FCC Test Report

(Co-Located)

Report No.:	RFBEMI-WTW-P23040655-4
FCC ID:	NOIKBN428
Product:	Electronic Display Device
Brand:	Rakuten kobo
Model No.:	N428
Received Date:	2023/5/4
Test Date:	2023/6/2 ~ 2023/9/20
Issued Date:	2023/10/6
Applicant:	NETRONIX, INC.
Address:	No. 945, Boai St., Jubei City, Hsin-Chu, 30265, Taiwan
Issued By:	Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch Lin Kou Laboratories
Lab Address:	No. 47-2, 14th Ling, Chia Pau Vil., Lin Kou Dist., New Taipei City, Taiwan
Test Location:	No. 47-2, 14th Ling, Chia Pau Vil., Lin Kou Dist., New Taipei City, Taiwan
FCC Registration / Designation Number:	198487 / TW2021

Testing Laboratory
2021

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Release Control Record

Issue No.	Description	Date Issued
RFBEMI-WTW-P23040655-4	Original release	2023/10/6

1 Certificate of Conformity

Product:	Electronic Display Device
Brand:	Rakuten kobo
Test Model:	N428
Sample Status:	Engineering sample
Applicant:	NETRONIX, INC.
Test Date:	2023/6/2 ~ 2023/9/20
Standard:	47 CFR FCC Part 15, Subpart C (Section 15.247) 47 CFR FCC Part 15, Subpart E (Section 15.407)
Measurement procedure:	ANSI C63.10-2013 KDB 789033 D02 General UNII Test Procedure New Rules v02r01 KDB 662911 D01 Multiple Transmitter Output v02r01 KDB 558074 D01 15.247 Meas Guidance v05r02

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 RF characteristics under the conditions specified in this report.

Prepared by : Jessica Cheng , **Date:** 2023/10/6

Jessica Cheng / Senior Specialist

Approved by : Jeremy Lin , **Date:** 2023/10/6

Jeremy Lin / Project Engineer

2 Summary of Test Results

Applied Standard	47 CFR FCC Part 15, Subpart C (Section 15.247) 47 CFR FCC Part 15, Subpart E (Section 15.407)		
FCC Clause	Test Item	Result	Remarks
15.205 / 15.209 / 15.247(d) 15.407(b)(9)	Unwanted Emissions below 1 GHz	Pass	Meet the requirement of limit. Minimum passing margin is -15.2dB at 45.86MHz.
15.205 / 15.209 / 15.247(d) 15.407(b) (1/10) 15.407(b) (4(i)/10)	Unwanted Emissions above 1 GHz & Conducted Out of Band Emission	Pass	Meet the requirement of limit. Minimum passing margin is -0.3dB at 2390.00MHz.
15.207 / 15.407(b)(9)	AC Power Conducted Emission	Pass	Meet the requirement of limit. Minimum passing margin is -17.04dB at 4.21936MHz.

Note: 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	Specification	Expanded Uncertainty (k=2) (±)
AC Power Conducted Emissions	9 kHz ~ 30 MHz	3.00 dB
Unwanted Emissions below 1 GHz	9 kHz ~ 30 MHz	2.38 dB
	30 MHz ~ 1 GHz	5.7 dB
Unwanted Emissions above 1 GHz	1 GHz ~ 6 GHz	4.83 dB
	6 GHz ~ 18 GHz	5.37 dB
	18 GHz ~ 40 GHz	5.24 dB

The other instruments specified are routine verified to remain within the calibrated levels, no measurement uncertainty is required to be calculated.

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product	Electronic Display Device	
Brand	Rakuten kobo	
Test Model	N428	
Status of EUT	Engineering sample	
Power Supply Rating	3.87Vdc from Battery or 5Vdc from USB port	
Modulation Type	BT EDR	GFSK, π/4-DQPSK, 8DPSK
	BT LE	GFSK
	2.4GHz	CCK, DQPSK, DBPSK for DSSS 64QAM, 16QAM, QPSK, BPSK for OFDM
	5GHz	64QAM, 16QAM, QPSK, BPSK for OFDM 256QAM for OFDM in 11ac mode
Modulation Technology	BT EDR	FHSS
	BT LE	DTS
	2.4GHz	DSSS, OFDM
	5GHz	OFDM
Transfer Rate	BT EDR	Up to 3 Mbps
	BT LE	Up to 1 Mbps
	2.4GHz	Up to 72.2 Mbps
	5GHz	Up to 433.3 Mbps
Operating Frequency	BT EDR	2.402 GHz ~ 2.48 GHz
	BT LE	2.402 GHz ~ 2.48 GHz
	2.4GHz	2.412 GHz ~ 2.462 GHz
	5GHz	5.18 GHz ~ 5.24 GHz 5.745 GHz ~ 5.825 GHz
Number of Channel	BT EDR	79
	BT LE	40
	2.4GHz	802.11b, 802.11g, 802.11n (HT20):11
	5GHz	802.11a, 802.11n (HT20), 802.11ac (VHT20):9 802.11n (HT40), 802.11ac (VHT40):4 802.11ac (VHT80):2
Output Power	BT EDR	1.807 mW (2.57 dBm)
	BT LE	1.69 mW (2.28 dBm)
	2.4GHz	165.196 mW (22.18 dBm)
	5GHz	5.18 GHz ~ 5.24 GHz : 17.742 mW (12.49 dBm) 5.745 GHz ~ 5.825 GHz : 15.668 mW (11.95 dBm)

Note:

1. The EUT has black & white, which are electrically identical to each other except for exterior color.
2. The EUT could be supplied with USB cable and different models could be chosen:

Brand	Model	Material	Color	Remark
Yih Fone	SH-0418	TPE	Black	Shieled:Y, 1.0M, Core:N/A
	SH-0420		White	
Both USB cables are identical to each other except for exterior color and model names				

3. The EUT has two eMMC as below table:

No	Model	Remark
1	PTE7A0YJ-32GE	1st source eMMC
2	MKEMF032GT1E-C	2nd source eMMC
From the above eMMC, the worst case was found in **No. 1**. Therefore only the test data of mode was recorded in this report.		

4. There are Bluetooth and WLAN (2.4 GHz & 5 GHz) technology used for the EUT.
5. Simultaneously transmission condition.

Condition	Technology	
1	WLAN (2.4 GHz)	Bluetooth
2	WLAN (5 GHz)	Bluetooth
Note: The emission of the simultaneous operation has been evaluated and no non-compliance was found.		

6. 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.

