Test Plan for RF Performance Evaluation of Wi-Fi Mobile Converged Devices

Version 1.3
June 2009
Interested parties may obtain permission to reproduce a limited number of copies by contacting CTIA or Wi-Fi Alliance at:

CTIA - The Wireless Association
1400 16th Street, NW
Suite 600
Washington, DC 20036
Phone: 1.202.785.0081
Fax: 1.202.466.3413
Email: certification@ctia.org

© Wi-Fi Alliance
3925 West Braker Lane
Austin, TX  78729
Phone: 1.512.305.0790
Fax: 1.512.305.0791
Email: certifications@wi-fi.org

Acknowledgments:
This test plan was created by the wireless industry with input from the following companies and their representatives:

<table>
<thead>
<tr>
<th>Company</th>
<th>Representative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azimuth Systems</td>
<td>Charles Wright</td>
</tr>
<tr>
<td>CETECOM, Inc</td>
<td>Lothar Schmidt</td>
</tr>
<tr>
<td>Cingular</td>
<td>Jason Brown</td>
</tr>
<tr>
<td>DSP Group</td>
<td>Graham Smith</td>
</tr>
<tr>
<td>ETS-Lindgren</td>
<td>Dr. Michael Foegelle</td>
</tr>
<tr>
<td>Ixia</td>
<td>Larry Green</td>
</tr>
<tr>
<td>Nokia Mobile Phones, Inc.</td>
<td>Alan Ewing</td>
</tr>
<tr>
<td>Philips Semiconductor</td>
<td>Steve Wilhoff</td>
</tr>
<tr>
<td>Sprint</td>
<td>Steve Shearer</td>
</tr>
<tr>
<td>Telecommunications Metrology</td>
<td>Alex Tkatch</td>
</tr>
<tr>
<td>Center of China Ministry of</td>
<td>Gao Hong</td>
</tr>
<tr>
<td>Information Industry</td>
<td>Patrick Green</td>
</tr>
<tr>
<td>Wi-Fi Alliance</td>
<td></td>
</tr>
</tbody>
</table>
### Change History

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>08-Aug-2006</td>
<td>Document Approved</td>
</tr>
</tbody>
</table>
| 1.1     | 20-Aug-2007| • Updated Purpose and References sections  
• Clarified text and added footnote in Radiated RF Tests nomenclature section  
• Clarified text in Minimum Measurement Distance section  
• Clarified testing conditions for cellular inactive state  
• Corrected step reference in step 14 of Receive Sensitivity Measurement. Removed repeated text.  
• Removed reference to CTIA website for traffic generator software download  
• Corrected step 1 and clarified language in step 9 regarding antenna connection in WLAN Access Point Testing Methodology section  
• Removed requirement for OFMD transmit mask test on Mobile Stations and Access Points  
• Updated WLAN Test SetEstimated Signal Level tables  
• Added Sample Summation test report table  
• Corrected title on Test 5.2.2. and 6.2.2 test report table  
• Added text to clarify that Wi-Fi desense testing is done in free-space only  
• Clarified that cellular desense testing is done in free-space only, and to perform reference measurements if not previously done  
• Removed references to specific test equipment from document |
| 1.2     | 26-June-2008| • 5 GHz TRP, TIS, & Reference Measurement frequency changes – Sections 5.1.1.2, 5.1.2.2, 5.2.1.2, 5.2.2.2, Table 5.2 5, 6.1.1.2, 6.1.2.2, 6.2.1.2, 6.2.2.2, Table B2, Table B3, Table B4, Table B5, Table B6, Table B7, New Appendix D  
• Other sections changed: Table B1 - CID Added, section 1.4 - CTIA Reference updated, Table A1 Channel change UTRA FDD Band I - IV, 4120/824.0 changed to 4132/826.4, Table B3 Reference changed from (2) to (1), Table 5.1.1 and table 6.1.1 - removed "Check TX Mask" from comments column |
| 1.3     | 16 June, 2009| • Added footnote to Section 1.2, 3rd sentence  
• Added text to Section 4.1, 2nd sentence  
• Added CTIA Request # to Appendix B table  
• Added Appendix E Device Capabilities Testing Matrix |
# Table of Contents

1. Introduction .................................................................................................................. 9
   1.1 Background .............................................................................................................. 9
   1.2 Scope .................................................................................................................... 9
   1.3 Purpose ................................................................................................................. 9
   1.4 References ............................................................................................................ 9
   1.5 Test Nomenclature Overview ................................................................................. 10
      1.5.1 Radiated RF Tests .......................................................................................... 10
      1.5.2 Conducted RF Tests ...................................................................................... 10
   1.6 Characterization of Measurements ......................................................................... 10
      1.6.1 Measurement Techniques ............................................................................... 10
      1.6.2 Measurement Uncertainty ............................................................................. 10
      1.6.3 Minimum Measurement Distance .................................................................... 11
      1.6.4 Equipment Required ...................................................................................... 11
      1.6.5 Quiet Zone Test Frequencies ......................................................................... 11
2. WLAN Client Testing Methodology .............................................................................. 12
   2.1 WLAN Test Set ...................................................................................................... 13
   2.2 Conducted RF Tests ............................................................................................... 14
      2.2.1 Test Set-up ..................................................................................................... 14
      2.2.2 Transmit Power Measurement ......................................................................... 14
      2.2.2.1 Discussion .................................................................................................. 14
      2.2.2.2 Unicast Test Packets ............................................................................... 14
      2.2.2.3 Test Procedure ......................................................................................... 15
      2.2.2.4 Results ..................................................................................................... 15
      2.2.3 Receive Sensitivity Measurement .................................................................... 15
         2.2.3.1 Discussion .............................................................................................. 15
         2.2.3.2 Unicast Test Packets ............................................................................. 16
         2.2.3.3 Test Procedure ..................................................................................... 16
         2.2.3.4 Results .................................................................................................. 16
   2.3 Radiated RF Tests .................................................................................................... 17
      2.3.1 Test Set-up ..................................................................................................... 17
      2.3.2 Radiated Power ............................................................................................... 17
         2.3.2.1 Discussion .............................................................................................. 17
         2.3.2.2 Unicast Test Packets ............................................................................. 17
         2.3.2.3 Test Procedure ..................................................................................... 17
         2.3.2.4 Results .................................................................................................. 18
      2.3.3 Receive Sensitivity Measurement .................................................................... 18
         2.3.3.1 Discussion .............................................................................................. 18
         2.3.3.2 Unicast Test Packets ............................................................................. 19
         2.3.3.3 Procedure .............................................................................................. 19
         2.3.3.4 Results .................................................................................................. 19
      2.3.4 Radiated Receiver Sensitivity Degradation, Simultaneous Operation (Wi-Fi Desense) ................................................................................................................................. 19
         2.3.4.1 Equipment .............................................................................................. 19
         2.3.4.2 Unicast Test Packets ............................................................................. 20
         2.3.4.3 Procedure .............................................................................................. 20
      2.3.5 Radiated Cellular Receiver Sensitivity Degradation, Simultaneous Operation (Cellular Desense) ................................................................................................................................. 20
         2.3.5.1 Equipment .............................................................................................. 20
   2.4 Conducted RF Tests ................................................................................................. 20
      2.4.1 Test Set-up ..................................................................................................... 20
      2.4.2 Transmit Power Measurement ......................................................................... 20
      2.4.2.1 Discussion .............................................................................................. 20
      2.4.2.2 Unicast Test Packets ............................................................................. 20
      2.4.2.3 Test Procedure ..................................................................................... 20
      2.4.2.4 Results .................................................................................................. 20
   2.5 Radiated RF Tests .................................................................................................... 20
      2.5.1 Test Set-up ..................................................................................................... 20
      2.5.2 Radiated Power ............................................................................................... 20
         2.5.2.1 Discussion .............................................................................................. 20
         2.5.2.2 Unicast Test Packets ............................................................................. 20
         2.5.2.3 Test Procedure ..................................................................................... 20
         2.5.2.4 Results .................................................................................................. 20
      2.5.3 Receive Sensitivity Measurement .................................................................... 20
         2.5.3.1 Discussion .............................................................................................. 20
         2.5.3.2 Unicast Test Packets ............................................................................. 20
         2.5.3.3 Procedure .............................................................................................. 20
         2.5.3.4 Results .................................................................................................. 20
      2.5.4 Radiated Receiver Sensitivity Degradation, Simultaneous Operation (Wi-Fi Desense) ................................................................................................................................. 20
         2.5.4.1 Equipment .............................................................................................. 20
         2.5.4.2 Unicast Test Packets ............................................................................. 20
         2.5.4.3 Procedure .............................................................................................. 20
         2.5.4.4 Results .................................................................................................. 20
      2.5.5 Radiated Cellular Receiver Sensitivity Degradation, Simultaneous Operation (Cellular Desense) ................................................................................................................................. 20
         2.5.5.1 Equipment .............................................................................................. 20
         2.5.5.2 Unicast Test Packets ............................................................................. 20
         2.5.5.3 Procedure .............................................................................................. 20
         2.5.5.4 Results .................................................................................................. 20

---

Certification Program Test Plan

Table of Contents

1. Introduction .................................................................................................................. 9
   1.1 Background .............................................................................................................. 9
   1.2 Scope .................................................................................................................... 9
   1.3 Purpose ................................................................................................................. 9
   1.4 References ............................................................................................................ 9
   1.5 Test Nomenclature Overview ................................................................................. 10
      1.5.1 Radiated RF Tests .......................................................................................... 10
      1.5.2 Conducted RF Tests ...................................................................................... 10
   1.6 Characterization of Measurements ......................................................................... 10
      1.6.1 Measurement Techniques ............................................................................... 10
      1.6.2 Measurement Uncertainty ............................................................................. 10
      1.6.3 Minimum Measurement Distance .................................................................... 11
      1.6.4 Equipment Required ...................................................................................... 11
      1.6.5 Quiet Zone Test Frequencies ......................................................................... 11
2. WLAN Client Testing Methodology .............................................................................. 12
   2.1 WLAN Test Set ...................................................................................................... 13
   2.2 Conducted RF Tests ............................................................................................... 14
      2.2.1 Test Set-up ..................................................................................................... 14
      2.2.2 Transmit Power Measurement ......................................................................... 14
      2.2.2.1 Discussion .............................................................................................. 14
      2.2.2.2 Unicast Test Packets ............................................................................. 14
      2.2.2.3 Test Procedure ..................................................................................... 15
      2.2.2.4 Results .................................................................................................. 15
      2.2.3 Receive Sensitivity Measurement .................................................................... 15
         2.2.3.1 Discussion .............................................................................................. 15
         2.2.3.2 Unicast Test Packets ............................................................................. 16
         2.2.3.3 Test Procedure ..................................................................................... 16
         2.2.3.4 Results .................................................................................................. 16
   2.3 Radiated RF Tests .................................................................................................... 17
      2.3.1 Test Set-up ..................................................................................................... 17
      2.3.2 Radiated Power ............................................................................................... 17
         2.3.2.1 Discussion .............................................................................................. 17
         2.3.2.2 Unicast Test Packets ............................................................................. 17
         2.3.2.3 Test Procedure ..................................................................................... 17
         2.3.2.4 Results .................................................................................................. 18
      2.3.3 Receive Sensitivity Measurement .................................................................... 18
         2.3.3.1 Discussion .............................................................................................. 18
         2.3.3.2 Unicast Test Packets ............................................................................. 19
         2.3.3.3 Procedure .............................................................................................. 19
         2.3.3.4 Results .................................................................................................. 19
      2.3.4 Radiated Receiver Sensitivity Degradation, Simultaneous Operation (Wi-Fi Desense) ................................................................................................................................. 19
         2.3.4.1 Equipment .............................................................................................. 19
         2.3.4.2 Unicast Test Packets ............................................................................. 20
         2.3.4.3 Procedure .............................................................................................. 20
      2.3.5 Radiated Cellular Receiver Sensitivity Degradation, Simultaneous Operation (Cellular Desense) ................................................................................................................................. 20
         2.3.5.1 Equipment .............................................................................................. 20
3. WLAN Access Point Testing Methodology

3.1 Conducted RF Tests

3.1.1 Test Set-up ................................................................. 23
3.1.2 Equipment ................................................................. 23
3.1.3 Transmit Power Measurement .............................. 23
3.1.3.1 Unicast Test Packets ........................................... 23
3.1.3.2 Test Procedure .................................................. 23
3.1.3.3 Results ............................................................... 24
3.1.4 Receive Sensitivity Measurement ......................... 24
3.1.4.1 Unicast Test Packets ........................................... 24
3.1.4.2 Test Procedure .................................................. 24
3.1.4.3 Results ............................................................... 25

3.2 Radiated RF Tests............................................................. 25
3.2.1 Test Set-up ................................................................. 25
3.2.2 Equipment ................................................................. 26
3.2.3 Radiated Power .......................................................... 26
3.2.3.1 Discussion .......................................................... 26
3.2.3.2 Unicast Test Packets ........................................... 26
3.2.3.3 Test Procedure .................................................. 26
3.2.3.4 Results ............................................................... 27
3.2.4 Receive Sensitivity Measurement ......................... 27
3.2.4.1 Discussion .......................................................... 27
3.2.4.2 Unicast Test Packets ........................................... 27
3.2.4.3 Test Procedure .................................................. 27
3.2.4.4 Results ............................................................... 28

4. Radiated Measurements......................................................... 29
4.1 Test Conditions for Device Under Test .................... 29

5. Mobile Station Testing......................................................... 30
5.1 Transmitter Performance ............................... 30
5.1.1 Conducted Power Output ................................. 30
5.1.1.1 DUT Requirements ........................................... 30
5.1.1.2 Frequency Channels .......................................... 30
5.1.1.3 Data Rates ........................................................ 30
5.1.1.4 Not Used ............................................................ 30
5.1.1.5 Results ............................................................... 30
5.1.2 Total Radiated Power (TRP) ........................... 30
5.1.2.1 DUT Requirements ........................................... 30
5.1.2.2 Frequency Channels .......................................... 30
5.1.2.3 Data Rates ........................................................ 31
5.1.2.4 Results ............................................................... 31

5.2 Receiver Performance ................................................... 31
5.2.1 Conducted Receiver Sensitivity ..................... 31
5.2.1.1 DUT Requirements ........................................... 31
5.2.1.2 Frequency Channels .......................................... 32
5.2.1.3 Data Rates ........................................................ 32
5.2.1.4 Results ............................................................... 32
5.2.2 Total Isotropic Sensitivity (TIS) .................. 32
5.2.2.1 DUT Requirements ........................................... 32
6. Access Point Testing

