CERTIFICATION TEST REPORT

Report Number. : 16U23818-E4V5

Applicant	:	APPLE, INC 1 INFINITE LOOP CUPERTINO, CA 95014, U.S.A.
Model	:	A1709, A1852
FCC ID	:	BCGA1709
EUT Description	:	TABLET DEVICE
Test Standard(s)	:	FCC 47 CFR PART 15 SUBPART E

Date Of Issue:
March 06, 2017

Prepared by:
UL Verification Services Inc.
47173 Benicia Street
Fremont, CA 94538, U.S.A.
TEL: (510) 771-1000
FAX: (510) 661-0888

NVLAP TESTING
NVLAP LAB CODE 200065-0

Revision History

Rev.	Issue Date	Revisions	Revised By
V1	02/03/2017	Initial Issue	Chin Pang
V2	02/16/2017	Updated antenna names	Tina Chu
V3	02/17/2017	Add Model Number	Chin Pang
V4	03/02/2017	Address TCB's Questions	Chin Pang
V5	03/06/2017	Address TCB's Questions	Chin Pang

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

TABLE OF CONTENTS

1. ATTESTATION OF TEST RESULTS 11

2. TEST METHODOLOGY 12

3. FACILITIES AND ACCREDITATION 12

4. CALIBRATION AND UNCERTAINTY 13

4.1. MEASURING INSTRUMENT CALIBRATION 13

4.2. SAMPLE CALCULATION 13

4.3. MEASUREMENT UNCERTAINTY 13

5. EQUIPMENT UNDER TEST 14

5.1. DESCRIPTION OF EUT 14

5.2. DESCRIPTION OF MODELS DIFFERENCES 14

5.3. MAXIMUM OUTPUT POWER 14

5.4. DESCRIPTION OF AVAILABLE ANTENNAS 17

5.5. SOFTWARE AND FIRMWARE 17

5.6. WORST-CASE CONFIGURATION AND MODE 18

5.7. DESCRIPTION OF TEST SETUP 19

6. TEST AND MEASUREMENT EQUIPMENT 25

7. ON TIME, DUTY CYCLE AND MEASUREMENT METHODS 26

7.1. ON TIME AND DUTY CYCLE 26

7.2. MEASUREMENT METHODS 30

8. ANTENNA PORT TEST RESULTS 31

8.1. 802.11n HT20 ANTENNA A MODE IN THE 5.2 GHz BAND 31

8.1.1. 26 dB BANDWIDTH 31
8.1.2. 99% BANDWIDTH 34
8.1.3. AVERAGE POWER 37
8.1.4. OUTPUT POWER AND PSD 38

8.2. 802.11n HT20 ANTENNA B MODE IN THE 5.2 GHz BAND 42

8.2.1. 26 dB BANDWIDTH 42
8.2.2. 99% BANDWIDTH 45
8.2.3. AVERAGE POWER 48
8.2.4. OUTPUT POWER AND PSD 49

8.3. 802.11n HT20 2Tx (ANTENNA A + ANTENNA B) CDD MODE IN THE 5.2 GHz BAND 53

8.3.1. 26 dB BANDWIDTH 53
8.3.2. 99% BANDWIDTH 57
8.3.3. AVERAGE POWER 61
8.3.4. OUTPUT POWER AND PSD 62

8.4. 802.11n HT20 2Tx (ANTENNA A + ANTENNA B) STBC MODE IN THE 5.2 GHz BAND 68

8.4.1. 26 dB BANDWIDTH 68

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.4.2. 99% BANDWIDTH 72
8.4.3. AVERAGE POWER 76
8.4.4. OUTPUT POWER AND PSD 77

8.5. 802.11n HT40 ANTENNA A MODE IN THE 5.2 GHz BAND 82
8.5.1. 26 dB BANDWIDTH 82
8.5.2. 99% BANDWIDTH 84
8.5.3. AVERAGE POWER 86
8.5.4. OUTPUT POWER AND PSD 87

8.6. 802.11n HT40 ANTENNA B MODE IN THE 5.2 GHz BAND 90
8.6.1. 26 dB BANDWIDTH 90
8.6.2. 99% BANDWIDTH 92
8.6.3. AVERAGE POWER 94
8.6.4. OUTPUT POWER AND PSD 95

8.7. 802.11n HT40 2Tx (ANTENNA A + ANTENNA B) CDD MODE IN THE 5.2 GHz BAND 98
8.7.1. 26 dB BANDWIDTH 98
8.7.2. 99% BANDWIDTH 101
8.7.3. AVERAGE POWER 104
8.7.4. OUTPUT POWER AND PSD 105

8.8. 802.11n HT40 2Tx (ANTENNA A + ANTENNA B) STBC MODE IN THE 5.2 GHz BAND ... 110

8.9. 802.11ac VHT80 ANTENNA A MODE IN THE 5.2 GHz BAND 111
8.9.1. 26 dB BANDWIDTH 111
8.9.2. 99% BANDWIDTH 112
8.9.3. AVERAGE POWER 113
8.9.4. OUTPUT POWER AND PSD 114

8.10. 802.11ac VHT80 ANTENNA B MODE IN THE 5.2 GHz BAND 117
8.10.1. 26 dB BANDWIDTH 117
8.10.2. 99% BANDWIDTH 118
8.10.3. AVERAGE POWER 119
8.10.4. OUTPUT POWER AND PSD 120

8.11. 802.11ac VHT80 2Tx (ANTENNA A + ANTENNA B) CDD MODE IN THE 5.2 GHz BAND 123
8.11.1. 26 dB BANDWIDTH 123
8.11.2. 99% BANDWIDTH 125
8.11.3. AVERAGE POWER 127
8.11.4. OUTPUT POWER AND PSD 128

8.12. 802.11ac VHT80 2Tx (ANTENNA A + ANTENNA B) STBC MODE IN THE 5.2 GHz BAND 132

8.13. 802.11n HT20 ANTENNA A MODE IN THE 5.3 GHz BAND 133
8.13.1. 26 dB BANDWIDTH 133
8.13.2. 99% BANDWIDTH 136
8.13.3. AVERAGE POWER 139
8.13.4. OUTPUT POWER AND PSD 140

8.14. 802.11n HT20 ANTENNA B MODE IN THE 5.3 GHz BAND 144
8.14.1. 26 dB BANDWIDTH 144
8.14.2. 99% BANDWIDTH 147
8.14.3. AVERAGE POWER 150
8.14.4. OUTPUT POWER AND PSD 151

8.15. 802.11n HT20 2Tx (ANTENNA A + ANTENNA B) CDD MODE IN THE 5.3 GHz BAND . 155

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.15.1. 26 dB BANDWIDTH 155
8.15.2. 99% BANDWIDTH 159
8.15.3. AVERAGE POWER 163
8.15.4. OUTPUT POWER AND PSD 164

8.16. 802.11n HT20 2Tx (ANTENNA A + ANTENNA B) STBC MODE IN THE 5.3 GHz BAND 169

8.17. 802.11n HT40 ANTENNA A MODE IN THE 5.3 GHz BAND 170
8.17.1. 26 dB BANDWIDTH 170
8.17.2. 99% BANDWIDTH 172
8.17.3. AVERAGE POWER 174
8.17.4. OUTPUT POWER AND PSD 175

8.18. 802.11n HT40 ANTENNA B MODE IN THE 5.3 GHz BAND 178
8.18.1. 26 dB BANDWIDTH 178
8.18.2. 99% BANDWIDTH 180
8.18.3. AVERAGE POWER 182
8.18.4. OUTPUT POWER AND PSD 183

8.19. 802.11n HT40 2Tx (ANTENNA A + ANTENNA B) CDD MODE IN THE 5.3 GHz BAND . 186
8.19.1. 26 dB BANDWIDTH 186
8.19.2. 99% BANDWIDTH 189
8.19.3. AVERAGE POWER 192
8.19.4. OUTPUT POWER AND PSD 193

8.20. 802.11n HT40 2Tx (ANTENNA A + ANTENNA B) STBC MODE IN THE 5.3 GHz BAND 197

8.21. 802.11ac VHT80 ANTENNA A MODE IN THE 5.3 GHz BAND 198
8.21.1. 26 dB BANDWIDTH 198
8.21.2. 99% BANDWIDTH 199
8.21.3. AVERAGE POWER 200
8.21.4. OUTPUT POWER AND PSD 201

8.22. 802.11ac VHT80 ANTENNA B MODE IN THE 5.3 GHz BAND 204
8.22.1. 26 dB BANDWIDTH 204
8.22.2. 99% BANDWIDTH 205
8.22.3. AVERAGE POWER 206
8.22.4. OUTPUT POWER AND PSD 207

8.23. 802.11ac VHT80 2Tx (ANTENNA A + ANTENNA B) CDD MODE IN THE 5.3 GHz BAND 210
8.23.1. 26 dB BANDWIDTH 210
8.23.2. 99% BANDWIDTH 212
8.23.3. AVERAGE POWER 214
8.23.4. OUTPUT POWER AND PSD 215

8.24. 802.11ac VHT80 2Tx (ANTENNA A + ANTENNA B) STBC MODE IN THE 5.3 GHz BAND 218

8.25. 802.11n HT20 ANTENNA A MODE IN THE 5.6 GHz BAND 219
8.25.1. 26 dB BANDWIDTH 219
8.25.2. 99% BANDWIDTH 222
8.25.3. AVERAGE POWER 225
8.25.4. OUTPUT POWER AND PSD 226

8.26. 802.11ac VHT20 ANTENNA A STRADDLE CHANNEL 144 RESULTS 230
8.26.1. OUTPUT POWER AND PSD 230
8.26.2. 6 dB BANDWIDTH 234

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.27. 802.11n HT20 ANTENNA B MODE IN THE 5.6 GHz BAND 235
8.27.1. 26 dB BANDWIDTH 235
8.27.2. 99% BANDWIDTH 238
8.27.3. AVERAGE POWER 241
8.27.4. OUTPUT POWER AND PSD 242

8.28. 802.11ac VHT20 ANTENNA B STRADDLE CHANNEL 144 RESULTS 246
8.28.1. OUTPUT POWER AND PSD 246
8.28.2. 6 dB BANDWIDTH 250

8.29. 802.11n HT20 2Tx (ANTENNA A + ANTENNA B) CDD MODE IN THE 5.6 GHz BAND . 251
8.29.1. 26 dB BANDWIDTH 251
8.29.2. 99% BANDWIDTH 256
8.29.3. AVERAGE POWER 261
8.29.4. OUTPUT POWER AND PSD 262

8.30. 802.11ac VHT20 2Tx (ANTENNA A + ANTENNA B) CDD STRADDLE CHANNEL 144 RESULTS 268
8.30.1. OUTPUT POWER AND PSD 268
8.30.2. 6 dB BANDWIDTH 274

8.31. 802.11n HT20 2Tx (ANTENNA A + ANTENNA B) STBC MODE IN THE 5.6 GHz BAND 276

8.32. 802.11n HT40 ANTENNA A MODE IN THE 5.6 GHz BAND 277
8.32.1. 26 dB BANDWIDTH 277
8.32.2. 99% BANDWIDTH 280
8.32.3. AVERAGE POWER 283
8.32.4. OUTPUT POWER AND PSD 284

8.33. 802.11ac VHT40 ANTENNA A STRADDLE CH 142 RESULTS 288
8.33.1. OUTPUT POWER AND PSD 288
8.33.2. 6 dB BANDWIDTH 292

8.34. 802.11n HT40 ANTENNA B MODE IN THE 5.6 GHz BAND 293
8.34.1. 26 dB BANDWIDTH 293
8.34.2. 99% BANDWIDTH 296
8.34.3. AVERAGE POWER 299
8.34.4. OUTPUT POWER AND PSD 300

8.35. 802.11ac VHT40 ANTENNA B STRADDLE CH 142 RESULTS 304
8.35.1. OUTPUT POWER AND PSD 304
8.35.2. 6 dB BANDWIDTH 308

8.36. 802.11n HT40 2Tx (ANTENNA A + ANTENNA B) CDD MODE IN THE 5.6 GHz BAND . 309
8.36.1. 26 dB BANDWIDTH 309
8.36.2. 99% BANDWIDTH 314
8.36.3. AVERAGE POWER 319
8.36.4. OUTPUT POWER AND PSD 320

8.37. 802.11ac VHT40 2Tx (ANTENNA A + ANTENNA B) CDD STRADDLE CHANNEL 142 RESULTS 326
8.37.1. OUTPUT POWER AND PSD 326
8.37.2. 6 dB BANDWIDTH 332

8.38. 802.11n HT40 2Tx (ANTENNA A + ANTENNA B) STBC MODE IN THE 5.6 GHz BAND 334

8.39. 802.11ac VHT80 ANTENNA A MODE IN THE 5.6 GHz BAND 335
8.39.1. 26 dB BANDWIDTH 335
8.39.2. 99% BANDWIDTH 338

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.39.3. AVERAGE POWER 341
8.39.4. OUTPUT POWER AND PSD 342

8.40. STRADDLE CHANNEL 138 RESULTS 345
8.40.1. OUTPUT POWER AND PSD 345
8.40.2. 6 dB BANDWIDTH 349

8.41. 802.11ac VHT80 ANTENNA B MODE IN THE 5.6 GHz BAND 350
8.41.1. 26 dB BANDWIDTH 350
8.41.2. 99% BANDWIDTH 353
8.41.3. AVERAGE POWER 356
8.41.4. OUTPUT POWER AND PSD 357

8.42. STRADDLE CHANNEL 138 RESULTS 360
8.42.1. OUTPUT POWER AND PSD 360
8.42.2. 6 dB BANDWIDTH 364

8.43. 802.11ac VHT80 2Tx (ANTENNA A + ANTENNA B) CDD MODE IN THE 5.6 GHz BAND 365
8.43.1. 26 dB BANDWIDTH 365
8.43.2. 99% BANDWIDTH 369
8.43.3. AVERAGE POWER 373
8.43.4. OUTPUT POWER AND PSD 374

8.44. STRADDLE CHANNEL 138 RESULTS 379
8.44.1. OUTPUT POWER AND PSD 379
8.44.2. 6 dB BANDWIDTH 385

8.45. 802.11n VHT80 2Tx (ANTENNA A + ANTENNA B) STBC MODE IN THE 5.6 GHz BAND 387

8.46. 802.11n HT20 ANTENNA A MODE IN THE 5.8 GHz BAND 388
8.46.1. 6 dB BANDWIDTH 388
8.46.2. 26 dB BANDWIDTH 391
8.46.3. 99% BANDWIDTH 394
8.46.4. AVERAGE POWER 397
8.46.5. OUTPUT POWER 398
8.46.6. PSD 400

8.47. 802.11n HT20 ANTENNA B MODE IN THE 5.8 GHz BAND 403
8.47.1. 6 dB BANDWIDTH 403
8.47.2. 26 dB BANDWIDTH 406
8.47.3. 99% BANDWIDTH 409
8.47.4. AVERAGE POWER 412
8.47.5. OUTPUT POWER 413
8.47.6. PSD 415

8.48. 802.11n HT20 2Tx (ANTENNA A + ANTENNA B) CDD MODE IN THE 5.8 GHz BAND . 418
8.48.1. 6 dB BANDWIDTH 418
8.48.2. 26 dB BANDWIDTH 422
8.48.3. 99% BANDWIDTH 426
8.48.4. AVERAGE POWER 430
8.48.5. OUTPUT POWER 431
8.48.6. PSD 433

8.49. 802.11n HT20 2Tx (ANTENNA A + ANTENNA B) STBC MODE IN THE 5.8 GHz BAND 438

8.50. 802.11n HT40 ANTENNA A MODE IN THE 5.8 GHz BAND 439
8.50.1. 6 dB BANDWIDTH 439

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.50.2. 26 dB BANDWIDTH 441
8.50.3. 99% BANDWIDTH 443
8.50.4. AVERAGE POWER 445
8.50.5. OUTPUT POWER 446
8.50.6. PSD 448

8.51. 802.11n HT40 ANTENNA B MODE IN THE 5.8 GHz BAND 451
8.51.1. 6 dB BANDWIDTH 451
8.51.2. 26 dB BANDWIDTH 453
8.51.3. 99% BANDWIDTH 455
8.51.4. AVERAGE POWER 457
8.51.5. OUTPUT POWER 458
8.51.6. PSD 460

8.52. 802.11n HT40 2Tx (ANTENNA A + ANTENNA B) CDD MODE IN THE 5.8 GHz BAND . 463
8.52.1. 6 dB BANDWIDTH 463
8.52.2. 26 dB BANDWIDTH 466
8.52.3. 99% BANDWIDTH 469
8.52.4. AVERAGE POWER 472
8.52.5. OUTPUT POWER 473
8.52.6. PSD 475

8.53. 802.11n HT40 2Tx (ANTENNA A + ANTENNA B) STBC MODE IN THE 5.8 GHz BAND 479

8.54. 802.11ac VHT80 ANTENNA A MODE IN THE 5.8 GHz BAND 480
8.54.1. 6 dB BANDWIDTH 480
8.54.2. 26 dB BANDWIDTH 481
8.54.3. 99% BANDWIDTH 482
8.54.4. AVERAGE POWER 483
8.54.5. OUTPUT POWER 484
8.54.6. PSD 486

8.55. 802.11ac VHT80 ANTENNA B MODE IN THE 5.8 GHz BAND 488
8.55.1. 6 dB BANDWIDTH 488
8.55.2. 26 dB BANDWIDTH 489
8.55.3. 99% BANDWIDTH 490
8.55.4. AVERAGE POWER 491
8.55.5. OUTPUT POWER 492
8.55.6. PSD 494

8.56. 802.11ac VHT80 2Tx (ANTENNA A + ANTENNA B) CDD MODE IN THE 5.8 GHz BAND 496
8.56.1. 6 dB BANDWIDTH 496
8.56.2. 26 dB BANDWIDTH 498
8.56.3. 99% BANDWIDTH 500
8.56.4. AVERAGE POWER 502
8.56.5. OUTPUT POWER 503
8.56.6. PSD 505

8.57. 802.11ac VHT80 2Tx (ANTENNA A + ANTENNA B) STBC MODE IN THE 5.8 GHz BAND 508

9. RADIATED TEST RESULTS 509

9.1. LIMITS AND PROCEDURE 509

9.2. TRANSMITTER ABOVE 1GHz 510
9.2.1. 11n HT20 ANTENNA A SISO MODE IN THE 5.2GHz BAND 510

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

9.2.2. 11n HT20 ANTENNA B SISO MODE IN THE 5.2GHz BAND 518
9.2.3. 11n HT20 2TX CDD MIMO MODE IN THE 5.2GHz BAND 526
9.2.4. 11n HT40 ANTENNA A SISO MODE IN THE 5.2GHz BAND 534
9.2.5. 11n HT40 ANTENNA B SISO MODE IN THE 5.2GHz BAND 540
9.2.6. 11n HT40 2TX CDD MIMO MODE IN THE 5.2GHz BAND 546
9.2.7. 11ac HT80 ANTENNA A SISO MODE IN THE 5.2GHz BAND 552
9.2.8. 11ac HT80 ANTENNA B SISO MODE IN THE 5.2GHz BAND 556
9.2.9. 11ac HT80 2TX CDD MIMO MODE IN THE 5.2GHz BAND 560
9.2.10. 11n HT20 ANTENNA A SISO MODE IN THE 5.3GHz BAND..... 564
9.2.11. 11n HT20 ANTENNA B SISO MODE IN THE 5.3GHz BAND..... 572
9.2.12. 11n HT20 2TX CDD MIMO MODE IN THE 5.3GHz BAND 580
9.2.13. 11n HT40 ANTENNA A SISO MODE IN THE 5.3GHz BAND..... 588
9.2.14. 11n HT40 ANTENNA B SISO MODE IN THE 5.3GHz BAND..... 594
9.2.15. 11n HT40 2TX CDD MIMO MODE IN THE 5.3GHz BAND 600
9.2.16. 11ac HT80 ANTENNA A SISO MODE IN THE 5.3GHz BAND..... 606
9.2.17. 11ac HT80 ANTENNA B SISO MODE IN THE 5.3GHz BAND..... 610
9.2.18. 11ac HT80 2TX CDD MIMO MODE IN THE 5.3GHz BAND..... 614
9.2.19. 11n HT20 ANTENNA A SISO MODE IN THE 5.6GHz BAND..... 618
9.2.20. 11n HT20 ANTENNA A SISO STRADDLE CHANNEL 144..... 628
9.2.21. 11n HT20 ANTENNA B SISO MODE IN THE 5.6GHz BAND..... 630
9.2.22. 11ac HT20 ANTENNA B SISO STRADDLE CHANNEL 144 640
9.2.23. 11n HT20 2TX CDD MIMO MODE IN THE 5.6GHz BAND 642
9.2.24. 11ac HT20 2TX CDD MIMO STRADDLE CHANNEL 144 652
9.2.25. 11n HT40 ANTENNA A SISO MODE IN THE 5.6GHz BAND..... 654
9.2.26. 11n HT40 ANTENNA A SISO STRADDLE CHANNEL 142..... 664
9.2.27. 11n HT40 ANTENNA B SISO MODE IN THE 5.6GHz BAND..... 666
9.2.28. 11n HT40 ANTENNA B SISO STRADDLE CHANNEL 142..... 676
9.2.29. 11n HT40 2TX CDD MIMO MODE IN THE 5.6GHz BAND 678
9.2.30. 11ac HT40 2TX CDD MIMO STRADDLE CHANNEL 142 688
9.2.31. 11ac HT80 ANTENNA A SISO MODE IN THE 5.6GHz BAND..... 690
9.2.32. 11ac HT80 ANTENNA A SISO STRADDLE CHANNEL 138 696
9.2.33. 11ac HT80 ANTENNA B SISO MODE IN THE 5.6GHz BAND..... 698
9.2.34. 11ac HT80 ANTENNA B SISO STRADDLE CHANNEL 138 704
9.2.35. 11ac HT80 2TX CDD MIMO MODE IN THE 5.6GHz BAND..... 706
9.2.36. 11ac HT80 2TX CDD MIMO STRADDLE CHANNEL 138 712
9.2.37. 11n HT20 ANTENNA A SISO MODE IN THE 5.8GHz BAND..... 714
9.2.38. 11n HT20 ANTENNA B SISO MODE IN THE 5.8GHz BAND..... 724
9.2.39. 11n HT20 2TX CDD MIMO MODE IN THE 5.8GHz BAND 734
9.2.40. 11n HT40 ANTENNA A SISO MODE IN THE 5.8GHz BAND..... 744
9.2.41. 11n HT40 ANTENNA B SISO MODE IN THE 5.8GHz BAND..... 752
9.2.42. 11n HT40 2TX CDD MIMO MODE IN THE 5.8GHz BAND 760
9.2.43. 11ac HT80 ANTENNA A SISO MODE IN THE 5.8GHz BAND..... 768
9.2.44. 11ac HT80 ANTENNA B SISO MODE IN THE 5.8GHz BAND..... 774
9.2.45. 11ac HT80 2TX CDD MIMO MODE IN THE 5.8GHz BAND..... 780

9.3. WORST-CASE CO-LOCATION..... 786

9.4. WORST-CASE BELOW 1 GHz 788

9.5. WORST-CASE 18 to 26 GHz 790

9.6. WORST-CASE 26 to 40 GHz 792

10. AC POWER LINE CONDUCTED EMISSIONS 794

10.1. EUT POWERED BY AC/DC ADAPTER VIA USB CABLE 795

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

10.2. EUT POWERED BY HOST PC VIA USB CABLE 797

11. DYNAMIC FREQUENCY SELECTION 799

11.1. OVERVIEW 799
11.1.1. LIMITS 799
11.1.2. TEST AND MEASUREMENT SYSTEM 803
11.1.3. TEST AND MEASUREMENT SOFTWARE 805
11.1.4. SETUP OF EUT (CLIENT MODE) 806
11.1.5. SETUP OF EUT (CLIENT-TO-CLIENT COMMUNICATIONS MODE) 807
11.1.6. DESCRIPTION OF EUT 808

11.2. CLIENT MODE RESULTS FOR 20 MHz BANDWIDTH 810
11.2.1. TEST CHANNEL 810
11.2.2. RADAR WAVEFORM AND TRAFFIC 810
11.2.3. OVERLAPPING CHANNEL TESTS 813
11.2.4. MOVE AND CLOSING TIME 813

11.3. CLIENT MODE RESULTS FOR 40 MHz BANDWIDTH 817
11.3.1. TEST CHANNEL 817
11.3.2. RADAR WAVEFORM AND TRAFFIC 817
11.3.3. OVERLAPPING CHANNEL TESTS 820
11.3.4. MOVE AND CLOSING TIME 820

11.4. CLIENT MODE RESULTS FOR 80 MHz BANDWIDTH 824
11.4.1. TEST CHANNEL 824
11.4.2. RADAR WAVEFORM AND TRAFFIC 824
11.4.3. OVERLAPPING CHANNEL TESTS 827
11.4.4. MOVE AND CLOSING TIME 827
11.4.5. 10-MINUTE CLIENT Tx MONITORING PERIOD 831

11.5. CLIENT-TO-CLIENT COMMUNICATIONS MODE RESULTS FOR 20 MHz BANDWIDTH 832
11.5.1. TEST CHANNEL 832
11.5.2. RADAR WAVEFORM AND TRAFFIC 832
11.5.3. OVERLAPPING CHANNEL TESTS 835
11.5.4. MOVE AND CLOSING TIME 835

11.6. CLIENT-TO-CLIENT COMMUNICATIONS MODE RESULTS FOR 40 MHz BANDWIDTH 839
11.6.1. TEST CHANNEL 839
11.6.2. RADAR WAVEFORM AND TRAFFIC 839
11.6.3. OVERLAPPING CHANNEL TESTS 842
11.6.4. MOVE AND CLOSING TIME 842

11.7. CLIENT-TO-CLIENT COMMUNICATIONS MODE RESULTS FOR 80 MHz BANDWIDTH 846
11.7.1. TEST CHANNEL 846
11.7.2. RADAR WAVEFORM AND TRAFFIC 846
11.7.3. OVERLAPPING CHANNEL TESTS 849
11.7.4. MOVE AND CLOSING TIME 849
11.7.5. 10-MINUTE CLIENT Tx MONITORING PERIOD 853

12. SETUP PHOTOS 854

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

1. ATTESTATION OF TEST RESULTS

COMPANY NAME: APPLE, INC.
1 INFINITE LOOP
CUPERTINO, CA 95014, U.S.A.

EUT DESCRIPTION: TABLET DEVICE

MODEL: A1709, A1852

SERIAL NUMBER: DLXSR04VHQG (CONDUCTED); DLXSG09THLXJ (RADIATED)
DLXSR07YHQG8 (DFS)

DATE TESTED: DECEMBER 27, 2016 – FEBARUAY 01, 2017

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
CFR 47 Part 15 Subpart E	Pass

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL Verification Services Inc. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Approved & Released For
UL Verification Services Inc. By:

CHIN PANG
SENIOR ENGINEER
UL VERIFICATION SERVICES INC.

