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March 20, 2015

Spirent Communications
7340 Executive Way, Suite A
Frederick, MD 21704

Dear Ryan Beach,

Enclosed is the EMC Wireless test report for compliance testing of the Spirent Communications, Nomad HD as tested to the requirements of Title 47 of the CFR, Ch. 1 (10-1-06 ed.), Part 15, Subpart B and ICES-003, Issue 5 August 2012 for a Class A Digital Device, and FCC Part 15 Subpart C and RSS-210, Issue 8, Dec. 2010 for Intentional Radiators.

Thank you for using the services of MET Laboratories, Inc. If you have any questions regarding these results or if MET can be of further service to you, please feel free to contact me.

Sincerely yours,
MET LABORATORIES, INC.

Jennifer Warnell
Documentation Department

Reference: (\Spirent Communications\EMC37860-FCC247 Rev. 3)

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# Electromagnetic Compatibility Criteria
# Test Report

for the

**Spirent Communications**
**Nomad HD**

**Tested under**
the FCC Certification Rules
contained in
Title 47 of the CFR, Parts 15 Subpart B & ICES-003
for Class A Digital Devices
&
15.247 Subpart C & RSS-210, Issue 8, Dec. 2010
for Intentional Radiators

**MET Report: EMC37860-FCC247 Rev. 3**

March 20, 2015

**Prepared For:**

**Spirent Communications**
**7340 Executive Way, Suite A**
**Frederick, MD 21704**

**Prepared By:**
**MET Laboratories, Inc.**
914 W. Patapsco Ave.
Baltimore, MD 21230

# Electromagnetic Compatibility Criteria
# Test Report

for the

## Spirent Communications
## Nomad HD

**Tested under**
the FCC Certification Rules
contained in
Title 47 of the CFR, Parts 15 Subpart B & ICES-003
for Class A Digital Devices
&
15.247 Subpart C & RSS-210, Issue 8, Dec. 2010
for Intentional Radiators

Jeffrey Pratt, Project Engineer
Electromagnetic Compatibility Lab

Jennifer Warnell
Documentation Department

**Engineering Statement:** The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of the FCC Rules Parts 15B, 15.247 and Industry Canada standards ICES-003, Issue 5 August 2012, RSS-210, Issue 8, Dec. 2010 under normal use and maintenance.

Asad Bajwa,
Director, Electromagnetic Compatibility Lab

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# Report Status Sheet

| Revision | Report Date | Reason for Revision |
|---|---|---|
| ∅ | March 17, 2014 | Initial Issue. |
| 1 | March 11, 2015 | Revised to reflect engineer corrections. |
| 2 | March 16, 2015 | Revised to reflect additional engineer corrections. |
| 3 | March 20, 2015 | Revised to reflect reviewer's requests |

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# Table of Contents

**I. Executive Summary ..... 1**
A. Purpose of Test ..... 2
B. Executive Summary ..... 2
**II. Equipment Configuration ..... 3**
A. Overview ..... 4
B. References ..... 5
C. Test Site ..... 5
D. Description of Test Sample ..... 6
E. Equipment Configuration ..... 7
F. Support Equipment ..... 7
G. Ports and Cabling Information ..... 7
H. Mode of Operation ..... 7
I. Method of Monitoring EUT Operation ..... 7
J. Modifications ..... 7
a) Modifications to EUT ..... 7
b) Modifications to Test Standard ..... 7
K. Disposition of EUT ..... 7
**III. Electromagnetic Compatibility Criteria for Unintentional Radiators ..... 8**
§ 15.107(a) Conducted Emissions Limits ..... 9
§ 15.109(a) Radiated Emissions Limits ..... 13
**IV. Electromagnetic Compatibility Criteria for Intentional Radiators ..... 17**
§ 15.203 Antenna Requirement ..... 18
§ 15.207(a) Conducted Emissions Limits ..... 19
§ 15.247(a)(1) 20 dB Occupied Bandwidth ..... 25
§15.247(a)(1) Average Time of Occupancy (Dwell Time) ..... 34
§15.247(a)(1) Number of RF Channels ..... 36
§15.247(a)(1) RF Channel Separation ..... 38
§ 15.247(b) Peak Power Output ..... 43
§ 15.247(d) Radiated Spurious Emissions Requirements and Band Edge ..... 49
§ 15.247(d) RF Spurious Emissions Requirements and Band Edge ..... 81
§ 15.247(g)(h) Declaration Statements for FHSS ..... 110
**V. Test Equipment ..... 112**
**VI. Certification & User's Manual Information ..... 114**
A. Certification Information ..... 115
B. Label and User's Manual Information ..... 119
**VII. ICES-003 Procedural & Labeling Requirements ..... 121**

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# List of Tables

Table 1. Executive Summary of EMC Part 15.247 ComplianceTesting ..... 2
Table 2. EUT Summary Table ..... 4
Table 3. References ..... 5
Table 4. Equipment Configuration ..... 7
Table 5. Support Equipment ..... 7
Table 6. Ports and Cabling Information ..... 7
Table 7. Conducted Limits for Radio Frequency Devices calculated from FCC Part 15 Subsections 15.107(a) (b) and 15.207(a) ..... 9
Table 8. Conducted Emissions - Voltage, AC Power, Phase Line (120 VAC, 60 Hz) ..... 10
Table 9. Conducted Emissions - Voltage, AC Power, Neutral Line (120 VAC, 60 Hz) ..... 11
Table 10. Radiated Emissions Limits calculated from FCC Part 15, §15.109 (a) (b) ..... 13
Table 11. Radiated Emissions Limits, Test Results, 30 MHz – 1 GHz, FCC Limits ..... 14
Table 12. Radiated Emissions Limits, Test Results, ICES-003 Limits ..... 15
Table 13. Antenna List ..... 18
Table 14. Conducted Limits for Intentional Radiators from FCC Part 15 § 15.207(a) ..... 19
Table 15. Conducted Emissions, 15.207(a), Phase Line, Test Results, Radios 1 and 2 ..... 20
Table 16. Conducted Emissions, 15.207(a), Phase Line, Test Results, Radios 3 and 4 ..... 21
Table 17. Conducted Emissions, 15.207(a), Neutral Line, Test Results, Radios 1 and 2 ..... 22
Table 18. Conducted Emissions, 15.207(a), Neutral Line, Test Results, Radios 3 and 4 ..... 23
Table 19. Average Time of Occupancy ..... 34
Table 20. Peak Output Power, Test Results ..... 44
Table 21. Restricted Bands of Operation ..... 49
Table 22. Radiated Emissions Limits Calculated from FCC Part 15, § 15.209 (a) ..... 50
Table 23. Test Equipment List ..... 113

# List of Plots

Plot 1. Conducted Emissions, Phase Line Plot ..... 10
Plot 2. Conducted Emissions, Neutral Line Plot ..... 11
Plot 3. Radiated Emissions, 30 MHz - 1 GHz, FCC Limits ..... 14
Plot 4. Radiated Emissions, ICES-003 Limits ..... 15
Plot 5. Conducted Emissions, 15.207(a), Phase Line, Radios 1 and 2 ..... 20
Plot 6. Conducted Emissions, 15.207(a), Phase Line, Radios 3 and 4 ..... 21
Plot 7. Conducted Emissions, 15.207(a), Neutral Line, Radios 1 and 2 ..... 22
Plot 8. Conducted Emissions, 15.207(a), Neutral Line, Radios 3 and 4 ..... 23
Plot 9. 20 dB Occupied Bandwidth, Low Channel, Radio 1 ..... 26
Plot 10. 20 dB Occupied Bandwidth, Mid Channel, Radio 1 ..... 26
Plot 11. 20 dB Occupied Bandwidth, High Channel, Radio 1 ..... 26
Plot 12. 20 dB Occupied Bandwidth, Low Channel, Radio 2 ..... 27
Plot 13. 20 dB Occupied Bandwidth, Mid Channel, Radio 2 ..... 27
Plot 14. 20 dB Occupied Bandwidth, High Channel, Radio 2 ..... 27
Plot 15. 20 dB Occupied Bandwidth, Low Channel, Radio 3 ..... 28
Plot 16. 20 dB Occupied Bandwidth, Mid Channel, Radio 3 ..... 28
Plot 17. 20 dB Occupied Bandwidth, High Channel, Radio 3 ..... 28
Plot 18. 20 dB Occupied Bandwidth, Low Channel, Radio 4 ..... 29
Plot 19. 20 dB Occupied Bandwidth, Mid Channel, Radio 4 ..... 29
Plot 20. 20 dB Occupied Bandwidth, High Channel, Radio 4 ..... 29
Plot 21. 99% Occupied Bandwidth, Low Channel, Radio 1 ..... 30
Plot 22. 99% Occupied Bandwidth, Mid Channel, Radio 1 ..... 30
Plot 23. 99% Occupied Bandwidth, High Channel, Radio 1 ..... 30

Plot 24. 99% Occupied Bandwidth, Low Channel, Radio 2 ..... 31
Plot 25. 99% Occupied Bandwidth, Mid Channel, Radio 2 ..... 31
Plot 26. 99% Occupied Bandwidth, High Channel, Radio 2 ..... 31
Plot 27. 99% Occupied Bandwidth, Low Channel, Radio 3 ..... 32
Plot 28. 99% Occupied Bandwidth, Mid Channel, Radio 3 ..... 32
Plot 29. 99% Occupied Bandwidth, High Channel, Radio 3 ..... 32
Plot 30. 99% Occupied Bandwidth, Low Channel, Radio 4 ..... 33
Plot 31. 99% Occupied Bandwidth, Mid Channel, Radio 4 ..... 33
Plot 32. 99% Occupied Bandwidth, High Channel, Radio 4 ..... 33
Plot 33. Dwell Time, Number of Bursts ..... 35
Plot 34. Dwell Time, Duration of Burst ..... 35
Plot 35. Number of Channels, 1 ..... 36
Plot 36. Number of Channels, 2 ..... 36
Plot 37. Number of Channels, 3 ..... 36
Plot 38. Number of Channels, 4 ..... 37
Plot 39. Channel Separation, Low Channel, Radio 1 ..... 39
Plot 40. Channel Separation, Mid Channel, Radio 1 ..... 39
Plot 41. Channel Separation, High Channel, Radio 1 ..... 39
Plot 42. Channel Separation, Low Channel, Radio 2 ..... 40
Plot 43. Channel Separation, Mid Channel, Radio 2 ..... 40
Plot 44. Channel Separation, High Channel, Radio 2 ..... 40
Plot 45. Channel Separation, Low Channel, Radio 3 ..... 41
Plot 46. Channel Separation, Mid Channel, Radio 3 ..... 41
Plot 47. Channel Separation, High Channel, Radio 3 ..... 41
Plot 48. Channel Separation, Low Channel, Radio 4 ..... 42
Plot 49. Channel Separation, Mid Channel, Radio 4 ..... 42
Plot 50. Channel Separation, High Channel, Radio 4 ..... 42
Plot 51. Peak Power Output, Low Channel, EIRP, Radio 1 ..... 45
Plot 52. Peak Power Output, Mid Channel, EIRP, Radio 1 ..... 45
Plot 53. Peak Power Output, High Channel, EIRP, Radio 1 ..... 45
Plot 54. Peak Power Output, Low Channel, EIRP, Radio 2 ..... 46
Plot 55. Peak Power Output, Mid Channel, EIRP, Radio 2 ..... 46
Plot 56. Peak Power Output, High Channel, EIRP, Radio 2 ..... 46
Plot 57. Peak Power Output, Low Channel, EIRP, Radio 3 ..... 47
Plot 58. Peak Power Output, Mid Channel, EIRP, Radio 3 ..... 47
Plot 59. Peak Power Output, High Channel, EIRP, Radio 3 ..... 47
Plot 60. Peak Power Output, Low Channel, EIRP, Radio 4 ..... 48
Plot 61. Peak Power Output, Mid Channel, EIRP, Radio 4 ..... 48
Plot 62. Peak Power Output, High Channel, EIRP, Radio 4 ..... 48
Plot 63. Radiated Spurious Emissions, Low Channel, 30 MHz – 1 GHz, Radio 1 ..... 51
Plot 64. Radiated Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Average, Radio 1 ..... 51
Plot 65. Radiated Spurious Emissions, Low Channel, Second Harmonic, Radio 1 ..... 51
Plot 66. Radiated Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Peak, Radio 1 ..... 52
Plot 67. Radiated Spurious Emissions, Low Channel, 7 GHz – 18 GHz, Average, Radio 1 ..... 52
Plot 68. Radiated Spurious Emissions, Low Channel, 7 GHz – 18 GHz, Peak, Radio 1 ..... 52
Plot 69. Radiated Spurious Emissions, Low Channel, 18 GHz – 25 GHz, Peak under Average, Radio 1 ..... 53
Plot 70. Radiated Spurious Emissions, Mid Channel 30 MHz – 1 GHz, Radio 1 ..... 53
Plot 71. Radiated Spurious Emissions, Mid Channel 1 GHz – 7 GHz, Average, Radio 1 ..... 53
Plot 72. Radiated Spurious Emissions, Mid Channel 1 GHz – 7 GHz, Peak, Radio 1 ..... 54
Plot 73. Radiated Spurious Emissions, Mid Channel 7 GHz – 18 GHz, Average, Radio 1 ..... 54
Plot 74. Radiated Spurious Emissions, Mid Channel 7 GHz – 18 GHz, Peak, Radio 1 ..... 54
Plot 75. Radiated Spurious Emissions, Mid Channel 18 GHz – 25 GHz, Peak under Average, Radio 1 ..... 55
Plot 76. Radiated Spurious Emissions, High Channel, 30 MHz – 1 GHz, Radio 1 ..... 55

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Plot 77. Radiated Spurious Emissions, High Channel, 1 GHz – 7 GHz, Average, Radio 1 ....55
Plot 78. Radiated Spurious Emissions, High Channel, Second Harmonic, Radio 1 ....56
Plot 79. Radiated Spurious Emissions, High Channel, 1 GHz – 7 GHz, Peak, Radio 1 ....56
Plot 80. Radiated Spurious Emissions, High Channel, 7 GHz – 18 GHz, Peak, Radio 1 ....56
Plot 81. Radiated Spurious Emissions, High Channel, 18 GHz – 25 GHz, Peak under Average, Radio 1 ....57
Plot 82. Radiated Spurious Emissions, Low Channel, 30 MHz – 1 GHz, Radio 2 ....58
Plot 83. Radiated Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Average, Radio 2 ....58
Plot 84. Radiated Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Peak, Radio 2 ....58
Plot 85. Radiated Spurious Emissions, Low Channel, 7 GHz – 18 GHz, Average, Radio 2 ....59
Plot 86. Radiated Spurious Emissions, Low Channel, 7 GHz – 18 GHz, Peak, Radio 2 ....59
Plot 87. Radiated Spurious Emissions, Low Channel, 18 GHz – 25 GHz, Peak under Average, Radio 2 ....59
Plot 88. Radiated Spurious Emissions, Mid Channel 30 MHz – 1 GHz, Radio 2 ....60
Plot 89. Radiated Spurious Emissions, Mid Channel 1 GHz – 7 GHz, Average, Radio 2 ....60
Plot 90. Radiated Spurious Emissions, Mid Channel 1 GHz – 7 GHz, Peak, Radio 2 ....60
Plot 91. Radiated Spurious Emissions, Mid Channel 7 GHz – 18 GHz, Average, Radio 2 ....61
Plot 92. Radiated Spurious Emissions, Mid Channel 7 GHz – 18 GHz, Peak, Radio 2 ....61
Plot 93. Radiated Spurious Emissions, Mid Channel 18 GHz – 25 GHz, Peak under Average, Radio 2 ....61
Plot 94. Radiated Spurious Emissions, High Channel, 30 MHz – 1 GHz, Radio 2 ....62
Plot 95. Radiated Spurious Emissions, High Channel, 1 GHz – 7 GHz, Average, Radio 2 ....62
Plot 96. Radiated Spurious Emissions, High Channel, 1 GHz – 7 GHz, Peak, Radio 2 ....62
Plot 97. Radiated Spurious Emissions, High Channel, 7 GHz – 18 GHz, Average, Radio 2 ....63
Plot 98. Radiated Spurious Emissions, High Channel, 7 GHz – 18 GHz, Peak, Radio 2 ....63
Plot 99. Radiated Spurious Emissions, High Channel, 18 GHz – 25 GHz, Peak under Average, Radio 2 ....63
Plot 100. Radiated Spurious Emissions, Low Channel, 30 MHz – 1 GHz, Radio 3 ....64
Plot 101. Radiated Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Average, Radio 3 ....64
Plot 102. Radiated Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Peak, Radio 3 ....64
Plot 103. Radiated Spurious Emissions, Low Channel, 7 GHz – 18 GHz, Average, Radio 3 ....65
Plot 104. Radiated Spurious Emissions, Low Channel, 7 GHz – 18 GHz, Peak, Radio 3 ....65
Plot 105. Radiated Spurious Emissions, Low Channel, 18 GHz – 25 GHz, Peak under Average, Radio 3 ....65
Plot 106. Radiated Spurious Emissions, Mid Channel 30 MHz – 1 GHz, Radio 3 ....66
Plot 107. Radiated Spurious Emissions, Mid Channel 1 GHz – 7 GHz, Average, Radio 3 ....66
Plot 108. Radiated Spurious Emissions, Mid Channel 1 GHz – 7 GHz, Peak, Radio 3 ....66
Plot 109. Radiated Spurious Emissions, Mid Channel 7 GHz – 18 GHz, Average, Radio 3 ....67
Plot 110. Radiated Spurious Emissions, Mid Channel 7 GHz – 18 GHz, Peak, Radio 3 ....67
Plot 111. Radiated Spurious Emissions, Mid Channel 18 GHz – 25 GHz, Peak under Average, Radio 3 ....67
Plot 112. Radiated Spurious Emissions, High Channel, 30 MHz – 1 GHz, Radio 3 ....68
Plot 113. Radiated Spurious Emissions, High Channel, 1 GHz – 7 GHz, Average, Radio 3 ....68
Plot 114. Radiated Spurious Emissions, High Channel, 1 GHz – 7 GHz, Peak, Radio 3 ....68
Plot 115. Radiated Spurious Emissions, High Channel, 7 GHz – 18 GHz, Average, Radio 3 ....69
Plot 116. Radiated Spurious Emissions, High Channel, 7 GHz – 18 GHz, Peak, Radio 3 ....69
Plot 117. Radiated Spurious Emissions, High Channel, 18 GHz – 25 GHz, Peak under Average, Radio 3 ....69
Plot 118. Radiated Spurious Emissions, Low Channel, 30 MHz – 1 GHz, Radio 4 ....70
Plot 119. Radiated Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Average, Radio 4 ....70
Plot 120. Radiated Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Peak, Radio 4 ....70
Plot 121. Radiated Spurious Emissions, Low Channel, 7 GHz – 18 GHz, Average, Radio 4 ....71
Plot 122. Radiated Spurious Emissions, Low Channel, 7 GHz – 18 GHz, Peak, Radio 4 ....71
Plot 123. Radiated Spurious Emissions, Low Channel, 18 GHz – 25 GHz, Peak under Average, Radio 4 ....71
Plot 124. Radiated Spurious Emissions, Mid Channel 30 MHz – 1 GHz, Radio 4 ....72
Plot 125. Radiated Spurious Emissions, Mid Channel 1 GHz – 7 GHz, Average, Radio 4 ....72
Plot 126. Radiated Spurious Emissions, Mid Channel 1 GHz – 7 GHz, Peak, Radio 4 ....72
Plot 127. Radiated Spurious Emissions, Mid Channel 7 GHz – 18 GHz, Average, Radio 4 ....73
Plot 128. Radiated Spurious Emissions, Mid Channel 7 GHz – 18 GHz, Peak, Radio 4 ....73
Plot 129. Radiated Spurious Emissions, Mid Channel 18 GHz – 25 GHz, Peak under Average, Radio 4 ....73

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Plot 130. Radiated Spurious Emissions, High Channel, 30 MHz – 1 GHz, Radio 4 ..... 74
Plot 131. Radiated Spurious Emissions, High Channel, 1 GHz – 7 GHz, Average, Radio 4 ..... 74
Plot 132. Radiated Spurious Emissions, High Channel, 1 GHz – 7 GHz, Peak, Radio 4 ..... 74
Plot 133. Radiated Spurious Emissions, High Channel, 7 GHz – 18 GHz, Average, Radio 4 ..... 75
Plot 134. Radiated Spurious Emissions, High Channel, 7 GHz – 18 GHz, Peak, Radio 4 ..... 75
Plot 135. Radiated Spurious Emissions, High Channel, 18 GHz – 25 GHz, Peak under Average, Radio 4 ..... 75
Plot 136. Simultaneous Transmission, 30 MHz – 1 GHz ..... 76
Plot 137. Simultaneous Transmission, 1 GHz – 7 GHz, Average ..... 76
Plot 138. Simultaneous Transmission, 1 GHz – 7 GHz, Peak ..... 77
Plot 139. Simultaneous Transmission, 7 GHz – 18 GHz, Average ..... 77
Plot 140. Simultaneous Transmission, 7 GHz – 18 GHz, Peak ..... 77
Plot 141. Simultaneous Transmission, 18 GHz – 25 GHz, Average ..... 78
Plot 142. Simultaneous Transmission, 18 GHz – 25 GHz, Peak ..... 78
Plot 143. RF Spurious Emissions, Low Channel, 30 MHz – 1 GHz, Radio 1 ..... 82
Plot 144. RF Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Radio 1 ..... 82
Plot 145. RF Spurious Emissions, Low Channel, 7 GHz – 18 GHz, Radio 1 ..... 82
Plot 146. RF Spurious Emissions, Low Channel, 18 GHz – 25 GHz, Radio 1 ..... 83
Plot 147. RF Spurious Emissions, Mid Channel, 30 MHz – 1 GHz, Radio 1 ..... 83
Plot 148. RF Spurious Emissions, Mid Channel, 1 GHz – 7 GHz, Radio 1 ..... 83
Plot 149. RF Spurious Emissions, Mid Channel, 7 GHz – 18 GHz, Radio 1 ..... 84
Plot 150. RF Spurious Emissions, Mid Channel, 18 GHz – 25 GHz, Radio 1 ..... 84
Plot 151. RF Spurious Emissions, High Channel, 30 MHz – 1 GHz, Radio 1 ..... 84
Plot 152. RF Spurious Emissions, High Channel, 1 GHz – 7 GHz, Radio 1 ..... 85
Plot 153. RF Spurious Emissions, High Channel, 7 GHz – 18 GHz, Radio 1 ..... 85
Plot 154. RF Spurious Emissions, High Channel, 18 GHz – 25 GHz, Radio 1 ..... 85
Plot 155. RF Spurious Emissions, Low Channel, 30 MHz – 1 GHz, Radio 2 ..... 86
Plot 156. RF Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Radio 2 ..... 86
Plot 157. RF Spurious Emissions, Low Channel, 7 GHz – 18 GHz, Radio 2 ..... 86
Plot 158. RF Spurious Emissions, Low Channel, 18 GHz – 25 GHz, Radio 2 ..... 87
Plot 159. RF Spurious Emissions, Mid Channel, 30 MHz – 1 GHz, Radio 2 ..... 87
Plot 160. RF Spurious Emissions, Mid Channel, 1 GHz – 7 GHz, Radio 2 ..... 87
Plot 161. RF Spurious Emissions, Mid Channel, 7 GHz – 18 GHz, Radio 2 ..... 88
Plot 162. RF Spurious Emissions, Mid Channel, 18 GHz – 25 GHz, Radio 2 ..... 88
Plot 163. RF Spurious Emissions, High Channel, 30 MHz – 1 GHz, Radio 2 ..... 88
Plot 164. RF Spurious Emissions, High Channel, 1 GHz – 7 GHz, Radio 2 ..... 89
Plot 165. RF Spurious Emissions, High Channel, 7 GHz – 18 GHz, Radio 2 ..... 89
Plot 166. RF Spurious Emissions, High Channel, 18 GHz – 25 GHz, Radio 2 ..... 89
Plot 167. RF Spurious Emissions, Low Channel, 30 MHz – 1 GHz, Radio 3 ..... 90
Plot 168. RF Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Radio 3 ..... 90
Plot 169. RF Spurious Emissions, Low Channel, 7 GHz – 18 GHz, Radio 3 ..... 90
Plot 170. RF Spurious Emissions, Low Channel, 18 GHz – 25 GHz, Radio 3 ..... 91
Plot 171. RF Spurious Emissions, Mid Channel, 30 MHz – 1 GHz, Radio 3 ..... 91
Plot 172. RF Spurious Emissions, Mid Channel, 1 GHz – 7 GHz, Radio 3 ..... 91
Plot 173. RF Spurious Emissions, Mid Channel, 7 GHz – 18 GHz, Radio 3 ..... 92
Plot 174. RF Spurious Emissions, Mid Channel, 18 GHz – 25 GHz, Radio 3 ..... 92
Plot 175. RF Spurious Emissions, High Channel, 30 MHz – 1 GHz, Radio 3 ..... 92
Plot 176. RF Spurious Emissions, High Channel, 1 GHz – 7 GHz, Radio 3 ..... 93
Plot 177. RF Spurious Emissions, High Channel, 7 GHz – 18 GHz, Radio 3 ..... 93
Plot 178. RF Spurious Emissions, High Channel, 18 GHz – 25 GHz, Radio 3 ..... 93
Plot 179. RF Spurious Emissions, Low Channel, 30 MHz – 1 GHz, Radio 4 ..... 94
Plot 180. RF Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Radio 4 ..... 94
Plot 181. RF Spurious Emissions, Low Channel, 7 GHz – 18 GHz, Radio 4 ..... 94
Plot 182. RF Spurious Emissions, Low Channel, 18 GHz – 25 GHz, Radio 4 ..... 95

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Plot 183. RF Spurious Emissions, Mid Channel, 30 MHz – 1 GHz, Radio 4 ....95
Plot 184. RF Spurious Emissions, Mid Channel, 1 GHz – 7 GHz, Radio 4 ....95
Plot 185. RF Spurious Emissions, Mid Channel, 7 GHz – 18 GHz, Radio 4 ....96
Plot 186. RF Spurious Emissions, Mid Channel, 18 GHz – 25 GHz, Radio 4 ....96
Plot 187. RF Spurious Emissions, High Channel, 30 MHz – 1 GHz, Radio 4 ....96
Plot 188. RF Spurious Emissions, High Channel, 1 GHz – 7 GHz, Radio 4 ....97
Plot 189. RF Spurious Emissions, High Channel, 7 GHz – 18 GHz, Radio 4 ....97
Plot 190. RF Spurious Emissions, High Channel, 18 GHz – 25 GHz, Radio 4 ....97
Plot 191. Band Edge, Radio 1, Low Channel, Average ....98
Plot 192. Band Edge, Radio 1, Low Channel, Peak ....98
Plot 193. Band Edge 247(d), Radio 1, Low Channel ....99
Plot 194. Band Edge, Radio 1, High Channel, Average ....99
Plot 195. Band Edge, Radio 1, High Channel, Peak ....100
Plot 196. Band Edge 247(d), Radio 1, High Channel ....100
Plot 197. Band Edge, Radio 2, Low Channel, Average ....101
Plot 198. Band Edge, Radio 2, Low Channel, Peak ....101
Plot 199. Band Edge 247(d), Radio 2, Low Channel ....102
Plot 200. Band Edge, Radio 2, High Channel, Average ....102
Plot 201. Band Edge, Radio 2, High Channel, Peak ....103
Plot 202. Band Edge 247(d), Radio 2, High Channel ....103
Plot 203. Band Edge, Radio 3, Low Channel, Average ....104
Plot 204. Band Edge, Radio 3, Low Channel, Peak ....104
Plot 205. Band Edge 247(d), Radio 3, Low Channel ....105
Plot 206. Band Edge, Radio 3, High Channel, Average ....105
Plot 207. Band Edge, Radio 3, High Channel, Peak ....106
Plot 208. Band Edge 247(d), Radio 3, High Channel ....106
Plot 209. Band Edge, Radio 4, Low Channel, Average ....107
Plot 210. Band Edge, Radio 4, Low Channel, Peak ....107
Plot 211. Band Edge 247(d), Radio 4, Low Channel ....108
Plot 212. Band Edge, Radio 4, High Channel, Average ....108
Plot 213. Band Edge, Radio 4, High Channel, Peak ....109
Plot 214. Band Edge 247(d), Radio 4, High Channel Electromagnetic Compatibility Criteria for Intentional Radiators ....109

# List of Figures

Figure 1. Block Diagram of Test Configuration ....6

# List of Photographs

Photograph 1. Spirent Communications Nomad HD ....6
Photograph 2. Conducted Emissions, Test Setup ....12
Photograph 3. Radiated Emission, Test Setup ....16
Photograph 4. Conducted Emissions, 15.207(a), Test Setup ....24
Photograph 5. Radiated Spurious Emissions, Test Setup, 30 MHz – 1 GHz ....79
Photograph 6. Radiated Spurious Emissions, Test Setup, 1 GHz – 7 GHz ....79
Photograph 7. Radiated Spurious Emissions, Test Setup, 7 GHz – 18 GHz ....80
Photograph 8. Radiated Spurious Emissions, Test Setup, 18 GHz – 25 GHz ....80

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# List of Terms and Abbreviations

| | |
|---|---|
| **AC** | **A**lternating **C**urrent |
| **ACF** | **A**ntenna **C**orrection **F**actor |
| **Cal** | **Cal**ibration |
| ***d*** | **M**easurement **D**istance |
| **dB** | **D**eci**b**els |
| **dBµA** | **D**eci**b**els above one **micro**amp |
| **dBµV** | **D**eci**b**els above one **micro**volt |
| **dBµA/m** | **D**eci**b**els above one **micro**amp **per m**eter |
| **dBµV/m** | **D**eci**b**els above one **micro**volt **per m**eter |
| **DC** | **D**irect **C**urrent |
| **E** | **E**lectric Field |
| **DSL** | **D**igital **S**ubscriber **L**ine |
| **ESD** | **E**lectro**s**tatic **D**ischarge |
| **EUT** | **E**quipment **U**nder **T**est |
| ***f*** | **F**requency |
| **FCC** | **F**ederal **C**ommunications **C**ommission |
| **GRP** | **G**round **R**eference **P**lane |
| **H** | Magnetic Field |
| **HCP** | **H**orizontal **C**oupling **P**lane |
| **Hz** | **H**ert**z** |
| **IEC** | **I**nternational **E**lectrotechnical **C**ommission |
| **kHz** | **k**ilo**h**ert**z** |
| **kPa** | **k**ilo**pa**scal |
| **kV** | **k**ilo**v**olt |
| **LISN** | **L**ine **I**mpedance **S**tabilization **N**etwork |
| **MHz** | **M**ega**h**ertz |
| **µH** | **microh**enry |
| µ | **microf**arad |
| **µs** | **micros**econds |
| **NEBS** | **N**etwork **E**quipment-**B**uilding **S**ystem |
| **PRF** | **P**ulse **R**epetition **F**requency |
| **RF** | **R**adio **F**requency |
| **RMS** | **R**oot-**M**ean-**S**quare |
| **TWT** | **T**raveling **W**ave **T**ube |
| **V/m** | **V**olts **per m**eter |
| **VCP** | **V**ertical **C**oupling **P**lane |

# I. Executive Summary

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## A. Purpose of Test

An EMC evaluation was performed to determine compliance of the Spirent Communications Nomad HD, with the requirements of Part 15, §15.247. All references are to the most current version of Title 47 of the Code of Federal Regulations in effect. In accordance with §2.1033, the following data is presented in support of the Certification of the Nomad HD. Spirent Communications should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the Nomad HD, has been **permanently** discontinued.

## B. Executive Summary

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 15, §15.247, in accordance with Spirent Communications, purchase order number 13688. All tests were conducted using measurement procedure ANSI C63.4-2003.

| FCC Reference 47 CFR Part 15.247:2005 | IC Reference RSS-210 Issue 8: 2010; RSS-GEN Issues 3: 2010 | Description | Compliance |
|---|---|---|---|
| 47 CFR Part 15.107 (a) | ICES-003 Issue 5 August 2012 | Conducted Emission Limits for a Class A Digital Device | Compliant |
| 47 CFR Part 15.109 (a) | ICES-003 Issue 5 August 2012 | Radiated Emission Limits for a Class A Digital Device | Compliant |
| Title 47 of the CFR, Part 15 §15.203 | N/A | Antenna Requirement | Compliant |
| Title 47 of the CFR, Part 15 §15.207(a) | RSS-GEN (7.2.4) | Conducted Emission Limits | Compliant |
| Title 47 of the CFR, Part 15 §15.247(a)(1) | RSS-Gen(4.6) | 20 dB Occupied Bandwidth | Compliant |
| | | 99% Occupied Bandwidth | Compliant |
| Title 47 of the CFR, Part 15 §15.247(a)(1) | RSS-210(A8.1) | Average Time of Occupancy (Dwell Time) | Compliant |
| Title 47 of the CFR, Part 15 §15.247(a)(1) | RSS-210(A8.1) | Number of RF Channels | Compliant |
| Title 47 of the CFR, Part 15 §15.247(a)(1) | RSS-210(A8.1) | RF Channel Separation | Compliant |
| Title 47 of the CFR, Part 15 §15.247(b) | RSS-210(A8.4) | Peak Power Output | Compliant |
| Title 47 of the CFR, Part 15 §15.247(d); §15.209; §15.205 | RSS-210(A8.5) | Radiated Spurious Emissions | Compliant |
| Title 47 of the CFR, Part 15 §15.247(d) | RSS-210(A8.5) | Spurious Conducted Emissions | Compliant |
| Title 47 of the CFR, Part 15 §15.247(g) & (h) | RSS-210(A8.1) | Declaration Statements for FHSS | Compliant |
| Title 47 of the CFR, Part 15 §15.247(i) | RSS-GEN (5.6) | Maximum Permissible Exposure (MPE) | Compliant |
| N/A | RSS-GEN (4.10) | Receiver Spurious Emissions | Compliant |

**Table 1. Executive Summary of EMC Part 15.247 ComplianceTesting**


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# II. Equipment Configuration

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# A. Overview

MET Laboratories, Inc. was contracted by Spirent Communications to perform testing on the Nomad HD, under Spirent Communications's purchase order number 13688.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Spirent Communications, Nomad HD.

The results obtained relate only to the item(s) tested.

| | | |
|---|---|---|
| **Model(s) Tested:** | Nomad HD | |
| **Model(s) Covered:** | Nomad HD | |
| **EUT Specifications:** | Primary Power: 120 VAC, 60 Hz | |
| | FCC ID: WR2-NOMADHD-01<br>IC: 11822A-NOMADHD01 | |
| | Type of Modulations: | FHSS |
| | Equipment Code: | DSS |
| | Peak RF Output Power: | -11.18 dBm |
| | EUT Frequency Ranges: | 2402 – 2481 MHz |
| **Analysis:** | The results obtained relate only to the item(s) tested. | |
| **Environmental Test Conditions:** | Temperature: 15-35º C | |
| | Relative Humidity: 30-60% | |
| | Barometric Pressure: 860-1060 mbar | |
| **Evaluated by:** | Jeff Pratt | |
| **Report Date(s):** | March 20, 2015 | |

**Table 2. EUT Summary Table**


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## B. References

| | |
|---|---|
| **CFR 47, Part 15, Subpart C** | Federal Communication Commission, Code of Federal Regulations, Title 47, Part 15: General Rules and Regulations, Allocation, Assignment, and Use of Radio Frequencies |
| **CFR 47, Part 15, Subpart B** | Electromagnetic Compatibility: Criteria for Radio Frequency Devices |
| **RSS-210, Issue 8, Dec. 2010** | Low-power Licence-exempt Radiocommunications Devices (All Frequency Bands): Category I Equipment |
| **RSS-GEN, Issue 3, Dec. 2010** | General Requirements and Information for the Certification of Radio Apparatus |
| **ICES-003, Issue 5 August 2012** | Electromagnetic Compatibility: Criteria for Radio Frequency Devices |
| **ANSI C63.4:2003** | Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz |
| **ISO/IEC 17025:2005** | General Requirements for the Competence of Testing and Calibration Laboratories |
| **ANSI C63.10-2009** | American National Standard for Testing Unlicensed Wireless Devices |

**Table 3. References**

## C. Test Site

All testing was performed at MET Laboratories, Inc., 914 W. Patapsco Ave. Baltimore, MD 21230. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

Radiated Emissions measurements were performed in a 3 meter semi-anechoic chamber (equivalent to an Open Area Test Site). In accordance with §2.948(a)(3), a complete site description is contained at MET Laboratories.

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## D. Description of Test Sample

The Spirent Communications Nomad HD, Equipment Under Test (EUT), is a table top HW device for Voice Quality and Call Performance verification of up to 4 mobile devices via both analog interfaces and Bluetooth radio.


**Photograph 1. Spirent Communications Nomad HD**

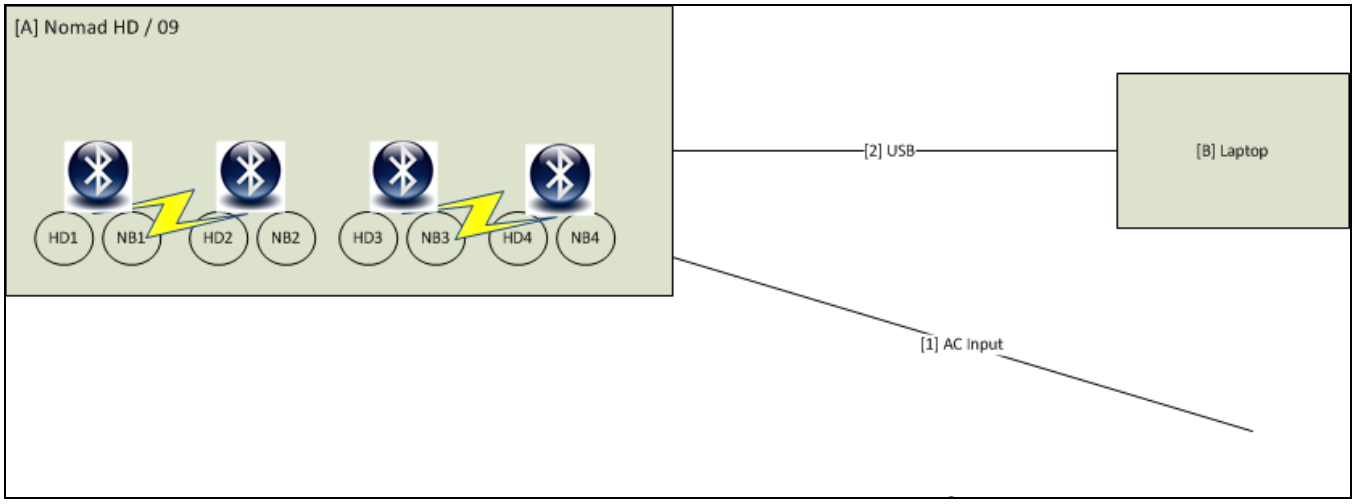


**Figure 1. Block Diagram of Test Configuration**


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## E. Equipment Configuration

The EUT was set up as outlined in Figure 1, Block Diagram of Test Setup. All cards, racks, etc., incorporated as part of the EUT is included in the following list.

| Ref. ID | Name / Description | Model Number | Serial Number |
|---|---|---|---|
| A | N/A | 09 | 09000002 |

**Table 4. Equipment Configuration**

## F. Support Equipment

Support equipment necessary for the operation and testing of the EUT is included in the following list.

| Ref. ID | Name / Description | Manufacturer | Model Number | Serial Number |
|---|---|---|---|---|
| B | Laptop | Dell | Latitude | 1YTQ4S1 |

**Table 5. Support Equipment**

## G. Ports and Cabling Information

| Ref. ID | Port Name on EUT | Cable Description | Qty. | Length (m) | Shielded (Y/N) | Termination Point |
|---|---|---|---|---|---|---|
| 1 | +12V | Power | 1 | 1.5 | Yes | -- |
| 2 | PC | USB Cable | 1 | 2 | -- | -- |

**Table 6. Ports and Cabling Information**

## H. Mode of Operation

Nomad HD will be controlled through a laptop software application connected to the device via a USB cable. The laptop software application will enable continuous Bluetooth testing, or continuous Narrowband (NB) port testing, or continuous High Definition (HD) port testing.

## I. Method of Monitoring EUT Operation

The Laptop test SW application will indicate that the software/Hardware is functioning properly.

## J. Modifications

**a) Modifications to EUT**
No modifications were made to the EUT.

**b) Modifications to Test Standard**
No modifications were made to the test standard.

## K. Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to Spirent Communications upon completion of testing.

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# III. Electromagnetic Compatibility Criteria for Unintentional Radiators

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## Electromagnetic Compatibility Criteria

### § 15.107 Conducted Emissions Limits

**Test Requirement(s):**

**15.107 (a)** Except for Class A digital devices, for equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in Table 7. Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminals.

**15.107 (b)** For a Class A digital device that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in Table 7. Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminals. The lower limit applies at the band edges.

**15.207(a)**, Except as shown in paragraphs (b) and (c) of this section*, charging, AC adapters or battery eliminators the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the Table 7, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequencies ranges.

| Frequency range (MHz) | Class A Conducted Limits (dBµV) | | *Class B Conducted Limits (dBµV) | |
|---|---|---|---|---|
| | Quasi-Peak | Average | Quasi-Peak | Average |
| * 0.15- 0.45 | 79 | 66 | 66 - 56 | 56 - 46 |
| 0.45 - 0.5 | 79 | 66 | 56 | 46 |
| 0.5 - 30 | 73 | 60 | 60 | 50 |
| Note 1 — The lower limit shall apply at the transition frequencies.<br>Note 2 — The limit decreases linearly with the logarithm if the frequency in the range 0.15 MHz to 0.5 MHz.<br>* -- Limits per Subsection 15.207(a). | | | | |

**Table 7. Conducted Limits for Radio Frequency Devices calculated from FCC Part 15 Subsections 15.107(a) (b) and 15.207(a)**

**Test Procedures:** The EUT was placed on a non-metallic table, 80 cm above the ground plane inside a semi-anechoic chamber. The method of testing, test conditions, and test procedures of ANSI C63.4 were used. The EUT was powered through a 50Ω/50µH LISN. An EMI receiver, connected to the measurement port of the LISN, scanned the frequency range from 150 kHz to 30 MHz in order to find the peak conducted emissions. All peak emissions within 6 dB of the limit were re-measured using a quasi-peak and/or average detector as appropriate.

**Test Results:** The EUT was compliant with the Class A requirement(s) of this section. Measured emissions were below applicable limits.

