



FCC CO-LOCATION RADIO TEST REPORT

FCC ID : 2AG7G-G1A
Equipment : Plume Adaptive WiFi with LTE
Brand Name : Plume Design Inc
Model Name : G1A with LTE
Applicant : Plume Design Inc
325 Lytton Ave., Palo Alto, CA 94301
Manufacturer : Plume Design Inc
325 Lytton Ave., Palo Alto, CA 94301
Standard : FCC Part 15 Subpart E §15.407

The product was received on Mar. 23, 2021 and testing was started from Aug. 11, 2021 and completed on Aug. 12, 2021. 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 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.

Approved by: Louis Wu

Sporton International Inc. EMC & Wireless Communications Laboratory
No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City 333, Taiwan (R.O.C.)



Table of Contents

History of this test report..... 3

Summary of Test Result..... 4

1 General Description 5

 1.1 Product Feature of Equipment Under Test..... 5

 1.2 Modification of EUT 5

 1.3 Testing Location 6

 1.4 Applicable Standards..... 6

2 Test Configuration of Equipment Under Test 7

 2.1 Carrier Frequency and Channel 7

 2.2 Test Mode..... 7

 2.3 Connection Diagram of Test System..... 8

 2.4 Support Unit used in test configuration and system 8

 2.5 EUT Operation Test Setup 8

3 Test Result 9

 3.1 Unwanted Emissions Measurement..... 9

 3.2 Antenna Requirements..... 13

4 List of Measuring Equipment..... 14

5 Uncertainty of Evaluation 15

Appendix A. Radiated Spurious Emission

Appendix B. Radiated Spurious Emission Plots

Appendix C. Duty Cycle Plots

Appendix D. Setup Photographs



History of this test report

Report No.	Version	Description	Issued Date
FR111911-05E	01	Initial issue of report	Aug. 16, 2021



Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
3.1	15.407(b)	Unwanted Emissions	Pass	Under limit 1.09 dB at 2375.450 MHz
3.2	15.203 15.407(a)	Antenna Requirement	Pass	-

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

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

Reviewed by: Keven Cheng

Report Producer: Ruby Zou



1 General Description

1.1 Product Feature of Equipment Under Test

WCDMA/LTE, Bluetooth - LE, Wi-Fi 2.4GHz 802.11b/g/n/ac/ax, and Wi-Fi 5GHz 802.11a/n/ac/ax.

Product Specification subjective to this standard	
Antenna Type	WWAN: PIFA Antenna WLAN <2400 MHz ~ 2483.5 MHz> <Ant. 1>: IFA Antenna <Ant. 2>: IFA Antenna <5180 MHz ~ 5320 MHz> <Ant. 1>: IFA Antenna <Ant. 2>: IFA Antenna <Ant. 3>: IFA Antenna <Ant. 4>: IFA Antenna <5500 MHz ~ 5825 MHz> <Ant. 1>: IFA Antenna <Ant. 2>: IFA Antenna Bluetooth - LE: IFA Antenna

Antenna information		
2400 MHz ~ 2483.5 MHz	Peak Gain (dBi)	Bluetooth-LE: 2.4 WLAN: Ant. 1: 3.5 Ant. 2: 2.7
5150 MHz ~ 5250 MHz	Peak Gain (dBi)	Ant. 1: 4.0 Ant. 2: 2.5 Ant. 3: 3.8 Ant. 4: 3.0

WWAN Antenna information		
LTE Band 41	Peak Gain (dBi)	2.4

Remark: The above EUT's information was declared by manufacturer. Please refer to Comments and Explanations in report summary.

1.2 Modification of EUT

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



1.3 Testing Location

Test Site	Sporton International Inc. EMC & Wireless Communications Laboratory
Test Site Location	No.52, Huaya 1st Rd., Guishan Dist., Taoyuan City 333, Taiwan (R.O.C.) TEL: +886-3-327-3456 FAX: +886-3-328-4978
Test Site No.	Sporton Site No. 03CH07-HY

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

FCC designation No.: TW1190

1.4 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 DTS 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.
- ♦ FCC KDB 971168 D01 Power Meas. License Digital Systems v03r01
- ♦ 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.

2 Test Configuration of Equipment Under Test

- 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). 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 find X Plane as worst plane.

2.1 Carrier Frequency and Channel

2400-2483.5 MHz Bluetooth – LE	
Channel	Freq. (MHz)
39	2480

2400-2483.5 MHz 802.11ax HE20		5150-5250 MHz 802.11a	
Channel	Freq. (MHz)	Channel	Freq. (MHz)
01	2412	36	5180

Remark: During the Radiated Spurious Emission test, the EUT turn on the WWAN functions simultaneously.

