TEST REPORT

of

JAPAN MIC

Product:	**Bluetooth 5.1 Module**
Brand:	**Fanstel**
Model:	**BC40C; BC40M; BC40P**
Model Difference:	**Antenna difference**
Applicant:	**Fanstel Corporation, Taipei**
Address	**10F-10, No. 79, Sec. 1, Hsin Tai Wu Rd.,Hsi-Chih, New Taipei City 221 Taiwan**

Test Performed by:

International Standards Laboratory Corp. LT Lab.
TEL: +886-3-263-8888 FAX: +886-3-263-8899
No. 120, Lane 180, Hsin Ho Rd., Lung-Tan Dist., Tao Yuan City 325, Taiwan

Report No.: **ISL-21LR190JAP**
Issue Date : **July 15, 2021**

VERIFICATION OF COMPLIANCE

Applicant:	Fanstel Corporation, Taipei
Equipment Under Test:	Bluetooth 5.1 Module
Brand:	Fanstel
Model Number:	BC40C; BC40M; BC40P
Model Difference:	Antenna difference
Date of Test:	June 28, 2021 ~ July 15, 2021
Date of EUT Received:	June 28, 2021

APPLICABLE STANDARDS	
STANDARD	**TEST RESULT**
ARIB STD-T66	Complied

The above equipment was tested by International Standards Laboratory Corp. for compliance with the requirements in the Radio equipment stipulated in the certification ordinance Item 19, Paragraph 1, Article 2. The results of testing in this report apply to the product/system that was tested only. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties. The antenna specification is provided by the applicant, and ISL does not bear the relevant responsibility.

Test By: Weitin Chen ***Date:*** July 15, 2021

Weitin Chen / Senior Engineer

Prepared By: Gigi yeh ***Date:*** July 15, 2021

Gigi Yeh / Senior Engineer

Approved By: Jerry Liu ***Date:*** July 15, 2021

Jerry Liu / Assistant Manager

Version

Version No.	Date	Description
00	July 15, 2021	Initial creation of document

TABLE OF CONTENTS

1. Description of Equipment under Test (EUT)

1.1 General Information

General:

Product Name:	Bluetooth 5.1 Module
Brand Name:	Fanstel
Model Name:	BC40C; BC40M; BC40P
Model Difference:	Antenna difference
Power Supply:	5Vdc from USB (JIG)
USB port	one (JIG)

Model Summaries:

module	BC40C	BC40M	BC40P
SoC	nRF5340 CLAA	nRF5340 CLAA	nRF5340 CLAA
Size	8.4x11.5x1.5 mm	8.4(10.1)x12.7x1.5mm	8.4x9x1.5mm
32 MHz and 32.768 kHz crystals	Integrated	Integrated	Integrated
DC converter inductors, VDD,VDDH	Integrated	Integrated	Integrated
BT Antenna	Chip	PCB trace	Pads for external
Max TX			
Operating temp.	-40ºC to +105ºC	-40ºC to +105ºC	-40ºC to +105ºC
Availability	Sample 05/2021	Sample 05/2021	Sample 06/2021

BLE:

Bluetooth Version	5.1
Rated Transmit Power	2.2 mW
Frequency Range	2.402GHz – 2.480GHz
Modulation Technique	GFSK
Channel number	40 channels
Dwell Time	N/A
Operating Mode	Point-to-Point

1.2 Antenna Specification

Antenna Type	BC40C: Chip Antenna BC40M: PCB trace Antenna BC40P: Pads for external Antenna
Peak Gain	BC40C: 1dBi BC40M: 1.53dBi BC40P: 0.54dBi
Impedance	50.0 ohms
Radiation pattern	Omni

1.3 Assemble

There is a shielding soldered on the module.

1.4 Support Equipment

Fig. 4-1 Configuration of Tested System

Equipment Used in Tested System

Item	Equipment	Mrf/Brand	Model name	Series No	Data Cable	Power Cable
1	Notebook	Lenovo	X220i	N/A	N/A	Non-shielded
2	Test Kit	N/A	N/A	N/A	N/A	N/A

Note: All the above equipment/cables were placed in worse case positions to maximize emission signals during emission test.

Grounding: Grounding was in accordance with the manufacturer's requirements and conditions for the intended use.

2. Description of Test Modes

The EUT has been tested at continuous TX and RX modes. And software was used to control the EUT for staying in above description test modes.
Channel low, mid and High with lowest data rate was chosen for testing.
Test data of model BC40C; BC40M; BC40P is the worst case which is reported.

A software tool or a built-in test-mode needs to be reported with the parameter settings for creating the appropriate selection. The software settings shall be reported because of the traceability requirement of the measurements. The settings are depending upon the IEEE standard & mode and the applied modulation. Most common settings are:

The settings for Bluetooth will be influenced by the throughput and the modulation. Most common settings are:

Bluetooth 5.1: GFSK modulation

Test channels in BT 5.1 LE mode

	TX
Channel Low	2402MHz
Channel Mid	2442MHz
Channel High	2480MHz

Test conditions

Temperature & humidity	Normal
Normal voltage	5.0 Vdc
Lower extreme voltage	5.5 Vdc
Higher extreme voltage	4.5 Vdc

3. General Description of Applied Standards

The EUT According to the Specifications, it must comply with the requirements of the following standards:

Radio equipment stipulated in Item 19, Paragraph 1, Article 2.

4. Measurement Uncertainty

ISO/IEC 17025 requires that an estimate of measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor (k=2)).

Parameters	Uncertainty
Frequency Error	± 727.3 Hz
Conducted Power	± 1.55 dB
Power Density	± 1.67 dB
Conducted Spurious Emission	± 1.55 dB
Adjacent Channel Power	± 1.55 dB
Time	± 0.01 %
DC Voltage	± 1 %

5. Summary of Tests

Article reference	Parameter	Status (Note 1)
General provisions		
5	Frequency tolerance	C
6	Occupied bandwidth	C
7	Spurious emission	C
Transmitting equipment		
14	Antenna Power	C
14.2	SAR	N/A
15	Frequency stabilization	C
Transmitting equipment		
20	Type configuration etc of transmitting antenna	C
22	Directional pattern of transmitting antenna	C
Receiving equipment		
24	Spurious emission of receiver	C
26	Refer to all articles for transmitting antenna	C
Operating frequency 2400-2483.5MHz		
49.20(1); a	High Frequency/modulation section cannot be operated easily	C
49.20(1); b	Communication method	C
49.20(1); c	Communication method	C
49.20(1); d	Spread Spectrum method	C
49.20(1); e	Antenna Power	C
49.20(1); f(1)	Absolute gain of transmitting antenna	C
49.20(1); f(2)	Angular width of principal radiation (AWPR)	C
49.20(1); g	Number of carriers within 1MHz bandwidth in OFDM	C
49.20(1); h	Diffusion bandwidth	C
49.20(1); i	Spreading factor	C
49.20(1); j	Frequency retention time (FH employed)	C
Note 1: C=Confirm NC=Not Confirm NT=Not Tested NA= Not Applicable		

