



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

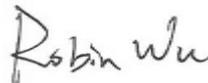
FCC Classification: Unlicensed National Information Infrastructure (UNII)

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)

Approved By
CEO

: 

(Marlin Chen)



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 |
| | | | | |

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§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 <input type="checkbox"/> Production <input checked="" type="checkbox"/> Pre-Production <input type="checkbox"/> 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.



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 | <p>2.4GHz: For 802.11b/g/n-HT20: 2412 ~ 2462 MHz For 802.11n-HT40: 2422 ~ 2452 MHz</p> <p>5GHz: For 802.11a/n-HT20: 5745~5825MHz For 802.11n-HT40: 5755~5795MHz</p> |
| 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, $N_{ANT} = 2$, $N_{SS} = 1$.

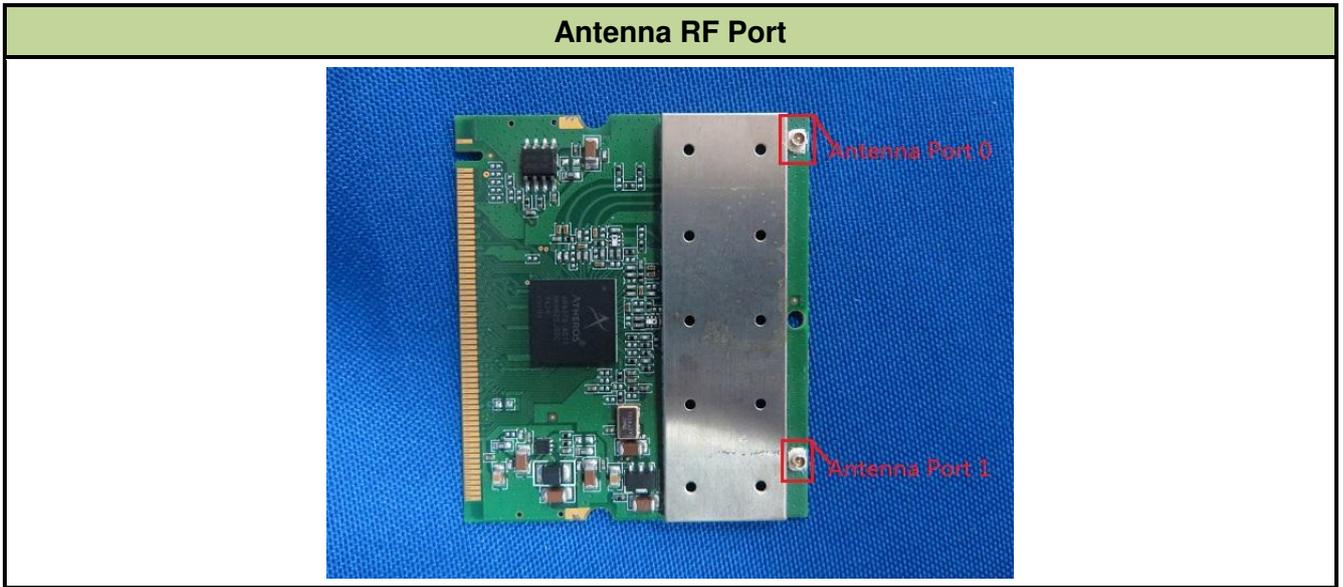
1. If all antennas have the same gain, G_{ANT} , Directional gain = $G_{ANT} + \text{Array Gain}$, where Array Gain is as follows.
 - For power spectral density (PSD) measurements on all devices, Array Gain = $10 \log (N_{ANT}/ N_{SS})$ dB = 3.01;
 - For power measurements on IEEE 802.11 devices, Array Gain = 0 dB for $N_{ANT} \leq 4$;
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;

