FCC Part 15.247

TEST REPORT

For

LugLoc INC.

550 NW 29th Street, Miami, Florida United States

FCC ID: 2AJ5H-GEGO

Report Type: Original Report	**Product Type:** Global Tracker Device

Report Producer: Himiko Chen

Report Number: RLK1801002-00B

Report Date: 2018-04-16

Reviewed By: Jerry Chang

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REVISION HISTORY

Revision	No.	Report Number	Issue Date	Description	Author/ Revised by
1.0	RLK1801002	RLK1801002-00B	2018.04.16	Original Report	Himiko

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1 General Information

1.1 Product Description for Equipment under Test (EUT)

Applicant	LugLoc INC. 550 NW 29th Street, Miami, Florida United States
Manufacturer	Goldtek Technology CO., LTD. 16F., No166, Jian 1st Rd., Zhonghe Dist., New Taipei City 235, Taiwan (R.O.C.)
Brand(Trade) Name	GEGO
Product (Equipment)	Global Tracker Device
Model Name	GEGO V1
Series Model	GEGO V1W
Model Discrepancy	Refer below Model Difference Table
Frequency Range	BLE mode : 2402 ~ 2480 MHz
Number of Channels	BLE mode : 40 Channels
Output Power	BLE mode : -1.46 dBm (0.0007 W)
Received Date	Mar 01, 2018
Date of Test	Mar 02, 2018 ~ Apr 16, 2018
Related Submittal(s)/Grant(s)	FCC Part 22H/24E with PCB FCC ID: 2AJ5H-GEGO
Modulation Type	BLE mode : GFSK 1Mbps

**All measurement and test data in this report was gathered from production sample serial number: 1801002 (Assigned by BACL, Taiwan).*

** Model Discrepancy:*

Model Difference Table		
Shell Color	GEGO V1	GEGO V1W
	Black	White

1.2 Operation Condition of EUT

Power Operation (Voltage Range)	☐ AC 120V/60Hz ☐ Adapter ☐ By Power Core
	☒ DC Type ☒ Battery 3.7V ☐ DC Power Supply ☒ External from USB Cable :5V ☐ External DC Adapter
	☐ Host System

1.3 Objective

This report is prepared on behalf of *LugLoc INC.* in accordance with Part 2, Subpart J, Part 15, Subparts A and C of the Federal Communication Commission's rules.

The objective is to determine compliance with FCC Part 15.247 rules for Output Power, Antenna Requirements, 6 dB Bandwidth, Power spectral density, 100 kHz Bandwidth of Band Edges Measurement, Conducted Emission by Antenna Port. AC Line Conducted Emission and Radiated Spurious Emissions.

1.4 Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

KDB 558074 D01 DTS Meas Guidance v04

1.5 Test Methodology

Parameter	Expanded Measurement uncertainty
RF output power with Power Meter	± 0.55 dB
Occupied Channel Bandwidth	± 4.45 %
RF Conducted test with Spectrum	± 1.45 dB
AC Power Line Conducted Emission	± 4.64 dB
Radiated Below 1G	± 5.83 dB
Radiated Above 1G-18G	± 5.35 dB
Radiated Above 18G-40G	± 4.49 dB

1.6 Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Taiwan) to collect test data is located on
☒70, Lane 169, Sec. 2, Datong Road, Xizhi Dist., New Taipei City 22183, Taiwan, R.O.C.
☒68-3, Lane 169, Sec. 2, Datong Road, Xizhi Dist., New Taipei City 22183, Taiwan, R.O.C.

Bay Area Compliance Laboratories Corp. (Taiwan) Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code: 3180) and the FCC designation No.TW3180 under the Mutual Recognition Agreement (MRA) in FCC Test. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.10-2013.

The Federal Communications Commission has the reports on file and is listed under FCC Registration No.: 974454. The test site has been approved by the FCC for public use and is listed in the FCC Public Access Link (PAL) database.

2 System Test Configuration

2.1 Description of Test Configuration

The system was configured for testing in engineering mode which was selected by manufacturer. No modification was made to the EUT

For BLE mode, there are totally 40 channels.

Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	21	2442
1	2404	--	--
2	2406	--	--
3	2408	37	2476
--	--	38	2478
19	2440	39	2480

For BLE mode: Channel 0, 19 and 39 were tested.

The worst-case data rates are determined to be as follows for each mode based upon investigation by measuring the average power and PSD across all date rates bandwidths, and modulations.
Radiated below 1G were tested worst output power mode.

2.2 Description of Worst Test Configuration

Modulation Used for Conformance Test			
Configuration	N_{TX}	Data Rate	Worst Data Rate
BLE mode	1	125 kbps-1 Mbps	1 Mbps

Worst Case of Power Setting				
EUT Exercise Software		nRFgo Studio-Direct Test Mode UART interface		
Configuration	N_{TX}	Low CH	Mid CH	High CH
BLE mode	1	Default	Default	Default

2.3 Support Equipment List and Details

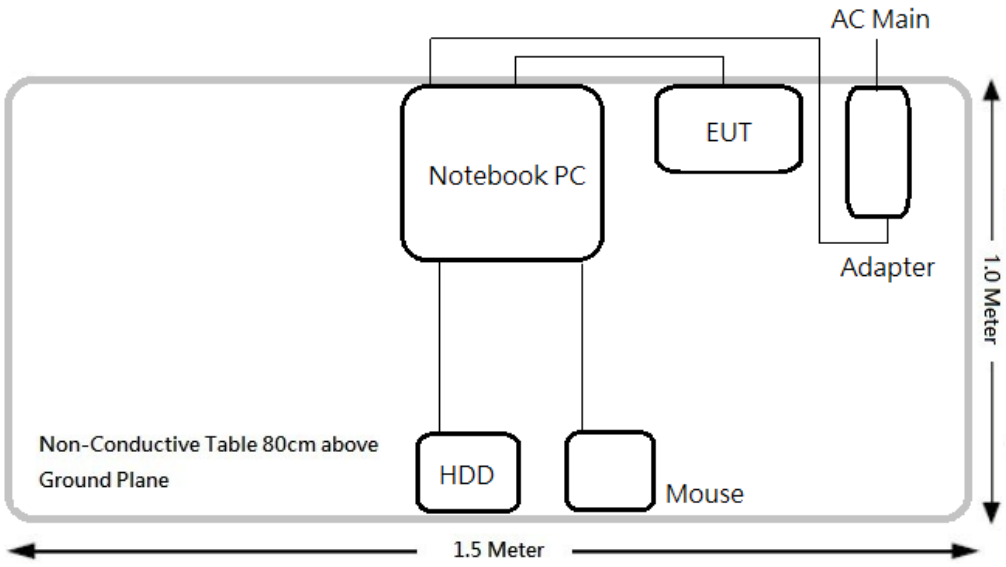
No.	Description	Manufacturer	Model Number	FCC ID
A	Notebook PC	DELL	Latitude E5470	DoC
B	USB Mouse	ASUS	MOBTU0A	DoC
C	USB 3.0 HDD	WD	WDBUZG0010BBK-WESN	DoC

2.4 External Cable List and Details

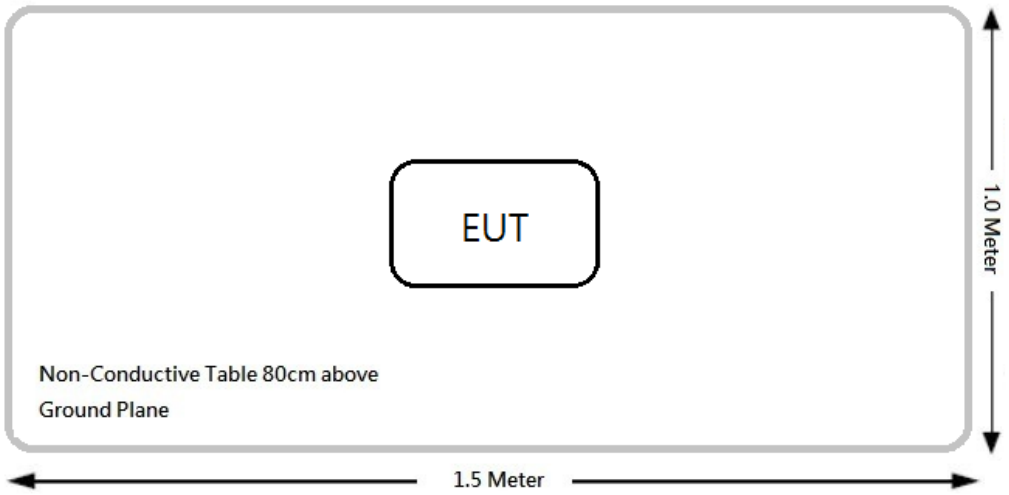
No.	Description	Length (m)	From	To
A	USB Cable	1.8	EUT	NB
B	USB Cable	1.8	Mouse	NB
C	USB Cable	1.0	HDD	NB

