

FCC Test Report

Report No.: RFBDKG-WTW-P21030577

FCC ID: JNZMR0091

Test Model: MR0091

Received Date: Mar. 16, 2021

Test Date: Mar. 23 to Apr. 15, 2021

Issued Date: Apr. 21, 2021

Applicant: LOGITECH FAR EAST LTD.

Address: 7700 Gateway Boulevard Newark California United States

Issued By: Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch
Hsin Chu Laboratory

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**FCC Registration /
Designation Number:** 723255 / TW2022



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Release Control Record

Issue No.	Description	Date Issued
RFBDKG-WTW-P21030577	Original release.	Apr. 21, 2021

1 Certificate of Conformity

Product: Wireless Mouse

Brand: Logitech

Test Model: MR0091

Sample Status: Engineering sample

Applicant: LOGITECH FAR EAST LTD.

Test Date: Mar. 23 to Apr. 15, 2021

Standards: 47 CFR FCC Part 15, Subpart C (Section 15.247)
ANSI C63.10: 2013

The above equipment has been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's EMC characteristics under the conditions specified in this report.

Prepared by :  , **Date:** Apr. 21, 2021
Claire Kuan / Specialist

Approved by :  , **Date:** Apr. 21, 2021
Clark Lin / Technical Manager

2 Summary of Test Results

47 CFR FCC Part 15, Subpart C (Section 15.247)			
FCC Clause	Test Item	Result	Remarks
15.207	AC Power Conducted Emission	NA	Without AC power port of the EUT.
15.205 / 15.209 / 15.247(d)	Radiated Emissions and Band Edge Measurement	PASS	Meet the requirement of limit. Minimum passing margin is -8.6 dB at 2375.08 MHz.
15.247(d)	Antenna Port Emission	PASS	Meet the requirement of limit.
15.247(a)(2)	6dB bandwidth	PASS	Meet the requirement of limit.
15.247(b)	Conducted power	PASS	Meet the requirement of limit.
15.247(e)	Power Spectral Density	PASS	Meet the requirement of limit.
15.203	Antenna Requirement	PASS	No antenna connector is used.

Note:

- For 2.4 GHz band compliance with rule 15.247(d) of the band-edge items, the test plots were recorded in Annex A.
- Determining compliance based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

2.1 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

Measurement	Frequency	Expanded Uncertainty (k=2) (±)
Radiated Emissions up to 1 GHz	9kHz ~ 30MHz	3.1 dB
	30MHz ~ 1GHz	5.5 dB
Radiated Emissions above 1 GHz	1GHz ~ 18GHz	5.1 dB
	18GHz ~ 40GHz	5.3 dB

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product	Wireless Mouse
Brand	Logitech
Test Model	MR0091
Status of EUT	Engineering sample
Power Supply Rating	1.5Vdc from battery
Modulation Type	GFSK
Modulation Technology	DTS
Transfer Rate	BT-LE: Up to 2 Mbps (*Note 1)
Operating Frequency	BT-LE: 2.402 ~ 2.480 GHz (*Note 1)
Number of Channel	BT-LE: 40 (*Note 1)
Output Power	BT-LE function: BT-LE 1M: 4.909 mW BT-LE 2M: 4.887 mW Logi bolt function: BT-LE 1M: 4.764 mW BT-LE 2M: 4.742 mW
Antenna Type	Refer to Note
Antenna Connector	Refer to Note
Accessory Device	NA
Cable Supplied	NA

Note:

1. BT-LE technique supports 1Mbps and 2Mbps data rates, both have been evaluated in this test report. Refer to “**section 3.2 Description of Test Modes**” for more detail specification.
2. This device have BT-LE and Logi bolt functions , the worse case was found in BT-LE function (except for Conducted power test item). Therefore only the test data of the type was recorded in this report.
3. The EUT have several appearances for marketing and the variant appearances will not affect the RF characteristics which clarified by manufacturer, the difference description as below.

Marketing name	M550 L	M650 L/ M650 L For Business	M750 L	M650 L Left	M550	M650/ M650 For Business	M750
Length (mm)	118.2	118.2	118.2	118.2	107.7	107.7	107.7
width(mm)	65.7	65.7	65.7	65.7	60.5	60.5	60.5
Height(mm)	41.5	41.5	41.5	41.5	38.3	38.3	38.3
Island	Small	Big	Big	Big	Small	Big	Big
DPI	No	No	Yes	No	No	No	Yes
Host LED	1	1	3	1	1	1	3
Battery Indicator	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Side buttons	No	Yes	Yes	Yes for lefty	No	Yes	Yes

4. The antenna provided to the EUT, please refer to the following table:

Antenna Gain (dBi)	Frequency Range (GHz)	Antenna Type	Connector Type
2	2.4~2.4835	PCB	None

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

3.2 Description of Test Modes

BT-LE function & Logi bolt function channels:

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

3.2.1 Test Mode Applicability and Tested Channel Detail

EUT CONFIGURE MODE	APPLICABLE TO				DESCRIPTION
	RE≥1G	RE<1G	PLC	APCM	
-	√	√	-	√	-

Where **RE≥1G**: Radiated Emission above 1GHz & Bandedge Measurement
RE<1G: Radiated Emission below 1GHz
PLC: Power Line Conducted Emission
APCM: Antenna Port Conducted Measurement

Note:

1. No need to concern of Conducted Emission due to the EUT is powered by battery.

Radiated Emission Test (Above 1GHz):

- ☒ 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).
- ☒ Following channel(s) was (were) selected for the final test as listed below.

AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TYPE	DATA RATE (Mbps)
0 to 39	0, 19, 39	GFSK	1
1 to 38	1, 19, 38	GFSK	2

Radiated Emission Test (Below 1GHz):

- ☒ 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).
- ☒ Following channel(s) was (were) selected for the final test as listed below.

AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TYPE	DATA RATE (Mbps)
0 to 39	0	GFSK	1

Antenna Port Conducted Measurement:

- ☒ This item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.
- ☒ 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).
- ☒ Following channel(s) was (were) selected for the final test as listed below.

AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TYPE	DATA RATE (Mbps)
0 to 39	0, 19, 39	GFSK	1
1 to 38	1, 19, 38	GFSK	2

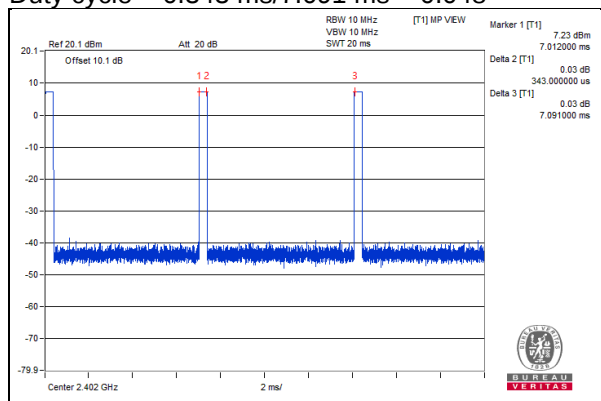
Test Condition:

Applicable to	Environmental Conditions	Input Power	Tested By
RE≥1G	25deg. C, 75%RH	1.5Vdc	Gary Cheng
RE<1G	22deg. C, 65%RH	1.5Vdc	Sampson Chen
APCM	25deg. C, 60%RH	1.5Vdc	Eric Peng

3.3 Duty Cycle of Test Signal

BT-LE 1M

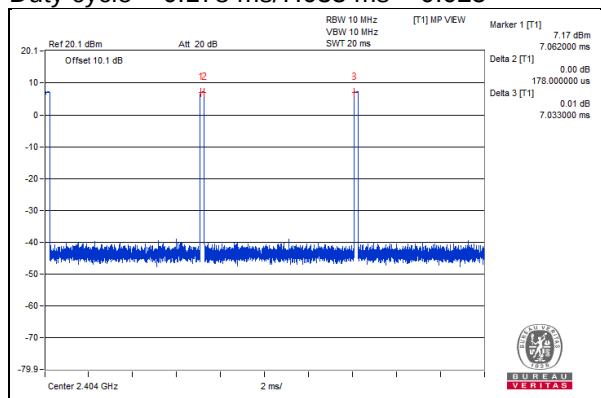
Duty cycle = 0.343 ms/7.091 ms = 0.048



Note: For BT-LE function & Logi bolt function mode, this is highest operational duty cycle.

