



FCC RF Test Report

APPLICANT : Thundercomm Technology Co., Ltd
EQUIPMENT : Cellular Module
BRAND NAME : TurboX
MODEL NAME : CM6125
FCC ID : 2AOHHTURBOXCM6125
STANDARD : FCC Part 15 Subpart C §15.247
CLASSIFICATION : (DTS) Digital Transmission System
TEST DATE(S) : Sep. 30, 2022 ~ Nov. 08, 2022

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)

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People's Republic of China



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REVISION HISTORY

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FR232517-01B	Rev. 01	Initial issue of report	Nov. 17, 2022



SUMMARY OF TEST RESULT

Report Section	FCC Rule	Description	Limit	Result	Remark
3.1	15.247(b)(3)	Peak Output Power	≤ 30dBm	Pass	-
3.2	15.247(d)	Radiated Band Edges and Spurious Emission	15.209(a) & 15.247(d)	Pass	Under limit 10.28 dB at 2499.48 MHz
3.3	15.207	AC Conducted Emission	15.207(a)	Pass	Under limit 9.40 dB at 0.51 MHz
3.4	15.203 & 15.247(b)	Antenna Requirement	15.203 & 15.247(b)	Pass	-

Note: This is a variant report. The change note could be referred to the Class II Permissive Change letter which is exhibit separately. The cellular module remains the same as the original module, only the antenna is different, so the conducted power is reused from the original report. Based on the similarity between current and previous project, only the related cases of two new antennas were tested and shown in this report, all the other test results are referred to the original report FR232517B.

Declaration of Conformity:

The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.

Comments and Explanations:

The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.



1 General Description

1.1 Applicant

Thundercomm Technology Co., Ltd

No. 107, Middle Datagu Road, Xiantao Street, Yubei District, Chongqing, China, 401122

1.2 Manufacturer

Thundercomm Technology Co., Ltd

No. 107, Middle Datagu Road, Xiantao Street, Yubei District, Chongqing, China, 401122

1.3 Product Feature of Equipment Under Test

Product Feature	
Equipment	Cellular Module
Brand Name	TurboX
Model Name	CM6125
FCC ID	2AOHHTURBOXCM6125
IMEI Code	Conducted: 869835050001758/869835050002558 Conduction: 869835050002210/869835050003010 Radiation: 869835050002210/869835050003010
HW Version	V03
SW Version	Turbox-CM6125_xx.xx_la1.0.V.userdebug.20220509.0843
EUT Stage	Identical Prototype

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	7.76 dBm (0.0060 W)
Antenna Type / Gain	<Ant.1>: Dipole Antenna with gain 2.90 dBi <Ant.2>: PIFA Antenna with gain 3.50 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.
	CO01-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 China 518103 TEL: +86-755-33202398		
Test Site No.	Sporton Site No.	FCC Designation No.	FCC Test Firm Registration No.
	03CH03-SZ	CN1256	421272

1.7 Test Software

Item	Site	Manufacturer	Name	Version
1.	03CH03-SZ	AUDIX	E3	6.2009-8-24
2.	CO01-SZ	AUDIX	E3	6.120613b

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:

1. All test items were verified and recorded according to the standards and without any deviation during the test.
2. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.



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.

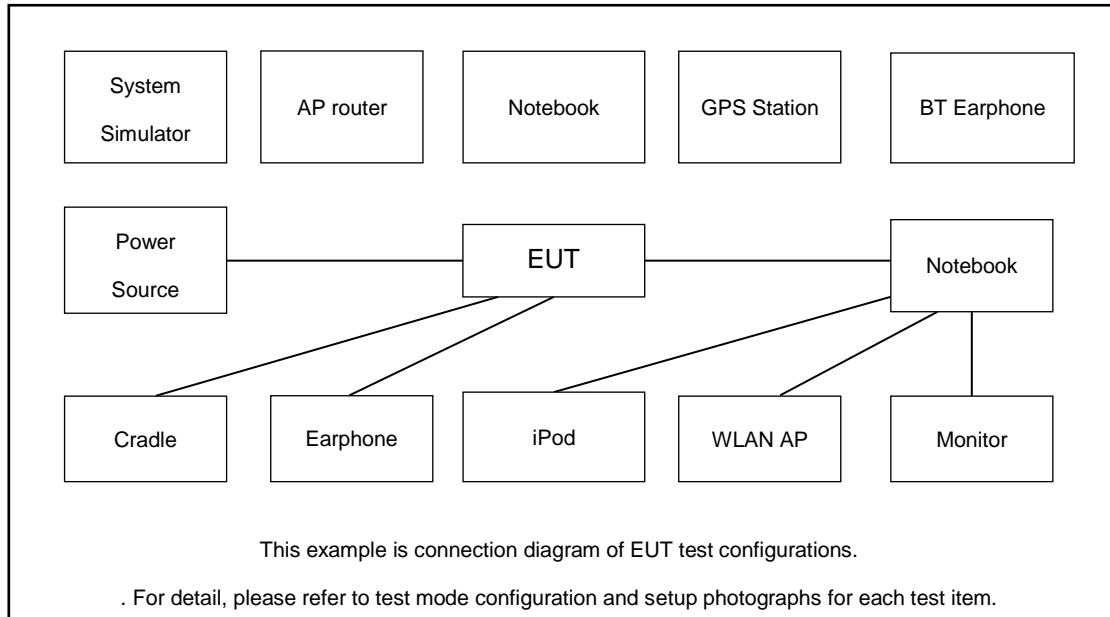
The following summary table is showing all test modes to demonstrate in compliance with the standard.

