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# Johnson Controls, Inc.

# RF TEST REPORT

**Report Type:**
FCC Part 15.247 & ISED RSS-247 RF report

**Model:**
FW-VAV

**REPORT NUMBER:**
210902556SHA-001

**ISSUE DATE:**
June 27, 2022

**DOCUMENT CONTROL NUMBER:**
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Intertek Testing Services Shanghai
Building No.86, 1198 Qinzhou Road (North)
Caohejing Development Zone
Shanghai 200233, China

Telephone: 86 21 6127 8200
www.intertek.com

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# TEST REPORT

Report no.: 210902556SHA-001

| | |
|---|---|
| **Applicant:** | Johnson Controls, Inc.<br>507 E Michigan St, Milwaukee, Wisconsin, United States |
| **Manufacturer:** | Johnson Controls, Inc.<br>507 E Michigan St, Milwaukee, Wisconsin, United States |
| **Factory** | Johnson Controls Air Conditioning and Refrigeration (Wuxi) Co., Ltd.<br>No.22 Block D, New District, Wuxi, Jiangsu Province, China |
| **FCC ID:** | OEJ-FWVAV |
| **IC:** | 279A-FWVAV |

**SUMMARY:**

| The equipment complies with the requirements according to the following standard(s) or Specification: |
|---|
| **47CFR Part 15 (2020):** Radio Frequency Devices (Subpart C)<br><br>**ANSI C63.10 (2013):** American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices<br><br>**RSS-247 Issue 2 (February 2017):** Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices<br><br>**RSS-Gen Issue 5 (March 2019) Amendment 1:** General Requirements for Compliance of Radio Apparatus |

| **PREPARED BY:** | **REVIEWED BY:** |
|---|---|
| Project Engineer<br>Eric Li | Reviewer<br>Wakeyou Wang |

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# Revision History

| Report No. | Version | Description | Issued Date |
|---|---|---|---|
| 210902556SHA-001 | Rev. 01 | Initial issue of report | June 27, 2022 |
| | | | |
| | | | |

# Measurement result summary

| TEST ITEM | FCC REFERANCE | IC REFERANCE | RESULT |
|---|---|---|---|
| Minimum 6dB Bandwidth | 15.247(a)(2) | RSS-247 Issue 2 Clause 5.2 | Pass |
| Maximum conducted output power and e.i.r.p. | 15.247(b)(3) | RSS-247 Issue 2 Clause 5.4 | Pass |
| Power spectrum density | 15.247(e) | RSS-247 Issue 2 Clause 5.2 | Pass |
| Emission outside the frequency band | 15.247(d) | RSS-247 Issue 2 Clause 5.5 | Pass |
| Radiated Emissions in restricted frequency bands | 15.247(d), 15.205&15.209 | RSS-Gen Issue 5 Clause 8.9&8.10 | Pass |
| Power line conducted emission | 15.207(a) | RSS-Gen Issue 5 Clause 8.8 | Pass |
| Occupied bandwidth | - | RSS-Gen Issue 5 Clause 6.6 | Tested |
| Antenna requirement | 15.203 | - | Pass |

*Notes: 1: NA =Not Applicable*

# 1 GENERAL INFORMATION

## 1.1 Description of Equipment Under Test (EUT)

| | |
|---|---|
| Product name: | EasyIO FW-VAV |
| Type/Model/PMN/HVIN: | FW-VAV |
| Description of EUT: | EUT is a controller with WIFI function, there is only one model, we test it and list the worst results in this report. |
| Rating: | 24VAC, 50/60Hz |
| EUT type: | ☒ Table top ☐ Floor standing |
| Software Version: | / |
| Hardware Version: | / |
| Sample Identification No.: | 0211213-14-002 |
| Sample received date: | 2021.9.24 |
| Date of test: | 2021.9.25-2021.9.30 |

## 1.2 Technical Specification

| | |
|---|---|
| Frequency Band: | 2400MHz ~ 2483.5MHz |
| Support Standards: | IEEE 802.11b, IEEE 802.11g, IEEE 802.11n-HT20, IEEE 802.11n-HT40 |
| Type of Modulation: | IEEE 802.11b: DSSS (CCK, DQPSK, DBPSK)<br>IEEE 802.11g: OFDM (64-QAM, 16-QAM, QPSK, BPSK)<br>IEEE 802.11n-HT20: OFDM (64-QAM, 16-QAM, QPSK, BPSK)<br>IEEE 802.11n-HT40: OFDM (64-QAM, 16-QAM, QPSK, BPSK) |
| Channel Number: | 11 Channels for 802.11b, 802.11g and 802.11n(HT20)<br>7 Channels for 802.11n(HT40) |
| Channel Separation: | 5 MHz |
| Antenna: | Dipole Antenna, Antenna 0: 2.0dBi, Antenna 1: 2.0dBi |

## 1.3 Antenna information

| Mode | Tx/Rx Function | Beamforming function | CDD function | Directional gain (dBi) |
|---|---|---|---|---|
| 802.11b | 1Tx/1Rx | NO | NO | - |
| 802.11g | 1Tx/1Rx | NO | NO | - |
| 802.11n(HT20) | 2Tx/2Rx | NO | NO | 2.0 |
| 802.11n(HT40) | 2Tx/2Rx | NO | NO | 2.0 |

Note: For 802.11b and 802.11g mode, it only supports 1TX.
For 802.11n modes, it can support 2TX, all the two transmit signals are completely uncorrelated with each other, so the directional gain = 10 log $((10^{G1/10} + 10^{G2/10} + \ldots + 10^{Gn/10}) / N_{ANT}$

## 1.4 Description of Test Facility

| | |
|---|---|
| Name: | Intertek Testing Services Shanghai |
| Address: | Building 86, No. 1198 Qinzhou Road(North), Shanghai 200233, P.R. China |
| Telephone: | 86 21 61278200 |
| Telefax: | 86 21 54262353 |

| | |
|---|---|
| The test facility is recognized, certified, or accredited by these organizations: | CNAS Accreditation Lab<br>Registration No. CNAS L0139 |
| | FCC Accredited Lab<br>Designation Number: CN1175 |
| | IC Registration Lab<br>CAB identifier.: CN0051 |
| | VCCI Registration Lab<br>Registration No.: R-14243, G-10845, C-14723, T-12252 |
| | A2LA Accreditation Lab<br>Certificate Number: 3309.02 |

# 2 TEST SPECIFICATIONS

## 2.1 Standards or specification

47CFR Part 15 (2020)
ANSI C63.10 (2013)
KDB 558074 (v05r02)
RSS-247 Issue 2 (February 2017)
RSS-Gen Issue 5 (March 2019) Amendment 1

## 2.2 Mode of operation during the test

While testing transmitting mode of EUT, the internal modulation and continuously transmission was applied.

| Software name | Manufacturer | Version | Supplied by |
|---|---|---|---|
| RF Test tool | - | - | Client |

The lowest, middle and highest channel were tested as representatives.

| Frequency Band (MHz) | Mode | Lowest (MHz) | Middle (MHz) | Highest (MHz) |
|---|---|---|---|---|
| 2400-2483.5 | 802.11b | 2412 | 2437 | 2462 |
| | 802.11g | 2412 | 2437 | 2462 |
| | 802.11n(HT20) | 2412 | 2437 | 2462 |
| | 802.11n(HT40) | 2422 | 2437 | 2452 |

**Data rate and Power setting:**
The pre-scan for the conducted power with all rates in each modulation and bands was used, and the worst case was found and used in all test cases. After this pre-scan, we choose the following table of the data rata as the worst case.

| Frequency Band (MHz) | Mode | Worst case data rate | Power Setting |
|---|---|---|---|
| 2400-2483.5 | 802.11b | 1Mbps | Default |
| | 802.11g | 6Mbps | Default |
| | 802.11n(HT20) | MCS0 | Default |
| | 802.11n(HT40) | MCS0 | Default |

## 2.3 Test software list

| Test Items | Software | Manufacturer | Version |
|---|---|---|---|
| Conducted emission | ESxS-K1 | R&S | V2.1.0 |
| Radiated emission | ES-K1 | R&S | V1.71 |

## 2.4 Test peripherals list

| Item No. | Name | Band and Model | Description |
|---|---|---|---|
| 1 | Laptop computer | DELL 5480 | - |

## 2.5 Test environment condition:

| Test items | Temperature | Humidity |
|---|---|---|
| Minimum 6dB Bandwidth | 25°C | 53%RH |
| Maximum conducted output power and e.i.r.p. | | |
| Power spectrum density | | |
| Emission outside the frequency band | | |
| Occupied bandwidth | | |
| Radiated Emissions in restricted frequency bands | 24°C | 54%RH |
| Power line conducted emission | 25°C | 54%RH |

## 2.6 Instrument list

| Conducted Emission | | | | | |
|---|---|---|---|---|---|
| Used | Equipment | Manufacturer | Type | Internal no. | Due date |
| ☒ | Test Receiver | R&S | ESCS 30 | EC 2107 | 2022-07-14 |
| ☒ | A.M.N. | R&S | ESH2-Z5 | EC 3119 | 2021-11-10 |
| ☐ | A.M.N. | R&S | ENV 216 | EC 3393 | 2022-07-14 |
| ☐ | A.M.N. | R&S | ENV4200 | EC 3558 | 2022-06-11 |
| Radiated Emission | | | | | |
| Used | Equipment | Manufacturer | Type | Internal no. | Due date |
| ☒ | Test Receiver | R&S | ESIB 26 | EC 3045 | 2022-09-16 |
| ☒ | Bilog Antenna | TESEQ | CBL 6112D | EC 4206 | 2022-09-24 |
| ☒ | Pre-amplifier | R&S | AFS42-00101800-25-S-42 | EC5262 | 2022-06-11 |
| ☐ | Horn antenna | R&S | HF 906 | EC 3049 | 2022-01-17 |
| ☒ | Horn antenna | ETS | 3117 | EC 4792-1 | 2022-02-25 |
| ☒ | Horn antenna | TOYO | HAP18-26W | EC 4792-3 | 2022-07-09 |
| ☐ | Active loop antenna | Schwarzbeck | FMZB1519 | EC 5345 | 2022-03-14 |
| RF test | | | | | |
| Used | Equipment | Manufacturer | Type | Internal no. | Due date |
| ☒ | PXA Signal Analyzer | Keysight | N9030A | EC 5338 | 2022-03-16 |
| ☐ | Power sensor | Agilent | U2021XA | EC 5338-1 | 2022-03-16 |
| ☐ | Vector Signal Generator | Agilent | N5182B | EC 5175 | 2022-03-16 |
| ☐ | Universal Radio Communication Tester | R&S | CMW500 | EC5944 | 2021-12-09 |
| ☐ | MXG Analog Signal Generator | Agilent | N5181A | EC 5338-2 | 2022-03-16 |
| ☐ | Mobile Test System | Litepoint | Iqxel | EC 5176 | 2022-01-16 |
| ☐ | Test Receiver | R&S | ESCI 7 | EC 4501 | 2022-09-16 |
| ☐ | Climate chamber | GWS | MT3065 | EC 6021 | 2022-07-04 |
| ☒ | Spectrum Analyzer | Keysight | N9030B | EC 6078 | 2022-06-11 |
| Tet Site | | | | | |
| Used | Equipment | Manufacturer | Type | Internal no. | Due date |
| ☒ | Shielded room | Zhongyu | - | EC 2838 | 2022-01-12 |

| | | | | | |
|---|---|---|---|---|---|
| ☐ | Shielded room | Zhongyu | - | EC 2839 | 2022-01-12 |
| ☒ | Semi-anechoic chamber | Albatross project | - | EC 3048 | 2022-07-14 |
| ☐ | Fully-anechoic chamber | Albatross project | - | EC 3047 | 2022-07-14 |
| Additional instrument | | | | | |
| Used | Equipment | Manufacturer | Type | Internal no. | Due date |
| ☒ | Therom-Hygrograph | ZJ1-2A | S.M.I.F. | EC 3783 | 2022-03-03 |
| ☐ | Therom-Hygrograph | ZJ1-2A | S.M.I.F. | EC 3481 | 2022-01-05 |
| ☒ | Therom-Hygrograph | ZJ1-2A | S.M.I.F. | EC 3442 | 2022-01-05 |
| ☒ | Therom-Hygrograph | ZJ1-2A | S.M.I.F. | EC 3324 | 2022-09-05 |
| ☐ | Pressure meter | YM3 | Shanghai Mengde | EC 3320 | 2022-07-14 |

