

EMC Test Report

Application for Grant of Equipment Authorization Class II Permissive Change/Reassessment

FCC Part 15, Subpart E

Model: HR54-700

FCC ID: PGRHR44

APPLICANT: Pace Americas Inc.
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Nevada City, CA 95959

TEST SITE(S): National Technical Systems - Silicon Valley
41039 Boyce Road.
Fremont, CA. 94538-2435

REPORT DATE: May 21, 2015

FINAL TEST DATES: February 11, April 16, 17, 21, 22, 23 and May
7, 2015

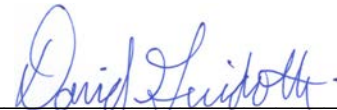
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REVISION HISTORY

Rev#	Date	Comments	Modified By
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SCOPE

An electromagnetic emissions test has been performed on the Pace Americas Inc. model HR54-700, pursuant to the following rules:

FCC Part 15, Subpart E requirements for UNII Devices

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 National Technical Systems - Silicon Valley test procedures:

ANSI C63.10-2009

FCC General UNII Test Procedures KDB789033

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.

The HR54-700 is a variant on the HR44-700, already FCC approved. The 802.11 radio was moved from a separate daughter card to the motherboard. The radio components remained unchanged. In addition, the motherboard was modified to allow for different A/V interface ports. The RF4CE radio was completely unchanged. Based on these changes, only spurious emissions were evaluated. Compliance with FCC Part 15 Subpart B was handled separately.

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.

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 Pace Americas Inc. model HR54-700 complied with the requirements of the following regulations:

FCC Part 15, Subpart E requirements for UNII Devices

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 Pace Americas Inc. model HR54-700 and therefore apply only to the tested sample. The sample was selected and prepared by Mark Rieger of Pace Americas Inc..

DEVIATIONS FROM THE STANDARDS

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

TEST RESULTS SUMMARY

UNII / LELAN DEVICES

Operation in the 5.15 – 5.25 GHz Band

FCC Rule Part	RSS Rule Part	Description	Measured Value / Comments	Limit / Requirement	Result
15.407 (a) (1) (iv)	-	Output Power	Unchanged from original filing		
15.407 (a) (1) (iv)	-	Power Spectral Density			

Operation in the 5.25 – 5.35 GHz Band

FCC Rule Part	RSS Rule Part	Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.407(a) (2)	-	26dB Bandwidth	Unchanged from original filing		
15.407(a) (2)	-	Output Power			
15.407(a) (2)	-	Power Spectral Density			

Operation in the 5.47 – 5.725 GHz Band

FCC Rule Part	RSS Rule Part	Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.407(a) (2)	-	26dB Bandwidth	Unchanged from original filing		
15.407(a) (2)	-	Output Power			
15.407(a) (2)	-	Power Spectral Density			

Operation in the 5.725 – 5.850 GHz Band

FCC Rule Part	RSS Rule Part	Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.407(e)		6dB Bandwidth	Unchanged from original filing		
15.407(a) (3)	-	Output Power			
15.407(a) (3)	-	Power Spectral Density			

Requirements for all U-NII/LELAN bands

FCC Rule Part	RSS Rule Part	Description	Measured Value / Comments	Limit / Requirement	Result
15.407	RSS-210 A9.5a	Modulation	Unchanged from original filing		
15.407(b) (1) and (5) / 15.209	RSS-210 A9.3	Spurious Emissions	52.9 dBμV/m @ 5040.1 MHz (-1.1 dB)	Refer to page 20	Complies
15.407 (c)	RSS-210 A9.5(4)	Operation in the absence of information to transmit	Unchanged from original filing		
15.407 (g)	RSS-210 A9.5 (5)	Frequency Stability			

GENERAL REQUIREMENTS APPLICABLE TO ALL BANDS

FCC Rule Part	RSS Rule part	Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.203	-	RF Connector	Unchanged from current approvals		
15.207	RSS GEN Table 3	AC Conducted Emissions	43.1 dBμV @ 0.436 MHz (-4.0 dB)	Refer to page 19	Complies
15.247 (b) (5) 15.407 (f)	RSS 102	RF Exposure Requirements	Unchanged from current approvals		

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
RF power, conducted (power meter)	dBm	25 to 7000 MHz	± 0.52 dB
RF power, conducted (Spectrum analyzer)	dBm	25 to 7000 MHz	± 0.7 dB
Conducted emission of transmitter	dBm	25 to 26500 MHz	± 0.7 dB
Conducted emission of receiver	dBm	25 to 26500 MHz	± 0.7 dB
Radiated emission (substitution method)	dBm	25 to 26500 MHz	± 2.5 dB
Radiated emission (field strength)	dB μ V/m	25 to 1000 MHz	± 3.6 dB
		1000 to 40000 MHz	± 6.0 dB
Conducted Emissions (AC Power)	dB μ V	0.15 to 30 MHz	± 2.4 dB

EQUIPMENT UNDER TEST (EUT) DETAILS**GENERAL**

The Pace Americas Inc. model HR54-700 is a set-top-box that incorporates 802.11abgn 2x2 and 2.4GHz 802.15.4 radios. Since the EUT would be placed on a tabletop during operation, the EUT was treated as tabletop equipment during testing to simulate the end-user environment. The electrical rating of the EUT is 120 Volts, 60 Hz, 1.3 Amps.

The sample was received on February 11, 2015 and tested on February 11, April 16, 17, 21, 22, 23 and May 7, 2015. The EUT consisted of the following component(s):

Company	Model	Description	Serial Number	FCC ID
Pace Americas	HR54-700	DVR	G54DA5DN000024	PGRHR44
DirecTV	EPS44R3-15	AC/DC Adapter	CL44E1452C2095	N/A

OTHER EUT DETAILS

The wifi and 802.15.4 radios use separate antennas.

The peak gain for the WiFi antennas: 3.3 dBi (2.4GHz), 4.1 dBi (5GHz)

The peak gain for the 802.15.4 antennas: 4.9 dBi (2.4GHz)

EUT uses the same wifi radio as the HR44, with the radio incorporated on to the motherboard. The same firmware and antennas are used.

ENCLOSURE

The EUT enclosure is primarily constructed of plastic. It measures approximately 33 cm wide by 25 cm deep by 5.5 cm high.

MODIFICATIONS

No modifications were made to the EUT during the time the product was at NTS Silicon Valley.

SUPPORT EQUIPMENT

The following equipment was used as support equipment for testing:

Company	Model	Description	Serial Number	FCC ID
Dell	Latitude 131L	Laptop Computer	35271456913	N/A

No remote support equipment was used during testing.

EUT INTERFACE PORTS

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

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
Serial (internal)	Laptop	multiwire	unshielded	2
Power Input	AC/DC Adapter	2 wire	unshielded	2
AC Power (ext supply)	AC Mains	3 wire	unshielded	2
SAT IN	Not connected	-	-	-
AV Out	Not connected	-	-	-
Digital Audio Out (Optical)	Not connected	-	-	-
Digital Audio Out (coax)	Not connected	-	-	-
HDMI	Not connected	-	-	-
Ethernet	Not connected	-	-	-
USB	Not connected	-	-	-
SATA	Not connected	-	-	-

EUT OPERATION

During emissions testing the EUT was transmitting in the mode, on the channel, & at the power called out in the individual tests. For 802.11b mode tests, 2Mb/s was used; MCS0 for n20 and n40. These represented the worse case modes.

Original testing also confirmed that the addition of the interface cables to the EUT did not affect the radio related emissions.

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	Designation / Registration Numbers		Location
	FCC	Canada	
Chamber 4	US0027	2845B-4	41039 Boyce Road Fremont, CA 94538-2435
Chamber 7	US0027	2845B-7	

ANSI C63.4 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.

CONDUCTED EMISSIONS CONSIDERATIONS

Conducted emissions testing is performed in conformance with ANSI C63.10. 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 guidelines and meet the Normalized Site Attenuation (NSA) requirements of ANSI C63.4.

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 C63.10 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 as specified in ANSI C63.4. 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 C63.10, 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.

