



Test report No. : 4790420462-US-R1-V0
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Issued date : 2022/8/2
FCC ID : 2APLE18300422

RADIO TEST REPORT

Product : Pro 5 Wire-Free Spotlight Camera
Model Name : VMC4060P
FCC ID : 2APLE18300422
Test Regulation : FCC 47 CFR Part 15 Subpart E (Section 15.407)
Received Date : 2022/6/21
Test Date : 2022/6/24 ~ 2022/6/30
Issued Date : 2022/8/2

Applicant : Arlo Technologies Inc
2200 Faraday Avenue, Suite 150, Carlsbad, CA 92008, USA

Issued By : Underwriters Laboratories Taiwan Co., Ltd.
Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd.,
Zhudong Township, Hsinchu County, Taiwan



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REVISION HISTORY

Original Test Report No.: 4790420462-US-R1-V0

[illegible]

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1. Attestation of Test Results

APPLICANT: Arlo Technologies Inc
2200 Faraday Avenue, Suite 150, Carlsbad, CA 92008, USA

MANUFACTURER: FUYU PRECISION COMPONENT CO.,LTD.
Lot M1 & Lot F, Quang Chau Industrial Park, Van Trung Commune,
Viet Yen District, Bac Giang Province, Vietnam

EUT DESCRIPTION: Pro 5 Wire-Free Spotlight Camera

BRAND: Arlo

MODEL: VMC4060P

SAMPLE STAGE: Engineering Verification Test sample

DATE of TESTED: 2022/6/24 ~ 2022/6/30

APPLICABLE STANDARDS	
STANDARD	Test Results
FCC 47 CFR PART 15 Subpart E (Section 15.407)	PASS

Underwriters Laboratories Taiwan Co., Ltd. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by Underwriters Laboratories Taiwan Co., Ltd. based on interpretations and/or observations of test results. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by Underwriters Laboratories Taiwan Co., Ltd. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by Underwriters Laboratories Taiwan Co., Ltd. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Prepared By:

Cindy Hsin
Project Handler

Date : 2022/8/2

Approved and Authorized By:

Eric Lee
Senior Laboratory Engineer

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2. Summary of Test Results

Summary of Test Results		
FCC Clause	Test Items	Result
15.407(e)	6dB Bandwidth	PASS
15.403(i)	26dB Bandwidth	PASS
2.1049	Occupied Bandwidth	See Note 1
15.407(a)(1/2/3)	Conducted Output Power	PASS
15.407(a)(1/2/3)	Power Spectral Density	PASS
15.407(g)	Frequency Stability	PASS
15.407(b) (1/2/3/4(i/ii)/9)	Radiated Emissions and Band Edge Measurement	PASS
15.407(b)(9)	AC Power Conducted Emission	PASS
15.203	Antenna Requirement	PASS
15.407(h)	Dynamic Frequency Selection	See Note 2

Note:

1. The Occupied Bandwidth was reference only.
2. The “Dynamic Frequency Selection measurement” was recorded in Report No.: 4790420462-US-R2-V0

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3. Test Methodology and Reference Procedures

The tests documented in this report were performed in accordance with 47 CFR FCC Part 2, KDB 789033 D02 General UNII Test Procedure New Rules v02r01, KDB414788 D01 Radiated Test Site v01r01, ANSI C63.10-2013 and KDB 662911 D01 Multiple Transmitter Output v02r01.

4. Facilities and Accreditation

Test Location	Underwriters Laboratories Taiwan Co., Ltd.
Address	Building B and Building E, No. 372-7, Sec. 4, Zhongxing Rd., Zhudong Township, Hsinchu County, Taiwan
Accreditation Certificate	Underwriters Laboratories Taiwan Co., Ltd. is accredited by TAF, Laboratory Code 3398.

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5. Measurement Uncertainty

For statement of conformity, accuracy method (Section 8.2.4 and 8.2.5 of ISO Guide 98-4) was applied as decision rule for measurement in this test report.

The following uncertainties have been calculated to provide a confidence level of 95 % using a coverage factor $k=2$.

Measurement	Frequency	Uncertainty
Conducted disturbance at mains terminals ports	150kHz ~ 30MHz	± 2.9 dB
RF Conducted	9 kHz - 40GHz	± 2.4 dB
Radiated disturbance below 30MHz	9 kHz - 30 MHz	± 1.9 dB
Radiated disturbance below 1 GHz	30MHz ~ 1GHz	± 5.8 dB
Radiated disturbance above 1 GHz	1GHz ~ 40GHz	± 4.8 dB

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6. Equipment under Test

6.1. Description of EUT

Product	Pro 5 Wire-Free Spotlight Camera	
Brand Name	Arlo	
Model Name	VMC4060P	
Operating Frequency	5180 ~ 5240 MHz, 5260 ~ 5320 MHz, 5500 ~ 5720 MHz, 5745 ~ 5825 MHz	
Modulation	64QAM, 16QAM, QPSK, BPSK	
Transfer Rate	802.11a: up to 54 Mbps 802.11n: up to MCS7	
Number of Channel	5180 ~ 5240 MHz	4 for 802.11a, 802.11n (HT20)
	5260 ~ 5320 MHz	4 for 802.11a, 802.11n (HT20)
	5500 ~ 5720 MHz	12 for 802.11a, 802.11n (HT20)
	5745 ~ 5825 MHz	5 for 802.11a, 802.11n (HT20)
Maximum Output Power	5180 ~ 5240 MHz: 20.11 dBm 5260 ~ 5320 MHz: 20.50 dBm 5500 ~ 5720 MHz: 20.79 dBm 5745 ~ 5825 MHz: 20.66 dBm	
Normal Voltage	5Vdc from adapter 3.85Vdc for battery	
Sample ID	Conducted Test: 5079774 Radiated Test: 5079774	

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Note:

1. The EUT incorporates a SISO function. Physically, the EUT provides one completed transmitters and one receivers.

Modulation Mode	Tx,Rx Function
802.11a	1TX,1RX
802.11n (HT20)	1TX,1RX

2. The EUT contains following accessory devices.

Product	Brand	Model	Description
AC Adapter	PIE	AD2158	Input: 100-240V, 50/60Hz, 0.3A, Output: 5.0V, 2A
AC Adapter	CWT	2AEA010	Input: 100-240V, 50/60Hz, 0.3A, Output: 5.0V, 2A
USB Cable	Nienyi	310-50012-04	Length: 0.9m
Battery	Arlo	A-4a	4800mAh,3.85V, 18.48WH

3. The above EUT information is declared by manufacturer and for more detailed features description, please refer the manufacturer's or user's manual.

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6.2. Channel List

FOR 5180 ~ 5240MHz

4 channels are provided for 802.11a, 802.11n (HT20):

Channel	Frequency	Channel	Frequency
36	5180 MHz	44	5220 MHz
40	5200 MHz	48	5240 MHz

FOR 5260 ~ 5320MHz

4 channels are provided for 802.11a, 802.11n (HT20):

Channel	Frequency	Channel	Frequency
52	5260 MHz	60	5300 MHz
56	5280 MHz	64	5320 MHz

FOR 5500 ~ 5720MHz

12 channels are provided for 802.11a, 802.11n (HT20):

Channel	Frequency	Channel	Frequency
100	5500 MHz	124	5620 MHz
104	5520 MHz	128	5640 MHz
108	5540 MHz	132	5660 MHz
112	5560 MHz	136	5680 MHz
116	5580 MHz	140	5700 MHz
120	5600 MHz	144	5720 MHz

FOR 5745 ~ 5825MHz:

5 channels are provided for 802.11a, 802.11n (HT20):

Channel	Frequency	Channel	Frequency
149	5745MHz	161	5805MHz
153	5765MHz	165	5825MHz
157	5785MHz	-	-

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6.3. Test Condition

Test Item	Test Site No.	Environmental Condition	Input Power	Test Date	Tested by
Antenna Port Conducted Measurement	SR4	22~24°C/ 62~68%RH	120Vac/ 60Hz	2022/06/24~ 2022/06/30	WaterNil Guan/ Patrick Kuan
Radiated Spurious Emission	966-2	22~24°C/ 57~68%RH	120Vac/ 60Hz	2022/06/24~ 2022/06/30	WaterNil Guan/ Rex Chen
AC power Line Conducted Emission	SR1	22~24°C/ 63~66%RH	120Vac/ 60Hz	2022/06/24~ 2022/06/29	Patrick Kuan

FCC Test Firm Registration Number: 498077

6.4. Description of Available Antennas

Ant. No.	Transmitter Circuit	Brand Name	Model Name	Ant. Type	Frequency Band (MHz)	Maximum Gain (dBi)
1	Chain (0)	N/A	N/A	Metal	2400~2500	2.1
					5150~5850	4.5

Note: The above antenna information was provided from customer and for more detailed features description, please refer the manufacturer's specification or user's manual.

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6.5. Test Mode Applicability and Tested Channel Detail

- The EUT has two Adapter types: 2AEA010 and AD2158 , above two types was pre-tested, the worst case was found in the 2AEA010. Therefore only the test data of the 2AEA010c was recorded in this report.
- For Antenna Port Conducted Measurement, this item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.
- For below 30MHz testing, investigation was done on three antenna orientations (parallel, perpendicular, and ground-parallel), parallel and perpendicular are the worst orientations, therefore testing was performed on these two orientations only.
- For below 1 GHz radiated emission and AC power line conducted emission have performed all modes of operation were investigated and the worst-case emissions are reported.
- Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

Test item	Mode	Frequency Band (MHz)	Modulation Technology	Available Channel	Test Channel	Data Rate
Radiated Emissions (Above 1GHz)	802.11a	5180-5240	OFDM	36 to 48	36, 44, 48	6Mbps
	802.11n(HT20)		OFDM	36 to 48	36, 44, 48	MCS0
	802.11a	5260-5320	OFDM	52 to 64	52, 60, 64	6Mbps
	802.11n(HT20)		OFDM	52 to 64	52, 60, 64	MCS0
	802.11a	5500-5720	OFDM	100 to 140	100, 116, 140	6Mbps
	802.11n(HT20)		OFDM	100 to 140	100, 116, 140	MCS0
	802.11a	5745-5825	OFDM	149 to 165	149, 157, 165	6Mbps
	802.11n(HT20)		OFDM	149 to 165	149, 157, 165	MCS0
Radiated Emissions (Below 1GHz)	802.11a	5180-5240	OFDM	100 to 140	116	MCS0
AC Power Line Conducted Emission	802.11a	5180-5240	OFDM	100 to 140	116	MCS0
Antenna Port Conducted Measurement	802.11a	5180-5240	OFDM	36 to 48	36, 44, 48	6Mbps
	802.11n(HT20)		OFDM	36 to 48	36, 44, 48	MCS0
	802.11a	5260-5320	OFDM	52 to 64	52, 60, 64	6Mbps
	802.11n(HT20)		OFDM	52 to 64	52, 60, 64	MCS0
	802.11a	5500-5720	OFDM	100 to 140	100, 116, 140	6Mbps
	802.11n(HT20)		OFDM	100 to 140	100, 116, 140	MCS0
	802.11a	5745-5825	OFDM	149 to 165	149, 157, 165	6Mbps
	802.11n(HT20)		OFDM	149 to 165	149, 157, 165	MCS0

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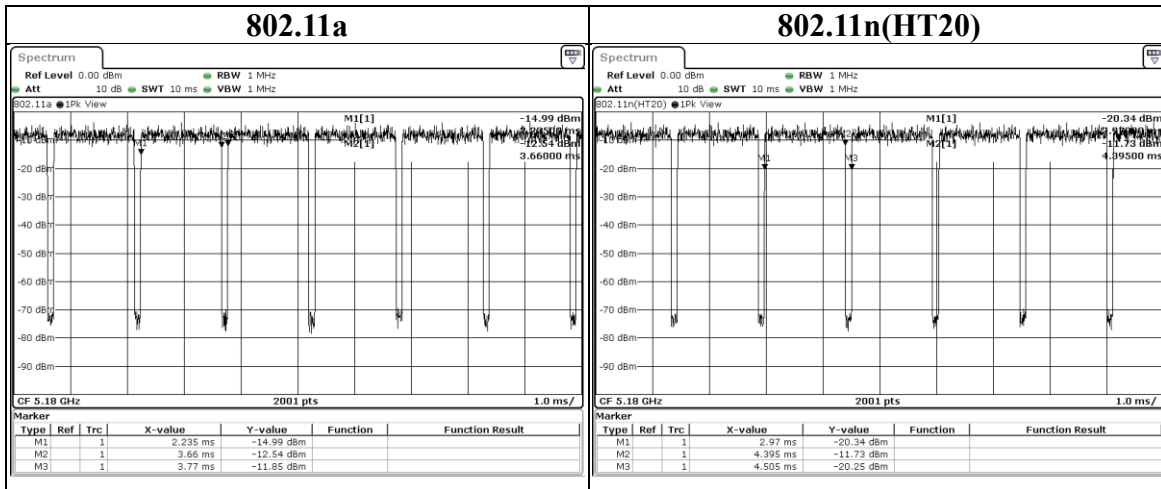
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6.6. Duty cycle

Mode	On Time (ms)	On+Off Time (ms)	Duty Cycle	Duty Factor (dB)	VBW Set (above 1GHz)
802.11a	1.425	1.535	0.9283	0.32	1kHz
802.11n(HT20)	1.425	1.535	0.9283	0.32	1kHz





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7. Test Equipment

Test Equipment List					
Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Expired date
Radiated Spurious Emission					
Spectrum Analyzer	Keysight	N9010A	MY56070827	2021/11/9	2022/11/8
EMI Test Receiver	Rohde & Schwarz	ESR7	101754	2021/12/10	2022/12/9
Loop Antenna	ETS lindgren	6502	00213440	2021/12/23	2022/12/22
Trilog-Broadband Antenna with 5dB Attenuator	Schwarzbeck & EMCI	VULB 9168 & N-6-05	774 & AT-N0538	2022/2/8	2023/2/7
Horn Antenna (1-18 GHz)	Schwarzbeck	BBHA 9120 D	01690	2021/12/13	2022/12/12
Horn Antenna (18-40 GHz)	Schwarzbeck	BBHA 9170	781	2021/12/17	2022/12/16
Preamplifier (30-1000 MHz)	EMCI	EMC330E	980405	2022/6/7	2023/6/6
Preamplifier (1-18 GHz)	EMCI	EMC051835BE	980406	2022/2/16	2023/2/15
Preamplifier (18-40GHz)	EMCI	EMC184040SEE	980426	2022/5/17	2023/5/16
Cables	Hanyitek	K1K50-UP0264-K1K50-2500	170214-4 & 170425-2	2021/12/3	2022/12/2
Cables	Hanyitek	K1K50-UP0264-K1K50-2500	170214-1 & 170214-2	2021/12/3	2022/12/2