Prepared By:

JINGANG LI
EMC LAB ENGINEER
UL VERIFICATION SERVICES INC.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, FCC 14-30, FCC KDB 662911 D01 v02r01, FCC KDB 905462 D02 v02/D03 v01r02/D06 v02/ D07 v01r01, FCC KDB 789033 D02 v01r03, FCC KDB 644545 D03 v01, ANSI C63.10-2013.

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 and 47266 Benicia Street, Fremont, California, USA. Line conducted emissions are measured only at the 47173 address. The following table identifies which facilities were utilized for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

47173 Benicia Street	47266 Benicia Street
☐ Chamber A (IC:2324B-1)	☒ Chamber D (IC:2324B-4)
☐ Chamber B (IC:2324B-2)	☒ Chamber E (IC:2324B-5)
☐ Chamber C (IC:2324B-3)	☐ Chamber F (IC:2324B-6)
	☒ Chamber G (IC:2324B-7)
	☐ Chamber H (IC:2324B-8)

The above test sites and facilities are covered under FCC Test Firm Registration # 208313.

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at http://ts.nist.gov/standards/scopes/2000650.htm.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

4.2. SAMPLE CALCULATION

Where relevant, the following sample calculation is provided:

Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)

36.5 dBuV + 18.7 dB/m + 0.6 dB – 26.9 dB = 28.9 dBuV/m

4.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

PARAMETER	UNCERTAINTY
Conducted Disturbance, 9KHz to 0.15 MHz	3.84 dB
Conducted Disturbance, 0.15 to 30 MHz	3.65 dB
Radiated Disturbance, 9KHz to 30 MHz	3.15 dB
Radiated Disturbance, 30 to 1000 MHz	5.36 dB
Radiated Disturbance,1000 to 18000 MHz	4.32 dB
Radiated Disturbance,18000 to 26000 MHz	4.45 dB
Radiated Disturbance,26000 to 40000 MHz	5.24 dB

Uncertainty figures are valid to a confidence level of 95%.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

5. EQUIPMENT UNDER TEST

5.1. DESCRIPTION OF EUT

The EUT is a tablet with multimedia functions (music, application support, and video), Cellular GSM/GPRS/EGPRS/CDMA2000 1xRTT/1x Advanced/EVDO Rev.A/EVDO Rev.B /WCDMA /HSPA+/DC- HSDPA/LTE FDD & Carrier Aggregation/TDD/TD-SCDMA radio, IEEE 802.11a/b/g/n/ac radio, and Bluetooth radio. The rechargeable battery is not user accessible.

5.2. DESCRIPTION OF MODELS DIFFERENCES

Both Model A1709 and A1852 have identical PCB layout, design and functionality, except that A1709 supports second electronic-UICC based SIM or “soft SIM” (called eSIM) beside the regular UICC based SIM and A1852 will come with eSIM removed. RF and electromagnetic characteristic are independent of the eSIM element. Both Models have exactly same technology and band support.Model A1709 is used for EMC/RSE and that data will be used for both Models

5.3. MAXIMUM OUTPUT POWER

The transmitter has a maximum average conducted output power as follows:
NOTE: Covered modes are test reduction modes. The output powers on the “covered modes are equal to or less than the mode referenced and use the same modulation.

5.2GHz Band

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
5180 - 5240	802.11a	Covered by 802.11n HT20 SISO	
	802.11n HT20 SISO	17.00	50.12
	802.11a 2TX CDD	Covered by 802.11n HT20 2TX CDD	
	802.11n HT20 2TX CDD	19.48	88.72
	802.11n HT20 2TX STBC	19.73	93.97
	802.11n HT20 2TX SDM	Covered by 802.11n HT20 2TX STBC	
	802.11ac VHT20 2TX SDM	Covered by 802.11n HT20 2TX STBC	
5190 - 5230	802.11n HT40 SISO	16.80	47.86
	802.11n HT40 2TX CDD	19.77	94.84
	802.11n HT40 2TX STBC	Covered by 802.11n HT40 2TX CDD	
	802.11ac VHT40 2TX STBC	Covered by 802.11n HT40 2TX CDD	
	802.11n HT40 2TX SDM	Covered by 802.11n HT40 2TX CDD	
	802.11ac VHT40 2TX SDM	Covered by 802.11n HT40 2TX CDD	
5210	802.11ac VHT80 SISO	14.00	25.12
	802.11ac VHT80 2TX CDD	15.45	35.08
	802.11ac VHT80 2TX STBC	Covered by 802.11ac VHT80 2TX CDD	
	802.11ac VHT80 2TX SDM	Covered by 802.11ac VHT80 2TX CDD	

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

5.3GHz Band

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
5260 - 5320	802.11a	Covered by 802.11n HT20 SISO	
	802.11n HT20 SISO	16.40	43.65
	802.11a 2TX CDD	Covered by 802.11n HT20 2TX CDD	
	802.11n HT20 2TX CDD	19.36	86.30
	802.11n HT20 2TX STBC	Covered by 802.11n HT20 2TX CDD	
	802.11ac VHT20 2TX STBC	Covered by 802.11n HT20 2TX CDD	
	802.11n HT20 2TX SDM	Covered by 802.11n HT20 2TX CDD	
	802.11ac VHT20 2TX SDM	Covered by 802.11n HT20 2TX CDD	
5270 - 5310	802.11n HT40 SISO	16.46	44.26
	802.11n HT40 2TX CDD	19.43	87.70
	802.11n HT40 2TX STBC	Covered by 802.11n HT40 2TX CDD	
	802.11ac VHT40 2TX STBC	Covered by 802.11n HT40 2TX CDD	
	802.11n HT40 2TX SDM	Covered by 802.11n HT40 2TX CDD	
	802.11ac VHT40 2TX SDM	Covered by 802.11n HT40 2TX CDD	
5290	802.11ac VHT80 SISO	13.00	19.95
	802.11ac VHT80 2TX CDD	14.49	28.12
	802.11ac VHT80 2TX STBC	Covered by 802.11ac VHT80 2TX CDD	
	802.11ac VHT80 2TX SDM	Covered by 802.11ac VHT80 2TX CDD	

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

5.6GHz Band

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
5500 - 5700	802.11a	Covered by 802.11n HT20 SISO	
5500 - 5700	802.11n HT20 SISO	15.00	31.62
5720	802.11ac VHT20 SISO (based on UNII-2C band output power)	13.23	21.04
5500 - 5700	802.11a 2TX CDD	Covered by 802.11n HT20 2TX CDD	
5500 - 5700	802.11n HT20 2TX CDD	17.87	61.24
5720	802.11ac VHT20 2TX CDD (based on UNII-2C band output power)	15.91	38.99
5500 - 5700	802.11n HT20 2TX STBC	Covered by 802.11n HT20 2TX CDD	
5500 - 5700	802.11ac VHT20 2TX STBC	Covered by 802.11n HT20 2TX CDD	
5500 - 5700	802.11n HT20 2TX SDM	Covered by 802.11n HT20 2TX CDD	
5500 - 5700	802.11ac VHT20 2TX SDM	Covered by 802.11n HT20 2TX CDD	
5720	802.11ac VHT20 2TX STBC/SDM (based on UNII-2C band output power)	Covered by 802.11n HT20 2TX CDD	
5510 - 5670	802.11n HT40 SISO	14.96	31.33
5710	802.11ac VHT40 SISO (based on UNII-2C band output power)	13.96	24.89
5510 - 5670	802.11n HT40 2TX CDD	17.99	62.95
5710	802.11ac VHT40 2TX CDD (based on UNII-2C band output power)	16.97	49.77
5510 - 5670	802.11n HT40 2TX STBC	Covered by 802.11n HT40 2TX CDD	
5510 - 5670	802.11ac VHT40 2TX STBC	Covered by 802.11n HT40 2TX CDD	
5710	802.11ac VHT40 2TX STBC (based on UNII-2C band output power)	Covered by 802.11n HT40 2TX CDD	
5510 - 5670	802.11n HT40 2TX SDM	Covered by 802.11n HT40 2TX CDD	
5510 - 5670	802.11ac VHT40 2TX SDM	Covered by 802.11n HT40 2TX CDD	
5710	802.11ac VHT40 2TX SDM (based on UNII-2C band output power)	Covered by 802.11n HT40 2TX CDD	
5530-5610	802.11ac VHT80 SISO	15.00	31.62
5690	802.11ac VHT80 SISO (based on UNII-2C band output power)	14.53	28.38
5530-5610	802.11ac VHT80 2TX CDD	17.95	62.37
5690	802.11ac VHT80 2TX CDD (based on UNII-2C band output power)	17.37	54.58
5530-5610	802.11ac VHT80 2TX STBC	Covered by 802.11ac VHT80 2TX CDD	
5690	802.11ac VHT80 2TX STBC(based on UNII-2C band output power)	Covered by 802.11ac VHT80 2TX CDD	
5530-5610	802.11ac VHT80 2TX SDM	Covered by 802.11ac VHT80 2TX CDD	
5690	802.11ac VHT80 2TX SDM (based on UNII-2C band output power)	Covered by 802.11ac VHT80 2TX CDD	

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

5.8GHz Band

Frequency Range (MHz)	Mode	Output Power (dBm)	Output Power (mW)
5745 - 5825	802.11a	Covered by 802.11n HT20 SISO	
	802.11n HT20 SISO	15.00	31.62
	802.11a 2TX CDD	Covered by 802.11n HT20 2TX CDD	
	802.11n HT20 2TX CDD	17.73	59.29
	802.11n HT20 2TX STBC	Covered by 802.11n HT20 2TX CDD	
	802.11ac VHT20 2TX STBC	Covered by 802.11n HT20 2TX CDD	
	802.11n HT20 2TX SDM	Covered by 802.11n HT20 2TX CDD	
	802.11ac VHT20 2TX SDM	Covered by 802.11n HT20 2TX CDD	
5755 - 5795	802.11n HT40 SISO	14.98	31.48
	802.11n HT40 2TX CDD	17.77	59.84
	802.11n HT40 2TX STBC	Covered by 802.11n HT40 2TX CDD	
	802.11ac VHT40 2TX STBC	Covered by 802.11n HT40 2TX CDD	
	802.11n HT40 2TX SDM	Covered by 802.11n HT40 2TX CDD	
	802.11ac VHT40 2TX SDM	Covered by 802.11n HT40 2TX CDD	
5775	802.11ac VHT80 SISO	14.92	31.05
	802.11ac VHT80 2TX CDD	17.74	59.43
	802.11ac VHT80 2TX STBC	Covered by 802.11ac VHT80 2TX CDD	
	802.11ac VHT80 2TX SDM	Covered by 802.11ac VHT80 2TX CDD	

5.4. DESCRIPTION OF AVAILABLE ANTENNAS

Frequency Band (GHz)	Antenna Gain (dBi)	
	Antenna A	Antenna B
5.2	1.66	2.65
5.3	2.28	2.81
5.5	3.69	3.10
5.8	3.40	3.18

5.5. SOFTWARE AND FIRMWARE

The software installed in the EUT during testing was 14E232.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

5.6. WORST-CASE CONFIGURATION AND MODE

For radiated harmonics spurious below 1GHz, 18-40GHz and power line conducted emissions were performed with the EUT set at the CDD mode at highest power setting among the CDD/STBC/SDM modes as worst-case scenario.

The output power for PSD and spurious tests was set higher than maximum for the purposes of testing only.

For SISO modes, there are two transmission antennas. The antenna used in any given time can be either Antenna A, or Antenna B. All antenna ports have the same power; output power and PSD measurement for SISO modes on both antennas are reported. For 2TX MIMO modes, Antenna A/Antenna B, used at the same time.

The fundamental of the EUT was investigated in three orthogonal orientations X (Flatbed), Y (Landscape), Z (Portrait), it was determined that (see table below) was worst-case orientations. Therefore, all final radiated testing was performed with the EUT in (see table below) orientation.

Frequency Band (GHz)	Mode	Antenna Port	Worst-case Orientation
5.2-5.8	1TX SISO	Antenna A	Landscape
		Antenna B	Landscape
	2TX MIMO	Antenna A + Antenna B	Landscape

Worst-case data rates as provided by the client were:

802.11a mode: 6 Mbps
802.11n HT20 mode: MCS0
802.11n HT40 mode: MCS0
802.11ac VHT20 mode: MCS0
802.11ac VHT40 mode: MCS0
802.11ac VHT80 mode: MCS0

802.11ac VHT20 and VHT40 mode are different from 802.11nHT20 and HT40 only in control messages and have the same power settings.

There are two vendors of the WiFi/Bluetooth radio modules: variant 1 and variant 2. The Wi-Fi/Bluetooth radio modules have the same mechanical outline (e.g., the same package dimension and pin-out layout), use the same on-board antenna matching circuit, have an identical antenna structure, and are built and tested to conform to the same specifications and to operate within the same tolerances.

Baseline testing was performed on the two variants to determine the worst case on all conducted power and radiated emissions.

For simultaneous transmission of multiple channels from the same antenna in BT/BLE and WLAN 5 GHz bands. Baseline testing was performed on various configurations to determine the worst case on radiated emissions.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

5.7. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer	Model	Serial Number	FCC ID
Laptop	Apple	A1286	7313700NAGW	N/A
Laptop AC/DC adapter	Apple	A1343	C062172045DDJ94A6	N/A
Earphone	Apple	NA	NA	N/A
EUT AC/DC adapter	Apple	A1357	W010A051	N/A

I/O CABLES (CONDUCTED TEST)

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	Antenna	1	SMA	Un-Shielded	0.2	To spectrum Analyzer
2	USB	1	USB	Shielded	1	N/A
3	AC	1	AC	Un-shielded	2	N/A

I/O CABLES (RADIATED ABOVE 1 GHZ)

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
None Used						

I/O CABLES (RADIATED BELOW 1 GHZ AND AC LINE CONDUCTED: AC/DC ADAPTER CONFIGURATION)

I/O Cable List						
Cable No	Port	# of identical	Connector Type	Cable Type	Cable Length (m)	Remarks
1	Earphone Jack	1	3.5mm Audio	Shielded	0.9	N/A
2	USB	1	USB	shielded	1	N/A

I/O CABLES (AC LINE CONDUCTED: LAPTOP CONFIGUARTION)

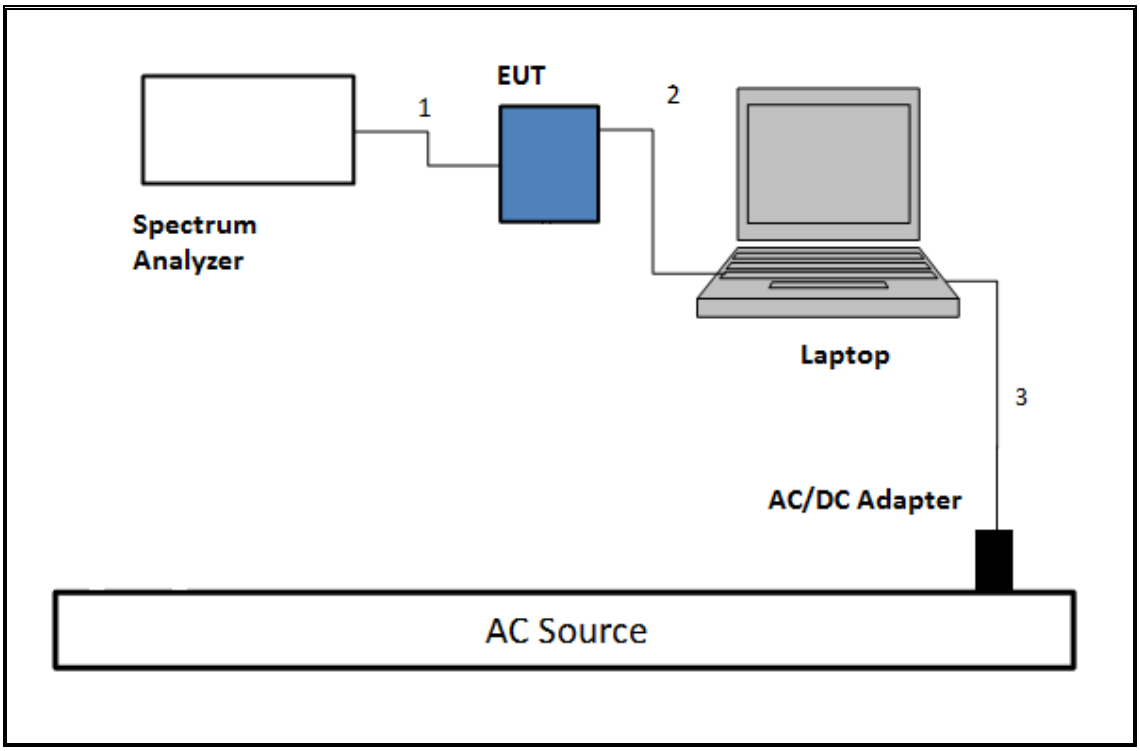
I/O Cable List						
Cable No	Port	# of identical	Connector Type	Cable Type	Cable Length (m)	Remarks
1	Earphone Jack	1	3.5mm Audio	Shielded	0.9	N/A
2	USB	1	USB	Shielded	1	N/A
3	AC	1	AC	Un-shielded	2	N/A

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

TEST SETUP - CONDUCTED TESTS

The EUT was connected to a host Laptop via USB cable adapter and spectrum analyzer to antenna port. Test software exercised the EUT.

SETUP DIAGRAM

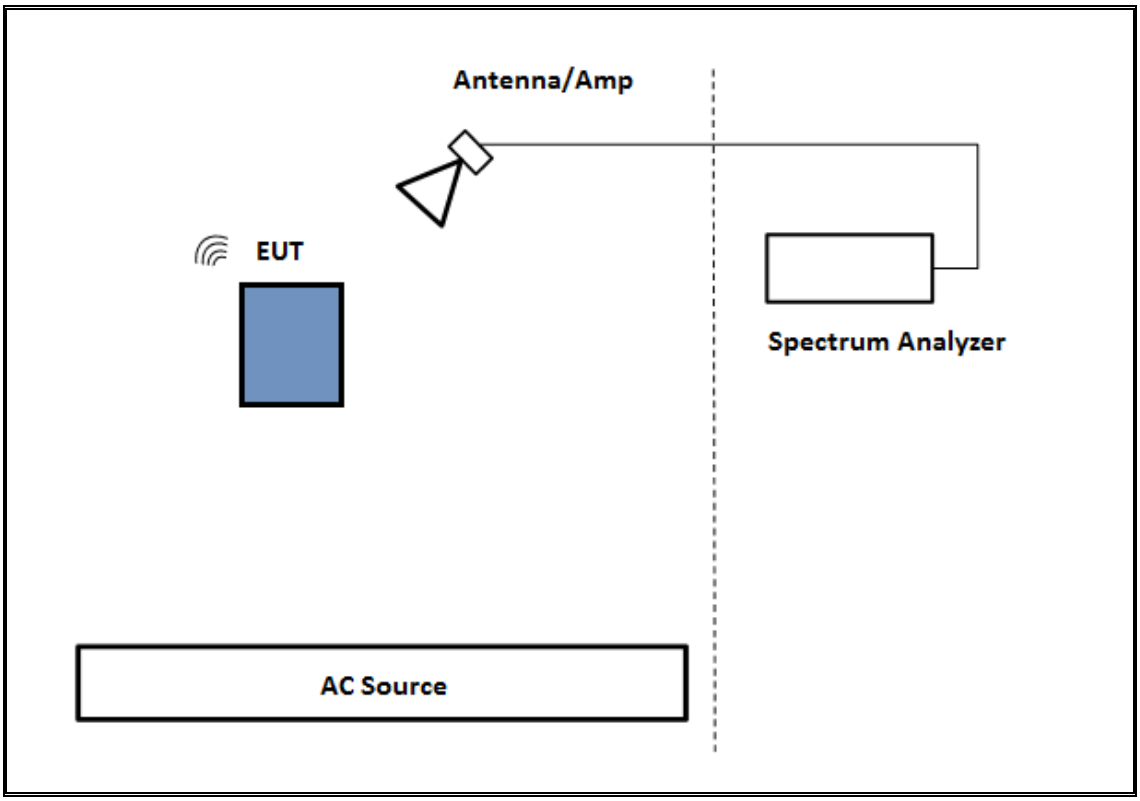


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

TEST SETUP- RADIATED-ABOVE 1 GHZ

The EUT was powered by battery. Test software exercised the EUT.

SETUP DIAGRAM

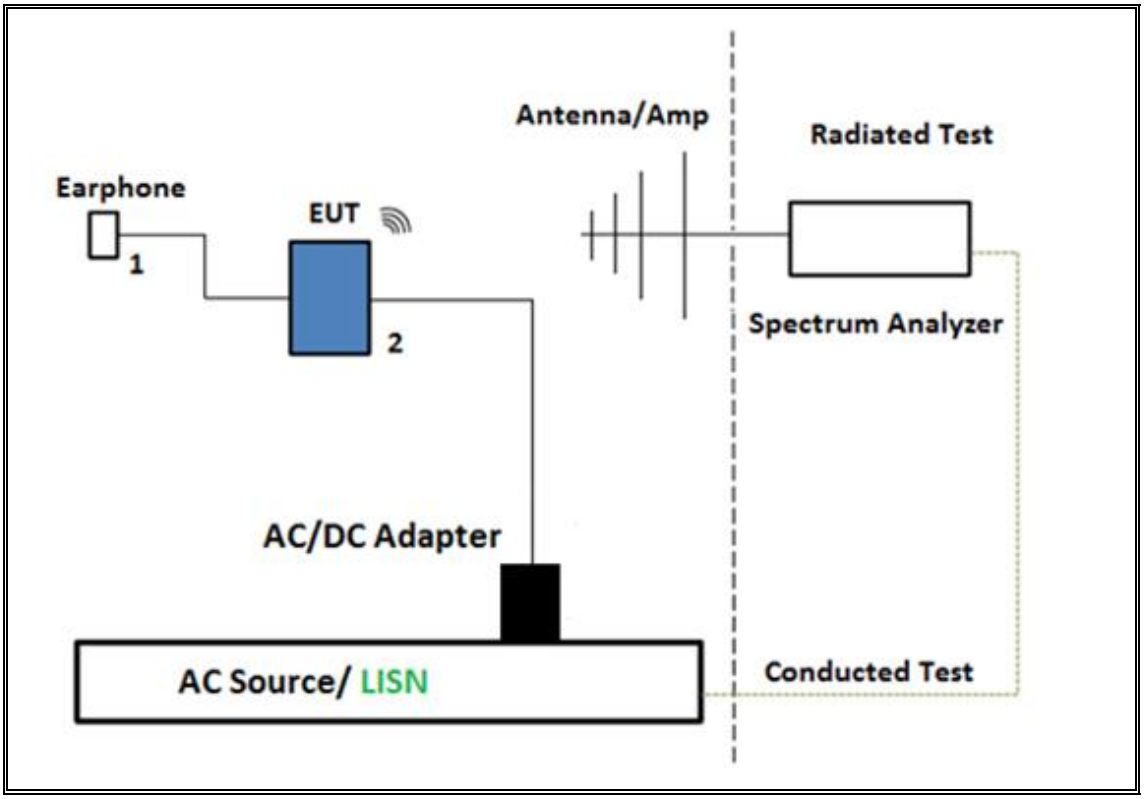


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

TEST SETUP- BELOW 1GHz

The EUT was powered by AC/DC adapter and connected with earphone. Test software exercised the EUT.

SETUP DIAGRAM

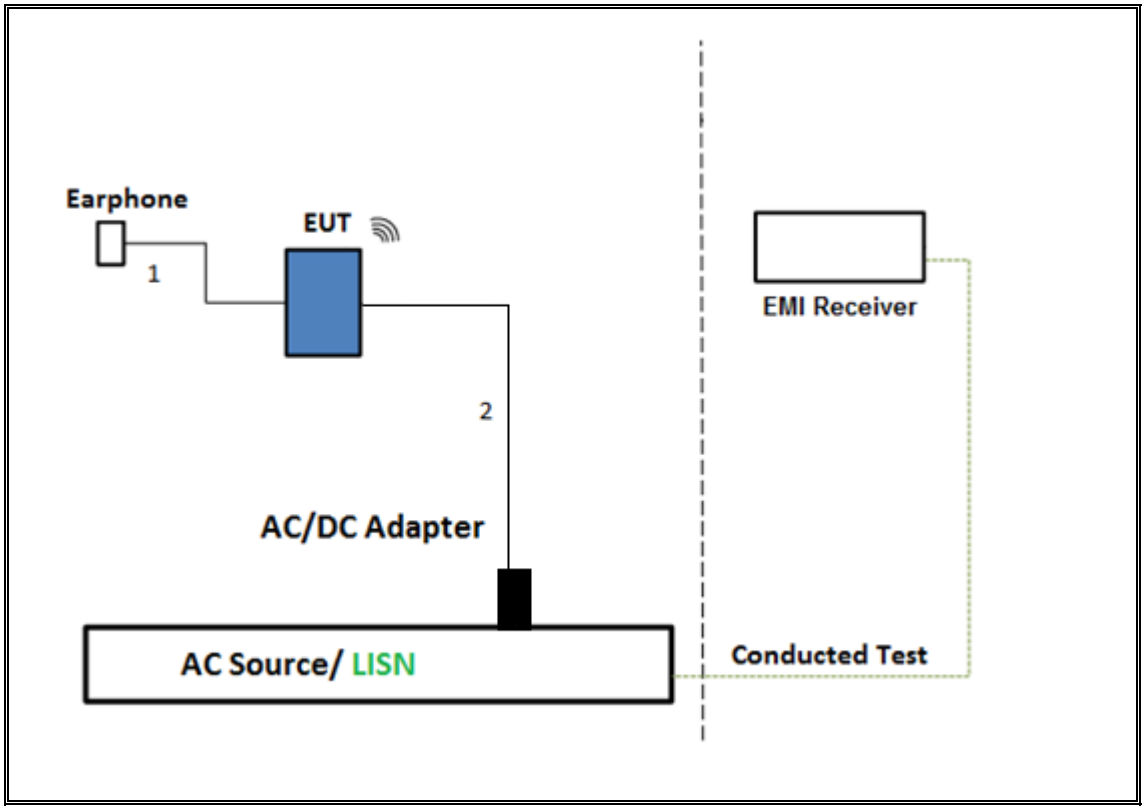


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

TEST SETUP- AC LINE CONDUCTED: AC/DC ADAPTER CONFIGURATION

The EUT was tested with earphone connected and powered by AC/DC adapter via USB cable. Test software exercised the EUT.

