

# RADIO TEST REPORT

**Product** : Essential 2 Camera Family  
**Model Name** : VMC3052  
**Series Model** : VMC2052, VMC3050, VMC2050  
**FCC ID** : 2APLE18300425  
**Test Regulation** : FCC 47 CFR Part 15 Subpart C (Section 15.247)  
**Received Date** : 2023/3/16  
**Test Date** : 2023/4/7 ~ 2023/4/20  
**Issued Date** : 2023/6/26

**Applicant** : Arlo Technologies Inc  
2200 Faraday Avenue, Suite 150, Carlsbad, CA 92008, USA

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



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Test report No. : 4790738132-US-R1-V0  
Page : 2 of 56  
Issued date : 2023/6/26  
FCC ID : 2APLE18300425

# REVISION HISTORY

**Original Test Report No.: 4790738132-US-R1-V0**

Revision	Test report No.	Date	Page revised	Contents
Original	4790738132-US-R1-V0	2023/6/26	-	Initial issue

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## 1. Attestation of Test Results

**APPLICANT:** Arlo Technologies Inc  
2200 Faraday Avenue, Suite 150, Carlsbad, CA 92008, USA

**MANUFACTURER:** Fuyu Precision Component Company Limited  
Lot M1 and Lot F, Quang Chau Industrial Park, Van Trung  
Commune, Viet Yen District, Bac Giang Province, Viet Nam

**EUT DESCRIPTION:** Essential 2 Camera Family

**BRAND:** Arlo

**MODEL:** VMC3052

**SERIES MODEL:** VMC2052, VMC3050, VMC2050

**SAMPLE STAGE:** Engineering Verification Test sample

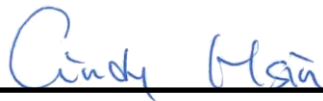
**DATE of TESTED:** 2023/4/7 ~ 2023/4/20

APPLICABLE STANDARDS	
STANDARD	Test Results
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 : 2023/6/26

Approved and Authorized By:



Eric Lee  
Senior Laboratory Engineer

Date : 2023/6/26

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## 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

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### 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.

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## 5. Measurement Uncertainty

For statement of conformity, accuracy method (Section 4.3.4 of ISO Guide 115) 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  $k=2$ .

Determining compliance based on the results of the compliance measurement, not considering measurement instrumentation uncertainty.

Measurement	Frequency	Uncertainty
Conducted disturbance at mains terminals ports	150kHz ~ 30MHz	$\pm 2.9$ dB
RF Conducted	9 kHz - 40GHz	$\pm 2.4$ dB
Radiated disturbance below 30MHz	9 kHz - 30 MHz	$\pm 1.9$ dB
Radiated disturbance below 1 GHz	30MHz ~ 1GHz	$\pm 5.8$ dB
Radiated disturbance above 1 GHz	1GHz ~ 40GHz	$\pm 4.8$ dB

## 6. Equipment under Test

### 6.1. Description of EUT

<b>Product</b>	Essential 2 Camera Family
<b>Brand Name</b>	Arlo
<b>Model Name</b>	VMC3052
<b>Series Model</b>	VMC2052, VMC3050, VMC2050
<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>	8.59 dBm
<b>Normal Voltage</b>	5Vdc from host 3.69Vdc for battery
<b>Sample ID</b>	5971598



Note:

1. The models difference table as below:

Model	Main Board (PCBA Board)	LED Board (PCBA board)	Image Sensor (2K/FHD)	LED (IR)	Lens (2K/FHD)	MECH (Enclosure)	Battery Type
VMC3052	PCB layout and circuit is the same except for image sensor	PCB layout and circuit is the same except for IR LED quantity	2K 2560 x 1440 Image Sensor : GC4023	IR LED *2	2K lens	Large housing	4 cell battery (A-18)
VMC3050						Regular housing	1 cell battery (A-19)
VMC2052			FHD 1920 x 1080 Image Sensor : SC2333	IR LED *1	FHD Lens	Large housing	4 cell battery (A-18)
VMC2050						Regular housing	1 cell battery (A-19)

2. The EUT contains following accessory devices:

Product	Brand	Model	Description
USB Cable	Nienyi	310-50024-01	Length: 0.9 m

3. The EUT could be supplied with rechargeable battery as the following table:

Brand Name	Model	Description
Arlo	A-19	4650mAh,3.69V, 17.1585Wh For VMC3050 & VMC2050
Arlo	A-18	18.6Ah,3.69V, 68.63Wh For VMC3052 & VMC2052

4. The above EUT information is declared by manufacturer and for more detailed features description, please refer the manufacturer's or user's manual, the laboratory shall not be held responsible.

## 6.2. Channel List

40 channels are provided to this EUT:

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (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

### 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/ 56~61%RH	5Vdc from host	2023/04/07~ 2023/04/20	WaterNil Guan
Radiated Spurious Emission	966-2	22~26°C/ 56~61%RH	5Vdc from host	2023/04/07~ 2023/04/20	WaterNil Guan
AC power Line Conducted Emission	SR1	23~25°C/ 56~59%RH	5Vdc from host	2023/04/07~ 2023/04/08	WaterNil Guan

FCC Test Firm Registration Number: 498077

### Sample Calculation:

#### Antenna Port Conducted Measurement:

- Where relevant, the follow sample calculation is provided:  
 Result Value (dBm) = Reading Value (dBm) +Attenuator Factor (dB) + Cable Loss (dB).  
 Example: Result Value (10dBm) = Reading Value (-2dBm) +Attenuator Factor (10dB) + Cable Loss(2dB).  
 \*Test plot only shown the “Result Value”.

#### Radiated Spurious Emission:

- Where relevant, the follow sample calculation is provided:  
 Result Value (dBuV/m) = Reading Value (dBuV) + Correction Factor (dB/m).  
 Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Loss (dB) - Preamp Factor (dB).  
 Example: Result Value (34.5dBuV/m) = Reading Value (40.1dBuV) + Antenna Factor (18.7dB/m) + Cable Loss (4.2dB) - Preamp Factor (28.5dB).

#### AC power Line Conducted Emission:

- Where relevant, the follow sample calculation is provided:  
 Result Value (dBuV) = Reading Value (dBuV) + Correction Factor (dB).  
 Correction Factor (dB) = Insertion loss(dB) + Cable loss(dB).  
 Example: Result Value (53.7dBuV) = Reading Value (35.1dBuV) + Insertion loss(18.1dB) + Cable loss(0.5dB).

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#### 6.4. Description of Available Antennas

Ant. No.	Transmitter Circuit	Brand Name	Model Name	Ant. Type	Maximum Gain (dBi)	Connector Type
1	Chain (0)	NA	NA	PIFA	2.8	i-pex(MHF)

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, the laboratory shall not be held responsible.

## 6.5. Test Mode Applicability and Tested Channel Detail

- The fundamental of the EUT was investigated in three orthogonal axes X-Y/Y-Z/X-Z, it was determined that Y-Z plane was worst-case. Therefore, all final radiated testing was performed with the EUT in Y-Z plane.
- The EUT has two types for battery: A-19 and A-18. The worst case was A-18 by pretest. Therefore, the test data of the A-18 was recorded in this report only.
- The EUT has four types for model: VMC3050, VMC3052, VMC2050, and VMC2052. The worst case was VMC3052 by pretest. Therefore the test data of the VMC3052 was recorded in this report only.
- The EUT has two types for power source: 5V from adapter (2AEA010BA3B) and 3.69Vdc from battery and 5Vdc from host, the worst case was 5Vdc from host by pretested. the worst case was found in the 5Vdc. Therefore the test data of the 5Vdc from host was recorded in this report only.
- 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.
- 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 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.
- 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).

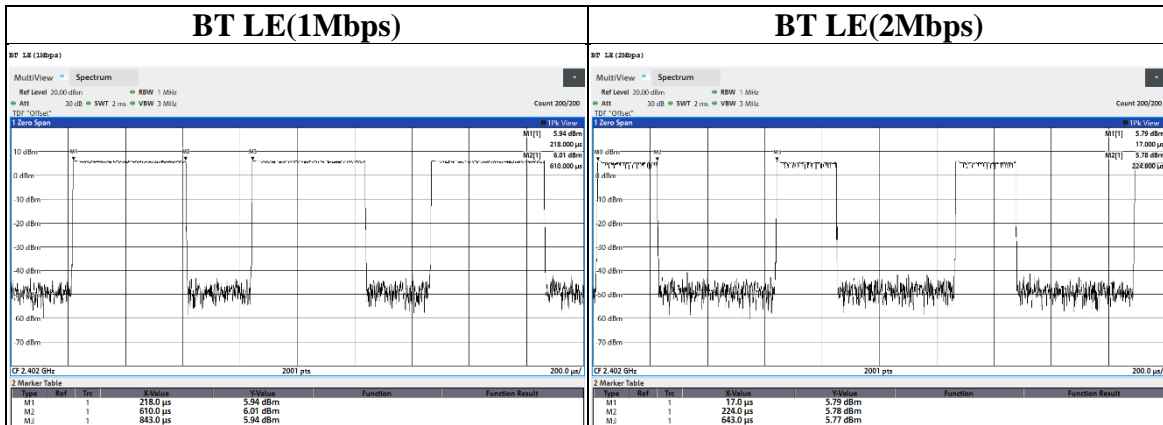
Test Item	Modulation Type	Available Channel	Test Channel	Data Rate
Radiated Emissions	GFSK	0 to 39	0,19,39	1 Mbps
	GFSK			2 Mbps
Radiated Emissions (Below 1GHz)	GFSK	0 to 39	19	1 Mbps
AC Power Line Conducted Emission	GFSK	0 to 39	19	1 Mbps
Antenna Port Conducted Measurement	GFSK	0 to 39	0,19,39	1 Mbps
	GFSK			2 Mbps

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### 6.6. Duty cycle

Mode	On Time (ms)	On+Off Time (ms)	Duty Cycle	Duty Factor (dB)	VBW Set (above 1GHz)
BT LE(1Mbps)	0.392	0.625	0.6272	2.03	3kHz
BT LE(2Mbps)	0.207	0.626	0.3307	4.81	5.1kHz



## 7. Test Equipment

Test Equipment List					
Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Expired date
<b>Radiated Spurious Emission</b>					
Spectrum Analyzer	Keysight	N9010A	MY56070827	2023/4/7	2024/4/6
EMI Test Receiver	Rohde & Schwarz	ESR7	101754	2022/12/13	2023/12/12
Loop Antenna	ETS lindgren	6502	00213440	2023/1/4	2024/1/3
Trilog-Broadband Antenna with 5dB Attenuator	Schwarzbeck & EMCI	VULB 9168 & N-6-05	774 & AT-N0538	2023/2/13	2024/2/12
Horn Antenna (1-18 GHz)	Schwarzbeck	BBHA 9120 D	01690	2022/12/21	2023/12/20
Horn Antenna (18-40 GHz)	Schwarzbeck	BBHA 9170	781	2022/12/30	2023/12/29
Preamplifier (30-1000 MHz)	EMCI	EMC330E	980405	2022/6/7	2023/6/6
Preamplifier (1-18 GHz)	EMCI	EMC051835BE	980406	2023/2/17	2024/2/16
Preamplifier (18-40GHz)	EMCI	EMC184040SEE	980426	2022/5/17	2023/5/16
Cables	Hanyitek	K1K50-UP0264-K1K50-2500	170214-4 & 170425-2	2022/12/1	2023/11/30
Cables	Hanyitek	K1K50-UP0264-K1K50-2500	170214-1 & 170214-2	2022/12/1	2023/11/30