Summary table of Test Cases	
Test Item	Data Rate / Modulation
	Bluetooth – LE / GFSK
	Ant. 1/ Ant. 2
Radiated TCs	Mode 1: Bluetooth Tx CH00_2402 MHz_1Mbps Mode 2: Bluetooth Tx CH19_2440 MHz_1Mbps Mode 3: Bluetooth Tx CH39_2480 MHz_1Mbps Co-location mode: BLE Tx CH39 + LTE Band 7 Tx
AC Conducted Emission	Mode 1 : WCDMA Band V Idle + Bluetooth Link + WLAN Link(2.4G) + Adapter + Ant. 1 Mode 2 : WCDMA Band V Idle + Bluetooth Link + WLAN Link(2.4G) + Adapter + Ant. 2

Remark:

- 1. BLE support data rate 1Mbps only.
- 2. For Radiated Test Cases, The tests were performed with Adapter.

2.3 Connection Diagram of Test System



2.4 Support Unit used in test configuration and system

Item	Equipment	Trade Name	Model Name	FCC ID	Data Cable	Power Cord
1.	Base Station	Anritsu	MT8820C	N/A	N/A	Unshielded, 1.8m
2.	WLAN AP	Dlink	DIR-820L	KA2IR820LA1	N/A	Unshielded, 1.8m
3.	Notebook	Lenovo	E540	FCC DoC	N/A	AC I/P: Unshielded, 1.2 m DC O/P: Shielded, 1.8 m
4.	Bluetooth Earphone	Samsung	EO-MG900	PYAHS-107W	N/A	N/A
5.	Test Jig	N/A	N/A	N/A	N/A	N/A
6.	Antenna 1	N/A	N/A	N/A	N/A	N/A
7.	Antenna 2	N/A	N/A	N/A	N/A	N/A
8.	WWAN Antenna	N/A	N/A	N/A	N/A	N/A
9.	Adapter	N/A	N/A	N/A	N/A	N/A

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.

3 Test Result

3.1 Output Power Measurement

3.1.1 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.

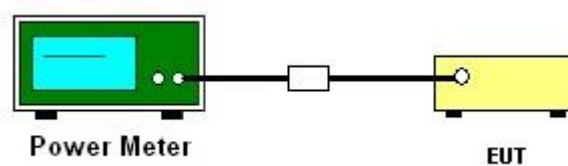
3.1.2 Measuring Instruments

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 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.

3.1.4 Test Setup





3.1.5 Test Result of Peak Output Power

Test Mode	Antenna	Freq (MHz)	Conducted Peak Power [dBm]	Conducted Limit [dBm]	EIRP [dBm]	EIRP Limit [dBm]	Verdict
BLE_1M	Ant.1	2402	6.36	≤30.00	9.26	≤36.00	PASS
		2440	7.76	≤30.00	10.66	≤36.00	PASS
		2480	6.25	≤30.00	9.15	≤36.00	PASS
BLE_1M	Ant.2	2402	6.36	≤30.00	9.86	≤36.00	PASS
		2440	7.76	≤30.00	11.26	≤36.00	PASS
		2480	6.25	≤30.00	9.75	≤36.00	PASS



3.2 Radiated Band Edges and Spurious Emission Measurement

3.2.1 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

3.2.2 Measuring Instruments

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

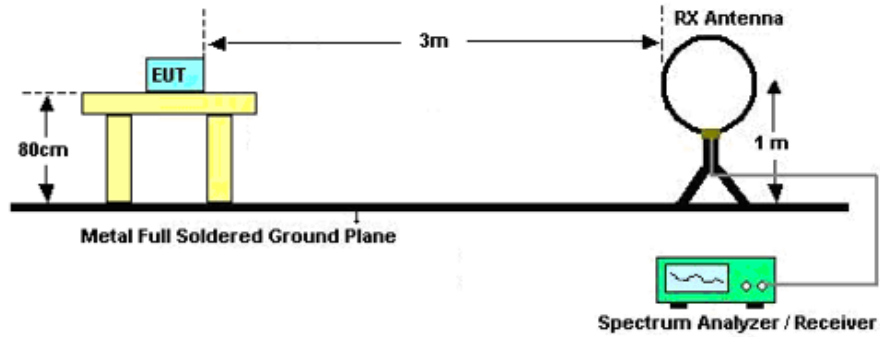


3.2.3 Test Procedures

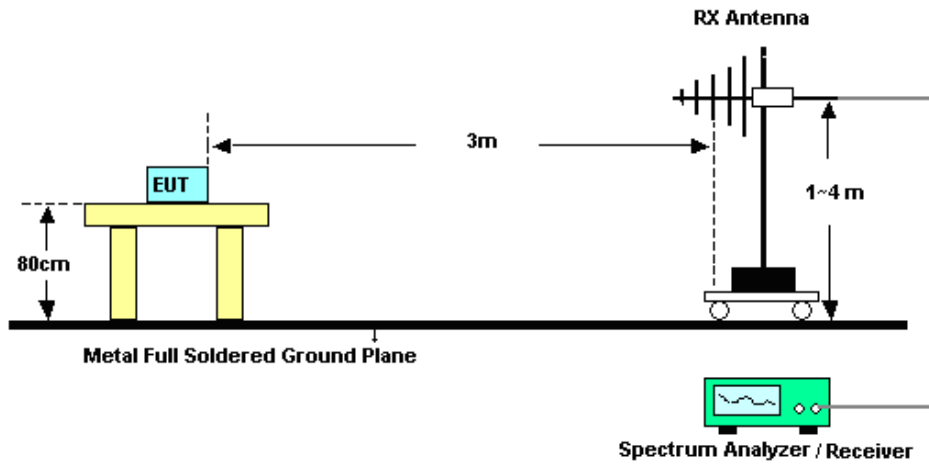
1. The testing follows ANSI C63.10-2013 clause 11.11 & 11.12
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better 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; $VBW \geq RBW$; Sweep = auto; Detector function = peak; Trace = max hold;
 - (3) Set RBW = 1 MHz, VBW= 3MHz for $f \geq 1$ GHz for peak measurement.
For average measurement:
 - $VBW = 10$ Hz, when duty cycle is no less than 98 percent.
 - $VBW \geq 1/T$, 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.

