FCC CO-LOCATION RADIO TEST REPORT

FCC ID	:	**A4RGZRNL**
Equipment	:	**Interactive Media Streaming Device**
Model Name	:	**GZRNL**
Applicant	:	**Google LLC** **1600 Amphitheatre Parkway,** **Mountain View, California, 94043 USA**
Standard	:	**FCC Part 15 Subpart E §15.407**

The product was received on Feb. 10, 2020 and testing was started from Feb. 25, 2020 and completed on Mar. 25, 2020. We, SPORTON INTERNATIONAL INC., EMC & Wireless Communications Laboratory, would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The report must not be used by the client to claim product certification, approval, or endorsement by TAF or any agency of government.

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.

Louis Wu

Approved by: Louis Wu

SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory
No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.)

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History of this test report

Report No.	Version	Description	Issued Date
FR971035-01F	01	Initial issue of report	Mar. 31, 2020

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 3.18 dB at 5149.240 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: Wii Chang

Report Producer: Yimin Ho

1 General Description

1.1 Product Feature of Equipment Under Test

Product Feature	
Equipment	Interactive Media Streaming Device
Model Name	GZRNL
FCC ID	A4RGZRNL
EUT supports Radios application	WLAN 11b/g/n HT20 WLAN 11a/n HT20/HT40 WLAN 11ac VHT20/VHT40/VHT80 Bluetooth BR/EDR/LE
EUT Stage	Identical Prototype

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

EUT Information List	
S/N	Performed Test Item
01091HFDD013AA	Radiated Spurious Emission

1.2 Product Specification of Equipment Under Test

Standards-related Product Specification	
Tx/Rx Frequency Range	2400 MHz ~ 2483.5 MHz 5180 MHz ~ 5240 MHz
Antenna Type / Gain	**Bluetooth:** PIFA Antenna with gain 3.02 dBi **<5180 MHz ~ 5240 MHz>**: PIFA Antenna with gain 4.58 dBi
Type of Modulation	Bluetooth BR (1Mbps) : GFSK Bluetooth LE : GFSK 802.11a : OFDM (BPSK / QPSK / 16QAM / 64QAM)

1.3 Modification of EUT

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

1.4 Testing Location

Test Site	SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory
Test Site Location	No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.) TEL: +886-3-327-0868 FAX: +886-3-327-0855
Test Site No.	**Sporton Site No.**
	03CH12-HY

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

FCC designation No.: TW0007

1.5 Applicable Standards

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

- FCC Part 15 Subpart E
- 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.
- ANSI C63.10-2013

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

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, pre-scanned in three orthogonal panels, X, Y, Z. The worst cases (X plane) were recorded in this report.

2.1 Carrier Frequency and Channel

2400-2483.5 MHz Bluetooth		2400-2483.5 MHz Bluetooth-LE		5150-5250 MHz 802.11a	
Channel	**Freq. (MHz)**	**Channel**	**Freq. (MHz)**	**Channel**	**Freq. (MHz)**
78	2480	39	2480	36	5180

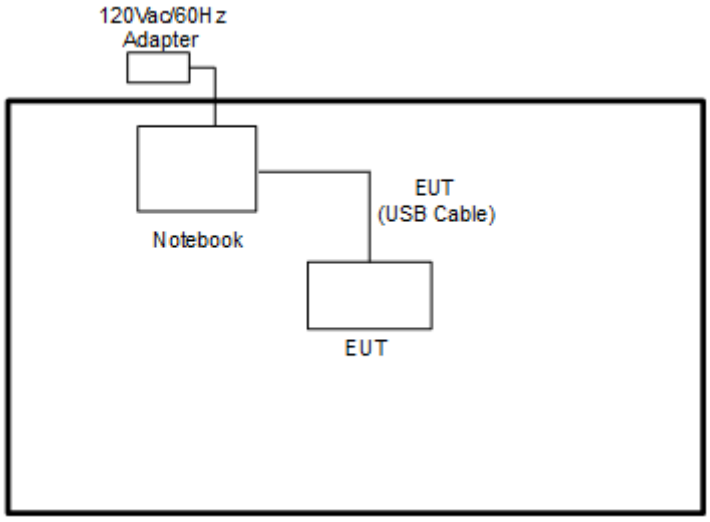
2.2 Test Mode

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

<Co-Location>

Modulation	Data Rate
Bluetooth BR + 5GHz 802.11a	**1Mbps + 6Mbps**
Bluetooth LE + 5GHz 802.11a	**1Mbps + 6Mbps**

2.3 Connection Diagram of Test System



2.4 Support Unit used in test configuration and system

Item	Equipment	Trade Name	Model Name	FCC ID	Data Cable	Power Cord
1.	Notebook	DELL	Latitude 3400	FCC DoC	N/A	AC I/P: Unshielded, 1.2 m DC O/P: Shielded, 1.8 m

2.5 EUT Operation Test Setup

The RF test items, utility “CMD” 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.

$$E=\frac{1000000\sqrt{30P}}{3}$$ 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

See list of measuring equipment of 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

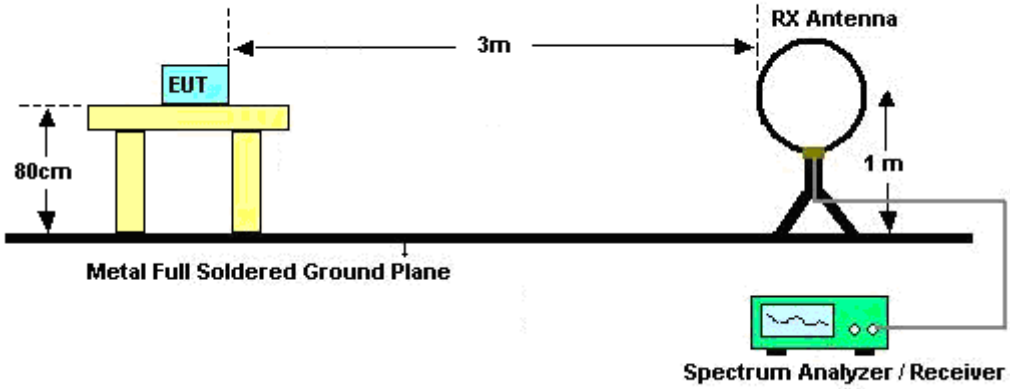
   - RBW = 1 MHz
   - VBW ≥ 3 MHz
   - Detector = Peak
   - Sweep time = auto
   - Trace mode = max hold

