EMC Test Report

Application for Grant of Equipment Authorization

Industry Canada RSS-Gen Issue 3 / RSS 210 Issue 8
FCC Part 15 Subpart C

Model: AF24

IC CERTIFICATION #:	6545A-AF24
FCC ID:	SWX-AF24
APPLICANT:	Ubiquiti Networks 91 E. Tasman Drive San Jose, CA 95134
TEST SITE(S):	Elliott Laboratories 41039 Boyce Road. Fremont, CA. 94538-2435
IC SITE REGISTRATION #:	2845B-4, 2845B-5, 2845B-7
REPORT DATE:	April 30, 2012
FINAL TEST DATES:	April 12, 16, 17 and 24, 2012
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REVISION HISTORY

Rev#	Date	Comments	Modified By
-	4-30-2012	First release	

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SCOPE

An electromagnetic emissions test has been performed on the Ubiquiti Networks model AF24, pursuant to the following rules:

Industry Canada RSS-Gen Issue 3
RSS 210 Issue 8 "Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment"
FCC Part 15 Subpart C

Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in the following reference standards and as outlined in Elliott Laboratories test procedures:

ANSI C63.4:2003

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant Industry Canada performance and procedural standards.

Final system data was gathered in a mode that tended to maximize emissions by varying orientation of EUT, orientation of power and I/O cabling, antenna search height, and antenna polarization.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

OBJECTIVE

The primary objective of the manufacturer is compliance with the regulations outlined in the previous section.

Prior to marketing in the USA, all unlicensed transmitters and transceivers require certification. Receive-only devices operating between 30 MHz and 960 MHz are subject to either certification or a manufacturer's declaration of conformity, with all other receive-only devices exempt from the technical requirements.

Prior to marketing in Canada, Class I transmitters, receivers and transceivers require certification. Class II devices are required to meet the appropriate technical requirements but are exempt from certification requirements.

Certification is a procedure where the manufacturer submits test data and technical information to a certification body and receives a certificate or grant of equipment authorization upon successful completion of the certification body's review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units, which are subsequently manufactured.

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product which may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

STATEMENT OF COMPLIANCE

The tested sample of Ubiquiti Networks model AF24 complied with the requirements of the following regulations:

Industry Canada RSS-Gen Issue 3
RSS 210 Issue 8 "Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment"
FCC Part 15 Subpart C

Maintenance of compliance is the responsibility of the manufacturer. Any modifications to the product should be assessed to determine their potential impact on the compliance status of the device with respect to the standards detailed in this test report.

The test results recorded herein are based on a single type test of Ubiquiti Networks model AF24 and therefore apply only to the tested sample. The sample was selected and prepared by Jennifer Sanchez of Ubiquiti Networks.

DEVIATIONS FROM THE STANDARDS

No deviations were made from the published requirements listed in the scope of this report.

TEST RESULTS SUMMARY

DEVICES OPERATING IN THE 24 GHz BANDS

FCC Rule Part	RSS Rule Part	Description	Measured Value / Comments	Limit / Requirement	Result
15.249(b)(1)	RSS 210 A12 (a)	Fundamental Signal Strength	127.0dBµV/m @ 24137.0MHz (-1.0dB)	FCC: 2500mV/m @ 3m IC: 25000mV/m @ 3m	Complies
15.249 (a) / 15.209	RSS 210 A12 (d) & Table 2	Radiated Spurious Emissions, 40 - 100 GHz	36.3 dBµV/m @ 48200.0 MHz (-17.7 dB)	Harmonics 2500uV/m @ 3m, 50dBc or general limits (see page 17)	Complies
15.249(b)(2)	RSS 210 A12 (b)	Frequency Stability	0.001% (9.9 ppm)	0.001% (10 ppm)	Complies
15.249(b)(3)	RSS 210 A12 (c)	Antenna Gain	33dBi stated	At least 33 dBi	Complies

GENERAL REQUIREMENTS APPLICABLE TO ALL BANDS

FCC Rule Part	RSS Rule part	Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.203	-	RF Connector	Integral antenna	Unique or integral antenna required	Complies
15.207	RSS GEN Table 2	AC Conducted Emissions	54.4 dBµV @ 23.129 MHz (-5.6 dB)	Refer to page 16	Complies
15.247 (b) (5) 15.407 (f)	RSS 102	RF Exposure Requirements	Refer to MPE calculations and RSS 102 declaration and User Manual statements.	Refer to OET 65, FCC Part 1 and RSS 102	Complies
-	RSP 100 RSS GEN 7.1.5	User Manual	See manual exhibit	Statement required regarding non-interference	Complies
-	RSP 100 RSS GEN 7.1.5	User Manual	Integral antenna – no statement required	Statement for products with detachable antenna	Complies
-	RSP 100 RSS GEN 4.4.1	99% Bandwidth	96.64 MHz	Information only	N/A

MEASUREMENT UNCERTAINTIES

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level and were calculated in accordance with UKAS document LAB 34.

Measurement Type	Measurement Unit	Frequency Range	Expanded Uncertainty
Radiated emission (field strength)	dBµV/m	25 to 1000 MHz	± 3.6 dB
		1000 to 40000 MHz	± 6.0 dB
Conducted Emissions (AC Power)	dBµV	0.15 to 30 MHz	± 2.4 dB

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Ubiquiti Networks model AF24 is a 24GHz point to point radio supporting 2x2 MIMO. Since the EUT would be pole or wall-mounted, the EUT was mounted to a non-conductive tripod during testing. The EUT is powered by a 50V/1.2A POE power supply.

The sample was received on March 28, 2012 and tested on April 12, 16, 17 and 24, 2012. The EUT consisted of the following component(s):

Company	Model	Description	Serial Number	FCC ID
Ubiquiti Networks	AF24	Wireless backhaul radio	Pre-production	SWX-AF24

ANTENNA SYSTEM

The antenna system consists of integral 33dBi antennas for Tx and Rx.

ENCLOSURE

The EUT enclosure is primarily constructed of metal. It measures approximately 42.6 cm wide by 30.3 cm deep by 64.9 cm high.

MODIFICATIONS

No modifications were made to the EUT during the time the product was at Elliott.

SUPPORT EQUIPMENT

The following equipment was used as support equipment for testing:

Company	Model	Description	Serial Number	FCC ID
Dell	Vostro	Laptop Computer	60YDSN1	DoC

EUT INTERFACE PORTS

The I/O cabling configuration during testing was as follows:

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
Data	POE Adapter	Ethernet	Shielded	10.0
POE Power	AC Mains	Three wire	Unshielded	1.0
Configuration	Remote Computer	Ethernet	Shielded	10.0

The Auxiliary port was not connected during testing. Ubiquiti stated that this is for alignment purposes and therefore would not normally be connected.

EUT OPERATION

During testing, the EUT was set to transmit a continuous modulated signal at the desired channel.

TEST SITE

GENERAL INFORMATION

Final test measurements were taken at the test sites listed below. Pursuant to section 2.948 of the FCC's Rules and section 3.3 of RSP-100, construction, calibration, and equipment data has been filed with the Commission and with industry Canada.

Site	Registration Numbers		Location
	FCC	Canada	
Chamber 4	211948	2845B-4	41039 Boyce Road Fremont, CA 94538-2435
Chamber 5	211948	2845B-5	
Chamber 7	A2LA accreditation	2845B-7	

ANSI C63.4:2003 recommends that ambient noise at the test site be at least 6 dB below the allowable limits. Ambient levels are below this requirement. The test site(s) contain separate areas for radiated and conducted emissions testing. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent requirements of ANSI C63.4:2003.

CONDUCTED EMISSIONS CONSIDERATIONS

Conducted emissions testing is performed in conformance with ANSI C63.4:2003. Measurements are made with the EUT connected to the public power network through a nominal, standardized RF impedance, which is provided by a line impedance stabilization network, known as a LISN. A LISN is inserted in series with each current-carrying conductor in the EUT power cord.

RADIATED EMISSIONS CONSIDERATIONS

The FCC has determined that radiation measurements made in a shielded enclosure are not suitable for determining levels of radiated emissions. Radiated measurements are performed in an open field environment or in a semi-anechoic chamber. The test sites are maintained free of conductive objects within the CISPR defined elliptical area incorporated in ANSI C63.4:2003 guidelines and meet the Normalized Site Attenuation (NSA) requirements of ANSI C63.4:2003.

MEASUREMENT INSTRUMENTATION

RECEIVER SYSTEM

An EMI receiver as specified in CISPR 16-1-1 is used for emissions measurements. The receivers used can measure over the frequency range of 9 kHz up to 2000 MHz. These receivers allow both ease of measurement and high accuracy to be achieved. The receivers have Peak, Average, and CISPR (Quasi-peak) detectors built into their design so no external adapters are necessary. The receiver automatically sets the required bandwidth for the CISPR detector used during measurements. If the repetition frequency of the signal being measured is below 20Hz, peak measurements are made in lieu of Quasi-Peak measurements.

For measurements above the frequency range of the receivers, a spectrum analyzer is utilized because it provides visibility of the entire spectrum along with the precision and versatility required to support engineering analysis. Average measurements above 1000MHz are performed on the spectrum analyzer using the linear-average method with a resolution bandwidth of 1 MHz and a video bandwidth of 10 Hz, unless the signal is pulsed in which case the average (or video) bandwidth of the measuring instrument is reduced to onset of pulse desensitization and then increased.

INSTRUMENT CONTROL COMPUTER

The receivers utilize either a Rohde & Schwarz EZM Spectrum Monitor/Controller or contain an internal Spectrum Monitor/Controller to view and convert the receiver measurements to the field strength at an antenna or voltage developed at the LISN measurement port, which is then compared directly with the appropriate specification limit. This provides faster, more accurate readings by performing the conversions described under Sample Calculations within the Test Procedures section of this report. Results are printed in a graphic and/or tabular format, as appropriate. A personal computer is used to record all measurements made with the receivers.

The Spectrum Monitor provides a visual display of the signal being measured. In addition, the controller or a personal computer run automated data collection programs which control the receivers. This provides added accuracy since all site correction factors, such as cable loss and antenna factors are added automatically.

LINE IMPEDANCE STABILIZATION NETWORK (LISN)

Line conducted measurements utilize a fifty microhenry Line Impedance Stabilization Network as the monitoring point. The LISN used also contains a 250 uH CISPR adapter. This network provides for calibrated radio frequency noise measurements by the design of the internal low pass and high pass filters on the EUT and measurement ports, respectively.

FILTERS/ATTENUATORS

External filters and precision attenuators are often connected between the receiving antenna or LISN and the receiver. This eliminates saturation effects and non-linear operation due to high amplitude transient events.

