RADIO TEST REPORT

Product	:	WLAN and BT Wireless Module
Model Name	:	WBU058-BGA-V11
Series Model	:	WBU058-BGA-V13, WBU058-BGA-V15
FCC ID	:	RX3-WBU058BGA
Test Regulation	:	FCC 47 CFR Part 15 Subpart C (Section 15.247)
Received Date	:	2024/8/9
Test Date	:	2024/08/13 ~ 2024/09/06
Issued Date	:	2024/10/7

Applicant	:	Hon Hai Precision Industry Co., Ltd. No.151, Sec. 1, Nankan Rd., Lujhu Dist.,Taoyuan City 33859, Taiwan
Issued By	:	Underwriters Laboratories Taiwan Co., Ltd. Building A, B and E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan

Testing Laboratory
3398

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REVISION HISTORY

Original Test Report No.: 4791426387A-US-R5-V0

Revision	Test report No.	Date	Page revised	Contents
Original	4791426387A-US-R5-V0	2024/10/7	-	Initial issue

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1. Attestation of Test Results

APPLICANT:	Hon Hai Precision Industry Co., Ltd. No.151, Sec. 1, Nankan Rd., Lujhu Dist.,Taoyuan City 33859, Taiwan
MANUFACTURER:	HON HAI PRECISION IND. CO., LTD No.151, Sec. 1, Nankan Rd., Lujhu Dist.,Taoyuan City 33859, Taiwan
EUT DESCRIPTION:	WLAN and BT Wireless Module
BRAND:	FOXCONN
MODEL:	WBU058-BGA-V11
SERIES MODEL:	WBU058-BGA-V13, WBU058-BGA-V15
SAMPLE STAGE:	Engineering Verification Test Sample
DATE of TESTED:	2024/08/13 ~ 2024/09/06

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. 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 Date : 2024/10/7
Project Handler

Approved and Authorized By:

Eric Lee Date : 2024/10/7
Senior Laboratory Engineer

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

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 and KDB 662911 D01 Multiple Transmitter Output v02r01.

4. Facilities and Accreditation

Test Location	Underwriters Laboratories Taiwan Co., Ltd.
Address	Building A, B and E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan
Accreditation Certificate	Underwriters Laboratories Taiwan Co., Ltd. is accredited by TAF, Laboratory Code 3398.

5. Measurement Uncertainty

For statement of conformity, Simple acceptance (Section 3.1.4 of IEC 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	3.1 dB
RF Conducted	9 kHz - 40GHz	2.3 dB
Radiated disturbance below 30MHz	9 kHz - 30 MHz	3.2 dB
Radiated disturbance below 1 GHz	30MHz ~ 1GHz	6.1 dB
Radiated disturbance above 1 GHz	1GHz ~ 40GHz	5.1 dB

6. Equipment under Test

6.1. Description of EUT

Product	WLAN and BT Wireless Module
Brand Name	FOXCONN
Model Name	WBU058-BGA-V11
Series Model	WBU058-BGA-V13, WBU058-BGA-V15
Normal Voltage	3.3Vdc from Host

Operating Frequency	2402MHz ~ 2480MHz
Modulation	GFSK
Transfer Rate	Up to 2 Mbps
Maximum Output Power	8.09 dBm
Sample ID	Conducted Test:7472206
	Radiated Test:7528177

Note:

1. The differences between the models are shown in the table below.:

Model	Light Sensor	IR	Power Switch	Thermal Sensor	MIC
WBU058-BGA-V11	V	V	V	-	-
WBU058-BGA-V13	V	V	V	V	-
WBU058-BGA-V15	V	V	V	-	V

2. 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 for BT-LE mode:

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	Input Power	Test Date	Tested by
Antenna Port Conducted Measurement	SR4	23~25℃/ 63~67%RH	3.3Vdc	2024/08/20~ 2024/09/06	Rex Chen/ Jubo Shen
Radiated Spurious Emission	966-2	22~26℃/ 62~68%RH	3.3Vdc	2024/08/13~ 2024/08/28	Rex Chen
AC power Line Conducted Emission	SR1	24℃/ 62%RH	120Vac/ 60Hz	2024/08/21	Rex Chen

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).

6.4. Description of Available Antennas

Ant. No.	Transmitter Circuit	Frequency Range	Brand Name	Model Name	Maximum Gain (dBi)	Ant. Type	Connector Type
BT ANT1	Chain0	2.4~2.4835GHz	FOXCONN	WBU058-BGA	2.81	Printing	N/A
BT ANT2	Chain1	2.4~2.4835GHz	FOXCONN	WBU058-BGA	1.53	Printing	N/A

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

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	39	1 Mbps
AC Power Line Conducted Emission	GFSK	0 to 39	39	1 Mbps
Antenna Port Conducted Measurement	GFSK	0 to 39	0,19,39	1 Mbps
	GFSK			2 Mbps

- The fundamental of the EUT was investigated in three orthogonal axes X-Y/Y-Z/X-Z, it was determined that X-Y plane was worst-case. Therefore, all final radiated testing was performed with the EUT in X-Y plane.

  The antenna BT ANT1 has the highest gain, therefore, the fundamental of the EUT was investigated in this antenna. It determined that the antenna BT ANT1 was worst-case, and the BT ANT1 was selected for the final test.

  The EUT has 3 types of Models: WBU058-BGA-V11, WBU058-BGA-V13, and WBU058-BGA-V15, The above Model was pre-tested radiated emission, the worst case was found in Model: WBU058-BGA-V11, and therefore only the worst case test data was recorded in this report.

- In the transmit mode, GFSK 1 Mbps channel 39 has the highest RF output power. Therefore, the AC conduction were performed using this worst-case mode.

- In the transmit mode, GFSK 1 Mbps channel 39 has the highest RF output power. Therefore, all final tests for the spurious emission (below 1GHz) were performed using this worst-case mode.

- 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.

Simultaneously transmission condition:

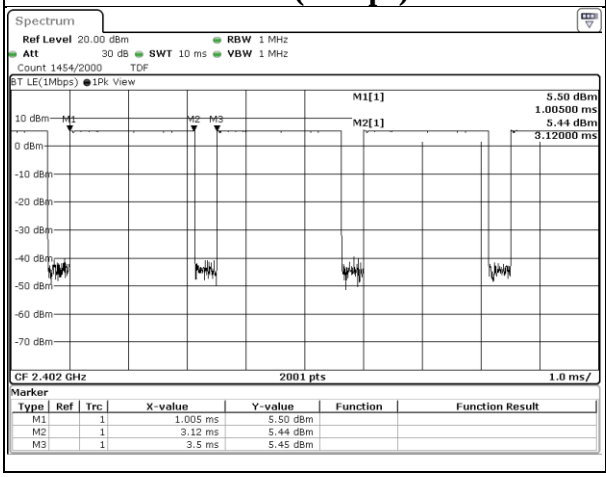
Condition	Technology	
1	BT LE	WLAN (2.4GHz)
2	BT LE	WLAN (5GHz)
3	BT LE	WLAN (6GHz)

Note: The emission of the simultaneous operation has been evaluated and no non-compliance was found.

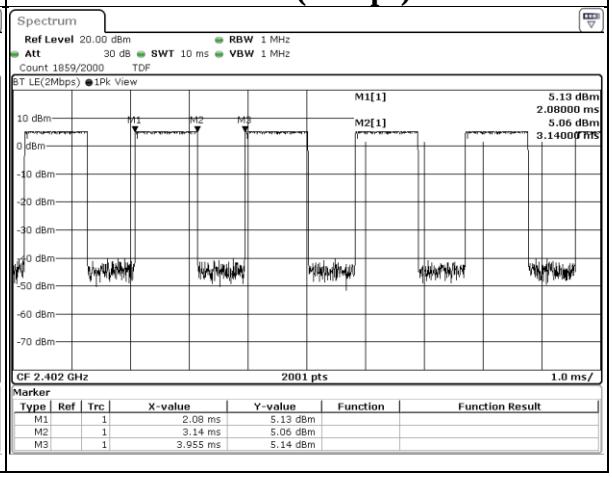
6.6. Duty cycle

Mode	On Time (ms)	On+Off Time (ms)	Duty Cycle	Duty Factor (dB)	VBW Set (above 1GHz)
BT LE(1Mbps)	2.115	2.495	0.8477	0.72	510Hz
BT LE(2Mbps)	1.060	1.875	0.5653	2.48	1kHz

BT LE(1Mbps)



BT LE(2Mbps)



7. Test Equipment

Test Equipment List					
Equipment	**Manufacturer**	**Model No.**	**Serial No.**	**Cal. Date**	**Expired date**
Radiated Spurious Emission					
Spectrum Analyzer	Keysight	N9010A	MY56070827	2024/3/29	2025/3/28
EMI Test Receiver	Rohde & Schwarz	ESR7	101754	2023/11/22	2024/11/21
Loop Antenna	ETS lindgren	6502	00213440	2023/12/13	2024/12/12
Trilog-Broadband Antenna with 5dB Attenuator	Schwarzbeck & EMCI	VULB 9168 & N-6-05	774 & AT-N0538	2024/1/5	2025/1/4
Horn Antenna (1-18 GHz)	Schwarzbeck	BBHA 9120 D	01690	2023/12/8	2024/12/7
Horn Antenna (18-40 GHz)	Schwarzbeck	BBHA 9170	781	2023/12/27	2024/12/26
Preamplifier (30-1000 MHz)	EMCI	EMC330E	980405	2024/5/28	2025/5/27
Preamplifier (1-18 GHz)	EMCI	EMC051835BE	980406	2024/1/23	2025/1/22
Preamplifier (18-40GHz)	EMCI	EMC184040SEE	980426	2024/4/16	2025/4/15
Cables (9k-18 GHz)	Hanyitek	K1K50-UP0264-K1K50-2500	170214-4 & 170425-2	2023/11/29	2024/11/28
Cables (18-40GHz)	Hanyitek	K1K50-UP0264-K1K50-2500	170214-1 & 170214-2	2023/11/29	2024/11/28

Test Equipment List					
Equipment	**Manufacturer**	**Model No.**	**Serial No.**	**Cal. Date**	**Expired date**
Antenna Port Conducted Measurement					
Signal Analyzer	Rohde & Schwarz	FSVA3044	101281	2024/3/18	2025/3/17
Signal Analyzer	Rohde & Schwarz	FSV40	101490	2023/9/13	2024/9/12
Attenuator	EMCI	EMC-40ATK2W10	17002	2023/11/15	2024/11/14
USB Power Sensor	Anritsu	MA24408A	12031	2024/7/13	2025/7/12
Temperature &Humidity Test Chamber	GIANT FORCE	GTH-150- 40-CP-AR	MAA1701-010	2024/3/6	2025/3/5
AC power Line Conducted Emission					
EMI Test Receiver	Rohde & Schwarz	ESR7	101753	2023/10/23	2024/10/22
Two-Line V-Network	Rohde & Schwarz	ENV216	102136	2024/5/14	2025/5/13
Impuls-Begrenzer Pulse Limiter	Rohde & Schwarz	ESH3-Z2	102219-Qt	2023/9/7	2024/9/6
Cables	TITAN	CFD200	T0732ACFD 20020A300-2	2024/5/14	2025/5/13

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_EMC	UL-3A1.2

8. Description of Test Setup

Tx Mode

Support Equipment

ID	Equipment	Brand Name	Model Name	S/N	Remark
A	Laptop	DELL	Latitude E5470	3JFKWF2	Provided by Lab
B	DC Power Supply	Gwinstek	GPD-2303S	N/A	Provided by Lab

I/O Cables

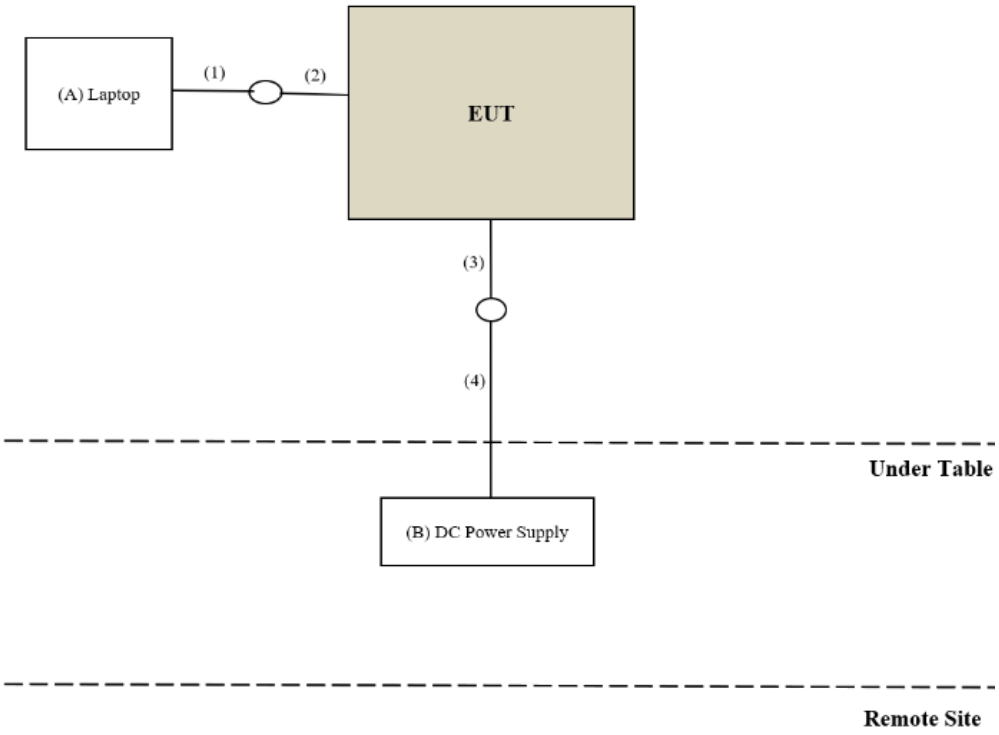
ID	Equipment	Brand Name	Model Name	Length (m)	Remark
1	USB Cable	UGREEN	VW-1	0.53	Supplied by client
2	DC Cable	TAYA	PT0020-2	0.1	Supplied by client
3	DC Cable	TAYA	PT0020-2	0.1	Supplied by client
4	DC Cable	TAYA	PT0020-2	2	Provided by Lab

