MEASUREMENT REPORT
FCC PART 15.407 WLAN 802.11a/n

FCC ID:	TK4WLM200NX
APPLICANT:	Compex Systems Pte Ltd

Application Type:	Certification
Product:	WIRELESS-N NETWORK MINI PCI ADAPTER
Model No.:	WLM200NX
Brand Name:	COMPEX
FCC Classification:	Unlicensed National Information Infrastructure (UNII)
FCC Rule Part(s):	Part 15.407
Test Procedure(s):	ANSI C63.10-2013, KDB 662911 D01v02r01 KDB 789033 D02 UNII Test Procedures v01r03,
Test Date:	August 16 ~ 30, 2016

Reviewed By Manager : Robin Wu
(Robin Wu)

Approved By CEO : Marlinchen
(Marlin Chen)

ACCREDITED
TESTING LABORATORY CERTIFICATE #3628.01

The test results relate only to the samples tested.
This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in KDB 789033 D02v01r03. Test results reported herein relate only to the item(s) tested.
The test report shall not be reproduced except in full without the written approval of MRT Technology (Suzhou) Co., Ltd.

Revision History

Report No.	Version	Description	Issue Date	Note
1608RSU01102	Rev. 01	Initial report	08-31-2016	Valid

CONTENTS

Description Page

§2.1033 General Information 5

1. INTRODUCTION 6

1.1. Scope 6
1.2. MRT Test Location 6

2. PRODUCT INFORMATION 7

2.1. Equipment Description 7
2.2. Operation Frequency / Channel list 7
2.3. Description of Available Antennas 8
2.4. Description of Antenna RF Port 9
2.5. Test Mode 9
2.6. Test Software 9
2.7. Device Capabilities 10
2.8. Test Configuration 11
2.9. EMI Suppression Device(s)/Modifications 11
2.10. Labeling Requirements 11

3. DESCRIPTION OF TEST 12

3.1. Evaluation Procedure 12
3.2. AC Line Conducted Emissions 12
3.3. Radiated Emissions 13

4. ANTENNA REQUIREMENTS 14

5. TEST EQUIPMENT CALIBRATION DATE 15

6. MEASUREMENT UNCERTAINTY 16

7. TEST RESULT 17

7.1. Summary 17
7.2. 26dB Bandwidth Measurement 18
7.2.1. Test Limit 18
7.2.2. Test Procedure used 18
7.2.3. Test Setting 18
7.2.4. Test Setup 18
7.2.5. Test Result 19
7.3. 6dB Bandwidth Measurement 24
7.3.1. Test Limit 24
7.3.2. Test Procedure used 24

7.3.3. Test Setting 24
7.3.4. Test Setup 24
7.3.5. Test Result 25
7.4. Output Power Measurement 30
7.4.1. Test Limit 30
7.4.2. Test Procedure Used 30
7.4.3. Test Setting 30
7.4.4. Test Setup 30
7.4.5. Test Result 31
7.5. Power Spectral Density Measurement 34
7.5.1. Test Limit 34
7.5.2. Test Procedure Used 34
7.5.3. Test Setting 34
7.5.4. Test Setup 35
7.5.5. Test Result 36
7.6. Frequency Stability Measurement 41
7.6.1. Test Limit 41
7.6.2. Test Procedure Used 41
7.6.3. Test Setup 41
7.6.4. Test Result 42
7.7. Radiated Spurious Emission Measurement 43
7.7.1. Test Limit 43
7.7.2. Test Procedure Used 43
7.7.3. Test Setting 43
7.7.4. Test Setup 44
7.7.5. Test Result 46
7.8. Radiated Restricted Band Edge Measurement 74
7.8.1. Test Limit 74
7.8.2. Test Result of Radiated Restricted Band Edge 76
7.9. AC Conducted Emissions Measurement 108
7.9.1. Test Limit 108
7.9.2. Test Setup 108
7.9.3. Test Result 109

8. CONCLUSION 111

§2.1033 General Information

Applicant:	Compex Systems Pte Ltd
Applicant Address:	No:9 Harrison Road, Harrison Industrial Building, #05-01, Singapore 369651
Manufacturer:	Compex Systems Pte Ltd
Manufacturer Address:	No:9 Harrison Road, Harrison Industrial Building, #05-01, Singapore 369651
Test Site:	MRT Technology (Suzhou) Co., Ltd
Test Site Address:	D8 Building, Youxin Industrial Park, No.2 Tian'edang Rd., Wuzhong Economic Development Zone, Suzhou, China
FCC Registration No.:	809388
FCC Rule Part(s):	Part 15.247
Model No.:	WLM200NX
Test Device Serial No.:	N/A ☐ Production ☒ Pre-Production ☐ Engineering
FCC Classification:	Unlicensed National Information Infrastructure (UNII)

Test Facility / Accreditations

Measurements were performed at MRT Laboratory located in Tian'edang Rd., Suzhou, China.

- **MRT facility is a FCC registered (MRT Reg. No. 809388) test facility with the site description report on file and has met all the requirements specified in Section 2.948 of the FCC Rules.**
- **MRT facility is an IC registered (MRT Reg. No. 11384A-1) test laboratory with the site description on file at Industry Canada.**
- **MRT facility is a VCCI registered (R-4179, G-814, C-4664, T-2206) test laboratory with the site description on file at VCCI Council.**
- **MRT Lab is accredited to ISO 17025 by the American Association for Laboratory Accreditation (A2LA) under the American Association for Laboratory Accreditation Program (A2LA Cert. No. 3628.01) in EMC, Telecommunications and Radio testing for FCC, Industry Canada, EU and TELEC Rules.**

American Association for Laboratory Accreditation

Accredited Laboratory

A2LA has accredited

MRT TECHNOLOGY (SUZHOU) CO., LTD.

Suzhou, China

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005 (General requirements for the competence of testing and calibration laboratories. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).

Presented this 17th day of June 2014.

President & CEO
For the Accreditation Council
Certificate Number 3628.01
Valid to August 31, 2016

For the tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.

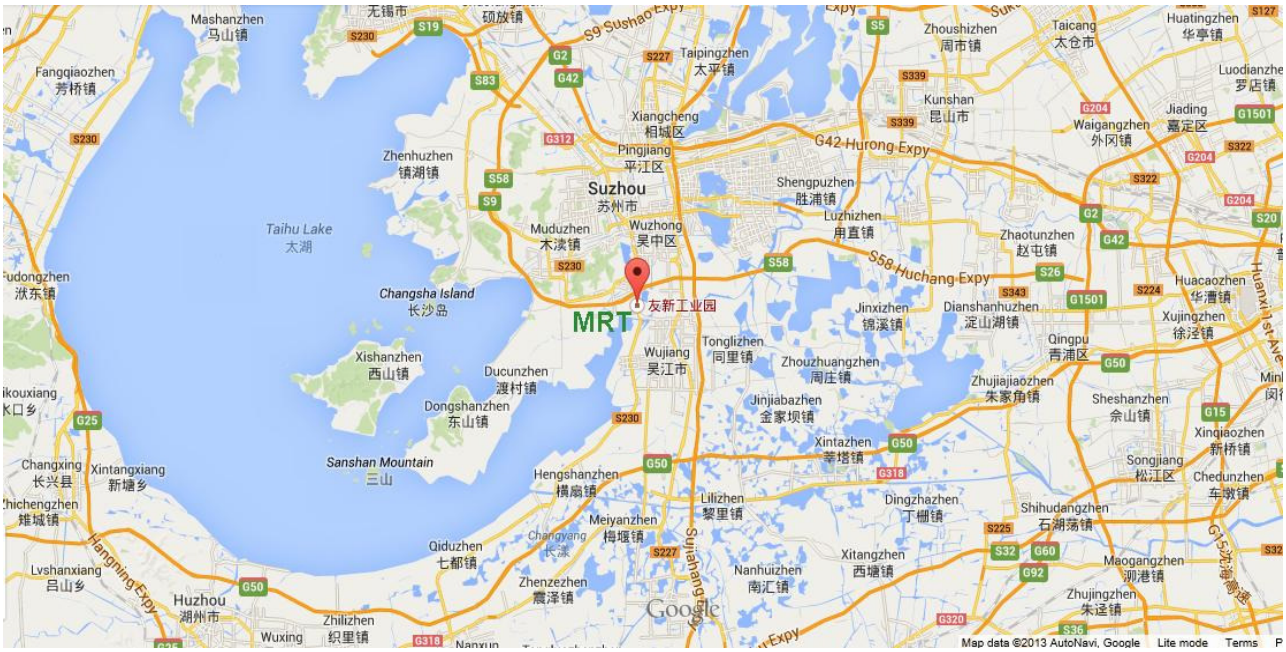
1. INTRODUCTION

1.1. Scope

Measurement and determination of electromagnetic emissions (EMC) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission and the Industry Canada Certification and Engineering Bureau.

1.2. MRT Test Location

The map below shows the location of the MRT LABORATORY, its proximity to the Taihu Lake. These measurement tests were conducted at the MRT Technology (Suzhou) Co., Ltd. Facility located at D8 Building, Youxin Industrial Park, No.2 Tian'edang Rd., Wuzhong Economic Development Zone, Suzhou, China. The detailed description of the measurement facility was found to be in compliance with the requirements of § 2.948 according to ANSI C63.4-2009 on September 30, 2013.



2. PRODUCT INFORMATION

2.1. Equipment Description

Product Name	WIRELESS-N NETWORK MINI PCI ADAPTER
Model No.	WLM200NX
Brand Name	COMPEX
WLAN Specification	
Frequency Range	**2.4GHz:** For 802.11b/g/n-HT20: 2412 ~ 2462 MHz For 802.11n-HT40: 2422 ~ 2452 MHz **5GHz:** For 802.11a/n-HT20: 5745~5825MHz For 802.11n-HT40: 5755~5795MHz
Type of Modulation	802.11b: DSSS 802.11g/a/n: OFDM

2.2. Operation Frequency / Channel list

802.11a/n-HT20

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

802.11n-HT40

Channel	Frequency	Channel	Frequency	Channel	Frequency
151	5755 MHz	159	5795 MHz	--	--

2.3. Description of Available Antennas

Antenna Type	Frequency Band (GHz)	Manufacturer	Tx Paths	Max Peak Gain (dBi)	Directional Gain (dBi)	
					For Power	For PSD
Dipole Antenna	2.4	Compex Systems Pte Ltd	2	2	2	5.01
	5		2	2	2	5.01
PCB Antenna	2.4	Taoglas Antenna Solutions	2	3	3	6.01
	5		2	5	5	8.01

Note:

The EUT supports Cyclic Delay Diversity (CDD) mode, and CDD signals are correlated.

