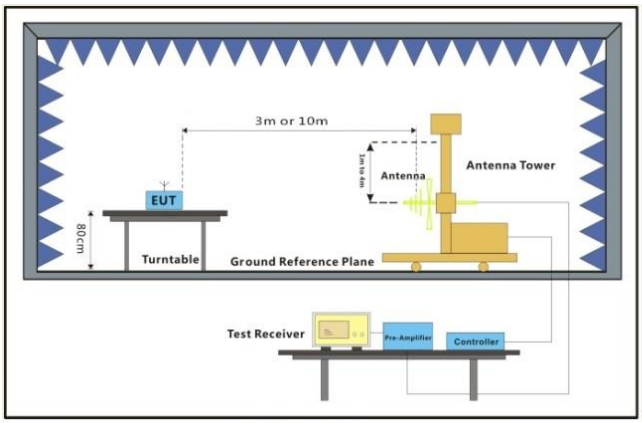
7.8.1 E.U.T. Operation

Operating Environment:

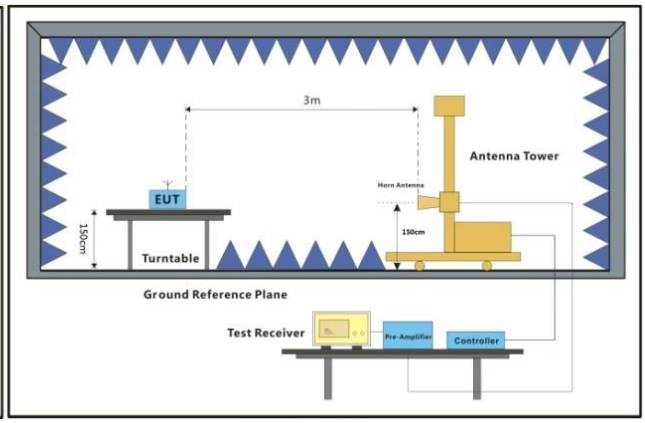
Temperature: 23.1 °C Humidity: 51.4 % RH :

Test mode b : TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation.

7.8.2 Test Setup Diagram



30MHz-1GHz



Above 1GHz

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7.8.3 Measurement Procedure and Data

a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.

b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter fully-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.

c. The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

d. 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.

e. 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 rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

f. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

g. 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.

h. Test the EUT in the lowest channel, the middle channel, the Highest channel.

i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case.

j. Repeat above procedures until all frequencies measured was complete.

Remark:

1) For emission below 1GHz, through pre-scan found the worst case is the lowest channel. Only the worst case is recorded in the report. Correction Factor = Antenna Factor + Cable Loss.

2) For emission above 1GHz,The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

Final Test Level =Receiver Reading + Antenna Factor + Cable Factor – Preamplifier Factor

3) Scan from 9kHz to 40GHz, the disturbance above 18GHz and below 30MHz was very low. The points marked on above plots are the highest emissions could be found when testing, so only above points had been displayed. The amplitude of spurious emissions from the radiator which are attenuated more than 20dB below the limit need not be reported.

4) For frequencies above 1GHz, the field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For the emissions whose peak level is lower than the average limit, only the peak measurement is shown in the report.

5). Margin = Limit – Reading

6). Pol = Polarization

7). Corr.: Correction Factor

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Worse test reulst as shown below:

Mode: b

Frequency (MHz)	Antenna Polarization	Emission Level (dBµV/m)		Limit (dBµV/m)		Remark
		Peak	Average	Peak	Average	
2390.000	V	55.3	42.9	74.0	54.0	Pass
2483.500	V	60.5	48.8	74.0	54.0	Pass

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7.9 Radiated Spurious Emissions

Test Requirement 47 CFR Part 15, Subpart C 15.205 & 15.209, Section 3.3 & RSS-Gen Section 8.9

Test Method: ANSI C63.10 (2013) Section 6.4&6.5&6.6

Limit:

FCC:

Frequency(MHz)	Field strength(microvolts/meter)	Measurement distance(meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3
Remark: The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90kHz, 110-490kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.		

IC:

Table 5 – General field strength limits at frequencies above 30 MHz

Frequency (MHz)	Field strength (μV/m at 3 m)
30 – 88	100
88 – 216	150
216 – 960	200
Above 960	500

Table 6 – General field strength limits at frequencies below 30 MHz

Frequency	Magnetic field strength (H-Field) (μA/m)	Measurement distance (m)
9 - 490 kHz 1	6.37/F (F in kHz)	300
490 - 1705 kHz	63.7/F (F in kHz)	30
1.705 - 30 MHz	0.08	30

Note 1: The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector.