Test Equipment List					
Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Expired date
<b>Antenna Port Conducted Measurement</b>					
Spectrum Analyzer	Rohde & Schwarz	FSV40	101490	2022/9/12	2023/9/11
Attenuator	EMCI	EMC-40ATK2W10	17002	2022/12/9	2023/12/8
Pulse Power Sensor	Anritsu	MA2411B	1531202	2023/1/4	2024/1/3
Power Meter	Anritsu	ML2495A	1645002	2023/1/4	2024/1/3
<b>AC power Line Conducted Emission</b>					
EMI Test Receiver	Rohde & Schwarz	ESR7	101753	2022/11/10	2023/11/9
Two-Line V-Network	Rohde & Schwarz	ENV216	102136	2022/8/29	2023/8/28
Impuls-Begrenzer Pulse Limiter	Rohde & Schwarz	ESH3-Z2	102219-Qt	2022/8/30	2023/8/29
Cables	TITAN	CFD200	T0732ACFD200 20A300-2	2022/4/9	2023/4/8

UL Software		
Description	Name	Version
Radiated measurement	e3	6.191211 (V6)
Conducted measurement	RF-Conducted-FCC 15247	ver 1.0
AC power Line Conducted Emission	EZ_EMCC	UL-3A1.2

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## 8. Description of Test Setup

### Support Equipment

ID	Equipment	Brand Name	Model Name	S/N	Remark
A	Laptop	DELL	Latitude E5470	3JFKWF2	Provided by Lab

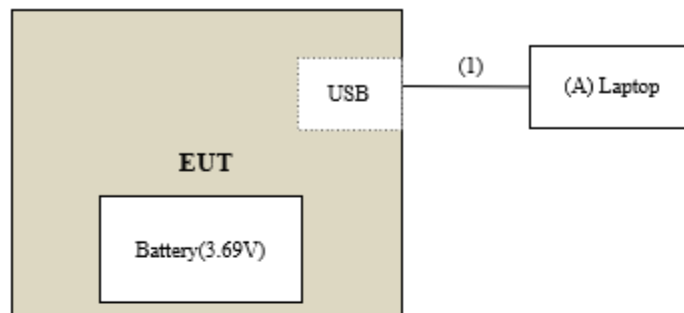
### I/O Cables

ID	Equipment	Brand Name	Model Name	Length (m)	Remark
1	USB Cable	Nienyi	310-50024-01	0.9	Provided by Client

## Test Setup

Controlled using a bespoke application (Typing RF command by terminal tool(Putty version 0.62)) 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



-----  
**Under Table**

-----  
**Remote Site**

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## 9. Test Results

### 9.1. 6dB Bandwidth

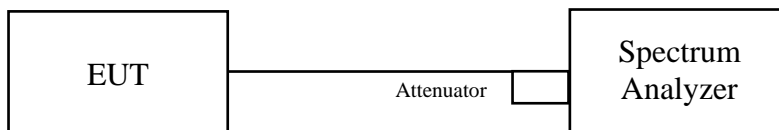
#### Requirements

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.

**Test Data**

<b>Mode</b>	<b>CH</b>	<b>Freq (MHz)</b>	<b>6dB BW (MHz)</b>	<b>Limit (MHz)</b>	<b>Result</b>
BT LE(1Mbps)	0	2402	0.650	0.5	PASS
BT LE(1Mbps)	19	2440	0.655	0.5	PASS
BT LE(1Mbps)	39	2480	0.660	0.5	PASS
BT LE(2Mbps)	0	2402	1.135	0.5	PASS
BT LE(2Mbps)	19	2440	0.968	0.5	PASS
BT LE(2Mbps)	39	2480	1.116	0.5	PASS

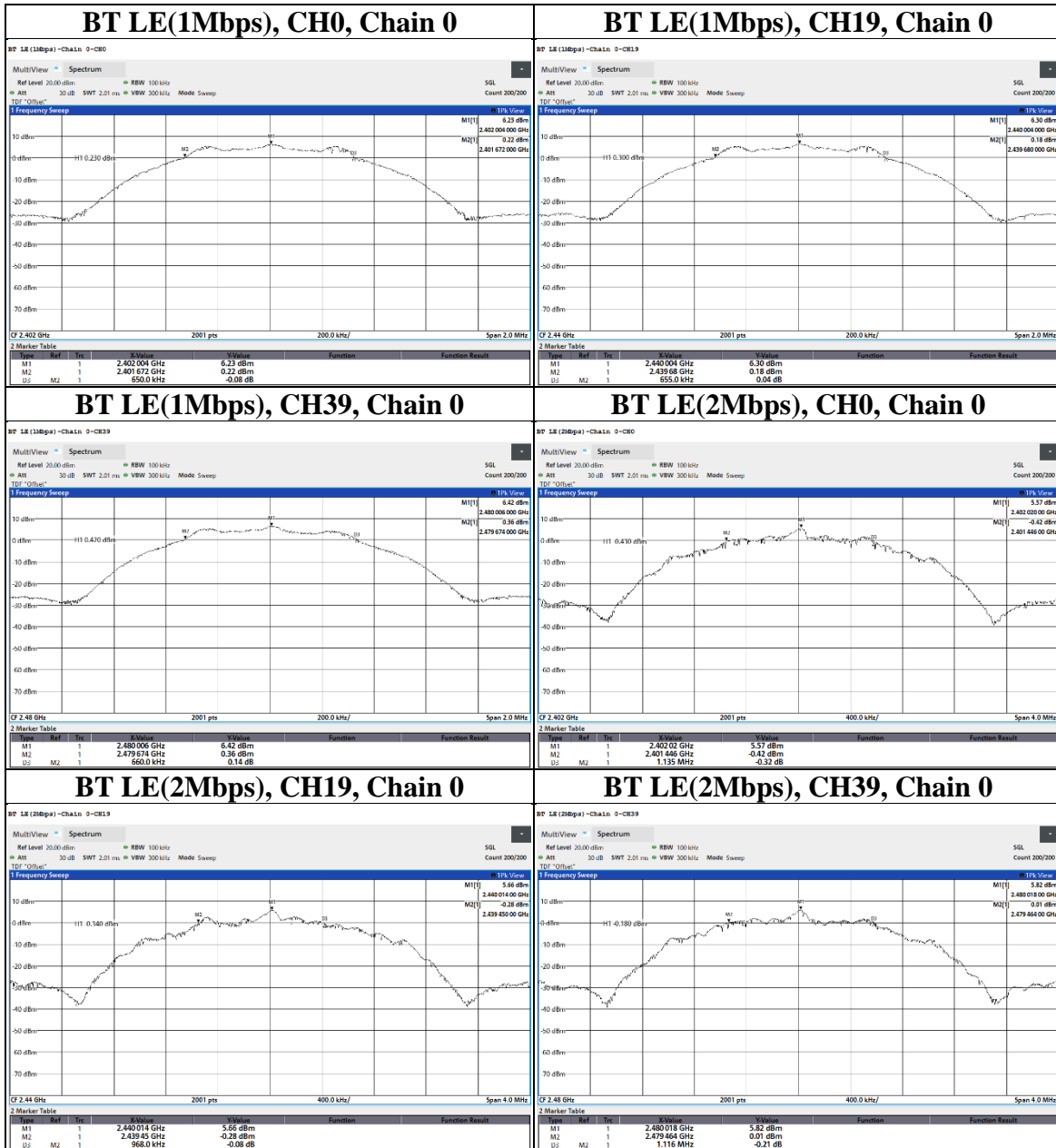
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## 9.2. Conducted Output Power

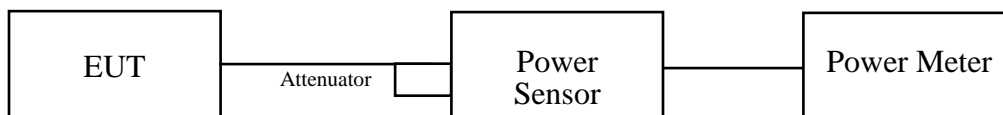
### Requirements

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****Peak Power****BT LE\_1Mbps**

Channel	Frequency (MHz)	Peak Power (mW)	Peak Power (dBm)	Limit (dBm)	Pass/Fail
0	2402	7.211	8.58	30	PASS
19	2440	7.228	8.59	30	PASS
39	2480	7.047	8.48	30	PASS

**BT LE\_2Mbps**

Channel	Frequency (MHz)	Peak Power (mW)	Peak Power (dBm)	Limit (dBm)	Pass/Fail
0	2402	7.129	8.53	30	PASS
19	2440	7.161	8.55	30	PASS
39	2480	6.823	8.34	30	PASS

**Average Power (Reference Only)****BT LE\_1Mbps**

Channel	Frequency (MHz)	Average Power (mW)	Average Power (dBm)
0	2402	6.887	8.38
19	2440	6.918	8.40
39	2480	6.637	8.22

**BT LE\_2Mbps**

Channel	Frequency (MHz)	Average Power (mW)	Average Power (dBm)
0	2402	6.653	8.23
19	2440	6.683	8.25
39	2480	6.339	8.02

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### 9.3. Power Spectral Density

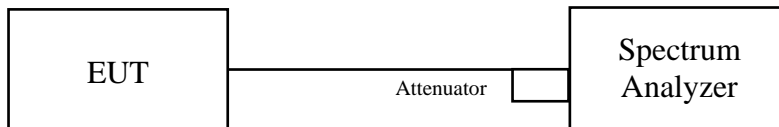
#### Requirements

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.