3.2 Antenna Description of EUT

1. The antenna information is listed as below.

Function	Gain (dBi)	Antenna Type	Connector Type
BT EDR	3.91	Chip	none
BT LE	3.91	Chip	none
WLAN 2.4GHz	3.91	Chip	none
WLAN 5GHz	3.41	Chip	none

*Detail antenna specification please refer to antenna datasheet and/or antenna measurement report

2. The EUT incorporates a SISO function:

2.4 GHz Band		
Modulation Mode	**TX & RX Configuration**	
802.11b	1TX	1RX
802.11g	1TX	1RX
802.11n (HT20)	1TX	1RX
5 GHz Band		
Modulation Mode	**TX & RX Configuration**	
802.11a	1TX	1RX
802.11n (HT20)	1TX	1RX
802.11n (HT40)	1TX	1RX
802.11ac (VHT20)	1TX	1RX
802.11ac (VHT40)	1TX	1RX
802.11ac (VHT80)	1TX	1RX

3.3 Description of Test Modes

79 channels are provided for BT-EDR:

Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	20	2422	40	2442	60	2462
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		

40 channels are provided for BT-LE:

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

FOR 2412 ~ 2462 MHz

11 channels are provided for 802.11b, 802.11g, 802.11n (HT20):

Channel	Frequency	Channel	Frequency
1	2412 MHz	7	2442 MHz
2	2417 MHz	8	2447 MHz
3	2422 MHz	9	2452 MHz
4	2427 MHz	10	2457 MHz
5	2432 MHz	11	2462 MHz
6	2437 MHz		

FOR 5180 ~ 5240 MHz

4 channels are provided for 802.11a, 802.11n (HT20), 802.11ac (VHT20):

Channel	Frequency	Channel	Frequency
36	5180 MHz	44	5220 MHz
40	5200 MHz	48	5240 MHz

2 channels are provided for 802.11n (HT40), 802.11ac (VHT40):

Channel	Frequency	Channel	Frequency
38	5190 MHz	46	5230 MHz

1 channel is provided for 802.11ac (VHT80):

Channel	Frequency
42	5210 MHz

FOR 5745 ~ 5825 MHz:

5 channels are provided for 802.11a, 802.11n (HT20), 802.11ac (VHT20):

Channel	Frequency	Channel	Frequency
149	5745 MHz	161	5805 MHz
153	5765 MHz	165	5825 MHz
157	5785 MHz		

2 channels are provided for 802.11n (HT40), 802.11ac (VHT40):

Channel	Frequency	Channel	Frequency
151	5755 MHz	159	5795 MHz

1 channel is provided for 802.11ac (VHT80):

Channel	Frequency
155	5775 MHz

3.3.1 Test Mode Applicability and Tested Channel Detail

Pre-Scan:	1. The eMMC has the following models: PTE7A0YJ-32GE/MKEMF032GT1E-C. Pre-scan these models of eMMC and find the worst case as a representative test condition. 2. For Radiated, pre-scan AC Adapter via USB Cable/Laptop via USB Cable/Battery and find the worst case as a representative test condition. 3. EUT can be used in the following ways: X-axis/ Y-axis/ Z-axis. Pre-scan these ways and find the worst case as a representative test condition. 4. EUT can transmit Simultaneously in the following conditions: WLAN (5 GHz) + Bluetooth / WLAN (2.4 GHz) + Bluetooth. Pre-scan in these conditions and find the worst case as a representative test condition
Worst Case:	1. eMMC Worst Condition: PTE7A0YJ-32GE. 2. For Radiated Worst Condition: Laptop via USB Cable. 3. X-axis/ Y-axis/ Z-axis Worst Condition: X-axis. 4. Simultaneously transmission Worst Condition: WLAN (2.4 GHz) + Bluetooth for Unwanted Emission above 1GHz and Unwanted Emission below 1GHz.

EUT Configure Mode	Applicable To				Description
	RE≥1G	RE<1G	PLC	OB	
A	√	√	√	√	Laptop via USB Cable
B	-	-	√	-	AC Adapter via USB Cable

Where **RE≥1G:** Radiated Emission above 1GHz
RE<1G: Radiated Emission below 1GHz
PLC: Power Line Conducted Emission
OB: Conducted Out-Band Emission 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.

EUT Configure Mode	Mode	Freq. Range (MHz)	Available Channel	Tested Channel	Modulation Technology
A	BTLE+ 802.11g	2402 ~ 2480	0 to 39	19 + 1	GFSK
		2412 ~ 2462	1 to 11		OFDM

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.

EUT Configure Mode	Mode	Freq. Range (MHz)	Available Channel	Tested Channel	Modulation Technology
A	BTLE+ 802.11g	2402 ~ 2480	0 to 39	19 + 1	GFSK
		2412 ~ 2462	1 to 11		OFDM

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.

EUT Configure Mode	Mode	Freq. Range (MHz)	Available Channel	Tested Channel	Modulation Technology
A, B	BTLE+ 802.11g	2402 ~ 2480	0 to 39	19 + 1	GFSK
		2412 ~ 2462	1 to 11		OFDM

Conducted Out-Band Emission Measurement:

☒ 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.

EUT Configure Mode	Mode	Freq. Range (MHz)	Available Channel	Tested Channel	Modulation Technology
A	BTLE+ 802.11g	2402 ~ 2480	0 to 39	19 + 1	GFSK
		2412 ~ 2462	1 to 11		OFDM

Test Condition:

Applicable To	Environmental Conditions	Input Power	Tested By
RE>1G	26deg. C, 67%RH	120Vac, 60Hz	Jed Wu
RE<1G	17deg. C, 59%RH	120Vac, 60Hz	Jed Wu
PLC	25deg. C, 75%RH	120Vac, 60Hz	Jed Wu
OB	26deg. C, 67%RH	120Vac, 60Hz	Jed Wu

3.4 Description of Support Units

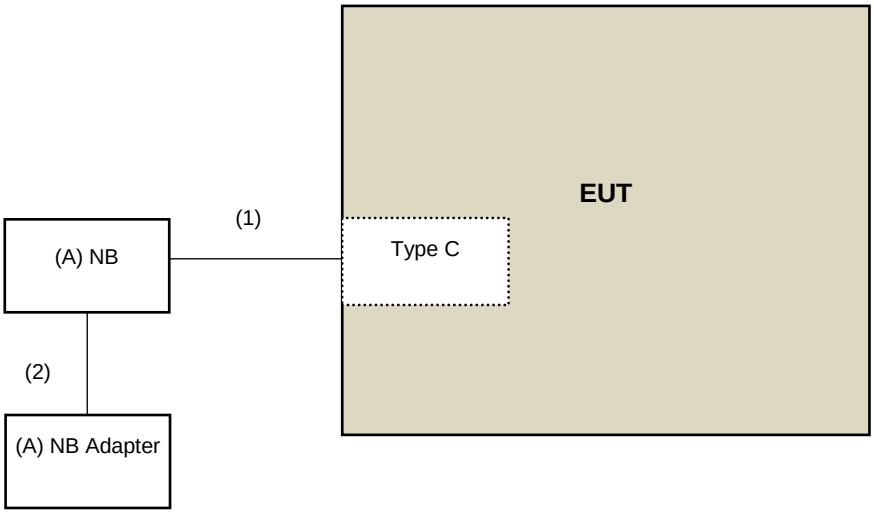
The ET has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A	NB	LENOVO	IdeaPad 5 15ITL05	N/A	N/A	Provided by Lab
B	NB Adapter	LENOVO	ADLX65CLGU2A	N/A	N/A	Provided by Lab
C	Adapter	APPLE	A1385	N/A	N/A	Provided by Lab