6.1 Transmitter Performance

6.1.1 Conducted Power Output ................................................................. 37
6.1.1.1 APUT Requirements ................................................................. 37
6.1.1.2 Frequency Channels ................................................................. 37
6.1.1.3 Data Rates ................................................................................ 37
6.1.1.4 Not Used ................................................................................. 37
6.1.1.5 Results ..................................................................................... 37
6.1.2 Total Radiated Power (TRP) ........................................................... 37
6.1.2.1 APUT Requirements ................................................................. 37
6.1.2.2 Frequency Channels ................................................................. 37
6.1.2.3 Data Rates ................................................................................ 38
6.1.2.4 Results ..................................................................................... 38

6.2 Receiver Performance ........................................................................ 38

6.2.1 Conducted Receive Sensitivity ......................................................... 38
6.2.1.1 APUT Requirements ................................................................. 38
6.2.1.2 Frequency Channels ................................................................. 38
6.2.1.3 Data Rates ................................................................................ 39
6.2.1.4 Results ..................................................................................... 39
6.2.2 Total Isotropic Sensitivity (TIS) ....................................................... 39
6.2.2.1 APUT Requirements ................................................................. 39
6.2.2.2 Frequency Channels ................................................................. 39
6.2.2.3 Data Rates ................................................................................ 39
6.2.2.4 Results ..................................................................................... 40

7. WLAN Test Set ................................................................................ 41

7.1 Estimated Signal Levels .................................................................... 41
7.2 Test AP and WLAN Station Requirements ....................................... 44
7.2.1 Basic Parameters .......................................................................... 44
7.2.2 RF Parameters ............................................................................. 44
7.3 WLAN Receiver RF Requirements .................................................. 45
7.4 Attenuator Requirements .................................................................. 46

8. Appendix A – Harmonic Interference Selection Matrices .................. 48

9. Appendix B – Summary Test Report .................................................. 50
10. Appendix C – RF Power Measurement ........................................... 61
11. APPENDIX D – IEEE 802.11a Supported Channel Option Examples .. 62
12. Appendix E – Device Testing Configurations

List of Figures

Figure 2.1 – Block Schematic Diagram – WLAN Test Set .......................................................... 13
Figure 2.2 – Block Schematic Diagram – Conducted RF Tests .................................................. 14
Figure 2.3 – Block Schematic Diagram – Radiated RF Tests .................................................... 17
Figure 2.4 – Test Configuration – Cellular Desense due to Wi-Fi ........................................... 21
Figure 3.1 – Block Schematic Diagram – Conducted RF Test for AP ........................................ 23
Figure 3.2 – Block Schematic Diagram – Radiated RF Tests for AP .......................................... 25

List of Tables

Table 1.1 - Minimum Measurement Distance ........................................................................... 11
Table 5.1 – Wi-Fi Channel and Data Rate for TIS Wi-Fi Desense ............................................. 33
Table 5.2 – Channel setting for Wi-Fi U-NII Band for TIS Cellular Desense ............................ 35
Table 7.1 – Conducted TX Test ................................................................................................. 41
Table 7.2 – Conducted RX Test ................................................................................................. 42
Table 7.3 – Radiated TX Test .................................................................................................... 43
Table A.1 – IEEE 802.11b/g Products ..................................................................................... 48
Table A.2 – IEEE 802.11a Products .......................................................................................... 49
Table B.1 – Sample Summation ................................................................................................. 50
Table B.2 – Conducted Power Output Results .......................................................................... 50
Table B.3 – Mode Radiated Figure of Merit Results ................................................................. 51
Table B.4 – Radiated Reference Measurements Results ............................................................. 51
Table B.5 – Conducted Receiver Sensitivity Results ................................................................. 53
Table B.6 – Mode Sensitivity Figure of Merit Results ............................................................... 54
Table B.7 – Sensitivity Reference Measurements Results ......................................................... 55
Table B.8 – Highest Cellular Frequency Channel Test Results ............................................... 57
Table B.9 – Harmonic Interference Tests Results 802.11b&g ..................................................... 58
Table B.10 – Harmonic Interference Tests Results 802.11a ...................................................... 58
Table B.11 – Cellular Desense Test Results for 802.11b&g Operation ....................................... 59
Table B.12 – Cellular Desense Test Results for 802.11a Operation ......................................... 60
List of Acronyms and Definitions

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACK</td>
<td>Acknowledge</td>
</tr>
<tr>
<td>AMPS</td>
<td>Advanced Mobile Phone System</td>
</tr>
<tr>
<td>APSD</td>
<td>Automatic Power Save Delivery</td>
</tr>
<tr>
<td>APUT</td>
<td>Access Point Under Test</td>
</tr>
<tr>
<td>BPSK</td>
<td>Binary Phase Shift Keying</td>
</tr>
<tr>
<td>CCK</td>
<td>Complementary Code Keying</td>
</tr>
<tr>
<td>CDMA</td>
<td>Code Division Multiple Access</td>
</tr>
<tr>
<td>DBPSK</td>
<td>Differential Binary Phase Shift Keying</td>
</tr>
<tr>
<td>DQPSK</td>
<td>Differential Quadrature Phase Shift Keying</td>
</tr>
<tr>
<td>DSSS</td>
<td>Direct Sequence Spread Spectrum</td>
</tr>
<tr>
<td>DUT</td>
<td>Device Under Test</td>
</tr>
<tr>
<td>EUT</td>
<td>Equipment Under Test</td>
</tr>
<tr>
<td>FRR</td>
<td>Frame Reception Rate</td>
</tr>
<tr>
<td>GSM</td>
<td>Global System for Mobile communication</td>
</tr>
<tr>
<td>iDEN</td>
<td>Integrated Digital Enhanced Network</td>
</tr>
<tr>
<td>LAN</td>
<td>Local Area Network</td>
</tr>
<tr>
<td>LCR</td>
<td>Low Chip Rate</td>
</tr>
<tr>
<td>OFDM</td>
<td>Orthogonal Frequency Division Multiplexing</td>
</tr>
<tr>
<td>PER</td>
<td>Packet Error Rate</td>
</tr>
<tr>
<td>PHS</td>
<td>Personal Handyphone System (Japan)</td>
</tr>
<tr>
<td>QAM</td>
<td>Quadrature Amplitude Modulation</td>
</tr>
<tr>
<td>QPSK</td>
<td>Quadrature Phase Shift Keying</td>
</tr>
<tr>
<td>RSSI</td>
<td>Receive Signal Strength Indicator</td>
</tr>
<tr>
<td>Rx</td>
<td>Receive Signal Strength Indicator</td>
</tr>
<tr>
<td>SSID</td>
<td>Service Set Identifier</td>
</tr>
<tr>
<td>STA</td>
<td>Station</td>
</tr>
<tr>
<td>TIS</td>
<td>Total Isotropic Sensitivity</td>
</tr>
<tr>
<td>TRP</td>
<td>Total Radiated Power</td>
</tr>
<tr>
<td>Tx</td>
<td>Transmit</td>
</tr>
<tr>
<td>UMTS</td>
<td>Universal Mobile Telecommunications System</td>
</tr>
<tr>
<td>UTRA-FDD</td>
<td>UMTS Terrestrial Radio Access - Frequency Division Duplexing</td>
</tr>
<tr>
<td>UTRA-TDD</td>
<td>UMTS Terrestrial Radio Access - Time Division Duplexing</td>
</tr>
<tr>
<td>WLAN</td>
<td>Wireless Local Area Network</td>
</tr>
</tbody>
</table>
1. INTRODUCTION

1.1 Background

Increasingly the wireless market is seeing converged handset devices that incorporate both cellular and wireless local area network (WLAN or Wi-Fi) functionality. Cellular operators are becoming one of the largest classes of Wi-Fi service providers\(^1\) and are increasingly working to integrate more WLAN support into their overall operations. Due to the many potential applications and deployment scenarios that converged equipment may ultimately function in, operators and handset vendors are interested in a uniform method of profiling the RF performance of converged devices. With this profile data gathered in a uniform way, equipment designers, system operators, and RF engineers have the flexibility to determine their own appropriate RF performance criteria based on their engineering assessments, and they can easily identify equipment that is suitable for each deployment and application.

1.2 Scope

This Test Document contains the proposed test methodologies and performance criteria for the RF performance evaluation of Wi-Fi mobile converged devices. The scope of testing includes devices that support IEEE 802.11a, IEEE 802.11b or 802.11g, as well as one or more cellular technologies. Support for IEEE standards must be confirmed through Wi-Fi Alliance baseline certification—that is, devices tested using this test plan must first be Wi-Fi CERTIFIED for IEEE 802.11a, 802.11b, or 802.11g\(^2\). Cellular technologies include, but are not limited to, GSM, CDMA, UMTS, operating at conventional 450, 800, 900, 1800, 1900 and 2100 MHz frequencies.

1.3 Purpose

The purpose of this document is first to define the test methodology for the RF Testing of Wi-Fi mobile converged devices and then to specify the test conditions for each proposed test. The testing covers client devices and access points, and specifies conducted as well as radiated tests.

The test methodology requires the device be placed in a standard operational mode. Although recognizing that the use of special test modes would enable more simplified testing and the use of formal test equipment, the test methodology proposed in this document allows the testing of any Wi-Fi mobile device in a mode that is as close as possible to its native operation.

This test plan is part of the CTIA and Wi-Fi Alliance certification programs. The CTIA Certification Program is explained in a separate document titled CTIA Certification Program Management Document \[4\]. The Wi-Fi Alliance Certification Program is explained in a separate document titled Wi-Fi Alliance Program Management Document \[5\].

1.4 References

(1) - “Test Plan for Mobile Station Over the Air Performance/Method of Measurement for Radiated RF Power and Receiver Performance”, latest revision, CTIA

---

\(^1\) Planet Wireless, September, 2004 “PW Hotspot Operator Database: Public-WLAN coverage by operator, country, and region”

1.5 Test Nomenclature Overview

1.5.1 Radiated RF Tests

Radiated tests are those RF Tests that are carried out in a test environment which meets the requirements of the CTIA Test Plan [1], Section 3. These include TX Power (TRP) in WLAN mode, Receive Sensitivity (TIS) in WLAN mode, Receive Sensitivity of WLAN with cellular active (in a call), and Receive Sensitivity of the cellular radio(s) with WLAN active.

1.5.2 Conducted RF Tests

Conducted tests are those RF Tests where the test equipment is connected to the antenna connector of the device under test by co-axial cables. These tests are formulated to measure basic RF performance such as sensitivity and transmit power. These tests may require the use of screened compartments.

1.6 Characterization of Measurements

1.6.1 Measurement Techniques

This document relies on the measurement techniques within a CTIA Test Plan developed specifically for the purposes of measurement of radiated transmit power and sensitivity. These techniques are described in detail in Section 2, Scope of Measurements, of the CTIA Test Plan for Mobile Station Over the Air Performance [1]. That section describes fully the nature of the measurement technique used in this document.

The following sub-sections of this document contain information to expand the CTIA Test Plan [1] for use with 802.11 a, b and g devices. These sections are meant to clarify for the user how the CTIA Test Plan [1] can be utilized for Wi-Fi devices.

1.6.2 Measurement Uncertainty

A complete and thorough expanded uncertainty budget is required of those facilities performing tests for the purposes of certification of devices against this test plan. Laboratories shall use Section 7 and Appendix G of the CTIA Test Plan [1] as guidance for the determination of measurement uncertainty. The laboratory is also responsible for identifying any other contributing factors to their uncertainty

---

3 TRP and TIS in cellular mode are defined in the CTIA Test Plan for Mobile Station Over the Air Performance [1]
budget. In addition to the maintenance of such an uncertainty budget, the total measurement uncertainty is to be reported in the final evaluation report.

### 1.6.3 Minimum Measurement Distance

This section describes the minimum measurement distance based on a 300 mm test volume, R, which the far-field test site shall provide. The measurement distance is defined as the distance from the center of rotation of the EUT to the phase center of the measurement antenna. The minimum measurement distance is specified in Table 1.1, below.

<table>
<thead>
<tr>
<th>Frequency Band</th>
<th>Minimum Measurement Distance R, meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISM (2400 – 2497 MHz)</td>
<td>TBD</td>
</tr>
<tr>
<td>U-NIII (5000 – 6000 MHz)</td>
<td>TBD</td>
</tr>
</tbody>
</table>

The minimum acceptable measurement distance is the larger of $3D$ (the amplitude uncertainty limit) and $3\lambda$ (the reactive Near-Field limit), where $D$ is the dimension of the radiator and $\lambda$ is the free-space wavelength at the measurement frequency. It is recommended, however, that the measurement distance be greater than the largest of $2D^2/\lambda$ (the phase uncertainty limit), $3D$, and $3\lambda$. For a free space test, $D$ would simply be the largest dimension of the EUT, but some portion of the phantom must be included for phantom (simulated use) tests. For purposes of this test plan, $D$ is selected to be the dimension of that part of the phantom that participates significantly in determining the TRP or TIS of the EUT, and is chosen as 300 mm. The requirement of $2D^2/\lambda$ is suggested rather than required. When using a range distance down to the higher of either $3D$ or $3\lambda$, the impact to TRP and TIS must be included in the calculation of the overall Measurement Uncertainty.

### 1.6.4 Equipment Required

Additional equipment needed:

1. ISM-band sleeve dipole probe antenna with less than ±0.1 dB of asymmetry in the azimuth plane pattern.
2. ISM-band reference loop probe antenna with less than ±0.1 dB of asymmetry in the azimuth plane pattern.
3. U-NII-band sleeve dipole probe antenna with less than ±0.1 dB of asymmetry in the azimuth plane pattern.
4. U-NII-band reference loop probe antenna with less than ±0.1 dB of asymmetry in the azimuth plane pattern (this requirement waived until a U-NIII-band loop probe antenna is available).