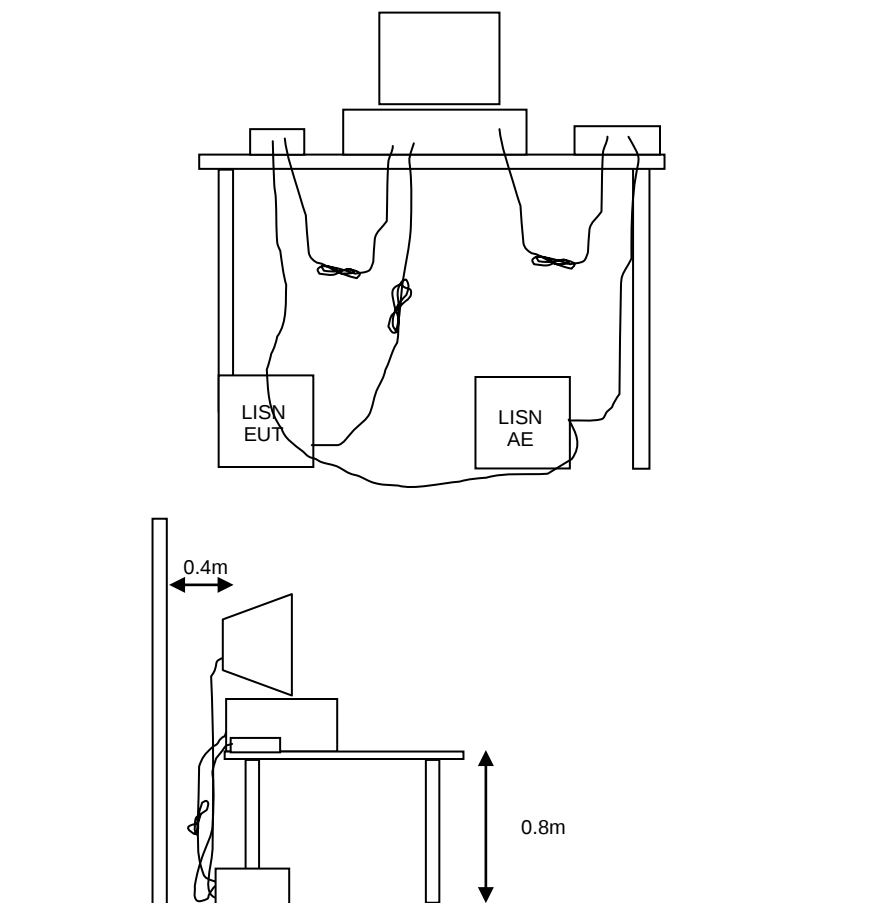


Figure 1 Typical Conducted Emissions Test Configuration

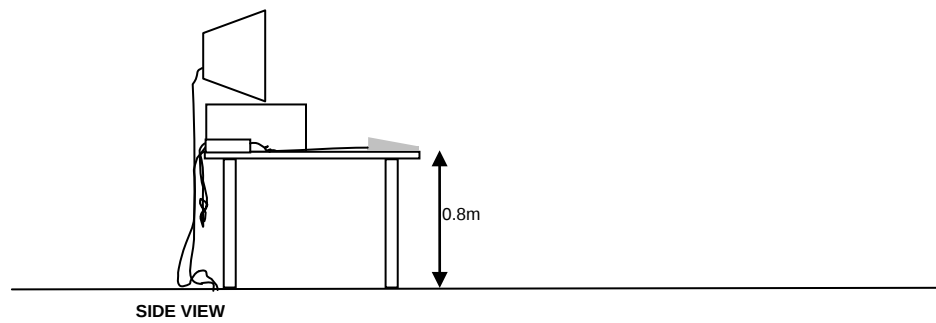
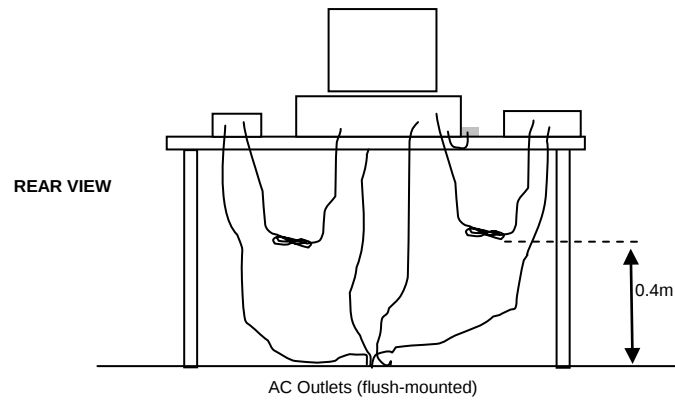
RADIATED EMISSIONS

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.

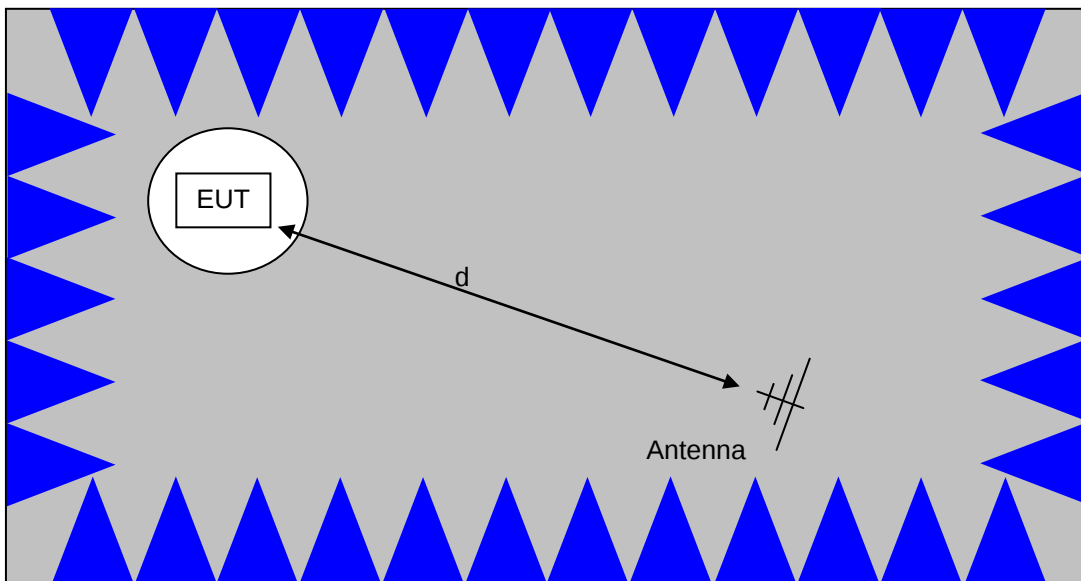
A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

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.

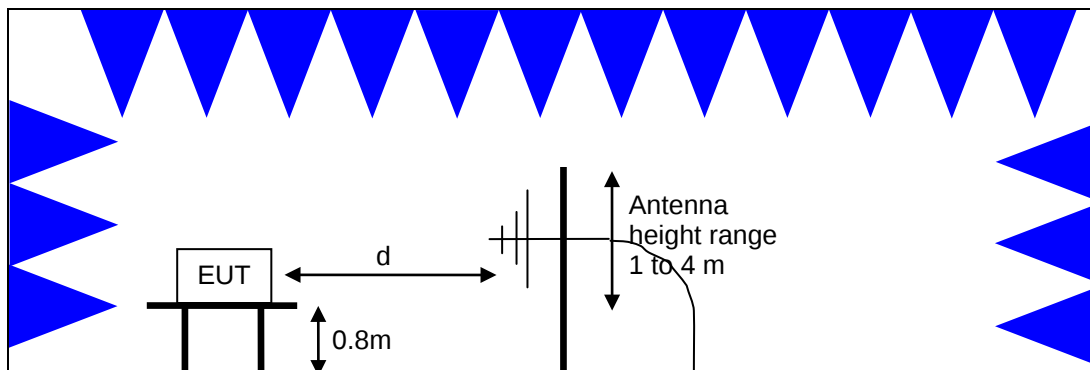


Typical Test Configuration for Radiated Field Strength Measurements



The 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.

