FCC Test Report

Report No.:	RFBENL-WTW-P20110404-3
FCC ID:	RYK-WPEQ261ACNIBT
Test Model:	WPEQ-261ACNI(BT)
Received Date:	Nov. 12, 2020
Test Date:	Nov. 27, 2020
Issued Date:	Dec. 07, 2020
Applicant:	SparkLAN Communications, Inc.
Address:	8F., No.257, Sec. 2, Tiding Blvd., Neihu District, Taipei City 11493, Taiwan (R.O.C.)
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. 19, Hwa Ya 2nd Rd., Wen Hwa Vil., Kwei Shan Dist., Taoyuan City 33383, Taiwan
FCC Registration / Designation Number:	788550 / TW0003

Table of Contents

Release Control Record

Issue No.	Description	Date Issued
RFBENL-WTW-P20110404-3	Original release	Dec. 07, 2020

1 Certificate of Conformity

Product:	802.11ac/a/b/g/n 2T2R Industrial-graded Wi-Fi / Bluetooth 4.2 Combo Half mini PCIe Module
Brand:	SparkLAN
Test Model:	WPEQ-261ACNI(BT)
Sample Status:	R&D sample
Applicant:	SparkLAN Communications, Inc.
Test Date:	Nov. 27, 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 RF characteristics under the conditions specified in this report.

Prepared by : Pettie Chen , **Date:** Dec. 07, 2020

Pettie Chen / Senior Specialist

Approved by : Bruce Chen , **Date:** Dec. 07, 2020

Bruce Chen / Senior Project Engineer

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 -22.92dB at 5.88597MHz.
15.247(a)(1)(iii)	Number of Hopping Frequency Used	N/A	Refer to note 1
15.247(a)(1)(iii)	Dwell Time on Each Channel	N/A	Refer to note 1
15.247(a)(1)	1. Hopping Channel Separation 2. Spectrum Bandwidth of a Frequency Hopping Sequence Spread Spectrum System	N/A	Refer to note 1
15.247(b)	Maximum Peak Output Power	N/A	Refer to note 1
15.205 / 15.209 / 15.247(d)	Radiated Emissions and Band Edge Measurement	Pass	Meet the requirement of limit. Minimum passing margin is -1.0dB at 32.81MHz.
15.247(d)	Antenna Port Emission	N/A	Refer to note 1
15.203	Antenna Requirement	Pass	For Antenna 1~6: Antenna connectors are IPEX MHF I at modular side & RP-SMA (M) at antenna side not standard connector. For Antenna 7: Antenna connector is I-PEX not a standard connector.

Note:
1. This report is a partial report. Therefore, only Radiated Emissions and Band Edge Measurement and AC Power Conducted Emission was verified and recorded in this report. Other testing data please refer to the original BV CPS report no.: RF180828C27-3.
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	2.94 dB
Radiated Emissions up to 1 GHz	30MHz ~ 200MHz	3.86 dB
	200MHz ~ 1000MHz	3.87 dB
Radiated Emissions above 1 GHz	1GHz ~ 18GHz	2.29 dB
	18GHz ~ 40GHz	2.29 dB

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product	802.11ac/a/b/g/n 2T2R Industrial-graded Wi-Fi / Bluetooth 4.2 Combo Half mini PCIe Module
Brand	SparkLAN
Test Model	WPEQ-261ACNI(BT)
Sample Status	R&D sample
Nominal Voltage	3.3Vdc (host)
Modulation Type	GFSK, π/4-DQPSK, 8DPSK
Modulation Technology	FHSS
Transfer Rate	1/2/3Mbps
Operating Frequency	2402~2480MHz
Number of Channel	79
Output Power	1.663mW
Antenna Type	Refer to Note
Antenna Connector	Refer to Note
Accessory Device	Antenna
Cable Supplied	NA

Note:

1. This report is prepared for FCC class II permissive change. The difference compared with original report is adding an antenna (Model: AD-301PF). Therefore, only Radiated Emissions and Band Edge Measurement and AC Power Conducted Emission was verified and recorded in this report. Other testing data please refer to the original BV CPS report no.: RF180828C27-3.
2. The EUT uses following antenna. (Antenna 7 is the new antenna)

No.	Transmitter Circuit	Brand	Model	Antenna Type	2.4G gain with cable loss (dBi)	5G gain with cable loss (dBi)	Connector Type
1	Chain(0) Chain(1)	Sparklan	AD-301N	Dipole	4.4	B1&2: 5.2 B3&4: 5.8	IPEX MHF I at modular side & RP-SMA (M) at antenna side
2	Chain(0) Chain(1)	Sparklan	AD-103AG	Dipole	2.02	B1&2: 1.93 B3&4: 2.03	
3	Chain(0) Chain(1)	Sparklan	AD-305N	Dipole	5.0	5.0	
4	Chain(0) Chain(1)	Sparklan	AD-303N	Dipole	3.0	3.0	
5	Chain(0) Chain(1)	Sparklan	AD-302N	Dipole	3.0	2.0	

No.	Antenna Type	Brand	Model	Connector Type	Gain (dBi)					
						2400MHz	2420MHz	2440MHz	2460MHz	2483MHz
6	Omni-Directional	Data Alliance	A2x2P2miniS12i	IPEX MHF I at modular side & RP-SMA (M) at antenna side	WIFI 1	-0.23	1.02	1.32	2.51	3.90
					WIFI 2	-0.19	0.95	1.10	2.30	3.80

No.	Transmitter Circuit	Brand	Model	Antenna Type	2.4G gain with cable loss (dBi)	5G gain with cable loss (dBi)	Connector Type
7	Chain(0) Chain(1)	Sparklan	AD-301PF	PIFA	2.65	4.86	I-PEX

3. 2.4GHz & 5GHz technologies cannot transmit at same time.
   WLAN & BT technologies cannot transmit at same time

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)
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		

3.2.1 Test Mode Applicability and Tested Channel Detail

EUT Configure Mode	Applicable to			Description
	RE≥1G	RE<1G	PLC	
-	√	√	√	EUT with antenna 7

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

Note: The EUT had been pre-tested on the positioned of each 3 axis. The worst case was found when positioned on **Z-plane**.

