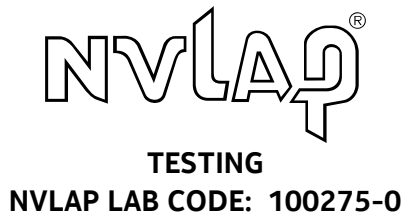




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RF Transmitter Certification C2PC Test Report (FCC ID: 2AD8UAZRBRH1)

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 with New
Omni-Directional Antenna FA2RA**

GPCL Report Number
TR2018-0163 FCC

GPCL Project Number
2018-0163

Date Issued
September 7, 2018

TABLE OF CONTENTS

1.	ATTESTATION OF TEST RESULTS	4
2.	SUMMARY OF THE TEST RESULTS	5
2.1	<i>Measurement Uncertainties for EMC Radiated Emissions</i>	
2.2	<i>Measurement Uncertainties for Antenna Port Conducted Testing</i>	
3.	GENERAL INFORMATION	6
3.1	<i>Product Descriptions</i>	
3.2	<i>Accessories</i>	
3.3	<i>Description of Antenna(s)</i>	
4.	REQUIRED MEASUREMENTS AND RESULTS	8
4.1	<i>Regulatory Requirements</i>	
4.2	<i>UNII-1/3 Band Carrier Frequencies</i>	
4.3	<i>Test Configurations and Setup</i>	
4.4	<i>Measurement Required: Maximum Power Output and Maximum Outdoor EIRP — FCC Section 15.407 (a)(1)(3)(4)</i>	
4.5	<i>Measurement Required: Unwanted Radiated Out-Of-Band Emissions — FCC Section 15.407 (b)(4-5)(8)</i>	
4.6	<i>Measurement Required: Unwanted Radiated Spurious Emissions — FCC Section 15.407 (b)(4-8)</i>	
5.	PHOTOGRAPHS OF EUT SETUP	34
6.	LIST OF TEST EQUIPMENT	36
7.	TEST FACILITIES	37
8.	REFERENCES	38

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:

Reviewed By:

Signed:



9/7/2018

Date

Q. Yu
GPCL Compliance Engineer

Signed:



9/7/2018

Date

Steve Gordon
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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)	1M18132006 (AZRB, Radiated, HW: 474510A.101) P818240001 (FA2RA Antenna) U7173700002 (APAB AC PSU, HW: 474130A.102)
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
Date Tested	August 7 – September 5, 2018
Type of Equipment	Transceiver
Submission Type	C2PC 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: 896745/US5302
Test Engineers	M. Soli 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.

This test report is a supplemental one to the TR2018-0033 and TR2018-0099 FCC test reports submitted in the AZRB original and Class II filings which remain valid.

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	15.407 (a)(1)(3)	Maximum Power Output and Maximum Outdoor EIRP	Conducted	Yes
4.5	15.407 (b)(4-5)(8)	Unwanted Radiated Out-of-Band Emissions	Radiated	Yes
4.6	15.407 (b)(4-8)	Unwanted Radiated Spurious Emissions		Yes

2.1 Measurement Uncertainties for EMC 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, (<i>e.g.</i> , ANSI C63.4, CISPR 11, 14, 32, <i>etc.</i> , using ESHS 30, EMC-60, LISNs/AMNs and antennas)	Radiated Emissions (AR-4 - AR-9 Semi-Anechoic Chambers)	30 – 200 200 – 1000	$\pm 5.1 \sim \pm 5.4$ dB $\pm 4.3 \sim \pm 4.7$ 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 for FA2RA Antenna	5170-5250 MHz (UNII-1)	Antennas with Max Gain ≤ 6 dBi: 26dBm per chain and 29dBm total
	5735-5835 MHz (UNII-3)	Antennas with Max Gain ≤ 7.5 dBi: 25.5dBm per chain and 28.5dBm 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)	≤ 125 mW (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 seven antennas available of two types to be equipped for this low power Band 46 LAA RRH AZRB, see the table below. Six of them (#1-#6) have been qualified in the original FCC certification

and Class II authorization for meeting FCC Section 15.203 and KDB 353028 D01 requirements on antennas. The #7 is the new antenna to be added and qualified.

The demonstration of meeting the FCC Section 15.203 and KDB 353028 D01 requirements on antennas presented in Exhibit 5 of the AZRB original filing is still valid for the new antenna #7, 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

Ant 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
6	GO4806-06664	Omni-Directional 1219(L) × 52(D)	5150 ~ 5925	Tx/Rx 1/2	6.0	6.0
7	FA2RA	Omni-Directional , 235(L) × 51(D)	5150 ~ 5850	Tx/Rx 1/2	7.5*	7.5*

- The peak gain ≤ 6dbi for UNII-1 and ≤ 7.5dbi for UNII-3.

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

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

Antenna No	Model	Antenna Type	Max Gain in Elevation Angle 30° 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
6	GO4806-06664	Omni-Directional	-9.0
7	FA2RC	Omni-Directional	-8.0

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

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

5	2205	Directional	5150 ~ 5925	9.5	9.5	Original Filing
6	GO4806-06664	Omni-Directional	5150 ~ 5925	6.0	6.0	C2PC

The compliance of the EUT with the new omni-directional antenna #7 FA2RA at its the maximum power setting was evaluated in this report.

4. REQUIRED MEASUREMENTS AND RESULTS

4.1 Regulatory Requirements

Per 2.1043(b)(2), when a Class II permissive change is made by the grantee, the grantee shall provide complete information and the results of tests of the characteristics affected by such change. Since the only change is adding a new omni-directional antenna FA2RA whose maximum antenna gain in UNII-3 band and maximum antenna sky gain (in elevation angles 30° above the horizontal plane) in UNII-1 band is higher than that of the omni-directional antenna #6 GO4806-06664 tested and qualified previously, the new omni-directional antenna #7 GO4806-06664 needs to be evaluated. 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. Only the maximum output power, the maximum outdoor EIRP and the radiated unwanted emissions are required to be evaluated. The peak power spectrum density (PPSD) test in the UNII-3 band for the FA2RA #7 antenna which has the maximum power at 25.5dBm per port was waived based on the fact that the PPSD of the AZRB has been measured for various modulations and channels previously at 27dBm per port and the PPSD measured were all lower than 28.5dBm/500kHz, the PPSD limit for FA2RA #7 antenna, with more than 13dB margin. The FCC Part 15 Subpart B Section 15.109 and 15.107 Class B requirements for unintentional radiators have been evaluated in both original and C2PC filings.

The regulatory requirements are provided in the following:

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

Section 15.204(c) 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. Compliance testing shall be performed using the highest gain antenna for each type of antenna to be certified with the intentional radiator. During this testing, the intentional radiator shall be operated at its maximum available output power level. The antenna type refers to antennas that have similar in-band and out-of-band radiation patterns. Any antenna that is of the same type and of equal or less directional gain as an antenna that is authorized with the intentional radiator may be marketed with, and used with, that intentional radiator. No retesting of this system configuration is required.

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 was required. For systems that can operate at different power levels, test data with the highest output power must be submitted. If the antenna list exhibit includes antennas of the same type but with different manufacturers/vendors, test data for only one manufacturer version needs to be submitted.

(2) Output Power and Maximum Outdoor EIRP Limit (FCC 15.407 (a)(1)(3)(4))

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. A narrower resolution bandwidth can be used, provided that the measured power is integrated over the full reference bandwidth.

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

(3) Unwanted Emission Limits (FCC 15.407 (b)(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 5.725-5.85 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.
- ii. 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.
- iii. 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.
- iv. 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, 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) $f < 1\text{GHz}$, the limits specified in 15.209 need to be met by QPK or PK;
 - (ii) $f > 1\text{GHz}$, 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) $f < 1\text{GHz}$, the limits specified in 15.209 need to be met by QPK or PK;
 - (ii) $f > 1\text{GHz}$, 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.

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			

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	60MHz
36, 40, 44	5180, 5200, 5220	
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

The maximum gain of the #7 antenna is 6dBi in UNII-1 and 7.5dBi in UNII-3. Therefore, it has the same maximum power setting as that of the #1-#4 and #6 antennas in UNII-1 band which has been evaluated before. 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 or to Be Tested

Band	Total Per Port Power Setting for Antennas #1-#4 & #6 ($G^{\max} \leq 6$ dBi)	Total Per Port Power Setting for Antenna #7 ($G^{\max} = 6$ dBi in UNII-1 & $G^{\max} = 7.5$ dBi in UNII-3)	Total Per Port Power Setting for Antenna #5 ($G^{\max} = 9.5$ dBi)
UNII-1	26 dBm	26 dBm	22.5 dBm
UNII-3	27 dBm	25.5 dBm	23.5 dBm

The worst or near worst cases of the unwanted radiated emissions identified from the baseline conducted emissions tests among various modulation types (Q/16QAM, 64QAM and 256QAM) and bandwidth modes (20MHz, 40MHz and 60MHz) were selected and evaluated for the new antenna.

The test setup diagrams are given below.