Test Setup

Controlled using a bespoke application (WCN Combo Tool Ver 2.2036.00) 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

Tx Mode



9. Test Results

9.1. 6dB Bandwidth

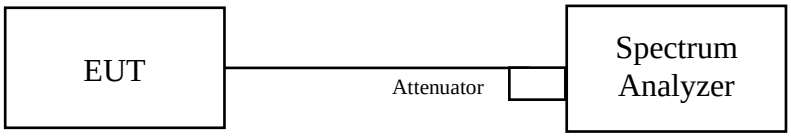
Requirements

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

Test procedure

a. Set resolution bandwidth (RBW) = 100kHz.
b. Set the video bandwidth (VBW) ≥ 3 x RBW, Detector = Peak.
c. Trace mode = max hold.
d. Sweep = auto couple.
e. 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

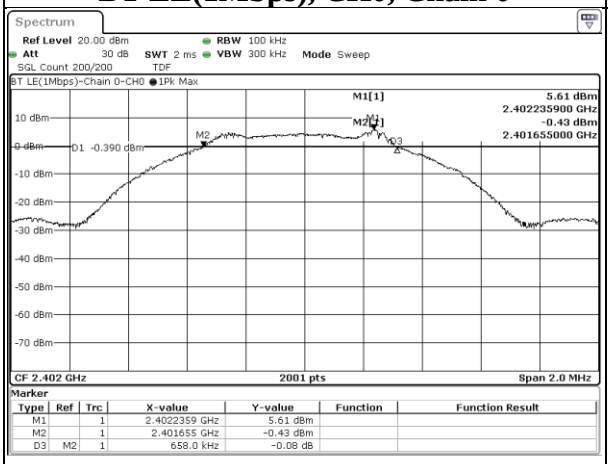


The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

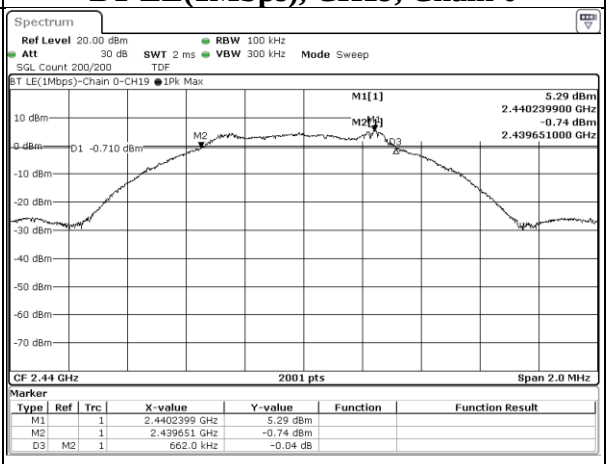
Test Data

Mode	CH	Freq (MHz)	6dB BW (MHz)	Limit (MHz)	Result
BT LE(1Mbps)	0	2402	0.658	0.5	PASS
BT LE(1Mbps)	19	2440	0.662	0.5	PASS
BT LE(1Mbps)	39	2480	0.661	0.5	PASS
BT LE(2Mbps)	0	2402	1.154	0.5	PASS
BT LE(2Mbps)	19	2440	1.164	0.5	PASS
BT LE(2Mbps)	39	2480	1.236	0.5	PASS

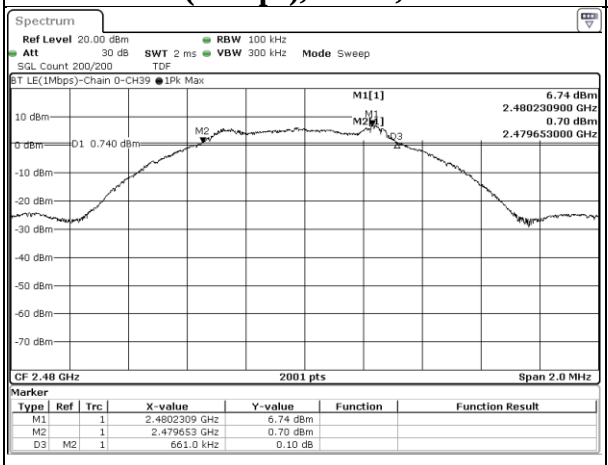
BT LE(1Mbps), CH0, Chain 0



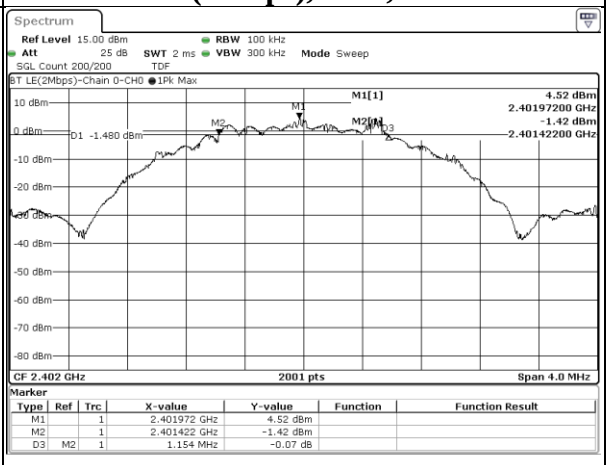
BT LE(1Mbps), CH19, Chain 0



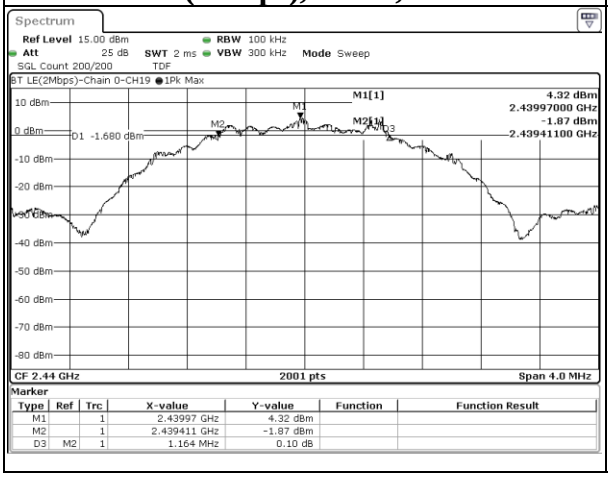
BT LE(1Mbps), CH39, Chain 0



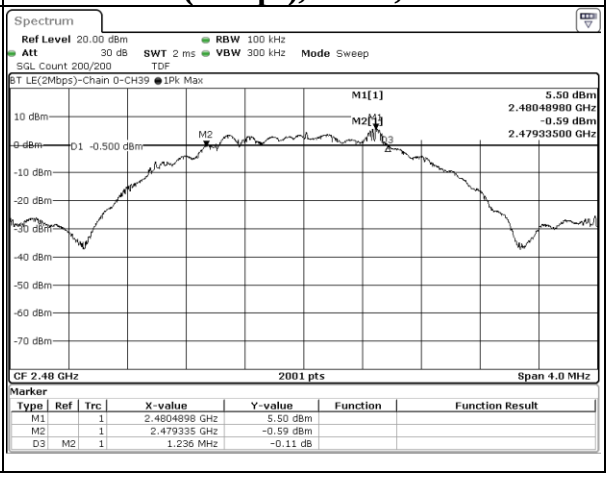
BT LE(2Mbps), CH0, Chain 0



BT LE(2Mbps), CH19, Chain 0



BT LE(2Mbps), CH39, Chain 0



9.2. Conducted Output Power

Requirements

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

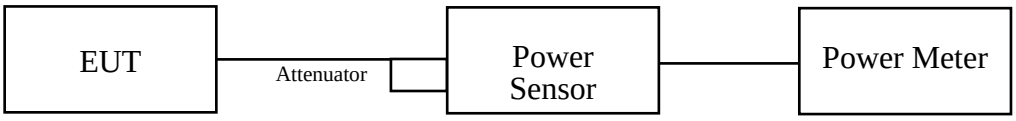
Note:
1. P_{Out} = maximum conducted output power in dBm, G_{TX} = the maximum transmitting antenna directional gain in dBi, B is the 26 dB emission bandwidth in megahertz
2. If EUT with Multiple Transmitter Output:
   a. Directional Gain = 10 log[($10^{G1/20}$ + $10^{G2/20}$ +...+$10^{Gn/20}$)^2 / Nant] dBi.
   Nant: Number of Transmit Antennas
   G1, G2,..., Gn: Gain of Individual Antennas
   Example: two antenna and gain 5 dBi / 3dBi, so if it was used for TxBF power measurement
   Directional Gain = 10 log[(105/20 + 103/20)2 / 2] dBi = 7.07 dBi
   b. Per KDB 662911 Method of conducted output power measurement on IEEE 802.11 devices, CDD
   Array Gain = 0 dB (i.e., no array gain) for NANT ≤ 4;
   Array Gain = 0 dB (i.e., no array gain) for channel widths ≥ 40 MHz for any NANT;
   Array Gain = 5 log(NANT/NSS) dB or 3 dB, whichever is less for 20-MHz channel widths with NANT ≥ 5.
   Example: Maximum antenna gain = 5 dBi and NANT ≤ 4, so if it was used for CDD power measurement
   Directional Gain = 5 dBi + Array Gain = 5 dBi + 0 dB = 5 dBi
   c. For power measurement of KDB 662911 is used with multiple transmitter output. Total conducted power is the sum of the conducted power levels measured at the various output ports.

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.

a. Set the RBW ≥ DTS bandwidth.
b. Set VBW ≥ 3 × RBW.
c. Set span ≥ 3 x RBW.
d. Sweep time = auto couple.
e. Detector = peak.
f. Trace mode = max hold.
g. Allow trace to fully stabilize.
h. Use peak marker function to determine the peak amplitude 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

Mode	CH	Freq. (MHz)	Peak Power (dBm) Chain 0	Total Power (mW)	Total Power (dBm)	AVG Power (dBm) Chain 0	Total Power (mW)	Total Power (dBm)	Limit (dBm)	Result
BT LE(1Mbps)	0	2402	6.88	4.875	6.88	6.72	4.699	6.72	30	Pass
	19	2440	6.72	4.699	6.72	6.53	4.498	6.53	30	Pass
	39	2480	8.09	6.442	8.09	7.99	6.295	7.99	30	Pass
BT LE(2Mbps)	0	2402	6.87	4.864	6.87	6.71	4.688	6.71	30	Pass
	19	2440	6.79	4.775	6.79	6.6	4.571	6.6	30	Pass
	39	2480	8.03	6.353	8.03	7.89	6.152	7.89	30	Pass

Note: Average Power is for reference Only.

9.3. Power Spectral Density

Requirements

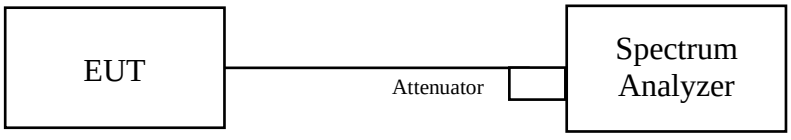
The Maximum of Power Spectral Density Measurement is 8dBm in any 3 kHz (If G_{TX} > 6 dBi, then PSD = 8 – (G_{TX} – 6)).

Note:
1. PSD = power spectral density that he same method as used to determine the conducted output power shall be used to determine the power spectral density. And power spectral density in dBm/MHz.
2. G_{TX} = the maximum transmitting antenna directional gain in dBi.
3. If EUT with Multiple Transmitter Output:
   a. Directional Gain = 10 log[($10^{G1/20}$ + $10^{G2/20}$ +...+$10^{Gn/20}$)^2 / Nant] dBi.
   Nant: Number of Transmit Antennas
   G1, G2,..., Gn: Gain of Individual Antennas
   Example: two antenna and gain 5 dBi / 3dBi, so if it was used for power density measurement
   Directional Gain = 10 log[($10^{5/20}$ + $10^{3/20}$)^2 / 2] dBi = 7.07 dBi
   b. "PSD per chain" of the report shown is maximum value for each chain, at the "Total PSD" is summing entire spectra across corresponding frequency bins on the various outputs by computer, refer KDB 662911 Method a) for calculating total power density.
   c. Method a) of power density measurement of KDB 662911 is used for calculating total power density with multiple transmitter output. Total power density is summing entire spectra across corresponding frequency bins on the various outputs by computer.

