

Report on the Radio Testing  
For  
Pace plc  
on  
2.4 GHz WiFi Module  
Report no. TRA-028175-47-01A  
27th November 2015

RF915 2.0



Report Number: TRA-028175-47-01A  
Issue: A

REPORT ON THE RADIO TESTING OF A  
Pace plc  
2.4 GHz WiFi Module  
WITH RESPECT TO SPECIFICATION  
FCC 47CFR 15.247

TEST DATE: 1st October - 13th November 2015

Written by: D Winstanley

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Date: 2015.11.27 09:53:00 Z

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27th November 2015

Disclaimers:

- [1] THIS DOCUMENT MAY BE REPRODUCED ONLY IN ITS ENTIRETY AND WITHOUT CHANGE  
[2] THE RESULTS CONTAINED IN THIS DOCUMENT RELATE ONLY TO THE ITEM(S) TESTED

RF915 2.0

## 1 Revision Record

| <i>Issue Number</i> | <i>Issue Date</i>     | <i>Revision History</i> |
|---------------------|-----------------------|-------------------------|
| A                   | 27th November<br>2015 | Original                |
|                     |                       |                         |

## 2 Summary

|                             |                                                                                                                                                          |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| TEST REPORT NUMBER:         | TRA-028175-47-01A                                                                                                                                        |
| WORKS ORDER NUMBER          | TRA-028175-00                                                                                                                                            |
| PURPOSE OF TEST:            | USA: Testing of radio frequency equipment per the relevant authorization procedure of chapter 47 of CFR (code of federal regulations) Part 2, subpart J. |
| TEST SPECIFICATION(S):      | 47CFR15.247                                                                                                                                              |
| EQUIPMENT UNDER TEST (EUT): | 2.4 GHz WiFi Module                                                                                                                                      |
| FCC IDENTIFIER:             | NQ82G401                                                                                                                                                 |
| EUT SERIAL NUMBER:          | Unknown                                                                                                                                                  |
| MANUFACTURER/AGENT:         | Pace plc                                                                                                                                                 |
| ADDRESS:                    | Victoria Road<br>Saltaire<br>Shipley<br>West Yorkshire<br>BD18 3LF<br>United Kingdom                                                                     |
| CLIENT CONTACT:             | Robert Turner<br>☎ 01274 537080<br>✉ robert.turner@pace.com                                                                                              |
| ORDER NUMBER:               | Not Applicable                                                                                                                                           |
| TEST DATE:                  | 1st October - 13th November 2015                                                                                                                         |
| TESTED BY:                  | D Winstanley, A Tosif<br>Element                                                                                                                         |

## 2.1 Test Summary

| Test Method and Description                                                             |      | Requirement Clause<br>47CFR15 | Applicable<br>to this<br>equipment  | Result / Note |
|-----------------------------------------------------------------------------------------|------|-------------------------------|-------------------------------------|---------------|
| Radiated spurious emissions<br>(restricted bands of operation and<br>cabinet radiation) |      | 15.205                        | <input checked="" type="checkbox"/> | Note 2        |
| AC power line conducted<br>emissions                                                    |      | 15.207                        | <input type="checkbox"/>            | Note 1        |
| Occupied bandwidth                                                                      |      | 15.247(a)(2)                  | <input checked="" type="checkbox"/> | Pass          |
| Conducted carrier power                                                                 | Peak | 15.247(b)(3)                  | <input type="checkbox"/>            | Pass          |
|                                                                                         | Max. |                               | <input checked="" type="checkbox"/> |               |
| Conducted / radiated RF power<br>out-of-band                                            |      | 15.247(d)                     | <input checked="" type="checkbox"/> | Pass          |
| Power spectral density,<br>conducted                                                    |      | 15.247(e)                     | <input checked="" type="checkbox"/> | Pass          |
| Calculation of duty correction                                                          |      | 15.35(c)                      | <input type="checkbox"/>            | N/A           |

### Notes:

1. See Test report TRA-028175-47-06A. AC Power line Conducted emissions were recorded For complete device with all radio devices active simultaneously
2. See Test report TRA-028175-47-00A. Radiated spurious emissions results for device containing the 2.4 GHz WiFi module detailed in this report.

The results contained in this report relate only to the items tested, in the condition at time of test, and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

The apparatus was set up and exercised using the configurations, modes of operation and arrangements defined in this report only. Any modifications made are identified in Section 8 of this report.

Particular operating modes, apparatus monitoring methods and performance criteria required by the standards tested to have been performed except where identified in Section 5.2 of this test report (Deviations from Test Standards).

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## 4 Introduction

This report TRA-028175-47-01A presents the results of the antenna port conducted Radio testing on a Pace plc, 2.4 GHz WiFi Module to specification 47CFR15 Radio Frequency Devices.

The testing was carried out for Pace plc by Element, at the address(es) detailed below.

|                          |                                                                                             |                                     |                                                                                                    |
|--------------------------|---------------------------------------------------------------------------------------------|-------------------------------------|----------------------------------------------------------------------------------------------------|
| <input type="checkbox"/> | Element Hull<br>Unit E<br>South Orbital Trading Park<br>Hedon Road<br>Hull<br>HU9 1NJ<br>UK | <input checked="" type="checkbox"/> | Element Skelmersdale<br>Unit 1<br>Pendle Place<br>Skelmersdale<br>West Lancashire<br>WN8 9PN<br>UK |
|--------------------------|---------------------------------------------------------------------------------------------|-------------------------------------|----------------------------------------------------------------------------------------------------|

This report details the configuration of the equipment, the test methods used and any relevant modifications where appropriate.

All test and measurement equipment under the control of the laboratory and requiring calibration is subject to an established programme and procedures to control and maintain measurement standards. The quality management system meets the principles of ISO 9001, and has quality control procedures for monitoring the validity of tests undertaken. Records and sufficient detail are retained to establish an audit trail of calibration records relating to its test results for a defined period. Under control of the established calibration programme, key quantities or values of the test & measurement instrumentation are within specification and comply with the relevant traceable internationally recognised and appropriate standard specifications, which are UKAS calibrated as such where these properties have a significant effect on results. Participation in inter-laboratory comparisons and proficiency testing ensures satisfactory correlation of results conform to Elements own procedures, as well as statistical techniques for analysis of test data providing the appropriate confidence in measurements.

Throughout this report EUT denotes equipment under test.

FCC Site Listing:

Element is accredited for the above sites under the US-EU MRA, Designation number UK0009.

The test site requirements of ANSI C63.4-2014 are met up to 1GHz.

The test site SVSWR requirements of CISPR 16-1-4:2010 are met over the frequency range 1 GHz to 18 GHz.

## **5 Test Specifications**

### **5.1 Normative References**

- FCC 47 CFR Ch. I – Part 15 – Radio Frequency Devices.
- ANSI C63.10-2013 – American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.
- ANSI C63.4-2014 – American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
- Industry Canada RSS-210, Issue 8, December 2010 – Licence-exempt Radio Apparatus (All Frequency Bands): Category I Equipment.
- Industry Canada RSS-Gen, Issue 4, November 2014 – General Requirements for Compliance of Radio Apparatus

### **5.2 Deviations from Test Standards**

There were no deviations from the test standard.

## 6 Glossary of Terms

|               |                                                                  |
|---------------|------------------------------------------------------------------|
| <b>§</b>      | denotes a section reference from the standard, not this document |
| <b>AC</b>     | Alternating Current                                              |
| <b>ANSI</b>   | American National Standards Institute                            |
| <b>BW</b>     | bandwidth                                                        |
| <b>C</b>      | Celsius                                                          |
| <b>CFR</b>    | Code of Federal Regulations                                      |
| <b>CW</b>     | Continuous Wave                                                  |
| <b>dB</b>     | decibel                                                          |
| <b>dBm</b>    | dB relative to 1 milliwatt                                       |
| <b>DC</b>     | Direct Current                                                   |
| <b>DSSS</b>   | Direct Sequence Spread Spectrum                                  |
| <b>EIRP</b>   | Equivalent Isotropically Radiated Power                          |
| <b>ERP</b>    | Effective Radiated Power                                         |
| <b>EUT</b>    | Equipment Under Test                                             |
| <b>FCC</b>    | Federal Communications Commission                                |
| <b>FHSS</b>   | Frequency Hopping Spread Spectrum                                |
| <b>Hz</b>     | hertz                                                            |
| <b>IC</b>     | Industry Canada                                                  |
| <b>ITU</b>    | International Telecommunication Union                            |
| <b>LBT</b>    | Listen Before Talk                                               |
| <b>m</b>      | metre                                                            |
| <b>max</b>    | maximum                                                          |
| <b>MIMO</b>   | Multiple Input and Multiple Output                               |
| <b>min</b>    | minimum                                                          |
| <b>MRA</b>    | Mutual Recognition Agreement                                     |
| <b>N/A</b>    | Not Applicable                                                   |
| <b>PCB</b>    | Printed Circuit Board                                            |
| <b>PDF</b>    | Portable Document Format                                         |
| <b>Pt-mpt</b> | Point-to-multipoint                                              |
| <b>Pt-pt</b>  | Point-to-point                                                   |
| <b>RF</b>     | Radio Frequency                                                  |
| <b>RH</b>     | Relative Humidity                                                |
| <b>RMS</b>    | Root Mean Square                                                 |
| <b>Rx</b>     | receiver                                                         |
| <b>s</b>      | second                                                           |
| <b>SVSWR</b>  | Site Voltage Standing Wave Ratio                                 |
| <b>Tx</b>     | transmitter                                                      |
| <b>UKAS</b>   | United Kingdom Accreditation Service                             |
| <b>V</b>      | volt                                                             |
| <b>W</b>      | watt                                                             |
| <b>Ω</b>      | ohm                                                              |

## 7 Equipment Under Test

### 7.1 EUT Identification

- Name: 2.4 GHz WiFi Module
- Serial Number: Unknown
- Model Number: 2G401
- Build Revision
  - 260-2251000 Layer 3 TV DDR3 Main Board Assembly
  - 262-2227000 Layer 3 TV Server Front Panel assembly
  - 260-2264000 PCA 2.4G WIFI MODULE
  - 260-E397020 PCA 5G WIFI
- Software Version
  - Video Soc
  - BootLoader: CBL v1.74
  - Firmware version: v1.161
  - Bluetooth Driver version: BCM20705B0\_002.001.014.0590.0927
  - CableModem
  - CM Bootloader : v1.144
  - CM App: v1.144-ltw

### 7.2 System Equipment

Equipment listed below is host device required for equipment functionality and/or monitoring during testing. The compliance levels achieved in this report relate only to the EUT and not items given in the following list.

- Name: DOCSIS 3 HYBRID GATEWAY STB
- Sample Number: S03
- Serial Number: PAN900000146
- Model Number: ND7506

### 7.3 EUT Mode of Operation

#### 7.3.1 Transmission

WiFi transmitter control was via commands sent through a terminal program (Tera Term in this case). The commands provided by the manufacturer setup the device into a permanent transmit mode. The commands allowed adjustment of the following parameters of significant interest.

| Modulation Scheme | Channel | Power setting | Data Rate | Transmit Chain Setting          |
|-------------------|---------|---------------|-----------|---------------------------------|
| 802.11b           | 1       | 106           | 11 mbps   | txchain 1, txchain 2, txchain 4 |
|                   | 6       | 106           | 11 mbps   | txchain 1, txchain 2, txchain 4 |
|                   | 11      | 106           | 11 mbps   | txchain 1, txchain 2, txchain 4 |
|                   |         |               |           |                                 |
| 802.11 g          | 1       | 95            | 54 mbps   | txchain 1, txchain 2, txchain 4 |
|                   | 6       | 104           | 54 mbps   | txchain 1, txchain 2, txchain 4 |
|                   | 11      | 104           | 54 mbps   | txchain 1, txchain 2, txchain 4 |
|                   |         |               |           |                                 |
| 802.11n HT20      | 1       | 90            | MCS7      | txchain 1, txchain 2, txchain 4 |
|                   | 6       | 107           | MCS7      | txchain 1, txchain 2, txchain 4 |
|                   | 11      | 106           | MCS7      | txchain 1, txchain 2, txchain 4 |
|                   |         |               |           |                                 |
| 802.11n HT40      | 3       | 88            | MCS23     | txchain 1, txchain 2, txchain 4 |
|                   | 6       | 103           | MCS23     | txchain 1, txchain 2, txchain 4 |
|                   | 9       | 91            | MCS23     | txchain 1, txchain 2, txchain 4 |

txchain 1 : Chain 0 only

txchain 2 : Chain 1 only

txchain 4 : Chain 2 only

txchain 7 : Chains 0, 1 and 2 simultaneously

Where applicable only the selected chain under test is active, unused chains are terminated in a load.

## 7.4 EUT Radio Parameters

### 7.4.1 General

|                                                                             |                             |
|-----------------------------------------------------------------------------|-----------------------------|
| <b>Frequency of operation:</b>                                              | 2400 – 2483.5 MHz           |
| <b>Modulation type(s):</b>                                                  | DSSS, OFDM                  |
| <b>Occupied channel bandwidth(s):</b>                                       | 20 MHz – 40 MHz             |
| <b>Channel spacing:</b>                                                     | 5 MHz                       |
| <b>Declared output power(s):</b>                                            | Up to 1 Watt (conducted)    |
| <b>Warning against use of alternative antennas in user manual (yes/no):</b> | Not Applicable              |
| <b>Location of notice for license exempt use:</b>                           | Label / user manual / both. |
| <b>Duty cycle:</b>                                                          | Upto 100 %                  |

### 7.4.2 Antennas

Antennas are not taken into account for determining the power settings as recorded 7.3.1.

