

FCC Test Report

FCC ID : 2AK2I-APEN-D2-M3
Equipment : Active Pen
Model No. : APEN-D2-M3
Brand Name : Flatfrog
Applicant : FlatFrog Laboratories AB
Address : Scheelevägen 15 A, Alfa 2,223 63
Lund,Sweden
Manufacturer : Solidyear Co., Ltd.
Address : 18F., Building B, No.97, Sec. 1, Xintai 5th Rd.,
Xizhi Dist., New Taipei City 221, Taiwan R.O.C.
Standard : 47 CFR FCC Part 15.249
Received Date : Jan. 20, 2017
Tested Date : Mar. 02 ~ Mar. 17, 2017

We, International Certification Corp., would like to declare that the tested sample has been evaluated and in compliance with the requirement of the above standards. The test results contained in this report refer exclusively to the product. It may be duplicated completely for legal use with the approval of the applicant. It shall not be reproduced except in full without the written approval of our laboratory.

Reviewed by:



Along Chen / Assistant Manager

Approved by:



Gary Chang / Manager



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Release Record

Report No.	Version	Description	Issued Date
FR712001	Rev. 01	Initial issue	Aug. 17, 2017

Summary of Test Results

FCC Rules	Test Items	Measured	Result
15.207	AC Power Line Conducted Emissions	Note	N/A
15.249(a)	Field Strength of Fundamental	Meet the requirement of limit	Pass
15.249(a)(d)	Field Strength of Harmonics and Emissions Radiated outside of the Specified Frequency Bands	Meet the requirement of limit	Pass
15.215(c)	20dB bandwidth	Meet the requirement of limit	Pass
15.203	Antenna Requirement	Meet the requirement of limit	Pass

Note: The EUT consumes DC power from battery, therefore this test is not required.

1 General Description

1.1 Information

1.1.1 Specification of the Equipment under Test (EUT)

RF General Information				
Frequency Range (MHz)	Modulation	Ch. Freq. (MHz)	Channel Number	Channel Bandwidth (MHz)
2400-2483.5	GFSK	2402-2480	0-78 [79]	2

1.1.2 Antenna Details

Ant. No.	Type	Gain (dBi)	Connector
1	SMD	5.19	N/A

1.1.3 EUT Operational Condition

Power Supply Type	1.5Vdc AAAAbattery
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Note: The equipment tests are performed using a new battery.

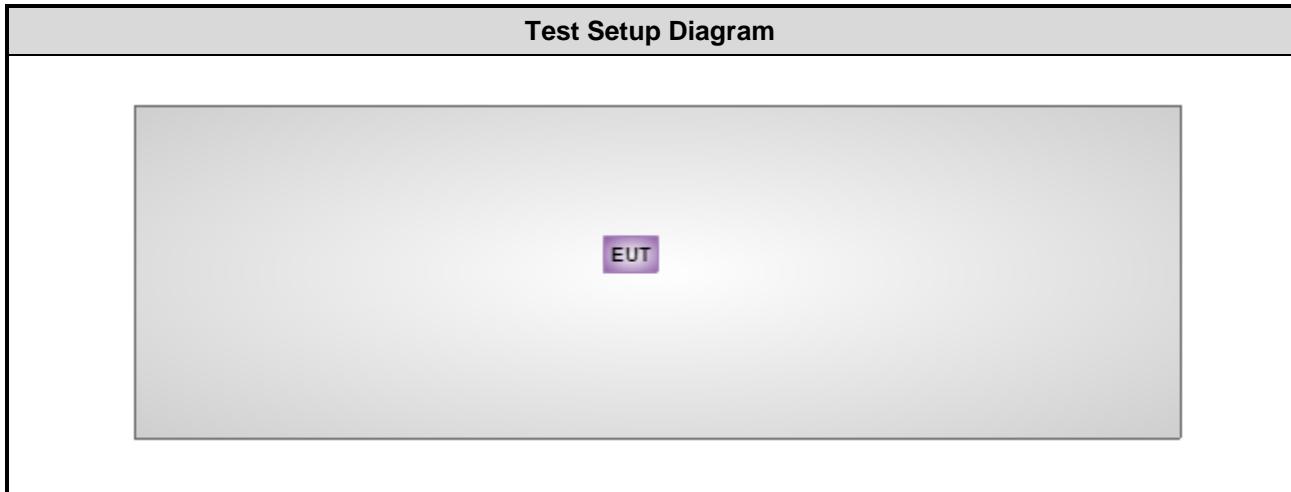
1.1.4 Accessories

Accessories		
No.	Equipment	Description
1	Dry cell	Power Rating: 1.5Vdc

1.1.5 Channel List

Frequency band (MHz)				2400~2483.5			
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	---	---