2.5 Block Diagram of Test Setup

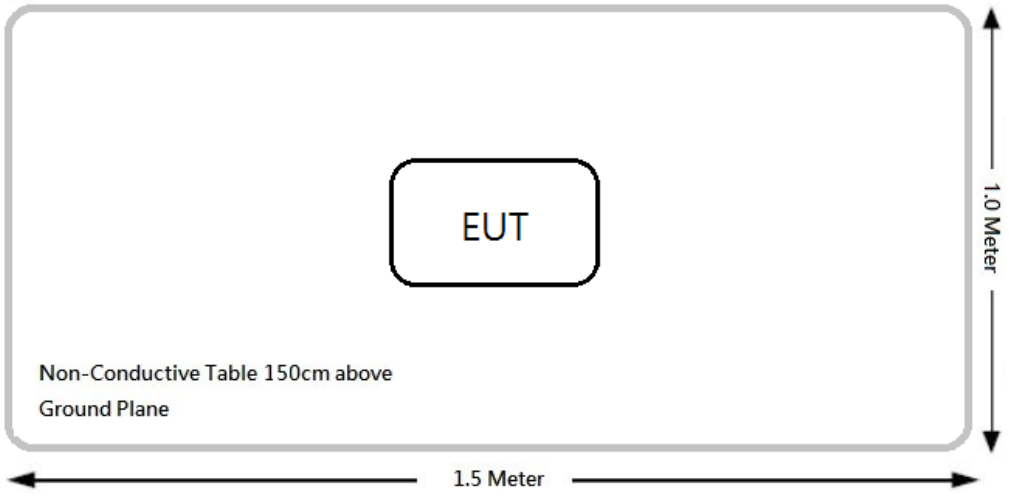
Conduction



Radiation below 1G



Radiation above 1G



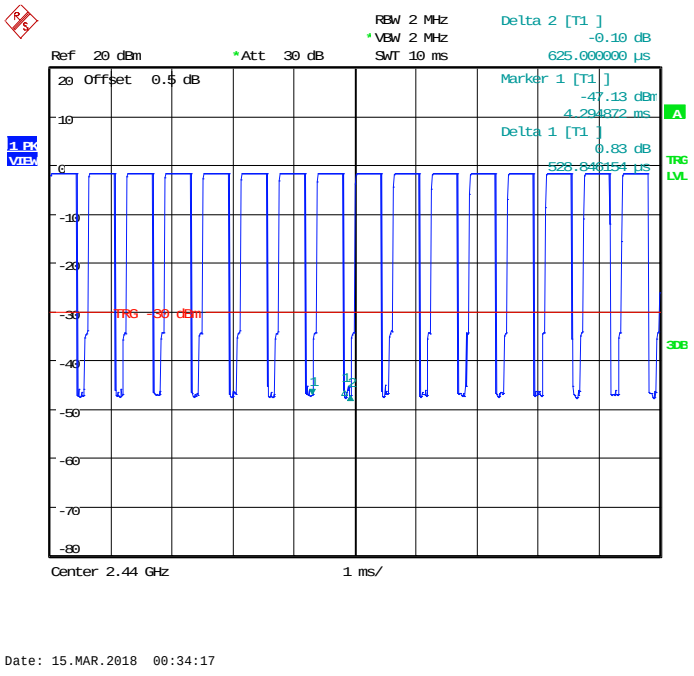
2.6 Duty Cycle

According to KDB 558074 D01 DTS Meas Guidance v04 section 6.0:
All measurements are to be performed with the EUT transmitting at 100% duty cycle at its maximum power control level; however, if 100% duty cycle cannot be achieved, measurements of duty cycle, x, and maximum power transmission duration, T, are required for each tested mode of operation.

Configuration	On Time (ms)	Period (ms)	Duty Cycle (%)	Duty Factor (dB)
BLE mode	0.52	0.62	83.87	0.76

Note: Duty Factor = 10*log (1/Duty cycle)

BLE mode



3 Summary of Test Results

FCC Rules	Description of Test	Result
§15.247(i), §1.1310 ,§ 2.1091	Maximum Permissible Exposure (MPE)	Compliance
§15.203	Antenna Requirement	Compliance
§15.207(a)	AC Line Conducted Emissions	Compliance
§15.205, §15.209, §15.247(d)	Spurious Emissions	Compliance
§15.247(a)(2)	6 dB Emission Bandwidth	Compliance
§15.247(b)(3)	Maximum Peak Output Power	Compliance
§15.247(d)	100 kHz Bandwidth of Frequency Band Edge	Compliance
§15.247(e)	Power Spectral Density	Compliance

4 FCC § 15.247(i), §1.1310, § 2.1091 - Maximum Permissible Exposure (MPE)

4.1 Applicable Standard

According to subpart §1.1310, systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

Limits for Maximum Permissible Exposure (MPE) (§1.1310, §2.1091)

(B) Limits for General Population/Uncontrolled Exposure				
Frequency Range (MHz)	**Electric Field Strength (V/m)**	**Magnetic Field Strength (A/m)**	**Power Density (mW/cm^2)**	**Averaging Time (minutes)**
0.3–1.34	614	1.63	*(100)	30
1.34–30	824/f	2.19/f	*($180/f^2$)	30
30–300	27.5	0.073	0.2	30
300–1500	/	/	f/1500	30
1500–100,000	/	/	1.0	30

f = frequency in MHz; * = Plane-wave equivalent power density;

According to §1.1310 and §2.1091 RF exposure is calculated.

Calculated Formulary:

Predication of MPE limit at a given distance
$S = PG/4\pi R^2$ = power density (in appropriate units, e.g. mW/cm^2);
P = power input to the antenna (in appropriate units, e.g., mW);
G = power gain of the antenna in the direction of interest relative to an isotropic radiator, the power gain factor, is normally numeric gain;
R = distance to the center of radiation of the antenna (appropriate units, e.g., cm);
For simultaneously transmit system, the calculated power density should comply with:

$$\sum_i \frac{S_i}{S_{Limit,i}} \leq 1$$

4.2 RF Exposure Evaluation Result

MPE evaluation:

Mode	Frequency Range (MHz)	Antenna Gain		Target Power		Evaluation Distance (cm)	Power Density (mW/cm^2)	MPE Limit (mW/cm^2)
		(dBi)	(numeric)	(dBm)	(mW)			
GSM 850	824-849	4.07	2.553	22.5	177.8	20	0.0903	0.55
PCS 1900	1850-1910	5.44	3.499	20	100.0	20	0.0696	1
WCDMA Band V	824-849	4.07	2.553	23	199.5	20	0.1013	0.55
WCDMA Band II	1850-1910	5.44	3.499	23	199.5	20	0.1389	1
BLE	2402-2480	0.5	1.122	-1	0.794	20	0.0002	1

*Due to GSM not have GPRS and EDGE, so only one Averaging Time and the power calculate as below
GSM 850: 31.5 – 9 = 22.5 (dBm) and PCS 1900 = 29 – 9 = 20 (dBm)

The BLE and WCDMA Band V can transmit simultaneously:

$=S_{BLE}/S_{limit\text{-}BLE} + S_{WCDMA\ BAND\ V}/S_{limit\text{-}WCDMA\ BAND\ V} =$ 0.0002/1 + 0.1013/0.55 = 0.1844 <1.0

Result: MPE evaluation meet 20 cm the requirement of standard.

5 FCC §15.203 – Antenna Requirements

5.1 Applicable Standard

According to § 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 shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the user of a standard antenna jack or electrical connector is prohibited.

And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna does not exceed 6 dBi

5.2 Antenna List and Details

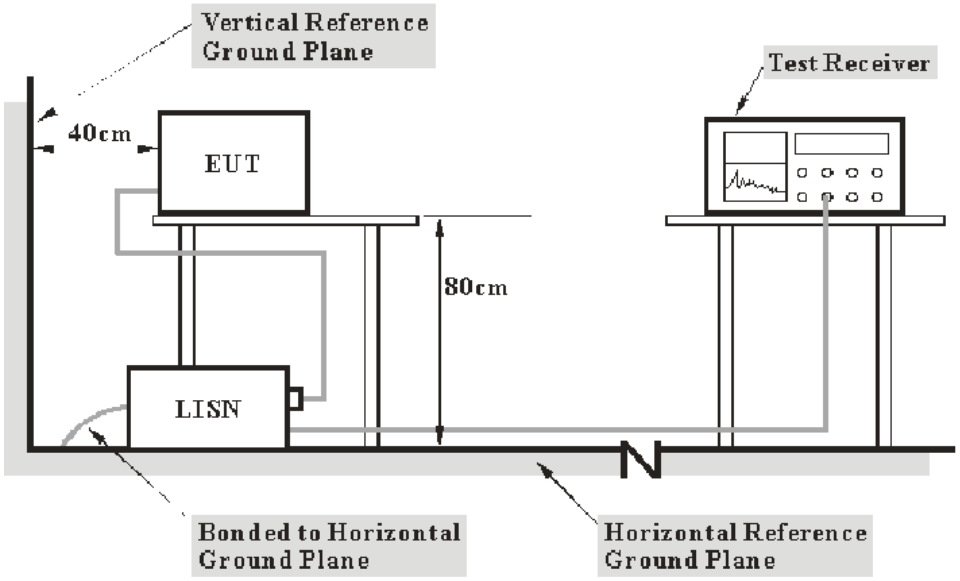
Manufacturer	Model	Antenna Type	Antenna Gain	Result
JOHANSON TECHNOLOGY	2450AT18A100	Miniature Ceramic Chip Antenna	0.50 dBi	Compliance

6 FCC §15.207 - AC Line Conducted Emissions

6.1 Applicable Standard

FCC §15.207

6.2 EUT Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.207 limits.

6.3 EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz. During the conducted emission test, the EMI test receiver was set with the following configurations

Frequency Range	Receiver RBW
150 kHz - 30 MHz	9 kHz

6.4 Test Procedure

During the conducted emission test, the adapter was connected to the outlet of the LISN. Maximizing procedure was performed on the six (6) highest emissions of the EUT. All data was recorded in the Quasi-peak and average detection mode.