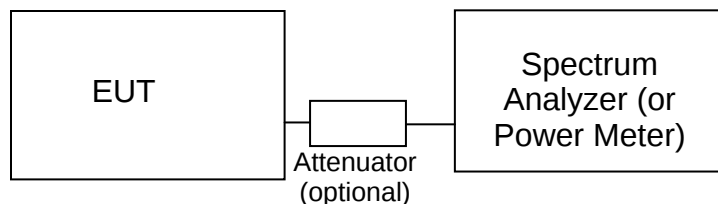
Floor-standing equipment is placed on the floor with insulating supports between the unit and the ground plane.



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

CONDUCTED EMISSIONS FROM ANTENNA PORT

Direct measurements of power, bandwidth and power spectral density are performed, where possible, with the antenna port of the EUT connected to either the power meter or spectrum analyzer via a suitable attenuator and/or filter. These are used to ensure that the front end of the measurement instrument is not overloaded by the fundamental transmission.

**Test Configuration for Antenna Port Measurements**

Measurement bandwidths (video and resolution) are set in accordance with the relevant standards and NTS Silicon Valley's test procedures for the type of radio being tested. When power measurements are made using a resolution bandwidth less than the signal bandwidth the power is calculated by summing the power across the signal bandwidth using either the analyzer channel power function or by capturing the trace data and calculating the power using software. In both cases the summed power is corrected to account for the equivalent noise bandwidth (ENBW) of the resolution bandwidth used.

If power averaging is used (typically for certain digital modulation techniques), the EUT is configured to transmit continuously. Power averaging is performed using either the built-in function of the analyzer or, if the analyzer does not feature power averaging, using external software. In both cases the average power is calculated over a number of sweeps (typically 100). When the EUT cannot be configured to continuously transmit then either the analyzer is configured to perform a gated sweep to ensure that the power is averaged over periods that the device is transmitting or power averaging is disabled and a max-hold feature is used.

If a power meter is used to make output power measurements the sensor head type (peak or average) is stated in the test data table.

BANDWIDTH MEASUREMENTS

The 6dB, 20dB, 26dB and/or 99% signal bandwidth are measured using the bandwidths recommended by ANSI C63.10 and 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 bands¹ (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	$2400/F_{\text{KHz}} @ 300\text{m}$	$67.6-20*\log_{10}(F_{\text{KHz}}) @ 300\text{m}$
0.490-1.705	$24000/F_{\text{KHz}} @ 30\text{m}$	$87.6-20*\log_{10}(F_{\text{KHz}}) @ 30\text{m}$
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

FCC 15.407 (a) OUTPUT POWER LIMITS

The table below shows the limits for output power and output power density. Where the signal bandwidth is less than 20 MHz the maximum output power is reduced to the power spectral density limit plus 10 times the log of the bandwidth (in MHz).

Operating Frequency (MHz)	Output Power	Power Spectral Density
5150 – 5250	250mW (24 dBm)	11 dBm/MHz
5725 – 5855	1 Watts (30 dBm)	30 dBm/500kHz

For system using antennas with gains exceeding 6dBi, the output power and power spectral density limits are reduced by 1dB for every dB the antenna gain exceeds 6dBi.

SPURIOUS EMISSIONS LIMITS –UNII and LELAN DEVICES

The spurious emissions limits for signals below 1GHz are the FCC/RSS-GEN general limits. For emissions above 1GHz, signals in restricted bands are subject to the FCC/RSS GEN general limits. All other signals have a limit of –27dBm/MHz, which is a field strength of 68.3dBuV/m/MHz at a distance of 3m. For devices operating in the 5725-5850Mhz bands under the LELAN/UNII rules, the limit within 10MHz of the allocated band is increased to –17dBm/MHz.

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

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

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

<u>Manufacturer</u>	<u>Description</u>	<u>Model</u>	<u>Asset #</u>	<u>Calibrated</u>	<u>Cal Due</u>
Radiated Emissions, 1,000 - 25,000 MHz, 16-Apr-15					
EMCO	Antenna, Horn, 1-18 GHz	3115	786	12/20/2013	12/20/2015
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	870	2/20/2015	2/20/2016
Hewlett Packard	SpecAn 30 Hz -40 GHz, SV (SA40) Red	8564E (84125C)	1148	9/20/2014	9/20/2015
Micro-Tronics	Band Reject Filter, 2400-2500 MHz	BRM50702-02	2238	9/16/2014	9/16/2015
A. H. Systems	Red System Horn, 18-40GHz	SAS-574, p/n: 2581	2161	7/9/2014	7/9/2015
Radiated Emissions, 1000 - 18,000 MHz, 17-Apr-15					
EMCO	Antenna, Horn, 1-18 GHz	3115	786	12/20/2013	12/20/2015
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	870	2/20/2015	2/20/2016
Hewlett Packard	SpecAn 30 Hz -40 GHz, SV (SA40) Red	8564E (84125C)	1148	9/20/2014	9/20/2015
Micro-Tronics	Band Reject Filter, 5470-5725 MHz	BRC50704-02	1681	8/13/2014	8/13/2015
Micro-Tronics	Band Reject Filter, 5150-5350 MHz	BRC50703-02	2239	9/16/2014	9/16/2015
Radiated Emissions, 1,000 - 11,000 MHz, 17-Apr-15					
EMCO	Antenna, Horn, 1-18 GHz	3115	786	12/20/2013	12/20/2015
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	870	2/20/2015	2/20/2016
Hewlett Packard	SpecAn 30 Hz -40 GHz, SV (SA40) Red	8564E (84125C)	1148	9/20/2014	9/20/2015
Micro-Tronics	Band Reject Filter, 5470-5725 MHz	BRC50704-02	1681	8/13/2014	8/13/2015
Micro-Tronics	Band Reject Filter, 5725-5875 MHz	BRC50705-02	1682	7/15/2014	7/15/2015
Radiated Spurious Emissions, 1000 - 18,000 MHz, 20-Apr-15					
EMCO	Antenna, Horn, 1-18 GHz	3115	786	12/20/2013	12/20/2015
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	870	2/20/2015	2/20/2016
Hewlett Packard	SpecAn 30 Hz -40 GHz, SV (SA40) Red	8564E (84125C)	1148	9/20/2014	9/20/2015
Micro-Tronics	Band Reject Filter, 5725-5875 MHz	BRC50705-02	1682	7/15/2014	7/15/2015
Radiated Emissions, 30 - 40,000 MHz, 21-Apr-15					
EMCO	Antenna, Horn, 1-18 GHz	3115	786	12/20/2013	12/20/2015
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	870	2/20/2015	2/20/2016
Hewlett Packard	SpecAn 30 Hz -40 GHz, SV (SA40) Red	8564E (84125C)	1148	9/20/2014	9/20/2015
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1538	12/20/2014	12/20/2015
Micro-Tronics	Band Reject Filter, 5470-5725 MHz	BRC50704-02	1681	8/13/2014	8/13/2015
Micro-Tronics	Band Reject Filter, 5725-5875 MHz	BRC50705-02	1682	7/15/2014	7/15/2015



