



FCC RADIO CO-LOCATION TEST REPORT

FCC ID : 2AJZB-0308
Equipment : Digital Media Streaming Device
Model Name : EX69VW
Applicant : Verdegrass LLC
233 South 13th Street, Suite 1100, Lincoln,
Nebraska 68508
Standard : FCC Part 15 Subpart E §15.407

The product was completed on Jul. 19, 2017. We, SPORTON INTERNATIONAL INC., 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.)



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History of this test report

Report No.	Version	Description	Issued Date
FR742534-04C	01	Initial issue of report	May 18, 2018



Summary of Test Result

Report Clause	Ref Std. Clause	Test Items	Result (PASS/FAIL)
3.1	15.407(b)	Unwanted Emissions	Pass
3.2	15.203 15.407(a)	Antenna Requirement	Pass

Reviewed by: Louis Wu

Report Producer: Wii Chang



1 General Description

1.1 Product Feature of Equipment Under Test

Product Feature	
Equipment	Digital Media Streaming Device
Model Name	EX69VW
FCC ID	2AJZB-0308
EUT supports Radios application	WLAN 11a/b/g/n HT20 HT40 WLAN 11ac VHT20/VHT40/VHT80 Bluetooth BR/EDR/LE
Antenna Type	<2412 MHz ~ 2472 MHz> Ant. 1 : Fixed internal Antenna Ant. 2 : Fixed internal Antenna <5745 MHz ~ 5825 MHz> Ant. 1 : Fixed internal Antenna Ant. 2 : Fixed internal Antenna Bluetooth LE : Fixed Internal Antenna

1.2 Modification of EUT

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



1.3 Testing Location

Sporton Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code : 1190) and the FCC designation No. TW0007 under the FCC 2.948(e) by Mutual Recognition Agreement (MRA) in FCC Test.

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: +886-3-327-3456 FAX: +886-3-328-4978
Test Site No.	Sporton Site No. 03CH13-HY

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

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 662911 D01 Multiple Transmitter Output v02r01.
- FCC KDB Publication No. 558074 D01 DTS Meas. Guidancev04
- 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

- a. The EUT has been associated with peripherals and configuration operated in a manner tended to maximize its emission characteristics in a typical application. Frequency range investigated: radiation emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower). For radiated measurement, all the possible configuration was pre-scanned with power adaptor and peripherals (HDMI, USB and IR connector). It was determined that the worst configuration was EUT with adaptor but no peripherals. The final radiated testing was performed with EUT with adaptor but no peripherals.

2.1 Carrier Frequency and Channel

5725-5850 MHz Band 4 (U-NII-3)		2400-2483.5 MHz 802.11b		2400-2483.5 MHz Bluetooth LE	
Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)
149	5785	12	2467	19	2440

2.2 Test Mode

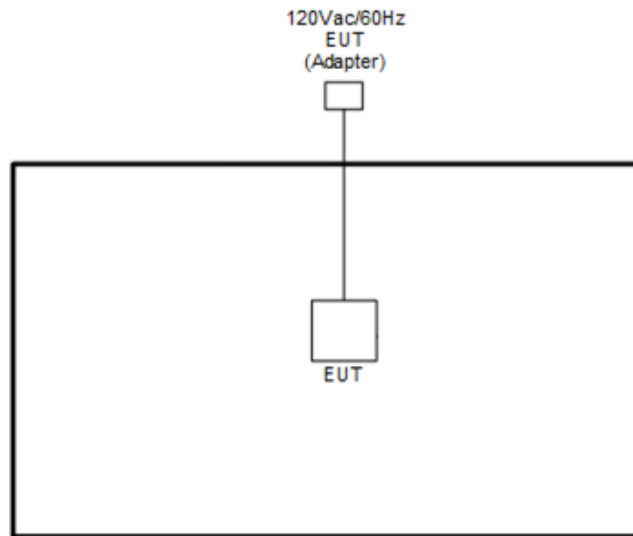
Final test mode of conducted test items and radiated spurious emissions are considering the modulation and worse data rates as below table.