BT-LE 2M

Duty cycle = 0.178 ms/7.033 ms = 0.025



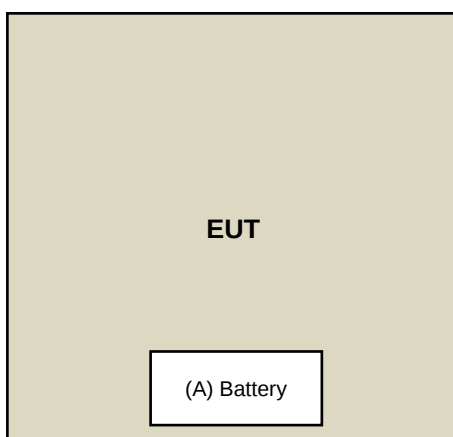
Note: For BT-LE function & Logi bolt function mode, this is highest operational duty cycle.

3.4 Description of Support Units

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	Battery	Panasonic	AA	NA	NA	Provided by Lab

3.4.1 Configuration of System under Test



3.5 General Description of Applied Standards and References

The EUT is a RF Product. According to the specifications of the manufacturer, it must comply with the requirements of the following standards and references:

Test Standard:

FCC Part 15, Subpart C (15.247)

ANSI C63.10-2013

All test items have been performed and recorded as per the above standards.

References Test Guidance:

KDB 558074 D01 15.247 Meas Guidance v05r02

All test items have been performed as a reference to the above KDB test guidance.

4 Test Types and Results

4.1 Radiated Emission and Bandedge Measurement

4.1.1 Limits of Radiated Emission and Bandedge Measurement

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:

Frequencies (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.

4.1.2 Test Instruments

For Radiated Emission test: (Below 1GHz)

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	CALIBRATED DATE	CALIBRATED UNTIL
Test Receiver Agilent	N9038A	MY51210202	Dec. 01, 2020	Nov. 30, 2021
Pre-Amplifier EMCI	EMC001340	980142	May 25, 2020	May 24, 2021
Loop Antenna Electro-Metrics	EM-6879	264	Mar. 05, 2021	Mar. 04, 2022
RF Cable	5D-FB	LOOPCAB-001	Jan. 07, 2021	Jan. 06, 2022
RF Cable	5D-FB	LOOPCAB-002	Jan. 07, 2021	Jan. 06, 2022
Pre-Amplifier EMCI	EMC330N	980701	Mar. 10, 2021	Mar. 09, 2022
Trilog Broadband Antenna SCHWARZBECK	VULB 9168	9168-406	Nov. 06, 2020	Nov. 05, 2021
RF Cable	8D	966-4-1	Mar. 17, 2021	Mar. 16, 2022
RF Cable	8D	966-4-2	Mar. 17, 2021	Mar. 16, 2022
RF Cable	8D	966-4-3	Mar. 17, 2021	Mar. 16, 2022
Fixed attenuator Mini-Circuits	UNAT-5+	PAD-ATT5-03	Jan. 11, 2021	Jan. 10, 2022
Software	ADT_Radiated_V8.7.08	NA	NA	NA
Boresight Antenna Tower & Turn Table Max-Full	MF-7802BS	MF780208530	NA	NA

Note:

1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. The test was performed in 966 Chamber No. 4.
3. Tested Date: Mar. 23, 2021

For Radiated Emission test: (Above 1GHz)

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	CALIBRATED DATE	CALIBRATED UNTIL
Test Receiver Agilent	N9038A	MY51210202	Dec. 01, 2020	Nov. 30, 2021
Horn_Antenna SCHWARZBECK	BBHA 9120D	9120D-783	Nov. 22, 2020	Nov. 21, 2021
Pre-Amplifier EMCI	EMC 12630 SE	980638	Apr. 07, 2021	Apr. 06, 2022
RF Cable	EMC104-SM-SM-1200	160922	Dec. 25, 2020	Dec. 24, 2021
RF Cable	EMC104-SM-SM-2000	180502	Apr. 29, 2020	Apr. 28, 2021
RF Cable	EMC104-SM-SM-6000	180418	Apr. 29, 2020	Apr. 28, 2021
Pre-Amplifier EMCI	EMC184045SE	980387	Jan. 11, 2021	Jan. 10, 2022
Horn_Antenna SCHWARZBECK	BBHA 9170	BBHA9170519	Nov. 22, 2020	Nov. 21, 2021
RF Cable	EMC102-KM-KM-1200	160924	Jan. 11, 2021	Jan. 10, 2022
RF Cable	EMC-KM-KM-4000	200214	Mar. 10, 2021	Mar. 09, 2022
Software	ADT_Radiated_V8.7.08	NA	NA	NA
Boresight Antenna Tower & Turn Table Max-Full	MF-7802BS	MF780208530	NA	NA

Note:

1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. The test was performed in 966 Chamber No. 4.
3. Tested Date: Apr. 15, 2021

For other test items:

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	CALIBRATED DATE	CALIBRATED UNTIL
Spectrum Analyzer R&S	FSV40	100964	May 29, 2020	May 28, 2021
Power meter Anritsu	ML2495A	1529002	July 22, 2020	July 21, 2021
Power sensor Anritsu	MA2411B	1339443	July 22, 2020	July 21, 2021
Fixed Attenuator Mini-Circuits	MDCS18N-10	MDCS18N-10-01	Apr. 14, 2020	Apr. 13, 2021
Software	ADT_RF Test Software V6.6.5.4	NA	NA	NA

NOTE:

1. The test was performed in Oven room 2.
2. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
3. Tested Date: Mar. 26, 2021

4.1.3 Test Procedures

For Radiated emission below 30MHz

- 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. The test-receiver system was set to Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

Note:

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

For Radiated emission above 30MHz

- 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. The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.
- 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:

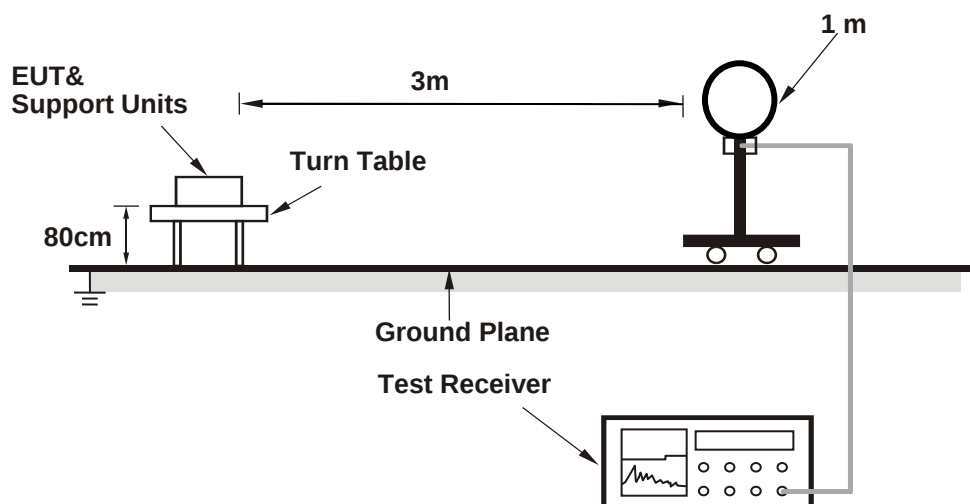
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Average detection (AV) at frequency above 1GHz.
4. All modes of operation were investigated and the worst-case emissions are reported.

4.1.4 Deviation from Test Standard

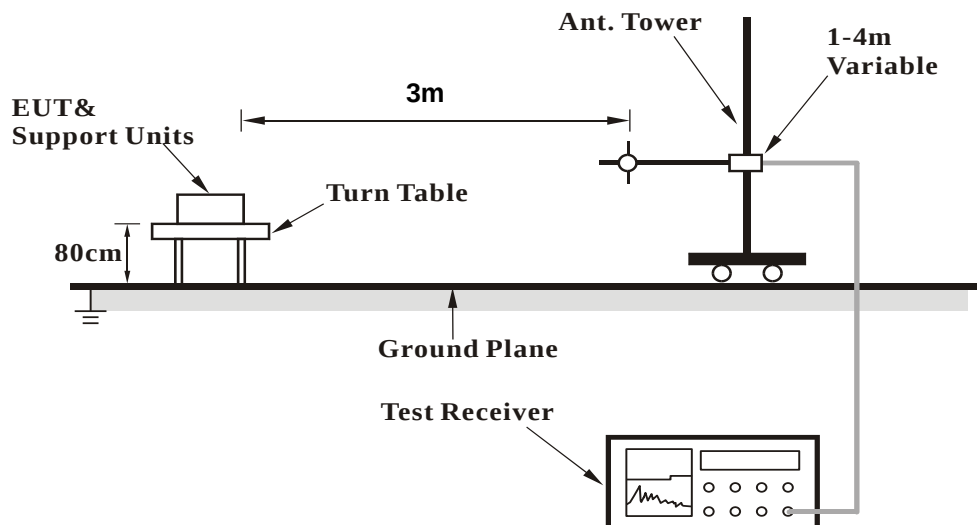
No deviation.