1.2 Test Setup Chart



1.3 The Equipment List

Test Item	Radiated Emission				
Test Site	966 chamber1 / (03CH01-WS)				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	R&S	FSV40	101498	Nov. 25, 2016	Nov. 24, 2017
Receiver	R&S	ESR3	101658	Nov. 24, 2016	Nov. 23, 2017
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-522	Aug. 04, 2016	Aug. 03, 2017
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	BBHA 9120 D 1096	Dec. 21, 2016	Dec. 20, 2017
Horn Antenna 18G-40G	SCHWARZBECK	BBHA 9170	BBHA 9170517	Oct. 25, 2016	Oct. 24, 2017
Loop Antenna	R&S	HFH2-Z2	100330	Nov. 10, 2016	Nov. 09, 2017
Loop Antenna Cable	KOAX KABEL	101354-BW	101354-BW	Dec. 09, 2016	Dec. 08, 2017
Preamplifier	EMC	EMC02325	980225	Aug. 05, 2016	Aug. 04, 2017
Preamplifier	Agilent	83017A	MY39501308	Oct. 06, 2016	Oct. 05, 2017
Preamplifier	EMC	EMC184045B	980192	Aug. 24, 2016	Aug. 23, 2017
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16014/4	Dec. 09, 2016	Dec. 08, 2017
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16019/4	Dec. 09, 2016	Dec. 08, 2017
RF Cable	HUBER+SUHNER	SUCOFLEX104	MY16139/4	Dec. 09, 2016	Dec. 08, 2017
LF cable 1M	EMC	EMCCFD400-NM-N M-1000	16052	Dec. 09, 2016	Dec. 08, 2017
LF cable 3M	Woken	CFD400NL-LW	CFD400NL-001	Dec. 09, 2016	Dec. 08, 2017
LF cable 10M	Woken	CFD400NL-LW	CFD400NL-002	Dec. 09, 2016	Dec. 08, 2017
Measurement Software	AUDIX	e3	6.120210g	NA	NA

Note: Calibration Interval of instruments listed above is one year.

Test Item	RF Conducted				
Test Site	(TH01-WS)				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	R&S	FSV40	101499	Dec. 16, 2016	Dec. 15, 2017
Power Meter	Anritsu	ML2495A	1241002	Oct. 06, 2016	Oct. 05, 2017
Power Sensor	Anritsu	MA2411B	1207366	Oct. 06, 2016	Oct. 05, 2017
DC POWER SOURCE	GW INSTEK	GPC-6030D	EM892433	Oct. 20, 2016	Oct. 19, 2017
Measurement Software	Sporton	Sporton_1	1.3.30	NA	NA

Note: Calibration Interval of instruments listed above is one year.

1.4 Test Standards

According to the specification of EUT, the EUT must comply with following standards and KDB documents.

47 CFR FCC Part 15.249

ANSI C63.10-2013

1.5 Measurement Uncertainty

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor (k=2)

Measurement Uncertainty	
Parameters	Uncertainty
Bandwidth	±34.134 Hz
AC conducted emission	±2.90 dB
Radiated emission ≤ 1GHz	±3.66 dB
Radiated emission > 1GHz	±5.63 dB

2 Test Configuration

2.1 Testing Condition

Test Item	Test Site	Ambient Condition	Tested By
Radiated Emissions	03CH01-WS	22°C / 62%	Vincent Yeh Kevin Lee
RF Conducted	TH01-WS	22°C / 62%	Vincent Yeh

- FCC Designation No.: TW2732
- FCC site registration No.: 181692
- IC site registration No.: 10807A-1

2.2 The Worst Test Modes and Channel Details

Test item	Mode	Test Frequency (MHz)	Test Configuration
Field Strength of Fundamental	GFSK	2402, 2440, 2480	---
Radiated Emissions (below 1GHz)	GFSK	2480	---
Radiated Emissions (Above 1GHz)	GFSK	2402, 2440, 2480	---
20dB bandwidth	GFSK	2402, 2440, 2480	---

3 Transmitter Test Results

3.1 Radiated Emission

This section includes field strength of fundamental, field strength of harmonics and emissions radiated outside of the operating frequency bands.

3.1.1 Limit of field strength of fundamental and field strength of harmonics

Fundamental Frequency	Field strength of fundamental (millivolts/meter)	Field strength of harmonics (microvolts/meter)
2400–2483.5 MHz	50	500

3.1.2 Limit of Unwanted Emissions

Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in below table, whichever is the lesser attenuation.

Radiated emission limits			
Frequency Range (MHz)	Field Strength (uV/m)	Field Strength (dBuV/m)	Measure Distance (m)
0.009~0.490	2400/F(kHz)	48.5 - 13.8	300
0.490~1.705	24000/F(kHz)	33.8 - 23	30
1.705~30.0	30	29	30
30~88	100	40	3
88~216	150	43.5	3
216~960	200	46	3
Above 960	500	54	3

Note 1:

Quasi-Peak value is measured for frequency below 1GHz except for 9–90 kHz, 110–490 kHz frequency band. Peak and average value are measured for frequency above 1GHz. The limit on average radio frequency emission is as above table. The limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit

Note 2:

Measurements may be performed at a distance other than what is specified provided. When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor as below, Frequency at or above 30 MHz: 20 dB/decade Frequency below 30 MHz: 40 dB/decade.

3.1.3 Test Procedures

1. Measurement is made at a semi-anechoic chamber that incorporates a turntable allowing a EUT rotation of 360°. A continuously-rotating, remotely-controlled turntable is installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission frequency. The EUT is placed at test table. For emissions testing at or below 1 GHz, the table height is 80 cm above the reference ground plane. For emission measurements above 1 GHz, the table height is 1.5 m
2. Measurement is made with the antenna positioned in both the horizontal and vertical planes of polarization. The measurement antenna is varied in height (1m ~ 4m) above the reference ground plane to obtain the maximum signal strength. Distance between EUT and antenna is 3 m.
3. This investigation is performed with the EUT rotated 360°, the antenna height scanned between 1 m and 4 m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations.

