



# FCC RADIO TEST REPORT

**FCC ID** : UZ7WS5002  
**Equipment** : WS50 Wearable Computer  
**Brand Name** : Zebra  
**Model Name** : WS5002  
**Applicant** : Zebra Technologies Corporation  
1 Zebra Plaza, Holtsville, NY 11742  
**Manufacturer** : Zebra Technologies Corporation  
1 Zebra Plaza, Holtsville, NY 11742  
**Standard** : FCC Part 15 Subpart C §15.247

The product was received on Mar. 19, 2024 and testing was performed from Mar. 29, 2024 to Apr. 04, 2024. We, Sporton International Inc. Wensan Laboratory, would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this variant report apply exclusively to the tested model / sample. Without written approval from Sporton International Inc. Wensan Laboratory, the test report shall not be reproduced except in full.

Approved by: Louis Wu

**Sporton International Inc. Wensan Laboratory**

No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City 333010, Taiwan (R.O.C.)



## Table of Contents

History of this test report.....	3
Summary of Test Result.....	4
<b>1 General Description.....</b>	<b>5</b>
1.1 Product Feature of Equipment Under Test.....	5
1.2 Product Specification of Equipment Under Test.....	6
1.3 Modification of EUT .....	6
1.4 Testing Location .....	7
1.5 Applicable Standards.....	7
<b>2 Test Configuration of Equipment Under Test.....</b>	<b>8</b>
2.1 Carrier Frequency Channel .....	8
2.2 Test Mode.....	9
2.3 Connection Diagram of Test System.....	10
2.4 EUT Operation Test Setup .....	10
<b>3 Test Result.....</b>	<b>11</b>
3.1 Output Power Measurement.....	11
3.2 Radiated Band Edges and Spurious Emission Measurement .....	12
3.3 Antenna Requirements.....	15
<b>4 List of Measuring Equipment .....</b>	<b>16</b>
<b>5 Measurement Uncertainty .....</b>	<b>17</b>
<b>Appendix A. Conducted Test Results</b>	
<b>Appendix B. Radiated Spurious Emission</b>	
<b>Appendix C. Radiated Spurious Emission Plots</b>	
<b>Appendix D. Duty Cycle Plots</b>	
<b>Appendix E. Setup Photographs</b>	





### Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
-	15.247(a)(1)	Number of Channels	Not Required	-
-	15.247(a)(1)	Hopping Channel Separation	Not Required	-
-	15.247(a)(1)	Dwell Time of Each Channel	Not Required	-
-	15.247(a)(1)	20dB Bandwidth	Not Required	-
-	2.1049	99% Occupied Bandwidth	Not Required	-
3.1	15.247(b)(1) 15.247(b)(4)	Peak Output Power	Pass	-
-	15.247(d)	Conducted Band Edges	Not Required	-
-	15.247(d)	Conducted Spurious Emission	Not Required	-
3.2	15.247(d)	Radiated Band Edges and Radiated Spurious Emission	Pass	30.42 dB under the limit at 2344.34 MHz
-	15.207	AC Conducted Emission	Not Required	-
3.3	15.203	Antenna Requirement	Pass	-

**Note:**

1. Not required means after assessing, test items are not necessary to carry out.
2. This is a variant report by removing NFC function and changing model name. All the test cases were performed on original report which can be referred to Sporton Report Number FR1O0707-02A. Based on the original report, the test cases were verified.

**Conformity Assessment Condition:**

1. The test results (PASS/FAIL) with all measurement uncertainty excluded are presented against the regulation limits or in accordance with the requirements stipulated by the applicant/manufacturer who shall bear all the risks of non-compliance that may potentially occur if measurement uncertainty is taken into account.
2. The measurement uncertainty please refer to each test result in the section "Measurement Uncertainty".

**Disclaimer:**

The product specifications of the EUT presented in the test report that may affect the test assessments are declared by the manufacturer who shall take full responsibility for the authenticity.

**Reviewed by: Wei Chen**

**Report Producer: Michelle Chen**



# 1 General Description

## 1.1 Product Feature of Equipment Under Test

Product Feature	
Equipment	WS50 Wearable Computer
Brand Name	Zebra
Model Name	WS5002
FCC ID	UZ7WS5002
EUT supports Radios application	WLAN 11a/b/g/n HT20/HT40 WLAN 11ac VHT20/VHT40/VHT80 Bluetooth BR/EDR/LE
HW Version	MV
SW Version	11-38-19.00-RN-U00-PRD-WTX-04
MFD	25DEC23
EUT Stage	Identical Prototype

Remark: The EUT's information above is declared by manufacturer.