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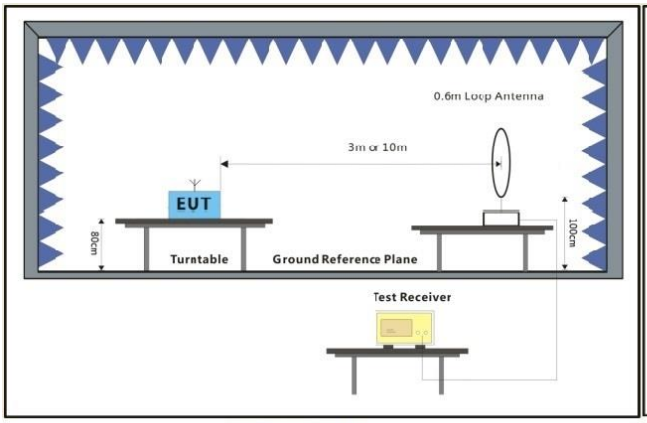
7.9.1 E.U.T. Operation

Operating Environment:

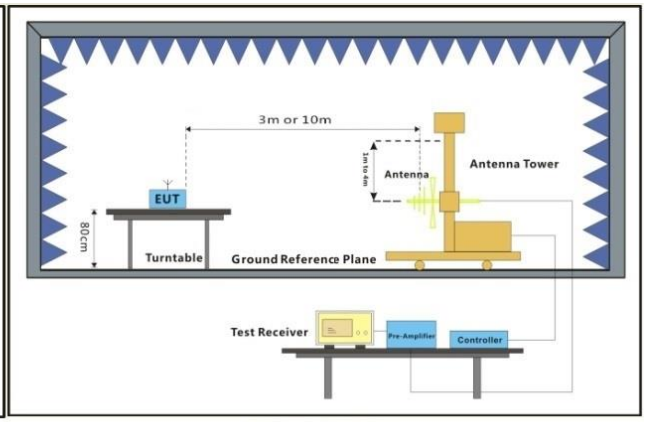
Temperature: 22.8 °C Humidity: 53.3 % RH :

Test mode b : TX mode_Keep the EUT in continuously transmitting mode with GFSK modulation.

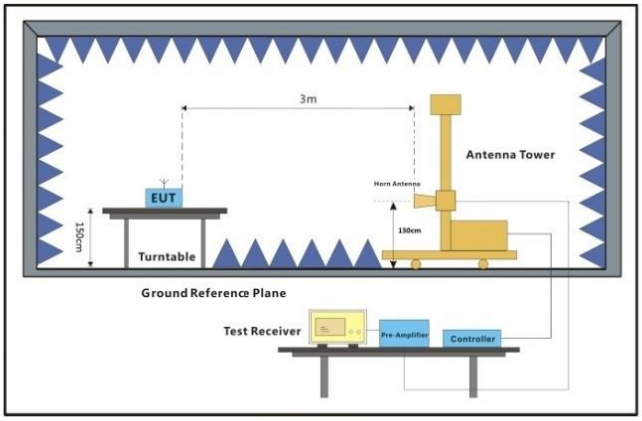
7.9.2 Test Setup Diagram



Below 30MHz



30MHz-1GHz



Above 1GHz

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7.9.3 Measurement Procedure and Data

a. For below 1GHz, the EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 or 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.

b. For above 1GHz, the EUT was placed on the top of a rotating table 1.5 meters above the ground at a 3 meter fully-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation.

c. The EUT was set 3 or 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

d. 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.

e. 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 rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

f. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

g. 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.

h. Test the EUT in the lowest channel, the middle channel, the Highest channel.

i. The radiation measurements are performed in X, Y, Z axis positioning for Transmitting mode, and found the X axis positioning which it is the worst case.

j. Repeat above procedures until all frequencies measured was complete.

Remark:

1) For emission below 1GHz, through pre-scan found the worst case is the lowest channel. Only the worst case is recorded in the report.

2) The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

Final Test Level =Receiver Reading + Antenna Factor + Cable Factor – Preamplifier Factor

3) Scan from 9kHz to 40GHz, the disturbance above 18GHz and below 30MHz was very low. The points marked on above plots are the highest emissions could be found when testing, so only above points had been displayed. The amplitude of spurious emissions from the radiator which are attenuated more than 20dB below the limit need not be reported.

4) For frequencies above 1GHz, the field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. For the emissions whose peak level is lower than the average limit, only the peak measurement is shown in the report.

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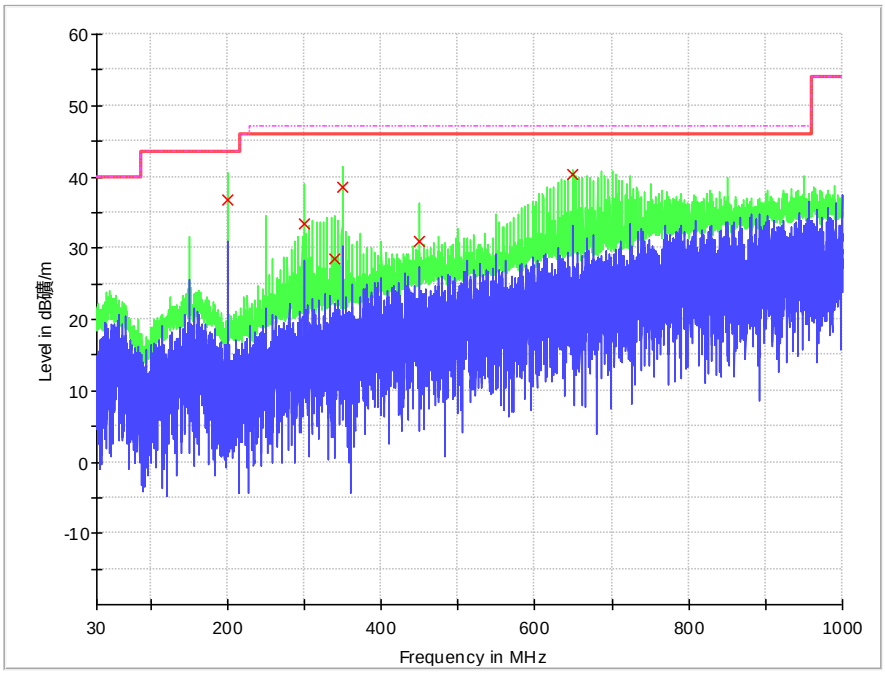
Mode:b

