FCC Part 15.247

TEST REPORT

For

InnovArt Design Inc. (TW)

B1F., No. 121, Ln. 296, Sec. 6, Minquan E. Rd., Neihu Dist., Taipei City 114, Taiwan (R.O.C.)

FCC ID: 2ATGJCARWINK001A

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Product Type:	**LED Emoji Display**
Report Number :	**RLK190326001-00B**
Report Date :	**2019/06/17**
Reviewed By:	**Jerry Chang** Jerry Chang

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***Note**: This test report is prepared for the customer shown above and for the device described herein. It may not be duplicated or used in part without prior written consent from Bay Area Compliance Laboratories Corp. (Taiwan)*

Revision History

Revision	Report Number	Issue Date	Description	Author/Revised by
1.0	RLK190326001-00B	2019/06/17	Original Report	Himiko Chen

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1 General Information

1.1 Product Description for Equipment under Test (EUT)

Applicant	**InnovArt Design Inc. (TW)** B1F., No. 121, Ln. 296, Sec. 6, Minquan E. Rd., Neihu Dist., Taipei City 114, Taiwan (R.O.C.)
Manufacturer	**SlingX Corp** 2F, No15, Yijiang Street, Zhongshan Dist. 10456, Taipei, Taiwan
Brand(Trade) Name	CarWink
Product (Equipment)	LED Emoji Display
Model Name	**CARWINK001A**
EUT Function	BT4.1 (BLE only)
Frequency Range	2402 ~ 2480 MHz
Number of Channels	40 Channels
Output Power	-3.64 dBm (0.00043 W)
Received Date	Mar. 26, 2019
Date of Test	Apr. 11, 2019 ~ Apr. 22, 2019
Modulation Type	GFSK

**All measurement and test data in this report was gathered from production sample serial number: 190326001 (Assigned by BACL, Taiwan).*

1.2 Operation Condition of EUT

Power Operation (Voltage Range)	☐ AC 120V/60Hz ☐ Adapter ☐ By Power Core
	☐ DC Type ☐ DC Power Supply ☒ Battery : *Brand Name: J.S. Power Co., LTD.* *Model: SlingX03* *3.7V ⎓ 3000mAh* ☒ External from USB Cable: 5Vdc ☐ External DC Adapter
	☐ Host System

1.3 Objective and Test Methodology

The Objective of this Test Report was to document the compliance of the InnovArt Design Inc. (TW) Appliance (Model: CARWINK001A) to the requirements of the following Standards:

- Part 2, Subpart J, Part 15, Subparts A and C, section 15.247 of the Federal Communication Commission's rules.

- ANSI C63.10-2013 of t American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

- KDB 558074 of "GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUMSYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES"

1.4 Measurement Uncertainty

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	± 2.66 dB
Radiated Below 1G	±3.57 dB
Radiated Above 1G-18G	± 4.29 dB
Radiated Above 18G-40G	± 4.67 dB

1.5 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.

The test site has been approved by the FCC under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database. The FCC Registration No.: 974454. Designation No.: TW3180

2 System Test Configuration

2.1 Test Channels and Description of Worst Test Configuration

The system was configured for testing in testing mode which was provided by manufacturer.

No special accessory, No modification was made to the EUT and No special equipment used during test.

For BLE mode, there are totally 40 channels.

Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	**2402**	20	2442
2	2404	---	---
3	2406	---	---
4	2408	37	2476
---	---	38	2478
19	**2440**	**39**	**2480**

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 Peak power and PSD across all date rates bandwidths, and modulations.
Radiated below 1G were tested worst output power mode. The mode charging via USB was worst that evaluation charging via USB and Battery..

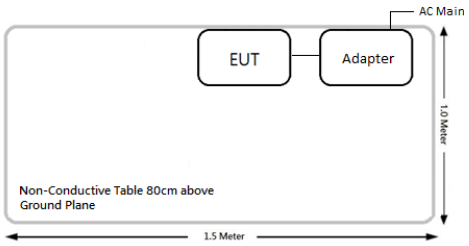
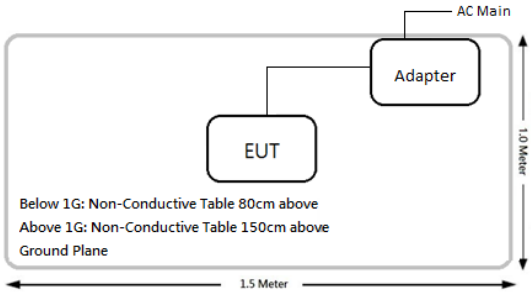
Modulation Used for Conformance Test			
Configuration	**NTX**	**Data Rate**	**Worst Data Rate**
BLE mode	1	125 kbps-1 Mbps	1 Mbps

Worst Case of Power Setting				
EUT Exercise Software		**nRFgo Studio**		
Configuration	**NTX**	**Low CH**	**Mid CH**	**High CH**
BLE mode	1	Default	Default	Default

2.2 Support Equipment List and External Cable List

No.	Description	Manufacturer	Model Number	BSMI	FCC ID / DoC
A	Adapter	DVE	DSA-5PFU1-05	NA	DoC
B	Adapter	Apple	A1385	N/A	DoC

2.3 Block Diagram of Test Setup

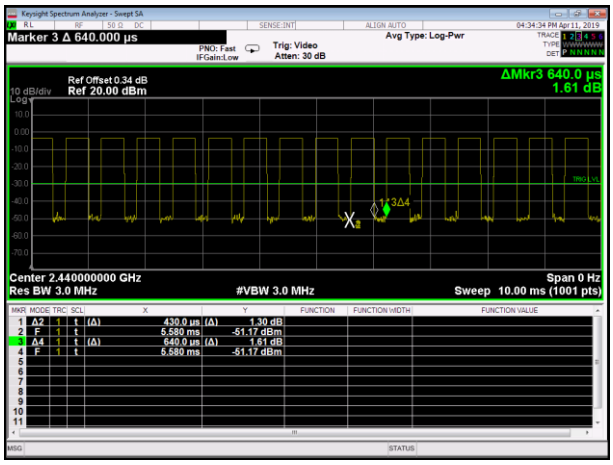
Conduction	Radiation
	

2.4 Duty Cycle

According to KDB 558074 D01 15.247 Meas Guidance v05r02:

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	0.43	0.64	67.19%	1.73

BLE mode	-
	-

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

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 15.247(i)and 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/4πR^2 = power density (in appropriate units, e.g. mW/cm2);

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)			
BLE	2402-2480	0.5	1.122	-3.00	0.501	20	0.0001	1

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 6dBi

5.2 Antenna List and Details

Manufacturer	Model	Antenna Type	Antenna Gain	Result
ACX	AT3216-B2R7HAAT	Chip Antenna	0.5	Compliance

The EUT has an internal antenna arrangement, which was permanently attached, fulfill the requirement of this section.

