FCC CO-LOCATION RADIO TEST REPORT

FCC ID	:	**A4RG8HHN**
Equipment	:	**Phone**
Model Name	:	**G8HHN**
Applicant	:	**Google LLC** **1600 Amphitheatre Parkway,** **Mountain View, California, 94043 USA**
Standard	:	**FCC Part 15 Subpart E §15.407**

The product was received on Aug. 24, 2023 and testing was performed from Aug. 26, 2023 to Sep. 09, 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.

Louis Wu

Approved by: Louis Wu

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

Table of Contents

History of this test report **3**
Summary of Test Result **4**
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 Connection Diagram of Test System 8
2.3 EUT Operation Test Setup 8
3 Test Result **9**
3.1 Unwanted Emissions Measurement 9
3.2 Antenna Requirements 15
4 List of Measuring Equipment **16**
5 Measurement Uncertainty **17**
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	Issue Date
FR380306I	01	Initial issue of report	Nov. 06, 2023
FR380306I	02	Revise section 2.1 This report is an updated version, replacing the report issued on Nov. 06, 2023.	Dec. 05, 2023

Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)	Remark
3.1	15.247(d) 15.407(b)	Unwanted Emissions	Pass	1.81 dB under the limit at 5149.50 MHz
3.2	15.203	Antenna Requirement	Pass	-

Conformity Assessment Condition:

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

Disclaimer:

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

Reviewed by: William Chen

Report Producer: Lucy Wu

1 General Description

1.1 Product Feature of Equipment Under Test

Product Feature
General Specs GSM/WCDMA/LTE/5G NR, Bluetooth, BLE, BLE channel sounding, Wi-Fi 2.4GHz 802.11b/g/n/ac/ax, Wi-Fi 5GHz 802.11a/n/ac/ax, Wi-Fi 6GHz 802.11a/ax, NFC, WPC Rx and GNSS Rx. **Antenna Type** WLAN: **<Ant. 4>:** ILA Antenna **<Ant. 3>:** IFA Antenna Bluetooth: **<Ant. 4>:** ILA Antenna **<Ant. 3>:** IFA Antenna

EUT Information List	
S/N	**Performed Test Item**
38031JEKB01519	Radiated Spurious Emission

Antenna information		
2400 MHz ~ 2483.5 MHz	Peak Gain (dBi)	<Ant. 4>: -1.2 <Ant. 3>: -1.2
5150 MHz ~ 5250 MHz	Peak Gain (dBi)	<Ant. 4>: -3.1 <Ant. 3>: -3.4
5925 MHz ~ 6425 MHz	Peak Gain (dBi)	<Ant. 4>: -2.9 <Ant. 3>: -3.8

Remark: The EUT's information above is declared by manufacturer. Please refer to Disclaimer in report summary.

1.2 Modification of EUT

No modifications made to the EUT during the testing.

1.3 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.**
	03CH22-HY

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

FCC designation No.: TW3786

1.4 Applicable Standards

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

- FCC Part 15 Subpart E
- FCC Part 15 Subpart C §15.247
- FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01.
- FCC KDB Publication No. 558074 D01 15.247 Meas Guidance v05r02
- FCC KDB 414788 D01 Radiated Test Site v01r01.
- FCC KDB 662911 D01 Multiple Transmitter Output v02r01.
- ANSI C63.10-2013

Remark:

1. All the test items were validated and recorded in accordance with the standards without any modification during the testing.
2. The TAF code is not including all the FCC KDB listed without accreditation.

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). 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 antenna in three orthogonal axis (X: flat, Y: portrait, Z: landscape) and accessory (Adapter or Earphone), and adjusting the measurement antenna orientation, following C63.10 exploratory test procedures.

2.1 Carrier Frequency and Channel

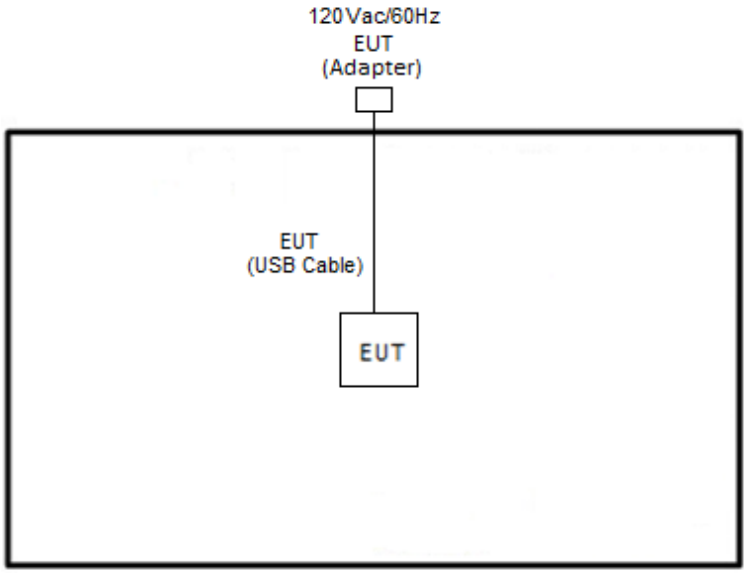
2400-2483.5 MHz			
Bluetooth – LE 2Mbps		802.11g	
Channel	Channel	Channel	Freq. (MHz)
39	2480	06	2437

5150-5250 MHz		5925-6425 MHz	
802.11a		802.11a	
Channel	Freq. (MHz)	Channel	Freq. (MHz)
36	5180	01	5955

<Co-Location>

Modulation	Data Rate	Worst Plane
2.4GHz 802.11g for MIMO <Ant. 4+3> + 5GHz 802.11a for MIMO <Ant. 4+3>	6 Mbps + 6 Mbps	Z Plane with Adapter
2.4GHz 802.11g for MIMO <Ant. 4+3> + 6GHz 802.11a for MIMO <Ant. 4+3>	6 Mbps + 6 Mbps	X Plane with Adapter
Bluetooth – LE for <Ant. 3> + 5GHz 802.11a for MIMO <Ant. 4+3>	GFSK + 6 Mbps	X Plane with Adapter

2.2 Connection Diagram of Test System



2.3 EUT Operation Test Setup

The RF test items, utility “CMD v1.17.11461.0” 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 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

<For 2402 MHz ~ 2480 MHz>

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. If the output power of this device is measured by spectrum analyzer, the attenuation under this paragraph shall be 30 dB instead of 20 dB.

<For 5150 MHz ~ 5250 MHz>

For transmitters operating in the 5150-5250 MHz band: all emissions outside of the 5150-5350 MHz band shall not exceed an EIRP of –27dBm/MHz.

<For 5925 MHz ~ 6425 MHz>

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

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.

$$E=\frac{1000000\sqrt{30P}}{3}$$ μV/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 1000 MHz
   - RBW = 120 kHz
   - VBW = 300 kHz
   - Detector = Peak
   - Trace mode = max hold

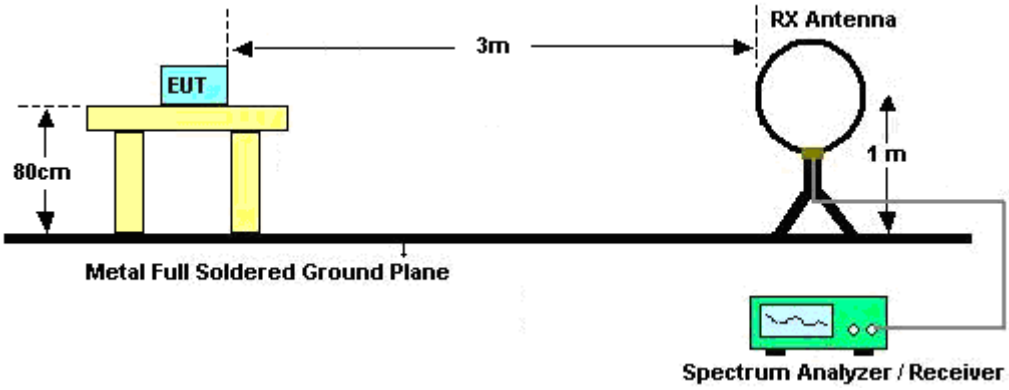
   (2) Procedure for Peak Unwanted Emissions Measurements Above 1000 MHz
   - RBW = 1 MHz
   - VBW ≥ 3 MHz
   - Detector = Peak
   - Sweep time = auto
   - Trace mode = max hold

   (3) Procedures for Average Unwanted Emissions Measurements Above 1000 MHz
   - RBW = 1 MHz
   - VBW = 10 Hz, when duty cycle is no less than 98 percent.
   - VBW ≥ 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 “-“.

