FCC CO-LOCATION RADIO TEST REPORT

FCC ID	:	**WR974100118120**
Equipment	:	**SmartCamera with voice control**
Brand Name	:	**ecobee**
Model Name	:	**EBSCV01**
Applicant	:	**ecobee Incorporated** **207 Queens Quay West, Suite 600, Toronto, Ontario, M5J 1A7, Canada**
Manufacturer	:	**Wistron Corporation** **21F, No. 88, Sec. 1, Hsin Tai Wu Rd., Hsichih Dist, New Taipei City 221,Taiwan R.O.C**
Standard	:	**FCC Part 15 Subpart E §15.407**

The product was received on Jul. 23, 2019 and testing was started from Aug. 26, 2019 and completed on Aug. 27, 2019. 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
FR972333G	01	Initial issue of report	Oct. 24, 2019

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 2.37 dB at 2483.520 MHz
-	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

Bluetooth, Wi-Fi 2.4GHz 802.11b/g/n, Wi-Fi 5GHz 802.11a/n/ac, and Sub-gig

Product Specification subjective to this standard	
Antenna Type	WLAN: PIFA Antenna Bluetooth: PIFA Antenna Sub-gig: PIFA Antenna

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.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.**
	03CH11-HY

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

FCC Designation No. TW0007

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 KDB 789033 D02 General UNII Test Procedures New Rules v02r01.
- FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v05r02
- FCC KDB 414788 D01 Radiated Test Site v01r01.
- 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. This EUT has also been tested and complied with the requirements of FCC Part 15, Subpart B, recorded in a separate test report.

2 Test Configuration of Equipment Under Test

The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). For radiated measurement, 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

920.00-927.35 MHz		2400-2483.5 MHz		2400-2483.5 MHz		5150-5250 MHz	
Sub-gig		Bluetooth - LE		802.11n HT20		802.11ac VTH20	
Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)
0	920.00	39	2480	11	2462	36	5180

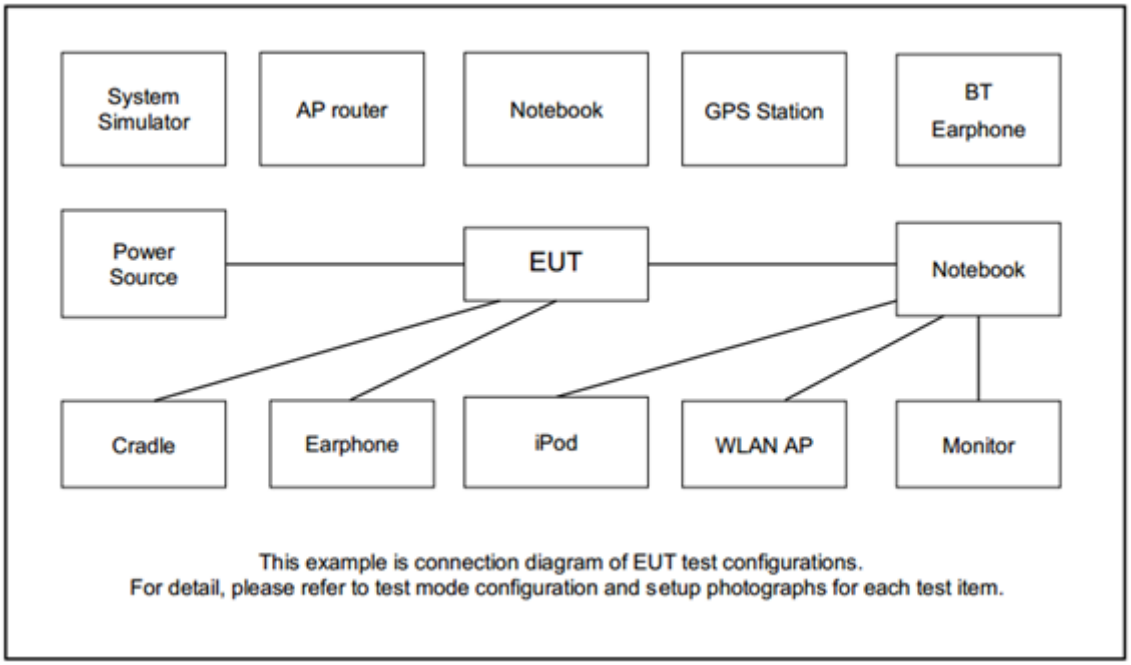
2.2 Test Mode

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

<Co-Location>

Modulation	Data Rate
Bluetooth - LE for Ant. 2 + 2.4GHz 802.11n HT20 for Ant. 1 + Sub-gig for Ant. 3	2Mbps + MCS0 + FSK
Bluetooth - LE for Ant. 2 + 5GHz 802.11ac VHT20 for Ant. 1 + Sub-gig for Ant. 3	2Mbps + MCS0 + FSK

2.3 Connection Diagram of Test System



2.4 EUT Operation Test Setup

The RF test items, utility “adb cmd” was installed in EUT 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) Section 15.407(b)(1) to (b)(3) specify the unwanted emission limits 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.[3]

(ii) Section 15.407(b)(4) specifies the unwanted emission limit for the U-NII-3 band. A band emissions mask is specified in Section 15.407(b)(4)(i). The emission limits are in terms of a Peak detector. An alternative to the band emissions mask is specified in Section 15.407(b)(4)(ii). The alternative limits are based on the highest antenna gain specified in the filing. There are also marketing and importation restrictions for the devices using the alternative limit.[4]

Note 3: An out-of-band emission that complies with both the average and peak limits of Section 15.209 is not required to satisfy the -27 dBm/MHz peak emission limit.

