Variant FCC RF Test Report

APPLICANT	:	TP-LINK TECHNOLOGIES CO., LTD.
EQUIPMENT	:	AC1900 Wireless Dual Band Gigabit Access Point
BRAND NAME	:	TP-LINK
MODEL NAME	:	EAP330
FCC ID	:	TE7EAP330
STANDARD	:	FCC Part 15 Subpart E §15.407
CLASSIFICATION	:	(NII) Unlicensed National Information Infrastructure

The product testing was completed on Jul. 19, 2016. We, SPORTON INTERNATIONAL (SHENZHEN) 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 test results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL (SHENZHEN) INC., the test report shall not be reproduced except in full.

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Testing Laboratory
2353

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REVISION HISTORY

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FR640501-01B	Rev. 01	This is a variant report for EAP330. All the test cases were performed on the original test report which can be referred to Sporton Report Number FG640501B. Based on the original test report, only adding the Beamforming power and RSE test data.	Sep. 06, 2016

SUMMARY OF TEST RESULT

Report Section	FCC Rule	IC Rule	Description	Limit	Result	Remark
3.1	15.407(a)	RSS-247 Section 6	Maximum Conducted Output Power	FCC ≤24 dBm (depend on band)	Pass	-
3.2	15.407(b)	RSS-247 Section 6	Unwanted Emissions	≤ -17, -27 dBm (depend on band)&15.209(a)	Pass	Under limit 1.01 dB at 34.850 MHz
3.3	15.407(c)	RSS-247 6.4(2)	Automatically Discontinue Transmission	Discontinue Transmission	Pass	-
3.4	15.203 & 15.407(a)	N/A	Antenna Requirement	N/A	Pass	-

1 General Description

1.1 Applicant

TP-LINK TECHNOLOGIES CO., LTD.
Building 24 (floors 1,3,4,5) and 28 (floors1-4) Central Science and Technology Park, Shennan Rd, Nanshan, Shenzhen, China

1.2 Manufacturer

TP-LINK TECHNOLOGIES CO., LTD.
Building 24 (floors 1,3,4,5) and 28 (floors1-4) Central Science and Technology Park, Shennan Rd, Nanshan, Shenzhen, China

1.3 Feature of Equipment Under Test

Product Feature & Specification	
Equipment	AC1900 Wireless Dual Band Gigabit Access Point
Brand Name	TP-LINK
Model Name	EAP330
FCC ID	TE7EAP330
EUT supports Radios application	WLAN2.4GHz 802.11b/g/n HT20/HT40/ WLAN2.4GHz 802.11ac VHT20/VHT40 WLAN5GHz 802.11a/n HT20/HT40/ WLAN5GHz 802.11ac VHT20/VHT40/VHT80
EUT Stage	Identical Prototype

Remark: The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

1.4 Product Specification of Equipment Under Test

Product Specification subjective to this standard	
Tx/Rx Frequency Range	5180 MHz ~ 5240 MHz
Maximum Output Power to Antenna <TX Beamforming Modes>	**<5180 MHz ~ 5240 MHz>** 802.11n HT20 : 24.22 dBm / 0.2642 W 802.11n HT40 : 20.28 dBm / 0.1067 W 802.11ac VHT20 : 23.66 dBm / 0.2323 W 802.11ac VHT40 : 20.15 dBm / 0.1035 W 802.11ac VHT80 : 17.25 dBm / 0.0531 W
Antenna Type	Chain Port 1 : PIFA Antenna Chain Port 2 : PIFA Antenna Chain Port 3 : PIFA Antenna
Antenna Gain	**<5180 MHz ~ 5240 MHz>**: Chain Port 1 : 6.39 dBi Chain Port 2 : 6.57 dBi Chain Port 3 : 5.43 dBi
TX Beamforming Gain (Y)	**<5180 MHz ~ 5240 MHz>** MIMO Ant. 1+2+3 : 4.35 dBi
Type of Modulation	802.11a/n : OFDM (BPSK / QPSK / 16QAM / 64QAM) 802.11ac : OFDM (BPSK / QPSK / 16QAM / 64QAM / 256QAM)
Antenna Function Description	

	Chain Port 1	Chain Port 2	Chain Port 3
802.11a/n/ac MIMO	V	V	V

Remark: Only 802.11n and 11ac support TX Beamforming

1.5 Modification of EUT

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

1.6 Testing Location

Test Site	SPORTON INTERNATIONAL (SHENZHEN) INC.
Test Site Location	1F & 2F, Building A, Morning Business Center, No. 4003 ShiGu Rd., Xili Town, Nanshan District, Shenzhen, Guangdong, P. R. China TEL: +86-755-8637-9589 FAX: +86-755-8637-9595
Test Site No.	**Sporton Site No.**
	TH01-SZ

Test Site	SPORTON INTERNATIONAL (SHENZHEN) INC.	
Test Site Location	No. 3 Building, the third floor of south, Shahe River west, Fengzeyuan warehouse, Nanshan District, Shenzhen, Guangdong, P. R. China TEL: +86-755- 3320-2398	
Test Site No.	**Sporton Site No.**	**FCC/IC Registration No.**
	03CH03-SZ	565805/4086F

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

1.7 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 v01r03
- FCC KDB 662911 D01 Multiple Transmitter Output v02r01.
- FCC KDB 644545 D03 Guidance for IEEE 802 11ac New Rules v01
- 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: radiated emission (9 kHz to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower).

The final configuration from all the combinations and the worst-case data rates were investigated by measuring the maximum power across all the data rates and modulation modes under section 2.2.

Based on the worst configuration found above, the RF power setting is set individually to meet FCC compliance limit for the final conducted and radiated tests shown in section 2.3.

2.1 Carrier Frequency Channel

Frequency Band	Channel	Freq. (MHz)	Channel	Freq. (MHz)
5180- 5240 MHz Band 1 (U-NII-1)	36	5180	44	5220
	38	**5190**	**46**	**5230**
	40	5200	48	5240
	42	5210		

Note: The above Frequency and Channel in boldface were 802.11n HT40.