3.2.4 Test Setup

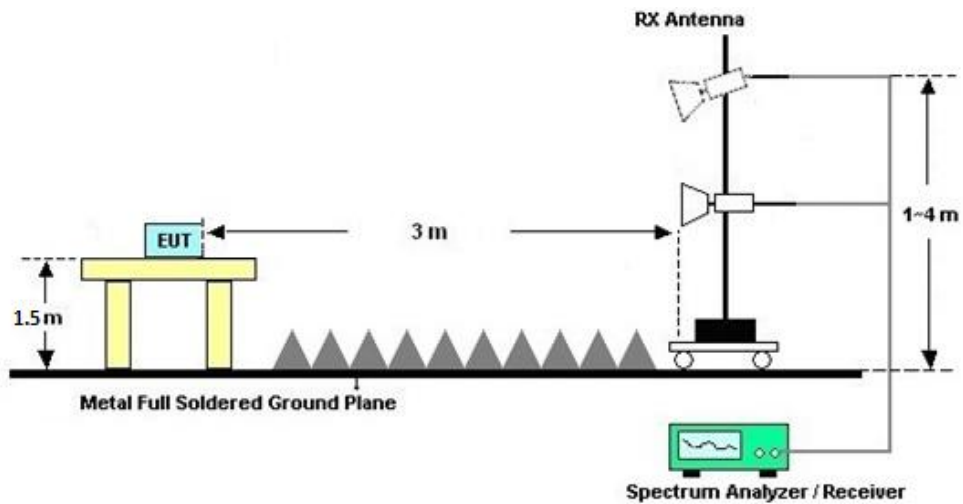
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz





3.2.5 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.

3.2.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix B.

3.2.7 Duty Cycle

Please refer to Appendix C.

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

Please refer to Appendix B.



3.3 AC Conducted Emission Measurement

3.3.1 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.

3.3.2 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 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.

3.3.4 Test Setup



3.3.5 Test Result of AC Conducted Emission

Please refer to Appendix A.



3.4 Antenna Requirements

3.4.1 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.

3.4.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.4.3 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. 06, 2022	Oct. 14, 2022~Nov. 08, 2022	Apr. 05, 2023	Radiation (03CH03-SZ)
EXA Spectrum Analyzer	KEYSIGHT	N9010A	MY55150246	10Hz~44GHz;	Apr. 06, 2022	Oct. 14, 2022~Nov. 08, 2022	Apr. 05, 2023	Radiation (03CH03-SZ)
Loop Antenna	R&S	HFH2-Z2	100354	9kHz~30MHz	Jul. 28, 2022	Oct. 14, 2022~Nov. 08, 2022	Jul. 27, 2024	Radiation (03CH03-SZ)
Bilog Antenna	TeseQ	CBL6112D	35408	30MHz~2GHz	Aug. 09, 2022	Oct. 14, 2022~Nov. 08, 2022	Aug. 08, 2023	Radiation (03CH03-SZ)
Double Ridge Horn Antenna	SCHWARZBECK	BBHA9120D	9120D-1355	1GHz~18GHz	Apr. 08, 2022	Oct. 14, 2022~Nov. 08, 2022	Apr. 07, 2023	Radiation (03CH03-SZ)
HF Amplifier	MITEQ	TTA1840-35-HG	1871923	18GHz~40GHz	Oct. 22, 2021	Oct. 14, 2022~Nov. 08, 2022	Oct. 21, 2022	Radiation (03CH03-SZ)
HF Amplifier	MITEQ	TTA1840-35-HG	1871923	18GHz~40GHz	Oct. 21, 2022		Oct. 20, 2023	Radiation (03CH03-SZ)
SHF-EHF Horn	com-power	AH-840	101071	18Ghz~40GHz	Apr. 10, 2022	Oct. 14, 2022~Nov. 08, 2022	Apr. 09, 2023	Radiation (03CH03-SZ)
Amplifier	Burgeon	BPA-530	102211	0.01Hz~3000MHz	Oct. 22, 2021	Oct. 14, 2022~Nov. 08, 2022	Oct. 21, 2022	Radiation (03CH03-SZ)
Amplifier	Burgeon	BPA-530	102211	0.01Hz~3000MHz	Oct. 21, 2022		Oct. 20, 2023	Radiation (03CH03-SZ)
HF Amplifier	MITEQ	AMF-7D-00101800-30-10P-R	1943528	1GHz~18GHz	Oct. 22, 2021	Oct. 14, 2022~Nov. 08, 2022	Oct. 21, 2022	Radiation (03CH03-SZ)
HF Amplifier	MITEQ	AMF-7D-00101800-30-10P-R	1943528	1GHz~18GHz	Oct. 21, 2022		Oct. 20, 2023	Radiation (03CH03-SZ)
Amplifier	Agilent Technologies	83017A	MY39501302	500MHz~26.5GHz	Dec. 27, 2021	Oct. 14, 2022~Nov. 08, 2022	Dec. 26, 2022	Radiation (03CH03-SZ)
AC Power Source	Chroma	61601	616010001985	N/A	NCR	Oct. 14, 2022~Nov. 08, 2022	NCR	Radiation (03CH03-SZ)
Turn Table	EM	EM1000	N/A	0~360 degree	NCR	Oct. 14, 2022~Nov. 08, 2022	NCR	Radiation (03CH03-SZ)
Antenna Mast	EM	EM1000	N/A	1 m~4 m	NCR	Oct. 14, 2022~Nov. 08, 2022	NCR	Radiation (03CH03-SZ)
EMI Receiver	R&S	ESR7	101630	9kHz~7GHz;	Jul. 07, 2022	Sep. 30, 2022	Jul. 06, 2023	Conduction (CO01-SZ)
AC LISN	R&S	ENV216	100063	9kHz~30MHz	Sep. 15, 2022	Sep. 30, 2022	Sep. 14, 2023	Conduction (CO01-SZ)
AC LISN (for auxiliary equipment)	EMCO	3816/2SH	00103892	9kHz~30MHz	Oct. 29, 2021	Sep. 30, 2022	Oct. 28, 2022	Conduction (CO01-SZ)
AC Power Source	Chroma	61602	616020000891	100Vac~250Vac	Jul. 07, 2022	Sep. 30, 2022	Jul. 06, 2023	Conduction (CO01-SZ)