ANTENNAS

A loop antenna is used below 30 MHz. For the measurement range 30 MHz to 1000 MHz either a combination of a biconical antenna and a log periodic or a bi-log antenna is used. Above 1000 MHz, horn antennas are used. The antenna calibration factors to convert the received voltage to an electric field strength are included with appropriate cable loss and amplifier gain factors to determine an overall site factor, which is then programmed into the test receivers or incorporated into the test software.

ANTENNA MAST AND EQUIPMENT TURNTABLE

The antennas used to measure the radiated electric field strength are mounted on a non-conductive antenna mast equipped with a motor-drive to vary the antenna height. Measurements below 30 MHz are made with the loop antenna at a fixed height of 1m above the ground plane.

ANSI C63.4:2003 specifies that the test height above ground for table mounted devices shall be 80 centimeters. Floor mounted equipment shall be placed on the ground plane if the device is normally used on a conductive floor or separated from the ground plane by insulating material from 3 to 12 mm if the device is normally used on a non-conductive floor. During radiated measurements, the EUT is positioned on a motorized turntable in conformance with this requirement.

INSTRUMENT CALIBRATION

All test equipment is regularly checked to ensure that performance is maintained in accordance with the manufacturer's specifications. All antennas are calibrated at regular intervals with respect to tuned half-wave dipoles. An exhibit of this report contains the list of test equipment used and calibration information.

TEST PROCEDURES

EUT AND CABLE PLACEMENT

The regulations require that interconnecting cables be connected to the available ports of the unit and that the placement of the unit and the attached cables simulate the worst case orientation that can be expected from a typical installation, so far as practicable. To this end, the position of the unit and associated cabling is varied within the guidelines of ANSI C63.4:2003, and the worst-case orientation is used for final measurements.

CONDUCTED EMISSIONS

Conducted emissions are measured at the plug end of the power cord supplied with the EUT. Excess power cord length is wrapped in a bundle between 30 and 40 centimeters in length near the center of the cord. Preliminary measurements are made to determine the highest amplitude emission relative to the specification limit for all the modes of operation. Placement of system components and varying of cable positions are performed in each mode. A final peak mode scan is then performed in the position and mode for which the highest emission was noted on all current carrying conductors of the power cord.

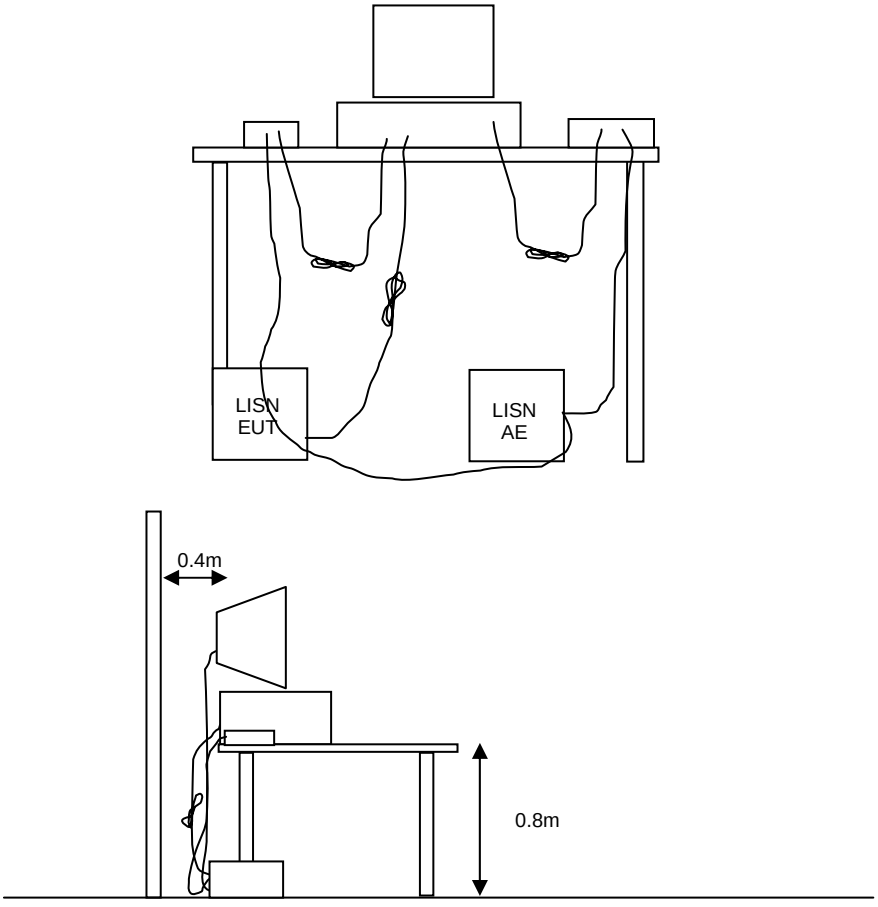


Figure 1 Typical Conducted Emissions Test Configuration

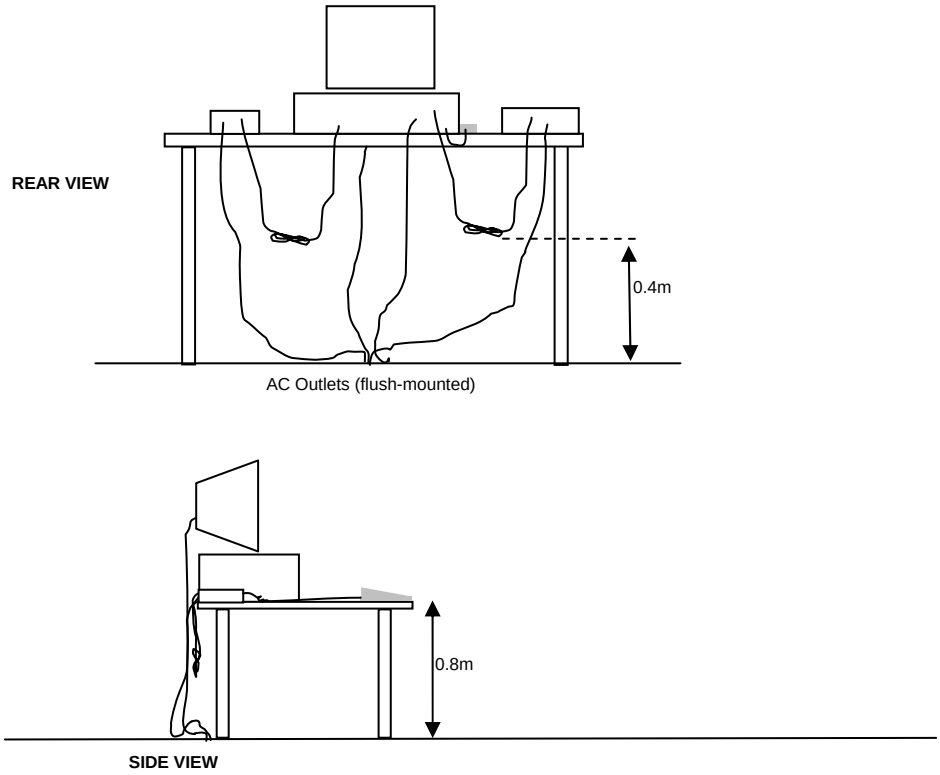
RADIATED EMISSIONS

A preliminary scan of the radiated emissions is performed in which all significant EUT frequencies are identified with the system in a nominal configuration. At least two scans are performed, one scan for each antenna polarization (horizontal and vertical; loop parallel and perpendicular to the EUT). During the preliminary scans, the EUT is rotated through 360˚, the antenna height is varied (for measurements above 30 MHz) and cable positions are varied to determine the highest emission relative to the limit. Preliminary scans may be performed in a fully anechoic chamber for the purposes of identifying the frequencies of the highest emissions from the EUT.

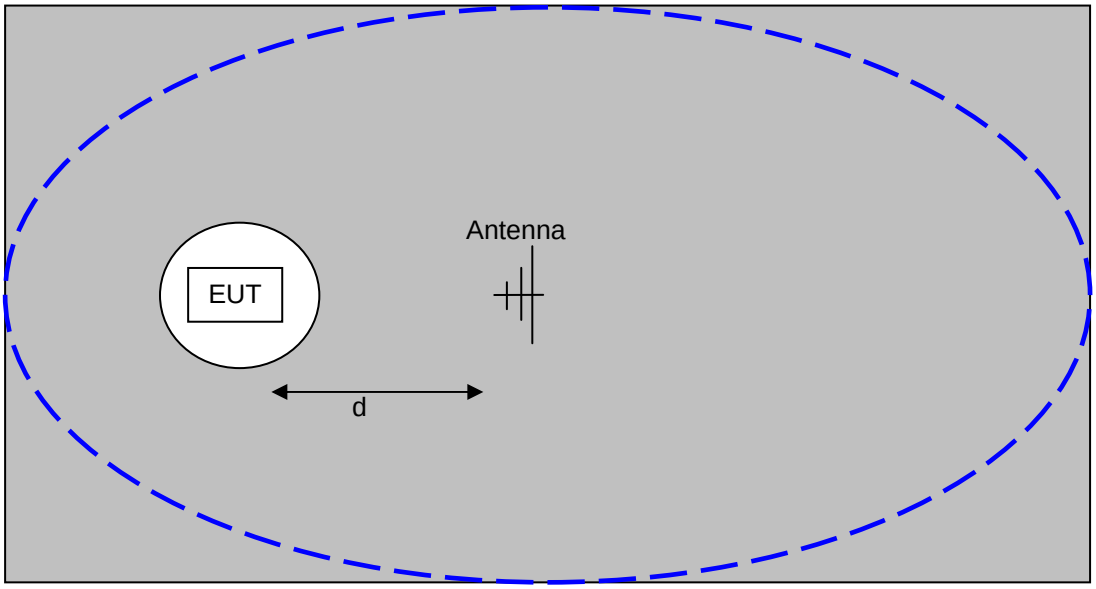
A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

Final maximization is a phase in which the highest amplitude emissions identified in the spectral search are viewed while the EUT azimuth angle is varied from 0 to 360 degrees relative to the receiving antenna. The azimuth, which results in the highest emission is then maintained while varying the antenna height from one to four meters (for measurements above 30 MHz, measurements below 30 MHz are made with the loop antenna at a fixed height of 1m). The result is the identification of the highest amplitude for each of the highest peaks. Each recorded level is corrected in the receiver using appropriate factors for cables, connectors, antennas, and preamplifier gain.