   (3) Procedures for Average Unwanted Emissions Measurements Above 1000MHz

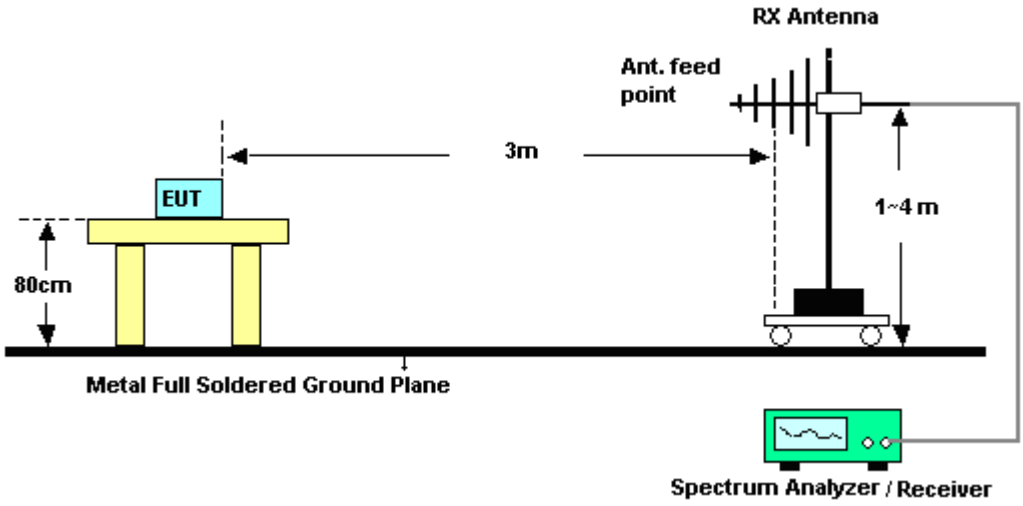
   - RBW = 1 MHz
   - VBW = 10 Hz, when duty cycle is no less than 98 percent.
   - VBW ≥ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.
2. 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.

3.1.4 Test Setup

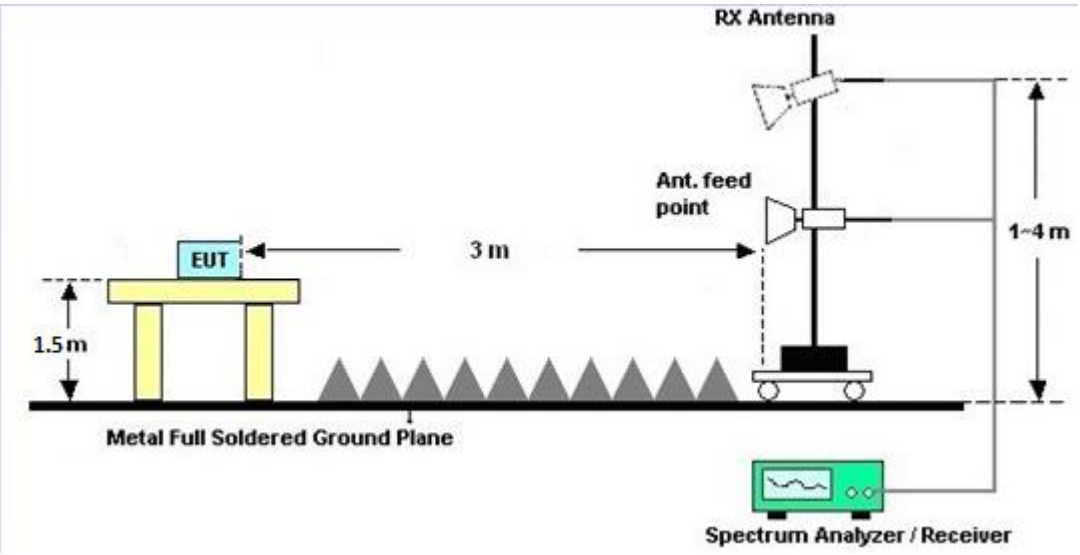
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



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 a comparison data 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

If transmitting antenna directional gain is greater than 6 dBi, both the peak transmit power and the peak power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