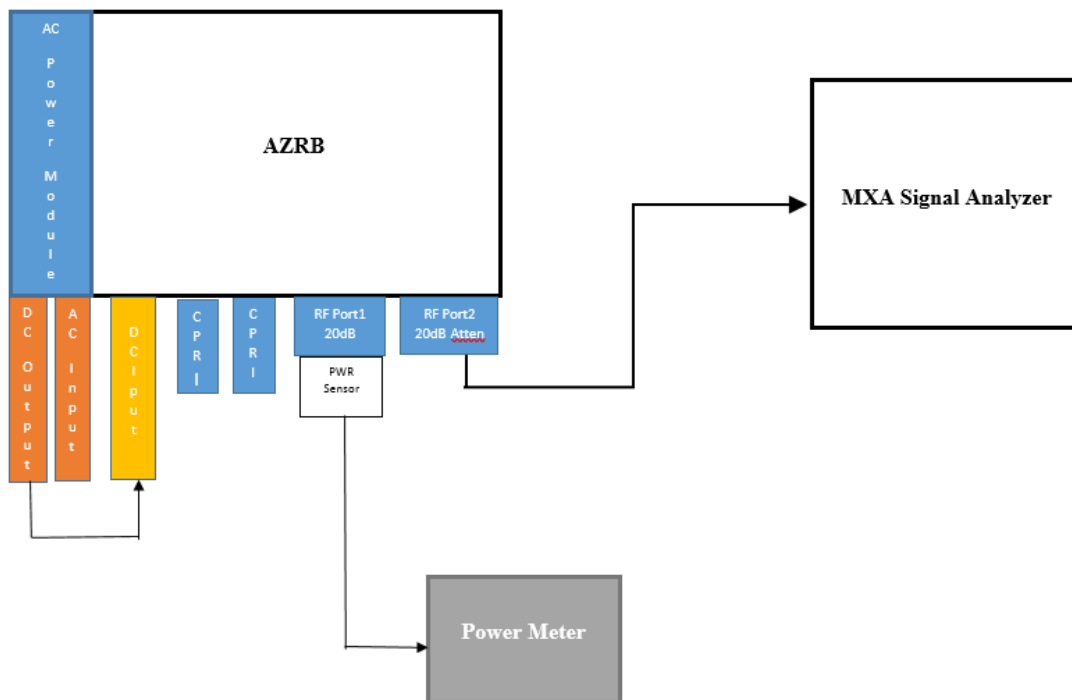


Figure 4.3.1 Setup Diagram of Conducted Test

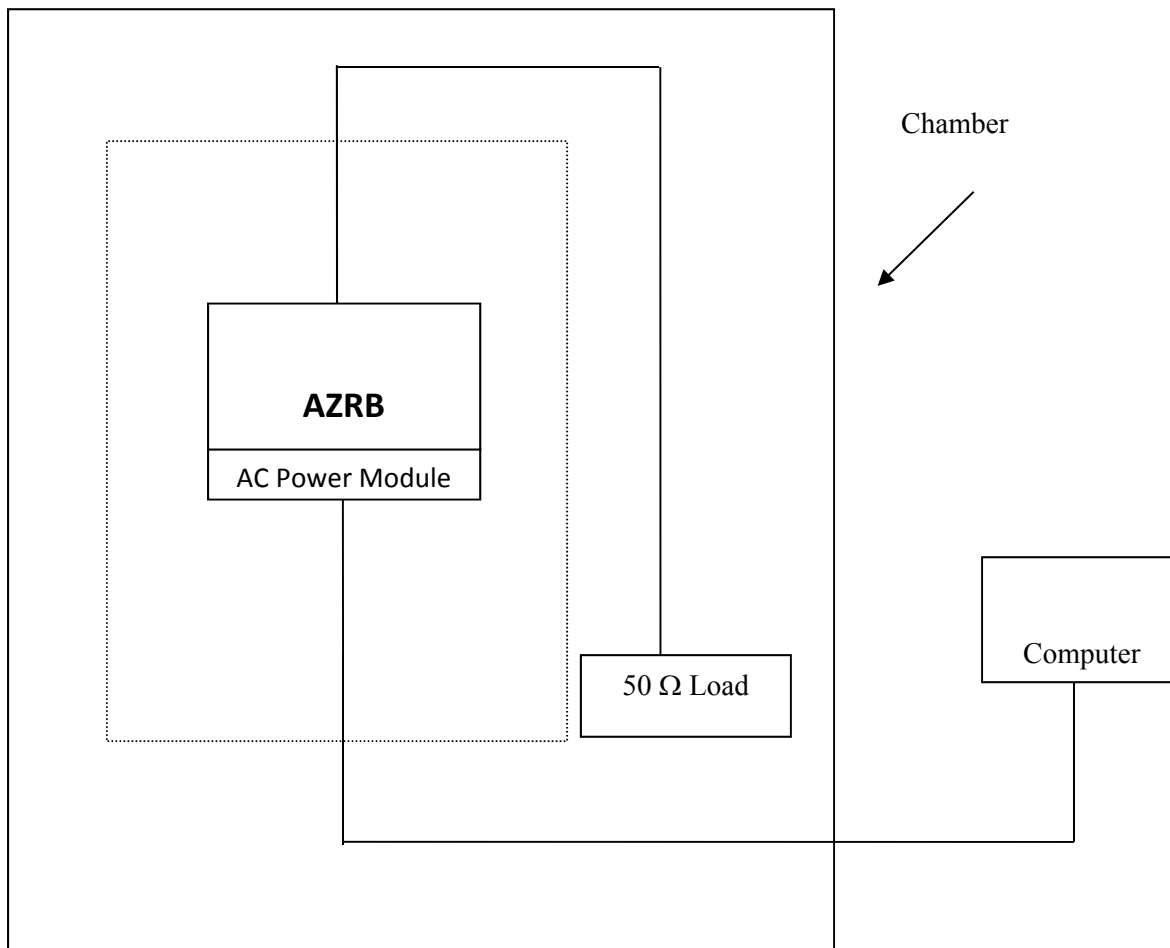


Figure 4.3.2 Setup Diagram of Radiated Test

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

For FA2RA antenna, its maximum output power was measured at the both antenna ports for all channels listed in Table 4.2.2 in UNII-3 band and various modulations. The measurement follows the procedures given in KDB 789033 D02.

The maximum 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

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

the directional antenna gain of correlated signals is equal to

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

where $G_1, G_2, \dots, G_N$ 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 { $G_1, G_2, \dots, G_N$ } + Array Gain = Max { $G_1, G_2, \dots, G_N$ }, 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 { $G_1, G_2, \dots, G_N$ } + 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 in (dBi)	Max Directional Gain for Total Power (dBi)	Total PSD Limit	Total Power Limit (dBm)
UNII-1	#7	6.0	6.0	17.00 (dBm/MHz)	30.00
UNII-3	#7	7.5	7.5	28.5 (dBm/500kHz)	28.5

For UNII-1 band, there is no change in the power and PSD limits compared with that for the antenna #6. Therefore, there are no tests required for the antenna #7 in UNII-1 band.

For UNII-3 band, the maximum power per port is 25.5dBm for the antenna #7 which is lower than that of the antenna #6 (27dBm). The PPSD of the AZRB has been measured for various modulations and channels previously at 27dBm per port for the antenna #6 and the PPSD measured were all lower than 28.5dBm/500kHz, the PPSD limit for FA2RA #7 antenna, with more than 13dB margin. Therefore, as stated before, the peak power spectrum density (PPSD) test in the UNII-3 band can be waived for the FA2RA #7 antenna.

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.

Table 4.6.2(a) Maximum Mean Combined RF Power Output at Antenna Ports for 5GHz 20MHz Carrier at 25.5dBm for UNII-3 for Antenna #7

Bands (GHz)	Ch No/ Freq (MHz)	Modulation	Port 1 (dBm)	Port 2 (dBm)	Total Power (dBm)	Power Limit (dBm)	Test Results
UNII-3 (5.74-5.835)	149/5745	Q/16QAM	25.49	25.28	28.40	28.5	Pass
	157/5785	Q/16QAM	25.38	25.45	28.43	28.5	Pass
		64QAM	25.40	25.39	28.41	28.5	Pass
		256QAM	25.37	25.48	28.44	28.5	Pass
	165/5825	256QAM	25.40	25.40	28.40	28.5	Pass

The conducted output power measured at both ports are provided in Table 4.6.2. The maximum EIRP (dBm) in the elevation angle above 30 Degrees in UNII-1 Band (5.15-5.25 GHz) is given in Table 4.6.3.

**Table 4.6.2(b) Maximum Mean Combined RF Power Output at Antenna Ports for 5GHz
Two-20MHz Carriers at 25.5dBm for UNII-3 with Antenna #7**

Bands (GHz)	Ch No/ Freq (MHz)	Modulation	Port 1 (dBm)	Port 2 (dBm)	Total Power (dBm)	Power Limit (dBm)	Test Results
UNII-3 (5.74-5.835)	149, 153/5745, 5765	256QAM	25.15	25.41	28.29	28.5	Pass
	157, 161/ 5785, 5805	Q/16QAM	25.35	25.47	28.42	28.5	Pass
		64QAM	25.14	25.42	28.29	28.5	Pass
		256QAM	25.17	25.42	28.31	28.5	Pass
	161, 165/5805, 5825	Q/16QAM	25.46	25.50	28.49	28.5	Pass

**Table 4.6.2(c) 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-3 (5.74-5.835)	149, 153, 157/ 5745, 5765, 5785	64QAM	25.18	25.49	28.35	28.5	Pass
	157, 161, 165/ 5785, 5805, 5825	256QAM	25.48	25.45	28.48	28.5	Pass

For UNII-3 band, the maximum total output power measured for the EUT equipped with the antenna #7 among all operation modes supported was 28.49dBm, below the FCC required limits.

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

Table 4.6.3 Maximum Total Mean Output Power at Antenna Ports

Antennas Equipped	Power (dBm) UNII-3 (5.725-5.835 GHz)	Power Limit (dBm)	Test Results
#7 ($G^{\max} = 7.5$ dBi)	28.49	28.5	Pass

For UNII-1 band, the power setting for antennas with the maximum gain ≤ 6 dBi is 26dBm per port per Table 4.3.1. The test report TR2018-0033 FCC, Section 4.6 Table 4.6.5, or Exhibit 12 in the original filing under FCC ID 2AD8UAZRBRH1, showed that the maximum output power per port measured among all operation modes supported for 26dBm power setting is slightly less than 26dBm per port.

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. Since the EUT does *not* have beamforming function and two signals are *uncorrelated*, the directional antenna gain is the gain of an individual antenna per KDB 662911.

The maximum EIRP (dBm) of the EUT equipped with the antenna #7 given in Section 3.3 in the elevation angle above 30 Degrees in UNII-1 Band (5.15-5.25 GHz) is given in the table below.

**Table 4.4.1 Maximum EIRP (dBm) in the Elevation Angle above 30 Degrees
in UNII-1 Band (5.15-5.25 GHz)**

Antenna No	Max Power Per Port (dBm)	Antenna Max Directional Gain above 30° (dBi)	Max EIRP above 30° (dBm)	Limit (dBm)	Results
7	26.0	-8.0	18.0	21	pass

The maximum EIRP of the EUT equipped with the antennas #7 at the elevation angles above 30 degrees is less than 21 dBm (125mW), the limit for an outdoor access point in UNII-1 band, and is in full compliance with the Rules of the Commission.