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

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



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

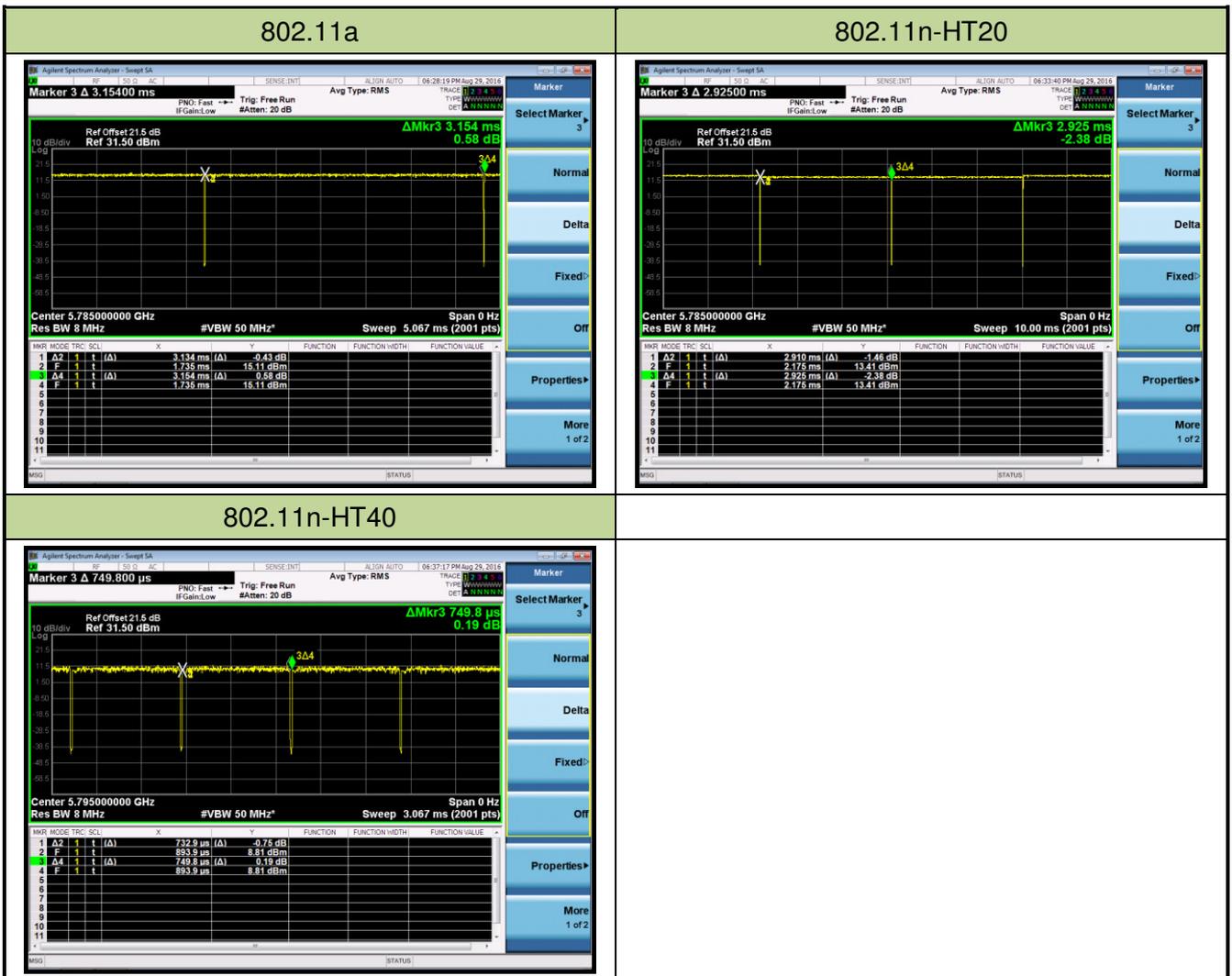
The test utility software used during testing was “ART”, and the version was “v09 b27”.

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% |



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

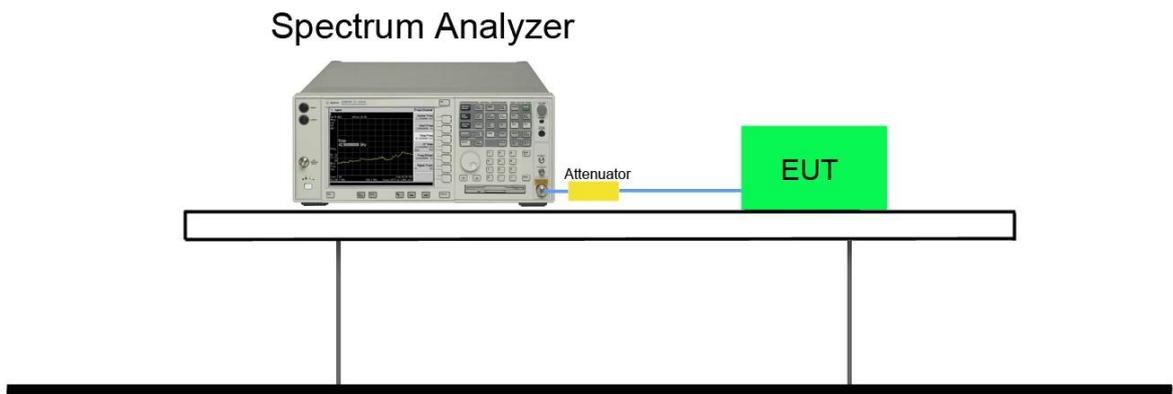
7.2.2. Test Procedure used

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 $\geq 3 \times$ 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)

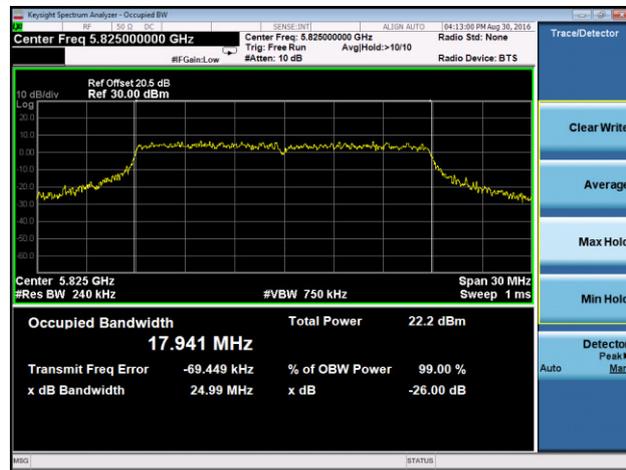


802. 11n-HT40 26dB Bandwidth & 99% Bandwidth - Ant 0 / Ant 0 + 1
Channel 151 (5755MHz)

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.

