



Test report No. : 4789623666-US-R4-V0  
Page : 1 of 43  
Issued date : Apr. 19, 2021  
FCC ID : 2ADEZWUBT236ACN

## RADIO TEST REPORT

**Product** : 802.11ac/a/b/g/n USB Dongle  
**Model Name** : 100097489  
**FCC ID** : 2ADEZWUBT236ACN  
**Test Regulation** : FCC 47 CFR Part 15 Subpart C (Section 15.247)  
**Received Date** : Jul. 22, 2020  
**Test Date** : Sep. 7, 2020 ~ Oct. 14, 2020  
**Issued Date** : Apr. 19, 2021

**Applicant** : Life Technologies Holdings Pte Ltd  
33, Marsiling Industrial Estate Road 3, #07-06, Singapore  
739256

**Issued By** : Underwriters Laboratories Taiwan Co., Ltd.  
Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd.,  
Zhudong Township, Hsinchu County, Taiwan



The results reported herein have been performed in accordance with the laboratory's terms of accreditation. This report shall not be reproduced except in full without the written approval of the Laboratory. The results in this report are responsible of the test sample(s) provided by the client only and are not to be used to indicate applicability to other similar products.

### **Underwriters Laboratories Taiwan Co., Ltd.**

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan  
Telephone :+886-2-7737-3000  
Facsimile (FAX ) :+886-3-583-7948

Doc No: 17-EM-F0876 / 5.0





## Table Of Contents

<b>1. Attestation of Test Results .....</b>	<b>4</b>
<b>2. Summary of Test Results .....</b>	<b>5</b>
<b>3. Test Methodology and Reference Procedures.....</b>	<b>6</b>
<b>4. Facilities and Accreditation.....</b>	<b>6</b>
<b>5. Measurement Uncertainty .....</b>	<b>7</b>
<b>6. Equipment under Test .....</b>	<b>8</b>
6.1. Description of EUT.....	8
6.2. Channel List.....	9
6.3. Test Condition.....	10
6.4. Description Of Available Antennas .....	10
6.5. Test Mode Applicability and Tested Channel Detail.....	11
6.6. Duty cycle .....	12
<b>7. Test Equipment.....</b>	<b>13</b>
<b>8. Description of Test Setup.....</b>	<b>15</b>
<b>9. Test Results.....</b>	<b>16</b>
9.1. 6dB Bandwidth .....	16
9.2. Conducted output power .....	18
9.3. Power Spectral Density.....	20
9.4. Conducted Out of Band Emission.....	22
9.5. Radiated Spurious Emission .....	25
9.6. AC Power Line Conducted Emission .....	35
<b>Appendix I Radiated Band Edge Measurement .....</b>	<b>41</b>
<b>Appendix II Radiated Spurious Emission Measurement .....</b>	<b>43</b>

### Underwriters Laboratories Taiwan Co., Ltd.

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone :+886-2-7737-3000

Facsimile (FAX ) :+886-3-583-7948

Doc No: 17-EM-F0876 / 5.0



## 1. Attestation of Test Results

**APPLICANT:** Life Technologies Holdings Pte Ltd  
 33, Marsiling Industrial Estate Road 3, #07-06, Singapore 739256

**MANUFACTURER** SparkLAN Communications, Inc.  
 8F., No.257, Sec. 2, Tiding Blvd., Neihu District, Taipei City 11493,  
 Taiwan

**EUT DESCRIPTION:** 802.11ac/a/b/g/n USB Dongle

**MODEL:** 100097489

**SAMPLE STAGE:** Production Unit

**DATE of TESTED:** Sep. 7, 2020 ~ Oct. 14, 2020

<b>APPLICABLE STANDARDS</b>	
<b>STANDARD</b>	<b>Test Results</b>
FCC 47 CFR PART 15 Subpart C (Section 15.247)	PASS

Underwriters Laboratories Taiwan Co., Ltd. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by Underwriters Laboratories Taiwan Co., Ltd. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

**Note:** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by Underwriters Laboratories Taiwan Co., Ltd. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by Underwriters Laboratories Taiwan Co., Ltd. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Prepared By:

Cindy Hsin  
 Project Handler

Date : Apr. 19, 2021

Approved and Authorized By:

Mike Cai  
 Engineer Project Associate

Date : Apr. 19, 2021

### Underwriters Laboratories Taiwan Co., Ltd.

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan  
 Telephone :+886-2-7737-3000  
 Facsimile (FAX) :+886-3-583-7948



## 2. Summary of Test Results

Summary of Test Results		
FCC Clause	Test Items	Result
15.247(a)(2)	6dB Bandwidth	PASS
15.247(b)	Conducted Output Power	PASS
15.247(e)	Power Spectral Density	PASS
15.247(d)	Antenna Port Emission	PASS
15.205 / 15.209 / 15.247(d)	Radiated Emissions and Band Edge Measurement	PASS
15.207	AC Power Conducted Emission	PASS
15.203	Antenna Requirement	PASS

Note:

1. For the Radiated Band Edge test plots were recorded in Appendix I, the Radiated Emissions test plots were recorded in Appendix II.

### Underwriters Laboratories Taiwan Co., Ltd.

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone :+886-2-7737-3000

Facsimile (FAX ) :+886-3-583-7948

Doc No: 17-EM-F0876 / 5.0



### 3. Test Methodology and Reference Procedures

The tests documented in this report were performed in accordance with 47 CFR FCC Part 2, KDB558074 D01 Meas Guidance v05r02, KDB414788 D01 Radiated Test Site v01r01, ANSI C63.10-2013.

### 4. Facilities and Accreditation

<b>Test Location</b>	Underwriters Laboratories Taiwan Co., Ltd.
<b>Address</b>	Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan
<b>Accreditation Certificate</b>	Underwriters Laboratories Taiwan Co., Ltd. is accredited by TAF, Laboratory Code 3398. The full scope of accreditation can be viewed at <a href="http://accreditation.taftw.org.tw/taf/public/basic/viewApplyItems.action?unitNo=3398">http://accreditation.taftw.org.tw/taf/public/basic/viewApplyItems.action?unitNo=3398</a>

#### **Underwriters Laboratories Taiwan Co., Ltd.**

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone :+886-2-7737-3000

Facsimile (FAX ) :+886-3-583-7948



## 5. Measurement Uncertainty

For statement of conformity, accuracy method (Section 8.2.4 and 8.2.5 of ISO Guide 98-4) was applied as decision rule for measurement in this test report.

The following uncertainties have been calculated to provide a confidence level of 95 % using a coverage factor  $k=2$ .

Test Item	Measurement Frequency Range	K	U(dB)
Conducted disturbance at mains terminals ports	0.15MHz ~ 30MHz	2	1.5
RF Conducted	9 kHz - 40GHz	2	1.0
Radiated disturbance below 30MHz	9 kHz - 30 MHz	2	1.9
Radiated disturbance below 1 GHz	30MHz ~ 1GHz	2	5.4
Radiated disturbance above 1GHz	1GHz ~ 40GHz	2	4.7

### Underwriters Laboratories Taiwan Co., Ltd.

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone :+886-2-7737-3000

Facsimile (FAX ) :+886-3-583-7948

Doc No: 17-EM-F0876 / 5.0



## 6. Equipment under Test

### 6.1. Description of EUT

<b>Product</b>	802.11ac/a/b/g/n USB Dongle
<b>Model Name</b>	100097489
<b>Operating Frequency</b>	2402MHz ~ 2480MHz
<b>Modulation</b>	GFSK
<b>Transfer Rate</b>	Up to 2 Mbps
<b>Number of Channel</b>	40
<b>Maximum Output Power</b>	3.94 dBm
<b>Normal Voltage</b>	5 Vdc
<b>S/N</b>	20960Y1050004
<b>Software Version</b>	N/A

Note:

1. The above EUT information is declared by manufacturer and for more detailed features description, please refer the manufacturer's or user's manual.