Radiated emission below 1GHz

Horizontal (worse plots was shown as below)



Frequency (MHz)	QuasiPeak (dBµV/m)	Pol.	Corr. (dB/m)	Margin (dB)	Limit (dBµV/m)	Result
199.942857	36.7	H	10.6	6.8	43.5	Pass
299.950000	33.4	H	14.9	12.6	46.0	Pass
339.367857	28.4	H	15.9	17.6	46.0	Pass
349.953571	38.6	H	16.0	7.4	46.0	Pass
449.960714	30.9	H	18.7	15.2	46.0	Pass
649.975000	40.3	H	22.6	5.8	46.0	Pass

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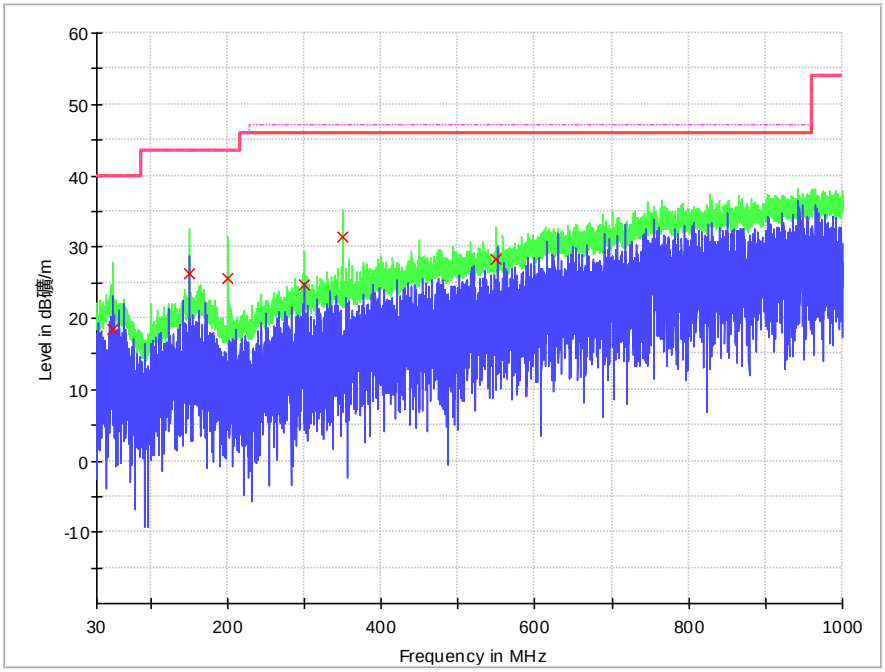
Vertical (worse plots was shown as below)



Frequency (MHz)	QuasiPeak (dBµV/m)	Pol.	Corr. (dB/m)	Margin (dB)	Limit (dBµV/m)	Result
49.932143	18.5	V	14.2	21.5	40.0	Pass
149.939286	26.3	V	14.1	17.2	43.5	Pass
199.942857	25.6	V	10.6	17.9	43.5	Pass
299.950000	24.7	V	14.9	21.4	46.0	Pass
349.953571	31.3	V	16.0	14.7	46.0	Pass
549.967857	28.3	V	20.5	17.7	46.0	Pass

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Above 1GHz

Channel:Low

Frequency (MHz)	Antenna Polarization	Emission Level (dBµV/m)		Limit (dBµV/m)		Remark
		Peak	Average	Peak	Average	
4804.000	H	42.6	29.3	74.0	54.0	Pass
7206.000	H	47.9	34.5	74.0	54.0	Pass
9608.000	H	49.2	36.1	74.0	54.0	Pass
4804.000	V	44.0	30.4	74.0	54.0	Pass
7206.000	V	47.6	34.7	74.0	54.0	Pass
9608.000	V	49.1	36.1	74.0	54.0	Pass

Channel:Middle

Frequency (MHz)	Antenna Polarization	Emission Level (dBµV/m)		Limit (dBµV/m)		Remark
		Peak	Average	Peak	Average	
4880.000	H	43.0	29.8	74.0	54.0	Pass
7320.000	H	49.0	35.5	74.0	54.0	Pass
9760.000	H	50.7	37.6	74.0	54.0	Pass
4880.000	V	44.2	31.4	74.0	54.0	Pass
7320.000	V	48.8	35.6	74.0	54.0	Pass
9760.000	V	50.8	37.6	74.0	54.0	Pass

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Channel: High

Frequency (MHz)	Antenna Polarization	Emission Level (dBµV/m)		Limit (dBµV/m)		Remark
		Peak	Average	Peak	Average	
4960.000	H	43.4	30.0	74.0	54.0	Pass
7440.000	H	48.8	35.6	74.0	54.0	Pass
9920.000	H	50.2	37.2	74.0	54.0	Pass
4960.000	V	44.1	32.0	74.0	54.0	Pass
7440.000	V	49.0	35.7	74.0	54.0	Pass
9920.000	V	50.8	37.1	74.0	54.0	Pass