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 kHz ≤ RBW ≤ 100 kHz.
d. Set the VBW ≥ 3 × 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

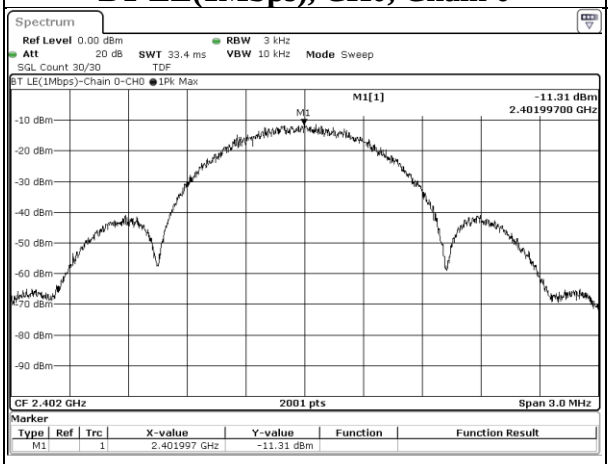


The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

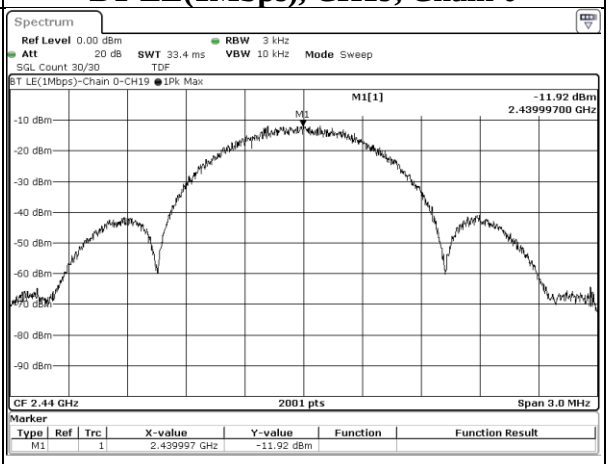
Test Data

Mode	CH	Freq (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Result
BT LE(1Mbps)	0	2402	-11.31	8	PASS
BT LE(1Mbps)	19	2440	-11.92	8	PASS
BT LE(1Mbps)	39	2480	-9.85	8	PASS
BT LE(2Mbps)	0	2402	-13.29	8	PASS
BT LE(2Mbps)	19	2440	-13.58	8	PASS
BT LE(2Mbps)	39	2480	-12.53	8	PASS

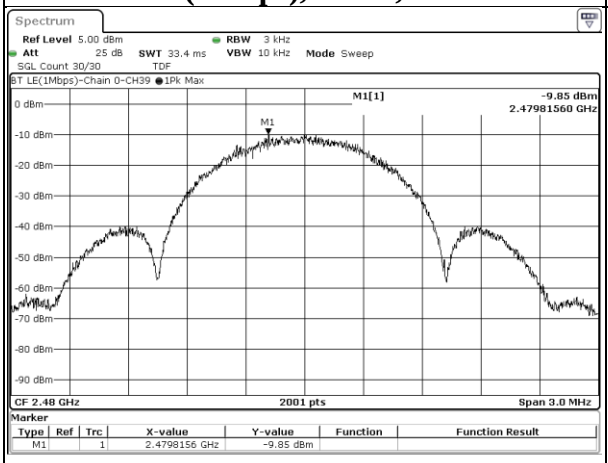
BT LE(1Mbps), CH0, Chain 0



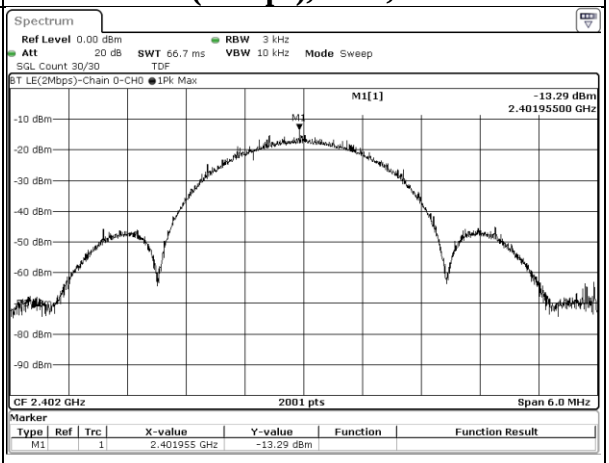
BT LE(1Mbps), CH19, Chain 0



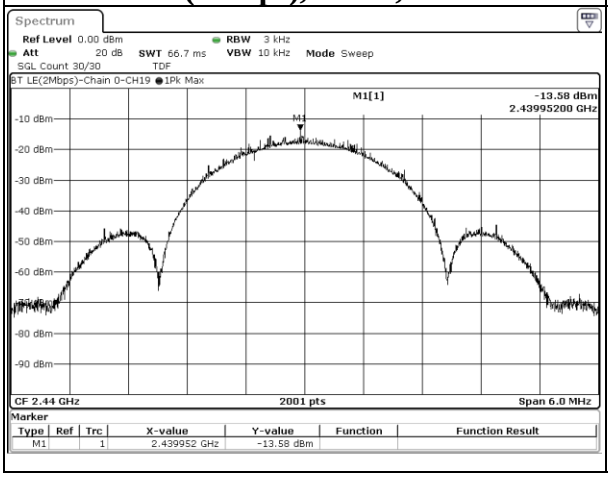
BT LE(1Mbps), CH39, Chain 0



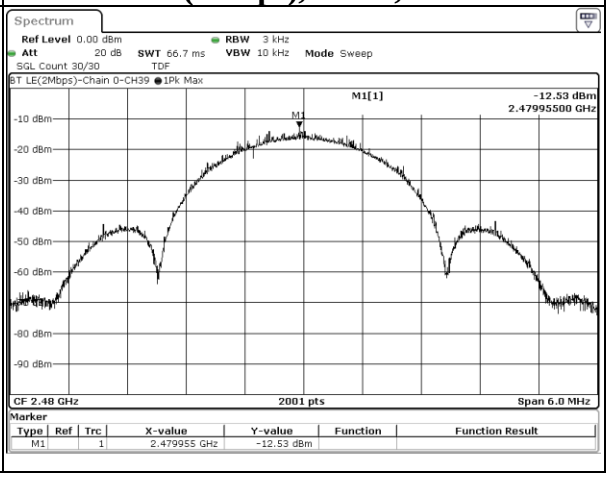
BT LE(2Mbps), CH0, Chain 0



BT LE(2Mbps), CH19, Chain 0



BT LE(2Mbps), CH39, Chain 0



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.

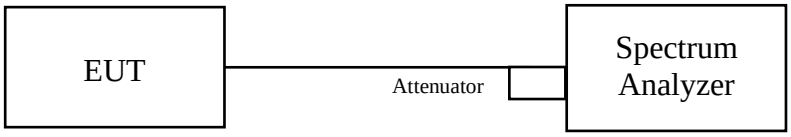
Test procedure

Measurement Procedure REF

1. Set the RBW = 100 kHz.
2. Set the VBW ≥ 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 ≥ 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.

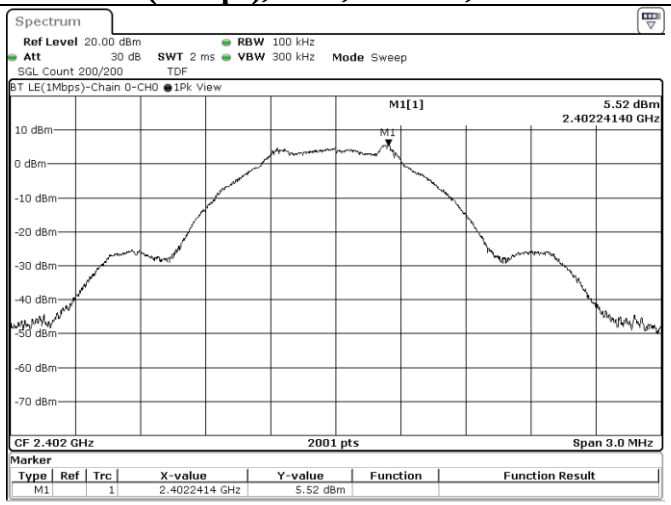
Test Setup



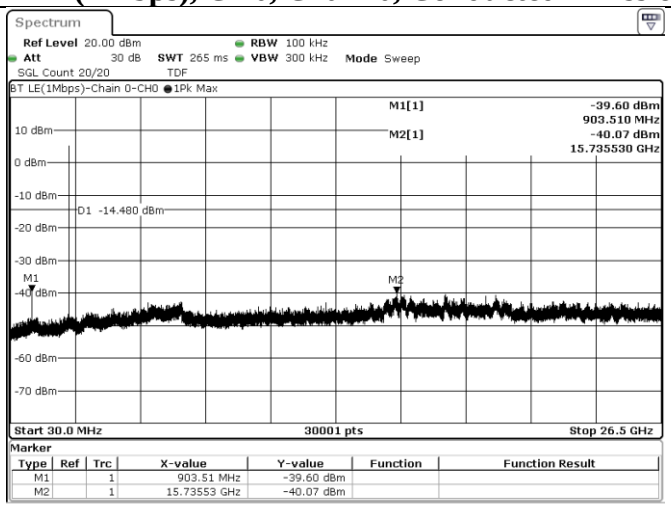
The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

Test Data

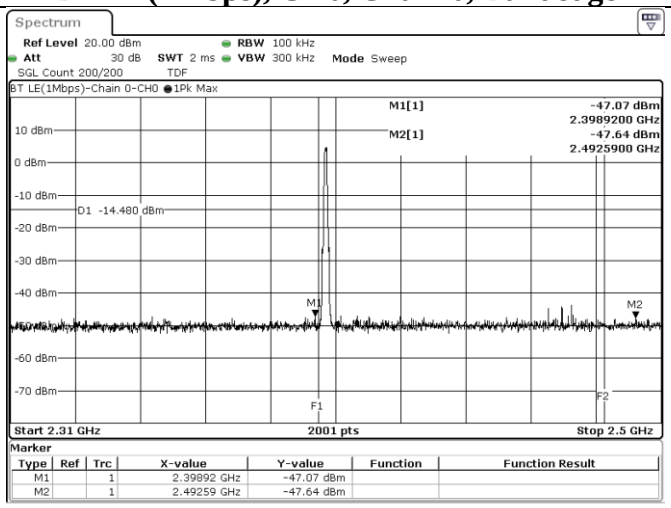
BT LE(1Mbps), CH0, Chain 0, Reference



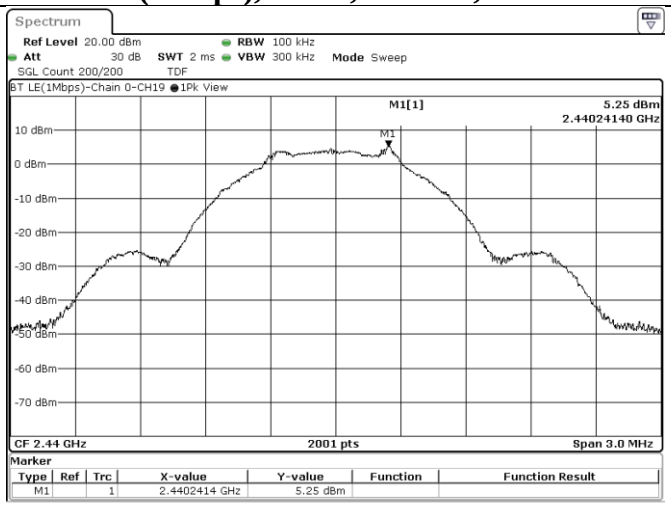
BT LE(1Mbps), CH0, Chain 0, Conducted Emission