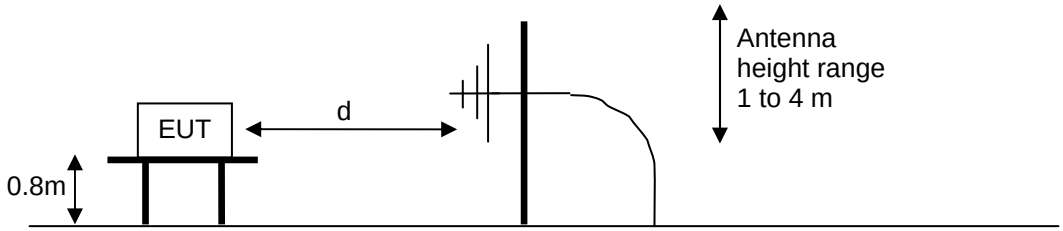
When testing above 18 GHz, the receive antenna is located at 1meter from the EUT and the antenna height is restricted to a maximum of 2.5 meters.



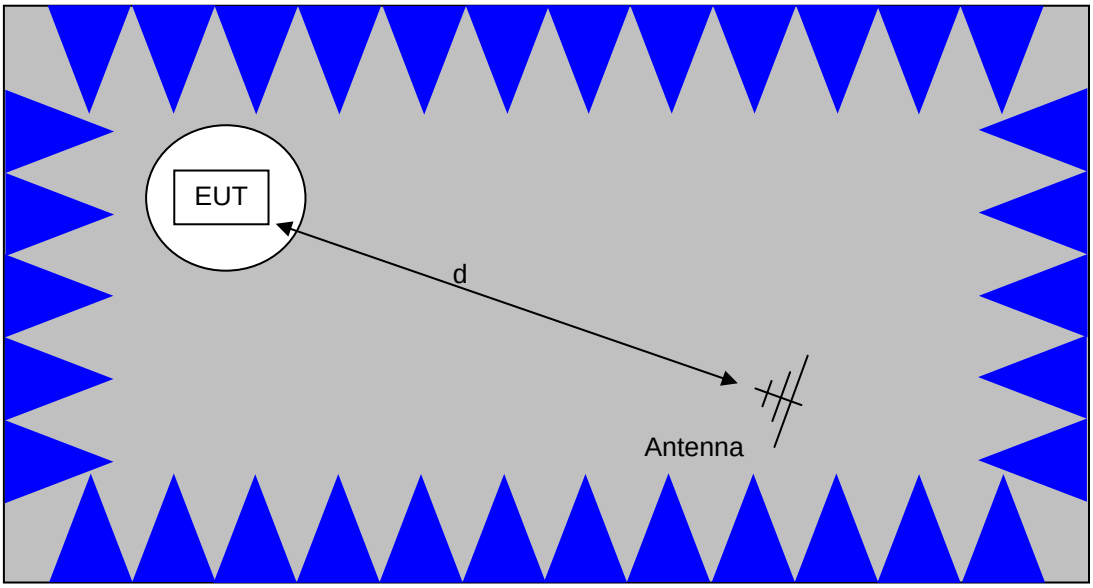
Typical Test Configuration for Radiated Field Strength Measurements



The ground plane extends beyond the ellipse defined in CISPR 16 / CISPR 22 / ANSI C63.4 and is large enough to accommodate test distances (d) of 3m and 10m. Refer to the test data tables for the actual measurement distance.

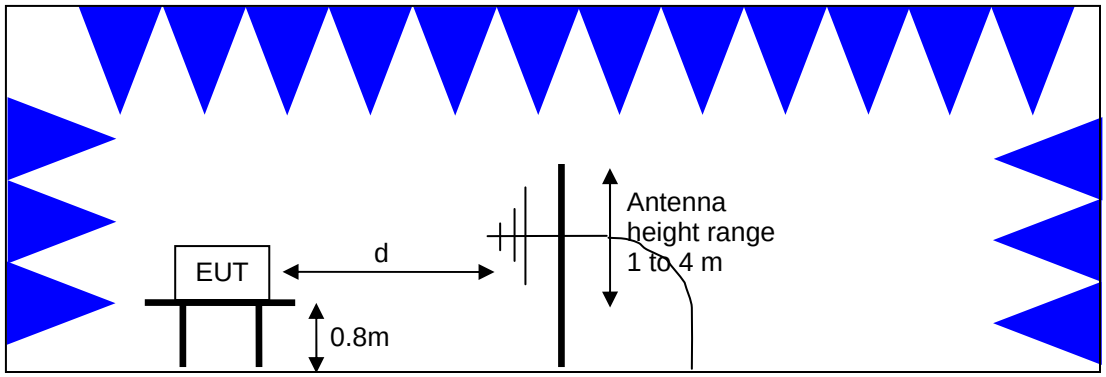


Test Configuration for Radiated Field Strength Measurements
OATS- Plan and Side Views



The anechoic materials on the walls and ceiling ensure compliance with the normalized site attenuation requirements of CISPR 16 / CISPR 22 / ANSI C63.4 for an alternate test site at the measurement distances used.

Floor-standing equipment is placed on the floor with insulating supports between the unit and the ground plane.



Test Configuration for Radiated Field Strength Measurements
Semi-Anechoic Chamber, Plan and Side Views

BANDWIDTH MEASUREMENTS

The 6dB, 20dB and/or 26dB signal bandwidth is measured in using the bandwidths recommended by ANSI C63.4. When required, the 99% bandwidth is measured using the methods detailed in RSS GEN.

SPECIFICATION LIMITS AND SAMPLE CALCULATIONS

The limits for conducted emissions are given in units of microvolts, and the limits for radiated emissions are given in units of microvolts per meter at a specified test distance. Data is measured in the logarithmic form of decibels relative to one microvolt, or dB microvolts (dBuV). For radiated emissions, the measured data is converted to the field strength at the antenna in dB microvolts per meter (dBuV/m). The results are then converted to the linear forms of uV and uV/m for comparison to published specifications.

For reference, converting the specification limits from linear to decibel form is accomplished by taking the base ten logarithm, then multiplying by 20. These limits in both linear and logarithmic form are as follows:

CONDUCTED EMISSIONS SPECIFICATION LIMITS: FCC 15.207; FCC 15.107(a), RSS GEN

The table below shows the limits for the emissions on the AC power line from an intentional radiator and a receiver.

Frequency (MHz)	Average Limit (dBuV)	Quasi Peak Limit (dBuV)
0.150 to 0.500	Linear decrease on logarithmic frequency axis between 56.0 and 46.0	Linear decrease on logarithmic frequency axis between 66.0 and 56.0
0.500 to 5.000	46.0	56.0
5.000 to 30.000	50.0	60.0

GENERAL TRANSMITTER RADIATED EMISSIONS SPECIFICATION LIMITS

The table below shows the limits for the spurious emissions from transmitters that fall in restricted bands[1] (with the exception of transmitters operating under FCC Part 15 Subpart D and RSS 210 Annex 9), the limits for all emissions from a low power device operating under the general rules of RSS 310 (tables 3 and 4), RSS 210 (table 2) and FCC Part 15 Subpart C section 15.209.

Frequency Range (MHz)	Limit (uV/m)	Limit (dBuV/m @ 3m)
0.009-0.490	$2400/F_{KHz}$ @ 300m	$67.6-20*\log_{10}(F_{KHz})$ @ 300m
0.490-1.705	$24000/F_{KHz}$ @ 30m	$87.6-20*\log_{10}(F_{KHz})$ @ 30m
1.705 to 30	30 @ 30m	29.5 @ 30m
30 to 88	100 @ 3m	40 @ 3m
88 to 216	150 @ 3m	43.5 @ 3m
216 to 960	200 @ 3m	46.0 @ 3m
Above 960	500 @ 3m	54.0 @ 3m

[1] The restricted bands are detailed in FCC 15.203, RSS 210 Table 1 and RSS 310 Table 2

RADIATEDFUNDAMENTAL & SPURIOUS EMISSIONS SPECIFICATION LIMITS – 15.249 and RSS 210 A12

The table below shows the limits for the fundamental emission and for its harmonics. Harmonics that that fall in restricted bands[2] and all other spurious emissions are subject to the general limits of RSS 210 and FCC Part 15 Subpart C.

Frequency Range (MHz)	Limit for Fundamental @ 3m	Limit for Harmonics @ 3m
24000 – 24250	2,500,000 uV/m 128dBuV/m	2500 uV/m 68dBuV/m

SAMPLE CALCULATIONS - CONDUCTED EMISSIONS

Receiver readings are compared directly to the conducted emissions specification limit (decibel form) as follows:

$$R_r - S = M$$

where:

R_r = Receiver Reading in dBuV

S = Specification Limit in dBuV

M = Margin to Specification in +/- dB

[2] The restricted bands are detailed in FCC 15.203, RSS 210 Table 1 and RSS 310 Table 2

SAMPLE CALCULATIONS - RADIATED EMISSIONS

Receiver readings are compared directly to the specification limit (decibel form). The receiver internally corrects for cable loss, preamplifier gain, and antenna factor. The calculations are in the reverse direction of the actual signal flow, thus cable loss is added and the amplifier gain is subtracted. The Antenna Factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

A distance factor, when used for electric field measurements above 30MHz, is calculated by using the following formula:

$$F_d = 20*LOG_{10} (D_m/D_s)$$

where:

F_d = Distance Factor in dB

D_m = Measurement Distance in meters

D_s = Specification Distance in meters

For electric field measurements below 30MHz the extrapolation factor is either determined by making measurements at multiple distances or a theoretical value is calculated using the formula:

$$F_d = 40*LOG_{10} (D_m/D_s)$$

Measurement Distance is the distance at which the measurements were taken and Specification Distance is the distance at which the specification limits are based. The antenna factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

The margin of a given emission peak relative to the limit is calculated as follows:

$$R_c = R_r + F_d$$

and

$$M = R_c - L_s$$

where:

R_r = Receiver Reading in dBuV/m

F_d = Distance Factor in dB

R_c = Corrected Reading in dBuV/m

L_s = Specification Limit in dBuV/m

M = Margin in dB Relative to Spec

SAMPLE CALCULATIONS - FIELD STRENGTH TO EIRP CONVERSION

Where the radiated electric field strength is expressed in terms of the equivalent isotropic radiated power (eirp), or where a field strength measurement of output power is made in lieu of a direct measurement, the following formula is used to convert between eirp and field strength at a distance of d (meters) from the equipment under test:

$$E = \frac{1000000 \sqrt{30 P}}{d} \quad \text{microvolts per meter}$$

where P is the eirp (Watts)

For a measurement at 3m the conversion from a logarithmic value for field strength (dBuV/m) to an eirp power (dBm) is -95.3dB.