2.2 Test Mode

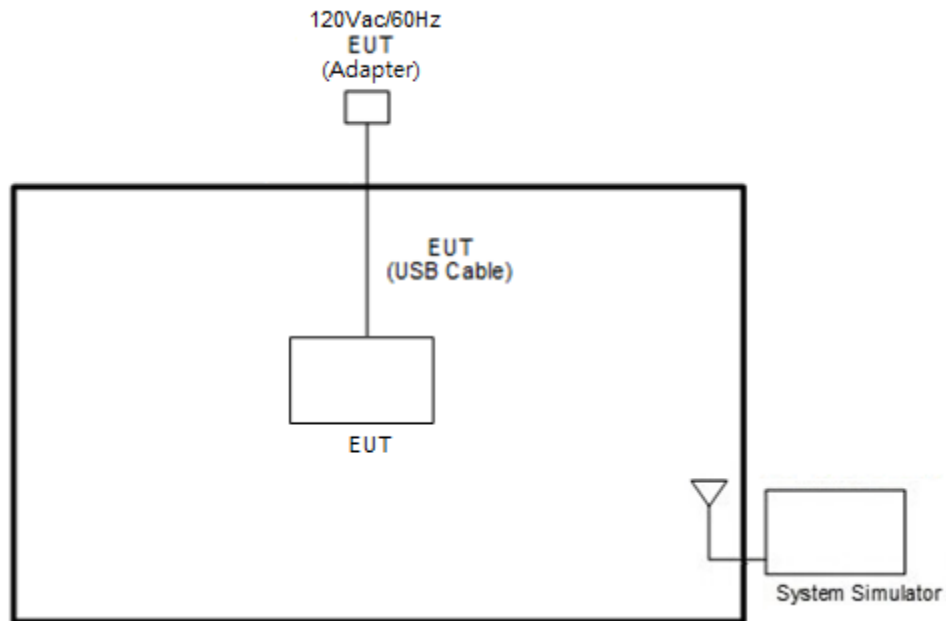
Final test modes are considering the modulation and worse data rates as below table.

<Co-Location>

Modulation	Data Rate
Bluetooth-LE + WLAN 2.4GHz 802.11ax HE20 for MIMO <Ant. 1+2> + WLAN 5GHz 802.11a for MIMO <Ant. 1+2+3+4> + LTE Band 41	1Mbps + MCS0 + 6Mbps + QPSK

2.3 Connection Diagram of Test System

<Co-Location 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.	System Simulator	Anritsu	MT8820C	N/A	N/A	Unshielded,1.8m

2.5 EUT Operation Test Setup

The RF test items, utility “accessMTool V3.1.0.2” 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.

<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) For transmitters operating within the 5.925-7.125 GHz band: Any emissions outside of the 5.925-7.125 GHz band must not exceed an e.i.r.p. of -27 dBm/MHz.

EIRP (dBm)	Field Strength at 3m (dBμV/m)
- 27 (RMS)	68.3
- 7 (Peak)	88.3

According 987594 D02 U-NII 6GHz EMC Measurement v01 section G:
 Unwanted emissions outside of restricted bands are measured with a RMS detector.
 In addition, 15.35(b) applies where the peak emissions must be limited to no more than 20 dB above the average limit



3.1.1 Measuring Instruments

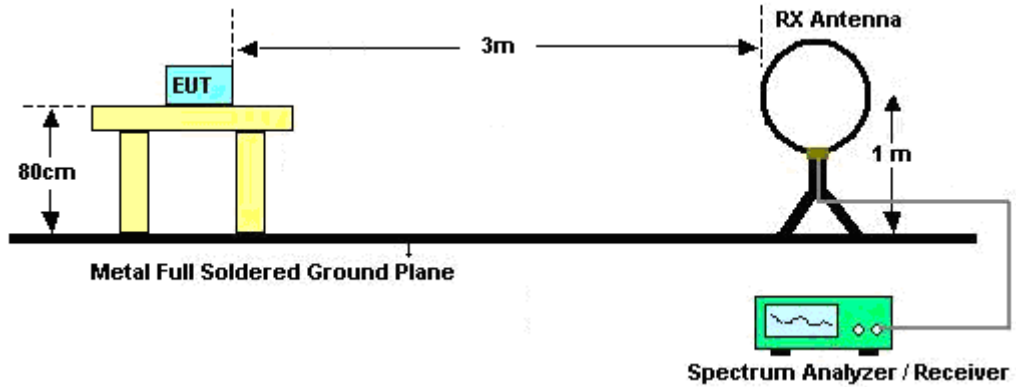
See list of measuring equipment of this test report.

3.1.2 Test Procedures

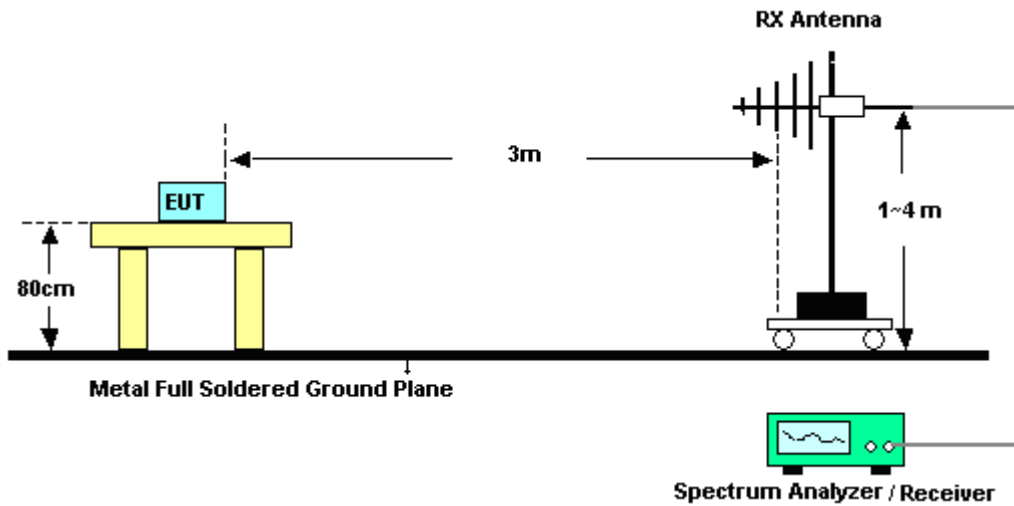
1. The testing follows FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01. Section G) Unwanted emissions measurement.
 - (1) Procedure for Unwanted Emissions Measurements Below 1000MHz
 - RBW = 120 kHz
 - VBW = 300 kHz
 - Detector = Peak
 - Trace mode = max hold
 - (2) Procedure for Peak 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 was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
3. The EUT was set 3 meters from the interference receiving antenna which was 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 was 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. For testing below 1GHz, if the emission level of the EUT in peak mode was 3 dB lower than the limit specified, then peak values of EUT will be reported, otherwise, the emissions will be repeated one by one using the CISPR quasi-peak method and reported.
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.