Note:

1. Radiated emission below 1GHz
120kHz measurement bandwidth of test receiver and Quasi-peak detector is for radiated emission
2. Radiated emission above 1GHz / Peak value except fundamental
RBW=1MHz, VBW=3MHz and Peak detector

Radiated emission above 1GHz / Average value

The average value is: Average = Peak value + 20log(Duty cycle) Where the duty factor is calculated from following formula:

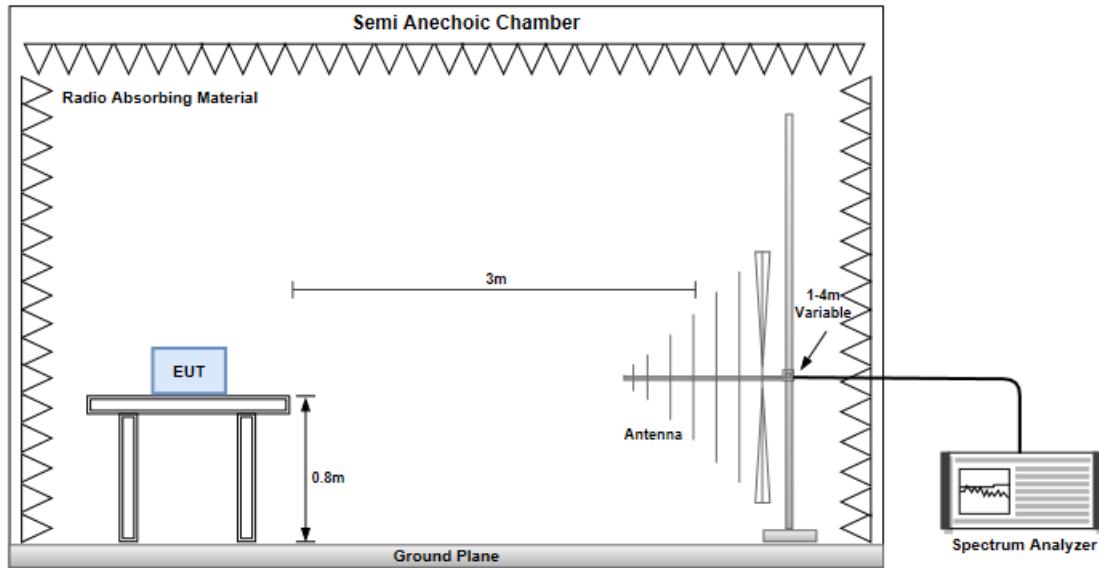
3.
$$20\log(\text{Duty cycle}) = 20\log \frac{45 * 0.28261 \text{ ms}}{100 \text{ ms}} = -17.91 \text{ dB}$$

Please see page 22 for plotted duty

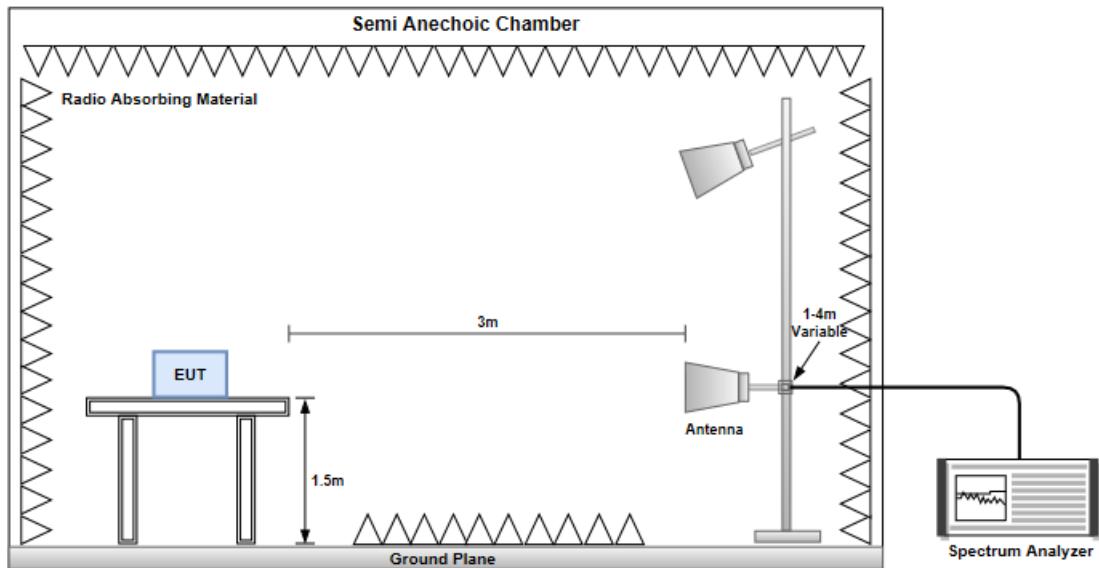
4. Radiated emission above 1GHz / Average value for other emissions
RBW=1MHz, VBW=10Hz and Peak detector
5. Radiated emission Peak value for fundamental
RBW=3MHz, VBW=10MHz and Peak detector