NCR: No Calibration Required



5 Uncertainty of Evaluation

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 Emission Measurement (150 kHz ~ 30 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	2.2dB
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Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	5.0dB
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Uncertainty of Radiated Emission Measurement (1000 MHz ~ 18000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	4.9dB
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Uncertainty of Radiated Emission Measurement (18000 MHz ~ 40000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	5.0dB
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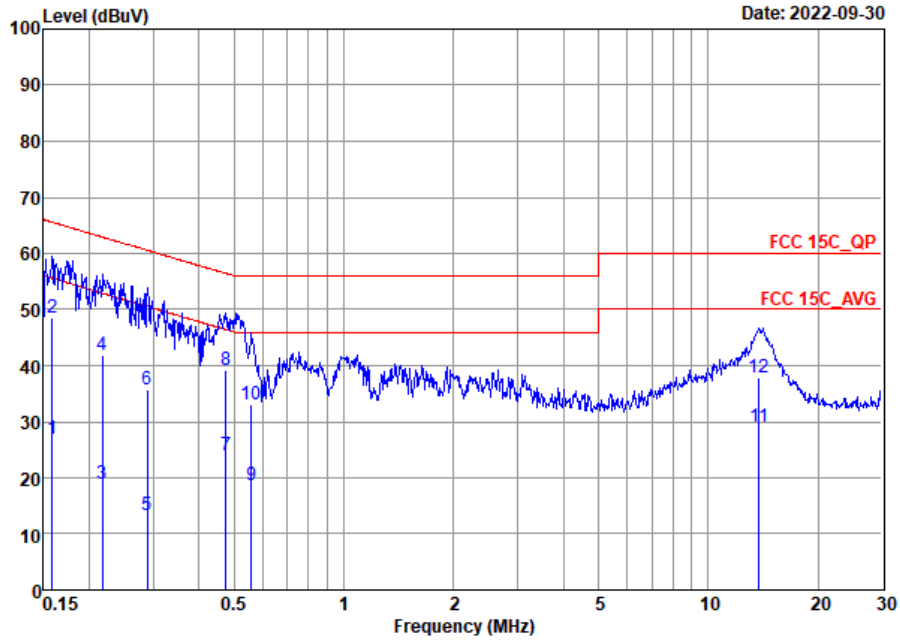
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Appendix A. AC Conducted Emission Test Results

Mode 1(Ant. 1):

Test Engineer :	Lily Qiu	Temperature :	22~25°C
		Relative Humidity :	50~55%
Test Voltage :	120Vac / 60Hz	Phase :	Line
Remark :	All emissions not reported here are more than 10 dB below the prescribed limit.		

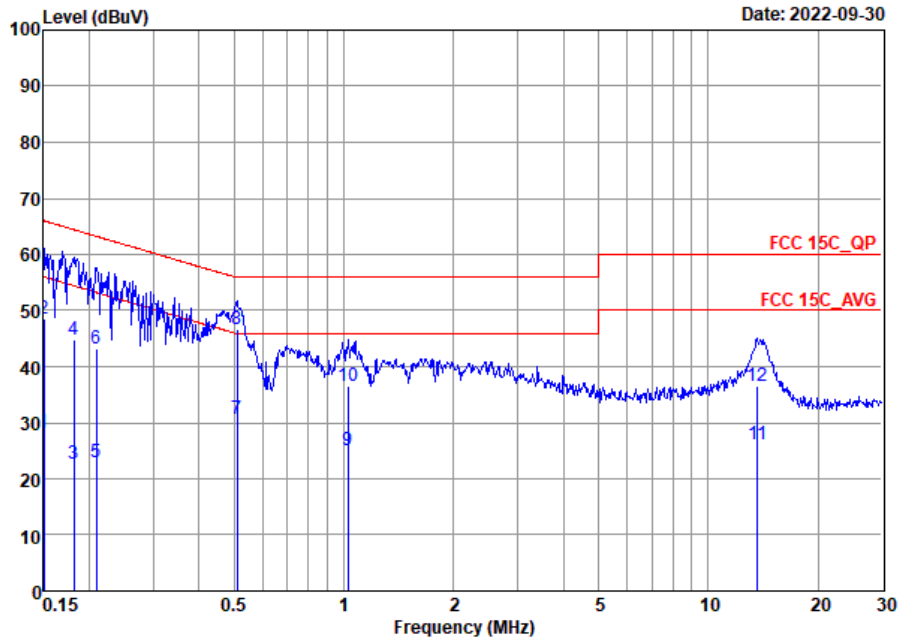


Site : CO01-SZ
Condition: FCC 15C_QP LISN_20220811_ L LINE

	Freq	Level	Over	Limit	Read	LISN	Cable	Remark
	MHz	dBuV	Limit	Line	Level	Factor	Loss	
			dB	dBuV	dBuV	dB	dB	
1	0.16	26.93	-28.63	55.56	6.00	10.20	10.73	Average
2 *	0.16	48.43	-17.13	65.56	27.50	10.20	10.73	QP
3	0.22	18.91	-34.01	52.92	-1.60	10.19	10.32	Average
4	0.22	41.91	-21.01	62.92	21.40	10.19	10.32	QP
5	0.29	13.41	-37.13	50.54	-7.60	10.16	10.85	Average
6	0.29	35.71	-24.83	60.54	14.70	10.16	10.85	QP
7	0.47	23.98	-22.47	46.45	2.09	10.12	11.77	Average
8	0.47	39.28	-17.17	56.45	17.39	10.12	11.77	QP
9	0.56	18.60	-27.40	46.00	-3.10	10.11	11.59	Average
10	0.56	33.00	-23.00	56.00	11.30	10.11	11.59	QP
11	13.77	29.00	-21.00	50.00	8.91	9.76	10.33	Average
12	13.77	37.90	-22.10	60.00	17.81	9.76	10.33	QP



Test Engineer :	Lily Qiu	Temperature :	22~25°C
		Relative Humidity :	50~55%
Test Voltage :	120Vac / 60Hz	Phase :	Neutral
Remark :	All emissions not reported here are more than 10 dB below the prescribed limit.		