4.5 MEASUREMENT REQUIRED: UNWANTED RADIATED OUT-OF-BAND EMISSIONS — FCC SECTION 15.407 (b)(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 #7 which has the highest antenna gain among all omni-directional antennas.

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

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

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,

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

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

Table 4.5.1 FCC 15.407 UNII-1/3 Out-of-Band limits

Band (GHz)	Frequency to Be Investigated (GHz)	E ^{lim} (dBμV/m) at 3m	Detector	RBW (MHz)
5.15–5.25	$f < 4.5$ & $f > 5.46$	54/68.2 for restric bands, 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	5.625-5.950	$75^1 \leq \Delta f$: 68.2	PK	1
		$25^2 \leq \Delta f^4 \leq 75^1$: 68.2 to 105.2	PK	
		$5^3 \leq \Delta f \leq 25^2$: 105.2 to 110.8	PK	
		$0 \leq \Delta f \leq 5^3$: 110.8 to 122.2	PK	

¹: 5.65GHz and 5.925GHz

²: 5.7GHz and 5.875GHz

³: 5.720GHz and 5.855GHz

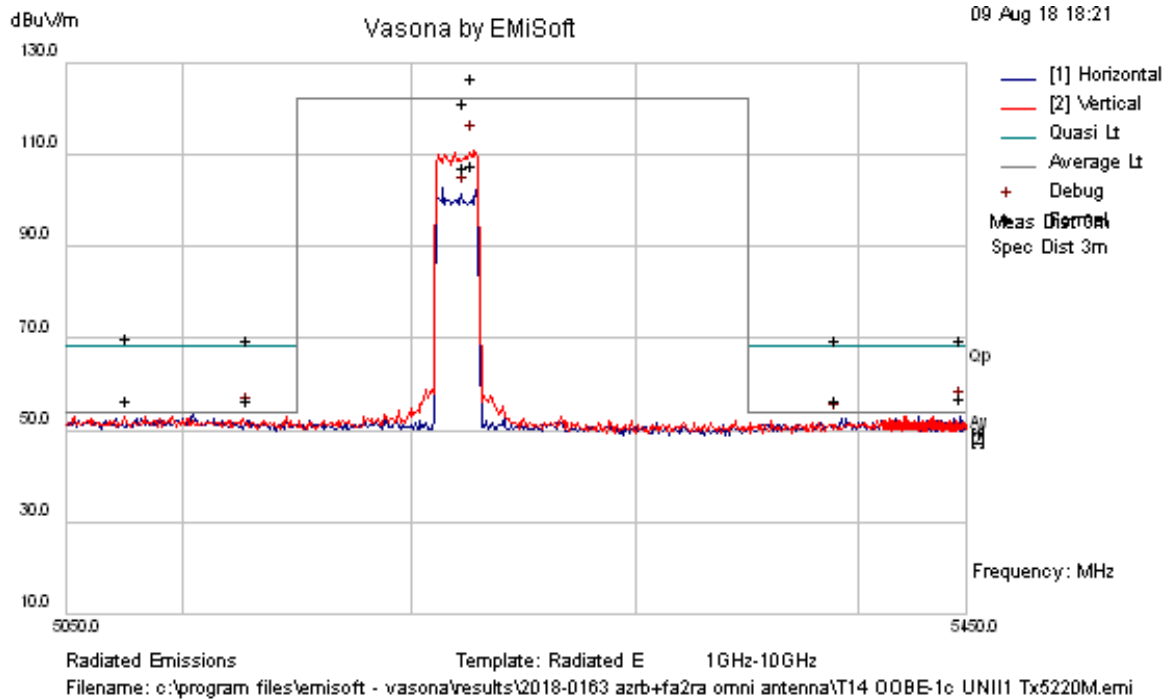
⁴: Δf : frequency away from band edges at 5.725 GHz and 5.85GHz, respectively.

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 the next

section. 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 configurations, channels and modulations, as stated in Section 4.3, which give the out-of-band emissions with the minimum emission margins for one-20MHz carrier, two-20MHz carriers and three-20MHz carriers from the baseline conducted evaluations at the antenna ports were evaluated by the radiated measurement for the EUT equipped with antenna #7. The results were shown below in Figures 4.5.1 and 4.5.2.

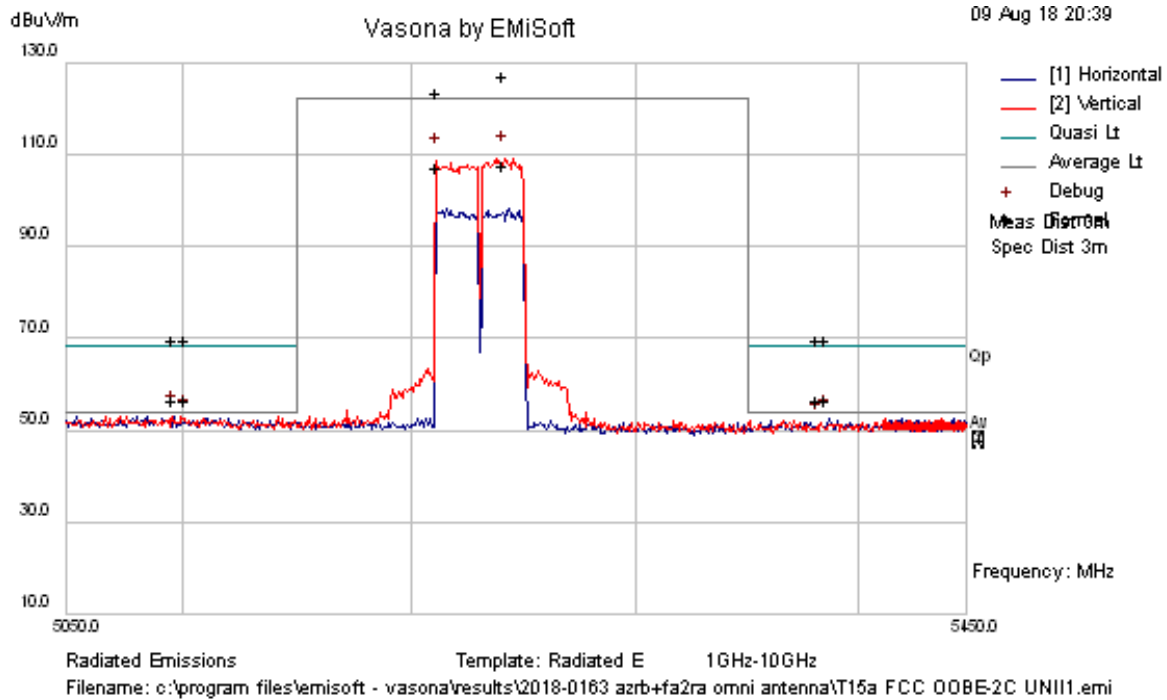
The unwanted radiated out-of-band emissions measured with the EUT equipped with the antenna #7 transmitting in the UNII-1 and UNII-3 bands are all below the FCC required limits in both the restricted and non-restricted bands (see Table 4.5.1 where the restricted bands are provided in Table 4.1.1) and are in full compliance with the Rules of the Commission.



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
5226.9	99.57	25.18	-3.69	121.05	Peak	V	181	11	122.2	-1.15	Pass	NA
5447.7	29.58	25.19	-3.52	51.26	Average	H	162	331	54	-2.74	Pass	
5390.71	29.34	25.19	-3.57	50.96	Average	H	220	67	54	-3.04	Pass	
5128.75	29.37	25.17	-3.77	50.76	Average	H	364	192	54	-3.24	Pass	
5076.05	29.36	25.16	-3.82	50.71	Average	V	276	58	54	-3.29	Pass	
5076.05	43.23	25.16	-3.82	64.57	Peak	V	276	58	68.2	-3.63	Pass	
5390.71	42.59	25.19	-3.57	64.21	Peak	H	220	67	68.2	-3.99	Pass	
5447.7	42.46	25.19	-3.52	64.13	Peak	H	162	331	68.2	-4.07	Pass	
5128.75	42.7	25.17	-3.77	64.09	Peak	H	364	192	68.2	-4.11	Pass	
5222.85	94.08	25.18	-3.7	115.56	Peak	H	99	86	122.2	-6.64	Pass	
5226.9	80.36	25.18	-3.69	101.84	Average	V	181	11	122	-20.16	Pass	
5222.85	80.1	25.18	-3.7	101.58	Average	H	99	86	122	-20.42	Pass	

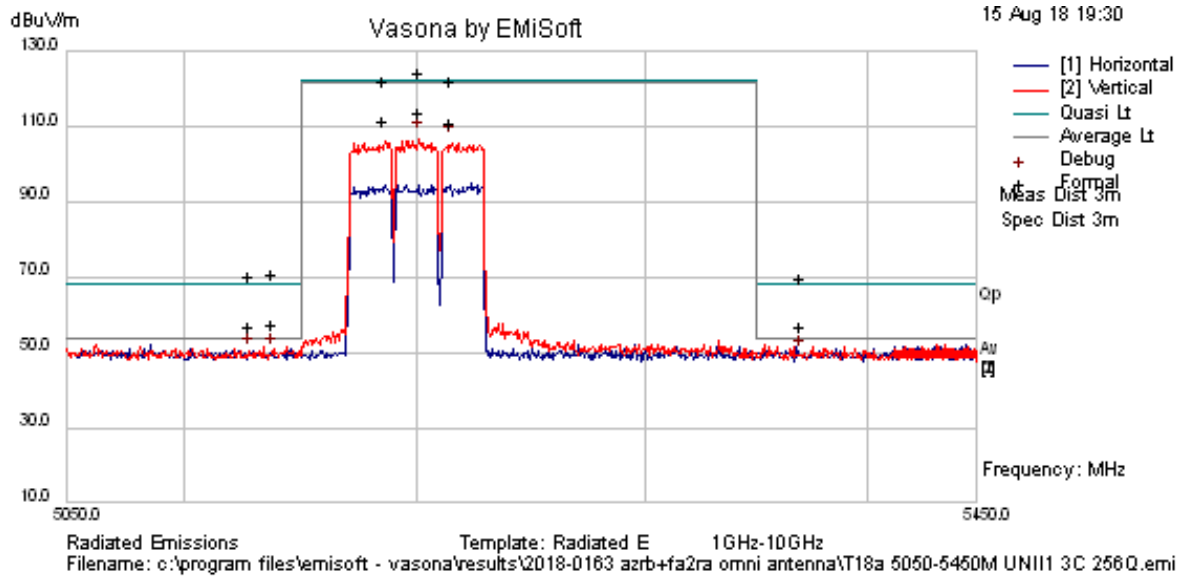
Figure 4.5.1(a) The Radiated Out-of-Band Emissions Evaluated for One 20MHz Carrier at UNII-1 Channel 44 (5220MHz), 26dBm, 64QAM, Omni-Directional Antenna #7 (Preview RBW: 30kHz, Formal RBW: 1MHz).