SKU List				
Helix SKU	Scanner	Battery	Camera	Mounting
SKU 3-1	N/A	Standard Battery	Yes	Wrist Strap
SKU 3-2	N/A	Standard Battery	N/A	Wrist Strap

Specification of Accessories				
Adaptor	Brand Name	Zebra	Model Number	PWR-WUA5V12W0US
Standard Battery	Brand Name	Zebra	Model Number	BT-000446
USB charging cable with cup	Brand Name	Zebra	Model Number	CBL-WS5X-USB1-01
USB C CABLE	Brand Name	Zebra	Model Number	CBL-TC2X-USBC-01



Supported Unit used in test configuration and system				
Converged Scanner Shell	Brand Name	Zebra	Part Number	SG-WS5X-SHLCS-01
Replacement Finger Trigger for Converged	Brand Name	Zebra	Part Number	SG-WS5X-TRGA-01
Wrist Shell	Brand Name	Zebra	Part Number	SG-WS5X-SHLWR-01
Wrist Strap	Brand Name	Zebra	Part Number	SG-WS5X-WSTRP-01
Wrist Mount (without strap)	Brand Name	Zebra	Part Number	SG-WS5X-WSTMT-01
Wrist Mount with strap	Brand Name	Zebra	Part Number	SG-WS5X-WPLTS-01
Back of Hand Mount for Converged	Brand Name	Zebra	Part Number	SG-WS5X-BHMT-01
Thin Mount	Brand Name	Zebra	Part Number	SG-WS5X-TNMNT-01
Black Strap	Brand Name	Zebra	Part Number	SG-WS5X-BNDBK-01
Blur Strap	Brand Name	Zebra	Part Number	SG-WS5X-BNDBL-01
Clip Mount	Brand Name	Zebra	Part Number	SG-WS5X-CPMNT-01
Clip for Clip Mount	Brand Name	Zebra	Part Number	SG-WS5X-MCLIP-01
Shell for Clip Mount	Brand Name	Zebra	Part Number	SG-WS5X-SHELL-01
Headphone 1	Brand Name	Zebra	Part Number	HS2100
Headphone 2	Brand Name	Zebra	Part Number	HDST-35MM-PTT1-01
Generic Lanyard	Brand Name	Zebra	Part Number	N/A

## 1.2 Product Specification of Equipment Under Test

Product Specification is subject to this standard	
Tx/Rx Frequency Range	2402 MHz ~ 2480 MHz
Number of Channels	79
Carrier Frequency of Each Channel	2402+n*1 MHz; n=0~78
Maximum Output Power to Antenna	Bluetooth BR (1Mbps): 6.95 dBm (0.0050 W) Bluetooth EDR (2Mbps): 6.38 dBm (0.0043 W) Bluetooth EDR (3Mbps): 6.48 dBm (0.0044 W)
Antenna Type / Gain	PIFA Antenna with gain 2.50 dBi
Type of Modulation	Bluetooth BR (1Mbps) : GFSK Bluetooth EDR (2Mbps) : π/4-DQPSK Bluetooth EDR (3Mbps) : 8-DPSK

**Remark:**

1. For other wireless features of this EUT, test report will be issued separately.
2. The above EUT's information was declared by manufacturer. Please refer to Disclaimer in report summary.

## 1.3 Modification of EUT

No modifications made to the EUT during the testing.



### 1.4 Testing Location

<b>Test Site</b>	Sporton International Inc. Wensan Laboratory
<b>Test Site Location</b>	No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City 333010, Taiwan (R.O.C.) TEL: +886-3-327-0868 FAX: +886-3-327-0855
<b>Test Site No.</b>	<b>Sporton Site No.</b> TH05-HY, 03CH11-HY

**Note:** The test site complies with ANSI C63.4 2014 requirement.

FCC designation No.: TW3786

### 1.5 Applicable Standards

According to the specifications declared by the manufacturer, the EUT must comply with the requirements of the following standards:

- ♦ FCC Part 15 Subpart C §15.247
- ♦ FCC KDB Publication No. 558074 D01 15.247 Meas Guidance v05r02
- ♦ ANSI C63.10-2013

**Remark:**

1. All the test items were validated and recorded in accordance with the standards without any modification during the testing.
2. The TAF code is not including all the FCC KDB listed without accreditation.
3. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.