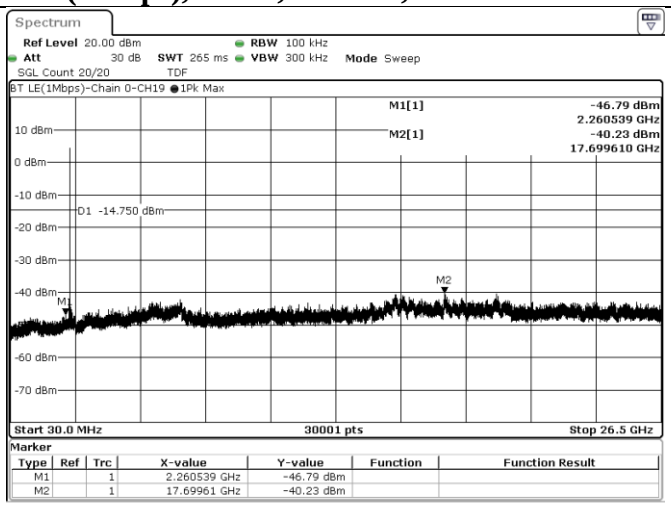
BT LE(1Mbps), CH0, Chain 0, Bandedge



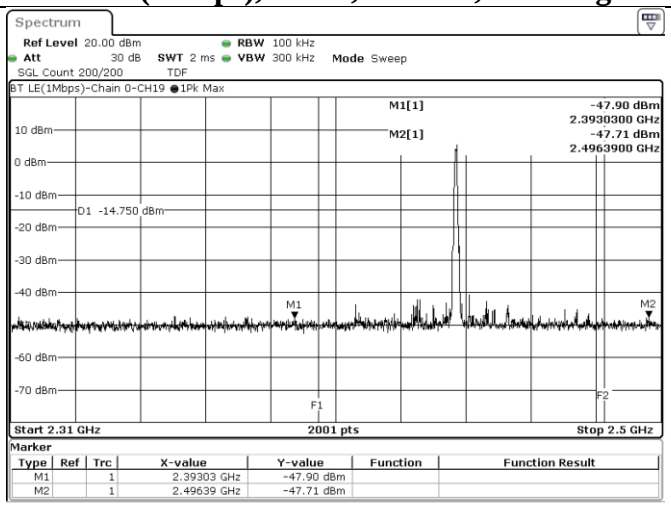
BT LE(1Mbps), CH19, Chain 0, Reference



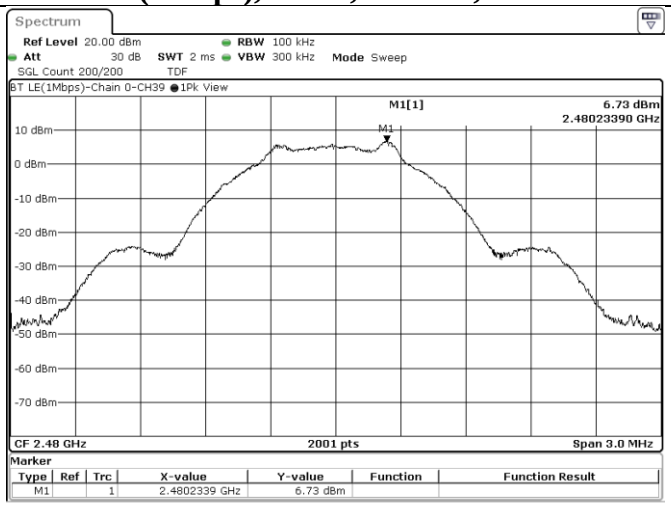
BT LE(1Mbps), CH19, Chain 0, Conducted Emission



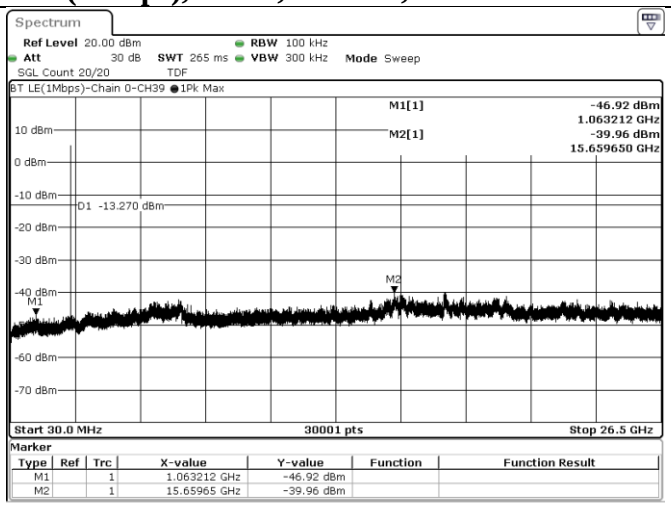
BT LE(1Mbps), CH19, Chain 0, Bandedge



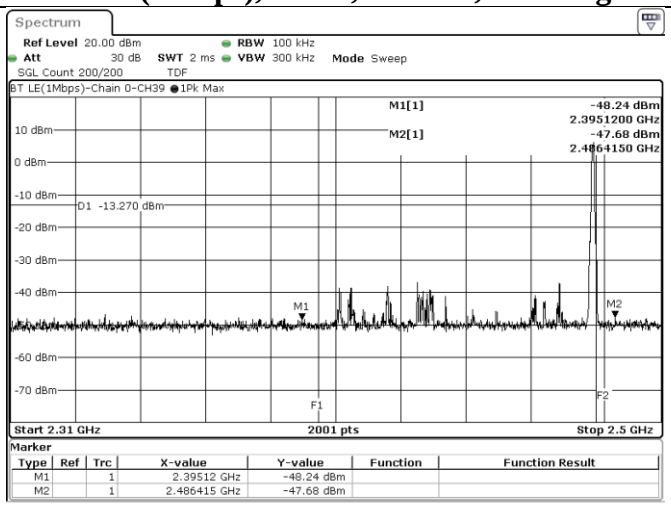
BT LE(1Mbps), CH39, Chain 0, Reference



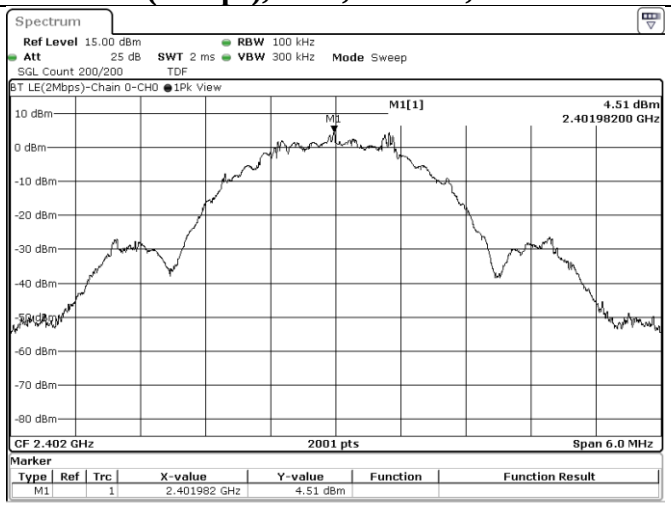
BT LE(1Mbps), CH39, Chain 0, Conducted Emission



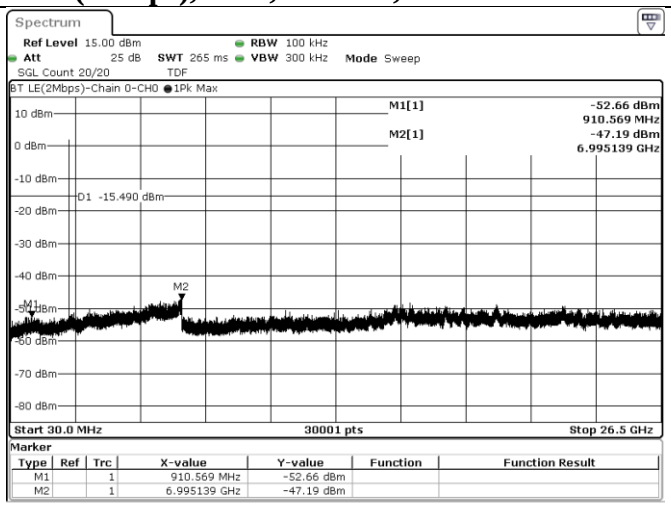
BT LE(1Mbps), CH39, Chain 0, Bandedge



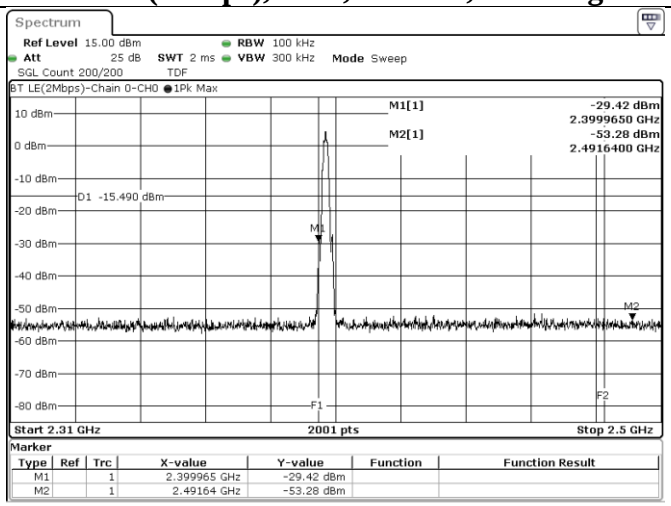
BT LE(2Mbps), CH0, Chain 0, Reference



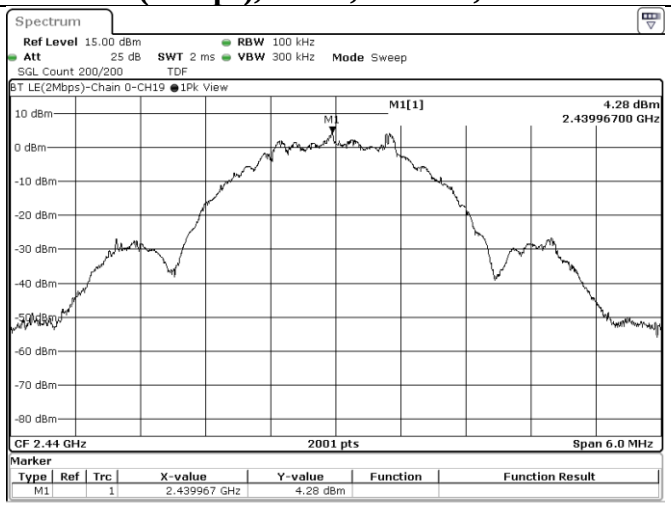
BT LE(2Mbps), CH0, Chain 0, Conducted Emission



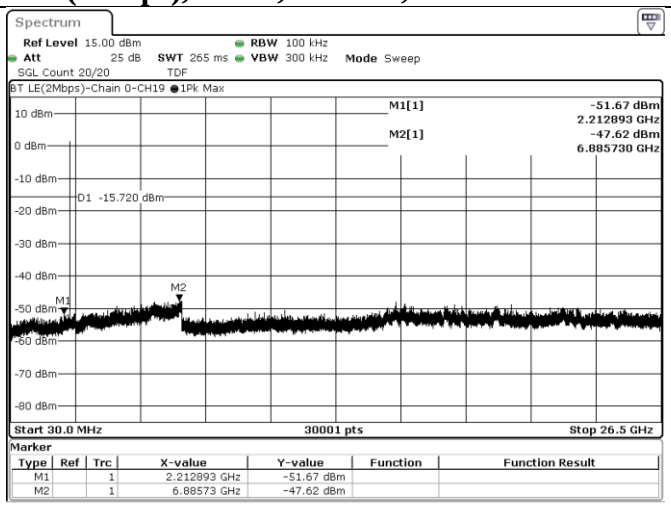
BT LE(2Mbps), CH0, Chain 0, Bandedge



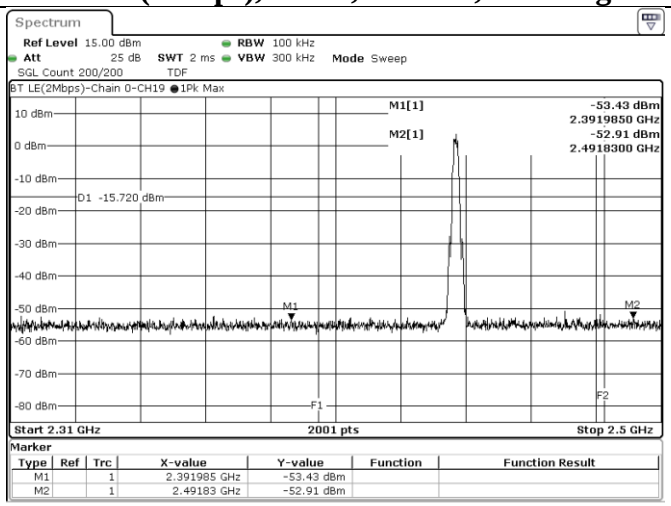
BT LE(2Mbps), CH19, Chain 0, Reference



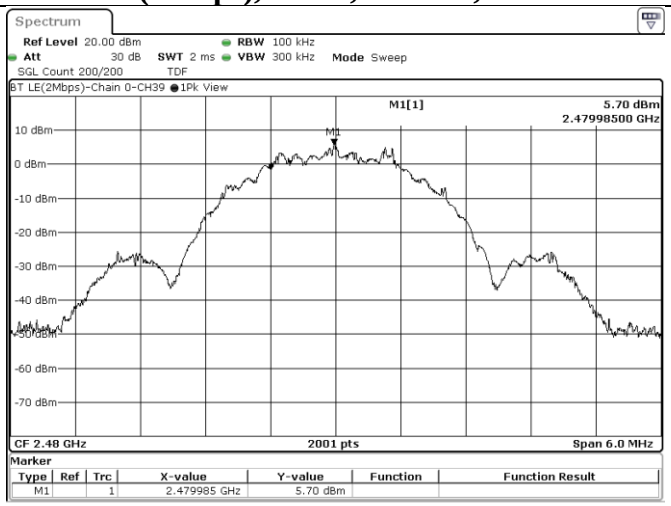
BT LE(2Mbps), CH19, Chain 0, Conducted Emission



