FCC Test Report (GFSK)

Report No.:	RFBDKG-WTW-P20060123
FCC ID:	JNZMR0086
Test Model:	MR0086
Received Date:	June 30, 2020
Test Date:	July 03 to 07, 2020
Issued Date:	July 29, 2020
Applicant:	LOGITECH FAR EAST LTD.
Address:	#2 Creation Rd. 4, Science-Based Ind. Park Hsinchu Taiwan, R.O.C.
Issued By:	Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch Hsin Chu Laboratory
Lab Address:	E-2, No.1, Li Hsin 1st Road, Hsinchu Science Park, Hsinchu City 300, Taiwan
Test Location:	E-2, No.1, Li Hsin 1st Road, Hsinchu Science Park, Hsinchu City 300, Taiwan
FCC Registration / Designation Number:	723255 / TW2022

Table of Contents

Release Control Record 4

1 Certificate of Conformity 5

2 Summary of Test Results 6

2.1 Measurement Uncertainty 6
2.2 Modification Record 6

3 General Information 7

3.1 General Description of EUT (GFSK) 7
3.2 Description of Test Modes 8
3.2.1 Test Mode Applicability and Tested Channel Detail 9
3.3 Duty Cycle of Test Signal 11
3.4 Description of Support Units 12
3.4.1 Configuration of System under Test 12
3.5 General Description of Applied Standards and References 13

4 Test Types and Results 14

4.1 Radiated Emission and Bandedge Measurement 14
4.1.1 Limits of Radiated Emission and Bandedge Measurement 14
4.1.2 Test Instruments 15
4.1.3 Test Procedures 17
4.1.4 Deviation from Test Standard 18
4.1.5 Test Setup 18
4.1.6 EUT Operating Conditions 19
4.1.7 Test Results 20
4.2 Conducted Emission Measurement 25
4.2.1 Limits of Conducted Emission Measurement 25
4.2.2 Test Instruments 25
4.2.3 Test Procedures 26
4.2.4 Deviation from Test Standard 26
4.2.5 Test Setup 26
4.2.6 EUT Operating Conditions 26
4.2.7 Test Results 27
4.3 6dB Bandwidth Measurement 29
4.3.1 Limits of 6dB Bandwidth Measurement 29
4.3.2 Test Setup 29
4.3.3 Test Instruments 29
4.3.4 Test Procedure 29
4.3.5 Deviation from Test Standard 29
4.3.6 EUT Operating Conditions 29
4.3.7 Test Results 30
4.4 Conducted Output Power Measurement 31
4.4.1 Limits of Conducted Output Power Measurement 31
4.4.2 Test Setup 31
4.4.3 Test Instruments 31
4.4.4 Test Procedures 31
4.4.5 Deviation from Test Standard 31
4.4.6 EUT Operating Conditions 31
4.4.7 Test Results 32
4.5 Power Spectral Density Measurement 33
4.5.1 Limits of Power Spectral Density Measurement 33
4.5.2 Test Setup 33
4.5.3 Test Instruments 33
4.5.4 Test Procedure 33
4.5.5 Deviation from Test Standard 33
4.5.6 EUT Operating Condition 33

4.5.7 Test Results 34
4.6 Conducted Out of Band Emission Measurement 35
4.6.1 Limits of Conducted Out of Band Emission Measurement 35
4.6.2 Test Setup 35
4.6.3 Test Instruments 35
4.6.4 Test Procedure 35
4.6.5 Deviation from Test Standard 35
4.6.6 EUT Operating Condition 35
4.6.7 Test Results 35
5 Pictures of Test Arrangements 37
Annex A - Band-Edge Measurement 38
Appendix – Information of the Testing Laboratories 39

Release Control Record

Issue No.	Description	Date Issued
RFBDKG-WTW-P20060123	Original release.	July 29, 2020

1 Certificate of Conformity

Product:	Wireless mouse
Brand:	logitech G
Test Model:	MR0086
Sample Status:	ENGINEERING SAMPLE
Applicant:	LOGITECH FAR EAST LTD.
Test Date:	July 03 to 07, 2020
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 : Cherry Chuo , **Date:** July 29, 2020

Cherrry Chuo / Specialist

Approved by : , **Date:** July 29, 2020

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	PASS	Meet the requirement of limit. Minimum passing margin is -4.53 dB at 0.48203 MHz.
15.205 / 15.209 / 15.247(d)	Radiated Emissions and Band Edge Measurement	PASS	Meet the requirement of limit. Minimum passing margin is -3.0 dB at 2483.50 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:
1. For 2.4 GHz band compliance with rule 15.247(d) of the band-edge items, the test plots were recorded in Annex A.
2. 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) (±)
Conducted Emissions at mains ports	150kHz ~ 30MHz	1.9 dB
Conducted emissions	-	2.5 dB
Radiated Emissions up to 1 GHz	9kHz ~ 30MHz	3.1 dB
	30MHz ~ 1GHz	5.4 dB
Radiated Emissions above 1 GHz	1GHz ~ 18GHz	5.0 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 (GFSK)

Product	Wireless mouse
Brand	logitech G
Test Model	MR0086
Status of EUT	ENGINEERING SAMPLE
Power Supply Rating	3.7Vdc from battery or 5Vdc from USB interface
Modulation Type	GFSK
Transfer Rate	Up to 2 Mbps
Operating Frequency	2.403 ~ 2.481 GHz
Number of Channel	79
Output Power	5.023 mW
Antenna Type	Refer to Note
Antenna Connector	Refer to Note
Accessory Device	NA
Cable Supplied	USB cable x1 (Shielded with one core, 1.8m)

Note:

1. The EUT may have a lot of colors for marketing requirement.
2. The EUT power needs to be supplied from a battery, the information is as below table:

Brand	Model No.	Spec.
SYNERGY	AHB521630PJT-04	3.7V, 240mAh, 0.9Wh

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

Brand	Model	Antenna Net Gain(dBi)	Frequency range	Antenna Type	Connector Type
Logitech	NA	1.68	2.4~2.4835GHz	Printed Antenna	None

4. For conducted emissions, the EUT was pre-tested under the following modes:

Test Mode	Description
Mode A	**Power from adapter**
Mode B	Power from Laptop

From the above modes, the worst case was found in **Mode A**. Therefore only the test data of the mode was recorded in this report.

5. For radiated emissions, the EUT was pre-tested under the following modes:

Test Mode	Description
Mode A	**Power from adapter**
Mode B	Power from battery

From the above modes, the worst spurious emission was found in **Mode A**. Therefore only the test data of the modes were recorded in this report.

6. The above EUT information is declared by manufacturer and for more detailed features description, please refers to the manufacturer's specifications or user's manual.
7. 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

79 channels are provided to this EUT:

Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)
1	2403	21	2423	41	2443	61	2463
2	2404	22	2424	42	2444	62	2464
3	2405	23	2425	43	2445	63	2465
4	2406	24	2426	44	2446	64	2466
5	2407	25	2427	45	2447	65	2467
6	2408	26	2428	46	2448	66	2468
7	2409	27	2429	47	2449	67	2469
8	2410	28	2430	48	2450	68	2470
9	2411	29	2431	49	2451	69	2471
10	2412	30	2432	50	2452	70	2472
11	2413	31	2433	51	2453	71	2473
12	2414	32	2434	52	2454	72	2474
13	2415	33	2435	53	2455	73	2475
14	2416	34	2436	54	2456	74	2476
15	2417	35	2437	55	2457	75	2477
16	2418	36	2438	56	2458	76	2478
17	2419	37	2439	57	2459	77	2479
18	2420	38	2440	58	2460	78	2480
19	2421	39	2441	59	2461	79	2481
20	2422	40	2442	60	2462		

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

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
1 to 79	1, 40, 79	GFSK

Power Line Conducted Emission Test:

☒ 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
1 to 79	1	GFSK

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
1 to 79	1	GFSK

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.