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8 Photographs

Remark: Photos refer to Appendix: External Photo, Internal Photo, and Setup Photo

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9 Appendix

9.1 Bandwidth

802.11b:

99% Bandwidth

DUT Frequency (MHz)	Bandwidth (MHz)	Limit Min (MHz)	Limit Max (MHz)
2402.000000	1.0481	---	---
2440.000000	1.0485	---	---
2480.000000	1.0530	---	---

Minimum Emission Bandwidth 6 dB

DUT Frequency (MHz)	Bandwidth (MHz)	Limit Min (MHz)	Limit Max (MHz)
2402.000000	0.6993	0.500000	---
2440.000000	0.6933	0.500000	---
2480.000000	0.7184	0.500000	---

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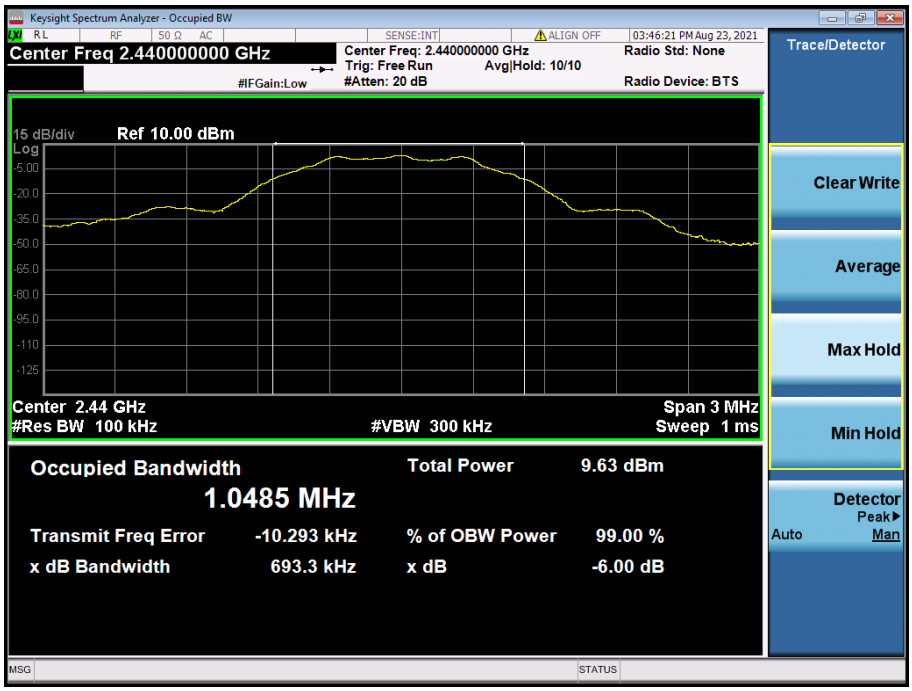

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Measurement

Setting	Instrument Value	Target Value
Span	3.000 MHz	3.000 MHz
RBW	100.000 kHz	>= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	400	~ 400
Sweeptime	3.2ms	AUTO
Reference Level	10.000 dBm	10.000 dBm
Attenuation	20.000 dB	AUTO
Detector	Peak	Peak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	FFT	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.30 dB	0.30 dB
Run	8 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.06 dB	0.30 dB

Remark: Cable loss 0.8dB was considered and set in system configuration.

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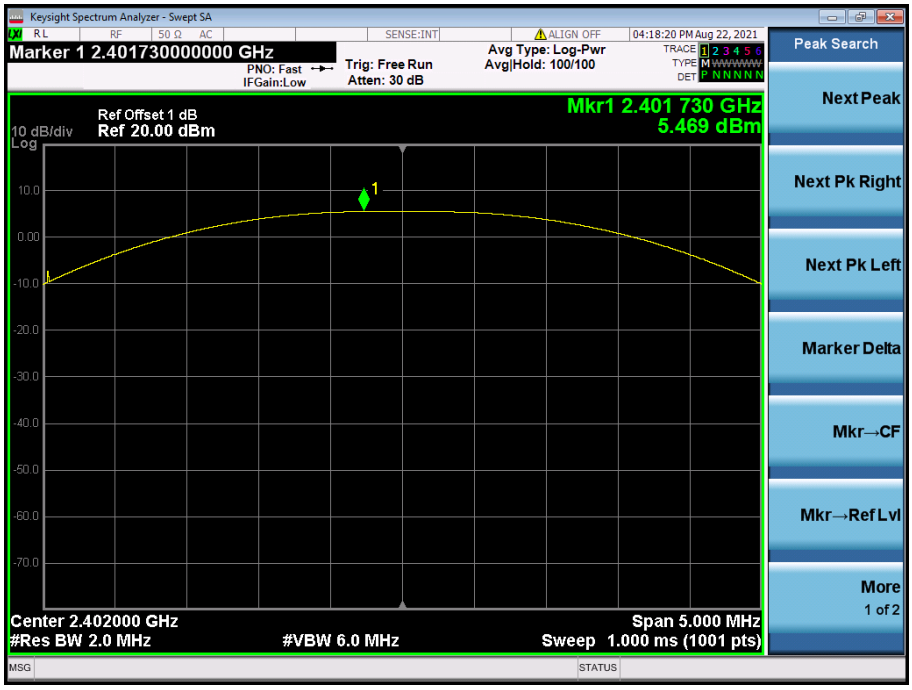
9.2 RF output power

Operation Mode	DUT Frequency (MHz)	Limit Max (dBm)	Gated Level (dBm)	Result
BLE	2402.000000	30.0	5.469	PASS
BLE	2440.000000	30.0	5.869	PASS
BLE	2480.000000	30.0	6.131	PASS

Remark: Antenna gain: 2 dBi

Remark: Cable loss 0.8dB was considered and set in system configuration.