<u>Manufacturer</u>	<u>Description</u>	<u>Model</u>	<u>Asset #</u>	<u>Calibrated</u>	<u>Cal Due</u>
Micro-Tronics	Band Reject Filter, 2400-2500 MHz	BRM50702-02	1683	8/4/2014	8/4/2015
Hewlett Packard	High Pass filter, 8.2 GHz (Purple System)	P/N 84300-80039	1767	11/14/2014	11/14/2015
A. H. Systems	Red System Horn, 18-40GHz	SAS-574, p/n: 2581	2161	7/9/2014	7/9/2015
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	2197	2/13/2014	2/13/2016
Micro-Tronics	Band Reject Filter, 5150-5350 MHz	BRC50703-02	2239	9/16/2014	9/16/2015
Hewlett Packard	9KHz-1300MHz pre-amp	8447F	2777	3/4/2015	3/5/2016
Conducted Emissions - AC Power Ports, 22-Apr-15					
EMCO	LISN, 10 kHz-100 MHz	3825/2	1293	2/13/2014	5/13/2015
Rohde & Schwarz	Pulse Limiter	ESH3 Z2	1401	5/15/2014	5/15/2015
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1630	6/21/2014	6/21/2015
Radio Antenna Port (Power and Spurious Emissions), 23-Apr-15					
Agilent Technologies	PSA, Spectrum Analyzer, (installed options, 111, 115, 123, 1DS, B7J, HYX,	E4446A	2139	4/8/2015	4/8/2016
Radiated Emissions, 1,000 - 18,000 MHz, 07-May-15					
EMCO	Antenna, Horn, 1-18 GHz	3115	487	7/29/2014	7/29/2016
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	870	2/20/2015	2/20/2016
Hewlett Packard	SpecAn 30 Hz -40 GHz, SV (SA40) Red	8564E (84125C)	1148	9/20/2014	9/20/2015
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1538	12/20/2014	12/20/2015
Micro-Tronics	Band Reject Filter, 5725-5875 MHz	BRC50705-02	2241	9/16/2014	9/16/2015

Appendix B Test Data

T98161 Pages 26 – 62



EMC Test Data

Client:	Pace Americas, Inc.	Job Number:	J97945
Product	HR54-700	T-Log Number:	T98161
		Project Manager:	Irene Rademacher
Contact:	Mark Rieger	Project Coordinator:	-
Emissions Standard(s):	FCC 15.247 / FCC 15.E (New Rules)	Class:	B
Immunity Standard(s):	-	Environment:	-

EMC Test Data

For The

Pace Americas, Inc.

Product

HR54-700

Date of Last Test: 5/7/2015

Client:	Pace Americas, Inc.	Job Number:	J97945
Model:	HR54-700	T-Log Number:	T98161
Contact:	Mark Rieger	Project Manager:	Irene Rademacher
Standard:	FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator:	-
		Class:	N/A

Power vs. Data Rate

In normal operating modes the card uses power settings stored on EEPROM to set the output power. For a given nominal output power the actual transmit power normally is reduced as the data rate increases, therefore testing was performed at the data rate in the mode with highest power to determine compliance with the requirements.

The following power measurements were made using a **GATED** average power meter and with the device configured in a continuous transmit mode on **Ant 1** at the various data rates in each mode to verify the highest power mode:

Sample Notes

Sample S/N: G33DT4PA003103 (HR44) G54DA5DN000024 (HR54)

Wifi MAC: BC307D5B7E36

Driver: 5.99 RC 188.10

Date of Test: 2/11/2015
 Test Engineer: Jack Liu
 Test Location: FT Chamber# 7

4/16/2015
 Mark Hill
 FT Chamber# 7

Mode	Data Rate	Power (dBm)	Power setting
802.11b	1	24.1 eirp	20.0
	2	24.3 eirp	
	5.5	24.3 eirp	
	11	24.2 eirp	
802.11a Ant 1	9	18.9	19.0
	12	18.9	
	18	18.9	
	24	18.8	
	36	18.8	
	48	18.8	
	54	18.8	

performed radiated - Ant 0

EMC Test Data

Client:	Pace Americas, Inc.	Job Number:	J97945
Model:	HR54-700	T-Log Number:	T98161
Contact:	Mark Rieger	Project Manager:	Irene Rademacher
Standard:	FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator:	-
		Class:	N/A

Mode	Data Rate	Power (dBm)	Power setting
802.11n 20MHz Ant 1	6.5	18.8	19.0
	13	18.8	
	19.5	18.7	
	26	18.7	
	39	18.6	
	52	18.6	
	58.5	18.7	
	65	18.7	
802.11n/ac 40MHz	13.5	18.0	19.0
	27	18.0	
	40.5	18.0	
	54	17.9	
	81	17.9	
	108	17.9	
	121.5	17.9	
	135	17.9	

Note : Power setting - the software power setting used during testing, included for reference only.

Client: Pace Americas, Inc.	Job Number: J97945
Model: HR54-700	T-Log Number: T98161
Contact: Mark Rieger	Project Manager: Irene Rademacher
Standard: FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator: -
	Class: N/A

Duty Cycle

Date of Test: 2/11/2015
 Test Engineer: Jack Liu
 Test Location: FT Chamber# 7

Duty cycle measurements performed on the worse case data rate for power.

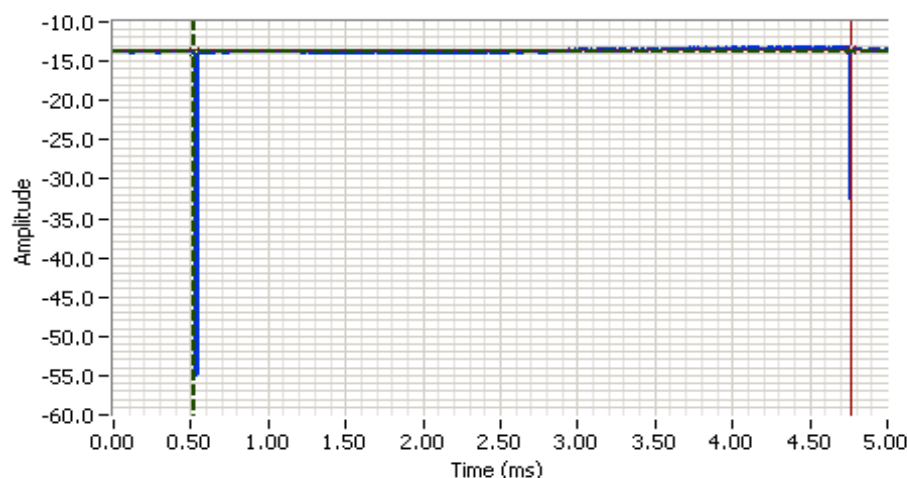
Notes: Measurements taken with maximum RBW/VBW settings allowed.

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
11b	2Mbps	1.00	Yes	4.23	0	0	236
11a	6Mbps	0.99	Yes	1.33	0	0	752
n20	MCS0	0.99	Yes	1.33	0	0	752
n40	MCS0	0.95	Yes	0.362	0.2341445	0.468289	2762

* Correction factor when using RMS/Power averaging - $10 \cdot \log(1/x)$

** Correction factor when using linear voltage average - $20 \cdot \log(1/x)$

T = Minimum transmission duration



Analyzer Settings

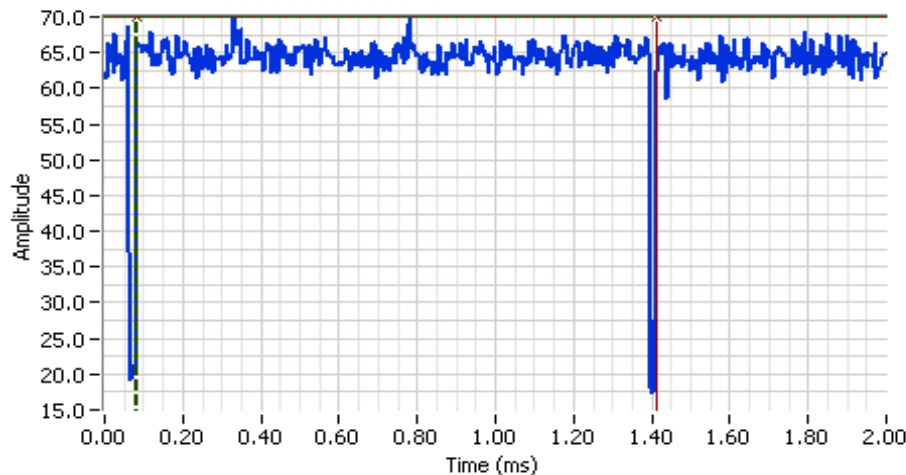
Rohde&Schwarz, ESI
 CF: 2412.000 MHz
 SPAN: 0.000 MHz
 RB: 10.000 MHz
 VB: 10.000 MHz
 Detector: POS
 Attn: 20 DB
 RL Offset: 0.0 DB
 Sweep Time: 5.0ms
 Ref Lvl: -6.0 DBM