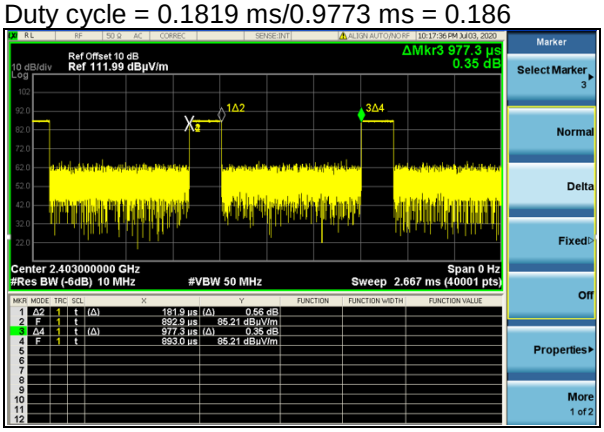
Available Channel	Tested Channel	Modulation Type
1 to 79	1, 40, 79	GFSK

Test Condition:

Applicable To	Environmental Conditions	Input Power (System)	Tested by
RE≥1G	25deg. C, 75%RH	120Vac, 60Hz	Kevin Ko
RE<1G	28deg. C, 73%RH	120Vac, 60Hz	Kevin Ko
PLC	25deg. C, 60%RH	120Vac, 60Hz	Jyunchun Lin
APCM	25deg. C, 75%RH	120Vac, 60Hz	Kevin Ko

3.3 Duty Cycle of Test Signal

Duty cycle = 0.1819 ms/0.9773 ms = 0.186



3.4 Description of Support Units

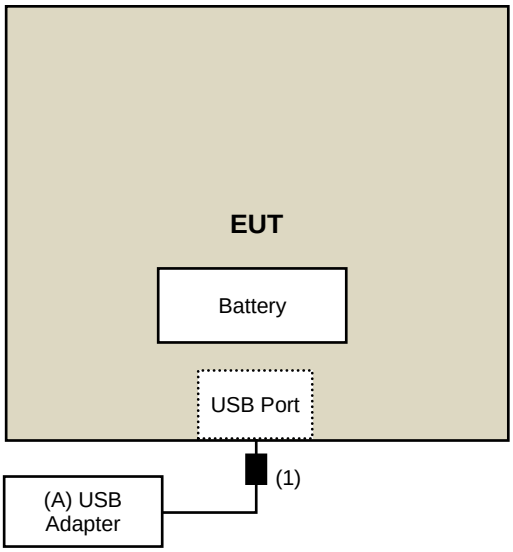
The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A	USB Adapter	ASUS	EXA1205UA	NA	NA	Provided by Lab

ID	Descriptions	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1.	USB Cable	1	1	Yes	1	Supplied by client

Note: The core is originally attached to the cable.

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 & BandEdge test:

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	CALIBRATED DATE	CALIBRATED UNTIL
Test Receiver Keysight	N9038A	MY51210202	Dec. 13, 2019	Dec. 12, 2020
Pre-Amplifier EMCI	EMC001340	980142	May 25, 2020	May 24, 2021
Loop Antenna Electro-Metrics	EM-6879	264	Feb. 18, 2020	Feb. 17, 2021
RF Cable	NA	LOOPCAB-001	Jan. 08, 2020	Jan. 07, 2021
RF Cable	NA	LOOPCAB-002	Jan. 08, 2020	Jan. 07, 2021
Pre-Amplifier Mini-Circuits	ZFL-1000VH2B	AMP-ZFL-05	Apr. 28, 2020	Apr. 27, 2021
Trilog Broadband Antenna SCHWARZBECK	VULB 9168	9168-361	Nov. 11, 2019	Nov. 10, 2020
RF Cable	8D	966-3-1	Mar. 17, 2020	Mar. 16, 2021
RF Cable	8D	966-3-2	Mar. 17, 2020	Mar. 16, 2021
RF Cable	8D	966-3-3	Mar. 17, 2020	Mar. 16, 2021
Fixed attenuator Mini-Circuits	UNAT-5+	PAD-3m-3-01	Sep. 26, 2019	Sep. 25, 2020
Horn_Antenna SCHWARZBECK	BBHA9120-D	9120D-406	Nov. 24, 2019	Nov. 23, 2020
Pre-Amplifier EMCI	EMC12630SE	980384	Jan. 15, 2020	Jan. 14, 2021
RF Cable	EMC104-SM-SM-1200	160922	Jan. 15, 2020	Jan. 14, 2021
RF Cable	EMC104-SM-SM-2000	180601	June 09, 2020	June 08, 2021
RF Cable	EMC104-SM-SM-6000	180602	June 09, 2020	June 08, 2021
Spectrum Analyzer Keysight	N9030A	MY54490679	July 17, 2019	July 16, 2020
Pre-Amplifier EMCI	EMC184045SE	980387	Jan. 15, 2020	Jan. 14, 2021
Horn_Antenna SCHWARZBECK	BBHA 9170	BBHA9170519	Nov. 24, 2019	Nov. 23, 2020
RF Cable	EMC102-KM-KM-1200	160924	Jan. 15, 2020	Jan. 14, 2021
RF Cable	EMC-KM-KM-4000	200214	Mar. 11, 2020	Mar. 10, 2021
Software	ADT_Radiated_V8.7.08	NA	NA	NA
Antenna Tower & Turn Table Max-Full	MF-7802	MF780208406	NA	NA
Boresight Antenna Fixture	FBA-01	FBA-SIP01	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. 3.
3. Tested Date: July 03 to 07, 2020

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 26, 2019	July 25, 2020
Power sensor Anritsu	MA2411B	1339443	July 26, 2019	July 25, 2020
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: July 07, 2020

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:

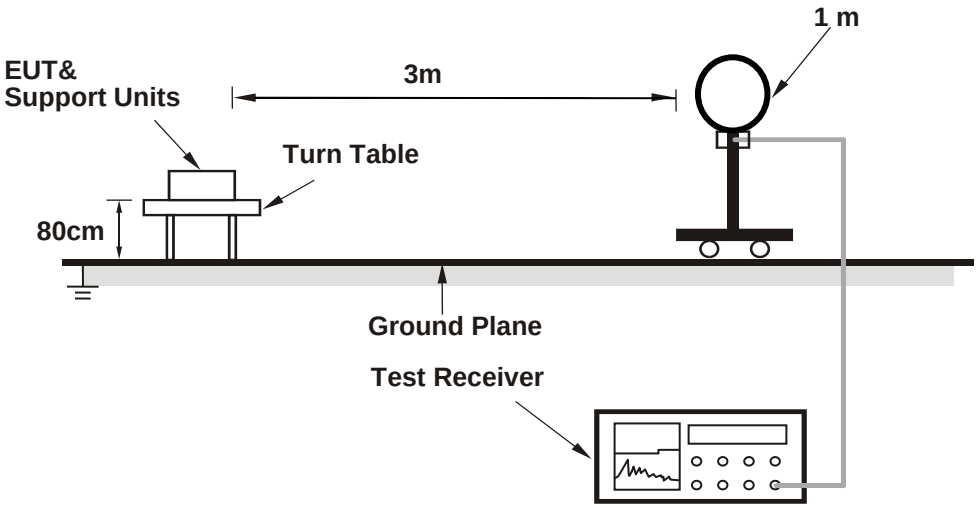
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
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

