FCC PART 15 SUBPART C TEST REPORT

FCC PART 15.247

Report Reference No.....	**: BSL24030101P01-R01**
FCC ID.....	**: 2BFDP-HK**
Compiled by (position+printed name+signature)..	: Engineer/ Cindy Zheng
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Date of issue.....	: March 15, 2024

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Testing Laboratory Name.....	**: BSL Testing Co., Ltd.**
Address.....	: 1/F, Building B, Xinshidai GR Park,Shiyan Street, Bao'an District, Shenzhen,Guangdong, 518052, People's Republic of China
Applicant's name.....	**: Changsha hongkai Technology co., ltd**
Address.....	: Room 2501, Building 2, Xiangyu Central Garden, No.249,WuYi Road, Furong District, Changsha, China
Test specification.....	**:**
Standard.....	: **FCC Part 15.247**

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Equipment description.....	**: 360VRM**
Trade Mark.....	: N/A
Manufacturer.....	: Changsha hongkai Technology co., ltd
Model/Type reference.....	: HK
Listed Models	: 9860, 9801, 9805, 9806, 9807, 9801-2, 9801C, 9801F, 9802C, 9803BPLUS, 9803C, 9803D, 9804B, 9806F, 9808A, 9808B, 98-001, 98-002, 6803, 6805, 6807, 6809, 6812, 6801C, 6801E, 6802B2, 6802ES, 6825B, 6828S, 6812PLUS, 98001PLUS
Modulation	: GFSK
Frequency.....	From 2402MHz to 2480MHz
Ratings.....	: DC 12V
Result.....	: **PASS**

TEST REPORT

Equipment under Test	:	**360VRM**
Model /Type	:	HK
Listed Models	:	9860, 9801, 9805, 9806, 9807, 9801-2, 9801C, 9801F, 9802C, 9803BPLUS, 9803C, 9803D, 9804B, 9806F, 9808A, 9808B, 98-001, 98-002, 6803, 6805, 6807, 6809, 6812, 6801C, 6801E, 6802B2, 6802ES, 6825B, 6828S, 6812PLUS, 98001PLUS
Model Declaration	:	All the models are electrical identical including the same software parameter and hardware design, same mechanical structure and design, the only difference is the model named different.
Applicant	:	**Changsha hongkai Technology co., ltd**
Address	:	Room 2501, Building 2, Xiangyu Central Garden, No.249,WuYi Road, Furong District, Changsha, China
Manufacturer	:	**Changsha hongkai Technology co., ltd**
Address	:	Room 2501, Building 2, Xiangyu Central Garden, No.249,WuYi Road, Furong District, Changsha, China

Test Result:	**PASS**

The test report merely corresponds to the test sample.
It is not permitted to copy extracts of these test result without the written permission of the test laboratory.

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1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules Part 15.247: Frequency Hopping, Direct Spread Spectrum and Hybrid Systems that are in operation within the bands of 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.
ANSI C63.10-2013: American National Standard for Testing Unlicensed Wireless Devices
KDB558074 D01 V05r02: Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

2 SUMMARY

2.1 General Remarks

Date of receipt of test sample	:	March 1, 2024
Testing commenced on	:	March 1, 2024
Testing concluded on	:	March 14, 2024

2.2 Product Description

Product Description:	360VRM
Model/Type reference:	HK
Power supply:	DC 12.0V
Adapter information (Auxiliary test supplied by testing Lab）	N/A
Testing sample ID：	BSL24030101P01-R01-1# (Engineer sample), BSL24030101P01-R01-2# (Normal sample)
Bluetooth BLE	
Supported type:	Bluetooth low Energy
Modulation:	GFSK
Operation frequency:	2402MHz to 2480MHz
Channel number:	40
Channel separation:	2 MHz
Antenna type:	Ceramic antenna
Antenna gain:	0 dBi

2.3 Equipment Under Test

Power supply system utilised

Power supply voltage	:	○	230V / 50 Hz	○	120V / 60Hz
		○	12 V DC	○	24 V DC
		●	Other (specified in blank below)		

DC 12V

2.4 Short description of the Equipment under Test (EUT)

This is a 360VRM.
For more details, refer to the user's manual of the EUT.

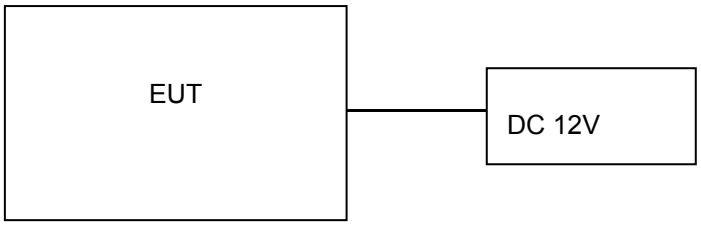
2.5 EUT operation mode

The Applicant provides communication tools software(Engineer mode) to control the EUT for staying in continuous transmitting (Duty Cycle more than 98%) and receiving mode for testing .There are 40 channels provided to the EUT and Channel 00/19/39 were selected to test.

Operation Frequency：

Channel	Frequency (MHz)
00	**2402**
01	2404
02	2406
⋮	⋮
19	**2440**
⋮	⋮
37	2476
38	2478
39	**2480**

2.6 Block Diagram of Test Setup



2.7 Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended for the device filing to comply with Section 15.247 of the FCC Part 15, Subpart C Rules.

2.8 Modifications

No modifications were implemented to meet testing criteria.

3 TEST ENVIRONMENT

3.1 Address of the test laboratory

BSL Testing Co., Ltd.
1/F, Building B, Xinshidai GR Park,Shiyan Street, Bao'an District, Shenzhen,Guangdong, 518052, People's Republic of China

3.2 Test Facility

FCC-Registration No.: 562200 Designation Number: CN1338
BSL Testing Co.,Ltd. has been listed on the US Federal Communications Commission list of test facilities recognized to perform electromagnetic emissions measurements.

Industry Canada Registration Number. Is: 11093A CAB identifier: CN0019
The Laboratory has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing.