4.1.5 Test Setup

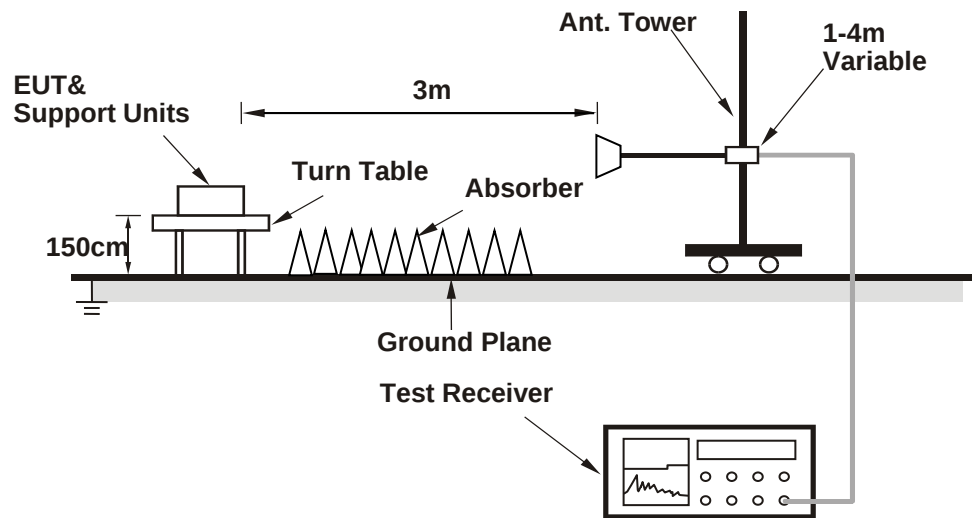
For Radiated emission below 30MHz



For Radiated emission 30MHz to 1GHz



For Radiated emission above 1GHz



For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.1.6 EUT Operating Conditions

- a. Placed the EUT on the testing table.
 - b. Controlling software (RF Sample with Receiver [Number Lock]) has been activated to set the EUT under transmission condition continuously at specific channel frequency.
- ◆ BLE1M TX Modulated low duty cycle on channel 2402MHz
 - BLE1M TX Modulated low duty cycle on channel 2440MHz
 - BLE1M TX Modulated low duty cycle on channel 2480MHz
 - BLE2M TX Modulated low duty cycle on channel 2404MHz
 - BLE2M TX Modulated low duty cycle on channel 2440MHz
 - BLE2M TX Modulated low duty cycle on channel 2478MHz

4.1.7 Test Results

Above 1GHz Data:

BT-LE 1M

RF Mode	TX BT-LE 1M	Channel	CH 0 : 2402 MHz
Frequency Range	1GHz ~ 25GHz	Detector Function	Peak (PK) Average (AV)

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	2378.24	54.7 PK	74.0	-19.3	1.23 H	46	59.1	-4.4
2	2378.24	44.1 AV	54.0	-9.9	1.23 H	46	48.5	-4.4
3	*2402.00	102.4 PK			1.23 H	46	106.8	-4.4
4	*2402.00	76.1 AV			1.23 H	46	80.5	-4.4
5	4804.00	47.5 PK	74.0	-26.5	1.35 H	17	47.5	0.0
6	4804.00	21.2 AV	54.0	-32.8	1.35 H	17	21.2	0.0
Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	2315.40	54.7 PK	74.0	-19.3	4.00 V	171	59.0	-4.3
2	2315.40	43.5 AV	54.0	-10.5	4.00 V	171	47.8	-4.3
3	*2402.00	98.6 PK			4.00 V	171	103.0	-4.4
4	*2402.00	72.3 AV			4.00 V	171	76.7	-4.4
5	4804.00	45.4 PK	74.0	-28.6	1.05 V	220	45.4	0.0
6	4804.00	19.1 AV	54.0	-34.9	1.05 V	220	19.1	0.0

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.
6. The average value of fundamental and harmonic frequency is: Average = Peak value + 20 log(Duty cycle) Where the duty factor is calculated from following formula:

$$20 \log(\text{Duty cycle}) = 20 \log(0.343 \text{ ms} / 7.091 \text{ ms}) = -26.3 \text{ dB}$$
Please see section 3.3 for plotted duty.

RF Mode	TX BT-LE 1M	Channel	CH 19 : 2440 MHz
Frequency Range	1GHz ~ 25GHz	Detector Function	Peak (PK) Average (AV)

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	*2440.00	102.4 PK			1.22 H	45	106.8	-4.4
2	*2440.00	76.1 AV			1.22 H	45	80.5	-4.4
3	4880.00	47.9 PK	74.0	-26.1	1.36 H	8	47.8	0.1
4	4880.00	21.6 AV	54.0	-32.4	1.36 H	8	21.5	0.1
5	7320.00	53.5 PK	74.0	-20.5	1.31 H	173	47.2	6.3
6	7320.00	27.2 AV	54.0	-26.8	1.31 H	173	20.9	6.3
Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	*2440.00	97.9 PK			3.98 V	161	102.3	-4.4
2	*2440.00	71.6 AV			3.98 V	161	76.0	-4.4
3	4880.00	45.1 PK	74.0	-28.9	1.00 V	231	45.0	0.1
4	4880.00	18.8 AV	54.0	-35.2	1.00 V	231	18.7	0.1
5	7320.00	55.7 PK	74.0	-18.3	1.05 V	224	49.4	6.3
6	7320.00	29.4 AV	54.0	-24.6	1.05 V	224	23.1	6.3

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.
6. The average value of fundamental and harmonic frequency is: Average = Peak value + 20 log(Duty cycle) Where the duty factor is calculated from following formula:

$$20 \log(\text{Duty cycle}) = 20 \log(0.343 \text{ ms} / 7.091 \text{ ms}) = -26.3 \text{ dB}$$
 Please see section 3.3 for plotted duty.

RF Mode	TX BT-LE 1M	Channel	CH 39 : 2480 MHz
Frequency Range	1GHz ~ 25GHz	Detector Function	Peak (PK) Average (AV)

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	*2480.00	101.8 PK			1.16 H	46	106.3	-4.5
2	*2480.00	75.5 AV			1.16 H	46	80.0	-4.5
3	2490.95	54.2 PK	74.0	-19.8	1.16 H	46	58.7	-4.5
4	2490.95	27.9 AV	54.0	-26.1	1.16 H	46	32.4	-4.5
5	4960.00	48.2 PK	74.0	-25.8	1.42 H	8	47.6	0.6
6	4960.00	21.9 AV	54.0	-32.1	1.42 H	8	21.3	0.6
7	7440.00	54.1 PK	74.0	-19.9	1.33 H	159	47.4	6.7
8	7440.00	27.8 AV	54.0	-26.2	1.33 H	159	21.1	6.7
Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	*2480.00	98.8 PK			3.98 V	167	103.3	-4.5
2	*2480.00	72.5 AV			3.98 V	167	77.0	-4.5
3	2490.55	54.0 PK	74.0	-20.0	3.98 V	167	58.5	-4.5
4	2490.55	27.7 AV	54.0	-26.3	3.98 V	167	32.2	-4.5
5	4960.00	45.7 PK	74.0	-28.3	1.03 V	221	45.1	0.6
6	4960.00	19.4 AV	54.0	-34.6	1.03 V	221	18.8	0.6
7	7440.00	55.2 PK	74.0	-18.8	1.00 V	211	48.5	6.7
8	7440.00	28.9 AV	54.0	-25.1	1.00 V	211	22.2	6.7

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.
6. The average value of fundamental and harmonic frequency is: Average = Peak value + 20 log(Duty cycle) Where the duty factor is calculated from following formula:

$$20 \log(\text{Duty cycle}) = 20 \log(0.343 \text{ ms} / 7.091 \text{ ms}) = -26.3 \text{ dB}$$
Please see section 3.3 for plotted duty.

