

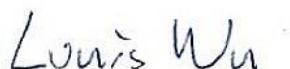


FCC CO-LOCATION RADIO TEST REPORT

FCC ID : UZ7WLMT0
Equipment : Touch Computer
Brand Name : Zebra
Model Name : WLMT0
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 E §15.407

The product was received on Jan. 18, 2023 and testing was performed from Jan. 24, 2023 to Feb. 28, 2023. 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 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.)



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History of this test report

Report No.	Version	Description	Issue Date
FR2D2704G	01	Initial issue of report	Mar. 03, 2023

Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
3.1	15.407(b)	Unwanted Emissions	Pass	1.15 dB under the limit at 5354.840 MHz
3.2	15.203 15.407(a)	Antenna Requirement	Pass	-

Declaration of Conformity:

1. The test results (PASS/FAIL) with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.
It's means measurement values may risk exceeding the limit of regulation standards, if measurement uncertainty is include in test results.
2. The measurement uncertainty please refer to this report "Uncertainty of Evaluation".

Comments and Explanations:

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

Reviewed by: Keven Cheng

Report Producer: Rachel Hsieh

1 General Description

1.1 Product Feature of Equipment Under Test

Product Feature	
Equipment	Touch Computer
Brand Name	Zebra
Model Name	WLMT0
FCC ID	UZ7WLMT0
EUT supports Radios application	NFC WLAN 11a/b/g/n HT20/HT40 WLAN 11ac VHT20/VHT40/VHT80/VHT160 WLAN 11ax HE20/HE40/HE80/HE160 Bluetooth BR/EDR/LE
Sample 1	Scanner (SE4710)
Sample 2	Scanner (SE5500)
HW Version	DV
SW Version	13-08-06.00-TG-UOO-PRD-ATH-04
FW Version	FUSION_QA_4_1.0.0.010_T
MFD	06FEB23
EUT Stage	Identical Prototype

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

Specification of Accessories				
Battery 1 Standard Battery (3800mAh)	Brand Name	Zebra	Model Number	BT-000473

Supported Unit Used in Test Configuration and System				
Battery 2 Standard BLE Beacon Battery (3800mAh)	Brand Name	Zebra	Model Number	BT-000473B
Battery 3 Extended Battery (5200mAh)	Brand Name	Zebra	Model Number	BT-000473E
Adapter 1 Cigarette Lighter Adapter	Brand Name	Zebra	Part Number	CHG-AUTO-USB1-01
Adapter 2 USB Wall Charger	Brand Name	Zebra	Part Number	PWR-WUA5V12W0US
Earphone 1 3.5mm PTT Headset	Brand Name	Zebra	Part Number	HDST-35MM-PTT1-01
Earphone 2 USB-C Audio Headset	Brand Name	Zebra	Part Number	HDST-USBC-PTT1-01
USB Cable (Type C to Type A)	Brand Name	Zebra	Part Number	CBL-TC5X-USBC2A-01
Type C-Audio Cable (Type C to 3.5mm)	Brand Name	Zebra	Part Number	ADP-USBC-35MM1-01

1.2 Product Specification of Equipment Under Test

Product Specification is subject to this standard			
Tx/Rx Channel Frequency Range	2402 MHz ~ 2480 MHz 2412 MHz ~ 2462 MHz 5250 MHz ~ 5350 MHz		
Antenna Type / Gain	<Bluetooth> Monopole Antenna with gain -1.10 dBi <2412 MHz ~ 2462 MHz> <Ant. 0> : Monopole Antenna with gain -1.10 dBi <Ant. 1> : IFA Antenna Antenna with gain -1.23 dBi <5250 MHz ~ 5350 MHz> <Ant. 0> : Monopole Antenna with gain -0.55 dBi <Ant. 1> : IFA Antenna Antenna with gain -0.26 dBi		
Type of Modulation	Bluetooth BR (1Mbps): GFSK 802.11ax : OFDMA (BPSK / QPSK / 16QAM / 64QAM / 256QAM / 1024QAM)		
Antenna Function for Transmitter		Ant. 0	Ant. 1
	Bluetooth	✓	-
	802.11ax	✓	✓
	802.11ax MIMO	✓	✓

Remark:

1. MIMO Ant. 0+1 is a calculated result from sum of the power MIMO Ant. 0 and MIMO Ant. 1.
2. The EUT's information above is declared by manufacturer. Please refer to Comments and Explanations in report summary.

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. Wensan Laboratory
Test Site Location	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
Test Site No.	Sporton Site No. 03CH15-HY

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

FCC designation No.: TW3786



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 E
- ♦ FCC Part 15 Subpart C §15.247
- ♦ FCC KDB Publication No. 558074 D01 15.247 Meas Guidance v05r02
- ♦ FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01.
- ♦ FCC KDB 414788 D01 Radiated Test Site v01r01.
- ♦ FCC KDB 662911 D01 Multiple Transmitter Output v02r01.
- ♦ 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

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, 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 case emissions were reported in this report.

2.1 Carrier Frequency and Channel

2400-2483.5 MHz				5250-5350 MHz	
Bluetooth		802.11ax HE20		802.11ax HE80	
Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)
78	2480	1	2412	58	5290

2.2 Test Mode

Final test modes are considering the modulation and worse data rates as below table.

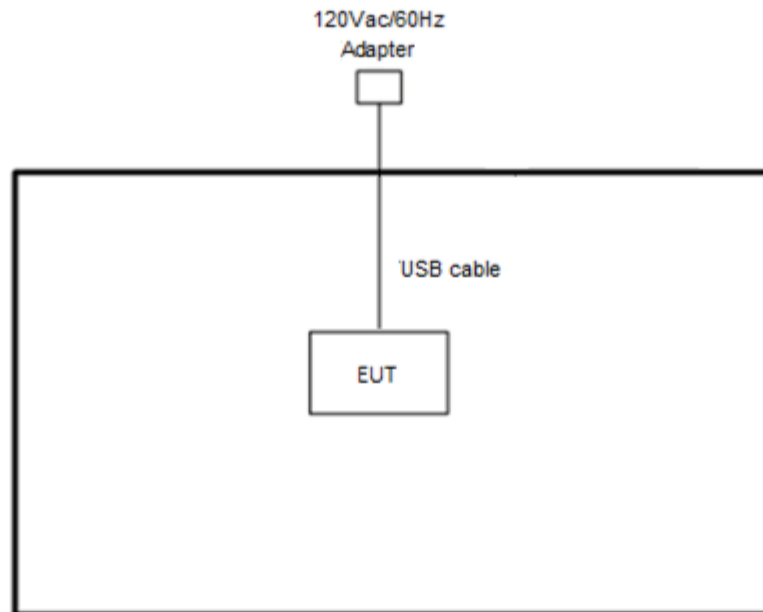
<Co-Location>

Test Mode	Modulation	Data Rate
Mode 1	WLAN 2.4GHz 802.11ax HE20 for MIMO <Ant. 0+1> + WLAN 5GHz 802.11ax HE80 for MIMO <Ant. 0+1>	MCS0 + MCS0
Mode 2	Bluetooth for Ant. 0 + WLAN 2.4GHz 802.11ax HE20 for Ant. 1 + WLAN 5GHz 802.11ax HE80 for MIMO <Ant. 0+1>	1Mbps + MCS0 + MCS0

Remark: For Radiated Test Cases, the tests were performed with Adapter 2, Battery 1 and Sample 1.

2.3 Connection Diagram of Test System

<Co-Location Tx Mode>



2.4 EUT Operation Test Setup

The RF test items, utility "QRCT v4.0.00260" 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 Unwanted Emissions Measurement

This section is to measure unwanted emissions through radiated measurement for band edge spurious emissions and out of band emissions measurement.

