

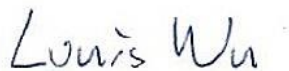


FCC RADIO TEST REPORT

FCC ID : UZ7EC55BK
Equipment : Enterprise Computer
Brand Name : Zebra
Model Name : EC55BK
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 Jul. 22, 2020 and testing was started from Sep. 23, 2020 and completed on Oct. 20, 2020. We, SPORTON INTERNATIONAL INC., EMC & Wireless Communications 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 of SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory, the test report shall not be reproduced except in full.



Reviewed by: Louis Wu

SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory

No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.)



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History of this test report

Report No.	Version	Description	Issued Date
FR070405A	01	Initial issue of report	Nov. 05, 2020

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)	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	Under limit 26.44 dB at 2376.570 MHz
-	15.207	AC Conducted Emission	Not Required	-
3.3	15.203 & 15.247(b)	Antenna Requirement	Pass	-

Note:

1. Not required means after assessing, test items are not necessary to carry out.
2. This is a variant report. The difference between EC55AK and EC55BK is the performance for cellular bands. The detail of similarity and difference can be found in Operation Description. All the test cases were performed on original report which can be referred to Sporton Report Number FR070401A as appendix E. Based on the original report, the test cases were verified.

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.

Reviewed by: Wii Chang

Report Producer: Tina Chuang

1 General Description

1.1 Product Feature of Equipment Under Test

Product Feature	
Equipment	Enterprise Computer
Brand Name	Zebra
Model Name	EC55BK
FCC ID	UZ7EC55BK
EUT supports Radios application	GSM/WCDMA/HSPA/LTE/NFC/GNSS WLAN 11a/b/g/n HT20/HT40 WLAN 11ac VHT20/VHT40/VHT80 Bluetooth BR/EDR/LE
HW Version	EV2
SW Version	Android version 10
FW Version	10-13-12.00-QG-U0D-PRD-HEL-04
MFD	02JUL20
EUT Stage	Engineering sample

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

Specification of Accessories				
AC Adapter	Brand Name	Zebra	Part Number	PWR-WUA5V15W0US
USB TYPE-C to TYPE-C cable	Brand Name	Zebra	Part Number	CBL-EC5X-USBC3A-01
Battery 1	Brand Name	Zebra	Part Number	BT-000424-00
Battery 2	Brand Name	Zebra	Part Number	BT-000424-08
Earphone 1	Brand Name	Zebra	Part Number	HDST-35MM-PTVP-01
Earphone 2	Brand Name	Zebra	Part Number	HS2100-OTH
USB TYPE C to 3.5mm audio connector	Brand Name	Symbol	Part Number	ADP-USBC-35MM1-01
3.5mm Jack 43"(1.1m) Standard Cable	Brand Name	Zebra	Part Number	CBL-HS2100-3MS1-01
Trigger Handle	Brand Name	Zebra	Part Number	TRG-EC5X-SNP1-01
Soft Holster	Brand Name	Zebra	Part Number	SG-EC5X-HLSTR1-01
Protective Boot	Brand Name	Zebra	Part Number	SG-EC5X-BOOT1-01

Sample list				
	Sample 1	Sample 2	Sample 3	Sample 4
Operating System	ANDROID	ANDROID	ANDROID	ANDROID
RAM	3GB	3GB	4GB	4GB
FLASH	32GB	32GB	64GB	64GB
Scanner	NO	SE4100	SE4100	SE4100
Front Camera	5MP	NO	5MP	5MP
Rear Camera	13MP	13MP	13MP	13MP
	MICRO SD	MICRO SD	MICRO SD	MICRO SD
	GMS	GMS	GMS	GMS
Back connector	NO I/O CONNECTOR	2-PIN	2-PIN	8-PIN
	ROW - Excludes China	ROW - Excludes China	ROW - Excludes China	ROW - Excludes China

1.2 Product Specification of Equipment Under Test

Product Specification subjective 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) : 4.08 dBm (0.0026 W) Bluetooth EDR (2Mbps) : 3.55 dBm (0.0023 W) Bluetooth EDR (3Mbps) : 4.01 dBm (0.0025 W)
Antenna Type / Gain	PIFA Antenna type with gain 1.5 dBi
Type of Modulation	Bluetooth BR (1Mbps) : GFSK Bluetooth EDR (2Mbps) : $\pi/4$ -DQPSK Bluetooth EDR (3Mbps) : 8-DPSK

1.3 Modification of EUT

No modifications are made to the EUT during all test items.