3.2.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.2.3 Antenna Gain

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

4 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100315	9 kHz~30 MHz	Dec. 26, 2019	Feb. 25, 2020~ Mar. 25, 2020	Dec. 25, 2020	Radiation (03CH12-HY)
Bilog Antenna	TESEQ	CBL 6111D & 00800N1D01 N-06	37059 & 01	30MHz~1GHz	Oct. 12, 2019	Feb. 25, 2020~ Mar. 25, 2020	Oct. 11, 2020	Radiation (03CH12-HY)
Horn Antenna	SCHWARZBECK	BBHA 9120D	9120D-1328	1GHz ~ 18GHz	Nov. 14, 2019	Feb. 25, 2020~ Mar. 25, 2020	Nov. 13, 2020	Radiation (03CH12-HY)
SHF-EHF Horn Antenna	SCHWARZBECK	BBHA 9170	BBHA9170584	18GHz ~ 40GHz	Dec. 10, 2019	Feb. 25, 2020~ Mar. 25, 2020	Dec. 09, 2020	Radiation (03CH12-HY)
Preamplifier	SONOMA	310N	187312	9kHz~1GHz	Dec. 03, 2019	Feb. 25, 2020~ Mar. 25, 2020	Dec. 02, 2020	Radiation (03CH12-HY)
Preamplifier	Jet-Power	JAP00101800 -30-10P	160118550004	1GHz~18GHz	Sep. 27, 2019	Feb. 25, 2020~ Mar. 25, 2020	Sep. 26, 2020	Radiation (03CH12-HY)
Preamplifier	Keysight	83017A	MY53270148	1GHz~26.5GHz	Dec. 20, 2019	Feb. 25, 2020~ Mar. 25, 2020	Dec. 19, 2020	Radiation (03CH12-HY)
Preamplifier	EMEC	EM18G40G	060715	18GHz ~ 40GHz	Dec. 13, 2019	Feb. 25, 2020~ Mar. 25, 2020	Dec. 12, 2020	Radiation (03CH12-HY)
Spectrum Analyzer	Rohde & Schwarz	FSV40	101408	10Hz~40GHz	Aug. 13, 2019	Feb. 25, 2020~ Mar. 25, 2020	Aug. 12, 2020	Radiation (03CH12-HY)
Hygrometer	TECPEL	DTM-303B	TP161243	N/A	May 11, 2020	Feb. 25, 2020~ Mar. 25, 2020	May 10, 2021	Radiation (03CH12-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 126E	0058/126E	30M-18G	Dec. 12, 2019	Feb. 25, 2020~ Mar. 25, 2020	Dec. 11, 2020	Radiation (03CH12-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	505134/2	30M~40GHz	Feb. 25, 2020	Feb. 25, 2020~ Mar. 25, 2020	Feb. 24, 2021	Radiation (03CH12-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	800740/2	30M~40GHz	Feb. 25, 2020	Feb. 25, 2020~ Mar. 25, 2020	Feb. 24, 2021	Radiation (03CH12-HY)
Controller	EMEC	EM1000	N/A	Control Turn table & Ant Mast	N/A	Feb. 25, 2020~ Mar. 25, 2020	N/A	Radiation (03CH12-HY)
Antenna Mast	EMEC	AM-BS-4500-B	N/A	1m~4m	N/A	Feb. 25, 2020~ Mar. 25, 2020	N/A	Radiation (03CH12-HY)
Turn Table	EMEC	TT2000	N/A	0~360 Degree	N/A	Feb. 25, 2020~ Mar. 25, 2020	N/A	Radiation (03CH12-HY)
Software	Audix	E3 6.2009-8-24	RK-000989	N/A	N/A	Feb. 25, 2020~ Mar. 25, 2020	N/A	Radiation (03CH12-HY)
Filter	Wainwright	WLK4-1000-1530-8000-40SS	SN11	1.53GHz Low Pass Filter	Sep. 15, 2019	Feb. 25, 2020~ Mar. 25, 2020	Sep. 14, 2020	Radiation (03CH12-HY)
Filter	Wainwright	WHKX8-5872.5-6750-18000-40ST	SN6	6.75GHz High Pass Filter	Jul. 02, 2019	Feb. 25, 2020~ Mar. 25, 2020	Jul. 01, 2020	Radiation (03CH12-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))	**5.1**

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**5.6**

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**5.0**

Appendix A. Radiated Spurious Emission

Test Engineer :	Jack Cheng , Lance Chiang and Chuan Chu	Temperature :	20~24°C
		Relative Humidity :	50~56%

2.4GHz 2480MHz + 5GHz 5180MHz

BT_Tx_Ch78+11a_Tx_Ch36 (Band Edge @ 3m)

BT+WIFI Ant. Simultaneously	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
BT CH78 2480MHz	*	2480	104.29	-	-	100.26	27.34	5.95	29.26	400	86	P	H
	*	2480	79.53	-	-	-	-	-	-	-	-	A	H
		2483.76	55.22	-18.78	74	51.19	27.33	5.95	29.25	400	86	P	H
		2483.76	30.46	-23.54	54	-	-	-	-	-	-	A	H
													H
	*	2480	100.49	-	-	96.46	27.34	5.95	29.26	400	94	P	V
	*	2480	75.73	-	-	-	-	-	-	-	-	A	V
		2483.6	53.55	-20.45	74	49.52	27.33	5.95	29.25	400	94	P	V
		2483.6	28.79	-25.21	54	-	-	-	-	-	-	A	V
													V
802.11a CH 36 5180MHz		5149.76	68.76	-5.24	74	56.72	31.8	8.97	28.73	305	73	P	H
		5149.24	47.76	-6.24	54	35.72	31.8	8.97	28.73	305	73	A	H
	*	5180	109.51	-	-	97.51	31.74	8.99	28.73	305	73	P	H
	*	5180	99.01	-	-	87.01	31.74	8.99	28.73	305	73	A	H
													H
		5149.24	60.84	-13.16	74	48.8	31.8	8.97	28.73	322	95	P	V
		5138.32	43.7	-10.3	54	31.65	31.82	8.96	28.73	322	95	A	V
	*	5180	101.93	-	-	89.93	31.74	8.99	28.73	322	95	P	V
	*	5180	92.27	-	-	80.27	31.74	8.99	28.73	322	95	A	V
													V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

