

TEST REPORT

Of

JAPAN MIC

Product : Bluetooth 5.0, 802.15.4 module

Brand: Fanstel

Model: BT840

Series Model: BT840F, BT840E, BT840H

Model Difference: Antenna. Please see page 5 for detail

Applicant: Fanstel Corporation, Taipei

Address: 10F-10, No. 79, Sec. 1, Hsin Tai Wu Rd.,
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Test Performed by:

International Standards Laboratory Corp.

<LT Lab.>

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Report No.: **ISL-19LR205JAPBLE**

Issue Date : **2019/08/26**

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 5.0, 802.15.4 module
Brand Name: Fanstel
Model No.: BT840
Series Model: BT840F, BT840E, BT840H
Model Difference: Antenna. Please see page 5 for detail
Date of Test: 2019/08/12 ~ 2019/08/21
Date of EUT Received: 2019/07/29

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>2019/08/26</u>
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Prepared By:	<u>Elisa Chen</u>	Date:	<u>2019/08/26</u>
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	Jerry Liu / Technical Manager		

Version

Version No.	Date	Description
00	2019/08/26	Initial creation of document

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1. Description of Equipment under Test (EUT)

1.1. GENERAL INFORMATION

General:

Product Name	Bluetooth 5.0, 802.15.4 module
Brand Name	Fanstel
Model Name	BT840
Series Model	BT840F , BT840E ,BT840H
Model Difference	Antenna. Please see table below for detail.
Power Supply	5Vdc from USB (JIG)
USB port	one (JIG)

Model Summaries

module	BT840F	BT840	BT840E	BT840H
SoC	nRF52840-QIAA	nRF52840-QIAA	nRF52840-QIAA	nRF52840-QIAA
Size	15x20.8x1.9mm	14x16x1.9mm	14x16x1.9mm	14x16x1.9mm
BT Antenna	PCB trace	PCB trace	u.FL	MHF4
BT range at 1Mbps	510 meters	180 M, estimated		
BT range at 125 Kbps	930 meters		>1000 M	>1000 M

BT:

Bluetooth Version	5.0
Rated Transmit Power	7 mW
Frequency Range	2.402GHz – 2.480GHz
Modulation Technique	GFSK
Channel number	40 channels
Dwell Time	N/A
Antenna	BT840: PCB Antenna, -3.52dBi BT840E: Dipole Antenna, 0dBi BT840F: PCB Antenna, 0.34dBi BT840H: Dipole Antenna, 0dBi

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

There is a shielding soldered on the module.

<p>BT840E</p>	<p>BT840F</p>
<p>BT840H</p>	<p>BT840</p>

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 BT840F 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 5.0: GFSK modulation

Test channels in BT 5.0 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

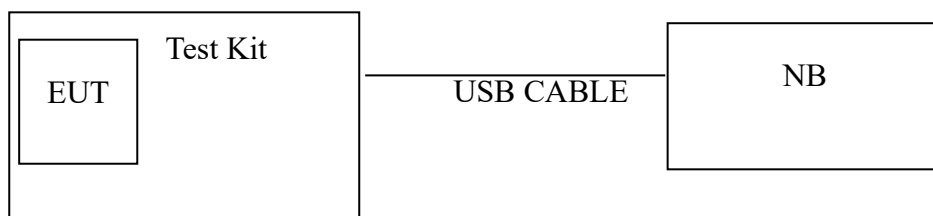


Table 5-1 Equipment Used in Tested System

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:

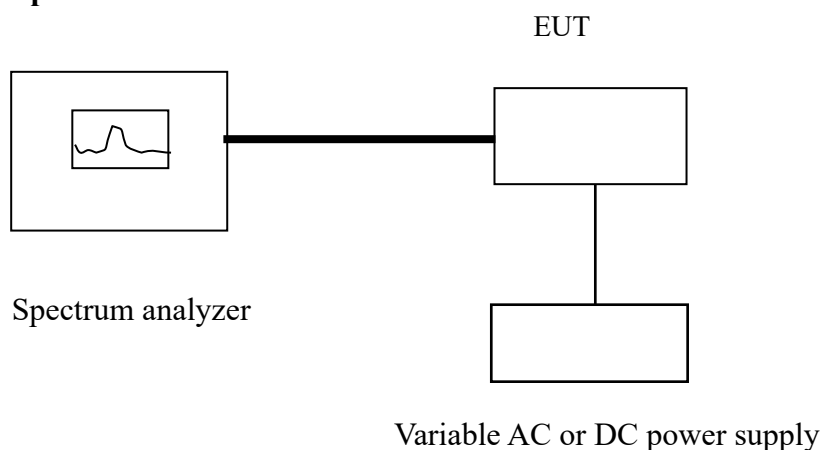
BT 5.0: Antenna power: 10mW

Antenna power tolerance: + 20% to – 80%

6.1.2. Measurement Equipment Used:

Conducted Emission Test Site					
Equipment Type	MFR	Model Number	Serial Number	Last Cal.	Cal Due.
Power Meter 05	Anritsu	ML2495A	1116010	10/28/2018	10/27/2019
Power Sensor 05	Anritsu	MA2411B	34NKF50	10/28/2018	10/27/2019
DC Power supply	ABM	8185D	N/A	01/10/2019	01/09/2020
AC Power supply	EXTECH	CFC105W	NA	N/A	N/A
Splitter	MCLI	PS4-199	12465	12/26/2017	12/25/2019
Spectrum analyzer	keysight	N9010A	MY56070257	10/15/2018	10/14/2019
Spectrum analyzer	R&S	FSP40	100116	01/10/2019	01/09/2020

6.1.3. Test Setup:



6.1.4. Test Procedure:

1. Set the EUT at hopping off and modulation on.
2. Set the EUT 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: 20 °C

Relative humidity: 65 %

Test Date: 2019/08/15

Rated Power Density =

7.00 mW

Antenna Gain=

0.34 dBi

		Channel Low	Channel Mid	Channel High	Limit
Normal Voltage 5 V	Conducted Power (dBm)	8.16	8.23	8.47	N/A
	Conducted Power (mW)	6.54	6.65	7.04	10mW
	Power Tolerance	-6.57	-5.00	0.53	+20% to -80%
Upper Voltage 5.5 V	Conducted Power (dBm)	8.15	8.23	8.47	N/A
	Conducted Power (mW)	6.54	6.65	7.03	10mW
	Power Tolerance	-6.63	-5.07	0.46	+20% to -80%
Lower Voltage 4.5 V	Conducted Power (dBm)	8.16	8.23	8.47	N/A
	Conducted Power (mW)	6.54	6.65	7.03	10mW
	Power Tolerance	-6.59	-5.00	0.46	+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: 20 °C Relative humidity: 65 % Test Date: 2019/08/15

BT LE mode:

		Channel Low	Channel Mid	Channel High	Limit
Normal Voltage 5 V	Measured Frequency (MHz)	2402.05760	2442.05860	2480.05960	+/-50ppm
	Frequency Tolerance (ppm)	23.98	24.00	24.03	
Upper Voltage 5.5 V	Measured Frequency (MHz)	2402.05760	2442.05860	2480.05940	+/-50ppm
	Frequency Tolerance (ppm)	23.98	24.00	23.95	
Lower Voltage 4.5 V	Measured Frequency (MHz)	2402.05760	2442.05860	2480.05960	+/-50ppm
	Frequency Tolerance (ppm)	23.98	24.00	24.03	

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 = 300MHz, VBW=1kHz, center frequency = 2402MHz, 2442MHz, 2484MHz 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:

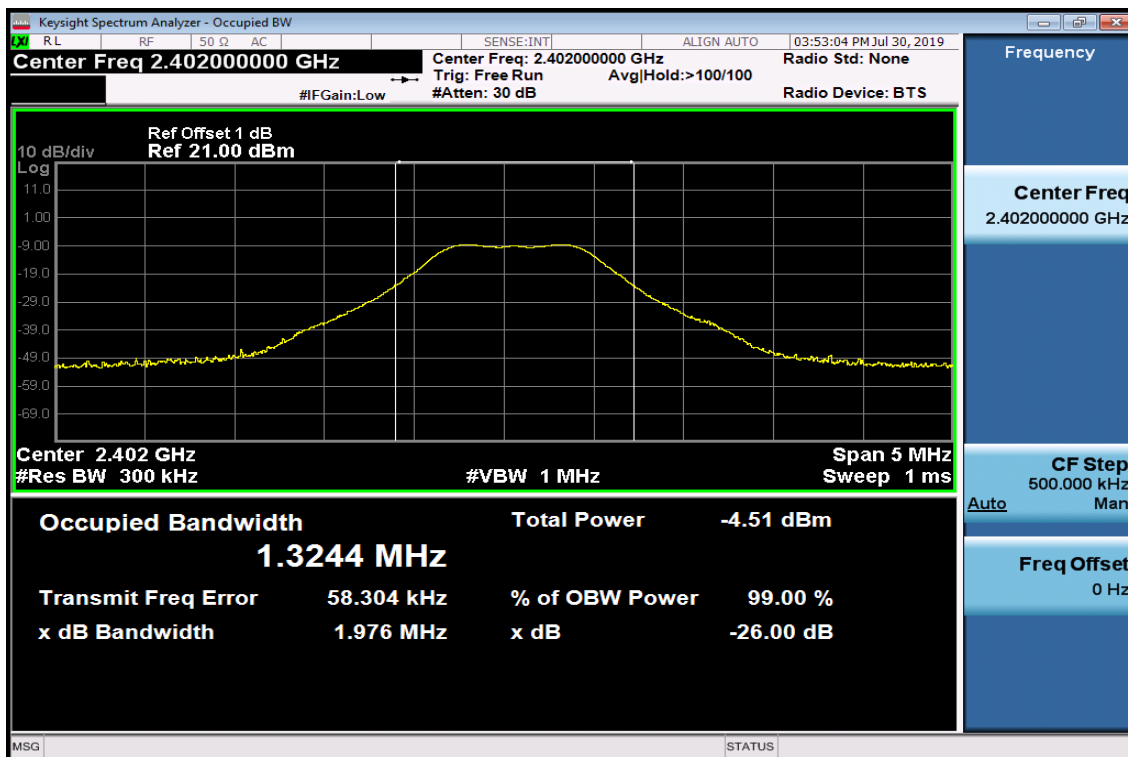
Ambient temperature: 20 °C Relative humidity: 65 %

Test Date: 2019/08/15

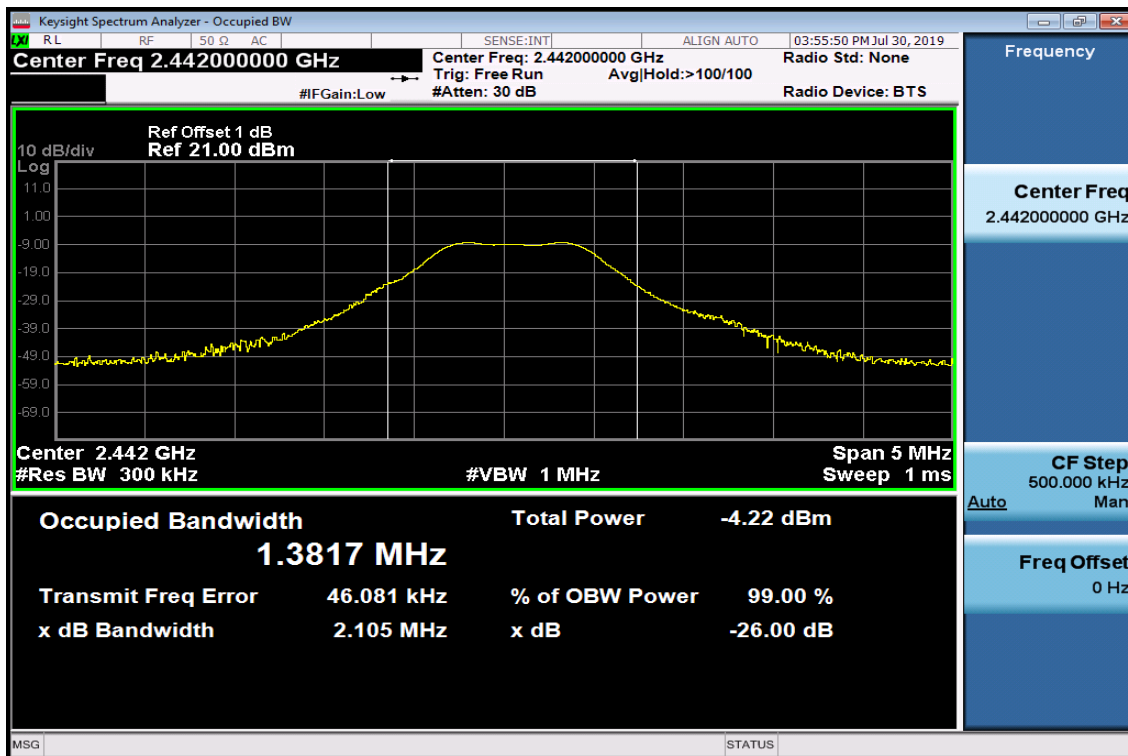
BT LE mode	Low channel (MHz)	Mid channel (MHz)	High channel (MHz)	Limit	Remark
Normal Voltage 5 V	1.32	1.38	1.37	<26MHz	Pass
Upper Voltage 5.5 V	1.32	1.38	1.32	<26MHz	Pass
Lower Voltage 4.5 V	1.32	1.38	1.38	<26MHz	Pass

Normal voltage for BT LE mode:

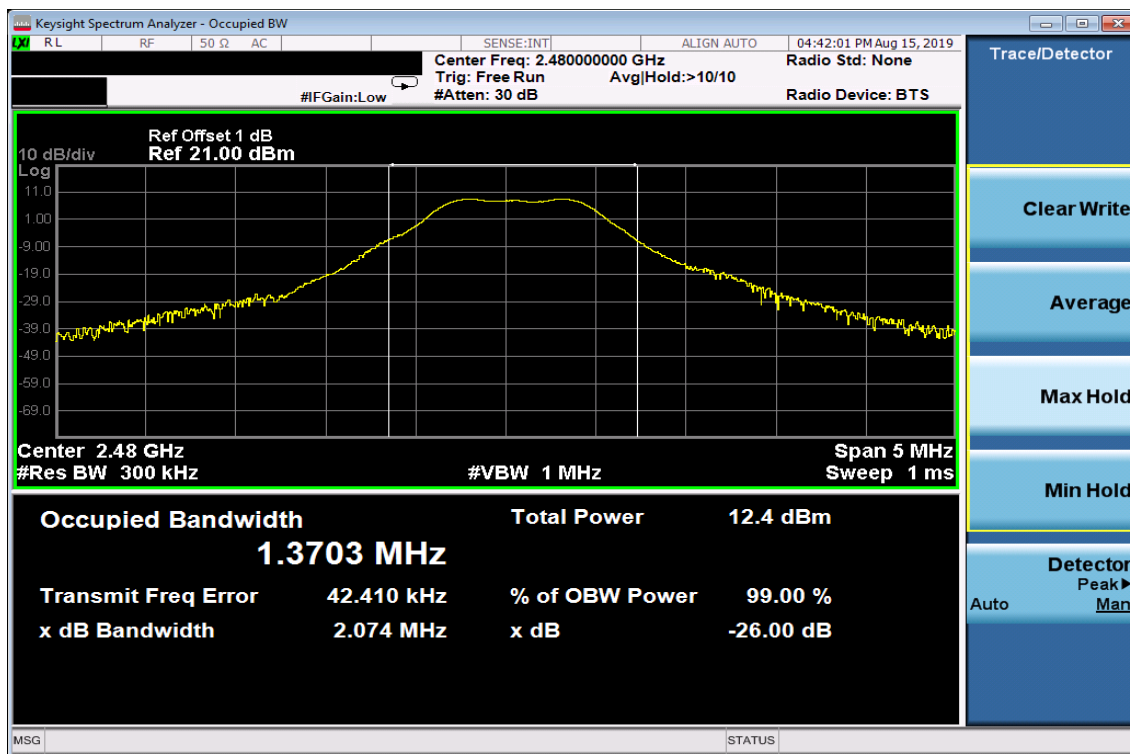
Low



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=1kHz, 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.

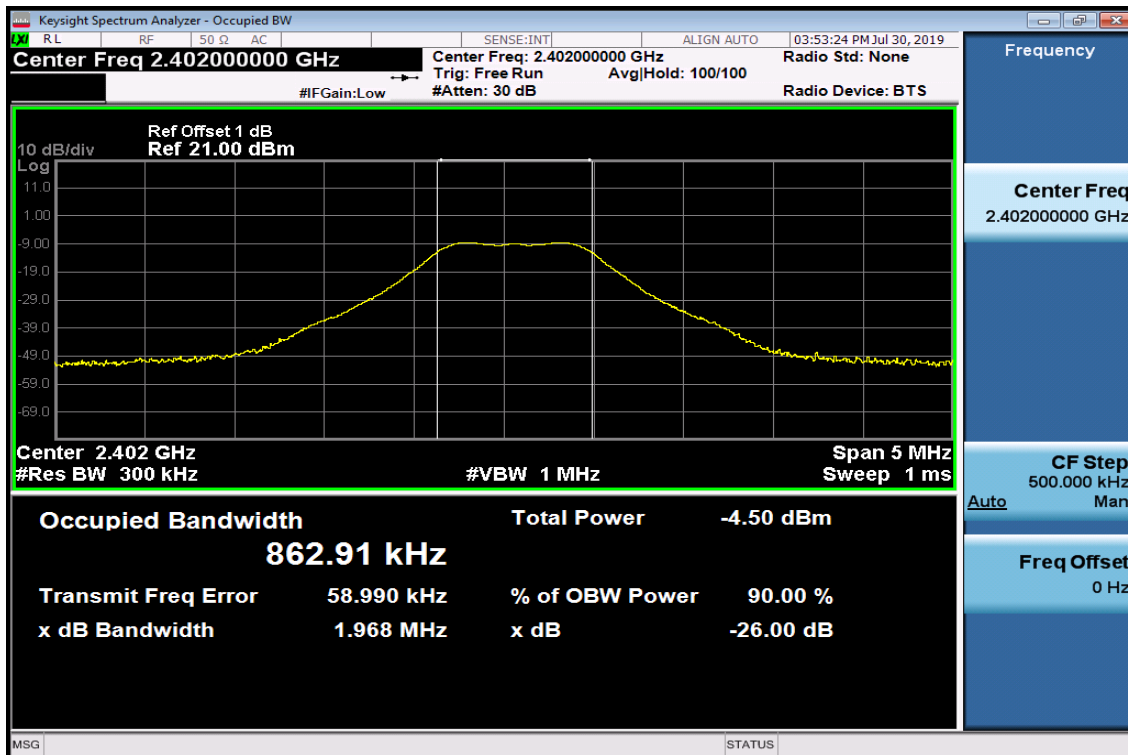
6.4.5. Test results:

Ambient temperature: 20 °C Relative humidity: 65 % Test Date: 2019/08/15

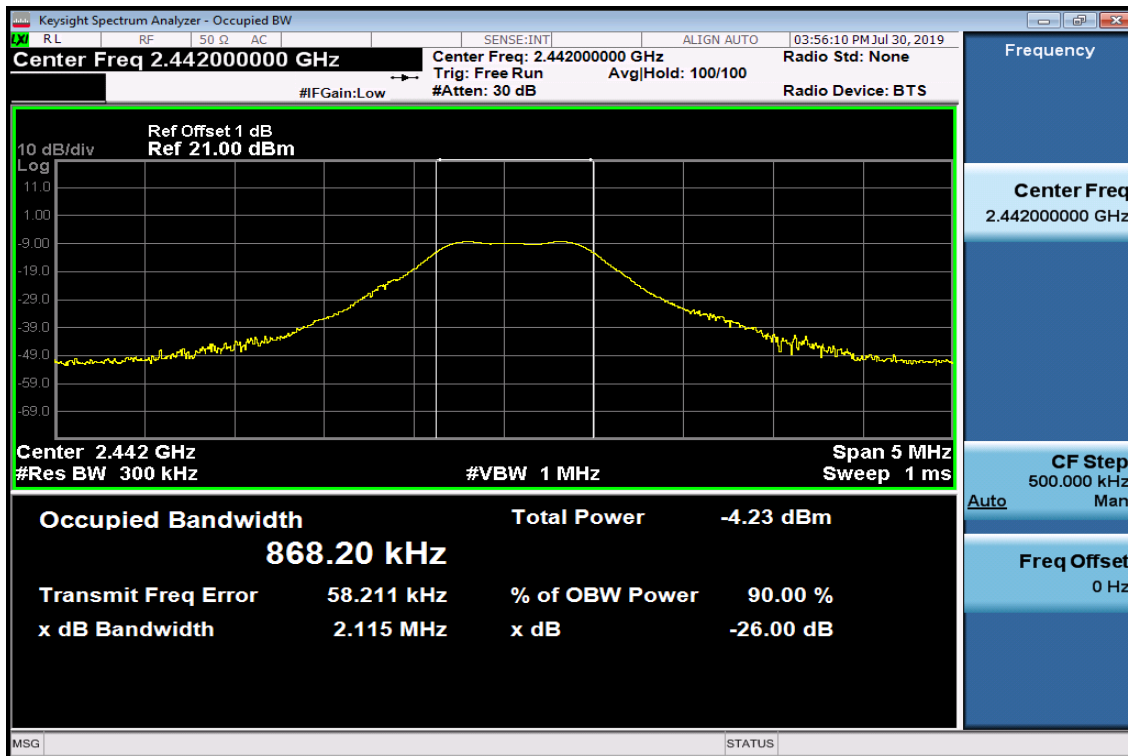
Mode: LE	Low channel (MHz)	Mid channel (MHz)	High channel (MHz)	Limit
Normal Voltage 5 V	0.86	0.87	0.86	>500kHz
Upper Voltage 5.5 V	0.86	0.87	0.86	>500kHz
Lower Voltage 4.5 V	0.86	0.87	0.86	>500kHz

Normal voltage for BT LE mode:

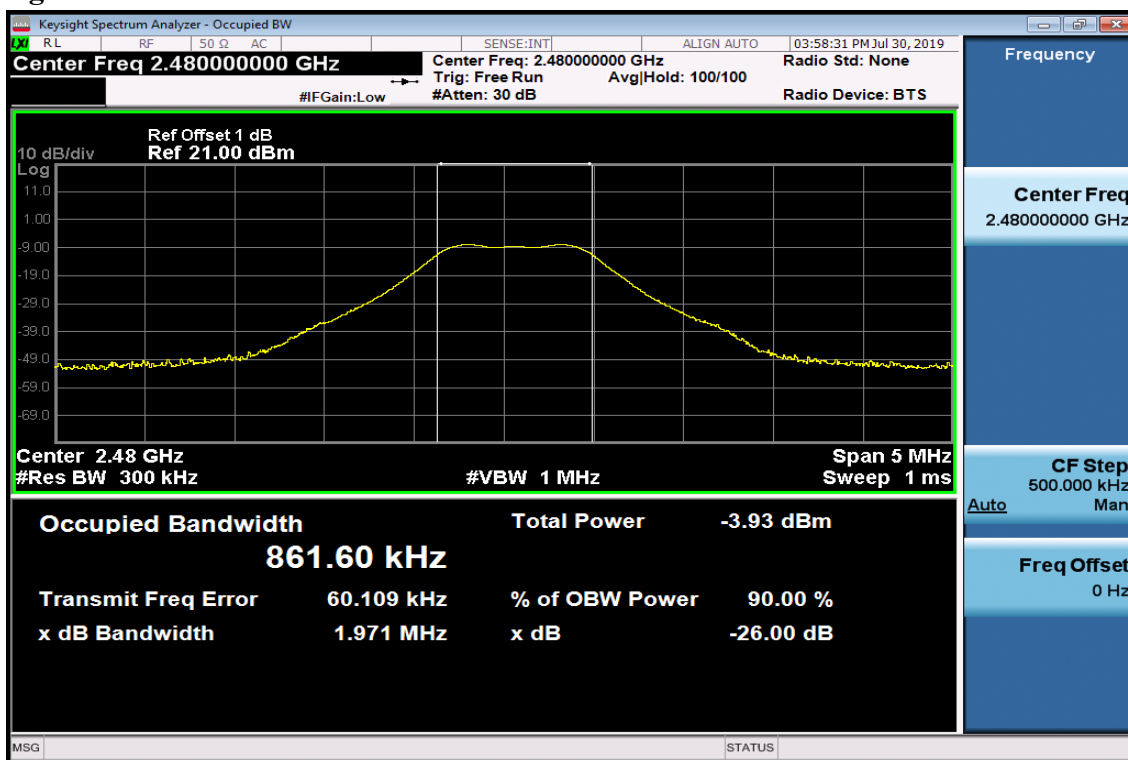
Low



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:

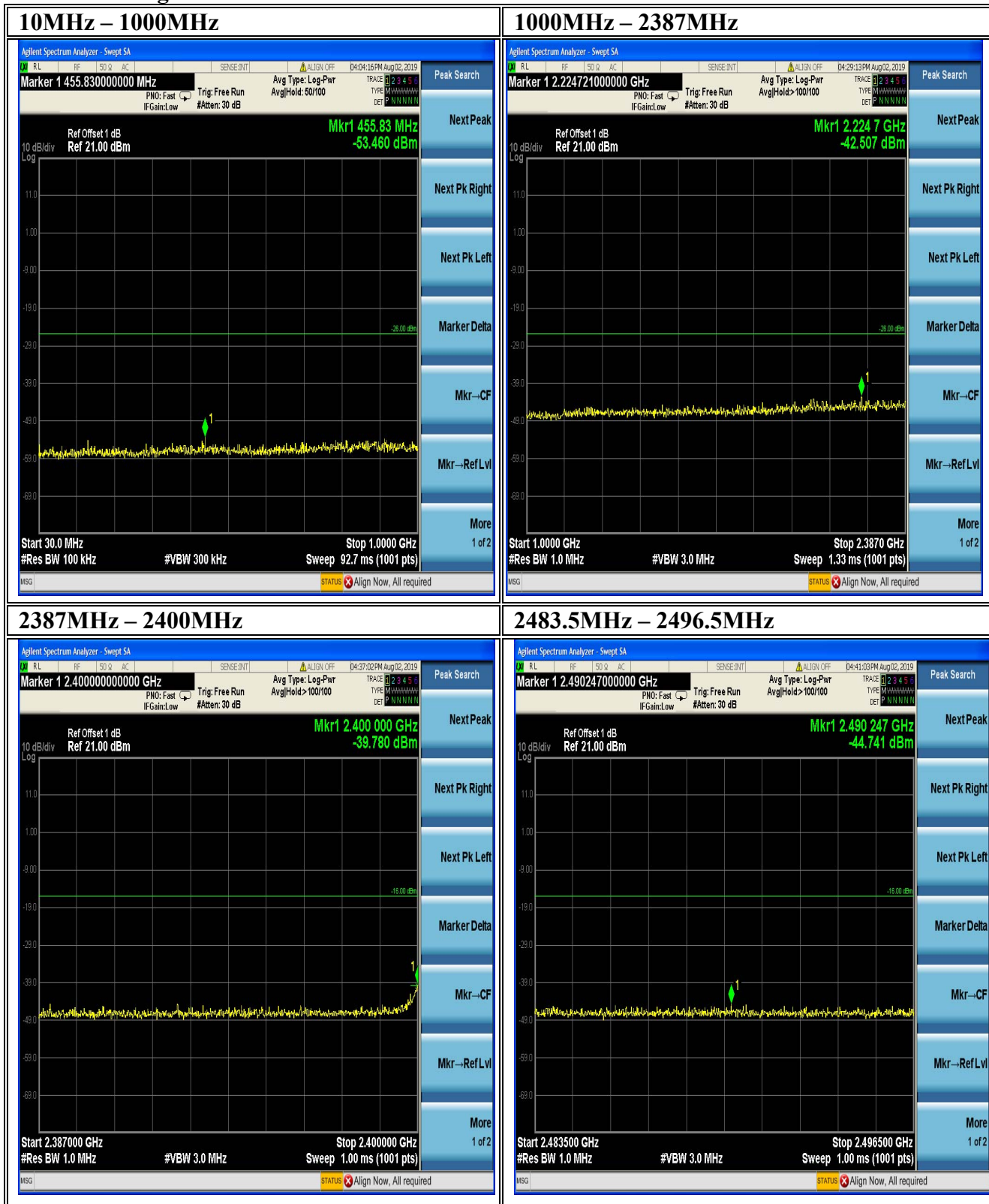
1. Set the EUT at hopping off and modulation on.
2. Set the ETU operate at channel low, mid and high and normal voltage.
3. Set the spectrum analyzer Ref level= -10dBm; attenuation=0dB; RBW=100kHz, BW=100kHz, Sweep = auto Start=10MHz, Stop=1000MHz. Max hold view, mark highest level.
4. Set the spectrum 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: 20 °C Relative humidity: 65 % Test Date: 2019/08/20