**Test Data**

Mode	CH	Freq (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Result
BT LE(1Mbps)	0	2402	-9.94	8	PASS
BT LE(1Mbps)	19	2440	-8.66	8	PASS
BT LE(1Mbps)	39	2480	-8.33	8	PASS
BT LE(2Mbps)	0	2402	-11.5	8	PASS
BT LE(2Mbps)	19	2440	-11.93	8	PASS
BT LE(2Mbps)	39	2480	-12.9	8	PASS

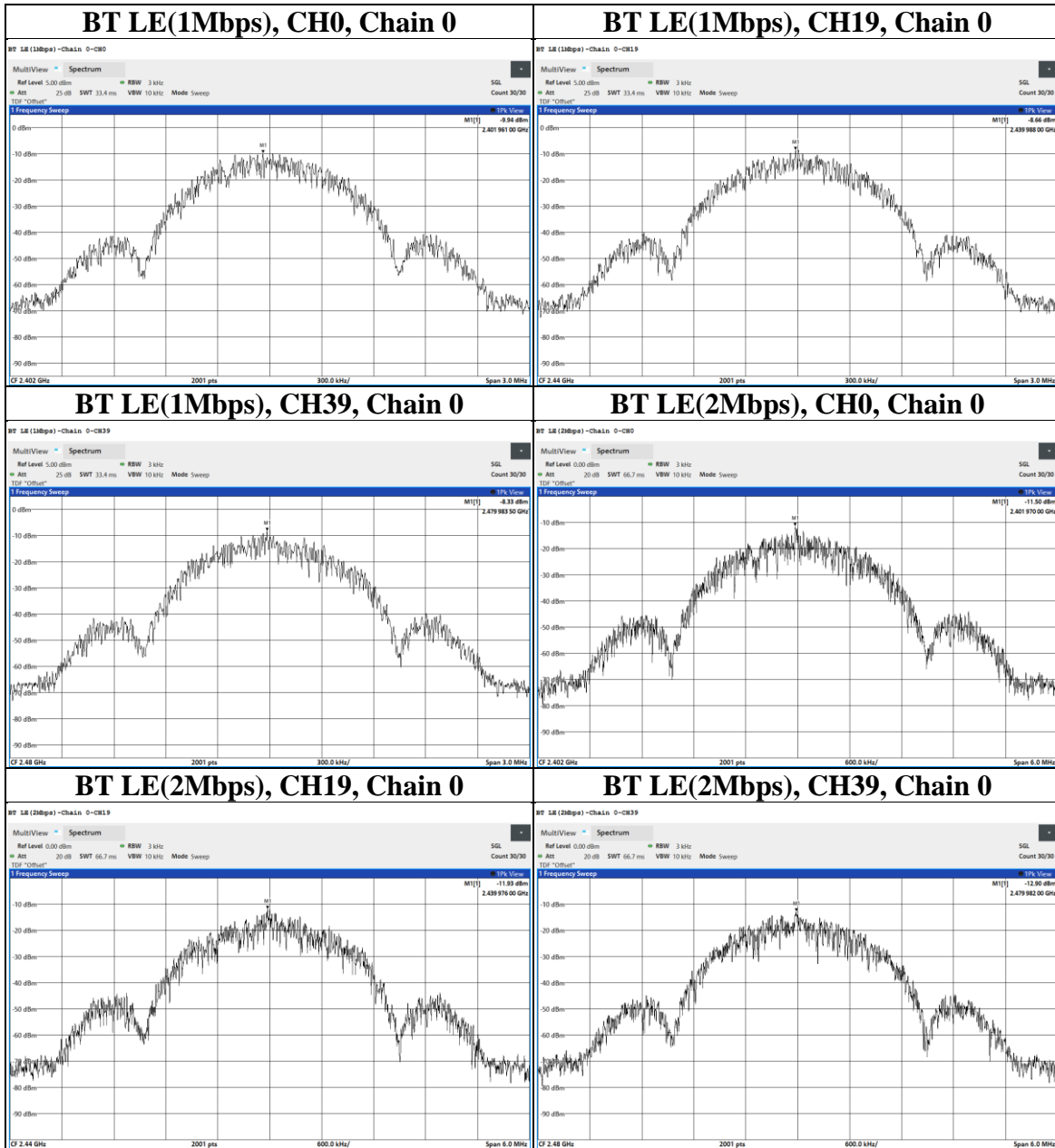
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## 9.4. Conducted Out of Band Emission

### 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

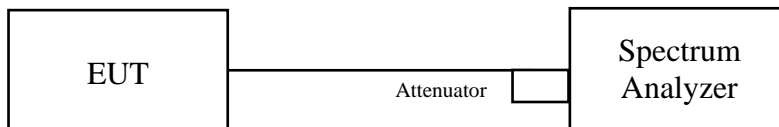
Measurement Procedure REF

- a. Set the RBW = 100 kHz.
- b. Set the VBW  $\geq$  300 kHz.
- c. Set the span to 1.5 times the DTS bandwidth.
- d. Detector = peak.
- e. Sweep time = auto couple.
- f. Trace mode = max hold.
- g. Allow trace to fully stabilize.
- h. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.

Measurement Procedure OOBE

- a. Set RBW = 100 kHz.
- b. Set VBW  $\geq$  300 kHz.
- c. Detector = peak.
- d. Sweep = auto couple.
- e. Trace Mode = max hold.
- f. Allow trace to fully stabilize.
- g. Use the peak marker function to determine the maximum amplitude level.

### Test Setup



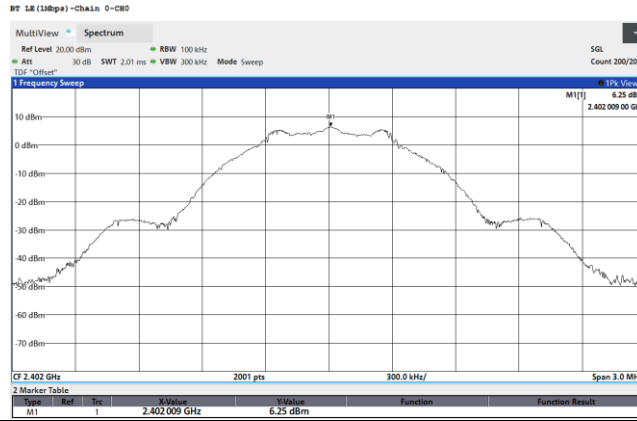
The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

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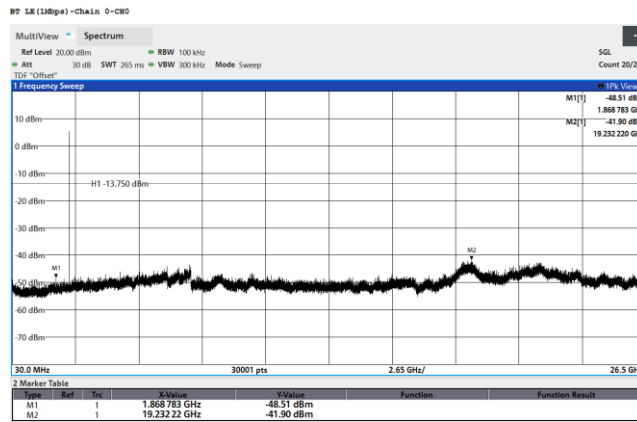
Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan  
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## Test Data

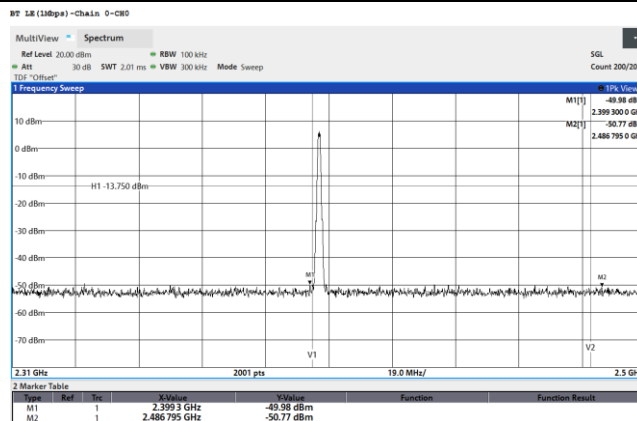
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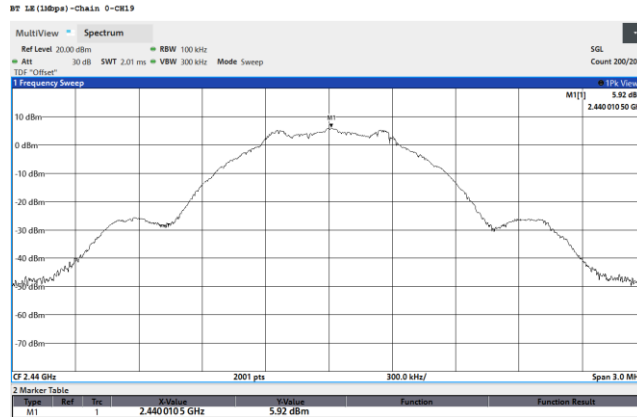
### BT LE(1Mbps), CH0, Chain 0, Conducted Emission



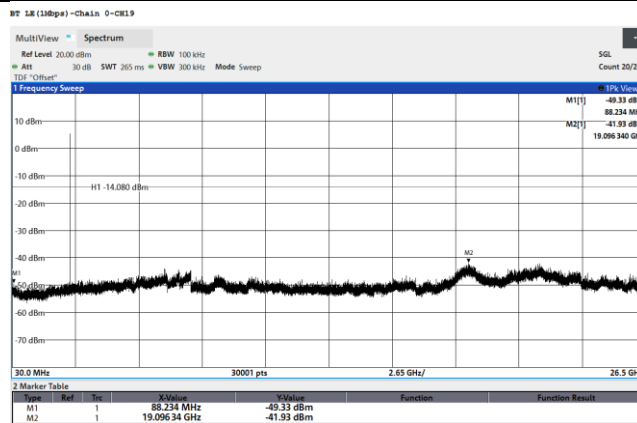
### BT LE(1Mbps), CH0, Chain 0, Bandedge



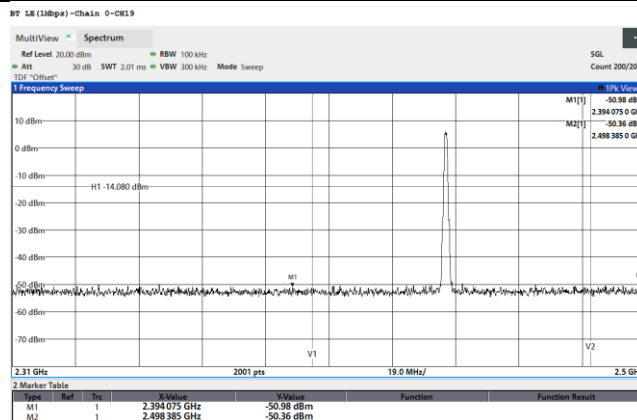
### BT LE(1Mbps), CH19, Chain 0, Reference



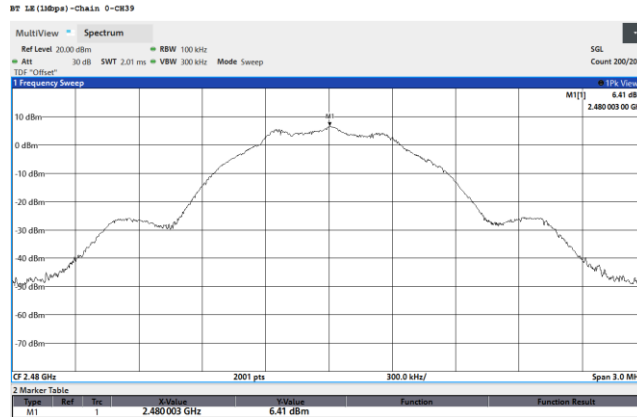
### BT LE(1Mbps), CH19, Chain 0, Conducted Emission