3.1.4 Test Setup

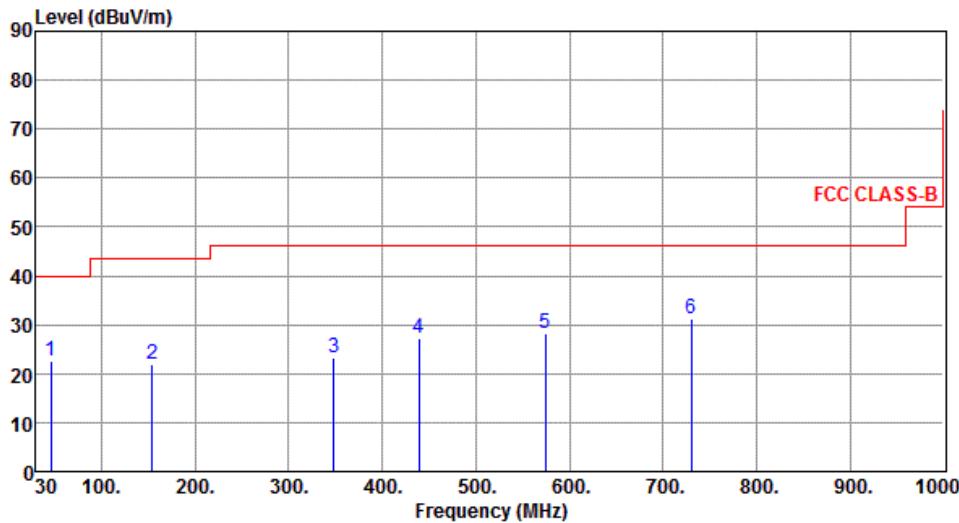
Radiated Emissions below 1 GHz

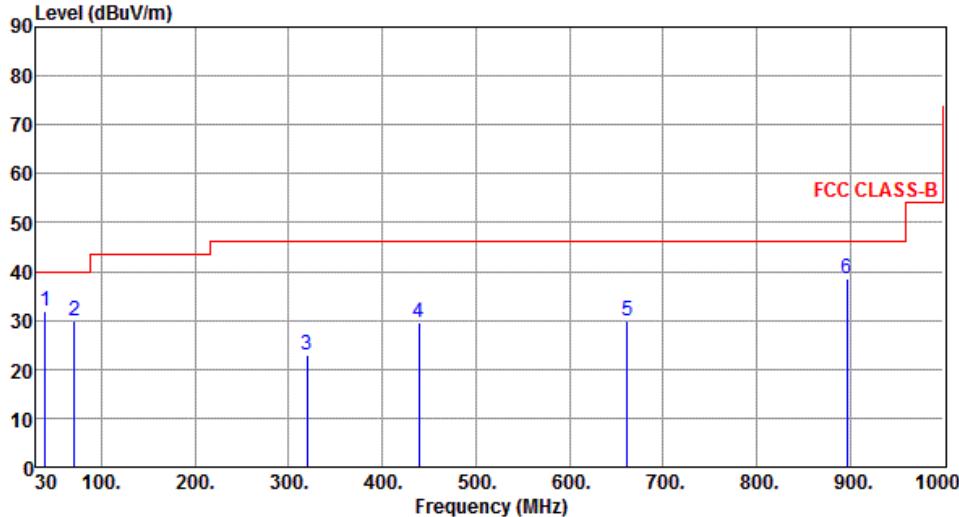


Radiated Emissions above 1 GHz



3.1.5 Transmitter Radiated Unwanted Emissions (Below 1GHz)

Modulation	GFSK	Test Freq. (MHz)	2480																																																																																				
Polarization	Horizontal																																																																																						
																																																																																							
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Freq.</th> <th style="text-align: left;">Emission</th> <th style="text-align: left;">Margin</th> <th style="text-align: left;">SA</th> <th style="text-align: left;">Factor</th> <th style="text-align: left;">Remark</th> <th style="text-align: left;">ANT</th> <th style="text-align: left;">Turn</th> </tr> <tr> <th style="text-align: left;">level</th> <th style="text-align: left;">level</th> <th style="text-align: left;">Margin</th> <th style="text-align: left;">reading</th> <th style="text-align: left;">Factor</th> <th style="text-align: left;">Remark</th> <th style="text-align: left;">High</th> <th style="text-align: left;">Table</th> </tr> <tr> <th style="text-align: left;">MHz</th> <th style="text-align: left;">dBuV/m</th> <th style="text-align: left;">dBuV/m</th> <th style="text-align: left;">dB</th> <th style="text-align: left;">dBuV</th> <th style="text-align: left;">dB</th> <th style="text-align: left;">cm</th> <th style="text-align: left;">deg</th> </tr> </thead> <tbody> <tr> <td>1</td><td>45.52</td><td>22.73</td><td>40.00</td><td>-17.27</td><td>30.30</td><td>-7.57</td><td>Peak</td><td>---</td><td>---</td></tr> <tr> <td>2</td><td>154.16</td><td>21.87</td><td>43.50</td><td>-21.63</td><td>30.01</td><td>-8.14</td><td>Peak</td><td>---</td><td>---</td></tr> <tr> <td>3</td><td>348.16</td><td>23.26</td><td>46.00</td><td>-22.74</td><td>29.55</td><td>-6.29</td><td>Peak</td><td>---</td><td>---</td></tr> <tr> <td>4</td><td>439.34</td><td>27.24</td><td>46.00</td><td>-18.76</td><td>31.25</td><td>-4.01</td><td>Peak</td><td>---</td><td>---</td></tr> <tr> <td>5</td><td>574.17</td><td>28.23</td><td>46.00</td><td>-17.77</td><td>29.51</td><td>-1.28</td><td>Peak</td><td>---</td><td>---</td></tr> <tr> <td>6</td><td>730.34</td><td>31.09</td><td>46.00</td><td>-14.91</td><td>29.66</td><td>1.43</td><td>Peak</td><td>---</td><td>---</td></tr> </tbody> </table>				Freq.	Emission	Margin	SA	Factor	Remark	ANT	Turn	level	level	Margin	reading	Factor	Remark	High	Table	MHz	dBuV/m	dBuV/m	dB	dBuV	dB	cm	deg	1	45.52	22.73	40.00	-17.27	30.30	-7.57	Peak	---	---	2	154.16	21.87	43.50	-21.63	30.01	-8.14	Peak	---	---	3	348.16	23.26	46.00	-22.74	29.55	-6.29	Peak	---	---	4	439.34	27.24	46.00	-18.76	31.25	-4.01	Peak	---	---	5	574.17	28.23	46.00	-17.77	29.51	-1.28	Peak	---	---	6	730.34	31.09	46.00	-14.91	29.66	1.43	Peak	---	---
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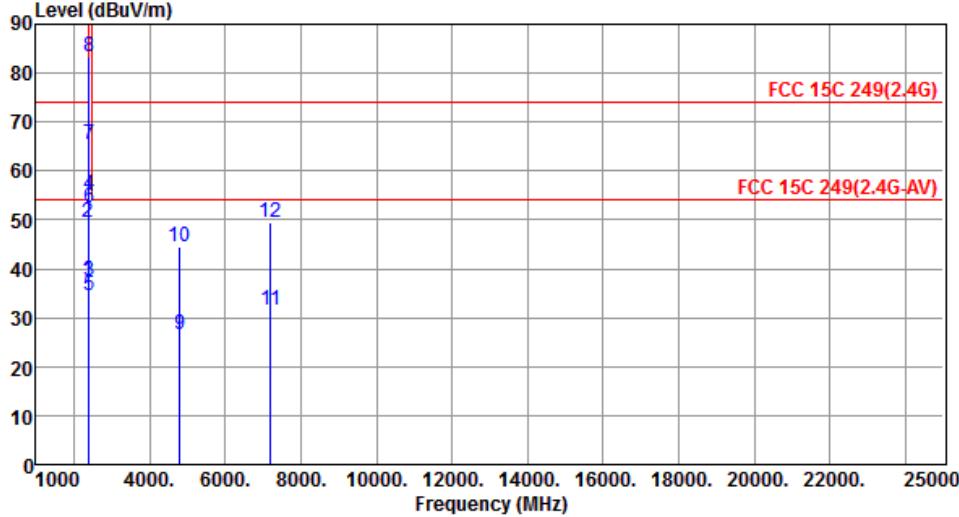
Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)