5.1 Antenna Power and Tolerance

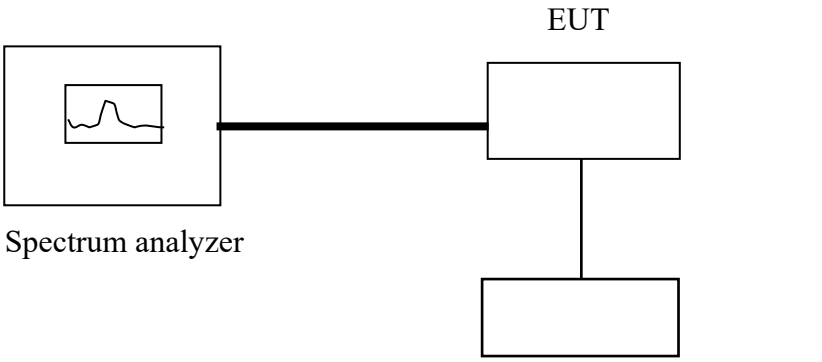
5.1.1 Limit

BT: Antenna power: 3mW/MHz
Wifi(1-14): Antenna power: 10mW/MHz
BT 4.0 Antenna power: 10mW
Antenna power tolerance: + 20% to – 80%

5.1.2 Measurement Equipment Used

Refer to section Appendix A: Equipment List for detail.

5.1.3 Test Setup



5.1.4 Test Procedure

1. Set the EUT at hopping off and modulation on.
2. Set the ETU operates at channel low, mid and high and normal/Upper/Lower voltage.
3. Connect the EUT to power meter.
4. Record the power level.
5. Varied input voltage to + 10% and - 10% normal voltage and repeat procedure 1 to 4 again.

5.1.5 Test Results

Ambient temperature: 25℃ Relative humidity: 60% Test Date: 2021/07/12

BLE
Rated Power =2.2
Antenna Gain=1.53

		Channel Low	Channel Mid	Channel High	Limit
Normal Voltage 5 V	Conducted Power (dBm)	3.577	3.511	3.565	N/A
	Conducted Power (mW)	2.279	2.244	2.272	10mW
	Power Tolerance	3.58	2.018	3.295	+20% to -80%
Upper Voltage 5.5 V	Conducted Power (dBm)	3.569	3.506	3.565	N/A
	Conducted Power (mW)	2.275	2.242	2.272	10mW
	Power Tolerance	3.39	1.901	3.295	+20% to -80%
Lower Voltage 4.5 V	Conducted Power (dBm)	3.655	3.51	3.57	N/A
	Conducted Power (mW)	2.32	2.244	2.275	10mW
	Power Tolerance	5.457	1.995	3.414	+20% to -80%

Remark:
1. Conducted Power (mW/MHz)= 10^(Conducted Power(dBm/MHz)/10)
2. P (mW/MHz) = Raw power (in mW, measured by power sensor) / [spreading bandwidth (MHz) x duty-cycle]

5.2 Frequency Tolerance

5.2.1 Limit:

50ppm

5.2.2 Measurement Equipment Used

Refer to section Appendix A: Equipment List for detail.

5.2.3 Test Setup

Refer to section 5.1.3 for detail.

5.2.4 Test Procedure

1. Set the EUT modulation off.
2. Set the ETU operates at channel low, mid and high and normal voltage.
3. Set the spectrum analyzer RBW = 300Hz, VBW=300Hz and Span = 20kHz
4. Max hold, View, Peak High, Mark and snap the screen and record the mark.
5. Varied input voltage to + 10% and - 10% normal voltage and repeat procedure 1 to 4 again.

5.2.5 Test Results

Ambient temperature: 25℃ Relative humidity: 60% Test Date: 2021/07/12

BLE

		Channel Low	Channel Mid	Channel High	Limit
Normal Voltage 5 V	Measured Frequency (MHz)	2402.041	2442.042	2480.042	+/-50ppm
	Frequency Tolerance (ppm)	17.152	17.035	17.097	
Upper Voltage 5.5 V	Measured Frequency (MHz)	2402.041	2442.042	2480.043	+/-50ppm
	Frequency Tolerance (ppm)	17.069	17.035	17.177	
Lower Voltage 4.5 V	Measured Frequency (MHz)	2402.041	2442.042	2480.043	+/-50ppm
	Frequency Tolerance (ppm)	17.069	17.035	17.177	

5.3 Occupied Bandwidth

5.3.1 Limit

802.11 b/g /n(HT20), BT(LE) < 26MHz
802.11 n(HT40) < 38MHz
BT normal mode < 83.5MHz

5.3.2 Measurement Equipment Used

Refer to section Appendix A: Equipment List for detail.

5.3.3 Test Setup

Refer to section 5.1.3 for detail.

5.3.4 Test Procedure:

1. Set the EUT modulation on.
2. Set the ETU operate at channel low, mid and high and normal voltage.
3. Set the spectrum analyzer RBW = 300kHz, VBW=1MHz
4. Set span large enough to capture all products of the modulation process.
5. Turn on 99% spectrum OBW function on, Max hold, View, and snap the screen and record the mark.
6. Varied input voltage to + 10% and - 10% normal voltage and repeat procedure 1 to 4 again.