Antennas must be assessed on a case by case basis to determine if correction is required to take antenna array gain into account.

### 7.4.3 Product specific declarations

|                                                                               |                |
|-------------------------------------------------------------------------------|----------------|
| <b>Multiple antenna configuration(s), e.g. MIMO:</b>                          | Not Applicable |
| <b>Fixed pt-pt operations (yes/no):</b>                                       | No             |
| <b>Installation manual advice on pt-pt operational restrictions (yes/no):</b> | Not Applicable |
| <b>Fixed pt-mpt operations (yes/no):</b>                                      | Not Applicable |
| <b>Simultaneous tx (yes/no):</b>                                              | Yes            |

## 7.5 EUT Description

The NQ82G401 is a cost effective PCIe 2.4GHz WiFi module board. It is for incorporation into products designed on behalf of or by Pace Plc, not for sale or distribution as a standalone module.

It incorporates the Broadcom BCM4360 IC and supports 3x3 MIMO and is capable of supporting 802.11a/b/g/n modes. The module utilises the Skyworks SKY65971 Low noise Amplifier and is designed for use in the US.

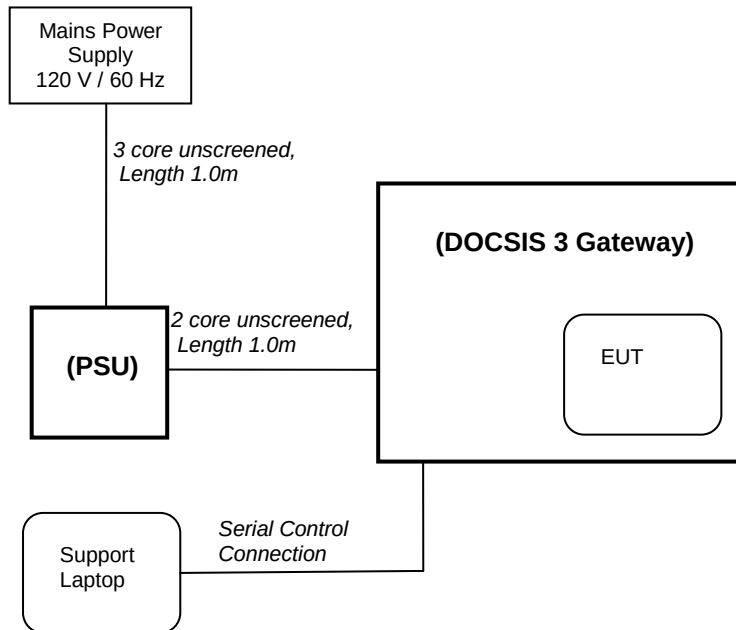
## **8 Modifications**

No modifications were performed during this assessment.

## 9 EUT Test Setup

### 9.1 Block Diagram

The following diagram shows basic EUT interconnections with cable type and cable lengths identified:



## 10 General Technical Parameters

### 10.1 Normal Conditions

The E U T was tested under the normal environmental conditions of the test laboratory, except where otherwise stated. The normal power source applied was approx. 5 V dc from the adaptor / 3V dc from alkaline batteries / 110 V ac, 60 Hz, from the mains.

### 10.2 Varying Test Conditions

There are no specific frequency stability requirements for the type of device. The results contained in this report demonstrate that the occupied bandwidth is contained within the authorised band and the manufacturer has declared sufficient frequency stability (refer to section 7.4).

Variation of supply voltage is required to ensure stability of the declared output power. During carrier power testing the following variations were made:

|                                     | <b>Category</b> | <b>Nominal</b>  | <b>Variation</b> |
|-------------------------------------|-----------------|-----------------|------------------|
| <input checked="" type="checkbox"/> | Mains           | 110 V ac +/-2 % | 85 % and 115 %   |
| <input type="checkbox"/>            | Battery         | New battery     | N/A              |

## 11 Occupied Bandwidth

### 11.1 Definition

The emission bandwidth (-6 dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated -6 dB below the maximum in-band spectral density of the modulated signal.

### 11.2 Test Parameters

|                                                              |                                                |
|--------------------------------------------------------------|------------------------------------------------|
| Test Location:                                               | Element Skelmersdale                           |
| Test Chamber:                                                | Radio Lab                                      |
| Test Standard and Clause:                                    | FCC: ANSI C63.10-2013, Clause 11.8, KDB 558074 |
| EUT Channels / Frequencies Measured:                         | 2412 MHz / 2437 MHz / 2462 MHz                 |
| EUT Channel Bandwidths:                                      | 20 MHz / 40 MHz                                |
| Deviations From Standard:                                    | None                                           |
| Measurement BW:<br>(FCC requirement: 100 kHz)                | 100 kHz                                        |
| Spectrum Analyzer Video BW:<br>(requirement at least 3x RBW) | 300 kHz                                        |
| Measurement Span:<br>(requirement 2 to 5 times OBW)          | 20 MHz<br>25 MHz<br>50 MHz                     |
| Measurement Detector:                                        | Peak                                           |

### Environmental Conditions (Normal Environment)

|                    |                                   |
|--------------------|-----------------------------------|
| Temperature: 24 °C | +15 °C to +35 °C (as declared)    |
| Humidity: 32 % RH  | 20 % RH to 75 % RH (as declared)  |
| Supply: 110V ac    | 110 V ac $\pm 10$ % (as declared) |

### 11.3 Test Limit

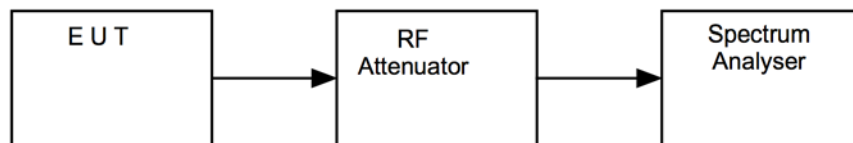
The minimum -6 dB bandwidth shall be at least 500 kHz.

### 11.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure iii, the bandwidth of the EUT was measured on a spectrum analyser.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst-case configuration in each bandwidth.

**Figure iii Test Setup**



### 11.5 Test Equipment

| <i>Type of Equipment</i> | <i>Maker/Supplier</i> | <i>Model Number</i> | <i>Element Number</i> | <i>Calibration Due Date</i> |
|--------------------------|-----------------------|---------------------|-----------------------|-----------------------------|
| Spectrum Analyser        | R&S                   | FSU26               | REF909                | 13/02/2016                  |
| Spectrum Analyser        | R&S                   | FSU26               | UH405                 | 11/05/2016                  |
| 10 dB Attenuator         | Radiall               | R411820121          | N/A                   | In Use                      |
| 20 dB Attenuator         | Radiall               | R411810121          | N/A                   | In Use                      |

## 11.6 Test Results

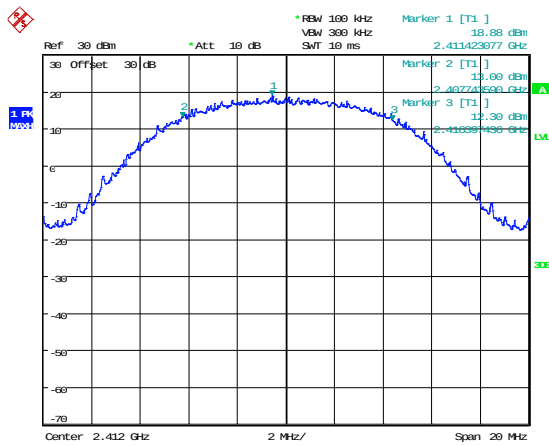
| <b>FCC 15.247. Modulation: 802.11b; Data rate:11Mbps</b> |                      |                            |                            |                            |               |
|----------------------------------------------------------|----------------------|----------------------------|----------------------------|----------------------------|---------------|
| <b>Channel Frequency (MHz)</b>                           | <b>Power setting</b> | <b>F<sub>L</sub> (MHz)</b> | <b>F<sub>H</sub> (MHz)</b> | <b>6dB Bandwidth (kHz)</b> | <b>Result</b> |
| 2412                                                     | 106                  | 2407.744                   | 2416.397                   | 8653.846                   | PASS          |
| 2437                                                     | 106                  | 2432.635                   | 2441.673                   | 9038.462                   | PASS          |
| 2462                                                     | 106                  | 2457.487                   | 2466.378                   | 8891.026                   | PASS          |

| <b>FCC 15.247. Modulation: 802.11g; Data rate:54Mbps</b> |                      |                            |                            |                            |               |
|----------------------------------------------------------|----------------------|----------------------------|----------------------------|----------------------------|---------------|
| <b>Channel Frequency (MHz)</b>                           | <b>Power setting</b> | <b>F<sub>L</sub> (MHz)</b> | <b>F<sub>H</sub> (MHz)</b> | <b>6dB Bandwidth (kHz)</b> | <b>Result</b> |
| 2412                                                     | 95                   | 2403.777                   | 2420.123                   | 16346.154                  | PASS          |
| 2437                                                     | 104                  | 2428.876                   | 2445.199                   | 16323.257                  | PASS          |
| 2462                                                     | 104                  | 2453.877                   | 2470.095                   | 16217.949                  | PASS          |

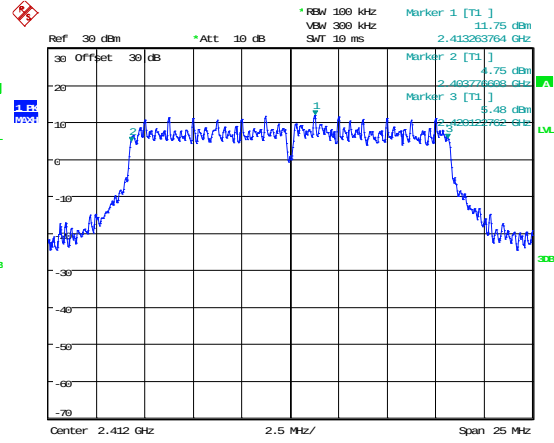
| <b>FCC 15.247. Modulation: 802.11N HT20; Data rate:MCS7</b> |                      |                            |                            |                            |               |
|-------------------------------------------------------------|----------------------|----------------------------|----------------------------|----------------------------|---------------|
| <b>Channel Frequency (MHz)</b>                              | <b>Power setting</b> | <b>F<sub>L</sub> (MHz)</b> | <b>F<sub>H</sub> (MHz)</b> | <b>6dB Bandwidth (kHz)</b> | <b>Result</b> |
| 2412                                                        | 90                   | 2403.144                   | 2420.884                   | 17740.384                  | PASS          |
| 2437                                                        | 107                  | 2428.130                   | 2445.871                   | 17740.385                  | PASS          |
| 2462                                                        | 106                  | 2453.156                   | 2470.856                   | 17700.321                  | PASS          |

| <b>FCC 15.247. Modulation: 802.11N HT40; Data rate:MCS23</b> |                      |                            |                            |                            |               |
|--------------------------------------------------------------|----------------------|----------------------------|----------------------------|----------------------------|---------------|
| <b>Channel Frequency (MHz)</b>                               | <b>Power setting</b> | <b>F<sub>L</sub> (MHz)</b> | <b>F<sub>H</sub> (MHz)</b> | <b>6dB Bandwidth (kHz)</b> | <b>Result</b> |
| 2422                                                         | 88                   | 2403.726                   | 2440.248                   | 36522.435                  | PASS          |
| 2437                                                         | 103                  | 2418.705                   | 2455.328                   | 36623.354                  | PASS          |
| 2452                                                         | 91                   | 2434.356                   | 2470.237                   | 35881.410                  | PASS          |