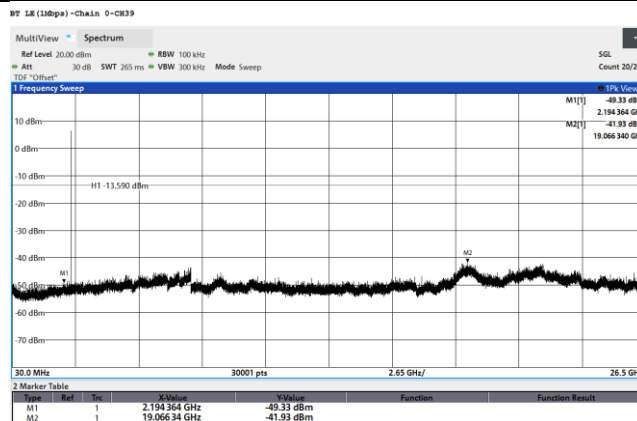
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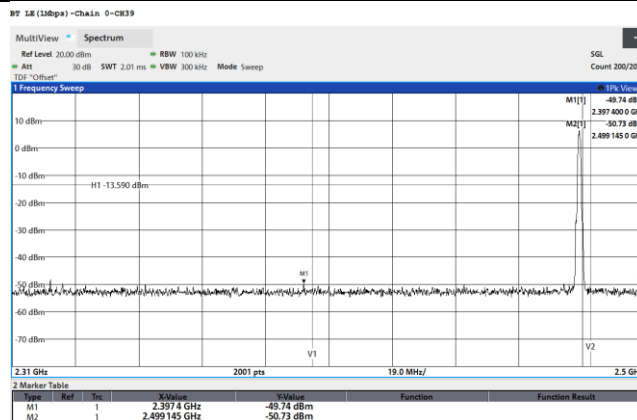
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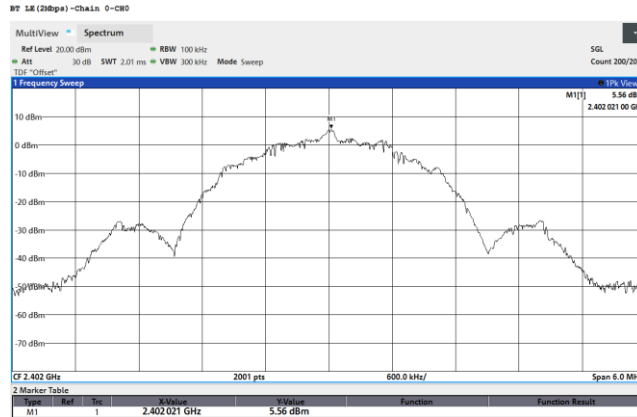
### BT LE(1Mbps), CH39, Chain 0, Conducted Emission



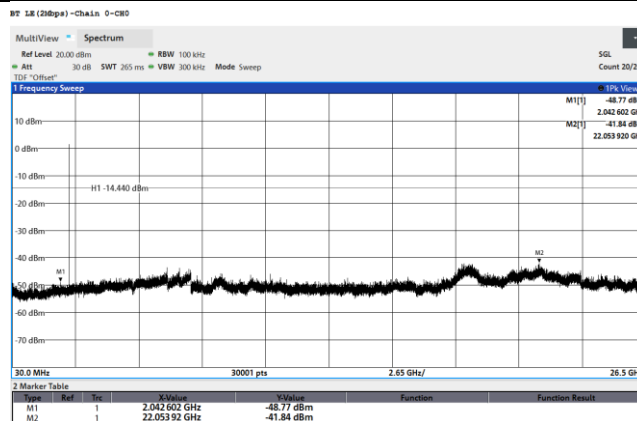
### BT LE(1Mbps), CH39, Chain 0, Bandedge



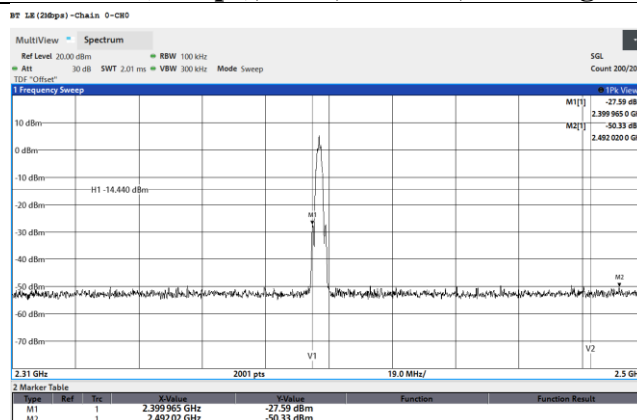
### BT LE(2Mbps), CH0, Chain 0, Reference



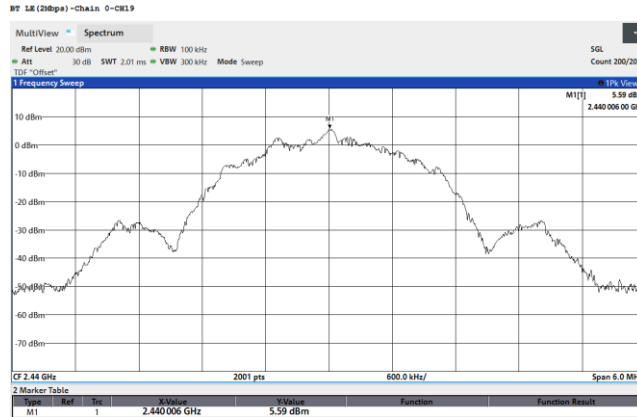
### BT LE(2Mbps), CH0, Chain 0, Conducted Emission



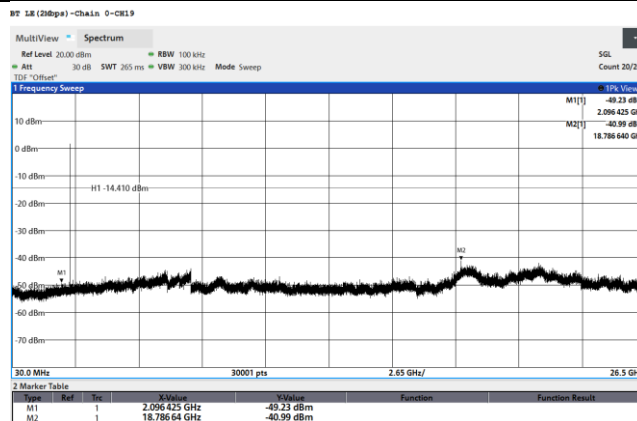
### BT LE(2Mbps), CH0, Chain 0, Bandedge



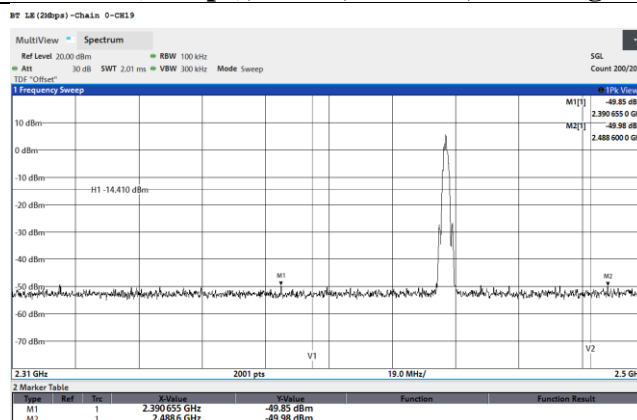
### BT LE(2Mbps), CH19, Chain 0, Reference



### BT LE(2Mbps), CH19, Chain 0, Conducted Emission

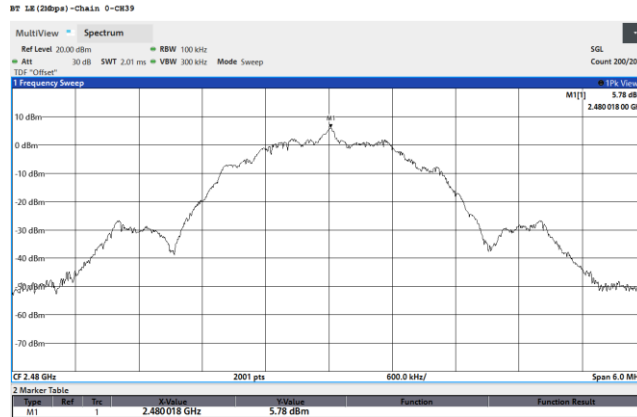


### BT LE(2Mbps), CH19, Chain 0, Bandedge

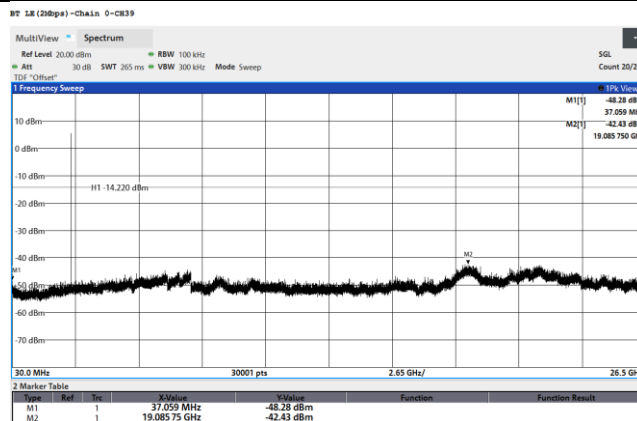




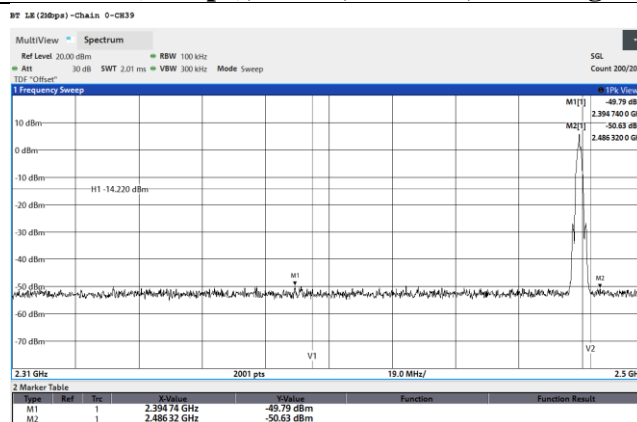
### BT LE(2Mbps), CH39, Chain 0, Reference



### BT LE(2Mbps), CH39, Chain 0, Conducted Emission



### BT LE(2Mbps), CH39, Chain 0, Bandedge



## 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.

## 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.

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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.

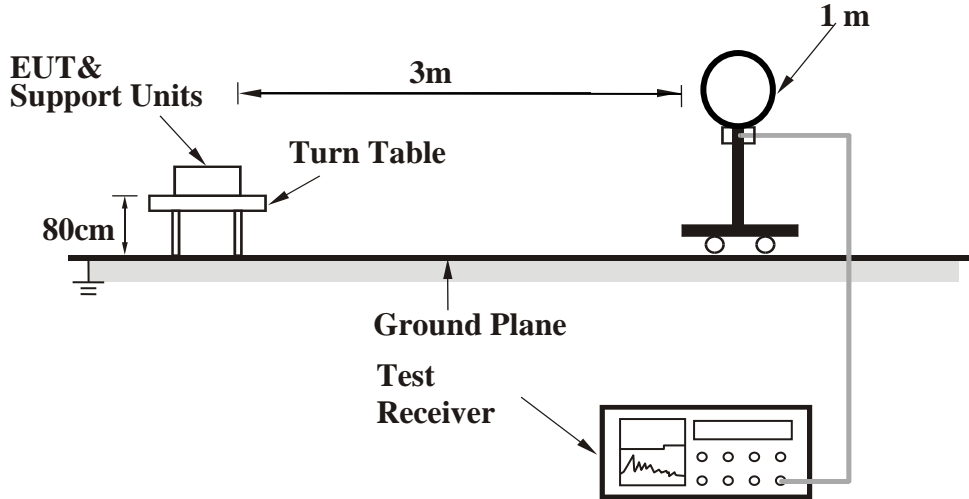
Configuration	Average	
	RBW	VBW
Bluetooth LE	1MHz	Refer to section 6.6 for duty cycle.