Appendix A Test Equipment Calibration Data

Radiated Emissions, 30 - 40,000 MHz, 12-Apr-12

Manufacturer	Description	Model	Asset #	Cal Due
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	1549	5/25/2013
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1756	5/25/2012
Hewlett Packard	Head (Inc W1-W4, 1742 , 1743) Blue	84125C	1772	5/9/2012
Hewlett Packard	Preamplifier, 100 kHz - 1.3 GHz	8447D OPT 010	1826	5/17/2012
A.H. Systems	Spare System Horn, 18-40GHz	SAS-574, p/n: 2581	2162	5/3/2012
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	2199	2/23/2013
Hewlett Packard	SpecAn 9 kHz - 40 GHz, (SA40) Purple	8564E (84125C)	2415	7/28/2012

Frequency Stability, 16-Apr-12

Manufacturer	Description	Model	Asset #	Cal Due
Agilent	PSA, Spectrum Analyzer, (installed options, 111, 115, 123, 1DS, B7J, HYX,	E4446A	2139	2/23/2013

Radiated Emissions, 40 - 100 GHz, 17-Apr-12

Manufacturer	Description	Model	Asset #	Cal Due
Hewlett Packard	SpecAn 9 KHz-26.5 GHz, Non-Program	8563E	284	1/16/2013

Conducted Emissions - AC Power Ports, 24-Apr-12

Manufacturer	Description	Model	Asset #	Cal Due
Rohde & Schwarz	Pulse Limiter	ESH3 Z2	1398	1/26/2013
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1538	12/6/2012
Fischer Custom Comm.	LISN, 50uH, 25 Amps, Dual Line	FCC-LISN-50/250-25-2-01	1575	2/16/2013

Appendix B Test Data

T86927 Pages 23 - 41

Client:	Ubiquiti Networks	Job Number:	J86893
Model:	AirFiber (24GHz)	T-Log Number:	T86927
		Account Manager:	Michelle Kim
Contact:	Jennifer Sanchez		-
Emissions Standard(s):	FCC 15.249, EN 300 440	Class:	A
Immunity Standard(s):	EN 301 489-1/-3	Environment:	-

EMC Test Data

For The

Ubiquiti Networks

Model

AirFiber (24GHz)

Date of Last Test: 4/24/2012

Client:	Ubiquiti Networks	Job Number:	J86893
Model:	AirFiber (24GHz)	T-Log Number:	T86927
		Account Manager:	Michelle Kim
Contact:	Jennifer Sanchez		
Standard:	FCC 15.249, EN 300 440	Class:	A

Radiated Emissions

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

General Test Configuration

The EUT was located on the turntable for radiated emissions testing. The EUT was tested in all three orthogonal orientations.

The test distance and extrapolation factor (if applicable) are detailed under each run description.

Note, preliminary testing indicates that the emissions were maximized by orientation of the EUT and elevation of the measurement antenna. Maximized testing indicated that the emissions were maximized by orientation of the EUT, elevation of the measurement antenna, and manipulation of the EUT's interface cables.

Ambient Conditions:

Temperature: 21 °C

Rel. Humidity: 39 %

Summary of Results

Run #	Test Performed	Limit	Result	Value / Margin
1	Transmitter Radiated Spurious Emissions, 40 - 100 GHz	FCC 15.209 & 15.249 RSS 210/RSS GEN	Pass	36.3 dBµV/m @ 48200.0 MHz (-17.7 dB)
2	Fundamental Signal Field Strength	FCC 15.49 RSS 210 Annex A12	Pass	127.0dBµV/m @ 24137.0MHz (-1.0dB)
3	99% Bandwidth (center channel)	RSS-GEN	N/A	96.64 MHz

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	Ubiquiti Networks	Job Number:	J86893
Model:	AirFiber (24GHz)	T-Log Number:	T86927
		Account Manager:	Michelle Kim
Contact:	Jennifer Sanchez		
Standard:	FCC 15.249, EN 300 440	Class:	A

Run #1: Maximized Radiated Emissions, 40-100 GHz, Transmitter Spurious Emissions

Date of Test: 4/17/2012 Config. Used: 1
Test Engineer: David Bare Config Change: None
Test Location: Fremont Chamber #5 EUT Voltage: 48V POE

Frequency Range	Test Distance	Limit Distance	Extrapolation Factor
40 - 100 GHz	0.05	3	-35.6

Note:	The limit in 15.249 for a fundamental signal in the 24.0-24.25 GHz band is 2500mV/m (128.0 dBuV/m), harmonics are limited to 2500uV/m (68dBuV/m) and all other spurious are required to meet 15.209 limits.
Note:	The field strength of any spurious emissions may not exceed the field strength of the fundamental signal.
Note:	The field strength of any spurious emissions may not exceed the 15.209 limit when the spurious emission falls in a restricted band. Additionally the spurious emissions can exceed the limit calculated above if the 15.209 limit is higher.

Low Channel

Frequency	Level	Pol	RSS 210 / FCC 15.249		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
48200.000	36.3	V	54.0	-17.7	Avg	0	1.0	
72300.000	50.0	V	54.0	-4.0	Avg	0	1.0	
96400.000	51.0	V	54.0	-3.0	Avg	0	1.0	

Note 1:	No emisisons above 40 GHz were detected above the noise floor of the measurement system.

High Channel

Frequency	Level	Pol	RSS 210 / FCC 15.249		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
48400.000	36.3	V	54.0	-17.7	Avg	0	1.0	
72600.000	50.0	V	54.0	-4.0	Avg	0	1.0	
94800.000	51.0	V	54.0	-3.0	Avg	0	1.0	

Note 1:	No emisisons above 40 GHz were detected above the noise floor of the measurement system.

Client:	Ubiquiti Networks	Job Number:	J86893
Model:	AirFiber (24GHz)	T-Log Number:	T86927
		Account Manager:	Michelle Kim
Contact:	Jennifer Sanchez		
Standard:	FCC 15.249, EN 300 440	Class:	A

Run #2: Maximized Readings - Fundamental Emission

Low Channel
Fundamental Field Strength

Frequency	Level	Pol	RSS 210 / FCC 15.249		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
24101.750	115.4	V	128.0	-12.6	AVG	0	1.0	RB 1 MHz;VB 10 Hz;Pk
24057.500	125.6	V	128.0	-2.4	PK	0	1.0	RB 1 MHz;VB 3 MHz;Pk
24089.000	116.0	H	128.0	-12.0	AVG	0	1.0	RB 1 MHz;VB 10 Hz;Pk
24137.000	127.0	H	128.0	-1.0	PK	0	1.0	RB 1 MHz;VB 3 MHz;Pk

High Channel
Fundamental Field Strength

Frequency	Level	Pol	RSS 210 / FCC 15.249		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
24188.130	115.3	V	128.0	-12.7	AVG	0	1.0	RB 1 MHz;VB 10 Hz;Peak
24191.330	126.4	V	128.0	-1.6	PK	0	1.0	RB 1 MHz;VB 3 MHz;Peak
24167.130	115.8	H	128.0	-12.2	AVG	0	1.0	RB 1 MHz;VB 10 Hz;Peak
24174.370	126.8	H	128.0	-1.2	PK	0	1.0	RB 1 MHz;VB 3 MHz;Peak

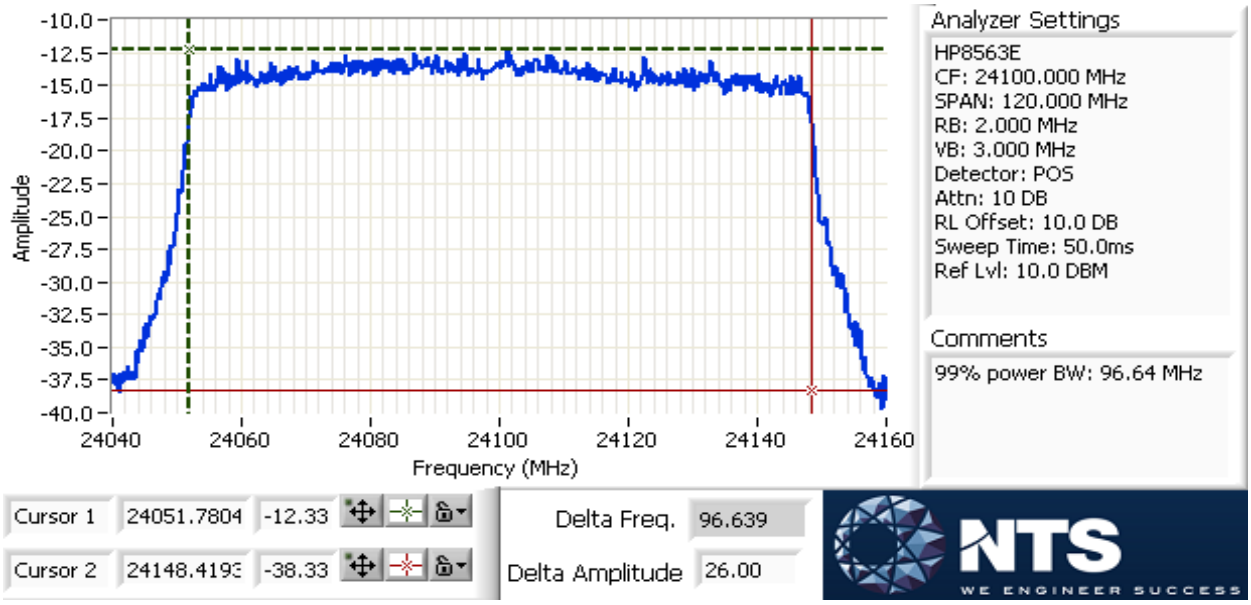
Client:	Ubiquiti Networks	Job Number:	J86893
Model:	AirFiber (24GHz)	T-Log Number:	T86927
		Account Manager:	Michelle Kim
Contact:	Jennifer Sanchez		
Standard:	FCC 15.249, EN 300 440	Class:	A

Run #3: Bandwidth Measurement(s)

Date of Test: 4/17/2012
Test Engineer: David Bare
Test Location: Fremont Chamber #5

Config. Used: 1
Config Change: None
EUT Voltage: 48V POE

Frequency (MHz)	Resolution Bandwidth (MHz)	Video Bandwidth (MHz)	99% Bandwidth (MHz)
24100	2	3	96.64



Note 1:	99% bandwidth measured in accordance with RSS GEN, with RB > 1% of the span and VB > RB

Client:	Ubiquiti Networks	Job Number:	J86893
Model:	AirFiber (24GHz)	T-Log Number:	T86927
		Account Manager:	Michelle Kim
Contact:	Jennifer Sanchez		
Standard:	FCC 15.249, EN 300 440	Class:	A

Radiated Emissions

(Elliott Laboratories Fremont Facility, Semi-Anechoic Chamber)

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 4/12/2012
Test Engineer: Rafael Varelas
Test Location: Fremont Chamber #7
Config. Used: 1
Config Change: None
EUT Voltage: 48 V POE

General Test Configuration

The EUT and any local support equipment were located on the turntable for radiated emissions testing. Any remote support equipment was located outside the semi-anechoic chamber. Any cables running to remote support equipment where routed through metal conduit and when possible passed through a ferrite clamp upon exiting the chamber.

