MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*

914 WEST PATAPSCO AVENUE ● BALTIMORE, MARYLAND 21230-3432 ● PHONE (410) 354-3300 ● FAX (410) 354-3313
33439 WESTERN AVENUE ● UNION CITY, CALIFORNIA 94587 ● PHONE (510) 489-6300 ● FAX (510) 489-6372
3162 BELICK STREET ● SANTA CLARA, CA 95054-2401 ● PHONE (408) 748-3585 ● FAX (510) 489-6372

June 8, 2009

Ubiquiti Networks
91 E. Tasman
San Jose, CA 95134

Dear Robert Pera,

Enclosed is the EMC test report for compliance testing of the Ubiquiti Networks, M2 tested to the requirements of ETSI EN 300 328 V1.7.1 (2006-10) (Article 3.2 of R&TTE Directive).

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 Sanchez
Documentation Department

Reference: (\Ubiquiti Networks\EMCS81509-EN328)

Certificates and reports shall not be reproduced except in full, without the written permission of MET Laboratories, Inc.

MET Laboratories, Inc. *Safety Certification - EMI - Telecom Environmental Simulation*

914 WEST PATAPSCO AVENUE ● BALTIMORE, MARYLAND 21230-3432 ● PHONE (410) 354-3300 ● FAX (410) 354-3313
33439 WESTERN AVENUE ● UNION CITY, CALIFORNIA 94587 ● PHONE (510) 489-6300 ● FAX (510) 489-6372
3162 BELICK STREET ● SANTA CLARA, CA 95054-2401 ● PHONE (408) 748-3585 ● FAX (510) 489-6372

Electromagnetic Compatibility Criteria
Test Report

For the

Ubiquiti Networks
Model M2

Tested under

ETSI EN 300 328 V1.7.1 (2006-10)

(Article 3.2 of R&TTE Directive)

MET Report: EMCS81509-EN328

June 8, 2009

Prepared For:

Ubiquiti Networks
91 E. Tasman
San Jose, CA 95134

Prepared By:
MET Laboratories, Inc.
3162 Belick St.
Santa Clara, CA 95054

Certificates and reports shall not be reproduced except in full, without the written permission of MET Laboratories, Inc.

Electromagnetic Compatibility Criteria
Test Report

For the

Ubiquiti Networks
Model M2

Tested under

ETSI EN 300 328 V1.7.1 (2006-10)

(Article 3.2 of R&TTE Directive)

MET Report: EMCS81509-EN300328

Anderson Soungpanya, Project Engineer
Electromagnetic Compatibility Lab

Jennifer Sanchez
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 ETSI EN 300 328 V1.7.1 (2006-10) of the EU Rules under normal use and maintenance.

Shawn McMillen, Manager
Electromagnetic Compatibility Lab

 © 2011, MET Laboratories, Inc.

Report Status Sheet

Revision	Report Date	Reason for Revision
∅	June 8, 2009	Initial Issue.

 © 2011, MET Laboratories, Inc.

Table of Contents

I. Requirements Summary 1
II. Equipment Configuration 3
A. Overview 4
B. References 4
C. Test Site 5
D. Description of Test Sample 5
E. Equipment Configuration 7
F. Ports and Cabling Information 7
G. Mode of Operation 8
H. Method of Monitoring EUT Operation 8
I. Modifications 8
a) Modifications to EUT 8
b) Modifications to Test Standard 8
J. Disposition of EUT 8
III. Conformance Requirements 9
4.3.2 Maximum Spectral Power Density 13
4.3.3 Frequency Range 25
4.3.5 Medium Access Protocol 40
4.3.6 Transmitter Spurious Emissions - Conducted 41
4.3.6 Transmitter Spurious Emissions - Radiated 63
4.3.7 Receiver Spurious Emissions 92
IV. Test Equipment 98

 © 2011, MET Laboratories, Inc.

List of Tables

Table 1. Summary of EMC ETSI EN 300 328 V1.7.1 (2006-10) (Article 3.2 of R&TTE Directive) Compliance Testing 2
Table 2. Test References 4
Table 3. Equipment Configuration 7
Table 4. Support Equipment 7
Table 5. Ports and Cabling Information 7
Table 6. Isotropic Radiated Power Test Results – DSSS mode 11
Table 7. Isotropic Radiated Power Test Results – OFDM mode 11
Table 8. Isotropic Radiated Power Test Results – HT20 12
Table 9. Isotropic Radiated Power Test Results – HT40 12
Table 10. Frequency Range Test Results – DSSS mode 26
Table 11. Frequency Range Test Results – OFDM mode 26
Table 12. Frequency Range Test Results – HT20 mode 27
Table 13. Frequency Range Test Results – HT40 mode 27
Table 14. Transmitter limits for narrowband spurious emissions 41
Table 15. Transmitter limits for wideband spurious emissions 41
Table 16. Transmitter Limits for Narrowband Spurious Emissions 63
Table 17. Transmitter Limits for Wideband Spurious Emissions 63
Table 18. Narrowband spurious emission limits for receivers 92
Table 19. Wideband spurious emission limits for receivers 92

 © 2011, MET Laboratories, Inc.

List of Plots

Plot 1. Spectral Density Power Determination – Low Channel, DSSS mode 15
Plot 2. Spectral Density Power – Low Channel, DSSS mode 15
Plot 3. Spectral Density Power Determination – Mid Channel, DSSS mode 16
Plot 4. Spectral Density Power – Mid Channel, DSSS mode 16
Plot 5. Spectral Density Power Determination – High Channel, DSSS mode 17
Plot 6. Spectral Density Power – High Channel, DSSS mode 17
Plot 7. Spectral Density Power Determination – Low Channel, OFDM mode 18
Plot 8. Spectral Density Power – Low Channel, OFDM mode 18
Plot 9. Spectral Density Power Determination – Mid Channel, OFDM mode 19
Plot 10. Spectral Density Power – Mid Channel, OFDM mode 19
Plot 11. Spectral Density Power Determination – High Channel, OFDM mode 20
Plot 12. Spectral Density Power – High Channel, OFDM mode 20
Plot 13. Spectral Density Power Determination – Low Channel, HT20 mode 21
Plot 14. Spectral Density Power – Low Channel, HT20 mode 21
Plot 15. Spectral Density Power Determination – Mid Channel, HT20 mode 22
Plot 16. Spectral Density Power – Mid Channel, HT20 mode 22
Plot 17. Spectral Density Power Determination – High Channel, HT20 mode 23
Plot 18. Spectral Density Power – High Channel, HT20 mode 23
Plot 19. Spectral Density Power Determination – Mid Channel, HT40 mode 24
Plot 20. Spectral Density Power – Mid Channel, HT40 mode 24
Plot 21. Frequency Range Test Results – Nominal Temp/Low Voltage, (DSSS mode) 28
Plot 22. Frequency Range Test Results – Nominal Temp/Nominal Voltage, (DSSS mode) 28
Plot 23. Frequency Range Test Results – Nominal Temp/Maximum Voltage, (DSSS mode) 28
Plot 24. Frequency Range Test Results – Low Temp/Low Voltage, (DSSS mode) 29
Plot 25. Frequency Range Test Results – Low Temp/Nominal Voltage, (DSSS mode) 29
Plot 26. Frequency Range Test Results – Low Temp/Maximum Voltage, (DSSS mode) 29
Plot 27. Frequency Range Test Results – Maximum Temp/Low Voltage, (DSSS mode) 30
Plot 28. Frequency Range Test Results – Maximum Temp/Nominal Voltage, (DSSS mode) 30
Plot 29. Frequency Range Test Results – Maximum Temp/Maximum Voltage, (DSSS mode) 30
Plot 30. Frequency Range Test Results – Nominal Temp/Low Voltage, (OFDM mode) 31
Plot 31. Frequency Range Test Results – Nominal Temp/Nominal Voltage, (OFDM mode) 31
Plot 32. Frequency Range Test Results – Nominal Temp/Maximum Voltage, (OFDM mode) 31
Plot 33. Frequency Range Test Results – Low Temp/Low Voltage, (OFDM mode) 32
Plot 34. Frequency Range Test Results – Low Temp/Nominal Voltage, (OFDM mode) 32
Plot 35. Frequency Range Test Results – Low Temp/Maximum Voltage, (OFDM mode) 32
Plot 36. Frequency Range Test Results – Maximum Temp/Low Voltage, (OFDM mode) 33
Plot 37. Frequency Range Test Results – Maximum Temp/Nominal Voltage, (OFDM mode) 33
Plot 38. Frequency Range Test Results – Maximum Temp/Maximum Voltage, (OFDM mode) 33
Plot 39. Frequency Range Test Results – Nominal Temp/Low Voltage, (HT20 mode) 34
Plot 40. Frequency Range Test Results – Nominal Temp/Nominal Voltage, (HT20 mode) 34
Plot 41. Frequency Range Test Results – Nominal Temp/Maximum Voltage, (HT20 mode) 34
Plot 42. Frequency Range Test Results – Low Temp/Low Voltage, (HT20 mode) 35
Plot 43. Frequency Range Test Results – Low Temp/Nominal Voltage, (HT20 mode) 35
Plot 44. Frequency Range Test Results – Low Temp/Maximum Voltage, (HT20 mode) 35
Plot 45. Frequency Range Test Results – Maximum Temp/Low Voltage, (HT20 mode) 36
Plot 46. Frequency Range Test Results – Maximum Temp/Nominal Voltage, (HT20 mode) 36
Plot 47. Frequency Range Test Results – Maximum Temp/Maximum Voltage, (HT20 mode) 36
Plot 48. Frequency Range Test Results – Nominal Temp/Low Voltage, (HT40 mode) 37
Plot 49. Frequency Range Test Results – Nominal Temp/Nominal Voltage, (HT40 mode) 37
Plot 50. Frequency Range Test Results – Nominal Temp/Maximum Voltage, (HT40 mode) 37
Plot 51. Frequency Range Test Results – Low Temp/Low Voltage, (HT40 mode) 38
Plot 52. Frequency Range Test Results – Low Temp/Nominal Voltage, (HT40 mode) 38
Plot 53. Frequency Range Test Results – Low Temp/Maximum Voltage, (HT40 mode) 38
Plot 54. Frequency Range Test Results – Maximum Temp/Low Voltage, (HT40 mode) 39

 © 2011, MET Laboratories, Inc.

Plot 55. Frequency Range Test Results – Maximum Temp/Nominal Voltage, (HT40 mode) 39
Plot 56. Frequency Range Test Results – Maximum Temp/Maximum Voltage, (HT40 mode) 39
Plot 57. Low channel (2412 MHz) Spurious Emission 30 MHz - 1GHz DSSS Mode 43
Plot 58. Low channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz DSSS Mode 43
Plot 59. Low channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz DSSS Mode 44
Plot 60. Low channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz DSSS Mode 44
Plot 61. Mid channel (2412 MHz) Spurious Emission 30 MHz - 1GHz DSSS Mode 45
Plot 62. Mid channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz DSSS Mode 45
Plot 63. Mid channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz DSSS Mode 46
Plot 64. Mid channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz DSSS Mode 46
Plot 65. High channel (2412 MHz) Spurious Emission 30 MHz - 1GHz DSSS Mode 47
Plot 66. High channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz DSSS Mode 47
Plot 67. High channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz DSSS Mode 48
Plot 68. High channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz DSSS Mode 48
Plot 69. Low channel (2412 MHz) Spurious Emission 30 MHz - 1GHz OFDM Mode 49
Plot 70. Low channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz OFDM Mode 49
Plot 71. Low channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz OFDM Mode 50
Plot 72. Low channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz OFDM Mode 50
Plot 73. Mid channel (2412 MHz) Spurious Emission 30 MHz - 1GHz OFDM Mode 51
Plot 74. Mid channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz OFDM Mode 51
Plot 75. Mid channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz OFDM Mode 52
Plot 76. Mid channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz OFDM Mode 52
Plot 77. High channel (2412 MHz) Spurious Emission 30 MHz - 1GHz OFDM Mode 53
Plot 78. High channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz OFDM Mode 53
Plot 79. High channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz OFDM Mode 54
Plot 80. High channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz OFDM Mode 54
Plot 81. Low channel (2412 MHz) Spurious Emission 30 MHz - 1GHz HT20 Mode 55
Plot 82. Low channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz HT20 Mode 55
Plot 83. Low channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz HT20 Mode 56
Plot 84. Low channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz HT20 Mode 56
Plot 85. Mid channel (2412 MHz) Spurious Emission 30 MHz - 1GHz HT20 Mode 57
Plot 86. Mid channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz HT20 Mode 57
Plot 87. Mid channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz HT20 Mode 58
Plot 88. Mid channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz HT20 Mode 58
Plot 89. High channel (2412 MHz) Spurious Emission 30 MHz - 1GHz HT20 Mode 59
Plot 90. High channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz HT20 Mode 59
Plot 91. High channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz HT20 Mode 60
Plot 92. High channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz HT20 Mode 60
Plot 93. Mid channel (2412 MHz) Spurious Emission 30 MHz - 1GHz HT40 Mode 61
Plot 94. Mid channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz HT40 Mode 61
Plot 95. Mid channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz HT40 Mode 62
Plot 96. Mid channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz HT40 Mode 62
Plot 97. Low channel (2412 MHz) Spurious Emission 30 MHz - 1GHz DSSS Mode 64
Plot 98. Low channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz DSSS Mode 64
Plot 99. Low channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz DSSS Mode 65
Plot 100. Low channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz DSSS Mode 65
Plot 101. Mid channel (2462 MHz) Spurious Emission 30 MHz - 1GHz DSSS Mode 66
Plot 102. Mid channel (2462 MHz) Spurious Emission 1 GHz - 12.75 GHz DSSS Mode 66
Plot 103. Mid channel (2462 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz DSSS Mode 67
Plot 104. Mid channel (2462 MHz) Spurious Emission 5.15 GHz - 5.3 GHz DSSS Mode 67
Plot 105. High channel (2462 MHz) Spurious Emission 30 MHz - 1GHz DSSS Mode 68
Plot 106. High channel (2462 MHz) Spurious Emission 1 GHz - 12.75 GHz DSSS Mode 68
Plot 107. High channel (2462 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz DSSS Mode 69
Plot 108. High channel (2462 MHz) Spurious Emission 5.15 GHz - 5.3 GHz DSSS Mode 69
Plot 109. Low channel (2412 MHz) Spurious Emission 30 MHz - 1GHz OFDM Mode 70
Plot 110. Low channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz OFDM Mode 70

 © 2011, MET Laboratories, Inc.

Plot 111. Low channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz OFDM Mode 71
Plot 112. Low channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz OFDM Mode 71
Plot 113. Mid channel (2412 MHz) Spurious Emission 30 MHz - 1GHz OFDM Mode 72
Plot 114. Mid channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz OFDM Mode 72
Plot 115. Mid channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz OFDM Mode 73
Plot 116. Mid channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz OFDM Mode 73
Plot 117. High channel (2462 MHz) Spurious Emission 30 MHz - 1GHz OFDM Mode 74
Plot 118. High channel (2462 MHz) Spurious Emission 1 GHz - 12.75 GHz OFDM Mode 74
Plot 119. High channel (2462 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz OFDM Mode 75
Plot 120. High channel (2462 MHz) Spurious Emission 5.15 GHz - 5.3 GHz OFDM Mode 75
Plot 121. Low channel (2412 MHz) Spurious Emission 30 MHz - 1GHz HT20 Mode 76
Plot 122. Low channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz HT20 Mode 76
Plot 123. Low channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz HT20 Mode 77
Plot 124. Low channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz HT20 Mode 77
Plot 125. Mid channel (2412 MHz) Spurious Emission 30 MHz - 1GHz HT20 Mode 78
Plot 126. Mid channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz HT20 Mode 78
Plot 127. Mid channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz HT20 Mode 79
Plot 128. Mid channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz HT20 Mode 79
Plot 129. High channel (2462 MHz) Spurious Emission 30 MHz - 1GHz HT20 Mode 80
Plot 130. High channel (2462 MHz) Spurious Emission 1 GHz - 12.75 GHz HT20 Mode 80
Plot 131. High channel (2462 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz HT20 Mode 81
Plot 132. High channel (2462 MHz) Spurious Emission 5.15 GHz - 5.3 GHz HT20 Mode 81
Plot 133. Low channel (2412 MHz) Spurious Emission 30 MHz - 1GHz HT40 Mode 82
Plot 134. Low channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz HT40 Mode 82
Plot 135. Low channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz HT40 Mode 83
Plot 136. Low channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz HT40 Mode 83
Plot 137. Mid channel (2412 MHz) Spurious Emission 30 MHz - 1GHz HT40 Mode 84
Plot 138. Mid channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz HT40 Mode 84
Plot 139. Mid channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz HT40 Mode 85
Plot 140. Mid channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz HT40 Mode 85
Plot 141. High channel (2462 MHz) Spurious Emission 30 MHz - 1GHz HT40 Mode 86
Plot 142. High channel (2462 MHz) Spurious Emission 1 GHz - 12.75 GHz HT40 Mode 86
Plot 143. High channel (2462 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz HT40 Mode 87
Plot 144. High channel (2462 MHz) Spurious Emission 5.15 GHz - 5.3 GHz HT40 Mode 87
Plot 145. Receiver Radiated Spurious Emission 30 MHz - 1GHz (Port 1) 94
Plot 146. Receiver Radiated Spurious Emission 1 GHz - 12.75 GHz (Port 1) 94
Plot 147. Receiver Conducted Spurious Emission 30 MHz - 1GHz (Port 1) 95
Plot 148. Receiver Conducted Spurious Emission 1 GHz - 12.75 GHz (Port 1) 95
Plot 149. Receiver Radiated Spurious Emission 30 MHz - 1GHz (MIMO) 96
Plot 150. Receiver Radiated Spurious Emission 1 GHz - 12.75 GHz (MIMO) 96
Plot 151. Receiver Conducted Spurious Emission 30 MHz - 1GHz (MIMO) 97
Plot 152. Receiver Conducted Spurious Emission 1 GHz - 12.75 GHz (MIMO) 97

List of Photographs

Photograph 1. Ubiquiti Networks M2 5
Photograph 2. Radiated Emissions Setup, 30MHz – 1GHz 88
Photograph 3. Radiated Emissions Setup, 30MHz – 1GHz. MIMO Mode 89
Photograph 4. Radiated Emissions Setup, 1GHz – 18GHz 90
Photograph 5. Radiated Emissions Setup, 1GHz – 18GHz. MIMO Mode 91

 © 2011, MET Laboratories, Inc.

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
CISPR	**C**omite **I**nternational **S**pecial des **P**erturbations **R**adioelectriques (International Special Committee on Radio Interference)
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	**micro**Henry
µF	**micro**Farad
µs	**micros**econds
PRF	**P**ulse **R**epetition **F**requency
RF	**R**adio **F**requency
RMS	**R**oot-**M**ean-**S**quare
V/m	**V**olts **per m**eter
VCP	**V**ertical **C**oupling **P**lane

© 2011, MET Laboratories, Inc.

I. Requirements Summary

 © 2011, MET Laboratories, Inc.

A. Requirements Summary

ETSI EN 300 328 Section Number	Descriptive Name	Compliance			Comments
		Yes	No	N/A	
Sections 4.3.1	Effective Radiated Power	√			Compliant
Sections 4.3.2	Maximum Spectral Power Density	√			Compliant
Sections 4.3.3	Frequency Range	√			Compliant
Sections 4.3.5	Medium Access Protocol	√			Compliant
Sections 4.3.6	Transmitter Spurious Emissions	√			Compliant
Sections 4.3.7	Receiver Spurious Emissions	√			Compliant

Table 1. Summary of EMC ETSI EN 300 328 V1.7.1 (2006-10) (Article 3.2 of R&TTE Directive) Compliance Testing

 © 2011, MET Laboratories, Inc.

II. Equipment Configuration

 © 2011, MET Laboratories, Inc.

A. Overview

MET Laboratories, Inc. was contracted by Ubiquiti Networks to perform testing on a M2.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the Ubiquiti Networks model M2.

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

Model(s) Tested:	M2
Model(s) Number:	M2
EUT Specifications:	Primary Power: 15VDC 0.8A POE
	Secondary Power: N/A
Lab Ambient (Normal) Test Conditions:	Temperature: 15-35º C
	Relative Humidity: 30-60%
	Atmospheric Pressure: 860-1060 mbar
Extreme Test Conditions:	Voltage: ±10% of 230VAC 50Hz `
	Temperature: -20 to +70º C
	Relative Humidity: 30-60%
Evaluated by:	Anderson Soungpanya
Date(s):	April 21, April 22, April 28, 2009 & May 7, 2009

B. References

ETSI EN 300 328 V1.7.1 (2006-10)	Electromagnetic compatibility and Radio spectrum Matters (ERM); Wideband Transmission systems; data transmission equipment in the 2.4 GHz ISM band and using spread spectrum modulation techniques; Part1: Technical characteristics and test conditions

Table 2. Test References

 © 2011, MET Laboratories, Inc.

C. Test Site

All testing was performed at MET Laboratories, Inc., 3162 Belick Street, Santa Clara, CA 95054. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

D. Description of Test Sample

The Ubiquiti Networks M2, is a 2GHz, DSSS/gn MIMO 2X2 Outdoor radio.

Photograph 1. Ubiquiti Networks M2

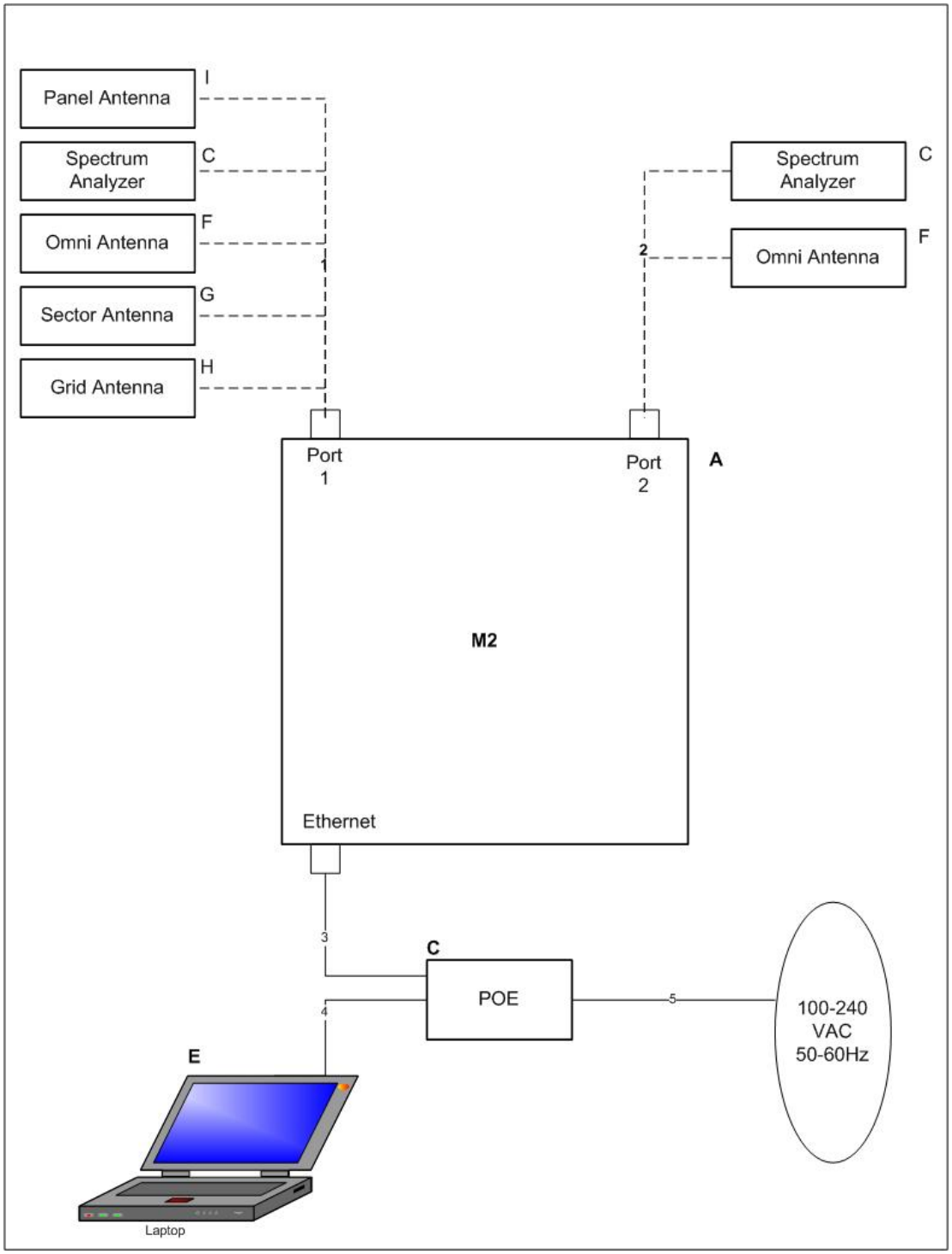


Figure 1. Block Diagram of Test Configuration

 © 2011, MET Laboratories, Inc.

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	Part Number	Serial Number
A	M2	M2	M2	4-16-09
C	POE	UB1-POE-15-8	NA	0901-0004848

Table 3. Equipment Configuration

F. Support Equipment

Ubiquiti Networks supplied support equipment necessary for the operation and testing of the M2. All support equipment supplied is listed in the following Support Equipment List.

Ref. ID	Name / Description	Manufacturer	Model Number	*Customer Supplied Calibration Data
M2				
N	Spectrum Analyzer	Agilent	E4447A	NA
E	Laptop	Dell	Vostro 1000	NA
F	6 dBi Omni Antennas	Ubiquiti Networks	O-2G-6	NA
G	16 dBi Sector Antenna	Ubiquiti Networks	AMS-2G-16	NA
H	18 dBi Grid Antenna	Ubiquiti Networks	AG-2G-25	NA
I	25 dBi Panel Antenna	Ubiquiti Networks	RP-2G-18	NA

Table 4. Support Equipment

G. Ports and Cabling Information

Ref. ID	Port name on EUT	Cable Description or reason for no cable	Qty.	Length (m)	Shielded (Y/N)	Termination Box ID & Port Name
M2						
1	A, Antenna Port1	Coaxial Cable	1	.1	Y	F or G or H or I
2	A, Antenna Port2	Coaxial Cable	1	.1	Y	F or G or H or I
3	A, Ethernet	CAT 5	1	.5	Y	C
4	C, Data	CAT 5	1	.5	N	E, Laptop
5	C, POE	Power Cord	1	.5	N	100-240V AC power

Table 5. Ports and Cabling Information

 © 2011, MET Laboratories, Inc.

H. Mode of Operation

The M2 uses Atheros Radio Test Software.

I. Method of Monitoring EUT Operation

A Spectrum Analyzer and a Power Meter was use to monitor the EUT's transmitter channel and power output.

J. Modifications

a) Modifications to EUT

No modifications were made to the EUT.

b) Modifications to Test Standard

No modifications were made to the EUT.

K. Disposition of EUT

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

 © 2011, MET Laboratories, Inc.

III. Conformance Requirements

 © 2011, MET Laboratories, Inc.

Conformance Requirements

4.2.1 Effective Radiated Power

Test Requirement(s): **ETSI EN 300 328-1, Clause 4.3.1:**

4.3.1.1 Definition

The effective radiated power is defined as the total power of the transmitter.

4.3.1.2 Limit

The effective radiated power shall be equal to or less than -10 dBW (100 mW) E.I.R.P. This limit shall apply for any combination of power level and intended antenna assembly.

Test Procedure: The EUT was connected directly to a power meter capable of measuring the peak and average RF power of a modulated carrier. Measurements were carried out in all modulations available and at the low, mid and high channels of the transmit band. Both normal and extreme test conditions were observed. The EIRP was calculated the following equation:

P = A + G + 10 log (1/x); where A is the measured power, x is the duty cycle and G is the antenna assembly gain.

Test Results: The EUT as tested was found compliant with the specified limits in clause 4.3.1.2.

Test Engineer: Anderson Soungpanya

Test Date: April 28, 2009

 © 2011, MET Laboratories, Inc.

Conformance Requirements

Effective Isotropic Radiated Power Test Results

Channel	Temperature	Voltage	Mode	Conducted Power (dBm)	Antenna Gain (dBi)	EIRP
Low	Nominal	Nominal	DSSS	13.43	6	19.43
Mid	Nominal	Nominal	DSSS	12.35	6	18.35
High	Nominal	Nominal	DSSS	12.21	6	18.21
Low	Maximum	Minimum	DSSS	13.16	6	19.16
Low	Maximum	Maximum	DSSS	13.18	6	19.18
Mid	Maximum	Minimum	DSSS	11.80	6	17.80
Mid	Maximum	Maximum	DSSS	11.76	6	17.76
High	Maximum	Minimum	DSSS	11.78	6	17.78
High	Maximum	Maximum	DSSS	11.75	6	17.75
Low	Minimum	Minimum	DSSS	13.56	6	19.56
Low	Minimum	Maximum	DSSS	13.58	6	19.58
Mid	Minimum	Minimum	DSSS	12.07	6	18.07
Mid	Minimum	Maximum	DSSS	12.05	6	18.05
High	Minimum	Minimum	DSSS	12.43	6	18.43
High	Minimum	Maximum	DSSS	12.42	6	18.42

Table 6. Isotropic Radiated Power Test Results – DSSS mode

Channel	Temperature	Voltage	Mode	Conducted Power (dBm)	Antenna Gain (dBi)	EIRP
Low	Nominal	Nominal	OFDM	13.50	6	19.50
Mid	Nominal	Nominal	OFDM	12.37	6	18.37
High	Nominal	Nominal	OFDM	12.48	6	18.48
Low	Maximum	Minimum	OFDM	12.95	6	18.95
Low	Maximum	Maximum	OFDM	12.93	6	18.93
Mid	Maximum	Minimum	OFDM	11.67	6	17.67
Mid	Maximum	Maximum	OFDM	11.59	6	17.59
High	Maximum	Minimum	OFDM	11.67	6	17.67
High	Maximum	Maximum	OFDM	11.65	6	17.65
Low	Minimum	Minimum	OFDM	13.49	6	19.49
Low	Minimum	Maximum	OFDM	13.48	6	19.48
Mid	Minimum	Minimum	OFDM	12.89	6	18.89
Mid	Minimum	Maximum	OFDM	13.01	6	19.01
High	Minimum	Minimum	OFDM	13.13	6	19.13
High	Minimum	Maximum	OFDM	13.03	6	19.03

Table 7. Isotropic Radiated Power Test Results – OFDM mode

 © 2011, MET Laboratories, Inc.

Effective Isotropic Radiated Power Test Results

Channel	Temperature	Voltage	Mode	Conducted Power (dBm)	Antenna Gain (dBi)	EIRP
Low	Nominal	Nominal	HT20	13.03	6	19.03
Mid	Nominal	Nominal	HT20	12.72	6	18.72
High	Nominal	Nominal	HT20	12.58	6	18.58
Low	Maximum	Minimum	HT20	12.41	6	18.41
Low	Maximum	Maximum	HT20	12.44	6	18.44
Mid	Maximum	Minimum	HT20	12.50	6	18.50
Mid	Maximum	Maximum	HT20	12.22	6	18.22
High	Maximum	Minimum	HT20	12.92	6	18.92
High	Maximum	Maximum	HT20	12.90	6	18.90
Low	Minimum	Minimum	HT20	13.78	6	19.78
Low	Minimum	Maximum	HT20	13.75	6	19.75
Mid	Minimum	Minimum	HT20	13.25	6	19.25
Mid	Minimum	Maximum	HT20	13.13	6	19.13
High	Minimum	Minimum	HT20	13.23	6	19.23
High	Minimum	Maximum	HT20	13.25	6	19.25

Table 8. Isotropic Radiated Power Test Results – HT20

Channel	Temperature	Voltage	Mode	Conducted Power (dBm)	Antenna Gain (dBi)	EIRP
Mid	Nominal	Nominal	HT40	13.24	6	19.24
Mid	Maximum	Minimum	HT40	12.44	6	18.44
Mid	Maximum	Maximum	HT40	12.27	6	18.27
Mid	Minimum	Minimum	HT40	13.32	6	19.32
Mid	Minimum	Maximum	HT40	13.38	6	19.38

Table 9. Isotropic Radiated Power Test Results – HT40

 © 2011, MET Laboratories, Inc.

Conformance Requirements

4.3.2 Maximum Spectral Power Density

Test Requirement(s): **ETSI EN 300 328 Section 4.3.2:**

4.3.2.1 Definition
The maximum spectral power density is defined as the highest level of power in Watts per Hertz generated by the transmitter within the power envelope.

4.3.2.2 Limit
For equipment using FHSS modulation, the maximum spectral power density shall be limited to -10 dBW (100mW) per 100 KHz EIRP. For equipment using other types of modulation than FHSS (e.g. DSSS, OFDM, etc), the maximum spectral power density shall be limited to 10mW per MHz EIRP.

Test Procedure: The EUT was connected directly to a spectrum analyzer through an attenuator. The EUT was set to transmit at the highest power level in the appropriate modulation. For DTS modulations, the spectrum analyzer was set with a resolution band width of 1MHz, a positive peak detector, max hold function and a span three times the Occupied Band width. The frequency which produced the highest output across the channel bandwidth was recorded. The spectrum analyzer was then set to this frequency and the channel power/MHz was measured using the spectrum analyzer's channel power function. The maximum spectral power density EIRP was determined using the following equation:
P = A + G + 10 log (1/x); where A is the measured power, x is the duty cycle and G is the antenna assembly gain.

Test Results: The EUT as tested was found compliant with the specified limits of Clause 4.3.2.2.

Maximum SPD <= 10mW (10 dBm) per MHz EIRP in Normal Test Condition, SPD = Spectral Power Density.

Test Engineer: Anderson Soungpanya

Test Date: April 21 & 22, 2009

 © 2011, MET Laboratories, Inc.

Maximum Spectral Power Density Tables

Frequency (MHz)	Mode	Measured Maximum Spectral Power Density (dBm)	Antenna Gain (dBi)	Maximum SPD Limit (dBm)	EIRP Maximum Spectral Power Density	Margin dB
2412	DSSS	3.70	6	10	9.70	0.30
2437	DSSS	2.35	6	10	8.35	1.65
2462	DSSS	2.39	6	10	8.39	1.61

Maximum Spectral Power Density EIRP Tests Results – DSSS

Frequency (MHz)	Mode	Measured Maximum Spectral Power Density (dBm)	Antenna Gain	Maximum SPD Limit (dBm)	EIRP Maximum Spectral Power Density	Margin dB
2412	OFDM	1.56	6	10	7.56	2.44
2437	OFDM	-0.06	6	10	5.94	4.06
2462	OFDM	0.04	6	10	6.04	3.96

Maximum Spectral Power Density EIRP Tests Results – OFDM

Frequency (MHz)	Mode	Measured Maximum Spectral Power Density (dBm)	Antenna Gain (dBi)	Maximum SPD Limit (dBm)	EIRP Maximum Spectral Power Density	Margin dB
2412	HT20	0.62	6	10	6.62	3.38
2437	HT20	0.09	6	10	6.09	3.91
2462	HT20	-0.11	6	10	5.89	4.11

Maximum Spectral Power Density EIRP Tests Results – HT20

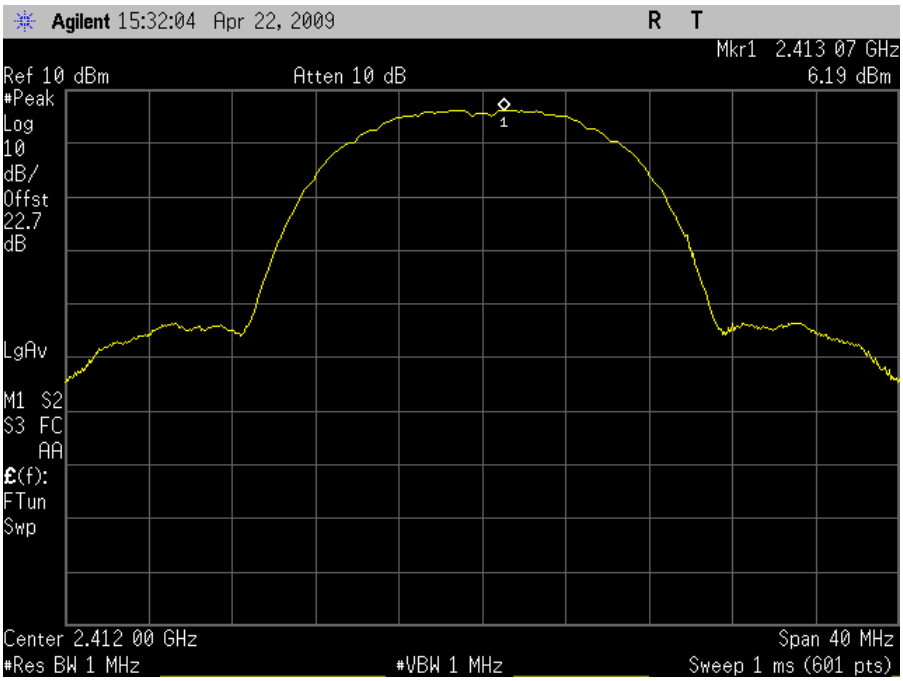
Frequency (MHz)	Mode	Measured Maximum Spectral Power Density (dBm)	Antenna Gain	Maximum SPD Limit (dBm)	EIRP Maximum Spectral Power Density	Margin dB
2437	HT40	-1.60	6	10	4.40	6.60

Maximum Spectral Power Density EIRP Tests Results – HT40

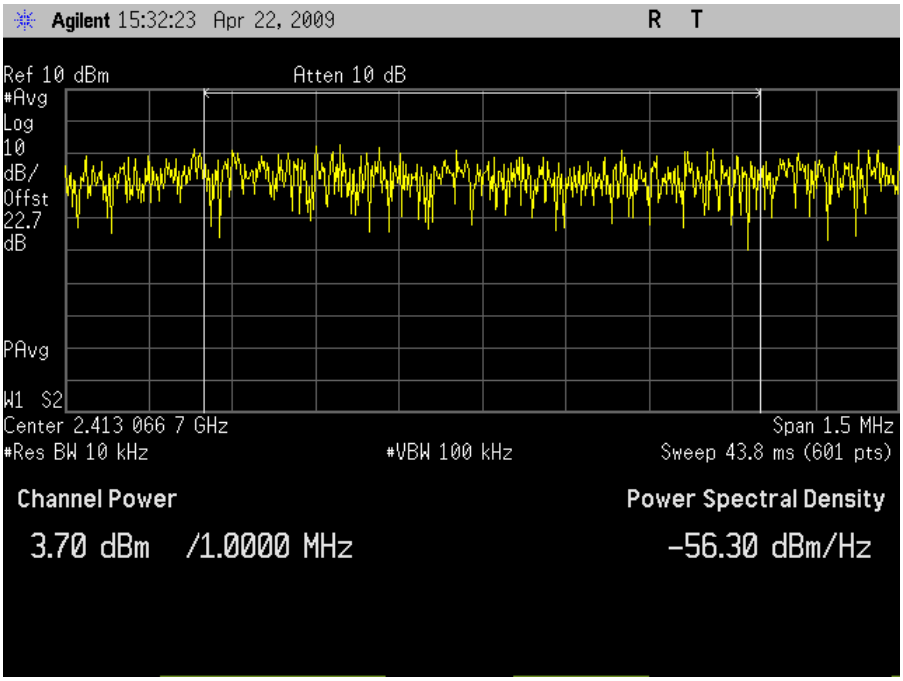
 © 2011, MET Laboratories, Inc.

Conformance Requirements

Maximum Spectral Density Power Test Results – DSSS mode



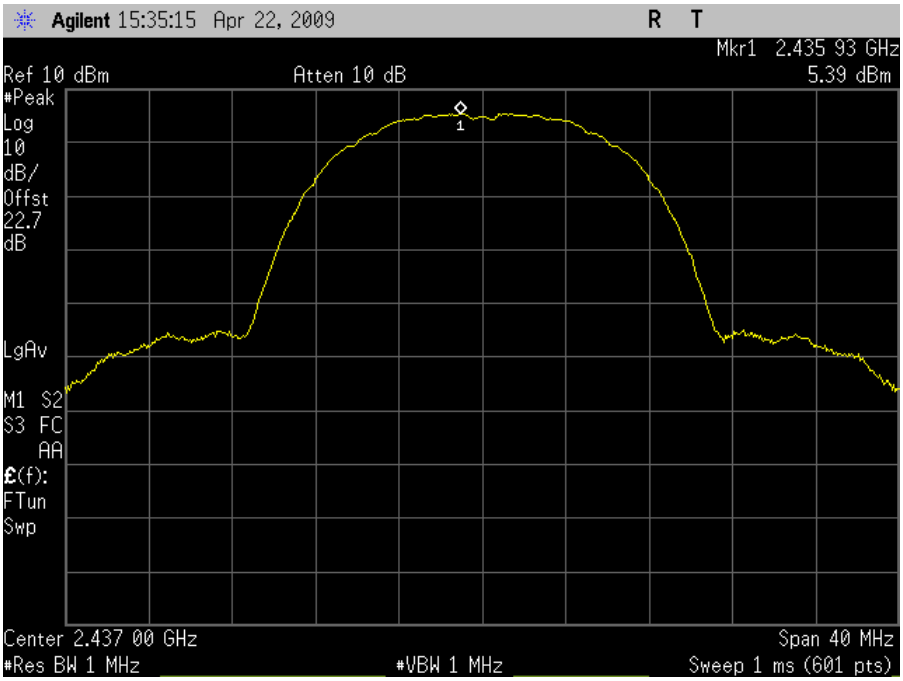
Plot 1. Spectral Density Power Determination – Low Channel, DSSS mode



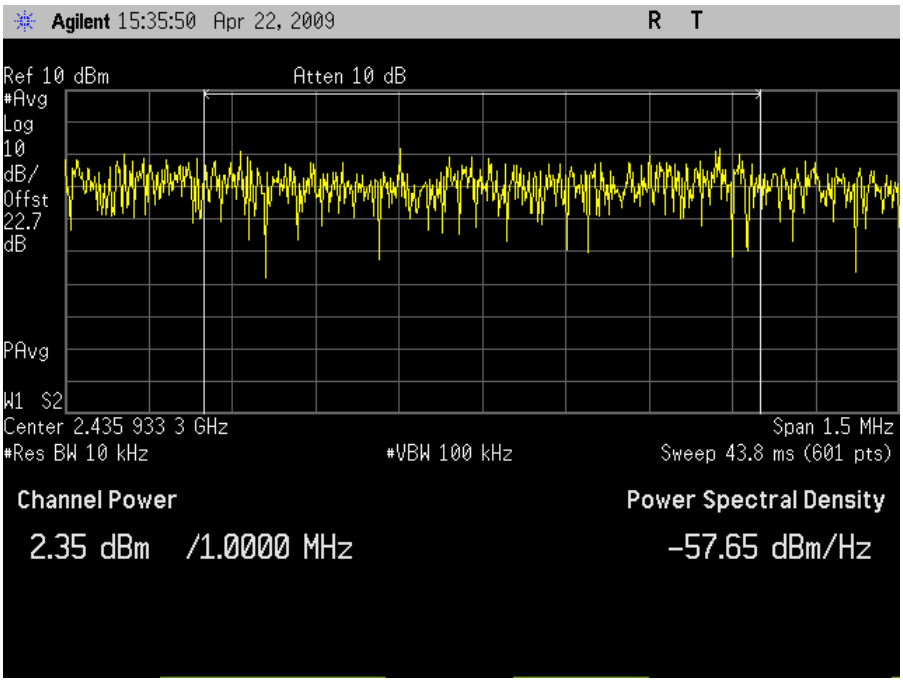
Plot 2. Spectral Density Power – Low Channel, DSSS mode

© 2011, MET Laboratories, Inc.