ID	Cable Descriptions	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1	Type-A to C Cable	1	1	Y	0	Supplied by applicant
2	DC Cable	1	2	N	0	Provided by Lab

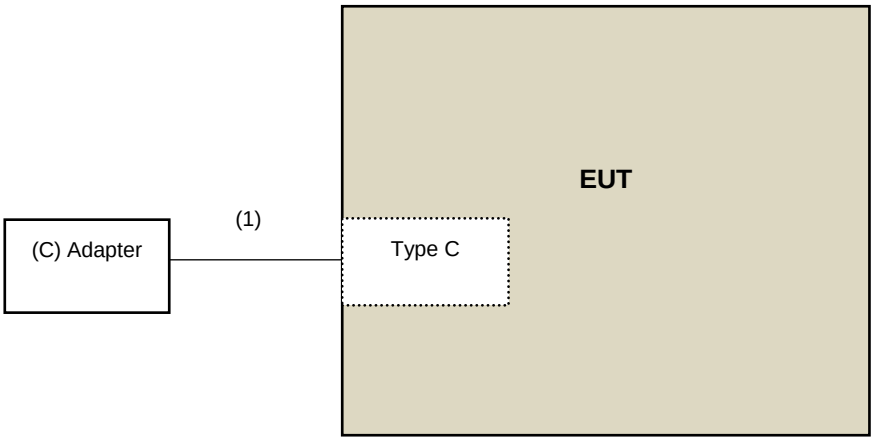
3.4.1 Configuration of System under Test

Mode A



Remote Site

Mode B



Remote Site

3.5 General Description of Applied Standards

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)
FCC Part 15, Subpart E (15.407)
ANSI C63.10-2013

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

References Test Guidance:
KDB 789033 D02 General UNII Test Procedure New Rules v02r01
KDB 662911 D01 Multiple Transmitter Output v02r01
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.

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.

Limits of unwanted emission out of the restricted bands

Applicable To	Limit	
789033 D02 General UNII Test Procedure New Rules v02r01	Field Strength at 3 m	
	PK: 74 (dBμV/m)	AV: 54 (dBμV/m)

For transmitters operating in the 5.15-5.25 GHz band:

Applicable To	EIRP Limit	Equivalent Field Strength at 3 m
15.407(b)(1)	PK: -27 (dBm/MHz)	PK: 68.2 (dBμV/m)

For transmitters operating in the 5.725-5.850 GHz band:

Applicable To	EIRP Limit	Equivalent Field Strength at 3 m
15.407(b)(4)(i)	PK: -27 (dBm/MHz) *1 PK: 10 (dBm/MHz) *2 PK: 15.6 (dBm/MHz) *3 PK: 27 (dBm/MHz) *4	PK: 68.2 (dBμV/m) *1 PK: 105.2 (dBμV/m) *2 PK: 110.8 (dBμV/m) *3 PK: 122.2 (dBμV/m) *4
*1 beyond 75 MHz or more above of the band edge. *2 below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above. *3 below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above. *4 from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.		

Note: The following formula is used to convert the equipment isotropic radiated power (eirp) to field strength:

$E = \frac{1000000\sqrt{30P}}{3}$ μV/m, where P is the eirp (Watts).

4.1.2 Test Instruments

Unwanted Emissions below 1 GHz

Description & Manufacturer	Model no.	Serial No.	Calibrated Date	Calibrated Until
MXE EMI Receiver Agilent	N9038A	MY51210129	2023/3/24	2024/3/23
MXE EMI Receiver Agilent	N9038A	MY51210137	2022/6/9	2023/6/8
Signal Analyzer R&S	FSV40	101544	2023/5/9	2024/5/8
Preamplifier HP	8447D	2432A03504	2023/2/16	2024/2/15
Bi_Log Antenna Schwarzbeck	VULB 9168	137	2022/10/21	2023/10/20
RF Coaxial Cable Pacific	8D-FB	Cable-CH6-02	2022/6/30	2023/6/29
Coupling / Decoupling Network Schwarzbeck	CDNE-M2	00097	2023/5/25	2024/5/24
Coupling / Decoupling Network Schwarzbeck	CDNE-M3	00091	2023/5/25	2024/5/24
Turn Table ADT	TT100	0306	NA	NA
Tower ADT	AT100	0306	NA	NA
Software BVADT	Radiated_V8.7.08	NA	NA	NA

Notes:

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 Linkou 966 Chamber 6 (CH 6).
3. Tested Date: 2023/6/2

Unwanted Emissions above 1 GHz

Description & Manufacturer	Model no.	Serial No.	Calibrated Date	Calibrated Until
MXE EMI Receiver Agilent	N9038A	MY51210129	2023/3/24	2024/3/23
Signal Analyzer R&S	FSV40	101544	2023/5/9	2024/5/8
Signal Analyzer R&S	FSV40	101042	2022/9/5	2023/9/4
Preamplifier HP	8449B	3008A01201	2023/2/16	2024/2/15
Preamplifier EMCI	EMC0126545	980076	2023/2/16	2024/2/15
Horn Antenna ETS-Lindgren	3117-PA	00215857	2022/11/13	2023/11/12
Horn Antenna EMCO	3115	00028257	2022/11/13	2023/11/12
Preamplifier EMCI	EMC184045B	980175	2022/9/3	2023/9/2
Preamplifier EMCI	EMC184045B	980235	2023/2/16	2024/2/15
Horn Antenna Schwarzbeck	BBHA 9170	212	2022/10/20	2023/10/19
RF Coaxial Cable HUBER+SUHNER	SF-104	Cable-CH6-01	2022/9/20	2023/9/19
RF Coaxial Cable EMEC	EM102-KMKM-3.5	EM102-KMKM-3.5-02	2022/7/7	2023/7/6
Band Pass Filter Micro-Tronics	BRM17690	005	2023/5/25	2024/5/24
Notch Filter Micro-Tronics	BRC50703-01	010	2023/5/25	2024/5/24
High Pass Filter Wainwright	WHK 3.1/18G-10SS	SN 8	2023/5/25	2024/5/24
Boresight antenna tower fixture BV	BAF-02	6	NA	NA
Horn Antenna EMCO	3115	00028257	2022/11/13	2023/11/12
RF Coaxial Cable EMCI	EMC104	190801	2022/9/20	2023/9/19
RF Coaxial Cable EMCI	EMC104	190804	2022/7/7	2023/7/6
Turn Table ADT	TT100	0306	NA	NA
Tower ADT	AT100	0306	NA	NA
Software BVADT	Radiated_V7.7.1.1.1	NA	NA	NA