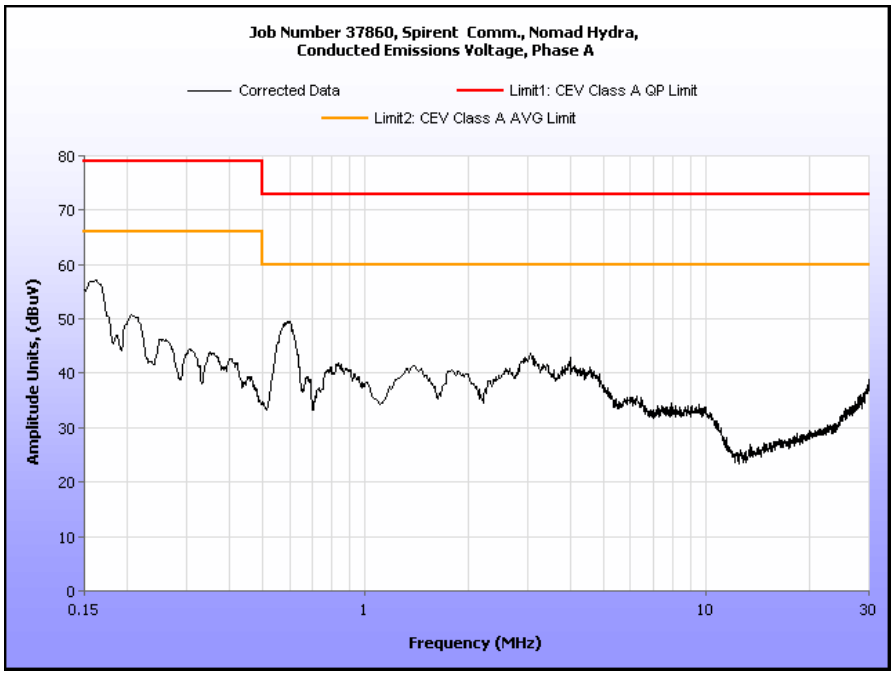
**Test Engineer(s):** Jeff Pratt

**Test Date(s):** 03/12/13

## Conducted Emissions - Voltage, AC Power, Phase Line (120 VAC, 60 Hz)

| Frequency (MHz) | Uncorrected Meter Reading (dBuV) QP | Cable Loss (dB) | Corrected Measurement (dBuV) QP | Limit (dBuV) QP | Margin (dB) QP | Uncorrected Meter Reading (dBuV) Avg. | Cable Loss (dB) | Corrected Measurement (dBuV) AVG | Limit (dBuV) AVG | Margin (dB) AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.152 | 54.21 | 0 | 54.21 | 65.89 | -11.68 | 44.12 | 0 | 44.12 | 55.89 | -11.77 |
| 0.586 | 46.58 | 0 | 46.58 | 56 | -9.42 | 40.48 | 0 | 40.48 | 46 | -5.52 |
| 2.827 | 40.91 | 0 | 40.91 | 56 | -15.09 | 34.14 | 0 | 34.14 | 46 | -11.86 |
| 3.205 | 40.35 | 0 | 40.35 | 56 | -15.65 | 32.83 | 0 | 32.83 | 46 | -13.17 |
| 3.555 | 38.37 | 0 | 38.37 | 56 | -17.63 | 28.06 | 0 | 28.06 | 46 | -17.94 |
| 4.941 | 40.82 | 0 | 40.82 | 56 | -15.18 | 32.37 | 0 | 32.37 | 46 | -13.63 |

**Table 8. Conducted Emissions - Voltage, AC Power, Phase Line (120 VAC, 60 Hz)**




**Plot 1. Conducted Emissions, Phase Line Plot**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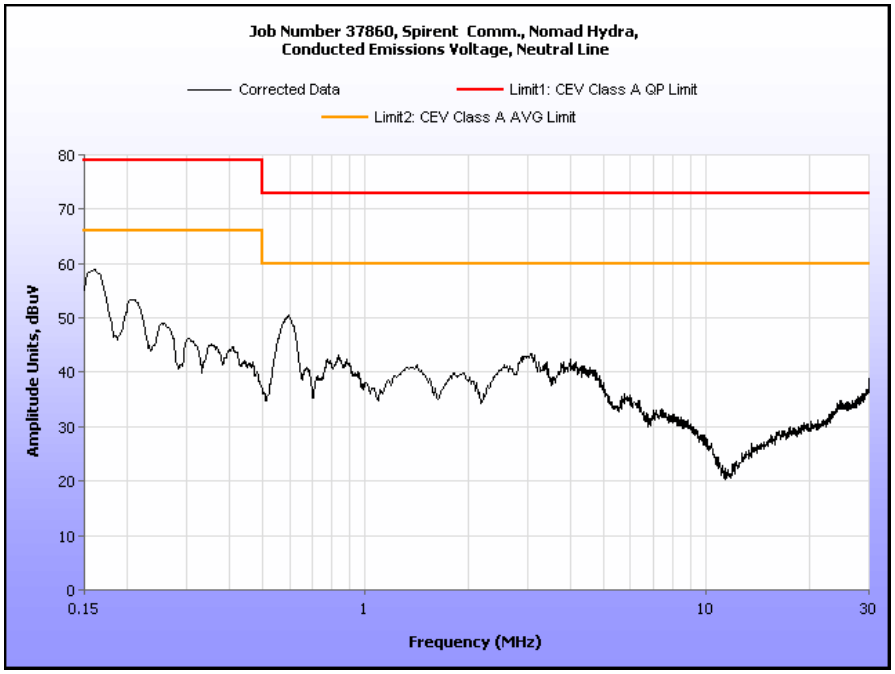
## Conducted Emissions - Voltage, AC Power, Neutral Line (120 VAC, 60 Hz)

| Frequency (MHz) | Uncorrected Meter Reading (dBuV) QP | Cable Loss (dB) | Corrected Measurement (dBuV) QP | Limit (dBuV) QP | Margin (dB) QP | Uncorrected Meter Reading (dBuV) Avg. | Cable Loss (dB) | Corrected Measurement (dBuV) AVG | Limit (dBuV) AVG | Margin (dB) AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.152 | 57.14 | 0 | 57.14 | 65.89 | -8.75 | 46.62 | 0 | 46.62 | 55.89 | -9.27 |
| 0.202 | 50.8 | 0 | 50.8 | 63.53 | -12.73 | 41.28 | 0 | 41.28 | 53.53 | -12.25 |
| 0.589 | 48 | 0 | 48 | 56 | -8 | 41.99 | 0 | 41.99 | 46 | -4.01 |
| 0.772 | 38.83 | 0 | 38.83 | 56 | -17.17 | 32.07 | 0 | 32.07 | 46 | -13.93 |
| 3.177 | 45.65 | 0 | 45.65 | 56 | -10.35 | 36.79 | 0 | 36.79 | 46 | -9.21 |
| 4.601 | 38.03 | 0 | 38.03 | 56 | -17.97 | 29.89 | 0 | 29.89 | 46 | -16.11 |

**Table 9. Conducted Emissions - Voltage, AC Power, Neutral Line (120 VAC, 60 Hz)**




**Plot 2. Conducted Emissions, Neutral Line Plot**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## Conducted Emission Limits Test Setup

**Photograph 2. Conducted Emissions, Test Setup**


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## Radiated Emission Limits

### § 15.109 Radiated Emissions Limits

**Test Requirement(s):** **15.109 (a)** Except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the Class B limits expressed in Table 10.

**15.109 (b)** The field strength of radiated emissions from a Class A digital device, as determined at a distance of 10 meters, shall not exceed the Class A limits expressed in Table 10.

| Frequency (MHz) | Field Strength (dBµV/m) | |
|---|---|---|
| | §15.109 (b), Class A Limit (dBµV) @ 10m | §15.109 (a),Class B Limit (dBµV) @ 3m |
| 30 - 88 | 39.00 | 40.00 |
| 88 - 216 | 43.50 | 43.50 |
| 216 - 960 | 46.40 | 46.00 |
| Above 960 | 49.50 | 54.00 |

**Table 10. Radiated Emissions Limits calculated from FCC Part 15, §15.109 (a) (b)**

**Test Procedures:** The EUT was placed on a non-metallic table, 80 cm above the ground plane inside a semi-anechoic chamber. The method of testing and test conditions of ANSI C63.4 were used. An antenna was located 3 m from the EUT on an adjustable mast. A pre-scan was first performed in order to find prominent radiated emissions. For final emissions measurements at each frequency of interest, the EUT was rotated and the antenna height was varied between 1 m and 4 m in order to maximize the emission. Measurements in both horizontal and vertical polarities were made and the data was recorded. Unless otherwise specified, measurements were made using a quasi-peak detector with a 120 kHz bandwidth.

**Test Results:** The EUT was compliant with the Class A requirement(s) of this section. Measured emissions were below applicable limits.

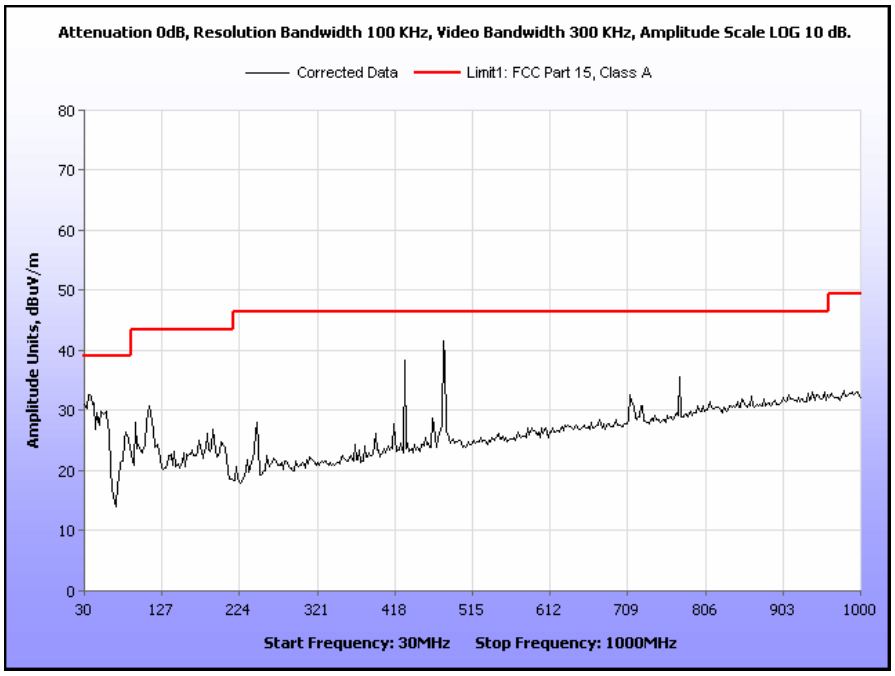
**Test Engineer(s):** Jeff Pratt

**Test Date(s):** 03/15/13

## Radiated Emissions Limits Test Results, Class B

| Frequency (MHz) | EUT Azimuth (Degrees) | Antenna Polarity (H/V) | Antenna HEIGHT (m) | Uncorrected Amplitude (dBuV) | Antenna Correction Factor (dB) (+) | Cable Loss (dB) (+) | Distance Correction Factor (dB) (-) | Corrected Amplitude (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 55.751503 | 252 | H | 1.93 | 9.39 | 7.52 | 0.69 | 10.46 | 7.14 | 39.00 | -31.86 |
| 55.751503 | 354 | V | 1.54 | 26.07 | 7.52 | 0.69 | 10.46 | 23.82 | 39.00 | -15.18 |
| 192.10421 | 193 | H | 1.96 | 16.90 | 11.51 | 1.12 | 10.46 | 19.07 | 43.50 | -24.43 |
| 192.10421 | 195 | V | 1.59 | 15.34 | 11.51 | 1.12 | 10.46 | 17.51 | 43.50 | -25.99 |
| 247.77555 | 250 | H | 1.82 | 10.54 | 12.14 | 1.32 | 10.46 | 13.54 | 46.40 | -32.86 |
| 247.77555 | 7 | V | 1.44 | 11.32 | 12.14 | 1.32 | 10.46 | 14.32 | 46.40 | -32.08 |
| 430.07164 | 65 | H | 1.54 | 20.96 | 16.80 | 1.68 | 10.46 | 28.98 | 46.40 | -17.42 |
| 430.07164 | 361 | V | 1.70 | 30.03 | 16.80 | 1.68 | 10.46 | 38.05 | 46.40 | -8.35 |
| 480.01002 | 8 | H | 2.03 | 24.61 | 17.90 | 1.82 | 10.46 | 33.87 | 46.40 | -12.53 |
| 480.01002 | 60 | V | 1.89 | 28.94 | 17.90 | 1.82 | 10.46 | 38.20 | 46.40 | -8.20 |
| 774.13325 | 75 | H | 1.61 | 18.82 | 21.48 | 2.37 | 10.46 | 32.21 | 46.40 | -14.19 |
| 774.13325 | 39 | V | 1.49 | 16.82 | 21.48 | 2.37 | 10.46 | 30.21 | 46.40 | -16.19 |

**Table 11. Radiated Emissions Limits, Test Results, 30 MHz – 1 GHz, FCC Limits**




**Plot 3. Radiated Emissions, 30 MHz - 1 GHz, FCC Limits**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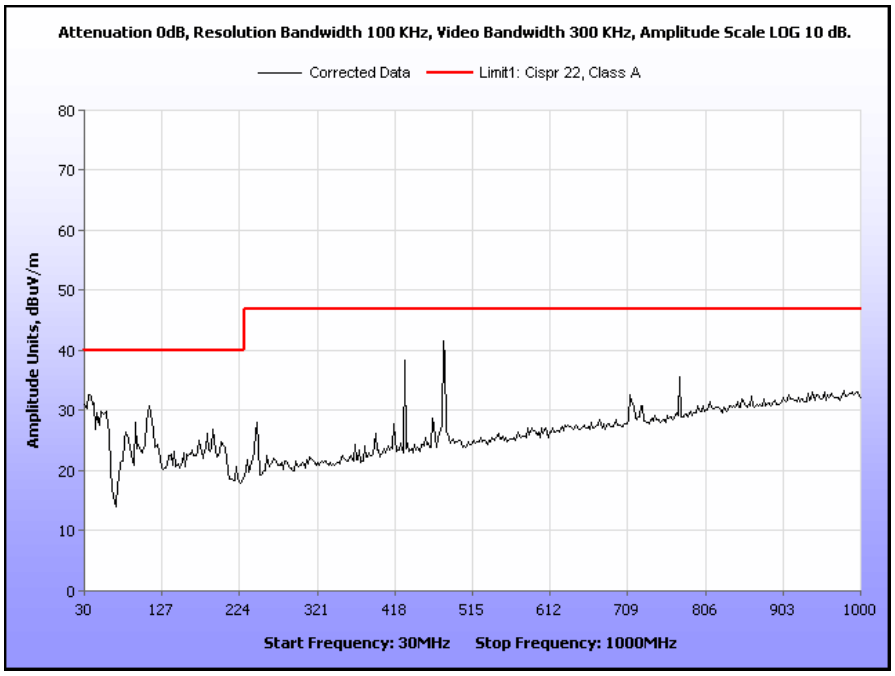
## Radiated Emissions Limits Test Results, Class B

| Frequency (MHz) | EUT Azimuth (Degrees) | Antenna Polarity (H/V) | Antenna HEIGHT (m) | Uncorrected Amplitude (dBuV) | Antenna Correction Factor (dB) (+) | Cable Loss (dB) (+) | Distance Correction Factor (dB) (-) | Corrected Amplitude (dBuV/m) | Limit (dBuV/m) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 55.751503 | 252 | H | 1.93 | 9.39 | 7.52 | 0.69 | 10.46 | 7.14 | 40.00 | -32.86 |
| 55.751503 | 354 | V | 1.54 | 26.07 | 7.52 | 0.69 | 10.46 | 23.82 | 40.00 | -16.18 |
| 192.10421 | 193 | H | 1.96 | 16.90 | 11.51 | 1.12 | 10.46 | 19.07 | 40.00 | -20.93 |
| 192.10421 | 195 | V | 1.59 | 15.34 | 11.51 | 1.12 | 10.46 | 17.51 | 40.00 | -22.49 |
| 247.77555 | 250 | H | 1.82 | 10.54 | 12.14 | 1.32 | 10.46 | 13.54 | 47.00 | -33.46 |
| 247.77555 | 7 | V | 1.44 | 11.32 | 12.14 | 1.32 | 10.46 | 14.32 | 47.00 | -32.68 |
| 430.07164 | 65 | H | 1.54 | 20.96 | 16.80 | 1.68 | 10.46 | 28.98 | 47.00 | -18.02 |
| 430.07164 | 361 | V | 1.70 | 30.03 | 16.80 | 1.68 | 10.46 | 38.05 | 47.00 | -8.95 |
| 480.01002 | 8 | H | 2.03 | 24.61 | 17.90 | 1.82 | 10.46 | 33.87 | 47.00 | -13.13 |
| 480.01002 | 60 | V | 1.89 | 28.94 | 17.90 | 1.82 | 10.46 | 38.20 | 47.00 | -8.80 |
| 774.13325 | 75 | H | 1.61 | 18.82 | 21.48 | 2.37 | 10.46 | 32.21 | 47.00 | -14.79 |
| 774.13325 | 39 | V | 1.49 | 16.82 | 21.48 | 2.37 | 10.46 | 30.21 | 47.00 | -16.79 |

**Table 12. Radiated Emissions Limits, Test Results, ICES-003 Limits**




**Plot 4. Radiated Emissions, ICES-003 Limits**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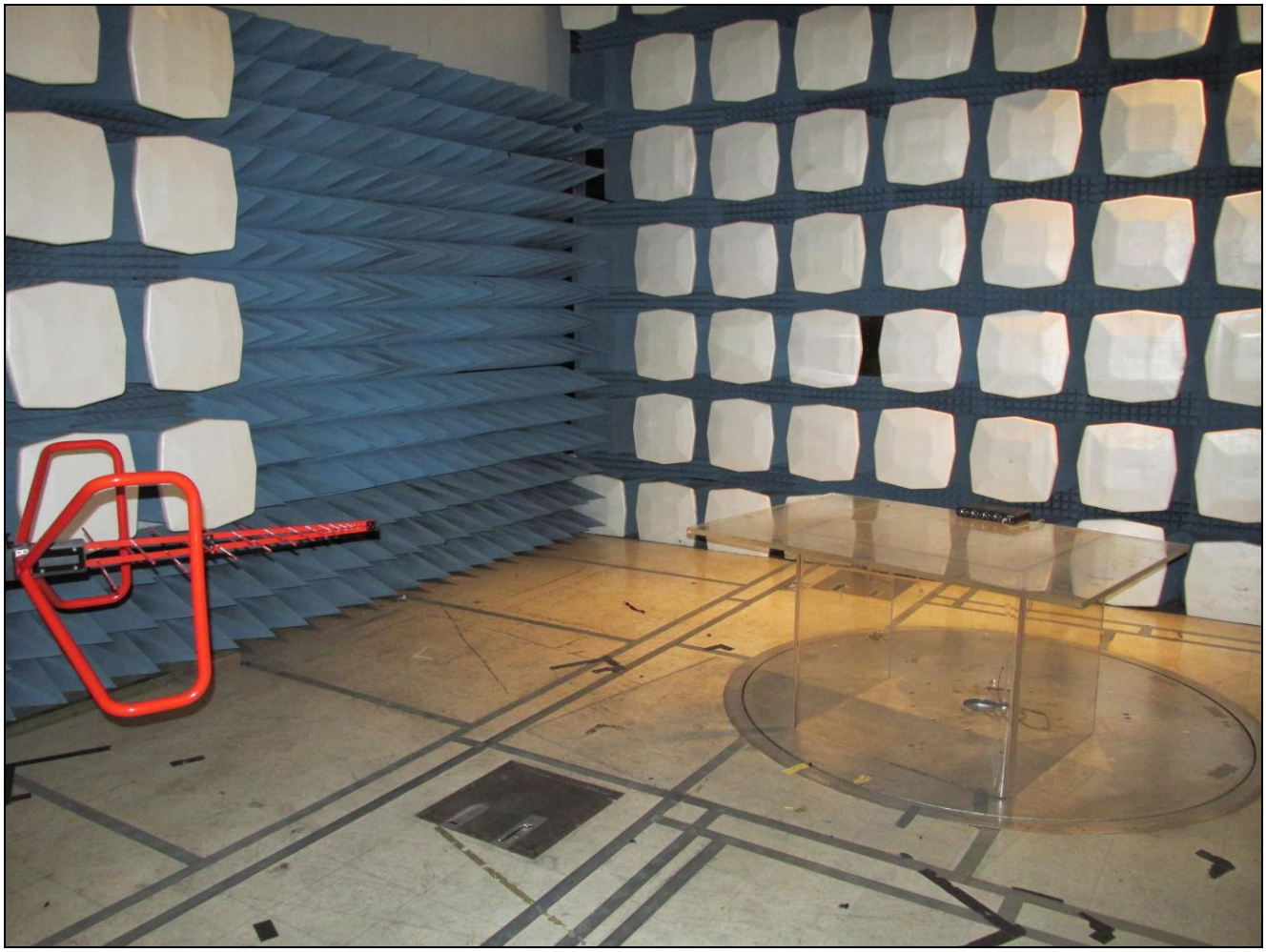
## Radiated Emission Limits Test Setup



**Photograph 3. Radiated Emission, Test Setup**

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# IV. Electromagnetic Compatibility Criteria for Intentional Radiators

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# Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.203 Antenna Requirement

**Test Requirement:** **§ 15.203:** An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

The structure and application of the EUT were analyzed to determine compliance with Section 15.203 of the Rules. Section 15.203 states that the subject device must meet at least one of the following criteria:

a.) Antenna must be permanently attached to the unit.

b.) Antenna must use a unique type of connector to attach to the EUT.

c.) Unit must be professionally installed. Installer shall be responsible for verifying that the correct antenna is employed with the unit.

**Results:** The EUT as tested is compliant the criteria of §15.203. The EUT has an integral antenna.

**Test Engineer(s):** Jeff Pratt

**Test Date(s):** 03/14/13

| Gain | Type | Model | Manufacturer |
|---|---|---|---|
| 3 dBi | F shaped microstrip | To be provided | To be provided |

**Table 13. Antenna List**

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# Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.207(a) Conducted Emissions Limits

**Test Requirement(s):** **§ 15.207 (a):** For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30MHz, shall not exceed the limits in the following table, as measured using a 50 μH/50 Σ line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

| Frequency range (MHz) | § 15.207(a), Conducted Limit (dBμV) | |
|---|---|---|
| | Quasi-Peak | Average |
| * 0.15- 0.45 | 66 - 56 | 56 - 46 |
| 0.45 - 0.5 | 56 | 46 |
| 0.5 - 30 | 60 | 50 |

**Table 14. Conducted Limits for Intentional Radiators from FCC Part 15 § 15.207(a)**

**Test Procedure:** The EUT was placed on a 0.8 m-high wooden table inside a screen room. The EUT was situated such that the back of the EUT was 0.4 m from one wall of the vertical ground plane, and the remaining sides of the EUT were no closer than 0.8 m from any other conductive surface. The EUT was powered from a 50 Ω/50 μH Line Impedance Stabilization Network (LISN). The EMC receiver scanned the frequency range from 150 kHz to 30 MHz. Conducted Emissions measurements were made in accordance with *ANSI C63.4-2003 "Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9kHz to 40 GHz"*. The measurements were performed over the frequency range of 0.15 MHz to 30 MHz using a 50 Ω/50 μH LISN as the input transducer to an EMC/field intensity meter. For the purpose of this testing, the transmitter was turned on. Scans were performed with the transmitter on.

**Test Results:** The EUT was compliant with this requirement. Measured emissions were below applicable limits.

**Test Engineer(s):** Jeff Pratt

**Test Date(s):** 03/12/13

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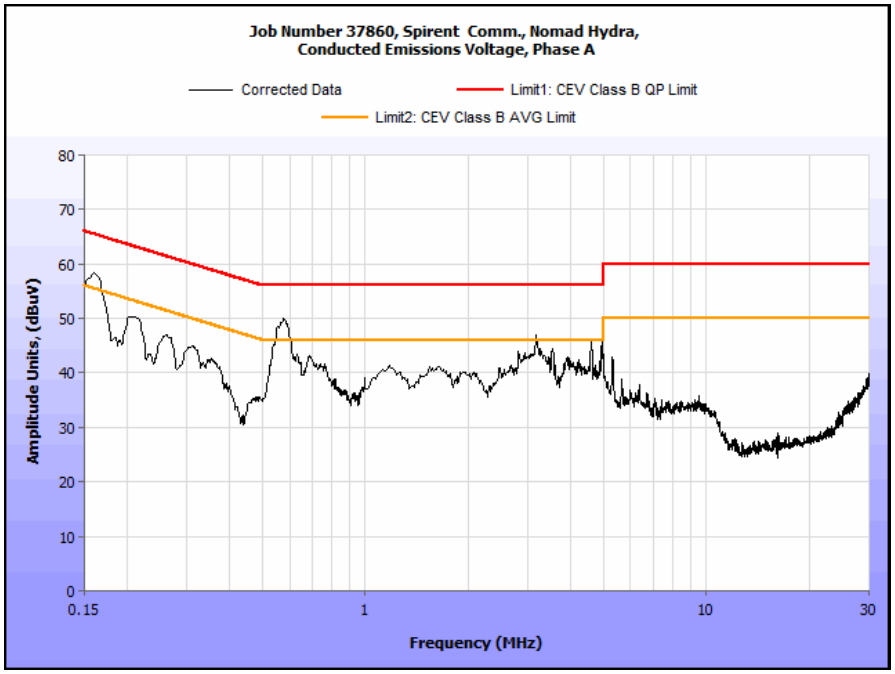
## 15.207(a) Conducted Emissions Test Results

| Frequency (MHz) | Uncorrected Meter Reading (dBuV) QP | Cable Loss (dB) | Corrected Measurement (dBuV) QP | Limit (dBuV) QP | Margin (dB) QP | Uncorrected Meter Reading (dBuV) Avg. | Cable Loss (dB) | Corrected Measurement (dBuV) AVG | Limit (dBuV) AVG | Margin (dB) AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.151 | 54.64 | 0 | 54.64 | 65.95 | -11.31 | 44.79 | 0 | 44.79 | 55.95 | -11.16 |
| 0.581 | 46.33 | 0 | 46.33 | 56 | -9.67 | 39.87 | 0 | 39.87 | 46 | -6.13 |
| 3.187 | 40.51 | 0 | 40.51 | 56 | -15.49 | 33.15 | 0 | 33.15 | 46 | -12.85 |
| 3.527 | 40.01 | 0 | 40.01 | 56 | -15.99 | 32.85 | 0 | 32.85 | 46 | -13.15 |
| 4.593 | 40.58 | 0 | 40.58 | 56 | -15.42 | 32.71 | 0 | 32.71 | 46 | -13.29 |
| 4.942 | 40.96 | 0 | 40.96 | 56 | -15.04 | 32.59 | 0 | 32.59 | 46 | -13.41 |

**Table 15. Conducted Emissions, 15.207(a), Phase Line, Test Results, Radios 1 and 2**




**Plot 5. Conducted Emissions, 15.207(a), Phase Line, Radios 1 and 2**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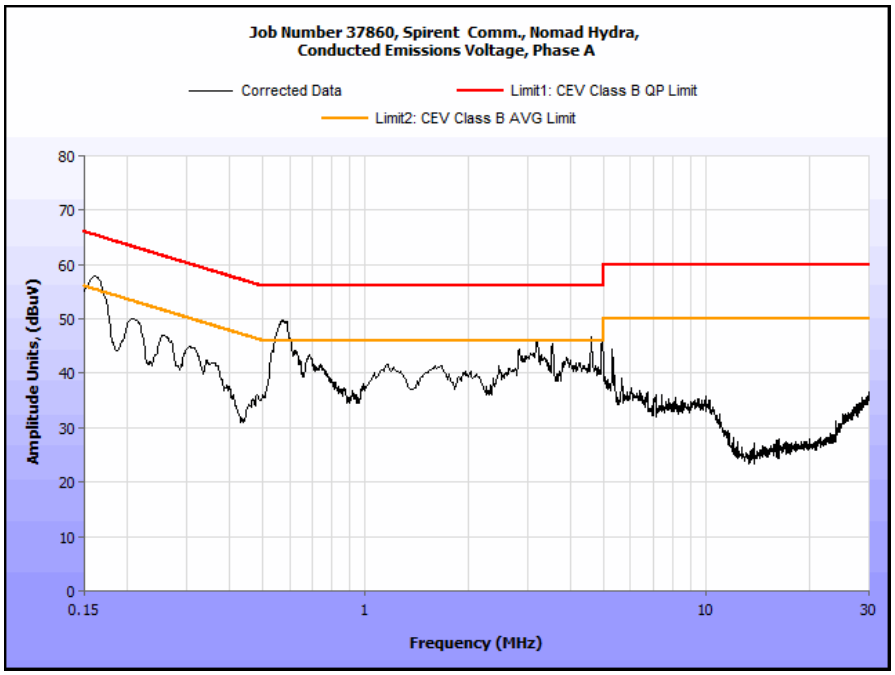
| Frequency (MHz) | Uncorrected Meter Reading (dBuV) QP | Cable Loss (dB) | Corrected Measurement (dBuV) QP | Limit (dBuV) QP | Margin (dB) QP | Uncorrected Meter Reading (dBuV) Avg. | Cable Loss (dB) | Corrected Measurement (dBuV) AVG | Limit (dBuV) AVG | Margin (dB) AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.153 | 54.53 | 0 | 54.53 | 65.84 | -11.31 | 45.03 | 0 | 45.03 | 55.84 | -10.81 |
| 0.202 | 47.45 | 0 | 47.45 | 63.53 | -16.08 | 38.53 | 0 | 38.53 | 53.53 | -15 |
| 0.57 | 46.52 | 0 | 46.52 | 56 | -9.48 | 40.2 | 0 | 40.2 | 46 | -5.8 |
| 3.176 | 42.37 | 0 | 42.37 | 56 | -13.63 | 35.32 | 0 | 35.32 | 46 | -10.68 |
| 4.587 | 40.39 | 0 | 40.39 | 56 | -15.61 | 32.06 | 0 | 32.06 | 46 | -13.94 |
| 4.942 | 41.08 | 0 | 41.08 | 56 | -14.92 | 32.74 | 0 | 32.74 | 46 | -13.26 |

**Table 16. Conducted Emissions, 15.207(a), Phase Line, Test Results, Radios 3 and 4**

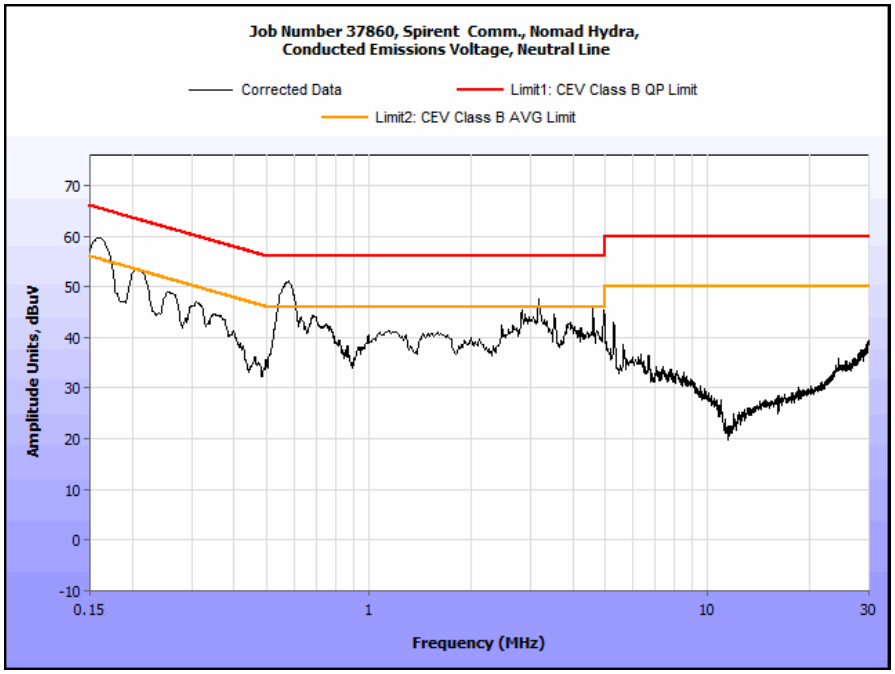



**Plot 6. Conducted Emissions, 15.207(a), Phase Line, Radios 3 and 4**

## 15.207(a) Conducted Emissions Test Results

| Frequency (MHz) | Uncorrected Meter Reading (dBuV) QP | Cable Loss (dB) | Corrected Measurement (dBuV) QP | Limit (dBuV) QP | Margin (dB) QP | Uncorrected Meter Reading (dBuV) Avg. | Cable Loss (dB) | Corrected Measurement (dBuV) AVG | Limit (dBuV) AVG | Margin (dB) AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.152 | 57.11 | 0 | 57.11 | 65.89 | -8.78 | 46.92 | 0 | 46.92 | 55.89 | -8.97 |
| 0.203 | 50.75 | 0 | 50.75 | 63.49 | -12.74 | 41.39 | 0 | 41.39 | 53.49 | -12.1 |
| 0.587 | 46.98 | 0 | 46.98 | 56 | -9.02 | 40.63 | 0 | 40.63 | 46 | -5.37 |
| 2.827 | 40.89 | 0 | 40.89 | 56 | -15.11 | 34.07 | 0 | 34.07 | 46 | -11.93 |
| 3.18 | 41.94 | 0 | 41.94 | 56 | -14.06 | 35.18 | 0 | 35.18 | 46 | -10.82 |
| 4.948 | 39.77 | 0 | 39.77 | 56 | -16.23 | 32.12 | 0 | 32.12 | 46 | -13.88 |

**Table 17. Conducted Emissions, 15.207(a), Neutral Line, Test Results, Radios 1 and 2**




**Plot 7. Conducted Emissions, 15.207(a), Neutral Line, Radios 1 and 2**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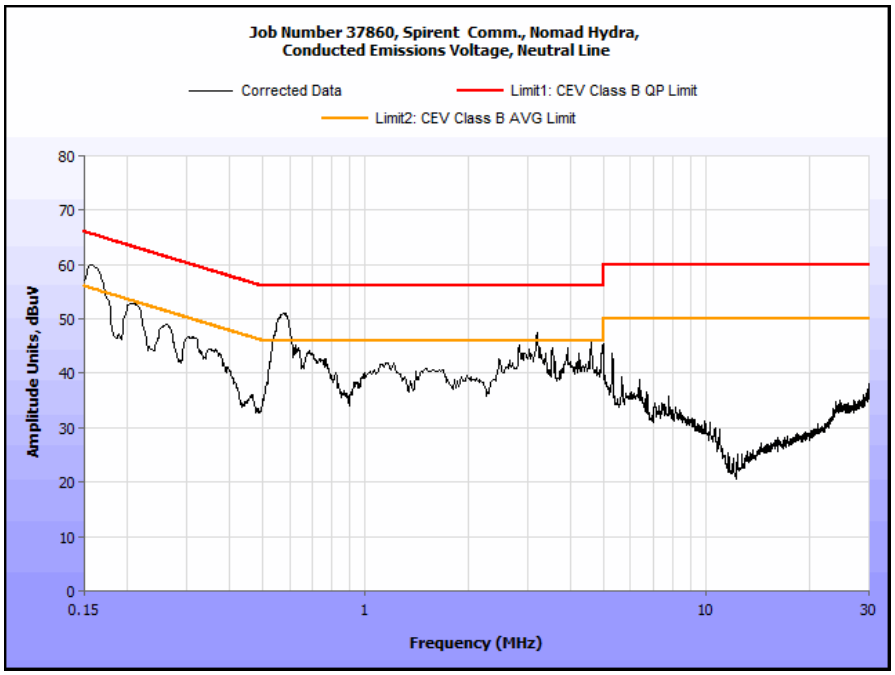
| Frequency (MHz) | Uncorrected Meter Reading (dBuV) QP | Cable Loss (dB) | Corrected Measurement (dBuV) QP | Limit (dBuV) QP | Margin (dB) QP | Uncorrected Meter Reading (dBuV) Avg. | Cable Loss (dB) | Corrected Measurement (dBuV) AVG | Limit (dBuV) AVG | Margin (dB) AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.152 | 57.1 | 0 | 57.1 | 65.89 | -8.79 | 46.83 | 0 | 46.83 | 55.89 | -9.06 |
| 0.201 | 50.55 | 0 | 50.55 | 63.57 | -13.02 | 40.81 | 0 | 40.81 | 53.57 | -12.76 |
| 0.582 | 47.73 | 0 | 47.73 | 56 | -8.27 | 41.43 | 0 | 41.43 | 46 | -4.57 |
| 3.177 | 42.96 | 0 | 42.96 | 56 | -13.04 | 36.26 | 0 | 36.26 | 46 | -9.74 |
| 4.593 | 41.26 | 0 | 41.26 | 56 | -14.74 | 34.07 | 0 | 34.07 | 46 | -11.93 |
| 4.941 | 41.22 | 0 | 41.22 | 56 | -14.78 | 33.48 | 0 | 33.48 | 46 | -12.52 |

**Table 18. Conducted Emissions, 15.207(a), Neutral Line, Test Results, Radios 3 and 4**




**Plot 8. Conducted Emissions, 15.207(a), Neutral Line, Radios 3 and 4**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## 15.207(a) Conducted Emissions Test Setup Photo

**Photograph 4. Conducted Emissions, 15.207(a), Test Setup**


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# Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.247(a)(1) 20 dB Occupied Bandwidth

**Test Requirements:** **§ 15.247(a):** Operation under the provisions of this section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

For systems using digital modulation techniques, the EUT may operate in the 902-928 MHz, 2400-2483.5 MHz and 5725-5850 MHz bands. For DTS, the minimum 6 dB bandwidth shall be at least 500 kHz. For frequency hopping systems, the EUT shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater.

**Test Procedure:** The bandwidth of the fundamental frequency was measured with the spectrum analyzer using a RBW approximately equal to 1% of the total emission bandwidth. The 20 dB bandwidth was measured and recorded.

**Test Results** The EUT was compliant with § 15.247 (a)(2).

**Test Engineer(s):** Ben Taylor

**Test Date(s):** 03/20/15

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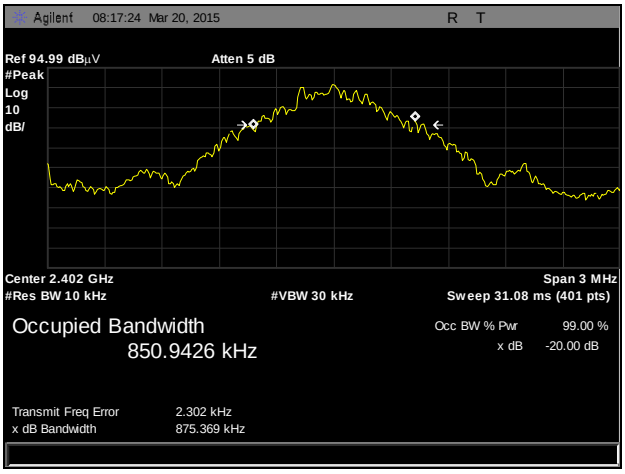
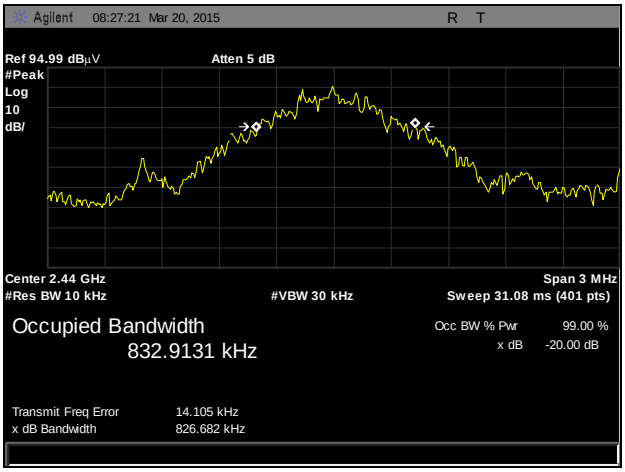
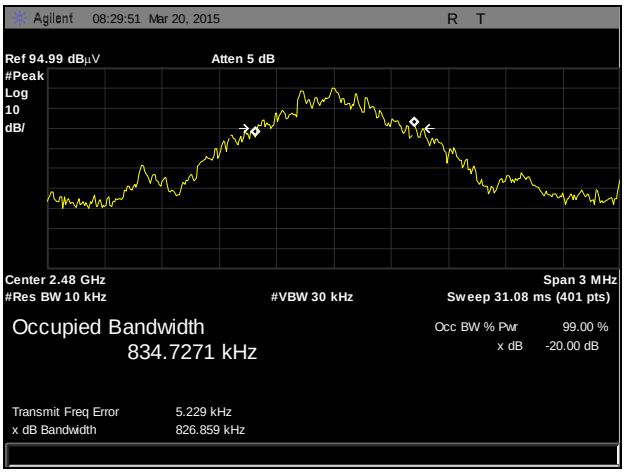
## 20 dB Occupied Bandwidth Test Results



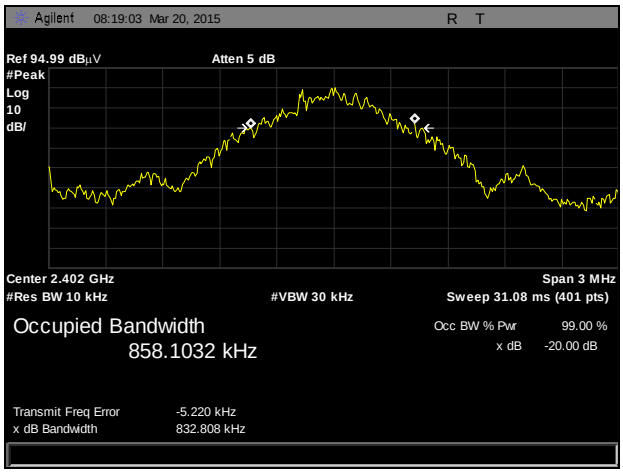

**Plot 9. 20 dB Occupied Bandwidth, Low Channel, Radio 1**



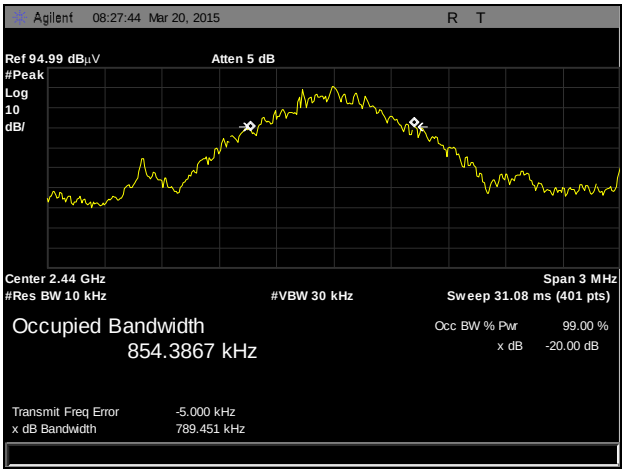

**Plot 10. 20 dB Occupied Bandwidth, Mid Channel, Radio 1**



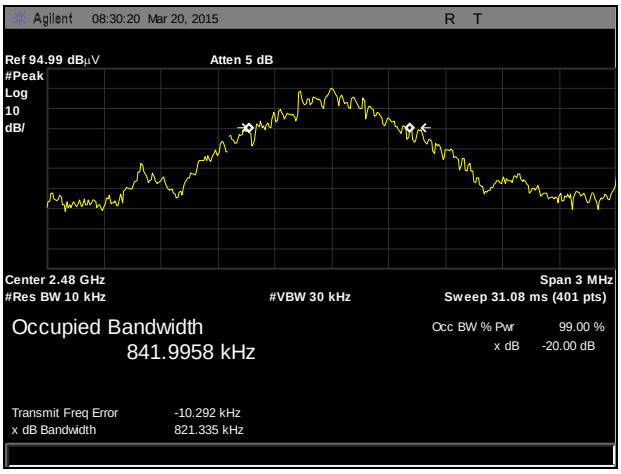

**Plot 11. 20 dB Occupied Bandwidth, High Channel, Radio 1**



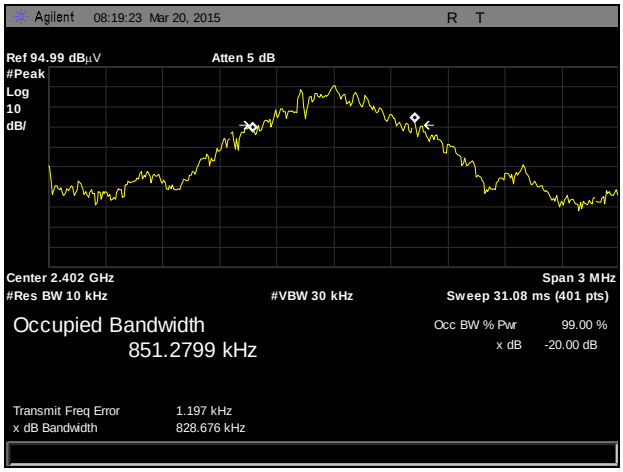

**Plot 12. 20 dB Occupied Bandwidth, Low Channel, Radio 2**



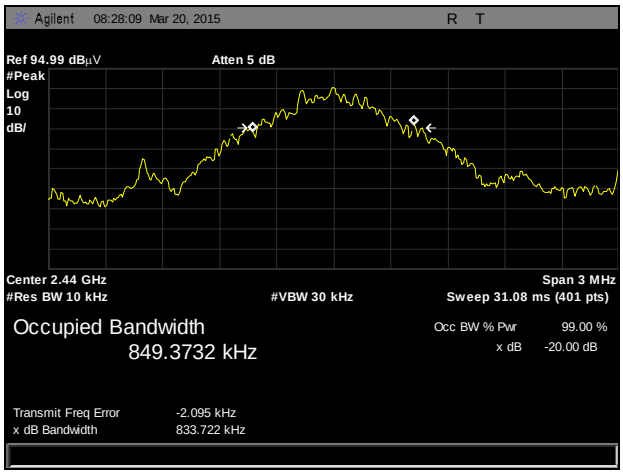

**Plot 13. 20 dB Occupied Bandwidth, Mid Channel, Radio 2**



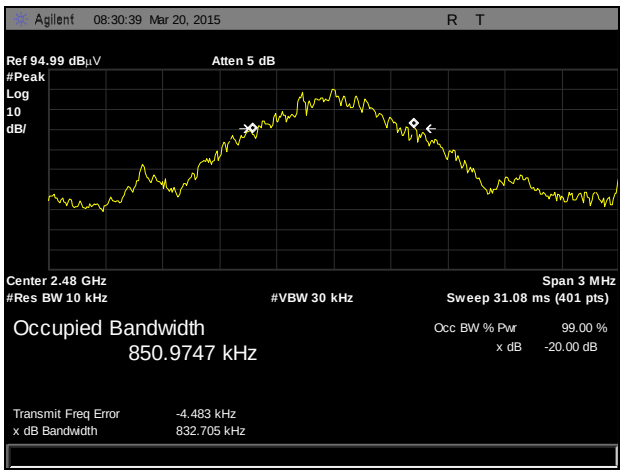

**Plot 14. 20 dB Occupied Bandwidth, High Channel, Radio 2**



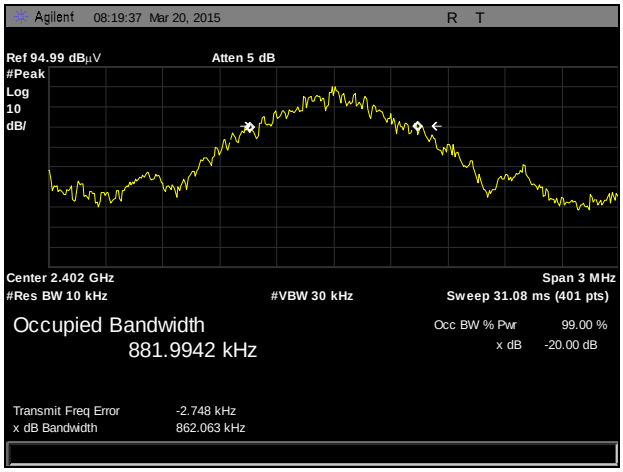

**Plot 15. 20 dB Occupied Bandwidth, Low Channel, Radio 3**



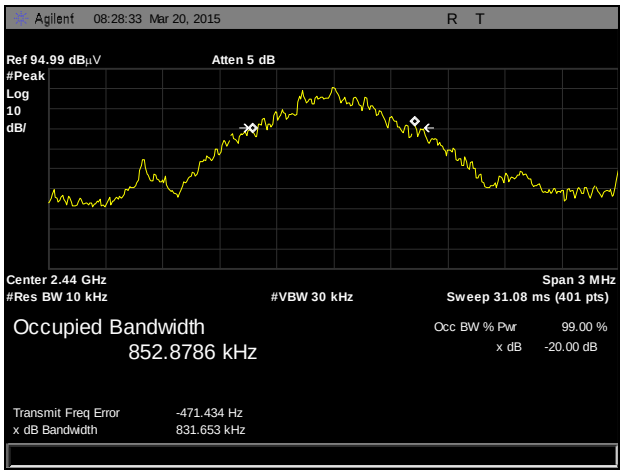

**Plot 16. 20 dB Occupied Bandwidth, Mid Channel, Radio 3**



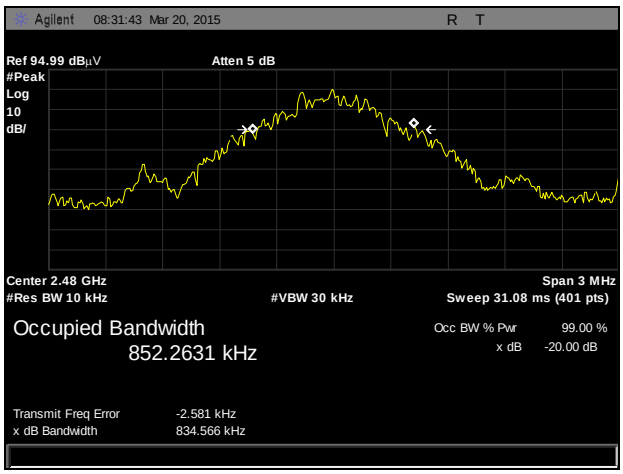

**Plot 17. 20 dB Occupied Bandwidth, High Channel, Radio 3**




**Plot 18. 20 dB Occupied Bandwidth, Low Channel, Radio 4**




**Plot 19. 20 dB Occupied Bandwidth, Mid Channel, Radio 4**




**Plot 20. 20 dB Occupied Bandwidth, High Channel, Radio 4**

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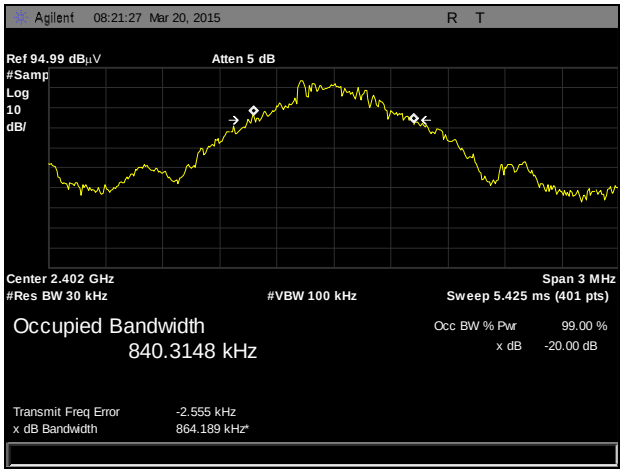
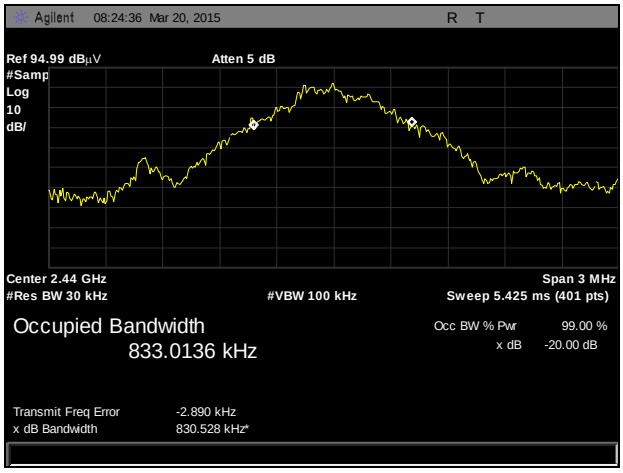
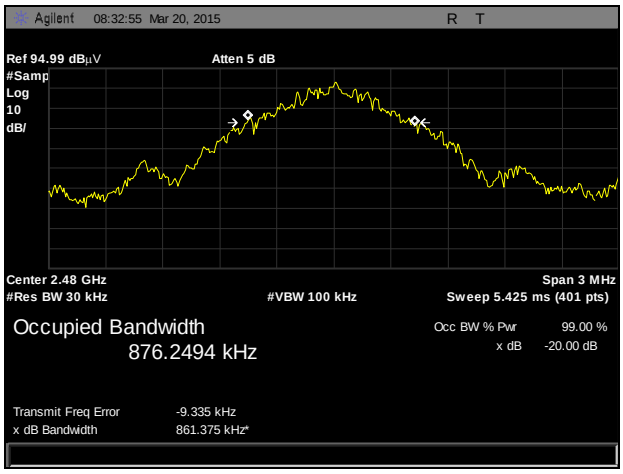
## 99% Occupied Bandwidth Test Results