BT-LE 2M

RF Mode	TX BT-LE 2M	Channel	CH 1 : 2404 MHz
Frequency Range	1GHz ~ 25GHz	Detector Function	Peak (PK) Average (AV)

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	2375.08	55.3 PK	74.0	-18.7	1.24 H	45	59.7	-4.4
2	2375.08	45.4 AV	54.0	-8.6	1.24 H	45	49.8	-4.4
3	*2404.00	102.3 PK			1.24 H	45	106.7	-4.4
4	*2404.00	70.4 AV			1.24 H	45	74.8	-4.4
5	4808.00	48.3 PK	74.0	-25.7	1.38 H	0	48.3	0.0
6	4808.00	16.4 AV	54.0	-37.6	1.38 H	0	16.4	0.0
Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	2335.10	54.6 PK	74.0	-19.4	3.97 V	171	58.9	-4.3
2	2335.10	45.2 AV	54.0	-8.8	3.97 V	171	49.5	-4.3
3	*2404.00	98.9 PK			3.97 V	171	103.3	-4.4
4	*2404.00	67.0 AV			3.97 V	171	71.4	-4.4
5	4808.00	45.0 PK	74.0	-29.0	1.04 V	236	45.0	0.0
6	4808.00	13.1 AV	54.0	-40.9	1.04 V	236	13.1	0.0

Remarks:

- Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
- Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
- Margin value = Emission Level – Limit value
- The other emission levels were very low against the limit.
- " * ": Fundamental frequency.
- The average value of fundamental and harmonic frequency is: Average = Peak value + 20 log(Duty cycle) Where the duty factor is calculated from following formula:

$$20 \log(\text{Duty cycle}) = 20 \log(0.178 \text{ ms} / 7.033 \text{ ms}) = -31.9 \text{ dB}$$
 Please see section 3.3 for plotted duty.

RF Mode	TX BT-LE 2M	Channel	CH 19 : 2440 MHz
Frequency Range	1GHz ~ 25GHz	Detector Function	Peak (PK) Average (AV)

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	*2440.00	102.6 PK			1.24 H	40	107.0	-4.4
2	*2440.00	70.7 AV			1.24 H	40	75.1	-4.4
3	4880.00	47.8 PK	74.0	-26.2	1.36 H	1	47.7	0.1
4	4880.00	15.9 AV	54.0	-38.1	1.36 H	1	15.8	0.1
5	7320.00	53.5 PK	74.0	-20.5	1.27 H	186	47.2	6.3
6	7320.00	21.6 AV	54.0	-32.4	1.27 H	186	15.3	6.3
Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	*2440.00	99.1 PK			3.97 V	185	103.5	-4.4
2	*2440.00	67.2 AV			3.97 V	185	71.6	-4.4
3	4880.00	44.7 PK	74.0	-29.3	1.04 V	233	44.6	0.1
4	4880.00	12.8 AV	54.0	-41.2	1.04 V	233	12.7	0.1
5	7320.00	56.1 PK	74.0	-17.9	1.03 V	238	49.8	6.3
6	7320.00	24.2 AV	54.0	-29.8	1.03 V	238	17.9	6.3

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.
6. The average value of fundamental and harmonic frequency is: Average = Peak value + 20 log(Duty cycle) Where the duty factor is calculated from following formula:

$$20 \log(\text{Duty cycle}) = 20 \log(0.178 \text{ ms} / 7.033 \text{ ms}) = -31.9 \text{ dB}$$
 Please see section 3.3 for plotted duty.

RF Mode	TX BT-LE 2M	Channel	CH 38 : 2478 MHz
Frequency Range	1GHz ~ 25GHz	Detector Function	Peak (PK) Average (AV)

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	*2478.00	101.4 PK			1.17 H	46	105.9	-4.5
2	*2478.00	69.5 AV			1.17 H	46	74.0	-4.5
3	2486.86	54.6 PK	74.0	-19.4	1.17 H	46	59.1	-4.5
4	2486.86	22.7 AV	54.0	-31.3	1.17 H	46	27.2	-4.5
5	4956.00	47.5 PK	74.0	-26.5	1.35 H	23	46.9	0.6
6	4956.00	15.6 AV	54.0	-38.4	1.35 H	23	15.0	0.6
7	7434.00	53.6 PK	74.0	-20.4	1.32 H	187	46.9	6.7
8	7434.00	21.7 AV	54.0	-32.3	1.32 H	187	15.0	6.7
Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	*2478.00	98.4 PK			3.95 V	155	102.9	-4.5
2	*2478.00	66.5 AV			3.95 V	155	71.0	-4.5
3	2494.87	55.3 PK	74.0	-18.7	3.95 V	155	59.8	-4.5
4	2494.87	23.4 AV	54.0	-30.6	3.95 V	155	27.9	-4.5
5	4956.00	45.4 PK	74.0	-28.6	1.06 V	238	44.8	0.6
6	4956.00	13.5 AV	54.0	-40.5	1.06 V	238	12.9	0.6
7	7434.00	56.0 PK	74.0	-18.0	1.03 V	239	49.3	6.7
8	7434.00	24.1 AV	54.0	-29.9	1.03 V	239	17.4	6.7

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.
6. The average value of fundamental and harmonic frequency is: Average = Peak value + 20 log(Duty cycle) Where the duty factor is calculated from following formula:

$$20 \log(\text{Duty cycle}) = 20 \log(0.178 \text{ ms} / 7.033 \text{ ms}) = -31.9 \text{ dB}$$
 Please see section 3.3 for plotted duty.

Below 1GHz Data:

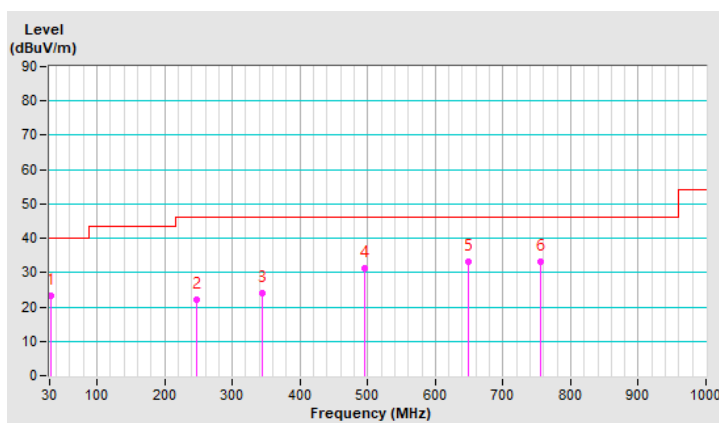
BT-LE 1M

RF Mode	TX BT-LE 1M	Channel	CH 0 : 2402 MHz
Frequency Range	9kHz ~ 1GHz	Detector Function	Quasi-Peak (QP)

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	31.48	23.1 QP	40.0	-16.9	2.00 H	60	36.8	-13.7
2	246.94	22.1 QP	46.0	-23.9	2.00 H	333	34.9	-12.8
3	343.96	24.1 QP	46.0	-21.9	1.00 H	280	33.6	-9.5
4	495.99	31.4 QP	46.0	-14.6	2.00 H	284	36.4	-5.0
5	648.04	33.1 QP	46.0	-12.9	1.50 H	229	34.4	-1.3
6	756.46	33.2 QP	46.0	-12.8	1.50 H	360	32.2	1.0

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit of frequency range 30MHz~1000MHz.
5. The emission levels were very low against the limit of frequency range 9kHz~30MHz: the amplitude of spurious emissions attenuated more than 20 dB below the permissible value to be report.