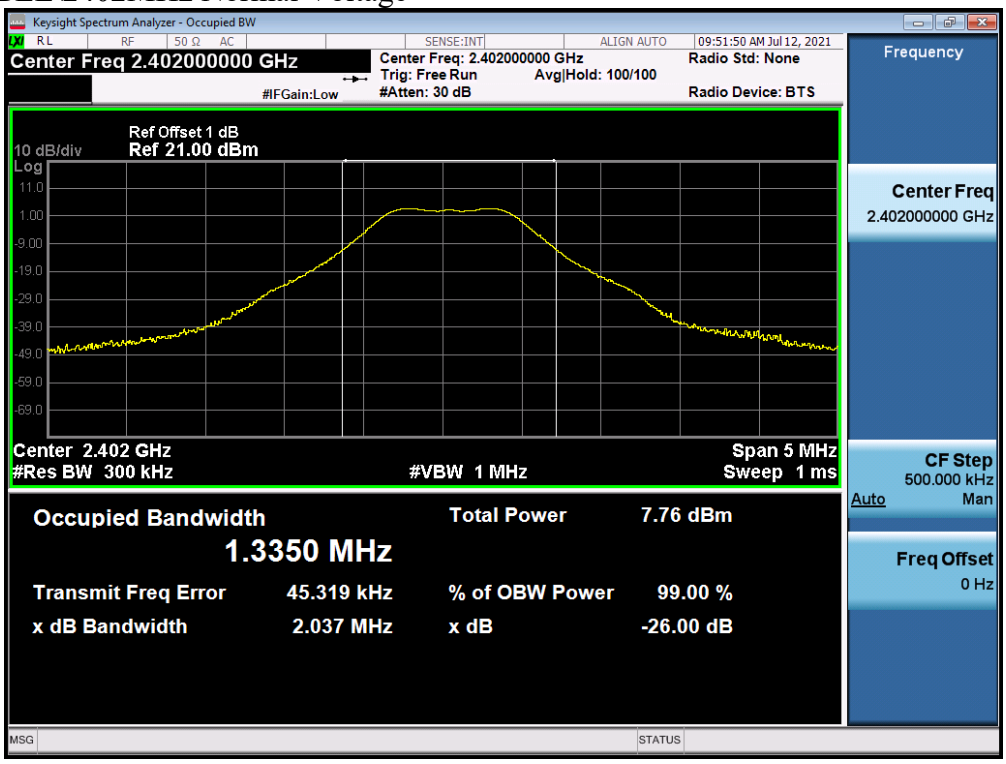
5.3.5 Test Result

Ambient temperature: 25℃ Relative humidity: 60% Test Date: 2021/07/12

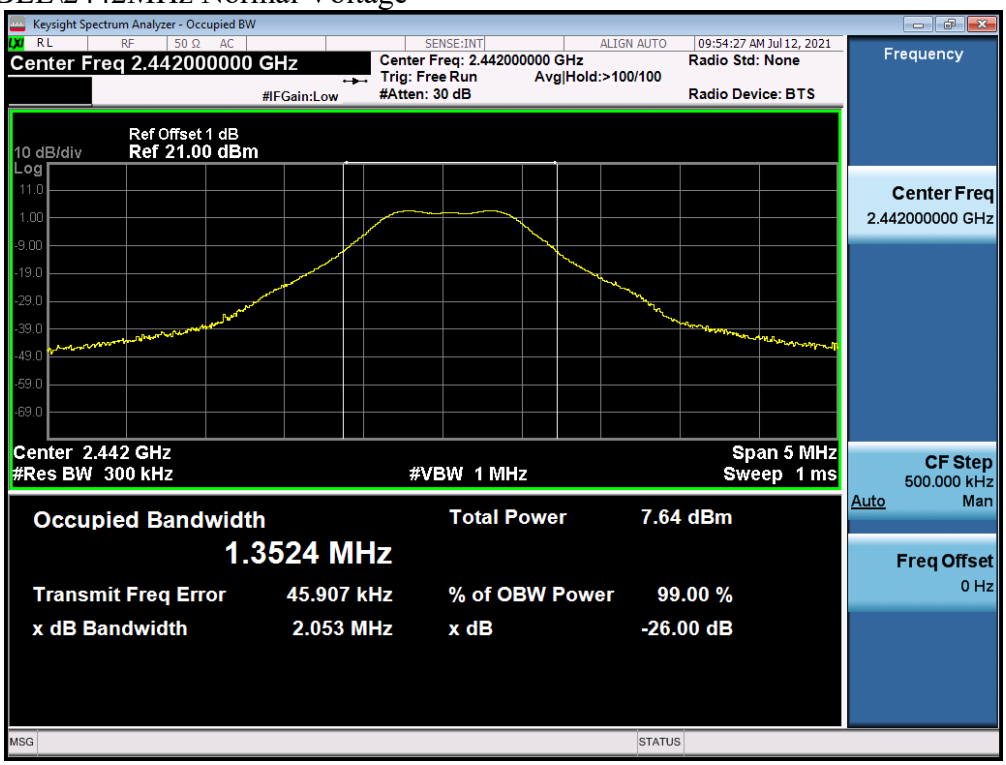
BLE

	Low channel (MHz)	Mid channel (MHz)	High channel (MHz)	Limit	Remark
Normal Voltage 5 V	1.335	1.352	1.354	<26MHz	PASS
Upper Voltage 5.5 V	1.335	1.353	1.354	<26MHz	PASS
Lower Voltage 4.5 V	1.337	1.354	1.355	<26MHz	PASS

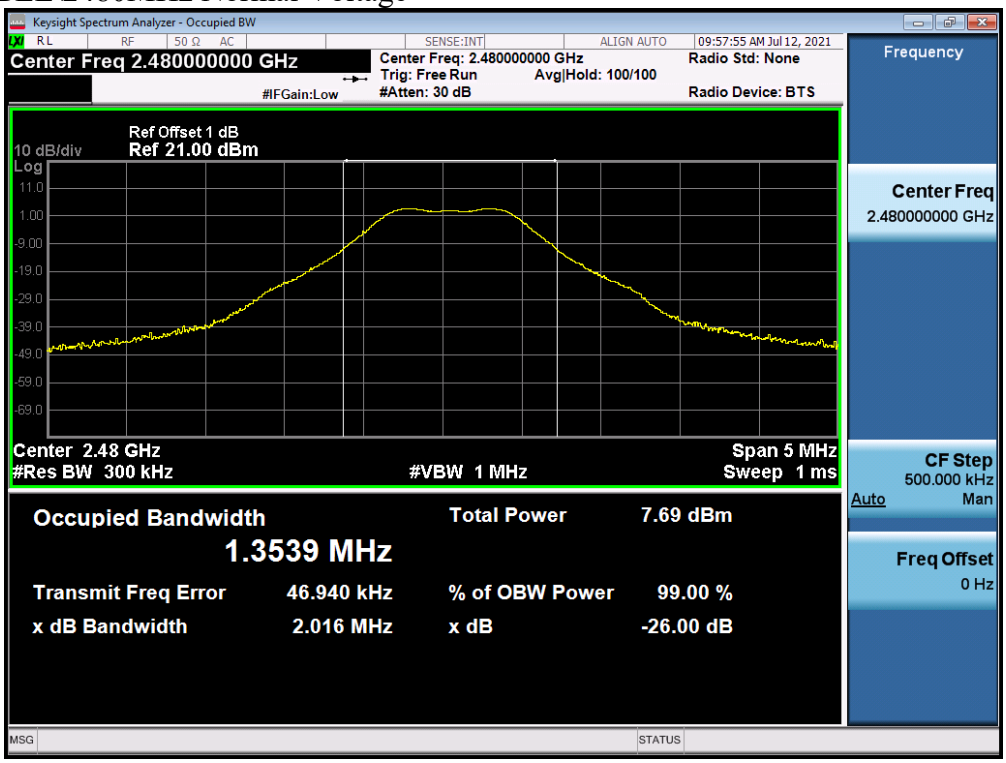
Test Data: BLE\2402MHz Normal Voltage



Test Data: BLE\2442MHz Normal Voltage



Test Data: BLE\2480MHz Normal Voltage



5.4 Spreading Bandwidth (90%)

5.4.1 Limit

> 500kHz
Spread Factor: 1~13ch>5, 14ch >10

5.4.2 Measurement Equipment Used

Refer to section Appendix A: Equipment List for detail.