Comments

11b - 2Mbps
 Cycle time = Ton = 4.228ms
 Off time = 0.02ms
 Duty Cycle = >99%

Cursor 1	0.5210	-13.85		Delta Time (ms)	4.248
Cursor 1	4.7695	-13.60		Delta Amplitude	0.25

Client: Pace Americas, Inc.	Job Number: J97945
Model: HR54-700	T-Log Number: T98161
Contact: Mark Rieger	Project Manager: Irene Rademacher
Standard: FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator: -
	Class: N/A



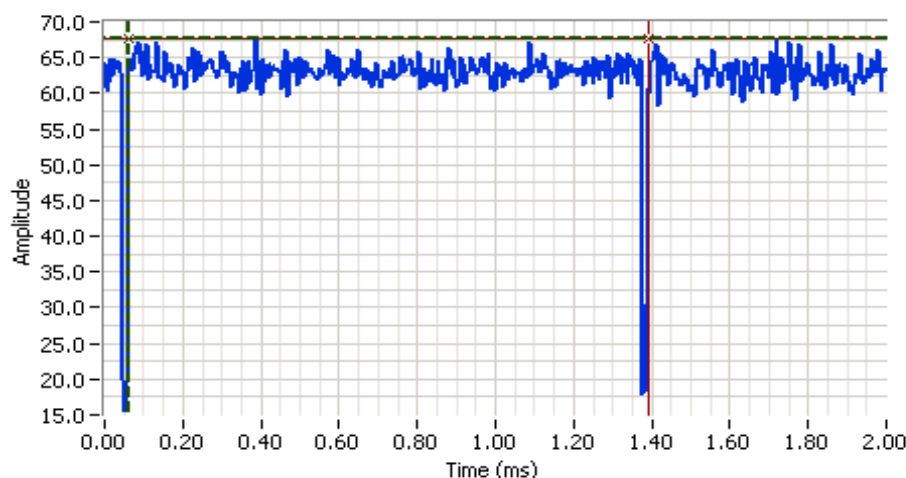
Analyzer Settings

Rohde&Schwarz, ESI
 CF: 5180.000 MHz
 SPAN: 0.000 MHz
 RB: 10.000 MHz
 VB: 10.000 MHz
 Detector: POS
 Attn: 0 DB
 RL Offset: 0.0 DB
 Sweep Time: 2.0ms
 Ref Lvl: 72.0 DBUV

Comments

a
 Cycle Time = 1.330ms
 Off time = 0.018ms
 Duty Cycle = 99%

Cursor 1	0.0825	69.88		Delta Time (ms)	1.330
Cursor 2	1.4124	69.88		Delta Amplitude	0.00



Analyzer Settings

Rohde&Schwarz, ESI
 CF: 5180.000 MHz
 SPAN: 0.000 MHz
 RB: 10.000 MHz
 VB: 10.000 MHz
 Detector: POS
 Attn: 0 DB
 RL Offset: 0.0 DB
 Sweep Time: 2.0ms
 Ref Lvl: 72.0 DBUV

Comments

n20
 Cycle Time = 1.330ms
 Off time = 0.018ms
 Duty Cycle = 99%

Cursor 1	0.0619	67.59		Delta Time (ms)	1.330
Cursor 2	1.3918	67.59		Delta Amplitude	0.00

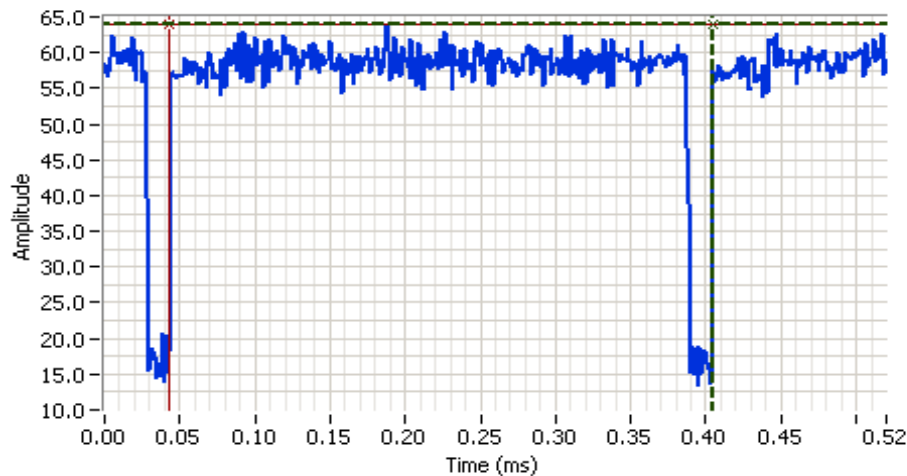


**NTS**

WE ENGINEER SUCCESS

EMC Test Data

Client: Pace Americas, Inc.	Job Number: J97945
Model: HR54-700	T-Log Number: T98161
Contact: Mark Rieger	Project Manager: Irene Rademacher
Standard: FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator: -
	Class: N/A



Analyzer Settings

Rohde&Schwarz, ESI
CF: 5190.000 MHz
SPAN: 0.000 MHz
RB: 10.000 MHz
VB: 10.000 MHz
Detector: POS
Attn: 0 DB
RL Offset: 0.0 DB
Sweep Time: 0.5ms
Ref Lvl: 72.0 DBUV

Comments

n40
Cycle Time = 0.362ms
Off time = 0.019ms
Duty Cycle = 95%

Cursor 1	0.4047	63.90		Delta Time (ms)	0.362
Cursor 2	0.0429	63.90		Delta Amplitude	0.00

**NTS**
WE ENGINEER SUCCESS

Client:	Pace Americas, Inc.	Job Number:	J97945
Model:	HR54-700	T-Log Number:	T98161
Contact:	Mark Rieger	Project Manager:	Irene Rademacher
Standard:	FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator:	-
		Class:	N/A

RSS 210 and FCC 15.407 (UNII) Radiated Spurious 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 and all local support equipment were located on the turntable for radiated spurious emissions testing.
 For radiated emissions testing the measurement antenna was located 3 meters from the EUT, unless otherwise noted.

Ambient Conditions:

Temperature: 20-23 °C
 Rel. Humidity: 28-33 %

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:	Pace Americas, Inc.	Job Number:	J97945
Model:	HR54-700	T-Log Number:	T98161
Contact:	Mark Rieger	Project Manager:	Irene Rademacher
Standard:	FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator:	-
		Class:	N/A

Summary of Results

Run #	Mode	Channel	Power Setting	Measured Power	Test Performed	Limit	Result / Margin
UNII1							
1	n20	36 - 5180MHz	19	21.6	Radiated Emissions, 1 - 40 GHz	FCC 15.209 / 15 E	52.9 dBµV/m @ 5040.1 MHz (-1.1 dB)
		40 - 5200MHz	19	22.3			51.6 dBµV/m @ 5039.9 MHz (-2.4 dB)
		48 - 5240MHz	19	23.3			52.7 dBµV/m @ 5460.0 MHz (-1.3 dB)
UNII2a							
3	n20	52 - 5260MHz	20	22.2	Radiated Emissions, 1 - 40 GHz	FCC 15.209 / 15 E	51.8 dBµV/m @ 5040.2 MHz (-2.2 dB)
		60 - 5300MHz	20	22.3			51.6 dBµV/m @ 5041.7 MHz (-2.4 dB)
		64 - 5320MHz	20	22.4			49.3 dBµV/m @ 5040.1 MHz (-4.7 dB)
UNII2c							
5	n40	102 - 5510MHz	20	21.8	Radiated Emissions, 1 - 40 GHz	FCC 15.209 / 15 E	49.7 dBµV/m @ 4283.3 MHz (-4.3 dB)
		110 - 5550MHz	20	21.9			48.0 dBµV/m @ 5105.6 MHz (-6.0 dB)
		134 - 5670MHz	20	22.5			39.5 dBµV/m @ 7475.1 MHz (-14.5 dB)
UNII3							
7	n20	149 - 5745MHz	20	22.2	Radiated Emissions, 1 - 40 GHz	FCC 15.209 / 15 E	44.8 dBµV/m @ 5410.2 MHz (-9.2 dB)
		157 - 5785MHz	23	25.4			52.7 dBµV/m @ 5418.9 MHz (-1.3 dB)
		165 - 5820MHz	23	25.5			51.4 dBµV/m @ 5425.3 MHz (-2.6 dB)

Client:	Pace Americas, Inc.	Job Number:	J97945
Model:	HR54-700	T-Log Number:	T98161
Contact:	Mark Rieger	Project Manager:	Irene Rademacher
Standard:	FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator:	-
		Class:	N/A

Procedure Comments:

Measurements performed in accordance with FCC KDB 789033

Peak measurements performed with: RBW=1MHz, VBW=3MHz, peak detector, max hold, auto sweep time

Unless otherwise stated/noted, emission has duty cycle $\geq 98\%$ and was measured using RBW=1MHz, VBW=10Hz, peak detector, linear average mode, auto sweep time, max hold.