Maximum Spectral Density Power Test Results



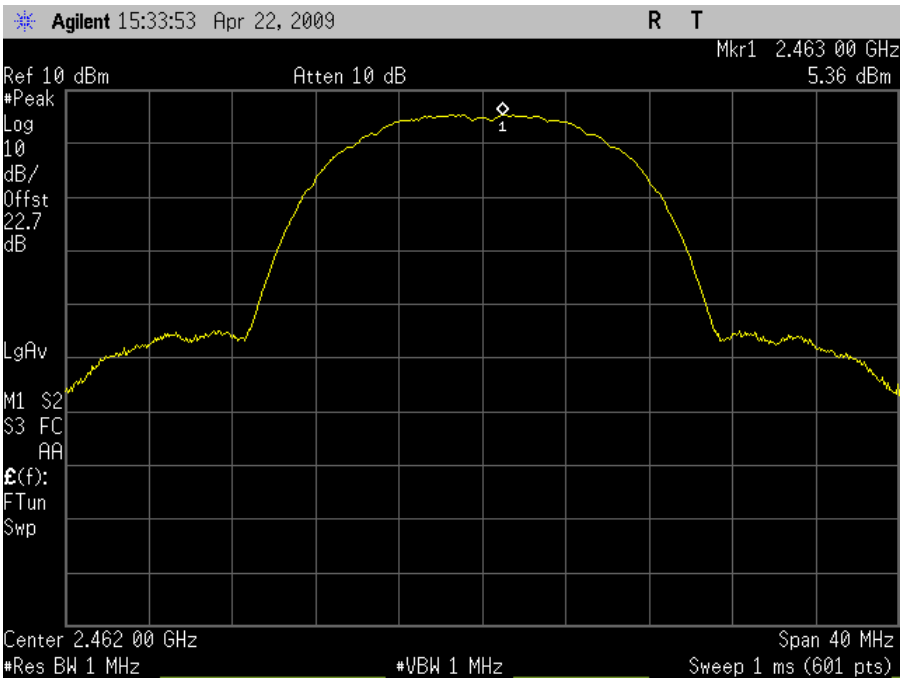
Plot 3. Spectral Density Power Determination – Mid Channel, DSSS mode



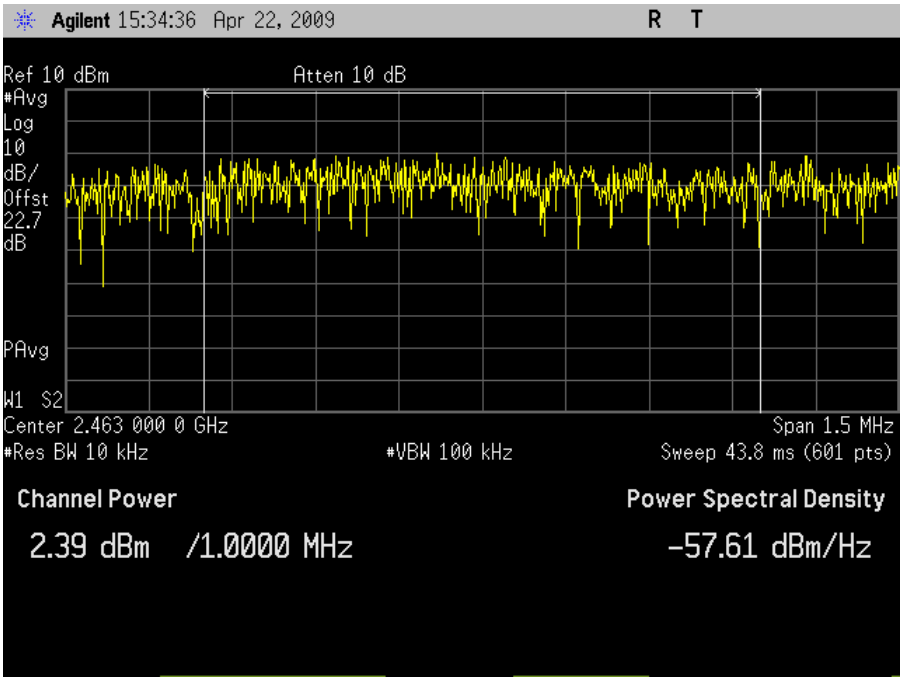
Plot 4. Spectral Density Power – Mid Channel, DSSS mode

 © 2011, MET Laboratories, Inc.

Maximum Spectral Density Power Test Results



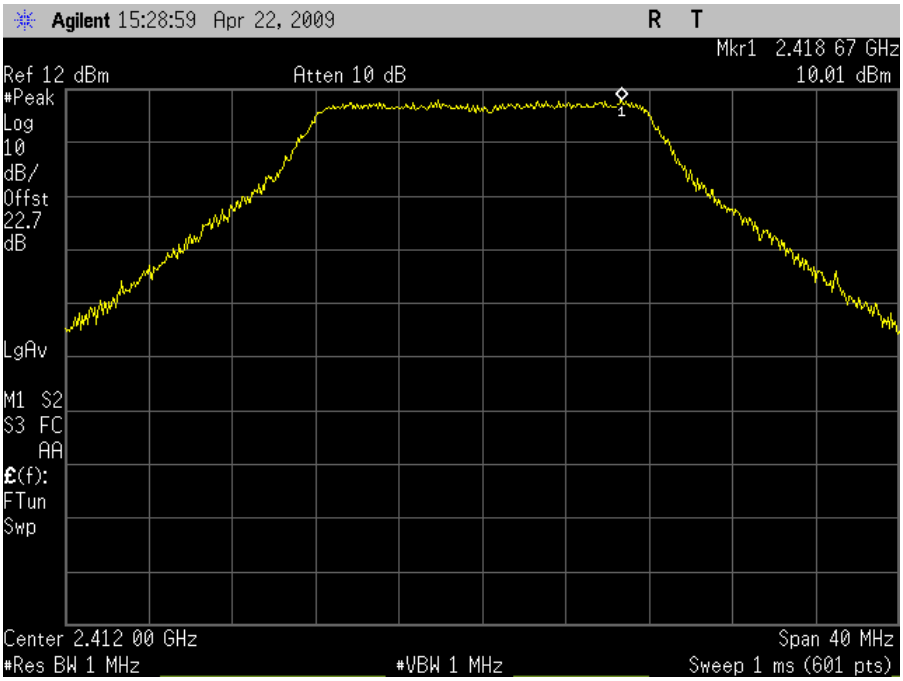
Plot 5. Spectral Density Power Determination – High Channel, DSSS mode



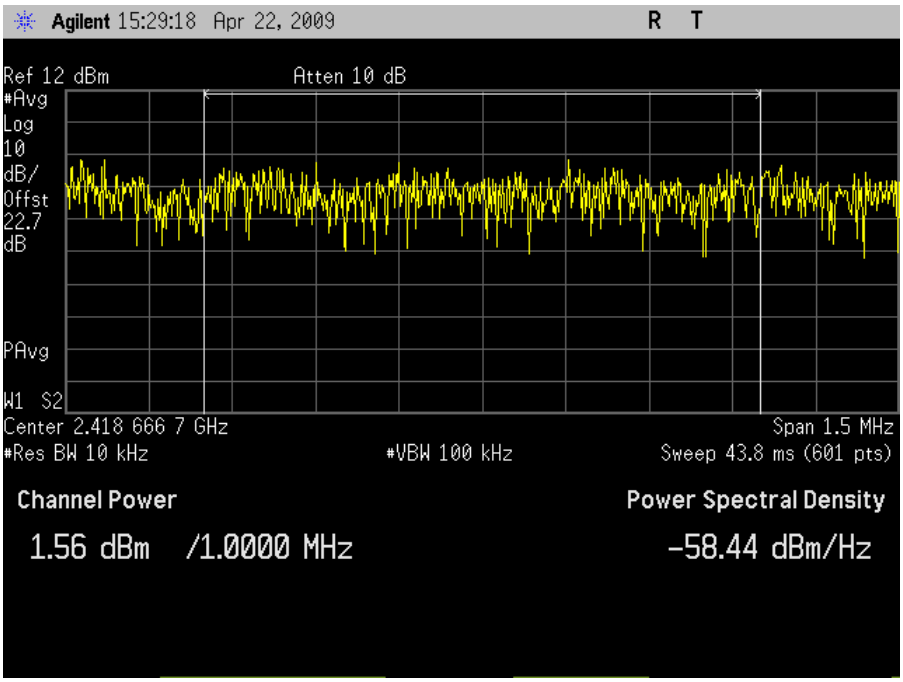
Plot 6. Spectral Density Power – High Channel, DSSS mode

© 2011, MET Laboratories, Inc.

Maximum Spectral Density Power Test Results – OFDM Mode



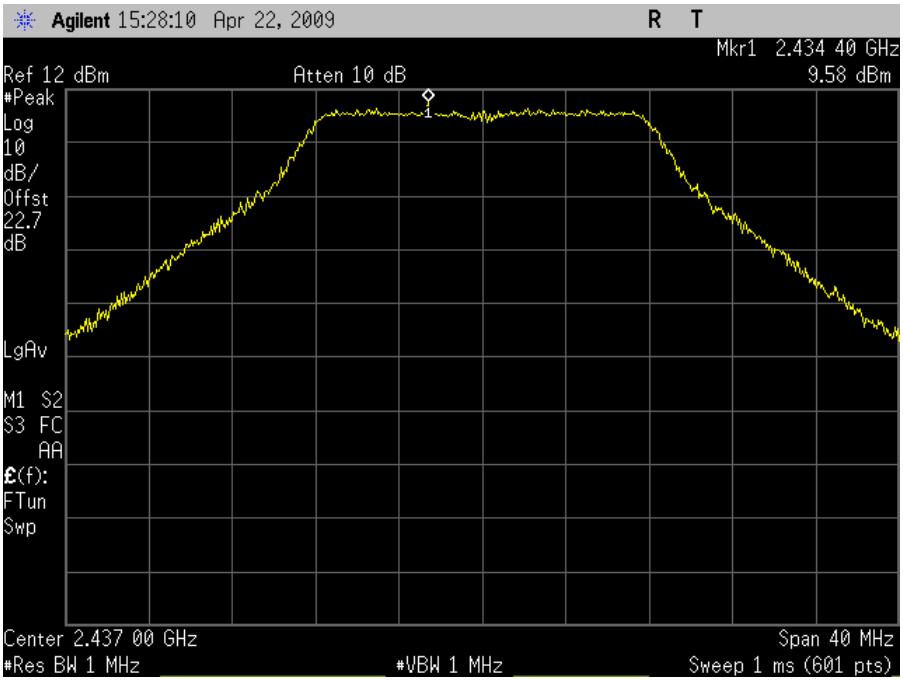
Plot 7. Spectral Density Power Determination – Low Channel, OFDM mode



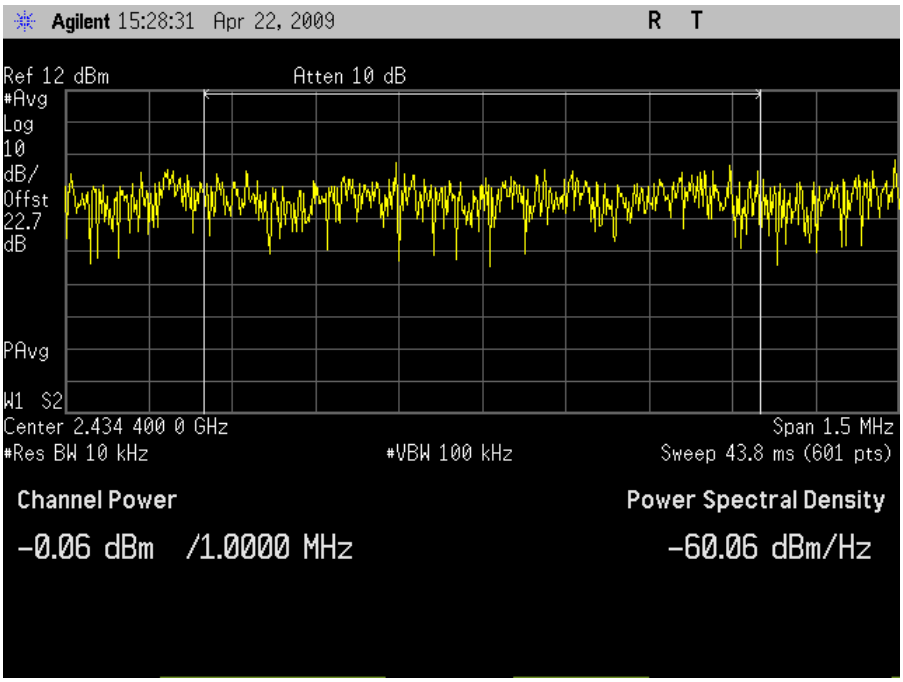
Plot 8. Spectral Density Power – Low Channel, OFDM mode

 © 2011, MET Laboratories, Inc.

Maximum Spectral Density Power Test Results



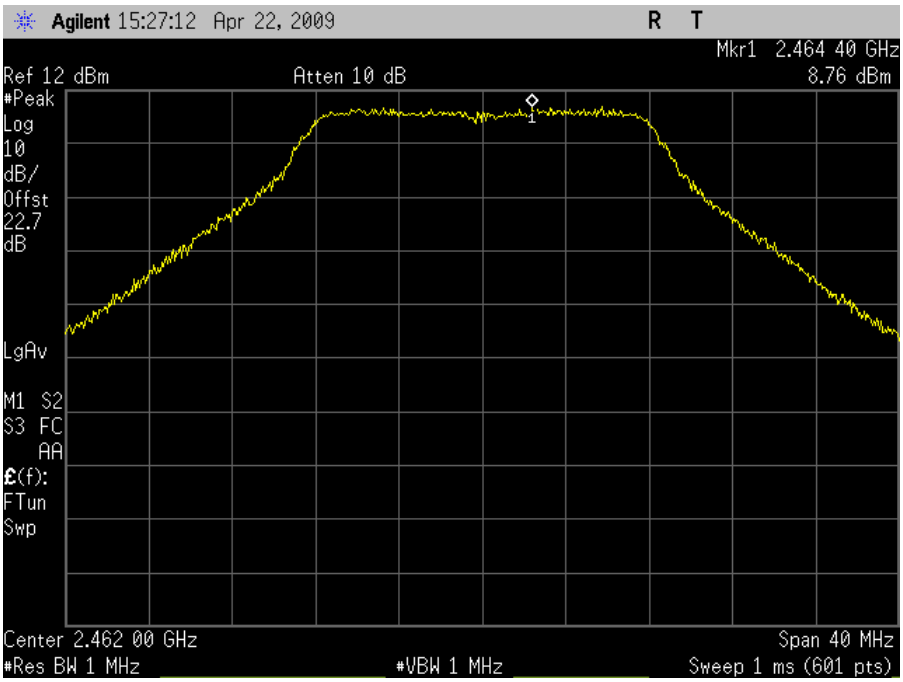
Plot 9. Spectral Density Power Determination – Mid Channel, OFDM mode



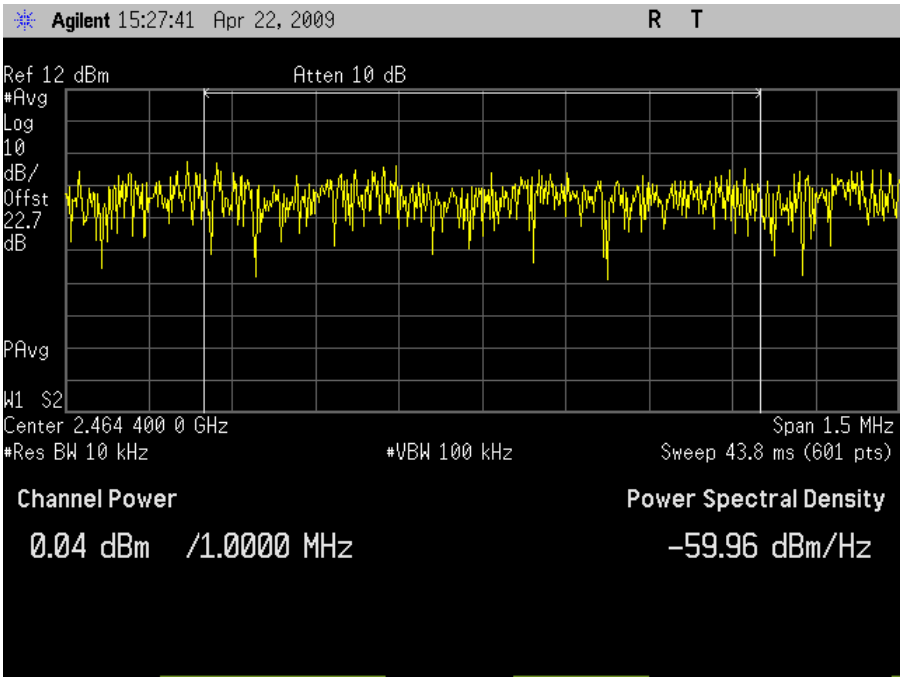
Plot 10. Spectral Density Power – Mid Channel, OFDM mode

 © 2011, MET Laboratories, Inc.

Maximum Spectral Density Power Test Results



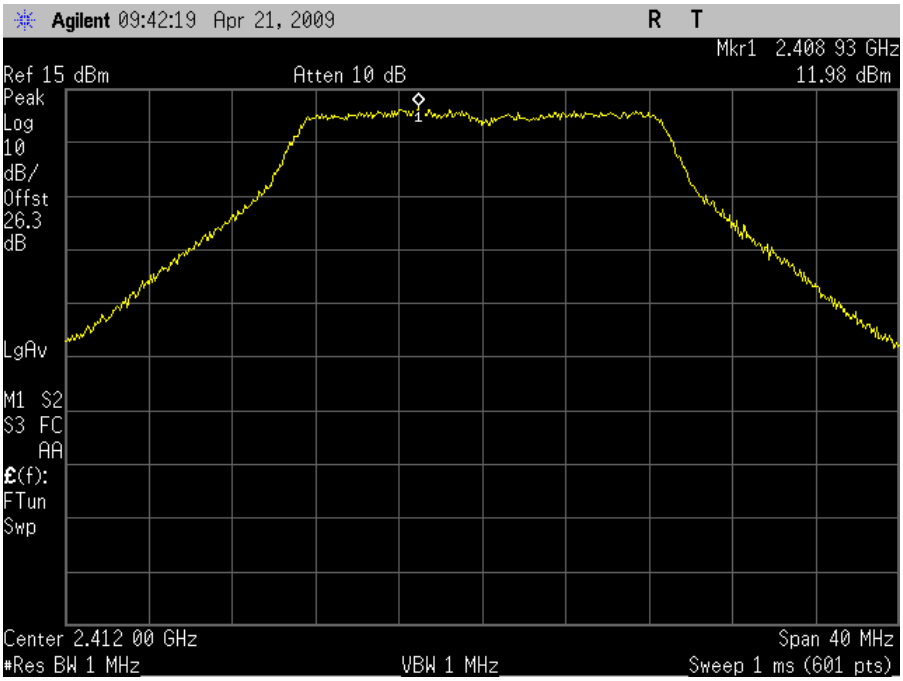
Plot 11. Spectral Density Power Determination – High Channel, OFDM mode



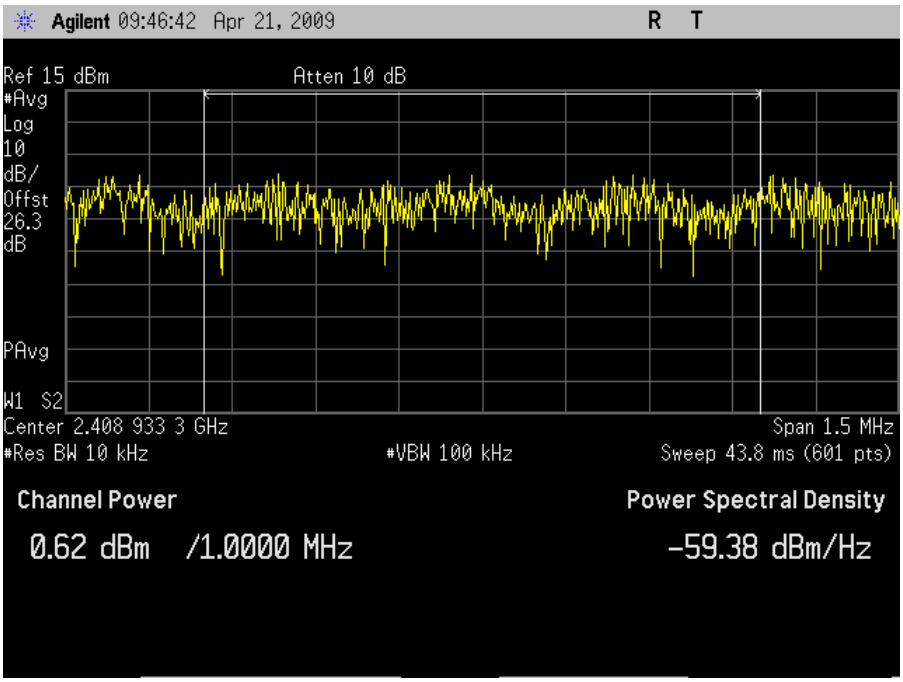
Plot 12. Spectral Density Power – High Channel, OFDM mode

 © 2011, MET Laboratories, Inc.

Maximum Spectral Density Power Test Results – HT20 Mode



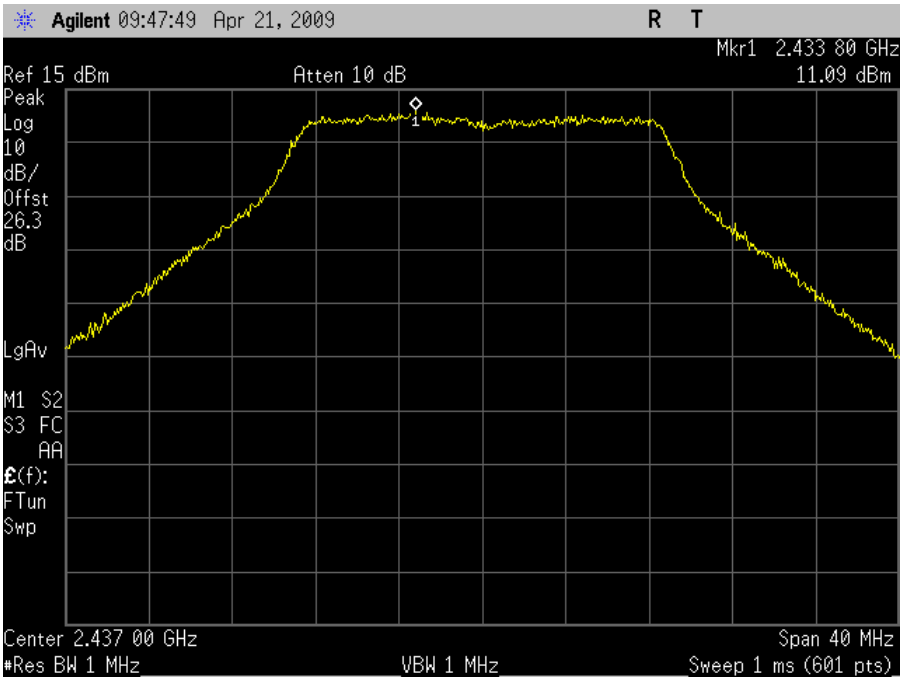
Plot 13. Spectral Density Power Determination – Low Channel, HT20 mode



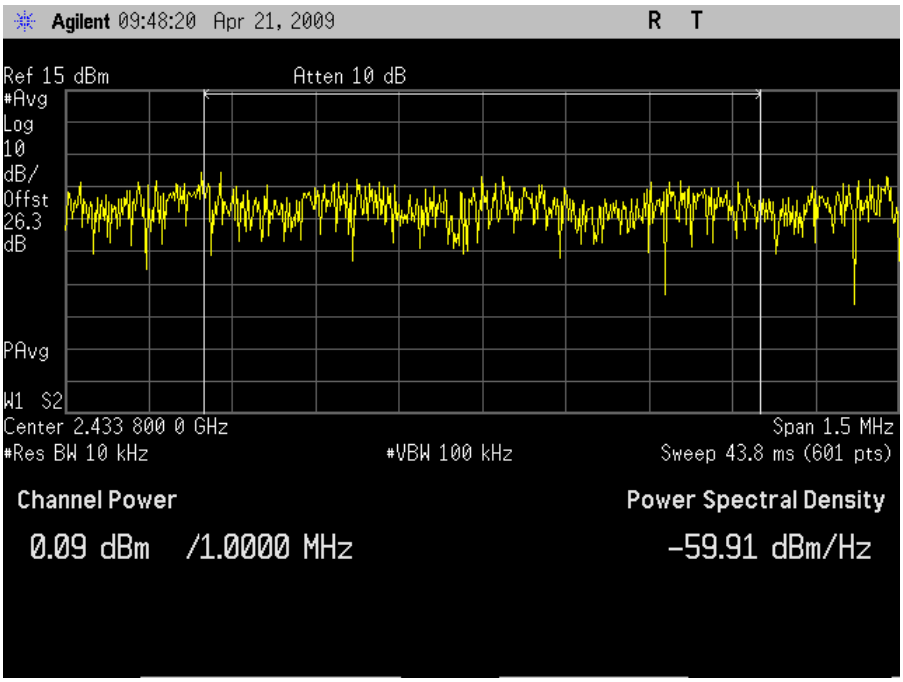
Plot 14. Spectral Density Power – Low Channel, HT20 mode

 © 2011, MET Laboratories, Inc.

Maximum Spectral Density Power Test Results



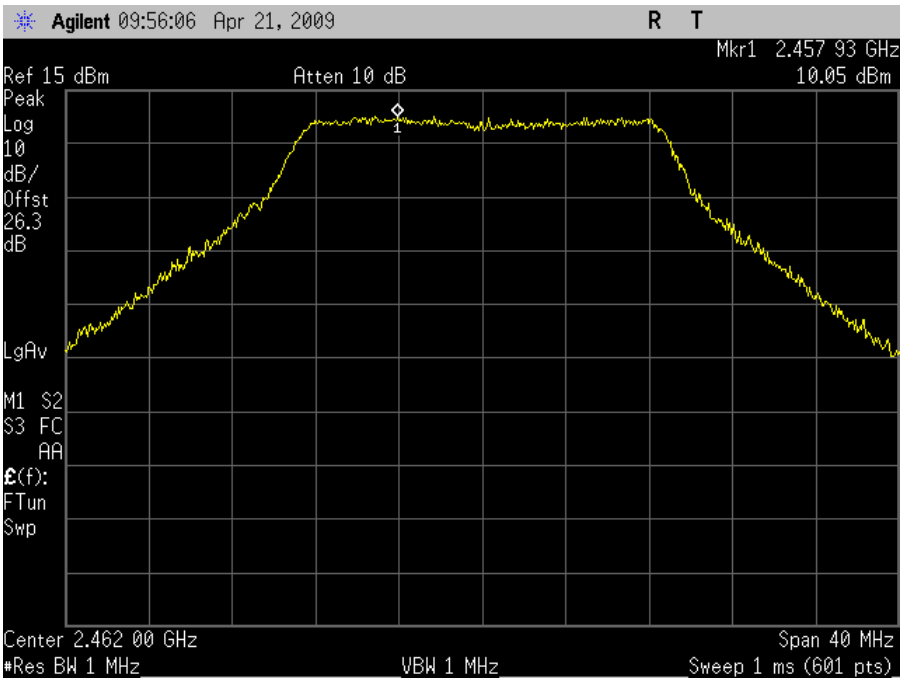
Plot 15. Spectral Density Power Determination – Mid Channel, HT20 mode



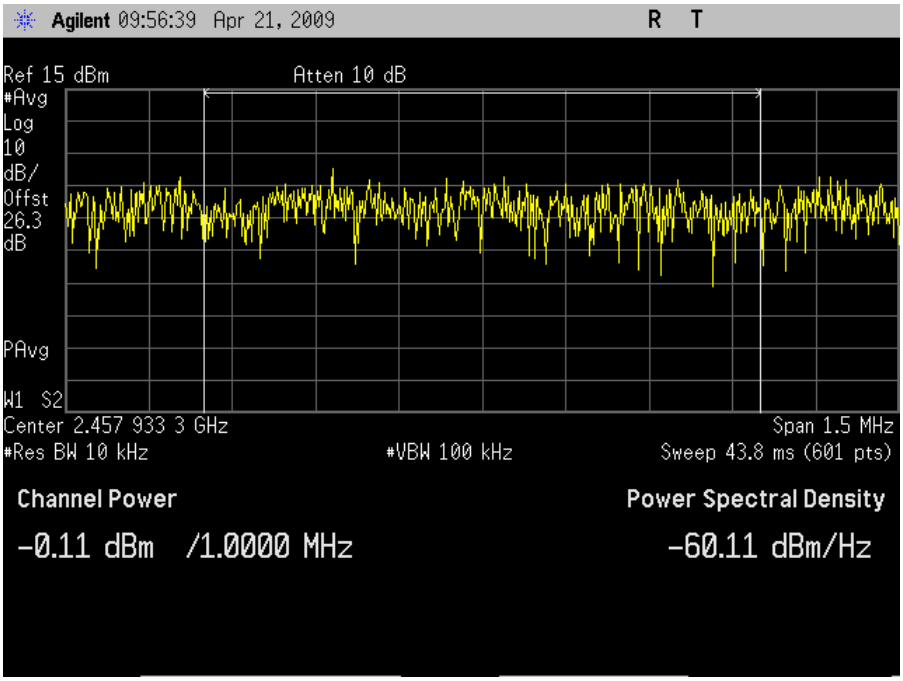
Plot 16. Spectral Density Power – Mid Channel, HT20 mode

 © 2011, MET Laboratories, Inc.

Maximum Spectral Density Power Test Results



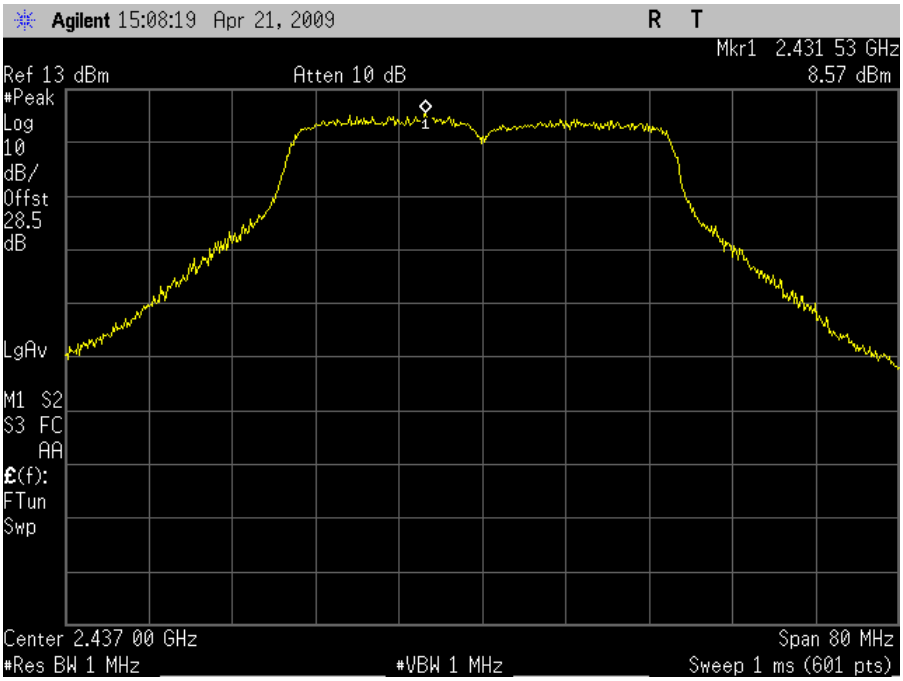
Plot 17. Spectral Density Power Determination – High Channel, HT20 mode



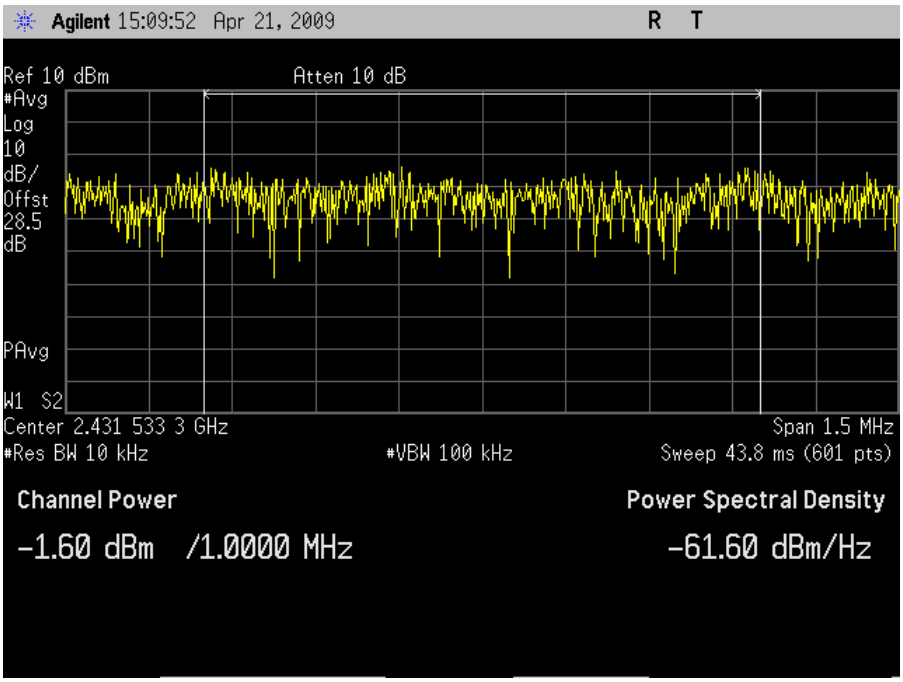
Plot 18. Spectral Density Power – High Channel, HT20 mode

 © 2011, MET Laboratories, Inc.

Maximum Spectral Density Power Test Results – HT40



Plot 19. Spectral Density Power Determination – Mid Channel, HT40 mode



Plot 20. Spectral Density Power – Mid Channel, HT40 mode

 © 2011, MET Laboratories, Inc.

Conformance Requirements

4.3.3 Frequency Range

Test Requirement(s): **EN 300 328 Clause 4.3.3:**

4.3.3.1 Definition

The frequency range of the equipment is determined by the lowest and highest frequencies occupied by the power envelope. *fH* is the highest frequency of the power envelope: it is the frequency furthest above the frequency of maximum power where the output power drops below the level of -80 dBm/Hz e.i.r.p. spectral power density (-30 dBm if measured in a100 kHz bandwidth). *fL* is the lowest frequency of the power envelope; it is the frequency furthest below the frequency of maximum power where the output power drops below the level equivalent to -80 dBm/Hz e.i.r.p. spectral power density (or -30 dBm if measured in a 100 kHz bandwidth).

For a given operating frequency, the width of the power envelope is (*fH* - *fL*). In equipment that allows adjustment or selection of different operating frequencies, the power envelope takes up different positions in the allocated band. The frequency range is determined by the lowest value of *fL* and the highest value of *fH* resulting from the adjustment of the equipment to the lowest and highest operating frequencies.

4.3.3.2 Limit

For all equipment the frequency range shall lie within the band 2,4 GHz to 2,4835 GHz (*fL* > 2,4 GHz and *fH* < 2,4835 GHz).

Test Procedure: The EUT was connected directly to a spectrum analyzer through a attenuator. The resolution band width of the spectrum analyzer was set to 100 KHz with video averaging and a minimum of 50 sweeps. The lowest and highest carrier frequencies generated by all modulations was set to transmit at the highest rated power level of the EUT. The frequency at which the spectral density dropped by 30dBm from the maximum level measured was recorded for both the upper and lower frequencies of the transmit band. This procedure was carried out at both normal and extreme conditions.

Test Results: The EUT as tested was found compliant with the specified limits of Clause 4.2.3.

Test Engineer: Anderson Soungpanya

Test Date: April 28, 2009

 © 2011, MET Laboratories, Inc.

Conformance Requirements

4.3.3 Frequency Range Test Results

Frequency Range					
Temp	Voltage	Mode	*fH - fL*	Limit	Margin
Nominal	Minimum	DSSS	70.330	83.5	13.170
Nominal	Nominal	DSSS	69.830	83.5	13.670
Nominal	Maximum	DSSS	69.830	83.5	13.670
Minimum	Minimum	DSSS	69.830	83.5	13.670
Minimum	Nominal	DSSS	70.000	83.5	13.500
Minimum	Maximum	DSSS	70.000	83.5	13.500
Maximum	Minimum	DSSS	69.830	83.5	13.670
Maximum	Nominal	DSSS	70.500	83.5	13.000
Maximum	Maximum	DSSS	69.830	83.5	13.670

Table 10. Frequency Range Test Results – DSSS mode

Frequency Range					
Temp	Voltage	Mode	*fH - fL*	Limit	Margin
Nominal	Minimum	OFDM	75.000	83.5	8.500
Nominal	Nominal	OFDM	75.170	83.5	8.330
Nominal	Maximum	OFDM	74.170	83.5	9.330
Minimum	Minimum	OFDM	76.500	83.5	7.000
Minimum	Nominal	OFDM	76.500	83.5	7.000
Minimum	Maximum	OFDM	76.170	83.5	7.330
Maximum	Minimum	OFDM	74.170	83.5	9.330
Maximum	Nominal	OFDM	73.000	83.5	10.500
Maximum	Maximum	OFDM	73.670	83.5	9.830

Table 11. Frequency Range Test Results – OFDM mode

 © 2011, MET Laboratories, Inc.

4.3.3 Frequency Range Test Results

Frequency Range					
Temp	Voltage	Mode	*fH - fL*	Limit	Margin
Nominal	Minimum	HT20	75.170	83.5	8.330
Nominal	Nominal	HT20	76.330	83.5	7.170
Nominal	Maximum	HT20	75.000	83.5	8.500
Minimum	Minimum	HT20	75.170	83.5	8.330
Minimum	Nominal	HT20	75.330	83.5	8.170
Minimum	Maximum	HT20	75.500	83.5	8.000
Maximum	Minimum	HT20	75.500	83.5	8.000
Maximum	Nominal	HT20	75.170	83.5	8.330
Maximum	Maximum	HT20	75.330	83.5	8.170

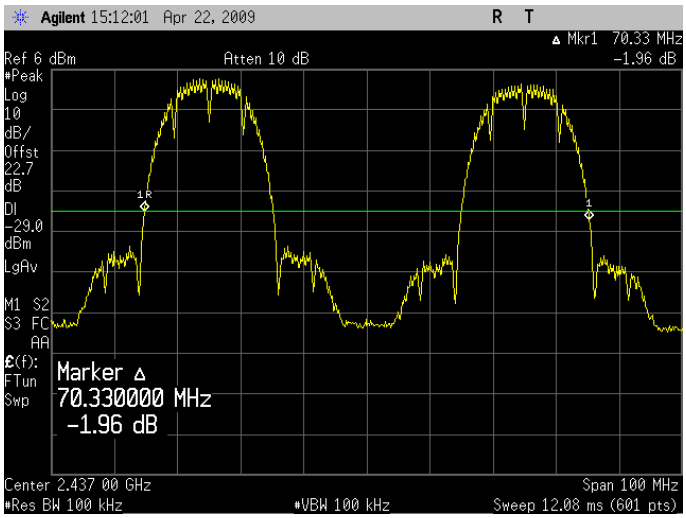
Table 12. Frequency Range Test Results – HT20 mode

Frequency Range					
Temp	Voltage	Mode	*fH - fL*	Limit	Margin
Nominal	Minimum	HT40	47.330	83.5	36.170
Nominal	Nominal	HT40	47.570	83.5	35.930
Nominal	Maximum	HT40	48.330	83.5	35.170
Minimum	Minimum	HT40	48.000	83.5	35.500
Minimum	Nominal	HT40	46.170	83.5	37.330
Minimum	Maximum	HT40	47.330	83.5	36.170
Maximum	Minimum	HT40	45.830	83.5	37.670
Maximum	Nominal	HT40	47.670	83.5	35.830
Maximum	Maximum	HT40	49.170	83.5	34.330

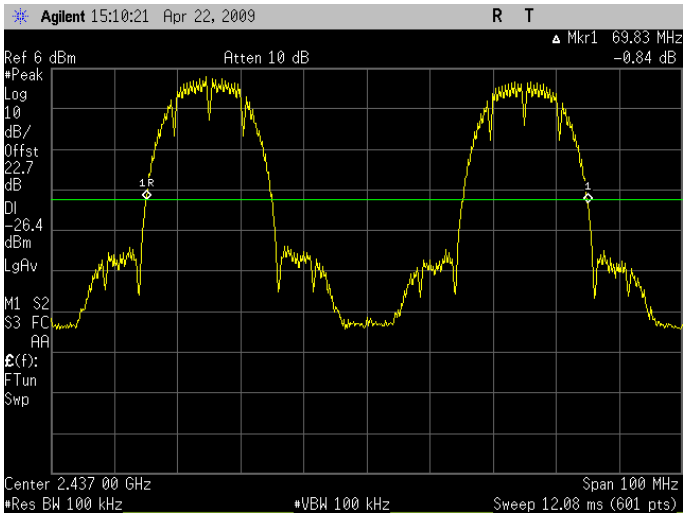
Table 13. Frequency Range Test Results – HT40 mode

 © 2011, MET Laboratories, Inc.

