

ISED C2PC Test Report

IC : 3147A-602230C

Equipment : 802.11 ac/a/b/g/n M.2 2230 + Bluetooth 4.2 module
(Please refer to section 1.1.1 for more details.)

Model No. : ST60-2230C
(Please refer to section 1.1.1 for more details.)

Brand Name : Laird Connectivity
(Please refer to section 1.1.1 for more details.)

Applicant : Laird Connectivity, Inc.

Address : W66N220 Commerce Court, Cedarburg,
Wisconsin 53012, USA

Manufacturer : Laird Connectivity, Inc.

Address : W66N220 Commerce Court, Cedarburg,
Wisconsin 53012, USA

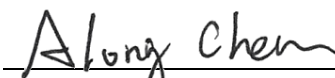
Standard : RSS-247 Issue 2 February 2017

Received Date : Jul. 20, 2020

Tested Date : Aug. 27 ~ Sep. 07, 2020

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:

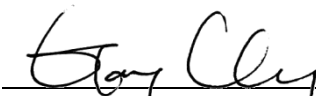

Gary Chang / Manager



Table of Contents

1	GENERAL DESCRIPTION	5
1.1	Information.....	5
1.2	Local Support Equipment List	9
1.3	Test Setup Chart	9
1.4	The Equipment List	10
1.5	Test Standards	11
1.6	Reference Guidance	11
1.7	Deviation from Test Standard and Measurement Procedure.....	11
1.8	Measurement Uncertainty	11
2	TEST CONFIGURATION.....	12
2.1	Testing Facility	12
2.2	The Worst Test Modes and Channel Details	12
3	TRANSMITTER TEST RESULTS	13
3.1	Conducted Emissions.....	13
3.2	Unwanted Emissions into Restricted Frequency Bands	18
4	TEST LABORATORY INFORMATION	32

Release Record

Report No.	Version	Description	Issued Date
CR740701-09AD	Rev. 01	Initial issue	Oct. 27, 2020

Summary of Test Results

IC Rules	Test Items	Measured	Result
RSS-Gen Section 8.8	Conducted Emissions	[dBuV]: 4.622MHz 47.57 (Margin -8.43dB) - QP	Pass
RSS-247 Section 5.5 RSS-Gen Section 8.9	Radiated Emissions	[dBuV/m at 3m]: 118.27MHz 41.94 (Margin -1.56dB) - QP	Pass

Declaration of Conformity:

The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.

Comments and Explanations:

The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

1 General Description

1.1 Information

This is a Class II Permissive Change report (C2PC).

This report is issued as a supplementary report to original report no. CR740701AD. The difference is concerned with following items:

1. Components of non-RF section are replaced to switch interface.
2. Adding two models

1.1.1 Product Details

The following models are provided to this EUT. (New additions are marked in boldface.)

Brand Name	Model Name	Product Name	Description
Laird Technologies	ST60-2230C	802.11 ac/a/b/g/n M.2 2230 + Bluetooth 4.2 module	For marketing purpose
	SU60-2230C		
Laird Connectivity	ST60-2230C-P	802.11 ac/a/b/g/n M.2 2230 + Bluetooth 4.2 module PCIe/UART interface	PCIe/UART interface
	ST60-2230C-PU	802.11 ac/a/b/g/n M.2 2230 + Bluetooth 4.2 module PCIe/USB interface	PCIe/USB interface

Here's a model list for comparison.

Model Name	PCB	WiFi	BT
ST60-2230C (Original)	ST60-2230C	SDIO	UART
ST60-2230C-P	ST60-2230C-P	PCIe	UART
ST60-2230C-PU	ST60-2230C-P	PCIe	USB

ST60-2230C PCB			ST60-2230C-P PCB		
CONFIG_HOST0	CONFIG_HOST1	CONFIG_HOST2	CONFIG_HOST0	CONFIG_HOST1	CONFIG_HOST2
R37	R36	R35	-	-	-
-	-	-	R61	R60	R35
-	-	-	R37	R60	R35

1.1.2 Specification of the Equipment under Test (EUT)

RF General Information				
Frequency Range (MHz)	Bluetooth Mode	Ch. Frequency (MHz)	Channel Number	Data Rate
2400-2483.5	BR	2402-2480	0-78 [79]	1 Mbps
2400-2483.5	EDR	2402-2480	0-78 [79]	2 Mbps
2400-2483.5	EDR	2402-2480	0-78 [79]	3 Mbps
Note 1: Bluetooth BR uses a GFSK.				
Note 2: Bluetooth EDR uses a combination of $\pi/4$ -DQPSK and 8DPSK.				

1.1.3 Antenna Details

Ant. No.	Model	Type	Connector	Operating Frequencies (MHz) / Antenna Gain (dBi)				
				2400~2483.5	5150~5250	5250~5350	5470~5725	5725~5850
1	LSR/001-0009	Dipole	IPEX U.FL	2	2	2	2	2
2	Laird NanoBlade-IP04	PCB Dipole	IPEX U.FL	2	3.9	3.9	4	4
3	Laird MAF95310 Mini NanoBlade Flex	PCB Dipole	IPEX U.FL	2.79	3.38	3.38	3.38	3.38
4	LSR/FlexPIFA 001-0016	PIFA	IPEX U.FL	2.5	3	3	3	3
5	Ethertronics WLAN_1000146	Isolated Magnetic Dipole	IPEX U.FL	2.5	3.5	3.5	3.5	3.5

1.1.4 Power Supply Type of Equipment under Test (EUT)

Power Supply Type	DC 3.3V from host
-------------------	-------------------

1.1.5 Accessories

N/A

1.1.6 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	---	---

1.1.7 Test Sample Information

MAC of Test Sample	Radiated Emission: C0EE40600DA4 AC Power Line Conducted Emission: C0EE40600DA4
---------------------------	---

1.1.8 Test Tool and Duty Cycle

Test Tool	CBT control
-----------	-------------

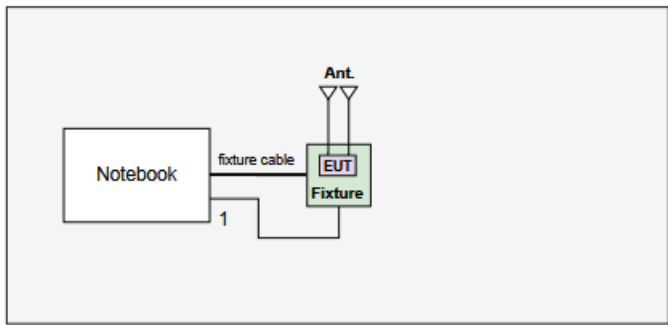
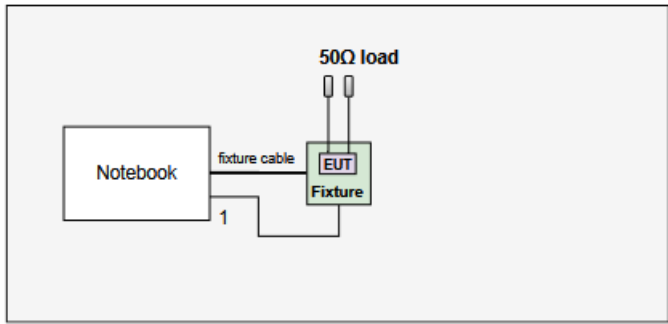
1.1.9 Power Index of Test Tool