5.4.3 Test Setup

Refer to section 5.1.3 for detail.

5.4.4 Test Procedure

1. Set the EUT modulation on.
2. Set the ETU operate at channel low, mid and high and normal voltage.
3. Set the spectrum analyzer RBW = 300kHz, VBW=1MHz, and Set span large enough to capture all products of the modulation process.
4. Turn on 90% spectrum OBW function, Max hold, View, and snap the screen and record the mark.
5. Varied input voltage to + 10% and - 10% normal voltage and repeat procedure 1 to 4 again.

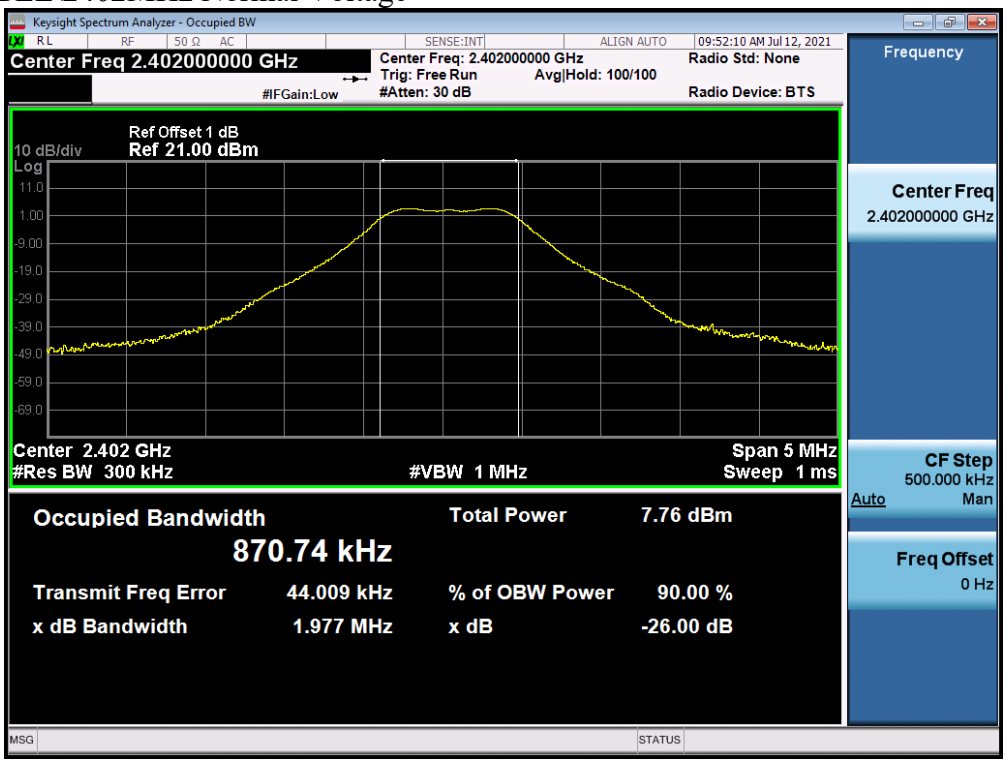
5.4.5 Test Results

Ambient temperature: 25℃ Relative humidity: 60% Test Date: 2021/07/12

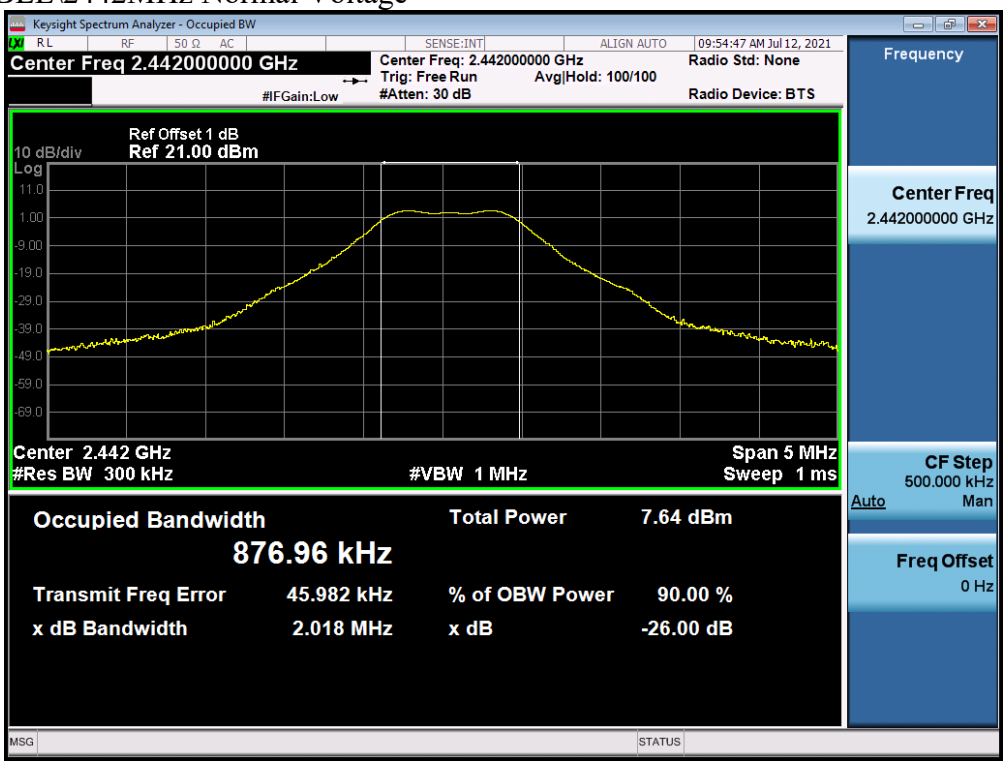
BLE

	Low channel (MHz)	Mid channel (MHz)	High channel (MHz)	Limit	Remark
Normal Voltage 5 V	0.871	0.877	0.878	>500KHz	PASS
Upper Voltage 5.5 V	0.872	0.875	0.878	>500KHz	PASS
Lower Voltage 4.5 V	0.87	0.876	0.876	>500KHz	PASS