1.4 Testing Location

Test Site	SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory
Test Site Location	No.52, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.) TEL: +886-3-327-3456 FAX: +886-3-328-4978
Test Site No.	Sporton Site No.
	TH05-HY

Test Site	SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory
Test Site Location	No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.) TEL: +886-3-327-0868 FAX: +886-3-327-0855
Test Site No.	Sporton Site No.
	03CH16-HY

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

FCC designation No.: TW1190 and TW0007

1.5 Applicable Standards

According to the specifications of 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 DTS Meas. Guidance v05r02
- ♦ ANSI C63.10-2013

Remark:

1. All test items were verified and recorded according to the standards and without any deviation during the test.
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

Channel	Frequency	Bluetooth Average Output Power		
		GFSK / 1Mbps		
		DH1	DH3	DH5
Ch00	2402MHz	3.78 dBm	3.66 dBm	3.64 dBm
Ch39	2441MHz	3.79 dBm	3.68 dBm	3.66 dBm
Ch78	2480MHz	3.86 dBm	3.74 dBm	3.73 dBm

Channel	Frequency	Bluetooth Average Output Power		
		$\pi/4$ -DQPSK / 2Mbps		
		2DH1	2DH3	2DH5
Ch00	2402MHz	0.50 dBm	0.42 dBm	0.41 dBm
Ch39	2441MHz	0.90 dBm	0.88 dBm	0.84 dBm
Ch78	2480MHz	0.58 dBm	0.47 dBm	0.45 dBm

Channel	Frequency	Bluetooth Average Output Power		
		8-DPSK / 3Mbps		
		3DH1	3DH3	3DH5
Ch00	2402MHz	0.60 dBm	0.47 dBm	0.43 dBm
Ch39	2441MHz	1.00 dBm	0.91 dBm	0.89 dBm
Ch78	2480MHz	0.71 dBm	0.54 dBm	0.50 dBm

Channel	Frequency	Bluetooth Peak Output Power		
		GFSK / 1Mbps		
		DH1	DH3	DH5
Ch00	2402MHz	4.02 dBm	3.97 dBm	3.96 dBm
Ch39	2441MHz	4.05 dBm	4.00 dBm	3.98 dBm
Ch78	2480MHz	4.08 dBm	4.05 dBm	4.02 dBm

5

Channel	Frequency	Bluetooth Peak Output Power		
		$\pi/4$ -DQPSK / 2Mbps		
		2DH1	2DH3	2DH5
Ch00	2402MHz	3.09 dBm	3.08 dBm	3.06 dBm
Ch39	2441MHz	3.55 dBm	3.52 dBm	3.50 dBm
Ch78	2480MHz	3.17 dBm	3.16 dBm	3.15 dBm

Channel	Frequency	Bluetooth Peak Output Power		
		8-DPSK / 3Mbps		
		3DH1	3DH3	3DH5
Ch00	2402MHz	3.62 dBm	3.58 dBm	3.43 dBm
Ch39	2441MHz	4.01 dBm	3.94 dBm	3.78 dBm
Ch78	2480MHz	3.71 dBm	3.66 dBm	3.52 dBm

Remark: The data rate was set in 1Mbps for all the test items due to the highest RF output power.