BT_Tx_Ch78+11a_Tx_Ch36 *(Harmonic @ 3m)*

BT+WIFI Ant. Simultaneously	Note	Frequency (MHz)	Level (dBµV/m)	Over Limit (dB)	Limit Line (dBµV/m)	Read Level (dBµV)	Antenna Factor (dB/m)	Path Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
BT CH78 2480MHz + 802.11a CH 36 5180MHz		4960	54.97	-19.03	74	43.62	31.24	8.83	28.72	100	15	P	H
		4960	44.89	-9.11	54	33.54	31.24	8.83	28.72	100	15	A	H
		7440	47.15	-26.85	74	56.49	36.4	13.3	59.04	100	0	P	H
		10360	51.86	-16.34	68.2	57.64	39.8	16.57	62.15	100	0	P	H
		15540	48.95	-25.05	74	51.78	38.02	19.79	60.64	100	0	P	H
		4960	59.2	-14.8	74	47.85	31.24	8.83	28.72	105	223	P	V
		4960	44.95	-9.05	54	33.6	31.24	8.83	28.72	105	223	A	V
		7440	46.33	-27.67	74	55.67	36.4	13.3	59.04	100	0	P	V
		10360	52.04	-16.16	68.2	57.82	39.8	16.57	62.15	100	0	P	V
		15540	48.72	-25.28	74	51.55	38.02	19.79	60.64	100	0	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

2.4GHz 2480MHz + 5GHz 5180MHz

BLE(1M)_Tx_Ch39+11a_Tx_Ch36 (Band Edge @ 3m)

BLE+WIFI Ant. Simultaneously	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(1M) CH39 2480MHz	*	2480	101.18	-	-	87.12	27.34	15.98	29.26	314	62	P	H
	*	2480	100.07	-	-	86.01	27.34	15.98	29.26	314	62	A	H
		2484.12	57.73	-16.27	74	43.67	27.33	15.98	29.25	314	62	P	H
		2483.88	44.91	-9.09	54	30.85	27.33	15.98	29.25	314	62	A	H
												P	H
												A	H
	*	2480	95.71	-	-	81.65	27.34	15.98	29.26	300	56	P	V
	*	2480	94.68	-	-	80.62	27.34	15.98	29.26	300	56	A	V
		2484.12	57.11	-16.89	74	43.05	27.33	15.98	29.25	300	56	P	V
		2493.52	44.62	-9.38	54	30.56	27.31	16	29.25	300	56	A	V
												P	V
												A	V
802.11a CH 36 5180MHz		5149.24	70.82	-3.18	74	58.78	31.8	8.97	28.73	335	79	P	H
		5149.76	49.55	-4.45	54	37.51	31.8	8.97	28.73	335	79	A	H
	*	5180	110.6	-	-	98.6	31.74	8.99	28.73	335	79	P	H
	*	5180	101.19	-	-	89.19	31.74	8.99	28.73	335	79	A	H
												P	H
												A	H
		5149.76	63.68	-10.32	74	51.64	31.8	8.97	28.73	319	91	P	V
		5149.76	44.78	-9.22	54	32.74	31.8	8.97	28.73	319	91	A	V
	*	5180	104.26	-	-	92.26	31.74	8.99	28.73	319	91	P	V
	*	5180	94.72	-	-	82.72	31.74	8.99	28.73	319	91	A	V
												P	V
												A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

BLE(1M)_Tx_Ch39+11a_Tx_Ch36 *(Harmonic @ 3m)*

BLE+WIFI Ant. Simultaneously	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(1M) CH39 2480MHz + 802.11a CH 36 5180MHz		4960	56.75	-17.25	74	45.4	31.24	8.83	28.72	100	12	P	H
		4960	43.78	-10.22	54	32.43	31.24	8.83	28.72	100	12	A	H
		7440	47.13	-26.87	74	56.47	36.4	13.3	59.04	100	0	P	H
		10360	51.24	-16.96	68.2	57.02	39.8	16.57	62.15	100	0	P	H
		15540	48.74	-25.26	74	51.57	38.02	19.79	60.64	100	0	P	H
		4960	56.14	-17.86	74	44.79	31.24	8.83	28.72	105	235	P	V
		4960	43.72	-10.28	54	32.37	31.24	8.83	28.72	105	235	A	V
		7440	46.56	-27.44	74	55.9	36.4	13.3	59.04	100	0	P	V
		10360	51.27	-16.93	68.2	57.05	39.8	16.57	62.15	100	0	P	V
		15540	47.84	-26.16	74	50.67	38.02	19.79	60.64	100	0	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

Emission below 1GHz

BLE(1M)_Tx_Ch39+11a_Tx_Ch36 (LF)

BLE+WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
Ant.				Limit	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(1M) CH39 2480MHz + 802.11a CH 36 5180MHz LF		59.1	33.52	-6.48	40	53.79	11.59	0.65	32.51	100	0	P	H
		119.24	23.23	-20.27	43.5	37.31	17.21	1.13	32.42	-	-	P	H
		208.48	29.18	-14.32	43.5	45.25	15	1.49	32.56	-	-	P	H
		664.38	38.36	-7.64	46	41.46	26.22	2.79	32.11	-	-	P	H
		896.21	33.29	-12.71	46	32.29	29	3.75	31.75	-	-	P	H
		947.62	34.51	-11.49	46	31.45	30.49	3.67	31.1	-	-	P	H
													H
													H
													H
													H
													H
													H
		30.97	31.18	-8.82	40	39.08	24.01	0.51	32.42	100	0	P	V
		60.07	30.81	-9.19	40	51.02	11.64	0.66	32.51	-	-	P	V
		213.33	24.5	-19	43.5	40.62	14.89	1.53	32.54	-	-	P	V
		664.38	36.66	-9.34	46	39.76	26.22	2.79	32.11	-	-	P	V
		886.51	33.07	-12.93	46	32.16	29.01	3.69	31.79	-	-	P	V
		953.44	35.06	-10.94	46	31.67	30.73	3.68	31.02	-	-	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	**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	Over	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
Ant.				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
1+2		(MHz)	(dBµV/m)	(dB)	(dBµV/m)	(dBµV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11b 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. 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