2.2 Pre-Scanned RF Power

Preliminary tests were performed in different data rate and data rate associated with the highest power were chosen for full test in the following tables. Final Output Power equals to Measured Output Power adds the duty factor.

<TX Beamforming Modes>

WLAN 5GHz 802.11n-HT20 Average Power (dBm)											
Power vs. Channel				Power vs. Data Rate							
Channel	Frequency (MHz)	Chain Port	MCS Index MCS0	Channel	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
CH 36	5180	1+2+3	24.04	CH 44	24.14	24.10	24.09	24.08	24.04	24.05	24.04
CH 44	5220	1+2+3	**24.22**								
CH 48	5240	1+2+3	23.89								

WLAN 5GHz 802.11n-HT40 Average Power (dBm)											
Power vs. Channel				Power vs. Data Rate							
Channel	Frequency (MHz)	Chain Port	MCS Index MCS0	Channel	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7
CH 38	5190	1+2+3	**20.28**	CH 38	20.25	20.15	20.09	20.08	20.09	20.20	20.16
CH 46	5230	1+2+3	20.12								

WLAN 5GHz 802.11ac VHT20 Average Power (dBm)												
Power vs. Channel				Power vs. Data Rate								
Channel	Frequency (MHz)	Chain Port	MCS Index MCS0	Channel	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	MCS8
CH 36	5180	1+2+3	23.46	CH 44	23.60	23.57	23.54	23.59	23.52	23.53	23.48	23.52
CH 44	5220	1+2+3	**23.66**									
CH 48	5240	1+2+3	23.53									

WLAN 5GHz 802.11ac VHT40 Average Power (dBm)													
Power vs. Channel				Power vs. Data Rate									
Channel	Frequency (MHz)	Chain Port	MCS Index MCS0	Channel	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	MCS8	MCS9
CH 38	5190	1+2+3	**20.15**	CH 38	20.07	20.05	20.01	20.03	20.04	20.01	19.98	20.00	20.00
CH 46	5230	1+2+3	20.06										

WLAN 5GHz 802.11ac VHT80 Average Power (dBm)													
Power vs. Channel				Power vs. Data Rate									
Channel	Frequency (MHz)	Chain Port	MCS Index MCS0	Channel	MCS1	MCS2	MCS3	MCS4	MCS5	MCS6	MCS7	MCS8	MCS9
CH 42	5210	1+2+3	**17.25**	CH 42	16.83	17.17	17.14	17.08	17.10	17.07	17.14	17.17	17.15

Note: Chain Port 1+2+3 is a calculated result from sum of the power Chain Port 1+2+3(1), Chain Port 1+2+3(2) and Chain Port 1+2+3(3).

2.3 Test Mode

Final test mode of conducted test items and radiated spurious emissions are considering the modulation and worse data rates from the power table described in section 2.2.

MIMO Antenna

Modulation	Data Rate
802.11n HT20	6 Mbps
802.11n HT40	MCS0
802.11ac VHT20	MCS0
802.11ac VHT40	MCS0
802.11ac VHT80	MCS0

Ch. #		Band I：5180-5240 MHz
		802.11n HT20
L	Low	36
M	Middle	44
H	High	48

Ch. #		Band I：5180-5240 MHz
		802.11n HT40
L	Low	38
M	Middle	-
H	High	46

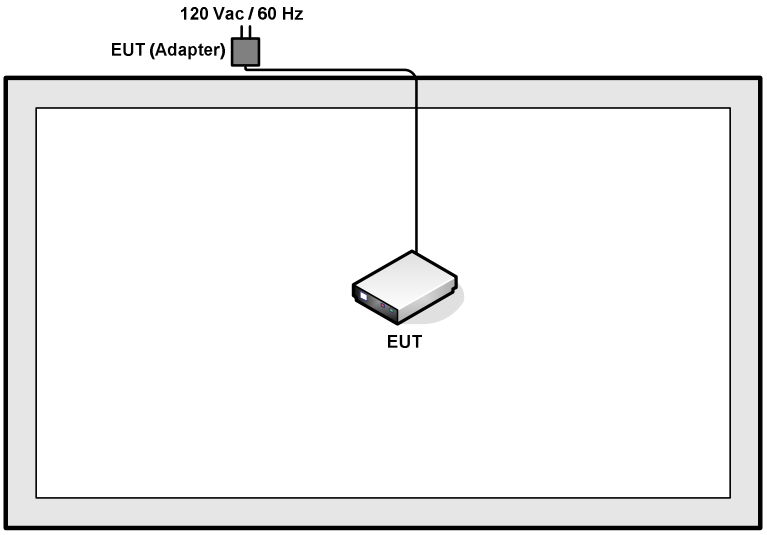
Ch. #		Band I：5180-5240 MHz
		802.11ac VHT20
L	Low	36
M	Middle	44
H	High	48

Ch. #		Band I：5180-5240 MHz
		802.11ac VHT40
L	Low	38
M	Middle	-
H	High	46

Ch. #		Band I：5180-5240 MHz
		802.11ac VHT80
L	Low	-
M	Middle	42
H	High	-

2.4 Connection Diagram of Test System

<WLAN Tx Mode>



2.5 EUT Operation Test Setup

For WLAN RF test items, an engineering test program was provided and enabled to make EUT continuously transmit/receive.

3 Test Result

3.1 Maximum Conducted Output Power Measurement

3.1.1 Limit of Maximum Conducted Output Power

For an indoor access point operating in the band 5.15–5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1W.

If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Note that U-NII-2 band, devices with a maximum e.i.r.p. greater than 500 mW shall implement TPC in order to have the capability to operate at least 6 dB below the maximum permitted e.i.r.p. of 1 W.