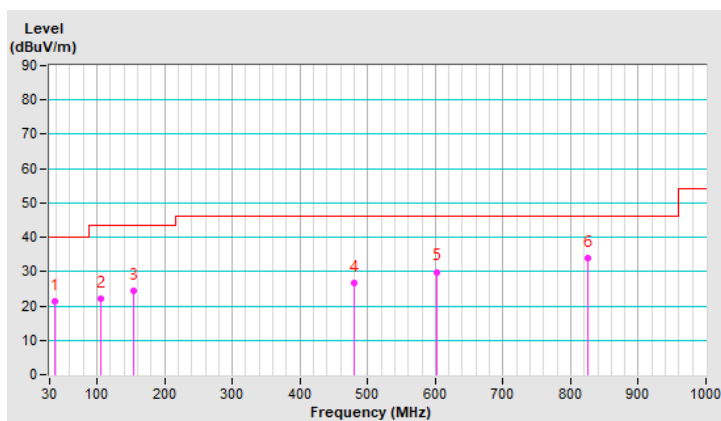


RF Mode	TX BT-LE 1M	Channel	CH 0 : 2402 MHz
Frequency Range	9kHz ~ 1GHz	Detector Function	Quasi-Peak (QP)

Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	38.71	21.4 QP	40.0	-18.6	1.00 V	286	34.3	-12.9
2	106.22	22.0 QP	43.5	-21.5	2.00 V	40	37.5	-15.5
3	154.81	24.4 QP	43.5	-19.1	1.50 V	115	36.2	-11.8
4	480.95	26.7 QP	46.0	-19.3	1.00 V	271	32.1	-5.4
5	602.20	29.9 QP	46.0	-16.1	2.00 V	360	32.1	-2.2
6	826.01	33.8 QP	46.0	-12.2	2.00 V	167	31.7	2.1

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit of frequency range 30MHz~1000MHz.
5. The emission levels were very low against the limit of frequency range 9kHz~30MHz: the amplitude of spurious emissions attenuated more than 20 dB below the permissible value to be report.

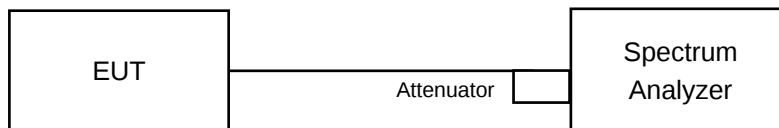


4.2 6dB Bandwidth Measurement

4.2.1 Limits of 6dB Bandwidth Measurement

The minimum of 6dB Bandwidth Measurement is 0.5 MHz.

4.2.2 Test Setup



4.2.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.2.4 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

4.2.5 Deviation from Test Standard

No deviation.

4.2.6 EUT Operating Conditions

The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

- ◆ BLE1M TX Modulated low duty cycle on channel 2402MHz
- BLE1M TX Modulated low duty cycle on channel 2440MHz
- BLE1M TX Modulated low duty cycle on channel 2480MHz
- BLE2M TX Modulated low duty cycle on channel 2404MHz
- BLE2M TX Modulated low duty cycle on channel 2440MHz
- BLE2M TX Modulated low duty cycle on channel 2478MHz

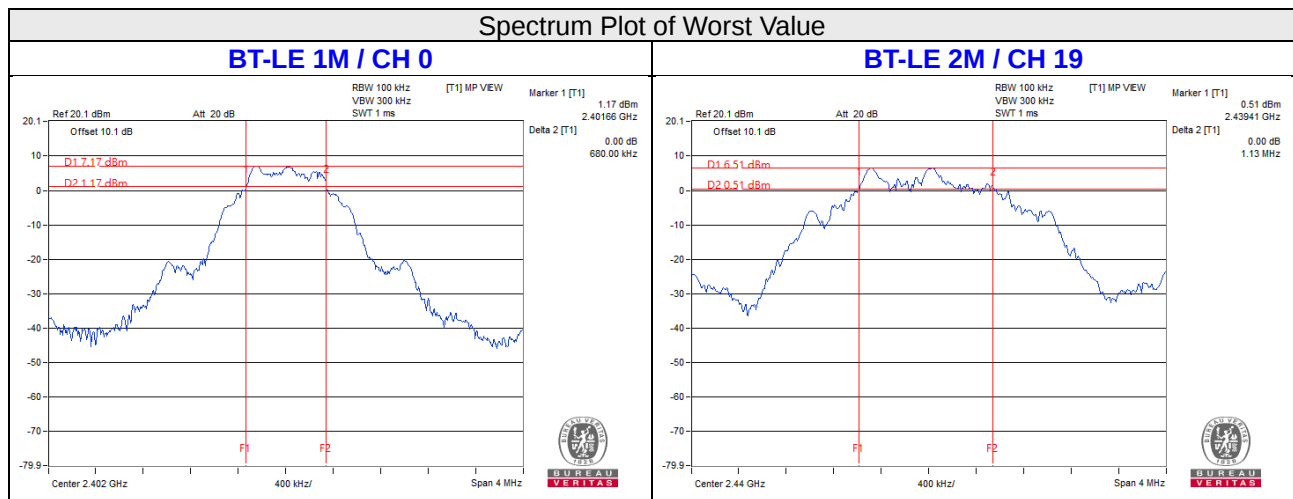
4.2.7 Test Results

BT-LE 1M

Channel	Frequency (MHz)	6dB Bandwidth (MHz)	Minimum Limit (MHz)	Pass / Fail
0	2402	0.68	0.5	Pass
19	2440	0.69	0.5	Pass
39	2480	0.71	0.5	Pass

BT-LE 2M

Channel	Frequency (MHz)	6dB Bandwidth (MHz)	Minimum Limit (MHz)	Pass / Fail
1	2404	1.19	0.5	Pass
19	2440	1.13	0.5	Pass
38	2478	1.13	0.5	Pass

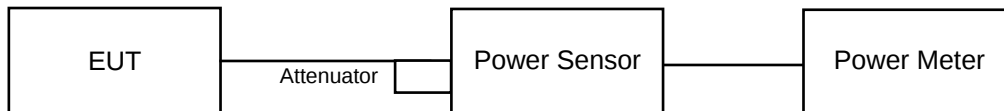


4.3 Conducted Output Power Measurement

4.3.1 Limits of Conducted Output Power Measurement

For systems using digital modulation in the 2400–2483.5 MHz bands: 1 Watt (30dBm)

4.3.2 Test Setup



4.3.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.3.4 Test Procedures

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.

Average power sensor was used to perform output power measurement, trigger and gating function of wide band power meter is enabled to measure max output power of TX on burst. Duty factor is not added to measured value.

4.3.5 Deviation from Test Standard

No deviation.

4.3.6 EUT Operating Conditions

The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

For BT-LE function & Logi bolt function mode:

- ◆ BLE1M TX Modulated low duty cycle on channel 2402MHz
- BLE1M TX Modulated low duty cycle on channel 2440MHz
- BLE1M TX Modulated low duty cycle on channel 2480MHz
- BLE2M TX Modulated low duty cycle on channel 2404MHz
- BLE2M TX Modulated low duty cycle on channel 2440MHz
- BLE2M TX Modulated low duty cycle on channel 2478MHz

4.3.7 Test Results

BT-LE function:

FOR PEAK POWER

BT-LE 1M

Channel	Frequency (MHz)	Peak Power (mW)	Peak Power (dBm)	Limit (dBm)	Pass/Fail
0	2402	4.909	6.91	30	Pass
19	2440	4.539	6.57	30	Pass
39	2480	4.111	6.14	30	Pass

BT-LE 2M

Channel	Frequency (MHz)	Peak Power (mW)	Peak Power (dBm)	Limit (dBm)	Pass/Fail
1	2404	4.887	6.89	30	Pass
19	2440	4.529	6.56	30	Pass
38	2478	4.121	6.15	30	Pass

FOR AVERAGE POWER

BT-LE 1M

Channel	Frequency (MHz)	Average Power (mW)	Average Power (dBm)
0	2402	4.875	6.88
19	2440	4.519	6.55
39	2480	4.083	6.11

BT-LE 2M

Channel	Frequency (MHz)	Average Power (mW)	Average Power (dBm)
1	2404	4.853	6.86
19	2440	4.498	6.53
38	2478	4.093	6.12

Logi bolt function:

FOR PEAK POWER

BT-LE 1M

Channel	Frequency (MHz)	Peak Power (mW)	Peak Power (dBm)	Limit (dBm)	Pass/Fail
0	2402	4.764	6.78	30	Pass
19	2440	4.416	6.45	30	Pass
39	2480	4.046	6.07	30	Pass

BT-LE 2M

Channel	Frequency (MHz)	Peak Power (mW)	Peak Power (dBm)	Limit (dBm)	Pass/Fail
1	2404	4.742	6.76	30	Pass
19	2440	4.406	6.44	30	Pass
38	2478	4.027	6.05	30	Pass

FOR AVERAGE POWER

BT-LE 1M

Channel	Frequency (MHz)	Average Power (mW)	Average Power (dBm)
0	2402	4.732	6.75
19	2440	4.385	6.42
39	2480	4.018	6.04

BT-LE 2M

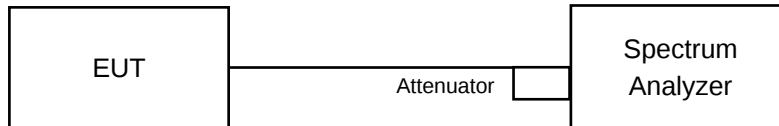
Channel	Frequency (MHz)	Average Power (mW)	Average Power (dBm)
1	2404	4.71	6.73
19	2440	4.375	6.41
38	2478	3.999	6.02

4.4 Power Spectral Density Measurement

4.4.1 Limits of Power Spectral Density Measurement

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

4.4.2 Test Setup



4.4.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.4.4 Test Procedure

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

4.4.5 Deviation from Test Standard

No deviation.