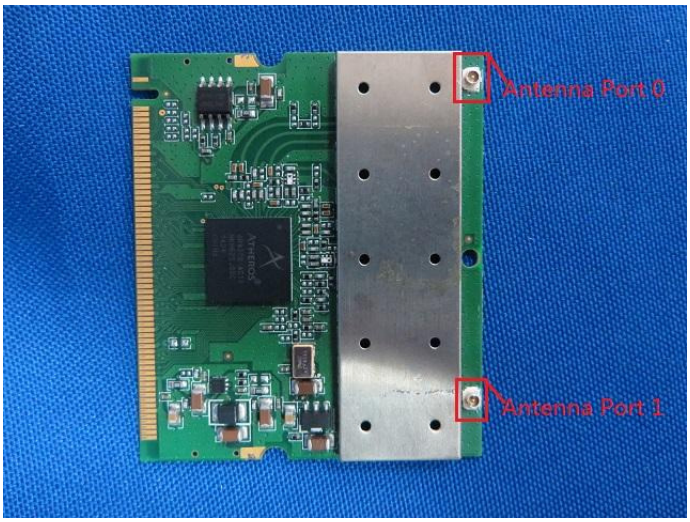
For CDD transmissions, directional gain is calculated as follows, N_{ANT} = 2, N_{SS} = 1.

1. If all antennas have the same gain, G_{ANT}, Directional gain = G_{ANT} + Array Gain, where Array Gain is as follows.
   - For power spectral density (PSD) measurements on all devices,
     Array Gain = 10 log (N_{ANT}/ N_{SS}) dB = 3.01;
   - For power measurements on IEEE 802.11 devices,
     Array Gain = 0 dB for N_{ANT} ≤ 4;
2. If antenna gains are not equal, the user may use either of the following methods to calculate directional gain, provided that each transmit antenna is driven by only one spatial stream:
   - Directional gain may be calculated by using the formulas applicable to equal gain antennas with G_{ANT} set equal to the gain of the antenna having the highest gain;
   - $$DirectionalGain = 10 \cdot \log\left[\frac{\sum_{j=1}^{N_{SS}}\left\{\sum_{k=1}^{N_{ANT}} g_{j,k}\right\}^2}{N_{ANT}}\right]$$

     $g_{j,k} = 10^{G_k/20}$ 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.

2.4. Description of Antenna RF Port

Antenna RF Port


2.5. Test Mode

Test Mode	Mode 1: Transmit by 802.11a
	Mode 2: Transmit by 802.11n-HT20
	Mode 3: Transmit by 802.11n-HT40

2.6. Test Software

The test utility software used during testing was “ART”, and the version was “v09 b27”.

2.7. Device Capabilities

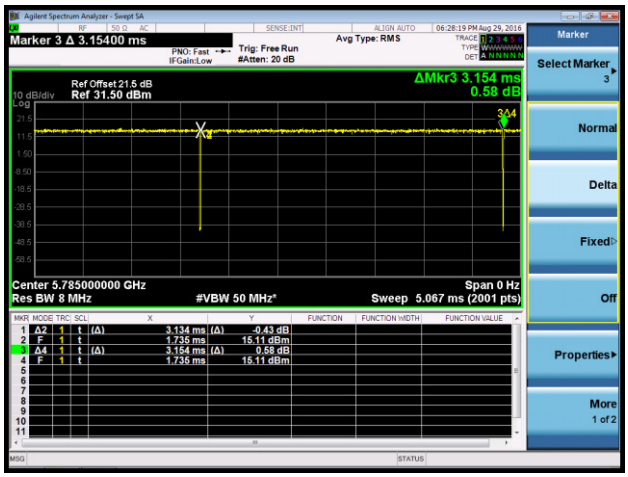
This device contains the following capabilities:

2.4GHz WLAN (DTS) and 5GHz WLAN (NII).

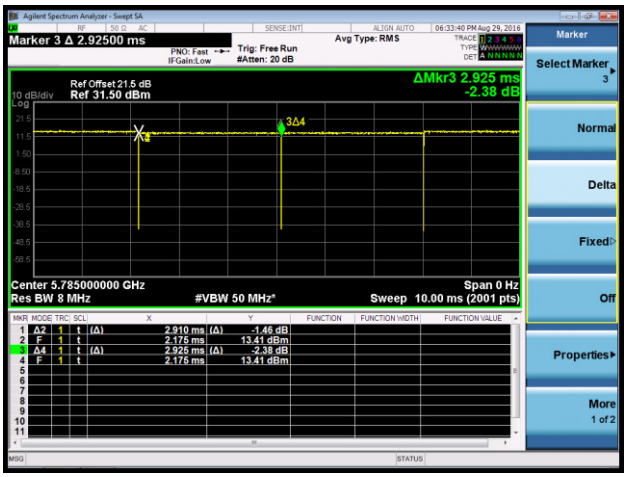
Note: 5GHz (NII) operation is possible in 20MHz and 40MHz channel bandwidths. The maximum achievable duty cycles for all modes were determined based on measurements performed on a spectrum analyzer in zero-span mode with RBW = 8MHz, VBW = 50MHz, and detector = average per the guidance of Section B)2)b) of KDB 789033 D02v01r03. The RBW and VBW were both greater than 50/T, where T is the minimum transmission duration, and the number of sweep points across T was greater than 100. The duty cycles are as follows:

Test Mode	Duty Cycle
802.11a	99.37%
802.11n-HT20	99.49%
802.11n-HT40	97.75%

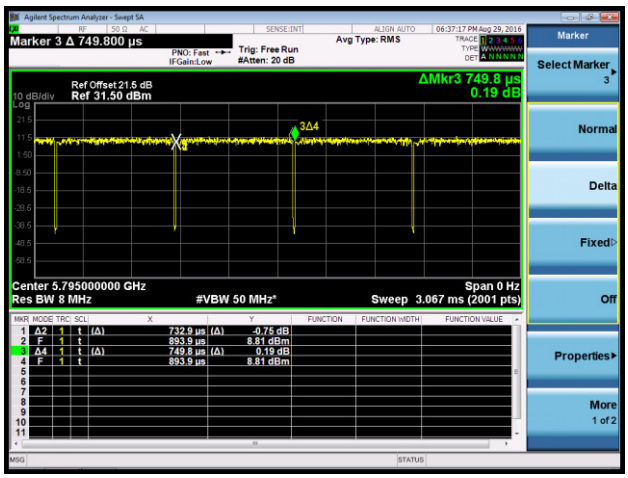
802.11a



802.11n-HT20



802.11n-HT40



2.8. Test Configuration

The **WIRELESS-N NETWORK MINI PCI ADAPTER FCC ID: TK4WLM200NX** was tested per the guidance of KDB 789033 D02v01r03. ANSI C63.10-2013 was used to reference the appropriate EUT setup for radiated spurious emissions testing and AC line conducted testing.

2.9. EMI Suppression Device(s)/Modifications

No EMI suppression device(s) were added and/or no modifications were made during testing.

2.10. Labeling Requirements

Per 2.1074 & 15.19; Docket 95-19

The label shall be permanently affixed at a conspicuous location on the device; instruction manual or pamphlet supplied to the user and be readily visible to the purchaser at the time of purchase. However, when the device is so small wherein placement of the label with specified statement is not practical, only the FCC ID must be displayed on the device per Section 15.19(a)(5). Please see attachment for FCC ID label and label location.

3. DESCRIPTION OF TEST

3.1. Evaluation Procedure

The measurement procedures described in the American National Standard for Testing Unlicensed Wireless Devices (ANSI C63.10-2013), and the guidance provided in KDB 789033 D02v01r03 were used in the measurement of the **WIRELESS-N NETWORK MINI PCI ADAPTER FCC ID: TK4WLM200NX.**

Deviation from measurement procedure…….....None

3.2. AC Line Conducted Emissions

The line-conducted facility is located inside an 8'x4'x4' shielded enclosure. A 1m x 2m wooden table 80cm high is placed 40cm away from the vertical wall and 80cm away from the sidewall of the shielded room. Two 10kHz-30MHz, 50Ω/50uH Line-Impedance Stabilization Networks (LISNs) are bonded to the shielded room floor. Power to the LISNs is filtered by external high-current high-insertion loss power line filters. These filters attenuate ambient signal noise from entering the measurement lines. These filters are also bonded to the shielded enclosure.

The EUT is powered from one LISN and the support equipment is powered from the second LISN. All interconnecting cables more than 1 meter were shortened to a 1 meter length by non-inductive bundling (serpentine fashion) and draped over the back edge of the test table. All cables were at least 40cm above the horizontal reference ground-plane. Power cables for support equipment were routed down to the second LISN while ensuring that that cables were not draped over the second LISN.

Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the receiver and exploratory measurements were made to determine the frequencies producing the maximum emission from the EUT. The receiver was scanned from 150kHz to 30MHz. The detector function was set to peak mode for exploratory measurements while the bandwidth of the analyzer was set to 9kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Each emission was also maximized by varying: power lines, the mode of operation or data exchange speed, or support equipment whichever determined the worst-case emission. Once the worst case emissions have been identified, the one EUT cable configuration/arrangement and mode of operation that produced these emissions are used for final measurements on the same test site. The analyzer is set to CISPR quasi-peak and average detectors with a 9kHz resolution bandwidth for final measurements.

An extension cord was used to connect to a single LISN which powered by EUT. The extension cord was calibrated with LISN, the impedance and insertion loss are compliance with the requirements as stated in ANSI C63.10-2013.

Line conducted emissions test results are shown in Section 7.10.

3.3. Radiated Emissions

The radiated test facilities consisted of an indoor 3 meter semi-anechoic chamber used for final measurements and exploratory measurements, when necessary. The measurement area is contained within the semi-anechoic chamber which is shielded from any ambient interference. For measurements above 1GHz absorbers are arranged on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections. For measurements below 1GHz, the absorbers are removed. A MF Model 210SS turntable is used for radiated measurement. It is a continuously rotatable, remote controlled, metallic turntable and 2 meters (6.56 ft.) in diameter. The turn table is flush with the raised floor of the chamber in order to maintain its function as a ground plane. An 80cm high PVC support structure is placed on top of the turntable.

For all measurements, the spectrum was scanned through all EUT azimuths and from 1 to 4 meter receive antenna height using a broadband antenna from 30MHz up to the upper frequency shown in 15.33(b)(1) depending on the highest frequency generated or used in the device or on which the device operates or tunes. For frequencies above 1GHz, linearly polarized double ridge horn antennas were used. For frequencies below 30MHz, a calibrated loop antenna was used. When exploratory measurements were necessary, they were performed at 1 meter test distance inside the semi-anechoic chamber using broadband antennas, broadband amplifiers, and spectrum analyzers to determine the frequencies and modes producing the maximum emissions. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The test set-up for frequencies below 1GHz was placed on top of the 0.8 meter high, 1 x 1.5 meter table; and test set-up for frequencies 1-40GHz was placed on top of the 1.5 meter high, 1 x 1.5 meter table. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Appropriate precaution was taken to ensure that all emissions from the EUT were maximized and investigated. The system configuration, clock speed, mode of operation or video resolution, if applicable, turntable azimuth, and receive antenna height was noted for each frequency found.