### 1.6.5 Quiet Zone Test Frequencies

Quiet zone test frequencies needed for Wi-Fi bands:

1. ISM-band: 2450 MHz ± 1MHz
2. U-NIII-band: 5500 MHz ± 1MHz
2. WLAN CLIENT TESTING METHODOLOGY

The test methodology proposed in this document allows the testing of any WI-FI mobile converged device in a mode that is as close as possible to its native operation. However, the methodology finally arrived at does require certain specific behavior of a client so that the test can be completed. The WLAN client is expected to be able to associate with an AP and stay fixed on the same RF channel for the duration of the test, even when the signal from the AP is below the sensitivity level for the PHY rate being tested. The Test AP will be transmitting data frames addressed to the WLAN client at about 50 frames per second, and the WLAN client is expected to be able to respond to all of these data frames with an ACK. The duration of radiated tests may run until the battery is expended.

The above requirements require the following client settings:

1. Disable scan mode during testing. Scanning for APs on other channels must be disabled
2. If applicable, disable Power Save Mode (Note that the Test AP will not support WMM APSD)
3. The client should actively attempt to re-associate with the AP after losing association due to the signal decreasing below the client’s sensitivity level.
4. If applicable, disable BlueTooth radio during tests
5. For non-coexistence tests, the cellular transmitter in the client should be inactive. For devices which cannot disable their cellular radio, this may be accomplished by testing within an appropriate shielded environment to isolate the DUT from any base station signals.

There may be other settings required to achieve the goals described above.

It should be noted that although the transmit and receive tests are described separately, the test procedures are such that it should be possible to conduct both the transmit power and receive sensitivity measurements at the same time.
2.1 WLAN Test Set

The RF tests described in this document are based upon a “WLAN Test Set”, which is shown diagrammatically in Figure 2.1.

Figure 2.1 – Block Schematic Diagram – WLAN Test Set

The WLAN Test Set comprises the following:

- Test Access Point and WLAN Station
  
  When testing Client devices, this module’s functions are similar to a WLAN Access Point, but with superior transmitter performance. It is connected to a Control PC and is used to generate unicast packets on any selected channel and at any selected fixed data rate, i.e. with retransmission and rate fall back functionality disabled. When testing Access Points, this module’s function are similar to a WLAN Station, but with superior transmitter performance.
  
  The RF Specifications are given in Section 7.2.

- WLAN Receiver
  
  Functionally this module is similar to a WLAN Sniffer but has a superior receive RSSI performance. The RF Specifications are given in Section 7.3. It is connected to a Control PC and is used to report the RSSI of received packets and to record the number of ACK control packets per second.

- Hybrid Combiner
  
  A hybrid combiner is suggested, although other methods of connecting RF signals are also acceptable, such as a resistive splitter or a circulator.

- AP Attenuator
  
  This attenuator is used to adjust the transmit output power from the Test AP, presented to the hybrid combiner.
RX Attenuator

This attenuator is used to adjust the level of the received signal from the hybrid combiner to the input of the WLAN Receiver.

The transmit output power of the Test Access Point and the RSSI reporting of the WLAN Receiver are subject to a validation procedure, which is performed immediately after each transmit and receiver sensitivity set of measurements, hence formal calibration of the WLAN Test Set is not required.

2.2 Conducted RF Tests

2.2.1 Test Set-up

The basic test set-up is shown in Figure 2.2.

![Figure 2.2 – Block Schematic Diagram – Conducted RF Tests](image)

2.2.2 Transmit Power Measurement

2.2.2.1 Discussion

The method used is based upon the validated RSSI, from the WLAN Receiver module in the WLAN Test Set, reporting the received signal strength of an ACK control frame from the DUT. The ACK control frames are sent in response to unicast data packets generated by the Test Access Point module in the WLAN Test Set.

The RSSI is measured across the header of the control packet with a time period that is not more than one period of a short preamble. The measurement is to be taken across several packets and a mean value calculated.

The ACK control frame is sent at the basic data rate at or below the data rate of the received signal. This effectively means that the transmitted data rate from the DUT will be 6, 12 or 24Mbps for OFDM rates, and 1, 2, and 5.5, 11 for DSSS-CCK rates. The vendor shall provide the list of data rates for the ACK control frames so that the Access Point data rate can be set correctly.

2.2.2.2 Unicast Test Packets

The unicast test data packets shall be 200 frame bytes at a rate of 50 frames a second, to approximate a voice data stream.
2.2.2.3  **Test Procedure**

The recommended procedure is:

1. The AP attenuator, in the WLAN Test Set, is set such that the signal received at the DUT antenna connector is at least 10dB higher than the sensitivity threshold.
2. The RX Attenuator, in the WLAN Test Set is set such that the received signal level from the DUT at the input of the WLAN Receiver is at least 10dB higher but not more than 50dB higher than the sensitivity threshold.
3. The Test AP, in the WLAN Test Set, is set to transmit on the desired channel and at the desired modulation and data rate.
4. The Device Under Test (DUT) associates with the Test AP.
5. The Test AP is set to continuously transmit unicast test data packets to the DUT.
6. The DUT will respond to the received unicast data packets with an ACK control frame.
7. The WLAN Receiver reports the reception of the ACK control frame together with the data rate and the RSSI reading to the Control PC. Calculate and record the mean value of RSSI over a period of about 10 seconds.
8. Repeat steps 3 to 7 for each required channel and data rate.
9. Create a Table of Channel, Modulation, Data Rate and Mean RSSI for each measurement. See Appendix B for recommended data reporting formats.

**Convert RSSI Readings:**

10. Remove the DUT and connect in its place a Vector Signal Generator capable of generating WLAN IEEE 802.11a/b/g frames.
11. Set the Signal Generator to send a WLAN ACK control frame, on the desired center frequency, with the correct modulation and data rate as per the first measurement in the Table created in step 9.
12. Set the WLAN Receiver to the same channel as the Signal Generator.
13. Monitor the RSSI reported by the WLAN Receiver.
14. Adjust the Signal Generator output level such that the RSSI reported by the WLAN Receiver is that recorded in the corresponding Receive Sensitivity measurement in the Table created in step 9, and record the Output Level of the Signal Generator, to the nearest dBm, in an extra column of the Table.

Note: To reduce the required output level of the Signal Generator, the RX Attenuator may be decreased in value and the difference accounted for in the tabulated results.

15. Repeat steps 11 - 14 for all the data rates and channels in the Table created in Step 9.

2.2.2.4  **Results**

The Results shall be in the form of a Table of Channel, Modulation, Data Rate, Mean RSSI, and Transmit Power dBm. See Appendix B for recommended data reporting formats.

2.2.3  **Receive Sensitivity Measurement**

2.2.3.1  **Discussion**

The method used is based upon the WLAN Receive, in the WLAN Test Set, reporting the number of ACK control frames per second being sent by the DUT in response to continuous unicast data packets
being sent from the Test AP. For this test the output transmitted power from the Test AP needs to be validated.

2.2.3.2 **Unicast Test Packets**

The unicast test data packets shall be 200 frame bytes at a rate of 50 frames a second, to approximate a voice data stream.

2.2.3.3 **Test Procedure**

The recommended procedure is:

1. The AP Attenuator, in the WLAN Test Set, is set such that the signal received at the DUT antenna connector is about 10dB higher than the sensitivity threshold.
2. The RX Attenuator, in the WLAN Test Set is set such that the received signal level from the DUT at the input of the WLAN Receiver is at least 10dB higher but not more than 50dB higher than the sensitivity threshold.
3. The Test AP is set up to transmit on the desired channel, modulation and data rate.
4. The Device Under Test (DUT) associates with the AP.
5. The Test AP is set to continuously transmit unicast data packets to the DUT.
6. The DUT will respond to the received unicast data packets with an ACK control frame.
7. The WLAN Receiver reports the reception of the ACK control frames to the Control PC.
8. The Control PC counts the number of data frames and the number of ACK control frames received over a time period needed to receive 100 (TBR) data frames and the corresponding ACKs. The frame reception rate (FRR) is computed as (# of ACKs received / # data frames transmitted)
9. The AP attenuator is increased, until the FRR reduces to the point where a 1dB increase causes the FRR to be less than 90%.
10. The AP Attenuator is decreased by 1dB and the value noted, “A” dB
11. Repeat steps 3 to 10 for each required channel, modulation and data rate.
12. Create a Table of Channel, Modulation, Data Rate, and AP Attenuator Setting. See Appendix B for recommended data reporting formats.

Convert the Test AP and AP Attenuator setting:

13. Measure the power level to an accuracy of 0.5dBm, “P”dBm as per the method described in Appendix C.
14. From the power level measured in step 13, add 10dB and deduct the value of the AP Attenuator noted in step 10, i.e. P + 10 – A. Record this value, the Receive Sensitivity, to an accuracy of 1dBm, in an extra column to the Table created in step 12.
15. Repeat steps 13 - 14 for all the channels, modulations, and data rates and used in the measurement taking.

2.2.3.4 **Results**

The results shall be in the form of a Table of Channel, Modulation, Data Rate, AP Attenuator setting and Receive Sensitivity (10%PER). See Appendix B for recommended data reporting formats.
2.3 **Radiated RF Tests**

It should be noted that as the transmitted power and the receive sensitivity measurements both use the ACK control packet generated by the DUT and received by the WLAN Receiver, it is possible to carry out both tests, one after the other, at each position of the test antennas used in the radiated RF measurements.

### 2.3.1 Test Set-up

The basic test set-up is similar to that for the radiated tests and is shown in Figure 2.3.

![Figure 2.3 – Block Schematic Diagram – Radiated RF Tests](image)

2.3.2 **Radiated Power**

#### 2.3.2.1 Discussion

The method used is similar to the conducted transmit measurement with the exception that the co-axial connection between the hybrid splitter and the DUT is now made using the DUT antenna(s) and a calibrated test antenna. The radiated path loss, from the position of the DUT antenna(s), including the test antenna, shall be calibrated.

The procedure described below relates to each individual measurement and will need to be repeated for each position and data rate specified for the device under test.

#### 2.3.2.2 Unicast Test Packets

The unicast test data packets shall be 200 frame bytes at a rate of 50 frames a second, to approximate a voice data stream.

#### 2.3.2.3 Test Procedure

The procedure is identical to that of the conducted transmit power measurement. The settings for the Test AP and RX attenuators will be different due to extra loss of the radiated path. It is assumed that path loss and gain of the Test Antenna are known.

The recommended procedure is:
1. The AP attenuator, in the WLAN Test Set, is set such that the signal received at the DUT antenna connector is at least 10dB higher than the sensitivity threshold.

2. The RX Attenuator, in the WLAN Test Set is set such that the received signal level from the DUT at the input of the WLAN Receiver is at least 10dB higher than the sensitivity threshold.

3. The Test AP, in the WLAN Test Set, is set up to transmit on the desired channel and at the desired modulation and data rate.

4. The Device Under Test (DUT) associates with the Test AP.

5. The Test AP is set to continuously transmit unicast data packets to the DUT.

6. The DUT will respond to the received unicast data packets with an ACK control frame.

7. The WLAN Receiver reports the reception of the ACK control frame together with the data rate and the RSSI reading to the Control PC. Note the mean value of RSSI over a period of about 10 seconds.

8. Repeat steps 3 to 7 for each required channel and data rate.

9. Create a Table of Channel, Modulation, Data Rate and Mean RSSI for each measurement. See Appendix B for recommended data reporting formats.

Convert RSSI Readings:

10. Remove the Test Antenna and connect in its place a Vector Signal Generator capable of generating WLAN IEEE 802.11a/b/g frames.

11. Increase the RX Attenuator setting by an amount equal to the path loss minus the gain of the Test Antenna.

12. Set the Signal Generator to send a WLAN ACK control frame, on the desired center frequency, with the correct modulation and data rate as per the first measurement in the Table created in step 9.

13. Set the WLAN Receiver to the same channel as the Signal Generator.

14. Monitor the RSSI reported by the WLAN Receiver.

15. Adjust the Signal Generator output level such that the RSSI reported by the WLAN Receiver is that recorded in the corresponding Receive Sensitivity measurement in the Table created in step 9, and record the Output Level of the Signal Generator, to the nearest dBm, in an extra column of the Table.

   Note: To reduce the required output level of the Signal Generator, the RX Attenuator may be decreased in value and the difference accounted for in the tabulated results.

16. Repeat steps 12 - 16 for all the data rates and channels in the Table created in Step 9.

2.3.2.4 Results

The Results shall be in the form of a Table of Channel, Modulation, Data Rate, Mean RSSI, and Transmit Power dBm. See Appendix B for recommended data reporting formats.

2.3.3 Receive Sensitivity Measurement

2.3.3.1 Discussion

The method used is similar to the conducted measurement with the exception that the co-axial connection between the hybrid splitter and the DUT is now made using the DUT antenna(s) and a calibrated test antenna. The radiated path loss from the position of the DUT antenna(s), including the test antenna, shall be validated.
2.3.3.2 Unicast Test Packets

The unicast test data packets shall be 200 frame bytes at a rate of 50 frames a second, to approximate a voice data stream.

2.3.3.3 Procedure

The recommended procedure is:

1. The AP Attenuator, in the WLAN Test Set, is set such that the signal received at the DUT antenna connector is about 10dB higher than the sensitivity threshold.
2. The RX Attenuator, in the WLAN Test Set is set such that the received signal level from the DUT at the input of the WLAN Receiver is at least 10dB higher but not more than 50dB higher than the sensitivity threshold.
3. The Test AP is set up to transmit on the desired channel, modulation and data rate.
4. The Device Under Test (DUT) associates with the AP.
5. The Test AP is set to continuously transmit unicast data packets to the DUT.
6. The DUT will respond to the received unicast data packets with an ACK control frame.
7. The WLAN Receiver reports the reception of the ACK control frames to the Control PC.
8. The Control PC counts the number of data frames and the number of ACK control frames received over a time period needed to receive 100 (TBR) data frames and the corresponding ACKs. The frame reception rate (FRR) is computed as (# of ACKs received / # data frames transmitted)
9. The AP attenuator is increased, until the FRR reduces to the point where a 1dB increase causes the FRR to be less than 90%.
10. The AP Attenuator is decreased by 1dB and the value noted, “A” dB
11. Repeat steps 1 to 10 for each required channel, modulation and data rate.
12. Create a Table of Channel, Modulation, Data Rate, and AP Attenuator Setting. See Appendix B for recommended data reporting formats.

Convert the Test AP and AP Attenuator setting:

13. Measure the power level to an accuracy of 0.5dBm, “P”dBm as per the method described in Appendix C.
14. From the power level measured in step 13, add 10dB and deduct the value of the AP Attenuator noted in step 10, i.e. P + 10 – A. Record this value, the Receive Sensitivity, to an accuracy of 1dBm, in an extra column to the Table created in step 12.
15. Repeat steps 13 - 14 for all the channels, modulations, and data rates and used in the measurement taking.