Modulation Mode	Test Frequency (MHz)		
	2402	2441	2480
GFSK/1Mbps	Default	Default	Default
$\pi/4$ -DQPSK /2Mbps	Default	Default	Default
8DPSK/3Mbps	Default	Default	Default

1.2 Local Support Equipment List

Support Equipment List					
No.	Equipment	Brand	Model	FCC ID	Remarks
1	Notebook	DELL	Latitude E5470	DoC	---
2	Fixture	Laird	DVK-SU60-223 0C_B0	---	Provided by applicant.
3	50Ω terminator	---	---	---	---

1.3 Test Setup Chart

Test Setup Diagram	
Conducted Emission  The diagram shows a Notebook connected to a Fixture via a fixture cable. The Fixture contains an EUT (Equipment Under Test) and is connected to an Antenna (Ant.). A ground connection labeled '1' is shown between the Notebook and the Fixture. Radiated Emission  The diagram shows a Notebook connected to a Fixture via a fixture cable. The Fixture contains an EUT (Equipment Under Test) and is connected to a 50Ω load. A ground connection labeled '1' is shown between the Notebook and the Fixture.	
No.	Signal cable / Length (m)
1	USB, 1m shielded.

1.4 The Equipment List

Test Item	Conducted Emission				
Test Site	Conduction room 1 / (CO01-WS)				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Receiver	R&S	ESR3	101658	Dec. 12, 2019	Dec. 11, 2020
LISN	R&S	ENV216	101579	Mar. 12, 2020	Mar. 11, 2021
RF Cable-CON	Woken	CFD200-NL	CFD200-NL-001	Oct. 22, 2019	Oct. 21, 2020
Measurement Software	AUDIX	e3	6.120210k	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

Test Item	Radiated Emission				
Test Site	966 chamber 3 / (03CH03-WS)				
Instrument	Manufacturer	Model No.	Serial No.	Calibration Date	Calibration Until
Spectrum Analyzer	R&S	FSV40	101499	Jan. 09, 2020	Jan. 08, 2021
Receiver	R&S	ESR3	101657	Feb. 14, 2020	Feb. 13, 2021
Bilog Antenna	SCHWARZBECK	VULB9168	VULB9168-685	Apr. 29, 2020	Apr. 28, 2021
Horn Antenna 1G-18G	SCHWARZBECK	BBHA 9120 D	BBHA 9120 D 1206	Dec. 27, 2019	Dec. 26, 2020
Horn Antenna 18G-40G	SCHWARZBECK	BBHA 9170	BBHA 9170517	Nov. 15, 2019	Nov. 14, 2020
Loop Antenna	R&S	HFH2-Z2	100330	Nov. 13, 2019	Nov. 12, 2020
Loop Antenna Cable	KOAX KABEL	101354-BW	101354-BW	Oct. 07, 2019	Oct. 06, 2020
Preamplifier	EMC	EMC02325	980225	Jul. 03, 2020	Jul. 02, 2021
Preamplifier	Agilent	83017A	MY39501309	Sep. 24, 2019	Sep. 23, 2020
Preamplifier	EMC	EMC184045B	980192	Jul. 21, 2020	Jul. 20, 2021
RF cable-3M	HUBER+SUHNER	SUCOFLEX104	MY22620/4	Sep. 27, 2019	Sep. 26, 2020
RF cable-8M	EMC	EMC104-SM-SM-8000	181107	Sep. 27, 2019	Sep. 26, 2020
RF cable-1M	HUBER+SUHNER	SUCOFLEX104	MY22624/4	Sep. 27, 2019	Sep. 26, 2020
LF cable-0.8M	EMC	EMC8D-NM-NM-800	EMC8D-NM-NM-800-001	Sep. 27, 2019	Sep. 26, 2020
LF cable-3M	EMC	EMC8D-NM-NM-3000	131103	Sep. 27, 2019	Sep. 26, 2020
LF cable-13M	EMC	EMC8D-NM-NM-13000	131104	Sep. 27, 2019	Sep. 26, 2020
Measurement Software	AUDIX	e3	6.120210g	NA	NA
Note: Calibration Interval of instruments listed above is one year.					

1.5 Test Standards

RSS-247 Issue 2 February 2017

RSS-Gen Issue 5 March 2019 Amendment 1

ANSI C63.10-2013

ANSI C63.4-2014

1.6 Reference Guidance

FCC KDB 558074 D01 15.247 Meas Guidance v05r02

1.7 Deviation from Test Standard and Measurement Procedure

None

1.8 Measurement Uncertainty

The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor ($k=2$)).

Measurement Uncertainty	
Parameters	Uncertainty
AC conducted emission	± 2.92 dB
Radiated emission ≤ 1 GHz	± 3.96 dB
Radiated emission > 1 GHz	± 4.51 dB

2 Test Configuration

2.1 Testing Facility

Test Laboratory	International Certification Corp.
Test Site	CO01-WS
Address of Test Site	No. 3-1, Lane 6, Wen San 3rd St., Kwei Shan District, Tao Yuan City 333, Taiwan, R.O.C.
Test Site	03CH03-WS
Address of Test Site	No. 14-1, Lane 19, Wen San 3rd St., Kwei Shan District, Tao Yuan City 333, Taiwan, R.O.C.

- FCC Designation No.: TW0009
- FCC site registration No.: 207696
- ISSED#: 10807A
- CAB identifier: TW2732

2.2 The Worst Test Modes and Channel Details

Test item	Modulation / Frequency (MHz)	Model	Test mode
Conducted Emissions	GFSK, 2402	ST60-2230C-P	Tested With PCB Dipole Antenna
		ST60-2230C-PU	
Radiated Emissions ≤1GHz	GFSK, 2402	ST60-2230C-P	Note 2
		ST60-2230C-PU	Note 2
Radiated Emissions >1GHz	GFSK, 2402	ST60-2230C-P	Note 2

NOTE:

- The EUT was pretested with 3 orientations placed on the table for the radiated emission measurement – X, Y, and Z-plane. The **Y-plane** results were found as the worst case and were shown in this report.
- 50Ω terminators are connected to antenna port of EUT for radiated emission measurement.
- Test channel of radiated emission refers to original test report since the channel has higher spurious emission.