Note 4: Only devices with antenna gains of 10 dBi or less may be approved using the emission limits specified in Section 15.247(d) till March 2, 2018; all other devices operating in this band must use the mask specified in Section 15.407(b)(4)(i).

3.1.2 Measuring Instruments

See list of measuring equipment of this test report.

3.1.3 Test Procedures

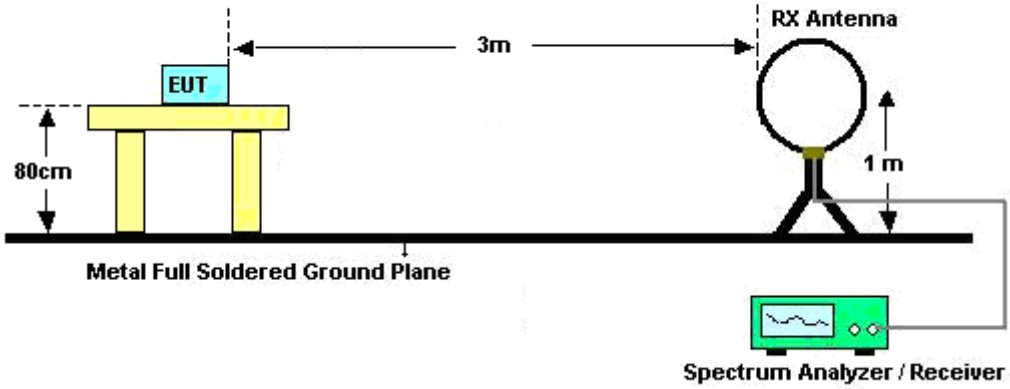
1. The testing follows FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01. Section G) Unwanted emissions measurement.
   (1) Procedure for Unwanted Emissions Measurements Below 1000MHz
   - RBW = 120 kHz
   - VBW = 300 kHz
   - Detector = Peak
   - Trace mode = max hold

   (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

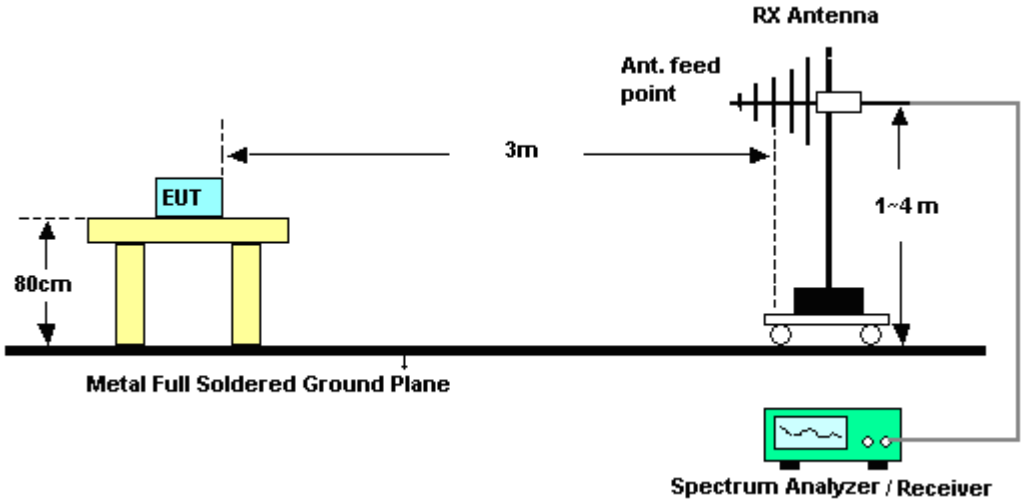
   (3) Procedures for Average Unwanted Emissions Measurements Above 1000MHz
   - RBW = 1 MHz
   - VBW = 10 Hz, when duty cycle is no less than 98 percent.
   - VBW ≥ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting 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

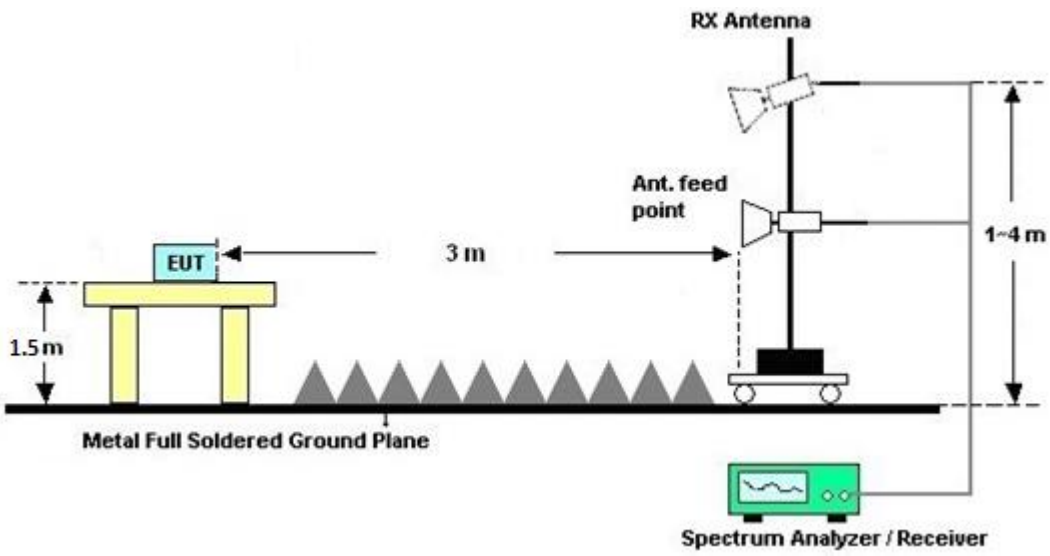
For radiated emissions below 30MHz



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.