## 2.7 Measurement uncertainty

The measurement uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

| Test item | Measurement uncertainty |
|---|---|
| Maximum peak output power | ± 0.74dB |
| Radiated Emissions in restricted frequency bands below 1GHz | ± 4.90dB |
| Radiated Emissions in restricted frequency bands above 1GHz | ± 5.02dB |
| Emission outside the frequency band | ± 2.89dB |
| Power line conducted emission | ± 3.19dB |

# 3 Minimum 6dB bandwidth

**Test result: Pass**

## 3.1 Limit

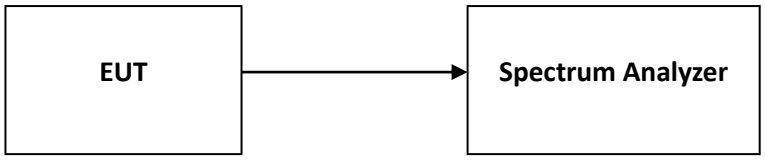
For systems using digital modulation techniques that may operate in the 902 - 928 MHz, 2400 - 2483.5 MHz and 5725 - 5850 MHz bands, the minimum 6 dB bandwidth shall be at least 500 kHz.

## 3.2 Measurement Procedure

The EUT was tested according to Subclause 11.8 of ANSI C63.10.

a) Set RBW = 100 kHz.
b) Set the video bandwidth (VBW) ≥ 3 × RBW.
c) Detector = Peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.
g) 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.

## 3.3 Test Configuration




## 3.4 Test Results of Minimum 6dB bandwidth

Please refer to Appendix A

# 4 Maximum conducted output power and e.i.r.p.

**Test result: Pass**

## 4.1 Limit

For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 W. (The e.i.r.p. shall not exceed 4 W)

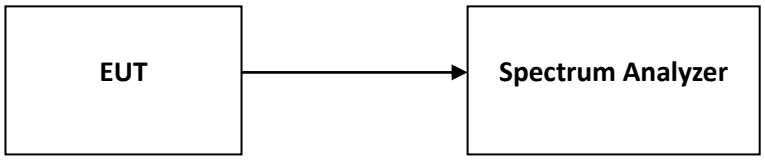
If the transmitting antenna of directional gain greater than 6dBi is used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi. If there have a beam forming type, the limit should be the minimum of 30dBm and 30+ (6 –antenna gain-beam forming gain).

## 4.2 Measurement Procedure

The EUT was tested according to Subclause 11.9.2.2 of ANSI C63.10.

a) Measure the duty cycle, x, of the transmitter output signal as described in Section 6.0.
b) Set span to at least 1.5 x OBW.
c) Set RBW = 1 % to 5 % of the OBW, not to exceed 1 MHz.
d) Set VBW ≥ 3 x RBW.
e) Number of points in sweep ≥ 2 x span / RBW. (This gives bin-to-bin spacing ≤ RBW/2, so that narrowband signals are not lost between frequency bins.)
f) Sweep time = auto.
g) Detector = RMS (i.e., power averaging), if available. Otherwise, use sample detector mode.
h) Do not use sweep triggering. Allow the sweep to “free run”.
i) Trace average at least 100 traces in power averaging (i.e., RMS) mode; however, the number of traces to be averaged shall be increased above 100 as needed such that the average accurately represents the true average over the on and off periods of the transmitter.
j) Compute power by integrating the spectrum across the OBW of the signal using the instrument’s band power measurement function with band limits set equal to the OBW band edges. If the instrument does not have a band power function, sum the spectrum levels (in power units) at intervals equal to the RBW extending across the entire OBW of the spectrum.
k) 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 %.

## 4.3 Test Configuration




## 4.4 Test Results of Maximum conducted output power

Please refer to Appendix A

# 5 Power spectrum density

**Test result:** **Pass**

## 5.1 Limit

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

If the transmitting antenna of directional gain greater than 6dBi is used, the power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6dBi. If there have a beam forming type, the limit should be the minimum of 8dBm/MHz and 8+ (6 –antenna gain-beam forming gain).

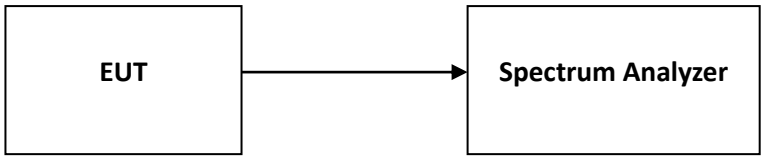
## 5.2 Measurement Procedure

The EUT was tested according to Subclause 11.10 of ANSI C63.10.

This procedure is applicable when the EUT cannot be configured to transmit continuously (i.e., duty cycle < 98 %), and when sweep triggering/signal gating cannot be used to measure only when the EUT is transmitting at its maximum power control level, and when the transmission duty cycle is constant (i.e., duty cycle variations are less than ± 2 %):

a) Measure the duty cycle (x) of the transmitter output signal as described in Section 6.0.
b) Set instrument center frequency to DTS channel center frequency.
c) Set span to at least 1.5 x OBW.
d) Set RBW to: 3 kHz ≤ RBW ≤ 100 kHz.
e) Set VBW ≥3 x RBW.
f) Detector = power averaging (RMS) or sample detector (when RMS not available).
g) Ensure that the number of measurement points in the sweep ≥ 2 x span/RBW.
h) Sweep time = auto couple.
i) Do not use sweep triggering. Allow sweep to “free run”.
j) Employ trace averaging (RMS) mode over a minimum of 100 traces.
k) Use the peak marker function to determine the maximum amplitude level.
l) Add 10 log (1/x), where x is the duty cycle measured in step (a, to the measured PSD to compute the average PSD during the actual transmission time.
m) If resultant value exceeds the limit, then reduce RBW (no less than 3 kHz) and repeat (note that this may require zooming in on the emission of interest and reducing the span in order to meet the minimum measurement point requirement as the RBW is reduced).

## 5.3 Test Configuration




## 5.4 Test Results of Power spectrum density

Please refer to Appendix A

# 6 Emission outside the frequency band

**Test result:** **Pass**

## 6.1 Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 30 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.

## 6.2 Measurement Procedure

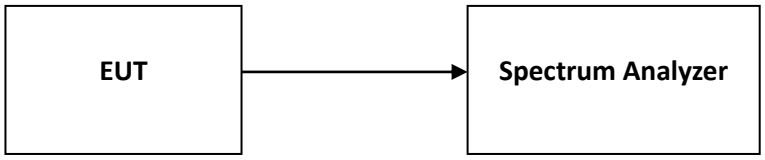
The EUT was tested according to Subclause 11.11 of ANSI C63.10.

**Reference level measurement**
Establish a reference level by using the following procedure:
a) Set instrument center frequency to DTS channel center frequency.
b) Set the span to ≥ 1.5 times the DTS bandwidth.
c) Set the RBW = 100 kHz.
d) Set the VBW ≥ 3 x RBW.
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum PSD level.

**Emission level measurement**
a) Set the center frequency and span to encompass frequency range to be measured.
b) Set the RBW = 100 kHz.
c) Set the VBW ≥ 3 x RBW.
d) Detector = peak.
e) Sweep time = auto couple.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use the peak marker function to determine the maximum amplitude level.

Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements specified in 11.1 a) or 11.1 b). Report the three highest emissions relative to the limit.

## 6.3 Test Configuration




## 6.4 The results of Emission outside the frequency band

Please refer to Appendix A

# 7 Radiated Emissions in restricted frequency bands

**Test result:** **Pass**

## 7.1 Limit

The radiated emissions which fall in the restricted bands, must also comply with the radiated emission limits specified showed as below:

| Frequencies (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 |

## 7.2 Measurement Procedure

The EUT was tested according to Subclause 11.12 of ANSI C63.10.

**For Radiated emission below 30MHz:**

a) The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meters 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) Both X and Y axes 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) The test-receiver system was set to Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

**NOTE:**

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

**For Radiated emission above 30MHz:**

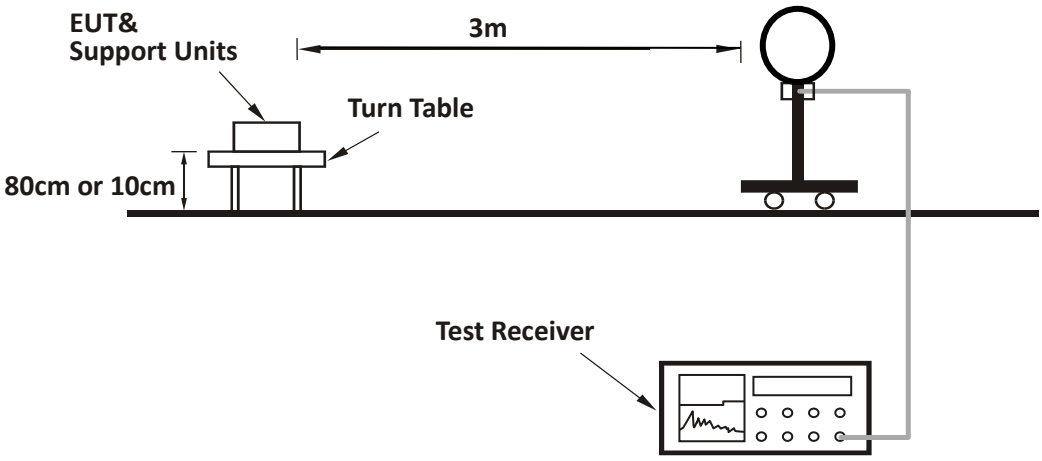
a) The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meters chamber room. For the floor-standing devices, the EUT was placed on the top of a rotating table 0.1 meters above the ground at 3 meters chamber room for test. The table was rotated 360 degrees to determine 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) The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.
f) The test-receiver system was set to peak and average detector 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.