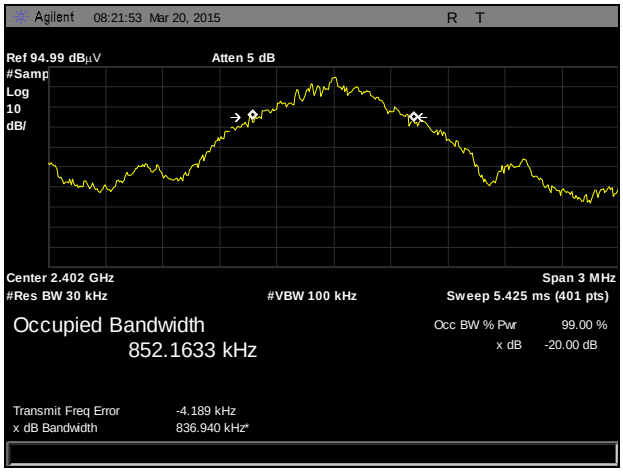

**Plot 21. 99% Occupied Bandwidth, Low Channel, Radio 1**



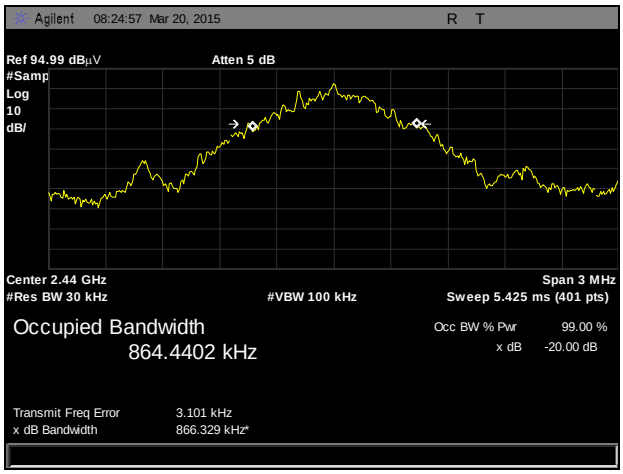

**Plot 22. 99% Occupied Bandwidth, Mid Channel, Radio 1**



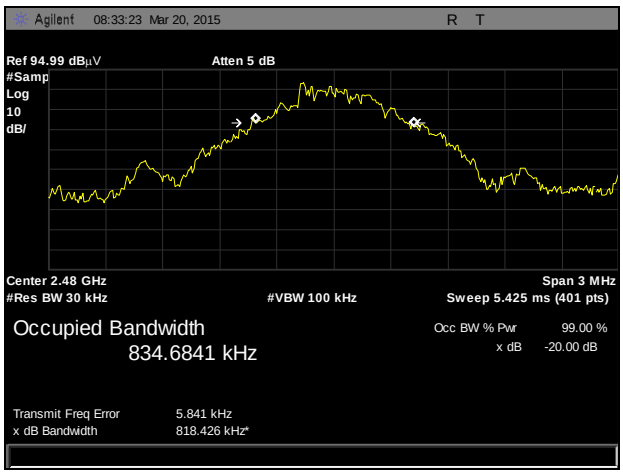

**Plot 23. 99% Occupied Bandwidth, High Channel, Radio 1**



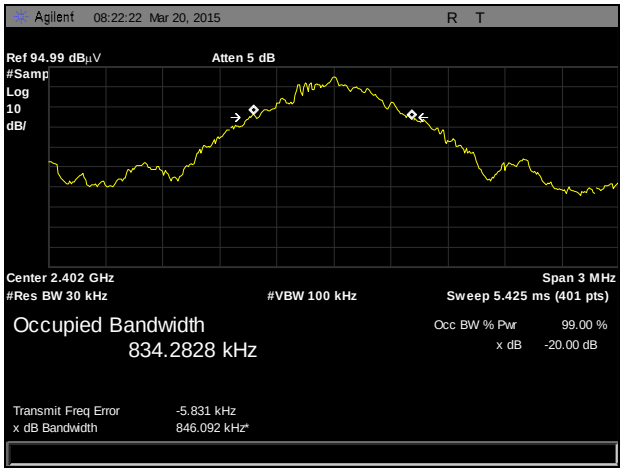

**Plot 24. 99% Occupied Bandwidth, Low Channel, Radio 2**



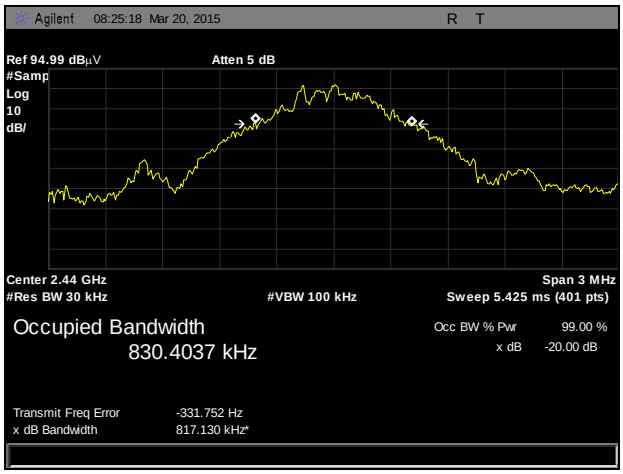

**Plot 25. 99% Occupied Bandwidth, Mid Channel, Radio 2**



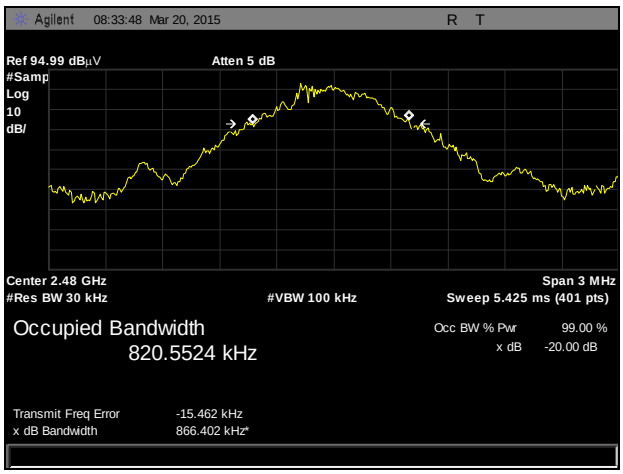

**Plot 26. 99% Occupied Bandwidth, High Channel, Radio 2**



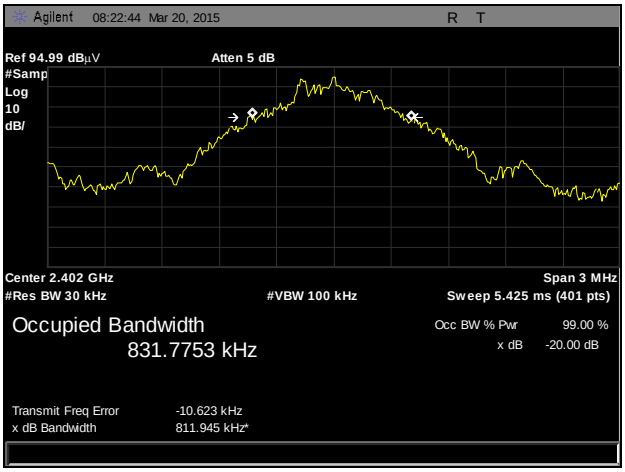

**Plot 27. 99% Occupied Bandwidth, Low Channel, Radio 3**



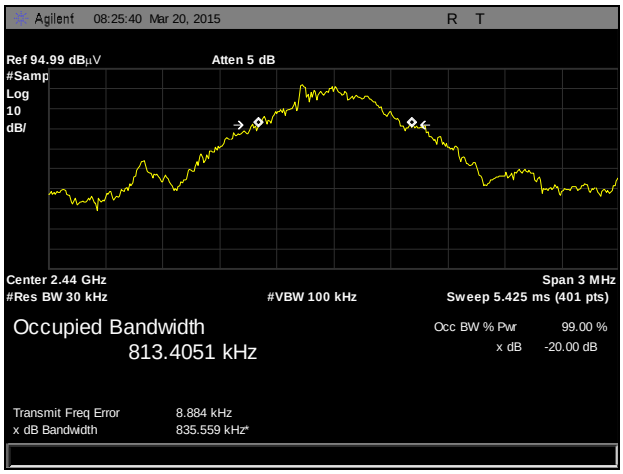

**Plot 28. 99% Occupied Bandwidth, Mid Channel, Radio 3**



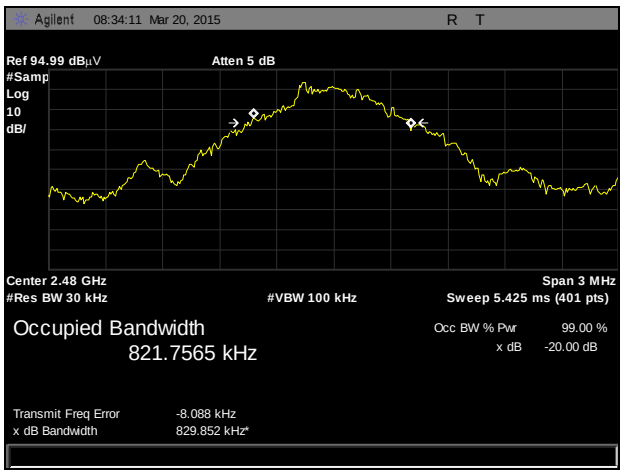

**Plot 29. 99% Occupied Bandwidth, High Channel, Radio 3**




**Plot 30. 99% Occupied Bandwidth, Low Channel, Radio 4**




**Plot 31. 99% Occupied Bandwidth, Mid Channel, Radio 4**




**Plot 32. 99% Occupied Bandwidth, High Channel, Radio 4**

## Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.247(a)(1) Average Time of Occupancy (Dwell Time)

**Remarks:** The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a period equal to 0.4 seconds times the number of channels.

Total hopping channels is 79. The EUT meets the specifications of Section 15.247(a) (1) (iii) for Number of Hopping Channels.

| | | |
|---|---|---|
| # of Channels | 79 | channels |
| Hopping Period | 31.6 | s |
| 5% of Hopping Period | 1.58 | s |
| # of Bursts in 5% of Hopping Period | 16 | bursts |
| # of Bursts per Hopping Period | 320 | bursts |
| Duration of Bursts | 445 | us |
| Total Time of Occupancy | 0.1424 | s |

**Table 19. Average Time of Occupancy**

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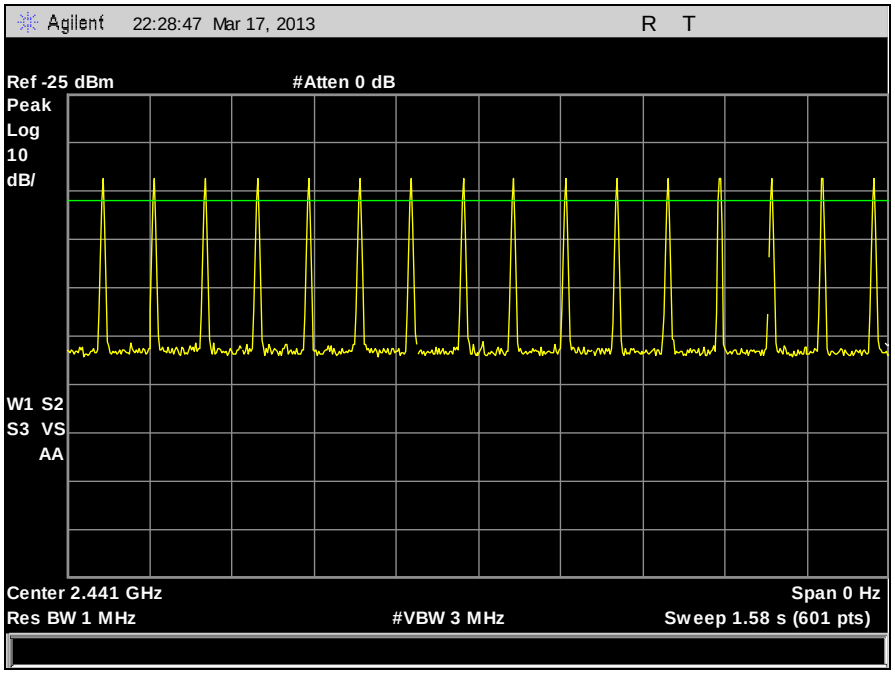
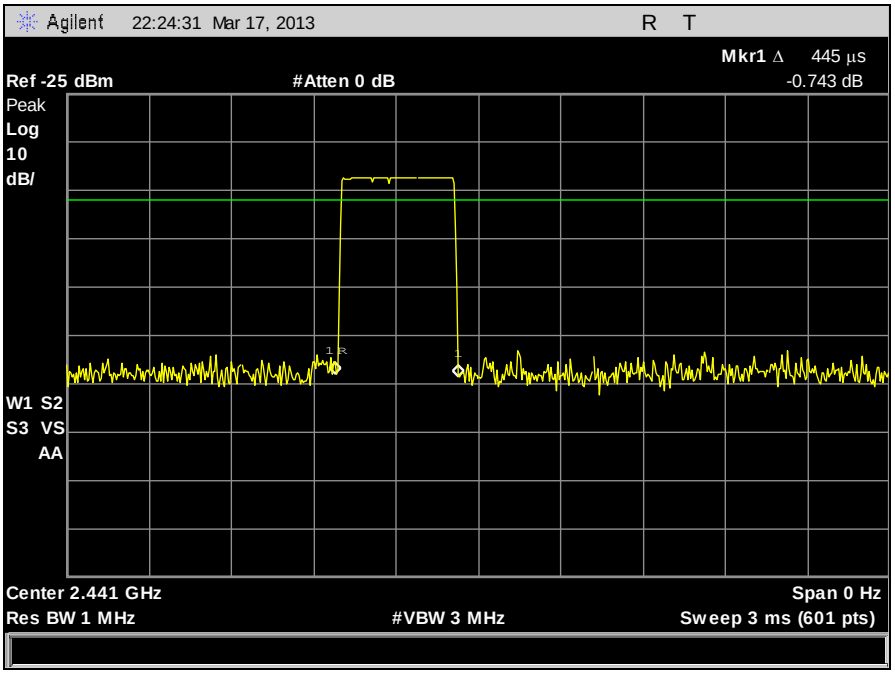
## Dwell Time




**Plot 33. Dwell Time, Number of Bursts**




**Plot 34. Dwell Time, Duration of Burst**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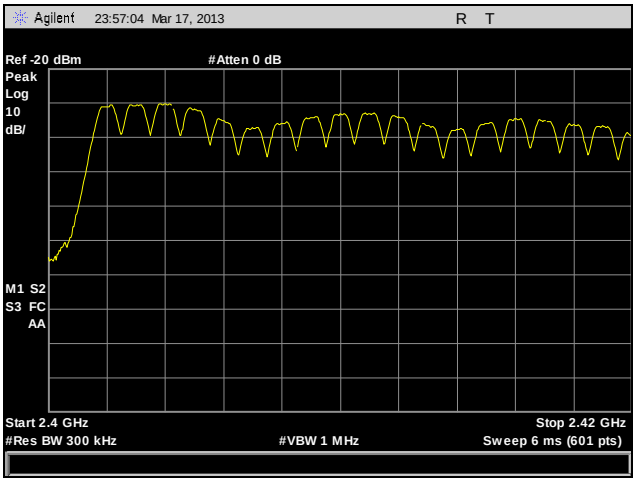
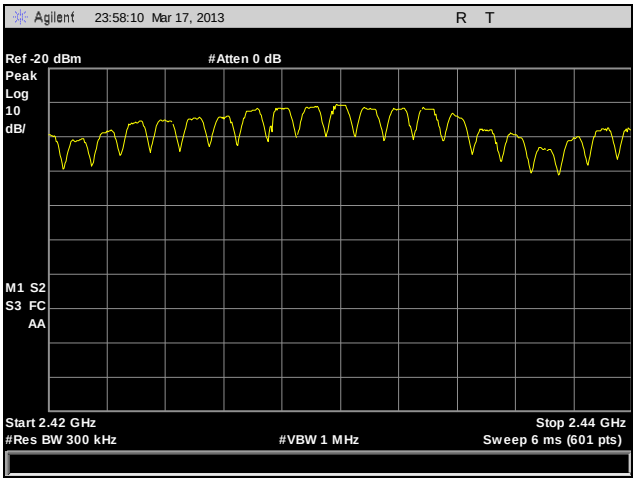
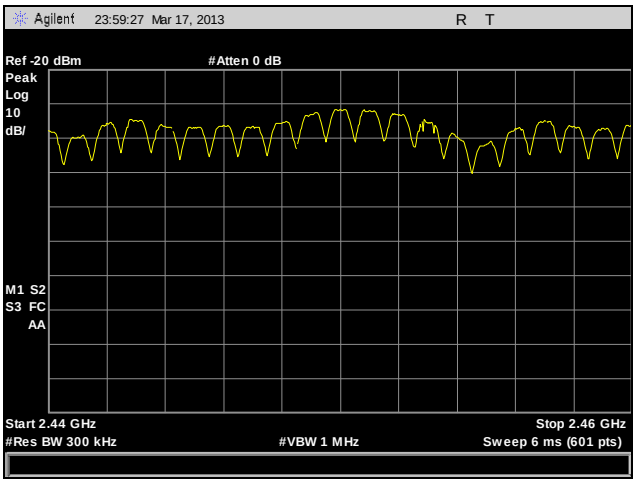
## § 15.247(a)(1) Number of RF Channels




**Plot 35. Number of Channels, 1**




**Plot 36. Number of Channels, 2**




**Plot 37. Number of Channels, 3**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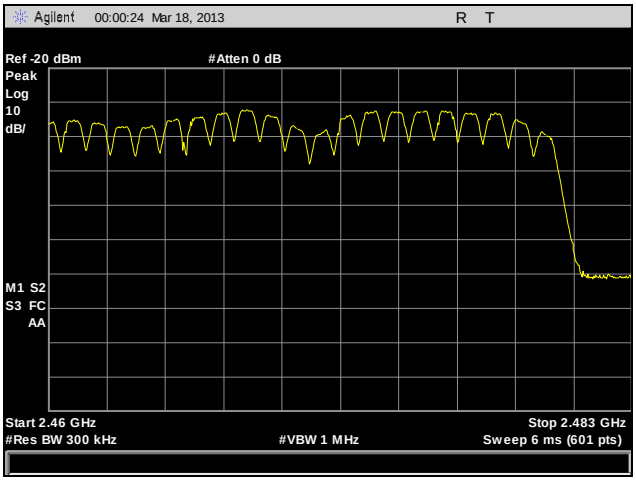


**Plot 38. Number of Channels, 4**


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# Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.247(a)(1) RF Channel Separation

**Requirement:** Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400–2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

**Remarks:** The RF channel separation was found to be 1MHz, which is greater than the 20dB bandwidth of the hopping channels. The EUT complies with this requirement.

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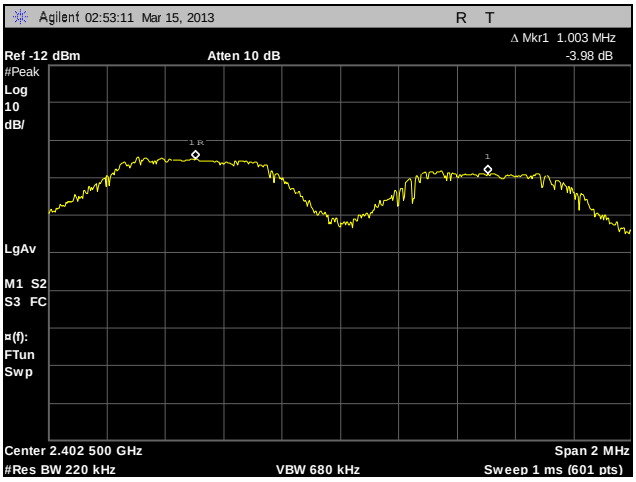
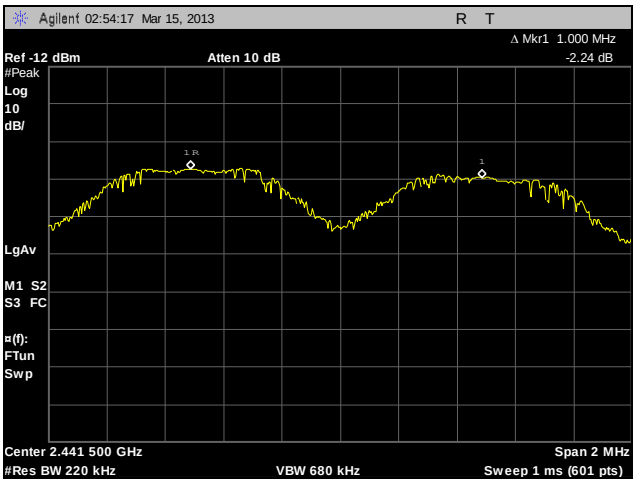
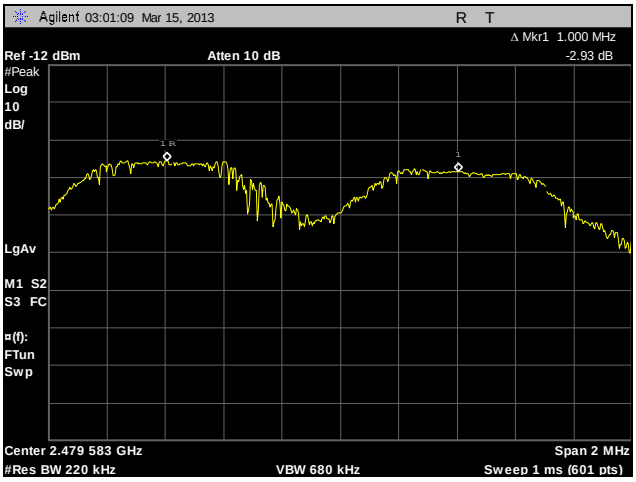



**Plot 39. Channel Separation, Low Channel, Radio 1**




**Plot 40. Channel Separation, Mid Channel, Radio 1**




**Plot 41. Channel Separation, High Channel, Radio 1**

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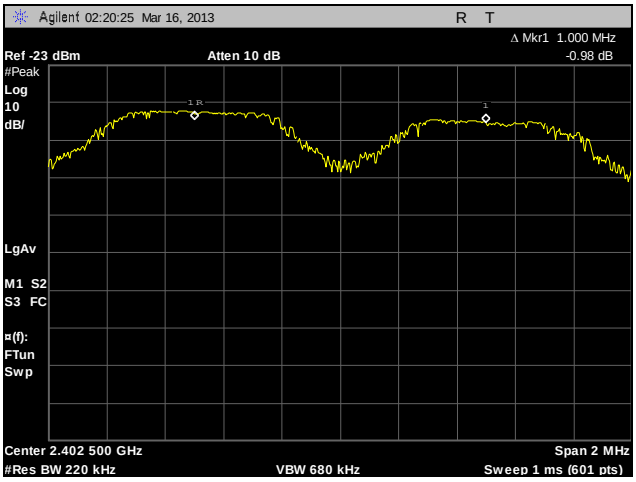
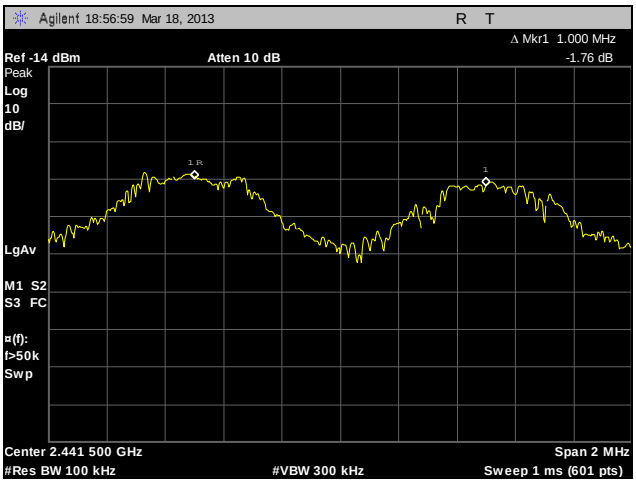
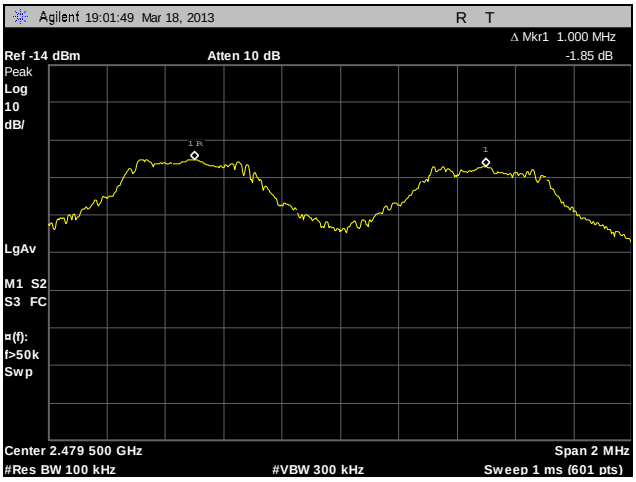



**Plot 42. Channel Separation, Low Channel, Radio 2**




**Plot 43. Channel Separation, Mid Channel, Radio 2**




**Plot 44. Channel Separation, High Channel, Radio 2**

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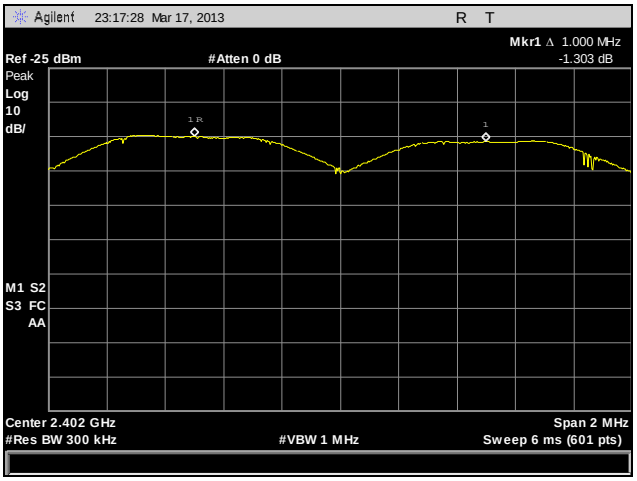
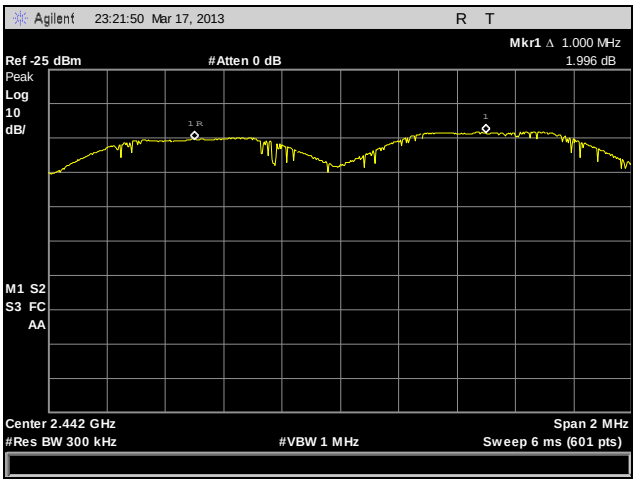
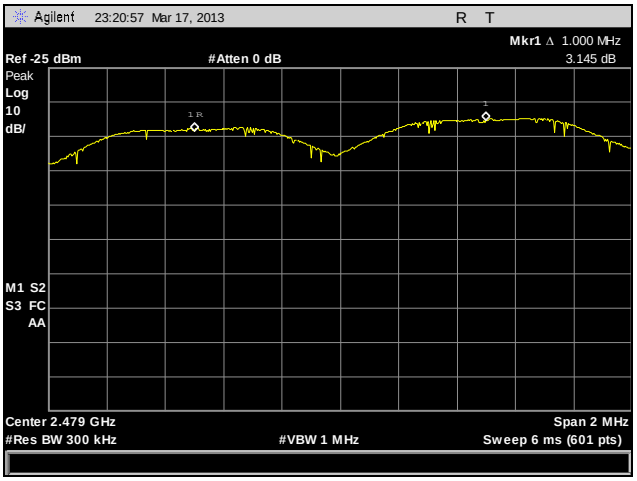



**Plot 45. Channel Separation, Low Channel, Radio 3**




**Plot 46. Channel Separation, Mid Channel, Radio 3**




**Plot 47. Channel Separation, High Channel, Radio 3**

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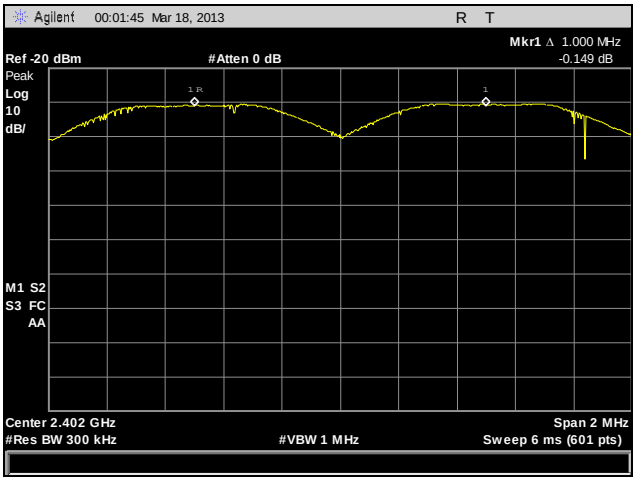
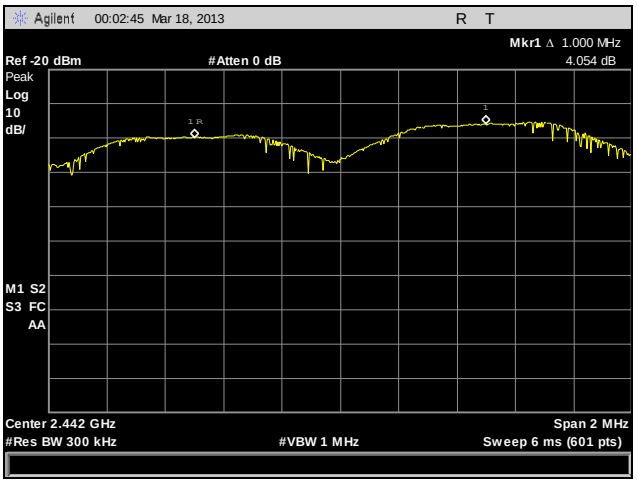
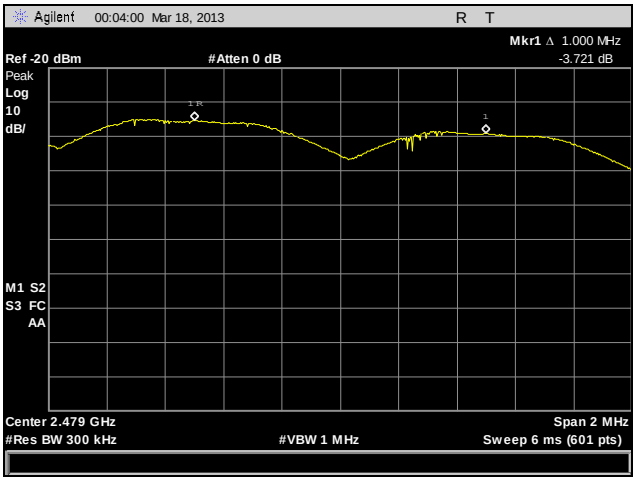



**Plot 48. Channel Separation, Low Channel, Radio 4**




**Plot 49. Channel Separation, Mid Channel, Radio 4**




**Plot 50. Channel Separation, High Channel, Radio 4**

# Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.247(b) Peak Power Output

**Test Requirements:**

**§15.247(b)(1):** For frequency hoppinig systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, the maximum peak conducted output power shall not exceed 1 watt.

**§15.247(c):** if transmitting antennas of directional gain greater than 6 dBi are used the peak output power from the intentional radiator shall be reduced below the stated values, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

Systems operating in the 2400 – 2483.5 MHz band and using a point to point application may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

Fixed, point-to-point operation excludes the use of point-to-multipoint systems, omni-directional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

**Test Procedure:**

The transmitter was placed on a 0.8m non-conducting table on a turntable in a semi-anechoic chamber and set to transmit on low, mid, and high channels. The turntable was rotated 360 degrees through three axes and the receiving antenna height was adjusted until the field strength of the fundamental emission was maximized. This field strength was converted to an EIRP using the following equation:

EIRP = E+20log(d)-104.77
Where E = field strength (dBuV/m)
d = measurement distance (m)
EIRP = equivalent isotropic radiated power (dBm)

The EUT utilizes a 3dBi microstrip antenna, so once the EIRP was found, the gain of the antenna was subtracted in order to find the EUT's conducted power.

**Test Results:** The EUT was compliant with the Peak Power Output limits of **§15.247(b)**.

**Test Engineer(s):** Jeff Pratt

**Test Date(s):** 04/05/13

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| Radio 1 | | | | |
|---|---|---|---|---|
| **Channel** | **Frequency (MHz)** | **Peak EIRP (dBm)** | **Antenna Gain (dBi)** | **Conducted Output Power (dBm)** |
| Low | 2402.5 | -9.8 | 3 | -12.8 |
| Mid | 2441.5 | -10.37 | 3 | -13.37 |
| High | 2481.5 | -10.47 | 3 | -13.47 |
| **Radio 2** | | | | |
| **Channel** | **Frequency (MHz)** | **Peak EIRP (dBm)** | **Antenna Gain (dBi)** | **Conducted Output Power (dBm)** |
| Low | 2402.5 | -11.38 | 3 | -14.38 |
| Mid | 2441.5 | -12.2 | 3 | -15.2 |
| High | 2481.5 | -9.55 | 3 | -12.55 |
| **Radio 3** | | | | |
| **Channel** | **Frequency (MHz)** | **Peak EIRP (dBm)** | **Antenna Gain (dBi)** | **Conducted Output Power (dBm)** |
| Low | 2402.5 | -11.19 | 3 | -14.19 |
| Mid | 2441.5 | -10.3 | 3 | -13.3 |
| High | 2481.5 | -10.68 | 3 | -13.68 |
| **Radio 4** | | | | |
| **Channel** | **Frequency (MHz)** | **Peak EIRP (dBm)** | **Antenna Gain (dBi)** | **Conducted Output Power (dBm)** |
| Low | 2402.5 | -9.22 | 3 | -12.22 |
| Mid | 2441.5 | -8.18 | 3 | -11.18 |
| High | 2481.5 | -9.16 | 3 | -12.16 |

**Table 20. Peak Output Power, Test Results**


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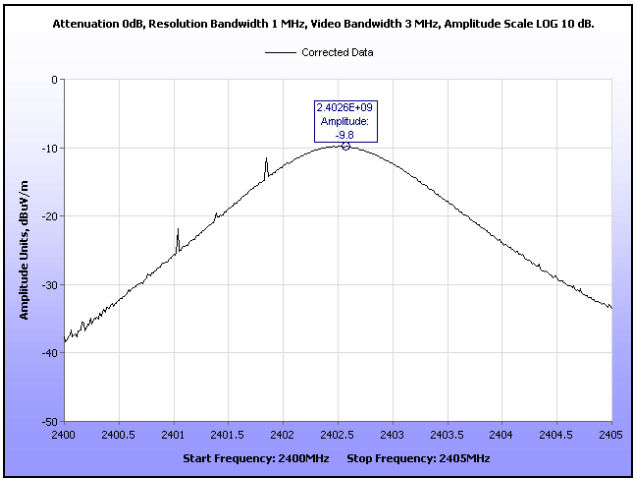
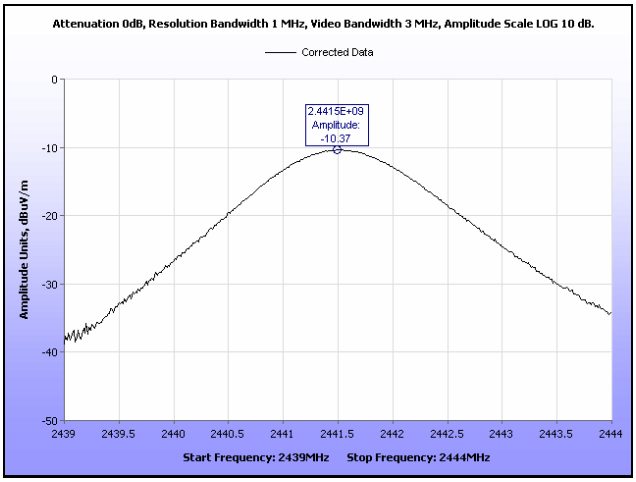
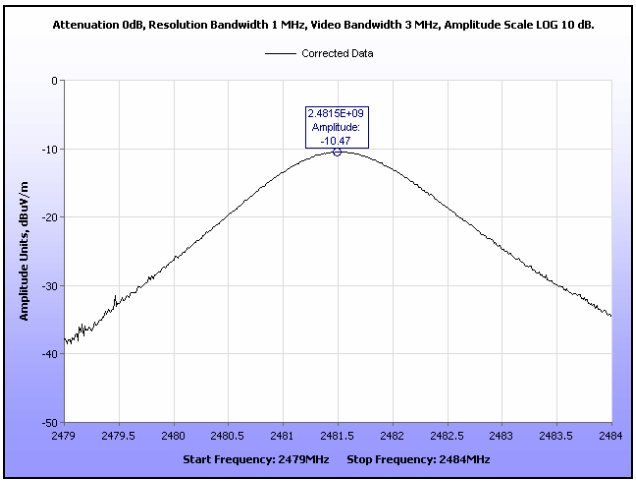
## Peak Power Output Test Results




**Plot 51. Peak Power Output, Low Channel, EIRP, Radio 1**




**Plot 52. Peak Power Output, Mid Channel, EIRP, Radio 1**




**Plot 53. Peak Power Output, High Channel, EIRP, Radio 1**

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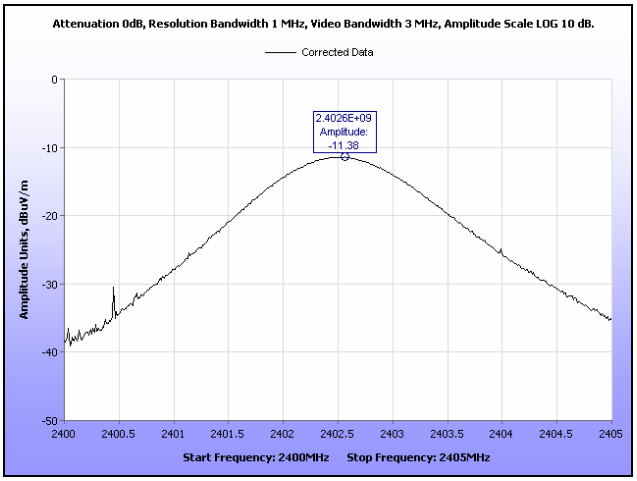
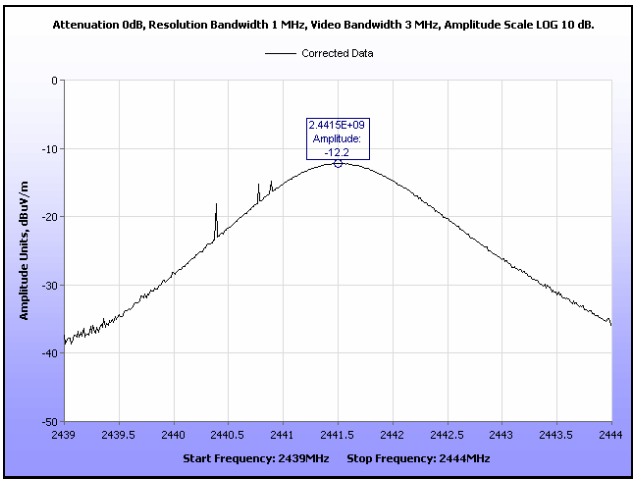
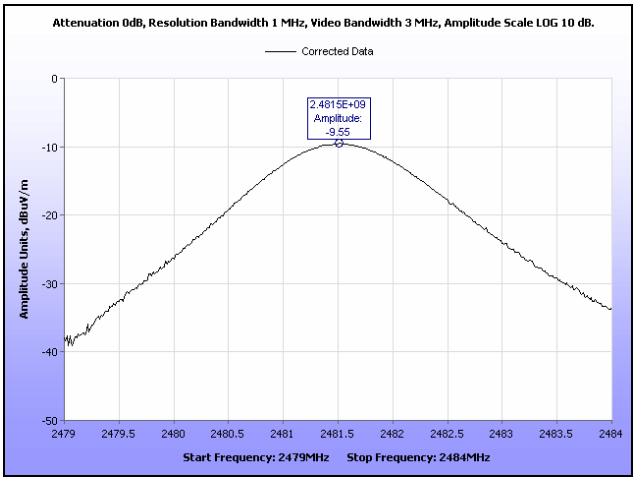



