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TESTING
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RF Transmitter Certification Test Report
(FCC ID: 2AD8UAZRBRH1)

Regulation

FCC CFR 47 Part 15 Subpart E, Section 15.407

Client

Nokia Solutions and Networks Oy

Product Evaluated

AZRB AirScale Micro RRH Band 46 LAA UNII 1&3 (PRI20181100)

GPCL Report Number
TR2018-0033 FCC

GPCL Project Number
2018-0033

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Revisions

Date	Revision	Section	Change

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The test results documented in this report refer exclusively to the test model/sample specified, under the conditions and modes of operation as described herein.

Prepared By:

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1. ATTESTATION OF TEST RESULTS

Company Name (Manufacturer)	Nokia Solutions and Networks Oy 2000 W. Lucent Lane Naperville, IL 60563
FCC ID	2AD8UAZRBRH1
Product Name	AZRB AirScale Micro RRH Band 46 LAA
Model Name	AZRB
Serial Number(s)	1M180528260 (Radiated), 1M180528224 (Conducted)
Test Requirement(s)	47 CFR FCC Part 15 Subpart E, Section 15.407
Test Procedures/Methods	• ANSI C63.10-2013 • FCC KDB 789033 D02, v02r01, December 2017 • FCC KDB 662911 D01, v02r01, October 2013 • FCC KDB 353028 D01, v01, April 2017
Frequency Band	5170-5250 MHz (UNII-1); 5735-5835 MHz (UNII-3) E-UTRAN Band 46
Operation Mode	Master Device
FCC Part 15 Subpart B Sections 15.107 and 15.109 Class B	Passed
Date Tested	February 21 – April 18, 2018
Type of Application	New Certification
Submission Type	Original Radio Equipment Certification
Test Laboratory	Nokia Global Product Compliance Laboratory 600-700 Mountain Avenue Murray Hill, New Jersey 07974-0636 USA FCC Registration No/Designation No: 328881/US5302
Test Engineers	S. Gordon, M. Soli, O. Okorie and J. Yadav

The above product has been evaluated and found to be in compliance with the Commission's Rules and Regulations set forth in the above standards.

FCC Section 2.911(e) Certification of Technical Test Data

The technical test data presented in this report are accurate.

2. SUMMARY OF THE TEST RESULTS

Applied Standards: 47 CFR FCC Part Subpart E Section 15.407 UNII-1 & UNII-3				
Section	**FCC Rules**	**Description of Tests**	**Test Condition**	**Results In Compliance**
4.4	15.403 (i) & 15.215(c)	Emission Bandwidth (26dB Bandwidth)	Conducted	Yes
4.5	15.407 (e)	Minimum Emission Bandwidth (6dB Bandwidth)		Yes
4.6	15.407 (a)(1)(3)(4)	Maximum Power Output and Maximum Outdoor EIRP		Yes
4.7	15.407 (a)(1)(3)(5)	Peak Power Spectrum Density		Yes
4.8	15.407 (b)(1)(4-5)(8)	Unwanted Radiated Out-of-Band Emissions	Radiated	Yes
4.9	15.407 (b)(1)(4-8)	Unwanted Radiated Spurious Emissions		Yes
4.10	15.407 (b)(6) & 15.207	AC Power Line Conducted Emissions	Conducted	Yes
	15.407 (g)	Frequency Stability*		Yes

* KDB 789033 D02 Section II.A.3: the grantee is responsible for ensuring that the EUT meets 15.407(g) requirements; however, the applications for equipment certification are not required to include test reports with explicit demonstration of compliance.

2.1. Measurement Uncertainties for EMC Conducted and Radiated Emissions

The results of the calculations to estimate uncertainties for the several test methods and standards are shown in the Table below. These are the worst-case values.

Worst-Case Estimated Measurement Uncertainties

Standard, Method or Procedure	Condition	Frequency MHz	Expanded Uncertainty (k=2)
a. EMC Emissions, (*e.g.*, ANSI C63.4, CISPR 11, 14, 22, *etc.*, using ESHS 30, EMC-60, LISNs/AMNs and antennas)	Conducted Emissions	0.009 - 30	± 2.0 dB
	Radiated Emissions (AR-8 Semi-Anechoic Chambers)	30 – 200 200 – 1000	±5.1 ~ ±5.4 dB ±4.3 ~ ±4.7 dB
	Radiated Emissions (OATS)	1000 – 18,000	±3.3 dB

2.2. Measurement Uncertainties for Antenna Port Conducted Testing

Worst-Case Estimated Measurement Uncertainties

Standard, Method or Procedure	Expanded Uncertainty (k=2)
RF Power	± 1.4 dB
Occupied Bandwidth	± 2.2 dB
Conducted Spurious Emissions	± 2.8 dB

3. GENERAL INFORMATION

3.1. Product Descriptions

Table 3.1.1 Product Specifications

Specification Items	Description	
Product Type	LAA LTE RRH	
Radio Type	Intentional Transceiver	
Power Type	DC: -38V to -57V AC: 80V to 276V (via external AC/DC Converter)	
FCC Rules	15.407	
Operation Mode	Master Device, Point to Multipoint	
Modulation	OFDM (QPSK, 16QAM, 64QAM, 256QAM)	
Technology	LAA LTE-TDD	
Frequency Range	5170-5250 MHz (UNII-1); 5735-5835 MHz (UNII-3) E-UTRAN Band 46	
Bandwidth(s)	20/40/60MHz	
Max Rated Conducted RF Power	5170-5250 MHz (UNII-1)	Antennas with Max Gain ≤ 6 dBi: 26dBm per chain and 29dBm total Antennas with Max Gain = 9.5 dBi: 22.5 dBm per chain and 25.5dBm total
	5735-5835 MHz (UNII-3)	Antennas with Max Gain ≤ 6 dBi: 27dBm per chain and 30dBm total Antennas with Max Gain = 9.5 dBi: 23.5 dBm per chain and 26.5dBm total
Max Rated EIRP Power	5170-5250 MHz (UNII-1	32dBm per port and 35dBm total
	5735-5835 MHz (UNII-3)	33dBm per port and 36dBm total
Max OD EIRP at any Elevation Angle above 30° from Horizon	5170-5250 MHz (UNII-1)	≤ 125mW (21 dBm) Outdoor
Software Version (Master)	FL18_ENB	
Hardware Version (Master)	474510A.X22	
Antennas	Refer to Section 3.5. No beamforming	

3.2. Accessories

A Nokia BBU, ASMi, was used for all testing. ASMi consists of an ASIA system module circuit pack and an ABIA baseband sub-module circuit pack. The ASMi was connected to the AZRB through fiber connection. The above accessory device is unmodified and is commercially available per FCC requirement given in 2.1033(b)(8).

3.3.Description of Antenna(s)

Currently, there are five available antennas of two types to be equipped for this low power Band 46 LAA RRH AZRB. The demonstration of meeting the FCC Section 15.203 and KDB 353028 D01 requirements on antennas has been presented in Exhibit 5, where it stated that unique (non-standard) antenna connectors were designed with the product and professional installation was used. There are provisions for special connectors to be used for any external antennas.

Table 3.3.1 UNII-1/3 Antenna Data from Manufacturers

Antenna No	Model Name	Antenna Type/ Size (mm)	Frequency (MHz)	Tx/Rx Port	Max Gain (dBi)	
					Port 1	Port 2
1	AARC	Directional 295(L) × 270(W) × 30(D)	5150 ~ 5850	Tx/Rx 1/2	4.91	4.91
2	FA2RC	Directional 160(L) × 110(W) × 44(D)	5150 ~ 5850	Tx/Rx 1/2	6.0	6.0
3	VVSSP-360S-F	Omni-Directional 600(L) × 100(R)	5150 ~ 5925	Tx/Rx 1/2	5.1	5.1
4	GQ2410-06645	Omni-Directional 634(L) × 127.5(R)	5150 ~ 5925	Tx/Rx 1/2	5.9	5.9
5	2205	Directional 198(W) × 24.5(D) × 198(H)	5150 ~ 5925	Tx/Rx 1/2	9.5	9.5

The antenna patterns in the UNII-1 band (5.17GHz-5.25GHz) were also measured for each port in the elevation angle above 30º from the horizontal plane and provided below.

Table 3.3.2 Measured Antenna Gains in UNII-1 Band in Elevation Angles 30º above the Horizontal Plane for Outdoor EUT

Antenna No	Model	Antenna Type	Max Gain in Elevation Angle 30º above Horizont (dBi)
1	AARC	Directional	-9.1
2	FA2RC	Directional	-7.0
3	VVSSP-360S-F	Omni-Directional	-9.5
4	GQ2410-06645	Omni-Directional	-11.0
5	2205	Directional	-7.0

Table 3.3.3 UNII-1/3 Antennas Tested (with the Highest Gain of Each Type)

Antenna No	Model Name	Antenna Type	Frequency (MHz)	Max Gain (dBi)	
				Port 1	Port 2
4	GQ2410-06645	Omni-Directional	5150 ~ 5925	5.9	5.9
5	2205	Directional	5150 ~ 5925	9.5	9.5

The compliance of the EUT with the maximum setting and the omni-directional antenna #4 and the directional antenna #5, which have the highest antenna gain among the same type, was evaluated, respectively.

4. REQUIRED MEASUREMENTS AND RESULTS

4.1. Regulatory Requirements

The tests in this report were performed for Unlicensed-National Information Infrastructure Devices Operating in the 5170-5250 MHz and 5735-5835 MHz Bands in accordance with the requirements of FCC CFR 47 Part 15 Subpart E. The requirements are provided in the following:

(1) Emission Bandwidth (FCC 15.403 (i), 15.215(c), KDB 789033D02 III.B)

The emission bandwidth shall be determined by the 26dB bandwidth. Determination of the emissions bandwidth is based on the use of measurement instrumentation employing a peak detector function with an instrument resolution bandwidth approximately equal to 1.0 percent of the emission bandwidth of the device under measurement.

In the case of intentional radiators operating under the provisions of Subpart E, the emission bandwidth may span across multiple contiguous frequency bands identified in that subpart. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage.

For devices operating in the 5.15−5.25 GHz band, any transmission that does not intentionally extend into the 5.25−5.35 GHz band must be down 26 dB above 5.25 GHz.

(2) Minimum Emission Bandwidth (FCC 15.407(e))

Within the 5.725-5.85 GHz band, the minimum 6 dB bandwidth of U-NII devices shall be at least 500 kHz.

(3) Output Power and Power Spectrum Density Limits (FCC 15.407 (a)(1)(3)(4)(5))

For an access point operating in the band 5.15-5.25 GHz, the maximum conducted output power 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. For an *outdoor* unit, the maximum EIRP at any elevation angle above 30 degrees as measured from the horizon must not exceed 125 mW (21 dBm).

For the band 5.725-5.85 GHz, the maximum conducted output power shall not exceed 1 W. In addition, the maximum power spectral density shall not exceed 30 dBm in any 500kHz 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 conducted output power must be measured with *rms* detector. The maximum power spectral density in the 5.725-5.85 GHz band is measured over a reference bandwidth of 500 kHz or the 26 dB emission bandwidth of the device, whichever is less. Measurements in the 5.15-5.25 GHz are made over

a bandwidth of 1 MHz or the 26dB emission bandwidth of the device, whichever is less. A narrower resolution bandwidth can be used, provided that the measured power is integrated over the full reference bandwidth.

(4) Unwanted Emission Limits (FCC 15.407 (b)(1)(4-8)), 15.209 (a) and 15.205 (a, b, c).

The peak emissions outside of the frequency bands of operation shall be attenuated in accordance with the following limits:

i. For transmitters operating in the 5.15-5.25 GHz band: all emissions outside of the 5.15-5.35 GHz band shall not exceed an EIRP of -27 dBm/MHz.

ii. For transmitters operating in the 5.725-5.85 GHz band: all emissions shall be limited to a level of −27 dBm/MHz at 75 MHz or more above or below the band edge increasing linearly to 10 dBm/MHz at 25 MHz above or below the band edge, and from 25 MHz above or below the band edge increasing linearly to a level of 15.6 dBm/MHz at 5 MHz above or below the band edge, and from 5 MHz above or below the band edge increasing linearly to a level of 27 dBm/MHz at the band edge.

iii. The emission measurements shall be performed using a minimum resolution bandwidth of 1 MHz. A lower resolution bandwidth may be employed near the band edge, when necessary, provided the measured energy is integrated to show the total power over 1 MHz.

iv. Unwanted emissions below 1 GHz must comply with the general field strength limits set forth in Section 15.209. Further, any U-NII devices using an AC power line are required to comply also with the conducted limits set forth in Section 15.207.

v. The provisions of Section 15.205 apply to UNII intentional radiators, where the field strength of emissions appearing *within Section 15.205 restricted frequency bands* shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1GHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1GHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the *average* value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

vi. When measuring the emission limits, the nominal carrier frequency shall be adjusted as close to the upper and lower frequency band edges as the design of the equipment permits.

Therefore,

1) the emissions from the UNII transmitter in the frequency spectrum up to the 10th harmonics are subject to the following requirements:

   a. For emissions outside the restricted bands, per 15.407(b)(6-7), KDB789033 D02 II.G.2.a-c,
      (i) f < 1GHz, the limits specified in 15.209 need to be met by QPK or PK;
      (ii) f > 1GHz, the limits specified in 15.407 (b)(1-4) for UNII-1/2/3 need to be met by PK;

   b. For emissions in the restricted bands, per 15.407(b)(6-7), 15.205 (b), KDB 789033 D02 II.G.1.a-c,
      (i) f < 1GHz, the limits specified in 15.209 need to be met by QPK or PK;

(ii) f > 1GHz, the limits specified in 15.209 need to be met by AVE and the limits specified in 15.407 (b)(1-4) for UNII-1/2/3 need to be met by PK

2) the emissions from the digital circuits of the EUT in the frequency spectrum up to the 5th harmonics are subject to the 15.109 limit.

3) the emissions from AC power lines in the frequency range of 150kHz and 30MHz are subject to the 15.107 and 15.207 limits.

Either radiated measurement with antenna in place or Antenna-port conducted measurement plus cabinet emissions test with antenna terminated can be used.

Table 4.1.1 FCC Part 15.205 (a) Restricted Bands of Operation

MHz	MHz	MHz	GHz
0.090 - 0.110	16.42 - 16.423	399.9 - 410	4.5 - 5.15
0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2690 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	Above 38.6
13.36 - 13.41			

(5) Frequency Stability (FCC 15.407 (g)).

Manufacturers of UNII devices are responsible for ensuring frequency stability such that an emission is maintained within the band of operation under all conditions of normal operation as specified in the users manual.

KDB 789033 D02 Section II.A.3 stated that the grantee is responsible for ensuring that the EUT meets Section 15.407(g) requirements; however, the applications for equipment certification are *not* required to include test reports with explicit demonstration of compliance.

(6) Antennas to Be Tested (15.203, 15.204, KDB 353028 D01)

Section 15.204(c)(2) requires that compliance testing use the *actual* antennas to be certified with the part 15 intentional radiator. All devices (*e.g.*, radio card, module) must be tested with the antennas connected to the device.

Section 15.204(b) states that an approved "transmission system" must always be marketed as a complete system, *i.e.,* including the antenna.

KDB 353028 D01 Section III.A stated that when submitting test data for part 15 transmitters to be used with multiple antennas, the testing for the highest gain of each type of antenna (*e.g.,* highest gain for each patch, yagi, grid, dish, monopole, etc.) was required. For systems that can operate at different power levels, test data with the highest output power must be submitted.

4.2. UNII-1/3 Band Carrier Frequencies

Table 4.2.1 (a) 5.1GHz UNII-1 (5170-5250MHz) Frequency Channel Plan

Channel No.	Freq (MHz)	Bandwidth
36	5180	20MHz
40	5200	
44	5220	
48	5240	
36, 40	5180, 5200	40MHz
44, 48	5220, 5240	
36, 40, 44	5180, 5200, 5220	60MHz
40, 44, 48	5200, 5220, 5240	

Table 4.2.1 (b) 5.8GHz UNII-3 (5735 -5835MHz) Frequency Channel Plan

Channel No.	Freq (MHz)	Bandwidth
149	5745	20MHz
153	5765	
157	5785	
161	5805	
165	5825	
149, 153	5745, 5765	40MHz
157, 161	5785, 5805	
161, 165	5805, 5825	
149, 153, 157	5745, 5765, 5785	60MHz
157, 161, 165	5785, 5805, 5825	

Table 4.2.2(a) 5.1GHz UNII-1 (5170 -5250MHz) Frequency Channels Used for Testing

Channel No.	Freq (MHz)	Bandwidth
36	5180	20MHz
44	5220	
48	5240	
36, 40	5180, 5200	40MHz
44, 48	5220, 5240	
36, 40, 44	5180, 5200, 5220	60MHz
40, 44, 48	5200, 5220, 5240	

Table 4.2.2(b) 5.8GHz UNII-3 (5735 -5835MHz) Channels Used for Testing

Channel No.	Freq (MHz)	Bandwidth
149	5745	20MHz
157	5785	
165	5825	
149, 153	5745, 5765	40MHz
157, 161	5785, 5805	
161, 165	5805, 5825	
149, 153, 157	5745, 5765, 5785	60MHz
157, 161, 165	5785, 5805, 5825	

4.3. Test Configurations and Setup

All measurements were performed with the EUT transmitting at 100% duty cycle (at least 98% if required by the EUT for amplitude control purposes) at the following power control level.

Table 4.3.1 Power Levels Tested

Band	Total Per Port Power Setting for Antennas #1-#4 ($G^{max} \leq 6$ dBi)	Total Per Port Power Setting for Antenna #5 ($G^{max} = 9.5$ dBi)
UNII-1	26 dBm	22.5 dBm
UNII-3	27 dBm	23.5 dBm

Various modulation types (Q/16QAM, 64QAM and 256QAM) and bandwidth modes (20MHz, 40MHz and 60MHz) were evaluated for the conducted and radiated tests, incluing RF power output, peak power spectrum density, emissions bandwidth and unwanted emissions.

The test setup diagrams are given below.

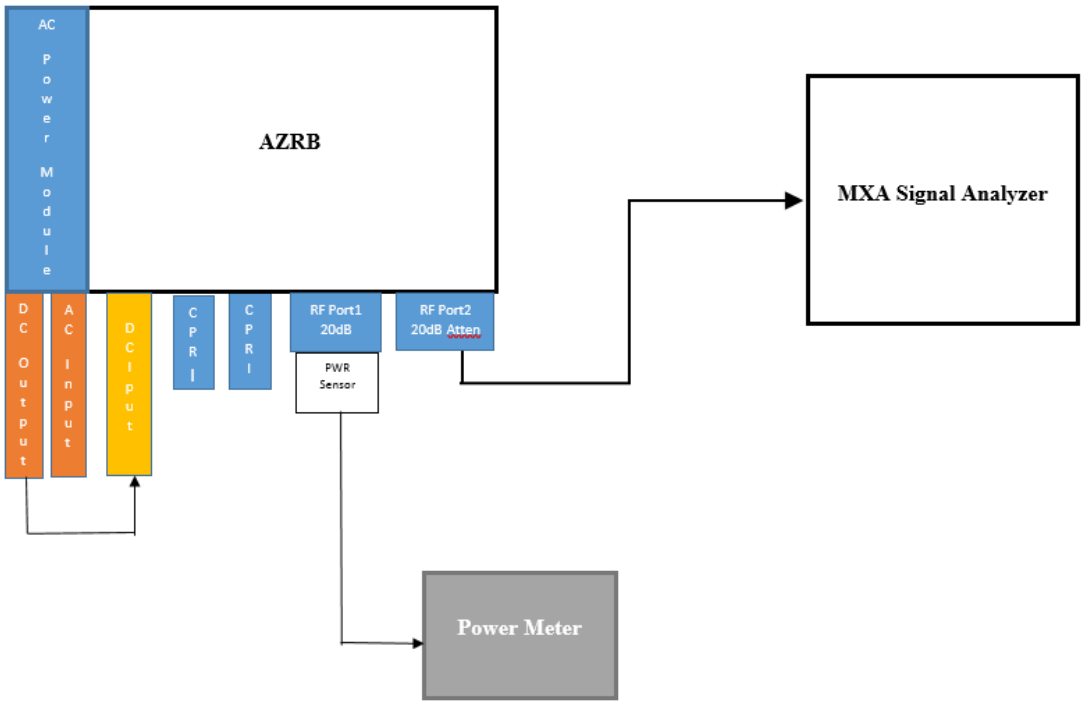


Figure 4.3.1 Setup Diagram of Conducted Test

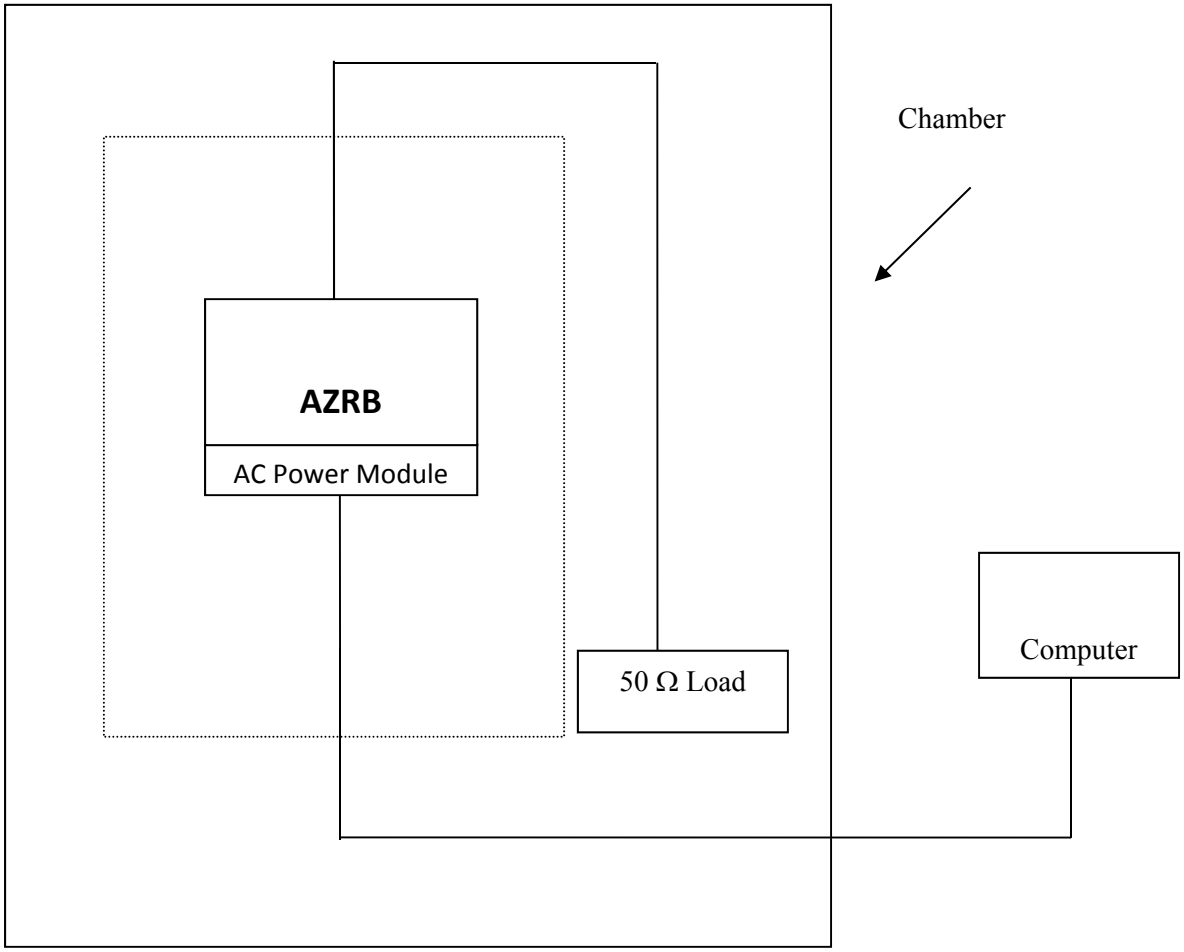


Figure 4.3.2 Setup Diagram of Radiated Test

4.4. MEASUREMENT REQUIRED: EMISSION BANDWIDTH (26 dB BANDWIDTH) – FCC SECTIONS 15.403 (i) & 15.215(c)

The measurement requirements of the emission bandwidth were provided in Section 4.1

The 26dB emission bandwidth was measured at one antenna port (port 2) for all channels listed in Table 4.2.2. The measurement follows the procedures given in KDB 789033 D02. The automatic bandwidth measurement function of the spectrum analyzer was utilized where the resolution bandwidth (RBW) is initially set to 1% of the bandwidth and the video bandwidth (VBW), that is 200kHz for 20MHz, 400kHz for 40MHz and 600kHz for 60MHz, the video bandwidth was set to 1MHz, and the peak detector with maximum hold and auto sweep was used. Then the maximum width of the emission that is 26 dB down from the maximum of the emission was measure and compared with the RBW setting of the analyzer. The RBW might be readjusted as needed until the RBW/EBW ration is approximately 1%.

The maximum allowable conducted power levels were used for this measurement. The measured results are tabluated below. Three plots which have the widest emission bandwidth are provided below.

Table 4.4.1(a) 26dB Emissions Bandwidth for One-20MHz Carrier UNII-1 (26dBm/port)

Bands (GHz)	Ch No/ Carrier Freq (MHz)	Modulation	Port 1 (MHz)	Port 2 (MHz)
UNII-1 (5.17-5.25)	36/5180	Q/16QAM	18.83	18.80
		256QAM	18.93	19.04
	44/5220	Q/16QAM	18.92	19.21
		256QAM	19.04	19.08
	48/5240	Q/16QAM	18.90	19.22
		256QAM	19.02	18.96

Table 4.4.1(b) 26dB Emissions Bandwidth for Two-20MHz Carriers UNII-1 (26dBm/port)

Bands (GHz)	Ch No/ Carrier Freq (MHz)	Modulation	Port 2 (MHz)
UNII-1 (5.17-5.25)	36, 40/ 5180, 5200	Q/16QAM	39.14
		256QAM	39.18
	44, 48/ 5220, 5240	Q/16QAM	39.02
		256QAM	39.31

Table 4.4.1(c) 26dB Emissions Bandwidth for Three-20 MHz Carriers UNII-1 (26dBm/port)

Bands (GHz)	Ch No/ Carrier Freq (MHz)	Modulation	Port 2 (MHz)
UNII-1 (5.17-5.25)	36, 40, 44/ 5180, 5200, 5220	Q/16QAM	59.44
		64QAM	59.65
		256QAM	59.63
	40, 44, 48/ 5200, 5220, 5240	Q/16QAM	59.53
		64QAM	59.58
		256QAM	59.65

Table 4.4.2(a) 26dB Emissions Bandwidth for One 20MHz Carrier UNII-3 (27dBm/port)

Bands (GHz)	Ch No/ Freq (MHz)	Modulation	Port 2 (MHz)
UNII-3 (5.735- 5.835)	149/5745	Q/16QAM	18.94
		256QAM	19.08
	157/5785	Q/16QAM	18.85
		256QAM	19.07
	165/5825	Q/16QAM	18.87
		256QAM	19.09

Table 4.4.2(b) 26dB Emissions Bandwidth for Two-20MHz Carriers UNII-3 (27dBm/port)

Bands (GHz)	Ch No/ Freq (MHz)	Modulation	Port 2 (MHz)
UNII-3 (5.74- 5.835)	149, 153/ 5745, 5765	Q/16QAM	39.15
		64QAM	39.32
		256QAM	39.38
	157, 161/ 5785, 5805	Q/16QAM	39.11
		256QAM	39.33
	161, 165/ 5805, 5825	Q/16QAM	39.02
		256QAM	39.20

Table 4.4.2(c) 26dB Emissions Bandwidth for Three-20MHz Carriers UNII-3 (27dBm/port)

Bands (GHz)	Ch No/ Freq (MHz)	Modulation	Port 2 (MHz)
UNII-3 (5.74- 5.835)	149, 153, 157/ 5745, 5765, 5785	Q/16QAM	59.68
		256QAM	59.67
	157, 161, 165/ 5785, 5805, 5825	Q/16QAM	59.62
		256QAM	59.64

For UNII-1, the 26dB emission bandwidth measured with 26dBm power setting was in the range of 18.80-19.22 MHz for one-20MHz carriers, 39.02-39.31 MHz for two-20MHz carriers, and 59.44-59.65 MHz for three-20MHz carriers. The maximum 26dB bandwidths measured are all less their nominal bandwidths. Therefore, any transmission that does not intentionally extend into the 5.25−5.35 GHz band is down 26 dB above 5.25 GHz and met the requirements of FCC Section 15.215(c) and KDB 789033D02 III.B for devices operating in the 5.15−5.25 GHz band.

For UNII-3, the 26dB emission bandwidth measured with 27dBm power setting was in the range of 18.85-19.09 MHz for one-20MHz carriers, 39.02-39.33 MHz for two-20MHz carriers and 59.62-59.68 MHz for three-20MHz carriers.

The maximum 26dB emissions bandwidths of the EUT measured at its antenna transmitting terminals across the UNII-1 and UNII-3 bands for various modulations are tabulated below. The results and measurements are in full compliance with the Rules of the Commission.

Table 4.4.3 Maximum 26dB Emissions Bandwidth (EBW) Measured

Bands (GHz)	Bandwidth (MHz)	Max 26dB EBW (MHz)	Test Limit	Test Results
UNII-1 (5.17-5.25)	1 x 20MHz	19.22	26dB EBW is outside 5.25 − 5.35GHz Band	Pass
	2 x 20MHz	39.31		Pass
	3 x 20MHz	59.65		Pass
UNII-3 (5.74- 5.835)	1 x 20MHz	19.09	NA	Pass
	2 x 20MHz	39.38		Pass
	3 x 20MHz	59.68		Pass

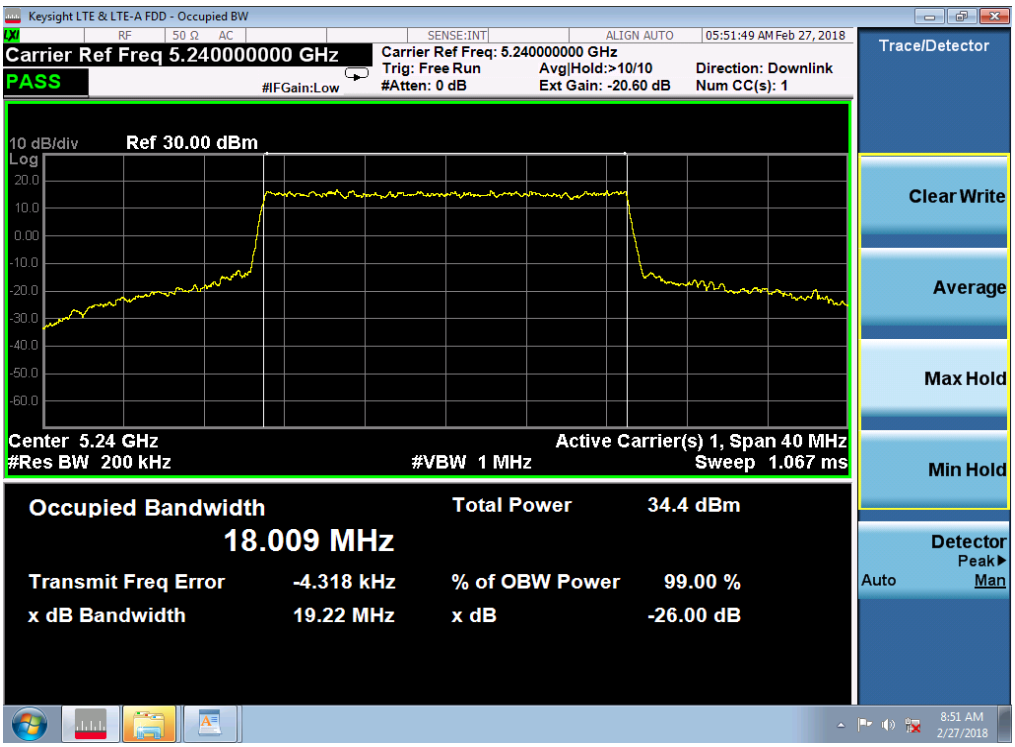


Figure 4.4.1(a) The Maximum 26dB Emission Bandwidth Measured (19.22MHz) for UNII-1 20 MHz Carrier at Ch 48/5240MHz, 26dBm, Q/16QAM, Port 2.

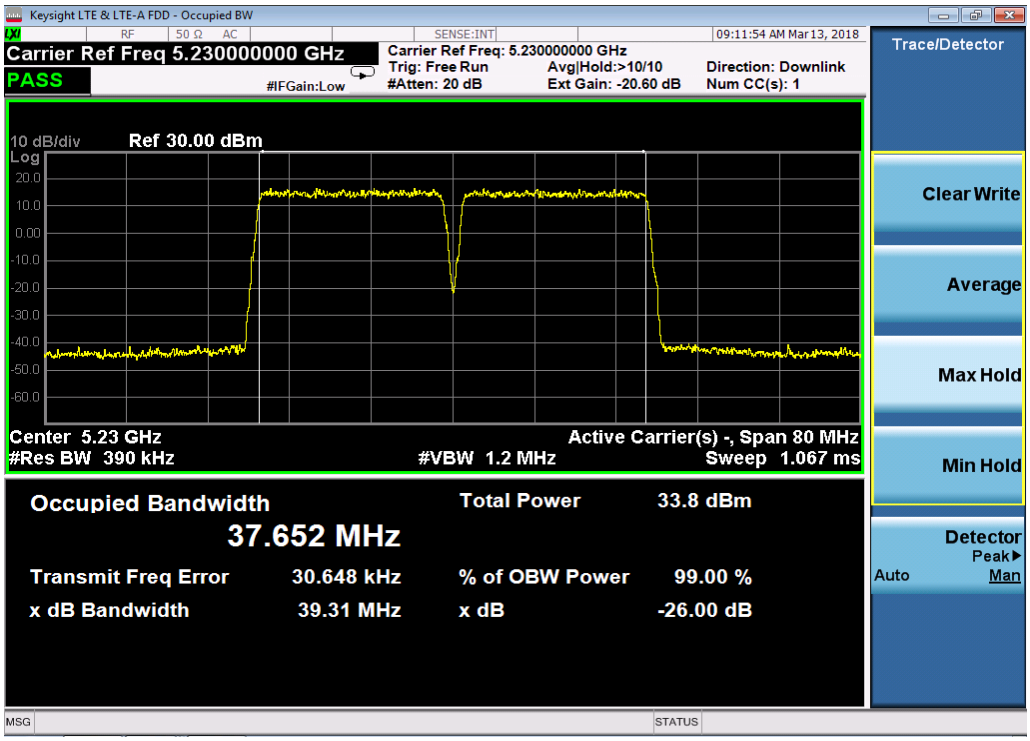


Figure 4.4.1(b) The Maximum 26dB Emission Bandwidth Measured (39.31MHz) for UNII-1 Two 20 MHz Carrier at Ch 44, 48/5220, 5240MHz, 26dBm, 256QAM, Port 2.