3.1.1 Limit of Unwanted Emissions

(1) Unwanted spurious emissions fallen in restricted bands shall comply with the general field strength limits as below table:

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

Note: The following formula is used to convert the EIRP to field strength.

$$E = \frac{1000000\sqrt{30P}}{3} \mu\text{V/m, where P is the eirp (Watts)}$$

EIRP (dBm)	Field Strength at 3m (dBμV/m)
- 27	68.3

(2) KDB789033 D02 v02r01 G)2)c)

(i) Sections 15.407(b)(1-3) specifies the unwanted emissions limit for the U-NII-1 and U-NII-2 bands. As specified, emissions above 1000 MHz that are outside of the restricted bands are subject to a peak emission limit of -27 dBm/MHz.

(ii) Section 15.407(b)(4) specifies the unwanted emissions limit for the U-NII-3 band. A band emissions mask is specified in Section 15.407(b)(4)(i). The emission limits are based on the use of a peak detector.

3.1.2 Measuring Instruments

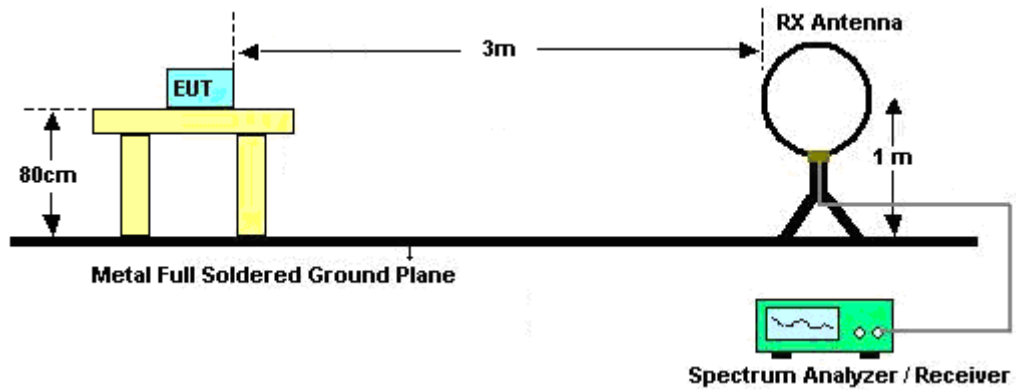
Please refer to the measuring equipment list in this test report.

3.1.3 Test Procedures

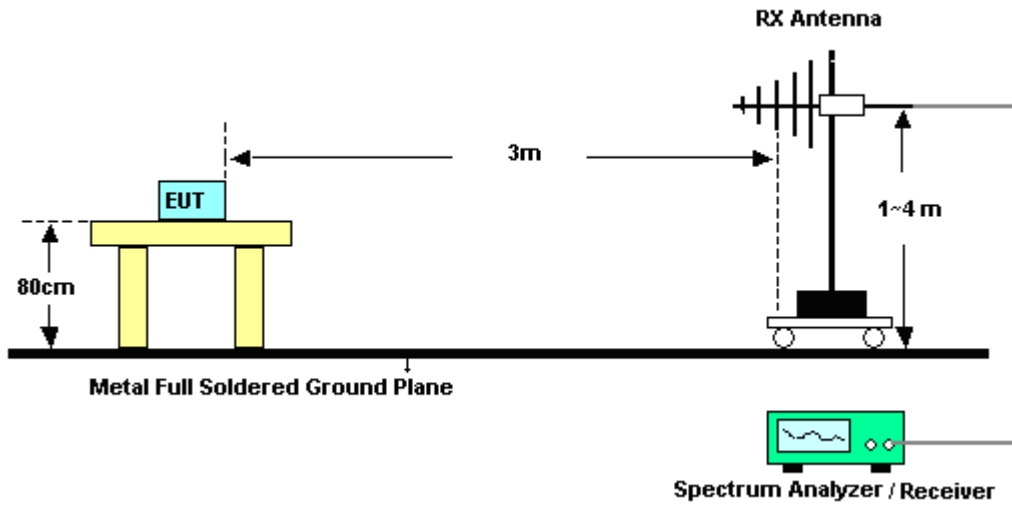
1. The testing follows FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01.
Section G) Unwanted emissions measurement.
 - (1) Procedure for Unwanted Emissions Measurements Below 1000MHz
 - RBW = 120 kHz
 - VBW = 300 kHz
 - Detector = Peak
 - Trace mode = max hold
 - (2) Procedure for Peak Unwanted Emissions Measurements Above 1000 MHz
 - RBW = 1 MHz
 - VBW $\geq$ 3 MHz
 - Detector = Peak
 - Sweep time = auto
 - Trace mode = max hold
 - (3) Procedures for Average Unwanted Emissions Measurements Above 1000MHz
 - RBW = 1 MHz
 - VBW = 10 Hz, when duty cycle is no less than 98 percent.
 - VBW $\geq$ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.
2. The EUT is placed on a turntable with 0.8 meter for frequency below 1 GHz and 1.5 meter for frequency above 1 GHz respectively above ground.
3. The EUT is set 3 meters away from the receiving antenna which is mounted on the top of a variable height antenna tower.
4. The antenna is a broadband antenna and its height is adjusted between one meter and four meters above ground to find the maximum value of the field strength for both horizontal polarization and vertical polarization of the antenna.
5. For each suspected emission, the EUT is arranged to its worst case and then adjust the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading.
6. Radiated testing below 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. When there is no suspected emission found and the emission level is with at least 6 dB margin against QP limit line, the position is marked as “-”.
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 “-”.

3.1.4 Test Setup

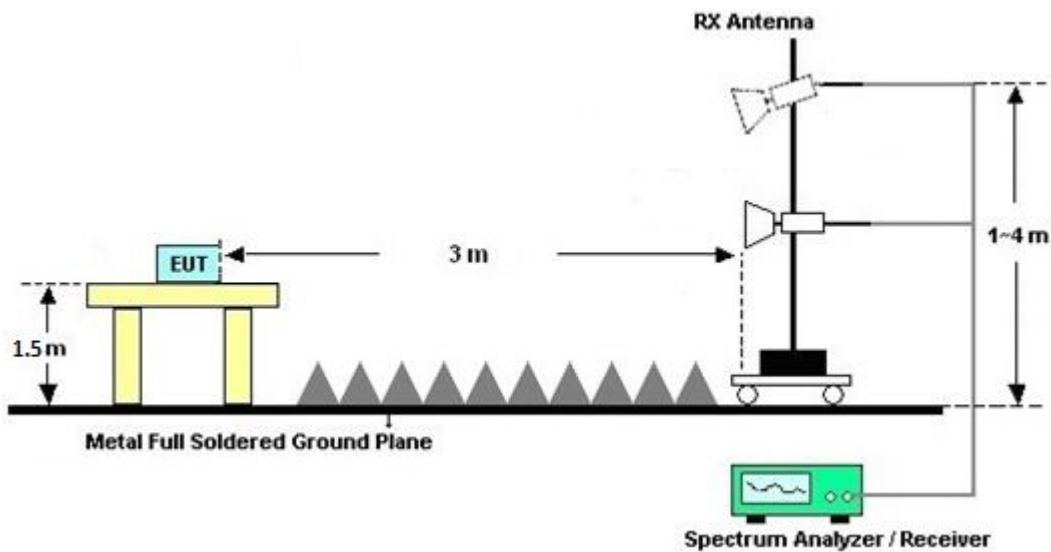
For radiated emissions below 30MHz



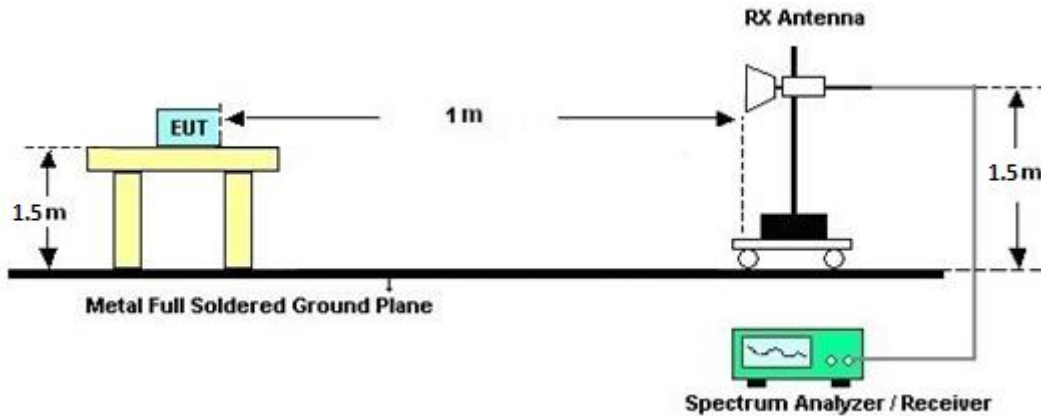
For radiated emissions from 30MHz to 1GHz