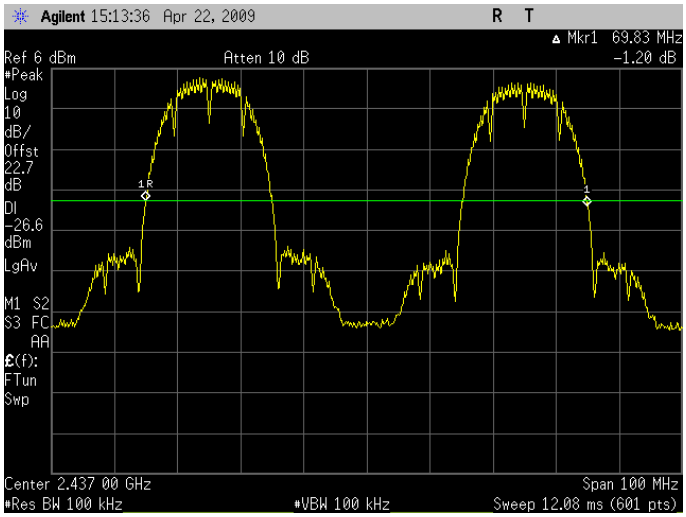
4.3.3 Frequency Range Test Results – DSSS Mode



Plot 21. Frequency Range Test Results – Nominal Temp/Low Voltage, (DSSS mode)

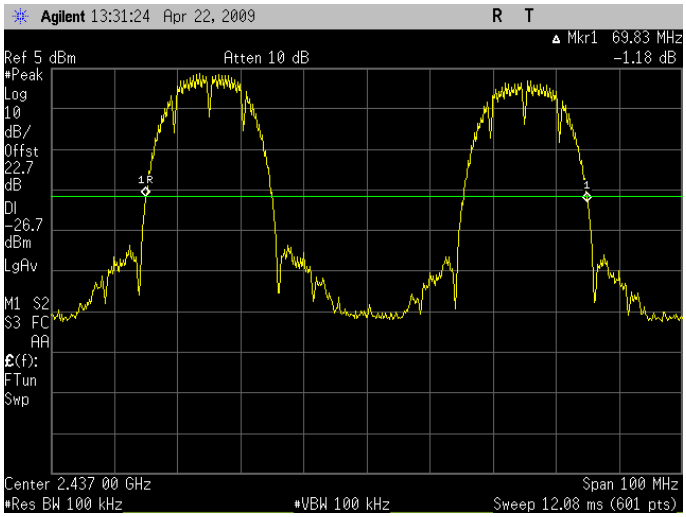


Plot 22. Frequency Range Test Results – Nominal Temp/Nominal Voltage, (DSSS mode)

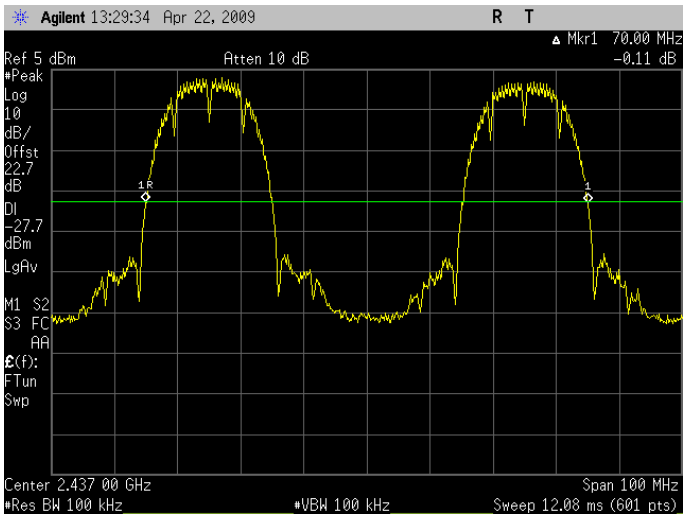


Plot 23. Frequency Range Test Results – Nominal Temp/Maximum Voltage, (DSSS mode)

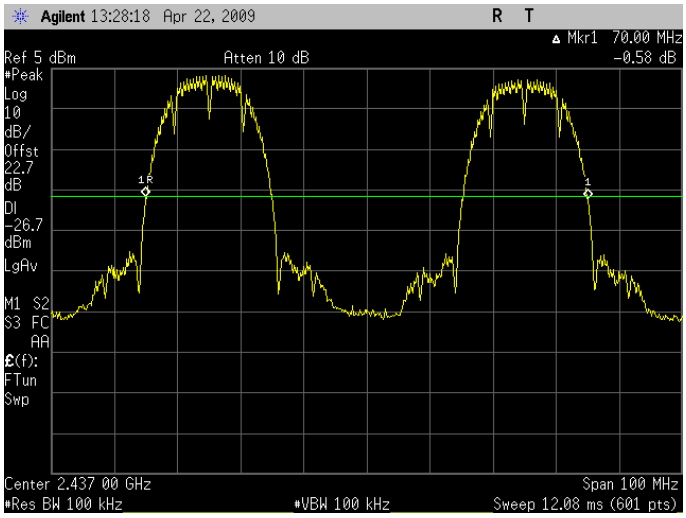
 © 2011, MET Laboratories, Inc.



Plot 24. Frequency Range Test Results – Low Temp/Low Voltage, (DSSS mode)

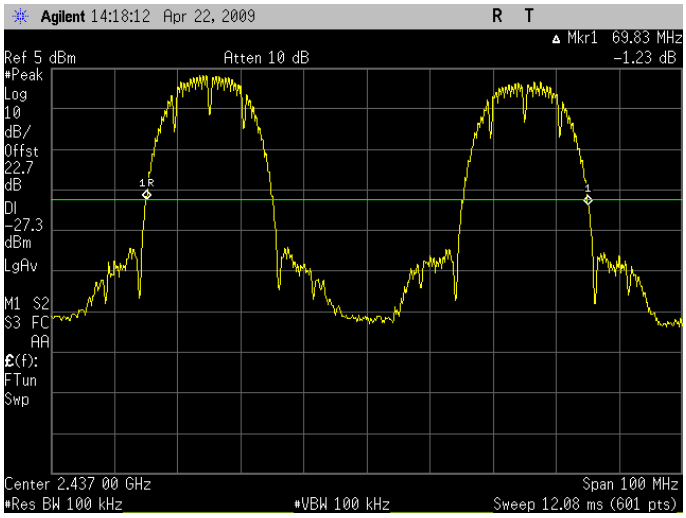


Plot 25. Frequency Range Test Results – Low Temp/Nominal Voltage, (DSSS mode)

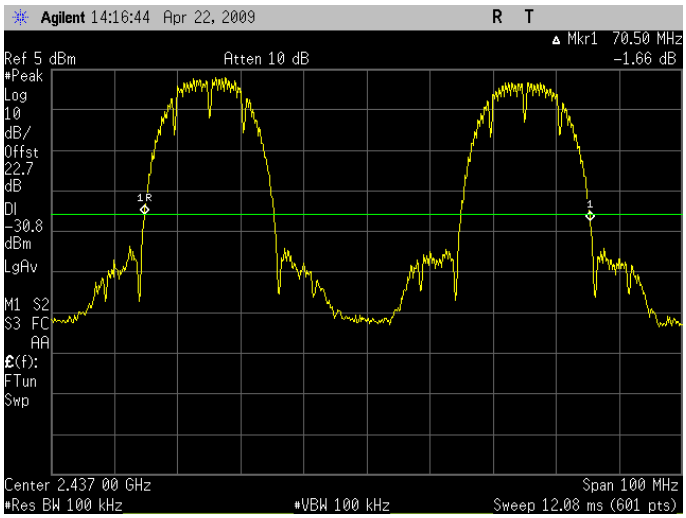


Plot 26. Frequency Range Test Results – Low Temp/Maximum Voltage, (DSSS mode)

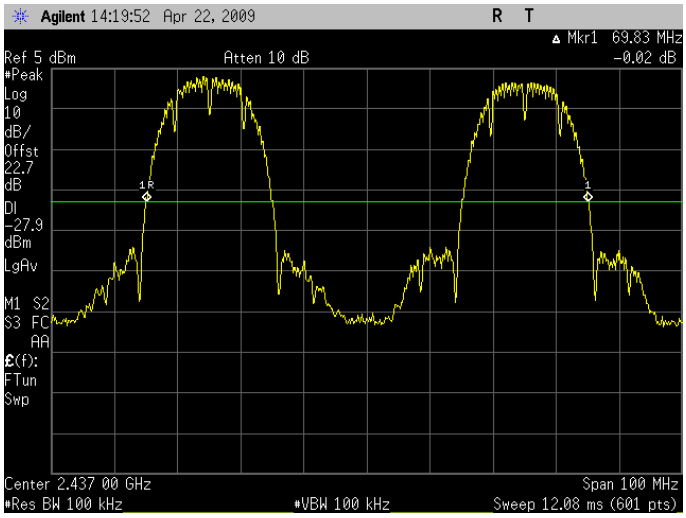
 © 2011, MET Laboratories, Inc.



Plot 27. Frequency Range Test Results – Maximum Temp/Low Voltage, (DSSS mode)



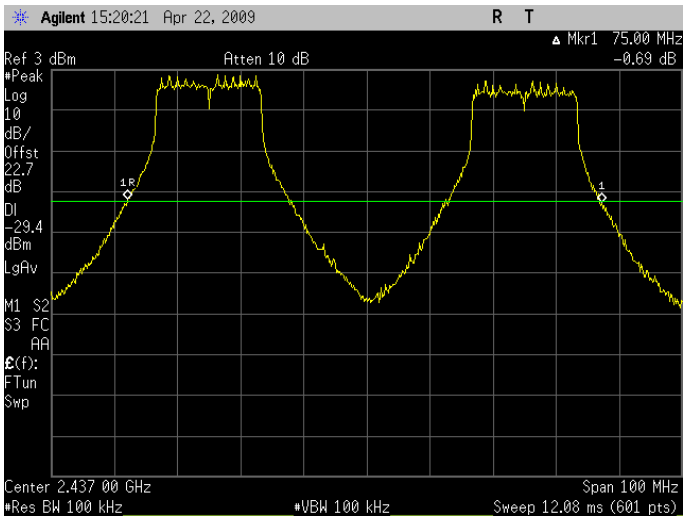
Plot 28. Frequency Range Test Results – Maximum Temp/Nominal Voltage, (DSSS mode)



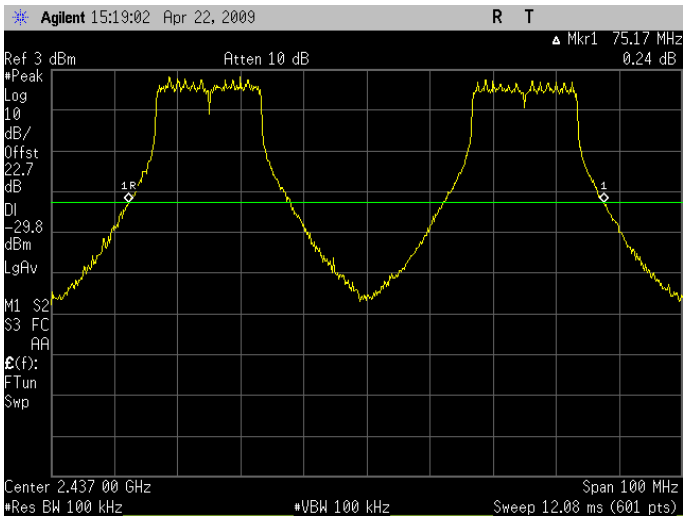
Plot 29. Frequency Range Test Results – Maximum Temp/Maximum Voltage, (DSSS mode)

© 2011, MET Laboratories, Inc.

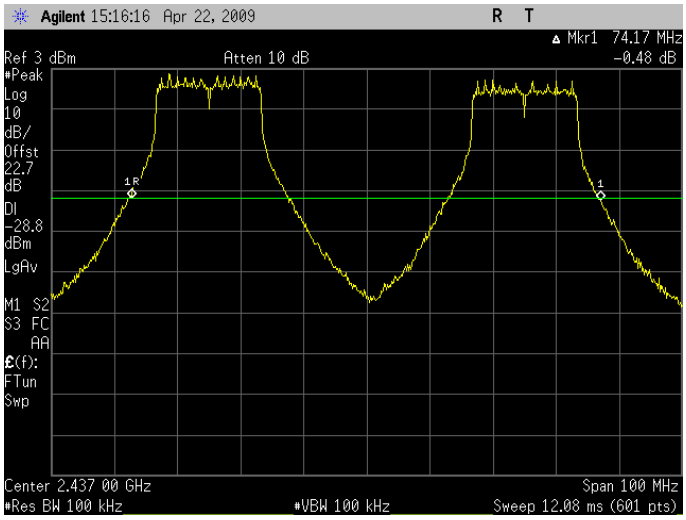
4.3.3 Frequency Range Test Results – OFDM Mode



Plot 30. Frequency Range Test Results – Nominal Temp/Low Voltage, (OFDM mode)

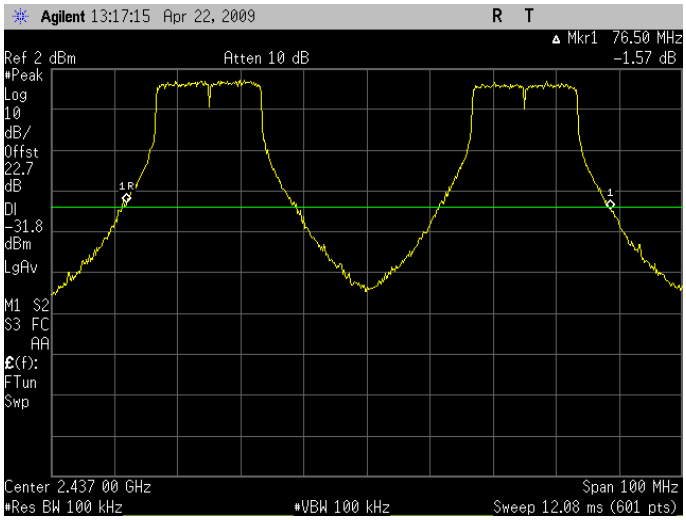


Plot 31. Frequency Range Test Results – Nominal Temp/Nominal Voltage, (OFDM mode)

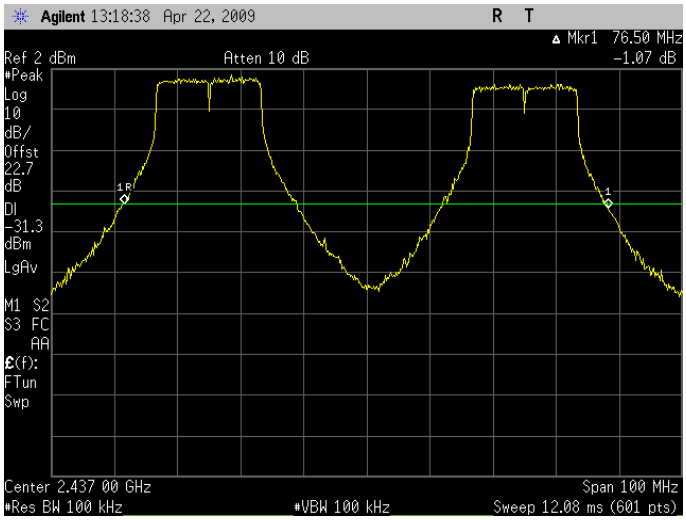


Plot 32. Frequency Range Test Results – Nominal Temp/Maximum Voltage, (OFDM mode)

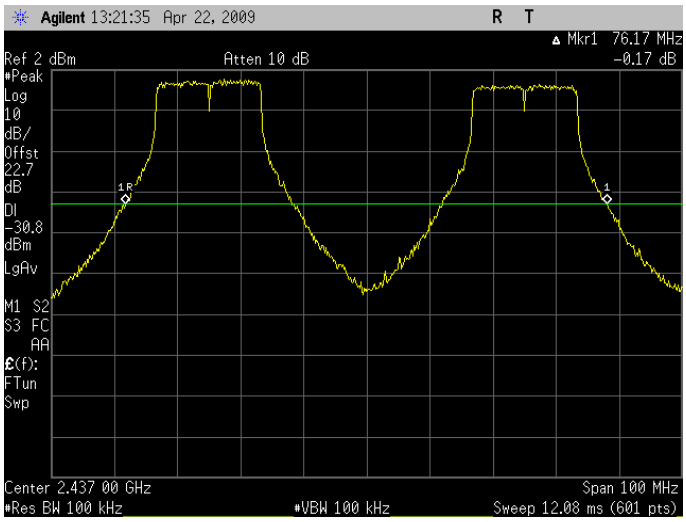
 © 2011, MET Laboratories, Inc.



Plot 33. Frequency Range Test Results – Low Temp/Low Voltage, (OFDM mode)

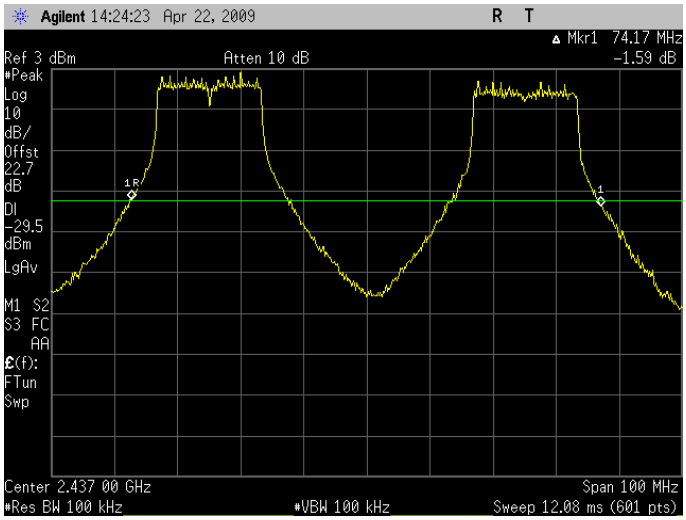


Plot 34. Frequency Range Test Results – Low Temp/Nominal Voltage, (OFDM mode)

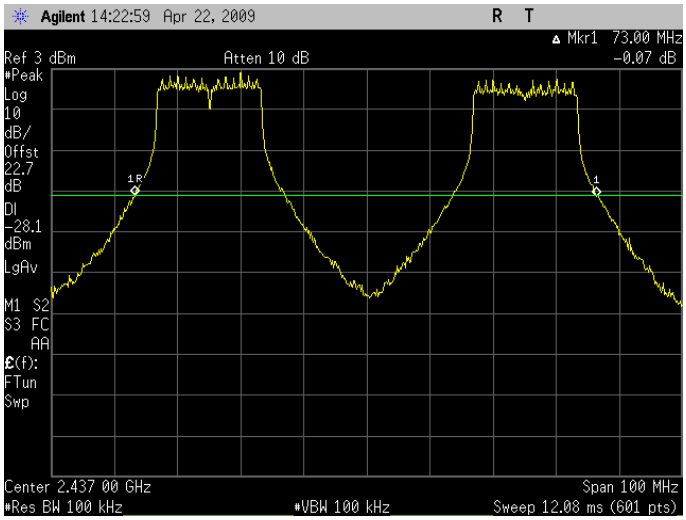


Plot 35. Frequency Range Test Results – Low Temp/Maximum Voltage, (OFDM mode)

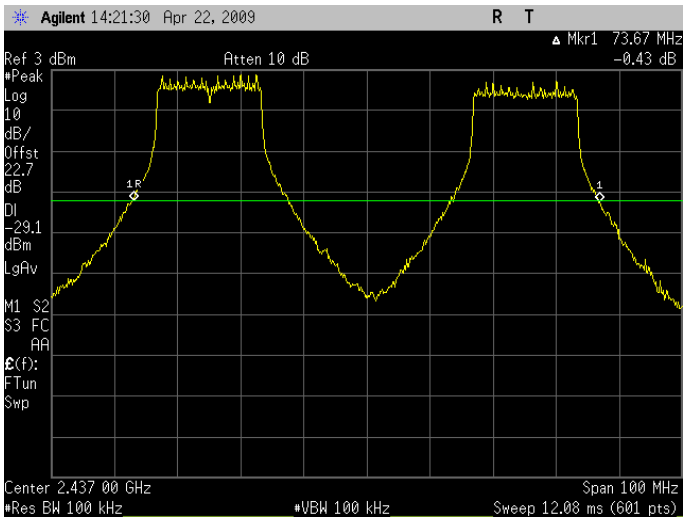
 © 2011, MET Laboratories, Inc.



Plot 36. Frequency Range Test Results – Maximum Temp/Low Voltage, (OFDM mode)



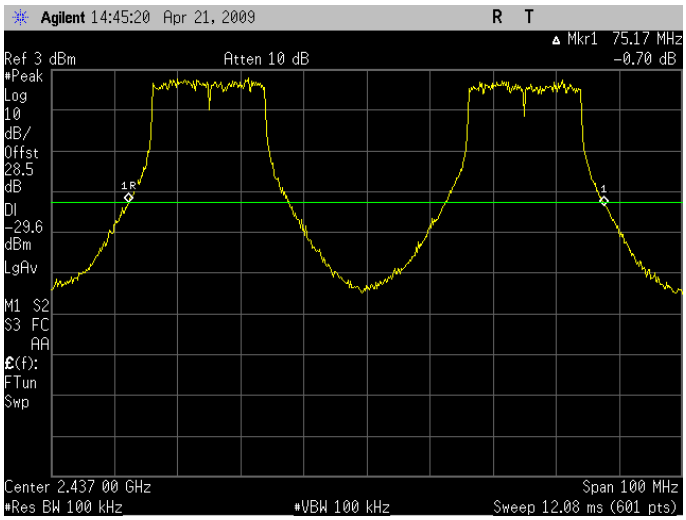
Plot 37. Frequency Range Test Results – Maximum Temp/Nominal Voltage, (OFDM mode)



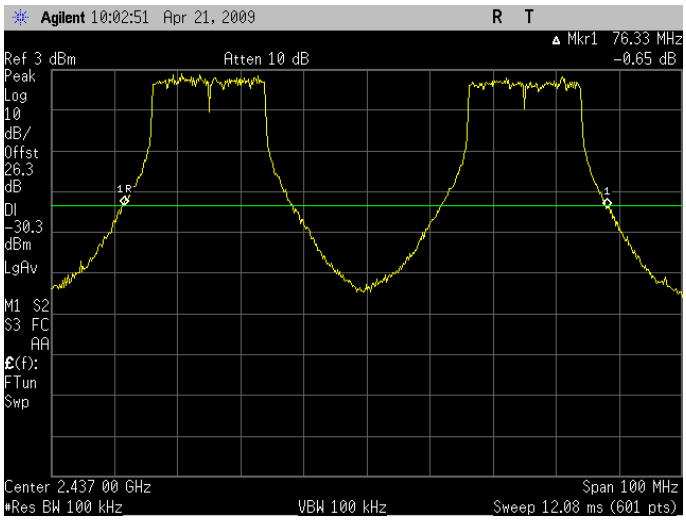
Plot 38. Frequency Range Test Results – Maximum Temp/Maximum Voltage, (OFDM mode)

© 2011, MET Laboratories, Inc.

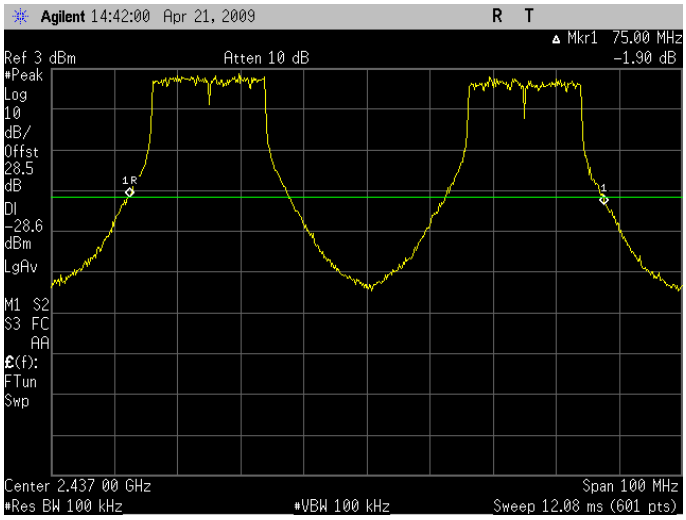
4.3.3 Frequency Range Test Results – HT20 Mode



Plot 39. Frequency Range Test Results – Nominal Temp/Low Voltage, (HT20 mode)

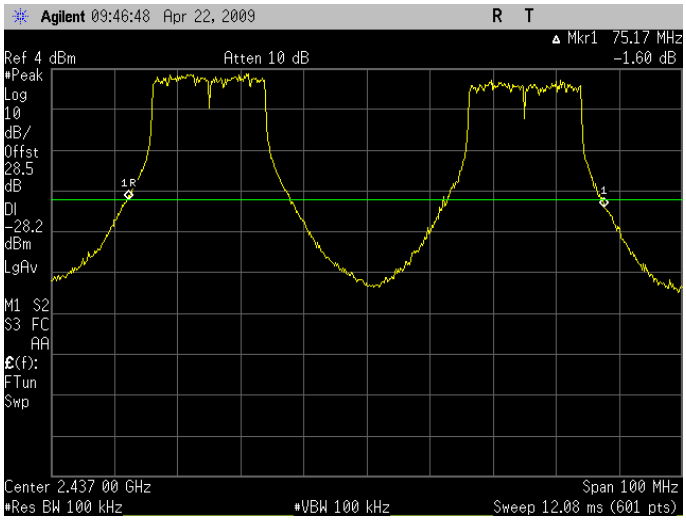


Plot 40. Frequency Range Test Results – Nominal Temp/Nominal Voltage, (HT20 mode)

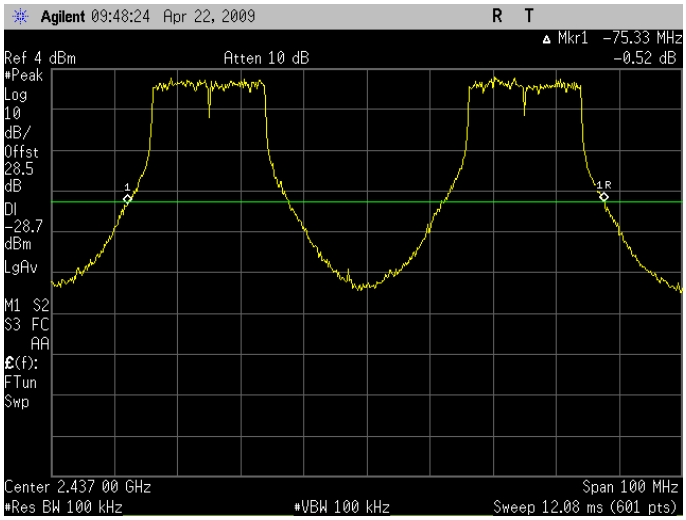


Plot 41. Frequency Range Test Results – Nominal Temp/Maximum Voltage, (HT20 mode)

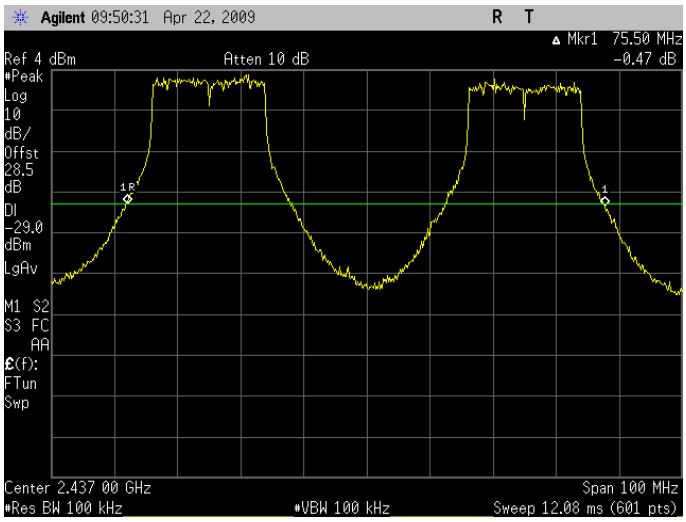
 © 2011, MET Laboratories, Inc.



Plot 42. Frequency Range Test Results – Low Temp/Low Voltage, (HT20 mode)

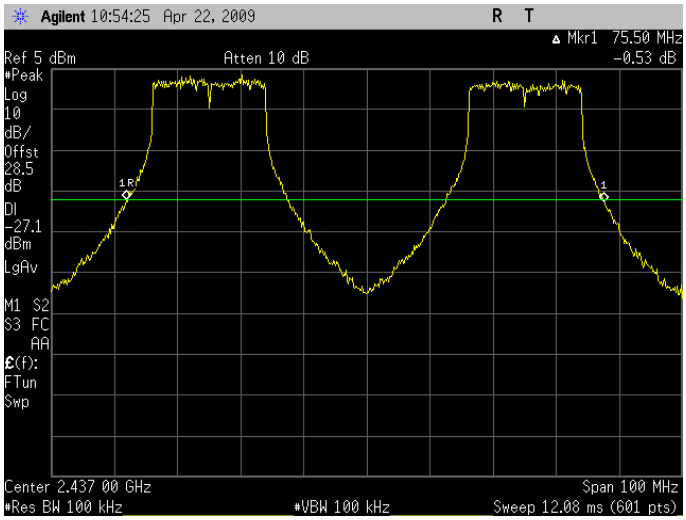


Plot 43. Frequency Range Test Results – Low Temp/Nominal Voltage, (HT20 mode)

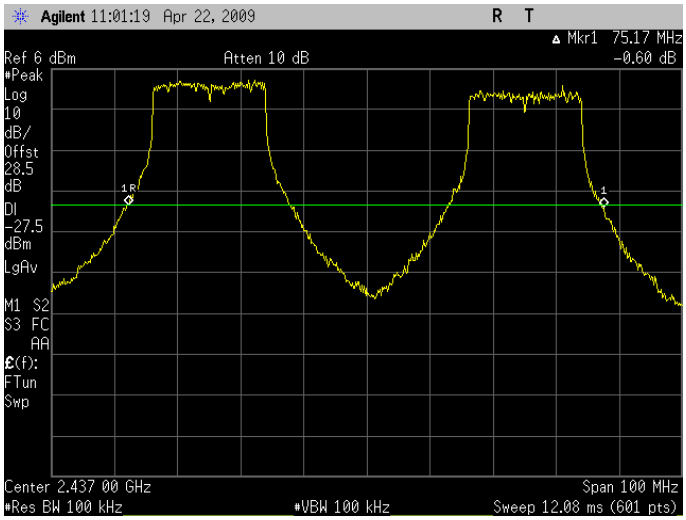


Plot 44. Frequency Range Test Results – Low Temp/Maximum Voltage, (HT20 mode)

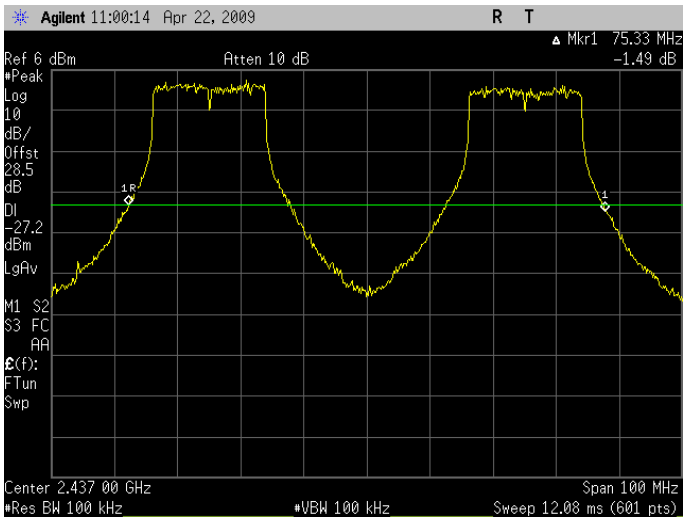
 © 2011, MET Laboratories, Inc.



Plot 45. Frequency Range Test Results – Maximum Temp/Low Voltage, (HT20 mode)



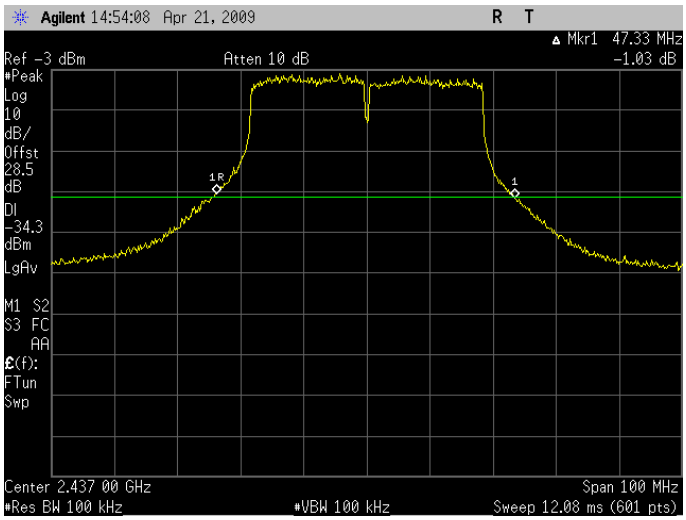
Plot 46. Frequency Range Test Results – Maximum Temp/Nominal Voltage, (HT20 mode)



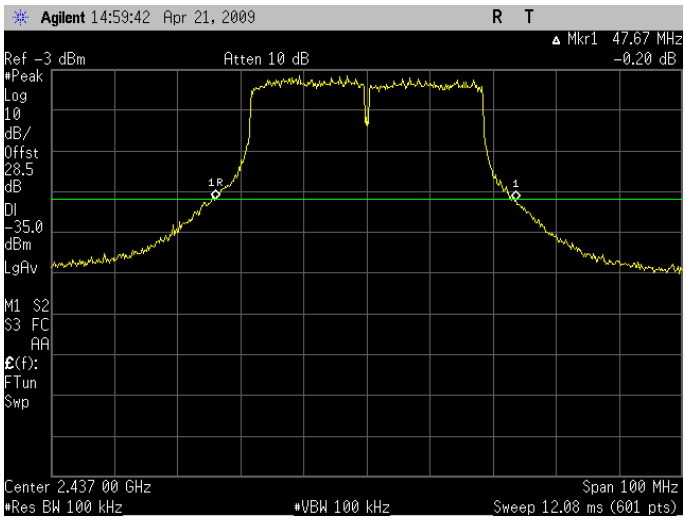
Plot 47. Frequency Range Test Results – Maximum Temp/Maximum Voltage, (HT20 mode)

© 2011, MET Laboratories, Inc.

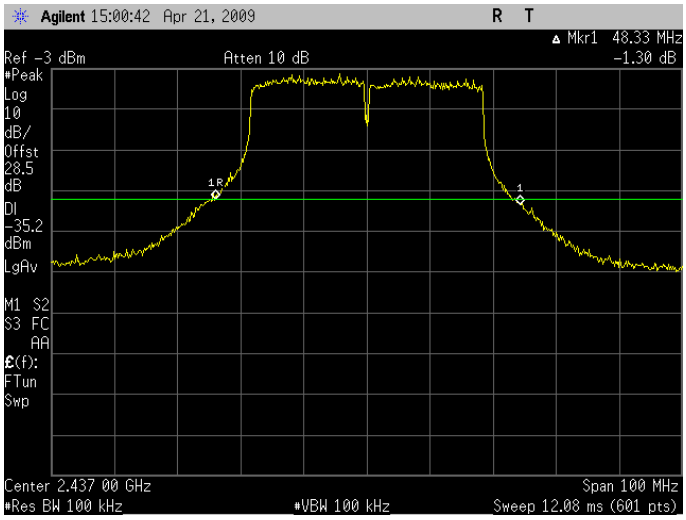
4.3.3 Frequency Range Test Results – HT40 Mode



Plot 48. Frequency Range Test Results – Nominal Temp/Low Voltage, (HT40 mode)

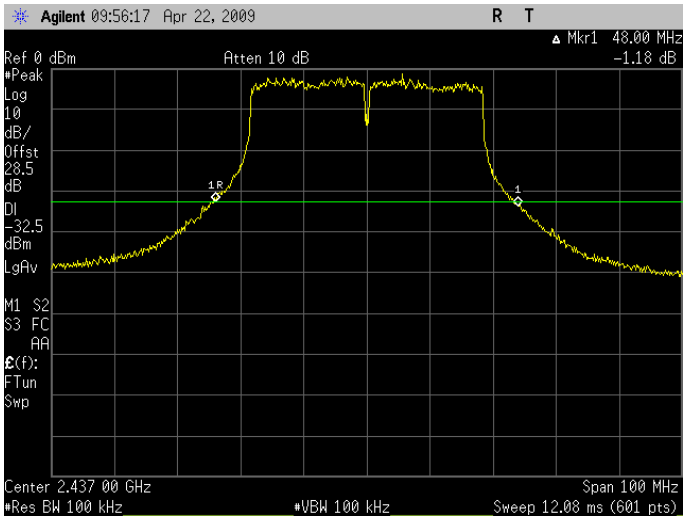


Plot 49. Frequency Range Test Results – Nominal Temp/Nominal Voltage, (HT40 mode)

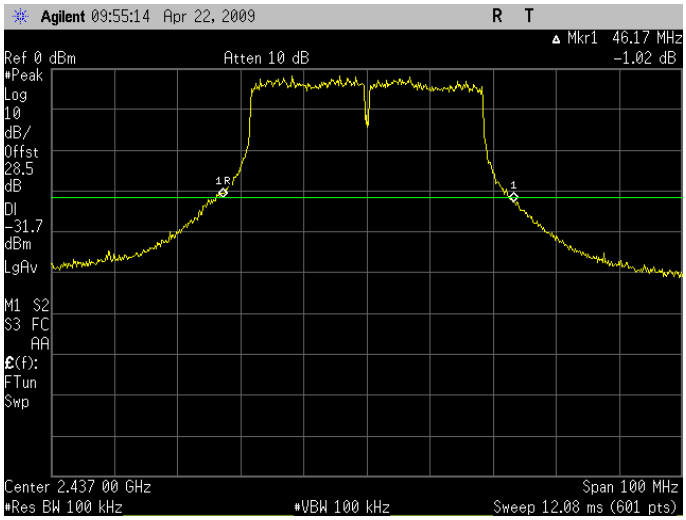


Plot 50. Frequency Range Test Results – Nominal Temp/Maximum Voltage, (HT40 mode)

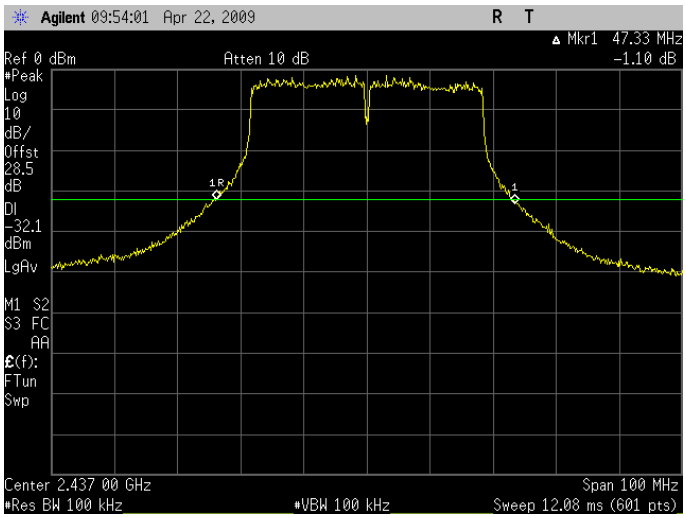
 © 2011, MET Laboratories, Inc.



Plot 51. Frequency Range Test Results – Low Temp/Low Voltage, (HT40 mode)

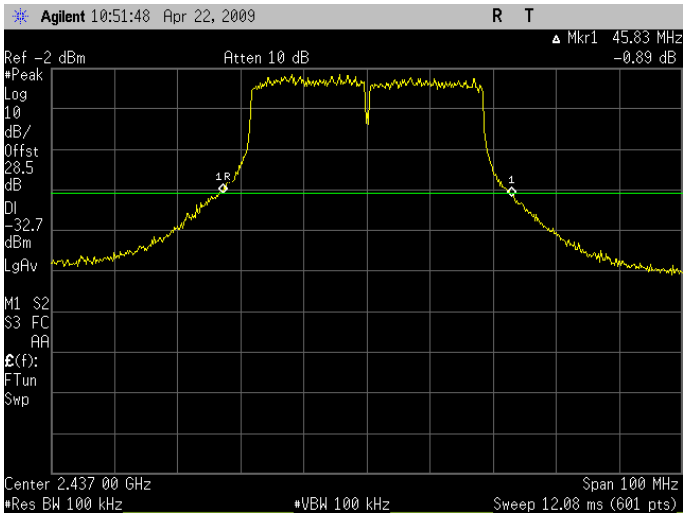


Plot 52. Frequency Range Test Results – Low Temp/Nominal Voltage, (HT40 mode)

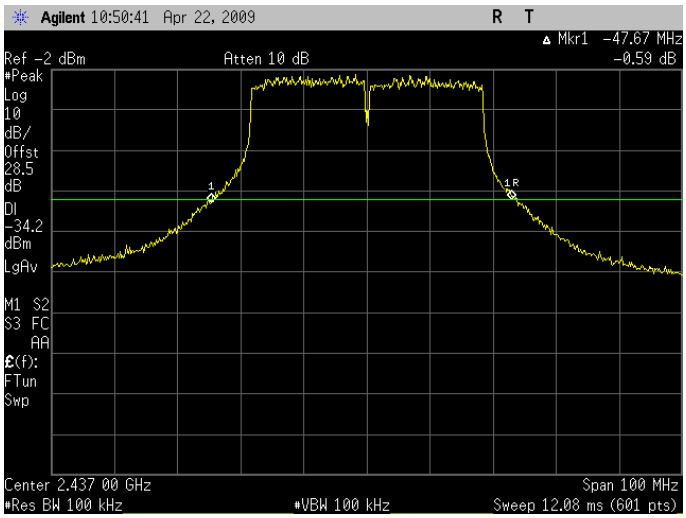


Plot 53. Frequency Range Test Results – Low Temp/Maximum Voltage, (HT40 mode)

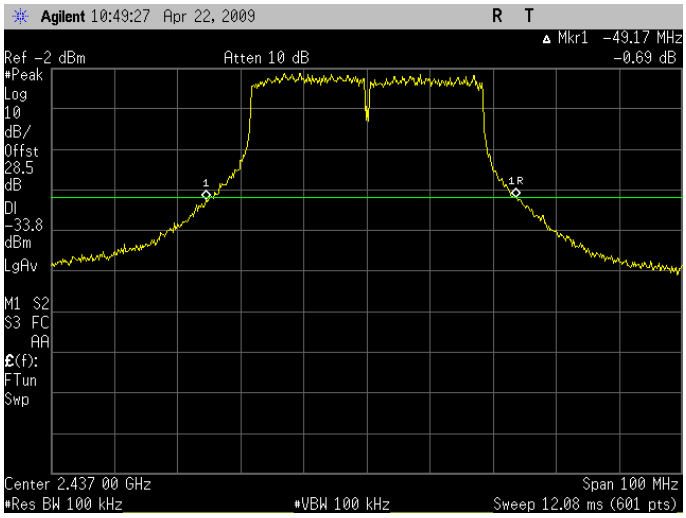
 © 2011, MET Laboratories, Inc.



Plot 54. Frequency Range Test Results – Maximum Temp/Low Voltage, (HT40 mode)



Plot 55. Frequency Range Test Results – Maximum Temp/Nominal Voltage, (HT40 mode)



Plot 56. Frequency Range Test Results – Maximum Temp/Maximum Voltage, (HT40 mode)

© 2011, MET Laboratories, Inc.