3.1.3 Test Setup

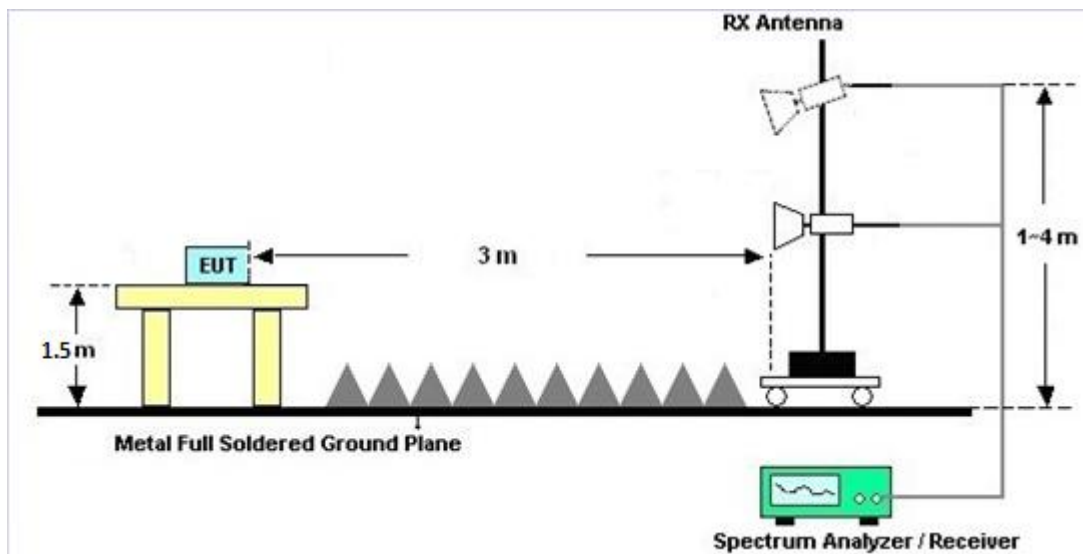
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated test above 1GHz





3.1.4 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.

3.1.5 Test Result of Radiated Spurious at Band Edges

Please refer to Appendix A and B.

3.1.6 Duty Cycle

Please refer to Appendix C.

3.1.7 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

If directional gain of transmitting antennas is greater than 6dBi, the power and the peak power spectral density 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.

3.2.2 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
Bilog Antenna	TESEQ	CBL 6111D & 00800N1D01 N-06	35419 & 03	30MHz~1GHz	Apr. 28, 2021	Aug. 11, 2021~ Aug. 12, 2021	Apr. 27, 2022	Radiation (03CH07-HY)
Double Ridge Horn Antenna	ESCO	3117	00075962	1GHz ~ 18GHz	Dec. 01, 2020	Aug. 11, 2021~ Aug. 12, 2021	Nov. 30, 2021	Radiation (03CH07-HY)
Hygrometer	Testo	DTM-303A	TP157075	N/A	Mar. 01, 2021	Aug. 11, 2021~ Aug. 12, 2021	Feb. 28, 2022	Radiation (03CH07-HY)
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100315	9 kHz~30 MHz	Jan. 04, 2021	Aug. 11, 2021~ Aug. 12, 2021	Jan. 03, 2022	Radiation (03CH07-HY)
Preamplifier	MITEQ	AMF-7D-001 01800-30-10 P	1590075	1GHz~18GHz	Apr. 22, 2021	Aug. 11, 2021~ Aug. 12, 2021	Apr. 21, 2022	Radiation (03CH07-HY)
Preamplifier	COM-POWER	PA-103A	161241	10MHz~1GHz	May 18, 2021	Aug. 11, 2021~ Aug. 12, 2021	May 17, 2022	Radiation (03CH07-HY)
Preamplifier	Agilent	8449B	3008A02362	1GHz~26.5GHz	Oct. 31, 2020	Aug. 11, 2021~ Aug. 12, 2021	Oct. 30, 2021	Radiation (03CH07-HY)
Preamplifier	EMEC	EM18G40G	0600789	18-40GHz	Jul. 23, 2021	Aug. 11, 2021~ Aug. 12, 2021	Jul. 22, 2022	Radiation (03CH07-HY)
Spectrum Analyzer	Agilent	N9030A	MY52350276	3Hz~44GHz	Jul. 22, 2021	Aug. 11, 2021~ Aug. 12, 2021	Jul. 21, 2022	Radiation (03CH07-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY15682-4	30MHz to 18GHz	Feb. 24, 2021	Aug. 11, 2021~ Aug. 12, 2021	Feb. 23, 2022	Radiation (03CH07-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY24971-4	9kHz to 18GHz	Feb. 24, 2021	Aug. 11, 2021~ Aug. 12, 2021	Feb. 23, 2022	Radiation (03CH07-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY28655-4	9kHz to 18GHz	Feb. 24, 2021	Aug. 11, 2021~ Aug. 12, 2021	Feb. 23, 2022	Radiation (03CH07-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	MY2858/2,80 1606/2	18GHz~40GHz	Feb. 24, 2021	Aug. 11, 2021~ Aug. 12, 2021	Feb. 23, 2022	Radiation (03CH07-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 126	532078/126E	30MHz~18GHz	Sep. 18, 2020	Aug. 11, 2021~ Aug. 12, 2021	Sep. 17, 2021	Radiation (03CH07-HY)
Controller	EMEC	EM1000	N/A	Control Ant Mast	Apr. 28, 2021	Aug. 11, 2021~ Aug. 12, 2021	Apr. 27, 2022	Radiation (03CH07-HY)
Controller	MF	MF-7802	N/A	Control Turn table	N/A	Aug. 11, 2021~ Aug. 12, 2021	N/A	Radiation (03CH07-HY)
Antenna Mast	EMEC	AM-BS-4500 E	N/A	Boresight mast 1M~4M	Apr. 28, 2021	Aug. 11, 2021~ Aug. 12, 2021	Apr. 27, 2022	Radiation (03CH07-HY)
Turn Table	ChainTek	Chaintek 3000	N/A	0~360 Degree	N/A	Aug. 11, 2021~ Aug. 12, 2021	N/A	Radiation (03CH07-HY)
Attenuator	HONOVA	5910 SMA-50-005-19-NE	ATT-36	N/A	Oct. 31, 2020	Aug. 11, 2021~ Aug. 12, 2021	Oct. 30, 2021	Radiation (03CH07-HY)
Software	Audix	E3 6.2009-8-24	N/A	N/A	N/A	Aug. 11, 2021~ Aug. 12, 2021	N/A	Radiation (03CH07-HY)
USB Data Logger	TECPEL	TR-32	HE17XB249 5	N/A	Mar. 09, 2021	Aug. 11, 2021~ Aug. 12, 2021	Mar. 08, 2022	Radiation (03CH07-HY)
SHF-EHF Horn Antenna	SCHWARZBECK	BBHA 9170	BBHA91702 51	18GHz~40GHz	Dec. 02, 2020	Aug. 11, 2021~ Aug. 12, 2021	Dec. 01, 2021	Radiation (03CH07-HY)