3.1.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

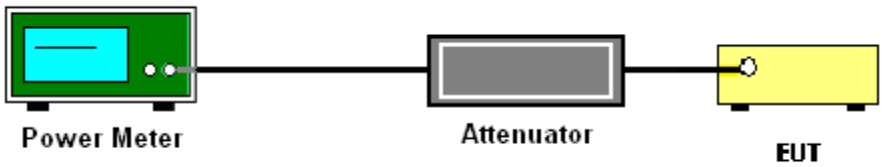
3.1.3 Test Procedures

The testing follows Method PM-G of FCC KDB 789033 D02 General UNII Test Procedures New Rules v01r03 for TX Beamforming modes.

Method PM-G (Measurement using a gated RF average power meter):

1. Measurement is performed using a wideband RF power meter.
2. The EUT is configured to transmit at its maximum power control level.
3. Measure the average power of the transmitter
4. Since the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.

3.1.4 Test Setup



3.1.5 Test Result of Maximum Conducted Output Power

FCC Band I															
Mod.	Data Rate	NTX	CH.	Freq. (MHz)	Ant	Average Conducted Power with duty factor (dBm)					FCC Power Limit (dBm)	DG (dBi)	FCC EIRP Power (dBm)	FCC EIRP Power Limit (dBm)	Pass/Fail
						Ant 1	Ant 2	Ant 3	Ant 4	SUM					
HT20	MCS0	3	36	5180	1+2+3	19.12	18.58	20.00		24.04	25.08	10.92	34.96	-	Pass
HT20	MCS0	3	44	5220	1+2+3	19.32	18.76	20.15		24.22	25.08	10.92	35.13	-	Pass
HT20	MCS0	3	48	5240	1+2+3	19.07	18.45	19.74		23.89	25.08	10.92	34.80	-	Pass
HT40	MCS0	3	38	5190	1+2+3	15.34	15.14	15.99		20.28	25.08	10.92	31.19	-	Pass
HT40	MCS0	3	46	5230	1+2+3	15.28	14.93	15.80		20.12	25.08	10.92	31.04	-	Pass
VHT20	MCS0	3	36	5180	1+2+3	18.49	18.02	19.43		23.46	25.08	10.92	34.38	-	Pass
VHT20	MCS0	3	44	5220	1+2+3	18.77	18.27	19.51		23.66	25.08	10.92	34.57	-	Pass
VHT20	MCS0	3	48	5240	1+2+3	18.74	18.12	19.33		23.53	25.08	10.92	34.45	-	Pass
VHT40	MCS0	3	38	5190	1+2+3	15.29	15.02	15.78		20.15	25.08	10.92	31.06	-	Pass
VHT40	MCS0	3	46	5230	1+2+3	15.16	14.92	15.73		20.06	25.08	10.92	30.97	-	Pass
VHT80	MCS0	3	42	5210	1+2+3	12.41	12.16	12.82		17.25	25.08	10.92	28.16	-	Pass

3.2 Unwanted Radiated Emission Measurement

This section as specified in FCC Part 15.407(b) is to measure unwanted emissions through radiated measurement for band edge spurious emissions and out of band emissions measurement. The unwanted emissions shall comply with 15.407(b)(1) to (6), and restricted bands per FCC Part15.205.

3.2.1 Limit of Unwanted Emissions

(1) For transmitters operating in the 5150-5250 MHz band: all emissions outside of the 5150-5350 MHz band shall not exceed an EIRP of –27dBm/MHz.

(2) Unwanted spurious emissions fallen in restricted bands per FCC Part15.205 shall comply with the general field strength limits set forth in § 15.209 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)
-17	78.3
- 27	68.3

(3) KDB789033 D02 v01r02 G)2)c) As specified in 15.407(b), emissions above 1000 MHz that are outside of the restricted bands are subject to a peak emission limit of -27 dBm/MHz (or -17 dBm/MHz as specified in 15.407(b)(4)). However, an out-of-band emission that complies with both the average and peak limits of 15.209 is not required to satisfy the -27 dBm/MHz or -17 dBm/MHz peak emission limit.

3.2.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.2.3 Test Procedures

1. The testing follows FCC KDB 789033 D02 General UNII Test Procedures New Rules v01r02. 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

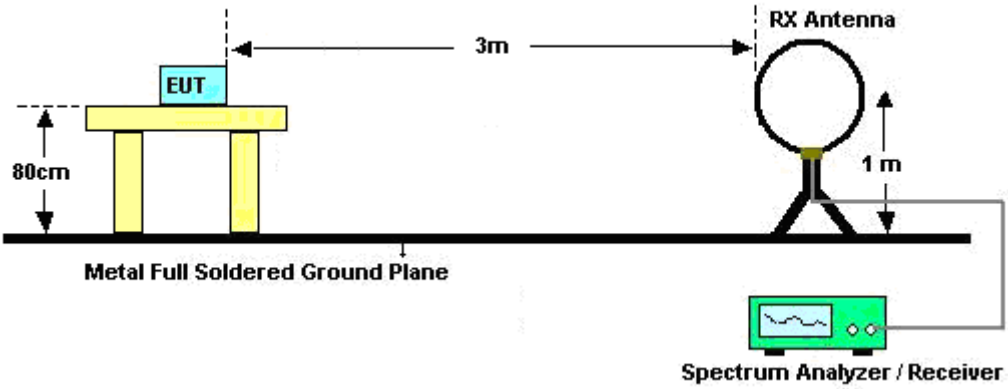
   (3) Procedures for Average Unwanted Emissions Measurements Above 1000MHz

   - 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.