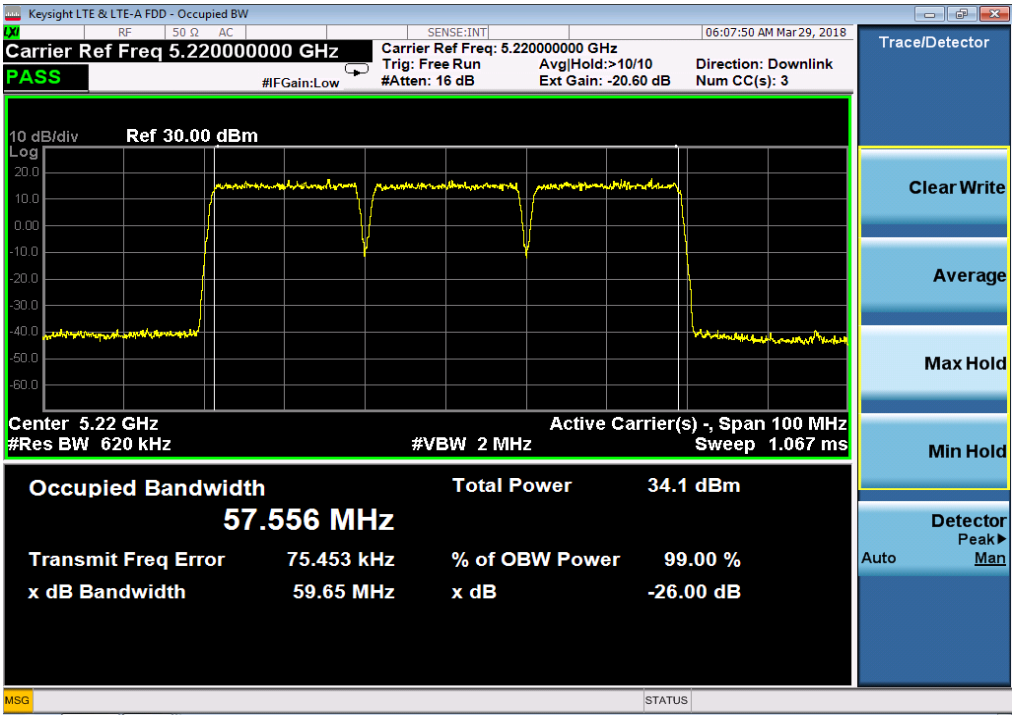


Figure 4.4.1(c) The Maximum 26dB Emission Bandwidth Measured (59.65MHz) for UNII-1 Three 20MHz Carrier at Ch 40, 44, 48/5200, 5220, 5240MHz, 26dBm, 256QAM, Port 2.

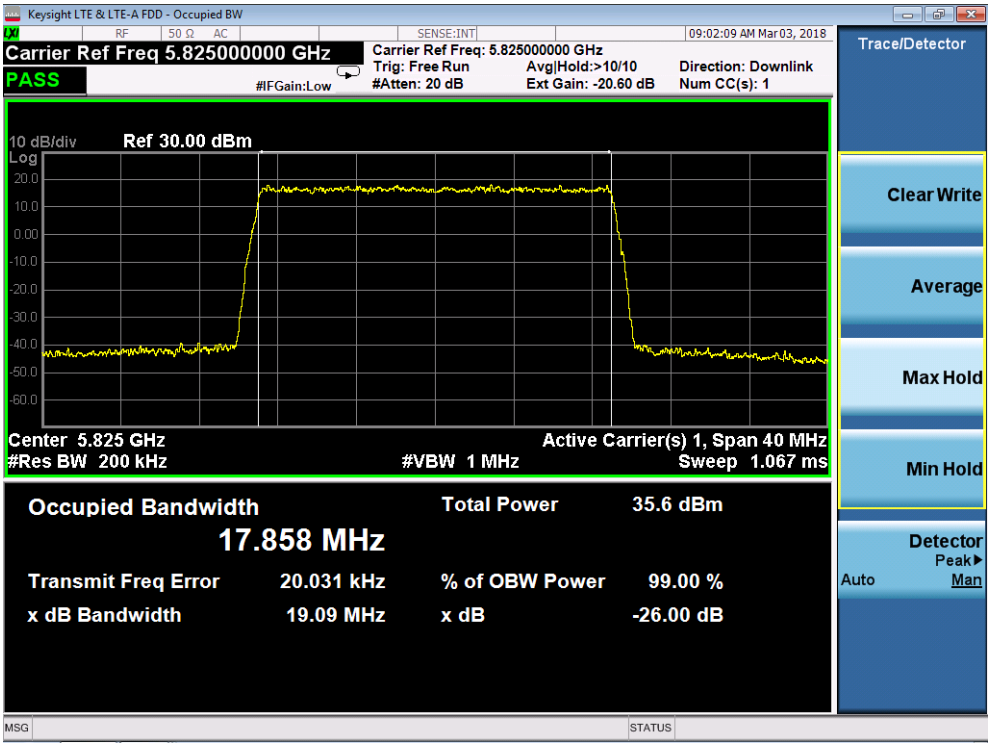


Figure 4.4.2(a) The Maximum 26dB Emission Bandwidth Measured (19.09MHz) for UNII-3 20 MHz Carrier at Ch 165/5825MHz, 27dBm, 256QAM, Port 2.

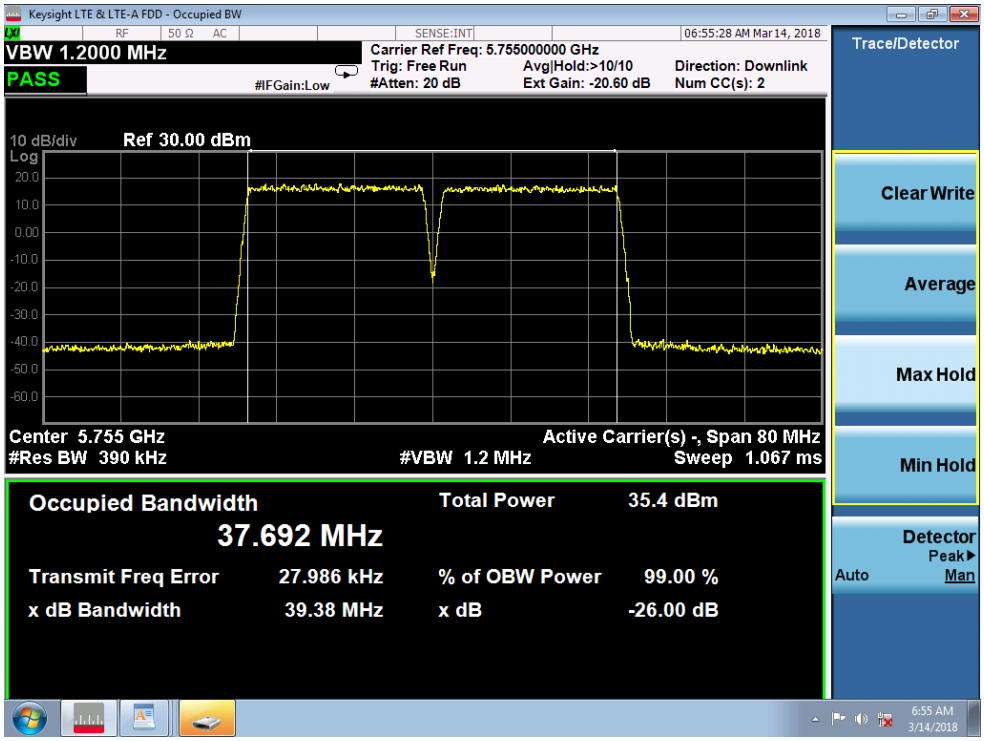


Figure 4.4.2(b) The Maximum 26dB Emission Bandwidth Measured (39.38MHz) for UNII-3 Two 20 MHz Carrier at Ch 149, 153/5745, 5765MHz, 27dBm, 256QAM, Port 2.

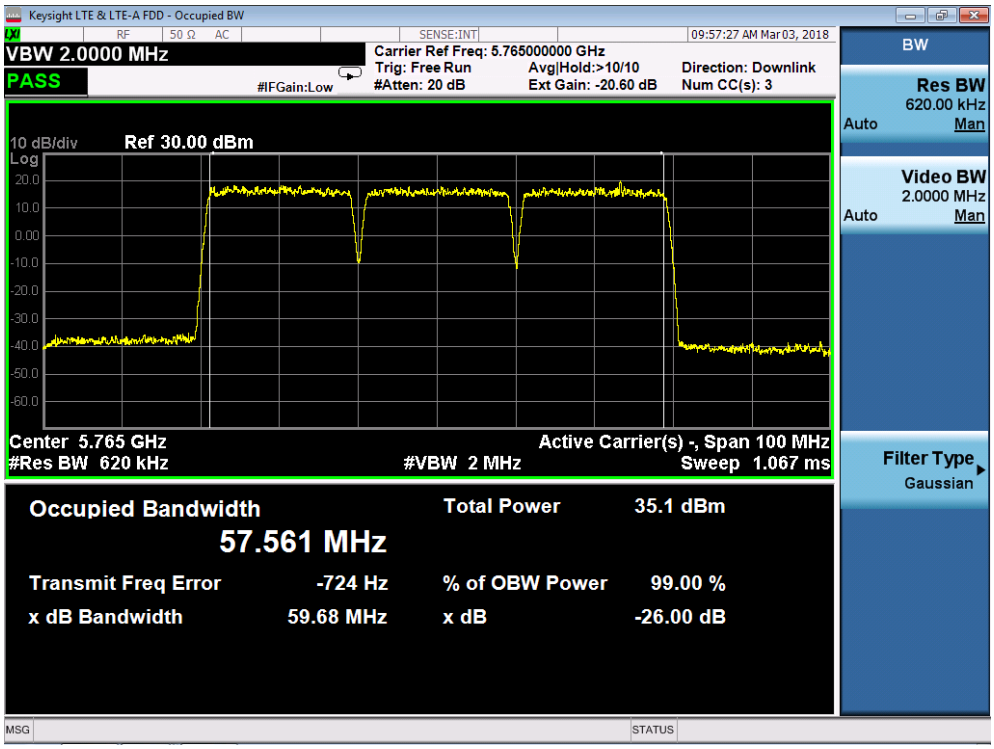


Figure 4.4.2(c) The Maximum 26dB Emission Bandwidth Measured (59.68MHz) for UNII-3 Three 20 MHz Carrier at Ch 149, 153, 157/5745, 5765, 5785 MHz, 27dBm, Q/16QAM, Port 2.

4.5.MEASUREMENT REQUIRED: MINIMUM EMISSION BANDWIDTH (6 dB BANDWIDTH) – FCC SECTION 15.407 (e)

The 6dB emission bandwidth was measured at one antenna port (port 2) for the UNII-3 20MHz middle channel listed in Table 4.2.2(b) with all modulations. The measurement follows the procedures given in KDB 789033 D02, Seciotn II.C.2. The RBW and VBW were set to 100kHz and 1MHz, respectively. The peak detector with maximum hold and auto sweep was used. Then the maximum width of the emissions that is 6 dB down from the maximum of the emission was measure.

Due to the significant large margin, only one power level, 27dBm per port, was measured for 6dB emission bandwidth. For UNII-3 with 27dBm per port, the 6dB emission bandwidths measured were in the range of 18.00-18.05 MHz for 20MHz carriers, which are well larger than 500kHz requirement. The measured results are tabluated below. The plot which has the smallest emission bandwidth is provided below.

Table 4.5.1 6dB Emission Bandwidth for 20MHz Carriers (27dBm/port) at Port 2

Bands (GHz)	Ch No/ Freq (MHz)	Modulation	6dB Bandwidth (MHz)	Test Limit	Test Results
UNII-3 (5.735- 5.835)	157/5785	Q/16QAM	18.00	≥ 500 kHz	Pass
		64QAM	18.03		Pass
		256QAM	18.05		Pass

The minimum 6dB emission bandwidth of the EUT measured at its antenna transmitting terminals for the UNII-3 band for all operation modes is 18.00 MHz, larger than 500kHz requirement. The results and measurements are in full compliance with the Rules of the Commission.

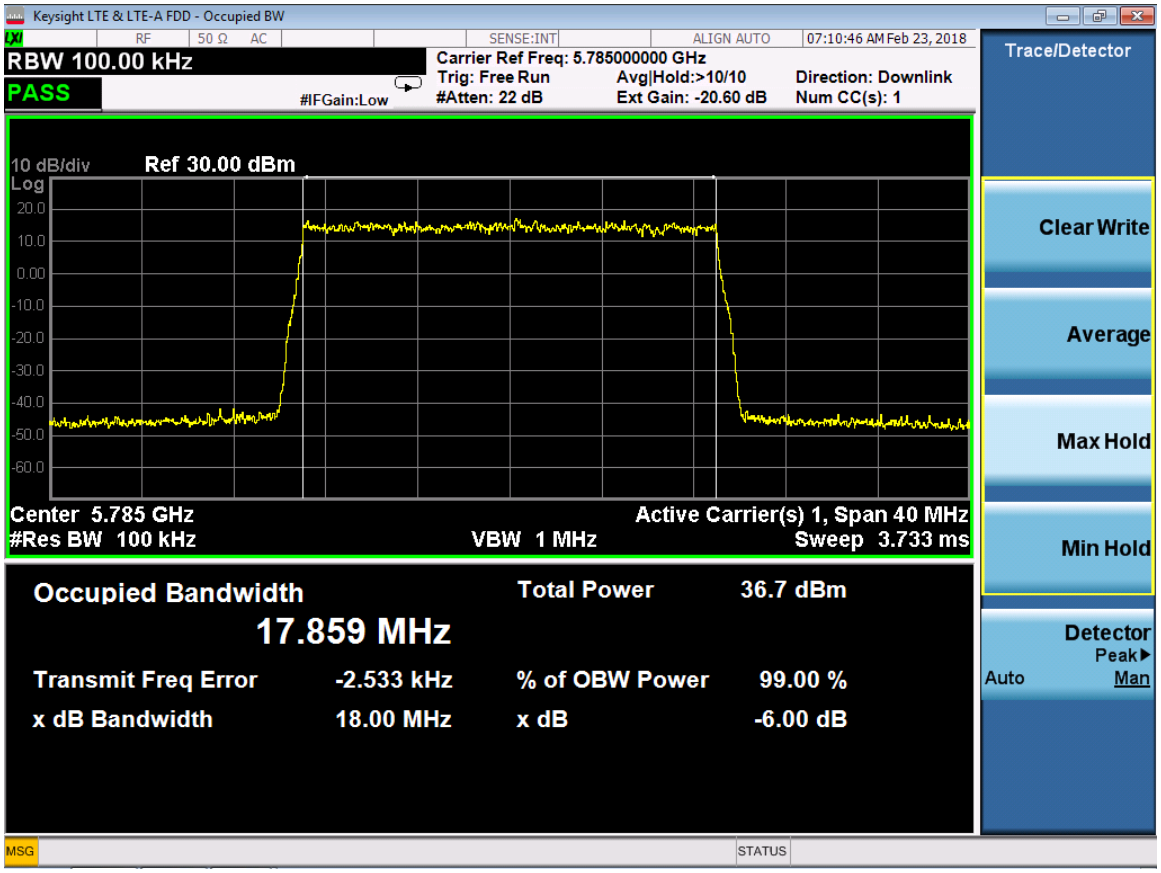


Figure 4.5.1 The Minimum 6dB Emission Bandwidth Measured (18.00MHz) for a 20MHz Carrier at Ch 157/5785MHz, 27dBm, Q/16QAM, Port 2.

4.6. MEASUREMENT REQUIRED: MAXIMUM POWER OUTPUT AND MAXIMUM OUTDOOR EIRP – FCC SECTION 15.407 (a)(1)(3)(4)

The maximum ouput power was measured at the both antenna ports for all channels listed in Table 4.2.2 and all modulations. The measurement follows the procedures given in KDB 789033 D02.

The power limit is 1W (30dBm). The maximum conducted output power shall be reduced by the amount in dB that the antenna gain exceeds 6 dBi.

For multiple antennas with equal transmit power but unequal gains, per KDB 662911 D01, the directional antenna gain of uncorrelated signals is equal to

$$\text{Directional Gain} = 10\log\left[\frac{10^{G_1/10} + 10^{G_2/10} + \ldots\ldots + 10^{G_N/10}}{N_{ANT}}\right] dBi, \quad \text{and}$$

the directional antenna gain of correlated signals is equal to

$$\text{Directional Gain} = 10\log\left[\frac{\left(10^{G_1/20} + 10^{G_2/20} + \ldots\ldots + 10^{G_N/20}\right)^2}{N_{ANT}}\right] dBi,$$

where G_1, G_2 ..., G_N are antenna gains.

For the spatial multiplexing (SM) transmissions, like 802.11n MCS8-15, the EUT operates with two uncorrelated spatial data streams on two transmitting ports. Per KDB 662911 D01 (Section (F)(2)(e)), the directional antenna gain may be calculated by using either of the following methods:

i. Directional Gain = Max{G_1, G_2 ..., G_N} + Array Gain = Max{ G_1, G_2 ..., G_N}, where Array Gain =10 *log* (N_{ANT}/N_{SS}) = 0
ii. Calculate the directional gain by using the formula for uncorrelated signals provided above if each antenna is only fed by its own data stream.

For Cyclic Delay Diversity (CDD) transmissions, per KDB 662911 D01 (Section (F)(2)(f)), the directional antenna gain may be calculated by using either of the following methods:

i. Directional Gain = Max{ G_1, G_2 ..., G_N} + Array Gain
   a. For power measurements, Array Gain = 0 if $N_{ANT} \leq 4$;
   b. For power spectrum density (PSD) measurement, Array Gain = 10 *log* (N_{ANT}/N_{SS}) dB, where N_{ss} is number of spatial streams and N_{ss} = 1 was suggested by the FCC for calculating the worst directional gain.
ii. Calculate the directional gain by using the formula for correlated signals provided above.

The EUT does not have beamforming function and two signals are not correlated. Hence, for the power and PSD limits, the directional antenna gain was calculated by using the equation above for uncorrelated signals. The limits for the combined maximum transmitting power and PSD are calculated and tabulated below.

Table 4.6.1. Transmitter Power and PSD Limits at Antenna Ports

Band	Antenna	Max Directional Gain for Spectral Density (dBi)	Max Directional Gain for Total Power (dBi)	Total PSD Limit	Total Power Limit (dBm)
UNII-1	#1-#4	6.0	6.0	17.00 (dBm/MHz)	30.00
	#5	9.5	9.5	13.5 (dBm/MHz)	26.5
UNII-3	#1-#4	6.0	6.0	30.00 (dBm/500kHz)	30.00
	#5	9.5	9.5	26.5 (dBm/500kHz)	26.5

The output power of the EUT was first verified by a power meter and then measured by a spectrum analyzer. The RBW and VBW were set to 1MHz and 3MHz, respectively. The RMS detector and trace average (≥ 100) were used. The output power was calculated by integrating the spectrum across the EBW of the carrier using the SA's band power measurement function with band limits set equal to the EBW band edges. The total combined output power was calculated by summing the measured output power in mW at the various antenna ports.

For UNII-1 band, the maximum total output power measured for the EUT equipped with the antennas #1-#4 among all operation modes supported was 28.59dBm for one-20MHz carriers, 28.51dBm for two-20MHz carriers, and 28.39dBm for three-20MHz carriers. They are all below the FCC required limits.

For UNII-3 band, the maximum total output power measured for the EUT equipped with the antennas #1-#4 among all operation modes supported was 29.63dBm for one-20MHz carriers, 29.2dBm for two-20MHz carriers, and 28.01 for three-20MHz MHz. They are all below the FCC required limits.

For UNII-1 band, the maximum total output power measured for the EUT equipped with the antenna #5 among all operation modes supported was 25.20dBm for one-20MHz carriers, 25.13dBm for two-20MHz carriers, and 24.90dBm for three-20MHz carriers. They are all below the FCC required limits.

For UNII-3 band, the maximum total output power measured for the EUT equipped the antenna #5 among all operation modes supported was 26.38dBm for one-20MHz carriers, 26.34dBm for two-20MHz carriers, and 26.03 for three-20MHz carriers. They are all below the FCC required limits.

The measurement results for the conducted output power at both ports and 12 plots which have maximum output power among them are provided below in Tables 4.6.2-4.6.5. The maximum EIRP (dBm) in the elevation angle above 30 Degrees in UNII-1 Band (5.15-5.25 GHz) is given in Table 4.6.6.

Table 4.6.2(a) Maximum Mean Combined RF Power Output at Antenna Ports for 5GHz 20MHz Carrier at 26dBm for UNII-1 and 27dBm for UNII-3 for Antennas #1-#4

Bands (GHz)	Ch No/ Freq (MHz)	Modulation	Port 1 (dBm)	Port 2 (dBm)	Total Power (dBm)	Power Limit (dBm)	Test Results
UNII-1 (5.17- 5.25)	36/5180	Q/16QAM	25.22	25.37	28.31	30	Pass
		64QAM	25.23	25.34	28.30	30	Pass
		256QAM	25.23	25.33	28.29	30	Pass
	44/5220	Q/16QAM	25.18	25.40	28.30	30	Pass
		64QAM	25.28	25.42	28.36	30	Pass
		256QAM	25.30	25.48	28.40	30	Pass
	48/5240	Q/16QAM	25.57	25.59	28.59	30	Pass
		64QAM	25.49	25.53	28.52	30	Pass
		256QAM	25.53	25.46	28.51	30	Pass
UNII-3 (5.74-5.835)	149/5745	Q/16QAM	26.48	26.67	29.59	30	Pass
		64QAM	26.59	26.65	29.63	30	Pass
		256QAM	26.51	26.67	29.60	30	Pass
	157/5785	Q/16QAM	26.44	26.45	29.46	30	Pass
		64QAM	26.64	26.41	29.54	30	Pass
		256QAM	26.62	26.38	29.51	30	Pass
	165/5825	Q/16QAM	26.25	26.45	29.36	30	Pass
		64QAM	26.35	26.47	29.42	30	Pass
		256QAM	26.27	26.47	29.38	30	Pass

Table 4.6.2(b) Maximum Mean Combined RF Power Output at Antenna Ports for 5GHz 20MHz Carrier at 22.5dBm for UNII-1 and 23.5dBm for UNII-3 for Antenna #5

Bands (GHz)	Ch No/ Freq (MHz)	Modulation	Port 1 (dBm)	Port 2 (dBm)	Total Power (dBm)	Power Limit (dBm)	Test Results
UNII-1 (5.17-5.25)	36/5180	Q/16QAM	21.93	22.02	24.99	26.5	Pass
		64QAM	21.94	22.02	24.99	26.5	Pass
		256QAM	21.95	22.02	25.00	26.5	Pass
	44/5220	Q/16QAM	22.09	21.88	25.00	26.5	Pass
		64QAM	22.09	22.20	25.16	26.5	Pass
		256QAM	22.08	22.18	25.14	26.5	Pass
	48/5240	Q/16QAM	22.16	22.21	25.20	26.5	Pass
		64QAM	22.12	22.20	25.17	26.5	Pass
		256QAM	22.12	22.19	25.17	26.5	Pass
UNII-3 (5.74- 5.835)	149/5745	Q/16QAM	23.28	23.43	26.37	26.5	Pass
		64QAM	23.26	23.41	26.35	26.5	Pass
		256QAM	23.28	23.45	26.38	26.5	Pass
	157/5785	Q/16QAM	23.19	23.40	26.31	26.5	Pass
		64QAM	23.23	23.37	26.31	26.5	Pass
		256QAM	23.27	23.38	26.34	26.5	Pass
	165/5825	Q/16QAM	23.15	23.38	26.28	26.5	Pass
		64QAM	23.11	23.16	26.15	26.5	Pass
		256QAM	23.12	23.17	26.16	26.5	Pass

Table 4.6.3(a) Maximum Mean Combined RF Power Output at Antenna Ports for 5GHz Two-20MHz Carriers at 26dBm for UNII-1 and 27dBm for UNII-3 with Antennas #1-#4

Bands (GHz)	Ch No/ Freq (MHz)	Modulation	Port 1 (dBm)	Port 2 (dBm)	Total Power (dBm)	Power Limit (dBm)	Test Results
UNII-1 (5.17-5.25)	36, 40/ 5180, 5200	Q/16QAM	25.40	25.59	28.51	30	Pass
		64QAM	25.16	25.53	28.36	30	Pass
		256QAM	25.32	25.62	28.48	30	Pass
	44, 48/ 5220, 5240	Q/16QAM	25.47	25.53	28.51	30	Pass
		64QAM	25.32	25.53	28.44	30	Pass
		256QAM	25.35	25.45	28.41	30	Pass
UNII-3 (5.74-5.835)	149, 153/ 5745, 5765	Q/16QAM	25.78	26.18	28.99	30	Pass
		64QAM	26.10	26.27	29.20	30	Pass
		256QAM	26.10	26.23	29.18	30	Pass
	157, 161/ 5785, 5805	Q/16QAM	26.10	26.18	29.15	30	Pass
		64QAM	26.08	26.09	29.10	30	Pass
		256QAM	26.09	26.13	29.12	30	Pass
	161, 165/ 5805, 5825	Q/16QAM	25.89	26.03	28.97	30	Pass
		64QAM	25.90	26.02	28.97	30	Pass
		256QAM	25.90	26.02	28.97	30	Pass

Table 4.6.3(b) Maximum Mean Combined RF Power Output at Antenna Ports for 5GHz Two-20MHz Carrier at 22.5dBm for UNII-1 and 23.5dBm for UNII-3 with Antenna #5

Bands (GHz)	Ch No/ Freq (MHz)	Modulation	Port 1 (dBm)	Port 2 (dBm)	Total Power (dBm)	Power Limit (dBm)	Test Results
UNII-1 (5.17-5.25)	36, 40/ 5180, 5200	Q/16QAM	21.92	22.16	25.05	26.5	Pass
		64QAM	21.96	22.28	25.13	26.5	Pass
		256QAM	21.92	22.25	25.10	26.5	Pass
	44, 48/ 5220, 5240	Q/16QAM	22.03	22.12	25.09	26.5	Pass
		64QAM	22.01	22.13	25.08	26.5	Pass
		256QAM	22.04	22.10	25.08	26.5	Pass
UNII-3 (5.74- 5.835)	149, 153/ 5745, 5765	Q/16QAM	23.26	23.39	26.34	26.5	Pass
		64QAM	23.16	23.37	26.28	26.5	Pass
		256QAM	23.20	23.39	26.31	26.5	Pass
	157, 161/ 5785, 5805	Q/16QAM	23.01	23.25	26.14	26.5	Pass
		64QAM	22.96	23.25	26.12	26.5	Pass
		256QAM	23.03	23.22	26.14	26.5	Pass
	161, 165/ 5805, 5825	Q/16QAM	23.02	23.14	26.09	26.5	Pass
		64QAM	22.96	23.12	26.05	26.5	Pass
		256QAM	23.05	23.11	26.09	26.5	Pass

Table 4.6.4(a) Maximum Mean Combined RF Power Output at Antenna Ports for 5GHz Three-20MHz Carriers at 26dBm for UNII-1 and 27dBm for UNII-3 for Antennas #1-#4

Bands (GHz)	Ch No/ Freq (MHz)	Modulation	Port 1 (dBm)	Port 2 (dBm)	Total Power (dBm)	Power Limit (dBm)	Test Results
UNII-1 (5.17-5.25)	36, 40, 44/ 5180, 5200, 5220	Q/16QAM	25.30	25.41	28.37	30	Pass
		64QAM	25.26	25.47	28.38	30	Pass
		256QAM	25.25	25.44	28.36	30	Pass
	40, 44, 48/ 5200, 5220, 5240	Q/16QAM	25.40	25.36	28.39	30	Pass
		64QAM	25.38	25.34	28.37	30	Pass
		256QAM	25.36	25.34	28.36	30	Pass
UNII-3 (5.74-5.835)	149, 153, 157/ 5745, 5765, 5785	Q/16QAM	25.05	24.94	28.01	30	Pass
		64QAM	25.03	24.56	27.81	30	Pass
		256QAM	25.04	24.59	27.83	30	Pass
	157, 161, 165/ 5785, 5805, 5825	Q/16QAM	24.73	24.55	27.65	30	Pass
		64QAM	25.12	24.88	28.01	30	Pass
		256QAM	25.10	24.59	27.86	30	Pass

Table 4.6.4(b) Maximum Mean Combined RF Power Output at Antenna Ports for 5GHz Three-20MHz Carriers at 22.5dBm for UNII-1 and 23.5dBm for UNII-3 with Antenna #5

Bands (GHz)	Ch No/ Freq (MHz)	Modulation	Port 1 (dBm)	Port 2 (dBm)	Total Power (dBm)	Power Limit (dBm)	Test Results
UNII-1 (5.17-5.25)	36, 40, 44/ 5180, 5200, 5220	Q/16QAM	21.67	21.90	24.80	26.5	Pass
		64QAM	21.68	21.94	24.82	26.5	Pass
		256QAM	21.69	21.93	24.82	26.5	Pass
	40, 44, 48/ 5200, 5220, 5240	Q/16QAM	21.74	21.92	24.84	26.5	Pass
		64QAM	21.74	22.01	24.89	26.5	Pass
		256QAM	21.77	22.00	24.90	26.5	Pass
UNII-3 (5.74-5.835)	149, 153, 157/ 5745, 5765, 5785	Q/16QAM	22.97	23.07	26.03	26.5	Pass
		64QAM	22.92	23.08	26.01	26.5	Pass
		256QAM	22.80	23.02	25.92	26.5	Pass
	157, 161, 165/ 5785, 5805, 5825	Q/16QAM	22.68	22.84	25.77	26.5	Pass
		64QAM	22.70	22.90	25.81	26.5	Pass
		256QAM	22.66	22.96	25.82	26.5	Pass

As a result, the maximum total mean output powers at antenna ports measured are:

Table 4.6.5 Maximum Total Mean Output Power at Antenna Ports

Antennas Equipped	Power (dBm) UNII-1 (5.15-5.25 GHz)	Power (dBm) UNII-3 (5.725-5.835 GHz)
#1-#4 ($G^{max} \leq 6$ dBi)	28.59	29.63
#5 ($G^{max} = 9.5$ dBi)	25.20	26.42

The maximum antenna gains at any elevation angle above 30 degrees as measured from the horizon were provided in Table 3.3.2. Per KDB 789033 D02 Section II.H.1, for a fixed infrastructure without electrically or mechanically steerable beam antennas, the elevation plane radiation pattern can be used to calculate the maximum EIRP. For MIMO devices, take the maximum gain of each antenna and apply the guidance in KDB 662911 for calculating the overall gain including directional gain for maximum EIRP calculation. As stated before, the EUT does not have beamforming function and two signals are not correlated. The directional antenna gain is the gain of an individual antenna per KDB 662911.

The maximum EIRPs of the EUT equipped with any antennas given in Section 3.3 are tabulated below and are all below the 21dBm limit for an outdoor access point in UNII-1 band.

Table 4.6.6 Maximum EIRP (dBm) in the Elevation Angle above 30 Degrees in UNII-1 Band (5.15-5.25 GHz)

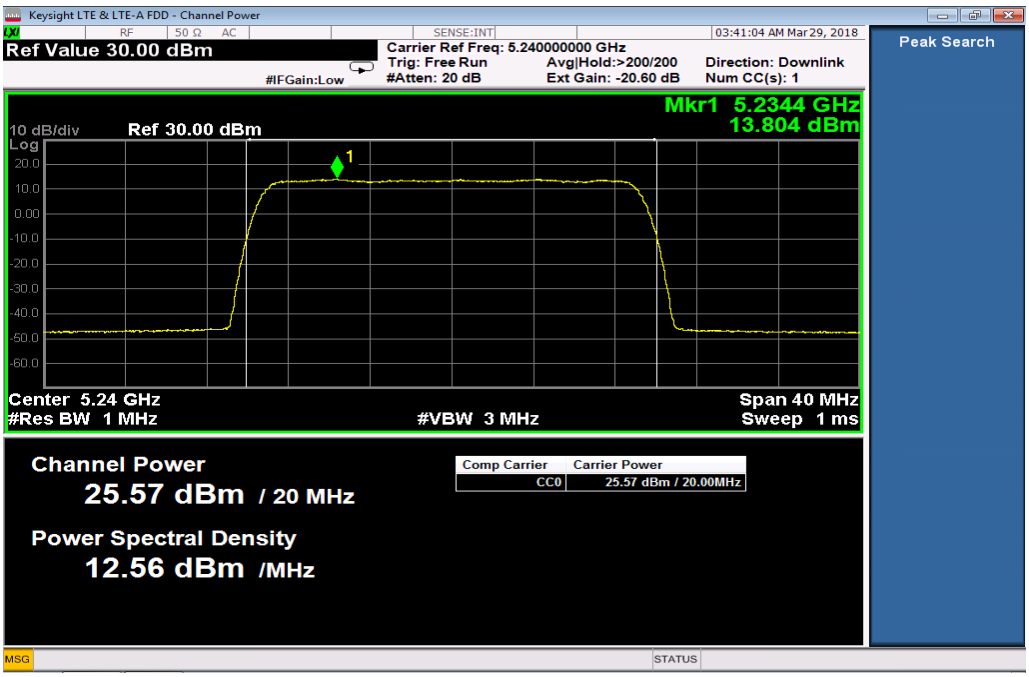
Antenna No	Max Power (dBm)	Antenna Max Directional Gain above 30° (dBi)	Max EIRP above 30° (dBm)	Limit (dBm)	Results
1	26.0	-9.1	16.9	21	Pass
2	26.0	-7	19.0	21	Pass
3	26.0	-9.5	16.5	21	Pass
4	26.0	-11	15.0	21	Pass
5	25.5	-7	18.5	21	Pass

For the antennas #1-#4, the maximum combined mean RF power outputs of the EUT at its antenna transmitting terminals across the UNII-1 and UNII-3 bands for all operation modes are a) 28.59dBm (0.72W, one-20MHz carriers), 28.51dBm (0.71W, two-20MHz carriers) and 28.39dBm (0.69W, three-20MHz carriers) for UNII-1 and b) 29.63dBm (0.92W, one-20MHz carriers), 29.2dBm (0.83W, two-20MHz carriers) and 28.01dBm (0.63W, three-20MHz carriers) for UNII-3, respectively. The maximum EIRPs of the EUT equipped with any antennas #1-#4 are all less than 35.63dBm.