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	Available Channel	Tested Channel	Modulation Technology	Modulation Type	Pakcet Type	Remark
-	0 to 78	0, 39, 78	FHSS	GFSK	DH5	-
	0 to 78	0, 39, 78	FHSS	8DPSK	3DH5	-

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	Available Channel	Tested Channel	Modulation Technology	Modulation Type	Pakcet Type	Remark
-	0 to 78	39	FHSS	GFSK	DH5	-

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	Available Channel	Tested Channel	Modulation Technology	Modulation Type	Pakcet Type	Remark
-	0 to 78	39	FHSS	GFSK	DH5	-

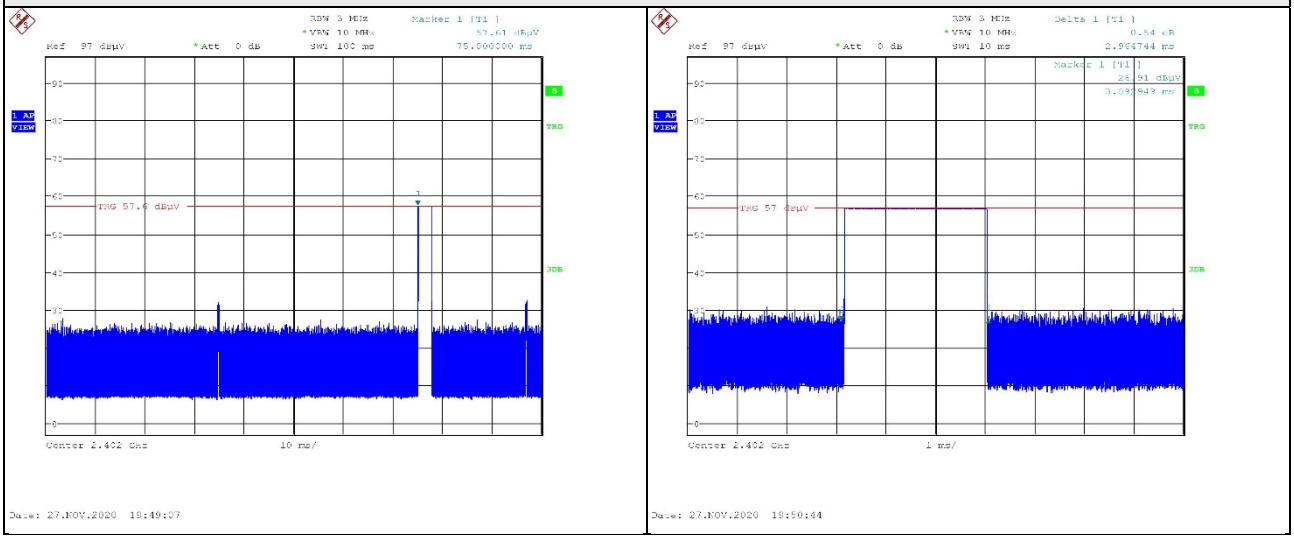
Test Condition:

Applicable to	Environmental Conditions	Input Power (system)	Tested by
RE≥1G	22deg. C, 69%RH	120Vac, 60Hz	Adair Peng
RE<1G	22deg. C, 69%RH	120Vac, 60Hz	Adair Peng
PLC	23deg. C, 67%RH	120Vac, 60Hz	Adair Peng

3.3 Duty cycle of test signal.

Duty cycle = 2.964/100 = 0.02964, Duty factor = 20 * log(0.02964) = -30.56

BT



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.

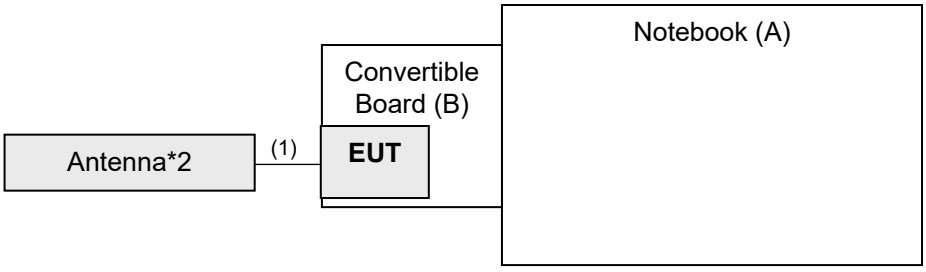
ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	Notebook	DELL	E5420	FHNX4S1	FCC DoC Approved	-
B.	Convertible Board	NA	NA	NA	NA	-

Note:

1. All power cords of the above support units are non-shielded (1.8m).

ID	Descriptions	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1.	Antenna cable	2	0.15	N	0	Provided by manufacturer