Notes:

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 Linkou 966 Chamber 6 (CH 6).
3. Tested Date: 2023/6/14

4.1.3 Test Procedure

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: 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 detect 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:

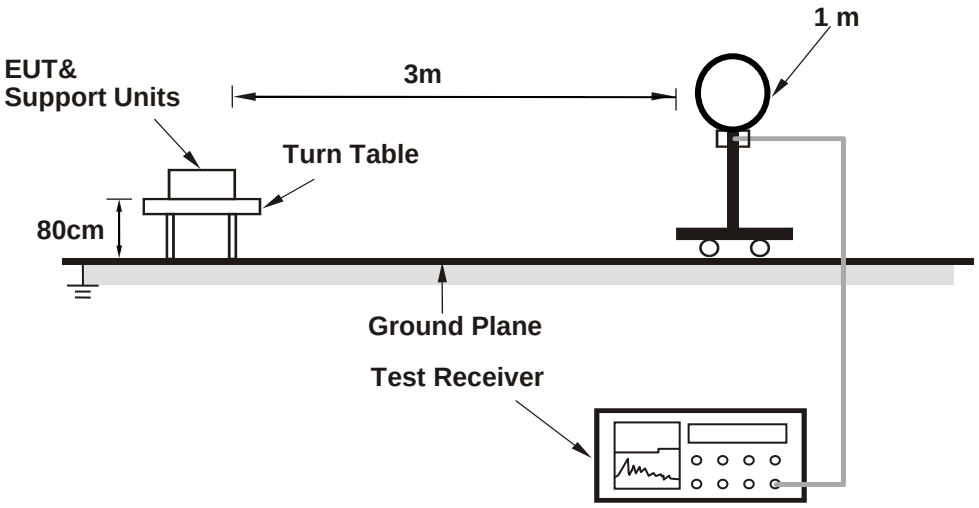
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is ≥ 1/T (Duty cycle < 98%) or 10Hz (Duty cycle ≥ 98%) for Average detection (AV) at frequency above 1GHz. All modes of operation were investigated and the worst-case emissions are reported.

4.1.4 Deviation from Test Standard

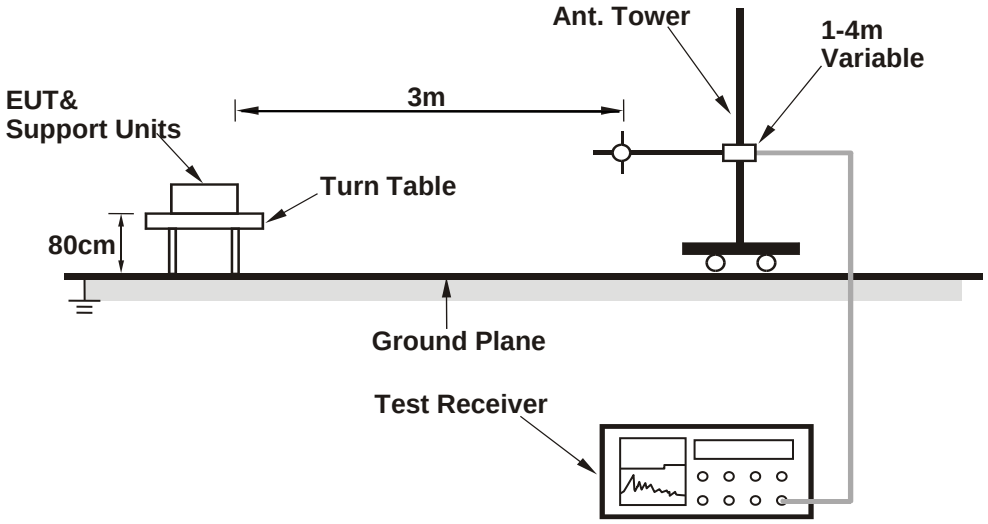
No deviation.

4.1.5 Test Setup

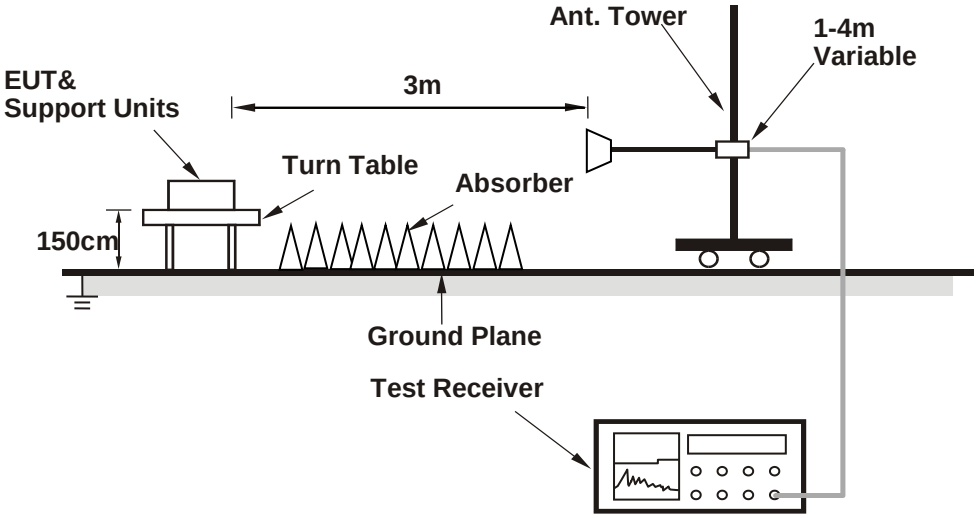
For Radiated emission below 30MHz



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 Condition

Controlling software (Tera Term V4.8) has been activated to set the EUT under transmission condition continuously at specific channel frequency.