SETUP DIAGRAM

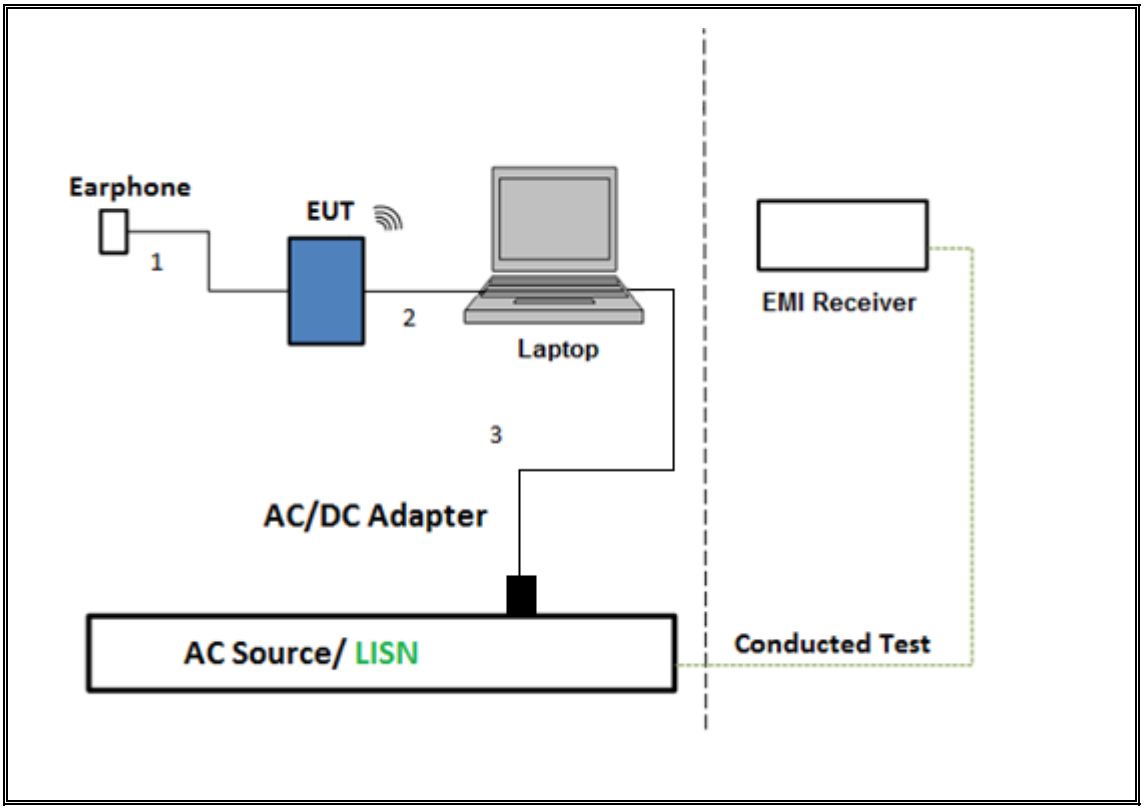


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

TEST SETUP- AC LINE CONDUCTED: LAPTOP CONFIGURATION

The EUT was tested with earphone connected and powered by host PC via USB cable. Test software exercised the EUT.

SETUP DIAGRAM



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

6. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

TEST EQUIPMENT LIST				
Description	**Manufacturer**	**Model**	**Asset**	**Cal Due**
Power Meter, P-series single channel	Agilent	N1911A	T227	10/11/2017
Power Sensor, P - series, 50MHz to 18GHz, Wideband	Agilent	N1921A	T1228	06/20/2017
Antenna, Horn 1-18GHz	ETS-Lindgren	3117	T344	02/22/2017
Antenna, Broadband Hybrid, 30MHz to 2000MHz	Sunol Sciences Corp.	JB3	T407	04/04/2017
RF Amplifier, 1-18GHz	MITEQ	AFS42-00101800-25-S-42	T740	11/29/2017
Amplifier, 10KHz to 1GHz, 32dB	Sonoma Instrument	310	T286	05/04/2017
Spectrum Analyzer, PXA, 3Hz to 44GHz	Keysight	N9030A	T905	06/21/2017
Antenna, Horn 1-18GHz	ETS Lindgren	3117	T300	11/10/2017
Antenna, Broadband Hybrid, 30MHz to 2000MHz	Sunol Sciences	JB3	T426	9/23/2017
Amplifier, 1 to 18GHz	Miteq	AFS42-00101800-25-S-42	T243	10/11/2017
Amplifier, 10KHz to 1GHz, 32dB	Sonoma	310N	T285	6/20/2017
Spectrum Analyzer, PXA 3Hz to 44GHz	Keysight	N9030A	T1613	9/23/2017
Antenna, Broadband Hybrid, 30MHz to 2000MHz	Sunol Sciences	JB3	T899	5/26/2017
Amplifier, 10KHz to 1GHz, 32dB	Sonoma	310N	T834	6/17/2017
Spectrum Analyzer, PXA 3Hz to 44GHz	Keysight	N9030A-544	T1210	6/30/2017
Spectrum Analyzer, PXA, 3Hz to 44GHz	Keysight	N9030A	T339	09/22/2017
Spectrum Analyzer, PSA, 3Hz to 44GHz	Keysight	E4446A	T123	10/20/2017
Antenna, Horn 18 to 26.5GHz	ARA	MWH-1826/B	T447	06/16/2017
Amplifier, 1 to 26.5GHz, 23.5dB Gain minimum	Keysight	8449B	T402	7/5/2017
Antenna, Horn 26.5GHz to 40GHz	ARA	MWH-2640/B	T446	05/25/2017
Amplifier, 26.5GHz to 40GHz	Miteq	NSP 4000 SP2	T88	04/07/2017
AC Line Conducted				
EMI Test Receiver 9Khz-7GHz	Rohde & Schwarz	ESCI7	T1124	10/07/2017
LISN for Conducted Emissions CISPR-16	Fischer	50/250-25-2-01	T1310	06/08/2017
UL AUTOMATION SOFTWARE				
Radiated Software	UL	UL EMC	Ver 9.5, April 26, 2016	
Conducted Software	UL	UL EMC	Ver 5.4, October 13, 2016	
AC Line Conducted Software	UL	UL EMC	Ver 9.5, May 26, 2015	

NOTE: *testing is completed before equipment calibration expiration date.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

7. ON TIME, DUTY CYCLE AND MEASUREMENT METHODS

7.1. ON TIME AND DUTY CYCLE

LIMITS

None; for reporting purposes only.

PROCEDURE

KDB 789033 Zero-Span Spectrum Analyzer Method.

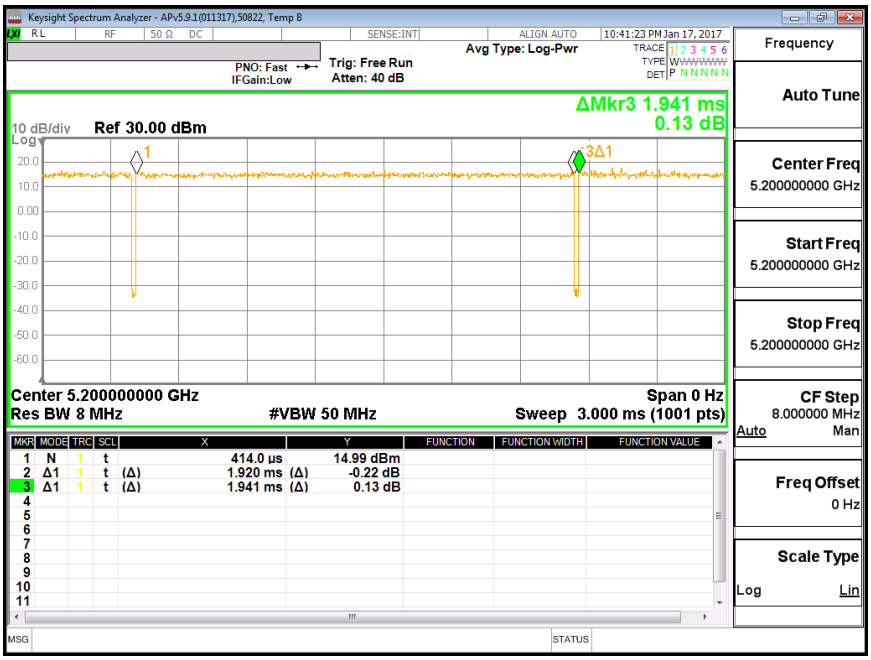
RESULTS

Mode	ON Time B (msec)	Period (msec)	Duty Cycle x (linear)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)	1/B Minimum VBW (kHz)
802.11n HT20 1TX	1.920	1.941	0.989	98.92%	0.00	0.010
802.11n HT20 CDD 2TX	1.914	1.938	0.988	98.76%	0.00	0.010
802.11n HT40 1TX	0.942	0.966	0.975	97.52%	0.11	1.062
802.11n HT40 CDD 2TX	0.944	0.966	0.977	97.72%	0.10	1.059
802.11ac VHT80 1TX	0.460	0.482	0.954	95.44%	0.20	2.174
802.11ac VHT80 CDD 2TX	0.460	0.481	0.956	95.63%	0.19	2.174

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

DUTY CYCLE PLOTS

DUTY CYCLE 802.11n HT20 1TX MODE



DUTY CYCLE 802.11n HT20 CDD 2TX MODE

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

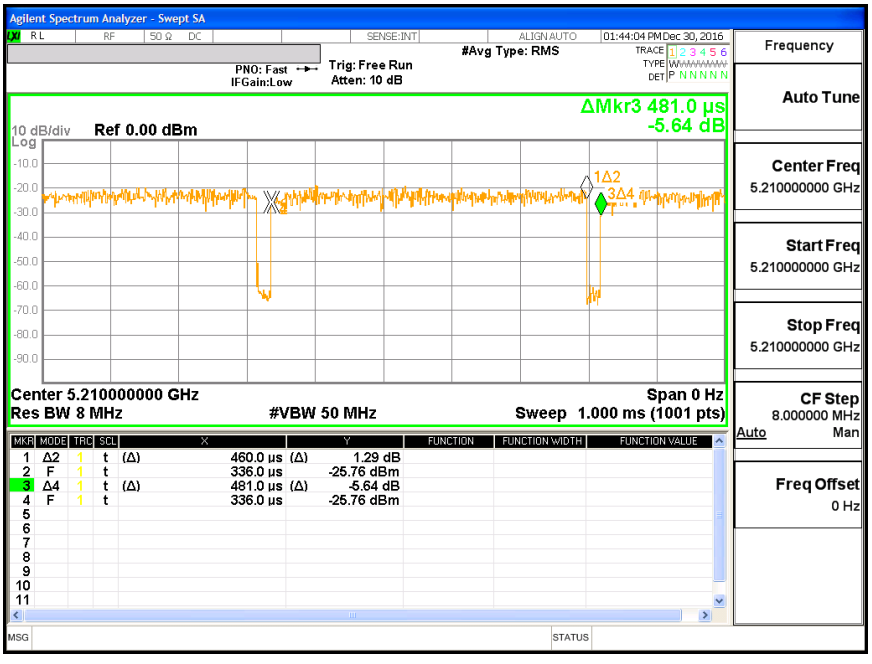
DUTY CYCLE 802.11n HT40 1TX MODE

DUTY CYCLE 802.11n HT40 CDD 2TX MODE

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

DUTY CYCLE 802.11ac VHT80 1TX MODE

DUTY CYCLE 802.11ac VHT80 CDD 2TX MODE



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

7.2. MEASUREMENT METHODS

6 dB Emission BW: KDB 789033 D02 v01r03, Section C.

26 dB Emission BW: KDB 789033 D02 v01r03, Section C.

99% Occupied BW: KDB 789033 D02 v01r03, Section D.

Conducted Output Power: KDB 789033 D02 v01r03, Section E.3.b (Method PM-G).

Power Spectral Density: KDB 789033 D02 v01r03, Section F (Method SA-2).

Unwanted emissions in restricted bands: KDB 789033 D02 v01r03, Sections G.3, G.4, G.5, and G.6.

Unwanted emissions in non-restricted bands: KDB 789033 D02 v01r03, Sections G.3, G.4, and G.5.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8. ANTENNA PORT TEST RESULTS

8.1. 802.11n HT20 ANTENNA A MODE IN THE 5.2 GHz BAND

8.1.1. 26 dB BANDWIDTH

LIMITS

None; for reporting purposes only.

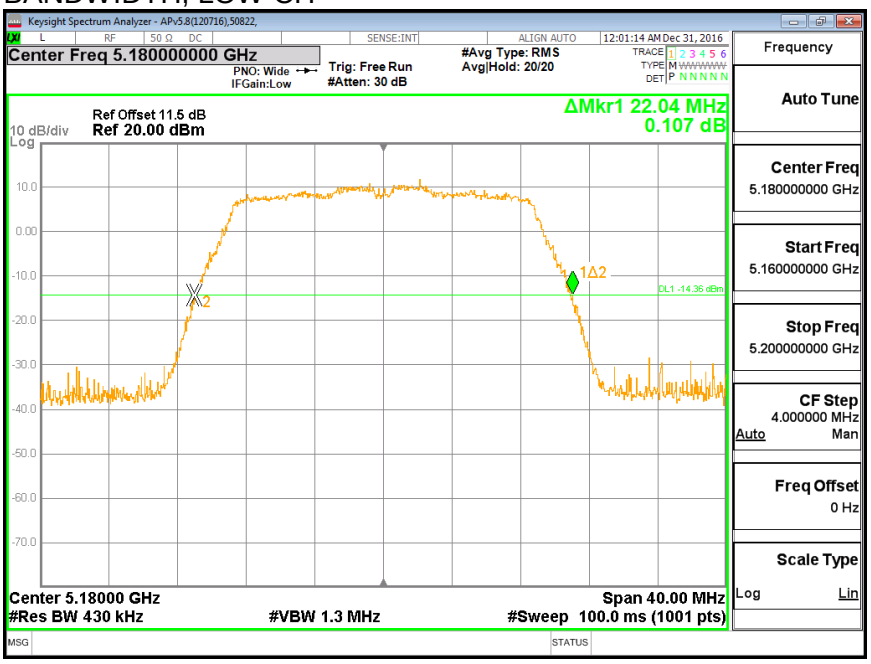
RESULTS

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5180	22.04
Mid	5200	22.12
High	5240	22.04

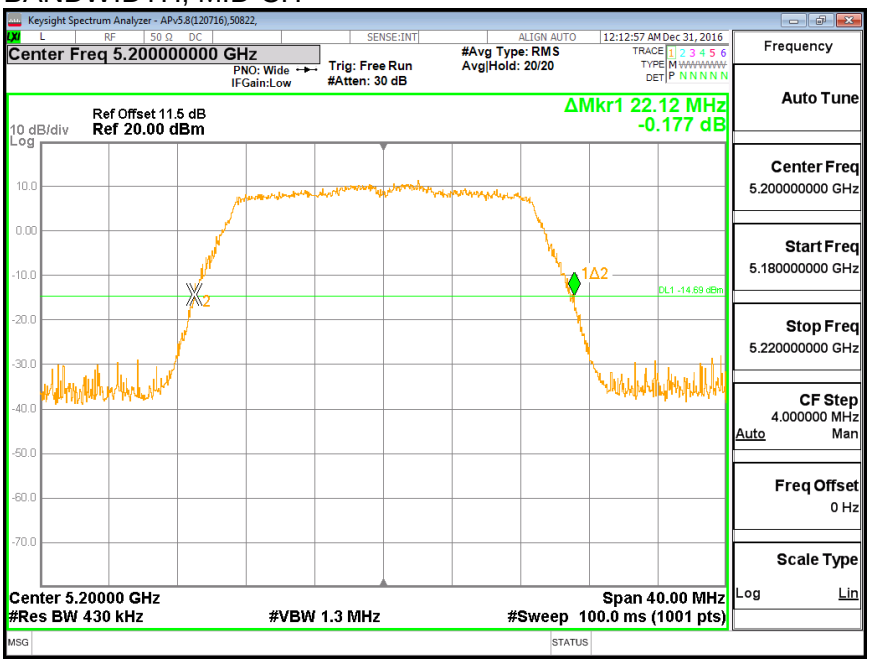
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

26 dB BANDWIDTH

BANDWIDTH, LOW CH

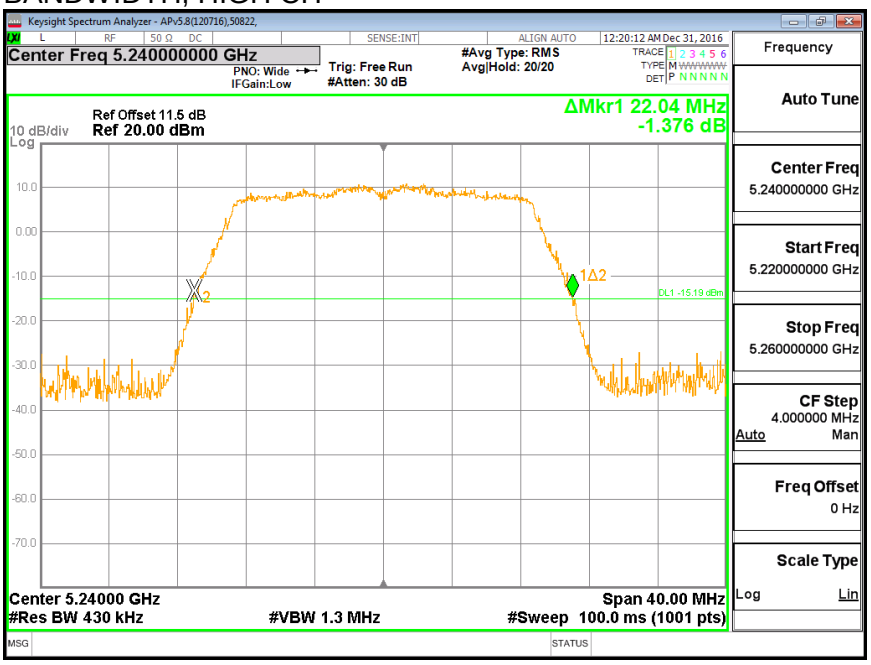


BANDWIDTH, MID CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

BANDWIDTH, HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.1.2. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

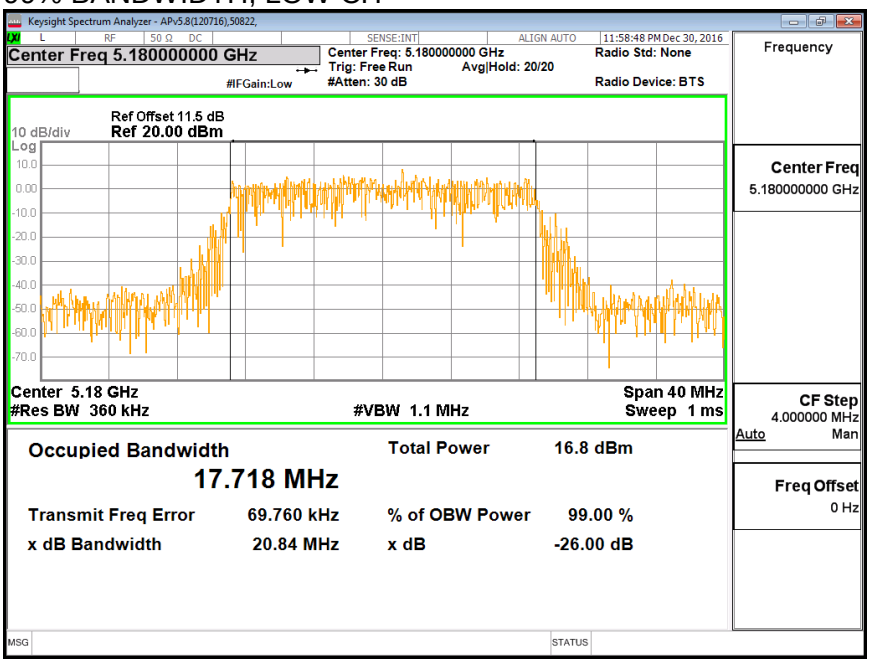
RESULTS

Channel	Frequency (MHz)	99% BW (MHz)
Low	5180	17.718
Mid	5200	17.754
High	5240	17.782

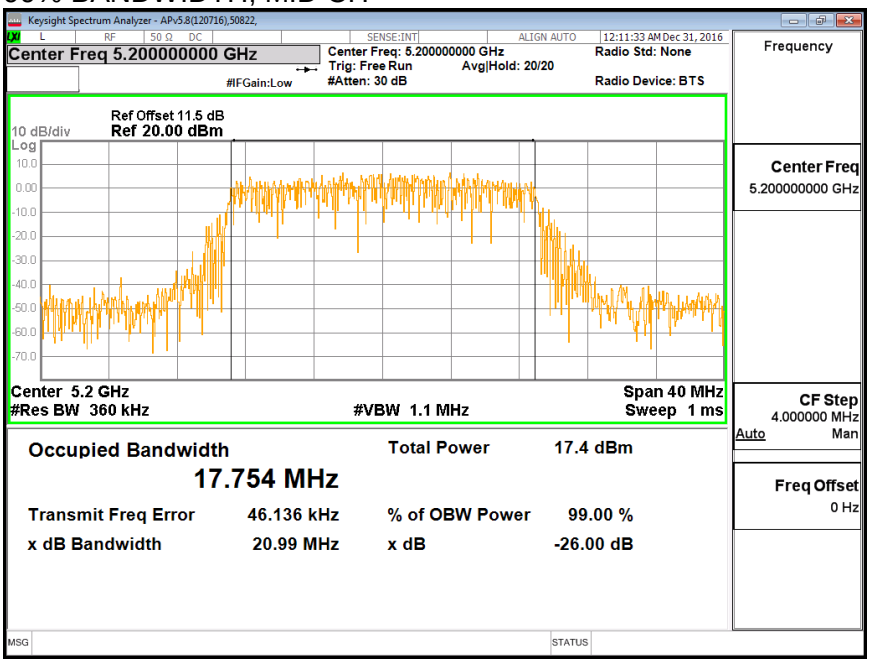
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

99% BANDWIDTH

99% BANDWIDTH, LOW CH

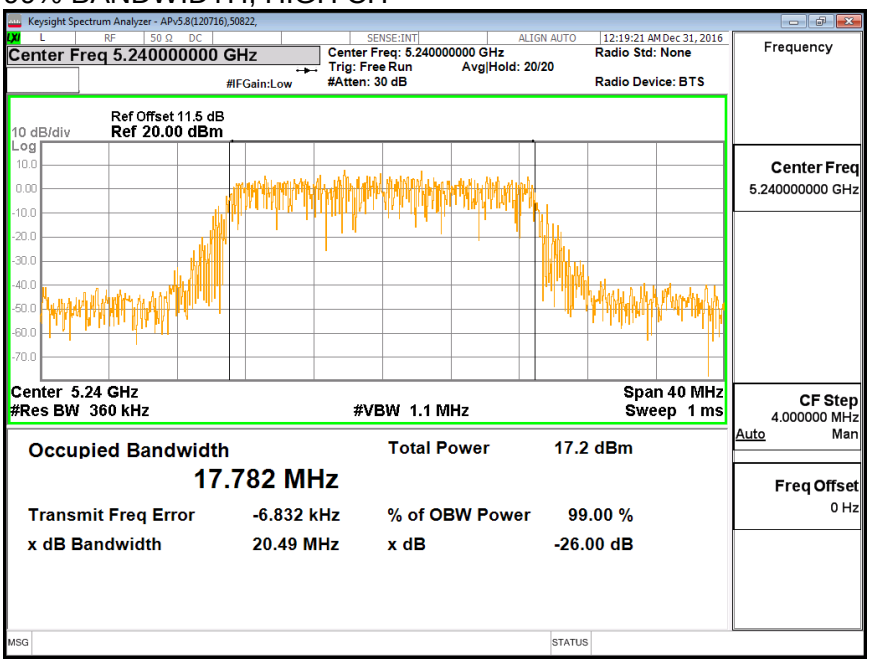


99% BANDWIDTH, MID CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

99% BANDWIDTH, HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.1.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

Measurements perform using a wideband gated RF power meter.

RESULTS

ID:	45256	Date:	1/20/17

Channel	Frequency (MHz)	Power (dBm)
Low	5180	15.96
Mid	5200	16.44
High	5240	16.30

UL VERIFICATION SERVICES INC. FORM NO: CCSUP4701J
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 771-1000 FAX: (510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.1.4. OUTPUT POWER AND PSD

LIMITS

FCC §15.407 (a) (1)

(i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

(ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

(iv) For mobile and portable client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

TEST PROCEDURE

Measurements perform using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.