For the antenna #5, the maximum combined mean RF power outputs of the EUT at its antenna transmitting terminals across the UNII-1 and UNII-3 bands for all operation modes are a) 25.20dBm (0.33W, one-20MHz carriers), 25.13dBm (0.33W, two-20MHz carriers) and 24.90dBm (0.31W, three-20MHz carriers for UNII-1 and b) 26.38dBm (0.43W, one-20MHz carriers), 26.34dBm (0.43W, two-20MHz carriers) and 26.03dBm (0.40W, three-20MHz carriers) for UNII-3, respectively. The maximum EIRPs of the EUT equipped with any antennas #1-#5 are all less than 35.92dBm.

The maximum EIRPs of the EUT equipped with any antennas #1-#5 at the elevation angles above 30 degrees are all less than 21 dBm (125mW).

They are all below FCC required limits and are in full compliance with the Rules of the Commission.



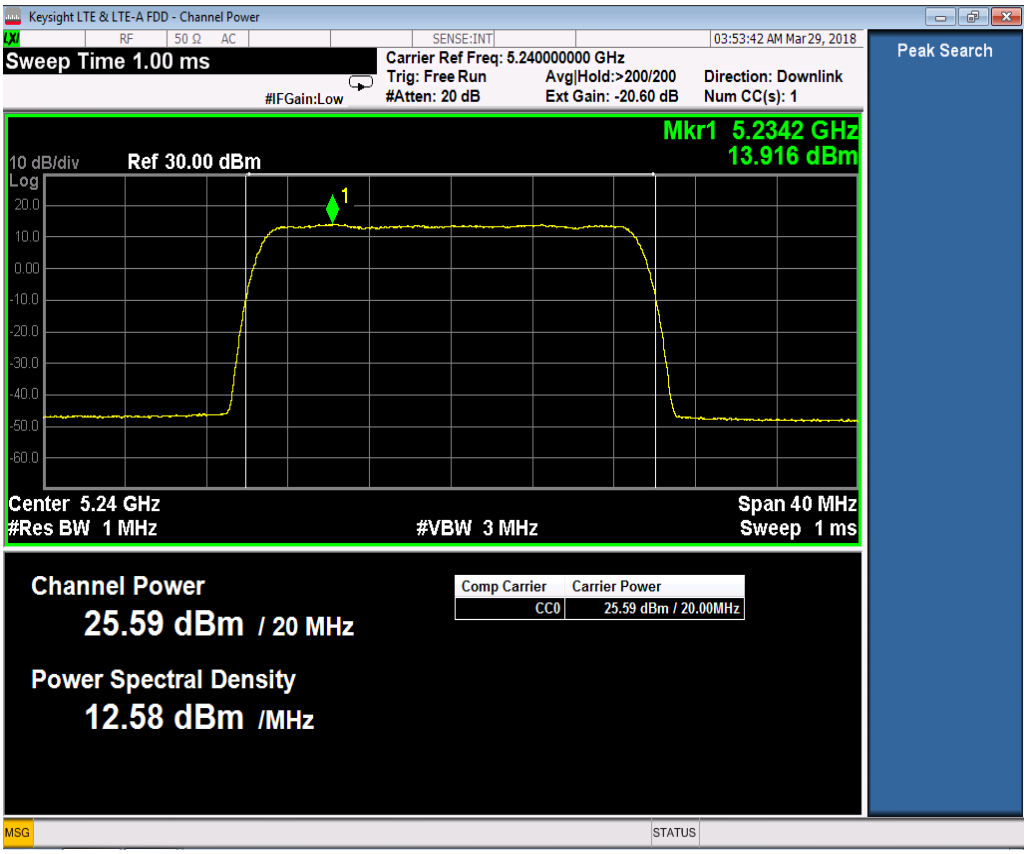
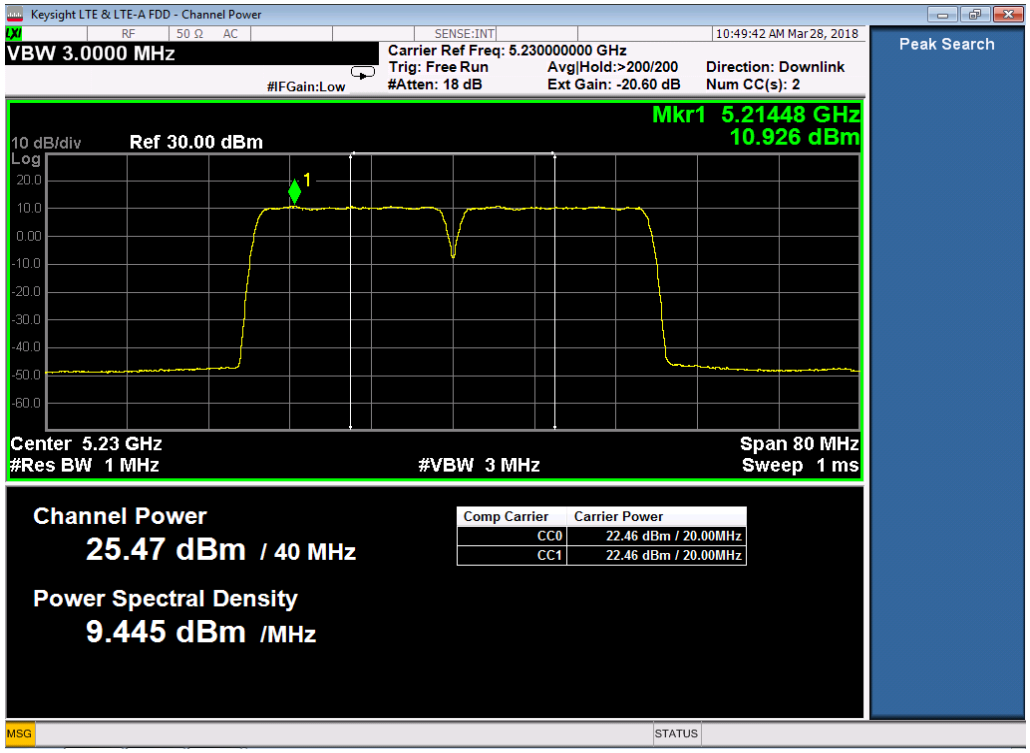


Figure 4.6.1 The Mean Output Power and PSD Measured for UNII-1 Q/16QAM 20MHz Carrier at Channel 48/5240MHz, 26dBm, Port 1 and Port 2, for EUT with Antennas #1-#4 (Combined Output Power 28.59 dBm).



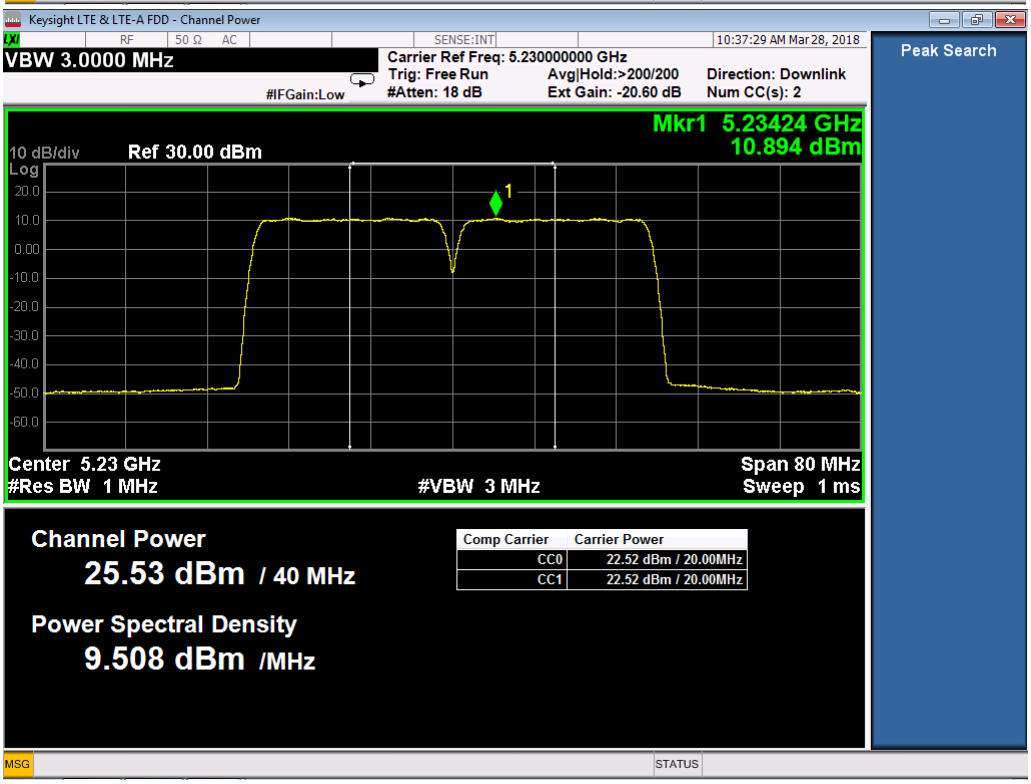
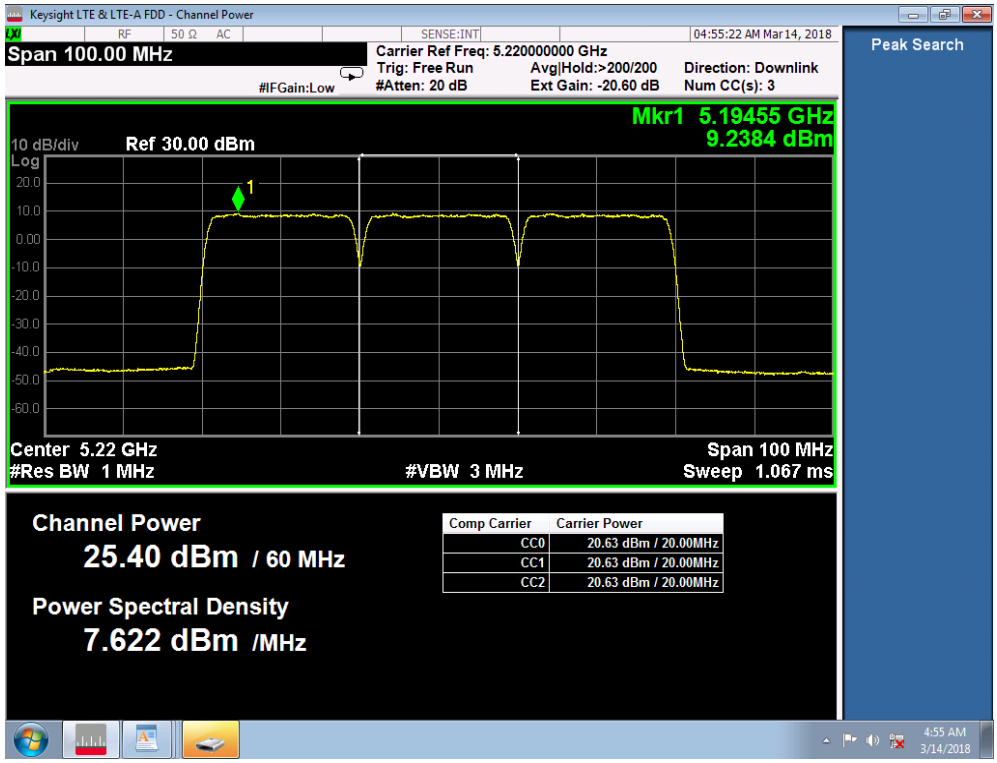


Figure 4.6.2 The Mean Output Power and PSD Measured for UNII-1 Q/16QAM Two 20MHz Carriers at Ch. 44, 48/5220, 5240MHz, 26dBm, Port 1 & Port 2, for EUT with Antennas #1-#4 (Combined Output Power 28.51 dBm).



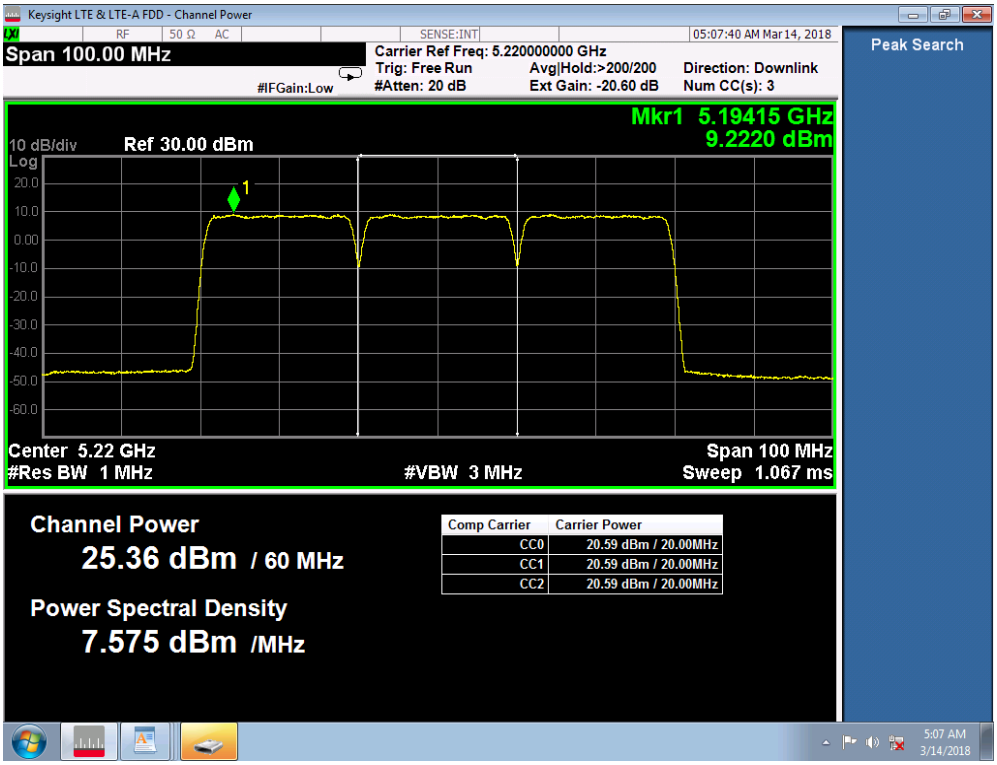
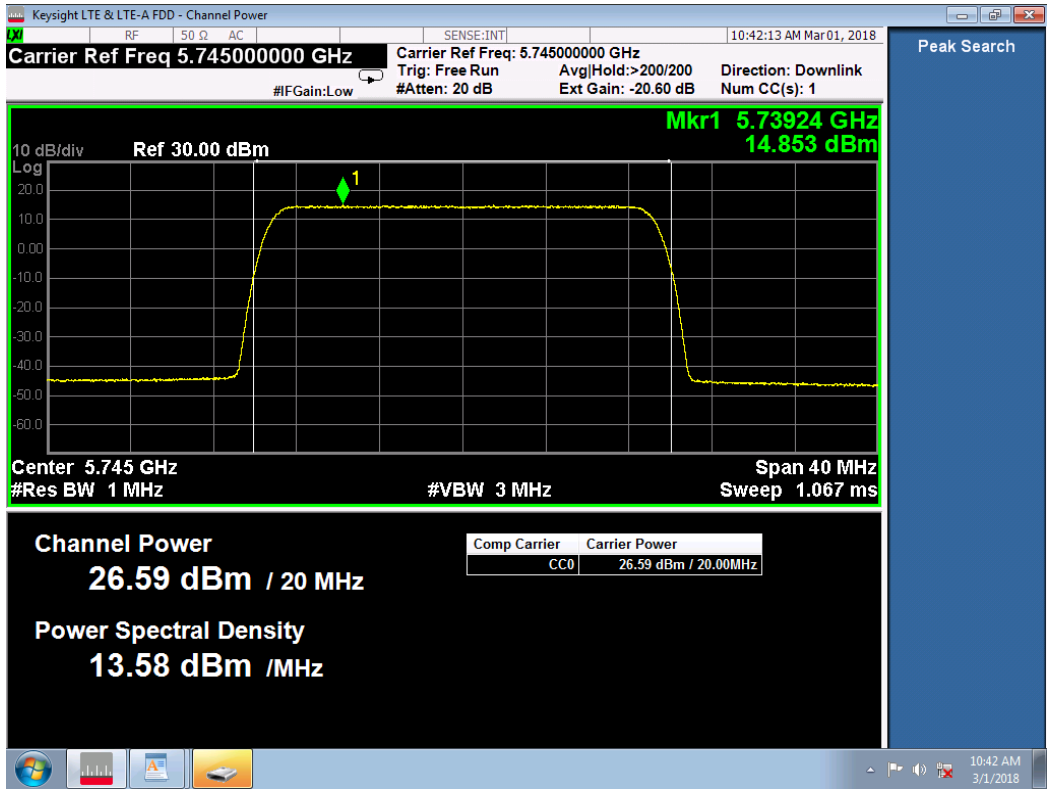


Figure 4.6.3 The Mean Output Power and PSD Measured for UNII-1 Q/16QAM Three 20MHz Carriers at Channel 40, 44, 48/5200, 5220, 5240MHz, 26dBm, Port 1 & Port 2, for EUT with Antennas #1-#4 (Combined Output Power 28.39 dBm).



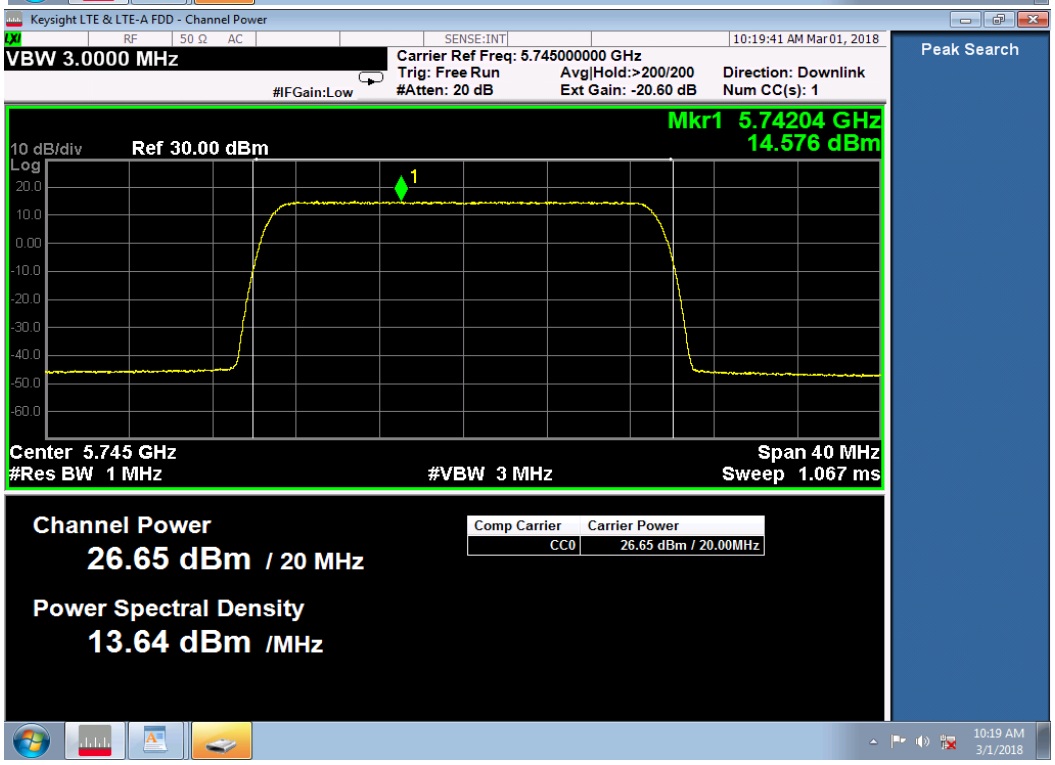
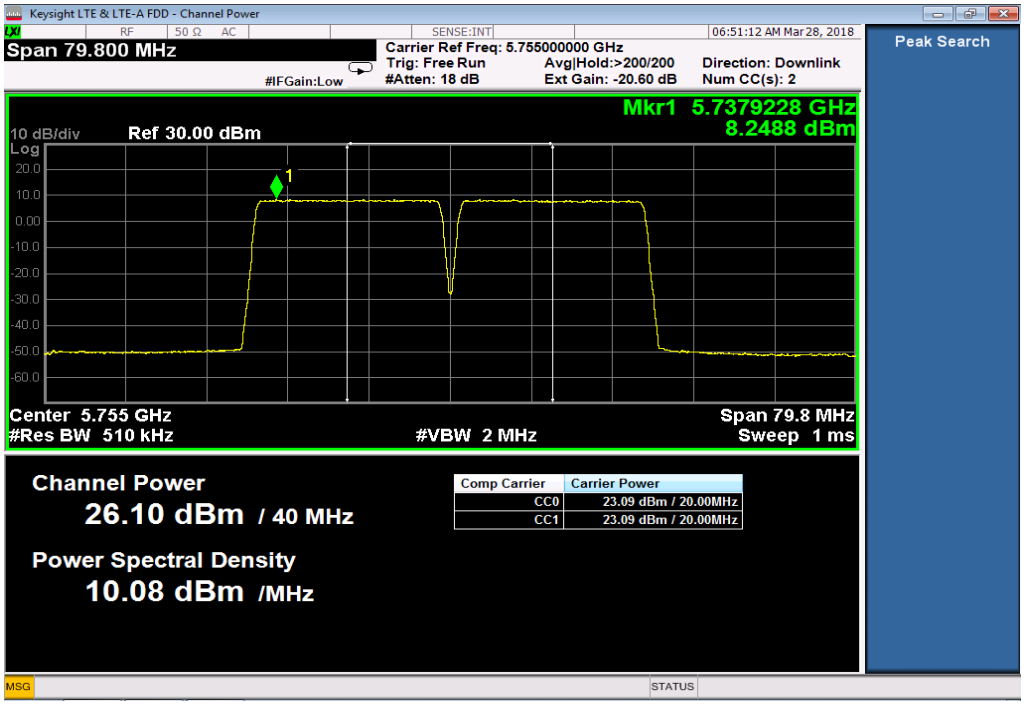


Figure 4.6.4 The Mean Output Power and PSD Measured for UNII-3 64QAM 20MHz Carrier at Channel 149/5745MHz, 27dBm, Port 1 and Port 2, for EUT with Antennas #1-#4 (Combined Output Power 29.63 dBm).



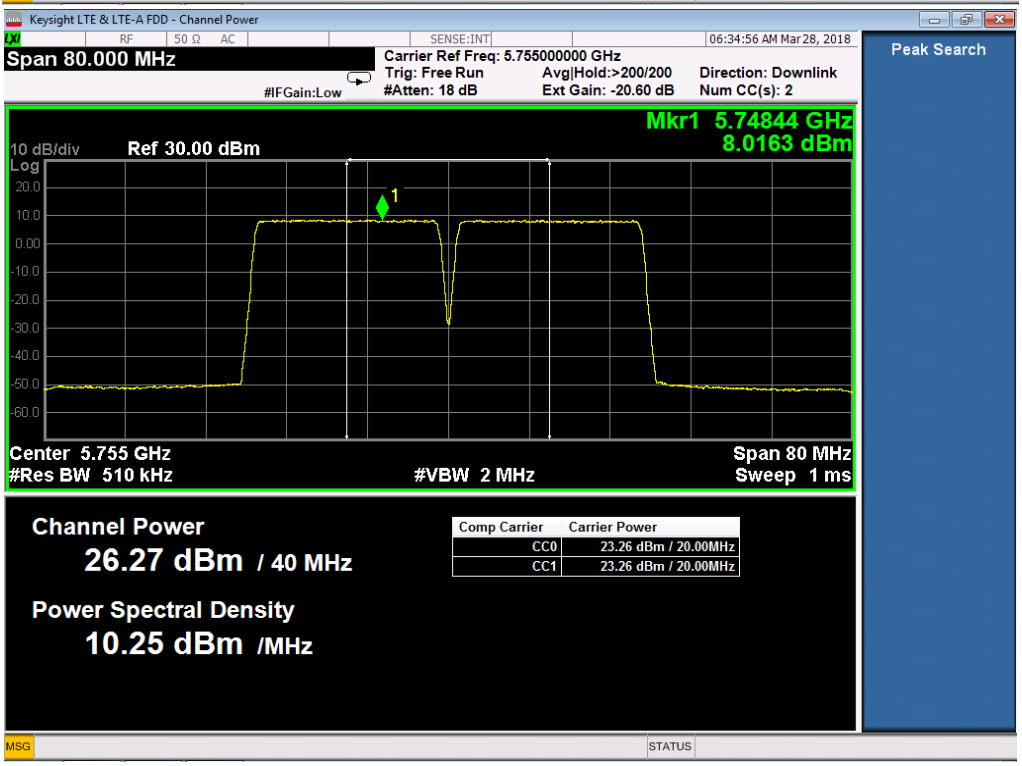
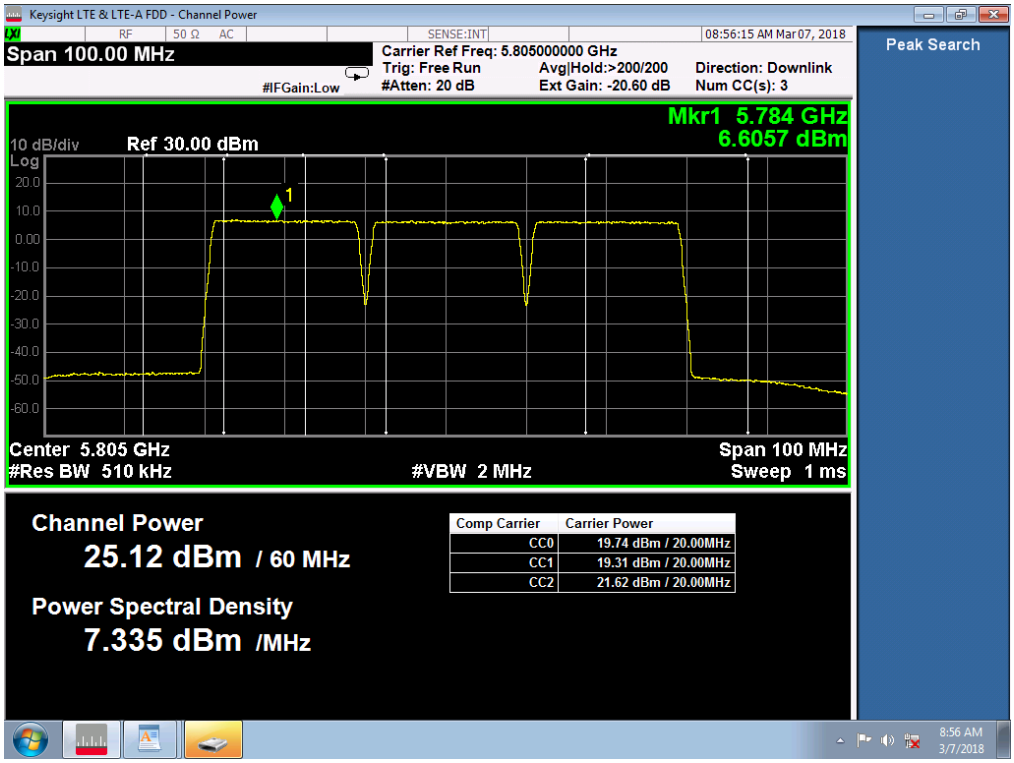


Figure 4.6.5 The Mean Output Power and PSD Measured for UNII-3 64QAM Two 20MHz Carriers at Channel 149, 153/5745, 5765MHz, 27dBm, Port 1 and Port 2, for EUT with Antennas #1-#4 (Combined Output Power 29.20 dBm).



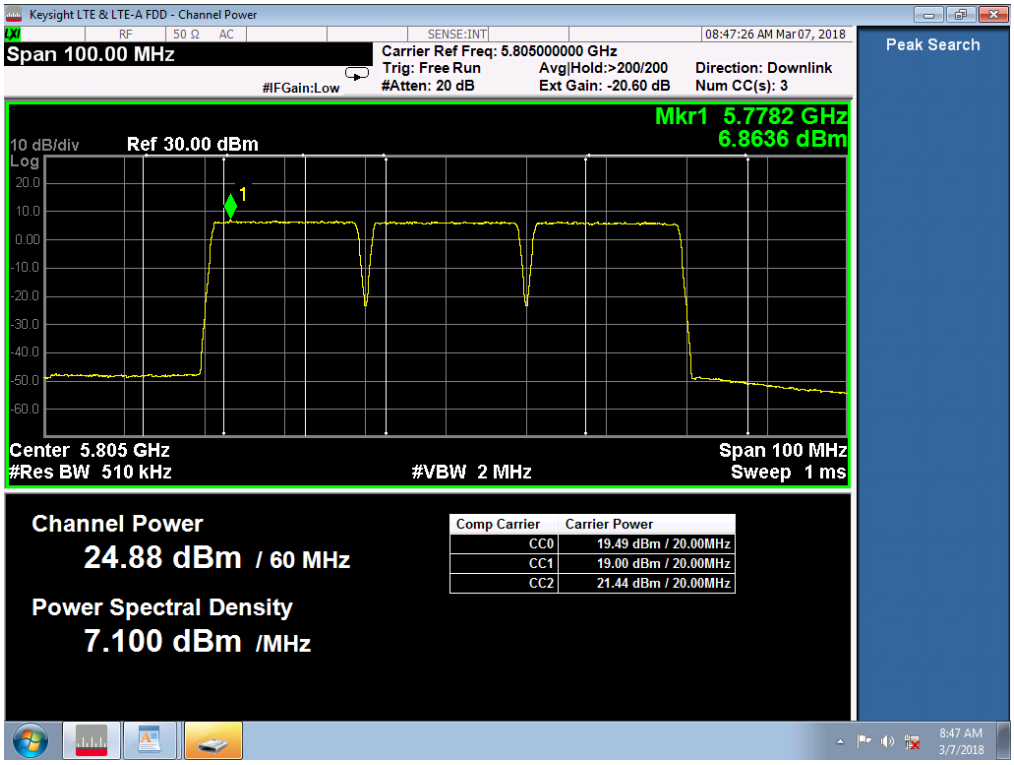
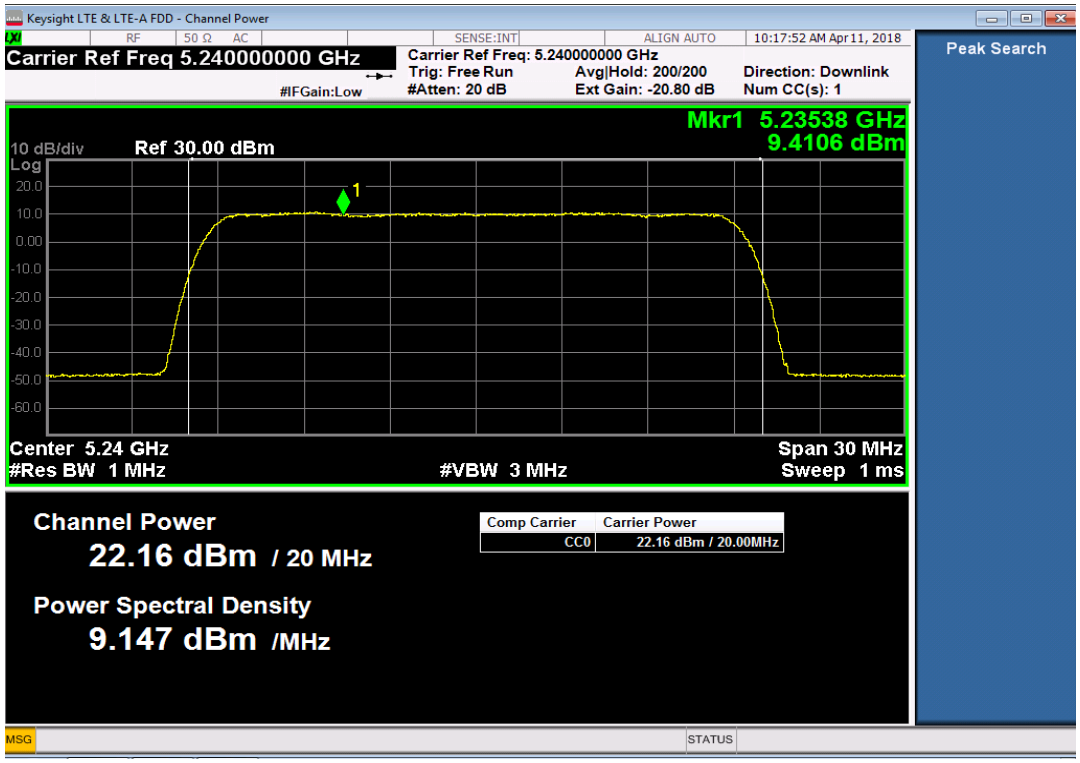


Figure 4.6.6 The Mean Output Power and PSD Measured for UNII-3 64QAM Three 20MHz Carriers at Channel 157, 161, 165/5785, 5805, 5825MHz, 27dBm, Port 1 and Port 2, for EUT with Antennas #1-#4 (Combined Output Power 28.01 dBm).