Final measurements were made in the semi-anechoic chamber using calibrated, linearly polarized broadband and horn antennas. The test setup was configured to the setup that produced the worst case emissions. The spectrum analyzer was set to investigate all frequencies required for testing to compare the highest radiated disturbances with respect to the specified limits. The turntable containing the EUT was rotated through 360 degrees and the height of the receive antenna was varied 1 to 4 meters and stopped at the azimuth and height producing the maximum emission. Each emission was maximized by changing the orientation of the EUT through three orthogonal planes and changing the polarity of the receive antenna, whichever produced the worst-case emissions. According to 3dB Beam-Width of horn antenna, the horn antenna should be always directed to the EUT when rising height.

4. ANTENNA REQUIREMENTS

Excerpt from §15.203 of the FCC Rules/Regulations:
"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section."

- The antenna of the **Wireless-A/B/G/N Network Mini PCIe Adapter** uses a unique connector.

Antenna Type	Antenna Connector Type
Dipole Antenna	IPEX connector
PCB Antenna	IPEX connector

Conclusion:
The **WIRELESS-N NETWORK MINI PCI ADAPTER FCC ID: TK4WLM200NX** unit complies with the requirement of §15.203.

5. TEST EQUIPMENT CALIBRATION DATE

Conducted Emissions - SR2

Instrument	Manufacturer	Type No.	Serial No.	Cali. Interval	Cali. Due Date
EMI Test Receiver	R&S	ESR7	101209	1 year	2016/11/03
Two-Line V-Network	R&S	ENV216	101683	1 year	2016/11/03
Two-Line V-Network	R&S	ENV216	101684	1 year	2016/11/03
Temperature/Humidity Meter	Yuhuaze	HTC-2	N/A	1 year	2016/12/20
Shielding Anechoic Chamber	Mikebang	Chamber-SR2	N/A	1 year	2017/05/10

Radiated Emission – AC2

Instrument	Manufacturer	Type No.	Serial No.	Cali. Interval	Cali. Due Date
Spectrum Analyzer	Agilent	N9020A	MRTSUE06106	1 year	2017/05/08
Microwave System Amplifier	Agilent	83017A	MY52090106	1 year	2017/03/29
Loop Antenna	Schwarzbeck	FMZB1519	1519-041	1 year	2016/12/14
Bilog Period Antenna	Schwarzbeck	VULB 9162	9162-047	1 year	2016/11/07
Horn Antenna	Schwarzbeck	BBHA9120D	9120D-1167	1 year	2016/11/07
Broadband Horn Antenna	Schwarzbeck	BBHA9170	BBHA9170549	1 year	2017/01/04
Temperature/Humidity Meter	Yuhuaze	HTC-2	N/A	1 year	2016/12/20
Anechoic Chamber	TDK	Chamber-AC2	N/A	1 year	2017/05/10

Conducted Test Equipment - TR3

Instrument	Manufacturer	Type No.	Serial No.	Cali. Interval	Cali. Due Date
Spectrum Analyzer	Agilent	N9020A	MY52090106	1 year	2017/05/08
USB Wideband Power Sensor	Boonton	55006	8911	1 year	2017/05/08
Temperature/Humidity Meter	Yuhuaze	HTC-2	N/A	1 year	2016/12/20

Software	Version	Function
e3	V8.3.5	EMI Test Software

6. MEASUREMENT UNCERTAINTY

Where relevant, the following test uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k = 2.

AC Conducted Emission Measurement - SR2
Measuring Uncertainty for a Level of Confidence of 95% (U=2Uc(y)): 150kHz~30MHz: 3.46dB
Radiated Emission Measurement - AC2
Measuring Uncertainty for a Level of Confidence of 95% (U=2Uc(y)): 9kHz ~ 1GHz: 4.18dB 1GHz ~ 40GHz: 4.76dB

7. TEST RESULT

7.1. Summary

Company Name: **Compex Systems Pte Ltd**

FCC ID: **TK4WLM200NX**

Data Rate(s) Tested: **6Mbps ~ 54Mbps (a);**
13/14.4Mbps ~ 130/144.4Mbps (n-HT20);
27/30Mbps ~ 270/300Mbps (n-HT40);

FCC Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
15.407(a)	26dB Bandwidth	N/A	Conducted	Pass	Section 7.2
15.407(e)	6dB Bandwidth	≥ 500kHz		Pass	Section 7.3
15.407(a)(3)	Maximum Conducted Output Power	≤ 30 dBm		Pass	Section 7.5
15.407(a)(3)	Peak Power Spectral Density	≤ 30 dBm/500kHz		Pass	Section 7.7
15.407(g)	Frequency Stability	N/A		Pass	Section 7.8
15.407(b)(4)(i)	Undesirable Emissions	≤ -27dBm/MHz EIRP ≤ -17dBm/MHz EIRP	Radiated	Pass	Section 7.9 & 7.10
15.205, 15.209 15.407(b)(5), (6), (7)	General Field Strength Limits (Restricted Bands and Radiated Emission Limits)	Emissions in restricted bands must meet the radiated limits detailed in 15.209		Pass	
15.207	AC Conducted Emissions 150kHz - 30MHz	< FCC 15.207 limits	Line Conducted	Pass	Section 7.11

Notes:

1) All channels, modes, and modulations/data rates were investigated among all UNII bands. For radiated emission test, every axis (X, Y, Z) was also verified. The test results shown in the following sections represent the worst case emissions.
2) The analyzer plots shown in this section were all taken with a correction table loaded into the analyzer. The correction table was used to account for the losses of the cables and attenuators used as part of the system to connect the EUT to the analyzer at all frequencies of interest.
3) All antenna port conducted emissions testing was performed on a test bench with the antenna port of the EUT connected to the spectrum analyzer through calibrated cables and attenuators.

7.2. 26dB Bandwidth Measurement

7.2.1. Test Limit

N/A

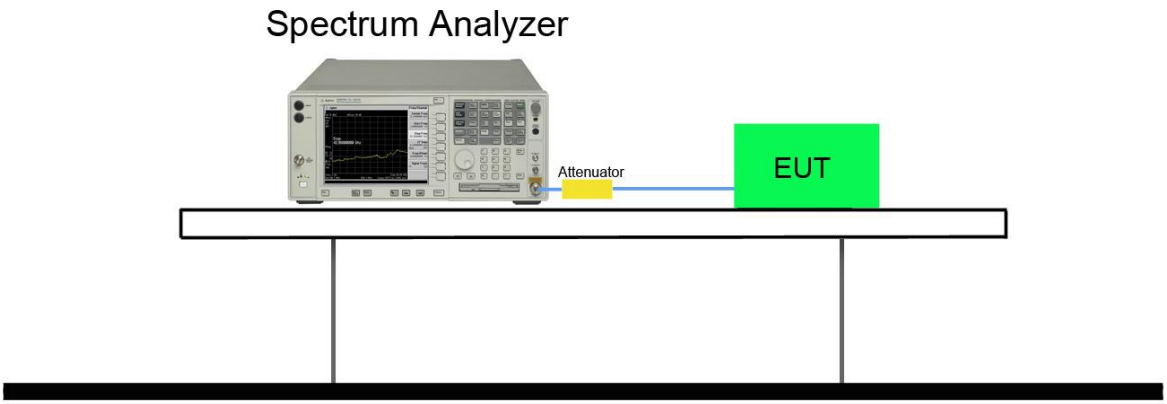
7.2.2. Test Procedure used

KDB 789033 D02v01r03 – Section C.1

7.2.3. Test Setting

1. The analyzers' automatic bandwidth measurement capability was used to perform the 26dB bandwidth measurement. The "X" dB bandwidth parameter was set to X = 26. The automatic bandwidth measurement function also has the capability of simultaneously measuring the 99% occupied bandwidth. The bandwidth measurement was not influenced by any intermediated power nulls in the fundamental emission.
2. RBW = approximately 1% of the emission bandwidth.
3. VBW ≥ 3 × RBW.
4. Detector = Peak.
5. Trace mode = max hold.

7.2.4. Test Setup

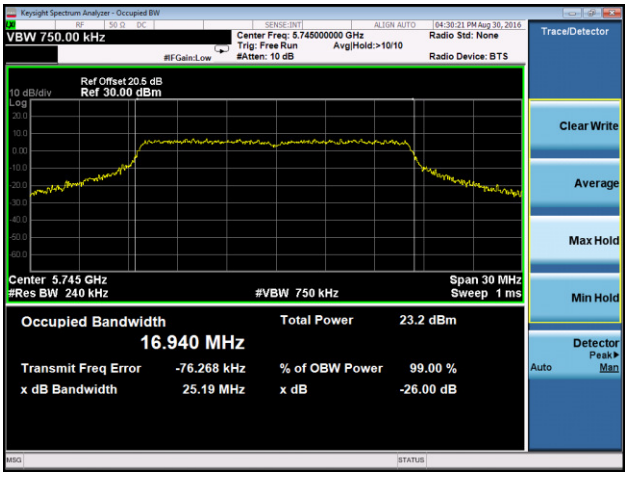


7.2.5. Test Result

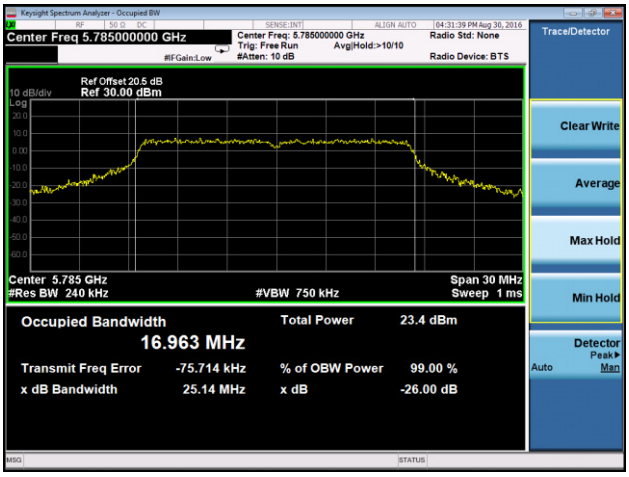
Test Mode	Data Rate (Mbps)	Channel No.	Frequency (MHz)	26dB Bandwidth (MHz)	99% Bandwidth (MHz)	Result
Ant 0						
802.11a	6	149	5745	25.19	16.94	Pass
802.11a	6	157	5785	25.14	16.96	Pass
802.11a	6	165	5825	23.76	16.93	Pass
Ant 1						
802.11a	6	149	5745	27.00	17.00	Pass
802.11a	6	157	5785	25.84	16.98	Pass
802.11a	6	165	5825	25.00	17.10	Pass
Ant 0 / Ant 0 + 1						
802.11n-HT20	6.5	149	5745	23.35	18.00	Pass
802.11n-HT20	6.5	157	5785	23.33	18.00	Pass
802.11n-HT20	6.5	165	5825	23.43	17.89	Pass
802.11n-HT40	13.5	151	5755	45.66	36.55	Pass
802.11n-HT40	13.5	159	5795	45.47	36.48	Pass
Ant 1 / Ant 0 + 1						
802.11n-HT20	6.5	149	5745	23.43	18.03	Pass
802.11n-HT20	6.5	157	5785	23.75	18.00	Pass
802.11n-HT20	6.5	165	5825	24.99	17.94	Pass
802.11n-HT40	13.5	151	5755	46.79	36.52	Pass
802.11n-HT40	13.5	159	5795	48.93	36.52	Pass