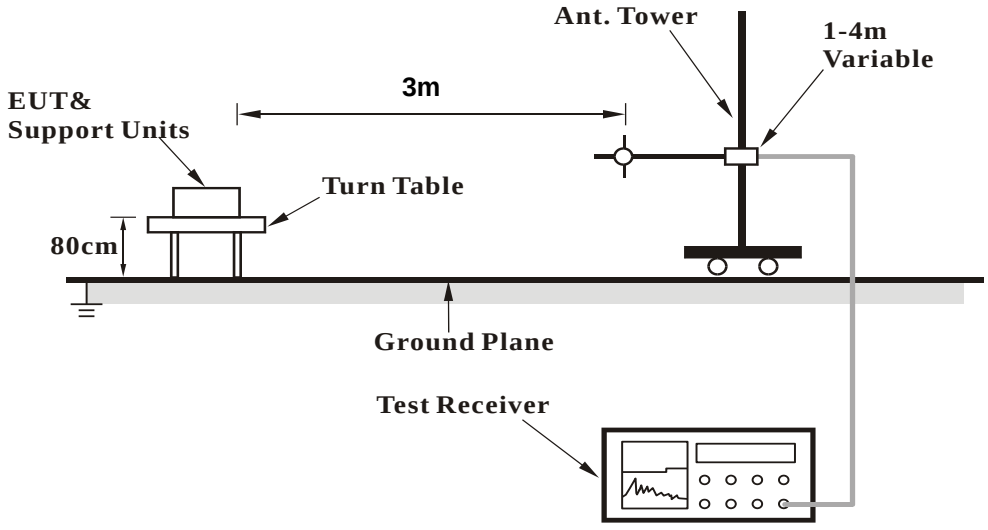
No deviation.

4.1.5 Test Setup

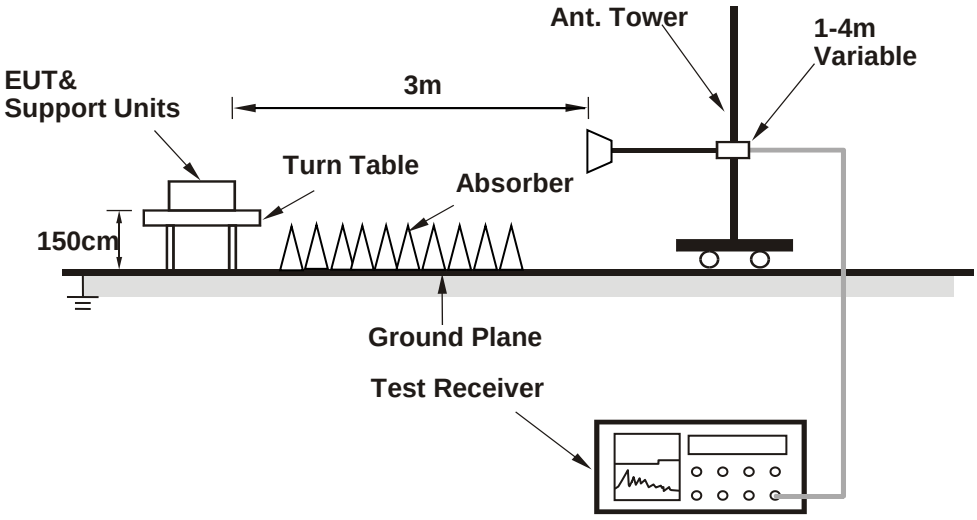
For Radiated emission below 30MHz



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 (Number lock) has been activated to set the EUT under transmission condition continuously.

- LS2 TX Modulated low duty cycle 2403MHz
- LS2 TX Modulated low duty cycle 2442MHz
- LS2 TX Modulated low duty cycle 2481MHz

4.1.7 Test Results

Above 1GHz Data:

Channel	TX Channel 1	**Detector Function**	Peak (PK) Average (AV)
Frequency Range	1GHz ~ 25GHz		

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	2387.50	47.6 PK	74.0	-26.4	1.55 H	359	49.5	-1.9
2	2387.50	42.1 AV	54.0	-11.9	1.55 H	359	44.0	-1.9
3	*2403.00	102.6 PK			1.55 H	359	104.5	-1.9
4	*2403.00	88.0 AV			1.55 H	359	89.9	-1.9
5	4806.00	41.2 PK	74.0	-32.8	3.18 H	68	38.3	2.9
6	4806.00	26.6 AV	54.0	-27.4	3.18 H	68	23.7	2.9
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	2387.50	47.5 PK	74.0	-26.5	3.87 V	305	49.4	-1.9
2	2387.50	40.8 AV	54.0	-13.2	3.87 V	305	42.7	-1.9
3	*2403.00	99.1 PK			3.87 V	305	101.0	-1.9
4	*2403.00	84.5 AV			3.87 V	305	86.4	-1.9
5	4806.00	41.0 PK	74.0	-33.0	1.68 V	224	38.1	2.9
6	4806.00	26.4 AV	54.0	-27.6	1.68 V	224	23.5	2.9

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(Duty cycle) = 20 log(0.1819 ms / 0.9773 ms) = -14.6 dB
   Please see section 3.3 for plotted duty.

Channel	TX Channel 40	Detector Function	Peak (PK) Average (AV)
Frequency Range	1GHz ~ 25GHz		

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	*2442.00	102.4 PK			1.53 H	12	104.4	-2.0
2	*2442.00	87.8 AV			1.53 H	12	89.8	-2.0
3	4884.00	47.3 PK	74.0	-26.7	3.20 H	77	44.5	2.8
4	4884.00	32.7 AV	54.0	-21.3	3.20 H	77	29.9	2.8
5	7326.00	54.7 PK	74.0	-19.3	2.44 H	20	45.8	8.9
6	7326.00	40.1 AV	54.0	-13.9	2.44 H	20	31.2	8.9
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	*2442.00	99.3 PK			3.83 V	312	101.3	-2.0
2	*2442.00	84.7 AV			3.83 V	312	86.7	-2.0
3	4884.00	47.7 PK	74.0	-26.3	1.66 V	237	44.9	2.8
4	4884.00	33.1 AV	54.0	-20.9	1.66 V	237	30.3	2.8
5	7326.00	51.4 PK	74.0	-22.6	1.61 V	285	42.5	8.9
6	7326.00	36.8 AV	54.0	-17.2	1.61 V	285	27.9	8.9

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(Duty cycle) = 20 log(0.1819 ms / 0.9773 ms) = -14.6 dB
   Please see section 3.3 for plotted duty.