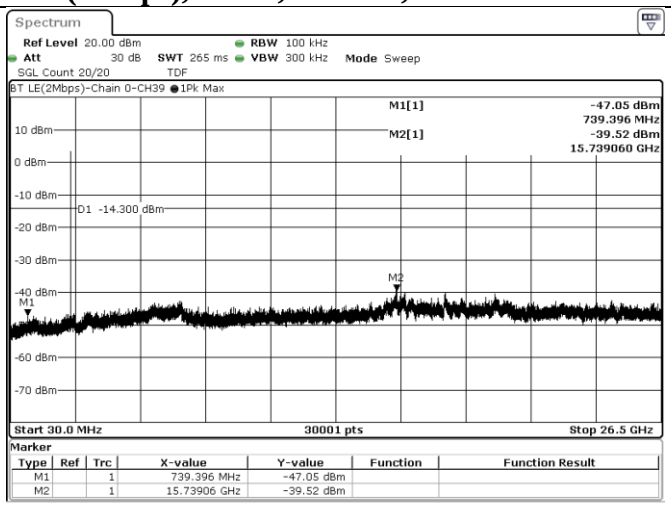
BT LE(2Mbps), CH19, Chain 0, Bandedge



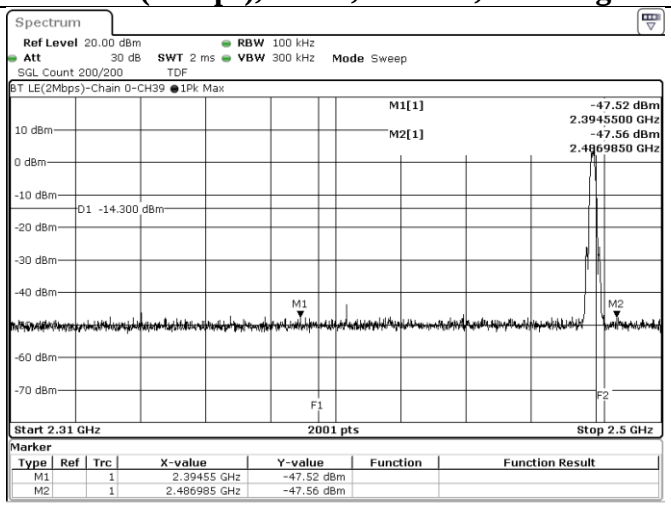
BT LE(2Mbps), CH39, Chain 0, Reference



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.

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 ≥ 1/T (Duty cycle < 98%) or 10Hz (Duty cycle ≥ 98%) for Average detection (AV) at frequency above 1GHz.

Peak

Frequency	RBW	VBW
9 kHz~150 kHz	200 Hz	600 Hz
150 kHz~30 MHz	10 kHz	30 kHz
30 MHz~1 GHz	120 kHz	360 kHz
Above 1GHz	1 MHz	3 MHz

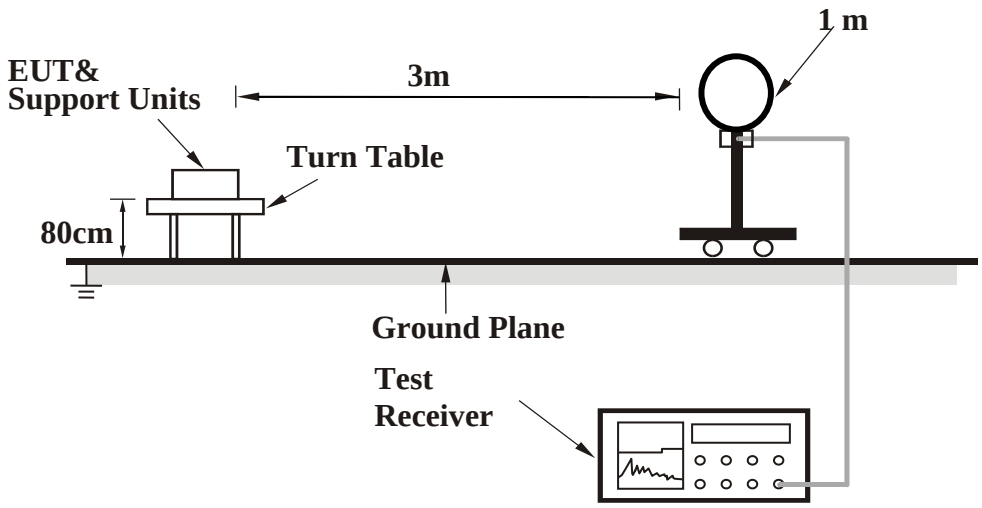
Average for above 1GHz

RBW	VBW
1MHz	Refer to section 6.6 for duty cycle.

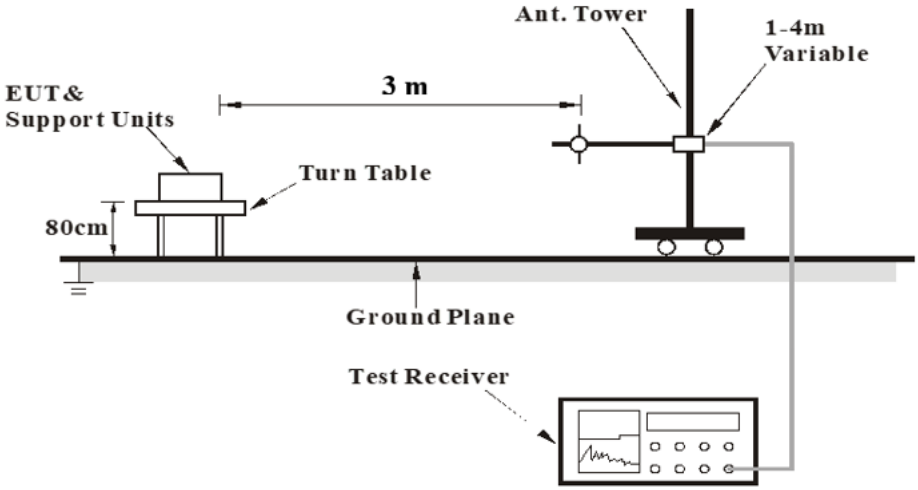
d. All modes of operation were investigated (includes all external accessories) and the worst-case emissions are reported, the other emission levels were low against the limit.
e. Test data of Result value (dBuV/m) = Reading value (dBuV/m) + Correction Factor (dB/m).
f. Test data of Margin(dB) = Result 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.

Test Setup

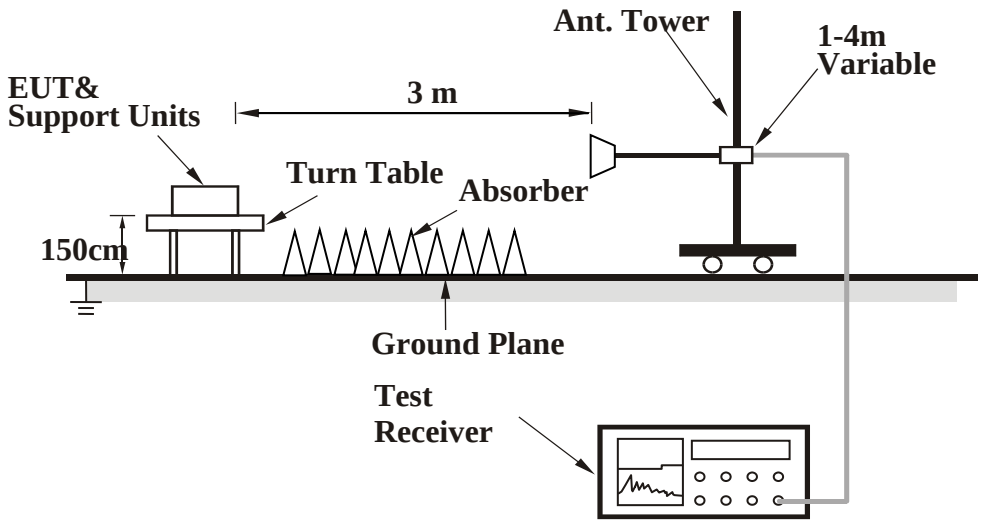
<Frequency Range 9 kHz ~ 30 MHz>



<Frequency Range 30 MHz ~ 1 GHz >



<Frequency Range above 1 GHz>



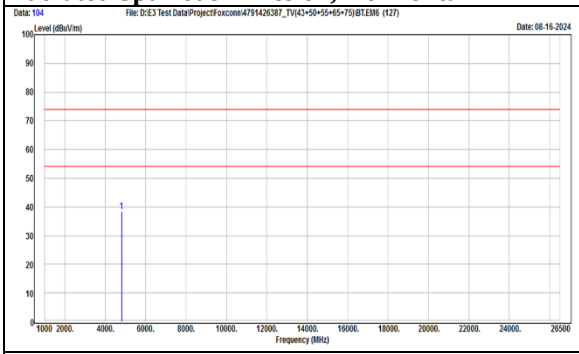
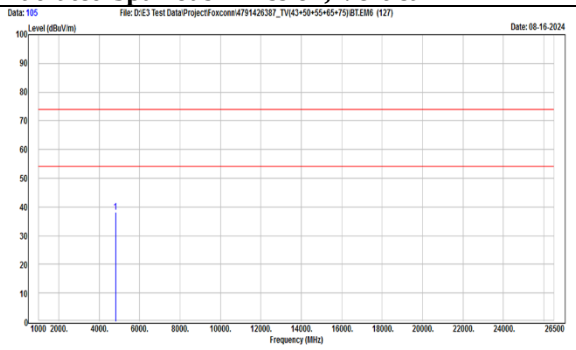
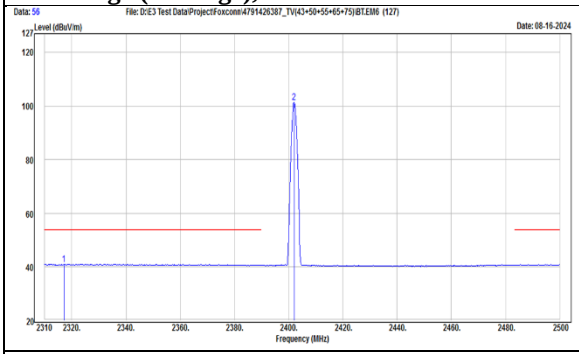
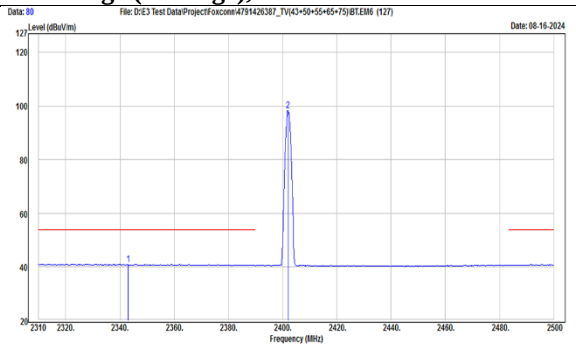
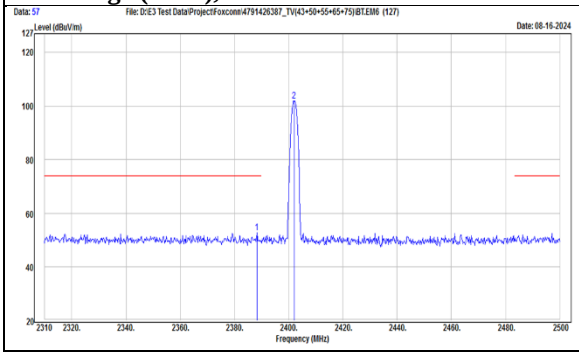
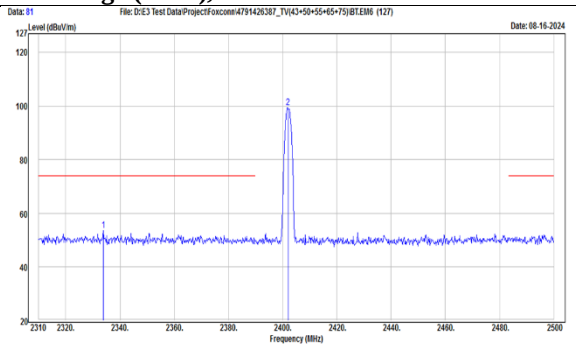
For the actual test configuration, please refer to the Setup Configurations.