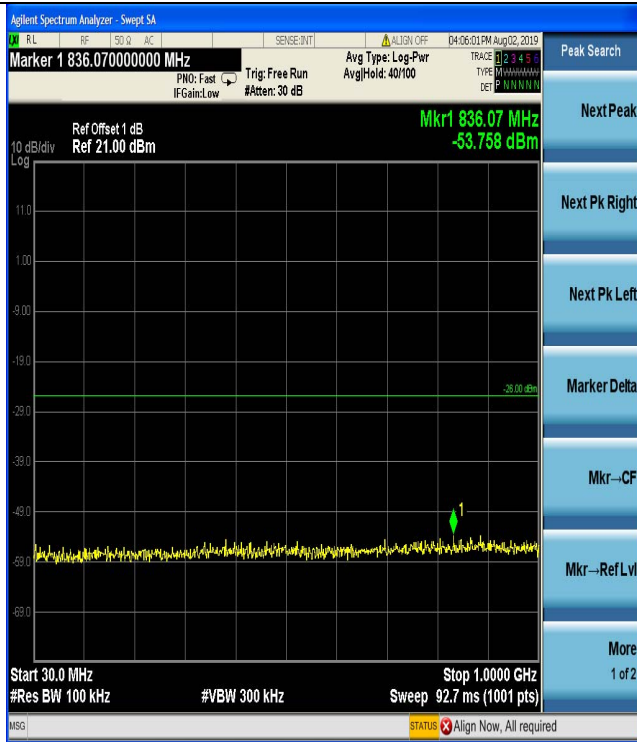
BT LE mode:
Normal Voltage: Channel Low



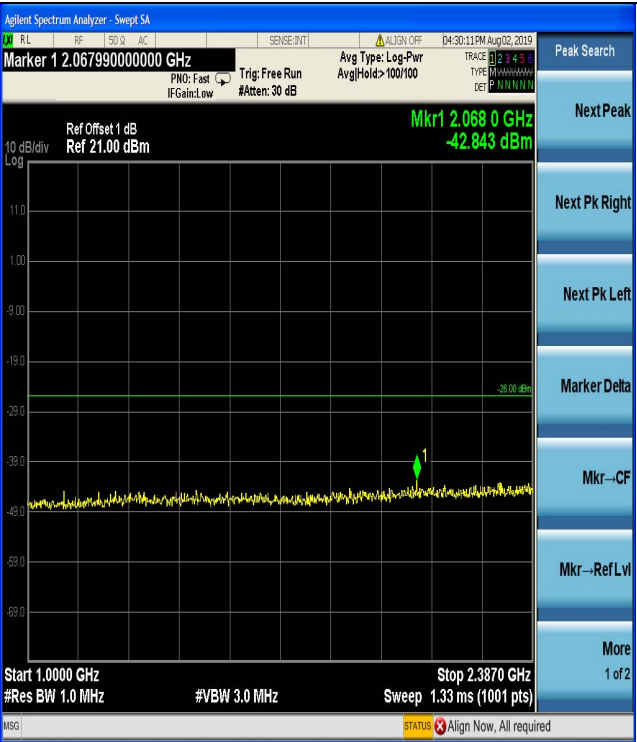


Normal Voltage: Channel Mid

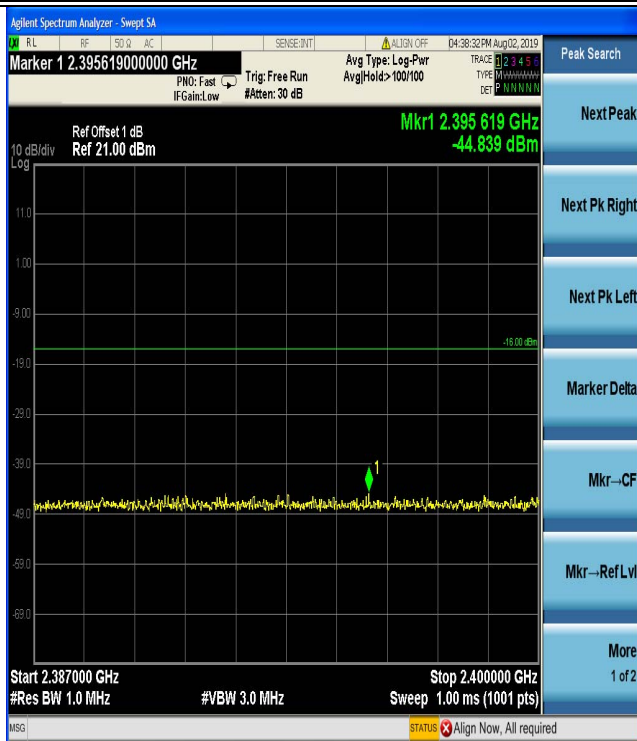
10MHz – 1000MHz



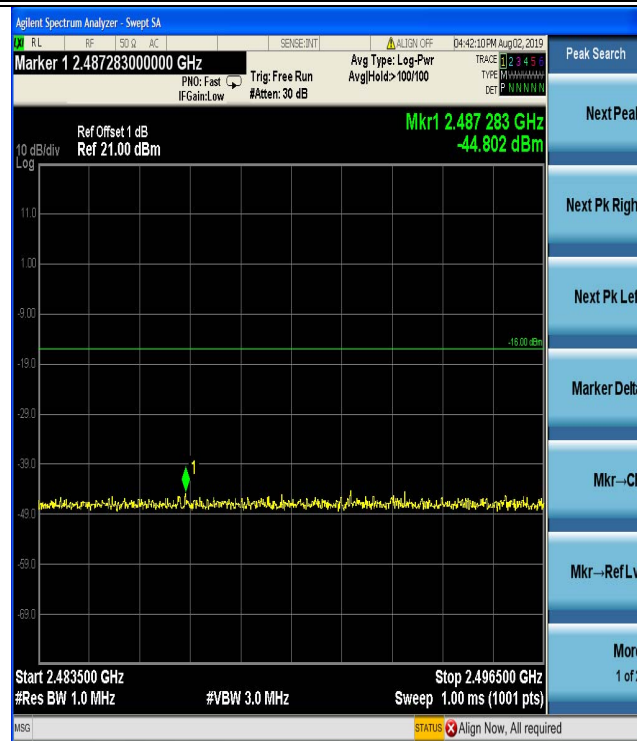
1000MHz – 2387MHz



2387MHz – 2400MHz



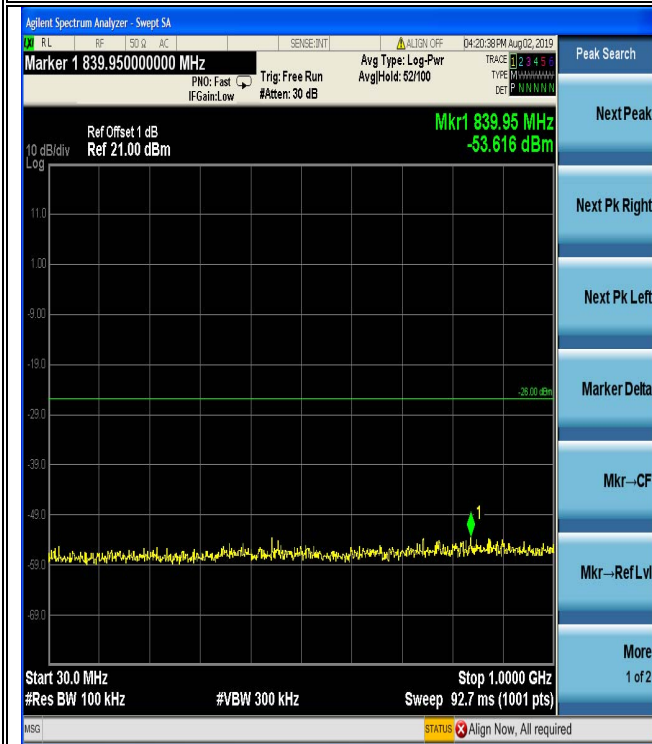
2483.5MHz – 2496.5MHz



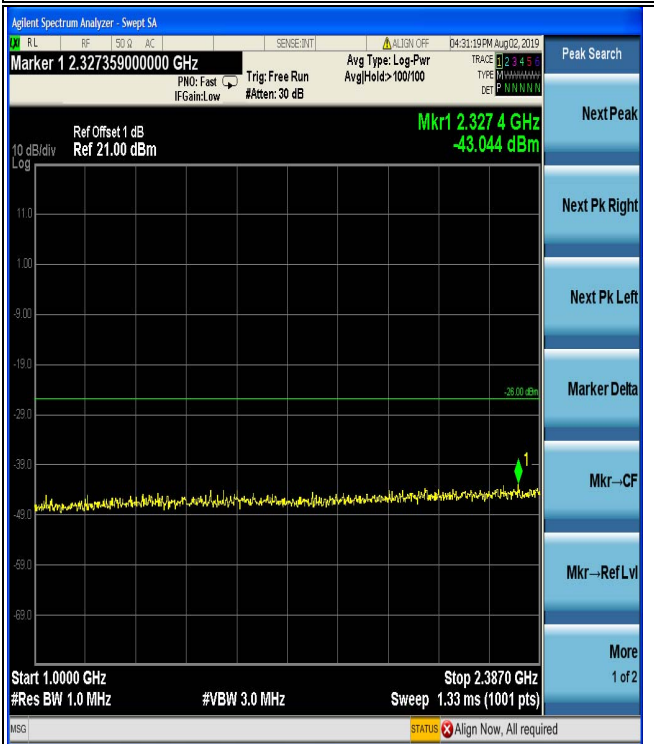


Normal Voltage: Channel High

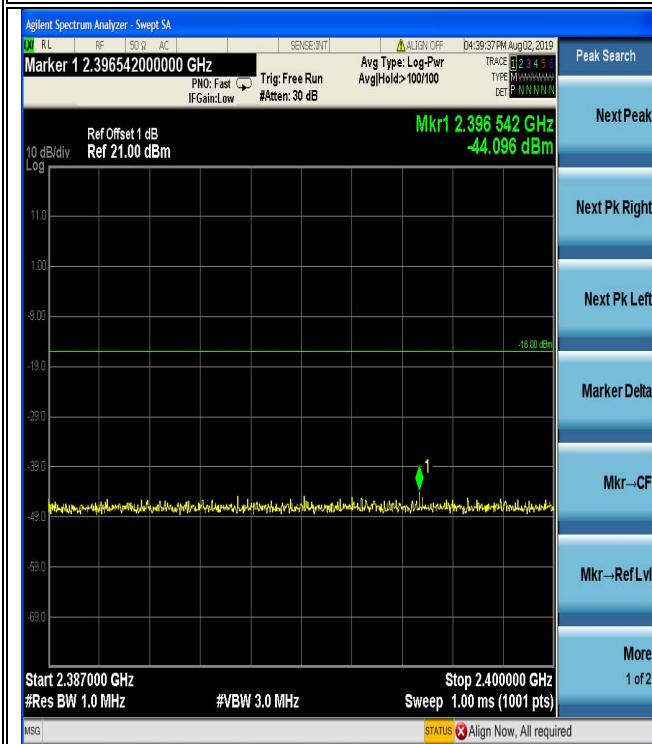
10MHz – 1000MHz



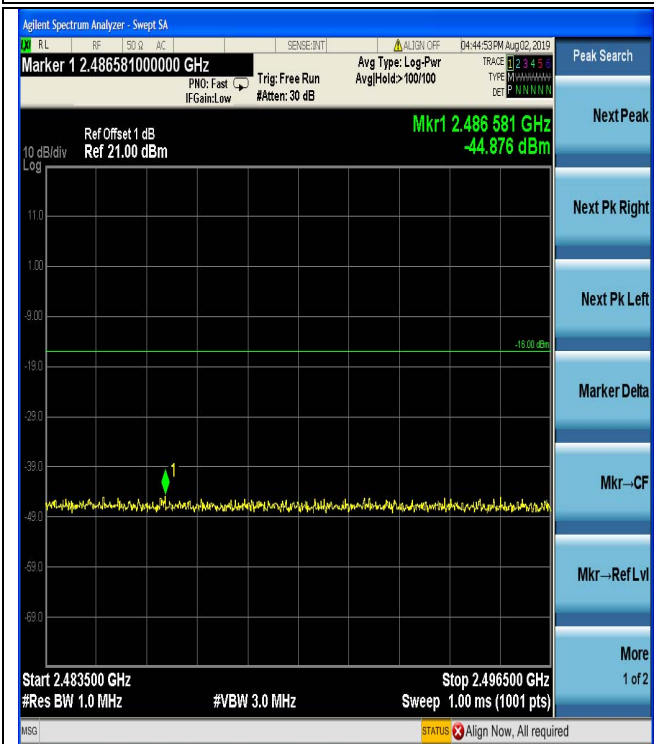
1000MHz – 2387MHz



2387MHz – 2400MHz



2483.5MHz – 2496.5MHz





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: 20 °C Relative humidity: 65 % Test Date: 2019/08/20

Normal Voltage for BT LE mode:

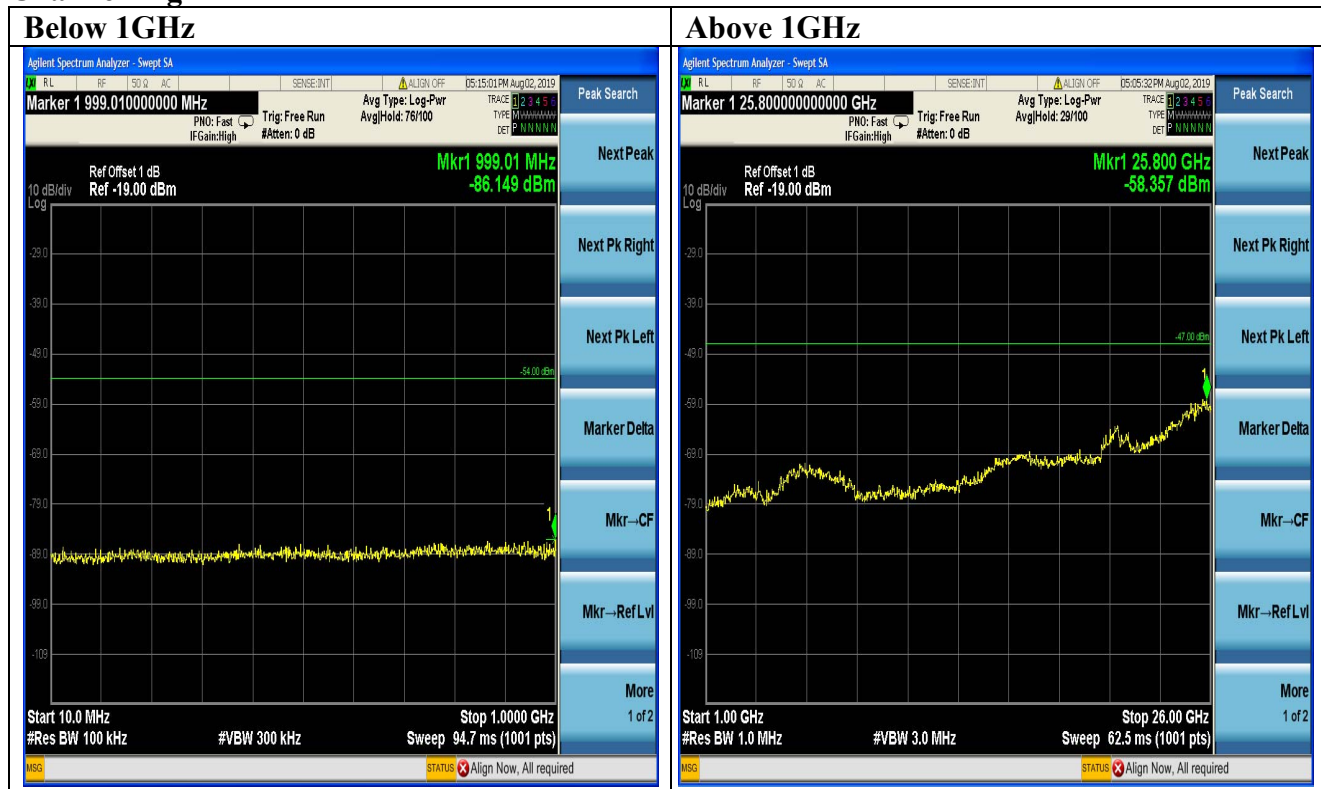
Channel Low



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:

$AWPR < 360/A$ (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= 0.34 dBi				
		Channel Low	Channel Mid	Channel High
Normal Voltage 5 V	Conducted power (mW)	6.540	6.650	7.037
	Radiated power (dBm)	8.50	8.57	8.81
	Radiated power (mW)	7.073	7.191	7.610
	Constant A	$7.073 / 16.4 < 1$	$7.191 / 16.4 < 1$	$7.610 / 16.4 < 1$
Upper Voltage 5.5 V	Conducted power (mW)	6.536	6.645	7.032
	Radiated power (dBm)	8.49	8.57	8.81
	Radiated power (mW)	7.068	7.186	7.605
	Constant A	$7.068 / 16.4 < 1$	$7.186 / 16.4 < 1$	$7.605 / 16.4 < 1$
Lower Voltage 4.5 V	Conducted power (mW)	6.539	6.650	7.032
	Radiated power (dBm)	8.50	8.57	8.81
	Radiated power (mW)	7.071	7.191	7.605
	Constant A	$7.071 / 16.4 < 1$	$7.191 / 16.4 < 1$	$7.605 / 16.4 < 1$

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) = $8.23 + \max. \text{ antenna Gain} - 20 \times \log f$ (f in MHz)

This voltage will be generated in the direction of the max. Gain.

2.4GHz

					Antenna Gain(dBi)				dBm
Channel Low	2402 MHz:	Pcs=	8.23	+	0.34	-	$20\log(2402)$	=	-59.04
Channel Mid	2442 MHz:	Pcs=	8.23	+	0.34	-	$20\log(2442)$	=	-59.18
Channel High	2480 MHz:	Pcs=	8.23	+	0.34	-	$20\log(2480)$	=	-59.32