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Test Equipment List					
Equipment	Manufacturer	Model No.	Serial No.	Cal. Date	Expired date
Antenna Port Conducted Measurement					
Spectrum Analyzer	Keysight	N9010A	MY56070834	2021/10/29	2022/10/28
USB Power Sensor	Anritsu	MA24408A	12031	2022/3/23	2023/3/22
Temperature & Humidity Test Chamber	GIANT FORCE	GTH-150-40-CP-AR	MAA1701-010	2022/3/11	2023/3/10
AC power Line Conducted Emission					
EMI Test Receiver	Rohde & Schwarz	ESR7	101753	2021/11/15	2022/11/14
Two-Line V-Network	Rohde & Schwarz	ENV216	102136	2021/8/30	2022/8/29
Impuls-Begrenzer Pulse Limiter	Rohde & Schwarz	ESH3-Z2	102219-Qt	2021/8/26	2022/8/25
Cables	TITAN	CFD200	T0732ACFD20 020A300-1	2022/3/16	2023/3/15

UL Software		
Description	Name	Version
Radiated measurement	e3	6.191211 (V6)
Conducted measurement	RF-Conducted-FCC 15407	ver 1.1
AC power Line Conducted Emission	EZ_EMC	UL-3A1.2

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8. Description of Test Setup

Support Equipment

ID	Equipment	Brand Name	Model Name	S/N	Remark
A	AC Adapter	CWT	2AEA010BA3B	332-50108-02	Provided by Client
B	Laptop	DELL	Latitude E5470	CXSKWF2	Provided by Lab

I/O Cables

ID	Equipment	Brand Name	Model Name	Length (m)	Remark
1	Magnetic USB Cable	Nienyi	310-50012-04	0.9	Provided by Client
2	Micro USB Cable	WONDER	WA-W07UA	0.8	Provided by Lab

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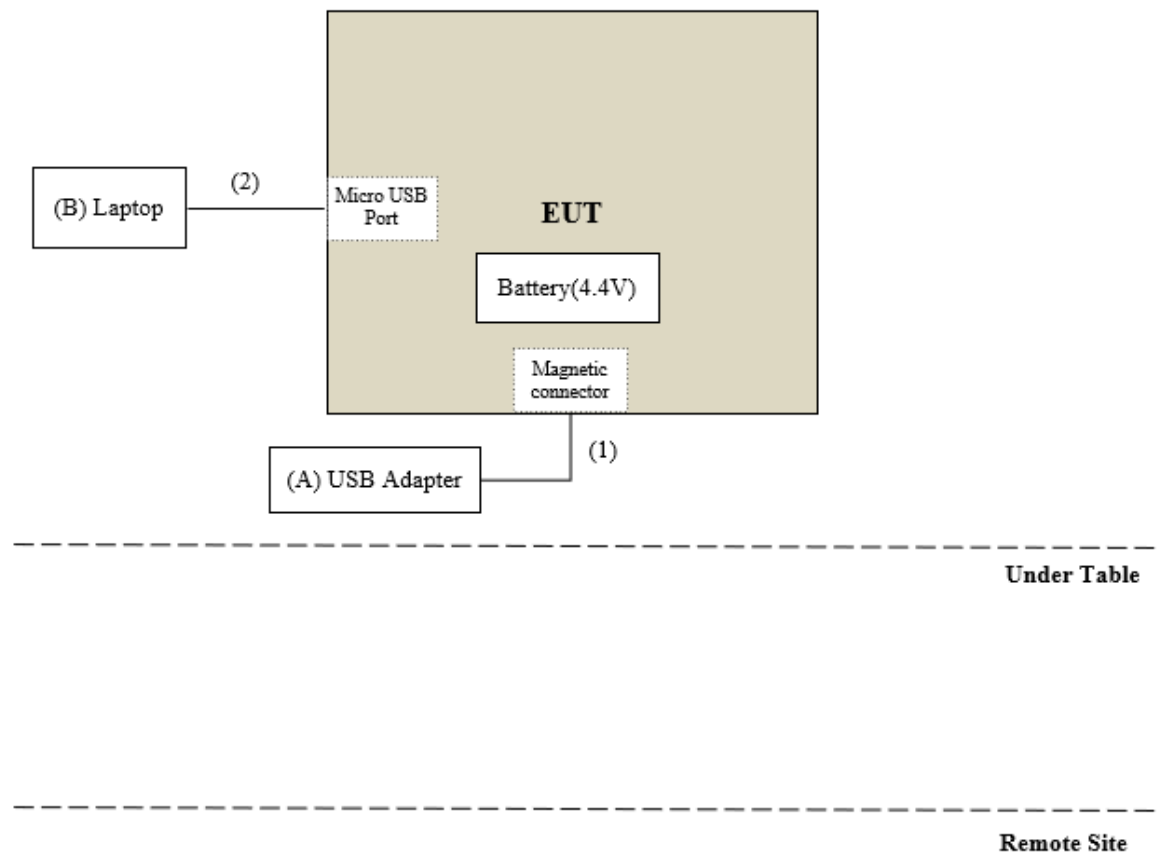
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Test Setup

Controlled using a bespoke application (Typing RF command by terminal tool(Putty version 0.62)) on a test Notebook. The application was used to enable a continuous transmission mode and to select the test channels, data rates, modulation schemes and power setting as required.

Setup Diagram for Test



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9. Test Results

9.1. 6dB Bandwidth

Requirements

The minimum 6 dB bandwidth shall be at least 500 kHz.

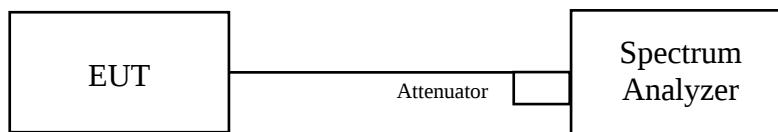
Test procedure

- Set resolution bandwidth (RBW) = 100kHz
- Set the video bandwidth (VBW) $\geq 3 \times$ RBW, Detector = Peak.
- Trace mode = max hold.
- Sweep = auto couple.
- Measure the maximum width of the emission that is constrained by the frequencies associated with the two amplitude points (upper and lower) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission

Note:

- Straddle Channel Bandwidth below 5725MHz = Delta 2 – Delta 4.
- Straddle Channel Bandwidth above 5725MHz = Delta 4 (marked on the 5745MHz).

Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

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Test Data

Mode	CH	Freq (MHz)	6dB BW (MHz)	Limit (MHz)	Result
			Chain 0		
802.11a	144 (U-NII-2C)	5720	13.163	0.5	Pass
	144 (U-NII-2C+U-NII-3)	5720	16.35	0.5	Pass
	144 (U-NII-3)	5720	3.187	0.5	Pass
	149	5745	16.331	0.5	Pass
	157	5785	16.314	0.5	Pass
	165	5825	16.335	0.5	Pass

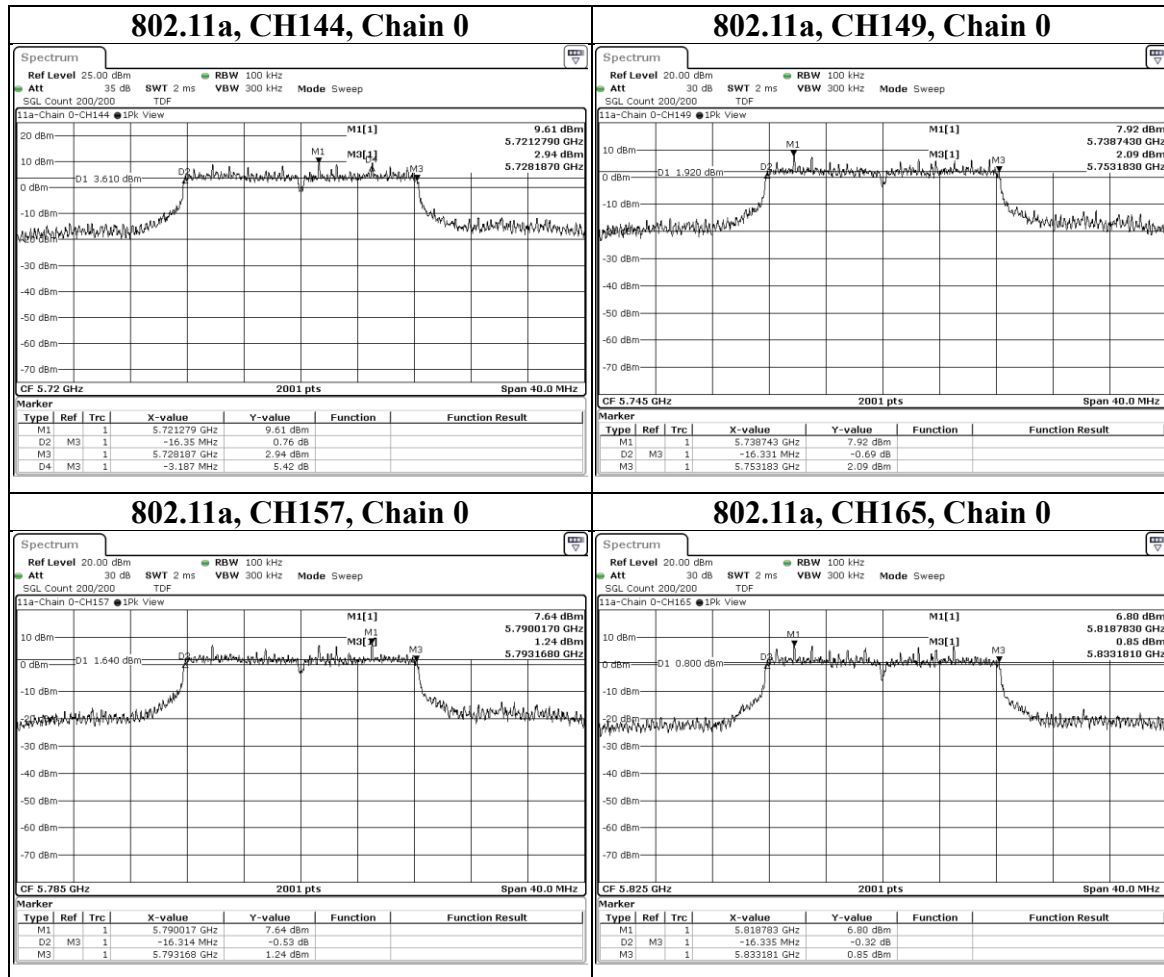
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Mode	CH	Freq (MHz)	6dB BW (MHz)	Limit (MHz)	Result
			Chain 0		
802.11n(HT20)	144 (U-NII-2C)	5720	13.148	0.5	Pass
	144 (U-NII-2C+U-NII-3)	5720	16.328	0.5	Pass
	144 (U-NII-3)	5720	3.18	0.5	Pass
	149	5745	16.356	0.5	Pass
	157	5785	16.312	0.5	Pass
	165	5825	16.339	0.5	Pass

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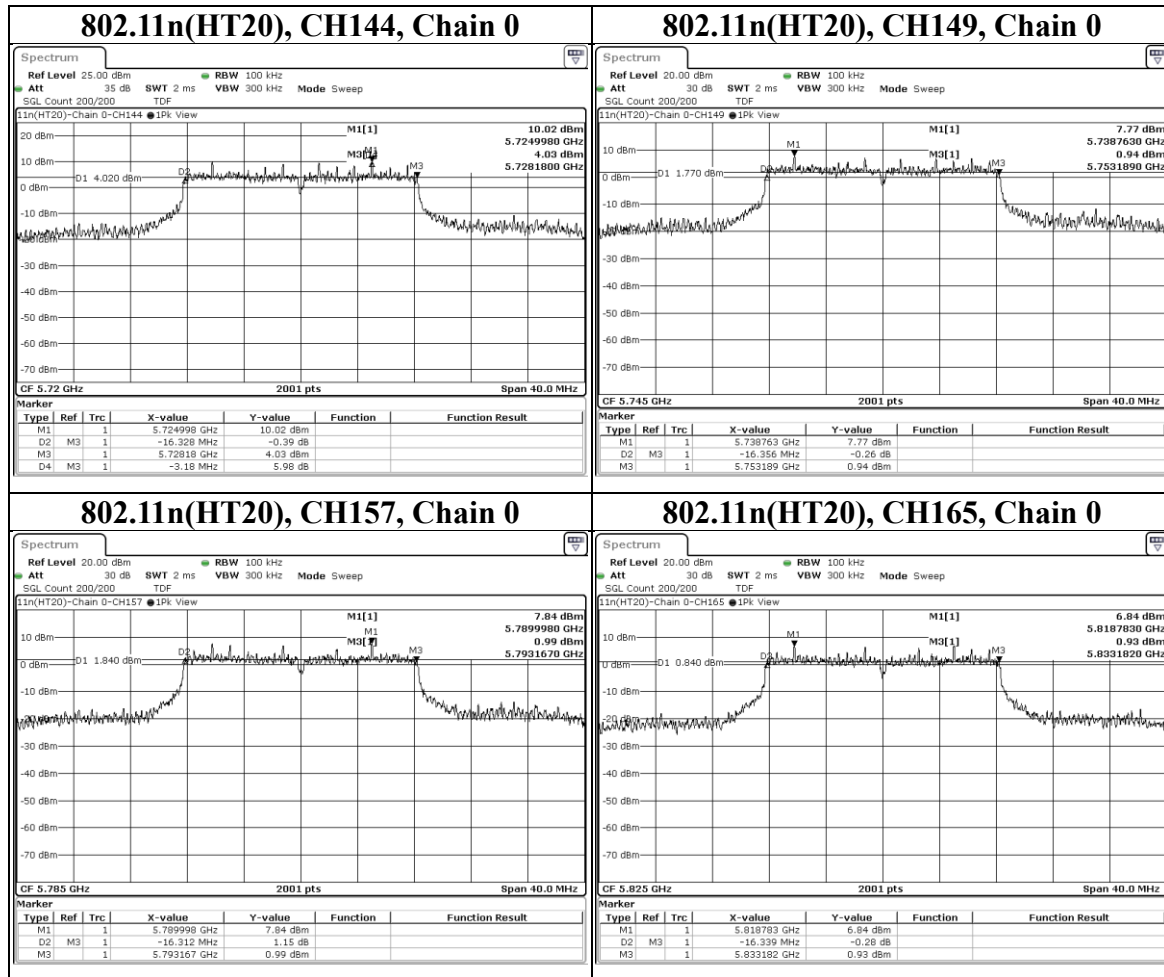
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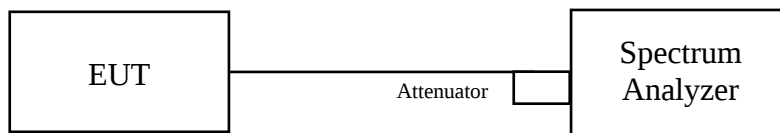


9.2. 26dB Bandwidth

Test procedure

- Set RBW = approximately 1% of the emission bandwidth.
- Set the VBW > RBW.
- Detector = Peak.
- Trace mode = max hold.
- Measure the maximum width of the emission that is 26 dB down from the peak of the emission. Compare this with the RBW setting of the analyzer. Readjust RBW and repeat measurement as needed until the RBW/EBW ratio is approximately 1%.

Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

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Test Data

Mode	CH	Freq (MHz)	26dB BW (MHz)	Limit (MHz)	Result
			Chain 0		
802.11a	36	5180	21.189	N/A	Pass
	44	5220	44.128	N/A	Pass
	48	5240	44.394	N/A	Pass
	52	5260	44.696	N/A	Pass
	60	5300	44.762	N/A	Pass
	64	5320	29.255	N/A	Pass
	100	5500	21.189	N/A	Pass
	116	5580	44.771	N/A	Pass
	140	5700	21.13	N/A	Pass
	144 (U-NII-2C)	5720	27.101	N/A	Pass
	144 (U-NII-2C+U-NII-3)	5720	44.695	N/A	Pass
	144 (U-NII-3)	5720	17.594	N/A	Pass

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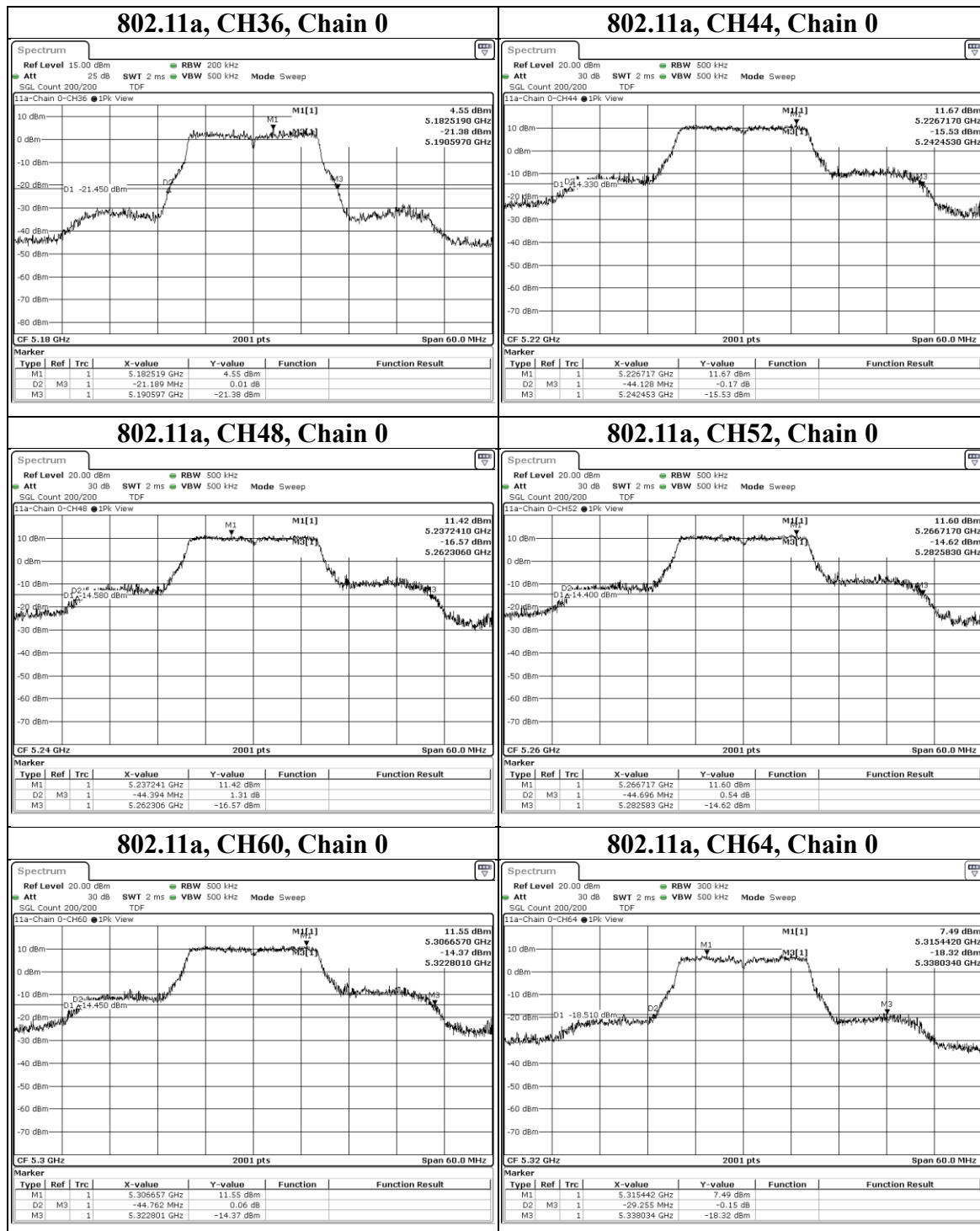
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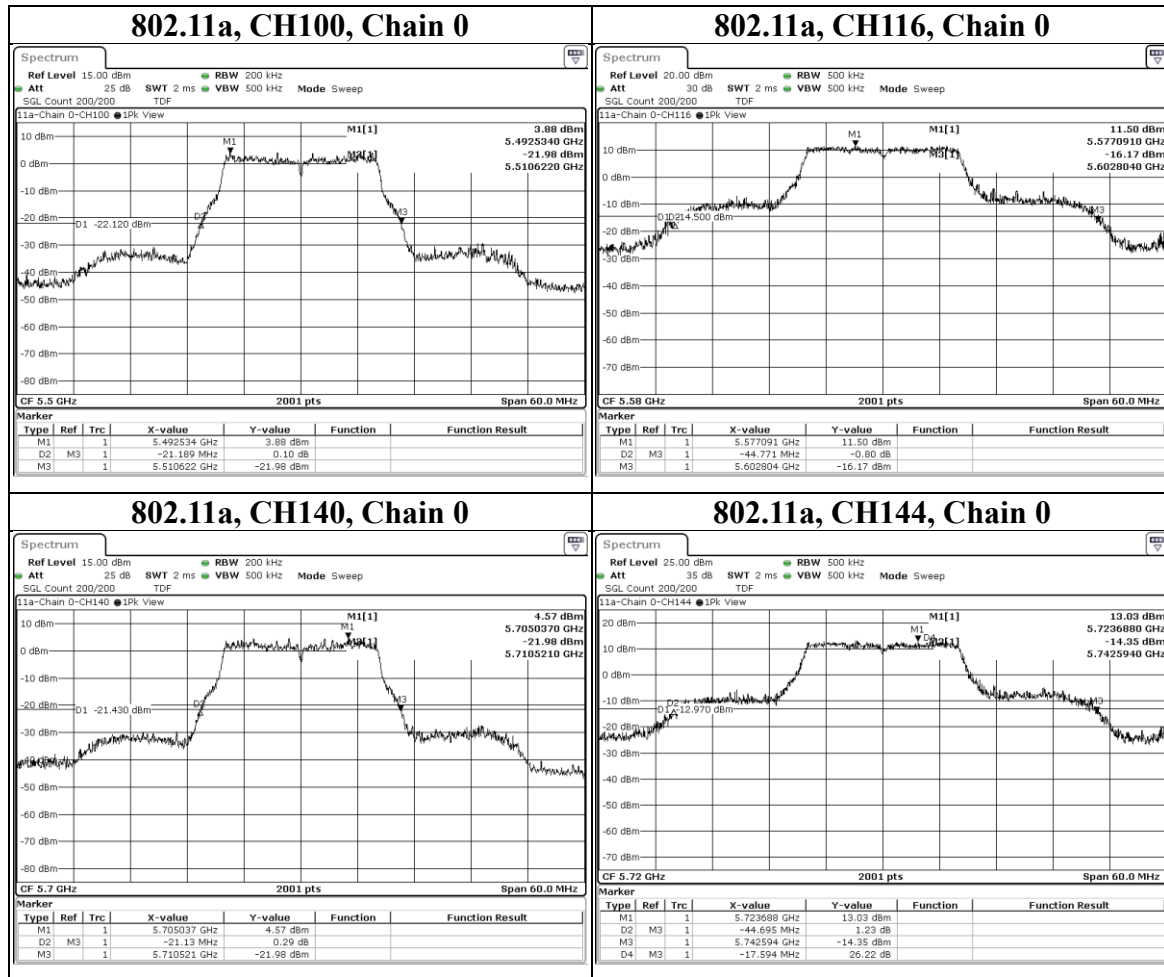
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Mode	CH	Freq (MHz)	26dB BW (MHz)	Limit (MHz)	Result
			Chain 0		
802.11n(HT20)	36	5180	21.084	N/A	Pass
	44	5220	44.162	N/A	Pass
	48	5240	44.332	N/A	Pass
	52	5260	44.424	N/A	Pass
	60	5300	44.582	N/A	Pass
	64	5320	31.652	N/A	Pass
	100	5500	21.275	N/A	Pass
	116	5580	44.795	N/A	Pass
	140	5700	21.352	N/A	Pass
	144 (U-NII-2C)	5720	27.083	N/A	Pass
	144 (U-NII-2C+U-NII-3)	5720	45.033	N/A	Pass
	144 (U-NII-3)	5720	17.95	N/A	Pass

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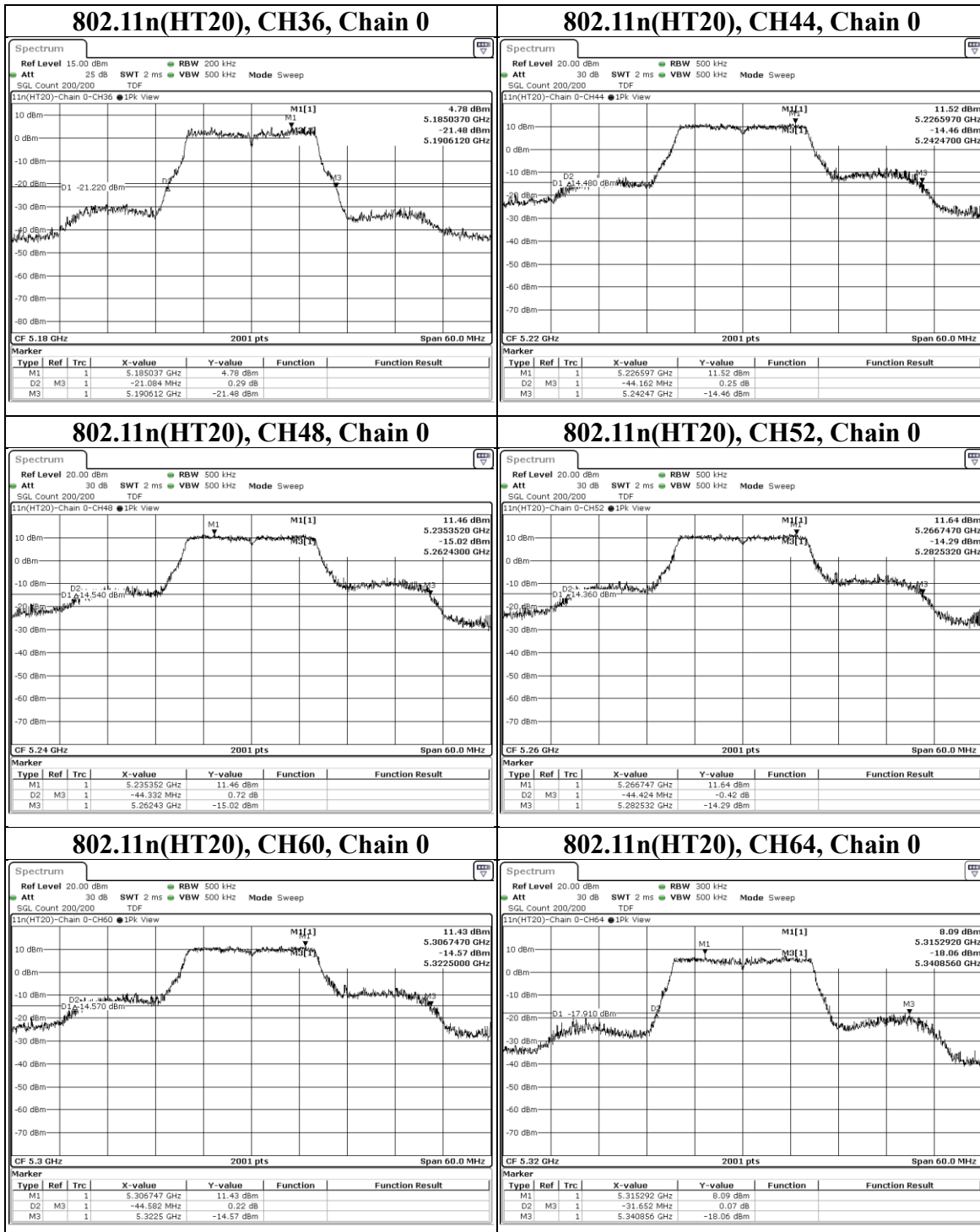
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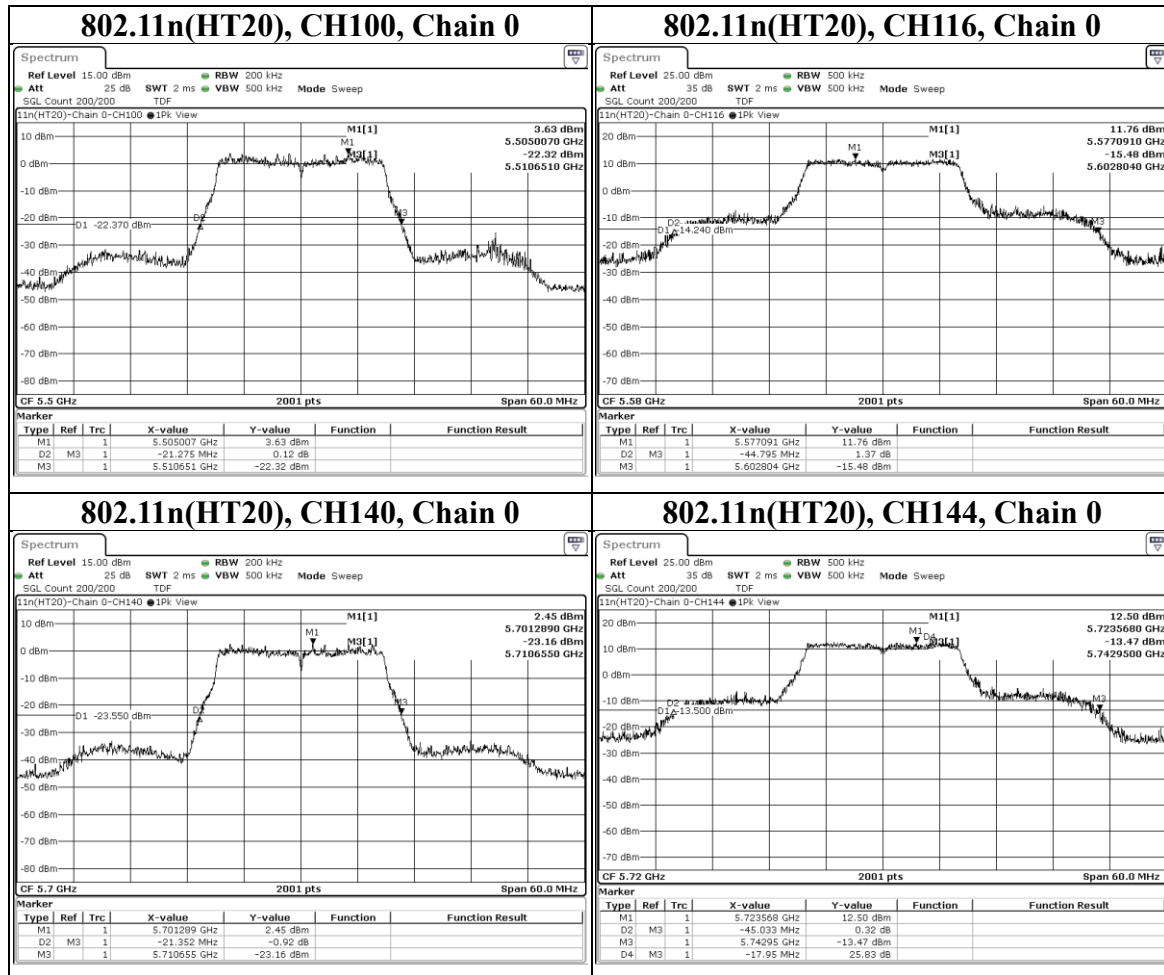
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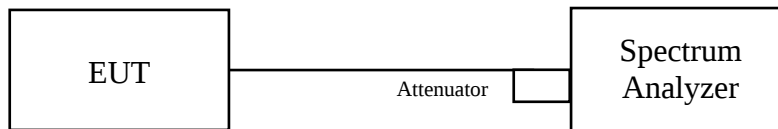


9.3. Occupied Bandwidth

Test procedure

- Set center frequency to the nominal EUT channel center frequency.
- Set span = 1.5 times to 5.0 times the OBW.
- Set RBW = 1% to 5% of the OBW
- Set VBW $\geq 3 \times$ RBW
- Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.
- Use the 99% power bandwidth function of the instrument (if available).
- If the instrument does not have a 99% power bandwidth function, the trace data points are recovered and directly summed in power units. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% occupied bandwidth is the difference between these two frequencies.

Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.



Test Data

Mode	CH	Freq (MHz)	OBW (MHz)	Limit (MHz)	Result
			Chain 0		
802.11a	36	5180	17.819	N/A	Pass
	44	5220	25.582	N/A	Pass
	48	5240	25.472	N/A	Pass
	52	5260	26.859	N/A	Pass
	60	5300	27.036	N/A	Pass
	64	5320	18.192	N/A	Pass
	100	5500	17.844	N/A	Pass
	116	5580	27	N/A	Pass
	140	5700	17.916	N/A	Pass
	144 (U-NII-2C)	5720	15.968	N/A	Pass
	144 (U-NII- 2C+U-NII-3)	5720	25.672	N/A	Pass
	144 (U-NII-3)	5720	9.704	N/A	Pass
	149	5745	25.781	N/A	Pass
	157	5785	24.542	N/A	Pass
	165	5825	19.785	N/A	Pass

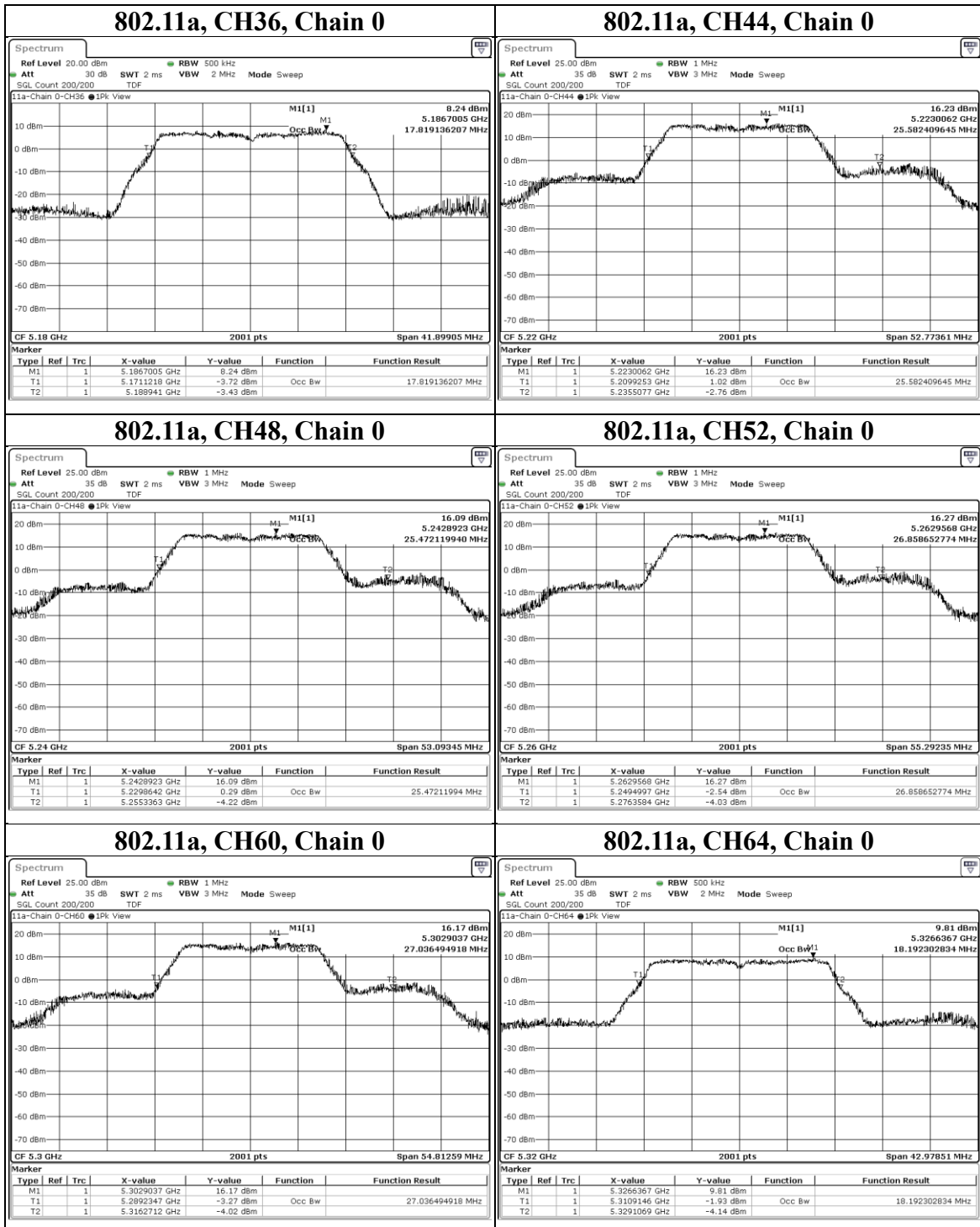
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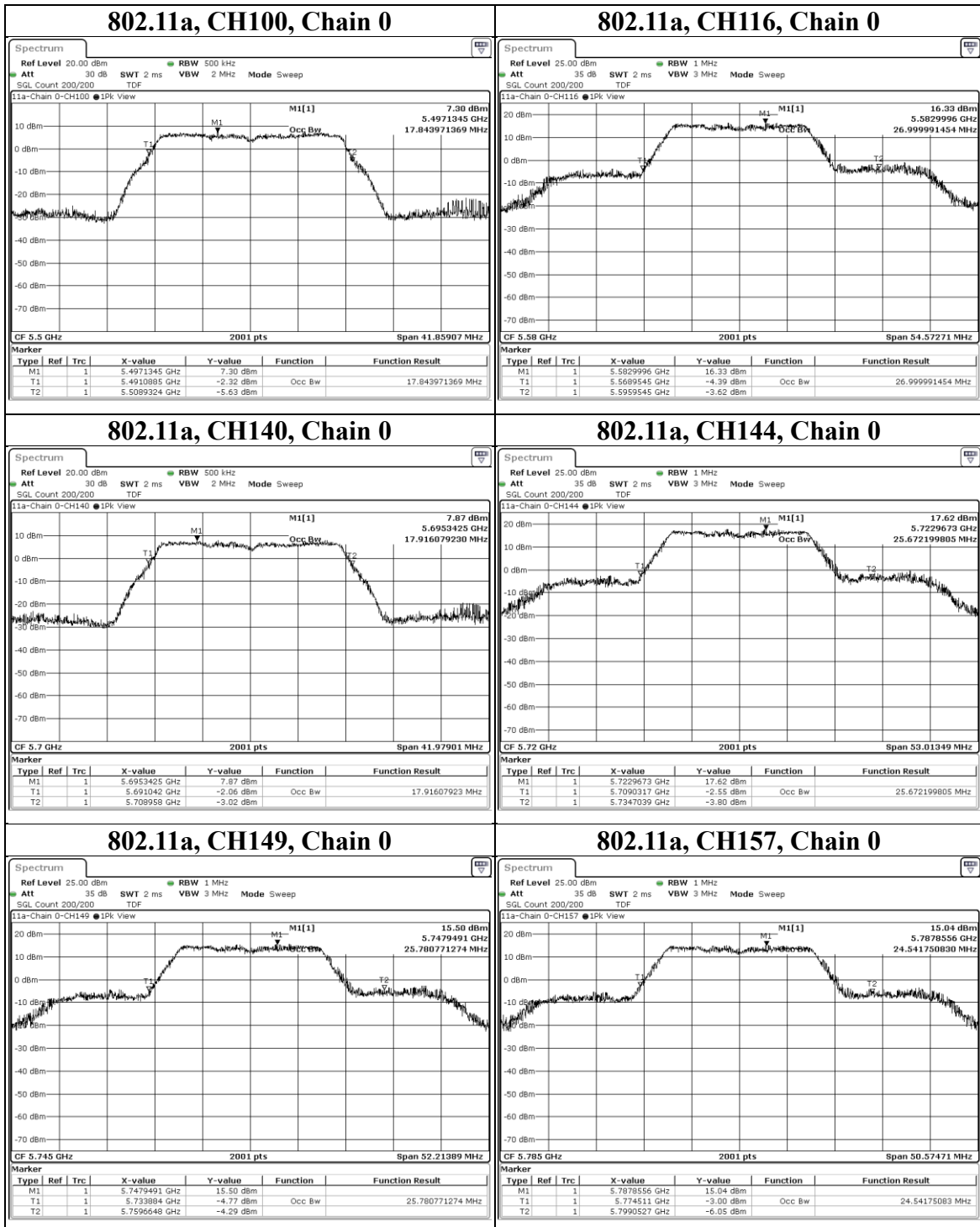
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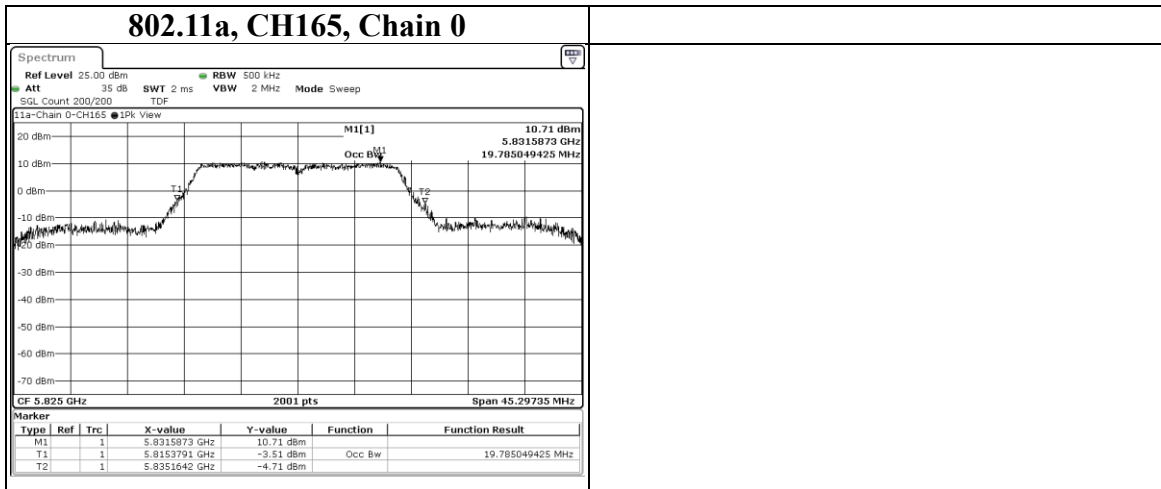
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Mode	CH	Freq (MHz)	OBW (MHz)	Limit (MHz)	Result
			Chain 0		
802.11n(HT20)	36	5180	17.794	N/A	Pass
	44	5220	24.846	N/A	Pass
	48	5240	24.086	N/A	Pass
	52	5260	26.11	N/A	Pass
	60	5300	26.93	N/A	Pass
	64	5320	18.881	N/A	Pass
	100	5500	18.65	N/A	Pass
	116	5580	26.121	N/A	Pass
	140	5700	18.735	N/A	Pass
	144 (U-NII-2C)	5720	15.689	N/A	Pass
	144 (U-NII-2C+U-NII-3)	5720	25.69	N/A	Pass
	144 (U-NII-3)	5720	10.001	N/A	Pass
	149	5745	26.169	N/A	Pass
	157	5785	24.017	N/A	Pass
	165	5825	20.234	N/A	Pass