(only worst case shown)



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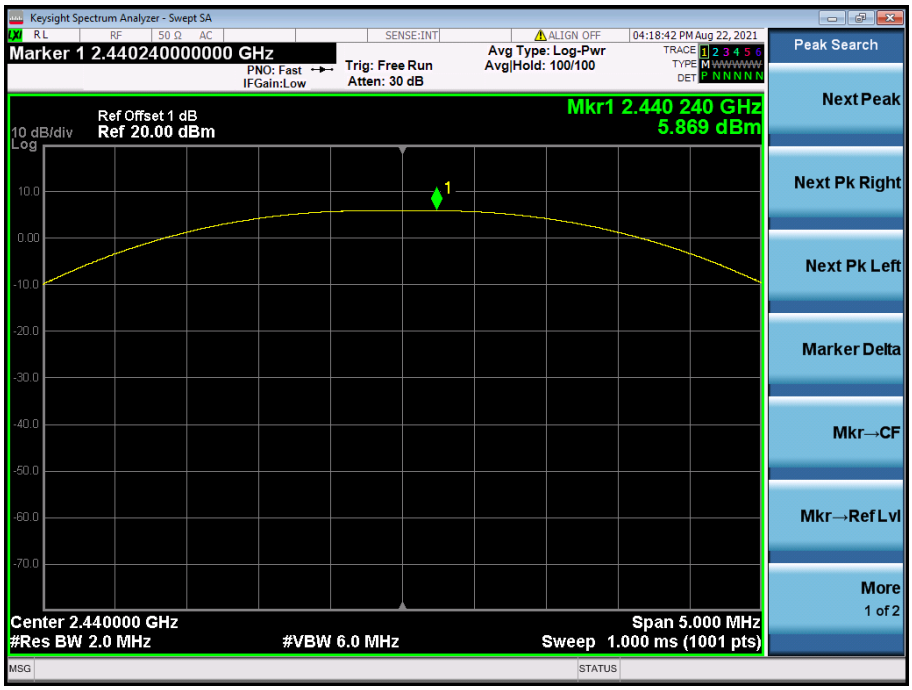

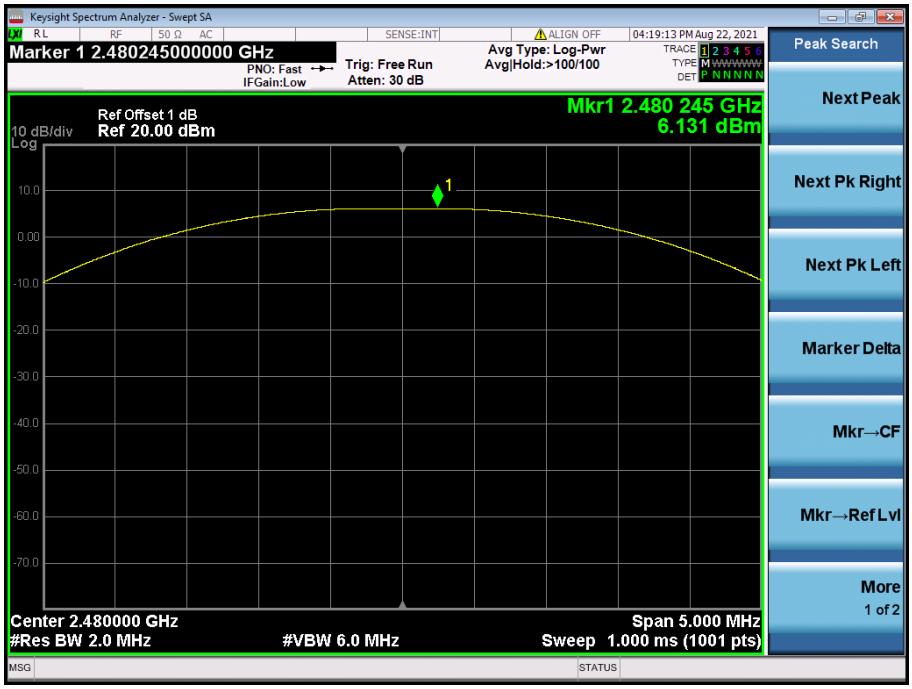

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Measurement

Setting	Instrument Value	Target Value
Span	5.000 MHz	5.000 MHz
RBW	2.000 MHz	<= 2.000 MHz
VBW	6.000 MHz	>= 6.000 MHz
SweepPoints	1001	1001
Sweeptime	1.0ms	1.0ms
Reference Level	20.000 dBm	0.000 dBm
Attenuation	30.000 dB	AUTO
Detector	Peak	Peak
SweepCount	1	1
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	Sweep	Sweep
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	45 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.30 dB	0.50 dB

Remark: Cable loss 0.8dB was considered and set in system configuration.