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

Description & Manufacturer	Model No.	Serial No.	Cal. Date	Cal. Due
Test Receiver ROHDE & SCHWARZ	ESR3	102579	Jul. 07, 2020	Jul. 06, 2021
Spectrum Analyzer ROHDE & SCHWARZ	FSP40	100269	Jun. 09, 2020	Jun. 08, 2021
BILOG Antenna SCHWARZBECK	VULB9168	9168-171	Nov. 04, 2020	Nov. 03, 2021
HORN Antenna SCHWARZBECK	9120D	209	Nov. 22, 2020	Nov. 21, 2021
HORN Antenna SCHWARZBECK	BBHA 9170	BBHA9170241	Nov. 22, 2020	Nov. 21, 2021
Loop Antenna TESEQ	HLA 6121	45745	Jul. 06, 2020	Jul. 05, 2021
Preamplifier Agilent (Below 1GHz)	8447D	2944A10738	Aug. 16, 2020	Aug. 15, 2021
Preamplifier Agilent (Above 1GHz)	8449B	3008A02465	Mar. 23, 2020	Mar. 22, 2021
RF Coaxial Cable WOKEN With 5dB PAD	8D-FB	Cable-CH3-01	Aug. 16, 2020	Aug. 15, 2021
RF signal cable HUBER+SUHNER	SUCOFLEX 104	Cable-CH3-03 (223653/4)	Aug. 16, 2020	Aug. 15, 2021
RF signal cable HUBER+SUHNER& EMCI	SUCOFLEX 104&EMC104-SM-S M-8000	Cable-CH3-03 (309224+170907)	Aug. 16, 2020	Aug. 15, 2021
Software BV ADT	ADT_Radiated_ V7.6.15.9.5	NA	NA	NA
Antenna Tower inn-co GmbH	MA 4000	013303	NA	NA
Antenna Tower Controller BV ADT	AT100	AT93021702	NA	NA
Turn Table BV ADT	TT100	TT93021702	NA	NA
Turn Table Controller BV ADT	SC100	SC93021702	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 HwaYa Chamber 3.

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 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:

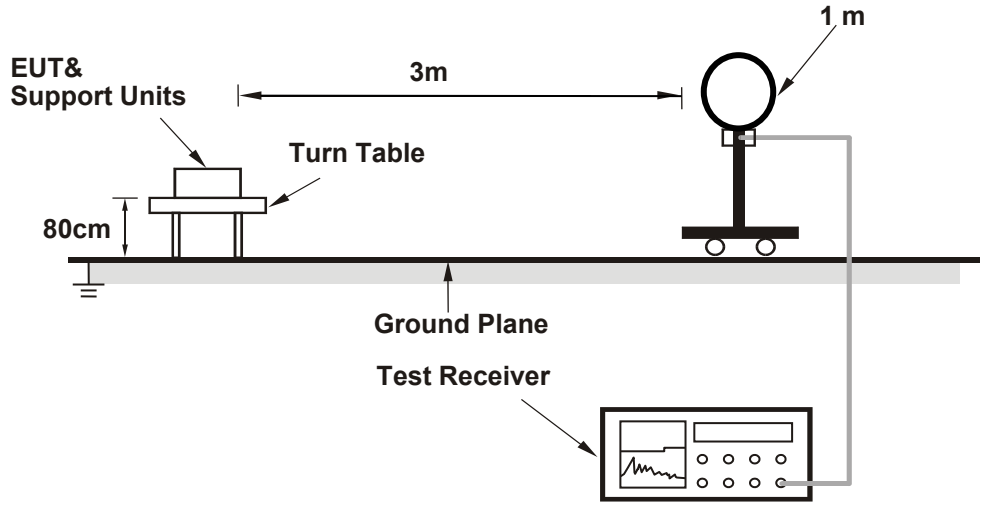
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) and Average detection (AV) at frequency above 1GHz. For fundamental and harmonic signal measurement, according to ANSI C63.10 section 7.5, the average value = peak value + duty cycle correction factor. The duty cycle correction factor refer to Chapter 3.3 of this report.
3. All modes of operation were investigated and the worst-case emissions are reported.

4.1.4 Deviation from Test Standard

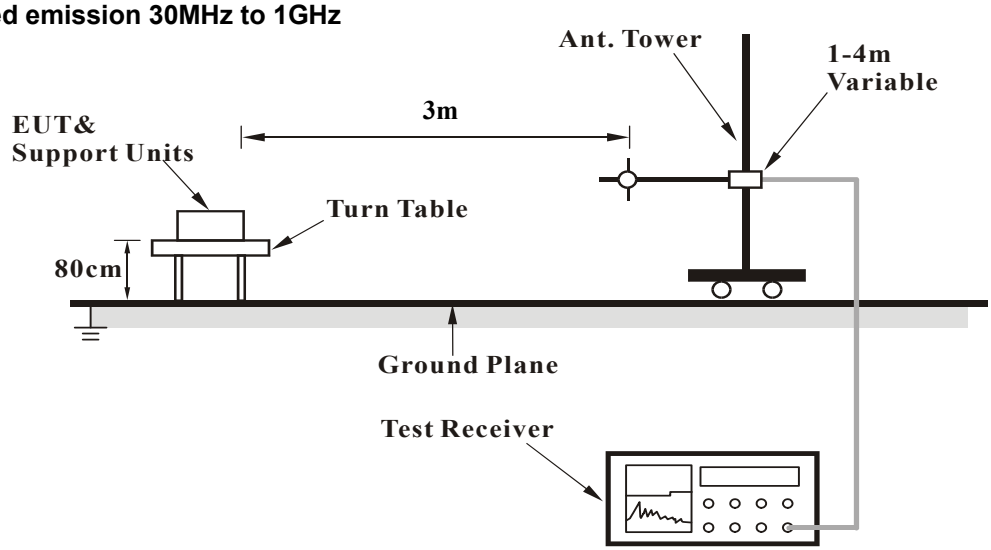
No deviation.