## 2 Test Configuration of Equipment Under Test

### 2.1 Carrier Frequency Channel

Frequency Band	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)
2400-2483.5 MHz	0	2402	27	2429	54	2456
	1	2403	28	2430	55	2457
	2	2404	29	2431	56	2458
	3	2405	30	2432	57	2459
	4	2406	31	2433	58	2460
	5	2407	32	2434	59	2461
	6	2408	33	2435	60	2462
	7	2409	34	2436	61	2463
	8	2410	35	2437	62	2464
	9	2411	36	2438	63	2465
	10	2412	37	2439	64	2466
	11	2413	38	2440	65	2467
	12	2414	39	2441	66	2468
	13	2415	40	2442	67	2469
	14	2416	41	2443	68	2470
	15	2417	42	2444	69	2471
	16	2418	43	2445	70	2472
	17	2419	44	2446	71	2473
	18	2420	45	2447	72	2474
	19	2421	46	2448	73	2475
	20	2422	47	2449	74	2476
	21	2423	48	2450	75	2477
	22	2424	49	2451	76	2478
	23	2425	50	2452	77	2479
	24	2426	51	2453	78	2480
	25	2427	52	2454	-	-
	26	2428	53	2455	-	-





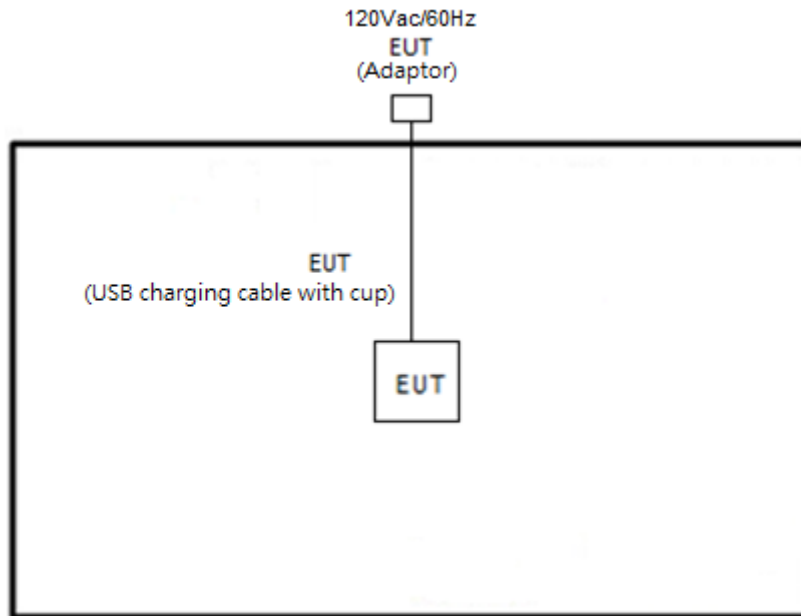
## 2.2 Test Mode

- a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: radiation emission (1 GHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). For radiated measurement, the measured emission level of the EUT was maximized by rotating the EUT on a turntable, adjusting the orientation of the EUT and EUT antenna in three orthogonal axis (X: flat, Y: portrait, Z: landscape), and adjusting the measurement antenna orientation, following C63.10 exploratory test procedures and only the worst plane, and the worst mode of radiated spurious emissions is Bluetooth 1Mbps mode, and recorded in this report.

The following summary table is showing all test modes to demonstrate in compliance with the standard.

Summary table of Test Cases	
Test Item	Data Rate / Modulation
Radiated Test Cases	Bluetooth BR 1Mbps GFSK
	Mode 1: CH00_2402 MHz
<b>Remark:</b>	
<ol style="list-style-type: none"> <li>For Radiated Test Cases, the worst mode data rate 1Mbps was reported only since the highest RF output power in the preliminary tests. The conducted spurious emissions and conducted band edge measurement for other data rates were not worse than 1Mbps, and no other significantly frequencies found in conducted spurious emission.</li> <li>For Radiated Test Cases, the tests were performed with SKU 3-1.</li> </ol>	

## 2.3 Connection Diagram of Test System



## 2.4 EUT Operation Test Setup

The RF test items, utility "QRCT Version 4.0.211.0" was installed in Notebook which was programmed in order to make the EUT get into the engineering modes to provide channel selection, power level, data rate and the application type and for continuous transmitting signals.

### **3 Test Result**

#### **3.1 Output Power Measurement**

##### **3.1.1 Limit of Output Power**

The maximum peak conducted output power of the intentional radiator shall not exceed the following:  
For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band 0.125 watts.  
If directional gain of transmitting antennas is greater than 6 dBi, the power shall be reduced by the same level in dB comparing to gain minus 6 dBi.

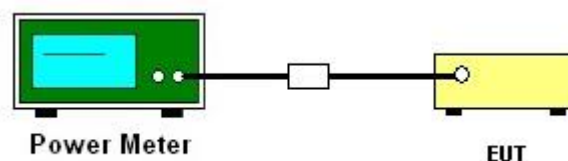
##### **3.1.2 Measuring Instruments**

Please refer to the measuring equipment list in this test report.