- d. All modes of operation were investigated (includes all external accessories) and the worst-case emissions are reported, the other emission levels were low against the limit.
- e. Test data of Result value (dBuV/m) = Reading value (dBuV/m) + Correction Factor (dB/m).
- f. Test data of Margin(dB) = Result value (dBuV/m) - Limit value (dBuV/m).
- g. Test data of Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Loss (dB) - Preamp Factor (dB).
- h. Test data of Notation "@" = Fundamental Frequency
- i. Test data of Notation "\*" = The peak result under 20 dB above and complies with AVG limit, AVG result is deemed to comply with AVG limit.

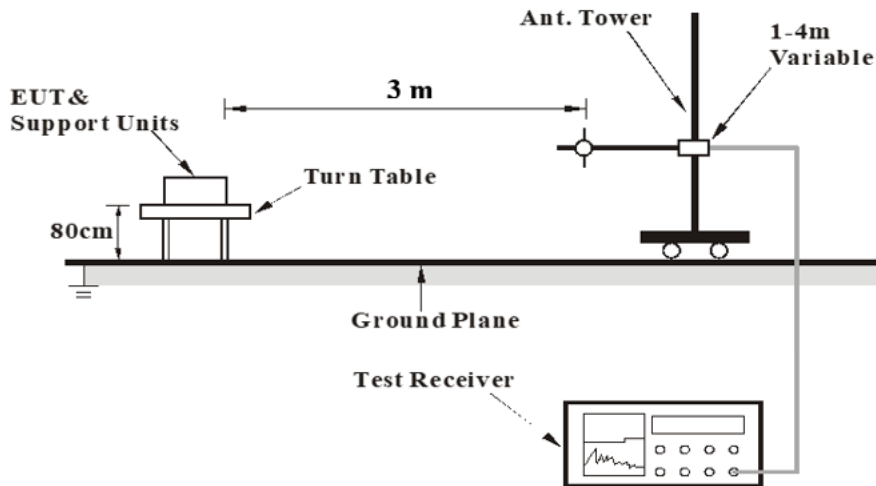
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**Test Setup**

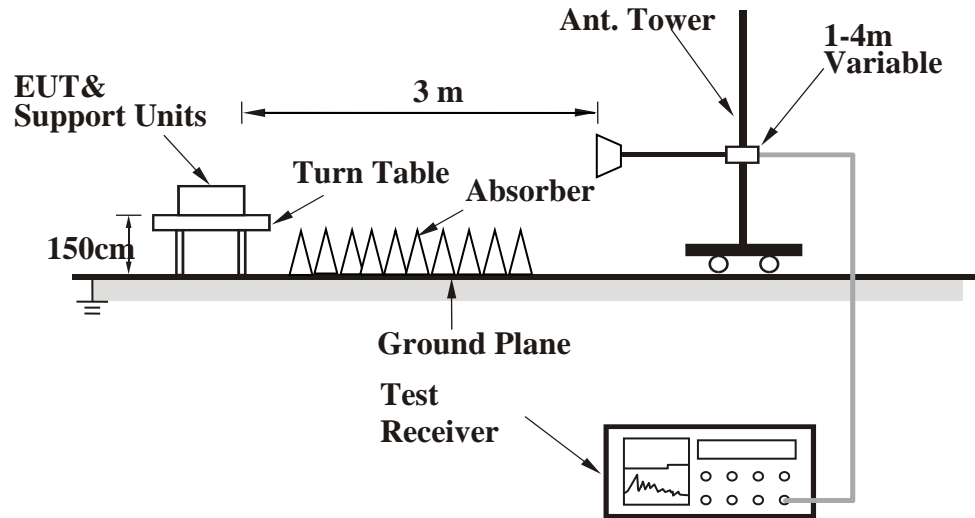
<Frequency Range 9 kHz ~ 30 MHz>



<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 1 GHz**

Mode	BT-LE-1Mbps	Channel	0
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Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		2370.23	31.3	15.9	47.2	54	-6.8	AVG
		2375.55	42	15.89	57.89	74	-16.11	PK
	@	2402	86.99	15.85	102.84	N/A	N/A	PK
	@	2402	86.65	15.85	102.5	N/A	N/A	AVG
	*	4804	36.35	2.14	38.49	74	-35.51	PK
Vertical		2311.71	41.8	15.96	57.76	74	-16.24	PK
		2340.59	31.07	15.96	47.03	54	-6.97	AVG
	@	2402	84.29	15.85	100.14	N/A	N/A	PK
	@	2402	84	15.85	99.85	N/A	N/A	AVG
	*	4804	36.24	2.14	38.38	74	-35.62	PK

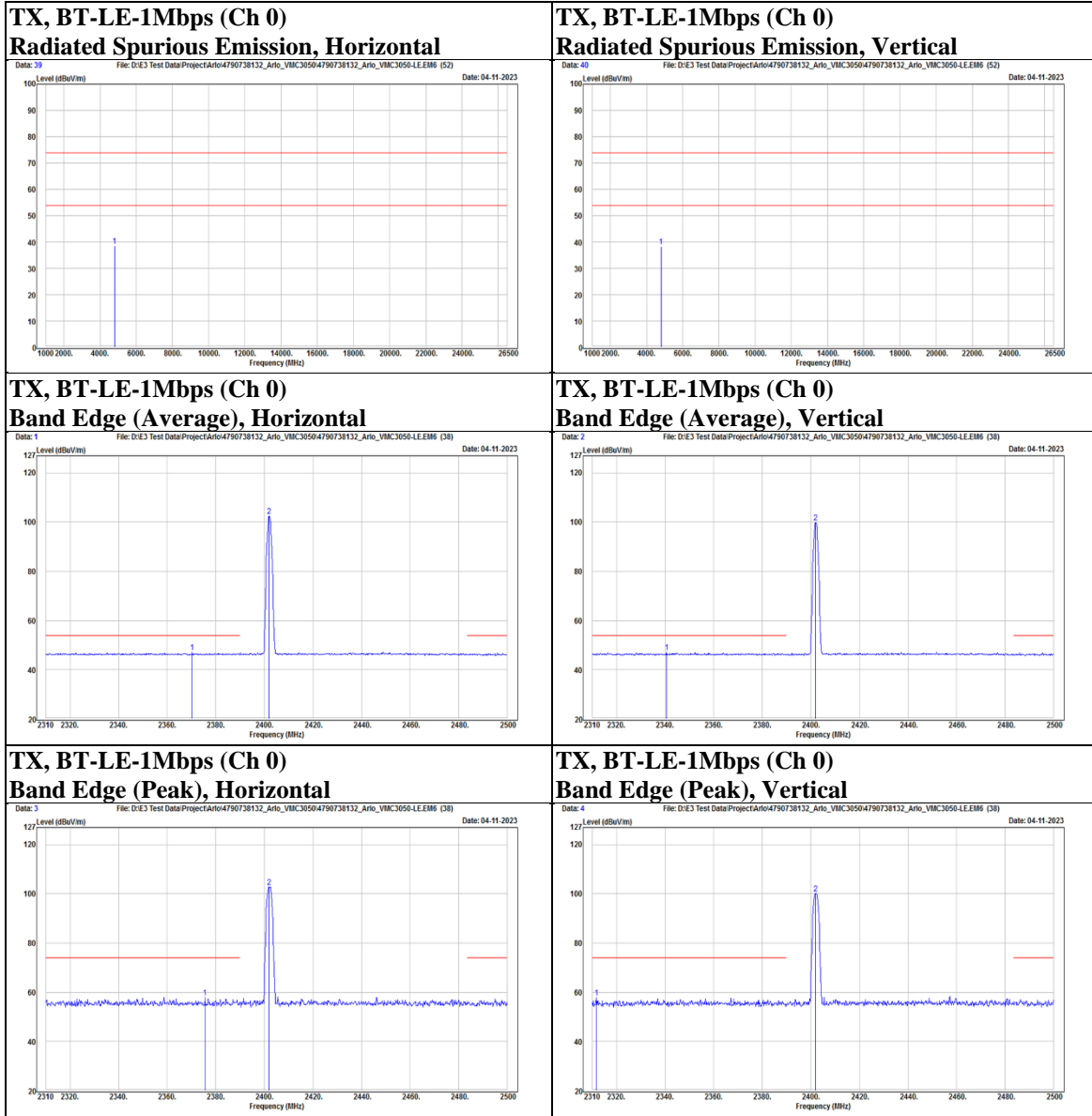
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Mode	BT-LE-1Mbps	Channel	19
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Polarization	Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
		(MHz)	(dBuV)	(dB/m)	(dBuV/m)	(dBuV/m)	(dB)	
Horizontal		2344.01	31.49	15.95	47.44	54	-6.56	AVG
		2359.97	41.37	15.93	57.3	74	-16.7	PK
	@	2440	87.49	15.99	103.48	N/A	N/A	PK
	@	2440	86.75	15.99	102.74	N/A	N/A	AVG
		2485.56	40.78	15.8	56.58	74	-17.42	PK
		2493.92	30.85	15.75	46.6	54	-7.4	AVG
	*	4880	36.73	2.21	38.94	74	-35.06	PK
Vertical		2333.37	41.54	15.95	57.49	74	-16.51	PK
		2387.14	31.05	15.87	46.92	54	-7.08	AVG
	@	2440	83.86	15.99	99.85	N/A	N/A	PK
	@	2440	83.36	15.99	99.35	N/A	N/A	AVG
		2490.12	30.98	15.77	46.75	54	-7.25	AVG
		2491.83	40.61	15.76	56.37	74	-17.63	PK
	*	4880	36.39	2.21	38.6	74	-35.4	PK