4.1.5 Test Setup

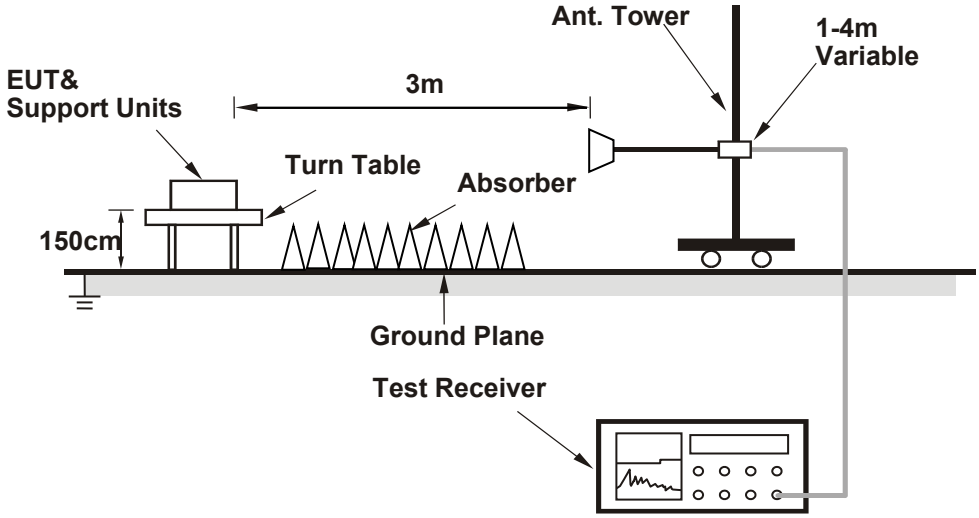
For Radiated emission below 30MHz



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. Set the EUT under transmission condition continuously at specific channel frequency.

4.1.7 Test Results

Above 1GHz data:

GFSK

CHANNEL	TX Channel 0	DETECTOR FUNCTION	Peak (PK) Average (AV)
FREQUENCY RANGE	1GHz ~ 25GHz		

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (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	60.86 PK	74.00	-13.14	1.75 H	215	26.50	34.36
2	2390.00	49.06 AV	54.00	-4.94	1.75 H	215	14.70	34.36
3	*2402.00	94.64 PK			1.75 H	215	60.30	34.34
4	*2402.00	64.08 AV			1.75 H	215	29.74	34.34
5	4804.00	55.29 PK	74.00	-18.71	1.17 H	15	49.20	6.09
6	4804.00	24.73 AV	54.00	-29.27	1.17 H	15	18.64	6.09
ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (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	60.86 PK	74.00	-13.14	1.68 V	239	26.50	34.36
2	2390.00	49.16 AV	54.00	-4.84	1.68 V	239	14.80	34.36
3	*2402.00	97.34 PK			1.68 V	239	63.00	34.34
4	*2402.00	66.78 AV			1.68 V	239	32.44	34.34
5	4804.00	56.29 PK	74.00	-17.71	2.16 V	269	50.20	6.09
6	4804.00	25.73 AV	54.00	-28.27	2.16 V	269	19.64	6.09

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. The other emission levels were very low against the limit
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency
6. For Fundamental frequency & harmonic:
   The average value of fundamental frequency is: average = peak value + 20log(Duty cycle) where the duty factor is calculated from following formula: 20Log(Duty cycle) = 20 log (2.964ms/100) = -30.56dB please refer to the plotted duty (refer to item 3.3).

CHANNEL	TX Channel 39	DETECTOR FUNCTION	Peak (PK) Average (AV)
FREQUENCY RANGE	1GHz ~ 25GHz		

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	*2441.00	94.39 PK			1.58 H	201	60.00	34.39
2	*2441.00	63.83 AV			1.58 H	201	29.44	34.39
3	4882.00	56.71 PK	74.00	-17.29	1.35 H	23	50.70	6.01
4	4882.00	26.15 AV	54.00	-27.85	1.35 H	23	20.14	6.01
ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	*2441.00	97.19 PK			1.81 V	235	62.80	34.39
2	*2441.00	66.63 AV			1.81 V	235	32.24	34.39
3	4882.00	58.01 PK	74.00	-15.99	2.23 V	266	52.00	6.01
4	4882.00	27.45 AV	54.00	-26.55	2.23 V	266	21.44	6.01

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. The other emission levels were very low against the limit
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency
6. For Fundamental frequency & harmonic:
   The average value of fundamental frequency is: average = peak value + 20log(Duty cycle) where the duty factor is calculated from following formula: 20Log(Duty cycle) = 20 log (2.964ms/100) = -30.56dB please refer to the plotted duty (refer to item 3.3).

CHANNEL	TX Channel 78	DETECTOR FUNCTION	Peak (PK) Average (AV)
FREQUENCY RANGE	1GHz ~ 25GHz		

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (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	95.07 PK			1.74 H	215	60.70	34.37
2	*2480.00	64.51 AV			1.74 H	215	30.14	34.37
3	2483.50	45.58 PK	74.00	-28.42	1.74 H	215	47.60	-2.02
4	2483.50	15.02 AV	54.00	-38.98	1.74 H	215	17.04	-2.02
5	4960.00	57.99 PK	74.00	-16.01	1.31 H	14	51.60	6.39
6	4960.00	27.43 AV	54.00	-26.57	1.31 H	14	21.04	6.39
ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (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	97.67 PK			1.61 V	238	63.30	34.37
2	*2480.00	67.11 AV			1.61 V	238	32.74	34.37
3	2483.50	45.98 PK	74.00	-28.02	1.61 V	238	48.00	-2.02
4	2483.50	15.42 AV	54.00	-38.58	1.61 V	238	17.44	-2.02
5	4960.00	58.99 PK	74.00	-15.01	2.30 V	272	52.60	6.39
6	4960.00	28.43 AV	54.00	-25.57	2.30 V	272	22.04	6.39

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. The other emission levels were very low against the limit
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency
6. For Fundamental frequency & harmonic:
   The average value of fundamental frequency is: average = peak value + 20log(Duty cycle) where the duty factor is calculated from following formula: 20Log(Duty cycle) = 20 log (2.964ms/100) = -30.56dB please refer to the plotted duty (refer to item 3.3).