2.3.3.4 Results

The results shall be in the form of a Table of Channel, Modulation, Data Rate, AP Attenuator setting and Receive Sensitivity. See Appendix B for recommended data reporting formats.

2.3.4 Radiated Receiver Sensitivity Degradation, Simultaneous Operation (Wi-Fi Desense)

2.3.4.1 Equipment

The test set-up is as per 2.3.1, but with the addition of a Cellphone base station emulator. The Cellphone emulator antenna is placed in a suitable position within the anechoic chamber. The test...
shall be carried out at only one position of the test antenna that corresponds to the maximum radiation of the DUT as determined in the TRP and TIS measurements. Wi-Fi desense shall be measured free-space only.

2.3.4.2 **Unicast Test Packets**

The unicast test data packets shall be 200 frame bytes at a rate of 50 frames a second, to approximate a voice data stream.

2.3.4.3 **Procedure**

The recommended procedure is:

1. The AP Attenuator, in the WLAN Test Set, is set such that the signal received at the DUT antenna connector is about 10dB higher than the sensitivity threshold.
2. The RX Attenuator, in the WLAN Test Set is set such that the received signal level from the DUT at the input of the WLAN Receiver is at least 10dB higher but not more than 50dB higher than the sensitivity threshold.
3. The Test AP is set up to transmit on the desired channel, modulation and data rate.
4. The Device Under Test (DUT) associates with the AP.
5. The Test AP is set to continuously transmit unicast data packets to the DUT.
6. The DUT will respond to the received unicast data packets with an ACK control frame.
7. The WLAN Receiver reports the reception of the ACK control frames to the Control PC and the number of ACK frames per second is noted.
8. The Control PC counts the number of data frames and the number of ACK control frames received over a time period needed to receive 100 (TBR) data frames and the corresponding ACKs. The frame reception rate (FRR) is computed as (# of ACKs received / # data frames transmitted)
9. The AP attenuator is increased, until the FRR reduces to the point where a 1dB increase causes the FRR to be less than 90%.
10. The AP Attenuator is decreased by 1dB and the value noted, “A”dB
11. The cellphone of the converged device is then activated, and using the Cellular Base Station, the device is made to simulate being in a standard voice call. The cellular phone shall be made to transmit at the highest power.
12. The AP Attenuator is then decreased, until the FRR is at the point where a 1dB increase causes the FRR to be less than 90%.
13. The AP Attenuator is decreased by 1dB and the value noted, “B”dB.
14. The Receive Sensitivity degradation is then calculated by subtracting the reading noted in step 10 from the reading noted in step 13, i.e. Receive sensitivity degradation is “B-A” dB. Note the Receive Degradation value.
15. Repeat steps 3 to 14 for each required channel, modulation and data rate.
16. Create a Table of Channel, Modulation, Data Rate and Receive Degradation.

2.3.5 **Radiated Cellular Receiver Sensitivity Degradation, Simultaneous Operation (Cellular Desense)**

2.3.5.1 **Equipment**

The test set up is shown in figure 2.4, where the Converged Device and the Access Point antenna are placed in a suitable position within an anechoic chamber. The test shall be carried out at only one position of the test antenna that corresponds to the maximum receive sensitivity (Reference
Polarization and Orientation Position) as determined in the TIS, free space, full channel, cellular DUT measurement. If the DUT’s cellular radio has not been tested previously, then a reference TIS measurement must also be made in the free-space configuration to determine the reference value and position.

2.3.5.2 Wi-Fi DUT Transmitter Stimulus

Continuous short unicast UDP packets are transmitted by the Access Point using the MAC address of the Wi-Fi DUT. The DUT will respond with continuous ACKs which will be transmitted at maximum power. A traffic generator runs on the PC AP Controller, and generates continuous unicast packets. The traffic generator software is available from the Wi-Fi Alliance web site as an executable. The AP Tx/Rx analog output is connected to the antenna, inside the chamber, using a variable attenuator. The purpose of the attenuator is to make sure that the transmit signal from the AP does not impact the relative sensitivity measurement in the DUT. If the DUT is an 802.11b device the ACKs will be transmitted at 1 Mbps (long preamble). With the AP data rate set to “auto” the AP transmitted data will be 11 Mbps. This setup will achieve a repetition time of approximately 630 µs. If the DUT is an 802.11g or an 802.11a device the ACKs will be transmitted at 6 Mbps. With the AP data rate set to “auto” the transmitted data from the AP will be 54 Mbps. This setup will achieve a repetition time of approximately 165 µs.

---

4 Sufficient attenuation to stop the AP Tx compromising relative sensitivity measurements, but allows DUT to run at desired data rate (maximum attenuation 30 dB).
5 Using short preamble the repetition rate will be approximately 400 µs.
6 Using short preamble the repetition time will be approximately 400 µs.
2.3.5.3 Procedure

TIS testing needs to be performed for the antenna in retracted and extended position if applicable. Follow the set up and test procedure described in section 6 of the CTIA “Test Plan for Mobile Station Over-The Air Performance” version 2.1, for the modulation to be tested.

1. Make the Cellular receiver sensitivity measurement, on three channels (low, middle, high), with the Wi-Fi radio off. Record the values.
2. Turn on the Wi-Fi radio and let the Wi-Fi DUT associate with the AP using appropriate settings of the DUT and AP\(^7\). Use transmitter stimulus described in section 2.3.5.2 of this document.
3. Start the traffic generator on the PC AP Controller to stimulate the Wi-Fi DUT transmitter.
4. The traffic generator will initially carry out a ping test on the DUT. If the ping response is good then UDP packet generation commences either on a continuous or for a pre-defined number basis. At the end of the packet generation a final ping test is carried out.
5. Increase the cellular base station emulator transmit power by 5 dB.
6. Make the Cellular relative receiver sensitivity\(^8\) measurement with the Wi-Fi radio on following the procedure described in section 6 corresponding to the modulation of the DUT.
7. Relative sensitivity measurements shall be repeated on all or any combination of intermediate channels, provided that the 500 kHz maximum separation rule is followed.
8. Record results. See Appendix B for recommended data reporting formats.

\(^7\) AP IP Address 10.10.2.10, DUT IP Address 10.10.2.12, no security, set AP to appropriate channel #, Power save mode off in the DUT, Auto data rate, do not select mixed mode (only b or g or a), select AP to short preamble mode.

\(^8\) Relative sensitivity is measured by moving the DUT positioner to the reference polarization and orientation position (best radiated receiver sensitivity). Choose the appropriate polarization and orientation settings that are closest in frequency (low, middle, high band) with frequency being measured. Using base station emulator, measure the appropriate Digital Error Rate as defined in sections 6.2 (CDMA), 6.3 (TDMA), 6.4 (GSM) of the CTIA Test Plan for Mobile Station Over the Air Performance [1], for the cellular modulation to be tested.
3. WLAN ACCESS POINT TESTING METHODOLOGY

The test set-up and equipment is similar to that used for the Client testing.

3.1 Conducted RF Tests

3.1.1 Test Set-up

The basic test set-up is shown in Figure 3.1. The Access Point under test (APUT) is controlled by the PC, through the Ethernet port. The WLAN Station is simply used to communicate with the APUT. The validation of the WLAN Station is similar to that required for the Test AP.

![Figure 3.1 – Block Schematic Diagram – Conducted RF Test for AP](image)

3.1.2 Equipment

The APUT shall be provided with facilities that enable the Control PC to set the SSID, channel, modulation and data rate.

3.1.3 Transmit Power Measurement

3.1.3.1 Unicast Test Packets

The unicast test data packets shall be 200 frame bytes at a rate of 50 frames a second, to approximate a voice data stream.

3.1.3.2 Test Procedure

The recommended procedure is:

1. The AP Attenuator is set such that the signal received at the WLAN APUT’s antenna connector is at least 10dB higher than the sensitivity threshold.
2. The RX Attenuator, in the WLAN Test Set is set such that the received signal level from the APUT at the input of the WLAN Receiver is at least 10dB higher but not more than 50dB higher than the sensitivity threshold.
3. The AP under test (APUT) is set up to transmit on the desired channel, modulation and at the desired data rate.
4. The WLAN Station, in the WLAN Test Set, associates with the APUT.
5. The WLAN Station is set to continuously transmit unicast test data packets to the APUT, which responds with ACK control packets.
6. The WLAN Receiver reports the reception of the APUT ACK transmissions together with the data rate and the RSSI reading to the Control PC. Note the mean value of RSSI over a period of about 10 seconds.
7. Repeat steps 3 to 6 for each required channel and data rate.
8. Create a Table of Channel, Modulation, Data Rate and Mean RSSI for each measurement. See Appendix B for recommended data reporting formats.

Convert RSSI Readings:
9. Disconnect the cable to the APUT and connect it to the input of a Vector Signal Generator capable of generating WLAN IEEE 802.11a/b/g frames.
10. Set the Signal Generator to send a WLAN ACK control frame, on the desired center frequency, with the correct modulation and data rate as per the first measurement in the Table created in step 8.
11. Set the WLAN Receiver to the same channel as the Signal Generator.
12. Monitor the RSSI reported by the WLAN Receiver.
13. Adjust the Signal Generator output level such that the RSSI reported by the WLAN Receiver is that recorded in the corresponding Receive Sensitivity measurement in the Table created in step 8, and record the Output Level of the Signal Generator, to the nearest dBm, in an extra column of the Table.

   Note: To reduce the required output level of the Signal Generator, the RX Attenuator may be decreased in value and the difference accounted for in the tabulated results.

14. Repeat steps 10 - 13 for all the channels, modulations, and data rates in the Table created in Step 8.

3.1.3.3 Results
The Results shall be in the form of a Table of Channel, Modulation, Data Rate, Mean RSSI, and Transmit Power dBm. See Appendix B for recommended data reporting formats.

3.1.4 Receive Sensitivity Measurement

3.1.4.1 Unicast Test Packets
The unicast test data packets shall be 200 frame bytes at a rate of 50 frames a second, to approximate a voice data stream.

3.1.4.2 Test Procedure
The recommended procedure is:
1. The AP Attenuator is set such that the signal received at the APUT antenna connector is about 10dB higher than the sensitivity threshold.
2. The RX Attenuator, in the WLAN Test Set is set such that the received signal level from the APUT at the input of the WLAN Receiver is at least 10dB higher but not more than 50dB higher than the sensitivity threshold.
3. The APUT is set up to transmit on the desired channel, modulation and data rate.
4. The WLAN Station, in the WLAN Test Set, associates with the APUT.
5. The WLAN Station is set to continuously transmit unicast data packets to the APUT.
6. The APUT will respond to the received unicast data packets with an ACK control frame.
7. The WLAN Receiver reports the reception of the ACK control frames to the Control PC.
8. The Control PC counts the number of data frames and the number of ACK control frames received over a time period needed to receive 100 (TBR) data frames and the corresponding ACKs. The frame reception rate (FRR) is computed as (# of ACKs received / # data frames transmitted).
9. The AP attenuator is increased, until the FRR reduces to the point where a 1dB increase causes the FRR to be less than 90%.
10. The AP Attenuator is decreased by 1dB and the value noted, “A”dB.
11. Repeat steps 3 to 10 for each required channel, modulation and data rate.
12. Create a Table of Channel, Modulation, Data Rate, and AP Attenuator Setting. See Appendix B for recommended data reporting formats.

Convert the Test AP and AP Attenuator setting:

Convert the Test AP and AP Attenuator setting:
13. Measure the power level to an accuracy of 0.5dBm, “P”dBm as per the method described in Appendix C.
14. From the power level measured in step 13, add 10dB and deduct the value of the AP Attenuator noted in step 9, i.e. “P + 10 – A”. Record this value, the Receive Sensitivity, to an accuracy of 1dBm in an extra column to the Table created in step 11.
15. Repeat steps 13 - 14 for all the channels, modulations, and data rates and used in the measurement taking.

3.1.4.3 Results

The results shall be in the form of a Table of Channel, Modulation, Data Rate, AP Attenuator setting and Receive Sensitivity (10%PER). See Appendix B for recommended data reporting formats.

3.2 Radiated RF Tests

3.2.1 Test Set-up

The basic test set-up is similar to that for the conducted tests and is shown in Figure 3.2.

Figure 3.2 – Block Schematic Diagram – Radiated RF Tests for AP
3.2.2  **Equipment**

The APUT shall be provided with facilities that enable the Control PC to set the SSID, channel, modulation and data rate.

3.2.3  **Radiated Power**

3.2.3.1  **Discussion**

The method used is similar to the conducted transmit measurement with the exception that the co-axial connection between the hybrid splitter and the APUT is now made using the APUT antenna(s) and a Validated test antenna. The radiated path loss, from the position of the APUT antenna(s), including the test antenna, shall be calibrated.

The procedure described below relates to each individual measurement and will need to be repeated for each position and data rate specified for the device under test.

3.2.3.2  **Unicast Test Packets**

The unicast test data packets shall be 200 frame bytes at a rate of 50 frames a second, to approximate a voice data stream.

3.2.3.3  **Test Procedure**

The procedure is identical to that of the conducted transmit power measurement. The settings for the AP and WLAN Receiver attenuators will be different due to extra loss of the radiated path.

The recommended procedure is:

1. The AP Attenuator is set such that the signal received at the WLAN APUT's antenna connector is at least 10dB higher than the sensitivity threshold.
2. The RX Attenuator, in the WLAN Test Set is set such that the received signal level from the APUT at the input of the WLAN Receiver is at least 10dB higher but not more than 50dB higher than the sensitivity threshold.
3. The AP under test (APUT) is set up to transmit on the desired channel, modulation and at the desired data rate.
4. The WLAN Station, in the WLAN Test Set, associates with the APUT.
5. The WLAN Station is set to continuously transmit unicast test data packets to the APUT, which responds with ACK control packets.
6. The WLAN Receiver reports the reception of the APUT ACK transmissions together with the data rate and the RSSI reading to the Control PC. Note the mean value of RSSI over a period of about 10 seconds.
7. Repeat steps 3 to 6 for each required channel and data rate.
8. Create a Table of Channel, Modulation, Data Rate and Mean RSSI for each measurement. See Appendix B for recommended data reporting formats.