Sample Notes

Sample S/N: G54DA5DN000024

Driver: 5.99 RC 188.10

Sample Notes

For UNII1 and UNII2a - testing performed in worse case mode (n20) from original testing/filing (J87430/R89420)

For UNII2c - testing performed in worse case mode (n40) from original testing/filing (J87430/R89420)

For UNII3 - testing performed in worse case mode (n20) from original testing/filing (J87430/R89059)

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
11n20	MCS0	0.99	Yes	1.312	0	0	762
11n40	MCS0	0.95	Yes	0.343	0.23	0.47	2915

Measurement Specific Notes:

Note 1:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB $\geq$ 3MHz, peak detector). Per KDB 789033 2) c) (i), compliance can be demonstrated by meeting the average and peak limits of 15.209, as an alternative.
Note 3:	Emission has duty cycle < 98%, but constant, average measurement performed: RBW=1MHz, VBW=10Hz, peak detector, linear averaging, auto sweep, trace average 100 * 1/DC traces, measurement corrected by Linear Voltage correction factor

Client: Pace Americas, Inc.	Job Number: J97945
Model: HR54-700	T-Log Number: T98161
Contact: Mark Rieger	Project Manager: Irene Rademacher
Standard: FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator: -
	Class: N/A

Run #1, Radiated Spurious Emissions, 1,000 - 40,000 MHz. Operation in the 5150-5250 MHz Band

Date of Test: 04/17/15

Test Location: Chamber 7

Test Engineer: John Caizzi

EUT Voltage: 120V / 60Hz

Run #1a: Low Channel

Channel: 36

Mode: n20

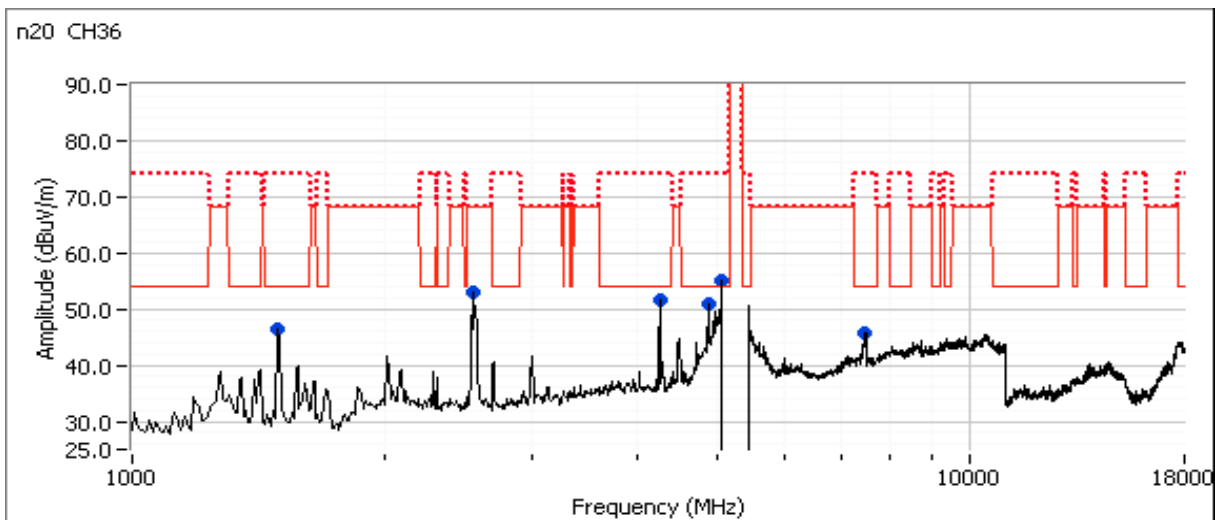
Tx Chain: 2x2

Data Rate: MCS0

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5040.120	52.9	H	54.0	-1.1	AVG	96	1.00	
4880.030	49.8	H	54.0	-4.2	AVG	72	1.00	
5039.800	62.4	H	74.0	-11.6	PK	96	1.00	
7484.670	40.0	V	54.0	-14.0	AVG	34	1.60	
4281.860	39.5	V	54.0	-14.5	AVG	285	1.81	
4276.000	59.4	V	74.0	-14.6	PK	285	1.81	
7471.330	57.7	V	74.0	-16.3	PK	34	1.60	
4880.070	56.8	H	74.0	-17.2	PK	72	1.00	
1498.040	35.7	V	54.0	-18.3	AVG	217	1.94	
1500.200	52.9	V	74.0	-21.1	PK	217	1.94	
2562.470	68.0	V	-	-	PK	90	1.46	Emission in non restricted band

Note: Scans made between 18 - 40 GHz with the measurement antenna moved around the card and its antennas 20-50cm from the device indicated there were no significant emissions in this frequency range

Note 2: For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.



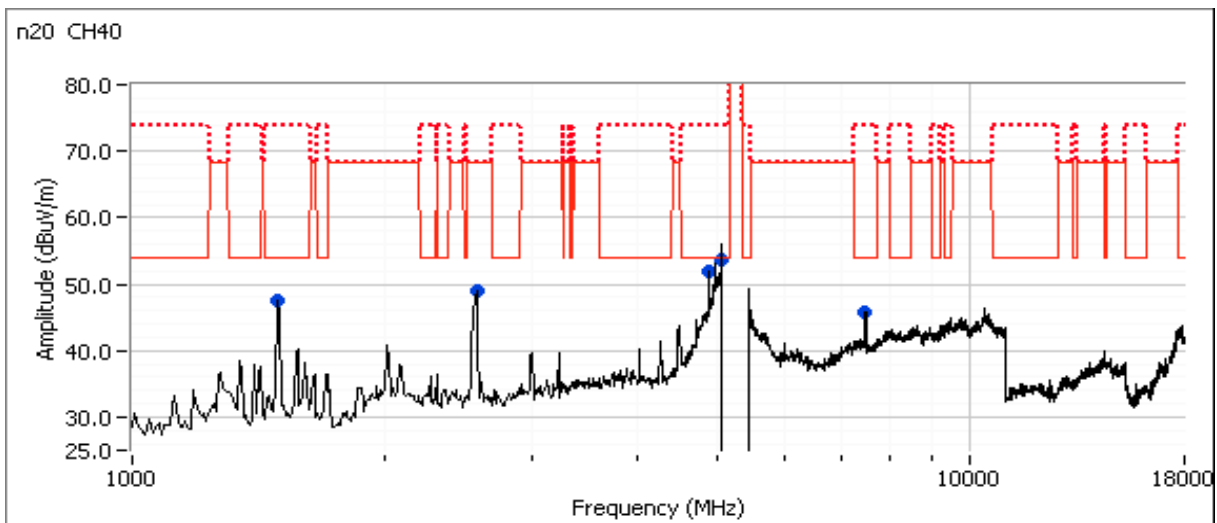
Client: Pace Americas, Inc.	Job Number: J97945
Model: HR54-700	T-Log Number: T98161
Contact: Mark Rieger	Project Manager: Irene Rademacher
Standard: FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator: -
	Class: N/A