4.3.5 Medium Access Protocol

Definition: **EN 300 328, Clause 4.3.5.1:** A medium access protocol is a mechanism designed to facilitate spectrum sharing with other devices in a wireless network.

Requirement(s): **EN 300 328, Clause 4.3.5.2:** A medium access protocol shall be implemented by the equipment.

Test Results: The EUT facilitates medium access protocol and there fore is compliant with the requirements of Clause 4.3.5.

Test Engineer: Anderson Soungpanya

Test Date: April 28, 2009

 © 2011, MET Laboratories, Inc.

4.3.6 Transmitter Spurious Emissions - Conducted

Test Requirement(s): **EN 300 328, Clause 4.3.4:**

4.3.6.1 Definition

Transmitter spurious emissions are emissions outside the frequency range(s) of the equipment as defined in *Clause 4.3.3.1* when the equipment is in Transmit mode and/or in Standby mode.

4.3.6.2 Limit

The spurious emissions of the transmitter shall not exceed the values in Table 14 and Table 15 and in the indicated bands.

Frequency Range	Limit when operating
30 MHz to 1 GHz	-36 dBm
above 1 GHz to 12,75 GHz	-30 dBm
1,8 GHz to 1,9 GHz 5,15 GHz to 5,3 GHz	-47 dBm

Table 14. Transmitter limits for narrowband spurious emissions

The above limit values apply to narrowband emissions, e.g. as caused by local oscillator leakage. The measurement bandwidth for such emissions may be as small as necessary to achieve a reliable measurement result.

Wideband emissions shall not exceed the values given in Table 15.

Frequency Range	Limit when operating
30 MHz to 1 GHz	-86 dBm
above 1 GHz to 12,75 GHz	-80 dBm
1,8 GHz to 1,9 GHz 5,15 GHz to 5,3 GHz	-97 dBm

Table 15. Transmitter limits for wideband spurious emissions

 © 2011, MET Laboratories, Inc.

Conformance Requirements

4.3.6 Transmitter Spurious Emissions - Conducted

Test Procedure: The EUT was connected directly to a spectrum analyzer through an attenuator. The resolution band width of the spectrum analyzer was set to 100 KHz and the video band width set to 30 KHz. A positive peak detector was used along with peak hold function. The measurement was performed using normal operation of the equipment.

Test Results: The EUT as tested was found compliant with the specified requirements of Clause 4.2.4.

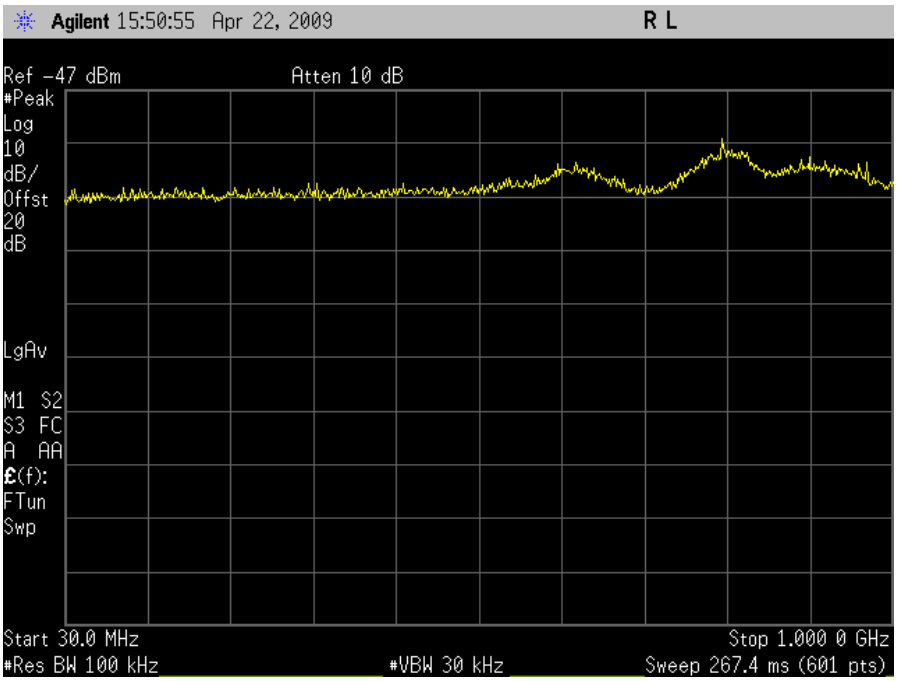
Test Engineer: Anderson Soungpanya

Test Date: April 21 & 22, 2009

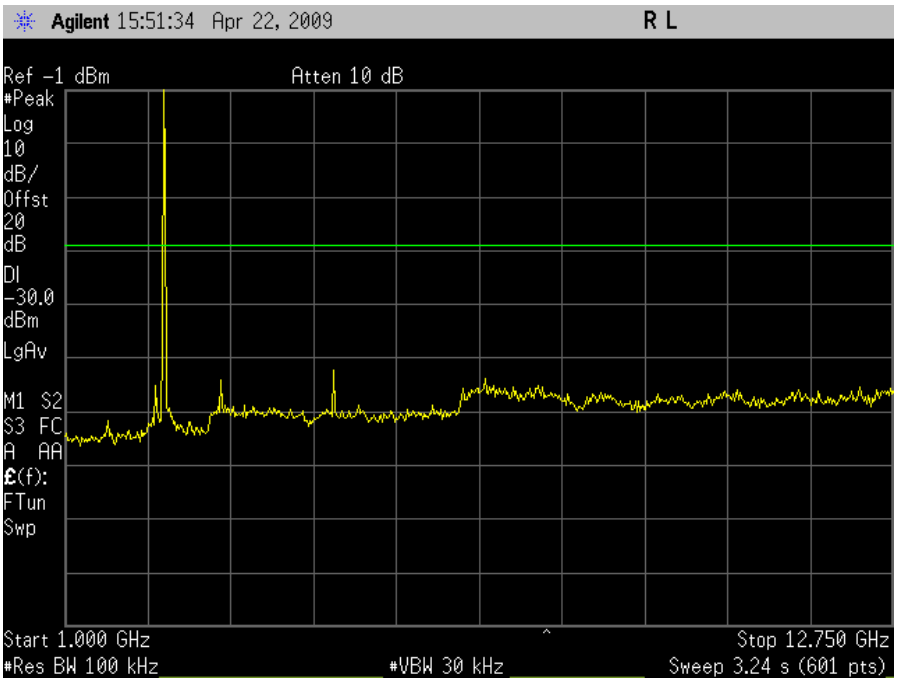
 © 2011, MET Laboratories, Inc.

Conformance Requirements

4.3.4 Transmitter Spurious Emissions - Conducted



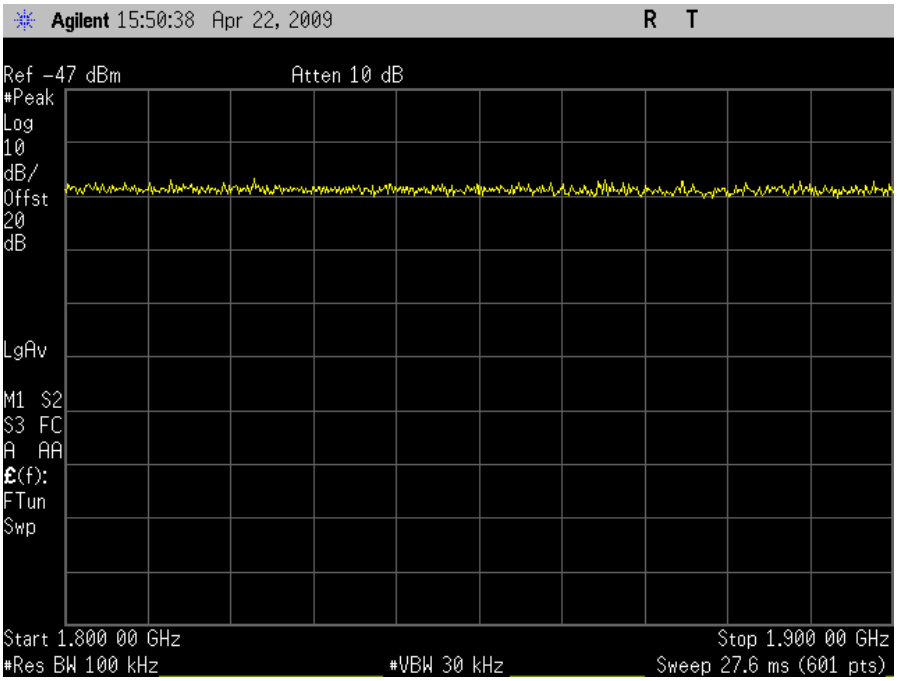
Plot 57. Low channel (2412 MHz) Spurious Emission 30 MHz - 1GHz DSSS Mode



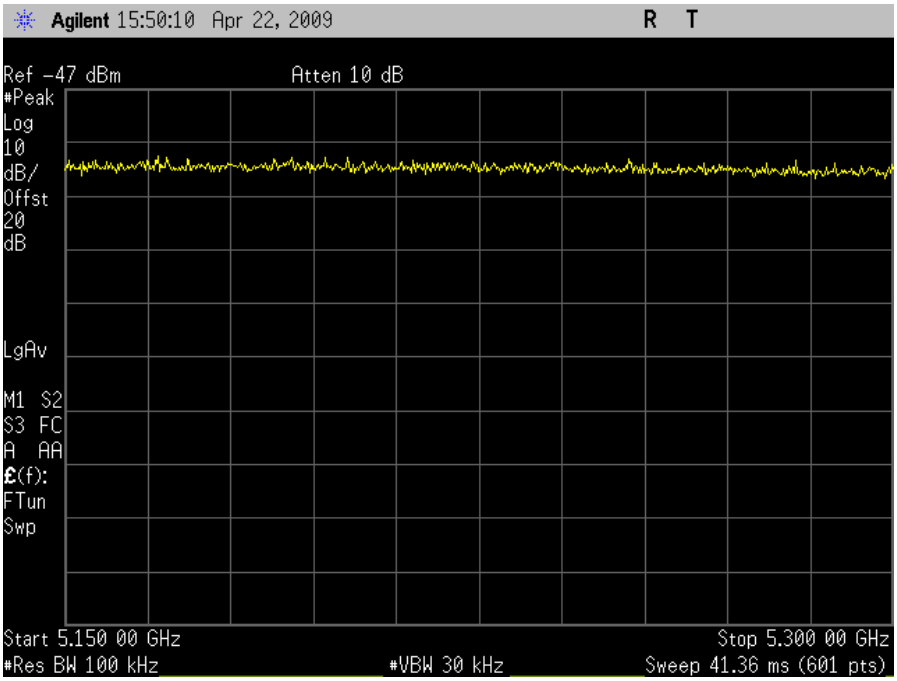
Plot 58. Low channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz DSSS Mode

 © 2011, MET Laboratories, Inc.

4.3.4 Transmitter Spurious Emissions - Conducted



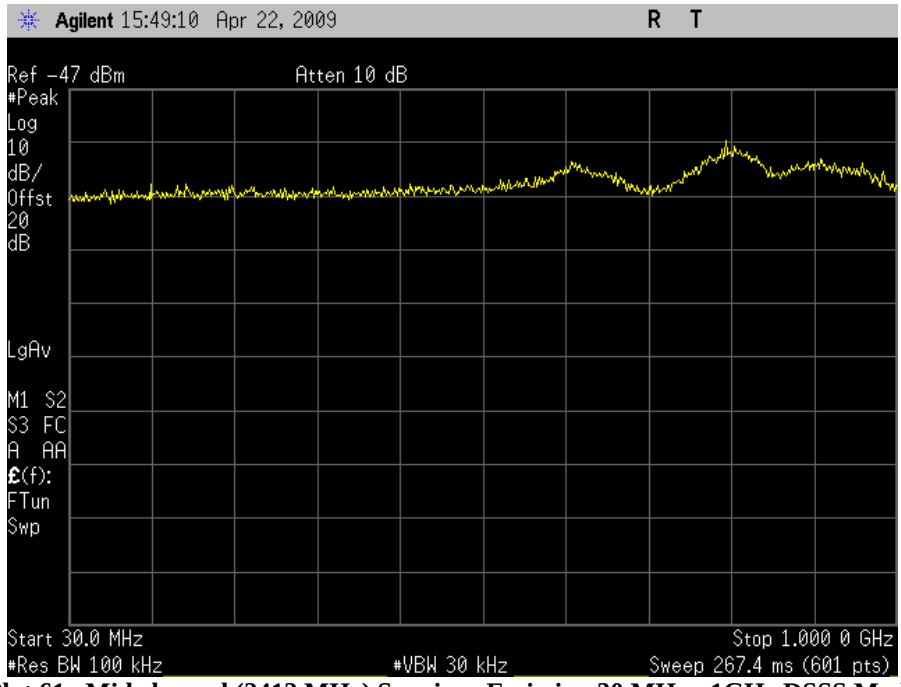
Plot 59. Low channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz DSSS Mode



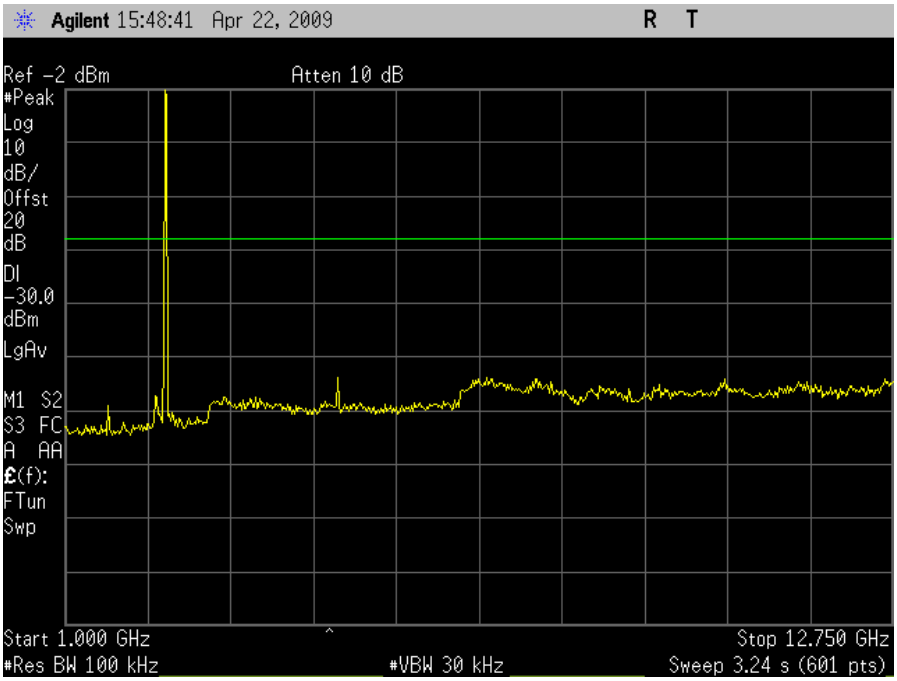
Plot 60. Low channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz DSSS Mode

 © 2011, MET Laboratories, Inc.

4.3.4 Transmitter Spurious Emissions - Conducted



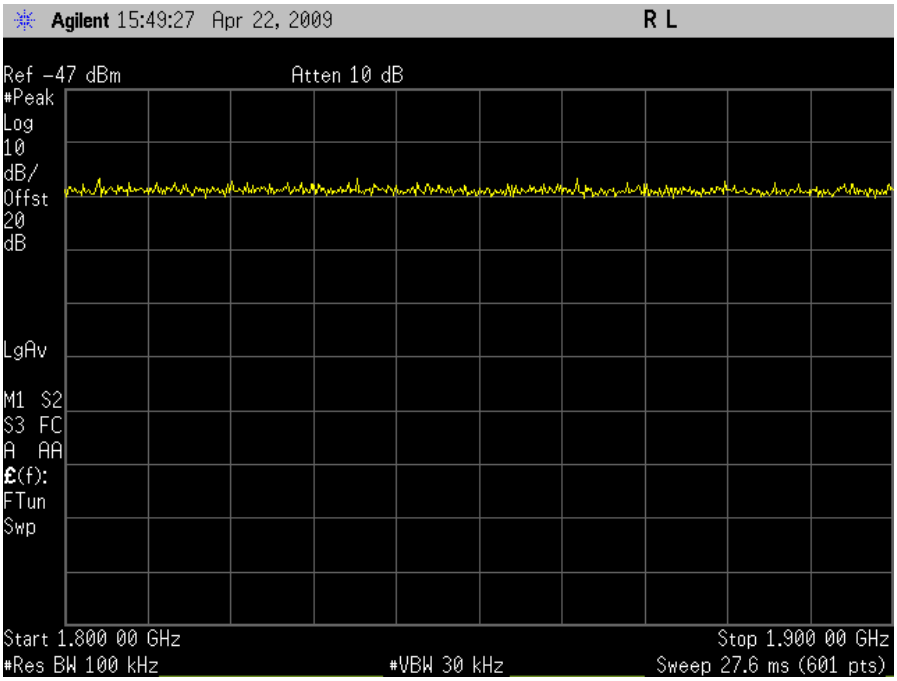
Plot 61. Mid channel (2412 MHz) Spurious Emission 30 MHz - 1GHz DSSS Mode



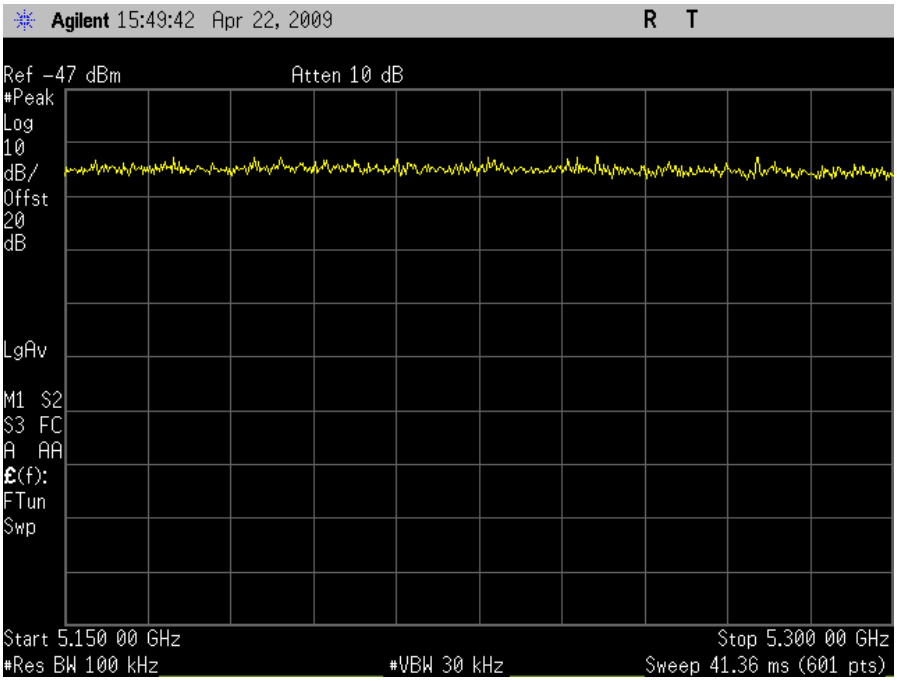
Plot 62. Mid channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz DSSS Mode

 © 2011, MET Laboratories, Inc.

4.3.4 Transmitter Spurious Emissions - Conducted



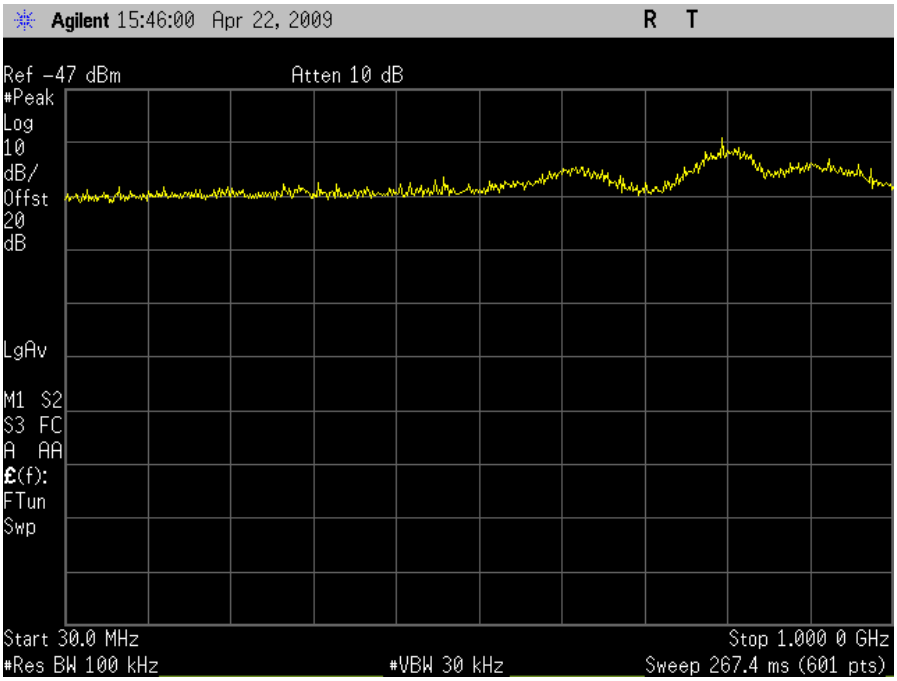
Plot 63. Mid channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz DSSS Mode



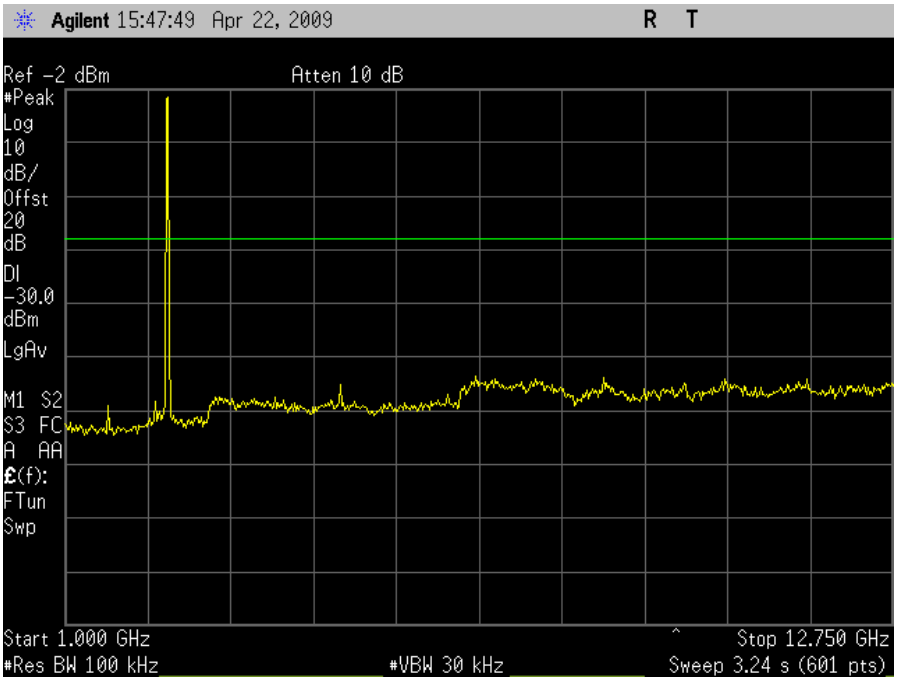
Plot 64. Mid channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz DSSS Mode

 © 2011, MET Laboratories, Inc.

4.3.4 Transmitter Spurious Emissions - Conducted



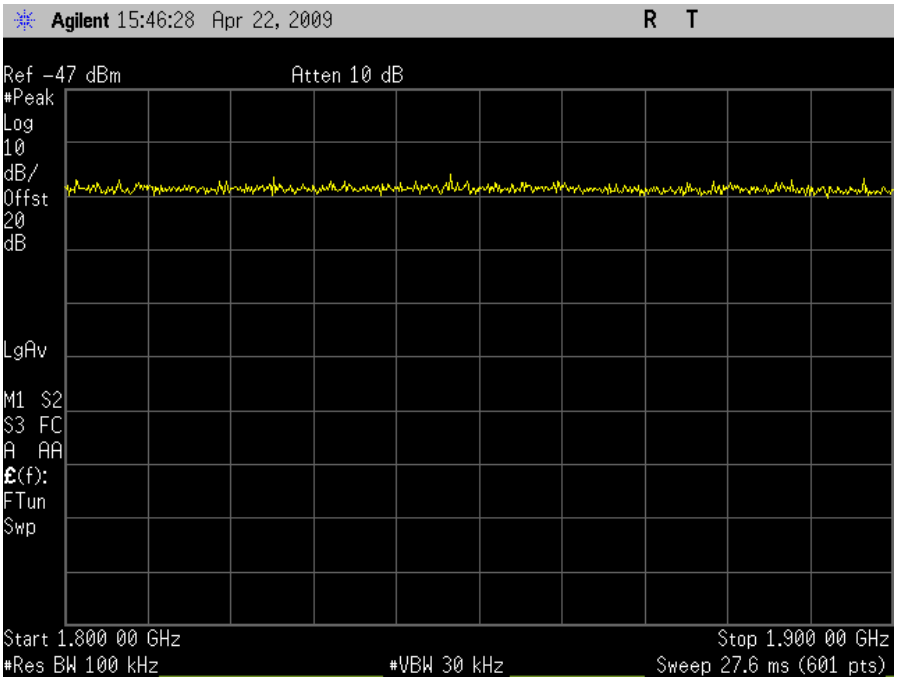
Plot 65. High channel (2412 MHz) Spurious Emission 30 MHz - 1GHz DSSS Mode



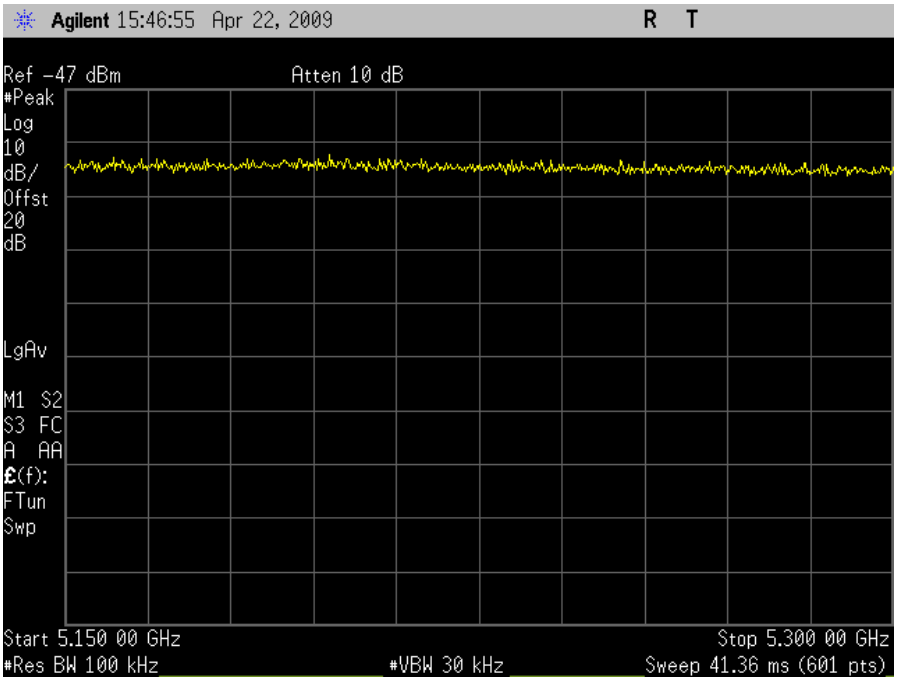
Plot 66. High channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz DSSS Mode

 © 2011, MET Laboratories, Inc.

4.3.4 Transmitter Spurious Emissions - Conducted



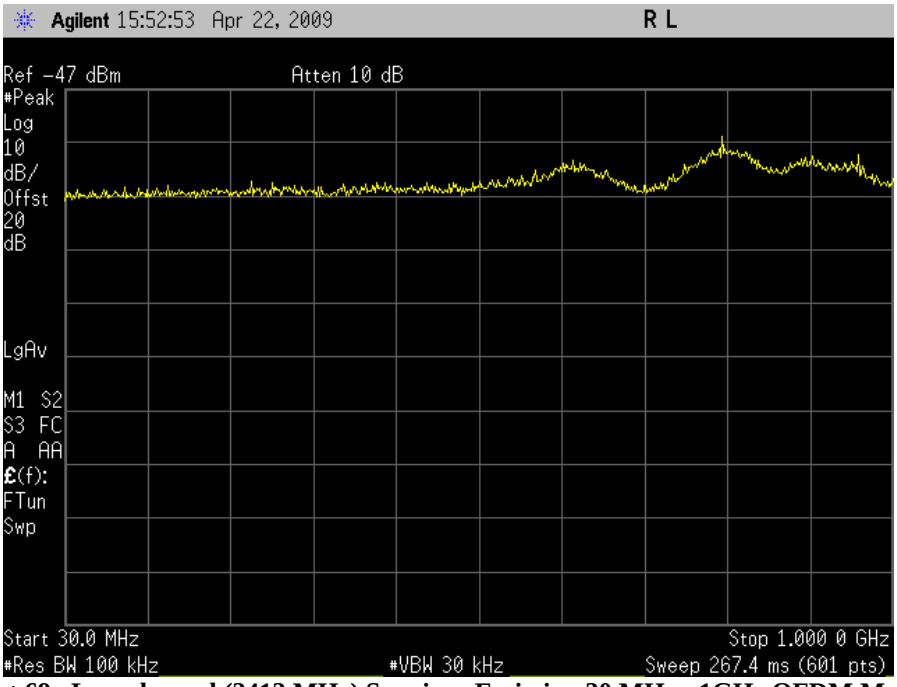
Plot 67. High channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz DSSS Mode



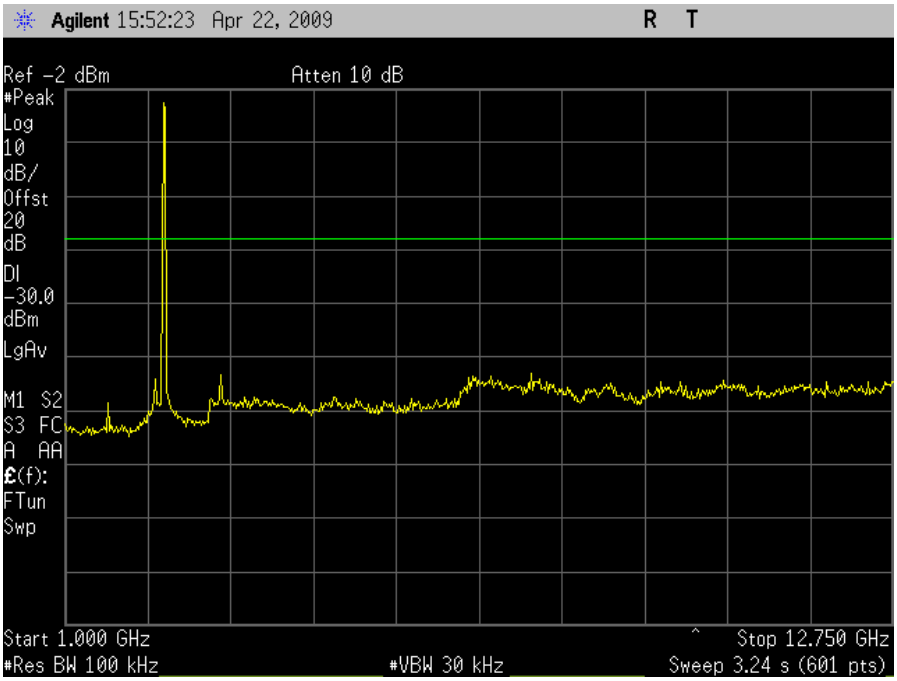
Plot 68. High channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz DSSS Mode

© 2011, MET Laboratories, Inc.

4.3.4 Transmitter Spurious Emissions - Conducted



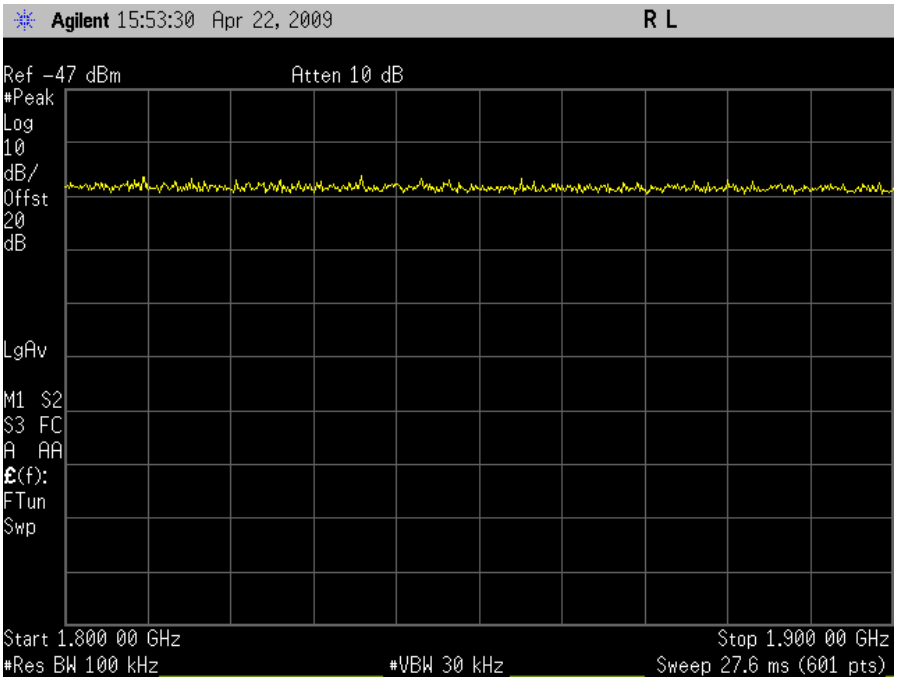
Plot 69. Low channel (2412 MHz) Spurious Emission 30 MHz - 1GHz OFDM Mode



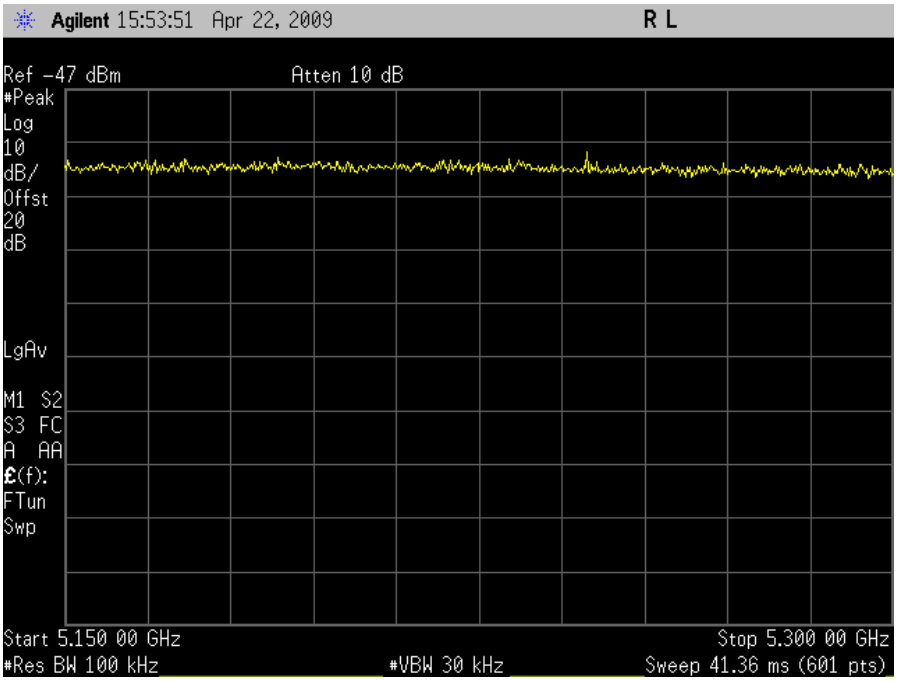
Plot 70. Low channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz OFDM Mode

 © 2011, MET Laboratories, Inc.

4.3.4 Transmitter Spurious Emissions - Conducted



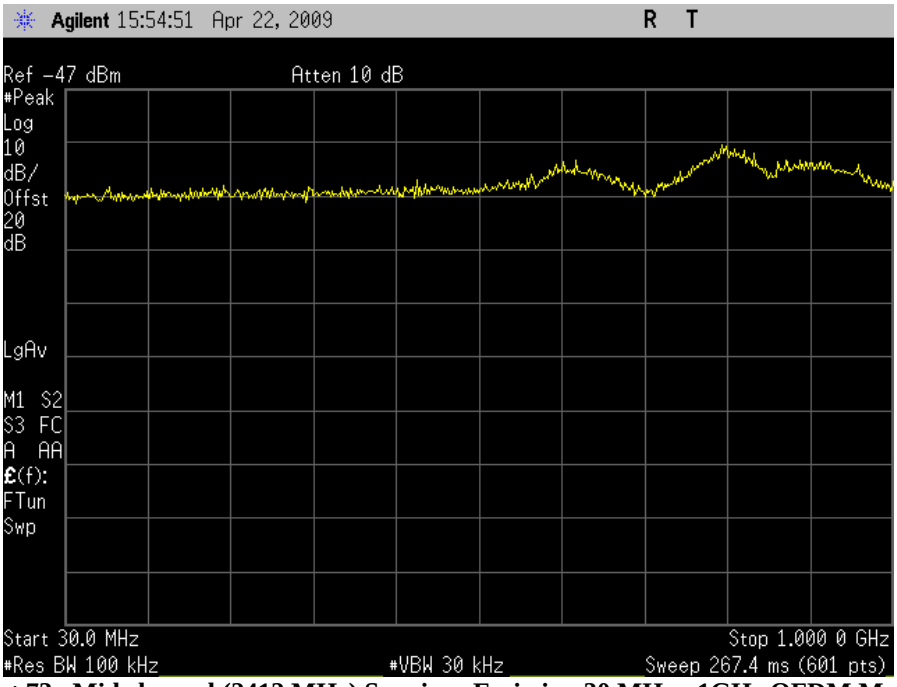
Plot 71. Low channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz OFDM Mode



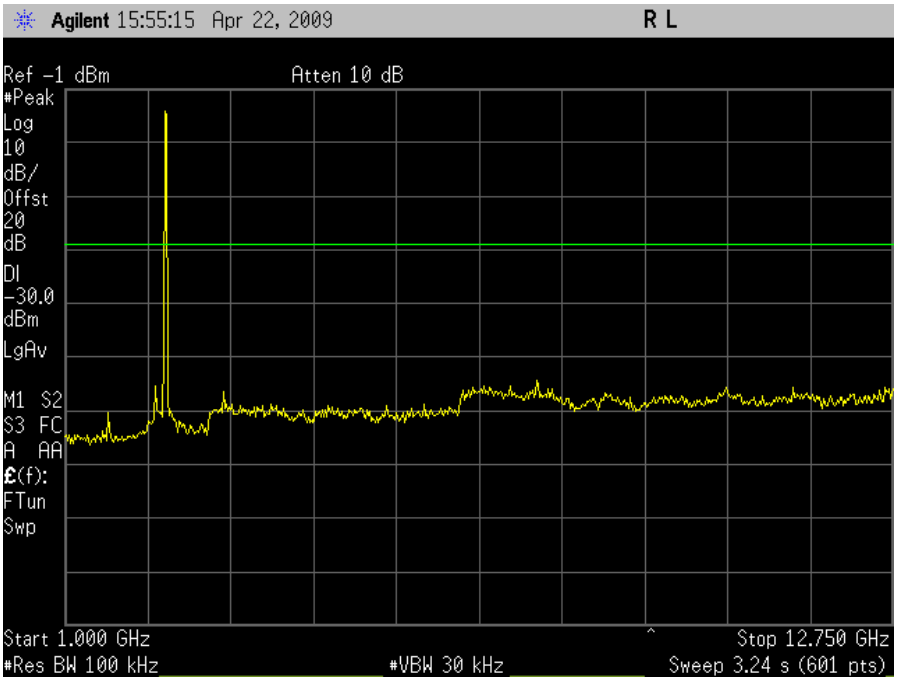
Plot 72. Low channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz OFDM Mode

 © 2011, MET Laboratories, Inc.

4.3.4 Transmitter Spurious Emissions - Conducted



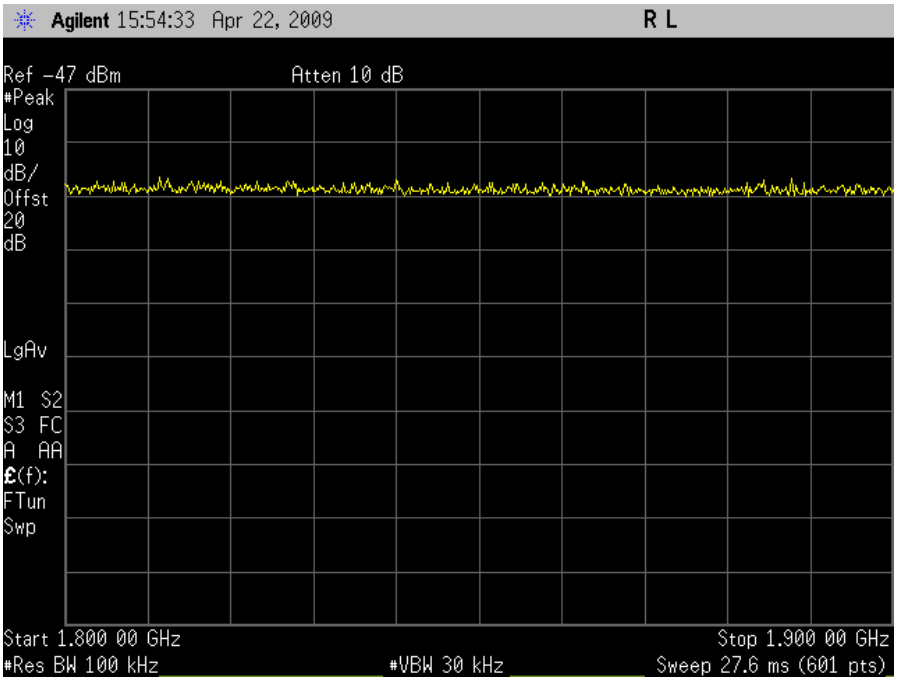
Plot 73. Mid channel (2412 MHz) Spurious Emission 30 MHz - 1GHz OFDM Mode



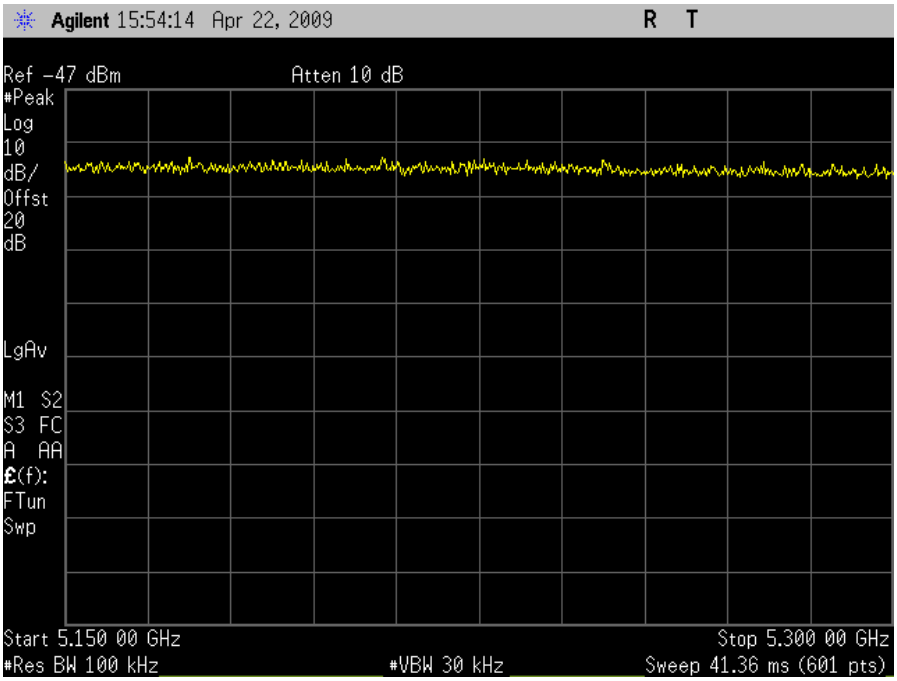
Plot 74. Mid channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz OFDM Mode

 © 2011, MET Laboratories, Inc.