802.11a 26dB Bandwidth & 99% Bandwidth - Ant 0

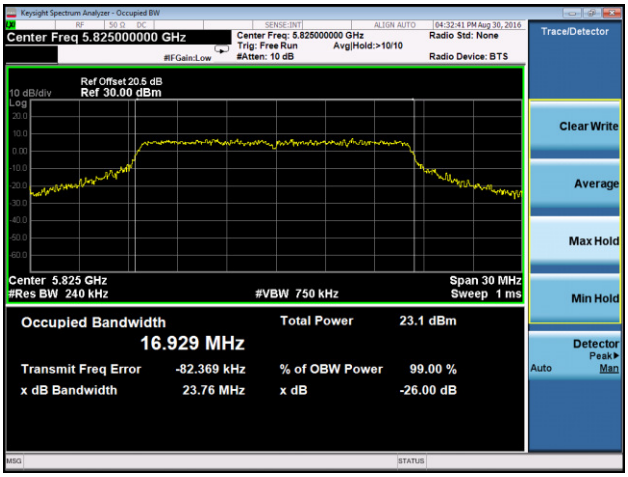
Channel 149 (5745MHz)



Channel 157 (5785MHz)

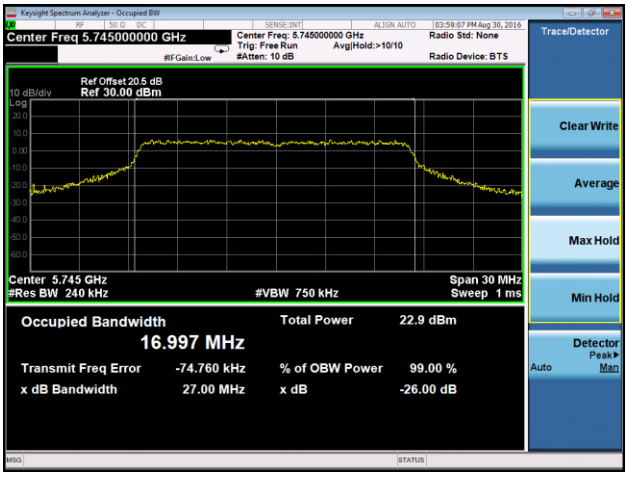


Channel 165 (5825MHz)

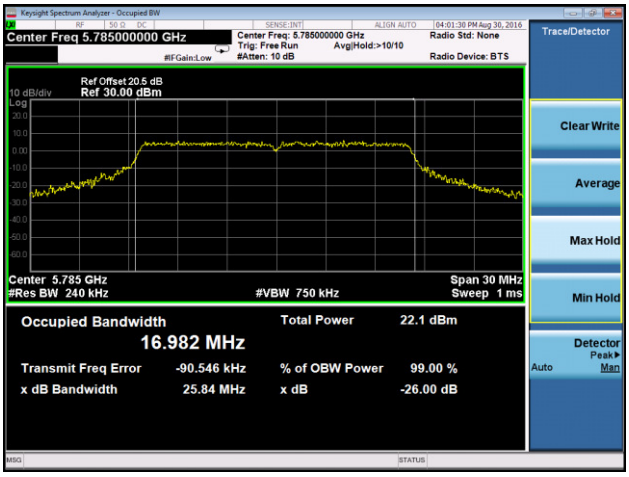


802.11a 26dB Bandwidth & 99% Bandwidth - Ant 1

Channel 149 (5745MHz)



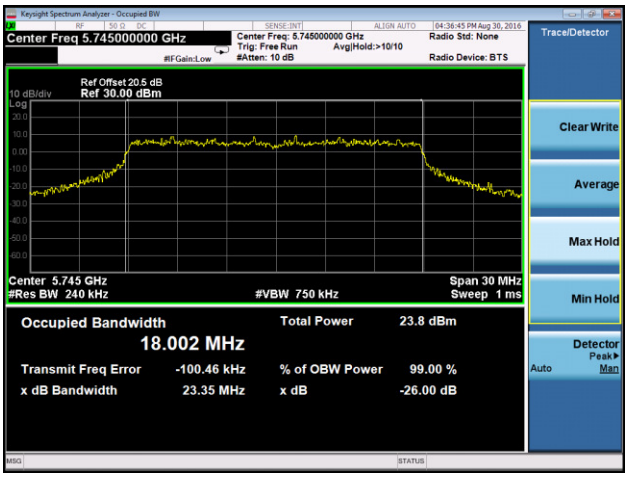
Channel 157 (5785MHz)



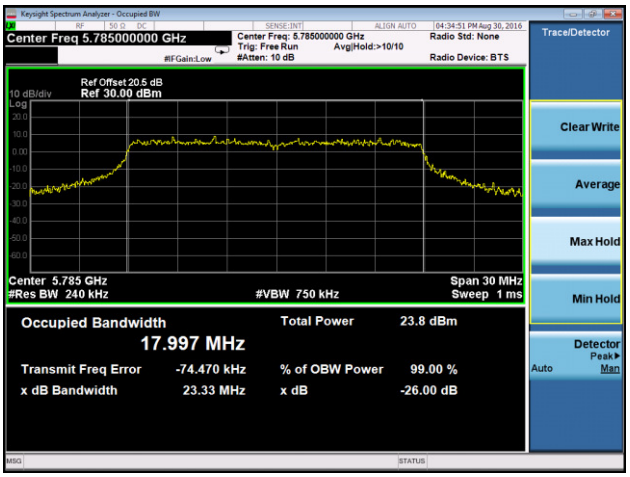
Channel 165 (5825MHz)

802. 11n-HT20 26dB Bandwidth & 99% Bandwidth - Ant 0 / Ant 0 + 1

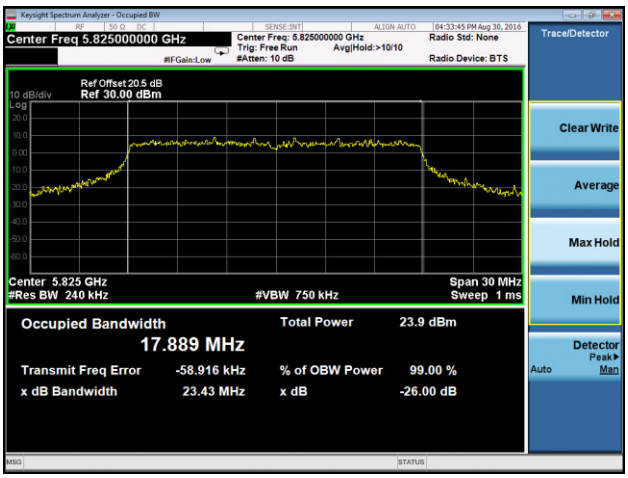
Channel 149 (5745MHz)



Channel 157 (5785MHz)

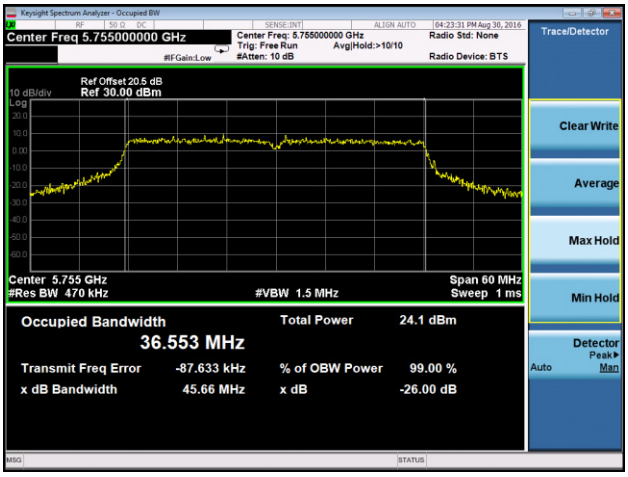


Channel 165 (5825MHz)



802. 11n-HT40 26dB Bandwidth & 99% Bandwidth - Ant 0 / Ant 0 + 1

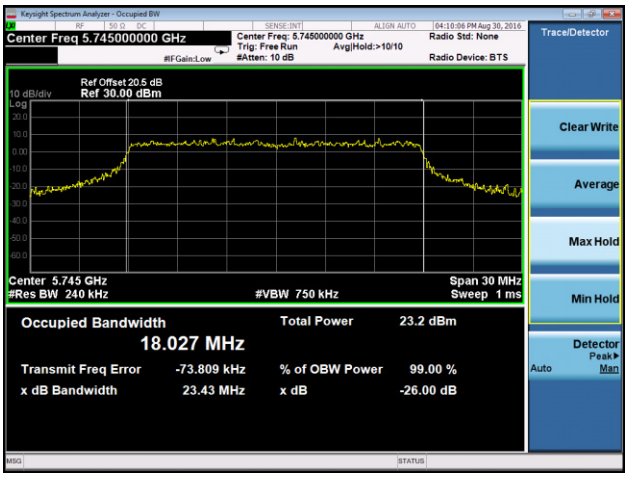
Channel 151 (5755MHz)



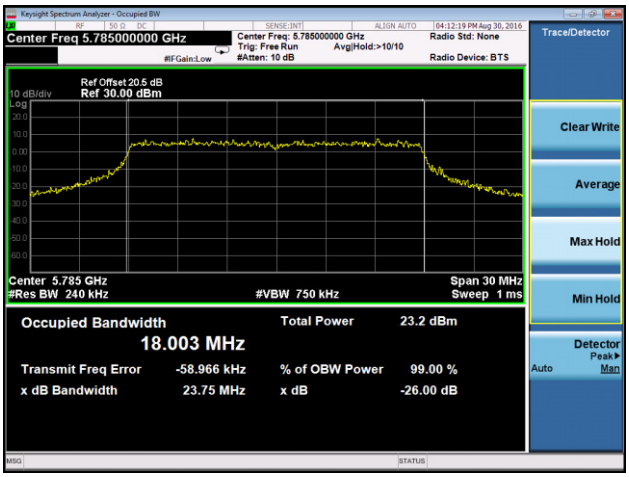
Channel 159 (5795MHz)

