FCC RF Test Report

APPLICANT	:	Ring LLC
EQUIPMENT	:	Ring Intercom
BRAND NAME	:	ring
MODEL NAME	:	5F99F2
FCC ID	:	2AEUPBHART011
STANDARD	:	FCC Part 15 Subpart C §15.247
CLASSIFICATION	:	(DTS) Digital Transmission System
TEST DATE(S)	:	Feb. 04, 2024 ~ Mar. 26, 2024

We, Sporton International Inc. (Shenzhen), would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of Sporton International Inc. (Shenzhen), the test report shall not be reproduced except in full.

Jason Jia

Approved by: Jason Jia

Sporton International Inc. (ShenZhen)

1/F, 2/F, Bldg 5, Shiling Industrial Zone, Xinwei Village, Xili, Nanshan, Shenzhen, 518055

People's Republic of China

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REVISION HISTORY

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FR412405A	Rev. 01	Initial issue of report	May 06, 2024

SUMMARY OF TEST RESULT

Report Section	FCC Rule	Description	Limit	Result	Remark
3.1	15.247(a)(2)	6dB Bandwidth	≥ 0.5MHz	Pass	-
3.1	-	99% Bandwidth	-	Report only	-
3.2	15.247(b)(3)	Peak Output Power	≤ 30dBm	Pass	-
3.3	15.247(e)	Power Spectral Density	≤ 8dBm/3kHz	Pass	-
3.4	15.247(d)	Conducted Band Edges and Spurious Emission	≤ 20dBc	Pass	-
3.5	15.247(d)	Radiated Band Edges and Spurious Emission	15.209(a) & 15.247(d)	Pass	Under limit 12.06 dB at 2483.72 MHz
3.6	15.207	AC Conducted Emission	15.207(a)	Pass	Under limit 11.70 dB at 0.483 MHz
3.7	15.203 & 15.247(b)	Antenna Requirement	15.203 & 15.247(b)	Pass	-

Conformity Assessment Condition:

1. The test results (PASS/FAIL) with all measurement uncertainty excluded are presented against the regulation limits or in accordance with the requirements stipulated by the applicant/manufacturer who shall bear all the risks of non-compliance that may potentially occur if measurement uncertainty is taken into account.
2. The measurement uncertainty please refer to each test result in the section “Measurement Uncertainty”

Disclaimer:

The product specifications of the EUT presented in the test report that may affect the test assessments are declared by the manufacturer who shall take full responsibility for the authenticity.

1 General Description

1.1 Applicant

Ring LLC
1523 26th Street, Santa Monica, CA 90404 USA

1.2 Manufacturer

Ring LLC
1523 26th Street, Santa Monica, CA 90404 USA

1.3 Product Feature of Equipment Under Test

Product Feature	
Equipment	Ring Intercom
Brand Name	ring
Model Name	5F99F2
FCC ID	2AEUPBHART011
SN Code	Conducted: G073J4034036006D Conduction: G073J403403700DT Radiation: G073J403403700DT

Remark: The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

1.4 Product Specification of Equipment Under Test

Standards-related Product Specification	
Tx/Rx Frequency Range	2402 MHz ~ 2480 MHz
Number of Channels	40
Carrier Frequency of Each Channel	40 Channel (37 hopping + 3 advertising channel)
Maximum Output Power to Antenna	BLE 1Mbps: 6.15 dBm (0.0041 W)
99% Occupied Bandwidth	BLE 1Mbps: 1.049 MHz
Antenna Type / Gain	Meandered Loop Antenna with gain 2.5 dBi
Type of Modulation	Bluetooth LE : GFSK

1.5 Modification of EUT

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

1.6 Testing Location

Sporton International Inc. (ShenZhen) is accredited to ISO/IEC 17025:2017 by American Association for Laboratory Accreditation with Certificate Number 5145.01.

Test Firm	Sporton International Inc. (ShenZhen)		
Test Site Location	1/F, 2/F, Bldg 5, Shiling Industrial Zone, Xinwei Village, Xili, Nanshan, Shenzhen, 518055 People's Republic of China TEL: +86-755-86379589 FAX: +86-755-86379595		
Test Site No.	**Sporton Site No.**	**FCC Designation No.**	**FCC Test Firm Registration No.**
	TH01-SZ	CN1256	421272

Test Firm	Sporton International Inc. (ShenZhen)		
Test Site Location	101, 1st Floor, Block B, Building 1, No. 2, Tengfeng 4th Road, Fenghuang Community, Fuyong Street, Baoan District, Shenzhen City, Guangdong Province 518103 People's Republic of China TEL: +86-755-86066985		
Test Site No.	**Sporton Site No.**	**FCC Designation No.**	**FCC Test Firm Registration No.**
	03CH03-SZ CO02-SZ	CN1256	421272

1.7 Test Software

Item	Site	Manufacturer	Name	Version
1.	03CH03-SZ	R&S	EMC32	10.60.0.0
2.	CO02-SZ	R&S	EMC32	10.60.0.0

1.8 Applicable Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- 47 CFR Part 15 Subpart C §15.247
- FCC KDB 558074 D01 15.247 Meas Guidance v05r02
- ANSI C63.10-2013

Remark: All test items were verified and recorded according to the standards and without any deviation during the test.

2 Test Configuration of Equipment Under Test

2.1 Carrier Frequency Channel

Frequency Band	Channel	Freq. (MHz)	Channel	Freq. (MHz)
2400-2483.5 MHz	0	2402	21	2444
	1	2404	22	2446
	2	2406	23	2448
	3	2408	24	2450
	4	2410	25	2452
	5	2412	26	2454
	6	2414	27	2456
	7	2416	28	2458
	8	2418	29	2460
	9	2420	30	2462
	10	2422	31	2464
	11	2424	32	2466
	12	2426	33	2468
	13	2428	34	2470
	14	2430	35	2472
	15	2432	36	2474
	16	2434	37	2476
	17	2436	38	2478
	18	2438	39	2480
	19	2440	-	-
	20	2442	-	-

2.2 Test Mode

a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: conduction emission (150 kHz to 30 MHz), radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). For radiated measurement, pre-scanned in three orthogonal panels, X, Y, Z. The worst cases (Y plane) were recorded in this report.

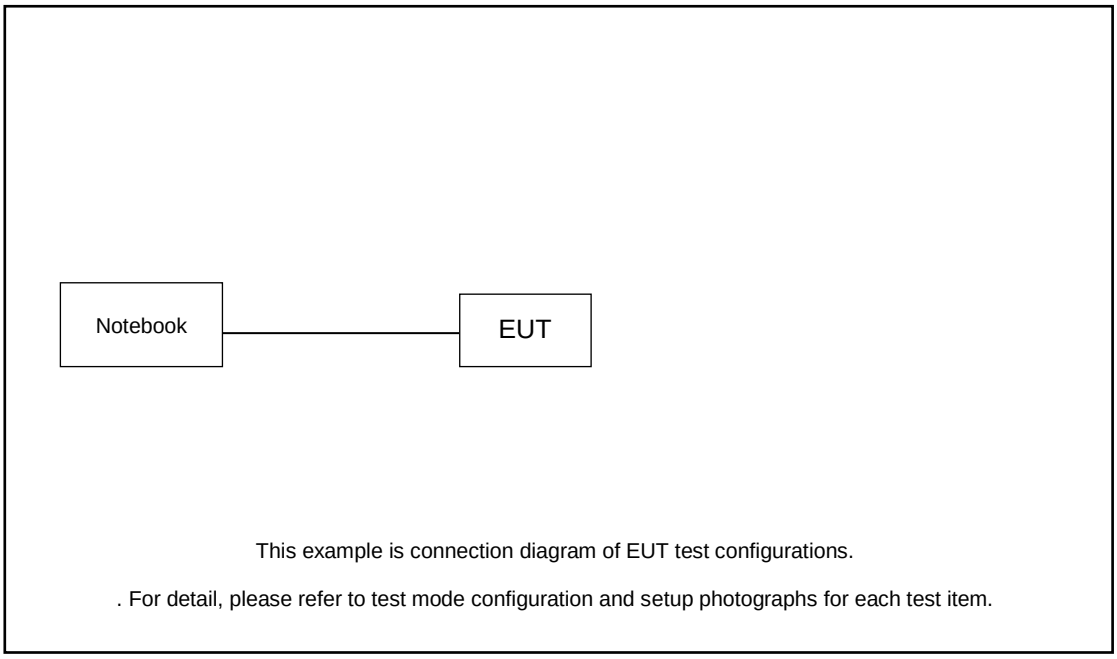
b. AC power line Conducted Emission was tested under maximum output power.

The following summary table is showing all test modes to demonstrate in compliance with the standard.

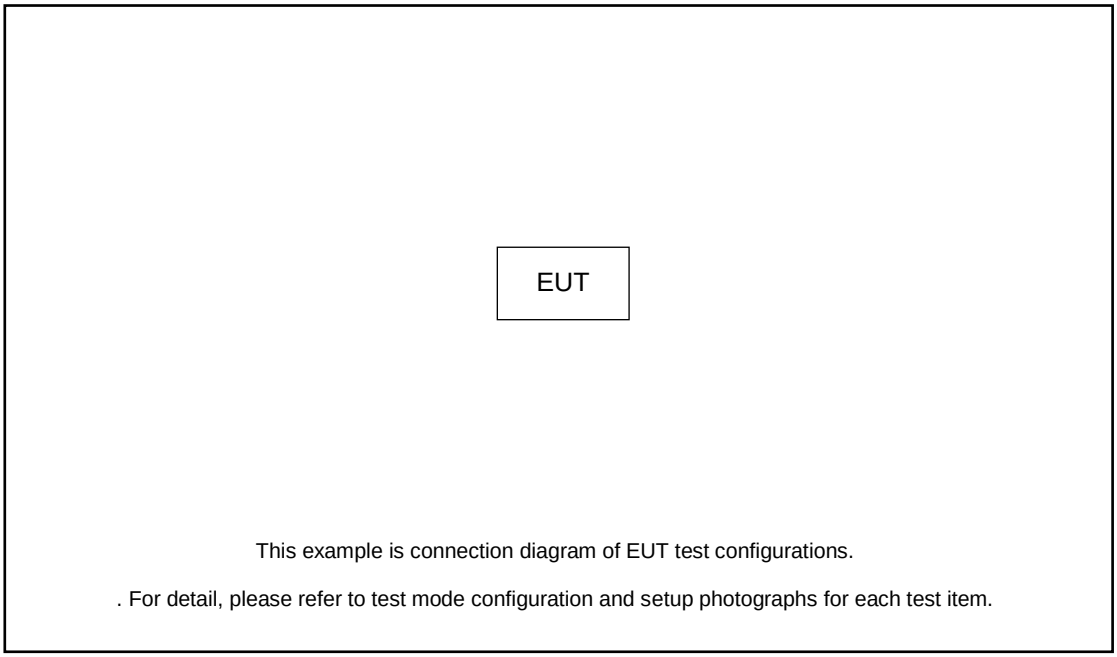
Summary table of Test Cases	
Test Item	**Data Rate / Modulation**
	Bluetooth – LE / GFSK
Conducted TCs	Mode 1: Bluetooth Tx CH00_2402 MHz_BLE Mode 2: Bluetooth Tx CH19_2440 MHz_BLE Mode 3: Bluetooth Tx CH39_2480 MHz_BLE
Radiated TCs	Mode 1: Bluetooth Tx CH00_2402 MHz_BLE Mode 2: Bluetooth Tx CH19_2440 MHz_BLE Mode 3: Bluetooth Tx CH39_2480 MHz_BLE
AC Conducted Emission	Mode 1: 2.4G WIFI Link + BLE TX + USB Cable + Notebook
Remark: For Radiated Test Cases, The tests were performance with Battery1.	

2.3 Connection Diagram of Test System

AC Conducted Emission:



Radiated Emission:



2.4 Support Unit used in test configuration and system

Item	Equipment	Trade Name	Model Name	FCC ID	Data Cable	Power Cord
1.	Notebook	DELL	Inspiron 15-7570	Fcc DoC	N/A	shielded cable DC O/P 1.8m Unshielded AC I/P cable 1.8m

2.5 EUT Operation Test Setup

For BLE function, the engineering test program was provided and enabled to make EUT continuous transmit.

For AC power line conducted emissions, the EUT was set to connect with the WLAN AP under large package sizes transmission.

2.6 Measurement Results Explanation Example

For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuator factor between EUT conducted output port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly the EUT RF output level.

Example :

The spectrum analyzer offset is derived from RF cable loss and attenuator factor.

Offset = RF cable loss + attenuator factor.

Following shows an offset computation example with cable loss 1.30 dB and 20dB attenuator.

Offset(dB) = RF cable loss(dB) + attenuator factor(dB).

= 1.30 + 20 = 21.30 (dB)

3 Test Result

3.1 6dB and 99% Bandwidth Measurement

3.1.1 Limit of 6dB and 99% Bandwidth

The minimum 6 dB bandwidth shall be at least 500 kHz.

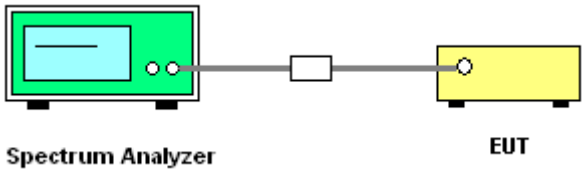
3.1.2 Measuring Instruments

The section 4.0 of List of Measuring Equipment of this test report is used for test.

3.1.3 Test Procedures

1. The testing follows ANSI C63.10-2013 clause 11.8
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 100 kHz. Set the Video bandwidth (VBW) = 300 kHz. In order to make an accurate measurement. The 6 dB bandwidth must be greater than 500 kHz.
5. For 99% Bandwidth Measurement, the spectrum analyzer's resolution bandwidth (RBW) is set 1% to 5% of the 99% OBW and the VBW is set to 3 times of the RBW.
6. Measure and record the results in the test report.