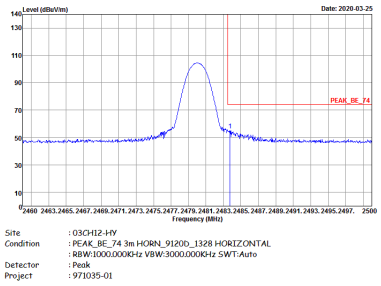
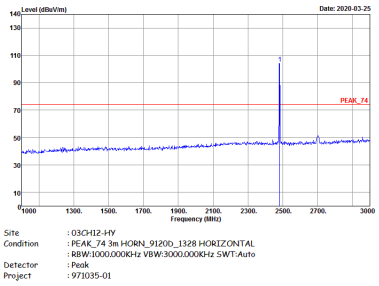
Test Engineer :	Jack Cheng , Lance Chiang and Chuan Chu	**Temperature :**	20~24°C
		Relative Humidity :	50~56%

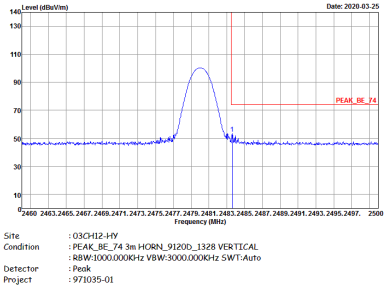
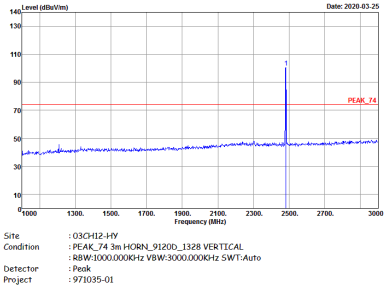
Note symbol

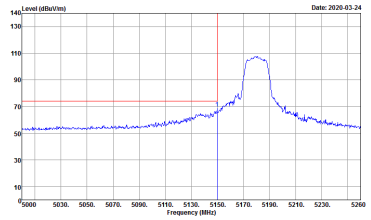
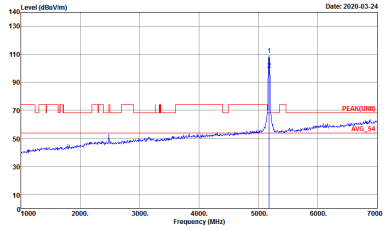
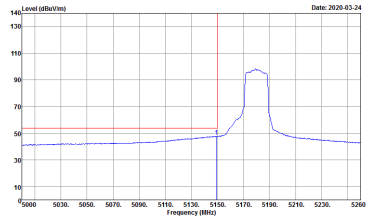
-L	**Low channel location**
-R	**High channel location**

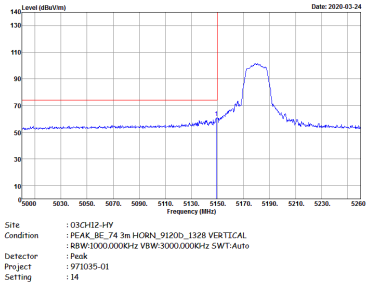
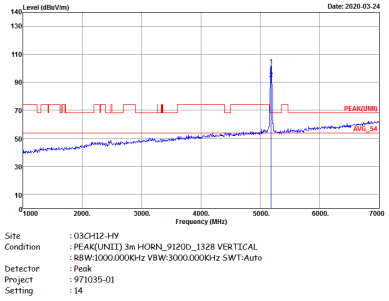
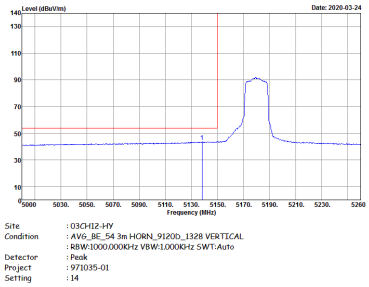
2.4GHz 2400~2483.5MHz+Band 1 - 5150~5250MHz

BT_Tx_Ch78+11a_Tx_Ch36 (Band Edge @ 3m)

BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BT CH78 2480MHz - L	
Simultaneously	Horizontal	Fundamental
Peak		
Avg.	Left blank	Left blank

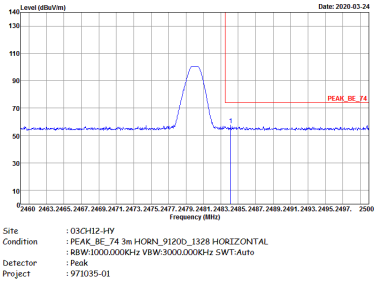
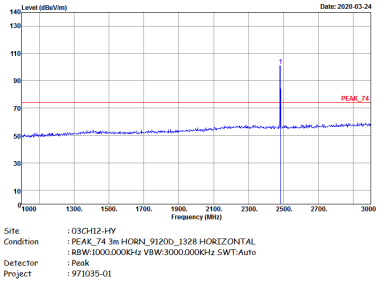
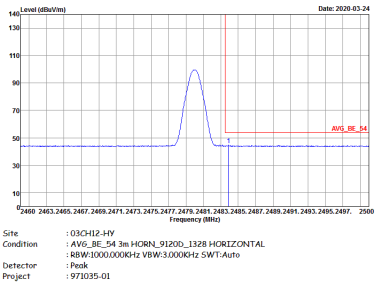
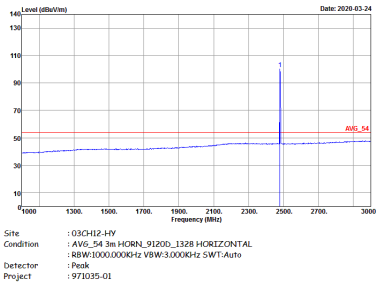
BT	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BT CH78 2480MHz - L	
Simultaneously	Vertical	Fundamental
Peak		
Avg.	Left blank	Left blank

