FCC RF CO-LOCATION TEST REPORT

FCC ID	:	UDX-60076015
Equipment	:	Wi-Fi Router
Brand Name	:	CISCO
Model Name	:	MX67W-HW
Applicant	:	Cisco Systems, Inc. 170 West Tasman Drive, San Jose, CA 95134
Standard	:	FCC Part 15 Subpart E §15.407

The product was received on Mar. 14, 2018 and testing was started from Apr. 27, 2018 and completed on Jun. 12, 2018. 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 INTERTIONAL INC. EMC & Wireless Communications Laboratory, the test report shall not be reproduced except in full.

Approved by: Jones Tsai

SPORTON INTERTIONAL 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
FR831426E	01	Initial issue of report	Jul. 16, 2018

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 4.44 dB at 374.900 MHz
3.2	15.203 15.407(a)	Antenna Requirement	Pass	-

Reviewed by: Joseph Lin

Report Producer: Maggie Chiang

1 General Description

1.1 Product Feature of Equipment Under Test

Wi-Fi 2.4GHz 802.11b/g/n/ac and Wi-Fi 5GHz 802.11a/n/ac

Product specification subjective to this standard	
Antenna Type	WLAN: Dipole 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: +886-3-327-0868 FAX: +886-3-327-0855
Test Site No.	**Sporton Site No.**
	03CH13-HY

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

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.
- 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).

2.1 Carrier Frequency and Channel

2400-2483.5 MHz 802.11n HT40		5745-5825 MHz 802.11n HT20	
Channel	**Freq. (MHz)**	**Channel**	**Freq. (MHz)**
03	2422	149	5745