##### **3.1.3 Test Procedures**

1. The testing follows ANSI C63.10-2013 clause 7.8.5.
1. The RF output of EUT is connected to the power meter by RF cable and attenuator. The path loss is compensated to the results for each measurement.
2. Set the maximum power setting and enable the EUT to transmit continuously.
3. Measure the conducted output power with cable loss and record the results in the test report.
4. Measure and record the results in the test report.

##### **3.1.4 Test Setup**



##### **3.1.5 Test Result of Peak Output Power**

Please refer to Appendix A.

##### **3.1.6 Test Result of Average Output Power (Reporting Only)**

Please refer to Appendix A.



### 3.2 Radiated Band Edges and Spurious Emission Measurement

#### 3.2.1 Limit of Radiated Band Edges and Spurious Emission

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics / spurious must be at least 20 dB below the highest emission level within the authorized band. In addition, radiated emissions which fall in the restricted bands must also comply with the limits as below.

Frequency (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

#### 3.2.2 Measuring Instruments

Please refer to the measuring equipment list in this test report.



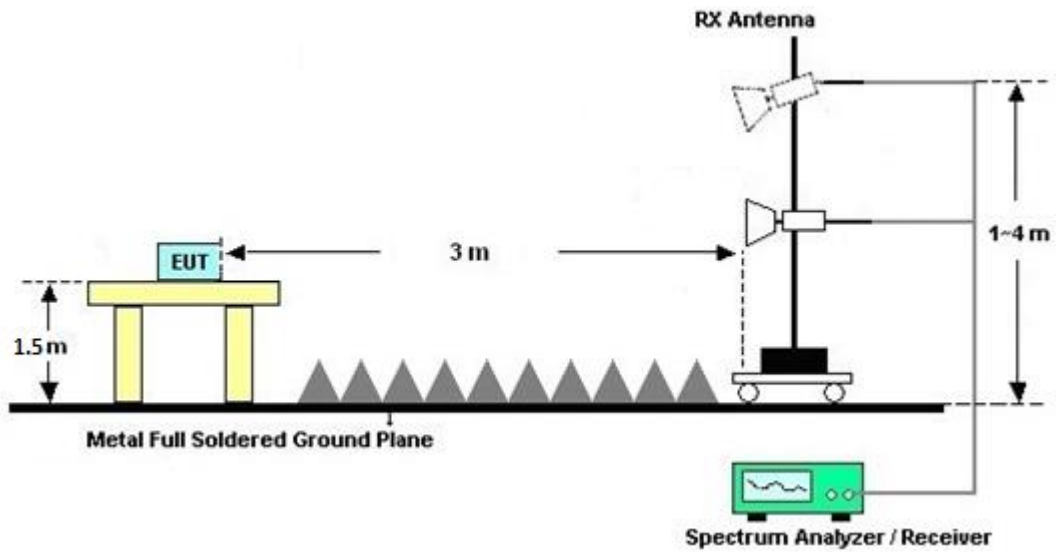
### 3.2.3 Test Procedures

1. The EUT is placed on a turntable with 1.5 meter for frequency above 1 GHz respectively above ground.
2. The EUT is set 3 meters away from the receiving antenna, which is mounted on the top of a variable height antenna tower.
3. For each suspected emission, the EUT is arranged to its worst case and then tune the Antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level to comply with the guidelines.
4. Set the maximum power setting and enable the EUT to transmit continuously.
5. Use the following spectrum analyzer settings:
  - (1) Span shall wide enough to fully capture the emission being measured;
  - (2) Set RBW = 100 kHz for  $f < 1$  GHz, RBW = 1 MHz for  $f > 1$  GHz ; VBW  $\geq$  RBW; Sweep = auto; Detector function = peak; Trace = max hold for peak
  - (3) For average measurement: use duty cycle correction factor method per 15.35(c).  
Duty cycle = On time/100 milliseconds  
On time =  $N_1 * L_1 + N_2 * L_2 + \dots + N_{n-1} * L_{n-1} + N_n * L_n$   
Where  $N_1$  is number of type 1 pulses,  $L_1$  is length of type 1 pulses, etc.  
Average Emission Level = Peak Emission Level +  $20 * \log$  (Duty cycle)
6. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
7. Radiated testing above 1 GHz is performed by adjusting the antenna tower from 1 m to 4 m and by rotating the turn table from 0 degree to 360 degrees to find the peak maximum hold reading for scanning all frequencies. When there is no suspected emission found and the harmonic emission level is with at least 6 dB margin against average limit line, the position is marked as “-“.