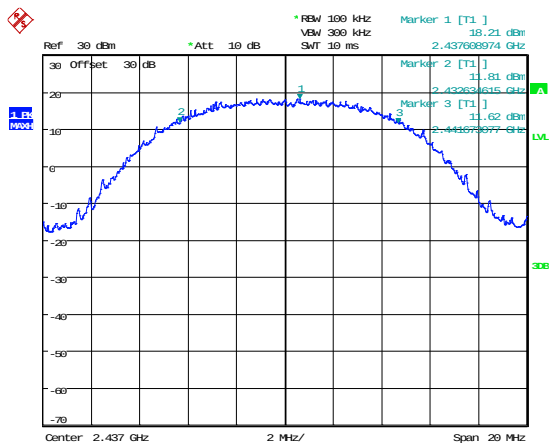
## 802.11b



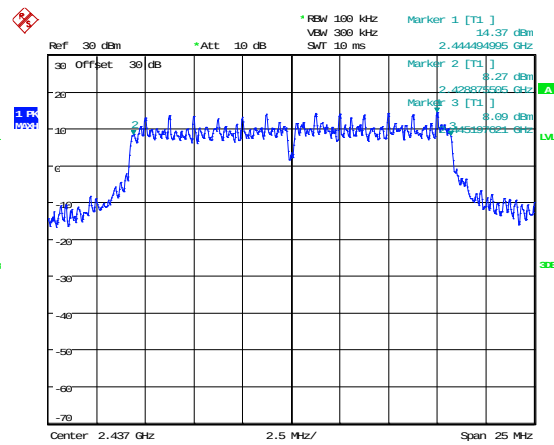
## 802.11g



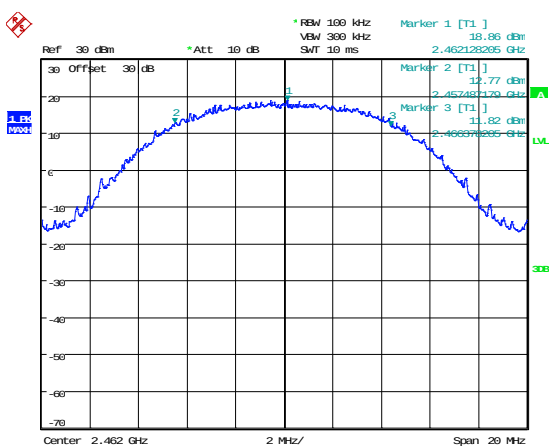
## 2412 MHz



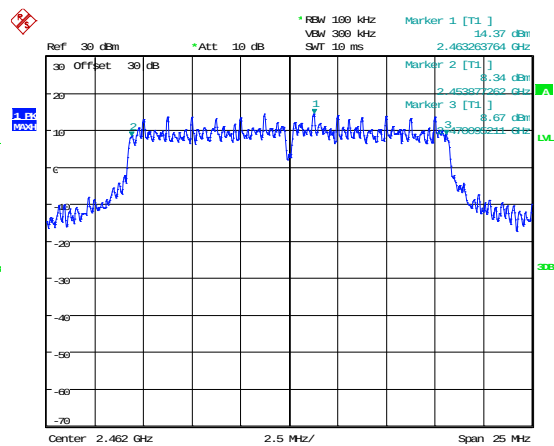
## 2412 MHz



## 2437 MHz



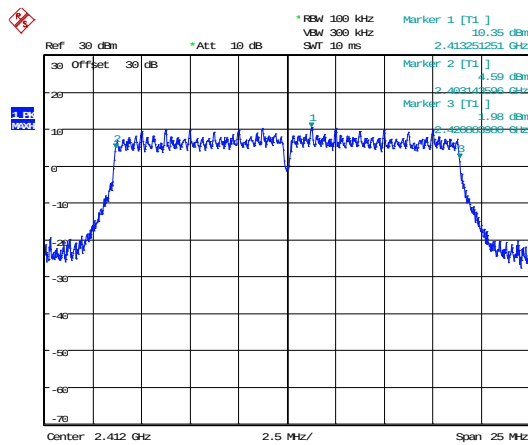
## 2437MHz



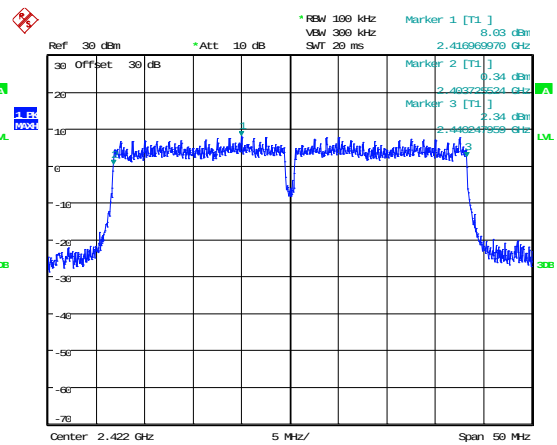
## 2462 MHz

## 2462 MHz

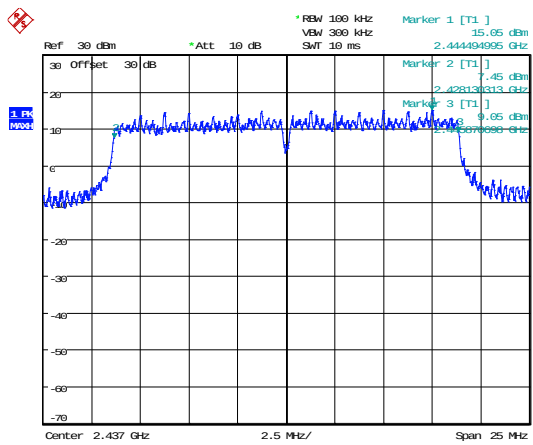
802.11N HT20



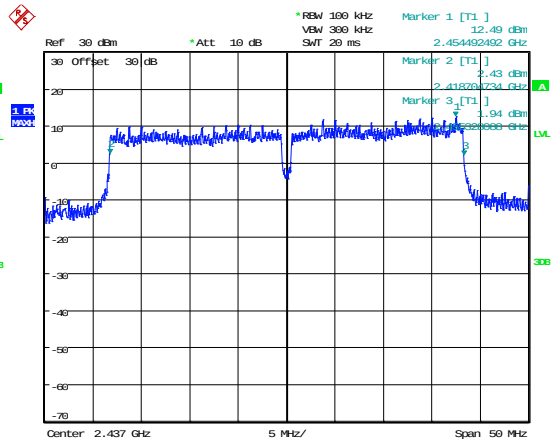
802.11N HT40



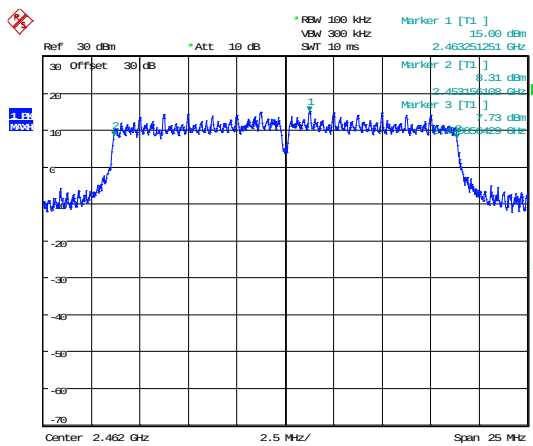
2412 MHz



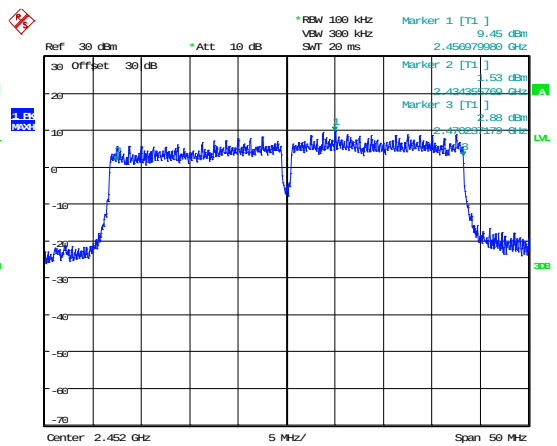
2422 MHz



2437 MHz



2437MHz



2462 MHz

2452 MHz

## 12 Maximum conducted output power

### 12.1 Definition

The maximum peak conducted output power is defined as the maximum power level measured with a peak detector using a filter with width and shape of which is sufficient to accept the signal bandwidth.

The maximum conducted output power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level.

### 12.2 Test Parameters

|                                         |                                                                                                 |
|-----------------------------------------|-------------------------------------------------------------------------------------------------|
| Test Location:                          | Element Skelmersdale                                                                            |
| Test Chamber:                           | Radio Lab                                                                                       |
| Test Standard and Clause:               | ANSI C63.10-2013, Clause 11.9.2, KDB 558074                                                     |
| EUT Channels / Frequencies Measured:    | 2412 MHz / 2437 MHz / 2462 MHz                                                                  |
| EUT Occupied Bandwidths:                | 20 MHz / 40 MHz                                                                                 |
| EUT Duty Cycle:                         | <98%                                                                                            |
| Deviations From Standard:               | None                                                                                            |
| Measurement BW:                         | 200 kHz<br>500 kHz<br>1 MHz<br>13MHz                                                            |
| Measurement Span:                       | 25 MHz<br>100MHz                                                                                |
| Measurement Detector:                   | RMS                                                                                             |
| Voltage Extreme Environment Test Range: | Mains Power = 85 % and 115 % of Nominal (FCC only requirement);<br>Battery Power = new battery. |

### Environmental Conditions (Normal Environment)

|                    |                                  |
|--------------------|----------------------------------|
| Temperature: xx °C | +15 °C to +35 °C (as declared)   |
| Humidity: xx % RH  | 20 % RH to 75 % RH (as declared) |

### 12.3 Test Limit

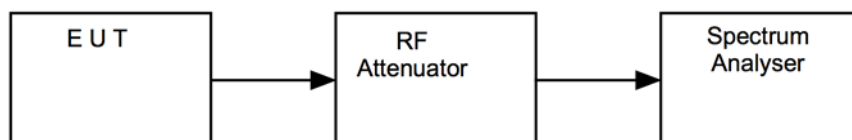
For systems employing digital modulation techniques operating in the bands 902 to 928 MHz, 2400 to 2483.5 MHz and 5725 to 5850 MHz, the maximum peak conducted output power shall not exceed 1 W.

## 12.4 Test Method

The EUT was setup as per section 9 of this report and, as per Figure iv, the analyser was used to measure each antenna output in turn, having taken account of all path losses. The resolution bandwidth of the spectrum analyser was set between 1 and 5 % of the EUT occupied bandwidth and the analyser band power function used to calculate the average power. The results were summed as in the tables be2412.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst case configuration in each bandwidth.

**Figure iv Test Set-up**



## 12.5 Test Equipment

| <i>Type of Equipment</i> | <i>Maker/Supplier</i> | <i>Model Number</i> | <i>Element Number</i> | <i>Calibration Due Date</i> |
|--------------------------|-----------------------|---------------------|-----------------------|-----------------------------|
| Spectrum Analyser        | R&S                   | FSU26               | REF909                | 13/02/2016                  |
| Spectrum Analyser        | R&S                   | FSU26               | UH405                 | 11/05/2016                  |
| 10 dB Attenuator         | Radiall               | R411820121          | N/A                   | In Use                      |
| 20 dB Attenuator         | Radiall               | R411810121          | N/A                   | In Use                      |

## 12.6 Test Results

| Modulation: 802.11b; Data rate: 11Mbps |               |               |                      |                 |            |
|----------------------------------------|---------------|---------------|----------------------|-----------------|------------|
| Channel (MHz)                          | Power setting | Antenna Chain | Analyzer Level (dBm) | Cable loss (dB) | Power (mW) |
| 2412                                   | 106           | 0             | -5.33                | 30              | 293.09     |
|                                        |               | 1             | -4.82                | 30              | 329.61     |
|                                        |               | 2             | -4.78                | 30              | 332.66     |
| Total:                                 |               |               |                      |                 | 955.36     |
| Result:                                |               |               |                      |                 | PASS       |
| 2437                                   | 106           | 0             | -5.31                | 30              | 294.44     |
|                                        |               | 1             | -4.80                | 30              | 331.13     |
|                                        |               | 2             | -4.71                | 30              | 338.06     |
| Total:                                 |               |               |                      |                 | 963.64     |
| Result:                                |               |               |                      |                 | PASS       |
| 2462                                   | 106           | 0             | -5.26                | 30              | 297.85     |
|                                        |               | 1             | -4.84                | 30              | 328.10     |
|                                        |               | 2             | -4.54                | 30              | 351.56     |
| Total:                                 |               |               |                      |                 | 977.51     |
| Result:                                |               |               |                      |                 | PASS       |

| Modulation: 802.11g; Data rate: 54Mbps |               |               |                      |                 |            |
|----------------------------------------|---------------|---------------|----------------------|-----------------|------------|
| Channel MHz                            | Power setting | Antenna Chain | Analyzer Level (dBm) | Cable loss (dB) | Power (mW) |
| 2412                                   | 95            | 0             | -1.24                | 23              | 149.97     |
|                                        |               | 1             | -0.38                | 23              | 182.81     |
|                                        |               | 2             | -0.20                | 23              | 190.55     |
| Total:                                 |               |               |                      |                 | 523.32     |
| Result:                                |               |               |                      |                 | PASS       |
| 2437                                   | 104           | 0             | 1.63                 | 23              | 290.40     |
|                                        |               | 1             | 2.09                 | 23              | 322.85     |
|                                        |               | 2             | 2.35                 | 23              | 342.77     |
| Total:                                 |               |               |                      |                 | 956.02     |
| Result:                                |               |               |                      |                 | PASS       |
| 2462                                   | 104           | 0             | 1.60                 | 23              | 288.40     |
|                                        |               | 1             | 2.23                 | 23              | 333.43     |
|                                        |               | 2             | 2.26                 | 23              | 335.74     |
| Total:                                 |               |               |                      |                 | 957.57     |
| Result:                                |               |               |                      |                 | PASS       |

| Modulation: 802.11n HT20; Data rate: MCS7 |               |               |                      |                 |            |
|-------------------------------------------|---------------|---------------|----------------------|-----------------|------------|
| Channel MHz                               | Power setting | Antenna Chain | Analyzer Level (dBm) | Cable loss (dB) | Power (mW) |
| 2412                                      | 90            | 0             | -3.09                | 23              | 97.95      |
|                                           |               | 1             | -2.16                | 23              | 121.34     |
|                                           |               | 2             | -2.00                | 23              | 125.89     |
| Total:                                    |               |               |                      |                 | 345.18     |
| Result:                                   |               |               |                      |                 | PASS       |
| 2437                                      | 107           | 0             | 1.82                 | 23              | 303.39     |
|                                           |               | 1             | 2.26                 | 23              | 335.74     |
|                                           |               | 2             | 2.53                 | 23              | 357.27     |
| Total:                                    |               |               |                      |                 | 996.40     |
| Result:                                   |               |               |                      |                 | PASS       |
| 2462                                      | 106           | 0             | 1.59                 | 23              | 287.74     |
|                                           |               | 1             | 2.26                 | 23              | 335.74     |
|                                           |               | 2             | 2.32                 | 23              | 340.41     |
| Total:                                    |               |               |                      |                 | 963.89     |
| Result:                                   |               |               |                      |                 | PASS       |

| Modulation: 802.11n HT40; Data rate: MCS23 |               |               |                      |                 |            |
|--------------------------------------------|---------------|---------------|----------------------|-----------------|------------|
| Channel MHz                                | Power setting | Antenna Chain | Analyzer Level (dBm) | Cable loss (dB) | Power (mW) |
| 2422                                       | 88            | 0             | -1.95                | 23              | 127.35     |
|                                            |               | 1             | -1.44                | 23              | 143.22     |
|                                            |               | 2             | -1.14                | 23              | 153.46     |
| Total:                                     |               |               |                      |                 | 424.03     |
| Result:                                    |               |               |                      |                 | PASS       |
| 2437                                       | 103           | 0             | 1.59                 | 23              | 287.74     |
|                                            |               | 1             | 2.12                 | 23              | 325.09     |
|                                            |               | 2             | 2.38                 | 23              | 345.14     |
| Total:                                     |               |               |                      |                 | 957.97     |
| Result:                                    |               |               |                      |                 | PASS       |
| 2452                                       | 91            | 0             | -1.10                | 23              | 154.88     |
|                                            |               | 1             | -0.79                | 23              | 166.34     |
|                                            |               | 2             | -0.52                | 23              | 177.01     |
| Total:                                     |               |               |                      |                 | 489.23     |
| Result:                                    |               |               |                      |                 | PASS       |

## 13 Out-of-band and conducted spurious emissions

### 13.1 Definition

#### *Out-of-band emission.*

Emission on a frequency or frequencies immediately outside the necessary bandwidth that results from the modulation process but excluding spurious emissions.