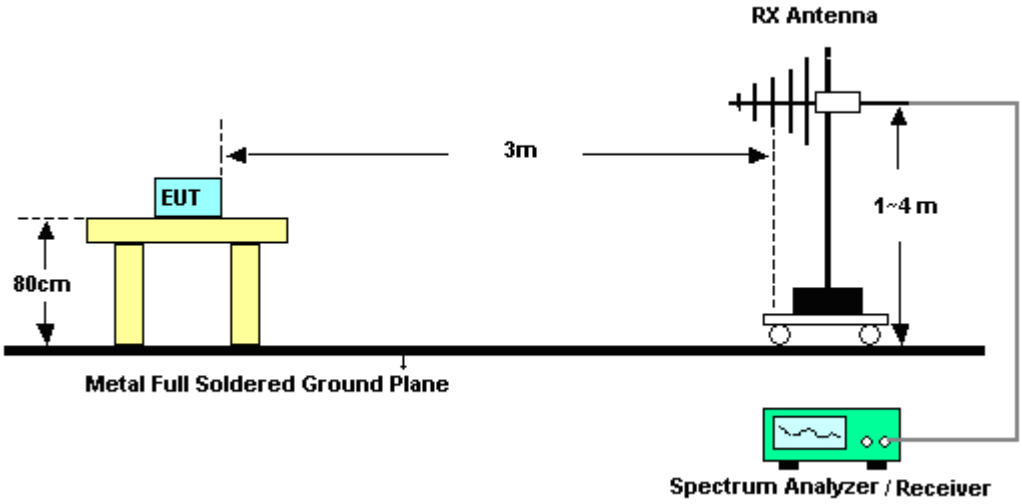
7. Radiated testing above 1 GHz is performed by adjusting the antenna tower from 1 m to 4 m and by rotating the turn table from 0 degree to 360 degrees to find the peak maximum hold reading for scanning all frequencies. When there is no suspected emission found and the harmonic emission level is with at least 6 dB margin against average limit line, the position is marked as "-".

3.1.4 Test Setup

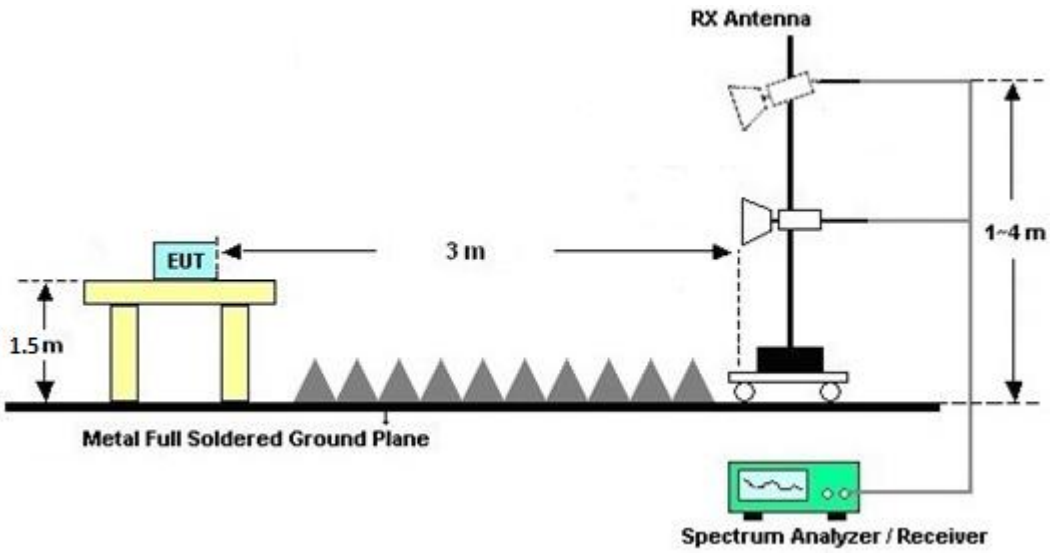
For radiated emissions below 30MHz



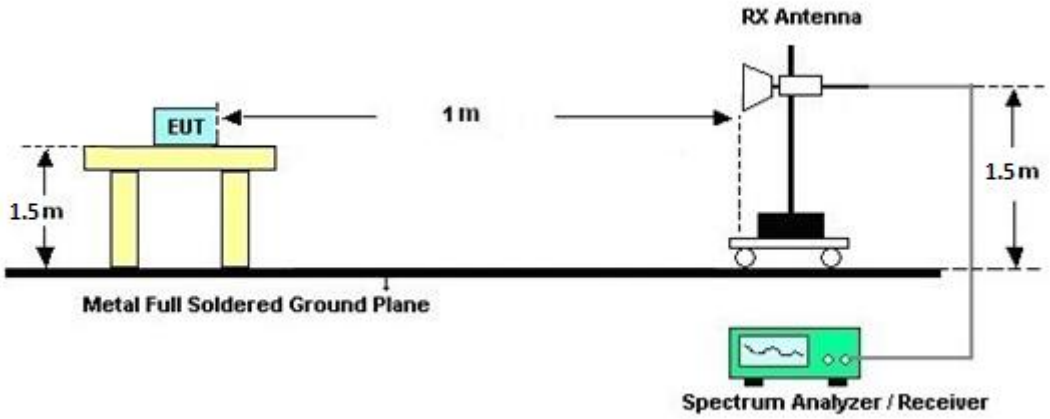
For radiated emissions from 30MHz to 1GHz



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 starts from 9 kHz to 30 MHz, is pre-scanned and the result which is 20 dB lower than the limit line is 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	Rohde & Schwarz	HFH2-Z2	100315	9kHz~30MHz	Feb. 28, 2023	Aug. 26, 2023~ Sep. 09, 2023	Feb. 27, 2024	Radiation (03CH22-HY)
Bilog Antenna with 6dB	TESEQ & WOKEN	CBL 6111D & 00802N1D-06	63304 & 002	N/A	Oct. 04, 2022	Aug. 26, 2023~ Sep. 09, 2023	Oct. 03, 2023	Radiation (03CH22-HY)
Amplifier	SONOMA	310N	421581	N/A	Jul. 15, 2023	Aug. 26, 2023~ Sep. 09, 2023	Jul. 14, 2024	Radiation (03CH22-HY)
Double Ridged Guide Horn Antenna	RFSPIN	DRH18-E	LE2C04A18EN	1GHz~18GHz	Jul. 12, 2023	Aug. 26, 2023~ Sep. 09, 2023	Jul. 11, 2024	Radiation (03CH22-HY)
SHF-EHF Horn Antenna	SCHWARZBECK	BBHA 9170	1223	18GHz-40GHz	Jul. 10, 2023	Aug. 26, 2023~ Sep. 09, 2023	Jul. 09, 2024	Radiation (03CH22-HY)
Amplifier	EMEC	EM01G18GA	060877	N/A	Sep. 29, 2022	Aug. 26, 2023~ Sep. 09, 2023	Sep. 28, 2023	Radiation (03CH22-HY)
Preamplifier	EMEC	EM18G40G	060801	18-40GHz	Jun. 27, 2023	Aug. 26, 2023~ Sep. 09, 2023	Jun. 26, 2024	Radiation (03CH22-HY)
Signal Analyzer	Keysight	N9010B	MY60241058	10Hz~44GHz	Jul. 06, 2023	Aug. 26, 2023~ Sep. 09, 2023	Jul. 05, 2024	Radiation (03CH22-HY)
Hygrometer	TECPEL	DTM-303A	TP211559	N/A	Nov. 17, 2022	Aug. 26, 2023~ Sep. 09, 2023	Nov. 16, 2023	Radiation (03CH22-HY)
Controller	EMEC	EM1000	N/A	Control Turn table & Ant Mast	N/A	Aug. 26, 2023~ Sep. 09, 2023	N/A	Radiation (03CH22-HY)
Antenna Mast	ChainTek	MBS-520-1	N/A	1m~4m	N/A	Aug. 26, 2023~ Sep. 09, 2023	N/A	Radiation (03CH22-HY)
Turn Table	ChainTek	T-200-S-1	N/A	0~360 Degree	N/A	Aug. 26, 2023~ Sep. 09, 2023	N/A	Radiation (03CH22-HY)
Software	Audix	E3 6.09824_2019122	RK-002347	N/A	N/A	Aug. 26, 2023~ Sep. 09, 2023	N/A	Radiation (03CH22-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	803951/2	9kHz~30MHz	Mar. 07, 2023	Aug. 26, 2023~ Sep. 09, 2023	Mar. 06, 2024	Radiation (03CH22-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	804390/2,804611/2,804615/2	N/A	Oct. 25, 2022	Aug. 26, 2023~ Sep. 09, 2023	Oct. 24, 2023	Radiation (03CH22-HY)

5 Measurement Uncertainty

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	5.92 dB

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	4.42 dB

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	4.40 dB

Uncertainty of Radiated Emission Measurement (18000 MHz ~ 40000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	5.38 dB