Note: The average levels are calculated from the peak level corrected with duty cycle correction factor (-24.76dB) derived from  $20 \log$  (dwell time/100ms). This correction is only for signals that hop with the fundamental signal, such as band-edge and harmonic. Other spurious signals that are independent of the hopping signal would not use this correction.

### 3.2.4 Test Setup

For radiated test above 1GHz



### 3.2.5 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix B and C.

### 3.2.6 Duty Cycle

Please refer to Appendix D.

### 3.2.7 Test Result of Radiated Spurious Emission

Please refer to Appendix B and C.



### **3.3 Antenna Requirements**

#### **3.3.1 Standard Applicable**

The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the rule.

#### **3.3.2 Antenna Anti-Replacement Construction**

An embedded-in antenna design is used.



## 4 List of Measuring Equipment

Instrument	Brand Name	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Horn Antenna	SCHWARZBECK	BBHA 9120 D	9120D-01620	1GHz~18GHz	Aug. 17, 2023	Apr. 01, 2024~ Apr. 04, 2024	Aug. 16, 2024	Radiation (03CH11-HY)
Preamplifier	E-INSTRUMENT TECH LTD.	ERA-10M-7000-MR	EC1900245	10MHz-7GHz	Jan. 09, 2024	Apr. 01, 2024~ Apr. 04, 2024	Jan. 08, 2025	Radiation (03CH11-HY)
Preamplifier	Jet-Power	JPA0118-55-303	17100018000 55007	1GHz~18GHz	Jun. 14, 2023	Apr. 01, 2024~ Apr. 04, 2024	Jun. 13, 2024	Radiation (03CH11-HY)
Spectrum Analyzer	Keysight	N9010A	MY54200486	10Hz~44GHz	Oct. 05, 2023	Apr. 01, 2024~ Apr. 04, 2024	Oct. 04, 2024	Radiation (03CH11-HY)
Controller	EMEC	EM 1000	N/A	Control Turn table & Ant Mast	N/A	Apr. 01, 2024~ Apr. 04, 2024	N/A	Radiation (03CH11-HY)
Antenna Mast	EMEC	AM-BS-4500-B	N/A	1~4m	N/A	Apr. 01, 2024~ Apr. 04, 2024	N/A	Radiation (03CH11-HY)
Turn Table	EMEC	TT 2000	N/A	0~360 Degree	N/A	Apr. 01, 2024~ Apr. 04, 2024	N/A	Radiation (03CH11-HY)
Software	Audix	E3 6.2009-8-24	RK-001053	N/A	N/A	Apr. 01, 2024~ Apr. 04, 2024	N/A	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	MY1595/2	30MHz~40GHz	Mar. 06, 2024	Apr. 01, 2024~ Apr. 04, 2024	Mar. 05, 2025	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	MY2859/2	30MHz~40GHz	Mar. 06, 2024	Apr. 01, 2024~ Apr. 04, 2024	Mar. 05, 2025	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	803951/2	30M~40G	Mar. 06, 2024	Apr. 01, 2024~ Apr. 04, 2024	Mar. 05, 2025	Radiation (03CH11-HY)
Filter	Wainwright	WHKX12-2700-3000-18000-60SS	SN3	3GHz High Pass Filter	Sep. 11, 2023	Apr. 01, 2024~ Apr. 04, 2024	Sep. 10, 2024	Radiation (03CH11-HY)
Hygrometer	TECPEL	DTM-303B	TP140325	N/A	Dec. 08, 2023	Apr. 01, 2024~ Apr. 04, 2024	Dec. 07, 2024	Radiation (03CH11-HY)
Hygrometer	TECPEL	DTM-303A	TP201996	N/A	Nov. 07, 2023	Mar. 29, 2024	Nov. 06, 2024	Conducted (TH05-HY)
Power Meter	Anritsu	ML2495A	1036004	N/A	Jul. 27, 2023	Mar. 29, 2024	Jul. 26, 2024	Conducted (TH05-HY)
Power Sensor	Anritsu	MA2411B	1027253	300MHz~40GHz	Jul. 27, 2023	Mar. 29, 2024	Jul. 26, 2024	Conducted (TH05-HY)
Power Sensor	DARE	RPR3006W	15100041SNO 10 (NO:248)	10MHz~6GHz	Jun. 05, 2023	Mar. 29, 2024	Jun. 04, 2024	Conducted (TH05-HY)
Signal Analyzer	Rohde & Schwarz	FSV40	101566	10Hz~40GHz	Aug. 23, 2023	Mar. 29, 2024	Aug. 22, 2024	Conducted (TH05-HY)