Channel	TX Channel 79	Detector Function	Peak (PK) Average (AV)
Frequency Range	1GHz ~ 25GHz		

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	*2481.00	102.3 PK			1.46 H	358	104.2	-1.9
2	*2481.00	87.7 AV			1.46 H	358	89.6	-1.9
3	2483.50	65.6 PK	74.0	-8.4	1.46 H	358	67.5	-1.9
4	**2483.50**	**51.0 AV**	**54.0**	**-3.0**	**1.46 H**	**358**	**52.9**	**-1.9**
5	4962.00	47.4 PK	74.0	-26.6	3.23 H	66	44.6	2.8
6	4962.00	32.8 AV	54.0	-21.2	3.23 H	66	30.0	2.8
7	7443.00	54.9 PK	74.0	-19.1	2.40 H	9	45.9	9.0
8	7443.00	40.3 AV	54.0	-13.7	2.40 H	9	31.3	9.0
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	*2481.00	98.8 PK			3.99 V	306	100.7	-1.9
2	*2481.00	84.2 AV			3.99 V	306	86.1	-1.9
3	2483.50	62.0 PK	74.0	-12.0	3.99 V	306	63.9	-1.9
4	2483.50	47.4 AV	54.0	-6.6	3.99 V	306	49.3	-1.9
5	4962.00	46.8 PK	74.0	-27.2	1.70 V	210	44.0	2.8
6	4962.00	32.2 AV	54.0	-21.8	1.70 V	210	29.4	2.8
7	7443.00	51.1 PK	74.0	-22.9	1.62 V	284	42.1	9.0
8	7443.00	36.5 AV	54.0	-17.5	1.62 V	284	27.5	9.0

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(Duty cycle) = 20 log(0.1819 ms / 0.9773 ms) = -14.6 dB
   Please see section 3.3 for plotted duty.

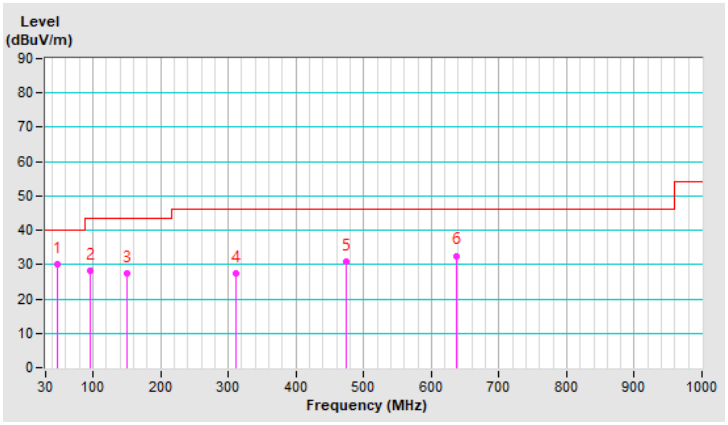
Below 1GHz Data:

Channel	TX Channel 1	**Detector Function**	Quasi-Peak (QP)
Frequency Range	9kHz ~ 1GHz		

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	46.95	30.0 QP	40.0	-10.0	2.00 H	288	37.7	-7.7
2	95.67	28.1 QP	43.5	-15.4	3.00 H	296	40.5	-12.4
3	151.23	27.6 QP	43.5	-15.9	3.00 H	128	34.5	-6.9
4	310.35	27.5 QP	46.0	-18.5	1.50 H	346	32.9	-5.4
5	474.31	31.0 QP	46.0	-15.0	2.00 H	77	31.9	-0.9
6	637.07	32.6 QP	46.0	-13.4	1.00 H	149	29.6	3.0

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.

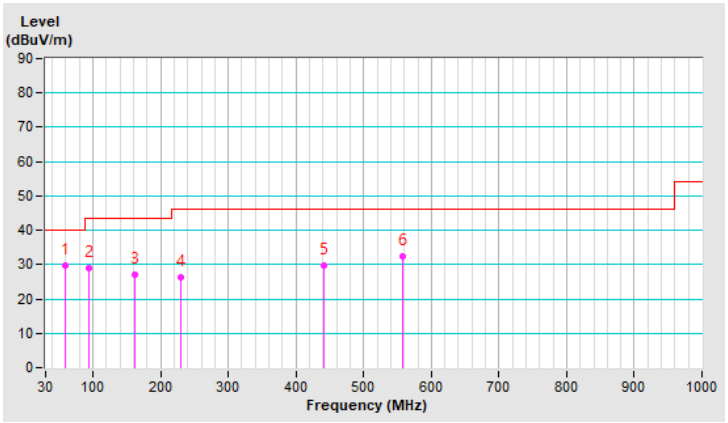


Channel	TX Channel 1	**Detector Function**	Quasi-Peak (QP)
Frequency Range	9kHz ~ 1GHz		

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	59.29	29.8 QP	40.0	-10.2	2.00 V	0	37.9	-8.1
2	94.94	28.9 QP	43.5	-14.6	2.00 V	216	41.5	-12.6
3	161.19	27.2 QP	43.5	-16.3	2.00 V	40	34.2	-7.0
4	229.09	26.2 QP	46.0	-19.8	2.00 V	0	35.4	-9.2
5	440.92	29.7 QP	46.0	-16.3	1.50 V	360	31.3	-1.6
6	558.41	32.5 QP	46.0	-13.5	2.00 V	102	31.7	0.8

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 Conducted Emission Measurement

4.2.1 Limits of Conducted Emission Measurement

Frequency (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15 - 0.5	66 - 56	56 - 46
0.50 - 5.0	56	46
5.0 - 30.0	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.

4.2.2 Test Instruments

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	CALIBRATED DATE	CALIBRATED UNTIL
Test Receiver R&S	ESCS 30	847124/029	Oct. 23, 2019	Oct. 22, 2020
Line-Impedance Stabilization Network (for EUT) R&S	ESH3-Z5	848773/004	Oct. 23, 2019	Oct. 22, 2020
Line-Impedance Stabilization Network (for Peripheral) R&S	ESH3-Z5	835239/001	Mar. 19, 2020	Mar. 18, 2021
50 ohms Terminator	50	3	Oct. 23, 2019	Oct. 22, 2020
RF Cable	5D-FB	COCCAB-001	Sep. 27, 2019	Sep. 26, 2020
Fixed attenuator EMCI	STI02-2200-10	005	Aug. 30, 2019	Aug. 29, 2020
Software BVADT	BVADT_Cond_ V7.3.7.4	NA	NA	NA

Note:

1. The calibration interval of the above test instruments are 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. The test was performed in Conduction 1.
3 Tested Date: July 03 2020

4.2.3 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.

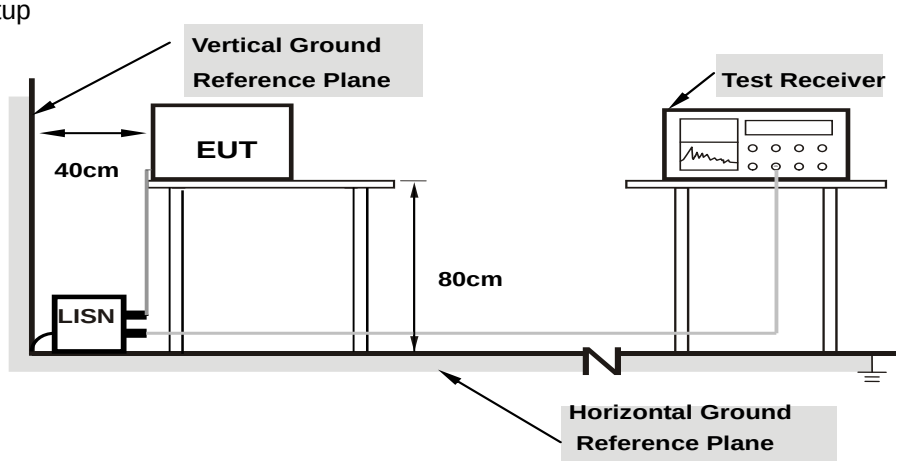
c. The frequency range from 150kHz to 30MHz was searched. Emission levels under (Limit - 20dB) was not recorded.