4 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Preamplifier	EMEC	EM18G40G	060715	18GHz ~ 40GHz	Dec. 06, 2018	Aug. 26, 2019~ Aug. 27, 2019	Dec. 05, 2019	Radiation (03CH11-HY)
Amplifier	SONOMA	310N	187312	9kHz~1GHz	Dec. 04, 2018	Aug. 26, 2019~ Aug. 27, 2019	Dec. 03, 2019	Radiation (03CH11-HY)
Bilog Antenna	TESEQ	CBL 6111D&N-6-06	35414&AT-N0 602	30MHz~1GHz	Oct. 13, 2018	Aug. 26, 2019~ Aug. 27, 2019	Oct. 12, 2019	Radiation (03CH11-HY)
Horn Antenna	SCHWARZBE CK	BBHA 9120 D	9120D-1326	1GHz ~ 18GHz	Oct. 30, 2018	Aug. 26, 2019~ Aug. 27, 2019	Oct. 29, 2019	Radiation (03CH11-HY)
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100488	9 kHz~30 MHz	Nov. 22, 2018	Aug. 26, 2019~ Aug. 27, 2019	Nov. 21, 2019	Radiation (03CH11-HY)
Preamplifier	Keysight	83017A	MY53270080	1GHz~26.5GHz	Nov. 14, 2018	Aug. 26, 2019~ Aug. 27, 2019	Nov. 13, 2020	Radiation (03CH11-HY)
Spectrum Analyzer	Keysight	N9010A	MY54200486	10Hz ~ 44GHz	Oct. 19, 2018	Aug. 26, 2019~ Aug. 27, 2019	Oct. 18, 2019	Radiation (03CH11-HY)
Antenna Mast	EMEC	AM-BS-4500-B	N/A	1~4m	N/A	Aug. 26, 2019~ Aug. 27, 2019	N/A	Radiation (03CH11-HY)
Turn Table	EMEC	TT 2000	N/A	0~360 Degree	N/A	Aug. 26, 2019~ Aug. 27, 2019	N/A	Radiation (03CH11-HY)
Preamplifier	MITEQ	AMF-7D-0010 1800-30-10P	1590074	1GHz~18GHz	May 20, 2019	Aug. 26, 2019~ Aug. 27, 2019	May 19, 2020	Radiation (03CH11-HY)
SHF-EHF Horn Antenna	SCHWARZBE CK	BBHA 9170	BBHA9170584	18GHz- 40GHz	Dec. 05, 2018	Aug. 26, 2019~ Aug. 27, 2019	Dec. 04, 2019	Radiation (03CH11-HY)
EMI Test Receiver	Keysight	N9038A(MXE)	MY54130085	N/A	Nov. 01, 2018	Aug. 26, 2019~ Aug. 27, 2019	Oct. 31, 2019	Radiation (03CH11-HY)
Software	Audix	E3 6.2009-8-24	RK-001042	N/A	N/A	Aug. 26, 2019~ Aug. 27, 2019	N/A	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY9837/4PE	9kHz-30MHz	Mar. 13, 2019	Aug. 26, 2019~ Aug. 27, 2019	Mar. 12, 2020	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	MY2859/2	30MHz-40GHz	Mar. 13, 2019	Aug. 26, 2019~ Aug. 27, 2019	Mar. 12, 2020	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY9837/4PE	30M-18G	Mar. 13, 2019	Aug. 26, 2019~ Aug. 27, 2019	Mar. 12, 2020	Radiation (03CH11-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	MY4274/2	30MHz-40GHz	Mar. 13, 2019	Aug. 26, 2019~ Aug. 27, 2019	Mar. 12, 2020	Radiation (03CH11-HY)
Filter	Wainwright	WLK4-1000-15 30-8000-40SS	SN11	1.53G Low Pass	Sep. 16, 2018	Aug. 26, 2019~ Aug. 27, 2019	Sep. 15, 2019	Radiation (03CH11-HY)
Filter	Wainwright	WHKX8-5872. 5-6750-18000- 40ST	SN3	6.75GHz High Pass	Sep. 17, 2018	Aug. 26, 2019~ Aug. 27, 2019	Sep. 16, 2019	Radiation (03CH11-HY)
Filter	Wainwright	WHKX12-2700 -3000-18000-6 0SS	SN3	2.7G High Pass	Sep. 16, 2018	Aug. 26, 2019~ Aug. 27, 2019	Sep. 15, 2019	Radiation (03CH11-HY)
Filter	Wainwright	WHKX12-1080 -1200-15000-6 0SS	SN2	1.2GHz High Pass Filter	Sep. 16, 2018	Aug. 26, 2019~ Aug. 27, 2019	Sep. 15, 2019	Radiation (03CH11-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))	**5.2**

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**5.5**

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**5.2**

Appendix A. Radiated Spurious Emission

Test Engineer :	Fu Chen	Temperature :	23.4~25.3°C
		Relative Humidity :	51.4~58%

Co-location

BLE(2M) + WIFI 802.11n HT20 + Sub-gig (Band Edge @ 3m)

