

TEST REPORT

Of

JAPAN MIC

Product : Bluetooth 5.1 Module

Brand: Fanstel

Model: BT40; BT40F; BT40E

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.>

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Report No.: ISL-21LR066JAP

Issue Date : 2021/04/09

Test results given in this report apply only to the specific sample(s) tested and are traceable to national or international standard through calibration of the equipment and evaluating measurement uncertainty herein.

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VERIFICATION OF COMPLIANCE

Applicant Fanstel Corporation, Taipei
Product Name: Bluetooth 5.1 Module
Brand Name: Fanstel
Model No.: BT40; BT40F; BT40E
Model Difference: Antenna difference
Date of Test: 2021/03/05 ~ 2021/04/08
Date of EUT Received: 2021/03/05

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 Article 2, Item (19) Appendix 43, B-1 (2). Item 19 of Article 2 Paragraph 1. 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.

Test By:	<u>Weitin Chen</u>	Date:	<u>2021/04/09</u>
	<i>Weitin Chen / Senior Engineer</i>		
Prepared By:	<u>Gigi yeh</u>	Date:	<u>2021/04/09</u>
	<i>Gigi Yeh / Senior Engineer</i>		
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	<i>Jerry Liu / Assistant Manager</i>		

Version

Version No.	Date	Description
00	2021/04/09	Initial creation of document

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1. Description of Equipment under Test (EUT)

1.1. GENERAL INFORMATION

General:

Product Name	Bluetooth 5.1 Module
Brand Name	Fanstel
Model Name	BT40; BT40F; BT40E
Model Difference	Antenna difference
Power Supply	5Vdc from USB (JIG)
USB port	one (JIG)

Model Summaries:

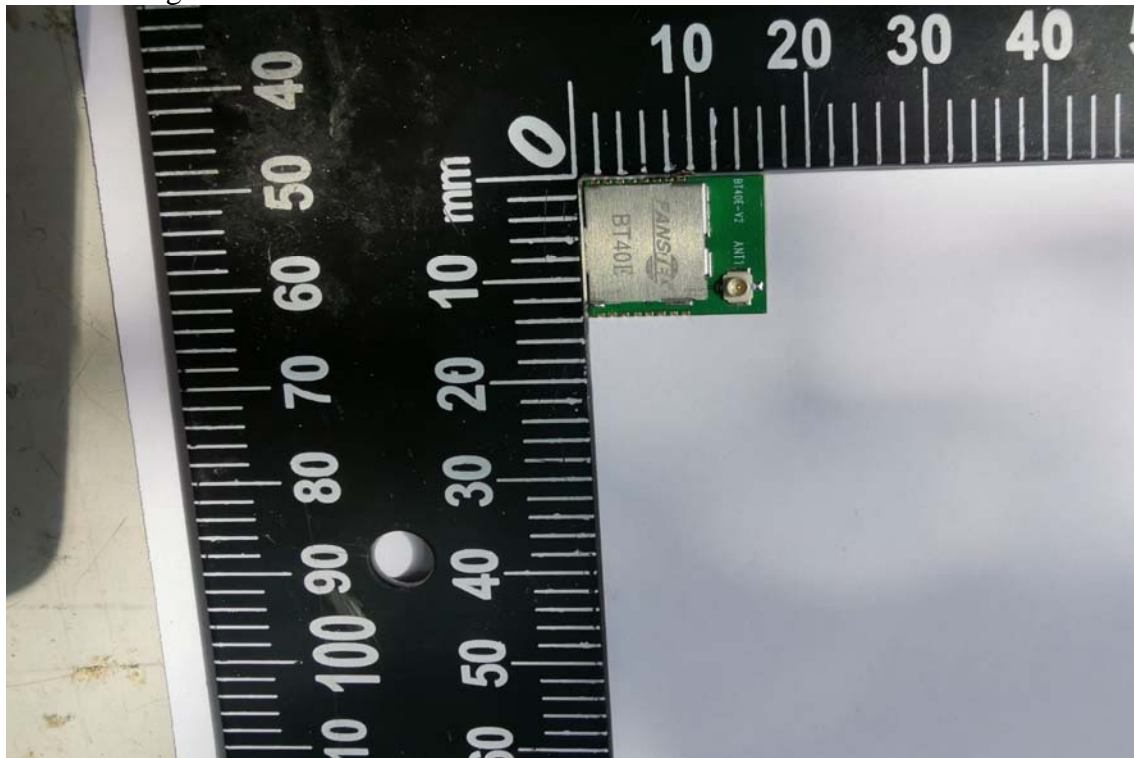
module	BT40F (PCB Ant.)	BT40	BT40E (Dipole Ant.)
SoC	nRF5340 QKAA	nRF5340 QKAA	nRF5340 QKAA
Size	15x20.8x1.9mm	14x16x1.9mm	14x16x1.9mm
32 MHz and 32.768 kHz crystals	Integrated	Integrated	Integrated
DC converter inductors, VDD, VDDH	Integrated	Integrated	Integrated
BT Antenna	PCB ANT 0.88dBi	PCB ANT -3.37dBi	Dipole ANT 6dBi
Max TX			
Operating temp.	-40°C to +105°C	-40°C to +105°C	-40°C to +105°C
Availability	Sample	Sample 1Q21	Sample

BLE:

Bluetooth Version	5.1
Rated Transmit Power	2 mW
Frequency Range	2.402GHz – 2.480GHz
Modulation Technique	GFSK
Channel number	40 channels
Dwell Time	N/A
Antenna	BT40E : Dipole Antenna, 6dBi BT40F : PCB Antenna, 0.88dBi BT40 : PCB Antenna, -3.37dBi

1.2. Assemble (Not easy to open/access issue)

There is a shielding soldered on the module.



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 BT40; BT40F; BT40E 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 5.2: GFSK modulation

Test channels in BT 5.2 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

The test kit is powered from 6Vdc battery

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 the certification ordinance Article 2, Item (19) Appendix 43, B-1 (2) and Item 19 of Article 2 Paragraph 1.

4. Test Facility

The measurement facilities used to collect the 3m Radiated Emission and AC power line conducted data are located on the address of **International Standards Laboratory Corp.** <LT Lab.> No. 120, Lane 180, Hsin Ho Rd., Lung-Tan Dist., Tao Yuan City 325, Taiwan which are constructed and calibrated to meet the FCC requirements in documents ANSI C63.4: 2014. FCC Registration Number is: TW1036, Canada Registration Number: 4067B-3.