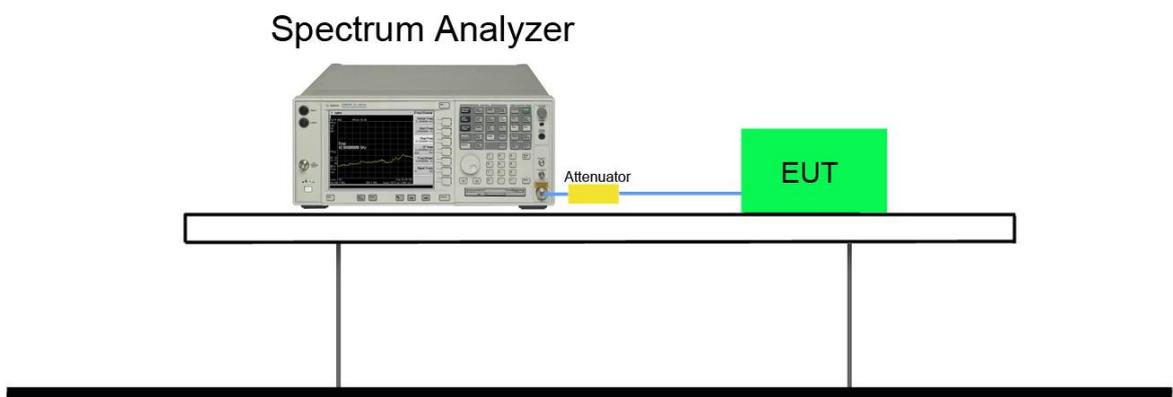
7.3.2. Test Procedure used

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 $\geq 3 \times$ 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)

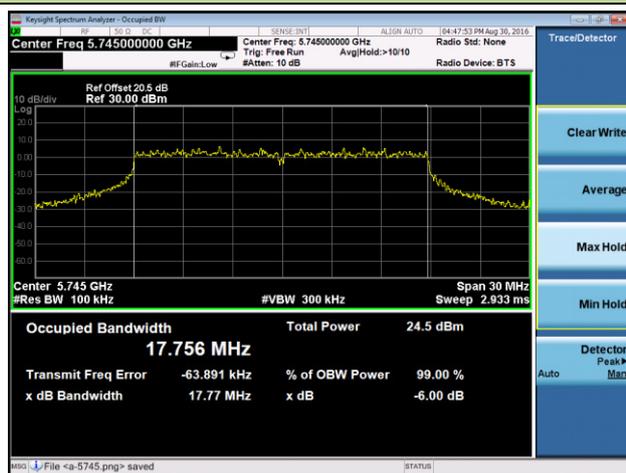
Channel 157 (5785MHz)


Channel 165 (5825MHz)

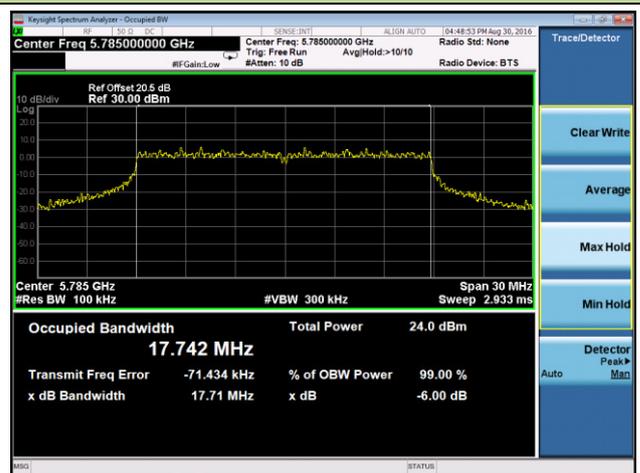


802.11n-HT20 6dB Bandwidth – Ant 0 / Ant 0 + 1

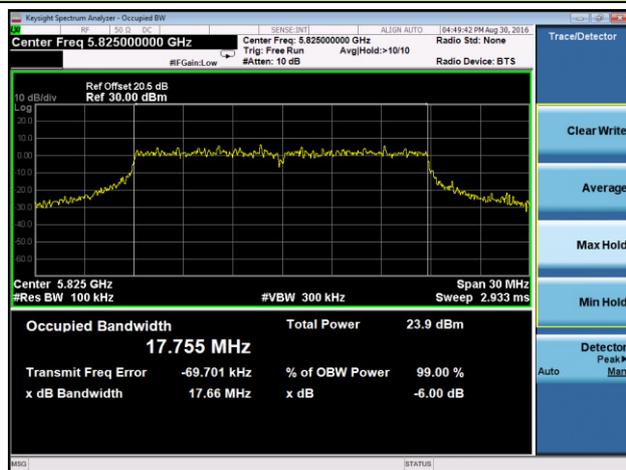
Channel 149 (5745MHz)