4.1.7 Test Results

Above 1GHz data:

Mode A

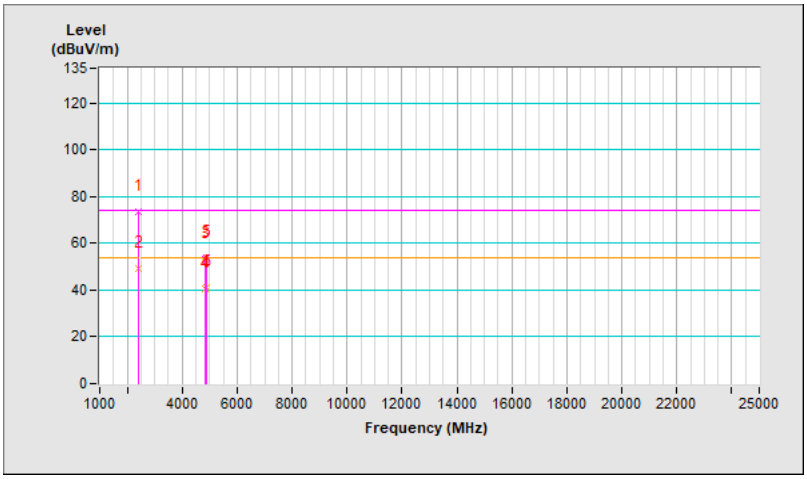
BTLE: CH 19 + 802.11g: CH 1

RF Mode	BTLE + 802.11g	**Channel**	CH 19：2440 MHz + CH 1：2412 MHz
Frequency Range	1 GHz ~ 25 GHz	**Detector Function & Bandwidth**	PK: RB=1 MHz, VB=3 MHz, DET=Peak AV: RB=1 MHz, VB=3 kHz, DET=Peak AV: RB=1 MHz, VB=1 kHz, DET=Peak
Input Power	120 Vac, 60 Hz	**Environmental Conditions**	26°C, 67% RH
Tested By	Jed Wu		

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	**2390.00**	**73.7 PK**	**74.0**	**-0.3**	**1.53 H**	**212**	**74.8**	**-1.1**
2	2390.00	49.1 AV	54.0	-4.9	1.53 H	212	50.2	-1.1
3	4824.00	53.2 PK	74.0	-20.8	1.62 H	231	45.4	7.8
4	4824.00	40.6 AV	54.0	-13.4	1.62 H	231	32.8	7.8
5	4880.00	53.6 PK	74.0	-20.4	1.62 H	231	45.7	7.9
6	4880.00	41.1 AV	54.0	-12.9	1.62 H	231	33.2	7.9

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.

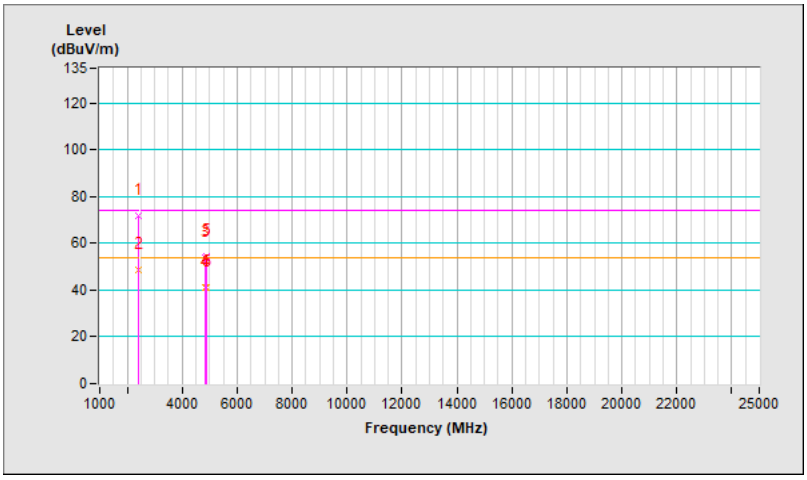


RF Mode	BTLE + 802.11g	**Channel**	CH 19：2440 MHz + CH 1：2412 MHz
Frequency Range	1 GHz ~ 25 GHz	**Detector Function & Bandwidth**	PK: RB=1 MHz, VB=3 MHz, DET=Peak AV: RB=1 MHz, VB=3 kHz, DET=Peak AV: RB=1 MHz, VB=1 kHz, DET=Peak
Input Power	120 Vac, 60 Hz	**Environmental Conditions**	26°C, 67% RH
Tested By	Jed Wu		

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	2390.00	71.7 PK	74.0	-2.3	3.30 V	162	71.6	0.1
2	2390.00	48.6 AV	54.0	-5.4	3.30 V	162	48.5	0.1
3	4824.00	53.6 PK	74.0	-20.4	1.88 V	143	49.0	4.6
4	4824.00	41.0 AV	54.0	-13.0	1.88 V	143	36.4	4.6
5	4880.00	54.2 PK	74.0	-19.8	1.88 V	143	49.5	4.7
6	4880.00	41.1 AV	54.0	-12.9	1.88 V	143	36.4	4.7

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.



Below 1GHz data:

Mode A

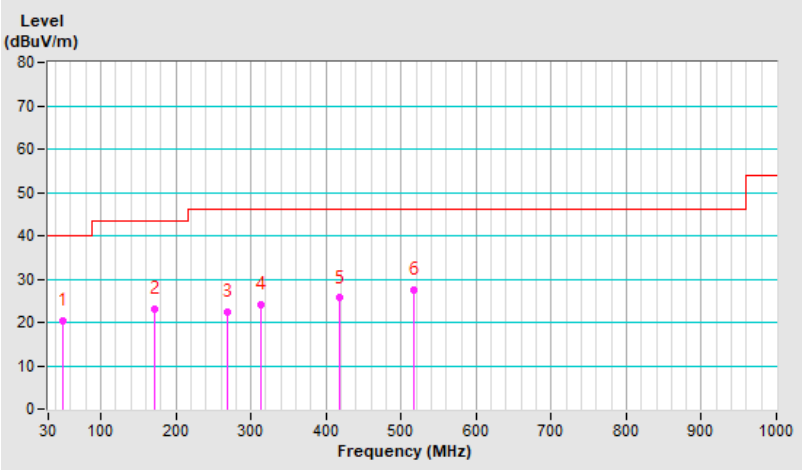
BTLE: CH 19 + 802.11g: CH 1

RF Mode	BTLE + 802.11g	**Channel**	CH 19：2440 MHz + CH 1：2412 MHz
Frequency Range	30 MHz ~ 1 GHz	**Detector Function & Bandwidth**	QP: RB=120kHz, DET=Quasi-Peak
Input Power	120 Vac, 60 Hz	**Environmental Conditions**	17°C, 59% RH
Tested By	Jed Wu		

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	48.87	20.3 QP	40.0	-19.7	1.89 H	236	28.70	-8.40
2	170.80	23.0 QP	43.5	-20.5	1.43 H	251	31.70	-8.70
3	267.75	22.5 QP	46.0	-23.5	1.76 H	204	29.80	-7.30
4	313.63	24.0 QP	46.0	-22.0	1.25 H	234	29.70	-5.70
5	418.87	25.6 QP	46.0	-20.4	1.69 H	62	29.00	-3.40
6	517.13	27.5 QP	46.0	-18.5	1.94 H	19	28.80	-1.30

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 30 MHz ~ 1 GHz.
5. The emission levels were very low against the limit of frequency range 9 kHz ~ 30 MHz: the amplitude of spurious emissions attenuated more than 20 dB below the permissible value to be report.