4.3.4 Transmitter Spurious Emissions - Conducted



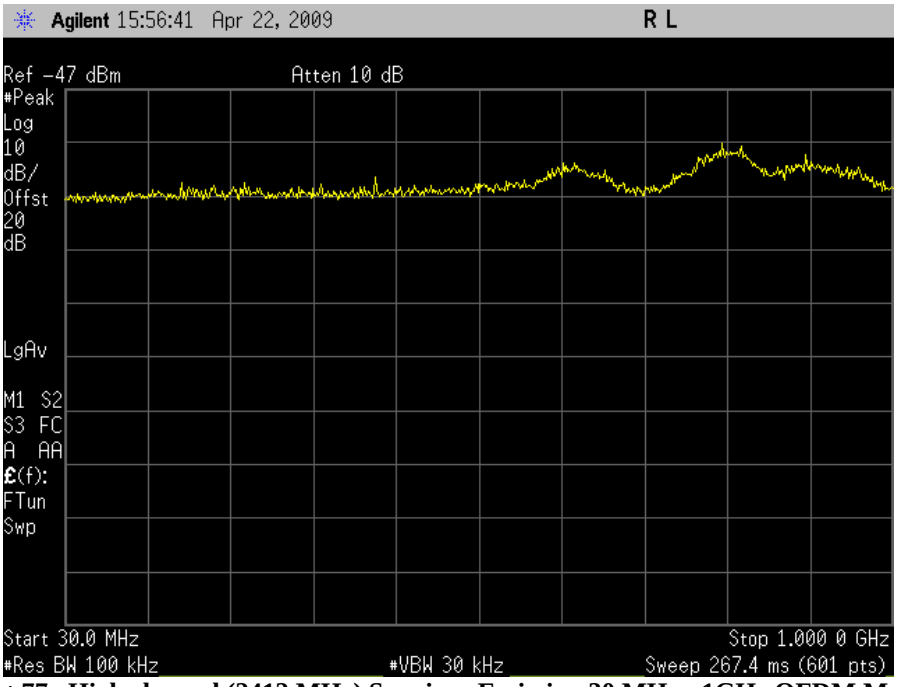
Plot 75. Mid channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz OFDM Mode



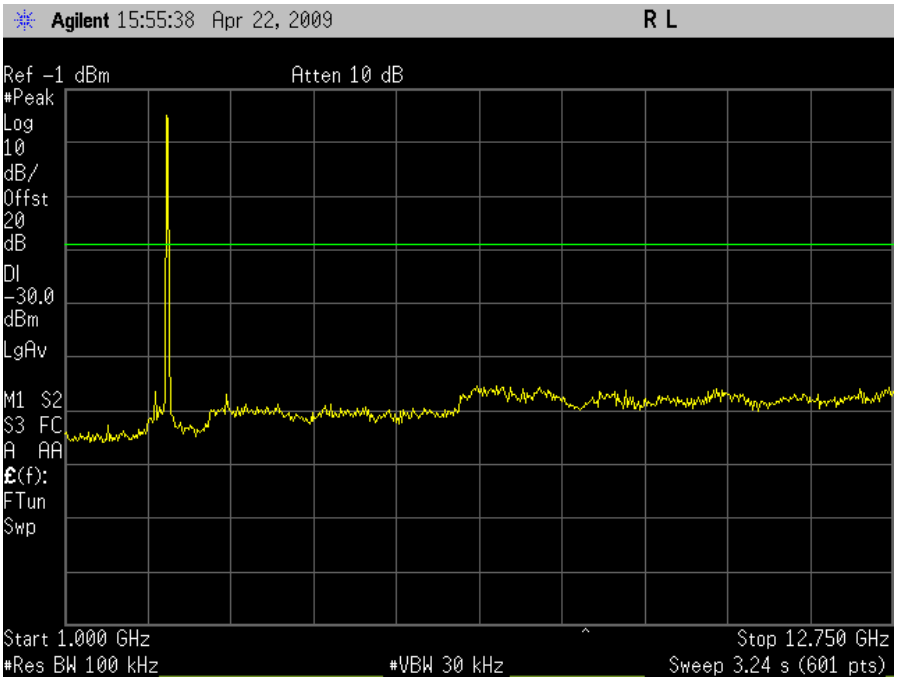
Plot 76. Mid channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz OFDM Mode

© 2011, MET Laboratories, Inc.

4.3.4 Transmitter Spurious Emissions - Conducted



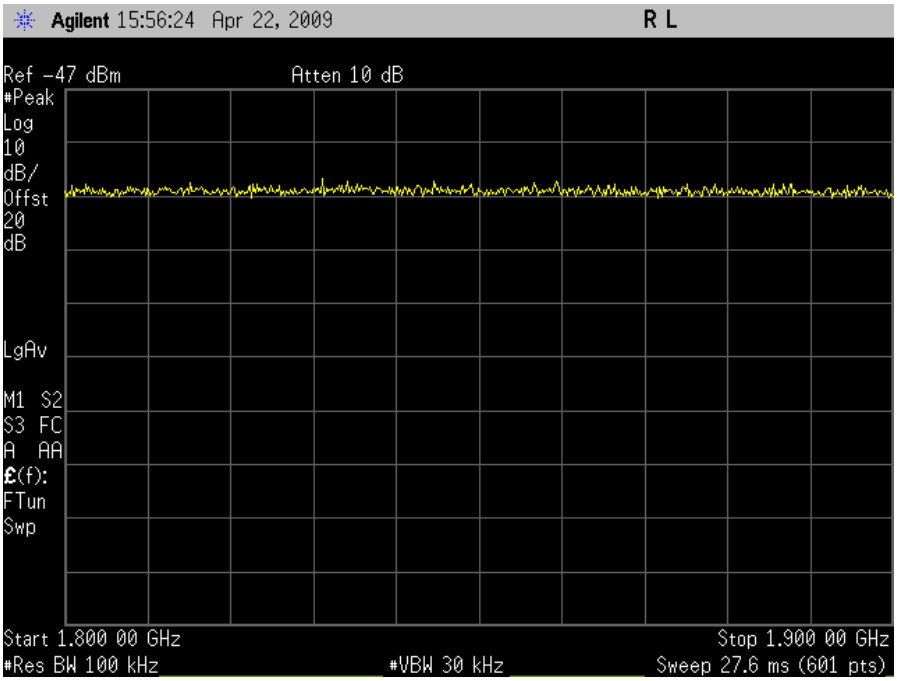
Plot 77. High channel (2412 MHz) Spurious Emission 30 MHz - 1GHz OFDM Mode



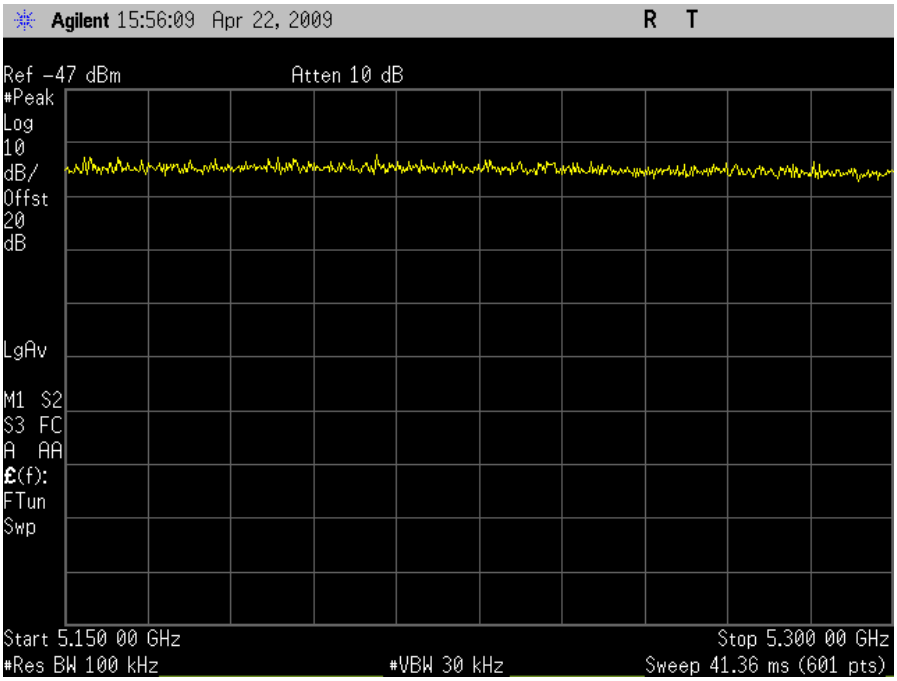
Plot 78. High channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz OFDM Mode

© 2011, MET Laboratories, Inc.

4.3.4 Transmitter Spurious Emissions - Conducted



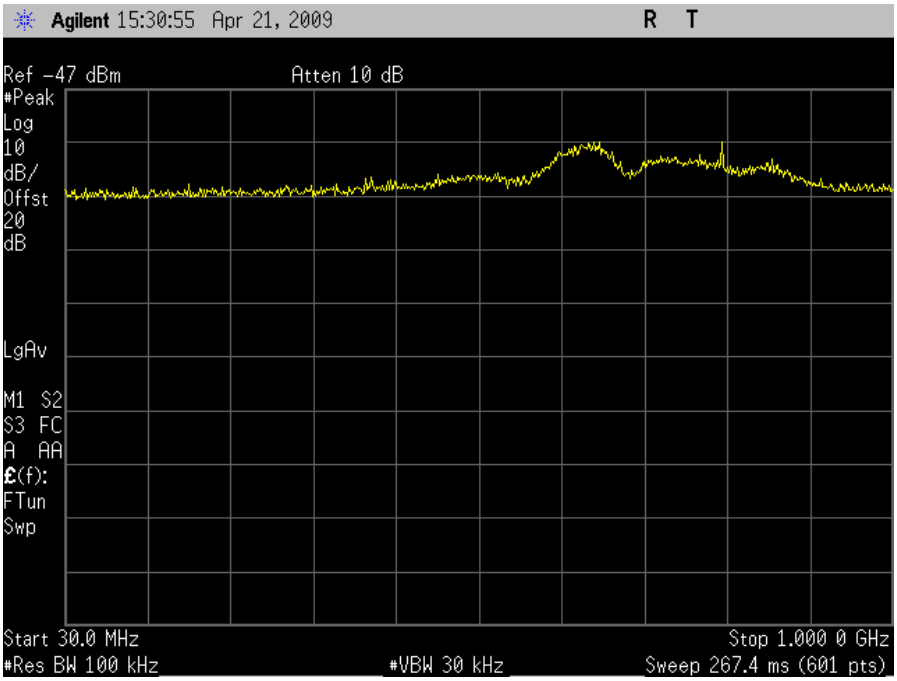
Plot 79. High channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz OFDM Mode



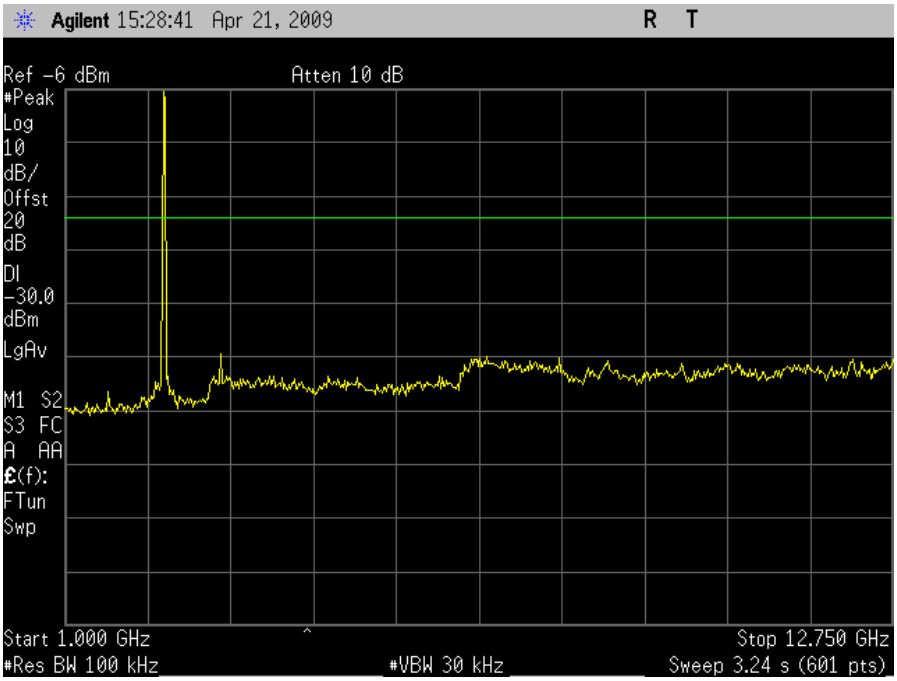
Plot 80. High channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz OFDM Mode

 © 2011, MET Laboratories, Inc.

4.3.4 Transmitter Spurious Emissions - Conducted



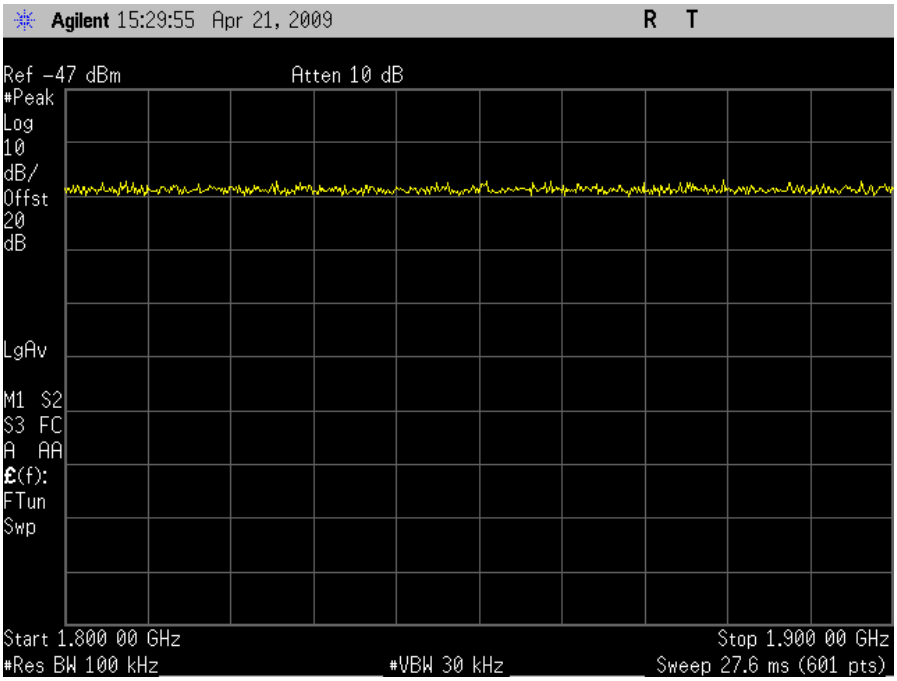
Plot 81. Low channel (2412 MHz) Spurious Emission 30 MHz - 1GHz HT20 Mode



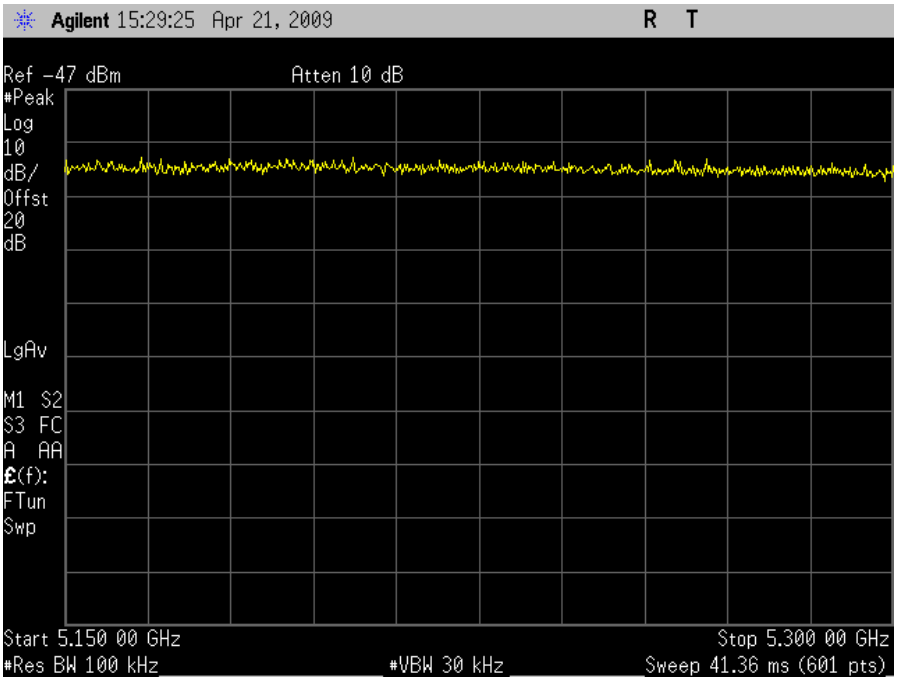
Plot 82. Low channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz HT20 Mode

© 2011, MET Laboratories, Inc.

4.3.4 Transmitter Spurious Emissions - Conducted



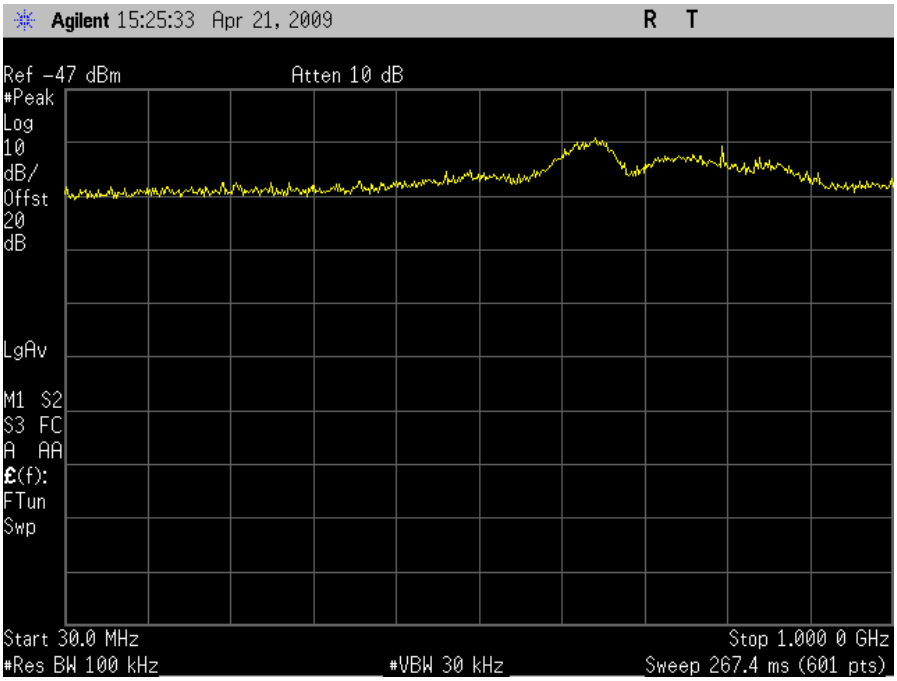
Plot 83. Low channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz HT20 Mode



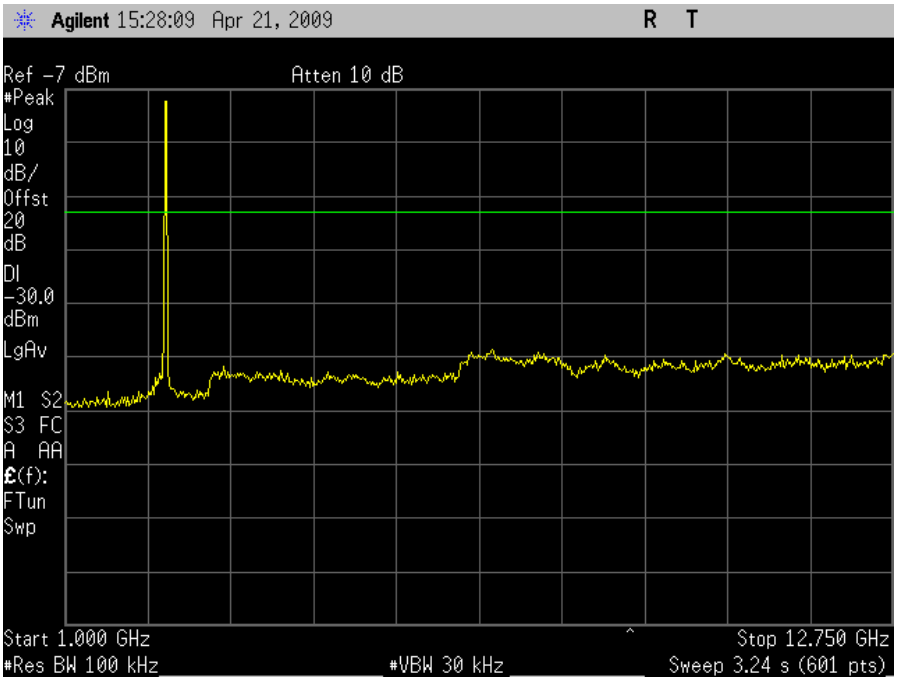
Plot 84. Low channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz HT20 Mode

 © 2011, MET Laboratories, Inc.

4.3.4 Transmitter Spurious Emissions - Conducted



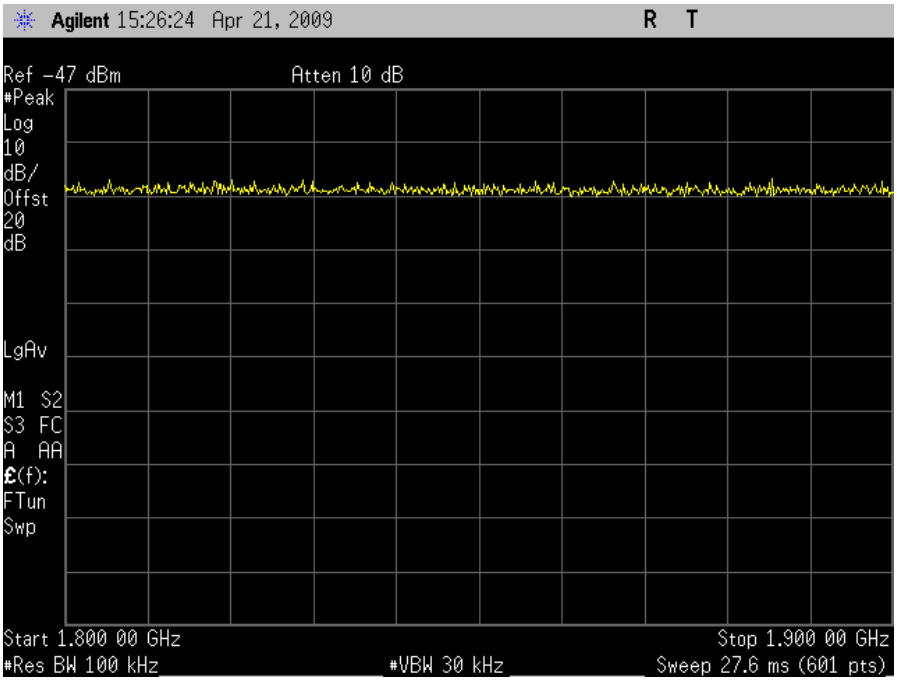
Plot 85. Mid channel (2412 MHz) Spurious Emission 30 MHz - 1GHz HT20 Mode



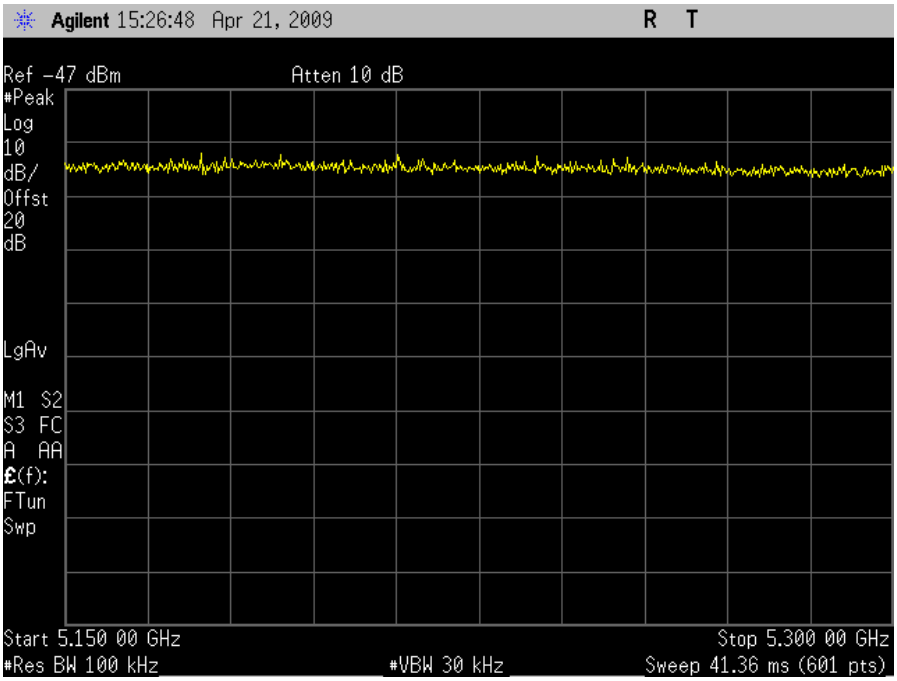
Plot 86. Mid channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz HT20 Mode

 © 2011, MET Laboratories, Inc.

4.3.4 Transmitter Spurious Emissions - Conducted



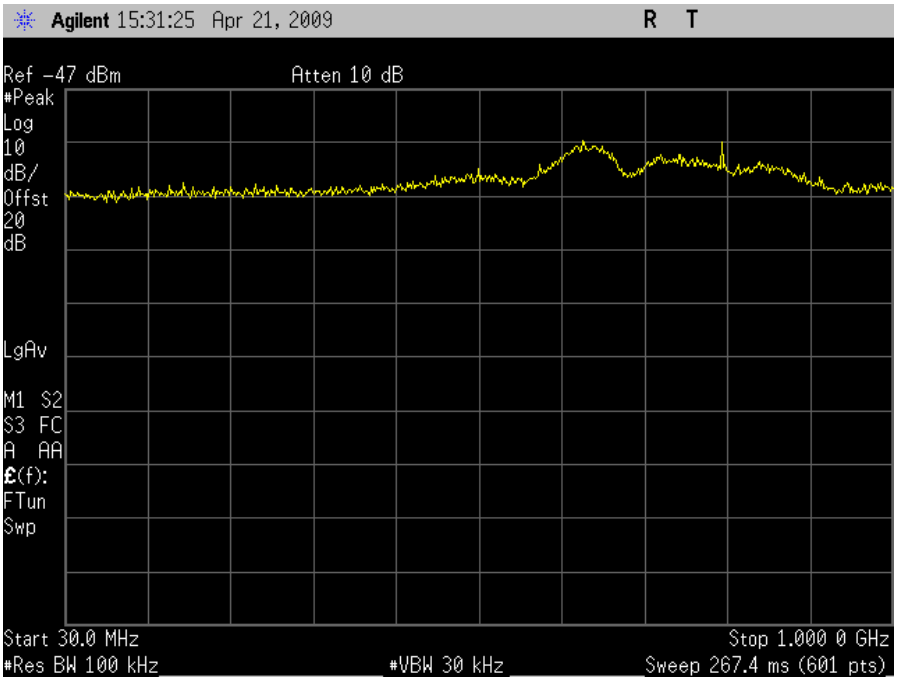
Plot 87. Mid channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz HT20 Mode



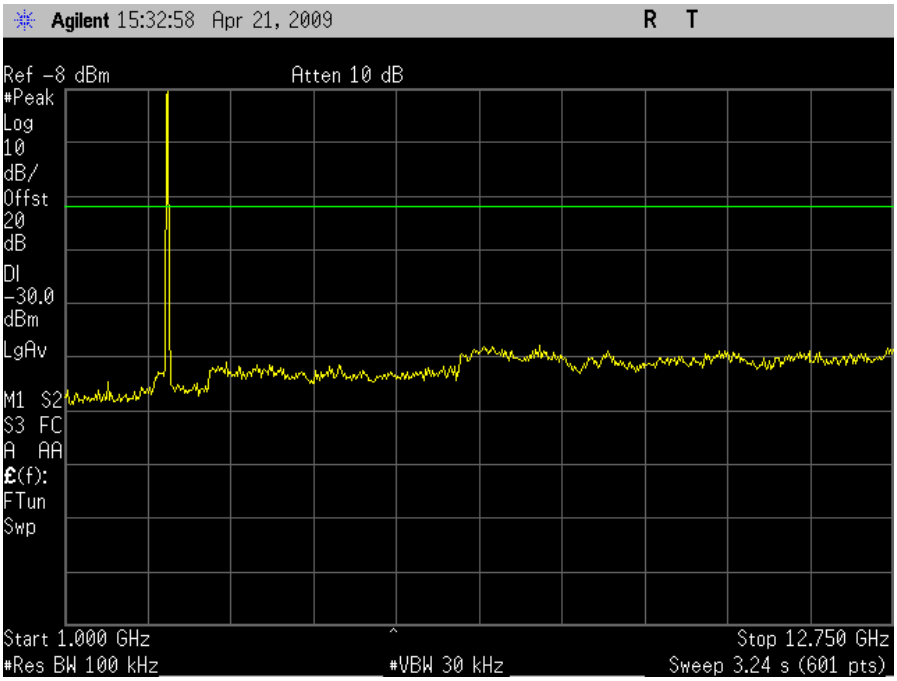
Plot 88. Mid channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz HT20 Mode

 © 2011, MET Laboratories, Inc.

4.3.4 Transmitter Spurious Emissions - Conducted



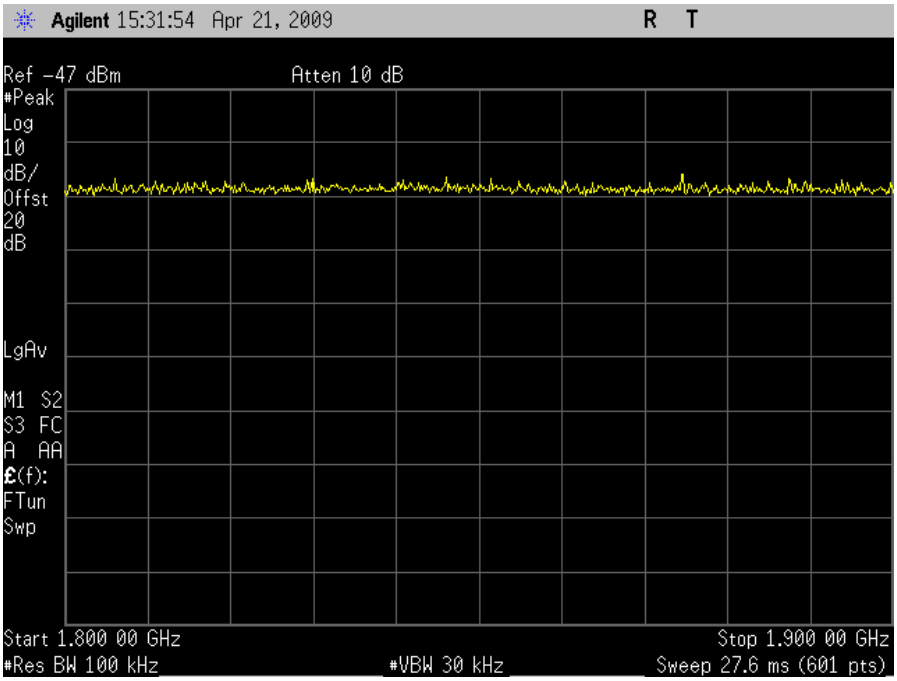
Plot 89. High channel (2412 MHz) Spurious Emission 30 MHz - 1GHz HT20 Mode



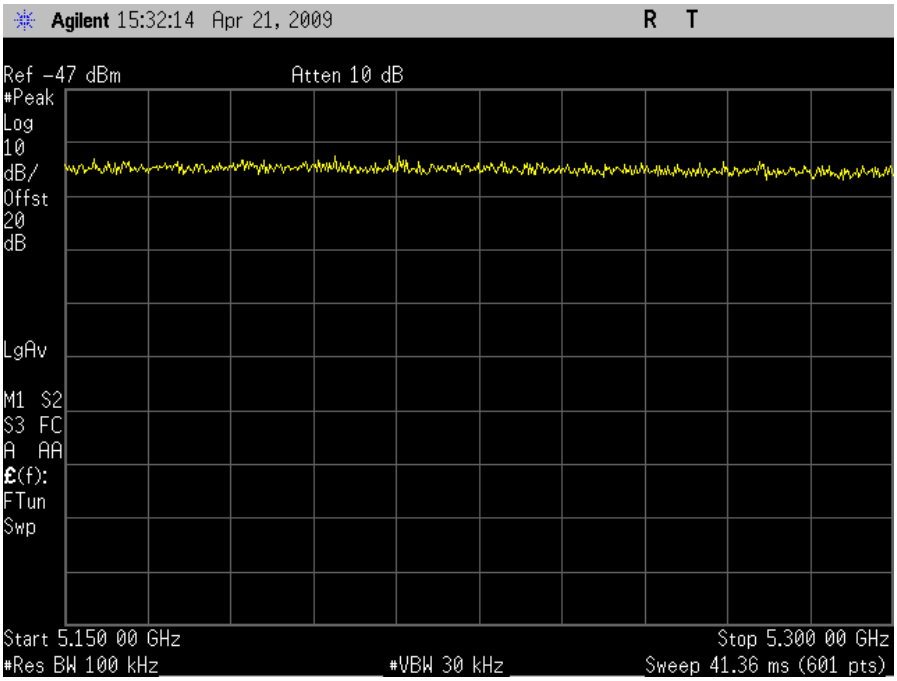
Plot 90. High channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz HT20 Mode

 © 2011, MET Laboratories, Inc.

4.3.4 Transmitter Spurious Emissions - Conducted



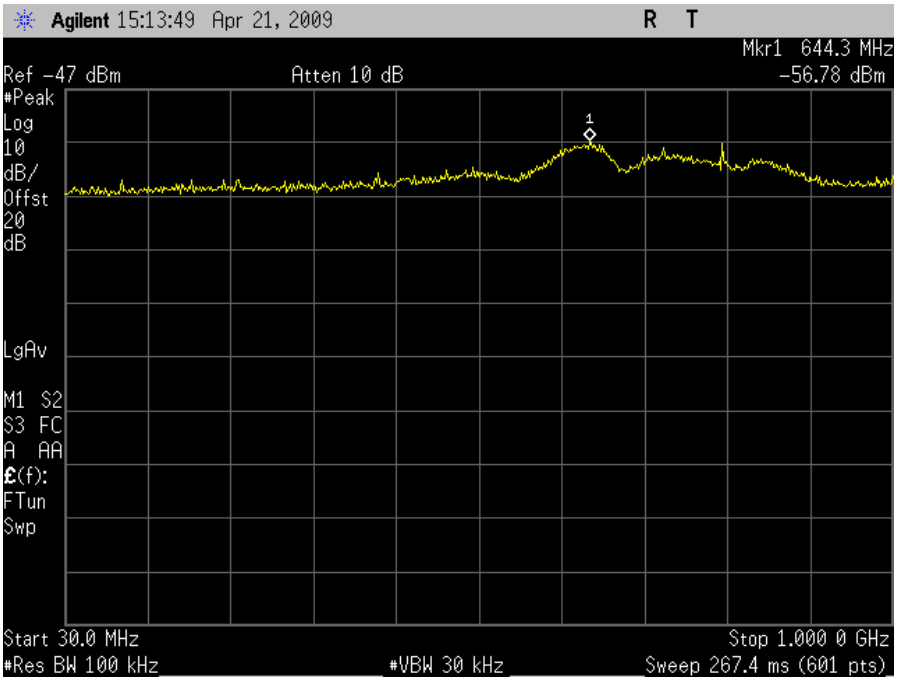
Plot 91. High channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz HT20 Mode



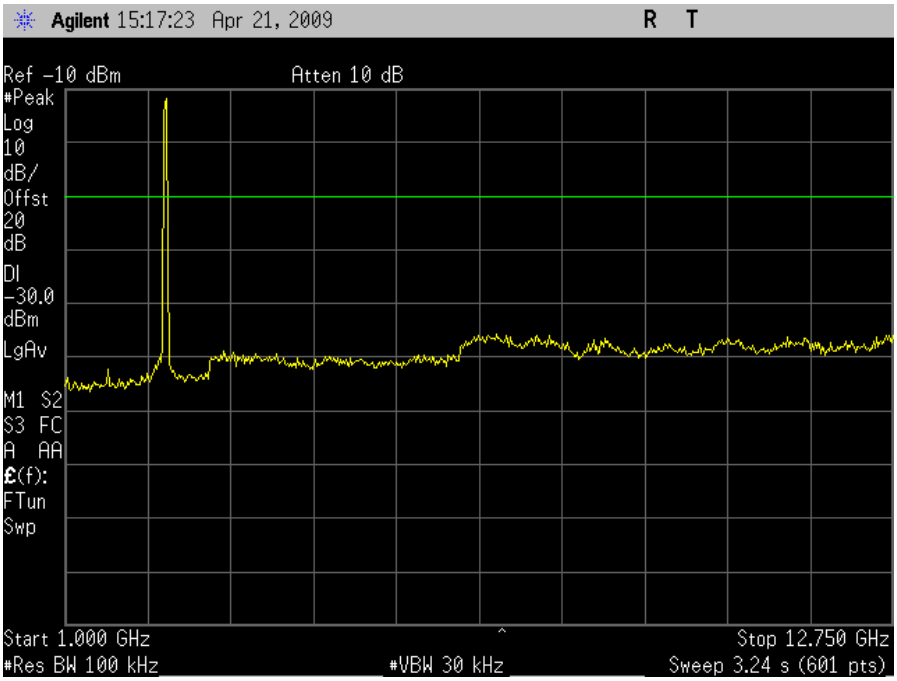
Plot 92. High channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz HT20 Mode

© 2011, MET Laboratories, Inc.

4.3.4 Transmitter Spurious Emissions - Conducted



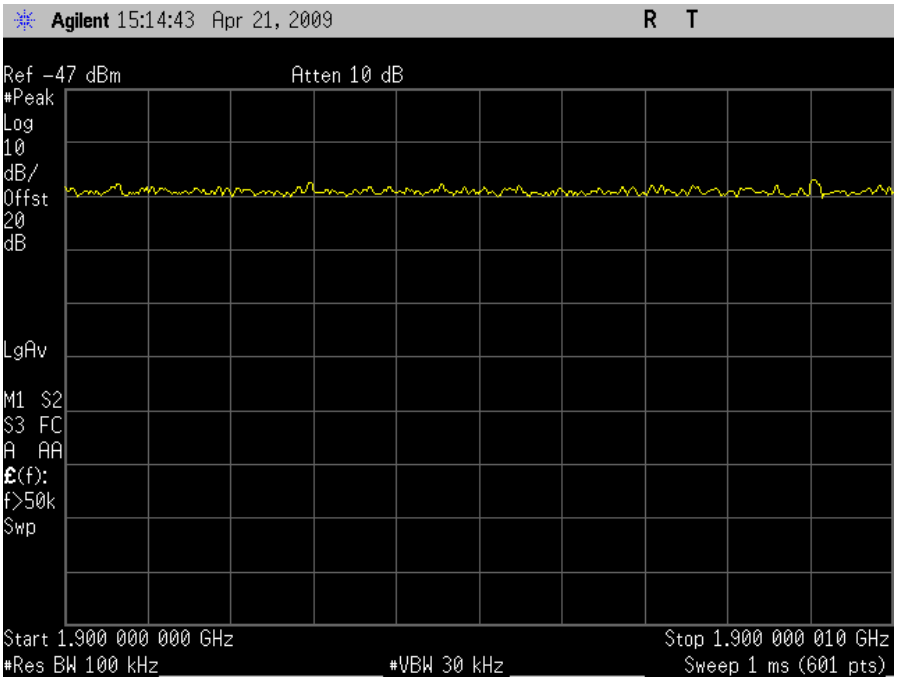
Plot 93. Mid channel (2412 MHz) Spurious Emission 30 MHz - 1GHz HT40 Mode



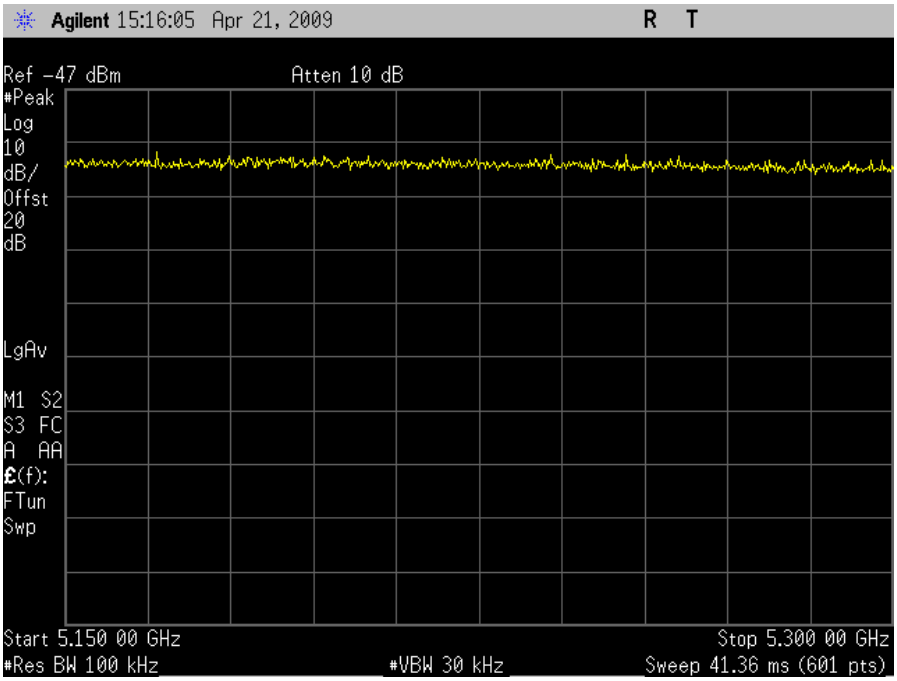
Plot 94. Mid channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz HT40 Mode

 © 2011, MET Laboratories, Inc.