Convert RSSI Readings:

9. Remove the APUT. Connect the APUT's antenna directly to a Vector Signal Generator capable of generating WLAN IEEE 802.11a/b/g frames.
10. Set the Signal Generator to send a WLAN ACK control frame, on the desired center frequency, with the correct modulation and data rate as per the first measurement in the Table created in step 8.
11. Set the WLAN Receiver to the same channel as the Signal Generator.
12. Monitor the RSSI reported by the WLAN Receiver.
13. Adjust the Signal Generator output level such that the RSSI reported by the WLAN Receiver is that recorded in the corresponding Receive Sensitivity measurement in the Table created in step 8, and record the Output Level of the Signal Generator, to the nearest dBm, in an extra column of the Table.

   Note: To reduce the required output level of the Signal Generator, the RX Attenuator may be decreased in value and the difference accounted for in the tabulated results.

14. Repeat steps 10 - 13 for all the channels, modulations, and data rates in the Table created in Step 8.

3.2.3.4 Results

The Results shall be in the form of a Table of Channel, Modulation, Data Rate, Mean RSSI, and Transmit Power dBm. See Appendix B for recommended data reporting formats.

3.2.4 Receive Sensitivity Measurement

3.2.4.1 Discussion

The method used is similar to the conducted measurement with the exception that the co-axial connection between the hybrid splitter and the DUT is now made using the DUT antenna(s) and a calibrated test antenna. The radiated path loss from the position of the DUT antenna(s), including the test antenna, shall be calibrated.

3.2.4.2 Unicast Test Packets

The unicast test data packets shall be 200 frame bytes at a rate of 50 frames a second, to approximate a voice data stream.

3.2.4.3 Test Procedure

The recommended procedure is:
1. The AP Attenuator is set such that the signal received at the APUT antenna connector is about 10dB higher than the sensitivity threshold.
2. The RX Attenuator, in the WLAN Test Set is set such that the received signal level from the APUT at the input of the WLAN Receiver is at least 10dB higher but not more than 50dB higher than the sensitivity threshold.
3. The APUT is set up to transmit on the desired channel, modulation and data rate.
4. The WLAN Station, in the WLAN Test Set, associates with the APUT.
5. The WLAN Station is set to continuously transmit unicast data packets to the APUT.
6. The APUT will respond to the received unicast data packets with an ACK control frame.
7. The WLAN Receiver reports the reception of the ACK control frames to the Control PC.
8. The Control PC counts the number of data frames and the number of ACK control frames received over a time period needed to receive 100 (TBR) data frames and the corresponding
ACKs. The frame reception rate (FRR) is computed as (# of ACKs received / # data frames transmitted)

9. The AP attenuator is increased, until the FRR reduces to the point where a 1dB increase causes the FRR to be less than 90%.

10. The AP Attenuator is decreased by 1dB and the value noted, “A”dB

11. Repeat steps 3 to 10 for each required channel, modulation and data rate.

12. Create a Table of Channel, Modulation, Data Rate, and AP Attenuator Setting. See Appendix B for recommended data reporting formats.

Convert the Test AP and AP Attenuator setting:

13. Measure the power level to an accuracy of 0.5dBm, “P”dBm as per the method described in Appendix C.

14. From the power level measured in step 13, add 10dB and deduct the value of the AP Attenuator noted in step 10, i.e. P + 10 – A. Record this value, the Receive Sensitivity, to an accuracy of 1dBm in an extra column to the Table created in step 12.

15. Repeat steps 13 - 14 for all the channels, modulations, and data rates and used in the measurement taking.

3.2.4.4 Results

The results shall be in the form of a Table of Channel, Modulation, Data Rate, AP Attenuator setting and Receive Sensitivity (10%PER). See Appendix B for recommended data reporting formats.
4. **RADIATED MEASUREMENTS**

4.1 **Test Conditions for Device Under Test**

The DUT shall be tested under conditions that most closely represent the actual working conditions of the device.

If the DUT is a handheld mobile device, then it should be placed on a turntable mounted on a SAM Head Phantom as described in Reference (1), or mounted for free space testing. See Appendix E for handheld product testing requirements.

If the DUT is an AP, it should be placed on its own on the turntable with the antennas in the vertical position, or as specified by the vendor.

If the DUT is a self contained Wi-Fi/Mobile Module with internal antennas, such as a PC Card, then the vendor may choose to

   Either

   - Supply the DUT together with one of its intended host platforms, e.g. a laptop computer. In this case, the combination should then be placed on the turntable and the results sheet should clearly state the combination that was used in the measurements.

   Or

   - Test the Module, on its own, mounted in a holder that orientates the module in the position that represents its normal use. In this case the results sheet should clearly state that the test did not include a host device.

   Or

   - Carry out both tests as above. This is the preferred method, but not mandatory.

If the DUT is a self contained Wi-Fi/Mobile Module without internal antennas, such as a mPCI Card, then the vendor must supply the complete device, which includes the antennas, for testing. No individual module testing is acceptable.

The test results shall include a description, and diagram or photograph of the test conditions used for the device under test.
5. MOBILE STATION TESTING

5.1 Transmitter Performance

5.1.1 Conducted Power Output

5.1.1.1 DUT Requirements

The DUT shall be provided to the Test Laboratory with the facility to connect directly to the RF test equipment. This may be via an existing antenna connector, or it may be a carefully modified unit to allow such connection. In the latter case, it is the responsibility of the supplier of the DUT to ensure that the connection is present and suitable.

5.1.1.2 Frequency Channels

The measurements shall be taken at the lowest, middle\(^9\) and highest channels supported by the device, in each of the 2.4GHz and 5GHz bands.

5.1.1.3 Data Rates

On each frequency channel, the transmit power output shall be measured at the following data rates:

- IEEE 802.11b 11Mbps
- IEEE 802.11g 6, 11, 12 and 24Mbps
- IEEE 802.11a 6, 12 and 24Mbps

5.1.1.4 Not Used

5.1.1.5 Results

Results should be represented in dBm and rounded to the closest integer value.

There is no pass / fail criteria.

5.1.2 Total Radiated Power (TRP)

5.1.2.1 DUT Requirements

The DUT shall be provided in an unmodified state.

5.1.2.2 Frequency Channels

For IEEE 802.11b/g devices the complete TRP measurement is made on Channel 6. Single point measurements are made on the highest and lowest supported channels. The selection of the location for the single point measurement should be chosen on a section of the radiation pattern that is smooth and at or near the maximum transmit power value.

\(^9\) For 5 GHz bands refer to Appendix D for the middle channel numbers per sub band.
For IEEE 802.11a devices the complete TRP measurement is made on the lowest channel of the lowest supported band and on the highest channel of the highest supported band. Single point measurements are made on each sub band at the lowest, middle\(^{10}\), and highest channels. See Appendix D for examples of some commonly supported 5 GHz bands. The selection of the location, the “Reference Position”, for the single point measurement should be chosen on a section of the radiation pattern that is smooth and at or near the maximum transmit power value.

In each case where a complete TRP measurement is made it shall be reported as the Mode Radiated Figure of Merit. In each case where a single point measurement is made it shall be reported as a Mode Radiated Reference Measurement.

### 5.1.2.3 Data Rates

On each frequency channels, the transmit power output shall be measured at the following data rates:

<table>
<thead>
<tr>
<th>Data Rates</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>IEEE 802.11b</td>
<td>11Mbps</td>
</tr>
<tr>
<td>IEEE 802.11g</td>
<td>6Mbps</td>
</tr>
<tr>
<td>IEEE 802.11a</td>
<td>6Mbps</td>
</tr>
</tbody>
</table>

### 5.1.2.4 Results

Results should be represented in dBm and rounded to the closest integer value.

Inferred TRP results from combinations not specifically tested can be derived using the table of conducted TX power results obtained in 5.1.1.5

There is no pass / fail criteria.

## 5.2 Receiver Performance

### 5.2.1 Conducted Receiver Sensitivity

#### 5.2.1.1 DUT Requirements

The DUT shall be provided with the facility to connect directly to the RF test equipment. This may be via an existing antenna connector, or it may be a carefully modified unit to allow such connection. In the latter case, it is the responsibility of the supplier of the DUT to ensure that the connection is present and suitable.

If the DUT is operating a combining diversity scheme then a combiner may be used such that the received signal is split between the antenna connections. In this case the splitter must be included when carrying out the validation procedure with the unused port being correctly terminated.

---

\(^{10}\) Refer to Appendix D for the middle channel numbers per sub band.
5.2.1.2 Frequency Channels

The measurements shall be taken at the lowest, middle\(^{11}\) and highest channels supported by the device, in each of the 2.4GHz and 5GHz bands.

5.2.1.3 Data Rates

On each frequency channel, receive sensitivity shall be measured at the following data rates:

- IEEE 802.11b 11Mbps
- IEEE 802.11g 6, 11, 24 and 54Mbps
- IEEE 802.11a 6, 24 and 54Mbps

5.2.1.4 Results

Results should be represented in dBm and rounded to the closest integer value.

There is no pass / fail criteria.

5.2.2 Total Isotropic Sensitivity (TIS)

5.2.2.1 DUT Requirements

The DUT shall be provided in an unmodified state.

5.2.2.2 Frequency Channels

For IEEE 802.11b/g devices the complete TIS measurement is made on Channel 6. Single point measurements are made on the highest and lowest supported channels. The selection of the location, the “Reference Position”, for the single point measurement should be chosen on a section of the radiation pattern that is smooth and at or near the maximum sensitivity value.

For IEEE 802.11a devices the complete TIS measurement is made on the lowest channel of the lowest supported band and on the highest channel of the highest supported band. Single point measurements are made on each sub band at the lowest, middle\(^{10}\), and highest channels. See Appendix D for examples of some commonly supported 5 GHz bands. The selection of the location, the “Reference Position”, for the single point measurement should be chosen on a section of the radiation pattern that is smooth and at or near the maximum sensitivity value.

In each case where a complete TIS measurement is made it shall be reported as the Mode Sensitivity Figure of Merit. In each case where a single point measurement is made it shall be reported as a Mode Sensitivity Reference Measurement.

5.2.2.3 Data Rates

On each frequency channels, receive sensitivity shall be measured at the following data rates:

\(^{11}\) For 5 GHz bands refer to Appendix D for the middle channel numbers per sub band.
IEEE 802.11b 11Mbps
IEEE 802.11g 54Mbps
IEEE 802.11a 54Mbps

5.2.2.4 Results

Results should be represented in dBm and rounded to the closest integer value.

There is no pass / fail criteria.

5.2.3 Radiated Receiver Sensitivity, Simultaneous Operation (Wi-Fi Desense)

5.2.3.1 DUT Requirements

The DUT shall be provided in an unmodified state.

5.2.3.2 Positions

While conducting the simultaneous operation mode evaluation, the “Reference Position” for the corresponding Wi-Fi mode, as determined in Test 5.2.2, shall be used.

5.2.3.3 Highest Cellular Frequency Channel Test

The device shall be set to operate at the highest cellular channel supported.

The Wi-Fi channel and data rate shall be set as shown in Table 5.1:

<table>
<thead>
<tr>
<th>Wi-Fi Mode</th>
<th>Channel</th>
<th>Data Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEEE 802.11b</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>IEEE 802.11g</td>
<td></td>
<td>54</td>
</tr>
<tr>
<td>IEEE 802.11a</td>
<td>Middle(^{12}) of each supported band</td>
<td>54</td>
</tr>
</tbody>
</table>

The Radiated Receiver Sensitivity Degradation shall be measured and recorded.

5.2.3.4 Harmonic Interference Tests

Reference shall be made to Appendix A and Tables A.1 and A.2.

For each cellular system supported by the device, the possible harmonic interferences are identified in Tables A1 and A2 for the 2.4GHz and 5GHz Wi-Fi bands respectively.

\(^{12}\) Refer to Appendix D for the middle channel numbers per sub band.
5.2.3.4.1 **IEEE 802.11b and .11g**

If the device supports IEEE 802.11b or 802.11g, then for each supported combination of cellular system and regulatory domain, reference is made to Table A.1.

- For each supported combination cellular system and regulatory domain
  1. Check the column corresponding to that cellular system and regulatory domain
  2. If one or more possible harmonic interferences are shown, at supported WI-Fi channels or regulatory domain, then select one combination – if no combination or no supported combination is shown, no test is required.
  3. The Radiated Receiver Sensitivity Degradation shall be measured and recorded against that cellular system
- Select the next supported cellular system and regulatory domain and repeat steps 1, 2 and 3.

5.2.3.4.2 **IEEE 802.11a**

If the device supports IEEE 802.11a, then for each supported combination of cellular system and regulatory domain, reference is made to Table A.2.

- For each supported combination cellular system and regulatory domain
  1. Check the column corresponding to that cellular system and regulatory domain
  2. If one or more possible harmonic interferences are shown, at supported WI-Fi channels or regulatory domain, then select one combination – if no combination or no supported combination is shown, no test is required.
  3. The Radiated Receiver Sensitivity Degradation shall be measured and recorded against that cellular system
- Select the next supported cellular system and regulatory domain and repeat steps 1, 2 and 3.

5.2.3.5 **Results**

Results should be represented in dB and rounded to the closest integer value.

There is no pass / fail criteria.

5.2.4 **Radiated Cellular Receiver Sensitivity, Simultaneous Operation (Cellular Desense)**

5.2.4.1 **DUT Requirements**

The DUT shall be provided in an unmodified state.

5.2.4.2 **DUT Polarization**

While conducting the simultaneous operation measurement, the “Reference Polarization and Orientation” position for the corresponding Cellular mode, as determined in the Cellular TIS measurement, shall be used. There will be three polarization and orientation values, one for each of the three bands (low, middle, high) and the polarization used should be the one closest to the frequency being measured.
5.2.4.3 Wi-Fi Frequency

Devices that operate in the 2.4 GHz band will be set to operate on channel 6 \((f_c = 2.437 \text{ GHz})\). Devices that operate in the 5 GHz band will be set to operate on the mid channel of the appropriate sub-band supported as shown in Table 5.2:

<table>
<thead>
<tr>
<th>Sub Band</th>
<th>Mid Channel #</th>
<th>Mid Channel Center Frequency (f_c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-NII Lower Band (5.15 GHz to 5.25 GHz)</td>
<td>44</td>
<td>5.200 GHz</td>
</tr>
<tr>
<td>U-NII Middle Band (5.25 GHz to 5.35 GHz)</td>
<td>60</td>
<td>5.300 GHz</td>
</tr>
<tr>
<td>U-NII Upper Band (5.725 GHz to 5.825 GHz)</td>
<td>157</td>
<td>5.765 GHz</td>
</tr>
<tr>
<td>European ETSI Band</td>
<td>120</td>
<td>5.620 GHz</td>
</tr>
</tbody>
</table>

If the device has a dual band radio then two sets of cellular desense measurements are required.