The test distance and extrapolation factor (if applicable) are detailed under each run description.

Note, preliminary testing indicates that the emissions were maximized by orientation of the EUT and elevation of the measurement antenna. Maximized testing indicated that the emissions were maximized by orientation of the EUT, elevation of the measurement antenna, and manipulation of the EUT's interface cables.

Ambient Conditions:

Temperature: 20.6 °C
Rel. Humidity: 34 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1a (Low Channel)	Transmitter Radiated Emissions 30 MHz - 40 GHz Maximized	FCC 15.249 RSS-210, A12	Pass	43.1 dBµV/m @ 176.85 MHz (-0.4 dB)
1b (High Channel)	Transmitter Radiated Emissions 30 MHz - 40 GHz Maximized	FCC 15.249 RSS-210, A12	Pass	43.4 dBµV/m @ 179.37 MHz (-0.1 dB)

Modifications Made During Testing

No modifications were made to the EUT during testing

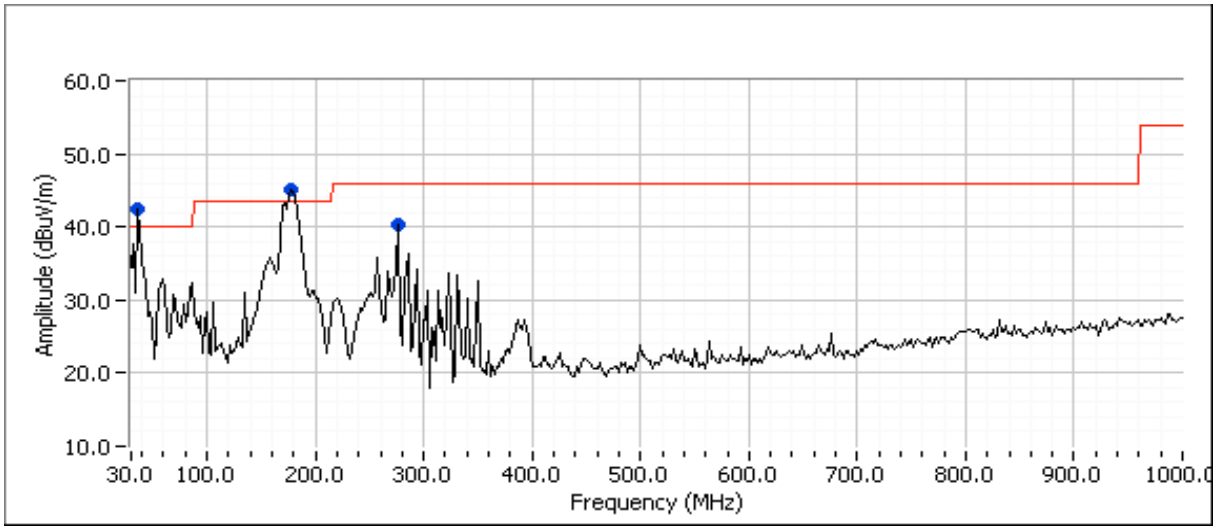
Deviations From The Standard

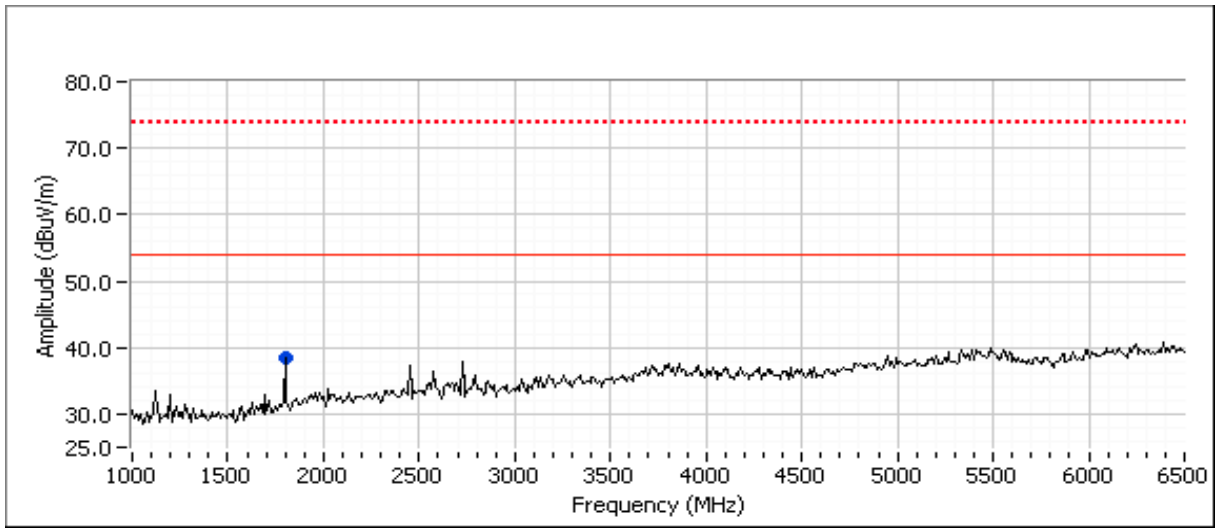
No deviations were made from the requirements of the standard.

Client:	Ubiquiti Networks	Job Number:	J86893
Model:	AirFiber (24GHz)	T-Log Number:	T86927
		Account Manager:	Michelle Kim
Contact:	Jennifer Sanchez		
Standard:	FCC 15.249, EN 300 440	Class:	A

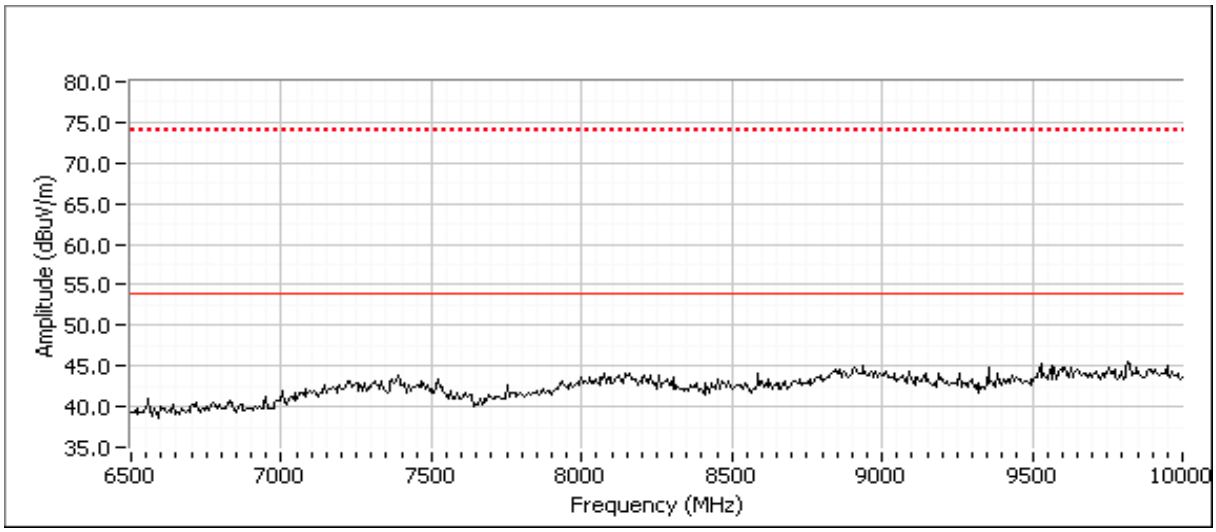
Run #1a: Maximized Readings, 30 MHz- 40,000 MHz
Low Channel 24.1 GHz

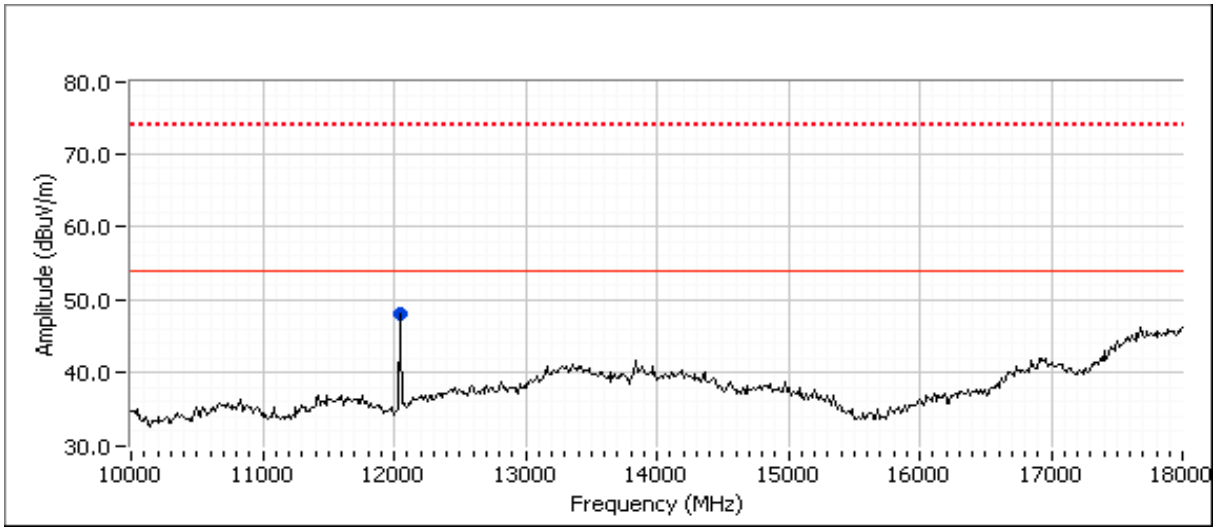
Frequency Range	Test Distance	Limit Distance	Extrapolation Factor
1000 - 10000 MHz	3	3	0.0
10000 - 40000 MHz	1	3	-9.5



