FCC RF CO-LOCATION TEST Report

FCC ID	:	**WR92221123114**
Equipment	:	**thermostat**
Brand Name	:	**ecobee**
Model Name	:	**ECB402**
Applicant	:	**ecobee Inc.** **207 Queens Quay West, Suite 600, Toronto, ON, Canada**
Manufacturer	:	**ecobee Inc.** **207 Queens Quay West, Suite 600, Toronto, ON, Canada**
Standard	:	**FCC Part 15 Subpart E §15.407**

The product was received on Jan. 17, 2019 and testing was started from Feb. 15, 2019 and completed on Apr. 02, 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.

Approved by: Jones Tsai

SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory

No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.)

Table of Contents

History of this test report

Report No.	Version	Description	Issued Date
FR911708G	01	Initial issue of report	Apr. 18, 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 0.56 dB at 2389.940 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: Maggie Chiang

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 Proprietary Sensor

Product Specification subjective to this standard	
Antenna Type	WLAN: Ceramic Chip Antenna Bluetooth: FPC Antenna Proprietary Sensor: IFA Meander Printed PCB Type 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.
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.**
	03CH13-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 414788 D01 Radiated Test Site v01r01.
- FCC KDB 662911 D01 Multiple Transmitter Output v02r01.
- FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v05r02
- 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 (Y plane) were recorded in this report.

2.1 Carrier Frequency and Channel

2400-2483.5 MHz Bluetooth - LE		2400-2483.5 MHz 802.11n HT40	
Channel	**Freq. (MHz)**	**Channel**	**Freq. (MHz)**
39	2480	03	2422

5725-5850 MHz 802.11a		902-928 MHz Sub-gig	
Channel	**Freq. (MHz)**	**Channel**	**Freq. (MHz)**
149	5745	00	920

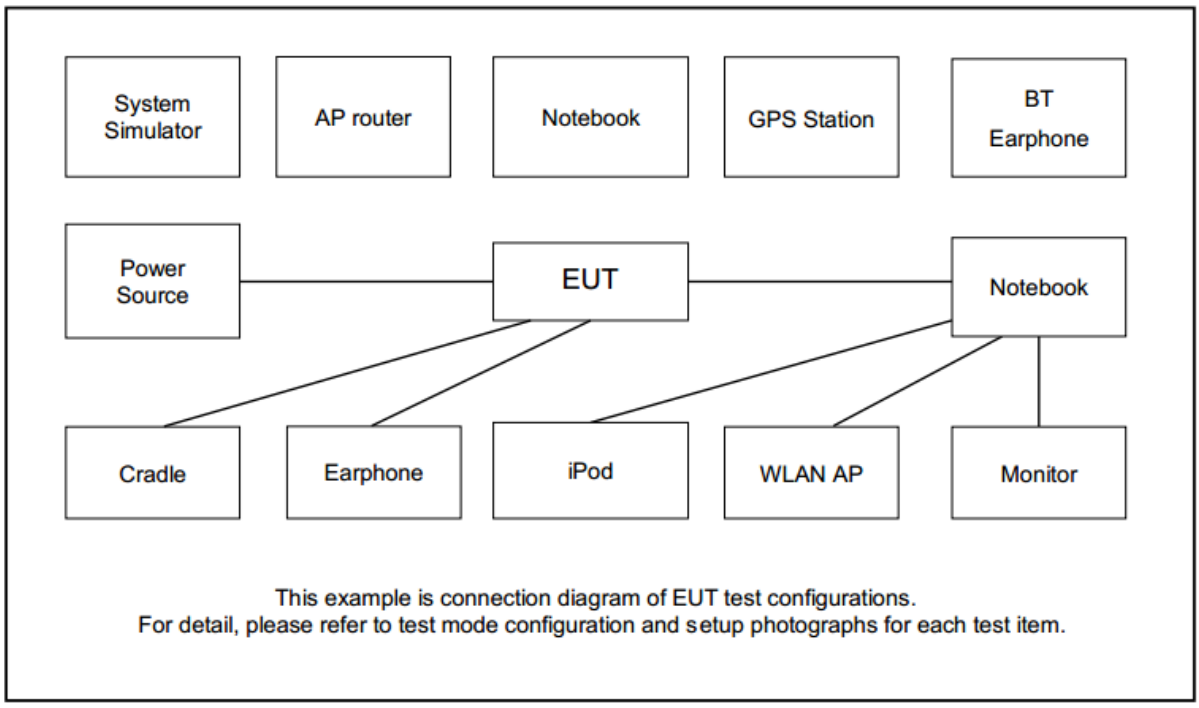
2.2 Test Mode

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

<Co-Location>

Modulation	Data Rate
2.4GHz 802.11n HT40 for Ant. 1 + Bluetooth-LE for Ant. 2 + Sub-gig for Ant. 3	**MCS0 + 2Mbps + FSK**
5GHz 802.11a for Ant. 1 + Bluetooth-LE for Ant. 2 + Sub-gig for Ant. 3	**MCS0 + 2Mbps + FSK**

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.	Adapter	Jameco	ADU240050	FCC DoC	N/A	AC I/P: Unshielded, 6m

2.5 EUT Operation Test Setup

The RF test items, utility “Putty” 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) 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