**Note:**

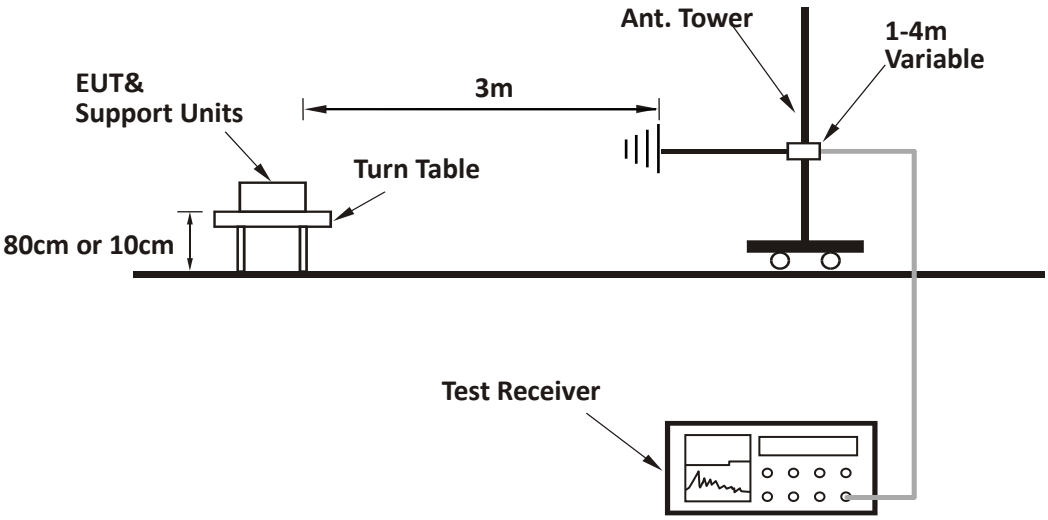
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is ≥ 1/T (Duty cycle < 98%) or 3 x RBW (Duty cycle ≥ 98%) for Average detection (AV) at frequency above 1GHz.
4. All modes of operation were investigated and the worst-case emissions were reported.

## 7.3 Test Configuration

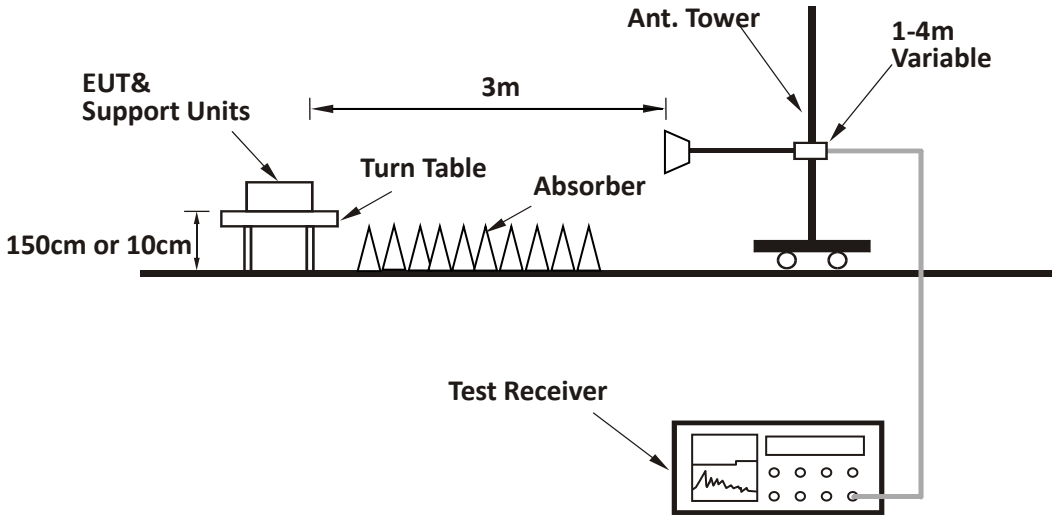
**For Radiated emission below 30MHz:**




**For Radiated emission 30MHz to 1GHz:**



**For Radiated emission above 1GHz:**

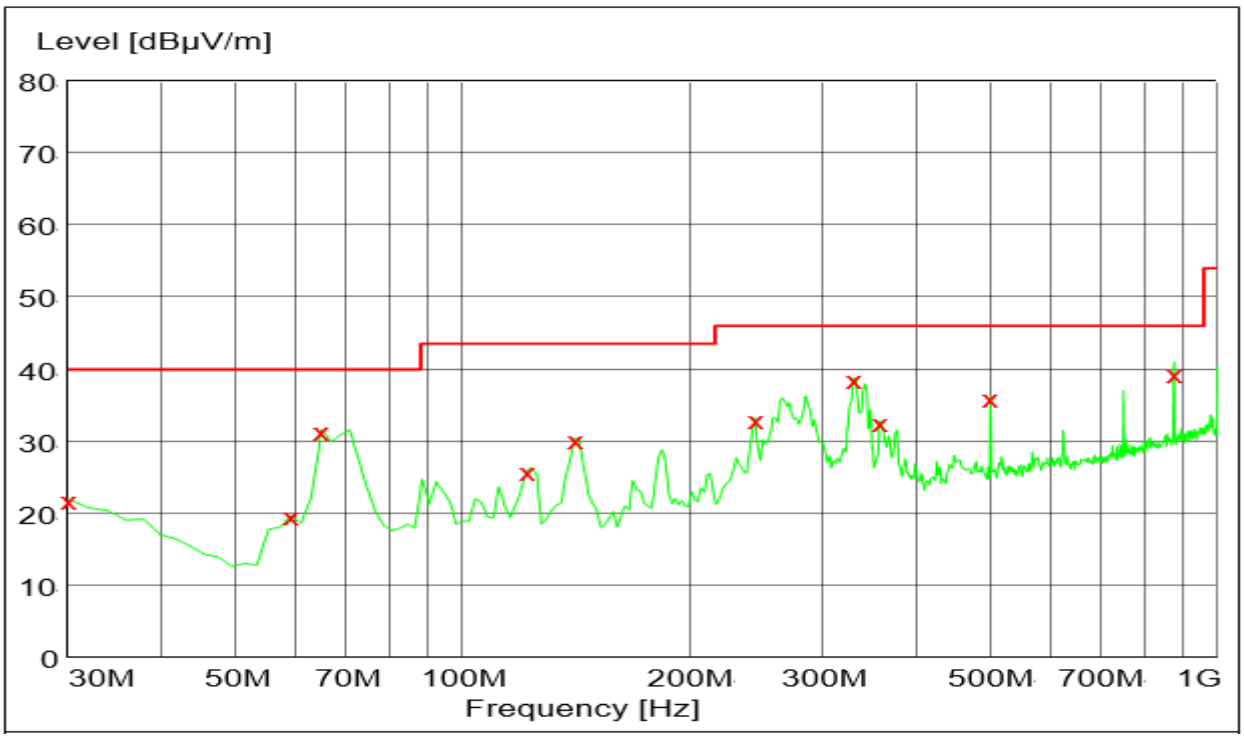


**TEST REPORT**

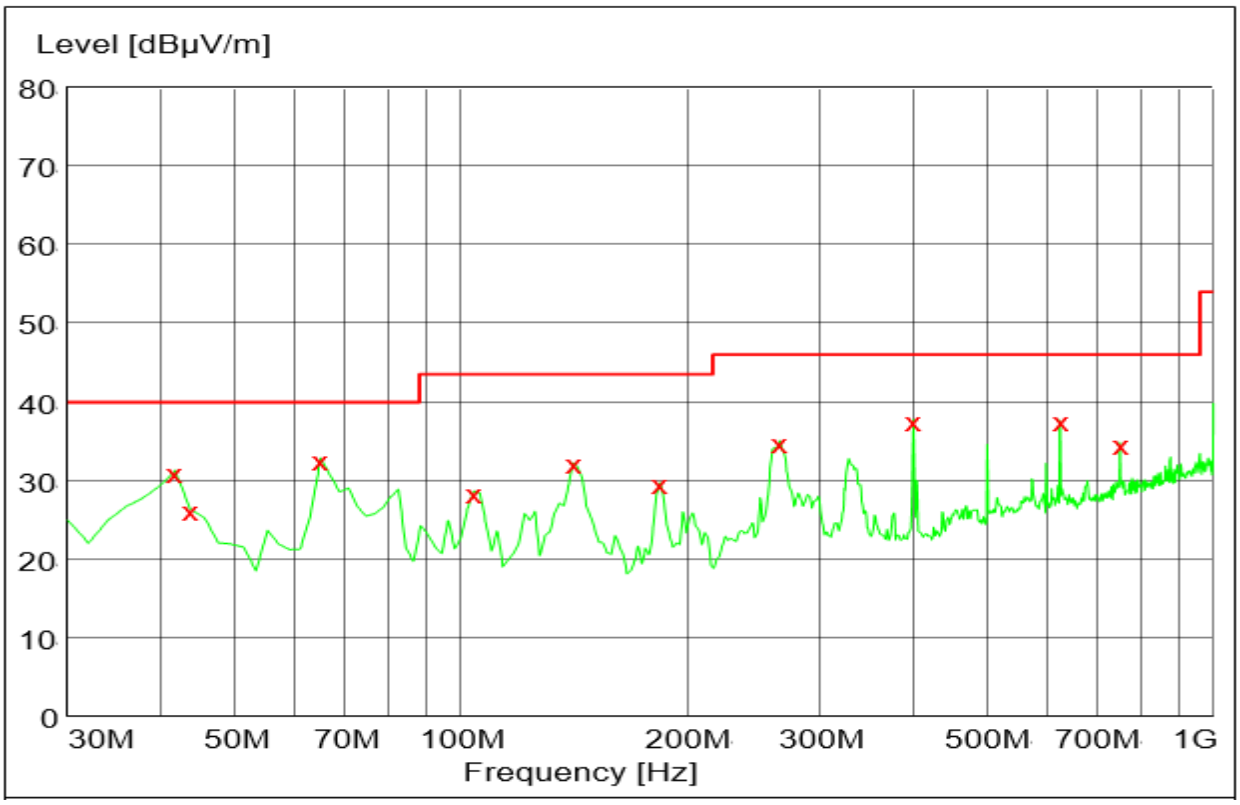
## 7.4 Test Results of Radiated Emissions

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit line per 15.31(o) was not reported.