<Co-Location>

Modulation	Data Rate
802.11b + Bluetooth LE	6 Mbps + 1 Mbps
802.11a + Bluetooth LE	6 Mbps + 1 Mbps

2.3 Connection Diagram of Test System

<Co-Location Mode>



2.4 EUT Operation Test Setup

The RF test items, programmed RF utility, "CMD" installed in the notebook make the EUT provide functions like channel selection and power level for continuous transmitting and receiving signals.



3 Test Result

3.1 Unwanted 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.

$$E = \frac{1000000\sqrt{30P}}{3} \mu\text{V/m, where P is the eirp (Watts)}$$



EIRP (dBm)	Field Strength at 3m (dBµV/m)
- 27	68.3

(2) KDB789033 D02 v02r01 G)2)c)

- (i) 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

The measuring equipment is listed in the section 4 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 \geq 3 MHz
- Detector = Peak
- Sweep time = auto
- Trace mode = max hold

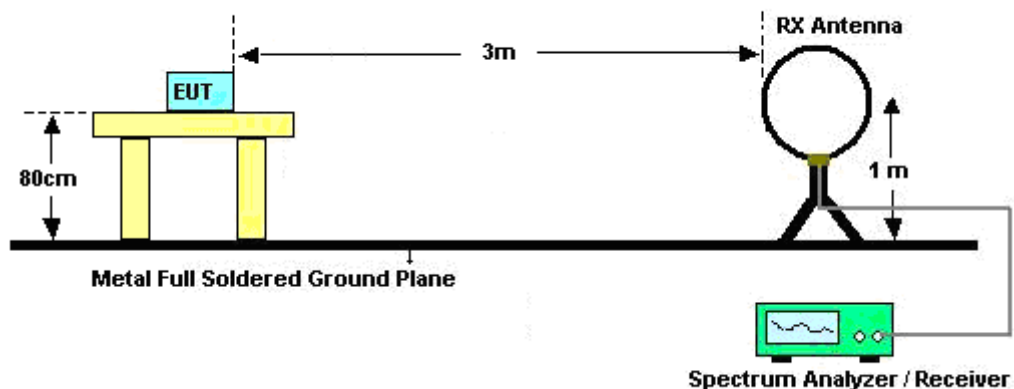
(3) Procedures for Average Unwanted Emissions Measurements Above 1000MHz

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

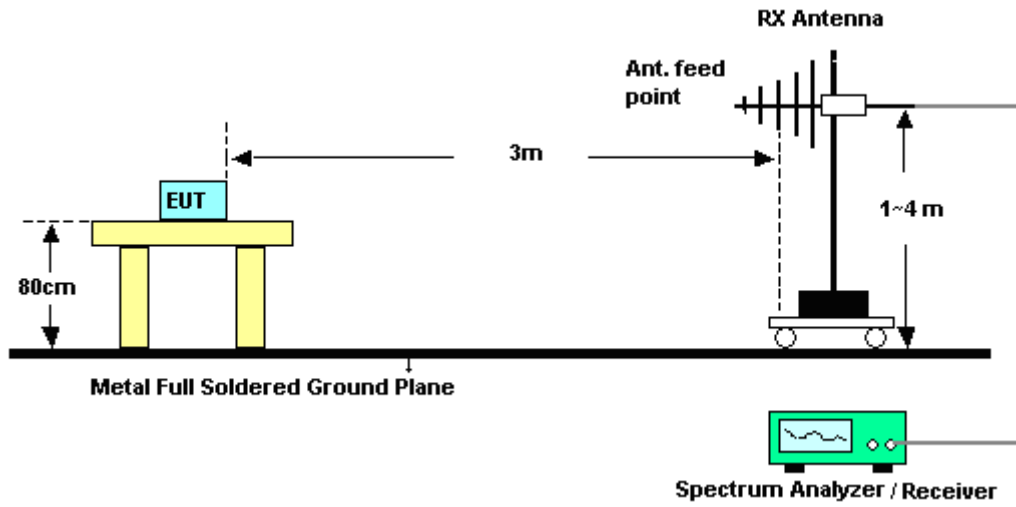
2. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
3. The EUT was set 3 meters from the interference receiving antenna which was mounted on the top of a variable height antenna tower.
4. The antenna is a broadband antenna and its height is adjusted between one meter and four meters above ground to find the maximum value of the field strength for both horizontal polarization and vertical polarization of the antenna.
5. For each suspected emission, the EUT was arranged to its worst case and then adjust the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading.
6. For testing below 1GHz, if the emission level of the EUT in peak mode was 3 dB lower than the limit specified, then peak values of EUT will be reported, otherwise, the emissions will be repeated one by one using the CISPR quasi-peak method and reported.
7. For testing above 1GHz, the emission level of the EUT in peak mode was 20dB lower than average limit (that means the emission level in average mode also complies with the limit in average mode), then peak values of EUT will be reported, otherwise, the emissions will be measured in average mode again and reported.