### Underwriters Laboratories Taiwan Co., Ltd.

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone :+886-2-7737-3000

Facsimile (FAX ) :+886-3-583-7948

Doc No: 17-EM-F0876 / 5.0



## 6.2. Channel List

40 channels are provided to this EUT:

Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)
0	2402	10	2422	20	2442	30	2462
1	2404	11	2424	21	2444	31	2464
2	2406	12	2426	22	2446	32	2466
3	2408	13	2428	23	2448	33	2468
4	2410	14	2430	24	2450	34	2470
5	2412	15	2432	25	2452	35	2472
6	2414	16	2434	26	2454	36	2474
7	2416	17	2436	27	2456	37	2476
8	2418	18	2438	28	2458	38	2478
9	2420	19	2440	29	2460	39	2480

### Underwriters Laboratories Taiwan Co., Ltd.

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone :+886-2-7737-3000

Facsimile (FAX ) :+886-3-583-7948

Doc No: 17-EM-F0876 / 5.0



### 6.3. Test Condition

Test Item	Test Site No.	Environmental Condition	Input Power	Test Date	Tested by
Antenna Port Conducted Measurement	SR4	22~26°C / 63~68%RH	120Vac / 60 Hz	Sep. 7, 2020 ~ Oct. 12, 2020	Carlos Chen
Radiated Spurious Emission	966-2	23~25°C / 64~68%RH	120Vac / 60 Hz	Sep. 7, 2020 ~ Oct. 12, 2020	Carlos Chen
AC power Line Conducted Emission	SR1	22~26°C / 63~68%RH	120Vac / 60 Hz	Sep. 7, 2020 ~ Oct. 14, 2020	Carlos Chen

FCC Test Firm Registration Number: 498077

### 6.4. Description Of Available Antennas

Ant. No.	Brand Name	Model Name	Ant. Type	Frequency Band (MHz)	Ant. Gain (dBi)
0	N/A	N/A	PCB	2400	2.5
				2450	3.2
				2500	2.8
1	N/A	N/A	PCB	2400	3.2
				2450	2.9
				2500	2.7

Note: The above antenna information was provided from customer and for more detailed features description, please refer the manufacturer's specification or user's manual.

### Underwriters Laboratories Taiwan Co., Ltd.

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone :+886-2-7737-3000

Facsimile (FAX) :+886-3-583-7948

Doc No: 17-EM-F0876 / 5.0



## 6.5. Test Mode Applicability and Tested Channel Detail

- Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- For below 1 GHz radiated emission and AC power line conducted emission have performed all modes of operation were investigated and the worst-case emissions are reported.
- For Antenna Port Conducted Measurement, this item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.
- The fundamental of the EUT was investigated in three orthogonal axes X/Y/Z, it was determined that X axis was worst-case. Therefore, all final radiated testing was performed with the EUT in X axis.
- For below 30MHz testing, investigation was done on three antenna orientations (parallel, perpendicular, and ground-parallel), parallel and perpendicular are the worst orientations, therefore testing was performed on these two orientations only.
- For AC power line conducted emissions, the pre-scan has been determined by AC power 120Vac/60Hz (worst case).

Test item	Modulation Type	Available Channel	Test Channel	Data Rate
Radiated Emissions (Above 1GHz)	GFSK	0 to 39	0,19,39	1.0
Radiated Emissions (Below 1GHz)	GFSK	0 to 39	19	1.0
AC Power Line Conducted Emission	GFSK	0 to 39	19	1.0
Antenna Port Conducted Measurement	GFSK	0 to 39	0,19,39	1.0

### Underwriters Laboratories Taiwan Co., Ltd.

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone :+886-2-7737-3000

Facsimile (FAX ) :+886-3-583-7948

Doc No: 17-EM-F0876 / 5.0

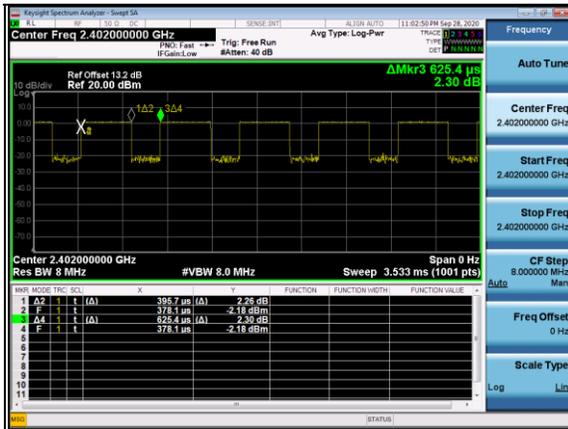


## 6.6. Duty cycle

### BT 4.0-LE

Duty cycle of test signal is < 98 %, duty factor shall be considered.

Duty cycle =  $0.395/0.625 = 0.632$ , Duty factor =  $10 * \log(1/0.632) = 1.99$



Note:  $T_{on} = \text{Mark2} - \text{Mark1}$ ,  $T_{on} + T_{off} = \text{Mark3} - \text{Mark1}$ .

## Underwriters Laboratories Taiwan Co., Ltd.

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone : +886-2-7737-3000

Facsimile (FAX) : +886-3-583-7948



## 7. Test Equipment

Test Equipment List					
Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Interval
<b>Radiated Spurious Emission</b>					
Spectrum Analyzer	Keysight	N9010A	MY56070827	Nov. 13, 2019	1 year
EMI Test Receiver	Rohde & Schwarz	ESR7	101754	Dec. 17, 2019	1 year
Loop Antenna	ETS lindgren	6502	00213440	Dec. 19, 2019	1 year
Trilog-Broadband Antenna with 5dB Attenuator	Schwarzbeck & EMCI	VULB 9168 & N-6-05	774 & AT-N0538	Jan. 3, 2020	1 year
Horn Antenna (1-18 GHz)	Schwarzbeck	BBHA 9120 D	01690	Jan. 3, 2020	1 year
Horn Antenna (18-40 GHz)	Schwarzbeck	BBHA 9170	781	Dec. 27, 2019	1 year
Preamplifier (30-1000 MHz)	EMCI	EMC330E	980405	Jun. 9, 2020	1 year
Preamplifier (1-18 GHz)	EMCI	EMC051835BE	980406	Feb. 4, 2020	1 year
Preamplifier (18-40GHz)	EMCI	EMC184040SEE	980426	May 19, 2020	1 year
Cables	Hanyitek	K1K50-UP0264-K1K50-2500	170214-4 & 170425-2	Jul. 2, 2020	1 year
Cables	Hanyitek	K1K50-UP0264-K1K50-2500	170214-1 & 170214-2	Jan. 8, 2020	1 year

### Underwriters Laboratories Taiwan Co., Ltd.

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone :+886-2-7737-3000

Facsimile (FAX ) :+886-3-583-7948

Doc No: 17-EM-F0876 / 5.0



Test report No. : 4789623666-US-R4-V0  
Page : 14 of 43  
Issued date : Apr. 19, 2021  
FCC ID : 2ADEZWUBT236ACN

Test Equipment List					
Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Interval
Antenna Port Conducted Measurement					
Spectrum Analyzer	Keysight	N9010A	MY56070834	Nov. 6, 2019	1 year
Pulse Power Sensor	Anritsu	MA2411B	1531202	Dec. 23, 2019	1 year
Power Meter	Anritsu	ML2495A	1645002	Dec. 23, 2019	1 year
AC power Line Conducted Emission					
EMI Test Receiver	Rohde & Schwarz	ESR7	101753	Nov. 19, 2019	1 year
Two-Line V-Network	Rohde & Schwarz	ENV216	102136	Aug. 19, 2020	1 year
Impuls-Begrenzer Pulse Limiter	Rohde & Schwarz	ESH3-Z2	102219-Qt	Aug. 12, 2020	1 year
Cables	HARBOUR INDUSTRIES	LL142	170205-5000-1	Feb. 5, 2020	1 year

UL Software		
Description	Name	Version
Radiated measurement	EZ EMC	1.1.4.2
Conducted measurement	Keysight.TestSystem	1.0.0.0
AC power Line Conducted Emission	EZ EMC	1.1.4.2

**Underwriters Laboratories Taiwan Co., Ltd.**

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone :+886-2-7737-3000

Facsimile (FAX ) :+886-3-583-7948

Doc No: 17-EM-F0876 / 5.0



## 8. Description of Test Setup

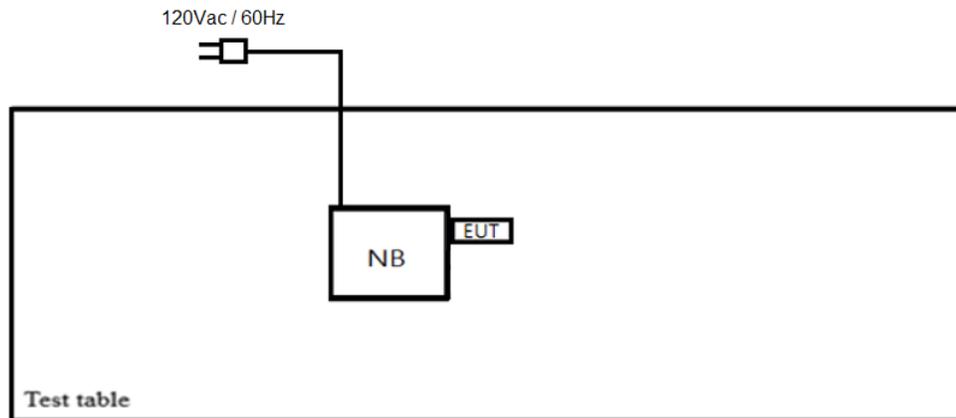
### Support Equipment

Equipment	Brand Name	Model Name	S/N	Remark
Notebook	Lenovo	T430	PBE38AK	N/A

### Test Setup

Controlled using a bespoke application (RTLBTAPP Version 5.1.2.4) on a test Notebook. The application was used to enable a continuous transmission mode and to select the test channels, data rates, modulation schemes and power setting as required.