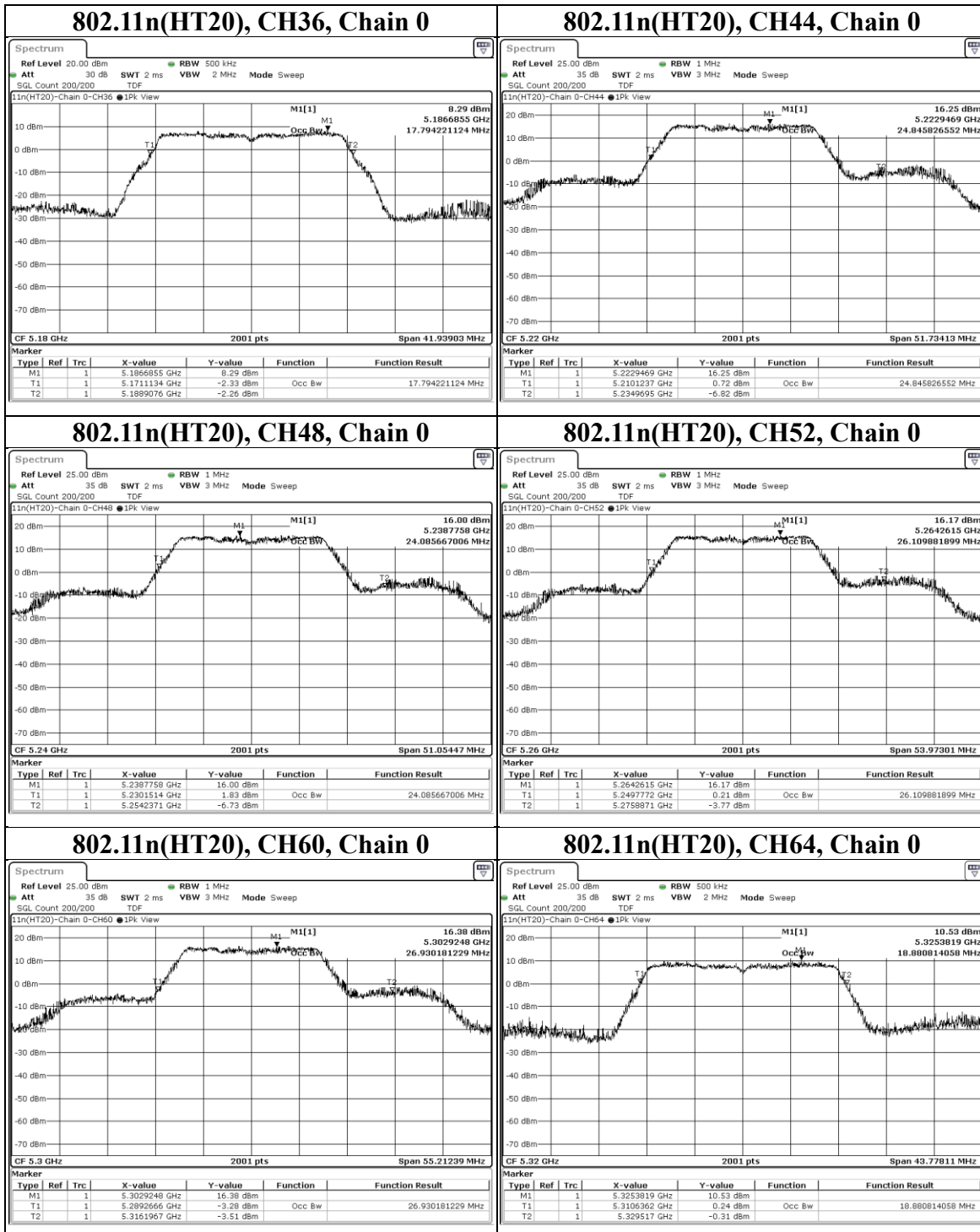
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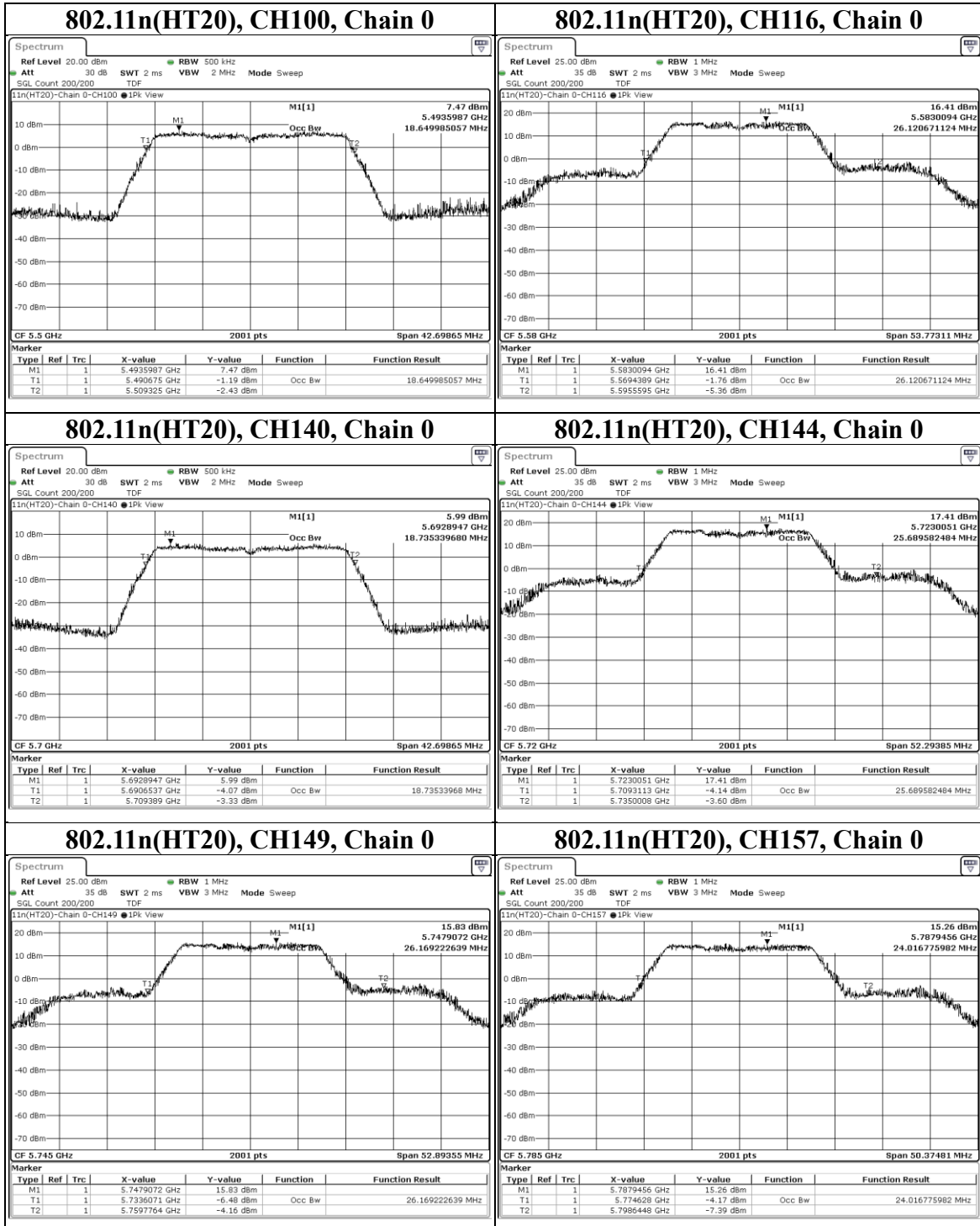
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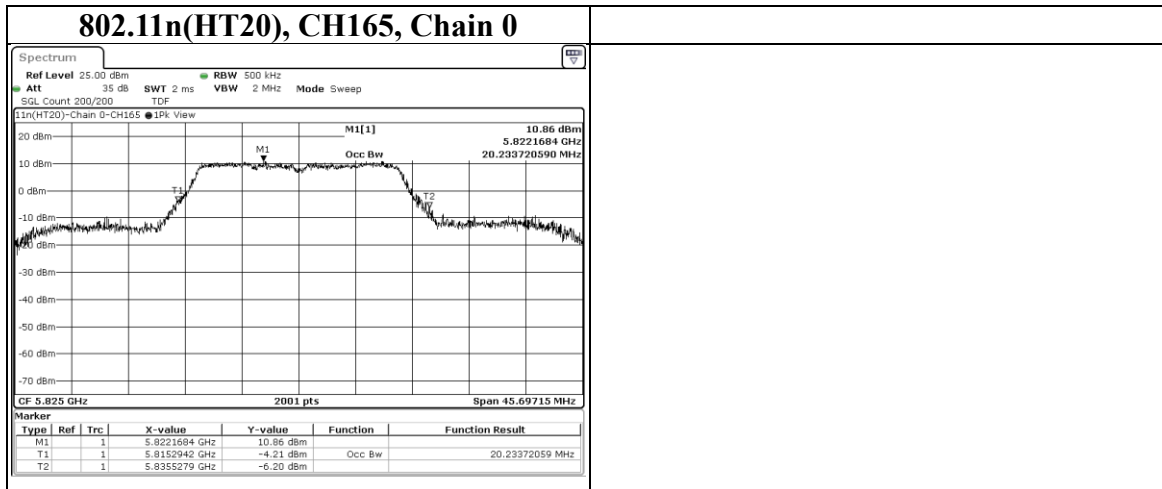
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9.4. Conducted output power

Requirements

Operation Band	EUT Category		Limit
U-NII-1		Outdoor Access Point	1 Watt (30 dBm) Max. e.i.r.p $\leq$ 125mW(21 dBm) at any elevation angle above 30 degrees as measured from the horizon If $G_{TX} > 6$ dBi, then $P_{Out} = 30 - (G_{TX} - 6)$
		Fixed point-to-point Access Point	1 Watt (30 dBm) If $G_{TX} > 23$ dBi, then $P_{Out} = 30 - (G_{TX} - 23)$
		Indoor Access Point	1 Watt (30 dBm) If $G_{TX} > 6$ dBi, then $P_{Out} = 30 - (G_{TX} - 6)$
	√	Client device	250mW (24 dBm) If $G_{TX} > 6$ dBi, then $P_{Out} = 23.98 - (G_{TX} - 6)$
U-NII-2A	√		250mW (24 dBm) or 11 dBm+10 log B* If $G_{TX} > 6$ dBi, then $P_{Out} = 23.98 - (G_{TX} - 6)$
U-NII-2C	√		250mW (24 dBm) or 11 dBm+10 log B* If $G_{TX} > 6$ dBi, then $P_{Out} = 23.98 - (G_{TX} - 6)$
U-NII-3	√		For Point-to-multipoint systems (P2M): 1 Watt (30 dBm). If $G_{TX} > 6$ dBi, then $P_{Out} = 30 - (G_{TX} - 6)$ For Point-to-point systems (P2P): 1 Watt (30 dBm)

Note:

- P_{Out} = maximum conducted output power in dBm,
- G_{TX} = the maximum transmitting antenna directional gain in dBi.
- B is the 26 dB emission bandwidth in megahertz
- Directional Gain = $G_{ant} + 10 \log (Nant)$ dBi.
Nant: Number of Transmit Antennas
G1, G2,..., Gn: Gain of Individual Antennas (Same for Each Antenna)
- Straddle Channel Power in each band = Straddle Channel Total Power * (Each band EBW / Straddle Channel Total EBW).

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Test Procedure

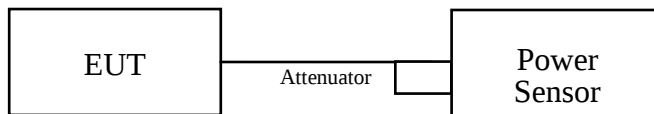
For Average Power Measurement

Test method PM

Method PM is used to perform output power measurement, trigger and gating function of wide band power meter is enabled to measure max output power of TX on burst and set the detector to AVERAGE. Duty factor is not added to measured value.

Test Setup

For Average Power Measurement



The loss between RF output port of the EUT and the input port of the Power Meter has been taken into consideration.

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Test Data

802.11a

Channel	Channel Frequency (MHz)	Maximum Conducted Power (mW)	Maximum Conducted Power (dBm)	Power Limit (dBm)	Pass/Fail
36	5180	41.02	16.13	23.98	PASS
44	5220	102.565	20.11	23.98	PASS
48	5240	101.625	20.07	23.98	PASS
52	5260	107.895	20.33	23.98	PASS
60	5300	105.439	20.23	23.98	PASS
64	5320	66.069	18.20	23.98	PASS
100	5500	44.978	16.53	23.98	PASS
116	5580	105.925	20.25	23.98	PASS
140	5700	43.954	16.43	23.98	PASS
144 (U-NII-2c Band)	5720	65.766	18.18	23.98	PASS
144 (U-NII-3 Band)	5720	42.658	16.30	30	PASS
149	5745	105.439	20.23	30	PASS
157	5785	103.039	20.13	30	PASS
165	5825	101.391	20.06	30	PASS

For Reference only – Straddle Channels Total Power

Channel	Channel Frequency (MHz)	Maximum Conducted Power (dBm)	Total Power (mW)	Total Power (dBm)
144	5720	20.35	108.393	20.35
Note: The total power was calculated through formula and record the value for reference only.				

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802.11n (HT20)

Channel	Channel Frequency (MHz)	Maximum Conducted Power (mW)	Maximum Conducted Power (dBm)	Power Limit (dBm)	Pass/Fail
36	5180	43.152	16.35	23.98	PASS
44	5220	102.565	20.11	23.98	PASS
48	5240	101.158	20.05	23.98	PASS
52	5260	110.662	20.44	23.98	PASS
60	5300	112.202	20.50	23.98	PASS
64	5320	58.076	17.64	23.98	PASS
100	5500	36.983	15.68	23.98	PASS
116	5580	119.95	20.79	23.98	PASS
140	5700	27.733	14.43	23.98	PASS
144 (U-NII-2c Band)	5720	66.374	18.22	23.98	PASS
144 (U-NII-3 Band)	5720	44.055	16.44	30	PASS
149	5745	116.413	20.66	30	PASS
157	5785	112.202	20.50	30	PASS
165	5825	103.992	20.17	30	PASS

For Reference only – Straddle Channels Total Power

Channel	Channel Frequency (MHz)	Maximum Conducted Power (dBm)	Total Power (mW)	Total Power (dBm)
144	5720	20.43	110.408	20.43

Note: The total power was calculated through formula and record the value for reference only.

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9.5. Power Spectral Density

Requirements

Operation Band	EUT Category		Limit
U-NII-1		Outdoor Access Point	17dBm/ MHz If $G_{TX} > 6$ dBi, then $PSD = 17 - (G_{TX} - 6)$
		Fixed point-to-point Access Point	17dBm/ MHz If $G_{TX} > 23$ dBi, then $PSD = 17 - (G_{TX} - 23)$
		Indoor Access Point	17dBm/ MHz If $G_{TX} > 6$ dBi, then $PSD = 17 - (G_{TX} - 6)$
	√	Client device	11dBm/ MHz If $G_{TX} > 6$ dBi, then $PSD = 11 - (G_{TX} - 6)$
U-NII-2A	√		11dBm/ MHz If $G_{TX} > 6$ dBi, then $PSD = 11 - (G_{TX} - 6)$
U-NII-2C	√		11dBm/ MHz If $G_{TX} > 6$ dBi, then $PSD = 11 - (G_{TX} - 6)$
U-NII-3	√		For Point-to-multipoint systems (P2M): 30dBm/ 500kHz. If $G_{TX} > 6$ dBi, then $PSD = 30 - (G_{TX} - 6)$ For Point-to-point systems (P2P): 30dBm/ 500kHz

Note:

1. PSD = power spectral density that the same method as used to determine the conducted output power shall be used to determine the power spectral density. And power spectral density in dBm/MHz
2. G_{TX} = the maximum transmitting antenna directional gain in dBi.
3. Directional Gain = $G_{ant} + 10 \log (N_{ant})$ dBi.

N_{ant} : Number of Transmit Antennas

$G_1, G_2, \dots, G_n$: Gain of Individual Antennas (Same for Each Antenna)

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Test procedure

For U-NII-1, U-NII-2A, U-NII-2C band:

Using method as below:

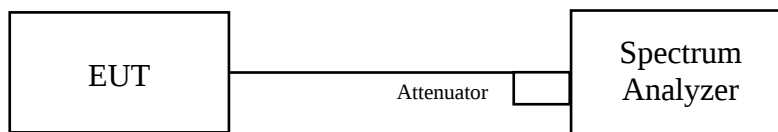
- Set span to encompass the entire emission bandwidth (EBW) of the signal.
- Set RBW = 1 MHz, Set VBW $\geq$ 3 RBW, Detector = RMS
- Sweep time = auto, trigger set to “free run”.
- Trace average at least 100 traces in power averaging mode.
- Record the max value. (if Duty cycle <98 %, add 10 log (1/duty cycle))

For U-NII-3 band:

Using method as below:

- Set span to encompass the entire emission bandwidth (EBW) of the signal.
- Set RBW = 300 kHz, Set VBW $\geq$ 1 MHz, Detector = RMS
- Use the peak marker function to determine the maximum power level in any 300 kHz band segment within the fundamental EBW.
- Scale the observed power level to an equivalent value in 500 kHz by adjusting (reducing) the measured power by a bandwidth correction factor (BWCF) where $BWCF = 10 \log (500 \text{ kHz}/300\text{kHz})$
- Sweep time = auto, trigger set to “free run”.
- Trace average at least 100 traces in power averaging mode.
- Record the max value. (if Duty cycle <98 %, add 10 log (1/duty cycle))

Test Setup



The loss between RF output port of the EUT and the input port of the Spectrum Analyzer has been taken into consideration.

