Testing Laboratory
3546

FCC Part 15.247

RSS-247 Issue 2, Feb 2017; RSS-Gen Issue 5, Mar 2019

TEST REPORT

For

Redpine Signals Inc

2107 N First Street, Suite 540, San Jose, CA 95131-2019, USA

FCC ID: XF6-M7DB7
IC: 8407A-M7DB7

Report Type	**CIIPC Report**
Product Name:	**Dual Band 802.11 a/b/g/n, Bluetooth 5.0 SIP Module**
Model Name:	**M7DB**
Report Number :	**RLK200519001-00A**
Report Date :	**2020/07/02**
Reviewed By :	**Zeus Chen** Zeus Chen
Prepared By:	
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Revision History

Revision	Report Number	Issue Date	Description
1.0	RLK200519001-00A	2020/07/02	CIIPC Report[Note1]

Note1: The original report number is RLK200203002-00B, and the CIIPC report is for adding antenna (PIFA Antenna (MARS-31A8 WiFi Antenna))

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1 General Information

1.1 Product Description for Equipment under Test (EUT)

Applicant	**Redpine Signals Inc** 2107 N First Street, Suite 540, San Jose, CA 95131-2019, USA
Manufacturer	**Redpine Signals Inc** 2107 N First Street, Suite 540, San Jose, CA 95131-2019, USA
Brand Name	REDPINE SIGNALS DRIVING WIRELESS CONVERGENCE
Product (Equipment)	**Dual Band 802.11 a/b/g/n, Bluetooth 5.0 SIP Module**
Model Name	**M7DB**
Frequency Range	2402 - 2480 MHz
Number of Channels	40 Channels
Output Power	**<PIFA Antenna: MARS-31A8 WiFi Antenna>** BLE 1Mbps: 16.34 dBm (0.0431 W) BLE 2Mbps: 16.98 dBm (0.0499 W)
Modulation Type	GFSK
Related Submittal(s)/Grant(s)	**FCC Part 15.247 DTS with FCC ID: XF6-M7DB7** **FCC Part 15.247 DSS with FCC ID: XF6-M7DB7** **FCC Part 15.247 NII with FCC ID: XF6-M7DB7** **IC RSS-247 DTS with IC: 8407A-M7DB7** **IC RSS-247 FHSS with IC: 8407A-M7DB7** **IC RSS-247 LE-LAN with IC: 8407A-M7DB7**
Received Date	2020-05-19
Date of Test	2020-06-02 – 2020-06-23

**All measurement and test data in this report was gathered from production sample serial number: 190914002(Assigned by BACL, Linkou Laboratory).*

1.2 Operation Condition of EUT

Power Operation (Voltage Range)	☐ AC 120 V/60 Hz ☐ Adapter ☐ By Power Cord.
	☒ DC Type ☒ DC Power Supply: 3.3V ☐ Battery: ☐ External from USB Cable ☐ External DC Adapter
	☐ Host System

1.3 Objective and Test Methodology

The Objective of this Test Report was to document the compliance of the Redpine Signals Inc. Appliance (Model: M7DB) 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.
- RSS-Gen Issue 5, Mar 2019— General Requirements for Compliance of Radio Apparatus
- RSS-247 Issue 2, Feb 2017— Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

1.4 Measurement Uncertainty

Parameter	Expanded Measurement uncertainty
RF output power	± 1.488 dB
Occupied Channel Bandwidth	± 453.927 Hz
RF Conducted Emission test	± 2.77 dB
AC Power Line Conducted Emission	± 2.66 dB
Radiated Below 1G	± 3.57 dB
Radiated Above 1G	± 5.32 dB

The test results with statement of conformity, the decision rules are based on the specifications and standards. The test results will not take the measurement uncertainty into account.

1.5 Environmental Conditions and Test Date

Test Site	Test Date	Temperature (°C)	Relative Humidity (% RH)	Test Engineer
Radiated (966A)	2020-06-02 to 2020-06-15	19.8-20.6	49-56	Leo Cheng
Conducted (TH-02)	2020-06-06 to 2020-06-23	23.1-23.5	56-61	Blake Wang

1.6 Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Linkou Laboratory) to collect test data is located on

☒ No.6, Wende 2Rd., Guishan Dist., Taoyuan City 33382, Taiwan (R.O.C.).

Bay Area Compliance Laboratories Corp. (Linkou Laboratory) Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code: 3546) by Mutual Recognition Agreement (MRA). 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.: 0027578244. Designation No.: TW3546. The Test Firm Registration No.: 181430.

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, there are totally 40 channels.

Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	**2402**	20	2442
1	2404	--	--
2	2406	--	--
3	2408	37	2476
--	--	38	2478
19	**2440**	**39**	**2480**

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

Modulation Used for Conformance Test			
Configuration	**NTX**	**Data Rate**	**Worst Data Rate**
BLE-1M	1	125 kbps-1 Mbps	1 Mbps
BLE-2M	1	125 kbps-2 Mbps	2 Mbps

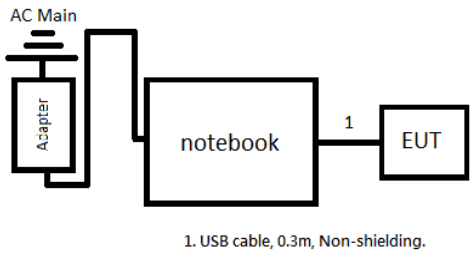
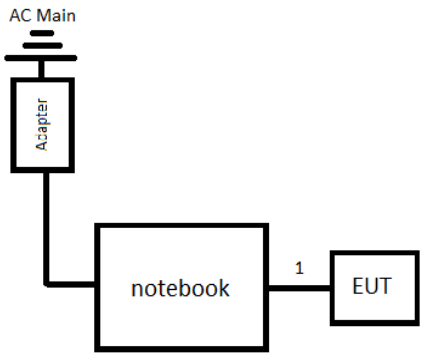
Worst Case of Power Setting				
EUT Exercise Software	FCC_PER_TEST_GUI.py			
PIFA Antenna (MARS-31A8 WiFi Antenna)				
Configuration	**NTX**	**Low CH**	**Mid CH**	**High CH**
BLE-1Mbps mode	1	12	13	16
BLE-2Mbps mode	1	14	15	17