4.3.4 Transmitter Spurious Emissions - Conducted



Plot 95. Mid channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz HT40 Mode



Plot 96. Mid channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz HT40 Mode

 © 2011, MET Laboratories, Inc.

4.3.6 Transmitter Spurious Emissions - Radiated

Test Requirement(s): **ETSI EN 300 328, Section 5.7.5:**

In accordance with *EN 300 328 Section 4.3.4*, the EUT shall meet the Spurious Emissions limits for emissions outside the transmit frequency band as shown in Table 16 and Table 17.

Frequency range	Limit when operating
30 MHz to 1 GHz	-36 dBm
above 1 GHz to 12,75 GHz	-30 dBm
1,8 GHz to 1,9 GHz 5,15 GHz to 5,3 GHz	-47 dBm

Table 16. Transmitter Limits for Narrowband Spurious Emissions

Frequency range	Limit when operating
30 MHz to 1 GHz	-86 dBm/Hz
above 1 GHz to 12,75 GHz	-80 dBm/Hz
1,8 GHz to 1,9 GHz 5,15 GHz to 5,3 GHz	-97 dBm/Hz

Table 17. Transmitter Limits for Wideband Spurious Emissions

Test Procedure: The EUT was placed on a 1.5m high wooden table inside a semi-anechoic chamber. The measurements were performed using normal operation of the equipment. The method of testing, test conditions, and test procedures of *Annex B* were used. The frequencies and amplitudes of field strengths were recorded for reference during final measurements.

The EUT was set to transmit at its highest output power at both the low and high channels of the transmit band as well as all applicable modulations. The receive antenna was adjusted between 1 and 4 m in order to find the maximum emission. The table was also rotated about 360^0. Both vertical and horizontal polarizations were used to determine the maximum emission.

In order to determine the magnitude of each emission within 6dB of the limit, other than the noise floor of the spectrum analyzer, the signal substitution method was used as described in Annex B of *EN 300 328*.

Test Results: The EUT as tested was found compliant with the specified limits of Clause 4.3.4.2.

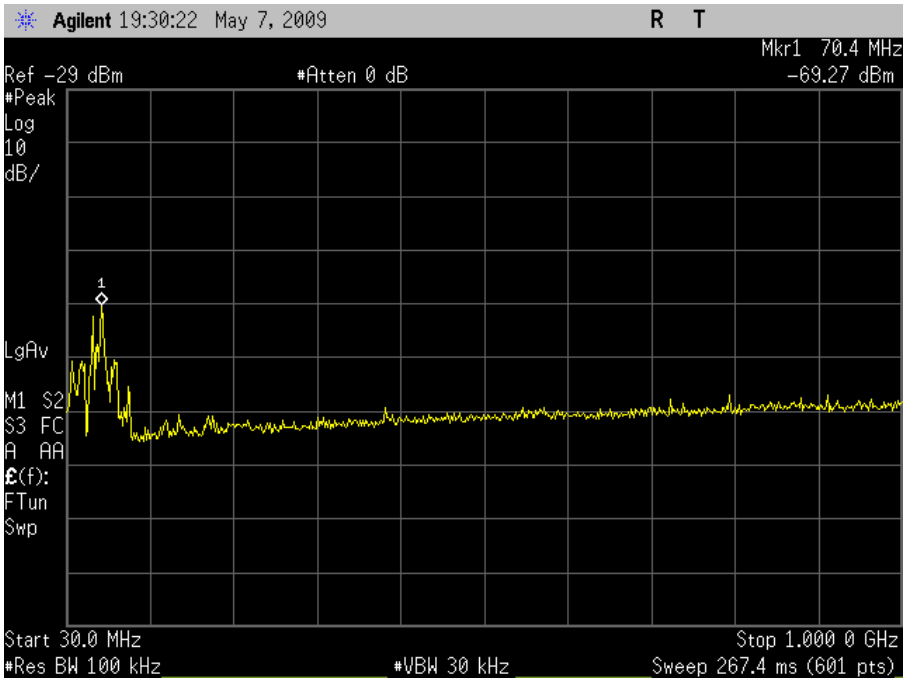
Test Engineer: Anderson Soungpanya

Test Date: May 7, 2009

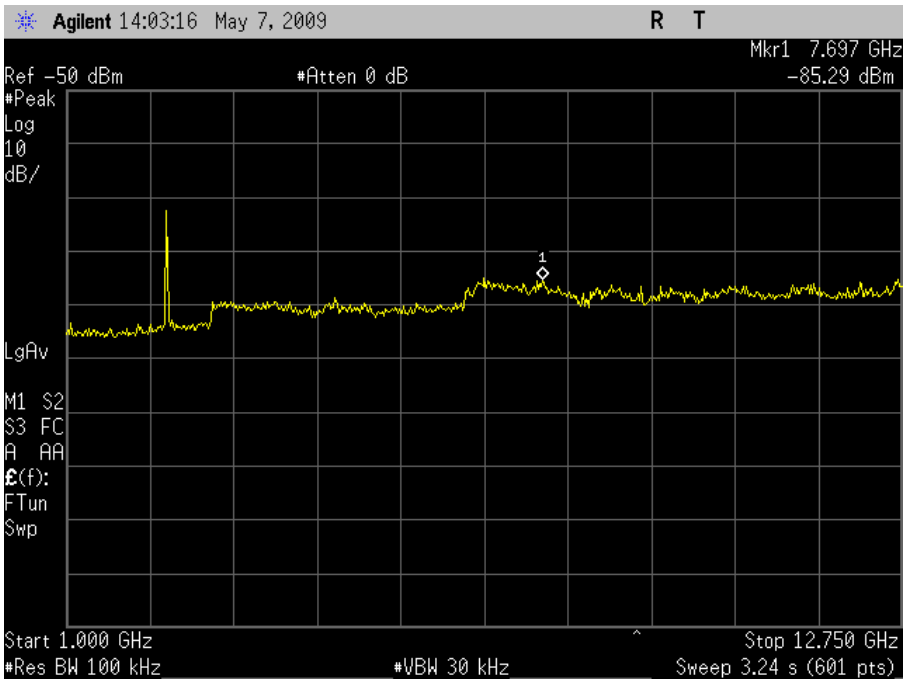
 © 2011, MET Laboratories, Inc.

Conformance Requirements

4.3.6 Transmitter Spurious Emissions – Radiated, DSSS Mode

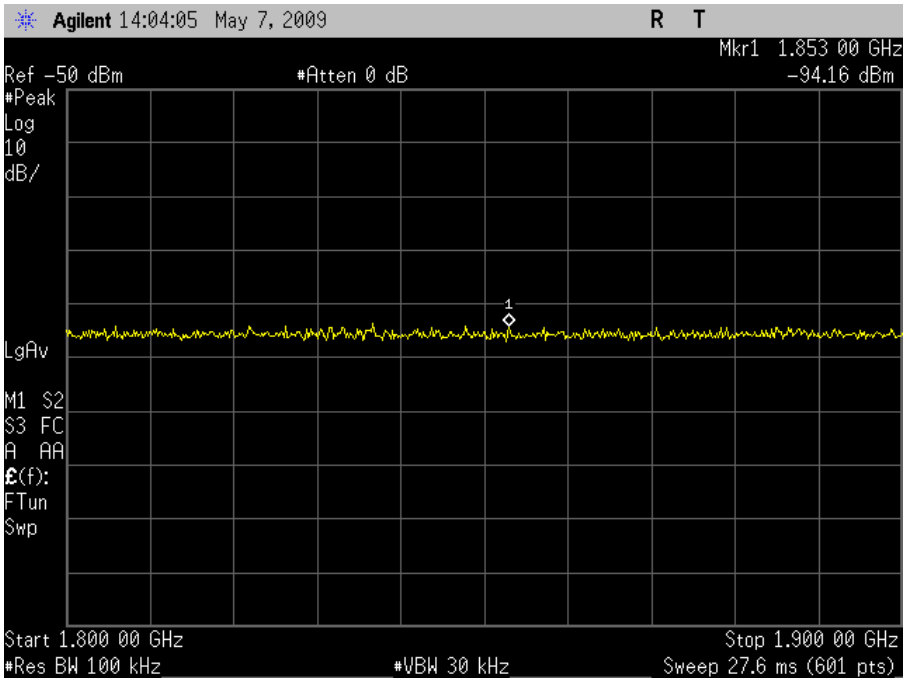


Plot 97. Low channel (2412 MHz) Spurious Emission 30 MHz - 1GHz DSSS Mode

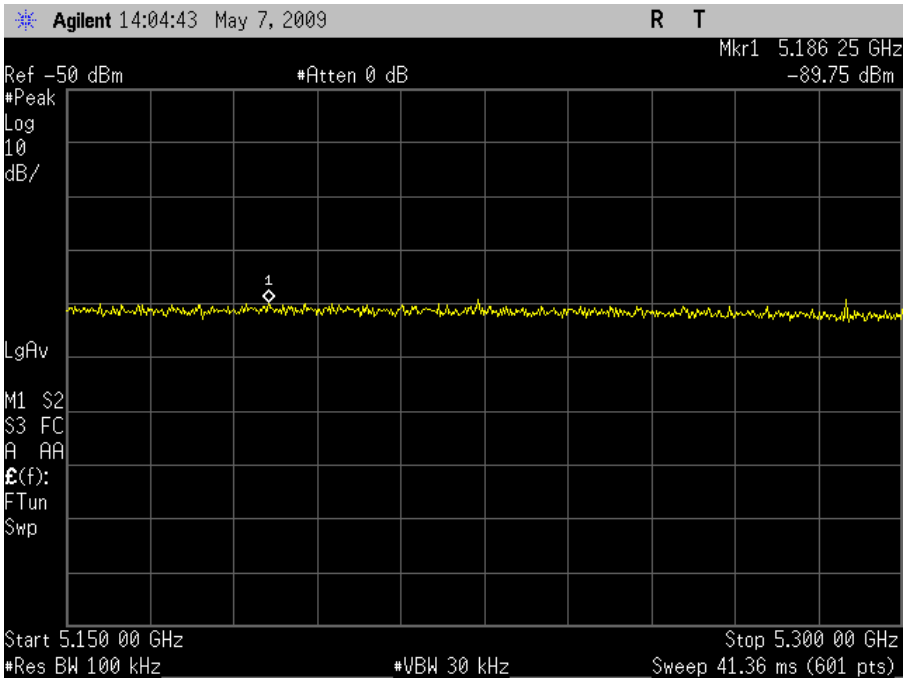


Plot 98. Low channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz DSSS Mode

 © 2011, MET Laboratories, Inc.

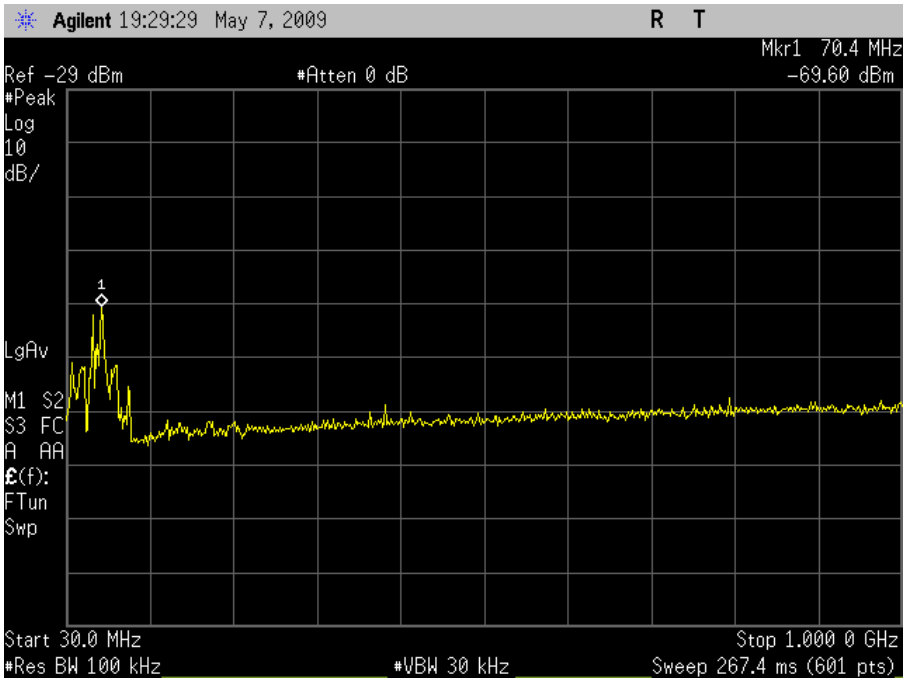


Plot 99. Low channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz DSSS Mode

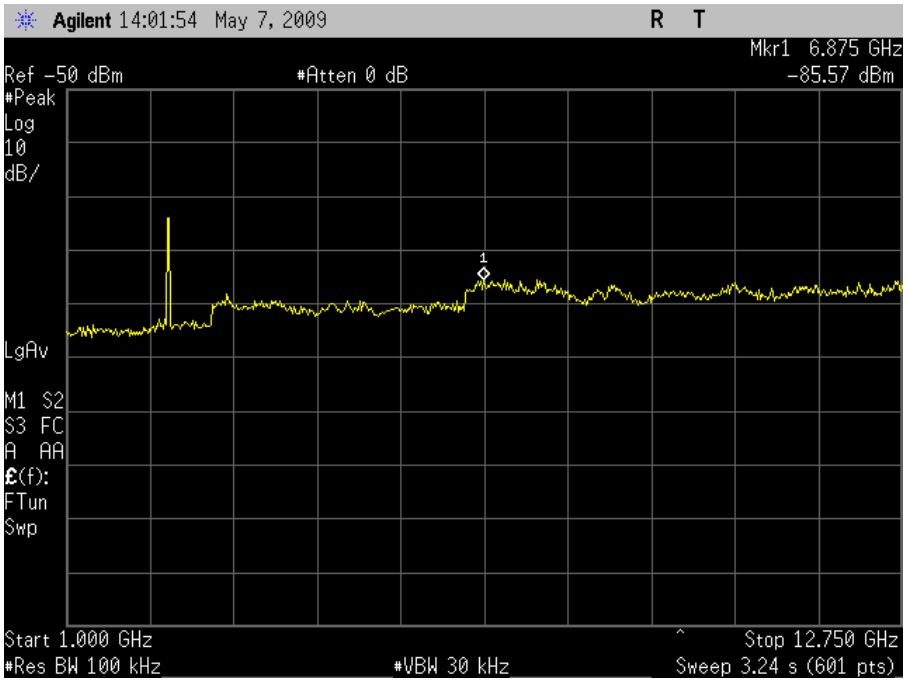


Plot 100. Low channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz DSSS Mode

© 2011, MET Laboratories, Inc.

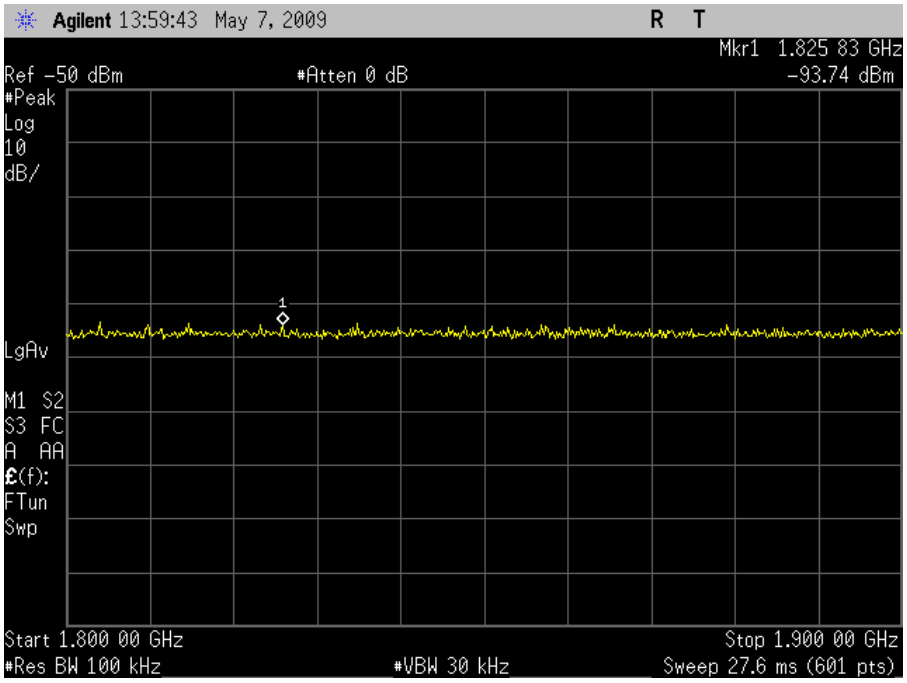


Plot 101. Mid channel (2462 MHz) Spurious Emission 30 MHz - 1GHz DSSS Mode

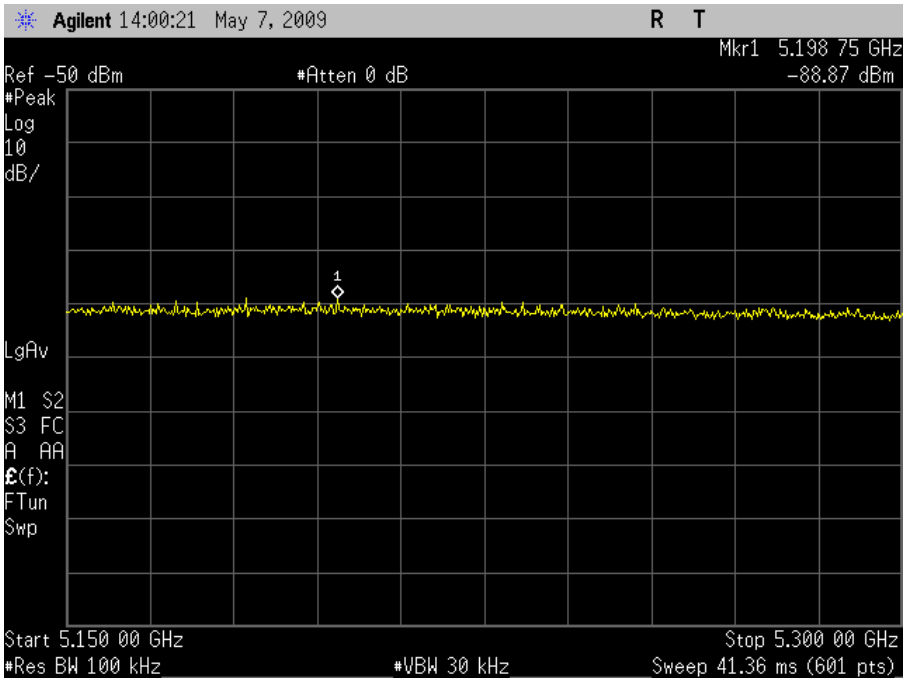


Plot 102. Mid channel (2462 MHz) Spurious Emission 1 GHz - 12.75 GHz DSSS Mode

© 2011, MET Laboratories, Inc.

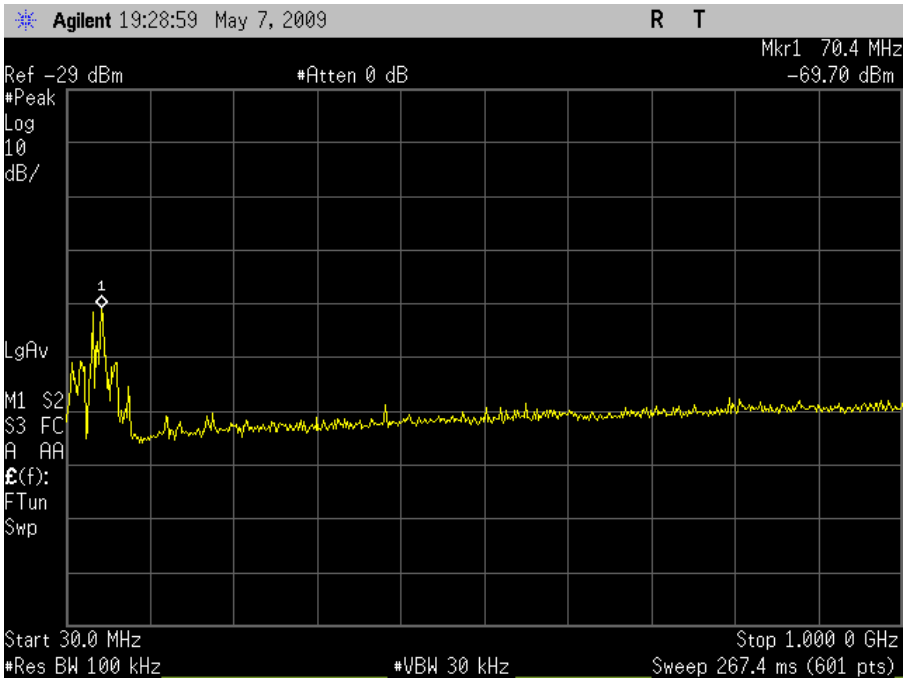


Plot 103. Mid channel (2462 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz DSSS Mode

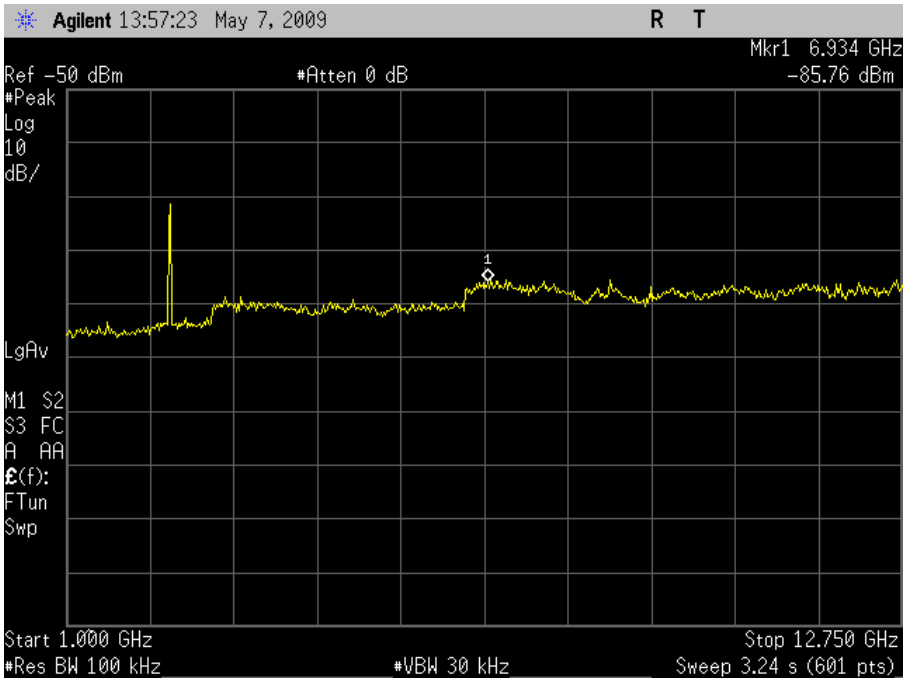


Plot 104. Mid channel (2462 MHz) Spurious Emission 5.15 GHz - 5.3 GHz DSSS Mode

© 2011, MET Laboratories, Inc.

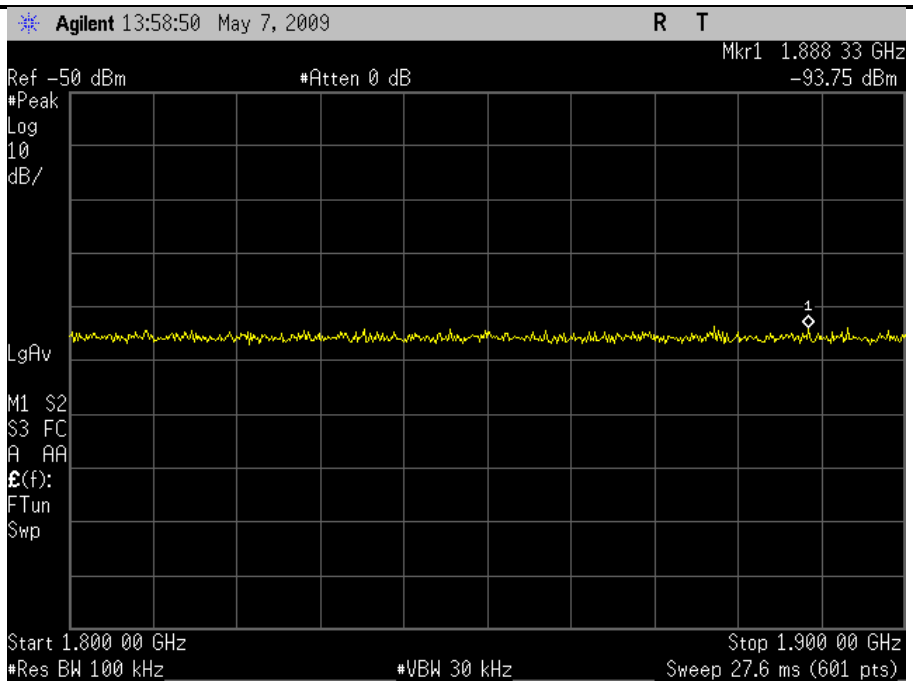


Plot 105. High channel (2462 MHz) Spurious Emission 30 MHz - 1GHz DSSS Mode

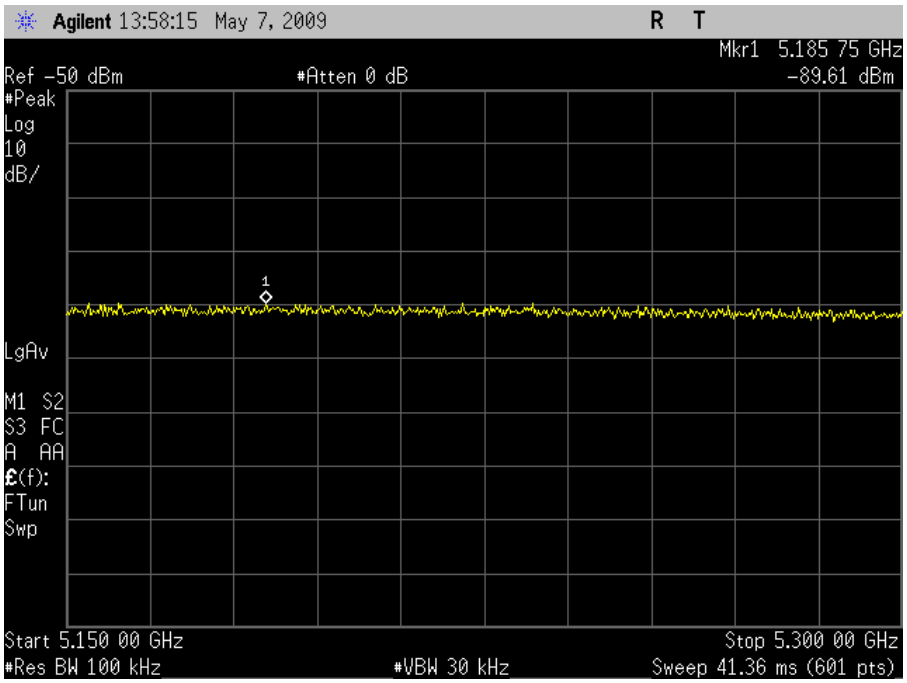


Plot 106. High channel (2462 MHz) Spurious Emission 1 GHz - 12.75 GHz DSSS Mode

© 2011, MET Laboratories, Inc.



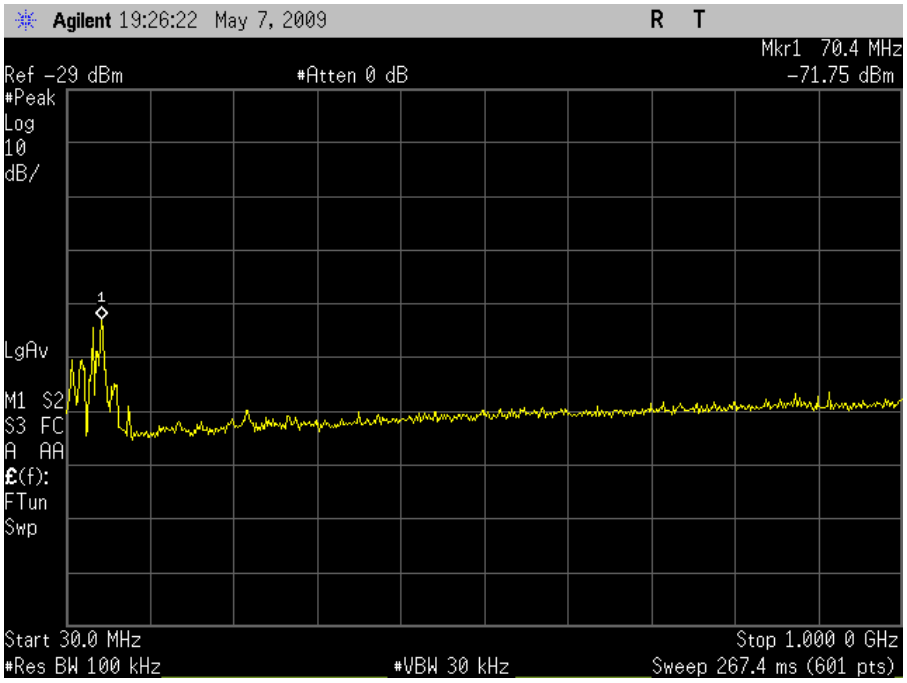
Plot 107. High channel (2462 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz DSSS Mode



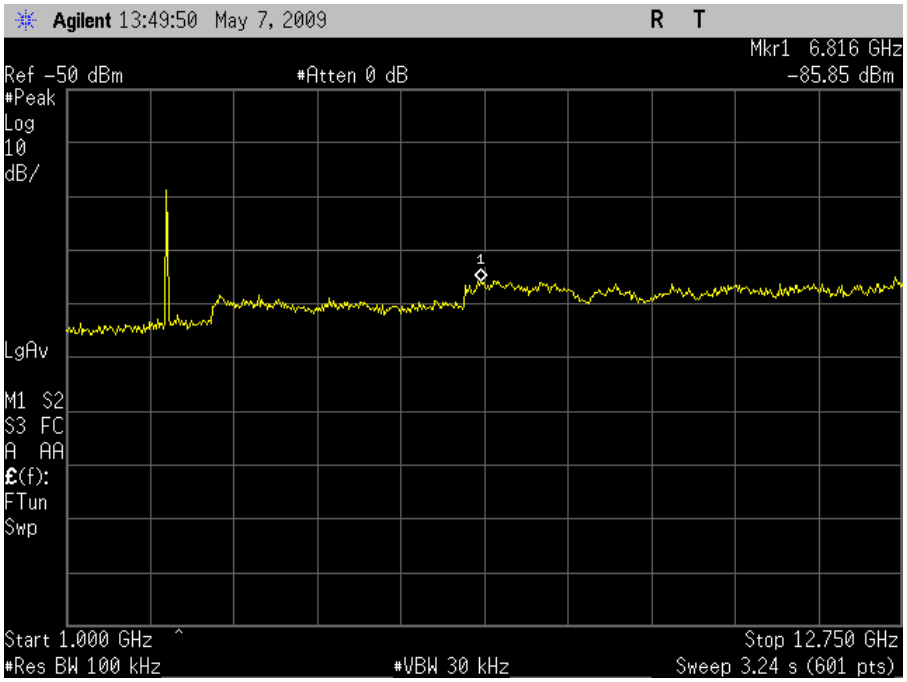
Plot 108. High channel (2462 MHz) Spurious Emission 5.15 GHz - 5.3 GHz DSSS Mode

© 2011, MET Laboratories, Inc.

4.3.6 Transmitter Spurious Emissions – Radiated, OFDM Mode

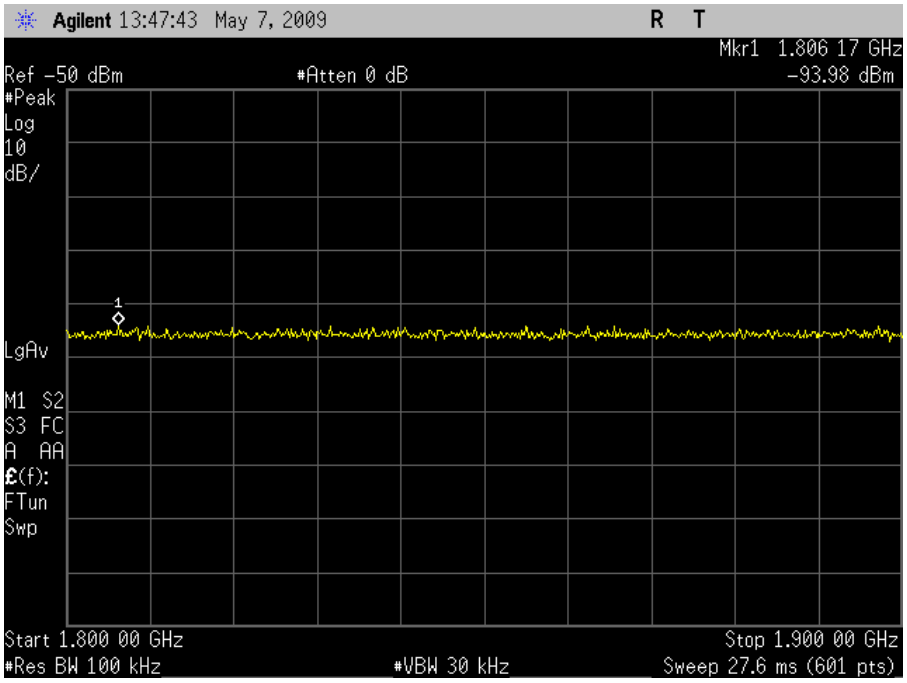


Plot 109. Low channel (2412 MHz) Spurious Emission 30 MHz - 1GHz OFDM Mode

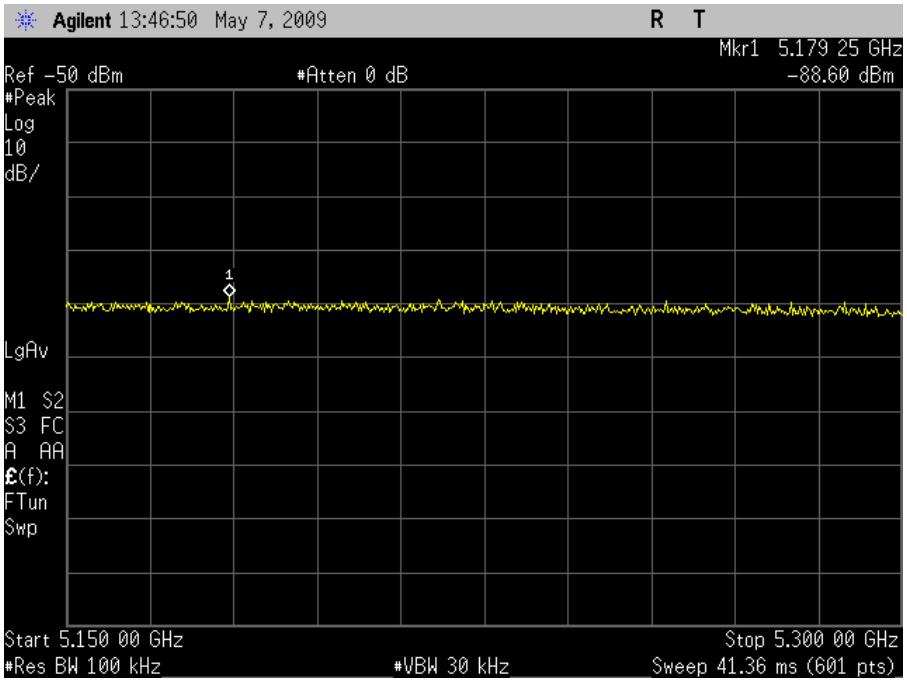


Plot 110. Low channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz OFDM Mode

 © 2011, MET Laboratories, Inc.

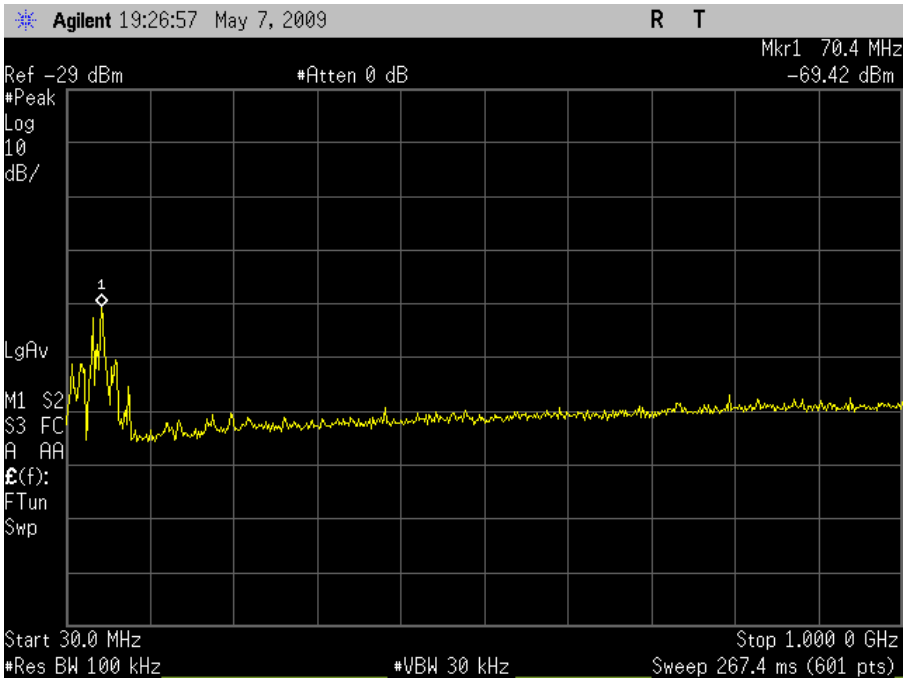


Plot 111. Low channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz OFDM Mode

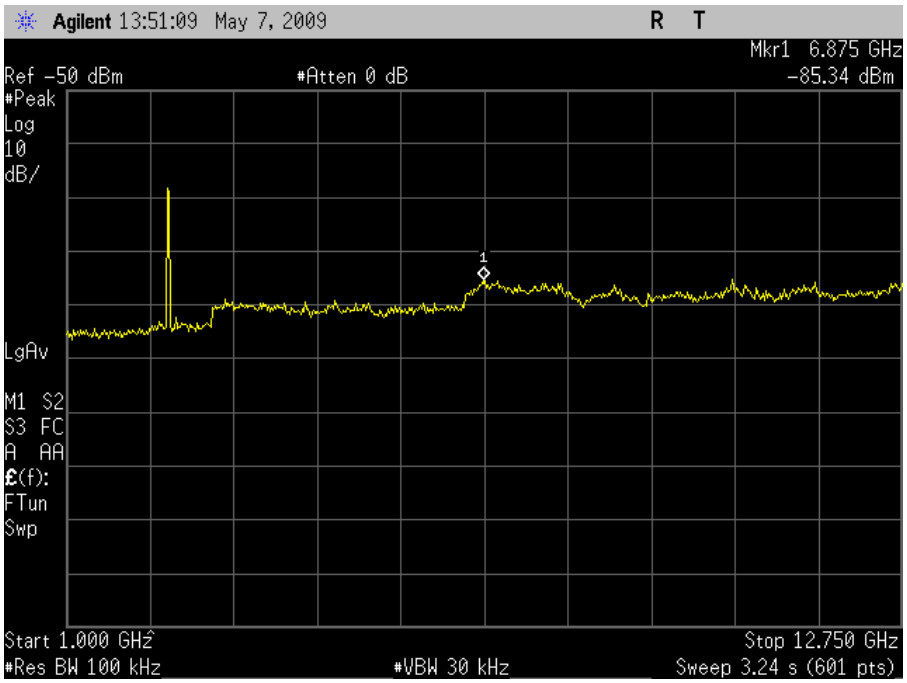


Plot 112. Low channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz OFDM Mode

© 2011, MET Laboratories, Inc.