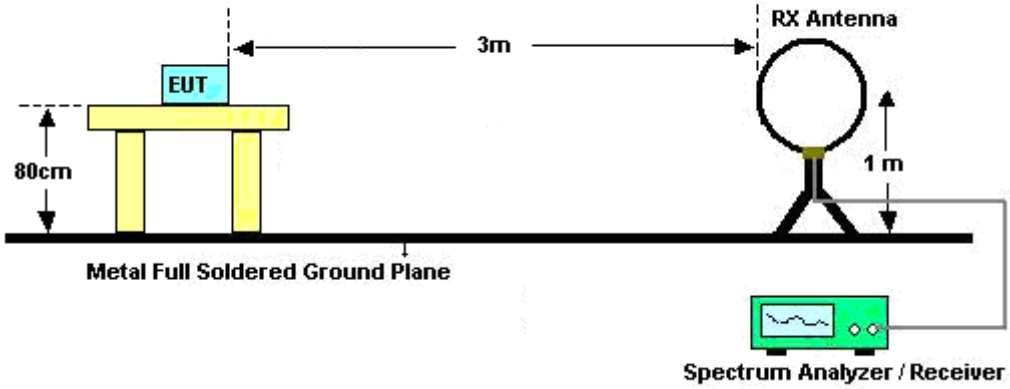
1. The testing follows FCC KDB 789033 D02 General UNII Test Procedures New Rules v02r01. Section G) Unwanted emissions measurement.
   (1) Procedure for Unwanted Emissions Measurements Below 1000MHz
   - RBW = 120 kHz
   - VBW = 300 kHz
   - Detector = Peak
   - Trace mode = max hold

   (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

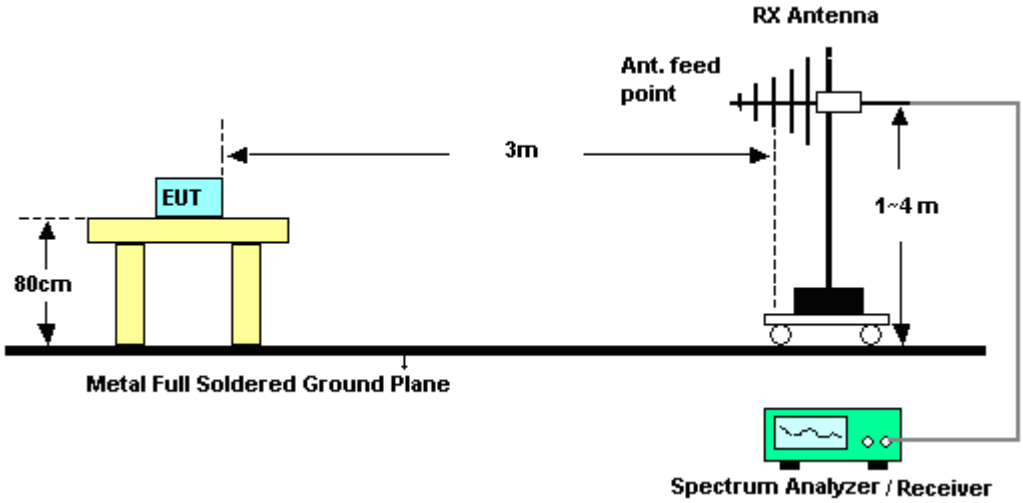
   (3) Procedures for Average Unwanted Emissions Measurements Above 1000MHz
   - RBW = 1 MHz
   - VBW = 10 Hz, when duty cycle is no less than 98 percent.
   - VBW ≥ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting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

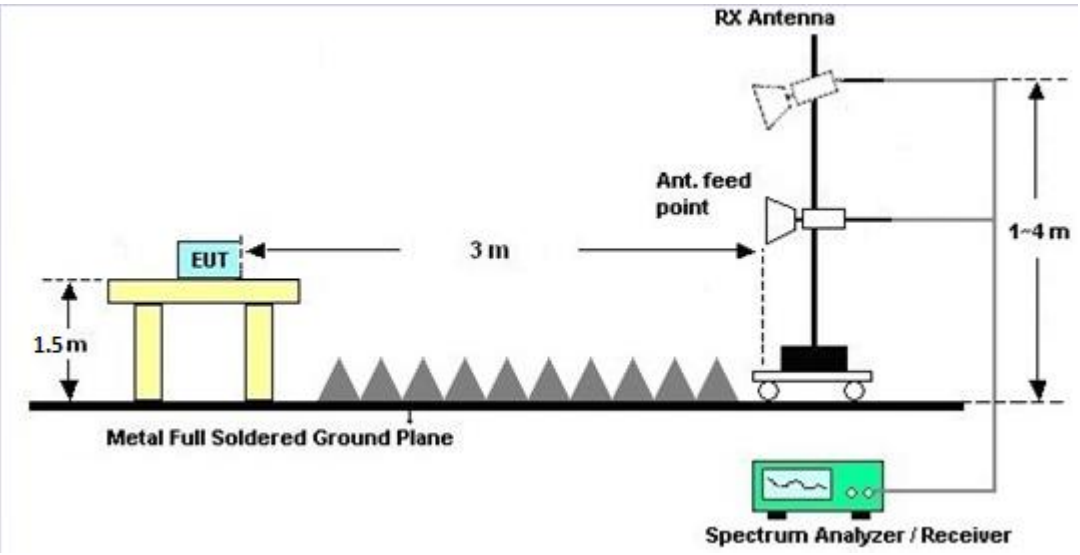
For radiated emissions below 30MHz



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.