4.4.6 EUT Operating Condition

The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

- ◆ BLE1M TX Modulated low duty cycle on channel 2402MHz
- BLE1M TX Modulated low duty cycle on channel 2440MHz
- BLE1M TX Modulated low duty cycle on channel 2480MHz
- BLE2M TX Modulated low duty cycle on channel 2404MHz
- BLE2M TX Modulated low duty cycle on channel 2440MHz
- BLE2M TX Modulated low duty cycle on channel 2478MHz

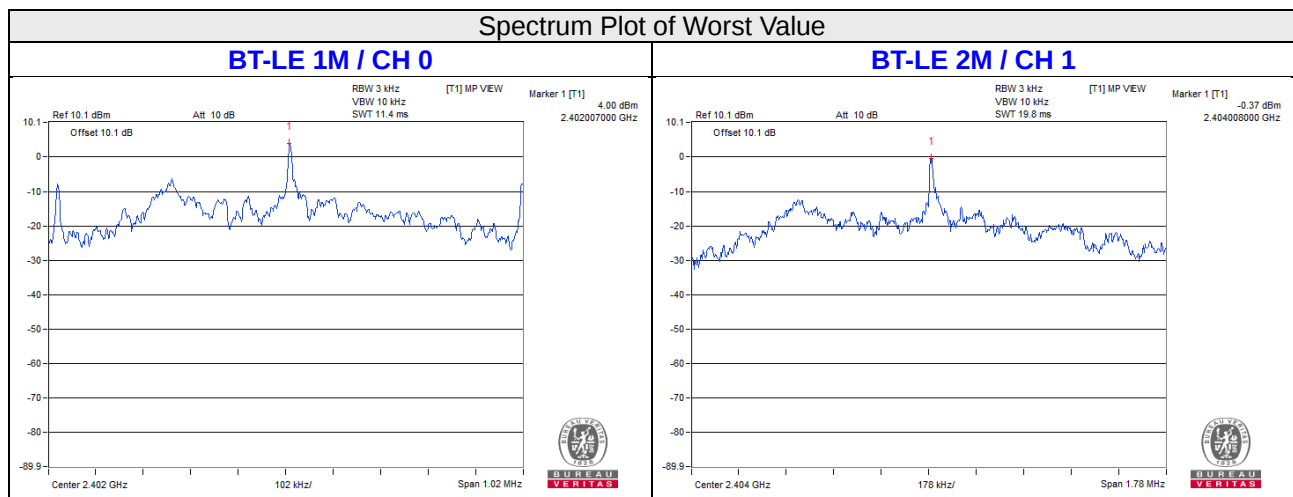
4.4.7 Test Results

BT-LE 1M

Channel	Freq. (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Pass /Fail
0	2402	4.00	8	Pass
19	2440	3.38	8	Pass
39	2480	2.78	8	Pass

BT-LE 2M

Channel	Freq. (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Pass /Fail
1	2404	-0.37	8	Pass
19	2440	-0.94	8	Pass
38	2478	-1.47	8	Pass

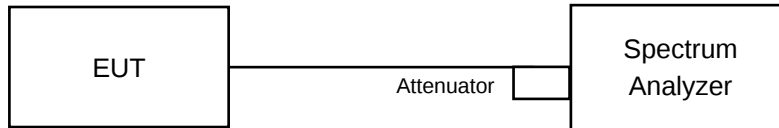


4.5 Conducted Out of Band Emission Measurement

4.5.1 Limits of Conducted Out of Band Emission Measurement

Below 20dB of the highest emission level of operating band (in 100kHz Resolution Bandwidth).

4.5.2 Test Setup



4.5.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.5.4 Test Procedure

MEASUREMENT PROCEDURE REF

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

MEASUREMENT PROCEDURE OOB

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

4.5.5 Deviation from Test Standard

No deviation.

4.5.6 EUT Operating Condition

The software provided by client enabled the EUT to transmit and receive data at lowest and highest channel frequencies individually.

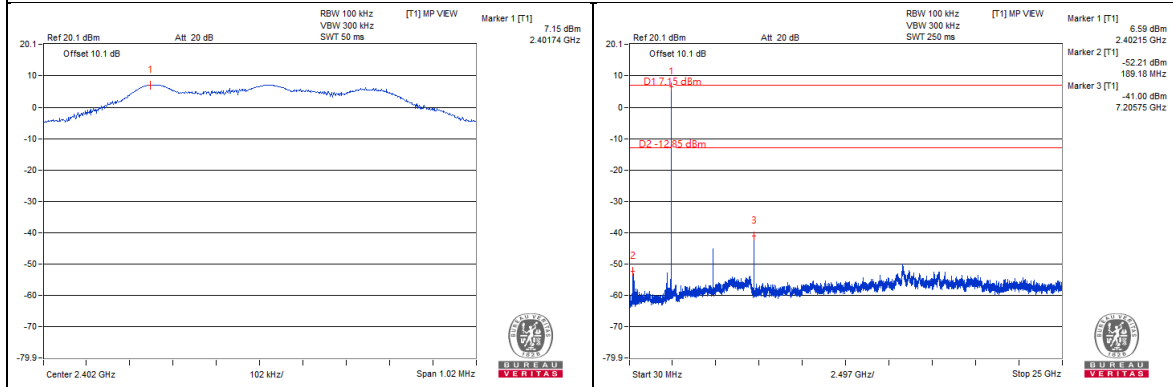
- ◆ BLE1M TX Modulated low duty cycle on channel 2402MHz
- BLE1M TX Modulated low duty cycle on channel 2480MHz
- BLE2M TX Modulated low duty cycle on channel 2404MHz
- BLE2M TX Modulated low duty cycle on channel 2478MHz

4.5.7 Test Results

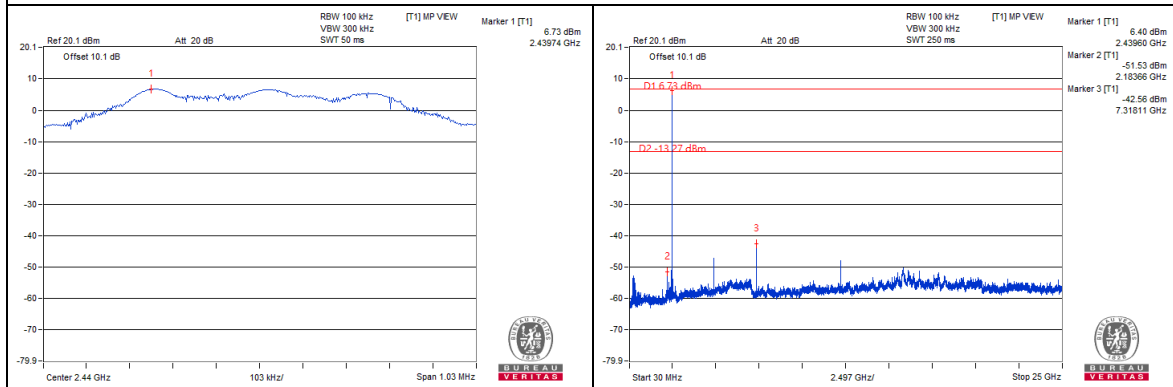
The spectrum plots are attached on the following pages. D1 line indicates the highest level, and D2 line indicates the 20dB offset below D1. It shows compliance with the requirement.