### Setup Diagram for Test



### **Underwriters Laboratories Taiwan Co., Ltd.**

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone : +886-2-7737-3000

Facsimile (FAX) : +886-3-583-7948

Doc No: 17-EM-F0876 / 5.0



## 9. Test Results

### 9.1. 6dB Bandwidth

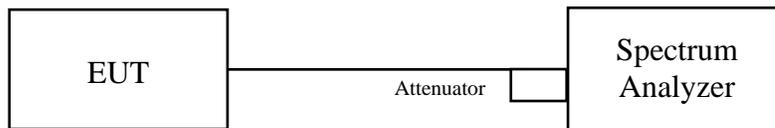
#### Requirements

The minimum 6 dB bandwidth shall be at least 500 kHz.

#### Test procedure

- Set resolution bandwidth (RBW) = 100kHz
- Set the video bandwidth (VBW)  $\geq 3 \times$  RBW, Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Measure the maximum width of the emission that is constrained by the frequencies associated with the two amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission

#### Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

#### **Underwriters Laboratories Taiwan Co., Ltd.**

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone :+886-2-7737-3000

Facsimile (FAX) :+886-3-583-7948

Doc No: 17-EM-F0876 / 5.0



**Test Data**

**BT 4.0-LE**

Channel	Frequency (MHz)	6dB Bandwidth (MHz)	Minimum Limit (MHz)	Pass / Fail
0	2402	0.709	0.5	Pass
19	2440	0.719	0.5	Pass
39	2480	0.712	0.5	Pass



**Underwriters Laboratories Taiwan Co., Ltd.**

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone :+886-2-7737-3000

Facsimile (FAX ) :+886-3-583-7948



## 9.2. Conducted output power

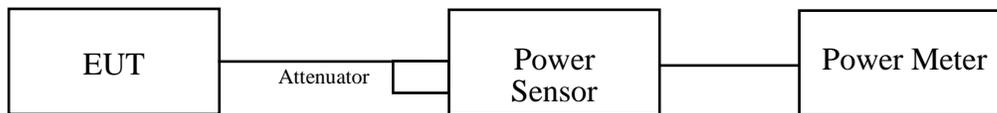
### Requirements

For systems using digital modulation in the 2400-2483.5 MHz bands: 1 Watt.

### Test Procedure

A peak power sensor was used on the output port of the EUT. A power meter was used to read the response of the peak power sensor. Record the power level.

### Test Setup



The loss between RF output port of the EUT and the input port of the Power Meter has been taken into consideration.



## Test Data

### BT 4.0-LE

#### Peak Power

Channel	Frequency (MHz)	Peak Power (mW)	Peak Power (dBm)	Limit (dBm)	Pass/Fail
0	2402	2.16	3.35	30	Pass
19	2440	2.41	3.82	30	Pass
39	2480	2.48	3.94	30	Pass

#### Average Power (Reference Only)

Channel	Frequency (MHz)	Average Power (mW)	Average Power (dBm)
0	2402	1.04	0.19
19	2440	1.23	0.91
39	2480	1.32	1.19

## Underwriters Laboratories Taiwan Co., Ltd.

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone :+886-2-7737-3000

Facsimile (FAX ) :+886-3-583-7948

Doc No: 17-EM-F0876 / 5.0



### 9.3. Power Spectral Density

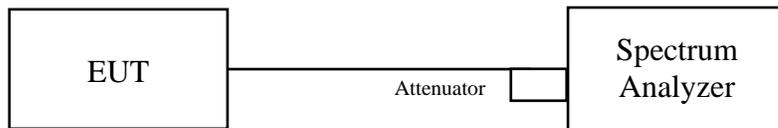
#### Requirements

The Maximum of Power Spectral Density Measurement is 8dBm in any 3 kHz.

#### Test procedure

- a. Set analyzer center frequency to DTS channel center frequency.
- b. Set the span to 1.5 times the DTS bandwidth.
- c. Set the RBW to:  $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$ .
- d. Set the VBW  $\geq 3 \times \text{RBW}$ .
- e. Detector = peak.
- f. Sweep time = auto couple.
- g. Trace mode = max hold.
- h. Allow trace to fully stabilize.
- i. Use the peak marker function to determine the maximum amplitude level within the RBW.

#### Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

#### **Underwriters Laboratories Taiwan Co., Ltd.**

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone :+886-2-7737-3000

Facsimile (FAX ) :+886-3-583-7948

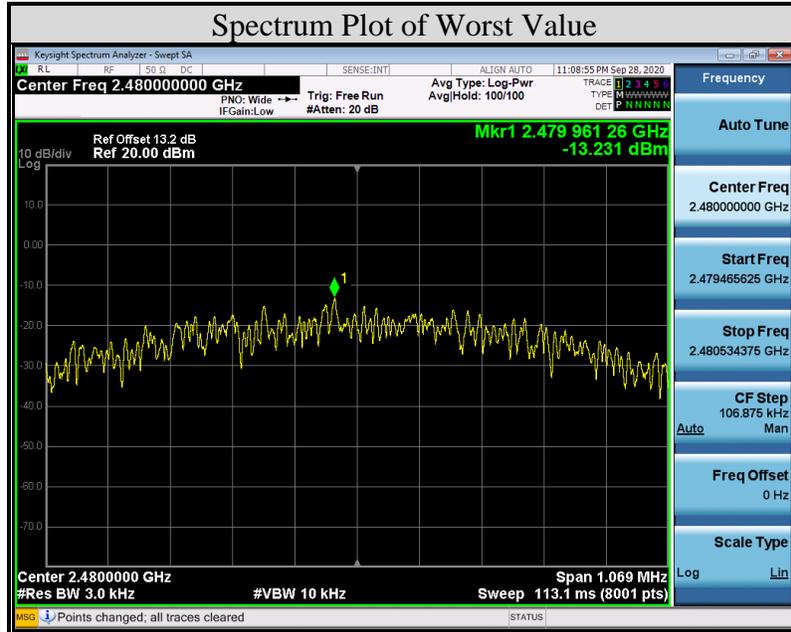
Doc No: 17-EM-F0876 / 5.0



**Test Data**

**BT 4.0-LE**

Channel	Freq. (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Pass /Fail
0	2402	-14.085	8	Pass
19	2440	-14.795	8	Pass
39	2480	-13.231	8	Pass



**Underwriters Laboratories Taiwan Co., Ltd.**

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone :+886-2-7737-3000

Facsimile (FAX ) :+886-3-583-7948



## 9.4. Conducted Out of Band Emission

### Requirements

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.

### Test procedure

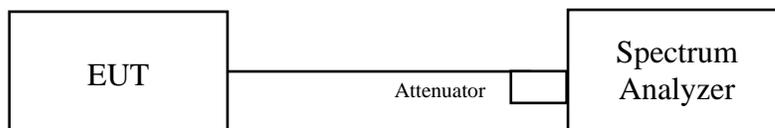
Measurement Procedure REF

1. Set the RBW = 100 kHz.
2. Set the VBW  $\geq$  300 kHz.
3. Set the span to 1.5 times the DTS bandwidth.
4. Detector = peak.
5. Sweep time = auto couple.
6. Trace mode = max hold.
7. Allow trace to fully stabilize.
8. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.

Measurement Procedure OOBE

1. Set RBW = 100 kHz.
2. Set VBW  $\geq$  300 kHz.
3. Detector = peak.
4. Sweep = auto couple.
5. Trace Mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum amplitude level.

### Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

### **Underwriters Laboratories Taiwan Co., Ltd.**

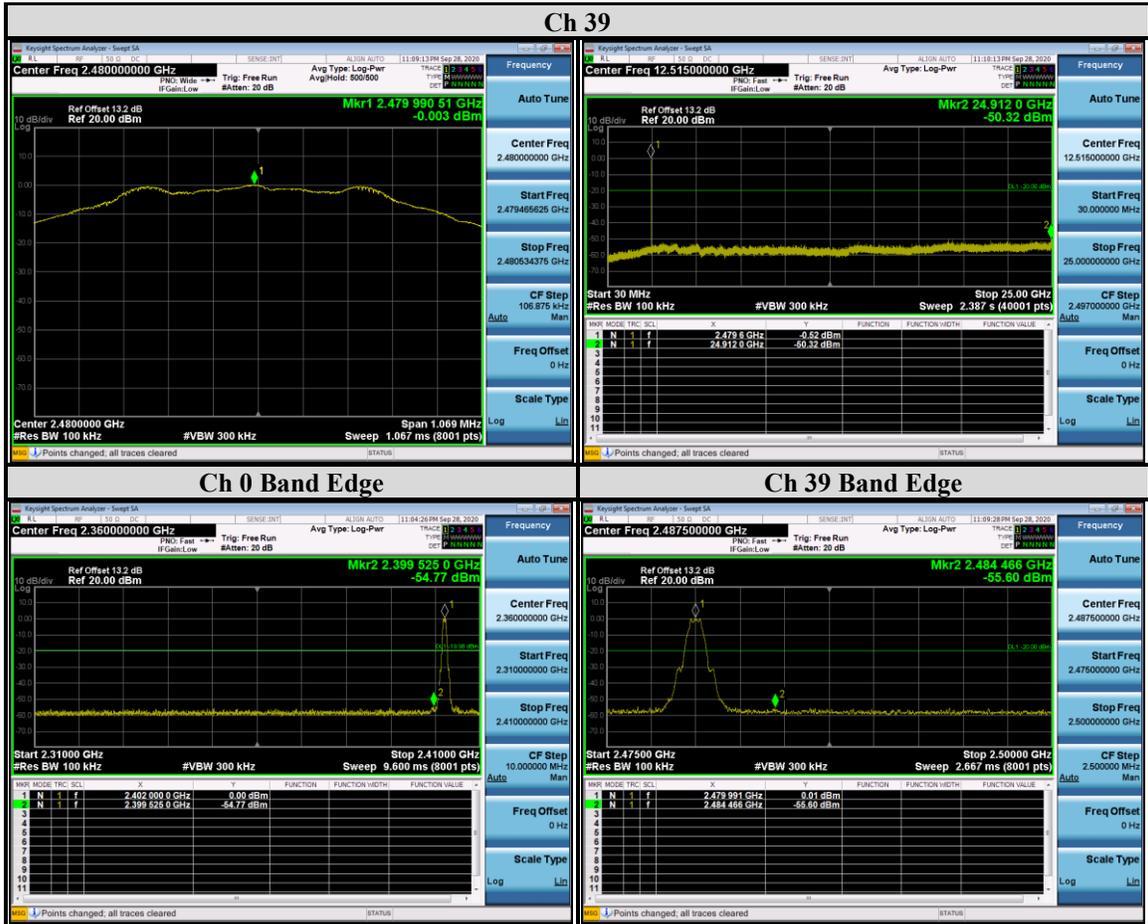
Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan  
Telephone : +886-2-7737-3000  
Facsimile (FAX) : +886-3-583-7948



**Test Data**

**BT 4.0-LE**





**Underwriters Laboratories Taiwan Co., Ltd.**

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone :+886-2-7737-3000

Facsimile (FAX) :+886-3-583-7948



## 9.5. Radiated Spurious Emission

### Requirements

Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified as below table. Other emissions shall be at least 20dB below the highest level of the desired power:

Frequency(MHz)	Field strength (microvolts/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

NOTE:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).
3. For frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.

### **Underwriters Laboratories Taiwan Co., Ltd.**

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone :+886-2-7737-3000

Facsimile (FAX ) :+886-3-583-7948

Doc No: 17-EM-F0876 / 5.0



## **Test Procedures**

[For 9 kHz ~ 30 MHz]

- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. Parallel, perpendicular, and ground-parallel orientations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. For measurement below 30MHz, the initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured. If the emission level of the EUT measured by the peak detector is lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

NOTE:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9kHz at frequency below 30MHz.

[For above 30 MHz]

- a. The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. For measurement below 1GHz, the initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured. If the emission level of the EUT measured by the peak detector is lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.
- f. The test-receiver system was set to peak and average detects function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

## **Underwriters Laboratories Taiwan Co., Ltd.**

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone :+886-2-7737-3000

Facsimile (FAX ) :+886-3-583-7948

Doc No: 17-EM-F0876 / 5.0



Note:

- a. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
- b. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
- c. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is  $\geq 1/T$  (Duty cycle < 98%) or 10Hz (Duty cycle  $\geq 98\%$ ) for Average detection (AV) at frequency above 1GHz.

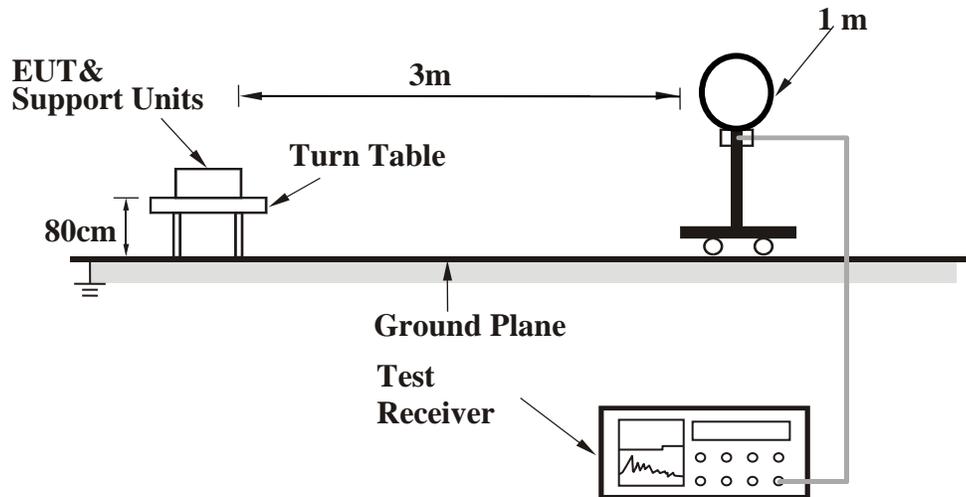
Configuration	Average	
	RBW	VBW
BT 4.0-LE	1MHz	3 kHz

Note: Refer to section 6.6 for duty cycle.

- d. All modes of operation were investigated (includes all external accessories) and the worst-case emissions are reported.

**Test Setup**

<Frequency Range 9 kHz ~ 30 MHz>



**Underwriters Laboratories Taiwan Co., Ltd.**

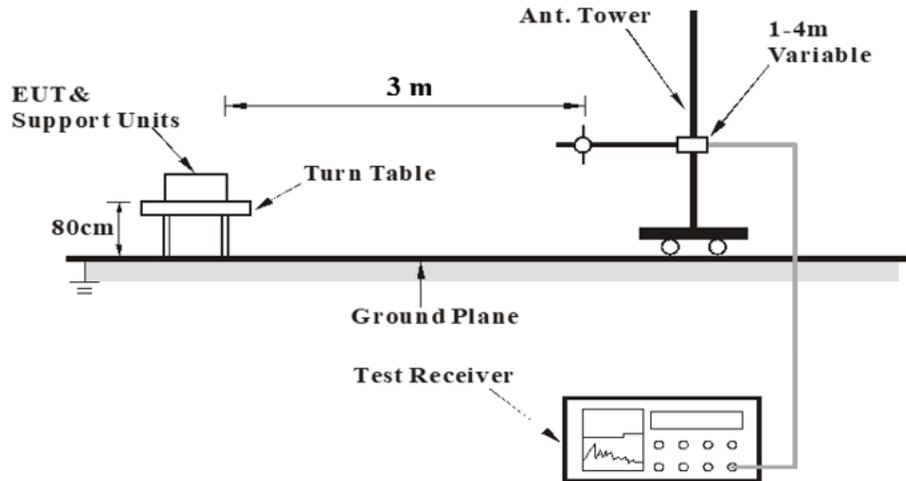
Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone :+886-2-7737-3000

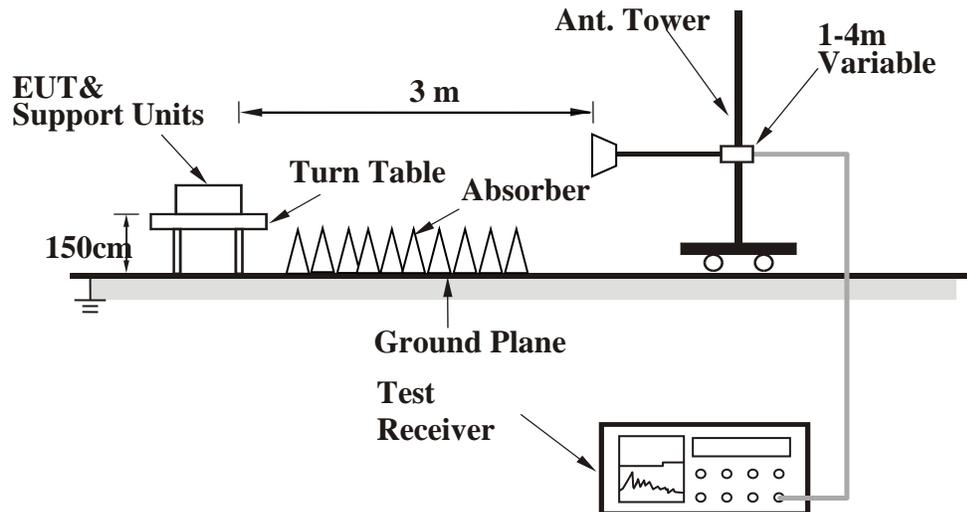
Facsimile (FAX ) :+886-3-583-7948

Doc No: 17-EM-F0876 / 5.0

<Frequency Range 30 MHz ~ 1 GHz >



<Frequency Range above 1 GHz>



For the actual test configuration, please refer to the Setup Configurations.