6 FCC §15.207 - AC Line Conducted Emissions

6.1 Applicable Standard

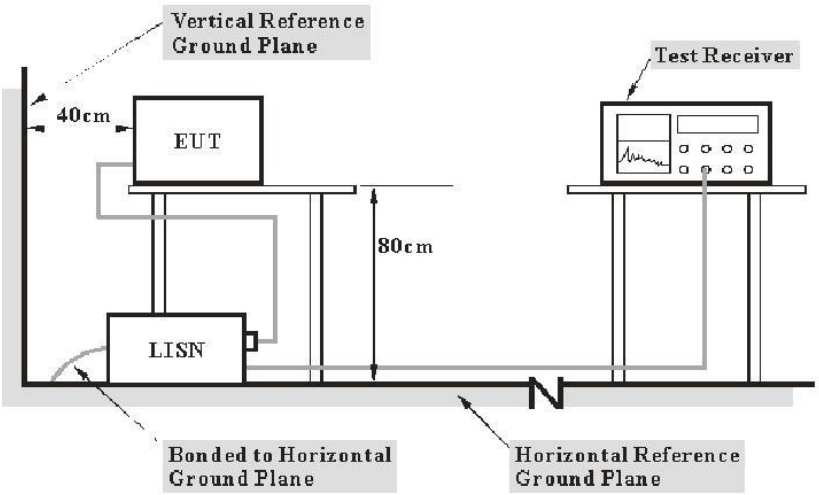
According to FCC §15.207

For an intentional radiator 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, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequencies ranges.

Channel	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15-0.5	66 to 56 Note 1	56 to 46 Note 2
0.5-5	56	46
5-30	60	50

Note 1: Decreases with the logarithm of the frequency. Note 2: A linear average detector is required

6.2 EUT Setup and Test Procedure



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.

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30MHz. 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

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.

6.3 Test Equipment List and Details

Description	Manufacture	Model	Serial No.	Cal. Date.	Cal. Due.
Conduction Room					
LISN	Rohde & Schwarz	ENV216	101612	2019/02/21	2020/02/20
LISN	Rohde & Schwarz	ENV216	101248	2018/06/27	2019/06/26
EMI Test Receiver	Rohde & Schwarz	ESR7	101419	2018/10/23	2019/10/22
Pulse Limiter	Rohde & Schwarz	ESH3Z2	TXZEM104	2018/08/03	2019/08/02
RF Cable	EMEC	EM-CB5D	001	2018/07/02	2019/07/01
Software	AUDIX	e3	V9.150826k	N.C.R	N.C.R

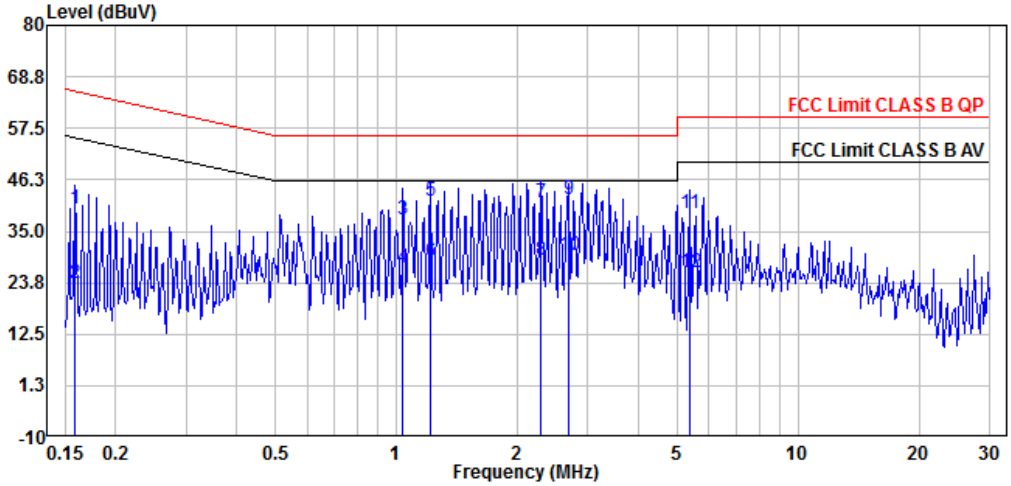
***Statement of Traceability:** The testing equipment's listed above have finished the calibration by Electronics Testing Center, Taiwan (ETC) or other laboratories which were accredited by TAF or equivalent organizations. The calibration result could be traceable to the International System of Units (SI).*

6.4 Test Environmental Conditions

Temperature:	20~25 ℃	**Relative Humidity:**	40~45 %
ATM Pressure:	1010hPa	**Test Engineer:**	Ray Huang
Test Date:	2019-04-12		