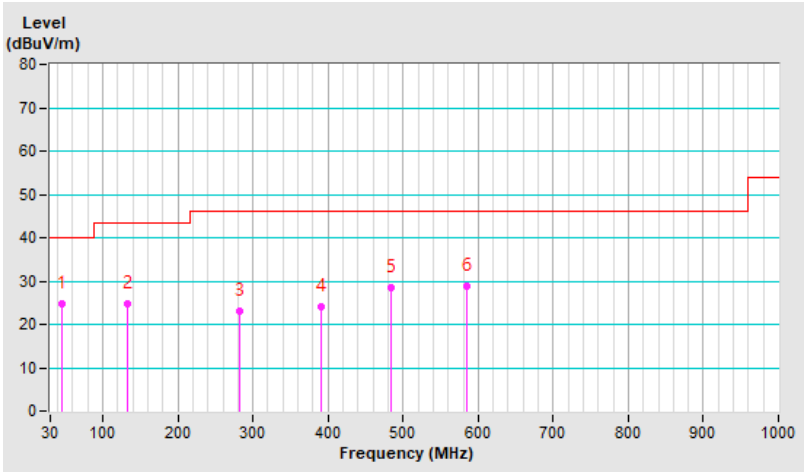


RF Mode	BTLE + 802.11g	**Channel**	CH 19：2440 MHz + CH 1：2412 MHz
Frequency Range	30 MHz ~ 1 GHz	**Detector Function & Bandwidth**	QP: RB=120kHz, DET=Quasi-Peak
Input Power	120 Vac, 60 Hz	**Environmental Conditions**	17°C, 59% RH
Tested By	Jed Wu		

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	**45.86**	**24.8 QP**	**40.0**	**-15.2**	**1.20 V**	**29**	**33.60**	**-8.80**
2	132.19	24.7 QP	43.5	-18.8	1.43 V	234	34.50	-9.80
3	281.28	23.1 QP	46.0	-22.9	1.35 V	120	29.80	-6.70
4	391.28	24.0 QP	46.0	-22.0	1.58 V	142	28.10	-4.10
5	483.72	28.4 QP	46.0	-17.6	1.97 V	14	30.40	-2.00
6	584.60	28.8 QP	46.0	-17.2	1.11 V	323	28.40	0.40

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 30 MHz ~ 1 GHz.
5. The emission levels were very low against the limit of frequency range 9 kHz ~ 30 MHz: 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

Mode A

Description & Manufacturer	Model no.	Serial No.	Calibrated Date	Calibrated Until
EMI Test Receiver R&S	ESR3	102413	2023/2/7	2024/2/6
EMI Test Receiver R&S	ESCS 30	100276	2023/4/20	2024/4/19
LISN R&S	ENV216	101197	2023/7/12	2024/7/11
LISN R&S	ENV216	101196	2023/5/22	2024/5/21
LISN Schwarzbeck	NNLK 8121	8121-808	2023/5/2	2024/5/1
LISN Schwarzbeck	NNLK 8121	8121-00759	2023/8/21	2024/8/20
LISN Schwarzbeck	NNLK 8121	8121-731	2023/6/9	2024/6/8
LISN Schwarzbeck	NNLK 8129	8129229	2023/6/27	2024/6/26
LISN R&S	ENV216	101195	2023/7/25	2024/7/24
Coupling / Decoupling Network TESEQ	CDN A201A	44601	2022/12/14	2023/12/13
RF Coaxial Cable PEWC	5D-FB	Cable-CO3-01	2023/9/13	2024/9/12
Fixed Attenuator STI	STI02-2200-10	NO.3	2022/10/21	2023/10/20
High Voltage Probe Schwarzbeck	TK9420	00982	2022/12/14	2023/12/13
Fixed Attenuator EMEC	EM-ATT30002602NN	NA	2023/3/24	2024/3/23
50 ohm terminal resistance LYNICS	0900510	E1-01-305	2023/2/13	2024/2/12
Isolation Transformer Erika Fiedler	D-65396	017	2023/9/14	2024/9/13
Software BVADT	Cond_V7.3.7.4	NA	NA	NA

Notes:

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 Linkou Conduction 3.
3. Tested Date: 2023/9/20

Mode B

Description & Manufacturer	Model no.	Serial No.	Calibrated Date	Calibrated Until
EMI Test Receiver R&S	ESR3	102413	2023/2/7	2024/2/6
EMI Test Receiver R&S	ESCS 30	100276	2023/4/20	2024/4/19
LISN R&S	ENV216	101197	2022/7/5	2023/7/4
LISN R&S	ENV216	101196	2023/5/22	2024/5/21
LISN Schwarzbeck	NNLK 8121	8121-808	2023/5/2	2024/5/1
LISN Schwarzbeck	NNLK 8121	8121-00759	2022/8/18	2023/8/17
LISN Schwarzbeck	NNLK 8129	8129229	2022/6/8	2023/6/7
LISN R&S	ENV216	101195	2022/8/1	2023/7/31
Coupling / Decoupling Network TESEQ	CDN A201A	44601	2022/12/14	2023/12/13
RF Coaxial Cable PEWC	5D-FB	Cable-CO3-01	2022/9/14	2023/9/13
Fixed Attenuator STI	STI02-2200-10	NO.3	2022/10/21	2023/10/20
High Voltage Probe Schwarzbeck	TK9420	00982	2022/12/14	2023/12/13
Fixed Attenuator EMEC	EM-ATT30002602NN	NA	2023/3/24	2024/3/23
50 ohm terminal resistance LYNICS	0900510	E1-011286	2022/9/19	2023/9/18
50 ohm terminal resistance LYNICS	0900510	E1-011285	2022/9/19	2023/9/18
50 ohm terminal resistance LYNICS	0900510	E1-01-305	2023/2/13	2024/2/12
Isolation Transformer Erika Fiedler	D-65396	017	2022/9/8	2023/9/7
Software BVADT	Cond_V7.3.7.4	NA	NA	NA

Notes:

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 Linkou Conduction 3.
3. Tested Date: 2023/6/2

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.