Horizontal




Vertical



**Test data below 1GHz**

| Antenna | Frequency (MHz) | Corrected Reading (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector |
|---|---|---|---|---|---|
| H | 64.99 | 31.60 | 40.00 | 8.40 | PK |
| H | 140.80 | 30.40 | 43.50 | 13.10 | PK |
| H | 243.83 | 33.20 | 46.00 | 12.80 | PK |
| H | 329.36 | 38.70 | 46.00 | 7.30 | PK |
| H | 500.42 | 36.20 | 46.00 | 9.80 | PK |
| H | 875.59 | 39.50 | 46.00 | 6.50 | PK |
| V | 41.66 | 31.20 | 40.00 | 8.80 | PK |
| V | 64.99 | 32.80 | 40.00 | 7.20 | PK |
| V | 140.80 | 32.30 | 43.50 | 11.20 | PK |
| V | 265.21 | 35.00 | 46.00 | 11.00 | PK |
| V | 399.34 | 37.70 | 46.00 | 8.30 | PK |
| V | 624.83 | 37.70 | 46.00 | 8.30 | PK |

**Test result above 1GHz:**

The emission was conducted from 1GHz to 25GHz

802.11b

| CH | Antenna | Frequency (MHz) | Corrected Reading (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector |
|---|---|---|---|---|---|---|
| L | H | 2390 | 50.30 | 74.00 | 23.30 | PK |
| | V | 2390 | 51.10 | 74.00 | 22.50 | PK |
| | V | 4824 | 45.60 | 74.00 | 28.80 | PK |
| M | H | 4874 | 45.70 | 74.00 | 28.30 | PK |
| H | H | 2483.5 | 50.80 | 74.00 | 23.20 | PK |
| | V | 2483.5 | 51.30 | 74.00 | 22.70 | PK |
| | H | 4924 | 46.10 | 74.00 | 27.80 | PK |

**TEST REPORT**

802.11g

| CH | Antenna | Frequency (MHz) | Corrected Reading (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector |
|---|---|---|---|---|---|---|
| L | H | 2390 | 54.70 | 74.00 | 18.40 | PK |
| | H | 2390 | 47.90 | 54.00 | 6.10 | AV |
| | V | 2390 | 55.20 | 74.00 | 17.80 | PK |
| | V | 2390 | 48.30 | 54.00 | 5.90 | AV |
| | H | 4824 | 45.70 | 74.00 | 27.60 | PK |
| M | H | 4874 | 46.80 | 74.00 | 26.20 | PK |
| H | H | 2483.5 | 55.20 | 74.00 | 17.80 | PK |
| | H | 2483.5 | 48.10 | 54.00 | 5.60 | AV |
| | V | 2483.5 | 56.30 | 74.00 | 17.30 | PK |
| | V | 2483.5 | 48.40 | 54.00 | 5.10 | AV |
| | H | 4924 | 47.70 | 74.00 | 26.30 | PK |

802.11n(HT20)

| CH | Antenna | Frequency (MHz) | Corrected Reading (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector |
|---|---|---|---|---|---|---|
| L | H | 2390 | 58.60 | 74.00 | 15.40 | PK |
| | H | 2390 | 50.10 | 54.00 | 3.90 | AV |
| | V | 2390 | 59.30 | 74.00 | 14.70 | PK |
| | V | 2390 | 50.50 | 54.00 | 3.50 | AV |
| | H | 4824 | 47.60 | 74.00 | 26.40 | PK |
| M | H | 4874 | 48.20 | 74.00 | 25.80 | PK |
| H | H | 2483.5 | 59.70 | 74.00 | 14.30 | PK |
| | H | 2483.5 | 51.30 | 54.00 | 2.70 | AV |
| | V | 2483.5 | 60.20 | 74.00 | 13.80 | PK |
| | V | 2483.5 | 51.40 | 54.00 | 2.60 | AV |
| | H | 4924 | 49.10 | 74.00 | 24.90 | PK |

**TEST REPORT**

802.11n(HT40)

| CH | Antenna | Frequency (MHz) | Corrected Reading (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Detector |
|---|---|---|---|---|---|---|
| L | H | 2390 | 60.80 | 74.00 | 13.20 | PK |
| | H | 2390 | 51.10 | 54.00 | 2.90 | AV |
| | V | 2390 | 61.30 | 74.00 | 12.70 | PK |
| | V | 2390 | 51.50 | 54.00 | 2.50 | AV |
| | H | 4824 | 47.40 | 74.00 | 25.60 | PK |
| M | H | 4874 | 47.70 | 74.00 | 25.30 | PK |
| H | H | 2483.5 | 60.60 | 74.00 | 13.20 | PK |
| | H | 2483.5 | 51.40 | 54.00 | 2.50 | AV |
| | V | 2483.5 | 61.20 | 74.00 | 12.40 | PK |
| | V | 2483.5 | 51.50 | 54.00 | 2.30 | AV |
| | H | 4924 | 47.80 | 74.00 | 24.20 | PK |

**TEST REPORT**

Remark: 1. Correct Factor = Antenna Factor + Cable Loss (+ Amplifier, for higher than 1GHz), the value was added to Original Receiver Reading by the software automatically.
2. Corrected Reading = Original Receiver Reading + Correct Factor
3. Margin = Limit - Corrected Reading
4. If the PK Corrected Reading is lower than AV limit, the AV test can be elided.

Example: Assuming Antenna Factor = 30.20dB/m, Cable Loss = 2.00dB,
Gain of Preamplifier = 32.00dB, Original Receiver Reading = 10.00dBuV,
Limit = 40.00dBuV/m.
Then Correct Factor = 30.20 + 2.00 – 32.00 = 0.20dB/m;
Corrected Reading = 10dBuV + 0.20dB/m = 10.20dBuV/m;
Margin = 40.00dBuV/m - 10.20dBuV/m = 29.80dB.

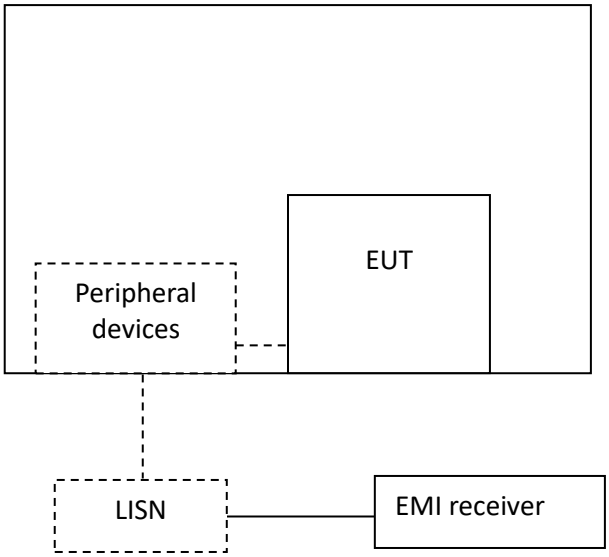
# 8 Power line conducted emission

**Test result:** **Pass**

## 8.1 Limit

| Frequency of Emission (MHz) | Conducted Limit (dBuV) | |
|---|---|---|
| | QP | AV |
| 0.15-0.5 | 66 to 56* | 56 to 46 * |
| 0.5-5 | 56 | 46 |
| 5-30 | 60 | 50 |
| * Decreases with the logarithm of the frequency. | | |

## 8.2 Test Configuration



## 8.3 Measurement Procedure

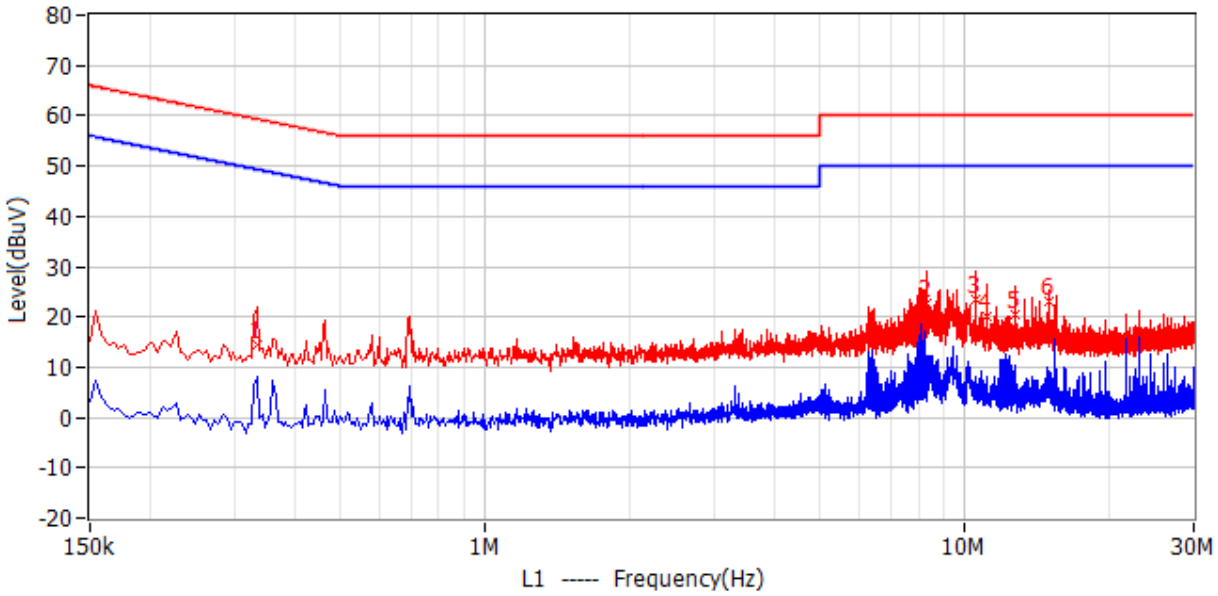
Measured levels of ac power-line conducted emission shall be the emission voltages from the voltage probe, where permitted, or across the 50 Ω LISN port (to which the EUT is connected), where permitted, terminated into a 50 Ω measuring instrument. All emission voltage and current measurements shall be made on each current-carrying conductor at the plug end of the EUT power cord by the use of mating plugs and receptacles on the LISN, if used. Equipment shall be tested with power cords that are normally supplied or recommended by the manufacturer and that have electrical and shielding characteristics that are the same as those cords normally supplied or recommended by the manufacturer. For those measurements using a LISN, the 50 Ω measuring port is terminated by a measuring instrument having 50 Ω input impedance. All other ports are terminated in 50 Ω loads.

Tabletop devices shall be placed on a platform of nominal size 1 m by 1.5 m, raised 80 cm above the reference ground plane. The vertical conducting plane or wall of an RF-shielded (screened) room shall be located 40 cm to the rear of the EUT. Floor-standing devices shall be placed either directly on the reference ground-plane or on insulating material as described in ANSI C63.4. All other surfaces of tabletop or floor-standing EUTs shall be at least 80 cm from any other grounded conducting surface, including the case or cases of one or more LISNs.

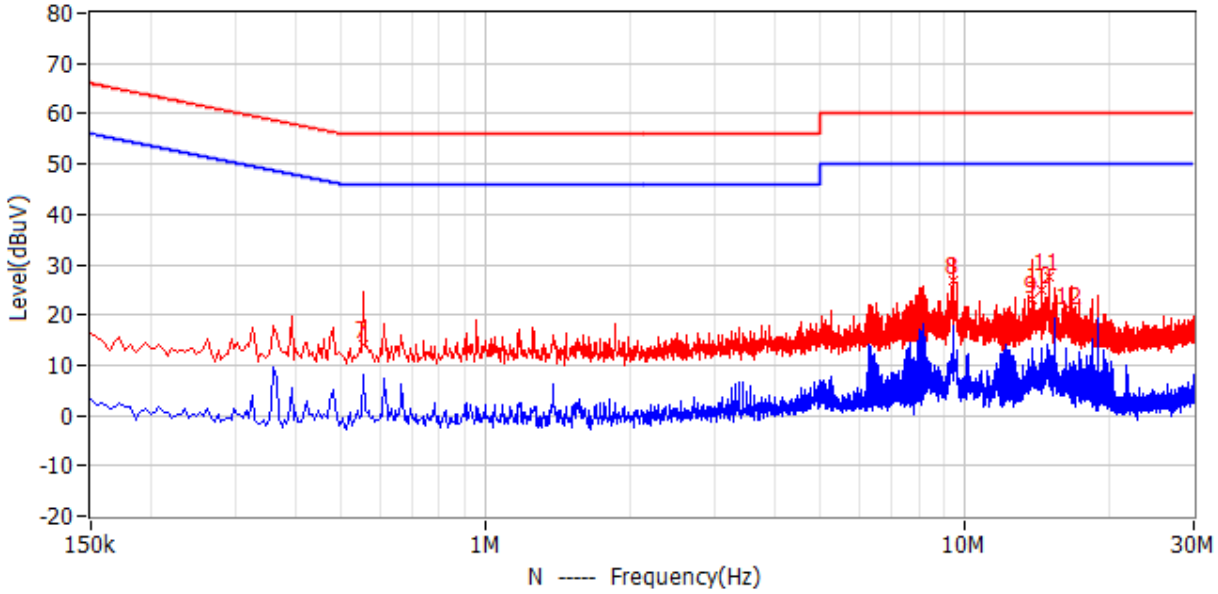
The bandwidth of the test receiver is set at 9 kHz.