6.5 AC Line Conducted Emission Test Plot and Data

Mode: AC 120 V/60 Hz, BLE mode, Line



	Freq	Read Level	Level	Factor	Limit Line	Over Limit	Remark
	MHz	dBuV	dBuV	dB	dBuV	dB	
1	0.159	20.01	39.88	19.87	65.54	-25.66	QP
2	0.159	3.63	23.50	19.87	55.54	-32.04	Average
3	1.040	17.56	37.46	19.90	56.00	-18.54	QP
4	1.040	7.08	26.98	19.90	46.00	-19.02	Average
5	1.219	21.57	41.48	19.91	56.00	-14.52	QP
6	1.219	8.36	28.27	19.91	46.00	-17.73	Average
7	2.288	21.24	41.21	19.97	56.00	-14.79	QP
8	2.288	8.62	28.59	19.97	46.00	-17.41	Average
9	2.683	22.08	42.05	19.97	56.00	-13.95	QP
10	2.683	9.83	29.80	19.97	46.00	-16.20	Average
11	5.367	18.89	38.91	20.02	60.00	-21.09	QP
12	5.367	5.84	25.86	20.02	50.00	-24.14	Average

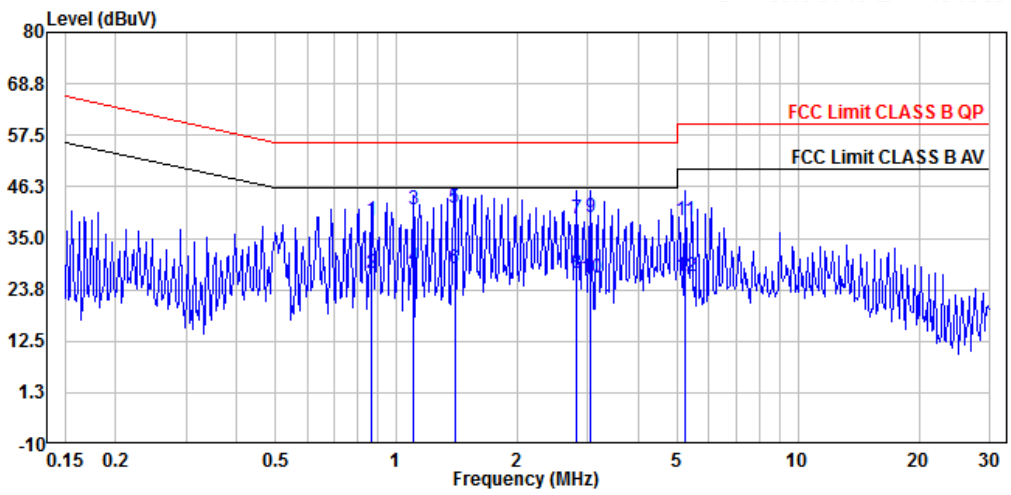
Note:

Level = Read Level + Factor

Over Limit (Margin) = Level – Limit Line

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

Mode: AC 120 V/60 Hz, BLE mode, Neutral



	Freq	Read Level	Level	Factor	Limit Line	Over Limit	Remark
	MHz	dBuV	dBuV	dB	dBuV	dB	
1	0.866	18.97	38.87	19.90	56.00	-17.13	QP
2	0.866	7.44	27.34	19.90	46.00	-18.66	Average
3	1.099	21.44	41.35	19.91	56.00	-14.65	QP
4	1.099	8.78	28.69	19.91	46.00	-17.31	Average
5	1.396	21.72	41.64	19.92	56.00	-14.36	QP
6	1.396	8.55	28.47	19.92	46.00	-17.53	Average
7	2.815	19.30	39.28	19.98	56.00	-16.72	QP
8	2.815	7.50	27.48	19.98	46.00	-18.52	Average
9	3.048	19.48	39.47	19.99	56.00	-16.53	QP
10	3.048	6.33	26.32	19.99	46.00	-19.68	Average
11	5.240	19.05	39.07	20.02	60.00	-20.93	QP
12	5.240	6.52	26.54	20.02	50.00	-23.46	Average

Note:

Level = Read Level + Factor

Over Limit (Margin) = Level – Limit Line

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 1MHz.

As Per FCC §15.205(a) 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	13.36-13.41	399.9-410	4.5-5.15
0.495-0.505	16.42-16.423	608-614	5.35-5.46
2.1735-2.1905	16.69475-16.69525	960-1240	7.25-7.75
4.125-4.128	25.5-25.67	1300-1427	8.025-8.5
4.17725-4.17775	37.5-38.25	1435-1626.5	9.0-9.2
4.20725-4.20775	73-74.6	1645.5-1646.5	9.3-9.5
6.215-6.218	74.8-75.2	1660-1710	10.6-12.7
6.26775-6.26825	108-121.94	1718.8-1722.2	13.25-13.4
6.31175-6.31225	123-138	2200-2300	14.47-14.5
8.291-8.294	149.9-150.05	2310-2390	15.35-16.2
8.362-8.366	156.52475-156.52525	2483.5-2500	17.7-21.4
8.37625-8.38675	156.7-156.9	2690-2900	22.01-23.12
8.41425-8.41475	162.0125-167.17	3260-3267	23.6-24.0
12.29-12.293	167.72-173.2	3332-3339	31.2-31.8
12.51975-12.52025	240-285	3345.8-3358	36.43-36.5
12.57675-12.57725	322-335.4	3600-4400	Above 38.6

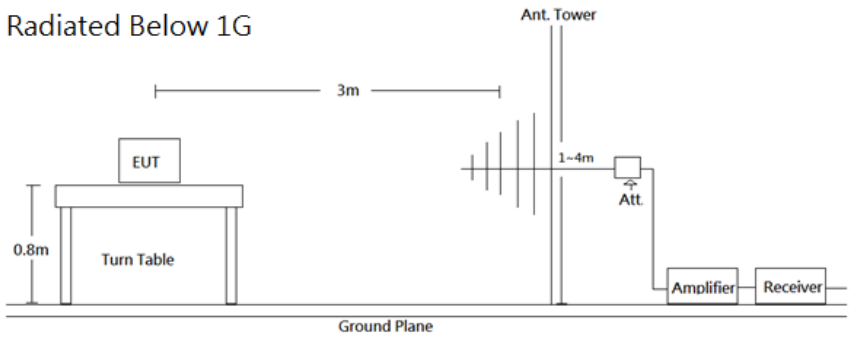
As per FCC §15.209(a): Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