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(2M)_CH39	*	2462	109.24	-	-	98.82	27.3	16.72	33.6	108	114	P	H
2480 MHz	*	2462	101.77	-	-	91.35	27.3	16.72	33.6	108	114	A	H
Ant 2		2483.8	67.91	-6.09	74	57.47	27.3	16.74	33.6	108	114	P	H
+		2483.52	51.63	-2.37	54	41.19	27.3	16.74	33.6	108	114	A	H
802.11n HT20													H
CH11													H
2462MHz	*	2462	104.42	-	-	94	27.3	16.72	33.6	118	195	P	V
Ant 1	*	2462	96.63	-	-	86.21	27.3	16.72	33.6	118	195	A	V
+		2484.44	61.23	-12.77	74	50.79	27.3	16.74	33.6	118	195	P	V
Sub-gig_CH00		2483.52	47.14	-6.86	54	36.7	27.3	16.74	33.6	118	195	A	V
920MHz													V
Ant 3													V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

BLE*(2M)* + WIFI 802.11n HT20 + Sub-gig (Harmonic @ 3m)

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(2M)_CH39 2480 MHz Ant 2 + 802.11n HT20 CH11 2462MHz Ant 1 + Sub-gig_CH00 920MHz Ant 3		1840	41.88	-32.12	74	44.16	25.18	6.51	33.97	100	0	P	H
		2760	44.83	-29.17	74	43.25	27.76	7.39	33.57	100	0	P	H
		3720	47.19	-26.81	74	66.51	29.24	9.81	58.37	100	0	P	H
		4924	40.19	-33.81	74	55.3	31.14	11.09	57.34	100	0	P	H
		4960	44.14	-29.86	74	58.98	31.32	11.11	57.27	100	0	P	H
		7386	43.55	-30.45	74	50.89	36.46	13.58	57.38	100	0	P	H
		7440	44.96	-29.04	74	52.3	36.48	13.62	57.44	100	0	P	H
													H
		1840	40.61	-33.39	74	42.89	25.18	6.51	33.97	100	0	P	V
		2760	45.79	-28.21	74	44.21	27.76	7.39	33.57	100	0	P	V
		4924	39.29	-34.71	74	54.4	31.14	11.09	57.34	100	0	P	V
		4960	42.23	-31.77	74	57.07	31.32	11.11	57.27	100	0	P	V
		7386	44.39	-29.61	74	51.73	36.46	13.58	57.38	100	0	P	V
		7440	43.2	-30.8	74	50.54	36.48	13.62	57.44	100	0	P	V
		1840	40.61	-33.39	74	42.89	25.18	6.51	33.97	100	0	P	V
													V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

Emission below 1GHz

BLE(2M) + WIFI 802.11n HT20 + Sub-gig (LF @ 3m)

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(2M)_CH39 2480 MHz Ant 2 + 802.11n HT20 CH11 2462MHz Ant 1 + Sub-gig_CH00 920MHz Ant 3		101.78	22.68	-20.82	43.5	37.7	15.95	1.35	32.32	-	-	P	H
		111.48	22.69	-20.81	43.5	36.78	16.82	1.4	32.31	-	-	P	H
		143.49	34.93	-8.57	43.5	48.51	17.11	1.6	32.29	100	0	P	H
		807.94	32.1	-13.9	46	31.83	28.17	3.94	31.84	-	-	P	H
		847.71	32.75	-13.25	46	31.27	29.05	4.06	31.63	-	-	P	H
	*	920	109.27	-	-	107.08	29.12	4.24	31.17	-	-	P	H
		949.56	34.29	-11.71	46	30.32	30.55	4.31	30.89	-	-	P	H
													H
													H
		39.7	25.09	-14.91	40	37.43	19.2	0.83	32.37	-	-	P	V
		72.68	24.79	-15.21	40	43.67	12.3	1.17	32.35	-	-	P	V
		140.58	32.83	-10.67	43.5	46.42	17.13	1.57	32.29	100	0	P	V
		733.25	29.92	-16.08	46	30.65	27.57	3.75	32.05	-	-	P	V
		865.17	32.6	-13.4	46	30.74	29.28	4.11	31.53	-	-	P	V
	*	920	106.13	-	-	103.94	29.12	4.24	31.17	-	-	P	V
		949.56	34.35	-11.65	46	30.38	30.55	4.31	30.89	-	-	P	V
													V
													V
Remark	1. No other spurious found. 2. All results are PASS against limit line.												

Co-location

BLE(2M) + WIFI 802.11n HT20 + Sub-gig (Band Edge @ 3m)

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(2M)_CH39	*	2480	99.16	-	-	88.73	27.3	16.73	33.6	109	320	P	H
2480 MHz	*	2480	97.89	-	-	87.46	27.3	16.73	33.6	109	320	A	H
Ant 2		2483.6	54.94	-19.06	74	44.5	27.3	16.74	33.6	109	320	P	H
+		2483.56	47.71	-6.29	54	37.27	27.3	16.74	33.6	109	320	A	H
802.11n HT20													H
CH36													H
5180MHz	*	2480	101.96	-	-	91.53	27.3	16.73	33.6	110	276	P	V
Ant 1	*	2480	100.67	-	-	90.24	27.3	16.73	33.6	110	276	A	V
+		2483.52	56.27	-17.73	74	45.83	27.3	16.74	33.6	110	276	P	V
Sub-gig_CH00		2483.52	49.73	-4.27	54	39.29	27.3	16.74	33.6	110	276	A	V
920MHz													V
Ant 3													V
Remark	1. No other spurious found. 2.All results are PASS against Peak and Average limit line.												