Channel 157 (5785MHz)

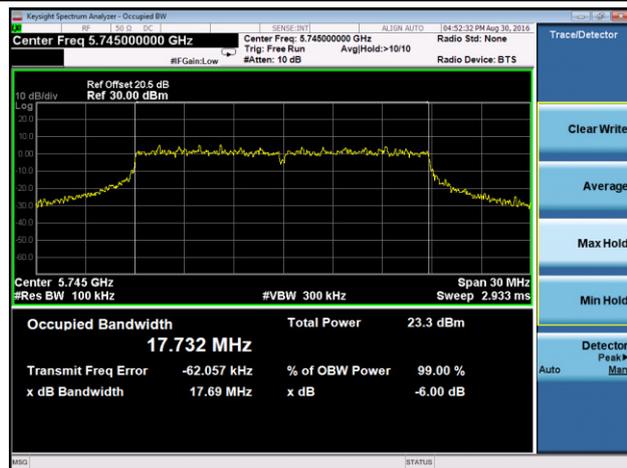
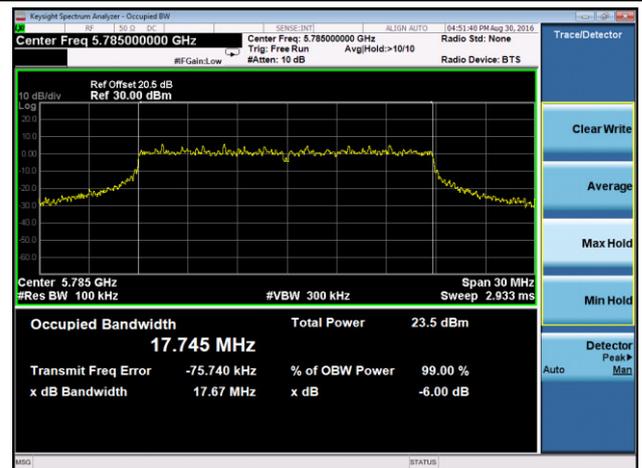


Channel 165 (5825MHz)



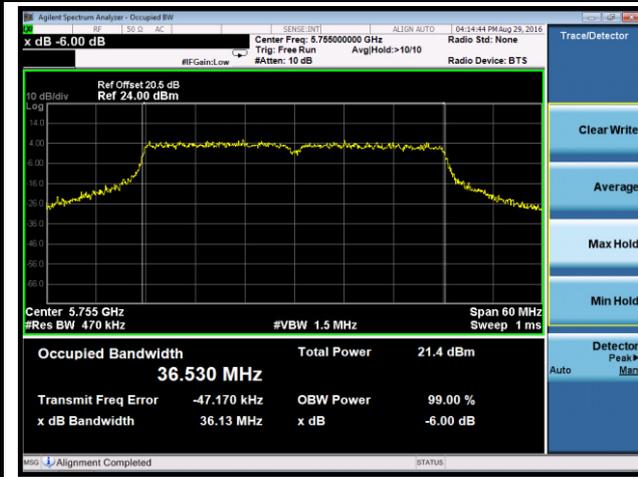
802.11n-HT40 6dB Bandwidth - Ant 0 / Ant 0 + 1
Channel 151 (5755MHz)

Channel 159 (5795MHz)

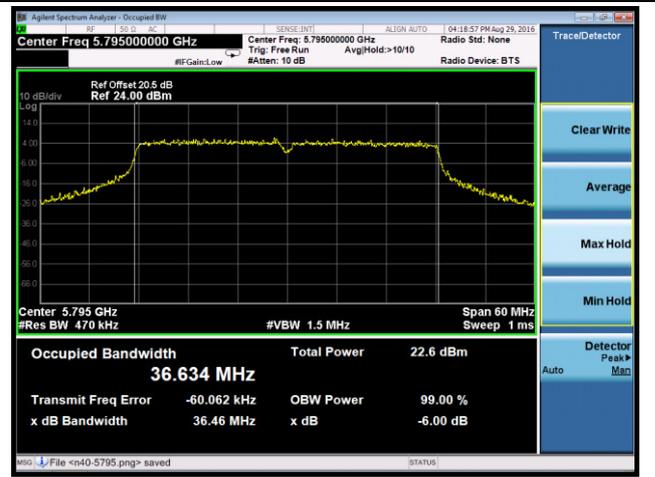
802.11n-HT20 6dB Bandwidth - Ant 1 / Ant 0 + 1
Channel 149 (5745MHz)

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.