Appendix A. Radiated Spurious Emission

Test Engineer :	Bank Lin and LU WEN-KAI	Temperature :	20~25°C
		Relative Humidity :	55~65%

WLAN (2.4GHz) 802.11g_Tx_CH06 + WLAN (5GHz) 802.11a_Tx_CH36

2.4GHz 2400~2483.5MHz

WIFI 802.11g (Band Edge @ 3m)

WIFI Ant. 4+3	Note	Frequency (MHz)	Level (dBμV/m)	Margin (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)
802.11g CH 06 2437MHz		2389.2	57.72	-16.28	74	43.98	26.91	19.29	32.46	100	144	P	H
		2389.52	44.39	-9.61	54	30.66	26.9	19.29	32.46	100	144	A	H
	*	2437	112.83	-	-	99.15	26.8	19.38	32.5	100	144	P	H
	*	2437	104.58	-	-	90.9	26.8	19.38	32.5	100	144	A	H
		2483.76	63.27	-10.73	74	49.43	26.9	19.47	32.53	100	144	P	H
		2483.6	49.17	-4.83	54	35.33	26.9	19.47	32.53	100	144	A	H
		2389.36	60.9	-13.1	74	47.16	26.91	19.29	32.46	159	78	P	V
		2389.84	46.5	-7.5	54	32.78	26.9	19.29	32.47	159	78	A	V
	*	2437	114.84	-	-	101.16	26.8	19.38	32.5	159	78	P	V
	*	2437	106.59	-	-	92.91	26.8	19.38	32.5	159	78	A	V
		2484.16	63.94	-10.06	74	50.1	26.9	19.47	32.53	159	78	P	V
		2483.6	49.84	-4.16	54	36	26.9	19.47	32.53	159	78	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 Ant. 4+3	Note	Frequency (MHz)	Level (dBμV/m)	Margin (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)
802.11a CH 36 5180MHz		5148.46	63.77	-10.23	74	50.58	32.5	14.47	33.78	278	127	P	H
		5149.5	52.19	-1.81	54	39	32.5	14.47	33.78	278	127	A	H
	*	5180	102.72	-	-	89.5	32.56	14.48	33.82	278	127	P	H
	*	5180	95.97	-	-	82.75	32.56	14.48	33.82	278	127	A	H
													H
													H
		5149.76	63.29	-10.71	74	50.1	32.5	14.47	33.78	100	293	P	V
		5149.76	51.39	-2.61	54	38.2	32.5	14.47	33.78	100	293	A	V
	*	5180	104.6	-	-	91.38	32.56	14.48	33.82	100	293	P	V
	*	5180	97.7	-	-	84.48	32.56	14.48	33.82	100	293	A	V
													V
													V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

WLAN (2.4GHz) 802.11g_Tx_CH06 + WLAN (5GHz) 802.11a_Tx_CH36

(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.	
4+3		(MHz)	(dBµV/m)	(dB)	(dBµV/m)	(dBµV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11g CH 06 2437MHz + 802.11a CH 36 5180MHz		4874	46.07	-27.93	74	32.64	32.55	14.46	33.58	-	-	P	H
		7311	50.46	-23.54	74	31.88	37.5	17.02	35.94	-	-	P	H
		7311	42.57	-11.43	54	23.99	37.5	17.02	35.94	-	-	A	H
		10360	49.76	-18.44	68.2	31.49	37.46	20.06	39.25	-	-	P	H
		15540	53.77	-20.23	74	32.83	41.26	24.21	44.53	-	-	P	H
		15540	42.84	-11.16	54	21.9	41.26	24.21	44.53	-	-	A	H
													H
													H
													H
													H
													H
													H
		4874	46.11	-27.89	74	32.68	32.55	14.46	33.58	-	-	P	V
		7311	50.86	-23.14	74	32.28	37.5	17.02	35.94	-	-	P	V
		7311	42.89	-11.11	54	24.31	37.5	17.02	35.94	-	-	A	V
		10360	49.8	-18.4	68.2	31.53	37.46	20.06	39.25	-	-	P	V
		15540	54.7	-19.3	74	33.76	41.26	24.21	44.53	-	-	P	V
		15540	43	-11	54	22.06	41.26	24.21	44.53	-	-	A	V
													V
													V
													V
													V
													V
													V
Remark	1. No other spurious found. 2. All results are PASS against 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

WLAN (2.4GHz) 802.11g_Tx_CH06 + WLAN (5GHz) 802.11a_Tx_CH36

(LF @ 3m)

WIFI Ant.	Note	Frequency	Level	Margin	Limit Line	Read Level	Antenna Factor	Path Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
4+3		(MHz)	(dBµV/m)	(dB)	(dBµV/m)	(dBµV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11g CH 06 2437MHz + 802.11a CH 36 5180MHz LF		31.94	22.47	-17.53	40	30.23	23.94	1.05	32.75	-	-	P	H
		80.44	24.52	-15.48	40	41.88	13.36	2	32.72	-	-	P	H
		112.45	29.99	-13.51	43.5	43.38	17	2.33	32.72	-	-	P	H
		200.72	25.94	-17.56	43.5	40.62	15.01	2.99	32.68	-	-	P	H
		309.36	23.22	-22.78	46	33.14	19.2	3.61	32.73	-	-	P	H
		958.29	35.57	-10.43	46	29.48	31.27	6.14	31.32	-	-	P	H
		30.97	28.94	-11.06	40	36.04	24.62	1.04	32.76	-	-	P	V
		59.1	23.43	-16.57	40	42.59	11.81	1.77	32.74	-	-	P	V
		80.44	25.05	-14.95	40	42.41	13.36	2	32.72	-	-	P	V
		153.19	27.62	-15.88	43.5	40.94	16.72	2.67	32.71	-	-	P	V
		561.56	28.53	-17.47	46	30.42	26.2	4.79	32.88	-	-	P	V
		956.35	36.1	-9.9	46	30.07	31.23	6.14	31.34	-	-	P	V
Remark	1. No other spurious found. 2. All results are PASS against limit line. 3. The emission position marked as "-" means no suspected emission found and emission level has at least 6dB margin against limit or emission is noise floor only.												

WLAN (2.4GHz) 802.11g_Tx_CH06 + WLAN (6GHz) 802.11a_Tx_CH01

2.4GHz 2400~2483.5MHz

WIFI 802.11g (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.
4+3		(MHz)	(dBµV/m)	(dB)	(dBµV/m)	(dBµV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11g CH 06 2437MHz		2389.2	58.92	-15.08	74	45.18	26.91	19.29	32.46	150	91	P	H
		2390	45.84	-8.16	54	32.12	26.9	19.29	32.47	150	91	A	H
	*	2437	113.46	-	-	99.78	26.8	19.38	32.5	150	91	P	H
	*	2437	105.35	-	-	91.67	26.8	19.38	32.5	150	91	A	H
		2484.16	62.5	-11.5	74	48.66	26.9	19.47	32.53	150	91	P	H
		2483.52	48.5	-5.5	54	34.66	26.9	19.47	32.53	150	91	A	H
		2389.52	56.55	-17.45	74	42.82	26.9	19.29	32.46	387	109	P	V
		2390	43.77	-10.23	54	30.05	26.9	19.29	32.47	387	109	A	V
	*	2437	113.24	-	-	99.56	26.8	19.38	32.5	387	109	P	V
	*	2437	104.88	-	-	91.2	26.8	19.38	32.5	387	109	A	V
		2484.16	61.68	-12.32	74	47.84	26.9	19.47	32.53	387	109	P	V
		2484.16	46.87	-7.13	54	33.03	26.9	19.47	32.53	387	109	A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

Band 5 - 5925~6425MHz

WIFI 802.11a (Band Edge @ 3m)

WIFI Ant. 4+3	Note	Frequency (MHz)	Level (dBμV/m)	Margin (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)
802.11a CH 01 5955MHz		5924.12	70.48	-17.72	88.2	56.31	34	14.96	34.79	100	117	P	H
		5924.96	57.66	-10.54	68.2	43.49	34	14.96	34.79	100	117	A	H
	*	5955	111.04	-	-	96.86	34.02	14.99	34.83	100	117	P	H
	*	5955	103.76	-	-	89.58	34.02	14.99	34.83	100	117	A	H
		5924.4	67.26	-20.94	88.2	53.09	34	14.96	34.79	250	55	P	V
		5924.96	57.6	-10.6	68.2	43.43	34	14.96	34.79	250	55	A	V
	*	5955	110.86	-	-	96.68	34.02	14.99	34.83	250	55	P	V
	*	5955	103.3	-	-	89.12	34.02	14.99	34.83	250	55	A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