5 Uncertainty of Evaluation

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

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	4.9 dB
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Uncertainty of Radiated Emission Measurement (1000 MHz ~ 18000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	6.1 dB
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Uncertainty of Radiated Emission Measurement (18000 MHz ~ 40000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	4.7 dB
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Appendix A. Radiated Spurious Emission

Test Engineer :	Jesse Wang, Stan Hsieh	Temperature :	22.5~25.8°C
		Relative Humidity :	54.3~59.6%



WLAN 2.4GHz 802.11ax HE20 CH01 Tx + WLAN 5GHz 802.11a CH36 Tx +

BLE(1M) CH39 Tx + WWAN LTE B41 CH40620 Link

2.4GHz 2400~2483.5MHz

BLE (Band Edge @ 3m)

BLE 1	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)
BLE CH 39 2480MHz		2376.13	60.7	-13.3	74	46.18	31.87	18.06	35.41	100	175	P	H
		2375.45	52.91	-1.09	54	38.4	31.87	18.05	35.41	100	175	A	H
	*	2480	108.22	-	-	92.97	32.47	18.23	35.45	100	175	P	H
	*	2480	107.74	-	-	92.49	32.47	18.23	35.45	100	175	A	H
		2483.732	59.26	-14.74	74	44.01	32.47	18.23	35.45	100	175	P	H
		2483.536	52.38	-1.62	54	37.13	32.47	18.23	35.45	100	175	A	H
		2376.13	59.96	-14.04	74	45.44	31.87	18.06	35.41	371	154	P	V
		2375.96	52.48	-1.52	54	37.96	31.87	18.06	35.41	371	154	A	V
	*	2480	108.94	-	-	93.69	32.47	18.23	35.45	371	154	P	V
	*	2480	108.45	-	-	93.2	32.47	18.23	35.45	371	154	A	V
		2483.634	59.89	-14.11	74	44.64	32.47	18.23	35.45	371	154	P	V
		2483.536	52.23	-1.77	54	36.98	32.47	18.23	35.45	371	154	A	V
	Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.											



**2.4GHz 2400~2483.5MHz
WIFI 802.11ax HE20 Full (Band Edge @ 3m)**

WIFI Ant. 1+2	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)
802.11ax HE20 Full CH 01 2412MHz		2388.71	62.16	-11.84	74	47.56	31.9	18.11	35.41	128	70	P	H
		2375.96	51	-3	54	36.48	31.87	18.06	35.41	128	70	A	H
	*	2412	115.17	-	-	100.43	32	18.16	35.42	128	70	P	H
	*	2412	106.21	-	-	91.47	32	18.16	35.42	128	70	A	H
		2484.614	56.62	-17.38	74	41.37	32.47	18.23	35.45	128	70	P	H
		2483.536	47.95	-6.05	54	32.7	32.47	18.23	35.45	128	70	A	H
		2389.05	60.9	-13.1	74	46.3	31.9	18.11	35.41	394	114	P	V
		2375.96	51.61	-2.39	54	37.09	31.87	18.06	35.41	394	114	A	V
	*	2412	112.96	-	-	98.22	32	18.16	35.42	394	114	P	V
	*	2412	105.41	-	-	90.67	32	18.16	35.42	394	114	A	V
	2484.124	55.75	-18.25	74	40.5	32.47	18.23	35.45	394	114	P	V	
	2484.124	46.65	-7.35	54	31.4	32.47	18.23	35.45	394	114	A	V	
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												



Band 1 - 5150~5250MHz
WIFI 802.11a (Band Edge @ 3m)

WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.	
Ant.				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.		
1+2+3+4		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)	
802.11a CH 36 5180MHz		5143.52	56.28	-17.72	74	45.58	34.2	11.79	35.29	100	109	P	H	
		5149.76	51.09	-2.91	54	40.38	34.2	11.79	35.28	100	109	A	H	
	*	5180	116.98	-	-	106.15	34.27	11.83	35.27	100	109	P	H	
	*	5180	109.65	-	-	98.82	34.27	11.83	35.27	100	109	A	H	
													H	
													H	
			5147.68	61.46	-12.54	74	50.75	34.2	11.79	35.28	103	136	P	V
			5149.5	52.73	-1.27	54	42.02	34.2	11.79	35.28	103	136	A	V
	*		5180	117.57	-	-	106.74	34.27	11.83	35.27	103	136	P	V
	*		5180	110.77	-	-	99.94	34.27	11.83	35.27	103	136	A	V
													V	
													V	
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.													



WLAN 2.4GHz 802.11ax HE20 CH01 Tx+ WLAN 5GHz 802.11a CH36 Tx +

BLE(1M) CH39 Tx + WWAN LTE B41 CH40620 Link

(Harmonic @ 3m)

WIFI Ant.	Note	Frequency	Level	Over Limit	Limit Line	Read Level	Antenna Factor	Path Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.	
1+2		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)	
Co-location		4824	53.76	-20.24	74	41.9	34.05	13.11	35.3	100	0	P	H	
		4824	43.02	-10.98	54	31.16	34.05	13.11	35.3	100	0	A	H	
		4960	52.03	-21.97	74	39.72	34.2	13.44	35.33	100	0	P	H	
		4960	43.2	-10.8	54	30.89	34.2	13.44	35.33	100	0	A	H	
		7440	41.55	-32.45	74	48.69	35.6	15.3	58.04	100	0	P	H	
		10360	44.3	-23.9	68.2	47.67	37.57	18.37	59.31	100	0	P	H	
		15540	47.09	-26.91	74	40.89	40.27	23.16	57.23	100	0	P	H	
			4824	52.61	-21.39	74	40.75	34.05	13.11	35.3	100	0	P	V
			4824	42.97	-11.03	54	31.11	34.05	13.11	35.3	100	0	A	V
			4960	52.26	-21.74	74	39.95	34.2	13.44	35.33	100	0	P	V
			4960	43.29	-10.71	54	30.98	34.2	13.44	35.33	100	0	A	V
			7440	41.36	-32.64	74	48.5	35.6	15.3	58.04	100	0	P	V
			10360	44.25	-23.95	68.2	47.62	37.57	18.37	59.31	100	0	P	V
			15540	54.35	-19.65	74	48.15	40.27	23.16	57.23	193	53	P	V
			15540	43.1	-10.9	54	36.9	40.27	23.16	57.23	193	53	A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.													



Emission below 1GHz

Co-location (LF)

Co-location	Note	Frequency	Level	Over	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.	
1+2+3+4		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)	
Co-location LF		30	28.89	-11.11	40	33.41	24.57	0.9	30.03	-	-	P	H	
		91.29	30.32	-13.18	43.5	43.73	14.79	1.61	29.99	-	-	P	H	
		167.16	35.06	-8.44	43.5	46.82	15.85	2.16	29.98	100	0	P	H	
		745.9	34.3	-11.7	46	31.99	27.54	4.24	29.69	-	-	P	H	
		913.2	32.66	-13.34	46	27.62	28.79	4.72	28.86	-	-	P	H	
		957.3	33.99	-12.01	46	26.73	30.67	4.9	28.68	-	-	P	H	
														H
														H
														H
														H
														H
														H
														H
														H
														H
			30	33.49	-6.51	40	38.01	24.57	0.9	30.03	100	0	P	V
			91.02	31.94	-11.56	43.5	45.41	14.73	1.61	29.99	-	-	P	V
			165.27	31.26	-12.24	43.5	42.94	15.94	2.15	29.98	-	-	P	V
		856.5	31.67	-14.33	46	27.18	28.82	4.62	29.21	-	-	P	V	
		904.1	32.38	-13.62	46	27.57	28.62	4.68	28.89	-	-	P	V	
		948.9	33.92	-12.08	46	27.17	30.23	4.87	28.72	-	-	P	V	
													V	
													V	
													V	
													V	
													V	
													V	
Remark	1. No other spurious found. 2. All results are PASS against 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	Peak or Average
H/V	Horizontal or Vertical



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

BLE	Note	Frequency	Level	Over	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)
BLE 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. 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 :	Jesse Wang, Stan Hsieh	Temperature :	22.5~25.8°C
		Relative Humidity :	54.3~59.6%

Note symbol

-L	Low channel location
-R	High channel location



WLAN 2.4GHz 802.11ax HE20 CH01 Tx + WLAN 5GHz 802.11a CH36 Tx +

BLE(1M) CH39 Tx + WWAN LTE B41 CH40620 Link

2.4GHz 2400~2483.5MHz

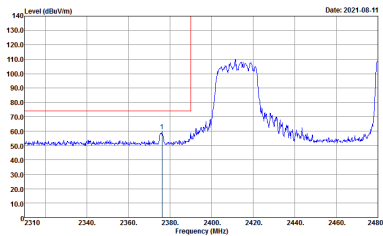
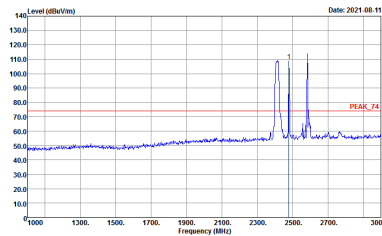
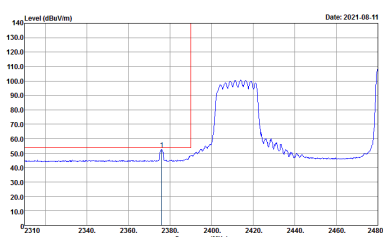
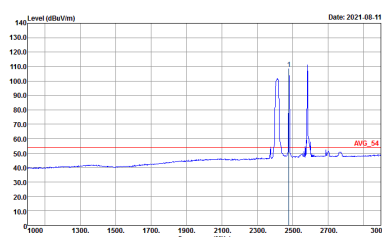
BLE (Band Edge @ 3m)

BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BLE CH39 2480MHz - L	
1	Horizontal	Fundamental
Peak	<p>Site : 03CH07-HY Condition : PEAK_BE_74 3m HF_ANT_00075962 HORIZONTAL : RBW:1000.000kHz VBW:3000.000kHz SWT:Auto</p>	<p>Site : 03CH07-HY Condition : PEAK_74 3m HF_ANT_00075962 HORIZONTAL : RBW:1000.000kHz VBW:3000.000kHz SWT:Auto</p>
Avg.	<p>Site : 03CH07-HY Condition : AVG_BE_54 3m HF_ANT_00075962 HORIZONTAL : RBW:1000.000kHz VBW:3.000kHz SWT:Auto</p>	<p>Site : 03CH07-HY Condition : AVG_54 3m HF_ANT_00075962 HORIZONTAL : RBW:1000.000kHz VBW:3.000kHz SWT:Auto</p>

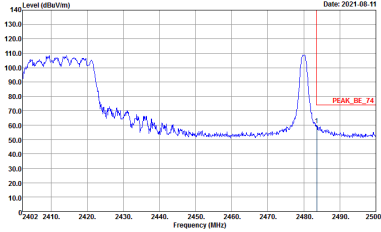
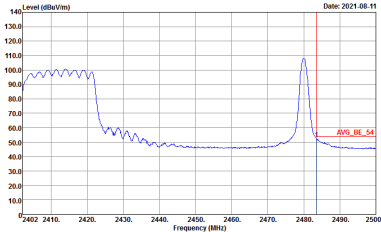


BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BLE CH39 2480MHz - R	
1	Horizontal	Fundamental
Peak	<p>Site : 03CH07-HY Condition : PEAK_BE_74 3m HF_ANT_00075962 HORIZONTAL : RBW:1000.0000kHz VBW:3000.0000kHz SWT:Auto</p>	Left blank
Avg.	<p>Site : 03CH07-HY Condition : AVG_BE_54 3m HF_ANT_00075962 HORIZONTAL : RBW:1000.0000kHz VBW:3.0000kHz SWT:Auto</p>	Left blank



BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BLE CH39 2480MHz - L	
1	Vertical	Fundamental
Peak	 <p>Site Condition : 03CH07-HY : PEAK_BE_74 3m HF_ANT_00075962 VERTICAL : RBW:1000.000kHz VBW:3000.000kHz SWF:Auto</p>	 <p>Site Condition : 03CH07-HY : PEAK_74 3m HF_ANT_00075962 VERTICAL : RBW:1000.000kHz VBW:3000.000kHz SWF:Auto</p>
Avg.	 <p>Site Condition : 03CH07-HY : AVG_BE_54 3m HF_ANT_00075962 VERTICAL : RBW:1000.000kHz VBW:3.000kHz SWF:Auto</p>	 <p>Site Condition : 03CH07-HY : AVG_54 3m HF_ANT_00075962 VERTICAL : RBW:1000.000kHz VBW:3.000kHz SWF:Auto</p>

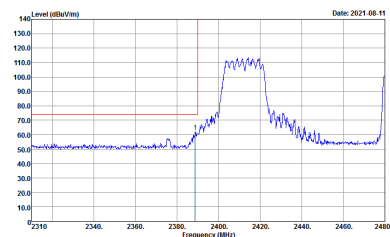
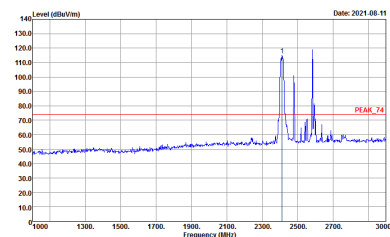
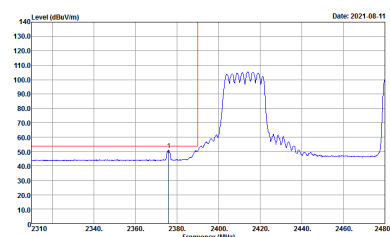
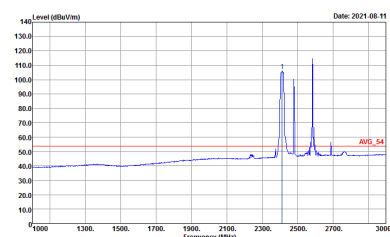


BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BLE CH39 2480MHz - R	
1	Vertical	Fundamental
Peak	 <p>Site : 03CH07-HY Condition : PEAK_BE_74 3m HF_ANT_00075962 VERTICAL : RBW:1000.0000kHz VBW:3000.0000kHz SWT:Auto</p>	Left blank
Avg.	 <p>Site : 03CH07-HY Condition : AVG_BE_54 3m HF_ANT_00075962 VERTICAL : RBW:1000.0000kHz VBW:3.0000kHz SWT:Auto</p>	Left blank