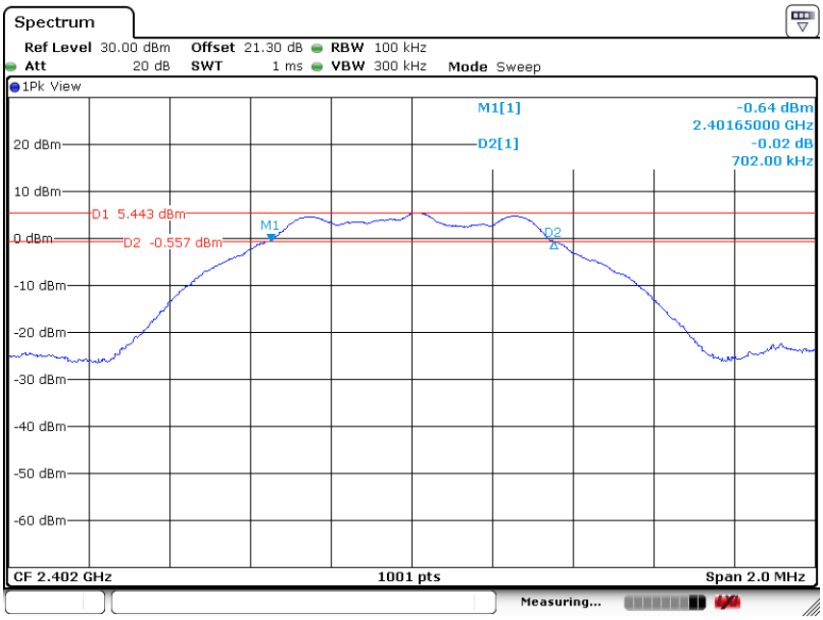
3.1.4 Test Setup



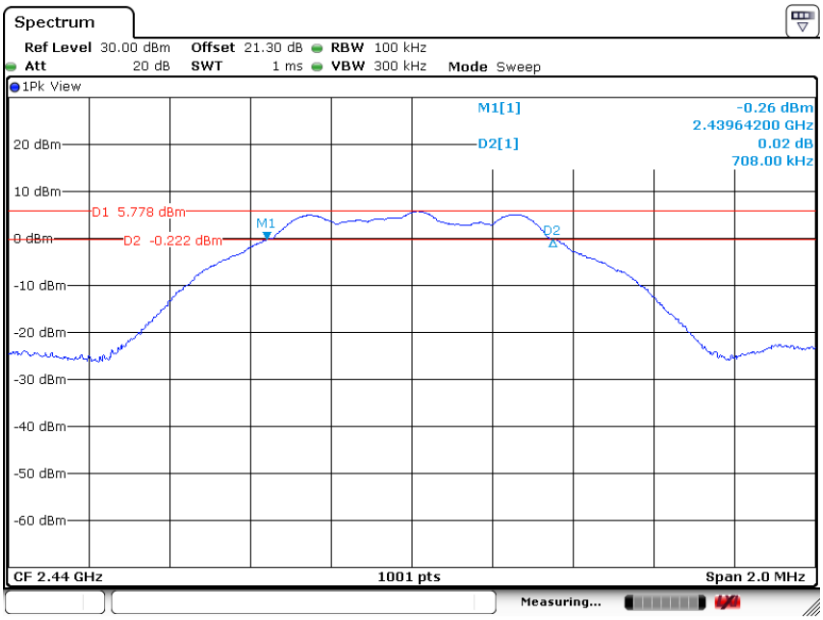
3.1.5 Test Result of 6dB Bandwidth

Please refer to Appendix A.

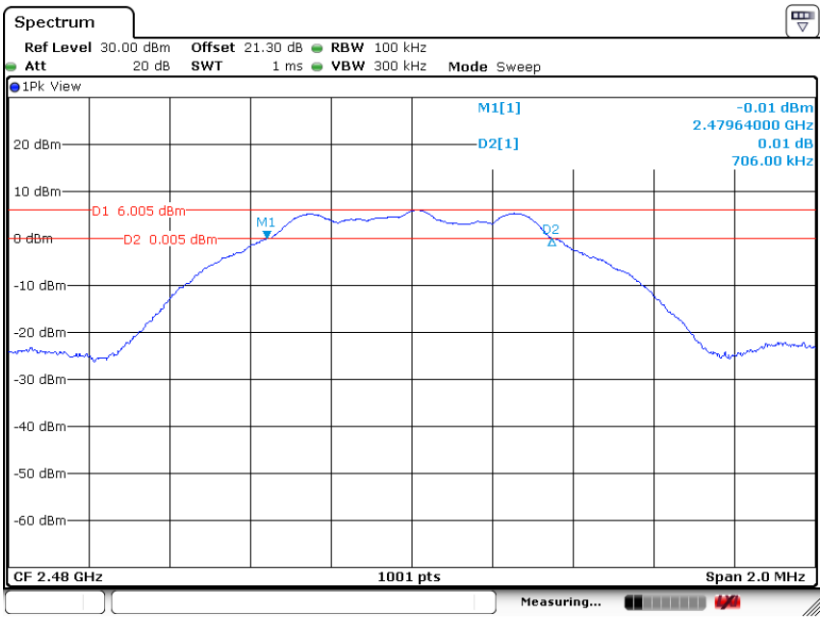
6 dB Bandwidth Plot on Channel 00



6 dB Bandwidth Plot on Channel 19



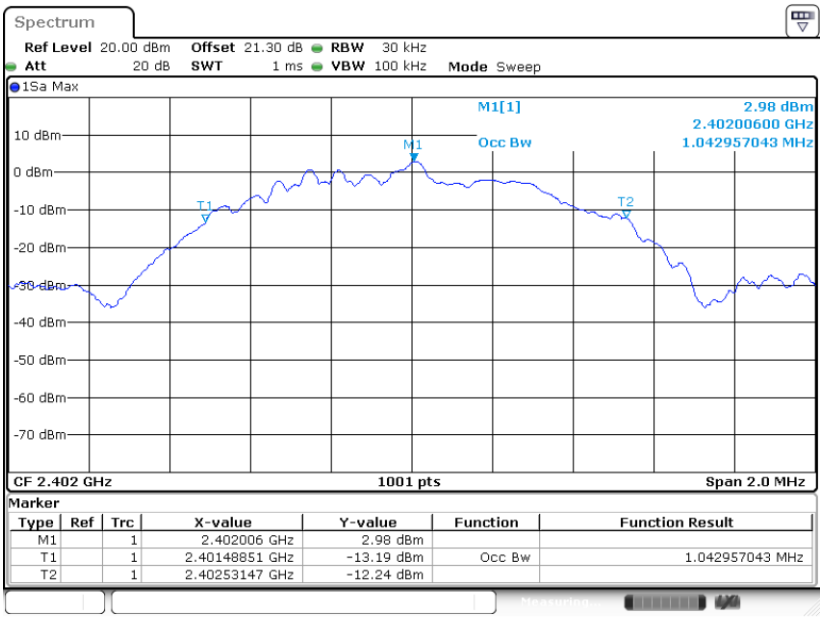
6 dB Bandwidth Plot on Channel 39



3.1.6 Test Result of 99% Occupied Bandwidth

Please refer to Appendix A.

99% Occupied Bandwidth Plot on Channel 00



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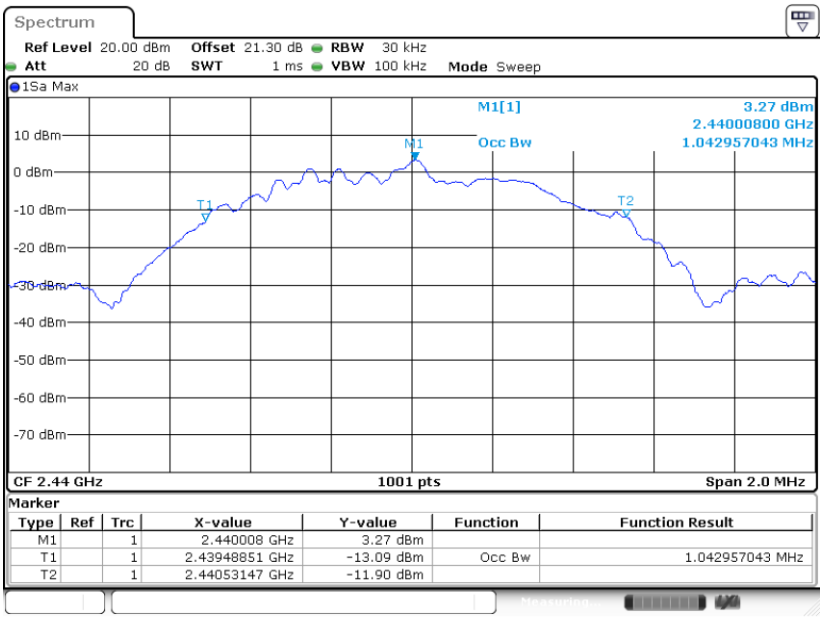
99% Occupied Bandwidth Plot on Channel 19



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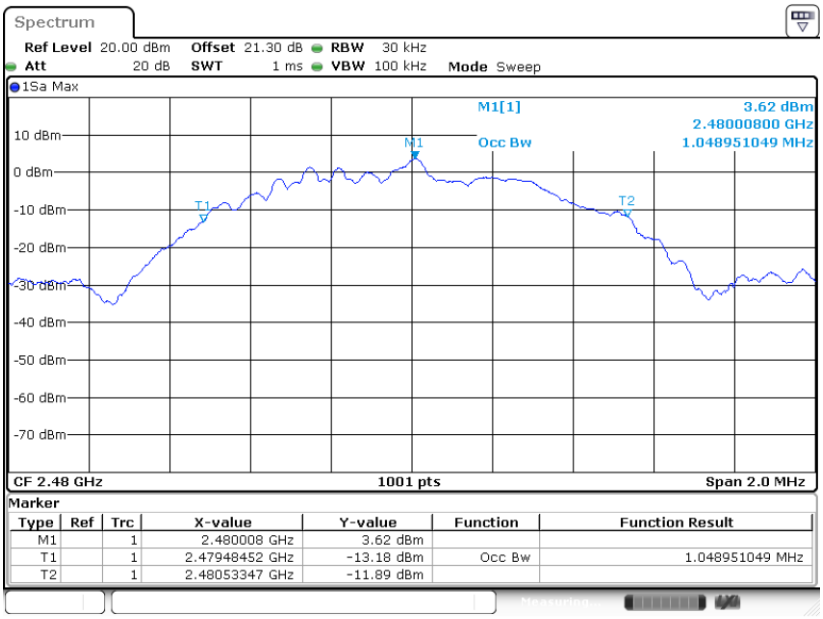
99% Occupied Bandwidth Plot on Channel 39



Note : The occupied channel bandwidth is maintained within the band of operation for all of the modulations.

3.2 Output Power Measurement

3.2.1 Limit of Output Power

For systems using digital modulation in the 2400-2483.5MHz, the limit for peak output power is 30dBm. If transmitting antenna of directional gain greater than 6dBi is used, the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the antenna exceeds 6 dBi. In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of the antenna exceeds 6dBi.

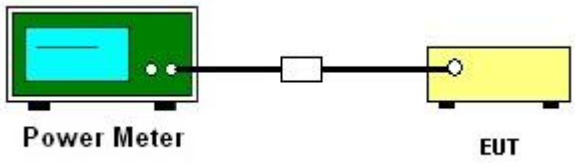
3.2.2 Measuring Instruments

The section 4.0 of List of Measuring Equipment of this test report is used for test.

3.2.3 Test Procedures

1. The testing follows the Measurement Procedure of ANSI C63.10-2013 clause 11.9.1.3 PKPM1 Peak power meter or ANSI C63.10-2013 clause 11.9.2.3.1 Method AVGPM method.
2. The RF output of EUT was connected to the power meter by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Measure the conducted output power and record the results in the test report.

3.2.4 Test Setup



3.2.5 Test Result of Peak Output Power

Please refer to Appendix A.

3.2.6 Test Result of Average Output Power (Reporting Only)

Please refer to Appendix A.

3.3 Power Spectral Density Measurement

3.3.1 Limit of Power Spectral Density

The peak power spectral density shall not be greater than 8dBm in any 3kHz band at any time interval of continuous transmission.

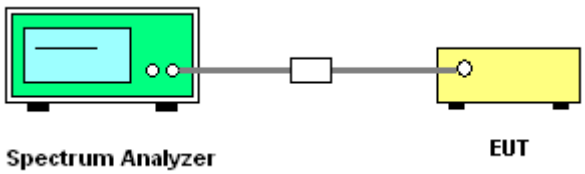
3.3.2 Measuring Instruments

The section 4.0 of List of Measuring Equipment of this test report is used for test.

3.3.3 Test Procedures

1. The testing follows Measurement Procedure of ANSI C63.10-2013 clause 11.10.2 Method PKPSD.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Make the measurement with the spectrum analyzer's resolution bandwidth (RBW) = 3 kHz. Video bandwidth VBW = 10 kHz In order to make an accurate measurement, set the span to 1.5 times DTS Channel Bandwidth. (6dB BW)
5. Detector = peak, Sweep time = auto couple, Trace mode = max hold, Allow trace to fully stabilize. Use the peak marker function to determine the maximum power level.
6. Measure and record the results in the test report.
7. The Measured power density (dBm)/ 100kHz is a reference level and used as 20dBc down limit line for Conducted Band Edges and Conducted Spurious Emission.