A2LA-Lab Cert. No.: 4707.01
BSL Testing Co.,Ltd. has been listed by American Association for Laboratory Accreditation to perform electromagnetic emission measurement.

The 3m-Semi anechoic test site fulfils CISPR 16-1-4 according to ANSI C63.10 and CISPR 16-1-4:2010.

3.3 Environmental conditions

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

Temperature:	23 ° C
Humidity:	44 %
Atmospheric pressure:	950-1050mbar

AC Main Conducted testing：

Temperature:	24 ° C
Humidity:	47 %
Atmospheric pressure:	950-1050mbar

Conducted testing：

Temperature:	24 ° C
Humidity:	46 %
Atmospheric pressure:	950-1050mbar

3.4 Summary of measurement results

Test Specification clause	Test case	Test Mode	Test Channel	Recorded In Report		Test result
§15.247(e)	Power spectral density	BLE 1Mpbs	☒ Lowest ☒ Middle ☒ Highest	BLE 1Mpbs	☒ Lowest ☒ Middle ☒ Highest	complies
§15.247(a)(2)	Spectrum bandwidth – 6 dB bandwidth	BLE 1Mpbs	☒ Lowest ☒ Middle ☒ Highest	BLE 1Mpbs	☒ Lowest ☒ Middle ☒ Highest	complies
§15.247(b)(3)	Maximum output Peak power	BLE 1Mpbs	☒ Lowest ☒ Middle ☒ Highest	BLE 1Mpbs	☒ Lowest ☒ Middle ☒ Highest	complies
§15.247(d)	Band edge compliance conducted	BLE 1Mpbs	☒ Lowest ☒ Highest	BLE 1Mpbs	☒ Lowest ☒ Highest	complies
§15.205	Band edge compliance radiated	BLE 1Mpbs	☒ Lowest ☒ Highest	BLE 1Mpbs	☒ Lowest ☒ Highest	complies
§15.247(d)	TX spurious emissions conducted	BLE 1Mpbs	☒ Lowest ☒ Middle ☒ Highest	BLE 1Mpbs	☒ Lowest ☒ Middle ☒ Highest	complies
§15.247(d)	TX spurious emissions radiated	BLE 1Mpbs	☒ Lowest ☒ Middle ☒ Highest	BLE 1Mpbs	☒ Lowest ☒ Middle ☒ Highest	complies
§15.209(a)	TX spurious Emissions radiated Below 1GHz	BLE 1Mpbs	-/-	BLE 1Mpbs	-/-	complies
§15.107(a) §15.207	Conducted Emissions < 30 MHz	BLE 1Mpbs	-/-	BLE 1Mpbs	-/-	N/A

Remark:
1. The measurement uncertainty is not included in the test result.
2. We tested all test mode and recorded worst case in report

3.5 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. The reader is cautioned that there may be errors within the calibration limits of the equipment and facilities. The measurement uncertainty was calculated for all measurements listed in this test report acc. to TR-100028-01" Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics; Part 1" and TR-100028-02 "Electromagnetic compatibility and Radio spectrum Matters (ERM);Uncertainties in the measurement of mobile radio equipment characteristics; Part 2 " and is documented in the BSL Testing Co., Ltd.quality system acc. to DIN EN ISO/IEC 17025. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

Hereafter the best measurement capability for BSL Testing Co., Ltd.:

Test	Range	Measurement Uncertainty	Notes
Radiated Emission	9KHz~30MHz	3.82 dB	(1)
Radiated Emission	30~1000MHz	4.06 dB	(1)
Radiated Emission	1~18GHz	5.14 dB	(1)
Radiated Emission	18-40GHz	5.38 dB	(1)
Conducted Disturbance	0.15~30MHz	2.14 dB	(1)
Transmitter power conducted	1~40GHz	0.57 dB	(1)
Conducted spurious emission	1~40GHz	1.60 dB	(1)
OBW	1~40GHz	25 Hz	(1)
PSD	1~40GHz	0.01 dBm/3KHz	(1)

(1) This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

3.6 Equipments Used during the Test

Conducted Emission					
Test Equipment	**Manufacturer**	**Model**	**Serial No.**	**Date of Cal.**	**Due Date**
Shielding Room	ZhongYu Electron	7.3(L)x3.1(W)x2.9(H)	BSL252	2023-10-28	2024-10-27
EMI Test Receiver	R&S	ESCI 7	BSL552	2023-10-28	2024-10-27
Coaxial Switch	ANRITSU CORP	MP59B	BSL225	2023-10-28	2024-10-27
ENV216 2-L-V-NETZNACHB.DE	ROHDE&SCHWARZ	ENV216	BSL226	2023-10-28	2024-10-27
Coaxial Cable	BSL	N/A	BSL227	N/A	N/A
EMI Test Software	AUDIX	E3	N/A	N/A	N/A
Thermo meter	KTJ	TA328	BSL233	2023-10-28	2024-10-27
Absorbing clamp	Elektronik-Feinmechanik	MDS21	BSL229	2023-10-28	2024-10-27
LISN	R&S	ENV216	308	2023-10-28	2024-10-27
LISN	R&S	ENV216	314	2023-10-28	2024-10-27