8DPSK

CHANNEL	TX Channel 0	DETECTOR FUNCTION	Peak (PK) Average (AV)
FREQUENCY RANGE	1GHz ~ 25GHz		

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (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	60.76 PK	74.00	-13.24	1.64 H	208	26.40	34.36
2	2390.00	48.96 AV	54.00	-5.04	1.64 H	208	14.60	34.36
3	*2402.00	95.14 PK			1.64 H	208	60.80	34.34
4	*2402.00	64.58 AV			1.64 H	208	30.24	34.34
5	4804.00	54.59 PK	74.00	-19.41	1.19 H	14	48.50	6.09
6	4804.00	24.03 AV	54.00	-29.97	1.19 H	14	17.94	6.09
ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (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	60.96 PK	74.00	-13.04	1.83 V	238	26.60	34.36
2	2390.00	49.06 AV	54.00	-4.94	1.83 V	238	14.70	34.36
3	*2402.00	97.84 PK			1.83 V	238	63.50	34.34
4	*2402.00	67.28 AV			1.83 V	238	32.94	34.34
5	4804.00	55.69 PK	74.00	-18.31	1.74 V	254	49.60	6.09
6	4804.00	25.13 AV	54.00	-28.87	1.74 V	254	19.04	6.09

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. The other emission levels were very low against the limit
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency
6. For Fundamental frequency & harmonic:
   The average value of fundamental frequency is: average = peak value + 20log(Duty cycle) where the duty factor is calculated from following formula: 20Log(Duty cycle) = 20 log (2.964ms/100) = -30.56dB please refer to the plotted duty (refer to item 3.3).

CHANNEL	TX Channel 39	DETECTOR FUNCTION	Peak (PK) Average (AV)
FREQUENCY RANGE	1GHz ~ 25GHz		

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	*2441.00	94.19 PK			1.70 H	211	59.80	34.39
2	*2441.00	63.63 AV			1.70 H	211	29.24	34.39
3	4882.00	57.81 PK	74.00	-16.19	1.23 H	20	51.80	6.01
4	4882.00	27.25 AV	54.00	-26.75	1.23 H	20	21.24	6.01
ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	*2441.00	96.89 PK			1.52 V	238	62.50	34.39
2	*2441.00	66.33 AV			1.52 V	238	31.94	34.39
3	4882.00	58.91 PK	74.00	-15.09	2.18 V	256	52.90	6.01
4	4882.00	28.35 AV	54.00	-25.65	2.18 V	256	22.34	6.01

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. The other emission levels were very low against the limit
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency
6. For Fundamental frequency & harmonic:
   The average value of fundamental frequency is: average = peak value + 20log(Duty cycle) where the duty factor is calculated from following formula: 20Log(Duty cycle) = 20 log (2.964ms/100) = -30.56dB please refer to the plotted duty (refer to item 3.3).

CHANNEL	TX Channel 78	DETECTOR FUNCTION	Peak (PK) Average (AV)
FREQUENCY RANGE	1GHz ~ 25GHz		

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (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	94.57 PK			1.70 H	215	60.20	34.37
2	*2480.00	64.01 AV			1.70 H	215	29.64	34.37
3	2483.50	44.68 PK	74.00	-29.32	1.70 H	215	46.70	-2.02
4	2483.50	14.12 AV	54.00	-39.88	1.70 H	215	16.14	-2.02
5	4960.00	60.09 PK	74.00	-13.91	1.30 H	17	53.70	6.39
6	4960.00	29.53 AV	54.00	-24.47	1.30 H	17	23.14	6.39
ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (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	97.67 PK			1.63 V	236	63.30	34.37
2	*2480.00	67.11 AV			1.63 V	236	32.74	34.37
3	2483.50	45.08 PK	74.00	-28.92	1.63 V	236	47.10	-2.02
4	2483.50	14.52 AV	54.00	-39.48	1.63 V	236	16.54	-2.02
5	4960.00	61.19 PK	74.00	-12.81	2.25 V	268	54.80	6.39
6	4960.00	30.63 AV	54.00	-23.37	2.25 V	268	24.24	6.39

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. The other emission levels were very low against the limit
4. Margin value = Emission Level – Limit value
5. " * ": Fundamental frequency
6. For Fundamental frequency & harmonic:
   The average value of fundamental frequency is: average = peak value + 20log(Duty cycle) where the duty factor is calculated from following formula: 20Log(Duty cycle) = 20 log (2.964ms/100) = -30.56dB please refer to the plotted duty (refer to item 3.3).

Below 1GHz worst-case data:

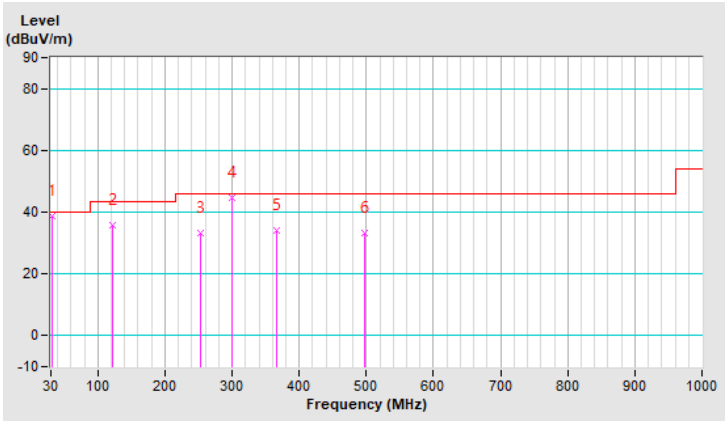
GFSK

CHANNEL	TX Channel 39	DETECTOR FUNCTION	Quasi-Peak (QP)
FREQUENCY RANGE	9kHz ~ 1GHz		