3.1.4 Test Setup

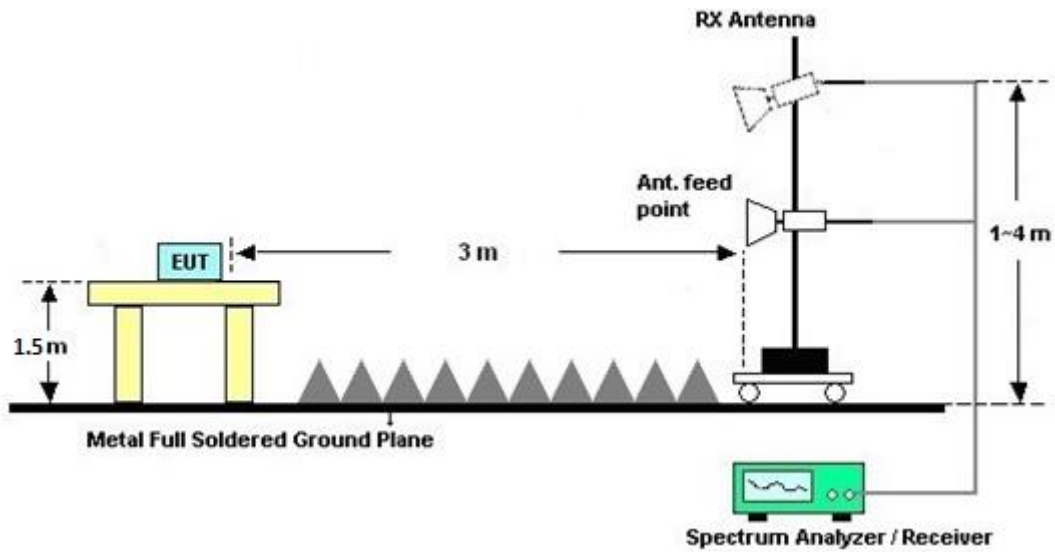
For radiated emissions below 30MHz



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 semi-Anechoic chamber, 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
Spectrum Analyzer	Keysight	N9010A	MY55370526	N/A	Mar. 15, 2017	Jul. 07, 2017~ Jul. 19, 2017	Mar. 14, 2018	Radiation (03CH13-HY)
EMI Test Receiver	Agilent	N9038A(MXE)	MY53290053	20Hz to 26.5GHz	Jan. 12, 2017	Jul. 07, 2017~ Jul. 19, 2017	Jan. 11, 2018	Radiation (03CH13-HY)
Loop Antenna	Rohde & Schwarz	HFH2-Z2	100315	9 kHz~30 MHz	May 15, 2017	Jul. 07, 2017~ Jul. 19, 2017	May 14, 2019	Radiation (03CH13-HY)
Bilog Antenna	TESEQ	CBL 6111D&00800 N1D01N-06	40103&04	30MHz to 1GHz	Jan. 07, 2017	Jul. 07, 2017~ Jul. 19, 2017	Jan. 06, 2018	Radiation (03CH13-HY)
Horn Antenna	SCHWARZBE CK	BBHA 9120 D	9120D-124 1	1GHz ~ 18GHz	May 02, 2017	Jul. 07, 2017~ Jul. 19, 2017	May 01, 2018	Radiation (03CH13-HY)
SHF-EHF Horn Antenna	SCHWARZBE CK	BBHA 9170	BBHA9170 584	18GHz- 40GHz	Nov. 08, 2016	Jul. 07, 2017~ Jul. 19, 2017	Nov. 07, 2017	Radiation (03CH13-HY)
Amplifier	Sonoma-Instru ment	310 N	187282	9KHz~1GHz	Dec. 21, 2016	Jul. 07, 2017~ Jul. 19, 2017	Dec. 20, 2017	Radiation (03CH13-HY)
Preamplifier	Keysight	83017A	MY532701 47	1GHz~26.5GHz	Jan. 09, 2017	Jul. 07, 2017~ Jul. 19, 2017	Jan. 08, 2018	Radiation (03CH13-HY)
Preamplifier	MITEQ	AMF-7D-0010 1800-30-10P	1590074	1GHz~18GHz	May 22, 2017	Jul. 07, 2017~ Jul. 19, 2017	May 21, 2018	Radiation (03CH13-HY)
Preamplifier	MITEQ	TTA 1840-35-HG	1887435	18GHz ~ 40GHz	Oct. 13, 2016	Jul. 07, 2017~ Jul. 19, 2017	Oct. 12, 2017	Radiation (03CH13-HY)
Antenna Mast	EMEC	AM-BS-4500- B	N/A	1m~4m	N/A	Jul. 07, 2017~ Jul. 19, 2017	N/A	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% ($U = 2Uc(y)$)	4.90