## 8.4 Test Results of Power line conducted emission

L Line




N Line



**TEST REPORT**

**Test Data:**

| No. | Frequency | Limit dBuV | Level dBuV | Delta dB | Reading dBuV | Factor dB | Detector | Phase |
|---|---|---|---|---|---|---|---|---|
| 1 | 334.500kHz | 59.3 | 14.5 | -44.8 | 4.2 | 10.3 | QP | L1 |
| 2 | 8.304MHz | 60.0 | 22.7 | -37.3 | 11.9 | 10.8 | QP | L1 |
| 3 | 10.518MHz | 60.0 | 23.3 | -36.7 | 12.4 | 10.9 | QP | L1 |
| 4 | 11.072MHz | 60.0 | 20.2 | -39.8 | 9.3 | 10.9 | QP | L1 |
| 5 | 12.732MHz | 60.0 | 20.5 | -39.5 | 9.6 | 10.9 | QP | L1 |
| 6 | 14.946MHz | 60.0 | 23.0 | -37.0 | 12.1 | 10.9 | QP | L1 |
| 7 | 555.000kHz | 56.0 | 14.0 | -42.0 | 3.6 | 10.4 | QP | N |
| 8 | 9.411MHz | 60.0 | 26.7 | -33.3 | 15.8 | 10.9 | QP | N |
| 9 | 13.848MHz | 60.0 | 23.0 | -37.0 | 12.2 | 10.8 | QP | N |
| 10 | 14.393MHz | 60.0 | 25.1 | -34.9 | 14.3 | 10.8 | QP | N |
| 11 | 14.946MHz | 60.0 | 27.6 | -32.4 | 16.8 | 10.8 | QP | N |
| 12 | 16.611MHz | 60.0 | 20.8 | -39.2 | 9.8 | 11.0 | QP | N |

*Remark: 1. Correct Factor = LISN Factor + Cable Loss, the value was added to Original Receiver Reading by the software automatically.*
*2. Level = Original Receiver Reading + Correct Factor*
*3. Delta = Level - Limit*
*4. If the PK Corrected Reading is lower than AV limit, the AV test can be elided.*

# 9 Occupied Bandwidth

**Test result:** **Tested**

## 9.1 Limit

None

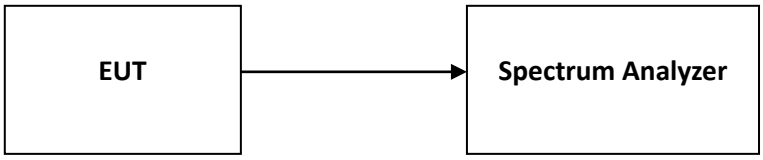
## 9.2 Measurement Procedure

The occupied bandwidth per RSS-Gen Issue 4 Clause 6.6 was measured using the Spectrum Analyzer.

The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.

The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3x RBW.

## 9.3 Test Configuration




## 9.4 The results of Occupied Bandwidth

Please refer to Appendix A

# 10 Antenna requirement

**Requirement:**
An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall 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.

**Result:**
EUT uses permanently attached antenna to the intentional radiator, so it can comply with the provisions of this section.

# Appendix A: Test results

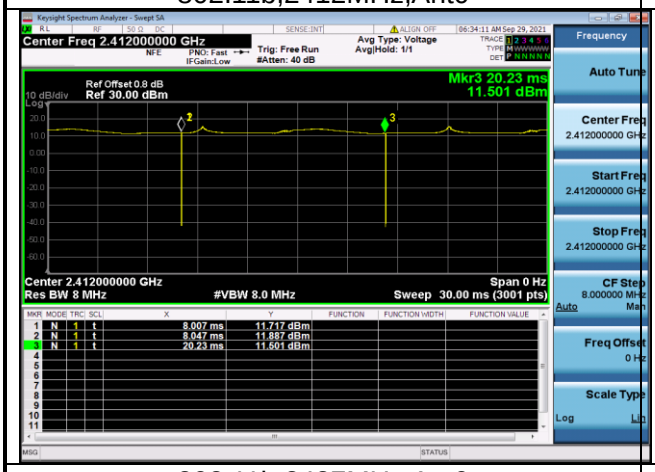
1. Duty Cycle

1.1 Test Data

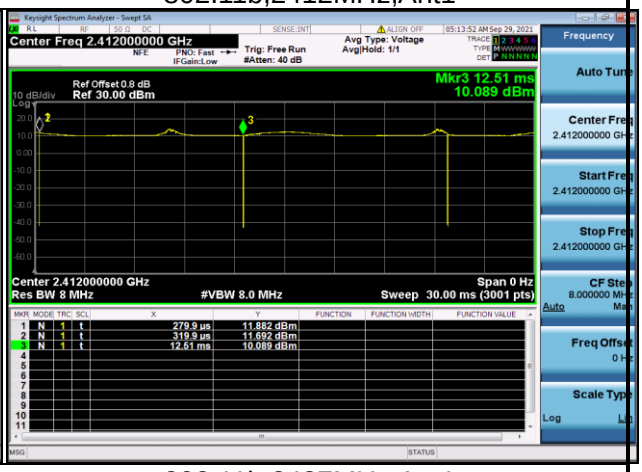
| WLAN Duty Cycle | | | | |
|---|---|---|---|---|
| Mode | Test Frequency (MHz) | Ant | Duty Cycle (%) | Duty Cycle Factor (dB) |
| 802.11b | 2412 | Ant0 | 99.67 | 0.00 |
| 802.11b | 2412 | Ant1 | 99.67 | 0.00 |
| 802.11b | 2437 | Ant0 | 99.67 | 0.00 |
| 802.11b | 2437 | Ant1 | 99.67 | 0.00 |
| 802.11b | 2462 | Ant0 | 99.59 | 0.00 |
| 802.11b | 2462 | Ant1 | 99.59 | 0.00 |
| 802.11g | 2412 | Ant0 | 97.60 | 0.11 |
| 802.11g | 2412 | Ant1 | 97.58 | 0.11 |
| 802.11g | 2437 | Ant0 | 97.58 | 0.11 |
| 802.11g | 2437 | Ant1 | 97.60 | 0.11 |
| 802.11g | 2462 | Ant0 | 97.60 | 0.11 |
| 802.11g | 2462 | Ant1 | 97.60 | 0.11 |
| 802.11n (HT20) | 2412 | Ant0 | 97.42 | 0.11 |
| 802.11n (HT20) | 2412 | Ant1 | 97.41 | 0.11 |
| 802.11n (HT20) | 2437 | Ant0 | 97.42 | 0.11 |
| 802.11n (HT20) | 2437 | Ant1 | 97.42 | 0.11 |
| 802.11n (HT20) | 2462 | Ant0 | 97.41 | 0.11 |
| 802.11n (HT20) | 2462 | Ant1 | 97.42 | 0.11 |
| 802.11n (HT40) | 2422 | Ant0 | 95.88 | 0.18 |
| 802.11n (HT40) | 2422 | Ant1 | 96.88 | 0.14 |
| 802.11n (HT40) | 2437 | Ant0 | 95.88 | 0.18 |
| 802.11n (HT40) | 2437 | Ant1 | 95.88 | 0.18 |
| 802.11n (HT40) | 2452 | Ant0 | 95.88 | 0.18 |
| 802.11n (HT40) | 2452 | Ant1 | 96.87 | 0.14 |