For radiated test from 1GHz to 18GHz



For radiated test above 18GHz



3.1.5 Test Results of Radiated Spurious Emissions (9 kHz ~ 30 MHz)

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line was not reported.

There is adequate comparison measurement of both open-field test site and alternative test site - semi-Anechoic chamber according to 414788 D01 Radiated Test Site v01r01, and the result came out very similar.

3.1.6 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix A and B.

3.1.7 Duty Cycle

Please refer to Appendix C.

3.1.8 Test Result of Radiated Spurious Emissions (30MHz ~ 10th Harmonic)

Please refer to Appendix A and B.



3.2 Antenna Requirements

3.2.1 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.

3.2.2 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
Loop Antenna	TESEQ	HLA 6120	31244	9 kHz~30 MHz	Mar. 18, 2022	Jan. 24, 2023~ Feb. 28, 2023	Mar. 17, 2023	Radiation (03CH15-HY)
Bilog Antenna	TESEQ	CBL 6111D & 00800N1D01N -06	0103 & 07	30MHz~1GHz	Apr. 24, 2022	Jan. 24, 2023~ Feb. 28, 2023	Apr. 23, 2023	Radiation (03CH15-HY)
Amplifier	SONOMA	310N	363440	9kHz~1GHz	Dec. 26, 2022	Jan. 24, 2023~ Feb. 28, 2023	Dec. 25, 2023	Radiation (03CH15-HY)
Horn Antenna	SCHWARZBE CK	BBHA 9120 D	9120D-02294	1GHz~18GHz	Jun. 23, 2022	Jan. 24, 2023~ Feb. 28, 2023	Jun. 22, 2023	Radiation (03CH15-HY)
SHF-EHF Horn Antenna	SCHWARZBE CK	BBHA 9170	BBHA917057 6	18GHz~40GHz	May 14, 2022	Jan. 24, 2023~ Feb. 28, 2023	May 13, 2023	Radiation (03CH15-HY)
Preamplifier	Jet-Power	JPA0118-55-30 3K	17100018000 54002	1GHz~18GHz	Sep. 28, 2022	Jan. 24, 2023~ Feb. 28, 2023	Sep. 27, 2023	Radiation (03CH15-HY)
Preamplifier	EM Electronics	EM01G18G	060802	1GHz-18GHz	Mar. 08, 2022	Jan. 24, 2023~ Feb. 28, 2023	Mar. 07, 2023	Radiation (03CH15-HY)
EMI Test Receiver	Keysight	N9038A(MXE)	MY54130085	20MHz~8.4GHz	Oct. 18, 2022	Jan. 24, 2023~ Feb. 28, 2023	Oct. 17, 2023	Radiation (03CH15-HY)
Spectrum Analyzer	Keysight	N9010	MY54200485	10Hz~44GHz	May 07, 2022	Jan. 24, 2023~ Feb. 28, 2023	May 06, 2023	Radiation (03CH15-HY)
Antenna Mast	ChainTek	MBS-520-1	N/A	1m~4m	N/A	Jan. 24, 2023~ Feb. 28, 2023	N/A	Radiation (03CH15-HY)
Turn Table	ChainTek	T-200-S-1	N/A	0~360 Degree	N/A	Jan. 24, 2023~ Feb. 28, 2023	N/A	Radiation (03CH15-HY)
Software	Audix	E3 6.2009-8-24 (k5)	RK-000451	N/A	N/A	Jan. 24, 2023~ Feb. 28, 2023	N/A	Radiation (03CH15-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104, 102E	MY582185/4, MY9838/4PE, 519228/2	30MHz~18G	Jun. 21, 2022	Jan. 24, 2023~ Feb. 28, 2023	Jun. 20, 2023	Radiation (03CH15-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	804011/2,804 012/2	30MHz-40GHz	Jan. 03, 2023	Jan. 24, 2023~ Feb. 28, 2023	Jan. 02, 2024	Radiation (03CH15-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY9837/4PE	9kHz~30MHz	Mar. 10, 2022	Jan. 24, 2023~ Feb. 28, 2023	Mar. 09, 2023	Radiation (03CH15-HY)

5 Uncertainty of Evaluation

Uncertainty of Radiated Emission Measurement (30 MHz ~ 1000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	6.3 dB
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Uncertainty of Radiated Emission Measurement (1000 MHz ~ 6000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	4.2 dB
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Uncertainty of Radiated Emission Measurement (6000 MHz ~ 18000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	5.4 dB
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Uncertainty of Radiated Emission Measurement (18000 MHz ~ 40000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	5.2 dB
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Appendix A. Radiated Spurious Emission

Test Engineer :	Eric Shou, Quentin Liu and Bigshow Wang	Temperature :	21~26°C
		Relative Humidity :	45~60%

2.4GHz 2400~2483.5MHz + Band 2 - 5250~5350MHz

WIFI 802.11axHE20 (Band edge @ 3m)

WIFI Ant	Note	Frequency	Level	Margin	Limit Line	Read Level	Antenna Factor	Path Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
0+1		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
11axHE20 CH 01 2412MHz		2390	64.49	-9.51	74	57.75	27.32	16.28	36.86	100	298	P	H
		2390	50.35	-3.65	54	43.61	27.32	16.28	36.86	100	298	A	H
	*	2412	110.21	-	-	103.28	27.47	16.32	36.86	100	298	P	H
	*	2412	102.11	-	-	95.18	27.47	16.32	36.86	100	298	A	H
													H
													H
													H
													H
													H
		2390	63.79	-10.21	74	57.05	27.32	16.28	36.86	346	23	P	V
		2390	51.26	-2.74	54	44.52	27.32	16.28	36.86	346	23	A	V
	*	2412	108.82	-	-	101.89	27.47	16.32	36.86	346	23	P	V
	*	2412	100.89	-	-	93.96	27.47	16.32	36.86	346	23	A	V
													V
													V
													V
													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 + Band 2 - 5250~5250MHz

WIFI 802.11axHE80 (Band edge @ 3m)

WIFI	Note	Frequency	Level	Margin	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
Ant.					Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
0+1		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
11axHE80 CH 58 5290MHz		5146.88	50.22	-23.78	74	44.06	33.2	9.69	36.73	321	318	P	H
		5120.02	39.18	-14.82	54	33.08	33.2	9.63	36.73	321	318	A	H
	*	5290	105.06	-	-	99.11	32.82	9.85	36.72	321	318	P	H
	*	5290	95.81	-	-	89.86	32.82	9.85	36.72	321	318	A	H
		5354.4	57.84	-16.16	74	51.77	32.91	9.88	36.72	321	318	P	H
		5353.96	46.97	-7.03	54	40.9	32.91	9.88	36.72	321	318	A	H
													H
													H
													H
													H
													H
													H
													H
		5145.52	51.66	-22.34	74	45.51	33.2	9.68	36.73	218	336	P	V
		5141.44	40.55	-13.45	54	34.4	33.2	9.68	36.73	218	336	A	V
	*	5290	109.39	-	-	103.44	32.82	9.85	36.72	218	336	P	V
	*	5290	100.69	-	-	94.74	32.82	9.85	36.72	218	336	A	V
		5356.38	64.65	-9.35	74	58.58	32.91	9.88	36.72	218	336	P	V
		5354.84	52.85	-1.15	54	46.78	32.91	9.88	36.72	218	336	A	V
													V
													V
													V
												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 + Band 2 - 5250~5350MHz