3 Transmitter Test Results

3.1 Conducted Emissions

3.1.1 Limit of Conducted Emissions

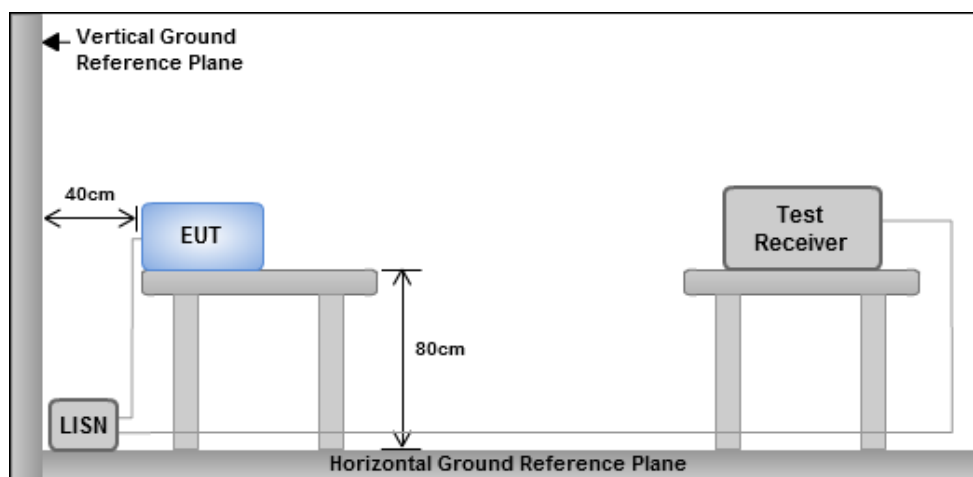
Conducted Emissions Limit		
Frequency Emission (MHz)	Quasi-Peak	Average
0.15-0.5	66 - 56 *	56 - 46 *
0.5-5	56	46
5-30	60	50

Note 1: * Decreases with the logarithm of the frequency.

3.1.2 Test Procedures

1. The device is placed on a test table, raised 80 cm above the reference ground plane. The vertical conducting plane is located 40 cm to the rear of the device.
2. The device is connected to line impedance stabilization network (LISN) and other accessories are connected to other LISN. Measured levels of AC power line conducted emission are across the 50 Ω LISN port.
3. AC conducted emission measurements is made over frequency range from 150 kHz to 30 MHz.
4. This measurement was performed with AC 120V/60Hz

3.1.3 Test Setup



- Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) are 80 cm from EUT and at least 80 cm from other units and other metal planes

PCB Dipole Antenna, With model: ST60-2230C-P

3.1.4 Test Result of Conducted Emissions

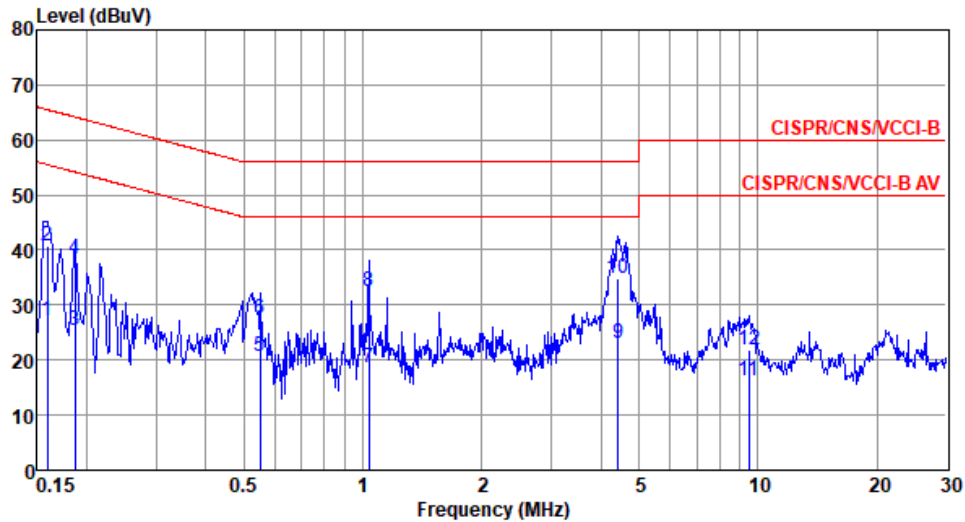
Modulation Mode	GFSK	Test Freq. (MHz)	2402																																																																																																																					
Power Phase	Line																																																																																																																							
Test by : Alex Tsai Temperature: 24°C Humidity: 63%																																																																																																																								
Level (dBuV) <table><thead><tr><th></th><th>Freq MHz</th><th>Level dBuV</th><th>Limit Line dBuV</th><th>Over Limit dB</th><th>Read Level dBuV</th><th>LISN factor dB</th><th>cable loss dB</th><th>Remark</th></tr></thead><tbody><tr><td>1</td><td>0.162</td><td>28.38</td><td>55.34</td><td>-26.96</td><td>18.69</td><td>9.64</td><td>0.05</td><td>Average</td></tr><tr><td>2</td><td>0.162</td><td>40.89</td><td>65.34</td><td>-24.45</td><td>31.20</td><td>9.64</td><td>0.05</td><td>QP</td></tr><tr><td>3</td><td>0.192</td><td>24.63</td><td>53.93</td><td>-29.30</td><td>14.94</td><td>9.63</td><td>0.06</td><td>Average</td></tr><tr><td>4</td><td>0.192</td><td>36.70</td><td>63.93</td><td>-27.23</td><td>27.01</td><td>9.63</td><td>0.06</td><td>QP</td></tr><tr><td>5</td><td>0.529</td><td>29.93</td><td>46.00</td><td>-16.07</td><td>20.21</td><td>9.63</td><td>0.09</td><td>Average</td></tr><tr><td>6</td><td>0.529</td><td>37.37</td><td>56.00</td><td>-18.63</td><td>27.65</td><td>9.63</td><td>0.09</td><td>QP</td></tr><tr><td>7</td><td>1.037</td><td>21.29</td><td>46.00</td><td>-24.71</td><td>11.54</td><td>9.63</td><td>0.12</td><td>Average</td></tr><tr><td>8</td><td>1.037</td><td>34.49</td><td>56.00</td><td>-21.51</td><td>24.74</td><td>9.63</td><td>0.12</td><td>QP</td></tr><tr><td>9</td><td>4.384</td><td>33.27</td><td>46.00</td><td>-12.73</td><td>23.32</td><td>9.65</td><td>0.30</td><td>Average</td></tr><tr><td>10*</td><td>4.384</td><td>47.18</td><td>56.00</td><td>-8.82</td><td>37.23</td><td>9.65</td><td>0.30</td><td>QP</td></tr><tr><td>11</td><td>21.600</td><td>20.16</td><td>50.00</td><td>-29.84</td><td>9.78</td><td>9.70</td><td>0.68</td><td>Average</td></tr><tr><td>12</td><td>21.600</td><td>24.34</td><td>60.00</td><td>-35.66</td><td>13.96</td><td>9.70</td><td>0.68</td><td>QP</td></tr></tbody></table>					Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark	1	0.162	28.38	55.34	-26.96	18.69	9.64	0.05	Average	2	0.162	40.89	65.34	-24.45	31.20	9.64	0.05	QP	3	0.192	24.63	53.93	-29.30	14.94	9.63	0.06	Average	4	0.192	36.70	63.93	-27.23	27.01	9.63	0.06	QP	5	0.529	29.93	46.00	-16.07	20.21	9.63	0.09	Average	6	0.529	37.37	56.00	-18.63	27.65	9.63	0.09	QP	7	1.037	21.29	46.00	-24.71	11.54	9.63	0.12	Average	8	1.037	34.49	56.00	-21.51	24.74	9.63	0.12	QP	9	4.384	33.27	46.00	-12.73	23.32	9.65	0.30	Average	10*	4.384	47.18	56.00	-8.82	37.23	9.65	0.30	QP	11	21.600	20.16	50.00	-29.84	9.78	9.70	0.68	Average	12	21.600	24.34	60.00	-35.66	13.96	9.70	0.68	QP
	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark																																																																																																																
1	0.162	28.38	55.34	-26.96	18.69	9.64	0.05	Average																																																																																																																
2	0.162	40.89	65.34	-24.45	31.20	9.64	0.05	QP																																																																																																																
3	0.192	24.63	53.93	-29.30	14.94	9.63	0.06	Average																																																																																																																
4	0.192	36.70	63.93	-27.23	27.01	9.63	0.06	QP																																																																																																																
5	0.529	29.93	46.00	-16.07	20.21	9.63	0.09	Average																																																																																																																
6	0.529	37.37	56.00	-18.63	27.65	9.63	0.09	QP																																																																																																																
7	1.037	21.29	46.00	-24.71	11.54	9.63	0.12	Average																																																																																																																
8	1.037	34.49	56.00	-21.51	24.74	9.63	0.12	QP																																																																																																																
9	4.384	33.27	46.00	-12.73	23.32	9.65	0.30	Average																																																																																																																
10*	4.384	47.18	56.00	-8.82	37.23	9.65	0.30	QP																																																																																																																
11	21.600	20.16	50.00	-29.84	9.78	9.70	0.68	Average																																																																																																																
12	21.600	24.34	60.00	-35.66	13.96	9.70	0.68	QP																																																																																																																
Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB). 2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).																																																																																																																								