6.5 Corrected Factor & Margin Calculation

Correct Factor is calculated by adding LISN/ISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

Correct Factor = LISN VDF + Cable Loss + Transient Limiter Attenuation

The "Margin (Over Limit)" column of the following data tables indicates the degree of compliance with the applicable limit. For example, an over limit of -7 dB means the emission is 7 dB below the limit. The equation for Over Limit calculation is as follows:

Margin (Over Limit) = Level – Limit Line

6.6 Test Equipment List and Details

Manufacturers	Descriptions	Models	Serial Numbers	Calibration Date	Calibration Due Date
LISN	Rohde & Schwarz	ENV216	101248	2017/07/20	2018/07/19
LISN	EMCO	3816/2	00075848	2017/08/02	2018/08/01
EMI Test Receiver	Rohde & Schwarz	ESR7	101419	2017/11/06	2018/11/05
Pulse Limiter	Rohde & Schwarz	ESH3Z2	TXZEM025	2017/08/11	2018/08/10
RF Cable	EMEC	EM-CB5D	001	2017/07/24	2018/07/23
Software	AUDIX	E3	V9.150826k	N.C.R	N.C.R

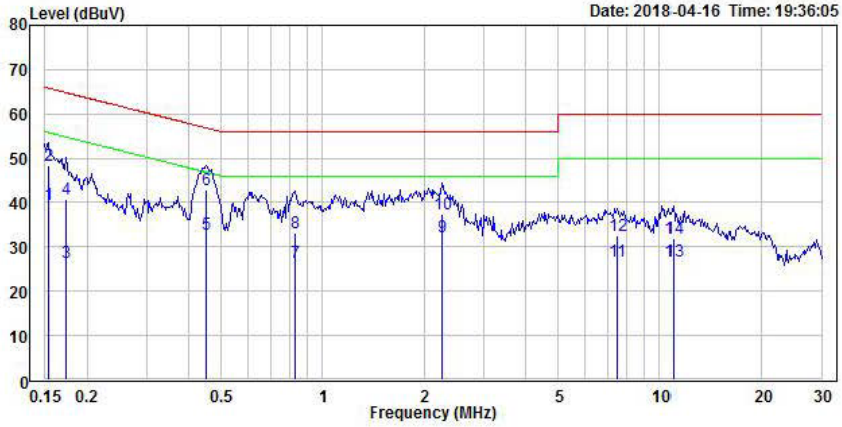
***Statement of Traceability:** BACL Corp. attests that all of the calibrations on the equipment items listed above were traceable to the SI System of Units via the R.O.C. Center for Measurement Standards of the Electronics Testing Center, Taiwan (ETC) or to another internationally recognized National Metrology Institute (NMI), and were compliant with the current Taiwan Accreditation Foundation (TAF) requirements.*

6.7 Test Environmental Conditions

Temperature:	23.36 ℃
Relative Humidity:	47 .11 %
ATM Pressure:	1010 hPa

6.8 Conducted Emissions Test Plots and Data

120V/60Hz, Charging Mode, Line



Condition: limit\FCC\FCC Conduction Clsaa-B QP.csv Line
EUT : Global Tracker Device
Mode : GEGO V1
Note : 120V/60Hz

	Freq	Level	Limit Line	Over Limit	Factor	Read Level	Remark	Pol/Phase
	MHz	dBuV	dBuV	dB	dB	dBuV		
1	0.154	39.60	55.80	-16.20	19.50	20.10	Average	Line
2	0.154	48.24	65.80	-17.56	19.50	28.74	QP	Line
3	0.173	26.51	54.81	-28.30	19.50	7.01	Average	Line
4	0.173	40.87	64.81	-23.94	19.50	21.37	QP	Line
5	0.450	32.73	46.87	-14.14	19.51	13.22	Average	Line
6	0.450	43.03	56.87	-13.84	19.51	23.52	QP	Line
7	0.832	26.51	46.00	-19.49	19.52	6.99	Average	Line
8	0.832	33.28	56.00	-22.72	19.52	13.76	QP	Line
9	2.270	32.13	46.00	-13.87	19.59	12.54	Average	Line
10	2.270	37.35	56.00	-18.65	19.59	17.76	QP	Line
11	7.500	26.89	50.00	-23.11	19.73	7.16	Average	Line
12	7.500	32.63	60.00	-27.37	19.73	12.90	QP	Line
13	10.906	26.78	50.00	-23.22	19.77	7.01	Average	Line
14	10.906	32.06	60.00	-27.94	19.77	12.29	QP	Line

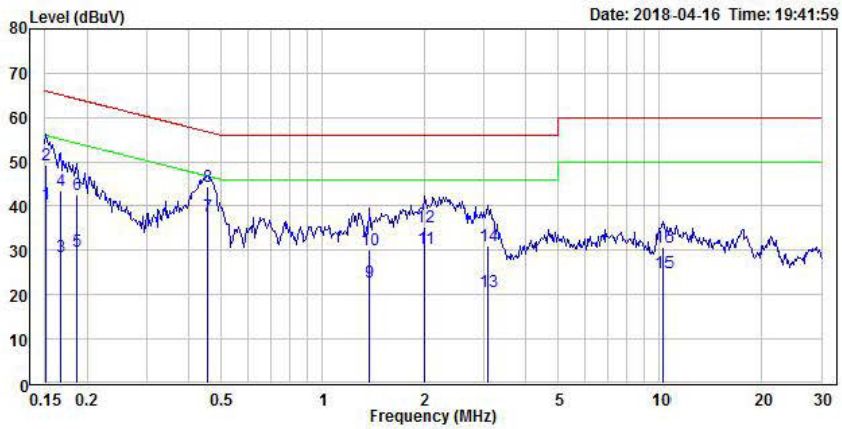
Note:

Level = Read Level + Correct Factor

Margin (Over Limit) = Level – Limit Line

Correct Factor = (LISN, ISN, PLC or current probe) Factor + Cable Loss + Attenuator

120V/60Hz, Charging Mode, Line



Condition: limit\FCC\FCC Conduction Clsaa-B QP.csv Neutral
EUT : Global Tracker Device
Mode : GEGO V1
Note : 120V/60Hz

	Freq	Level	Limit Line	Over Limit	Factor	Read Level	Remark	Pol/Phase
	MHz	dBuV	dBuV	dB	dB	dBuV		
1	0.151	40.46	55.93	-15.47	19.63	20.83	Average	Neutral
2	0.151	49.40	65.93	-16.53	19.63	29.77	QP	Neutral
3	0.166	28.65	55.14	-26.49	19.63	9.02	Average	Neutral
4	0.166	43.46	65.14	-21.68	19.63	23.83	QP	Neutral
5	0.186	29.91	54.21	-24.30	19.63	10.28	Average	Neutral
6	0.186	42.56	64.21	-21.65	19.63	22.93	QP	Neutral
7	0.454	37.85	46.80	-8.95	19.64	18.21	Average	Neutral
8	0.454	44.31	56.80	-12.49	19.64	24.67	QP	Neutral
9	1.374	22.66	46.00	-23.34	19.68	2.98	Average	Neutral
10	1.374	30.24	56.00	-25.76	19.68	10.56	QP	Neutral
11	2.014	30.35	46.00	-15.65	19.72	10.63	Average	Neutral
12	2.014	35.41	56.00	-20.59	19.72	15.69	QP	Neutral
13	3.097	20.60	46.00	-25.40	19.77	0.83	Average	Neutral
14	3.097	31.10	56.00	-24.90	19.77	11.33	QP	Neutral
15	10.233	24.86	50.00	-25.14	19.91	4.95	Average	Neutral
16	10.233	30.79	60.00	-29.21	19.91	10.88	QP	Neutral

Note:

Level = Read Level + Correct Factor

Margin (Over Limit) = Level – Limit Line

Correct Factor = (LISN, ISN, PLC or current probe) Factor + Cable Loss + Attenuator

7 FCC §15.209, §15.205, §15.247(d) – Spurious Emissions

7.1 Applicable Standard

As per FCC §15.35(d): Unless otherwise specified, on any frequency or frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz.

As Per FCC §15.205(a) and RSS-Gen except as show in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 – 0.110 0.495 – 0.505 2.1735 – 2.1905 4.125 – 4.128 4.17725 – 4.17775 4.20725 – 4.20775 6.215 – 6.218 6.26775 – 6.26825 6.31175 – 6.31225 8.291 – 8.294 8.362 – 8.366 8.37625 – 8.38675 8.41425 – 8.41475 12.29 – 12.293 12.51975 – 12.52025 12.57675 – 12.57725 13.36 – 13.41	16.42 – 16.423 16.69475 – 16.69525 25.5 – 25.67 37.5 – 38.25 73 – 74.6 74.8 – 75.2 108 – 121.94 123 – 138 149.9 – 150.05 156.52475 – 156.52525 156.7 – 156.9 162.0125 –167.17 167.72 – 173.2 240 – 285 322 – 335.4 399.9 – 410 608 – 614	960 – 1240 1300 – 1427 1435 – 1626.5 1645.5 – 1646.5 1660 – 1710 1718.8 – 1722.2 2200 – 2300 2310 – 2390 2483.5 – 2500 2690 – 2900 3260 – 3267 3.332 – 3.339 3 3458 – 3 358 3.600 – 4.400	4. 5 – 5. 15 5. 35 – 5. 46 7.25 – 7.75 8.025 – 8.5 9.0 – 9.2 9.3 – 9.5 10.6 – 12.7 13.25 – 13.4 14.47 – 14.5 15.35 – 16.2 17.7 – 21.4 22.01 – 23.12 23.6 – 24.0 31.2 – 31.8 36.43 – 36.5 Above 38.6