DIRECTIONAL ANTENNA GAIN

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

RESULTS

ID:	45256	Date:	1/20/17

Antenna Gain and Limits

Channel	Frequency (MHz)	Directional Gain for Power (dBi)	Directional Gain for PSD (dBi)	Power Limit (dBm)	PSD Limit (dBm)
Low	5180	1.66	1.66	24.00	11.00
Mid	5200	1.66	1.66	24.00	11.00
High	5240	1.66	1.66	24.00	11.00

Duty Cycle CF (dB)	0.00	Included in Calculations of Corr'd PSD

Output Power Results

Channel	Frequency (MHz)	Ant A Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5180	15.96	15.96	24.00	-8.04
Mid	5200	16.44	16.44	24.00	-7.56
High	5240	16.30	16.30	24.00	-7.70

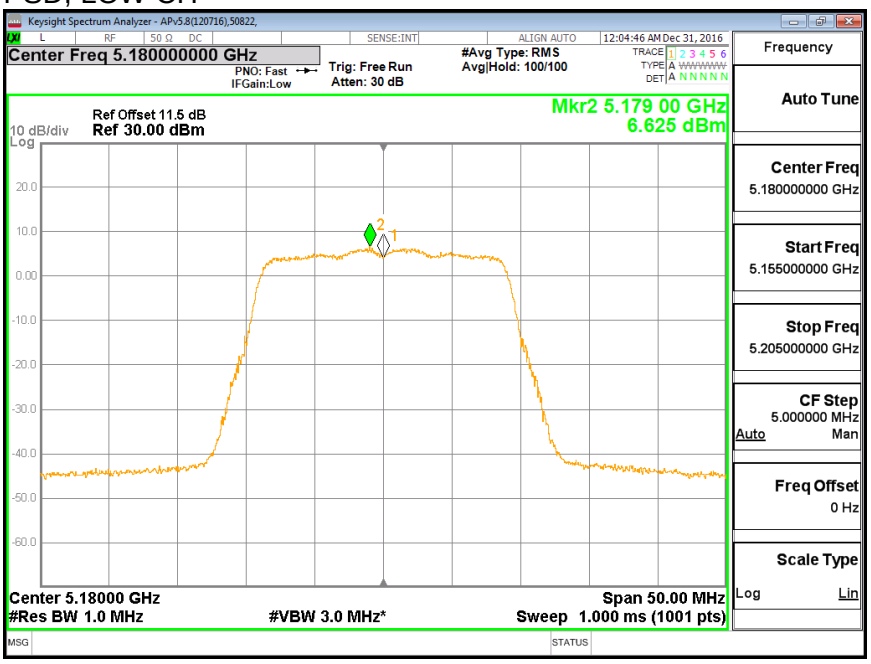
PSD Results

Channel	Frequency (MHz)	Ant A Meas PSD (dBm)	Total Corr'd PSD (dBm)	PSD Limit (dBm)	PSD Margin (dB)
Low	5180	6.63	6.63	11.00	-4.38
Mid	5200	6.44	6.44	11.00	-4.56
High	5240	6.46	6.46	11.00	-4.54

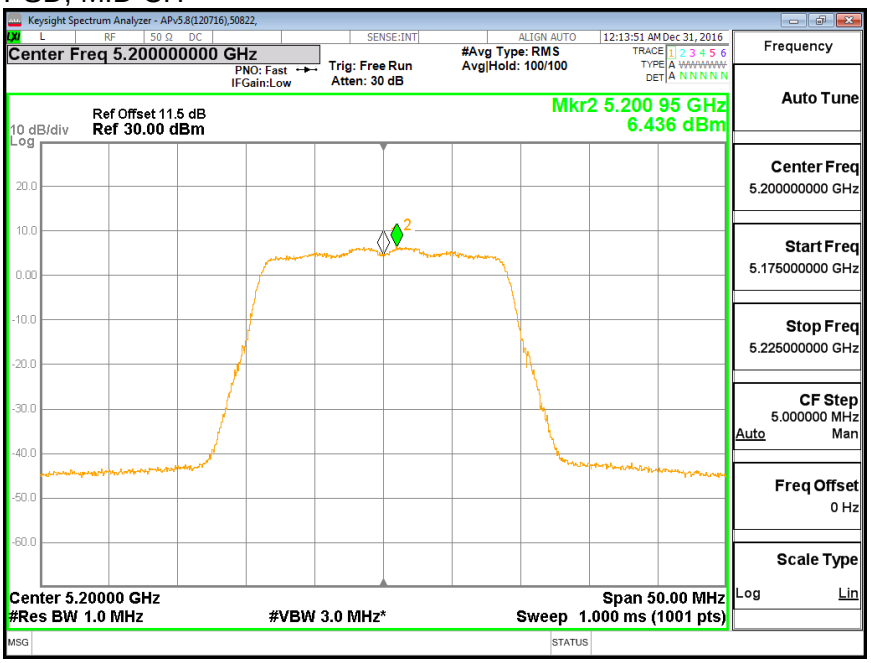
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

PSD

PSD, LOW CH

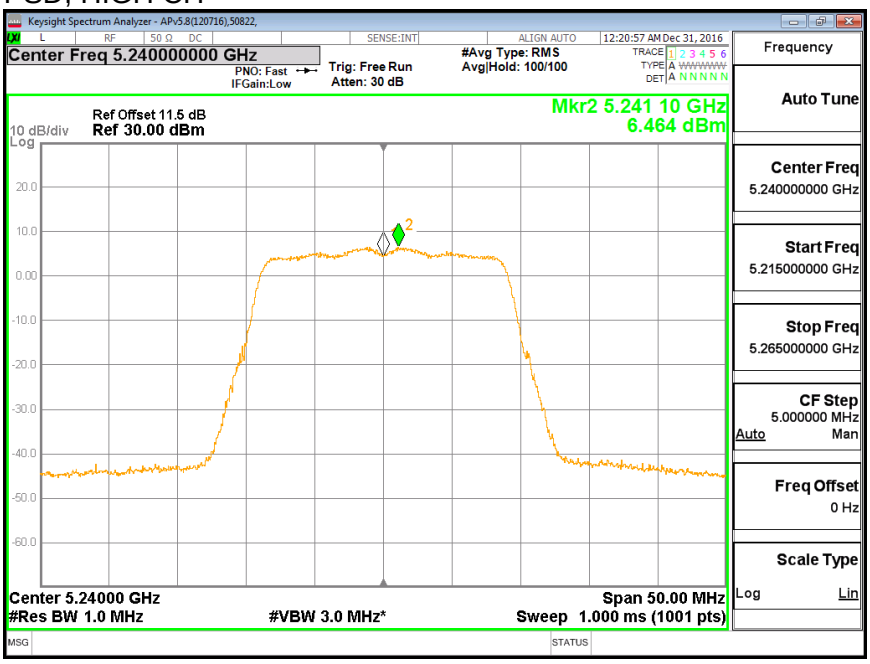


PSD, MID CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

PSD, HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.2. 802.11n HT20 ANTENNA B MODE IN THE 5.2 GHz BAND

8.2.1. 26 dB BANDWIDTH

LIMITS

None; for reporting purposes only.

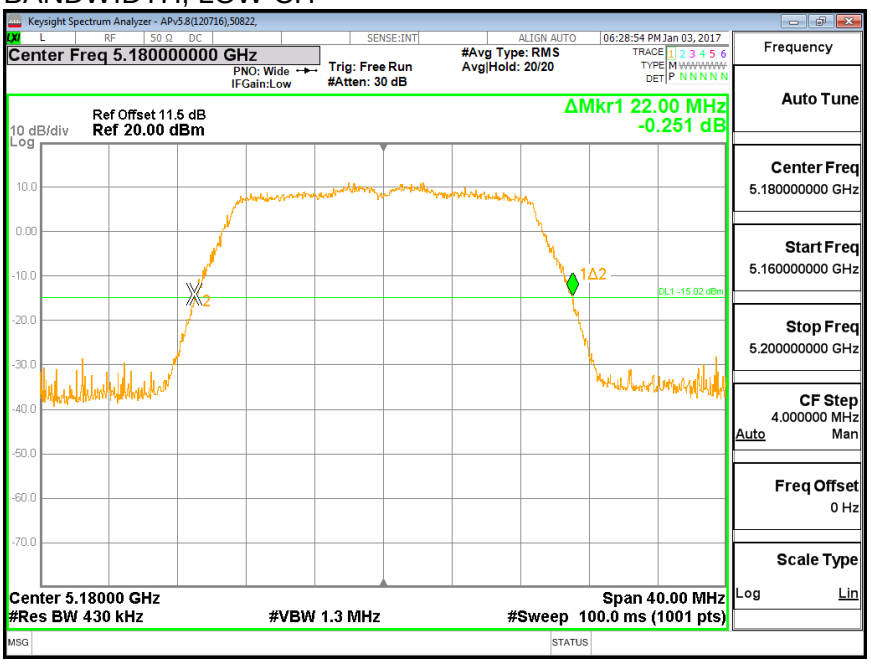
RESULTS

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5180	22.00
Mid	5200	21.84
High	5240	22.12

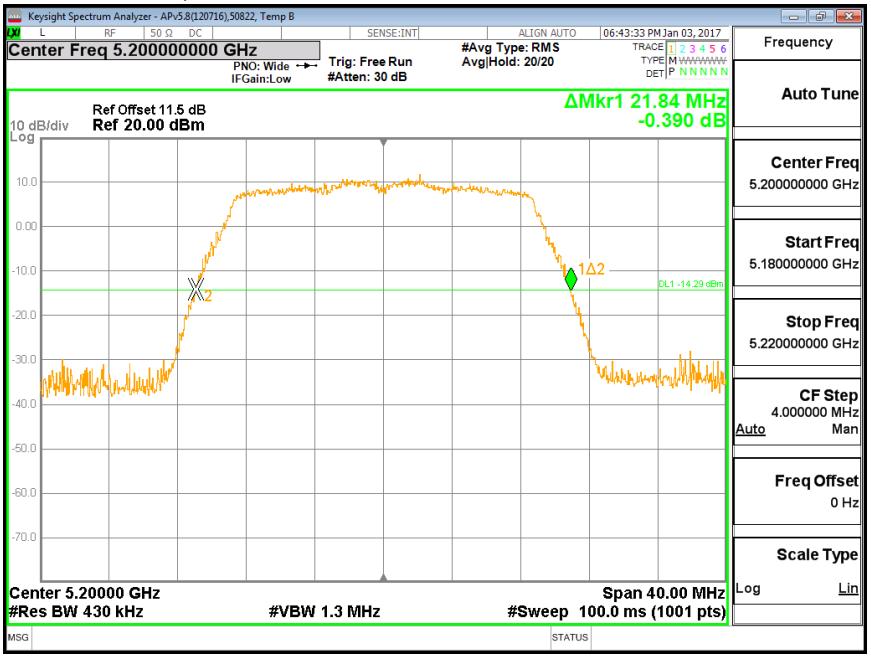
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

26 dB BANDWIDTH

BANDWIDTH, LOW CH

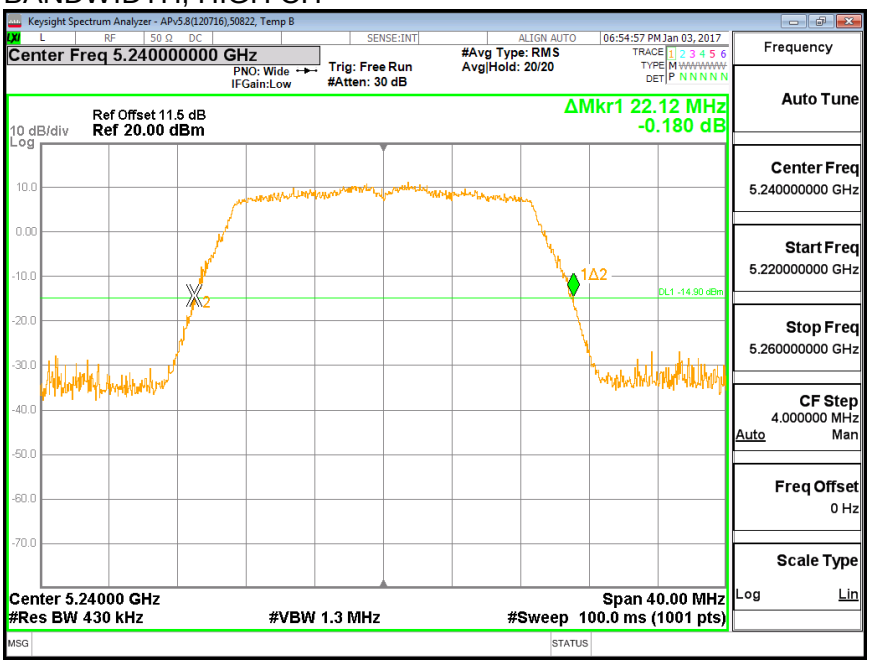


BANDWIDTH, MID CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

BANDWIDTH, HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.2.2. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

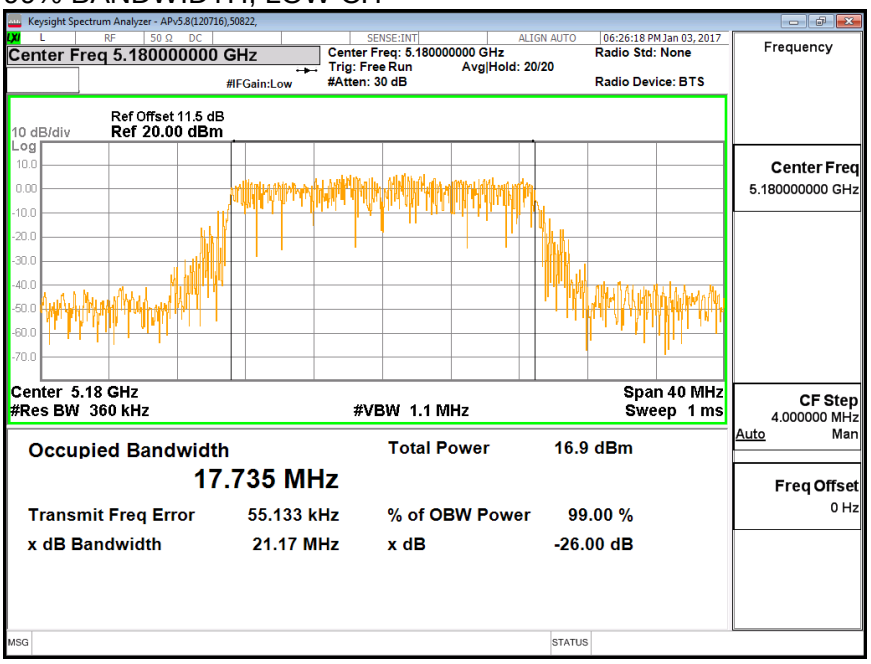
RESULTS

Channel	Frequency (MHz)	99% BW (MHz)
Low	5180	17.735
Mid	5200	17.654
High	5240	17.670

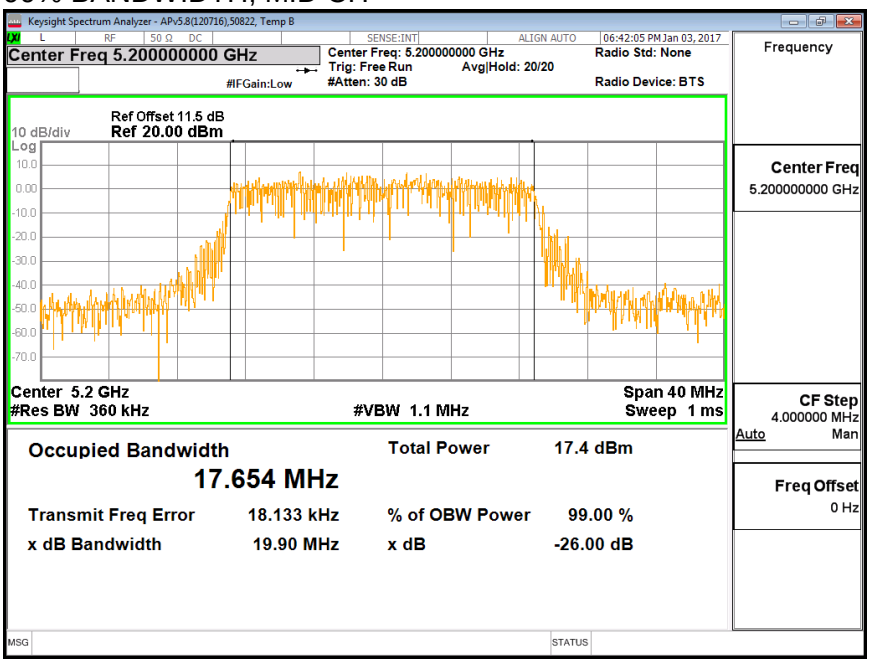
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

99% BANDWIDTH

99% BANDWIDTH, LOW CH

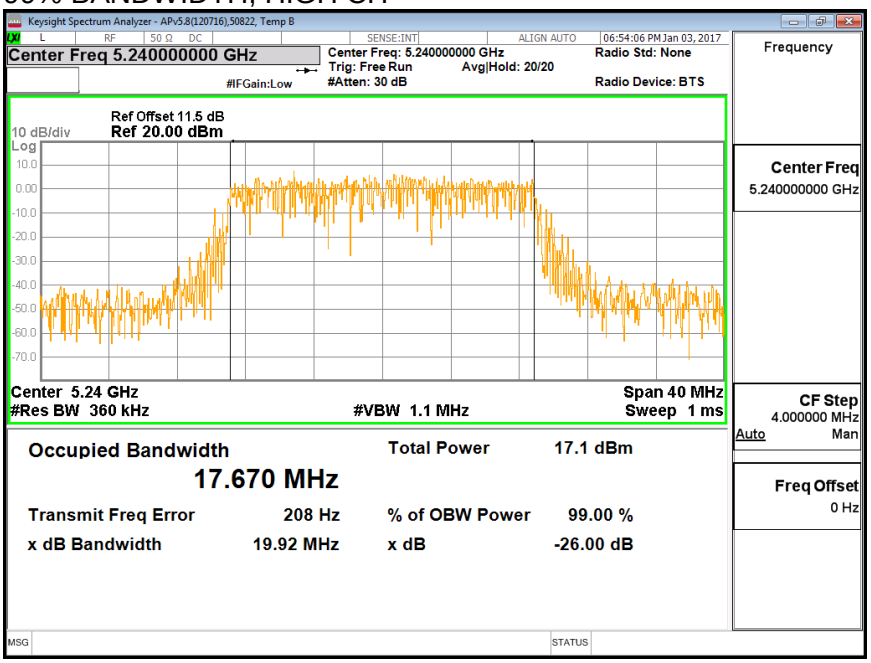


99% BANDWIDTH, MID CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

99% BANDWIDTH, HIGH CH



UL VERIFICATION SERVICES INC. FORM NO: CCSUP4701J
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 771-1000 FAX: (510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.2.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

Measurements perform using a wideband gated RF power meter.

RESULTS

ID:	45256	Date:	1/20/17

Channel	Frequency (MHz)	Power (dBm)
Low	5180	15.84
Mid	5200	16.79
High	5240	17.00

UL VERIFICATION SERVICES INC. FORM NO: CCSUP4701J
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 771-1000 FAX: (510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.2.4. OUTPUT POWER AND PSD

LIMITS

FCC §15.407 (a) (1)

(i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

(ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

(iv) For mobile and portable client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

TEST PROCEDURE

Measurements perform using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.

DIRECTIONAL ANTENNA GAIN

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

RESULTS

ID:	45256	Date:	1/20/17

Antenna Gain and Limits

Channel	Frequency (MHz)	Directional Gain for Power (dBi)	Directional Gain for PSD (dBi)	Power Limit (dBm)	PSD Limit (dBm)
Low	5180	2.65	2.65	24.00	11.00
Mid	5200	2.65	2.65	24.00	11.00
High	5240	2.65	2.65	24.00	11.00

Duty Cycle CF (dB)	0.00	Included in Calculations of Corr'd PSD

Output Power Results

Channel	Frequency (MHz)	Ant B Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5180	15.84	15.84	24.00	-8.16
Mid	5200	16.79	16.79	24.00	-7.21
High	5240	17.00	17.00	24.00	-7.00

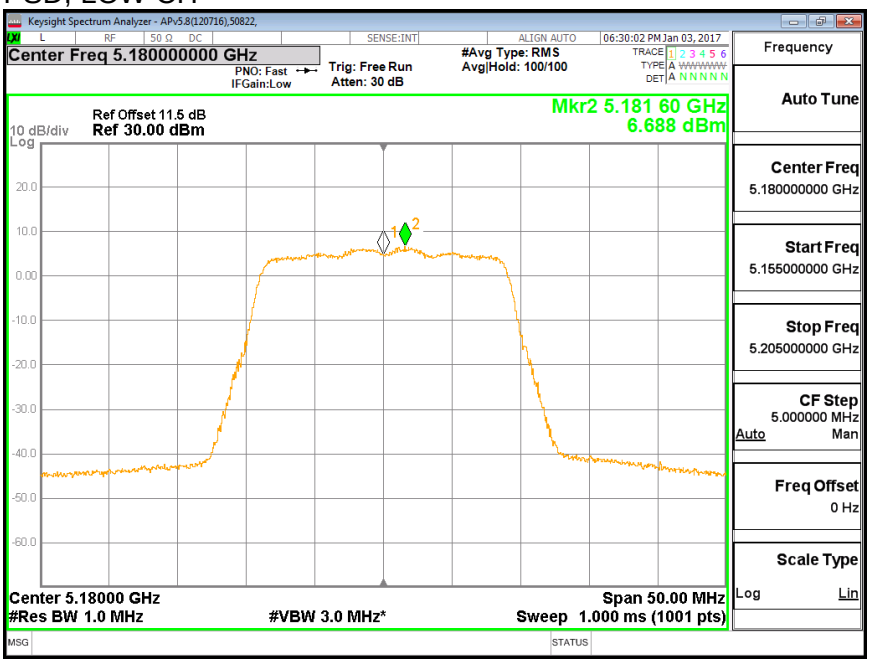
PSD Results

Channel	Frequency (MHz)	Ant B Meas PSD (dBm)	Total Corr'd PSD (dBm)	PSD Limit (dBm)	PSD Margin (dB)
Low	5180	6.69	6.69	11.00	-4.31
Mid	5200	6.62	6.62	11.00	-4.39
High	5240	6.41	6.41	11.00	-4.59

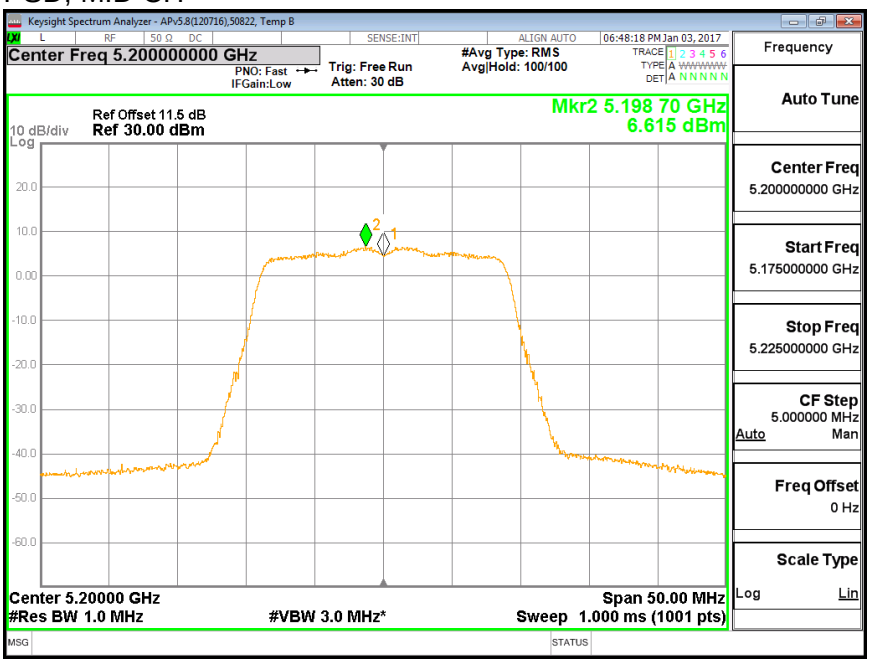
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

PSD

PSD, LOW CH

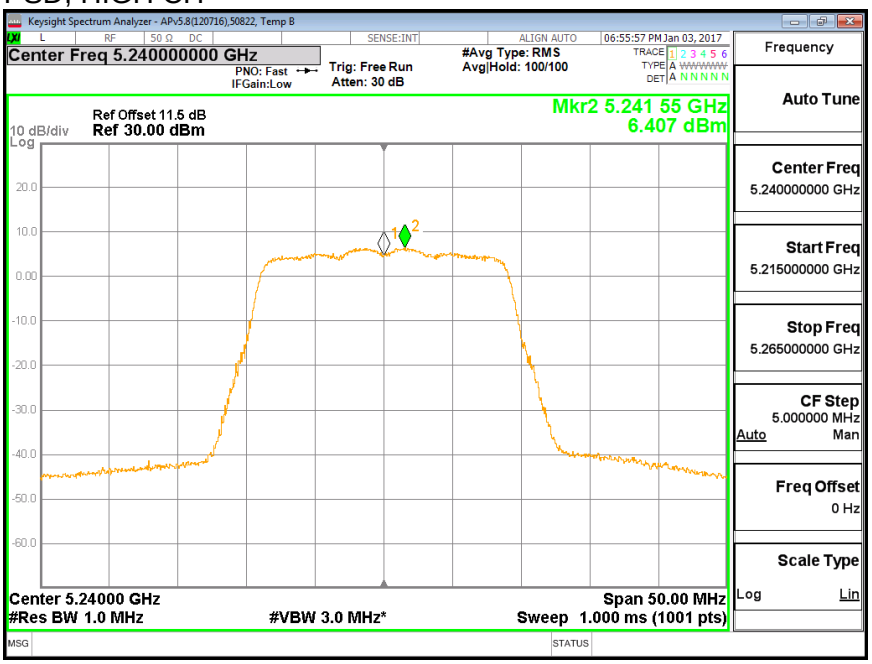


PSD, MID CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

PSD, HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.3. 802.11n HT20 2Tx (ANTENNA A + ANTENNA B) CDD MODE IN THE 5.2 GHz BAND

8.3.1. 26 dB BANDWIDTH

LIMITS

None; for reporting purposes only.