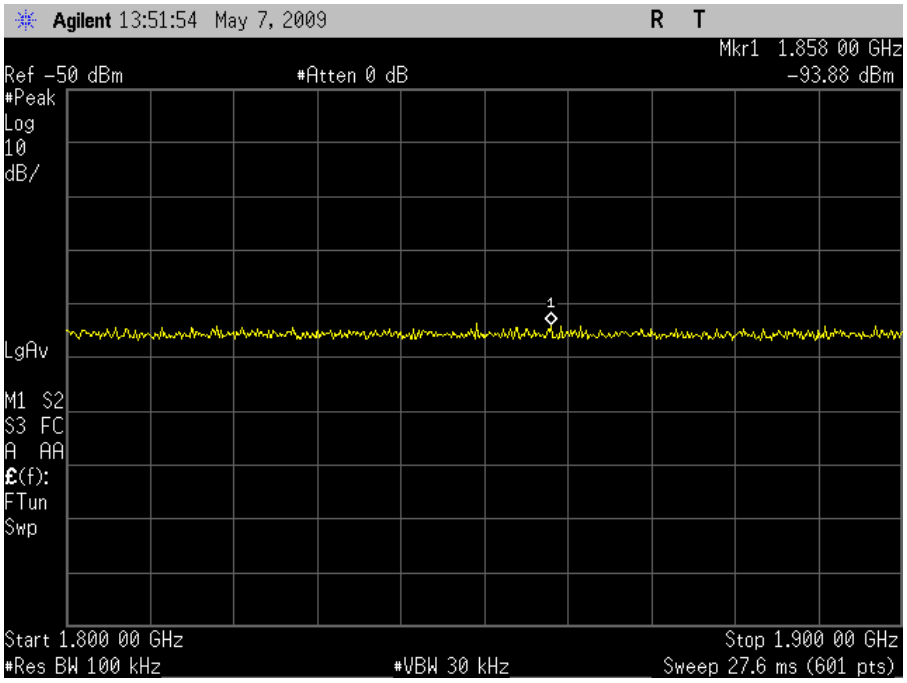


Plot 113. Mid channel (2412 MHz) Spurious Emission 30 MHz - 1GHz OFDM Mode

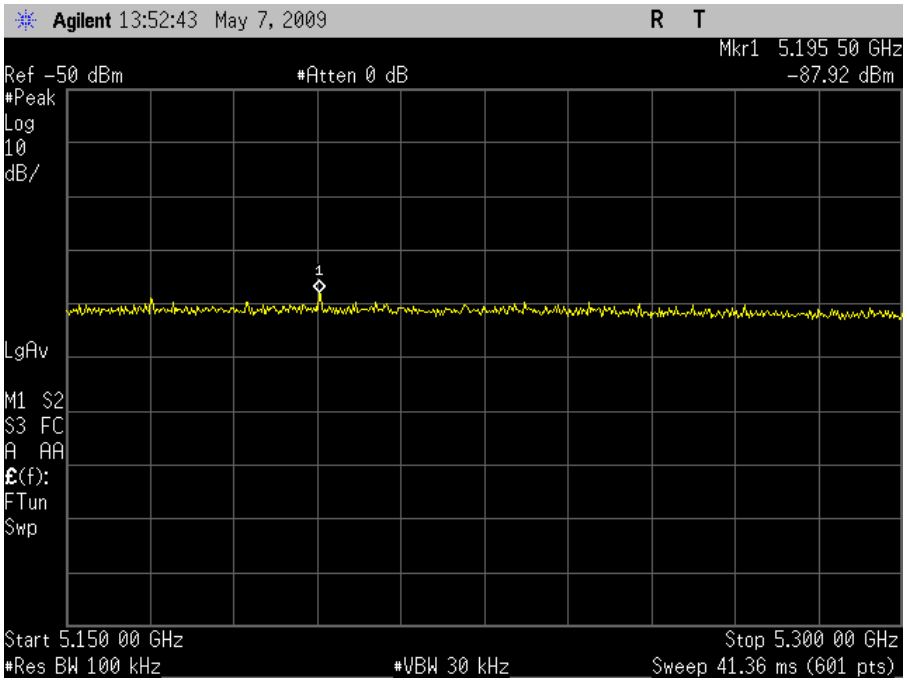


Plot 114. Mid channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz OFDM Mode

© 2011, MET Laboratories, Inc.

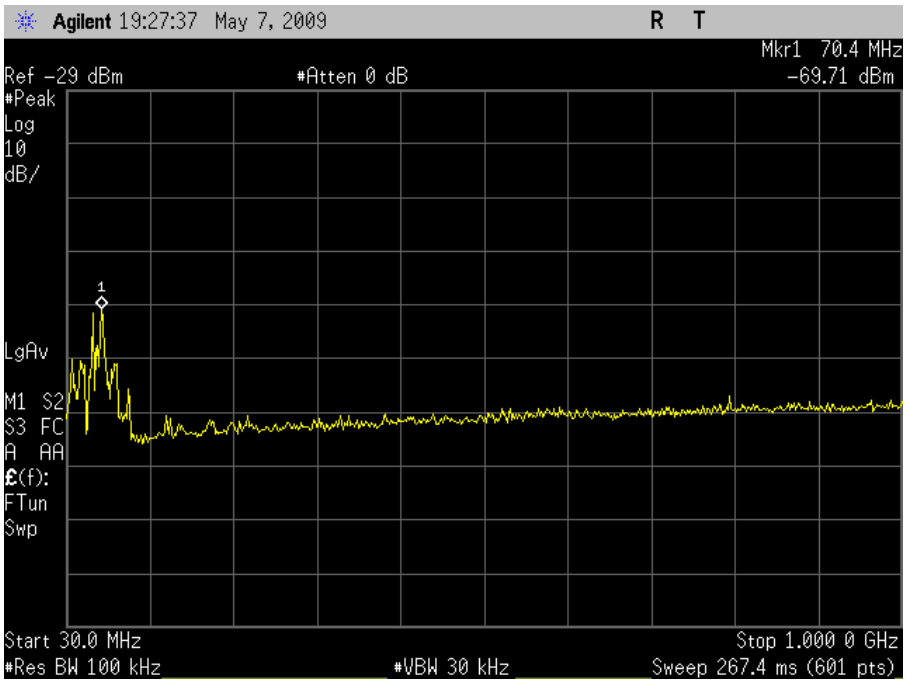


Plot 115. Mid channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz OFDM Mode

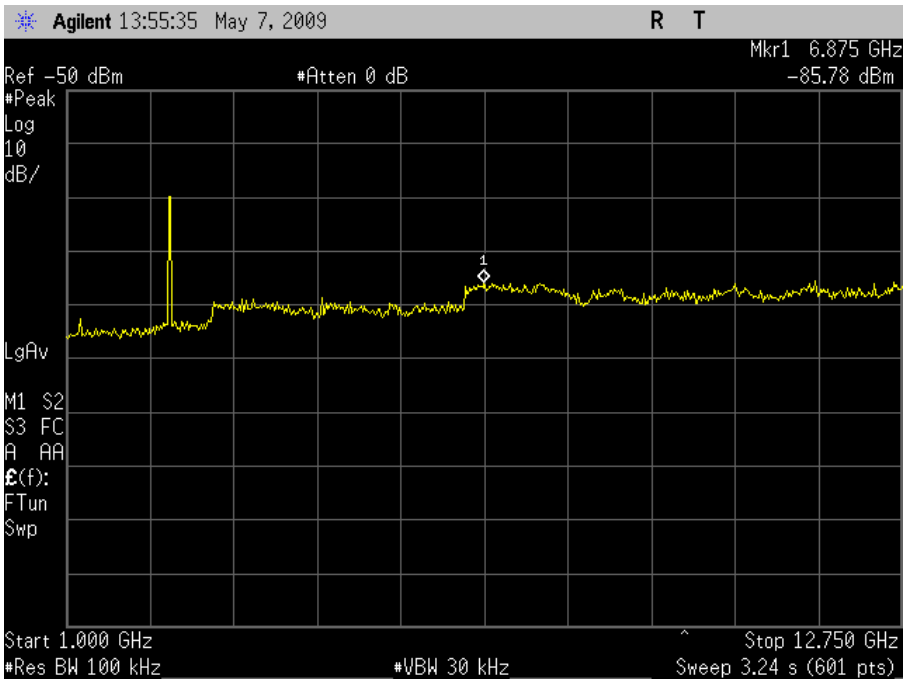


Plot 116. Mid channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz OFDM Mode

© 2011, MET Laboratories, Inc.

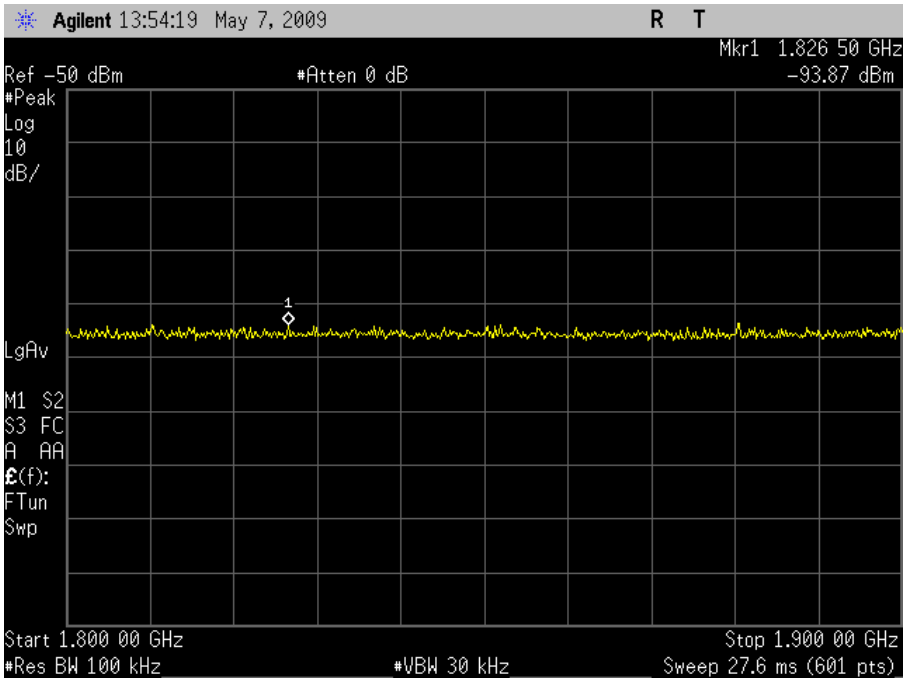


Plot 117. High channel (2462 MHz) Spurious Emission 30 MHz - 1GHz OFDM Mode

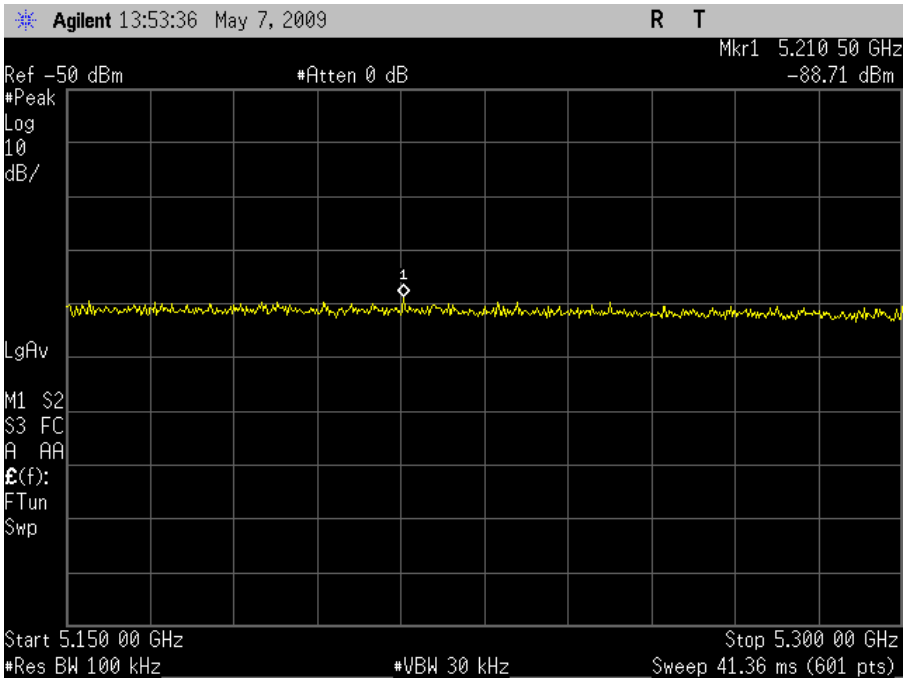


Plot 118. High channel (2462 MHz) Spurious Emission 1 GHz - 12.75 GHz OFDM Mode

 © 2011, MET Laboratories, Inc.



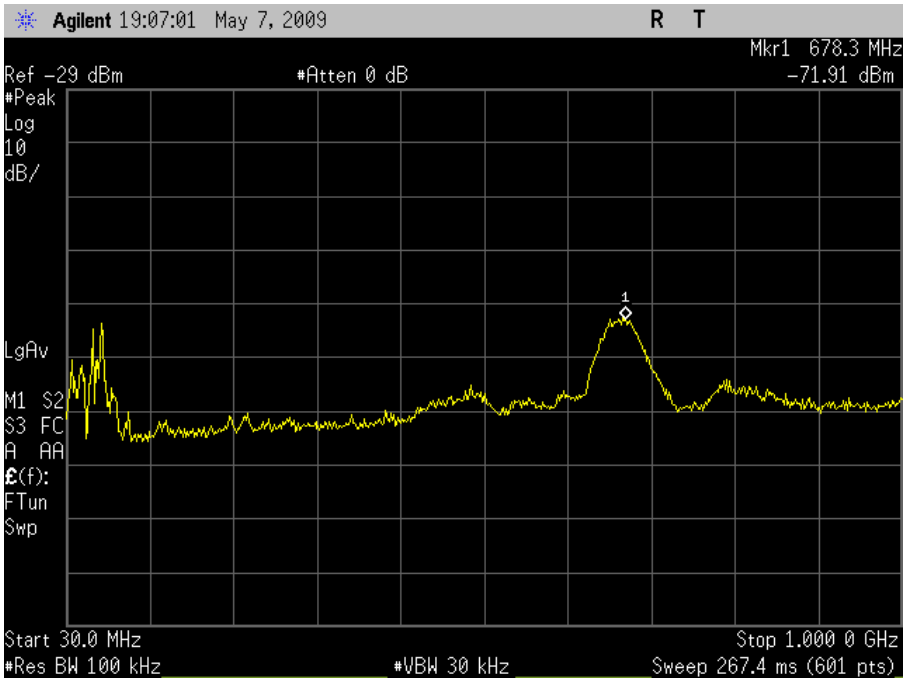
Plot 119. High channel (2462 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz OFDM Mode



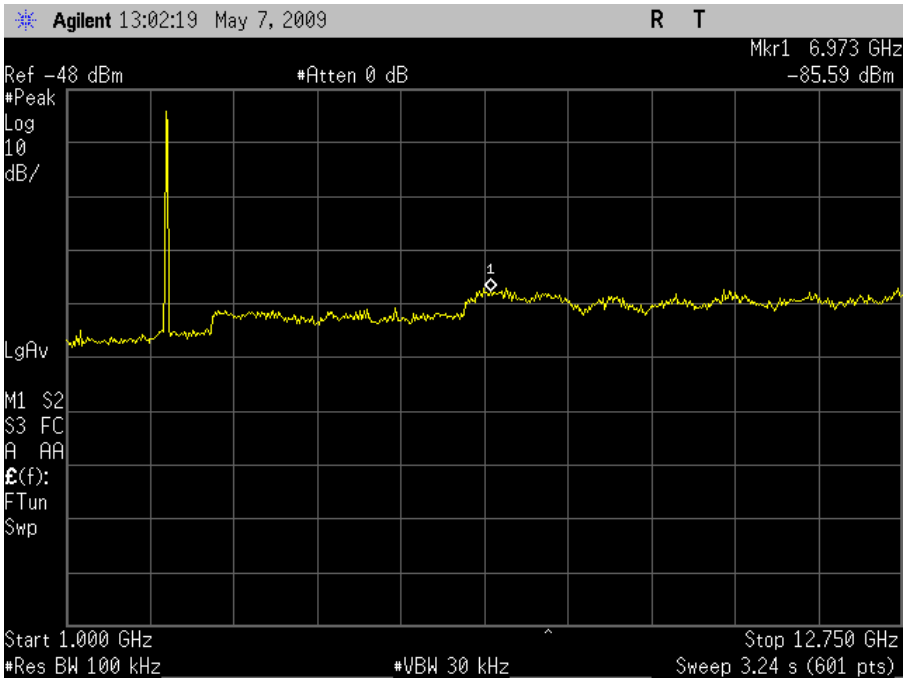
Plot 120. High channel (2462 MHz) Spurious Emission 5.15 GHz - 5.3 GHz OFDM Mode

© 2011, MET Laboratories, Inc.

4.3.6 Transmitter Spurious Emissions – Radiated, HT20 Mode

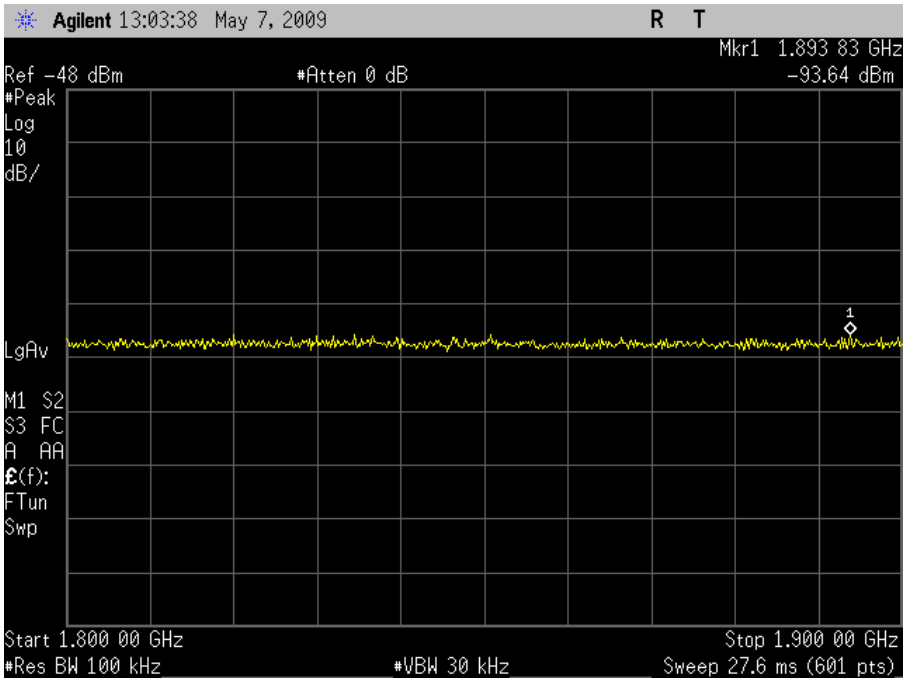


Plot 121. Low channel (2412 MHz) Spurious Emission 30 MHz - 1GHz HT20 Mode

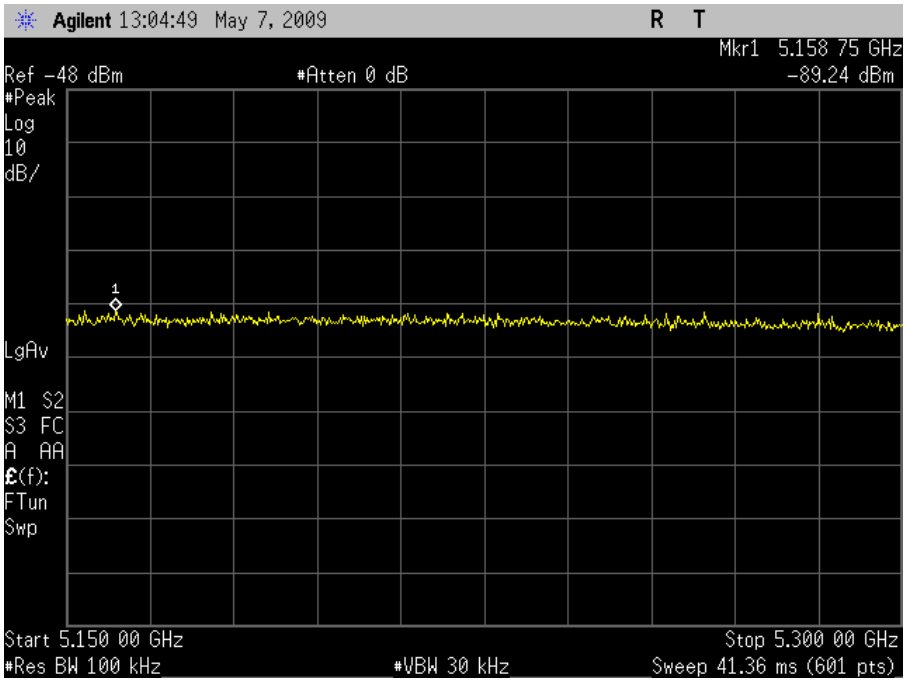


Plot 122. Low channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz HT20 Mode

© 2011, MET Laboratories, Inc.

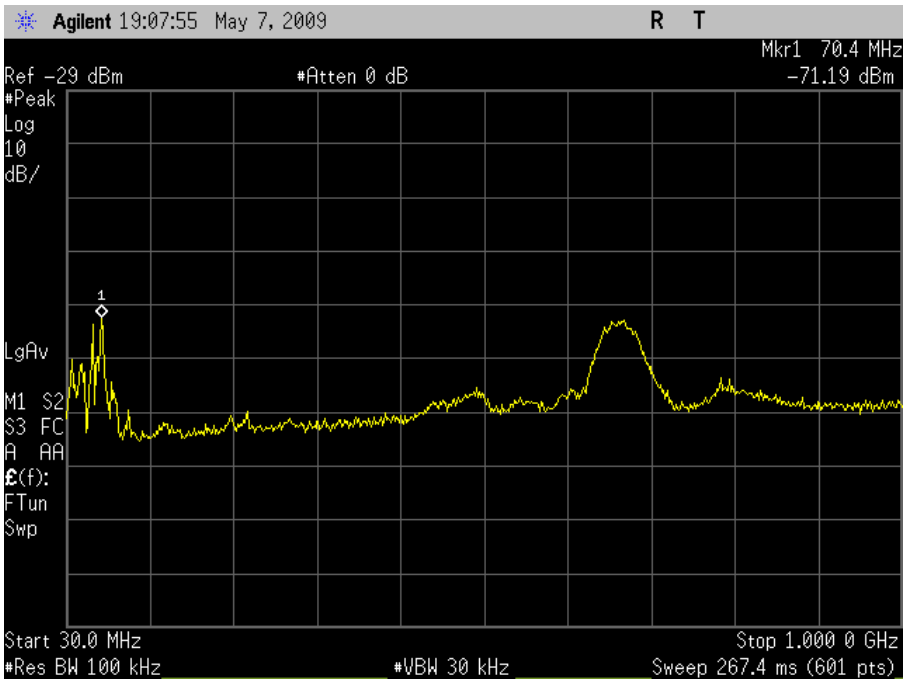


Plot 123. Low channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz HT20 Mode

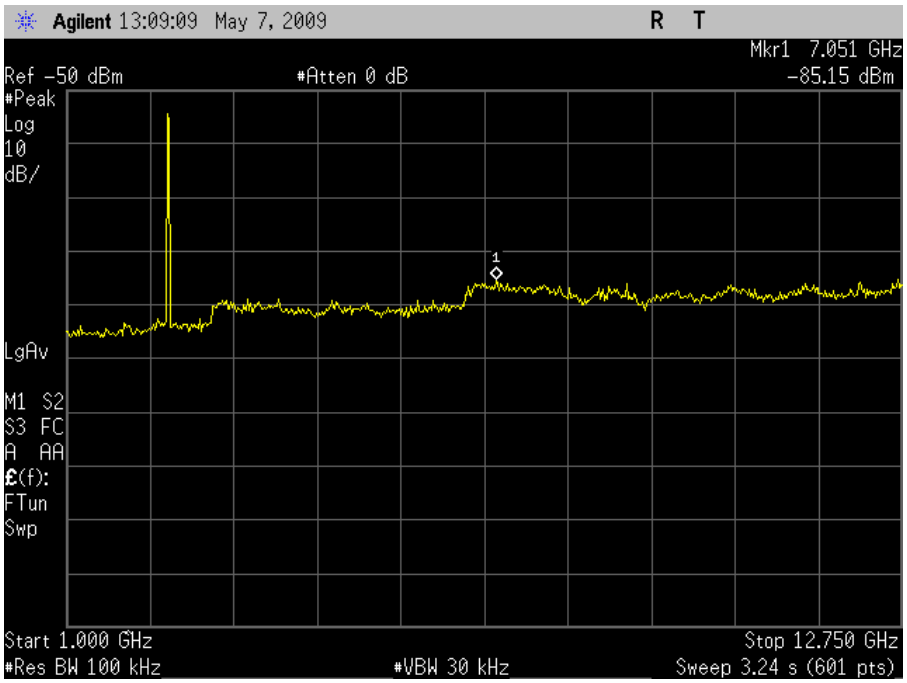


Plot 124. Low channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz HT20 Mode

© 2011, MET Laboratories, Inc.

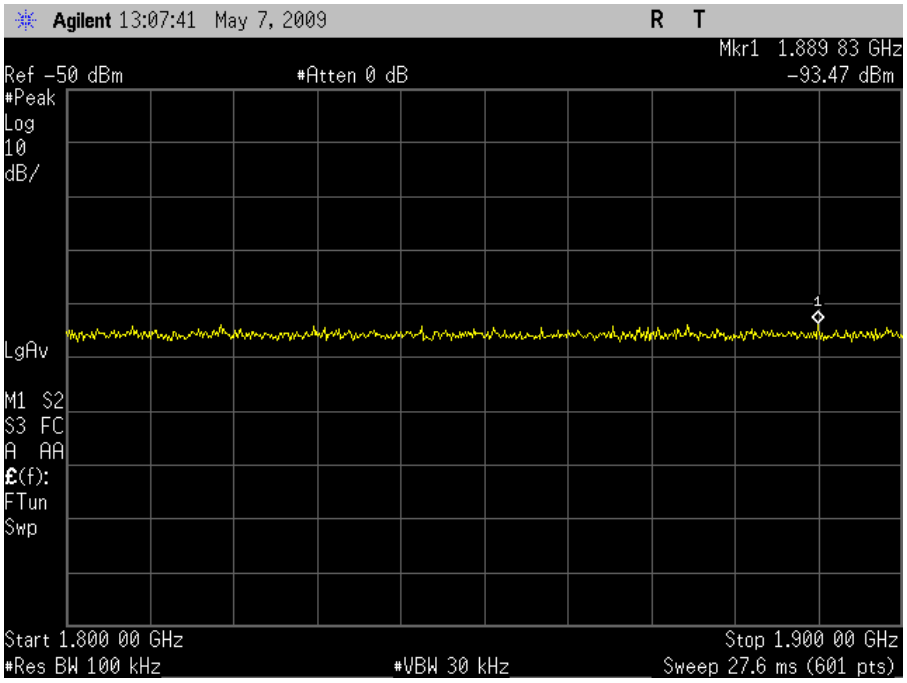


Plot 125. Mid channel (2412 MHz) Spurious Emission 30 MHz - 1GHz HT20 Mode

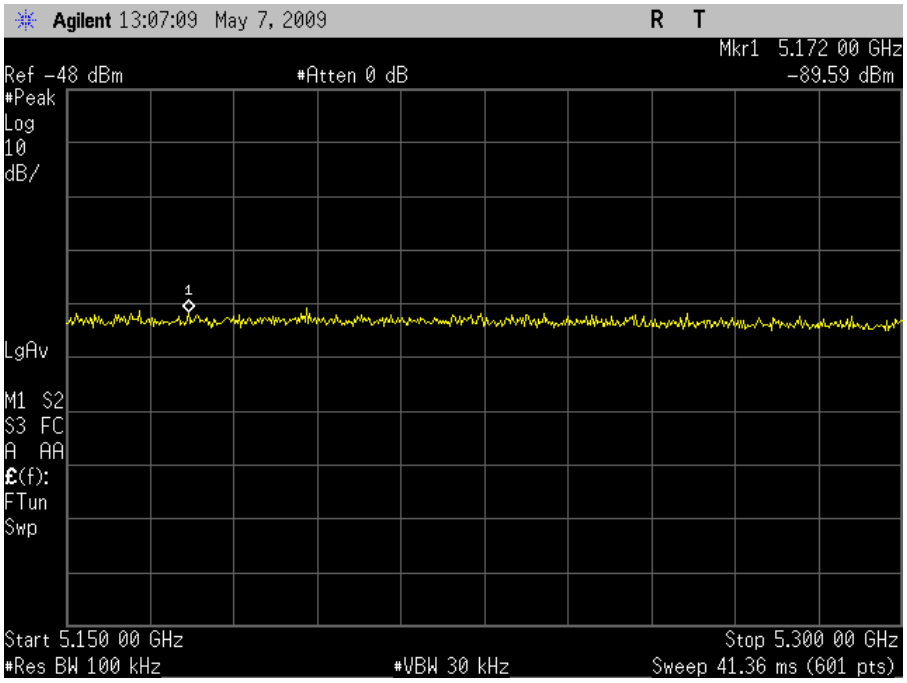


Plot 126. Mid channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz HT20 Mode

© 2011, MET Laboratories, Inc.

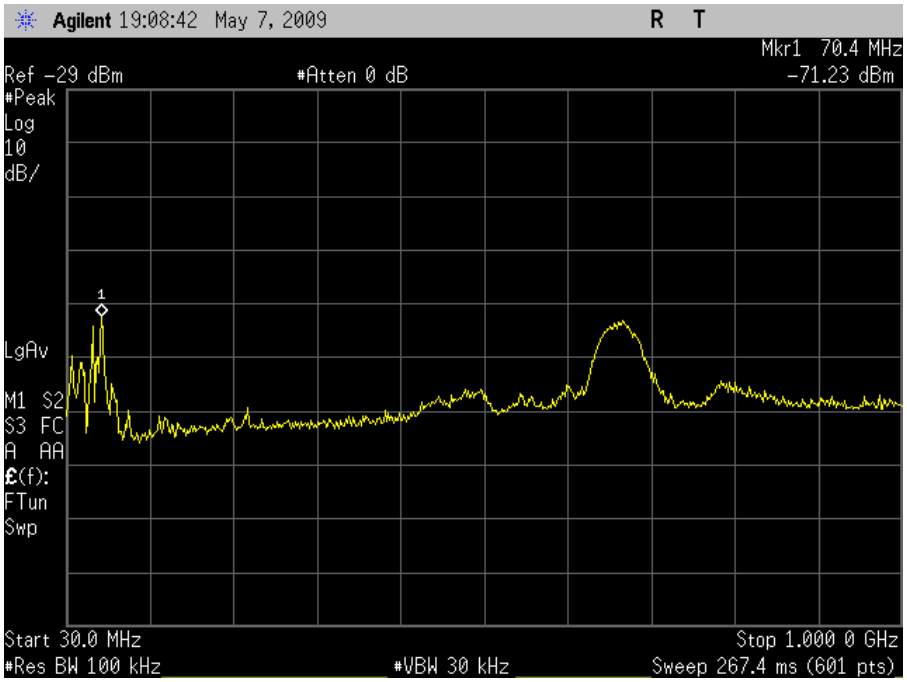


Plot 127. Mid channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz HT20 Mode

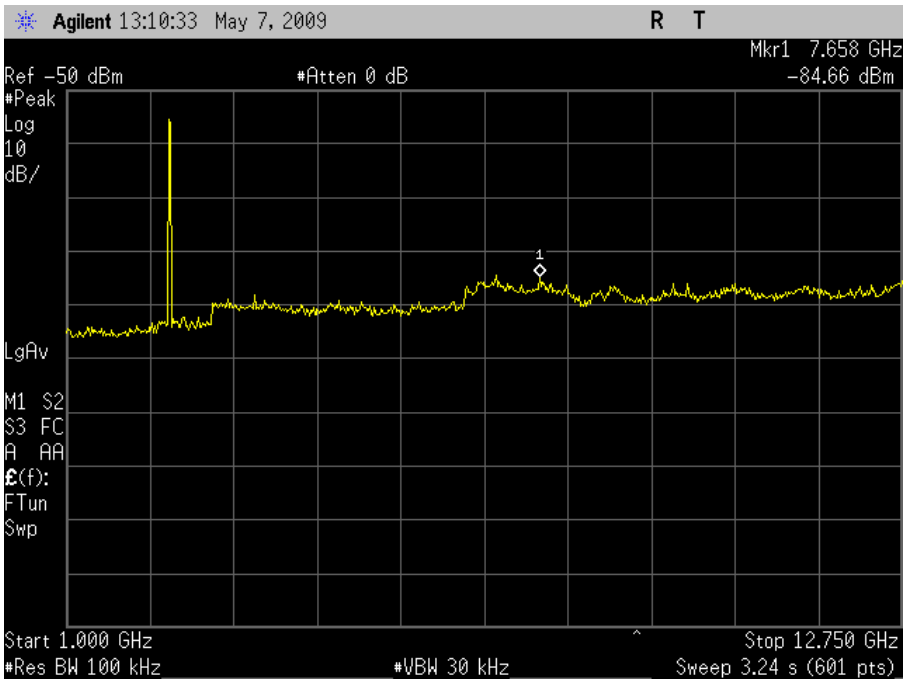


Plot 128. Mid channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz HT20 Mode

© 2011, MET Laboratories, Inc.

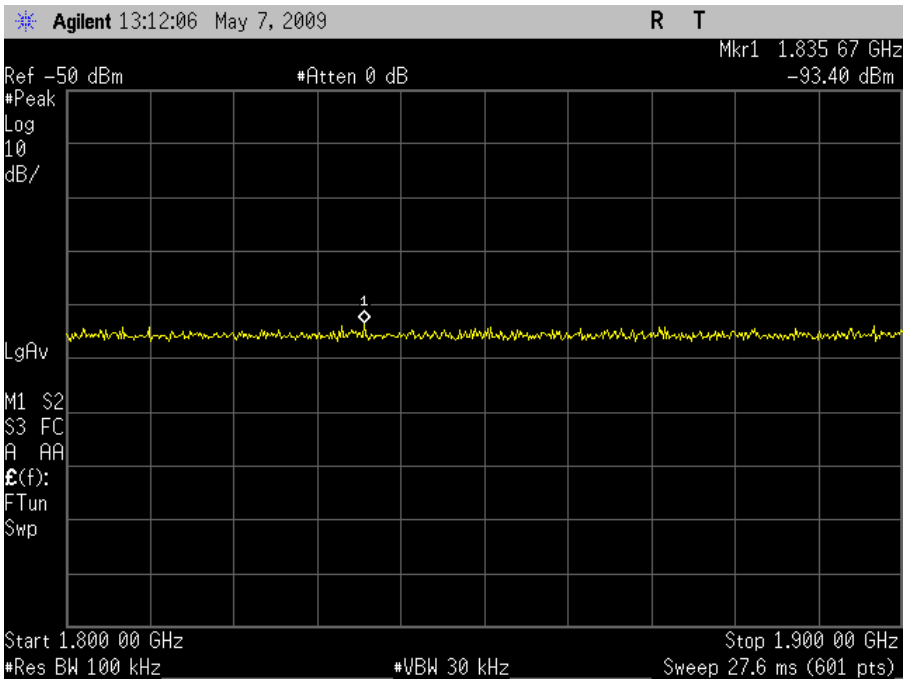


Plot 129. High channel (2462 MHz) Spurious Emission 30 MHz - 1GHz HT20 Mode

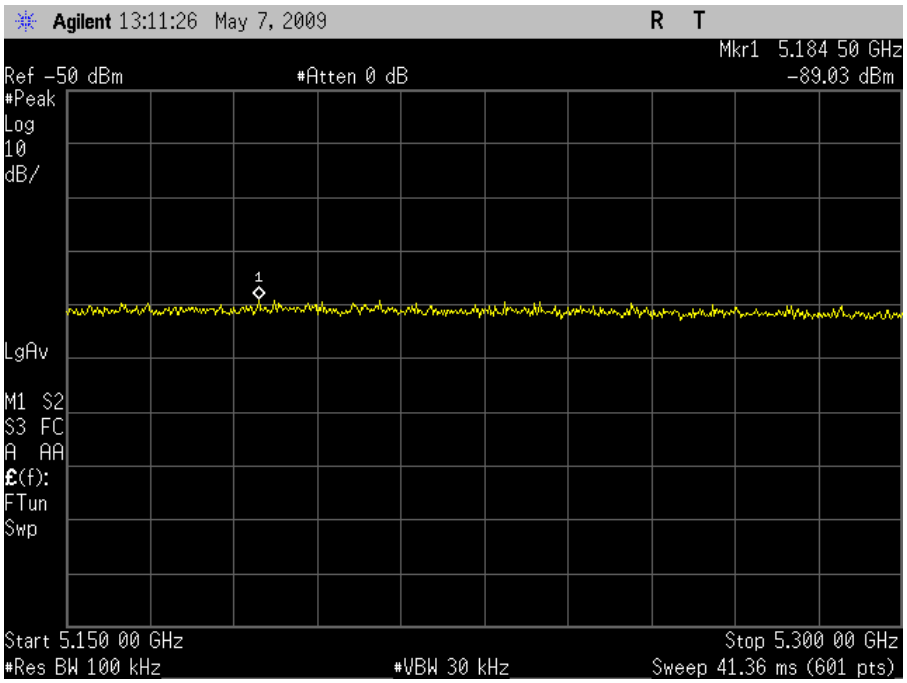


Plot 130. High channel (2462 MHz) Spurious Emission 1 GHz - 12.75 GHz HT20 Mode

© 2011, MET Laboratories, Inc.



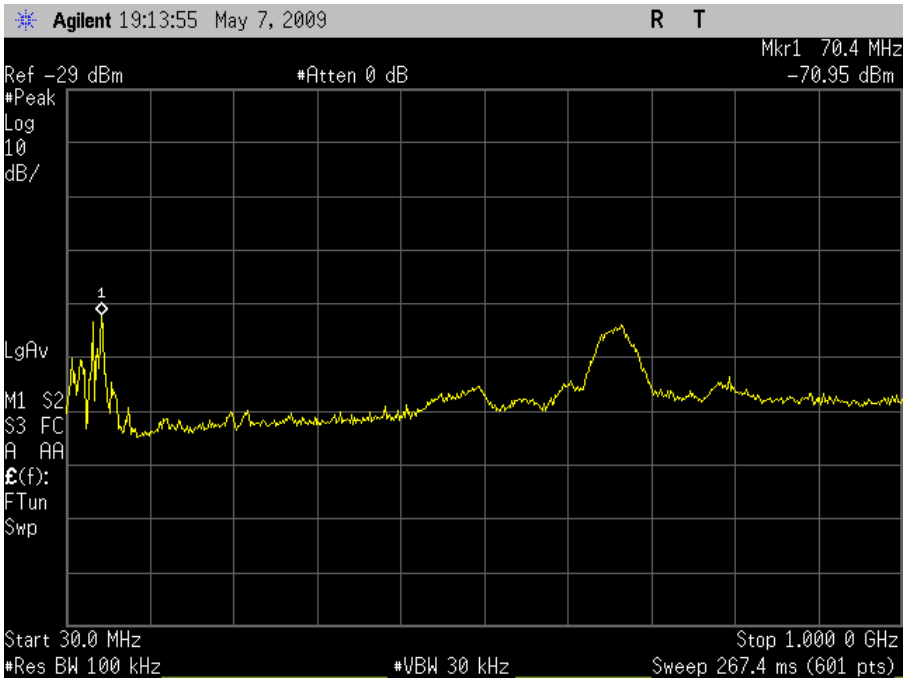
Plot 131. High channel (2462 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz HT20 Mode



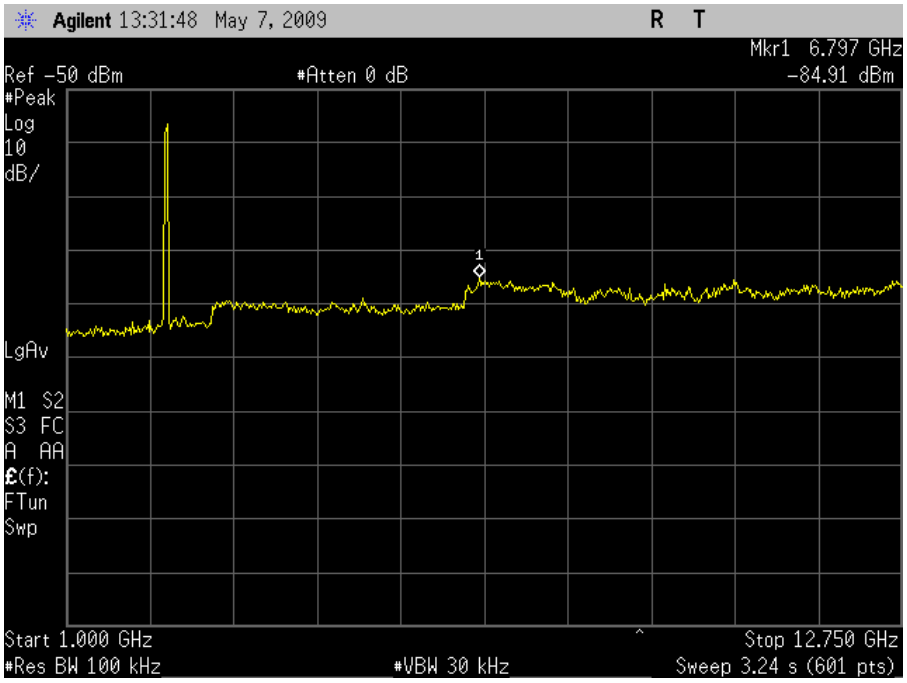
Plot 132. High channel (2462 MHz) Spurious Emission 5.15 GHz - 5.3 GHz HT20 Mode

© 2011, MET Laboratories, Inc.

4.3.6 Transmitter Spurious Emissions – Radiated, HT40 Mode

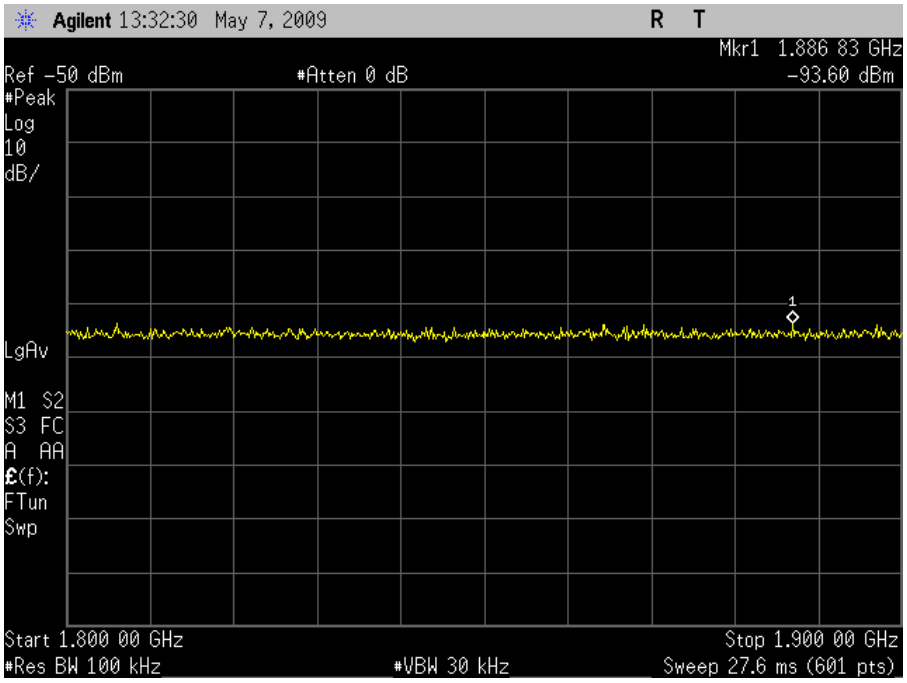


Plot 133. Low channel (2412 MHz) Spurious Emission 30 MHz - 1GHz HT40 Mode

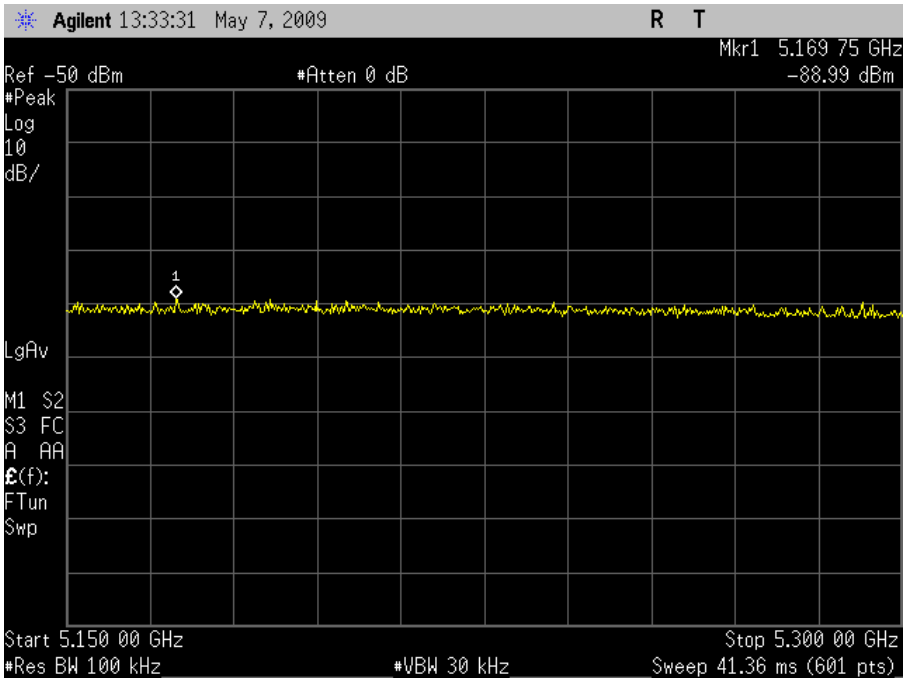


Plot 134. Low channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz HT40 Mode

 © 2011, MET Laboratories, Inc.