NOTE: 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.

4.2.4 Deviation from Test Standard

No deviation.

4.2.5 Test Setup



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

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

4.2.6 EUT Operating Conditions

Same as 4.1.6.

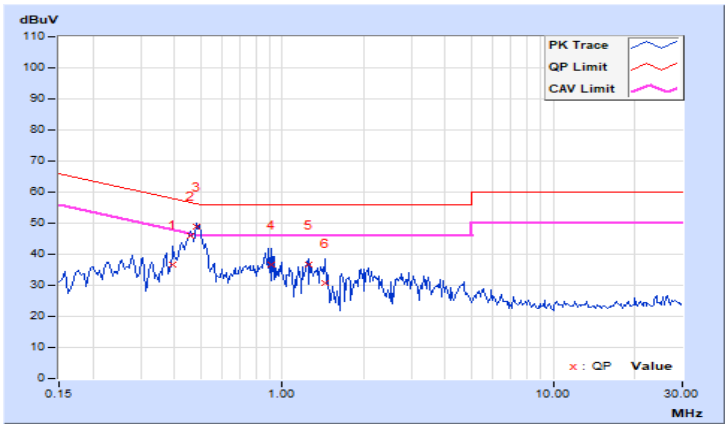
4.2.7 Test Results

Phase	Line (L)	Detector Function	Quasi-Peak (QP) / Average (AV)

Phase Of Power : Line (L)										
No	Frequency (MHz)	Correction Factor (dB)	Reading Value (dBuV)		Emission Level (dBuV)		Limit (dBuV)		Margin (dB)	
			Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
1	0.39609	10.06	26.62	4.96	36.68	15.02	57.93	47.93	-21.25	-32.91
2	0.45859	10.06	35.86	29.54	45.92	39.60	56.72	46.72	-10.80	-7.12
3	**0.48203**	**10.07**	**38.97**	**31.70**	**49.04**	**41.77**	**56.30**	**46.30**	**-7.26**	**-4.53**
4	0.91563	10.09	26.43	13.86	36.52	23.95	56.00	46.00	-19.48	-22.05
5	1.24609	10.12	26.55	20.55	36.67	30.67	56.00	46.00	-19.33	-15.33
6	1.43359	10.14	20.65	1.05	30.79	11.19	56.00	46.00	-25.21	-34.81

Remarks:

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level – Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value

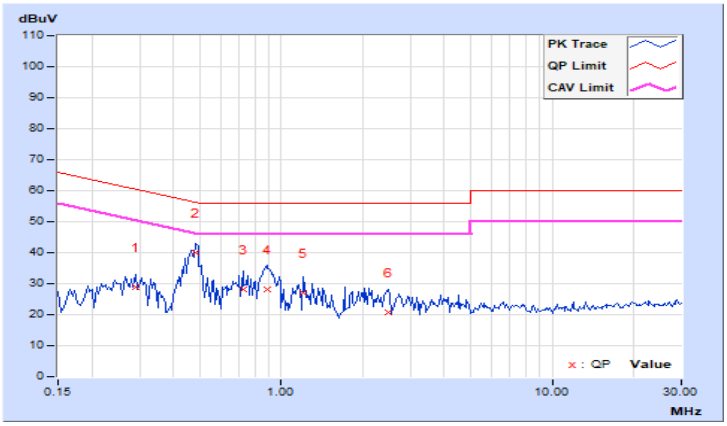


Phase	Neutral (N)	**Detector Function**	Quasi-Peak (QP) / Average (AV)

Phase Of Power : Neutral (N)										
No	**Frequency (MHz)**	**Correction Factor (dB)**	**Reading Value (dBuV)**		**Emission Level (dBuV)**		**Limit (dBuV)**		**Margin (dB)**	
			Q.P.	**AV.**	**Q.P.**	**AV.**	**Q.P.**	**AV.**	**Q.P.**	**AV.**
1	0.29063	10.05	18.98	10.89	29.03	20.94	60.51	50.51	-31.48	-29.57
2	0.48203	10.07	29.79	21.49	39.86	31.56	56.30	46.30	-16.44	-14.74
3	0.72422	10.10	18.15	10.95	28.25	21.05	56.00	46.00	-27.75	-24.95
4	0.88438	10.12	17.98	7.39	28.10	17.51	56.00	46.00	-27.90	-28.49
5	1.20703	10.15	17.06	9.12	27.21	19.27	56.00	46.00	-28.79	-26.73
6	2.48438	10.24	10.46	-0.96	20.70	9.28	56.00	46.00	-35.30	-36.72

Remarks:

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level – Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value

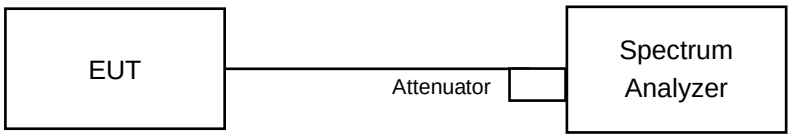


4.3 6dB Bandwidth Measurement

4.3.1 Limits of 6dB Bandwidth Measurement

The minimum of 6dB Bandwidth Measurement is 0.5 MHz.

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 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

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.