Modulation Mode	GFSK	Test Freq. (MHz)	2402
Power Phase	Neutral		

Test by : Alex Tsai

Temperature: 24°C

Humidity: 63%



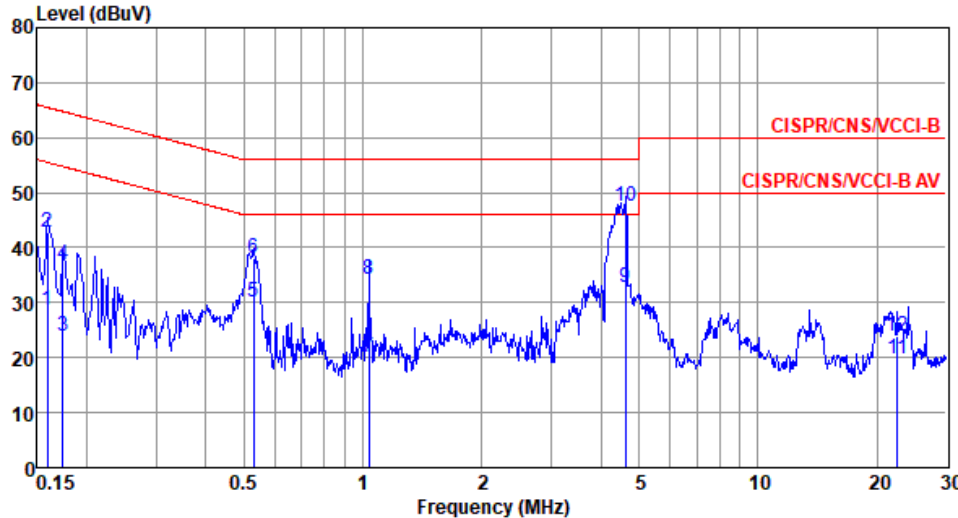
	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.159	27.03	55.52	-28.49	17.32	9.66	0.05	Average
2	0.159	40.81	65.52	-24.71	31.10	9.66	0.05	QP
3	0.186	25.47	54.20	-28.73	15.76	9.65	0.06	Average
4	0.186	38.41	64.20	-25.79	28.70	9.65	0.06	QP
5	0.549	20.79	46.00	-25.21	11.05	9.65	0.09	Average
6	0.549	27.32	56.00	-28.68	17.58	9.65	0.09	QP
7	1.037	18.69	46.00	-27.31	8.92	9.65	0.12	Average
8	1.037	32.49	56.00	-23.51	22.72	9.65	0.12	QP
9	4.430	22.99	46.00	-23.01	13.01	9.68	0.30	Average
10*	4.430	34.94	56.00	-21.06	24.96	9.68	0.30	QP
11	9.502	16.26	50.00	-33.74	6.15	9.73	0.38	Average
12	9.502	21.91	60.00	-38.09	11.80	9.73	0.38	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).