3.3.4 Test Setup

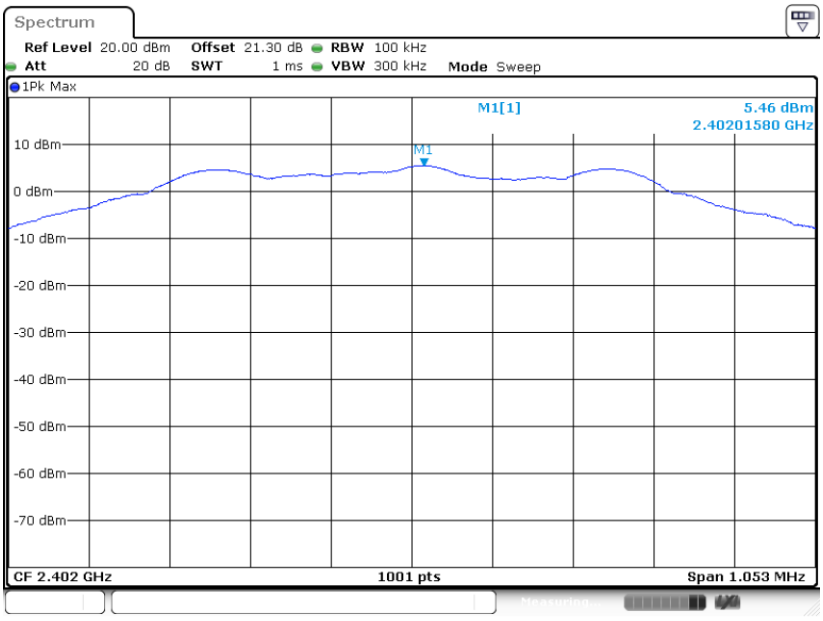


3.3.5 Test Result of Power Spectral Density

Please refer to Appendix A.

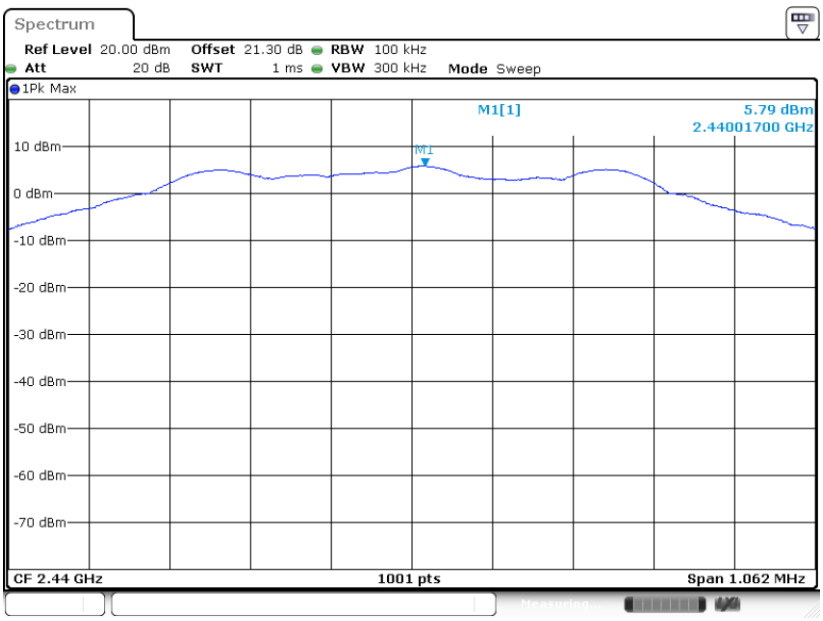
3.3.6 Test Result of Power Spectral Density Plots (100kHz)

PSD 100kHz Plot on Channel 00



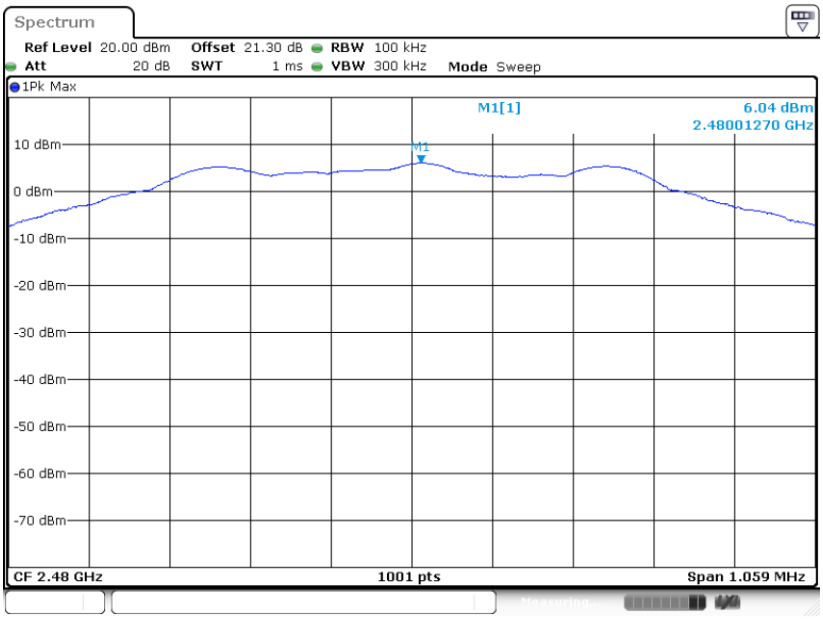
Date: 18.FEB.2024 22:25:24

PSD 100kHz Plot on Channel 19



Date: 18.FEB.2024 22:32:23

PSD 100kHz Plot on Channel 39



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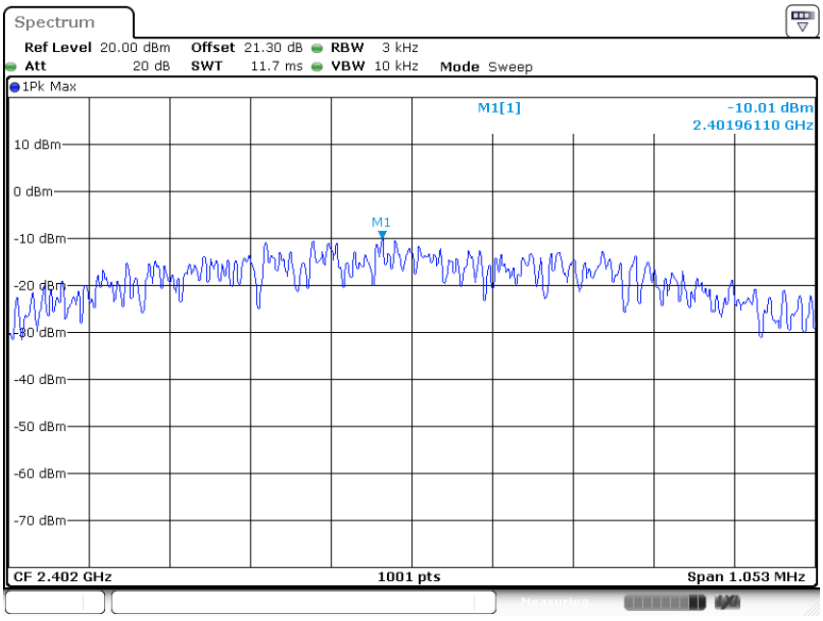
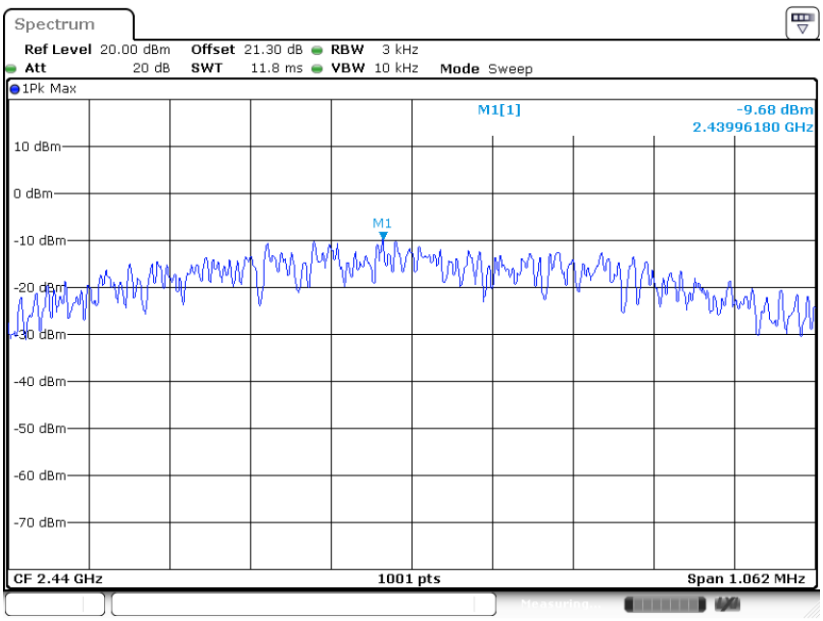
3.3.7 Test Result of Power Spectral Density Plots (3kHz)

PSD 3kHz Plot on Channel 00



Date: 18.FEB.2024 22:25:07

PSD 3kHz Plot on Channel 19



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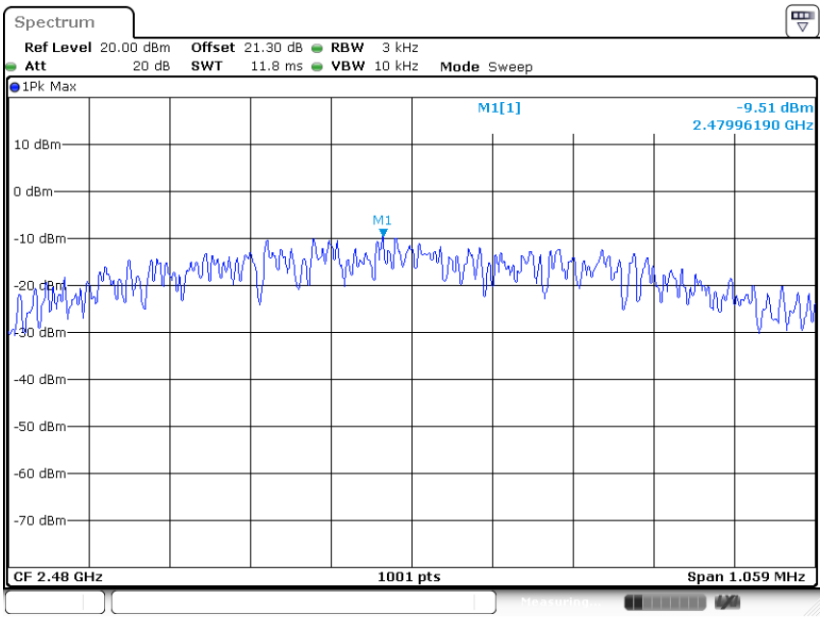
PSD 3kHz Plot on Channel 39



3.4 Conducted Band Edges and Spurious Emission Measurement

3.4.1 Limit of Conducted Band Edges and Spurious Emission

All harmonics/spurious must be at least 20 dB down from the highest emission level within the authorized band.

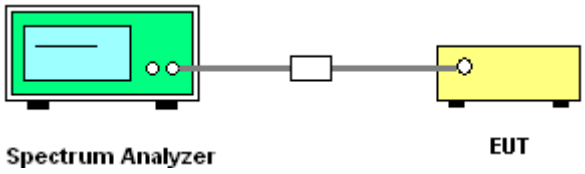
3.4.2 Measuring Instruments

The section 4.0 of List of Measuring Equipment of this test report is used for test.

3.4.3 Test Procedure

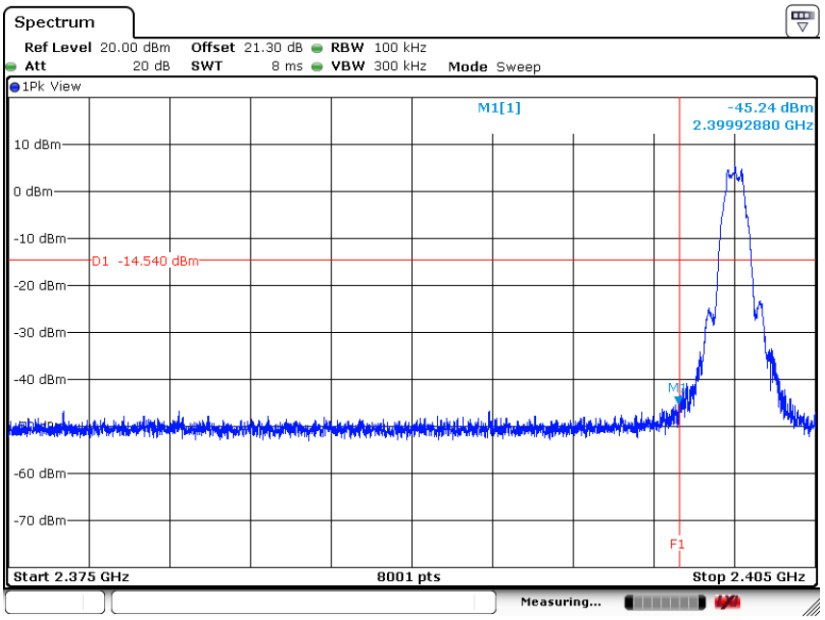
1. The testing follows ANSI C63.10-2013 clause 11.13
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Set RBW = 100 kHz, VBW=300 kHz, Peak Detector. Unwanted Emissions measured in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 20 dB relative to the maximum in-band peak PSD level in 100 kHz when maximum peak conducted output power procedure is used. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.
5. Measure and record the results in the test report.
6. The RF fundamental frequency should be excluded against the limit line in the operating frequency band.