## 1.2 Test Plots

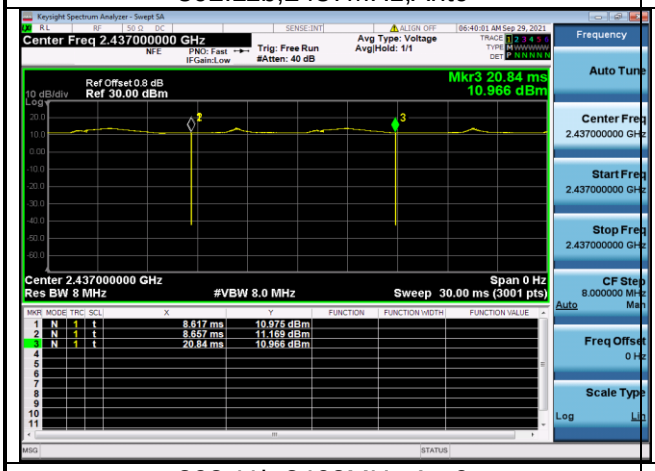
802.11b,2412MHz,Ant0



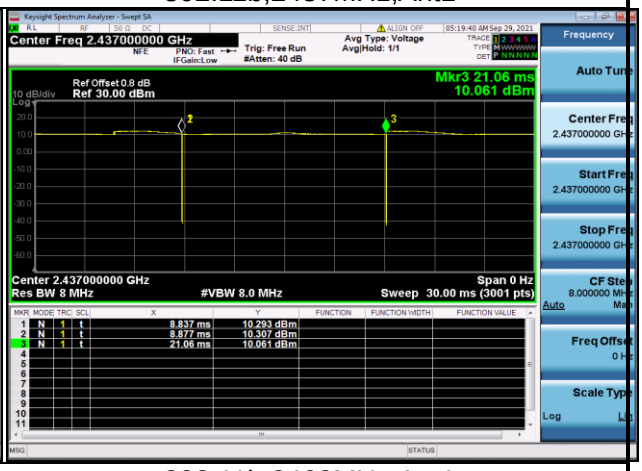

802.11b,2412MHz,Ant1



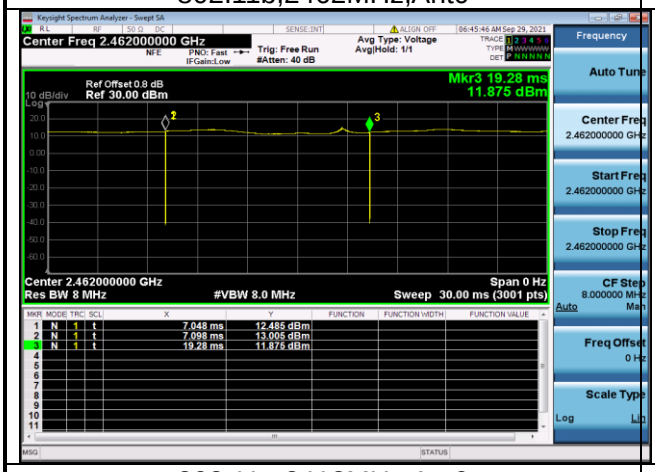

802.11b,2437MHz,Ant0



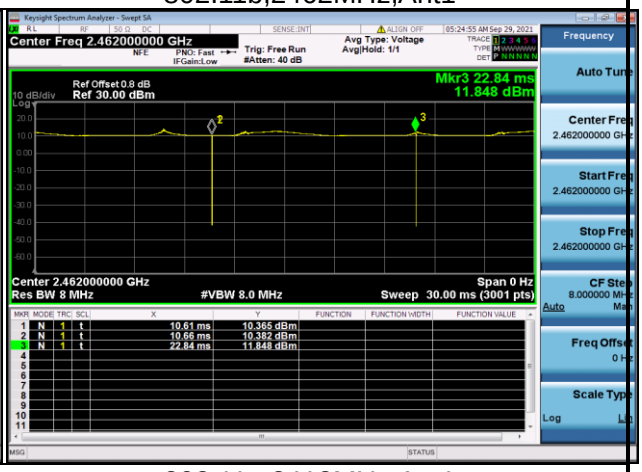

802.11b,2437MHz,Ant1




802.11b,2462MHz,Ant0



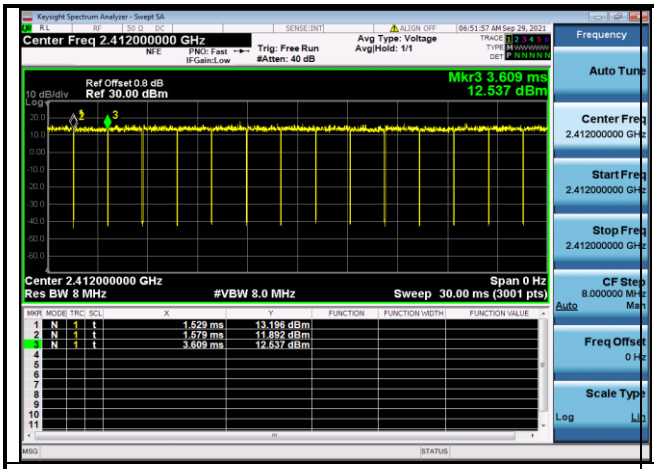

802.11b,2462MHz,Ant1



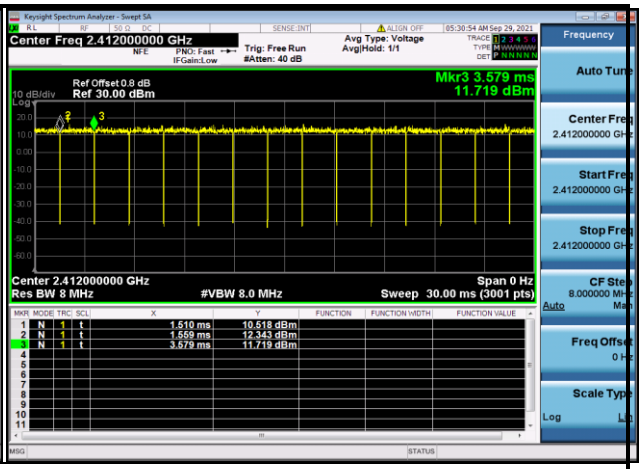

802.11g,2412MHz,Ant0

802.11g,2412MHz,Ant1

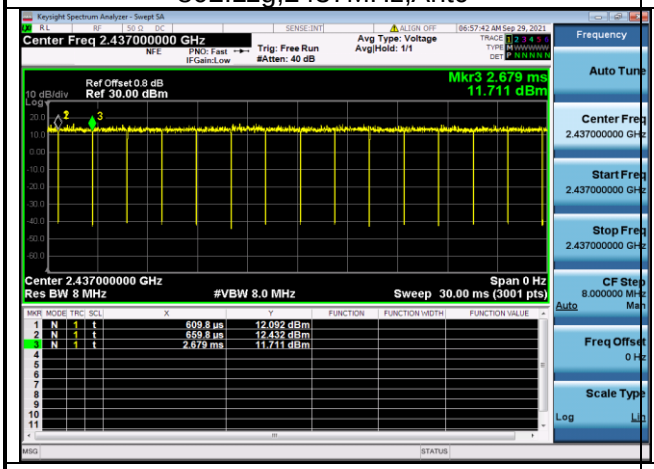
## TEST REPORT



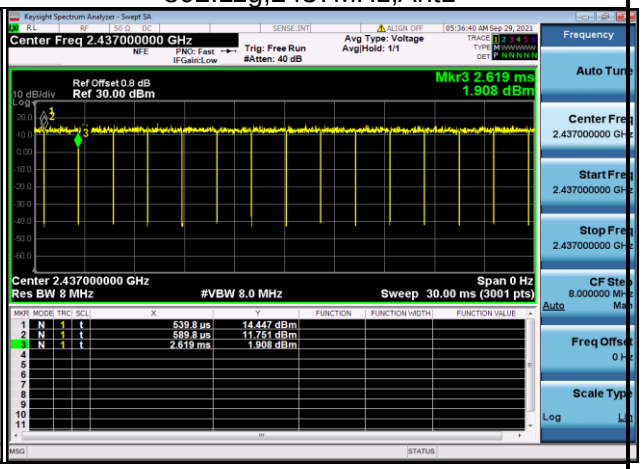

802.11g,2437MHz,Ant0



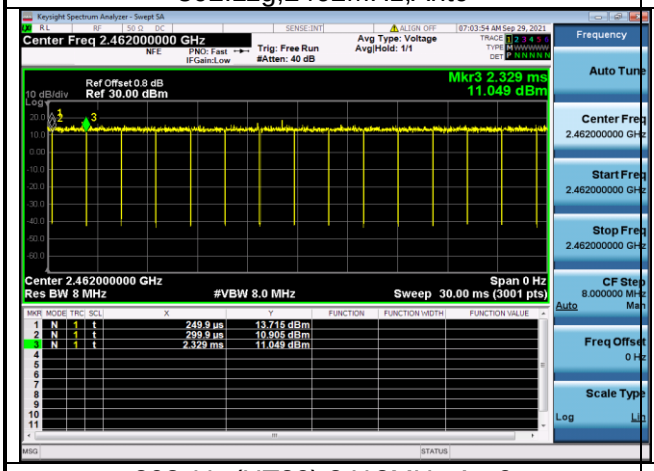

802.11g,2437MHz,Ant1



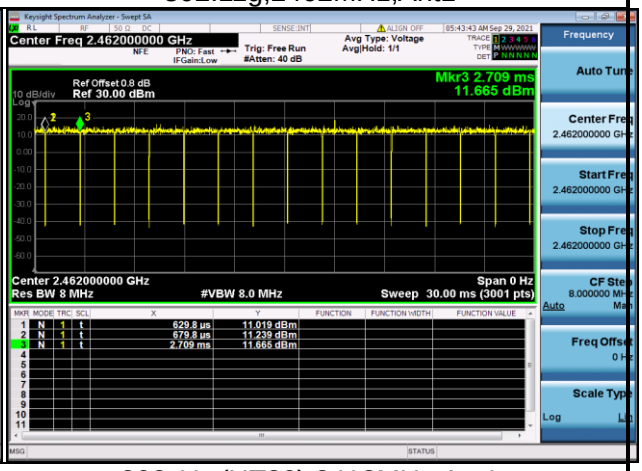

802.11g,2462MHz,Ant0




802.11g,2462MHz,Ant1

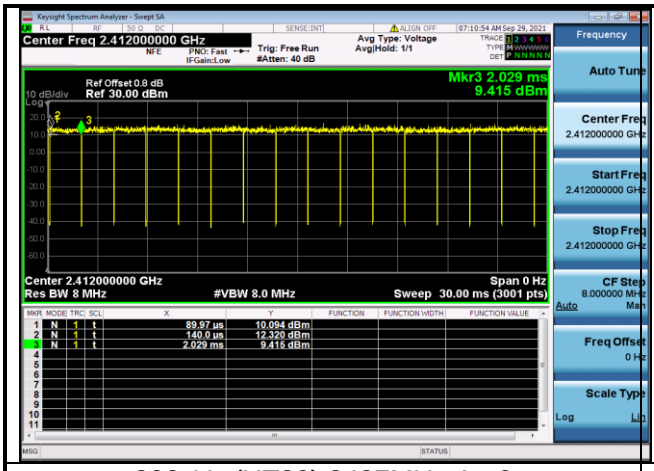



802.11n(HT20),2412MHz,Ant0

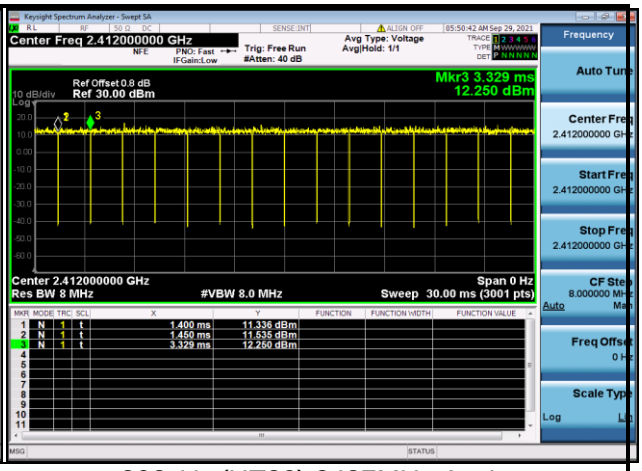



802.11n(HT20),2412MHz,Ant1

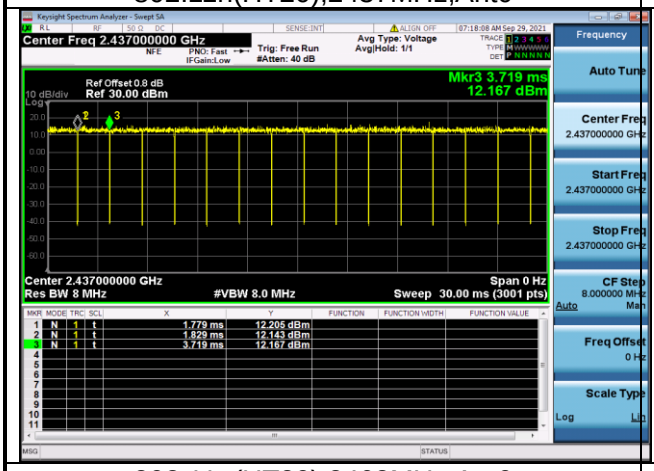
## TEST REPORT



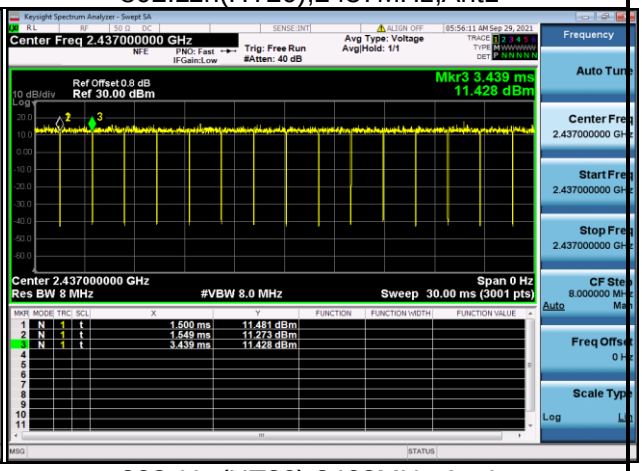

802.11n(HT20),2437MHz,Ant0



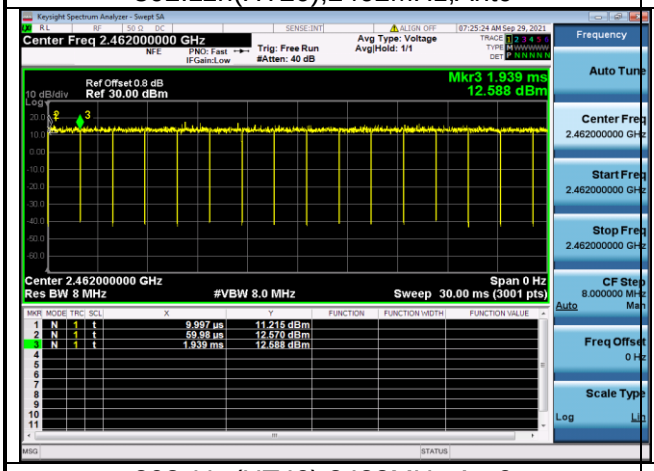

802.11n(HT20),2437MHz,Ant1



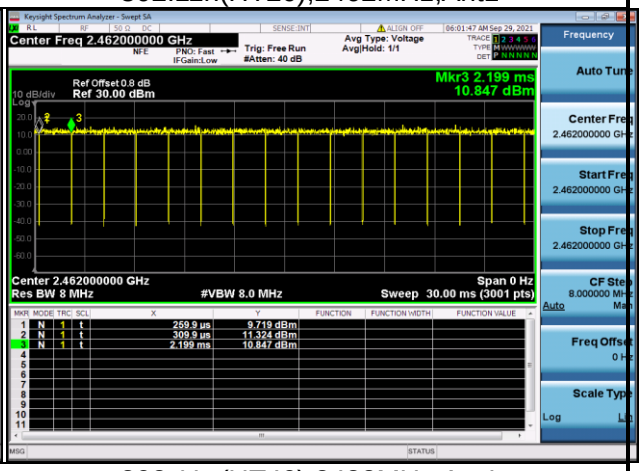

802.11n(HT20),2462MHz,Ant0




802.11n(HT20),2462MHz,Ant1

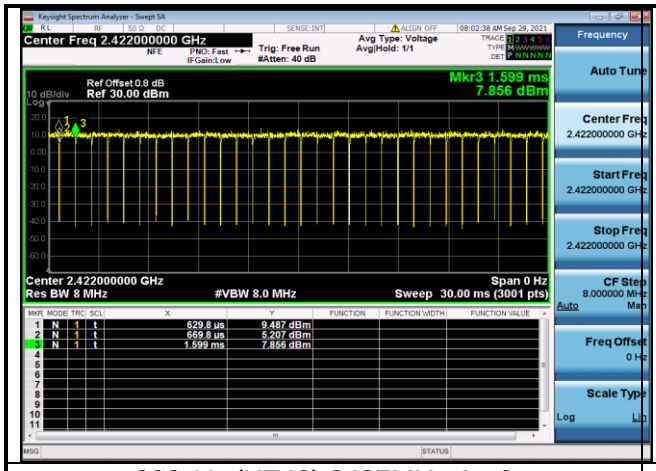



802.11n(HT40),2422MHz,Ant0

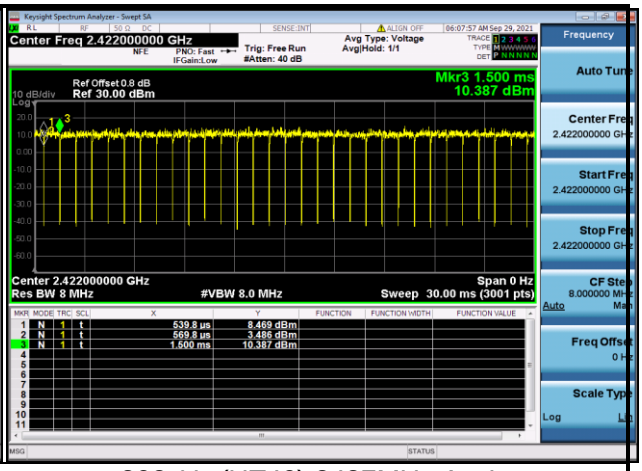



802.11n(HT40),2422MHz,Ant1

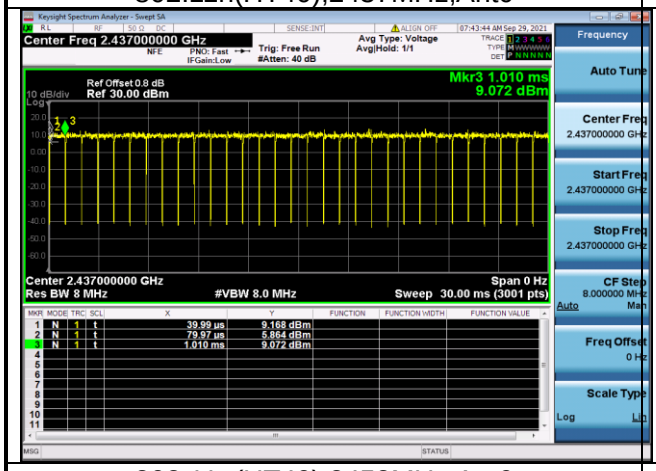
## TEST REPORT



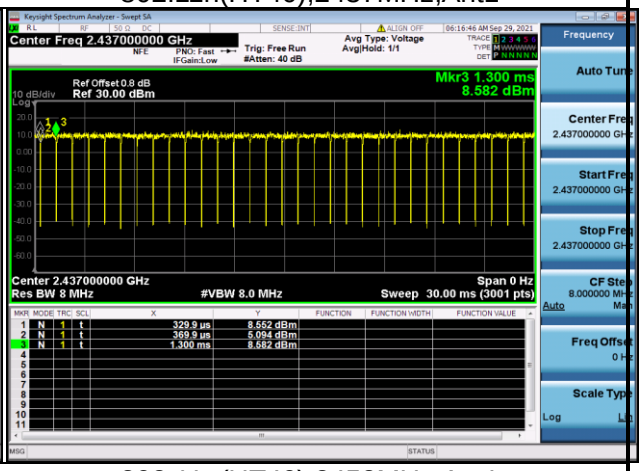

802.11n(HT40),2437MHz,Ant0