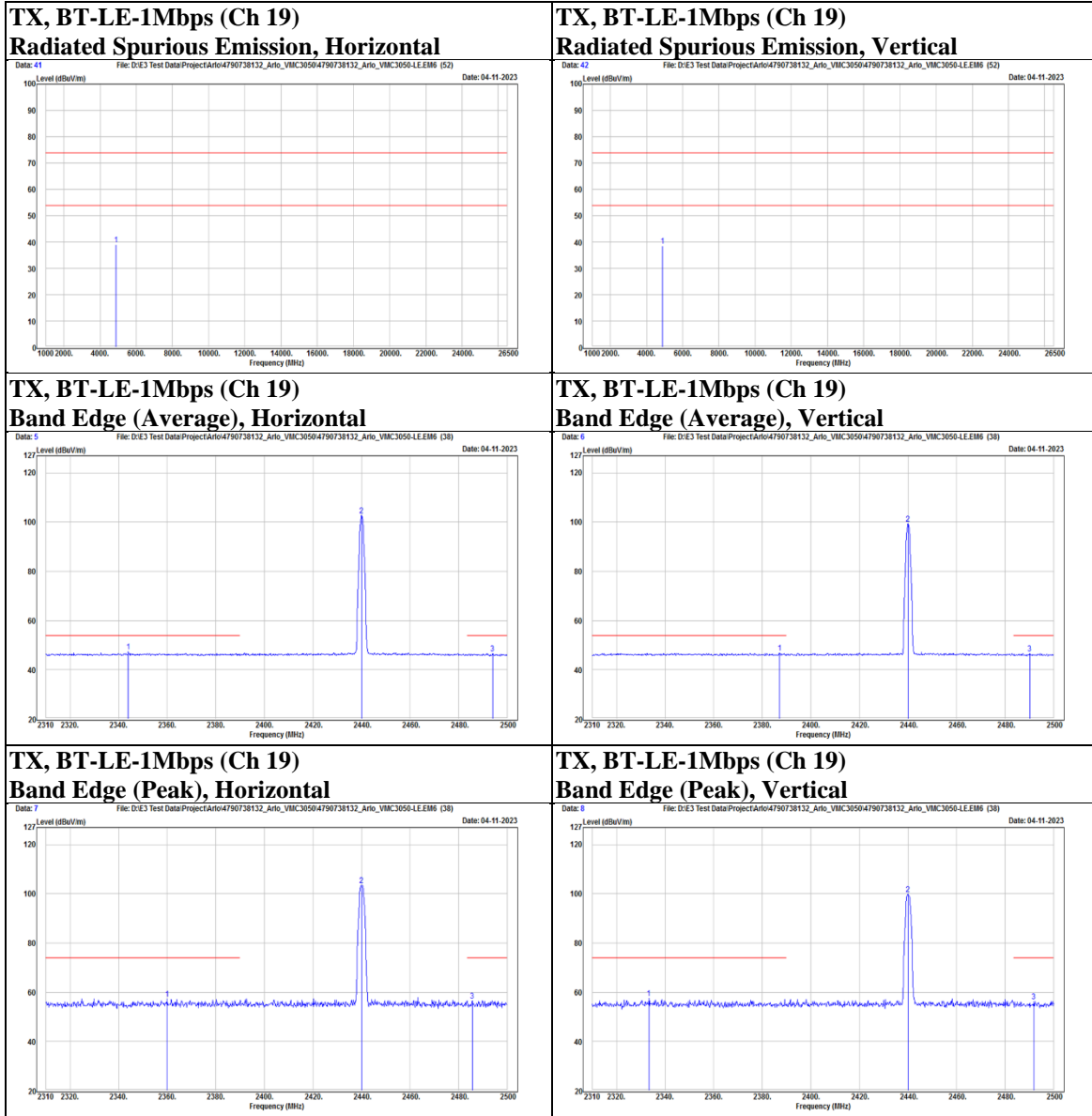
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Mode	BT-LE-1Mbps	Channel	39
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Polarization	Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
		(MHz)	(dBuV)	(dB/m)	(dBuV/m)	(dBuV/m)	(dB)	
Horizontal	@	2480	86.65	15.83	102.48	N/A	N/A	PK
	@	2480	86.26	15.83	102.09	N/A	N/A	AVG
		2484.23	41.31	15.81	57.12	74	-16.88	PK
		2486.89	30.88	15.79	46.67	54	-7.33	AVG
	*	4960	37.38	2.3	39.68	74	-34.32	PK
Vertical	@	2480	81.82	15.83	97.65	N/A	N/A	PK
	@	2480	81.34	15.83	97.17	N/A	N/A	AVG
		2486.32	41.82	15.79	57.61	74	-16.39	PK
		2486.32	31.01	15.79	46.8	54	-7.2	AVG
	*	4960	36.44	2.3	38.74	74	-35.26	PK

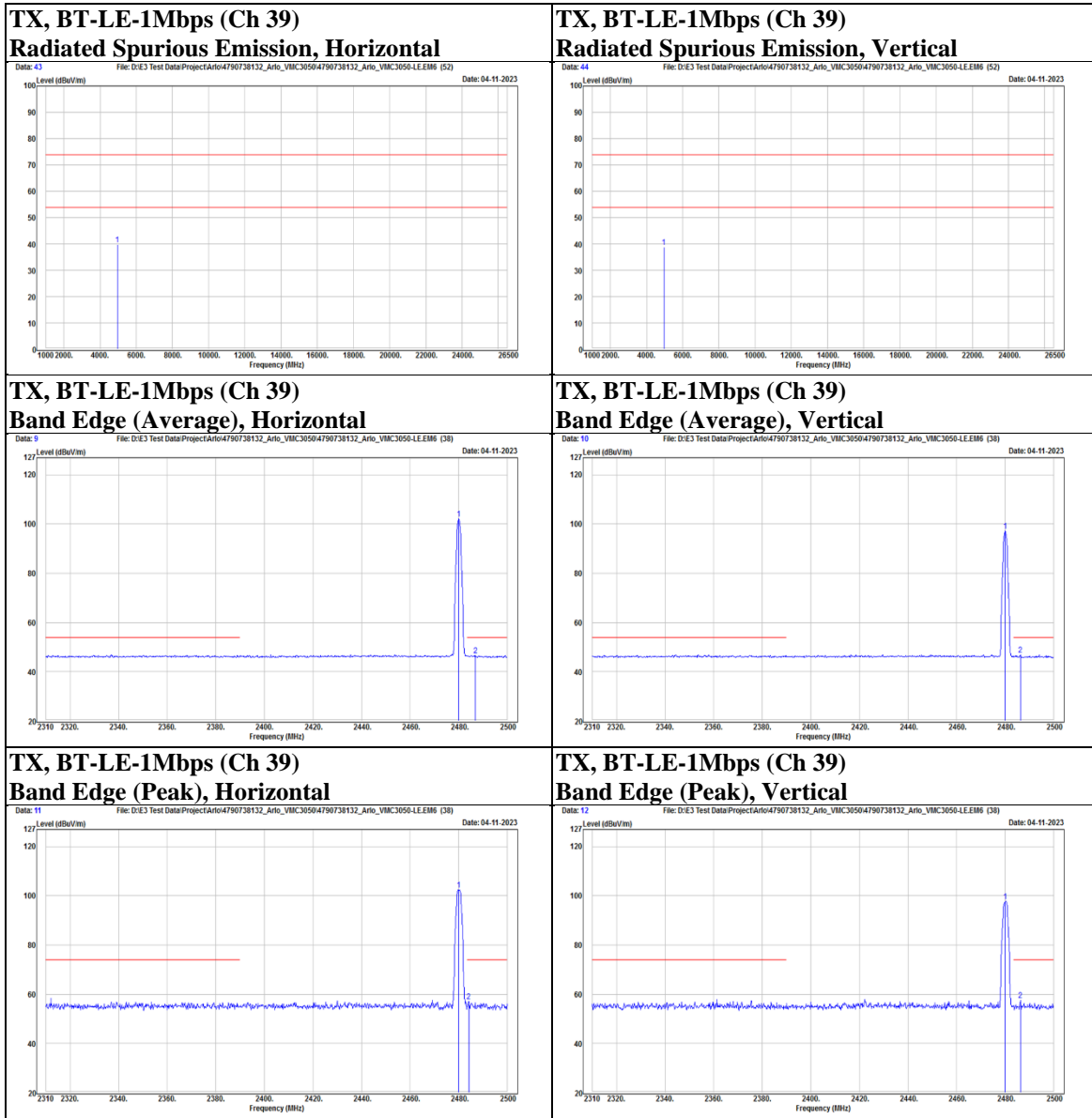
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Mode	BT-LE-2Mbps	Channel	0
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Polarization	Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
		(MHz)	(dBuV)	(dB/m)	(dBuV/m)	(dBuV/m)	(dB)	
Horizontal		2313.42	41.97	15.95	57.92	74	-16.08	PK
		2325.2	30.89	15.96	46.85	54	-7.15	AVG
	@	2402	86.18	15.85	102.03	N/A	N/A	PK
	@	2402	84.86	15.85	100.71	N/A	N/A	AVG
	*	4804	35.96	2.14	38.1	74	-35.9	PK
Vertical		2315.13	41.89	15.96	57.85	74	-16.15	PK
		2372.13	30.97	15.9	46.87	54	-7.13	AVG
	@	2402	84.12	15.85	99.97	N/A	N/A	PK
	@	2402	81.99	15.85	97.84	N/A	N/A	AVG
	*	4804	36.86	2.14	39	74	-35	PK

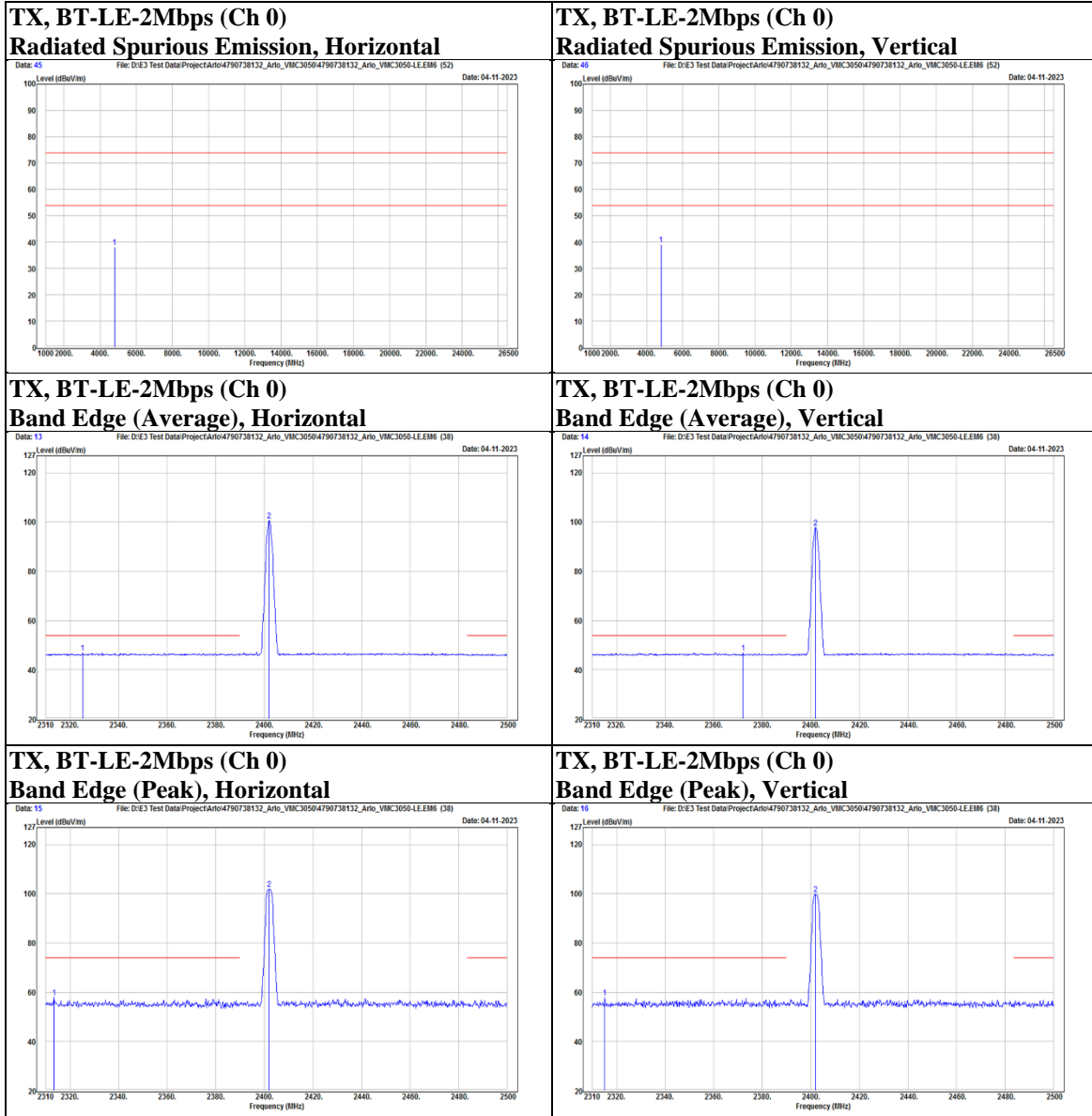
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Mode	BT-LE-2Mbps	Channel	19
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Polarization	Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
		(MHz)	(dBuV)	(dB/m)	(dBuV/m)	(dBuV/m)	(dB)	
Horizontal		2322.92	41.69	15.95	57.64	74	-16.36	PK
		2352.18	30.91	15.95	46.86	54	-7.14	AVG
	@	2440	86.74	15.99	102.73	N/A	N/A	PK
	@	2440	85.48	15.99	101.47	N/A	N/A	AVG
		2488.03	30.78	15.79	46.57	54	-7.43	AVG
		2491.26	42.65	15.76	58.41	74	-15.59	PK
	*	4880	36.56	2.21	38.77	74	-35.23	PK
Vertical		2321.59	30.68	15.96	46.64	54	-7.36	AVG
		2341.92	41.29	15.96	57.25	74	-16.75	PK
	@	2440	82.84	15.99	98.83	N/A	N/A	PK
	@	2440	80.62	15.99	96.61	N/A	N/A	AVG
		2489.17	40.8	15.78	56.58	74	-17.42	PK
		2495.44	30.81	15.74	46.55	54	-7.45	AVG
	*	4880	36.32	2.21	38.53	74	-35.47	PK