Radiation Test equipment					
Test Equipment	**Manufacturer**	**Model**	**Serial No.**	**Date of Cal.**	**Due Date**
3m Semi- Anechoic Chamber	ZhongYu Electron	9.2(L)*6.2(W)* 6.4(H)	BSL250	2023-10-28	2024-10-27
Control Room	ZhongYu Electron	6.2(L)*2.5(W)* 2.4(H)	BSL251	N/A	N/A
EMI Test Receiver	Rohde & Schwarz	ESU26	BSL203	2023-10-28	2024-10-27
BiConiLog Antenna	SCHWARZBECK MESS-ELEKTRONIK	VULB9163	BSL214	2023-10-28	2024-10-27
Double -ridged waveguide horn	SCHWARZBECK MESS-ELEKTRONIK	BBHA 9120 D	BSL208	2023-10-28	2024-10-27
Horn Antenna	ETS-LINDGREN	3160	BSL217	2023-10-28	2024-10-27
EMI Test Software	AUDIX	E3	N/A	N/A	N/A
Coaxial Cable	BSL	N/A	BSL213	2023-10-28	2024-10-27
Coaxial Cable	BSL	N/A	BSL211	2023-10-28	2024-10-27
Coaxial cable	BSL	N/A	BSL210	2023-10-28	2024-10-27
Coaxial Cable	BSL	N/A	BSL212	2023-10-28	2024-10-27
Amplifier(100kHz-3GHz)	HP	8347A	BSL204	2023-10-28	2024-10-27
Amplifier(2GHz-20GHz)	HP	84722A	BSL206	2023-10-28	2024-10-27
Amplifier (18-26GHz)	Rohde & Schwarz	AFS33-18002 650-30-8P-44	BSL218	2023-10-28	2024-10-27
Band filter	Amindeon	82346	BSL219	2023-10-28	2024-10-27
Power Meter	Anritsu	ML2495A	BSL540	2023-10-28	2024-10-27
Power Sensor	Anritsu	MA2411B	BSL541	2023-10-28	2024-10-27
Wideband Radio Communication Tester	Rohde & Schwarz	CMW500	BSL575	2023-10-28	2024-10-27
Splitter	Agilent	11636B	BSL237	2023-10-28	2024-10-27
Loop Antenna	ZHINAN	ZN30900A	BSL534	2023-10-28	2024-10-27

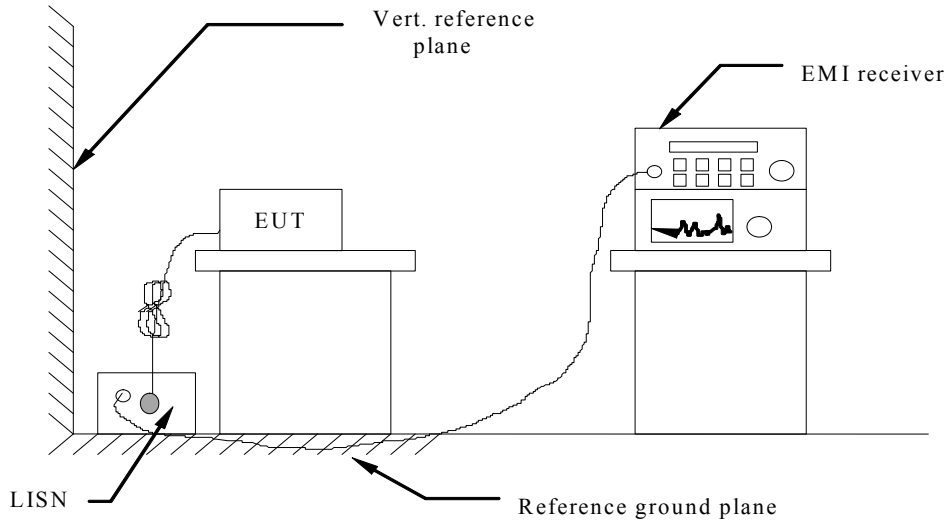
Breitband hornantenne	SCHWARZBECK	BBHA 9170	BSL579	2023-10-28	2024-10-27
Amplifier	TDK	PA-02-02	BSL574	2023-10-28	2024-10-27
Amplifier	TDK	PA-02-03	BSL576	2023-10-28	2024-10-27
PSA Series Spectrum Analyzer	Rohde & Schwarz	FSP	BSL578	2023-10-28	2024-10-27
Antenna tower	SKET	BK-4AT	BSL589	2023-10-28	2024-10-27

RF Conducted Test:					
Test Equipment	**Manufacturer**	**Model**	**Serial No.**	**Date of Cal.**	**Due Date**
MXA Signal Analyzer	Agilent	N9020A	BSL566	2023-10-28	2024-10-27
EMI Test Receiver	R&S	ESCI 7	BSL552	2023-10-28	2024-10-27
Spectrum Analyzer	Agilent	E4440A	BSL533	2023-10-28	2024-10-27
MXG vector Signal Generator	Agilent	N5182A	BSL567	2023-10-28	2024-10-27
ESG Analog Signal Generator	Agilent	E4428C	BSL568	2023-10-28	2024-10-27
USB RF Power Sensor	DARE	RPR3006W	BSL569	2023-10-28	2024-10-27
RF Switch Box	Shongyi	RFSW3003328	BSL571	2023-10-28	2024-10-27
Programmable Constant Temp & Humi Test Chamber	WEWON	WHTH-150L-40-880	BSL572	2023-10-28	2024-10-27

4 TEST CONDITIONS AND RESULTS

4.1 AC Power Conducted Emission

TEST CONFIGURATION



TEST PROCEDURE

1 The equipment was set up as per the test configuration to simulate typical actual usage per the user's manual. The EUT is a tabletop system, a wooden table with a height of 0.8 meters is used and is placed on the ground plane as per ANSI C63.10-2013.
2 Support equipment, if needed, was placed as per ANSI C63.10-2013
3 All I/O cables were positioned to simulate typical actual usage as per ANSI C63.10-2013
4 The EUT received power from adapter, the adapter received AC120V/60Hz and AC 240V/60Hz power through a Line Impedance Stabilization Network (LISN) which supplied power source and was grounded to the ground plane.
5 All support equipments received AC power from a second LISN, if any.
6 The EUT test program was started. Emissions were measured on each current carrying line of the EUT using a spectrum Analyzer / Receiver connected to the LISN powering the EUT.The LISN has two monitoring points: Line 1 (Hot Side) and Line 2 (Neutral Side). Two scans were taken: one with Line 1 connected to Analyzer / Receiver and Line 2 connected to a 50 ohm load; the second scan had Line 1 connected to a 50 ohm load and Line 2 connected to the Analyzer / Receiver.
7 Analyzer / Receiver scanned from 150 KHz to 30MHz for emissions in each of the test modes.
8 During the above scans, the emissions were maximized by cable manipulation.

AC Power Conducted Emission Limit

For intentional device, according to § 15.207(a) AC Power Conducted Emission Limits is as following：

Frequency range (MHz)	Limit (dBuV)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50
* Decreases with the logarithm of the frequency.		