The relative receiver Sensitivity Degradation shall be measured and recorded. All channels that are above the 5dB margin at the reference sensitivity polarization and orientation position need to be reported.

5.2.4.4 Cellular Technology and Frequency Band

The test shall be repeated for each technology and frequency band supported by the DUT, which may be any combination of the following:

- GSM at 850MHz (GSM 850)
- GSM at 900MHz (P-GSM 900)
- GSM at 1800MHz (DCS 1800)
- GSM at 1900MHz (PCS 1900)
- WCDMA at 850MHz (UTRA FDD Operating Band V)
- WCDMA at 1900MHz (UTRA FDD Operating Band II)
- WCDMA at 2100MHz (UTRA FDD Operating Band I)
- CDMA at 850MHz
- CDMA at 1900MHz
5.2.4.5 Results

Results should be recorded as % Digital Error Rate\(^{13}\). All channels that are above the 5dB margin at the reference sensitivity polarization need to be reported.

\(^{13}\) Digital Error Rate is a generic term to refer to the appropriate error measuring scheme in 6.2 (CDMA – FER), 6.3 (TDMA – BER) and 6.3 (GSM – RBER) of the CTIA “Test Plan for Mobile Station Over The Air Performance”, Version 2.1.
6. ACCESS POINT TESTING

6.1 Transmitter Performance

6.1.1 Conducted Power Output

6.1.1.1 APUT Requirements

The APUT shall be provided to the Test Laboratory with the facility to connect directly to the RF test equipment. This may be via an existing antenna connector, or it may be a carefully modified unit to allow such connection. In the latter case, it is the responsibility of the supplier of the APUT to ensure that the connection is present and suitable.

6.1.1.2 Frequency Channels

The measurements shall be taken at the lowest, middle\(^ {14} \) and highest channels supported by the device, in each of the 2.4GHz and 5GHz bands.

6.1.1.3 Data Rates

On each frequency channel, the transmit power output shall be measured at the following data rates:

- IEEE 802.11b: 11Mbps
- IEEE 802.11g: 6, 11, 12 and 24Mbps
- IEEE 802.11a: 6, 12 and 24Mbps

6.1.1.4 Not Used

6.1.1.5 Results

Results should be represented in dBm and rounded to the closest integer value.

There is no pass / fail criteria.

6.1.2 Total Radiated Power (TRP)

6.1.2.1 APUT Requirements

The APUT shall be provided in an unmodified state.

6.1.2.2 Frequency Channels

For IEEE 802.11b/g devices the complete TRP measurement is made on Channel 6. Single point measurements are made on the highest and lowest supported channels. The selection of the location, the "Reference Position", for the single point measurement should be chosen on a section of the radiation pattern that is smooth and at or near the maximum transmit power value.

\(^{14} \) For 5 GHz bands refer to Appendix D for the middle channel numbers per sub band.
For IEEE 802.11a devices the complete TRP measurement is made on the lowest channel of the lowest supported band and on the highest channel of the highest supported band. Single point measurements are made on each sub band at the lowest, middle\textsuperscript{14}, and highest channels. See Appendix D for examples of some commonly supported 5 GHz bands. The selection of the location, the “Reference Position”, for the single point measurement should be chosen on a section of the radiation pattern that is smooth and at or near the maximum transmit power value.

In each case where a complete TRP measurement is made it shall be reported as the Mode Radiated Figure of Merit. In each case where a single point measurement is made it shall be reported as a Mode Radiated Reference Measurement.

6.1.2.3 Data Rates

On each frequency channels, the transmit power output shall be measured at the following data rates:

<table>
<thead>
<tr>
<th>IEEE 802.11b</th>
<th>11Mbps</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEEE 802.11g</td>
<td>6Mbps</td>
</tr>
<tr>
<td>IEEE 802.11a</td>
<td>6Mbps</td>
</tr>
</tbody>
</table>

6.1.2.4 Results

Results should be represented in dBm and rounded to the closest integer value.

Inferred TRP results from combinations not specifically tested can be derived using the table of conducted TX power results obtained in 5.1.1.5

There is no pass / fail criteria.

6.2 Receiver Performance

6.2.1 Conducted Receive Sensitivity

6.2.1.1 APUT Requirements

The APUT shall be provided with the facility to connect directly to the RF test equipment. This may be via an existing antenna connector, or it may be a carefully modified unit to allow such connection. In the latter case, it is the responsibility of the supplier of the DUT to ensure that the connection is present and suitable.

If the APUT is operating a combining diversity scheme then a combiner may be used such that the received signal is split between the antenna connections. In this case the splitter must be included when carrying out the validation procedure with the unused port being correctly terminated.

6.2.1.2 Frequency Channels

The measurements shall be taken at the lowest, middle\textsuperscript{15} and highest channels supported by the device, in each of the 2.4GHz and 5GHz bands

\textsuperscript{15} For 5 GHz bands refer to Appendix D for the middle channel numbers per sub band.
6.2.1.3 Data Rates

On each frequency channel, receive sensitivity shall be measured at the following data rates:

<table>
<thead>
<tr>
<th>Standard</th>
<th>Data Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEEE 802.11b</td>
<td>11Mbps</td>
</tr>
<tr>
<td>IEEE 802.11g</td>
<td>6, 11, 24 and 54Mbps</td>
</tr>
<tr>
<td>IEEE 802.11a</td>
<td>6, 24 and 54Mbps</td>
</tr>
</tbody>
</table>

6.2.1.4 Results

Results should be represented in dBm and rounded to the closest integer value.

There is no pass / fail criteria.

6.2.2 Total Isotropic Sensitivity (TIS)

6.2.2.1 APUT Requirements

The APUT shall be provided in an unmodified state.

6.2.2.2 Frequency Channels

For IEEE 802.11b/g devices the complete TIS measurement is made on Channel 6. Single point measurements are made on the highest and lowest supported channels. The selection of the location for the single point measurement should be chosen on a section of the radiation pattern that is smooth and at or near the maximum sensitivity value.

For IEEE 802.11a devices the complete TIS measurement is made on the lowest channel of the lowest supported band and on the highest channel of the highest supported band. Single point measurements are made on each sub band at the lowest, middle\(^{16}\), and highest channels. See Appendix D for some commonly supported 5 GHz bands. The selection of the location for the single point measurement should be chosen on a section of the radiation pattern that is smooth and at or near the maximum sensitivity value.

In each case where a complete TIS measurement is made it shall be reported as the Mode Sensitivity Figure of Merit. In each case where a single point measurement is made it shall be reported as a Mode Sensitivity Reference Measurement.

6.2.2.3 Data Rates

On each frequency channels, receive sensitivity shall be measured at the following data rates:

<table>
<thead>
<tr>
<th>Standard</th>
<th>Data Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEEE 802.11b</td>
<td>11Mbps</td>
</tr>
<tr>
<td>IEEE 802.11g</td>
<td>54Mbps</td>
</tr>
</tbody>
</table>

\(^{16}\) Refer to Appendix D for the middle channel number per sub band.
6.2.2.4 Results

Results should be represented in dBm and rounded to the closest integer value.

There is no pass / fail criteria.
7. WLAN TEST SET

7.1 Estimated Signal Levels

The estimated signal levels for the various tests are tabulated in Tables 7.1 to 7.4. From these Tables the requirements for the Test AP TX Power, RX Attenuator and AP Attenuator can be calculated.

Table 7.1 – Conducted TX Test

<table>
<thead>
<tr>
<th>DUT Min Sensitivity, dBm</th>
<th>5GHz</th>
<th>2.4GHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFDM</td>
<td>-65</td>
<td>-65</td>
</tr>
<tr>
<td>Margin, dB</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Cable loss, dB</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Hybrid loss, dB</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Required Test AP TX Power, dBm</td>
<td>-45</td>
<td>-45</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DUT Min TX Power, dBm</th>
<th>5GHz</th>
<th>2.4GHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFDM</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>Margin, dB</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Cable loss, dB</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Hybrid loss, dB</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>RX Signal at RX Attn, dBm</td>
<td>-13</td>
<td>-13</td>
</tr>
<tr>
<td>WLAN RX Min Sensitivity, dBm</td>
<td>-68</td>
<td>-68</td>
</tr>
<tr>
<td>RX Attn setting, dB</td>
<td>55</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>63</td>
<td></td>
</tr>
</tbody>
</table>
### Table 7.2 – Conducted RX Test

<table>
<thead>
<tr>
<th></th>
<th>5GHz</th>
<th>2.4GHz</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OFDM</td>
<td>OFDM</td>
</tr>
<tr>
<td>DUT Max Sensitivity, dBm</td>
<td>-90</td>
<td>-90</td>
</tr>
<tr>
<td>Cable loss, dB</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Hybrid loss, dB</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Required Test AP TX Power, dBm</td>
<td><strong>-80</strong></td>
<td><strong>-80</strong></td>
</tr>
<tr>
<td>DUT Max TX Power, dBm</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>DUT Max Antenna Gain, dB</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Margin, dB</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Cable loss, dB</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Hybrid loss, dB</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>RX Signal at RX Attn, dBm</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>WLAN RX Min Sensitivity, dBm</td>
<td><strong>-68</strong></td>
<td><strong>-68</strong></td>
</tr>
<tr>
<td>RX Attn setting, dB</td>
<td><strong>71</strong></td>
<td><strong>71</strong></td>
</tr>
<tr>
<td></td>
<td>5GHz</td>
<td>2.4GHz</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------</td>
<td>--------</td>
</tr>
<tr>
<td></td>
<td>OFDM</td>
<td>OFDM</td>
</tr>
<tr>
<td>DUT Min Sensitivity, dBm</td>
<td>-65</td>
<td>-65</td>
</tr>
<tr>
<td>Margin, dB</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Required signal level, dBm</td>
<td>-55</td>
<td>-55</td>
</tr>
<tr>
<td>Distance, m</td>
<td>3.6</td>
<td>1.5</td>
</tr>
<tr>
<td>Path Loss, dB</td>
<td>57.9</td>
<td>43.6</td>
</tr>
<tr>
<td>Test Antenna Gain, dB</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Min DUT Antenna Gain, dB</td>
<td>-10</td>
<td>-10</td>
</tr>
<tr>
<td>Cable loss, dB</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Hybrid loss, dB</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td><strong>Required Test AP TX Power, dBm</strong></td>
<td><strong>9.9</strong></td>
<td><strong>-4.4</strong></td>
</tr>
<tr>
<td>DUT Min TX Power, dBm</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>DUT Min Antenna Gain, dB</td>
<td>-10</td>
<td>-10</td>
</tr>
<tr>
<td>Test Antenna Gain, dB</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Path Loss, dB</td>
<td>57.9</td>
<td>43.6</td>
</tr>
<tr>
<td>Margin, dB</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Cable loss, dB</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Hybrid loss, dB</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>RX Signal at RX Attn, dBm</td>
<td>-57.9</td>
<td>-43.6</td>
</tr>
<tr>
<td>WLAN RX Min Sensitivity, dBm</td>
<td>-68</td>
<td>-68</td>
</tr>
<tr>
<td><strong>RX Attn setting, dB</strong></td>
<td><strong>10.1</strong></td>
<td><strong>24.4</strong></td>
</tr>
</tbody>
</table>
Table 7.4 – Radiated RX Test

<table>
<thead>
<tr>
<th></th>
<th>5GHz</th>
<th>2.4GHz</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OFDM</td>
<td>OFDM</td>
</tr>
<tr>
<td>DUT Max Sensitivity, dBm</td>
<td>-90</td>
<td>-90</td>
</tr>
<tr>
<td>DUT Min Antenna Gain, dB</td>
<td>-10</td>
<td>-10</td>
</tr>
<tr>
<td>Distance, m</td>
<td>3.6</td>
<td>1.5</td>
</tr>
<tr>
<td>Path Loss, dB</td>
<td>57.9</td>
<td>43.6</td>
</tr>
<tr>
<td>Test Antenna Gain, dB</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Cable loss, dB</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Hybrid loss, dB</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td><strong>Required Test AP TX Power,</strong> dBm</td>
<td><strong>-25.1</strong></td>
<td><strong>-39.4</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>5GHz</th>
<th>2.4GHz</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OFDM</td>
<td>OFDM</td>
</tr>
<tr>
<td>DUT Min TX Power, dBm</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>DUT Min Antenna Gain, dB</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Test Antenna Gain, dB</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Path Loss, dB</td>
<td>57.9</td>
<td>43.6</td>
</tr>
<tr>
<td>Margin, dB</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Cable loss, dB</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Hybrid loss, dB</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>RX Signal at RX Attn, dBm</td>
<td><strong>-67.9</strong></td>
<td><strong>-53.6</strong></td>
</tr>
<tr>
<td>WLAN RX Min Sensitivity, dBm</td>
<td><strong>-68</strong></td>
<td><strong>-68</strong></td>
</tr>
<tr>
<td>RX Attn setting, dB</td>
<td>0.1</td>
<td>14.4</td>
</tr>
</tbody>
</table>

From these Tables, the following can be calculated:

- **AP Attenuator**
  The maximum required Test AP transmit Power is 9.9dBm and the minimum –85dBm
  Hence the AP Attenuator will need to be at least 95dB

- **RX Attenuator**
  The maximum required attenuation is 79dB, and the minimum is 0dB.

### 7.2 Test AP and WLAN Station Requirements

#### 7.2.1 Basic Parameters

The Test AP does not require support for encryption, fragmentation or QoS. In addition the Test AP will be set to not support APSD.