Note 2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

PCB Dipole Antenna, With model: ST60-2230C-PU

3.1.5 Test Result of Conducted Emissions

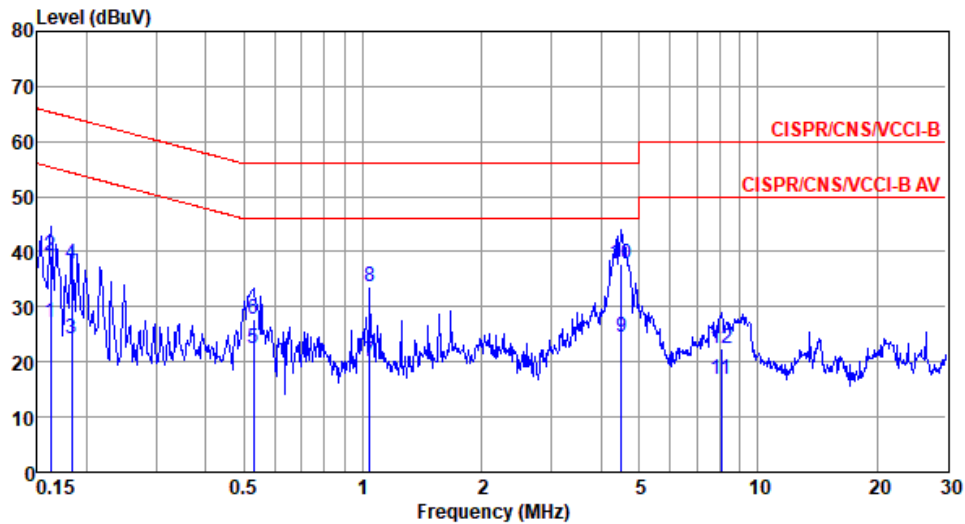
Modulation Mode	GFSK	Test Freq. (MHz)	2402																																																																																																																																							
Power Phase	Line																																																																																																																																									
Test by : Alex Tsai Temperature: 24°C Humidity: 63%																																																																																																																																										
Level (dBuV)  <table><tr><th></th><th>Freq</th><th>Level</th><th>Limit</th><th>Over</th><th>Read</th><th>LISN</th><th>cable</th><th>Remark</th></tr><tr><th></th><th>MHz</th><th>dBuV</th><th>Line</th><th>Limit</th><th>Level</th><th>factor</th><th>loss</th><th></th></tr><tr><th></th><th></th><th></th><th>dBuV</th><th>dB</th><th>dBuV</th><th>dB</th><th>dB</th><th></th></tr><tr><td>1</td><td>0.159</td><td>28.49</td><td>55.52</td><td>-27.03</td><td>18.80</td><td>9.64</td><td>0.05</td><td>Average</td></tr><tr><td>2</td><td>0.159</td><td>42.68</td><td>65.52</td><td>-22.84</td><td>32.99</td><td>9.64</td><td>0.05</td><td>QP</td></tr><tr><td>3</td><td>0.174</td><td>23.99</td><td>54.77</td><td>-30.78</td><td>14.30</td><td>9.63</td><td>0.06</td><td>Average</td></tr><tr><td>4</td><td>0.174</td><td>37.02</td><td>64.77</td><td>-27.75</td><td>27.33</td><td>9.63</td><td>0.06</td><td>QP</td></tr><tr><td>5</td><td>0.529</td><td>30.23</td><td>46.00</td><td>-15.77</td><td>20.51</td><td>9.63</td><td>0.09</td><td>Average</td></tr><tr><td>6</td><td>0.529</td><td>37.94</td><td>56.00</td><td>-18.06</td><td>28.22</td><td>9.63</td><td>0.09</td><td>QP</td></tr><tr><td>7</td><td>1.037</td><td>20.07</td><td>46.00</td><td>-25.93</td><td>10.32</td><td>9.63</td><td>0.12</td><td>Average</td></tr><tr><td>8</td><td>1.037</td><td>34.38</td><td>56.00</td><td>-21.62</td><td>24.63</td><td>9.63</td><td>0.12</td><td>QP</td></tr><tr><td>9</td><td>4.622</td><td>32.75</td><td>46.00</td><td>-13.25</td><td>22.78</td><td>9.66</td><td>0.31</td><td>Average</td></tr><tr><td>10*</td><td>4.622</td><td>47.57</td><td>56.00</td><td>-8.43</td><td>37.60</td><td>9.66</td><td>0.31</td><td>QP</td></tr><tr><td>11</td><td>22.535</td><td>19.91</td><td>50.00</td><td>-30.09</td><td>9.53</td><td>9.69</td><td>0.69</td><td>Average</td></tr><tr><td>12</td><td>22.535</td><td>23.90</td><td>60.00</td><td>-36.10</td><td>13.52</td><td>9.69</td><td>0.69</td><td>QP</td></tr></table>					Freq	Level	Limit	Over	Read	LISN	cable	Remark		MHz	dBuV	Line	Limit	Level	factor	loss					dBuV	dB	dBuV	dB	dB		1	0.159	28.49	55.52	-27.03	18.80	9.64	0.05	Average	2	0.159	42.68	65.52	-22.84	32.99	9.64	0.05	QP	3	0.174	23.99	54.77	-30.78	14.30	9.63	0.06	Average	4	0.174	37.02	64.77	-27.75	27.33	9.63	0.06	QP	5	0.529	30.23	46.00	-15.77	20.51	9.63	0.09	Average	6	0.529	37.94	56.00	-18.06	28.22	9.63	0.09	QP	7	1.037	20.07	46.00	-25.93	10.32	9.63	0.12	Average	8	1.037	34.38	56.00	-21.62	24.63	9.63	0.12	QP	9	4.622	32.75	46.00	-13.25	22.78	9.66	0.31	Average	10*	4.622	47.57	56.00	-8.43	37.60	9.66	0.31	QP	11	22.535	19.91	50.00	-30.09	9.53	9.69	0.69	Average	12	22.535	23.90	60.00	-36.10	13.52	9.69	0.69	QP
	Freq	Level	Limit	Over	Read	LISN	cable	Remark																																																																																																																																		
	MHz	dBuV	Line	Limit	Level	factor	loss																																																																																																																																			
			dBuV	dB	dBuV	dB	dB																																																																																																																																			
1	0.159	28.49	55.52	-27.03	18.80	9.64	0.05	Average																																																																																																																																		
2	0.159	42.68	65.52	-22.84	32.99	9.64	0.05	QP																																																																																																																																		
3	0.174	23.99	54.77	-30.78	14.30	9.63	0.06	Average																																																																																																																																		
4	0.174	37.02	64.77	-27.75	27.33	9.63	0.06	QP																																																																																																																																		
5	0.529	30.23	46.00	-15.77	20.51	9.63	0.09	Average																																																																																																																																		
6	0.529	37.94	56.00	-18.06	28.22	9.63	0.09	QP																																																																																																																																		
7	1.037	20.07	46.00	-25.93	10.32	9.63	0.12	Average																																																																																																																																		
8	1.037	34.38	56.00	-21.62	24.63	9.63	0.12	QP																																																																																																																																		
9	4.622	32.75	46.00	-13.25	22.78	9.66	0.31	Average																																																																																																																																		
10*	4.622	47.57	56.00	-8.43	37.60	9.66	0.31	QP																																																																																																																																		
11	22.535	19.91	50.00	-30.09	9.53	9.69	0.69	Average																																																																																																																																		
12	22.535	23.90	60.00	-36.10	13.52	9.69	0.69	QP																																																																																																																																		
Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB). 2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).																																																																																																																																										

Modulation Mode	GFSK	Test Freq. (MHz)	2402
Power Phase	Neutral		

Test by : Alex Tsai

Temperature: 24°C

Humidity: 63%



	Freq MHz	Level dBuV	Limit Line dBuV	Over Limit dB	Read Level dBuV	LISN factor dB	cable loss dB	Remark
1	0.162	27.20	55.34	-28.14	17.49	9.66	0.05	Average
2	0.162	39.26	65.34	-26.08	29.55	9.66	0.05	QP
3	0.183	24.26	54.33	-30.07	14.55	9.65	0.06	Average
4	0.183	37.70	64.33	-26.63	27.99	9.65	0.06	QP
5	0.529	22.29	46.00	-23.71	12.55	9.65	0.09	Average
6	0.529	27.77	56.00	-28.23	18.03	9.65	0.09	QP
7	1.043	20.13	46.00	-25.87	10.36	9.65	0.12	Average
8	1.043	33.55	56.00	-22.45	23.78	9.65	0.12	QP
9	4.501	24.57	46.00	-21.43	14.59	9.68	0.30	Average
10*	4.501	37.90	56.00	-18.10	27.92	9.68	0.30	QP
11	8.062	16.69	50.00	-33.31	6.60	9.72	0.37	Average
12	8.062	22.42	60.00	-37.58	12.33	9.72	0.37	QP

Note 1: Level (dBuV) = Read Level (dBuV) + LISN Factor (dB) + Cable Loss (dB).

2: Over Limit (dB) = Level (dBuV) – Limit Line (dBuV).

3.2 Unwanted Emissions into Restricted Frequency Bands

3.2.1 Limit of Unwanted Emissions into Restricted Frequency Bands

Restricted Band Emissions Limit			
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:
Qusai-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.