#### *Spurious emission.*

Emission on a frequency or frequencies that are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products, and frequency conversion products, but exclude out-of-band emissions.

### 13.2 Test Parameters

|                                                              |                                |
|--------------------------------------------------------------|--------------------------------|
| Test Location:                                               | Element Skelmersdale           |
| Test Chamber:                                                | Radio Lab                      |
| Test Standard and Clause:                                    | ANSI C63.10-2013, Clause 11.11 |
| EUT Channels / Frequencies Measured:                         | 2412 MHz / 2437 MHz / 2462 MHz |
| EUT Channel Bandwidths:                                      | 20 MHz / 40 MHz                |
| Deviations From Standard:                                    | None                           |
| Measurement BW:                                              | 100 kHz                        |
| Spectrum Analyzer Video BW:<br>(requirement at least 3x RBW) | >100kHz                        |
| Measurement Detector:                                        | Peak                           |
| Measurement Range:                                           | 9kHz to 25 GHz                 |

#### Environmental Conditions (Normal Environment)

|                    |                                   |
|--------------------|-----------------------------------|
| Temperature: 24 °C | +15 °C to +35 °C (as declared)    |
| Humidity: 32 % RH  | 20 % RH to 75 % RH (as declared)  |
| Supply: 110V ac    | 230 V ac $\pm 10$ % (as declared) |

### 13.3 Test Limit

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in FCC 47CFR15.209(a).

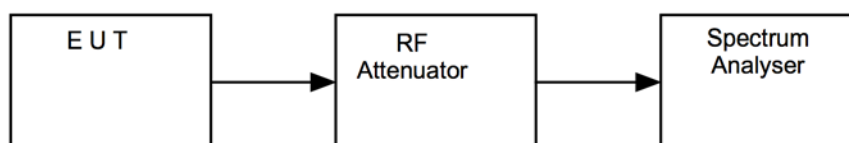
### 13.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure v, the emissions from the EUT were measured on a spectrum analyser.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst case configuration in each bandwidth.

Reference and band edge plots taken for chain with highest output power level, spurious emissions plots taken for each chain, plot for chain with highest output power only recorded below

**Figure v Test Setup**

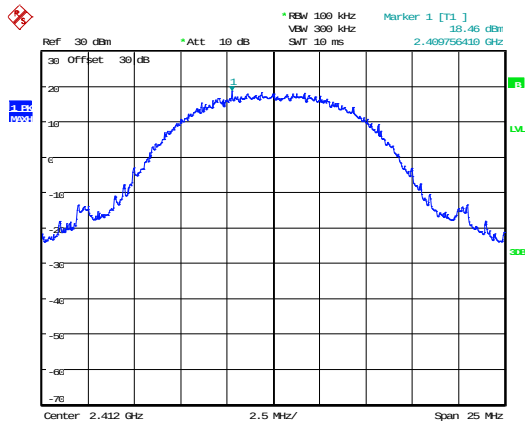


### 13.5 Test Equipment

| <i>Type of Equipment</i> | <i>Maker/Supplier</i> | <i>Model Number</i> | <i>Element Number</i> | <i>Calibration Due Date</i> |
|--------------------------|-----------------------|---------------------|-----------------------|-----------------------------|
| Spectrum Analyser        | R&S                   | FSU26               | REF909                | 13/02/2016                  |
| Spectrum Analyser        | R&S                   | FSU26               | UH405                 | 11/05/2016                  |
| 10 dB Attenuator         | Radiall               | R411820121          | N/A                   | In Use                      |
| 20 dB Attenuator         | Radiall               | R411810121          | N/A                   | In Use                      |

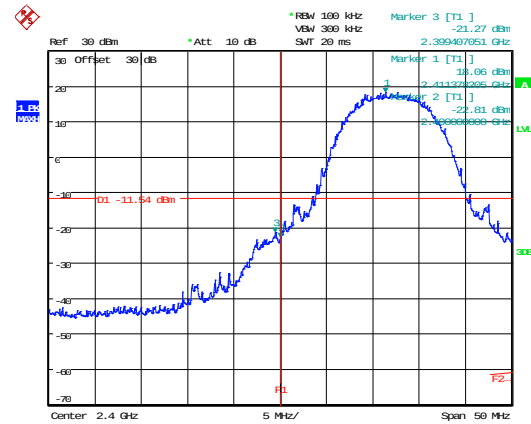
### 13.6 Test Results

| Modulation: 802.11b; Data rate: 11Mbps – 2412 MHz |                          |                      |                      |             |             |        |
|---------------------------------------------------|--------------------------|----------------------|----------------------|-------------|-------------|--------|
| Channel Frequency (MHz)                           | Emission Frequency (MHz) | Analyzer Level (dBm) | Emission Level (dBm) | Limit (dBm) | Margin (dB) | Result |
| No Significant Emissions Within 20 dB of Limit    |                          |                      |                      |             |             | PASS   |



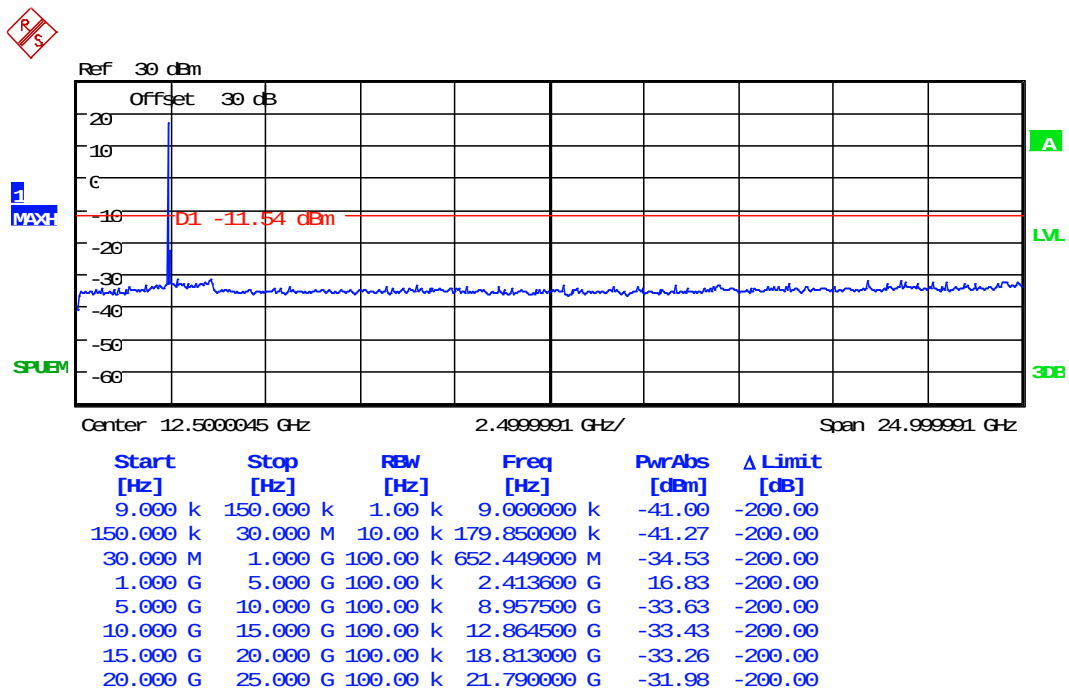
Date: 15.OCT.2015 15:34:41

Reference

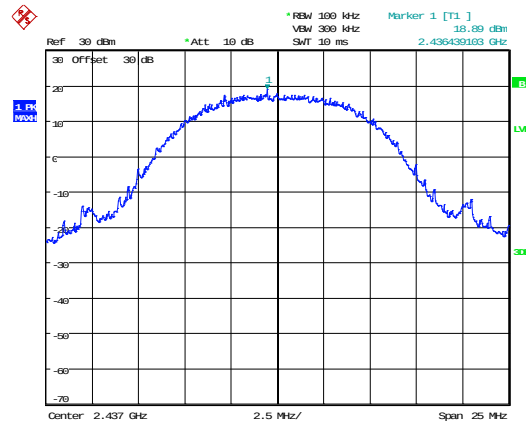


Date: 15.OCT.2015 15:36:32

Bandedge

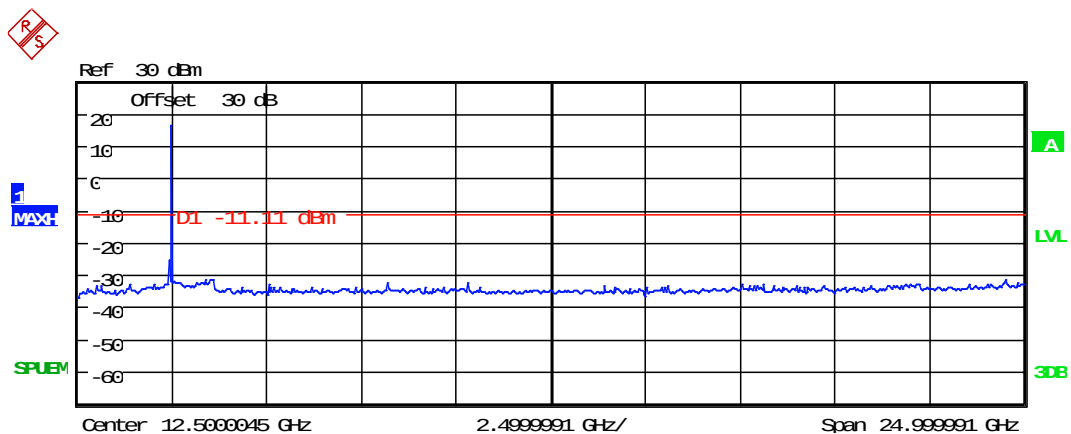


| Modulation: 802.11b; Data rate: 11Mbps – 2437 MHz |                          |                      |                      |             |             |        |
|---------------------------------------------------|--------------------------|----------------------|----------------------|-------------|-------------|--------|
| Channel Frequency (MHz)                           | Emission Frequency (MHz) | Analyzer Level (dBm) | Emission Level (dBm) | Limit (dBm) | Margin (dB) | Result |
| No Significant Emissions Within 20 dB of Limit    |                          |                      |                      |             |             | PASS   |