BLE*(2M)* + WIFI 802.11n HT20 + Sub-gig (Harmonic @ 3m)

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(2M)_CH39 2480 MHz Ant 2 + 802.11n HT20 CH36 5180MHz Ant 1 + Sub-gig_CH00 920MHz Ant 3		1840	40.67	-33.33	74	42.95	25.18	6.51	33.97	100	0	P	H
		2760	44.81	-29.19	74	43.23	27.76	7.39	33.57	100	0	P	H
		4260	58.66	-15.34	74	52.23	30.12	9.48	33.17	398	331	P	H
		4260	48.59	-5.41	54	42.16	30.12	9.48	33.17	398	331	A	H
		4960	52.96	-21.04	74	44.7	31.32	10.06	33.12	110	334	P	H
		4960	46.22	-7.78	54	37.96	31.32	10.06	33.12	110	334	A	H
		6100	61.33	-6.87	68.2	51.25	32.6	10.81	33.33	398	331	P	H
		7440	45.01	-28.99	74	51.98	36.48	13.99	57.44	100	0	P	H
		10360	50.5	-17.7	68.2	51.79	39.54	16.12	56.95	100	0	P	H
		15540	47.2	-26.8	74	45	38.3	20.56	56.66	100	0	P	H
		1840	40.85	-33.15	74	43.13	25.18	6.51	33.97	100	0	P	V
		2760	44.4	-29.6	74	42.82	27.76	7.39	33.57	100	0	P	V
		4260	57.39	-16.61	74	50.96	30.12	9.48	33.17	100	201	P	V
		4260	47.87	-6.13	54	41.44	30.12	9.48	33.17	100	201	A	V
		4960	54.27	-19.73	74	46.01	31.32	10.06	33.12	100	134	P	V
		4960	46.98	-7.02	54	38.72	31.32	10.06	33.12	100	134	A	V
		6100	61.4	-6.8	68.2	51.32	32.6	10.81	33.33	100	201	P	V
		7440	44.18	-29.82	74	51.15	36.48	13.99	57.44	100	0	P	V
		10360	50.09	-18.11	68.2	51.38	39.54	16.12	56.95	100	0	P	V
		15540	45.49	-28.51	74	43.29	38.3	20.56	56.66	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(2M) + WIFI 802.11n HT20 + Sub-gig (LF @ 3m)

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(2M)_CH39 2480 MHz Ant 2 + 802.11n HT20 CH36 5180MHz Ant 1 + Sub-gig_CH00 920MHz Ant 3		50.37	23.88	-16.12	40	41.37	13.94	0.94	32.37	-	-	P	H
		102.75	23.02	-20.48	43.5	37.88	16.1	1.36	32.32	-	-	P	H
		144.46	33.94	-9.56	43.5	47.51	17.1	1.61	32.28	100	0	P	H
		767.2	30.73	-15.27	46	30.96	27.88	3.85	31.96	-	-	P	H
		862.26	32.84	-13.16	46	30.99	29.3	4.1	31.55	-	-	P	H
	*	920	109.24	-	-	107.05	29.12	4.24	31.17	-	-	P	H
		949.56	34.66	-11.34	46	30.69	30.55	4.31	30.89	-	-	P	H
													H
													H
		51.34	25.64	-14.36	40	43.53	13.53	0.95	32.37	-	-	P	V
		131.85	33.32	-10.18	43.5	46.82	17.26	1.53	32.29	100	0	P	V
		142.52	32.29	-11.21	43.5	45.87	17.11	1.6	32.29	-	-	P	V
		561.56	27.72	-18.28	46	30.63	26.04	3.24	32.19	-	-	P	V
		812.79	30.35	-15.65	46	30.05	28.15	3.96	31.81	-	-	P	V
	*	920	106.49	-	-	104.3	29.12	4.24	31.17	-	-	P	V
		952.47	34.16	-11.84	46	30.03	30.68	4.32	30.87	-	-	P	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		(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)

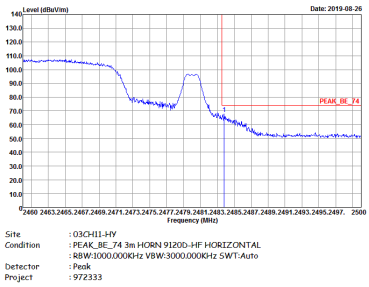
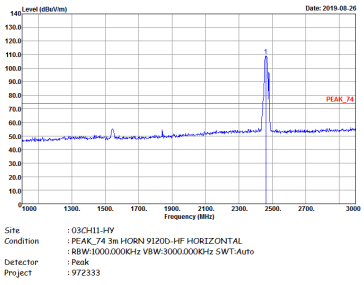
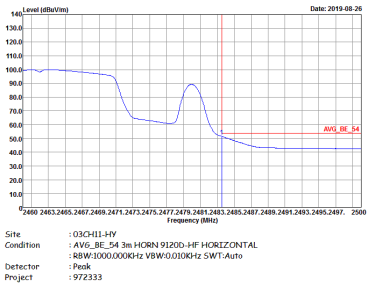
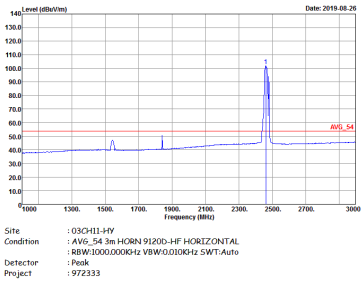
Both peak and average measured complies with the limit line, so test result is "PASS".