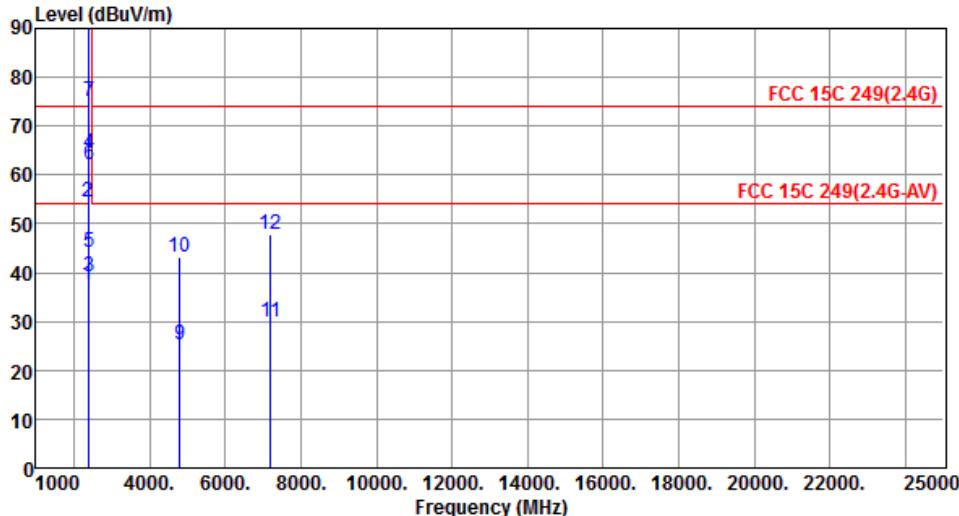
*Factor includes antenna factor , cable loss and amplifier gain

Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

Note 3: All spurious emissions below 30MHz are more than 20 dB below the limit.

3.1.1 Transmitter Radiated Unwanted Emissions (Above 1GHz)

Modulation	GFSK	Test Freq. (MHz)	2402																																																																																																																																								
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 <p>The plot shows the measured emission levels (blue lines) and the emission limits (red lines) for two FCC regulations. The x-axis represents Frequency in MHz from 1000 to 25000. The y-axis represents Level in dBuV/m from 0 to 90. The blue lines represent the measured levels at various frequencies, and the red lines represent the allowed emission limits. The plot includes points 1 through 12, which correspond to the data in the table below.</p>																																																																																																																																						
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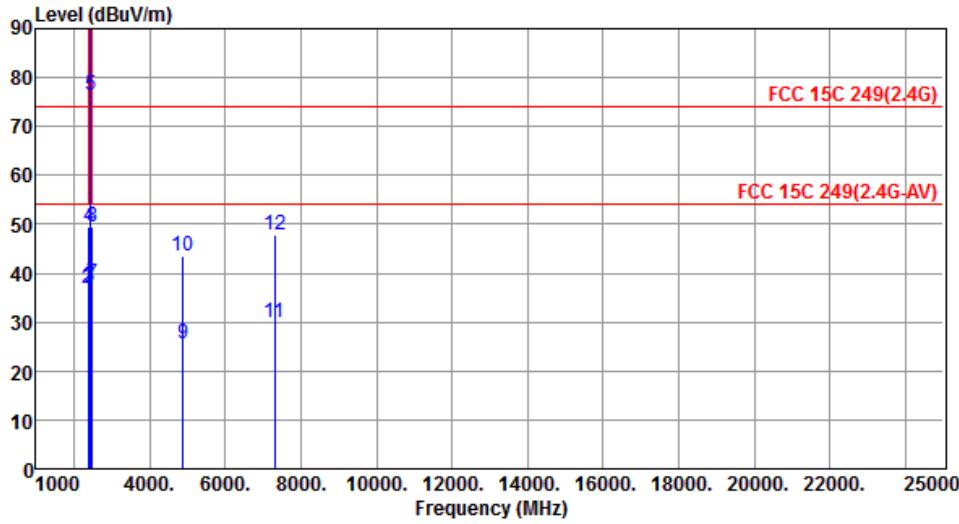
Modulation	GFSK	Test Freq. (MHz)	2440
Polarization	Horizontal		