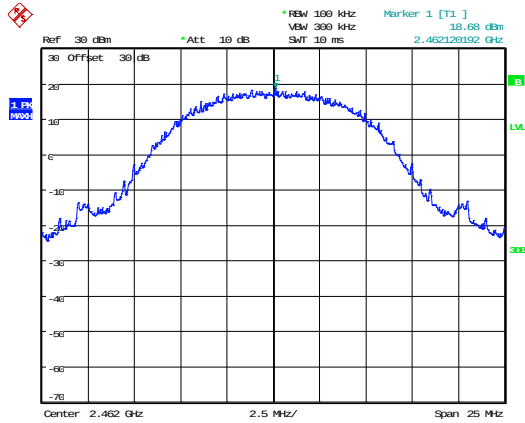
Date: 16.OCT.2015 13:58:44

## Reference



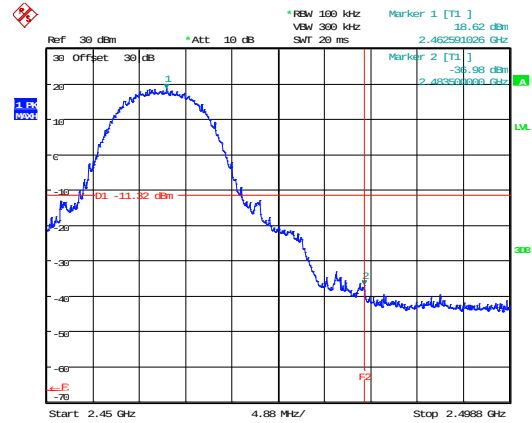
| Start [Hz] | Stop [Hz] | RBW [Hz] | Freq [Hz]    | PwrAbs [dBm] | Δ Limit [dB] |
|------------|-----------|----------|--------------|--------------|--------------|
| 9.000 k    | 150.000 k | 1.00 k   | 9.451923 k   | -38.92       | -200.00      |
| 150.000 k  | 30.000 M  | 10.00 k  | 182.835000 k | -37.59       | -200.00      |
| 30.000 M   | 1.000 G   | 100.00 k | 473.775000 M | -33.56       | -200.00      |
| 1.000 G    | 5.000 G   | 100.00 k | 2.436400 G   | 16.36        | -200.00      |
| 5.000 G    | 10.000 G  | 100.00 k | 8.192000 G   | -32.66       | -200.00      |
| 10.000 G   | 15.000 G  | 100.00 k | 10.296500 G  | -32.54       | -200.00      |
| 15.000 G   | 20.000 G  | 100.00 k | 17.546500 G  | -32.97       | -200.00      |
| 20.000 G   | 25.000 G  | 100.00 k | 24.506000 G  | -31.69       | -200.00      |

| Modulation: 802.11b; Data rate: 11Mbps – 2462MHz |                          |                      |                      |             |             |        |
|--------------------------------------------------|--------------------------|----------------------|----------------------|-------------|-------------|--------|
| Channel Frequency (MHz)                          | Emission Frequency (MHz) | Analyzer Level (dBm) | Emission Level (dBm) | Limit (dBm) | Margin (dB) | Result |
| No Significant Emissions Within 20 dB of Limit   |                          |                      |                      |             |             | PASS   |



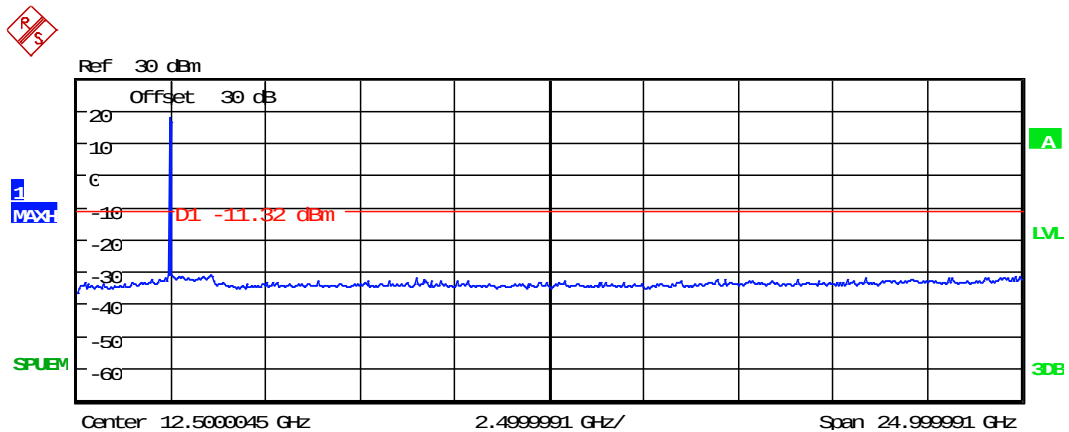
Date: 15.OCT.2015 16:18:15

Reference



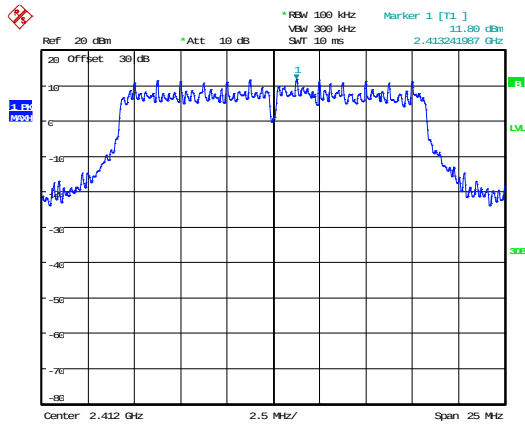
Date: 15.OCT.2015 16:19:46

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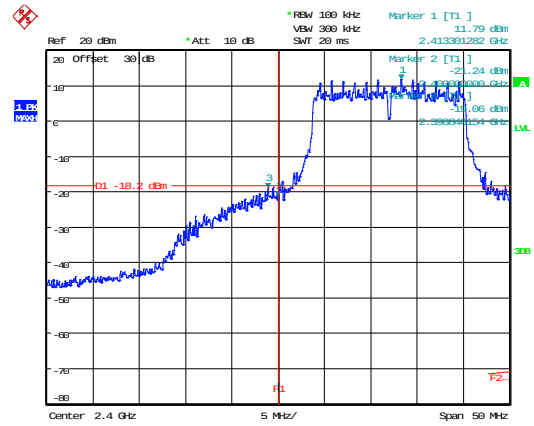
| Start [Hz] | Stop [Hz] | RBW [Hz] | Freq [Hz]    | PwrAbs [dBm] | Δ Limit [dB] |
|------------|-----------|----------|--------------|--------------|--------------|
| 9.000 k    | 150.000 k | 1.00 k   | 9.000000 k   | -37.77       | -200.00      |
| 150.000 k  | 30.000 M  | 10.00 k  | 167.910000 k | -36.71       | -200.00      |
| 30.000 M   | 1.000 G   | 100.00 k | 184.618000 M | -33.80       | -200.00      |
| 1.000 G    | 5.000 G   | 100.00 k | 2.463200 G   | 17.74        | -200.00      |
| 5.000 G    | 10.000 G  | 100.00 k | 8.987500 G   | -32.39       | -200.00      |
| 10.000 G   | 15.000 G  | 100.00 k | 10.045000 G  | -32.98       | -200.00      |
| 15.000 G   | 20.000 G  | 100.00 k | 19.072000 G  | -32.52       | -200.00      |
| 20.000 G   | 25.000 G  | 100.00 k | 24.857000 G  | -31.70       | -200.00      |

| Modulation: 802.11g; Data rate: 54Mbps – 2412 MHz |                          |                      |                      |             |             |        |
|---------------------------------------------------|--------------------------|----------------------|----------------------|-------------|-------------|--------|
| Channel Frequency (MHz)                           | Emission Frequency (MHz) | Analyzer Level (dBm) | Emission Level (dBm) | Limit (dBm) | Margin (dB) | Result |
| No Significant Emissions Within 20 dB of Limit    |                          |                      |                      |             |             | PASS   |



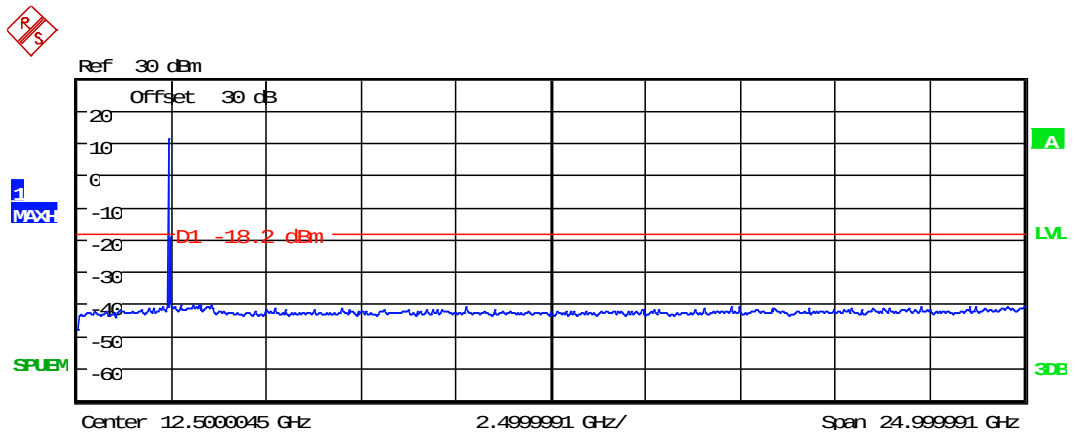
Date: 15.OCT.2015 15:28:19

Reference



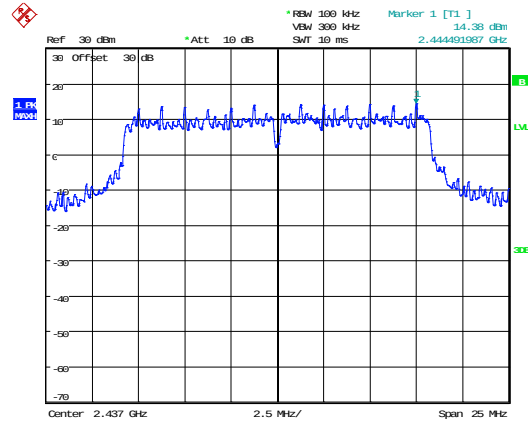
Date: 15.OCT.2015 15:29:13

Bandedge



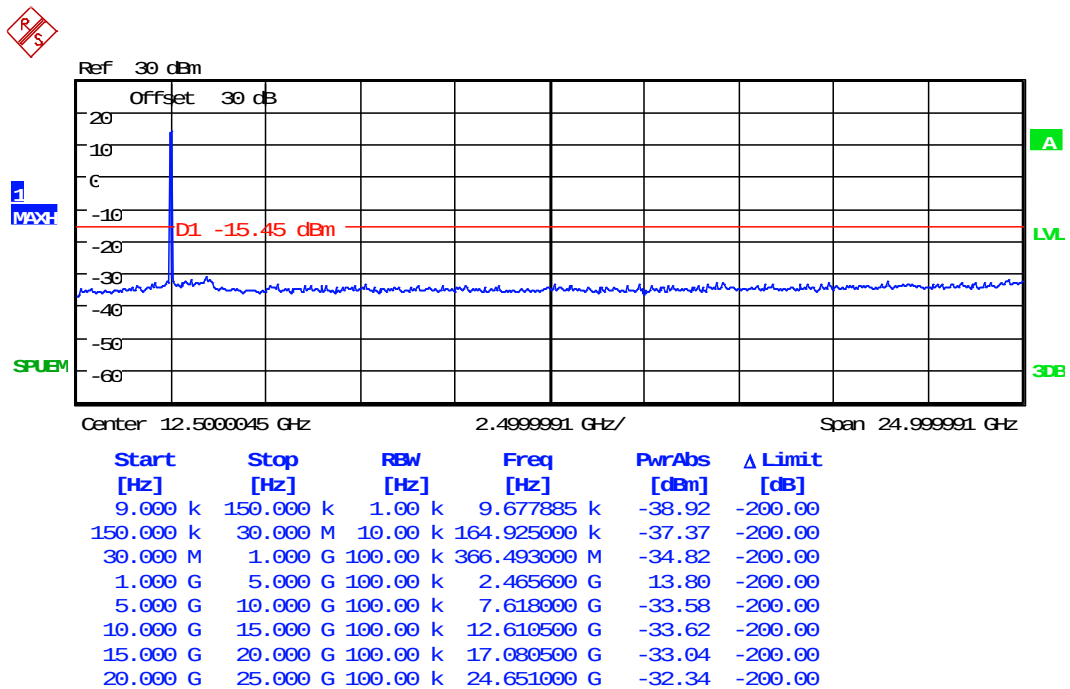
| Start [Hz] | Stop [Hz] | RBW [Hz] | Freq [Hz]    | PwrAbs [dBm] | Δ Limit [dB] |
|------------|-----------|----------|--------------|--------------|--------------|
| 9.000 k    | 150.000 k | 1.00 k   | 10.581731 k  | -48.77       | -200.00      |
| 150.000 k  | 30.000 M  | 10.00 k  | 197.760000 k | -48.33       | -200.00      |
| 30.000 M   | 1.000 G   | 100.00 k | 457.188000 M | -42.47       | -200.00      |
| 1.000 G    | 5.000 G   | 100.00 k | 2.414400 G   | 11.18        | -200.00      |
| 5.000 G    | 10.000 G  | 100.00 k | 5.208000 G   | -41.71       | -200.00      |
| 10.000 G   | 15.000 G  | 100.00 k | 10.258000 G  | -41.32       | -200.00      |
| 15.000 G   | 20.000 G  | 100.00 k | 17.447500 G  | -41.27       | -200.00      |
| 20.000 G   | 25.000 G  | 100.00 k | 23.724500 G  | -40.91       | -200.00      |

| Modulation: 802.11g; Data rate: 54Mbps – 2437 MHz |                          |                      |                      |             |             |        |
|---------------------------------------------------|--------------------------|----------------------|----------------------|-------------|-------------|--------|
| Channel Frequency (MHz)                           | Emission Frequency (MHz) | Analyzer Level (dBm) | Emission Level (dBm) | Limit (dBm) | Margin (dB) | Result |
| No Significant Emissions Within 20 dB of Limit    |                          |                      |                      |             |             | PASS   |