#### 7.2.2 RF Parameters

The basic RF requirements for the Test AP are:

- **Standards**  
  IEEE 802.11a, 802.11b, 802.11g
Signal Rate

For IEEE 802.11a/g
- 54, 48, 36, 24, 18, 12, 9, 6Mbps
For IEEE 802.11b
- 11, 5.5, 2, 1Mbps

Wireless Frequency Range

2.412 to 2.484GHz
4.915 to 5.32 GHz and 5.5 to 5.805GHz

Radio and Modulation Type

For IEEE 802.11b and 802.11g
- DSSS
  - DBPSK @ 1Mbps
  - DQPSK @ 2Mbps
  - CCK @ 5.5 and 11Mbps
For IEEE 802.11a and 802.11g
- OFDM
  - BPSK @ 6 and 9Mbps
  - QPSK @ 12 and 18Mbps
  - 16QAM @ 24 and 36Mbps
  - 64QAM @ 48 and 54Mbps

Minimum Receive Sensitivity

For IEEE 802.11a and 802.11g
- 6Mbps: -82dBm
- 9Mbps: -81dBm
- 12Mbps: -79dBm
- 18Mbps: -77dBm
- 24Mbps: -74dBm
- 36Mbps: -70dBm
- 48Mbps: -66dBm
- 54Mbps: -65dBm
For IEEE 802.11b and 802.11g
- 1Mbps: -86dBm
- 2Mbps: -83dBm
- 5.5Mbps: -79dBm
- 11Mbps: -76dBm

Maximum Transmit Output Power

Not less than 10dB at all frequencies and data rates

Transmit Relative Constellation Error

For OFDM
- 54Mbps: not to exceed –30dB
- 48Mbps: not to exceed –27dB
- 36Mbps: not to exceed –24dB
- 24Mbps: not to exceed –21dB
- 18Mbps: not to exceed –18dB
- 12Mbps: not to exceed –15dB
- 9Mbps: not to exceed –13dB
- 6Mbps: not to exceed –10dB

### 7.3 WLAN Receiver RF Requirements

The basic RF requirements for the WLAN Receiver are:

- **Standards**: IEEE 802.11a, IEEE 802.11b, IEEE 802.11g
- **Signal Rate**: For IEEE 802.11a/g
• 54, 48, 36, 24, 18, 12, 9, 6Mbps
  For IEEE 802.11b
  • 11, 5.5, 2, 1Mbps

Wireless Frequency Range
  2.412 to 2.484GHz
  4.915 to 5.32 GHz and 5.5 to 5.805GHz

Radio and Modulation Type
  For IEEE 802.11b and 802.11g
  DSSS
  • DBPSK @ 1Mbps
  • DQPSK @ 2Mbps
  • CCK @ 5.5 and 11Mbps
  For IEEE 802.11a and 802.11g
  OFDM
  • BPSK @ 6 and 9Mbps
  • QPSK @ 12 and 18Mbps
  • 16QAM @ 24 and 36Mbps
  • 64QAM @ 48 and 54Mbps

Minimum Receive Sensitivity
  For IEEE 802.11a and 802.11g
  • 6Mbps: -86dBm
  • 9Mbps: -84dBm
  • 12Mbps: -82dBm
  • 18Mbps: -80dBm
  • 24Mbps: -77dBm
  • 36Mbps: -73dBm
  • 48Mbps: -69dBm
  • 54Mbps: -68dBm
  For IEEE 802.11b and 802.11g
  • 1Mbps: -86dBm
  • 2Mbps: -83dBm
  • 5.5Mbps: -79dBm
  • 11Mbps: -76dBm

RSSI Reporting
  For signal levels >10dB and <50dB above Minimum Receive Sensitivity the reported RSSI shall be reported in steps of no more than 0.5dBm.

  Measurement of RSSI shall be in a time period equal or less than 800ns (one period of the OFDM short training symbol).

7.4 Attenuator Requirements

Minimum Frequency Range 2 to 6GHz
Minimum Attenuation 0dB
Maximum Attenuation Not less than 100dB
Step 1dB
Attenuator Accuracy 0.25dB
Impedance 50ohms nominal
Maximum Input power Not less than 23dBm
Note: For example, the attenuator could consist of two separate switched or programmable attenuators in series; 0-100dB in 10dB steps, and 0-10dB in 1 dB steps.
8. APPENDIX A – HARMONIC INTERFERENCE SELECTION MATRICIES

The following matrices are to be used for the selection of WLAN / Mobile Device Interference channel pairs. These modes are used in section 5.2.3.4 based upon which modes of operation. All frequencies quoted in the Appendix A Tables are in MHz.

<table>
<thead>
<tr>
<th>Table A.1 – IEEE 802.11b/g Products⁸</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Chan</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>8</td>
</tr>
<tr>
<td>9</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>11</td>
</tr>
<tr>
<td>12</td>
</tr>
<tr>
<td>13</td>
</tr>
<tr>
<td>14</td>
</tr>
</tbody>
</table>

Notes:

a) Interference is caused by 3rd harmonic of the other technology
b) UTRA FDD Band V Americas
c) UTRA FDD Band VI Japan
<table>
<thead>
<tr>
<th>Wi-Fi</th>
<th>GSM 850</th>
<th>GSM 900</th>
<th>GSM 1800</th>
<th>GSM 1900</th>
<th>CDMA-2000 US/Korea 800 MHz</th>
<th>CDMA-2000 UK 900 MHz</th>
<th>CDMA-2000 Korea 1700MHz</th>
<th>CDMA 2000 US 1900 MHz</th>
<th>UTRA FDD Band I – IV</th>
<th>UTRA TDD All Bands</th>
<th>PHS Asia</th>
<th>iDen 800 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>5005</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4196*</td>
<td>839.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>5040</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4200*</td>
<td>840.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>5180</td>
<td>594</td>
<td>1726.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8633*</td>
<td>1728.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>5200</td>
<td>628</td>
<td>1733.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8667*</td>
<td>1733.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>5220</td>
<td>661</td>
<td>1740.0</td>
<td></td>
<td></td>
<td>1329</td>
<td>872.0125</td>
<td></td>
<td>8700*</td>
<td>1740.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>5240</td>
<td>694</td>
<td>1746.6</td>
<td></td>
<td></td>
<td>1382</td>
<td>873.3375</td>
<td>0</td>
<td>1750.00</td>
<td>8733*</td>
<td>1746.6</td>
<td></td>
</tr>
<tr>
<td>52</td>
<td>5260</td>
<td>728</td>
<td>1753.4</td>
<td></td>
<td></td>
<td>1515</td>
<td>876.6625</td>
<td>67</td>
<td>1753.35</td>
<td>8767*</td>
<td>1753.4</td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>5280</td>
<td>975</td>
<td>880.2</td>
<td>761</td>
<td>1760.0</td>
<td>1648</td>
<td>879.9875</td>
<td>200</td>
<td>1760.00</td>
<td>8800*</td>
<td>1760.0</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>5300</td>
<td>991</td>
<td>883.4</td>
<td>794</td>
<td>1766.6</td>
<td>1782</td>
<td>883.3375</td>
<td>333</td>
<td>1766.66</td>
<td>8833*</td>
<td>1766.6</td>
<td></td>
</tr>
<tr>
<td>64</td>
<td>5320</td>
<td>1007</td>
<td>886.6</td>
<td>828</td>
<td>1773.4</td>
<td>1915</td>
<td>866.6625</td>
<td>467</td>
<td>1773.35</td>
<td>8867*</td>
<td>1773.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1000</td>
<td></td>
<td></td>
<td>914.9875</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>112</td>
<td>5560</td>
<td>528</td>
<td>1853.4</td>
<td></td>
<td></td>
<td>67</td>
<td>1853.35</td>
<td>9267*</td>
<td>1853.4</td>
<td>9267*</td>
<td>1853.4</td>
<td></td>
</tr>
<tr>
<td>116</td>
<td>5580</td>
<td>581</td>
<td>1860.0</td>
<td></td>
<td></td>
<td>200</td>
<td>1860.00</td>
<td>9300*</td>
<td>1860.0</td>
<td>9300*</td>
<td>1860.0</td>
<td></td>
</tr>
<tr>
<td>120</td>
<td>5600</td>
<td>594</td>
<td>1866.6</td>
<td></td>
<td></td>
<td>333</td>
<td>1866.65</td>
<td>9333*</td>
<td>1866.6</td>
<td>9333*</td>
<td>1866.6</td>
<td></td>
</tr>
<tr>
<td>124</td>
<td>5620</td>
<td>628</td>
<td>1873.4</td>
<td></td>
<td></td>
<td>467</td>
<td>1873.35</td>
<td>9367*</td>
<td>1873.4</td>
<td>9367*</td>
<td>1873.4</td>
<td></td>
</tr>
<tr>
<td>128</td>
<td>5640</td>
<td>661</td>
<td>1880.0</td>
<td></td>
<td></td>
<td>600</td>
<td>1880.00</td>
<td>9400*</td>
<td>1880.0</td>
<td>9400*</td>
<td>1880.0</td>
<td></td>
</tr>
<tr>
<td>132</td>
<td>5660</td>
<td>694</td>
<td>1886.6</td>
<td></td>
<td></td>
<td>733</td>
<td>1886.65</td>
<td>9433*</td>
<td>1886.6</td>
<td>9433*</td>
<td>1886.6</td>
<td></td>
</tr>
<tr>
<td>136</td>
<td>5680</td>
<td>728</td>
<td>1893.4</td>
<td></td>
<td></td>
<td>867</td>
<td>1893.35</td>
<td>9467*</td>
<td>1893.4</td>
<td>9467*</td>
<td>1893.4</td>
<td>1</td>
</tr>
<tr>
<td>140</td>
<td>5700</td>
<td>761</td>
<td>1900.0</td>
<td></td>
<td></td>
<td>1000</td>
<td>1900.00</td>
<td>9500*</td>
<td>1900.0</td>
<td>9500*</td>
<td>1900.0</td>
<td>17</td>
</tr>
<tr>
<td>149</td>
<td>5745</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1000</td>
<td>1900.00</td>
<td>9500*</td>
<td>1900.0</td>
<td>9500*</td>
<td>1900.0</td>
<td></td>
</tr>
<tr>
<td>153</td>
<td>5765</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1000</td>
<td>1900.00</td>
<td>9500*</td>
<td>1900.0</td>
<td>9500*</td>
<td>1900.0</td>
<td></td>
</tr>
<tr>
<td>157</td>
<td>5785</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1000</td>
<td>1900.00</td>
<td>9500*</td>
<td>1900.0</td>
<td>9500*</td>
<td>1900.0</td>
<td></td>
</tr>
<tr>
<td>161</td>
<td>5805</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1000</td>
<td>1900.00</td>
<td>9500*</td>
<td>1900.0</td>
<td>9500*</td>
<td>1900.0</td>
<td></td>
</tr>
<tr>
<td>165</td>
<td>5825</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1000</td>
<td>1900.00</td>
<td>9500*</td>
<td>1900.0</td>
<td>9500*</td>
<td>1900.0</td>
<td></td>
</tr>
<tr>
<td>196</td>
<td>4980</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1000</td>
<td>1900.00</td>
<td>9500*</td>
<td>1900.0</td>
<td>9500*</td>
<td>1900.0</td>
<td></td>
</tr>
</tbody>
</table>

Notes:

a) UTRA FDD Band I ROW  

b) UTRA FDD Band II Americas  

c) UTRA FDD Band III ROW and UTRA FDD Band IV Americas  

d) UTRA FDD Band III ROW  

e) UTRA FDD Band VI Japan including 10MHz channels  

f) UTRA TDD ROW (1900-1920)  

g) UTRA TDD Americas (1850-1910) including LCR  

h) UTRA TDD Americas (1930-1990) including LCR  

i) UTRA TDD Americas (1910 – 1930) including LCR  

j) UTRA TDD LCR ROW (1900 – 1920)  

k) UTRA TDD LCR Americas (1910-1930)  

l) UTRA TDD LCR Americas (1930-1990)
9. APPENDIX B – SUMMARY TEST REPORT

Table B.1 – Sample Summation

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wi-Fi Alliance CID&lt;sup&gt;17&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>CTIA Request #</td>
</tr>
<tr>
<td></td>
<td>Serial Number/ESN/IMEI</td>
</tr>
<tr>
<td></td>
<td>FCC ID Number</td>
</tr>
<tr>
<td></td>
<td>Hardware Version</td>
</tr>
<tr>
<td></td>
<td>Software Version</td>
</tr>
</tbody>
</table>

TEST 5.1.1 and 6.1.1. Conducted Power Output

Table B.2 – Conducted Power Output Results

<table>
<thead>
<tr>
<th>Mode</th>
<th>Channel</th>
<th>Data rate, Mbps</th>
<th>Result, dBm</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEEE 802.11b</td>
<td>Low</td>
<td>6</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mid</td>
<td>11</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>11</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>

| IEEE 802.11g  | Low     | 6               | 11          |         |
|               |         | 12              | 11          |          |
|               |         | 24              |             |          |
|               | Mid     | 6               | 11          |         |
|               |         | 12              | 11          |          |
|               |         | 24              |             |          |
|               | High    | 6               | 11          |         |
|               |         | 12              |             |          |

| IEEE 802.11a  | Low     | 6               |             |          |
|               |         | 12              |             |          |
|               |         | 24              |             |          |
|               | Mid<sup>18</sup> | 6 | 12 |        |
|               |         | 24              |             |          |
|               | High    | 6               | 12          |         |
|               |         | 24              |             |          |

<sup>17</sup> Vendor supplies the Wi-Fi Alliance CID (Certification Identifier) during the CWG application process.