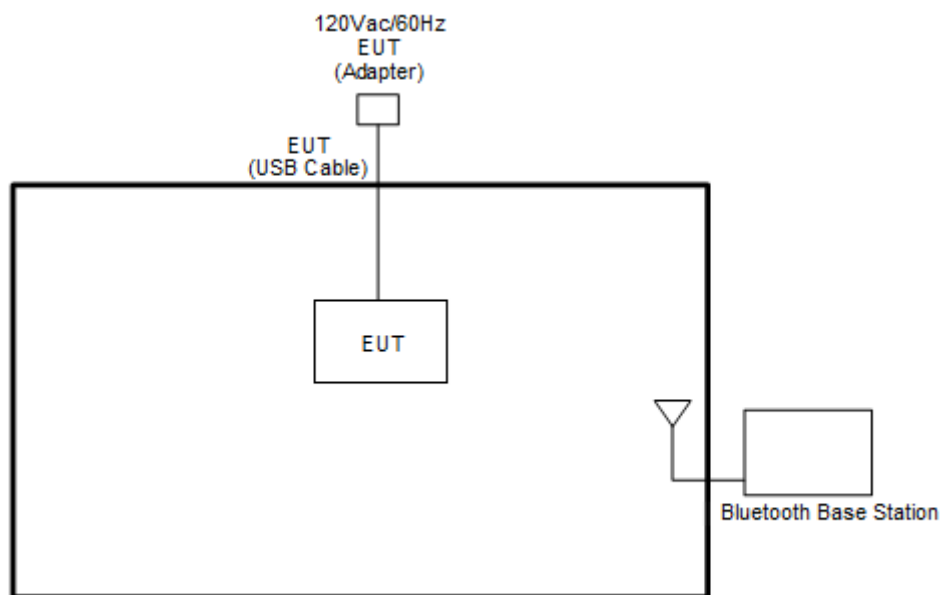
- a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated:, radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). For radiated measurement, pre-scanned in three orthogonal panels, X, Y, Z. The worst cases (X plane) were recorded in this report, 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	
Radiated Test Cases	Bluetooth BR 1Mbps GFSK
	Mode 1: CH00_2402 MHz
Remark:	
1. 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.	
2. For Radiated Test Cases, the tests were performed with Battery 1 and Sample 1	

2.3 Connection Diagram of Test System

<Bluetooth Tx Mode>



2.4 Support Unit used in test configuration and system

Item	Equipment	Brand Name	Model Name	FCC ID	Data Cable	Power Cord
1.	Bluetooth Base Station	R&S	CBT32	N/A	N/A	Unshielded, 1.8 m

2.5 EUT Operation Test Setup

The RF test items, utility “QRCT v4.0” 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.

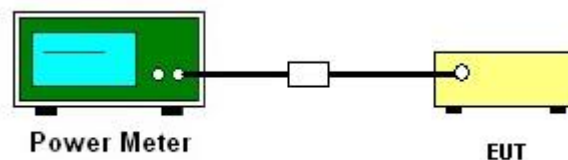
3.1.2 Measuring Instruments

See list of measuring equipment of 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 was connected to the power meter by RF cable and attenuator. The path loss was compensated to the results for each measurement.
2. Set to the maximum power setting and enable the EUT 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**

Test Engineer :	Kathy Chen			Temperature :	23.2℃
				Relative Humidity :	54.3%
DH	CH.	NTX	Peak Power (dBm)	Power Limit (dBm)	Test Result
DH1	0	1	4.02	20.97	Pass
	39	1	4.05	20.97	Pass
	78	1	4.08	20.97	Pass
2DH	CH.	NTX	Peak Power (dBm)	Power Limit (dBm)	Test Result
2DH1	0	1	3.09	20.97	Pass
	39	1	3.55	20.97	Pass
	78	1	3.17	20.97	Pass
3DH	CH.	NTX	Peak Power (dBm)	Power Limit (dBm)	Test Result
3DH1	0	1	3.62	20.97	Pass
	39	1	4.01	20.97	Pass
	78	1	3.71	20.97	Pass

3.1.6 Test Result of Average Output Power (Reporting Only)

Test Engineer :	Kathy Chen		Temperature :	23.2℃
			Relative Humidity :	54.3%
DH	CH.	NTX	Average Power (dBm)	Duty Factor (dB)
DH1	0	1	3.78	5.18
	39	1	3.79	5.18
	78	1	3.86	5.18
2DH	CH.	NTX	Average Power (dBm)	Duty Factor (dB)
2DH1	0	1	0.50	5.08
	39	1	0.90	5.08
	78	1	0.58	5.08
3DH	CH.	NTX	Average Power (dBm)	Duty Factor (dB)
3DH1	0	1	0.60	5.08
	39	1	1.00	5.08
	78	1	0.71	5.08

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

See list of measuring equipment of this test report.