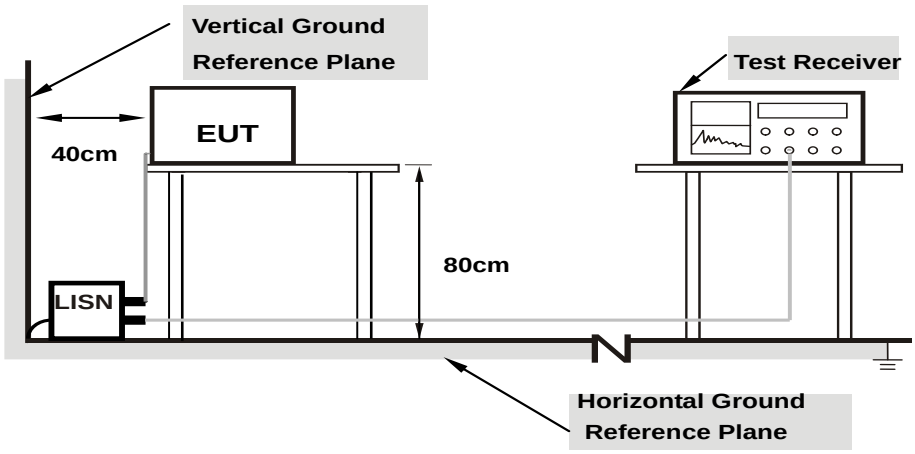
c. The frequency range from 150kHz to 30MHz was searched. Emission levels under (Limit - 20dB) was not recorded.

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 Condition

Same as item 4.1.6.

4.2.7 Test Results

Mode A

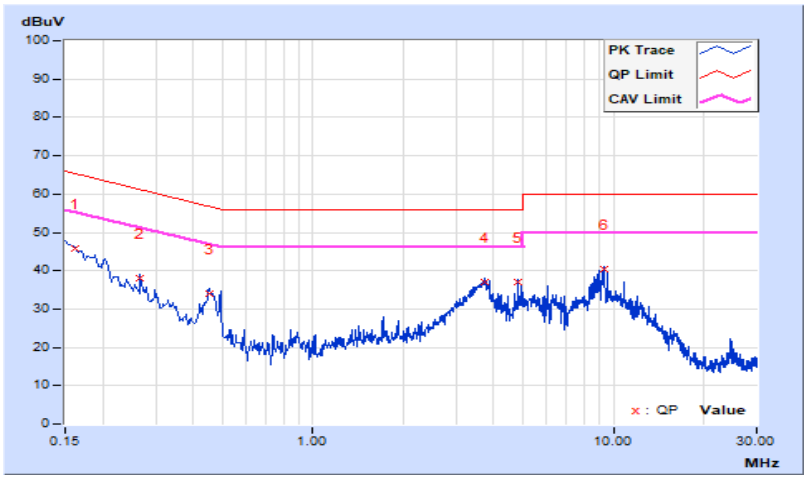
BTLE: CH 19 + 802.11g: CH 1

RF Mode	BTLE + 802.11g	Channel	CH 19：2440 MHz + CH 1：2412 MHz
Frequency Range	150 kHz ~ 30 MHz	Detector Function & Resolution Bandwidth	Quasi-Peak (QP) / Average (AV), 9 kHz
Input Power	120 Vac, 60 Hz	Environmental Conditions	25°C, 75% RH
Tested By	Jed Wu		

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	0.16173	9.62	36.07	23.16	45.69	32.78	65.37	55.37	-19.68	-22.59
2	0.26733	9.70	28.49	21.54	38.19	31.24	61.20	51.20	-23.01	-19.96
3	0.45097	9.75	24.13	14.30	33.88	24.05	56.86	46.86	-22.98	-22.81
4	3.71484	9.99	27.16	18.45	37.15	28.44	56.00	46.00	-18.85	-17.56
5	4.83730	10.06	26.82	19.56	36.88	29.62	56.00	46.00	-19.12	-16.38
6	9.27863	10.30	30.05	20.93	40.35	31.23	60.00	50.00	-19.65	-18.77

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

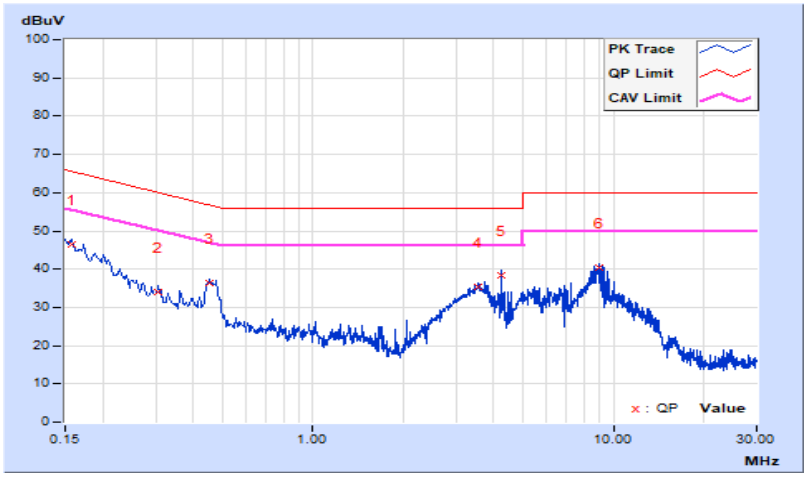


RF Mode	BTLE + 802.11g	**Channel**	CH 19：2440 MHz + CH 1：2412 MHz
Frequency Range	150 kHz ~ 30 MHz	**Detector Function & Resolution Bandwidth**	Quasi-Peak (QP) / Average (AV), 9 kHz
Input Power	120 Vac, 60 Hz	**Environmental Conditions**	25°C, 75% RH
Tested By	Jed Wu		

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	0.15760	9.67	36.64	22.44	46.31	32.11	65.59	55.59	-19.28	-23.48
2	0.30615	9.69	24.31	15.60	34.00	25.29	60.07	50.07	-26.07	-24.78
3	0.45506	9.67	26.63	14.13	36.30	23.80	56.78	46.78	-20.48	-22.98
4	3.55840	10.02	25.41	17.98	35.43	28.00	56.00	46.00	-20.57	-18.00
5	**4.21936**	**10.07**	**28.43**	**18.89**	**38.50**	**28.96**	**56.00**	**46.00**	**-17.50**	**-17.04**
6	8.95402	10.32	30.06	21.50	40.38	31.82	60.00	50.00	-19.62	-18.18