3.2.2 Test Procedures

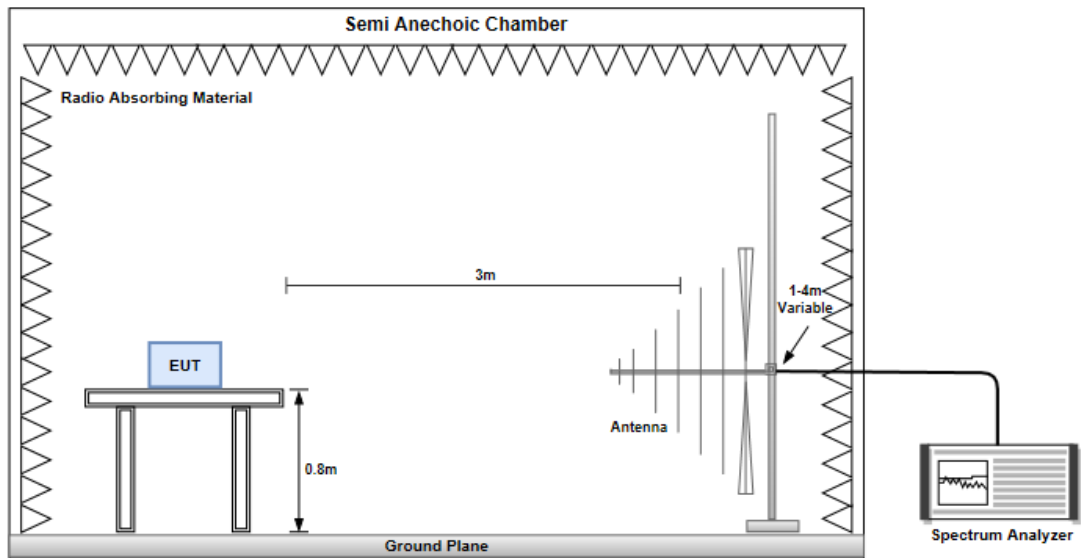
1. Measurement is made at a semi-anechoic chamber that incorporates a turntable allowing a EUT rotation of 360°. A continuously-rotating, remotely-controlled turntable is installed at the test site to support the EUT and facilitate determination of the direction of maximum radiation for each EUT emission 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:

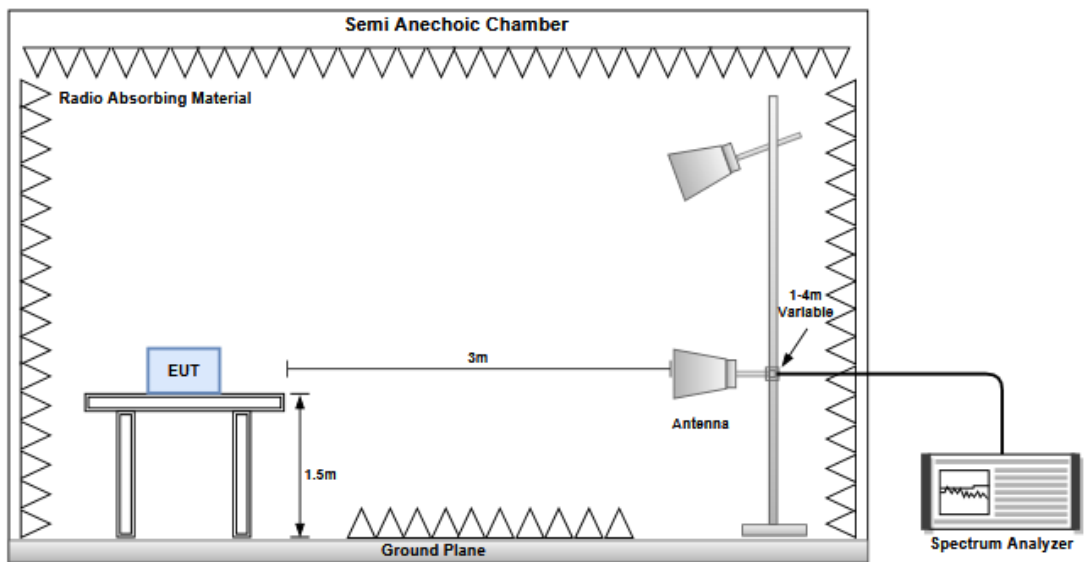
1. 120kHz measurement bandwidth of test receiver and Quasi-peak detector is for radiated emission below 1GHz.
2. Radiated emission above 1GHz / Peak value
RBW=1MHz, VBW=3MHz and Peak detector
Radiated emission above 1GHz / Average value for harmonics
The average value is: Average = Peak value + 20log(Duty cycle) Where the duty factor is calculated from following formula for DH5 packet type which has worst duty factor:
3.
$$20\log (\text{Duty cycle}) = 20\log \frac{1\text{s} / 1600 * 5}{100 \text{ ms}} = -30.1\text{dB}$$
4. Radiated emission above 1GHz / Average value for other emissions
RBW=1MHz, VBW=1/T and Peak detector

3.2.3 Test Setup

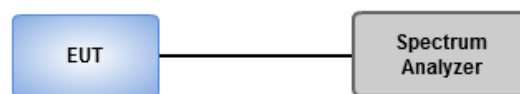
Radiated Emissions below 1 GHz



Radiated Emissions above 1 GHz



Conducted Emissions



With model: ST60-2230C-P

3.2.4 Transmitter Radiated Unwanted Emissions (Below 1GHz)

Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :BRAD WU Temperature(°C):24 Humidity(%):63			
Level (dBUV/m) </			

Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :BRAD WU Temperature(°C):24 Humidity(%):63			
Level (dBuV/m) </			

With model: ST60-2230C-PU

3.2.5 Transmitter Radiated Unwanted Emissions (Below 1GHz)

Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :BRAD WU Temperature(°C):24 Humidity(%):63			
Level (dBuV/m) <			

Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :BRAD WU Temperature(°C):24 Humidity(%):63			
Level (dBuV/m) </			

With model: ST60-2230C-P

3.2.6 Transmitter Radiated Unwanted Emissions (Above 1GHz)

Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Horizontal		
Test By :Roger Lu Temperature(°C):24 Humidity(%):63			
Level (dBuV/m)			

Modulation	GFSK	Test Freq. (MHz)	2402
Polarization	Vertical		
Test By :Roger Lu Temperature(°C):24 Humidity(%):63			
Level (dBuV/m) </			