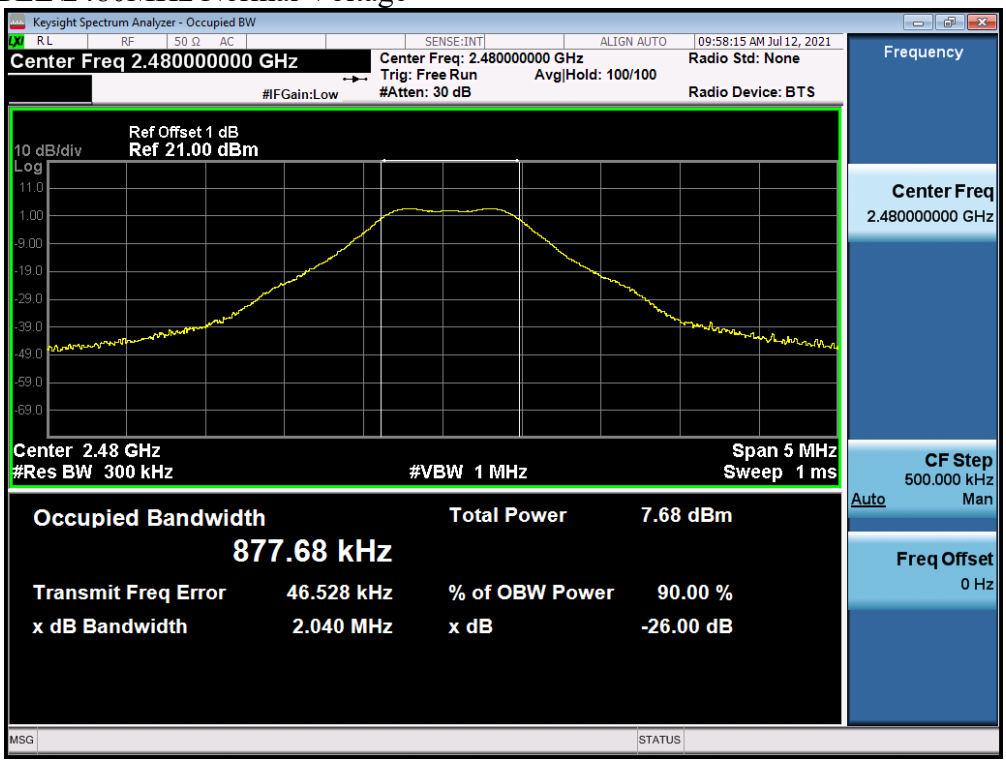
Test Data: BLE\2402MHz Normal Voltage



Test Data: BLE\2442MHz Normal Voltage



Test Data: BLE\2480MHz Normal Voltage



5.5 Transmitter Spurious Emissions

5.5.1 Limit

Frequency below 2.387 and above 2.4965GHz :2.5uW
Frequency between 2.387 – 2.400GHz, 2.4835-2.4965GHz: 25uW

5.5.2 Measurement Equipment Used

Refer to section Appendix A: Equipment List for detail.

5.5.3 Test Setup

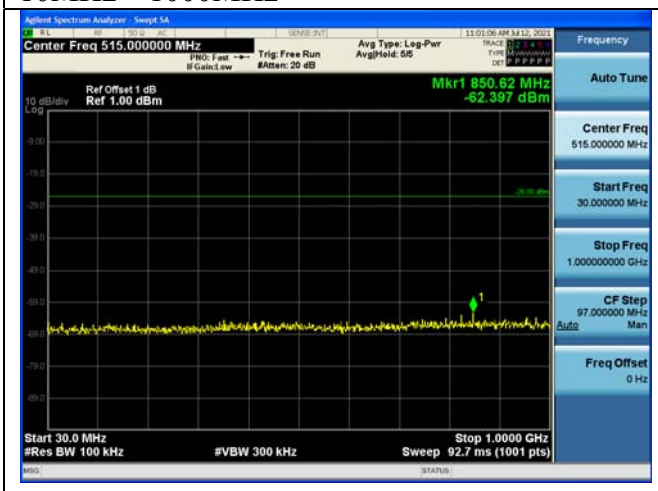
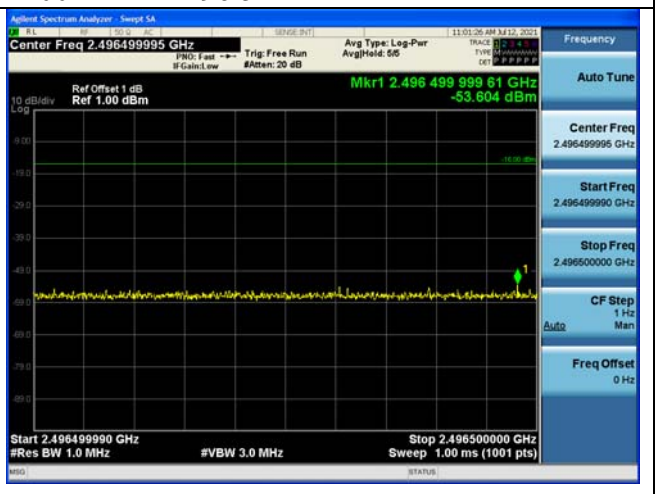
Refer to section 5.1.3 for detail.