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



Mode B

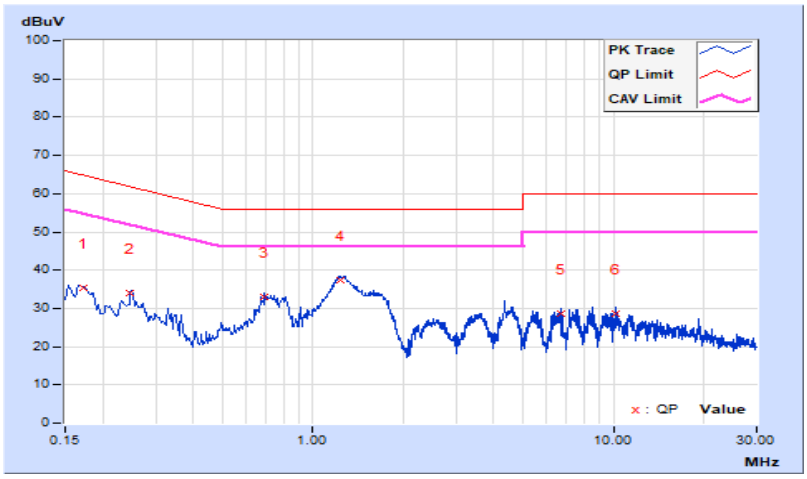
BTLE: CH 19 + 802.11g: CH 1

RF Mode	BTLE + 802.11g	Channel	CH 19 : 2440 MHz + CH 1 : 2412 MHz
Frequency Range	150 kHz ~ 30 MHz	Detector Function & Resolution Bandwidth	Quasi-Peak (QP) / Average (AV), 9 kHz
Input Power	120 Vac, 60 Hz	Environmental Conditions	25°C, 75% RH
Tested By	Jed Wu		

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	0.17192	9.63	25.56	8.23	35.19	17.86	64.87	54.87	-29.68	-37.01
2	0.24777	9.69	24.30	13.81	33.99	23.50	61.83	51.83	-27.84	-28.33
3	0.69164	9.77	23.09	16.65	32.86	26.42	56.00	46.00	-23.14	-19.58
4	1.24309	9.80	27.69	8.63	37.49	18.43	56.00	46.00	-18.51	-27.57
5	6.66609	10.16	18.39	10.61	28.55	20.77	60.00	50.00	-31.45	-29.23
6	10.24856	10.35	18.13	9.49	28.48	19.84	60.00	50.00	-31.52	-30.16

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

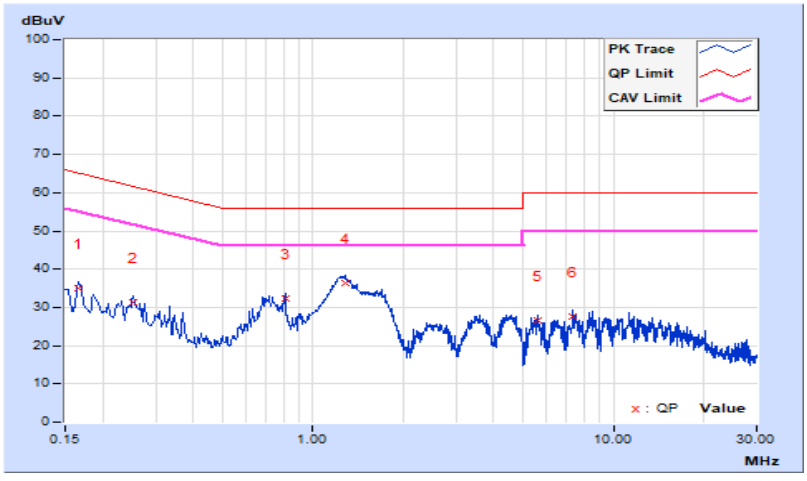


RF Mode	BTLE + 802.11g	**Channel**	CH 19：2440 MHz + CH 1：2412 MHz
Frequency Range	150 kHz ~ 30 MHz	**Detector Function & Resolution Bandwidth**	Quasi-Peak (QP) / Average (AV), 9 kHz
Input Power	120 Vac, 60 Hz	**Environmental Conditions**	25°C, 75% RH
Tested By	Jed Wu		

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	0.16564	9.69	25.25	1.55	34.94	11.24	65.18	55.18	-30.24	-43.94
2	0.25169	9.71	21.75	10.74	31.46	20.45	61.70	51.70	-30.24	-31.25
3	0.80897	9.72	22.63	14.08	32.35	23.80	56.00	46.00	-23.65	-22.20
4	1.27829	9.79	26.74	15.00	36.53	24.79	56.00	46.00	-19.47	-21.21
5	5.61012	10.14	16.40	8.19	26.54	18.33	60.00	50.00	-33.46	-31.67
6	7.34269	10.23	17.54	10.49	27.77	20.72	60.00	50.00	-32.23	-29.28

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

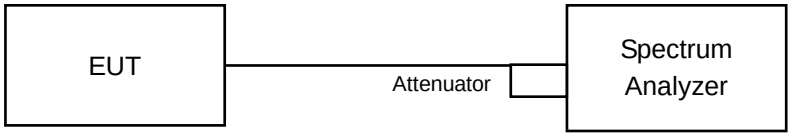


4.3 Conducted Out of Band Emission Measurement

4.3.1 Limits of Conducted Out of Band Emission Measurement

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

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

MEASUREMENT PROCEDURE REF

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

MEASUREMENT PROCEDURE OOBE

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

4.3.5 Deviation from Test Standard

No deviation.

4.3.6 EUT Operating Condition

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

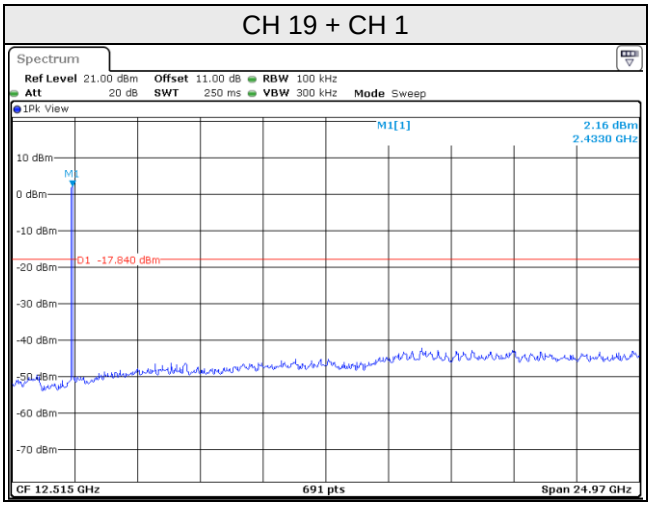
4.3.7 Test Results

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.

Mode A

BTLE: CH 19 + 802.11g: CH 1

CH 19 + CH 1



5 Construction Photos of EUT.

Please refer to the attached file (Test Setup Photo)

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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