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Uncertainty of Radiated Emission Measurement (1000 MHz ~ 18000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	5.40
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Uncertainty of Radiated Emission Measurement (18000 MHz ~ 40000 MHz)

Measuring Uncertainty for a Level of Confidence of 95% ($U = 2Uc(y)$)	4.30
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Appendix A. Radiated Spurious Emission

Test Engineer :	Alex Jheng, Bill Chang and Wilson Wu	Temperature :	24.0 ~ 24.5°C
		Relative Humidity :	53 ~ 56%

Co-location Mode

WIFI 802.11b and BLE (Harmonic @ 3m)

WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.
Ant.		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11b		4934	41.04	-32.96	74	58.12	31.98	7.55	57.1	100	0	P	H
CH 12		7401	49.21	-24.79	74	59.52	37.46	9.19	57.4	100	0	P	H
2467MHz		4934	40.59	-33.41	74	57.67	31.98	7.55	57.1	100	0	P	V
and		7401	47.72	-26.28	74	58.03	37.46	9.19	57.4	100	0	P	V
BLE													
CH 19													
2440MHz													

802.11a CDD and BLE (Harmonic @ 3m)

WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.
Ant.		(MHz)	(dBμV/m)	(dB)	(dBμV/m)	(dBμV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11a		11490	62.65	-11.35	74	66.87	40.38	11.3	56.41	174	161	P	H
CH 149		11490	53.48	-0.52	54	57.7	40.38	11.3	56.41	174	161	A	H
5785MHz		17235	60.91	-7.29	68.2	60.7	42.4	13.44	56.27	100	0	P	H
and		11490	57.16	-16.84	74	61.38	40.38	11.3	56.41	226	0	P	V
BLE		11490	48.94	-5.06	54	53.16	40.38	11.3	56.41	226	0	A	V
CH19		17235	61.41	-6.79	68.2	61.2	42.4	13.44	56.27	100	0	P	V
2440MHz													