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
5240.67	99.9	25.18	-3.68	121.39	Peak	V	104	222	122.2	-0.81	Pass	Tx
5386.19	29.24	25.19	-3.57	50.86	Average	H	326	204	54	-3.14	Pass	
5382.5	29.24	25.19	-3.57	50.85	Average	V	164	95	54	-3.15	Pass	
5096.21	29.46	25.16	-3.8	50.83	Average	V	157	67	54	-3.17	Pass	
5101.65	29.36	25.16	-3.8	50.73	Average	H	205	66	54	-3.27	Pass	
5101.65	42.7	25.16	-3.8	64.07	Peak	H	205	66	68.2	-4.13	Pass	
5096.21	42.57	25.16	-3.8	63.93	Peak	V	157	65	68.2	-4.27	Pass	
5386.19	42.19	25.19	-3.57	63.81	Peak	H	326	204	68.2	-4.39	Pass	
5382.5	42.19	25.19	-3.57	63.81	Peak	V	164	95	68.2	-4.39	Pass	
5210.95	96.28	25.17	-3.71	117.75	Peak	V	120	346	122.2	-4.45	Pass	
5240.67	80.35	25.18	-3.68	101.84	Average	V	104	222	122	-20.16	Pass	
5210.95	80.27	25.17	-3.71	101.74	Average	V	120	346	122	-20.26	Pass	

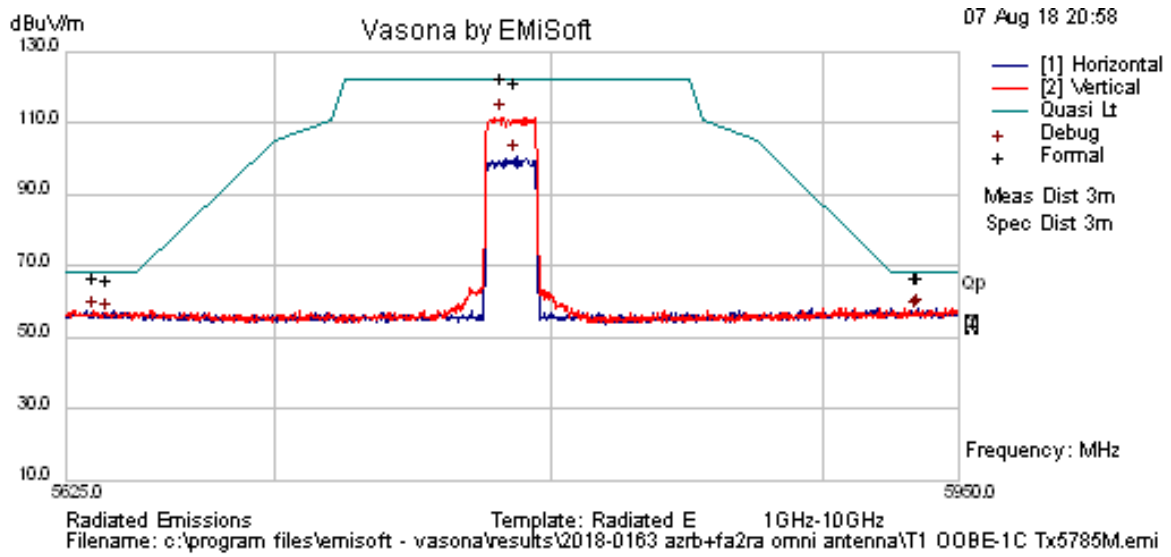
Figure 4.5.1(b) The Radiated Out-of-Band Emissions for Two 20MHz Carriers at UNII-1 Channels 44 (5220MHz) and 48 (5240), 26dBm Total, 64QAM, Omni-Directional Antenna #7 (Preview RBW: 30kHz, Formal RBW: 1MHz).



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
5137.56	30.26	22.2	-0.08	52.38	Average	V	166	83	54	-1.62	Pass	Left side
5127.77	30.11	22.2	-0.1	52.21	Average	H	229	295	54	-1.79	Pass	Left side
5370.61	29.28	22.21	0.43	51.92	Average	H	153	84	54	-2.08	Pass	Right side
5137.56	43.88	22.2	-0.08	66	Peak	V	166	83	68.2	-2.2	Pass	Left
5201.32	97.43	22.2	0.06	119.69	Peak	V	123	126	122.2	-2.51	Pass	Tx
5127.77	43.21	22.2	-0.1	65.3	Peak	H	229	295	68.2	-2.9	Pass	Left
5370.61	42.49	22.21	0.43	65.13	Peak	H	153	84	68.2	-3.07	Pass	Right
5186.24	95.17	22.2	0.03	117.4	Peak	V	109	220	122.2	-4.8	Pass	Tx
5215.23	94.86	22.2	0.09	117.16	Peak	V	126	325	122.2	-5.04	Pass	Tx
5201.32	86.68	22.2	0.06	108.94	Average	V	123	126	122	-13.06	Pass	Tx
5186.24	84.43	22.2	0.03	106.66	Average	V	109	220	122	-15.34	Pass	Tx
5215.23	83.66	22.2	0.09	105.96	Average	V	126	325	122	-16.04	Pass	Tx

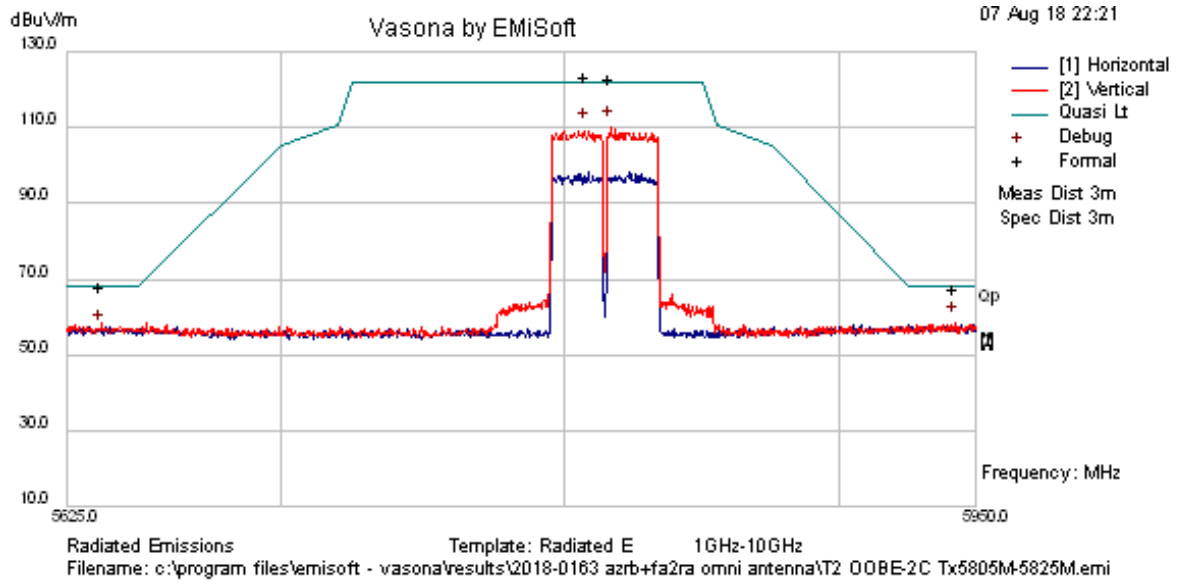
Figure 4.5.1(c) The Radiated Out-of-Band Emissions with the Minimum Margin for Three 20MHz Carriers at UNII-1 Channel 36 (5180MHz), 40 (5200 MHz) and 44 (5220 MHz), 26dBm Total, 256QAM, Omni-Directional Antenna #7 (Preview RBW: 30kHz, Formal RBW: 1MHz).