The AC mains conducted disturbance is calculated by adding the 10dB Pulse Limiter and Cable Factor and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

CD (dBuV) = RA (dBuV) + PL (dB) + CL (dB)

Where CD = Conducted Disturbance	CL = Cable Attenuation Factor (Cable Loss)
RA = Reading Amplitude	PL = 10 dB Pulse Limiter Factor

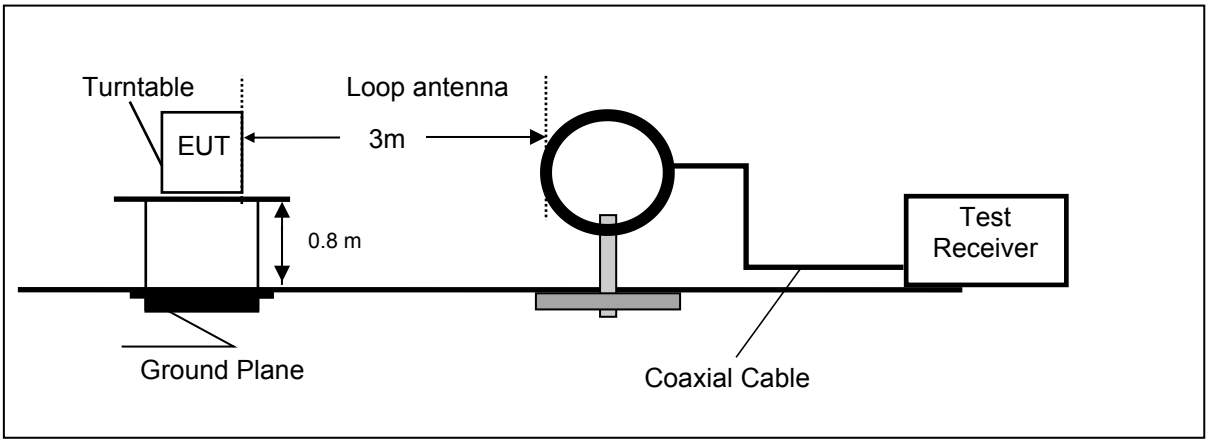
TEST RESULTS

The EUT is powered by the Battery,So this test item is not applicable for the EUT.