5.5.4 Test Procedure

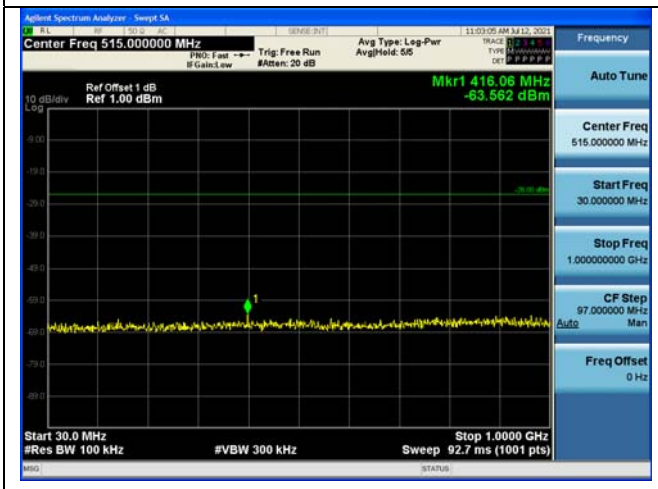
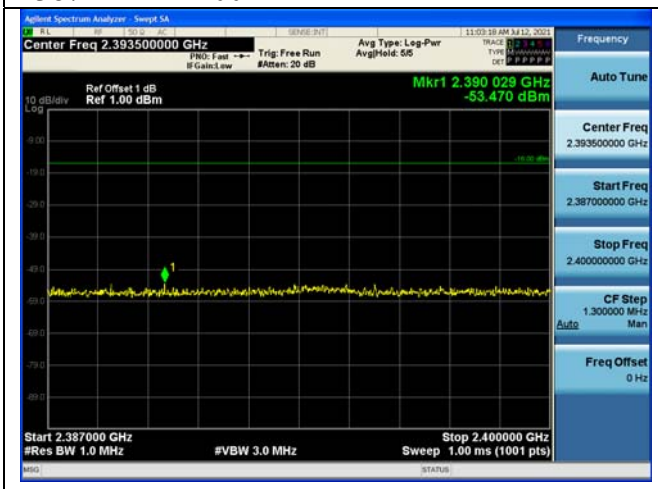
1. Set the EUT at hopping off and modulation on.
2. Set the ETU operate at channel low, mid and high and normal voltage.
3. Set the RBW=100 kHz, VBW=300 kHz for frequency below 1GHz and RBW=1MHz, VBW= 3MHz for frequency above 1GHz.
4. Measured the max. level of the following frequency range:
   10MHz – 1000MHz;
   1000MHz – 2387MHz;
   2387MHz – 2400MHz;
   2483.5MHz – 2496.5MHz;
   2496.5MHz – 26GHz.
5. Varied input voltage to + 10% and - 10% normal voltage and repeat procedure 1 to 4 again.
6. The Worst data was report.

5.5.5 Test Results

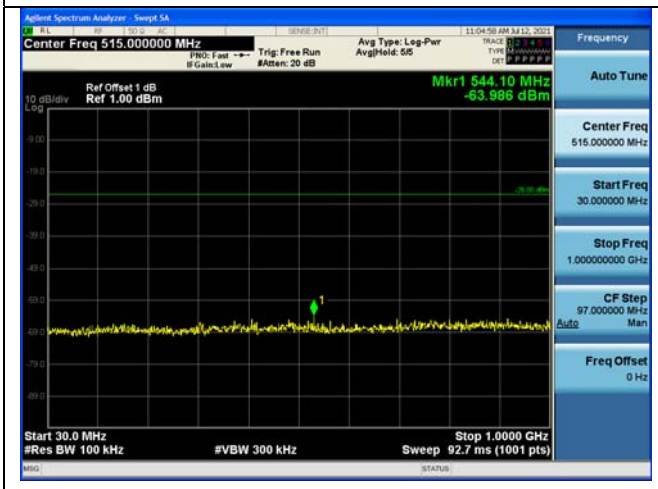
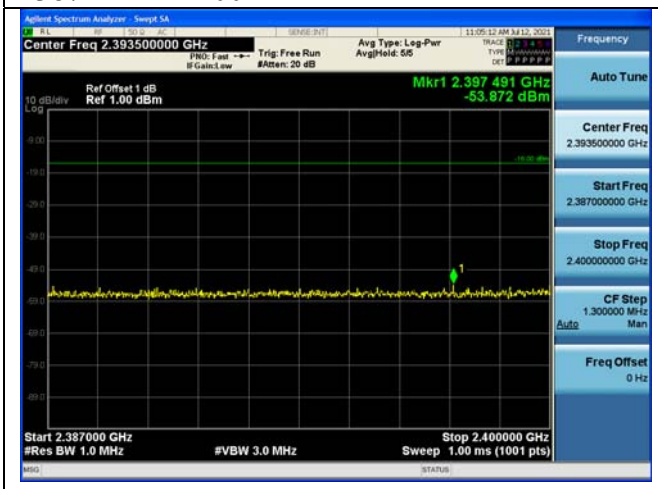
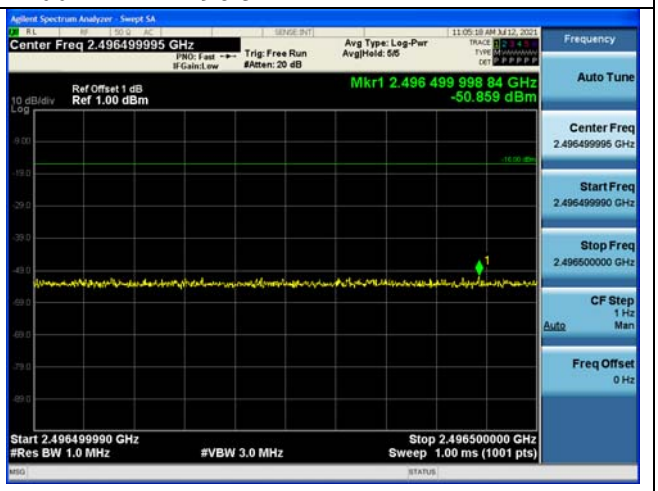
Test Data: BLE\2402MHz

10MHz – 1000MHz	1000MHz – 2387MHz
	
2387MHz – 2400MHz	2400MHz – 2496.5MHz
	
2496.5MHz – 26GHz	
	

Test Data: BLE\2442MHz

10MHz – 1000MHz	1000MHz – 2387MHz
	
2387MHz – 2400MHz	**2400MHz – 2496.5MHz**
	
2496.5MHz – 26GHz	
	

Test Data: BLE\2480MHz

10MHz – 1000MHz	1000MHz – 2387MHz
	
2387MHz – 2400MHz	**2400MHz – 2496.5MHz**
	
2496.5MHz – 26GHz	
	

5.6 Limitation of Collateral Emission of Receiver

5.6.1 Limit

Frequency below 1GHz : 4nW
Frequency above 1GHz : 20nW

5.6.2 Measurement Equipment Used

Refer to section Appendix A: Equipment List for detail.