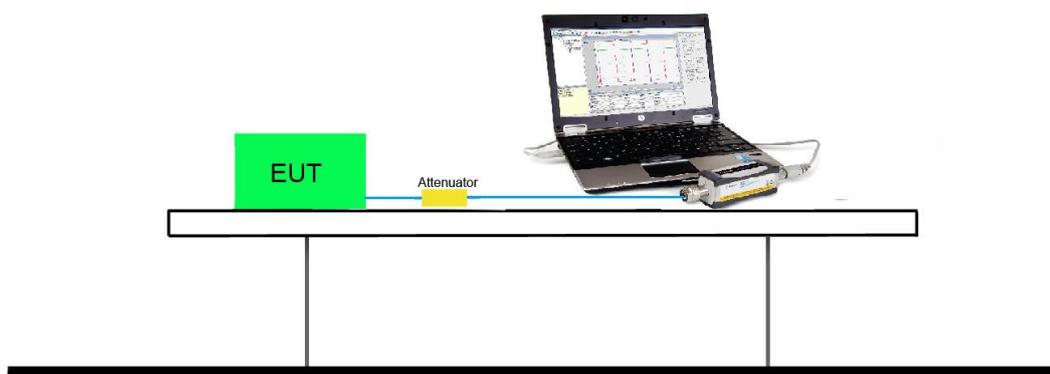
7.4.2. Test Procedure Used

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

7.4.3. Test Setting

Average power measurements were performed 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 |

1Tx

| 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 |

2Tx

| 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) = $10 \cdot \log\{10^{(\text{Ant 0 Average Power} / 10)} + 10^{(\text{Ant 1 Average Power} / 10)}\}$.

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.

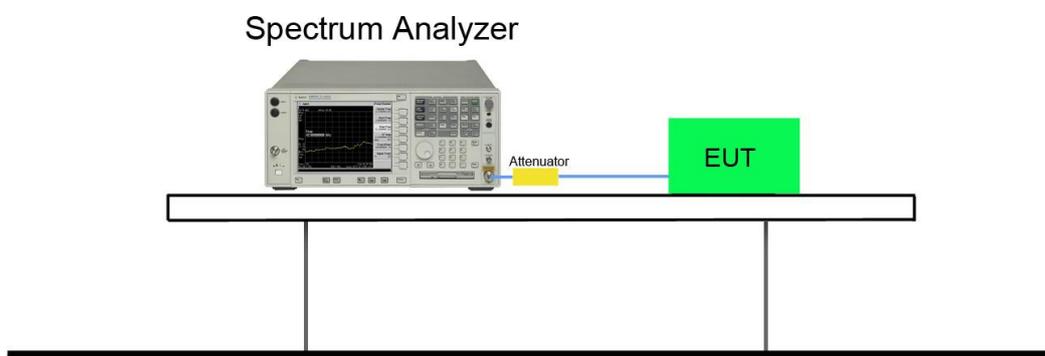
7.5.2. Test Procedure Used

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 $\geq 2 \times (\text{span} / \text{RBW})$
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 $10 \cdot \log(1/x)$, 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 $10 \cdot \log(1/0.25) = 6$ 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 $10 \cdot \log(500\text{kHz}/100\text{kHz}) = 7$ dB to the measured result