3.2.3 Test Procedures

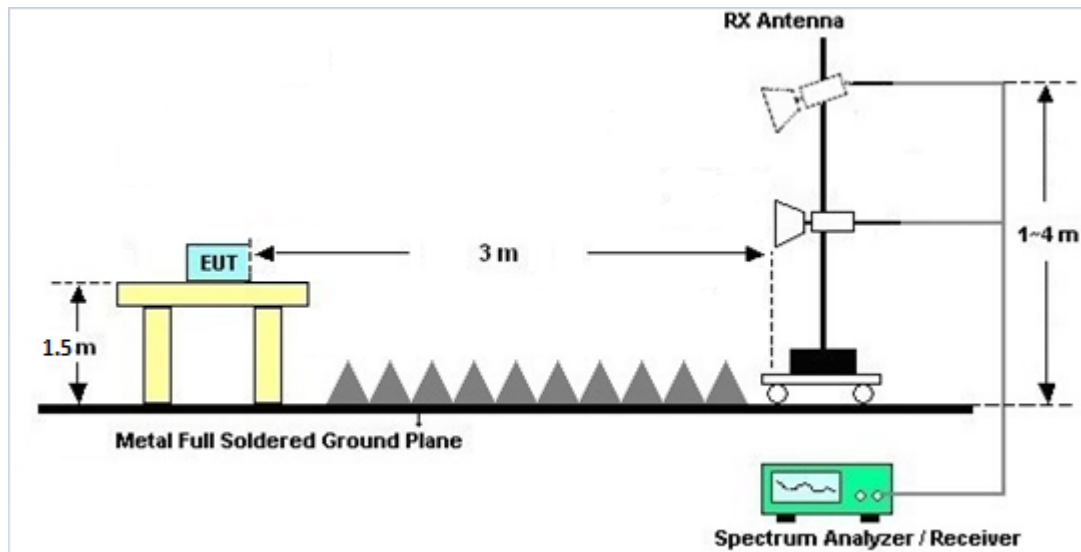
1. The EUT was placed on a turntable with 1.5 meter for frequency above 1GHz respectively above ground.
2. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
3. For each suspected emission, the EUT was arranged to its worst 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 to the maximum power setting and enable the EUT 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=1MHz 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
$$\text{On time} = N_1 * L_1 + N_2 * L_2 + \dots + N_{n-1} * L_{n-1} + N_n * L_n$$

Where N_1 is number of type 1 pulses, L_1 is length of type 1 pulses, etc.
Average Emission Level = Peak Emission Level + $20 * \log(\text{Duty cycle})$
6. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
7. For testing above 1GHz, the emission level of the EUT in peak mode was 20dB lower than average limit (that means the emission level in average mode also complies with the limit in average mode), then peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.

Note: The average levels were calculated from the peak level corrected with duty cycle correction factor (-24.79dB) derived from $20 \log(\text{dwell time}/100\text{ms})$. 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 emissions above 1GHz



3.2.5 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix A and B.

3.2.6 Duty Cycle

Please refer to Appendix C.

3.2.7 Test Result of Radiated Spurious Emission

Please refer to Appendix A and B.



3.3 Antenna Requirements

3.3.1 Standard Applicable

If directional gain of transmitting antennas is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi. 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.

3.3.3 Antenna Gain

The antenna peak gain of EUT is less than 6 dBi. Therefore, it is not necessary to reduce maximum peak output power limit.