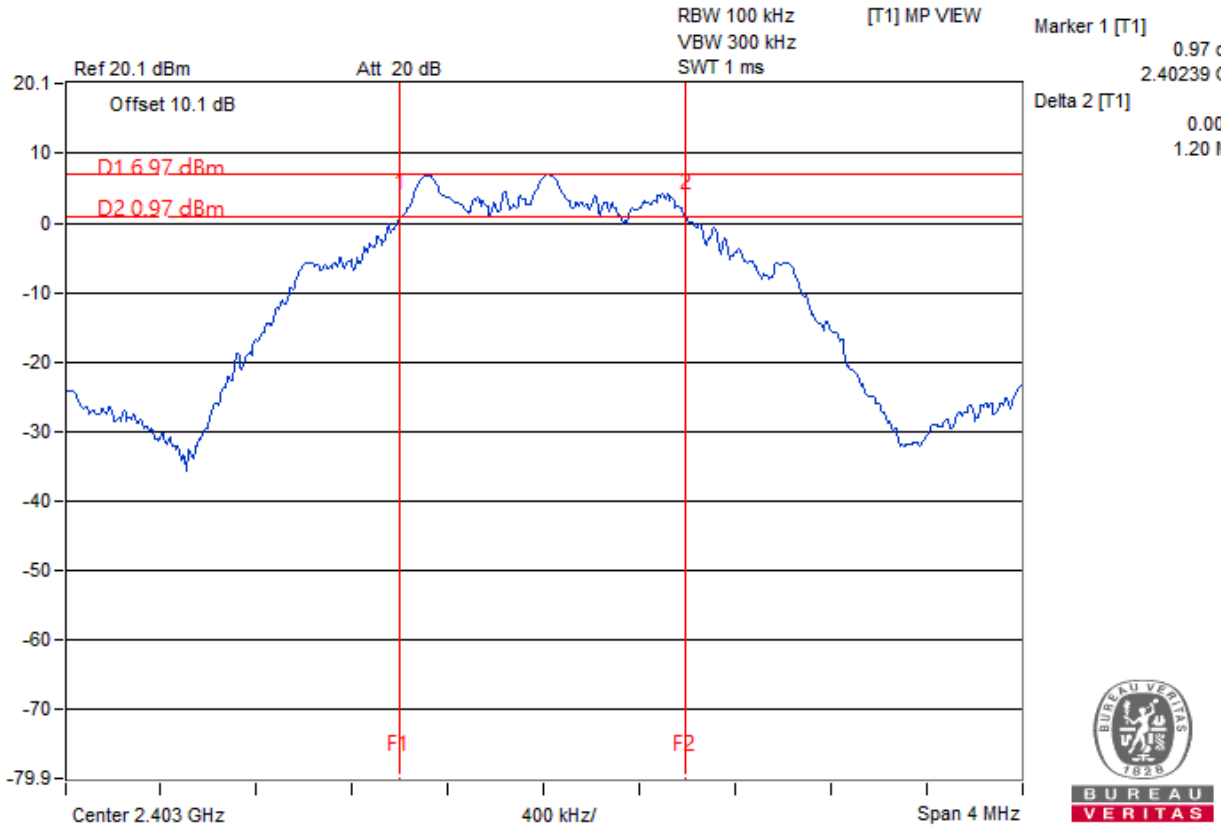
- LS2 TX Modulated low duty cycle 2403MHz
- LS2 TX Modulated low duty cycle 2442MHz
- LS2 TX Modulated low duty cycle 2481MHz

4.3.7 Test Results

Channel	Frequency (MHz)	6dB Bandwidth (MHz)	Minimum Limit (MHz)	Pass / Fail
1	2403	1.2	0.5	Pass
40	2442	1.2	0.5	Pass
79	2481	1.21	0.5	Pass

Spectrum Plot of Worst Value

CH 1

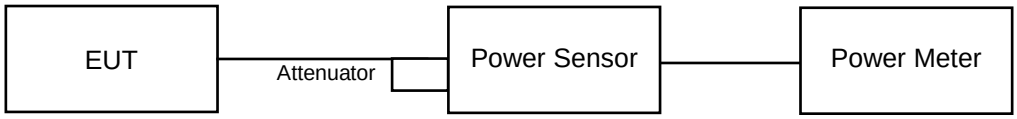


4.4 Conducted Output Power Measurement

4.4.1 Limits of Conducted Output Power Measurement

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

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 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.

4.4.5 Deviation from Test Standard

No deviation.

4.4.6 EUT Operating Conditions

Same as Item 4.3.6.

4.4.7 Test Results

FOR PEAK POWER

Channel	Frequency (MHz)	Peak Power (mW)	Peak Power (dBm)	Limit (dBm)	Pass/Fail
1	2403	5.023	7.01	30	Pass
40	2442	4.909	6.91	30	Pass
79	2481	4.571	6.60	30	Pass

FOR AVERAGE POWER

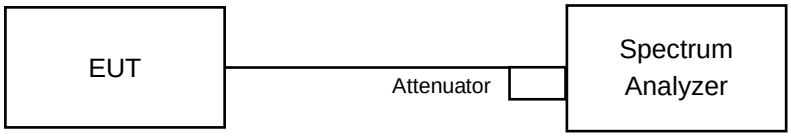
Channel	Frequency (MHz)	Average Power (mW)	Average Power (dBm)
1	2403	5	6.99
40	2442	4.875	6.88
79	2481	4.539	6.57

4.5 Power Spectral Density Measurement

4.5.1 Limits of Power Spectral Density Measurement

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

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

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.

4.5.5 Deviation from Test Standard

No deviation.

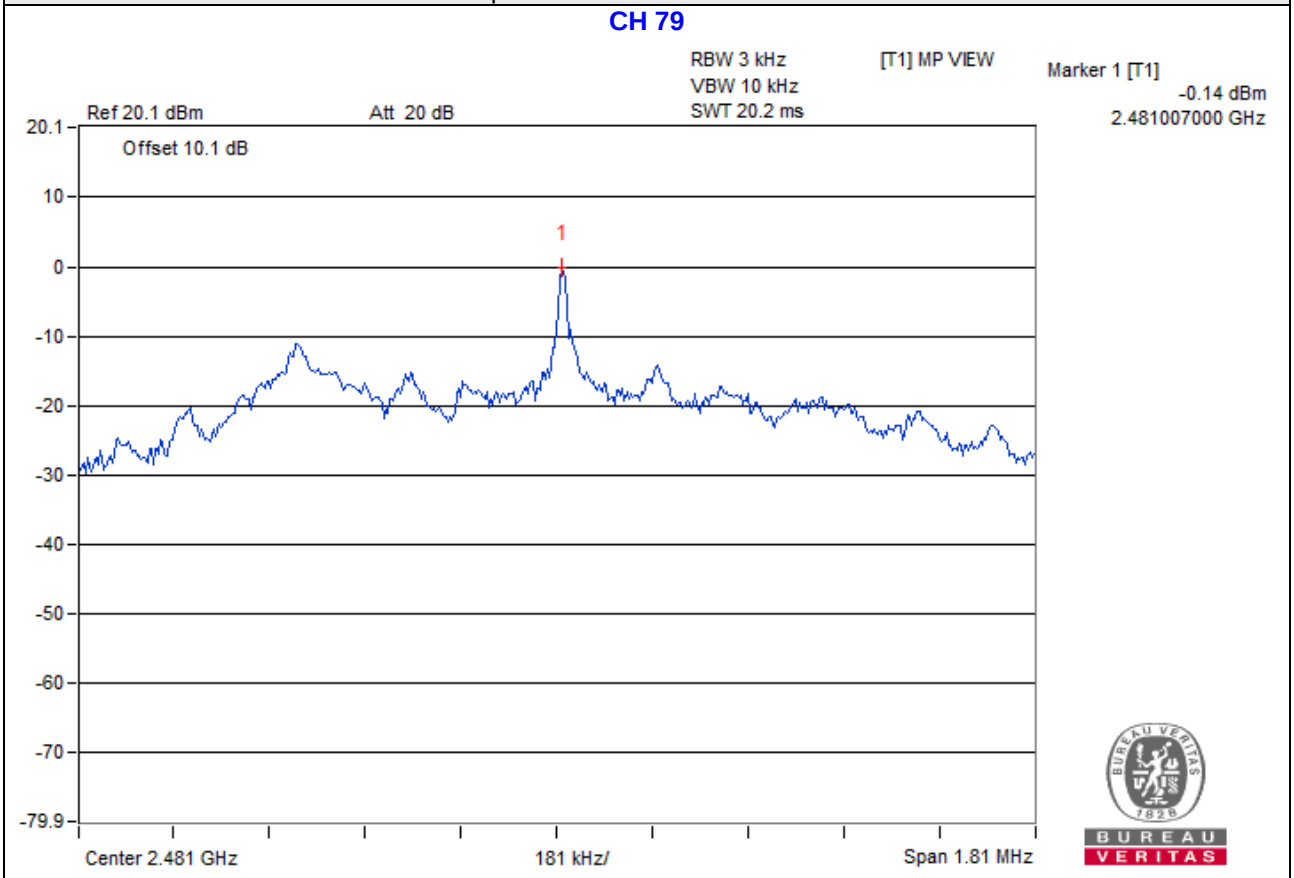
4.5.6 EUT Operating Condition

Same as Item 4.3.6.