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
5781.97	99.28	22.24	-3.26	118.26	Peak	V	116	160	122.2	-3.94	Pass	Tx
5787.01	98.3	22.24	-3.26	117.29	Peak	V	179	282	122.2	-4.91	Pass	Tx
5635.12	43.96	22.23	-3.38	62.82	Peak	H	238	331	68.2	-5.38	Pass	
5935.65	43.56	22.26	-3.15	62.66	Peak	V	109	184	68.2	-5.54	Pass	
5934.65	43.42	22.26	-3.15	62.53	Peak	H	373	127	68.2	-5.67	Pass	
5640.03	43.28	22.23	-3.37	62.15	Peak	V	225	274	68.2	-6.05	Pass	

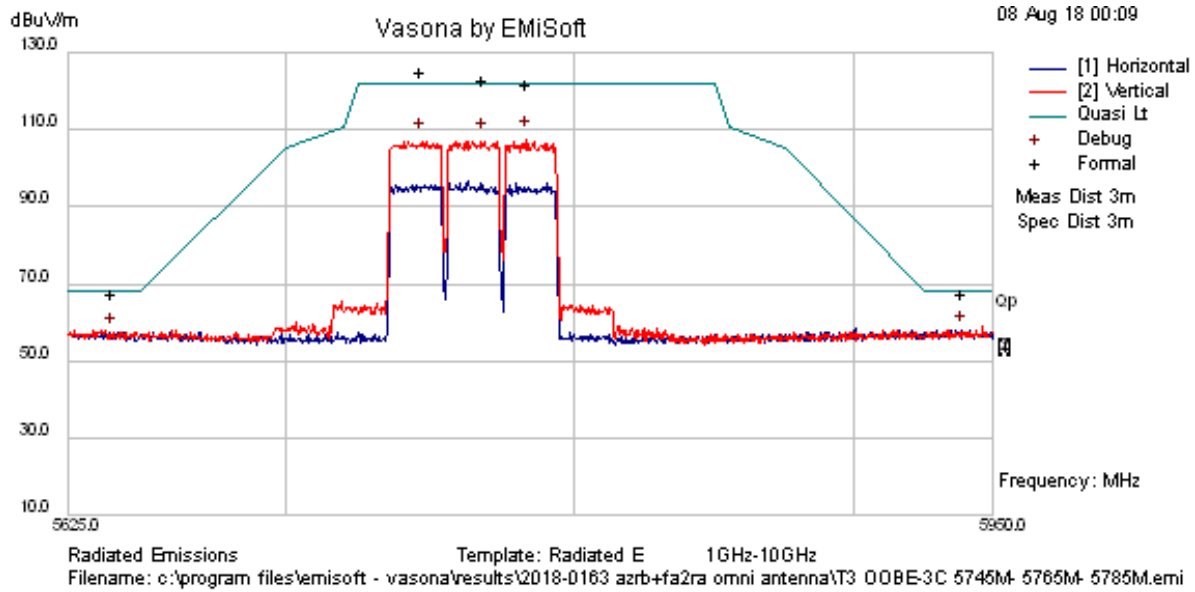
Figure 4.5.2(a) The Radiated Out-of-Band Emissions for One 20MHz Carrier at UNII-3 Channel 157 (5785MHz), 25.5dBm, 256QAM, Omni-Directional Antenna #7 (Preview RBW: 30kHz, Formal RBW: 1MHz).



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
5807.95	99.57	22.25	-3.24	118.57	Peak	V	113	60	122.2	-3.63	Pass	Tx
5816.96	98.8	22.25	-3.24	117.82	Peak	V	197	64	122.2	-4.38	Pass	Tx
5636.54	44.09	22.23	-3.37	62.95	Peak	H	99	57	68.2	-5.25	Pass	
5942.03	43.42	22.26	-3.14	62.53	Peak	V	330	261	68.2	-5.67	Pass	

Figure 4.5.2(b) The Radiated Out-of-Band Emissions for Two 20MHz Carriers at UNII-3 Channel 161 (5805MHz) and 165 (5825MHz), 25.5dBm Total, 256QAM, Omni-Directional Antenna #7 (Preview BW: 30kHz, 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
5747.34	101.3	22.24	-3.29	120.25	Peak	V	141	100	122.2	-1.95	Pass	Tx
5768.8	99.13	22.24	-3.27	118.1	Peak	V	112	219	122.2	-4.1	Pass	Tx
5783.85	98	22.24	-3.26	116.98	Peak	V	137	220	122.2	-5.22	Pass	Tx
5939.15	43.56	22.26	-3.14	62.67	Peak	H	208	51	68.2	-5.53	Pass	
5640.5	43.69	22.23	-3.37	62.55	Peak	H	149	29	68.2	-5.65		

Figure 4.5.2(c) The Radiated Out-of-Band Emissions Evaluated for Three 20MHz Carriers at UNII-3 Channel 149 (5745MHz), 153 (5765MHz) and 157 (5785MHz), 25.5dBm Total, 256QAM, Omni-Directional Antenna #7 (Preview RBW: 30k and Formal RBW: 1MHz).

4.6 MEASUREMENT REQUIRED: UNWANTED RADIATED SPURIOUS EMISSIONS – FCC SECTION 15.407 (b)(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 4.6.1 and 4.6.2, where the conversion between the EIRP and electrical field strength was given in the above section. 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 4.6.1. FCC 15.109 Class B and 15.209 Radiated Emissions Limits

Frequency (MHz)	Field Strength 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 74	54 74	1000	Ave. Peak
> 3000 - $5f_c$	54 74	54 74	1000	Ave. Peak
$5f_c$ - $10f_c$ / 40GHz		54 74	1000	Ave. Peak

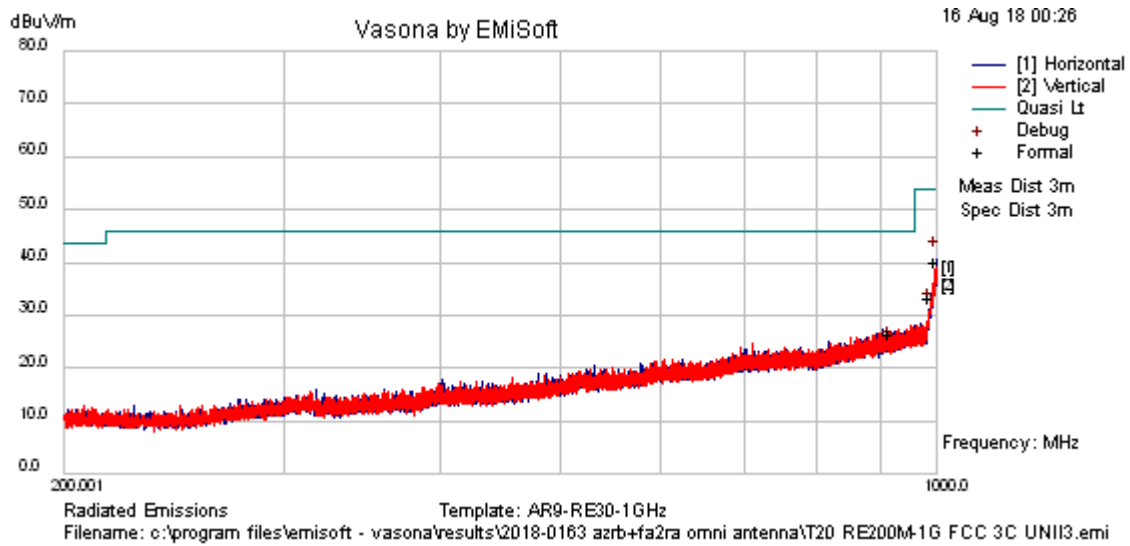
Table 4.6.2. Combined Worst Radiated Emission Limits per 15.407 UNII-1/3, 15.209 and 15.109 at 3m

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 the above Section	1000	Peak

The unwanted emissions were evaluated by radiated measurement from 30MHz to 40GHz. The emissions near the band edges were provided in the above section. The EUT with the omni-directional antenna #6 which had 6dBi gain in both UNII-1 and UNII-2 bands were evaluated in its C2PC filing. The configurations which give the spurious emissions with the minimum emission margin for the antenna #4 were evaluated for the EUT equipped with the antenna #6 for one-20MHz carrier, two-20MHz carriers and three-20MHz carriers. The peak gain of the antenna #7 is 6dBi in the UNII-1 band and 7.5dBi in the UNII-3 band. Therefore, only the carriers in the UNII-3 band were evaluated. The configurations, channels and modulations, which give the spurious emissions with the minimum emission margins for one-20MHz carrier, two-20MHz carriers and three-20MHz carriers in the UNII-3 band from the baseline conducted evaluations at the antenna ports, were selected and evaluated by the radiated measurement for the EUT equipped with antenna #7. Since there were no significant differences in the conducted emissions below 1GHz and above 18GHz observed, hence only the three-20MHz carriers near the high band-edge, which gave the worst or near worst conducted spurious emissions, were evaluated below 1GHz and above 18GHz. The reportable results were shown below in Figures 4.6.1.

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 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 radiated spurious emissions measured in the frequency range of 30MHz-40GHz for the EUT, which operated in UNII-3 band and was equipped with the new omni-directional antenna #7, met the FCC 15.407 and 15.209 requirements in both the restricted and non-restricted bands (see Table 4.6.2 where the restricted bands are provided in Table 4.1.1) for intentional radiators and the FCC 15.109 Class B requirements for unintentional radiators and are in full compliance with the Rules of the Commission.



FORMAL DATA

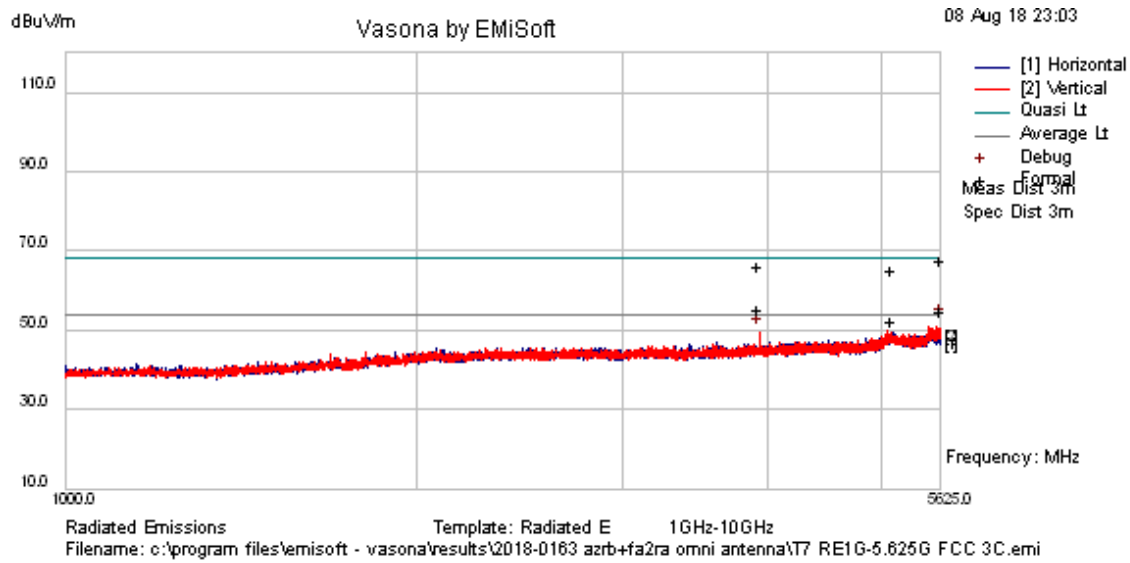
Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
918.237	28.58	2.44	-7.63	23.4	Quasi Max	H	130	229	46	-22.6	Pass	
989.065	34.2	2.79	-6.74	30.25	Quasi Max	V	99	144	54	-23.75	Pass	
1000	28.71	14.78	-6.56	36.93	Quasi Max	H	265	298	54	-17.07	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
1000	32.73	14.78	-6.56	40.95	Preview	H	100	135	54	-13.05	Pass	
918.237	29.24	2.44	-7.63	24.05	Debug	H	99	315	46	-21.95	Pass	
989.065	35.2	2.79	-6.74	31.25	Debug	V	99	315	54	-22.75	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.