**Plot 54. Peak Power Output, Low Channel, EIRP, Radio 2**




**Plot 55. Peak Power Output, Mid Channel, EIRP, Radio 2**




**Plot 56. Peak Power Output, High Channel, EIRP, Radio 2**

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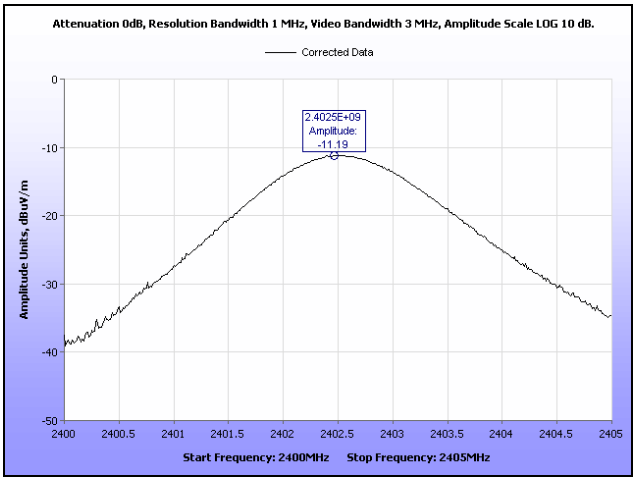
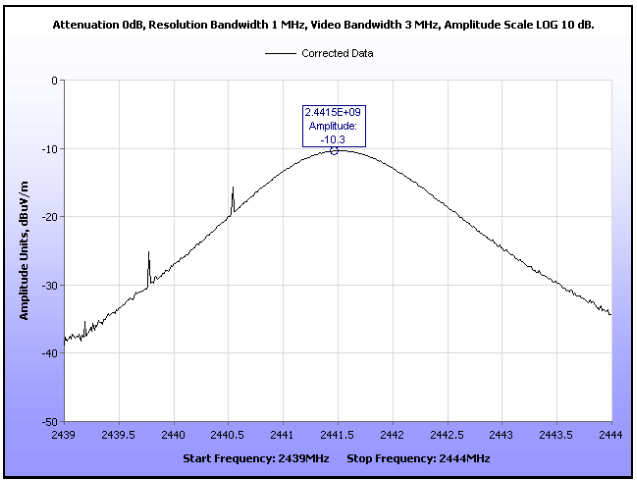
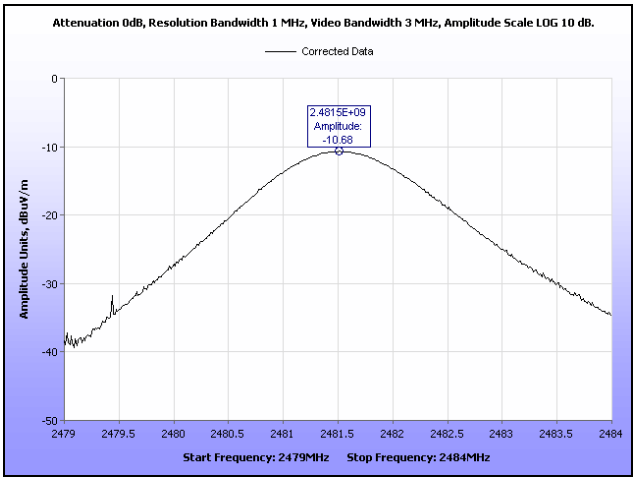



**Plot 57. Peak Power Output, Low Channel, EIRP, Radio 3**




**Plot 58. Peak Power Output, Mid Channel, EIRP, Radio 3**




**Plot 59. Peak Power Output, High Channel, EIRP, Radio 3**

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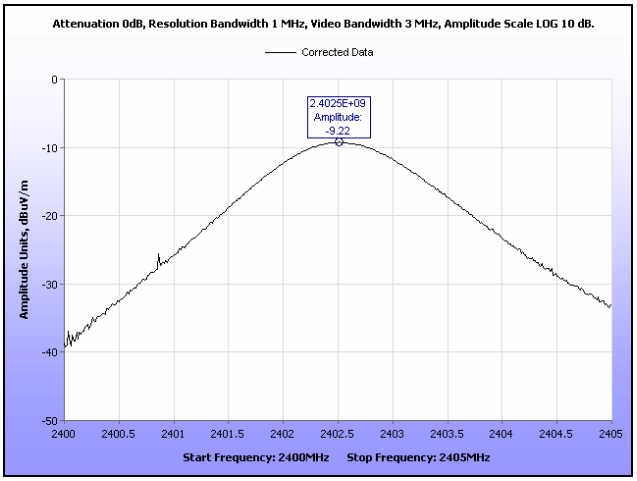
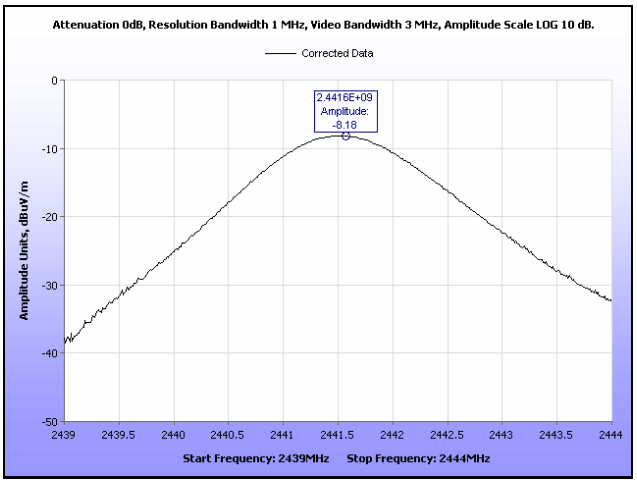
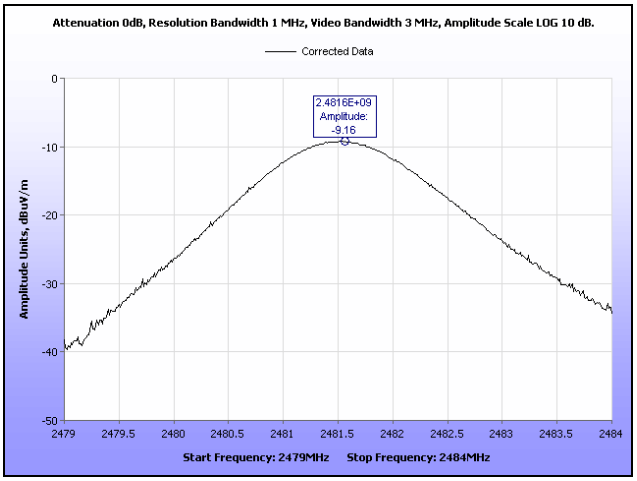



**Plot 60. Peak Power Output, Low Channel, EIRP, Radio 4**




**Plot 61. Peak Power Output, Mid Channel, EIRP, Radio 4**




**Plot 62. Peak Power Output, High Channel, EIRP, Radio 4**

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# Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.247(d) Radiated Spurious Emissions Requirements and Band Edge

**Test Requirements:** **§15.247(d); §15.205:** Emissions outside the frequency band.

**§15.247(d):** In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in § 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a).

**§15.205(a):** Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

| MHz | MHz | MHz | GHz |
|---|---|---|---|
| 0.090–0.110---------- | 16.42–16.423 | 399.9–410 | 4.5–5.15 |
| [1] 0.495–0.505---------- | 16.69475–16.69525 | 608–614 | 5.35–5.46 |
| 2.1735–2.1905---------- | 16.80425–16.80475 | 960–1240 | 7.25–7.75 |
| 4.125–4.128---------- | 25.5–25.67 | 1300–1427 | 8.025–8.5 |
| 4.17725–4.17775---------- | 37.5–38.25 | 1435–1626.5 | 9.0–9.2 |
| 4.20725–4.20775---------- | 73–74.6 | 1645.5–1646.5 | 9.3–9.5 |
| 6.215–6.218---------- | 74.8–75.2 | 1660–1710 | 10.6–12.7 |
| 6.26775–6.26825---------- | 108–121.94 | 1718.8–1722.2 | 13.25–13.4 |
| 6.31175–6.31225---------- | 123–138 | 2200–2300 | 14.47–14.5 |
| 8.291–8.294---------- | 149.9–150.05 | 2310–2390 | 15.35–16.2 |
| 8.362–8.366---------- | 156.52475–156.52525 | 2483.5–2500 | 17.7–21.4 |
| 8.37625–8.38675---------- | 156.7–156.9 | 2655–2900 | 22.01–23.12 |
| 8.41425–8.41475---------- | 162.0125–167.17 | 3260–3267 | 23.6–24.0 |
| 12.29–12.293---------- | 167.72–173.2 | 3332–3339 | 31.2–31.8 |
| 12.51975–12.52025---------- | 240–285 | 3345.8–3358 36. | 43–36.5 |
| 12.57675–12.57725---------- | 322–335.4 | 3600–4400 | ([2]) |

**Table 21. Restricted Bands of Operation**

[1] Until February 1, 1999, this restricted band shall be 0.490 – 0.510 MHz.
[2] Above 38.6

**Test Requirement(s):** **§ 15.209 (a):** Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in Table 22.

| Frequency (MHz) | § 15.209(a),Radiated Emission Limits (dBµV) @ 3m |
|---|---|
| 30 - 88 | 40.00 |
| 88 - 216 | 43.50 |
| 216 - 960 | 46.00 |
| Above 960 | 54.00 |

**Table 22. Radiated Emissions Limits Calculated from FCC Part 15, § 15.209 (a)**

**Test Procedure:** The transmitter was set to the mid channel at the highest output power and placed on a 0.8 m high wooden table inside in a semi-anechoic chamber. Measurements were performed with the EUT rotated 360 degrees and varying the adjustable antenna mast with 1 m to 4 m height to determine worst case orientation for maximum emissions. Measurement were repeated the measurement at the low and highest channels.

For frequencies from 30 MHz to 1 GHz, measurements were made using a quasi-peak detector with a 120 kHz bandwidth.

For intentional radiators with a digital device portion which operates below 10 GHz, the spectrum was investigated as per §15.33(a)(1) and §15.33(a)(4); i.e., the lowest RF signal generated or used in the device up to the 10th harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

In accordance with §15.35(b) the limit on the radio frequency emissions as measured using instrumentation with a peak detector function shall be 20 dB above the maximum permitted average limit for the frequency being investigated unless a different peak emission limit is otherwise specified in the rules.

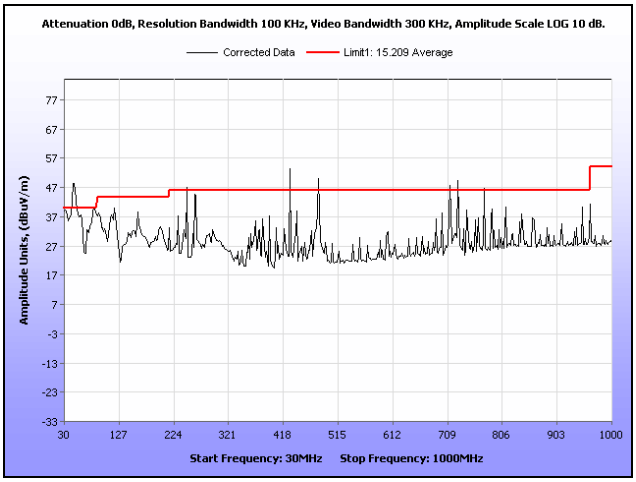
EUT Field Strength Final Amplitude = Raw Amplitude – Preamp gain + Antenna Factor + Cable Loss – Distance Correction Factor

**Test Results:** The EUT was compliant with the Radiated Spurious Emission limits of **§15.247(d)**.

**Test Engineer(s):** Jeff Pratt

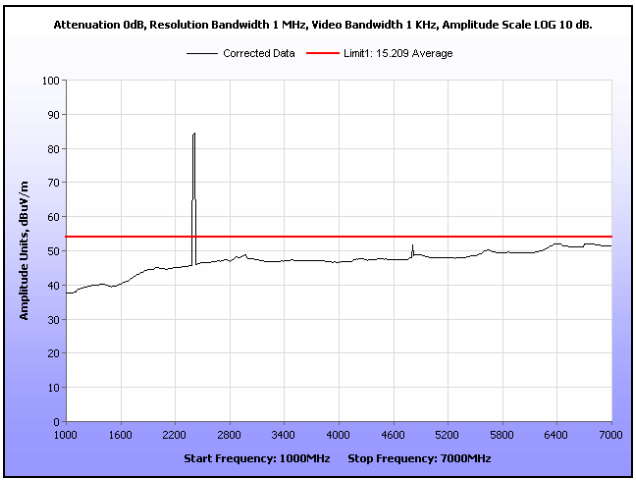
**Test Date(s):** 04/05/13

## Radiated Spurious Emissions Test Results

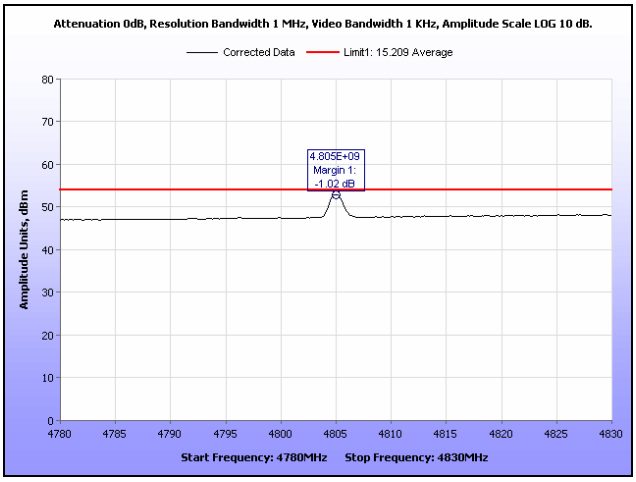



**Plot 63. Radiated Spurious Emissions, Low Channel, 30 MHz – 1 GHz, Radio 1**

Note: Emissions which exceed the 15.209 limit are digital and meet the Class A limits on digital emissions.




**Plot 64. Radiated Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Average, Radio 1**




**Plot 65. Radiated Spurious Emissions, Low Channel, Second Harmonic, Radio 1**

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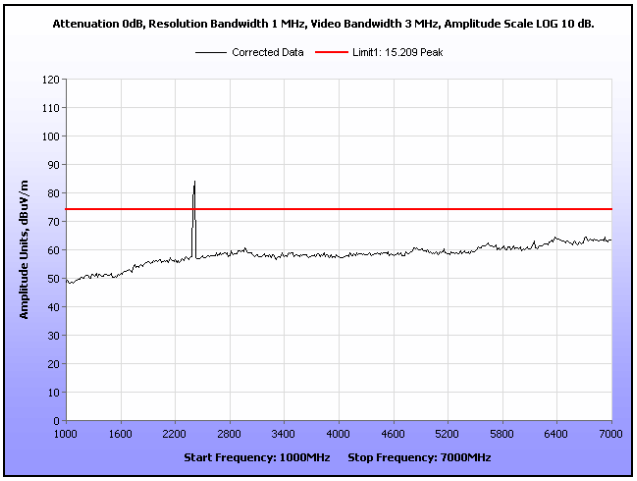
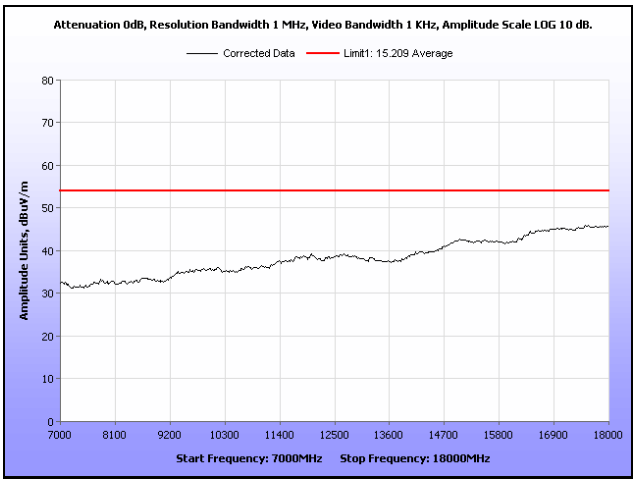
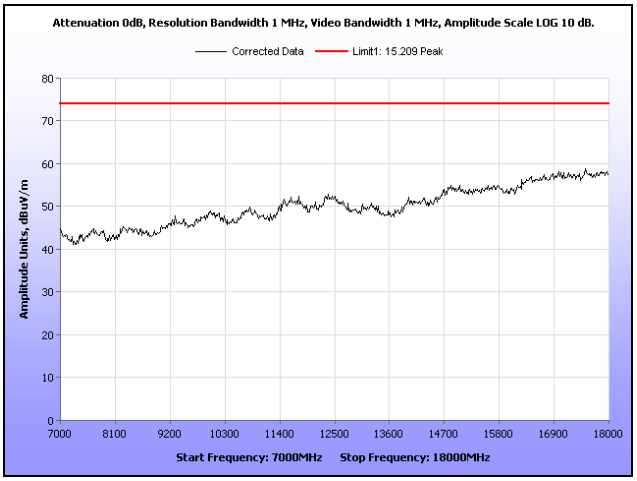



**Plot 66. Radiated Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Peak, Radio 1**




**Plot 67. Radiated Spurious Emissions, Low Channel, 7 GHz – 18 GHz, Average, Radio 1**




**Plot 68. Radiated Spurious Emissions, Low Channel, 7 GHz – 18 GHz, Peak, Radio 1**

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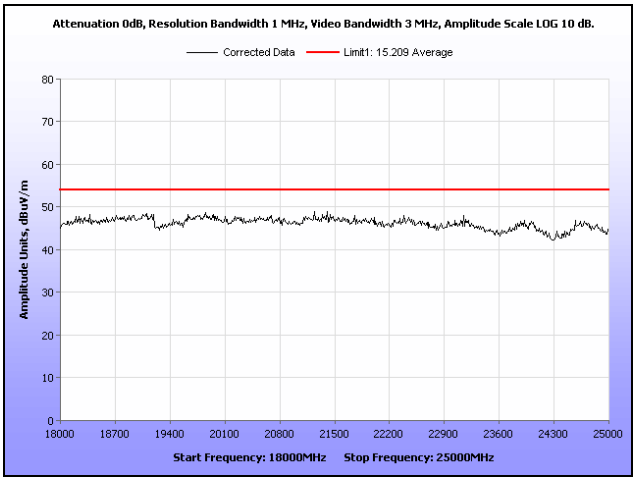
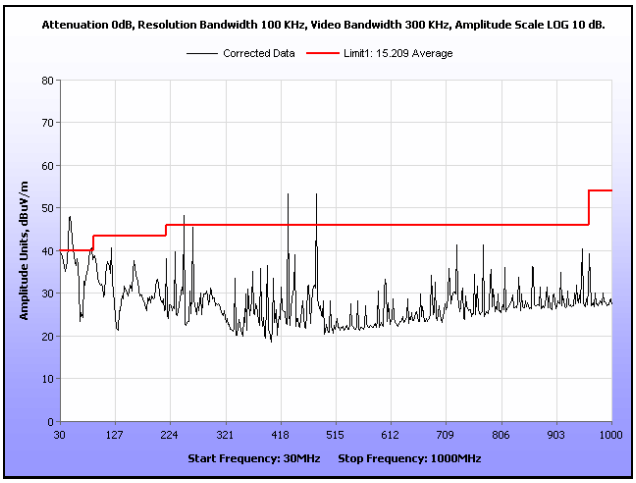
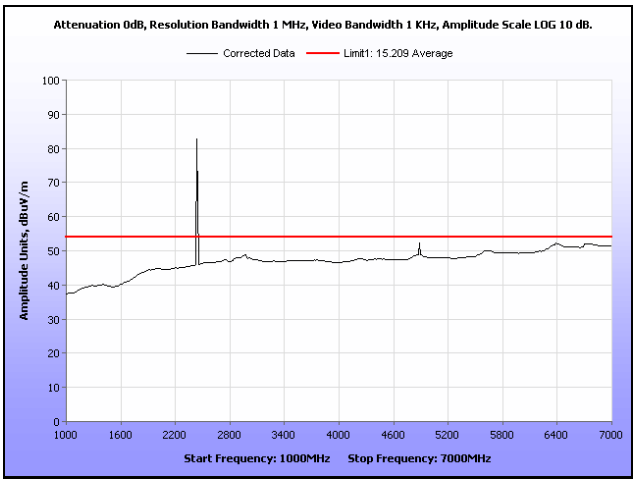



**Plot 69. Radiated Spurious Emissions, Low Channel, 18 GHz – 25 GHz, Peak under Average, Radio 1**

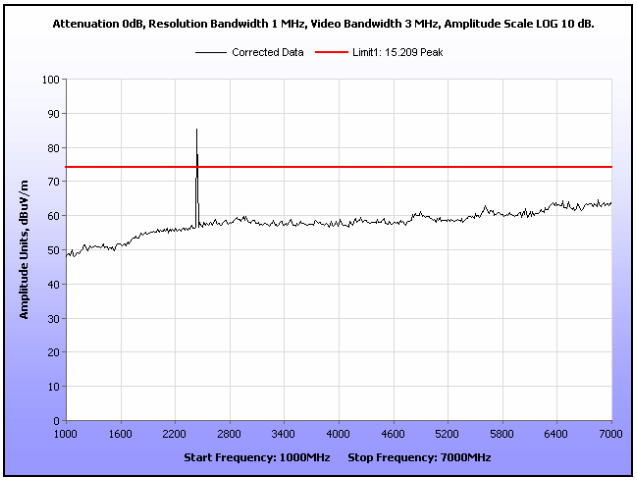



**Plot 70. Radiated Spurious Emissions, Mid Channel 30 MHz – 1 GHz, Radio 1**

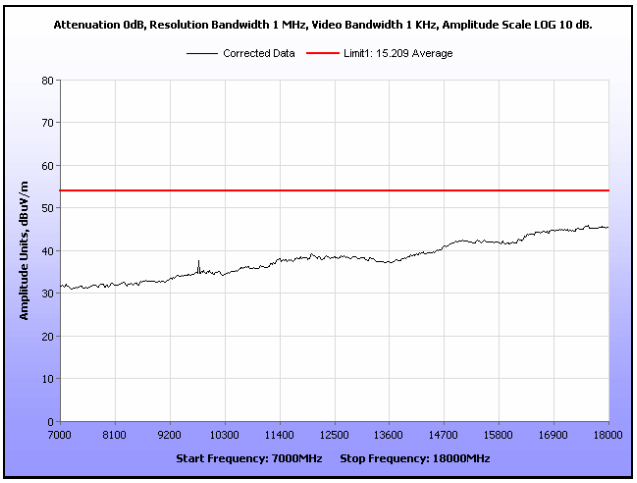
Note: Emissions which exceed the 15.209 limit are digital and meet the Class A limits on digital emissions.



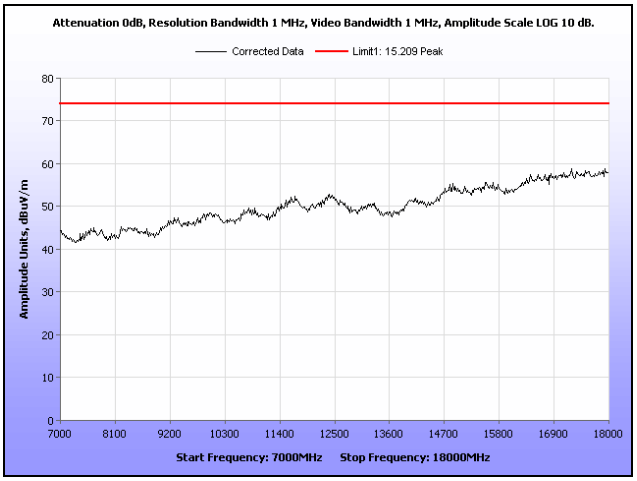

**Plot 71. Radiated Spurious Emissions, Mid Channel 1 GHz – 7 GHz, Average, Radio 1**



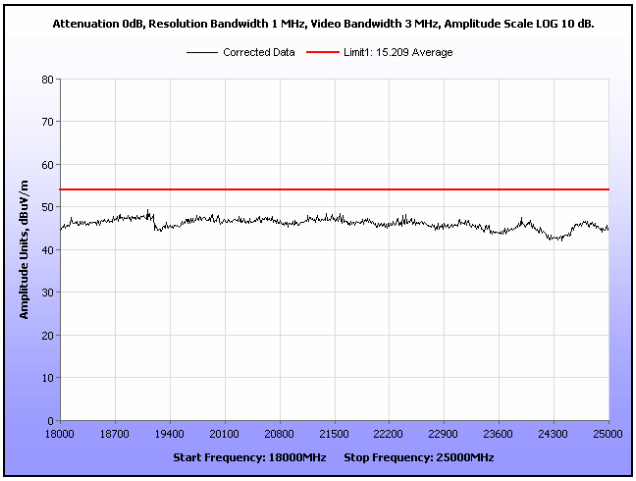

**Plot 72. Radiated Spurious Emissions, Mid Channel 1 GHz – 7 GHz, Peak, Radio 1**



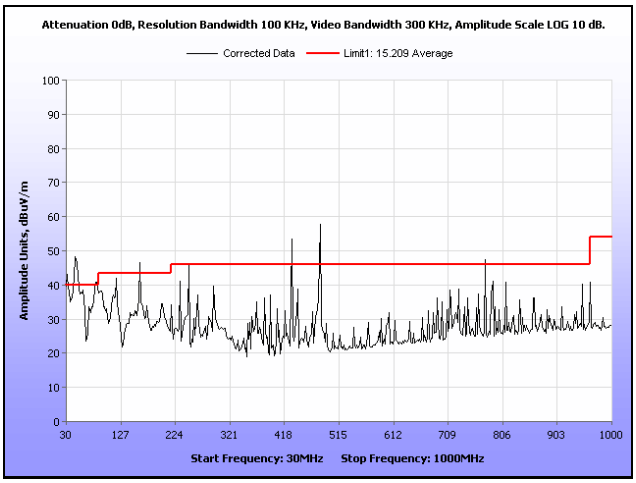

**Plot 73. Radiated Spurious Emissions, Mid Channel 7 GHz – 18 GHz, Average, Radio 1**




**Plot 74. Radiated Spurious Emissions, Mid Channel 7 GHz – 18 GHz, Peak, Radio 1**

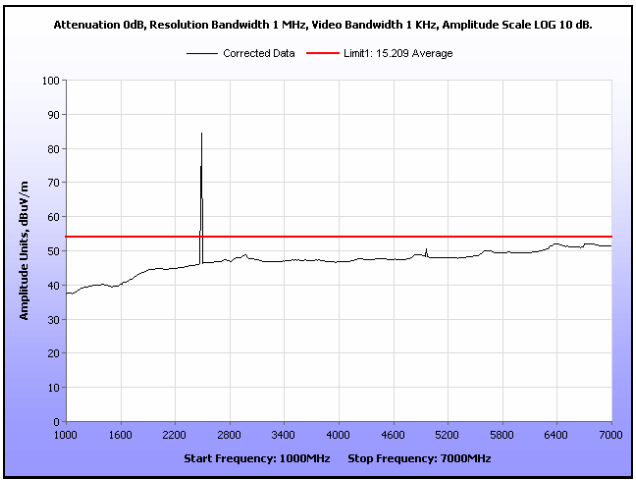



**Plot 75. Radiated Spurious Emissions, Mid Channel 18 GHz – 25 GHz, Peak under Average, Radio 1**

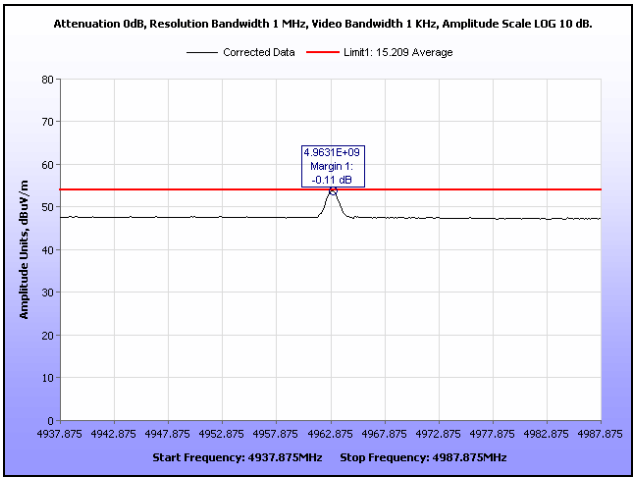



**Plot 76. Radiated Spurious Emissions, High Channel, 30 MHz – 1 GHz, Radio 1**

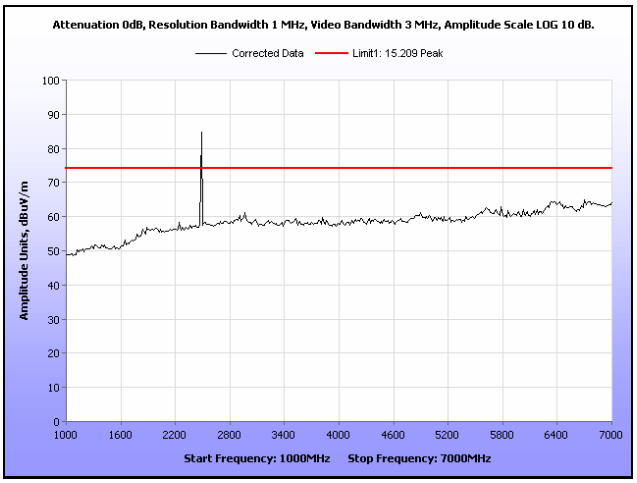
Note: Emissions which exceed the 15.209 limit are digital and meet the Class A limits on digital emissions.



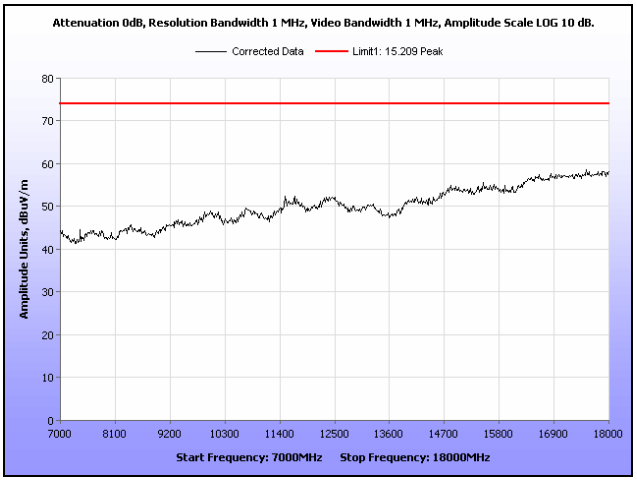

**Plot 77. Radiated Spurious Emissions, High Channel, 1 GHz – 7 GHz, Average, Radio 1**




**Plot 78. Radiated Spurious Emissions, High Channel, Second Harmonic, Radio 1**




**Plot 79. Radiated Spurious Emissions, High Channel, 1 GHz – 7 GHz, Peak, Radio 1**




**Plot 80. Radiated Spurious Emissions, High Channel, 7 GHz – 18 GHz, Peak, Radio 1**

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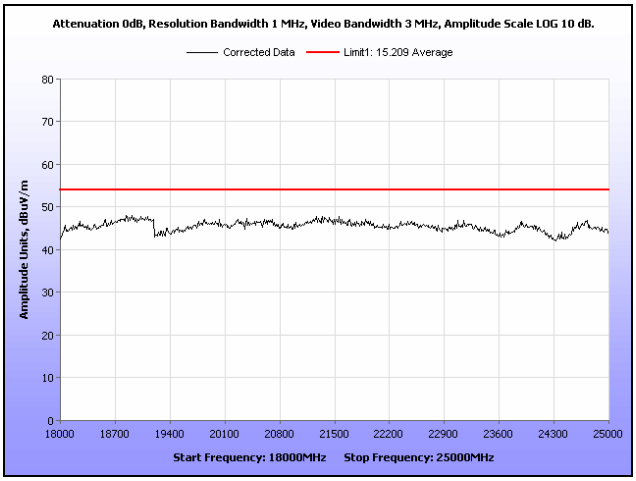
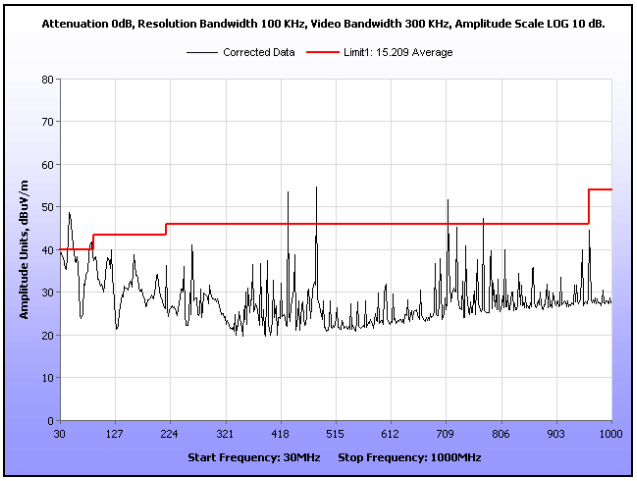
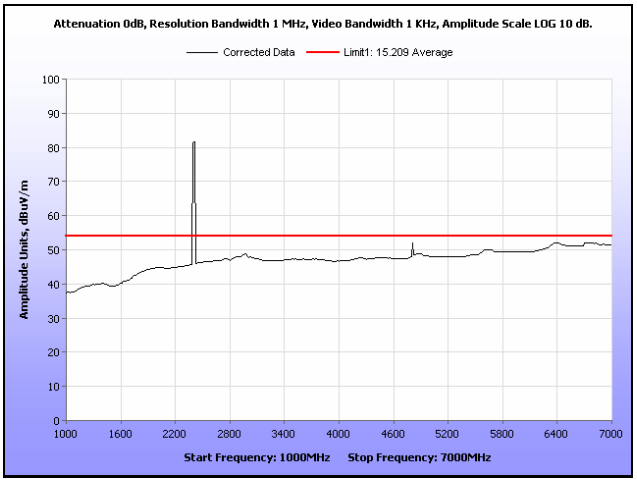



**Plot 81. Radiated Spurious Emissions, High Channel, 18 GHz – 25 GHz, Peak under Average, Radio 1**

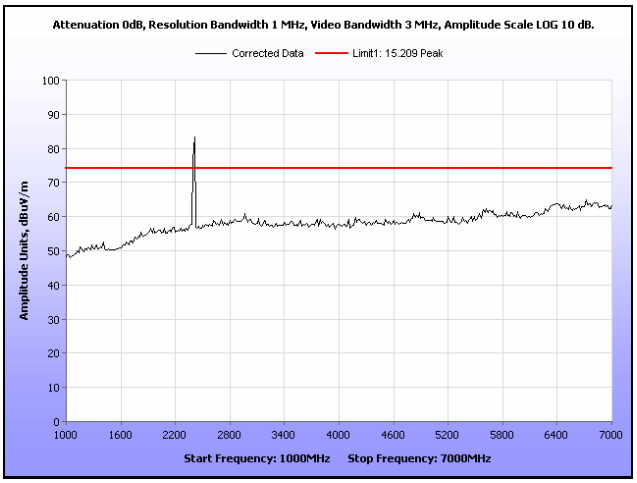



**Plot 82. Radiated Spurious Emissions, Low Channel, 30 MHz – 1 GHz, Radio 2**

Note: Emissions which exceed the 15.209 limit are digital and meet the Class A limits on digital emissions.




**Plot 83. Radiated Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Average, Radio 2**




**Plot 84. Radiated Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Peak, Radio 2**

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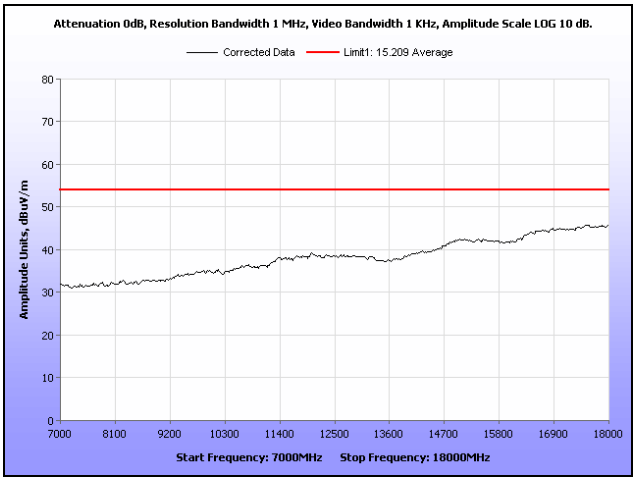
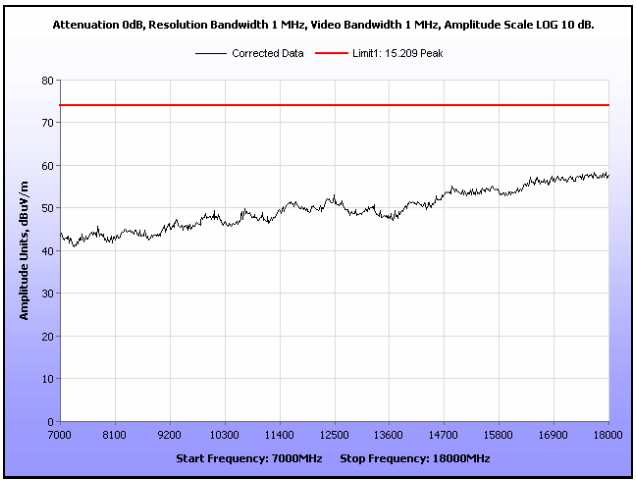
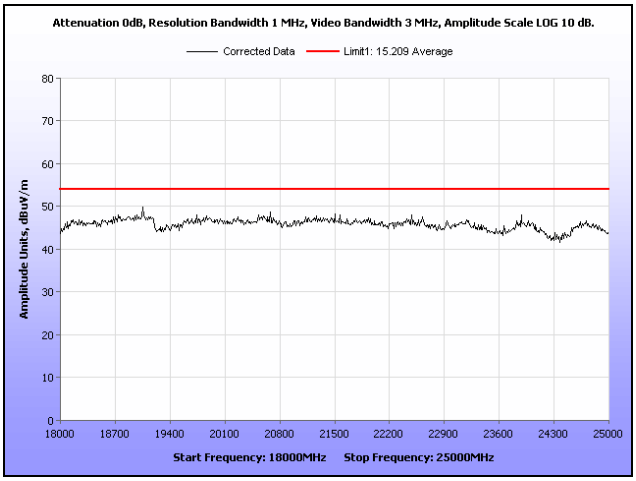



**Plot 85. Radiated Spurious Emissions, Low Channel, 7 GHz – 18 GHz, Average, Radio 2**




**Plot 86. Radiated Spurious Emissions, Low Channel, 7 GHz – 18 GHz, Peak, Radio 2**




**Plot 87. Radiated Spurious Emissions, Low Channel, 18 GHz – 25 GHz, Peak under Average, Radio 2**

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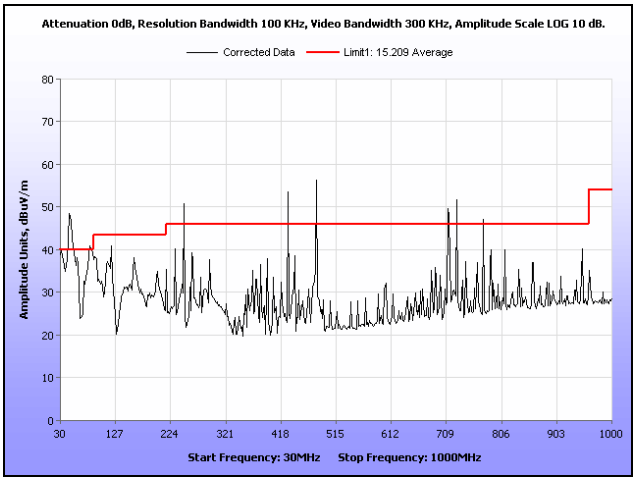
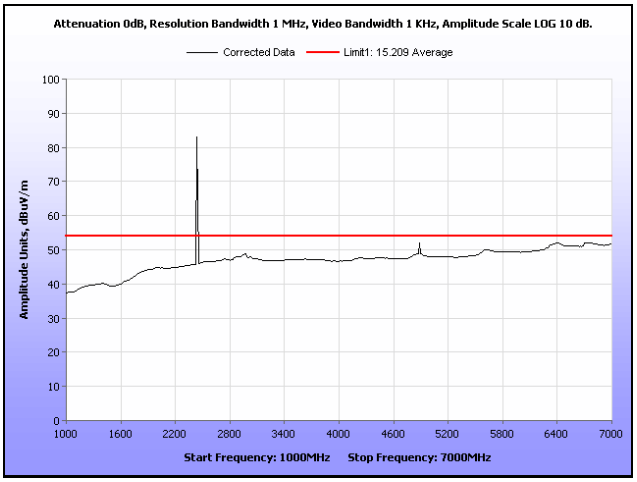
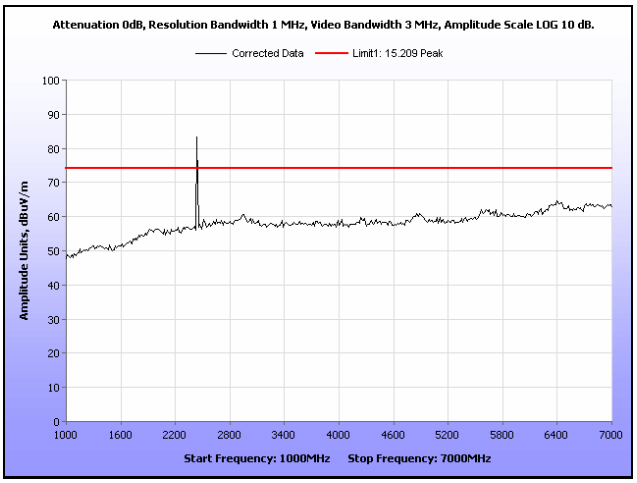



**Plot 88. Radiated Spurious Emissions, Mid Channel 30 MHz – 1 GHz, Radio 2**

Note: Emissions which exceed the 15.209 limit are digital and meet the Class A limits on digital emissions.