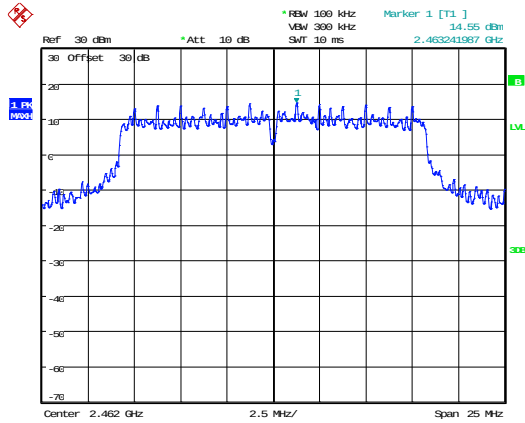


Date: 16.OCT.2015 14:08:12

## Reference

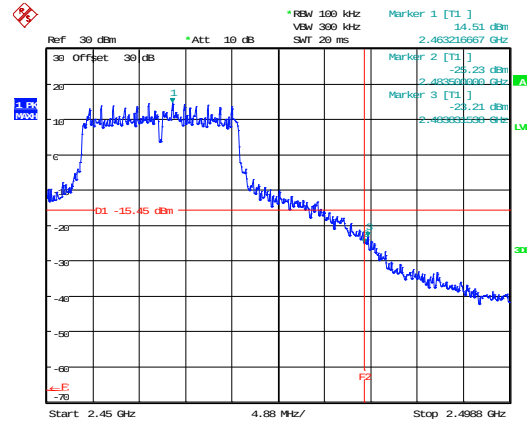


| Modulation: 802.11g; Data rate: 54Mbps – 2462MHz |                          |                      |                      |             |             |        |
|--------------------------------------------------|--------------------------|----------------------|----------------------|-------------|-------------|--------|
| Channel Frequency (MHz)                          | Emission Frequency (MHz) | Analyzer Level (dBm) | Emission Level (dBm) | Limit (dBm) | Margin (dB) | Result |
| No Significant Emissions Within 20 dB of Limit   |                          |                      |                      |             |             | PASS   |



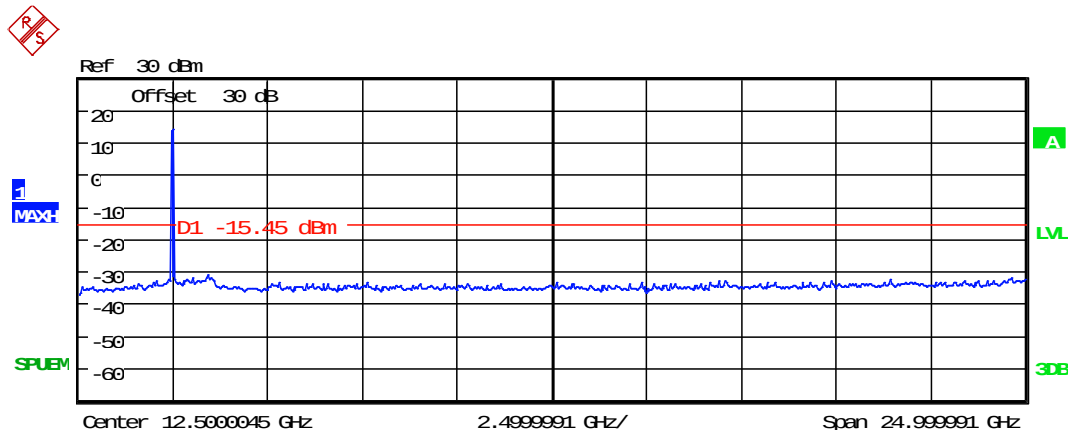
Date: 15.OCT.2015 16:20:42

Reference



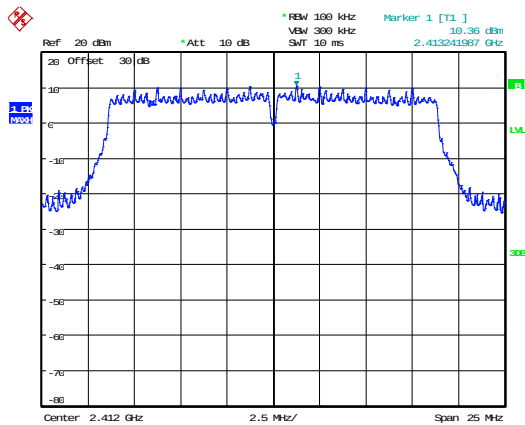
Date: 15.OCT.2015 16:21:14

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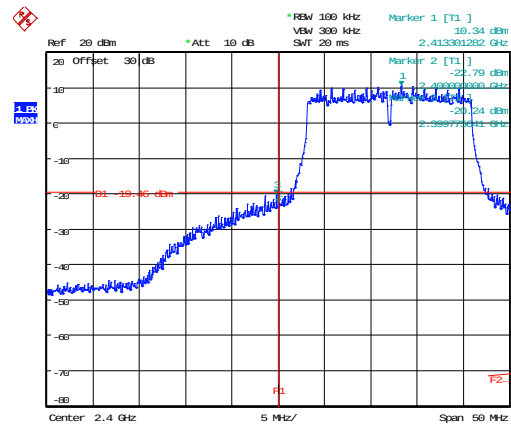


| Start [Hz] | Stop [Hz] | RBW [Hz] | Freq [Hz]    | PwrAbs [dBm] | Δ Limit [dB] |
|------------|-----------|----------|--------------|--------------|--------------|
| 9.000 k    | 150.000 k | 1.00 k   | 9.677885 k   | -38.92       | -200.00      |
| 150.000 k  | 30.000 M  | 10.00 k  | 164.925000 k | -37.37       | -200.00      |
| 30.000 M   | 1.000 G   | 100.00 k | 366.493000 M | -34.82       | -200.00      |
| 1.000 G    | 5.000 G   | 100.00 k | 2.465600 G   | 13.80        | -200.00      |
| 5.000 G    | 10.000 G  | 100.00 k | 7.618000 G   | -33.58       | -200.00      |
| 10.000 G   | 15.000 G  | 100.00 k | 12.610500 G  | -33.62       | -200.00      |
| 15.000 G   | 20.000 G  | 100.00 k | 17.080500 G  | -33.04       | -200.00      |
| 20.000 G   | 25.000 G  | 100.00 k | 24.651000 G  | -32.34       | -200.00      |

| Modulation: 802.11n HT20; Data rate: MCS7 – 2412 MHz |                          |                      |                      |             |             |        |
|------------------------------------------------------|--------------------------|----------------------|----------------------|-------------|-------------|--------|
| Channel Frequency (MHz)                              | Emission Frequency (MHz) | Analyzer Level (dBm) | Emission Level (dBm) | Limit (dBm) | Margin (dB) | Result |
| No Significant Emissions Within 20 dB of Limit       |                          |                      |                      |             |             | PASS   |



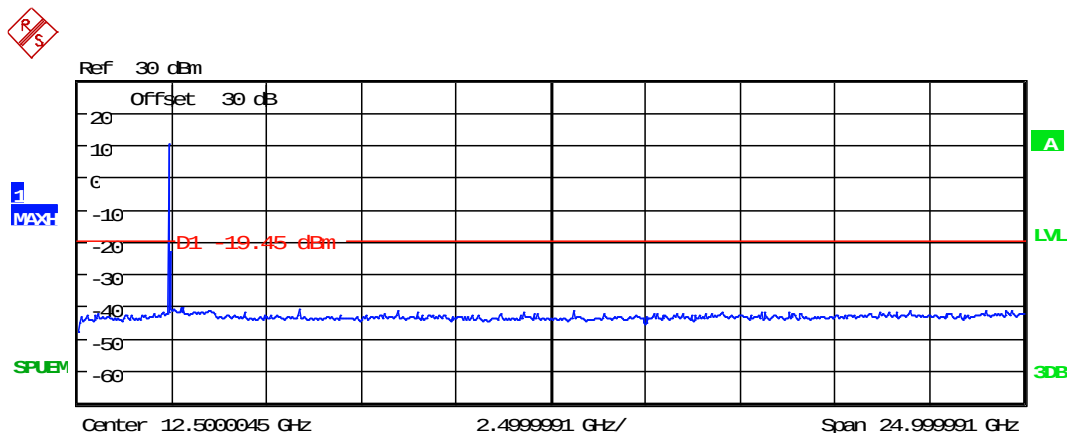
Date: 15.OCT.2015 15:21:19



Date: 15.OCT.2015 15:22:02

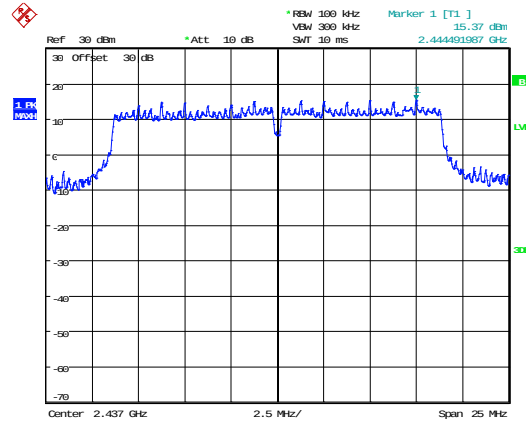
Reference

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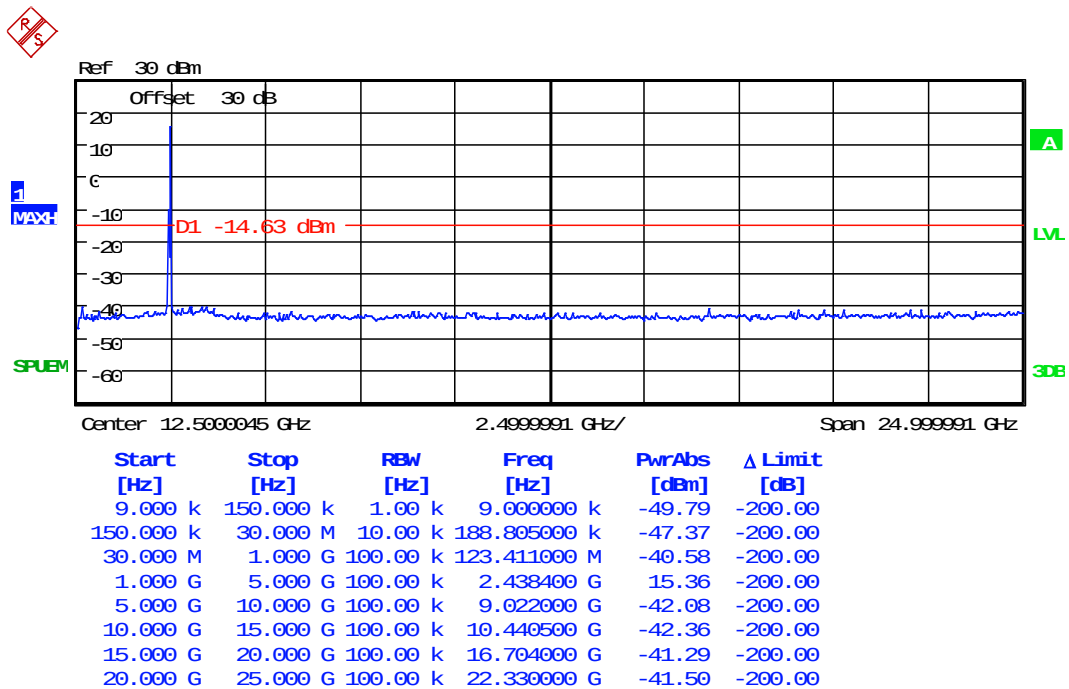
| Start [Hz] | Stop [Hz] | RBW [Hz] | Freq [Hz]    | PwrAbs [dBm] | Δ Limit [dB] |
|------------|-----------|----------|--------------|--------------|--------------|
| 9.000 k    | 150.000 k | 1.00 k   | 10.355769 k  | -49.24       | -200.00      |
| 150.000 k  | 30.000 M  | 10.00 k  | 167.910000 k | -48.33       | -200.00      |
| 30.000 M   | 1.000 G   | 100.00 k | 517.716000 M | -42.76       | -200.00      |
| 1.000 G    | 5.000 G   | 100.00 k | 2.414400 G   | 9.88         | -200.00      |
| 5.000 G    | 10.000 G  | 100.00 k | 5.838000 G   | -41.20       | -200.00      |
| 10.000 G   | 15.000 G  | 100.00 k | 13.107500 G  | -41.61       | -200.00      |
| 15.000 G   | 20.000 G  | 100.00 k | 18.146500 G  | -41.93       | -200.00      |
| 20.000 G   | 25.000 G  | 100.00 k | 24.523500 G  | -41.49       | -200.00      |

| Modulation: 802.11n HT20; Data rate: MCS7 – 2437 MHz |                          |                      |                      |             |             |        |
|------------------------------------------------------|--------------------------|----------------------|----------------------|-------------|-------------|--------|
| Channel Frequency (MHz)                              | Emission Frequency (MHz) | Analyzer Level (dBm) | Emission Level (dBm) | Limit (dBm) | Margin (dB) | Result |
| No Significant Emissions Within 20 dB of Limit       |                          |                      |                      |             |             | PASS   |