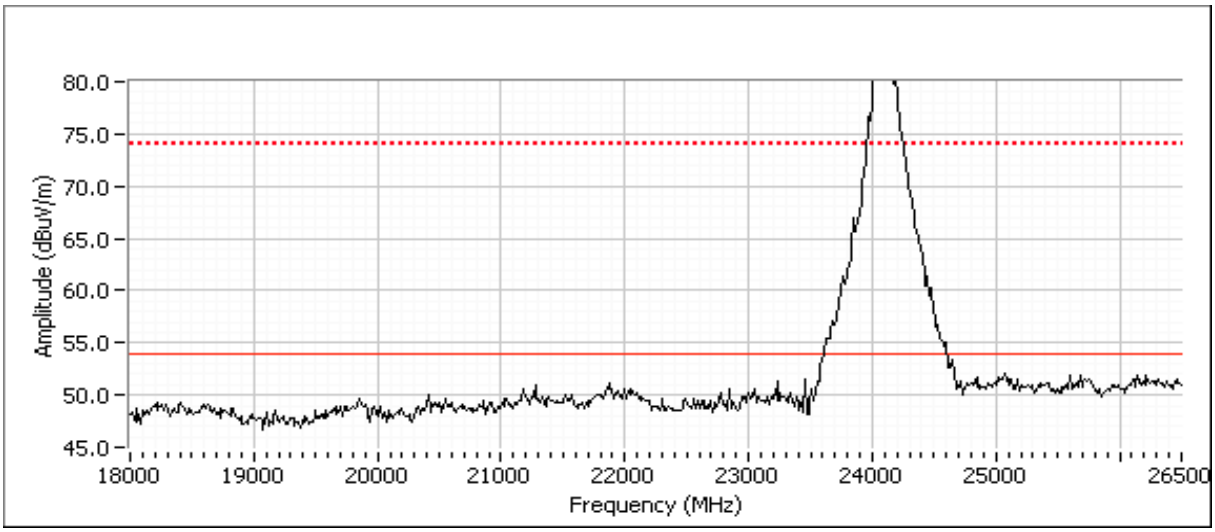


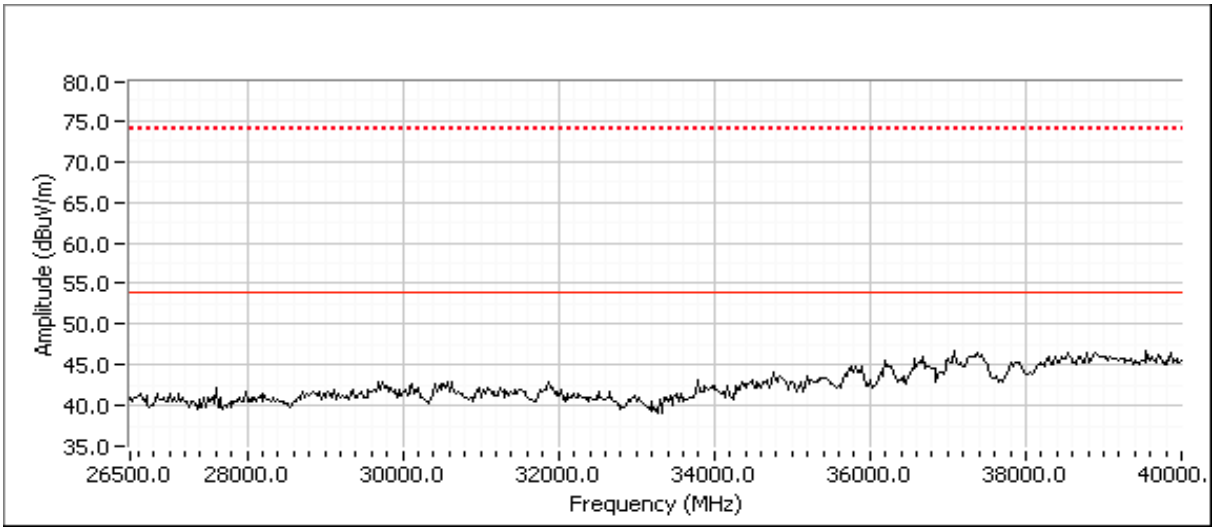
Client:	Ubiquiti Networks	Job Number:	J86893
Model:	AirFiber (24GHz)	T-Log Number:	T86927
		Account Manager:	Michelle Kim
Contact:	Jennifer Sanchez		
Standard:	FCC 15.249, EN 300 440	Class:	A





Client:	Ubiquiti Networks	Job Number:	J86893
Model:	AirFiber (24GHz)	T-Log Number:	T86927
		Account Manager:	Michelle Kim
Contact:	Jennifer Sanchez		
Standard:	FCC 15.249, EN 300 440	Class:	A





Client:	Ubiquiti Networks	Job Number:	J86893
Model:	AirFiber (24GHz)	T-Log Number:	T86927
		Account Manager:	Michelle Kim
Contact:	Jennifer Sanchez		
Standard:	FCC 15.249, EN 300 440	Class:	A

Preliminary peak readings captured during pre-scan (peak readings vs. average limit)

Frequency	Level	Pol	RSS 210 / FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
37.361	42.4	V	40.0	2.4	Peak	238	2.0	
176.849	45.0	H	43.5	1.5	Peak	9	1.0	
276.605	40.4	V	46.0	-5.6	Peak	44	2.0	
1797.500	38.5	V	54.0	-15.5	Peak	172	1.0	
12040.000	48.0	V	54.0	-6.0	Peak	184	1.3	

Frequency Range	Test Distance	Limit Distance	Extrapolation Factor
1000 - 40000 MHz	3	3	0.0

Final peak and average readings

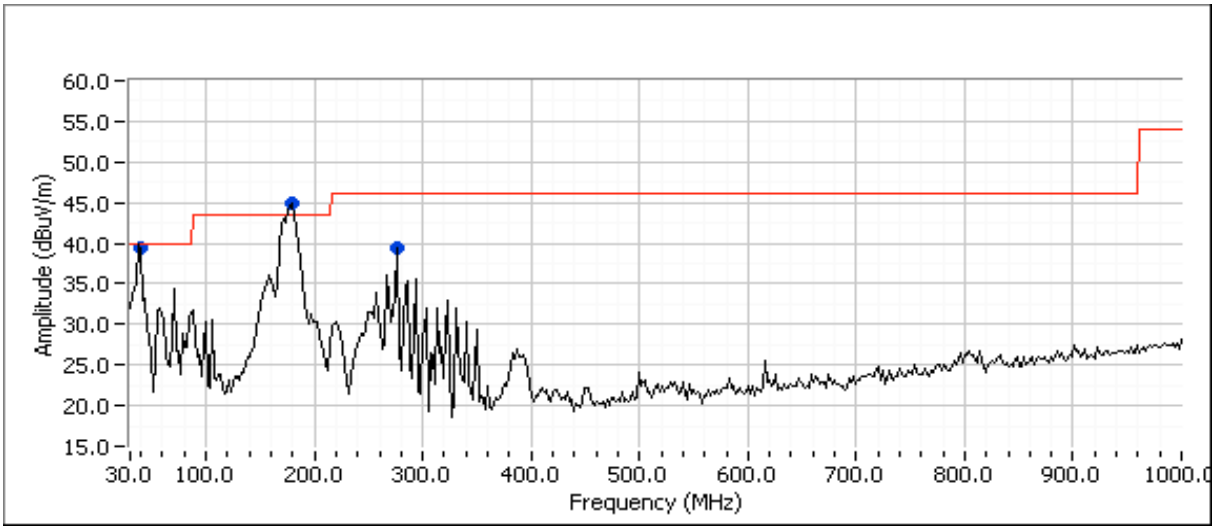
Frequency	Level	Pol	RSS 210 / FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
176.849	43.1	H	43.5	-0.4	QP	9	1.2	QP (1.00s)
276.605	39.1	V	46.0	-6.9	QP	44	2.0	QP (1.00s)
37.361	32.1	V	40.0	-7.9	QP	238	1.0	QP (1.00s)
12049.970	52.8	V	54.0	-1.2	AVG	184	1.4	RB 1 MHz;VB 10 Hz;Peak
12049.890	56.9	V	74.0	-17.1	PK	184	1.4	RB 1 MHz;VB 3 MHz;Peak

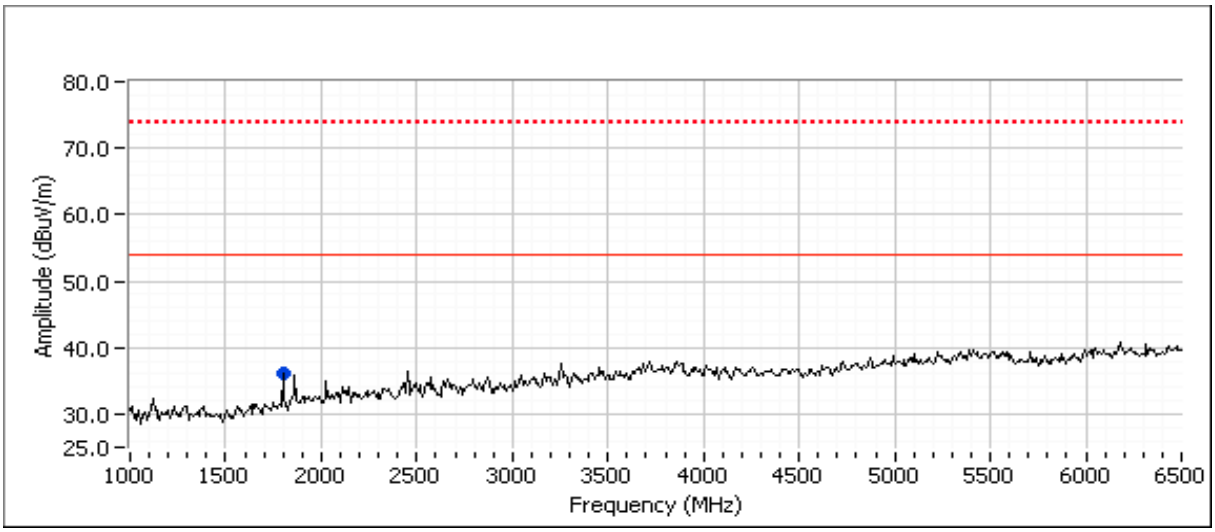
Note:	The limit in 15.249 for a fundamental signal in the 24.0-24.25 GHz band is 2500mV/m (128.0 dBuV/m), harmonics are limited to 2500uV/m (68dBuV/m) and all other spurious are required to meet 15.209 limits.
Note:	The field strength of any spurious emissions may not exceed the field strength of the fundamental signal.
Note:	Per 15.249(e), peak field strength along the antenna azimuth is limited to 128 dBuV/m.