802.11ax HE20_Tx_Ch01 + 802.11ax HE80_Tx_Ch58 (Harmonic @ 3m)

WIFI	Note	Frequency	Level	Margin	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
Ant.					Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
Simultaneously		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11ax HE20 Ch01 + 802.11ax HE80 Ch58		4824	54.49	-19.51	74	49.38	32.44	9.41	36.74	257	236	P	H
		4824	44	-10	54	38.89	32.44	9.41	36.74	257	236	A	H
		7053.333	56.53	-11.67	68.2	61.39	36.11	11.32	52.29	221	118	P	H
		10580	49.87	-18.33	68.2	52.7	38.96	13	54.79	-	-	P	H
		15870	53.07	-20.93	74	54.89	37.59	15.69	55.1	-	-	P	H
		15870	43.15	-10.85	54	44.97	37.59	15.69	55.1	-	-	A	H
													H
													H
													H
													H
													H
													H
													H
		4824	53.88	-20.12	74	48.77	32.44	9.41	36.74	256	58	P	V
		4824	44.15	-9.85	54	39.04	32.44	9.41	36.74	256	58	A	V
		7053.333	53.63	-14.57	68.2	58.49	36.11	11.32	52.29	100	318	P	V
		10580	49.42	-18.78	68.2	52.25	38.96	13	54.79	-	-	P	V
		15870	52.45	-21.55	74	54.27	37.59	15.69	55.1	-	-	P	V
		15870	42.19	-11.81	54	44.01	37.59	15.69	55.1	-	-	A	V
													V
													V
													V
													V
													V
												V	
Remark	1. No other spurious found.												
	2. All results are PASS against Peak and Average limit line.												
	3. The emission position marked as "-" means no suspected emission found with sufficient margin against limit line or noise floor only.												

Emission below 1GHz

802.11ax HE20_Tx_Ch01 + 802.11ax HE80_Tx_Ch58 (LF @ 3m)

[illegible]

Bluetooth + 2.4GHz 2400~2483.5MHz + Band 2 - 5250~5350MHz

Bluetooth (Band edge @ 3m)

BT	Note	Frequency	Level	Margin	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
Ant					Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
0		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
BT_Tx Ch78 2480MHz	*	2480	107.07	-	-	99.68	27.82	16.42	36.85	100	320	P	H
	*	2480	82.29	-	-	-	-	-	-	-	-	A	H
		2487.68	52.12	-21.88	74	44.68	27.85	16.44	36.85	100	320	P	H
		2487.68	27.34	-26.66	54	-	-	-	-	-	-	A	H
													H
													H
													H
													H
													H
													H
													H
	*	2480	106.74	-	-	99.35	27.82	16.42	36.85	359	223	P	V
	*	2480	81.96	-	-	-	-	-	-	-	-	A	V
		2491.76	52.15	-21.85	74	44.69	27.87	16.44	36.85	359	223	P	V
		2491.76	27.37	-26.63	54	-	-	-	-	-	-	A	V
													V
													V
													V
													V
													V
												V	
												V	
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

Bluetooth + 2.4GHz 2400~2483.5MHz + Band 2 - 5250~5350MHz

WIFI 802.11axHE20 (Band edge @ 3m)

[illegible]

Bluetooth + 2.4GHz 2400~2483.5MHz + Band 2 - 5250~5350MHz

WIFI 802.11axHE80 (Band edge @ 3m)

[illegible]



Bluetooth + 2.4GHz 2400~2483.5MHz + Band 2 - 5250~5350MHz

Bluetooth _Tx_Ch78 + 802.11ax HE20 _Tx_Ch01 + 802.11ax HE80 _Tx_Ch58 (Harmonic @ 3m)

WIFI	Note	Frequency	Level	Margin	Limit	Read	Antenna	Path	Preampl	Ant	Table	Peak	Pol.
Ant.					Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
Simultaneously		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
Bluetooth_Tx Ch78 + 802.11ax HE20 Ch01 + 802.11ax HE80 Ch58		4824	46.78	-27.22	74	41.67	32.44	8.95	36.74	-	-	P	H
		4960	47.33	-26.67	74	41.75	32.94	8.84	36.73	-	-	P	H
		4960	22.55	-31.45	54	-	-	-	-	-	-	A	H
		7053.333	57.27	-10.93	68.2	62.13	36.11	10.48	52.29	230	125	P	H
		7440	49.97	-24.03	74	54.44	36.34	10.86	52.21	-	-	P	H
		7440	25.19	-28.81	54	-	-	-	-	-	-	A	H
		10580	51.16	-17.04	68.2	53.99	38.96	12.49	54.79	-	-	P	H
		15870	51.87	-22.13	74	53.69	37.59	15.11	55.1	-	-	P	H
		15870	41.93	-12.07	54	43.75	37.59	15.11	55.1	-	-	A	H
													H
													H
													H
		4824	51.55	-22.45	74	46.44	32.44	8.95	36.74	400	335	P	V
		4824	40.26	-13.74	54	35.15	32.44	8.95	36.74	400	335	A	V
		4960	48.27	-25.73	74	42.69	32.94	8.84	36.73	-	-	P	V
		4960	23.49	-30.51	54	-	-	-	-	-	-	A	V
		7053.333	54.1	-14.1	68.2	58.96	36.11	10.48	52.29	100	300	P	V
		7440	49.58	-24.42	74	54.05	36.34	10.86	52.21	-	-	P	V
		7440	24.80	-29.20	54	-	-	-	-	-	-	A	V
		10580	50.63	-17.57	68.2	53.46	38.96	12.49	54.79	-	-	P	V
		15870	51.95	-22.05	74	53.77	37.59	15.11	55.1	-	-	P	V
		15870	41.93	-12.07	54	43.75	37.59	15.11	55.1	-	-	A	V
													V
													V
Remark	1. No other spurious found.												
	2. All results are PASS against Peak and Average limit line.												
Remark	3. The emission position marked as "-" means no suspected emission found with sufficient margin against limit line or noise floor only.												