WLAN (2.4GHz) 802.11g_Tx_CH06 + WLAN (6GHz) 802.11a_Tx_CH01

(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.	
4+3		(MHz)	(dBµV/m)	(dB)	(dBµV/m)	(dBµV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11g CH 06 2437MHz + 802.11a CH 01 5955MHz		4874	50.51	-23.49	74	37.08	32.55	14.46	33.58	121	59	P	H
		4874	40.63	-13.37	54	27.2	32.55	14.46	33.58	121	59	A	H
		7311	55.73	-18.27	74	37.15	37.5	17.02	35.94	100	97	P	H
		7311	44.38	-9.62	54	25.8	37.5	17.02	35.94	100	97	A	H
		11910	51.95	-22.05	74	32.67	39.22	20.57	40.51	-	-	P	H
		11910	41.8	-12.2	54	22.52	39.22	20.57	40.51	-	-	A	H
		17865	56.39	-17.61	74	34.79	41.33	26.14	45.87	-	-	P	H
		17865	45.31	-8.69	54	23.71	41.33	26.14	45.87	-	-	A	H
													H
													H
													H
													H
		4874	48.83	-25.17	74	35.4	32.55	14.46	33.58	382	117	P	V
		4874	38.63	-15.37	54	25.2	32.55	14.46	33.58	382	117	A	V
		7311	56.26	-17.74	74	37.68	37.5	17.02	35.94	261	109	P	V
		7311	45.46	-8.54	54	26.88	37.5	17.02	35.94	261	109	A	V
		11910	52.52	-21.48	74	33.24	39.22	20.57	40.51	-	-	P	V
		11910	41.69	-12.31	54	22.41	39.22	20.57	40.51	-	-	A	V
		17865	56.53	-17.47	74	34.93	41.33	26.14	45.87	-	-	P	V
		17865	45.44	-8.56	54	23.84	41.33	26.14	45.87	-	-	A	V
													V
													V
													V
													V
Remark	1. No other spurious found. 2. All results are PASS against limit line. 3. The emission position marked as "-" means no suspected emission found with sufficient margin against limit line or noise floor only.												

BLE(2M)_Tx_CH39 + WLAN (5GHz) 802.11a_Tx_CH36

2.4GHz 2400~2483.5MHz

BLE (Band Edge @ 3m)

BLE Ant.	Note	Frequency	Level	Margin	Limit Line	Read Level	Antenna Factor	Path Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
3		(MHz)	(dBµV/m)	(dB)	(dBµV/m)	(dBµV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
BLE CH 39 2480MHz	*	2480	113.2	-	-	99.36	26.9	19.47	32.53	193	83	P	H
	*	2480	111.53	-	-	97.69	26.9	19.47	32.53	193	83	A	H
		2483.6	55.27	-18.73	74	41.43	26.9	19.47	32.53	193	83	P	H
		2483.52	46.45	-7.55	54	32.61	26.9	19.47	32.53	193	83	A	H
													H
													H
	*	2480	110.46	-	-	96.62	26.9	19.47	32.53	300	119	P	V
	*	2480	108.71	-	-	94.87	26.9	19.47	32.53	300	119	A	V
		2483.6	53.37	-20.63	74	39.53	26.9	19.47	32.53	300	119	P	V
		2483.52	44.53	-9.47	54	30.69	26.9	19.47	32.53	300	119	A	V
													V
													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 Ant. 4+3	Note	Frequency (MHz)	Level (dBμV/m)	Margin (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)
802.11a CH 36 5180MHz		5149.5	60.67	-13.33	74	47.48	32.5	14.47	33.78	120	54	P	H
		5149.76	49.69	-4.31	54	36.5	32.5	14.47	33.78	120	54	A	H
	*	5180	106.93	-	-	93.71	32.56	14.48	33.82	120	54	P	H
	*	5180	100.03	-	-	86.81	32.56	14.48	33.82	120	54	A	H
													H
													H
		5145.6	57.08	-16.92	74	43.87	32.51	14.47	33.77	322	107	P	V
		5150	47.75	-6.25	54	34.57	32.5	14.46	33.78	322	107	A	V
	*	5180	102.27	-	-	89.05	32.56	14.48	33.82	322	107	P	V
	*	5180	95.85	-	-	82.63	32.56	14.48	33.82	322	107	A	V
													V
													V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

BLE(2M)_Tx_CH39 + WLAN (5GHz) 802.11a_Tx_CH36

(Harmonic @ 3m)

	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)
BLE CH 39 2480MHz + 802.11a CH 36 5180MHz		4960	46.45	-27.55	74	32.91	32.7	14.4	33.56	-	-	P	H
		7440	50.93	-23.07	74	32.45	37.32	17.2	36.04	105	235	P	H
		7440	40.7	-13.3	54	22.22	37.32	17.2	36.04	105	235	A	H
		10360	49.61	-18.59	68.2	31.34	37.46	20.06	39.25	-	-	P	H
		15540	54.21	-19.79	74	33.27	41.26	24.21	44.53	-	-	P	H
		15540	44.95	-9.05	54	24.01	41.26	24.21	44.53	-	-	A	H
													H
													H
													H
													H
													H
													H
		4960	45.49	-28.51	74	31.95	32.7	14.4	33.56	-	-	P	V
		7440	52.4	-21.6	74	33.92	37.32	17.2	36.04	100	360	P	V
		7440	43.62	-10.38	54	25.14	37.32	17.2	36.04	100	360	A	V
		10360	49.23	-18.97	68.2	30.96	37.46	20.06	39.25	-	-	P	V
		15540	54.22	-19.78	74	33.28	41.26	24.21	44.53	-	-	P	V
		15540	44.96	-9.04	54	24.02	41.26	24.21	44.53	-	-	A	V
													V
													V
													V
													V
													V
													V
Remark	1. No other spurious found. 2. All results are PASS against limit line. 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 **Margin** 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:

WIFI	Note	Frequency	Level	Margin	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
Ant.					Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
4+3		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11g CH 01 2412MHz		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. Margin (dB) = Level(dBμV/m) – Limit Line(dBμV/m)

For Peak Limit @ 2390MHz:

1. Level(dBμV/m)

= Antenna Factor(dB/m) + Path Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)

= 32.22(dB/m) + 4.58(dB) + 54.51(dBμV) – 35.86 (dB)

= 55.45 (dBμV/m)

2. Margin (dB)

= Level(dBμV/m) – Limit Line(dBμV/m)

= 55.45(dBμV/m) – 74(dBμV/m)

= -18.55(dB)

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. Margin (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

Test Engineer :	Bank Lin and LU WEN-KAI	**Temperature :**	20~25°C
		Relative Humidity :	55~65%

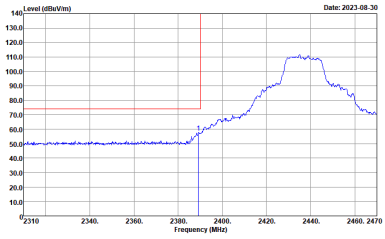
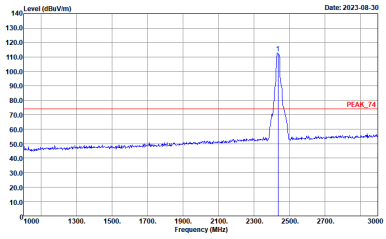
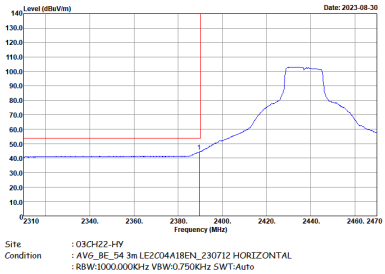
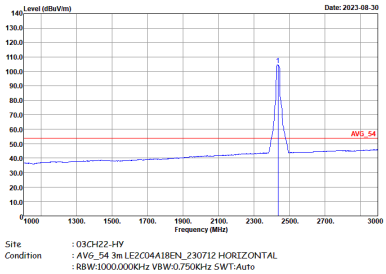
Note symbol

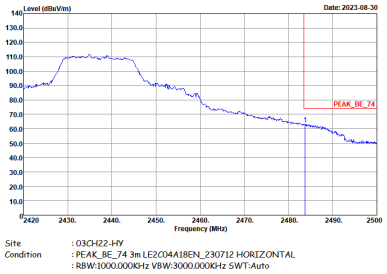
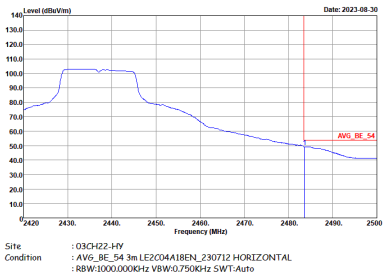
-L	**Low channel location**
-R	**High channel location**