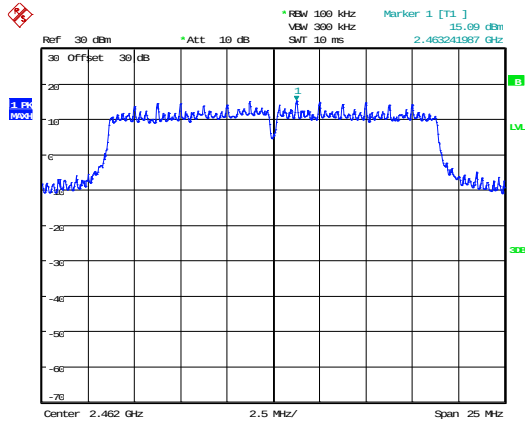


Date: 16.OCT.2015 14:31:55

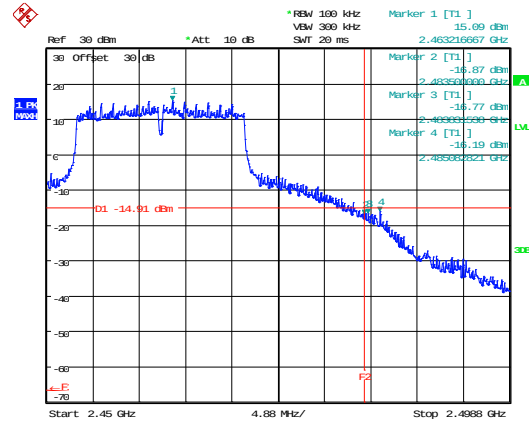
## Reference



| Modulation: 802.11n HT20; Data rate: MCS7 – 2462MHz |                          |                      |                      |             |             |        |
|-----------------------------------------------------|--------------------------|----------------------|----------------------|-------------|-------------|--------|
| Channel Frequency (MHz)                             | Emission Frequency (MHz) | Analyzer Level (dBm) | Emission Level (dBm) | Limit (dBm) | Margin (dB) | Result |
| No Significant Emissions Within 20 dB of Limit      |                          |                      |                      |             |             | PASS   |



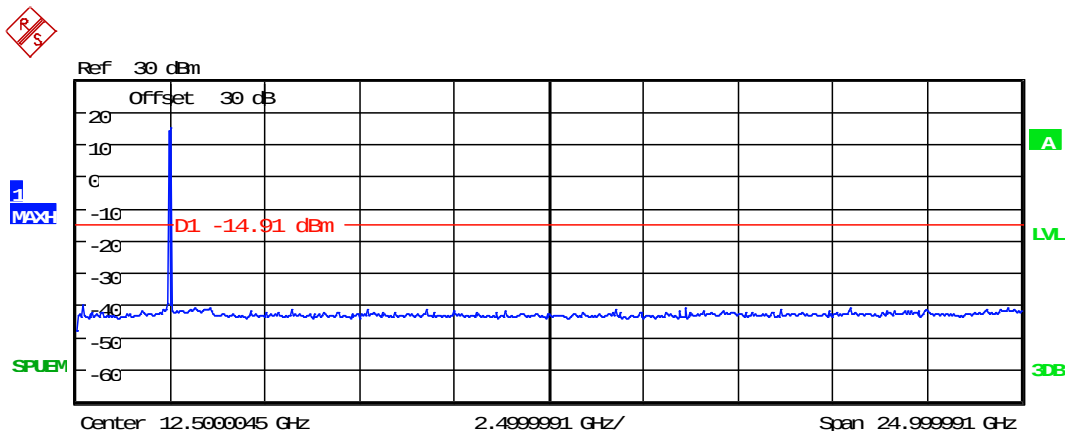
Date: 15.OCT.2015 16:15:13



Date: 15.OCT.2015 16:16:38

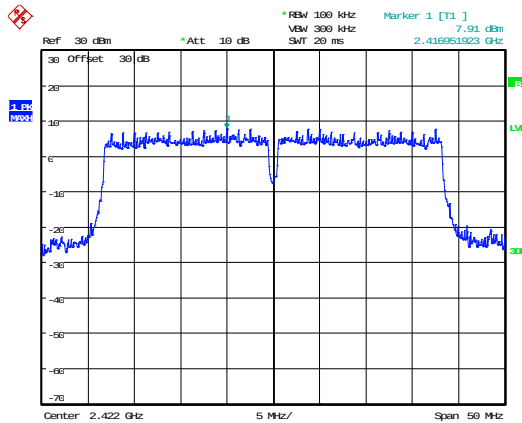
Reference

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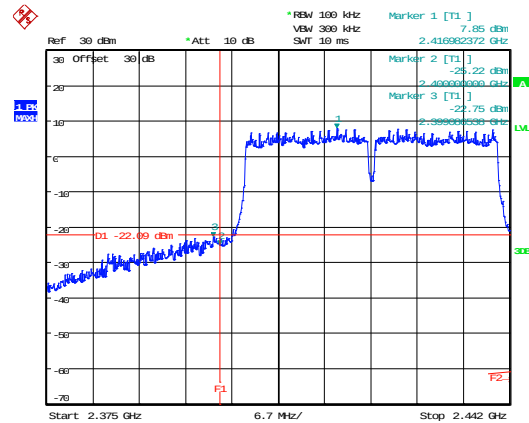
| Start [Hz] | Stop [Hz] | RBW [Hz] | Freq [Hz]    | PwrAbs [dBm] | Δ Limit [dB] |
|------------|-----------|----------|--------------|--------------|--------------|
| 9.000 k    | 150.000 k | 1.00 k   | 9.225962 k   | -49.51       | -200.00      |
| 150.000 k  | 30.000 M  | 10.00 k  | 197.760000 k | -48.33       | -200.00      |
| 30.000 M   | 1.000 G   | 100.00 k | 147.176000 M | -39.99       | -200.00      |
| 1.000 G    | 5.000 G   | 100.00 k | 2.466800 G   | 14.53        | -200.00      |
| 5.000 G    | 10.000 G  | 100.00 k | 5.677500 G   | -41.39       | -200.00      |
| 10.000 G   | 15.000 G  | 100.00 k | 14.273000 G  | -41.39       | -200.00      |
| 15.000 G   | 20.000 G  | 100.00 k | 16.105500 G  | -41.22       | -200.00      |
| 20.000 G   | 25.000 G  | 100.00 k | 24.625500 G  | -41.16       | -200.00      |

| Modulation: 802.11n HT40; Data rate: MCS23 – 2422 MHz |                          |                      |                      |             |             |        |
|-------------------------------------------------------|--------------------------|----------------------|----------------------|-------------|-------------|--------|
| Channel Frequency (MHz)                               | Emission Frequency (MHz) | Analyzer Level (dBm) | Emission Level (dBm) | Limit (dBm) | Margin (dB) | Result |
| No Significant Emissions Within 20 dB of Limit        |                          |                      |                      |             |             | PASS   |



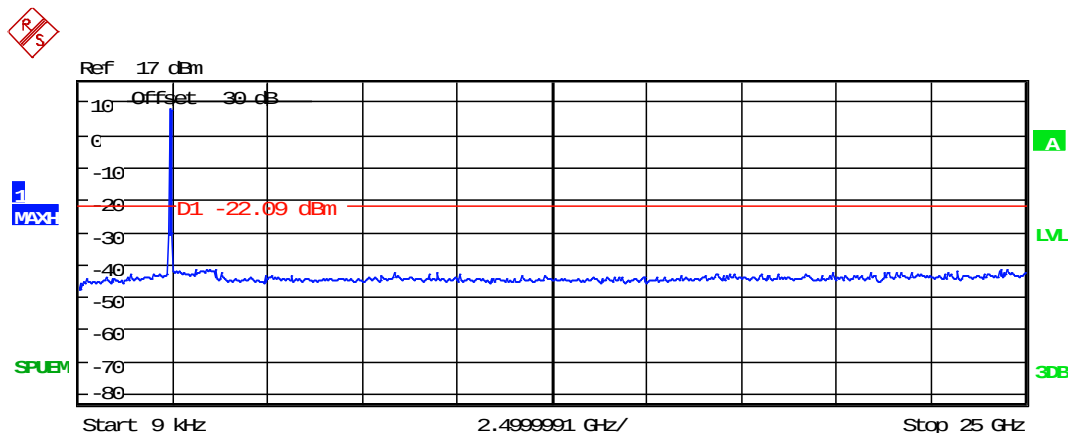
Date: 15.OCT.2015 15:44:23

Reference



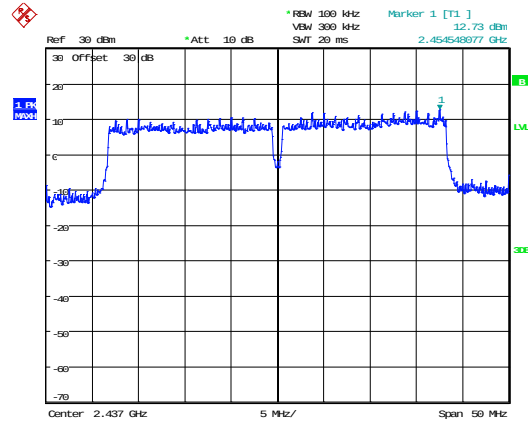
Date: 15.OCT.2015 15:44:57

Bandedge



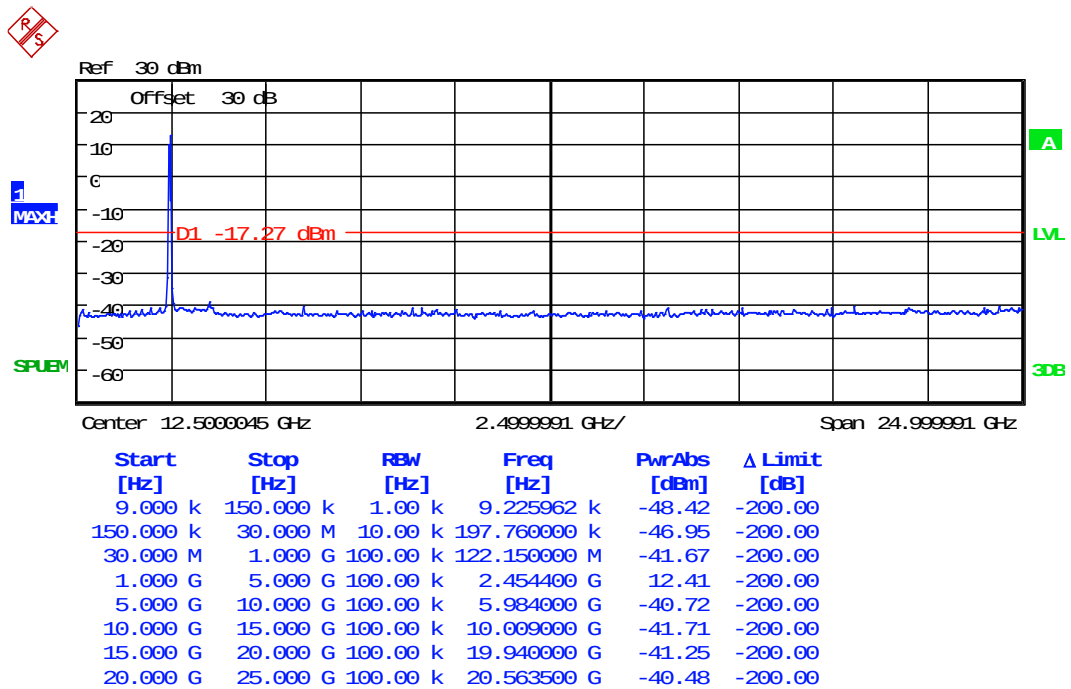
| Start [Hz] | Stop [Hz] | RBW [Hz] | Freq [Hz]    | PwrAbs [dBm] | Δ Limit [dB] |
|------------|-----------|----------|--------------|--------------|--------------|
| 9.000 k    | 150.000 k | 1.00 k   | 11.033654 k  | -49.34       | -200.00      |
| 150.000 k  | 30.000 M  | 10.00 k  | 150.000000 k | -47.81       | -200.00      |
| 30.000 M   | 1.000 G   | 100.00 k | 714.044000 M | -44.41       | -200.00      |
| 1.000 G    | 5.000 G   | 100.00 k | 2.416800 G   | 7.98         | -200.00      |
| 5.000 G    | 10.000 G  | 100.00 k | 8.317000 G   | -42.98       | -200.00      |
| 10.000 G   | 15.000 G  | 100.00 k | 10.047500 G  | -43.27       | -200.00      |
| 15.000 G   | 20.000 G  | 100.00 k | 19.926000 G  | -42.95       | -200.00      |
| 20.000 G   | 25.000 G  | 100.00 k | 24.510000 G  | -41.76       | -200.00      |

| Modulation: 802.11n HT40; Data rate: MCS23 – 2437 MHz |                          |                      |                      |             |             |        |
|-------------------------------------------------------|--------------------------|----------------------|----------------------|-------------|-------------|--------|
| Channel Frequency (MHz)                               | Emission Frequency (MHz) | Analyzer Level (dBm) | Emission Level (dBm) | Limit (dBm) | Margin (dB) | Result |
| No Significant Emissions Within 20 dB of Limit        |                          |                      |                      |             |             | PASS   |