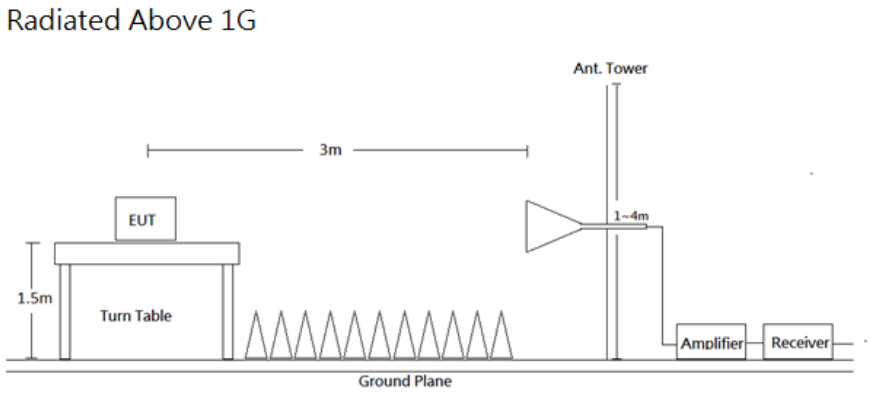
Frequency (MHz)	Field Strength (micro volts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

** 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 470-806MHz. 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 20dB. 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 and Test Procedure





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.

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

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.

7.3 Test Equipment List and Details

Description	Manufacture	Model	Serial No.	Cal. Date.	Cal. Due.
966A Room					
Bilog Antenna with 6 dB Attenuator	SUNOL SCIENCES & MINI-CIRCUITS	JB6/UNAT-6+	A050115/15542_01	2018/12/11	2019/12/10
Horn Antenna	ETS-Lindgren	3115	00040736	2019/03/22	2020/03/21
Horn Antenna	ETS-Lindgren	3116	62638	2018/08/29	2019/08/28
Preamplifier	Sonoma	310N	130602	2018/07/04	2019/07/03
Preamplifier	EM Electronics Corp.	EM01G18G	060657	2018/12/07	2019/12/06
Microware Preamplifier	EM Electronics Corporation	EM18G40G	060656	2019/01/11	2020/01/10
EMI Test Receiver	Rohde & Schwarz	ESR7	101419	2018/10/23	2019/10/22
Signal Analyzer	Rohde & Schwarz	FSV40	101435	2019/02/14	2020/02/13
Micro flex Cable	UTIFLEX	FSCM 64639 / (2M)	93D0127	2018/07/31	2019/07/30
Micro flex Cable	UTIFLEX	UFA210A-1-3149-300300	MFR64639 226389-001	2018/11/16	2019/11/15
Micro flex Cable	ROSNOL	K1K50-UP0264-K1K50-450CM	160309-1	2019/03/04	2020/03/03
Micro flex Cable	ROSNOL	K1K50-UP0264-K1K50-80CM	160309-2	2019/01/16	2020/01/15
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	AUDIX	e3	E3LK-01	N.C.R	N.C.R
Conducted Room					
Signal Analyzer	Agilent	N9010A	US47140126	2019/03/27	2020/03/26
Cable	WOKEN	SFL402	S02-160323-07	2019/02/11	2020/02/10

***Statement of Traceability:** The testing equipment's listed above have finished the calibration by Electronics Testing Center, Taiwan (ETC) or other laboratories which were accredited by TAF or equivalent organizations. The calibration result could be traceable to the International System of Units (SI).*

7.4 Test Environmental Conditions

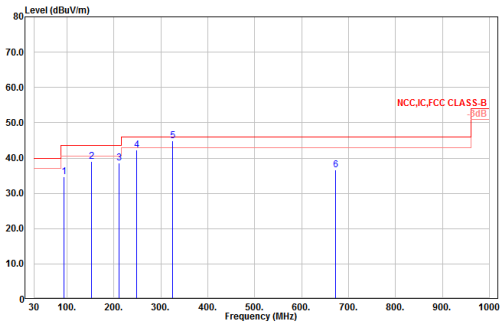
Temperature:	20~25 ℃	**Relative Humidity:**	50~55 %
ATM Pressure:	1014 hPa	**Test Engineer:**	Leo Chang
Conducted Test Date:	2019-04-11	**Radiated Test Date:**	2019-04-12

7.5 Radiated Emission Test Plot and Data

Transmitting mode (Pre-scan with three orthogonal axis, and worse case as Z axis)

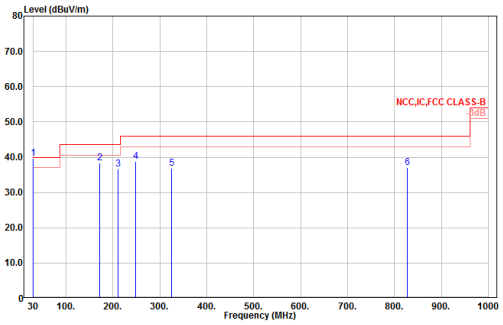
Below 1G (30 MHz-1 GHz) test the output power worst mode: High Channel

Horizontal



	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m		
1	94.020	34.74	43.50	-8.76	56.66	-21.92	Peak	horizontal
2	153.190	39.08	43.50	-4.42	57.42	-18.34	Peak	horizontal
3	211.390	38.61	43.50	-4.89	59.02	-20.41	Peak	horizontal
4	249.220	42.33	46.00	-3.67	61.75	-19.42	Peak	horizontal
5 !	325.850	44.80	46.00	-1.20	62.04	-17.24	QP	horizontal
6	672.140	36.56	46.00	-9.44	47.36	-10.80	Peak	horizontal

Vertical



	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark	Pol/Phase
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m		
1 !	30.000	39.77	40.00	-0.23	45.60	-5.83	QP	vertical
2	172.590	38.36	43.50	-5.14	57.89	-19.53	Peak	vertical
3	211.390	36.70	43.50	-6.80	57.11	-20.41	Peak	vertical
4	249.220	38.71	46.00	-7.29	58.13	-19.42	Peak	vertical
5	325.850	36.94	46.00	-9.06	54.18	-17.24	Peak	vertical
6	826.370	36.98	46.00	-9.02	45.79	-8.81	Peak	vertical