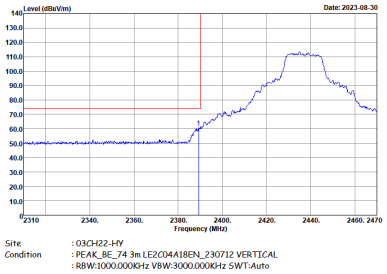
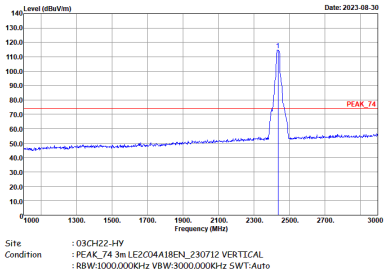
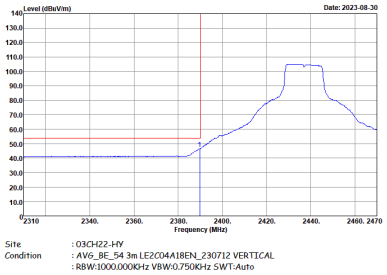
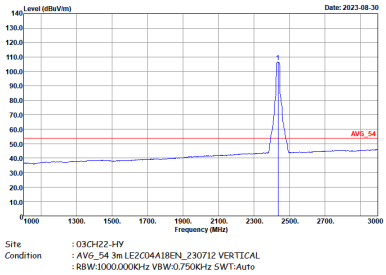
WLAN (2.4GHz) 802.11g_Tx_CH06 + WLAN (5GHz) 802.11a_Tx_CH36

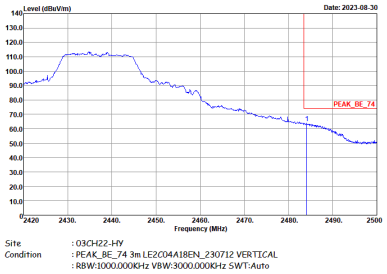
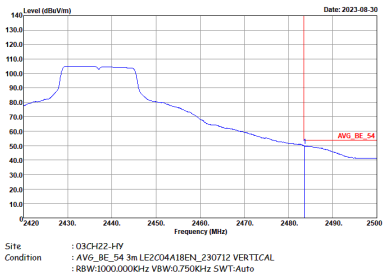
2.4GHz 2400~2483.5MHz

WIFI 802.11g (Band Edge @ 3m)

WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	802.11g CH06 2437MHz - L	
4+3	Horizontal	Fundamental
Peak		
Avg.		

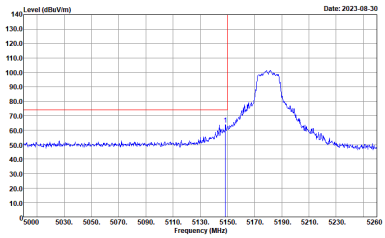
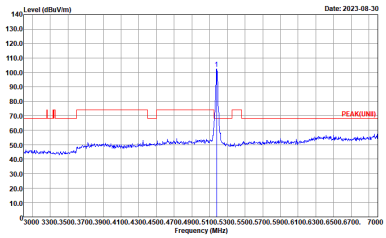
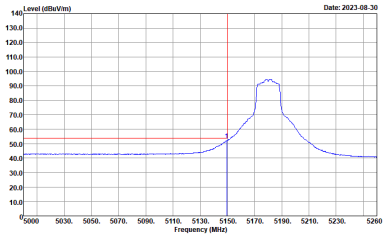
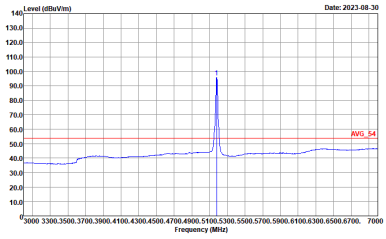
WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	802.11g CH06 2437MHz - R	
4+3	Horizontal	Fundamental
Peak		Left blank
Avg.		Left blank

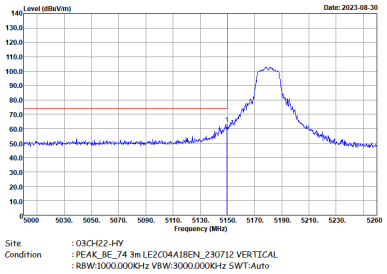
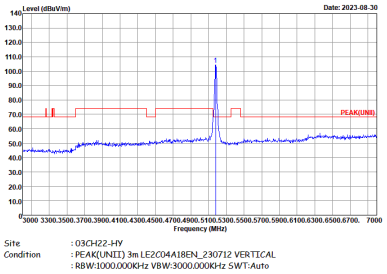
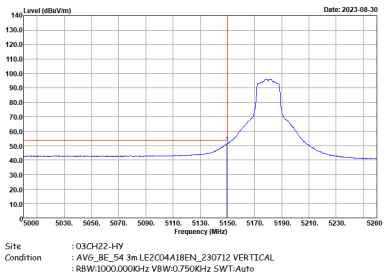
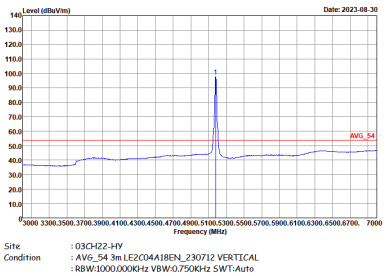
WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	802.11g CH06 2437MHz - L	
4+3	Vertical	Fundamental
Peak		
Avg.		

WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	802.11g CH06 2437MHz - R	
4+3	Vertical	Fundamental
Peak		Left blank
Avg.		Left blank

Band 1 - 5150~5250MHz

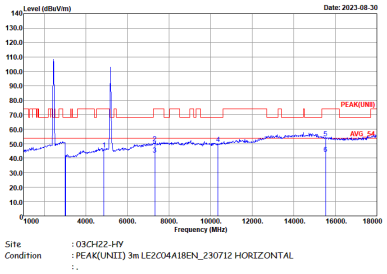
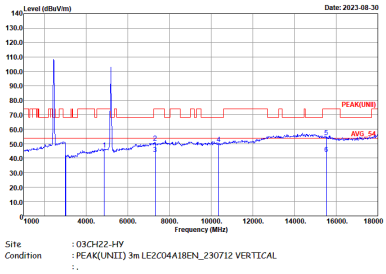
WIFI 802.11a (Band Edge @ 3m)

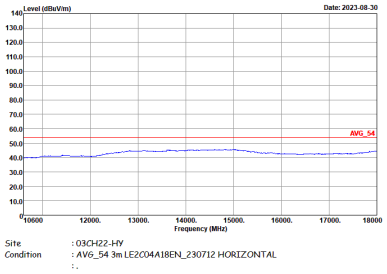
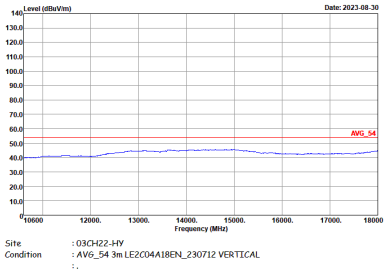
WIFI	Band 1 5150~5250MHz Band Edge @ 3m	
ANT	802.11a CH36 5180MHz	
4+3	Horizontal	Fundamental
Peak		
Avg.		

WIFI	Band 1 5150~5250MHz Band Edge @ 3m	
ANT	802.11a CH36 5180MHz	
4+3	Vertical	Fundamental
Peak		
Avg.		

WLAN (2.4GHz) 802.11g_Tx_CH06 + WLAN (5GHz) 802.11a_Tx_CH36

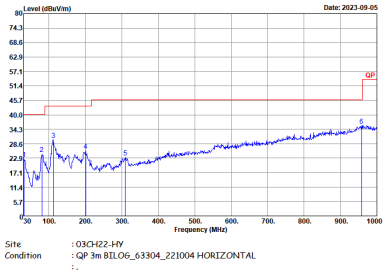
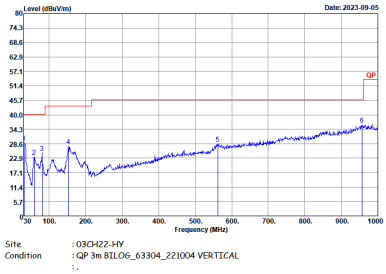
(Harmonic @ 3m)

WIFI	WIFI 802.11g + WIFI 802.11a Harmonic @ 3m	
ANT	11g_Tx_Ch06 + 11a_Tx_Ch36	
4+3	Horizontal	Vertical
Peak Avg.		

WIFI	WIFI 802.11g + WIFI 802.11a Harmonic @ 3m	
ANT	11g_Tx_Ch06 + 11a_Tx_Ch36	
4+3	Horizontal	Vertical
10.6G ~18G Avg.		