BT-LE 1M

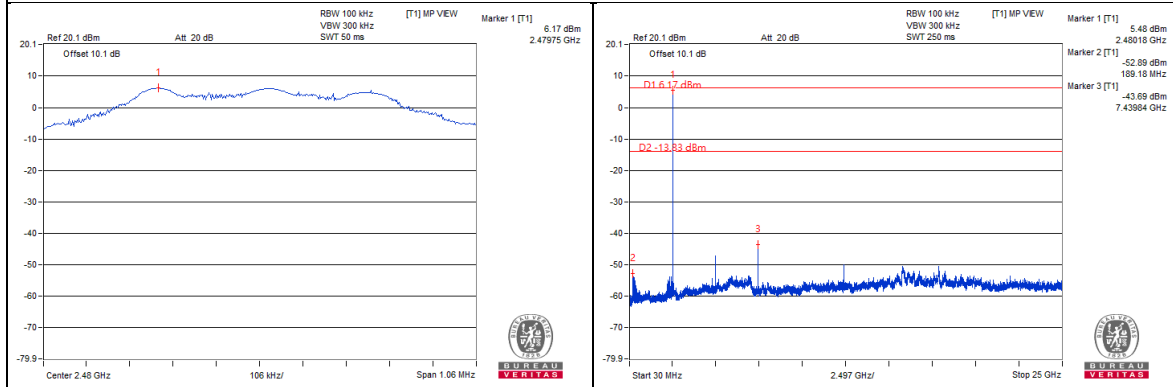
CH 0



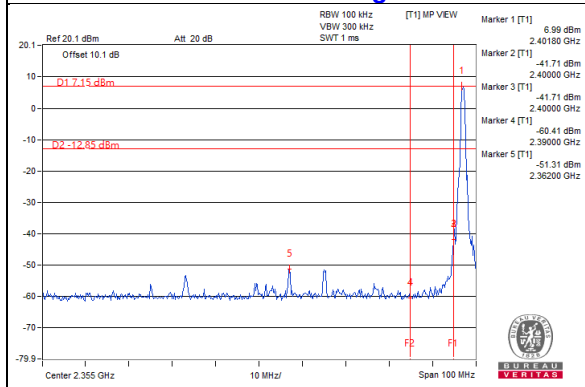
CH 19



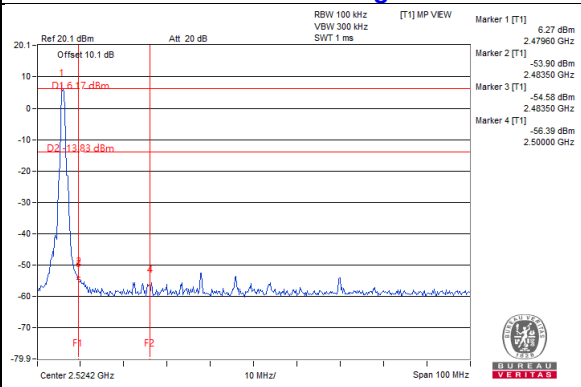
CH 39



CH 0 Band edge

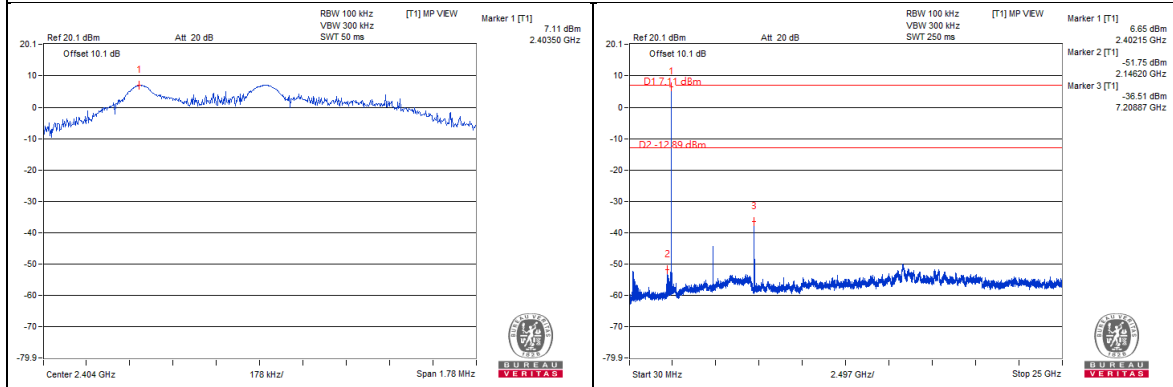


CH 39 Band edge

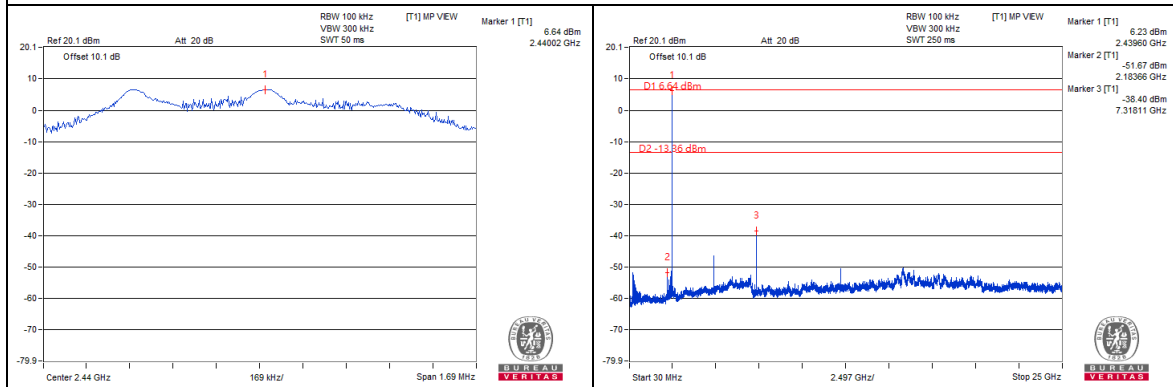


BT-LE 2M

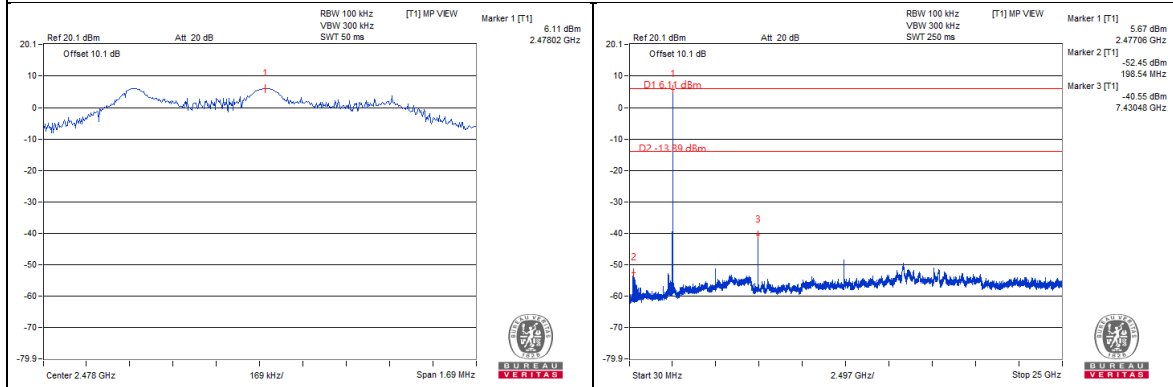
CH 1



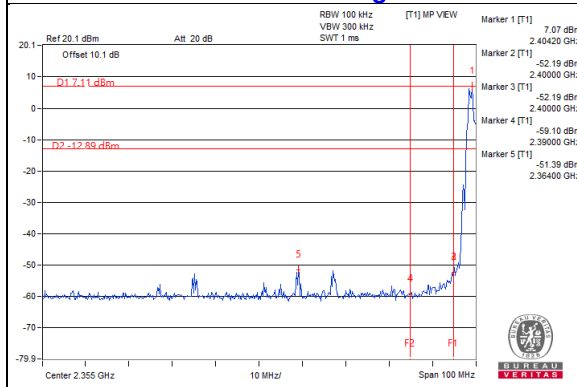
CH 19



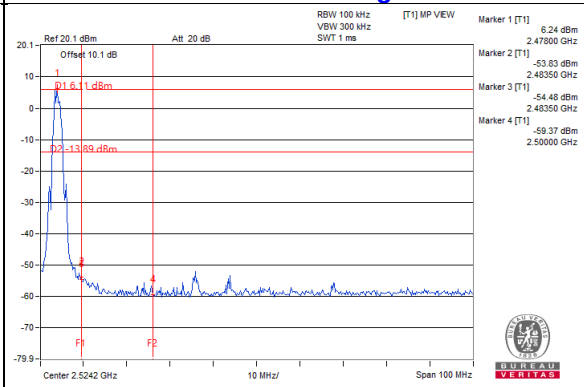
CH 38



CH 1 Band edge



CH 38 Band edge

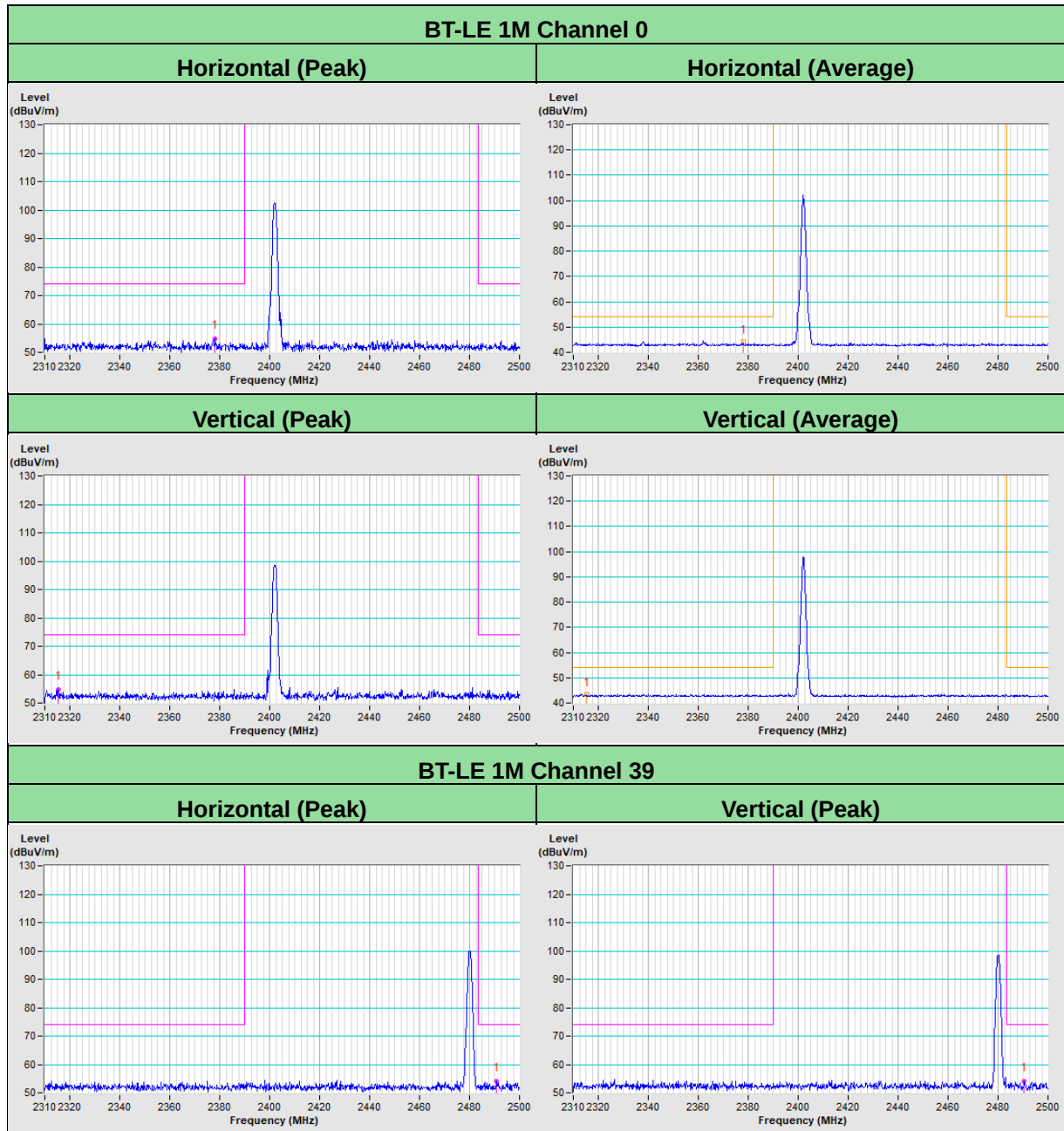


5 Pictures of Test Arrangements

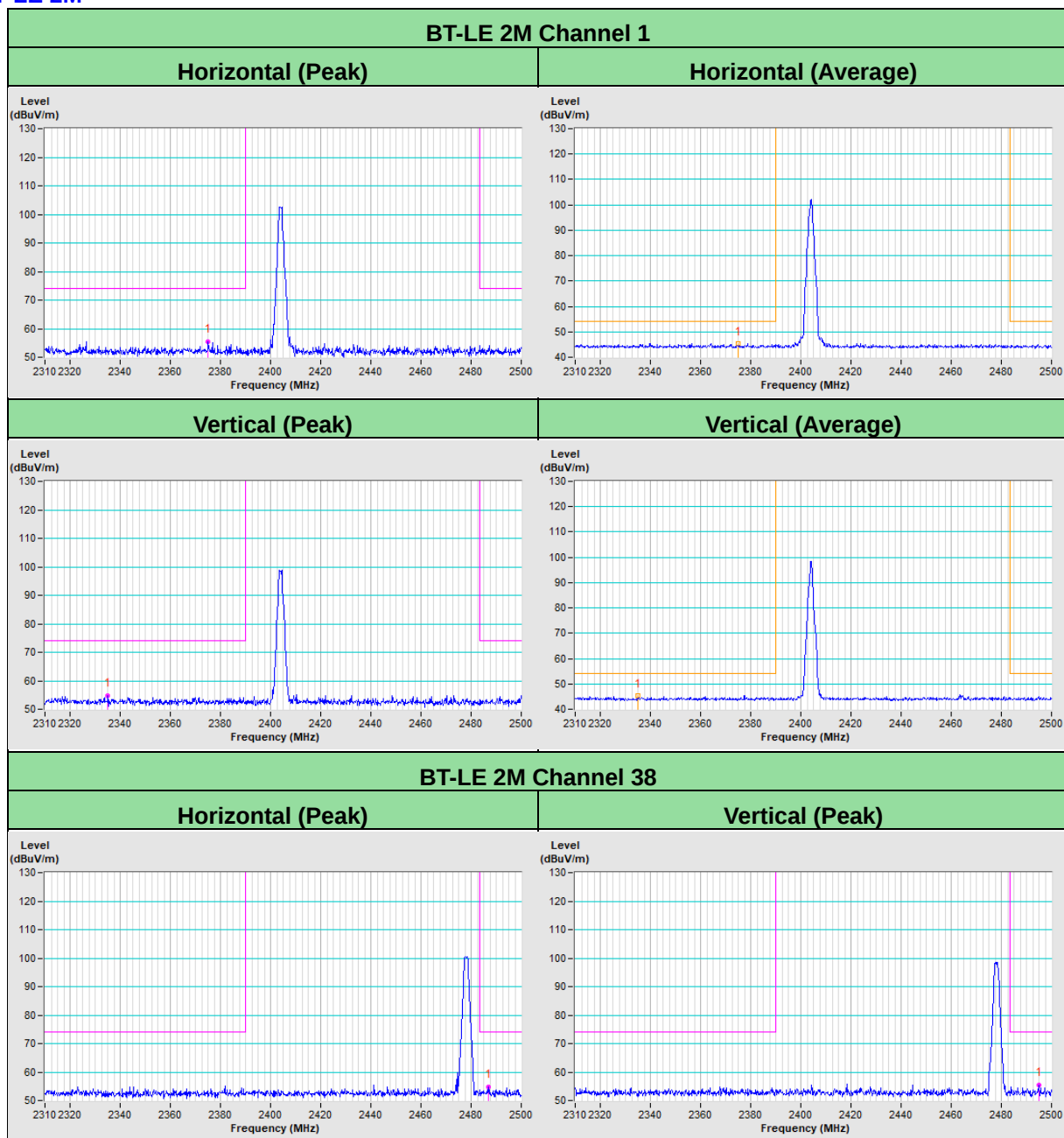
Please refer to the attached file (Test Setup Photo).

Annex A - Band-Edge Measurement

BT-LE 1M



BT-LE 2M



Appendix – Information of the Testing Laboratories

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are FCC recognized accredited test firms and accredited according to ISO/IEC 17025.

If you have any comments, please feel free to contact us at the following:

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Web Site: www.bureauveritas-adt.com

The address and road map of all our labs can be found in our web site also.

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