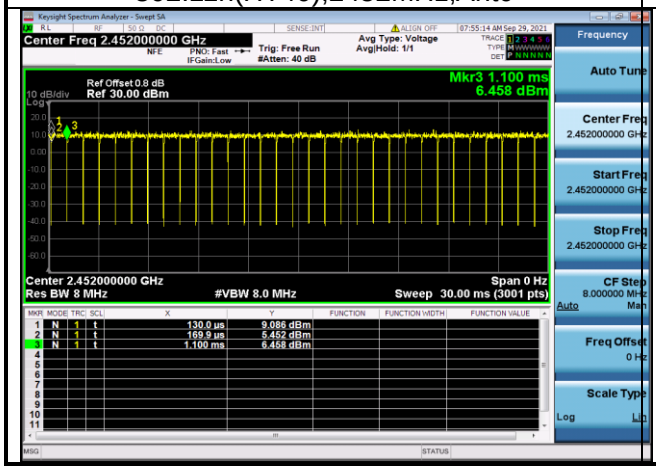

802.11n(HT40),2437MHz,Ant1

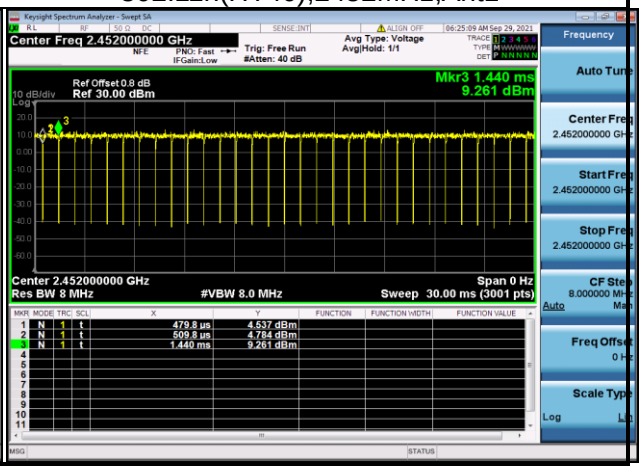



802.11n(HT40),2452MHz,Ant0




802.11n(HT40),2452MHz,Ant1



2. Minimum 6dB bandwidth

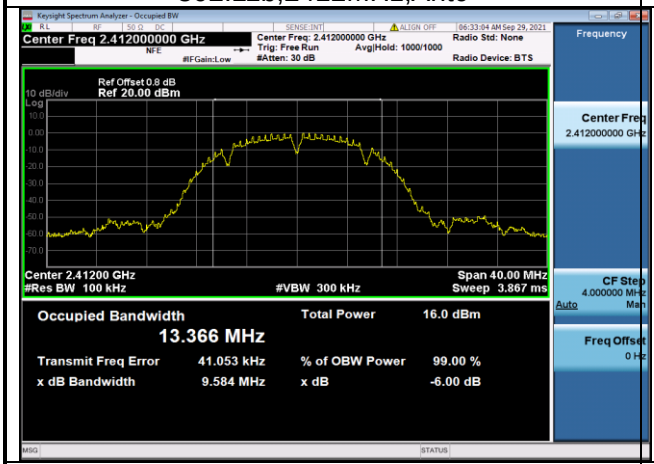
2.1 Test Data

| WLAN Occupied 6dB Bandwidth | | | | |
|---|---|---|---|---|
| Mode | Test Frequency (MHz) | Ant | Occupied Bandwidth (MHz) | Result |
| 802.11b | 2412 | Ant0 | 9.58 | Pass |
| 802.11b | 2412 | Ant1 | 9.56 | Pass |
| 802.11b | 2437 | Ant0 | 10.08 | Pass |
| 802.11b | 2437 | Ant1 | 10.08 | Pass |
| 802.11b | 2462 | Ant0 | 10.08 | Pass |
| 802.11b | 2462 | Ant1 | 9.59 | Pass |
| 802.11g | 2412 | Ant0 | 15.14 | Pass |
| 802.11g | 2412 | Ant1 | 15.15 | Pass |
| 802.11g | 2437 | Ant0 | 15.10 | Pass |
| 802.11g | 2437 | Ant1 | 15.14 | Pass |
| 802.11g | 2462 | Ant0 | 15.13 | Pass |
| 802.11g | 2462 | Ant1 | 15.16 | Pass |
| 802.11n (HT20) | 2412 | Ant0 | 15.13 | Pass |
| 802.11n (HT20) | 2412 | Ant1 | 15.12 | Pass |
| 802.11n (HT20) | 2437 | Ant0 | 15.14 | Pass |
| 802.11n (HT20) | 2437 | Ant1 | 15.12 | Pass |
| 802.11n (HT20) | 2462 | Ant0 | 15.10 | Pass |
| 802.11n (HT20) | 2462 | Ant1 | 15.14 | Pass |
| 802.11n (HT40) | 2422 | Ant0 | 32.61 | Pass |
| 802.11n (HT40) | 2422 | Ant1 | 33.88 | Pass |
| 802.11n (HT40) | 2437 | Ant0 | 35.05 | Pass |
| 802.11n (HT40) | 2437 | Ant1 | 33.90 | Pass |
| 802.11n (HT40) | 2452 | Ant0 | 32.64 | Pass |
| 802.11n (HT40) | 2452 | Ant1 | 33.89 | Pass |