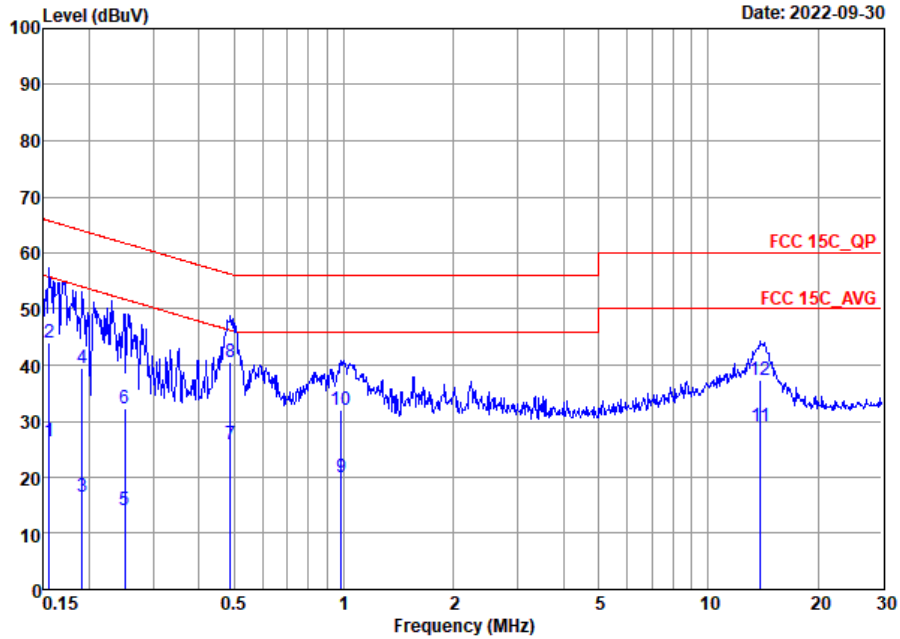
Site : CO01-SZ
 Condition: FCC 15C_QP LISN_20220811_N NEUTRAL

	Freq	Level	Over Limit	Limit Line	Read Level	LISN Factor	Cable Loss	Remark
	MHz	dBuV	dB	dBuV	dBuV	dB	dB	
1	0.15	28.26	-27.74	56.00	7.10	10.31	10.85	Average
2	0.15	48.56	-17.44	66.00	27.40	10.31	10.85	QP
3	0.18	22.59	-31.83	54.42	1.90	10.30	10.39	Average
4	0.18	44.69	-19.73	64.42	24.00	10.30	10.39	QP
5	0.21	22.81	-30.42	53.23	2.30	10.27	10.24	Average
6	0.21	43.31	-19.92	63.23	22.80	10.27	10.24	QP
7	0.51	30.60	-15.40	46.00	8.60	10.20	11.80	Average
8 *	0.51	46.60	-9.40	56.00	24.60	10.20	11.80	QP
9	1.03	24.95	-21.05	46.00	4.50	10.22	10.23	Average
10	1.03	36.65	-19.35	56.00	16.20	10.22	10.23	QP
11	13.62	26.03	-23.97	50.00	5.80	9.90	10.33	Average
12	13.62	36.43	-23.57	60.00	16.20	9.90	10.33	QP



Mode 2(Ant. 2):

Test Engineer :	Lily Qiu	Temperature :	22~25°C
		Relative Humidity :	50~55%
Test Voltage :	120Vac / 60Hz	Phase :	Line
Remark :	All emissions not reported here are more than 10 dB below the prescribed limit.		