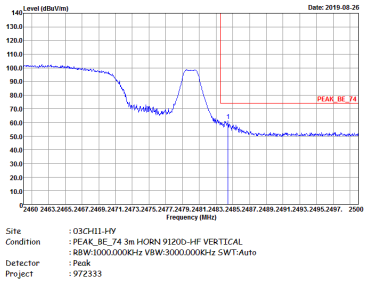
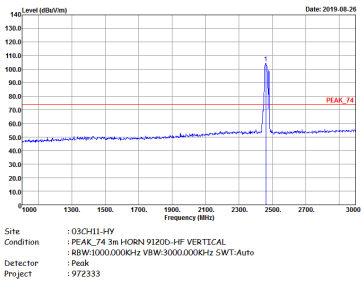
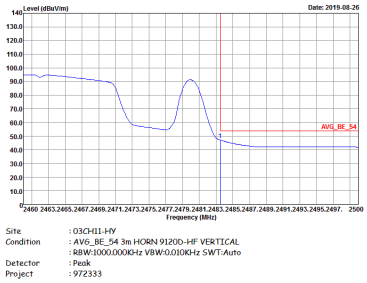
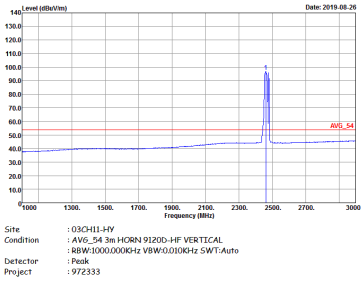
Appendix B. Radiated Spurious Emission Plots

Test Engineer :	Fu Chen	**Temperature :**	23.4~25.3°C
		Relative Humidity :	51.4~58%

Co-location

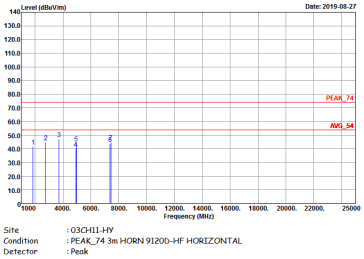
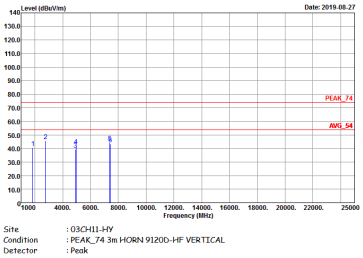
BLE(2M) + WIFI 802.11n HT20 + Sub-gig (Band Edge @ 3m)

ANT	BLE(2M)_Ch39_Ant 2 + WIFI 802.11n HT20_Ch11_Ant 1 + Sub-gig CH00_Ant 3	
Simultaneously	Horizontal	Fundamental
Peak		
Avg.		

ANT	BLE(2M)_Ch39_Ant 2 + WIFI 802.11n HT20_Ch11_Ant 1 + Sub-gig CH00_Ant 3	
Simultaneously	Vertical	Fundamental
Peak		
Avg.		

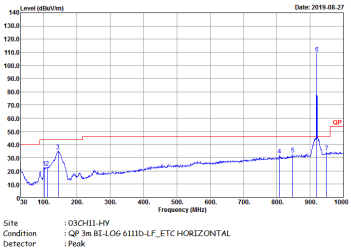
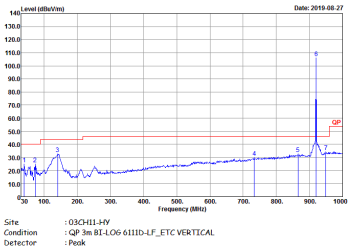
Co-location

BLE(2M) + WIFI 802.11n HT20 + Sub-gig (Harmonic @ 3m)

ANT	BLE(2M)_Ch39_Ant 2 + WIFI 802.11n HT20_Ch11_Ant 1 + Sub-gig CH00_Ant 3	
Simultaneously	Horizontal	Vertical
Peak Avg.		

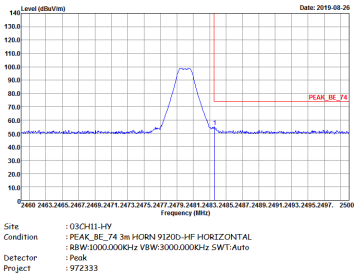
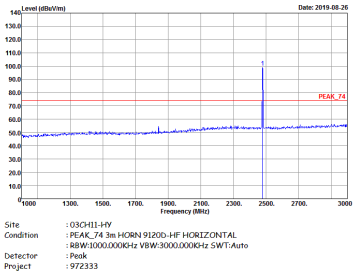
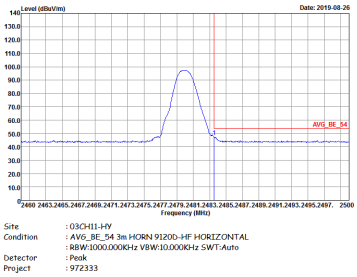
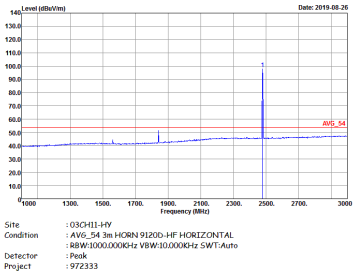
Co-location

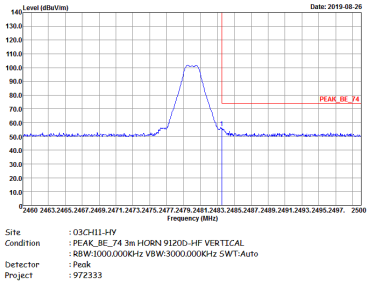
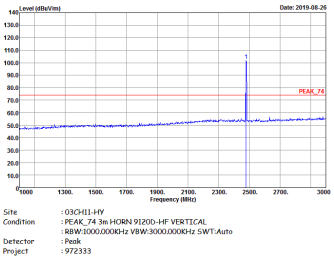
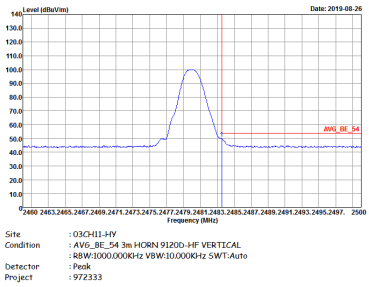
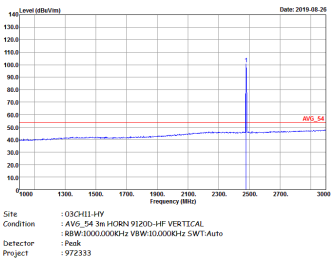
BLE(2M) + WIFI 802.11n HT20 + Sub-gig (LF @ 3m)