3.4.4 Test Setup



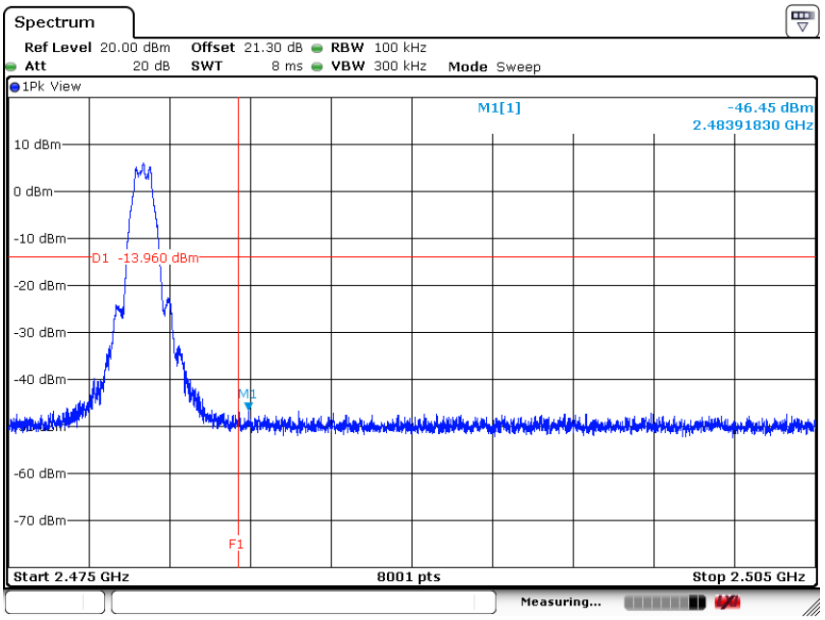
3.4.5 Test Result of Conducted Band Edges Plots

Low Band Edge Plot on Channel 00



Date: 18.FEB.2024 22:29:49

High Band Edge Plot on Channel 39

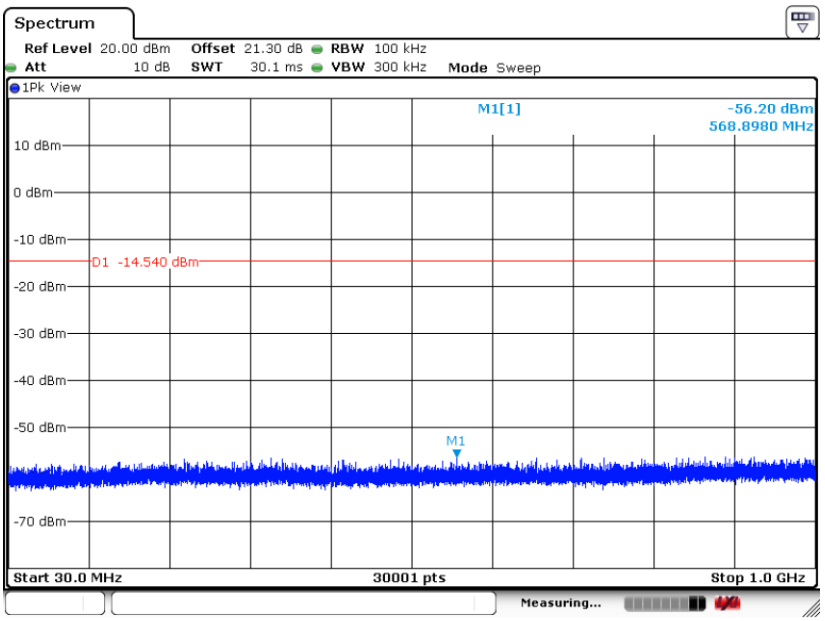


Date: 18.FEB.2024 22:39:27

3.4.6 Test Result of Conducted Spurious Emission Plots

Conducted Spurious Emission Plot on Bluetooth LE GFSK

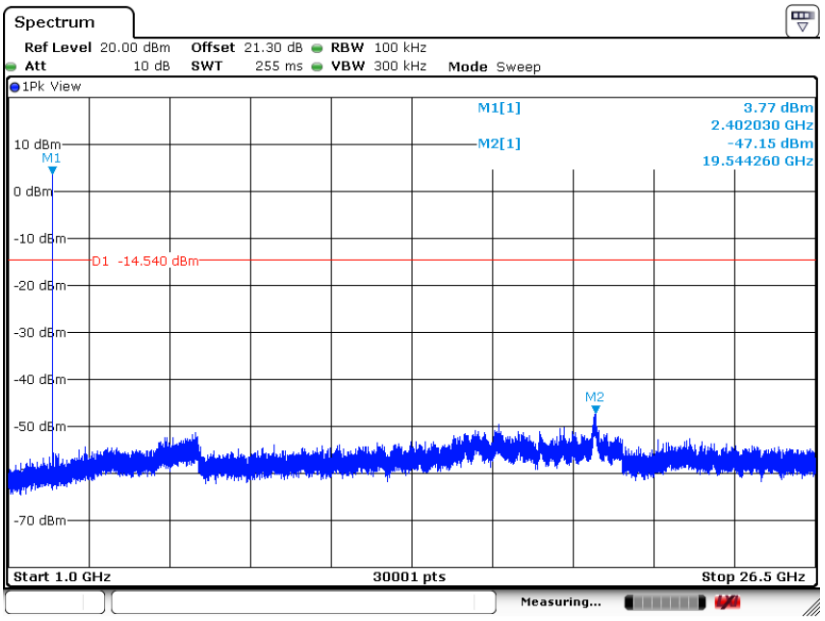
Channel 00



Date: 18.FEB.2024 22:29:22

Conducted Spurious Emission Plot on Bluetooth LE GFSK

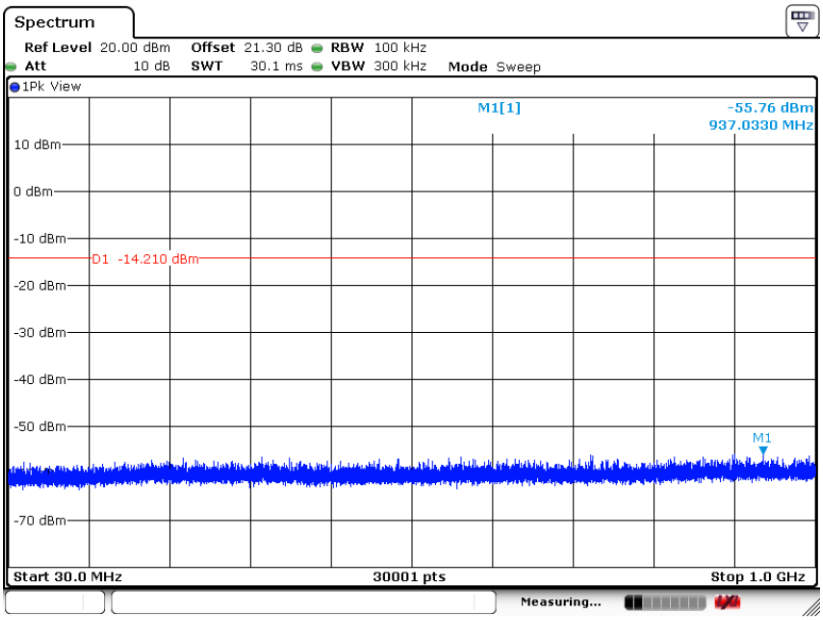
Channel 00



Date: 18.FEB.2024 22:29:36

Conducted Spurious Emission Plot on Bluetooth LE GFSK

Channel 19



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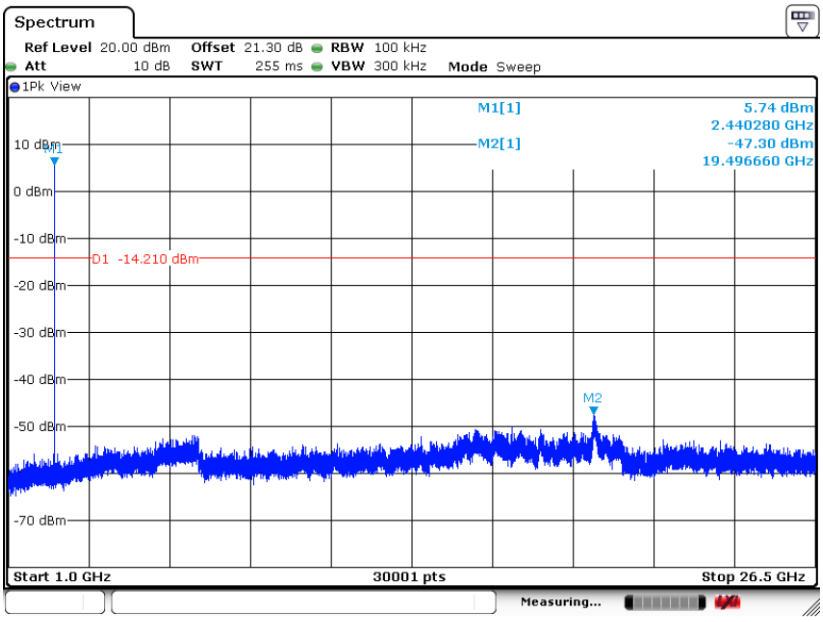
Conducted Spurious Emission Plot on Bluetooth LE GFSK

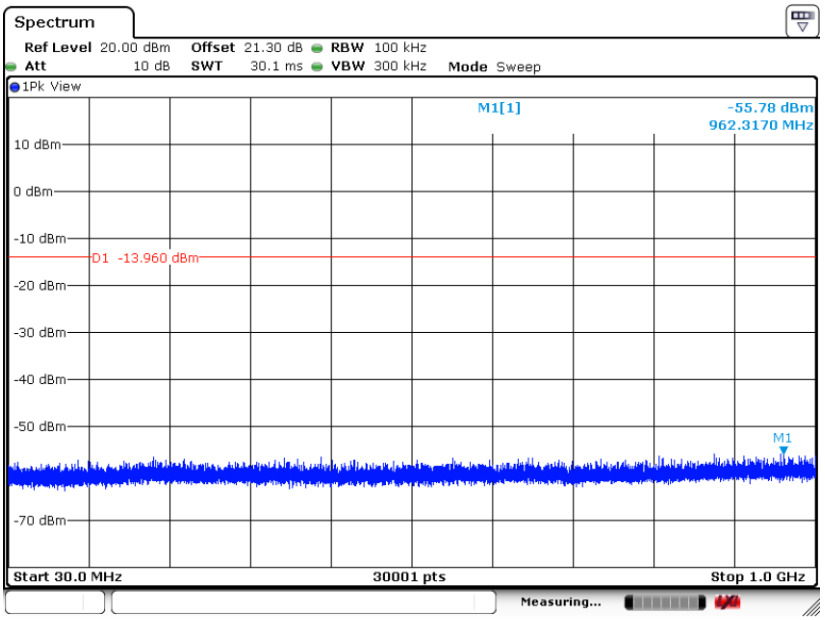
Channel 19



Date: 18.FEB.2024 22:33:39

Conducted Spurious Emission Plot on Bluetooth LE GFSK

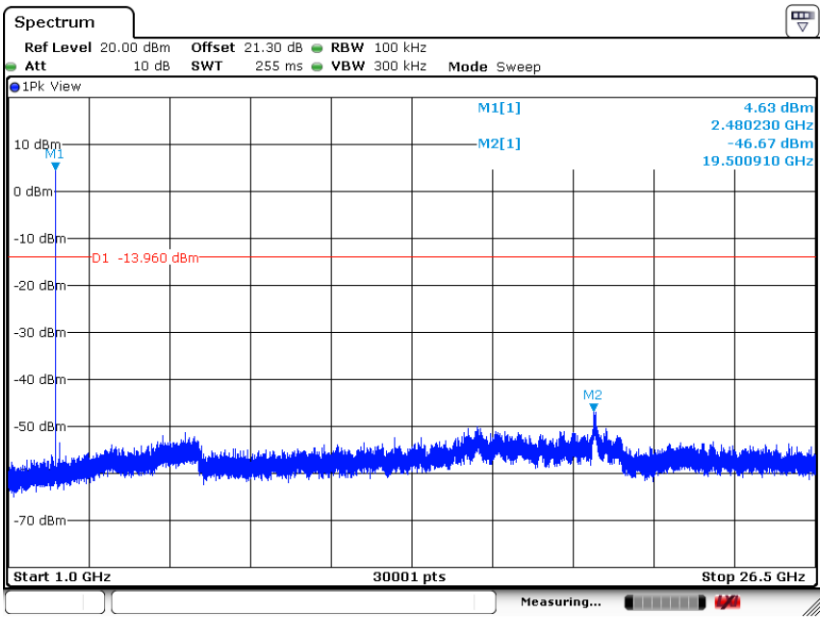
Channel 39



Date: 18.FEB.2024 22:40:12

Conducted Spurious Emission Plot on Bluetooth LE GFSK

Channel 39



Date: 18.FEB.2024 22:40:28

3.5 Radiated Band Edges and Spurious Emission Measurement

3.5.1 Limit of Radiated Band Edges and Spurious Emission

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. If the output power of this device was measured by spectrum analyzer, the attenuation under this paragraph shall be 30 dB instead of 20 dB. In addition, radiated emissions which fall in the restricted bands must also comply with the limits as below.

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

3.5.2 Measuring Instruments

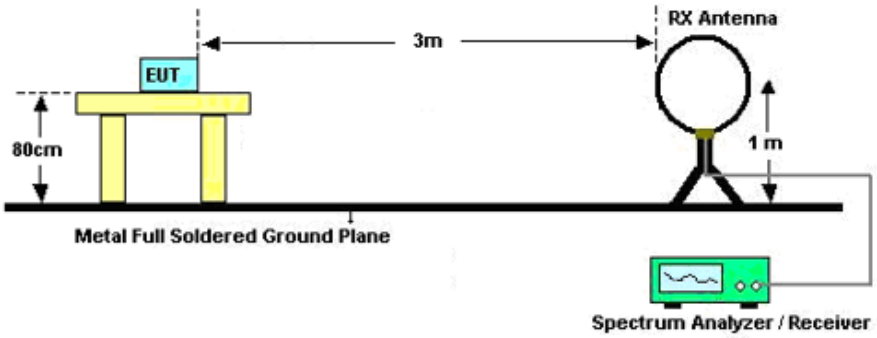
The section 4.0 of List of Measuring Equipment of this test report is used for test.