2.2 Support Equipment List and External Cable List

No.	Description	Manufacturer	Model Number
A	Notebook	DELL	Inspiron 15
B	Adapter	Chicony Power	HA65NS5-00 (DELL)

No.	Cable Description	Shielding Type	Length (m)	From	To
1	USB Cable	Non-Shielded	1	EUT	NB

2.3 Block Diagram of Test Setup

Conduction	Radiation
	

2.4 Duty Cycle

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-1Mbps	100	100	100	0.00
BLE-2Mbps	100	100	100	0.00

Note1: Adding antenna not affect the duty result, please refer to the original report. (Report No.: RLK200203002-00B)

3 Summary of Test Results

FCC/ISED Rules	Description of Test	Result
§15.247(i), §1.1310, §2.1091	Maximum Permissible Exposure (MPE)	Compliance
ISEDC RSS-102 Sec 2.5.2	Exemption Limits for Routine Evaluation – RF Exposure Evaluation	Compliance
§15.203 ISEDC RSS-Gen Sec 6.8	Antenna Requirement	Compliance
§15.207(a) ISEDC RSS-Gen Sec 6.8	AC Line Conducted Emissions	Compliance[Note1]
§15.205, §15.209, §15.247(d) ISED RSS-Gen Sec 8.9 and 8.10 ISEDC RSS-247 Sec 5.5	Spurious Emissions	Compliance [Note3]
§15.247(a)(2) ISEDC RSS-247 Sec 5.2 ISEDC RSS-Gen Sec 6.7	6 dB Emission Bandwidth	Compliance [Note2]
§15.247(b)(3) ISED RSS-247 Sec5.4(d)	Maximum Peak Output Power	Compliance
§15.247(d) ISEDC RSS-247 Sec 5.5	100 kHz Bandwidth of Frequency Band Edge	Compliance
§15.247(e) ISEDC RSS-247 Sec 5.2(b)	Power Spectral Density	Compliance

Note1: Adding antenna not affect the conducted emission test rule, please refer to the original report. (Report No.: RLK200203002-00B)

Note2: The power reduce is not affect the result, please refer to the original report. (Report No.: RLK200203002-00B)

Note3: It is not affect the conducted Spurious Emissions, please refer to the original report. (Report No.: RLK200203002-00B)

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

$S = PG/4\pi R^2$ = 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);

4.2 RF Exposure Evaluation Result

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	2.00	1.5849	17.00	50.1187	20	0.0158	1
BR/EDR	2402-2480	2.00	1.5849	21.00	125.8925	20	0.0397	1
Wi-Fi 2.4G	2412-2462	2.00	1.5849	25.00	316.2278	20	0.0998	1
Wi-Fi 5G	5150-5850	2.00	1.5849	14.50	28.1838	20	0.0089	1

Note: Wi-Fi and BT can't simultaneously.

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

5 RSS-102 Sec 2.5.2 - Exemption Limits for Routine Evaluation – RF Exposure Evaluation

5.1 Applicable Standard

According to subpart RSS-102 Sec 2.5.2,

> RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:
>
> - below 20 MHz[6] and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
> - at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $4.49/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz;
> - at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
> - at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;
> - at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).
>
> In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

5.2 RF Exposure Evaluation Result

BLE Max tune-up conducted output power is 17.00 dBm (50.1187 mW) at 2402 MHz, Antenna Gain = 2.00 dBi, EIRP = 19.00 dBm (0.0794 W), so the maximum conducted and E.I.R.P. source-based, time-averaged output is less than 2.68 W for general public use.

BR/EDR Max tune-up conducted output power is 21.00 dBm (125.8925mW) at 2402 MHz, Antenna Gain = 2.00 dBi, EIRP = 23.00 dBm (0.1995 W), so the maximum conducted and E.I.R.P. source-based, time-averaged output is less than 2.68 W for general public use.

Wi-Fi 2.4G Max tune-up conducted output power is 25.00 dBm (316.2278 mW) at 2437 MHz, Antenna Gain = 2.00 dBi, EIRP = 27.00 dBm (0.5012 W), so the maximum conducted and E.I.R.P. source-based, time-averaged output is less than 2.70 W for general public use.

Wi-Fi 5G Max tune-up conducted output power is 14.50 dBm (28.1839 mW) at 5825 MHz, Antenna Gain = 2.00 dBi, EIRP = 16.45 dBm (0.0442 W), so the maximum conducted and E.I.R.P. source-based, time-averaged output is less than 4.90 W for general public use.

Note: Wi-Fi and BT can't simultaneously.

Result: MPE test exempted.

6 FCC §15.203 and RSS-Gen Sec 6.8 - Antenna Requirements

6.1 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

According to RSS-Gen 6.8: Transmitter Antenna for Licence-Exempt Radio Apparatus

The applicant for equipment certification, as per RSP-100, must provide a list of all antenna types that may be used with the licence-exempt transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna.

Licence-exempt transmitters that have received equipment certification may operate with different types of antennas. However, it is not permissible to exceed the maximum equivalent isotropically radiated power (e.i.r.p.) limits specified in the applicable standard (RSS) for the licence-exempt apparatus.

Testing shall be performed using the highest gain antenna of each combination of licence-exempt transmitter and antenna type, with the transmitter output power set at the maximum level.Footnote8 When a measurement at the antenna connector is used to determine RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna manufacturer.

User manuals for transmitters equipped with detachable antennas shall also contain the following notice in a conspicuous location:

This radio transmitter (identify the device by certification number) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Immediately following the above notice, the manufacturer shall provide a list of all antenna types approved for use with the transmitter, indicating the maximum permissible antenna gain (in dBi).

6.2 Antenna List and Details

Brand	Model	Antenna Type	Antenna Gain (dBi)	Result
JOINSOON ELECTRONICS MFG .CO,LTO	MARS-31A8 WiFi Antenna	PIFA	2.00	Compliance

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

7 FCC §15.209, §15.205, §15.247(d), RSS-Gen Sec 8.9, 8.10 and RSS-247 Sec 5.5 – 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).