802. 11n-HT20 26dB Bandwidth & 99% Bandwidth - Ant 1 / Ant 0 + 1

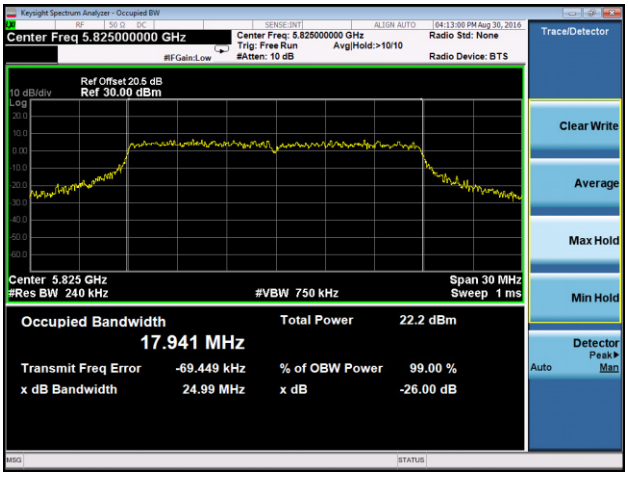
Channel 149 (5745MHz)



Channel 157 (5785MHz)



Channel 165 (5825MHz)



802. 11n-HT40 26dB Bandwidth & 99% Bandwidth - Ant 1 / Ant 0 + 1	
Channel 151 (5755MHz)	**Channel 159 (5795MHz)**

7.3. 6dB Bandwidth Measurement

7.3.1. Test Limit

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

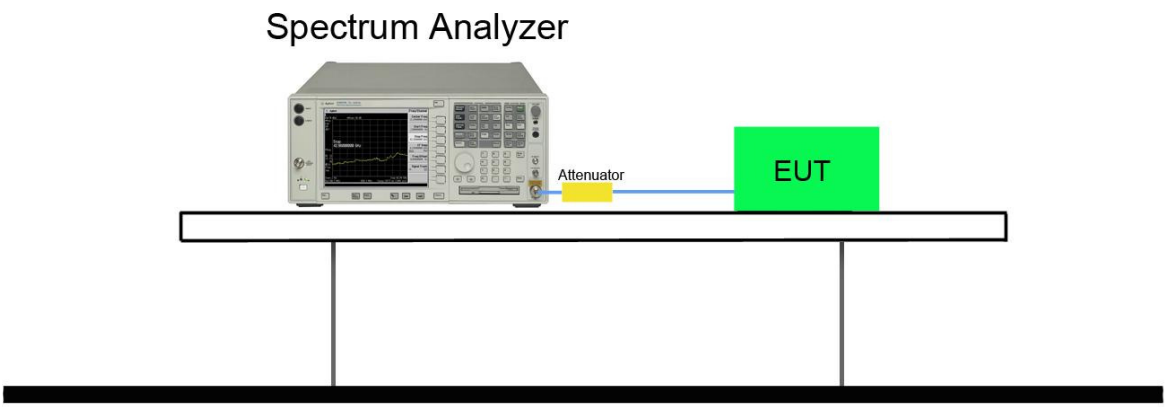
7.3.2. Test Procedure used

KDB 789033 D02v01r03 – Section C.2

7.3.3. Test Setting

1. Set center frequency to the nominal EUT channel center frequency.
2. RBW = 100 kHz.
3. VBW ≧ 3 × RBW.
4. Detector = Peak.
5. Trace mode = max hold.
6. Sweep = auto couple.
7. Allow the trace to stabilize.
8. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

7.3.4. Test Setup



7.3.5. Test Result

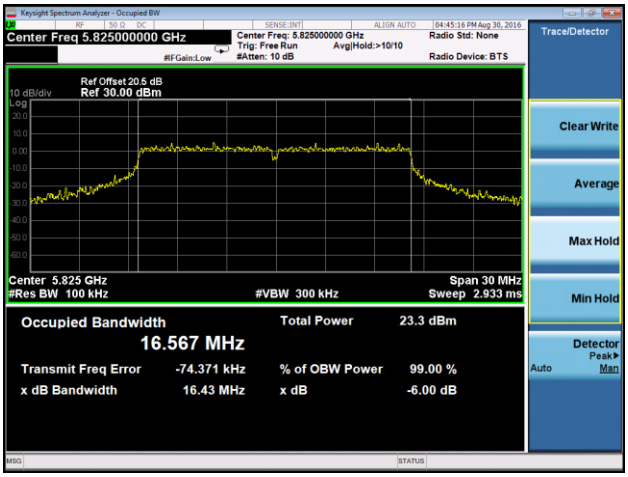
Test Mode	Data Rate (Mbps)	Channel No.	Frequency (MHz)	6dB Bandwidth (MHz)	Limit (MHz)	Result
Ant 0						
802.11a	6	149	5745	16.37	≥ 0.5	Pass
802.11a	6	157	5785	16.41	≥ 0.5	Pass
802.11a	6	165	5825	16.43	≥ 0.5	Pass
Ant 1						
802.11a	6	149	5745	16.36	≥ 0.5	Pass
802.11a	6	157	5785	16.41	≥ 0.5	Pass
802.11a	6	165	5825	16.45	≥ 0.5	Pass
Ant 0 / Ant 0 + 1						
802.11n-HT20	13	149	5745	17.77	≥ 0.5	Pass
802.11n-HT20	13	157	5785	17.71	≥ 0.5	Pass
802.11n-HT20	13	165	5825	17.66	≥ 0.5	Pass
802.11n-HT40	27	151	5755	36.14	≥ 0.5	Pass
802.11n-HT40	27	159	5795	36.11	≥ 0.5	Pass
Ant 1 / Ant 0 + 1						
802.11n-HT20	13	149	5745	17.69	≥ 0.5	Pass
802.11n-HT20	13	157	5785	17.67	≥ 0.5	Pass
802.11n-HT20	13	165	5825	17.68	≥ 0.5	Pass
802.11n-HT40	27	151	5755	36.13	≥ 0.5	Pass
802.11n-HT40	27	159	5795	36.46	≥ 0.5	Pass

802.11a 6dB Bandwidth - Ant 0

Channel 149 (5745MHz)

Channel 157 (5785MHz)

Channel 165 (5825MHz)



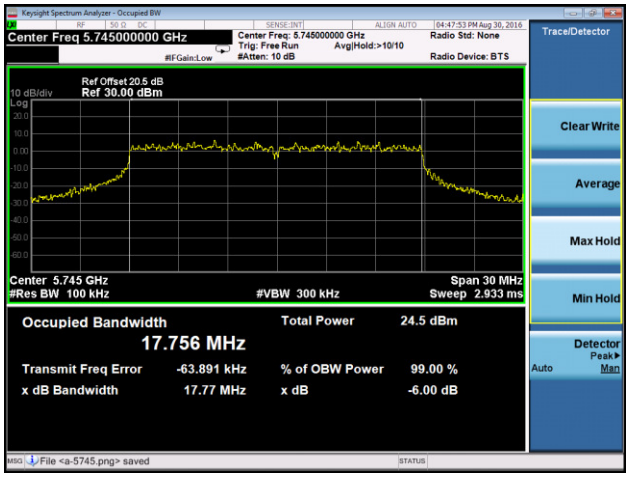
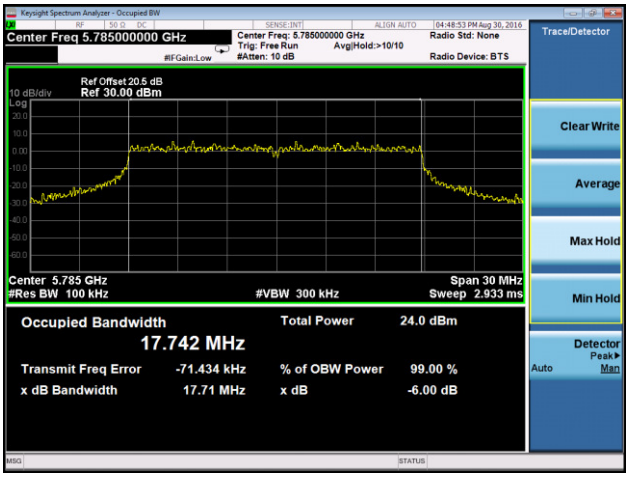
802.11a 6dB Bandwidth - Ant 1

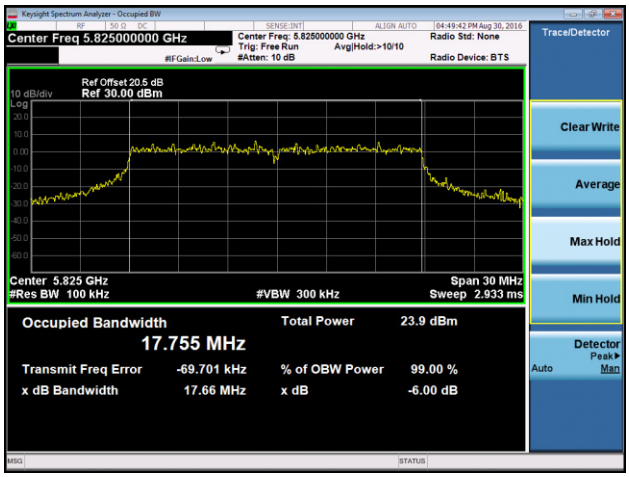
Channel 149 (5745MHz)

Channel 157 (5785MHz)

Channel 165 (5825MHz)	

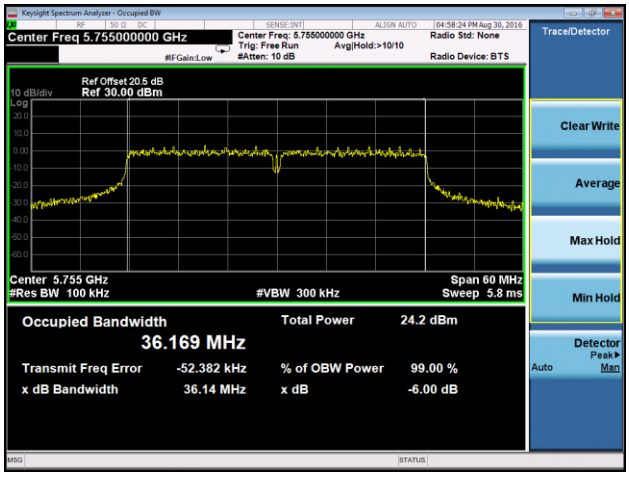
802.11n-HT20 6dB Bandwidth – Ant 0 / Ant 0 + 1

Channel 149 (5745MHz)	Channel 157 (5785MHz)
	

Channel 165 (5825MHz)	
	

802.11n-HT40 6dB Bandwidth - Ant 0 / Ant 0 + 1

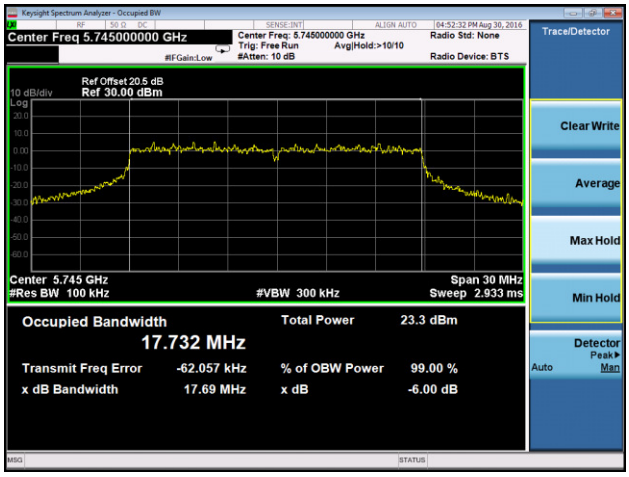
Channel 151 (5755MHz)