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

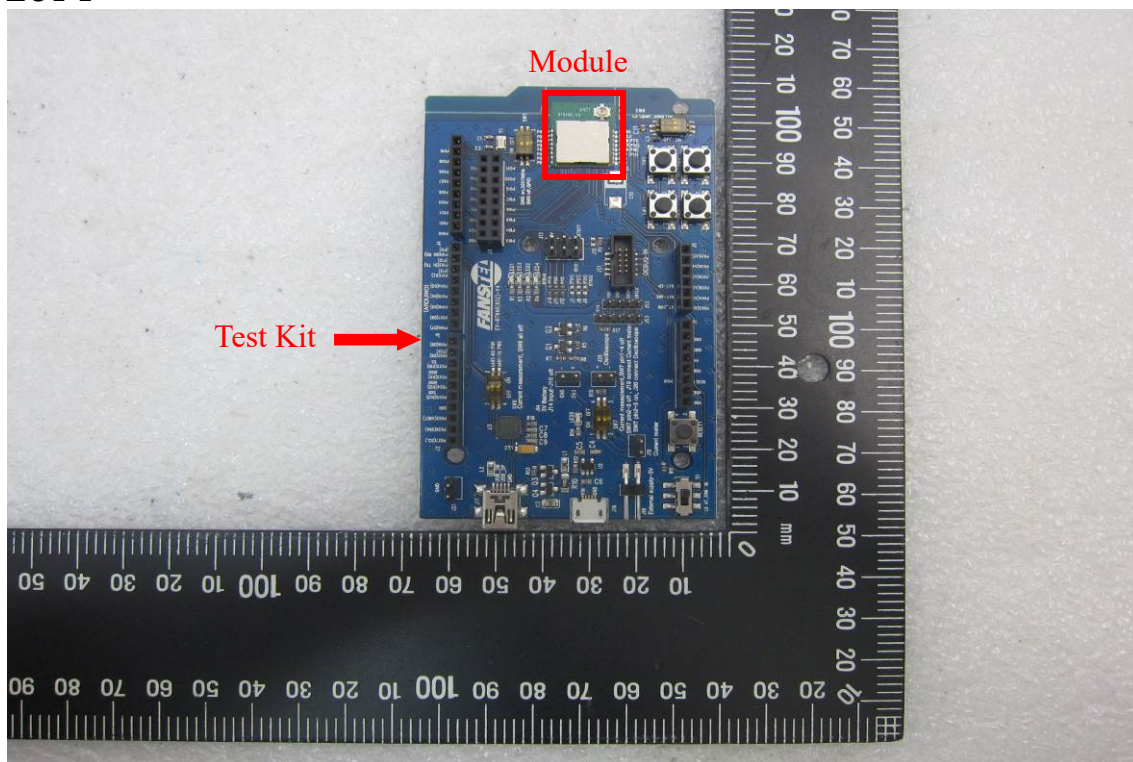
Test Setup



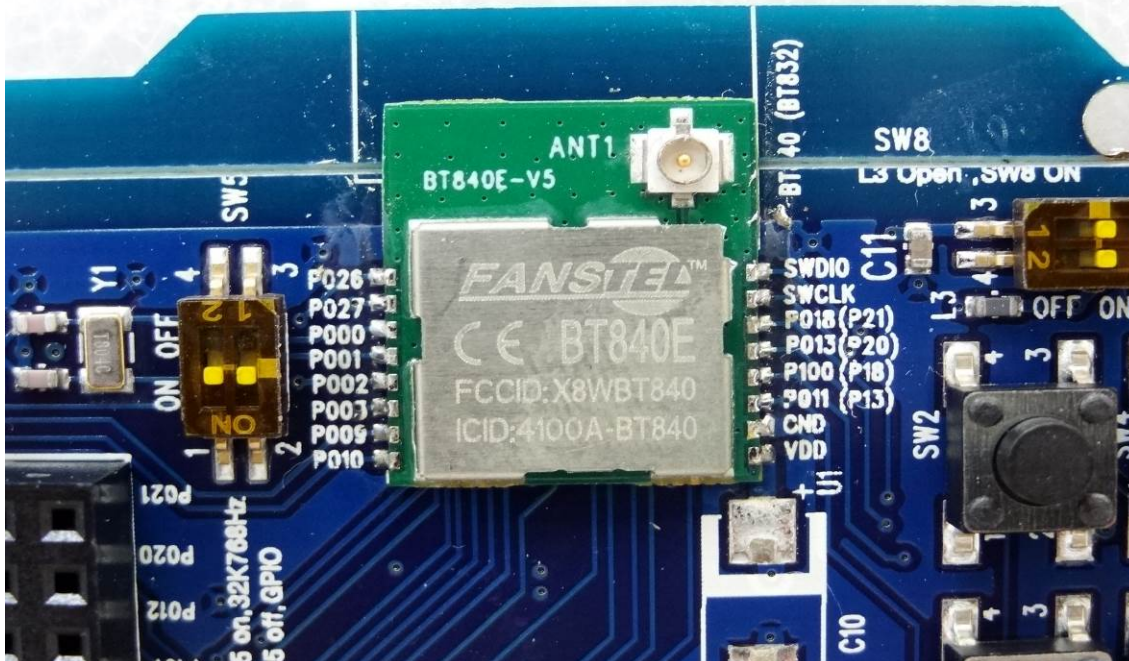
APPENDIX 2

Photographs of EUT

EUT 1



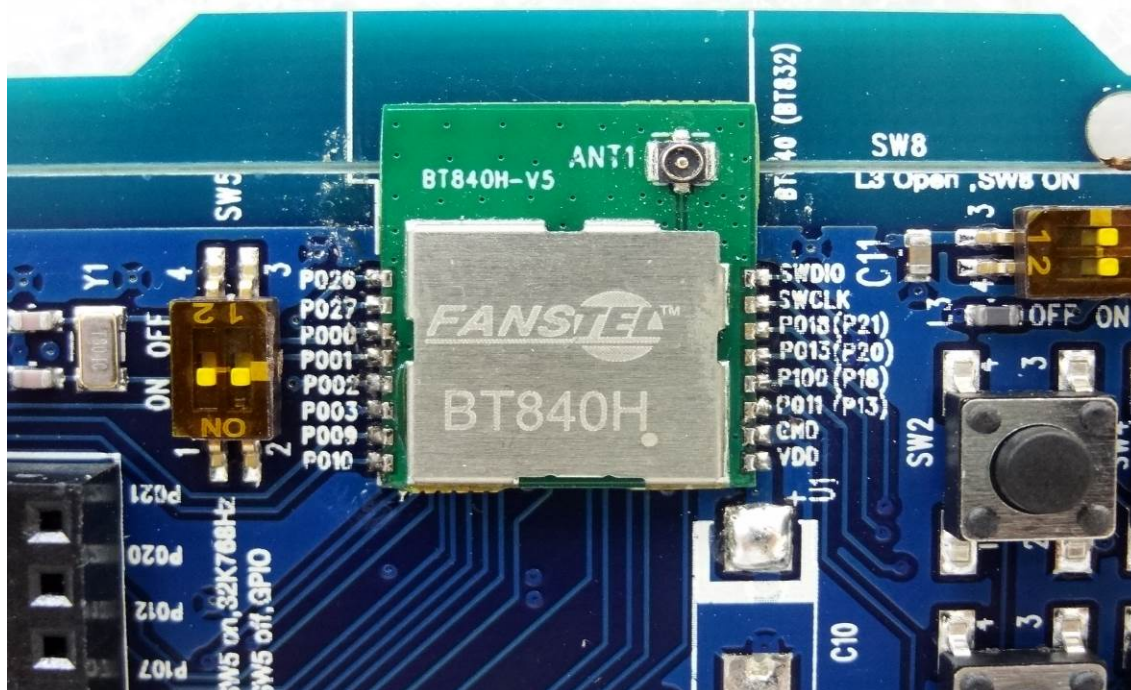
EUT 2 BT840E



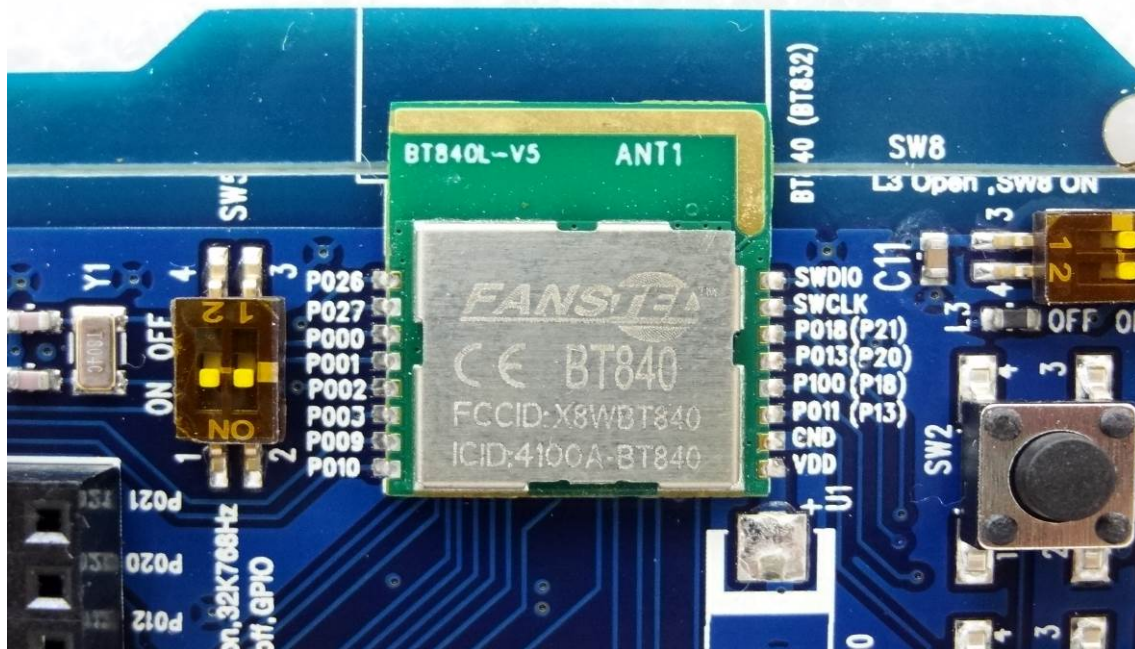
EUT 3 BT840F



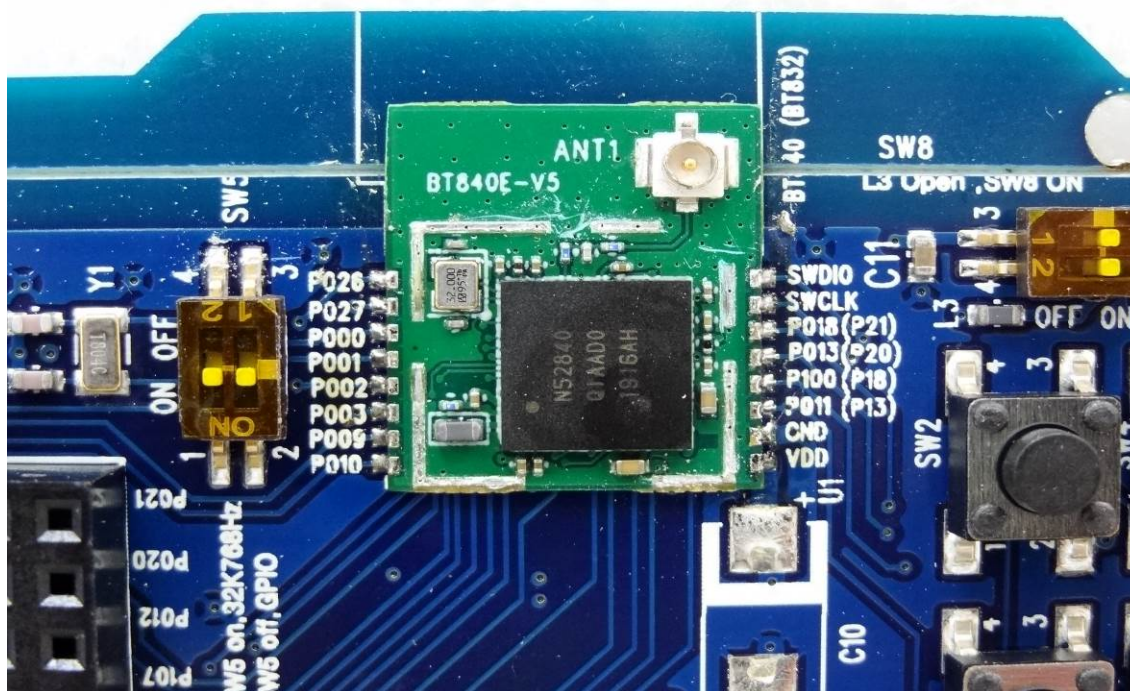