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	Peak or Average
H/V	Horizontal or Vertical

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

WIFI	Note	Frequency	Level	Margin	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
Ant.					Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
0+1		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11b		2390	55.45	-18.55	74	54.51	32.22	4.58	35.86	103	308	P	H
CH 01													
2412MHz		2390	43.54	-10.46	54	42.6	32.22	4.58	35.86	103	308	A	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. Over Limit(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. Over Limit(dB)
 = Level(dBμV/m) – Limit Line(dBμV/m)
 = 55.45(dBμV/m) – 74(dBμV/m)
 = -18.55(dB)

For Average 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) + 42.6(dBμV) – 35.86 (dB)
 = 43.54 (dBμV/m)
2. Over Limit(dB) = Level(dBμV/m) – Limit Line(dBμV/m)
 = 43.54(dBμV/m) – 54(dBμV/m)
 = -10.46(dB)

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



Appendix B. Radiated Spurious Emission Plots

Test Engineer :	Eric Shou, Quentin Liu and Bigshow Wang	Temperature :	21~26°C
		Relative Humidity :	45~60%

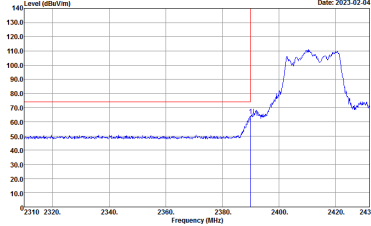
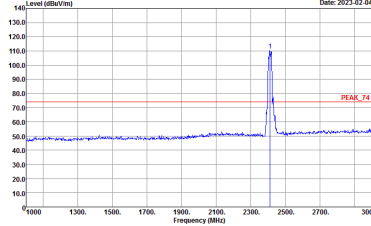
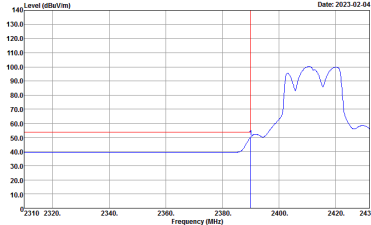
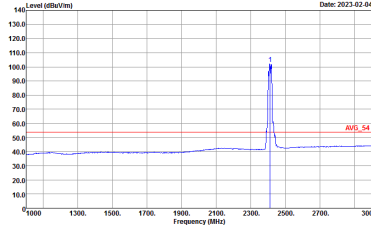
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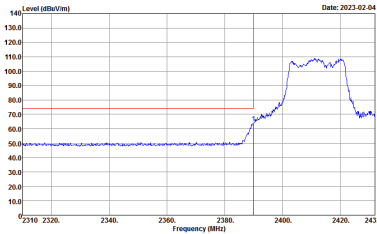
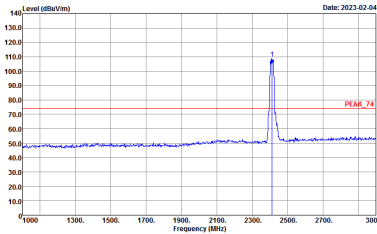
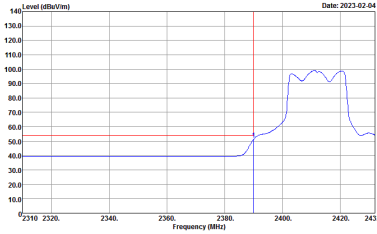
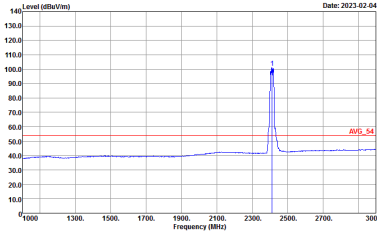
-L	Low channel location
-R	High channel location



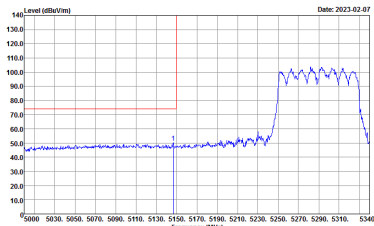
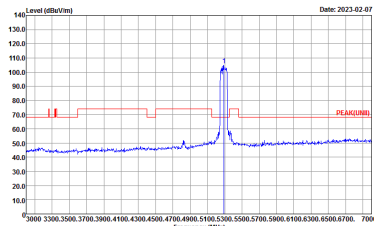
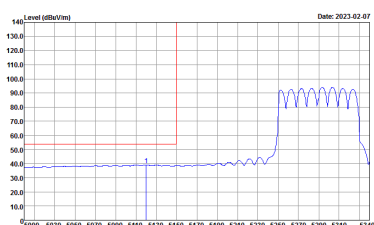
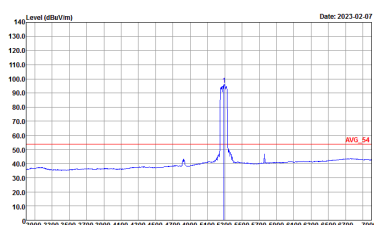
2.4GHz 2400~2483.5MHz + Band 2 - 5250~5350MHz

WIFI 802.11ax HE20 (Band Edge @ 3m)

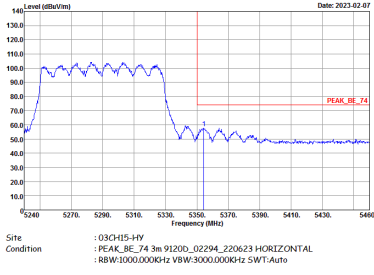
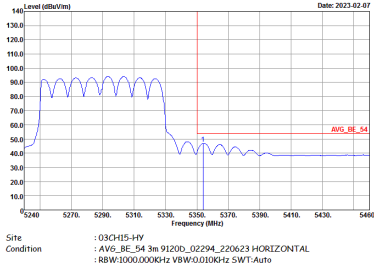
WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
Ant	11ax HE20_Tx_Ch01 2402MHz	
0+1	Horizontal	Fundamental
Peak	 Site : 03CH15-HY Condition : PEAK_BE_74 3m 91200_02294_220623 HORIZONTAL RBW:1000.000KHz VBW:3000.000KHz SWT:Auto	 Site : 03CH15-HY Condition : PEAK_F4 3m 91200_02294_220623 HORIZONTAL RBW:1000.000KHz VBW:3000.000KHz SWT:Auto
Avg.	 Site : 03CH15-HY Condition : AVG_BE_54 3m 91200_02294_220623 HORIZONTAL RBW:1000.000KHz VBW:0.010KHz SWT:Auto	 Site : 03CH15-HY Condition : AVG_F4 3m 91200_02294_220623 HORIZONTAL RBW:1000.000KHz VBW:0.010KHz SWT:Auto

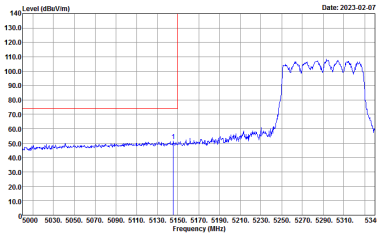
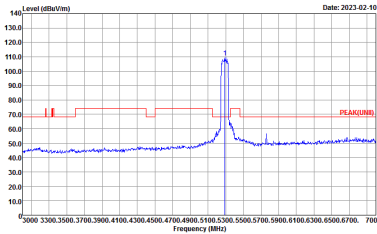
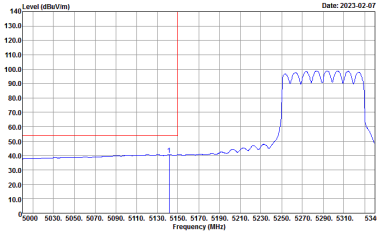
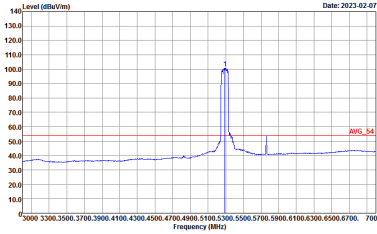
WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
Ant	11ax HE20_Tx_Ch01 2402MHz	
0+1	Vertical	Fundamental
Peak	 Site : 03CH15-HY Condition : PEAK_BE_74 3m 91200_02294_220623 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto	 Site : 03CH15-HY Condition : PEAK_F4 3m 91200_02294_220623 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto
	 Site : 03CH15-HY Condition : AVG_BE_54 3m 91200_02294_220623 VERTICAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto	 Site : 03CH15-HY Condition : AVG_F4 3m 91200_02294_220623 VERTICAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto
Avg.		