**Emission below 1GHz
WIFI 802.11b and BLE (LF)**

WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	Preamp	Ant	Table	Peak	Pol.
Ant.				Limit	Line	Level	Factor	Loss	Factor	Pos	Pos	Avg.	
2		(MHz)	(dBµV/m)	(dB)	(dBµV/m)	(dBµV)	(dB/m)	(dB)	(dB)	(cm)	(deg)	(P/A)	(H/V)
802.11b CH 12 2467MHz and BLE CH 19 2440MHz		93.72	33.38	-10.12	43.5	53.89	10.66	1	32.29			P	H
		134.76	31.67	-11.83	43.5	48.8	13.91	1.19	32.28			P	H
		282.72	30.42	-15.58	46	45.36	15.46	1.68	32.15			P	H
		665.4	39.12	-6.88	46	45.33	23.35	2.51	32.18	100	0	P	H
		703.9	38.1	-7.9	46	43.78	23.74	2.64	32.16			P	H
		759.2	35.71	-10.29	46	39.76	25.2	2.71	32.06			P	H
		77.79	29.74	-10.26	40	50.69	10.31	0.95	32.3			P	V
		108.03	32.31	-11.19	43.5	49.16	14.33	1	32.29			P	V
		281.91	27.44	-18.56	46	42.4	15.45	1.68	32.16			P	V
		497.4	34.45	-11.55	46	43.55	20.82	2.2	32.2			P	V
		695.5	36.57	-9.43	46	42.48	23.54	2.62	32.17	100	0	P	V
	755.7	34.73	-11.27	46	38.88	25.14	2.68	32.07			P	V	
Remark	1. No other spurious found. 2. All results are PASS against limit line.												



802.11a CDD and BLE (LF @ 3m)

WIFI Ant. 1+2	Note	Frequency (MHz)	Level (dBμV/m)	Over Limit (dB)	Limit Line (dBμV/m)	Read Level (dBμV)	Antenna Factor (dB/m)	Cable Loss (dB)	Preamp Factor (dB)	Ant Pos (cm)	Table Pos (deg)	Peak Avg. (P/A)	Pol. (H/V)
802.11a CH 149 5785MHz and BLE CH19 2440MHz		94.53	33.16	-10.34	43.5	53.53	10.8	1	32.29			P	H
		133.95	33.98	-9.52	43.5	51.25	13.77	1.19	32.28			P	H
		282.99	33.43	-12.57	46	48.37	15.46	1.68	32.15			P	H
		659.8	42.79	-3.21	46	49.01	23.34	2.51	32.19	118	343	QP	H
		659.8	47.68	1.68	46	53.9	23.34	2.51	32.19	118	343	P	H
		707.4	43.39	-2.61	46	48.95	23.86	2.64	32.16	113	33	QP	H
		707.4	48.06	2.06	46	53.62	23.86	2.64	32.16	113	33	P	H
		755.7	39.72	-6.28	46	43.87	25.14	2.68	32.07	100	0	P	H
		78.87	31.84	-8.16	40	52.67	10.43	0.95	32.3			P	V
		108.03	31.52	-11.98	43.5	48.37	14.33	1	32.29			P	V
		282.72	30.13	-15.87	46	45.07	15.46	1.68	32.15			P	V
		673.8	40.48	-5.52	46	46.61	23.37	2.57	32.18	100	0	P	V
		706.7	41.49	-4.51	46	47.05	23.86	2.64	32.16			P	V
	757.8	39.13	-6.87	46	43.22	25.17	2.71	32.07			P	V	
Remark	1. No other spurious found. 2. All results are PASS against limit line.												



Note symbol

*	Fundamental Frequency which can be ignored. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
!	Test result is over limit line.
P/A	Peak or Average
H/V	Horizontal or Vertical



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

WIFI	Note	Frequency	Level	Over	Limit	Read	Antenna	Cable	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		2390	55.45	-18.55	74	54.51	32.22	4.58	35.86	103	308	P	H
CH 01													
2412MHz		2390	43.54	-10.46	54	42.6	32.22	4.58	35.86	103	308	A	H

- 1. Level(dBμV/m) =
Antenna Factor(dB/m) + Cable Loss(dB) + Read Level(dBμV) - Preamp Factor(dB)
- 2. Over Limit(dB) = Level(dBμV/m) – Limit Line(dBμV/m)

For Peak Limit @ 2390MHz:

- 1. Level(dBμV/m)
= Antenna Factor(dB/m) + Cable 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) + Cable 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 :	Alex Jheng, Bill Chang and Wilson Wu	Temperature :	24.0 ~ 24.5°C
		Relative Humidity :	53 ~ 56%