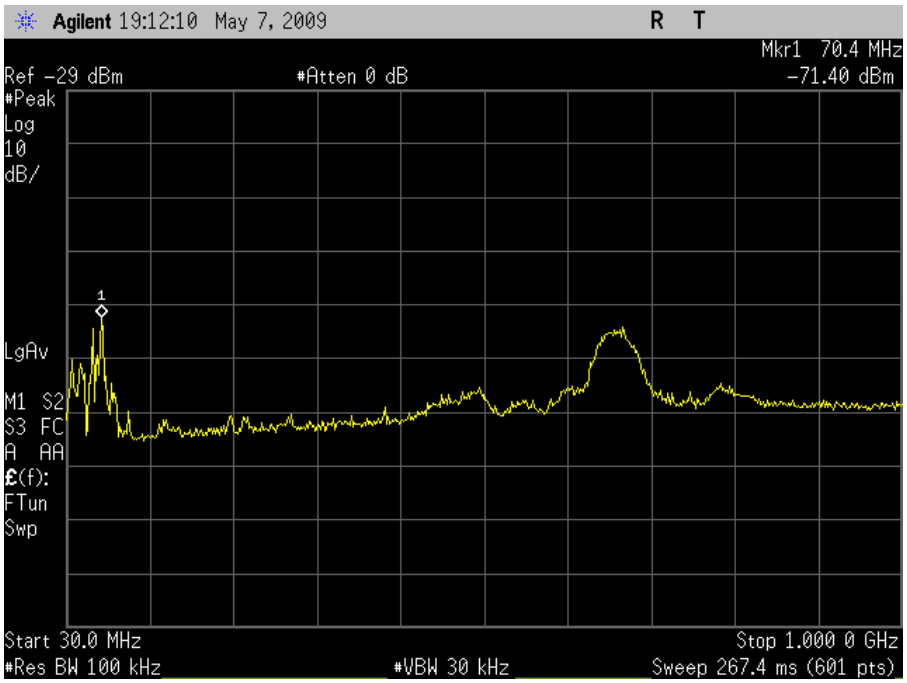


Plot 135. Low channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz HT40 Mode

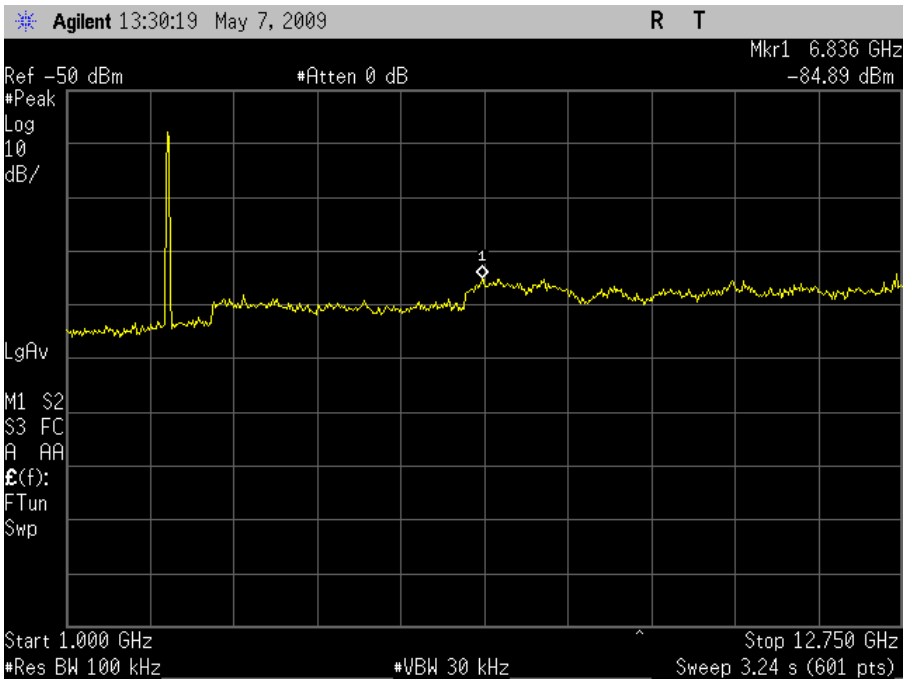


Plot 136. Low channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz HT40 Mode

© 2011, MET Laboratories, Inc.

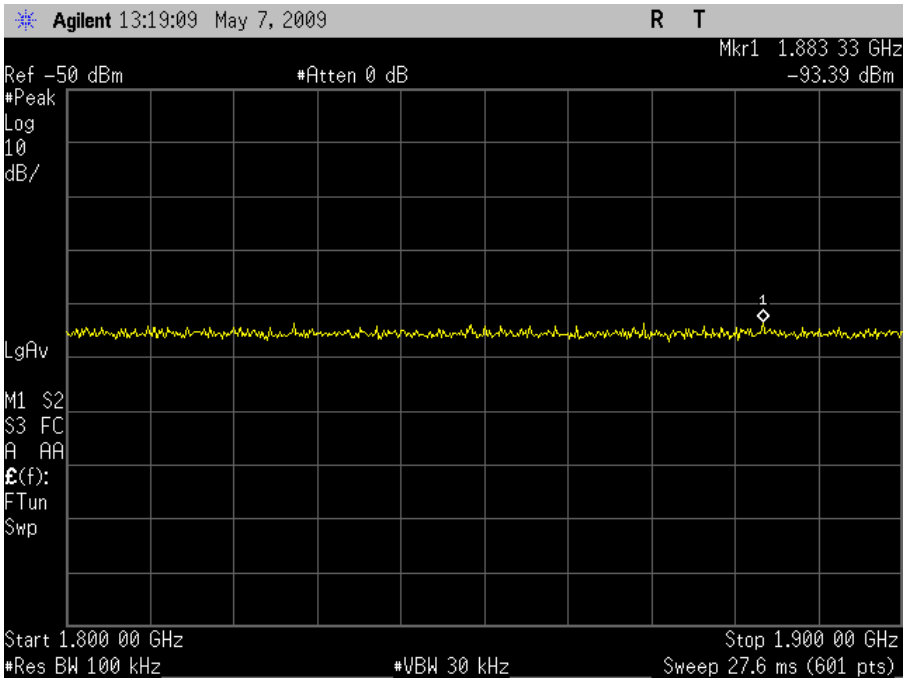


Plot 137. Mid channel (2412 MHz) Spurious Emission 30 MHz - 1GHz HT40 Mode

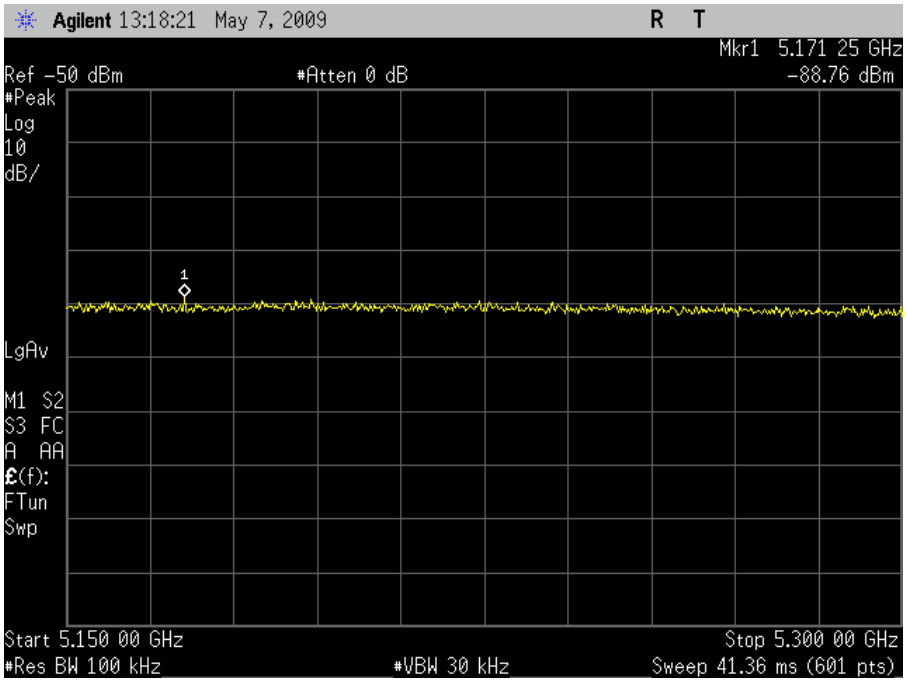


Plot 138. Mid channel (2412 MHz) Spurious Emission 1 GHz - 12.75 GHz HT40 Mode

© 2011, MET Laboratories, Inc.

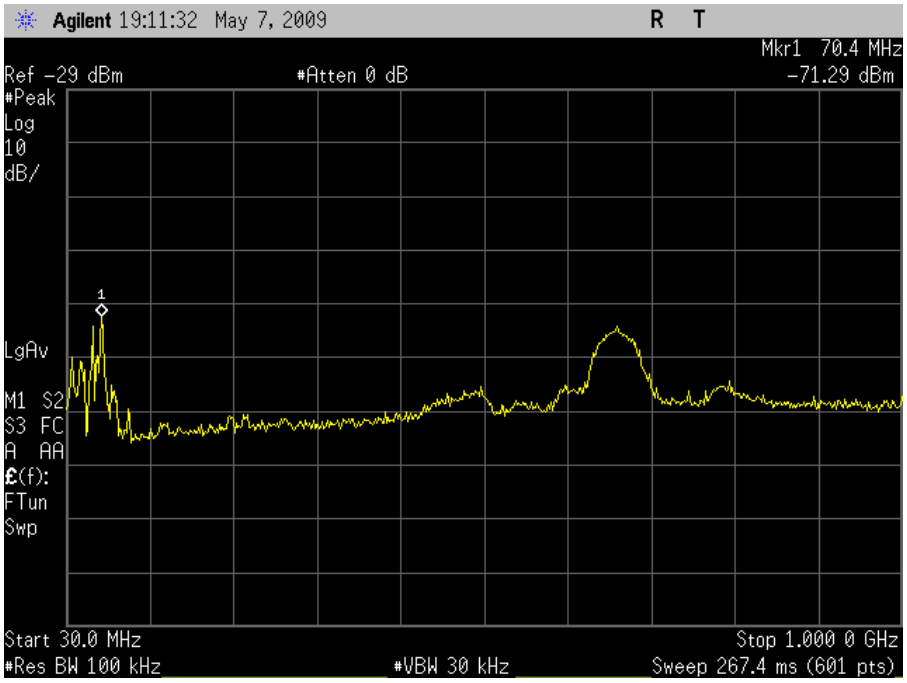


Plot 139. Mid channel (2412 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz HT40 Mode

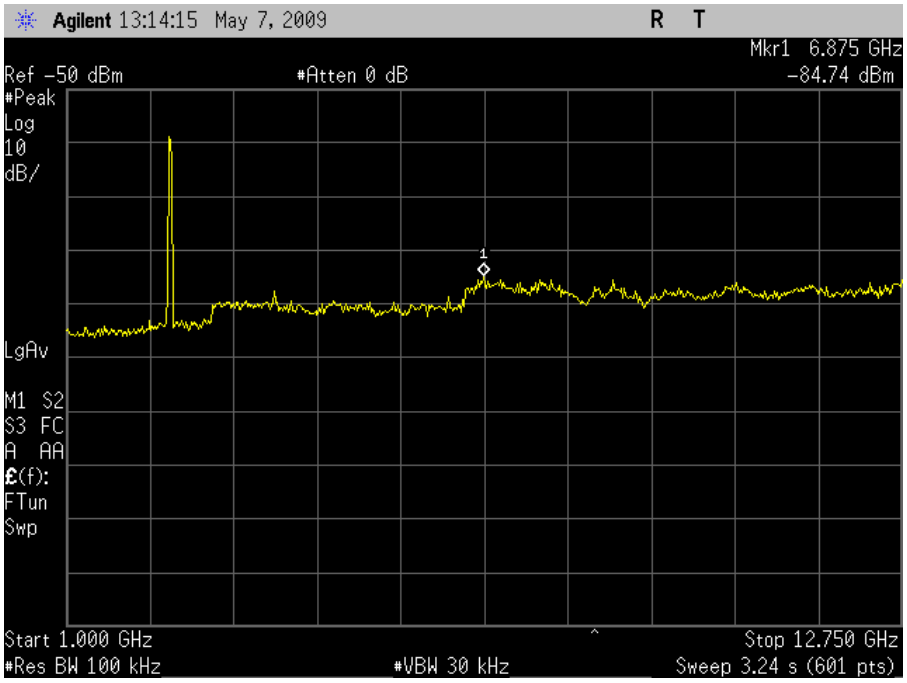


Plot 140. Mid channel (2412 MHz) Spurious Emission 5.15 GHz - 5.3 GHz HT40 Mode

© 2011, MET Laboratories, Inc.

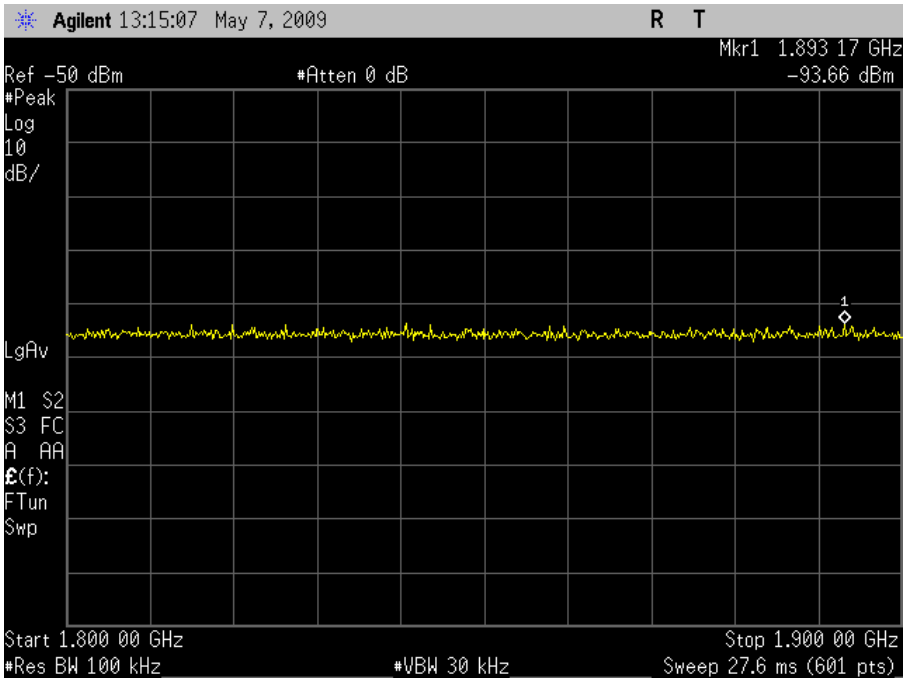


Plot 141. High channel (2462 MHz) Spurious Emission 30 MHz - 1GHz HT40 Mode

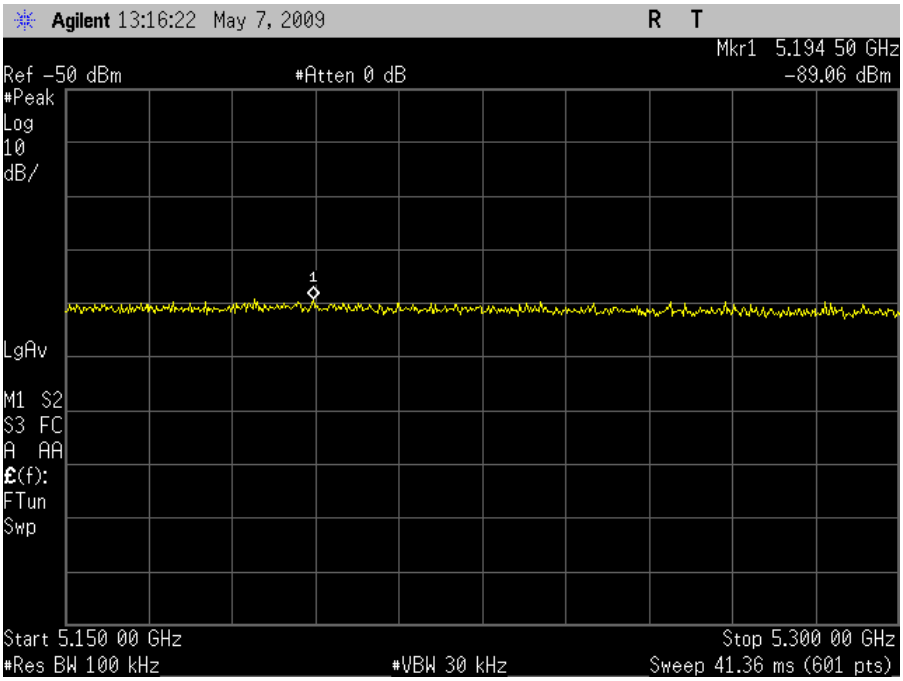


Plot 142. High channel (2462 MHz) Spurious Emission 1 GHz - 12.75 GHz HT40 Mode

© 2011, MET Laboratories, Inc.



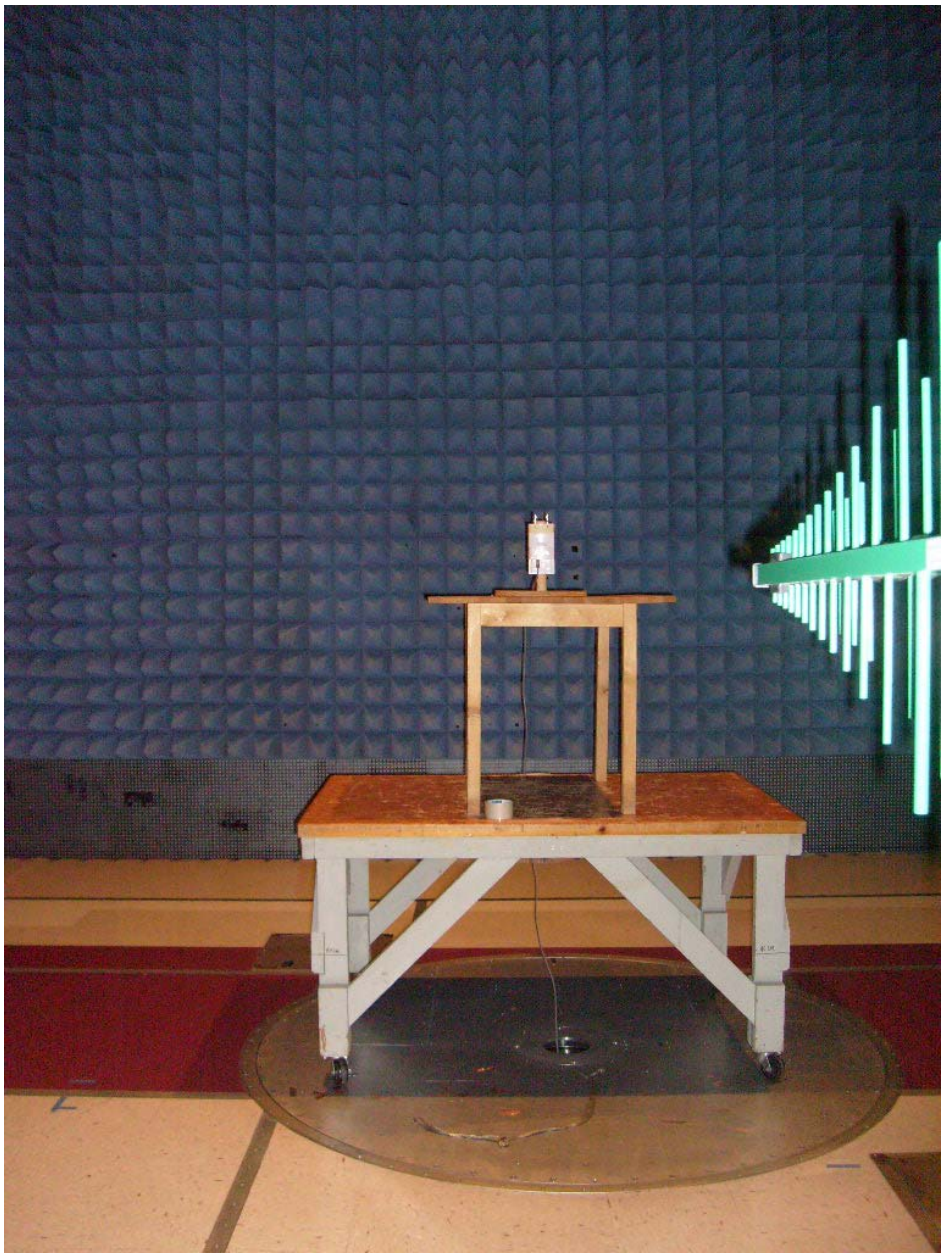
Plot 143. High channel (2462 MHz) Spurious Emission 1.8GHz Hz - 1.9 GHz HT40 Mode



Plot 144. High channel (2462 MHz) Spurious Emission 5.15 GHz - 5.3 GHz HT40 Mode

© 2011, MET Laboratories, Inc.

Radiated Emissions Test Setup Photographs



Photograph 2. Radiated Emissions Setup, 30MHz – 1GHz

 © 2011, MET Laboratories, Inc.

Radiated Emissions Test Setup Photographs

Photograph 3. Radiated Emissions Setup, 30MHz – 1GHz. MIMO Mode

 © 2011, MET Laboratories, Inc.

Radiated Emissions Test Setup Photographs

Photograph 4. Radiated Emissions Setup, 1GHz – 18GHz

 © 2011, MET Laboratories, Inc.

Radiated Emissions Test Setup Photographs

Photograph 5. Radiated Emissions Setup, 1GHz – 18GHz. MIMO Mode

 © 2011, MET Laboratories, Inc.

Conformance Requirements

4.3.7 Receiver Spurious Emissions

Test Requirement(s): 4.3.7.1 Definition

Receiver spurious emissions are emissions at any frequency when the equipment is in received mode.

4.3.7.2 Limit

The spurious emissions of the receiver shall not exceed the values in tables Table 18 and Table 19 and in the indicated bands.

Frequency Range	Limit
30 MHz to 1 GHz	-57 dBm
above 1 GHz to 12,75 GHz	-47 dBm

Table 18. Narrowband spurious emission limits for receivers

The above limit values apply to narrowband emissions, e.g. as caused by local oscillator leakage. The measurement bandwidth for such emissions may be as small as necessary to get a reliable measurement result.

Wideband emissions shall not exceed the values given in Table 19.

Frequency Range	Limit
30 MHz to 1 GHz	-107dBm/Hz
above 1 GHz to 12,75 GHz	-97 dBm/Hz

Table 19. Wideband spurious emission limits for receivers

 © 2011, MET Laboratories, Inc.

Test Procedure: The EUT was placed on a 1.5m high wooden table inside a semi-anechoic chamber. The measurements were performed using normal operation of the equipment. The method of testing, test conditions, and test procedures of *Annex B* were used. The frequencies and amplitudes of field strengths were recorded for reference during final measurements.

The EUT was set to transmit at its highest output power at both the low and high channels of the transmit band as well as all applicable modulations. The receive antenna was adjusted between 1 and 4 m in order to find the maximum emission. The table was also rotated about 360^0. Both vertical and horizontal polarizations were used to determine the maximum emission.

In order to determine the magnitude of each emission within 6dB of the limit, other than the noise floor of the spectrum analyzer, the signal substitution method was used as described in Annex B of *EN 300 328*.

Test Results: The EUT as tested was found compliant with the specified limits of Clause 4.3.5.2.

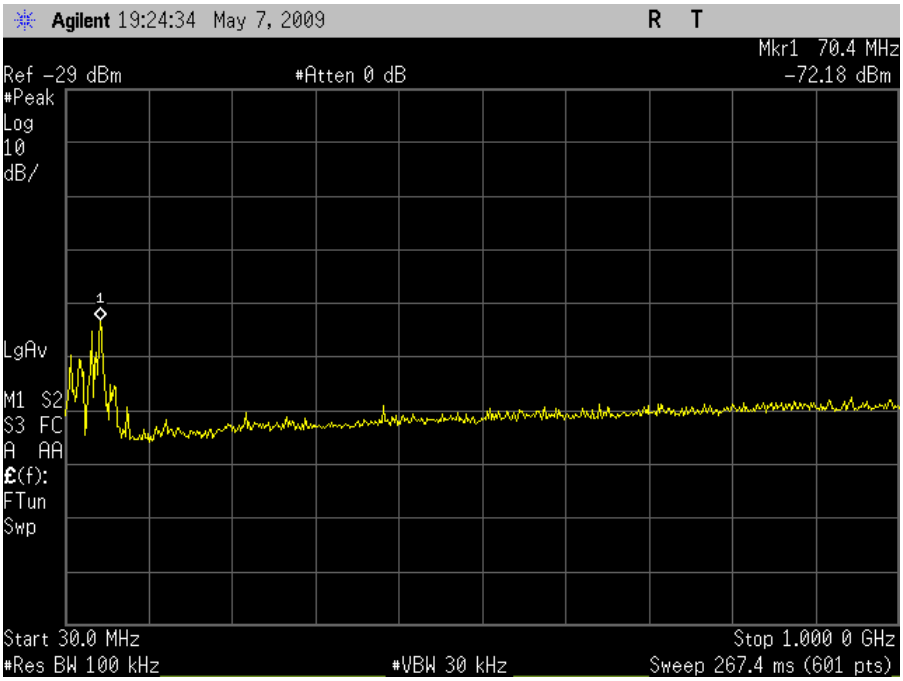
Test Engineer: Anderson Soungpanya

Test Date: May 7, 2009

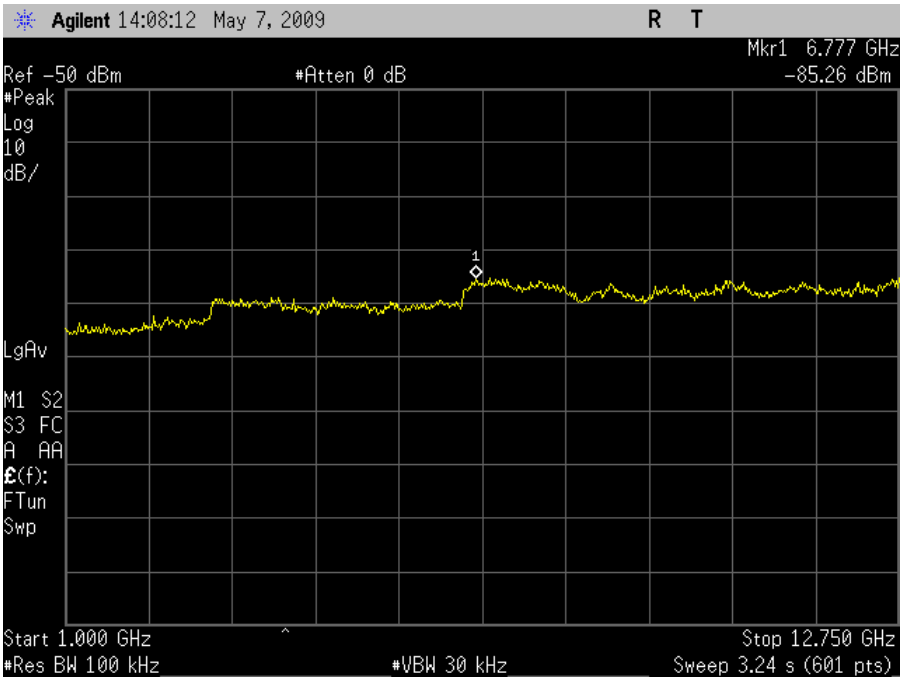
 © 2011, MET Laboratories, Inc.

Conformance Requirements

4.3.5 Receiver Spurious Emissions – Port 1



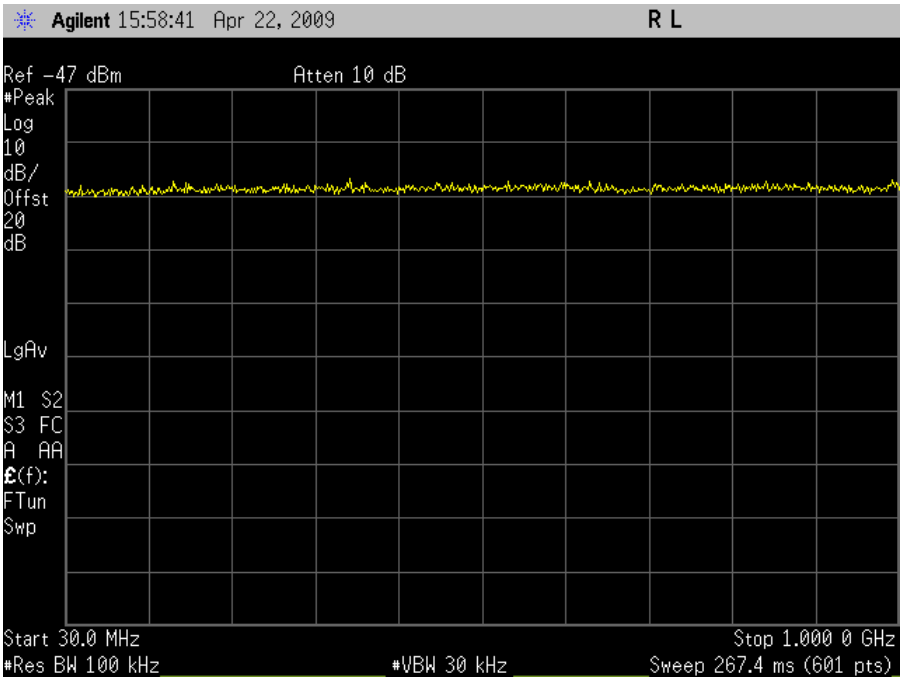
Plot 145. Receiver Radiated Spurious Emission 30 MHz - 1GHz (Port 1)



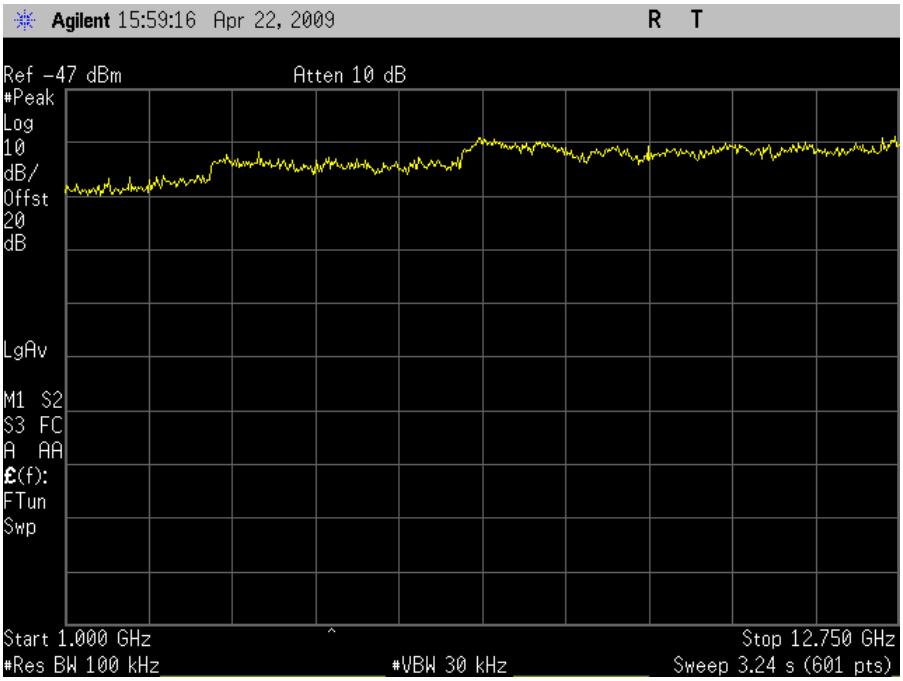
Plot 146. Receiver Radiated Spurious Emission 1 GHz - 12.75 GHz (Port 1)

 © 2011, MET Laboratories, Inc.

Receiver Conducted Spurious



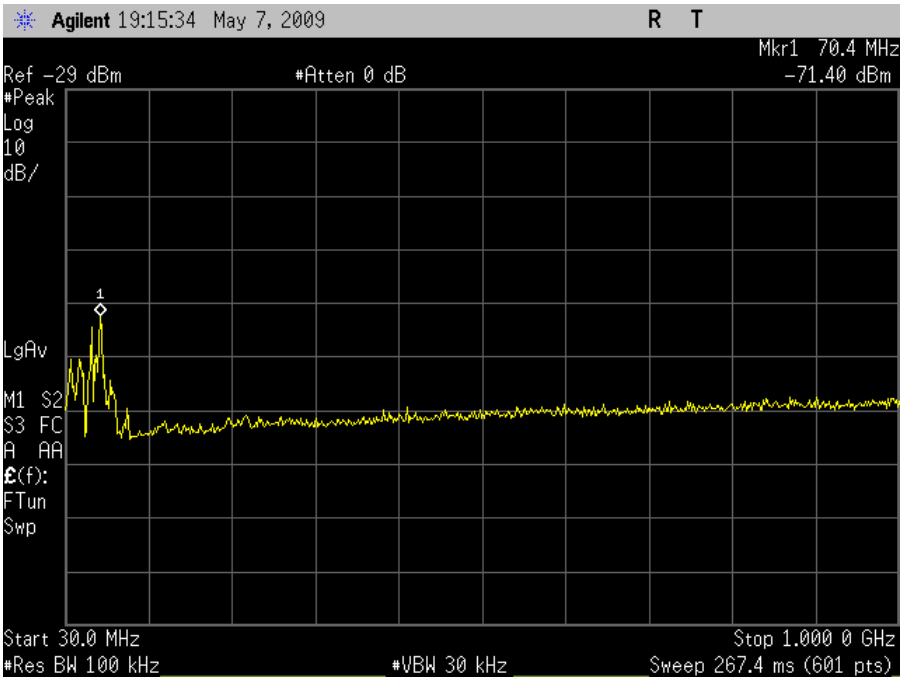
Plot 147. Receiver Conducted Spurious Emission 30 MHz - 1GHz (Port 1)



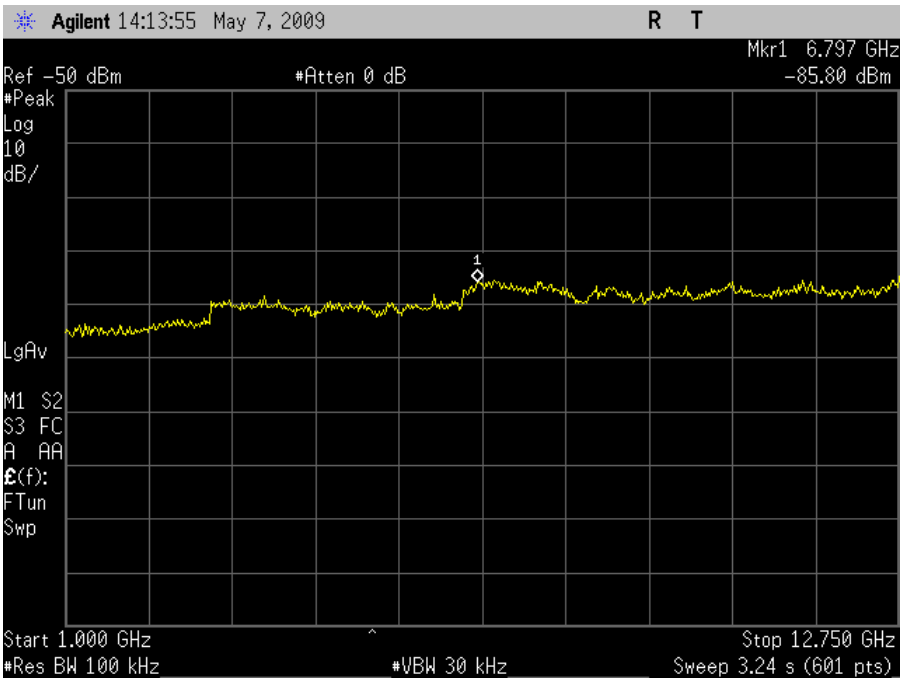
Plot 148. Receiver Conducted Spurious Emission 1 GHz - 12.75 GHz (Port 1)

 © 2011, MET Laboratories, Inc.

Receiver Spurious Emissions – MIMO



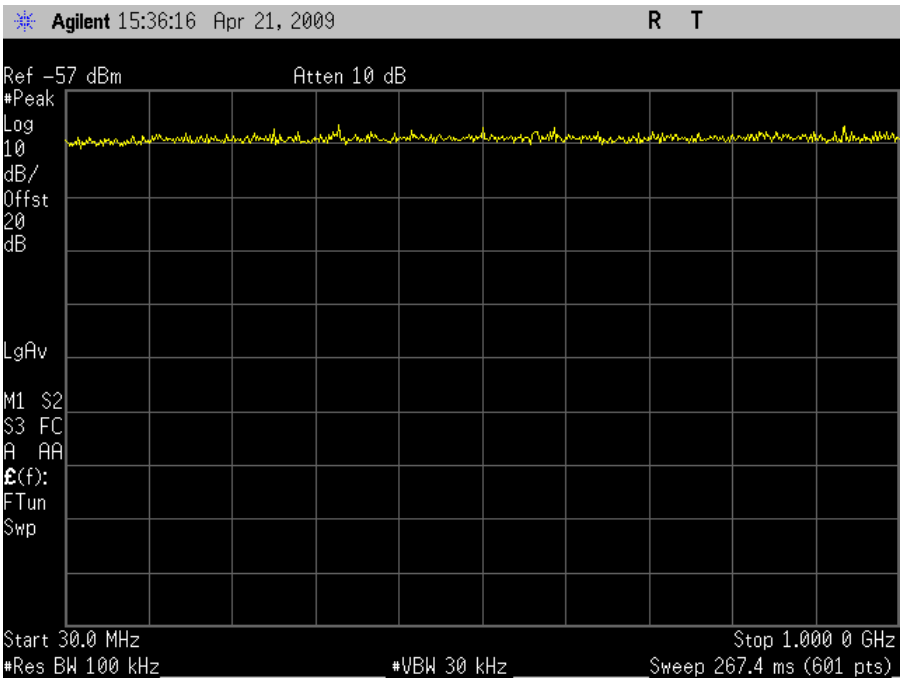
Plot 149. Receiver Radiated Spurious Emission 30 MHz - 1GHz (MIMO)



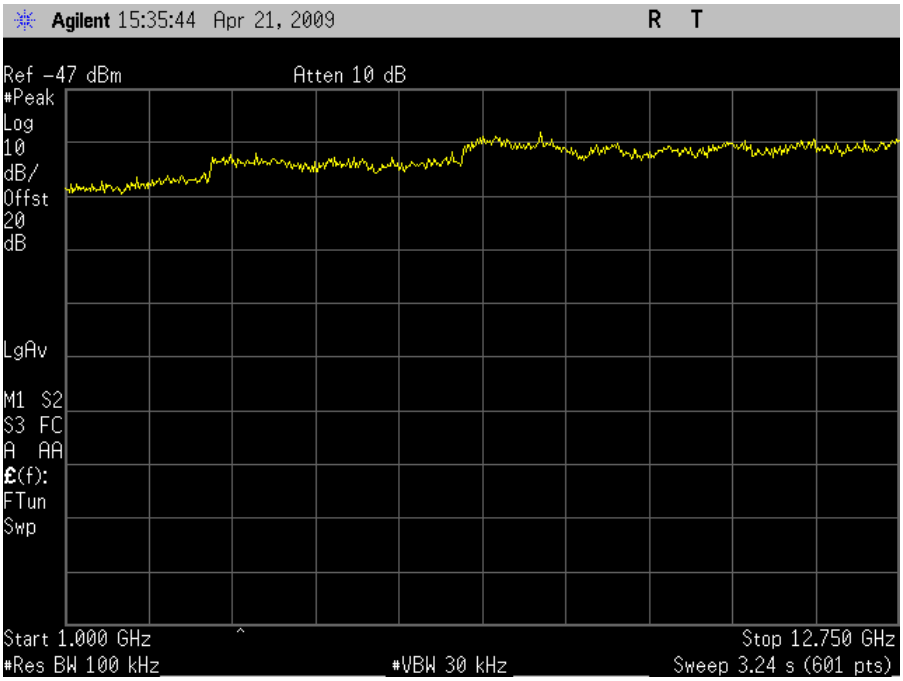
Plot 150. Receiver Radiated Spurious Emission 1 GHz - 12.75 GHz (MIMO)

© 2011, MET Laboratories, Inc.

Receiver Conducted Spurious



Plot 151. Receiver Conducted Spurious Emission 30 MHz - 1GHz (MIMO)



Plot 152. Receiver Conducted Spurious Emission 1 GHz - 12.75 GHz (MIMO)

© 2011, MET Laboratories, Inc.

IV. Test Equipment

 © 2011, MET Laboratories, Inc.

Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ANSI/NCSL Z540-1-1994 and ANSI/ISO/IEC 17025:2000.

MET Asset #	Equipment	Manufacturer	Model	Last Cal Date	Cal Due Date
1S2583	SPECTRUM ANALYZER	AGILENT	E4447A	1/12/09	1/12/10
1S2229	TEMPERATURE CHAMBER	TENNY ENGINEERING	T630	1/31/09	1/31/10
1S2498	VARIABLE POWER SUPPLY	VARIAC	5021CT DVAM	SEE NOTE	
1S2484	BILOG ANTENNA	TESEQ	CBL 6112D	1/21/2008	7/21/2009
1S2198	HORN ANTENNA	EMCO	3115	9/10/08	9/10/09
1S2482	5M CHAMBER	PANASHEILD	641431	11/18/08	11/18/09

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

 © 2011, MET Laboratories, Inc.

End of Report

 © 2011, MET Laboratories, Inc.