Emission below 1GHz

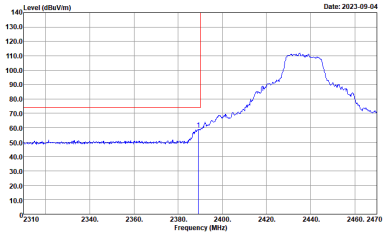
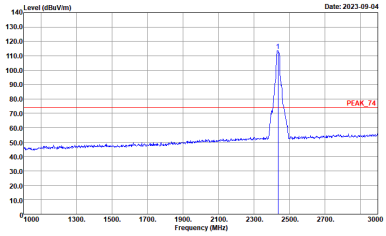
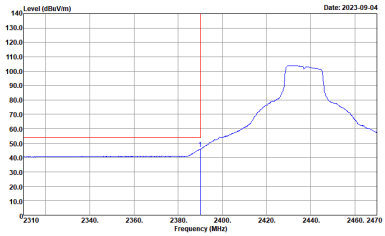
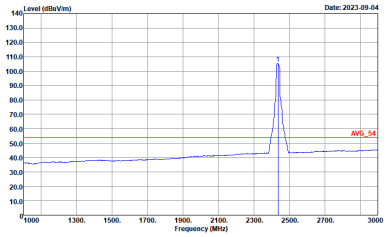
WLAN (2.4GHz) 802.11g_Tx_CH06 + WLAN (5GHz) 802.11a_Tx_CH36 (LF)

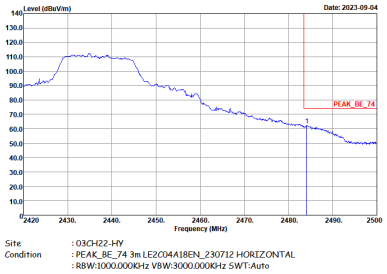
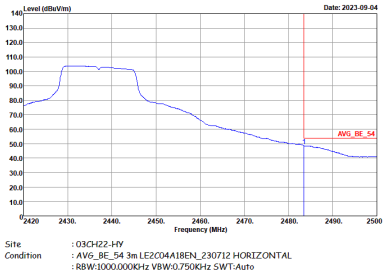
WIFI	WIFI 802.11g + WIFI 802.11a @ 3m	
ANT	11g_Tx_Ch06 + 11a_Tx_Ch36 LF	
4+3	Horizontal	Vertical
QP / Peak		

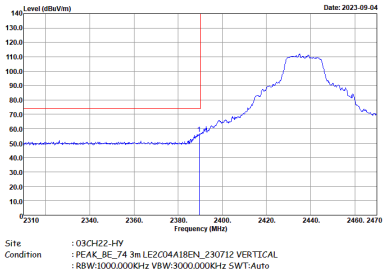
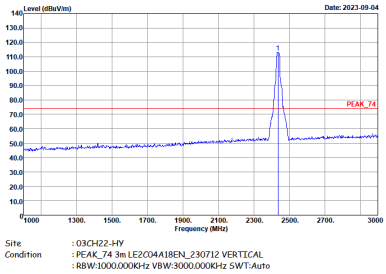
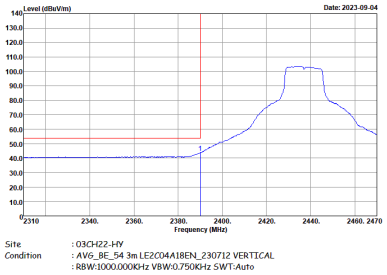
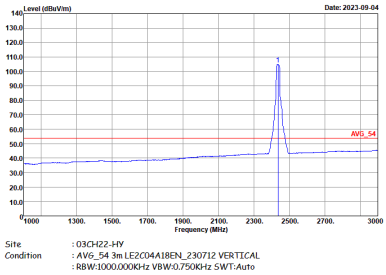
WLAN (2.4GHz) 802.11g_Tx_CH06 + WLAN (6GHz) 802.11a_Tx_CH01

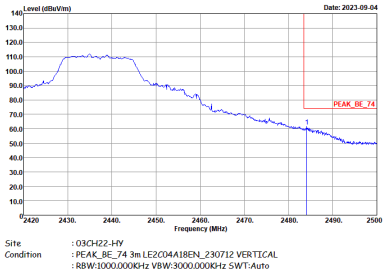
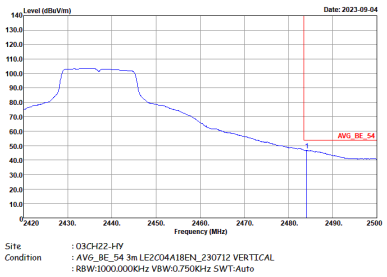
2.4GHz 2400~2483.5MHz

WIFI 802.11g (Band Edge @ 3m)

WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	802.11g CH06 2437MHz - L	
4+3	Horizontal	Fundamental
Peak		
Avg.		

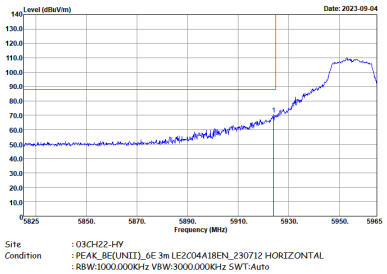
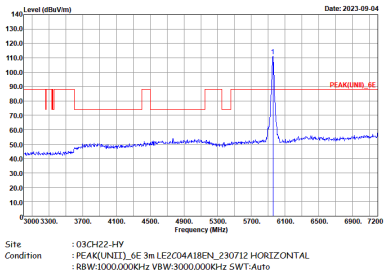
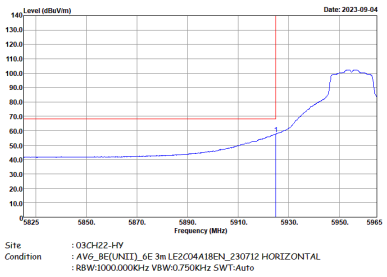
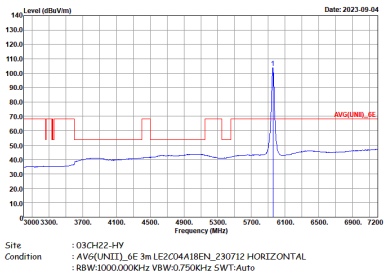
WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	802.11g CH06 2437MHz - R	
4+3	Horizontal	Fundamental
Peak		Left blank
Avg.		Left blank

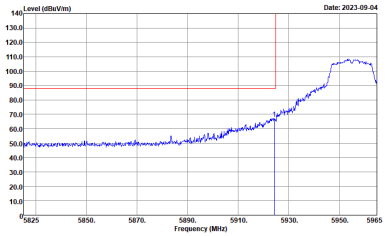
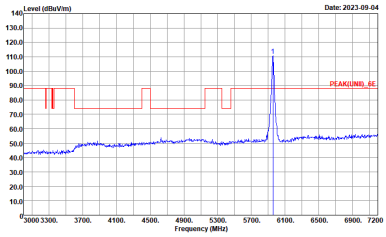
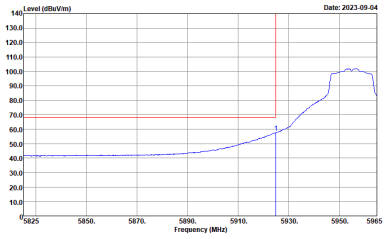
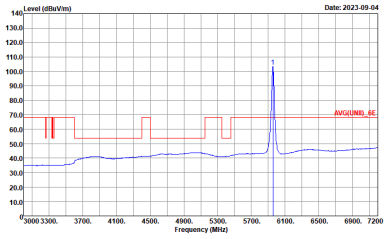
WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	802.11g CH06 2437MHz - L	
4+3	Vertical	Fundamental
Peak		
Avg.		

WIFI	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	802.11g CH06 2437MHz - R	
4+3	Vertical	Fundamental
Peak		Left blank
Avg.		Left blank

Band 5 - 5925~6425MHz

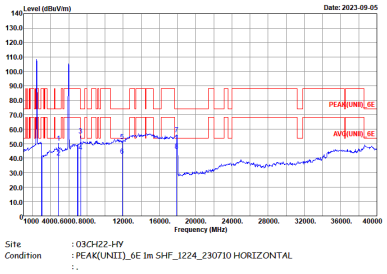
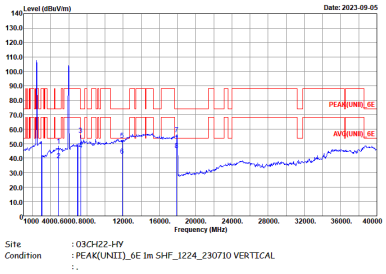
WIFI 802.11a (Band Edge @ 3m)

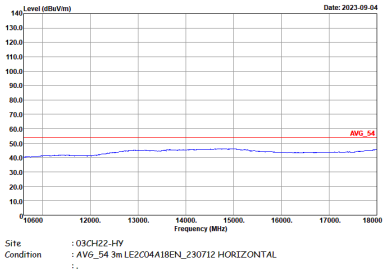
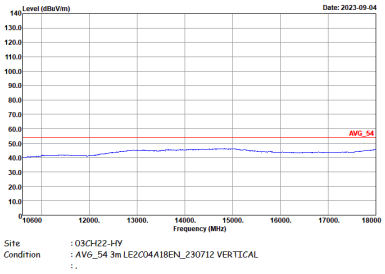
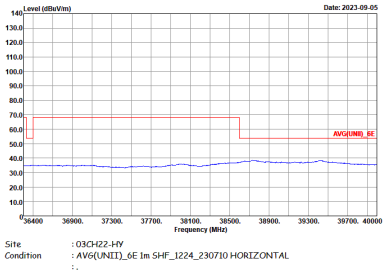
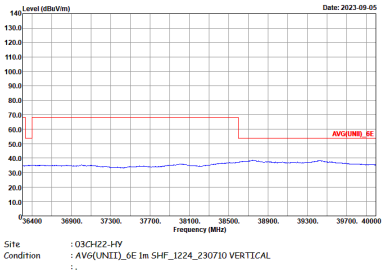
WIFI	Band 5 5925~6425MHz Band Edge @ 3m	
ANT	802.11a CH01 5955MHz	
4+3	Horizontal	Fundamental
Peak		
Avg.		