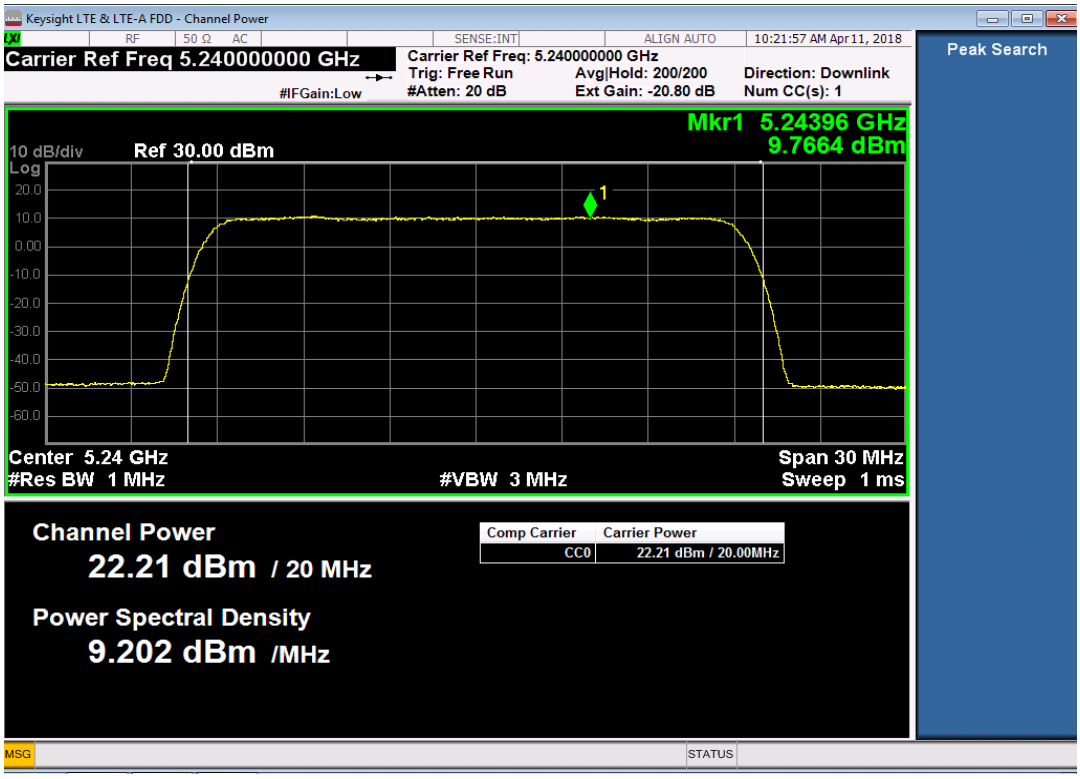
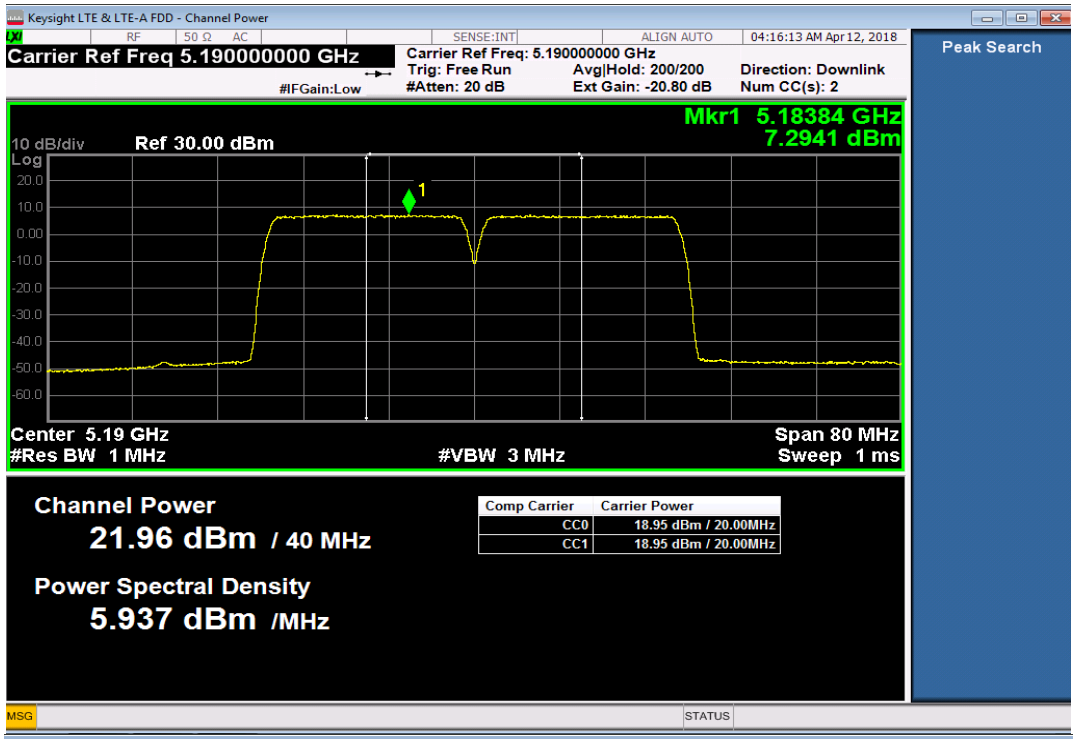


Figure 4.6.7 The Mean Output Power and PSD Measured for UNII-1 Q/16QAM 20MHz Carrier at Channel 48/5240MHz, 22.5dBm, Port 1 and Port 2, for EUT with Directional Antenna #5 (Combined Output Power 25.20 dBm).



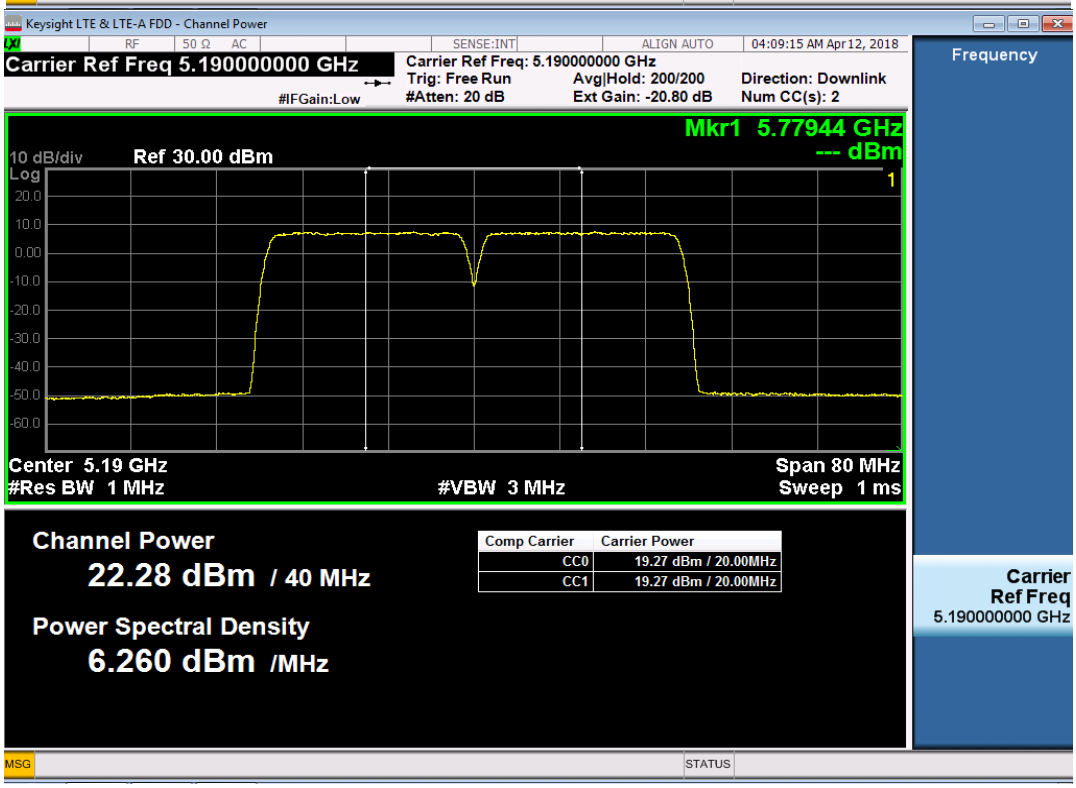
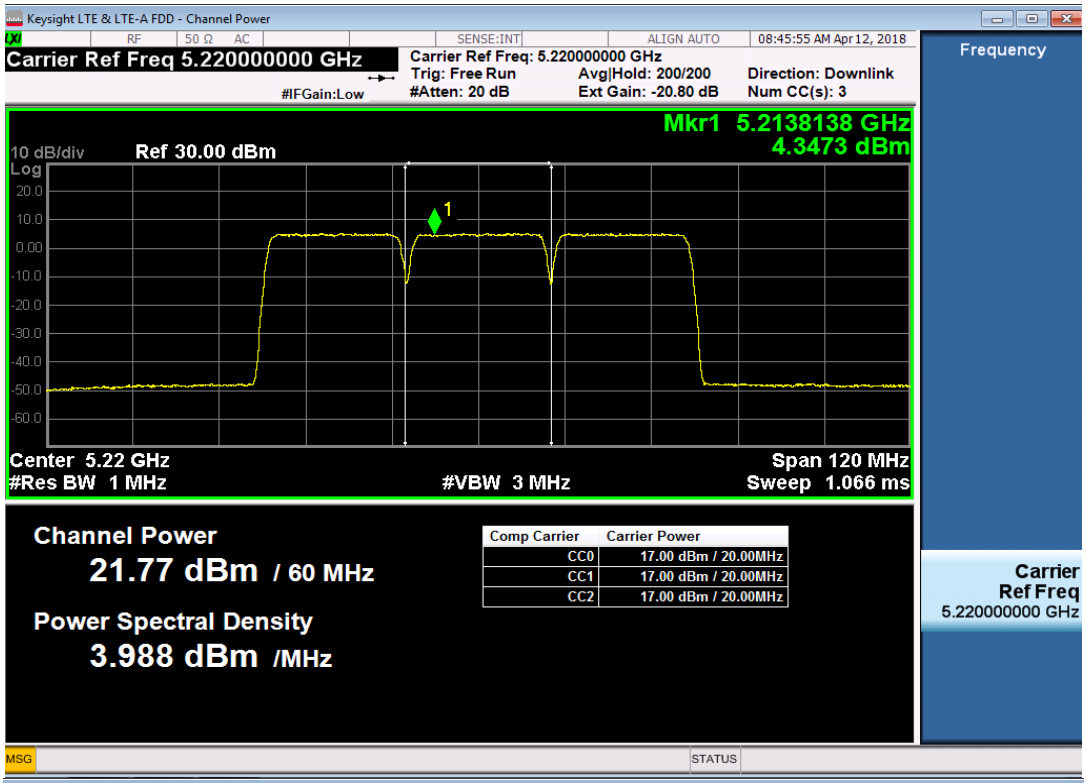


Figure 4.6.8 The Mean Output Power and PSD Measured for UNII-1 64QAM Two 20MHz Carriers at Channel 36, 40/5180, 5200MHz, 22.5dBm, Port 1 & Port 2, for EUT with Directional Antenna #5 (Combined Output Power 25.13 dBm).



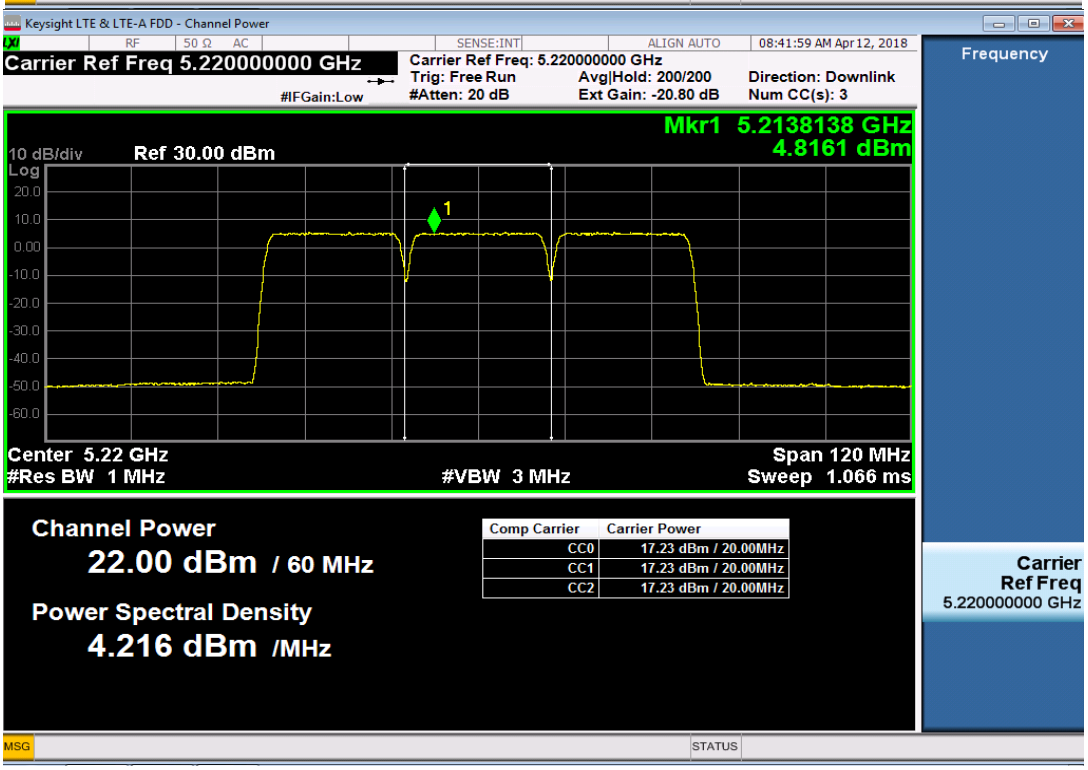


Figure 4.6.9 The Mean Output Power and PSD Measured for UNII-1 256QAM Three 20MHz Carriers at Channel 40, 44, 48/5200, 5220, 5240MHz, 22.5dBm, Port 1 & Port 2, for EUT with Directional Antennas #5 (Combined Output Power 24.90 dBm).

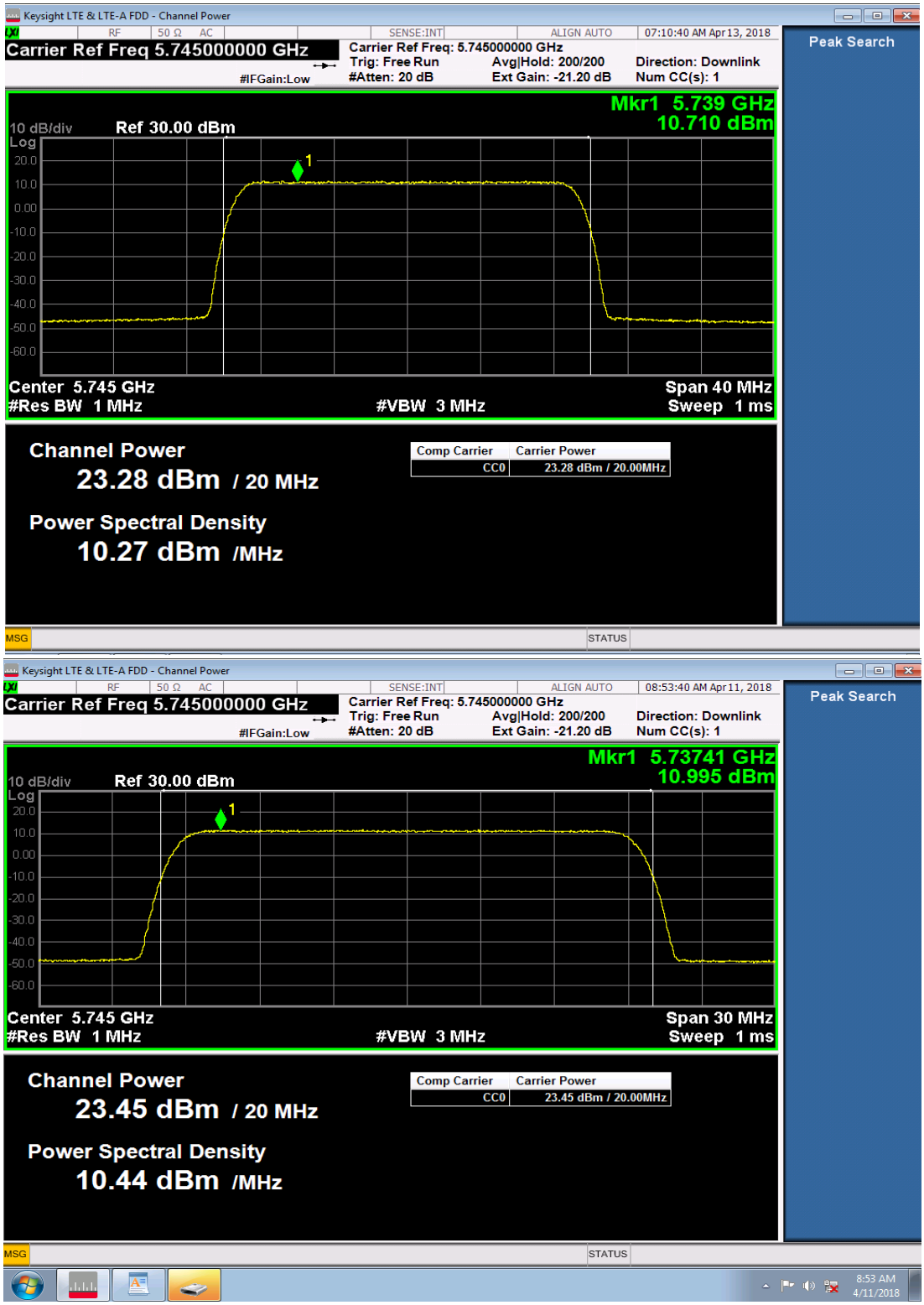


Figure 4.6.10 The Mean Output Power and PSD Measured for UNII-3 256QAM 20MHz Carrier at Channel 149/5745MHz, 23.5dBm, Port 1 and Port 2, for EUT with Directional Antenna #5 (Combined Output Power 26.38 dBm).

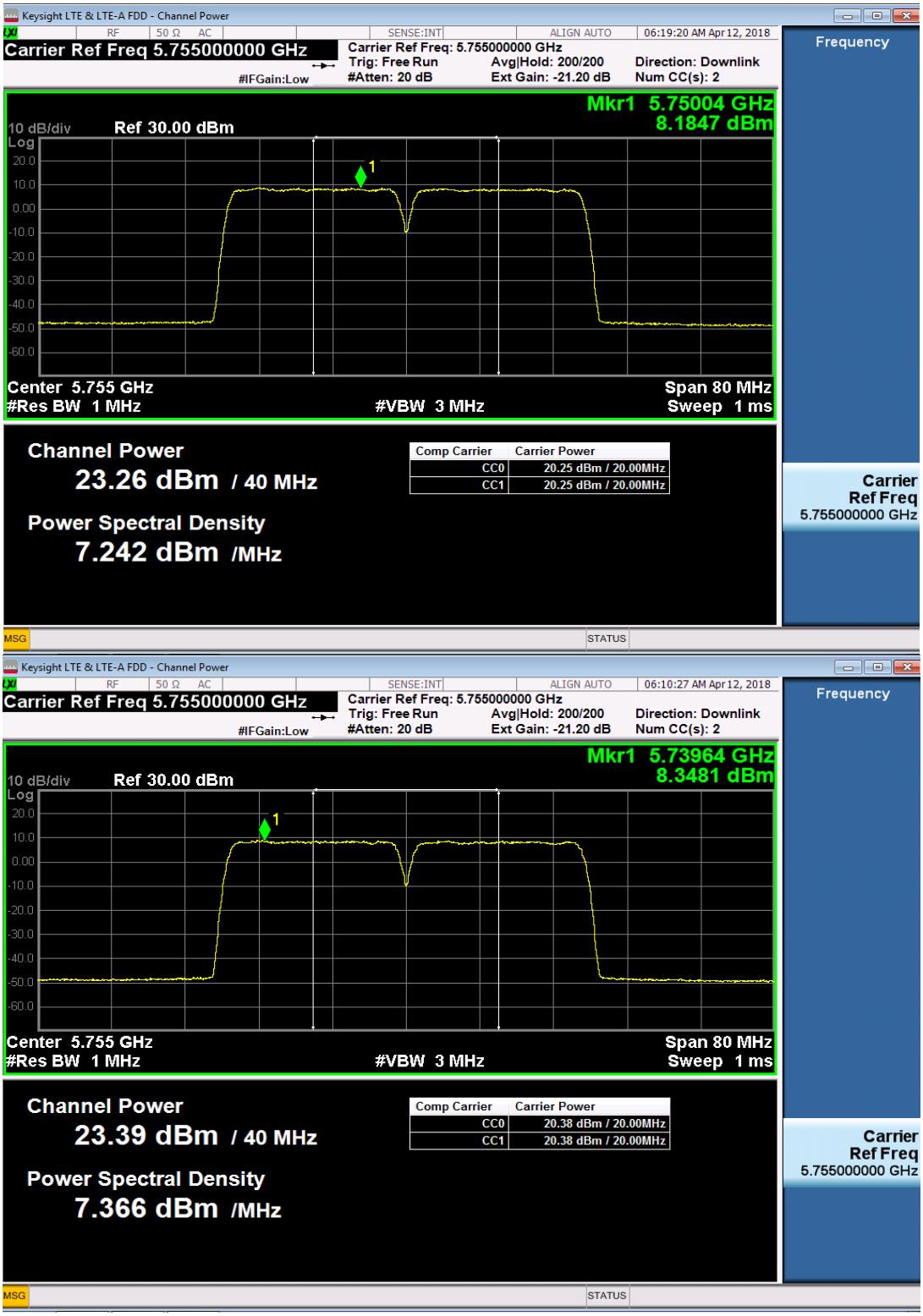
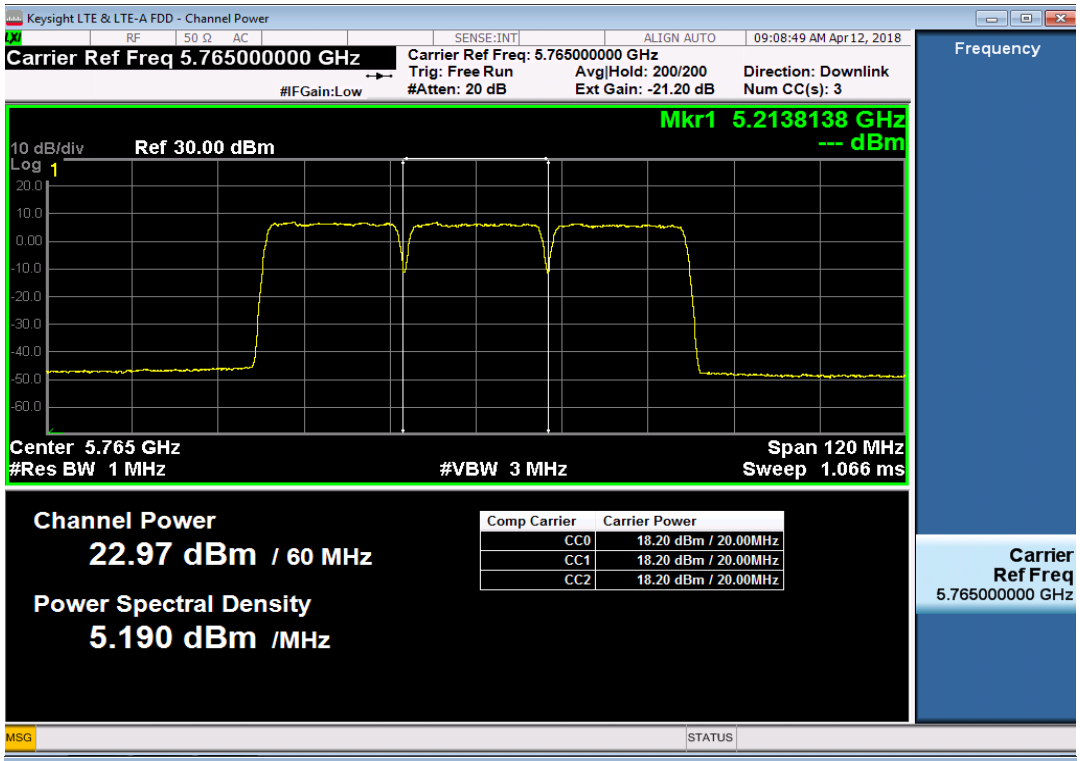


Figure 4.6.11 The Mean Output Power and PSD Measured for UNII-3 Q/16QAM Two 20MHz Carriers at Channel 149, 153/5745, 5765MHz, 23.5dBm, Port 1 & Port 2, for EUT with Directional Antenna #5 (Combined Output Power 26.34 dBm).



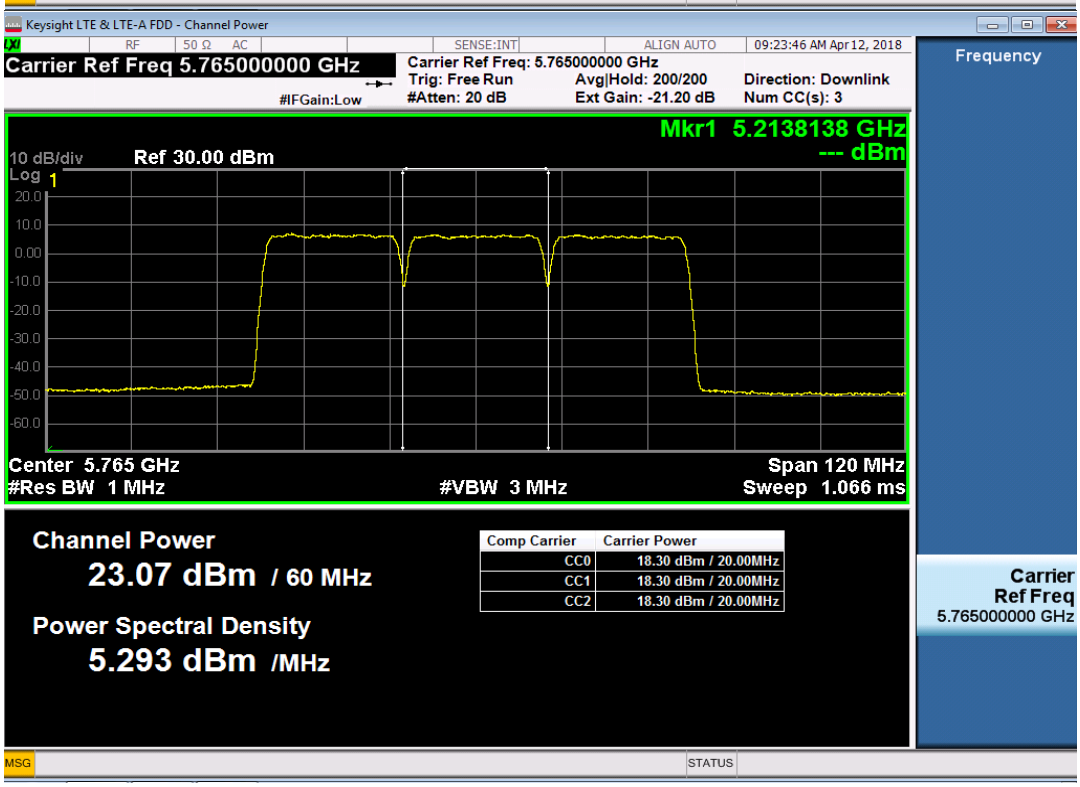


Figure 4.6.12 The Mean Output Power and PSD Measured for Q/16QAM Three 20MHz Carriers at Channels 149, 153 and 157/5745, 5765 and 5785MHz, 23.5dBm, Port 1 & Port 2, for EUT with Directional Antenna #5 (Combined Output Power 26.03dBm).

4.7.MEASUREMENT REQUIRED: PEAK POWER SPECTRUM DENSITY – FCC SECTION 15.407 (a)(1)(3)(5)

The peak power spectrum density (PPSD) measures the maximum value of the time average of the PSD measured during a period of continuous transmission.

The PPSD was measured at the both antenna ports for all 20MHz channels listed in Table 4.2.2 for all modulations. The measurement follows the procedures given in KDB 789033 D02.

The FCC limits are **17dBm/MHz** for UNII-1 and **30dBm/500kHz (or 33dBm/MHz**) for UNII-3. The peak conducted PSD shall be reduced by the amount in dB that the antenna gain exceeds 6 dBi. The PPSD limits calculated were provided in Table 4.6.1.

The PSD was measured by a spectrum analyzer. The RBW and VBW were set to 1MHz and 3MHz, respectively. The RMS detector and trace average (≥ 100) were used. The PPSD can be found by using either the peak search function on the instrument to find the peak of the spectrum or the spectrum analyzer's PSD function.

Normally, the total PPSD was calculated by the PPSD measured at the port which usually has higher PPSD based on the measurement for output power plus 3dB for two ports. When the margin is slim, the PPSD measurement was performed at both ports to obtain the combined PPSD value, where the total PPSD was obtained by summing the PPSD measured at both antenna ports.

For UNII-1 band, the minimum margin of total PPSD measured for the EUT equipped with the antennas #1-#4 among all operation modes supported was 0.13dB/MHz for 20MHz carriers, where the total RF power output setting is at 26dBm. The total PPSD measured are all below the FCC required limits.

For UNII-3 band, the minimum margin of total PPSD measured for the EUT equipped with the antennas #1-#4 among all operation modes supported was 15.07dB/MHz for 20MHz carriers, where the total RF power output setting is at 27.0dBm. The total PPSD measured are all below the FCC required limits.

For UNII-1 band, the minimum margin of total PPSD measured for the EUT equipped with the antennas #5 among all operation modes supported was 0.25dB/MHz for 20MHz carriers, where the total RF power output setting is at 22.5dBm. The total PPSD measured are all below the FCC required limits.

For UNII-3 band, the minimum margin of total PPSD measured for the EUT equipped with the antennas #5 among all operation modes supported was 13.95dB/MHz for 20MHz carriers, where the total RF power output setting is at 23.5dBm. The total PPSD measured are all below the FCC required limits.

The measurement results are given below. The PPSD plots which have the smallest margin are provided in Figures 4.7.1-4.7.4.

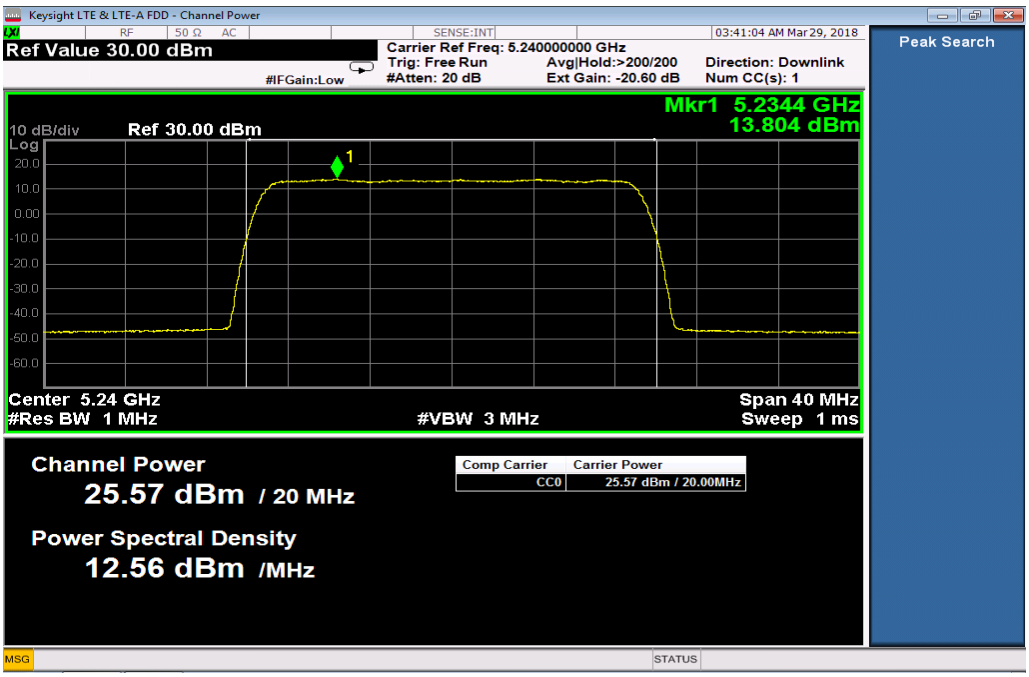
The combined PPSD of the EUT at its antenna transmitting terminals across the UNII-1 and UNII-3 bands for all operation modes are all below FCC required limits and are in full compliance with the Rules of the Commission.