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	100488	9 kHz~30 MHz	Jan. 07, 2019	Feb. 15, 2019~ Apr. 02, 2019	Jan. 06, 2020	Radiation (03CH13-HY)
Horn Antenna	SCHWARZBECK	BBHA 9120 D	9120D-1241	1GHz ~ 18GHz	Jun. 29, 2018	Feb. 15, 2019~ Apr. 02, 2019	Jun. 28, 2019	Radiation (03CH13-HY)
Bilog Antenna	TESEQ	CBL 6111D&00800N1D01N-06	37059&01	30MHz~1GHz	Oct. 13, 2018	Feb. 15, 2019~ Apr. 02, 2019	Oct. 12, 2019	Radiation (03CH13-HY)
SHF-EHF Horn Antenna	SCHWARZBECK	BBHA 9170	BBHA9170584	18GHz- 40GHz	Dec. 05, 2018	Feb. 15, 2019~ Apr. 02, 2019	Dec. 04, 2019	Radiation (03CH13-HY)
Preamplifier	Keysight	83017A	MY53270080	1GHz~26.5GHz	Nov. 14, 2018	Feb. 15, 2019~ Apr. 02, 2019	Nov. 13, 2020	Radiation (03CH13-HY)
Preamplifier	MITEQ	AMF-7D-00101800-30-10P	1590074	1GHz~18GHz	May 21, 2018	Feb. 15, 2019~ Apr. 02, 2019	May 20, 2019	Radiation (03CH13-HY)
Amplifier	Sonoma-Instrument	310 N	187282	9KHz~1GHz	Dec. 18, 2018	Feb. 15, 2019~ Apr. 02, 2019	Dec. 17, 2019	Radiation (03CH13-HY)
Amplifier	MITEQ	TTA1840-35-HG	1871923	18GHz~40GHz, VSWR : 2.5:1 max	Jul. 16, 2018	Feb. 15, 2019~ Apr. 02, 2019	Jul. 15, 2019	Radiation (03CH13-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 126E	0030/126E	30M-18G	Feb. 13, 2019	Feb. 15, 2019~ Apr. 02, 2019	Feb. 12, 2020	Radiation (03CH13-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	804793/4	30M-18G	Feb. 13, 2019	Feb. 15, 2019~ Apr. 02, 2019	Feb. 12, 2020	Radiation (03CH13-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 104	MY24961/4	30M-18G	Feb. 13, 2019	Feb. 15, 2019~ Apr. 02, 2019	Feb. 12, 2020	Radiation (03CH13-HY)
Spectrum Analyzer	Agilent	N9010A	MY53470118	10Hz~44GHz	Apr. 17, 2018	Feb. 15, 2019~ Apr. 02, 2019	Apr. 16, 2019	Radiation (03CH13-HY)
Antenna Mast	EMEC	AM-BS-4500-B	N/A	1m~4m	N/A	Feb. 15, 2019~ Apr. 02, 2019	N/A	Radiation (03CH13-HY)
Turn Table	EMEC	TT2000	N/A	0~360 Degree	N/A	Feb. 15, 2019~ Apr. 02, 2019	N/A	Radiation (03CH13-HY)
Software	AUDIX	E3 6.2009-8-24c	RK-001124	N/A	N/A	Feb. 15, 2019~ Apr. 02, 2019	N/A	Radiation (03CH13-HY)
EMI Test Receiver	Keysight	N9038A(MXE)	MY54130085	20Hz ~ 8.4GHz	Nov. 01, 2018	Feb. 15, 2019~ Apr. 02, 2019	Oct. 31, 2019	Radiation (03CH13-HY)
Filter	Wainwright	WHKX12-2700-3000-18000-60SS	SN2	3G High Pass	Jul. 16, 2018	Feb. 15, 2019~ Apr. 02, 2019	Jul. 15, 2019	Radiation (03CH13-HY)
Filter	Woken	WHKX8-5872.5-6750-18000-40ST	SN3	6.75G Highpass	Sep.17, 2018	Feb. 15, 2019~ Apr. 02, 2019	Sep.16, 2019	Radiation (03CH13-HY)
Filter	Wainwright	WHKX12-1080-1200-15000-60ST	SN3	1.2G Low Pass	Jul. 05, 2018	Feb. 15, 2019~ Apr. 02, 2019	Jul. 04, 2019	Radiation (03CH13-HY)

5 Uncertainty of Evaluation

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**4.9**

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**5.4**

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

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	**4.3**

Appendix A. Radiated Spurious Emission

Test Engineer :	Alex Jheng, Fu Chen, and Wilson Wu	Temperature :	24.5~25.3°C
		Relative Humidity :	50~55%

Co-location

BLE + WIFI 802.11n HT40 + Sub-gig (Band Edge @ 3m)