**Plot 89. Radiated Spurious Emissions, Mid Channel 1 GHz – 7 GHz, Average, Radio 2**




**Plot 90. Radiated Spurious Emissions, Mid Channel 1 GHz – 7 GHz, Peak, Radio 2**

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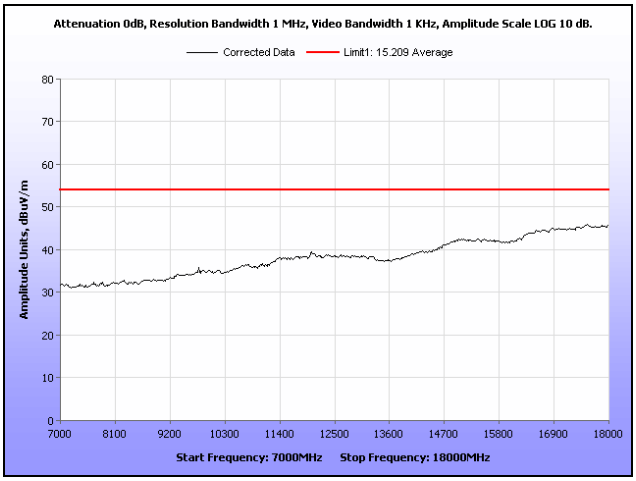
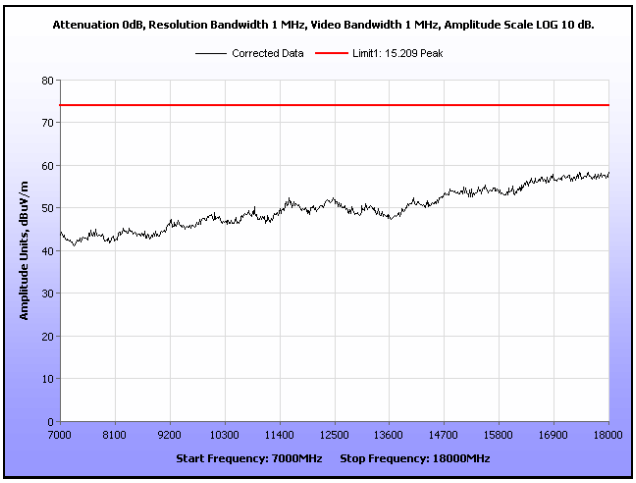
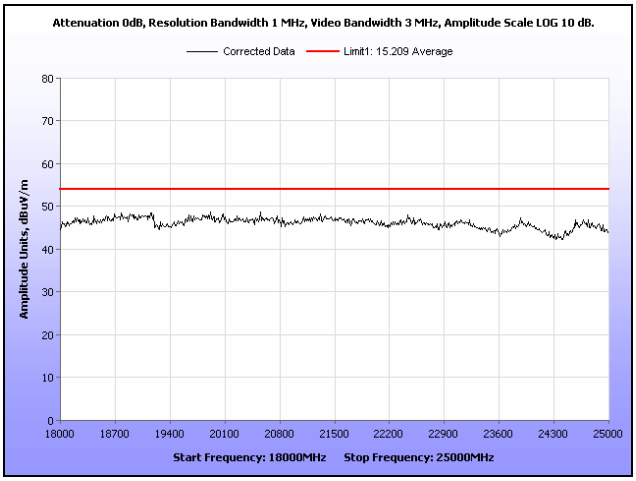



**Plot 91. Radiated Spurious Emissions, Mid Channel 7 GHz – 18 GHz, Average, Radio 2**




**Plot 92. Radiated Spurious Emissions, Mid Channel 7 GHz – 18 GHz, Peak, Radio 2**




**Plot 93. Radiated Spurious Emissions, Mid Channel 18 GHz – 25 GHz, Peak under Average, Radio 2**

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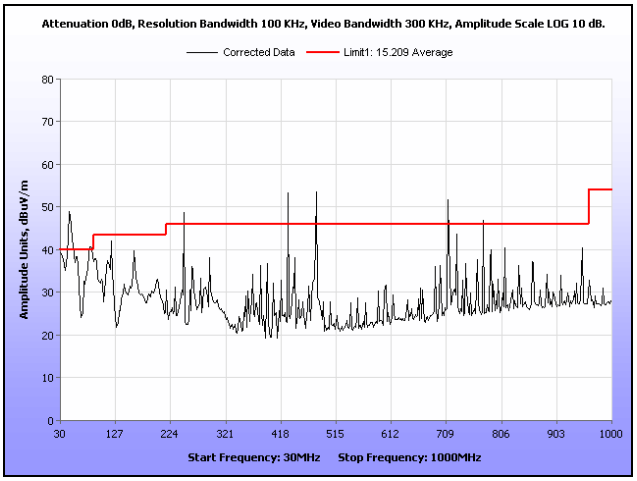
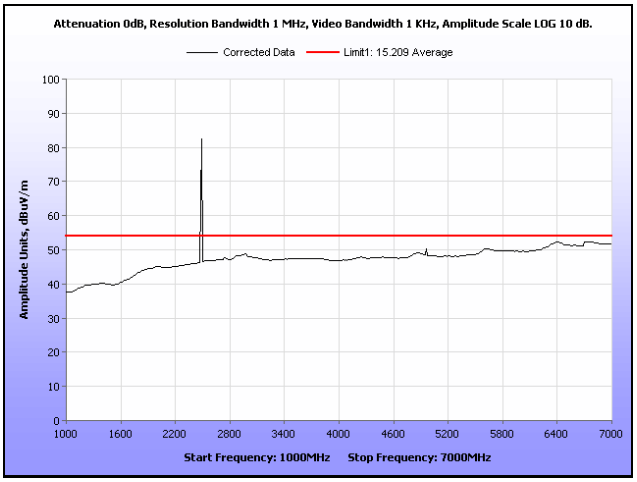
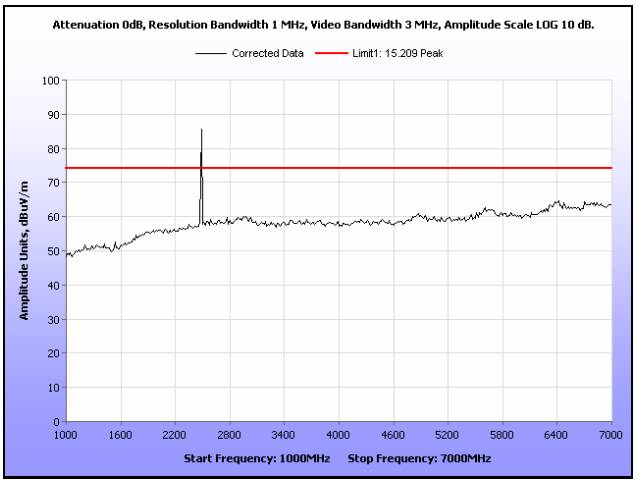



**Plot 94. Radiated Spurious Emissions, High Channel, 30 MHz – 1 GHz, Radio 2**

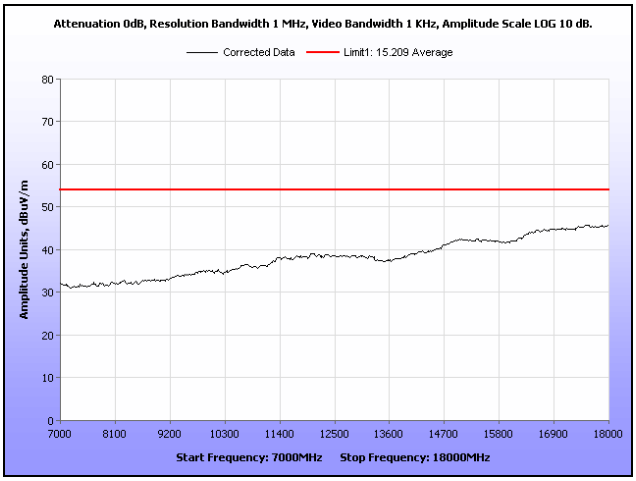
Note: Emissions which exceed the 15.209 limit are digital and meet the Class A limits on digital emissions.



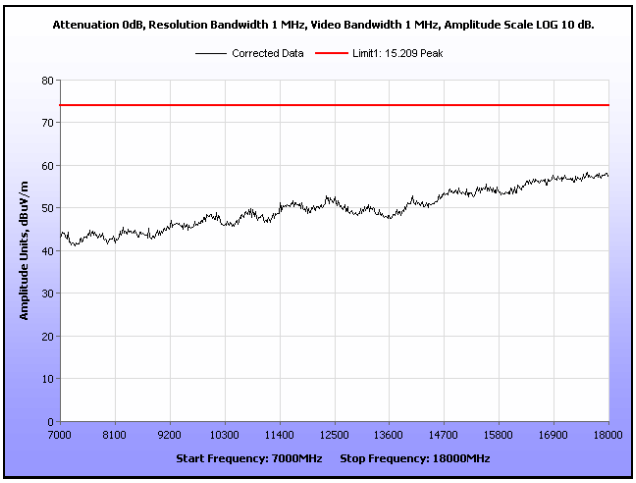

**Plot 95. Radiated Spurious Emissions, High Channel, 1 GHz – 7 GHz, Average, Radio 2**



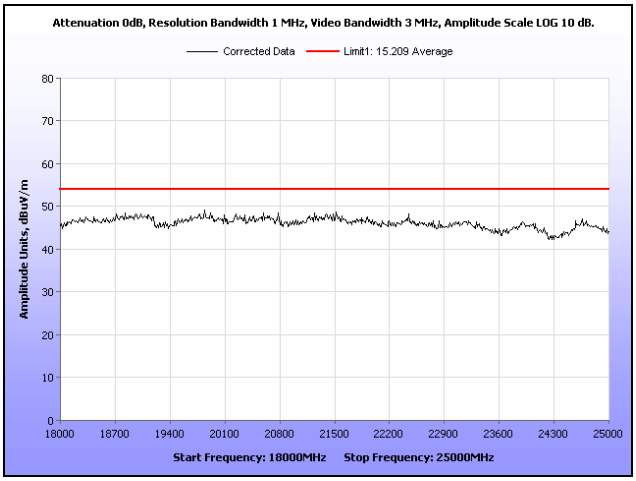

**Plot 96. Radiated Spurious Emissions, High Channel, 1 GHz – 7 GHz, Peak, Radio 2**




**Plot 97. Radiated Spurious Emissions, High Channel, 7 GHz – 18 GHz, Average, Radio 2**




**Plot 98. Radiated Spurious Emissions, High Channel, 7 GHz – 18 GHz, Peak, Radio 2**




**Plot 99. Radiated Spurious Emissions, High Channel, 18 GHz – 25 GHz, Peak under Average, Radio 2**

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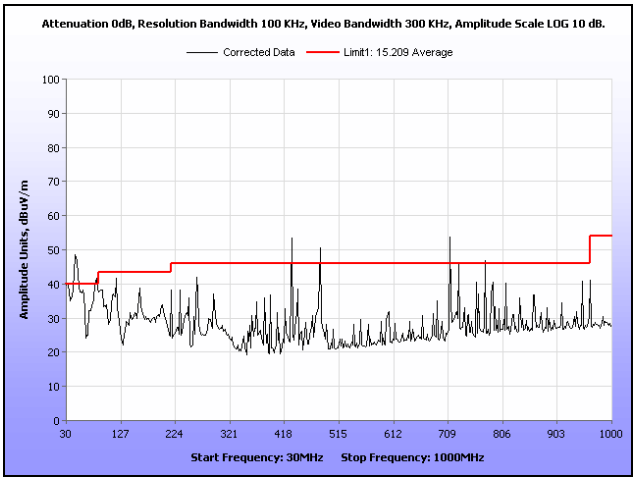
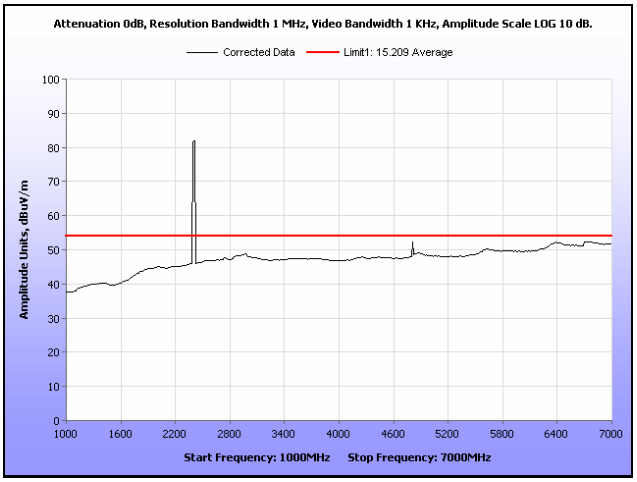
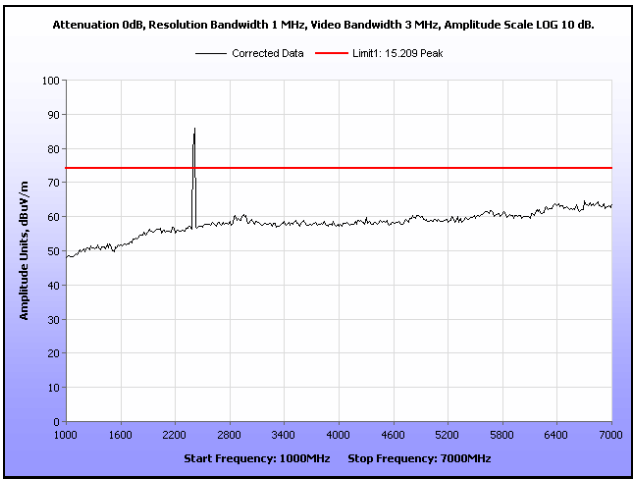



**Plot 100. Radiated Spurious Emissions, Low Channel, 30 MHz – 1 GHz, Radio 3**

Note: Emissions which exceed the 15.209 limit are digital and meet the Class A limits on digital emissions.




**Plot 101. Radiated Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Average, Radio 3**




**Plot 102. Radiated Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Peak, Radio 3**

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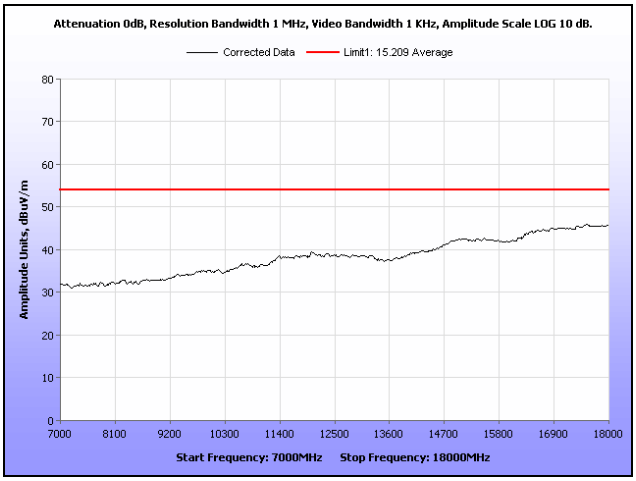
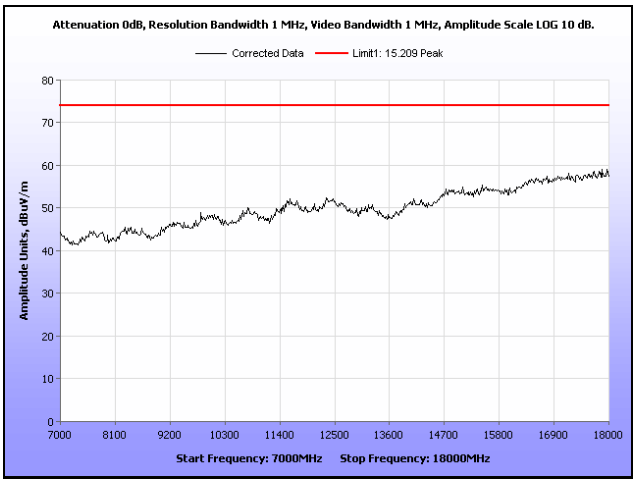
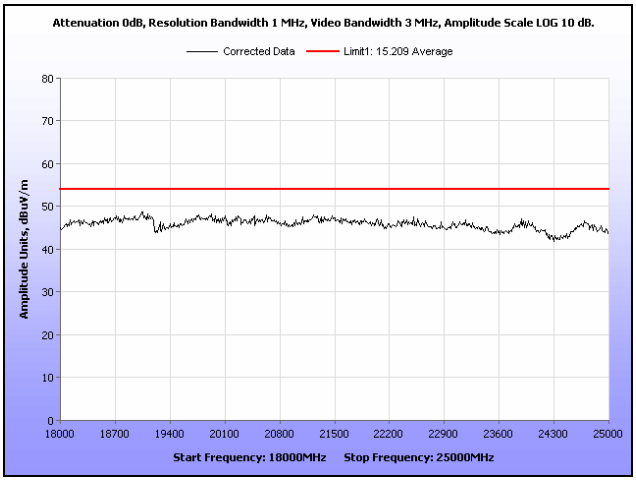



**Plot 103. Radiated Spurious Emissions, Low Channel, 7 GHz – 18 GHz, Average, Radio 3**




**Plot 104. Radiated Spurious Emissions, Low Channel, 7 GHz – 18 GHz, Peak, Radio 3**




**Plot 105. Radiated Spurious Emissions, Low Channel, 18 GHz – 25 GHz, Peak under Average, Radio 3**

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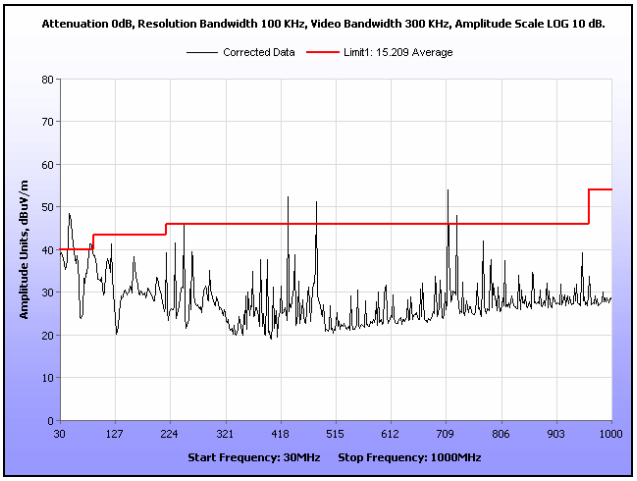
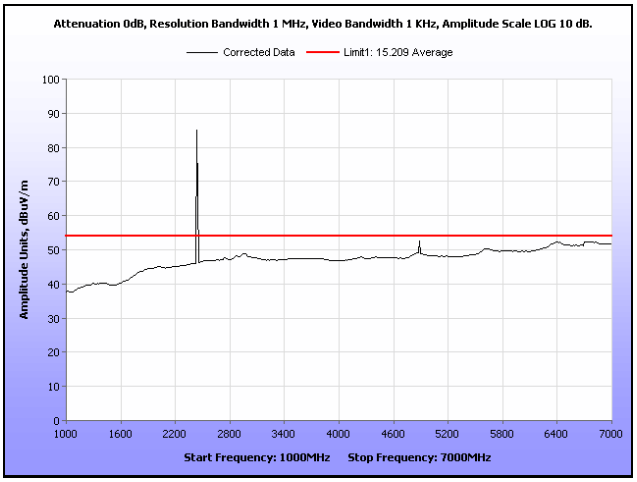
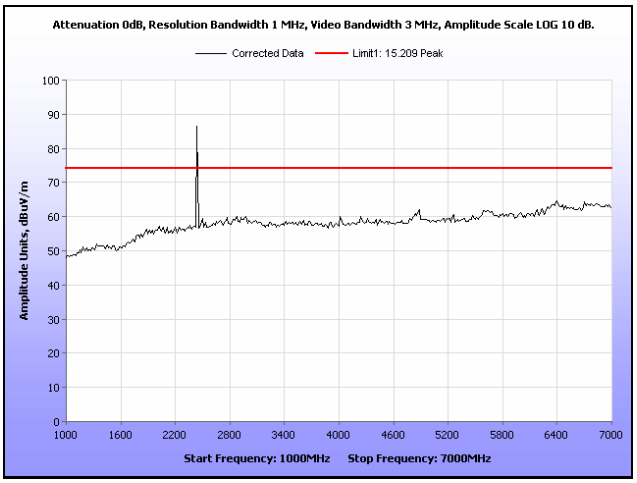



**Plot 106. Radiated Spurious Emissions, Mid Channel 30 MHz – 1 GHz, Radio 3**

Note: Emissions which exceed the 15.209 limit are digital and meet the Class A limits on digital emissions.




**Plot 107. Radiated Spurious Emissions, Mid Channel 1 GHz – 7 GHz, Average, Radio 3**




**Plot 108. Radiated Spurious Emissions, Mid Channel 1 GHz – 7 GHz, Peak, Radio 3**

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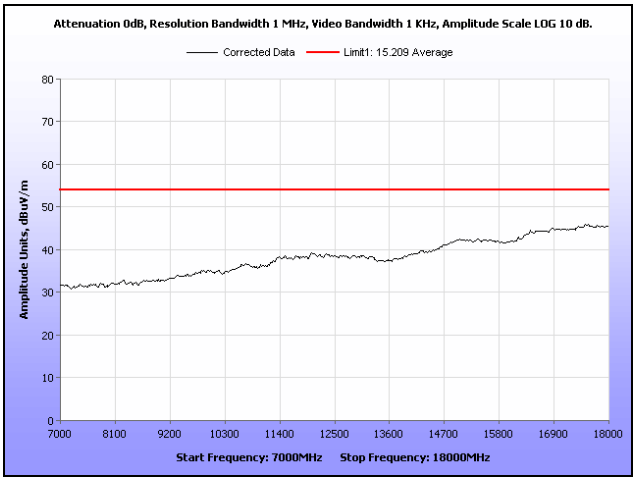
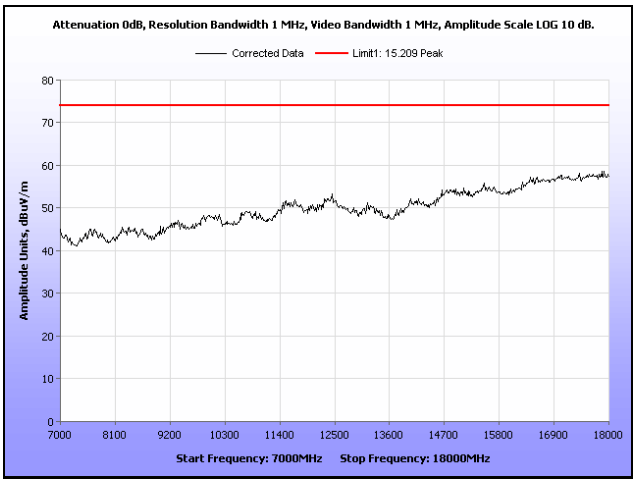
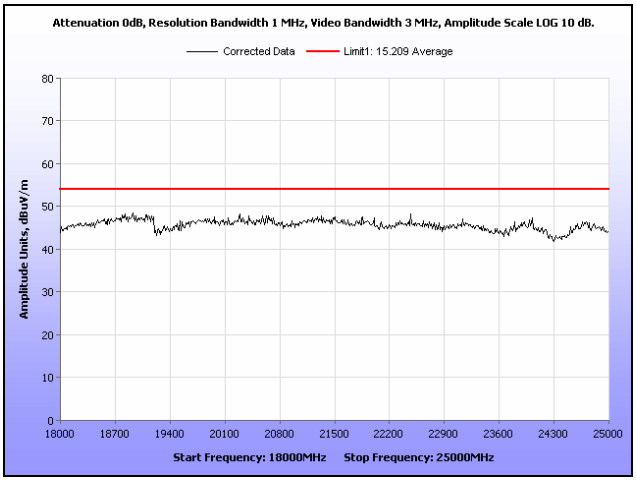



**Plot 109. Radiated Spurious Emissions, Mid Channel 7 GHz – 18 GHz, Average, Radio 3**




**Plot 110. Radiated Spurious Emissions, Mid Channel 7 GHz – 18 GHz, Peak, Radio 3**




**Plot 111. Radiated Spurious Emissions, Mid Channel 18 GHz – 25 GHz, Peak under Average, Radio 3**

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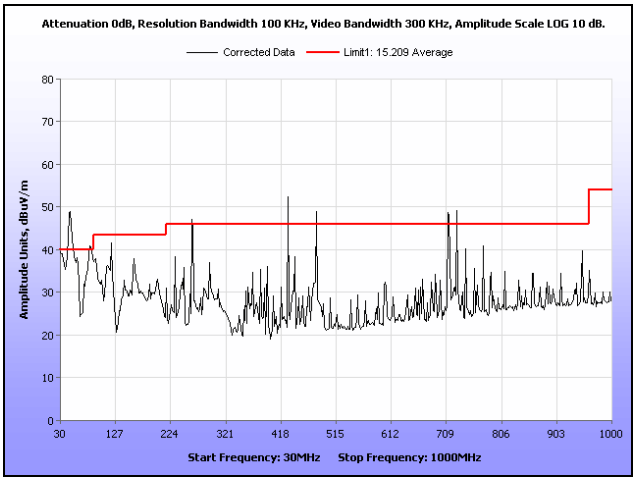
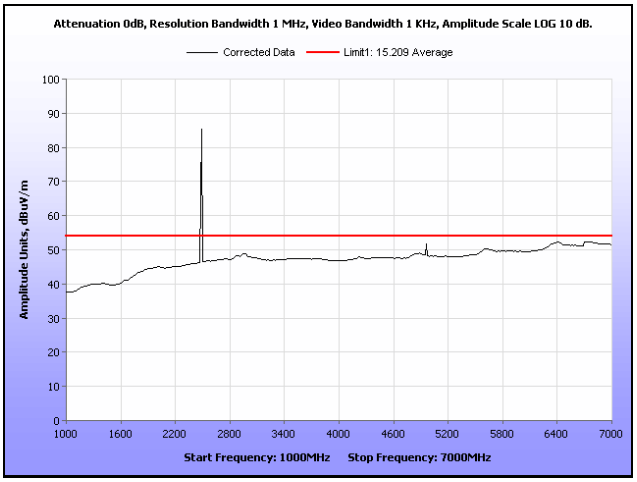
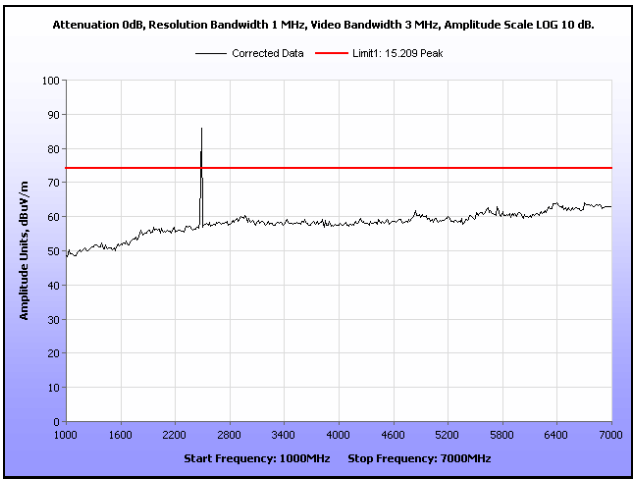



**Plot 112. Radiated Spurious Emissions, High Channel, 30 MHz – 1 GHz, Radio 3**

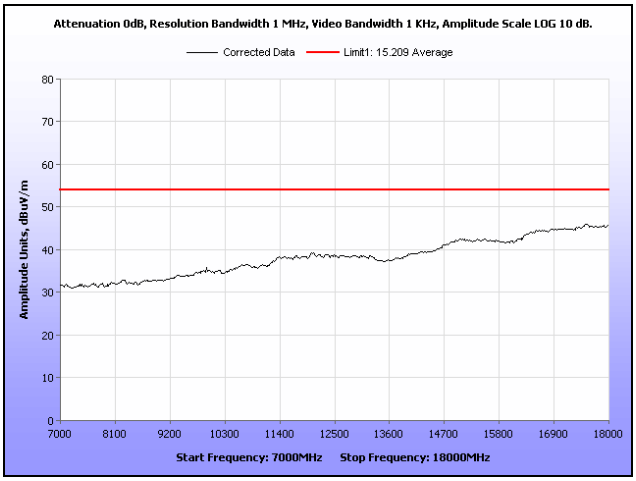
Note: Emissions which exceed the 15.209 limit are digital and meet the Class A limits on digital emissions.



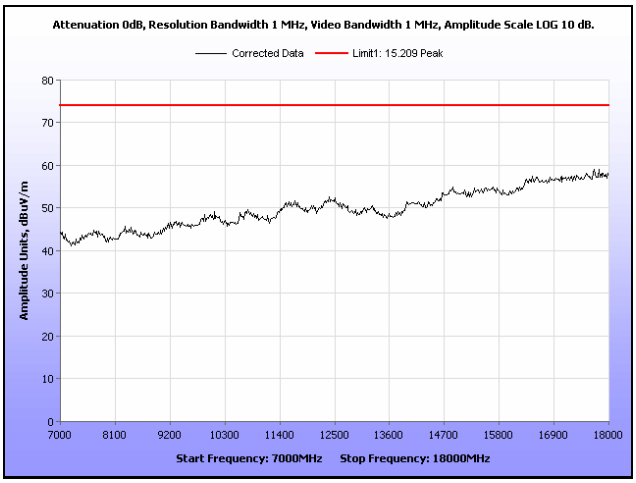

**Plot 113. Radiated Spurious Emissions, High Channel, 1 GHz – 7 GHz, Average, Radio 3**



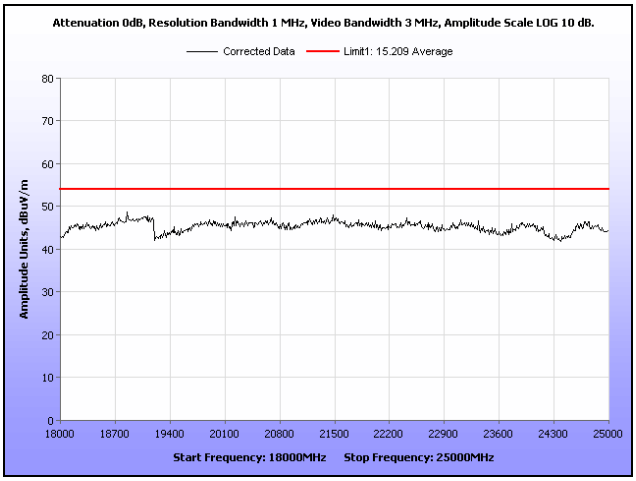

**Plot 114. Radiated Spurious Emissions, High Channel, 1 GHz – 7 GHz, Peak, Radio 3**




**Plot 115. Radiated Spurious Emissions, High Channel, 7 GHz – 18 GHz, Average, Radio 3**




**Plot 116. Radiated Spurious Emissions, High Channel, 7 GHz – 18 GHz, Peak, Radio 3**




**Plot 117. Radiated Spurious Emissions, High Channel, 18 GHz – 25 GHz, Peak under Average, Radio 3**

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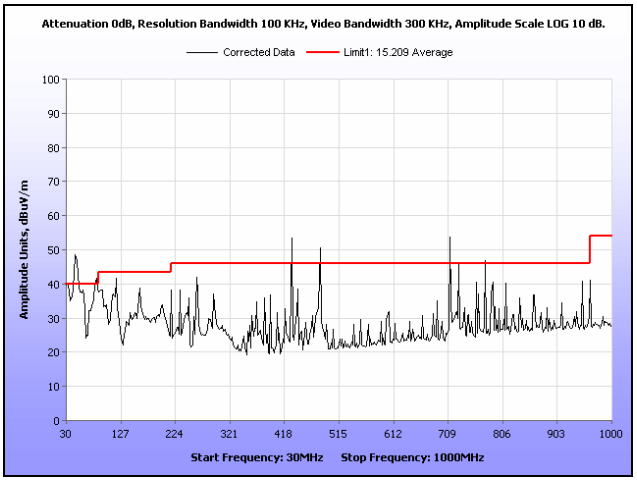
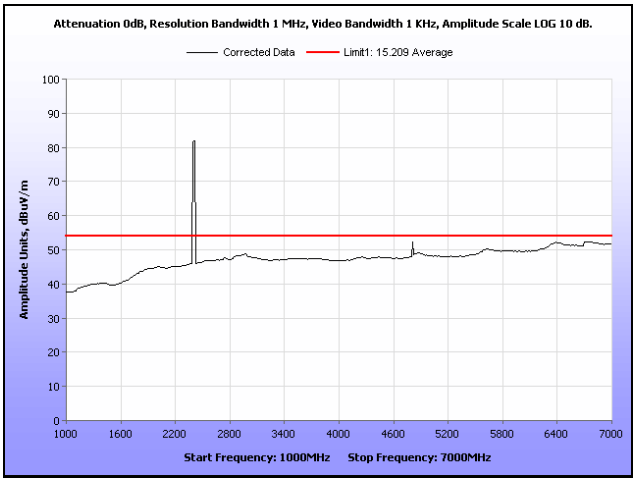
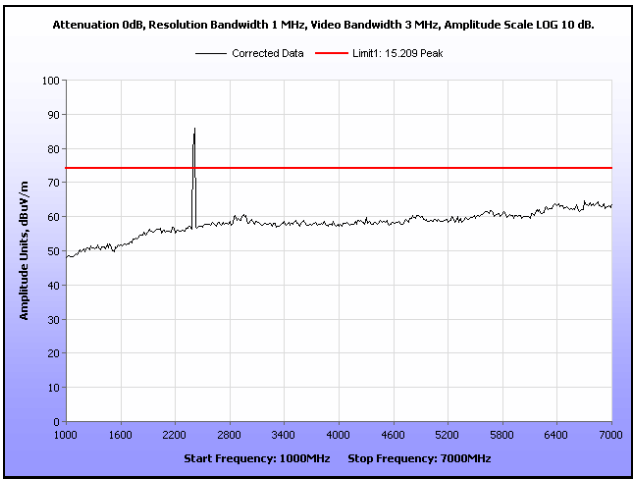



**Plot 118. Radiated Spurious Emissions, Low Channel, 30 MHz – 1 GHz, Radio 4**

Note: Emissions which exceed the 15.209 limit are digital and meet the Class A limits on digital emissions.




**Plot 119. Radiated Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Average, Radio 4**




**Plot 120. Radiated Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Peak, Radio 4**

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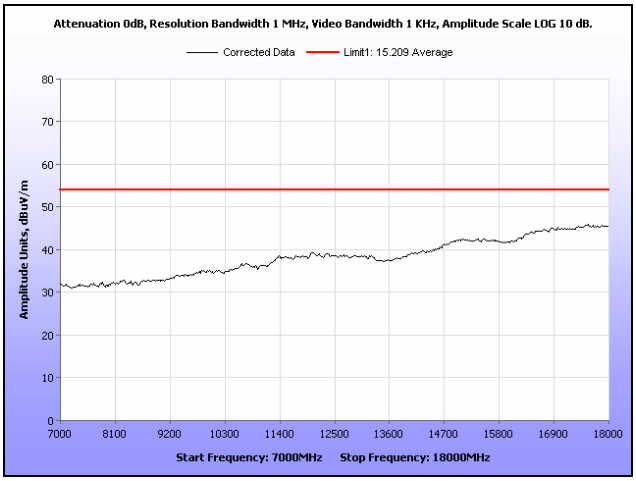
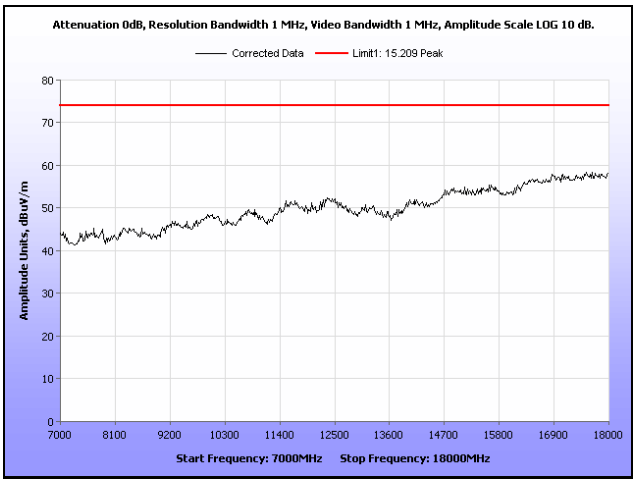
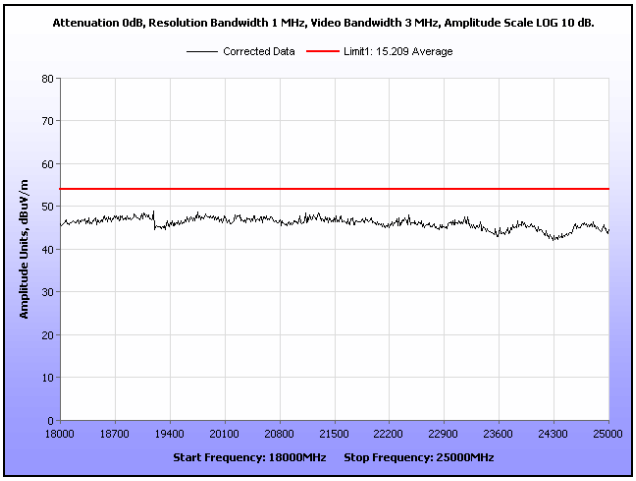



**Plot 121. Radiated Spurious Emissions, Low Channel, 7 GHz – 18 GHz, Average, Radio 4**




**Plot 122. Radiated Spurious Emissions, Low Channel, 7 GHz – 18 GHz, Peak, Radio 4**




**Plot 123. Radiated Spurious Emissions, Low Channel, 18 GHz – 25 GHz, Peak under Average, Radio 4**

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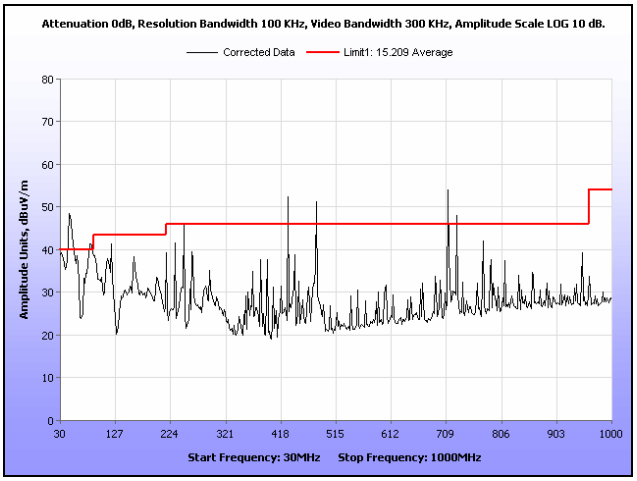
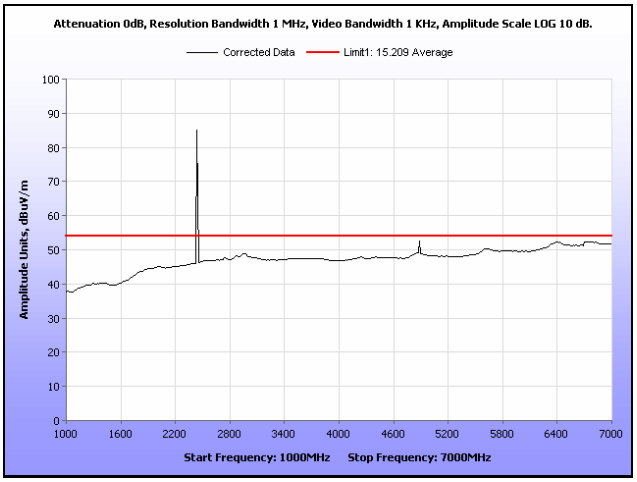
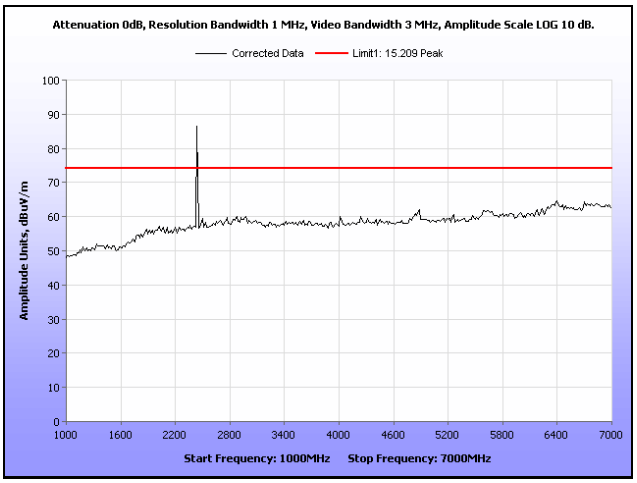



**Plot 124. Radiated Spurious Emissions, Mid Channel 30 MHz – 1 GHz, Radio 4**

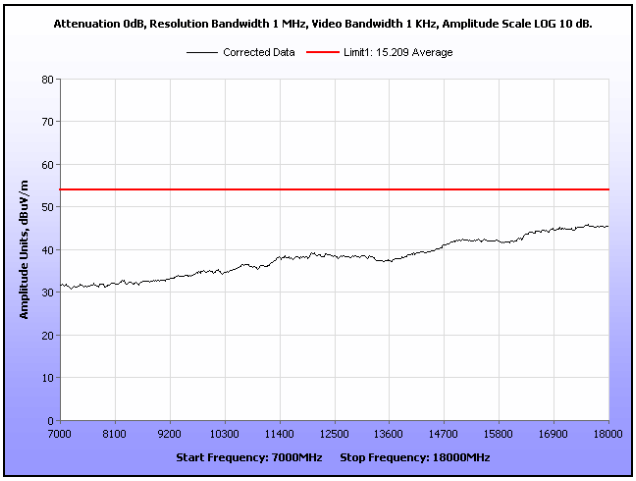
Note: Emissions which exceed the 15.209 limit are digital and meet the Class A limits on digital emissions.



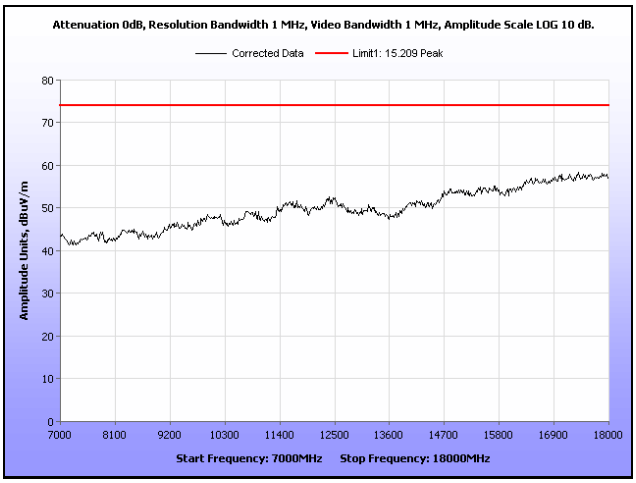

**Plot 125. Radiated Spurious Emissions, Mid Channel 1 GHz – 7 GHz, Average, Radio 4**



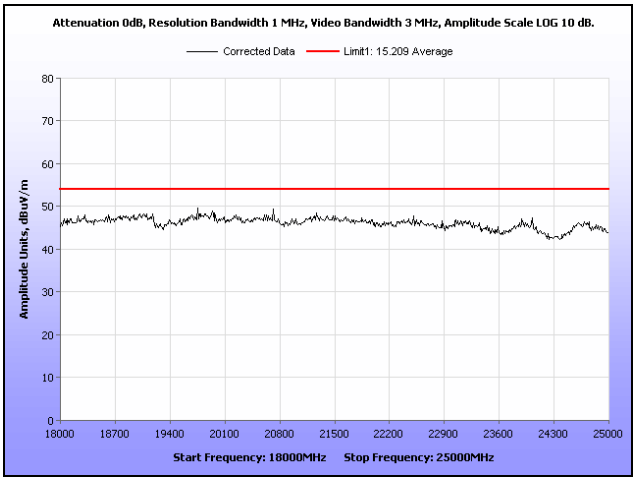

**Plot 126. Radiated Spurious Emissions, Mid Channel 1 GHz – 7 GHz, Peak, Radio 4**




**Plot 127. Radiated Spurious Emissions, Mid Channel 7 GHz – 18 GHz, Average, Radio 4**




**Plot 128. Radiated Spurious Emissions, Mid Channel 7 GHz – 18 GHz, Peak, Radio 4**




**Plot 129. Radiated Spurious Emissions, Mid Channel 18 GHz – 25 GHz, Peak under Average, Radio 4**

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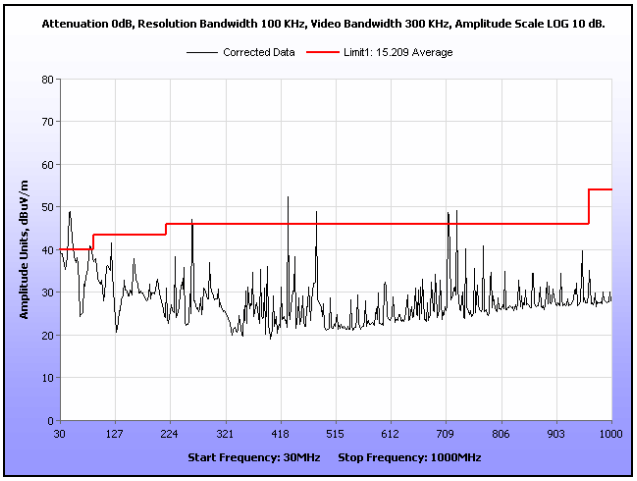
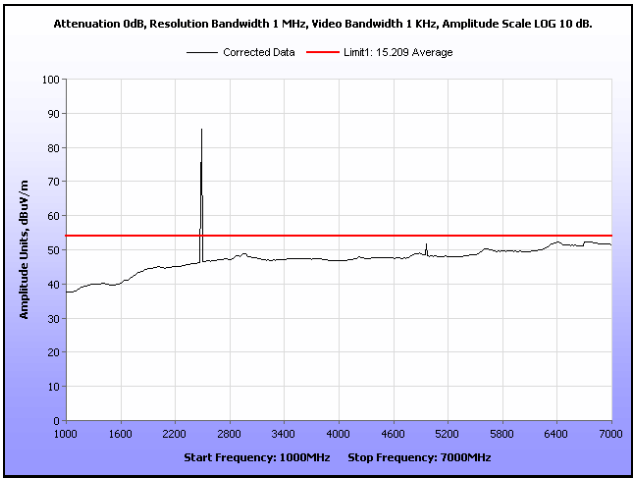
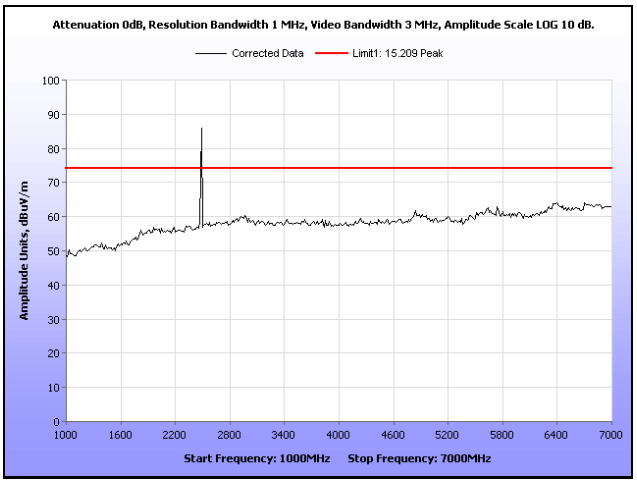



**Plot 130. Radiated Spurious Emissions, High Channel, 30 MHz – 1 GHz, Radio 4**

Note: Emissions which exceed the 15.209 limit are digital and meet the Class A limits on digital emissions.