3.5.3 Test Procedures

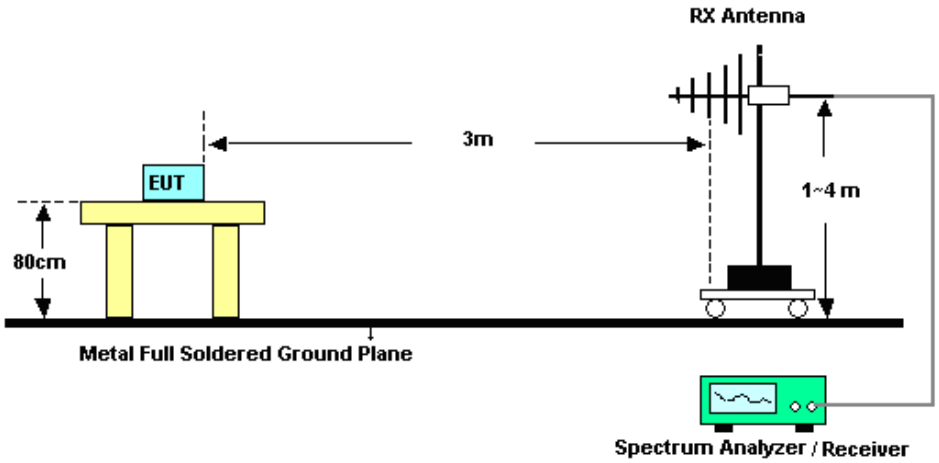
1. The testing follows ANSI C63.10-2013 clause 11.11 & 11.12
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level.
3. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
4. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
5. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
6. For testing below 1GHz, if the emission level of the EUT in peak mode was 3 dB lower than the limit specified, then peak values of EUT will be reported, otherwise, the emissions will be repeated one by one using the CISPR quasi-peak method and reported.
7. For testing above 1GHz, the emission level of the EUT in peak mode was 20dB lower than peak limit (that means the emission level in average mode also complies with the limit in average mode), then peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.
8. Use the following spectrum analyzer settings:
   (1) Span shall wide enough to fully capture the emission being measured;
   (2) Set RBW=100 kHz for f < 1 GHz; VBW ≥ RBW; Sweep = auto; Detector function = peak; Trace = max hold;
   (3) Set RBW = 1 MHz, VBW= 3MHz for f ≥ 1 GHz for peak measurement.
   For average measurement:
   - VBW = 10 Hz, when duty cycle is no less than 98 percent.
   - VBW ≥ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

3.5.4 Test Setup

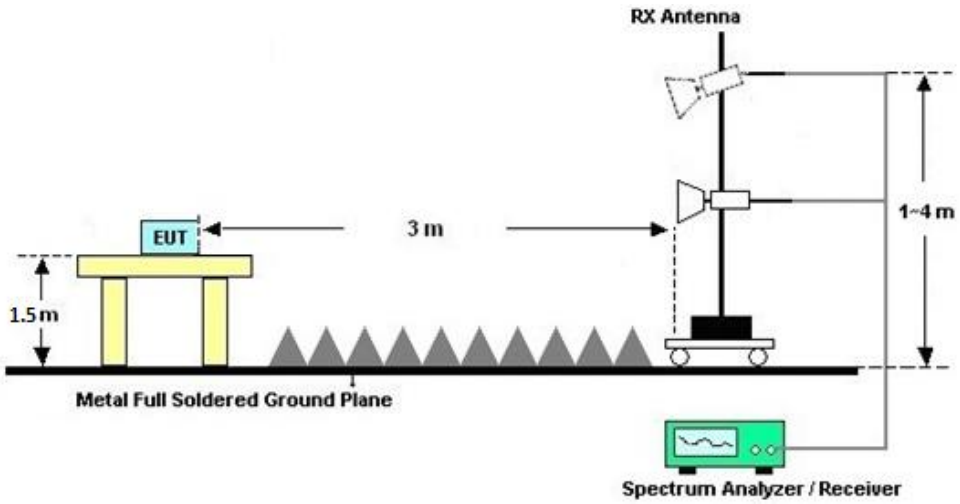
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



3.5.5 Test Results of Radiated Spurious Emissions (9 kHz ~ 30 MHz)

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line was not reported.

There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

3.5.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix C.

3.5.7 Duty Cycle

Please refer to Appendix D.

3.5.8 Test Result of Radiated Spurious Emission (30MHz ~ 10th Harmonic or 40GHz, whichever is lower)

Please refer to Appendix C.

3.6 AC Conducted Emission Measurement

3.6.1 Limit of AC Conducted Emission

For equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table.

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.

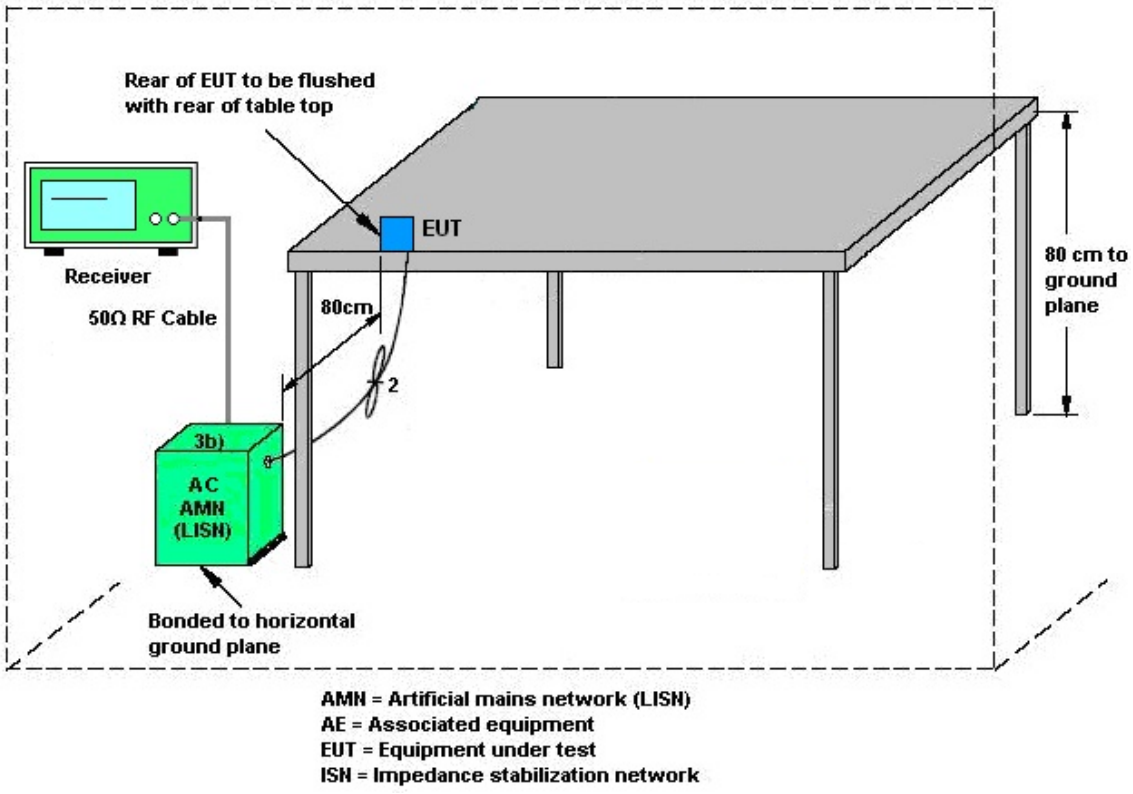
3.6.2 Measuring Instruments

The section 4.0 of List of Measuring Equipment of this test report is used for test.

3.6.3 Test Procedures

1. The EUT was placed 0.4 meter from the conducting wall of the shielding room was kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network (LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. The FCC states that a 50 ohm, 50 microhenry LISN should be used.
6. Both sides of AC line were checked for maximum conducted interference.
7. The frequency range from 150 kHz to 30 MHz was searched.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF Bandwidth = 9kHz) with Maximum Hold Mode. Then measurement is also conducted by Average Detector and Quasi-Peak Detector Function respectively.

3.6.4 Test Setup



AMN = Artificial mains network (LISN)
AE = Associated equipment
EUT = Equipment under test
ISN = Impedance stabilization network

3.6.5 Test Result of AC Conducted Emission

Please refer to Appendix B.

3.7 Antenna Requirements

3.7.1 Standard Applicable

If directional gain of transmitting antennas is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the rule.

3.7.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.7.3 Antenna Gain

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.

4 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
EMI Test Receiver&SA	KEYSIGHT	N9038A	MY54450083	20Hz~8.4GHz	Apr. 04, 2023	Feb. 04, 2024	Apr. 03, 2024	Radiation (03CH03-SZ)
EXA Spectrum Anaiyzer	KEYSIGHT	N9010A	MY55150246	10Hz~44GHz;	Apr. 04, 2023	Feb. 04, 2024	Apr. 03, 2024	Radiation (03CH03-SZ)
Loop Antenna	R&S	HFH2-Z2	100354	9kHz~30MHz	Jul. 28, 2022	Feb. 04, 2024	Jul. 27, 2024	Radiation (03CH03-SZ)
Bilog Antenna	TeseQ	CBL6112D	35408	30MHz-2GHz	Aug. 20, 2023	Feb. 04, 2024	Aug. 19, 2025	Radiation (03CH03-SZ)
Double Ridge Horn Antenna	SCHWARZBECK	BBHA9120D	9120D-1355	1GHz~18GHz	Apr. 08, 2023	Feb. 04, 2024	Apr. 07, 2024	Radiation (03CH03-SZ)
SHF-EHF Horn	com-power	AH-840	101071	18Ghz-40GHz	Apr. 08, 2023	Feb. 04, 2024	Apr. 07, 2024	Radiation (03CH03-SZ)
Amplifier	Burgeon	BPA-530	102211	0.01Hz ~3000MHz	Oct. 18, 2023	Feb. 04, 2024	Oct. 17, 2024	Radiation (03CH03-SZ)
HF Amplifier	MITEQ	AMF-7D-00101800-30-10P-R	1943528	1GHz~18GHz	Oct. 18, 2023	Feb. 04, 2024	Oct. 17, 2024	Radiation (03CH03-SZ)
Amplifier	Agilent Technologies	83017A	MY39501302	500MHz~26.5GHz	Dec. 27, 2023	Feb. 04, 2024	Dec. 26, 2024	Radiation (03CH03-SZ)
HF Amplifier	MITEQ	TTA1840-35-HG	1871923	18GHz~40GHz	Jul. 07, 2023	Feb. 04, 2024	Jul.06, 2024	Radiation (03CH03-SZ)
AC Power Source	Chroma	61601	616010002729	1 N/A	Oct. 18, 2023	Feb. 04, 2024	Oct. 17, 2024	Radiation (03CH03-SZ)
Turn Table	EM	EM1000	N/A	0~360 degree	NCR	Feb. 04, 2024	NCR	Radiation (03CH03-SZ)
Antenna Mast	EM	EM1000	N/A	1 m~4 m	NCR	Feb. 04, 2024	NCR	Radiation (03CH03-SZ)
Spectrum Analyzer	R&S	FSV40	101078	10Hz~40GHz	Apr. 06, 2023	Feb. 18, 2024	Apr. 05, 2024	Conducted (TH01-SZ)
Pulse Power Senor	Anritsu	MA2411B	1339473	30MHz~40GHz	Dec. 29, 2023	Feb. 18, 2024	Dec. 28, 2024	Conducted (TH01-SZ)
Power Meter	Anritsu	ML2495A	1218010	50MHz Bandwidth	Aug. 21, 2023	Feb. 18, 2024	Aug. 20, 2024	Conducted (TH01-SZ)
Thermo meter	Anymetre	JR593	#7	-10℃ ～ 50℃ 10%RH~99%RH	Apr. 08, 2023	Feb. 18, 2024	Apr. 07, 2024	Conducted (TH01-SZ)
EMI Receiver	R&S	ESR7	102297	9kHz~7GHz;	Jul. 07, 2023	Mar. 26, 2024	Jul. 06, 2024	Conduction (CO02-SZ)
AC LISN	R&S	ENV216	101499	9kHz~30MHz	Jul. 07, 2023	Mar. 26, 2024	Jul. 06, 2024	Conduction (CO02-SZ)
AC Power Source	CHROMA	61601	616010002470	100Vac~250Vac	Dec.25, 2022	Mar. 26, 2024	Dec. 24, 2024	Conduction (CO02-SZ)

NCR: No Calibration Required

5 Measurement Uncertainty

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI 63.10-2013. All the measurement uncertainty value were shown with a coverage K=2 to indicate 95% level of confidence. The measurement data show herein meets or exceeds the CISPR measurement uncertainty values specified in CISPR 16-4-2 and can be compared directly to specified limit to determine compliance.