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	**32.81**	**38.90 QP**	**40.00**	**-1.10**	**2.00 H**	**216**	**49.80**	**-10.90**
2	122.78	35.70 QP	43.50	-7.80	1.50 H	6	46.30	-10.60
3	252.12	33.20 QP	46.00	-12.80	1.01 H	253	41.60	-8.40
4	299.91	44.50 QP	46.00	-1.50	1.01 H	254	51.10	-6.60
5	365.99	34.10 QP	46.00	-11.90	1.01 H	156	39.30	-5.20
6	498.13	33.40 QP	46.00	-12.60	2.00 H	181	35.70	-2.30

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. The other emission levels were very low against the limit of frequency range 30MHz~1000MHz.
4. Margin value = Emission Level – Limit value
5. The emission levels were very low against the limit of frequency range 9kHz~30MHz: the amplitude of spurious emissions attenuated more than 20dB below the permissible value to be report.

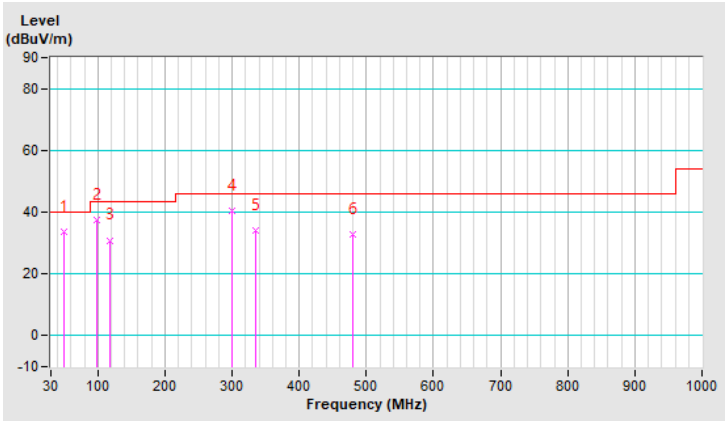


CHANNEL	TX Channel 39	DETECTOR FUNCTION	Quasi-Peak (QP)
FREQUENCY RANGE	9kHz ~ 1GHz		

ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 3 M								
NO.	FREQ. (MHz)	EMISSION LEVEL (dBuV/m)	LIMIT (dBuV/m)	MARGIN (dB)	ANTENNA HEIGHT (m)	TABLE ANGLE (Degree)	RAW VALUE (dBuV)	CORRECTION FACTOR (dB/m)
1	49.68	33.70 QP	40.00	-6.30	1.00 V	333	42.80	-9.10
2	98.88	37.60 QP	43.50	-5.90	1.00 V	54	51.10	-13.50
3	117.16	30.90 QP	43.50	-12.60	1.00 V	6	42.10	-11.20
4	299.91	40.50 QP	46.00	-5.50	1.49 V	186	47.10	-6.60
5	335.06	34.00 QP	46.00	-12.00	1.49 V	15	39.70	-5.70
6	479.86	32.80 QP	46.00	-13.20	1.99 V	14	35.40	-2.60

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. The other emission levels were very low against the limit of frequency range 30MHz~1000MHz.
4. Margin value = Emission Level – Limit value
5. The emission levels were very low against the limit of frequency range 9kHz~30MHz: the amplitude of spurious emissions attenuated more than 20dB 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.	Cal. Date	Cal. Due
Test Receiver ROHDE & SCHWARZ	ESR3	102412	Feb. 17, 2020	Feb. 16, 2021
RF signal cable (with 10dB PAD) Woken	5D-FB	Cable-cond2-01	Sep. 04, 2020	Sep. 03, 2021
LISN ROHDE & SCHWARZ (EUT)	ESH2-Z5	100100	Jan. 20, 2020	Jan. 19, 2021
LISN ROHDE & SCHWARZ (Peripheral)	ESH3-Z5	100312	Aug. 18, 2020	Aug. 17, 2021
Software ADT	BV ADT_Cond_ V7.3.7.4	NA	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 HwaYa Shielded Room 2. (Conduction 2)
3. The VCCI Site Registration No. is C-12047.

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.

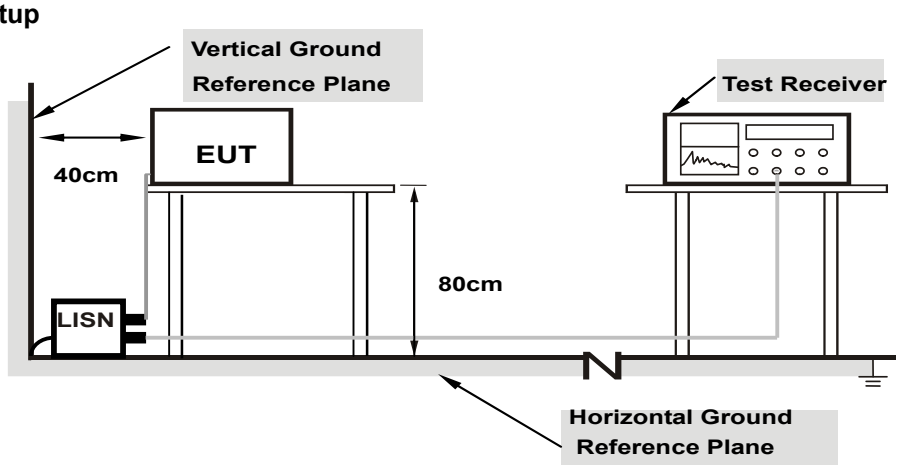
c. The frequency range from 150kHz to 30MHz was searched. Emission levels under (Limit - 20dB) was not recorded.