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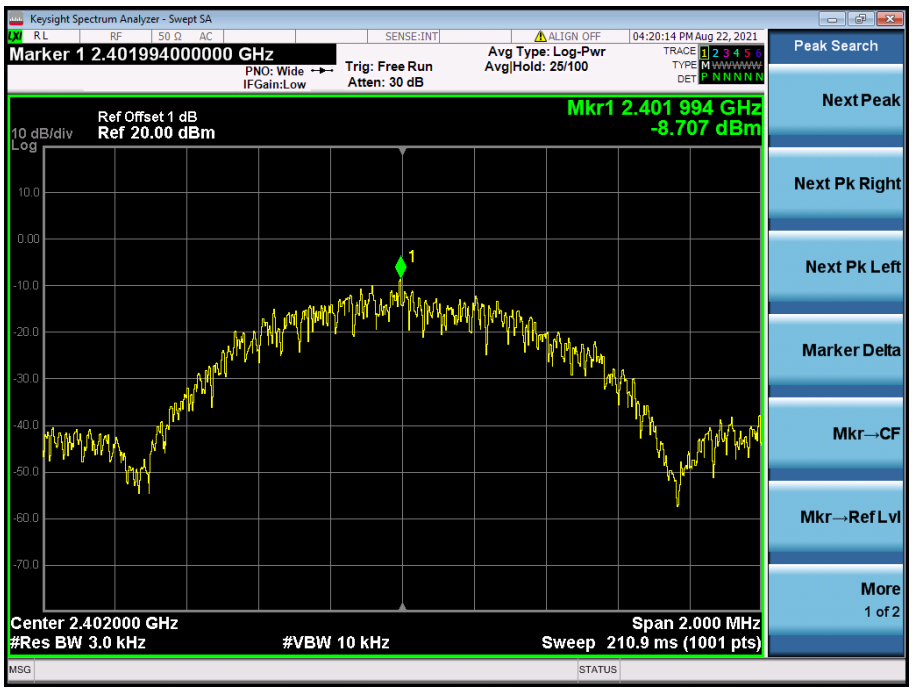
9.3 Power Spectral Density

DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
2402.000000	2401.994	-8.707	8.0	PASS
2440.000000	2439.998	-8.368	8.0	PASS
2480.000000	2480.002	-8.084	8.0	PASS



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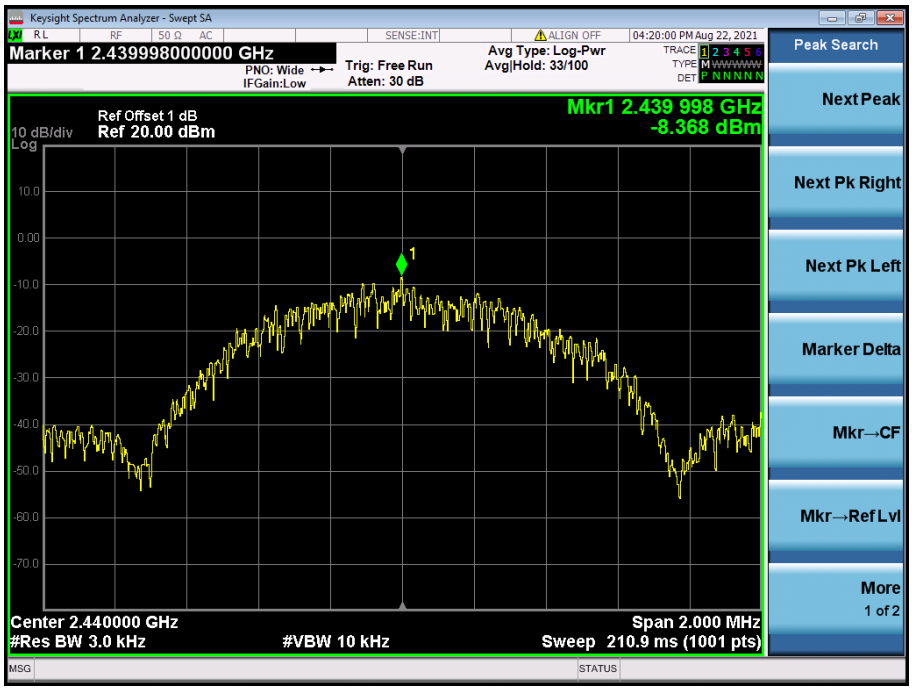