Client:	Ubiquiti Networks	Job Number:	J86893
Model:	AirFiber (24GHz)	T-Log Number:	T86927
		Account Manager:	Michelle Kim
Contact:	Jennifer Sanchez		
Standard:	FCC 15.249, EN 300 440	Class:	A

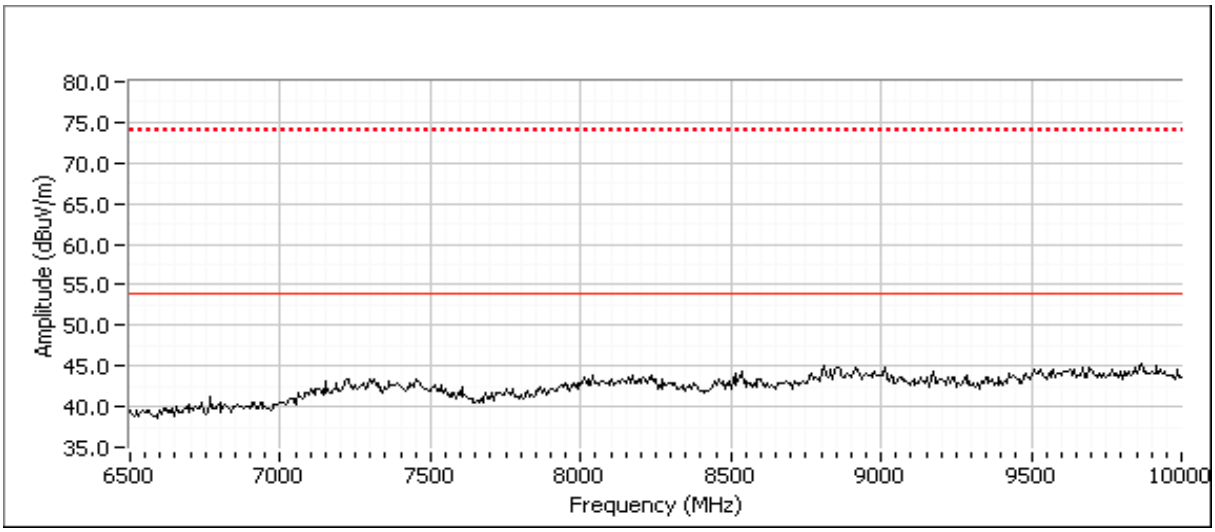
Run #1b: Maximized Readings, 30 MHz - 40,000 MHz
High Channel 24.2 GHz

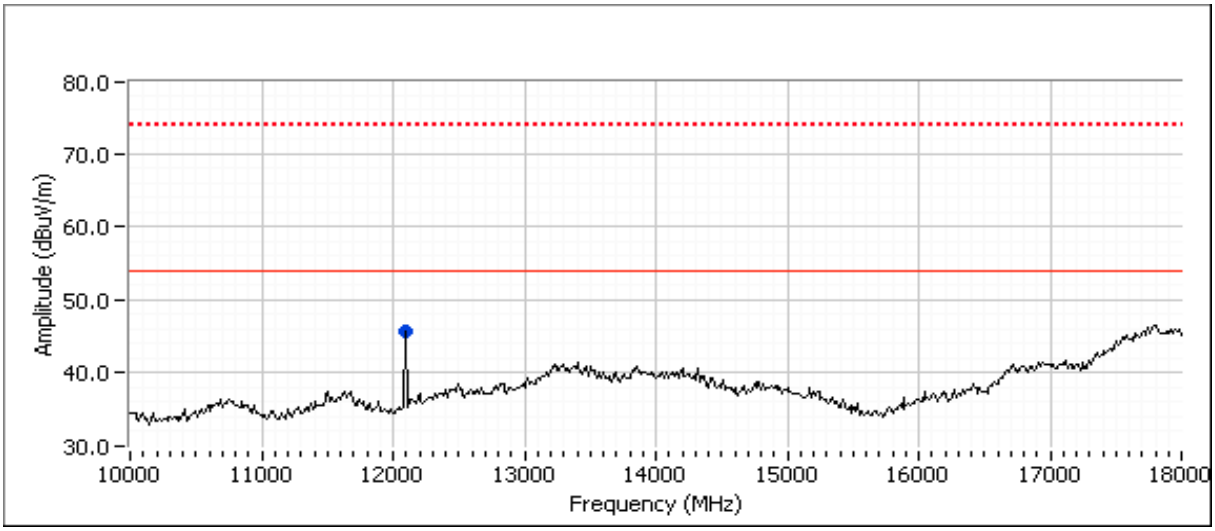
Frequency Range	Test Distance	Limit Distance	Extrapolation Factor
1000 - 10000 MHz	3	3	0.0
10000 - 40000 MHz	1	3	-9.5



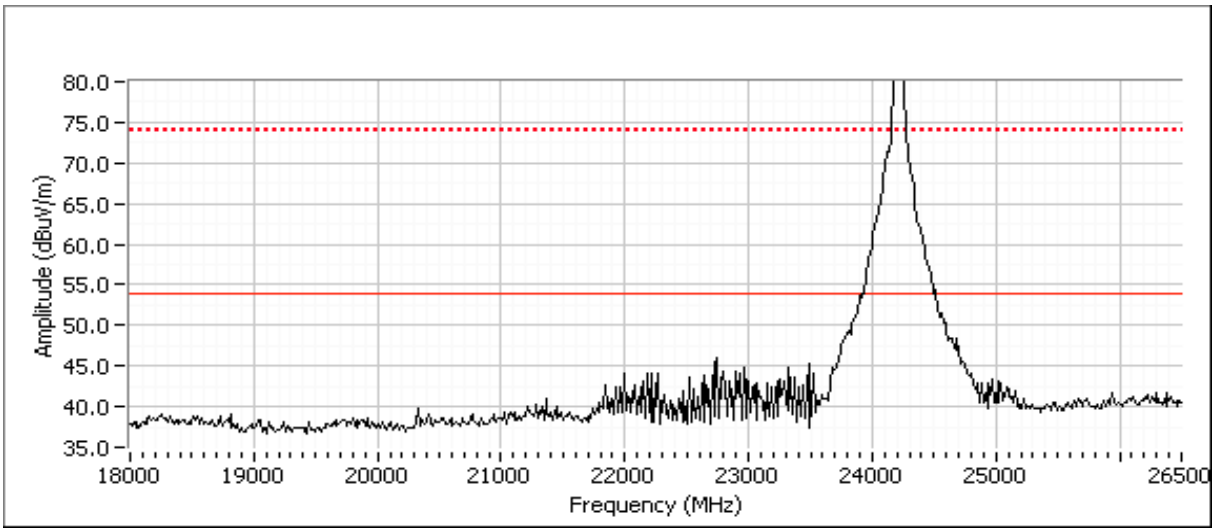


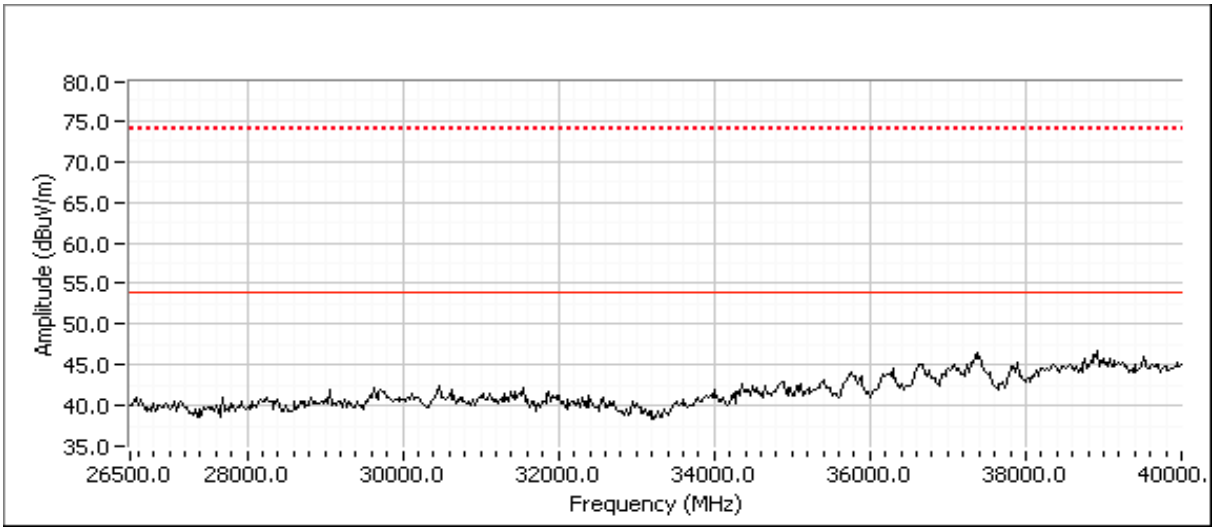
Client:	Ubiquiti Networks	Job Number:	J86893
Model:	AirFiber (24GHz)	T-Log Number:	T86927
		Account Manager:	Michelle Kim
Contact:	Jennifer Sanchez		
Standard:	FCC 15.249, EN 300 440	Class:	A





Client:	Ubiquiti Networks	Job Number:	J86893
Model:	AirFiber (24GHz)	T-Log Number:	T86927
		Account Manager:	Michelle Kim
Contact:	Jennifer Sanchez		
Standard:	FCC 15.249, EN 300 440	Class:	A





Client:	Ubiquiti Networks	Job Number:	J86893
Model:	AirFiber (24GHz)	T-Log Number:	T86927
		Account Manager:	Michelle Kim
Contact:	Jennifer Sanchez		
Standard:	FCC 15.249, EN 300 440	Class:	A

Preliminary peak readings captured during pre-scan (peak readings vs. average limit)

Frequency	Level	Pol	RSS 210 / FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
38.502	39.4	V	40.0	-0.6	Peak	226	2.0	
179.371	45.0	H	43.5	1.5	Peak	6	1.0	
276.559	39.4	V	46.0	-6.6	Peak	226	2.0	
12100.120	45.8	V	54.0	-8.2	Peak	223	1.0	
1797.500	*36.0*	*V*	*54.0*	*-18.0*	*Peak*	*172*	*1.0*	

Frequency Range	Test Distance	Limit Distance	Extrapolation Factor
1000 - 40000 MHz	3	3	0.0

Final peak and average readings

Frequency	Level	Pol	RSS 210 / FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
179.371	43.4	H	43.5	-0.1	QP	10	1.2	QP (1.00s)
38.502	25.8	V	40.0	-14.2	QP	226	1.0	QP (1.00s)
276.559	39.4	V	46.0	-6.6	QP	218	1.9	QP (1.00s)
12099.950	50.1	V	54.0	-3.9	AVG	216	1.0	RB 1 MHz;VB 10 Hz;Peak
12100.070	55.2	V	74.0	-18.8	PK	216	1.0	RB 1 MHz;VB 3 MHz;Peak

Note:	The limit in 15.249 for a fundamental signal in the 24.0-24.25 GHz band is 2500mV/m (128.0 dBuV/m), harmonics are limited to 2500uV/m (68dBuV/m) and all other spurious are required to meet 15.209 limits.
Note:	The field strength of any spurious emissions may not exceed the field strength of the fundamental signal.
Note:	Per 15.249(e), peak field strength along the antenna azimuth is limited to 128 dBuV/m.