2.4GHz 2400~2483.5MHz +Band 2 - 5250~5350MHz
WIFI 802.11ax HE80 (Band Edge @ 3m)

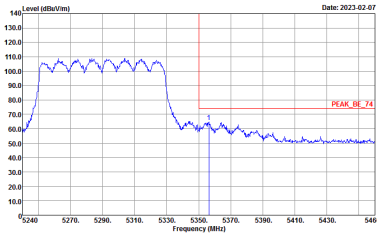
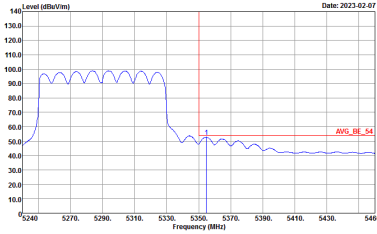
WIFI	Band 2 5250~5350MHz Band Edge @ 3m	
ANT	11ax HE80_Tx_Ch58 5290MHz- L	
0+1	Horizontal	Fundamental
Peak	 Site : 03CH15-HY Condition : PEAK_BE_74 3m 91200_02294_220623 HORIZONTAL RBW:1000.000KHz VBW:3000.000KHz SWT:Auto	 Site : 03CH15-HY Condition : PEAK(UNIT) 3m 91200_02294_220623 HORIZONTAL RBW:1000.000KHz VBW:3000.000KHz SWT:Auto
	 Site : 03CH15-HY Condition : AVG_BE_54 3m 91200_02294_220623 HORIZONTAL RBW:1000.000KHz VBW:0.010KHz SWT:Auto	 Site : 03CH15-HY Condition : AVG_54 3m 91200_02294_220623 HORIZONTAL RBW:1000.000KHz VBW:0.010KHz SWT:Auto
Avg.		



WIFI	Band 2 5250~5350MHz Band Edge @ 3m	
ANT	11ax HE80_Tx_Ch58 5290MHz- R	
0+1	Horizontal	Fundamental
Peak	 Site : 03CH15-HY Condition : PEAK_BE_74 3m 91200_02294_220623 HORIZONTAL : RBW:3000.000KHz VBW:3000.000KHz SWT:Auto	-
Avg.	 Site : 03CH15-HY Condition : AVG_BE_54 3m 91200_02294_220623 HORIZONTAL : RBW:3000.000KHz VBW:3000.000KHz SWT:Auto	-

WIFI	Band 2 5250~5350MHz Band Edge @ 3m	
ANT	11ax HE80_Tx_Ch58 5290MHz- L	
0+1	Vertical	Fundamental
Peak	 Site : 03CH15-HY Condition : PEAK_BE_74 3m 9120D_02294_220623 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto	 Site : 03CH15-HY Condition : PEAK(FUND) 3m 9120D_02294_220623 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto
	 Site : 03CH15-HY Condition : AVG_BE_54 3m 9120D_02294_220623 VERTICAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto	 Site : 03CH15-HY Condition : AVG_54 3m 9120D_02294_220623 VERTICAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto
Avg.		

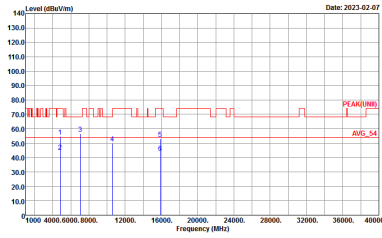
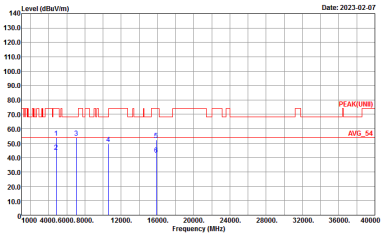


WIFI	Band 2 5250~5350MHz Band Edge @ 3m	
ANT	11ax HE80_Tx_Ch58 5290MHz- R	
0+1	Vertical	Fundamental
Peak	 Site : 03CH15-HY Condition : PEAK_BE_74 3m 91200_02294_220623 VERTICAL : RBW:1000.000kHz VBW:3000.000kHz SWT:Auto	-
Avg.	 Site : 03CH15-HY Condition : AVG_BE_54 3m 91200_02294_220623 VERTICAL : RBW:1000.000kHz VBW:3000.000kHz SWT:Auto	-

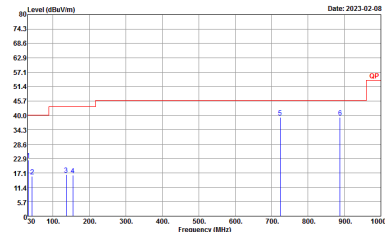
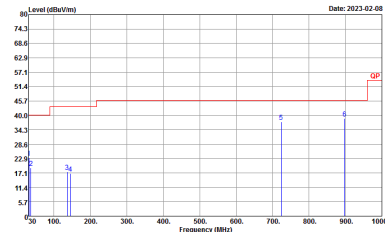


2.4GHz 2400~2483.5MHz + Band 2 - 5250~5350MHz

802.11ax HE20_Tx_Ch01 + 802.11ax HE80_Tx_Ch58 (Harmonic @ 3m)

WIFI	2.4GHz 2400~2483.5MHz +Band 2 5250~5350MHz Harmonic @ 3m	
Ant.	11ax HE20_Tx_Ch01+11ax HE80_Tx_Ch58	
Simultaneously	Horizontal	Vertical
Peak Avg.	 Site : 03CH15-HV Condition : PEAK(UNIT) 3m 91200_02294_220623 HORIZONTAL	 Site : 03CH15-HV Condition : PEAK(UNIT) 3m 91200_02294_220623 VERTICAL

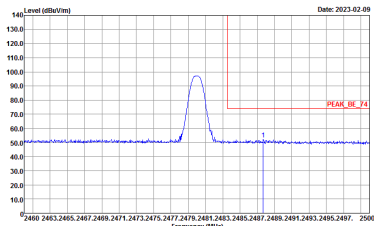
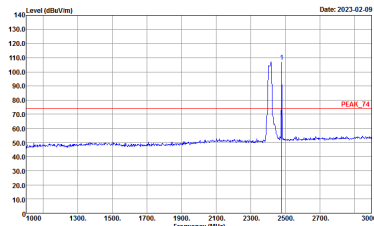
Emission below 1GHz
2.4GHz 2400~2483.5MHz +Band 2 - 5250~5350MHz (LF)

WIFI	2.4GHz 2400~2483.5MHz +Band 2 5250~5350MHz LF @ 3m	
Ant.	11ax HE20_Tx_Ch01+11ax HE80_Tx_Ch58	
Simultaneously	Horizontal	Vertical
QP / Peak	 Site : 03CH15-HV Condition : QP 3m 1381LOG HORIZONTAL Date: 2023-02-08	 Site : 03CH15-HV Condition : QP 3m 1381LOG VERTICAL Date: 2023-02-08

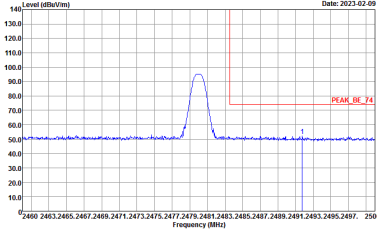
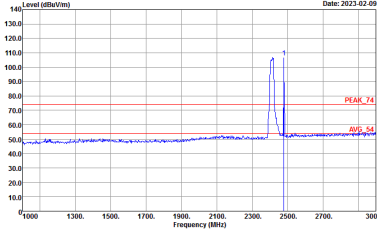


Bluetooth + 2.4GHz 2400~2483.5MHz + Band 2 - 5250~5350MHz

Bluetooth (Band Edge @ 3m)

BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BT_Tx_Ch78 2480MHz	
0	Horizontal	Fundamental
Peak	 Site : 03CH15-HY Condition : PEAK_BE_74 3m 91200_02294_220623 HORIZONTAL :	 Site : 03CH15-HY Condition : PEAK_74 3m 91200_02294_220623 HORIZONTAL :