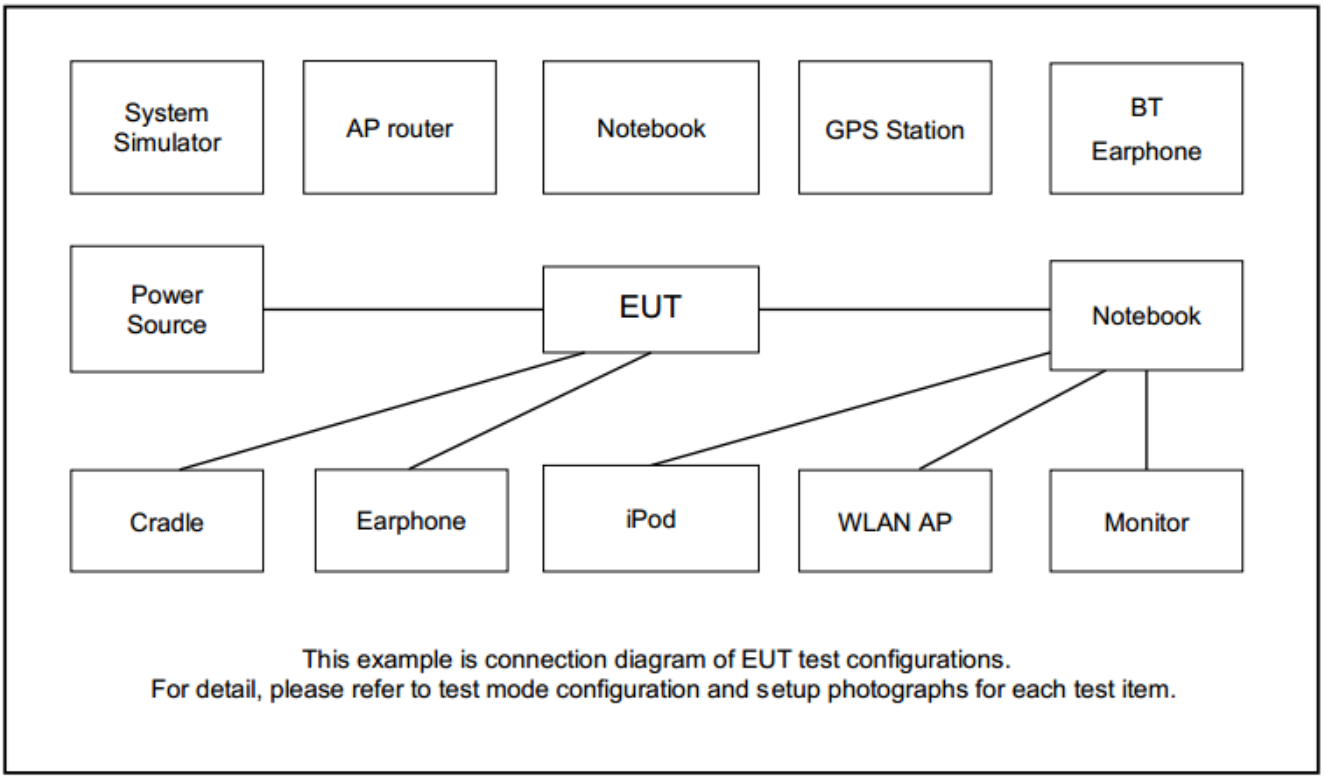
2.2 Test Mode

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

<Co-Location>

Modulation	Data Rate
11n (HT40) + 11n (HT20)	**Normal Mode**

2.3 Connection Diagram of Test System



2.4 EUT Operation Test Setup

The RF test items, utility “QRCT” 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

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) 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 ≥ 3 MHz
- Detector = Peak
- Sweep time = auto
- Trace mode = max hold

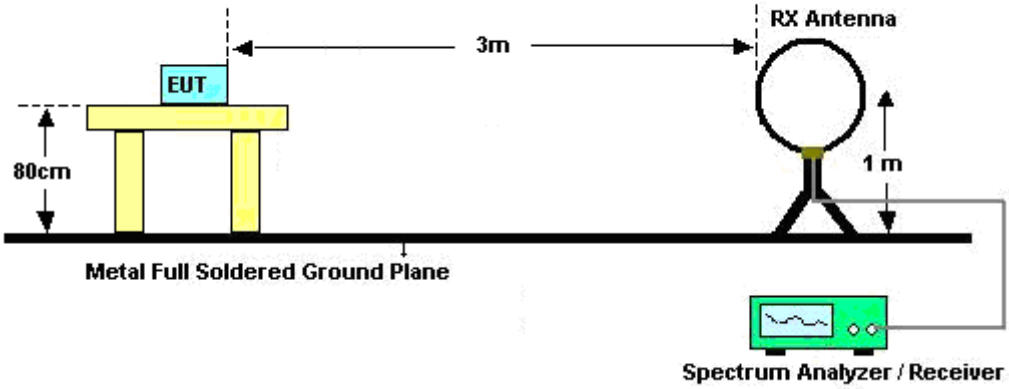
(3) Procedures for Average Unwanted Emissions Measurements Above 1000MHz

- 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.

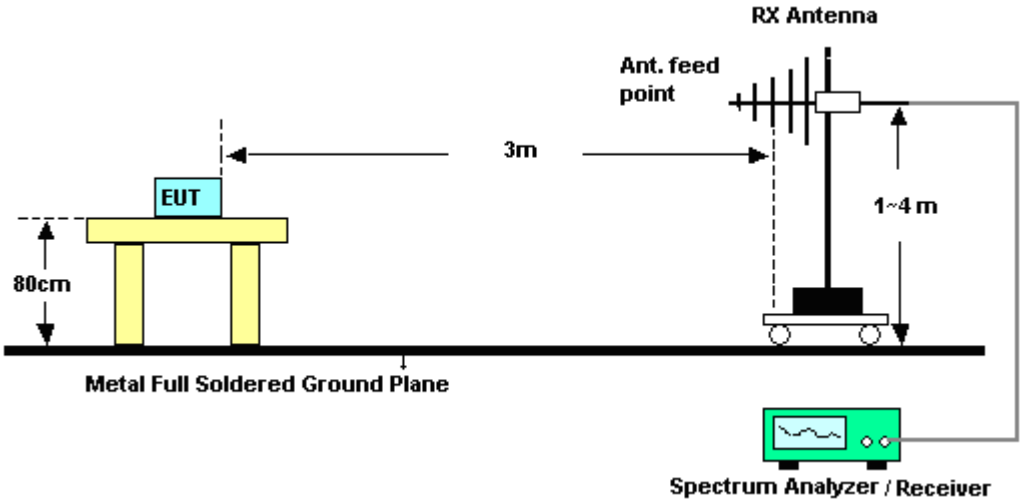
2. he EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
3. The EUT was set 3 meters from the interference receiving antenna which was mounted on the top of a variable height antenna tower.
4. The antenna is a broadband 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