## Test Data

### Above 1GHz Data

#### BT 4.0-LE

EUT Test Condition		Measurement Detail	
Channel	Channel 0	Frequency Range	1 GHz ~ 26.5 GHz

Antenna Polarity & Test Distance: Horizontal at 3 m							
Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	
-	2321	40.74	6.73	47.47	74	-26.53	Peak
@	2402	84.63	6.73	91.36	-	-	Peak
-	2360.2	28.47	6.73	35.2	54	-18.8	Average
@	2402	80.68	6.73	87.41	-	-	Average
*	4804	47.34	3.47	50.81	74	-23.19	Peak
Antenna Polarity & Test Distance: Vertical at 3 m							
Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	
-	2379.2	41.15	6.73	47.88	74	-26.12	Peak
@	2402	85.75	6.73	92.48	-	-	Peak
-	2368	28.49	6.73	35.22	54	-18.78	Average
@	2402	81.62	6.73	88.35	-	-	Average
*	4804	41.77	3.47	45.24	74	-28.76	Peak

#### Remarks:

1. Result value (dBuV/m) = Reading value (dBuV/m) + Correction Factor (dB/m).
2. Margin(dB) = Result value (dBuV/m) - Limit value (dBuV/m).
3. Correction Factor (dB/m) = Antenna Factor (dBuV/m) + Cable Loss (dB) - Preamp Factor (dB).
4. "@": Fundamental Frequency.
5. "\* \*": The peak result complies with AVG limit, AVG result is deemed to comply with AVG limit.
6. The other emission levels were very low against the limit.

### Underwriters Laboratories Taiwan Co., Ltd.

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan  
Telephone :+886-2-7737-3000  
Facsimile (FAX ) :+886-3-583-7948



EUT Test Condition		Measurement Detail	
Channel	Channel 19	Frequency Range	1 GHz ~ 26.5 GHz

Antenna Polarity & Test Distance: Horizontal at 3 m							
Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	
-	2350.4	40.66	6.73	47.39	74	-26.61	Peak
@	2440	86.5	6.57	93.07	-	-	Peak
-	2486.8	40.13	6.53	46.66	74	-27.34	Peak
-	2342.6	28.53	6.73	35.26	54	-18.74	Average
@	2440	82.54	6.57	89.11	-	-	Average
-	2492.6	28.53	6.52	35.05	54	-18.95	Average
*	4880	47.86	3.64	51.5	74	-22.5	Peak
Antenna Polarity & Test Distance: Vertical at 3 m							
Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	
-	2349.2	40.6	6.73	47.33	74	-26.67	Peak
@	2440	86.53	6.57	93.1	-	-	Peak
-	2486.6	40.17	6.53	46.7	74	-27.3	Peak
-	2321.6	28.69	6.74	35.43	54	-18.57	Average
@	2440	82.6	6.57	89.17	-	-	Average
-	2491.2	28.45	6.53	34.98	54	-19.02	Average
*	4880	41.37	3.64	45.01	74	-28.99	Peak

Remarks:

1. Result value (dBuV/m) = Reading value (dBuV/m) + Correction Factor (dB/m).
2. Margin(dB) = Result value (dBuV/m) - Limit value (dBuV/m).
3. Correction Factor (dB/m) = Antenna Factor (dBuV/m) + Cable Loss (dB) - Preamp Factor (dB).
4. "@": Fundamental Frequency.
5. "\*": The peak result complies with AVG limit, AVG result is deemed to comply with AVG limit.
6. The other emission levels were very low against the limit.

### Underwriters Laboratories Taiwan Co., Ltd.

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone :+886-2-7737-3000

Facsimile (FAX ) :+886-3-583-7948

Doc No: 17-EM-F0876 / 5.0



EUT Test Condition		Measurement Detail	
Channel	Channel 39	Frequency Range	1 GHz ~ 26.5 GHz

Antenna Polarity & Test Distance: Horizontal at 3 m							
Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	
@	2480	86.98	6.53	93.51	-	-	Peak
-	2497.8	39.92	6.53	46.45	74	-27.55	Peak
@	2480	82.79	6.53	89.32	-	-	Average
-	2486	28.82	6.53	35.35	54	-18.65	Average
*	4960	46.25	3.75	50	74	-24	Peak
Antenna Polarity & Test Distance: Vertical at 3 m							
Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	
@	2480	87.25	6.53	93.78	-	-	Peak
-	2487.4	41.24	6.53	47.77	74	-26.23	Peak
@	2480	83.03	6.53	89.56	-	-	Average
-	2484.2	28.79	6.53	35.32	54	-18.68	Average
*	4960	39.18	3.75	42.93	74	-31.07	Peak

Remarks:

1. Result value (dBuV/m) = Reading value (dBuV/m) + Correction Factor (dB/m).
2. Margin(dB) = Result value (dBuV/m) - Limit value (dBuV/m).
3. Correction Factor (dB/m) = Antenna Factor (dBuV/m) + Cable Loss (dB) - Preamp Factor (dB).
4. "@": Fundamental Frequency.
5. "\*": The peak result complies with AVG limit, AVG result is deemed to comply with AVG limit.
6. The other emission levels were very low against the limit.

**Underwriters Laboratories Taiwan Co., Ltd.**

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone :+886-2-7737-3000

Facsimile (FAX ) :+886-3-583-7948

Doc No: 17-EM-F0876 / 5.0



### 9 kHz ~ 30 MHz Data

For 9 kHz to 30 MHz radiated emission have performed all modes of operation were investigated. The amplitude of spurious emissions attenuated more than 20 dB below the permissible value is not required to be report.

No non-compliance noted:

#### **KDB 414788 D01 OATS and Chamber Correlation Justification**

- Base on FCC 15.31 (f) (2): measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field.

- OATs and chamber correlation testing had been performed and chamber measured test results is the worst case test result.

Although these tests were performed other than open area test site, adequate comparison measurements were confirmed against 30m open area test site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788.