WIFI	Band 5 5925~6425MHz Band Edge @ 3m	
ANT	802.11a CH01 5955MHz	
4+3	Vertical	Fundamental
Peak	 Site : 03CH22-HY Condition : PEAK_BE(UNII)_6E 3m LE2C04A18EN_230712 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto	 Site : 03CH22-HY Condition : PEAK(UNII)_6E 3m LE2C04A18EN_230712 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto
Avg.	 Site : 03CH22-HY Condition : AVG_BE(UNII)_6E 3m LE2C04A18EN_230712 VERTICAL : RBW:1000.000KHz VBW:0.750KHz SWT:Auto	 Site : 03CH22-HY Condition : AVG(UNII)_6E 3m LE2C04A18EN_230712 VERTICAL : RBW:1000.000KHz VBW:0.750KHz SWT:Auto

WLAN (2.4GHz) 802.11g_Tx_CH06 + WLAN (6GHz) 802.11a_Tx_CH01

(Harmonic @ 3m)

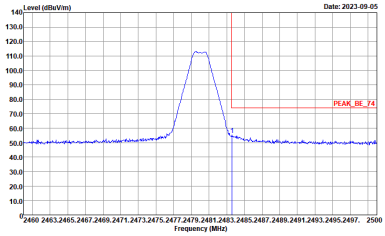
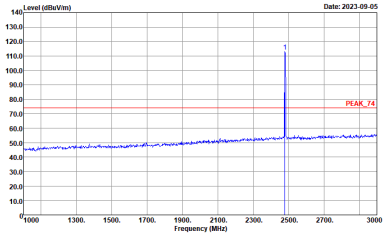
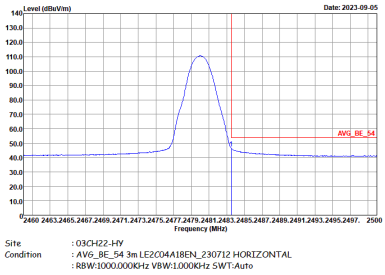
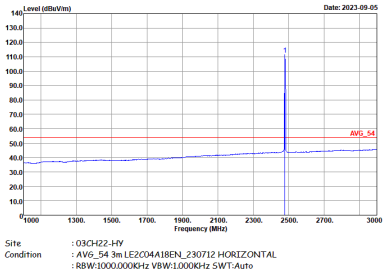
WIFI	WIFI 802.11g + WIFI 802.11a Harmonic @ 3m	
ANT	11g_Tx_Ch06 + 11a_Tx_Ch01	
4+3	Horizontal	Vertical
Peak Avg.		

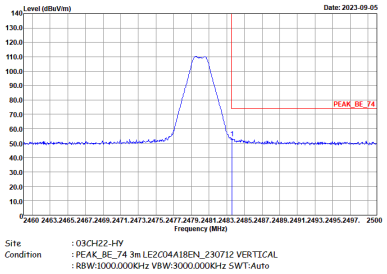
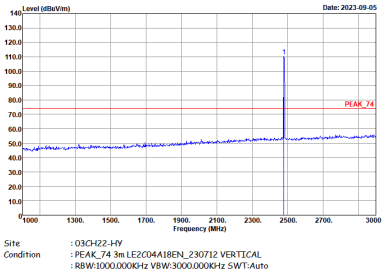
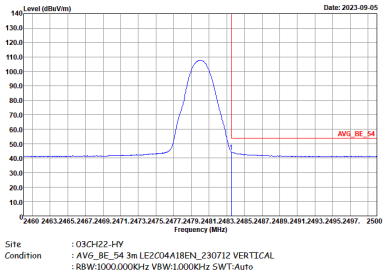
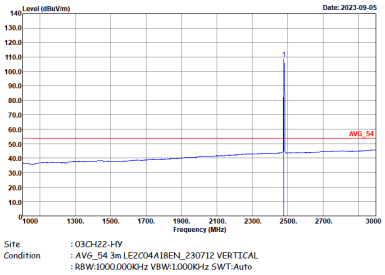
WIFI	WIFI 802.11g + WIFI 802.11a Harmonic @ 3m	
ANT	11g_Tx_Ch06 + 11a_Tx_Ch01	
4+3	Horizontal	Vertical
10.6G ~18G Avg.		
36.4G ~40G Avg.		

BLE(2M)_Tx_CH39 + WLAN (5GHz) 802.11a_Tx_CH36

2.4GHz 2400~2483.5MHz

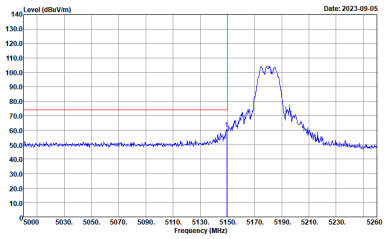
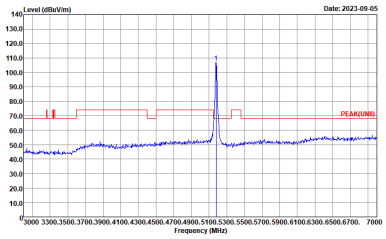
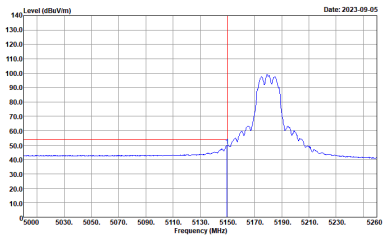
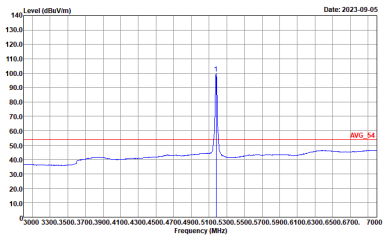
BLE (Band Edge @ 3m)

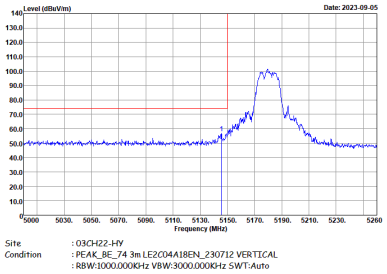
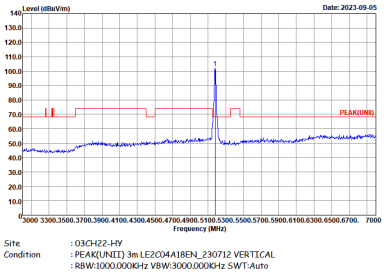
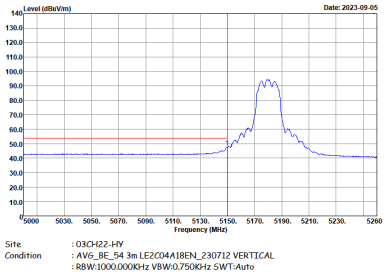
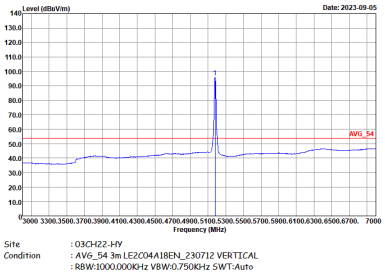
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BLE CH39 2480MHz	
3	Horizontal	Fundamental
Peak		
Avg.		

BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BLE CH39 2480MHz	
3	Vertical	Fundamental
Peak		
Avg.		