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

Above 1G (1 GHz-26.5 GHz)

BLE mode:

Low CH

Horizontal

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2318.670	40.51	54.00	-13.49	47.91	-7.40	Average
2318.670	48.50	74.00	-25.50	55.86	-7.36	Peak
2401.800	89.40			96.86	-7.46	Average
2401.800	90.51			97.97	-7.46	Peak
4804.000	43.17	54.00	-10.83	42.44	0.73	Average
4804.000	49.26	74.00	-24.74	48.53	0.73	Peak
7206.000	36.87	54.00	-17.13	31.65	5.22	Average
7206.000	48.87	74.00	-25.13	43.65	5.22	Peak

Vertical

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2318.874	36.90	54.00	-17.10	44.26	-7.36	Average
2318.874	46.35	74.00	-27.65	53.71	-7.36	Peak
2402.412	88.62			96.08	-7.46	Average
2402.412	89.68			97.14	-7.46	Peak
4804.000	42.12	54.00	-11.88	41.39	0.73	Average
4804.000	49.16	74.00	-24.84	48.43	0.73	Peak
7206.000	36.57	54.00	-17.43	31.35	5.22	Average
7206.000	47.57	74.00	-26.43	42.35	5.22	Peak

Middle CH

Horizontal

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2311.920	43.37	54.00	-10.63	50.72	-7.35	Average
2311.920	50.44	74.00	-23.56	57.79	-7.35	Peak
2440.080	88.05			95.55	-7.50	Average
2440.080	89.21			96.71	-7.50	Peak
2548.560	37.09	54.00	-16.91	44.49	-7.40	Average
2548.560	46.01	74.00	-27.99	53.41	-7.40	Peak
4880.000	44.39	54.00	-9.61	43.44	0.95	Average
4880.000	50.88	74.00	-23.12	49.93	0.95	Peak
7320.000	37.59	54.00	-16.41	31.94	5.65	Average
7320.000	48.59	74.00	-25.41	42.94	5.65	Peak

Vertical

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2311.920	38.85	54.00	-15.15	46.20	-7.35	Average
2311.920	47.38	74.00	-26.62	54.73	-7.35	Peak
2440.080	87.89			95.39	-7.50	Average
2440.080	89.01			96.51	-7.50	Peak
2548.560	37.28	54.00	-16.72	44.77	-7.49	Average
2548.560	46.15	74.00	-27.85	53.55	-7.40	Peak
4880.000	43.95	54.00	-10.05	43.00	0.95	Average
4880.000	50.72	74.00	-23.28	49.77	0.95	Peak
7320.000	37.76	54.00	-16.24	32.11	5.65	Average
7320.000	48.76	74.00	-25.24	43.11	5.65	Peak

High CH

Horizontal

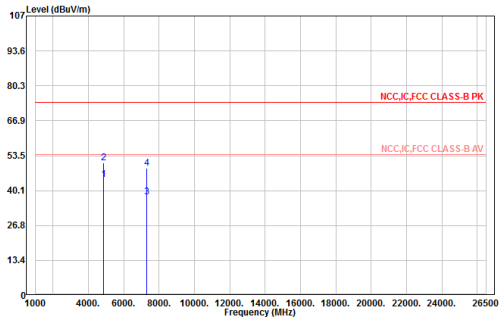
Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2480.268	86.51			93.99	-7.48	Average
2480.268	87.62			95.10	-7.48	Peak
2483.500	34.95	54.00	-19.05	42.43	-7.48	Average
2483.500	53.31	74.00	-20.69	60.79	-7.48	Peak
4960.000	45.51	54.00	-8.49	44.50	1.01	Average
4960.000	52.44	74.00	-21.56	51.43	1.01	Peak
7440.000	37.85	54.00	-16.15	31.74	6.11	Average
7440.000	48.27	74.00	-25.73	42.16	6.11	Peak

Vertical

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2479.800	87.05			94.53	-7.48	Average
2479.800	88.16			95.64	-7.48	Peak
2483.500	35.15	54.00	-18.85	42.63	-7.48	Average
2483.500	52.76	74.00	-21.24	60.24	-7.48	Peak
4960.000	43.86	54.00	-10.14	42.85	1.01	Average
4960.000	51.65	74.00	-22.35	50.64	1.01	Peak
7440.000	38.65	54.00	-15.35	32.54	6.11	Average
7440.000	49.34	74.00	-24.66	43.23	6.11	Peak

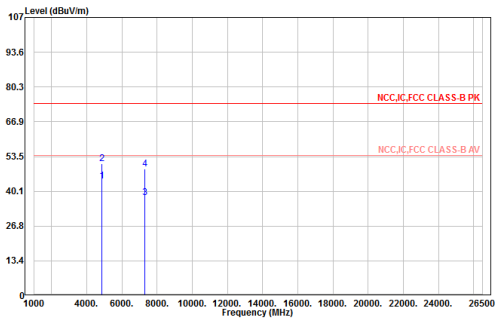
Above 1G (1 GHz-26.5 GHz): test the output power worst mode: High Channel

Horizontal



		Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark	Pol/Phase
		MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m		
1	!	4880.000	44.39	54.00	-9.61	43.44	0.95	Average	horizontal
2		4880.000	50.88	74.00	-23.12	49.93	0.95	Peak	horizontal
3	!	7320.000	37.59	54.00	-16.41	31.94	5.65	Average	horizontal
4		7320.000	48.59	74.00	-25.41	42.94	5.65	Peak	horizontal

Vertical



		Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark	Pol/Phase
		MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m		
1	!	4880.000	43.95	54.00	-10.05	43.00	0.95	Average	vertical
2		4880.000	50.72	74.00	-23.28	49.77	0.95	Peak	vertical
3	!	7320.000	37.76	54.00	-16.24	32.11	5.65	Average	vertical
4		7320.000	48.76	74.00	-25.24	43.11	5.65	Peak	vertical