As per FCC §15.209(a): Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

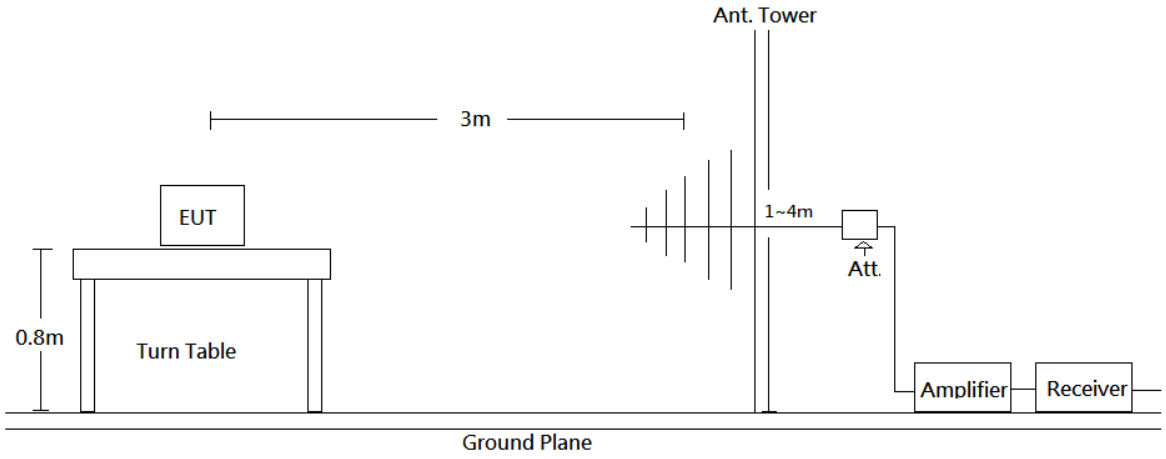
Frequency (MHz)	Field Strength (micro volts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

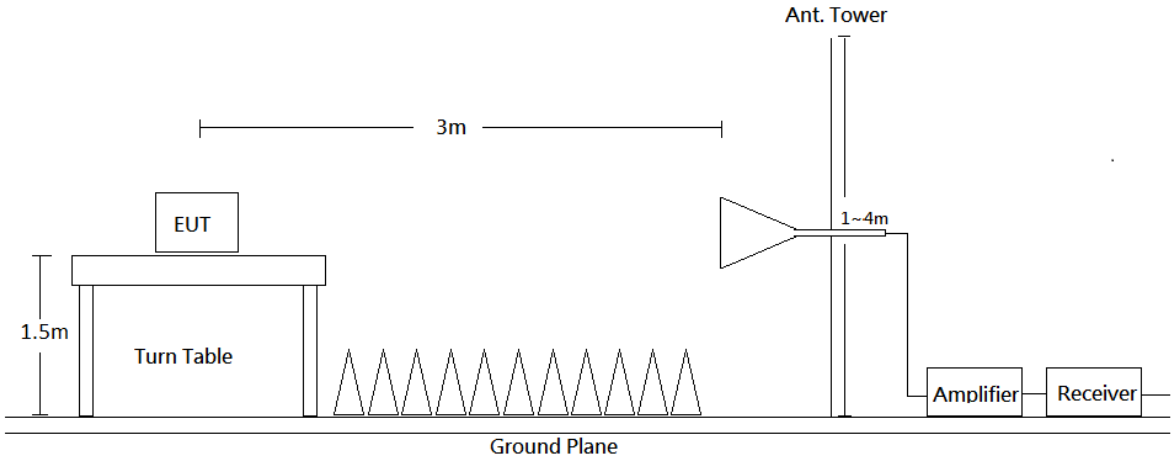
As per FCC §15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c).

7.2 EUT Setup

Blow 1 GHz:



Above 1 GHz:



Radiated emission tests were performed in the 3 meters chamber test site, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC Part 15.209 and FCC 15.247 Limits.

7.3 EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 26.5 GHz. During the radiated emission test, the EMI test receiver was set with the following configurations measurement method 6.3 in ANSI C63.10.

Frequency Range	RBW	VBW	Detector	Duty cycle	Measurement method
30-1000 MHz	120 kHz	/	QP		QP
Above 1 GHz	1 MHz	3 MHz	PK		PK
	1 MHz	3 MHz	RMS	>98%	Ave
	1 MHz	1/T	PK	<98%	Ave

7.4 Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

All data was recorded in the Quasi-peak detector mode from 30 MHz to 1 GHz and PK and average detector modes for frequencies above 1 GHz.

7.5 Corrected Factor & Margin Calculation

The Correct Factor is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain from the Meter Reading. The basic equation is as follows:

Correct Factor = Antenna Factor + Cable Loss - Amplifier Gain

The “Margin” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -7 dB means the emission is 7 dB below the limit. The equation for margin calculation is as follows:

Margin = Result –Limit

7.6 Test Results Summary

According to the data in the following table, the EUT complied with the FCC §15.209 Limit. Refer to CISPR16-4-2:2011 and CISPR 16-4-1:2009, the measured level complies with the limit if

$Lm + U(Lm) \leq Llim + Ucispr$

In BACL, U(Lm) is less than Ucispr, if Lm is less than Llim, it implies that the EUT complies with the limit.

7.7 Test Equipment List and Details

Description	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due Date
966A Room					
Bilog Antenna with 6 dB Attenuator	SUNOL SCIENCES & MINI-CIRCUITS	JB6/UNAT-6+	A050115/15542_01	2017/12/20	2018/12/19
Horn Antenna	EMCO	3115	9311-4158	2017/05/24	2018/05/23
Horn Antenna	ETS-Lindgren	3116	62638	2017/09/13	2018/09/12
Preamplifier	Sonoma	310N	130602	2017/07/03	2018/07/02
Preamplifier	EM Electronics Corp.	EM01G18G	060657	2017/12/14	2018/12/13
Microware Preamplifier	EM Electronics Corporatino	EM18G40G	060656	2018/01/15	2019/01/14
EMI Test Receiver	Rohde & Schwarz	ESR7	101419	2017/11/06	2018/11/05
Spectrum Analyzer	Rohde & Schwarz	FSV40	101203	2017/07/13	2018/07/12
Microflex Cable	UTIFLEX	UFB311A-Q-1440-300300	220490-006	2017/10/31	2018/10/30
Microflex Cable	UTIFLEX	UFA210A-1-3149-300300	MFR64639 226389-001	2017/11/10	2018/11/09
Microflex Cable	ROSNOL	K1K50-UP0264-K1K50-450CM	160309-1	2018/03/05	2019/03/04
Microflex Cable	ROSNOL	K1K50-UP0264-K1K50-80CM	160309-2	2018/01/17	2019/01/16
Turn Table	Champro	TT-2000	060772-T	N.C.R	N.C.R
Antenna Tower	Champro	AM-BS-4500-B	060772-A	N.C.R	N.C.R
Controller	Champro	EM1000	60772	N.C.R	N.C.R
Software	Farad	EZ_EMC	BACL-03A1	N.C.R	N.C.R
Conducted Room					
Spectrum Analyzer	Rohde & Schwarz	FSU26	200268	2017/05/08	2018/05/07
Cable	WOKEN	SFL402	S02-160323-07	2018/02/12	2019/02/11

***Statement of Traceability:** BACL Corp. attests that all of the calibrations on the equipment items listed above were traceable to the SI System of Units via the R.O.C. Center for Measurement Standards of the Electronics Testing Center, Taiwan (ETC) or to another internationally recognized National Metrology Institute (NMI), and were compliant with the current Taiwan Accreditation Foundation (TAF) requirements.*

7.8 Test Environmental Conditions

Temperature:	25.5° C
Relative Humidity:	58 %
ATM Pressure:	1010 hPa

The testing was performed by Ian from 2018-03-01 to 2018-04-16.

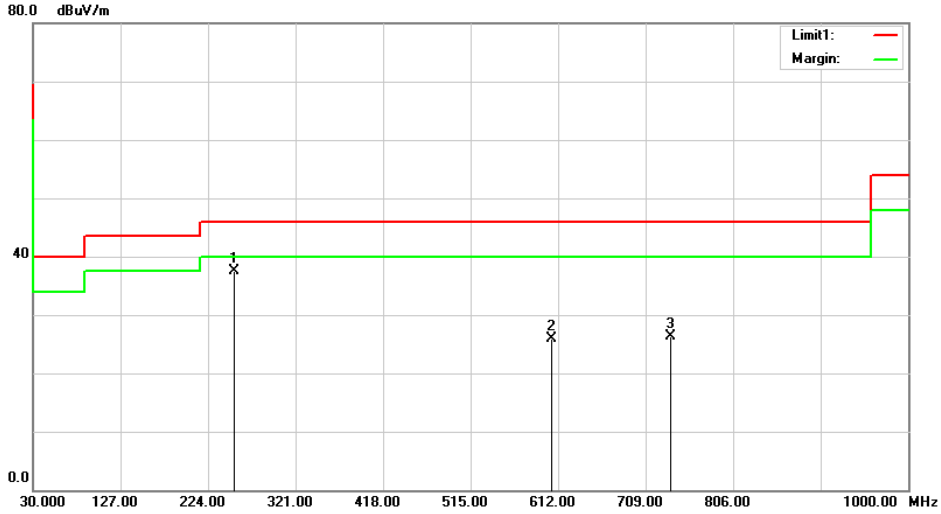
7.9 Test Results

BLE Mode: Transmitting Mode *(Pre-scan with three orthogonal axis, and worse case as X axis)*

Below 1G (30 MHz-1 GHz) test the output power worst mode:

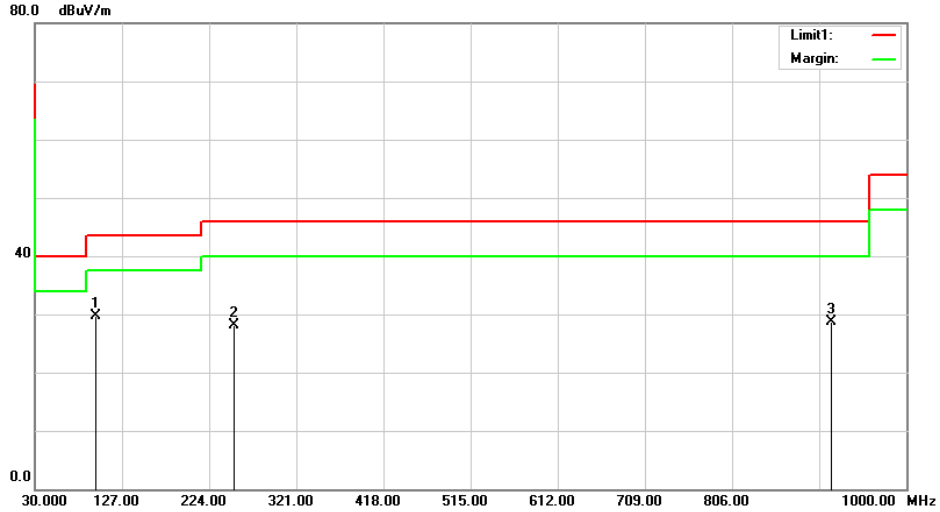
BLE mode: Worst case is BLE Low Channel

Horizontal



Frequency (MHz)	Reading (dBuV)	Correct Factor(dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Degree (˚)	Remark
253.1000	49.12	-11.70	37.42	46.00	-8.58	100	139	peak
604.2400	29.97	-4.12	25.85	46.00	-20.15	100	360	peak
736.1600	28.59	-2.28	26.31	46.00	-19.69	100	268	peak

Vertical

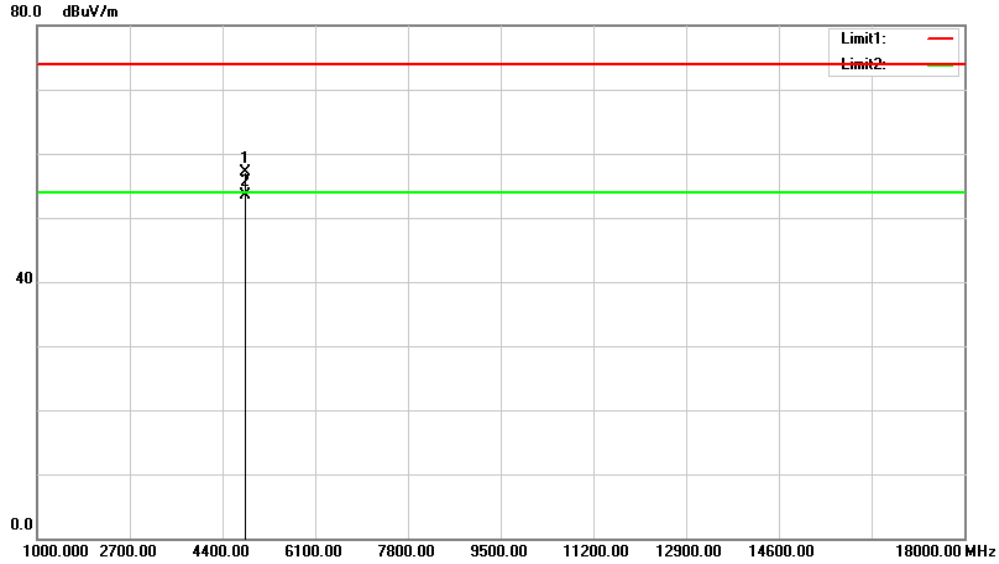


Frequency (MHz)	Reading (dBuV)	Correct Factor(dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Degree (˚)	Remark
97.9000	44.77	-15.01	29.76	43.50	-13.74	100	0	peak
252.1300	39.96	-11.76	28.20	46.00	-17.80	100	35	peak
916.5800	27.12	1.51	28.63	46.00	-17.37	100	90	peak

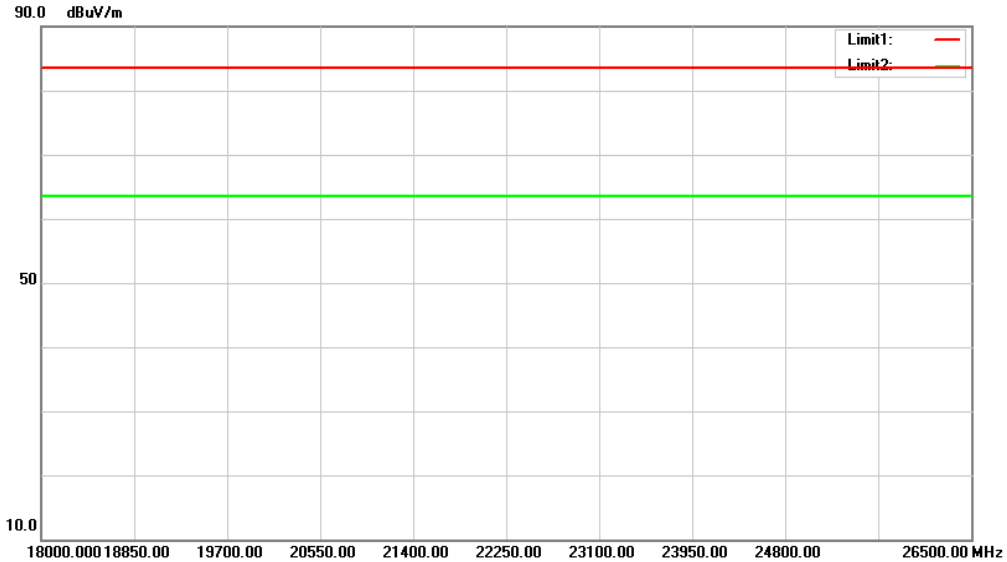
Above 1G (1 GHz-26.5 GHz) test the output power worst mode: Worst case is BLE mode Low channel

Horizontal

1GHz-18GHz:

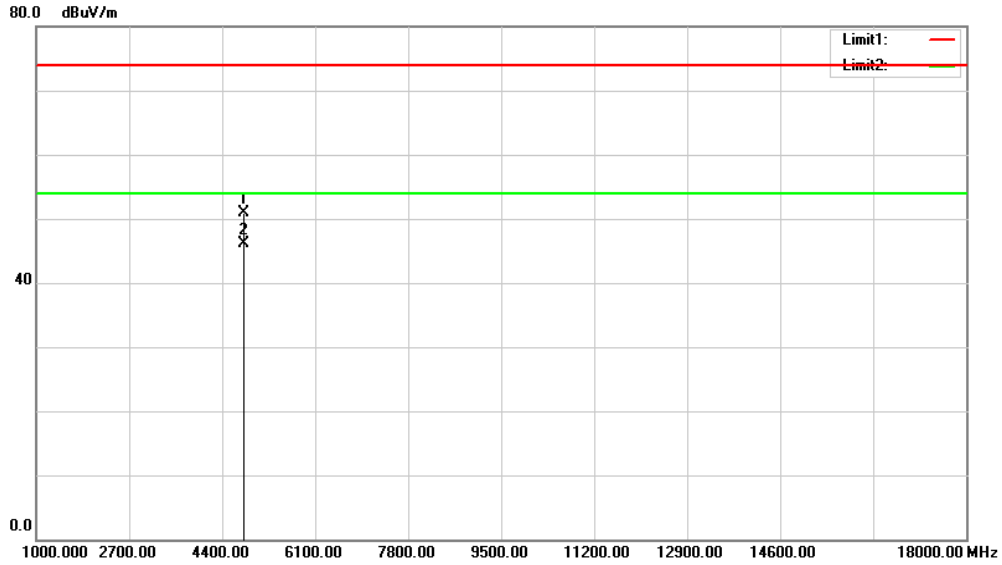


18GHz-26.5GHz:

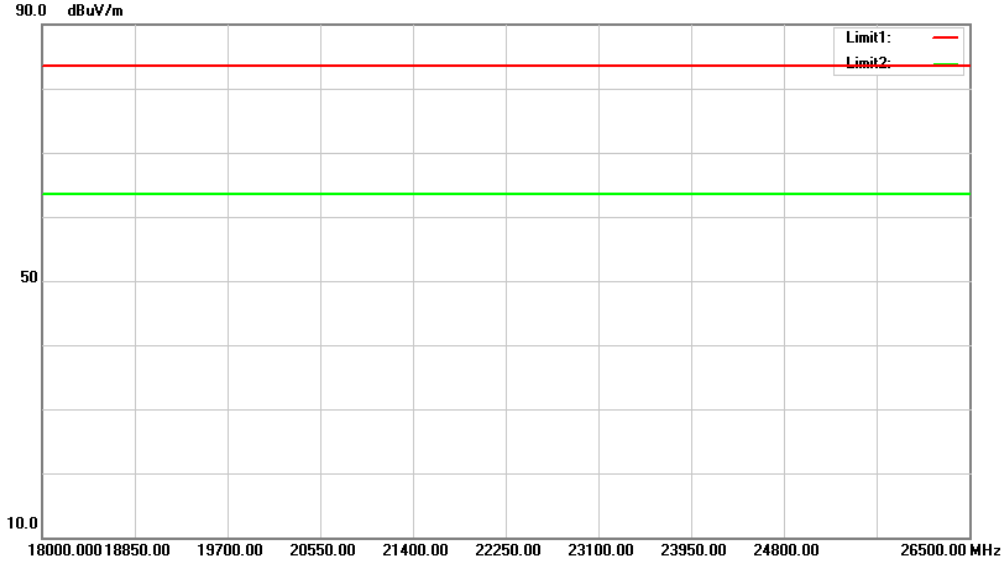


Vertical

1GHz-18GHz:



18GHz-26.5GHz:



BLE mode

Horizontal

Frequency (MHz)	Reading (dBuV)	Correct Factor(dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Degree (˚)	Remark
Low Channel								
2329.190	64.54	-5.02	59.52	74.00	-14.48	100	165	peak
2329.190	34.85	-5.02	29.83	54.00	-24.17	100	165	AVG
2402.000	94.72	-4.86	89.86	N/A	N/A	100	156	peak
2402.000	94.44	-4.86	89.58	N/A	N/A	100	156	AVG
4808.000	56.07	0.99	57.06	74.00	-16.94	150	259	peak
4808.000	52.52	0.99	53.51	54.00	-0.49	150	259	AVG
Mid Channel								
2389.040	45.22	-4.89	40.33	74.00	-33.67	150	115	peak
2389.040	31.48	-4.89	26.59	54.00	-27.41	150	115	AVG
2439.770	92.49	-4.78	87.71	N/A	N/A	150	153	peak
2439.770	91.76	-4.78	86.98	N/A	N/A	150	153	AVG
2487.650	43.38	-4.67	38.71	74.00	-35.29	150	74	peak
2487.650	30.45	-4.67	25.78	54.00	-28.22	150	74	AVG
4876.000	55.26	1.23	56.49	74.00	-17.51	150	263	peak
4876.000	51.74	1.23	52.97	54.00	-1.03	150	263	AVG
High Channel								
2479.780	91.36	-4.68	86.68	N/A	N/A	150	151	peak
2479.780	90.60	-4.68	85.92	N/A	N/A	150	151	AVG
2498.500	56.29	-4.64	51.65	74.00	-22.35	150	148	peak
2498.500	32.49	-4.64	27.85	54.00	-26.15	150	148	AVG
4961.000	53.81	1.52	55.33	74.00	-18.67	150	257	peak
4961.000	50.07	1.52	51.59	54.00	-2.41	150	257	AVG

Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported

Vertical

Frequency (MHz)	Reading (dBuV)	Correct Factor(dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Degree (˚)	Remark
Low Channel								
2329.190	52.97	-5.02	47.95	74.00	-26.05	150	58	peak
2329.190	31.05	-5.02	26.03	54.00	-27.97	150	58	AVG
2402.000	83.38	-4.86	78.52	N/A	N/A	150	62	peak
2402.000	82.60	-4.86	77.74	N/A	N/A	150	62	AVG
4791.000	49.98	0.93	50.91	74.00	-23.09	150	152	peak
4791.000	45.24	0.93	46.17	54.00	-7.83	150	152	AVG
Mid Channel								
2389.230	50.14	-4.89	45.25	74.00	-28.75	150	132	peak
2389.230	34.25	-4.89	29.36	54.00	-24.64	150	132	AVG
2439.770	83.64	-4.78	78.86	N/A	N/A	150	226	peak
2439.770	82.91	-4.78	78.13	N/A	N/A	150	226	AVG
2494.680	45.50	-4.65	40.85	74.00	-33.15	150	163	peak
2494.680	33.36	-4.65	28.71	54.00	-25.29	150	163	AVG
4876.000	47.65	1.23	48.88	74.00	-25.12	150	190	peak
4876.000	44.11	1.23	45.34	54.00	-8.66	150	190	AVG
High Channel								
2479.780	78.68	-4.68	74.00	N/A	N/A	150	129	peak
2479.780	77.83	-4.68	73.15	N/A	N/A	150	129	AVG
2491.300	47.66	-4.66	43.00	74.00	-31.00	150	168	peak
2491.300	34.33	-4.66	29.67	54.00	-24.33	150	168	AVG
4961.000	48.41	1.52	49.93	74.00	-24.07	150	186	peak
4961.000	45.16	1.52	46.68	54.00	-7.32	150	186	AVG

Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported

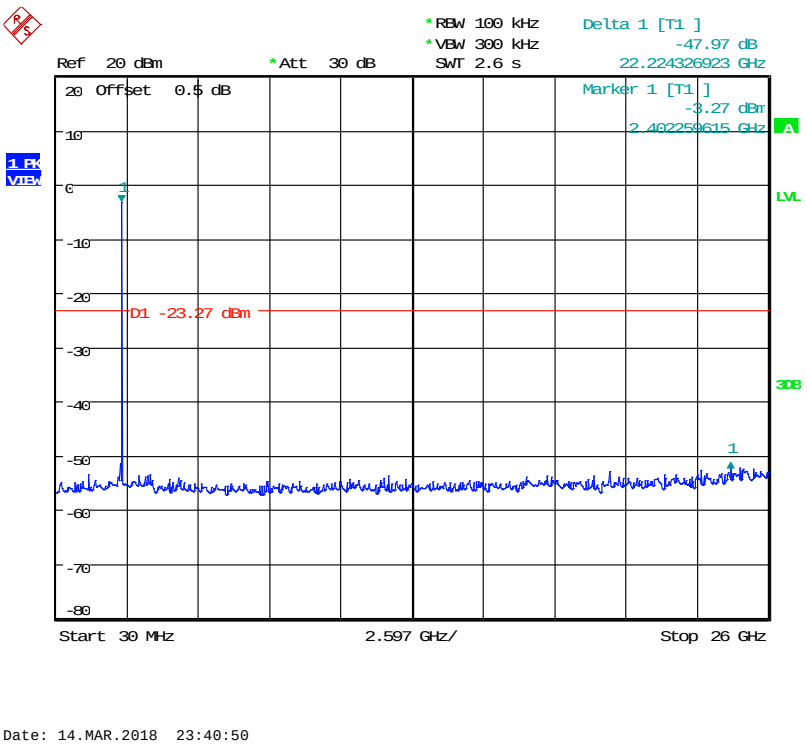
Conducted Spurious Emissions:

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
BLE mode				
Low	2402	47.97	≥ 20	Compliance
Mid	2440	49.03	≥ 20	Compliance
High	2480	49.86	≥ 20	Compliance

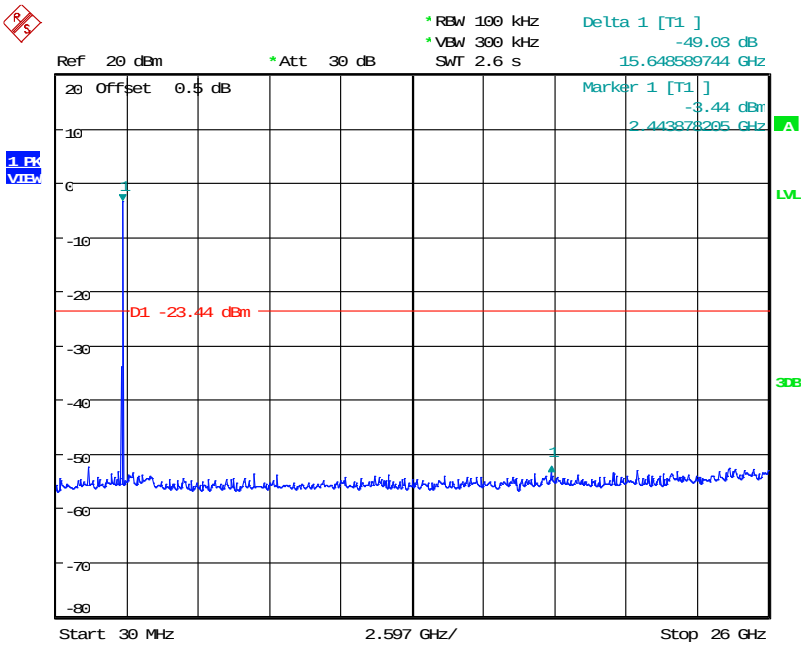
Please refer to the following plots

BLE mode:

Low Channel

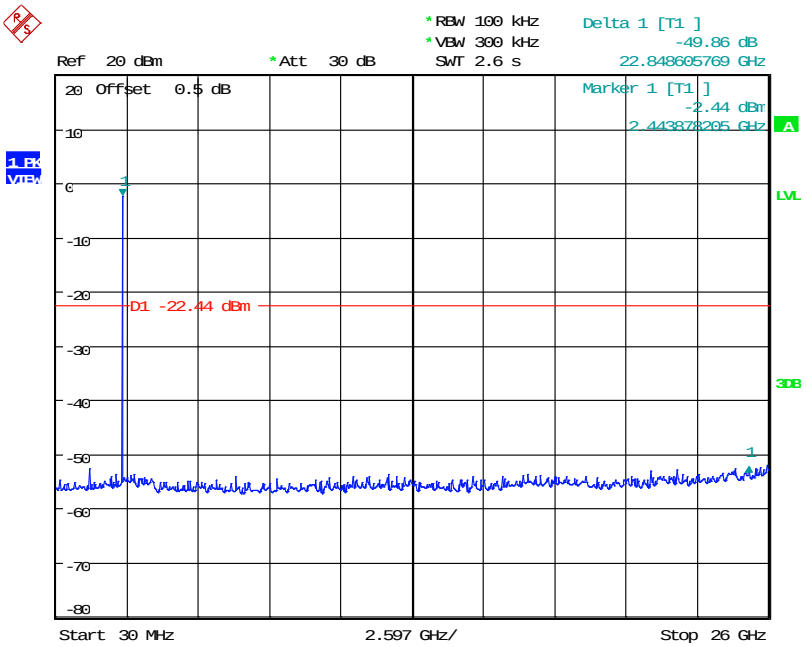


Middle Channel



Date: 14.MAR.2018 23:42:05

High Channel



Date: 14.MAR.2018 23:47:41

8 FCC §15.247(a)(2) – 6 dB Emission Bandwidth

8.1 Applicable Standard

According to FCC §15.247(a) (2).

Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

8.2 Test Procedure

According to ANSI C63.10-2013

6 dB Emission Bandwidth
The steps for the first option are as follows:
a) Set RBW = 100 kHz.
b) Set the VBW ≥ [3 × RBW].
c) Detector = peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.
g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

8.3 Test Equipment List and Details

Descriptions	Manufacturers	Models	Serial Numbers	Calibration Date	Calibration Due Date
Spectrum Analyzer	Rohde & Schwarz	FSU26	200268	2017/05/08	2018/05/07
Cable	WOKEN	SFL402	S02-160323-07	2018/02/20	2019/02/19

***Statement of Traceability:** BACL Corp. attests that all of the calibrations on the equipment items listed above were traceable to the SI System of Units via the R.O.C. Center for Measurement Standards of the Electronics Testing Center, Taiwan (ETC) or to another internationally recognized National Metrology Institute (NMI), and were compliant with the current Taiwan Accreditation Foundation (TAF) requirements.*

8.4 Test Environmental Conditions

Temperature:	26° C
Relative Humidity:	58 %
ATM Pressure:	1010 hPa

The testing was performed by Ian Tu from 2018-03-01 to 2018-04-16.