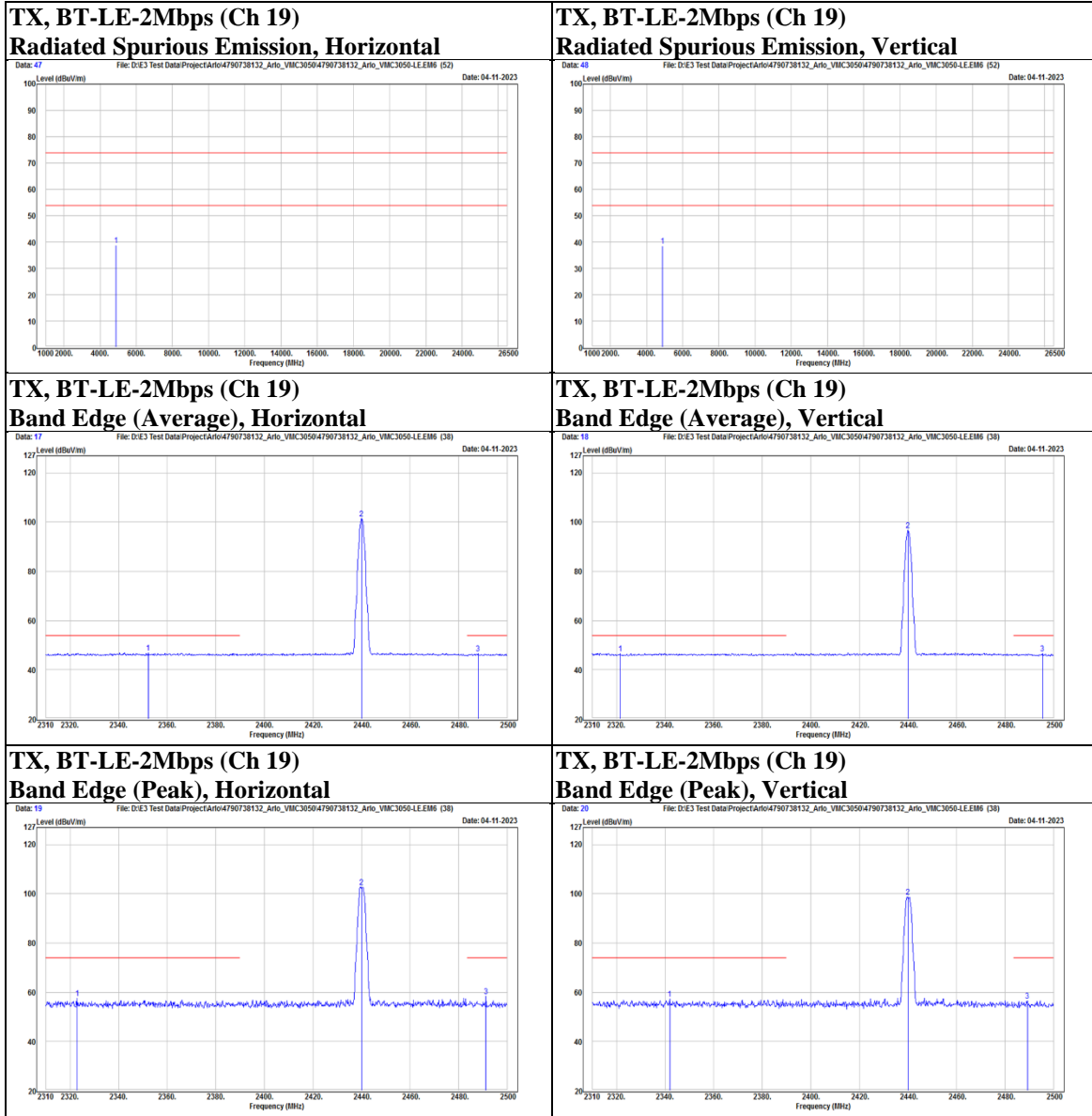
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Mode	BT-LE-2Mbps	Channel	39
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Polarization	Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
		(MHz)	(dBuV)	(dB/m)	(dBuV/m)	(dBuV/m)	(dB)	
Horizontal	@	2480	86.13	15.83	101.96	N/A	N/A	PK
	@	2480	84.01	15.83	99.84	N/A	N/A	AVG
		2490.12	30.82	15.77	46.59	54	-7.41	AVG
		2494.49	41.6	15.74	57.34	74	-16.66	PK
	*	4960	36.83	2.3	39.13	74	-34.87	PK
Vertical	@	2480	81.21	15.83	97.04	N/A	N/A	PK
	@	2480	78.38	15.83	94.21	N/A	N/A	AVG
		2484.23	30.59	15.81	46.4	54	-7.6	AVG
		2485.94	40.79	15.79	56.58	74	-17.42	PK
	*	4960	36.74	2.3	39.04	74	-34.96	PK

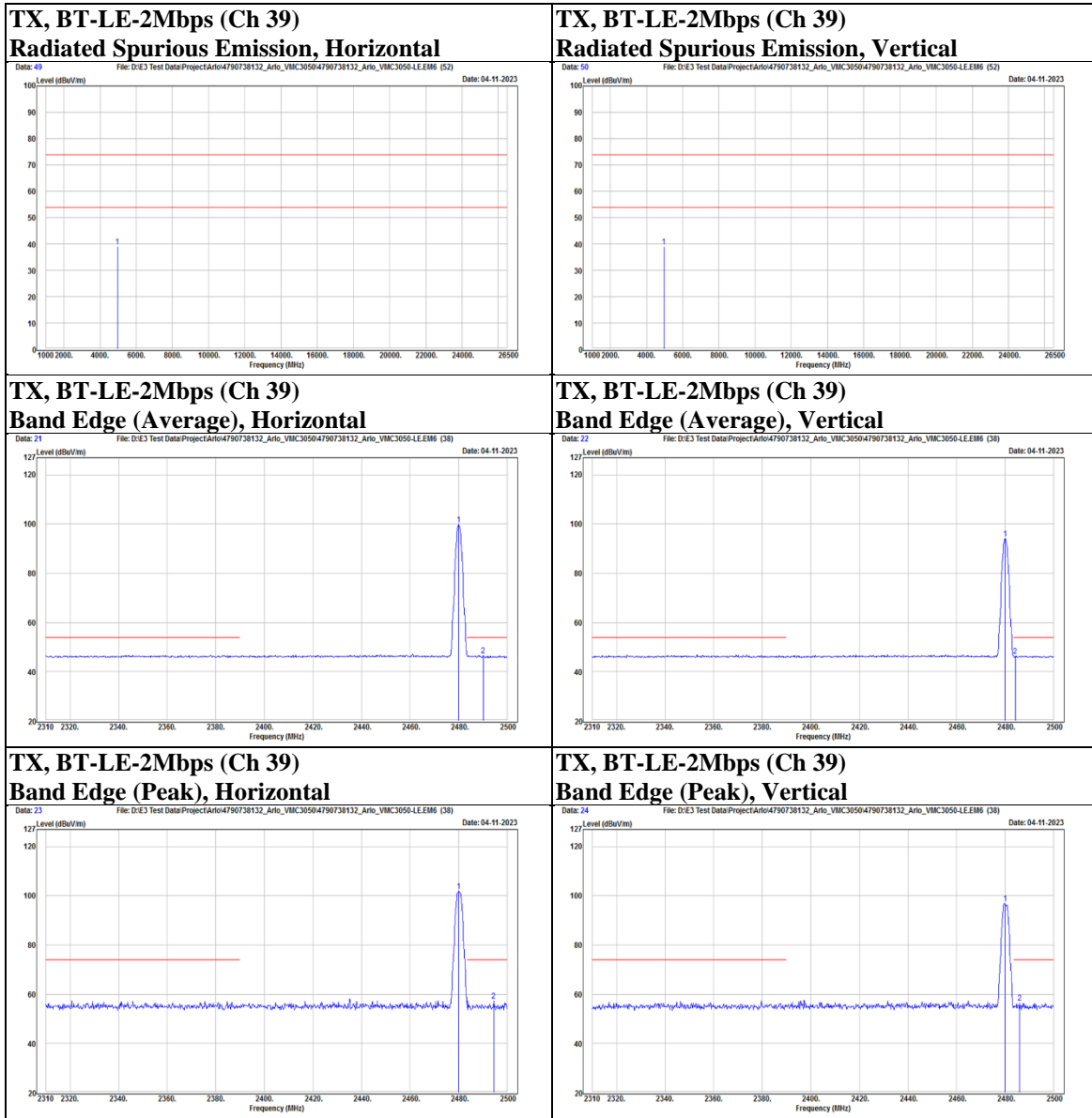
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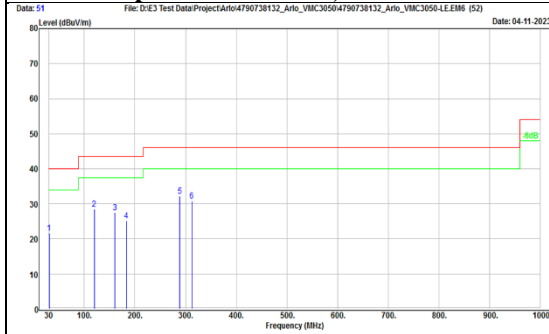
**Below 1 GHz**