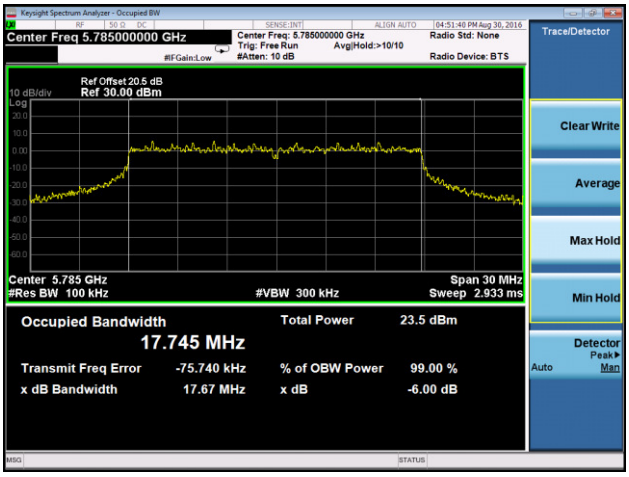
Channel 159 (5795MHz)

802.11n-HT20 6dB Bandwidth – Ant 1 / Ant 0 + 1

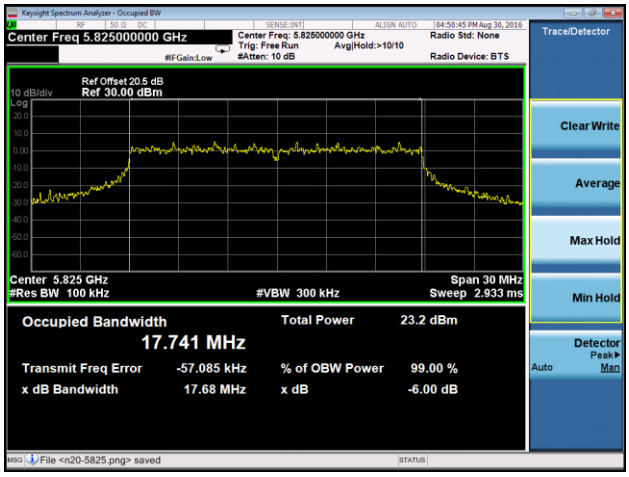
Channel 149 (5745MHz)

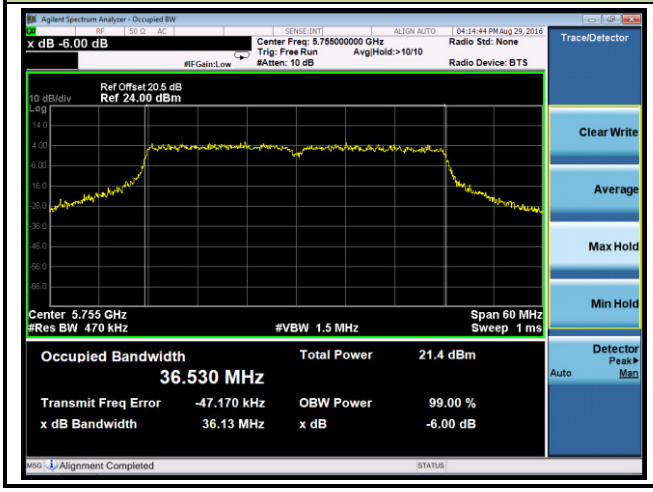
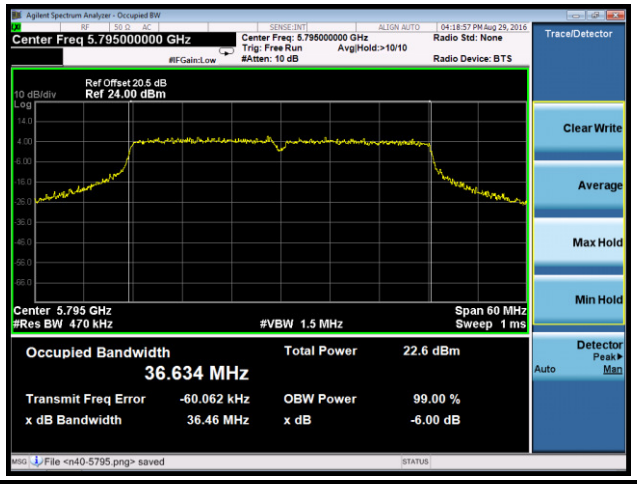


Channel 157 (5785MHz)



Channel 165 (5825MHz)



802.11n-HT40 6dB Bandwidth - Ant 1 / Ant 0 + 1	
Channel 151 (5755MHz)	**Channel 159 (5795MHz)**
	

7.4. Output Power Measurement

7.4.1. Test Limit

For the band 5.725-5.85 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W (30dBm).

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

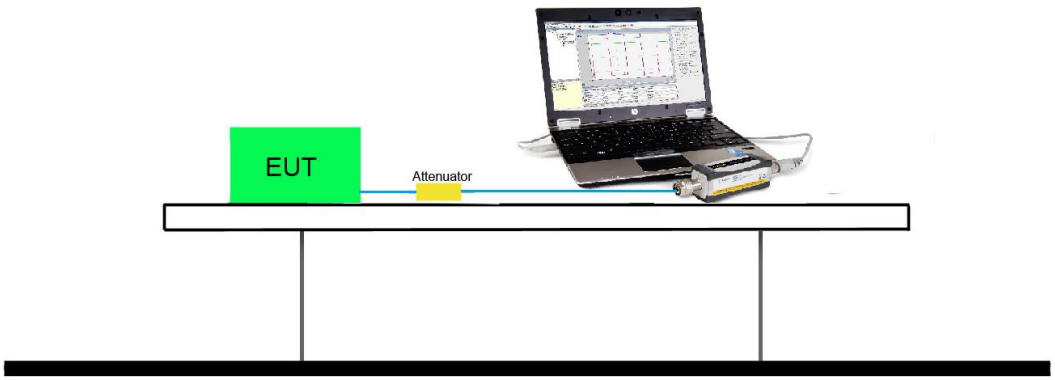
7.4.2. Test Procedure Used

KDB 789033 D02v01r03 - Section E) 3) b) Method PM-G

7.4.3. Test Setting

Average power measurements were perform only when the EUT was transmitting at its maximum power control level using a broadband power meter with a pulse sensor. The power meter implemented triggering and gating capabilities which were set up such that power measurements were recorded only during the ON time of the transmitter. The trace was averaged over 100 traces to obtain the final measured average power.

7.4.4. Test Setup



7.4.5. Test Result

Power output test was verified over all data rates of each mode shown as below, and then choose the maximum power output (yellow marker) for final test of each channel.

N_{Tx}	802.11a	MCS Index for 802.11n	Data Rate (Mbps)			
			20MHz Bandwidth		40MHz Bandwidth	
			800ns GI	400ns GI	800ns GI	400ns GI
1	6	0	6.5	7.2	13.5	15.0
1	9	1	13.0	14.4	27.0	30.0
1	12	2	19.5	21.7	40.5	45.0
1	18	3	26.0	28.9	54.0	60.0
1	24	4	39.0	43.3	81.0	90.0
1	36	5	52.0	57.8	108.0	120.0
1	48	6	58.5	65.0	121.5	135.0
1	54	7	65.0	72.2	135.0	150.0

N_{Tx}	MCS Index for 802.11n	Data Rate (Mbps)			
		20MHz Bandwidth		40MHz Bandwidth	
		800ns GI	400ns GI	800ns GI	400ns GI
2	8	13.0	14.4	27.0	30.0
2	9	26.0	28.9	54.0	60.0
2	10	39.0	43.3	81.0	90.0
2	11	52.0	57.8	108.0	120.0
2	12	78.0	86.7	162.0	180.0
2	13	104.0	115.6	216.0	240.0
2	14	117.0	130.0	243.0	270.0
2	15	130.0	144.0	270.0	300.0

Note: Power output test was verified over all data rates of each mode shown as above, and then choose the maximum power output (yellow marker) for final test of each channel.

Output power at various data rates:

Test Mode	Bandwidth	Channel	Frequency (MHz)	Data Rate (Mbps)	Average Power (dBm)
Ant 0					
802.11a	20	157	5785	6	20.68
				24	20.11
				54	19.56
Ant 0 / Ant 0 + 1					
802.11n	20	157	5785	13.0	19.64
				26.0	19.17
				39.0	18.65
				52.0	18.01
				78.0	17.78
				104.0	17.36
				117.0	16.97
				130.0	16.67
802.11n	40	157	5785	27.0	19.62
				54.0	19.13
				81.0	18.58
				108.0	18.14
				162.0	17.87
				216.0	17.32
				243.0	16.58
				270.0	16.08

1T$_X$

Test Mode	Data Rate (Mbps)	Channel No.	Freq. (MHz)	Average Power (dBm)	Average Power Limit (dBm)	Result
Ant 0						
11a	6	149	5745	20.23	≤ 30.00	Pass
11a	6	157	5785	20.68	≤ 30.00	Pass
11a	6	165	5825	20.17	≤ 30.00	Pass
Ant 1						
11a	6	149	5745	20.15	≤ 30.00	Pass
11a	6	157	5785	19.87	≤ 30.00	Pass
11a	6	165	5825	19.71	≤ 30.00	Pass

2T$_X$

Test Mode	Data Rate (Mbps)	Channel No.	Freq. (MHz)	Ant 0 Average Power (dBm)	Ant 1 Average Power (dBm)	Total Average Power (dBm)	Average Power Limit (dBm)	Result
11n-HT20	13	149	5745	19.88	19.26	22.59	≤ 30.00	Pass
11n-HT20	13	157	5785	19.64	19.22	22.45	≤ 30.00	Pass
11n-HT20	13	165	5825	19.74	19.36	22.56	≤ 30.00	Pass
11n-HT40	27	151	5755	19.62	19.52	22.58	≤ 30.00	Pass
11n-HT40	27	159	5795	19.41	19.07	22.25	≤ 30.00	Pass

Note: The Total Average Power (dBm) = $10*\log\{10^{(\text{Ant 0 Average Power /10})} + 10^{(\text{Ant 1 Average Power /10})}\}$.

7.5. Power Spectral Density Measurement

7.5.1. Test Limit

For the band 5.725-5.85 GHz, the maximum power spectral density shall not exceed 30 dBm in any 500-kHz band.