#### **Underwriters Laboratories Taiwan Co., Ltd.**

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone :+886-2-7737-3000

Facsimile (FAX ) :+886-3-583-7948

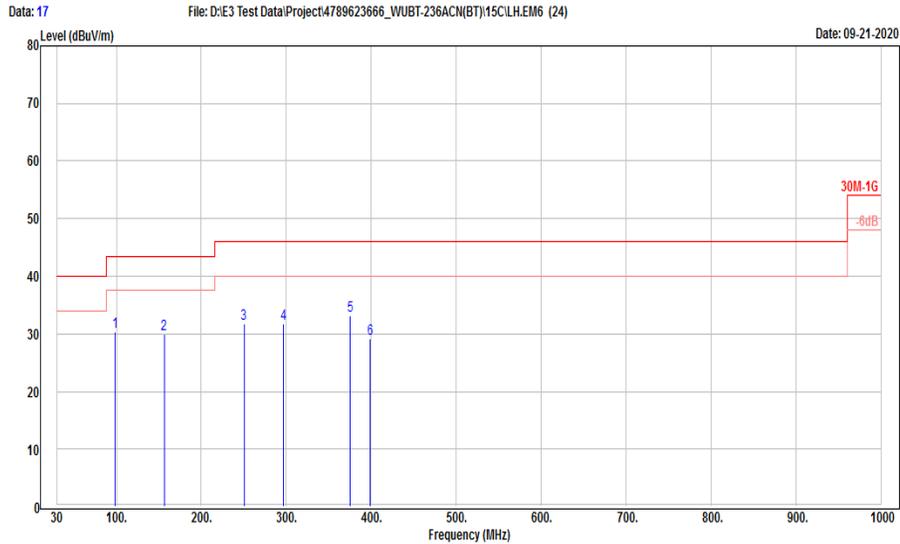


### 30 MHz ~ 1 GHz Data

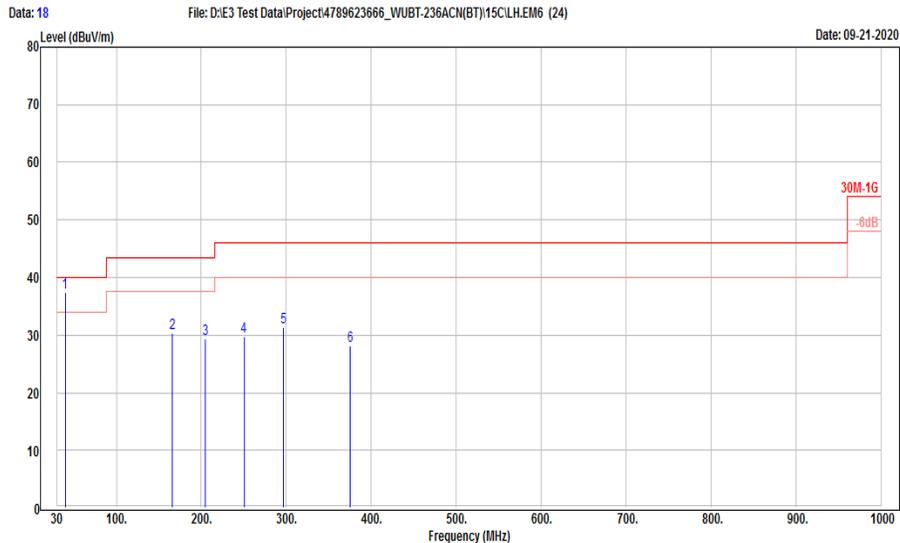
#### BT 4.0-LE

EUT Test Condition		Measurement Detail	
Channel	Channel 19	Frequency Range	30 MHz ~ 1 GHz

#### Horizontal



#### Vertical



### Underwriters Laboratories Taiwan Co., Ltd.

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone : +886-2-7737-3000

Facsimile (FAX) : +886-3-583-7948

Doc No: 17-EM-F0876 / 5.0



Antenna Polarity & Test Distance: Horizontal at 3 m							
Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	
-	98.87	46.85	-16.44	30.41	43.5	-13.09	Peak
-	156.1	41.23	-11.36	29.87	43.5	-13.63	Peak
-	250.19	43.51	-11.84	31.67	46	-14.33	Peak
-	296.75	42.01	-10.17	31.84	46	-14.16	Peak
-	375.32	40.86	-7.69	33.17	46	-12.83	Peak
-	398.6	36.34	-7.21	29.13	46	-16.87	Peak
Antenna Polarity & Test Distance: Vertical at 3 m							
Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV/m)	dB/m	(dBuV/m)	(dBuV/m)	(dB)	
-	39.7	49.33	-11.91	37.42	40	-2.58	Peak
-	165.8	41.48	-11.1	30.38	43.5	-13.12	Peak
-	204.6	43.3	-13.89	29.41	43.5	-14.09	Peak
-	250.19	41.5	-11.84	29.66	46	-16.34	Peak
-	296.75	41.48	-10.17	31.31	46	-14.69	Peak
-	375.32	35.75	-7.69	28.06	46	-17.94	Peak

Remarks:

1. Result value (dBuV/m) = Reading value (dBuV/m) + Correction Factor (dB/m).
2. Margin(dB) = Result value (dBuV/m) - Limit value (dBuV/m).
3. Correction Factor (dB/m) = Antenna Factor (dBuV/m) + Cable Loss (dB) - Preamp Factor (dB).
4. The peak result complies with QP limit, QP result is deemed to comply with QP limit.
5. The other emission levels were very low against the limit.

**Underwriters Laboratories Taiwan Co., Ltd.**

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone :+886-2-7737-3000

Facsimile (FAX ) :+886-3-583-7948

Doc No: 17-EM-F0876 / 5.0



## 9.6. AC Power Line Conducted Emission

### Requirements

Frequency (MHz)	Conducted limit (dB $\mu$ V)	
	Quasi-peak	Average
0.15 - 0.5	66 - 56	56 - 46
0.50 - 5.0	56	46
5.0 - 30	60	50

Note:

1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

### Test Procedures

- a. The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50uH of coupling impedance for the measuring instrument.
- b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.
- c. The frequency range from 150kHz to 30MHz was searched. Emission levels under (Limit - 20dB) was not recorded.

NOTE:

1. The resolution bandwidth and video bandwidth of test receiver is 9kHz for quasi-peak detection (QP) and average detection (AV) at frequency 0.15MHz-30MHz.

### **Underwriters Laboratories Taiwan Co., Ltd.**

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

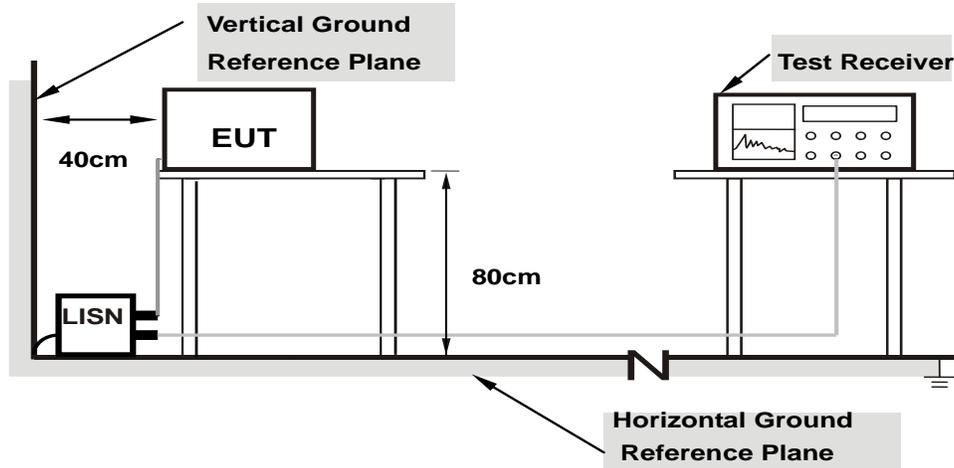
Telephone :+886-2-7737-3000

Facsimile (FAX ) :+886-3-583-7948

Doc No: 17-EM-F0876 / 5.0



## Test Setup



**Note: 1.Support units were connected to second LISN.**

For the actual test configuration, please refer to the Setup Configurations.

## **Underwriters Laboratories Taiwan Co., Ltd.**

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone :+886-2-7737-3000

Facsimile (FAX ) :+886-3-583-7948

Doc No: 17-EM-F0876 / 5.0

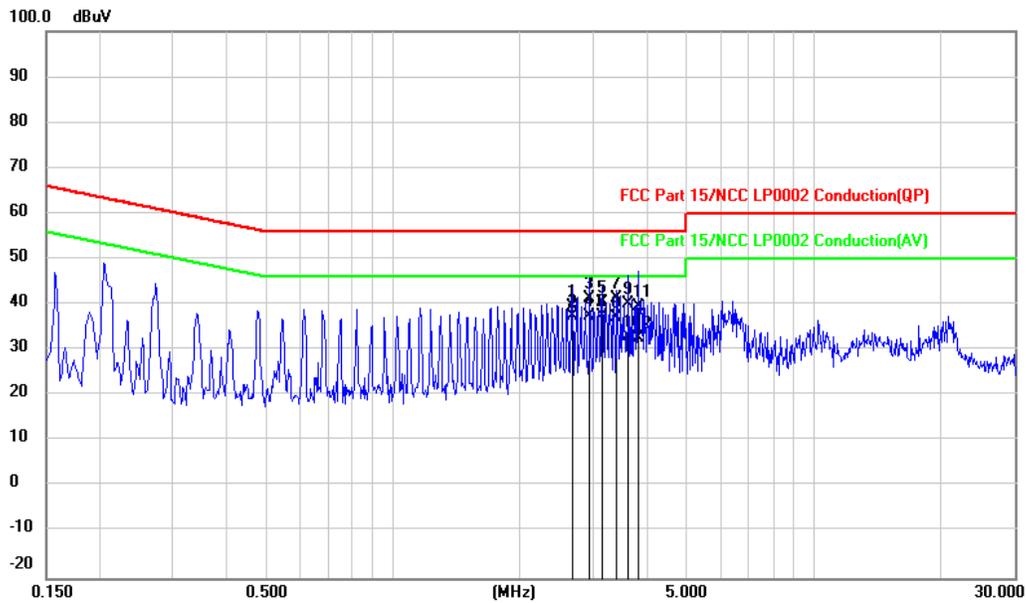


## Test Data

### BT 4.0-LE

EUT Test Condition		Measurement Detail	
Channel	Channel 19	Frequency Range	150 kHz ~ 30 MHz

### Phase of Power : Line (L)



## Underwriters Laboratories Taiwan Co., Ltd.

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone : +886-2-7737-3000

Facsimile (FAX) : +886-3-583-7948

Doc No: 17-EM-F0876 / 5.0



No.	Frequency (MHz)	Reading (dBuV)	Correct dB	Result (dBuV)	Limit (dBuV)	Margin (dB)	Remark
1	2.6657	20.00	19.56	39.56	56.00	-16.44	QP
2	2.6657	17.88	19.56	37.44	46.00	-8.56	AVG
3	2.9395	21.82	19.56	41.38	56.00	-14.62	QP
4	2.9395	18.02	19.56	37.58	46.00	-8.42	AVG
5	3.1449	20.75	19.57	40.32	56.00	-15.68	QP
6	3.1449	17.76	19.57	37.33	46.00	-8.67	AVG
7	3.4187	21.78	19.57	41.35	56.00	-14.65	QP
8	3.4187	17.61	19.57	37.18	46.00	-8.82	AVG
9	3.6242	20.67	19.58	40.25	56.00	-15.75	QP
10	3.6242	13.45	19.58	33.03	46.00	-12.97	AVG
11	3.8297	19.87	19.58	39.45	56.00	-16.55	QP
12	3.8297	13.09	19.58	32.67	46.00	-13.33	AVG

Remarks:

1. Result value (dBuV) = Reading value (dBuV) + Correction Factor (dB)
2. Margin(dB) = Result value (dBuV) - Limit value (dBuV)
3. Correction Factor(dB) = Insertion loss(dB) + Cable loss(dB)
4. The other emission levels were very low against the limit.