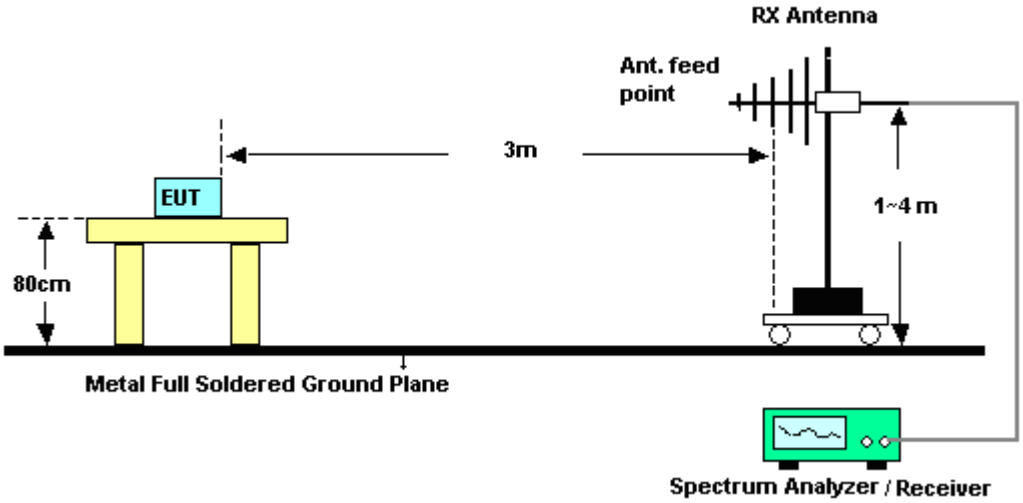
2. The EUT was placed on a turntable with 0.8 meter for frequency below 1GHz and 1.5 meter for frequency above 1GHz respectively above ground.
3. The EUT was set 3 meters from the interference receiving antenna which was mounted on the top of a variable height antenna tower.
4. The antenna is a broadband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

3.2.4 Test Setup

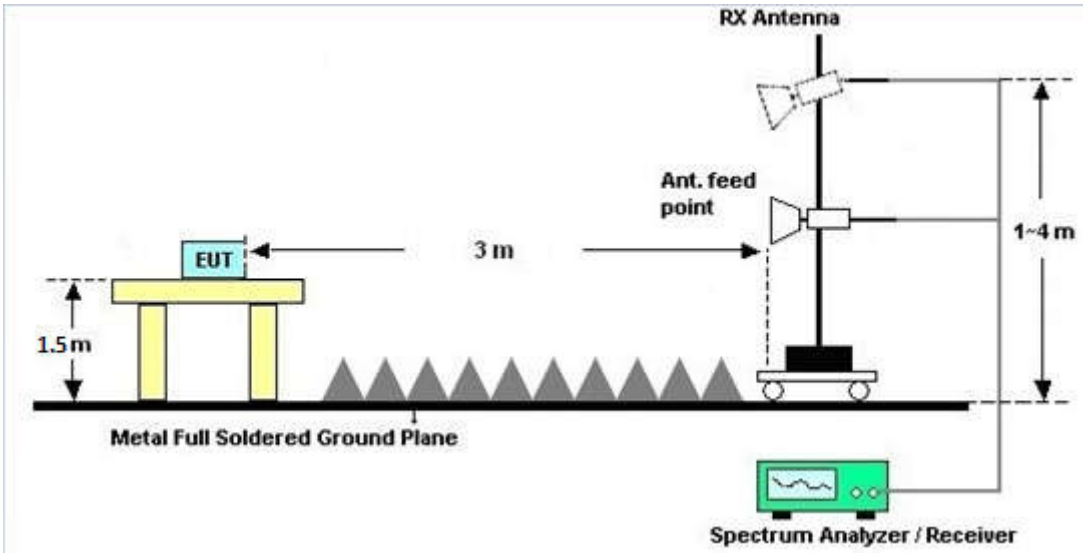
For radiated emissions below 30MHz



For radiated emissions from 30MHz to 1GHz



For radiated emissions above 1GHz



3.2.5 Test Results of Radiated 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 per 15.31(o) was not reported.

3.2.6 Test Result of Radiated Band Edges

Please refer to Appendix A.

3.2.7 Duty Cycle

Please refer to Appendix B.

3.2.8 Test Result of Unwanted Radiated Emission (30MHz ~ 10th Harmonic)

Please refer to Appendix A.

3.3 Automatically Discontinue Transmission

3.3.1 Limit of Automatically Discontinue Transmission

The device shall automatically discontinue transmission in case of either absence of information to transmit or operational failure. These provisions are not intended to preclude the transmission of control or signaling information or the use of repetitive codes used by certain digital technologies to complete frame or burst intervals. Applicants shall include in their application for equipment authorization to describe how this requirement is met.

3.3.2 Measuring Instruments

The measuring equipment is listed in the section 4 of this test report.

3.3.3 Test Result of Automatically Discontinue Transmission

While the EUT is not transmitting any information, the EUT can automatically discontinue transmission and become standby mode for power saving. The EUT can detect the controlling signal of ACK message transmitting from remote device and verify whether it shall resend or discontinue transmission.

3.4 Antenna Requirements

3.4.1 Standard Applicable

According to FCC 47 CFR Section 15.407(a)(1)(2) ,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.

3.4.2 Antenna Anti-Replacement Construction

An embedded-in antenna design is used.

3.4.3 Antenna Gain

TX Beamforming modes

FCC KDB 662911 D01 Multiple Transmitter Output v02r01

For CDD transmissions, directional gain is calculated as

$$DirectionalGain = 10 \cdot \log \left[\frac{\sum_{j=1}^{N_{SS}} \left\{ \sum_{k=1}^{N_{ANT}} g_{j,k} \right\}^2}{N_{ANT}} \right]$$

where

Each antenna is driven by no more than one spatial stream;

N_{SS} = the number of independent spatial streams of data;

N_{ANT} = the total number of antennas

$g_{j,k} = 10^{G_k/20}$ if the kth antenna is being fed by spatial stream j, or zero if it is not;

G_k is the gain in dBi of the kth antenna.

The EUT supports beamforming for 802.11ac modes.

The directional gain calculation is following F)2)e)ii) of KDB 662911 D01 v02r01.

The power and PSD limit should be modified if the directional gain of EUT is over 6 dBi,

The directional gain "DG" is calculated as following table.