As per RSS-Gen 8.9,

Except when the requirements applicable to a given device state otherwise, emissions from licence-exempt transmitters shall comply with the field strength limits shown in Table 4 and Table 5 below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

Table 4 – General Field Strength Limits for Licence-Exempt Transmitters at Frequencies Above 30 MHz

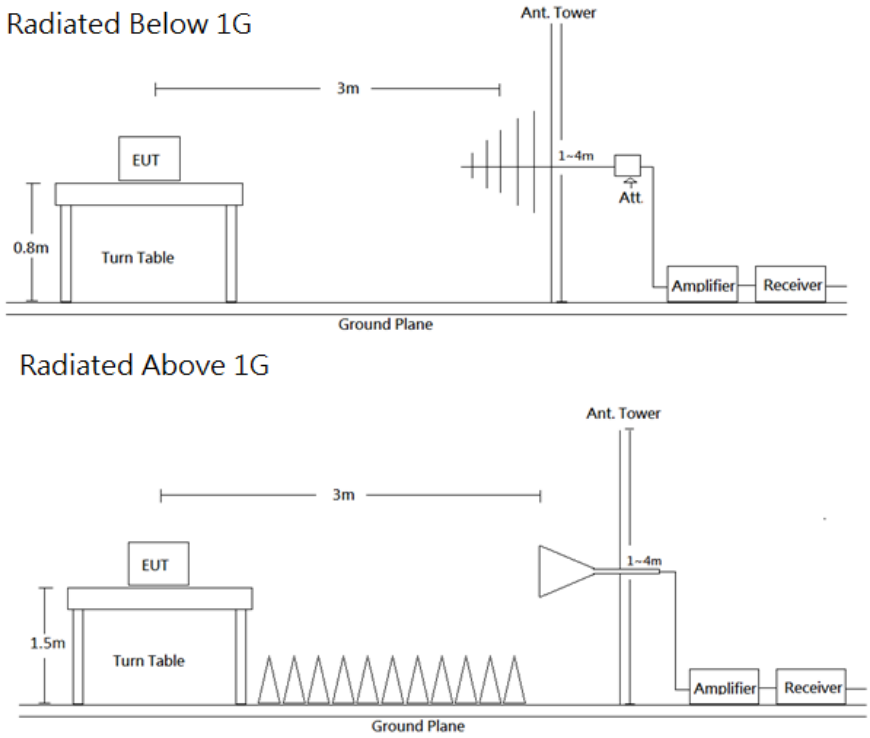
Frequency (MHz)	Field Strength (μv/m at 3 metres)
30-88	100
88-216	150
216-960	200
Above 960*	500

* Unless otherwise specified, for all frequencies greater than 1 GHz, the radiated emission limits for licence-exempt radio apparatus stated in applicable RSSs (including RSS-Gen) are based on measurements using a linear average detector function having a minimum resolution bandwidth of 1 MHz. If an average limit is specified for the EUT, then the peak emission shall also be measured with instrumentation properly adjusted for such factors as pulse desensitization to ensure the peak emission is less than 20 dB above the average limit.

Note: Transmitting devices are not permitted in restricted frequency bands unless stated otherwise in the specific RSS.

As per RSS-247 §5.5, in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

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	Duty cycle	Measurement method
30-1000 MHz	120 kHz	/	-	QP
Above 1 GHz	1 MHz	3 MHz	-	PK
	1 MHz	10 Hz	>98%	Ave
	1 MHz	1/T	<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.
Radiation 3M Room (966A)					
Active Loop	EMCO	6502	0001-3322	2020/03/16	2021/03/15
Bilog Antenna/6 dB Attenuator	SUNOL SCIENCES & EMEC /EMCI	JB3/N-6-06	A111513/AT-N0668	2020/03/19	2021/03/18
Horn Antenna	ETS-Lindgren	3115	00109141	2019/07/05	2020/07/04
Horn Antenna	ETS-Lindgren	3160-09	00123852	2019/07/11	2020/07/10
Preamplifier	A.H. Systems	PAM-0118	470	2020/03/16	2021/03/15
Preamplifier	A.H. Systems	PAM-1840VH	174	2020/03/25	2021/03/24
Signal and Spectrum Analyzer	Rohde & Schwarz	FSV40	101456	2019/07/12	2020/07/11
Microflex Cable (1m)	EMCI	EMC106-SM-SM-2000	180515	2019/08/07	2020/08/06
Microflex Cable (2m)	MTJ	H0919	00000-MT28A-100	2019/08/07	2020/08/06
Microflex Cable (8m)	UTIFLEX	UFA210A-1-3149-300300	MFR 64639 232490-001	2019/08/07	2020/08/06
Turn Table	Chaintek	T-200-S-1	003501	N.C.R	N.C.R
Antenna Tower	Chaintek	MBD-400-1	003504	N.C.R	N.C.R
Controller	Chaintek	3000-1	003507	N.C.R	N.C.R
Software	Audix	e3 v9	E3LK-01	N.C.R	N.C.R
Conducted Room(TH-02)					
Signal Analyzer 40GHZ	Rohde & Schwarz	FSV40-N	102248	2019/09/11	2020/09/10
RF Cable	MTJ	MT40S	MT40S-001	Each Use	/

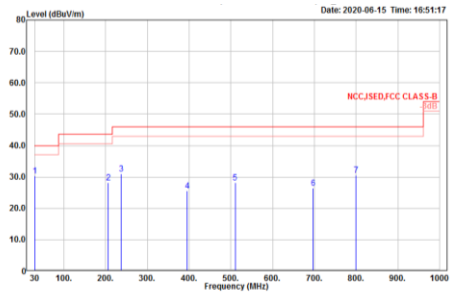
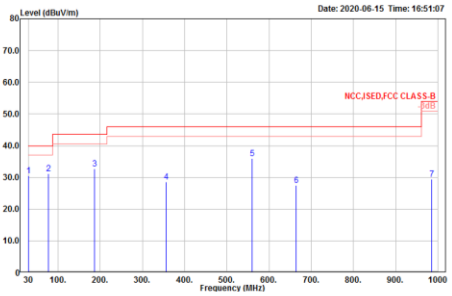
***Statement of Traceability:** The testing equipment's listed above have finished the calibration by Electronics Testing Center, Taiwan (ETC) or other laboratories which were accredited by TAF or equivalent organizations. The calibration result could be traceable to the International System of Units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

7.4 Test Result

PIFA Antenna (MARS-31A8 WiFi Antenna)