Uncertainty of Conducted Measurement

Test Item	Uncertainty
Conducted Spurious Emission & Bandedge	±1.34 dB
Occupied Channel Bandwidth	±0.012 MHz
Conducted Power	±1.34 dB
Conducted Power Spectral Density	±1.32 dB
Frequency	±1.3 Hz

Uncertainty of AC Conducted Emission Measurement (0.15 MHz ~ 30 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	2.5 dB

Uncertainty of Radiated Emission Measurement (9 KHz ~ 30 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	5.0 dB

Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	5.0 dB

Uncertainty of Radiated Emission Measurement (1 GHz ~ 18 GHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	4.9 dB

Uncertainty of Radiated Emission Measurement (18 GHz ~ 40 GHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	5.0 dB

---------- THE END ----------

Appendix A. Conducted Test Results

Appendix A. Test Result of Conducted Test Items

Test Engineer:	Liu Qiu Qiu	Temperature:	21~25	°C
Test Date:	2024/2/18	Relative Humidity:	51~54	%

TEST RESULTS DATA
6dB and 99% Occupied Bandwidth

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	99% Occupied BW (MHz)	6dB BW (MHz)	6dB BW Limit (MHz)	Pass/Fail
BLE	1Mbps	1	0	2402	1.043	0.702	0.50	Pass
BLE	1Mbps	1	19	2440	1.043	0.708	0.50	Pass
BLE	1Mbps	1	39	2480	1.049	0.706	0.50	Pass

TEST RESULTS DATA
Peak Power Table

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Peak Conducted Power (dBm)	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail
BLE	1Mbps	1	0	2402	5.56	30.00	2.50	8.06	36.00	Pass
BLE	1Mbps	1	19	2440	5.93	30.00	2.50	8.23	36.00	Pass
BLE	1Mbps	1	39	2480	6.15	30.00	2.50	8.41	36.00	Pass

TEST RESULTS DATA
Average Power Table

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Duty Factor (dB)	Average Conducted Power (dBm)	Conducted Power Limit (dBm)	DG (dBi)	EIRP Power (dBm)	EIRP Power Limit (dBm)	Pass /Fail
BLE	1Mbps	1	0	2402	2.04	5.40	30.00	2.50	7.90	36.00	Pass
BLE	1Mbps	1	19	2440	2.04	5.60	30.00	2.50	8.10	36.00	Pass
BLE	1Mbps	1	39	2480	2.04	5.80	30.00	2.50	8.30	36.00	Pass

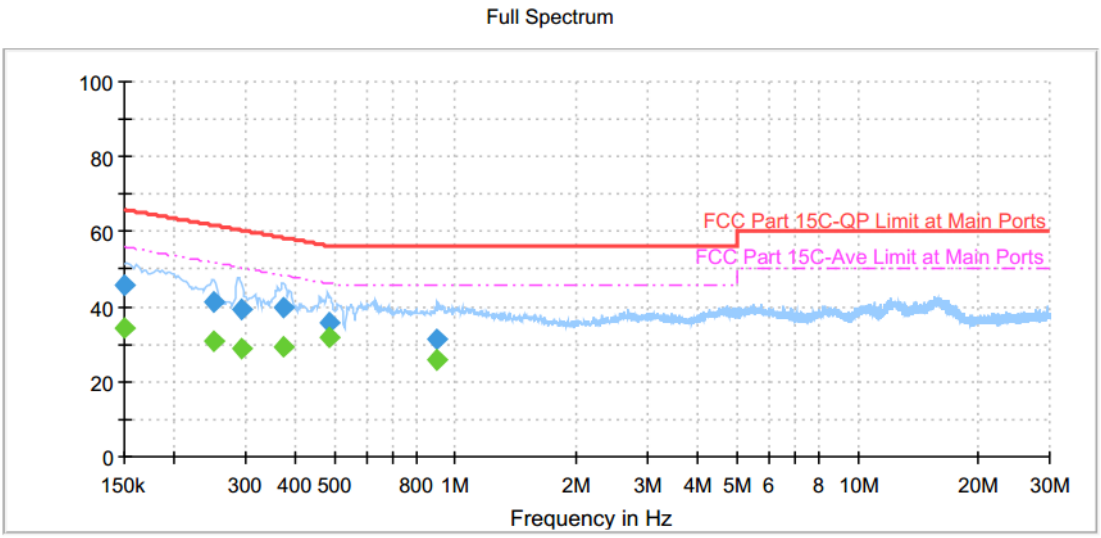
TEST RESULTS DATA
Peak Power Density

Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Peak PSD (dBm /100kHz)	Peak PSD (dBm /3kHz)	DG (dBi)	Peak PSD Limit (dBm /3kHz)	Pass/Fail	Power Setting
BLE	1Mbps	1	0	2402	5.46	-10.01	2.50	8.00	Pass	8
BLE	1Mbps	1	19	2440	5.79	-9.68	2.50	8.00	Pass	8
BLE	1Mbps	1	39	2480	6.04	-9.51	2.50	8.00	Pass	8

Note: PSD (dBm/ 100kHz) is a reference level used for Conducted Band Edges and Conducted Spurious Emission 20dBc limit.

Appendix B. AC Conducted Emission Test Results

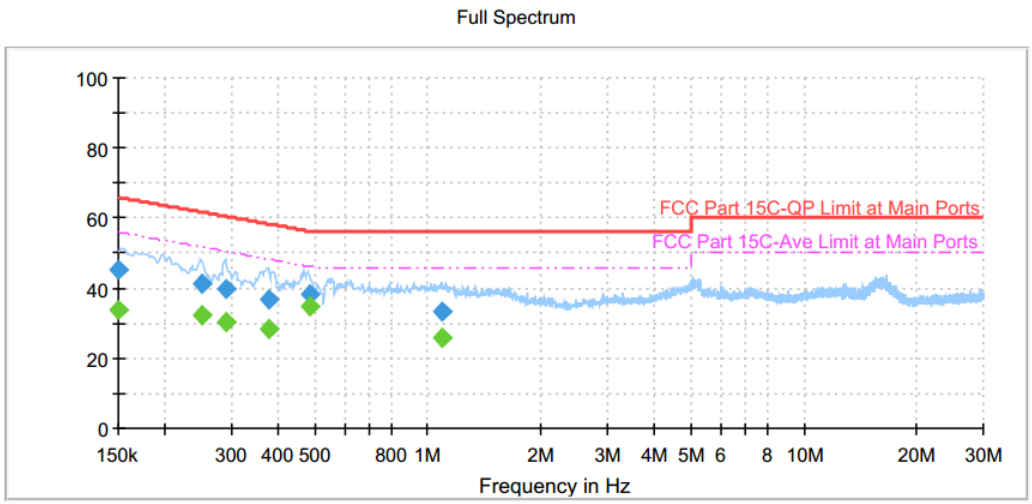
Test Engineer :	ZhangTao	**Temperature :**	24~25℃
		Relative Humidity :	48~49%
Test Voltage :	120Vac / 60Hz	**Phase :**	Line
Remark :	All emissions not reported here are more than 10 dB below the prescribed limit.		



Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Line	Filter	Corr. (dB)
0.150405	45.93	---	65.98	20.04	L1	OFF	19.7
0.150405	---	34.13	55.98	21.85	L1	OFF	19.7
0.251160	41.34	---	61.72	20.37	L1	OFF	19.7
0.251160	---	30.99	51.72	20.73	L1	OFF	19.7
0.293550	39.41	---	60.42	21.01	L1	OFF	19.7
0.293550	---	28.63	50.42	21.80	L1	OFF	19.7
0.375180	39.72	---	58.39	18.67	L1	OFF	19.7
0.375180	---	29.40	48.39	18.99	L1	OFF	19.7
0.485250	36.04	---	56.25	20.21	L1	OFF	19.7
0.485250	---	32.00	46.25	14.25	L1	OFF	19.7
0.901680	31.52	---	56.00	24.48	L1	OFF	19.8
0.901680	---	25.97	46.00	20.03	L1	OFF	19.8

Test Engineer :	ZhangTao	**Temperature :**	24~25℃
		Relative Humidity :	48~49%
Test Voltage :	120Vac / 60Hz	**Phase :**	Neutral
Remark :	All emissions not reported here are more than 10 dB below the prescribed limit.		



Final_Result

Frequency (MHz)	QuasiPeak (dBµV)	Average (dBµV)	Limit (dBµV)	Margin (dB)	Line	Filter	Corr. (dB)
0.150000	45.50	---	66.00	20.50	N	OFF	19.7
0.150000	---	34.04	56.00	21.96	N	OFF	19.7
0.249180	41.17	---	61.78	20.61	N	OFF	19.7
0.249180	---	32.20	51.78	19.59	N	OFF	19.7
0.291120	39.82	---	60.49	20.67	N	OFF	19.7
0.291120	---	30.29	50.49	20.20	N	OFF	19.7
0.379500	37.06	---	58.29	21.23	N	OFF	19.7
0.379500	---	28.56	48.29	19.73	N	OFF	19.7
0.483000	38.16	---	56.29	18.13	N	OFF	19.7
0.483000	---	34.59	46.29	11.70	N	OFF	19.7
1.095000	33.26	---	56.00	22.74	N	OFF	19.7
1.095000	---	25.73	46.00	20.27	N	OFF	19.7

Note:

1. Level(dBµV) = Read Level(dBµV) + LISN Factor(dB) + Cable Loss(dB)
2. Over Limit(dB) = Level(dBµV) – Limit Line(dBµV)

Appendix C. Radiated Spurious Emission Test Data

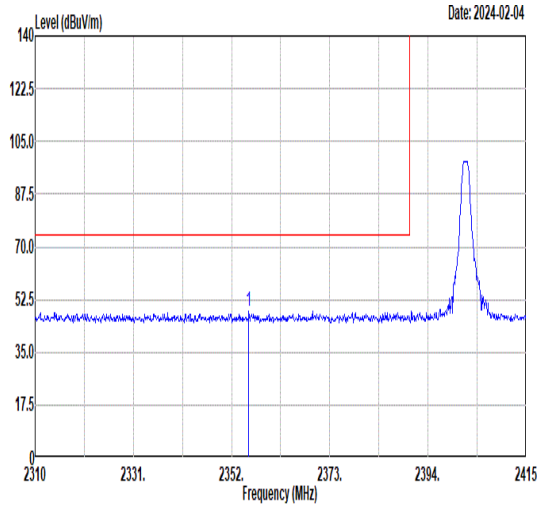
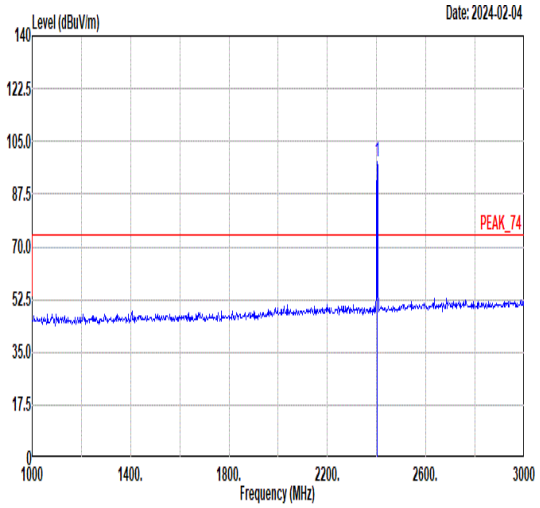
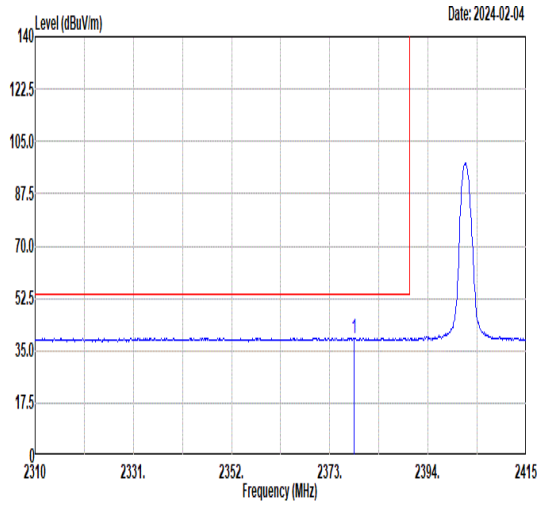
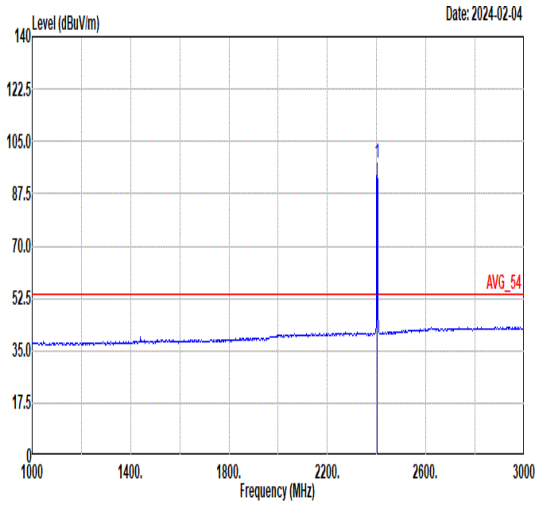
Test Engineer :	Reid Huang	Relative Humidity :	48~49%
		Temperature :	24~25°C

Radiated Spurious Emission Test Modes

Mode	Band (MHz)	Modulation	Channel	Frequency	Data Rate	Remark
Mode 1	2400-2483.5	Bluetooth-LE_GSFK	00	2402	1Mbps	-
Mode 2	2400-2483.5	Bluetooth-LE_GSFK	19	2440	1Mbps	-
Mode 3	2400-2483.5	Bluetooth-LE_GSFK	39	2480	1Mbps	-
Mode 4	2400-2483.5	LF	39	2480	1Mbps	-

Summary of each worse mode

Mode	Modulation	Ch.	Freq. (MHz)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Pol.	Peak Avg.	Result	Remark
1	Bluetooth-LE_GSFK	00	2380.88	39.46	54.00	-14.54	V	Average	Pass	Band Edge
1	Bluetooth-LE_GSFK	00	4824	42.35	74	-31.65	H	Peak	Pass	Harmonic
2	Bluetooth-LE_GSFK	19	-	-	-	-	-	-	-	Band Edge
2	Bluetooth-LE_GSFK	19	7320.00	43.69	74.00	-30.31	H	Peak	Pass	Harmonic
3	Bluetooth-LE_GSFK	39	2483.72	41.94	54.00	-12.06	H	Average	Pass	Band Edge
3	Bluetooth-LE_GSFK	39	7440.00	43.60	74.00	-30.40	H	Peak	Pass	Harmonic
4	Bluetooth-LE_GSFK	39	948.59	31.41	46	-14.59	H	Peak	Pass	LF