## 5 Measurement Uncertainty

### Uncertainty of Radiated Emission Measurement (1000 MHz ~ 6000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ( $U = 2Uc(y)$ )	4.3 dB
---	--------

### Uncertainty of Radiated Emission Measurement (6000 MHz ~ 18000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ( $U = 2Uc(y)$ )	4.3 dB
---	--------

**Appendix A. Test Result of Conducted Test Items**

Test Engineer:	Willy Chang	Temperature:	21~25	°C
Test Date:	2024/3/29	Relative Humidity:	51~54	%

**TEST RESULTS DATA****Peak Power Table**

DH	CH.	NTX	Peak Power (dBm)	Power Limit (dBm)	Test Result
DH1	39	1	6.95	20.97	Pass
2DH1	39	1	6.38	20.97	Pass
3DH1	39	1	6.48	20.97	Pass

**TEST RESULTS DATA****Average Power Table*****(Reporting Only)***

DH	CH.	NTX	Average Power (dBm)	Duty Factor (dB)	Duty Factor (dB)
DH1	39	1	5.98	5.17	8.00
2DH1	39	1	4.33	5.08	8.00
3DH1	39	1	4.44	5.11	8.00



## Appendix B. Radiated Spurious Emission

Test Engineer :	Fu Chen, Sam Chou and Troye Hsieh	Temperature :	20.0~20.8°C
		Relative Humidity :	53.2~64.8%

### 2.4GHz 2400~2483.5MHz

#### BT (Band Edge @ 3m)

BT	Note	Frequency	Level	Over	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.	
		( MHz )	( dBμV/m )	( dB )	Limit	Level	Factor	Loss	Factor	Pos	Pos	Avg.		
					Line	( dBμV )	( dB/m )	( dB )	( dB )	( cm )	( deg )	( P/A )	( H/V )	
BT CH00 2402MHz		2344.335	43.58	-30.42	74	44.32	27.3	6.75	34.79	200	188	P	H	
		2344.335	18.82	-35.18	54	-	-	-	-	-	-	A	H	
	*	2402	100.46	-	-	100.97	27.5	6.79	34.8	200	188	P	H	
	*	2402	75.7	-	-	-	-	-	-	-	-	A	H	
													H	
														H
			2388.12	43.13	-30.87	74	43.67	27.48	6.78	34.8	400	129	P	V
			2388.12	18.37	-35.63	54	-	-	-	-	-	-	A	V
	*		2402	94.61	-	-	95.12	27.5	6.79	34.8	400	129	P	V
	*		2402	69.85	-	-	-	-	-	-	-	-	A	V
														V
													V	
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.													



2.4GHz 2400~2483.5MHz  
BT (Harmonic @ 3m)

BT	Note	Frequency ( MHz )	Level ( dBμV/m )	Over Limit ( dB )	Limit Line ( dBμV/m )	Read Level ( dBμV )	Antenna Factor ( dB/m )	Path Loss ( dB )	Preamp Factor ( dB )	Ant Pos ( cm )	Table Pos ( deg )	Peak Avg. (P/A)	Pol. (H/V)
BT CH 00 2402MHz		4804	42.38	-31.62	74	55.95	32.42	11.81	57.8	-	-	P	H
		4804	17.62	-36.38	54	-	-	-	-	-	-	A	H
													H
													H
													H
													H
													H
													H
													H
													H
													H
													H
													H
													H
													H
													H
													H
													H
													H
			4804	41.32	-32.68	74	54.89	32.42	11.81	57.8	-	-	P
		4804	16.56	-37.44	54	-	-	-	-	-	-	A	V
													V
													V
													V
													V
													V
													V
													V
													V
													V
													V
													V
													V
<b>Remark</b>	<ol style="list-style-type: none"> <li>No other spurious found.</li> <li>All results are PASS against Peak and Average limit line.</li> <li>The emission position marked as "-" means no suspected emission found with sufficient margin against limit line or noise floor only.</li> </ol>												



**Note symbol**

*	<b>Fundamental Frequency</b> which can be ignored. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
!	Test result is <b>over limit</b> line.
P/A	<b>Peak</b> or <b>Average</b>
H/V	<b>Horizontal</b> or <b>Vertical</b>



A calculation example for radiated spurious emission is shown as below:

BT	Note	Frequency	Level	Margin	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
		( MHz )	( dBµV/m )	( dB )	( dBµV/m )	( dBµV )	( dB/m )	( dB )	( dB )	( cm )	( deg )	( P/A )	( H/V )
BT CH 00 2402MHz		2390	55.45	-18.55	74	54.51	32.22	4.58	35.86	103	308	P	H