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

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

Horizontal	Vertical
	

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	30.000	30.28	40.00	-9.72	39.04	-8.76	Peak
2	206.540	28.27	43.50	-15.23	50.20	-21.93	Peak
3	236.610	31.00	46.00	-15.00	52.88	-21.88	Peak
4	395.690	25.51	46.00	-20.49	43.73	-18.22	Peak
5	510.150	28.27	46.00	-17.73	44.02	-15.75	Peak
6	696.390	26.40	46.00	-19.60	39.16	-12.76	Peak
7	799.210	30.61	46.00	-15.39	41.97	-11.36	Peak

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1	30.000	30.57	40.00	-9.43	39.33	-8.76	Peak
2	77.530	31.23	40.00	-8.77	55.97	-24.74	Peak
3	186.170	32.64	43.50	-10.86	54.96	-22.32	Peak
4	355.920	28.68	46.00	-17.32	47.66	-18.98	Peak
5	559.620	35.91	46.00	-10.09	50.90	-14.99	Peak
6	664.380	27.49	46.00	-18.51	40.71	-13.22	Peak
7	984.480	29.53	54.00	-24.47	39.08	-9.55	Peak

Level = Reading Level + Correct Factor

Over Limit = Level – 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-1Mbps mode:

Low CH

Horizontal

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2362.000	41.35	54.00	-12.65	51.14	-9.79	Average
2362.000	50.61	74.00	-23.39	60.40	-9.79	Peak
2401.900	101.66			111.34	-9.68	Average
2401.900	102.86			112.54	-9.68	Peak
3202.700	34.55	54.00	-19.45	41.70	-7.15	Average
3202.700	41.20	74.00	-32.80	48.35	-7.15	Peak
4804.000	46.40	54.00	-7.60	49.52	-3.12	Average
4804.000	52.56	74.00	-21.44	55.68	-3.12	Peak
7206.000	51.65	54.00	-2.35	47.97	3.68	Average
7206.000	58.66	74.00	-15.34	54.98	3.68	Peak

Vertical

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2375.000	36.61	54.00	-17.39	46.36	-9.75	Average
2375.000	50.95	74.00	-23.05	60.70	-9.75	Peak
2401.900	87.81			97.49	-9.68	Average
2401.900	89.01			98.69	-9.68	Peak
3202.700	34.18	54.00	-19.82	41.33	-7.15	Average
3202.700	41.14	74.00	-32.86	48.29	-7.15	Peak
4804.000	44.25	54.00	-9.75	47.37	-3.12	Average
4804.000	50.93	74.00	-23.07	54.05	-3.12	Peak
7206.000	53.16	54.00	-0.84	49.48	3.68	Average
7206.000	59.25	74.00	-14.75	55.57	3.68	Peak

Middle CH

Horizontal

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2376.308	37.41	54.00	-16.59	47.16	-9.75	Average
2376.308	49.72	74.00	-24.28	59.47	-9.75	Peak
2439.954	101.32			110.88	-9.56	Average
2439.954	102.57			112.13	-9.56	Peak
2491.016	37.49	54.00	-16.51	46.89	-9.40	Average
2491.016	50.05	74.00	-23.95	59.45	-9.40	Peak
4880.000	46.53	54.00	-7.47	49.39	-2.86	Average
4880.000	52.71	74.00	-21.29	55.57	-2.86	Peak
7320.000	50.17	54.00	-3.83	46.17	4.00	Average
7320.000	57.02	74.00	-16.98	53.02	4.00	Peak

Vertical

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2353.318	36.43	54.00	-17.57	46.25	-9.82	Average
2353.318	49.13	74.00	-24.87	58.95	-9.82	Peak
2440.438	86.84			96.40	-9.56	Average
2440.438	88.07			97.63	-9.56	Peak
2518.362	37.55	54.00	-16.45	46.84	-9.29	Average
2518.362	50.76	74.00	-23.24	60.05	-9.29	Peak
4880.000	45.08	54.00	-8.92	47.94	-2.86	Average
4880.000	51.72	74.00	-22.28	54.58	-2.86	Peak
7320.000	52.90	54.00	-1.10	48.90	4.00	Average
7320.000	58.83	74.00	-15.17	54.83	4.00	Peak

High CH

Horizontal

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2479.758	104.39			113.82	-9.43	Average
2479.758	105.56			114.99	-9.43	Peak
2483.694	47.18	54.00	-6.82	56.60	-9.42	Average
2483.694	58.42	74.00	-15.58	67.84	-9.42	Peak
4960.000	50.50	54.00	-3.50	53.04	-2.54	Average
4960.000	56.20	74.00	-17.80	58.74	-2.54	Peak
7440.000	49.81	54.00	-4.19	45.56	4.25	Average
7440.000	57.17	74.00	-16.83	52.92	4.25	Peak

Vertical

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2480.250	90.15			99.58	-9.43	Average
2480.250	91.35			100.78	-9.43	Peak
2512.476	37.76	54.00	-16.24	47.07	-9.31	Average
2512.476	51.04	74.00	-22.96	60.35	-9.31	Peak
4960.000	49.10	54.00	-4.90	51.64	-2.54	Average
4960.000	54.94	74.00	-19.06	57.48	-2.54	Peak
7440.000	52.83	54.00	-1.17	48.58	4.25	Average
7440.000	58.99	74.00	-15.01	54.74	4.25	Peak

BLE-2Mbps mode:

Low CH

Horizontal

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2361.400	40.32	54.00	-13.68	50.11	-9.79	Average
2361.400	50.81	74.00	-23.19	60.60	-9.79	Peak
2401.600	100.16			109.84	-9.68	Average
2401.600	103.36			113.04	-9.68	Peak
4804.000	45.50	54.00	-8.50	48.62	-3.12	Average
4804.000	52.98	74.00	-21.02	56.10	-3.12	Peak
7206.000	50.60	54.00	-3.40	46.92	3.68	Average
7206.000	58.69	74.00	-15.31	55.01	3.68	Peak

Vertical

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2355.300	36.45	54.00	-17.55	46.27	-9.82	Average
2355.300	49.77	74.00	-24.23	59.59	-9.82	Peak
2401.600	86.75			96.43	-9.68	Average
2401.600	89.96			99.64	-9.68	Peak
4804.000	43.56	54.00	-10.44	46.68	-3.12	Average
4804.000	50.78	74.00	-23.22	53.90	-3.12	Peak
7206.000	53.28	54.00	-0.72	49.60	3.68	Average
7206.000	59.21	74.00	-14.79	55.53	3.68	Peak