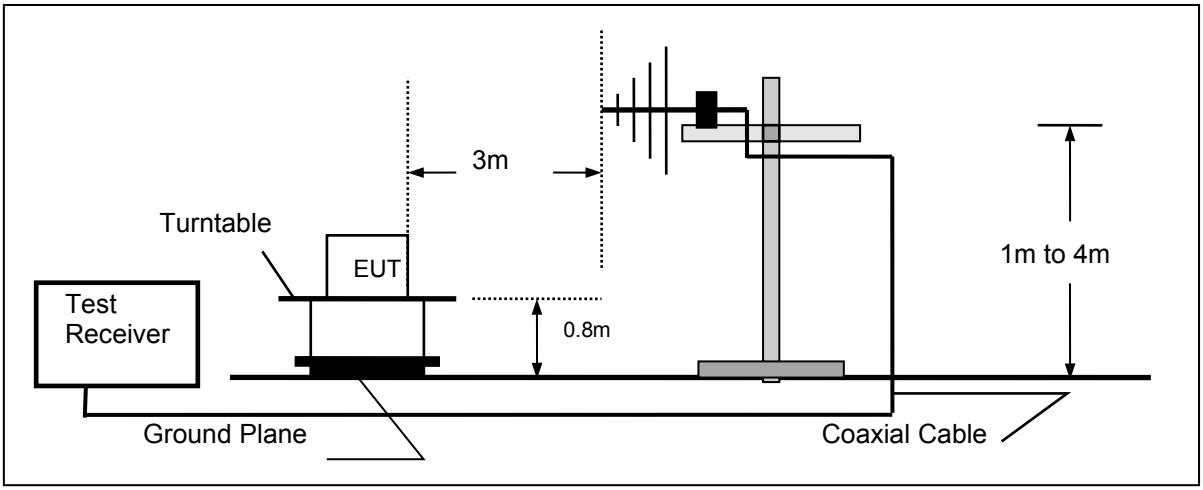
4.2 Radiated Emissions and Band Edge

TEST CONFIGURATION

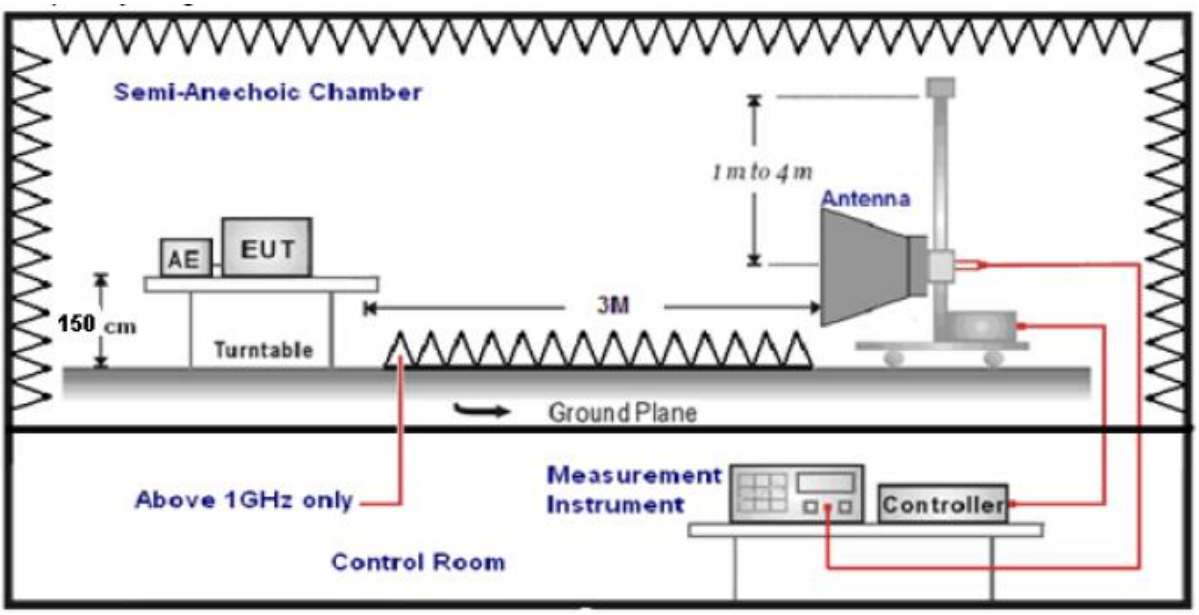
Frequency range 9 KHz – 30MHz



Frequency range 30MHz – 1000MHz



Frequency range above 1GHz-25GHz



TEST PROCEDURE

1. The EUT was placed on a turn table which is 0.8m above ground plane when testing frequency range 9 KHz –1GHz;the EUT was placed on a turn table which is 1.5m above ground plane when testing frequency range 1GHz – 25GHz.
2. Maximum procedure was performed by raising the receiving antenna from 1m to 4m and rotating the turn table from 0℃ to 360℃ to acquire the highest emissions from EUT.
3. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
4. Repeat above procedures until all frequency measurements have been completed.
5. The EUT minimum operation frequency was 32.768KHz and maximum operation frequency was 2480MHz.so radiated emission test frequency band from 9KHz to 25GHz.
6. The distance between test antenna and EUT as following table states:

Test Frequency range	Test Antenna Type	Test Distance
9KHz-30MHz	Active Loop Antenna	3
30MHz-1GHz	Ultra-Broadband Antenna	3
1GHz-18GHz	Double Ridged Horn Antenna	3
18GHz-25GHz	Horn Anternna	1

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

Test Frequency range	Test Receiver/Spectrum Setting	Detector
9KHz-150KHz	RBW=200Hz/VBW=3KHz,Sweep time=Auto	QP
150KHz-30MHz	RBW=9KHz/VBW=100KHz,Sweep time=Auto	QP
30MHz-1GHz	RBW=120KHz/VBW=1000KHz,Sweep time=Auto	QP
1GHz-40GHz	Peak Value: RBW=1MHz/VBW=3MHz, Sweep time=Auto Average Value: RBW=1MHz/VBW=10Hz, Sweep time=Auto	Peak

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor(if any) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CL - AG

Where FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
RA = Reading Amplitude	AG = Amplifier Gain
AF = Antenna Factor	

Transd=AF +CL-AG

RADIATION LIMIT

For intentional device, according to § 15.209(a), the general requirement of field strength of radiated emission from intentional radiators at a distance of 3 meters shall not exceed the following table. According to § 15.247(d), in any 100kHz bandwidth outside the frequency band in which the EUT is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the100kHz bandwidth within the band that contains the highest level of desired power.

The pre-test have done for the EUT in three axes and found the worst emission at position shown in test setup photos.

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

TEST RESULTS

Remark:

1. This test was performed with EUT in X, Y, Z position and the worse case was found when EUT in X position.
2. BLE 1Mpbs were tested at Low, Middle, and High channel and recorded worst mode at BLE 1Mpbs.
3. Radiated emission test from 9 KHz to 10th harmonic of fundamental was verified, and no emission found except system noise floor in 9 KHz to 30MHz and not recorded in this report.

For 30MHz-1GHz

Horizontal

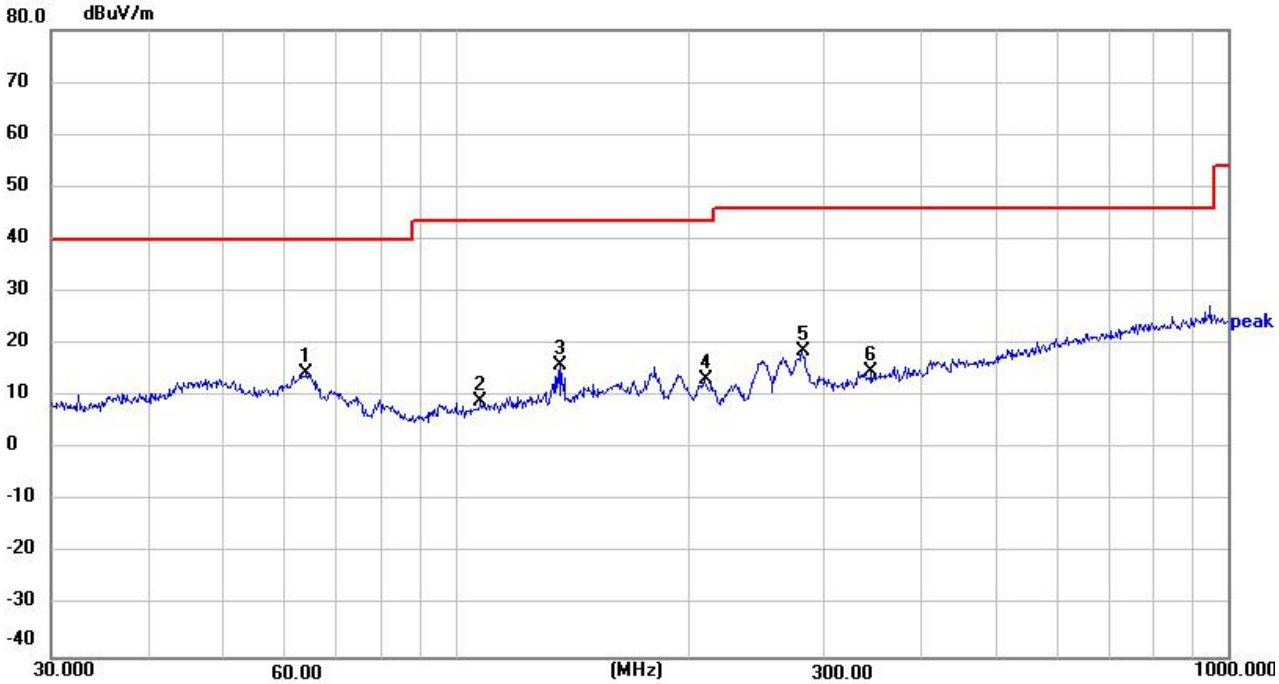
No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Azimuth (deg.)	P/F
1 *	46.6664	40.78	-16.47	24.31	40.00	-15.69	QP	100	0	P
2	65.8031	34.23	-17.98	16.25	40.00	-23.75	QP	100	0	P
3	96.0986	39.21	-20.19	19.02	43.50	-24.48	QP	100	0	P
4	162.0414	34.08	-15.98	18.10	43.50	-25.40	QP	100	0	P
5	261.9753	29.91	-16.89	13.02	46.00	-32.98	QP	100	0	P
6	330.1949	28.69	-14.84	13.85	46.00	-32.15	QP	100	0	P