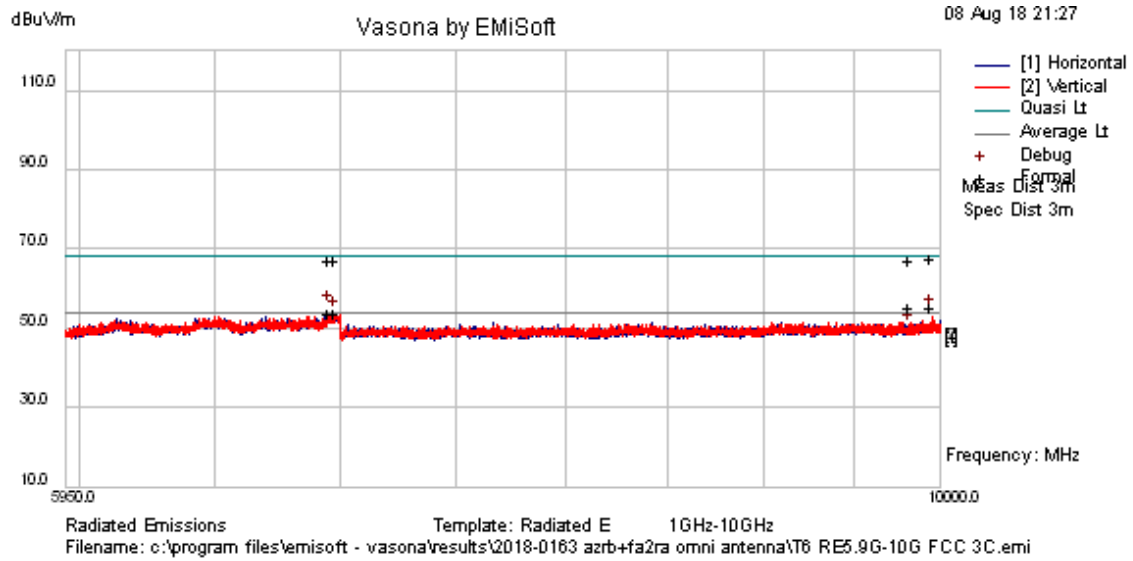
Figure 4.6.1(a) The Radiated Unwanted Emissions in 30MHz-200MHz for the EUT with Antenna #7 in UNII-3, Three 20MHz Carriers at Channel 157 (5785MHz), 161 (5805MHz) and 165 (5825MHz), 25.5dBm Total, QPSK/16QAM, against FCC Part 15.209 and 15.109 Class B Limits at 3m.



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
3932.2	33.83	21.37	-4.71	50.5	Average	V	116	308	54	-3.5	Pass	
5625	31.36	22.23	-3.38	50.21	Average	V	106	86	54	-3.79	Pass	NA
5625	44.38	22.23	-3.38	63.23	Peak	V	106	86	68.2	-4.97	Pass	
5119.66	29.46	22.2	-3.78	47.88	Average	H	316	201	54	-6.12	Pass	
3932.2	44.64	21.37	-4.71	61.31	Peak	V	116	308	68.2	-6.89	Pass	
5119.66	42.04	22.2	-3.78	60.45	Peak	H	316	201	68.2	-7.75	Pass	

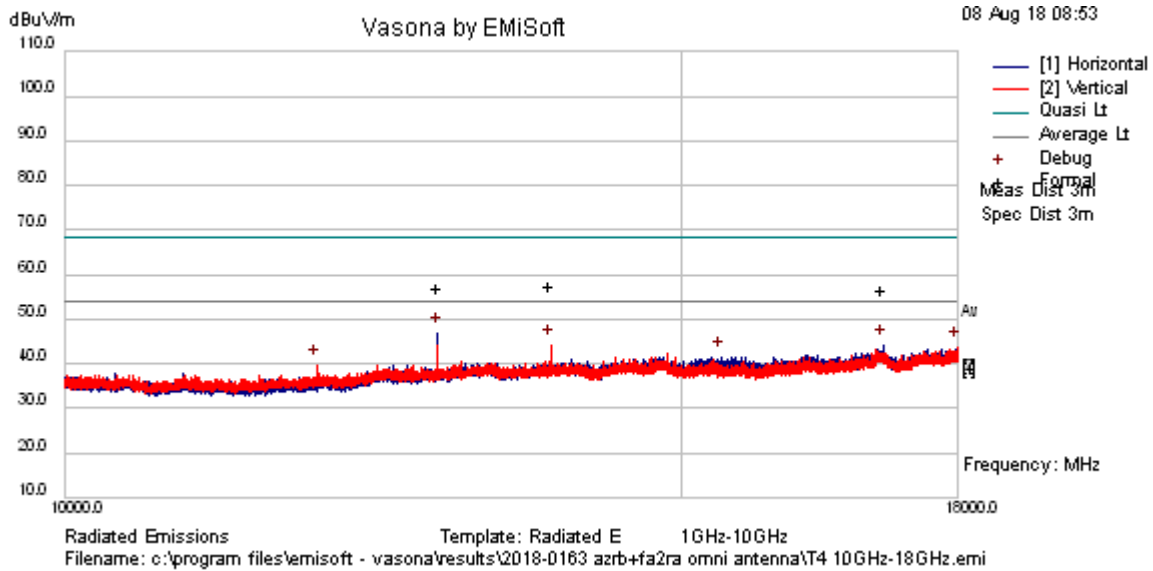
Figure 4.6.1(b) The Radiated Unwanted Emissions in 1GHz-5.625GHz Evaluated for the EUT with Antenna #7 in UNII-3, Three 20MHz Carriers at Channel 157 (5785MHz), 161 (5805MHz) and 165 (5825MHz), QPSK/16QAM, 25.5dBm Total, against FCC Part 15.407 and 15.209 Limits at 3m (Formal 1MHz RBW Peak & Average).



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
9949.08	28.78	23.93	-1.89	50.83	Average	V	130	68	54	-3.17	Pass	NA
9822.47	28.84	23.88	-2.03	50.69	Average	V	316	195	54	-3.31	Pass	NA
6985.4	29.34	22.59	-2.61	49.32	Average	H	209	245	54	-4.68	Pass	NA
6963	29.15	22.58	-2.62	49.11	Average	H	108	150	54	-4.89	Pass	NA
9949.08	41.16	23.93	-1.89	63.2	Peak	V	130	68	68.2	-5	Pass	
9822.47	40.91	23.88	-2.03	62.76	Peak	V	316	195	68.2	-5.44	Pass	
6963	42.74	22.58	-2.62	62.71	Peak	H	108	150	68.2	-5.49	Pass	
6985.4	42.47	22.59	-2.61	62.45	Peak	H	209	245	68.2	-5.75		

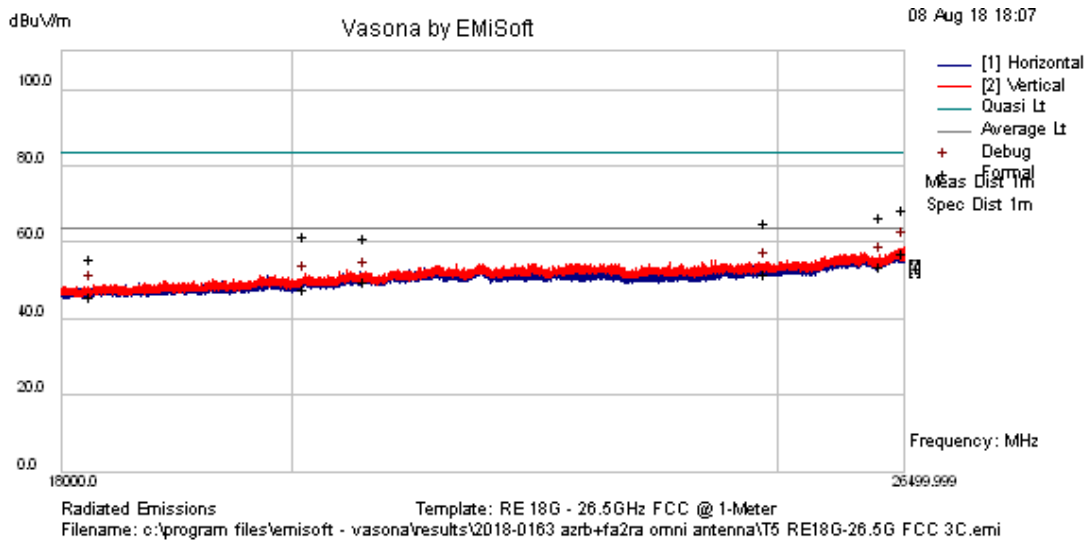
Figure 4.6.1(c) The Radiated Unwanted Emissions in 5.95GHz-10GHz Evaluated for the EUT with Antenna #7 in UNII-3, Three-20MHz Carriers at Channel 157 (5785MHz), 161 (5805MHz) and 165 (5825MHz), QPSK/16QAM, 25.5dBm Total, against FCC Part 15.407 and 15.209 Limits at 3m (Formal 1MHz RBW Peak & Average,).