ANT	BLE(2M)_Ch39_Ant 2 + WIFI 802.11n HT20_Ch11_Ant 1 + Sub-gig CH00_Ant 3	
Simultaneously	Horizontal	Vertical
QP / Peak		

Co-location

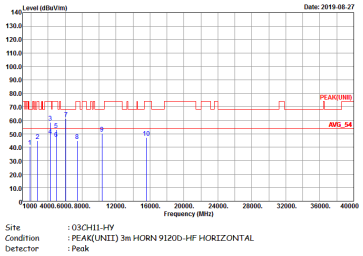
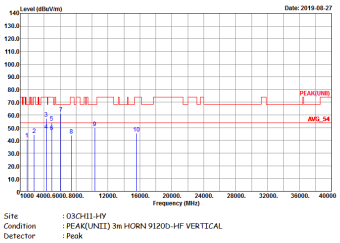
BLE(2M) + WIFI 802.11n HT20 + Sub-gig (Band Edge @ 3m)

ANT	BLE(2M)_Ch39_Ant 2 + WIFI 802.11n HT20_Ch36_Ant 1 + Sub-gig CH00_Ant 3	
Simultaneously	Horizontal	Fundamental
Peak		
Avg		

ANT	BLE(2M)_Ch39_Ant 2 + WIFI 802.11n HT20_Ch36_Ant 1 + Sub-gig CH00_Ant 3	
Simultaneously	Vertical	Fundamental
Peak		
Avg		

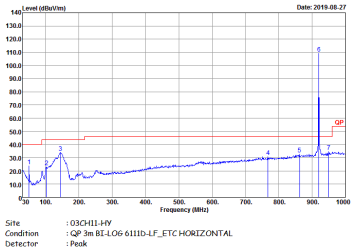
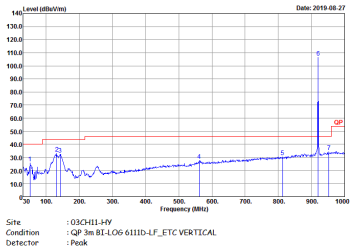
Co-location

BLE(2M) + WIFI 802.11n HT20 + Sub-gig (Harmonic @ 3m)

ANT	BLE(2M)_Ch39_Ant 2 + WIFI 802.11n HT20_Ch36_Ant 1 + Sub-gig CH00_Ant 3	
Simultaneously	Horizontal	Vertical
Peak Avg.		

Co-location

BLE(2M) + WIFI 802.11n HT20 + Sub-gig (LF @ 3m)

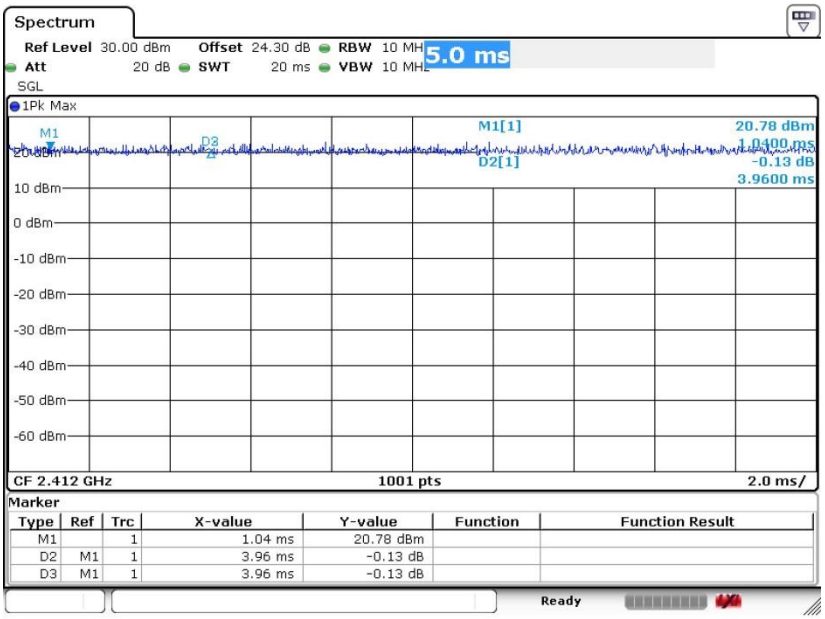
ANT	BLE(2M)_Ch39_Ant 2 + WIFI 802.11n HT20_Ch36_Ant 1 + Sub-gig CH00_Ant 3	
Simultaneously	Horizontal	Vertical
QP / Peak		

Appendix C. Duty Cycle Plots

Antenna	Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting	Duty Factor(dB)
1	2.4GHz 802.11n HT20	100.00	-	-	10Hz	0.00
1	5GHz 802.11ac VHT20	100.00	-	-	10Hz	0.00
2	Bluetooth – LE for 2Mbps	30.99	194	5.15	10kHz	5.09
3	Sub-gig	100.00	-	-	10Hz	0.00