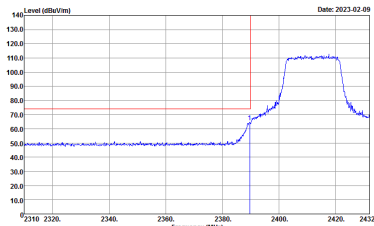
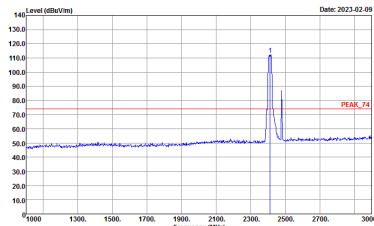
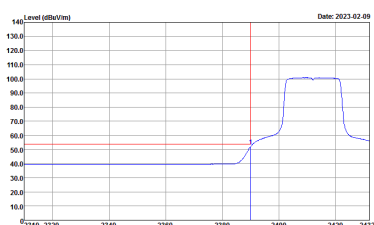
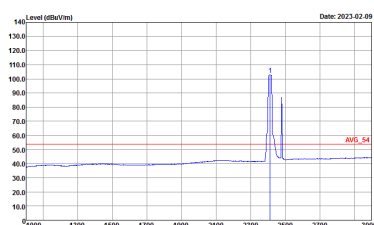


BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BT_Tx_Ch78 2480MHz	
0	Vertical	Fundamental
Peak	 Site : 03CH15-HY Condition : PEAK_BC_74 3m 91200_02294_220623 VERTICAL :-	 Site : 03CH15-HY Condition : PEAK_74 3m 91200_02294_220623 VERTICAL :-

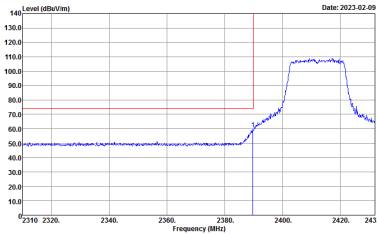
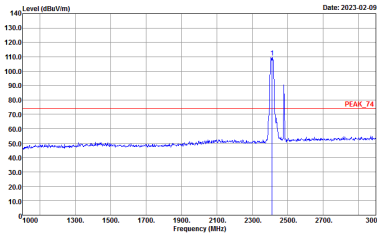
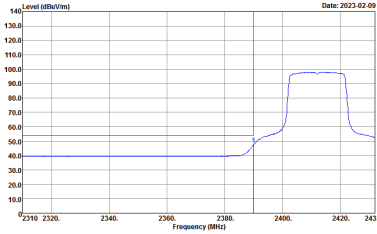
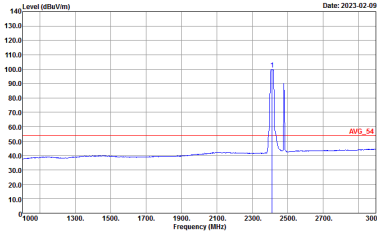


2.4GHz 2400~2483.5MHz + Band 2 - 5250~5350MHz

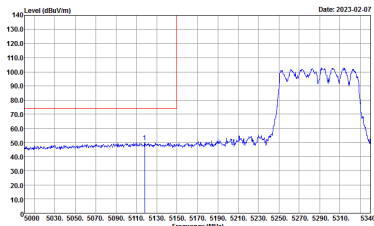
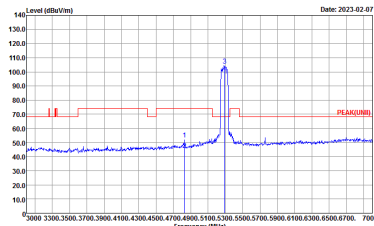
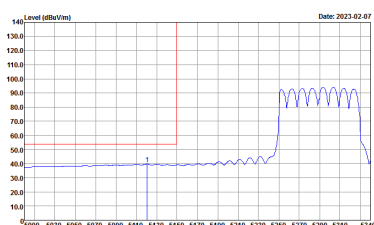
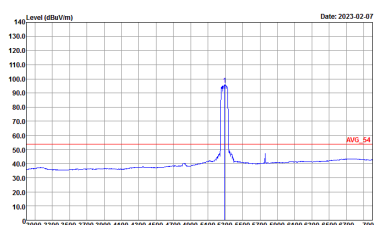
WIFI 802.11ax HE20 (Band Edge @ 3m)

WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	11ax HE20_Tx_Ch01 2402MHz	
1	Horizontal	Fundamental
Peak	 Site : 03CH15-HY Condition : PEAK_BE_74 3m 91200_02294_220623 HORIZONTAL :	 Site : 03CH15-HY Condition : PEAK_F4 3m 91200_02294_220623 HORIZONTAL :
Avg.	 Site : 03CH15-HY Condition : AV6_BE_54 3m 91200_02294_220623 HORIZONTAL :	 Site : 03CH15-HY Condition : AV6_F4 3m 91200_02294_220623 HORIZONTAL :



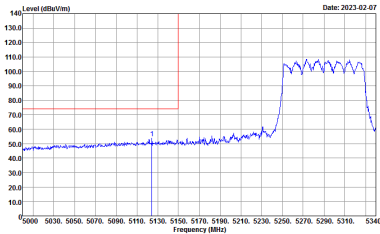
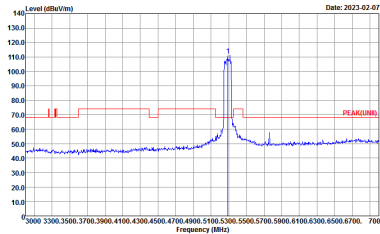
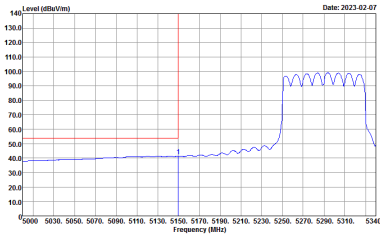
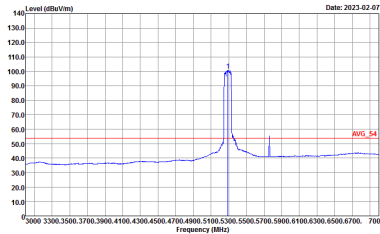
WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	11ax HE20_Tx_Ch01 2402MHz	
1	Vertical	Fundamental
Peak	 Site : 03CH15-HY Condition : PEAK_BC_74 3m 91200_02294_220623 VERTICAL : .	 Site : 03CH15-HY Condition : PEAK_74 3m 91200_02294_220623 VERTICAL : .
	 Site : 03CH15-HY Condition : AVG_BC_54 3m 91200_02294_220623 VERTICAL : .	 Site : 03CH15-HY Condition : AVG_54 3m 91200_02294_220623 VERTICAL : .

Bluetooth + 2.4GHz 2400~2483.5MHz + Band 2 - 5250~5350MHz
WIFI 802.11ax HE80 (Band Edge @ 3m)

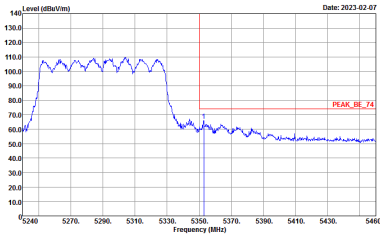
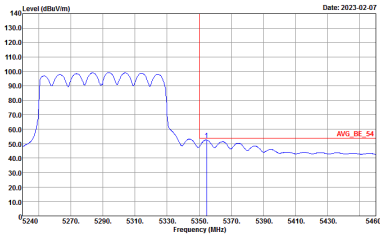
WIFI	Band 2 5250~5350MHz Band Edge @ 3m	
ANT	11ax HE80_Tx_Ch58 5290MHz- L	
0+1	Horizontal	Fundamental
Peak	 Site : 03CH15-HY Condition : PEAK_BE_74 3m 91200_02294_220623 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto	 Site : 03CH15-HY Condition : PEAK(FUND) 3m 91200_02294_220623 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto
	 Site : 03CH15-HY Condition : AVG_BE_54 3m 91200_02294_220623 HORIZONTAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto	 Site : 03CH15-HY Condition : AVG_54 3m 91200_02294_220623 HORIZONTAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto
Avg.		