WIFI Ant.	Note	Frequency	Level	Over Limit	Limit Line	Read Level	Antenna Factor	Path Loss	Preamp Factor	Ant Pos	Table Pos	Peak Avg.	Pol.
Simultaneously		(MHz)	(dBµV/m)	(dB)	(dBµV/m)	(dBµV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
BLE		2389.8	67.84	-6.16	74	56.27	27.23	3.99	29.58	400	15	P	H
CH39		2389.94	53.44	-0.56	54	41.87	27.23	3.99	29.58	400	15	A	H
2480 MHz	*	2422	102.63	-	-	90.94	27.32	4.02	29.58	400	15	P	H
Ant 2	*	2422	94.84	-	-	83.15	27.32	4.02	29.58	400	15	A	H
+		2486.63	53.26	-20.74	74	41.37	27.46	4.07	29.57	400	15	P	H
802.11n HT40		2483.5	41.98	-12.02	54	30.09	27.46	4.07	29.57	400	15	A	H
CH03		2389.66	66.46	-7.54	74	54.89	27.23	3.99	29.58	142	66	P	V
2422MHz		2389.94	52.62	-1.38	54	41.05	27.23	3.99	29.58	142	66	A	V
Ant 1	*	2422	102.27	-	-	90.58	27.32	4.02	29.58	142	66	P	V
+	*	2422	93.94	-	-	82.25	27.32	4.02	29.58	142	66	A	V
Sub-gig		2485.44	52.66	-21.34	74	40.77	27.46	4.07	29.57	142	66	P	V
CH00													
920MHz		2483.5	42.16	-11.84	54	30.27	27.46	4.07	29.57	142	66	A	V
Ant 3													
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

BLE + WIFI 802.11n HT40 + 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 CH39 2480 MHz Ant 2 + 802.11n HT40 CH03 2422MHz Ant 1 + Sub-gig CH00 920MHz Ant 3		2760	47.49	-26.51	74	43.53	28.09	5.43	29.56	100	0	P	H
		3680	36.82	-37.18	74	59.55	29.14	6.45	58.32	100	0	P	H
		3720	48.6	-25.4	74	71.39	29.2	6.37	58.36	100	0	P	H
		4844	38.75	-35.25	74	58.5	31.29	6.47	57.51	100	0	P	H
		4960	40.55	-33.45	74	59.49	31.53	6.81	57.28	100	0	P	H
		7266	43.27	-30.73	74	56.15	36.11	8.23	57.22	100	0	P	H
		7440	42.61	-31.39	74	55.36	36.49	8.19	57.43	100	0	P	H
		2760	48.14	-25.86	74	44.18	28.09	5.43	29.56	100	0	P	V
		3680	36.55	-37.45	74	59.28	29.14	6.45	58.32	100	0	P	V
		3720	52.09	-21.91	74	74.88	29.2	6.37	58.36	312	145	P	V
		3720	45.65	-8.35	54	68.44	29.2	6.37	58.36	312	145	A	V
		4844	38.01	-35.99	74	57.76	31.29	6.47	57.51	100	0	P	V
		4960	40.56	-33.44	74	59.5	31.53	6.81	57.28	100	0	P	V
		7266	43.21	-30.79	74	56.09	36.11	8.23	57.22	100	0	P	V
		7440	43.66	-30.34	74	56.41	36.49	8.19	57.43	100	0	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

BLE + WIFI 802.11a + 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 CH39 2480MHz Ant 2 + 802.11a CH149 5745MHz Ant 1 + Sub-gig CH00 920MHz Ant 3		5603.4	51.7	-16.5	68.2	42.89	32.04	6.32	29.55	213	87	P	H
		5671.8	50.6	-33.77	84.37	41.66	32.14	6.35	29.55	213	87	P	H
		5719.2	62.77	-47.81	110.58	53.74	32.21	6.37	29.55	213	87	P	H
		5724.6	71.72	-49.57	121.29	62.69	32.21	6.37	29.55	213	87	P	H
	*	5745	107.06	-	-	97.99	32.24	6.38	29.55	213	87	P	H
	*	5745	99.63	-	-	90.56	32.24	6.38	29.55	213	87	A	H
		5629	51.79	-16.41	68.2	42.94	32.07	6.33	29.55	381	190	P	V
		5699.2	53.5	-51.11	104.61	44.52	32.17	6.36	29.55	381	190	P	V
		5719	65.25	-45.27	110.52	56.22	32.21	6.37	29.55	381	190	P	V
		5724.8	76.07	-45.67	121.74	67.04	32.21	6.37	29.55	381	190	P	V
	*	5745	110.12	-	-	101.05	32.24	6.38	29.55	381	190	P	V
	*	5745	102.54	-	-	93.47	32.24	6.38	29.55	381	190	A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