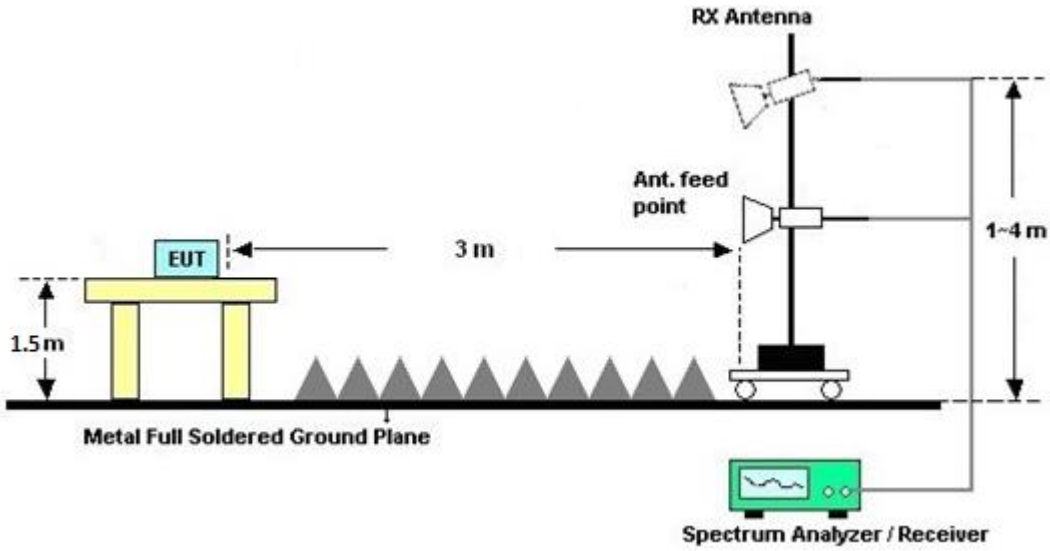
For radiated emissions below 30MHz



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.

3.1.7 Duty Cycle

Please refer to Appendix B.

3.1.8 Test Result of Radiated Spurious Emissions (30MHz ~ 10th Harmonic)

Please refer to Appendix A.

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	Nov. 10, 2017	Apr. 27, 2018 ~ Jun. 12, 2018	Nov. 09, 2018	Radiation (03CH13-HY)
Filter	Wainwright	WLKS1200-8SS	SN3	1.2G Low Pass	Nov. 21, 2017	Apr. 27, 2018 ~ Jun. 12, 2018	Nov. 20, 2018	Radiation (03CH13-HY)
Amplifier	MITEQ	TTA1840-35-HG	1871923	18GHz~40GHz, VSWR : 2.5:1 max	Jul. 18, 2017	Apr. 27, 2018 ~ Jun. 12, 2018	Jul. 17, 2018	Radiation (03CH13-HY)
Filter	Woken	WHKX8-5272.5-6750-18000-40ST	SN2	6.75G Highpass	Jul. 17, 2017	Apr. 27, 2018 ~ Jun. 12, 2018	Jul. 16, 2018	Radiation (03CH13-HY)
Amplifier	Sonoma-Instrument	310 N	187282	9KHz~1GHz	Jan. 19, 2018	Apr. 27, 2018 ~ Jun. 12, 2018	Jan. 18, 2020	Radiation (03CH13-HY)
Bilog Antenna	TESEQ	CBL 6111D&00800N1D01N-06	40103&07	30MHz to 1GHz	Jan. 10, 2018	Apr. 27, 2018 ~ Jun. 12, 2018	Jan. 09, 2019	Radiation (03CH13-HY)
Horn Antenna	SCHWARZBECK	BBHA 9120 D	9120D-1241	1GHz ~ 18GHz	Jun. 15, 2017	Apr. 27, 2018 ~ Jun. 12, 2018	Jun. 14, 2018	Radiation (03CH13-HY)
Preamplifier	MITEQ	AMF-7D-00101800-30-10P	1590074	1GHz~18GHz	May 22, 2017	Apr. 27, 2018 ~ May 01, 2018	May 21, 2018	Radiation (03CH13-HY)
Preamplifier	MITEQ	AMF-7D-00101800-30-10P	1590074	1GHz~18GHz	May 21, 2018	Jun. 12, 2018	May 20, 2019	Radiation (03CH13-HY)
Preamplifier	Keysight	83017A	MY53270147	1GHz~26.5GHz	Feb. 02, 2018	Apr. 27, 2018 ~ Jun. 12, 2018	Feb. 01, 2019	Radiation (03CH13-HY)
Spectrum Analyzer	Keysight	N9010A	MY55370526	10Hz~44GHz	Mar. 15, 2018	Apr. 27, 2018 ~ Jun. 12, 2018	Mar. 14, 2019	Radiation (03CH13-HY)
Antenna Mast	EMEC	AM-BS-4500-B	N/A	1m~4m	N/A	Apr. 27, 2018 ~ Jun. 12, 2018	N/A	Radiation (03CH13-HY)
Turn Table	EMEC	TT2000	N/A	0~360 Degree	N/A	Apr. 27, 2018 ~ Jun. 12, 2018	N/A	Radiation (03CH13-HY)
SHF-EHF Horn Antenna	SCHWARZBECK	BBHA 9170	BBHA9170584	18GHz- 40GHz	Nov. 27, 2017	Apr. 27, 2018 ~ Jun. 12, 2018	Nov. 26, 2018	Radiation (03CH13-HY)
EMI Test Receiver	Agilent	N9038A (MXE)	MY53290053	20Hz to 26.5GHz	Jan. 16, 2018	Apr. 27, 2018 ~ Jun. 12, 2018	Jan. 15, 2019	Radiation (03CH13-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 126E	MY1082/26EA	30M~18GHz	Oct. 17, 2017	Apr. 27, 2018 ~ Jun. 12, 2018	Oct. 16, 2018	Radiation (03CH13-HY)
RF Cable	HUBER + SUHNER	SUCOFLEX 102	505134/2	30M~40GHz	Oct. 17, 2017	Apr. 27, 2018 ~ Jun. 12, 2018	Oct. 16, 2018	Radiation (03CH13-HY)
Software	AUDIX	E3 6.2009-8-24c	RK-001124	N/A	N/A	Apr. 27, 2018 ~ Jun. 12, 2018	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))	4.9