Co-location Mode

WIFI 802.11b and BLE (Harmonic @ 3m)

WIFI	Co-location mode Harmonic @ 3m	
ANT	802.11b CH12 2467MHz and BLE CH19 2440MHz	
2	Horizontal	Vertical
Peak Avg.	<p>Site : 03CH13-HY Condition : PEAK 74 3m SHF HORN 584 HORIZONTAL</p>	<p>Site : 03CH13-HY Condition : PEAK 74 3m SHF HORN 584 VERTICAL</p>



802.11a CDD and BLE (Harmonic @ 3m)

WIFI	Co-location mode Harmonic @ 3m	
ANT	802.11a Ch149 5785MHz and BLE CH19 2440MHz	
1+2	Horizontal	Vertical
Peak Avg.	<p>Site : 03CH13-HY Condition : PEAK(UNII) 3m SHF HORN 584 HORIZONTAL</p>	<p>Site : 03CH13-HY Condition : PEAK(UNII) 3m SHF HORN 584 VERTICAL</p>



Emission below 1GHz
WIFI 802.11b and BLE (LF)

WIFI	Co-location mode	
ANT	WIFI 802.11b and BLE LF	
2	Horizontal	Vertical
QP / Peak	<p>Site : 03CH13-HY Condition : QP 3m STL06 40103 HORIZONTAL</p>	<p>Site : 03CH13-HY Condition : QP 3m STL06 40103 VERTICAL</p>



802.11a CDD and BLE (LF)

WIFI	Co-location mode	
ANT	802.11a CDD and BLE LF	
1+2	Horizontal	Vertical
QP / Peak	<p>Site : 03CH13-HY Condition : QP 3m BLE06 40103 HORIZONTAL</p>	<p>Site : 03CH13-HY Condition : QP 3m BLE06 40103 VERTICAL</p>



Appendix C. Duty Cycle Plots

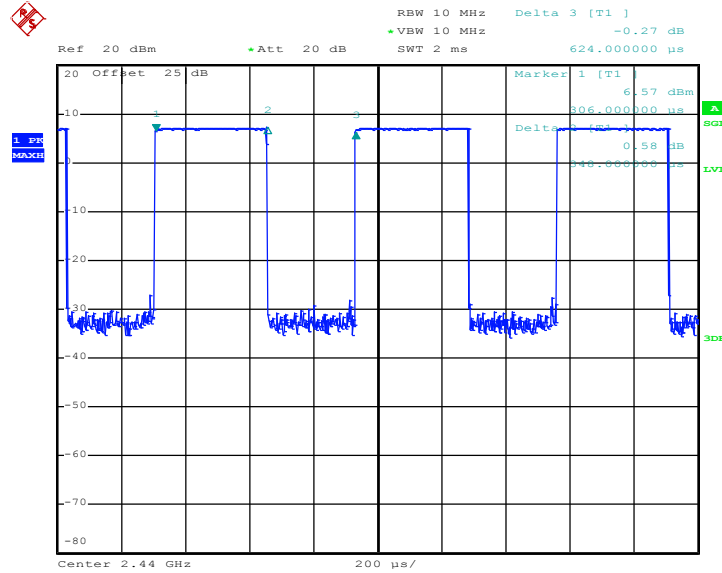
Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting
Bluetooth -LE	55.77	348	2.87	3Hz
802.11b	98.62	-	-	10Hz

<CDD Modes>

Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting
802.11a for Ant. 1	92.86	1430	0.70	1kHz
802.11a for Ant. 2	92.86	1430	0.70	1kHz