Test Data

Above 1 GHz

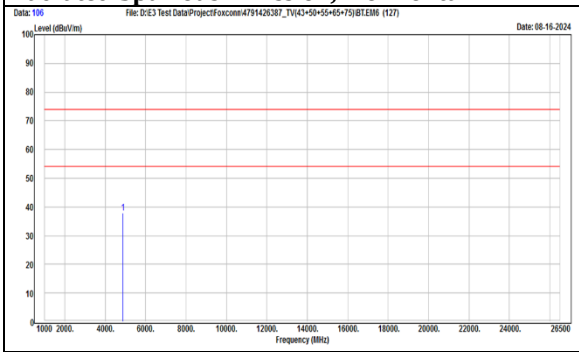
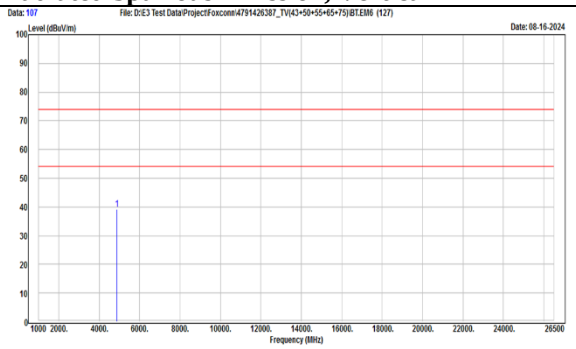
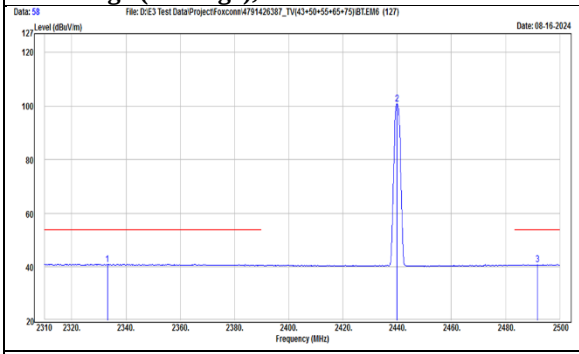
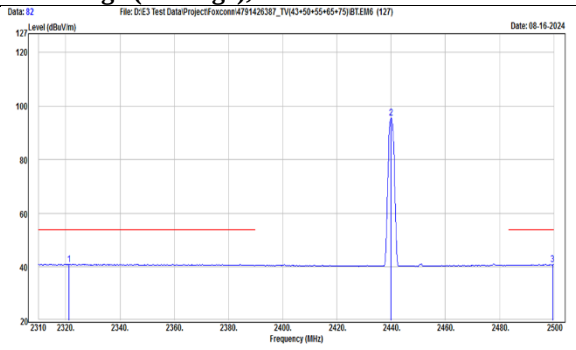
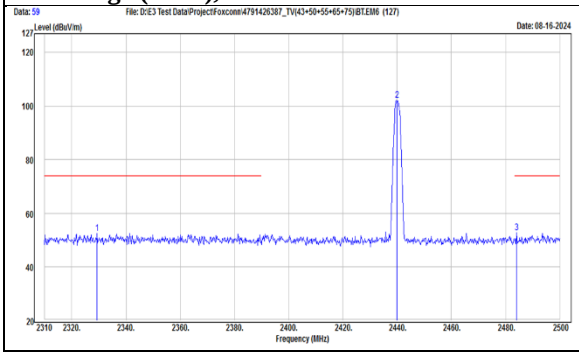
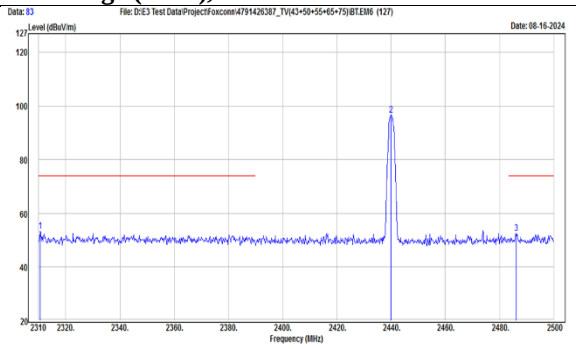
Mode	BT-LE-1Mbps	Channel	0

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		2317.22	28.25	12.8	41.05	54	-12.95	AVG
		2388.28	40.36	12.5	52.86	74	-21.14	PK
	@	2402	89.41	12.43	101.84	N/A	N/A	PK
	@	2402	88.96	12.43	101.39	N/A	N/A	AVG
	*	4804	35.52	2.88	38.4	74	-35.6	PK
Vertical		2333.94	40.83	12.73	53.56	74	-20.44	PK
		2343.06	28.32	12.69	41.01	54	-12.99	AVG
	@	2402	87.11	12.43	99.54	N/A	N/A	PK
	@	2402	85.93	12.43	98.36	N/A	N/A	AVG
	*	4804	35.15	2.88	38.03	74	-35.97	PK

TX, BT-LE-1Mbps (Ch 0) Radiated Spurious Emission, Horizontal	TX, BT-LE-1Mbps (Ch 0) Radiated Spurious Emission, Vertical
	
TX, BT-LE-1Mbps (Ch 0) Band Edge (Average), Horizontal	**TX, BT-LE-1Mbps (Ch 0) Band Edge (Average), Vertical**
	
TX, BT-LE-1Mbps (Ch 0) Band Edge (Peak), Horizontal	**TX, BT-LE-1Mbps (Ch 0) Band Edge (Peak), Vertical**
	

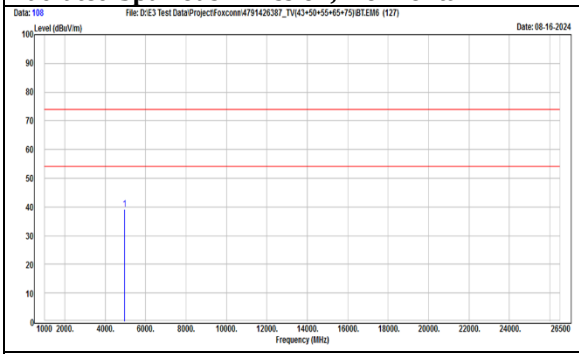
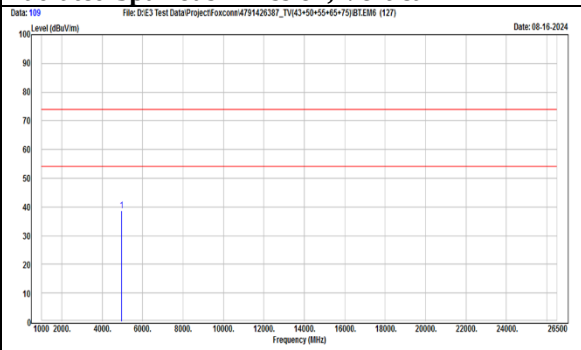
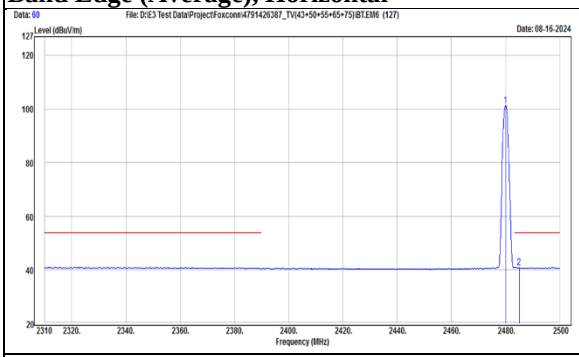
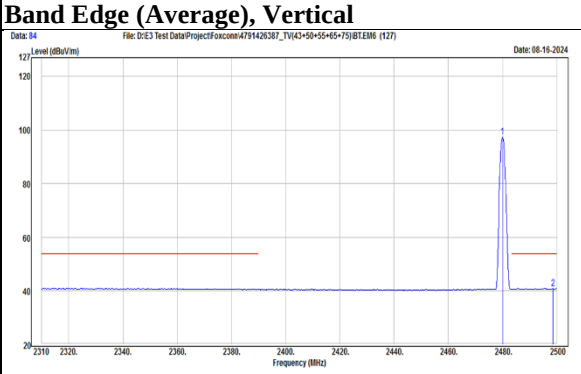
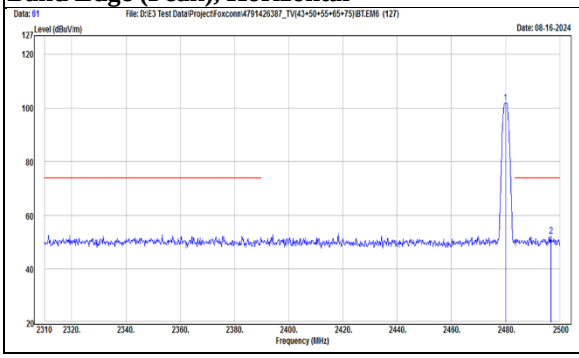
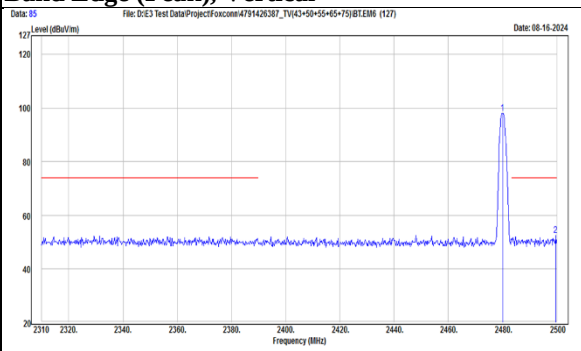
Mode	BT-LE-1Mbps	Channel	19

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		2329.38	39.83	12.74	52.57	74	-21.43	PK
		2333.18	28.33	12.73	41.06	54	-12.94	AVG
	@	2440	89.86	12.19	102.05	N/A	N/A	PK
	@	2440	88.58	12.19	100.77	N/A	N/A	AVG
		2484.04	40.35	12.38	52.73	74	-21.27	PK
		2491.83	28.49	12.45	40.94	54	-13.06	AVG
	*	4880	34.87	3.06	37.93	74	-36.07	PK
Vertical		2310.57	40.49	12.83	53.32	74	-20.68	PK
		2321.21	28.3	12.78	41.08	54	-12.92	AVG
	@	2440	84.44	12.19	96.63	N/A	N/A	PK
	@	2440	83.48	12.19	95.67	N/A	N/A	AVG
		2486.13	40.11	12.41	52.52	74	-21.48	PK
		2499.62	28.45	12.51	40.96	54	-13.04	AVG
	*	4880	36.08	3.06	39.14	74	-34.86	PK

TX, BT-LE-1Mbps (Ch 19) **Radiated Spurious Emission, Horizontal**	**TX, BT-LE-1Mbps (Ch 19)** **Radiated Spurious Emission, Vertical**
	
TX, BT-LE-1Mbps (Ch 19) **Band Edge (Average), Horizontal**	**TX, BT-LE-1Mbps (Ch 19)** **Band Edge (Average), Vertical**
	
TX, BT-LE-1Mbps (Ch 19) **Band Edge (Peak), Horizontal**	**TX, BT-LE-1Mbps (Ch 19)** **Band Edge (Peak), Vertical**
	

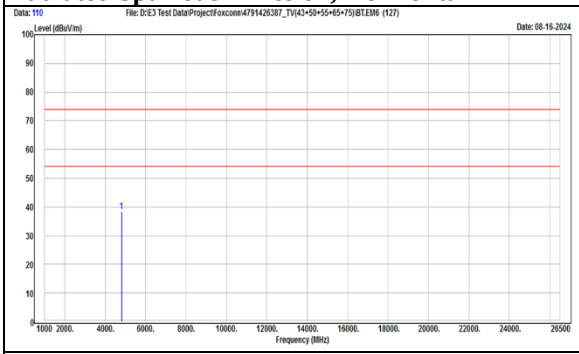
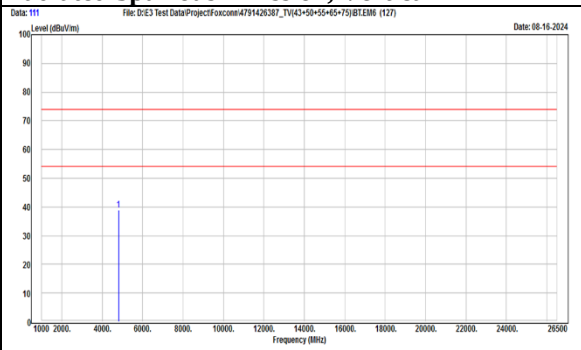
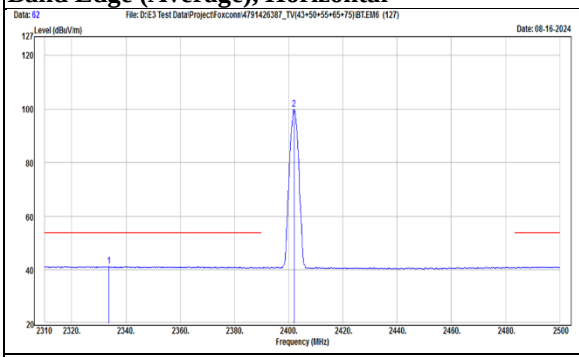
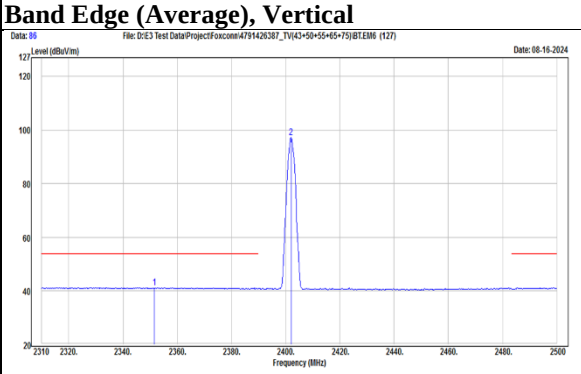
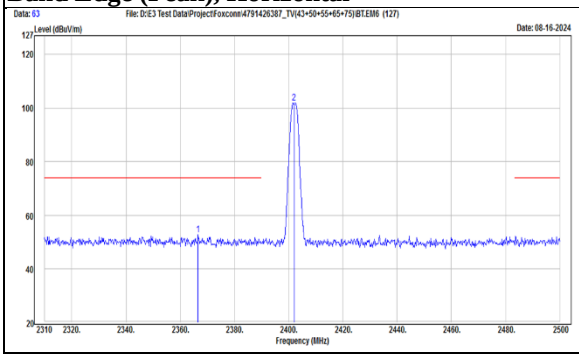
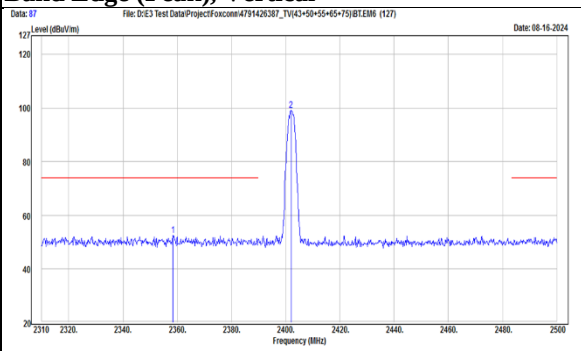
Mode	BT-LE-1Mbps	Channel	39