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

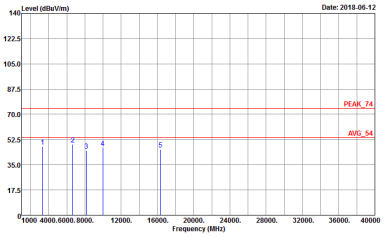
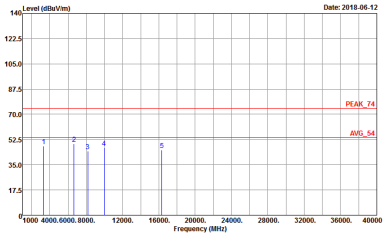
Appendix A. Radiated Spurious Emission Plots

Test Engineer :	Alex Jheng, Fu Chen, and Wilson Wu	Temperature :	24.5~25°C
		Relative Humidity :	47~48%

Note symbol

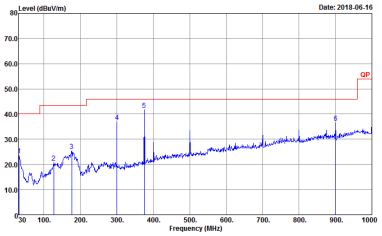
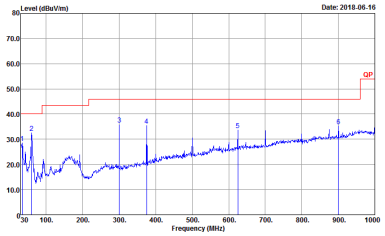
-L	**Low channel location**
-R	**High channel location**

11n (HT40) CH03 + 11n (HT20) Ch149 (Harmonic @ 3m)

	11n (HT40) CH03 + 11n (HT20) Ch149	
	Horizontal	**Vertical**
Peak **Avg.**	 Site : 03CH13-HY Condition : PEAK_74 3m SHF_HORN_576 HORIZONTAL Detector : Peak Mode : 21 1 3323.00 47.41 -26.59 74.00 42.14 28.47 6.57 29.77 100 0 Peak 2 6646.00 49.08 -24.92 74.00 35.57 34.66 9.05 30.20 100 0 Peak 3 8167.00 44.84 -29.16 74.00 53.81 36.84 10.52 57.09 100 0 Peak 4 9969.00 46.93 -27.07 74.00 53.16 38.68 11.63 57.10 100 0 Peak 5 16334.00 45.74 -28.26 74.00 48.79 37.90 14.18 55.83 100 0 Peak	 Site : 03CH13-HY Condition : PEAK_74 3m SHF_HORN_576 VERTICAL Detector : Peak Mode : 21 1 3323.00 47.88 -26.12 74.00 42.61 28.47 6.57 29.77 100 0 Peak 2 6646.00 49.42 -24.58 74.00 35.91 34.66 9.05 30.20 100 0 Peak 3 8167.00 44.53 -29.47 74.00 53.50 36.84 10.52 57.09 100 0 Peak 4 9969.00 46.99 -27.01 74.00 53.22 38.68 11.63 57.10 100 0 Peak 5 16334.00 45.15 -28.85 74.00 48.20 37.90 14.18 55.83 100 0 Peak