**Plot 131. Radiated Spurious Emissions, High Channel, 1 GHz – 7 GHz, Average, Radio 4**




**Plot 132. Radiated Spurious Emissions, High Channel, 1 GHz – 7 GHz, Peak, Radio 4**

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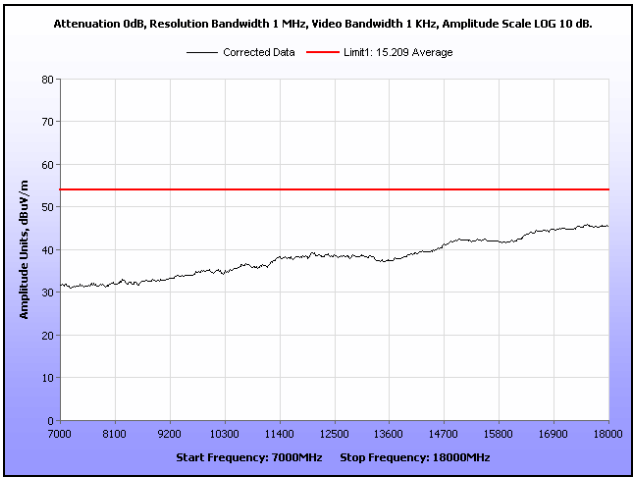
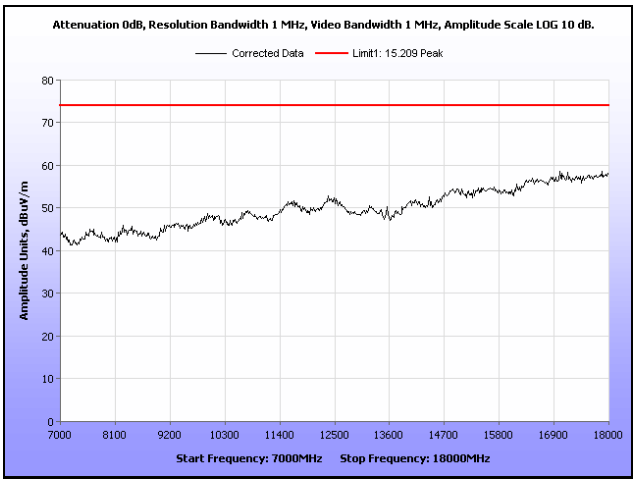
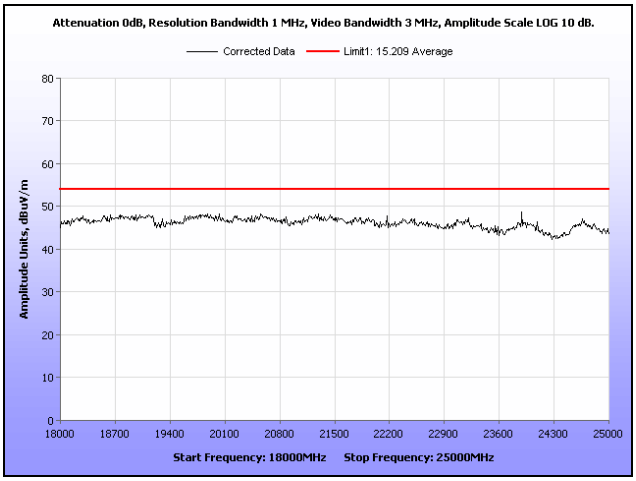



**Plot 133. Radiated Spurious Emissions, High Channel, 7 GHz – 18 GHz, Average, Radio 4**




**Plot 134. Radiated Spurious Emissions, High Channel, 7 GHz – 18 GHz, Peak, Radio 4**




**Plot 135. Radiated Spurious Emissions, High Channel, 18 GHz – 25 GHz, Peak under Average, Radio 4**

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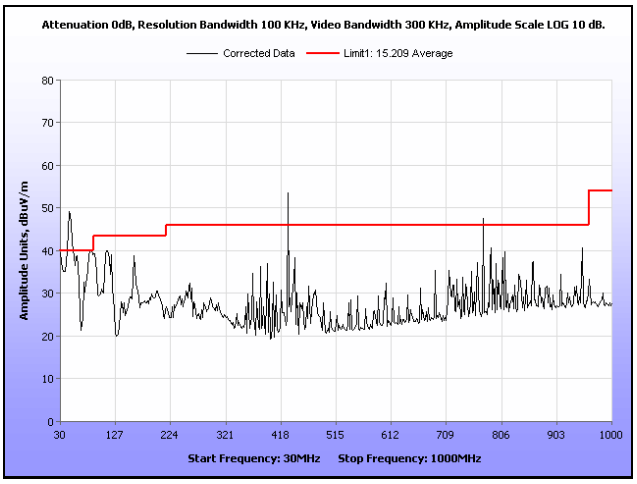
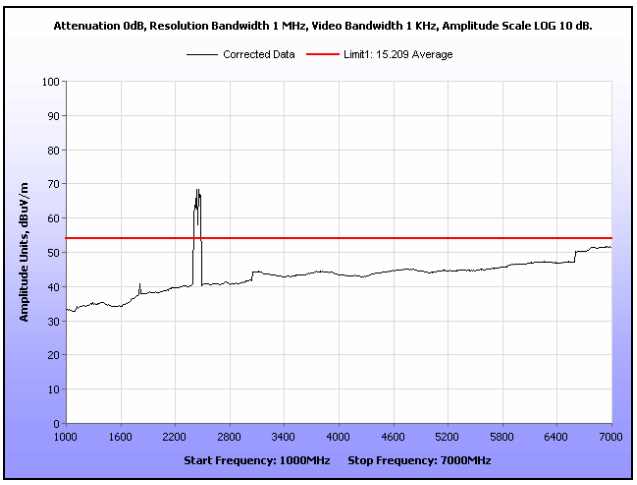
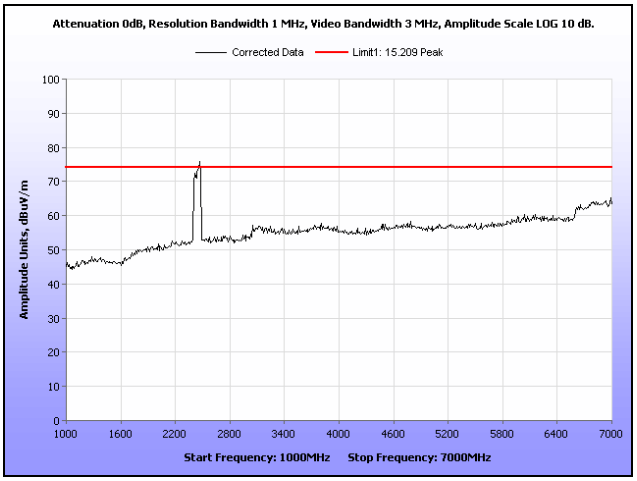
The EUT was set to transmit continuously using all four radios. Radio 1 was set to its lowest channel, radio 2 was set to its highest channel, radio 3 was set to transmit on channel 69, and radio 4 was set to transmit on its middle channel. These were the channels corresponding to the highest output power for each radio. The EUT was rotated 360 degrees through 3 axes and the receiving antenna height was adjusted until all emissions were maximized. The emissions were recorded and compared to the limits of 15.209.



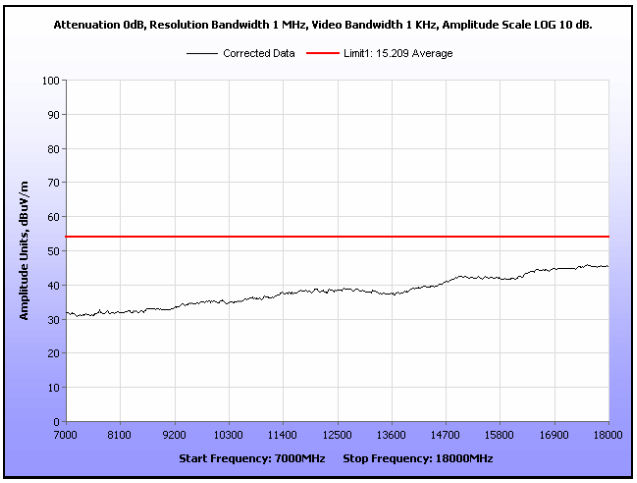

**Plot 136. Simultaneous Transmission, 30 MHz – 1 GHz**



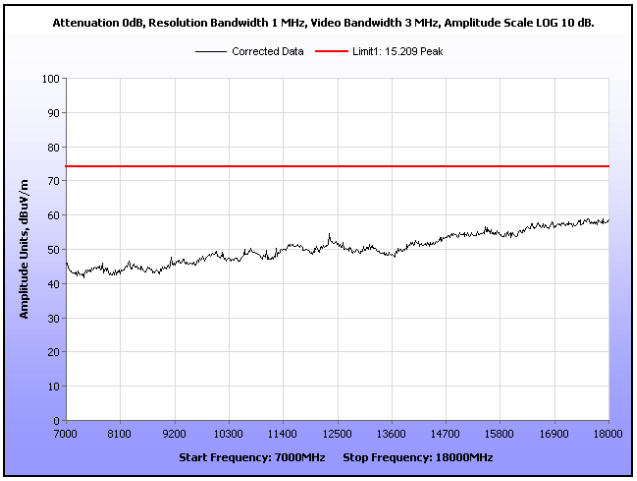

**Plot 137. Simultaneous Transmission, 1 GHz – 7 GHz, Average**




**Plot 138. Simultaneous Transmission, 1 GHz – 7 GHz, Peak**




**Plot 139. Simultaneous Transmission, 7 GHz – 18 GHz, Average**




**Plot 140. Simultaneous Transmission, 7 GHz – 18 GHz, Peak**

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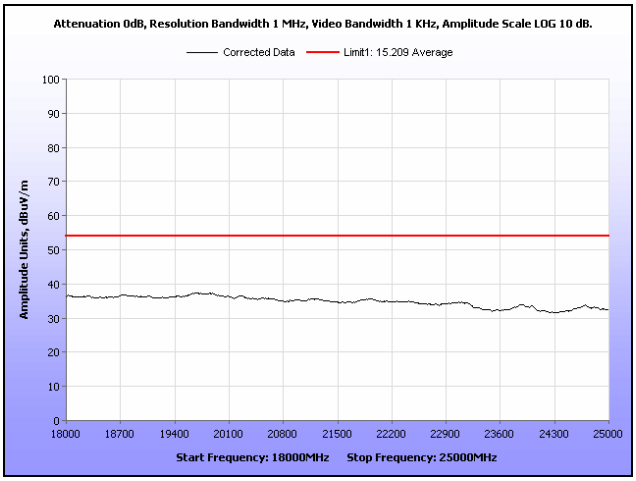
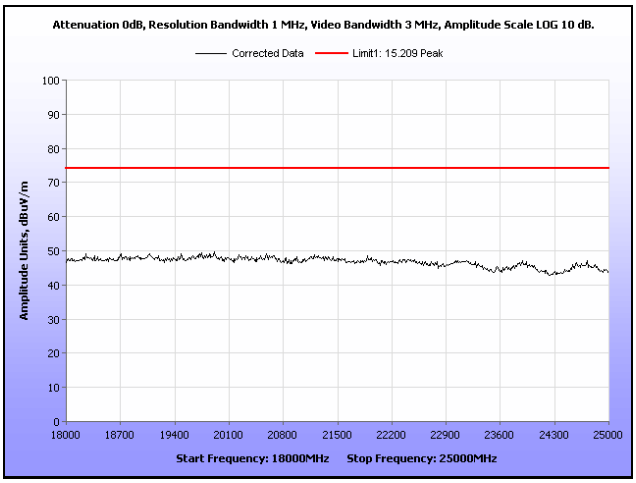



**Plot 141. Simultaneous Transmission, 18 GHz – 25 GHz, Average**




**Plot 142. Simultaneous Transmission, 18 GHz – 25 GHz, Peak**

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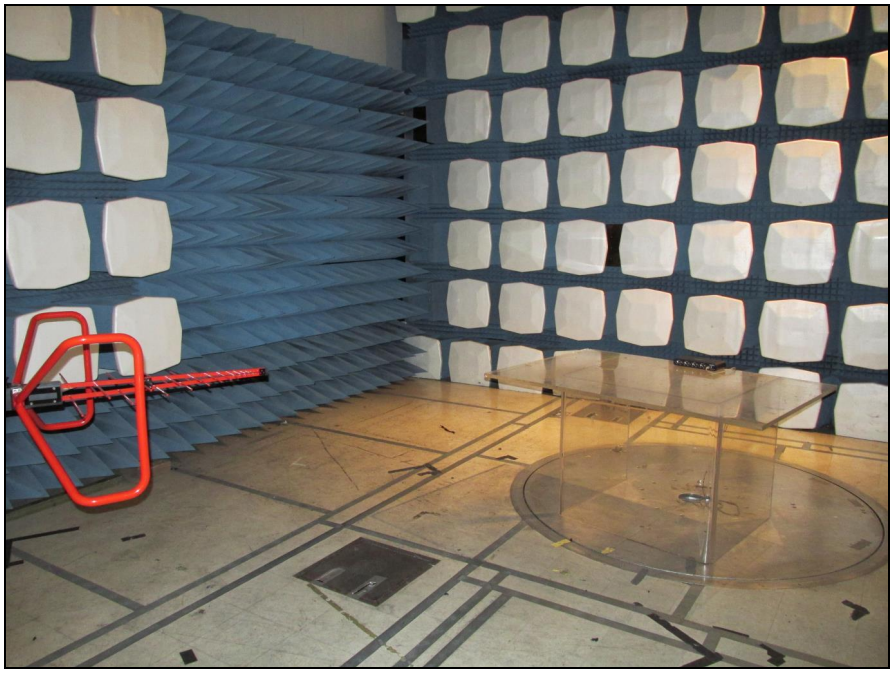
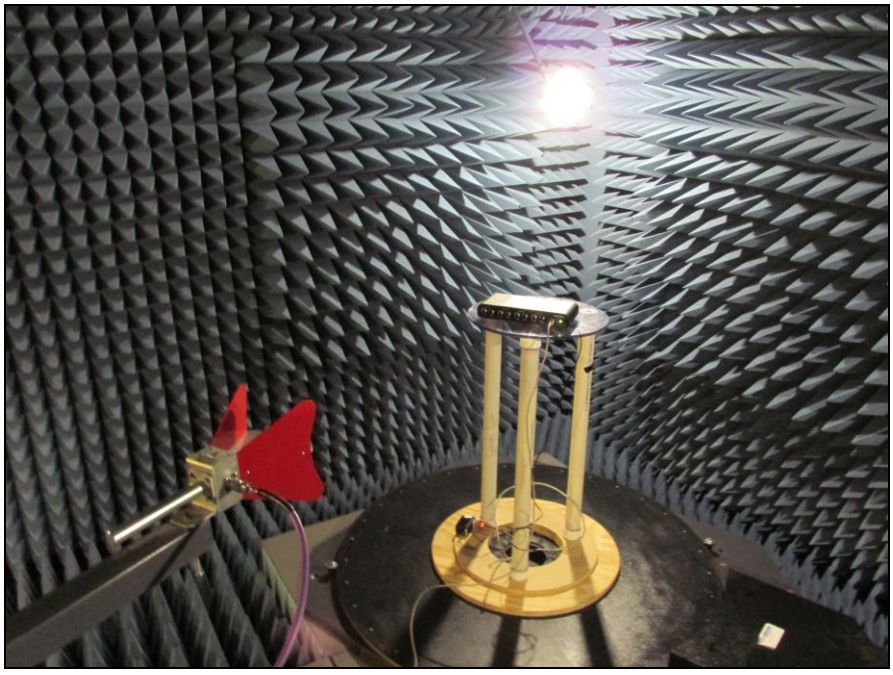
## Radiated Spurious Emissions Test Setup



**Photograph 5. Radiated Spurious Emissions, Test Setup, 30 MHz – 1 GHz**



**Photograph 6. Radiated Spurious Emissions, Test Setup, 1 GHz – 7 GHz**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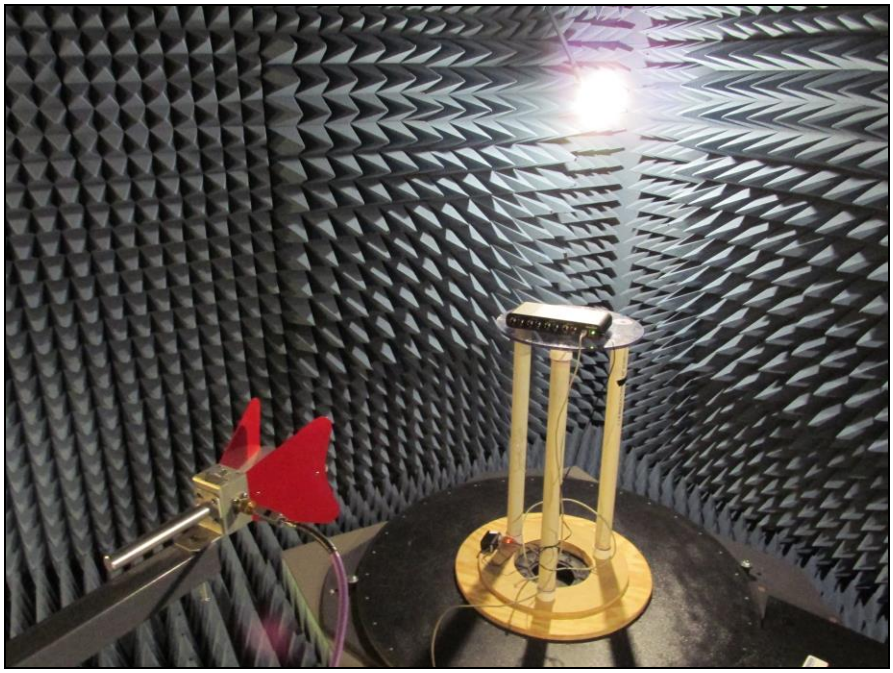
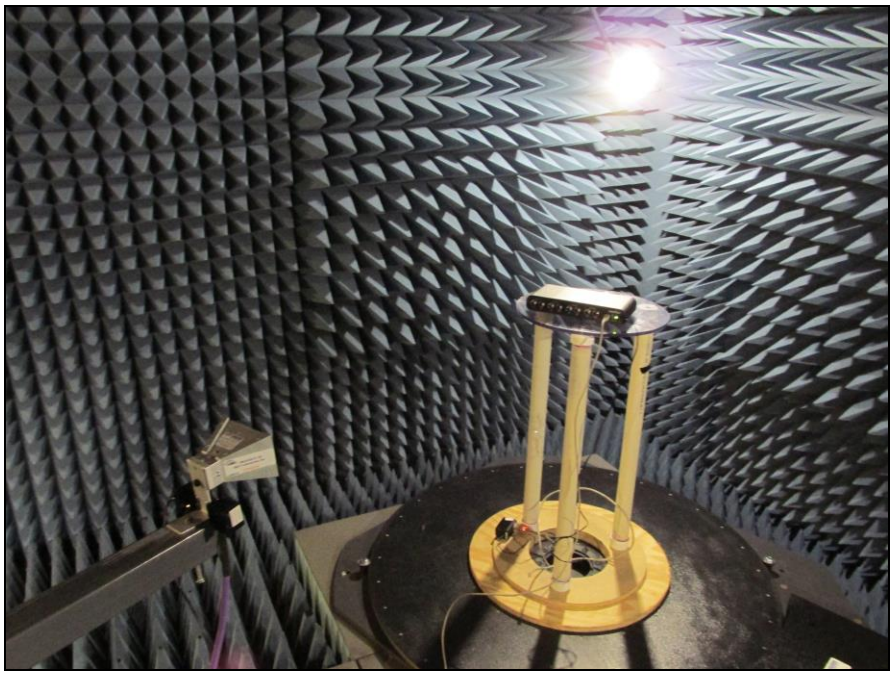


**Photograph 7. Radiated Spurious Emissions, Test Setup, 7 GHz – 18 GHz**



**Photograph 8. Radiated Spurious Emissions, Test Setup, 18 GHz – 25 GHz**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# Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.247(d) RF Spurious Emissions Requirements and Band Edge

**Test Requirement:** **15.247(d)** In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB.

**Test Procedure:** For intentional radiators with a digital device portion which operates below 10 GHz, the spectrum was investigated as per §15.33(a)(1) and §15.33(a)(4); i.e., the lowest RF signal generated or used in the device up to the 10$^{th}$ harmonic of the highest fundamental frequency or to 40 GHz, whichever is lower.

Since the EUT had an integral antenna, measurements could not be performed. Measurements needed to be taken radiated. An antenna was located 3 m away from the EUT and plots were taken. The EUT was rotated through all three orthogonal axes. The plots were corrected for both antenna correction factor and cable loss.

See following pages for detailed test results with RF Spurious Emissions.

**Test Results:** The EUT was compliant with the RF Spurious Emission limits of **§15.247(d)**.

**Test Engineer(s):** Jeff Pratt

**Test Date(s):** 04/05/13

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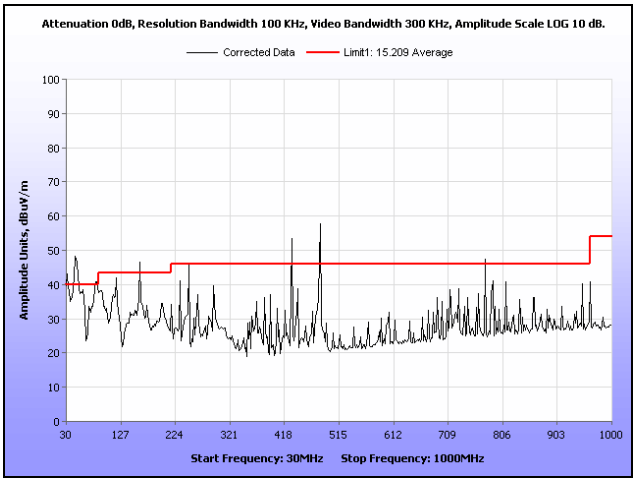
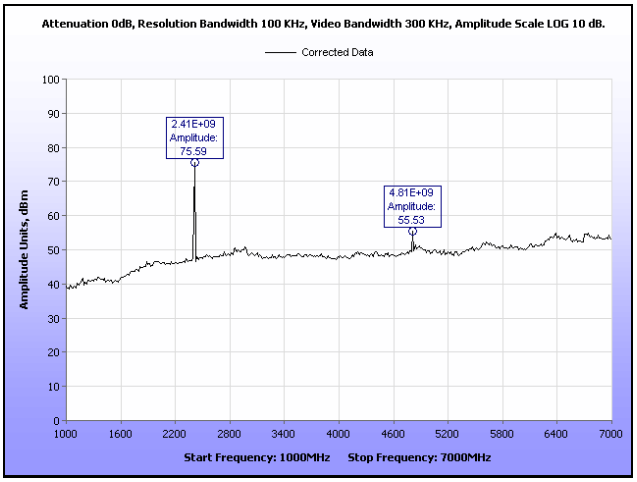
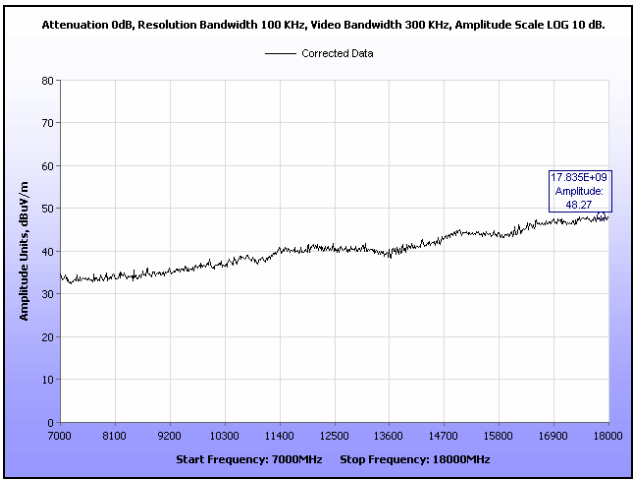
## RF Spurious Emissions Test Results




**Plot 143. RF Spurious Emissions, Low Channel, 30 MHz – 1 GHz, Radio 1**




**Plot 144. RF Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Radio 1**




**Plot 145. RF Spurious Emissions, Low Channel, 7 GHz – 18 GHz, Radio 1**

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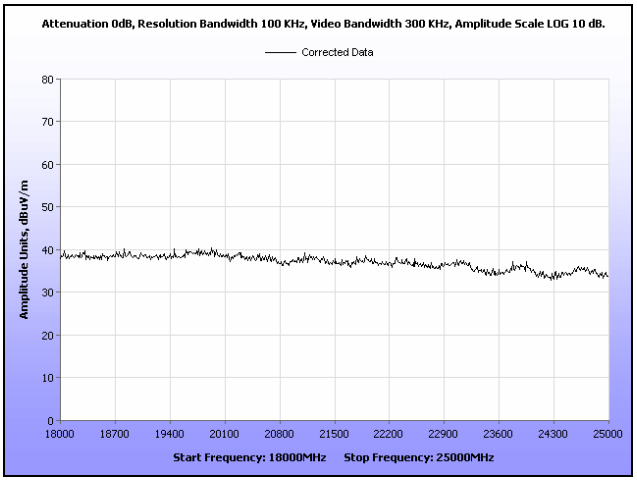
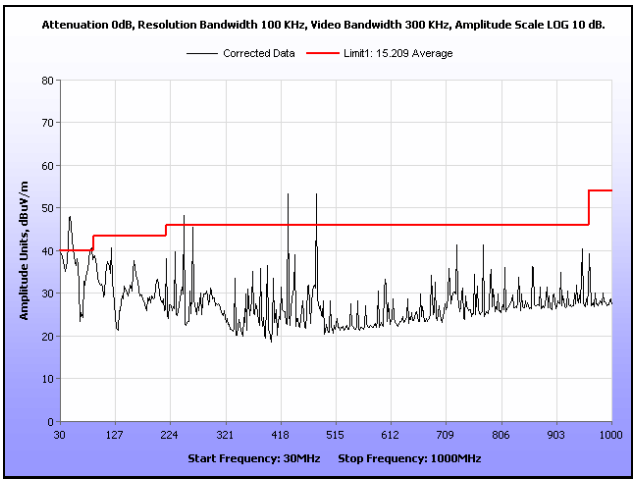
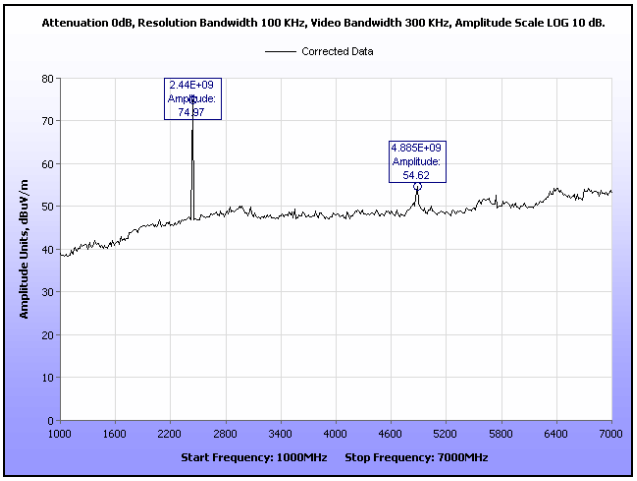



**Plot 146. RF Spurious Emissions, Low Channel, 18 GHz – 25 GHz, Radio 1**




**Plot 147. RF Spurious Emissions, Mid Channel, 30 MHz – 1 GHz, Radio 1**




**Plot 148. RF Spurious Emissions, Mid Channel, 1 GHz – 7 GHz, Radio 1**

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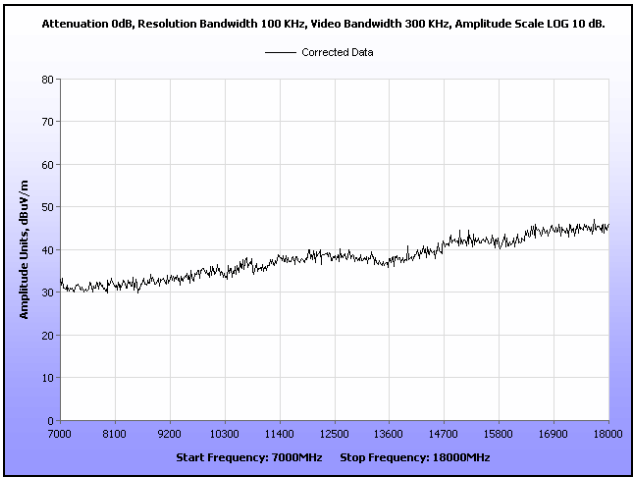
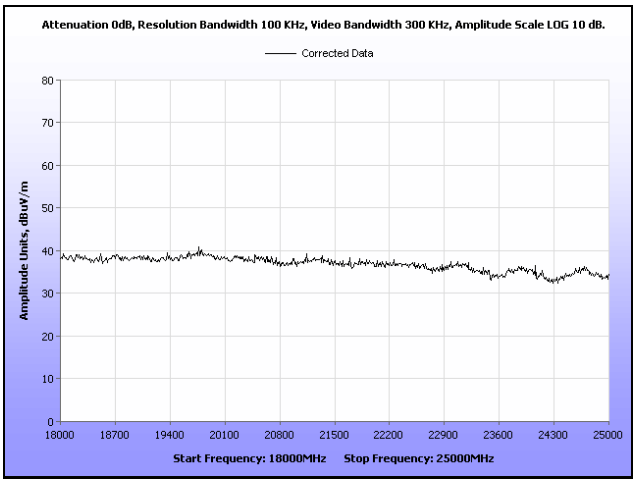
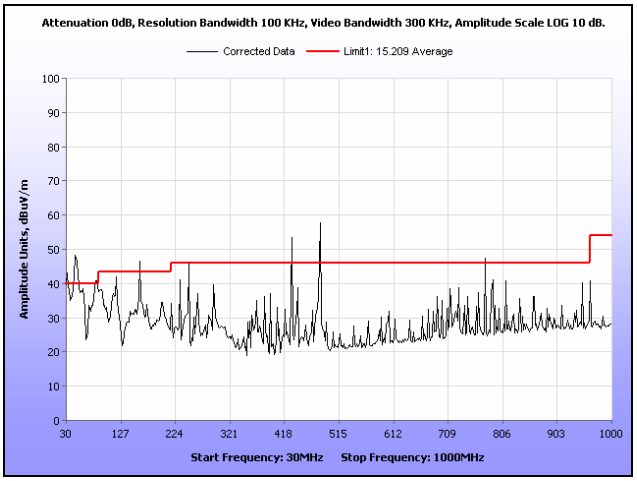


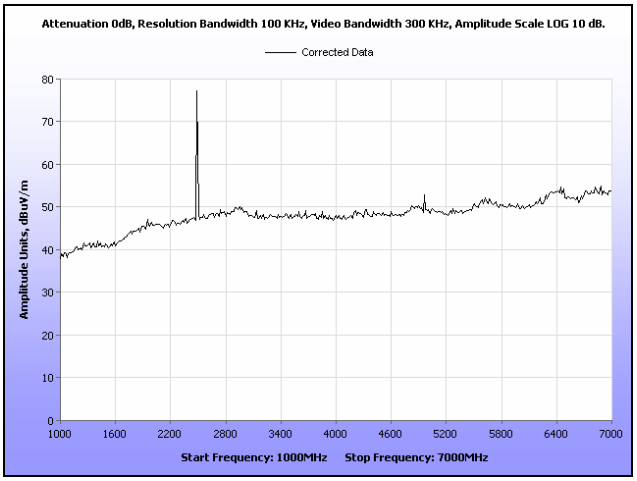

**Plot 149. RF Spurious Emissions, Mid Channel, 7 GHz – 18 GHz, Radio 1**



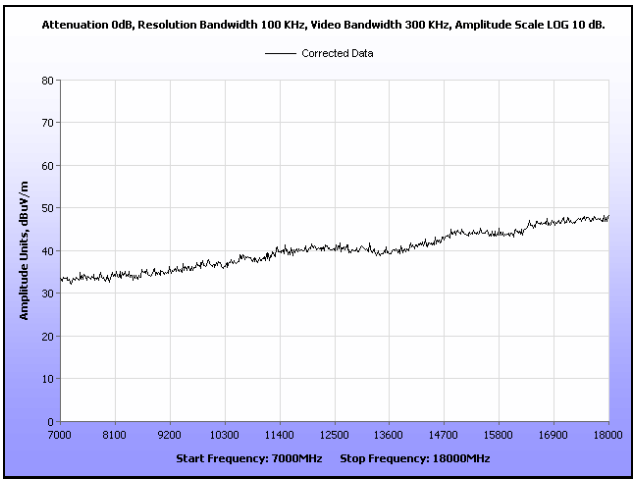

**Plot 150. RF Spurious Emissions, Mid Channel, 18 GHz – 25 GHz, Radio 1**



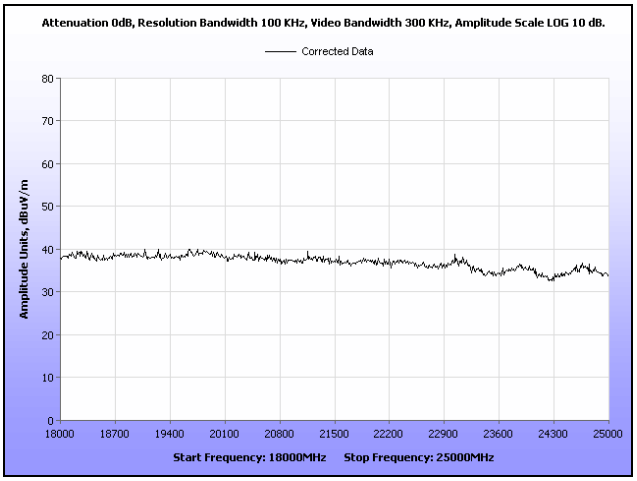

**Plot 151. RF Spurious Emissions, High Channel, 30 MHz – 1 GHz, Radio 1**




**Plot 152. RF Spurious Emissions, High Channel, 1 GHz – 7 GHz, Radio 1**




**Plot 153. RF Spurious Emissions, High Channel, 7 GHz – 18 GHz, Radio 1**




**Plot 154. RF Spurious Emissions, High Channel, 18 GHz – 25 GHz, Radio 1**

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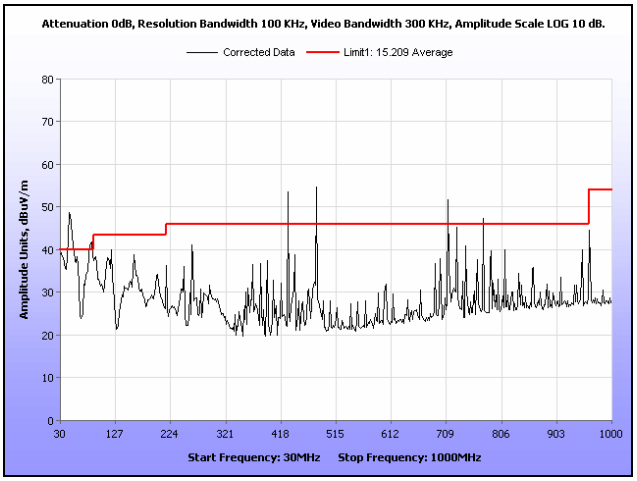
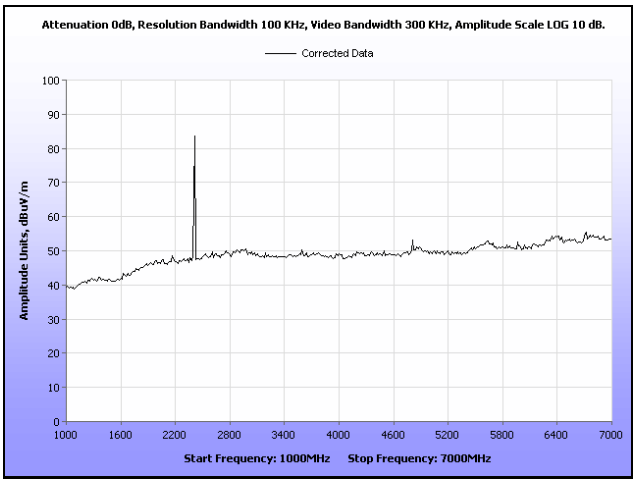
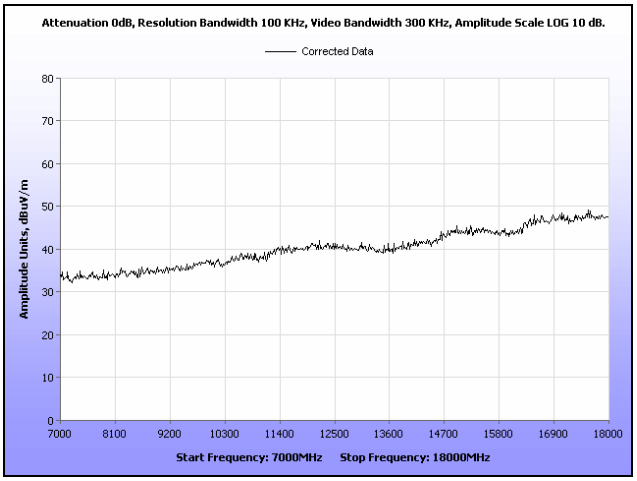


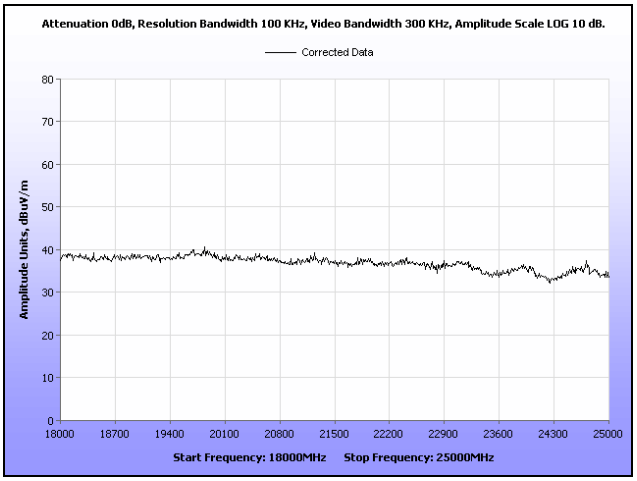

**Plot 155. RF Spurious Emissions, Low Channel, 30 MHz – 1 GHz, Radio 2**



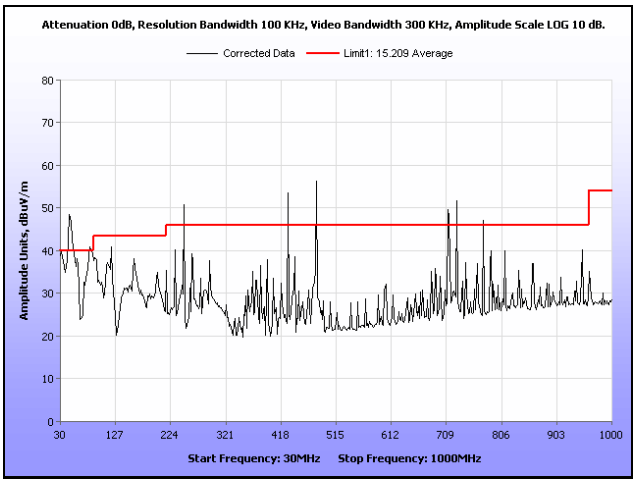

**Plot 156. RF Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Radio 2**



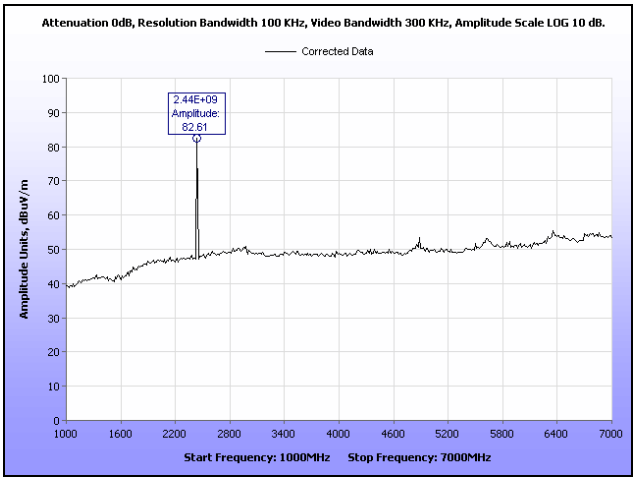

**Plot 157. RF Spurious Emissions, Low Channel, 7 GHz – 18 GHz, Radio 2**




**Plot 158. RF Spurious Emissions, Low Channel, 18 GHz – 25 GHz, Radio 2**




**Plot 159. RF Spurious Emissions, Mid Channel, 30 MHz – 1 GHz, Radio 2**




**Plot 160. RF Spurious Emissions, Mid Channel, 1 GHz – 7 GHz, Radio 2**

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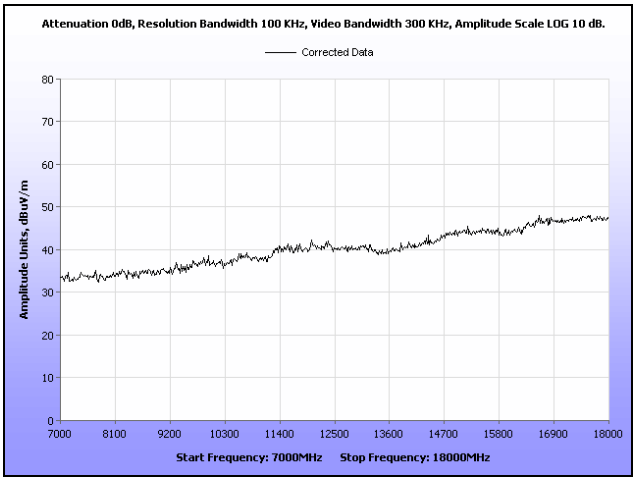
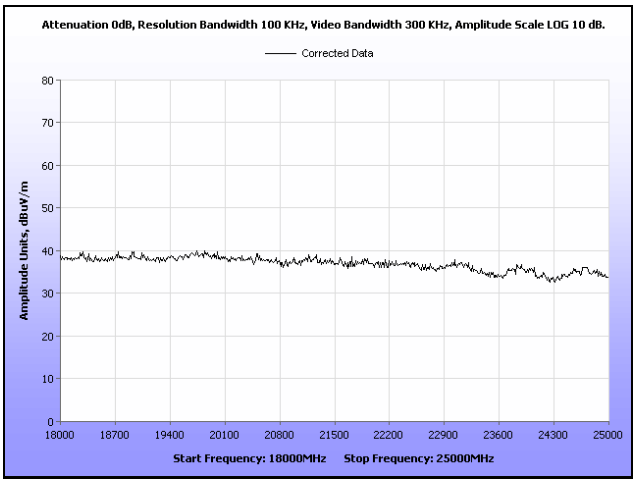
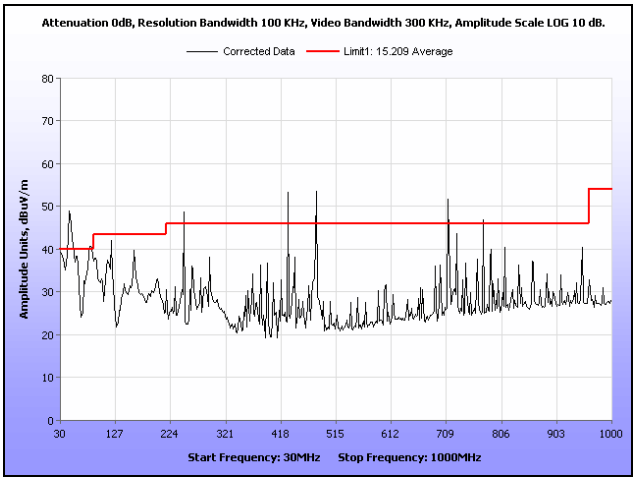



**Plot 161. RF Spurious Emissions, Mid Channel, 7 GHz – 18 GHz, Radio 2**




**Plot 162. RF Spurious Emissions, Mid Channel, 18 GHz – 25 GHz, Radio 2**




**Plot 163. RF Spurious Emissions, High Channel, 30 MHz – 1 GHz, Radio 2**

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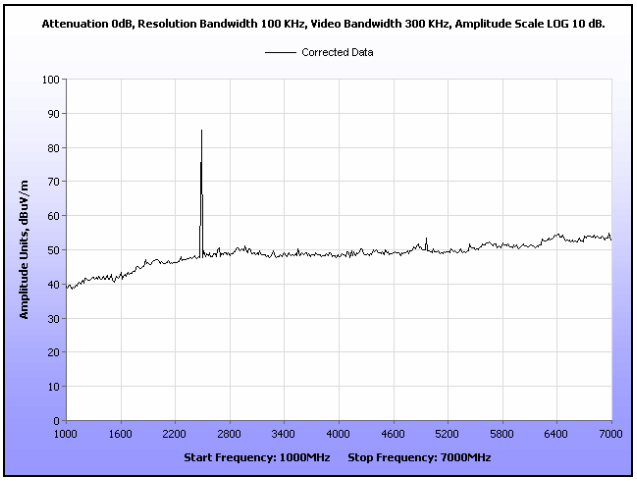
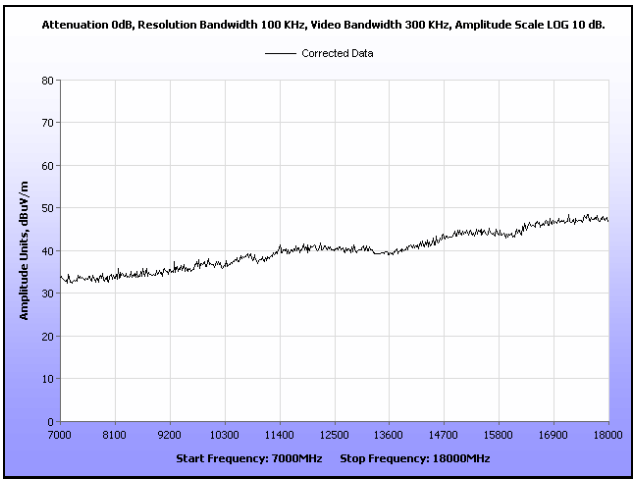
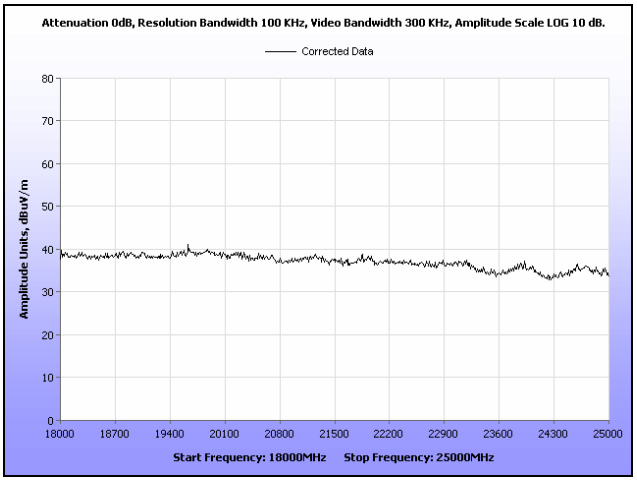