Note:1).Level (dBμV/m)= Reading (dBμV)+ Factor (dB/m)

2). Factor(dB/m)=Antenna Factor (dB/m) + Cable loss (dB) - Pre Amplifier gain (dB)

3). Margin(dB) = Limit (dBμV/m) - Level (dBμV/m)

Vertical



No.	Frequency (MHz)	Reading (dBuV)	Factor (dB/m)	Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Detector	Height (cm)	Azimuth (deg.)	P/F
1 *	64.2074	32.13	-17.72	14.41	40.00	-25.59	QP	100	360	P
2	107.8877	28.28	-19.15	9.13	43.50	-34.37	QP	100	360	P
3	136.9391	32.83	-16.91	15.92	43.50	-27.58	QP	100	360	P
4	210.0482	32.67	-19.33	13.34	43.50	-30.16	QP	100	360	P
5	281.0075	34.67	-16.16	18.51	46.00	-27.49	QP	100	360	P
6	345.5952	29.11	-14.45	14.66	46.00	-31.34	QP	100	360	P

Note:1).Level (dBμV/m)= Reading (dBμV)+ Factor (dB/m)
2). Factor(dB/m)=Antenna Factor (dB/m) + Cable loss (dB) - Pre Amplifier gain (dB)
3). Margin(dB) = Limit (dBμV/m) - Level (dBμV/m)

For 1GHz to 25GHz

GFSK (above 1GHz)

Frequency(MHz):			2402		Polarity:		HORIZONTAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4804.00	56.49	PK	74	17.51	60.85	32.40	5.11	41.87	-4.36
4804.00	46.11	AV	54	7.89	50.47	32.40	5.11	41.87	-4.36
7206.00	55.03	PK	74	18.97	55.66	36.58	6.43	43.64	-0.63
7206.00	45.21	AV	54	8.79	45.84	36.58	6.43	43.64	-0.63

Frequency(MHz):			2402		Polarity:		VERTICAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4804.00	56.18	PK	74	17.82	60.54	32.40	5.11	41.87	-4.36
4804.00	47.31	AV	54	6.69	51.67	32.40	5.11	41.87	-4.36
7206.00	55.25	PK	74	18.75	55.88	36.58	6.43	43.64	-0.63
7206.00	44.61	AV	54	9.39	45.24	36.58	6.43	43.64	-0.63

Frequency(MHz):			2440		Polarity:		HORIZONTAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4880.00	57.03	PK	74	16.97	60.98	32.56	5.34	41.85	-3.95
4880.00	46.83	AV	54	7.17	50.78	32.56	5.34	41.85	-3.95
7320.00	55.32	PK	74	18.68	55.68	36.54	6.81	43.71	-0.36
7320.00	45.22	AV	54	8.78	45.58	36.54	6.81	43.71	-0.36

Frequency(MHz):			2440		Polarity:		VERTICAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4880.00	56.90	PK	74	17.10	60.85	32.56	5.34	41.85	-3.95
4880.00	46.61	AV	54	7.39	50.56	32.56	5.34	41.85	-3.95
7320.00	55.51	PK	74	18.49	55.87	36.54	6.81	43.71	-0.36
7320.00	45.60	AV	54	8.40	45.96	36.54	6.81	43.71	-0.36

Frequency(MHz):			2480		Polarity:		HORIZONTAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4960.00	57.08	PK	74	16.92	60.54	32.73	5.64	41.83	-3.46
4960.00	47.28	AV	54	6.72	50.74	32.73	5.64	41.83	-3.46
7440.00	55.79	PK	74	18.21	55.85	36.50	7.23	43.79	-0.06
7440.00	45.62	PK	54	8.38	45.68	36.50	7.23	43.79	-0.06

Frequency(MHz):			2480		Polarity:		VERTICAL		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
4960.00	57.38	PK	74	16.62	60.84	32.73	5.64	41.83	-3.46
4960.00	47.31	AV	54	6.69	50.77	32.73	5.64	41.83	-3.46
7440.00	55.62	PK	74	18.38	55.68	36.50	7.23	43.79	-0.06
7440.00	45.52	PK	54	8.48	45.58	36.50	7.23	43.79	-0.06

REMARKS:

1. Emission level (dBuV/m) =Raw Value (dBuV)+Correction Factor (dB/m)
2. Correction Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)- Pre-amplifier
3. Margin value = Limit value- Emission level.
4. -- Mean the PK detector measured value is below average limit.
5. The other emission levels were very low against the limit.

Results of Band Edges Test (Radiated)

GFSK

Frequency(MHz):			**2402**		**Polarity:**		**HORIZONTAL**		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
2390.00	53.42	PK	74	20.58	63.84	27.42	4.31	42.15	-10.42
2390.00	51.12	AV	54	2.88	61.54	27.42	4.31	42.15	-10.42
Frequency(MHz):			**2402**		**Polarity:**		**VERTICAL**		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
2390.00	48.23	PK	74	25.77	58.65	27.42	4.31	42.15	-10.42
2390.00	46.36	AV	54	7.64	56.78	27.42	4.31	42.15	-10.42
Frequency(MHz):			**2480**		**Polarity:**		**HORIZONTAL**		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
2483.50	44.13	PK	74	29.87	54.24	27.70	4.47	42.28	-10.11
2483.50	42.36	AV	54	11.64	52.47	27.70	4.47	42.28	-10.11
Frequency(MHz):			**2480**		**Polarity:**		**VERTICAL**		
Frequency (MHz)	Emission Level (dBuV/m)		Limit (dBuV/m)	Margin (dB)	Raw Value (dBuV)	Antenna Factor (dB/m)	Cable Factor (dB)	Pre-amplifier (dB)	Correction Factor (dB/m)
2483.50	40.74	PK	74	33.26	50.85	27.70	4.47	42.28	-10.11
2483.50	38.52	AV	54	15.48	48.63	27.70	4.47	42.28	-10.11

REMARKS:
1. Emission level (dBuV/m) =Raw Value (dBuV)+Correction Factor (dB/m)
2. Correction Factor (dB/m) = Antenna Factor (dB/m)+Cable Factor (dB)- Pre-amplifier
3. Margin value = Limit value- Emission level.
4. -- Mean the PK detector measured value is below average limit.
5. The other emission levels were very low against the limit.