Table 4.7.1 Maximum Mean Combined PPSD at Antenna Ports for 5GHz 20MHz Carrier at 26dBm for UNII-1 and 27dBm for UNII-3 with Antenna #1-#4

Bands (GHz)	Ch No/ Freq (MHz)	Modulation	PPSD Port1 (dBm/MHz)	PPSD Port2 (dBm/MHz)	Total PPSD (dBm/MHz)	PPSD Limit (dBm/MHz)	Test Results
UNII-1 (5.17-5.25)	36/5180	Q/16QAM	13.792	13.783	16.80	17	Pass
		64QAM	13.336	13.426	16.39	17	Pass
		256QAM	13.222	13.637	16.44	17	Pass
	44/5220	Q/16QAM	13.625	13.994	16.82	17	Pass
		64QAM	13.417	13.326	16.38	17	Pass
		256QAM	13.404	13.666	16.55	17	Pass
	48/5240	Q/16QAM	13.804	13.916	16.87	17	Pass
		64QAM	13.671	13.806	16.75	17	Pass
		256QAM	13.612	13.487	16.56	17	Pass
UNII-3 (5.74-5.835)	149/5745	Q/16QAM	14.786	14.576	17.69	33	Pass
		64QAM	14.853	14.576	17.73	33	Pass
		256QAM	14.330	14.816	17.59	33	Pass
	157/5785	Q/16QAM	14.920	14.915	17.93	33	Pass
		64QAM	14.714	14.706	17.72	33	Pass
		256QAM	14.632	14.559	17.61	33	Pass
	165/5825	Q/16QAM	14.489	14.955	17.74	33	Pass
		64QAM	14.596	14.665	17.64	33	Pass
		256QAM	14.351	14.766	17.57	33	Pass

Table 4.7.2 Maximum Mean Combined PPSD at Antenna Ports for 5GHz 20MHz Carrier at 22.5dBm for UNII-1 and 23.5dBm for UNII-3 with Antenna #5

Bands (GHz)	Ch No/ Freq (MHz)	Modulation	PPSD Port1 (dBm/MHz)	PPSD Port2 (dBm/MHz)	Total PPSD (dBm/MHz)	PPSD Limit (dBm/MHz)	Test Results
UNII-1 (5.17-5.25)	36/5180	Q/16QAM	9.9175	10.021	12.98	13.5	Pass
		64QAM	9.6897	9.9444	12.83	13.5	Pass
		256QAM	10.302	9.7819	13.06	13.5	Pass
	44/5220	Q/16QAM	10.315	10.028	13.18	13.5	Pass
		64QAMfail	9.4458	9.7596	12.62	13.5	Pass
		256QAM	9.6845	9.8933	12.80	13.5	Pass
	48/5240	Q/16QAM	9.4106	9.7664	12.60	13.5	Pass
		64QAM	10.080	9.9507	13.03	13.5	Pass
		256QAM	10.540	9.9243	13.25	13.5	Pass
UNII-3 (5.74-5.835)	149/5745	Q/16QAM	11.408	10.744	14.10	29.5	Pass
		64QAM	11.632	11.448	14.55	29.5	Pass
		256QAM	10.710	10.995	13.87	29.5	Pass
	157/5785	Q/16QAM	11.063	11.482	14.29	29.5	Pass
		64QAM	11.054	10.890	13.98	29.5	Pass
		256QAM	11.175	11.327	14.26	29.5	Pass
	165/5825	Q/16QAM	11.237	11.327	14.29	29.5	Pass
		64QAM	10.561	10.756	13.67	29.5	Pass
		256QAM	11.410	10.444	13.96	29.5	Pass



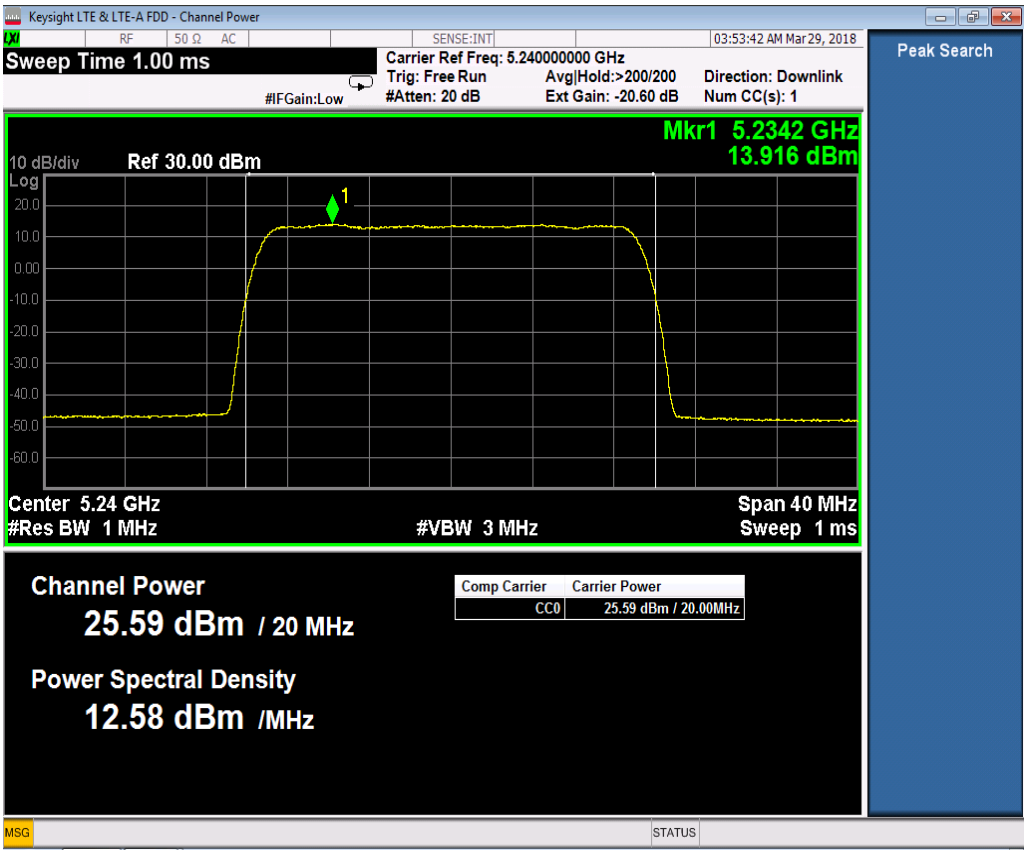
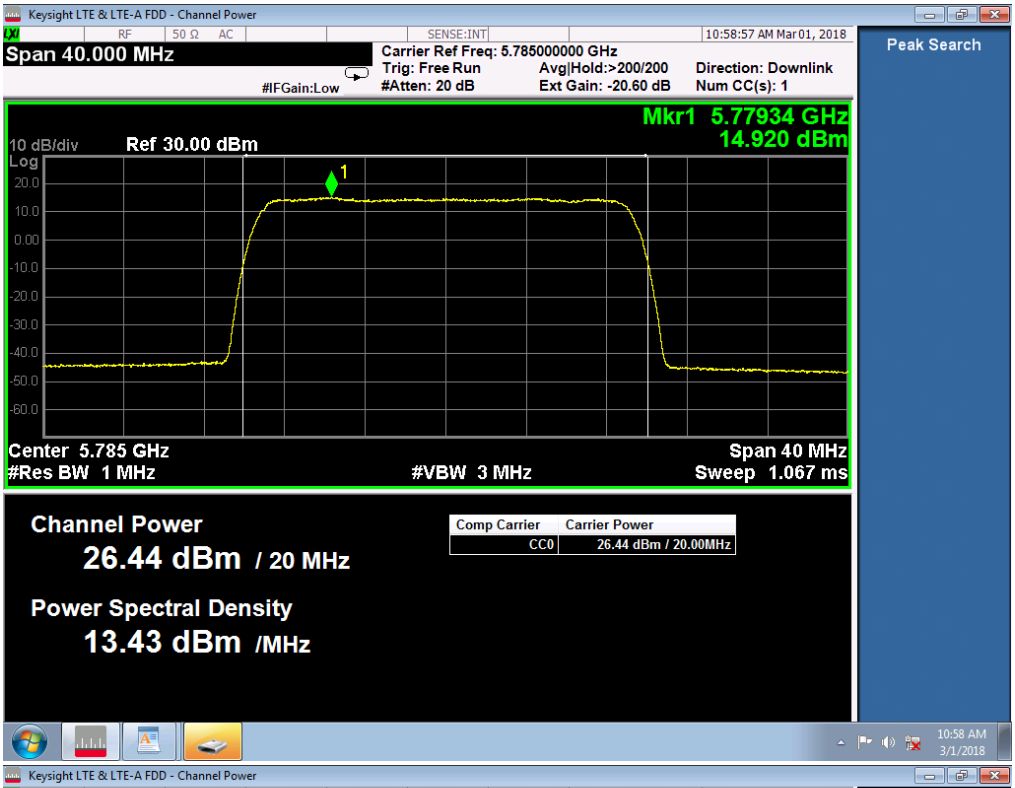


Figure 4.7.1 The Conducted PPSD Measured (Combined 16.87dBm/MHz) for 20MHz UNII-1 at Channel 48/5240MHz, 26dBm, Q/16QAM, Port 1 and Port 2, Antenna #1-#4.



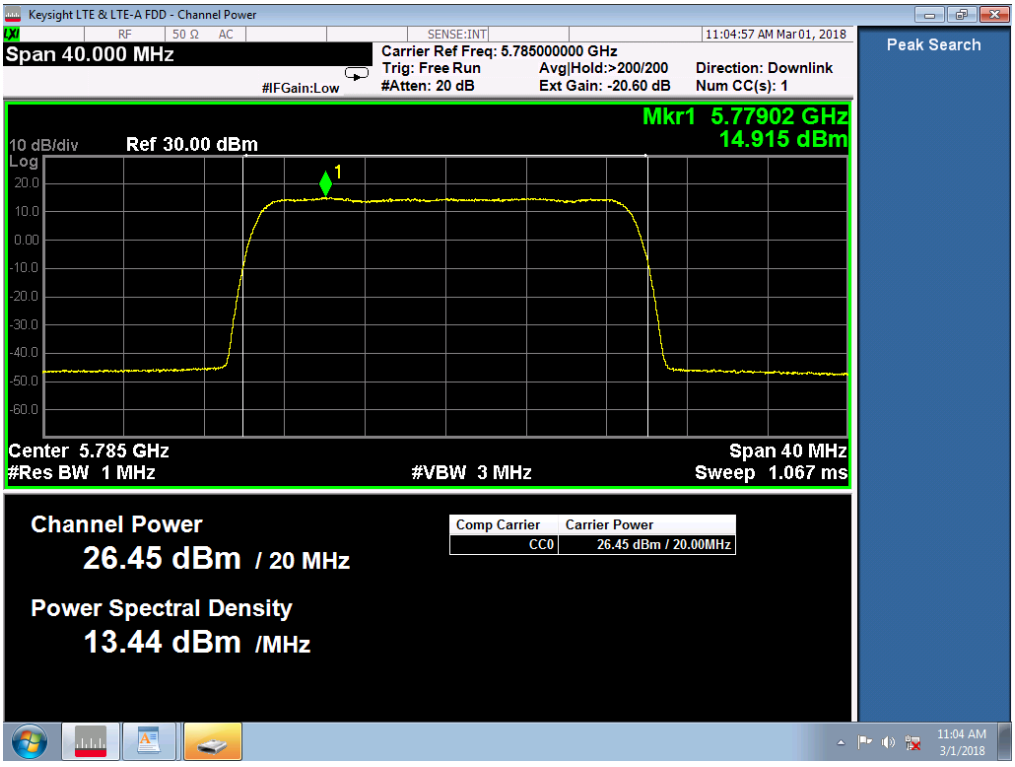
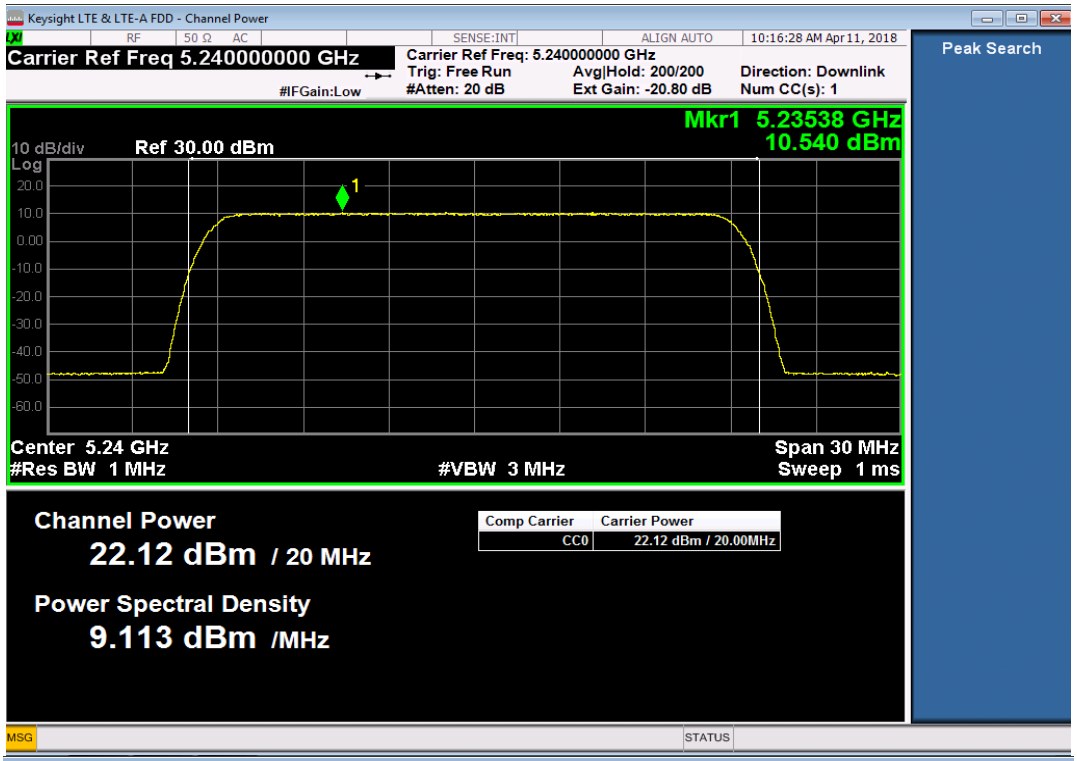


Figure 4.7.2 The Conducted PPSD Measured (Combined 17.93dBm/MHz) for 20MHz UNII-3 at Channel 157/5785MHz, 27dBm, Q/16QAM, Port 1 and Port 2, Antenna #1-#4.



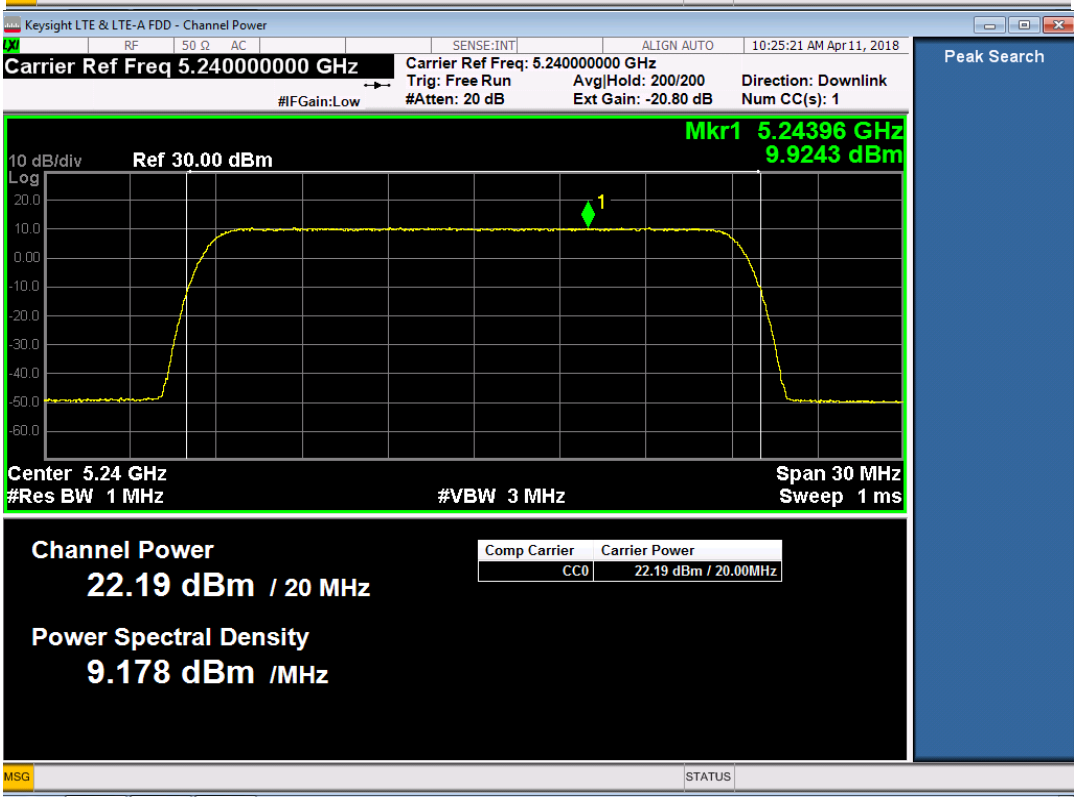
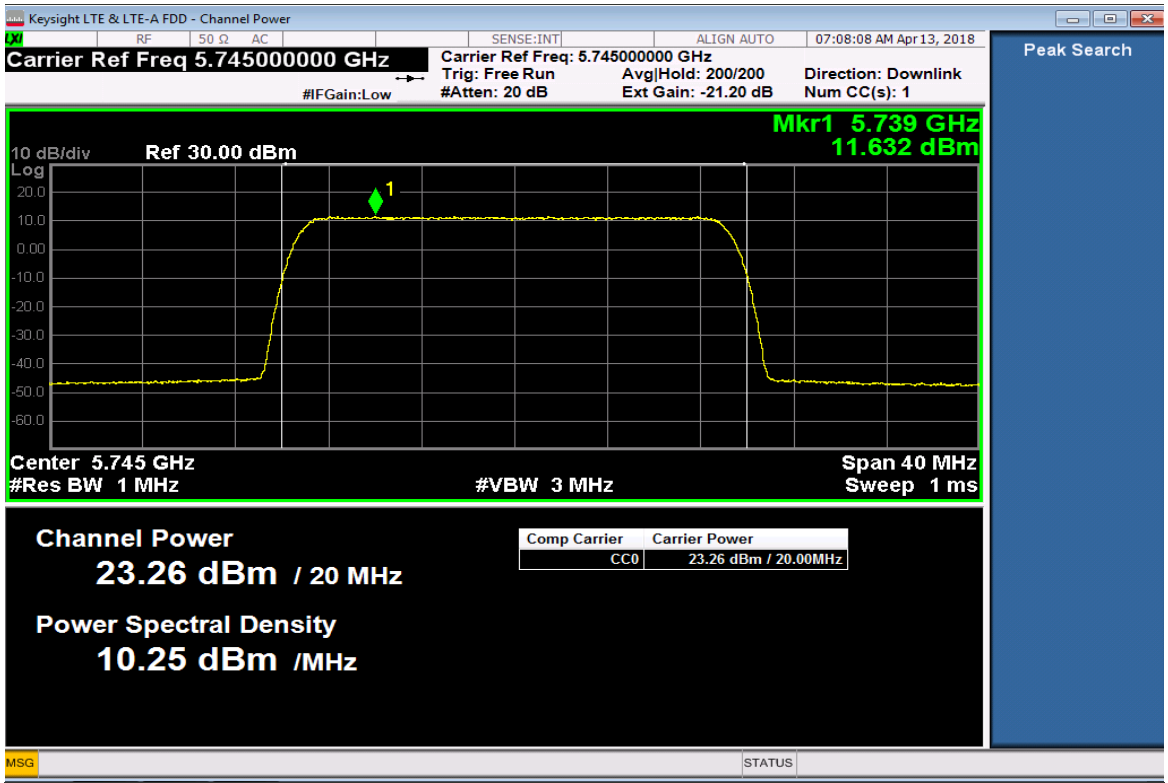


Figure 4.7.3 The Conducted PPSD Measured (Combined 13.25dBm/MHz) for 20MHz UNII-1 at Channel 48/5240MHz, 22.5dBm, 256QAM, Port 1 and Port 2, Antenna #5.



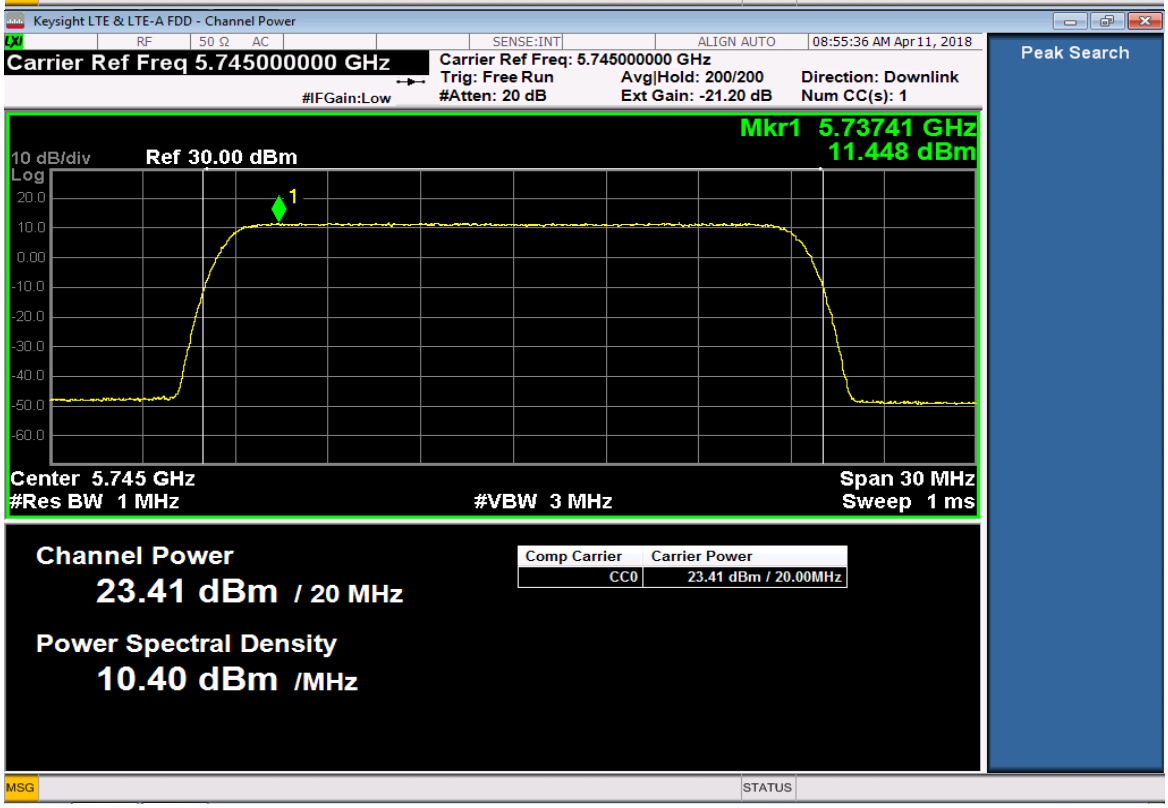


Figure 4.7.4 The Conducted PPSD Measured (Combined 14.55dBm/MHz) for 20MHz UNII-3 at Channel 149/5745MHz, 23.5dBm, 64QAM, Port 1 and Port 2, Antenna #5.

4.8. MEASUREMENT REQUIRED: UNWANTED RADITED OUT-OF-BAND EMISSIONS – FCC SECTION 15.407 (b)(1)(4-5)(8)

The requirements of the out-of-band emissions are provided in Section 4.1. Per KDB 789033 D02 guidance II.G.3.b, "The unwanted emission limits in both the restricted and non-restricted bands are based on radiated measurements; however, as an alternative, antenna-port conducted measurements in conjunction with cabinet emissions tests will be permitted to demonstrate compliance."

The out-of-band emissions were evaluated by radiated measurement per KDB 789033 D02 measurement guidance for the EUT equipped with the omni-directional antenna #4 which has the highest antenna gain among all omni-directional antennas and the directional antenna #5 which has the highest gain among all directional antennas, respectively.

Per KDB 789033 D02, for the radiated measurement, the field strength limit is obtained from the EIRP limit by

$$EIRP = \frac{\sqrt{\mathrm{E\ x\ d}}}{30},$$

where

- E is the field strength in V/m;
- d is the measurement distance in m;
- EIRP is the equivalent isotropically radiated power in W.

Therefore, with E in,

$$E\ (\mathrm{dB\mu V/m}) = EIRP(dBm) - 20 * \log(d) + 104.77.$$

At 3m with EIRP = - 27dBm, E = 68.2 dBμV/m.

Table 4.8.1 FCC 15.407 UNII-1/3 Out-of-Band limits

Band (GHz)	Frequency Investigated (GHz)	E^{lim} (dBuV/m) at 3m	Detector	RBW (MHz)
5.15–5.25	f < 4.5 & 5.46 < f	54/68.2 for restric band, 68.2 for non-restric band	AV/PK, PK	1
	4.5 < f < 5.15 & 5.35 < f < 5.46	54/68.2	AV/PK	
5.725–5.85	f < 5.650 & 5.925 < f	54/68.2 for restric band, 68.2 for non-restric band	AV/PK, PK	
	5.650 < f < 5.700 & 5.875 < f < 5.925	68.2 to 105.2	PK	
	5.700 < f < 5.720 & 5.855 < f < 5.875	105.2 to 110.8	PK	
	5.720 < f < 5.725 and 5.850 < f < 5.855	110.8 to 122.2	PK	

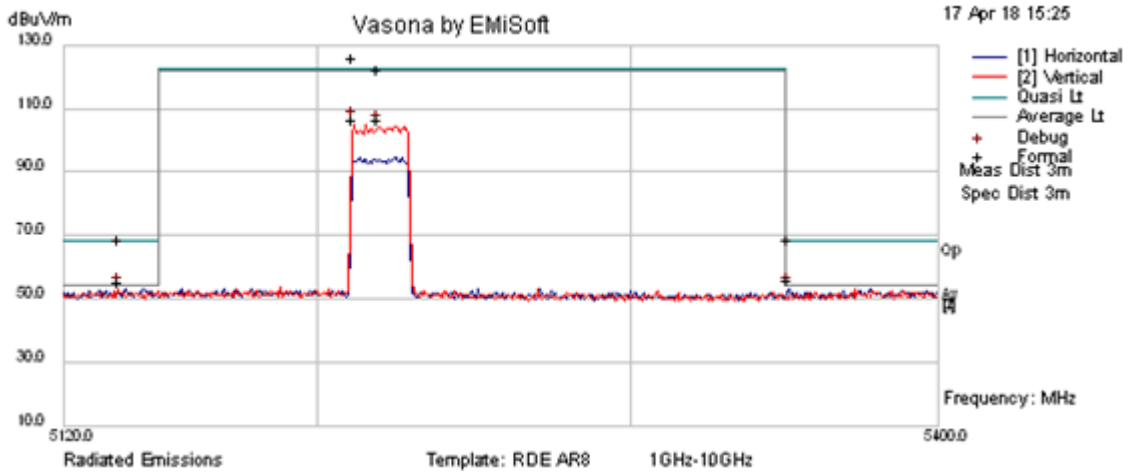
The out-of-band emissions provided in this section are the unwanted emissions outside and near the band edges. The unwanted emissions at the frequencies away from the band edges were provided in Section 4.9. The recommendations of ANSI C63.10 were followed for the EUT testing setup and cabling. The test setup diagram was given in Section 4.3. The emissions were maximized by rotating the turntable 360° and moving the receiving antenna height to scan and capture the emissions from the EUT. The out-of-band emissions for a 20MHz carrier located at the middle channel of the UNII-1/3 bands were prescanned for various carrier

modulations (Q/16QAM, 64QAM and 256QAM), respectively, to determine the worst modulation. The carrier with Q/16QAM modulation was found to have similar out-of-band emissions compared with that of 64QAM and 256QAM modulations. Then the out-of-band emissions of the channels near the low and high UNII-1/3 bands listed in Section 4.2 with Q/16QAM modulation were evaluated with power levels given in 4.3 for one-20MHz, two-20MHz and three-20MHz carriers.

The out-of-band emissions measured for the EUT equipped with both omni-directional antenna #4 and directional antenna #5 are all below the FCC average and/or peak limits required in both the restricted and non-restricted bands (see Table 4.8.1). The restricted bands are provided in Table 4.1.1.

The out-of-band emissions plots which give the minimum emission margin evaluated for one-20MHz carrier, two-20MHz carriers and three-20MHz carriers and for the EUT equipped with antennas #4 and #5 were shown below in Figures 4.8.1-4.8.4, respectively.

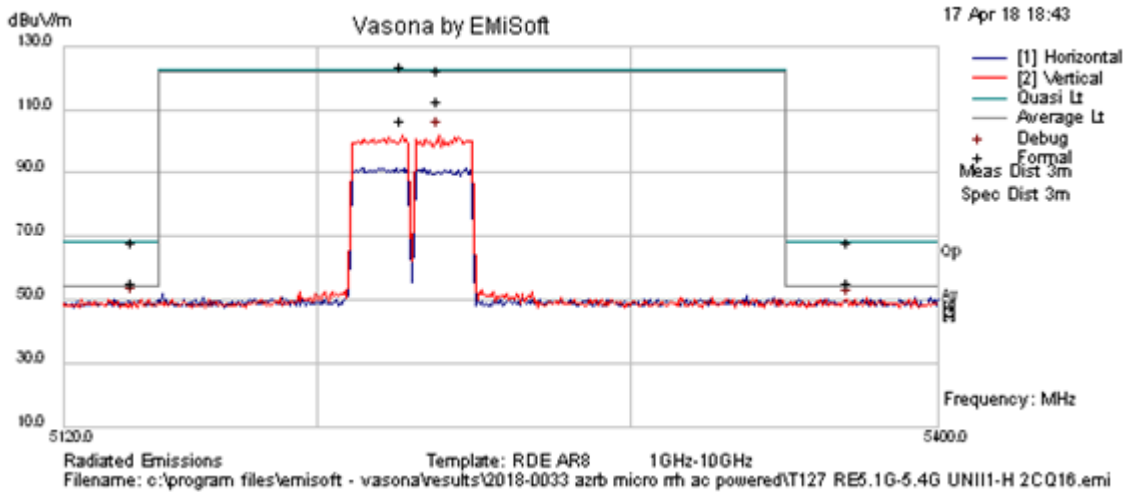
The unwanted radiated out-of-band emissions measured with the EUT transmitting in the UNII-1 and UNII-3 bands for all operation bandwidths are all below FCC required limits for the EUT equipped either omni-directional antenna or directional antenna, respectively, and are in full compliance with the Rules of the Commission.



Formal Data

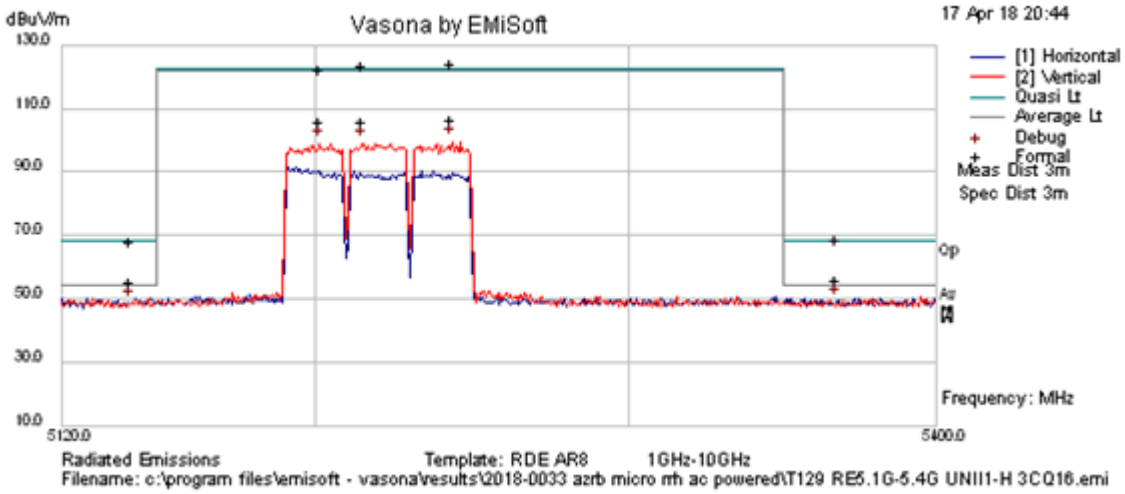
No	Freq.	Raw	Cable Loss	AF	Level	Emission Type	Pol	Hgt	Azt	Limit	Margin	Pass /	Comments
	MHz	dBuV	dB	dB	dBuV/m			cm	Deg.	dBuV/m	dB	Fail	
1	5211.46	100.13	20.52	0.93	121.58	Peak	V	135	102	122.2	-0.62	Pass	
2	5351.35	29.34	20.61	1.14	51.1	Average	H	166	18	54	-2.9	Pass	
3	5137.62	29.44	20.47	0.82	50.74	Average	V	194	72	54	-3.26	Pass	
4	5351.35	42.54	20.61	1.14	64.29	Peak	H	166	18	68.2	-3.91	Pass	
5	5219.5	96.57	20.53	0.94	118.04	Peak	V	118	99	122.2	-4.16	Pass	
6	5137.62	42.54	20.47	0.82	63.83	Peak	V	192	70	68.2	-4.37	Pass	
7	5211.46	80.37	20.52	0.93	101.82	Average	V	135	102	122	-20.18	Pass	
8	5219.5	80.25	20.53	0.94	101.72	Average	V	118	99	122	-20.28	Pass	

Figure 4.8.1(a) The Radiated Out-of-Band Emissions with the Minimum Margin Evaluated for One 20MHz Carrier at UNII-1 Channel 44 (5220MHz), 26dBm, Q/16QAM, Omni-Directional Antenna #4 (Preview RBW: 30k and Formal RBW: 1MHz, File No T121).