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
13762.6	35.32	8.13	2.1	45.54	Average	V	124	26	54	-8.46	Pass	NA
12779.5	35.46	7.5	1.7	44.66	Average	H	102	314	54	-9.34	Pass	NA
17979.1	24.43	10.44	4.65	39.53	Average	V	127	212	54	-14.47	Pass	
17134.4	25.04	9.58	4.75	39.37	Average	H	117	329	54	-14.63	Pass	NA
17979.1	38.38	10.44	4.65	53.47	Peak	V	99	318	68.2	-14.73	Pass	
13762.6	43.15	8.13	2.1	53.38	Peak	V	124	26	68.2	-14.82	Pass	
12779.5	43.57	7.5	1.7	52.77	Peak	H	102	314	68.2	-15.43	Pass	
15395.1	26.32	9.53	2.26	38.11	Average	H	161	169	54	-15.89	Pass	
17134.4	37.81	9.58	4.75	52.15	Peak	H	117	329	68.2	-16.05	Pass	NA
15395.1	39.93	9.53	2.26	51.71	Peak	H	161	169	68.2	-16.49	Pass	
11796.9	30.54	6.57	-0.02	37.09	Average	V	99	318	54	-16.91	Pass	
11796.9	43.15	6.57	-0.02	49.7	Peak	V	99	318	68.2	-18.5	Pass	

Figure 4.6.1(d) The Radiated Unwanted Emissions in 10GHz-18GHz Evaluated for the EUT with Antenna #7 in UNII-3, Three-20MHz Carriers at Channel 157 (5785MHz), 161 (5805MHz) and 165 (5825MHz), QPSK/16QAM, 25.5dBm Total, against FCC Part 15.407 and 15.209 Limits at 3m (Formal 1MHz RBW Peak & Average).



(Note: The top limit line should be at 78dB μ V/m.)

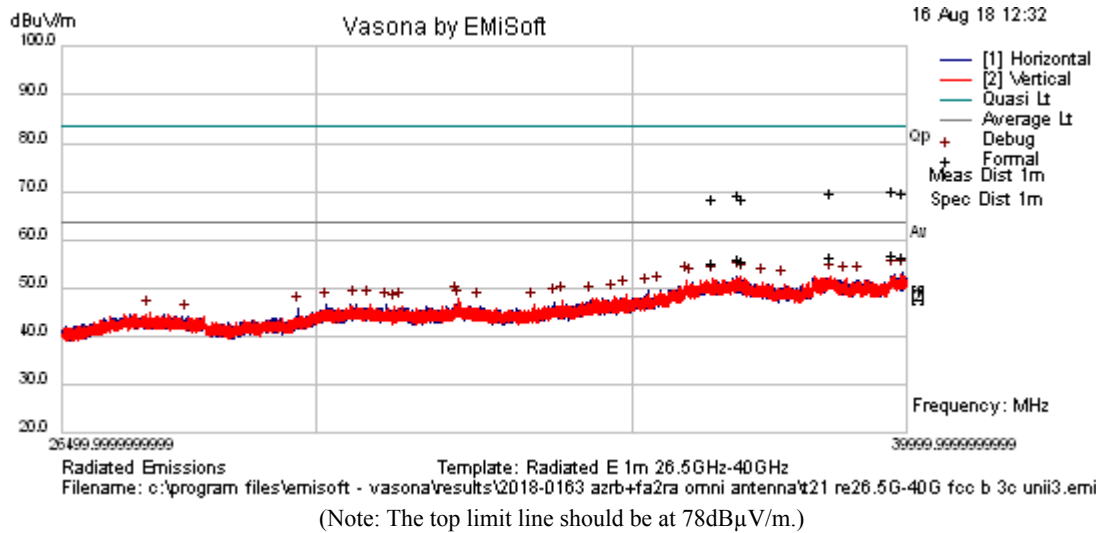
FORMAL DATA												
Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
26481.8	29.82	10.3	12.3	52.42	Average	V	144	339	63.5	-11.08	Pass	
26214.6	27.72	9.97	11.56	49.25	Average	H	170	160	63.5	-14.25	Pass	
24866.5	27.9	9.48	9.76	47.14	Average	V	140	281	63.5	-16.36	Pass	
20693.2	27.29	8.71	9.12	45.13	Average	V	124	192	63.5	-18.37	Pass	
26481.8	41.42	10.3	12.3	64.01	Peak	V	144	339	78	-13.99	Pass	
20128.7	26.02	8.43	8.64	43.09	Average	H	104	334	63.5	-20.41	Pass	
26214.6	40.33	9.97	11.56	61.86	Peak	H	170	160	78	-16.14	Pass	
18248.9	25.02	8.28	7.68	40.98	Average	H	164	131	63.5	-22.52	Pass	
24866.5	41.03	9.48	9.76	60.27	Peak	V	140	281	78	-17.73	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
26481.8	36.03	10.3	12.3	58.63	Preview	V	200	22	63.5	-4.87	Pass	
26214.6	32.83	9.97	11.56	54.36	Debug	H	99	352	63.5	-9.14	Pass	
24866.5	33.91	9.48	9.76	53.15	Debug	V	99	352	63.5	-10.35	Pass	
20693.2	32.95	8.71	9.12	50.78	Debug	V	99	352	63.5	-12.72	Pass	
20128.7	32.57	8.43	8.64	49.64	Debug	H	99	352	63.5	-13.86	Pass	
18248.9	31.19	8.28	7.68	47.15	Debug	H	99	352	63.5	-16.35	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 4.6.1(f) The Radiated Unwanted Emissions in 18GHz-26.5GHz Evaluated for the EUT with Antenna #7 in UNII-3, Three-20MHz Carriers at Channel 157 (5785MHz), 161 (5805MHz) and 165 (5825MHz), QPSK/16QAM, 25.5dBm Total, against FCC Part 15.407 and 15.209 Limits at 1m (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
39763.4	25.87	0	27.91	53.77	Average	H	110	0	63.5	-9.73	Pass	
38557.2	25.96	0	27.55	53.52	Average	V	244	0	63.5	-9.98	Pass	
39948.7	25.06	0	28.34	53.4	Average	H	145	0	63.5	-10.1	Pass	
36879.7	24.39	0	28.6	52.99	Average	V	182	0	63.5	-10.51	Pass	
36949.1	23.91	0	28.68	52.59	Average	V	199	0	63.5	-10.91	Pass	
36400.2	24.39	0	28.02	52.41	Average	V	247	0	63.5	-11.09	Pass	
39763.4	39.06	0	27.91	66.97	Peak	V	247	0	78	-11.03	Pass	
38557.2	39.33	0	27.55	66.89	Peak	V	244	0	78	-11.11	Pass	
39948.7	38.24	0	28.34	66.58	Peak	H	145	0	78	-11.42	Pass	
36879.7	37.6	0	28.6	66.2	Peak	V	182	0	78	-11.8	Pass	

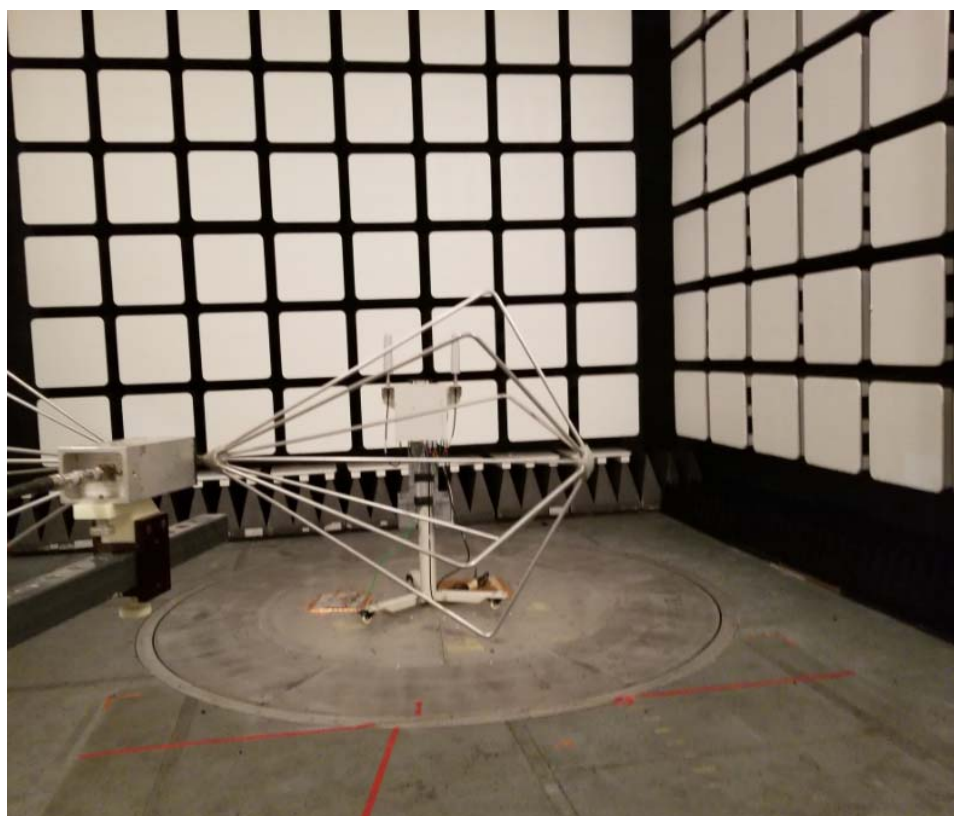
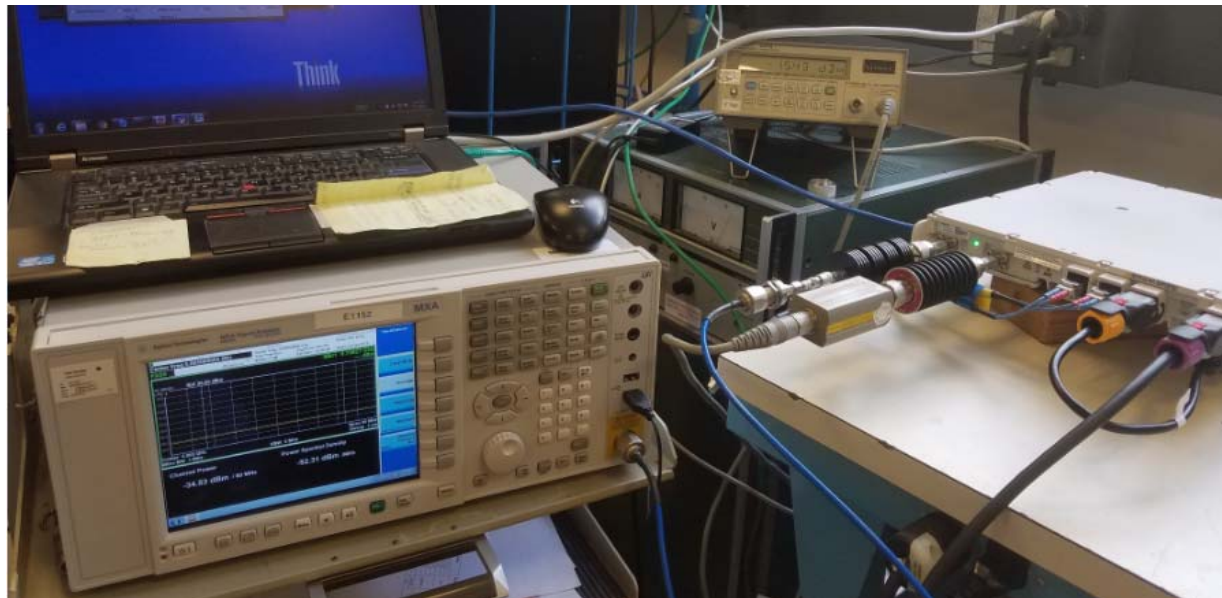
PREVIEW DATA