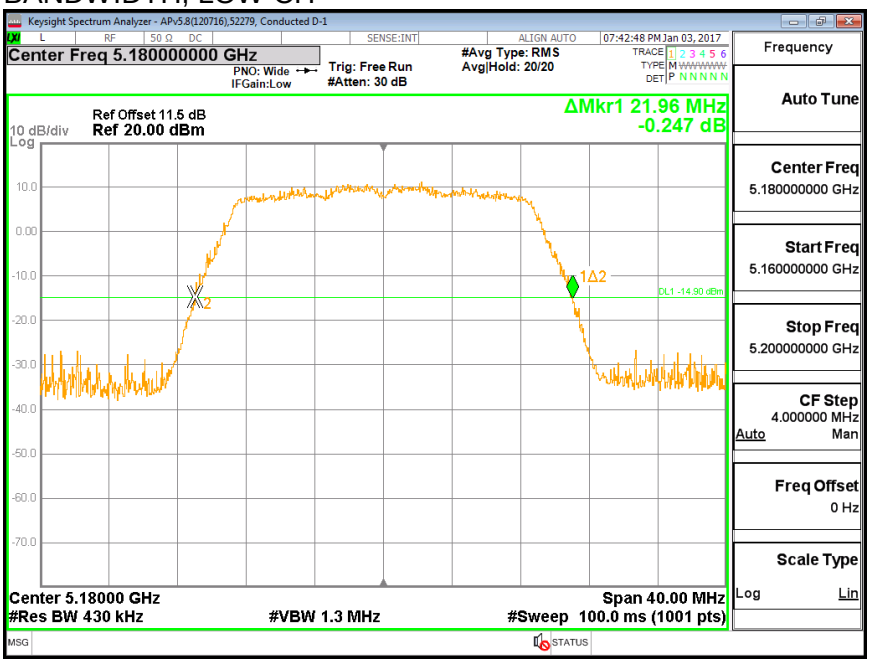
RESULTS

Channel	Frequency (MHz)	26 dB BW Ant A (MHz)	26 dB BW Ant B (MHz)
Low	5180	21.96	21.56
Mid	5200	21.96	21.60
High	5240	22.04	21.56

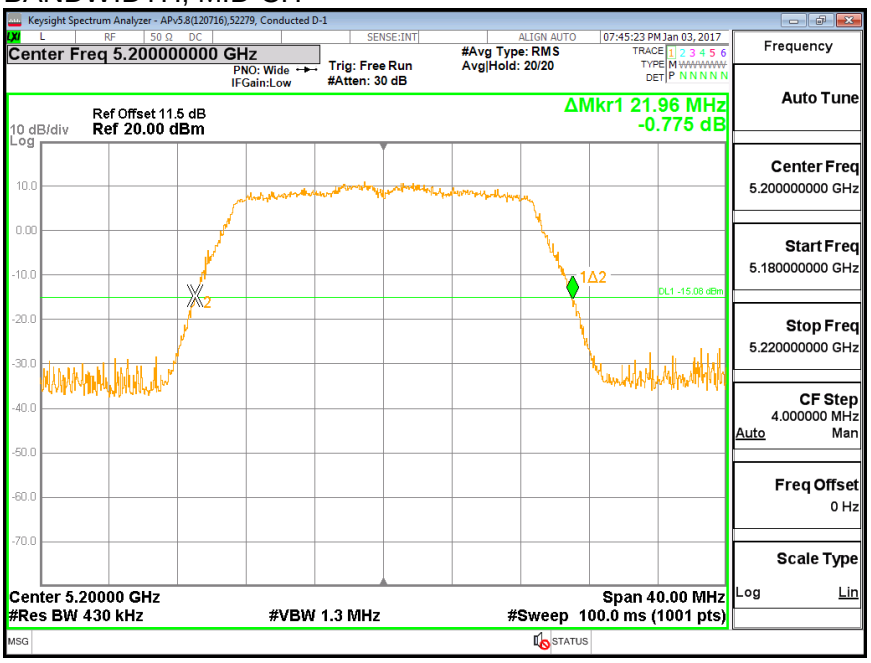
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

26 DB BANDWIDTH, ANTENNA A

BANDWIDTH, LOW CH

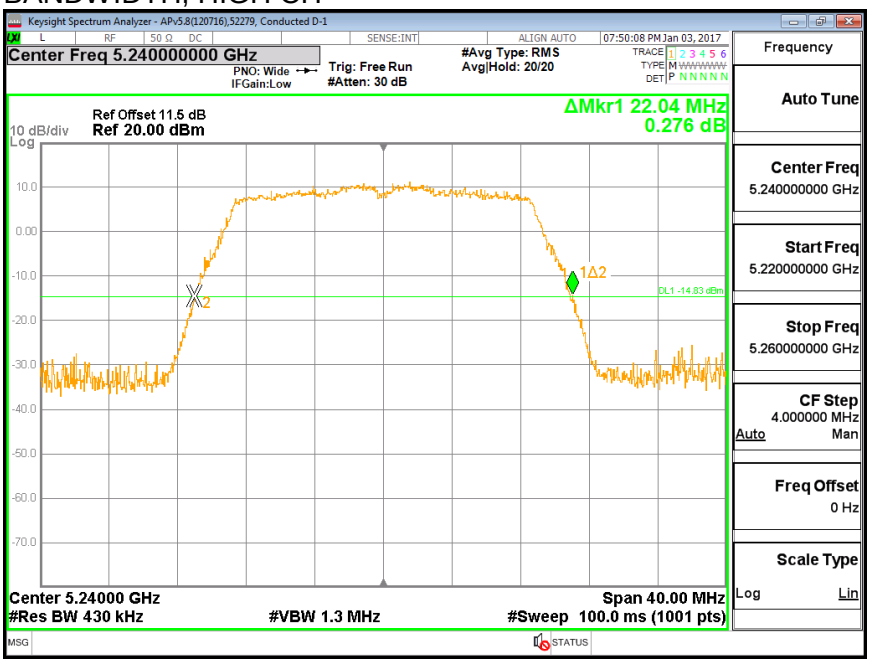


BANDWIDTH, MID CH



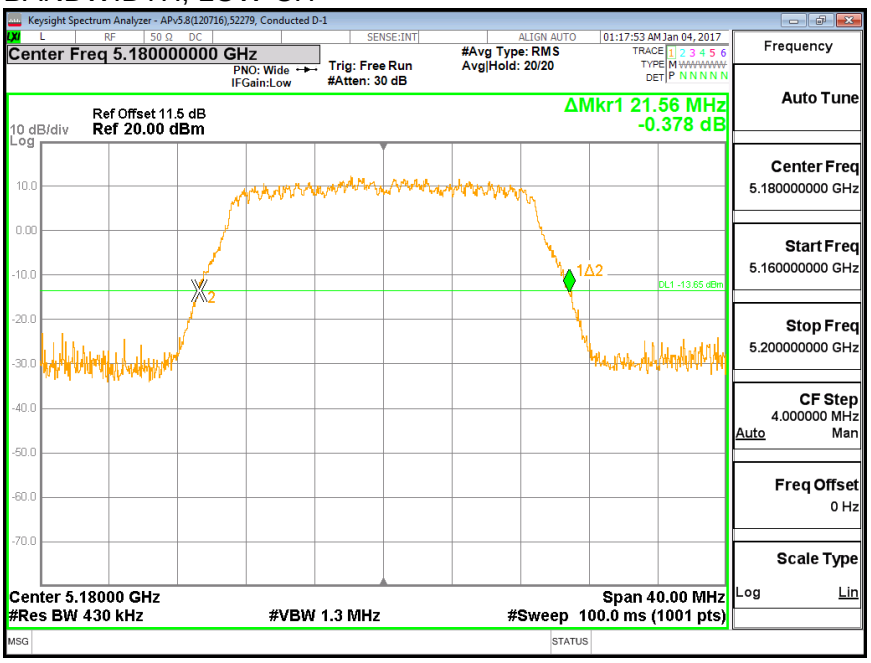
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

BANDWIDTH, HIGH CH



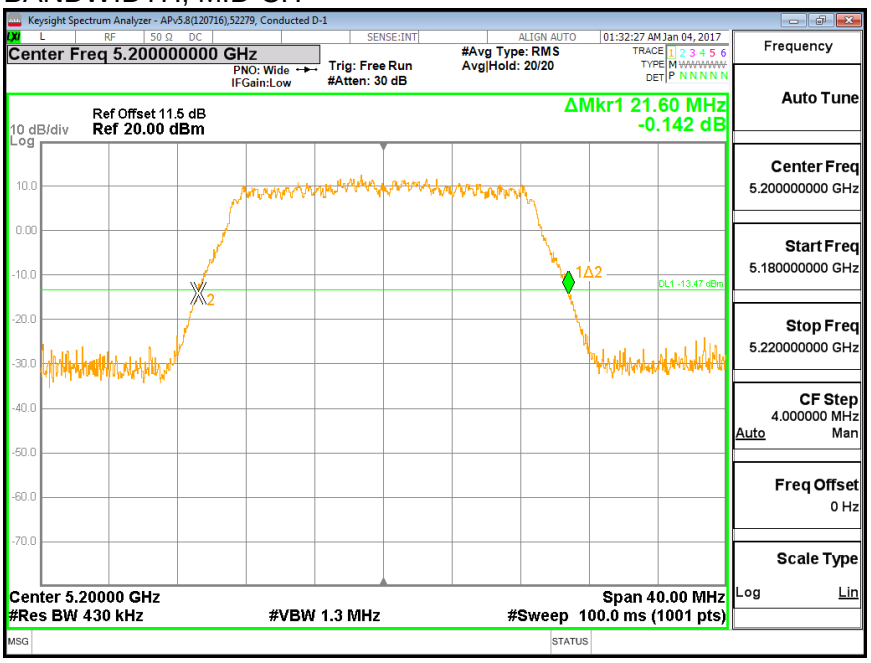
26 DB BANDWIDTH, ANTENNA B

BANDWIDTH, LOW CH

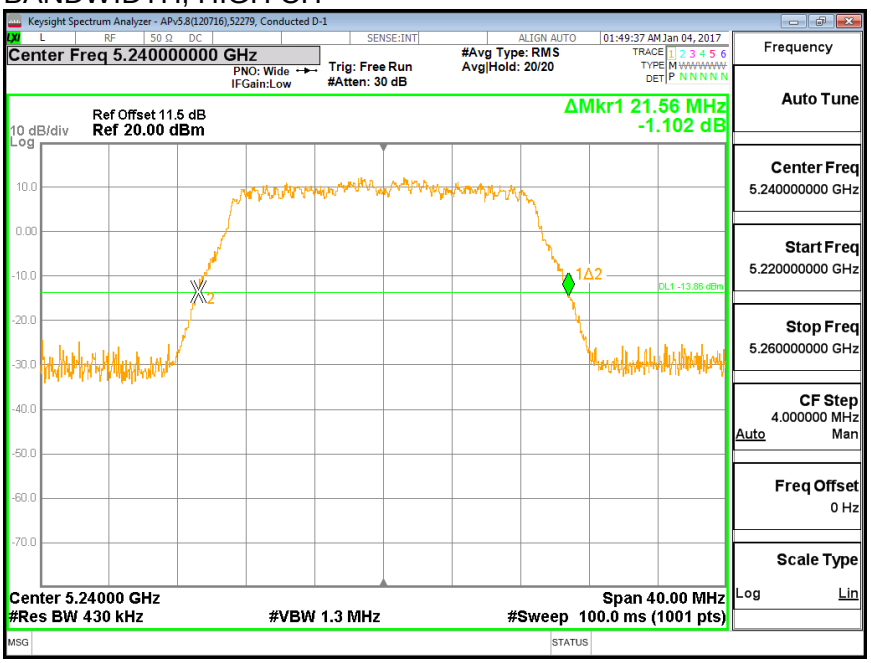


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

BANDWIDTH, MID CH



BANDWIDTH, HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.3.2. 99% BANDWIDTH

LIMITS

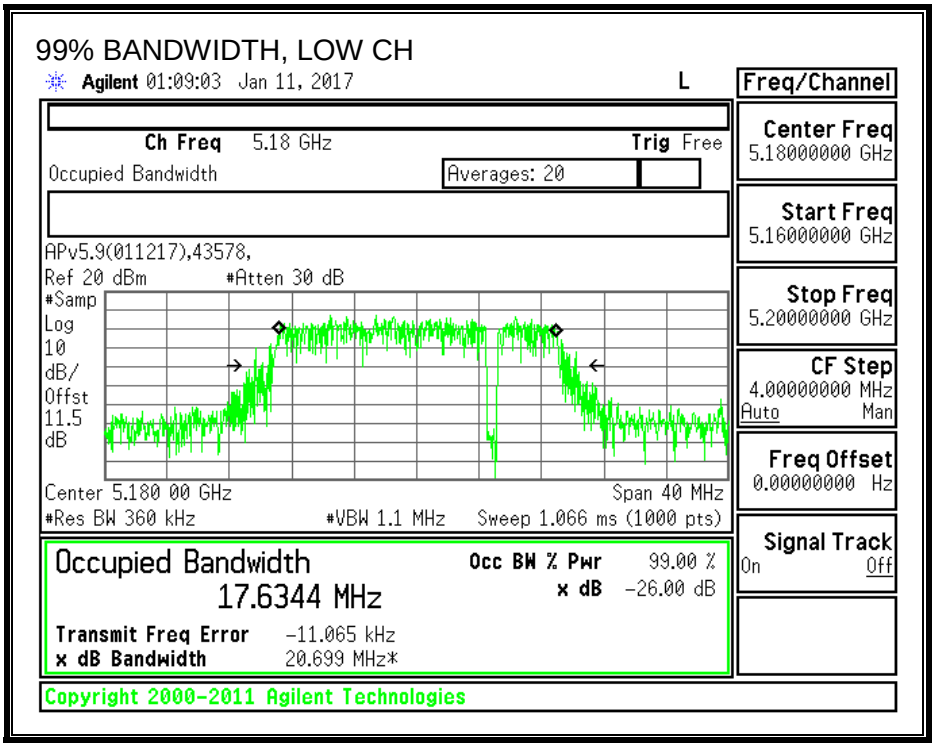
None; for reporting purposes only.

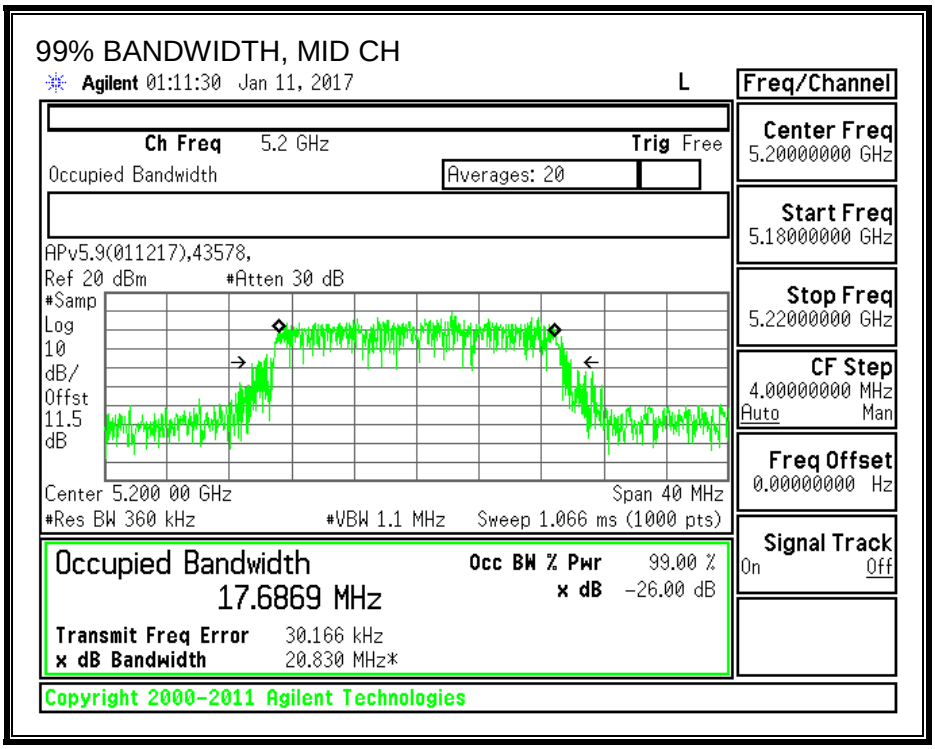
RESULTS

Channel	Frequency (MHz)	99% BW Ant A (MHz)	99% BW Ant B (MHz)
Low	5180	17.634	17.624
Mid	5200	17.687	17.807
High	5240	17.721	17.708

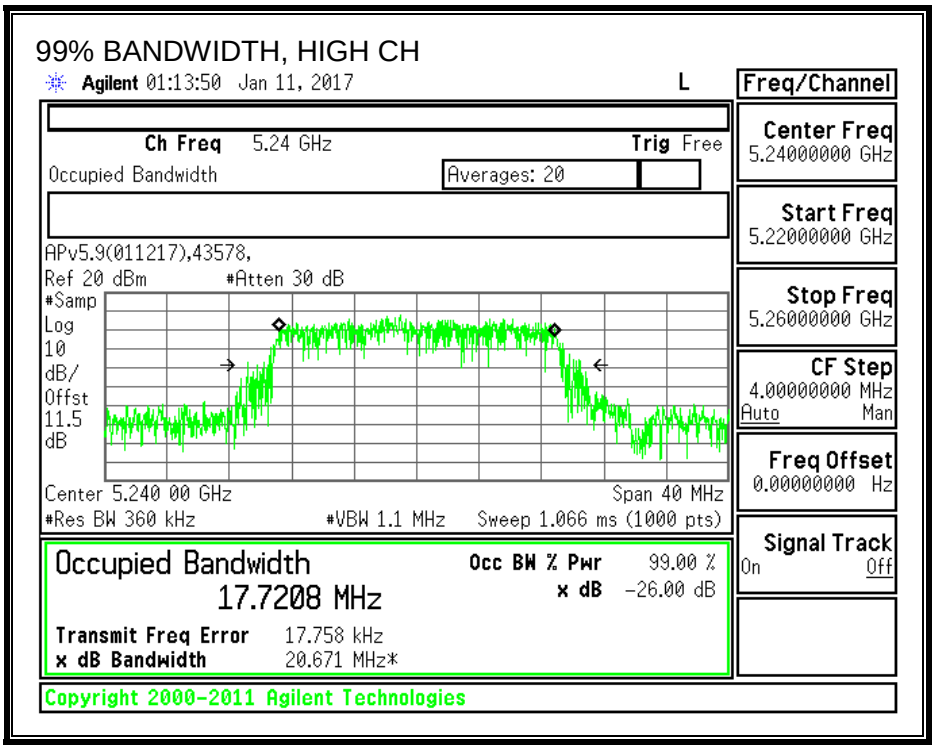
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

99% BANDWIDTH, ANTENNA A

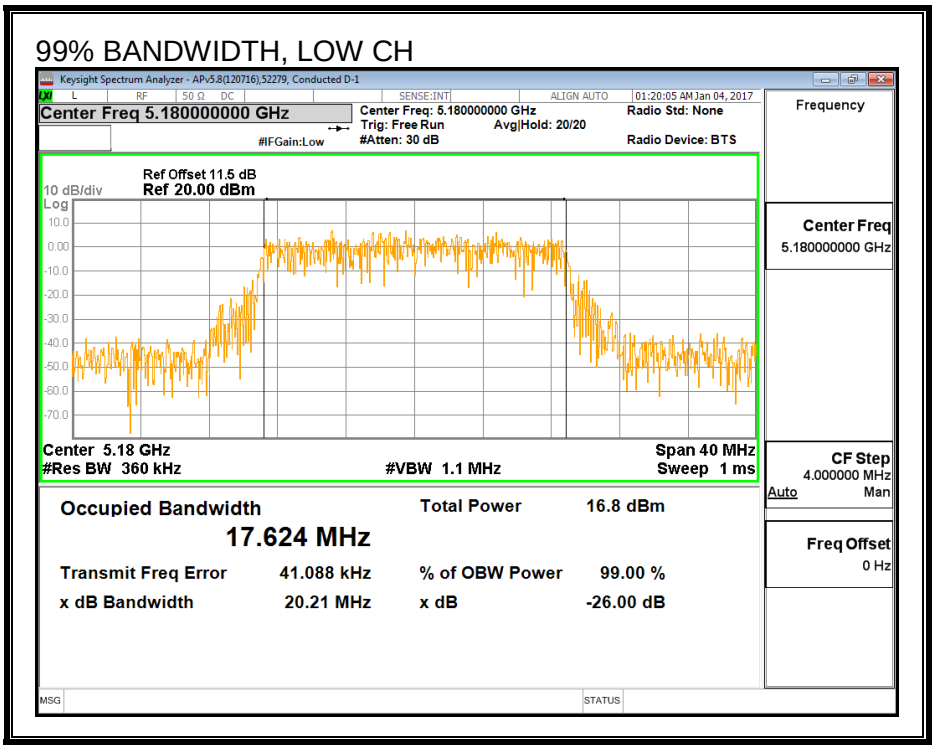




This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

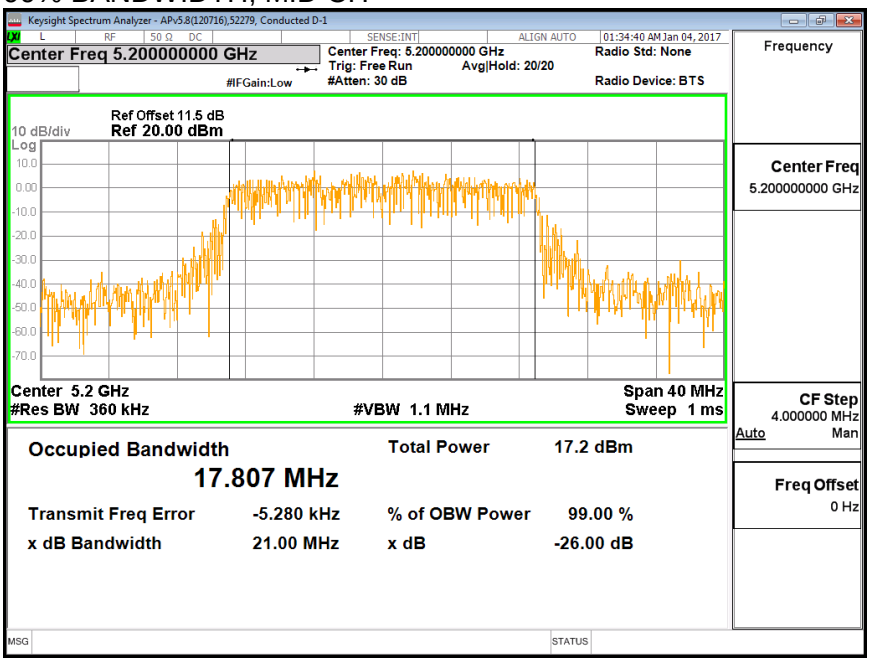


99% BANDWIDTH, ANTENNA B

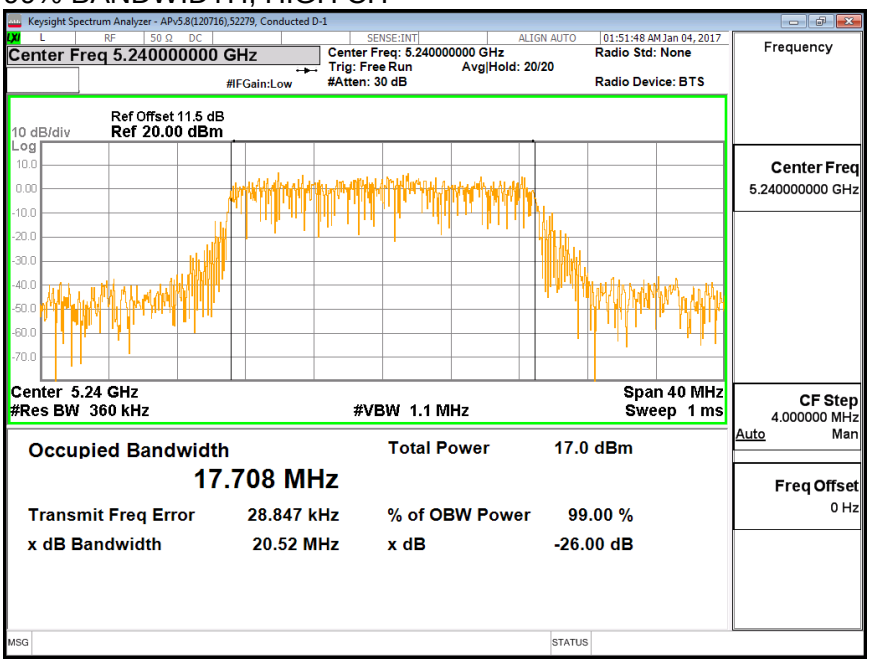


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

99% BANDWIDTH, MID CH



99% BANDWIDTH, HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.3.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

Measurements perform using a wideband gated RF power meter.

RESULTS

ID:	45256	Date:	1/20/17

Average Power Results

Channel	Frequency (MHz)	Ant A Power (dBm)	Ant B Power (dBm)	Total Power (dBm)
Low	5180	14.97	14.77	17.88
Mid	5200	16.44	16.50	19.48
High	5240	16.42	16.30	19.37

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.3.4. OUTPUT POWER AND PSD

LIMITS

FCC §15.407 (a) (1)

(i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

(ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

(iv) For mobile and portable client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

TEST PROCEDURE

Measurements perform using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

DIRECTIONAL ANTENNA GAIN

The TX chains are uncorrelated and the antenna gain is unequal among the chains. The directional gain is:

Ant A Antenna Gain (dBi)	Ant B Antenna Gain (dBi)	Uncorrelated Chains Directional Gain (dBi)
1.66	2.65	2.18

The TX chains are correlated and the antenna gain is unequal among the chains. The directional gain is:

Ant A Antenna Gain (dBi)	Ant B Antenna Gain (dBi)	Correlated Chains Directional Gain (dBi)
1.66	2.65	5.18

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

RESULTS

ID:	45256	Date:	1/20/17

Antenna Gain and Limits

Channel	Frequency (MHz)	Directional Gain for Power (dBi)	Directional Gain for PSD (dBi)	Power Limit (dBm)	PSD Limit (dBm)
Low	5180	2.18	5.18	24.00	11.00
Mid	5200	2.18	5.18	24.00	11.00
High	5240	2.18	5.18	24.00	11.00

Duty Cycle CF (dB)	0.00	Included in Calculations of Corr'd PSD

Output Power Results

Channel	Frequency (MHz)	Ant A Meas Power (dBm)	Ant B Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5180	14.97	14.77	17.88	24.00	-6.12
Mid	5200	16.44	16.50	19.48	24.00	-4.52
High	5240	16.42	16.30	19.37	24.00	-4.63

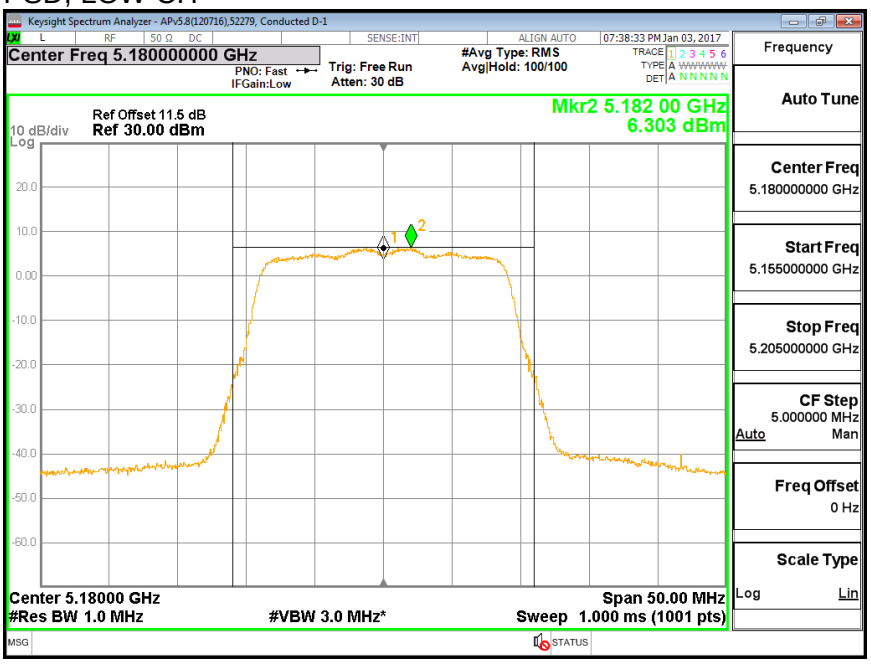
PSD Results

Channel	Frequency (MHz)	Ant A Meas PSD (dBm)	Ant B Meas PSD (dBm)	Total Corr'd PSD (dBm)	PSD Limit (dBm)	PSD Margin (dB)
Low	5180	6.30	6.30	9.31	11.00	-1.69
Mid	5200	6.44	6.29	9.38	11.00	-1.62
High	5240	6.37	6.33	9.36	11.00	-1.64

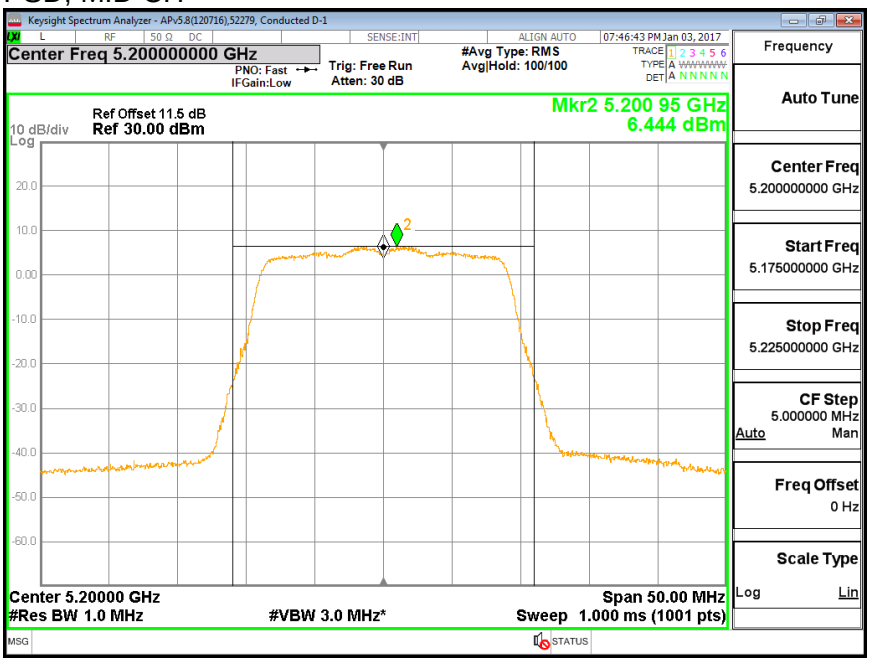
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