FORMAL DATA												
Freq. (MHz)	**Raw (dBuV)**	**Cable (dB)**	**Factor (dB)**	**Level (dBuV/m)**	**Emission Type**	**Pol (H/V)**	**Ht (cm)**	**Az (deg)**	**Limit (dBuV/m)**	**Margin (dB)**	**Pass /Fail**	**Comments**
5370.9	29.15	20.63	1.16	50.94	Average	V	130	67	54	-3.06	Pass	
5226.61	97.47	20.53	0.95	118.96	Peak	V	151	106	122.2	-3.24	Pass	
5141.99	29.34	20.48	0.83	50.65	Average	V	119	240	54	-3.35	Pass	
5238.4	96.48	20.54	0.97	117.99	Peak	V	136	104	122.2	-4.21	Pass	
5141.99	42.4	20.48	0.83	63.71	Peak	V	119	240	68.2	-4.49	Pass	
5370.9	41.87	20.63	1.16	63.66	Peak	V	130	67	68.2	-4.54	Pass	
5238.4	86.43	20.54	0.97	107.94	Average	V	137	105	122	-14.06	Pass	
5226.61	80.25	20.53	0.95	101.73	Average	V	151	106	122	-20.27	Pass	

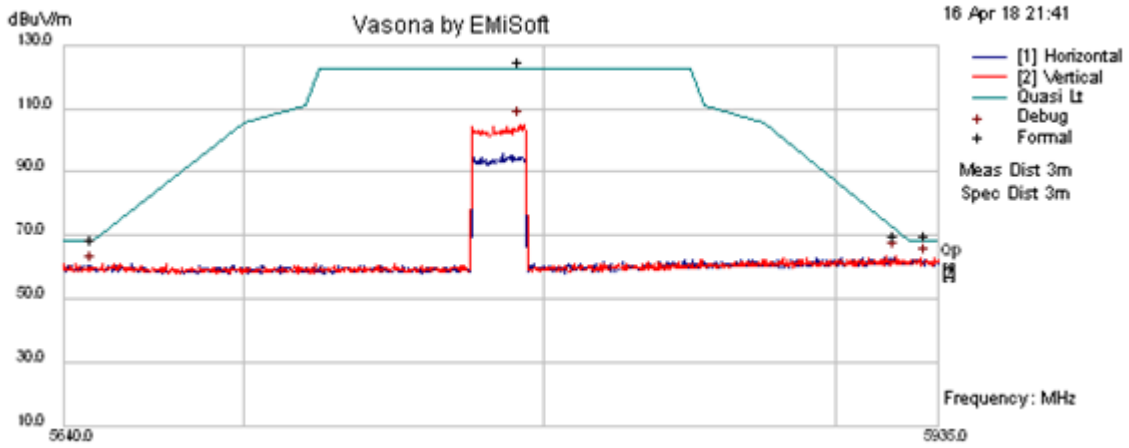
Figure 4.8.1(b) The Radiated Out-of-Band Emissions with the Minimum Margin for Two 20MHz Carriers at UNII-1 Channels 44 (5220MHz) and 48 (5240), 26dBm Total, Q/16QAM, Omni-Directional Antenna #4 (Preview RBW: 30k and Formal RBW: 1MHz).



FORMAL DATA

Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
5367.75	29.73	20.63	1.16	51.52	Average	V	186	260	54	-2.48	Pass	
5243.45	97.93	20.54	0.98	119.46	Peak	V	195	191	122.2	-2.74	Pass	
5141.99	29.34	20.48	0.83	50.65	Average	V	105	248	54	-3.35	Pass	
5214.83	97.31	20.53	0.94	118.77	Peak	V	162	145	122.2	-3.43	Pass	
5367.75	42.4	20.63	1.16	64.19	Peak	V	186	260	68.2	-4.01	Pass	
5141.99	42.4	20.48	0.83	63.71	Peak	V	105	248	68.2	-4.49	Pass	
5201.36	96.27	20.52	0.92	117.7	Peak	V	204	100	122.2	-4.5	Pass	
5243.45	80.18	20.54	0.98	101.71	Average	V	195	191	122	-20.29	Pass	

Figure 4.8.1(c) The Radiated Out-of-Band Emissions with the Minimum Margin for Three 20MHz Carriers at UNII-1 Channel 40 (5200MHz), 44 (5220 MHz) and 48 (5240 MHz), 26dBm Total, Q/16QAM, Omni-Directional Antenna #4 (Preview RBW: 30k and Formal RBW: 1MHz).

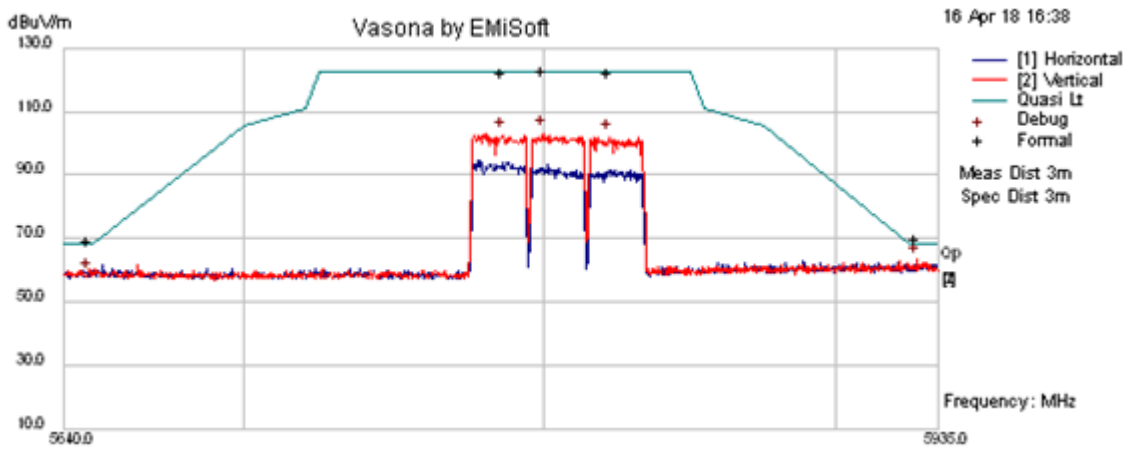


FORMAL DATA												
Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
5792.4	97.58	21.07	1.76	120.41	Peak	V	154	311	122.2	-1.79	Pass	Tx
5931.07	42.27	21.23	1.95	65.45	Peak	V	126	352	68.2	-2.75	Pass	
5649.78	41.61	20.89	1.56	64.07	Peak	V	103	231	68.2	-4.13	Pass	
5920.56	42.14	21.22	1.93	65.29	Peak	V	144	0	71.48	-6.18	Pass	

Figure 4.8.2(a) The Radiated Out-of-Band Emissions with the Minimum Margin for One 20MHz Carrier at UNII-3 Channel 157 (5785MHz), 27dBm, Q/16QAM, Omni-Directional Antenna #4 (Preview RBW: 30k and Formal RBW: 1MHz, File No T119).

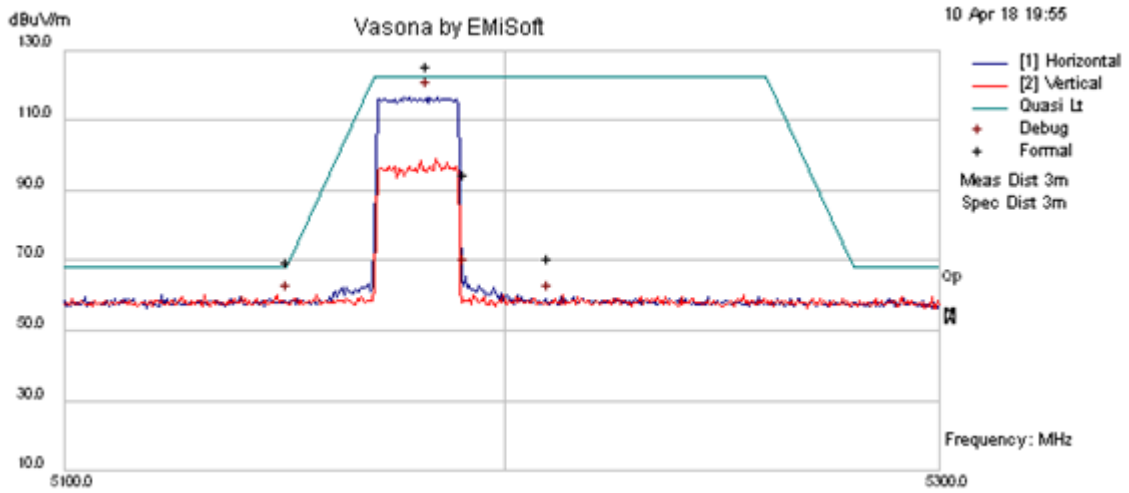
FORMAL DATA												
Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
5829.49	97.93	21.11	1.81	120.86	Peak	V	203	27	122.2	-1.34	Pass	Tx
5806.95	97.81	21.08	1.78	120.68	Peak	V	195	28	122.2	-1.52	Pass	Tx
5929.86	42.4	21.23	1.95	65.58	Peak	H	169	27	68.2	-2.62	Pass	
5648.63	42.01	20.89	1.56	64.46	Peak	V	104	13	68.2	-3.74	Pass	

Figure 4.8.2(b) The Radiated Out-of-Band Emissions with the Minimum Margin for Two 20MHz Carriers at UNII-3 Channel 161 (5805MHz) and 165 (5825MHz), 27dBm Total, Q/16QAM, Omni-Directional Antenna #4 (Preview RBW: 30k and Formal RBW: 1MHz, File No T116).



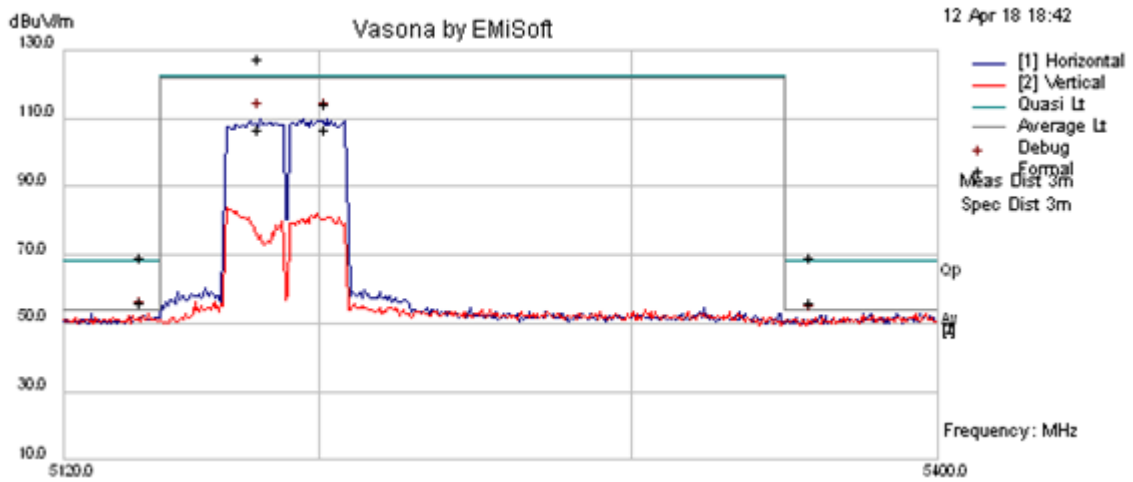
FORMAL DATA												
Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
5927.9	42.14	21.23	1.94	65.31	Peak	V	176	29	68.2	-2.89	Pass	
5800.37	95.77	21.08	1.77	118.62	Peak	V	174	23	122.2	-3.58	Pass	Tx
5648.63	42.01	20.89	1.56	64.46	Peak	V	104	29	68.2	-3.74	Pass	
5822.14	94.79	21.1	1.8	117.69	Peak	V	166	19	122.2	-4.51	Pass	Tx
5786.52	94.69	21.06	1.75	117.5	Peak	V	155	25	122.2	-4.7	Pass	Tx

Figure 4.8.2(c) The Radiated Out-of-Band Emissions with the Minimum Margin Evaluated for Three 20MHz Carriers at UNII-3 Channel 157 (5785MHz), 161 (5805MHz) and 165 (5825MHz), 27dBm Total, Q/16QAM, Omni-Directional Antenna #4 (Preview RBW: 30k and Formal RBW: 1MHz, File No T114a).



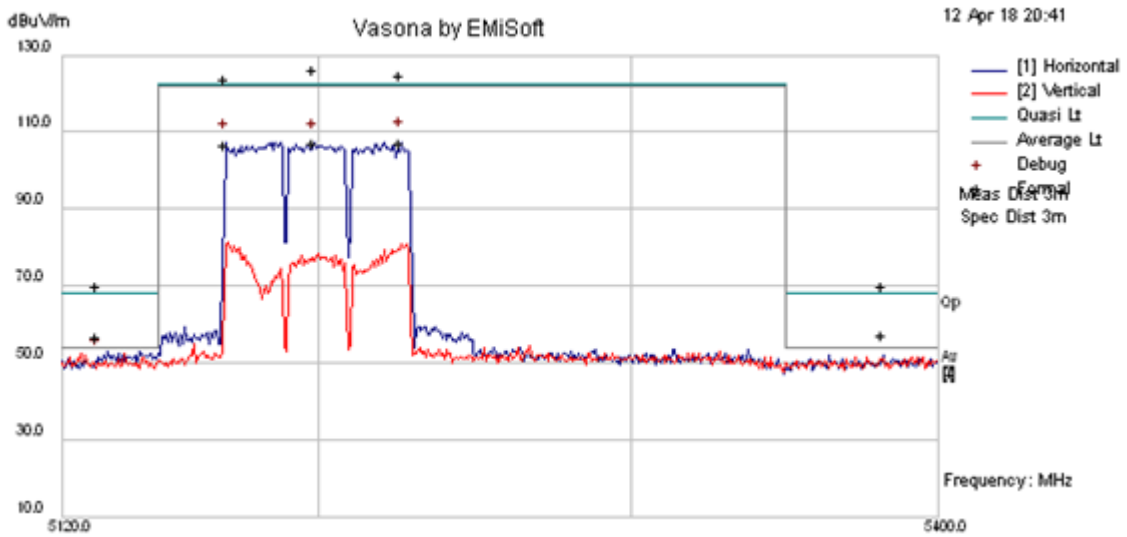
FORMAL DATA												
Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
5182.16	98.93	20.5	0.89	120.32	Peak	H	100	52	122.2	-1.88	Pass	tx
5150.57	43.01	20.48	0.84	64.33	Peak	V	376	86	69.74	-5.41	Pass	
5190.98	67.85	20.51	0.9	89.26	Peak	H	153	360	122.2	-32.94	Pass	tx
5210.05	44.26	20.52	0.93	65.71	Peak	V	181	0	122.2	-56.49	Pass	

Figure 4.8.3(a) The Radiated Out-of-Band Emissions with the Minimum Margin Evaluated for One 20MHz Carrier at UNII-1 Channel 36 (5180MHz), 22.5dBm, Q/16QAM, Directional Antenna #5 (Preview RBW: 100k and Formal RBW: 1MHz, File No T72).



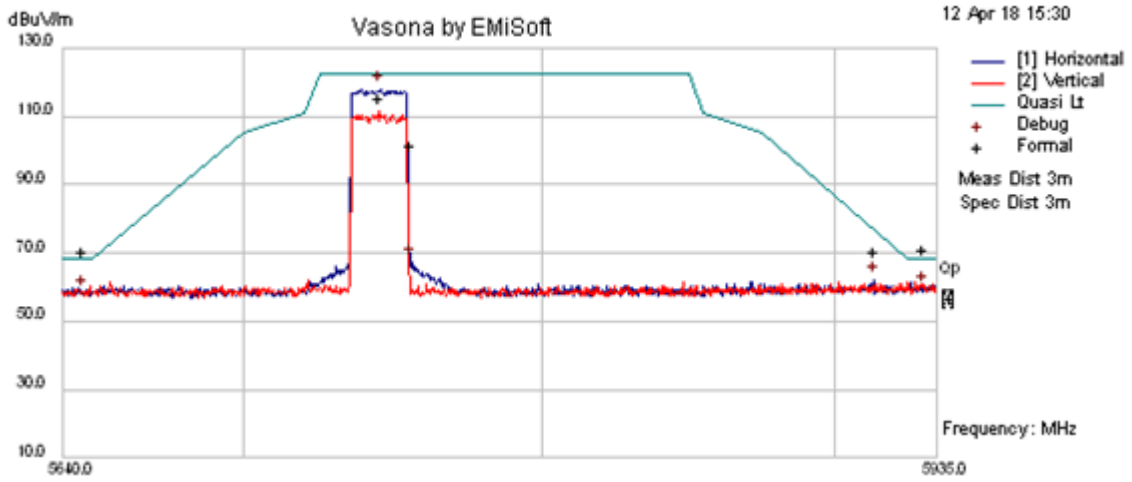
FORMAL DATA												
Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
5181.72	101.23	20.5	0.89	122.62	Peak	H	100	0	122.2	0.42	NA	tx
5358.9	29.78	20.62	1.15	51.54	AvgMax	V	130	0	54	-2.46	Pass	
5144.59	29.82	20.48	0.83	51.13	AvgMax	V	101	0	54	-2.87	Pass	left side
5358.9	42.61	20.62	1.15	64.38	Peak	V	130	0	68.2	-3.82	Pass	right side
5144.59	43.01	20.48	0.83	64.32	Peak	V	101	0	68.2	-3.88	Pass	
5202.48	87.86	20.52	0.92	109.3	Peak	H	100	0	122.2	-12.9	Pass	
5202.48	80.39	20.52	0.92	101.82	AvgMax	H	100	0	122	-20.18	Pass	tx
5181.72	80.4	20.5	0.89	101.79	AvgMax	H	100	0	122	-20.21	Pass	

Figure 4.8.3(b) The Radiated Out-of-Band Emissions with the Minimum Margin for Two 20MHz Carriers ats UNII-1 Channel 36 (5180MHz) and 40 (5200MHz), 22.5dBm Total, Q/16QAM, Directional Antenna #5 (Preview RBW: 30k and Formal RBW: 1MHz, File No T95b).



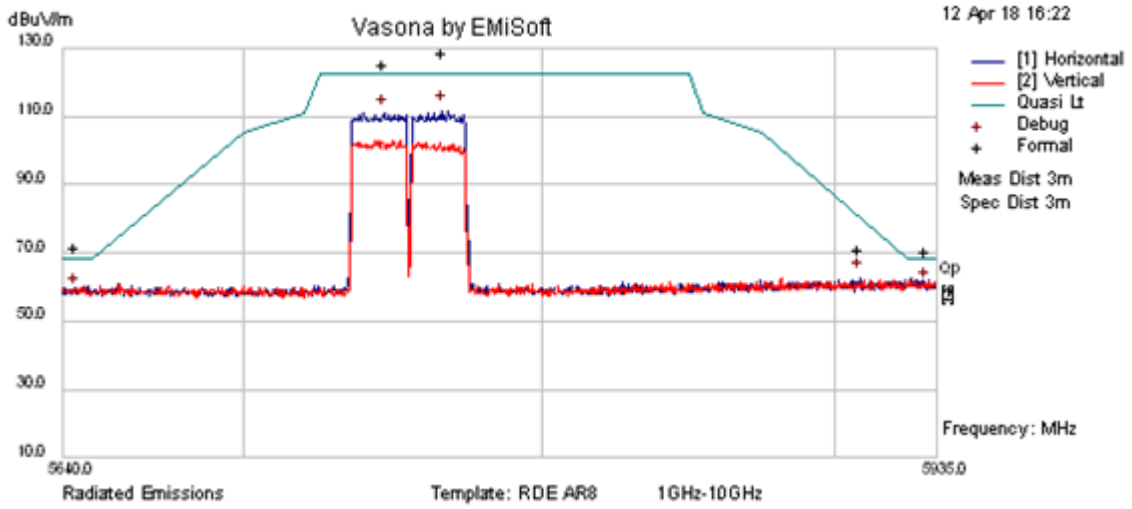
FORMAL DATA												
Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
5199.12	99.37	20.52	0.91	120.8	Peak	H	142	0	122.2	-1.4	Pass	Tx
5382.04	29.92	20.63	1.18	51.73	Average	H	115	0	54	-2.27	Pass	
5130.92	29.96	20.47	0.81	51.24	Average	V	137	0	54	-2.76	Pass	
5226.61	97.9	20.53	0.95	119.38	Peak	H	114	0	122.2	-2.82	Pass	Tx
5382.04	43.01	20.63	1.18	64.82	Peak	H	115	0	68.2	-3.38	Pass	
5171.06	97.14	20.5	0.87	118.5	Peak	H	143	0	122.2	-3.7	Pass	Tx
5130.92	43.15	20.47	0.81	64.43	Peak	V	137	0	68.2	-3.77	Pass	
5226.61	80.25	20.53	0.95	101.74	Average	H	114	0	122	-20.26	Pass	Tx

Figure 4.8.3(c) The Radiated Out-of-Band Emissions with the Minimum Margin for Three 20MHz Carriers at UNII-1 Channel 36 (5180MHz), 40 (5200MHz) and 44 (5220MHz), 22.5dBm Total, Q/16QAM, Directional Antenna #5 (Preview RBW: 30k and Formal RBW: 1MHz, File No T99).



FORMAL DATA												
Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
5745.64	87.86	21.01	1.7	110.57	Peak	H	124	0	122.2	-11.63	Pass	
5931.07	43.29	21.23	1.95	66.47	Peak	V	141	0	68.2	-1.73	Pass	
5647.05	43.29	20.89	1.56	65.74	Peak	V	153	0	68.2	-2.46	Pass	
5913.7	42.75	21.21	1.92	65.88	Peak	H	100	0	76.53	-10.65	Pass	
5756.03	73.78	21.02	1.71	96.52	Peak	H	108	0	122.2	-25.68	Pass	

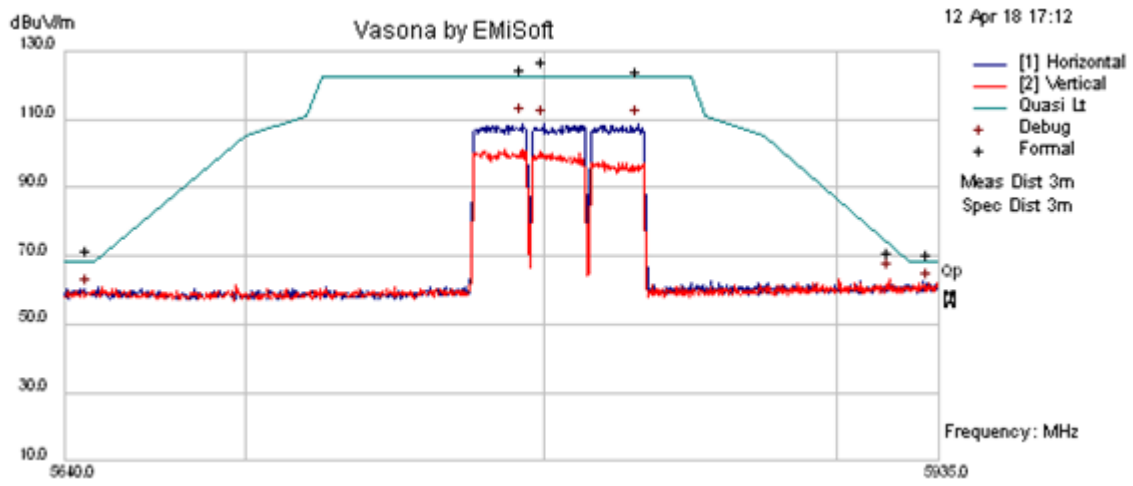
Figure 4.8.4 (a) The Radiated Out-of-Band Emissions with the Minimum Margin for One 20MHz Carrier at UNII-3 Channel 157 (5745MHz), 23.5dBm, Q/16QAM, Directional Antenna #5 (Preview RBW: 100k and Formal RBW: 1MHz, File No T88a).



FORMAL DATA

Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
5931.67	42.61	21.23	1.95	65.79	Peak	V	117	0	68.2	-2.41	Pass	
5644.46	44.39	20.89	1.55	66.84	Peak	V	100	0	68.2	-1.36	Pass	
5766.43	100.93	21.04	1.72	123.69	Peak	H	100	0	122.2	1.49	na	Tx
5746.68	97.42	21.01	1.7	120.13	Peak	H	153	0	122.2	-2.07	Pass	
5908.81	43.15	21.2	1.92	66.27	Peak	H	155	0	80.15	-13.88	Pass	

Figure 4.8.4 (b) The Radiated Out-of-Band Emissions with the Minimum Margin for Two 20MHz Carriers at UNII-3 Channels 157 (5745MHz) and 161 (5765MHz), 23.5dBm, Q/16QAM, Directional Antenna #5 (Preview RBW: 30k and Formal RBW: 1MHz, File No T91).



FORMAL DATA

Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
5931.67	42.75	21.23	1.95	65.93	Peak	V	112	0	68.2	-2.27	Pass	
5647.77	44.39	20.89	1.56	66.84	Peak	V	145	0	68.2	-1.36	Pass	
5917.86	43.43	21.21	1.93	66.57	Peak	V	101	0	73.46	-6.89	Pass	
5792.4	97.14	21.07	1.76	119.96	Peak	H	131	0	122.2	-2.24	Na	tx
5831.69	96.51	21.11	1.81	119.44	Peak	H	118	0	122.2	-2.76	Pass	
5799.68	99.37	21.08	1.77	122.21	Peak	H	100	0	122.2	0.01	Na	tx

Figure 4.8.4 (c) The Radiated Out-of-Band Emissions with the Minimum Margin for Three 20MHz Carriers at UNII-3 Channels 157 (5785MHz), 161 (5805MHz) and 165 (5825MHz), 23.5dBm Total, Q/16QAM, Directional Antenna #5 (Preview RBW: 30k and Formal RBW: 1MHz, File No T94).

4.9. MEASUREMENT REQUIRED: UNWANTED RADIATED SPURIOUS EMISSIONS – FCC SECTION 15.407 (b)(1)(4-8)

The requirements of the unwanted emissions are provided in Section 4.1. Per KDB 789033 D02 guidance II.G.3.b, "The unwanted emission limits in both the restricted and non-restricted bands are based on radiated measurements; however, as an alternative, antenna-port conducted measurements in conjunction with cabinet emissions tests will be permitted to demonstrate compliance."

The Limits of FCC 15.109 Class B, 15.209 and 15.407 were given in Tables 4.9.1 and 4.9.2, where the conversion between the EIRP and electrical field strength was given in Section 4.8. The restricted bands of operation specified in FCC 15.205(a) were provided in Section 4.1. The FCC 15.109 Class B limits are identical to the 15.209 limits between 30MHz and 30GHz for the EUT operating in UNII bands.

Table 4.9.1. FCC 15.109 Class B and 15.209 Radiated Emissions Limits

Frequency (MHz)	Field Stength at 3m (dB uV/m)		RBW (kHz)	Detector
	FCC 15.109 Class B	FCC 15.209		
10 - 30		49.5	9	QP
30 - 88	40	40	120	QP
88 - 216	43.5	43.5		
216 - 230	46	46		
230 - 960	46	46		
960 - 1000	54	54		
1000 - 3000	54	54	1000	Ave.
	74	74		Peak
> 3000 - 5 f_c	54	54	1000	Ave.
	74	74		Peak
5 f_c - 10 f_c / 40GHz		54	1000	Ave.
		74		Peak

Table 4.9.2. Combined Worst Radiated Emission Limits per 15.407 UNII-1/3, 15.209 and 15.109 at 3m

Frequency (MHz)	E (dBuV/m)	RBW (kHz)	Detector
10 - 30	47.7	9kHz	Peak
30 - 88	40/59	120kHz	QP/Peak
88 - 216	43.5/59		
216 - 960	46/59		
960 - 1000	54/59		
1G - 40G in Restricted Bands	54/68.2	1000	Ave/Peak
1G - 40G in Non-Restricted Bands	68.2	1000	Peak
Band Edges	See Section 4.8	1000	Peak

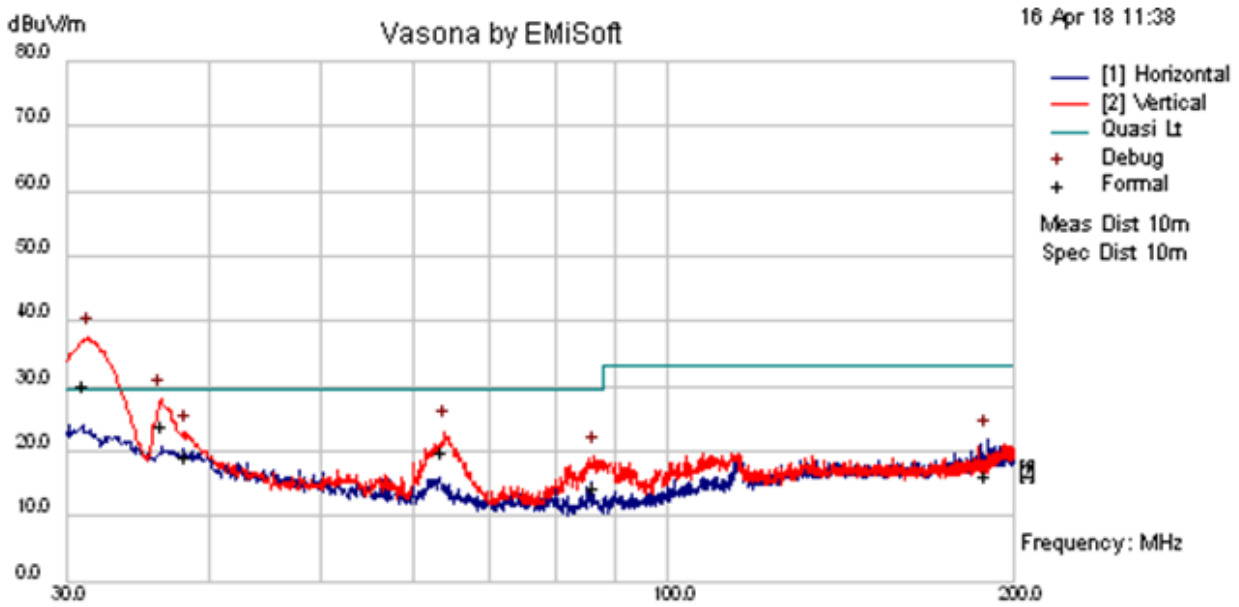
The unwanted emissions were evaluated by radiated measurement. As stated in Section 3.3, the EUT with the omni-directional antenna #4 which has the highest gain among all omni-directional antennas and the

directional antenna #5 which has the highest gain among all directional antennas were evaluated, respectively. The channels evaluated were listed in Section 4.2 with the configurations and power levels given in Section 4.3.

The emissions were investigated from 30MHz to 40GHz. The emissions near the band edges were provided in Section 4.8. The recommendations of ANSI C63.10 were followed for EUT testing setup and cabling. The measurement guidance given in KDB 789033 D02 was followed. The test setup diagram was given in Section 4.3. The radiated spurious emissions were measured at 10m distance for frequencies below 1GHz, at 3m distance for frequencies above 1GHz and below 18GHz, and at 1m distance for frequencies above 18GHz, respectively. The emissions were maximized by rotating the turntable 360° and moving the receiving antenna height to scan and capture the emissions from the EUT.

The unwanted emissions for a 20MHz carrier located at the middle channel of the UNII-1/3 band were pre-scanned first for various modulations (Q/16QAM, 64QAM and 256QAM), respectively, to determine the worst modulation. The carriers with different modulations were found to have similar performance in their radiated spurious emissions. The unwanted emissions at the channels near the low and high band edges were evaluated for one, two and three 20MHz carriers with Q/16QAM modulation mostly. The radiated emissions in the frequency range of 30MH-40GHz were measured for the EUT equipped with the directional antenna #5 first, where no emissions impacted by the carrier placement and modulations were observed in the frequency range below 1GHz and above 18GHz. The EUT with the antenna #5 has almost the same maximum EIRP with that of the EUT with the antenna #4. Therefore, the emissions of the EUT equipped with the antenna #4 were measured in the frequency range of 1G-18GHz only for the EUT with various carrier configurations. The unwanted emissions below 1GHz and above 18GHz up to 40GHz were conducted for the EUT with the antenna #4 transmitting three 20MHz UNII-3 carriers at full power. The results showed that the emission performance with the EUT transmitting in UNII-3 band is worse than that with the EUT transmitting in UNII-1 band in general due to the fact that the EUT transmits higher power in UNII-3 than in UNII-1.

The unwanted radiated spurious emissions measured in the frequency range of 30MHz-40GHz for the EUT, which operated in UNII-1/3 bands and was equipped with the omni-directional antenna #4 and the directional antenna #5, respectively, met the FCC 15.407 and 15.209 requirements for intentional radiators and the FCC 15.109 Class B requirements for unintentional radiators. The plots with the minimum margins in each frequency range evaluated for each antenna were provided in Figures 4.9.1 (antenna #4) and 4.9.2 (antenna #5), respectively.