Middle CH

Horizontal

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2324.520	37.12	54.00	-16.88	47.03	-9.91	Average
2324.520	49.68	74.00	-24.32	59.59	-9.91	Peak
2439.712	100.55			110.11	-9.56	Average
2439.712	103.78			113.34	-9.56	Peak
2546.918	37.71	54.00	-16.29	46.87	-9.16	Average
2546.918	50.06	74.00	-23.94	59.22	-9.16	Peak
4880.000	46.42	54.00	-7.58	49.28	-2.86	Average
4880.000	53.81	74.00	-20.19	56.67	-2.86	Peak
7320.000	50.30	54.00	-3.70	46.30	4.00	Average
7320.000	58.34	74.00	-15.66	54.34	4.00	Peak

Vertical

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2357.190	36.61	54.00	-17.39	46.43	-9.82	Average
2357.190	49.43	74.00	-24.57	59.25	-9.82	Peak
2440.680	86.69			96.25	-9.56	Average
2440.680	89.94			99.50	-9.56	Peak
2520.540	37.69	54.00	-16.31	46.98	-9.29	Average
2520.540	50.14	74.00	-23.86	59.43	-9.29	Peak
4880.000	44.31	54.00	-9.69	47.17	-2.86	Average
4880.000	51.50	74.00	-22.50	54.36	-2.86	Peak
7320.000	52.92	54.00	-1.08	48.92	4.00	Average
7320.000	59.91	74.00	-14.09	55.91	4.00	Peak

High CH

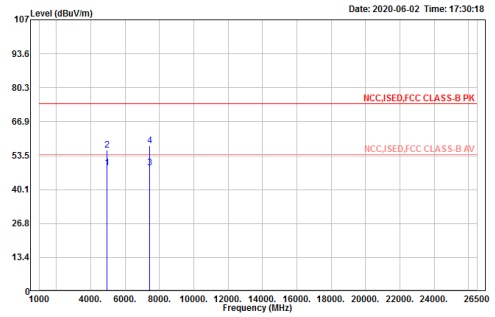
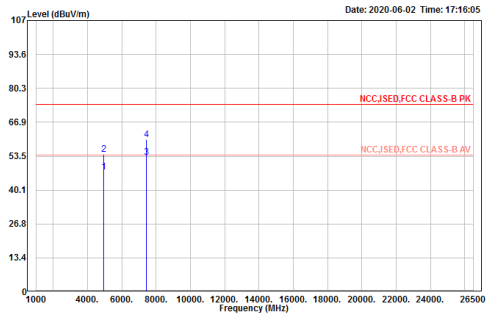
Horizontal

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2480.496	102.00			111.43	-9.43	Average
2480.496	105.17			114.60	-9.43	Peak
2483.530	52.68	54.00	-1.32	62.10	-9.42	Average
2483.530	60.41	74.00	-13.59	69.83	-9.42	Peak
4960.000	48.72	54.00	-5.28	51.26	-2.54	Average
4960.000	55.63	74.00	-18.37	58.17	-2.54	Peak
7440.000	48.77	54.00	-5.23	44.52	4.25	Average
7440.000	57.55	74.00	-16.45	53.30	4.25	Peak

Vertical

Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
2479.512	88.05			97.48	-9.43	Average
2479.512	91.26			100.69	-9.43	Peak
2483.776	40.88	54.00	-13.12	50.30	-9.42	Average
2483.776	50.53	74.00	-23.47	59.95	-9.42	Peak
4960.000	47.22	54.00	-6.78	49.76	-2.54	Average
4960.000	54.27	74.00	-19.73	56.81	-2.54	Peak
7440.000	52.95	54.00	-1.05	48.70	4.25	Average
7440.000	59.90	74.00	-14.10	55.65	4.25	Peak

Above 1G (1 GHz-26.5 GHz): The worst mode: BLE-2Mbps High CH.

Horizontal	Vertical
	

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1 !	4960.000	48.72	54.00	-5.28	51.26	-2.54	Average
2 !	4960.000	55.63	74.00	-18.37	58.17	-2.54	Peak
3 !	7440.000	48.77	54.00	-5.23	44.52	4.25	Average
4 !	7440.000	57.55	74.00	-16.45	53.30	4.25	Peak

	Freq	Level	Limit Line	Over Limit	Read Level	Factor	Remark
	MHz	dBuV/m	dBuV/m	dB	dBuV	dB/m	
1 !	4960.000	47.22	54.00	-6.78	49.76	-2.54	Average
2 !	4960.000	54.27	74.00	-19.73	56.81	-2.54	Peak
3 !	7440.000	52.95	54.00	-1.05	48.70	4.25	Average
4 !	7440.000	59.90	74.00	-14.10	55.65	4.25	Peak