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal	@	2480	89.63	12.35	101.98	N/A	N/A	PK
	@	2480	88.99	12.35	101.34	N/A	N/A	AVG
		2484.99	28.62	12.39	41.01	54	-12.99	AVG
		2496.77	39.92	12.48	52.4	74	-21.6	PK
	*	4960	36.03	3.2	39.23	74	-34.77	PK
Vertical	@	2480	85.81	12.35	98.16	N/A	N/A	PK
	@	2480	85.05	12.35	97.4	N/A	N/A	AVG
		2498.67	28.49	12.5	40.99	54	-13.01	AVG
		2499.62	39.91	12.51	52.42	74	-21.58	PK
	*	4960	35.42	3.2	38.62	74	-35.38	PK

TX, BT-LE-1Mbps (Ch 39) **Radiated Spurious Emission, Horizontal**	**TX, BT-LE-1Mbps (Ch 39)** **Radiated Spurious Emission, Vertical**
	
TX, BT-LE-1Mbps (Ch 39) **Band Edge (Average), Horizontal**	**TX, BT-LE-1Mbps (Ch 39)** **Band Edge (Average), Vertical**
	
TX, BT-LE-1Mbps (Ch 39) **Band Edge (Peak), Horizontal**	**TX, BT-LE-1Mbps (Ch 39)** **Band Edge (Peak), Vertical**
	

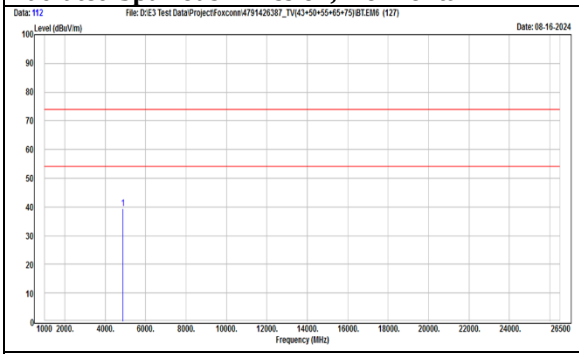
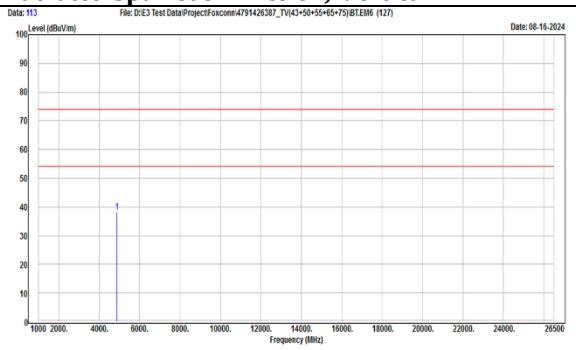
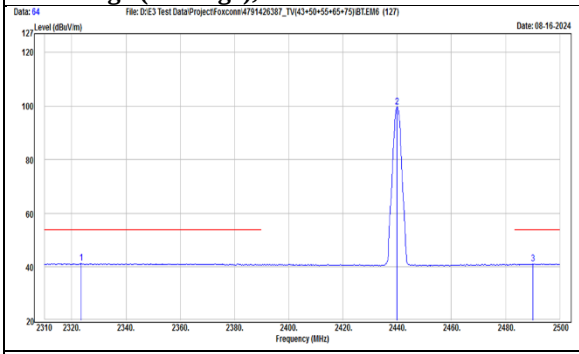
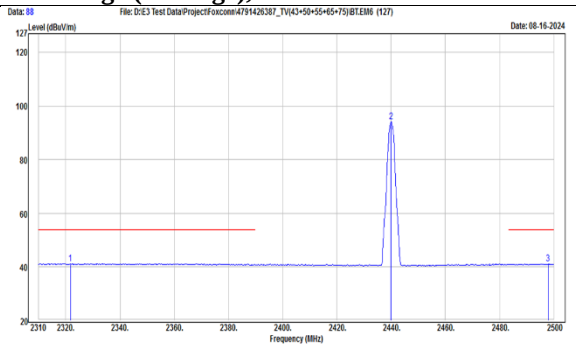
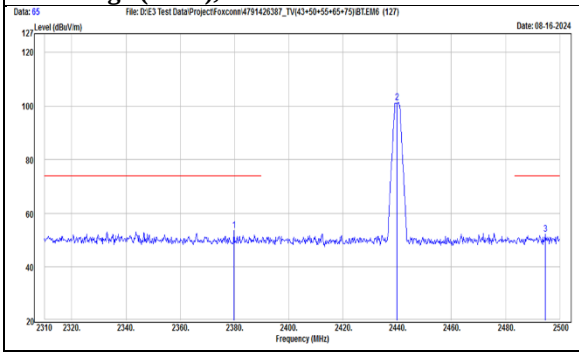
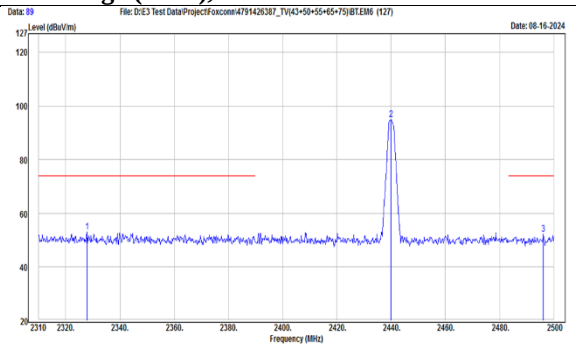
Mode	BT-LE-2Mbps	Channel	0

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		2333.75	28.67	12.73	41.4	54	-12.6	AVG
		2366.62	40.27	12.58	52.85	74	-21.15	PK
	@	2402	89.59	12.43	102.02	N/A	N/A	PK
	@	2402	87.56	12.43	99.99	N/A	N/A	AVG
	*	4804	35.63	2.88	38.51	74	-35.49	PK
Vertical		2351.61	28.72	12.65	41.37	54	-12.63	AVG
		2358.45	39.84	12.62	52.46	74	-21.54	PK
	@	2402	86.76	12.43	99.19	N/A	N/A	PK
	@	2402	84.85	12.43	97.28	N/A	N/A	AVG
	*	4804	36.05	2.88	38.93	74	-35.07	PK

TX, BT-LE-2Mbps (Ch 0) Radiated Spurious Emission, Horizontal	TX, BT-LE-2Mbps (Ch 0) Radiated Spurious Emission, Vertical
	
TX, BT-LE-2Mbps (Ch 0) Band Edge (Average), Horizontal	**TX, BT-LE-2Mbps (Ch 0) Band Edge (Average), Vertical**
	
TX, BT-LE-2Mbps (Ch 0) Band Edge (Peak), Horizontal	**TX, BT-LE-2Mbps (Ch 0) Band Edge (Peak), Vertical**
	

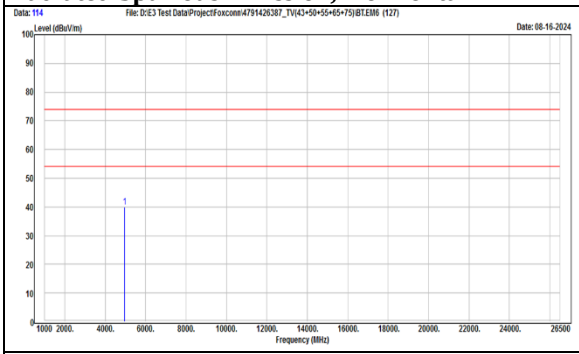
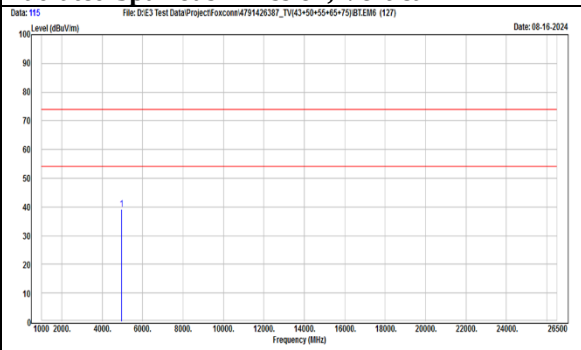
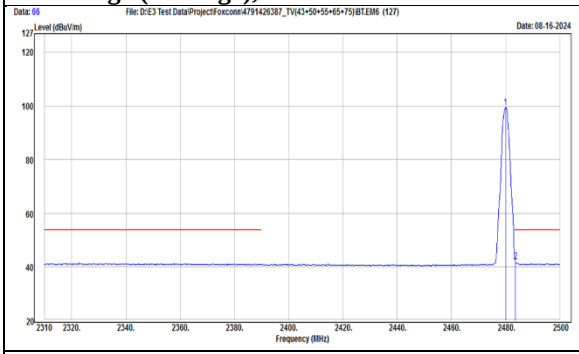
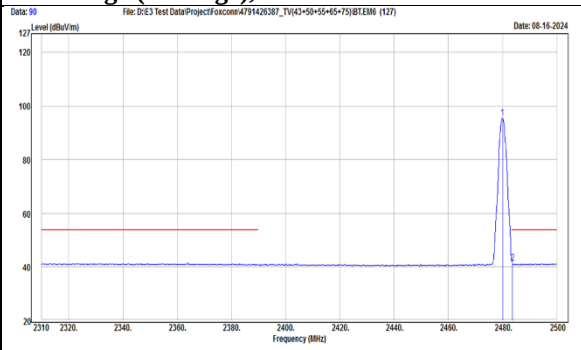
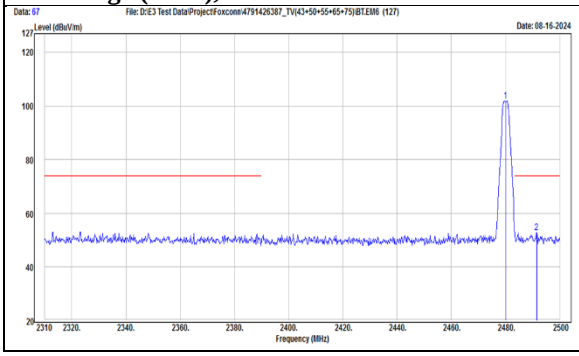
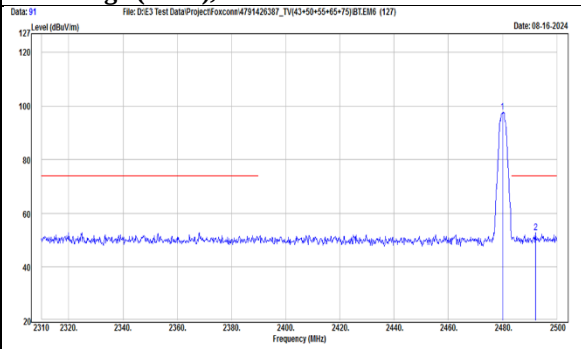
Mode	BT-LE-2Mbps	Channel	19

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		2323.49	28.62	12.77	41.39	54	-12.61	AVG
		2379.92	40.98	12.53	53.51	74	-20.49	PK
	@	2440	89.25	12.19	101.44	N/A	N/A	PK
	@	2440	87.58	12.19	99.77	N/A	N/A	AVG
		2490.12	28.77	12.43	41.2	54	-12.8	AVG
		2494.68	39.79	12.47	52.26	74	-21.74	PK
	*	4880	36.25	3.06	39.31	74	-34.69	PK
Vertical		2321.78	28.58	12.78	41.36	54	-12.64	AVG
		2327.86	40.29	12.75	53.04	74	-20.96	PK
	@	2440	82.71	12.19	94.9	N/A	N/A	PK
	@	2440	81.92	12.19	94.11	N/A	N/A	AVG
		2496.2	39.74	12.48	52.22	74	-21.78	PK
		2497.91	28.67	12.5	41.17	54	-12.83	AVG
	*	4880	35.02	3.06	38.08	74	-35.92	PK