<sup>18</sup> Refer to Appendix D for the middle channel numbers per sub band.
## TEST 5.1.2 and 6.1.2

**Total Radiated Power (TRP) – Mode Radiated Figure of Merit**

Table B.3 – Mode Radiated Figure of Merit Results

<table>
<thead>
<tr>
<th>Mode</th>
<th>Channel</th>
<th>Data rate, Mbps</th>
<th>Result, dBm TRP</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEEE 802.11b</td>
<td>6</td>
<td>11</td>
<td></td>
<td>Calculated as per Reference (1)</td>
</tr>
<tr>
<td>IEEE 802.11g</td>
<td>6</td>
<td>6</td>
<td></td>
<td>Calculated as per Reference (1)</td>
</tr>
<tr>
<td>IEEE 802.11a</td>
<td>Lowest Channel of Lowest supported band</td>
<td>6</td>
<td></td>
<td>Calculated as per Reference (1)</td>
</tr>
<tr>
<td>IEEE 802.11a</td>
<td>Highest Channel of Highest supported band</td>
<td>6</td>
<td></td>
<td>Calculated as per Reference (1)</td>
</tr>
</tbody>
</table>

### Radiated Reference Measurements

Table B.4 – Radiated Reference Measurements Results

<table>
<thead>
<tr>
<th>Mode</th>
<th>Channel</th>
<th>Data rate, Mbps</th>
<th>Reference Position</th>
<th>Transmit Power, dBm</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Theta</td>
<td>Phi</td>
<td></td>
</tr>
<tr>
<td>IEEE 802.11b</td>
<td>6</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IEEE 802.11g</td>
<td>6</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IEEE 802.11a</td>
<td>Lowest Channel of Lowest Supported Band</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Channel Type</td>
<td>Value</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>-------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle Channel of Lowest Supported Band</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highest Channel of Lowest Supported Band</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lowest Channel of Next Supported Band</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle Channel of Next Supported Band</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highest Channel of Next Supported Band</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lowest Channel of Next Supported Band</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle Channel of Next Supported Band</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highest Channel of Next Supported Band</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lowest Channel of Highest Supported Band</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle Channel of Highest Supported Band</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highest Channel of Highest Supported Band</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### TEST 5.2.1 and 6.2.1 Conducted Receiver Sensitivity

Table B.5 – Conducted Receiver Sensitivity Results

<table>
<thead>
<tr>
<th>Mode</th>
<th>Channel</th>
<th>Data rate, Mbps</th>
<th>Result, dBm</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEEE 802.11b</td>
<td>Low</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mid</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IEEE 802.11g</td>
<td>Low</td>
<td>6</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>24</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>54</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mid</td>
<td>6</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>24</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>54</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>6</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>24</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>IEEE 802.11a</td>
<td>Low</td>
<td>6</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>54</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mid&lt;sup&gt;19&lt;/sup&gt;</td>
<td>6</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>54</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>6</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>54</td>
<td></td>
</tr>
</tbody>
</table>

<sup>19</sup> Refer to Appendix D for the middle channel numbers per sub band.
## TEST 5.2.2 and 6.2.2  Total Isotropic Sensitivity (TIS)

### Total Isotropic Sensitivity (TIS) – Mode Sensitivity Figure of Merit

Table B.6 – Mode Sensitivity Figure of Merit Results

<table>
<thead>
<tr>
<th>Mode</th>
<th>Channel</th>
<th>Data rate, Mbps</th>
<th>Result, dBm</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEEE 802.11b</td>
<td>6</td>
<td>11</td>
<td></td>
<td>Calculated as per Reference (2)</td>
</tr>
<tr>
<td>IEEE 802.11g</td>
<td>6</td>
<td>54</td>
<td></td>
<td>Calculated as per Reference (2)</td>
</tr>
<tr>
<td>IEEE 802.11a</td>
<td>Lowest Channel of Lowest supported band</td>
<td>54</td>
<td></td>
<td>Calculated as per Reference (2)</td>
</tr>
<tr>
<td>IEEE 802.11a</td>
<td>Highest Channel of Highest supported band</td>
<td>54</td>
<td></td>
<td>Calculated as per Reference (1)</td>
</tr>
</tbody>
</table>
# Sensitivity Reference Measurements

Table B.7 – Sensitivity Reference Measurements Results

<table>
<thead>
<tr>
<th>Mode</th>
<th>Channel</th>
<th>Data rate, Mbps</th>
<th>Reference Position</th>
<th>Sensitivity, dBm</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Theta</td>
<td>Phi</td>
<td></td>
</tr>
<tr>
<td>IEEE 802.11b</td>
<td>6</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IEEE 802.11g</td>
<td>6</td>
<td>54</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>54</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>54</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IEEE 802.11a</td>
<td>Lowest Channel of Lowest Supported Band</td>
<td>54</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Middle Channel of Lowest Supported Band</td>
<td>54</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Highest Channel of Lowest Supported Band</td>
<td>54</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lowest Channel of Next Supported Band</td>
<td>54</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Middle Channel of Next Supported Band</td>
<td>54</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Highest Channel of Next Supported Band</td>
<td>54</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Channel Type</td>
<td>Value</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>-------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lowest Channel of Next Supported Band</td>
<td>54</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle Channel of Next Supported Band</td>
<td>54</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highest Channel of Next Supported Band</td>
<td>54</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lowest Channel of Highest Supported Band</td>
<td>54</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle Channel of Highest Supported Band</td>
<td>54</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Highest Channel of Highest Supported Band</td>
<td>54</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### TEST 5.2.3 Radiated Receiver Sensitivity, Simultaneous Operation (Wi-Fi Desense)

**Desensitization Reference Measurements**

**Test 5.2.3.3 Highest Cellular Frequency Channel Test**

Table B.8 – Highest Cellular Frequency Channel Test Results

<table>
<thead>
<tr>
<th>Mode</th>
<th>802.11</th>
<th>Highest Cellular Frequency</th>
<th>802.11 Data Rate, Mbps</th>
<th>Reference Position</th>
<th>Desense dB</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEEE 802.11b</td>
<td></td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IEEE 802.11g</td>
<td></td>
<td>6</td>
<td></td>
<td></td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>IEEE 802.11a</td>
<td>Mid</td>
<td></td>
<td></td>
<td></td>
<td>54</td>
<td></td>
</tr>
</tbody>
</table>
### Test 5.2.3.4  Harmonic Interference Tests

#### Table B.9 – Harmonic Interference Tests Results 802.11b&g

<table>
<thead>
<tr>
<th>Mode</th>
<th>Channel</th>
<th>Cellular</th>
<th>802.11 Data Rate, Mbps</th>
<th>Reference Position</th>
<th>Desense, dB</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IEEE 802.11 b</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>IEEE 802.11 g</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>54</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Table B.10 – Harmonic Interference Tests Results 802.11a

<table>
<thead>
<tr>
<th>Mode</th>
<th>Channel</th>
<th>Cellular</th>
<th>802.11 Data Rate, Mbps</th>
<th>Reference Position</th>
<th>Desense, dB</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IEEE 802.11a</strong></td>
<td></td>
<td></td>
<td>54</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Test 5.2.4 Relative Receiver Sensitivity, Simultaneous Operation (Cellular Desense)

#### 5.2.4.1 Wi-Fi 2.4 GHz Band

Table B.11 – Cellular Desense Test Results for 802.11b&g Operation

<table>
<thead>
<tr>
<th>Cellular Technology</th>
<th>Wi-Fi Channel</th>
<th>Reference Position ( \Theta )°</th>
<th>Reference Position ( \Phi )°</th>
<th>FER %</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>802.11b/g Ch. 6 (2.437GHz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low + 500 kHz</td>
<td>802.11b/g Ch. 6 (2.437GHz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low + 1000 kHz</td>
<td>802.11b/g Ch. 6 (2.437GHz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low + 1500 kHz</td>
<td>802.11b/g Ch. 6 (2.437GHz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low + 2000 kHz</td>
<td>802.11b/g Ch. 6 (2.437GHz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low + 2500 kHz</td>
<td>802.11b/g Ch. 6 (2.437GHz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low + 3000 kHz</td>
<td>802.11b/g Ch. 6 (2.437GHz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low + 3500 kHz</td>
<td>802.11b/g Ch. 6 (2.437GHz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low + xxxx kHz</td>
<td>802.11b/g Ch. 6 (2.437GHz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 5.2.4.2 Wi-Fi U-NII Middle Band GHz Band

Table B.12 – Cellular Desense Test Results for 802.11a Operation

<table>
<thead>
<tr>
<th>Cellular Technology</th>
<th>Wi-Fi Channel</th>
<th>Reference Position Theta°</th>
<th>Reference Position Phi°</th>
<th>FER %</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>XXXX</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>802.11a</td>
<td>Ch. 60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(5.300 GHz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low + 500 kHz</td>
<td>802.11a</td>
<td>Ch. 60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(5.300 GHz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low + 1000 kHz</td>
<td>802.11a</td>
<td>Ch. 60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(5.300 GHz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low + 1500 kHz</td>
<td>802.11a</td>
<td>Ch. 60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(5.300 GHz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low + 2000 kHz</td>
<td>802.11a</td>
<td>Ch. 60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(5.300 GHz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low + 2500 kHz</td>
<td>802.11a</td>
<td>Ch. 60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(5.300 GHz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low + 3000 kHz</td>
<td>802.11a</td>
<td>Ch. 60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(5.300 GHz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low + 3500 kHz</td>
<td>802.11a</td>
<td>Ch. 60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(5.300 GHz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low + xxxx kHz</td>
<td>802.11a</td>
<td>Ch. 60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(5.300 GHz)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
10. APPENDIX C – RF POWER MEASUREMENT

The following method shall be used in the conversion of the Test AP and AP Attenuator settings to a power level in dBM.

1. Remove the DUT and connect in its place the input of a matched diode detector or equivalent thereof. The output of the detector shall be connected to the vertical channel of an oscilloscope.
   a. The combination of the diode detector and the oscilloscope shall be capable of faithfully reproducing the duty cycle of the transmitted output signal.
   b. The observed duty cycle (Tx on / Tx on + off) shall be noted as $x \ (0 < x \leq 1)$.

2. Replace the matched diode detector with a wideband calibrated RF power meter with a matched thermocouple detector or an equivalent thereof and with an integration period that exceeds the repetition period of the transmitter by a factor 5 or more.

3. Set the Test AP to transmit on the same channel, modulation and data rate as the first row of the Table created in step 11.

4. Set the AP Attenuator to 10dB.

5. Set the AP to continuously transmit unicast data packets.

6. Measure the power level, “A”dBM.

7. Record the power level, to an accuracy of 0.5dBM, “P”dBM where $P = A + 10 \log (1/x) \text{ dBM}$.

Note: This test procedure is similar to that specified in ETSI EN 301 893 V1.3.1.
### 11. APPENDIX D – IEEE 802.11A SUPPORTED CHANNEL OPTION EXAMPLES

<table>
<thead>
<tr>
<th>Sub Band</th>
<th>Channel Range</th>
<th>Comments</th>
<th>TIS/TRP Channel</th>
<th>Reference Channel</th>
<th>Middle Channel Number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Option One – All UNII Bands</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UNII Low Band</td>
<td>36 to 48</td>
<td>Lowest Band</td>
<td>36</td>
<td>(36), 44, 48</td>
<td>44</td>
</tr>
<tr>
<td>UNII Middle Band</td>
<td>52 to 64</td>
<td>Next Highest Band</td>
<td>-</td>
<td>52, 60, 64</td>
<td>60</td>
</tr>
<tr>
<td>UNII Upper Band</td>
<td>149 to 161</td>
<td>Highest Band</td>
<td>161</td>
<td>149, 157, (161)</td>
<td>157</td>
</tr>
<tr>
<td><strong>Option Two – All UNII and ETSI Bands</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UNII Low Band</td>
<td>36 to 48</td>
<td>Lowest Band</td>
<td>36</td>
<td>(36), 44, 48</td>
<td>44</td>
</tr>
<tr>
<td>UNII Middle Band</td>
<td>52 to 64</td>
<td>Next Highest Band</td>
<td>-</td>
<td>52, 60, 64</td>
<td>60</td>
</tr>
<tr>
<td>ETSI European band</td>
<td>100 to 140</td>
<td>Next Highest Band</td>
<td>-</td>
<td>100, 120, 140</td>
<td>120</td>
</tr>
<tr>
<td>UNII Upper Band</td>
<td>149 to 161</td>
<td>Highest Band</td>
<td>161</td>
<td>149, 157, (161)</td>
<td>157</td>
</tr>
<tr>
<td><strong>Option Three – ETSI Band Only</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ETSI European band</td>
<td>100 to 140</td>
<td>One Band</td>
<td>100, 140</td>
<td>(100), 120, (140)</td>
<td>120</td>
</tr>
<tr>
<td><strong>Option Four – All UNII Bands and Channel 165</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UNII Low Band</td>
<td>36 to 48</td>
<td>Lowest Band</td>
<td>36</td>
<td>(36), 44, 48</td>
<td>44</td>
</tr>
<tr>
<td>UNII Middle Band</td>
<td>52 to 64</td>
<td>Next Highest Band</td>
<td>-</td>
<td>52, 60, 64</td>
<td>60</td>
</tr>
<tr>
<td>UNII Upper Band</td>
<td>149 to 161</td>
<td>Next Highest Band</td>
<td>-</td>
<td>149, 157, 161</td>
<td>157</td>
</tr>
<tr>
<td>USA</td>
<td>165</td>
<td>Highest Band</td>
<td>165</td>
<td>(165)</td>
<td>-</td>
</tr>
<tr>
<td><strong>Option Five - Lower Two UNII Bands</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UNII Low Band</td>
<td>36 to 48</td>
<td>Lowest Band</td>
<td>36</td>
<td>(36), 44, 48</td>
<td>44</td>
</tr>
<tr>
<td>UNII Mid Band</td>
<td>52 to 64</td>
<td>Highest Band</td>
<td>64</td>
<td>52, 60, (64)</td>
<td>60</td>
</tr>
</tbody>
</table>
12. APPENDIX E – DEVICE TESTING CONFIGURATIONS

Converged handheld devices that have moveable keyboards shall be tested with keyboard open, closed, or any other operational configurations as outlined in the table below.

<table>
<thead>
<tr>
<th>Device Capabilities</th>
<th>TIS/TRP</th>
<th>Tx/Rx Reference</th>
<th>Wi-Fi Desense</th>
<th>Cellular Desense</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wi-Fi Browser + Cellular Voice</strong></td>
<td>Free Space with all intended mechanical modes (including keyboard closed)</td>
<td>Free Space with all intended mechanical modes (including keyboard closed)</td>
<td>Free Space with one operational mechanical mode (preferably slider closed)</td>
<td>Free Space with one operational mechanical mode (preferably slider closed)</td>
</tr>
<tr>
<td><strong>Wi-Fi Browser + Wi-Fi VoIP + Cellular Voice</strong></td>
<td>SAM Right Ear with one mechanical position supporting Wi-Fi VoIP (keyboard closed) + Free Space with all intended mechanical modes (including keyboard closed)</td>
<td>SAM Right Ear with one mechanical position supporting Wi-Fi VoIP (keyboard closed) + Free Space with all intended mechanical modes (including keyboard closed)</td>
<td>Free Space with one operational mechanical mode (preferably slider closed)</td>
<td>Free Space with one operational mechanical mode (preferably slider closed)</td>
</tr>
</tbody>
</table>

Note: Mechanical modes can mean keyboard slider in all positions; open, closed, slider half rotated 90°, or other keyboard positions depending on product configuration.

- End -