Level = Reading Level + Correct Factor

Over Limit = Level – Limit

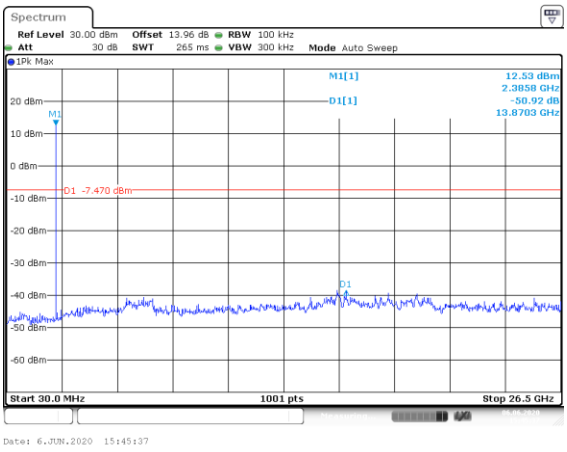
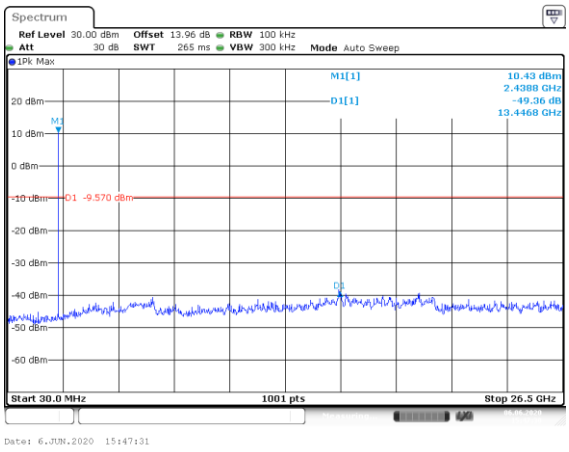
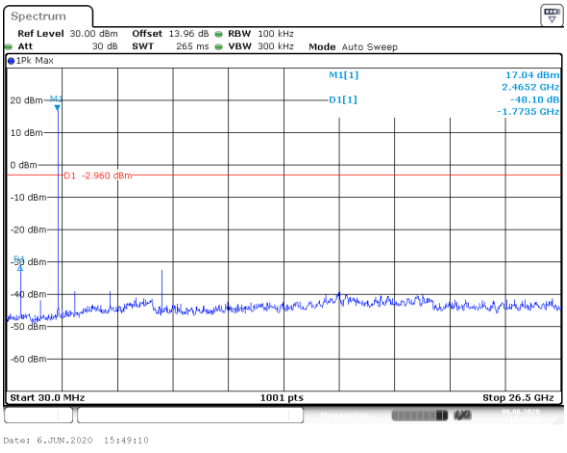
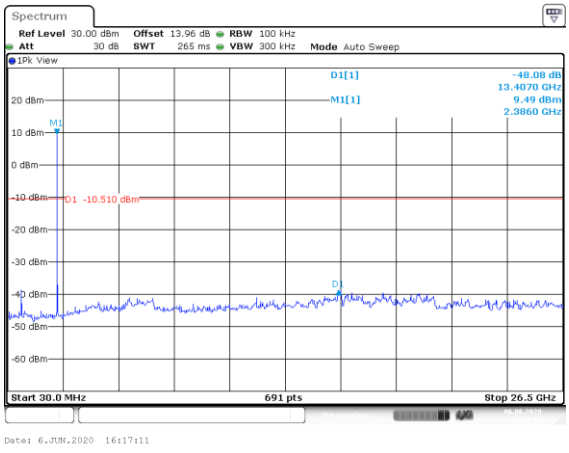
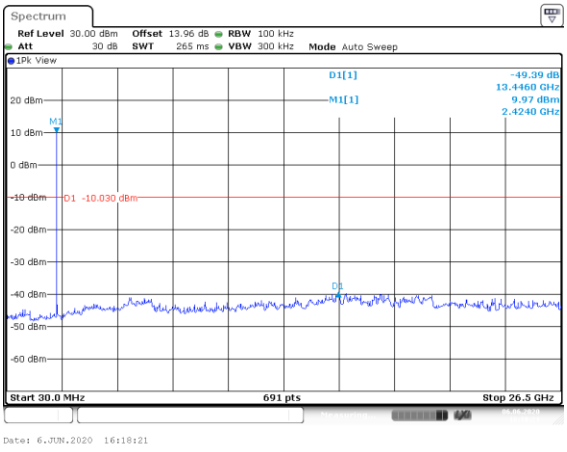
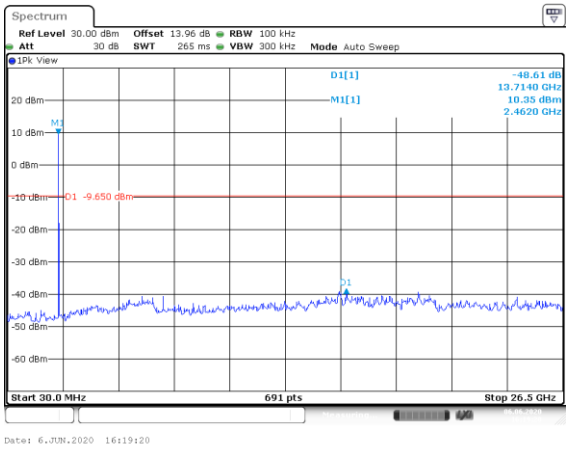
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain

Spurious emissions more than 20 dB below the limit were not reported

Conducted Spurious Emissions:

PIFA Antenna (MARS-31A8 WiFi Antenna)

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
BLE-1Mbps				
Low	2402	-50.92	≥ 20	Compliance
Mid	2440	-49.36	≥ 20	Compliance
High	2480	-48.10	≥ 20	Compliance
BLE-2Mbps				
Low	2402	-48.08	≥ 20	Compliance
Mid	2440	-49.39	≥ 20	Compliance
High	2480	-48.61	≥ 20	Compliance

BLE-1Mbps Low CH	BLE-1Mbps Middle CH
	
BLE-1Mbps High CH	**BLE-2Mbps Low CH**
	
BLE-2Mbps Middle CH	**BLE-2Mbps High CH**
	

8 FCC §15.247(b) (3) and RSS-247 Sec 5.4(d) – Maximum Output Power

8.1 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.

According to RSS-247 §5.4(d).

For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

8.2 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.

8.3 Test Equipment List and Details

Description	Manufacture	Model	Serial No.	Cal. Date.	Cal. Due.
Conducted Room(TH-02)					
USB Wideband Power Sensor	Agilent	U2021XA	MY56120026	2019/09/06	2020/09/05
RF Cable	MTJ	MT40S	MT40S-001	Each Use	/

***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 Results

PIFA Antenna (MARS-31A8 WiFi Antenna)

Mode	CH	Freq. (MHz)	Peak Output Power		Ant Gain (dBi)	EIRP Peak Output Power		Limit (dBm)	EIRP Limit (dBm)
			(dBm)	(W)		(dBm)	(W)		
BLE-1Mbps	Low	2402	13.96	0.0249	2.00	15.96	0.0394	30	36
	Middle	2440	14.14	0.0259	2.00	16.14	0.0411	30	36
	High	2480	16.34	0.0431	2.00	18.34	0.0682	30	36
BLE-2Mbps	Low	2402	15.03	0.0318	2.00	17.03	0.0505	30	36
	Middle	2440	15.81	0.0381	2.00	17.81	0.0604	30	36
	High	2480	16.98	0.0499	2.00	18.98	0.0791	30	36