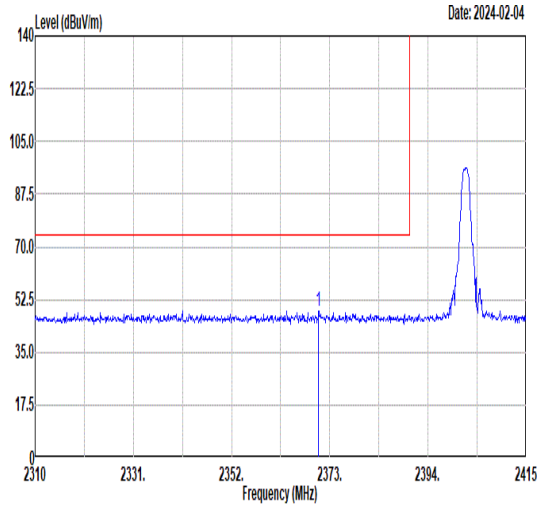
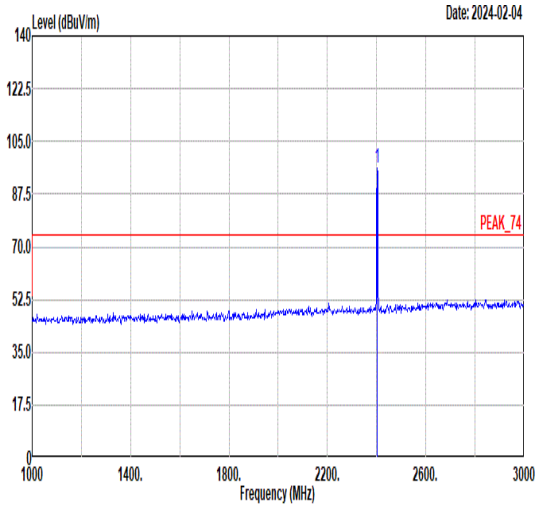
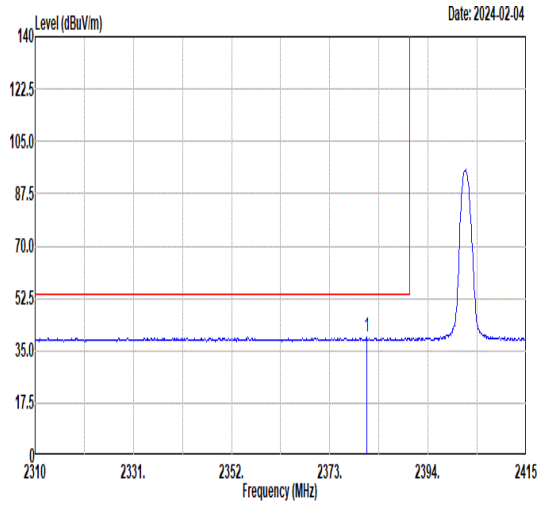
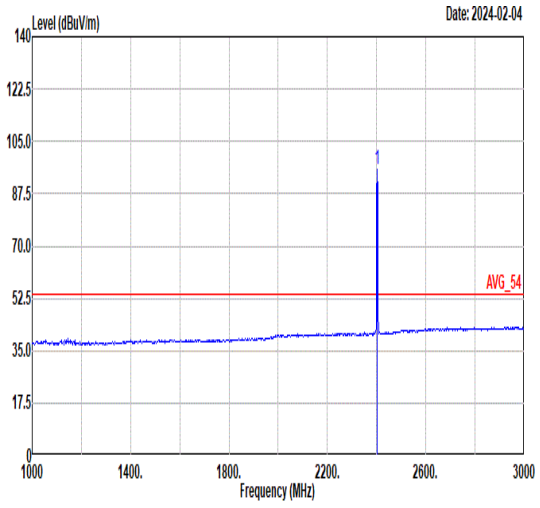
Mode	1	
	Band Edge	
	2400-2483.5_Bluetooth-LE_GSFK _CH00_2402MHz	
Pol.	Horizontal	Fundamental
Peak		
Avg		

	Freq	Level	Limit Line	Margin	Read Level	Ant Factor	Cable Loss	Preamp Factor	APos	TPos	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	dB	dB	cm	deg	
1	2355.68	48.79	74.00	-25.21	45.28	32.34	4.76	33.59	212	154	Peak

	Freq	Level	Limit Line	Margin	Read Level	Ant Factor	Cable Loss	Preamp Factor	APos	TPos	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	dB	dB	cm	deg	
1	2402.00	98.44	------	------	94.83	32.36	4.81	33.56	212	154	Peak

	Freq	Level	Limit Line	Margin	Read Level	Ant Factor	Cable Loss	Preamp Factor	APos	TPos	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	dB	dB	cm	deg	
1	2378.15	39.32	54.00	-14.68	35.76	32.35	4.78	33.57	212	154	Average

	Freq	Level	Limit Line	Margin	Read Level	Ant Factor	Cable Loss	Preamp Factor	APos	TPos	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	dB	dB	cm	deg	
1	2402.00	97.92	------	------	94.31	32.36	4.81	33.56	212	154	Average

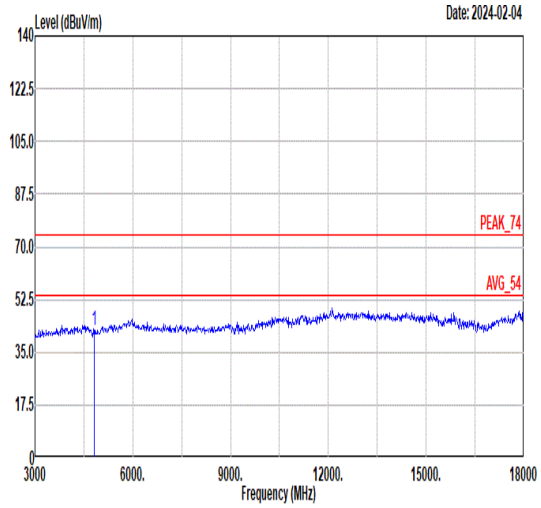
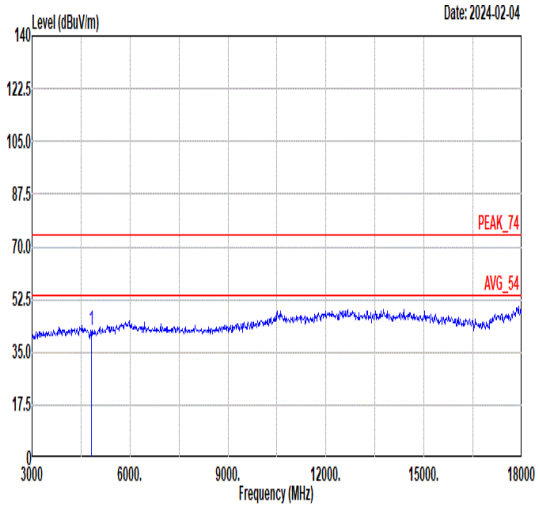
Mode	1	
	Band Edge	
	2400-2483.5_Bluetooth-LE_GSFK _CH00_2402MHz	
Pol.	Vertical	Fundamental
Peak		
Avg		

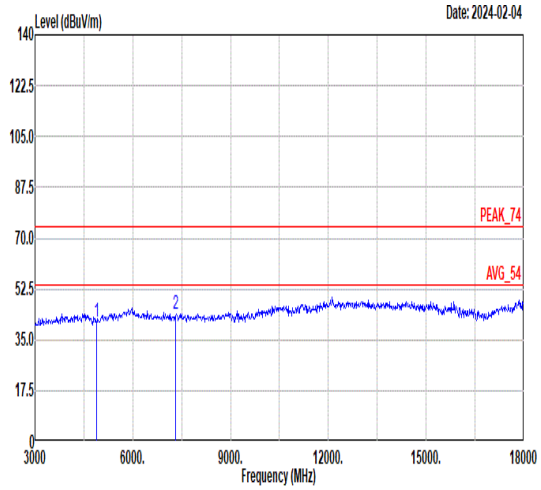
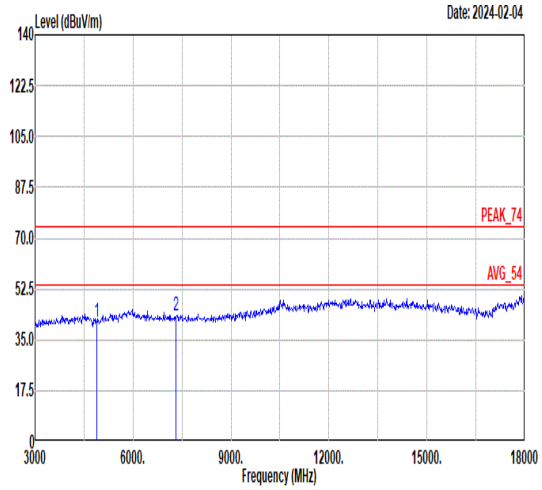
	Freq	Level	Limit Line	Margin	Read Level	Ant Factor	Cable Loss	Preamp Factor	APos	TPos	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	dB	dB	cm	deg	
1	2370.59	48.61	74.00	-25.39	45.06	32.35	4.78	33.58	105	147	Peak

	Freq	Level	Limit Line	Margin	Read Level	Ant Factor	Cable Loss	Preamp Factor	APos	TPos	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	dB	dB	cm	deg	
1	2402.00	96.26	------	------	92.65	32.36	4.81	33.56	105	147	Peak

	Freq	Level	Limit Line	Margin	Read Level	Ant Factor	Cable Loss	Preamp Factor	APos	TPos	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	dB	dB	cm	deg	
1	2380.88	39.46	54.00	-14.54	35.89	32.35	4.79	33.57	105	147	Average

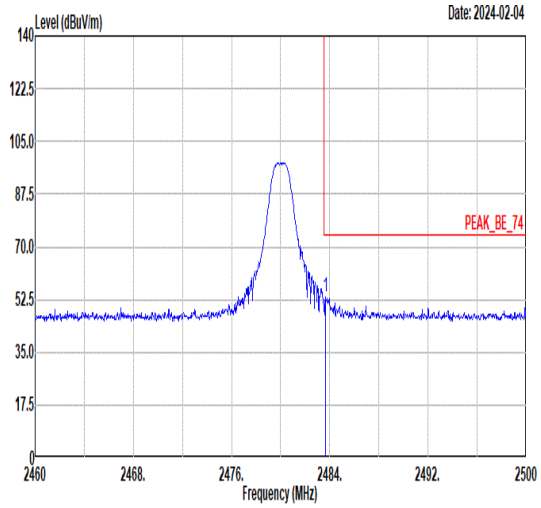
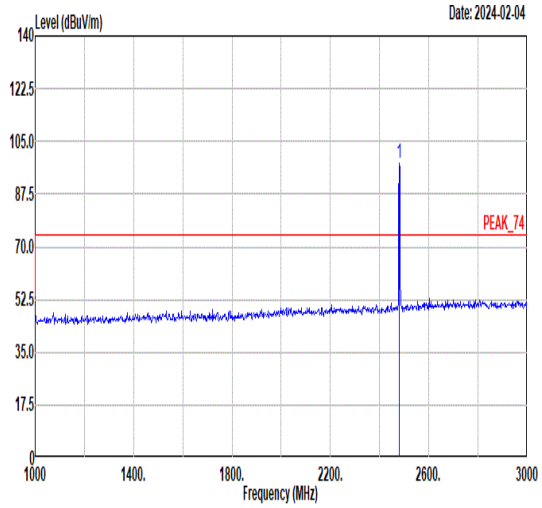
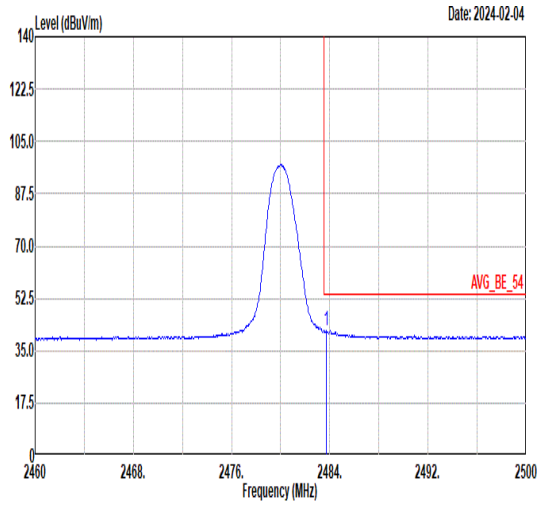
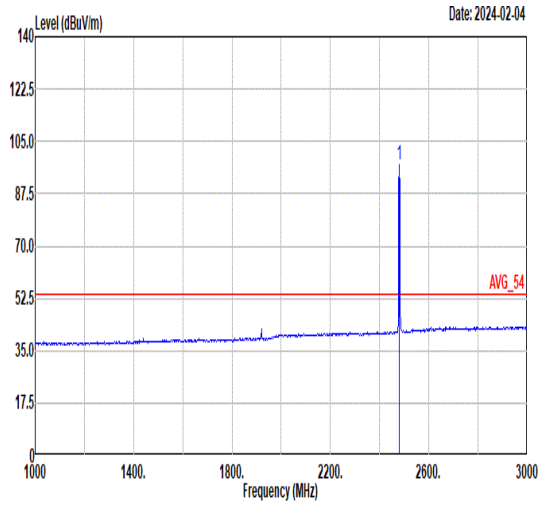
	Freq	Level	Limit Line	Margin	Read Level	Ant Factor	Cable Loss	Preamp Factor	APos	TPos	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	dB	dB	cm	deg	
1	2402.00	95.62	------	------	92.01	32.36	4.81	33.56	105	147	Average

Mode	1	
	Harmonic	
	2400-2483.5_Bluetooth-LE_GSFK _CH00_2402MHz	
Pol.	Horizontal	Vertical
Peak Avg	 Freq Level Limit Line Margin Read Level Ant Factor Cable Loss Preamp Factor APos TPos Remark MHz dBuV/m dBuV/m dB dBuV dB/m dB dB cm deg 1 4824.00 42.35 74.00 -31.65 57.68 34.40 7.75 57.48 -- -- Peak	 Freq Level Limit Line Margin Read Level Ant Factor Cable Loss Preamp Factor APos TPos Remark MHz dBuV/m dBuV/m dB dBuV dB/m dB dB cm deg 1 4824.00 42.05 74.00 -31.95 57.38 34.40 7.75 57.48 -- -- Peak