4.5.7 Test Results

Channel	Freq. (MHz)	PSD (dBm/3kHz)	Limit (dBm/3kHz)	Pass /Fail
1	2403	-0.19	8	Pass
40	2442	-0.43	8	Pass
79	2481	-0.14	8	Pass

Spectrum Plot of Worst Value

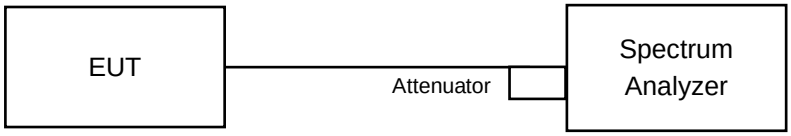


4.6 Conducted Out of Band Emission Measurement

4.6.1 Limits of Conducted Out of Band Emission Measurement

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

4.6.2 Test Setup



4.6.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.6.4 Test Procedure

MEASUREMENT PROCEDURE REF

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

4.6.5 Deviation from Test Standard

No deviation.

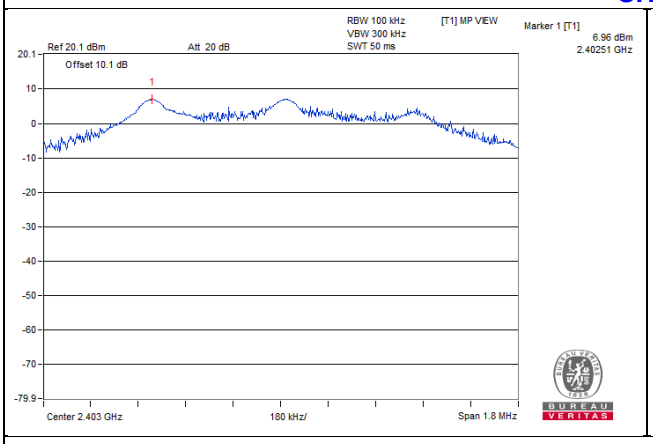
4.6.6 EUT Operating Condition

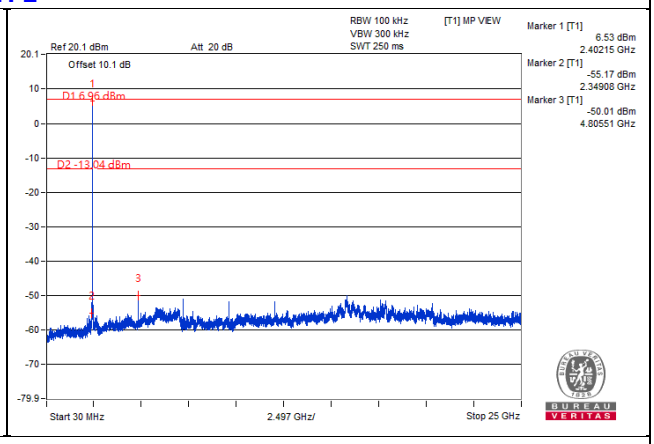
The software provided by client enabled the EUT to transmit and receive data at lowest and highest channel frequencies individually.

4.6.7 Test Results

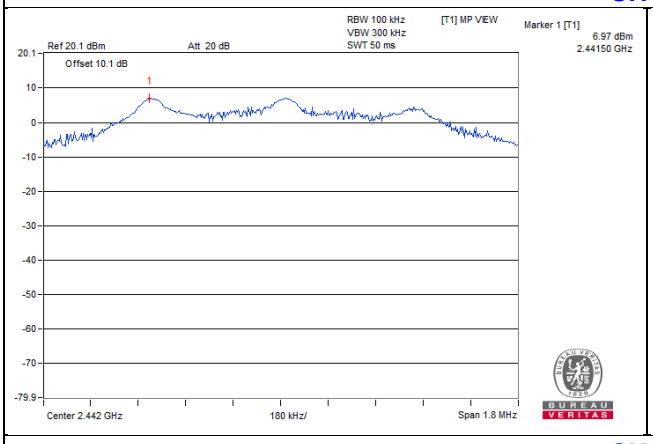
The spectrum plots are attached on the following pages. D1 line indicates the highest level, and D2 line indicates the 20dB offset below D1. It shows compliance with the requirement.