**Underwriters Laboratories Taiwan Co., Ltd.**

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

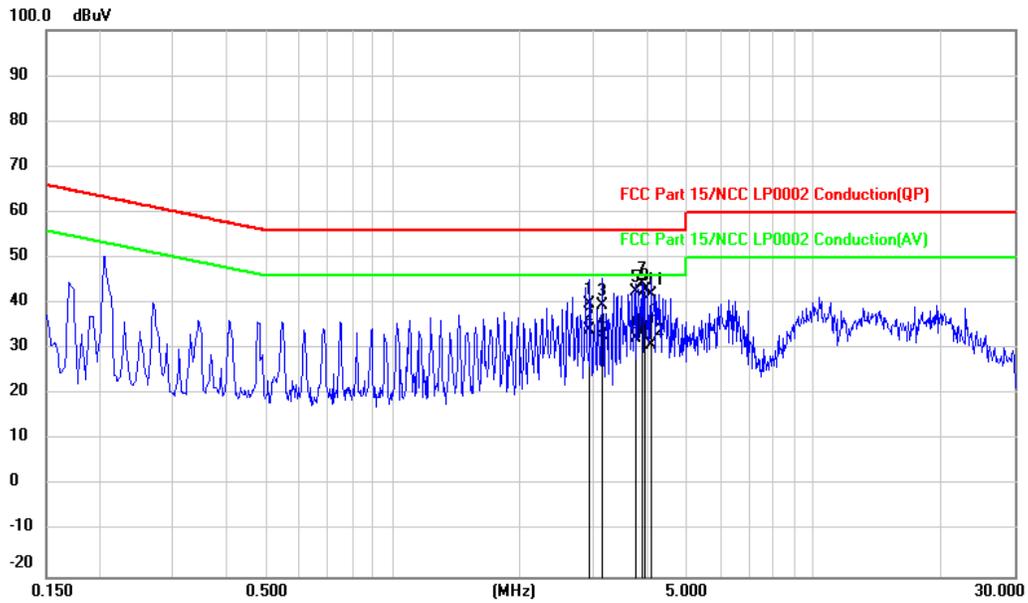
Telephone :+886-2-7737-3000

Facsimile (FAX ) :+886-3-583-7948

Doc No: 17-EM-F0876 / 5.0



### Phase of Power : Neutral (N)



### Underwriters Laboratories Taiwan Co., Ltd.

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone : +886-2-7737-3000

Facsimile (FAX) : +886-3-583-7948

Doc No: 17-EM-F0876 / 5.0



No.	Frequency (MHz)	Reading (dBuV)	Correct dB	Result (dBuV)	Limit (dBuV)	Margin (dB)	Remark
1	2.9410	20.39	19.56	39.95	56.00	-16.05	QP
2	2.9410	14.57	19.56	34.13	46.00	-11.87	AVG
3	3.1465	19.88	19.56	39.44	56.00	-16.56	QP
4	3.1465	13.42	19.56	32.98	46.00	-13.02	AVG
5	3.7623	23.11	19.58	42.69	56.00	-13.31	QP
6	3.7623	12.76	19.58	32.34	46.00	-13.66	AVG
7	3.8993	24.75	19.58	44.33	56.00	-11.67	QP
8	3.8993	13.62	19.58	33.20	46.00	-12.80	AVG
9	3.9681	23.34	19.58	42.92	56.00	-13.08	QP
10	3.9681	15.42	19.58	35.00	46.00	-11.00	AVG
11	4.1048	22.49	19.58	42.07	56.00	-13.93	QP
12	4.1048	11.34	19.58	30.92	46.00	-15.08	AVG

Remarks:

1. Result value (dBuV) = Reading value (dBuV) + Correction Factor (dB)
2. Margin(dB) = Result value (dBuV) - Limit value (dBuV)
3. Correction Factor(dB) = Insertion loss(dB) + Cable loss(dB)
4. The other emission levels were very low against the limit.