Band 1 - 5150~5250MHz

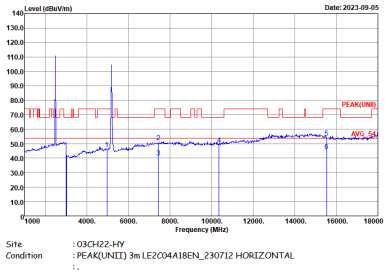
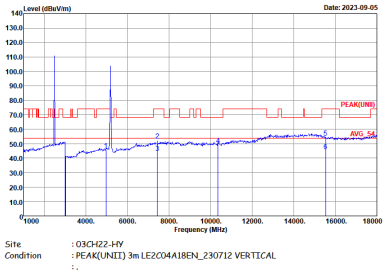
WIFI 802.11a (Band Edge @ 3m)

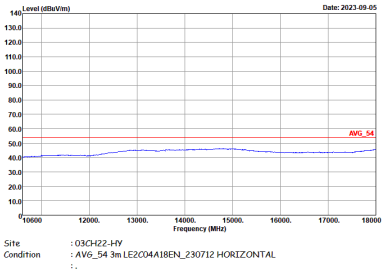
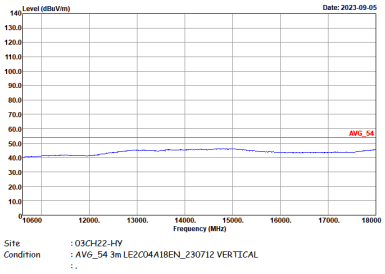
WIFI	Band 1 5150~5250MHz Band Edge @ 3m	
ANT	802.11a CH36 5180MHz	
4+3	Horizontal	Fundamental
Peak	 Site : 03CH22-HY Condition : PEAK_BE_74 3m LE2C04A18EN_230712 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto	 Site : 03CH22-HY Condition : PEAK(UNII) 3m LE2C04A18EN_230712 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto
Avg.	 Site : 03CH22-HY Condition : AVG_BE_54 3m LE2C04A18EN_230712 HORIZONTAL : RBW:1000.000KHz VBW:0.750KHz SWT:Auto	 Site : 03CH22-HY Condition : AVG_54 3m LE2C04A18EN_230712 HORIZONTAL : RBW:1000.000KHz VBW:0.750KHz SWT:Auto

WIFI	Band 1 5150~5250MHz Band Edge @ 3m	
ANT	802.11a CH36 5180MHz	
4+3	Vertical	Fundamental
Peak		
Avg.		

BLE(2M)_Tx_CH39 + WLAN (5GHz) 802.11a_Tx_CH36

(Harmonic @ 3m)

	BLE + WIFI 802.11a Harmonic @ 3m	
ANT	BLE_Tx_Ch39 + 11a_Tx_Ch36	
Simultaneously	Horizontal	Vertical
Peak Avg.		

	BLE + WIFI 802.11a Harmonic @ 3m	
ANT	BLE_Tx_Ch39 + 11a_Tx_Ch36	
Simultaneously	Horizontal	Vertical
10.6G ~18G Avg.		

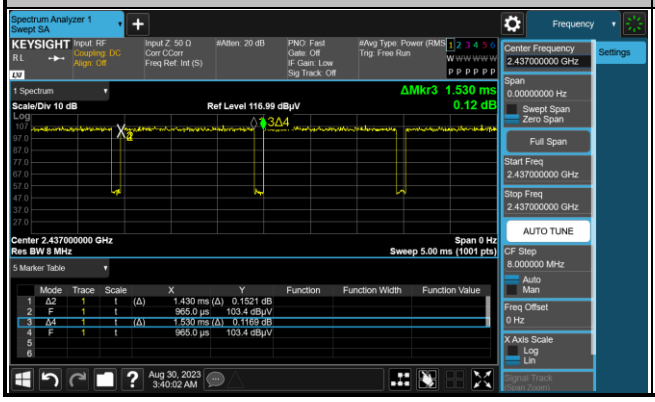
Appendix C. Duty Cycle Plots

<Mode 1>

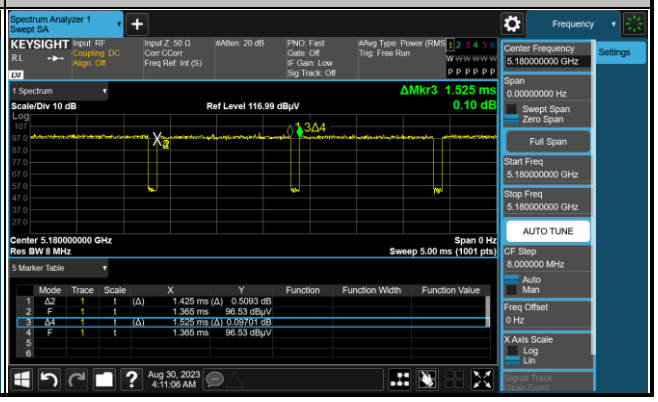
Antenna	Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting
4+3	2.4GHz 802.11g	93.46	1430	0.70	750Hz
4+3	5GHz 802.11a	93.44	1425	0.70	750Hz

MIMO <Ant. 4+3>

2.4GHz 802.11g



5GHz 802.11a

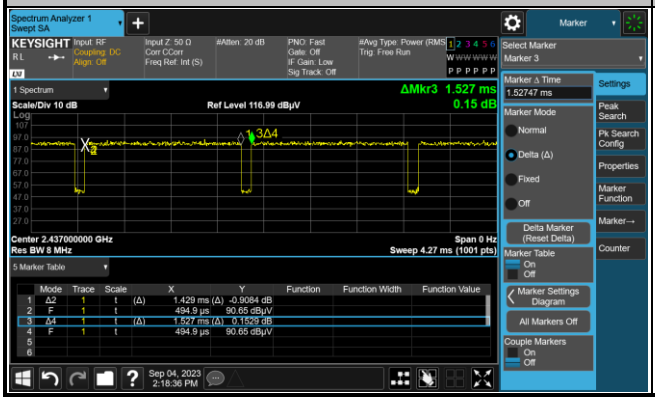


<Mode 2>

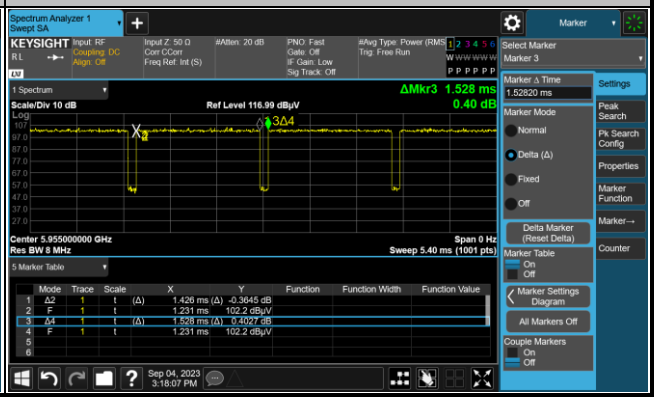
Antenna	Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting
4+3	2.4GHz 802.11g	93.58	1429	0.70	750Hz
4+3	6GHz 802.11a	93.32	1426	0.70	750Hz

MIMO <Ant. 4+3>

2.4GHz 802.11g



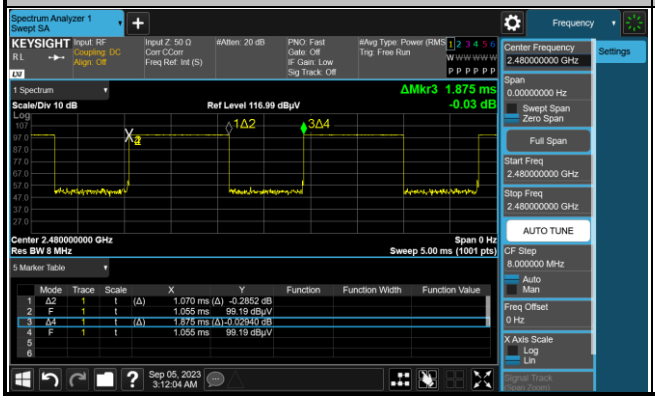
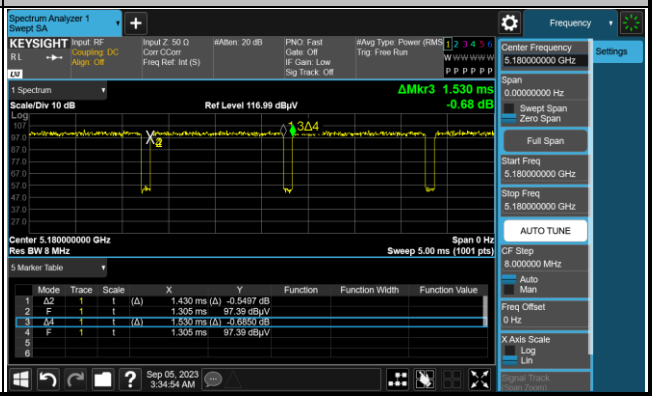
6GHz 802.11a



<Mode 3>

Antenna	Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting
3	Bluetooth - LE for 2Mbps	57.07	1070	0.93	1kHz
4+3	5GHz 802.11a	93.46	1430	0.70	750Hz

<Ant. 3> **MIMO <Ant. 4+3>**

Bluetooth - LE for 2Mbps	5GHz 802.11a
	

———THE END———