Emission below 1GHz

11n (HT40) CH03 + 11a (HT20) Ch149 (LF)

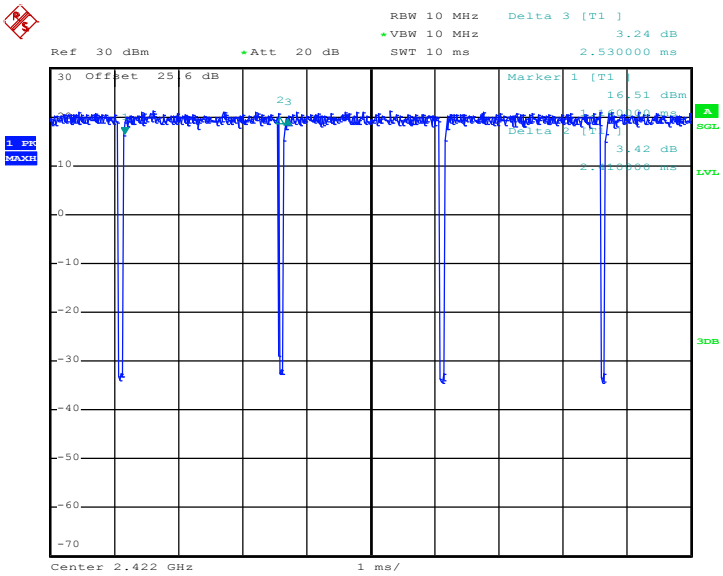
	11n (HT40) CH03 + 11a (HT20) Ch149	
	Horizontal	Vertical
QP / Peak	 Site : 03CH13-HY Condition : QP 3m BILOG_40103 HORIZONTAL Detector : Peak Mode : 22 1 31.62 23.67 -16.33 40.00 31.68 23.54 0.81 32.34 --- --- Peak 2 126.93 20.70 -22.80 43.50 34.04 17.56 1.32 32.28 --- --- Peak 3 176.34 25.43 -18.07 43.50 40.67 15.35 1.60 32.27 --- --- Peak 4 300.00 36.94 -9.06 46.00 47.67 19.30 2.04 32.13 --- --- Peak 5 374.90 41.56 -4.44 46.00 50.29 21.07 2.26 32.15 100 0 Peak 6 899.90 36.55 -9.45 46.00 35.48 29.03 3.44 31.51 --- --- Peak	 Site : 03CH13-HY Condition : QP 3m BILOG_40103 VERTICAL Detector : Peak Mode : 22 1 34.32 28.53 -11.47 40.00 37.39 22.69 0.81 32.34 --- --- Peak 2 59.70 32.44 -7.56 40.00 51.63 12.06 1.06 32.31 100 0 Peak 3 300.00 35.77 -10.23 46.00 46.50 19.30 2.04 32.13 --- --- Peak 4 374.90 35.36 -10.64 46.00 44.09 21.07 2.26 32.15 --- --- Peak 5 624.80 33.56 -12.44 46.00 36.78 26.00 2.87 32.20 --- --- Peak 6 899.90 35.32 -10.68 46.00 34.25 29.03 3.44 31.51 --- --- Peak

Appendix B. Duty Cycle Plots

Antenna	Band	Duty Cycle(%)	T(us)	1/T(kHz)	VBW Setting	Duty Factor(dB)
1+2	2.4GHz 802.11n HT40 for Ant. 1	95.26	2410	0.41	1kHz	0.21
1+2	2.4GHz 802.11n HT40 for Ant. 2	95.20	2380	0.42	1kHz	0.21
1+2	5GHz 802.11n HT20 for Ant. 1	98.58	-	-	10Hz	0.06
1+2	5GHz 802.11n HT20 for Ant. 2	98.23	-	-	10Hz	0.08