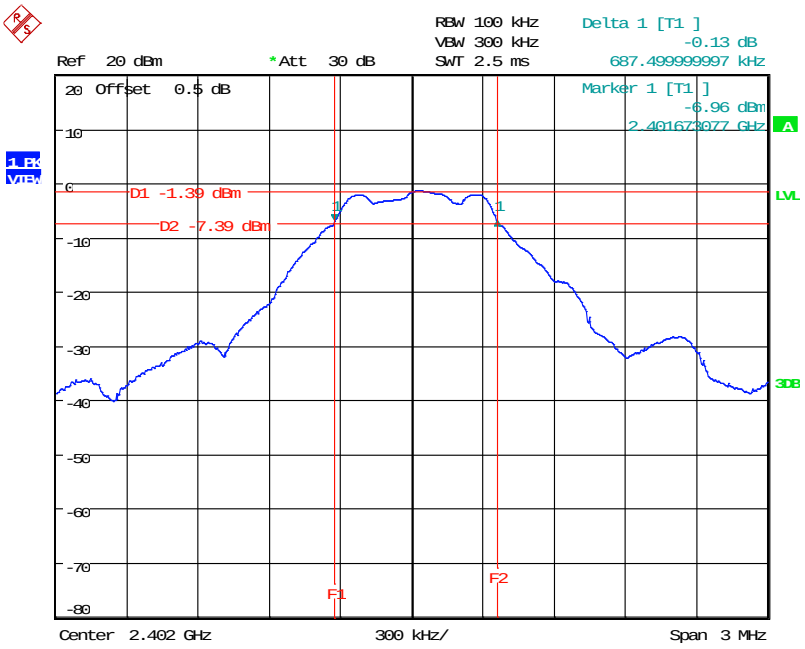
8.5 Test Results

Channel	Frequency (MHz)	6 dB OBW (MHz)	6dB Limit (MHz)	Result
BLE mode				
Low	2402	0.687	> 0.5	Compliance
Middle	2440	0.692	> 0.5	Compliance
High	2480	0.692	> 0.5	Compliance

Please refer to the following plots

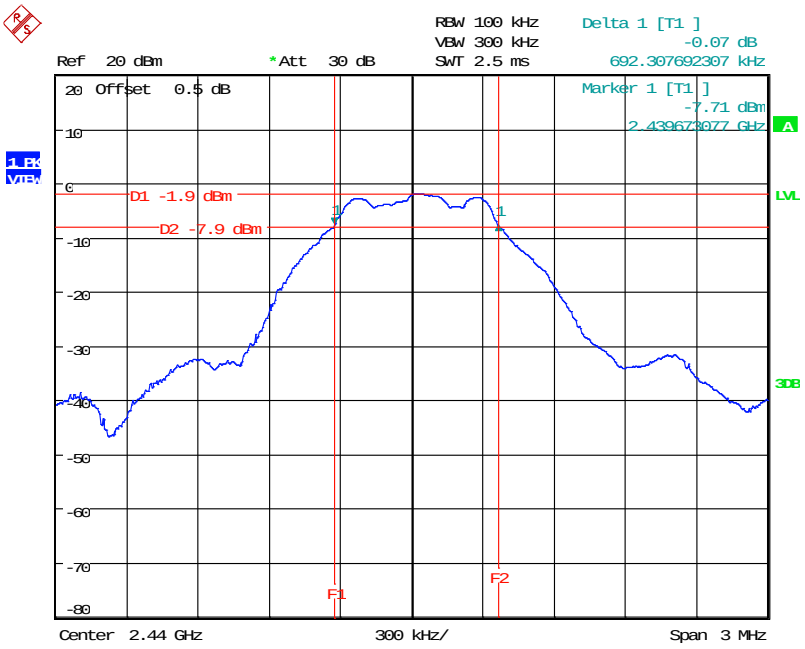
BLE mode:

Low Channel



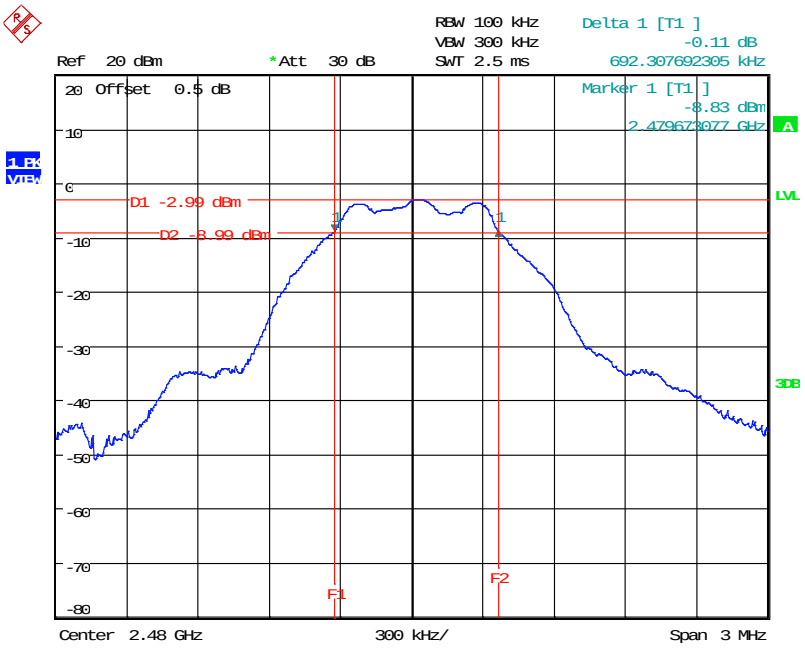
Date: 14.MAR.2018 22:34:11

Middle Channel



Date: 14.MAR.2018 22:52:02

High Channel



Date: 14.MAR.2018 22:55:40

9 FCC §15.247(b)(3) – Maximum Output Power

9.1 Applicable Standard

According to FCC §15.247(b) (3).

Systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

9.2 Test Procedure

1. Place the EUT on a bench and set it in transmitting mode.

2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to measuring equipment.

9.3 Test Equipment List and Details

Descriptions	Manufacturers	Models	Serial Numbers	Calibration Date	Calibration Due Date
Power Sensor	KEYSIGHT	U2021XA	MY54080018	2017/03/21	2018/03/20
Cable	WOKEN	SFL402	S02-160323-07	2018/02/20	2019/02/19

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9.4 Test Environmental Conditions

Temperature:	26° C
Relative Humidity:	58 %
ATM Pressure:	1010 hPa

The testing was performed by Ian from 2018-03-01 to 2018-04-16.

9.5 Test Results

Channel	Frequency (MHz)	Maximum peak Conducted Output Power (dBm)	Limit (dBm)	Result
BLE mode				
Low	2402	-1.46	30	Compliance
Middle	2440	-1.85	30	Compliance
High	2480	-1.84	30	Compliance

Channel	Frequency (MHz)	Average Output Power (dBm)	Duty Factor	Total Average Output Power (dBm)	Limit (dBm)	Result
BLE mode						
Low	2402	-2.63	0.76	-1.87	30	Compliance
Middle	2440	-3.01	0.76	-2.25	30	Compliance
High	2480	-4.02	0.76	-3.26	30	Compliance

10 FCC §15.247(d) – 100 kHz Bandwidth of Frequency Band Edge

10.1 Applicable Standard

According to FCC §15.247(d).

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

10.2 Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW to 100 kHz and VBW of spectrum analyzer to 300 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

10.3 Test Equipment List and Details

Descriptions	Manufacturers	Models	Serial Numbers	Calibration Date	Calibration Due Date
Spectrum Analyzer	Rohde & Schwarz	FSU26	200268	2017/05/08	2018/05/07
Cable	WOKEN	SFL402	S02-160323-07	2018/02/20	2019/02/19

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10.4 Test Environmental Conditions

Temperature:	26° C
Relative Humidity:	58 %
ATM Pressure:	1010 hPa

The testing was performed by Ian from 2018-03-01 to 2018-04-16

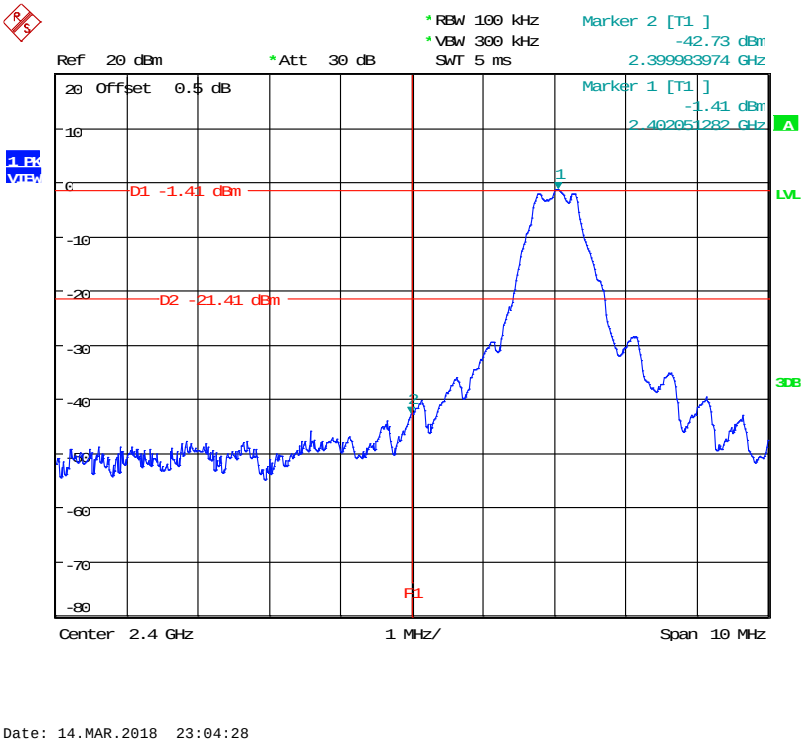
10.5 Test Results

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	RESULT
BLE mode				
Low	2402	42.73	≥ 20	PASS
High	2480	51.77	≥ 20	PASS