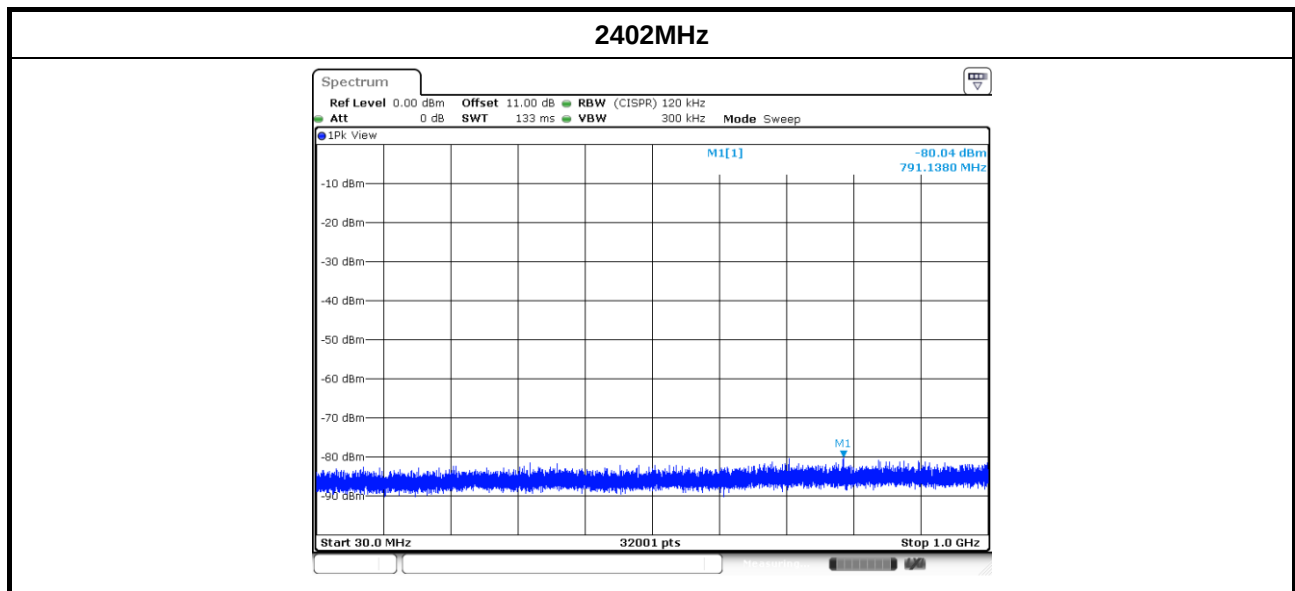
With model: ST60-2230C-P

3.2.7 Transmitter Conducted Unwanted Emissions (Below 1 GHz)

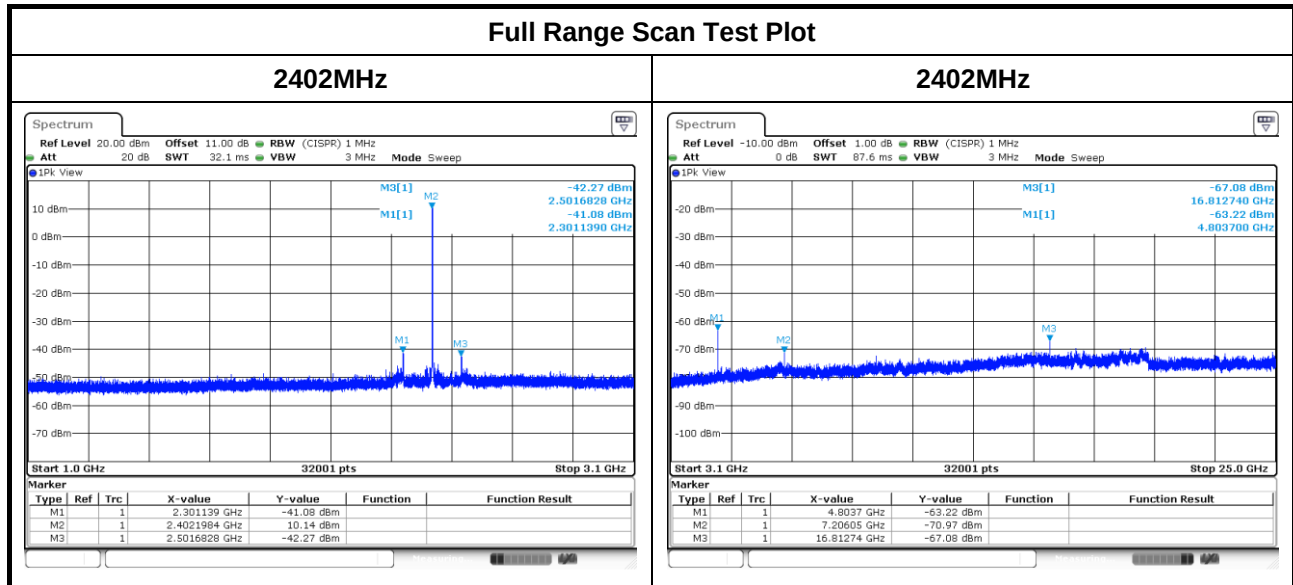
Modulation Mode		GFSK			Frequency	2402MHz	
Range (MHz)	Max Value (dBm)	DG (dBi)	GRF (dB)	EIRP (dBm)	E-Field (dBuV/m)	Min E-Field Limit (dBuV/m)	E-Field Margin (dB)
30~1000MHz	-80.04	2.79	4.70	-72.55	22.71	40.00	-17.29

Note:

1. GRF = Ground Reflection Factor.
2. DG = Directional Gain.
3. Worst case of emission limit below 1GHz is selected to be limit.



3.2.8 Transmitter Conducted Unwanted Emissions (Above 1GHz)



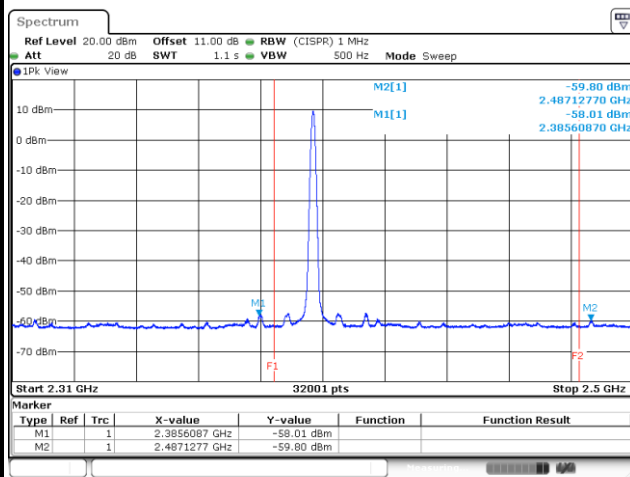
GFSK

Transmitter Conducted Unwanted Emissions Results in Band Edge

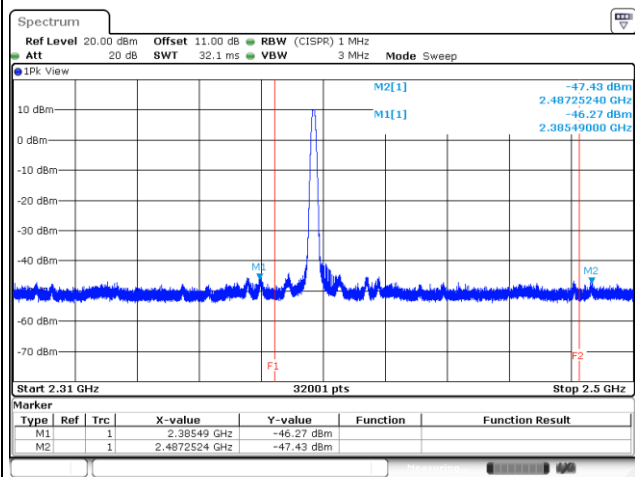
Test ch. Freq. (MHz)	Range (MHz)	Max Value (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)	Remark
2402	2310~2390	-46.27	2.79	-43.48	51.78	74.00	-22.22	PK
	2310~2390	-58.01	2.79	-55.22	40.04	54.00	-13.96	AV
	2483.5~2500	-47.43	2.79	-44.64	50.62	74.00	-23.38	PK
	2483.5~2500	-59.80	2.79	-57.01	38.25	54.00	-15.75	AV