5.6.3 Test Setup

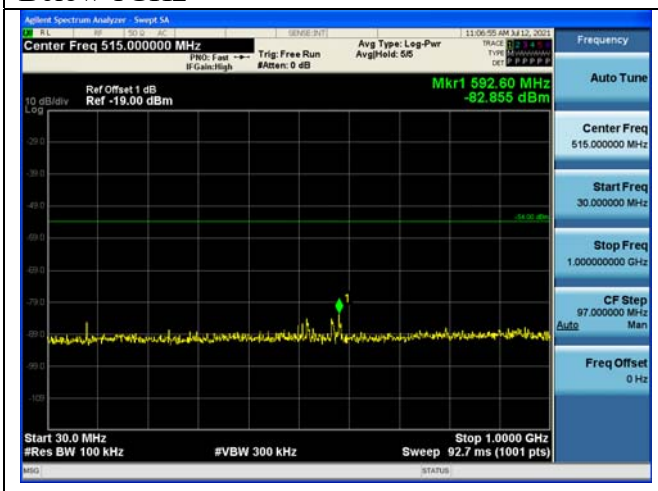
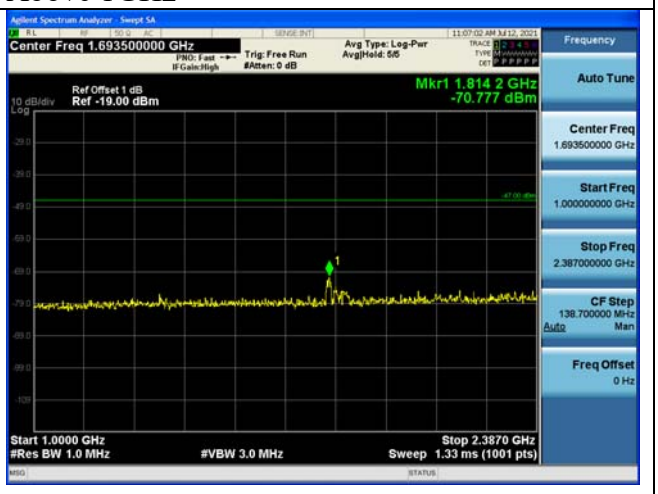
Refer to section 5.1.3 for detail.

5.6.4 Test Procedure

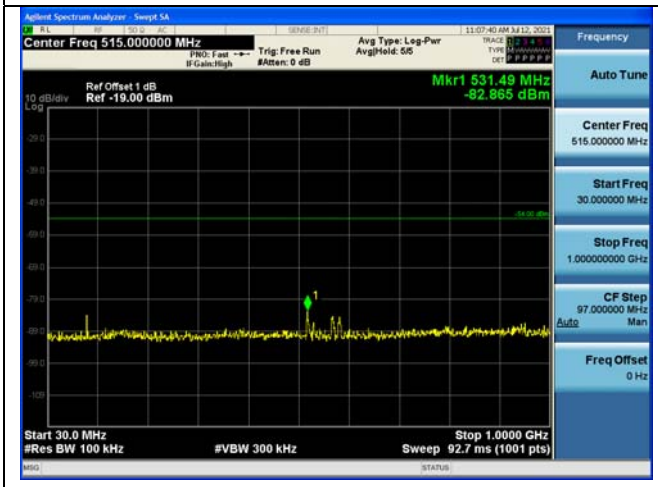
1. Setup the EUT at hopping off and modulation on.
2. Setup the ETU operate at channel low, mid and high and normal voltage.
3. Set the RBW=100kHz, VBW=300kHz, Sweep = auto, Start=10MHz, Stop=1GHz. Max hold view, mark highest level.
4. Set the RBW=1MHz, VBW=3MHz, Sweep = auto, Start=1GHz, Stop=26GHz. Max hold view, mark highest level.
5. Varied input voltage to + 10% and - 10% normal voltage and repeat procedure 1 to 4 again.
6. The Worst data was report.

5.6.5 Test Results

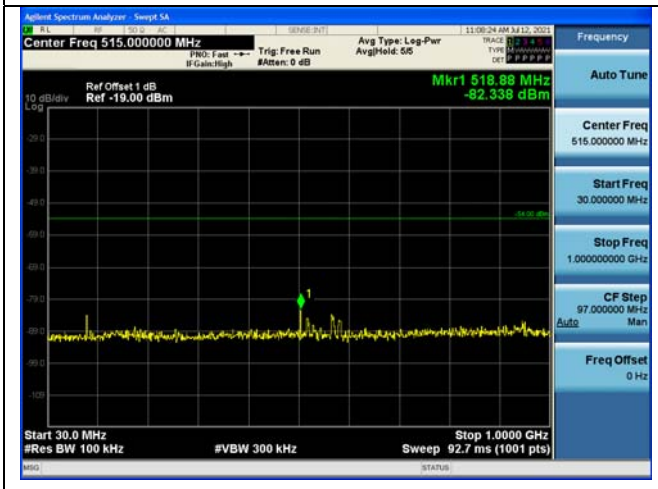
Test Data: BLE\2402MHz

Below 1GHz	Above 1GHz
	

Test Data: BLE\2442MHz

Below 1GHz	Above 1GHz
	

Test Data: BLE\2480MHz

Below 1GHz	Above 1GHz
	

5.7 Hopping Dwell Time

5.7.1 Limit

≤ 0.4s in one 28.5 sec period

5.7.2 Measurement Equipment Used

Refer to section Appendix A: Equipment List for detail.

5.7.3 Test Setup

Refer to section 5.1.3 for detail.

5.7.4 Test Procedure

1. Place the EUT on the table 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 the spectrum analyzer.
3. Set center frequency of spectrum analyzer = operating frequency.
4. Set the spectrum analyzer as RBW, VBW=1MHz, Span = 0Hz, Adjust Sweep = 30s.
5. Repeat above procedures until all frequency measured were complete.

5.7.5 Test Results

N/A

5.8 Angular Width of Principal Radiation (AWPR)

The angular width of principal radiation (AWPR), which follows from the antenna pattern specifications, shall satisfy the expression 360/A degree.

To be assessed:
AWPR < 360/A (degree)
A represent the value determined by dividing equivalent isotropic radiated power by the value obtained by applying an antenna power with the mean power (3mW for BT; 10mW for Wifi/ BLE) to the transmitting antenna with its absolute gain being 2.14 dBi.

Ambient temperature: 25℃ Relative humidity: 60% Test Date: 2021/07/12

BLE Antenna gain=1.53dBi

		Channel Low	Channel Mid	Channel High
Normal Voltage 5 V	Conducted power (mW)	2.279	2.244	2.272
	Radiated power (dBm)	5.107	5.041	5.095
	Radiated power (mW)	3.241	3.192	3.232
	Constant A	3.241/16.4<1	3.192/16.4<1	3.232/16.4<1
Upper Voltage 5.5 V	Conducted power (mW)	2.275	2.242	2.272
	Radiated power (dBm)	5.099	5.036	5.095
	Radiated power (mW)	3.235	3.189	3.232
	Constant A	3.235/16.4<1	3.189/16.4<1	3.232/16.4<1
Lower Voltage 4.5 V	Conducted power (mW)	2.32	2.244	2.275
	Radiated power (dBm)	5.185	5.04	5.1
	Radiated power (mW)	3.3	3.192	3.236
	Constant A	3.3/16.4<1	3.192/16.4<1	3.236/16.4<1

In these cases, according to article 49.20 (f)(2) of the Regulations the constant A should be equalized to 1.
As a result AWPR, 360 degrees, which is always satisfied.