Run #1b: Center Channel

Channel: 40 Mode: n20
 Tx Chain: 2x2 Data Rate: MCS0

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5039.940	51.6	H	54.0	-2.4	AVG	87	1.0	Note 4- RB 1 MHz;VB 10 Hz;Peak
4875.000	51.6	H	54.0	-2.4	Peak	68	1.0	Note 4
7500.000	47.4	V	54.0	-6.6	Peak	142	2.0	Note 4
4291.670	46.9	V	54.0	-7.1	Peak	320	2.5	Note 4
1491.670	45.2	V	54.0	-8.8	Peak	29	1.5	Note 4
5057.600	60.2	H	74.0	-13.8	PK	87	1.0	Note 4-RB 1 MHz;VB 3 MHz;Peak
2558.330	48.8	V	-	-	Peak	183	1.5	Note 4

Note:	Scans made between 18 - 40 GHz with the measurement antenna moved around the card and its antennas 20-50cm from the device indicated there were no significant emissions in this frequency range
Note 2:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 4	Measured in run 1a. These emissions do not change with channel, so do not come from the Wi-fi module.



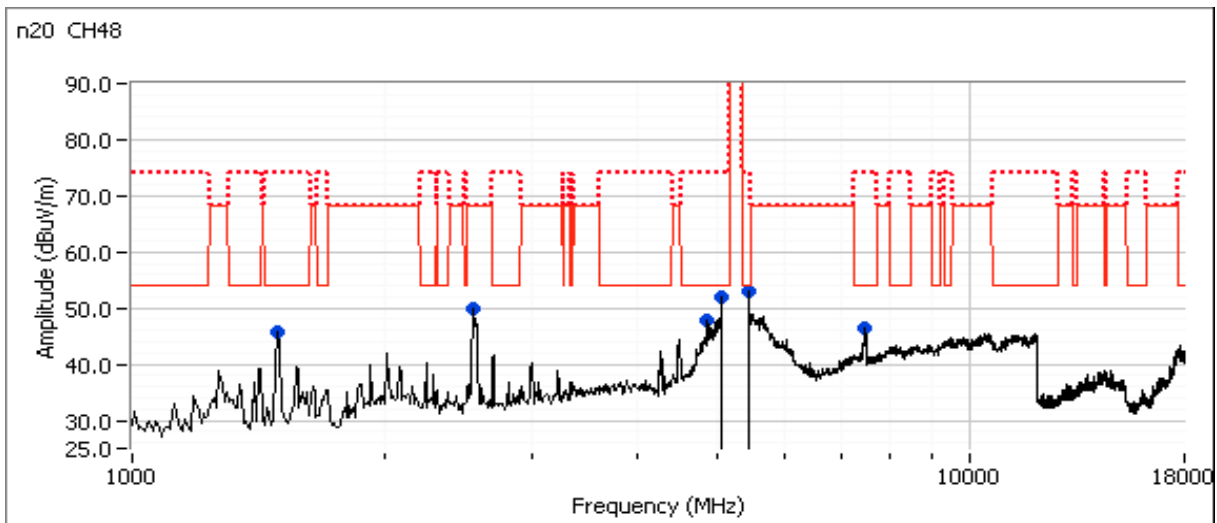
Client: Pace Americas, Inc.	Job Number: J97945
Model: HR54-700	T-Log Number: T98161
Contact: Mark Rieger	Project Manager: Irene Rademacher
Standard: FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator: -
	Class: N/A

Run #1c: High Channel

Channel: 48 Mode: 11n20
 Tx Chain: 2x2 Data Rate: MCS0

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5460.000	52.7	H	54.0	-1.3	AVG	288	1.50	Note 4- RB 1 MHz;VB 10 Hz;Peak
5041.670	51.9	H	54.0	-2.1	Peak	75	1.0	Note 4
4841.670	47.7	H	54.0	-6.3	Peak	53	1.5	Note 4
7460.000	46.6	V	54.0	-7.4	Peak	35	1.5	Note 4
1491.670	45.6	V	54.0	-8.4	Peak	200	2.0	Note 4
5459.750	63.7	H	74.0	-10.3	PK	288	1.50	Note 4-RB 1 MHz;VB 3 MHz;Peak
2558.330	50.0	V	-	-	Peak	42	1.0	Note 4

Note:	Scans made between 18 - 40 GHz with the measurement antenna moved around the card and its antennas 20-50cm from the device indicated there were no significant emissions in this frequency range
Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 4	Measured in run 1a. These emissions do not change with channel, so do not come from the Wi-fi module.



Client: Pace Americas, Inc.	Job Number: J97945
Model: HR54-700	T-Log Number: T98161
Contact: Mark Rieger	Project Manager: Irene Rademacher
Standard: FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator: -
	Class: N/A

Run #3, Radiated Spurious Emissions, 1,000 - 40,000 MHz. Operation in the 5250-5350 MHz Band

Date of Test: 04/17/15

Test Location: Chamber 7

Test Engineer: John Caizzi

EUT Voltage: 120V / 60Hz

Run #3a: Low Channel

Channel: 52

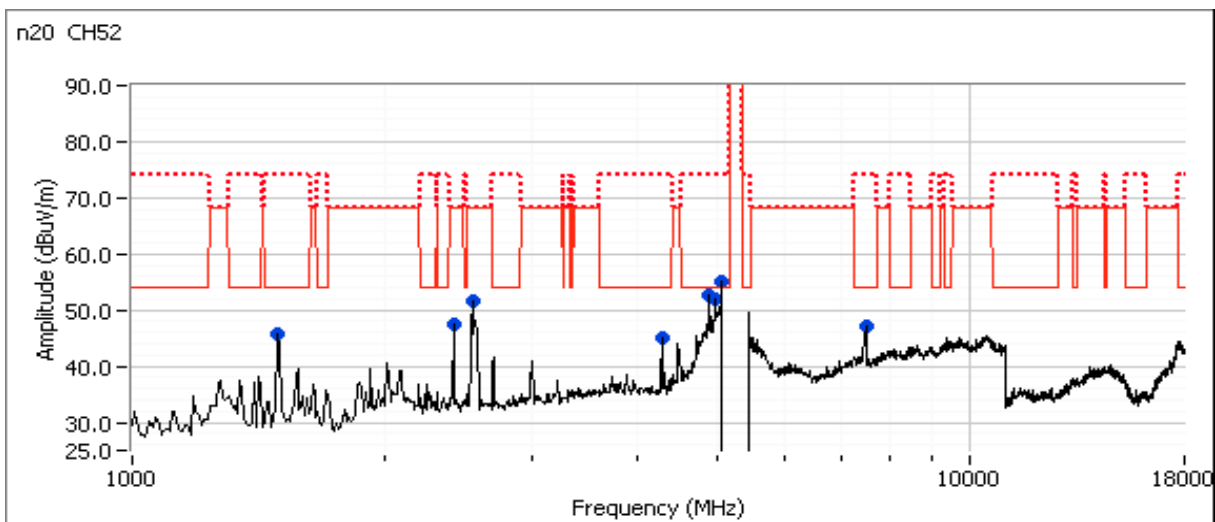
Mode: 11n20

Tx Chain: 2x2

Data Rate: MCS0

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBμV/m	v/h	Limit	Margin	PK/QP/Avg	degrees	meters	
5040.170	51.8	H	54.0	-2.2	AVG	85	1.0	Note 4- RB 1 MHz;VB 10 Hz;Peak
4960.000	49.1	H	54.0	-4.9	AVG	83	1.00	
4880.050	48.7	H	54.0	-5.3	AVG	58	1.0	Note 4- RB 1 MHz;VB 10 Hz;Peak
7500.000	47.0	V	54.0	-7.0	Peak	92	1.5	Note 4- PK reading with AVG limit
1491.670	45.7	V	54.0	-8.3	Peak	31	1.5	Note 4- PK reading with AVG limit
4291.670	44.9	V	54.0	-9.1	Peak	336	2.5	Note 4- PK reading with AVG limit
5040.290	59.1	H	74.0	-14.9	PK	85	1.0	Note 4- RB 1 MHz;VB 3 MHz;Peak
4959.160	59.0	H	74.0	-15.0	PK	83	1.00	
2550.000	51.7	V	-	-	Peak	73	1.5	Note 4
4879.970	55.8	H	74.0	-18.2	PK	58	1.0	Note 4- RB 1 MHz;VB 3 MHz;Peak

Note:	Scans made between 18 - 40 GHz with the measurement antenna moved around the card and its antennas 20-50cm from the device indicated there were no significant emissions in this frequency range
Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 4	Measured in run 1a. These emissions do not change with channel, so do not come from the Wi-fi module.