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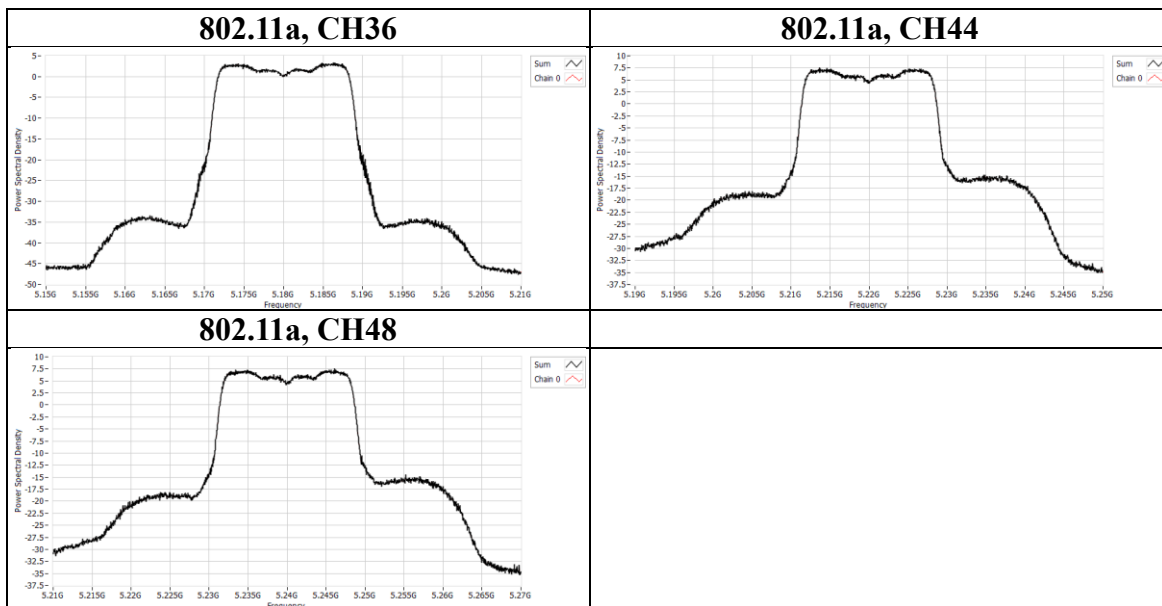
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Test Data

Mode (U-NII-1)	CH	Freq (MHz)	Directional Gain (dBi)	Total PSD (dBm/MHz)	Limit (dBm/MHz)	Result
802.11a	36	5180	4.5	3.33	11	Pass
	44	5220	4.5	7.51	11	Pass
	48	5240	4.5	7.51	11	Pass

Mode (U-NII-1)	CH	Freq (MHz)	PSD per Chain (dBm/MHz)
			Chain 0
802.11a	36	5180	3.33
	44	5220	7.505
	48	5240	7.507



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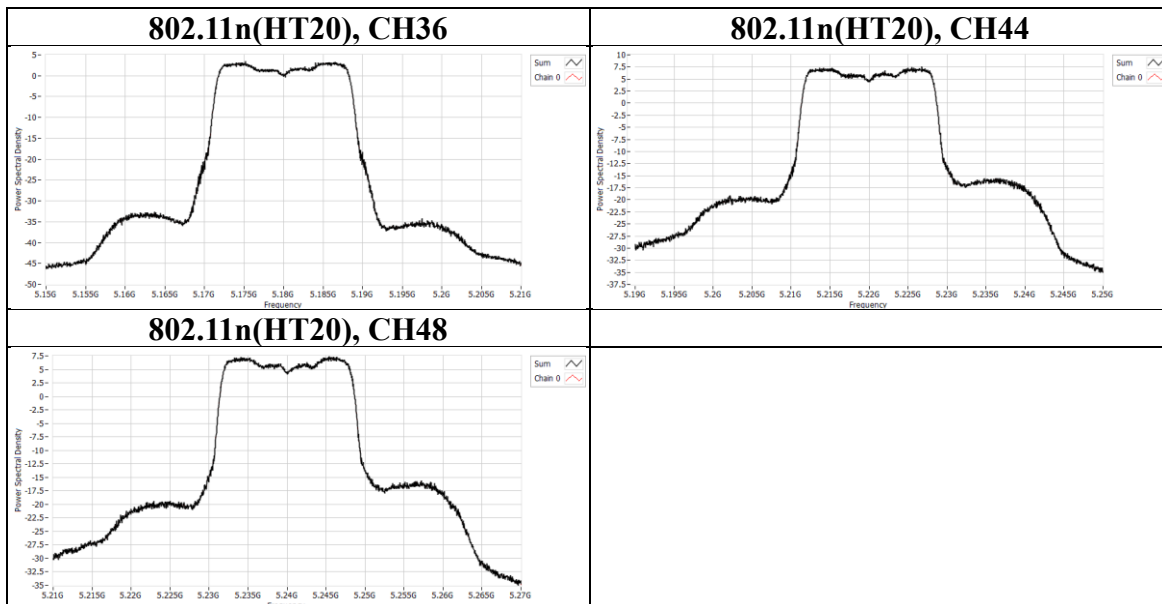
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Mode (U-NII-1)	CH	Freq (MHz)	Directional Gain (dBi)	Total PSD (dBm/MHz)	Limit (dBm/MHz)	Result
802.11n(HT20)	36	5180	4.5	3.37	11	Pass
	44	5220	4.5	7.61	11	Pass
	48	5240	4.5	7.41	11	Pass

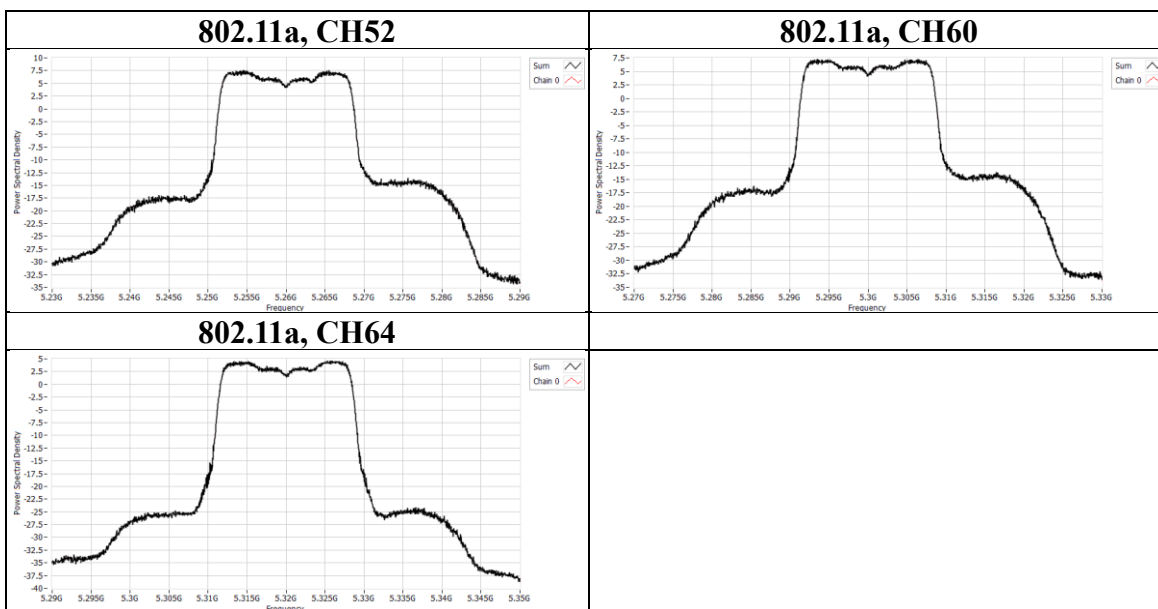
Mode (U-NII-1)	CH	Freq (MHz)	PSD per Chain (dBm/MHz)
			Chain 0
802.11n(HT20)	36	5180	3.375
	44	5220	7.609
	48	5240	7.415





Mode (U-NII-2A)	CH	Freq (MHz)	Directional Gain (dBi)	Total PSD (dBm/MHz)	Limit (dBm/MHz)	Result
802.11a	52	5260	4.5	7.6	11	Pass
	60	5300	4.5	7.21	11	Pass
	64	5320	4.5	4.65	11	Pass

Mode (U-NII-2A)	CH	Freq (MHz)	PSD per Chain (dBm/MHz)
			Chain 0
802.11a	52	5260	7.595
	60	5300	7.212
	64	5320	4.649

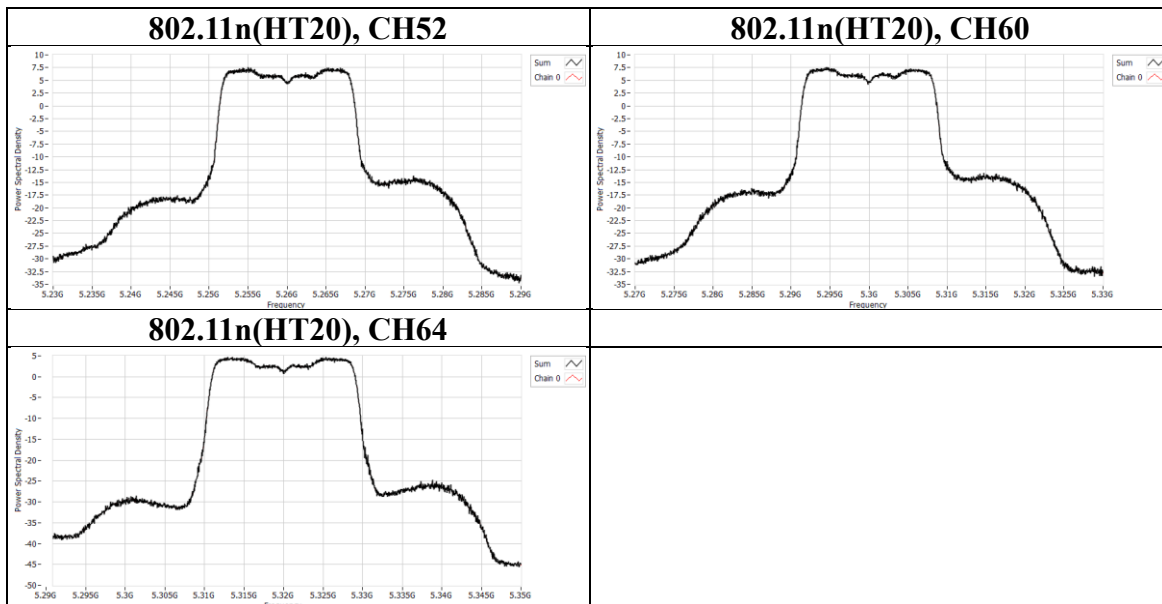




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Mode (U-NII-2A)	CH	Freq (MHz)	Directional Gain (dBi)	Total PSD (dBm/MHz)	Limit (dBm/MHz)	Result
802.11n(HT20)	52	5260	4.5	7.54	11	Pass
	60	5300	4.5	7.59	11	Pass
	64	5320	4.5	4.65	11	Pass

Mode (U-NII-2A)	CH	Freq (MHz)	PSD per Chain (dBm/MHz)
			Chain 0
802.11n(HT20)	52	5260	7.544
	60	5300	7.595
	64	5320	4.648



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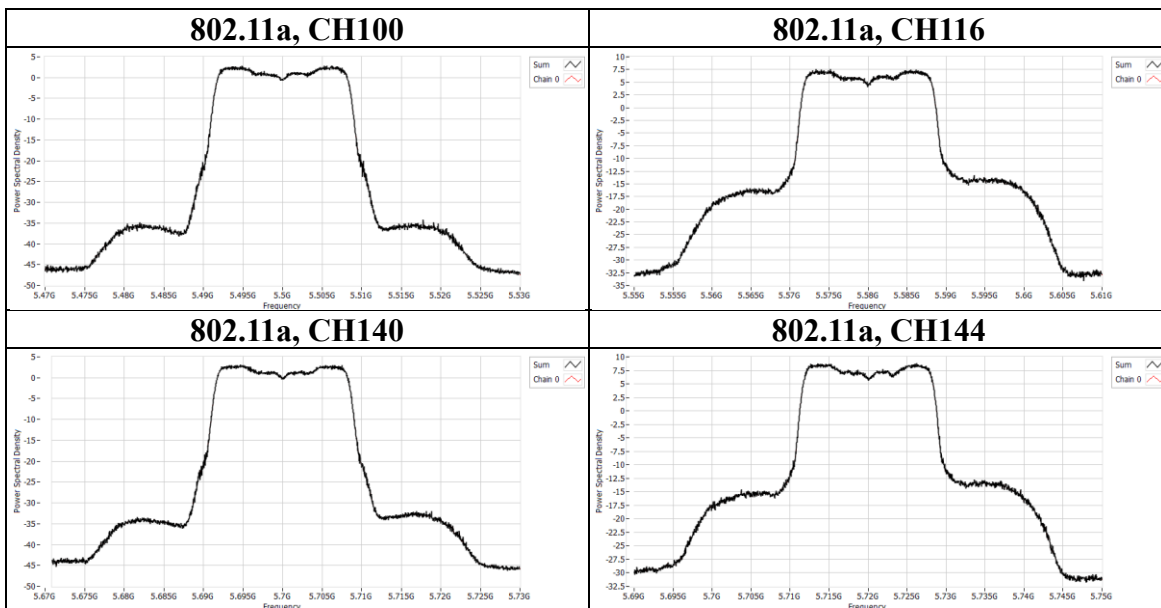
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Mode (U-NII-2C)	CH	Freq (MHz)	Directional Gain (dBi)	Total PSD (dBm/MHz)	Limit (dBm/MHz)	Result
802.11a	100	5500	4.5	2.8	11	Pass
	116	5580	4.5	7.59	11	Pass
	140	5700	4.5	3.12	11	Pass
	144	5720	4.5	8.81	11	Pass

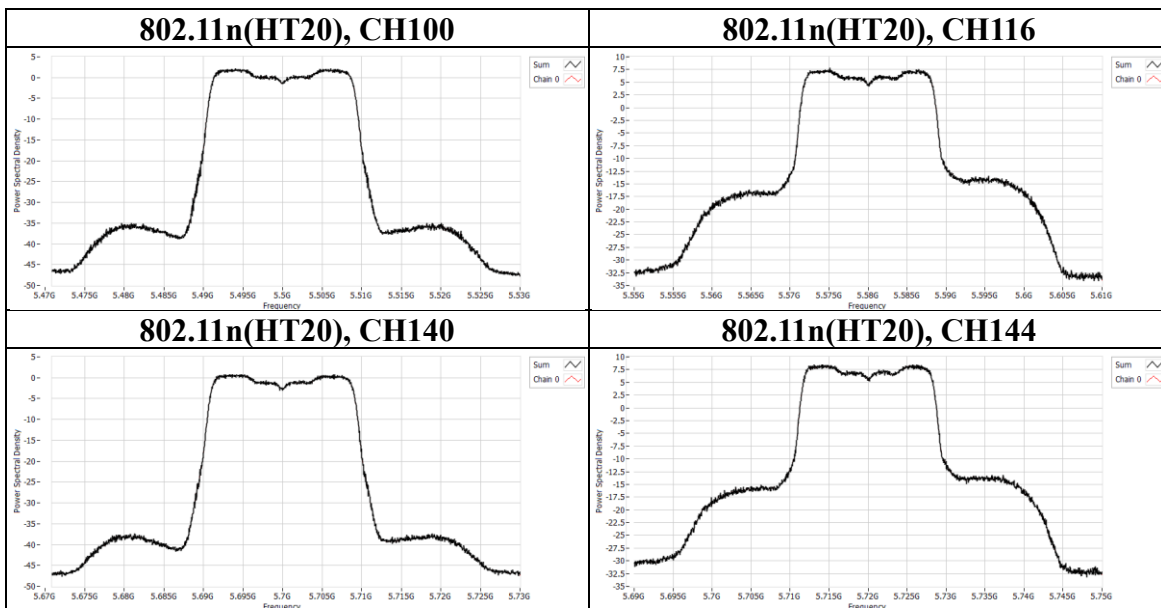
Mode (U-NII-2C)	CH	Freq (MHz)	PSD per Chain (dBm/MHz)
			Chain 0
802.11a	100	5500	2.805
	116	5580	7.594
	140	5700	3.119
	144	5720	8.81