7.5.4. Test Setup



7.5.5. Test Result

1Tx

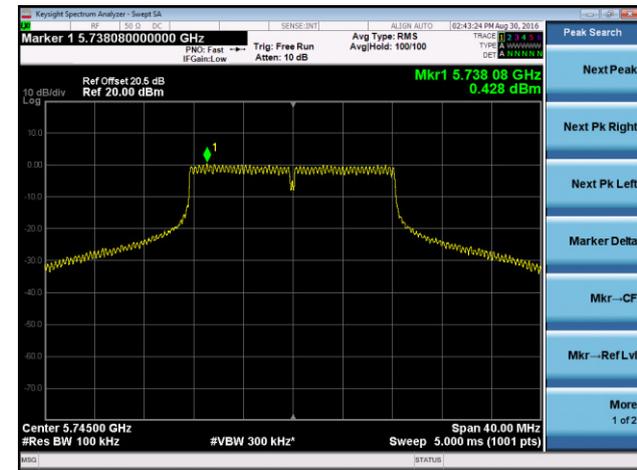
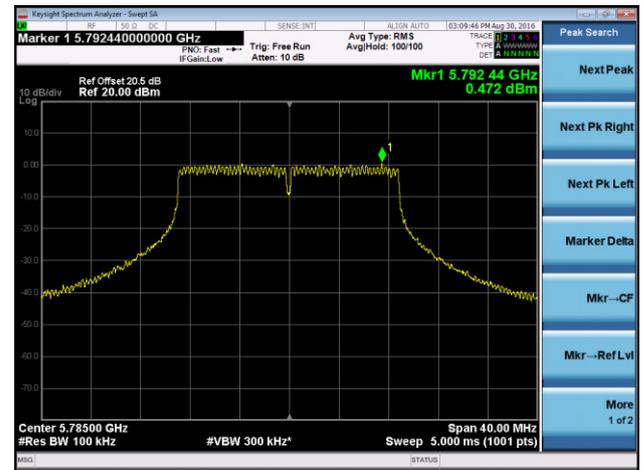
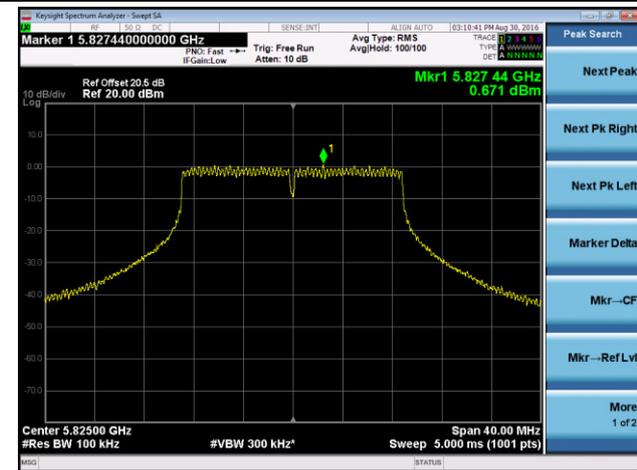
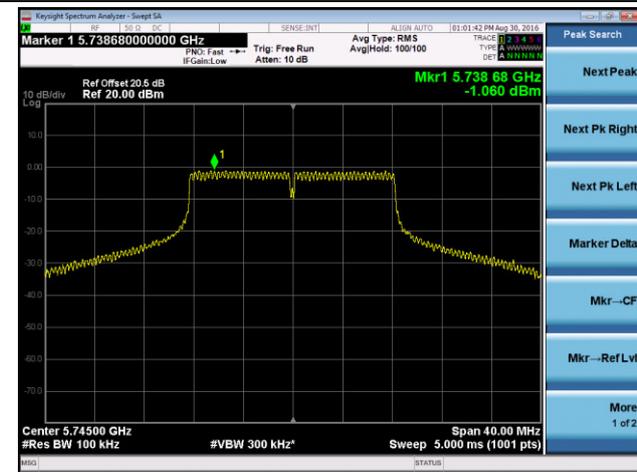
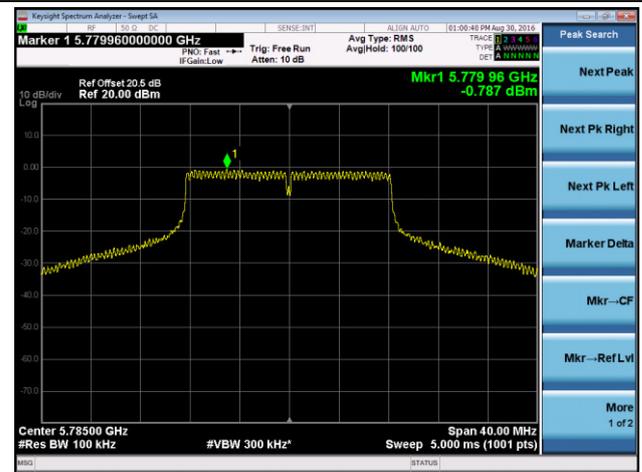
| Test Mode | Data Rate (Mbps) | Channel No. | Freq. (MHz) | PSD (dBm/100kHz) | Duty Cycle (%) | Constant Factor | Total PSD (dBm/500kHz) | Limit (dBm/500kHz) | Result |
|--------------|------------------|-------------|-------------|------------------|----------------|-----------------|------------------------|--------------------|--------|
| 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.

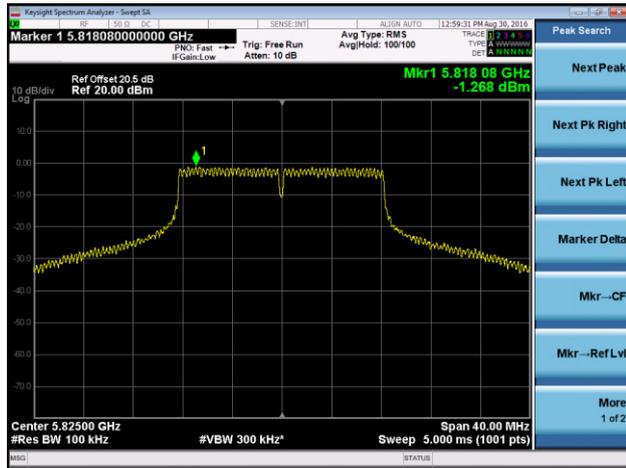
2Tx

| 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) = $10 \cdot \log\{10^{(\text{Ant 0 PSD}/10)} + 10^{(\text{Ant 1 PSD}/10)}\} + 10 \cdot \log(1/\text{duty cycle}) + \text{Constant Factor}$.