1. Path Loss(dB) = Cable loss(dB) + Filter loss(dB) + Attenuator loss(dB)
2. Level(dBµV/m) =  
Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBµV) - Preamp Factor(dB)
3. Margin (dB) = Level(dBµV/m) – Limit Line(dBµV/m)

**For Peak Limit @ 2390MHz:**

1. Level(dBµV/m)  
= Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBµV) - Preamp Factor(dB)  
= 32.22(dB/m) + 4.58(dB) + 54.51(dBµV) – 35.86 (dB)  
= 55.45 (dBµV/m)
2. Margin (dB)  
= Level(dBµV/m) – Limit Line(dBµV/m)  
= 55.45(dBµV/m) – 74(dBµV/m)  
= -18.55(dB)

**Peak measured complies with the limit line, so test result is “PASS”.**



### Appendix C. Radiated Spurious Emission Plots

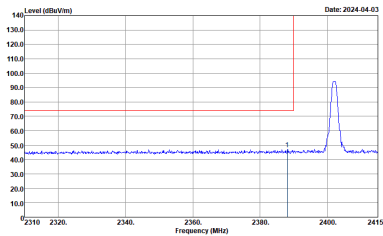
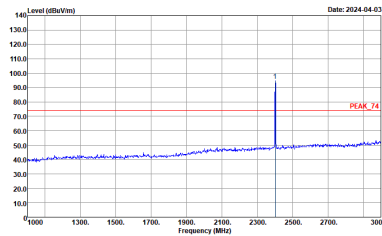
Test Engineer :	Fu Chen, Sam Chou and Troye Hsieh	Temperature :	20.0~20.8°C
		Relative Humidity :	53.2~64.8%

2.4GHz 2400~2483.5MHz

BT (Band Edge @ 3m)

BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BT CH00 2402MHz	
	Horizontal	Fundamental
Peak	<p>Site : 03CH11-HY Condition : PEAK_BE_74 3m 91200_01620_230817 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>	<p>Site : 03CH11-HY Condition : PEAK_74 3m 91200_01620_230817 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>



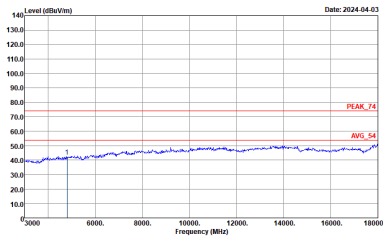
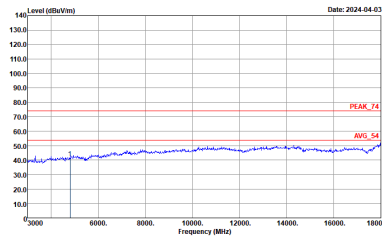
BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BT CH00 2402MHz	
	Vertical	Fundamental
Peak	 <p>Site : 03CHI1-HY Condition : PEAK_SE_74 3m 91200_01620_230817 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>	 <p>Site : 03CHI1-HY Condition : PEAK_74 3m 91200_01620_230817 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>



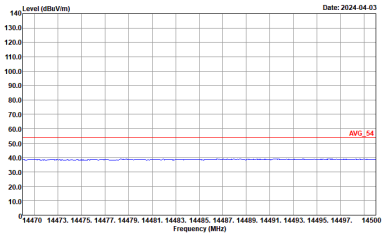
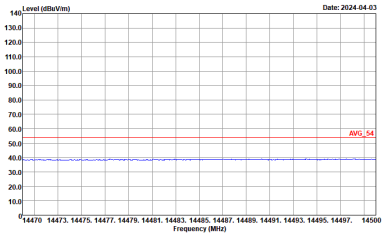
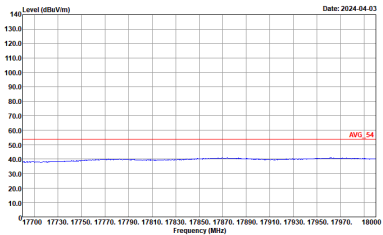
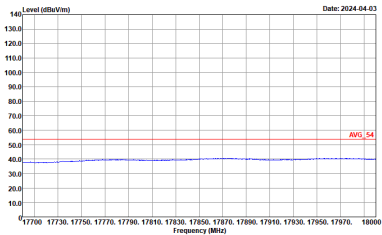


2.4GHz 2400~2483.5MHz

BT (Harmonic @ 3m)