Mode (U-NII-2C)	CH	Freq (MHz)	Directional Gain (dBi)	Total PSD (dBm/MHz)	Limit (dBm/MHz)	Result
802.11n(HT20)	100	5500	4.5	2.2	11	Pass
	116	5580	4.5	7.79	11	Pass
	140	5700	4.5	0.82	11	Pass
	144	5720	4.5	8.5	11	Pass

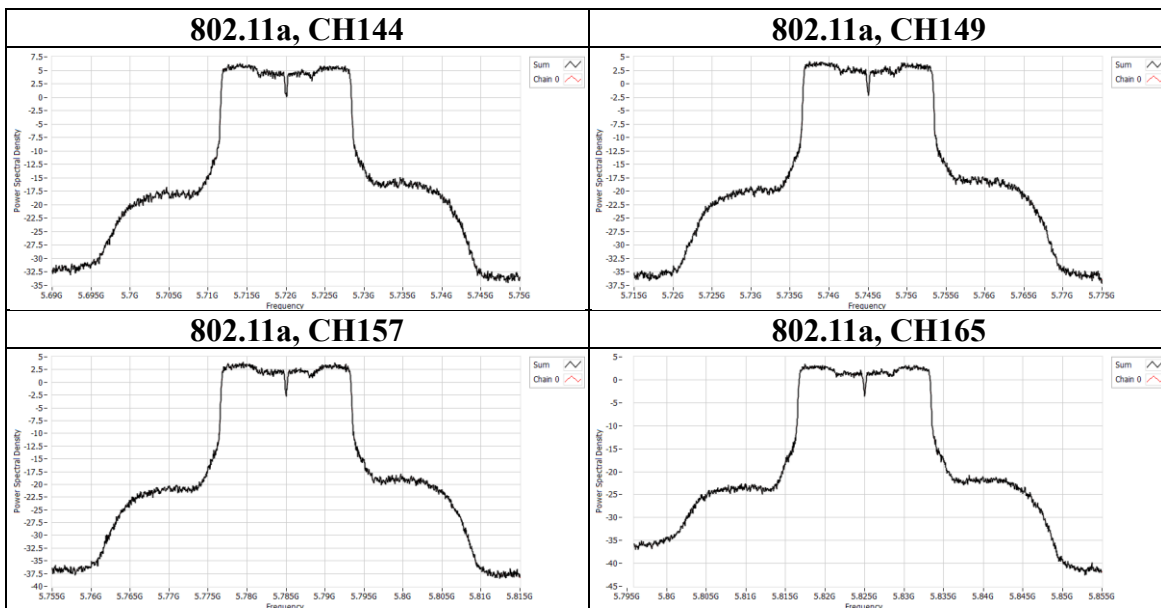
Mode (U-NII-2C)	CH	Freq (MHz)	PSD per Chain (dBm/MHz)
			Chain 0
802.11n(HT20)	100	5500	2.2
	116	5580	7.786
	140	5700	0.822
	144	5720	8.497





Mode (U-NII-3)	CH	Freq (MHz)	BWCF	Directional Gain (dBi)	Total PSD (dBm/500kHz)	Limit (dBm/500kHz)	Result
802.11a	144	5720	8.55	4.5	8.55	30	Pass
	149	5745	6.38	4.5	6.38	30	Pass
	157	5785	6.19	4.5	6.19	30	Pass
	165	5825	5.57	4.5	5.57	30	Pass

Mode (U-NII-3)	CH	Freq (MHz)	PSD per Chain (dBm/500kHz)
			Chain 0
802.11a	144	5720	6.332
	149	5745	4.165
	157	5785	3.974
	165	5825	3.355



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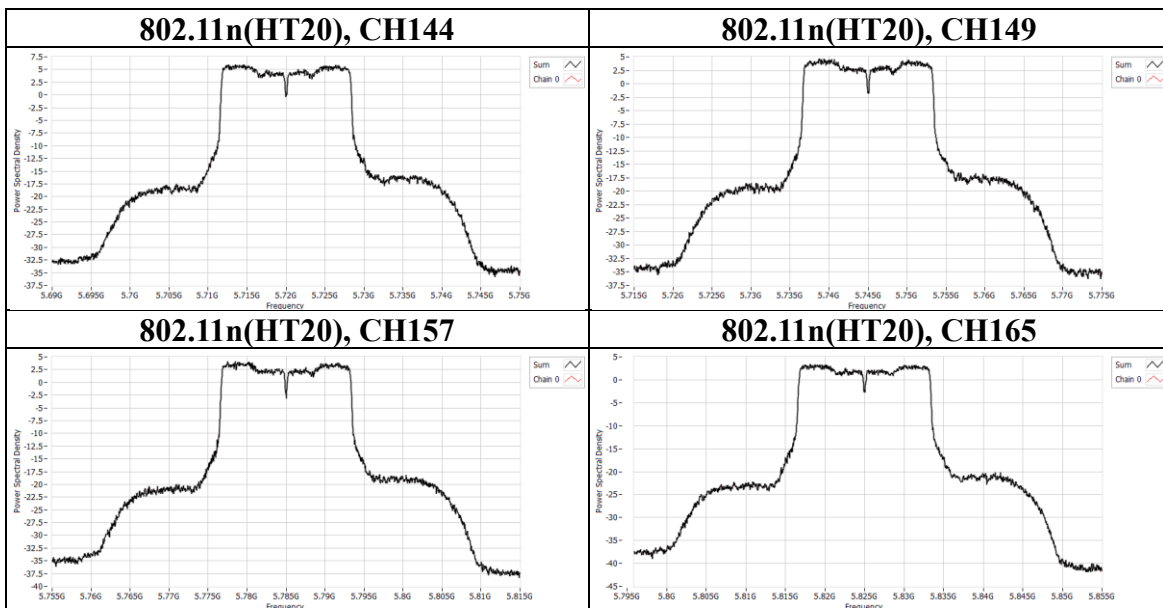
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Mode (U-NII-3)	CH	Freq (MHz)	BWCF	Directional Gain (dBi)	Total PSD (dBm/500kHz)	Limit (dBm/500kHz)	Result
802.11n(HT20)	144	5720	8.17	4.5	8.17	30	Pass
	149	5745	6.9	4.5	6.9	30	Pass
	157	5785	6.37	4.5	6.37	30	Pass
	165	5825	5.61	4.5	5.61	30	Pass

Mode (U-NII-3)	CH	Freq (MHz)	PSD per Chain (dBm/500kHz)
			Chain 0
802.11n(HT20)	144	5720	5.947
	149	5745	4.684
	157	5785	4.151
	165	5825	3.39





9.6. Frequency Stability

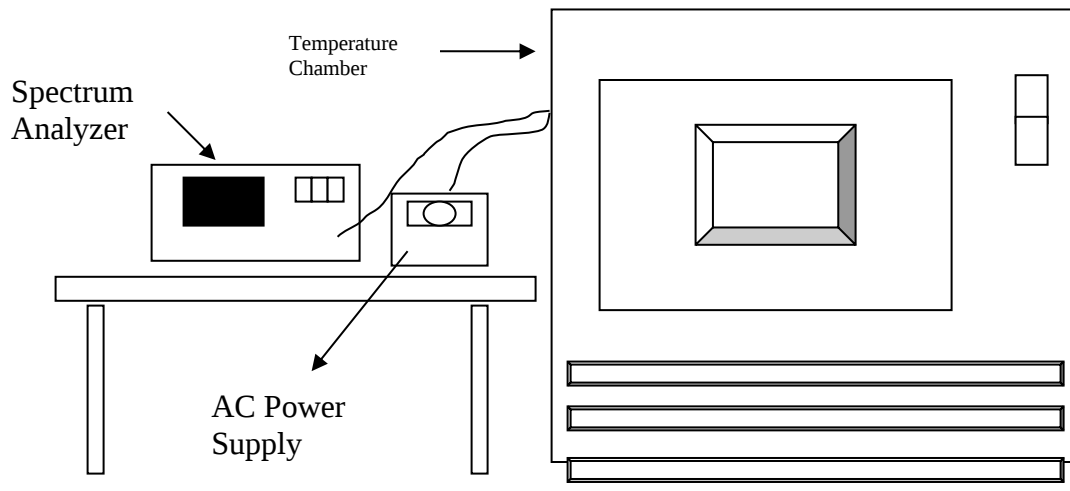
Requirements

The frequency of the carrier signal shall be maintained within band of operation.

Test procedure

- The EUT was placed inside the environmental test chamber and powered by nominal AC voltage.
- Turn the EUT on and couple its output to a spectrum analyzer.
- Turn the EUT off and set the chamber to the highest temperature specified.
- Allow sufficient time (approximately 30 min) for the temperature of the chamber to stabilize, turn the EUT on and measure the operating frequency after 2, 5, and 10 Minutes.
- Repeat step 2 and 3 with the temperature chamber set to the lowest temperature.
- The test chamber was allowed to stabilize at +20 degree C for a minimum of 30 Minutes. The supply voltage was then adjusted on the EUT from 85% to 115% and the frequency record.

Test Setup





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Test Data

Frequency Stability Versus Temp.									
Operating Frequency: 5180 MHz									
TEMP. (°C)	Power Supply (Vac)	0 Minute		2 Minute		5 Minute		10 Minute	
		Measured Frequency (MHz)	Freq. Drift (ppm)	Measured Frequency (MHz)	Freq. Drift (ppm)	Measured Frequency (MHz)	Freq. Drift (ppm)	Measured Frequency (MHz)	Freq. Drift (ppm)
50	120	5179.9997	-0.06	5179.996	-0.77	5179.9997	-0.06	5180	0.00
40	120	5179.9972	-0.54	5179.9951	-0.95	5179.9961	-0.75	5179.9944	-1.08
30	120	5180.0221	4.27	5180.0216	4.17	5180.0213	4.11	5180.025	4.83
20	120	5180.02	3.86	5180.0222	4.29	5180.0203	3.92	5180.0209	4.03
10	120	5179.987	-2.51	5179.9889	-2.14	5179.9887	-2.18	5179.9882	-2.28
0	120	5180.0068	1.31	5180.0053	1.02	5180.0058	1.12	5180.0072	1.39
-10	120	5180.01	1.93	5180.0122	2.36	5180.0102	1.97	5180.01	1.93
-20	120	5180.0019	0.37	5180	0.00	5180.0014	0.27	5179.998	-0.39
-30	120	5179.994	-1.16	5179.9952	-0.93	5179.9968	-0.62	5179.9972	-0.54
TEMP. (°C)	Power Supply (Vac)	0 Minute		2 Minute		5 Minute		10 Minute	
		Measured Frequency (MHz)	Freq. Drift (ppm)	Measured Frequency (MHz)	Freq. Drift (ppm)	Measured Frequency (MHz)	Freq. Drift (ppm)	Measured Frequency (MHz)	Freq. Drift (ppm)
20	138	5180.0206	3.98	5180.0221	4.27	5180.0208	4.02	5180.0209	4.03
20	102	5180.02	3.86	5180.0222	4.29	5180.0203	3.92	5180.0209	4.03
20	102	5180.0203	3.92	5180.0228	4.40	5180.0201	3.88	5180.0211	4.07

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9.7. Radiated Spurious Emission

Requirements

Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified 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:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).
3. For frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.

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Limits of unwanted emission out of the restricted bands

Applicable To		Limit	
789033 D02 General UNII Test Procedure New Rules v02r01		Field Strength at 3m	
		PK:74 (dBμV/m)	AV:54 (dBμV/m)
Frequency Band	Applicable To	EIRP Limit	Equivalent Field Strength at 3m
5150~5250 MHz	15.407(b)(1)	PK:-27 (dBm/MHz)	PK:68.2(dBμV/m)
5250~5350 MHz	15.407(b)(2)		
5470~5725 MHz	15.407(b)(3)		
5725~5850 MHz	15.407(b)(4)(i)	PK:-27 (dBm/MHz) ^{*1} PK:10 (dBm/MHz) ^{*2} PK:15.6 (dBm/MHz) ^{*3} PK:27 (dBm/MHz) ^{*4}	PK: 68.2(dBμV/m) ^{*1} PK:105.2 (dBμV/m) ^{*2} PK: 110.8(dBμV/m) ^{*3} PK:122.2 (dBμV/m) ^{*4}
*1 beyond 75 MHz or more above of the band edge. *2 below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above. *3 below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above. *4 from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.			

Note:

The following formula is used to convert the effective isotropic radiated power (eirp) to field strength:

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

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Test Procedures

[For 9 kHz ~ 30 MHz]

- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. Parallel, perpendicular, and ground-parallel orientations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. For measurement below 30MHz, the initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured. If the emission level of the EUT measured by the peak detector is lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.

NOTE:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9kHz at frequency below 30MHz.

[For above 30 MHz]

- a. The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. For measurement below 1GHz, the initial step in collecting conducted emission data is a spectrum analyzer peak detector mode pre-scanning the measurement frequency range. Significant peaks are then marked and then Quasi Peak detector mode re-measured. If the emission level of the EUT measured by the peak detector is lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.
- f. The test-receiver system was set to peak and average detects function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

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Note:

- a. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
- b. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
- c. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is $\geq 1/T$ (Duty cycle $< 98\%$) or 10Hz (Duty cycle $\geq 98\%$) for Average detection (AV) at frequency above 1GHz.

Configuration	Average	
	RBW	VBW
802.11a	1MHz	Refer to section 6.6 for duty cycle
802.11n (HT20)		

- d. All modes of operation were investigated (includes all external accessories) and the worst-case emissions are reported, the other emission levels were low against the limit.
- e. Test data of Result value (dBuV/m) = Reading value (dBuV/m) + Correction Factor (dB/m).
- f. Test data of Margin(dB) = Result value (dBuV/m) - Limit value (dBuV/m).
- g. Test data of Correction Factor (dB/m) = Antenna Factor (dBuV/m) + Cable Loss (dB) - Preamp Factor (dB).
- h. Test data of Notation "@" = Fundamental Frequency
- i. Test data of Notation "*" = Only required peak limit or the peak result under 20 dB above and complies with AVG limit, AVG result is deemed to comply with AVG limit.