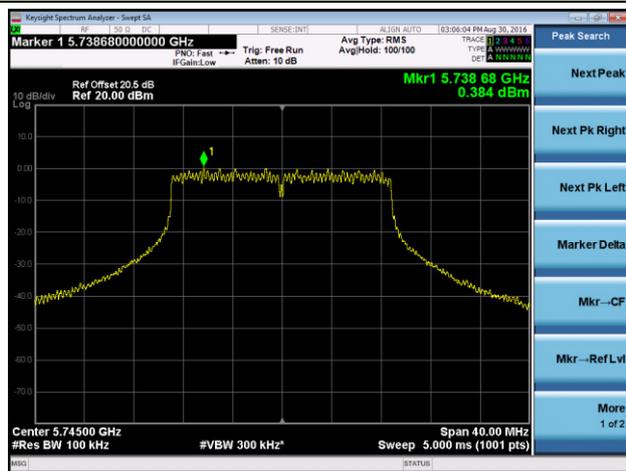
802.11a Power Spectral Density - Ant 0
Channel 149 (5745MHz)

Channel 157 (5785MHz)

Channel 165 (5825MHz)

802.11a Power Spectral Density - Ant 1
Channel 149 (5745MHz)

Channel 157 (5785MHz)


Channel 165 (5825MHz)

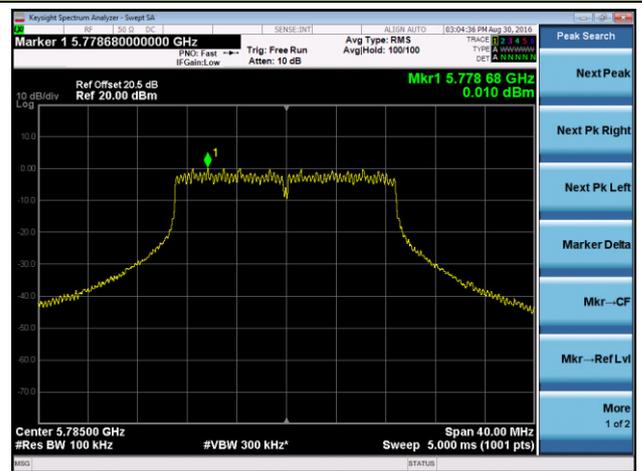


802.11n-HT20 Power Spectral Density - Ant 0 / Ant 0 + 1

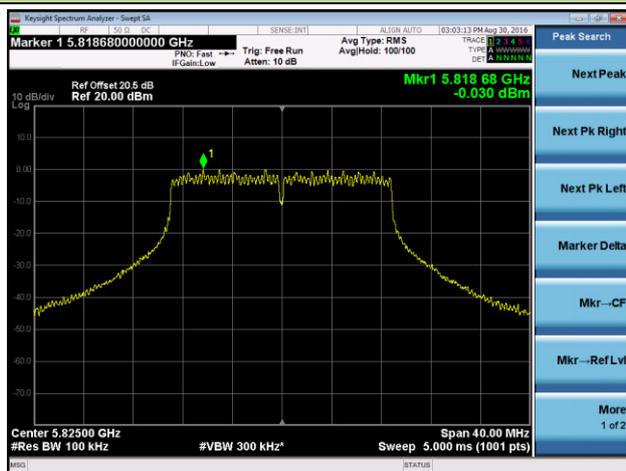
Channel 149 (5745MHz)



Channel 157 (5785MHz)

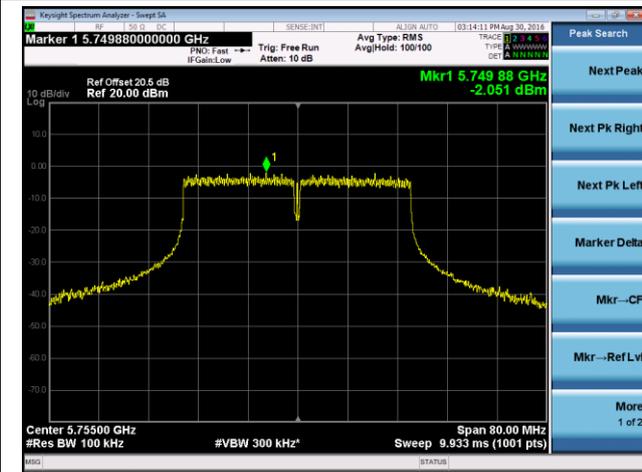


Channel 165 (5825MHz)