PSD, ANTENNA A

PSD, LOW CH

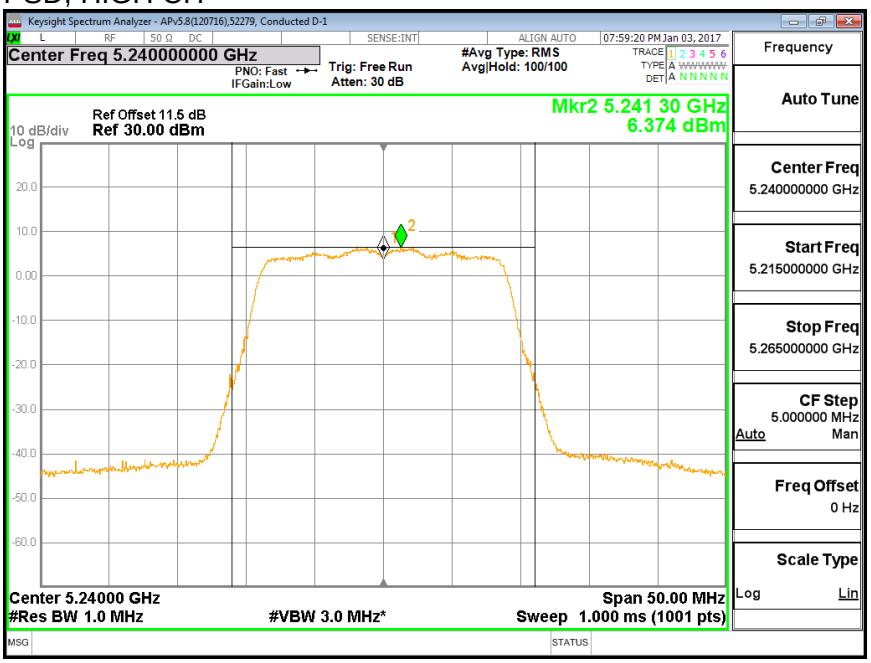


PSD, MID CH



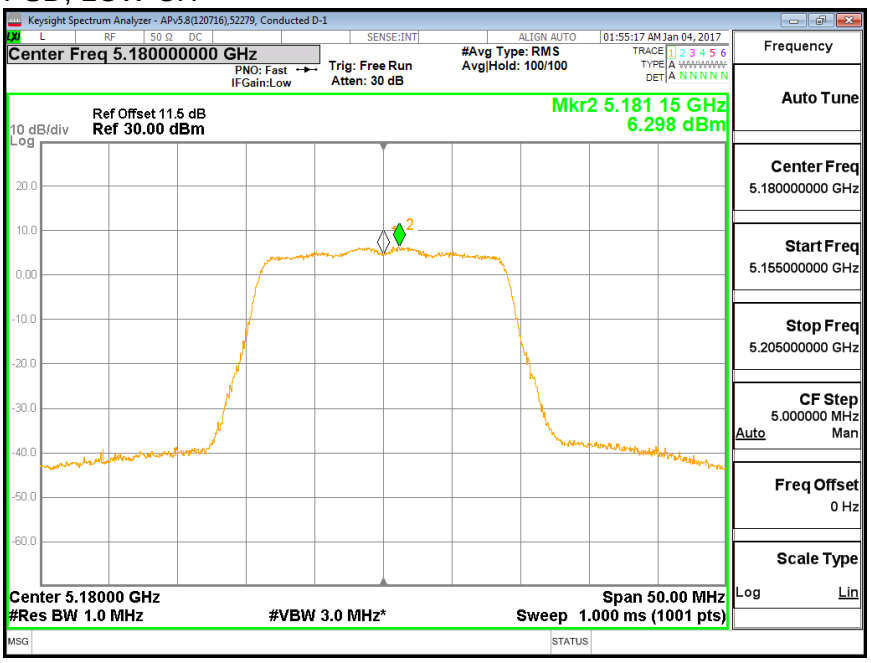
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

PSD, HIGH CH



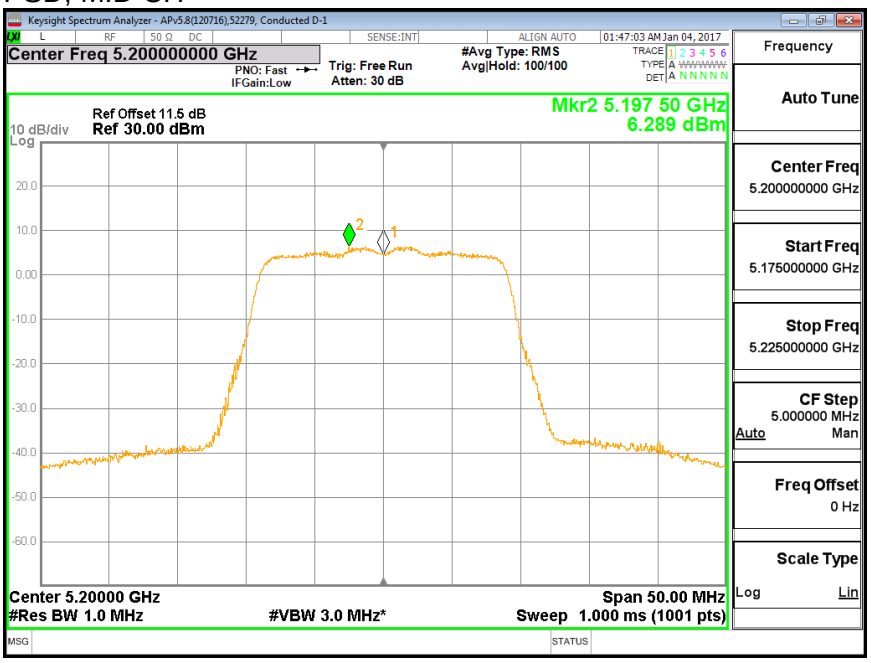
PSD, ANTENNA B

PSD, LOW CH

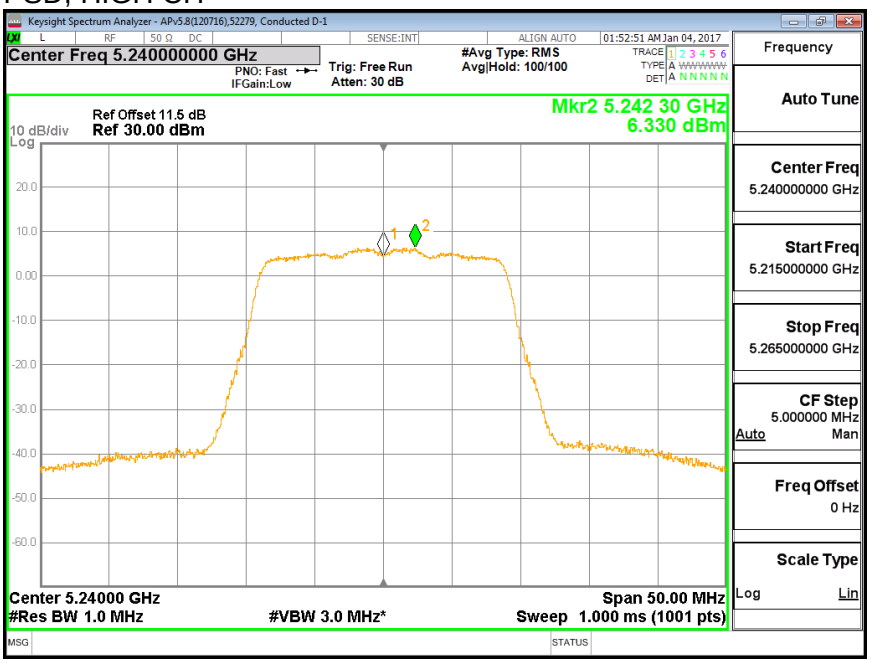


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

PSD, MID CH



PSD, HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.4. 802.11n HT20 2Tx (ANTENNA A + ANTENNA B) STBC MODE IN THE 5.2 GHz BAND

8.4.1. 26 dB BANDWIDTH

LIMITS

None; for reporting purposes only.

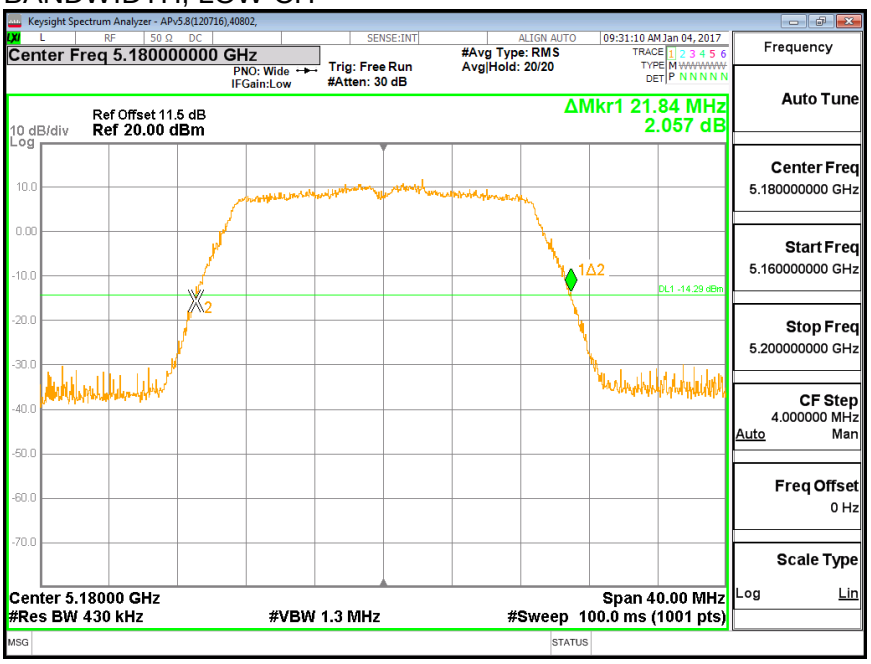
RESULTS

Channel	Frequency (MHz)	26 dB BW Ant A (MHz)	26 dB BW Ant B (MHz)
Low	5180	21.84	21.68
Mid	5200	21.88	21.72
High	5240	21.96	21.64

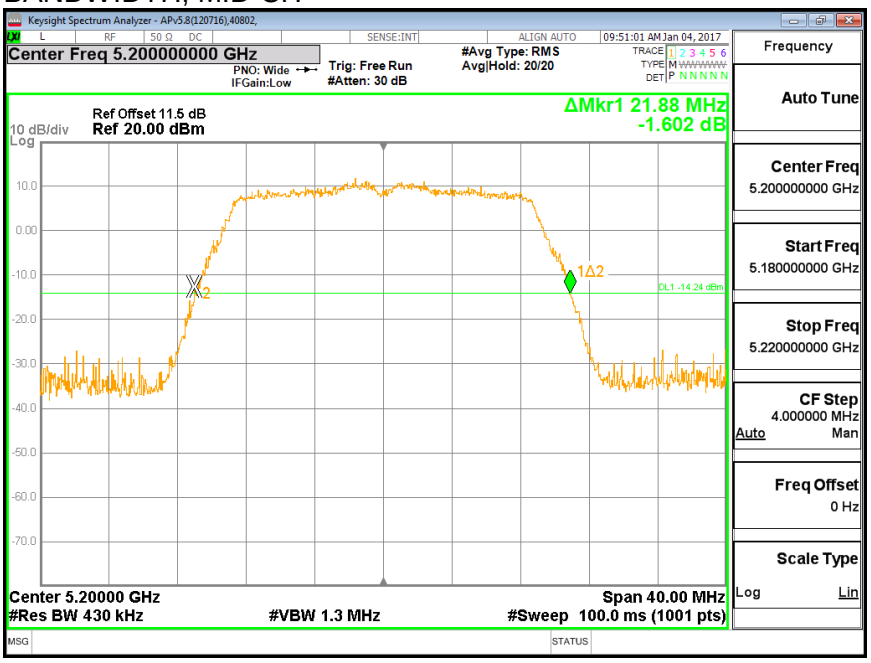
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

26 DB BANDWIDTH, ANTENNA A

BANDWIDTH, LOW CH

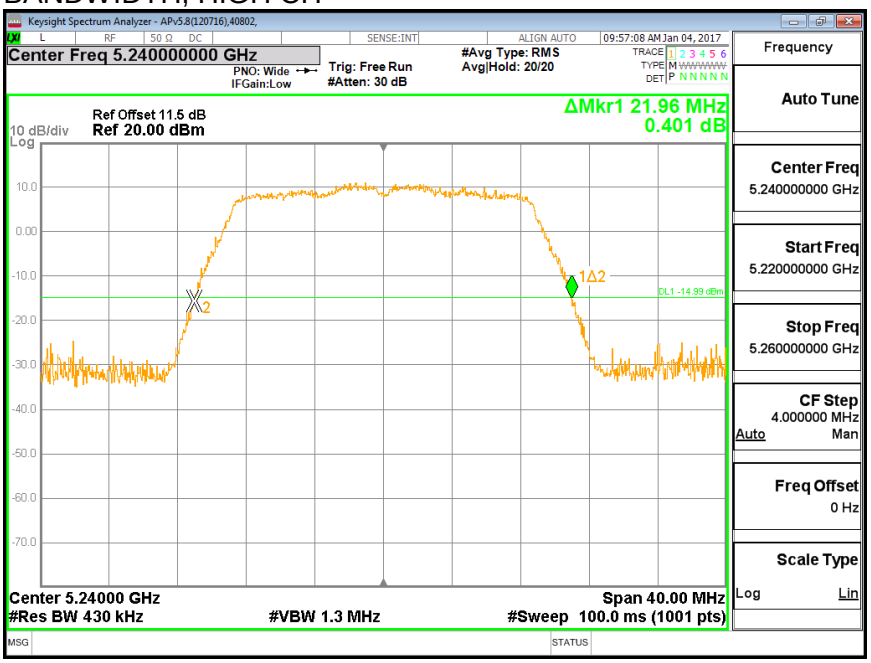


BANDWIDTH, MID CH



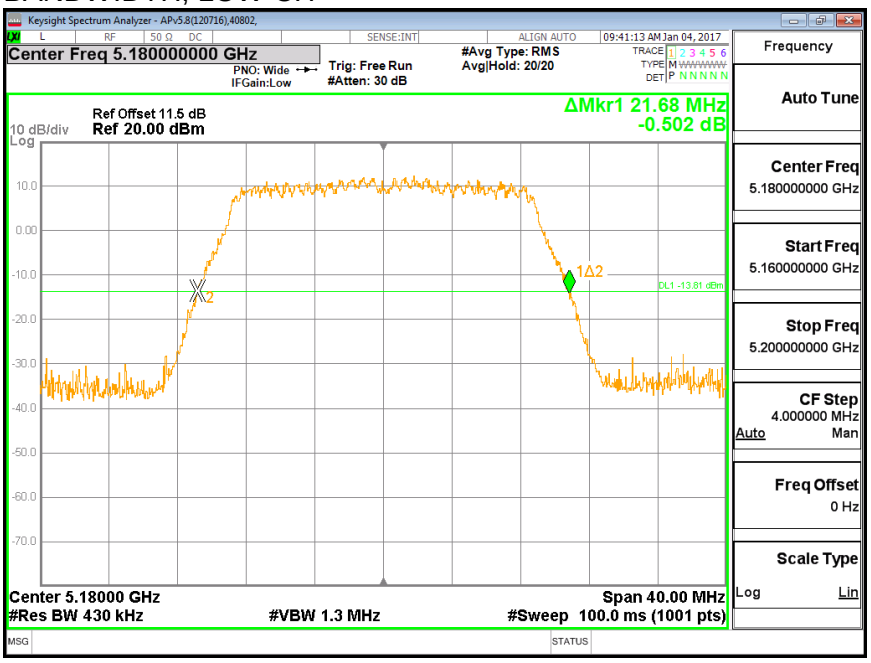
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

BANDWIDTH, HIGH CH



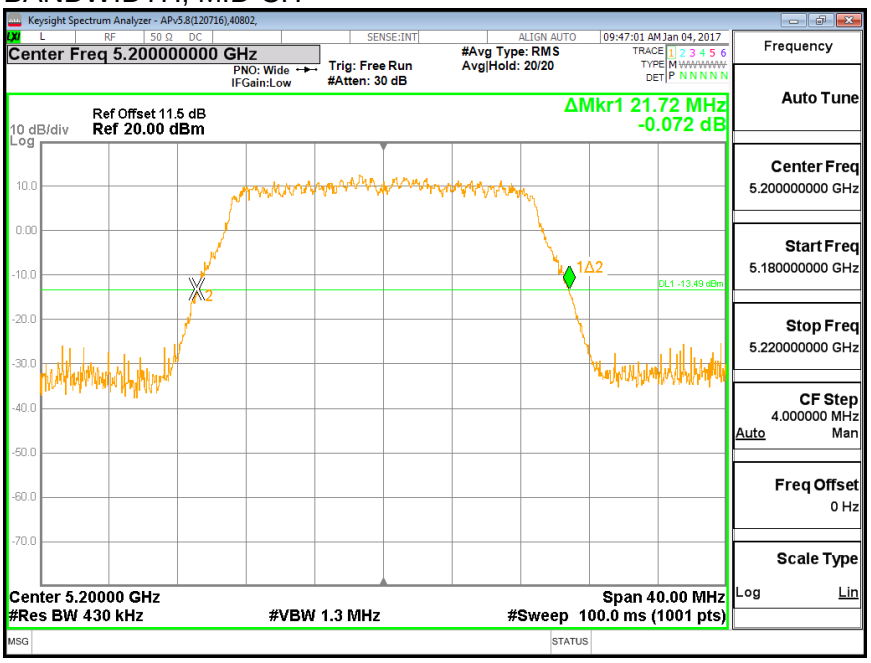
26 DB BANDWIDTH, ANTENNA B

BANDWIDTH, LOW CH

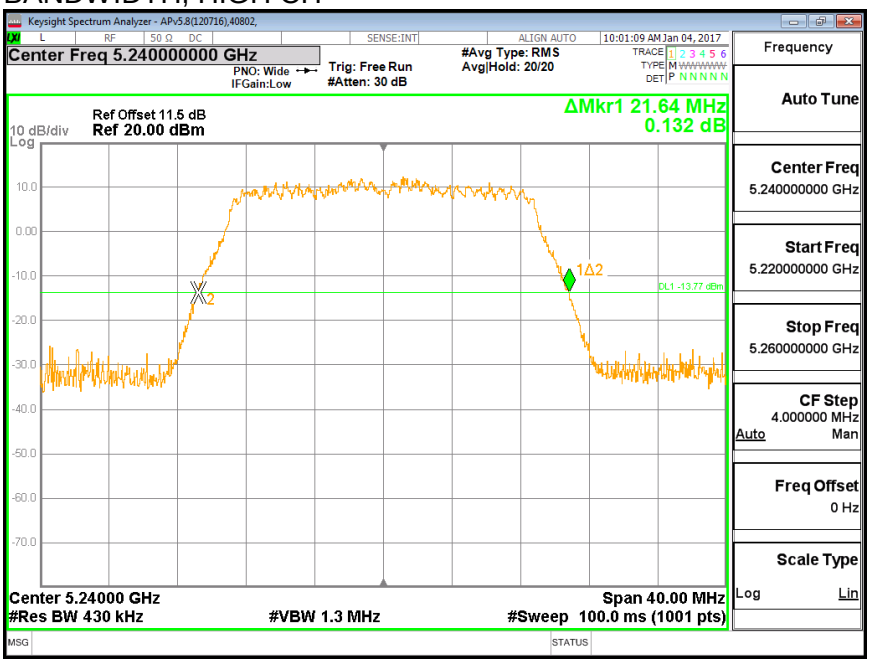


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

BANDWIDTH, MID CH



BANDWIDTH, HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.4.2. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

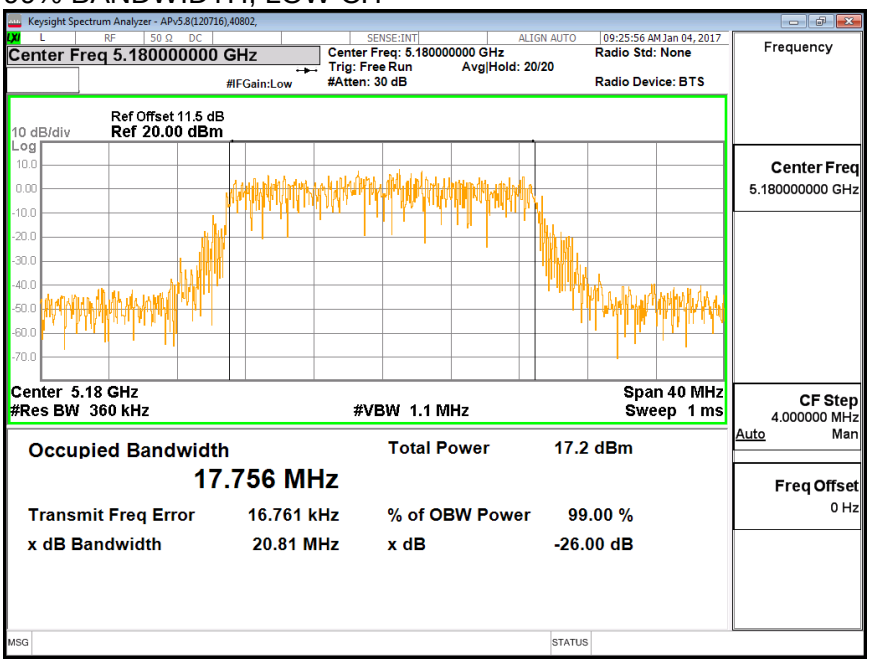
RESULTS

Channel	Frequency (MHz)	99% BW Ant A (MHz)	99% BW Ant B (MHz)
Low	5180	17.756	17.687
Mid	5200	17.810	17.747
High	5240	17.623	17.646

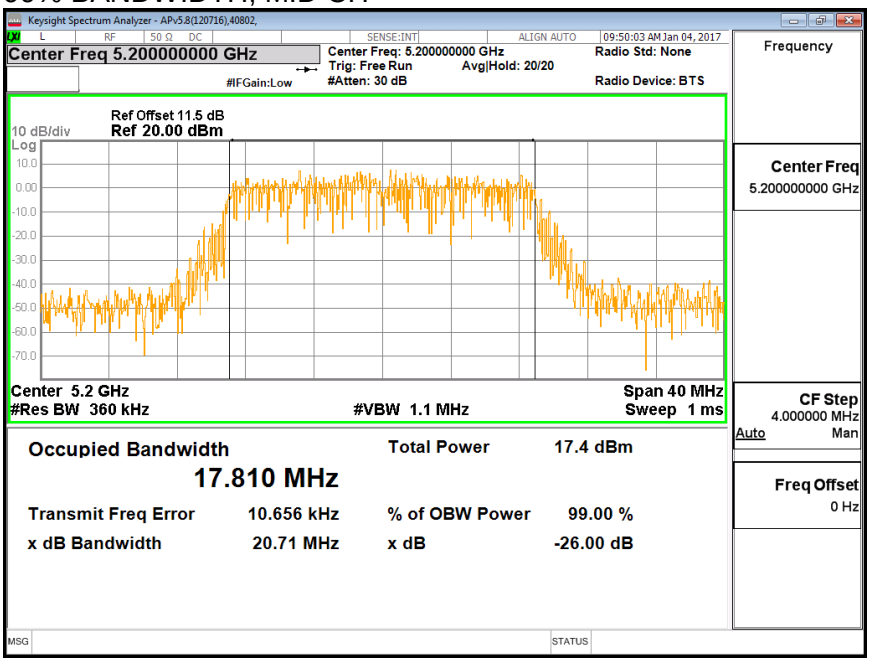
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

99% BANDWIDTH, ANTENNA A

99% BANDWIDTH, LOW CH

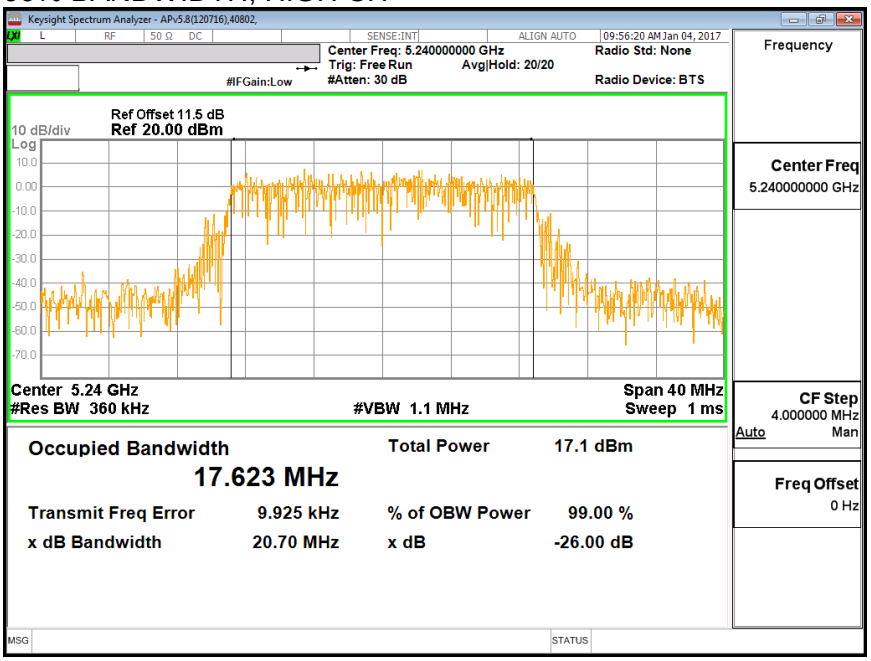


99% BANDWIDTH, MID CH



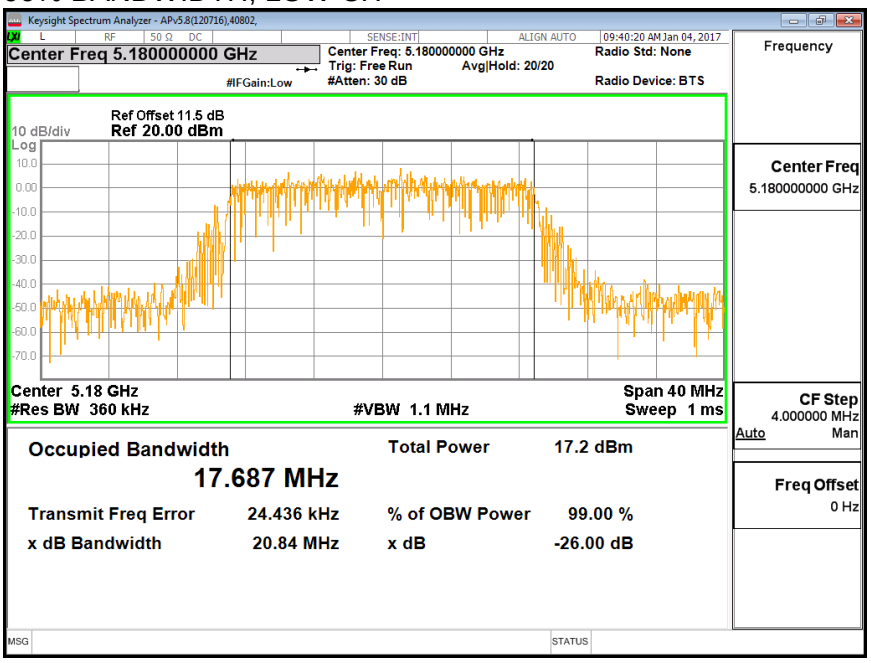
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