FORMAL DATA

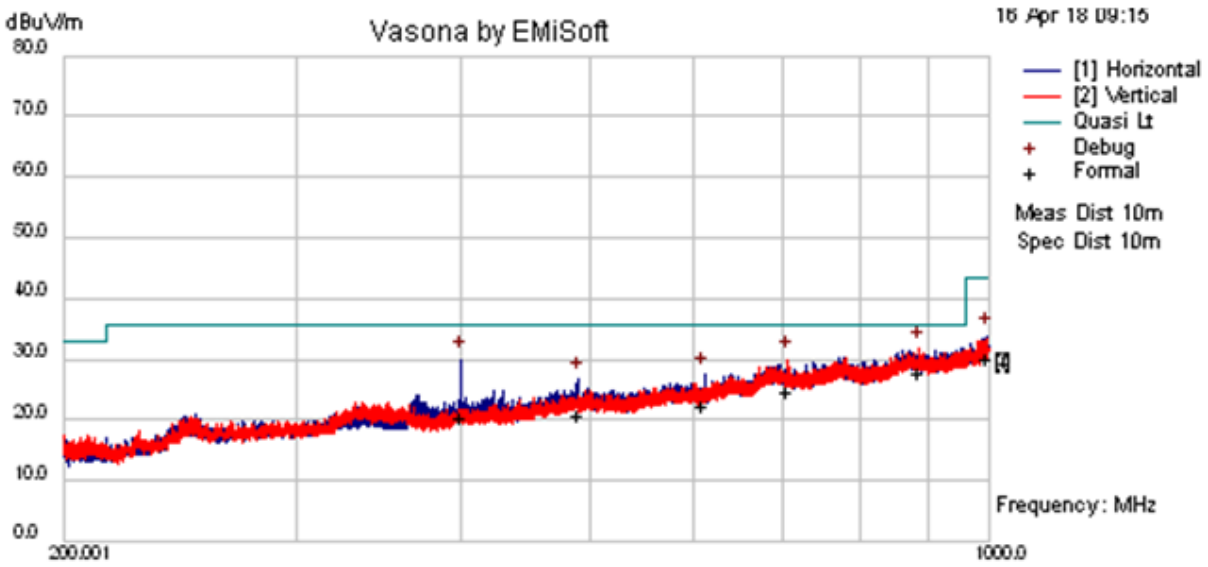
Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
31.057	39.18	6.37	-18.7	26.88	Quasi Max	V	183	13	29.5	-2.62	Pass	
36.359	33.68	6.37	-19.3	20.73	Quasi Max	V	178	22	29.5	-8.77	Pass	
63.679	33.03	6.48	-23	16.51	Quasi Max	V	188	7	29.5	-12.99	Pass	
38.109	28.99	6.37	-19.5	15.84	Quasi Max	V	173	23	29.5	-13.66	Pass	
86.3721	28.35	6.61	-23.9	11.04	Quasi Max	V	171	18	29.5	-18.46	Pass	
189.303	24.35	7.04	-18.4	12.98	Quasi Max	H	175	17	33	-20.02	Pass	

PREVIEW DATA

Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
31.3467	49.83	6.37	-18.7	37.49	Preview	V	100	135	29.5	7.99	Fail	
36.2525	40.91	6.37	-19.3	27.96	Preview	V	100	90	29.5	-1.54	Pass	
63.8597	39.55	6.48	-23	23.02	Preview	V	100	45	29.5	-6.48	Pass	
38.1764	35.7	6.37	-19.5	22.54	Preview	V	100	90	29.5	-6.96	Pass	
86.3721	36.31	6.61	-23.9	19	Debug	V	100	277	29.5	-10.5	Pass	
189.423	33.01	7.04	-18.4	21.65	Preview	H	385	225	33	-11.35	Pass	

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

Figure 4.9.1(a) The Radiated Unwanted Emissions in 30MHz-200MHz for the EUT with Antenna #4 in UNII-3, Three 20MHz Carriers at Channel 157 (5785MHz) Q/16QAM, 161 (5805MHz) 64QAM and 165 (5825MHz) 256QAM, 27dBm Total, against FCC Part 15.209 and 15.109 Class B Limits at 10m Distance (T113).



FORMAL DATA

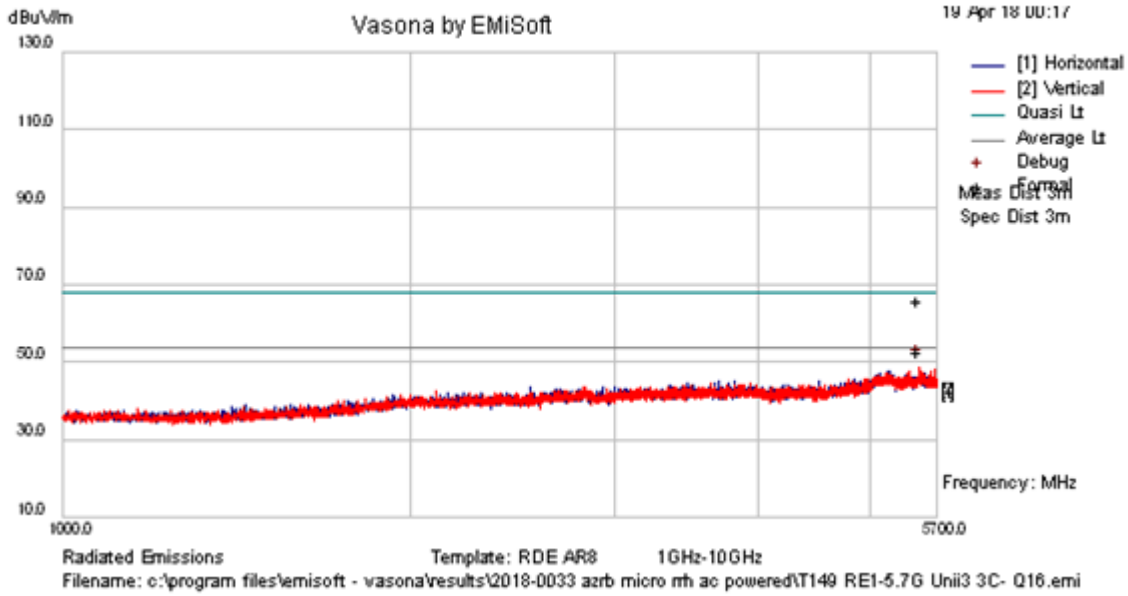
Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
887.654	24.35	8.73	-8.55	24.52	Quasi Max	V	188	20	35.6	-11.08	Pass	
705.934	23.9	8.4	-10.6	21.66	Quasi Max	V	177	27	35.6	-13.94	Pass	
610.619	23.71	8.21	-12.9	19.07	Quasi Max	H	188	32	35.6	-16.53	Pass	
997.555	24.35	8.91	-6.3	26.95	Quasi Max	H	179	21	43.5	-16.55	Pass	
490.958	23.62	7.98	-14	17.63	Quasi Max	H	178	29	35.6	-17.97	Pass	
399.379	25.02	7.78	-15.6	17.2	Quasi Max	H	178	8	35.6	-18.4	Pass	

PREVIEW DATA

Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
887.651	31.39	8.73	-8.55	31.57	Debug	V	100	319	35.6	-4.03	Pass	
705.855	32.12	8.4	-10.6	29.89	Debug	V	100	319	35.6	-5.71	Pass	
399.379	37.66	7.78	-15.6	29.84	Preview	H	200	0	35.6	-5.76	Pass	
610.619	31.97	8.21	-12.9	27.33	Debug	H	100	319	35.6	-8.27	Pass	
490.958	32.58	7.98	-14	26.59	Debug	H	100	319	35.6	-9.01	Pass	
997.555	31.19	8.91	-6.3	33.8	Preview	H	385	45	43.5	-9.7	Pass	

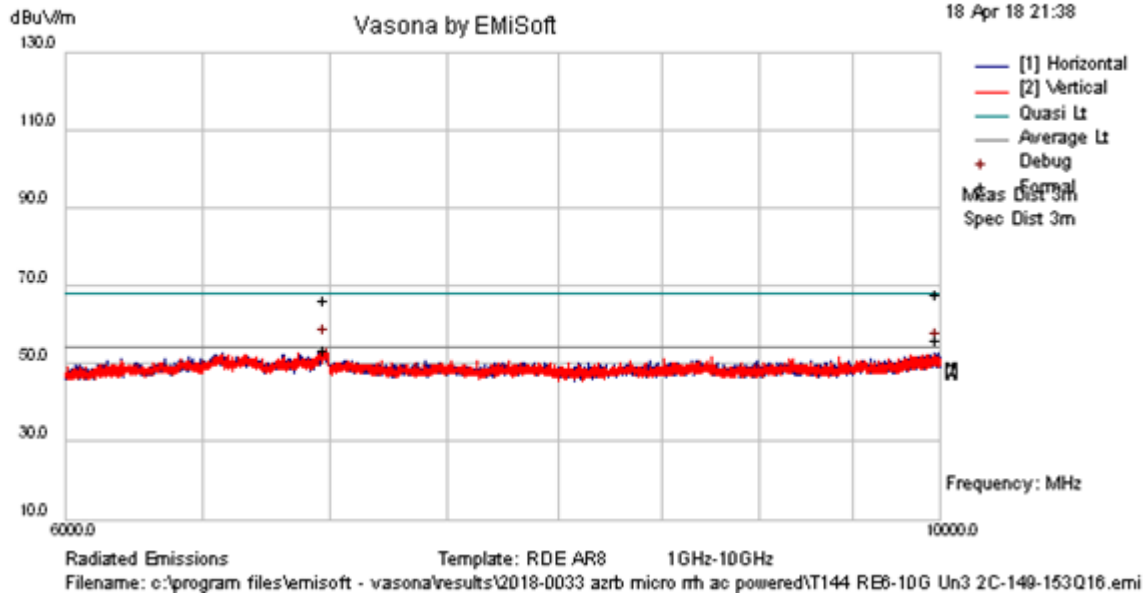
Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

Figure 4.9.1(b) The Radiated Unwanted Emissions in 200MHz-1GHz for the EUT with Antenna #4 in UNII-3, Three 20MHz Carriers at Channel 157 (5785MHz) Q/16QAM, 161 (5805MHz) 64QAM and 165 (5825MHz) 256QAM, 27dBm Total, against FCC Part 15.209 and 15.109 Class B Limits at 10m Distance (T112).



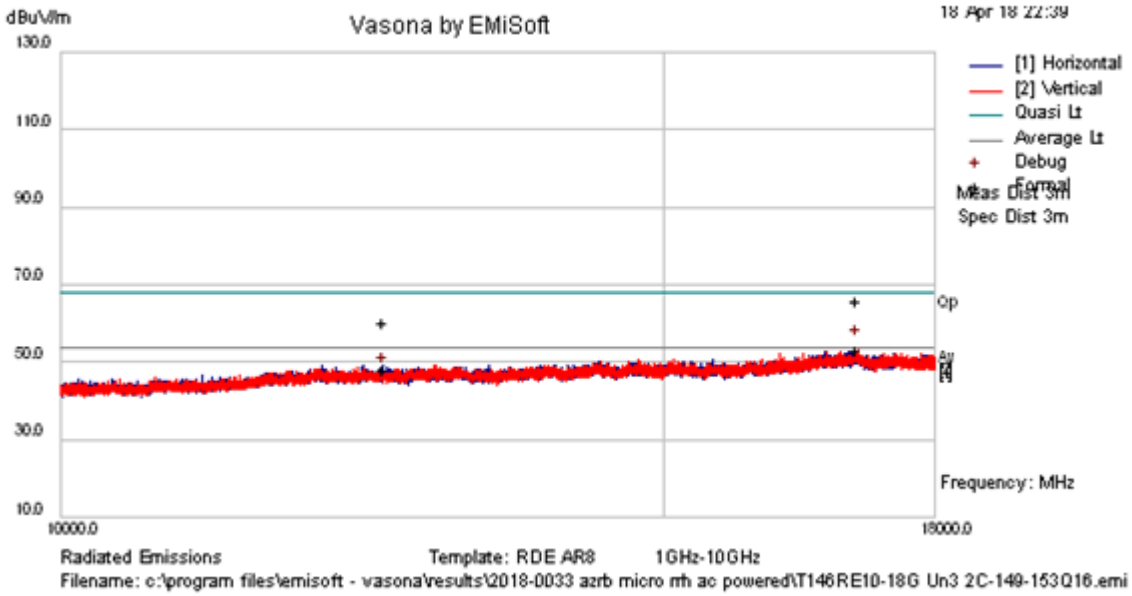
FORMAL DATA												
Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
5505.92	31.04	15.07	1.36	47.47	Average	V	175	221	54	-6.53	Pass	
5505.92	43.93	15.07	1.36	60.35	Peak	V	175	221	68.2	-7.85	Pass	

Figure 4.9.1(c) The Radiated Unwanted Emissions with the Minimum Margin in 1GHz-5GHz Evaluated for the EUT with Antenna #4 in UNII-3, Three 20MHz Carriers at Channel 149 (5745MHz), 153 (5765MHz) and 157 (5785MHz), Q/16QAM, 27dBm Total, against FCC Part 15.407 and 15.209 Limits at 3m Distance (Preview 30k RBW Peak, Formal 1MHz RBW Peak & Average).



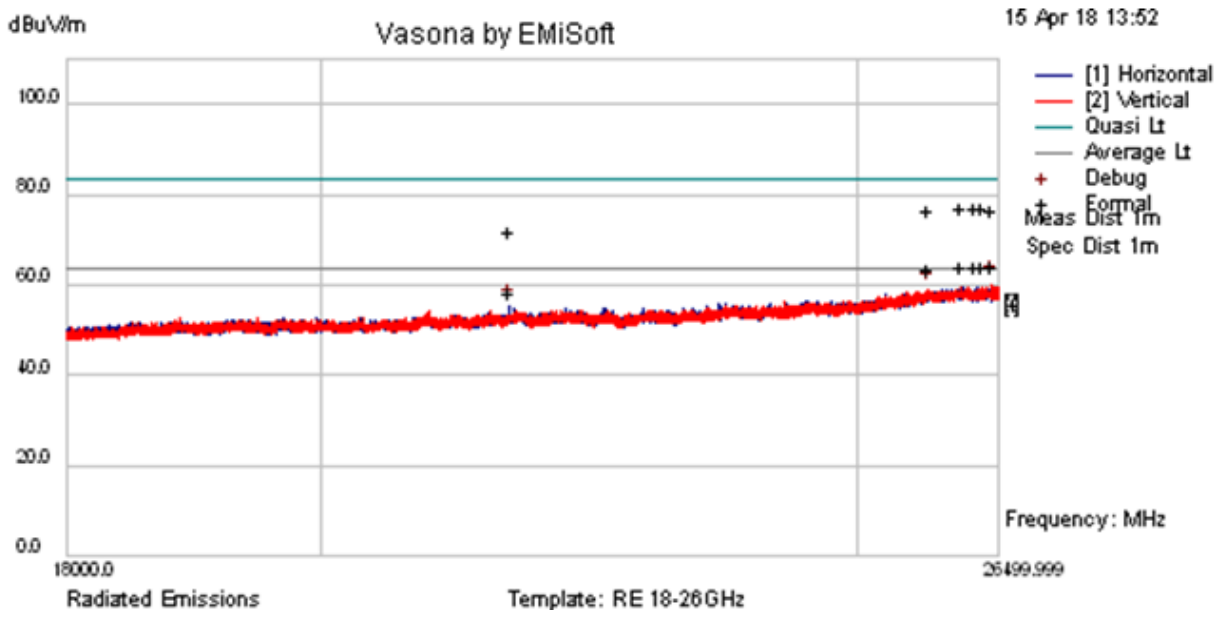
FORMAL DATA												
Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
9988.33	28.78	18.29	3.91	50.98	Average	H	143	303	54	-3.02	Pass	
9988.33	40.41	18.29	3.91	62.61	Peak	H	143	303	68.2	-5.59	Pass	
6983.9	29.64	15.86	2.67	48.16	Average	V	203	56	54	-5.84	Pass	
6983.9	42.67	15.86	2.67	61.19	Peak	V	203	56	68.2	-7.01	Pass	

Figure 4.9.1(d) The Radiated Unwanted Emissions with the Minimum Margin in 6GHz-10GHz Evaluated for the EUT with Antenna #4 in UNII-3, Three 20MHz Carriers at Channel 149 (5745MHz) and 153 (5765MHz), Q/16QAM, 27dBm Total, against FCC Part 15.407 and 15.209 Limits at 3m Distance (Preview 30k RBW Peak, Formal 1MHz RBW Peak & Average).



FORMAL DATA												
Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
17092.6	23.99	11.68	12.3	47.98	Average	V	136	123	54	-6.02	Pass	
17092.6	36.64	11.68	12.3	60.63	Peak	V	136	123	68.2	-7.57	Pass	
12433.3	25.65	9.63	7.51	42.78	Average	H	141	230	54	-11.22	Pass	
12433.3	38.1	9.63	7.51	55.23	Peak	H	141	230	68.2	-12.97	Pass	

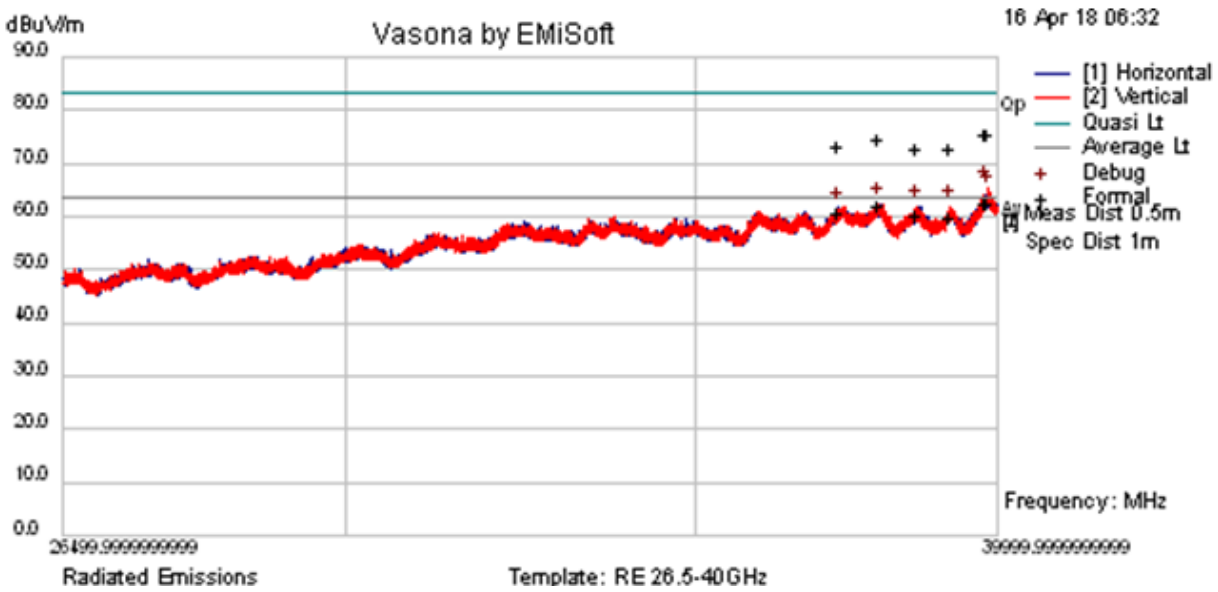
Figure 4.9.1(e) The Radiated Unwanted Emissions with the Minimum Margin in 10GHz-18GHz Evaluated for the EUT with Antenna #4 in UNII-3, Two 20MHz Carriers at Channel 149 (5745MHz) and 153 (5765MHz), Q/16QAM, 27dBm Total, against FCC Part 15.407 and 15.209 Limits at 3m Distance (Preview 30k RBW Peak, Formal 1MHz RBW Peak & Average).



FORMAL DATA

Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
26333.3	27.42	11.31	21.07	59.8	Average	V	104	182	63.5	-3.7	Pass	
26259.3	27.54	11.29	20.94	59.77	Average	H	128	238	63.5	-3.73	Pass	
26429.4	27.04	11.35	21.23	59.62	Average	V	129	238	63.5	-3.88	Pass	
26112.2	27.66	11.24	20.69	59.59	Average	H	120	337	63.5	-3.91	Pass	
25738.5	27.96	11.1	19.79	58.85	Average	V	100	349	63.5	-4.65	Pass	
21637.8	28.24	9.95	15.72	53.91	Average	H	117	340	63.5	-9.59	Pass	
26112.2	40.86	11.24	20.69	72.79	Peak	H	120	337	83.5	-10.71	Pass	
26333.3	40.19	11.31	21.07	72.57	Peak	V	104	182	83.5	-10.93	Pass	
26259.3	40.19	11.29	20.94	72.42	Peak	H	128	238	83.5	-11.08	Pass	
26429.4	39.79	11.35	21.23	72.36	Peak	V	129	238	83.5	-11.14	Pass	
25738.5	41.13	11.1	19.79	72.03	Peak	V	100	349	83.5	-11.47	Pass	
21637.8	41.54	9.95	15.72	67.22	Peak	H	117	340	83.5	-16.28	Pass	

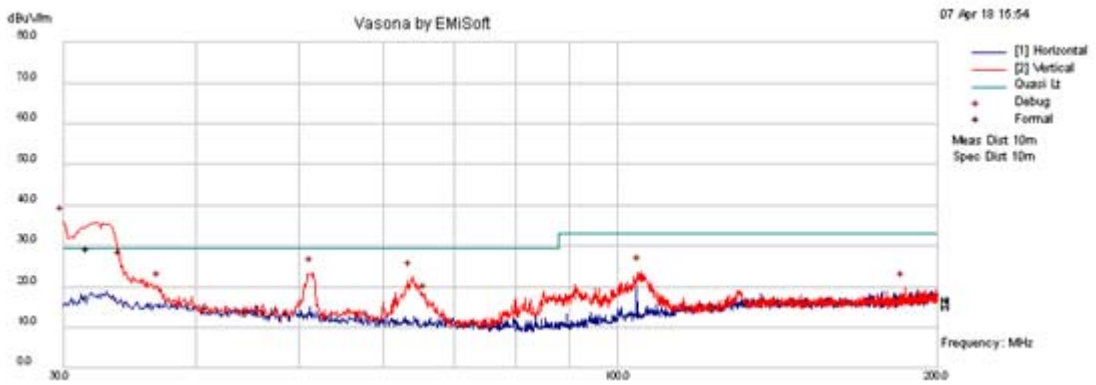
Figure 4.9.1(f) The Radiated Unwanted Emissions with the Minimum Margin in 18GHz-26.5GHz Evaluated for the EUT with Antenna #4 in UNII-3, Three 20MHz Carriers at Channel 157 (5785MHz) Q/16QAM, 161 (5805MHz) 64QAM and 165 (5825MHz) 256QAM, 27dBm Total, against FCC Part 15.407 and 15.209 Limits at 1m Distance (Preview 30k RBW Peak, Formal 1MHz RBW Peak & Average, T110a).



FORMAL DATA

Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
39866.6	37.1	0	22.13	59.23	Average	V	100	292	63.5	-4.27	Pass	
39828.3	37.18	0	22.04	59.22	Average	V	155	223	63.5	-4.28	Pass	
37982.3	36.5	0	22.09	58.59	Average	H	113	80	63.5	-4.91	Pass	non-restric
37288.8	34.83	0	22.5	57.33	Average	H	100	45	63.5	-6.17	Pass	non-restric
38605.1	35.14	0	21.49	56.63	Average	H	100	349	63.5	-6.87	Pass	
39190.4	35.22	0	21.2	56.42	Average	V	154	102	63.5	-7.08	Pass	
39828.3	50.16	0	22.04	72.2	Peak	V	155	223	83.5	-11.3	Pass	
39866.6	50.03	0	22.13	72.16	Peak	V	100	292	83.5	-11.34	Pass	
37982.3	48.91	0	22.09	71	Peak	H	113	80	83.5	-12.5	Pass	
37288.8	47.49	0	22.5	70	Peak	H	100	45	83.5	-13.5	Pass	
38605.1	48	0	21.49	69.49	Peak	H	100	349	83.5	-14.01	Pass	
39190.4	48.13	0	21.2	69.33	Peak	V	154	102	83.5	-14.17	Pass	

Figure 4.9.1(g) The Radiated Unwanted Emissions with the Minimum Margin in 26.5GHz-40GHz Evaluated for the EUT with Antenna #4 in UNII-3, Three 20MHz Carriers at Channel 157 (5785MHz) Q/16QAM, 161 (5805MHz) 64QAM and 165 (5825MHz) 256QAM, 27dBm Total, against FCC Part 15.407 and 15.209 Limits at 1m Distance (Preview 100k RBW Peak, Formal 1MHz RBW Peak & Average, T111).

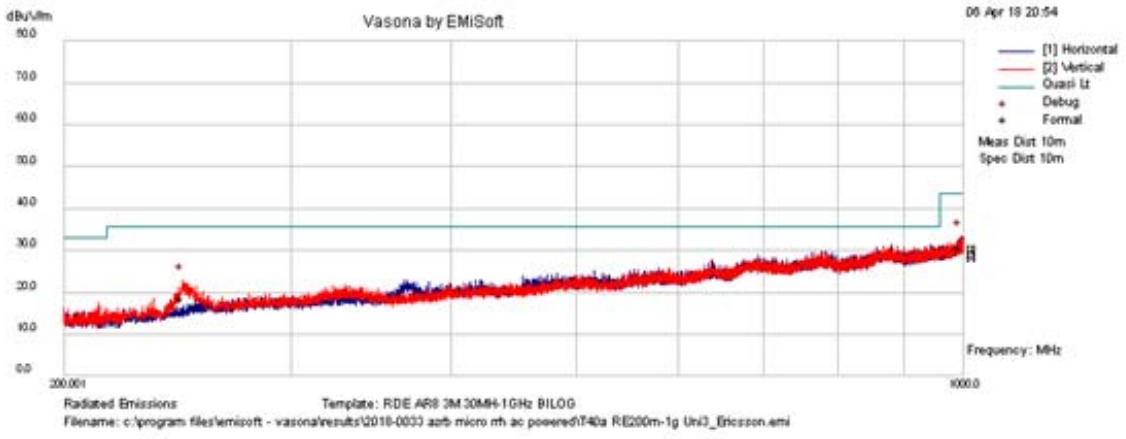


FORMAL DATA												
Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
31.754	38.29	6.37	-18.8	25.9	Quasi Max	V	166	303	29.5	-3.6	Pass	

PREVIEW DATA												
Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
30	47.98	6.37	-18.5	35.82	Preview	V	100	315	29.5	6.32	Fail	
34.0401	37.76	6.37	-19.1	25.08	Preview	V	100	270	29.5	-4.42	Pass	
51.5471	38.41	6.39	-21.5	23.3	Preview	V	100	315	29.5	-6.2	Pass	
63.9559	39.05	6.48	-23	22.51	Preview	V	100	45	29.5	-6.99	Pass	
105.126	38.57	6.7	-21.5	23.78	Preview	V	100	45	33	-9.22	Pass	
37.022	32.87	6.37	-19.4	19.84	Preview	V	100	270	29.5	-9.66	Pass	
65.976	33.44	6.5	-23.1	16.82	Preview	V	100	0	29.5	-12.68	Pass	
186.557	31.36	7.03	-18.5	19.9	Preview	V	100	0	33	-13.1	Pass	

Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

Figure 4.9.2(a) The Radiated Unwanted Emissions with the Minimum Margin in 30MHz-200MHz Evaluated for the EUT with Antenna #5 in UNII-3, Two 20MHz Carriers at Channel 161 (5805MHz) and 165 (5825MHz), Q/16QAM, 23.5dBm Total, against FCC Part 15.209 and 15.109 Class B Limits at 10m Distance (T47b).



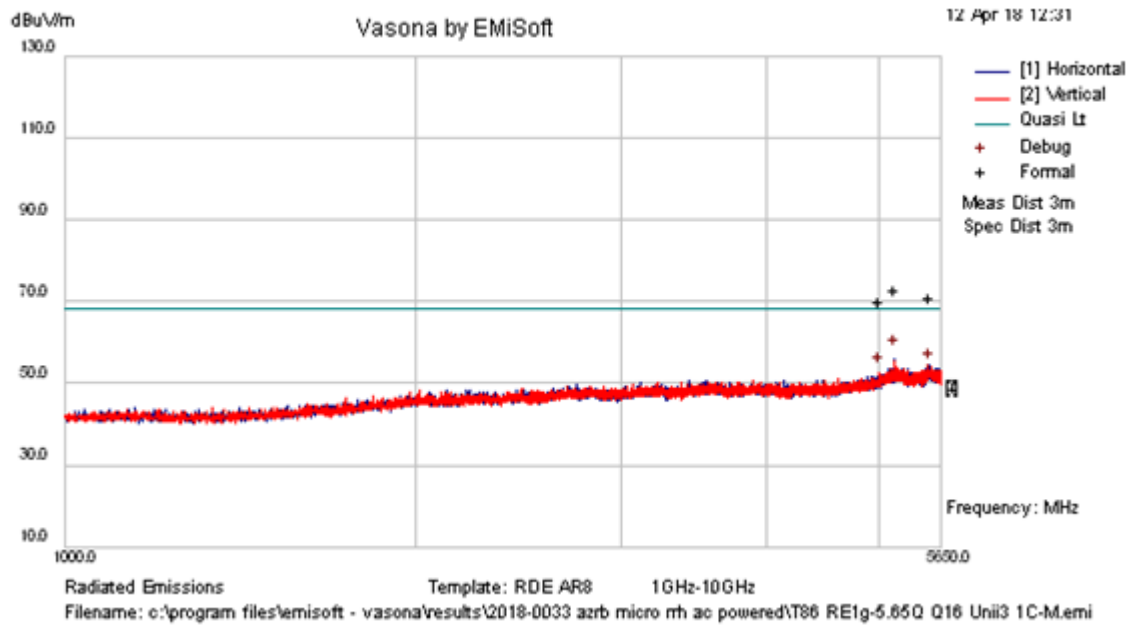
FORMAL DATA												
Freq. (MHz)	**Raw (dBuV)**	**Cable (dB)**	**Factor (dB)**	**Level (dBuV/m)**	**Emission Type**	**Pol (H/V)**	**Ht (cm)**	**Az (deg)**	**Limit (dBuV/m)**	**Margin (dB)**	**Pass /Fail**	**Comments**
997.956	24.43	8.91	-6.27	27.07	Quasi Max	V	170	26	43.5	-16.43	Pass	
247.491	27.48	7.29	-19.9	14.92	Quasi Max	V	169	24	35.6	-20.68	Pass	
253.551	25.57	7.31	-19.5	13.38	Quasi Max	V	171	23	35.6	-22.22	Pass	

PREVIEW DATA

Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
997.956	30.58	8.91	-6.27	33.22	Preview	V	100	135	43.5	-10.28	Pass	
247.491	35.4	7.29	-19.9	22.84	Preview	V	100	45	35.6	-12.76	Pass	

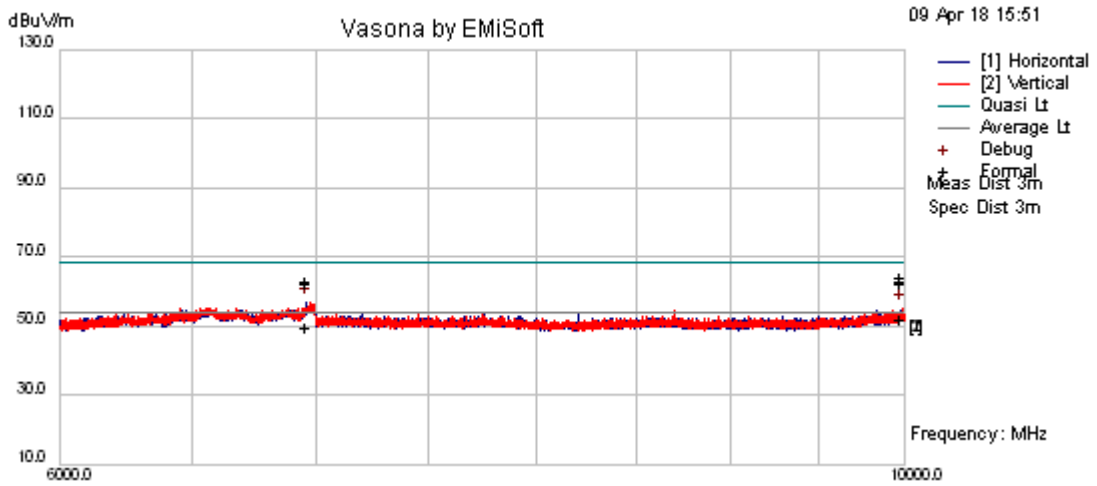
Note: Preview data was measured using a peak detector to identify frequencies of interest for formal measurement. Formal data consist of all frequencies in the preview list within 6 dB of specification limit or the top six frequencies. Failure in preview data does not necessarily constitute failure in formal data.

Figure 4.9.2(b) The Radiated Unwanted Emissions with the Minimum Margin in 200MHz-1GHz Evaluated for the EUT with Antenna #5 in UNII-3, Three 20MHz Carriers at Channels 157 (5785MHz) Q/16QAM, 161 (5805MHz) 64QAM and 165 (5825MHz) 256QAM, 23.5dBm Total, against FCC Part 15.209 and 15.109 Class B Limits at 10m Distance (T40a).



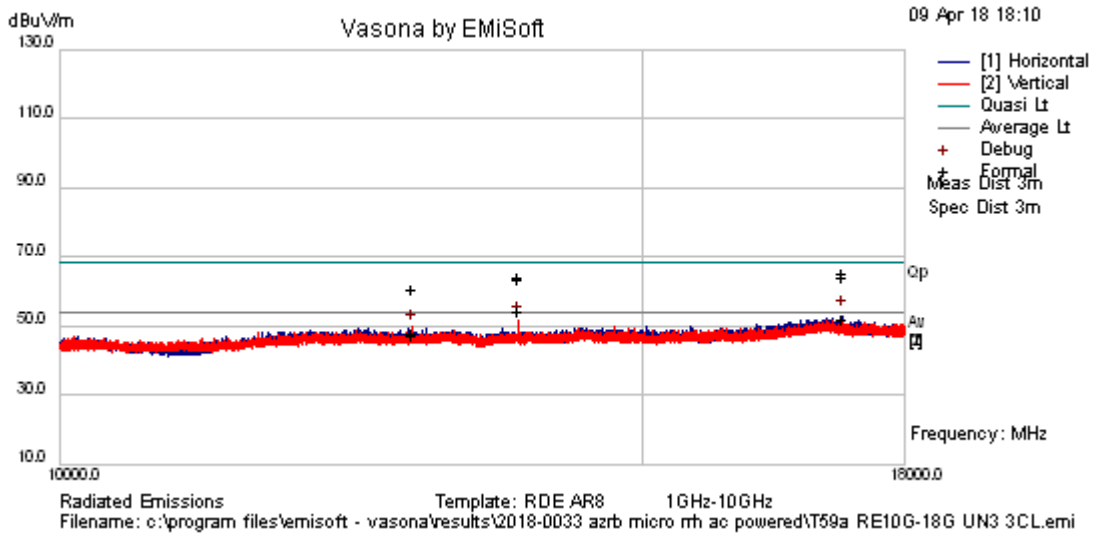
FORMAL DATA												
Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
5161	46.1	20.49	0.86	67.44	Peak	H	128	-1	68.2	-0.76	Pass	
5538.6	43.29	20.76	1.4	65.45	Peak	V	135	324	68.2	-2.75	Pass	
5013.69	43.57	20.39	0.63	64.59	Peak	V	141	354	68.2	-3.61	Pass	
5135.26	29.82	20.47	0.82	51.11	Average	H	319	41	54	-2.89	Pass	
5444.21	29.15	20.67	1.27	51.09	Average	V	116	76	54	-2.91	Pass	
5085.48	29.2	20.44	0.74	50.38	Average	H	239	323	54	-3.62	Pass	
5444.21	42.27	20.67	1.27	64.21	Peak	V	116	76	68.2	-3.99	Pass	
5135.26	42.27	20.47	0.82	63.56	Peak	H	319	41	68.2	-4.64	Pass	
5085.48	41.61	20.44	0.74	62.79	Peak	H	239	323	68.2	-5.41	Pass	

Figure 4.9.2(c) The Radiated Unwanted Emissions with the Minimum Margin in 1GHz-5.65GHz Evaluated for the EUT with Antenna #5 in UNII-3, One 20MHz Carrier at Channel 157 (5785MHz), Q/16QAM, 23.5dBm, against FCC Part 15.407 and 15.209 Limits at 3m Distance (Preview 30k RBW Peak, Formal 1MHz RBW Peak & Average, T86a).