BLE + WIFI 802.11a + 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 CH39 2480MHz Ant 2 + 802.11a CH149 5745MHz Ant 1 + Sub-gig CH 00 920MHz Ant 3		2760	47.04	-26.96	74	42.82	28.09	5.69	29.56	100	0	P	H
		3680	48.26	-25.74	74	41.66	29.14	6.94	29.48	100	0	P	H
		4960	49.66	-24.34	74	39.5	31.53	8.07	29.44	100	0	P	H
		7440	45.32	-28.68	74	57.66	36.49	8.6	57.43	100	0	P	H
		11490	59.55	-14.45	74	65.47	39.92	10.46	56.3	100	229	P	H
		11490	49	-5	54	54.92	39.92	10.46	56.3	100	229	A	H
		17235	50.09	-18.11	68.2	52.87	40.84	12.95	56.57	100	0	P	H
		2760	47.02	-26.98	74	42.8	28.09	5.69	29.56	100	0	P	V
		3680	50.03	-23.97	74	43.43	29.14	6.94	29.48	100	0	P	V
		4960	50.45	-23.55	74	40.29	31.53	8.07	29.44	100	0	P	V
		7440	46.81	-27.19	74	59.15	36.49	8.6	57.43	100	0	P	V
		11490	58.28	-15.72	74	64.2	39.92	10.46	56.3	100	219	P	V
		11490	47.78	-6.22	54	53.7	39.92	10.46	56.3	100	219	A	V
		17235	50.26	-17.94	68.2	53.04	40.84	12.95	56.57	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 + WIFI 802.11n HT40 + Sub-gig (LF @ 3m)

WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Path	Preamp	Ant	Table	Peak	Pol.
Ant.				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
Simultaneously		(MHz)	(dBµV/m)	(dB)	(dBµV/m)	(dBµV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
BLE CH39 2480 MHz Ant 2 + 802.11n HT40 CH03 2422MHz Ant 1 + Sub-gig CH00 920MHz Ant 3		30.97	32.99	-7.01	40	30.84	24.13	10.31	32.29	100	0	P	H
		105.66	28.3	-15.2	43.5	33.15	16.63	10.73	32.21	-	-	P	H
		310.33	30.48	-15.52	46	31.91	19.36	11.36	32.15	-	-	P	H
		398.6	33.13	-12.87	46	31.77	21.88	11.64	32.16	-	-	P	H
		492.69	35.05	-10.95	46	31.56	23.93	11.73	32.17	-	-	P	H
		564.47	37.48	-8.52	46	31.75	26.02	11.93	32.22	-	-	P	H
	*	920	110.55	-	-	99.84	29.39	12.56	31.24	-	-	P	H
													H
													H
													H
													H
													H
		30.97	33.54	-6.46	40	31.39	24.13	10.31	32.29	100	0	P	V
		46.49	31.53	-8.47	40	37.25	16.18	10.39	32.29	-	-	P	V
		151.25	28.33	-15.17	43.5	32.54	17.05	10.91	32.17	-	-	P	V
		301.6	30.86	-15.14	46	32.4	19.27	11.34	32.15	-	-	P	V
		479.11	35.15	-10.85	46	31.89	23.72	11.71	32.17	-	-	P	V
		564.47	37.59	-8.41	46	31.86	26.02	11.93	32.22	-	-	P	V
	*	920	103.78	-	-	93.07	29.39	12.56	31.24	-	-	P	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		(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

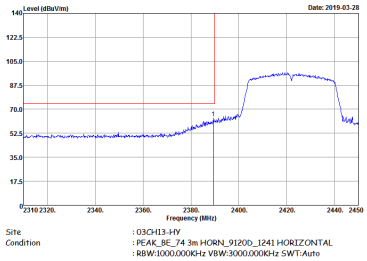
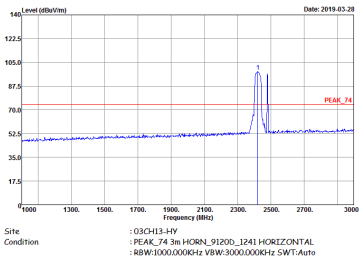
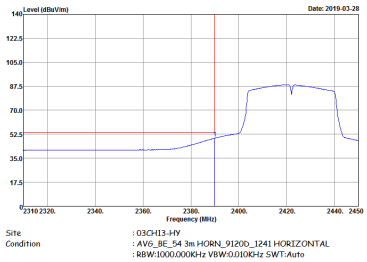
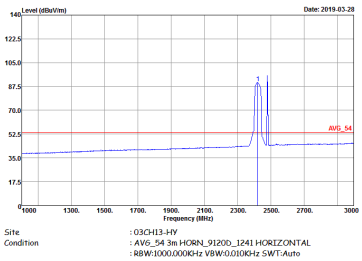
Test Engineer :	Alex Jheng, Fu Chen, and Wilson Wu	**Temperature :**	24.5~25.3°C
		Relative Humidity :	50~55%

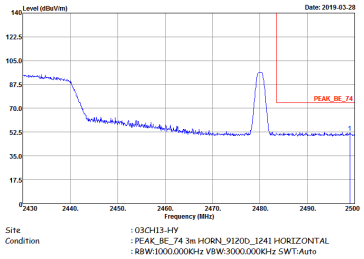
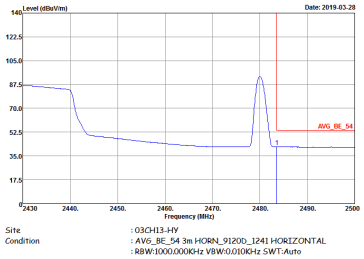
Note symbol