**Underwriters Laboratories Taiwan Co., Ltd.**

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone :+886-2-7737-3000

Facsimile (FAX ) :+886-3-583-7948

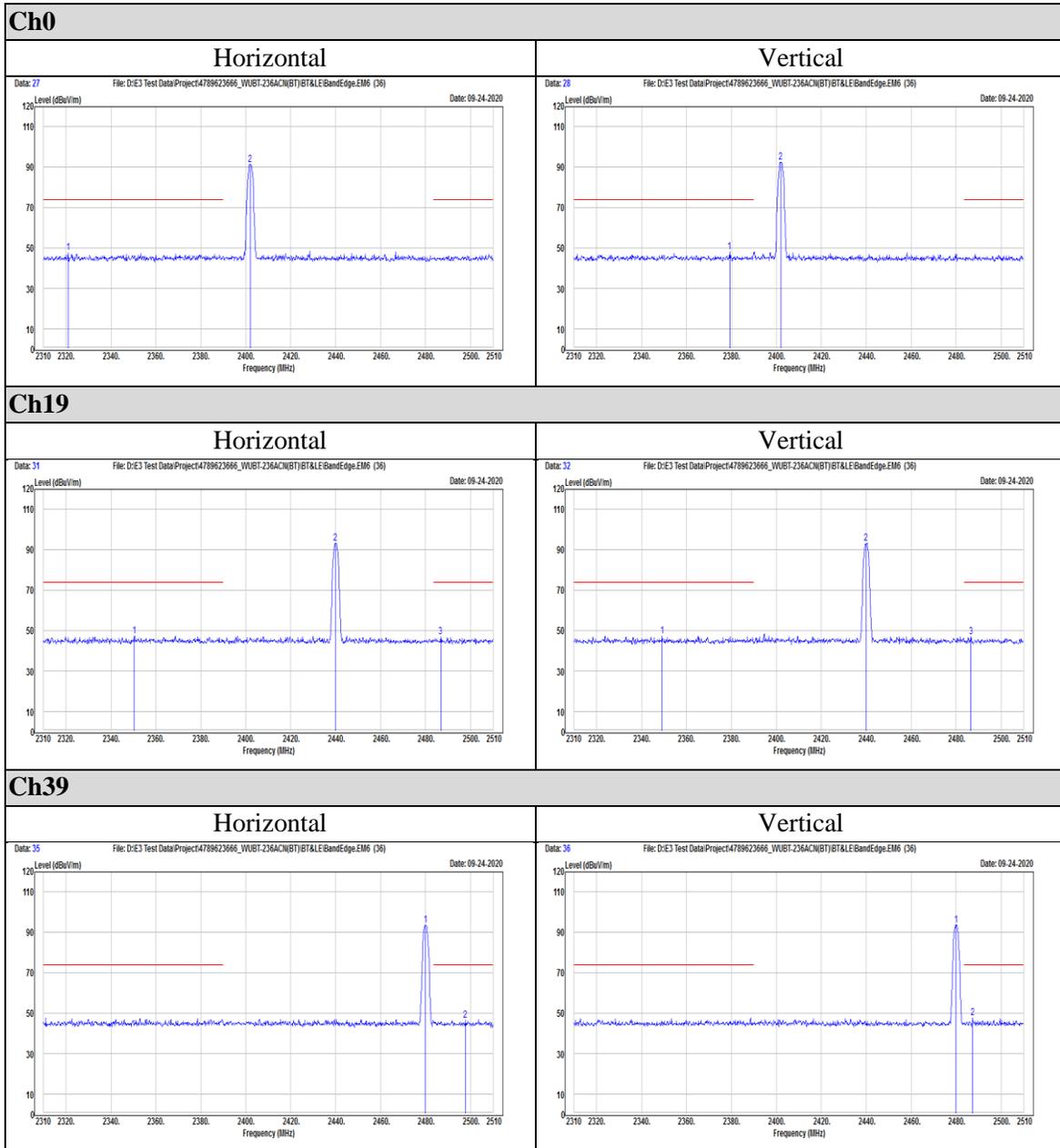
Doc No: 17-EM-F0876 / 5.0



## Appendix I Radiated Band Edge Measurement

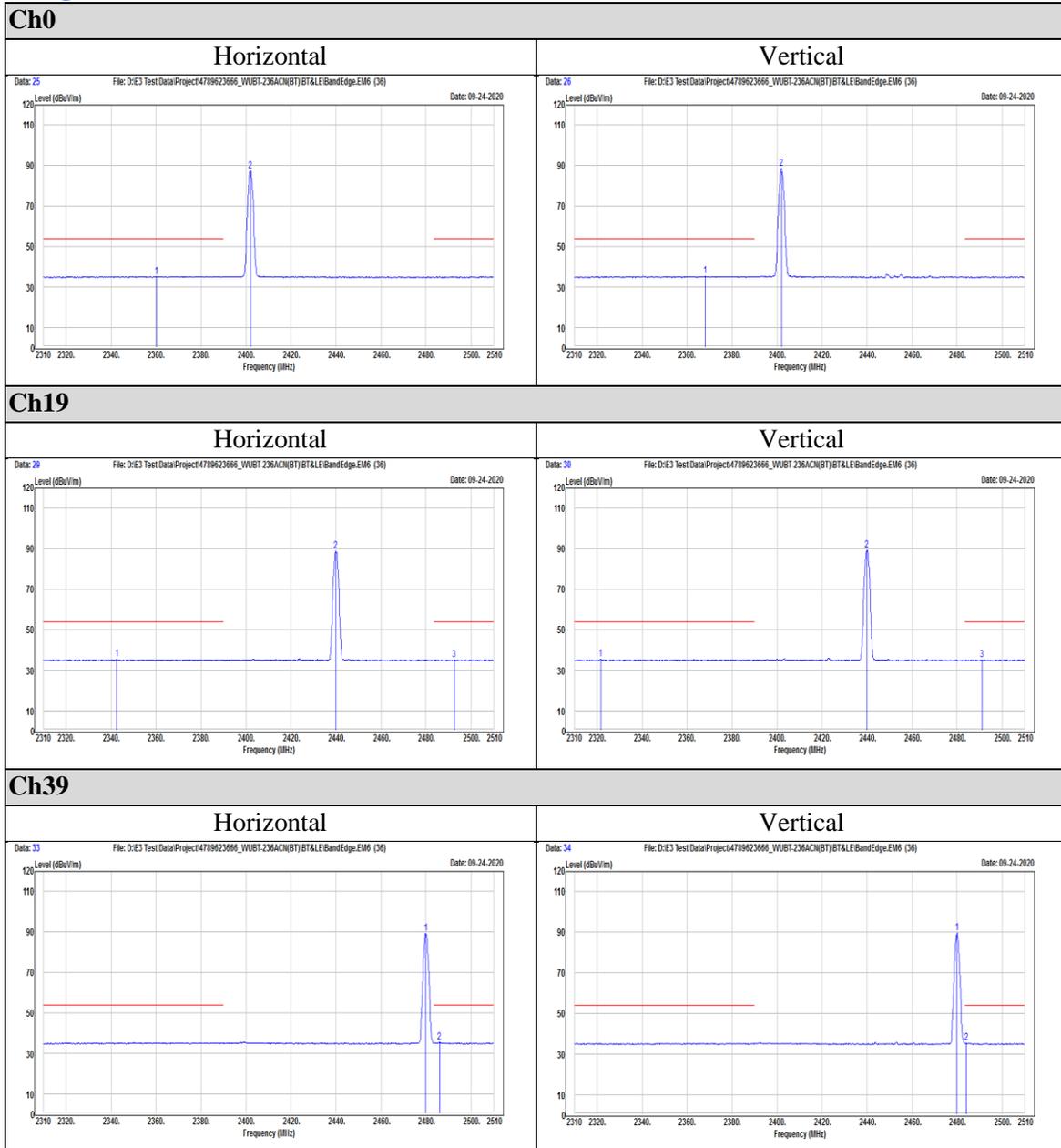
### BT 4.0-LE

#### Peak





### Average



### Underwriters Laboratories Taiwan Co., Ltd.

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

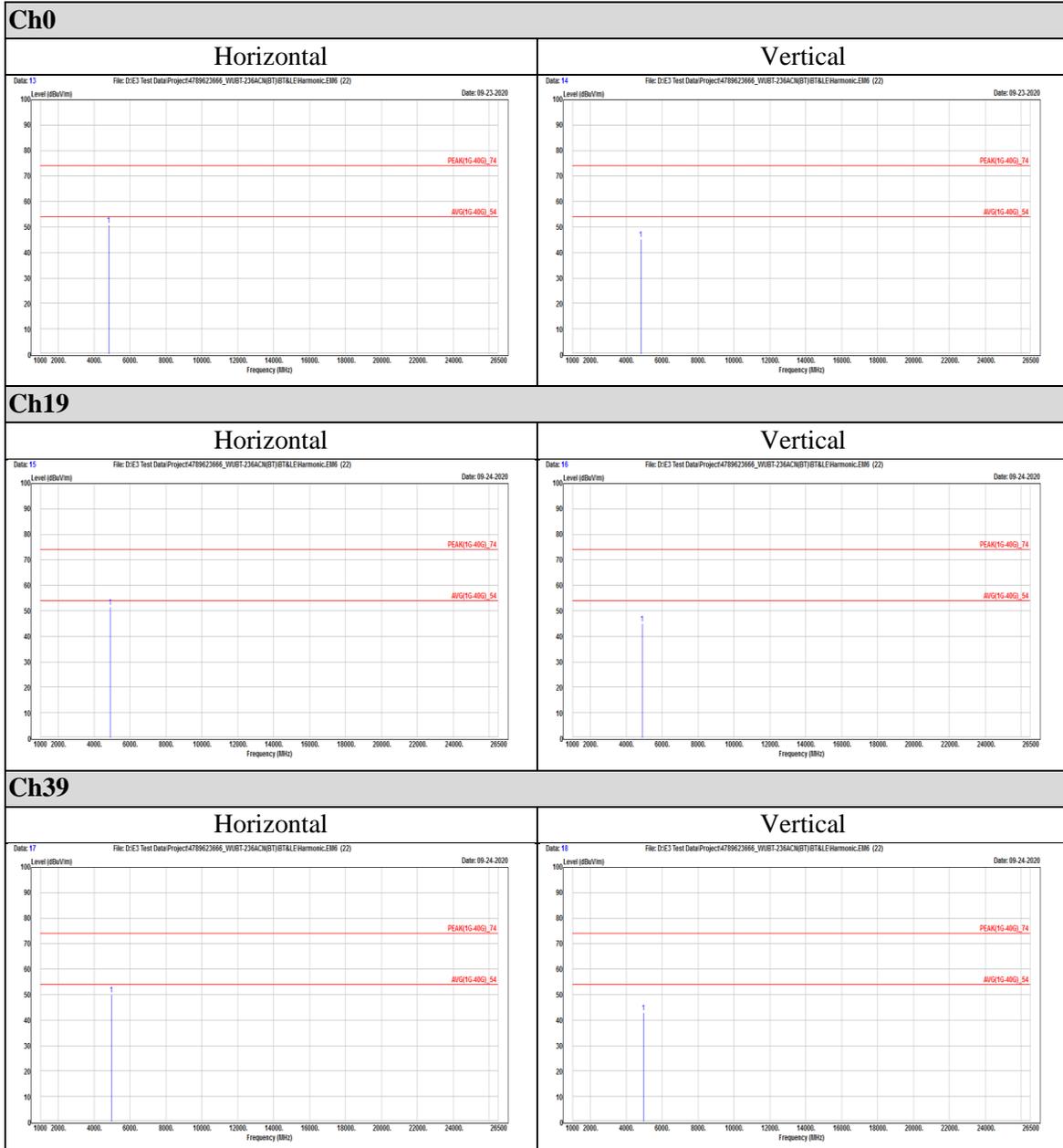
Telephone : +886-2-7737-3000

Facsimile (FAX) : +886-3-583-7948



## Appendix II Radiated Spurious Emission Measurement

### BT 4.0-LE



**Underwriters Laboratories Taiwan Co., Ltd.**

Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Telephone : +886-2-7737-3000

Facsimile (FAX) : +886-3-583-7948

Doc No: 17-EM-F0876 / 5.0