5. Support Equipment

Fig. 5-1 Configuration of Tested System

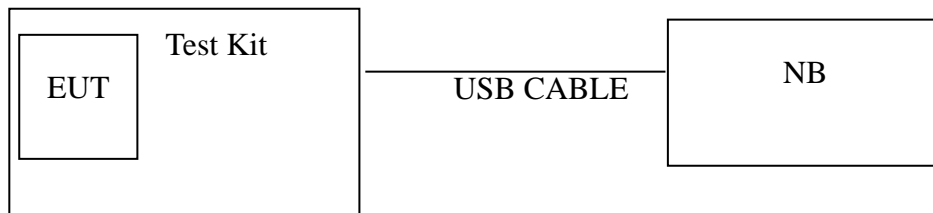


Table 5-1 Equipment Used in Tested System

Item	Equipment	Mfr./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

6. Summary of Tests

Article reference	Report reference	Parameter	Status (Note 1)
General provisions			
5	6.2	Frequency tolerance	C
6	6.3	Occupied bandwidth	C
7	6.5	Spurious emission	C
Transmitting equipment			
14	6.1	Antenna Power	C
14.2	--	SAR	N/A
15	6.2	Frequency stabilization	C
Transmitting equipment			
20	1.2	Type configuration etc of transmitting antenna	C
22	1.2	Directional pattern of transmitting antenna	C
Receiving equipment			
24	6.6	Spurious emission of receiver	C
26	1.2	Refer to all articles for transmitting antenna	C
Operating frequency 2400-2483.5MHz			
49.20(1); a	1.3	High Frequency/modulation section cannot be operated easily	C
49.20(1); b	1.1	Communication method	C
49.20(1); c	1.1	Communication method	C
49.20(1); d	1.1	Spread Spectrum method	N/A
49.20(1); e	6.1	Antenna Power	C
49.20(1); f(1)	1.2	Absolute gain of transmitting antenna	C
49.20(1); f(2)	6.8	Angular width of principal radiation (AWPR)	C
49.20(1); g		Number of carriers within 1MHz bandwidth in OFDM	N/A
49.20(1); h	6.4	Diffusion bandwidth	C
49.20(1); i	6.4	Spreading factor	N/A
49.20(1); j	6.7	Frequency retention time (FH employed)	N/A
Note 1: C=Confirm NC=Not Confirm NT=Not Tested NA= Not Applicable			

6.1. Antenna Power and Tolerance

6.1.1. Limit:

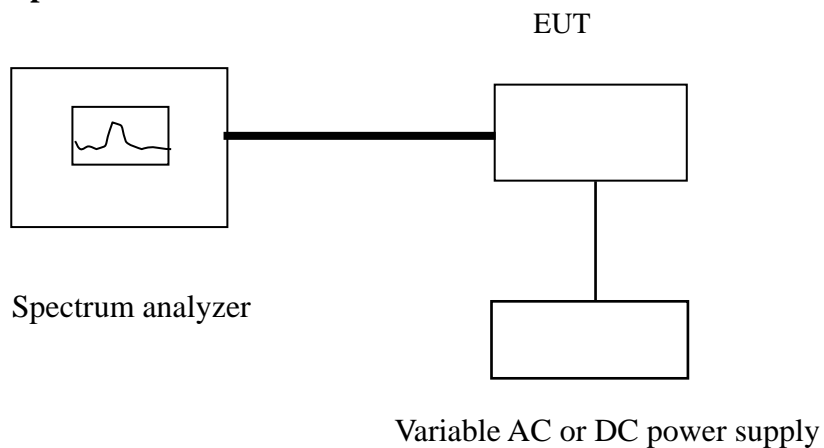
BT 5.2: Antenna power: 10mW

Antenna power tolerance: + 20% to – 80%

6.1.2. Measurement Equipment Used:

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	06/29/2020	06/29/2021
Conducted	Power Sensor	DARE	RPR3006W	14I00889SNO36	06/29/2020	06/29/2021
Conducted	Temperature Chamber	KSON	THS-B4H100	2287	03/11/2021	03/11/2022
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	Power Meter	Anritsu	ML2495A	1116010	09/25/2020	09/25/2021

6.1.3. Test Setup:



6.1.4. 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.

6.1.5. Test results:

BT LE:

Ambient temperature: 24°C

Relative humidity: 71%

Test Date: 2021/04/06

Rated Power Density =

2.0 mW

Antenna Gain=

6 dBi

		Channel Low	Channel Mid	Channel High	Limit
Normal Voltage 5 V	Conducted Power (dBm)	3.41	3.34	3.38	N/A
	Conducted Power (mW)	2.19	2.16	2.18	10mW
	Power Tolerance	9.56	7.89	8.96	+20% to -80%
Upper Voltage 5.5 V	Conducted Power (dBm)	3.40	3.34	3.37	N/A
	Conducted Power (mW)	2.19	2.16	2.17	10mW
	Power Tolerance	9.44	7.81	8.69	+20% to -80%
Lower Voltage 4.5 V	Conducted Power (dBm)	3.40	3.34	3.38	N/A
	Conducted Power (mW)	2.19	2.16	2.18	10mW
	Power Tolerance	9.49	7.86	8.76	+20% to -80%

Remark:

1. Conducted Power (mW)= $10^{(\text{Conducted Power(dBm/MHz)}/10)}$

6.2. Frequency Tolerance

6.2.1. Limit:

50ppm

6.2.2. Measurement Equipment Used:

Refer to section 6.1.2 for detail.

6.2.3. Test Setup:

Refer to section 6.1.3 for detail.

6.2.4. 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.

6.2.5. Test results:

Ambient temperature: 24°C Relative humidity: 71% Test Date: 2021/04/06

BT LE mode:

		Channel Low	Channel Mid	Channel High	Limit
Normal Voltage 5 V	Measured Frequency (MHz)	2401.91120	2441.90980	2479.90820	+/-50ppm
	Frequency Tolerance (ppm)	-36.97	-36.94	-37.02	
Upper Voltage 5.5 V	Measured Frequency (MHz)	2401.91120	2441.90980	2479.90800	+/-50ppm
	Frequency Tolerance (ppm)	-36.97	-36.94	-37.10	
Lower Voltage 4.5 V	Measured Frequency (MHz)	2401.91120	2441.90980	2479.90820	+/-50ppm
	Frequency Tolerance (ppm)	-36.97	-36.94	-37.02	

6.3. Occupied Bandwidth

6.3.1. Limit:

802.11 b/g /n(HT20), BT(LE) < 26MHz

802.11 n(HT40)<38MHz

BT normal mode<83.5MHz

BT(LE) < 26MHz

6.3.2. Measurement Equipment Used:

Refer to section 6.1.2 for detail.

6.3.3. Test Setup:

Refer to section 6.1.3 for detail.

6.3.4. 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, center frequency = 2402MHz, 2442MHz, 2480MHz and Span = 5MHz
4. Turn on 99% spectrum OBW function on, 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.