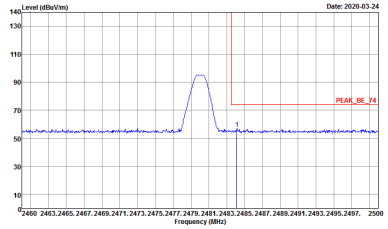
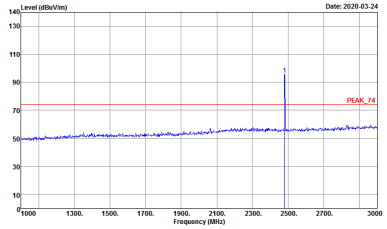
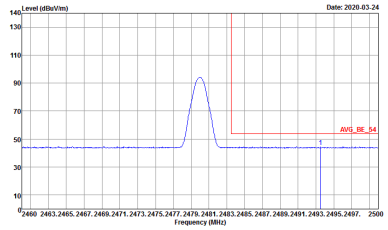
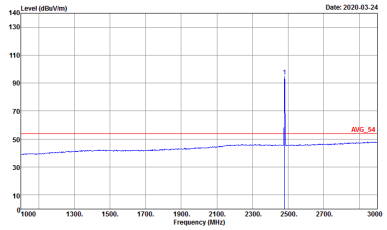
WIFI	Band 1 5150~5250MHz Band Edge @ 3m	
ANT	802.11a CH36 5180MHz - L	
Simultaneously	Horizontal	Fundamental
Peak	 Site : 03CH12-HY Condition : PEAK_BE_74 3m HORN_9120D_1328 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 971035-01 Setting : 14	 Site : 03CH12-HY Condition : PEAK(UNII) 3m HORN_9120D_1328 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 971035-01 Setting : 14
Avg.	 Site : 03CH12-HY Condition : AVG_BE_54 3m HORN_9120D_1328 HORIZONTAL : RBW:1000.000KHz VBW:1.000KHz SWT:Auto Detector : Peak Project : 971035-01 Setting : 14	Left blank

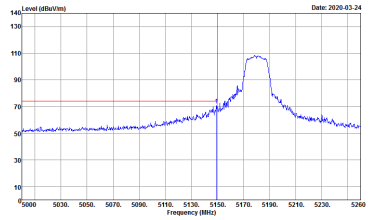
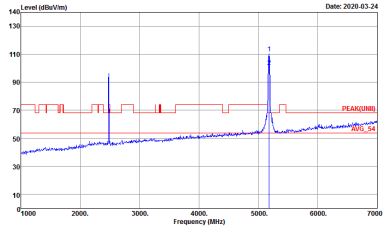
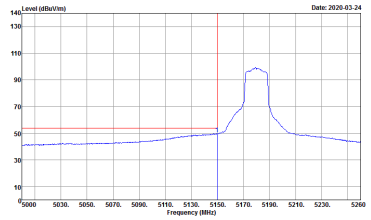
WIFI	Band 1 5150~5250MHz Band Edge @ 3m	
ANT	802.11a CH36 5180MHz - L	
Simultaneously	Vertical	Fundamental
Peak		
Avg.		Left blank

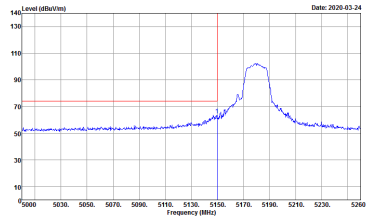
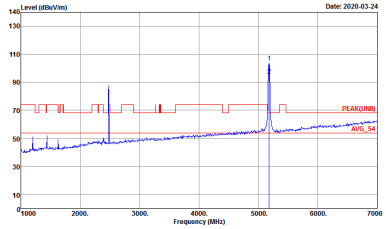
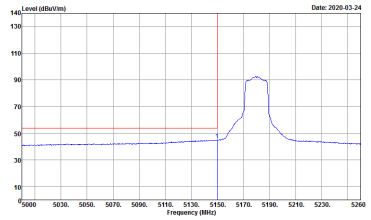
2.4GHz 2400~2483.5MHz+Band 1 - 5150~5250MHz

BLE(1M)_Tx_Ch39+11a_Tx_Ch36 (Band Edge @ 3m)

BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BLE(1M) CH39 2480MHz - L	
Simultaneously	Horizontal	Fundamental
Peak		
Avg.		

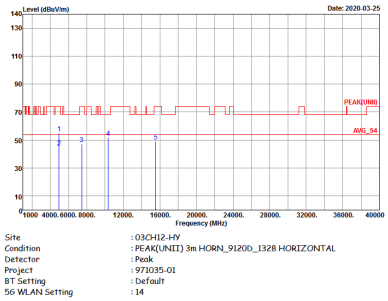
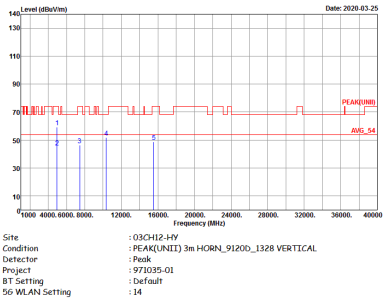
BLE	2.4GHz 2400~2483.5MHz Band Edge @ 3m	
ANT	BLE(1M) CH39 2480MHz - L	
Simultaneously	Vertical	Fundamental
Peak	 Site : 03CH12-HY Condition : PEAK_BE_74 3m HORN_9120D_1328 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 971035-01	 Site : 03CH12-HY Condition : PEAK_74 3m HORN_9120D_1328 VERTICAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 971035-01
Avg.	 Site : 03CH12-HY Condition : AVG_BE_54 3m HORN_9120D_1328 VERTICAL : RBW:1000.000KHz VBW:3.000KHz SWT:Auto Detector : Peak Project : 971035-01	 Site : 03CH12-HY Condition : AVG_54 3m HORN_9120D_1328 VERTICAL : RBW:1000.000KHz VBW:3.000KHz SWT:Auto Detector : Peak Project : 971035-01