WIFI	Band 2 5250~5350MHz Band Edge @ 3m	
ANT	11ax HE80_Tx_Ch58 5290MHz- R	
0+1	Horizontal	Fundamental
Peak		-
Avg.		-

WIFI	Band 2 5250~5350MHz Band Edge @ 3m	
ANT	11ax HE80_Tx_Ch58 5290MHz- L	
0+1	Vertical	Fundamental
Peak	 Site : 03CH15-HY Condition : PEAK_BE_74 3m 91200_02294_220623 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto	 Site : 03CH15-HY Condition : PEAK(FUND) 3m 91200_02294_220623 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto
Avg.	 Site : 03CH15-HY Condition : AVG_BE_54 3m 91200_02294_220623 VERTICAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto	 Site : 03CH15-HY Condition : AVG_54 3m 91200_02294_220623 VERTICAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto

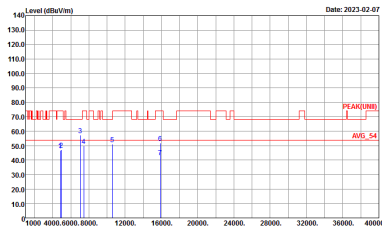
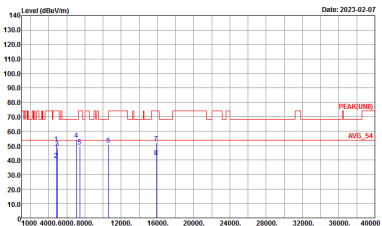


WIFI	Band 2 5250~5350MHz Band Edge @ 3m	
ANT	11ax HE80_Tx_Ch58 5290MHz- R	
0+1	Vertical	Fundamental
Peak	 Site : 03CH15-HY Condition : PEAK_BE_74 3m 91200_02294_220623 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto	-
Avg.	 Site : 03CH15-HY Condition : AVG_BE_54 3m 91200_02294_220623 VERTICAL : RBW:1000.000KHz VBW:0.010KHz SWT:Auto	-

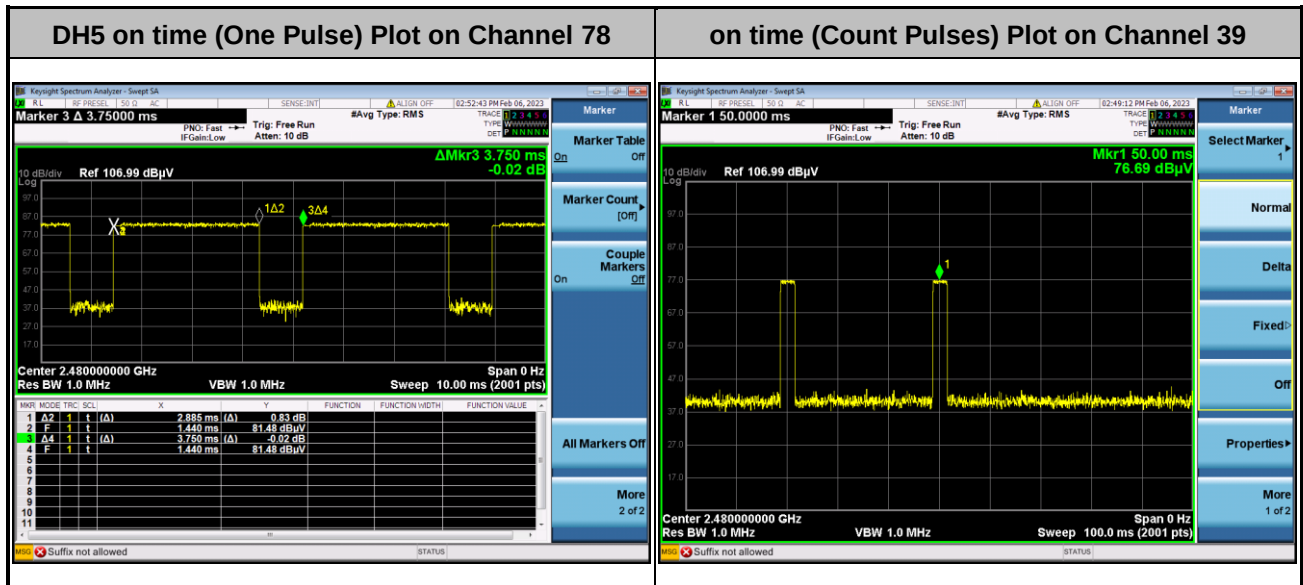


Bluetooth + 2.4GHz 2400~2483.5MHz + Band 2 - 5250~5350MHz

Bluetooth CH78 Tx+ 802.11ax HE20_Tx_Ch01+ 802.11ax HE80_Tx_Ch58 (Harmonic @ 3m)

WIFI	BT+2.4GHz 2400~2483.5MHz +Band 1 5150~5250MHz Harmonic @ 3m	
Ant.	11ax HE20_Tx_Ch01+11ax HE80_Tx_Ch58	
Simultaneously	Horizontal	Vertical
Peak Avg.	 Site : 03CH15-HY Condition : PEAR[UNIT] 3m 91200_02294_220623 HORIZONTAL	 Site : 03CH15-HY Condition : PEAR[UNIT] 3m 91200_02294_220623 VERTICAL

Appendix C. Duty Cycle Plots



Note:

1. Worst case Duty cycle = on time/100 milliseconds = $2 * 2.885 / 100 = 5.77 \%$
2. Worst case Duty cycle correction factor = $20 * \log(\text{Duty cycle}) = -24.78 \text{ dB}$
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

$$2.885 \text{ ms} \times 20 \text{ channels} = 57.7 \text{ ms}$$

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. $[100 \text{ ms} / 57.7 \text{ ms}] = 2 \text{ hops}$

Thus, the maximum possible ON time:

$$2.885 \text{ ms} \times 2 = 5.77 \text{ ms}$$

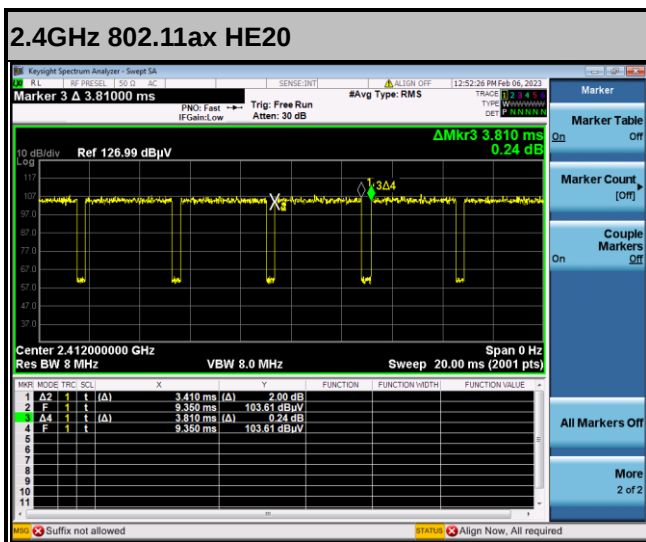
Worst case Duty Cycle Correction factor, which is derived from the maximum possible ON time,

$$20 \times \log(5.77 \text{ ms}/100 \text{ ms}) = -24.78 \text{ dB}$$



Antenna	Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting
1	2.4GHz 802.11ax HE20	89.50	3410	0.29	300Hz
0+1	2.4GHz 802.11ax HE20	97.71	5120	0.20	300Hz
0+1	5GHz 802.11ax HE80	98.94	-	-	10Hz
0+1	5GHz 802.11ax HE80	99.27	-	-	10Hz

<Ant. 1>





MIMO < Ant. 0+1>