5.2G Band Antenna	DG for Power (dBi)	DG for PSD (dBi)	Power Limit Reduction (dB)	PSD Limit Reduction (dB)
1	6.39	6.39	0.39	0.39
2	6.57	6.57	0.57	0.57
3	5.43	5.43	0.00	0.00
1+2	9.49	9.49	3.49	3.49
1+3	8.93	8.93	2.93	2.93
2+3	9.03	9.03	3.03	3.03
1+2+3	10.92	10.92	4.92	4.92

Power Limit Reduction = DG(Power) – 6dBi, (min = 0)

PSD Limit Reduction = DG(PSD) – 6dBi, (min = 0)

4 List of Measuring Equipment

Instrument	Manufacturer	Model No.	Serial No.	Characteristics	Calibration Date	Test Date	Due Date	Remark
Pulse Power Senor	Anritsu	MA2411B	1207253	30MHz~40GHz	Jan. 12, 2016	Jun. 06, 2016	Jan. 11, 2017	Conducted (TH01-SZ)
Power Meter	Anritsu	ML2495A	1218010	50MHz Bandwidth	Jan. 12, 2016	Jun. 06, 2016	Jan. 11, 2017	Conducted (TH01-SZ)
EMI Test Receiver&SA	KEYSIGHT	N9038A	MY54450083	20Hz~8.4GHz	May 07, 2016	Jul. 19, 2016	May 06, 2017	Radiation (03CH03-SZ)
EXA Spectrum Anaiyzer	KEYSIGHT	N9010A	MY55150246	10Hz~44GHz;	May 07, 2016	Jul. 19, 2016	May 06, 2017	Radiation (03CH03-SZ)
Loop Antenna	R&S	HFH2-Z2	100354	9kHz~30MHz	May 07, 2016	Jul. 19, 2016	May 06, 2017	Radiation (03CH03-SZ)
Bilog Antenna	TeseQ	CBL6112D	35408	30MHz~2GHz	May 21, 2016	Jul. 19, 2016	May 20, 2017	Radiation (03CH03-SZ)
Double Ridge Horn Antenna	SCHWARZBECK	BBHA9120D	9120D-1355	1GHz~18GHz	May 07, 2016	Jul. 19, 2016	May 06, 2017	Radiation (03CH03-SZ)
SHF-EHF Horn	com-power	AH-840	101071	18GHz~40GHz	Aug. 19, 2015	Jul. 19, 2016	Aug. 18, 2016	Radiation (03CH03-SZ)
Amplifier	PREAMP LIFIER	BPA-530	102210	0.01Hz ~3000MHz	Oct. 20, 2015	Jul. 19, 2016	Oct. 19, 2016	Radiation (03CH03-SZ)
Amplifier	Agilent Technologies	83017A	MY39501302	500MHz~26.5GHz	Jan. 12, 2016	Jul. 19, 2016	Jan. 11, 2017	Radiation (03CH03-SZ)
HF Amplifier	MITEQ	AMF-7D-00101800-30-10P-R	1943528	1GHz~18GHz	Oct. 20, 2015	Jul. 19, 2016	Oct. 19, 2016	Radiation (03CH03-SZ)
HF Amplifier	MITEQ	TTA1840-35-HG	1871923	18GHz~40GHz	Jul. 18, 2016	Jul. 19, 2016	Jul. 17, 2017	Radiation (03CH03-SZ)
AC Power Source	Chroma	61601	616010001985	N/A	NCR	Jul. 19, 2016	NCR	Radiation (03CH03-SZ)
Turn Table	EM	EM1000	N/A	0~360 degree	NCR	Jul. 19, 2016	NCR	Radiation (03CH03-SZ)
Antenna Mast	EM	EM1000	N/A	1 m~4 m	NCR	Jul. 19, 2016	NCR	Radiation (03CH03-SZ)

NCR: No Calibration Required

5 Uncertainty of Evaluation

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

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

Uncertainty of Radiated Emission Measurement (1GHz ~ 18GHz)

Measuring Uncertainty for a Level of Confidence of 95% (U = 2Uc(y))	4.8 dB

Uncertainty of Radiated Emission Measurement (18GHz ~ 40GHz)

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

Appendix A. Radiated Spurious Emission

Band 1 5150~5250MHz

WIFI 802.11n HT20 (Band Edge @ 3m)

WIFI Ant. 1+2+3	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)
802.11n HT20 CH 36 5180MHz		5100.36	57.77	-16.23	74	51.39	32.92	7.16	33.7	250	218	P	H
		5099.58	49.46	-4.54	54	43.08	32.92	7.16	33.7	250	218	A	H
	*	5180	116.65	-	-	109.99	32.94	7.37	33.65	250	218	P	H
	*	5180	109.13	-	-	102.47	32.94	7.37	33.65	250	218	A	H
		5148.2	57.39	-16.61	74	50.87	32.93	7.26	33.67	185	124	P	V
		5107.12	45.25	-8.75	54	38.87	32.92	7.16	33.7	185	124	A	V
	*	5180	113.12	-	-	106.46	32.94	7.37	33.65	185	124	P	V
	*	5180	104.07	-	-	97.41	32.94	7.37	33.65	185	124	A	V
802.11n HT20 CH 44 5220MHz		5134.16	59.04	-14.96	74	52.54	32.93	7.26	33.69	150	228	P	H
		5133.12	50.25	-3.75	54	43.75	32.93	7.26	33.69	150	228	A	H
	*	5220	116.66	-	-	109.99	32.94	7.37	33.64	150	228	P	H
	*	5220	109.83	-	-	103.16	32.94	7.37	33.64	150	228	A	H
		5372.16	55.88	-18.12	74	49.05	32.97	7.39	33.53	150	228	P	H
		5437.44	50.52	-3.48	54	43.58	32.99	7.43	33.48	150	228	A	H
		5135.98	54.62	-19.38	74	48.12	32.93	7.26	33.69	204	118	P	V
		5133.64	46.49	-7.51	54	39.99	32.93	7.26	33.69	204	118	A	V
	*	5220	113.89	-	-	107.22	32.94	7.37	33.64	204	118	P	V
	*	5220	104.04	-	-	97.37	32.94	7.37	33.64	204	118	A	V
		5379.36	51.26	-22.74	74	44.41	32.98	7.39	33.52	204	118	P	V
		5372.64	42.89	-11.11	54	36.06	32.97	7.39	33.53	204	118	A	V