4.3 Maximum Peak Output Power

Limit

The Maximum Peak Output Power Measurement is 30dBm.

Test Procedure

Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power sensor.

Test Configuration

Test Results

Type	Channel	Output power (dBm)	Limit (dBm)	Result
GFSK 1Mbps	00	-1.124	30.00	Pass
	19	-1.568		
	39	-1.865		

Note: 1.The test results including the cable lose.S

4.4 Power Spectral Density

Limit

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

Test Procedure

1. Use this procedure when the maximum peak conducted output power in the fundamental emission is used to demonstrate compliance.
2. Set the RBW ≥ 3 kHz.
3. Set the VBW ≥ 3× RBW.
4. Set the span to 1.5 times the DTS channel bandwidth.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum power level.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.
11. The resulting peak PSD level must be 8dBm.

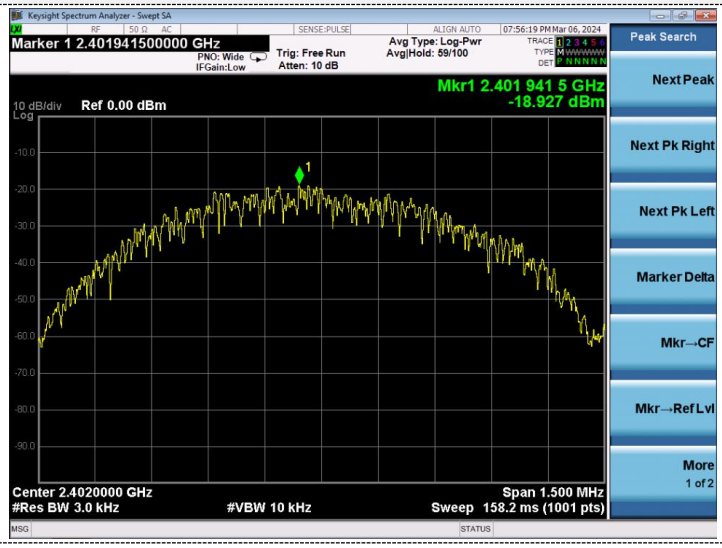
Test Configuration

Test Results

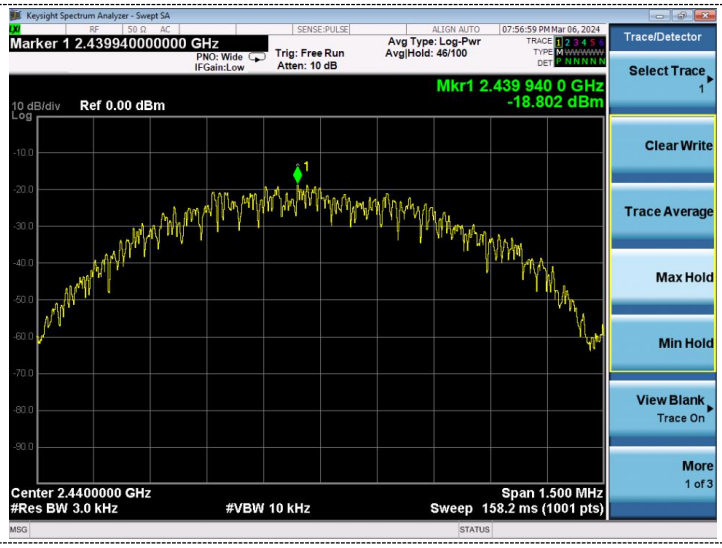
Type	Channel	Power Spectral Density (dBm/3KHz)	Limit (dBm/3KHz)	Result
GFSK 1Mbps	00	-18.927	8.00	Pass
	19	-18.802		
	39	-19.003		

Test plot as follows:

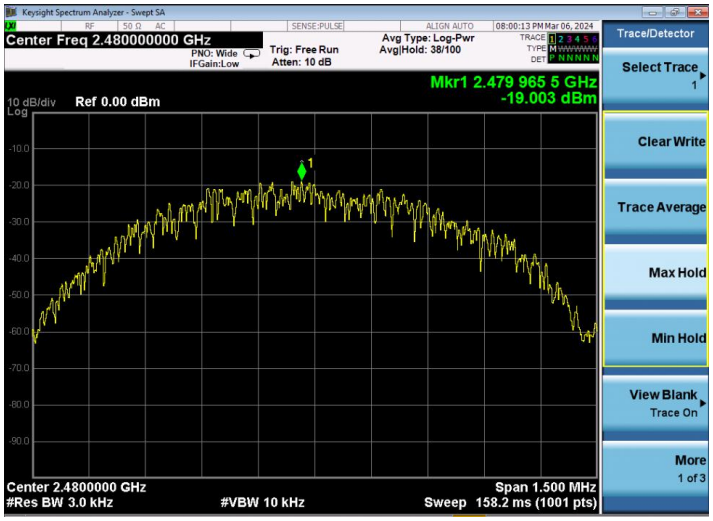
BLE GFSK 1Mpbs



CH00



CH19



CH39

4.5 6dB Bandwidth

Limit

For digital modulation systems, the minimum 6 dB bandwidth shall be at least 500 kHz

Test Procedure

The transmitter output was connected to the spectrum analyzer through an attenuator. The bandwidth of the fundamental frequency was measured by spectrum analyzer with 100 KHz RBW and 300 KHz VBW. The 6dB bandwidth is defined as the total spectrum the power of which is higher than peak power minus 6dB.