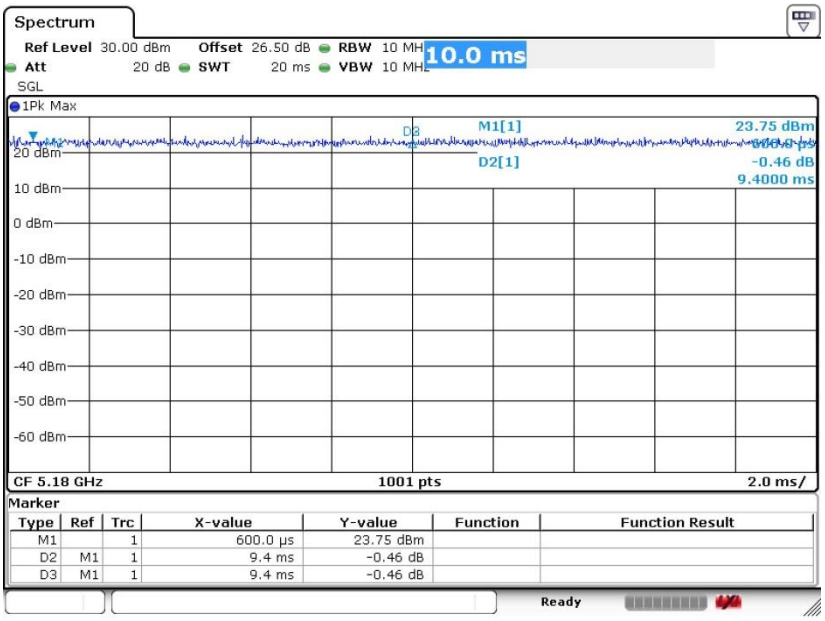
<Ant. 1>

2.4GHz 802.11n HT20



Date: 7.AUG.2019 02:50:37

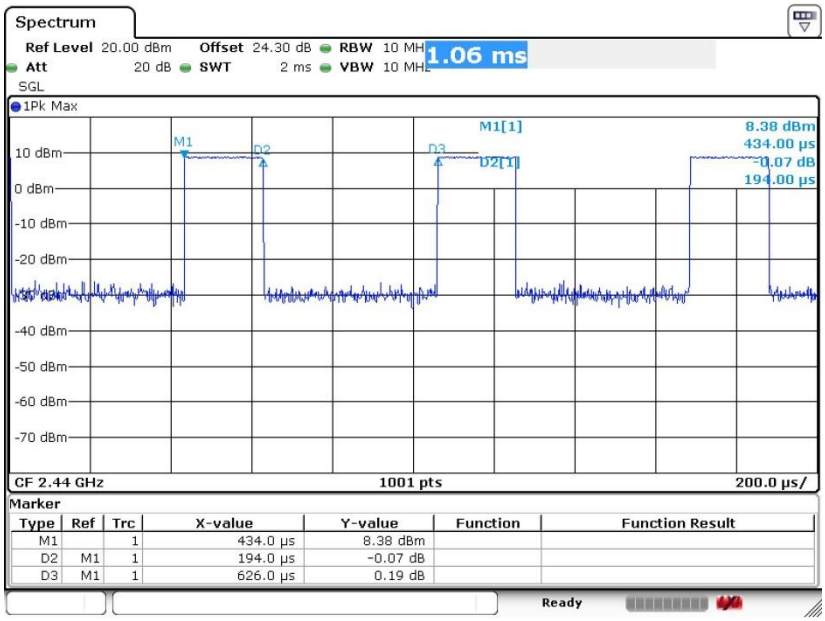
5GHz 802.11ac VHT20



Date: 7.AUG.2019 05:23:54

<Ant. 2>

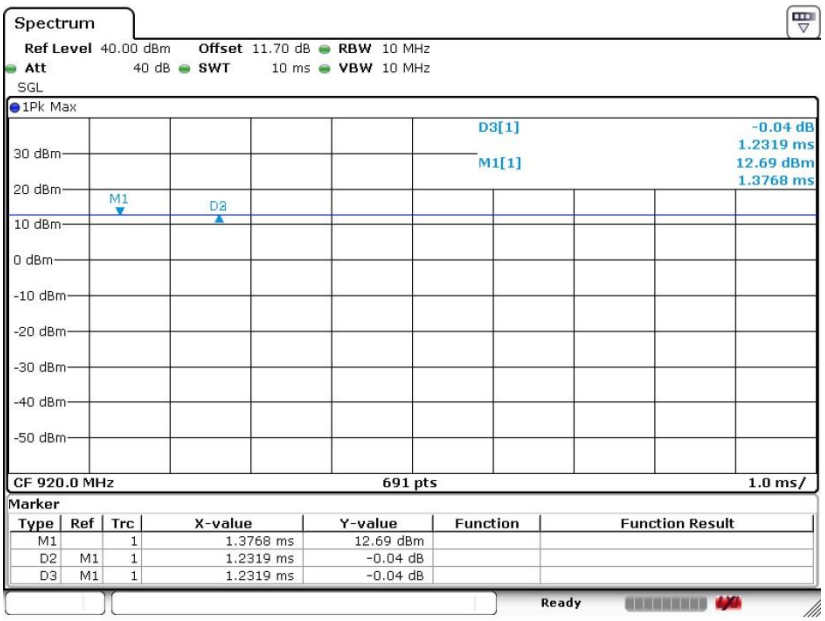
Bluetooth – LE for 2Mbps



Date: 7.AUG.2019 03:43:36

<Ant. 3>

Sub-gig



Date: 16.AUG.2019 13:13:33

———THE END———