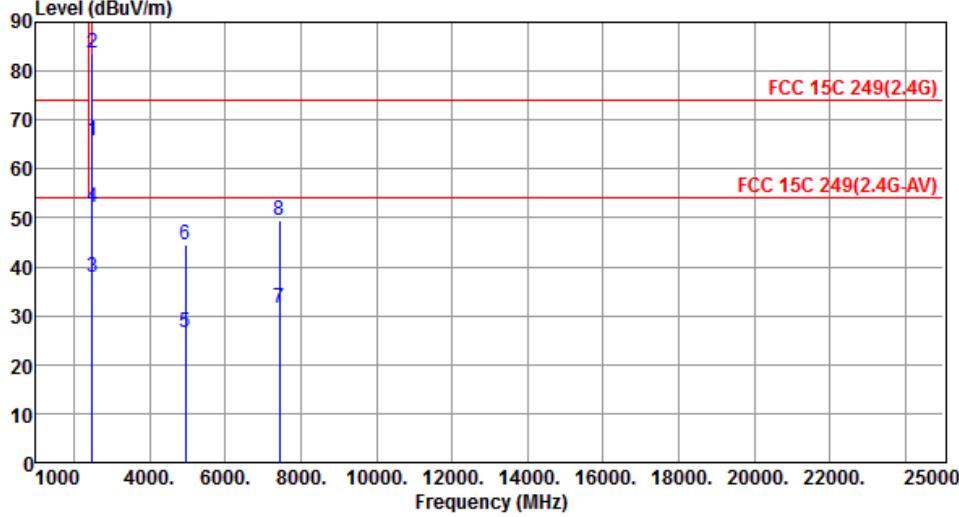
Freq. level	Emission level MHz	Margin dB	SA reading dBuV	Factor dB	Remark	ANT High cm	Turn Table deg		
1	2390.00	37.42	54.00	-16.58	40.60	-3.18	Average	348	2
2	2390.00	48.93	74.00	-25.07	52.11	-3.18	Peak	348	2
3	2400.00	37.26	54.00	-16.74	40.40	-3.14	Average	348	2
4	2400.00	49.32	74.00	-24.68	52.46	-3.14	Peak	348	2
5	2440.00	66.41	94.00	-27.59	69.39	-2.98	Average	348	2
6	2440.00	84.32	114.00	-29.68	87.30	-2.98	Peak	348	2
7	2483.50	37.51	54.00	-16.49	40.31	-2.80	Average	348	2
8	2483.50	49.49	74.00	-24.51	52.29	-2.80	Peak	348	2
9	4880.00	26.70	54.00	-27.30	22.74	3.96	Average	235	8
10	4880.00	44.61	74.00	-29.39	40.65	3.96	Peak	235	8
11	7320.00	31.82	54.00	-22.18	23.41	8.41	Average	100	238
12	7320.00	49.73	74.00	-24.27	41.32	8.41	Peak	100	238

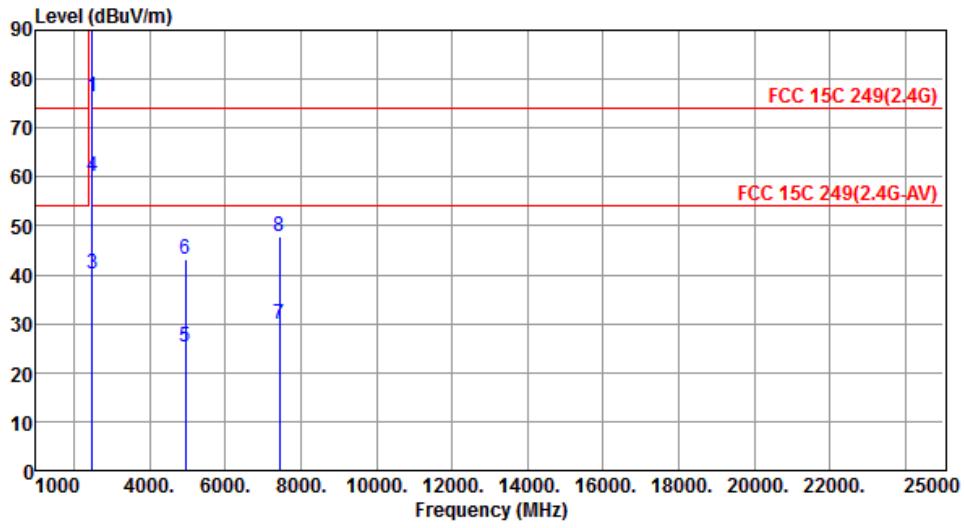
Note 1: Emission Level (dB_{BV}/m) = SA Reading (dB_{BV}/m) + Factor* (dB)

*Factor includes antenna factor, cable loss and amplifier gain

Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).