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

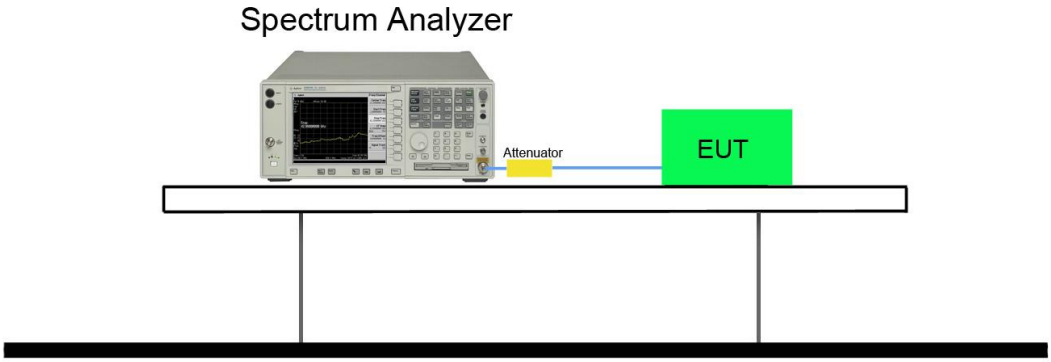
7.5.2. Test Procedure Used

KDB 789033 D02v01r03 - Section F

7.5.3. Test Setting

1. Analyzer was set to the center frequency of the UNII channel under investigation
2. Span was set to encompass the entire 26dB EBW of the signal.
3. RBW = 1MHz, if measurement bandwidth of Maximum PSD is specified in 500 kHz, RBW = 100 kHz
4. VBW = 3MHz
5. Number of sweep points ≥ 2 × (span / RBW)
6. Detector = power averaging (Average)
7. Sweep time = auto
8. Trigger = free run
9. Use the peak search function on the instrument to find the peak of the spectrum and record its value.
10. Add 10*log(1/x), where x is the duty cycle, to the measured power in order to compute the average power during the actual transmission times (because the measurement represents an average over both the on and off times of the transmission). For example, add 10*log(1/0.25) = 6 dB if the duty cycle is 25 percent.
11. When the measurement bandwidth of Maximum PSD is specified in 500 kHz, add a constant factor 10*log(500kHz/100kHz) = 7 dB to the measured result

7.5.4. Test Setup



7.5.5. Test Result

1T$_X$

Test Mode	Data Rate (Mbps)	Channel No.	Freq. (MHz)	PSD (dBm/ 100kHz)	Duty Cycle (%)	Constant Factor	Total PSD (dBm/ 500kHz)	Limit (dBm/ 500kHz)	Result
Ant 0									
11a	6	149	5745	0.43	99.37	7	7.43	≤ 30.00	Pass
11a	6	157	5785	0.47	99.37	7	7.47	≤ 30.00	Pass
11a	6	165	5825	0.67	99.37	7	7.67	≤ 30.00	Pass
Ant 1									
11a	6	149	5745	-1.06	99.37	7	5.94	≤ 30.00	Pass
11a	6	157	5785	-0.79	99.37	7	6.21	≤ 30.00	Pass
11a	6	165	5825	-1.27	99.37	7	5.73	≤ 30.00	Pass

Note: When EUT duty cycle < 98%, Total PSD (dBm/500kHz) = PSD (dBm/100kHz) + 10*Log(1/duty cycle) + Constant Factor.

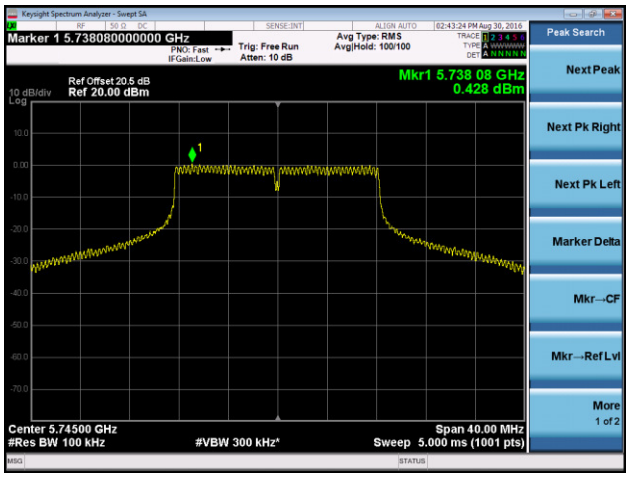
2T$_X$

Test Mode	Data Rate (Mbps)	Channel No.	Freq. (MHz)	Ant 0 PSD (dBm/ 100kHz)	Ant 1 PSD (dBm/ 100kHz)	Duty Cycle (%)	Constant Factor	Total PSD (dBm/ 500kHz)	Limit (dBm/ 500kHz)	Result
Ant 0 + 1										
11n-HT20	13	149	5745	0.38	-0.81	99.49	7	9.84	≤ 27.99	Pass
11n-HT20	13	157	5785	0.01	-0.88	99.49	7	9.60	≤ 27.99	Pass
11n-HT20	13	165	5825	-0.03	-1.38	99.49	7	9.36	≤ 27.99	Pass
11n-HT40	27	151	5755	-2.05	-3.44	97.75	7	7.42	≤ 27.99	Pass
11n-HT40	27	159	5795	-2.70	-3.53	97.75	7	7.01	≤ 27.99	Pass

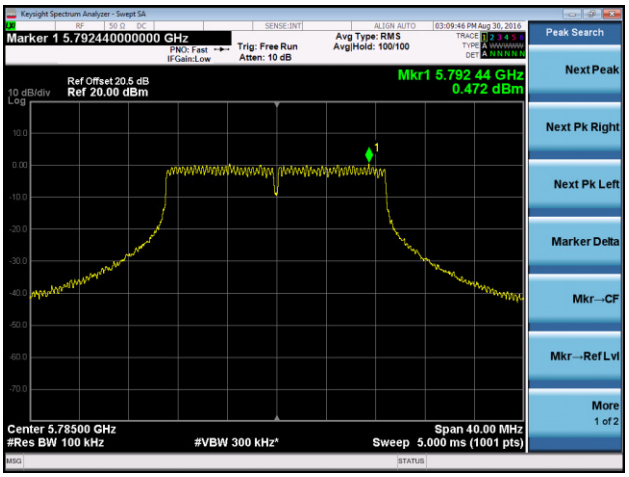
Note: When EUT duty cycle < 98%, Total PSD (dBm/500kHz) = $10*\log\{10^{(\text{Ant 0 PSD}/10)} + 10^{(\text{Ant 1 PSD}/10)}\}$ + 10*log(1/duty cycle) + Constant Factor.

802.11a Power Spectral Density - Ant 0

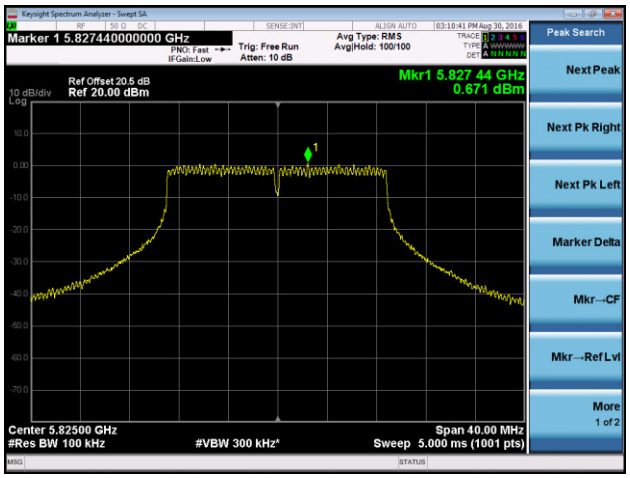
Channel 149 (5745MHz)



Channel 157 (5785MHz)

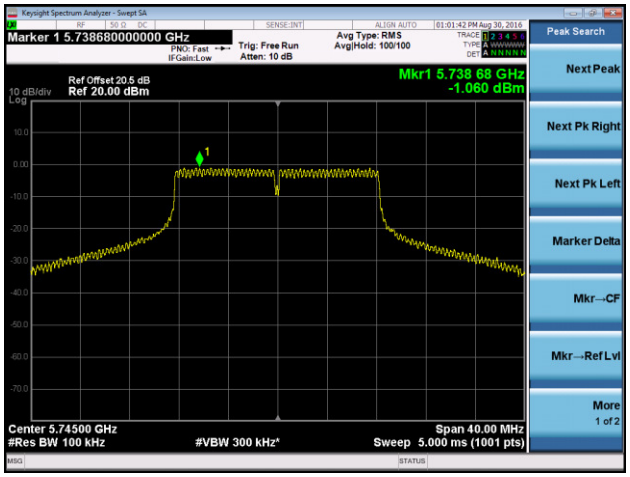


Channel 165 (5825MHz)

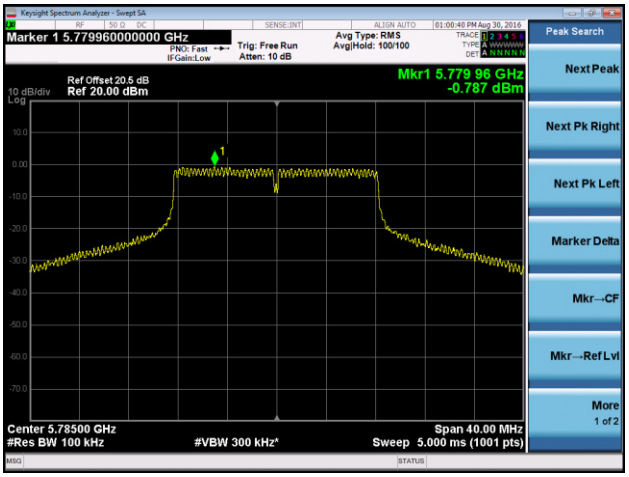


802.11a Power Spectral Density - Ant 1

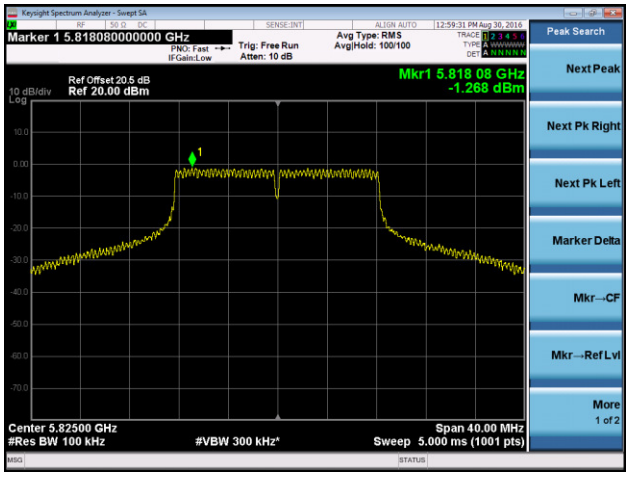
Channel 149 (5745MHz)



Channel 157 (5785MHz)