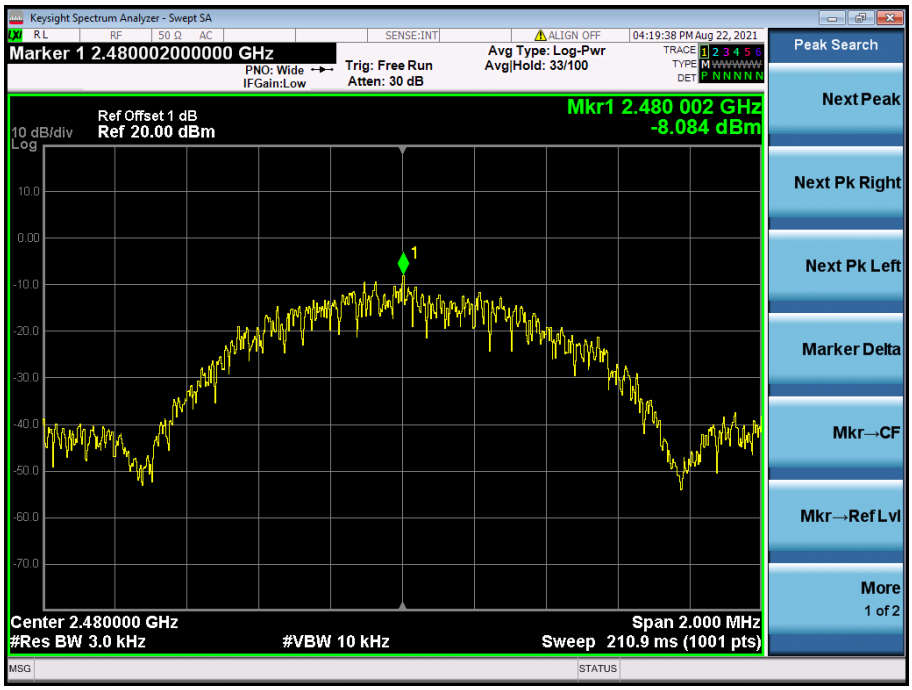

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Measurement

Setting	Instrument Value	Target Value
Span	2.000 MHz	2.000 MHz
RBW	3.000 kHz	<= 3.000 kHz
VBW	10.000 kHz	>= 10.000 kHz
SweepPoints	1001	1001
Sweeptime	210.9ms	210.9ms
Reference Level	20.000 dBm	0.000 dBm
Attenuation	30.000 dB	AUTO
Detector	Peak	Peak
SweepCount	1	1
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	Sweep	Sweep
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	45 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.30 dB	0.50 dB

Remark: Cable loss 0.8dB was considered and set in system configuration.

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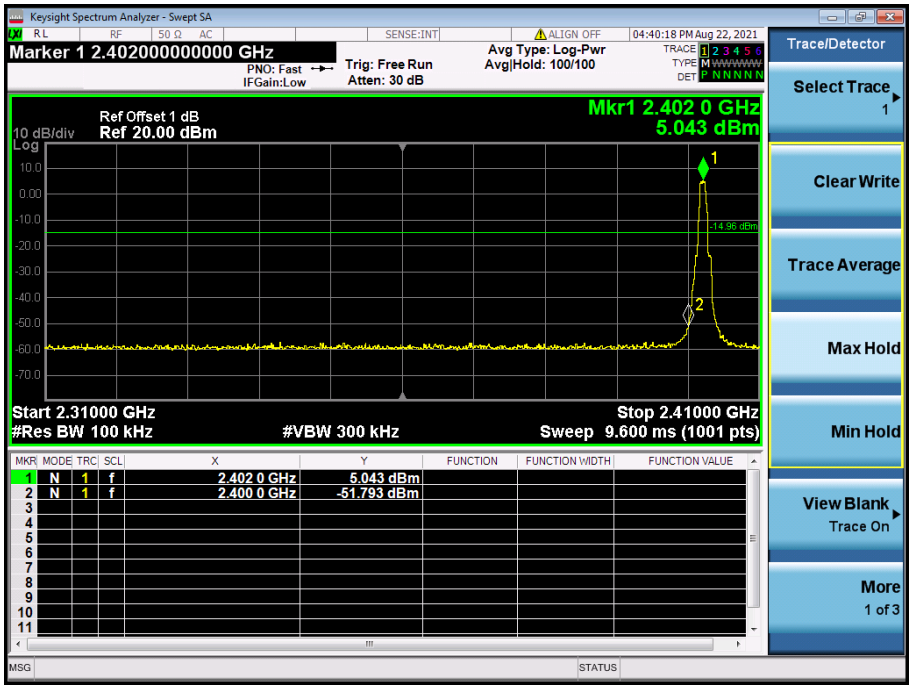
9.4 Band Edge

Band Edge Low



Inband Peak

Frequency (MHz)	Level (dBm)
2402.000	5.04

Remark: Limit = Inband peak - 20dB

Measurements

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2400.000	-51.793	36.833	-14.96	PASS