6.3.5. Test results:

Ambient temperature: 24°C

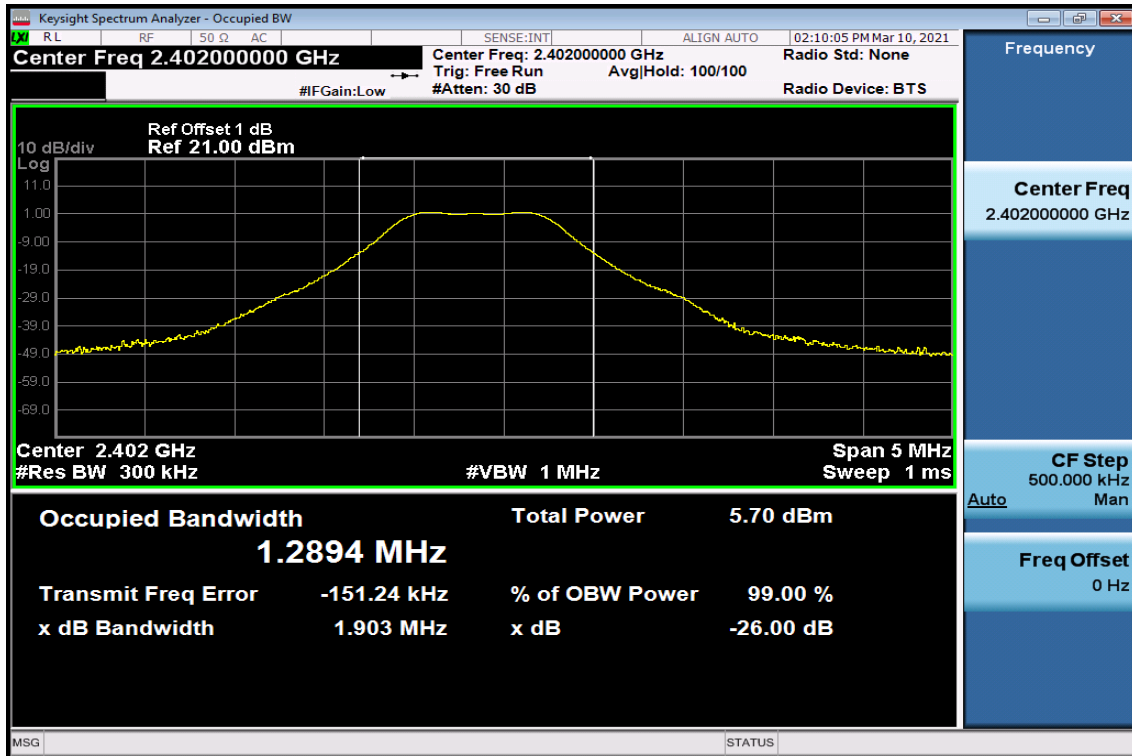
Relative humidity: 71%

Test Date: 2021/04/06

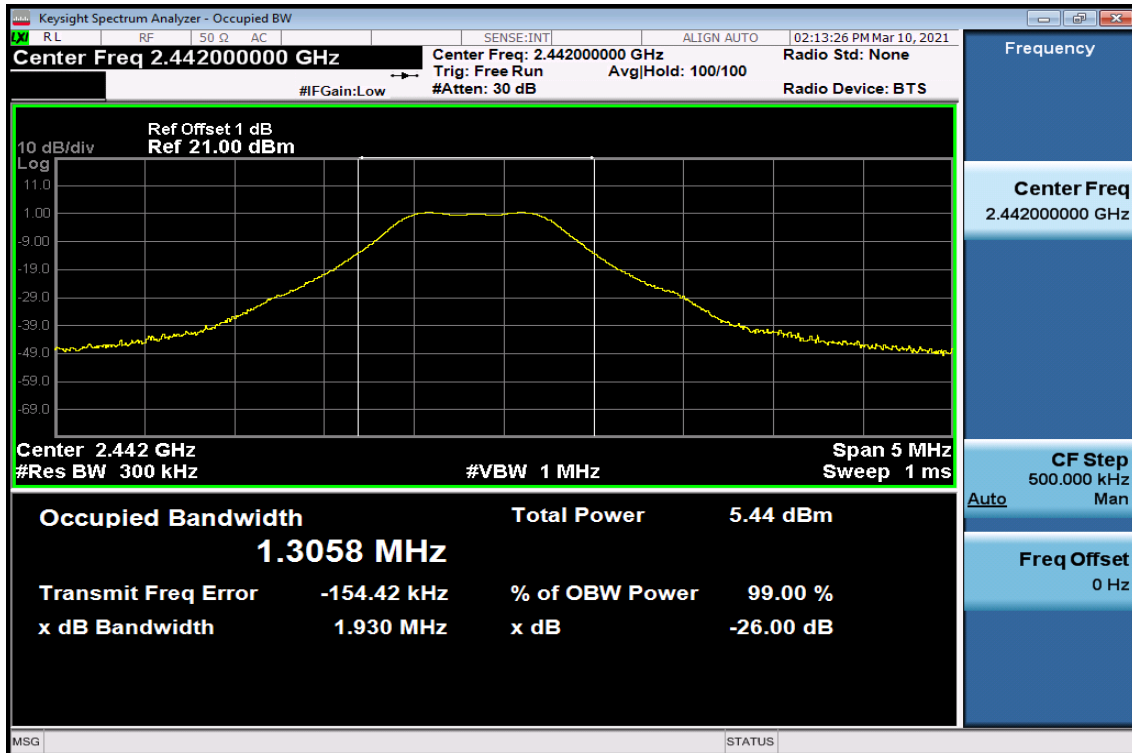
BT LE mode	Low channel (MHz)	Mid channel (MHz)	High channel (MHz)	Limit	Remark
Normal Voltage 5 V	1.29	1.31	1.31	<26MHz	Pass
Upper Voltage 5.5 V	1.29	1.31	1.31	<26MHz	Pass
Lower Voltage 4.5 V	1.29	1.31	1.31	<26MHz	Pass

Normal voltage for BT LE mode:

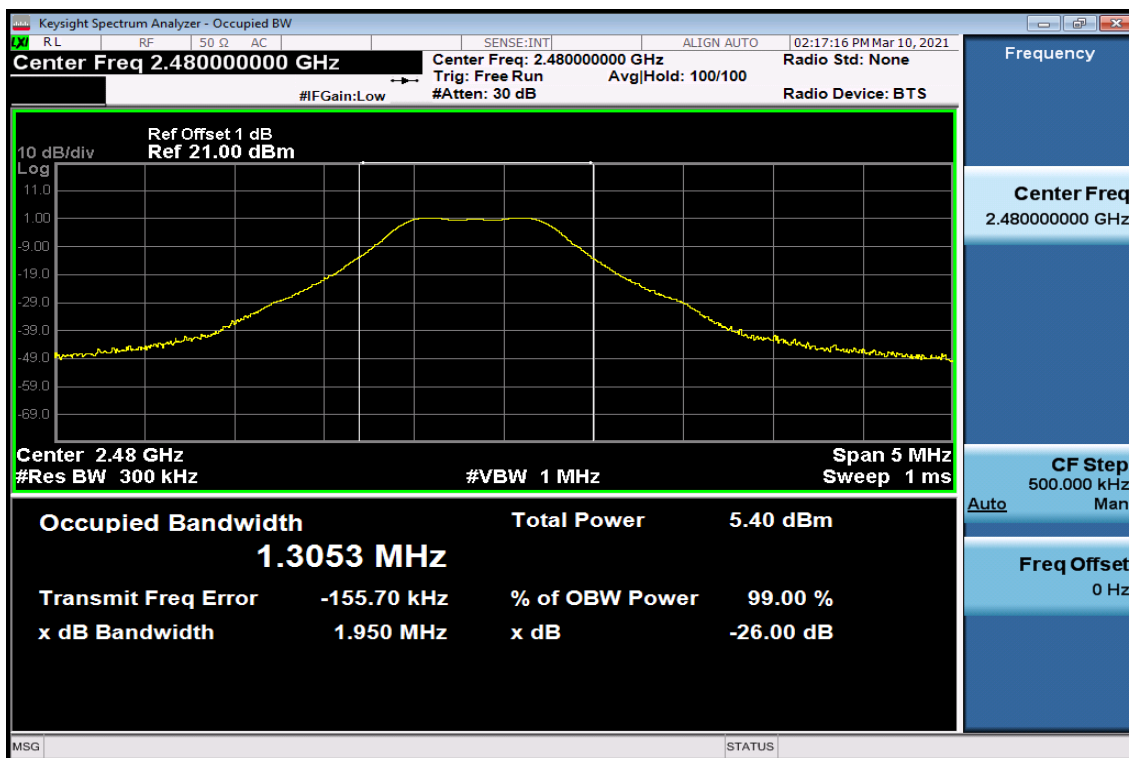
Low



Mid



High



6.4. Spreading Bandwidth (90%)

6.4.1. Limit:

> 500kHz

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

6.4.2. Measurement Equipment Used:

Refer to section 6.1.2 for detail.

6.4.3. Test Setup:

Refer to section 6.1.3 for detail.

6.4.4. 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, center frequency =2402MHz, 2442MHz, 2480MHz and Span = 5MHz
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.

6.4.5. Test results:

Ambient temperature: 24°C

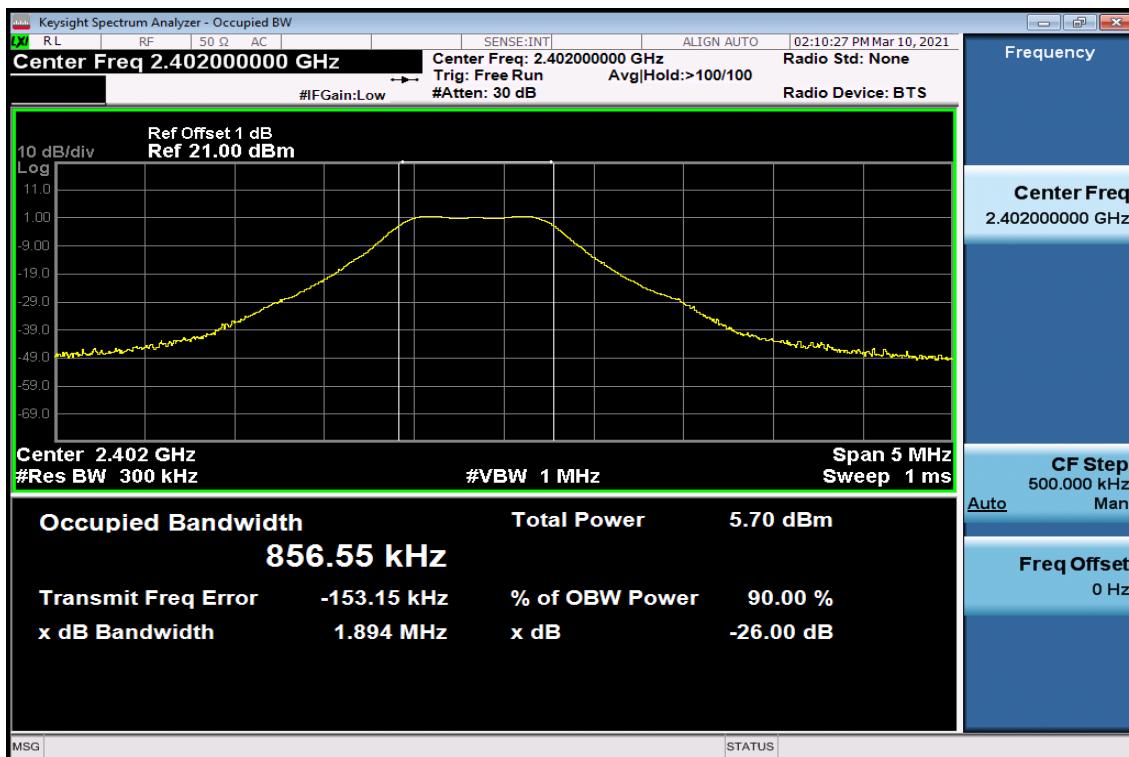
Relative humidity: 71%

Test Date: 2021/04/06

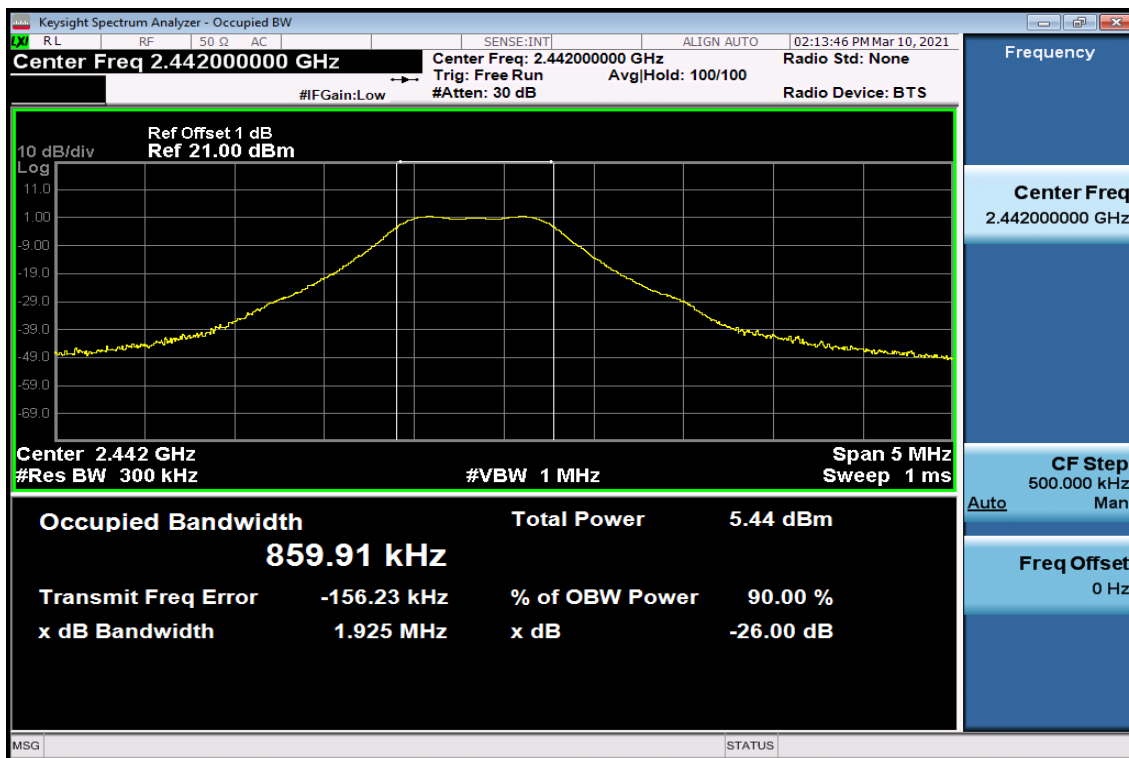
Mode: LE	Low channel (MHz)	Mid channel (MHz)	High channel (MHz)	Limit
Normal Voltage 5 V	0.86	0.86	0.86	>500kHz
Upper Voltage 5.5 V	0.86	0.86	0.86	>500kHz
Lower Voltage 4.5 V	0.86	0.86	0.86	>500kHz