Note1: Conducted Power Limit: 1W = 30 dBm, 4W = 36 dBm

Mode	CH	Freq. (MHz)	Average Output Power		Ant Gain (dBi)	EIRP Average Output Power		Limit (dBm)	EIRP Limit (dBm)
			(dBm)	(W)		(dBm)	(W)		
BLE-1Mbps	Low	2402	13.44	0.0221	2.00	15.44	0.0350	30	36
	Middle	2440	13.63	0.0231	2.00	15.63	0.0366	30	36
	High	2480	15.84	0.0384	2.00	17.84	0.0608	30	36
BLE-2Mbps	Low	2402	14.07	0.0255	2.00	16.07	0.0405	30	36
	Middle	2440	14.93	0.0311	2.00	16.93	0.0493	30	36
	High	2480	16.06	0.0404	2.00	18.06	0.0640	30	36

Note1: Conducted Power Limit: 1W = 30 dBm, 4W = 36 dBm

Note2: Duty Cycle is 100% and Duty Factor is 0 dB

9 FCC §15.247(d) and RSS-247 Sec 5.5– 100 kHz Bandwidth of Frequency Band Edge

9.1 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)).

According to RSS-247 §5.5. In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

9.2 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.

9.3 Test Equipment List and Details

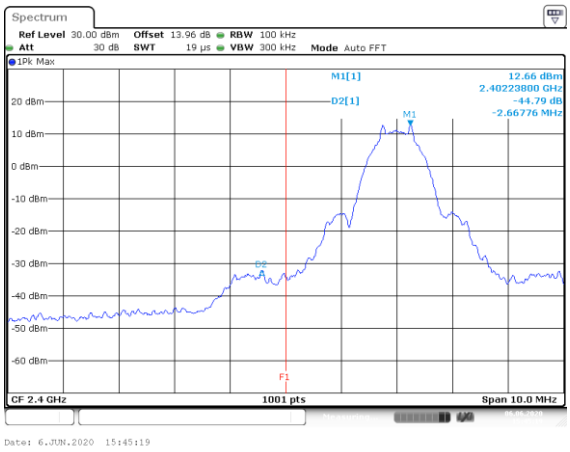
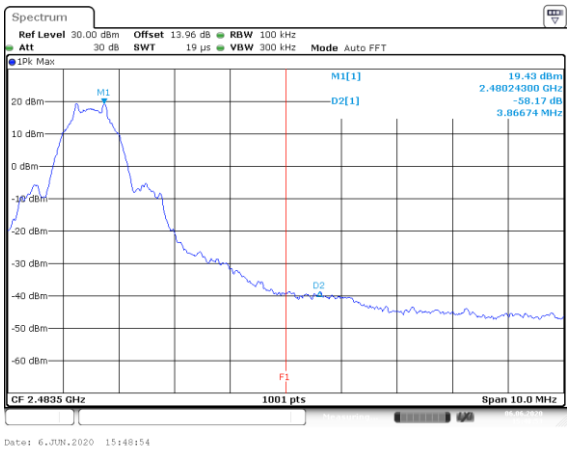
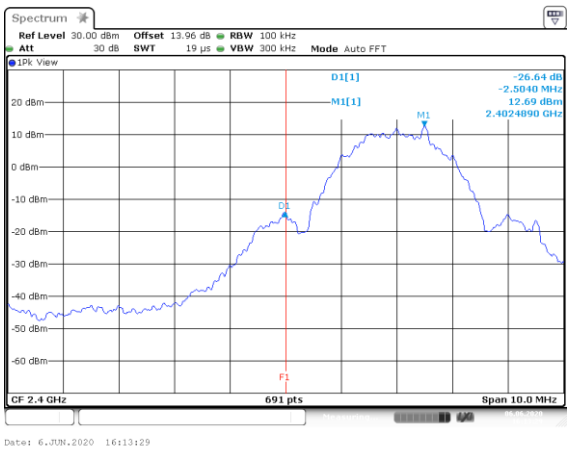
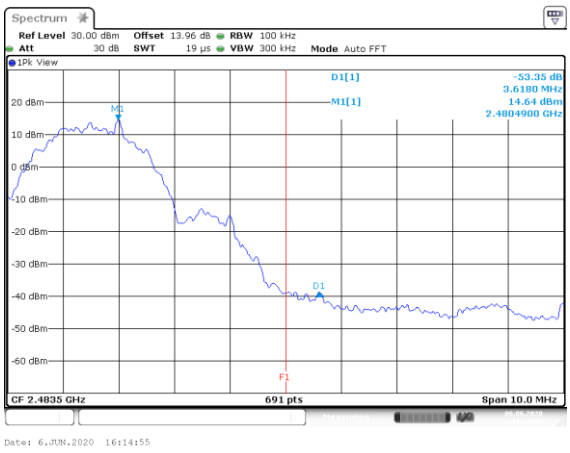
Description	Manufacture	Model	Serial No.	Cal. Date.	Cal. Due.
Conducted Room(TH-02)					
Signal Analyzer 40GHZ	Rohde & Schwarz	FSV40-N	102248	2019/09/11	2020/09/10
RF Cable	MTJ	MT40S	MT40S-001	Each Use	/

***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 Results

PIFA Antenna (MARS-31A8 WiFi Antenna)

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	Result
BLE-1Mbps				
Low	2402	-44.79	≥ 20	Compliance
High	2480	-58.17	≥ 20	Compliance
BLE-2Mbps				
Low	2402	-26.24	≥ 20	Compliance
High	2480	-53.35	≥ 20	Compliance

BLE-1Mbps Left Side	BLE-1Mbps Right Side
	
BLE-2Mbps Left Side	**BLE-2Mbps Right Side**
	

10 FCC §15.247(e) and RSS-247 Sec 5.2(b) – Power Spectral Density

10.1 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.

According to RSS-247 §5.2(b).

The transmitter power spectral density conducted from the transmitter 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 section 5.4(d), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

10.2 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.