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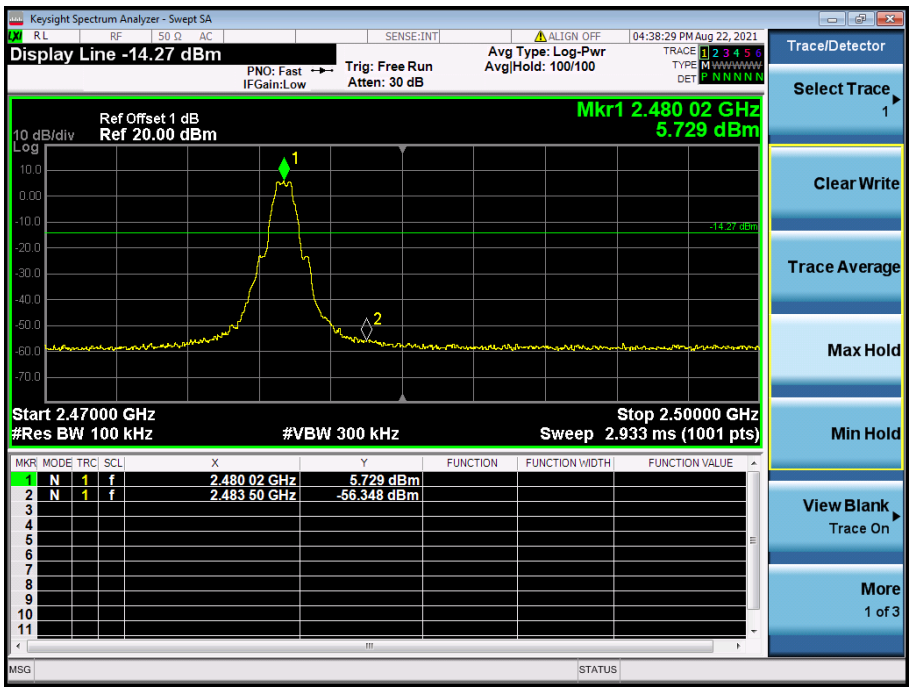
Band Edge High



Inband Peak

Frequency (MHz)	Level (dBm)
2480.020	5.73

Remark: Limit = Inband peak - 20dB

Measurements

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2483.500	-56.348	42.078	-14.27	PASS

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Measurement 1

Setting	Instrument Value	Target Value
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	1001	~ 1001
Sweeptime	9.6 ms	AUTO
Reference Level	20.000 dBm	20.000 dBm
Attenuation	30.000 dB	AUTO
Detector	Peak	Peak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	Sweep	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	12 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.00 dB	0.50 dB

Measurement 2

Setting	Instrument Value	Target Value
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	1001	~ 1001
Sweeptime	2.933 ms	AUTO
Reference Level	20.000 dBm	20.000 dBm
Attenuation	30.000 dB	AUTO
Detector	Peak	Peak
SweepCount	100	100
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	Sweep	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	9 / max. 150	max. 150
Stable	3 / 3	3
Max Stable Difference	0.18 dB	0.50 dB

Remark: Cable loss 0.8dB was considered and set in system configuration.

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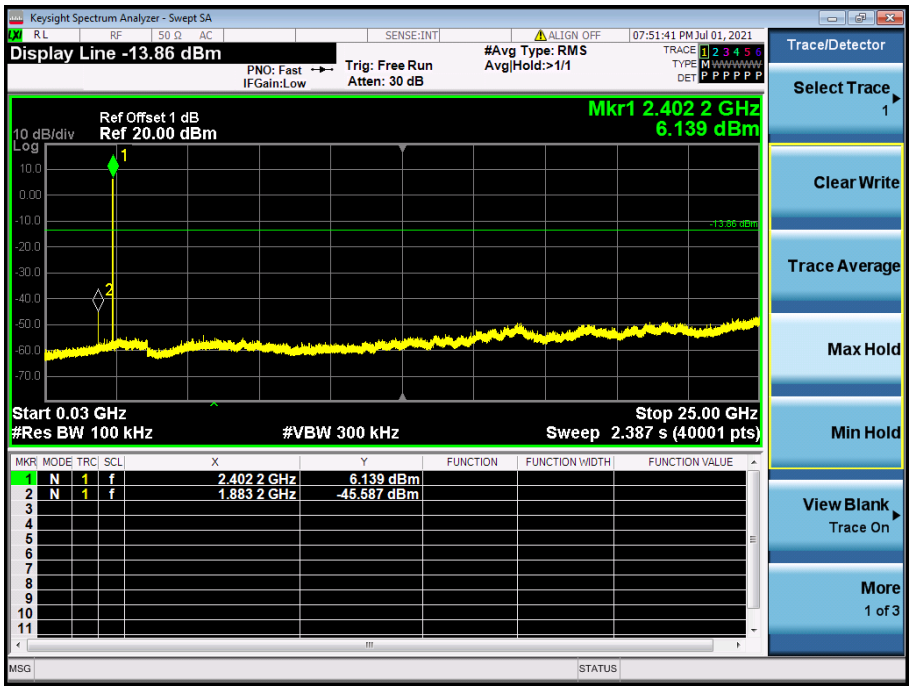
9.5 Conducted spurious emission

Remark: only worst case shown



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Pre Measurement 1

Setting	Instrument Value	Target Value
RBW	100.000 kHz	<= 100.000 kHz
VBW	300.000 kHz	>= 300.000 kHz
SweepPoints	40001	~ 40001
Sweeptime	2.387s	AUTO
Reference Level	20.000 dBm	20.000 dBm
Attenuation	30.000 dB	AUTO
Detector	RMS	RMS
SweepCount	3	3
Filter	3 dB	3 dB
Trace Mode	Max Hold	Max Hold
Sweeptype	Sweep	AUTO
Preamp	off	off
Stablemode	Trace	Trace
Stablevalue	0.50 dB	0.50 dB
Run	8 / max. 40	max. 40
Stable	3 / 3	3
Max Stable Difference	0.00 dB	0.50 dB

Remark:

1) Cable loss 0.8dB was considered and set in system configuration.

2) No unwanted emission (25-40GHz) were detected, only worse plots were shown as above.

- End of the Report -

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