802.11n HT20 CH 48 5240MHz		5125.58	56.18	-17.82	74	49.78	32.93	7.16	33.69	164	235	P	H
		5080.6	48.83	-5.17	54	42.48	32.92	7.15	33.72	164	235	A	H
	*	5240	117.74	-	-	111.04	32.95	7.37	33.62	164	235	P	H
	*	5240	109.48	-	-	102.78	32.95	7.37	33.62	164	235	A	H
		5401.2	57.73	-16.27	74	50.86	32.98	7.39	33.5	164	235	P	H
		5400.48	50.17	-3.83	54	43.3	32.98	7.39	33.5	164	235	A	H
		5124.02	51.53	-22.47	74	45.13	32.93	7.16	33.69	150	158	P	V
		5136.76	41.55	-12.45	54	35.05	32.93	7.26	33.69	150	158	A	V
	*	5240	112.26	-	-	105.56	32.95	7.37	33.62	150	158	P	V
	*	5240	104.36	-	-	97.66	32.95	7.37	33.62	150	158	A	V
		5398.8	50.09	-23.91	74	43.22	32.98	7.39	33.5	150	158	P	V
		5458.32	43.23	-10.77	54	36.24	32.99	7.47	33.47	150	158	A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

Band 1 5150~5250MHz

WIFI 802.11n HT20 (Harmonic @ 3m)

WIFI Ant. 1+2+3	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)
802.11n HT20 CH 36 5180MHz		7535	68.79	-5.21	74	80.34	37.74	9.14	58.43	150	113	P	H
		7535	43.7	-10.3	54	55.25	37.74	9.14	58.43	150	113	A	H
		10360	55.49	-18.51	74	64.2	39.71	10.58	59	196	202	P	H
		10360	48.42	-5.58	54	57.13	39.71	10.58	59	196	202	A	H
		15540	48.56	-25.44	74	57.24	37.97	13.04	59.69	150	0	P	H
		7525	61.89	-12.11	74	73.44	37.74	9.14	58.43	150	206	P	V
		7525	37.22	-16.78	54	48.77	37.74	9.14	58.43	150	206	A	V
		10360	56.97	-17.03	74	65.68	39.71	10.58	59	178	206	P	V
		10360	48.88	-5.12	54	57.59	39.71	10.58	59	178	206	A	V
		15540	49.17	-24.83	74	57.85	37.97	13.04	59.69	150	0	P	V
802.11n HT20 CH 44 5220MHz		7465	69.06	-4.94	74	80.64	37.69	9.15	58.42	150	132	P	H
		7465	37.47	-16.53	54	49.05	37.69	9.15	58.42	150	132	A	H
		10440	57.06	-16.94	74	65.65	39.85	10.58	59.02	250	198	P	H
		10440	46.11	-7.89	54	54.7	39.85	10.58	59.02	250	198	A	H
		15660	50.17	-23.83	74	58.89	37.88	13.15	59.75	150	0	P	H
		7520	68.67	-5.33	74	80.21	37.74	9.15	58.43	150	205	P	V
		7520	42.67	-11.33	54	54.21	37.74	9.15	58.43	150	205	A	V
		10440	58.83	-15.17	74	67.42	39.85	10.58	59.02	165	206	P	V
		10440	49.37	-4.63	54	57.96	39.85	10.58	59.02	165	206	A	V
		15660	50.27	-23.73	74	58.99	37.88	13.15	59.75	150	0	P	V
802.11n HT20 CH 48 5240MHz		7530	69.5	-4.5	74	81.05	37.74	9.14	58.43	150	205	P	H
		7530	43.5	-10.5	54	55.05	37.74	9.14	58.43	150	205	A	H
		10480	56	-18	74	64.48	39.96	10.59	59.03	248	235	P	H
		10480	43.31	-10.69	54	51.79	39.96	10.59	59.03	248	235	A	H
		15720	50.62	-23.38	74	59.36	37.82	13.23	59.79	150	0	P	H
		7545	67.1	-6.9	74	78.67	37.76	9.14	58.47	150	201	P	V
		7545	37.21	-16.79	54	48.78	37.76	9.14	58.47	150	201	A	V
		10480	58.19	-15.81	74	66.67	39.96	10.59	59.03	150	205	P	V
		10480	47.43	-6.57	54	55.91	39.96	10.59	59.03	150	205	A	V
		15720	50.8	-23.2	74	59.54	37.82	13.23	59.79	150	0	P	V

Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.

Band 1 5150~5250MHz

WIFI 802.11n HT40 (Band Edge @ 3m)