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 item 4.1.6.

4.2.7 Test Results

Worst-case data:

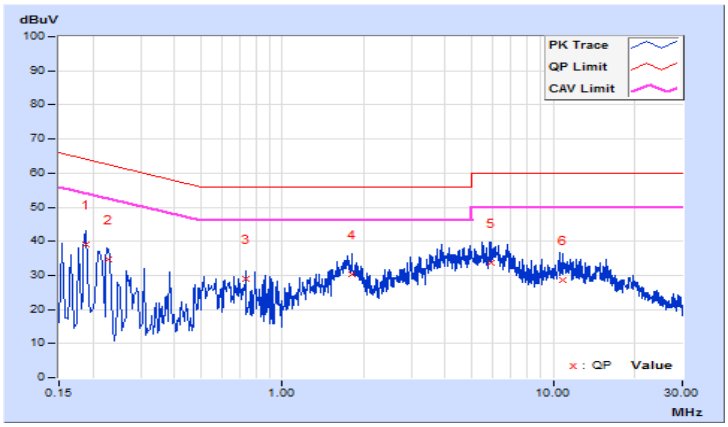
GFSK

Phase	Line (L)	Detector Function	Quasi-Peak (QP) / Average (AV)
Channel	TX Channel 39		

No	Freq.	Corr. Factor	Reading Value		Emission Level		Limit		Margin	
			[dB (uV)]		[dB (uV)]		[dB (uV)]		(dB)	
	[MHz]	(dB)	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
1	0.18910	10.10	28.89	8.68	38.99	18.78	64.08	54.08	-25.09	-35.30
2	0.22820	10.10	24.54	6.98	34.64	17.08	62.51	52.51	-27.87	-35.43
3	0.73259	10.13	18.95	3.08	29.08	13.21	56.00	46.00	-26.92	-32.79
4	1.81566	10.17	19.99	10.57	30.16	20.74	56.00	46.00	-25.84	-25.26
5	**5.88597**	**10.25**	**23.50**	**16.83**	**33.75**	**27.08**	**60.00**	**50.00**	**-26.25**	**-22.92**
6	10.85949	10.31	18.17	12.17	28.48	22.48	60.00	50.00	-31.52	-27.52

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.

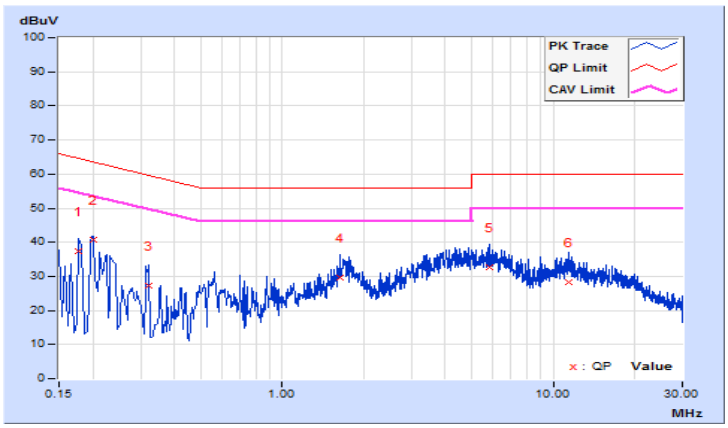


Phase	Neutral (N)	Detector Function	Quasi-Peak (QP) / Average (AV)
Channel	TX Channel 39		

No	Freq.	Corr. Factor	Reading Value		Emission Level		Limit		Margin	
			[dB (uV)]		[dB (uV)]		[dB (uV)]		(dB)	
	[MHz]	(dB)	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
1	0.17737	10.06	27.38	5.20	37.44	15.26	64.61	54.61	-27.17	-39.35
2	0.19978	10.06	30.60	13.79	40.66	23.85	63.62	53.62	-22.96	-29.77
3	0.32187	10.07	17.18	1.39	27.25	11.46	59.66	49.66	-32.41	-38.20
4	1.62798	10.14	19.54	8.78	29.68	18.92	56.00	46.00	-26.32	-27.08
5	5.85469	10.28	22.44	15.85	32.72	26.13	60.00	50.00	-27.28	-23.87
6	11.36388	10.42	17.80	11.68	28.22	22.10	60.00	50.00	-31.78	-27.90

Remarks:

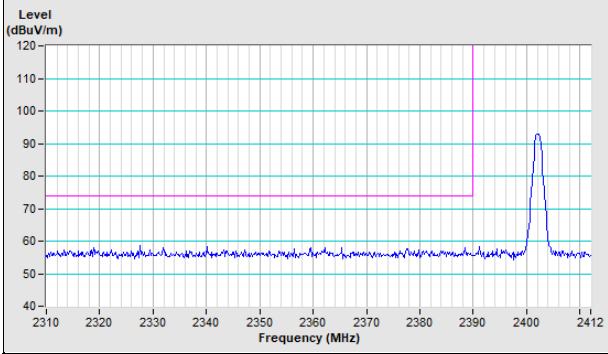
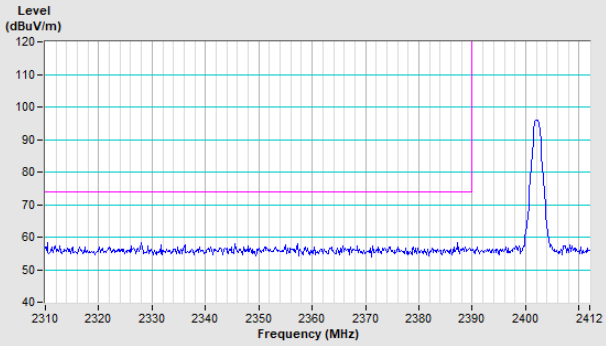
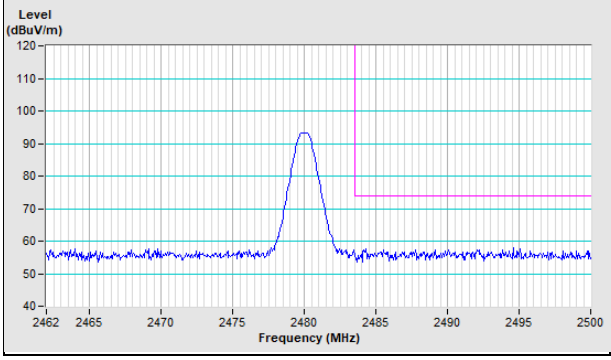
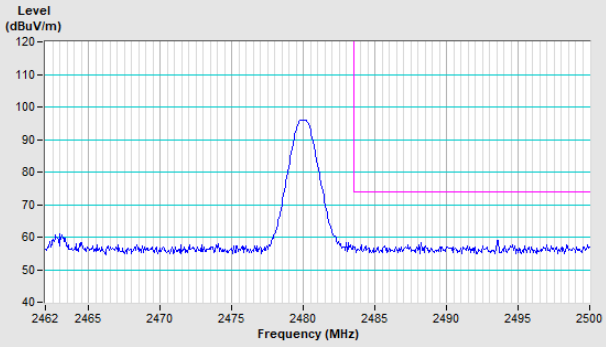
1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level - Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value.

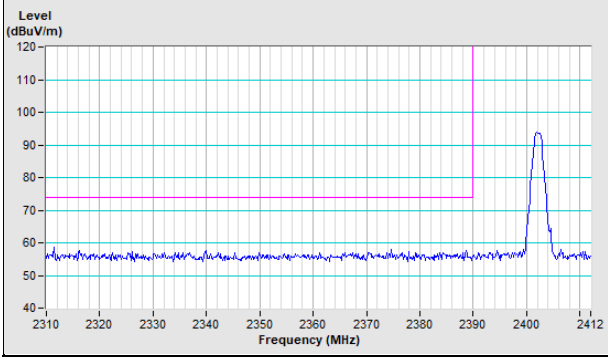
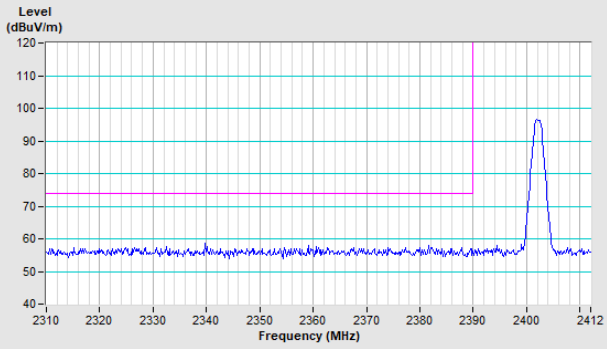
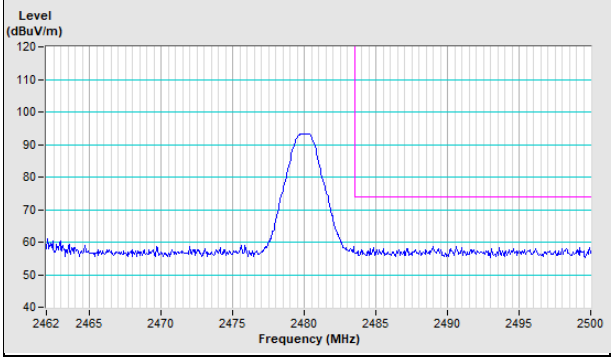
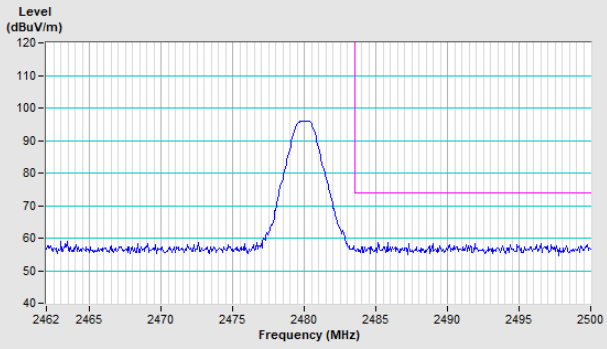


5 Pictures of Test Arrangements

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

Annex A- Band-edge Measurement

BT_GFSK Channel 0	
Horizontal (Peak)	Vertical (Peak)
	
BT_GFSK Channel 78	
Horizontal (Peak)	Vertical (Peak)
	

BT_8DPSK Channel 0	
Horizontal (Peak)	Vertical (Peak)
	
BT_8DPSK Channel 78	
Horizontal (Peak)	Vertical (Peak)
	

Appendix – Information on 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 and approved according to ISO/IEC 17025.

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

Lin Kou EMC/RF Lab
Tel: 886-2-26052180
Fax: 886-2-26051924

Hsin Chu EMC/RF/Telecom Lab
Tel: 886-3-6668565
Fax: 886-3-6668323

Hwa Ya EMC/RF/Safety Lab
Tel: 886-3-3183232
Fax: 886-3-3270892

Email: service.adt@tw.bureauveritas.com
Web Site: www.bureauveritas-adt.com

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

--- END ---