Result = Reading + Correct Factor

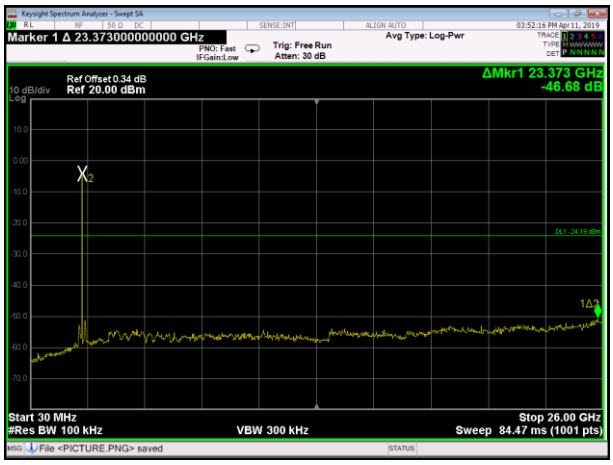
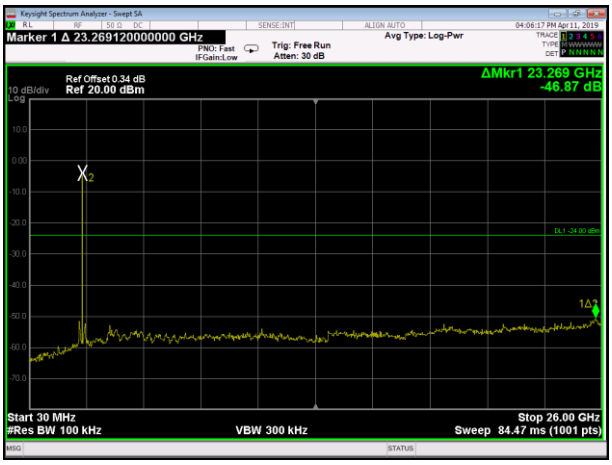
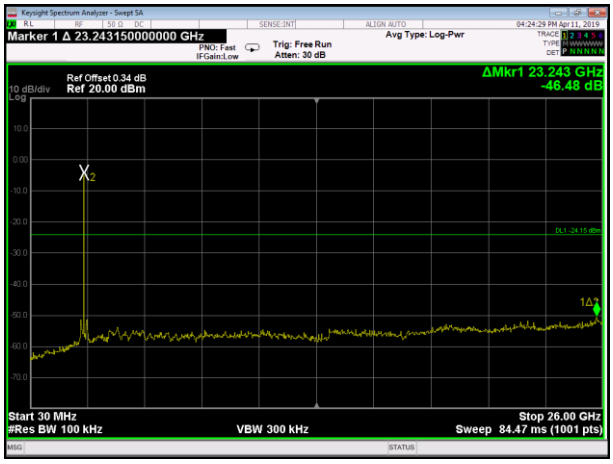
Margin = Result – Limit

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	46.68	≥ 20	Compliance
Mid	2440	46.87	≥ 20	Compliance
High	2480	46.48	≥ 20	Compliance

Low CH	Middle CH
	
High CH	**-**
	-

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, the steps for the first option are as follows:

(1) Set RBW = 100 kHz. (2) Set the VBW ≥ [3 × RBW]. (3) Detector = peak. (4) Trace mode = max hold.

(5) Sweep = auto couple. (6) Allow the trace to stabilize. (7) 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

Description	Manufacture	Model	Serial No.	Cal. Date.	Cal. Due.
Conducted Room					
Signal Analyzer	Agilent	N9010A	US47140126	2019/03/27	2020/03/26
Cable	WOKEN	SFL402	S02-160323-07	2019/02/11	2020/02/10