**Plot 164. RF Spurious Emissions, High Channel, 1 GHz – 7 GHz, Radio 2**




**Plot 165. RF Spurious Emissions, High Channel, 7 GHz – 18 GHz, Radio 2**




**Plot 166. RF Spurious Emissions, High Channel, 18 GHz – 25 GHz, Radio 2**

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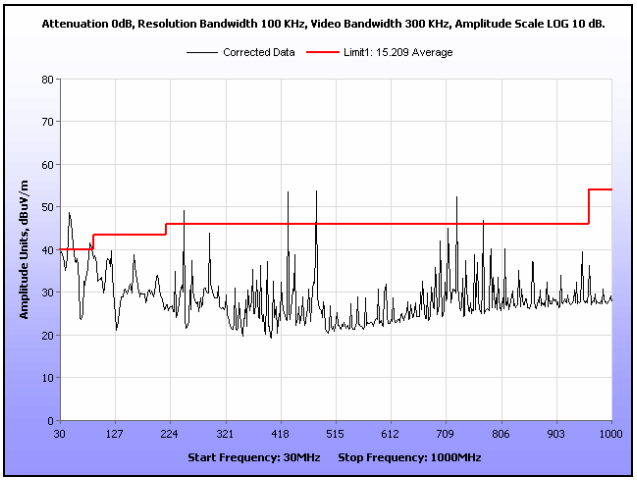
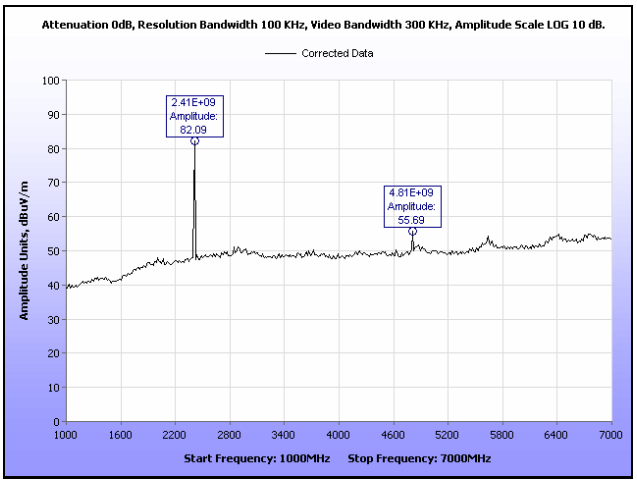
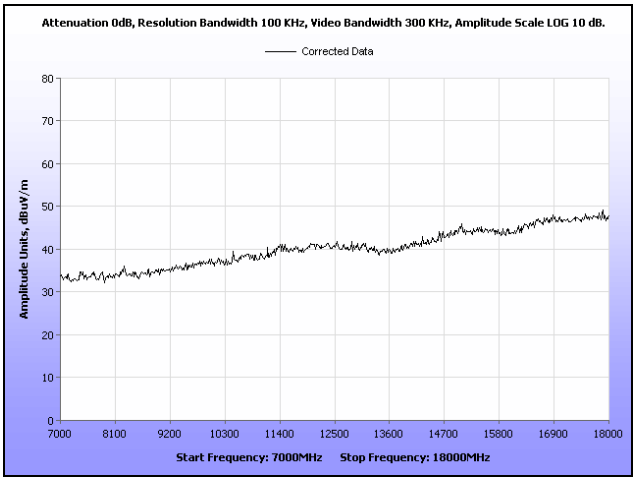



**Plot 167. RF Spurious Emissions, Low Channel, 30 MHz – 1 GHz, Radio 3**




**Plot 168. RF Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Radio 3**




**Plot 169. RF Spurious Emissions, Low Channel, 7 GHz – 18 GHz, Radio 3**

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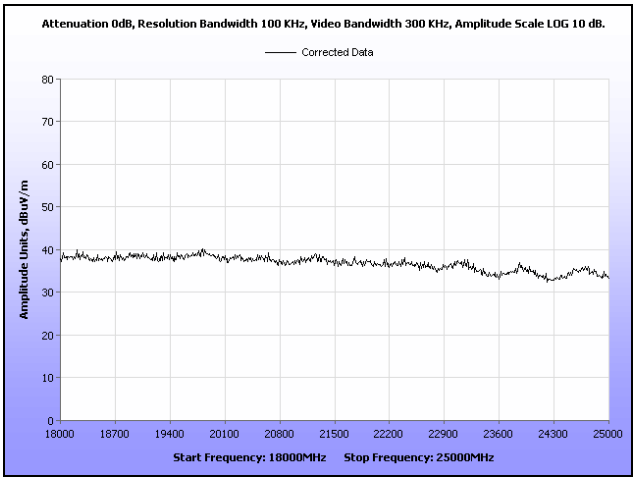
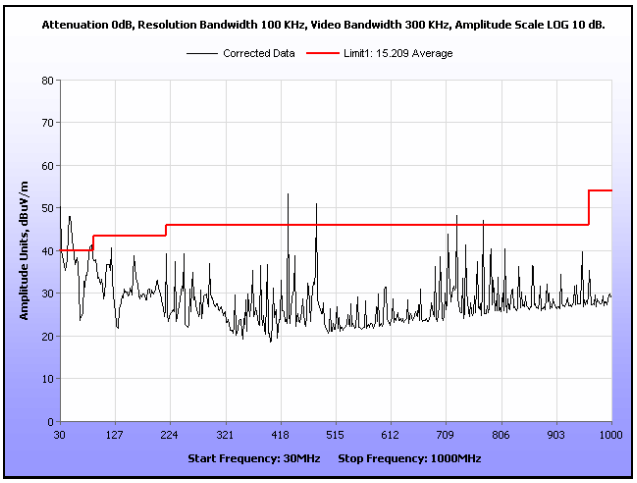
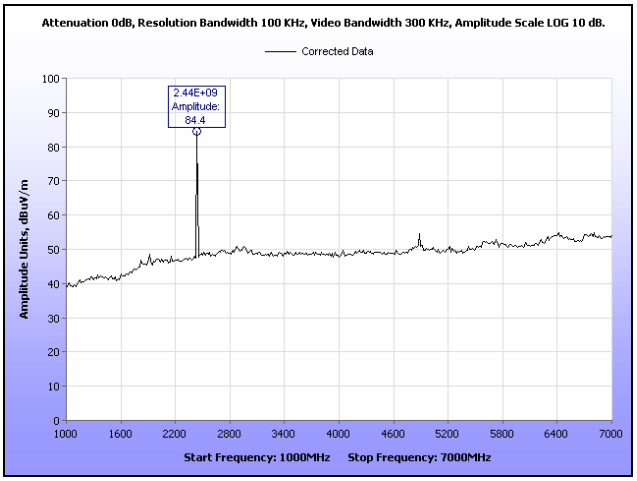



**Plot 170. RF Spurious Emissions, Low Channel, 18 GHz – 25 GHz, Radio 3**




**Plot 171. RF Spurious Emissions, Mid Channel, 30 MHz – 1 GHz, Radio 3**




**Plot 172. RF Spurious Emissions, Mid Channel, 1 GHz – 7 GHz, Radio 3**

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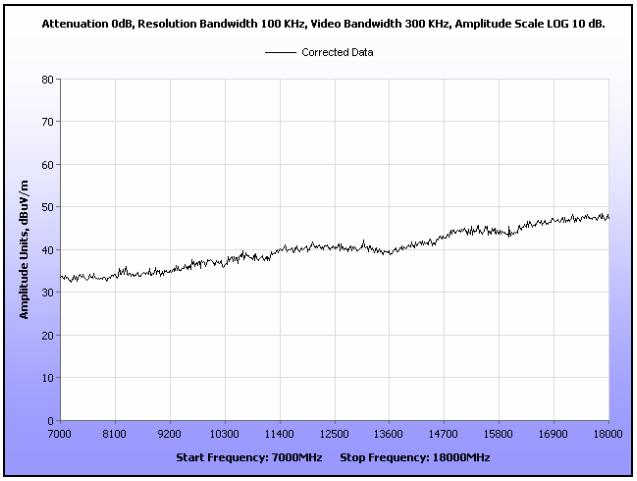
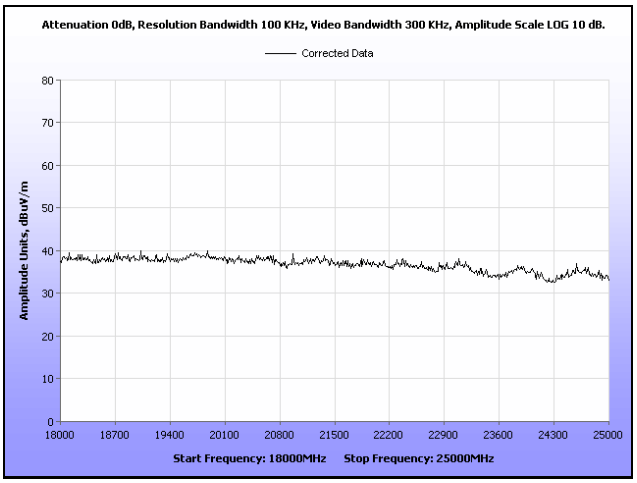
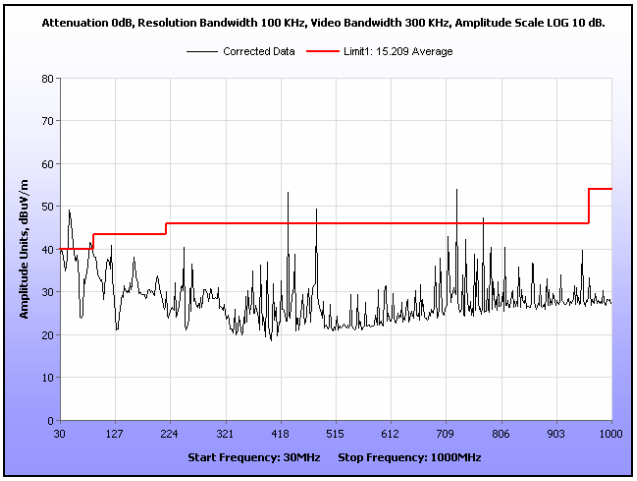



**Plot 173. RF Spurious Emissions, Mid Channel, 7 GHz – 18 GHz, Radio 3**




**Plot 174. RF Spurious Emissions, Mid Channel, 18 GHz – 25 GHz, Radio 3**




**Plot 175. RF Spurious Emissions, High Channel, 30 MHz – 1 GHz, Radio 3**

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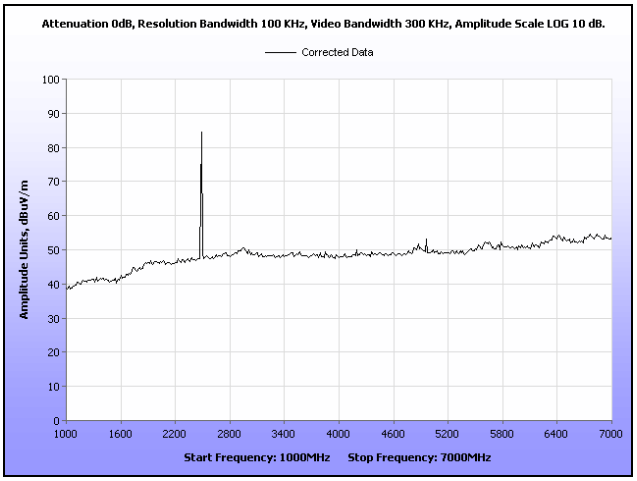
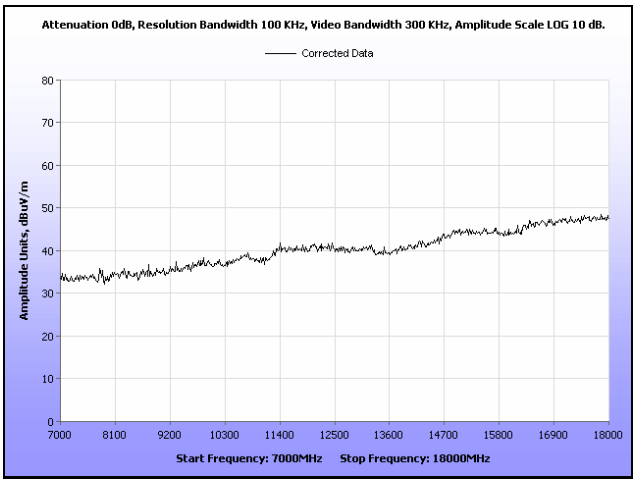
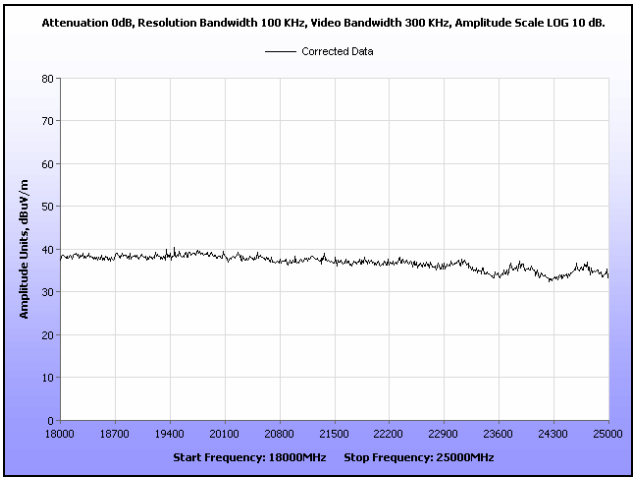



**Plot 176. RF Spurious Emissions, High Channel, 1 GHz – 7 GHz, Radio 3**




**Plot 177. RF Spurious Emissions, High Channel, 7 GHz – 18 GHz, Radio 3**




**Plot 178. RF Spurious Emissions, High Channel, 18 GHz – 25 GHz, Radio 3**

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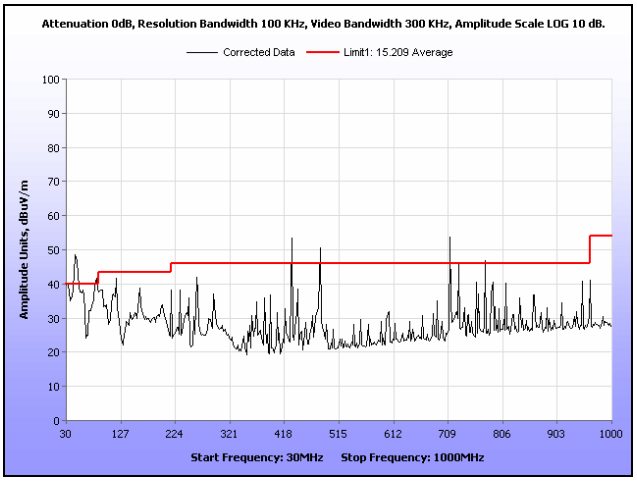
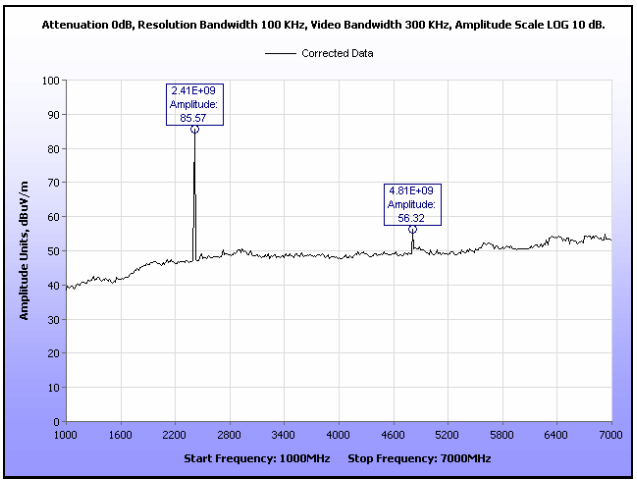
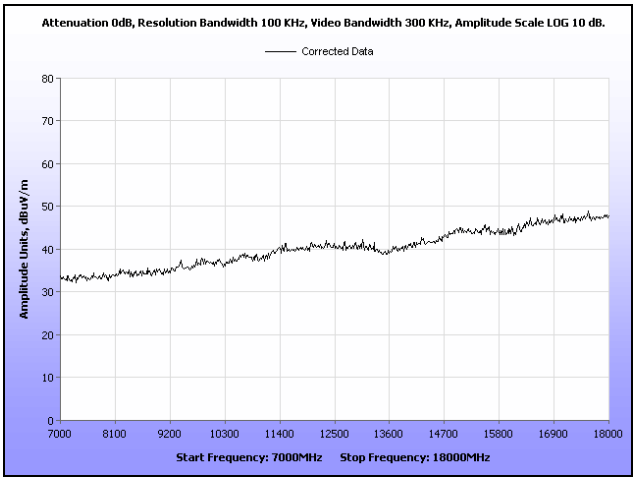



**Plot 179. RF Spurious Emissions, Low Channel, 30 MHz – 1 GHz, Radio 4**




**Plot 180. RF Spurious Emissions, Low Channel, 1 GHz – 7 GHz, Radio 4**




**Plot 181. RF Spurious Emissions, Low Channel, 7 GHz – 18 GHz, Radio 4**

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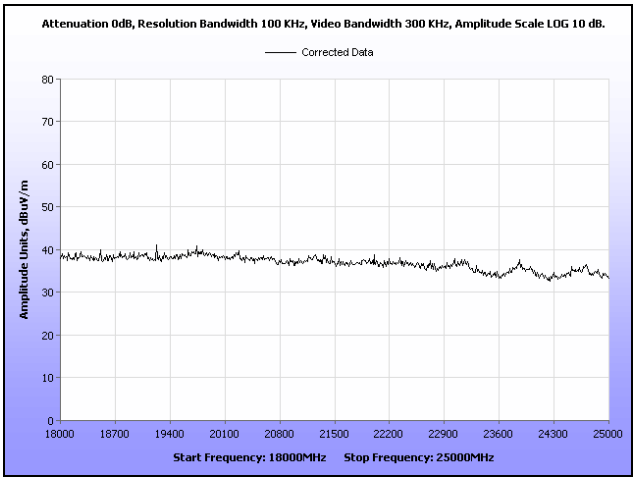
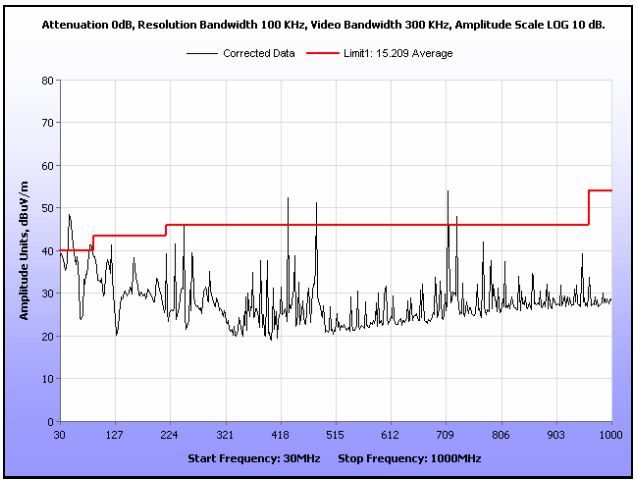
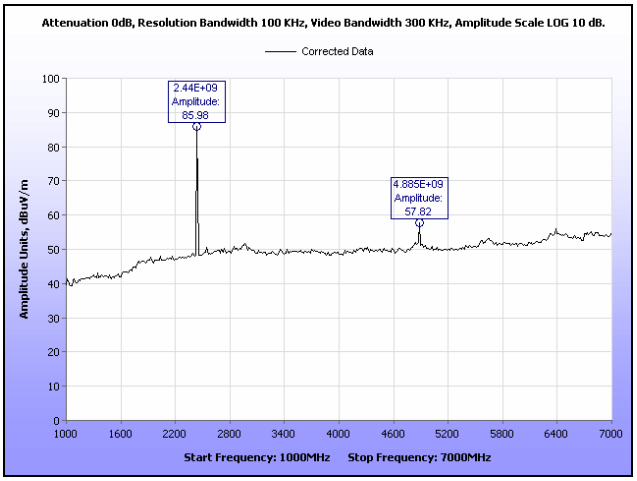



**Plot 182. RF Spurious Emissions, Low Channel, 18 GHz – 25 GHz, Radio 4**




**Plot 183. RF Spurious Emissions, Mid Channel, 30 MHz – 1 GHz, Radio 4**




**Plot 184. RF Spurious Emissions, Mid Channel, 1 GHz – 7 GHz, Radio 4**

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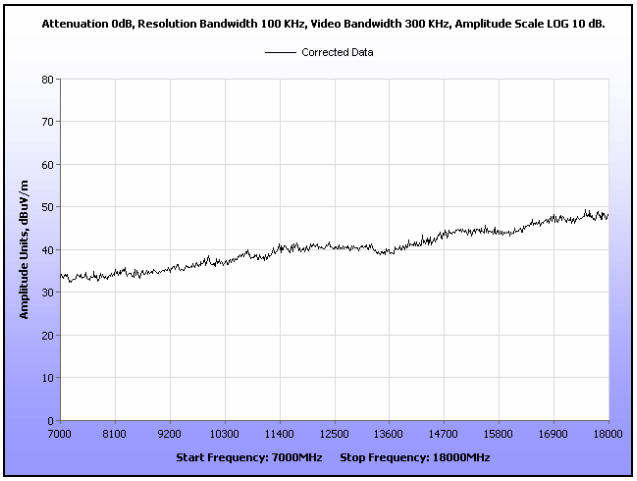
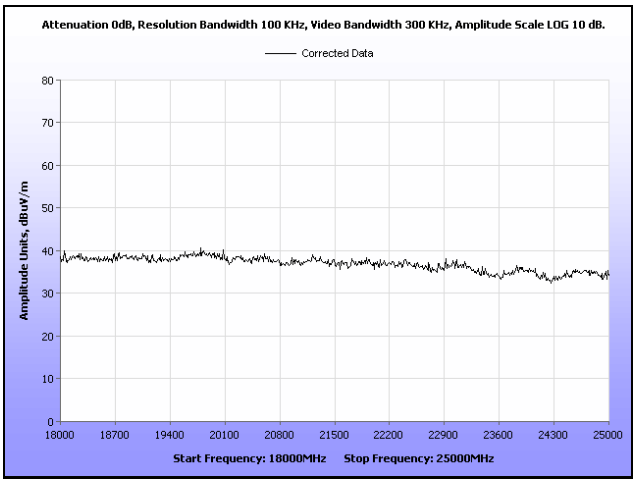
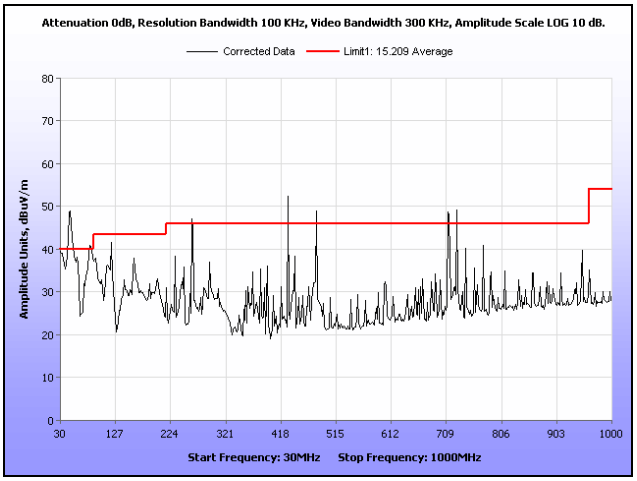



**Plot 185. RF Spurious Emissions, Mid Channel, 7 GHz – 18 GHz, Radio 4**




**Plot 186. RF Spurious Emissions, Mid Channel, 18 GHz – 25 GHz, Radio 4**




**Plot 187. RF Spurious Emissions, High Channel, 30 MHz – 1 GHz, Radio 4**

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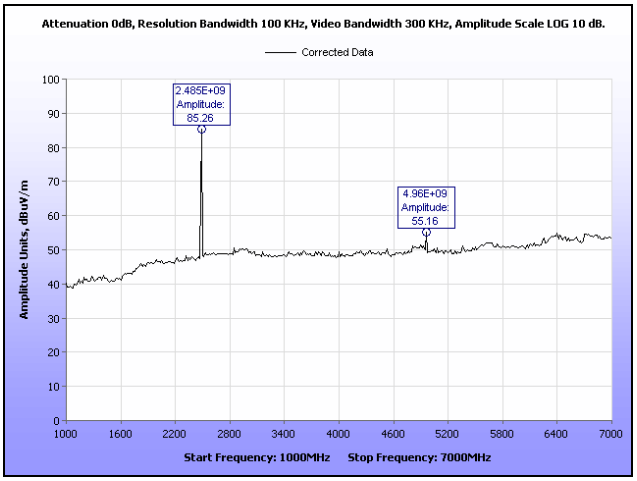
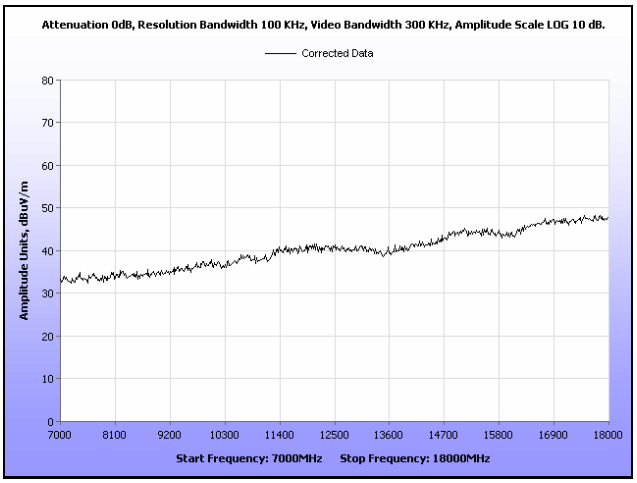
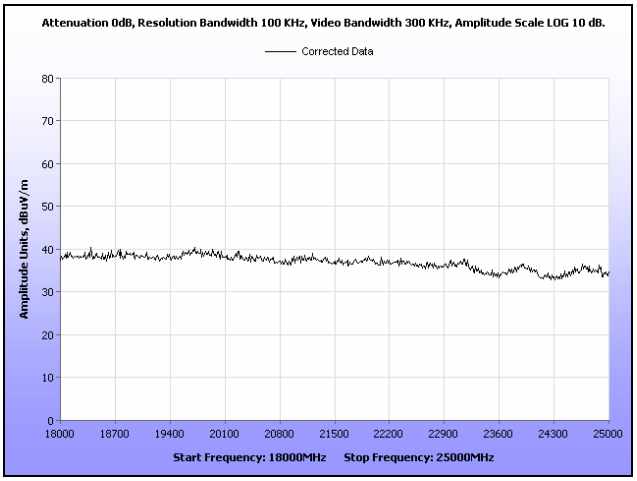



**Plot 188. RF Spurious Emissions, High Channel, 1 GHz – 7 GHz, Radio 4**




**Plot 189. RF Spurious Emissions, High Channel, 7 GHz – 18 GHz, Radio 4**




**Plot 190. RF Spurious Emissions, High Channel, 18 GHz – 25 GHz, Radio 4**

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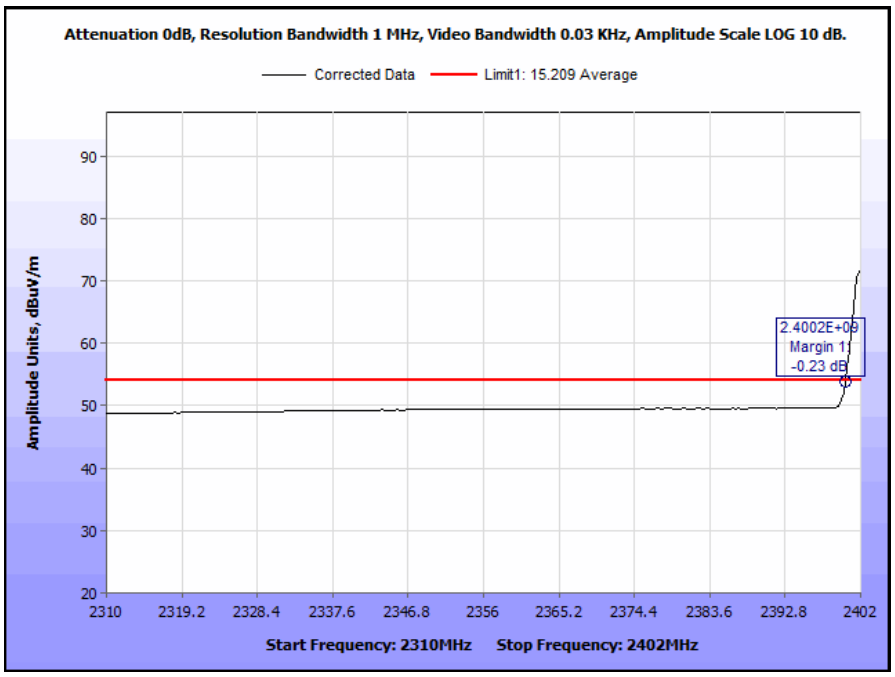
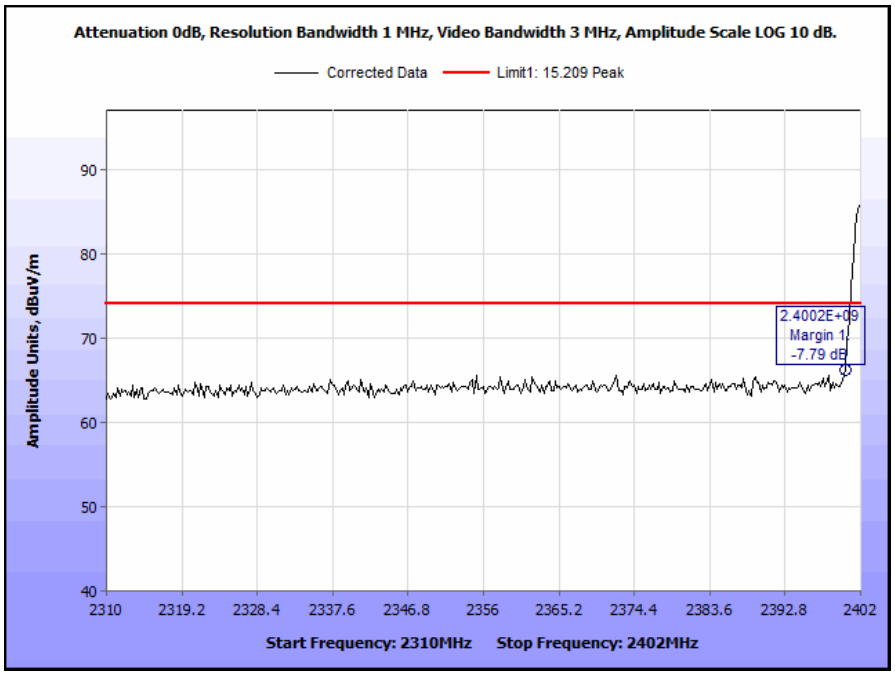
## Band Edge




**Plot 191. Band Edge, Radio 1, Low Channel, Average**




**Plot 192. Band Edge, Radio 1, Low Channel, Peak**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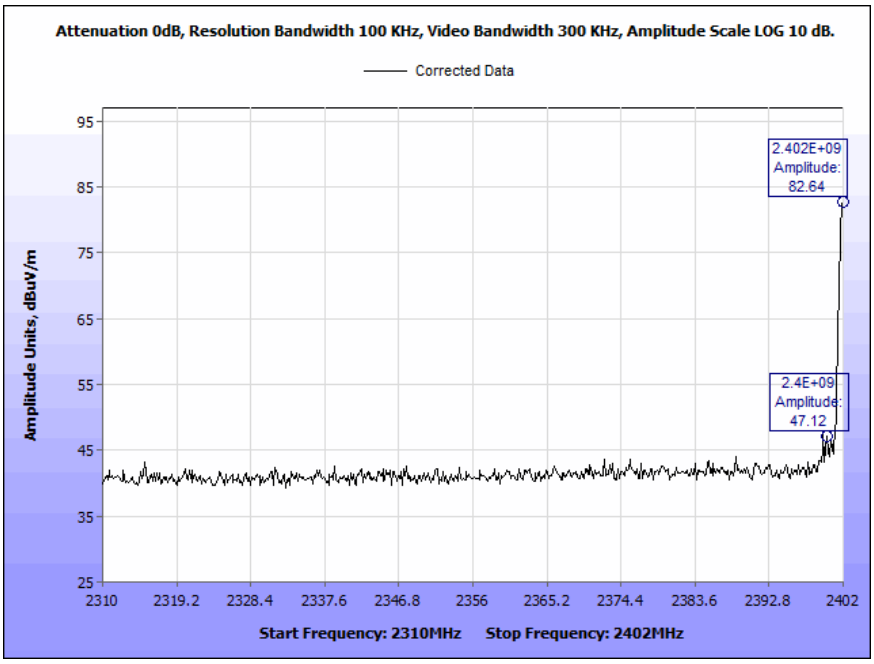
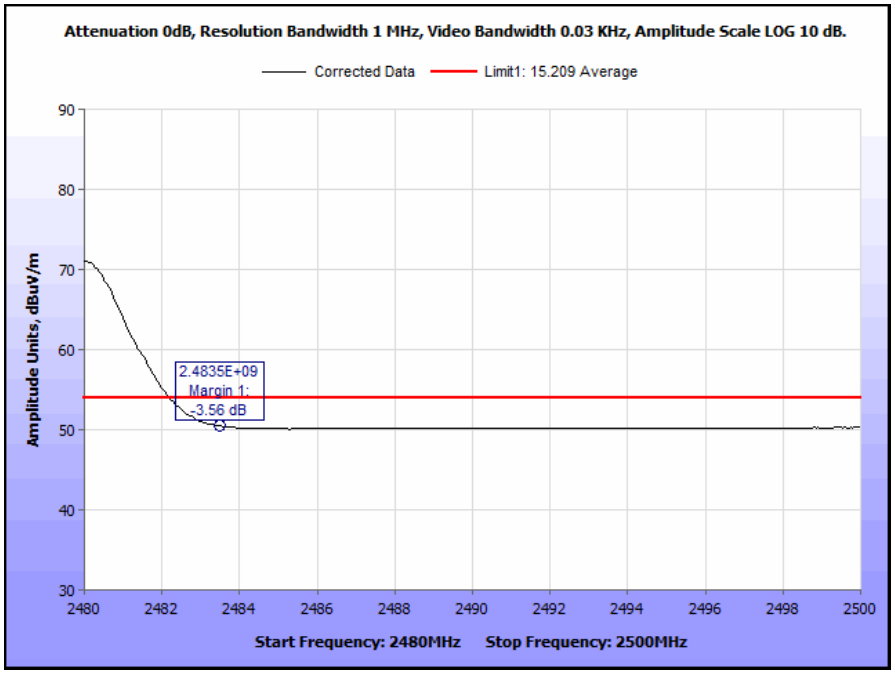



**Plot 193. Band Edge 247(d), Radio 1, Low Channel**




**Plot 194. Band Edge, Radio 1, High Channel, Average**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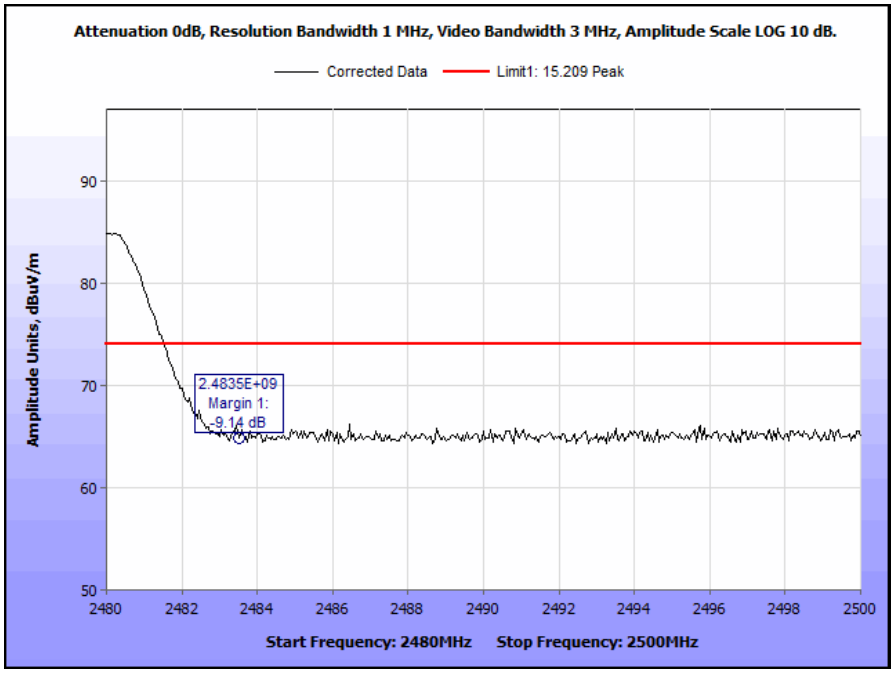
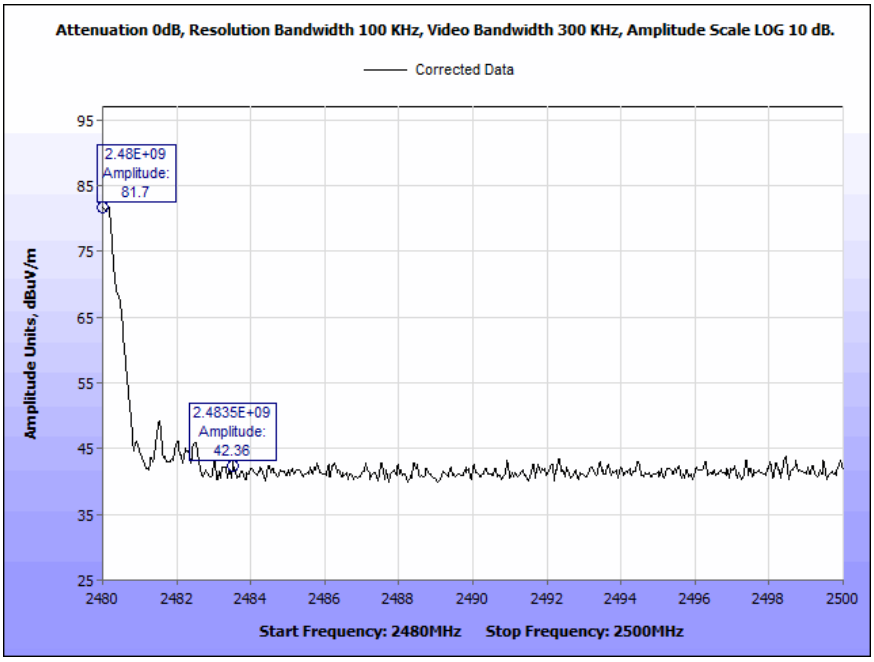



**Plot 195. Band Edge, Radio 1, High Channel, Peak**




**Plot 196. Band Edge 247(d), Radio 1, High Channel**

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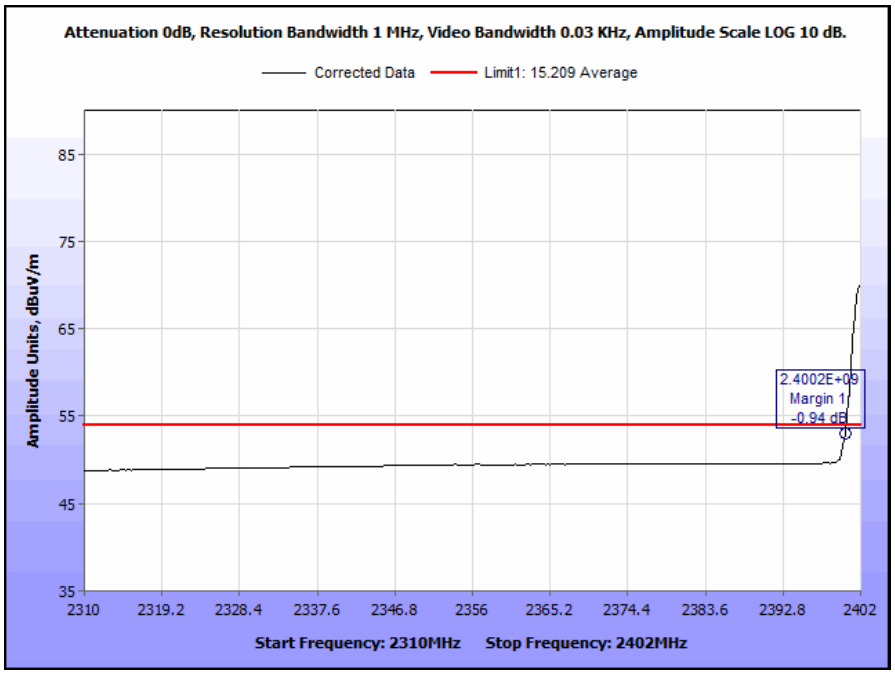
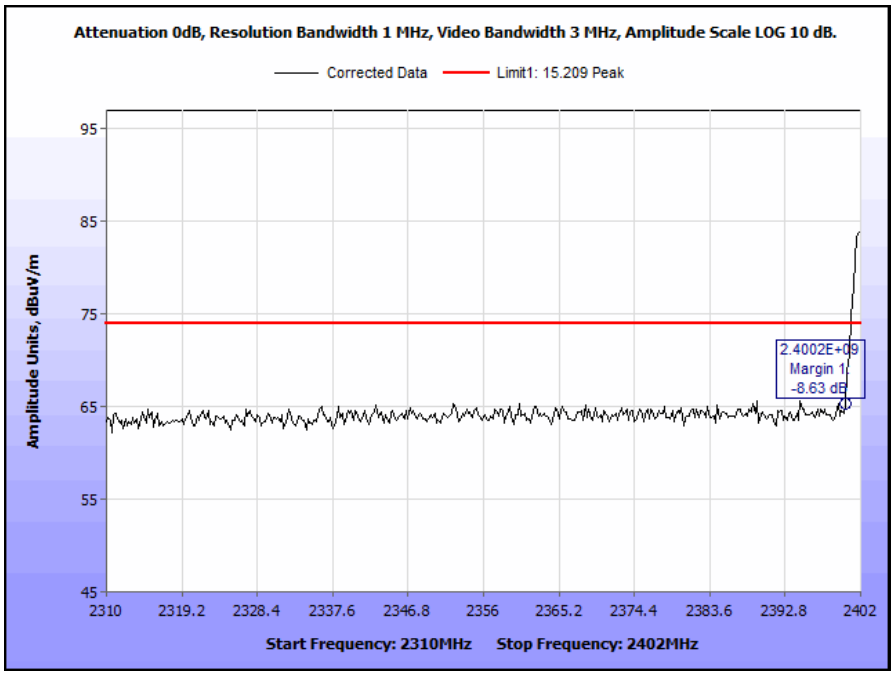