Normal voltage for BT LE mode:

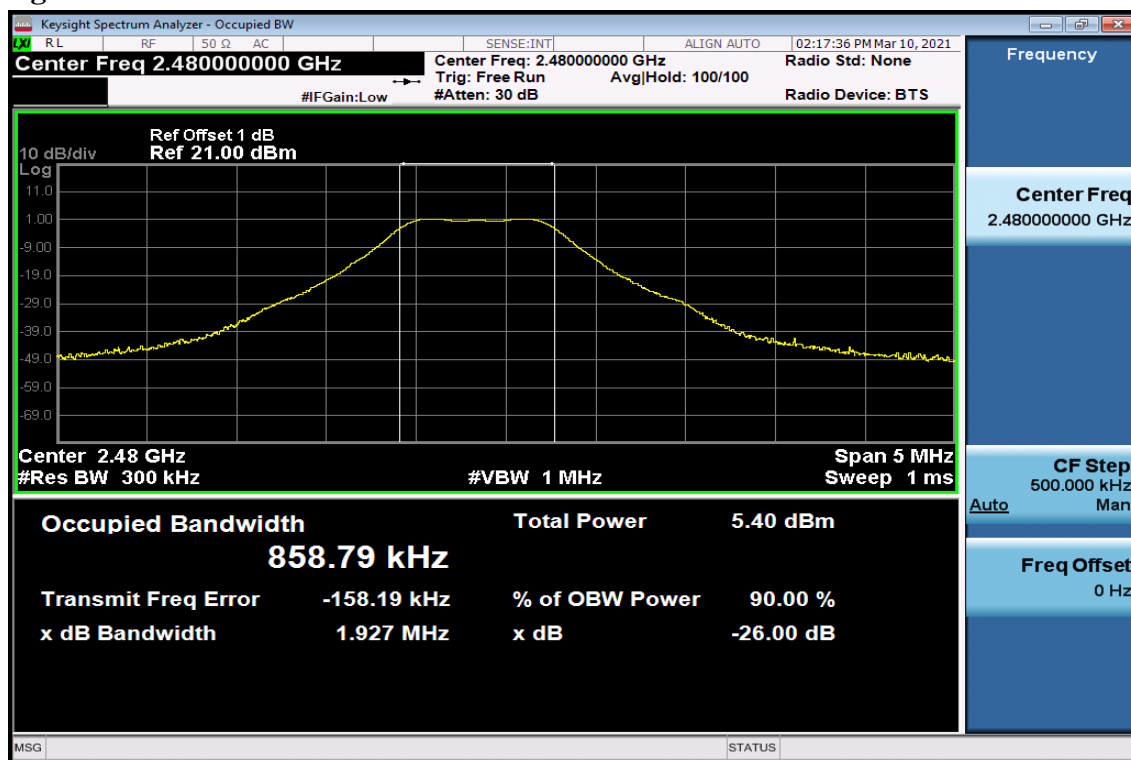
Low



Mid



High



6.5. Transmitter Spurious Emissions

6.5.1. Limit:

Frequency below 2.387 and above 2.4965GHz: 2.5uW

Frequency between 2.387 – 2.400GHz, 2.4835-2.4965GHz: 25uW

6.5.2. Measurement Equipment Used:

Refer to section 6.1.2 for detail.

6.5.3. Test Setup:

Refer to section 6.1.3 for detail.

6.5.4. 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 spectrum analyzer Ref level= -10dBm; attenuation=0dB; RBW=100kHz, BW=100kHz, Sweep = auto Start=10MHz, Stop=1000MHz. Max hold view, mark highest level.
4. Set the spectrum analyzer Ref level= -10dBm; attenuation=0dB; RBW=1MHz, BW=1MHz, Sweep = auto Start=1000MHz, Stop=2387MHz. Max hold view, mark highest level.
5. Set the spectrum analyzer Ref level= -10dBm; attenuation=0dB; RBW=1MHz, RBW=1MHz, Sweep = auto, Start=2387MHz, Stop=2400MHz. Max hold view, mark highest level.
6. Set the spectrum analyzer Ref level= -10dBm; attenuation=0dB; RBW=1MHz, BW=1MHz, Sweep = auto Start=2483.5MHz, Stop=2496.5MHz. Max hold view, mark highest level.
7. Set the spectrum analyzer Ref level= -10dBm; attenuation=0dB; RBW=1MHz, BW=1MHz, Sweep = auto, Start=2496.5MHz, Stop=26GHz. Max hold view, mark highest level.
8. Varied input voltage to + 10% and - 10% normal voltage and repeat procedure 1 to 7 again.
9. The Worst data was report.

6.5.5. Test Results:

Refer to next page for plots.