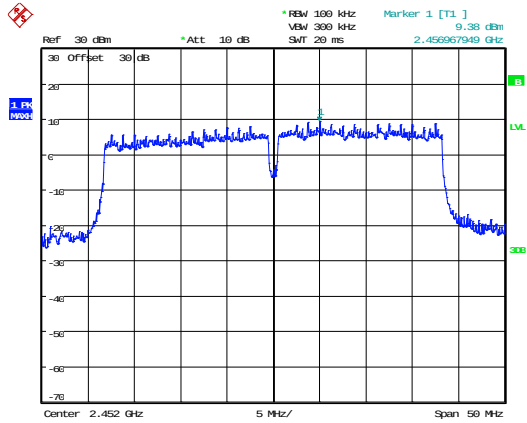


Date: 16.OCT.2015 14:37:45

## Reference

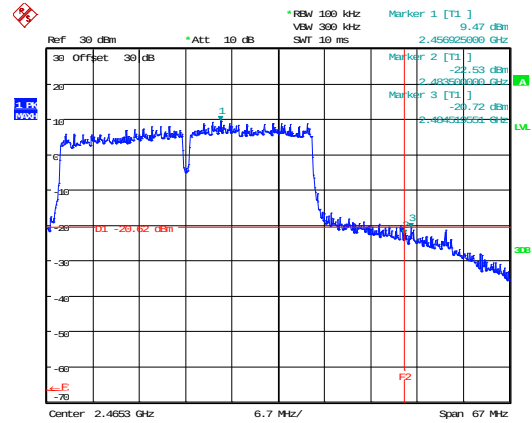


| Modulation: 802.11n HT40; Data rate: MCS23 – 2452MHz |                          |                      |                      |             |             |        |
|------------------------------------------------------|--------------------------|----------------------|----------------------|-------------|-------------|--------|
| Channel Frequency (MHz)                              | Emission Frequency (MHz) | Analyzer Level (dBm) | Emission Level (dBm) | Limit (dBm) | Margin (dB) | Result |
| No Significant Emissions Within 20 dB of Limit       |                          |                      |                      |             |             | PASS   |



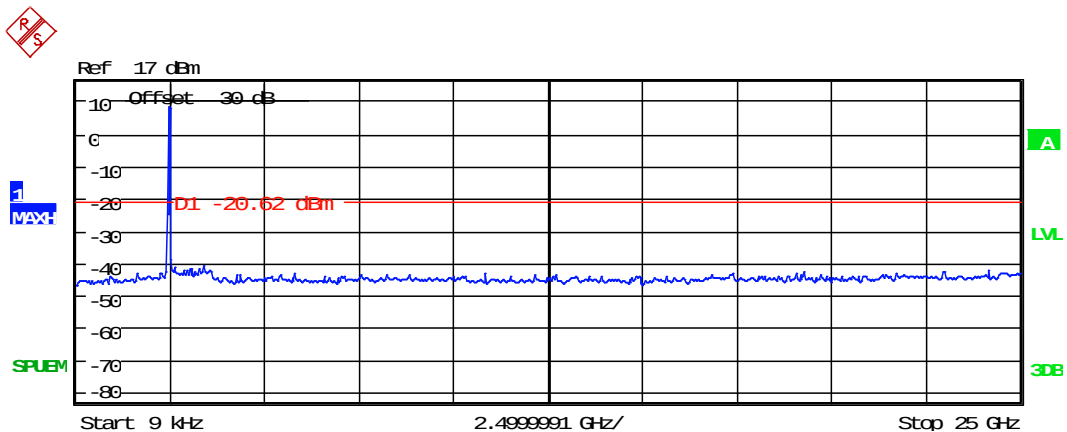
Date: 15.OCT.2015 16:06:28

Reference



Date: 15.OCT.2015 16:07:55

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| Start [Hz] | Stop [Hz] | RBW [Hz] | Freq [Hz]    | PwrAbs [dBm] | Δ Limit [dB] |
|------------|-----------|----------|--------------|--------------|--------------|
| 9.000 k    | 150.000 k | 1.00 k   | 9.225962 k   | -47.20       | -200.00      |
| 150.000 k  | 30.000 M  | 10.00 k  | 152.985000 k | -47.37       | -200.00      |
| 30.000 M   | 1.000 G   | 100.00 k | 891.457000 M | -44.24       | -200.00      |
| 1.000 G    | 5.000 G   | 100.00 k | 2.455600 G   | 8.51         | -200.00      |
| 5.000 G    | 10.000 G  | 100.00 k | 5.783500 G   | -43.13       | -200.00      |
| 10.000 G   | 15.000 G  | 100.00 k | 10.800500 G  | -43.15       | -200.00      |
| 15.000 G   | 20.000 G  | 100.00 k | 19.252000 G  | -43.05       | -200.00      |
| 20.000 G   | 25.000 G  | 100.00 k | 24.139000 G  | -42.51       | -200.00      |

## 14 Power spectral density

### 14.1 Definition

The power per unit bandwidth.

### 14.2 Test Parameters

|                                                              |                                |
|--------------------------------------------------------------|--------------------------------|
| Test Location:                                               | Element Skelmersdale           |
| Test Chamber:                                                | Radio Lab                      |
| Test Standard and Clause:                                    | ANSI C63.10-2013, Clause 11.10 |
| EUT Channels / Frequencies Measured:                         | 2412 MHz / 2437 MHz / 2462 MHz |
| EUT Channel Bandwidths:                                      | 20 MHz / 40 MHz                |
| Deviations From Standard:                                    | None                           |
| Measurement BW:                                              | 3 kHz                          |
| Spectrum Analyzer Video BW:<br>(requirement at least 3x RBW) | 10 kHz, 20 kHz, 30 kHz, 50 kHz |
| Measurement Span:<br>(requirement 1.5 times Channel BW)      | 13MHz, 25MHz, 50MHz            |
| Measurement Detector:                                        | Peak                           |

### Environmental Conditions (Normal Environment)

|                    |                                   |
|--------------------|-----------------------------------|
| Temperature: 24 °C | +15 °C to +35 °C (as declared)    |
| Humidity: 32 % RH  | 20 % RH to 75 % RH (as declared)  |
| Supply: 110V ac    | 230 V ac $\pm 10\%$ (as declared) |

### 14.3 Test Limit

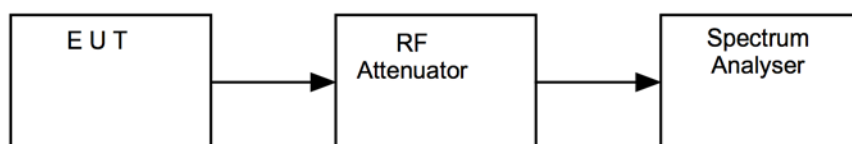
The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

#### 14.4 Test Method

With the EUT setup as per section 9 of this report and connected as per Figure vi, the peak emission of the EUT was measured on a spectrum analyser, with path losses taken into account.

The measurements were performed with EUT set at its maximum duty. All modulation schemes, data rates and power settings were used to observe the worst case configuration in each bandwidth.

**Figure vi Test Setup**



#### 14.5 Test Equipment

| <i>Type of Equipment</i> | <i>Maker/Supplier</i> | <i>Model Number</i> | <i>Element Number</i> | <i>Calibration Due Date</i> |
|--------------------------|-----------------------|---------------------|-----------------------|-----------------------------|
| Spectrum Analyser        | R&S                   | FSU26               | REF909                | 13/02/2016                  |
| Spectrum Analyser        | R&S                   | FSU26               | UH405                 | 11/05/2016                  |
| 10 dB Attenuator         | Radiall               | R411820121          | N/A                   | In Use                      |
| 20 dB Attenuator         | Radiall               | R411810121          | N/A                   | In Use                      |

## 14.6 Test Results

| Modulation: 802.11b; Data rate: 11Mbps |               |               |                      |                 |            |
|----------------------------------------|---------------|---------------|----------------------|-----------------|------------|
| Channel (MHz)                          | Power setting | Antenna Chain | Analyzer Level (dBm) | Cable loss (dB) | Power (mW) |
| 2412                                   | 106           | 0             | -30.81               | 30.00           | 0.83       |
|                                        |               | 1             | -30.28               | 30.00           | 0.94       |
|                                        |               | 2             | -29.99               | 30.00           | 1.00       |
| Total (dBm):                           |               |               |                      |                 | 4.42       |
| Result:                                |               |               |                      |                 | Pass       |
| 2437                                   | 106           | 0             | -30.79               | 30.00           | 0.83       |
|                                        |               | 1             | -30.70               | 30.00           | 0.85       |
|                                        |               | 2             | -30.95               | 30.00           | 0.80       |
| Total (dBm):                           |               |               |                      |                 | 3.96       |
| Result:                                |               |               |                      |                 | Pass       |
| 2462                                   | 106           | 0             | -30.62               | 30.00           | 0.87       |
|                                        |               | 1             | -30.59               | 30.00           | 0.87       |
|                                        |               | 2             | -30.29               | 30.00           | 0.94       |
| Total (dBm):                           |               |               |                      |                 | 4.27       |
| Result:                                |               |               |                      |                 | Pass       |

| Modulation: 802.11g; Data rate: 54Mbps |               |               |                      |                 |            |
|----------------------------------------|---------------|---------------|----------------------|-----------------|------------|
| Channel MHz                            | Power setting | Antenna Chain | Analyzer Level (dBm) | Cable loss (dB) | Power (mW) |
| 2412                                   | 90            | 0             | -25.25               | 23.00           | 0.60       |
|                                        |               | 1             | -24.70               | 23.00           | 0.68       |
|                                        |               | 2             | -24.78               | 23.00           | 0.66       |
| Total (dBm):                           |               |               |                      |                 | 2.87       |
| Result:                                |               |               |                      |                 | Pass       |
| 2437                                   | 107           | 0             | -22.97               | 23.00           | 1.01       |
|                                        |               | 1             | -22.81               | 23.00           | 1.04       |
|                                        |               | 2             | -22.38               | 23.00           | 1.15       |
| Total (dBm):                           |               |               |                      |                 | 5.06       |
| Result:                                |               |               |                      |                 | Pass       |
| 2462                                   | 106           | 0             | -22.74               | 23.00           | 1.06       |
|                                        |               | 1             | -22.09               | 23.00           | 1.23       |
|                                        |               | 2             | -22.24               | 23.00           | 1.19       |
| Total (dBm):                           |               |               |                      |                 | 5.42       |
| Result:                                |               |               |                      |                 | Pass       |

| Modulation: 802.11n HT20; Data rate: MCS7 |               |               |                      |                 |            |
|-------------------------------------------|---------------|---------------|----------------------|-----------------|------------|
| Channel MHz                               | Power setting | Antenna Chain | Analyzer Level (dBm) | Cable loss (dB) | Power (mW) |
| 2412                                      | 95            | 0             | -26.75               | 23.00           | 0.42       |
|                                           |               | 1             | -26.21               | 23.00           | 0.48       |
|                                           |               | 2             | -26.19               | 23.00           | 0.48       |
| Total (dBm):                              |               |               |                      |                 | 1.40       |
| Result:                                   |               |               |                      |                 | Pass       |
| 2437                                      | 104           | 0             | -22.40               | 23.00           | 1.15       |
|                                           |               | 1             | -21.87               | 23.00           | 1.30       |
|                                           |               | 2             | -21.89               | 23.00           | 1.29       |
| Total (dBm):                              |               |               |                      |                 | 5.72       |
| Result:                                   |               |               |                      |                 | Pass       |
| 2462                                      | 104           | 0             | -22.87               | 23.00           | 1.03       |
|                                           |               | 1             | -21.71               | 23.00           | 1.35       |
|                                           |               | 2             | -22.01               | 23.00           | 1.26       |
| Total (dBm):                              |               |               |                      |                 | 5.60       |
| Result:                                   |               |               |                      |                 | Pass       |

| Modulation: 802.11n HT40; Data rate: MCS23 |               |               |                      |                 |            |
|--------------------------------------------|---------------|---------------|----------------------|-----------------|------------|
| Channel MHz                                | Power setting | Antenna Chain | Analyzer Level (dBm) | Cable loss (dB) | Power (mW) |
| 2422                                       | 88            | 0             | -27.23               | 23.00           | 0.38       |
|                                            |               | 1             | -26.68               | 23.00           | 0.43       |
|                                            |               | 2             | -26.60               | 23.00           | 0.44       |
| Total (dBm):                               |               |               |                      |                 | 0.94       |
| Result:                                    |               |               |                      |                 | Pass       |
| 2437                                       | 103           | 0             | -23.32               | 23.00           | 0.93       |
|                                            |               | 1             | -22.81               | 23.00           | 1.04       |
|                                            |               | 2             | -21.93               | 23.00           | 1.28       |
| Total (dBm):                               |               |               |                      |                 | 5.12       |
| Result:                                    |               |               |                      |                 | Pass       |
| 2452                                       | 91            | 0             | -26.38               | 23.00           | 0.46       |
|                                            |               | 1             | -25.49               | 23.00           | 0.56       |
|                                            |               | 2             | -25.28               | 23.00           | 0.59       |
| Total (dBm):                               |               |               |                      |                 | 2.08       |
| Result:                                    |               |               |                      |                 | Pass       |

## 15 Measurement Uncertainty

### Calculated Measurement Uncertainties

All statements of uncertainty are expanded standard uncertainty using a coverage factor of 1.96 to give a 95 % confidence:

#### [1] Radiated spurious emissions

Uncertainty in test result (30 MHz to 1 GHz) = **4.6 dB**

Uncertainty in test result (1 GHz to 18 GHz) = **4.7 dB**

#### [2] AC power line conducted emissions

Uncertainty in test result = **3.4 dB**

#### [3] Occupied bandwidth

Uncertainty in test result = **15.5 %**

#### [4] Conducted carrier power

Uncertainty in test result (Power Meter) = **1.08 dB**

#### [5] Conducted / radiated RF power out-of-band

Uncertainty in test result – up to 8.1 GHz = **3.31 dB**

Uncertainty in test result – 8.1 GHz to 15.3 GHz = **4.43 dB**

Uncertainty in test result (30 MHz to 1 GHz) = **4.6 dB**

Uncertainty in test result (1 GHz to 18 GHz) = **4.7 dB**

#### [6] Power spectral density

Uncertainty in test result (Spectrum Analyser) = **2.48 dB**