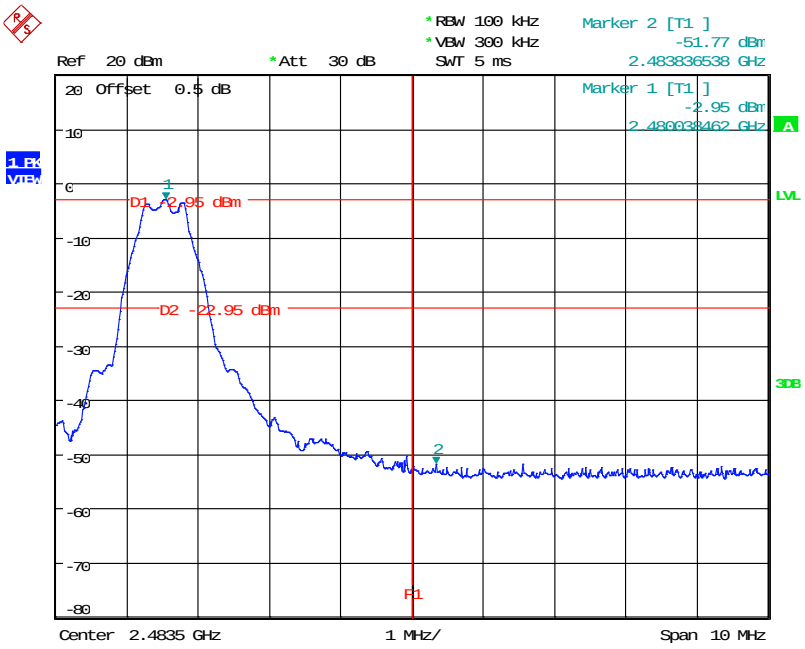
Please refer to the following plots

BLE mode:

Band Edge, Left Side



Band Edge, Right Side



Date: 14.MAR.2018 23:18:53

11 FCC §15.247(e) – Power Spectral Density

11.1 Applicable Standard

According to FCC §15.247(e).

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. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

11.2 Test Procedure

According to ANSI C63.10-2013

a) Set analyzer center frequency to DTS channel center frequency.

b) Set the span to 1.5 times the DTS bandwidth.

c) Set the RBW to 3 kHz ≤ RBW ≤ 100 kHz.

d) Set the VBW ≥ [3 × RBW].

e) Detector = peak.

f) Sweep time = auto couple.

g) Trace mode = max hold.

h) Allow trace to fully stabilize.

i) Use the peak marker function to determine the maximum amplitude level within the RBW.

j) If measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat

11.3 Test Equipment List and Details

Descriptions	Manufacturers	Models	Serial Numbers	Calibration Date	Calibration Due Date
Spectrum Analyzer	Rohde & Schwarz	FSU26	200268	2017/05/08	2018/05/07
Cable	WOKEN	SFL402	S02-160323-07	2018/02/20	2019/02/19

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11.4 Test Environmental Conditions

Temperature:	26° C
Relative Humidity:	58 %
ATM Pressure:	1010 hPa

The testing was performed by Ian from 2018-03-01 to 2018-04-16.

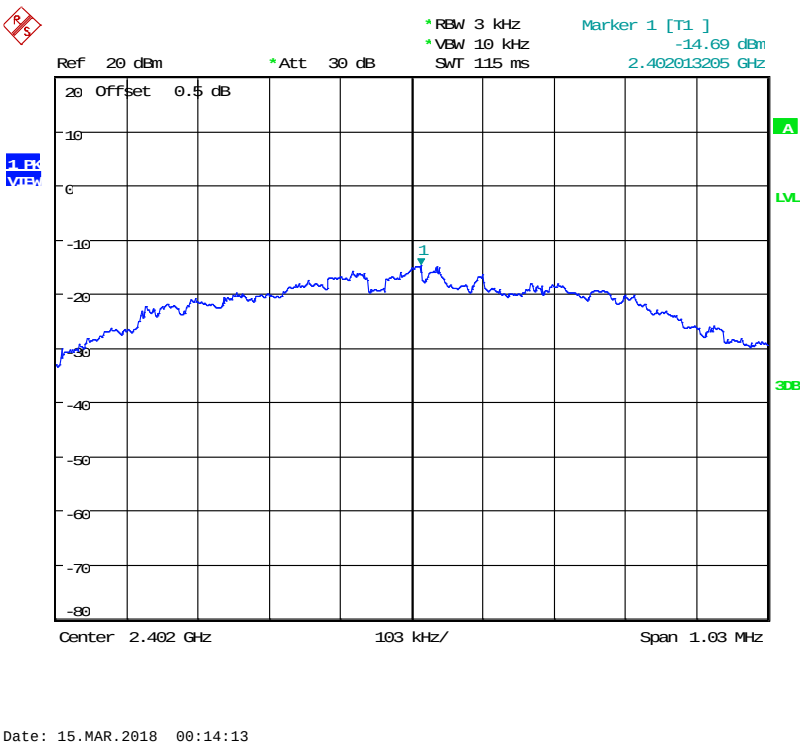
11.5 Test Results

Channel	Frequency (MHz)	PSD (dBm/3 kHz)	Limit (dBm/3 kHz)	Result
BLE mode				
Low	2402	-14.69	8	Compliance
Middle	2440	-15.07	8	Compliance
High	2480	-15.51	8	Compliance

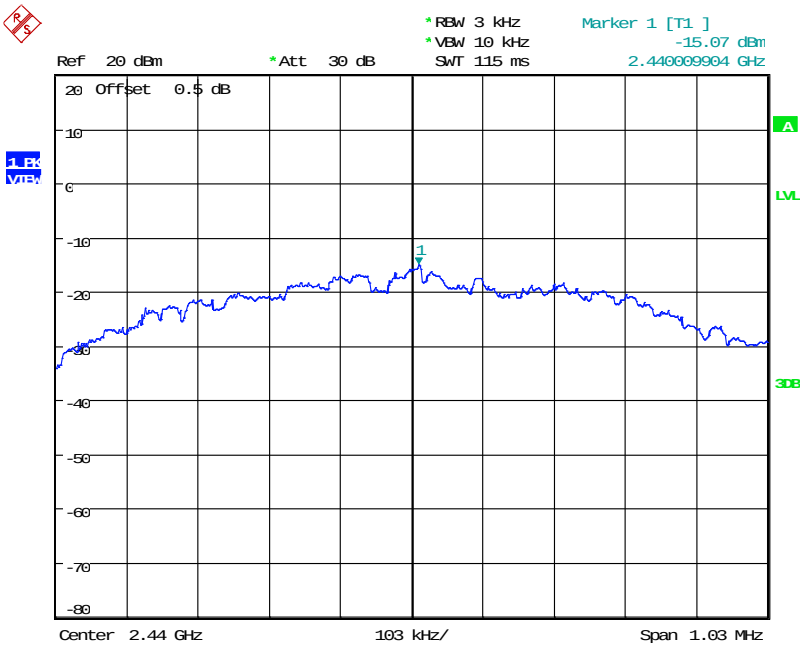
Please refer to the following plots

BLE mode:

Low Channel

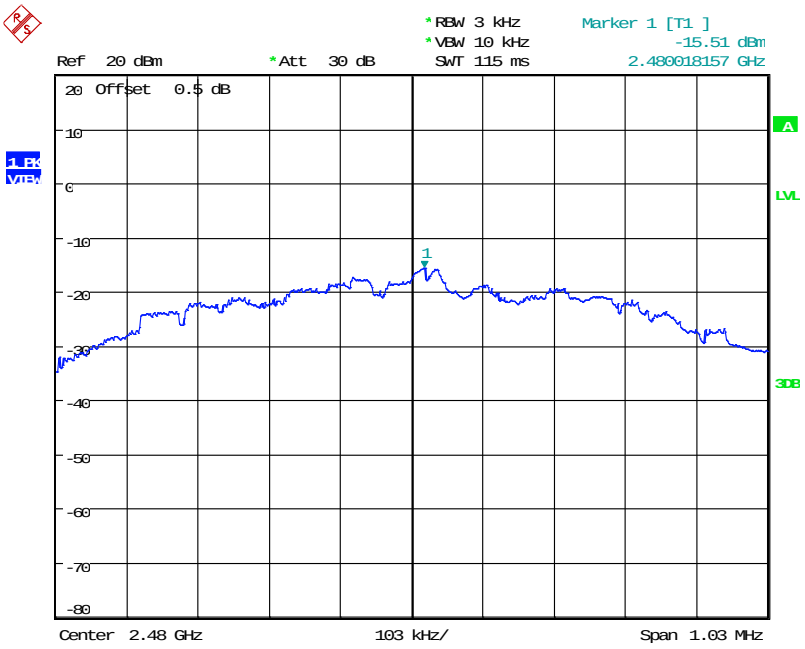


Middle Channel



Date: 15.MAR.2018 00:16:01

High Channel



Date: 15.MAR.2018 00:20:35

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