4 List of Measuring Equipment

Instrument	Brand Name	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Hygrometer	Testo	608-H1	34893241	N/A	Mar. 02, 2020	Oct. 20, 2020	Mar. 01, 2021	Conducted (TH05-HY)
Power Meter	Agilent	E4416A	GB41292344	N/A	Dec. 27, 2019	Oct. 20, 2020	Dec. 26, 2020	Conducted (TH05-HY)
Signal Analyzer	Rohde & Schwarz	FSV40	101397	10Hz~40GHz	Nov. 15, 2019	Oct. 20, 2020	Nov. 14, 2020	Conducted (TH05-HY)
BT Base Station	Rohde & Schwarz	CBT	101136	BT 3.0	Oct. 27, 2019	Oct. 20, 2020	Oct. 26, 2020	Conducted (TH05-HY)
Switch Box & RF Cable	EM Electronics	EMSW18SE	SW200302	N/A	Mar. 17, 2020	Oct. 20, 2020	Mar. 16, 2021	Conducted (TH05-HY)
Horn Antenna	SCHWARZBECK	BBHA 9120 D	9120D-1212	1G~18GHz	May 20, 2019	Sep. 23, 2020	May 19, 2020	Radiation (03CH16-HY)
Preamplifier	Jet-Power	JPA0118-55-303	1710001800054001	1GHz~18GHz	Sep. 04, 2020	Sep. 23, 2020	Sep. 03, 2021	Radiation (03CH16-HY)
Preamplifier	Keysight	83017A	MY53270264	1GHz~26.5GHz	Dec. 11, 2019	Sep. 23, 2020	Dec. 10, 2020	Radiation (03CH16-HY)
EMI Test Receiver	Keysight	N9038A(MXE)	MY57290111	3Hz~26.5GHz	Dec. 05, 2019	Sep. 23, 2020	Dec. 04, 2020	Radiation (03CH16-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY11680/4PE	NA	Aug. 29, 2020	Sep. 23, 2020	Aug. 28, 2021	Radiation (03CH16-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY11688/4PE	NA	Aug. 29, 2020	Sep. 23, 2020	Aug. 28, 2021	Radiation (03CH16-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	EC-A5-300-5757	NA	Aug. 29, 2020	Sep. 23, 2020	Aug. 28, 2021	Radiation (03CH16-HY)
Hygrometer	TECPEL	DTM-303B	TP162965	N/A	Oct. 25, 2019	Sep. 23, 2020	Oct. 24, 2020	Radiation (03CH16-HY)
Software	Audix	E3 6.2009-8-24	RK-001136	N/A	N/A	Sep. 23, 2020	N/A	Radiation (03CH16-HY)
Controller	ChainTek	3000-1	N/A	Control Turn table & Ant Mast	N/A	Sep. 23, 2020	N/A	Radiation (03CH16-HY)
Antenna Mast	ChainTek	MBS-520-1	N/A	1m~4m	N/A	Sep. 23, 2020	N/A	Radiation (03CH16-HY)
Turn Table	ChainTek	T-200-S-1	N/A	0~360 Degree	N/A	Sep. 23, 2020	N/A	Radiation (03CH16-HY)



5 Uncertainty of Evaluation

Uncertainty of Radiated Emission Measurement (1000 MHz ~ 18000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	6.3
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Appendix A. Radiated Spurious Emission

Test Engineer :	Jacky Hung, Andy Yang and CR Liro	Temperature :	20~25°C
		Relative Humidity :	50~60%

2.4GHz 2400~2483.5MHz

BT (Band Edge @ 3m)

BT	Note	Frequency	Level	Over Limit	Limit Line	Read Level	Antenna Factor	Path Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
BT CH00 2402MHz		2359.035	47.47	-26.53	74	40.98	27.76	8.5	29.77	120	150	P	H
		2359.035	22.68	-31.32	54	-	-	-	-	-	-	A	H
	*	2402	99.67	-	-	93.28	27.6	8.58	29.79	120	150	P	H
	*	2402	74.88	-	-	-	-	-	-	-	-	A	H
													H
													H
		2376.57	47.56	-26.44	74	41.11	27.69	8.54	29.78	291	356	P	V
		2376.57	22.77	-31.23	54	-	-	-	-	-	-	A	V
	*	2402	95.6	-	-	89.21	27.6	8.58	29.79	291	356	P	V
	*	2402	70.81	-	-	-	-	-	-	-	-	A	V
													V
													V

**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	37.84	-36.16	74	52.94	31.02	13.36	59.48	100	0	P	H
		4804	13.05	-40.95	54	-	-	-	-	-	-	A	H
													H
													H
		4804	38.29	-35.71	74	53.39	31.02	13.36	59.48	100	0	P	V
		4804	13.5	-40.5	54	-	-	-	-	-	-	A	V
													V
													V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



Note symbol

*	Fundamental Frequency which can be ignored. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
!	Test result is over limit line.
P/A	P eak or A verage
H/V	H orizontal or V ertical