Mode	2	
	Harmonic	
	2400-2483.5_Bluetooth-LE_GSFK _CH19_2440MHz	
Pol.	Horizontal	Vertical
Peak Avg		

	Freq	Level	Limit Line	Margin	Read Level	Ant Factor	Cable Loss	Preamp Factor	APos	TPos	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	dB	dB	cm	deg	
1	4880.00	41.41	74.00	-32.59	56.79	34.37	7.77	57.52	--	--	Peak
2	7320.00	43.69	74.00	-30.31	57.62	36.04	8.96	58.93	--	--	Peak

	Freq	Level	Limit Line	Margin	Read Level	Ant Factor	Cable Loss	Preamp Factor	APos	TPos	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	dB	dB	cm	deg	
1	4880.00	41.11	74.00	-32.89	56.49	34.37	7.77	57.52	--	--	Peak
2	7320.00	43.39	74.00	-30.61	57.32	36.04	8.96	58.93	--	--	Peak

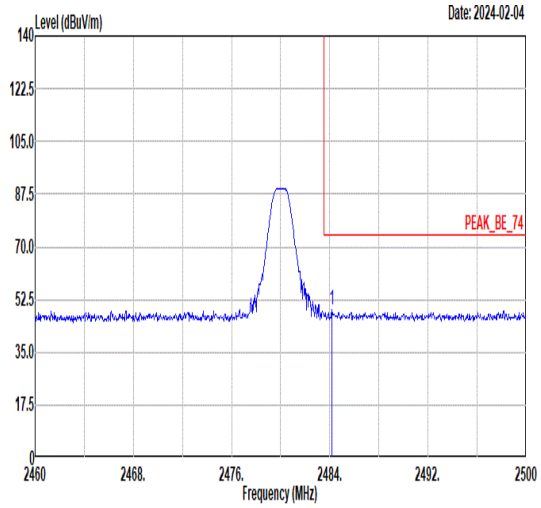
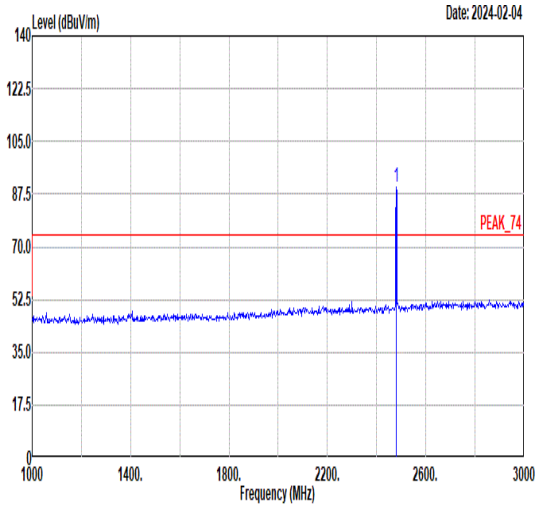
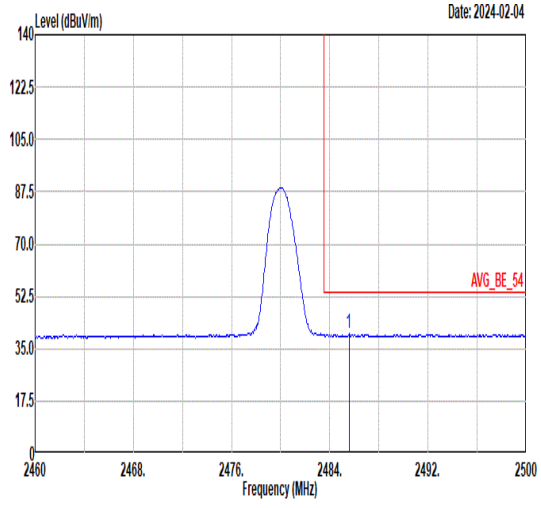
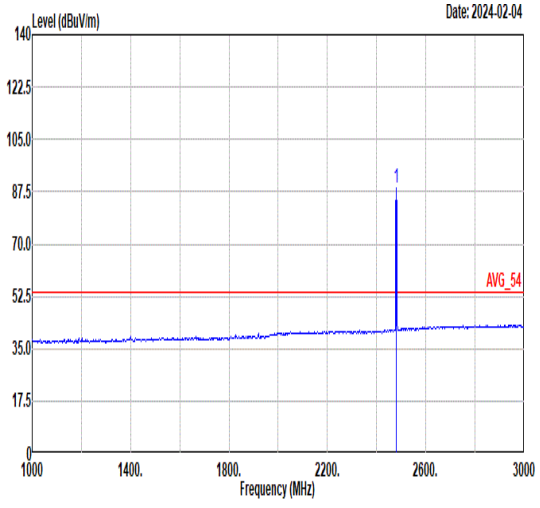
Mode	3	
	Band Edge	
	2400-2483.5_Bluetooth-LE_GSFK _CH39_2480MHz	
Pol.	Horizontal	Fundamental
Peak		
Avg		

	Freq	Level	Limit Line	Margin	Read Level	Ant Factor	Cable Loss	Preamp Factor	APos	TPos	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	dB	dB	cm	deg	
1	2483.68	53.60	74.00	-20.40	49.79	32.40	4.92	33.51	214	152	Peak

	Freq	Level	Limit Line	Margin	Read Level	Ant Factor	Cable Loss	Preamp Factor	APos	TPos	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	dB	dB	cm	deg	
1	2480.00	97.74	------	------	93.94	32.39	4.92	33.51	214	152	Peak

	Freq	Level	Limit Line	Margin	Read Level	Ant Factor	Cable Loss	Preamp Factor	APos	TPos	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	dB	dB	cm	deg	
1	2483.72	41.94	54.00	-12.06	38.13	32.40	4.92	33.51	214	152	Average

	Freq	Level	Limit Line	Margin	Read Level	Ant Factor	Cable Loss	Preamp Factor	APos	TPos	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	dB	dB	cm	deg	
1	2480.00	97.26	------	------	93.46	32.39	4.92	33.51	214	152	Average

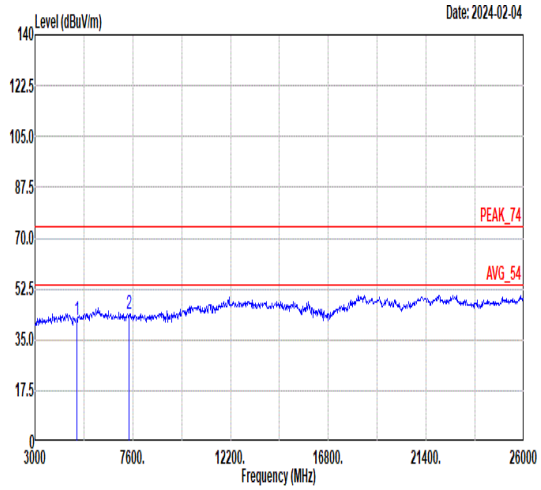
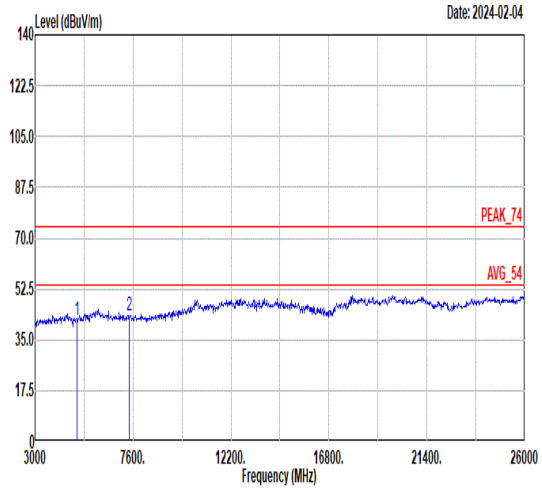
Mode	3	
	Band Edge	
	2400-2483.5_Bluetooth-LE_GSFK _CH39_2480MHz	
Pol.	Vertical	Fundamental
Peak		
Avg		

	Freq	Level	Limit Line	Margin	Read Level	Ant Factor	Cable Loss	Preamp Factor	APos	TPos	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	dB	dB	cm	deg	
1	2484.16	49.31	74.00	-24.69	45.50	32.40	4.92	33.51	111	143	Peak

	Freq	Level	Limit Line	Margin	Read Level	Ant Factor	Cable Loss	Preamp Factor	APos	TPos	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	dB	dB	cm	deg	
1	2480.00	89.62	------	------	85.82	32.39	4.92	33.51	111	143	Peak

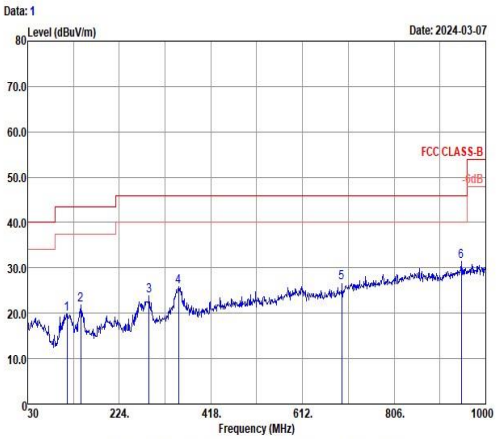
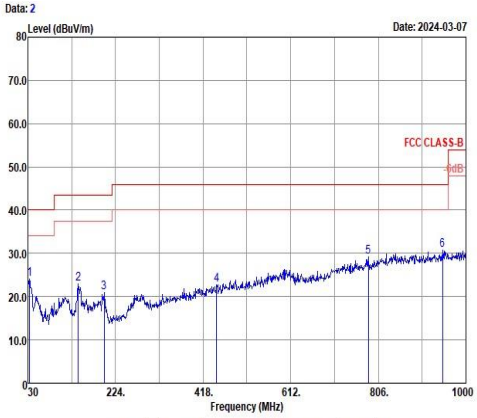
	Freq	Level	Limit Line	Margin	Read Level	Ant Factor	Cable Loss	Preamp Factor	APos	TPos	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	dB	dB	cm	deg	
1	2485.56	39.92	54.00	-14.08	36.11	32.40	4.92	33.51	111	143	Average

	Freq	Level	Limit Line	Margin	Read Level	Ant Factor	Cable Loss	Preamp Factor	APos	TPos	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	dB	dB	cm	deg	
1	2480.00	88.95	------	------	85.15	32.39	4.92	33.51	111	143	Average

Mode	3	
	Harmonic	
	2400-2483.5_Bluetooth-LE_GSFK _CH39_2480MHz	
Pol.	Horizontal	Vertical
Peak Avg		

	Freq	Level	Limit Line	Margin	Read Level	Ant Factor	Cable Loss	Preamp Factor	APos	TPos	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	dB	dB	cm	deg	
1	4960.00	41.79	74.00	-32.21	57.24	34.32	7.81	57.58	--	--	Peak
2	7440.00	43.60	74.00	-30.40	57.45	35.94	9.19	58.98	--	--	Peak

	Freq	Level	Limit Line	Margin	Read Level	Ant Factor	Cable Loss	Preamp Factor	APos	TPos	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	dB	dB	cm	deg	
1	4960.00	41.49	74.00	-32.51	56.94	34.32	7.81	57.58	--	--	Peak
2	7440.00	43.30	74.00	-30.70	57.15	35.94	9.19	58.98	--	--	Peak

Mode	4	
	LF	
	2400-2483.5_Bluetooth-LE_GSFK _CH39_2480MHz	
Pol.	Horizontal	Vertical
QP/ Peak		

	Freq	Level	Over Limit	Limit Line	ReadAntenna Level	Antenna Factor	Cable Loss	Preamp Factor	A/Pos	T/Pos	Remark
	MHz	dBuV/m	dB	dBuV/m	dBuV	dB/m	dB	dB	cm	deg	
1	113.42	19.88	-23.62	43.50	37.53	16.00	1.13	34.78	---	---	Peak
2	142.52	21.81	-21.69	43.50	36.93	18.35	1.25	34.72	---	---	Peak
3	287.05	23.91	-22.09	46.00	38.05	18.72	1.76	34.62	---	---	Peak
4	349.13	25.91	-20.09	46.00	38.37	20.20	1.94	34.60	---	---	Peak
5	695.42	26.71	-19.29	46.00	31.30	27.02	2.80	34.41	---	---	Peak
6	948.59	31.41	-14.59	46.00	32.71	29.74	3.26	34.30	---	---	Peak

	Freq	Level	Over Limit	Limit Line	ReadAntenna Level	Antenna Factor	Cable Loss	Preamp Factor	A/Pos	T/Pos	Remark
	MHz	dBuV/m	dB	dBuV/m	dBuV	dB/m	dB	dB	cm	deg	
1	33.88	23.98	-16.02	40.00	39.85	18.46	0.57	34.90	---	---	Peak
2	141.55	23.03	-20.47	43.50	38.23	18.27	1.25	34.72	---	---	Peak
3	198.78	20.84	-22.66	43.50	38.01	16.05	1.48	34.70	---	---	Peak
4	448.07	22.62	-23.38	46.00	32.18	22.70	2.24	34.50	---	---	Peak
5	783.69	29.09	-16.91	46.00	32.67	27.76	3.00	34.34	---	---	Peak
6	948.59	30.69	-15.31	46.00	31.99	29.74	3.26	34.30	---	---	Peak

Appendix D. Duty Cycle Plots

Band	Duty Cycle(%)	T(ms)	1/T(kHz)	VBW Setting
Bluetooth LE	62.98	0.393	2.545	3KHz

Bluetooth LE