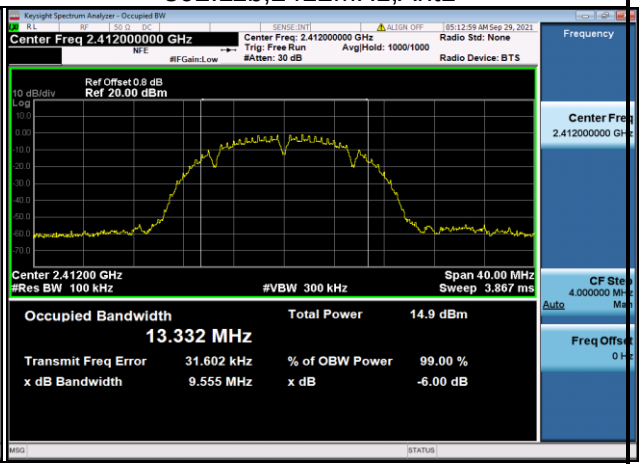
**TEST REPORT**

2.2 Test Plots

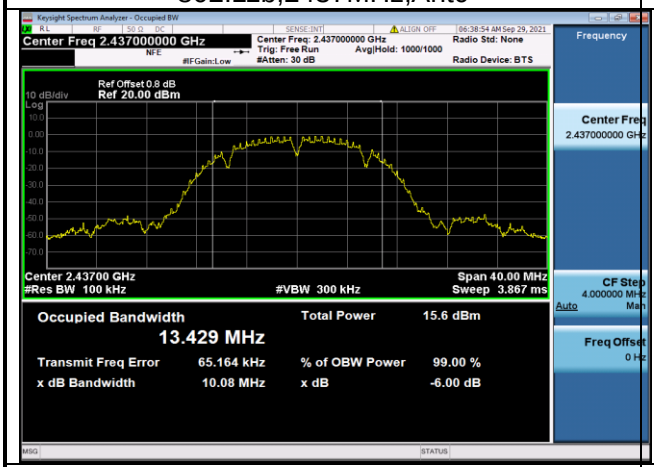
802.11b,2412MHz,Ant0



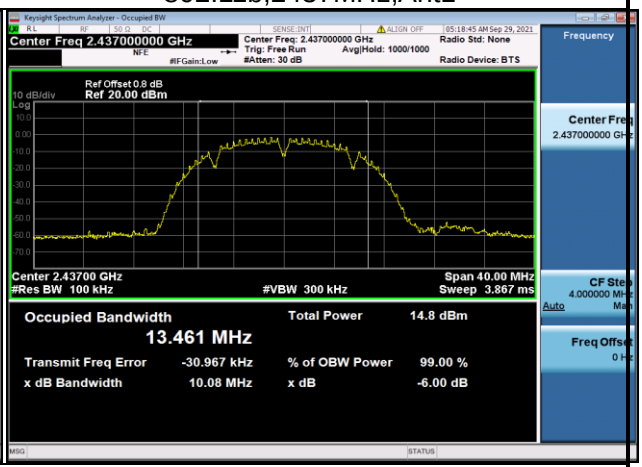

802.11b,2412MHz,Ant1



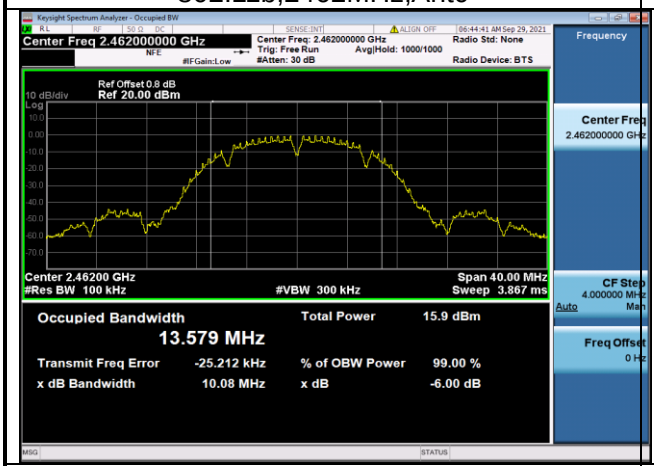

802.11b,2437MHz,Ant0



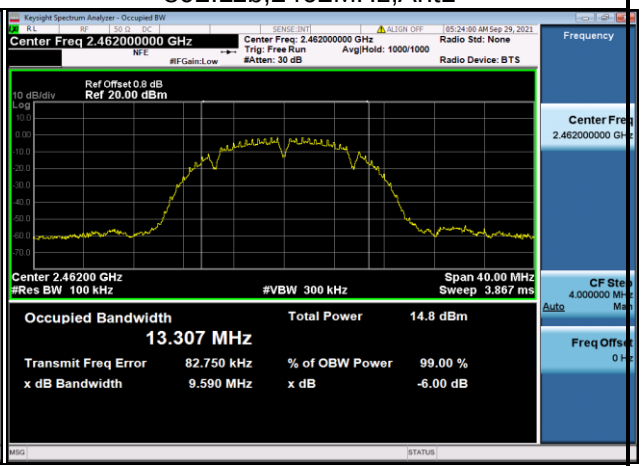

802.11b,2437MHz,Ant1




802.11b,2462MHz,Ant0



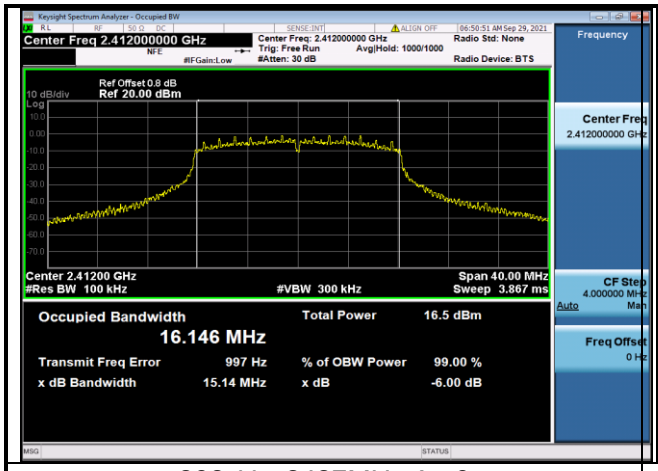

802.11b,2462MHz,Ant1



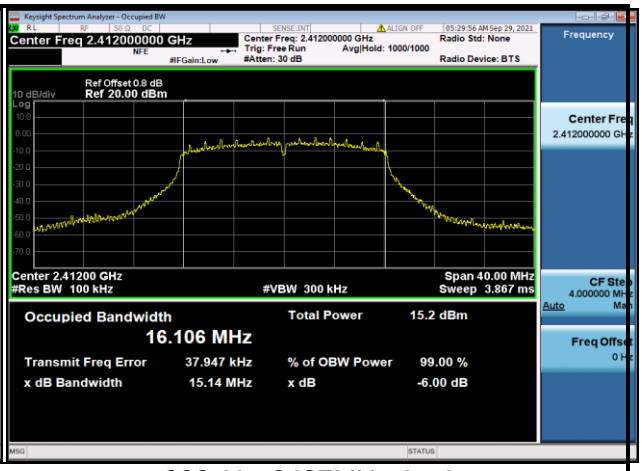

802.11g,2412MHz,Ant0

802.11g,2412MHz,Ant1

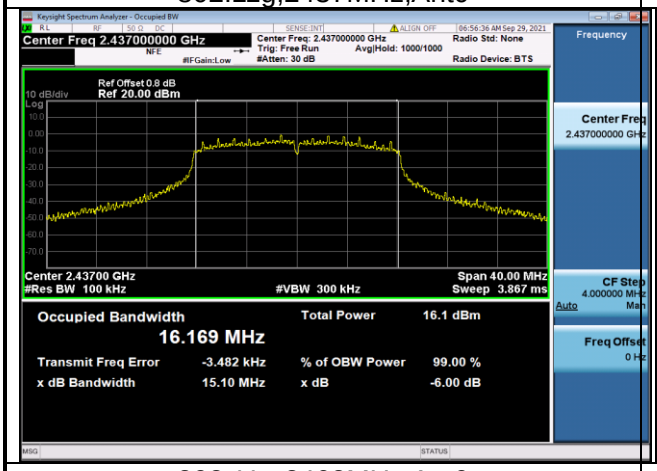
## TEST REPORT



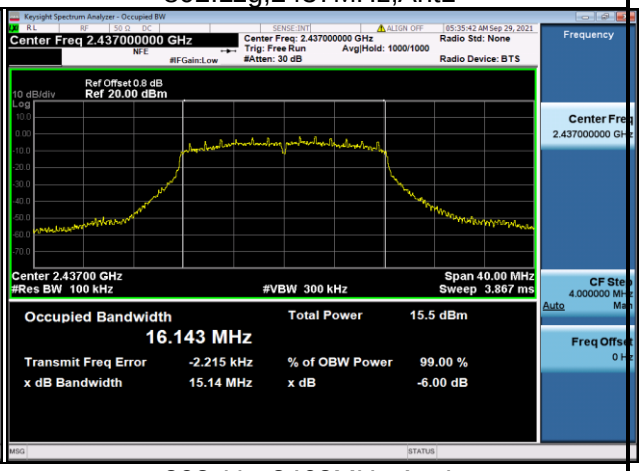

802.11g,2437MHz,Ant0



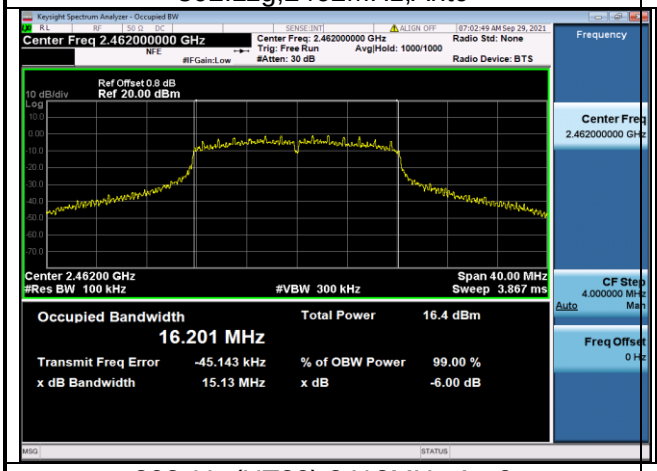

802.11g,2437MHz,Ant1



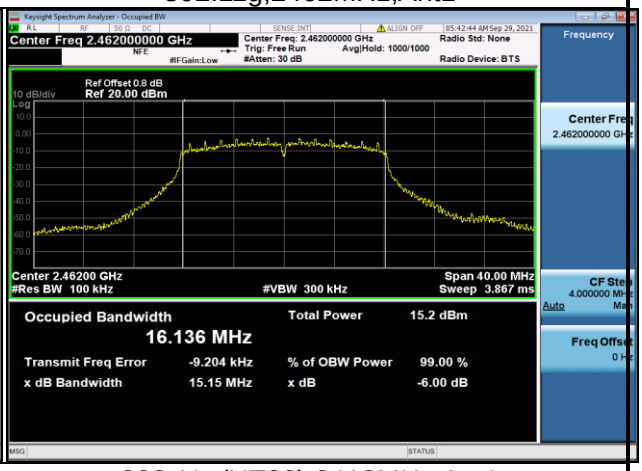

802.11g,2462MHz,Ant0




802.11g,2462MHz,Ant1




802.11n(HT20),2412MHz,Ant0




802.11n(HT20),2412MHz,Ant1