Modulation	GFSK	Test Freq. (MHz)	2440																																																																																																																																		
Polarization	Vertical																																																																																																																																				
 <p>The graph plots Level (dBuV/m) on the y-axis (0 to 90) against Frequency (MHz) on the x-axis (1000 to 25000). Two horizontal red lines represent FCC limits: a top line at 75 dBuV/m labeled 'FCC 15C 249(2.4G)' and a bottom line at 54 dBuV/m labeled 'FCC 15C 249(2.4G-AV)'. Thirteen vertical blue lines represent measured emission levels, labeled 1 through 12. Lines 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 are clustered around 2.4 GHz. Lines 11 and 12 are at 7.32 GHz. The plot shows a significant increase in emission levels at the higher frequency band.</p>																																																																																																																																					
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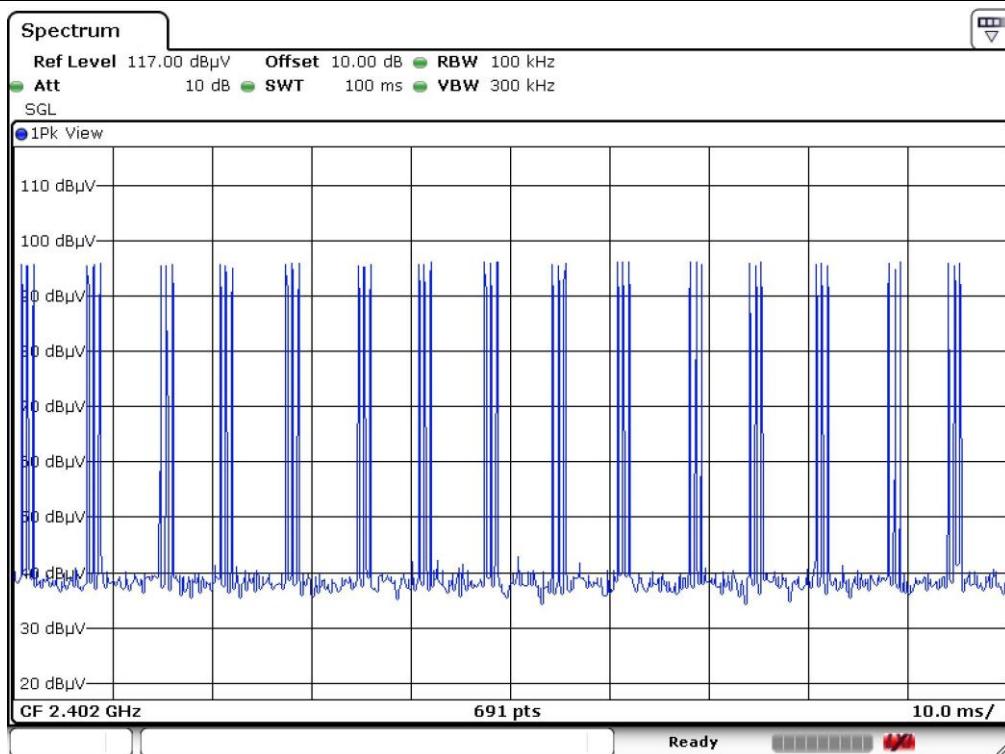
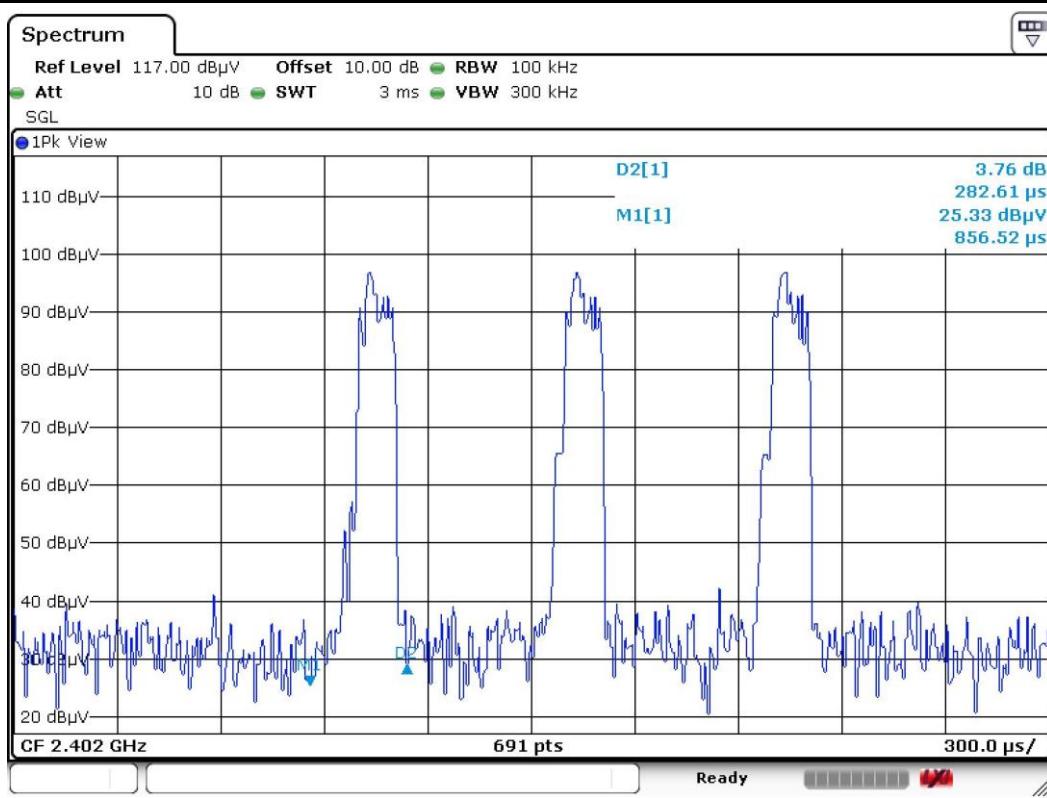
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 <p>The graph plots Level (dBuV/m) on the y-axis (0 to 90) against Frequency (MHz) on the x-axis (1000 to 25000). Two horizontal red lines represent FCC limits: a top line at approximately 75 dBuV/m labeled 'FCC 15C 249(2.4G)' and a bottom line at approximately 55 dBuV/m labeled 'FCC 15C 249(2.4G-AV)'. Blue vertical lines indicate measurement points: 1 (2480.00 MHz, 76.37 dBuV/m), 2 (2480.00 MHz, 94.28 dBuV/m), 3 (2483.50 MHz, 40.22 dBuV/m), 4 (2483.50 MHz, 60.22 dBuV/m), 5 (4960.00 MHz, 25.30 dBuV/m), 6 (4960.00 MHz, 43.21 dBuV/m), 7 (7440.00 MHz, 29.95 dBuV/m), and 8 (7440.00 MHz, 47.86 dBuV/m).</p>																																																																																													
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Note 1: Emission Level (dBuV/m) = SA Reading (dBuV/m) + Factor* (dB)

*Factor includes antenna factor , cable loss and amplifier gain

Note 2: Margin (dB) = Emission level (dBuV/m) – Limit (dBuV/m).