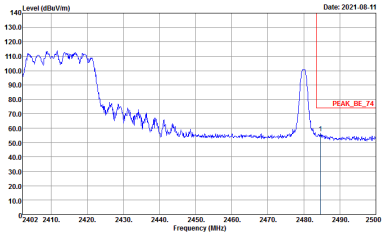
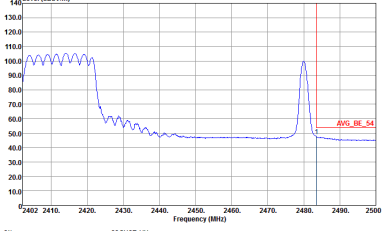


2.4GHz 2400~2483.5MHz

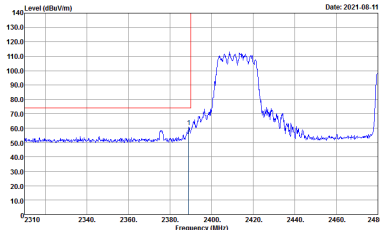
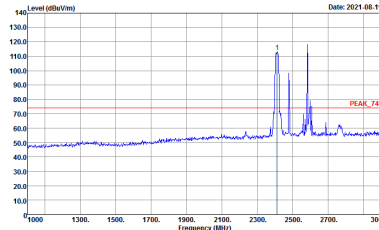
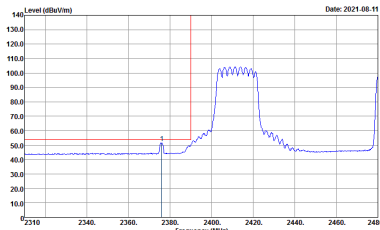
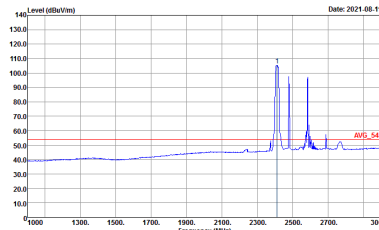
WIFI 802.11ax HE20 Full (Band Edge @ 3m)

WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	802.11ax HE20 Full CH01 2412MHz - L	
1+2	Horizontal	Fundamental
Peak	 <p>Site Condition : 03CH07-HY : PEAK_BE_74 3m HF_ANT_00075962 HORIZONTAL : RBW:1000.000kHz VBW:3000.000kHz SWF:Auto</p>	 <p>Site Condition : 03CH07-HY : PEAK_74 3m HF_ANT_00075962 HORIZONTAL : RBW:1000.000kHz VBW:3000.000kHz SWF:Auto</p>
Avg.	 <p>Site Condition : 03CH07-HY : AVG_BE_54 3m HF_ANT_00075962 HORIZONTAL : RBW:1000.000kHz VBW:1.000kHz SWF:Auto</p>	 <p>Site Condition : 03CH07-HY : AVG_54 3m HF_ANT_00075962 HORIZONTAL : RBW:1000.000kHz VBW:1.000kHz SWF:Auto</p>



WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	802.11ax HE20 Full CH01 2412MHz - R	
1+2	Horizontal	Fundamental
Peak	 <p>Site : 03CH07-HY Condition : PEAK_BE_74 3m HF_ANT_00075962 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>	Left blank
Avg.	 <p>Site : 03CH07-HY Condition : AVG_BE_54 3m HF_ANT_00075962 HORIZONTAL : RBW:1000.000KHz VBW:1.000KHz SWT:Auto</p>	Left blank



WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	802.11ax HE20 Full CH01 2412MHz - L	
1+2	Vertical	Fundamental
Peak	 <p>Site : 03CH07-HY Condition : PEAK_BE_74 3m HF_ANT_00075962 VERTICAL : RBW:1000.000kHz VBW:3000.000kHz SWT:Auto</p>	 <p>Site : 03CH07-HY Condition : PEAK_74 3m HF_ANT_00075962 VERTICAL : RBW:1000.000kHz VBW:3000.000kHz SWT:Auto</p>
Avg.	 <p>Site : 03CH07-HY Condition : AVG_BE_54 3m HF_ANT_00075962 VERTICAL : RBW:1000.000kHz VBW:1.000kHz SWT:Auto</p>	 <p>Site : 03CH07-HY Condition : AVG_54 3m HF_ANT_00075962 VERTICAL : RBW:1000.000kHz VBW:1.000kHz SWT:Auto</p>



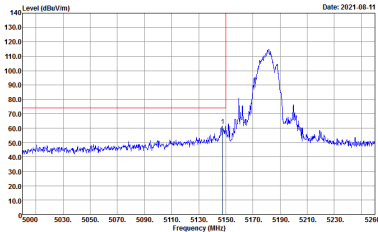
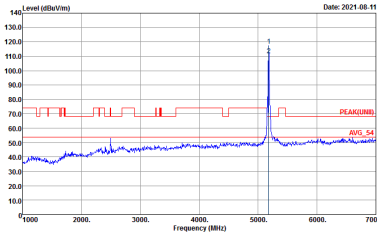
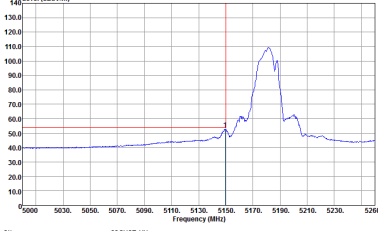
WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	802.11ax HE20 Full CH01 2412MHz - R	
1+2	Vertical	Fundamental
Peak	<p>Site : 03CH07-HY Condition : PEAK_BE_74 3m HF_ANT_00075962 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>	Left blank
Avg.	<p>Site : 03CH07-HY Condition : AVG_BE_54 3m HF_ANT_00075962 VERTICAL : RBW:1000.000KHz VBW:1.000KHz SWT:Auto</p>	Left blank