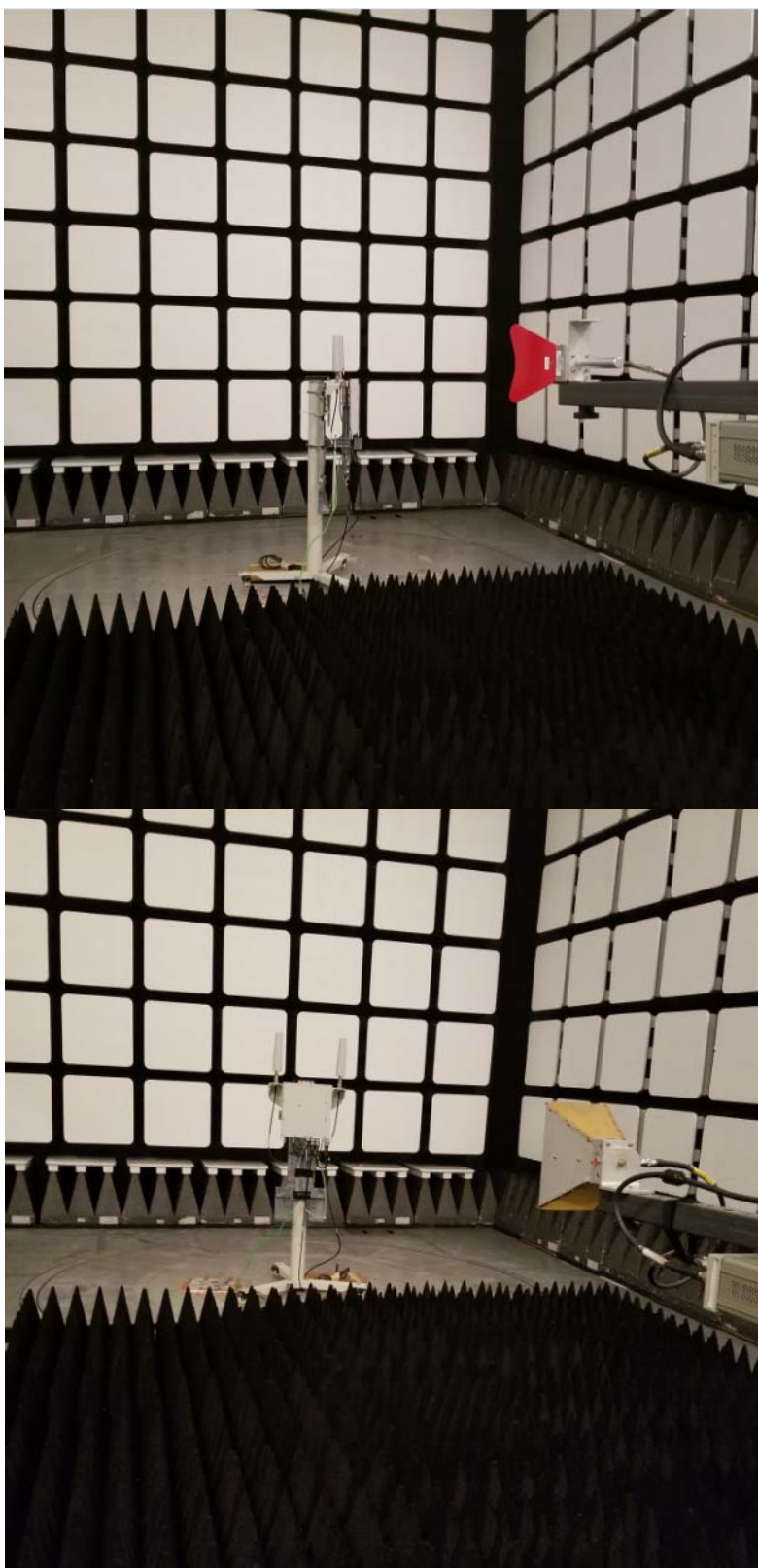
Freq. (MHz)	Raw (dBuV)	Cable (dB)	Factor (dB)	Level (dBuV/m)	Emission Type	Pol (H/V)	Ht (cm)	Az (deg)	Limit (dBuV/m)	Margin (dB)	Pass /Fail	Comments
39948.7	24.76	0	28.34	53.1	Preview	H	100	264	63.5	-10.4	Pass	
39763.4	25.16	0	27.91	53.07	Preview	H	175	154	63.5	-10.43	Pass	
36879.7	23.99	0	28.6	52.59	Preview	V	250	132	63.5	-10.91	Pass	
38557.2	24.77	0	27.55	52.32	Preview	V	200	0	63.5	-11.18	Pass	
36949.1	23.35	0	28.68	52.03	Preview	V	200	264	63.5	-11.47	Pass	
36400.2	23.95	0	28.02	51.97	Preview	V	200	176	63.5	-11.53	Pass	
38851	24.6	0	27.3	51.91	Preview	V	175	110	63.5	-11.59	Pass	
39090.7	24.52	0	27.2	51.72	Preview	H	225	22	63.5	-11.78	Pass	
35950.3	24.42	0	27.23	51.65	Preview	V	125	154	63.5	-11.85	Pass	

Figure 4.6.1(g) The Radiated Unwanted Emissions in 26.5GHz-40GHz Evaluated for the EUT with Antenna #7 in UNII-3, Three-20MHz Carriers at Channel 157 (5785MHz), 161 (5805MHz) and 165 (5825MHz), QPSK/16QAM, 25.5dBm Total, against FCC Part 15.407 and 15.209 Limits at 1m (Preview 30k RBW Peak, Formal 1MHz RBW Peak & Average).

5. PHOTOGRAPHS OF EUT SETUP

The setup photos of the conducted and radiated emissions tests were provided below.





6. LIST OF TEST EQUIPMENT

Table 6.1 List of Test Equipment Used

Equipment	Manufacturer	Model	Serial #	Last Cal Date	Cal Due
Ridged Horn Ant 26.5 GHz - 40 GHz	A.H. Systems	SAS-200/573	137	2017-10-04	2019-10-04
Double Ridged Horn Antenna 18-40 GHz	EMC Test Systems	3116	2539	2017-06-16	2019-06-16
Multi-Device Controller	EMC Test Systems	2090	0004-1507	NA	NA
Biconical Antenna	EMCO	3109	2187	2016-12-01	2018-12-01
Log Periodic Ant	EMCO	3146	2082	2017-05-24	2019-05-24
Double-Ridged Waveguide Horn 1-18 GHz	ETS Lindgren	3117	00135198	2017-06-09	2019-06-09
Double-Ridged Waveguide Horn 1-18 GHz	EMCO	3115	9909-5914	2016-11-07	2018-11-07
Pre-Amplifier 1-26.5 GHz	Hewlett Packard	8449B	3008A01384	2018-04-10	2020-04-10
Test Receiver EMI 20Hz to 40 GHz	Rohde & Schwarz	ESIB40	100119	2017-11-06	2019-11-06
Test Receiver EMI 20Hz - 40GHz -155 dBm +30 dBm	Rohde & Schwarz	ESU40	100246	2016-12-05	2018-12-05
Amplifier 9kHz-1GHz	Sonoma Instrument	310N	185785	2018-01-09	2020-01-09
Preamplifier 1-26.5 GHz	Hewlett Packard	8449B	3008A01270	2018-01-17	2019-01-17
Attenuator 6dB	Weinschel	2/6	CD2545	2017-03-03	2019-03-03
Attenuator 6dB	Weinschel	2/6	CD2518	2017-05-01	2019-05-01
Attenuator 6dB	Weinschel	2/6	CD2534	2017-05-23	2019-05-23
Attenuator 3dB	Weinschel	2-3	CC8591	2017-07-21	2019-07-21
Attenuator 3dB	Weinschel	2-3	CC9590	2017-06-28	2019-06-28
High Pass Filter 5-40GHz Filter	RLC Electronics Inc	F-19414	1444001	NA	NA
MXA Signal Analyzer 20Hz-26.5GHz	Agilent Technologies	N9020A	MY53420147	2017-03-13	2019-03-13
Attenuator, 10dB DC-40 GHz, 20W	Fairview Microwave	SA4023-10	E1247	NA	NA
Power Sensor 10 MHz-18 GHz	Hewlett Packard	8481A	US37294629	2017-05-26	2019-05-26
RF Power Meter	Hewlett Packard	437B	3125U21137	2016-12-15	2018-12-15
Attenuator, 3 dB DC - 4 GHz, 2W	Macom	2082-6171-03	E1344	N/A	N/A
Attenuator 20 dB DC - 4 GHz, 2W	Pasternack	PE7001-20	E1345	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 semi-anechoic chamber AR9 (FCC Site Registration Number: 896745, IC Filing Number: 6933F-9). The sites were constructed and are continuously in conformance with the requirements of ANSI C63.4 and CISPR Publication 32.

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.



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.