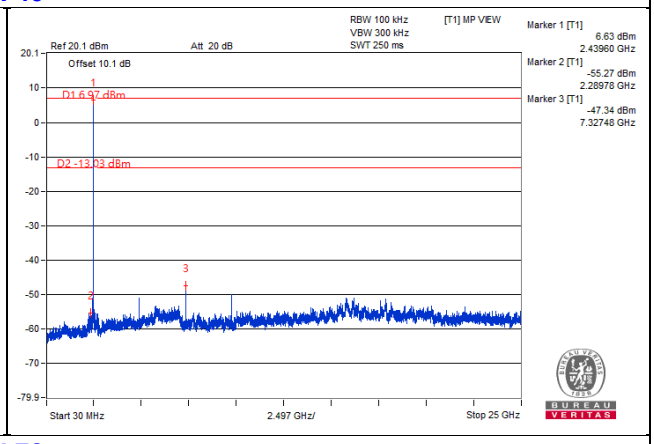
CH 1



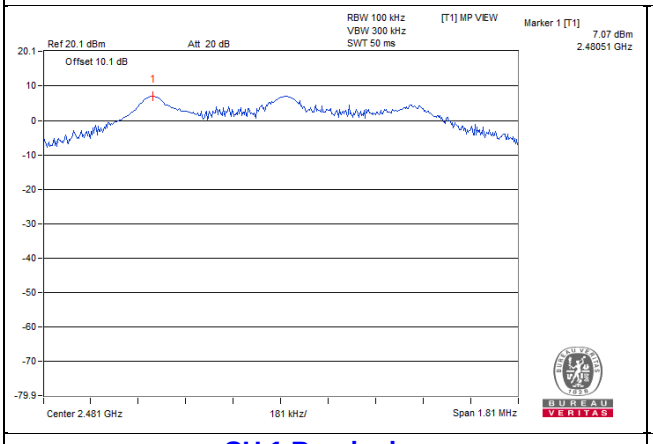


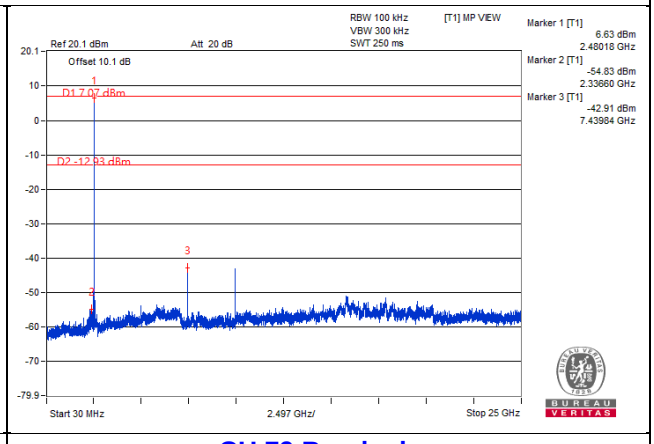
CH 40



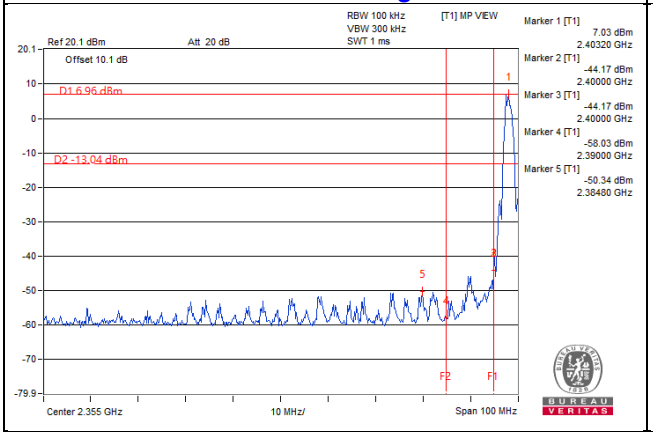


CH 79

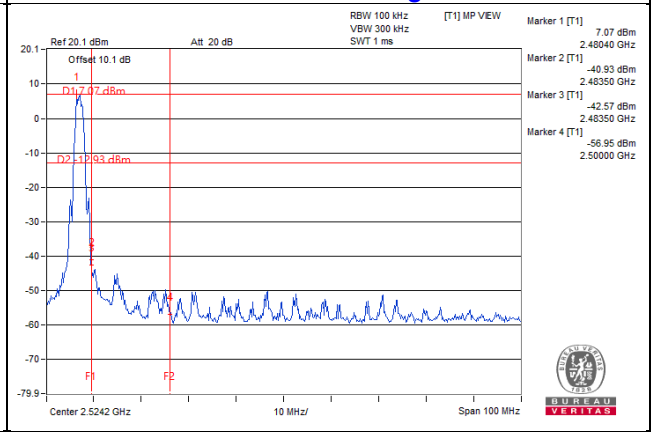




CH 1 Band edge



CH 79 Band edge



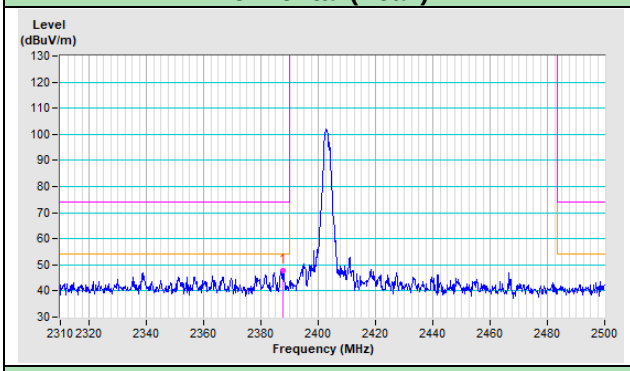
5 Pictures of Test Arrangements

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

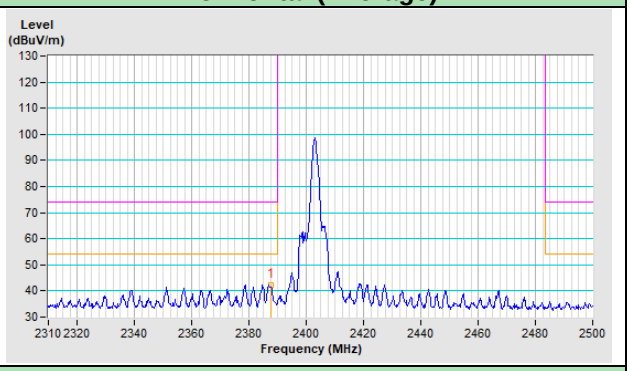
Annex A - Band-Edge Measurement

Channel 1

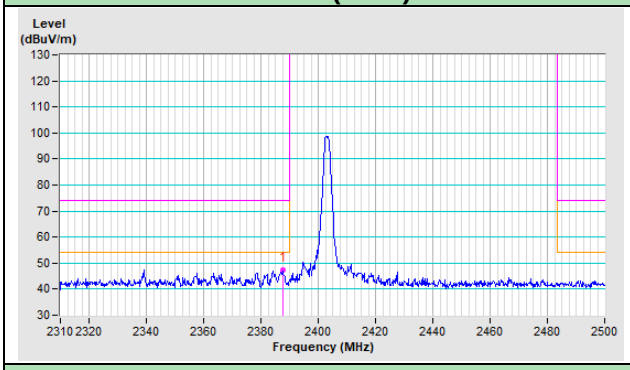
Horizontal (Peak)



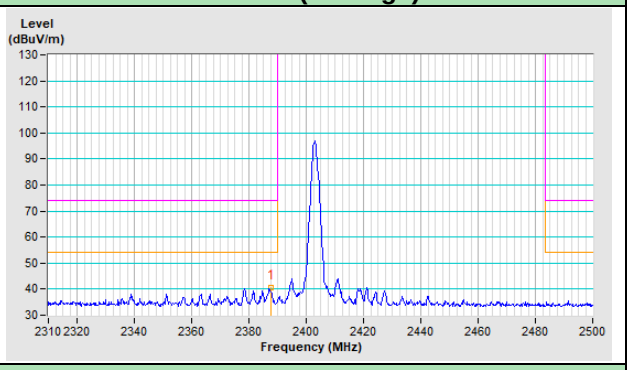
Horizontal (Average)



Vertical (Peak)

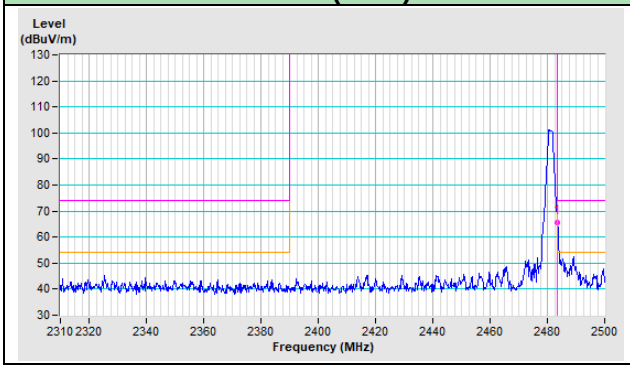


Vertical (Average)

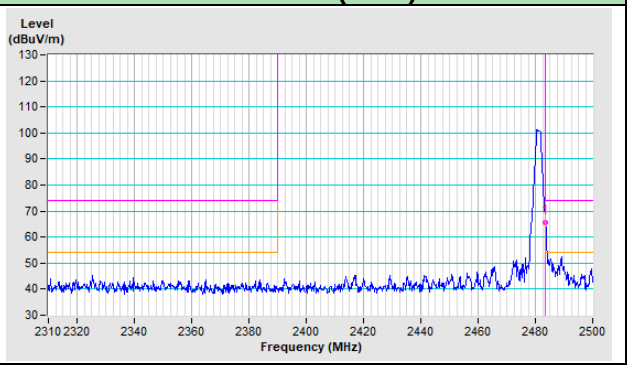


Channel 79

Vertical (Peak)



Horizontal (Peak)



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

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