WIFI Ant. 1+2+3	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)
802.11n HT40 CH 38 5190MHz		5148.72	62.79	-11.21	74	56.27	32.93	7.26	33.67	165	235	P	H
		5149.5	52.53	-1.47	54	46.01	32.93	7.26	33.67	165	235	A	H
	*	5190	113.07	-	-	106.41	32.94	7.37	33.65	165	235	P	H
	*	5190	102.77	-	-	96.11	32.94	7.37	33.65	165	235	A	H
		5359.68	50.13	-23.87	74	43.3	32.97	7.39	33.53	165	235	P	H
		5351.28	41.27	-12.73	54	34.44	32.97	7.39	33.53	165	235	A	H
		5150.02	57.97	-16.03	74	51.45	32.93	7.26	33.67	150	157	P	V
		5148.72	47.95	-6.05	54	41.43	32.93	7.26	33.67	150	157	A	V
	*	5190	107.13	-	-	100.47	32.94	7.37	33.65	150	157	P	V
	*	5190	97.77	-	-	91.11	32.94	7.37	33.65	150	157	A	V
		5444.88	46.59	-27.41	74	39.65	32.99	7.43	33.48	150	157	P	V
		5355.12	37.49	-16.51	54	30.66	32.97	7.39	33.53	150	157	A	V
802.11n HT40 CH 46 5230MHz		5147.94	53.92	-20.08	74	47.4	32.93	7.26	33.67	156	237	P	H
		5148.46	45.01	-8.99	54	38.49	32.93	7.26	33.67	156	237	A	H
	*	5230	112.95	-	-	106.25	32.95	7.37	33.62	156	237	P	H
	*	5230	103.81	-	-	97.11	32.95	7.37	33.62	156	237	A	H
		5388.48	53.94	-20.06	74	47.09	32.98	7.39	33.52	156	237	P	H
		5396.4	43.56	-10.44	54	36.71	32.98	7.39	33.52	156	237	A	H
		5147.16	52.43	-21.57	74	45.91	32.93	7.26	33.67	150	157	P	V
		5146.38	43.14	-10.86	54	36.62	32.93	7.26	33.67	150	157	A	V
	*	5230	108.55	-	-	101.85	32.95	7.37	33.62	150	157	P	V
	*	5230	100.08	-	-	93.38	32.95	7.37	33.62	150	157	A	V
		5390.64	48.77	-25.23	74	41.92	32.98	7.39	33.52	150	157	P	V
		5395.44	40.46	-13.54	54	33.61	32.98	7.39	33.52	150	157	A	V
Remark	3. No other spurious found. 4. All results are PASS against Peak and Average limit line.												

Band 1 5150~5250MHz
WIFI 802.11n HT40 (Harmonic @ 3m)

WIFI Ant. 1+2+3	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)
802.11n HT40 CH 38 5190MHz		10380	50.13	-23.87	74	58.82	39.74	10.58	59.01	250	0	P	H
		15570	49.43	-24.57	74	58.12	37.94	13.08	59.71	150	0	P	H
		10380	50.26	-23.74	74	58.95	39.74	10.58	59.01	250	0	P	V
		15570	48.99	-25.01	74	57.68	37.94	13.08	59.71	150	0	P	V
802.11n HT40 CH 46 5230MHz		7510	65.22	-8.78	74	77.54	37.72	8.36	58.4	150	205	P	H
		7510	35.78	-18.22	54	48.1	37.72	8.36	58.4	150	205	A	H
		10460	49.55	-24.45	74	58.54	39.89	10.15	59.03	250	0	P	H
		15690	50.29	-23.71	74	59.23	37.85	12.98	59.77	150	0	P	H
		7535	68.57	-5.43	74	80.12	37.74	9.14	58.43	150	220	P	V
		7535	38.67	-15.33	54	50.22	37.74	9.14	58.43	150	220	A	V
		10460	50.08	-23.92	74	58.63	39.89	10.59	59.03	250	0	P	V
		15690	49.08	-24.92	74	57.81	37.85	13.19	59.77	150	0	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

Band 1 5150~5250MHz

WIFI 802.11ac VHT80 (Band Edge @ 3m)

WIFI Ant. 1+2+3	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)
802.11ac VHT80 CH 42 5210MHz		5144.04	61.62	-12.38	74	55.1	32.93	7.26	33.67	250	230	P	H
		5149.76	52.54	-1.46	54	46.02	32.93	7.26	33.67	250	230	A	H
	*	5210	107.59	-	-	100.92	32.94	7.37	33.64	250	230	P	H
	*	5210	101.85	-	-	95.18	32.94	7.37	33.64	250	230	A	H
		5384.16	50.16	-23.84	74	43.31	32.98	7.39	33.52	250	230	P	H
		5384.4	40.73	-13.27	54	33.88	32.98	7.39	33.52	250	230	A	H
		5134.94	57.72	-16.28	74	51.22	32.93	7.26	33.69	190	122	P	V
		5149.76	49.78	-4.22	54	43.26	32.93	7.26	33.67	190	122	A	V
	*	5210	103.08	-	-	96.41	32.94	7.37	33.64	190	122	P	V
	*	5210	95.9	-	-	89.23	32.94	7.37	33.64	190	122	A	V
		5457.12	46.96	-27.04	74	39.97	32.99	7.47	33.47	190	122	P	V
		5352.24	37.86	-16.14	54	31.03	32.97	7.39	33.53	190	122	A	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

Band 1 5150~5250MHz

WIFI 802.11ac VHT80 (Harmonic @ 3m)

WIFI Ant. 1+2+3	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)
802.11ac		10420	50.67	-23.33	74	59.28	39.82	10.58	59.01	250	0	P	H
VHT80		15630	48.99	-25.01	74	57.72	37.89	13.12	59.74	150	0	P	H
CH 42		10420	50.87	-23.13	74	59.48	39.82	10.58	59.01	250	0	P	V
5210MHz		15630	49.4	-24.6	74	58.13	37.89	13.12	59.74	150	0	P	V
Remark	1. No other spurious found. 2. All results are PASS against Peak and Average limit line.												