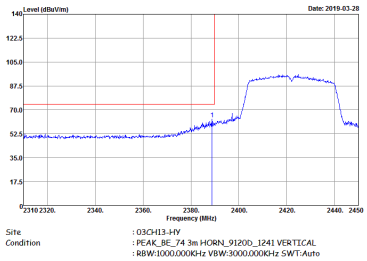
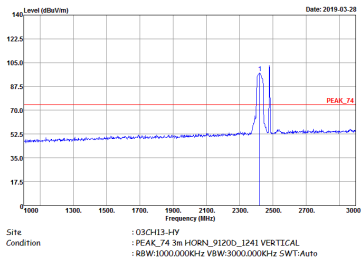
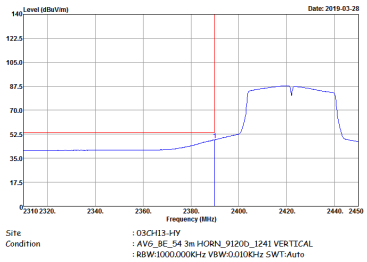
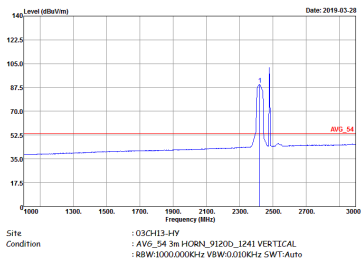
-L	**Low channel location**
-R	**High channel location**

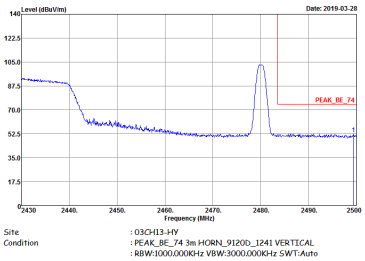
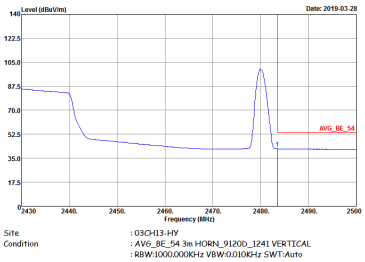
Co-location

BLE + WIFI 802.11g N40 + Sub-gig (Band Edge @ 3m)

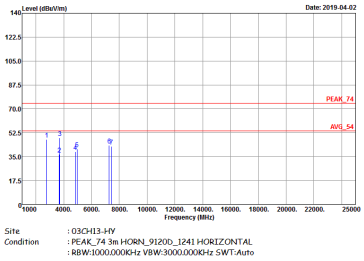
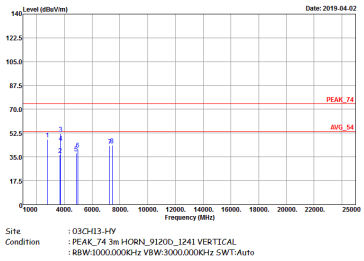
ANT	BLE_Ch39_Ant 2 + WIFI 802.11n HT40_Ch09_Ant 1 + Sub-gig CH00_Ant 3 - L	
Simultaneously	**Horizontal**	**Fundamental**
Peak		
Avg.		

ANT	BLE_Ch39_Ant 2 + WIFI 802.11n HT40_Ch09_Ant 1 + Sub-gig CH00 Ant 3 - R	
Simultaneously	**Horizontal**	**Fundamental**
Peak		Left blank
Avg.		Left blank

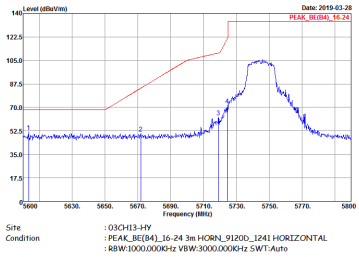
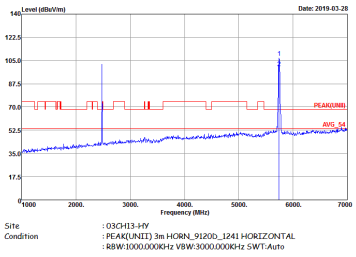
ANT	BLE_Ch39_Ant 2 + WIFI 802.11n HT40_Ch09_Ant 1 + Sub-gig CH00 Ant_3 - L	
Simultaneously	Vertical	Fundamental
Peak		
Avg.		

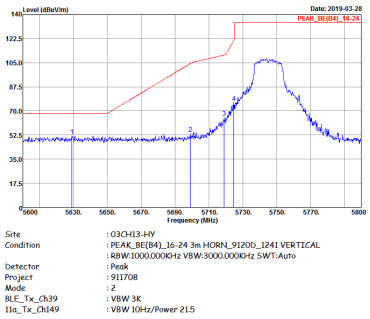
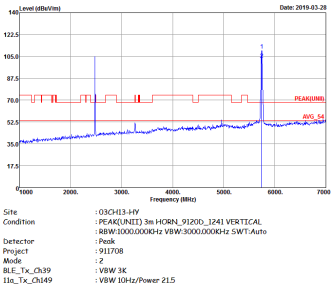
ANT	BLE_Ch39_Ant 2 + WIFI 802.11n HT40_Ch09_Ant 1 + Sub-gig CH00_Ant 3 - R	
Simultaneously	**Vertical**	**Fundamental**
Peak		Left blank
Avg.		Left blank

BLE + WIFI 802.11n HT40 + Sub-gig (Harmonic @ 3m)