EUT 4 BT840H



EUT 5 BT840



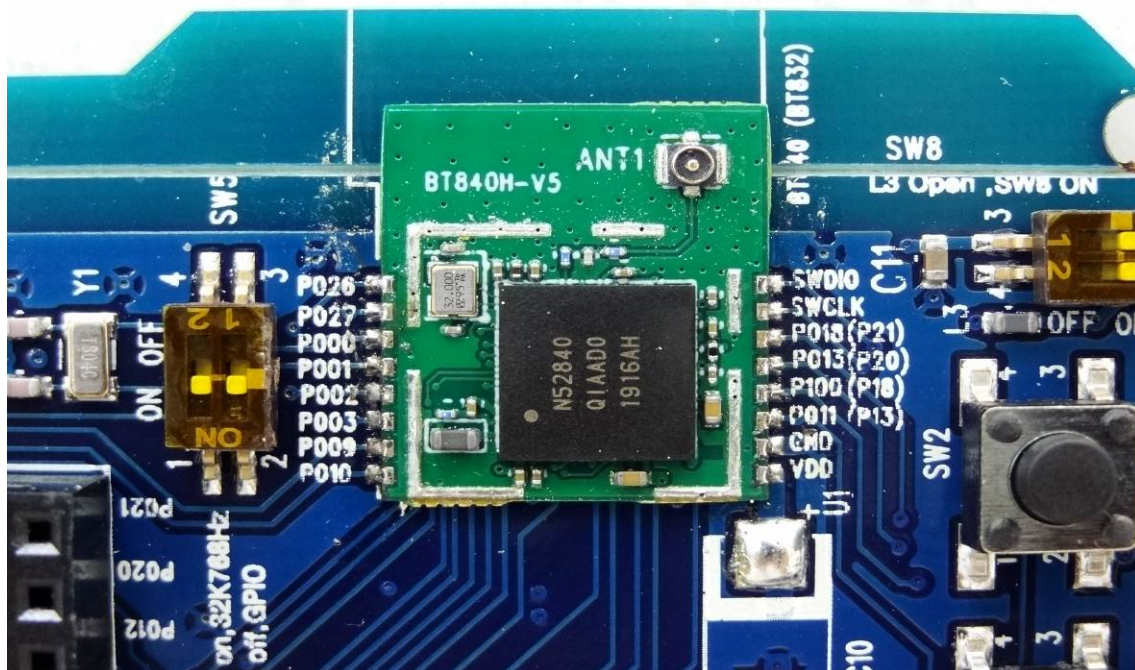
EUT 6 BT840E



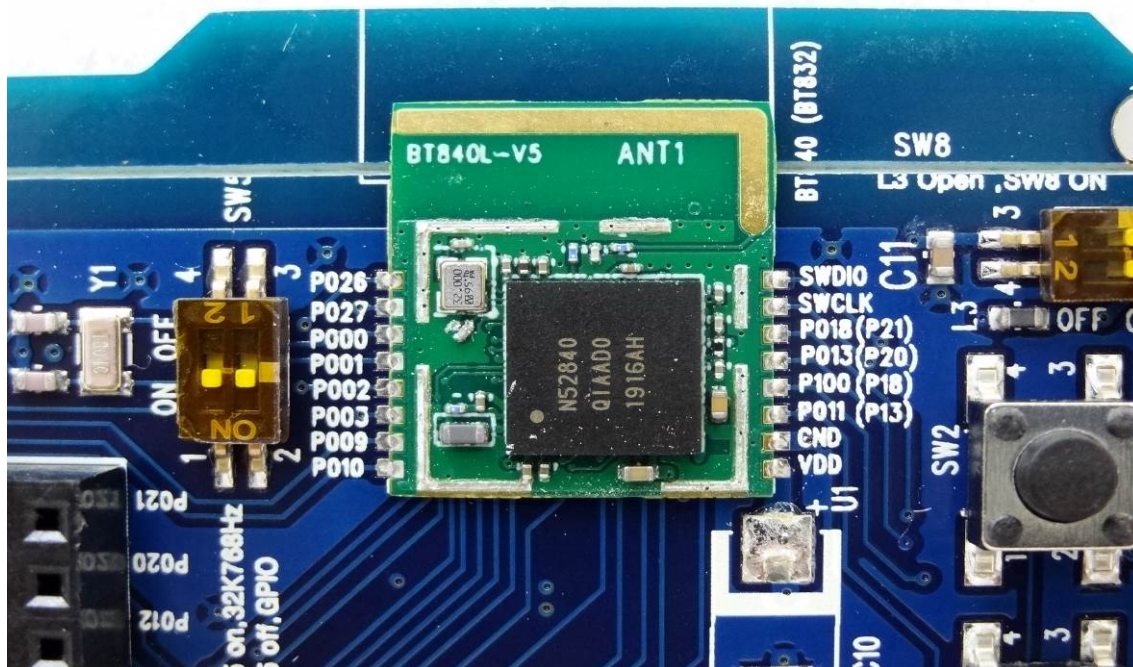
EUT 7 BT840F



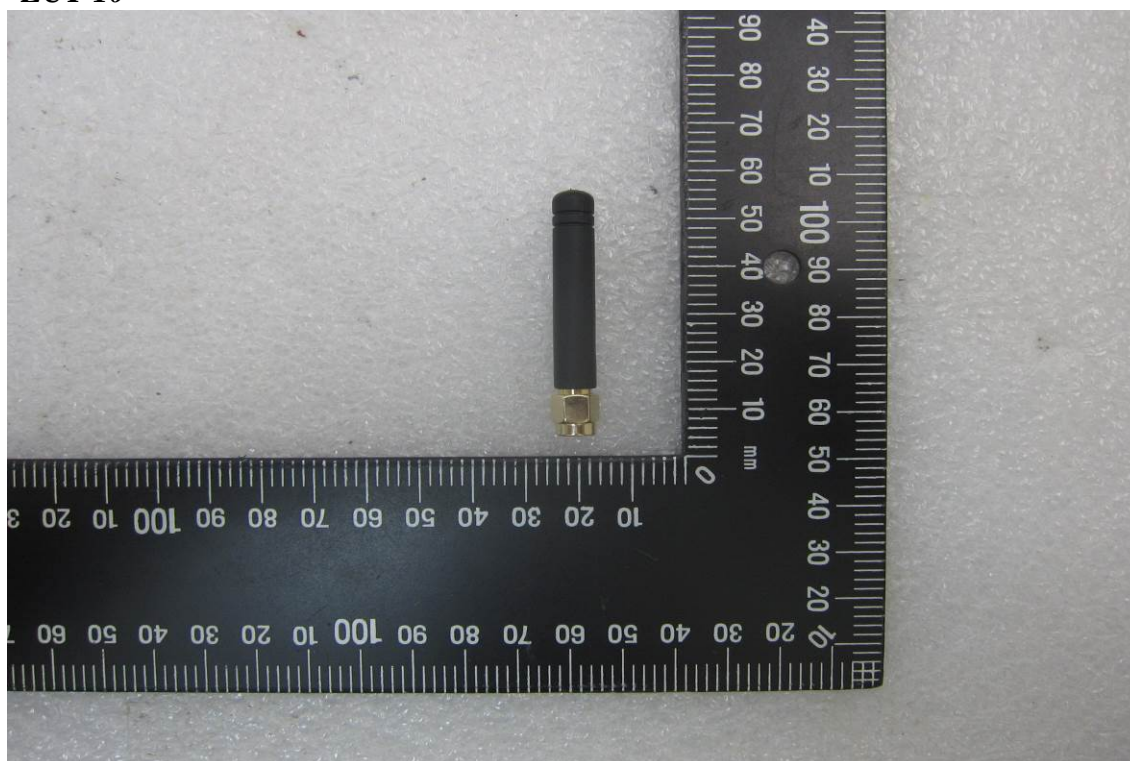
EUT 8 BT840H



EUT 9 BT840



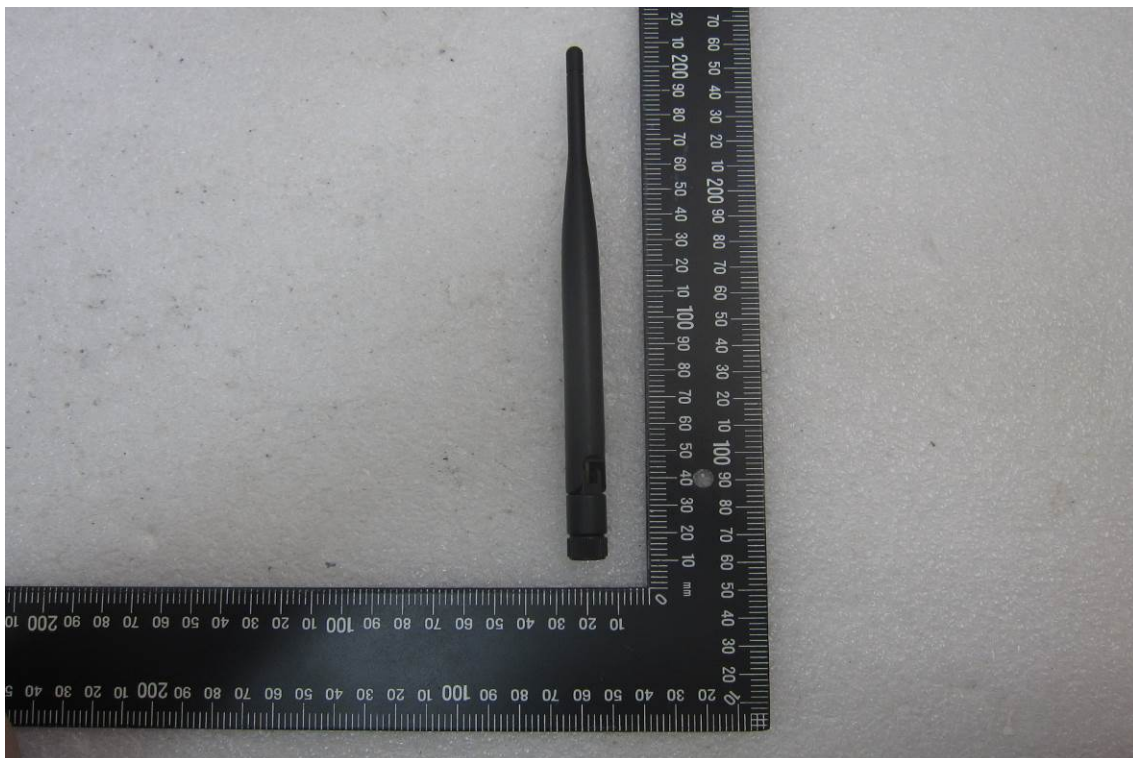
EUT 10



EUT 11



EUT 12



EUT 13



~ End of Report ~