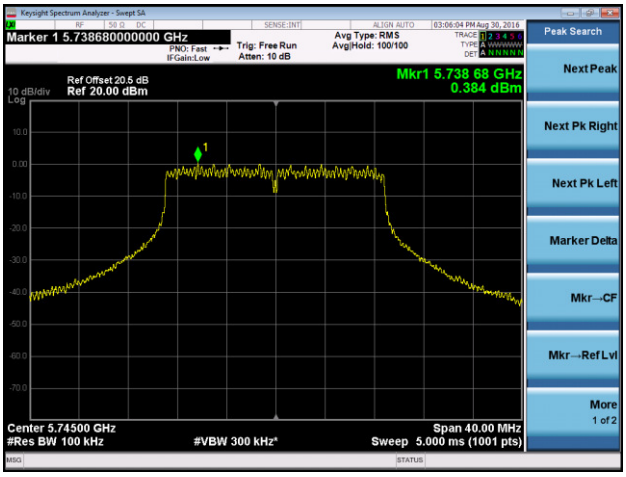


Channel 165 (5825MHz)

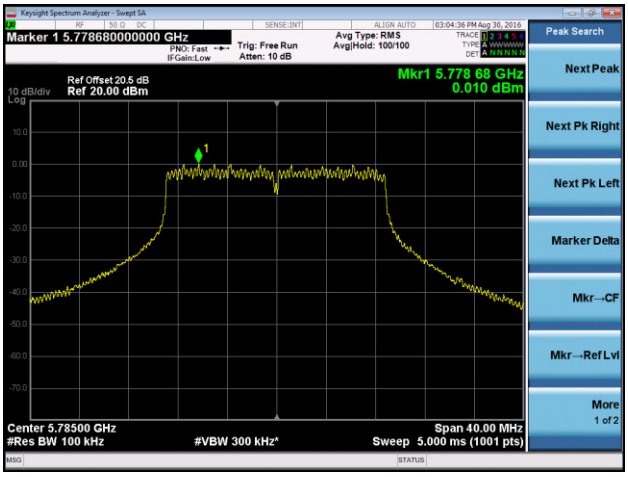


802.11n-HT20 Power Spectral Density - Ant 0 / Ant 0 + 1

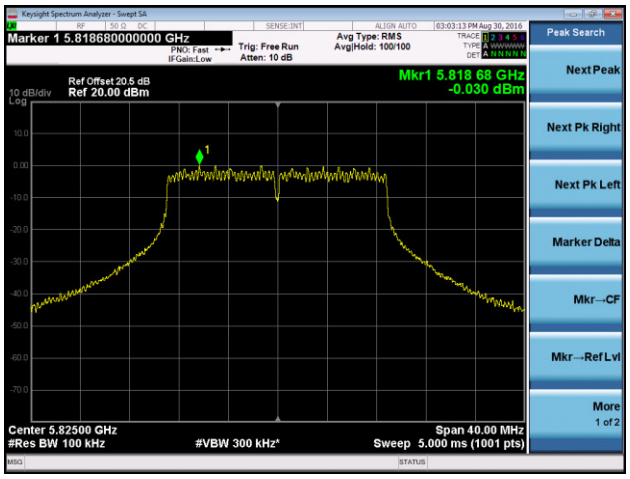
Channel 149 (5745MHz)



Channel 157 (5785MHz)

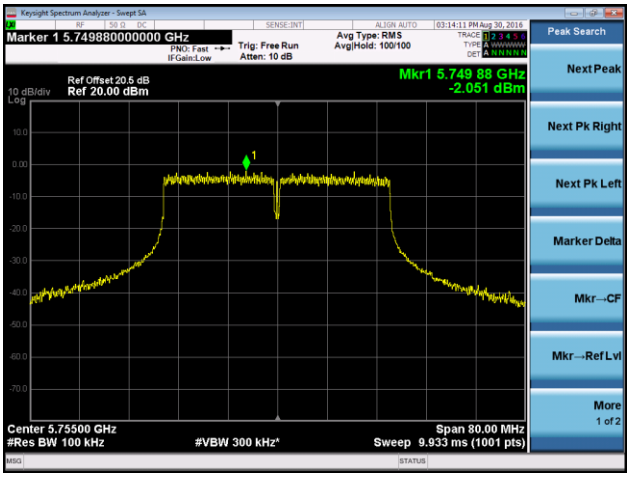


Channel 165 (5825MHz)

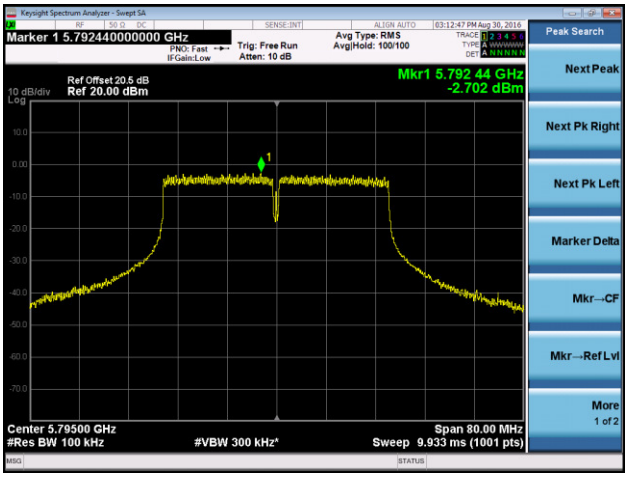


802.11n-HT40 Power Spectral Density - Ant 0 / Ant 0 + 1

Channel 151 (5755MHz)

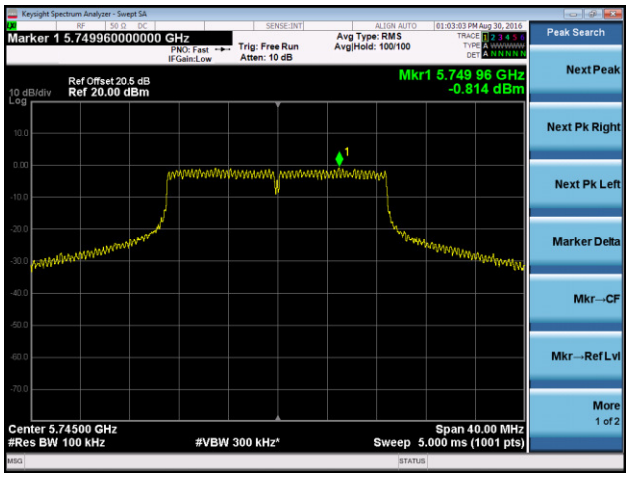


Channel 159 (5795MHz)

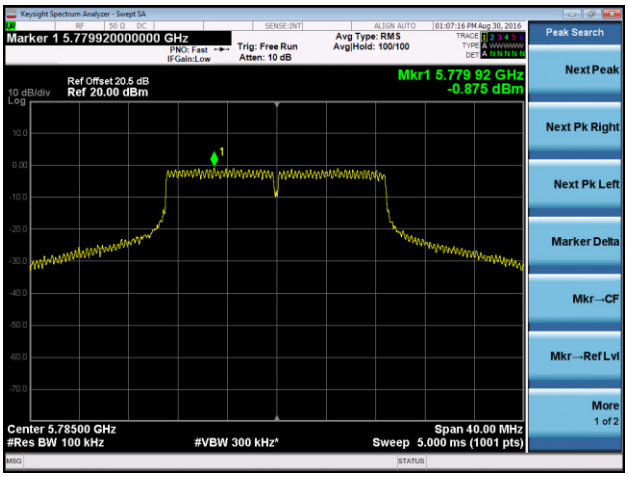


802.11n-HT20 Power Spectral Density - Ant 1 / Ant 0 + 1

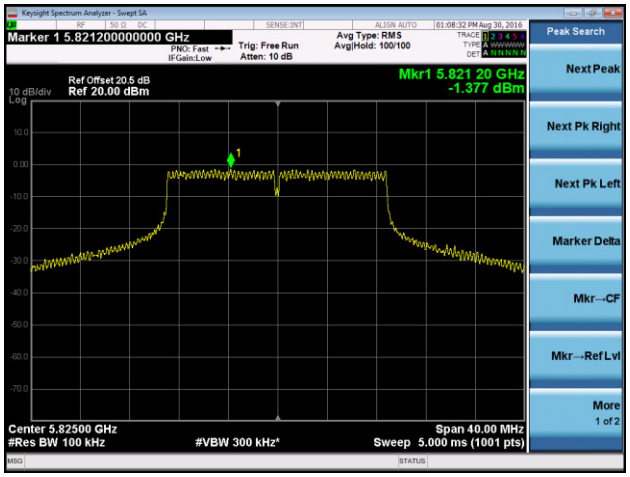
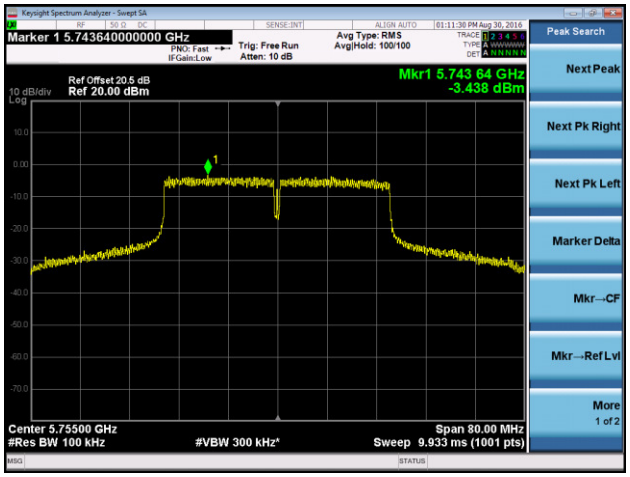
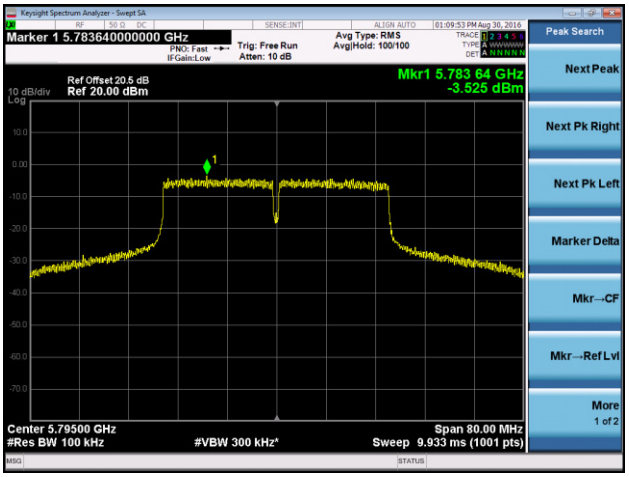
Channel 149 (5745MHz)



Channel 157 (5785MHz)



Channel 165 (5825MHz)



802.11n-HT40 Power Spectral Density - Ant 1 / Ant 0 + 1	
Channel 151 (5755MHz)	**Channel 159 (5795MHz)**