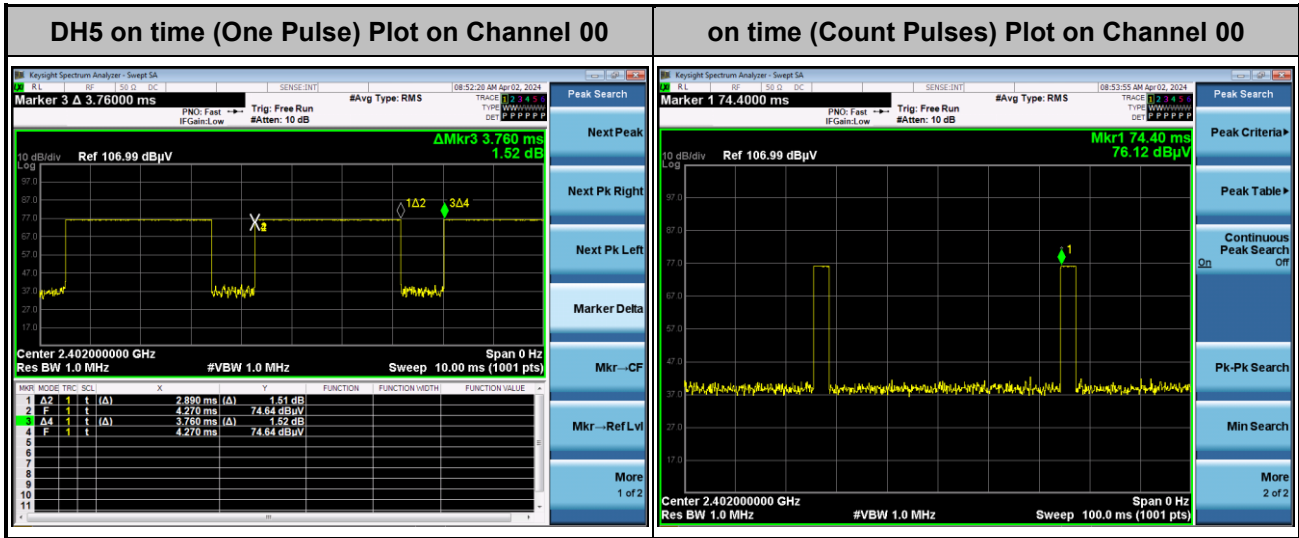
BT	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
	BT CH00 2402MHz	
	Horizontal	Vertical
Peak Avg.	 <p>Site : 03CH11-4FY Condition : PEAK_74 3m 91200_01620_230817 HORIZONTAL</p>	 <p>Site : 03CH11-4FY Condition : PEAK_74 3m 91200_01620_230817 VERTICAL</p>



BT	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
	BT CH00 2402MHz	
	Horizontal	Vertical
<p><b>14.47G</b> <b>~14.5G</b> <b>Avg.</b></p>	 <p>Site : 03CH11-HY Condition : AV6_54 3m 91200_01620_230817 HORIZONTAL</p>	 <p>Site : 03CH11-HY Condition : AV6_54 3m 91200_01620_230817 VERTICAL</p>
<p><b>17.7G</b> <b>~18G</b> <b>Avg</b></p>	 <p>Site : 03CH11-HY Condition : AV6_54 3m 91200_01620_230817 HORIZONTAL</p>	 <p>Site : 03CH11-HY Condition : AV6_54 3m 91200_01620_230817 VERTICAL</p>



### Appendix D. Duty Cycle Plots



**Note:**

1. Worst case Duty cycle = on time/100 milliseconds =  $2 * 2.89 / 100 = 5.78 \%$
2. Worst case Duty cycle correction factor =  $20 * \log(\text{Duty cycle}) = -24.76 \text{ dB}$
3. DH5 has the highest duty cycle worst case and is reported.

**Duty Cycle Correction Factor Consideration for AFH mode:**

Bluetooth normal hopping rate is 1600Hz and reduced to 800Hz in AFH mode; due to the reduced number of hopping frequencies, with the same packet configuration the dwell time in each channel frequency within 100msec period is longer in AFH mode than normal mode.

In AFH mode, the minimum hopping frequencies are 20, to get the longest dwell time DH5 packet is observed; the on time period to have DH5 packet completing one hopping sequence is

$$2.89 \text{ ms} \times 20 \text{ channels} = 57.8 \text{ ms}$$

There cannot be 2 complete hopping sequences within 100ms period, considering the random hopping behavior, maximum 2 hops can be possibly observed within the period.  $[100 \text{ ms} / 57.8 \text{ ms}] = 2 \text{ hops}$

Thus, the maximum possible ON time:

$$2.89 \text{ ms} \times 2 = 5.78 \text{ ms}$$

Worst case Duty Cycle Correction factor, which is derived from the maximum possible ON time,

$$20 \times \log(5.78 \text{ ms}/100 \text{ ms}) = -24.76 \text{ dB}$$