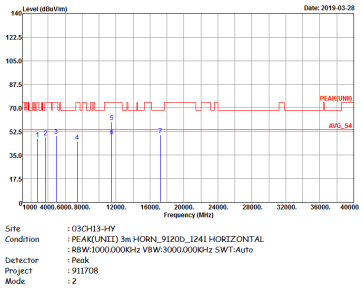
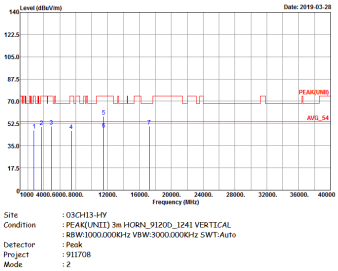
ANT	BLE_Ch39_Ant 2 + WIFI 802.11n HT40_Ch09_Ant 1 + Sub-gig CH00_Ant 3	
Simultaneously	Horizontal	Vertical
Peak Avg.		

BLE + WIFI 802.11a + Sub-gig (Band Edge @ 3m)

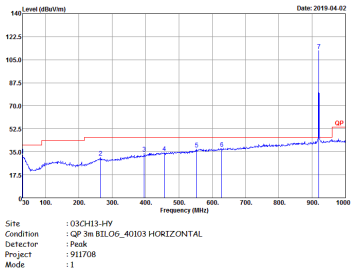
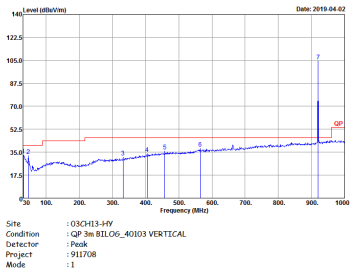
ANT	BLE_Ch39_Ant 2 + WIFI 802.11a_Ch149_Ant 1 + Sub-gig CH00_Ant 3	
Simultaneously	Horizontal	Fundamental
Peak		

ANT	BLE_Ch39_Ant 2 + WIFI 802.11a_Ch149_Ant 1 + Sub-gig CH00_Ant 3	
Simultaneously	**Vertical**	**Fundamental**
Peak		

BLE + WIFI 802.11a + Sub-gig (Harmonic @ 3m)

ANT	BLE_Ch39_Ant 2 + WIFI 802.11a_Ch149_Ant 1 + Sub-gig CH00_Ant 3	
Simultaneously	Horizontal	Vertical
Peak Avg.		

BLE + WIFI 802.11n HT40 + Sub-gig (LF @ 3m)

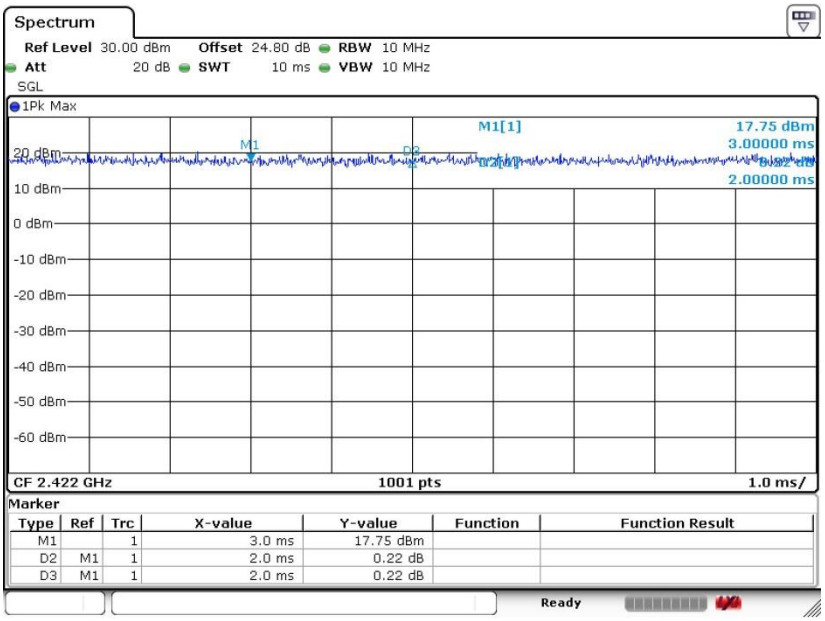
ANT	BLE_Ch39_Ant 2 + WIFI 802.11n HT40_Ch09_Ant 1 + Sub-gig CH00_Ant 3	
Simultaneously	Horizontal	Vertical
Peak Avg.		