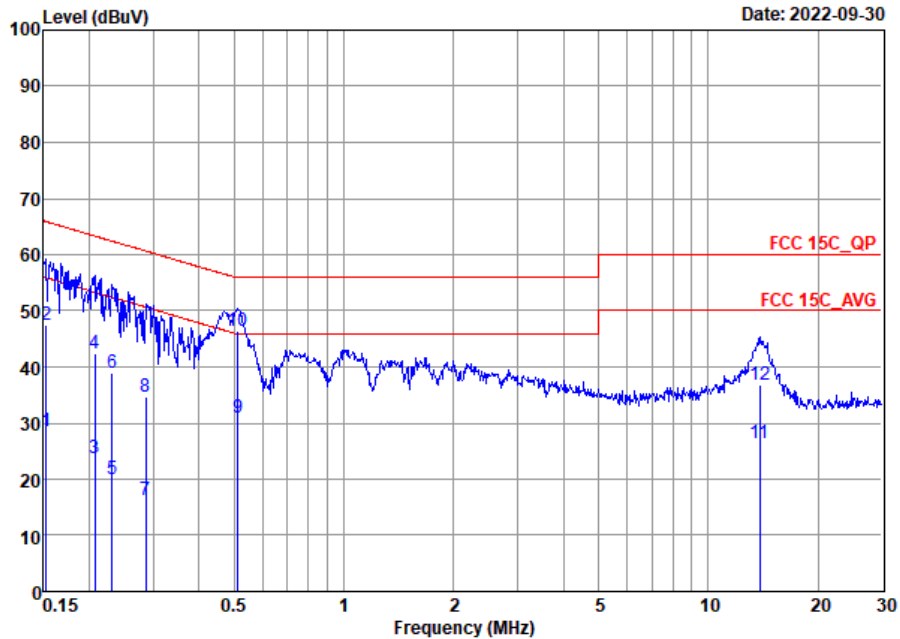


Site : CO01-SZ
 Condition: FCC 15C_QP LISN_20220811_ L LINE

	Freq	Level	Over Limit	Limit Line	Read Level	LISN Factor	Cable Loss	Remark
	MHz	dBuV	dB	dBuV	dBuV	dB	dB	
1	0.16	26.27	-29.42	55.69	5.30	10.20	10.77	Average
2	0.16	43.87	-21.82	65.69	22.90	10.20	10.77	QP
3	0.19	16.55	-37.43	53.98	-3.90	10.20	10.25	Average
4	0.19	39.45	-24.53	63.98	19.00	10.20	10.25	QP
5	0.25	14.15	-37.58	51.73	-6.60	10.18	10.57	Average
6	0.25	32.25	-29.48	61.73	11.50	10.18	10.57	QP
7	0.49	25.93	-20.26	46.19	4.00	10.12	11.81	Average
8 *	0.49	40.43	-15.76	56.19	18.50	10.12	11.81	QP
9	0.98	19.89	-26.11	46.00	-0.50	10.12	10.27	Average
10	0.98	31.89	-24.11	56.00	11.50	10.12	10.27	QP
11	13.91	29.19	-20.81	50.00	9.10	9.76	10.33	Average
12	13.91	37.29	-22.71	60.00	17.20	9.76	10.33	QP



Test Engineer :	Lily Qiu	Temperature :	22~25°C
		Relative Humidity :	50~55%
Test Voltage :	120Vac / 60Hz	Phase :	Neutral
Remark :	All emissions not reported here are more than 10 dB below the prescribed limit.		



Site : CO01-SZ
 Condition: FCC 15C_QP LISN_20220811_ N NEUTRAL

	Freq	Level	Over	Limit	Read	LISN	Cable	
	MHz	dBuV	Limit	Line	Level	Factor	Loss	Remark
			dB	dBuV	dBuV	dB	dB	
1	0.15	28.42	-27.45	55.87	7.30	10.31	10.81	Average
2	0.15	47.42	-18.45	65.87	26.30	10.31	10.81	QP
3	0.21	23.80	-29.52	53.32	3.29	10.28	10.23	Average
4	0.21	42.40	-20.92	63.32	21.89	10.28	10.23	QP
5	0.23	19.98	-32.41	52.39	-0.70	10.26	10.42	Average
6	0.23	38.98	-23.41	62.39	18.30	10.26	10.42	QP
7	0.29	16.15	-34.48	50.63	-4.90	10.22	10.83	Average
8	0.29	34.65	-25.98	60.63	13.60	10.22	10.83	QP
9	0.51	31.00	-15.00	46.00	9.00	10.20	11.80	Average
10 *	0.51	46.40	-9.60	56.00	24.40	10.20	11.80	QP
11	13.84	26.43	-23.57	50.00	6.21	9.89	10.33	Average
12	13.84	36.83	-23.17	60.00	16.61	9.89	10.33	QP

Note:

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



Appendix B. Radiated Spurious Emission

For Ant. 1:

2.4GHz 2400~2483.5MHz

BLE (Band Edge @ 3m)

BLE	Note	Frequency	Level	Margin	Limit Line	Read Level	Antenna Factor	Path Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
BLE CH 00 2402MHz		2376.99	50.89	-23.11	74	47.52	32.18	4.87	33.68	341	348	P	H
		2381.19	42.03	-11.97	54	38.65	32.19	4.87	33.68	341	348	A	H
	*	2402	102.33	-	-	98.84	32.25	4.9	33.66	341	348	P	H
	*	2402	101.73	-	-	98.24	32.25	4.9	33.66	341	348	A	H
		2353.575	51.42	-22.58	74	48.12	32.12	4.87	33.69	350	78	P	V
		2342.34	42.04	-11.96	54	38.81	32.09	4.83	33.69	350	78	A	V
	*	2402	99.5	-	-	96.01	32.25	4.9	33.66	350	78	P	V
	*	2402	98.82	-	-	95.33	32.25	4.9	33.66	350	78	A	V
BLE CH 39 2480MHz	*	2480	102.18	-	-	98.4	32.45	4.95	33.62	364	348	P	H
	*	2480	101.49	-	-	97.71	32.45	4.95	33.62	364	348	A	H
		2483.64	55.67	-18.33	74	51.88	32.46	4.95	33.62	364	348	P	H
		2484.28	43.35	-10.65	54	39.56	32.46	4.95	33.62	364	348	A	H
	*	2480	100.41	-	-	96.63	32.45	4.95	33.62	228	173	P	V
	*	2480	99.58	-	-	95.8	32.45	4.95	33.62	228	173	A	V
		2483.92	53.72	-20.28	74	49.93	32.46	4.95	33.62	228	173	P	V
		2484.6	42.69	-11.31	54	38.9	32.46	4.95	33.62	228	173	A	V
Remark	<ol style="list-style-type: none"> No other spurious found. All results are PASS against Peak and Average limit line. 												



2.4GHz 2400~2483.5MHz
BLE (Harmonic @ 3m)

Table with 14 columns: BLE, Note, Frequency (MHz), Level (dBµV/m), Margin (dB), Limit Line (dBµV/m), Read Level (dBµV), Antenna Factor (dB/m), Path Loss (dB), Preamp Factor (dB), Ant Pos (cm), Table Pos (deg), Peak Avg. (P/A), Pol. (H/V). Rows include BLE CH 00 (2402MHz), BLE CH 19 (2440MHz), and BLE CH 39 (2480MHz) with multiple frequency entries.

Remark

- 1. No other spurious found.
2. All results are PASS against Peak and Average limit line.