Band 1 - 5150~5250MHz
WIFI 802.11a (Band Edge @ 3m)

WIFI	Band 1 5150~5250MHz Band Edge @ 3m	
ANT	802.11a CH36 5180MHz	
1+2+3+4	Horizontal	Fundamental
Peak	<p>Site : 03CH07-HY Condition : PEAK_BE_74 3m HF_ANT_00075962 HORIZONTAL : RBW:1000.000kHz VBW:3000.000kHz SWF:Auto</p>	<p>Site : 03CH07-HY Condition : PEAK(LIN) 3m HF_ANT_00075962 HORIZONTAL : RBW:1000.000kHz VBW:3000.000kHz SWF:Auto</p>
Avg.	<p>Site : 03CH07-HY Condition : AVG_BE_54 3m HF_ANT_00075962 HORIZONTAL : RBW:1000.000kHz VBW:1.000kHz SWF:Auto</p>	Left blank



WIFI	Band 1 5150~5250MHz Band Edge @ 3m	
ANT	802.11a CH36 5180MHz	
1+2+3+4	Vertical	Fundamental
Peak	 <p>Site : 03CH07-HY Condition : PEAK_BE_74 3m HF_ANT_00075962 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>	 <p>Site : 03CH07-HY Condition : PEAK(UNII) 3m HF_ANT_00075962 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto</p>
Avg.	 <p>Site : 03CH07-HY Condition : AVG_BE_54 3m HF_ANT_00075962 VERTICAL : RBW:1000.000KHz VBW:1.000KHz SWT:Auto</p>	Left blank



WIFI 2.4G 802.11ax HE20 CH01 Tx+ WIFI 5G 802.11a CH36 Tx+

BLE(1M) CH39 Tx+ WWAN LTE B41 CH40620 Link

Co-location (Harmonic @ 3m)

Co-location Harmonic @ 3m		
ANT	Co-location	
1+2+3+4	Horizontal	Vertical
Peak	<p>Site : 03CH07-HY Condition : PEAK(UNII) 3m HF_ANT_00075962 HORIZONTAL Detector : Peak</p>	<p>Site : 03CH07-HY Condition : PEAK(UNII) 3m HF_ANT_00075962 VERTICAL Detector : Peak</p>



Emission below 1GHz
Co-location (LF)

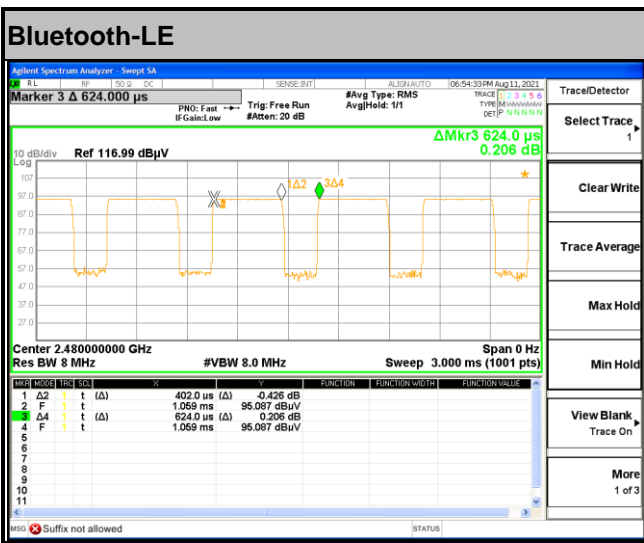
	Co-location	
ANT	Co-location LF	
1+2+3+4	Horizontal	Vertical
QP / Peak	<p>Site : 03CH07-HY Condition : QP 3m LF-ANT-35419(6) HORIZONTAL Detector : Peak</p>	<p>Site : 03CH07-HY Condition : QP 3m LF-ANT-35419(6) VERTICAL Detector : Peak</p>



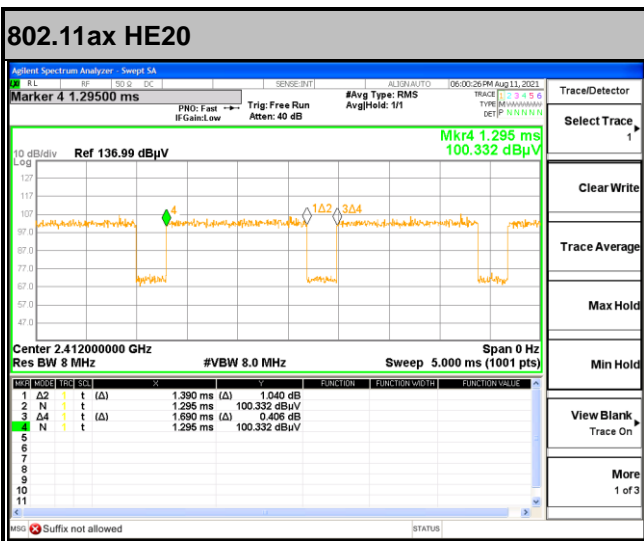
Appendix C. Duty Cycle Plots

Ant	Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting
1	Bluetooth-LE	64.42	402	2.49	3kHz
1+2	5GHz 802.11ax HE20	82.25	1390	0.72	1kHz
1+2+3+4	5GHz 802.11a	94.85	0.48	1kHz	

<Ant.1>



MIMO <Ant.1+2>



MIMO <Ant.1+2+3+4>