10.3 Test Equipment List and Details

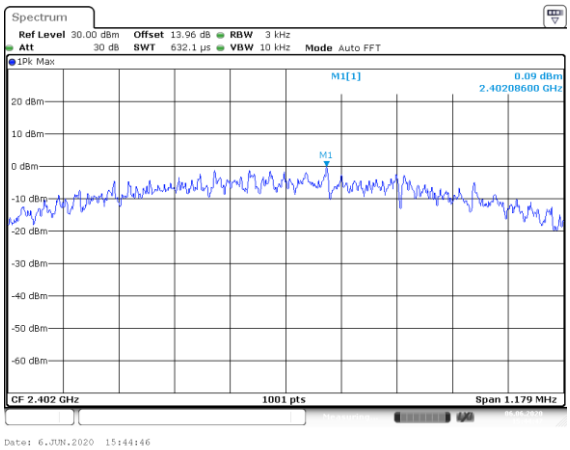
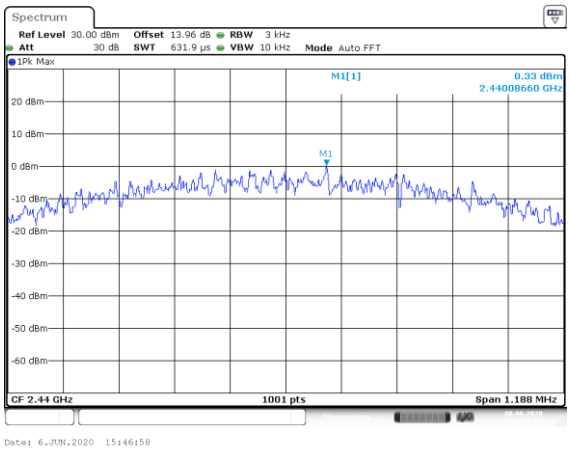
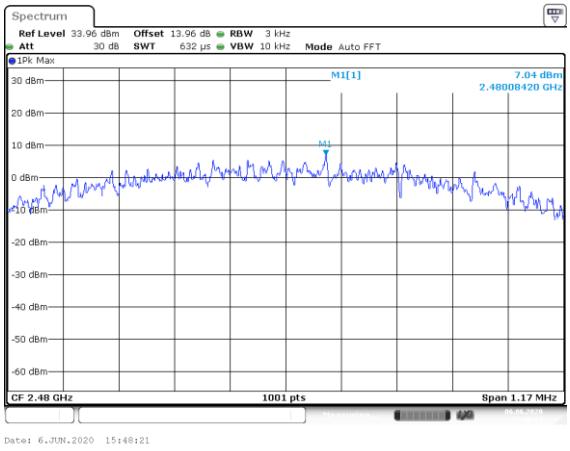
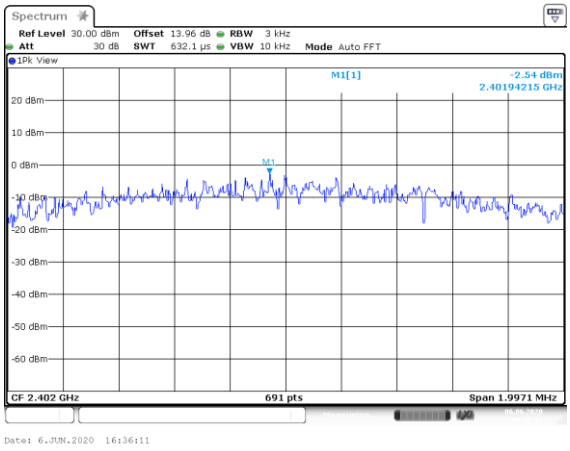
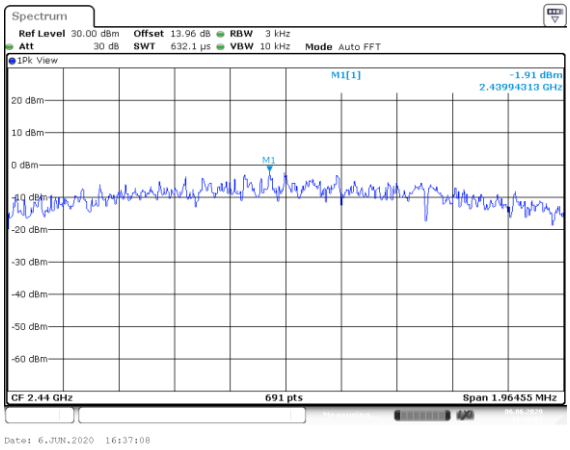
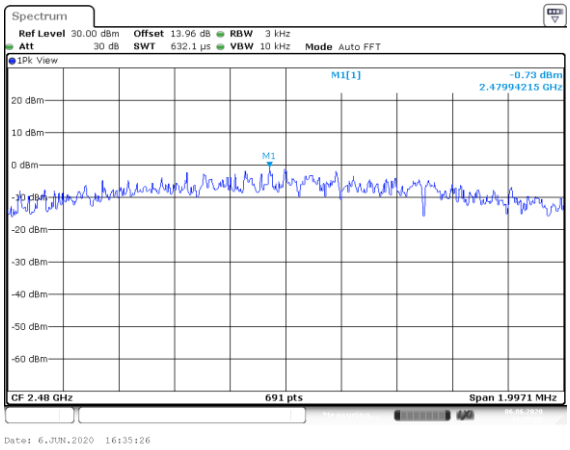
Description	Manufacture	Model	Serial No.	Cal. Date.	Cal. Due.
Conducted Room(TH-02)					
Signal Analyzer 40GHZ	Rohde & Schwarz	FSV40-N	102248	2019/09/11	2020/09/10
RF Cable	MTJ	MT40S	MT40S-001	Each Use	/

***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 Results

<Dipole Antenna: TAOGLAS/GW.71.5153>

Channel	Frequency (MHz)	PSD (dBm/3 kHz)	Limit (dBm/3 kHz)	Result
BLE-1Mbps				
Low	2402	0.09	8	Compliance
Middle	2440	0.33	8	Compliance
High	2480	7.04	8	Compliance
BLE-2Mbps				
Low	2402	-2.54	8	Compliance
Middle	2440	-1.91	8	Compliance
High	2480	-0.73	8	Compliance

BLE-1Mbps Low CH	BLE-1Mbps Middle CH
	
BLE-1Mbps High CH	**BLE-2Mbps Low CH**
	
BLE-2Mbps Middle CH	**BLE-2Mbps High CH**
	

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