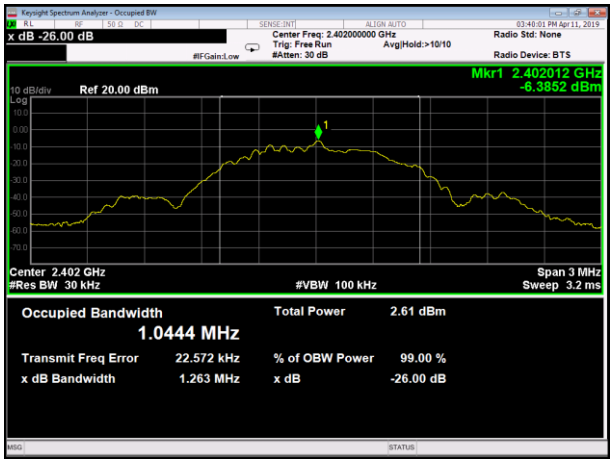
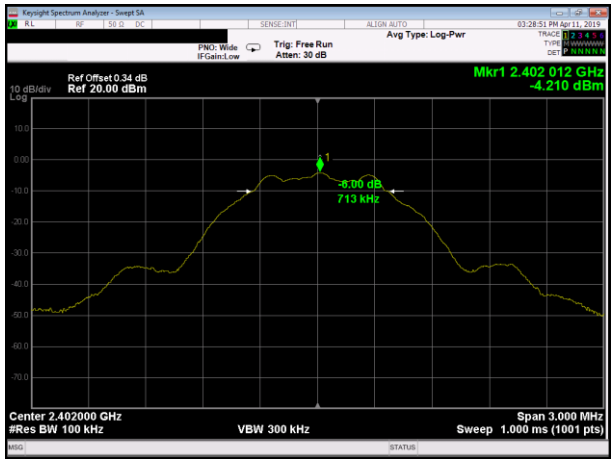
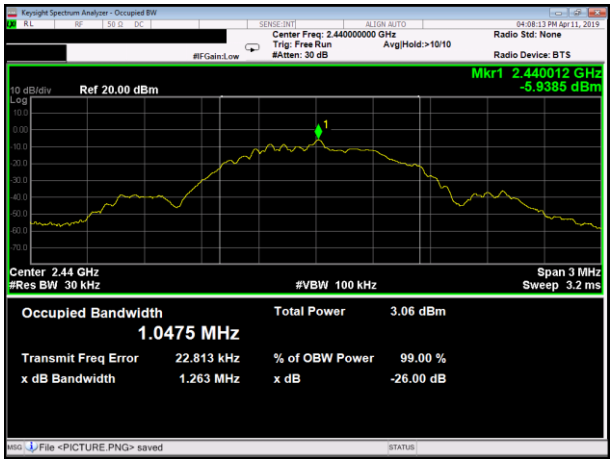
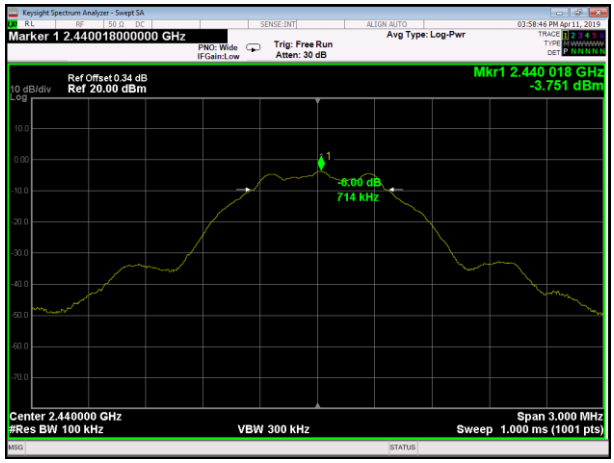
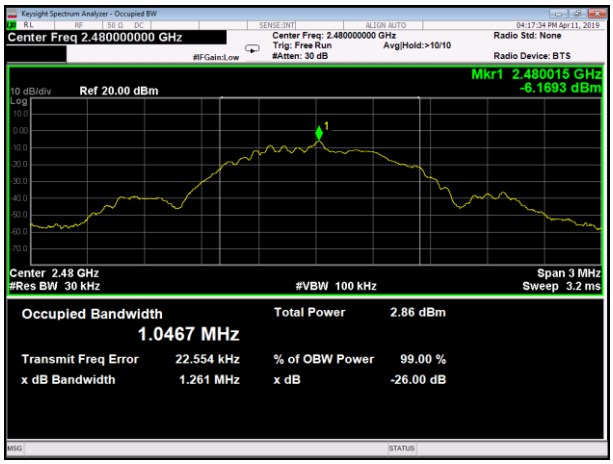
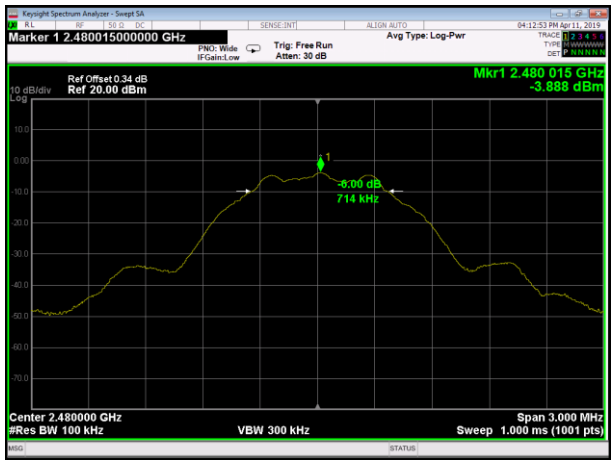
***Statement of Traceability:** The testing equipment's listed above have finished the calibration by Electronics Testing Center, Taiwan (ETC) or other laboratories which were accredited by TAF or equivalent organizations. The calibration result could be traceable to the International System of Units (SI).*

8.4 Test Environmental Conditions

Temperature:	20~25 ℃	**Relative Humidity:**	50~55 %
ATM Pressure:	1015 hPa	**Test Engineer:**	Leo Cheng
Conducted Test Date:	2019-04-11	-	-

8.5 Test Results

Channel	Frequency (MHz)	99% OBW (MHz)	6 dB BW (MHz)	6dB Limit (MHz)	Result
BLE mode					
Low	2402	1.0444	0.7130	> 0.5	Compliance
Middle	2440	1.0475	0.7140	> 0.5	Compliance
High	2480	1.0467	0.7140	> 0.5	Compliance

99% OBW Low CH	6 dB BW Low CH
	
99% OBW Middle CH	**6 dB BW Middle CH**
	
99% OBW High CH	**6 dB BW High CH**
	

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. (3). Add a correction factor to the display.

9.3 Test Equipment List and Details

Description	Manufacture	Model	Serial No.	Cal. Date.	Cal. Due.
Conducted Room					
Power Sensor	KEYSIGHT	U2021XA	MY54080018	2019/03/06	2020/03/05
Cable	WOKEN	SFL402	S02-160323-07	2019/02/11	2020/02/10

***Statement of Traceability:** The testing equipment's listed above have finished the calibration by Electronics Testing Center, Taiwan (ETC) or other laboratories which were accredited by TAF or equivalent organizations. The calibration result could be traceable to the International System of Units (SI).*

9.4 Test Environmental Conditions

Temperature:	20~25 ℃	**Relative Humidity:**	50~55 %
ATM Pressure:	1014 hPa	**Test Engineer:**	Leo Cheng
Conducted Test Date:	2019-04-11	-	-

9.5 Test Results

Channel	Frequency (MHz)	Peak Output Power (dBm)	Total Peak Output Power (W)	Limit (dBm)	Result
BLE mode					
Low	2402	-3.76	0.00042	30	Compliance
Middle	2440	-3.71	0.00042	30	Compliance
High	2480	-3.64	0.00043	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.