Client:	Ubiquiti Networks	Job Number:	J86893
Model:	AirFiber (24GHz)	T-Log Number:	T86927
		Account Manager:	Michelle Kim
Contact:	Jennifer Sanchez		
Standard:	FCC 15.249, EN 300 440	Class:	N/A

FCC Part 15.249
Frequency Stability

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

General Test Configuration

With the exception of the radiated spurious emissions tests, all measurements are made with the EUT's rf port connected to the measurement instrument via an attenuator or dc-block if necessary. All amplitude measurements are adjusted to account for the attenuation between EUT and measuring instrument. For frequency stability measurements the EUT was place inside an environmental chamber.

Radiated measurements are made with the EUT located on a non-conductive table, 3m from the measurement antenna.

Ambient Conditions:

Temperature: 23 °C
Rel. Humidity: 40 %

Summary of Results

Run #	Spacing	Data Rate	Test Performed	Limit	Pass / Fail	Result / Margin
1	-	-	Frequency Stability	FCC 15.249(b)(2)	Pass	Pass

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	Ubiquiti Networks	Job Number:	J86893
Model:	AirFiber (24GHz)	T-Log Number:	T86927
		Account Manager:	Michelle Kim
Contact:	Jennifer Sanchez		
Standard:	FCC 15.249, EN 300 440	Class:	N/A

Run #1: Frequency Stability

Date: 4/16/2012 Engineer: Jack Liu Location: FT Lab#6

Nominal Frequency: 24100 MHz Limit (0.001% of Nominal) (MHz): 0.241

10 ppm

Frequency Stability Over Temperature

The EUT was soaked at each temperature for a minimum of 30 minutes prior to making the measurements to ensure the EUT and chamber had stabilized at that temperature.

Temperature	Frequency Measured	Drift		
(Celsius)	(MHz)	(Hz)	(ppm)	
-20	24100.24	239750	9.9	0.0010%
-10	24100.23	229750	9.5	0.0010%
0	24100.22	224750	9.3	0.0009%
10	24100.18	183150	7.6	0.0008%
20	24100.09	91550	3.8	0.0004%
30	24099.76	-235850	-9.8	-0.0010%
40	24099.83	-171700	-7.1	-0.0007%
50	24099.91	-85850	-3.6	-0.0004%
	Worst case:	239750	9.9	0.0010%

Frequency Stability Over Input Voltage

Nominal Voltage is 120Vdc.

Voltage	Frequency Measured	Drift		
(Dc)	(MHz)	(Hz)	(ppm)	
85%	24100.14	142720	5.9	0.0006%
115%	24100.10	101550	4.2	0.0004%
	Worst case:	142720	5.9	0.0006%

Client:	Ubiquiti Networks	Job Number:	J86893
Model:	AirFiber (24GHz)	T-Log Number:	T86927
		Account Manager:	Michelle Kim
Contact:	Jennifer Sanchez		
Standard:	FCC 15.249, EN 300 440	Class:	A

Conducted Emissions

(Elliott Laboratories Fremont Facility, Semi-Anechoic Chamber)

Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 4/24/2012
Test Engineer: Rafael Varelas
Test Location: Fremont Chamber #4
Config. Used: 1
Config Change: None
EUT Voltage: 120V/60Hz

General Test Configuration

For floor-standing equipment, the EUT was located above a ground plane inside the semi-anechoic chamber, 80 cm from the LISN. A second LISN was used for any local support equipment. Remote support equipment was located outside of the semi-anechoic chamber. Any cables running to remote support equipment where routed through metal conduit and when possible passed through a ferrite clamp upon exiting the chamber.

Ambient Conditions:

Temperature: 20.3 °C
Rel. Humidity: 35 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	CE, AC Power,120V/60Hz	Class A	Pass	54.4 dBµV @ 23.129 MHz (-5.6 dB)

Modifications Made During Testing

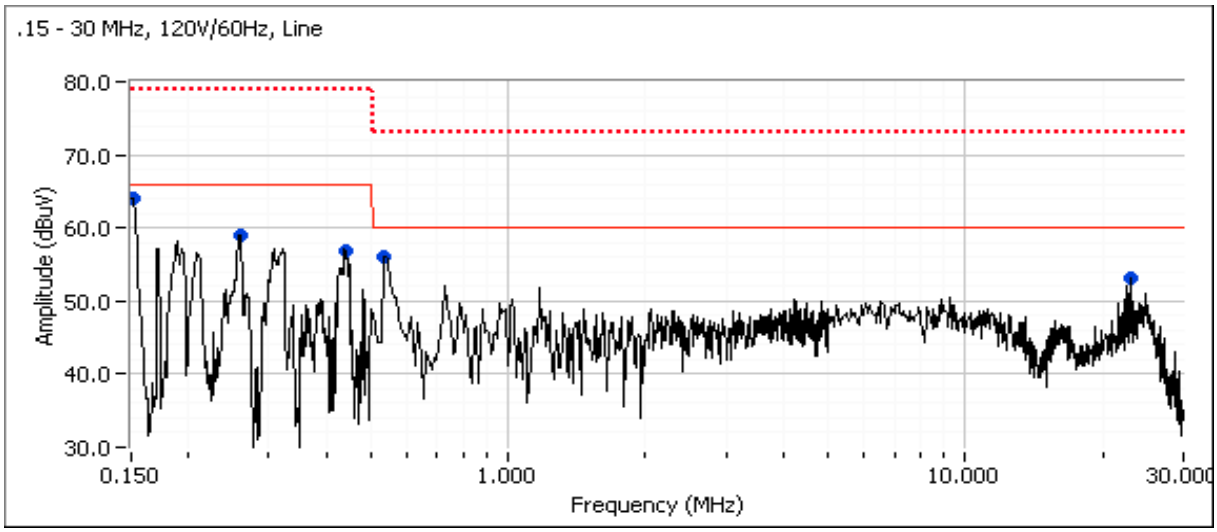
No modifications were made to the EUT during testing

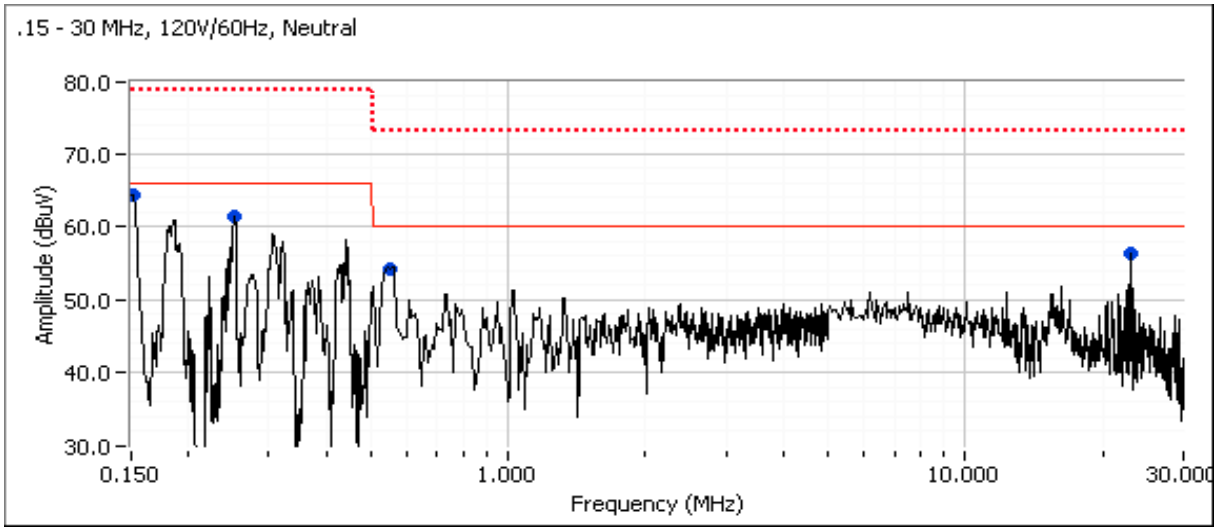
Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	Ubiquiti Networks	Job Number:	J86893
Model:	AirFiber (24GHz)	T-Log Number:	T86927
		Account Manager:	Michelle Kim
Contact:	Jennifer Sanchez		
Standard:	FCC 15.249, EN 300 440	Class:	A

Run #1: AC Power Port Conducted Emissions, 0.15 - 30MHz, 120V/60Hz





Client:	Ubiquiti Networks	Job Number:	J86893
Model:	AirFiber (24GHz)	T-Log Number:	T86927
		Account Manager:	Michelle Kim
Contact:	Jennifer Sanchez		
Standard:	FCC 15.249, EN 300 440	Class:	A

Preliminary peak readings captured during pre-scan (peak readings vs. average limit)

Frequency	Level	AC	Class A		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
0.150	64.0	Line 1	66.0	-2.0	Peak	
0.259	58.9	Line 1	66.0	-7.1	Peak	
0.441	56.9	Line 1	66.0	-9.1	Peak	
0.543	56.0	Line 1	60.0	-4.0	Peak	
23.129	53.1	Line 1	60.0	-6.9	Peak	
0.150	64.4	Neutral	66.0	-1.6	Peak	
0.255	61.3	Neutral	66.0	-4.7	Peak	
0.539	54.1	Neutral	60.0	-5.9	Peak	
23.129	56.3	Neutral	60.0	-3.7	Peak	

Final quasi-peak and average readings

Frequency	Level	AC	Class A		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
23.129	54.4	Neutral	60.0	-5.6	AVG	AVG (0.10s)
23.129	52.8	Line 1	60.0	-7.2	AVG	AVG (0.10s)
0.150	49.1	Neutral	66.0	-16.9	AVG	AVG (0.10s)
23.129	56.0	Neutral	73.0	-17.0	QP	QP (1.00s)
0.539	55.4	Neutral	73.0	-17.6	QP	QP (1.00s)
0.150	48.3	Line 1	66.0	-17.7	AVG	AVG (0.10s)
0.539	42.1	Neutral	60.0	-17.9	AVG	AVG (0.10s)
0.543	41.8	Line 1	60.0	-18.2	AVG	AVG (0.10s)
0.543	54.6	Line 1	73.0	-18.4	QP	QP (1.00s)
23.129	54.6	Line 1	73.0	-18.4	QP	QP (1.00s)
0.255	60.5	Neutral	79.0	-18.5	QP	QP (1.00s)
0.255	44.5	Neutral	66.0	-21.5	AVG	AVG (0.10s)
0.150	55.1	Neutral	79.0	-23.9	QP	QP (1.00s)
0.150	54.5	Line 1	79.0	-24.5	QP	QP (1.00s)

End of Report

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