Band Edge Test Plot

2402MHz - AV



2402MHz - PK

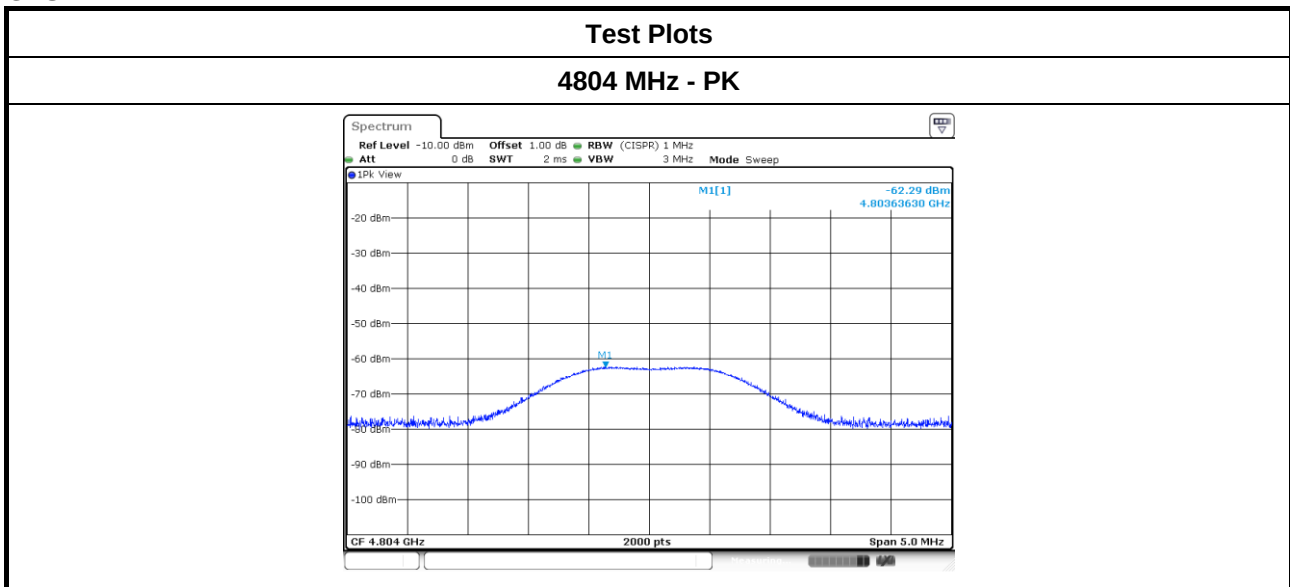


Transmitter Conducted Unwanted Emissions Results in Restricted Frequency Band							
Modulation Mode			GFSK	Frequency			2402MHz
Freq. (MHz)	Remark	Max Value chain0 (dBm)	DG (dBi)	EIRP (dBm)	E-Field (dBuV/m)	E-Field Limit (dBuV/m)	E-Field Margin (dB)
4804.00	PK	-62.29	2.79	-59.50	35.76	74.00	-38.24
4804.00	AV ^{note1}	-	-	-	-	54.00	-

Note:

1. If the PK margin greater than 20 dB, there is no need to get AVG reading.
2. DG = Directional Gain.

GFSK



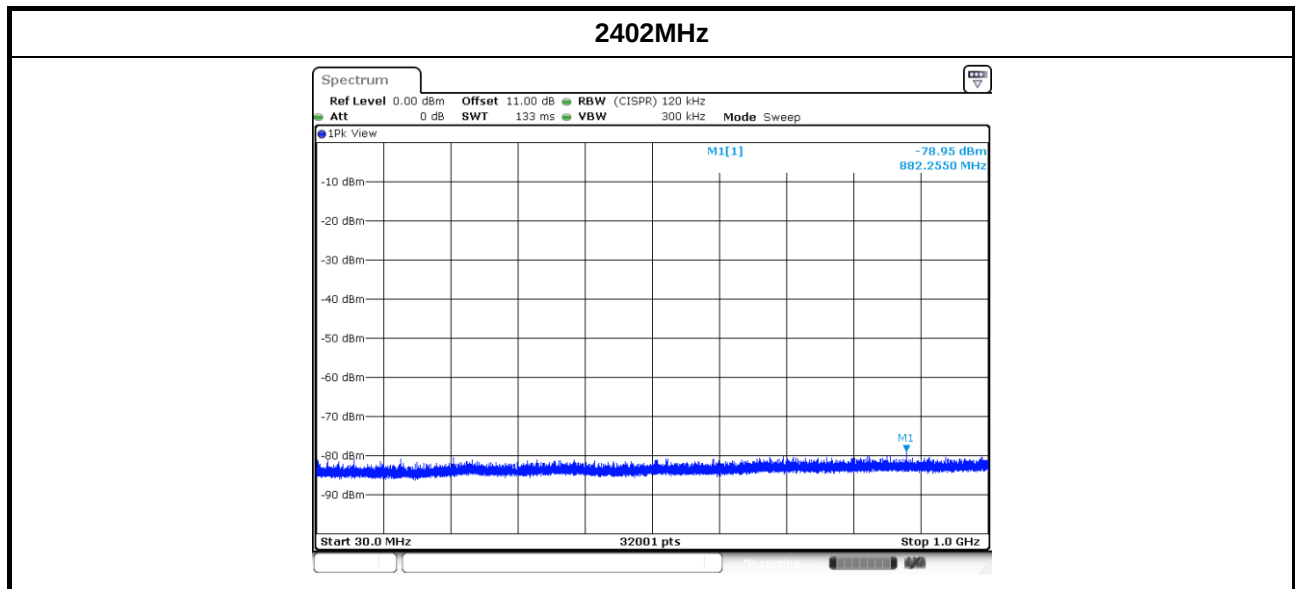
With model: ST60-2230C-PU

3.2.9 Transmitter Conducted Unwanted Emissions (Below 1 GHz)

Modulation Mode		GFSK			Frequency	2402MHz	
Range (MHz)	Max Value (dBm)	DG (dBi)	GRF (dB)	EIRP (dBm)	E-Field (dBuV/m)	Min E-Field Limit (dBuV/m)	E-Field Margin (dB)
30~1000MHz	-78.95	2.79	4.70	-71.46	23.80	40.00	-16.20

Note:

1. GRF = Ground Reflection Factor.
2. DG = Directional Gain.
3. Worst case of emission limit below 1GHz is selected to be limit.



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==