99% BANDWIDTH, HIGH CH



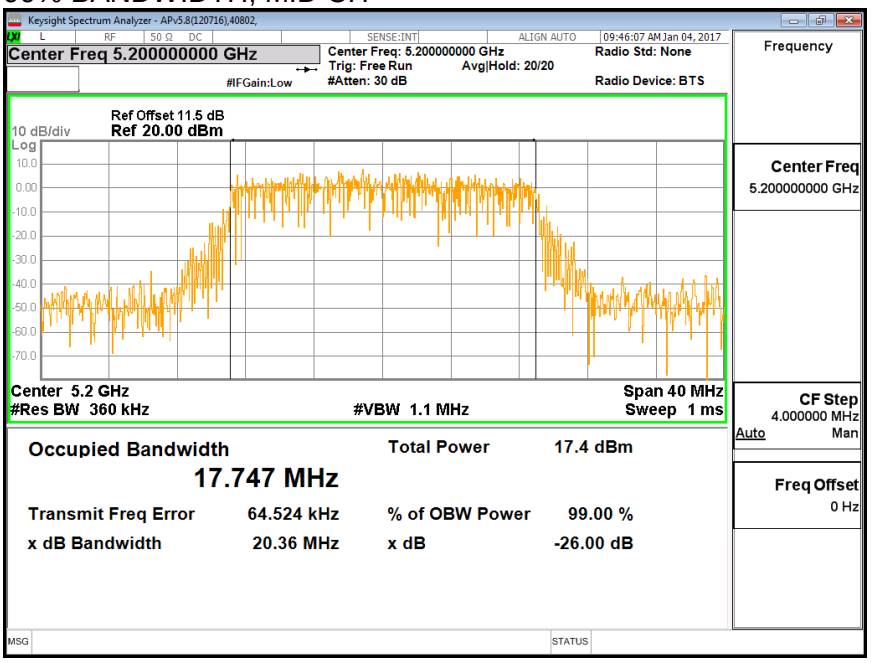
99% BANDWIDTH, ANTENNA B

99% BANDWIDTH, LOW CH

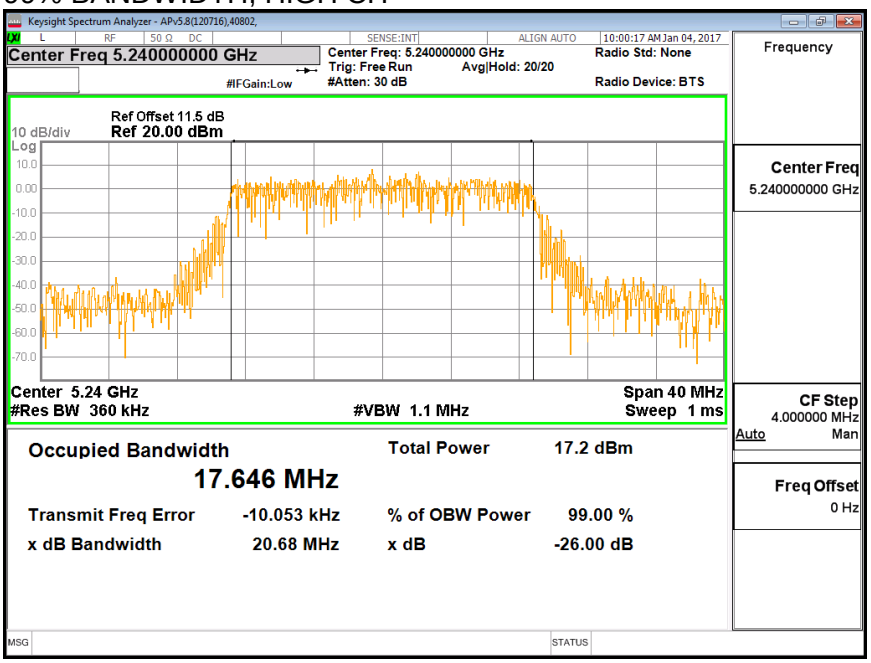


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

99% BANDWIDTH, MID CH



99% BANDWIDTH, HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.4.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

Measurements perform using a wideband gated RF power meter.

RESULTS

ID:	39472	Date:	1/30/17

Average Power Results

Channel	Frequency (MHz)	Ant A Power (dBm)	Ant B Power (dBm)	Total Power (dBm)
Low	5180	14.97	14.77	17.88
Mid	5200	16.44	16.98	19.73
High	5240	16.42	16.85	19.65

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.4.4. OUTPUT POWER AND PSD

LIMITS

FCC §15.407 (a) (1)

(i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

(ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

(iv) For mobile and portable client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

TEST PROCEDURE

Measurements perform using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

DIRECTIONAL ANTENNA GAIN

The TX chains are uncorrelated and the antenna gain is unequal among the chains. The directional gain is:

Ant A Antenna Gain (dBi)	Ant B Antenna Gain (dBi)	Uncorrelated Chains Directional Gain (dBi)
1.66	2.65	2.18

RESULTS

ID:	39472	Date:	1/30/17

Antenna Gain and Limits

Channel	Frequency (MHz)	Directional Gain for Power (dBi)	Directional Gain for PSD (dBi)	Power Limit (dBm)	PSD Limit (dBm)
Low	5180	2.18	2.18	24.00	11.00
Mid	5200	2.18	2.18	24.00	11.00
High	5240	2.18	2.18	24.00	11.00

Duty Cycle CF (dB)	0.00	Included in Calculations of Corr'd PSD

Output Power Results

Channel	Frequency (MHz)	Ant A Meas Power (dBm)	Ant B Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5180	14.97	14.77	17.88	24.00	-6.12
Mid	5200	16.44	16.98	19.73	24.00	-4.27
High	5240	16.42	16.85	19.65	24.00	-4.35

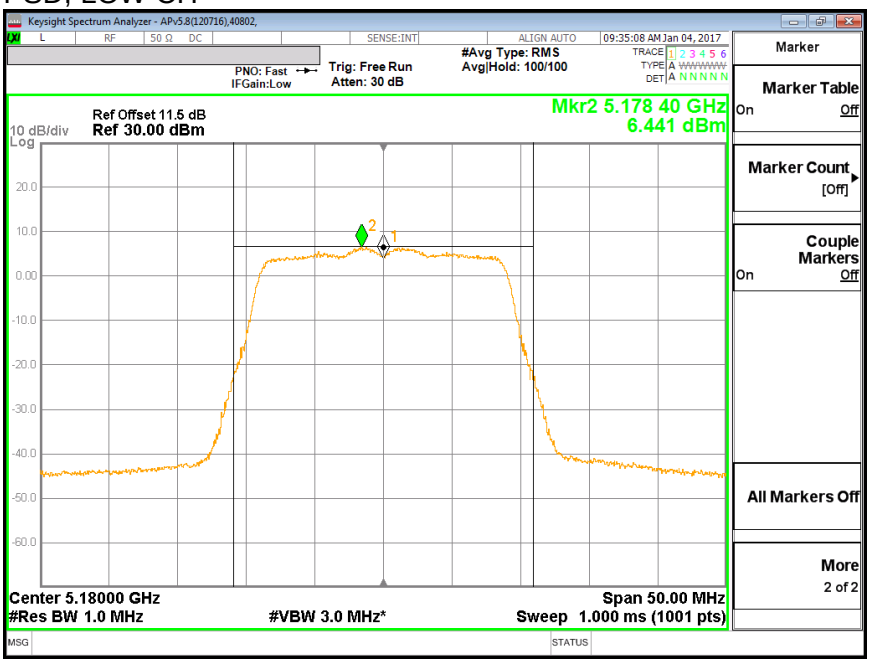
PSD Results

Channel	Frequency (MHz)	Ant A Meas PSD (dBm)	Ant B Meas PSD (dBm)	Total Corr'd PSD (dBm)	PSD Limit (dBm)	PSD Margin (dB)
Low	5180	6.44	6.60	9.53	11.00	-1.47
Mid	5200	7.03	6.69	9.87	11.00	-1.13
High	5240	6.83	6.51	9.68	11.00	-1.32

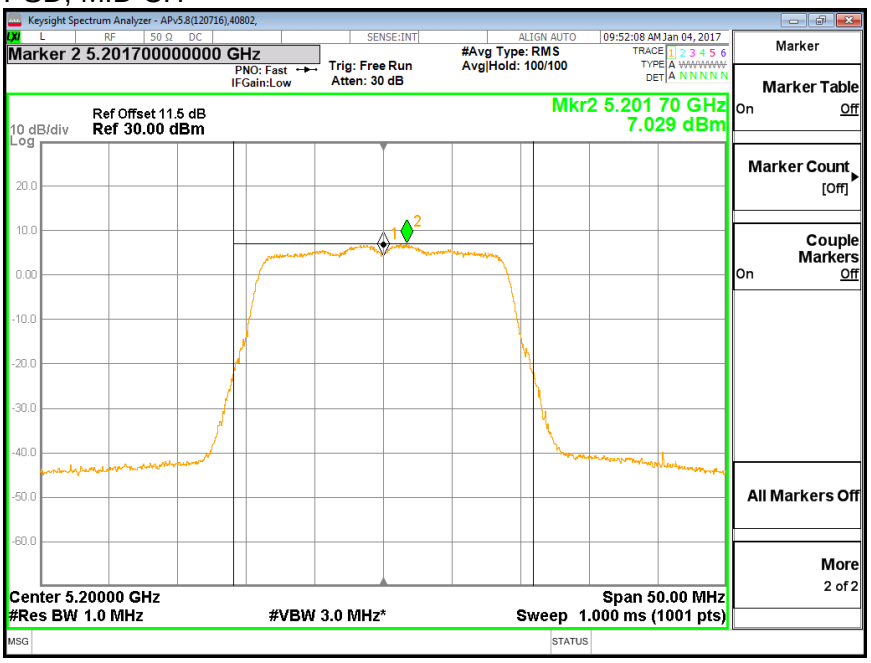
UL VERIFICATION SERVICES INC. FORM NO: CCSUP4701J
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 771-1000 FAX: (510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

PSD, ANTENNA A

PSD, LOW CH

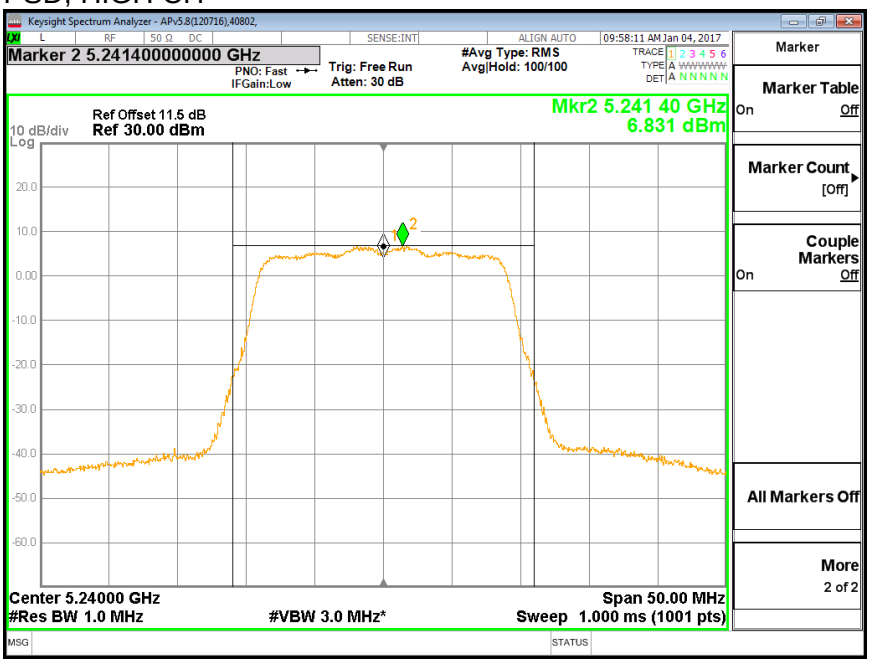


PSD, MID CH



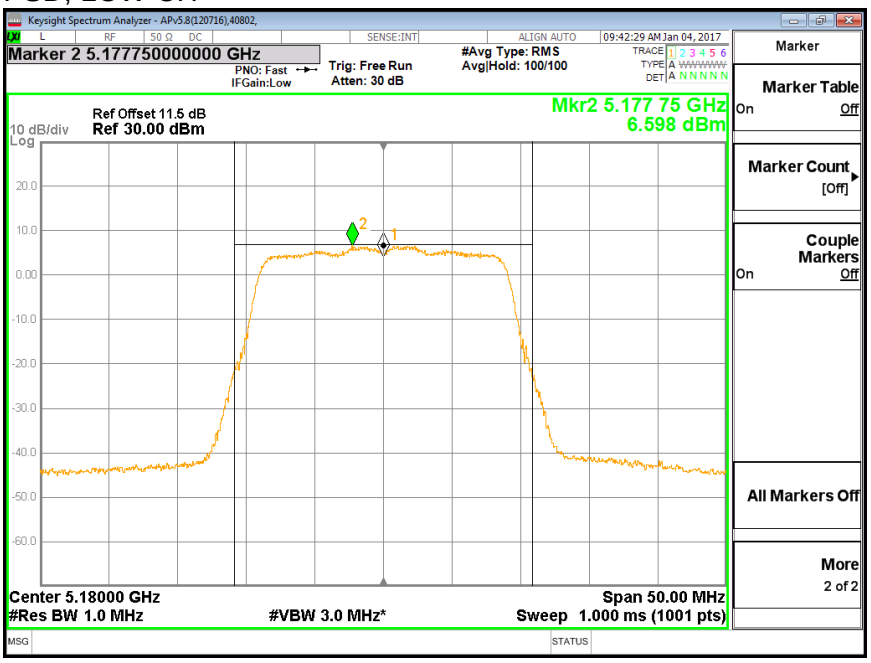
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

PSD, HIGH CH



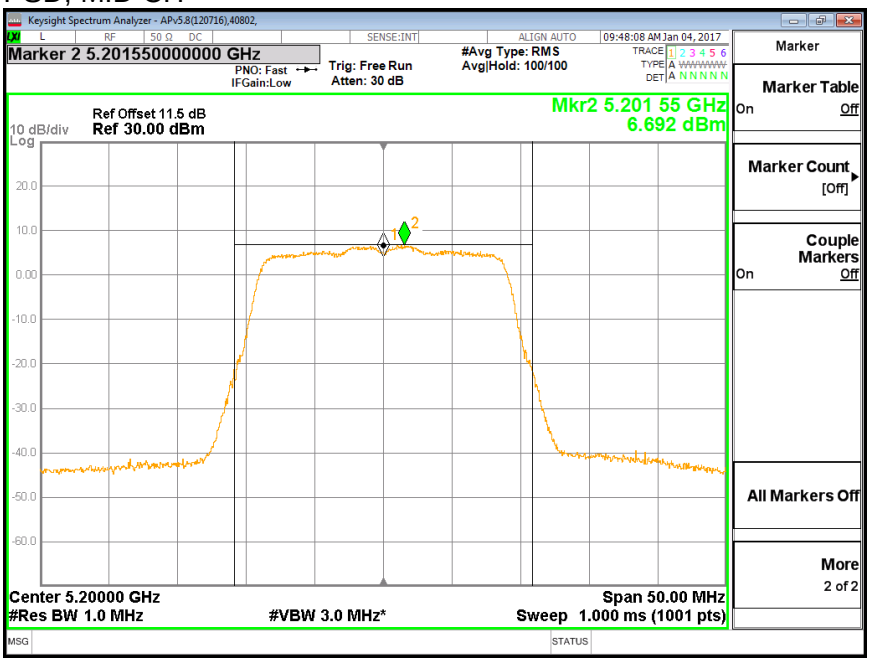
PSD, ANTENNA B

PSD, LOW CH

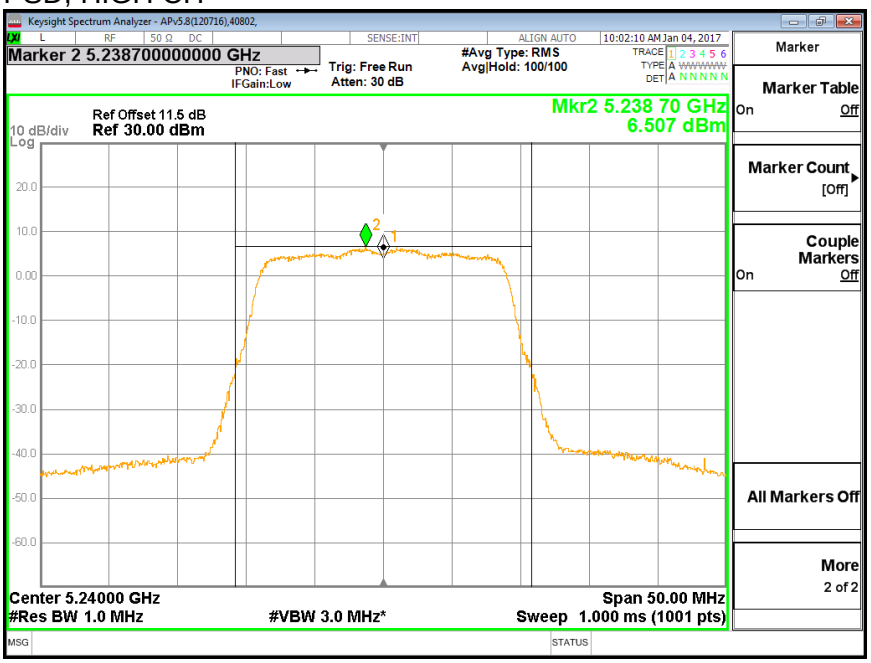


This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

PSD, MID CH



PSD, HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.5. 802.11n HT40 ANTENNA A MODE IN THE 5.2 GHz BAND

8.5.1. 26 dB BANDWIDTH

LIMITS

None; for reporting purposes only.

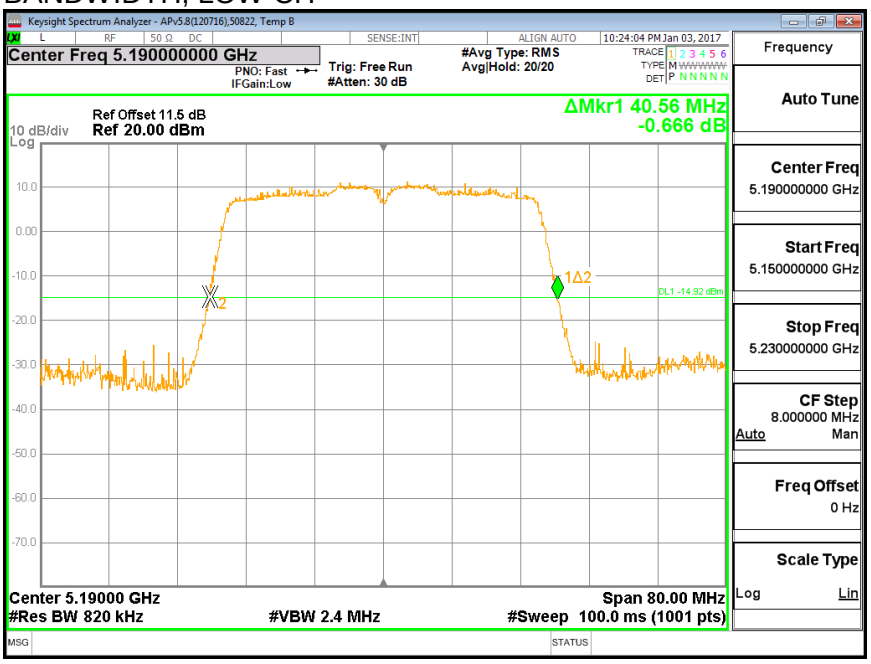
RESULTS

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5190	40.56
High	5230	40.72

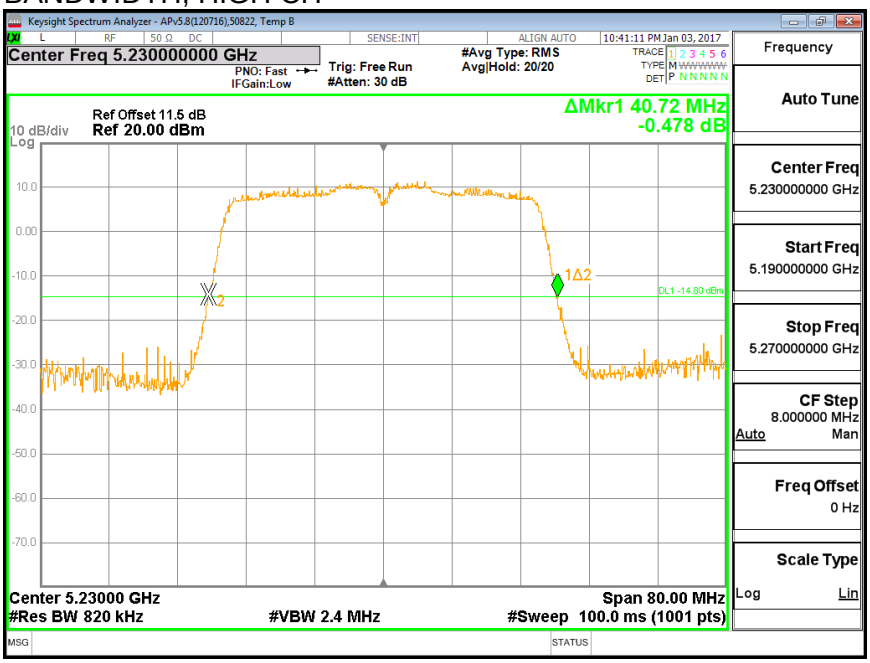
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

26 dB BANDWIDTH

BANDWIDTH, LOW CH



BANDWIDTH, HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.5.2. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

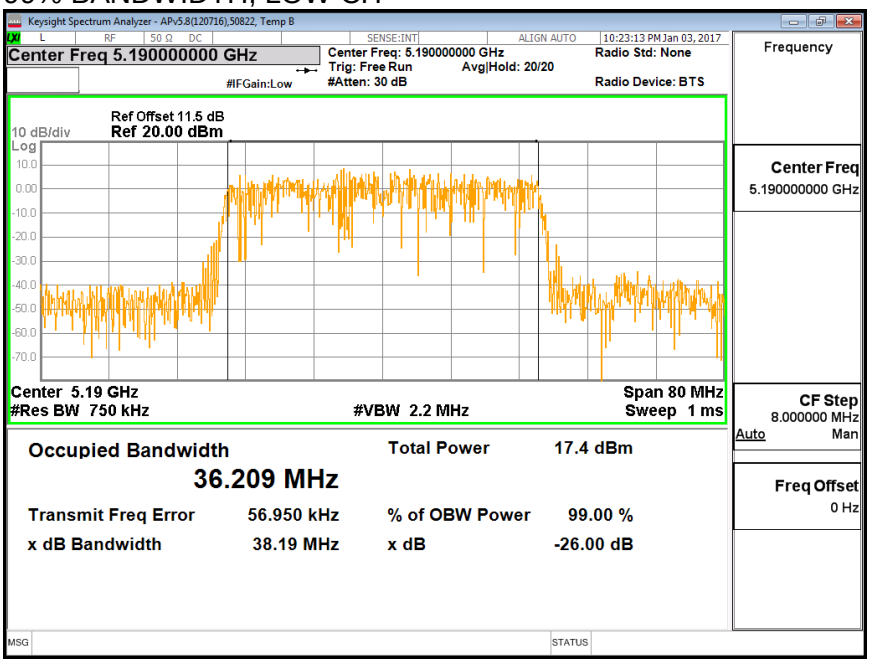
RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	5190	36.209
High	5230	36.178

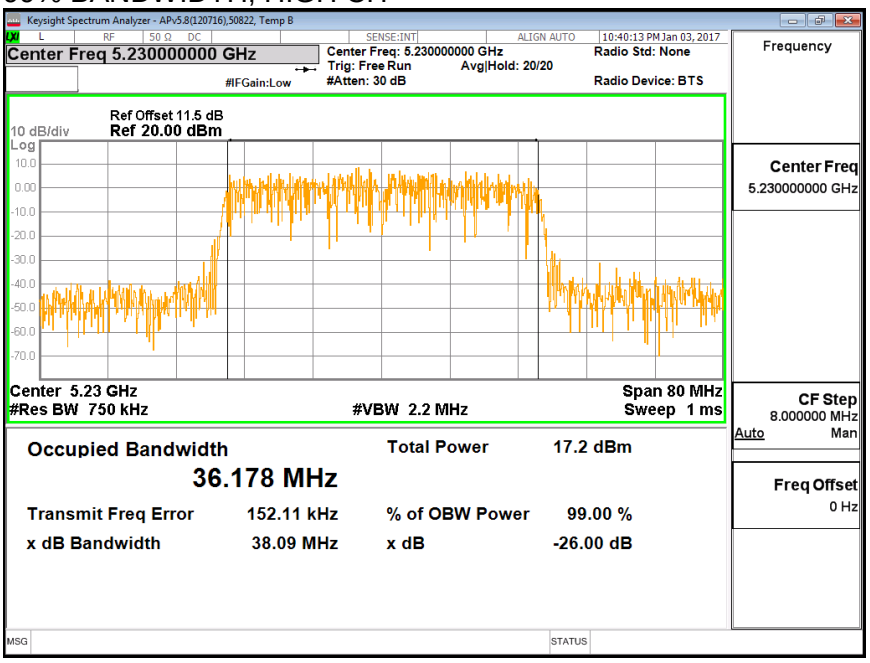
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

99% BANDWIDTH

99% BANDWIDTH, LOW CH



99% BANDWIDTH, HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.5.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

Measurements perform using a wideband gated RF power meter.

RESULTS

ID:	40802	**Date:**	1/21/17

Channel	Frequency (MHz)	Power (dBm)
Low	5190	14.26
High	5230	16.50

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.5.4. OUTPUT POWER AND PSD

LIMITS

FCC §15.407 (a) (1)

(i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

(ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

(iv) For mobile and portable client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

TEST PROCEDURE

Measurements perform using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.