2.4GHz 2400~2483.5MHz

BLE (LF @ 3m)

BLE	Note	Frequency (MHz)	Level (dBμV/m)	Margin (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
BLE CH 00 2402MHz		30	24.36	-15.64	40	30.37	25.86	0.53	32.4	-	-	P	H
		154.16	17.24	-26.26	43.5	31.26	16.9	1.27	32.19	-	-	P	H
		288.02	23.35	-22.65	46	33.68	19.63	1.76	31.72	-	-	P	H
		600.36	29.38	-16.62	46	31.14	26.38	2.56	30.7	-	-	P	H
		866.14	32.05	-13.95	46	31.43	28.97	3.09	31.44	-	-	P	H
		966.05	33.78	-20.22	54	31.05	30.82	3.26	31.35	-	-	P	H
		30	27.09	-12.91	40	33.1	25.86	0.53	32.4	-	-	P	V
		63.95	21.43	-18.57	40	40.79	12.24	0.8	32.4	-	-	P	V
		115.36	19.17	-24.33	43.5	32.87	17.4	1.1	32.2	-	-	P	V
		622.67	28.4	-17.6	46	30.12	26.43	2.6	30.75	-	-	P	V
		800.18	31.62	-14.38	46	31.09	28.89	2.94	31.3	-	-	P	V
		985.45	33.43	-20.57	54	30.88	30.41	3.29	31.15	-	-	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



Co-location mode: BLE CH39 + LTE Band 7

2.4GHz 2400~2483.5MHz (Band Edge @ 3m)

BLE Ant. 1	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
BLE CH39 & LTE B7	*	2480	102.88	-	-	99.13	32.45	4.92	33.62	167	303	P	H
	*	2480	101.82	-	-	98.07	32.45	4.92	33.62	167	303	A	H
		2483.68	55.38	-18.62	74	51.62	32.46	4.92	33.62	167	303	P	H
		2483.76	42.71	-11.29	54	38.95	32.46	4.92	33.62	167	303	A	H
	*	2480	102.5	-	-	98.75	32.45	4.92	33.62	110	348	P	V
	*	2480	101.82	-	-	98.07	32.45	4.92	33.62	110	348	A	V
		2483.64	54.97	-19.03	74	51.21	32.46	4.92	33.62	110	348	P	V
		2485.52	42.44	-11.56	54	38.68	32.46	4.92	33.62	110	348	A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



2.4GHz 2400~2483.5MHz (Harmonic @ 3m)

BLE Ant. 1	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
BLE CH39 & LTE B7		4960	42.36	-31.64	74	52.67	34.62	7.81	52.74	-	-	P	H
		5052.18	50.23	-23.77	74	60.48	34.58	7.86	52.69	-	-	P	H
		7440	45.12	-28.88	74	53.43	36.54	9.19	54.04	-	-	P	H
		7578.27	45.93	-28.07	74	54.15	36.58	9.15	53.95	-	-	P	H
		10104.36	46.65	-27.35	74	49.42	39.56	10.52	52.85	-	-	P	H
		4960	43.03	-30.97	74	53.34	34.62	7.81	52.74	-	-	P	V
		5052.18	50.2	-23.8	74	60.45	34.58	7.86	52.69	-	-	P	V
		7440	45.28	-28.72	74	53.59	36.54	9.19	54.04	-	-	P	V
		7578.27	49.6	-24.4	74	57.82	36.58	9.15	53.95	-	-	P	V
		10104.36	50	-24	74	52.77	39.56	10.52	52.85	-	-	P	V
	4960	43.03	-30.97	74	53.34	34.62	7.81	52.74	-	-	P	V	
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



For Ant. 2:

2.4GHz 2400~2483.5MHz

BLE (Band Edge @ 3m)

BLE	Note	Frequency	Level	Margin	Limit Line	Read Level	Antenna Factor	Path Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
BLE CH 00 2402MHz		2376.57	51.21	-22.79	74	47.94	32.18	4.77	33.68	350	219	P	H
		2373.735	41.47	-12.53	54	38.21	32.17	4.77	33.68	350	219	A	H
	*	2402	90.22	-	-	86.82	32.25	4.81	33.66	350	219	P	H
	*	2402	89.61	-	-	86.21	32.25	4.81	33.66	350	219	A	H
		2366.595	51.13	-22.87	74	47.89	32.15	4.77	33.68	400	120	P	V
		2385.18	41.44	-12.56	54	38.09	32.2	4.81	33.66	400	120	A	V
	*	2402	92.68	-	-	89.28	32.25	4.81	33.66	400	120	P	V
	*	2402	91.9	-	-	88.5	32.25	4.81	33.66	400	120	A	V
BLE CH 39 2480MHz		4960	44.1	-29.9	74	54.41	34.62	7.81	52.74	-	-	P	H
		7440	46.57	-27.43	74	54.88	36.54	9.19	54.04	-	-	P	H
		4960	43.6	-30.4	74	53.91	34.62	7.81	52.74	-	-	P	V
		7440	46.23	-27.77	74	54.54	36.54	9.19	54.04	-	-	P	V

Remark

- No other spurious found.
- All results are PASS against Peak and Average limit line.



2.4GHz 2400~2483.5MHz

BLE (Harmonic @ 3m)

BLE	Note	Frequency (MHz)	Level (dBμV/m)	Margin (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
BLE CH 00 2402MHz		4880	44.49	-29.51	74	54.92	34.65	7.76	52.84	-	-	P	H
		7320	46.45	-27.55	74	55.19	36.42	8.95	54.11	-	-	P	H
		4880	44.37	-29.63	74	54.8	34.65	7.76	52.84	-	-	P	V
		7320	45.65	-28.35	74	54.39	36.42	8.95	54.11	-	-	P	V
BLE CH 19 2440MHz		4880	44.49	-29.51	74	54.92	34.65	7.76	52.84	-	-	P	H
		7320	46.45	-27.55	74	55.19	36.42	8.95	54.11	-	-	P	H
		4880	44.37	-29.63	74	54.8	34.65	7.76	52.84	-	-	P	V
		7320	45.65	-28.35	74	54.39	36.42	8.95	54.11	-	-	P	V
BLE CH 39 2480MHz		4960	44.1	-29.9	74	54.41	34.62	7.81	52.74	-	-	P	H
		7440	46.57	-27.43	74	54.88	36.54	9.19	54.04	-	-	P	H
		4960	43.6	-30.4	74	53.91	34.62	7.81	52.74	-	-	P	V
		7440	46.23	-27.77	74	54.54	36.54	9.19	54.04	-	-	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