Emission below 1GHz

WIFI 802.11ac VHT80 (LF @ 3m)

WIFI Ant. 1+2+3	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)
802.11nac VHT80 LF		31.94	33.18	-6.82	40	38.48	25.86	0.62	31.78	-	-	P	H
		80.44	33.45	-6.55	40	48.49	15.8	0.83	31.67	100	230	P	H
		168.71	33.3	-10.2	43.5	46.52	16.98	1.15	31.35	-	-	P	H
		487.84	33.17	-12.83	46	39.09	23.25	1.99	31.16	-	-	P	H
		772.05	32.98	-13.02	46	34.28	27.34	2.59	31.23	-	-	P	H
		937.92	34.02	-11.98	46	33.22	29.19	2.88	31.27	-	-	P	H
		34.85	38.99	-1.01	40	45.55	24.6	0.62	31.78	100	125	QP	V
		39.7	38.36	-1.64	40	47	22.5	0.62	31.76	100	110	QP	V
		51.34	37.86	-2.14	40	52.89	15.86	0.83	31.72	100	100	QP	V
		60.07	36.14	-3.86	40	54.22	12.8	0.83	31.71	100	110	QP	V
		85.29	36.05	-3.95	40	50.27	16.6	0.83	31.65	100	152	QP	V
		158.04	36.83	-6.67	43.5	49.62	17.45	1.15	31.39	-	-	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	**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	Cable	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. 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)

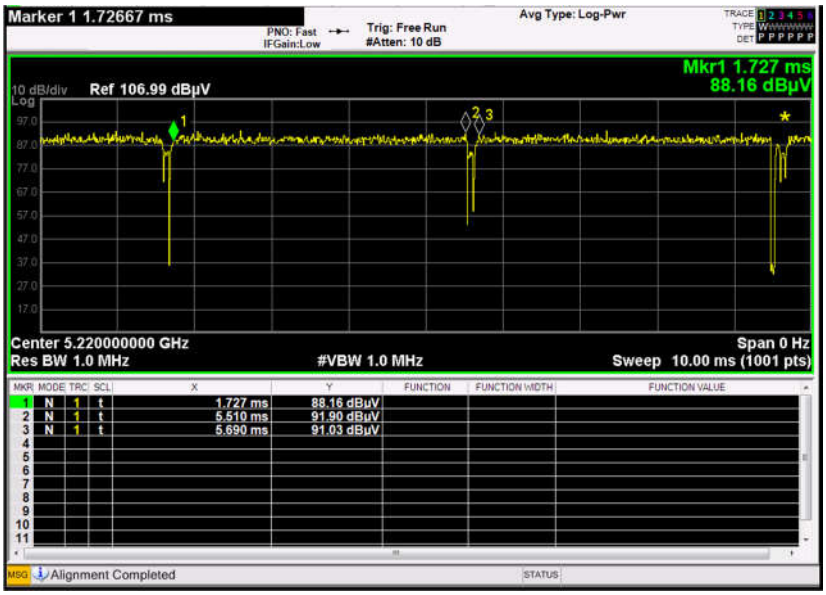
= -10.46(dB)

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

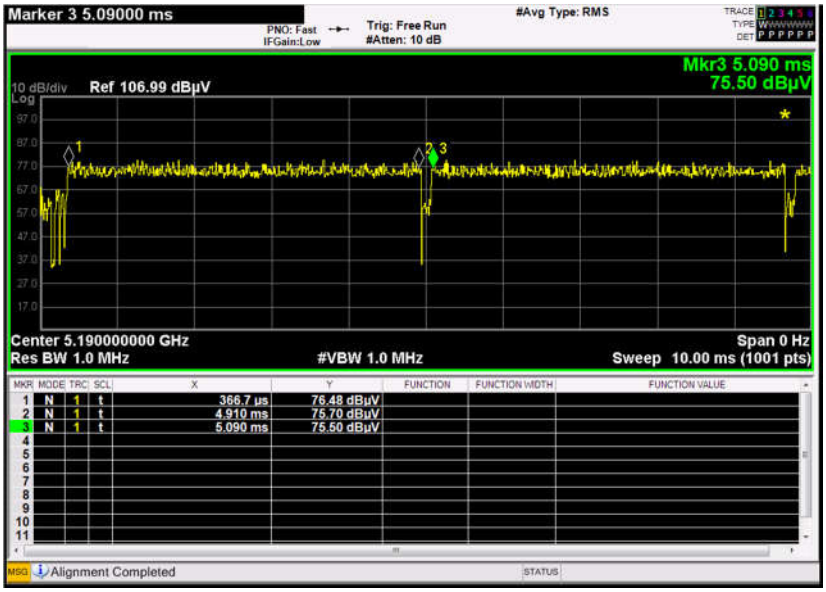
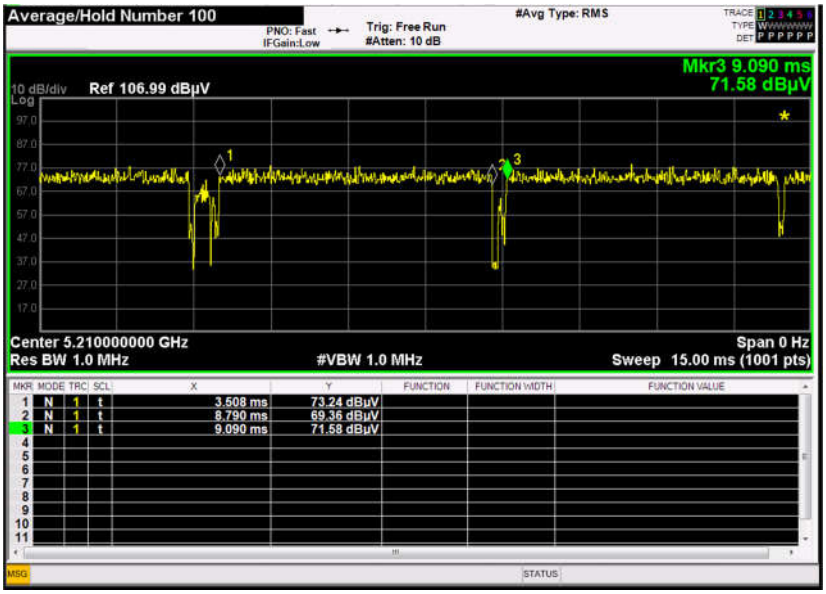
Appendix B. Duty Cycle Plots

Antenna	Band	Duty Cycle(%)	T(ms)	1/T(kHz)	VBW Setting
1+2+3	802.11n HT20	95.46	3.783	0.264	300Hz
1+2+3	802.11n HT40	89.83	4.243	0.236	300Hz
1+2+3	802.11ac VHT80	94.63	5.282	0.190	300Hz

802.11n HT20



802.11n HT40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