**Plot 197. Band Edge, Radio 2, Low Channel, Average**




**Plot 198. Band Edge, Radio 2, Low Channel, Peak**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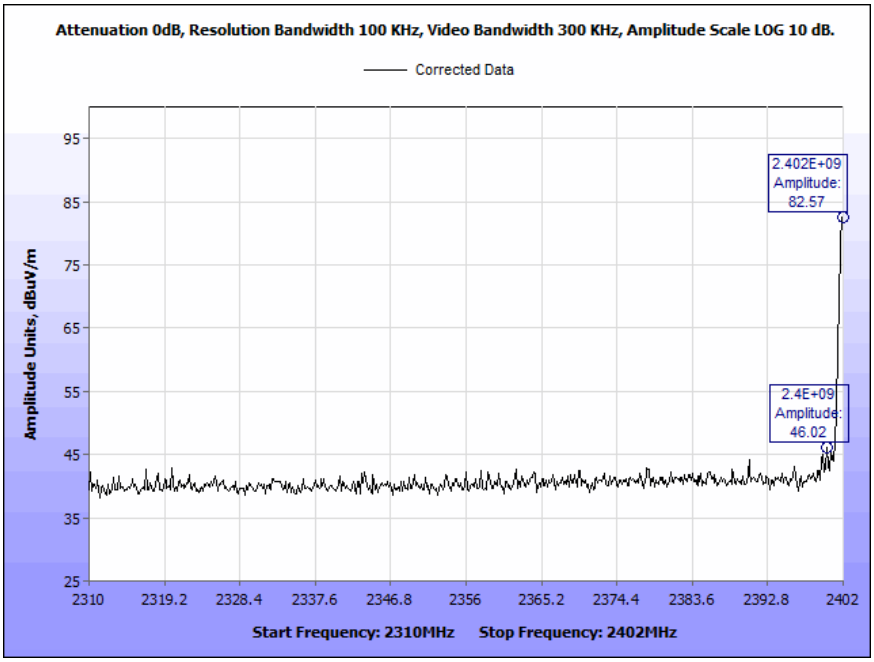
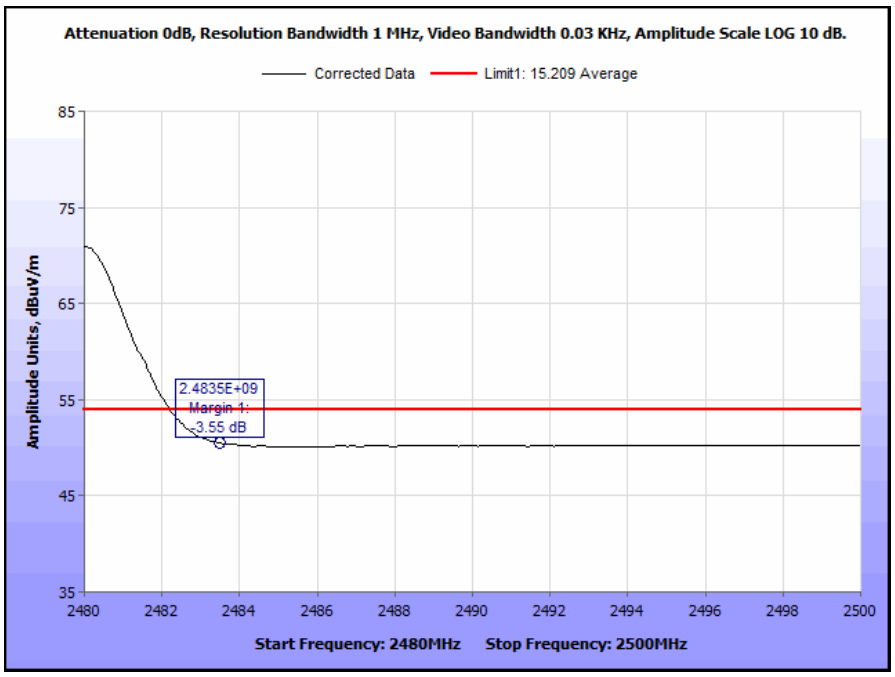



**Plot 199. Band Edge 247(d), Radio 2, Low Channel**




**Plot 200. Band Edge, Radio 2, High Channel, Average**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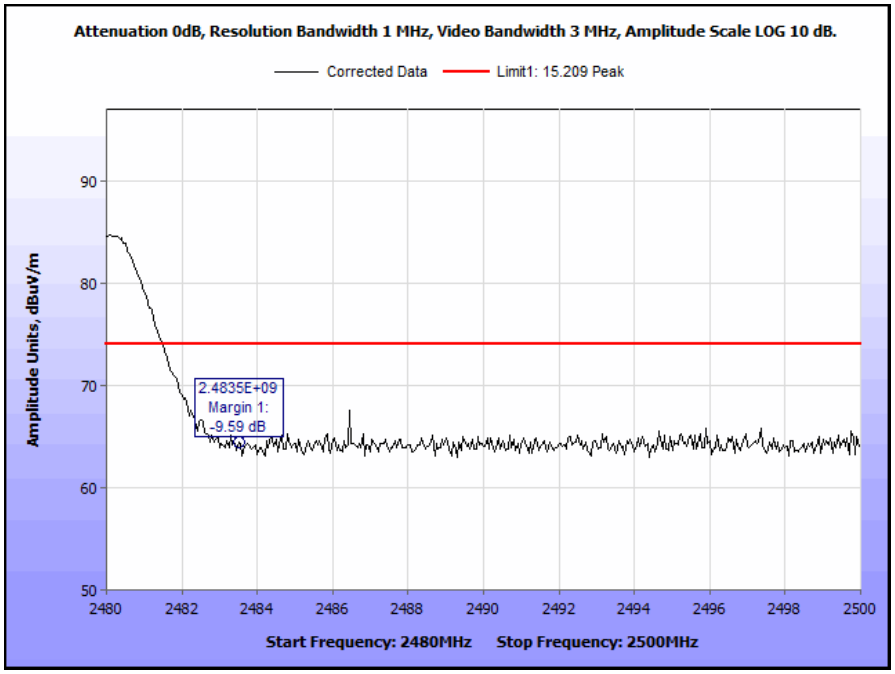
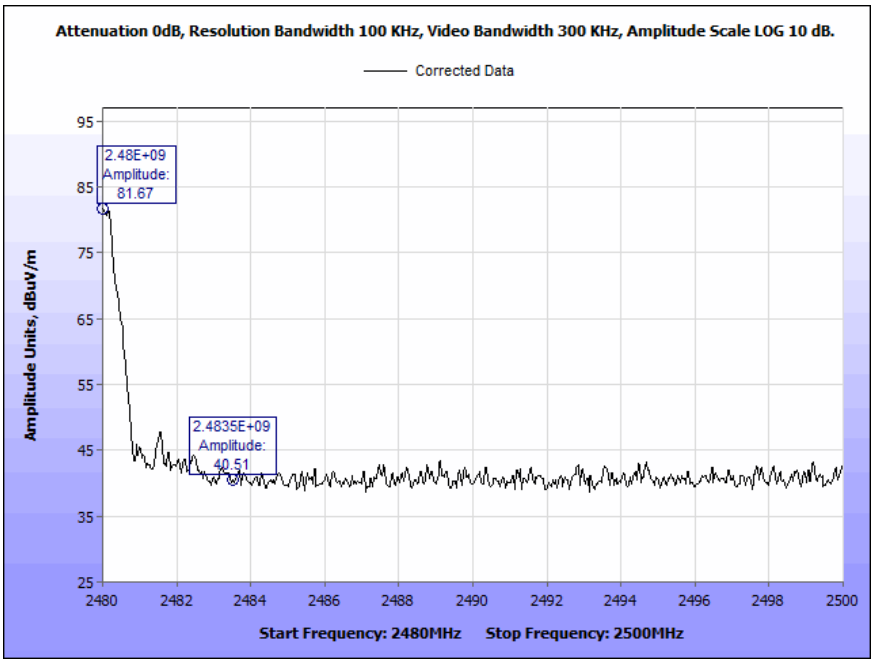



**Plot 201. Band Edge, Radio 2, High Channel, Peak**




**Plot 202. Band Edge 247(d), Radio 2, High Channel**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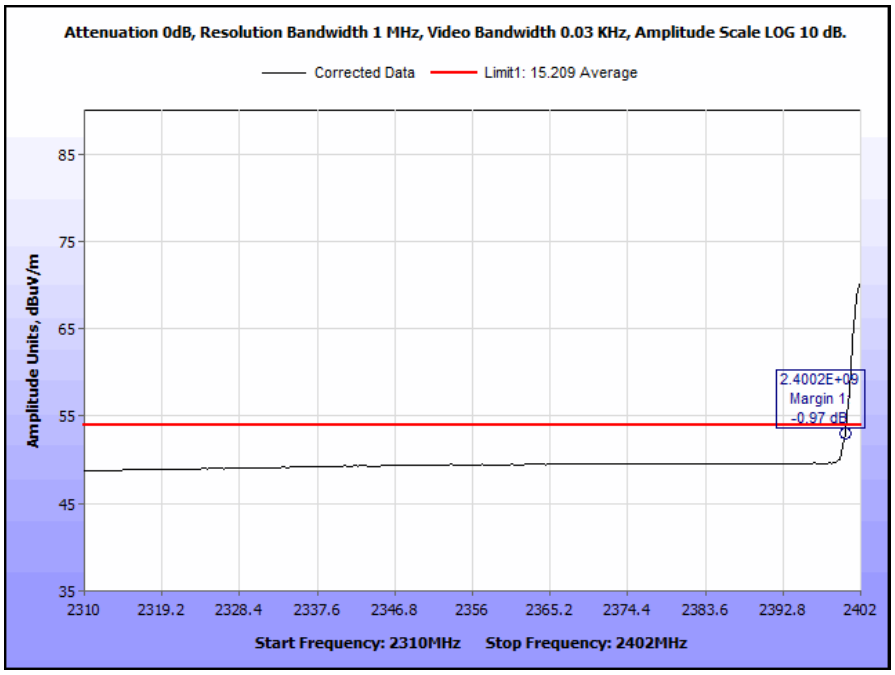
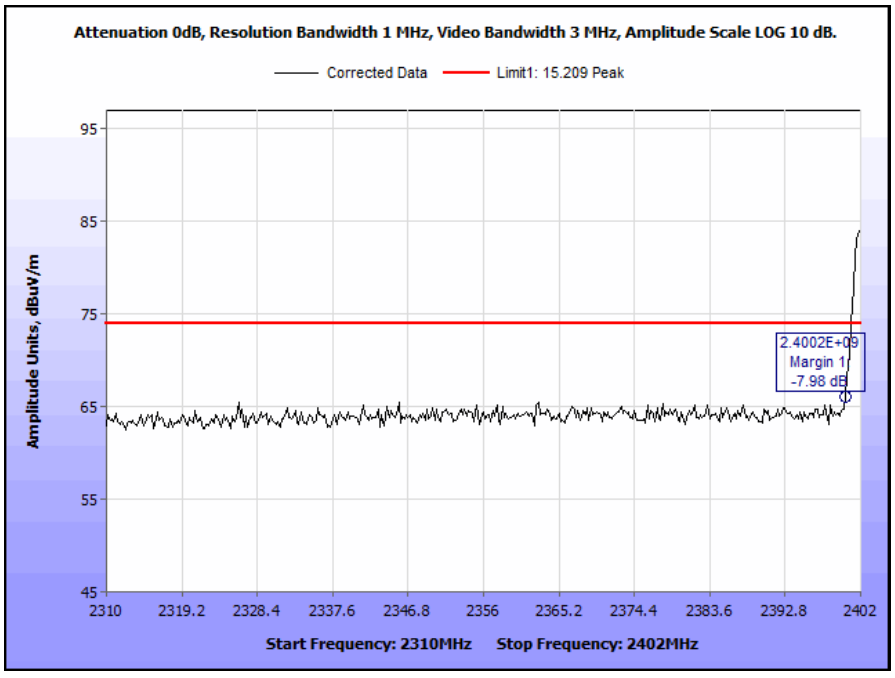



**Plot 203. Band Edge, Radio 3, Low Channel, Average**




**Plot 204. Band Edge, Radio 3, Low Channel, Peak**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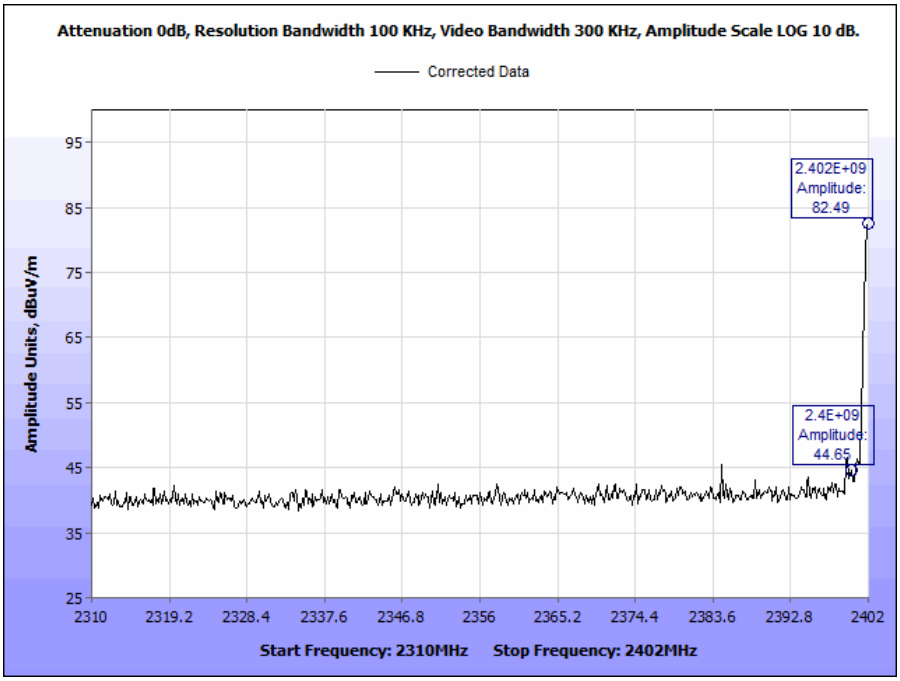
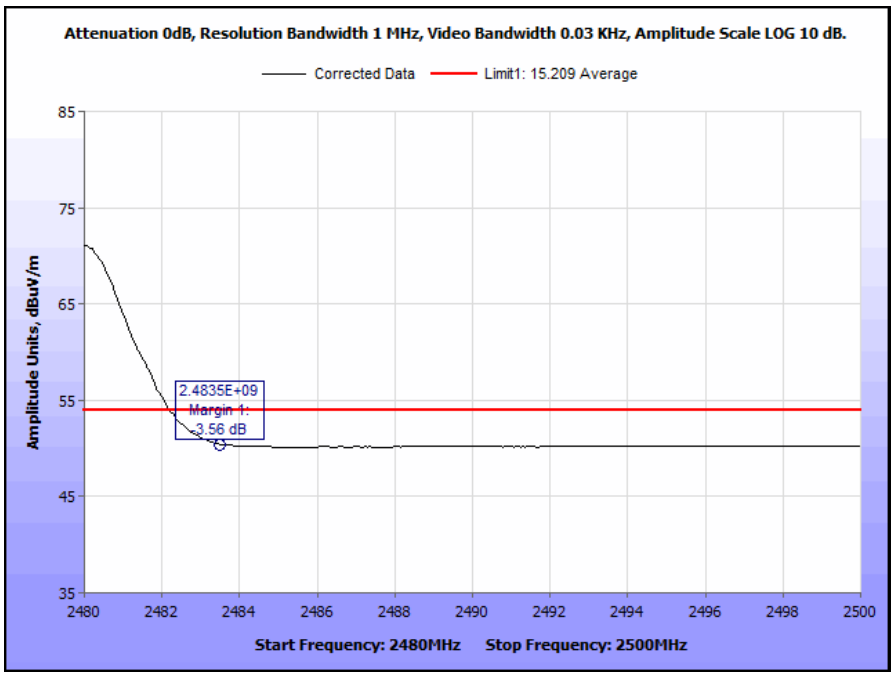



**Plot 205. Band Edge 247(d), Radio 3, Low Channel**




**Plot 206. Band Edge, Radio 3, High Channel, Average**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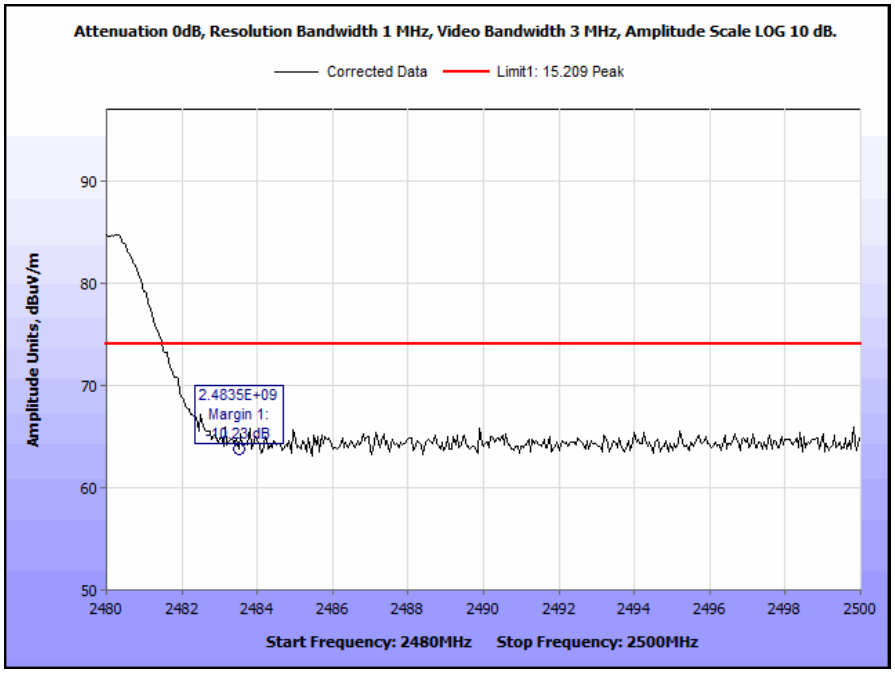
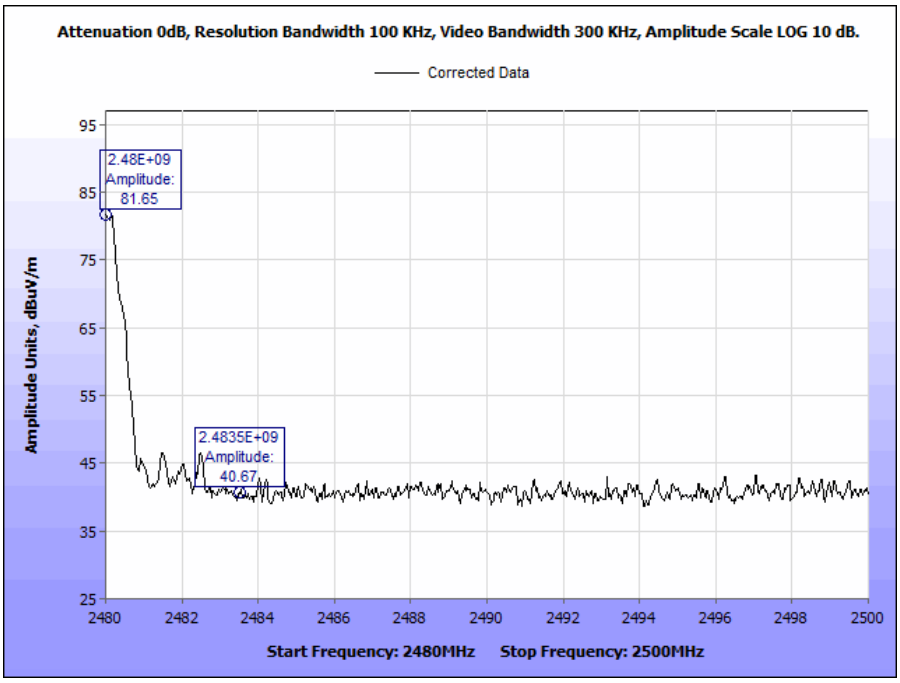



**Plot 207. Band Edge, Radio 3, High Channel, Peak**




**Plot 208. Band Edge 247(d), Radio 3, High Channel**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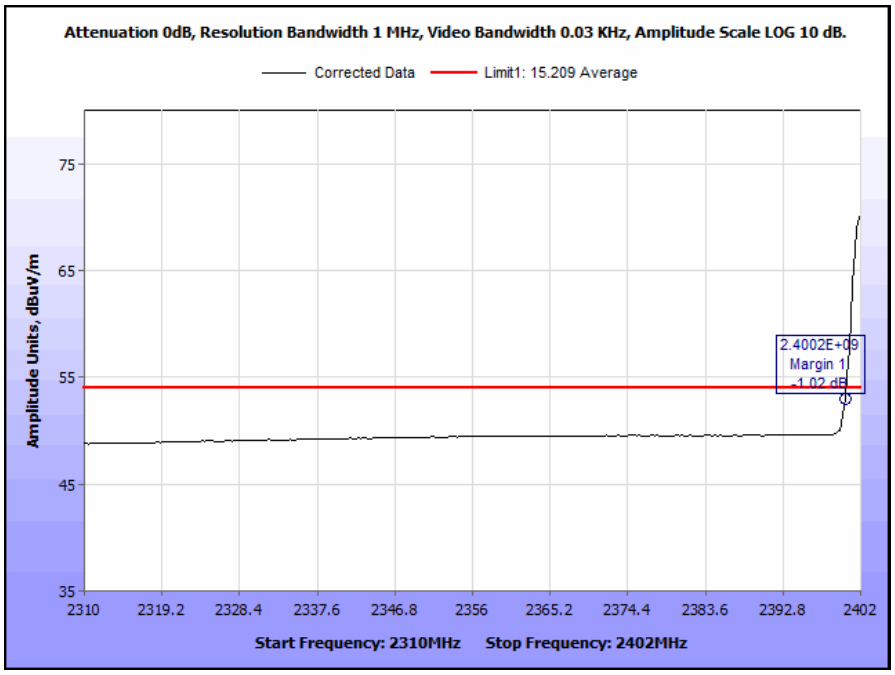
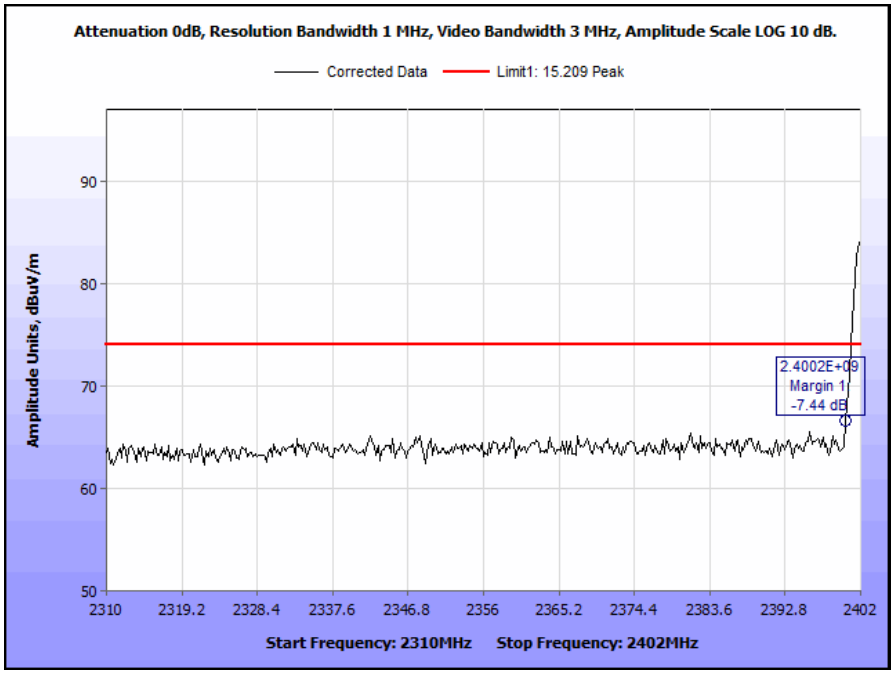



**Plot 209. Band Edge, Radio 4, Low Channel, Average**




**Plot 210. Band Edge, Radio 4, Low Channel, Peak**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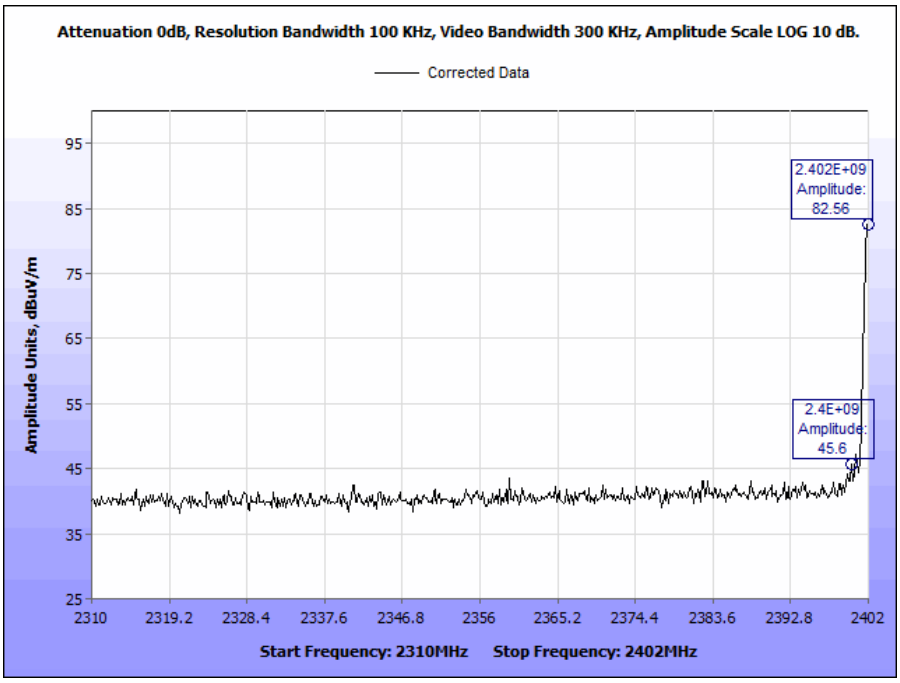
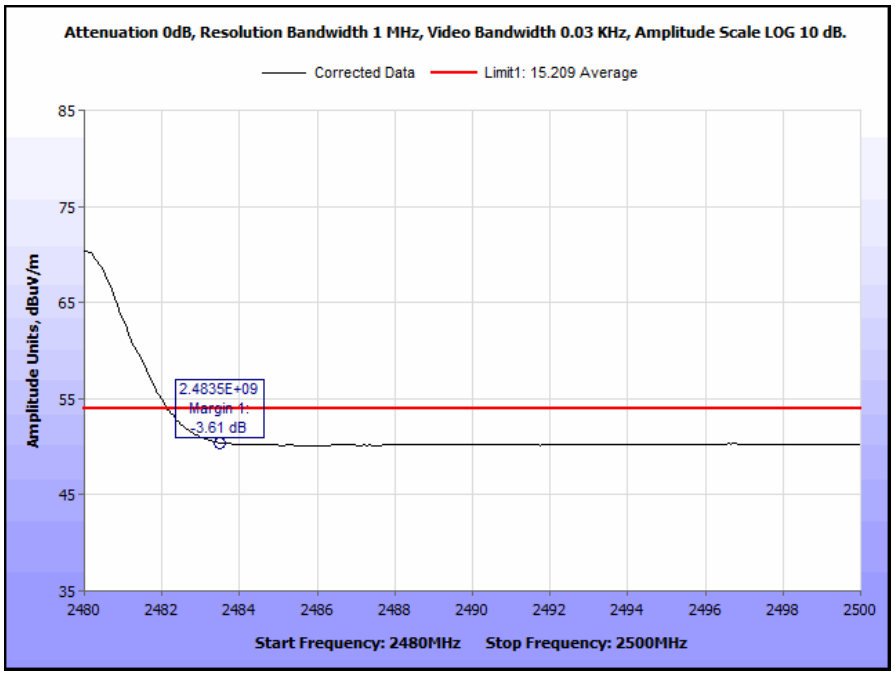



**Plot 211. Band Edge 247(d), Radio 4, Low Channel**




**Plot 212. Band Edge, Radio 4, High Channel, Average**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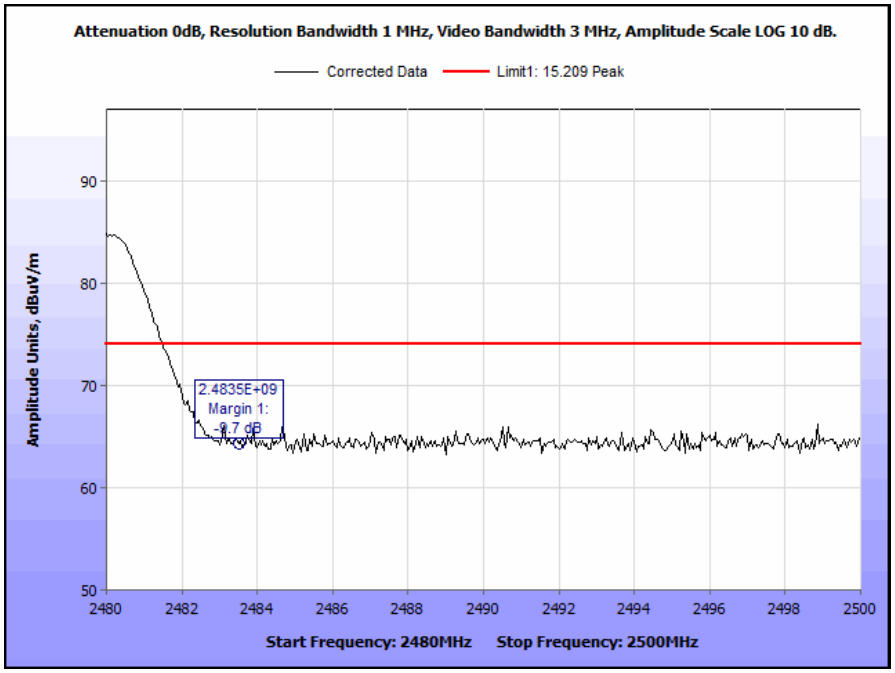
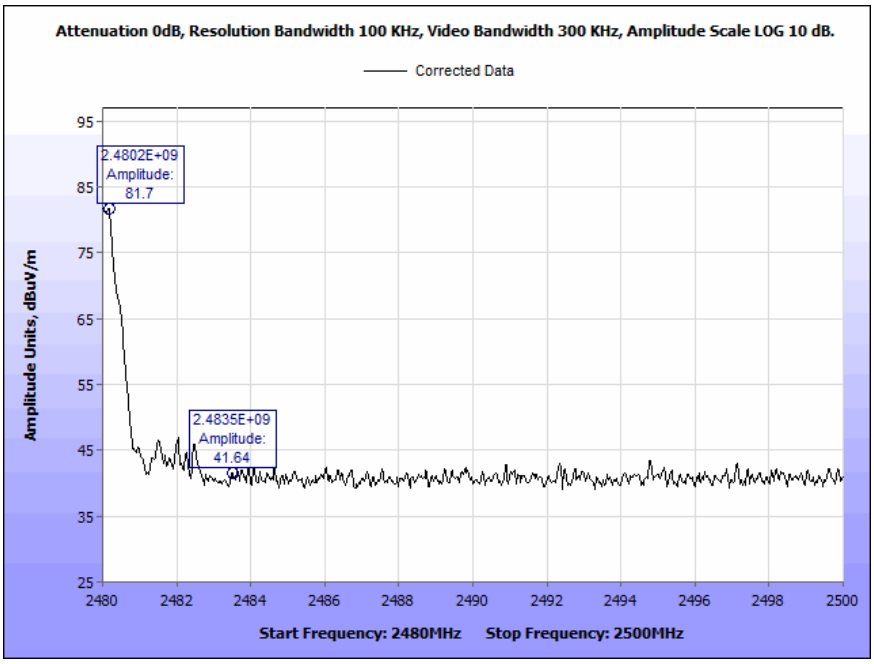



**Plot 213. Band Edge, Radio 4, High Channel, Peak**




**Plot 214. Band Edge 247(d), Radio 4, High Channel**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Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.247(g)(h) Declaration Statements for FHSS

**Test Requirements:**

(g) Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

(h) The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

**Test Results:** The EUT was compliant with the declaration statements of 15.247(g) and 15.247(h).

**Test Engineer:** Jeff Pratt

**Test Date:** 03/18/13

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# Electromagnetic Compatibility Criteria for Intentional Radiators

## § 15.247(i) Maximum Permissible Exposure

**RF Exposure Requirements:** **§1.1307(b)(1) and §1.1307(b)(2):** Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

**RF Radiation Exposure Limit:** **§1.1310:** As specified in this section, the Maximum Permissible Exposure (MPE) Limit shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Sec. 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Sec. 2.1093 of this chapter.

MPE Limit Calculation: EUT's operating frequencies @ 2400-2483.5MHz; highest conducted power = -11.18*dBm* (peak) therefore, **Limit for Uncontrolled exposure: 1 mW/cm$^2$ or 10 W/m$^2$**

Gain of Antenna Elements @ 2.4GHz= 3dBi

Equation from page 18 of OET 65, Edition 97-01

$$S = PG / 4\pi R^2 \quad \text{or} \quad R = \sqrt{PG / 4\pi S}$$

where, S = Power Density (mW/cm$^2$)
P = Power Input to antenna (0.076mW)
G = Antenna Gain (1.995)
R = Separation Distance between Antenna and User (20 cm)

$S = (0.076*1.995/ 4*3.14*20^2) = 0.00003 mW/cm^2$

Since S<1mW/cm$^2$, the device meets the RF exposure limits at a separation distance of 20cm with one radio operating at a time.

$S_4=(P_1G_1+P_2G_2+P_3G_3+P_4G_4)/(4*3.14*R^2)$
Where, $G_1=G_2=G_3=G_4=3dBi$
$P_1$= 0.052mW, $P_2$= 0.056mW, $P_3$= 0.047mW, $P_4$= 0.076mW
R = 20cm
$S_4 = (1.995*(0.052+0.056+0.047+0.076))/(4*3.14*20^2) = 0.00009 mW/cm^2$

Since S<1mW/cm$^2$, the device meets the RF exposure limits at a separation distance of 20cm with all radios transmitting simultaneously.

# IV. Test Equipment

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## Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2005.

| MET Asset # | Equipment | Manufacturer | Model | Last Cal Date | Cal Due Date |
|---|---|---|---|---|---|
| 1T4409 | EMI RECEIVER | ROHDE & SCHWARZ | ESIB7 | 7/16/2012 | 7/16/2013 |
| 1T4818 | COMB GENERATOR | COM-POWER | CGO-520 | SEE NOTE | |
| 1T4502 | COMB GENERATOR | COM-POWER | CGC-255 | 8/21/2012 | 2/21/2014 |
| 1T4771 | PSA SPECTRUM ANALYZER | AGILENT TECHNOLOGIES | E4446A | 2/15/2013 | 8/15/2014 |
| 1T4612 | SPECTRUM ANALYZER | AGILENT TECHNOLOGIES | E4407B | 5/23/2012 | 11/23/2014 |
| 1T4563 | LISN (10 AMP) | SOLAR ELECTRONICS | 9322-50-R-10-BNC | 11/27/2012 | 5/27/2014 |
| 1T4791 | THERM./CLOCK/HUMIDITY | CONTROL COMPANY | 06-662-4 | 3/8/2012 | 3/8/2014 |
| 1T4751 | ANTENNA - BILOG | SUNOL SCIENCES | JB6 | 1/8/2013 | 7/8/2014 |
| 1T4814 | COMB GENERATOR | COM-POWER | CGO-5100 | SEE NOTE | |
| 1T4442 | PRE-AMPLIFIER; MICROWAVE | MITEQ | AFS42-01001800-30-10P | SEE NOTE | |
| 1T4752 | PRE-AMPLIFIER | MITEQ | JS44-18004000-35-8P | SEE NOTE | |
| 1T4483 | ANTENNA; HORN | ETS-LINDGREN | 3117 | 8/6/202 | 2/6/2014 |
| 1T4745 | ANTENNA; HORN | ETS-LINDGREN | 3116 | 10/19/2012 | 10/19/2013 |
| 1T6658 | Spectrum Analyzer | Agilent | E4407B | 11/05/2014 | 11/05/2015 |
| 1T2665 | Antenna; Horn | EMCO | 3115 | 04/03/2014 | 10/03/2015 |

**Table 23. Test Equipment List**

Note: Functionally tested equipment is verified using calibrated instrumentation at the time of testing.


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# V. Certification & User's Manual Information


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# Certification & User's Manual Information

## A. Certification Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart I — Marketing of Radio frequency devices:

**§ 2.801 Radio-frequency device defined.**

As used in this part, a radio-frequency device is any device which in its operation is capable of Emitting radio-frequency energy by radiation, conduction, or other means. Radio- frequency devices include, but are not limited to:

(a) The various types of radio communication transmitting devices described throughout this chapter.

*(b) The incidental, unintentional and intentional radiators defined in Part 15 of this chapter.*

(c) The industrial, scientific, and medical equipment described in Part 18 of this chapter.

(d) Any part or component thereof which in use emits radio-frequency energy by radiation, conduction, or other means.

**§ 2.803 Marketing of radio frequency devices prior to equipment authorization.**

(a) Except as provided elsewhere in this chapter, no person shall sell or lease, or offer for sale or lease (including advertising for sale or lease), or import, ship or distribute for the purpose of selling or leasing or offering for sale or lease, any radio frequency device unless:

(1) In the case of a device subject to certification, such device has been authorized by the Commission in accordance with the rules in this chapter and is properly identified and labeled as required by §2.925 and other relevant sections in this chapter; or

(2) In the case of a device that is not required to have a grant of equipment authorization issued by the Commission, but which must comply with the specified technical standards prior to use, such device also complies with all applicable administrative (including verification of the equipment or authorization under a Declaration of Conformity, where required), technical, labeling and identification requirements specified in this chapter.

(d) Notwithstanding the provisions of paragraph (a) of this section, the offer for sale solely to business, commercial, industrial, scientific or medical users (but not an offer for sale to other parties or to end users located in a residential environment) of a radio frequency device that is in the conceptual, developmental, design or pre-production stage is permitted prior to equipment authorization or, for devices not subject to the equipment authorization requirements, prior to a determination of compliance with the applicable technical requirements *provided* that the prospective buyer is advised in writing at the time of the offer for sale that the equipment is subject to the FCC rules and that the equipment will comply with the appropriate rules before delivery to the buyer or to centers of distribution.

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(e)(1) Notwithstanding the provisions of paragraph (a) of this section, prior to equipment authorization or determination of compliance with the applicable technical requirements any radio frequency device may be operated, but not marketed, for the following purposes and under the following conditions:

*(i) Compliance testing;*

(ii) Demonstrations at a trade show provided the notice contained in paragraph (c) of this section is displayed in a conspicuous location on, or immediately adjacent to, the device;

(iii) Demonstrations at an exhibition conducted at a business, commercial, industrial, scientific or medical location, but excluding locations in a residential environment, provided the notice contained in paragraphs (c) or (d) of this section, as appropriate, is displayed in a conspicuous location on, or immediately adjacent to, the device;

(iv) Evaluation of product performance and determination of customer acceptability, provided such operation takes place at the manufacturer's facilities during developmental, design or pre-production states; or

(v) Evaluation of product performance and determination of customer acceptability where customer acceptability of a radio frequency device cannot be determined at the manufacturer's facilities because of size or unique capability of the device, provided the device is operated at a business, commercial, industrial, scientific or medical user's site, but not at a residential site, during the development, design or pre-production stages.

(e)(2) For the purpose of paragraphs (e)(1)(iv) and (e)(1)(v) of this section, the term *manufacturer's facilities* includes the facilities of the party responsible for compliance with the regulations and the manufacturer's premises, as well as the facilities of other entities working under the authorization of the responsible party in connection with the development and manufacture, but not the marketing, of the equipment.

(f) For radio frequency devices subject to verification and sold solely to business, commercial, industrial, scientific and medical users (excluding products sold to other parties or for operation in a residential environment), parties responsible for verification of the devices shall have the option of ensuring compliance with the applicable technical specifications of this chapter at each end user's location after installation, provided that the purchase or lease agreement includes a proviso that such a determination of compliance be made and is the responsibility of the party responsible for verification of the equipment.

## Certification & User's Manual Information

**The following is extracted from Title 47 of the Code of Federal Regulations, Part 2, Subpart J — Equipment Authorization Procedures:**

**§ 2.901 Basis and Purpose**

(a) In order to carry out its responsibilities under the Communications Act and the various treaties and international regulations, and in order to promote efficient use of the radio spectrum, the Commission has developed technical standards for radio frequency equipment and parts or components thereof. The technical standards applicable to individual types of equipment are found in that part of the rules governing the service wherein the equipment is to be operated.[1] *In addition to the technical standards provided, the rules governing the service may require that such equipment be verified by the manufacturer or importer*, be authorized under a Declaration of Conformity, or receive an equipment authorization from the Commission by one of the following procedures: certification or registration.

(b) The following sections describe the verification procedure, the procedure for a Declaration of Conformity, and the procedures to be followed in obtaining certification from the Commission and the conditions attendant to such a grant.

**§ 2.907 Certification.**

(a) Certification is an equipment authorization issued by the Commission, based on representation and test data submitted by the applicant.

(b) Certification attaches to all units subsequently marketed by the grantee which are identical (see Section 2.908) to the sample tested except for permissive changes or other variations authorized by the Commission pursuant to Section 2.1043.

[1] In this case, the equipment is subject to the rules of Part 15. More specifically, the equipment falls under Subpart B (of Part 15), which deals with unintentional radiators.

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## Certification & User's Manual Information

**§ 2.948 Description of measurement facilities.**

(a) Each party making measurements of equipment that is subject to an equipment authorization under Part 15 or Part 18 of this chapter, regardless of whether the measurements are filed with the Commission or kept on file by the party responsible for compliance of equipment marketed within the U.S. or its possessions, shall compile a description of the measurement facilities employed.

(1) If the measured equipment is subject to the verification procedure, the description of the measurement facilities shall be retained by the party responsible for verification of the equipment.

*(i) If the equipment is verified through measurements performed by an independent laboratory, it is acceptable for the party responsible for verification of the equipment to rely upon the description of the measurement facilities retained by or placed on file with the Commission by that laboratory. In this situation, the party responsible for the verification of the equipment is not required to retain a duplicate copy of the description of the measurement facilities.*

(ii) If the equipment is verified based on measurements performed at the installation site of the equipment, no specific site calibration data is required. It is acceptable to retain the description of the measurement facilities at the site at which the measurements were performed.

(2) If the equipment is to be authorized by the Commission under the certification procedure, the description of the measurement facilities shall be filed with the Commission's Laboratory in Columbia, Maryland. The data describing the measurement facilities need only be filed once but must be updated as changes are made to the measurement facilities or as otherwise described in this section. At least every three years, the organization responsible for filing the data with the Commission shall certify that the data on file is current.

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# Certification & User's Manual Information

## 1. Label and User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart A — General:

**§ 15.19 Labeling requirements.**

*(a) In addition to the requirements in Part 2 of this chapter, a device subject to certification or verification shall be labeled as follows:*

(1) Receivers associated with the operation of a licensed radio service, e.g., FM broadcast under Part 73 of this chapter, land mobile operation under Part 90, etc., shall bear the following statement in a conspicuous location on the device:

This device complies with Part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

(2) A stand-alone cable input selector switch, shall bear the following statement in a conspicuous location on the device:

This device is verified to comply with Part 15 of the FCC Rules for use with cable television service.

(3) All other devices shall bear the following statement in a conspicuous location on the device:

*This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.*

(4) Where a device is constructed in two or more sections connected by wires and marketed together, the statement specified under paragraph (a) of this section is required to be affixed only to the main control unit.

(5) When the device is so small or for such use that it is not practicable to place the statement specified under paragraph (a) of this section on it, the information required by this paragraph shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or, alternatively, shall be placed on the container in which the device is marketed. However, the FCC identifier or the unique identifier, as appropriate, must be displayed on the device.

**§ 15.21 Information to user.**

The users manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

## Verification & User's Manual Information

The following is extracted from Title 47 of the Code of Federal Regulations, Part 15, Subpart B — Unintentional Radiators:

**§ 15.105 Information to the user.**

(a) For a Class A digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at own expense.

(b) For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a residential environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

– Reorient or relocate the receiving antenna.

– Increase the separation between the equipment and receiver.

– Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

– Consult the dealer or an experienced radio/TV technician for help.

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## ICES-003 Procedural & Labeling Requirements

From the Industry Canada Electromagnetic Compatibility Advisory Bulletin entitled, "Implementation and Interpretation of the Interference-Causing Equipment Standard for Digital Apparatus, ICES-003" (EMCAB-3, Issue 2, July 1995):

> "At present, CISPR 22: 2002 and ICES technical requirements are essentially equivalent. Therefore, if you have CISPR 22: 2002 approval by meeting CISPR Publication 22, the only additional requirements are: to attach a note to the report of the test results for compliance, indicating that these results are deemed satisfactory evidence of compliance with ICES-003 of the Canadian Interference-Causing Equipment Regulations; to maintain these records on file for the requisite five year period; and to provide the device with a notice of compliance in accordance with ICES-003."

**Procedural Requirements:**

According to Industry Canada's Interference Causing Equipment Standard for Digital Apparatus ICES-003 Issue 4, February 2004:

Section 6.1: A record of the measurements and results, showing the date that the measurements were completed, shall be retained by the manufacturer or importer for a period of at least five years from the date shown in the record and made available for examination on the request of the Minister.

Section 6.2: A written notice indicating compliance must accompany each unit of digital apparatus to the end user. The notice shall be in the form of a label that is affixed to the apparatus. Where because of insufficient space or other constraints it is not feasible to affix a label to the apparatus, the notice may be in the form of a statement in the user's manual.

**Labeling Requirements:**

The suggested text for the notice, in English and in French, is provided below, from the Annex of ICES-003:

> This Class [2] digital apparatus complies with Canadian ICES-003.
>
> Cet appareil numérique de la classe [1] est conforme à la norme NMB-003 du Canada.

[2] Insert either A or B but not both as appropriate for the equipment requirements.

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# End of Report

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