5.9 Carrier Sense Capability

5.9.1 Limit

Shall not transmit when received signal level is above 100 mV

Automatic cessation of transmitting is required when the electric field strength is exceeding E (mV/m):
Antenna Voltage (in dBm) = 22.79 + max. antenna Gain - 20 x Log f (f in MHz)
This voltage will be generated in de direction of the max. Gain.

5.9.2 Measurement Equipment Used

Refer to section Appendix A: Equipment List for detail.

5.9.3 Test Setup

Refer to section 5.1.3 for detail.

5.9.4 Test Procedure

1. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port through splitter to spectrum.
2. Set center frequency of spectrum analyzer = operating frequency.
3. Set the spectrum analyzer as RBW, VBW=1MHz, Span = 50MHz, Sweep = Auto.
4. EUT link to device set it in normal mode.
5. Used spectrum analyzer trigger function and delta mark function.

5.9.5 Test Results

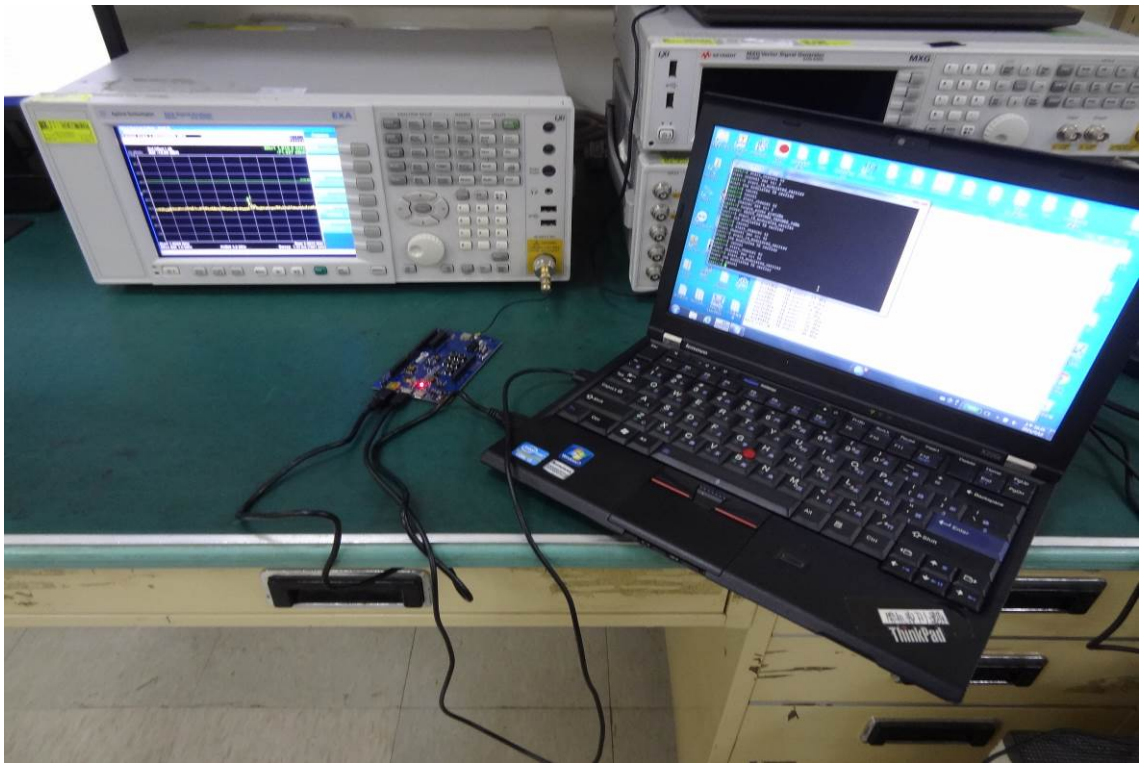
PASS

6. Appendix

6.1 Appendix A: Equipment List

Location Conducted	Equipment Name	Brand	Model	S/N	Last Cal. Date	Next Cal. Date
Conducted	Power Meter	Anritsu	ML2495A	1116010	09/25/2020	09/25/2021
Conducted	Power Sensor	Anritsu	MA2411B	34NKF50	09/25/2020	09/25/2021
Conducted	Power Sensor	DARE	RPR3006W	13I00030SNO33	01/04/2021	01/04/2022
Conducted	Power Sensor	DARE	RPR3006W	13I00030SNO34	01/04/2021	01/04/2022
Conducted	Power Sensor	DARE	RPR3006W	14I00889SNO35	06/23/2021	06/23/2022
Conducted	Power Sensor	DARE	RPR3006W	14I00889SNO36	06/23/2021	06/23/2022
Conducted	Temperature Chamber	KSON	THS-B4H100	2287	04/26/2021	04/26/2022
Conducted	DC Power supply	ABM	8185D	N/A	01/05/2021	01/05/2022
Conducted	AC Power supply	EXTECH	CFC105W	NA	N/A	N/A
Conducted	Spectrum analyzer	Keysight	N9010A	MY56070257	09/23/2020	09/23/2021
Conducted	Test Software	DARE	Radiation Ver:2013.1.23	NA	NA	NA
Conducted	Test Software	R&S	CMUGO Ver:2.0.0	N/A	N/A	N/A
Conducted	Universal Digital Radio Communication Tester	R&S	CMU200	111968	11/29/2020	11/29/2021
Conducted	Wideband Radio Communication Tester	R&S	CMW500	1201.002K501087 93-JG	10/28/2020	10/28/2021
Conducted	BT Simulator	Agilent	N4010A	MY48100200	NA	NA
Conducted	GPS Simulator	Welnavigate	GS-50	701523	NA	NA
Conducted (TS8997)	Wideband Radio Communication Tester	R&S	CMW500	168811	07/19/2020	07/19/2021
Conducted (TS8997)	Signal Generator	R&S	SMB100B	101085	10/28/2020	10/28/2021
Conducted (TS8997)	Vector Signal Generator	R&S	SMBV100A	263246	10/28/2020	10/28/2021
Conducted (TS8997)	Signal analyzer 40GHz	R&S	FSV40	101884	10/20/2020	10/20/2021
Conducted (TS8997)	OSP150 extension unit CAM-BUS	R&S	OSP150	101107	04/06/2021	04/06/2022
Conducted (TS8997)	Test Software	R&S	EMC32 Ver:11.10.00	NA	NA	NA

6.2 Appendix B: Photographs of Setup



6.3 Appendix C: Photographs of EUT

Please refer to the File of **ISL-21LR190P**

--- END ---