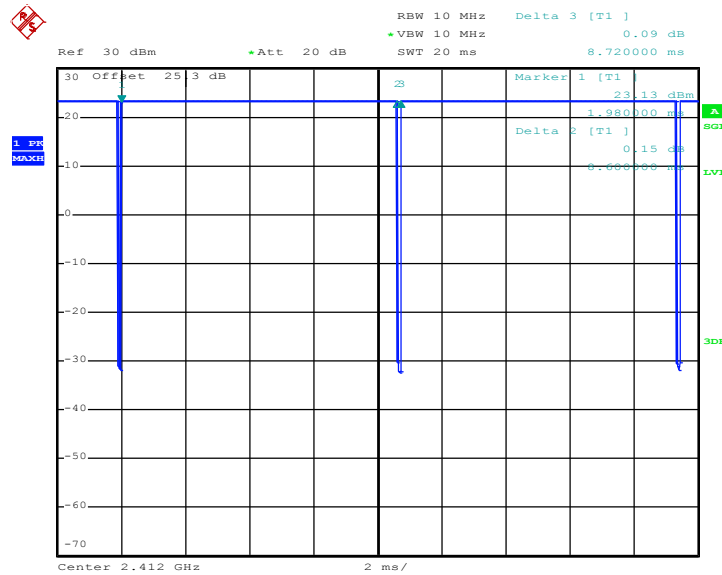


Bluetooth - LE



Date: 6.JUL.2017 01:25:46

802.11b

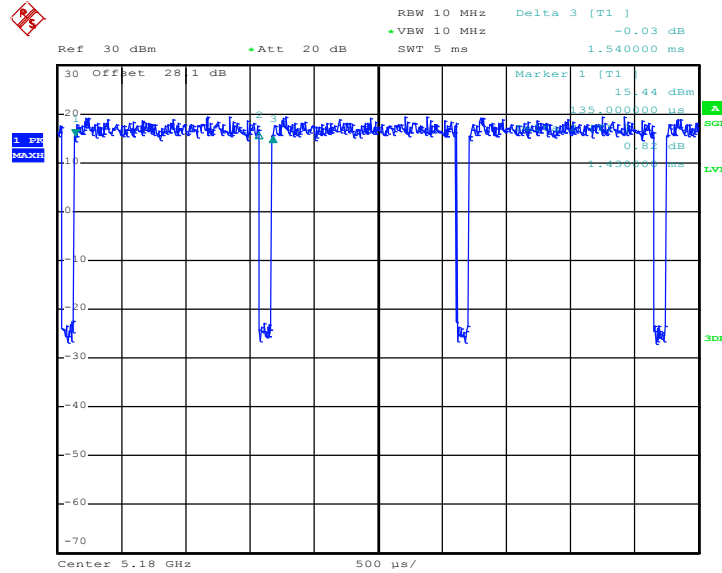


Date: 5.JUL.2017 21:35:48



MIMO <Ant. 1>

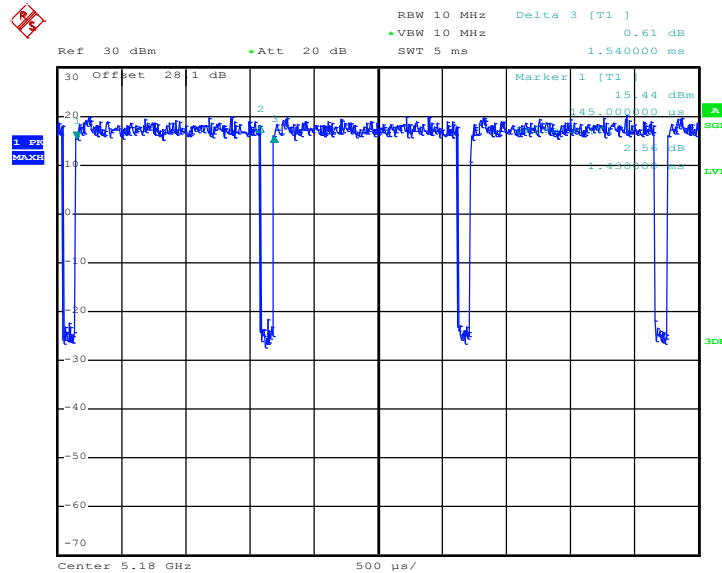
802.11a



Date: 5.JUL.2017 23:46:58

MIMO <Ant. 2>

802.11a



Date: 5.JUL.2017 23:47:47