Mode	BT-LE-1Mbps	Channel	19
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Polarization	Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
		(MHz)	(dBuV)	(dB/m)	(dBuV/m)	(dBuV/m)	(dB)	
Horizontal		30.97	34.56	-12.86	21.7	40	-18.3	PK
		120.21	42.52	-14.02	28.5	43.5	-15	PK
		160.95	39.09	-11.49	27.6	43.5	-15.9	PK
		183.26	38.32	-13.06	25.26	43.5	-18.24	PK
		288.99	43.08	-10.96	32.12	46	-13.88	PK
		312.27	41.08	-10.32	30.76	46	-15.24	PK
Vertical		35.82	39.65	-13.06	26.59	40	-13.41	PK
		120.21	36.93	-14.02	22.91	43.5	-20.59	PK
		173.56	39.18	-12.05	27.13	43.5	-16.37	PK
		225.94	36.29	-14.22	22.07	46	-23.93	PK
		312.27	33.86	-10.32	23.54	46	-22.46	PK
		340.4	35.39	-9.54	25.85	46	-20.15	PK

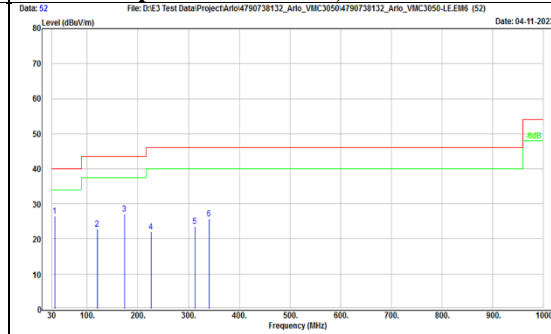
**TX, BT-LE-1Mbps (Ch 19)**

**Radiated Spurious Emission, Horizontal**



**TX, BT-LE-1Mbps (Ch 19)**

**Radiated Spurious Emission, Vertical**



**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.

## 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.

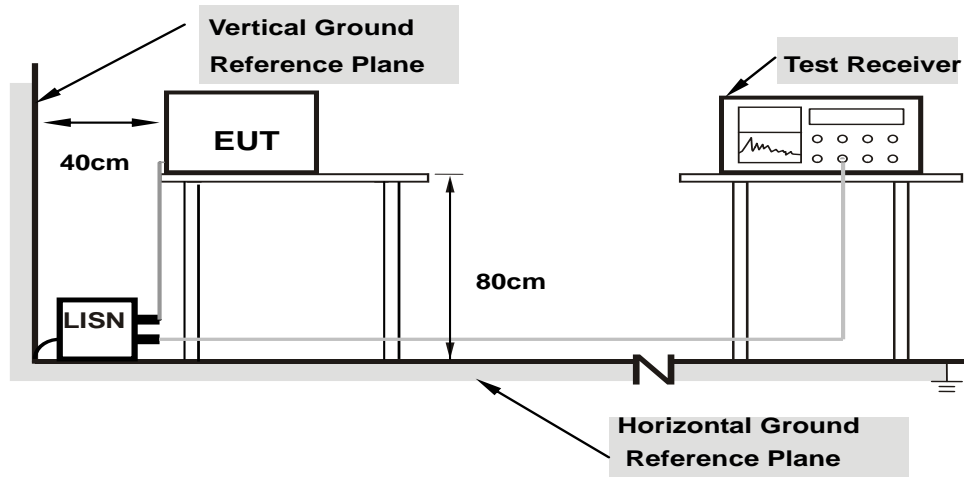
NOTE:

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.
2. All modes of operation were investigated (includes all external accessories) and the worst-case emissions are reported, the other emission levels were low against the limit.
3. Test data of Result value (dBuV) = Reading value (dBuV) + Correction Factor (dB).
4. Test data of Margin(dB) = Result value (dBuV) - Limit value (dBuV).
5. Test data of Correction Factor (dB) = Insertion loss(dB) + Cable loss(dB).

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## Test Setup

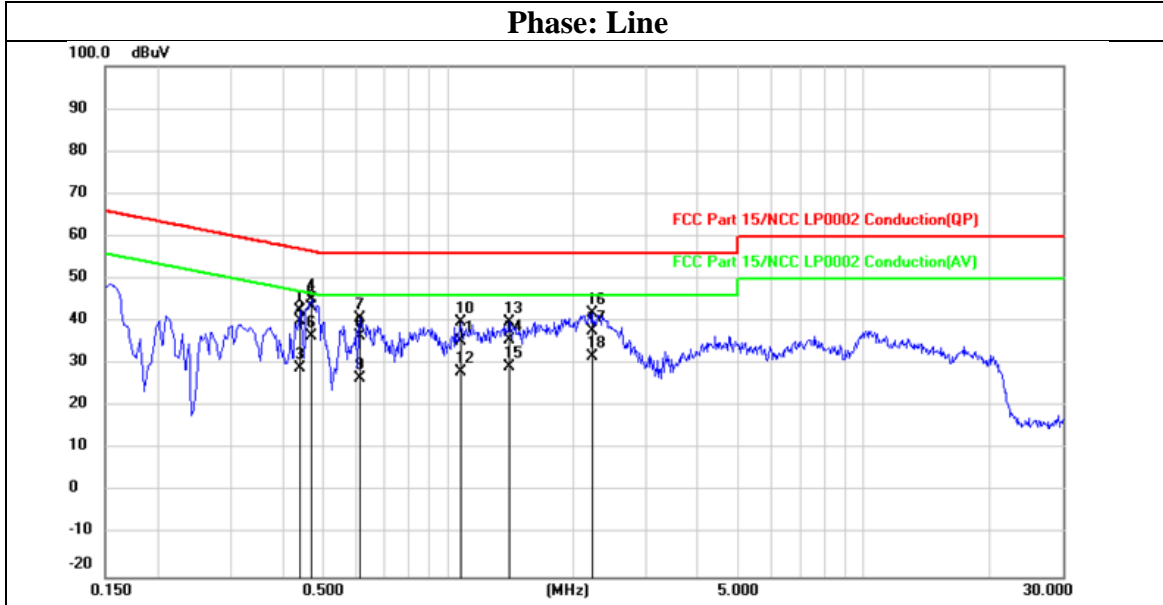


**Note: 1.Support units were connected to second LISN.**

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

### Test Data

Mode	LE1M_TX2440	Channel	19
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No.	Frequency (MHz)	Reading (dBuV)	Correct (dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Remark
1	0.4420	32.67	10.01	42.68	57.02	-14.34	peak
2	0.4420	30.16	10.01	40.17	57.02	-16.85	QP
3	0.4420	19.15	10.01	29.16	47.02	-17.86	AVG
4	0.4700	35.16	10.01	45.17	56.51	-11.34	peak
5	0.4700	33.37	10.01	43.38	56.51	-13.13	QP
6	0.4700	26.60	10.01	36.61	46.51	-9.90	AVG
7	0.6140	30.69	10.01	40.70	56.00	-15.30	peak
8	0.6140	26.64	10.01	36.65	56.00	-19.35	QP
9	0.6140	16.63	10.01	26.64	46.00	-19.36	AVG
10	1.0740	29.68	10.03	39.71	56.00	-16.29	peak
11	1.0740	25.30	10.03	35.33	56.00	-20.67	QP
12	1.0740	18.05	10.03	28.08	46.00	-17.92	AVG
13	1.4100	29.82	10.05	39.87	56.00	-16.13	peak
14	1.4100	25.73	10.05	35.78	56.00	-20.22	QP
15	1.4100	19.19	10.05	29.24	46.00	-16.76	AVG
16	2.2260	31.98	10.07	42.05	56.00	-13.95	peak
17	2.2260	27.58	10.07	37.65	56.00	-18.35	QP
18	2.2260	21.73	10.07	31.80	46.00	-14.20	AVG

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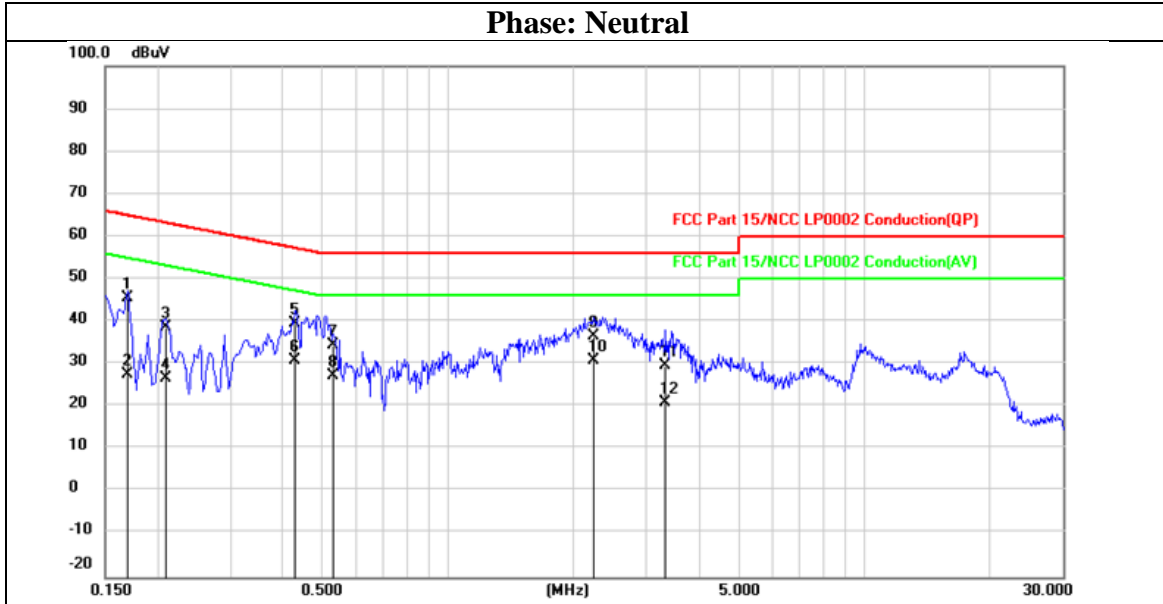
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Mode	LE1M_TX2440	Channel	19
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No.	Frequency	Reading	Correct	Result	Limit	Margin	Remark
	(MHz)	(dBuV)	(dB)	(dBuV)	(dBuV)	(dB)	
1	0.1700	35.46	10.00	45.46	64.96	-19.50	QP
2	0.1700	17.55	10.00	27.55	54.96	-27.41	AVG
3	0.2100	28.75	9.99	38.74	63.21	-24.47	QP
4	0.2100	16.55	9.99	26.54	53.21	-26.67	AVG
5	0.4300	29.58	10.00	39.58	57.25	-17.67	QP
6	0.4300	20.77	10.00	30.77	47.25	-16.48	AVG
7	0.5299	24.53	10.00	34.53	56.00	-21.47	QP
8	0.5299	17.23	10.00	27.23	46.00	-18.77	AVG
9	2.2380	26.63	10.06	36.69	56.00	-19.31	QP
10	2.2380	20.66	10.06	30.72	46.00	-15.28	AVG
11	3.3420	19.42	10.09	29.51	56.00	-26.49	QP
12	3.3420	10.85	10.09	20.94	46.00	-25.06	AVG

## END OF REPORT

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