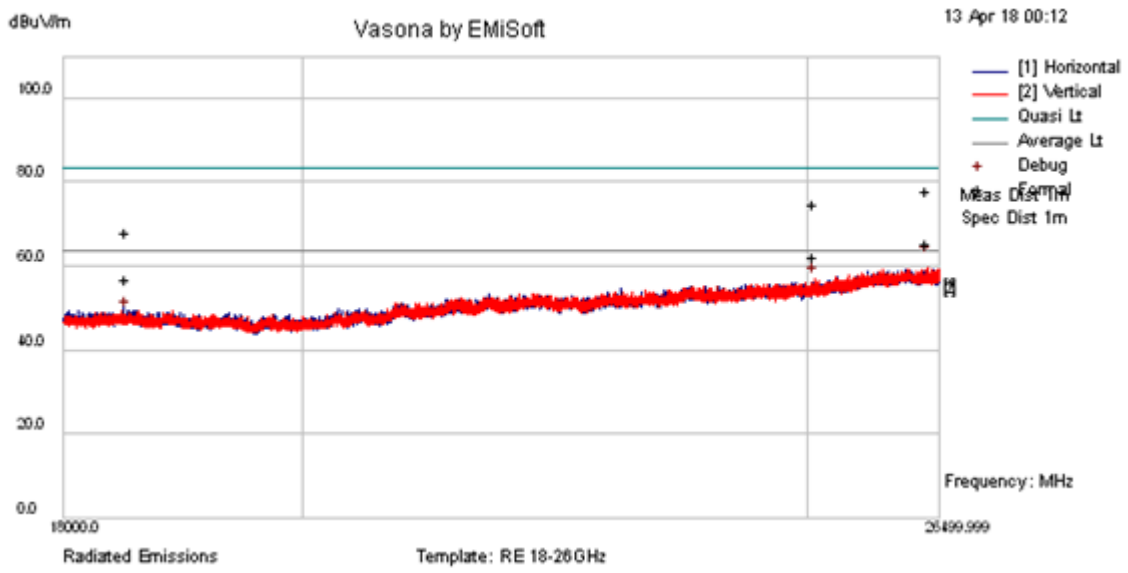
FORMAL DATA												
Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
9986.92	29.25	14.3	3.91	47.46	Average	V	264	298	54	-6.54	Pass	non-restric
9986.92	41.27	14.3	3.91	59.48	Peak	V	264	298	68.2	-8.72	Pass	
6964.61	30.01	12.19	2.66	44.86	Average	H	305	322	54	-9.14	Pass	non-restric
6964.61	43.15	12.19	2.66	58	Peak	H	305	322	68.2	-10.2	Pass	

Figure 4.9.2(d) The Radiated Unwanted Emissions with the Minimum Margin in 6GHz-10GHz Evaluated for the EUT with Antenna #5 in UNII-3, Two 20MHz Carriers at Channel 149 (5745MHz) and 153 (5765MHz), Q/16QAM, 23.5dBm Total, against FCC Part 15.407 and 15.209 Limits at 3m Distance (Preview 100k RBW Peak, Formal 1MHz RBW Peak and Average, T57).



FORMAL DATA												
Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
13762.6	31.36	10.63	7.71	49.7	Average	V	100	353	54	-4.3	Pass	
17259.7	23.42	11.64	12.13	47.19	Average	H	366	299	54	-6.81	Pass	
17259.7	37.08	11.64	12.13	60.85	Peak	H	362	302	68.2	-7.35	Pass	
13762.6	40.33	10.63	7.71	58.66	Peak	V	100	355	68.2	-9.54	Pass	
12779.5	25.26	9.64	7.84	42.74	Average	V	273	26	54	-11.26	Pass	
12779.5	38.42	9.64	7.84	55.9	Peak	V	273	26	68.2	-12.3	Pass	

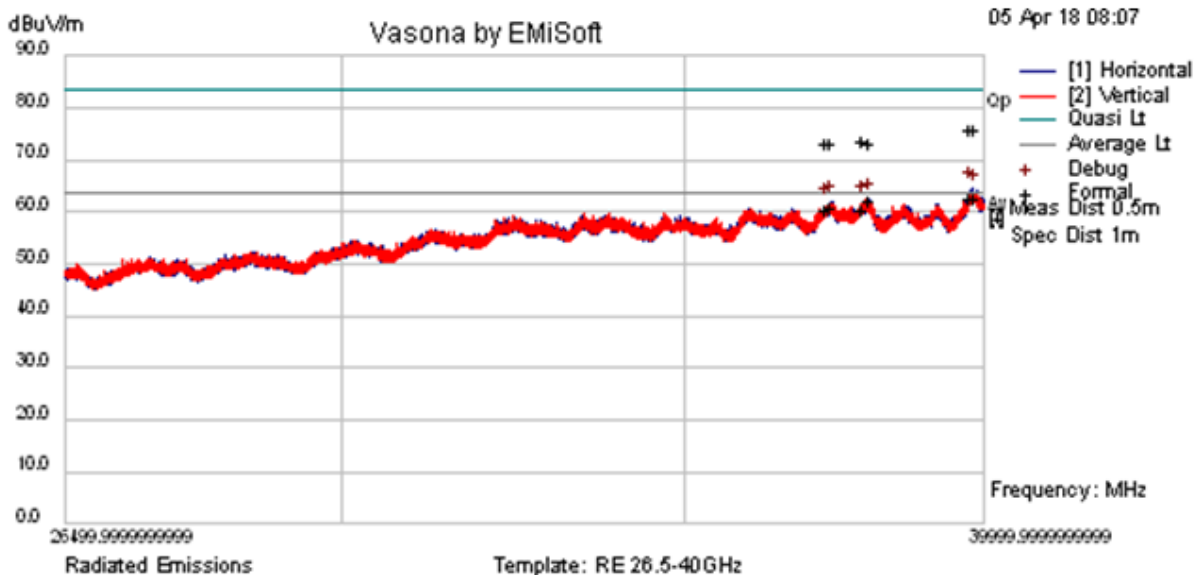
Figure 4.9.2(e) The Radiated Unwanted Emissions with the Minimum Margin in 10GHz-18GHz Evaluated for the EUT with Antenna #5 in UNII-3, Three 20MHz Carriers at Channel 149 (5745MHz), 153 (5765MHz) and 157 (5785MHz), Q/16QAM, 23.5dBm Total, against FCC Part 15.407 and 15.209 Limits at 3m Distance (Preview 100k RBW Peak, Formal 1MHz RBW Peak & Average).



FORMAL DATA

Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
26378.3	28.01	11.33	21.14	60.49	Average	V	100	303	63.5	-3.01	Pass	Non-restr
25083.8	28.24	10.87	17.93	57.04	Average	H	118	360	63.5	-6.46	Pass	Non-restr
26378.3	40.46	11.33	21.14	72.93	Peak	V	100	303	77.7	-4.81	Pass	
18511.9	27.54	9.2	15.13	51.87	Average	H	122	222	63.5	-11.63	Pass	Non-restr
25083.8	41.13	10.87	17.93	69.93	Peak	H	118	360	77.7	-7.81	Pass	
18511.9	38.56	9.2	15.13	62.89	Peak	H	122	222	77.7	-14.85	Pass	

Figure 4.9.2(f) The Radiated Unwanted Emissions in 18GHz-26.5GHz for the EUT with Antenna #5 in UNII-3, One 20MHz Carrier at Channel 165 (5825MHz), Q/16QAM, 23.5dBm, against FCC Part 15.407 and 15.209 Limits at 1m Distance (Preview 30k RBW Peak, Formal 1MHz RBW Peak & Average, T103).



Formal Data

No	Freq. MHz	Raw dBuV	Cable Loss dB	AF dB	Level dBuV/m	Emission Type	Pol	Hgt cm	Azt Deg.	Limit dBuV/m	Margin dB	Pass / Fail	Comments
1	39873.2	37.12	0	22.14	59.27	Average	H	146	240	63.5	-4.23	Pass	
2	39795.4	37.04	0	21.96	59.01	Average	H	110	238	63.5	-4.49	Pass	
3	38020.8	36.52	0	22.06	58.58	Average	H	192	289	63.5	-4.92	Pass	
4	37382	34.78	0	22.43	57.21	Average	H	165	325	63.5	-6.29	Pass	
5	37921.2	35.04	0	22.12	57.16	Average	V	175	275	63.5	-6.34	Pass	
6	37309.6	34.26	0	22.49	56.75	Average	V	176	52	63.5	-6.75	Pass	
7	39873.2	50.1	0	22.14	72.25	Peak	H	146	240	77.7	-5.49	Pass	
8	39795.4	50.24	0	21.96	72.2	Peak	H	110	238	77.7	-5.54	Pass	
9	37921.2	48.04	0	22.12	70.16	Peak	V	175	275	77.7	-7.58	Pass	

Figure 4.9.2(g) The Radiated Unwanted Emissions in 26.5GHz-40GHz for the EUT with Antenna #5 in UNII-3, Three 20MHz Carriers at Channel 157 (5785MHz) Q/16QAM, 161 (5805MHz) 64QAM and 165 (5825MHz) 256QAM , 23.5dBm Total, against FCC Part 15.407 and 15.209 Limits at 1m Distance (Preview 100k RBW Peak, Formal 1MHz RBW Peak & Average, T35).

4.10. MEASUREMENT REQUIRED: AC POWER LINE CONDUCTED EMISSIONS – FCC SECTIONS 15.407(b)(6) & 15.207

The AZRB AC version uses Nokia AirScale Micro AC PSU to converts 100-240VAC to -54VDC. The AC main plug consists of line, neutral and ground.

The FCC requirements specified in 15.407(b)(6) are provided in Section 4.1, where FCC states that any U-NII devices using an AC power line are required to comply with the conducted limits set forth in 15.207.

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

FCC 15.207(c) states that measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. Devices that include, or make provisions for, the use of battery chargers which permit operating while charging, AC adapters or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

The limits are given in Table 4.10.1.

Table 4.10.1. FCC 15.107 and 15.207 AC Power Line Conducted Emissions Limits

Frequency (MHz)	15.207 (dBµV)		15.107 Class B (dBµV)		RBW
	Quasi-Peak	Average	Quasi-Peak	Average	
0.15 – 0.5	66 – 56*	56 – 46*	66 – 56*	56 – 46*	9 kHz
0.5 – 5.0	56	46	56	46	
5.0 – 30.0	60	50	60	50	

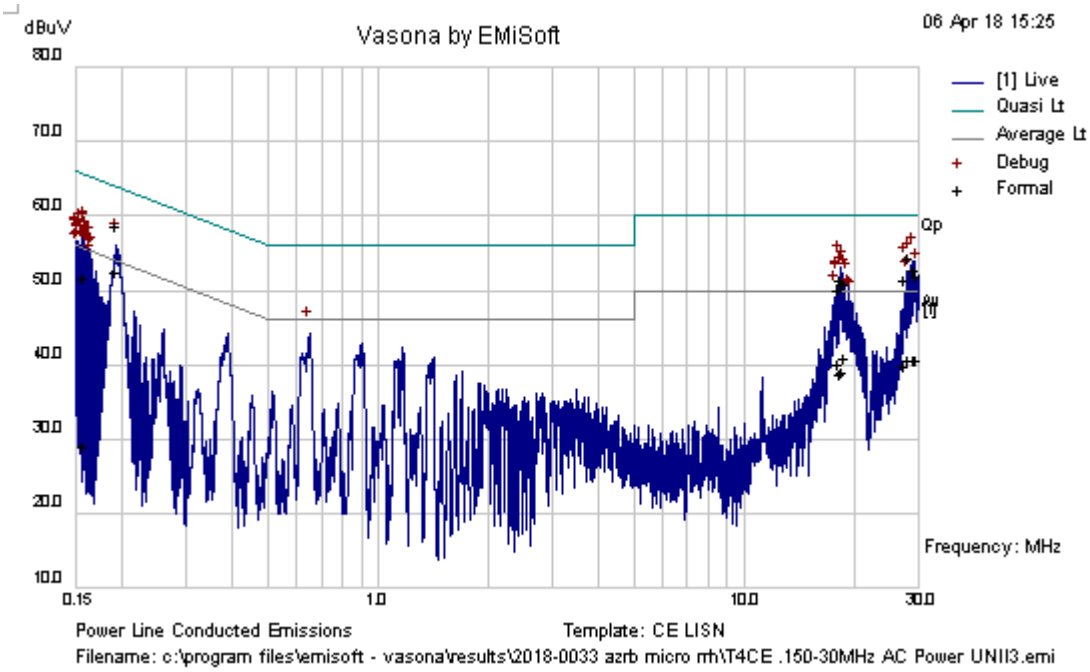
*Decreases with the logarithm of the frequency.

The AC power line conducted emissions of the EUT were evaluated with three UNII-3 20MHz 256QAM carriers transmitting at 5825MHz, 5805MHz, 5785MHz at the maximum power level at both ports, which have higher power level than UNII-1 carriers for the worst-case scenario.

The recommendations of ANSI C63.10 were followed for EUT testing setup and cabling. The test setup photo is given in Section 5.

The conducted emissions were measured at both AC power leads. The AC power line conducted emissions measured in the frequency spectrum 150kHz to 30MHz were all below 15.207 limits with the minimum margin of 4.46dB at 194kHz. The plots are provided in Figures 4.10.1 – 4.10.2.

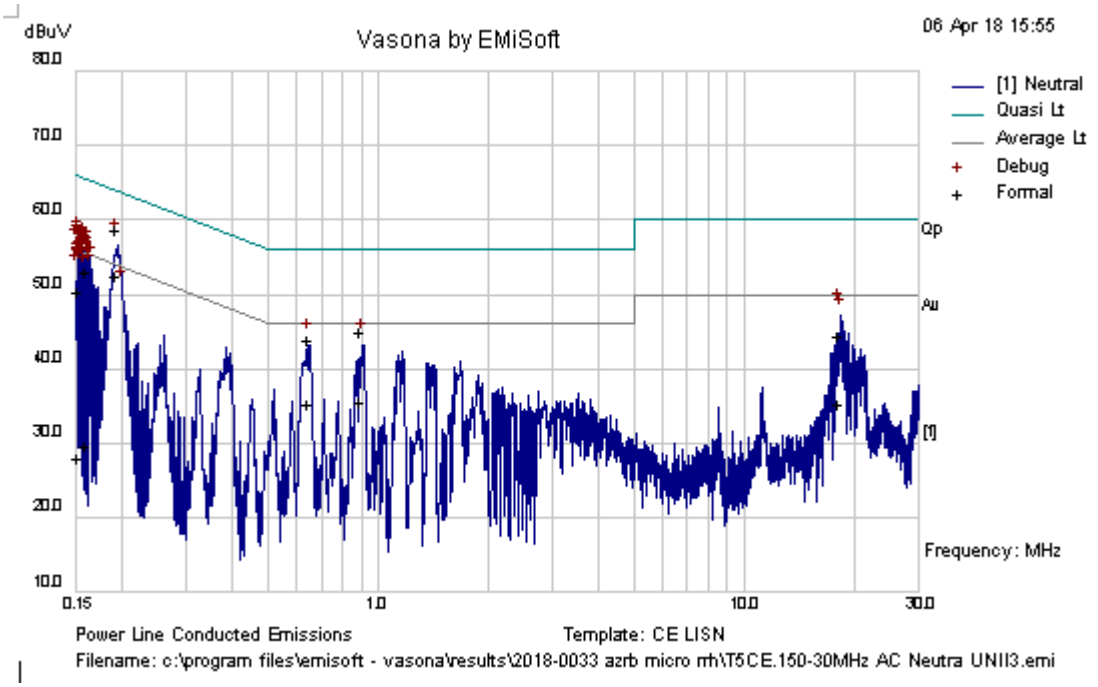
The FCC 15.107 Class B limits are identical to the 15.207 limits. Therefore, the EUT is in compliance with 15.207 requirements for intentional radiators and the 15.107 Class B requirements for unintentional radiators.



FORMAL DATA

Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV)	Emission Type	Line	Limit (dBuV)	Margin (dB)	Pass /Fail	Comments
0.193	39.02	10.11	0.1	49.23	Average	Line	53.91	-4.68	Pass	
0.193	45.28	10.11	0.1	55.48	Quasi Peak	Line	63.91	-8.43	Pass	
28.422	39.63	10.64	0.98	51.25	Quasi Peak	Line	60	-8.75	Pass	
29.383	37.94	10.65	0.93	49.52	Quasi Peak	Line	60	-10.48	Pass	
29.907	37.2	10.65	0.9	48.75	Quasi Peak	Line	60	-11.25	Pass	
18.569	37.04	10.55	0.7	48.3	Quasi Peak	Line	60	-11.7	Pass	
27.782	36.55	10.63	1	48.19	Quasi Peak	Line	60	-11.81	Pass	
18.938	26.54	10.56	0.7	37.8	Average	Line	50	-12.2	Pass	
18.692	36.41	10.56	0.7	47.67	Quasi Peak	Line	60	-12.33	Pass	
18.938	36.39	10.56	0.7	47.64	Quasi Peak	Line	60	-12.36	Pass	
29.384	25.96	10.65	0.93	37.54	Average	Line	50	-12.46	Pass	
29.907	25.94	10.65	0.9	37.49	Average	Line	50	-12.51	Pass	
28.422	25.85	10.64	0.98	37.46	Average	Line	50	-12.54	Pass	
18.363	35.72	10.55	0.7	46.98	Quasi Peak	Line	60	-13.02	Pass	
18.363	25.54	10.55	0.7	36.79	Average	Line	50	-13.21	Pass	

Figure 4.10.1 Conducted Emissions on AC Main Power Lead.



FORMAL DATA

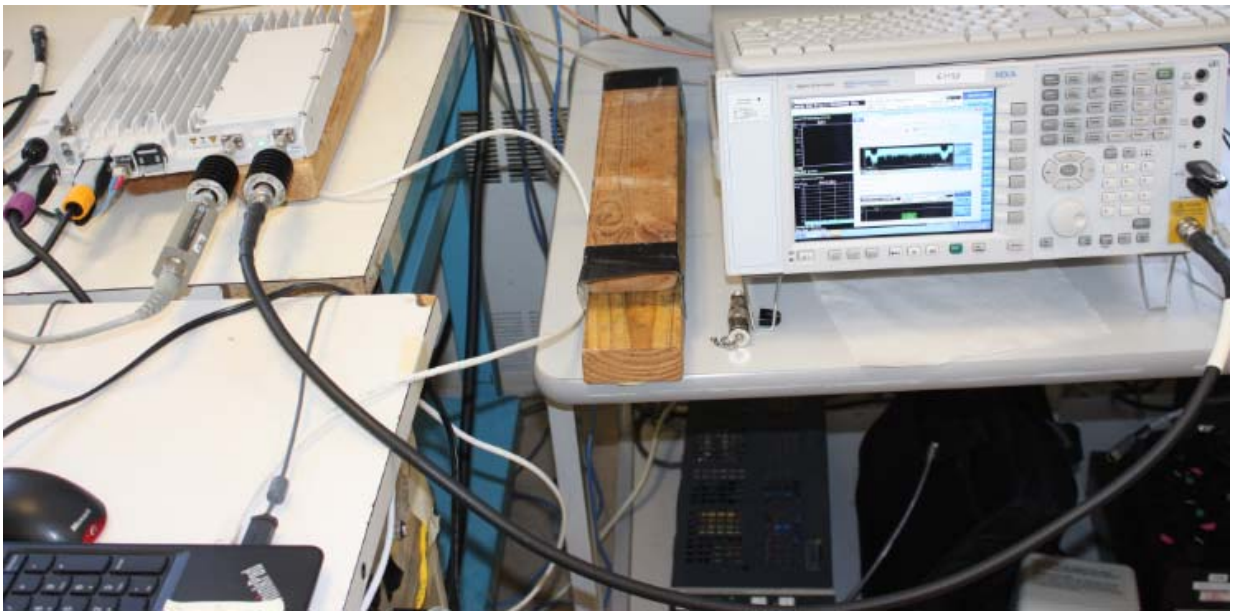
Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV)	Emission Type	Line	Limit (dBuV)	Margin (dB)	Pass /Fail	Comments
0.194	39.2	10.11	0.1	49.41	Average	Neutral	53.86	-4.46	Pass	
0.194	45.24	10.11	0.1	55.44	Quasi Peak	Neutral	63.86	-8.42	Pass	
0.901	22.07	10.2	0.1	32.38	Average	Neutral	46	-13.62	Pass	
0.649	21.71	10.18	0.1	31.98	Average	Neutral	46	-14.02	Pass	
0.901	31.32	10.2	0.1	41.63	Quasi Peak	Neutral	56	-14.37	Pass	
0.649	30.52	10.18	0.1	40.79	Quasi Peak	Neutral	56	-15.21	Pass	
0.161	39.66	10.09	0.1	49.86	Quasi Peak	Neutral	65.41	-15.55	Pass	
18.343	20.88	10.55	0.7	32.13	Average	Neutral	50	-17.87	Pass	
0.153	36.89	10.09	0.1	47.08	Quasi Peak	Neutral	65.84	-18.76	Pass	
18.343	29.93	10.55	0.7	41.18	Quasi Peak	Neutral	60	-18.82	Pass	
0.161	16.3	10.09	0.1	26.5	Average	Neutral	55.41	-28.92	Pass	
0.153	14.69	10.09	0.1	24.88	Average	Neutral	55.84	-30.95	Pass	

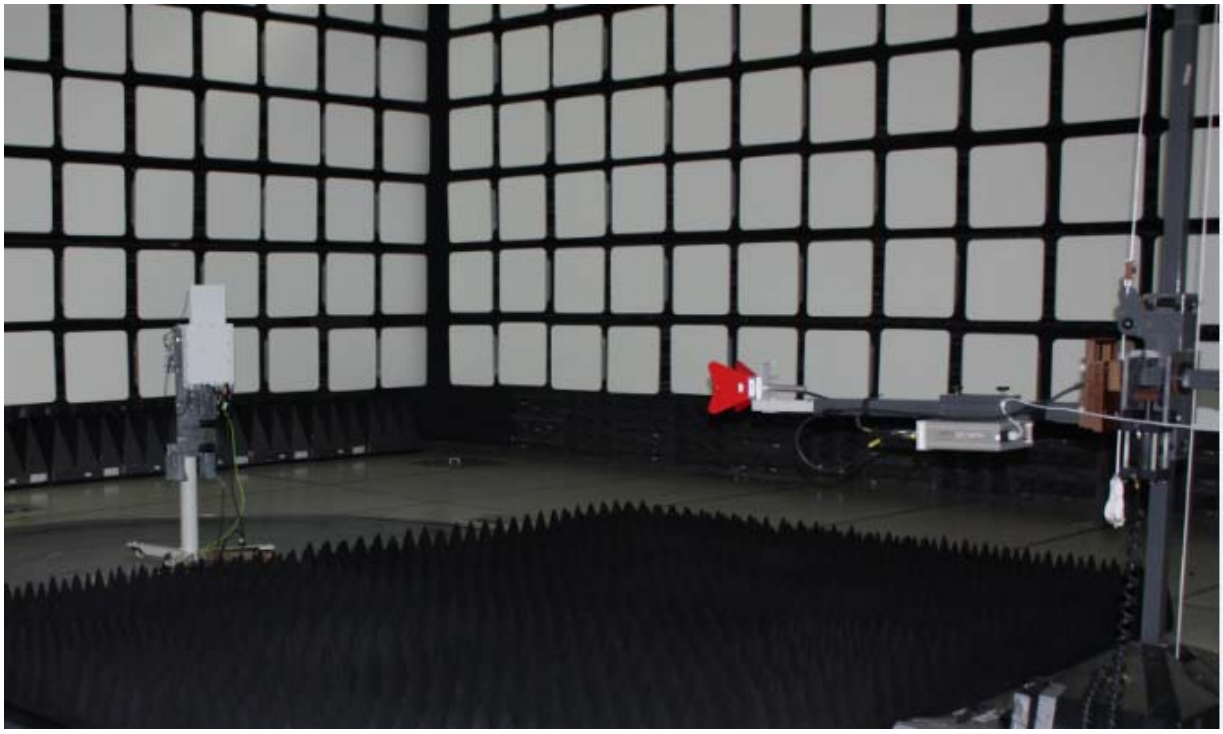
Figure 4.10.2 Conducted Emissions on AC Main Neutral Lead

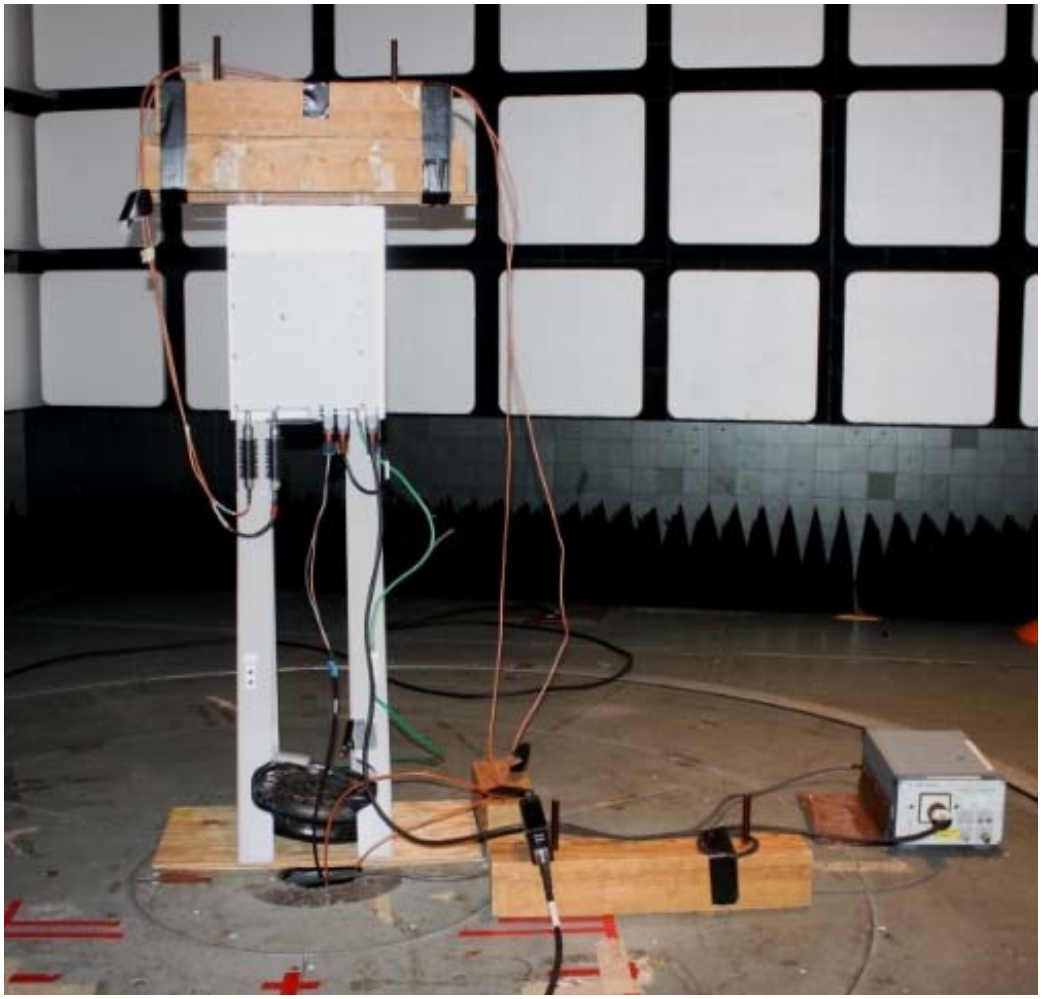
The AC power line conducted emissions of the EUT are below FCC 15.207 and FCC 15.107 Class B limits and in full compliance with the Rules of the Commission.

5. PHOTOGRAPHS OF EUT SETUP

The setup photos of the conducted and radiated emissions tests, including AC power line test, were provided below.







6. LIST OF TEST EQUIPMENT

Table 6.1 List of Test Equipment Used

Equipment	Manufacturer	Model	Serial #	Last Cal Date	Cal Cycle
MXA Signal Analyzer (20Hz-26.5GHz)	Agilent	N9020A	MY53420147	2017-03-13	24 mos
20 dB Attenuator (DC – 18 GHz, 25W)	Weinschel	46-20-34	BJ4772	N/A	N/A
20 dB Attenuator (DC – 18 GHz, 25W)	Weinschel	46-20-34-LIM	BN3127	N/A	N/A
RF Power Meter	Hewlett Packard	437B	3125U21137	2016-12-15	24 mos
Power Sensor (0.01-18 GHz)	Hewlett Packard	8481A	US37294629	2017-05-26	24 mos
EMC Receiver / SA (20Hz to 40 GHz)	Rohde & Schwarz	ESIB-40	100119	2017-10-30	24 mos
6 dB Attenuator (DC-18GHz, 5 Watt)	Weinschel	2-6dB	BX3432	2016-04-18	24 mos
3 dB Attenuator (DC-18GHz, 5 Watt)	Weinschel	2-3	CC8591	2017-07-21	24 mos
3 dB Attenuator (DC-18GHz, 5 Watt)	Weinschel	2-3	CC9590	2017-06-28	24 mos
Preamplifier (1-26.5 GHz, 30dB)	Hewlett Packard	8449B	3008A01267	2016-09-23	24 mos
Amplifier (9kHz-1GHz)	Sonoma Instrument	310N	186750	2016-07-27	24 mos
EMI Test Receiver (20Hz to 40 GHz)	Rohde & Schwarz	ESIB40	100100	2018-03-12	24 mos
Double-Ridged Horn (1-18 GHz)	ETS Lindgren	3117	00135198	2017-06-09	24 mos
Double-Ridged Horn (18-40 GHz)	EMC Test Systems	3116	2539	2017-06-16	24 mos
Standard Horn (26.5-40GHz)	A.H. Systems	SAS-200/573	137	2017-10-04	24 mos
Bilogical Antenna (25-2000MHz)	A.H. Systems	SAS-521-2	457	2017-03-27	24 mos
Log Periodic Antenna (0.2-1GHz)	EMCO	3146	2082	2017-05-24	24 mos
Biconical Antenna	EMCO	3109	2187	2016-12-01	24 mos
High Pass Filter (5-40GHz)	RLC Electronics Inc	F-19414	1444002	N/A	N/A
Data Logger (Pressure Humidity Temp)	Extech	SD700	Q668960	2016-08-15	24 mos
Micro-Ohmmeter	Extech	380460	H273544	2017-05-16	24 mos
Multi-Meter (True RMS)	Fluke	116	33860068WS	2017-02-16	24 mos

LISN 50µH 0.1 µF	Solar Electronics	8116-50-TS-100-N	981929	2017-05-22	24 mos
LISN 50µH 0.1 µF	Solar Electronics	8116-50-TS-100-N	981930	2017-05-22	24 mos
Current Probe (10kHz-500MHz)	Solar Electronics	9123-1N	976533	2017-06-30	24 mos
Amplifier (9KHz-1GHz)	Sonoma Instrument Co.	310	185794		24 mos
Multi-Device Controller	ETS Lindgren	2090	00078509	N/A	N/A

7. TEST FACILITIES

All measurement facilities used to collect the measurement data under normal condition are located at 600-700 Mountain Avenue, Murray Hill, New Jersey 07974-0636 USA. The field strength measurements of radiated spurious emissions are made in a FCC and IC registered 10 meter semi-anechoic chamber AR8 (FCC Site Registration Number: 328881, IC Filing Number: 6933F-8). The sites were constructed and are continuously in conformance with the requirements of ANSI C63.4 and CISPR Publication 22.

Nokia Global Product Compliance Laboratory is accredited with the US Department of Commerce National Institute of Standards and Technology's National Voluntary Laboratory Accreditation Program (NVLAP) for satisfactory compliance with criteria established in Title 15, Part 7 Code of Federal Regulations for offering test services for selected test methods in Electromagnetic Compatibility; Voluntary Control Council for Interference (VCCI), Japan; Australian Communications and Media Authority (ACMA). The laboratory is ISO 9001:2008 Certified.

United States Department of Commerce
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2017-08-17 through 2018-09-30
Effective Dates

For the National Voluntary Laboratory Accreditation Program

8. REFERENCES

[1]. Title 47 Code of Federal Regulations (CFR) Parts 2 and 15.

[2]. ANSI C63.10, American Nation Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices, 2013.

[3]. FCC KDB 789033 D02, Guidelines for Compliance Testing of Unlicensed National Information Infrastructure (U-NII) Devices (Part 15, Subpart E), December 2017, v02r01.

[4]. FCC KDB 662911D01, Emissions Testing of Transmitters with Multiple Outputs in the Same Band, October 2013, v02r01.

[5]. FCC KDB 353028 D01, Basic Equipment Authorization Guidance for Antennas Used with Part 15 Intentional Radiators, April 2017, v01.