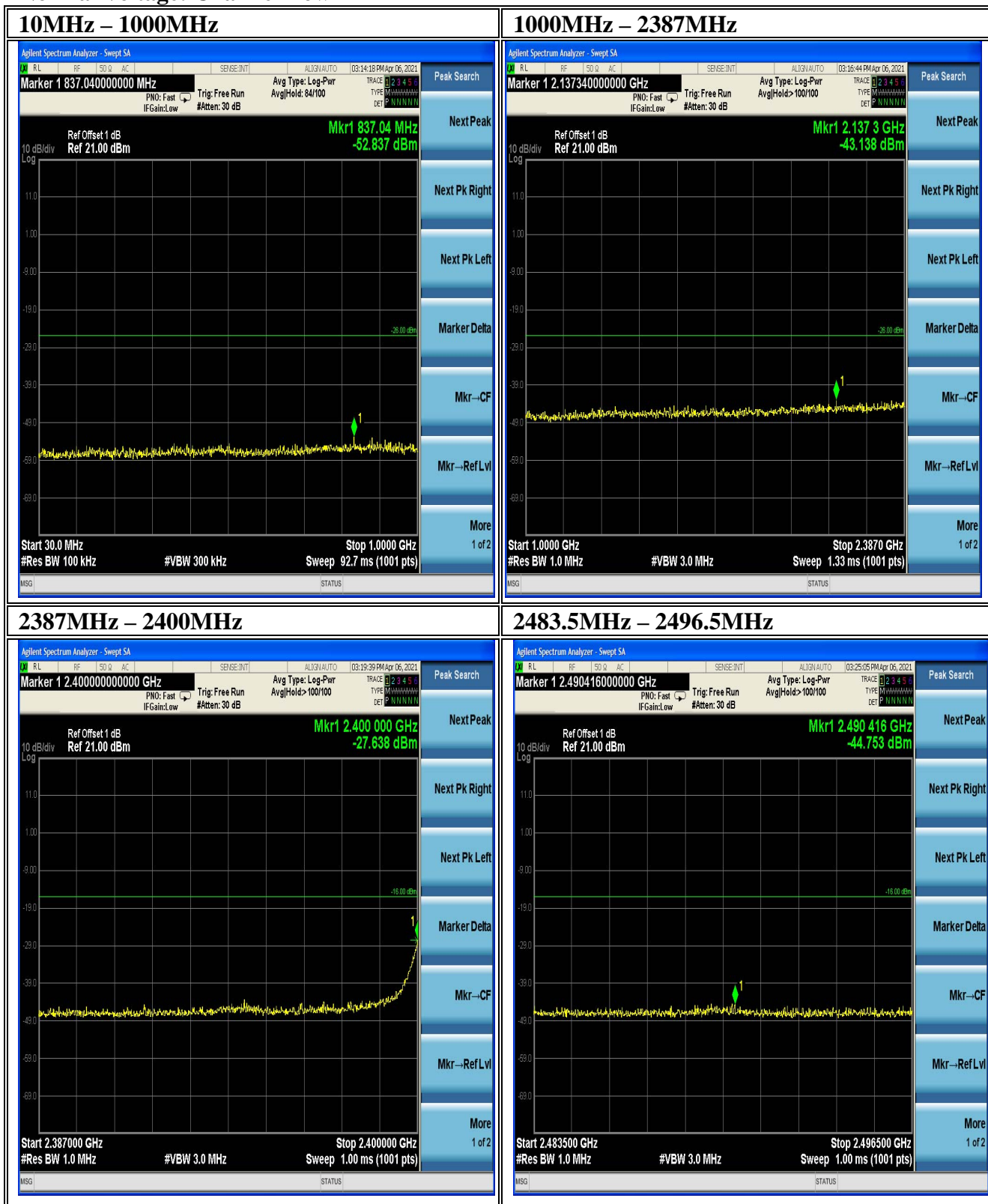
Ambient temperature: 24°C

Relative humidity: 71%

Test Date: 2021/04/06

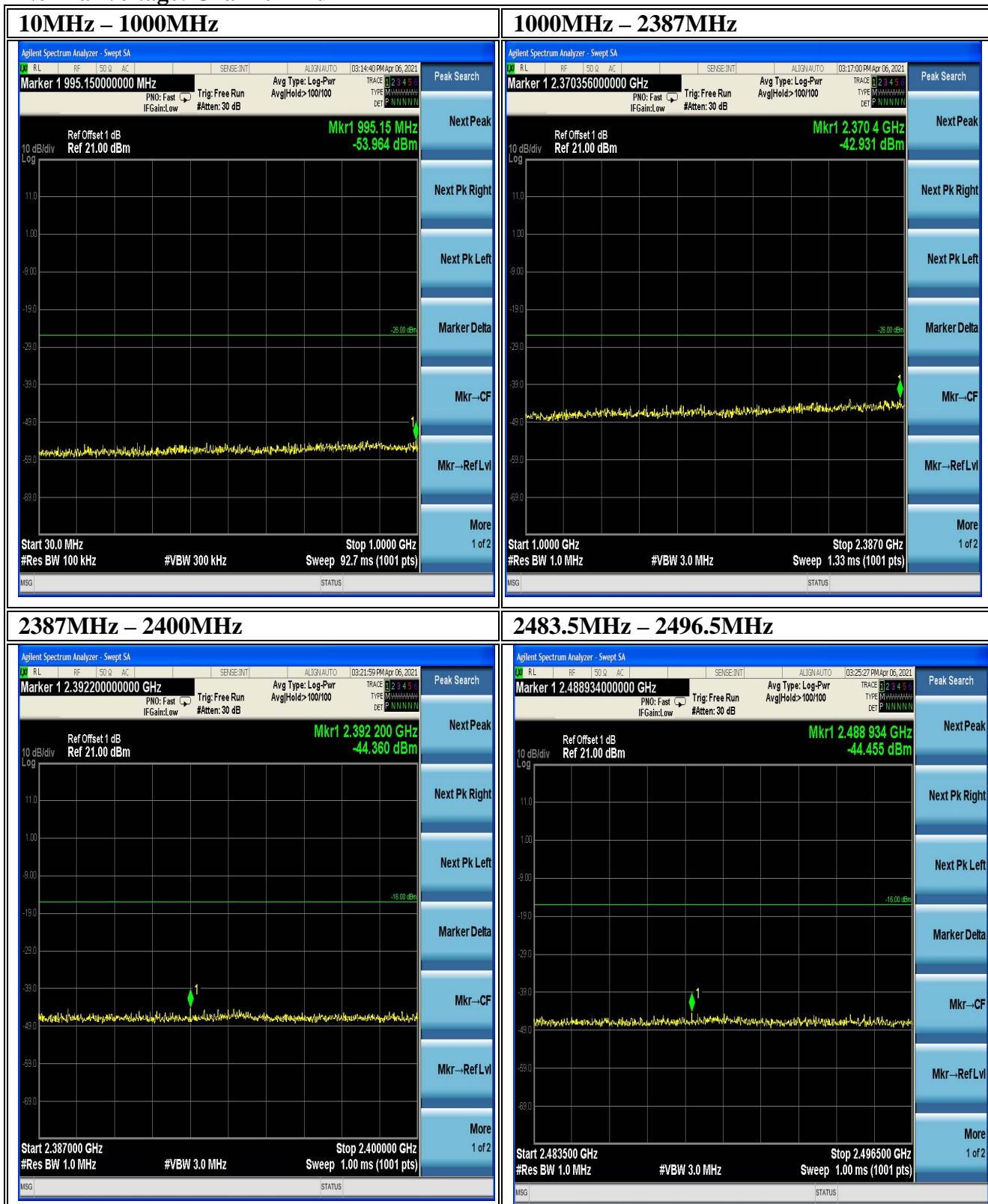
BT LE mode:

Normal Voltage: Channel Low



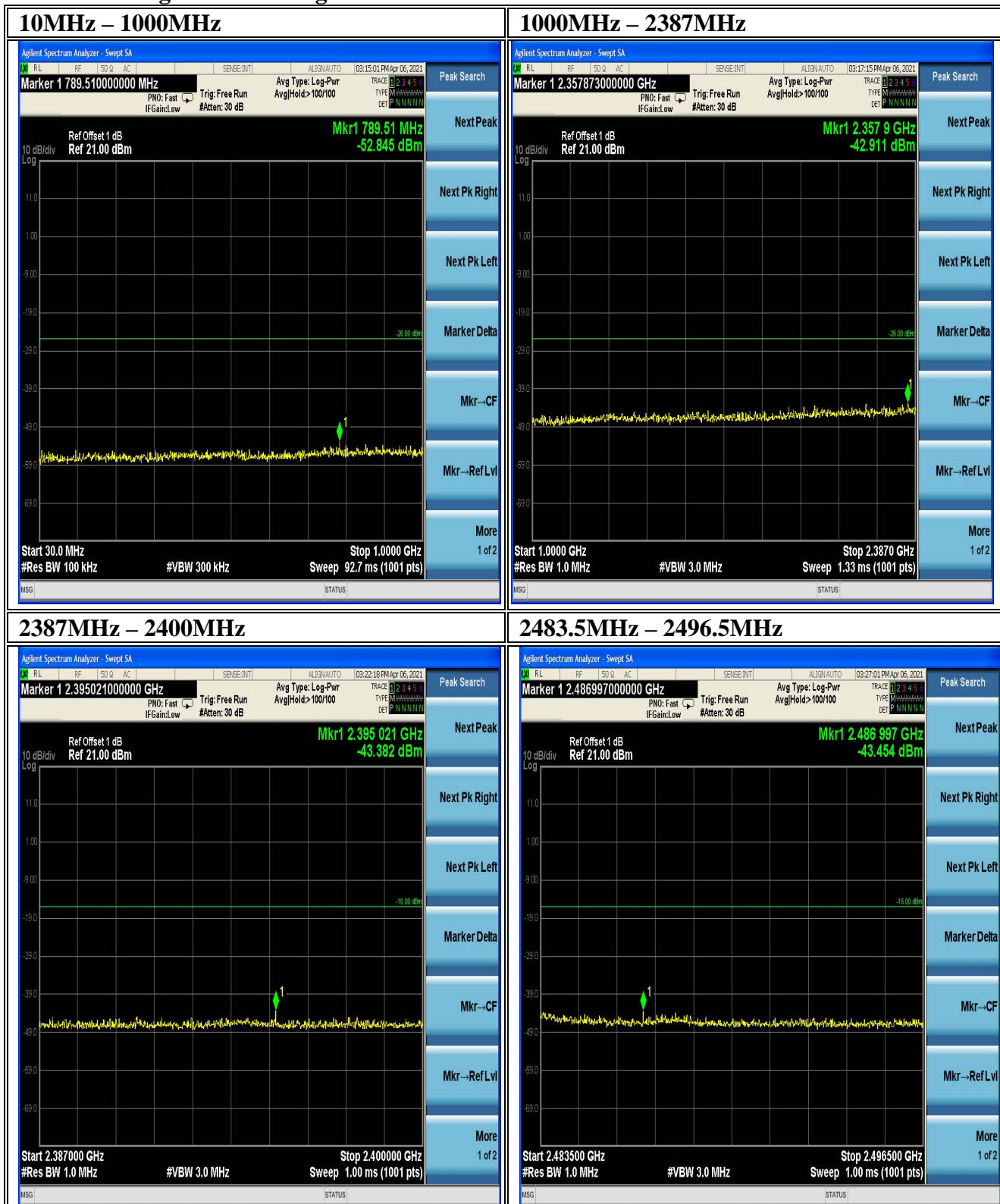


Normal Voltage: Channel Mid





Normal Voltage: Channel High





6.6. Limitation of Collateral Emission of Receiver

6.6.1. Limit:

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

6.6.2. Measurement Equipment Used:

Refer to section 6.1.2 for detail.

6.6.3. Test Setup:

Refer to section 6.1.3 for detail.

6.6.4. 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 spectrum analyzer Ref level: -10dBm; attenuation=0dB; RBW= 100kHz, VBW=100kHz, Sweep = auto, Start=10MHz, Stop=1GHz. Max hold view, mark highest level.
4. Set the spectrum analyzer Ref level: -10dBm, attenuation=0dB; RBW=1MHz, VBW=1MHz, Sweep = auto, Start=1GHz, Stop=13GHz. 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.

6.6.5. Test Results:

Refer to next page for plots.