WIFI	Band 1 5150~5250MHz Band Edge @ 3m	
ANT	802.11a CH36 5180MHz - L	
Simultaneously	Horizontal	Fundamental
Peak	 Site : 03CH12-HY Condition : PEAK_BE_74 3m HORN_9120D_1328 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 971035-01 Setting : 14	 Site : 03CH12-HY Condition : PEAK(UNII) 3m HORN_9120D_1328 HORIZONTAL : RBW:1000.000KHz VBW:3000.000KHz SWT:Auto Detector : Peak Project : 971035-01 Setting : 14
Avg.	 Site : 03CH12-HY Condition : AVG_BE_54 3m HORN_9120D_1328 HORIZONTAL : RBW:1000.000KHz VBW:1.000KHz SWT:Auto Detector : Peak Project : 971035-01 Setting : 14	Left blank

WIFI	Band 1 5150~5250MHz Band Edge @ 3m	
ANT	802.11a CH36 5180MHz - L	
Simultaneously	Vertical	Fundamental
Peak		
Avg.		Left blank

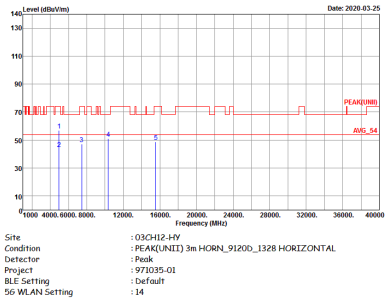
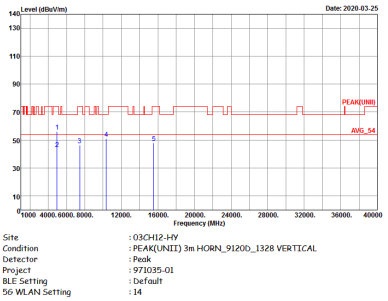
2.4GHz 2400~2483.5MHz+Band 1 - 5150~5250MHz

BT_Tx_Ch78+11a_Tx_Ch36 (Harmonic @ 3m)

WIFI	2.4GHz 2480 MHz+5GHz 5180MHz Harmonic @ 3m	
ANT	BT_Tx_CH78+11a_Tx_Ch36 2480+5180MHz	
Simultaneously	Horizontal	Vertical
Peak Avg.		

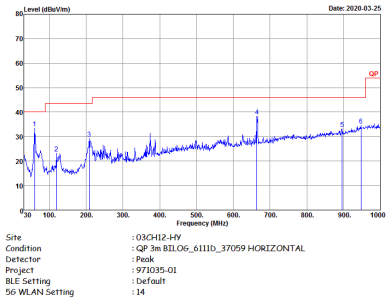
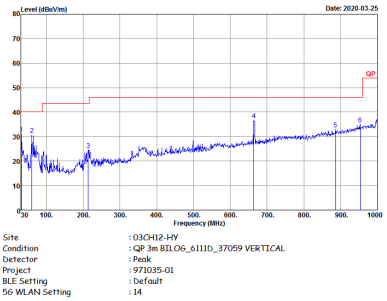
2.4GHz 2400~2483.5MHz+Band 1 - 5150~5250MHz

BLE(1M)_Tx_Ch39+11a_Tx_Ch36 (Harmonic @ 3m)

WIFI	2.4GHz 2480 MHz+5GHz 5180MHz Harmonic @ 3m	
ANT	BLE(1M)_Tx_CH39+11a_Tx_Ch36 2480+5180MHz	
Simultaneously	Horizontal	Vertical
Peak Avg.		

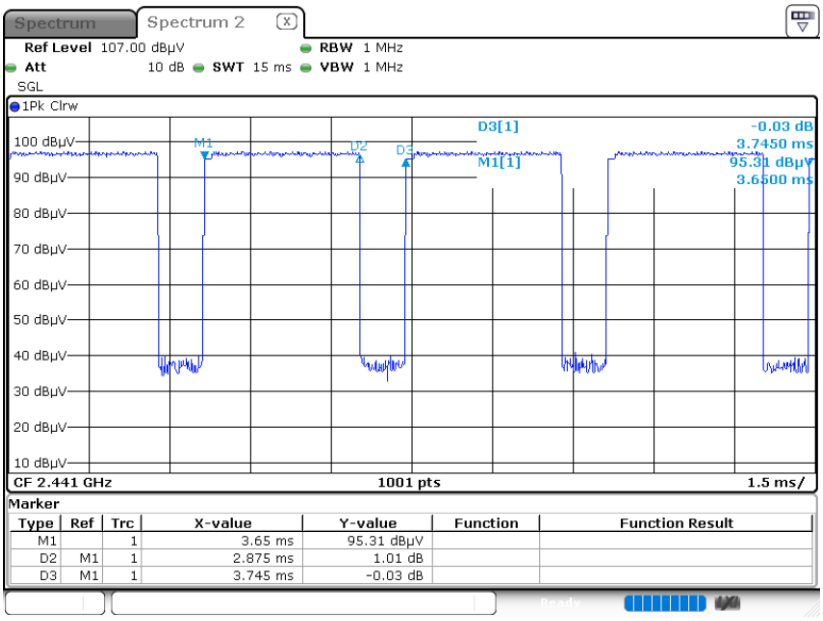
Emission below 1GHz

BLE(1M)_Tx_Ch39+11a_Tx_Ch36 (LF)