Appendix C. Duty Cycle Plots

Antenna	Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting	Duty Factor(dB)
1	2.4GHz 802.11n HT40	100.00	-	-	10Hz	0.00
1	5GHz 802.11a	100.00	350	2.86	10Hz	0.00
2	Bluetooth - LE	60.06	376	2.66	3kHz	2.21
3	Sub-gig	100.00	-	-	10Hz	0.00

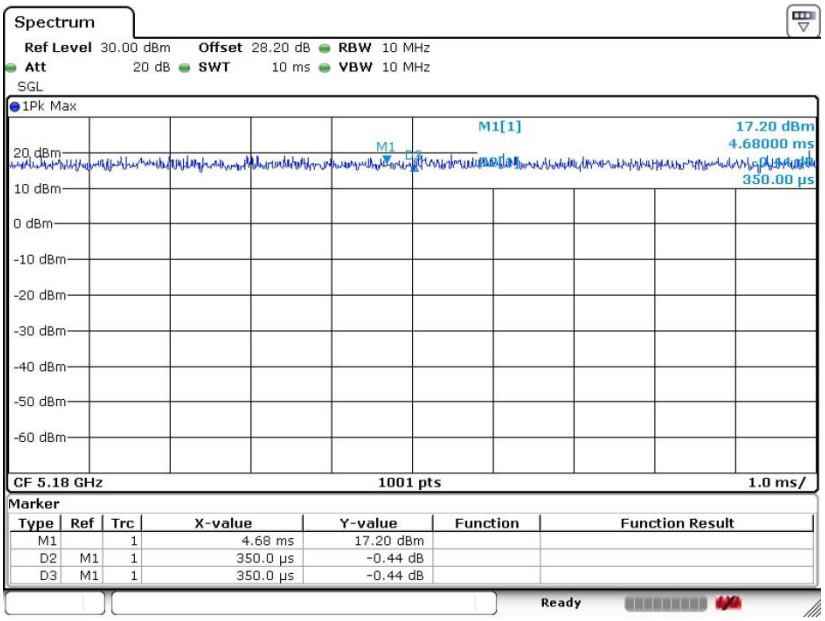
<Ant. 1>

2.4GHz 802.11n HT40



Date: 15.FEB.2019 16:55:35

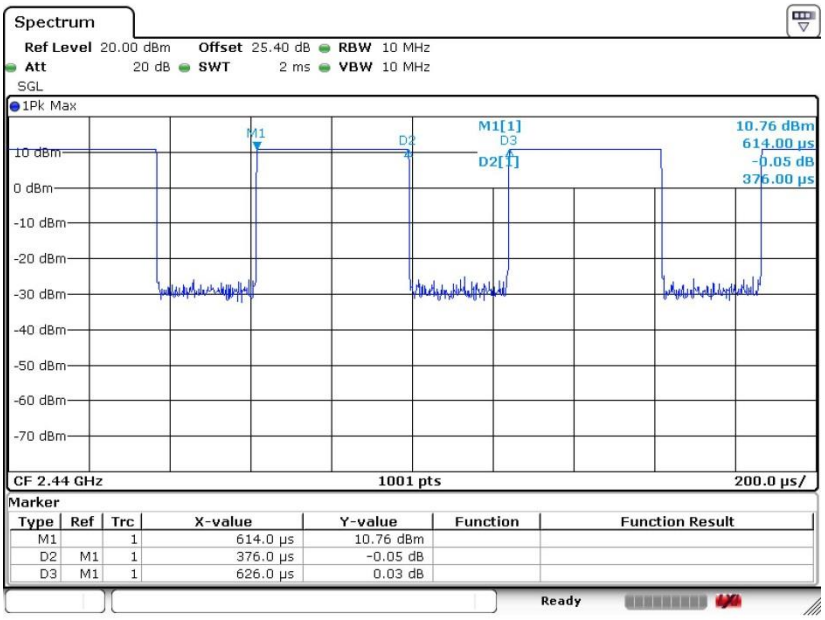
5GHz 802.11a



Date: 13.FEB.2019 09:13:34

<Ant. 2>

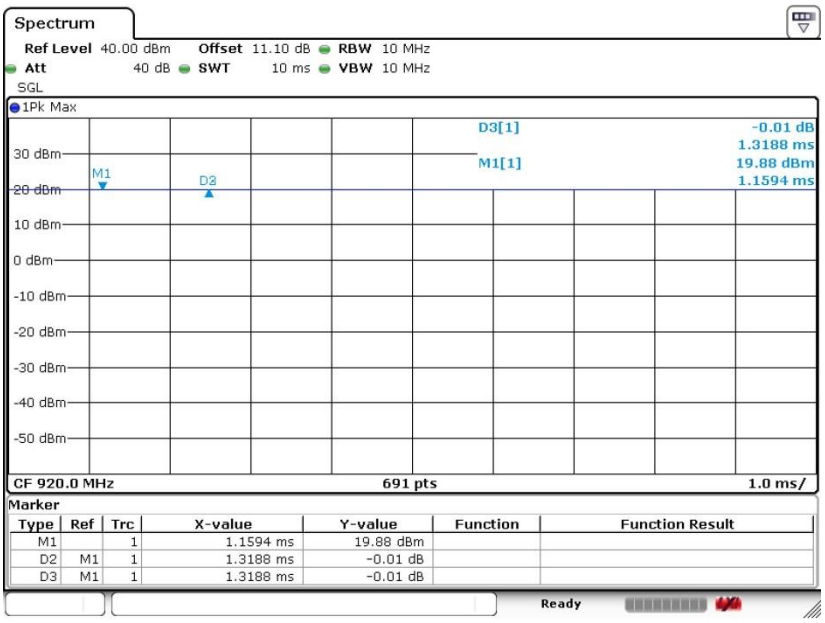
Bluetooth – LE



Date: 12.FEB.2019 15:42:59

<Ant. 3>

Sub-gig



Date: 20.MAR.2019 23:30:01

———THE END———