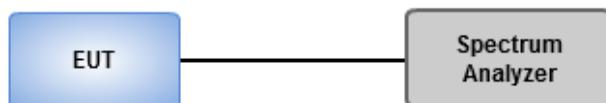
$$20\log (\text{Duty cycle}) = 20\log \frac{45 \times 0.28261 \text{ ms}}{100 \text{ ms}} = -17.91 \text{ dB}$$

3.2 20dB and Occupied Bandwidth

3.2.1 Test Procedures

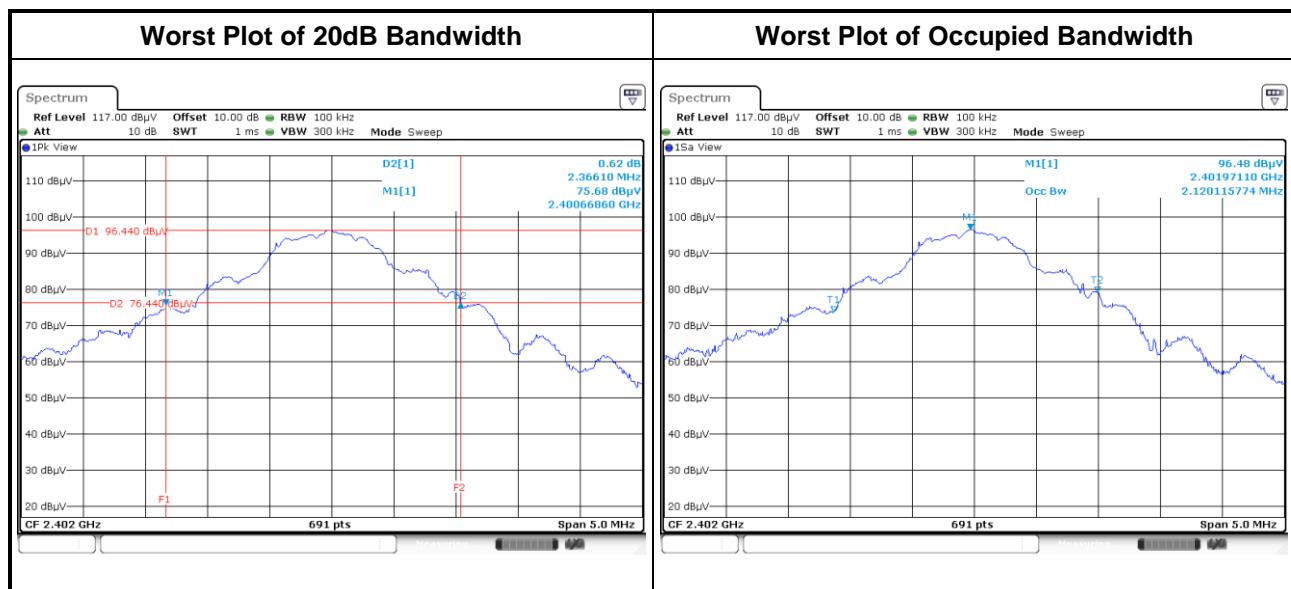
1. Set resolution bandwidth (RBW) = 100 kHz, Video bandwidth = 300 kHz.
2. Detector = Peak(20 dB bandwidth) / Sample(Occupied bandwidth), Trace mode = max hold.
3. Sweep = auto couple, Allow the trace to stabilize.
4. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower) that are attenuated by 20dB relative to the maximum level measured in the fundamental emission.
5. Use the occupied measurement function of spectrum analyzer to measure 99% occupied bandwidth

3.2.2 Test Setup



3.2.3 20dB and Occupied Bandwidth

Freq. (MHz)	20dB Bandwidth (MHz)	Occupied Bandwidth (MHz)
2402	2.37	2.12
2440	2.00	1.80
2480	1.96	1.85



4 Test laboratory information

Established in 2012, ICC provides foremost EMC & RF Testing and advisory consultation services by our skilled engineers and technicians. Our services employ a wide variety of advanced edge test equipment and one of the widest certification extents in the business.

International Certification Corp (EMC and Wireless Communication Laboratory), it is our definitive objective is to institute long term, trust-based associations with our clients. The expectation we set up with our clients is based on outstanding service, practical expertise and devotion to a certified value structure. Our passion is to grant our clients with best EMC / RF services by oriented knowledgeable and accommodating staff.

Our Test sites are located at Linkou District and Kwei Shan District. Location map can be found on our website <http://www.icertifi.com.tw>.

Linkou

Tel: 886-2-2601-1640

No. 30-2, Ding Fwu Tsuen, Lin
Kou District, New Taipei City,
Taiwan, R.O.C.

Kwei Shan

Tel: 886-3-271-8666

No. 3-1, Lane 6, Wen San 3rd St.,
Kwei Shan District, Tao Yuan City
333, Taiwan, R.O.C.

Kwei Shan Site II

Tel: 886-3-271-8640

No. 14-1, Lane 19, Wen San 3rd
St., Kwei Shan District, Tao Yuan
City 333, Taiwan, R.O.C.

If you have any suggestion, please feel free to contact us as below information.

Tel: 886-3-271-8666

Fax: 886-3-318-0155

Email: ICC_Service@icertifi.com.tw

—END—