WIFI	2.4GHz 2480 MHz+5GHz 5180MHz	
ANT	BLE(1M)_Tx_Ch39+11a_Tx_Ch36 LF	
Simultaneously	Horizontal	Vertical
QP / Peak		

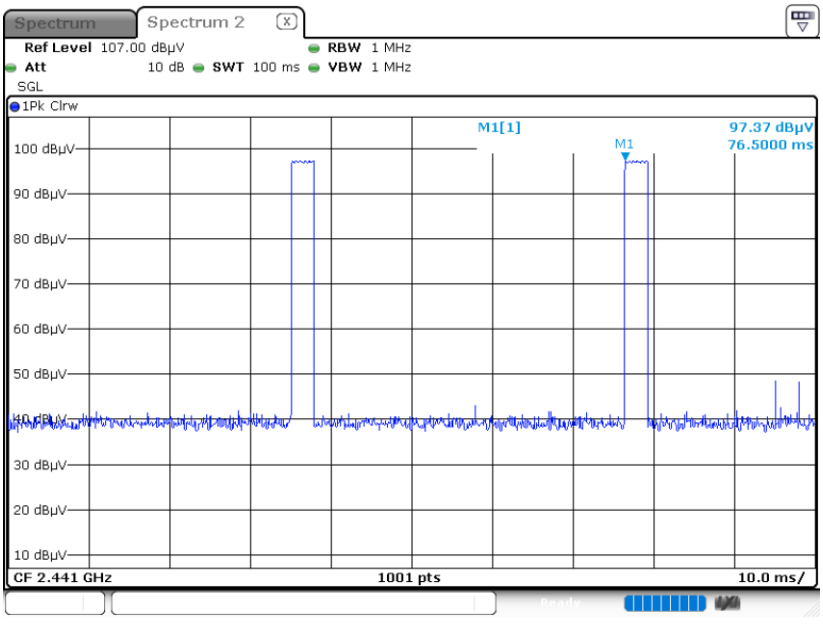
Appendix C. Duty Cycle Plots

3DH5 on time (One Pulse) Plot on Channel 39



Date: 17.FEB.2020 16:02:01

on time (Count Pulses) Plot on Channel 39



Date: 17.FEB.2020 16:06:52

Note:

1. Worst case Duty cycle = on time/100 milliseconds = 2 * 2.88 / 100 = 5.76 %
2. Worst case Duty cycle correction factor = 20*log(Duty cycle) = -24.81 dB
3. **3DH5** has the highest duty cycle worst case and is reported.

Duty Cycle Correction Factor Consideration for AFH mode:

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

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

2.88 ms x 20 channels = 57.6 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. [100ms / 57.6ms] = 2 hops

Thus, the maximum possible ON time:

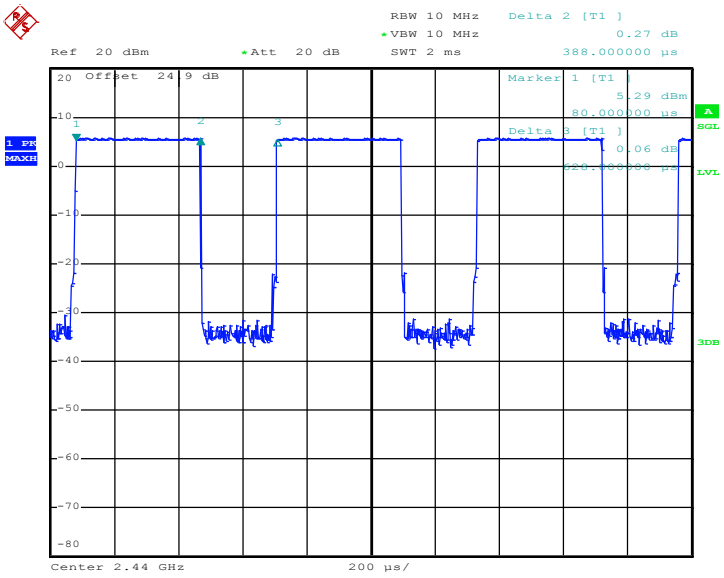
2.88 ms x 2 = 5.76 ms

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

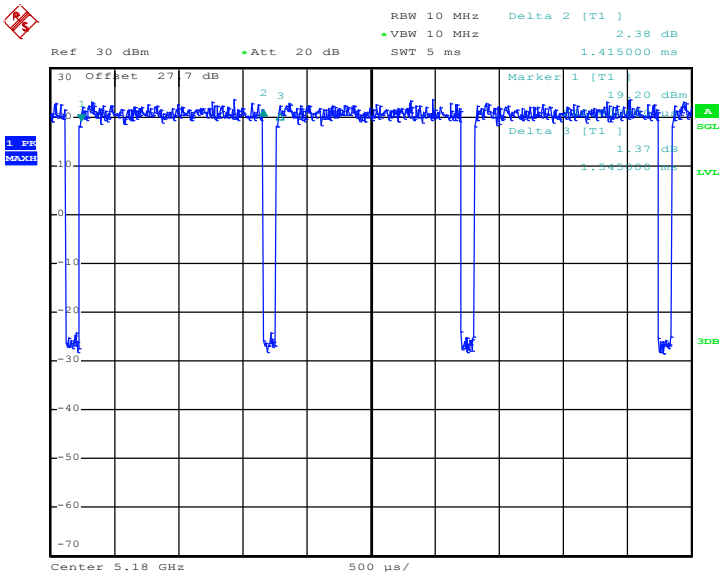
20 x log(5.76 ms/100ms) = -24.81 dB

Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting	Duty Factor(dB)
Bluetooth LE for 1 Mbps	61.78	388	2.58	3kHz	2.09
802.11a	91.59	1415	0.71	1kHz	0.38

Bluetooth - LE for 1Mbps



802.11a



THE END