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

BT	Note	Frequency	Level	Over	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
		(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
		2390	43.54	-10.46	54	42.6	32.22	4.58	35.86	103	308	A	H

$$1. \text{ Path Loss(dB) = Cable loss(dB) + Filter loss(dB) + Attenuator loss(dB)}$$

$$2. \text{ Level(dB}\mu\text{V/m) =}$$

$$\text{Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dB}\mu\text{V) - Preamp Factor(dB)}$$

$$3. \text{ Over Limit(dB) = Level(dB}\mu\text{V/m) - Limit Line(dB}\mu\text{V/m)}$$

For Peak Limit @ 2390MHz:

$$1. \text{ Level(dB}\mu\text{V/m)}$$

$$= \text{Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dB}\mu\text{V) - Preamp Factor(dB)}$$

$$= 32.22(\text{dB/m}) + 4.58(\text{dB}) + 54.51(\text{dB}\mu\text{V}) - 35.86(\text{dB})$$

$$= 55.45(\text{dB}\mu\text{V/m})$$

$$2. \text{ Over Limit(dB)}$$

$$= \text{Level(dB}\mu\text{V/m) - Limit Line(dB}\mu\text{V/m)}$$

$$= 55.45(\text{dB}\mu\text{V/m}) - 74(\text{dB}\mu\text{V/m})$$

$$= -18.55(\text{dB})$$

For Average Limit @ 2390MHz:

$$1. \text{ Level(dB}\mu\text{V/m)}$$

$$= \text{Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dB}\mu\text{V) - Preamp Factor(dB)}$$

$$= 32.22(\text{dB/m}) + 4.58(\text{dB}) + 42.6(\text{dB}\mu\text{V}) - 35.86(\text{dB})$$

$$= 43.54(\text{dB}\mu\text{V/m})$$

$$2. \text{ Over Limit(dB)}$$

$$= \text{Level(dB}\mu\text{V/m) - Limit Line(dB}\mu\text{V/m)}$$

$$= 43.54(\text{dB}\mu\text{V/m}) - 54(\text{dB}\mu\text{V/m})$$

$$= -10.46(\text{dB})$$

Both peak and average measured complies with the limit line, so test result is "PASS".

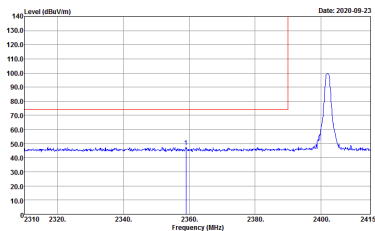
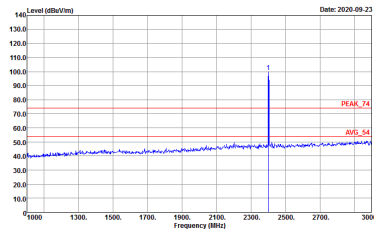


Appendix B. Radiated Spurious Emission Plots

Test Engineer :	Jacky Hung, Andy Yang and CR Liro	Temperature :	20~25°C
		Relative Humidity :	50~60%

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 : 03CH16-HY Condition : PEAK_BE_74 3m 91200_1212 HORIZONTAL RBW:1000.000kHz VBW:3000.000kHz SWT:Auto Detector : Peak</p>	 <p>Site : 03CH16-HY Condition : PEAK_74 3m 91200_1212 HORIZONTAL RBW:1000.000kHz VBW:3000.000kHz SWT:Auto Detector : Peak</p>

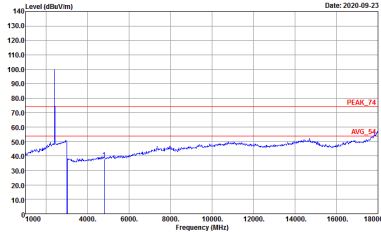
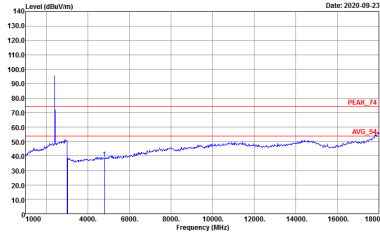


BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
	BT CH00 2402MHz	
	Vertical	Fundamental
Peak	<div><p>Level (dBuV/m)</p><p>Date: 2020-09-23</p><p>Frequency (MHz)</p><p>Site : 03CH16-HY Condition : PEAK_BE_74 3m 91200_1212 VERTICAL RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak</p></div>	<div><p>Level (dBuV/m)</p><p>Date: 2020-09-23</p><p>Frequency (MHz)</p><p>Site : 03CH16-HY Condition : PEAK_74 3m 91200_1212 VERTICAL RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak</p></div>

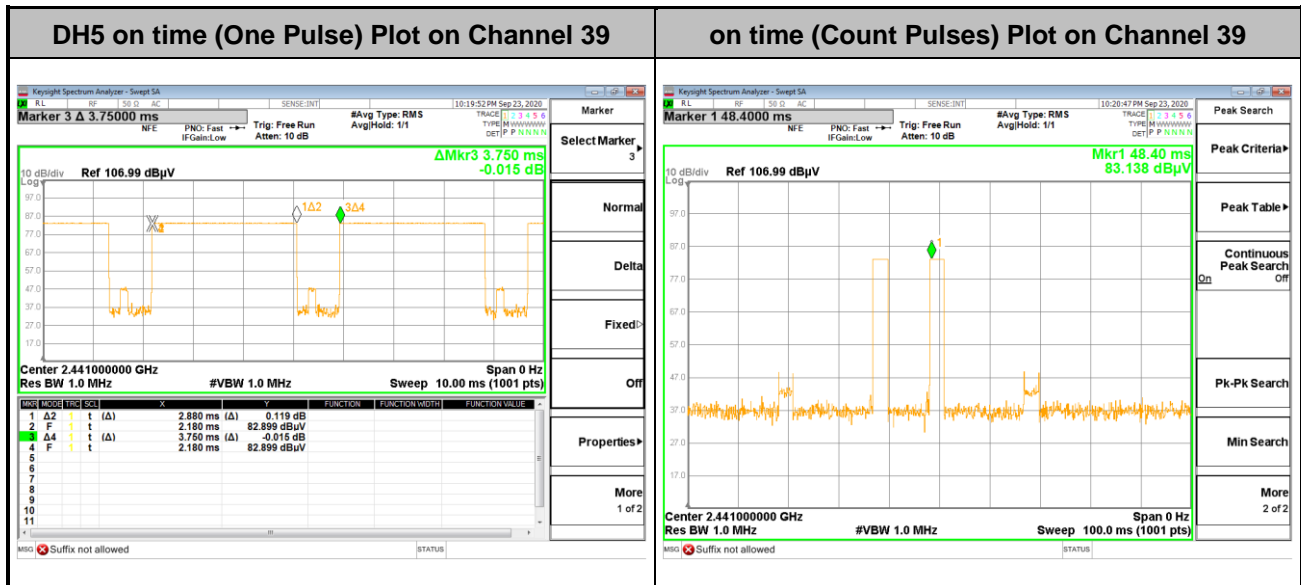


2.4GHz 2400~2483.5MHz

BT (Harmonic @ 3m)

BT	2.4GHz 2400~2483.5MHz Harmonic @ 3m	
	BT CH00 2402MHz	
	Horizontal	Vertical
Peak Avg.	 <p>Site : 03CH16-HY Condition : PEAK_74 3m 91200_1212 HORIZONTAL Detector : Peak</p>	 <p>Site : 03CH16-HY Condition : PEAK_74 3m 91200_1212 VERTICAL Detector : Peak</p>

Appendix C. Duty Cycle Plots



Note:

1. Worst case Duty cycle = on time/100 milliseconds = $2 * 2.88 / 100 = 5.76 \%$
2. Worst case Duty cycle correction factor = $20 * \log(\text{Duty cycle}) = -24.79 \text{ dB}$
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 period to have DH5 packet completing one hopping sequence is

$$2.88 \text{ ms} \times 20 \text{ channels} = 57.6 \text{ ms}$$

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. $[100 \text{ ms} / 57.6 \text{ ms}] = 2 \text{ hops}$

Thus, the maximum possible ON time:

$$2.88 \text{ ms} \times 2 = 5.76 \text{ ms}$$

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

$$20 \times \log(5.76 \text{ ms}/100 \text{ ms}) = -24.79 \text{ dB}$$



Appendix E. Original Report

Please refer to Sporton report number FR070401A as below.