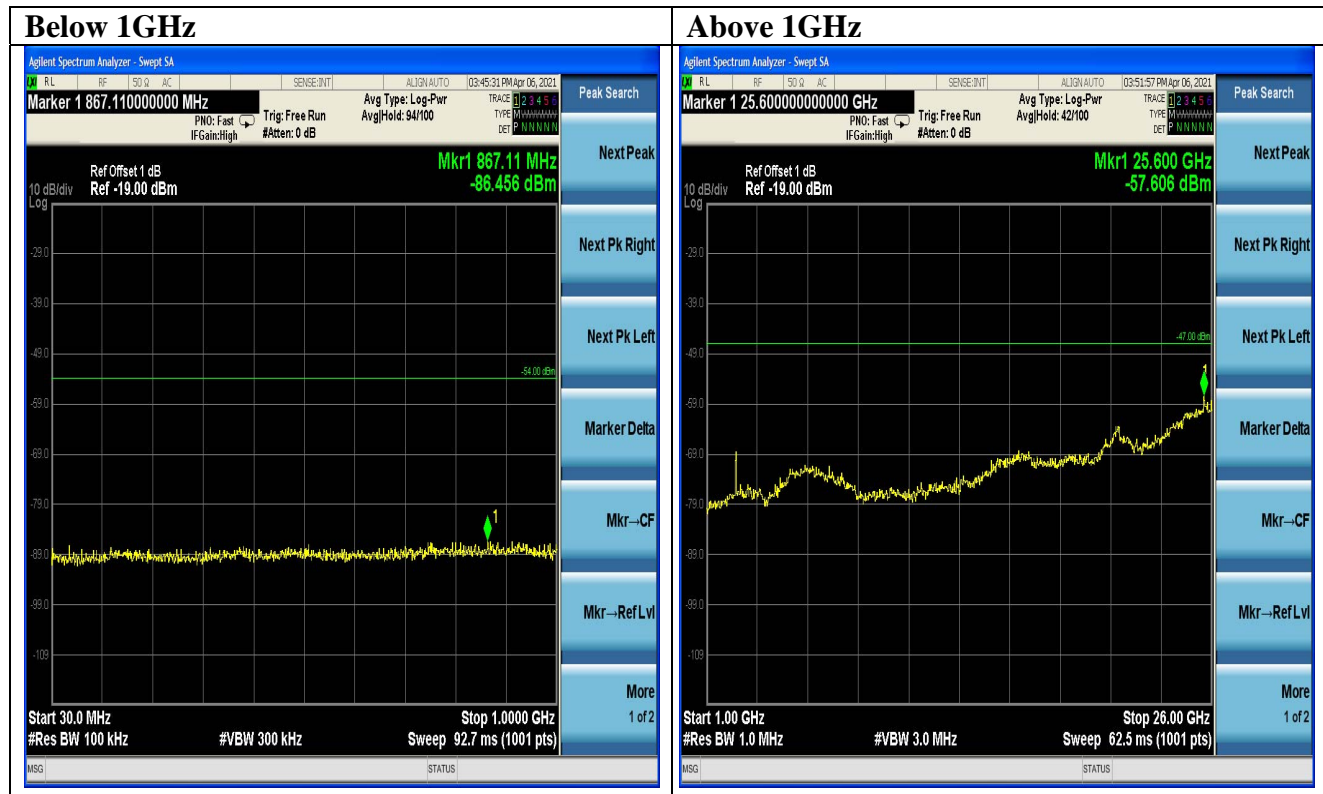
Ambient temperature: 24°C

Relative humidity: 71%

Test Date: 2021/04/06

Normal Voltage for BT LE mode:

Channel Low



Channel Mid



Channel High



6.7. Hopping Dwell Time

6.7.1. Limit:

≤ 0.4s in one 28.5 sec period

6.7.2. Measurement Equipment Used:

Refer to section 6.1.2 for detail.

6.7.3. Test Setup:

Refer to section 6.1.3 for detail.

6.7.4. 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.

6.7.5. Test Results:

N/A

6.8. 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:

$$AWPR < 360/A \text{ (degree)}$$

A represent the value determined by dividing equivalent isotropic radiated power by the value obtained by applying an antenna power with the mean power of 10 mW to the transmitting antenna with its absolute gain being 2.14 dBi.

BT LE mode:

Antenna gain= 6 dBi				
		Channel Low	Channel Mid	Channel High
Normal Voltage 5 V	Conducted power (mW)	2.191	2.158	2.179
	Radiated power (dBm)	9.41	9.34	9.38
	Radiated power (mW)	8.724	8.590	8.676
	Constant A	$8.724 / 16.4 < 1$	$8.590 / 16.4 < 1$	$8.676 / 16.4 < 1$
Upper Voltage 5.5 V	Conducted power (mW)	2.189	2.156	2.174
	Radiated power (dBm)	9.40	9.34	9.37
	Radiated power (mW)	8.714	8.584	8.654
	Constant A	$8.714 / 16.4 < 1$	$8.584 / 16.4 < 1$	$8.654 / 16.4 < 1$
Lower Voltage 4.5 V	Conducted power (mW)	2.190	2.157	2.175
	Radiated power (dBm)	9.40	9.34	9.38
	Radiated power (mW)	8.718	8.588	8.660
	Constant A	$8.718 / 16.4 < 1$	$8.588 / 16.4 < 1$	$8.660 / 16.4 < 1$

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.

6.9. Carrier Sense Capability

6.9.1. 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 the direction of the max. Gain.

2.4GHz

					Antenna Gain				dBm
Channel Low	2402 MHz:	Pcs=	22.79	+	6	-	20log(2402)	=	-38.82
Channel Mid	2442 MHz:	Pcs=	22.79	+	6	-	20log(2442)	=	-38.96
Channel High	2480 MHz:	Pcs=	22.79	+	6	-	20log(2480)	=	-39.10

6.9.2. Measurement Equipment Used:

Refer to section 6.1.2 for detail.

6.9.3. Test Setup:

Refer to section 6.1.3 for detail.

6.9.4. 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

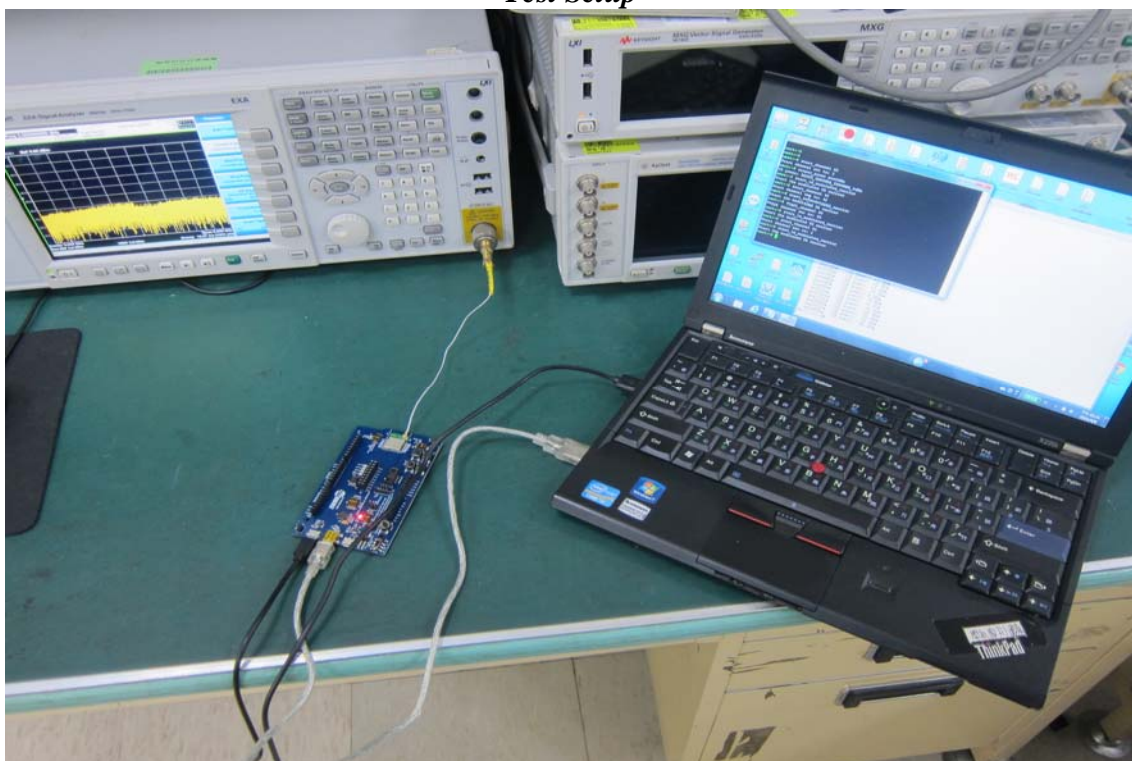
6.9.5. Test Results:

PASS

APPENDIX 1

Photographs of Set Up

Test Setup



APPENDIX 2

Photographs of EUT

Please refer to the file ISL-21LR066P