10.3 Test Equipment List and Details

Description	Manufacture	Model	Serial No.	Cal. Date.	Cal. Due.
Conducted Room					
Signal Analyzer	Agilent	N9010A	US47140126	2019/03/27	2020/03/26
Cable	WOKEN	SFL402	S02-160323-07	2019/02/11	2020/02/10

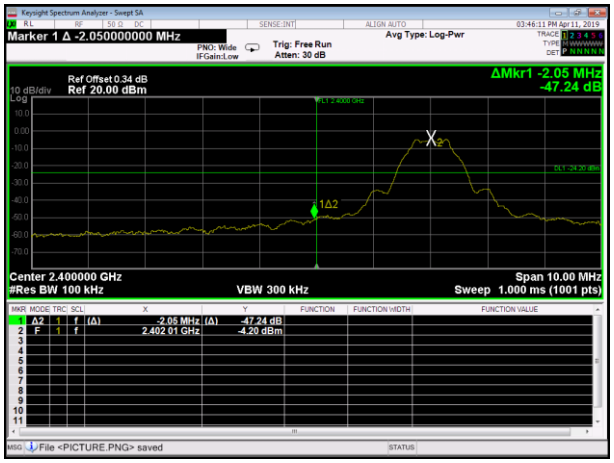
***Statement of Traceability:** The testing equipment's listed above have finished the calibration by Electronics Testing Center, Taiwan (ETC) or other laboratories which were accredited by TAF or equivalent organizations. The calibration result could be traceable to the International System of Units (SI).*

10.4 Test Environmental Conditions

Temperature:	20~25 ℃	**Relative Humidity:**	50~55 %
ATM Pressure:	1014 hPa	**Test Engineer:**	Leo Cheng
Conducted Test Date:	2019-04-11~2019-04-22	-	-

10.5 Test Results

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
BLE mode				
Low	2402	47.24	≥ 20	Compliance
High	2480	49.96	≥ 20	Compliance

Left Side	Right Side
	

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,

(1) Set analyzer center frequency to DTS channel center frequency.

(2) Set the span to 1.5 times the DTS bandwidth. (3) Set the RBW to 3 kHz ≤ RBW ≤ 100 kHz.

(4) Set the VBW ≥ [3 × RBW]. (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 amplitude level within the RBW.

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

11.3 Test Equipment List and Details

Description	Manufacture	Model	Serial No.	Cal. Date.	Cal. Due.
Conducted Room					
Signal Analyzer	Agilent	N9010A	US47140126	2019/03/27	2020/03/26
Cable	WOKEN	SFL402	S02-160323-07	2019/02/11	2020/02/10

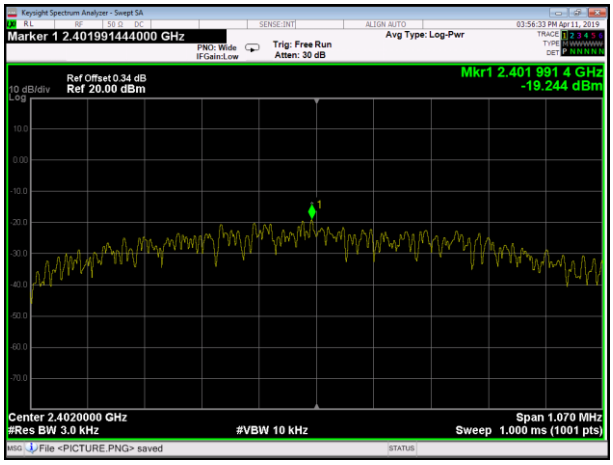
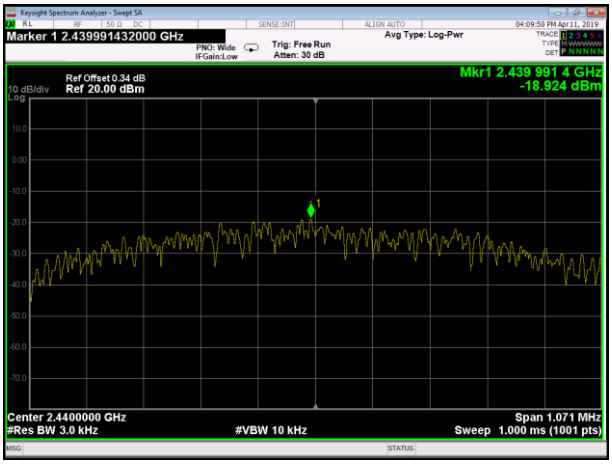
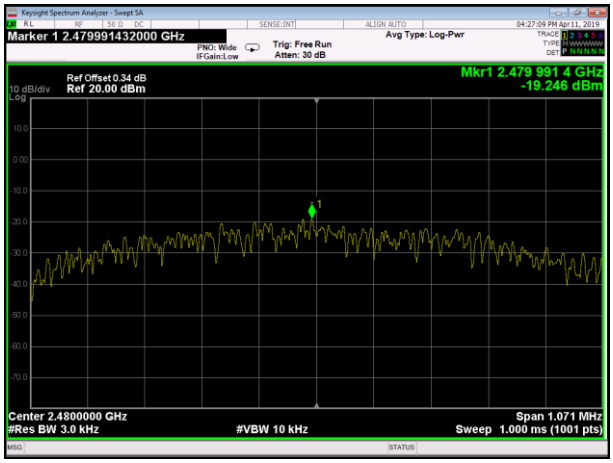
***Statement of Traceability:** The testing equipment's listed above have finished the calibration by Electronics Testing Center, Taiwan (ETC) or other laboratories which were accredited by TAF or equivalent organizations. The calibration result could be traceable to the International System of Units (SI).*

11.4 Test Environmental Conditions

Temperature:	20~25 ℃	**Relative Humidity:**	50~55 %
ATM Pressure:	1014 hPa	**Test Engineer:**	Leo Cheng
Conducted Test Date:	2019-04-11	-	-

11.5 Test Results

Channel	Frequency (MHz)	PSD (dBm/3 kHz)	Limit (dBm/3 kHz)	Result
BLE mode				
Low	2402	-19.244	8	Compliance
Middle	2440	-18.924	8	Compliance
High	2480	-19.246	8	Compliance

Low CH	Middle CH
	
High CH	**-**
	-

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