TX, BT-LE-2Mbps (Ch 19) Radiated Spurious Emission, Horizontal	TX, BT-LE-2Mbps (Ch 19) Radiated Spurious Emission, Vertical
	
TX, BT-LE-2Mbps (Ch 19) Band Edge (Average), Horizontal	**TX, BT-LE-2Mbps (Ch 19) Band Edge (Average), Vertical**
	
TX, BT-LE-2Mbps (Ch 19) Band Edge (Peak), Horizontal	**TX, BT-LE-2Mbps (Ch 19) Band Edge (Peak), Vertical**
	

Mode	BT-LE-2Mbps	Channel	39

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal	@	2480	89.59	12.35	101.94	N/A	N/A	PK
	@	2480	87.17	12.35	99.52	N/A	N/A	AVG
		2483.66	29.61	12.38	41.99	54	-12.01	AVG
		2491.45	40.37	12.44	52.81	74	-21.19	PK
	*	4960	36.87	3.2	40.07	74	-33.93	PK
Vertical	@	2480	85.33	12.35	97.68	N/A	N/A	PK
	@	2480	83.32	12.35	95.67	N/A	N/A	AVG
		2483.66	29.16	12.38	41.54	54	-12.46	AVG
		2492.21	40.33	12.45	52.78	74	-21.22	PK
	*	4960	36.04	3.2	39.24	74	-34.76	PK

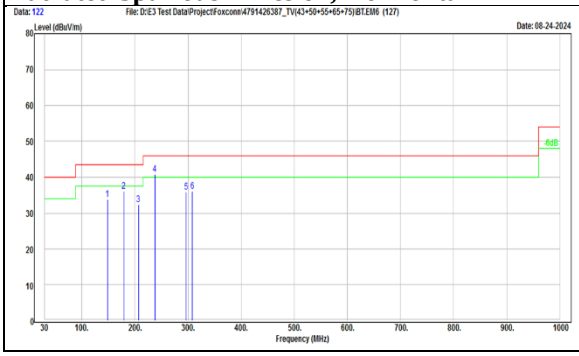
TX, BT-LE-2Mbps (Ch 39) **Radiated Spurious Emission, Horizontal**	**TX, BT-LE-2Mbps (Ch 39)** **Radiated Spurious Emission, Vertical**
	
TX, BT-LE-2Mbps (Ch 39) **Band Edge (Average), Horizontal**	**TX, BT-LE-2Mbps (Ch 39)** **Band Edge (Average), Vertical**
	
TX, BT-LE-2Mbps (Ch 39) **Band Edge (Peak), Horizontal**	**TX, BT-LE-2Mbps (Ch 39)** **Band Edge (Peak), Vertical**
	

Below 1 GHz

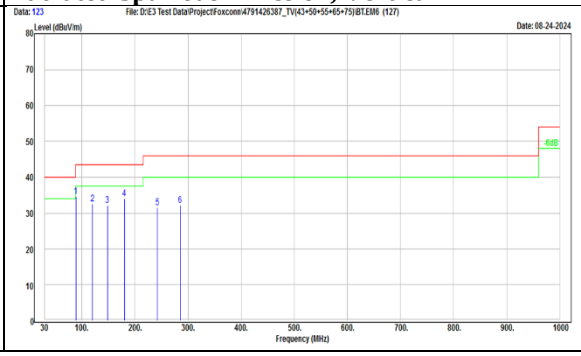
Mode	BT-LE-1Mbps	Channel	39

Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		148.34	45.65	-11.84	33.81	43.5	-9.69	PK
		179.38	48.65	-12.61	36.04	43.5	-7.46	PK
		206.54	47.09	-14.62	32.47	43.5	-11.03	PK
		237.58	53.71	-12.82	40.89	46	-5.11	PK
		296.75	46.19	-10.38	35.81	46	-10.19	PK
		308.39	46.2	-10.05	36.15	46	-9.85	PK
Vertical		89.17	52.27	-17.65	34.62	43.5	-8.88	PK
		120.21	46.54	-13.93	32.61	43.5	-10.89	PK
		148.34	43.95	-11.84	32.11	43.5	-11.39	PK
		180.35	46.68	-12.72	33.96	43.5	-9.54	PK
		242.43	43.91	-12.44	31.47	46	-14.53	PK
		285.11	42.82	-10.66	32.16	46	-13.84	PK

TX, BT-LE-1Mbps (Ch 39)
Radiated Spurious Emission, Horizontal



TX, BT-LE-1Mbps (Ch 39)
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 (dBμV)	
	Quasi-peak	Average
0.15 - 0.5	66 - 56	56 - 46
0.50 - 5.0	56	46
5.0 - 30	60	50

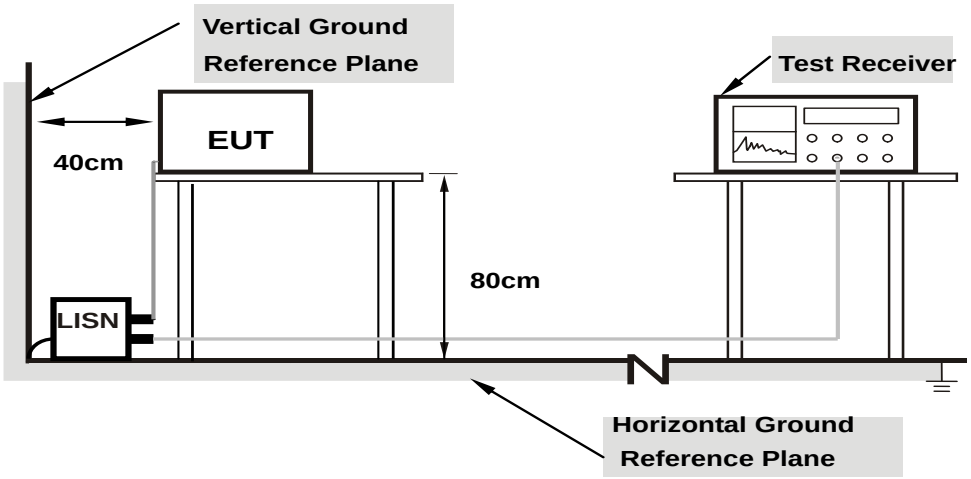
Note:
1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

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).

Test Setup



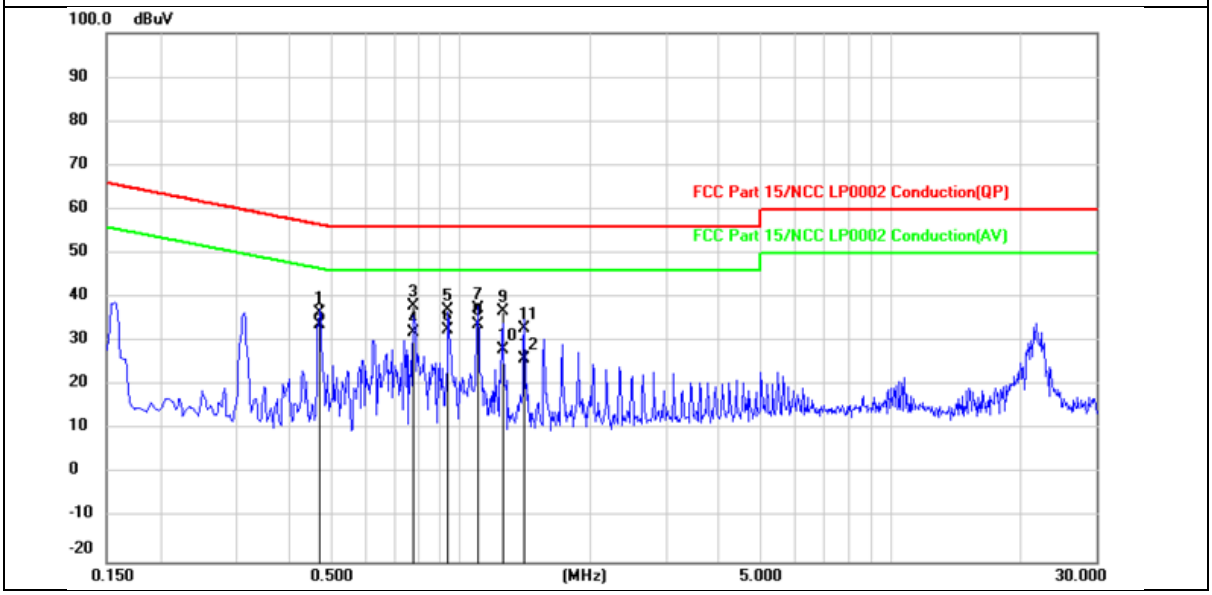
Note: 1.Support units were connected to second LISN.

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

Test Data

Mode	BLE(1M)_TX2480	Channel	39

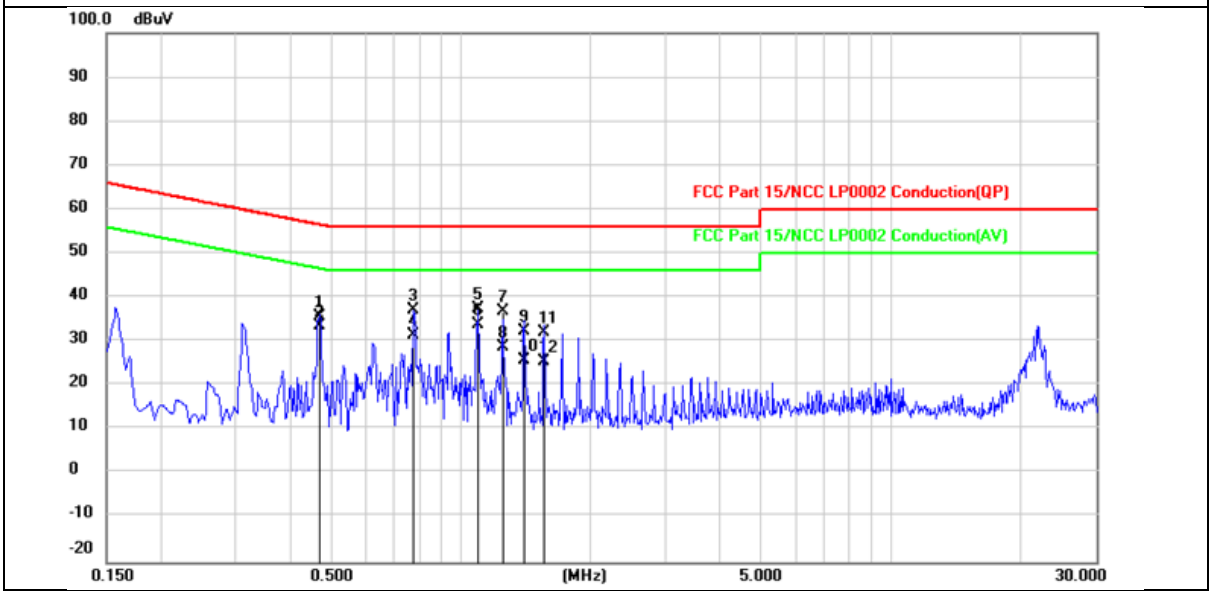
Phase: Line



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Remark
1	0.4700	26.59	9.95	36.54	56.51	-19.97	QP
2	0.4700	23.89	9.95	33.84	46.51	-12.67	AVG
3	0.7801	28.04	9.96	38.00	56.00	-18.00	QP
4	0.7801	21.95	9.96	31.91	46.00	-14.09	AVG
5	0.9352	27.16	9.97	37.13	56.00	-18.87	QP
6	0.9352	22.63	9.97	32.60	46.00	-13.40	AVG
7	1.0945	27.48	9.98	37.46	56.00	-18.54	QP
8	1.0945	23.83	9.98	33.81	46.00	-12.19	AVG
9	1.2514	26.76	9.99	36.75	56.00	-19.25	QP
10	1.2514	18.29	9.99	28.28	46.00	-17.72	AVG
11	1.4064	22.97	9.99	32.96	56.00	-23.04	QP
12	1.4064	15.99	9.99	25.98	46.00	-20.02	AVG

Mode	BLE(1M)_TX2480	Channel	39

Phase: Neutral



No.	Frequency (MHz)	Reading (dBuV)	Correct (dB)	Result (dBuV)	Limit (dBuV)	Margin (dB)	Remark
1	0.4694	25.82	9.95	35.77	56.52	-20.75	QP
2	0.4694	23.70	9.95	33.65	46.52	-12.87	AVG
3	0.7808	27.31	9.96	37.27	56.00	-18.73	QP
4	0.7808	21.39	9.96	31.35	46.00	-14.65	AVG
5	1.0947	27.34	9.97	37.31	56.00	-18.69	QP
6	1.0947	23.84	9.97	33.81	46.00	-12.19	AVG
7	1.2516	26.93	9.98	36.91	56.00	-19.09	QP
8	1.2516	18.86	9.98	28.84	46.00	-17.16	AVG
9	1.4067	22.46	9.99	32.45	56.00	-23.55	QP
10	1.4067	15.68	9.99	25.67	46.00	-20.33	AVG
11	1.5626	22.14	9.99	32.13	56.00	-23.87	QP
12	1.5626	15.61	9.99	25.60	46.00	-20.40	AVG

END OF REPORT