Emission below 1GHz

2.4GHz BLE (LF)

BLE	Note	Frequency	Level	Margin	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
2.4GHz BLE LF		30	24.36	-15.64	40	30.37	25.86	0.53	32.4	-	-	P	H
		154.16	17.24	-26.26	43.5	31.26	16.9	1.27	32.19	-	-	P	H
		288.02	23.35	-22.65	46	33.68	19.63	1.76	31.72	-	-	P	H
		600.36	29.38	-16.62	46	31.14	26.38	2.56	30.7	-	-	P	H
		866.14	32.05	-13.95	46	31.43	28.97	3.09	31.44	-	-	P	H
		966.05	33.78	-20.22	54	31.05	30.82	3.26	31.35	-	-	P	H
		30	27.09	-12.91	40	33.1	25.86	0.53	32.4	-	-	P	V
		63.95	21.43	-18.57	40	40.79	12.24	0.8	32.4	-	-	P	V
		115.36	19.17	-24.33	43.5	32.87	17.4	1.1	32.2	-	-	P	V
		622.67	28.4	-17.6	46	30.12	26.43	2.6	30.75	-	-	P	V
		800.18	31.62	-14.38	46	31.09	28.89	2.94	31.3	-	-	P	V
		985.45	33.43	-20.57	54	30.88	30.41	3.29	31.15	-	-	P	V
Remark	1. No other spurious found. 2. All results are PASS against limit line.												



Co-location mode: BLE CH39 + LTE Band 7

2.4GHz 2400~2483.5MHz (Band Edge @ 3m)

BLE Ant. 2	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
BLE CH 39& LTE B7	*	2480	92.59	-	-	88.84	32.45	4.92	33.62	364	64	P	H
	*	2480	91.81	-	-	88.06	32.45	4.92	33.62	364	64	A	H
		2495.6	50.89	-23.11	74	47.08	32.49	4.92	33.6	364	64	P	H
		2499.2	42.47	-11.53	54	38.65	32.5	4.92	33.6	364	64	A	H
	*	2480	86.72	-	-	82.97	32.45	4.92	33.62	377	179	P	V
	*	2480	86.07	-	-	82.32	32.45	4.92	33.62	377	179	A	V
		2499.24	52.12	-21.88	74	48.3	32.5	4.92	33.6	377	179	P	V
		2499.48	43.72	-10.28	54	39.9	32.5	4.92	33.6	377	179	A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



2.4GHz 2400~2483.5MHz (Harmonic @ 3m)

BLE Ant. 2	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
BLE CH 39& LTE B7		4960	44.48	-29.52	74	54.79	34.62	7.81	52.74	-	-	P	H
		5052	47.05	-26.95	74	57.3	34.58	7.86	52.69	-	-	P	H
		7440	45.09	-28.91	74	53.4	36.54	9.19	54.04	-	-	P	H
		7578	48.25	-25.75	74	56.47	36.58	9.15	53.95	-	-	P	H
		10104	48.12	-25.88	74	50.89	39.56	10.52	52.85	-	-	P	H
		4960	43.43	-30.57	74	53.74	34.62	7.81	52.74	-	-	P	V
		5052	53.83	-20.17	74	64.08	34.58	7.86	52.69	-	-	P	V
		7440	45.03	-28.97	74	53.34	36.54	9.19	54.04	-	-	P	V
		7578	52.95	-21.05	74	61.17	36.58	9.15	53.95	-	-	P	V
		10104	48.67	-25.33	74	51.44	39.56	10.52	52.85	-	-	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



Note symbol

*	Fundamental Frequency which can be ignored. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
!	Test result is Margin line.
P/A	Peak or Average
H/V	Horizontal or Vertical



A calculation example for radiated spurious emission is shown as below:

BLE	Note	Frequency	Level	Margin	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
BLE CH 00 2402MHz		2390	55.45	-18.55	74	54.51	32.22	4.58	35.86	103	308	P	H
		2390	43.54	-10.46	54	42.6	32.22	4.58	35.86	103	308	A	H

1. Path Loss(dB) = Cable loss(dB) + Filter loss(dB) + Attenuator loss(dB)
2. Level(dBμV/m) =
Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)
3. Margin (dB) = Level(dBμV/m) – Limit Line(dBμV/m)

For Peak Limit @ 2390MHz:

1. Level(dBμV/m)
= Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)
= 32.22(dB/m) + 4.58(dB) + 54.51(dBμV) – 35.86 (dB)
= 55.45 (dBμV/m)
2. Margin (dB)
= Level(dBμV/m) – Limit Line(dBμV/m)
= 55.45(dBμV/m) – 74(dBμV/m)
= -18.55(dB)

For Average Limit @ 2390MHz:

1. Level(dBμV/m)
= Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)
= 32.22(dB/m) + 4.58(dB) + 42.6(dBμV) – 35.86 (dB)
= 43.54 (dBμV/m)
2. Margin (dB)
= Level(dBμV/m) – Limit Line(dBμV/m)
= 43.54(dBμV/m) – 54(dBμV/m)
= -10.46(dB)

Both peak and average measured complies with the limit line, so test result is “PASS”.



Appendix C. Duty Cycle Plots

Band	Duty Cycle(%)	T(ms)	1/T(kHz)	VBW Setting
Bluetooth LE 1Mbps	63.49	0.400	2.5	3kHz

Bluetooth LE 1Mbps