MIMO <Ant. 1>

802.11n HT40



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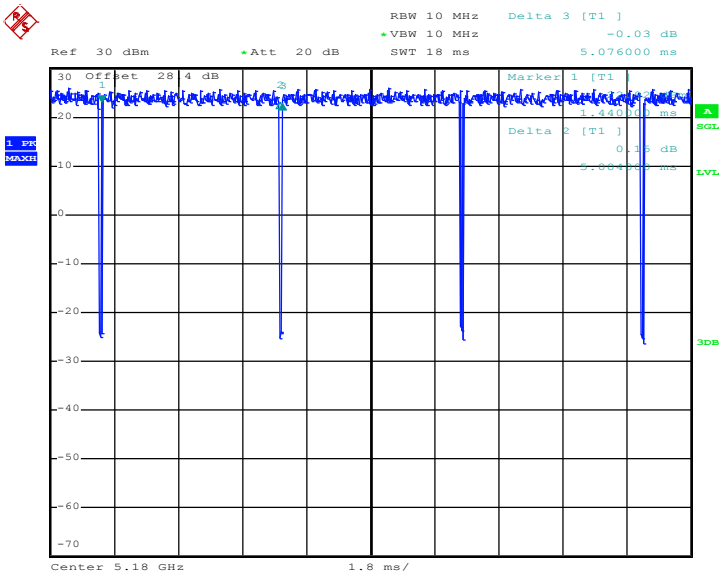
802.11n HT20



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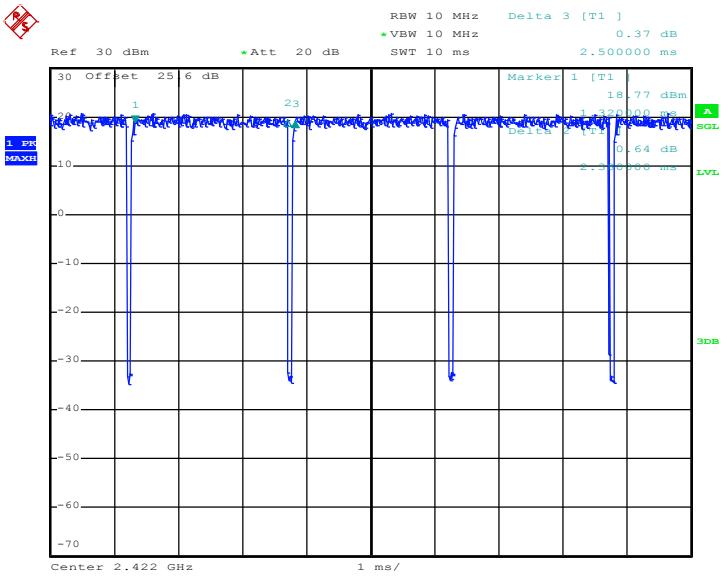
MIMO<Ant. 2>

802.11n HT40



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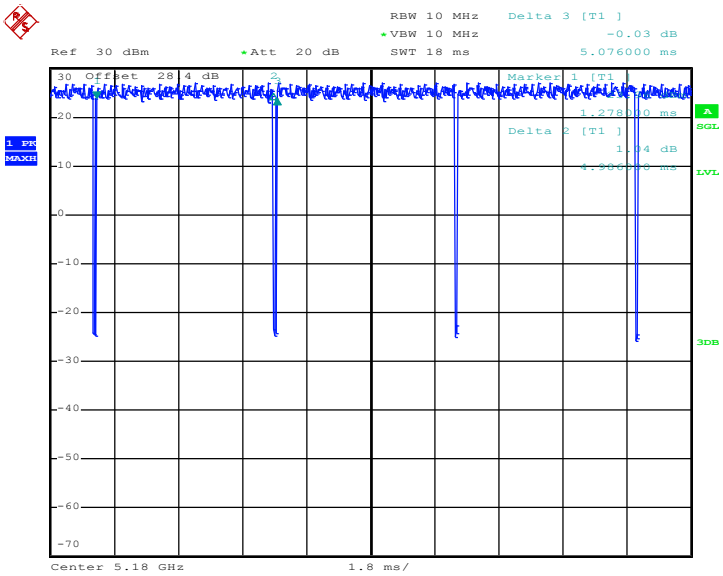
802.11n HT20



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