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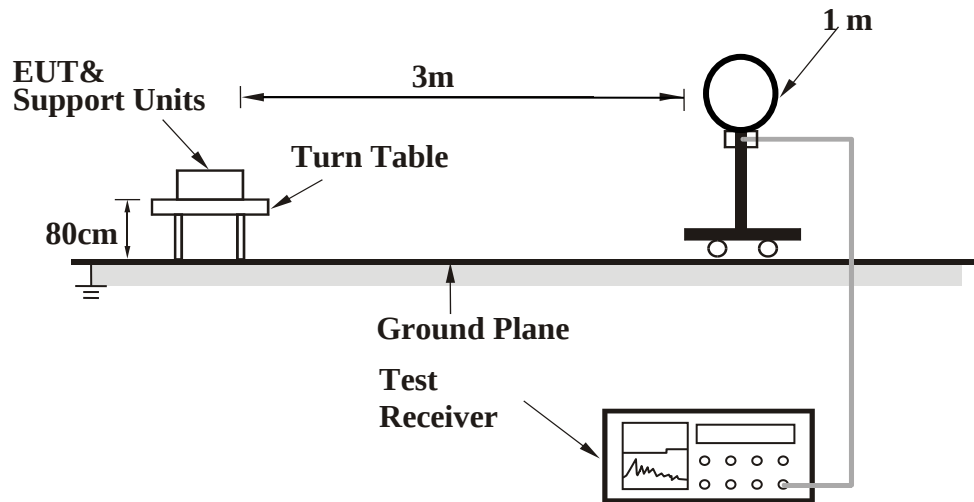
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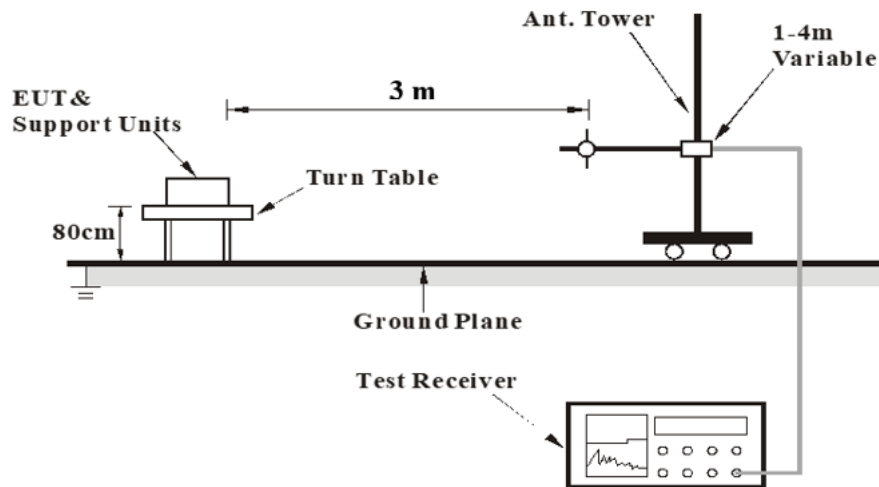


Test Setup

<Frequency Range 9 kHz ~ 30 MHz>



<Frequency Range 30 MHz ~ 1 GHz >



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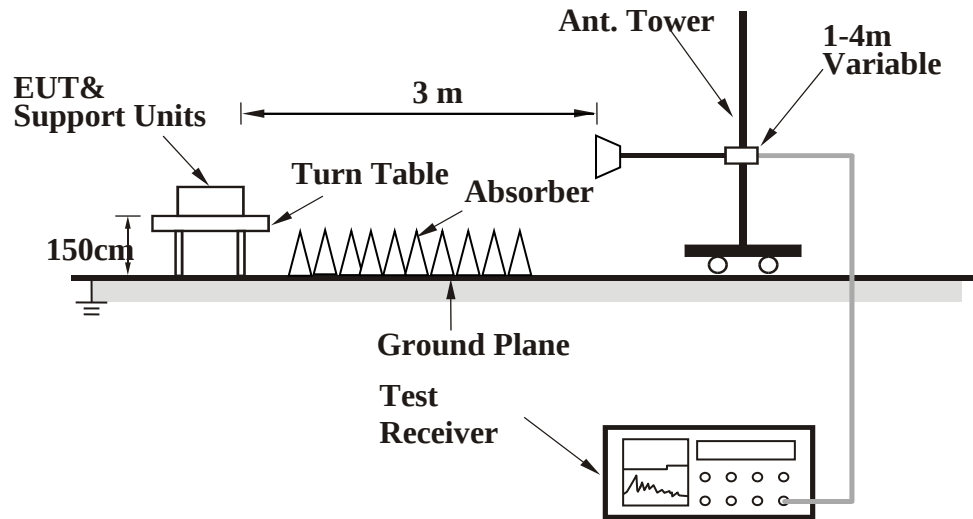
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<Frequency Range above 1 GHz>



For the actual test configuration, please refer to the Setup Configurations.

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Test Data

Above 1 GHz

Mode	802.11a	Channel	36
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Polarization	Notation	Frequency (MHz)	Reading (dBuV)	Correct (dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Remark
Horizontal		5141.75	41.77	19.41	61.18	74	-12.82	PK
		5148.75	32.86	19.4	52.26	54	-1.74	AVG
	@	5180	86.66	19.31	105.97	N/A	N/A	PK
	@	5180	77.28	19.31	96.59	N/A	N/A	AVG
	*	10360	30.67	17.51	48.18	68.2	-20.02	PK
Vertical		5148.75	34.28	19.4	53.68	54	-0.32	AVG
		5149.45	39.59	19.4	58.99	74	-15.01	PK
	@	5180	82.81	19.31	102.12	N/A	N/A	PK
	@	5180	80.51	19.31	99.82	N/A	N/A	AVG
	*	10360	30.69	17.51	48.2	68.2	-20	PK

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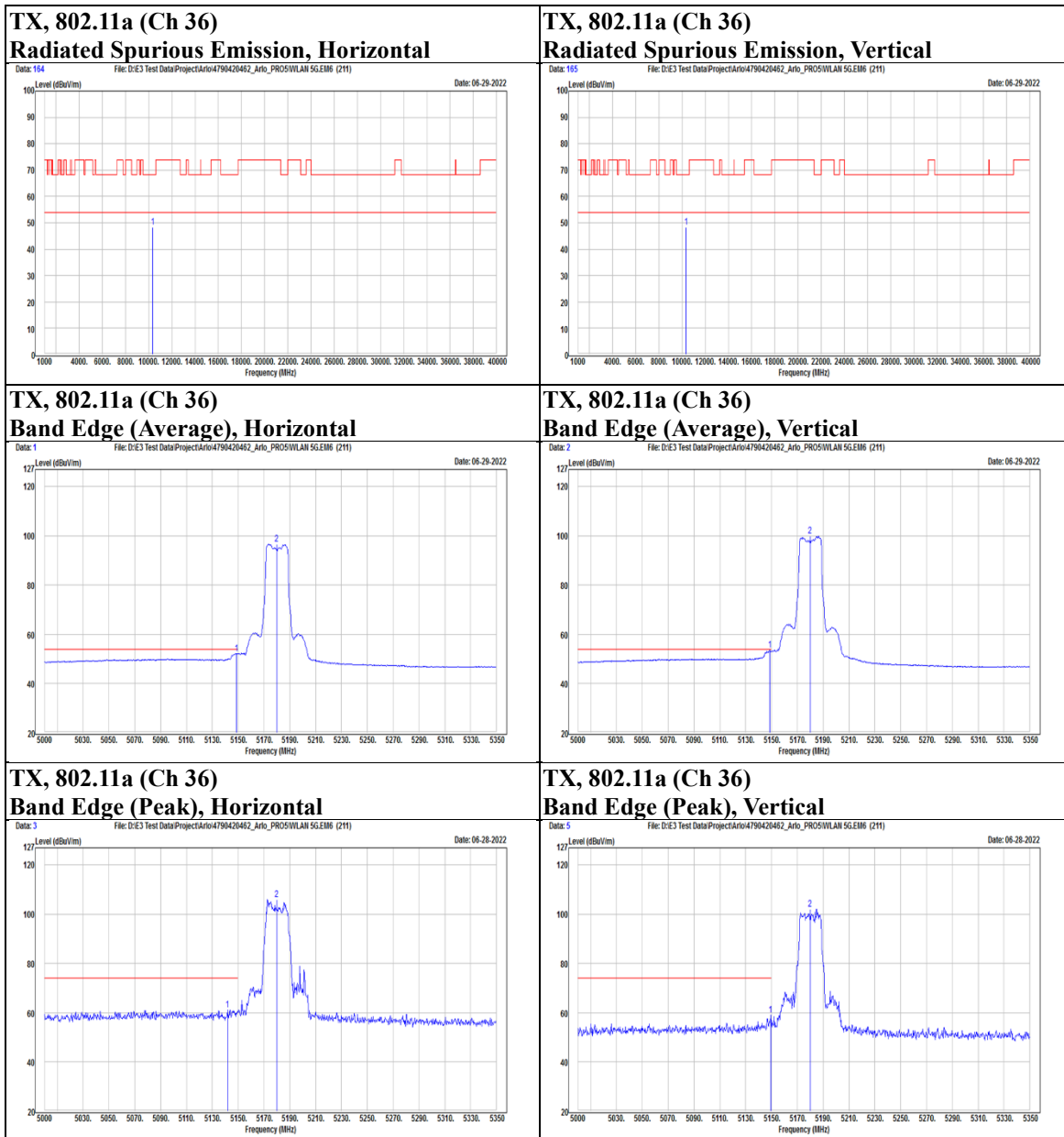
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Mode	802.11a	Channel	44
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Polarization	Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
		(MHz)	(dBuV)	(dB/m)	(dBuV/m)	(dBuV/m)	(dB)	
Horizontal		5089.6	42.25	19.37	61.62	74	-12.38	PK
		5130.55	30.92	19.41	50.33	54	-3.67	AVG
	@	5220	89.05	19.12	108.17	N/A	N/A	PK
	@	5220	80.62	19.12	99.74	N/A	N/A	AVG
	*	10440	30.09	17.81	47.9	68.2	-20.3	PK
Vertical		5061.25	37.34	19.17	56.51	74	-17.49	PK
		5085.75	31.12	19.34	50.46	54	-3.54	AVG
	@	5220	86.06	19.12	105.18	N/A	N/A	PK
	@	5220	84.46	19.12	103.58	N/A	N/A	AVG
	*	10440	30.79	17.81	48.6	68.2	-19.6	PK

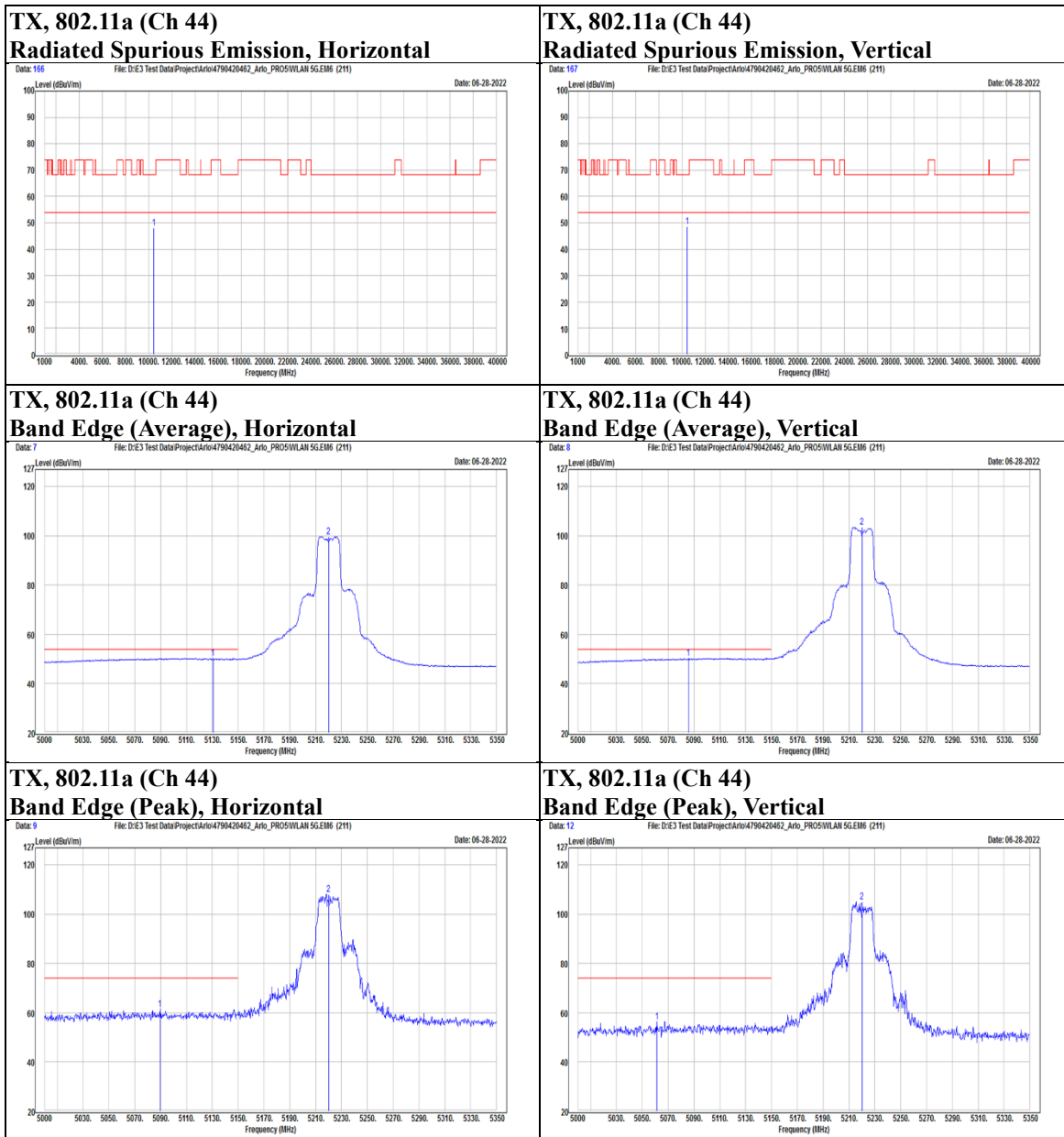
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Mode	802.11a	Channel	48
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Polarization	Notation	Frequency	Reading	Correct	Result	Limit	Margin	Remark
		(MHz)	(dBuV)	(dB/m)	(dBuV/m)	(dBuV/m)	(dB)	
Horizontal		5099.75	30.66	19.44	50.1	54	-3.9	AVG
		5122.85	42.44	19.42	61.86	74	-12.14	PK
	@	5240	89.16	18.97	108.13	N/A	N/A	PK
	@	5240	80.01	18.97	98.98	N/A	N/A	AVG
	*	10480	29.69	17.92	47.61	68.2	-20.59	PK
Vertical		5100.45	30.66	19.44	50.1	54	-3.9	AVG
		5128.8	36.23	19.41	55.64	74	-18.36	PK
	@	5240	85.09	18.97	104.06	N/A	N/A	PK
	@	5240	82.68	18.97	101.65	N/A	N/A	AVG
	*	10480	30.4	17.92	48.32	68.2	-19.88	PK

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