Test Configuration

Test Results

Type	Channel	6dB Bandwidth (MHz)	Limit (KHz)	Result
GFSK 1Mbps	00	0.6618	≥500	Pass
	19	0.6612		
	39	0.6637		

Test plot as follows:

BLE GFSK 1Mpbs

CH00

CH19

CH39

4.6 Out-of-band Emissions

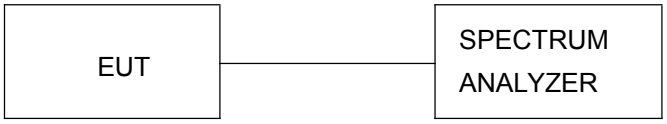
Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF con-ducted or a radiated measurement, pro-vided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter com-plies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required.

Test Procedure

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

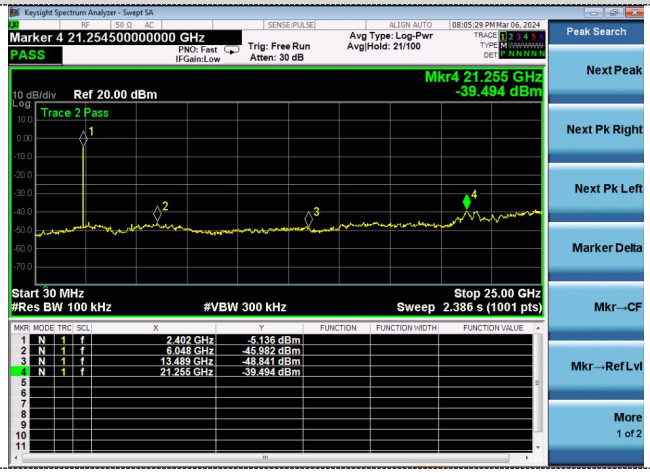
Test Configuration

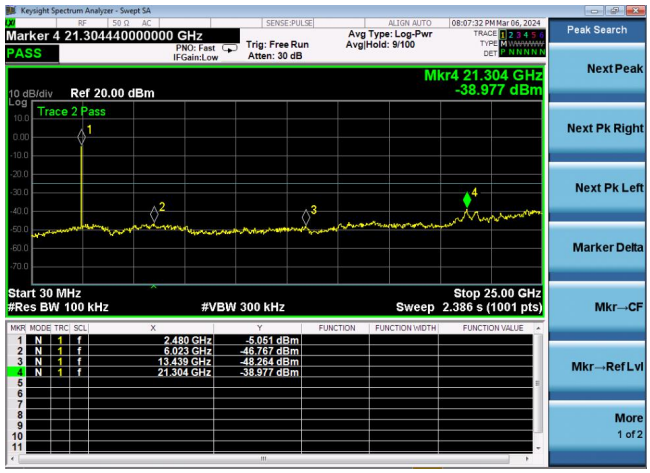


Test Results

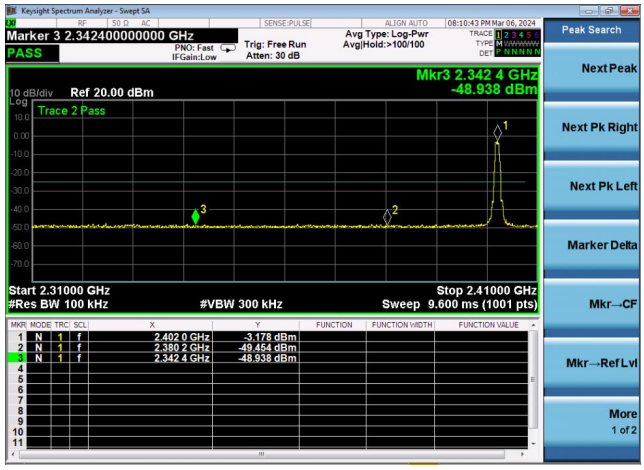
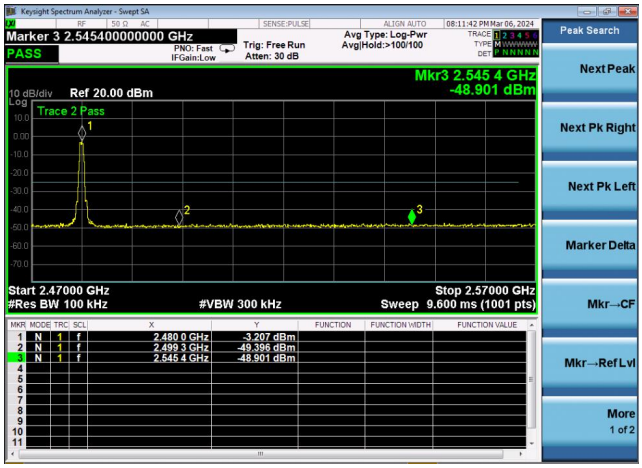
Remark: The measurement frequency range is from 30MHz to the 10th harmonic of the fundamental frequency. The lowest, middle and highest channels are tested to verify the spurious emissions and bandage measurement data.

Test plot as follows:

GFSK 1Mbps (CH00)	GFSK 1Mbps (CH19)
	
30MHz-25G	30MHz-25G

GFSK 1Mbps (CH39)	
	
30MHz-25G	

Band-edge Measurements for RF Conducted Emissions:

BLE GFSK 1Mpbs	
	
Left bandedge	Right bandedge

4.7 Antenna Requirement

Standard Applicable

For intentional device, according to FCC 47 CFR Section 15.203:

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator, the manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited

FCC CFR Title 47 Part 15 Subpart C Section 15.247(c) (1) (I):

(i) Systems operating in the 2400-2483.5 MHz band that is used exclusively for fixed. Point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6dBi.

Antenna Connected Construction

The maximum gain of antenna was 0 dBi.

Remark:The antenna gain is provided by the customer , if the data provided by the customer is not accurate, BSL Testing Co., Ltd. does not assume any responsibility.

5 Test Setup Photos of the EUT

Reference to the appendix I for details.

6 Photos of the EUT

Reference to the appendix II for details.

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