DIRECTIONAL ANTENNA GAIN

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

RESULTS

ID:	39472	Date:	1/30/17

Antenna Gain and Limits

Channel	Frequency (MHz)	Directional Gain for Power (dBi)	Directional Gain for PSD (dBi)	Power Limit (dBm)	PSD Limit (dBm)
Low	5190	1.66	1.66	24.00	11.00
High	5230	1.66	1.66	24.00	11.00

Duty Cycle CF (dB)	0.11	Included in Calculations of Corr'PSD

Output Power Results

Channel	Frequency (MHz)	Ant A Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5190	14.26	14.26	24.00	-9.74
High	5230	16.50	16.50	24.00	-7.50

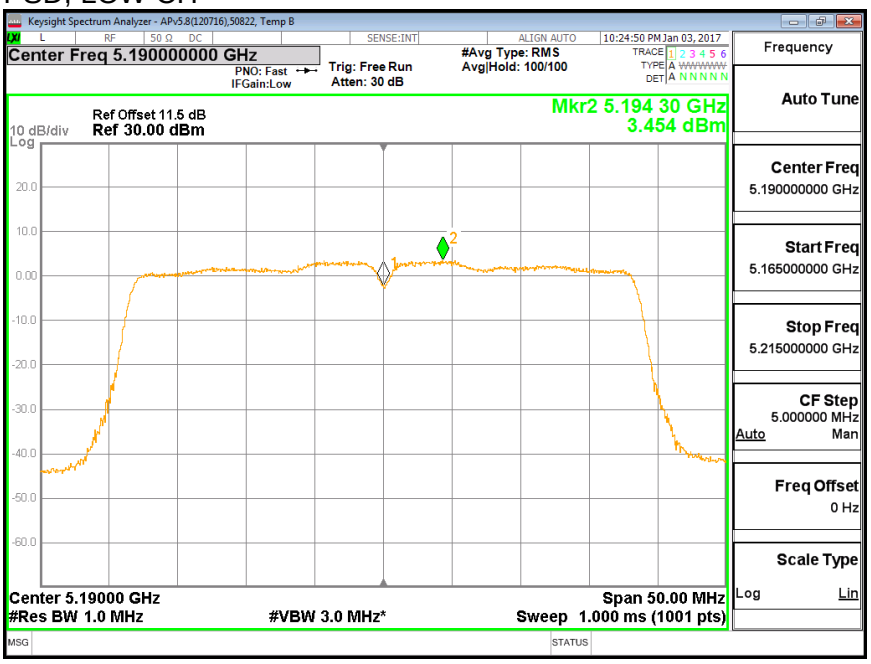
PSD Results

Channel	Frequency (MHz)	Ant A Meas PSD (dBm)	Total Corr'd PSD (dBm)	PSD Limit (dBm)	PSD Margin (dB)
Low	5190	3.45	3.56	11.00	-7.44
High	5230	3.55	3.66	11.00	-7.34

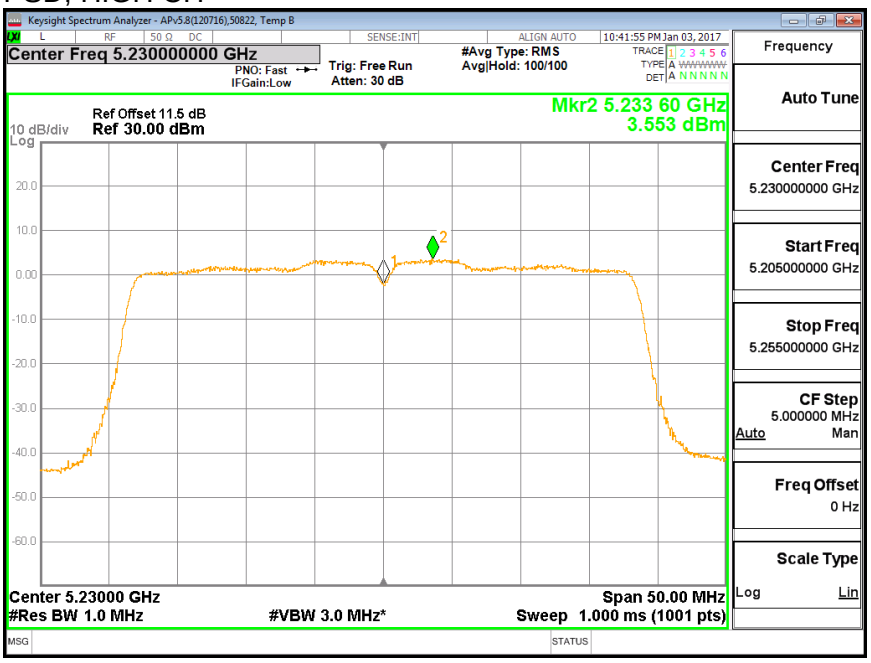
UL VERIFICATION SERVICES INC. FORM NO: CCSUP4701J
47173 BENICIA STREET, FREMONT, CA 94538, USA TEL: (510) 771-1000 FAX: (510) 661-0888
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

PSD

PSD, LOW CH



PSD, HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.6. 802.11n HT40 ANTENNA B MODE IN THE 5.2 GHz BAND

8.6.1. 26 dB BANDWIDTH

LIMITS

None; for reporting purposes only.

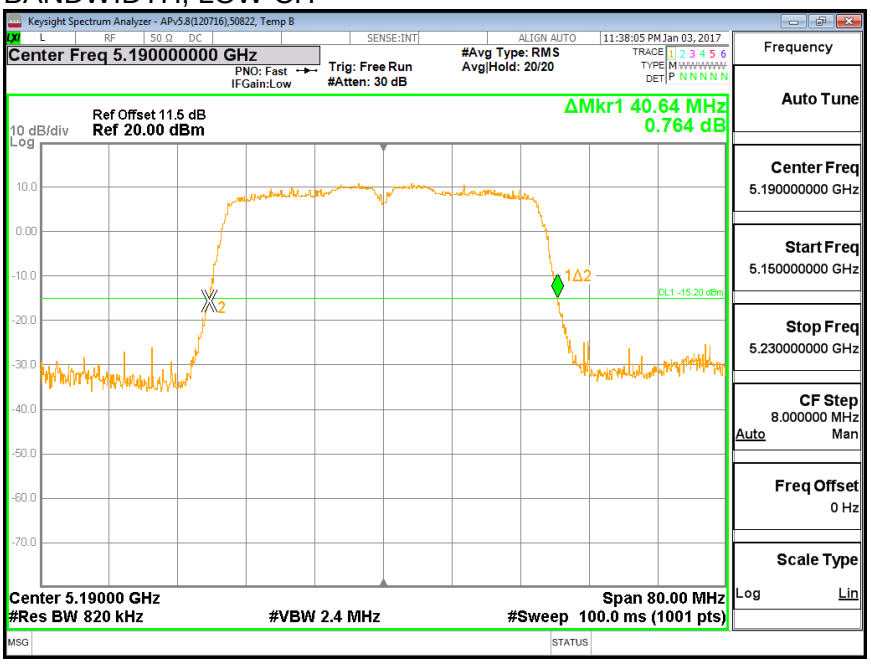
RESULTS

Channel	Frequency (MHz)	26 dB Bandwidth (MHz)
Low	5190	40.64
High	5230	40.56

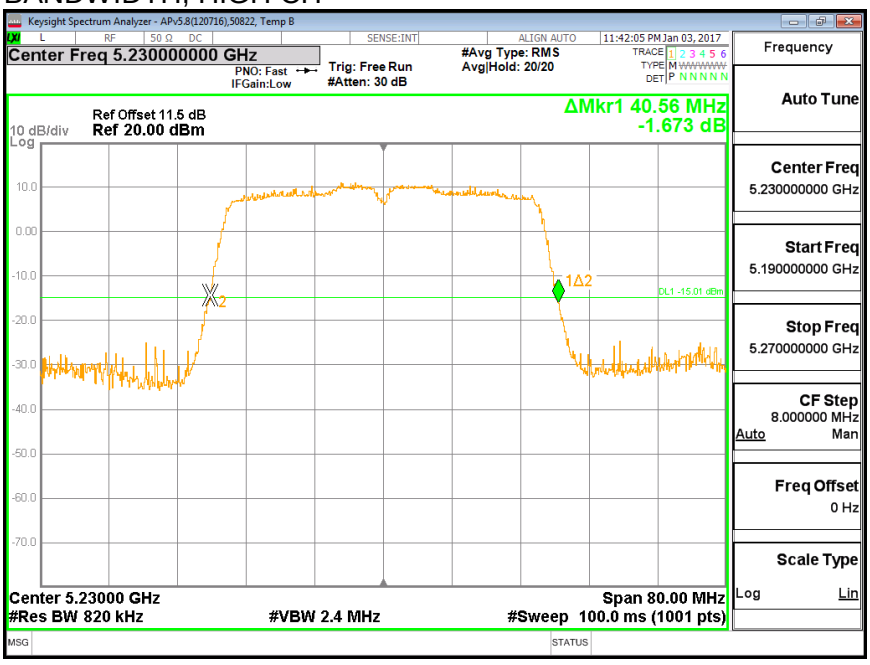
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

26 dB BANDWIDTH

BANDWIDTH, LOW CH



BANDWIDTH, HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.6.2. 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

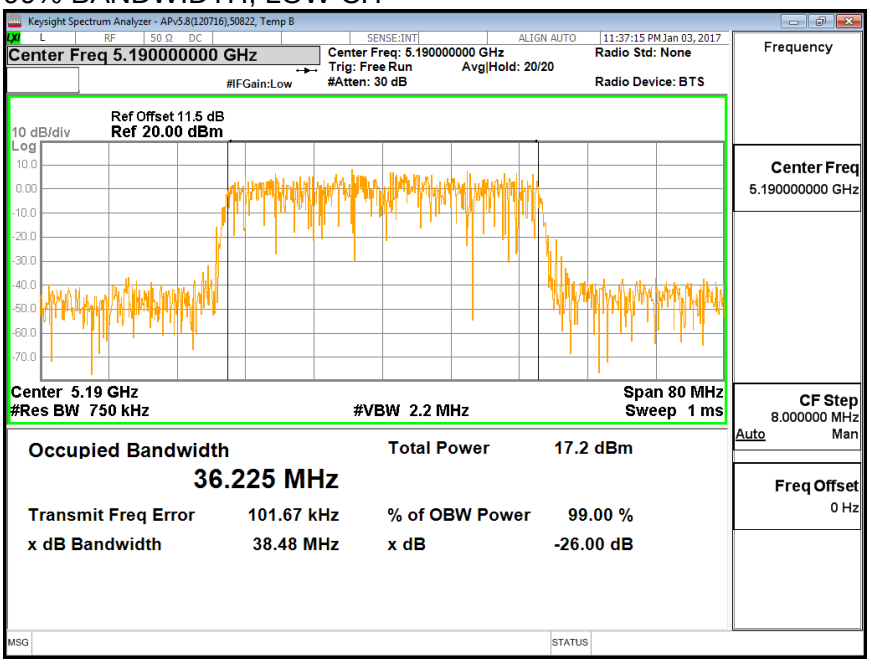
RESULTS

Channel	Frequency (MHz)	99% Bandwidth (MHz)
Low	5190	36.225
High	5230	36.372

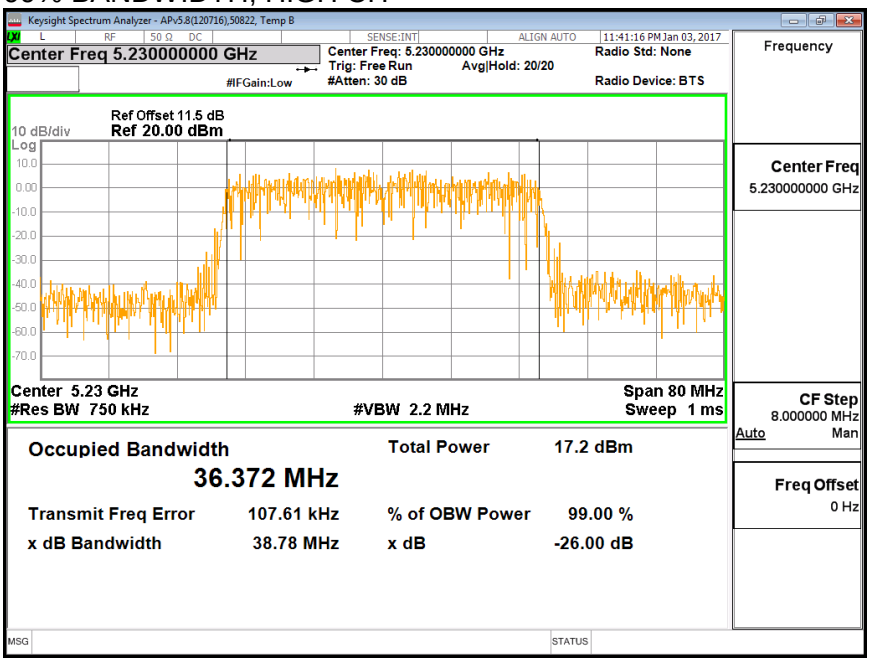
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

99% BANDWIDTH

99% BANDWIDTH, LOW CH



99% BANDWIDTH, HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.6.3. AVERAGE POWER

LIMITS

None; for reporting purposes only.

TEST PROCEDURE

Measurements perform using a wideband gated RF power meter.

RESULTS

ID:	39472	**Date:**	1/30/17

Channel	Frequency (MHz)	Power (dBm)
Low	5190	14.46
High	5230	16.80

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.6.4. OUTPUT POWER AND PSD

LIMITS

FCC §15.407 (a) (1)

(i) For an outdoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi. The maximum e.i.r.p. at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

(ii) For an indoor access point operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 17 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(iii) For fixed point-to-point access points operating in the band 5.15-5.25 GHz, the maximum conducted output power over the frequency band of operation shall not exceed 1 W. Fixed point-to-point U-NII devices may employ antennas with directional gain up to 23 dBi without any corresponding reduction in the maximum conducted output power or maximum power spectral density. For fixed point-to-point transmitters that employ a directional antenna gain greater than 23 dBi, a 1 dB reduction in maximum conducted output power and maximum power spectral density is required for each 1 dB of antenna gain in excess of 23 dBi. Fixed, point-to-point operations exclude the use of point-to-multipoint systems, omnidirectional applications, and multiple collocated transmitters transmitting the same information. The operator of the U-NII device, or if the equipment is professionally installed, the installer, is responsible for ensuring that systems employing high gain directional antennas are used exclusively for fixed, point-to-point operations.

(iv) For mobile and portable client devices in the 5.15-5.25 GHz band, the maximum conducted output power over the frequency band of operation shall not exceed 250 mW provided the maximum antenna gain does not exceed 6 dBi. In addition, the maximum power spectral density shall not exceed 11 dBm in any 1 megahertz band. If transmitting antennas of directional gain greater than 6 dBi are used, both the maximum conducted output power and the maximum power spectral density shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

TEST PROCEDURE

Measurements perform using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.

DIRECTIONAL ANTENNA GAIN

There is only one transmitter output therefore the directional gain is equal to the antenna gain.

This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

RESULTS

ID:	39472	Date:	1/30/17

Antenna Gain and Limits

Channel	Frequency (MHz)	Directional Gain for Power (dBi)	Directional Gain for PSD (dBi)	Power Limit (dBm)	PSD Limit (dBm)
Low	5190	2.65	2.65	24.00	11.00
High	5230	2.65	2.65	24.00	11.00

Duty Cycle CF (dB)	0.11	Included in Calculations of Corr'd PSD

Output Power Results

Channel	Frequency (MHz)	Ant B Meas Power (dBm)	Total Corr'd Power (dBm)	Power Limit (dBm)	Power Margin (dB)
Low	5190	14.46	14.46	24.00	-9.54
High	5230	16.80	16.80	24.00	-7.20

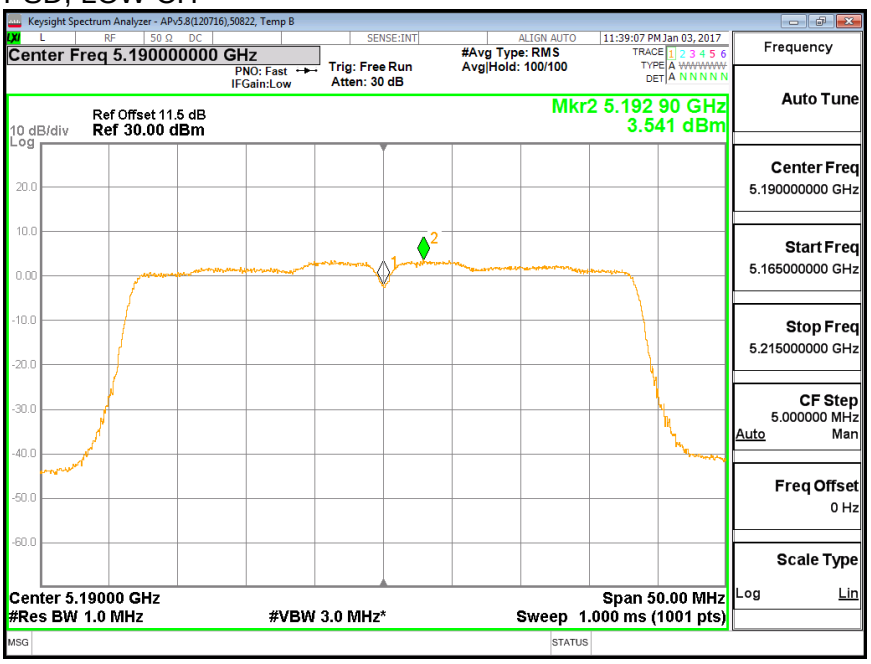
PSD Results

Channel	Frequency (MHz)	Ant B Meas PSD (dBm)	Total Corr'd PSD (dBm)	PSD Limit (dBm)	PSD Margin (dB)
Low	5190	3.54	3.65	11.00	-7.35
High	5230	3.52	3.63	11.00	-7.37

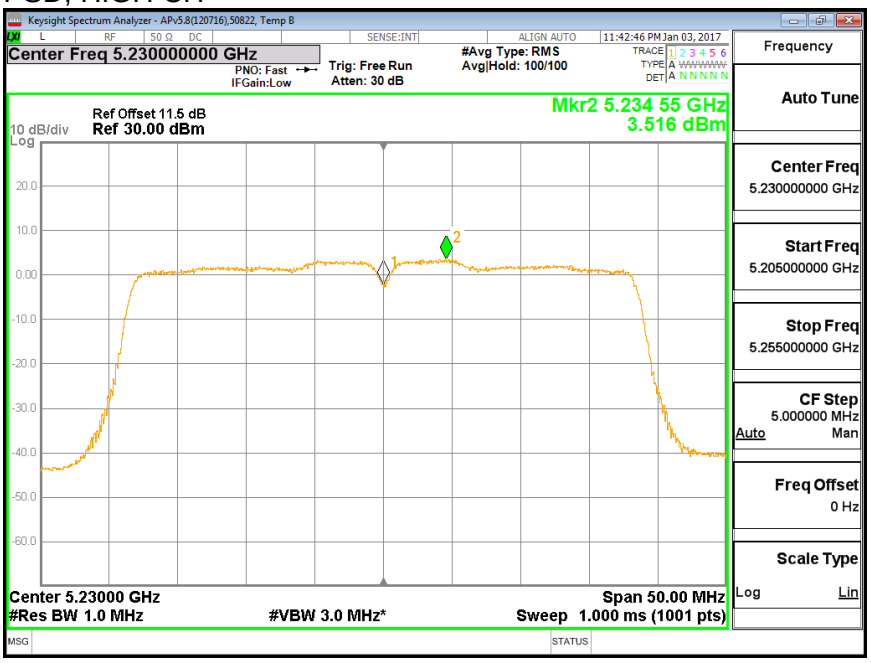
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

PSD

PSD, LOW CH



PSD, HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

8.7. 802.11n HT40 2Tx (ANTENNA A + ANTENNA B) CDD MODE IN THE 5.2 GHz BAND

8.7.1. 26 dB BANDWIDTH

LIMITS

None; for reporting purposes only.

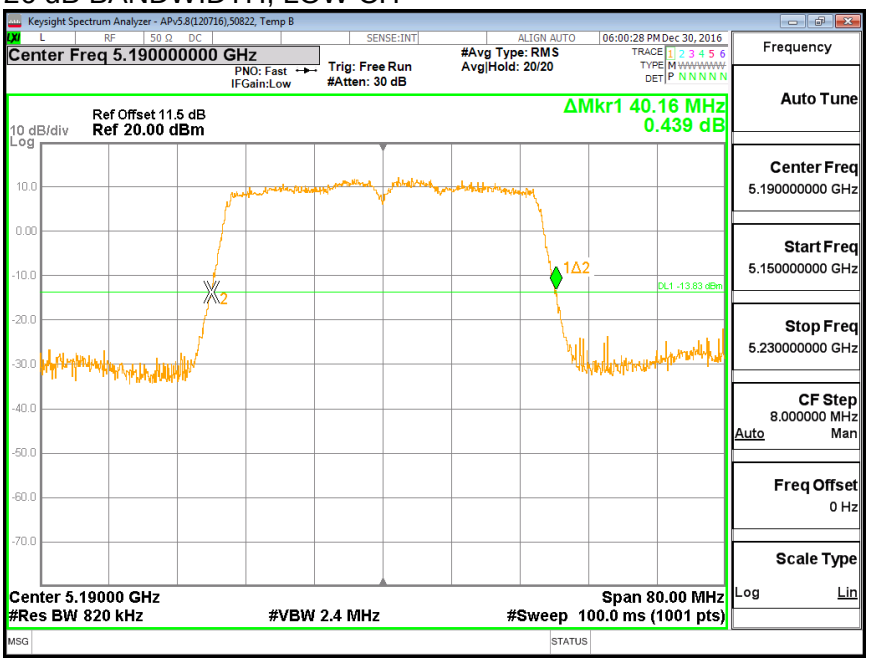
RESULTS

Channel	Frequency (MHz)	26 dB BW Ant A (MHz)	26 dB BW Ant B (MHz)
Low	5190	40.16	40.56
High	5230	40.32	40.64

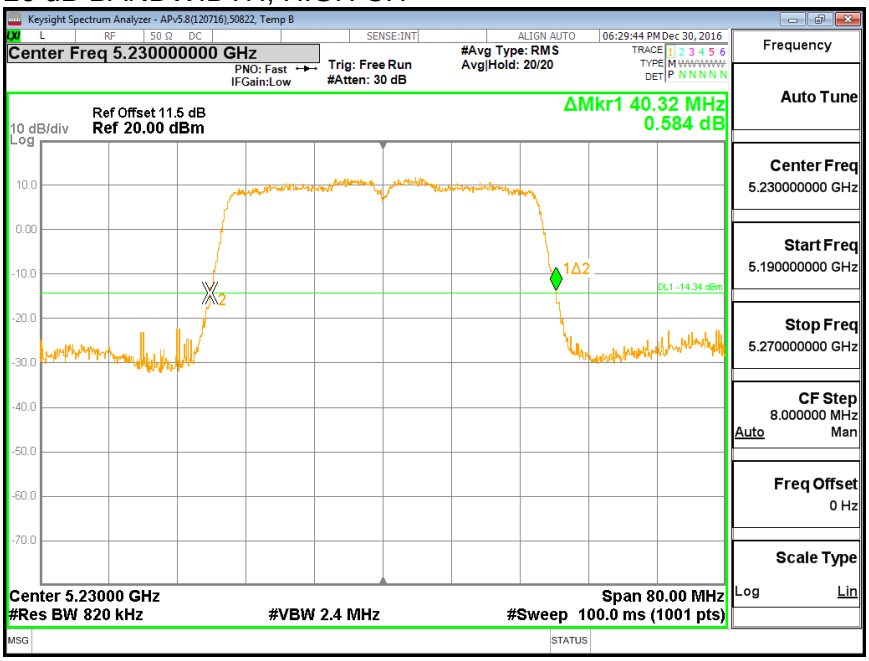
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

26 DB BANDWIDTH, ANTENNA A

26 dB BANDWIDTH, LOW CH



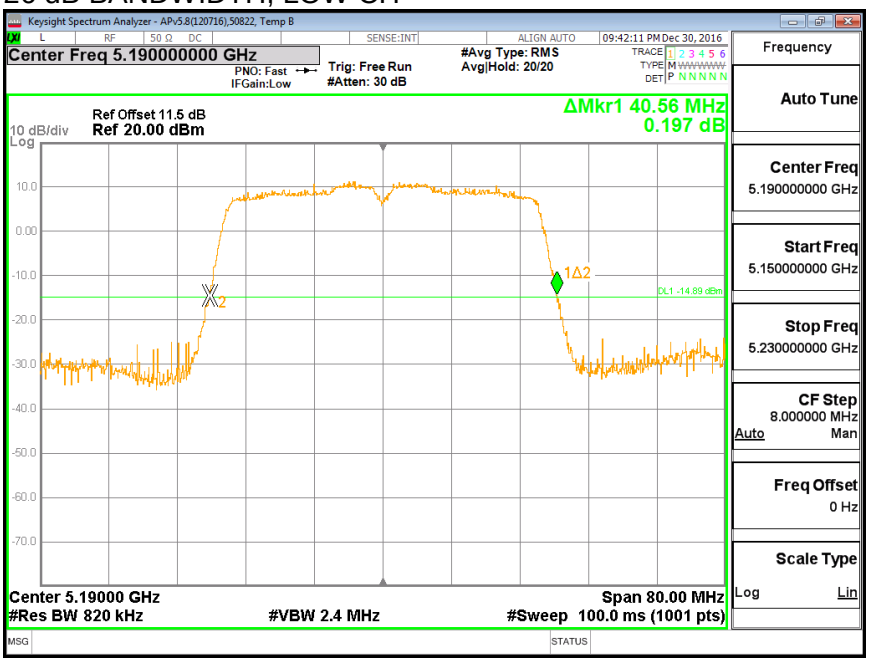
26 dB BANDWIDTH, HIGH CH



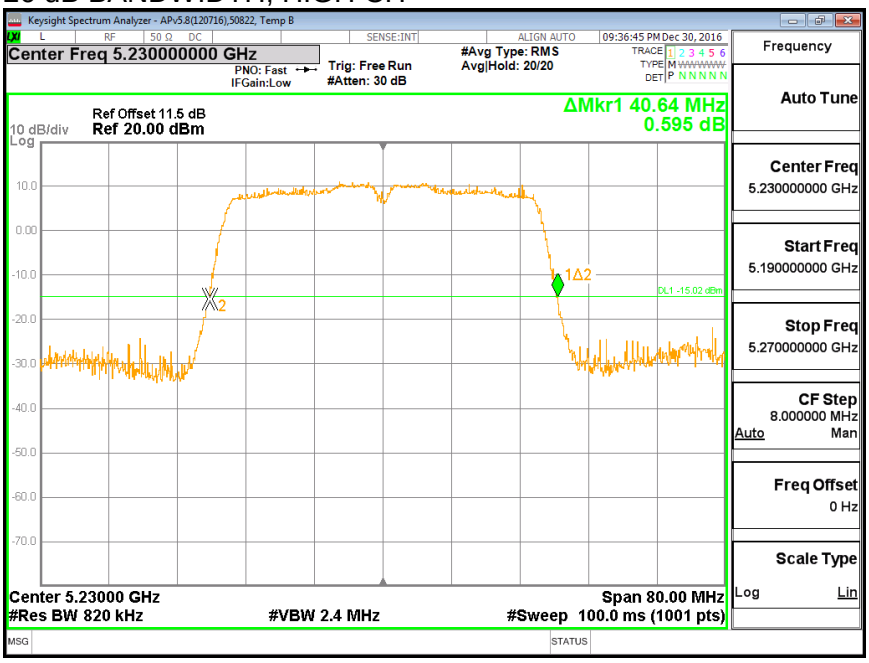
This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.

26 DB BANDWIDTH, ANTENNA B

26 dB BANDWIDTH, LOW CH



26 dB BANDWIDTH, HIGH CH



This report shall not be reproduced except in full, without the written approval of UL Verification Services Inc.