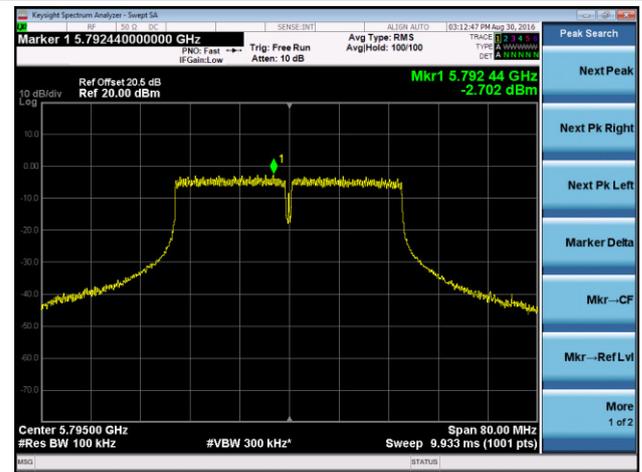


802.11n-HT40 Power Spectral Density - Ant 0 / Ant 0 + 1

Channel 151 (5755MHz)

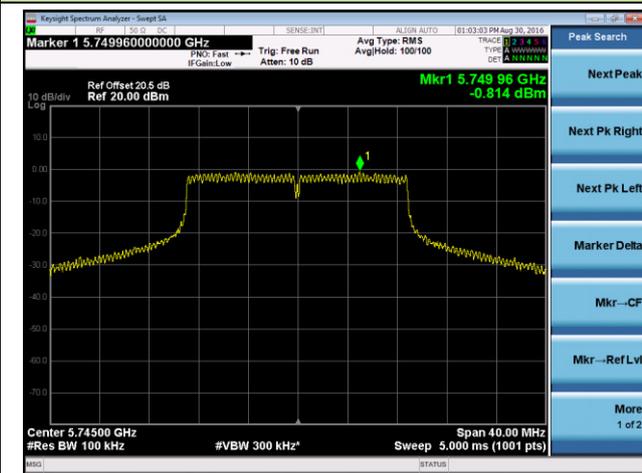


Channel 159 (5795MHz)

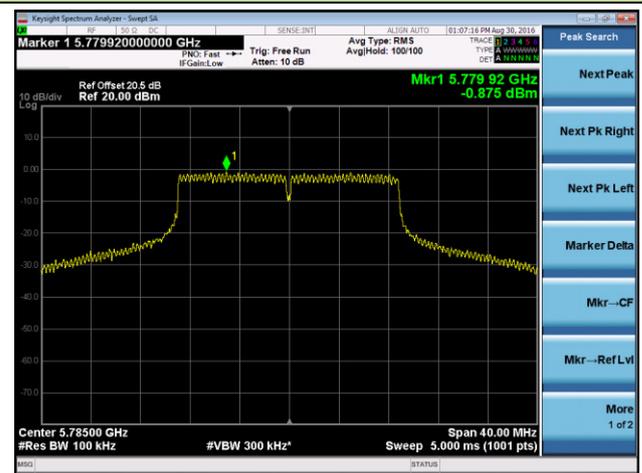


802.11n-HT20 Power Spectral Density - Ant 1 / Ant 0 + 1

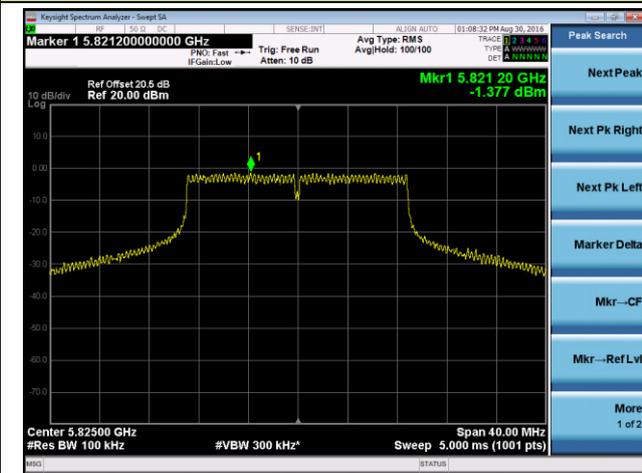
Channel 149 (5745MHz)



Channel 157 (5785MHz)

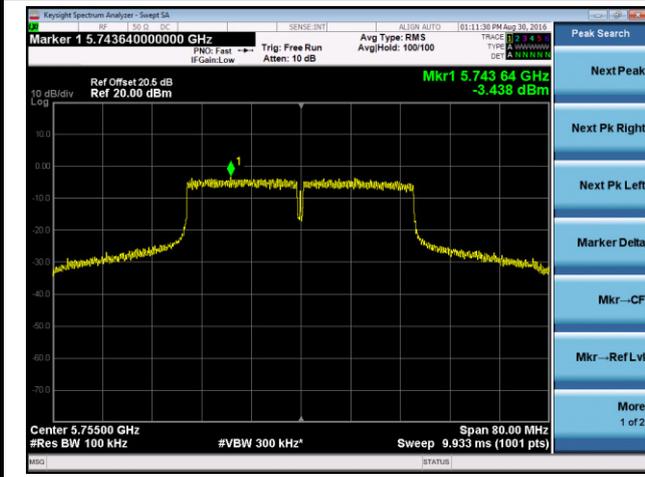


Channel 165 (5825MHz)



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

Channel 151 (5755MHz)



Channel 159 (5795MHz)