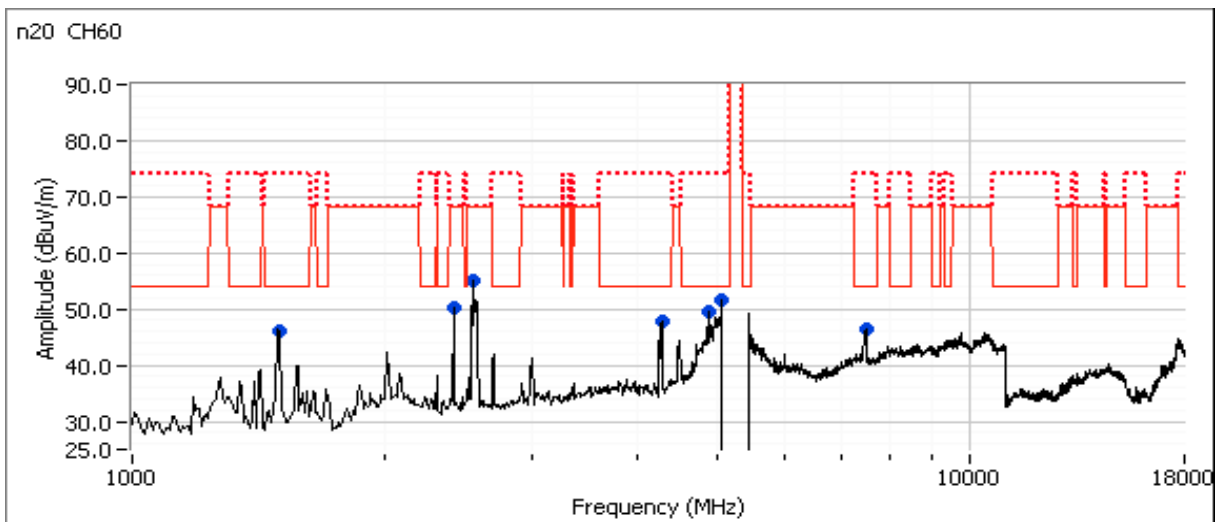
Client: Pace Americas, Inc.	Job Number: J97945
Model: HR54-700	T-Log Number: T98161
Contact: Mark Rieger	Project Manager: Irene Rademacher
Standard: FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator: -
	Class: N/A

Run #3b: Center Channel

Channel: 60 Mode: 11n20
 Tx Chain: 2x2 Data Rate: MCS0

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	PK/QP/Avg	degrees	meters	
5041.670	51.6	H	54.0	-2.4	Peak	54	1.0	Note 4- PK reading with AVG limit
4883.330	49.5	H	54.0	-4.5	Peak	88	1.0	Note 4- PK reading with AVG limit
4283.330	47.9	V	54.0	-6.1	Peak	295	2.5	Note 4- PK reading with AVG limit
7500.000	46.5	V	54.0	-7.5	Peak	346	2.5	Note 4- PK reading with AVG limit
1500.000	46.1	V	54.0	-7.9	Peak	225	2.0	Note 4
2550.000	55.1	V	-	-	Peak	102	1.5	Note 4
2416.670	50.3	H	-	-	Peak	170	2.5	Note 5

Note:	Scans made between 18 - 40 GHz with the measurement antenna moved around the card and its antennas 20-50cm from the device indicated there were no significant emissions in this frequency range
Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 4	Measured in run 1a. These emissions do not change with channel, so do not come from the Wi-fi module.
Note 5	Measured in run 3a. This emission does not change with channel, so does not come from the Wi-fi module.



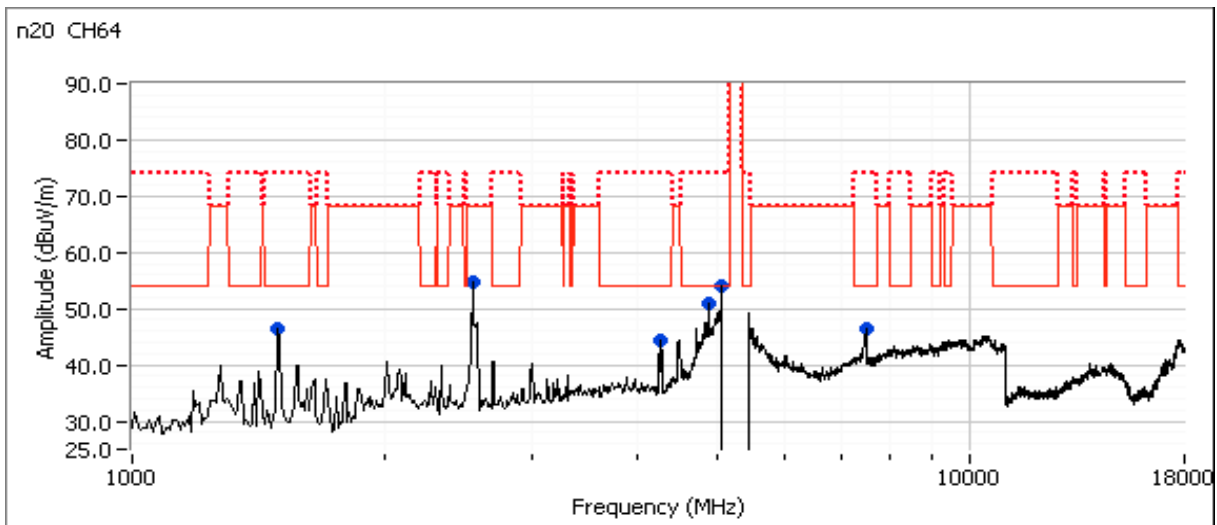
Client: Pace Americas, Inc.	Job Number: J97945
Model: HR54-700	T-Log Number: T98161
Contact: Mark Rieger	Project Manager: Irene Rademacher
Standard: FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator: -
	Class: N/A

Run #3c: High Channel

Channel: 64 Mode: 11n20
Tx Chain: 2x2 Data Rate: MCS0

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	PK/QP/Avg	degrees	meters	
5040.090	49.3	H	54.0	-4.7	AVG	58	1.0	Note 4- RB 1 MHz;VB 10 Hz;Peak
5040.440	57.9	H	74.0	-16.1	PK	58	1.0	Note 4- RB 1 MHz;VB 3 MHz;Peak
1491.670	46.6	V	54.0	-7.4	Peak	232	2.0	Note 4- PK reading with AVG limit
2550.000	54.9	V	-	-	Peak	86	1.5	Note 4
4258.330	44.2	V	54.0	-9.8	Peak	318	1.5	Note 4- PK reading with AVG limit
4875.000	50.8	H	54.0	-3.2	Peak	65	1.0	Note 4- PK reading with AVG limit
7500.000	46.4	V	54.0	-7.6	Peak	354	2.5	Note 4- PK reading with AVG limit

Note:	Scans made between 18 - 40 GHz with the measurement antenna moved around the card and its antennas 20-50cm from the device indicated there were no significant emissions in this frequency range
Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 4	Measured in run 1a. These emissions do not change with channel, so do not come from the Wi-fi module.



Client: Pace Americas, Inc.	Job Number: J97945
Model: HR54-700	T-Log Number: T98161
Contact: Mark Rieger	Project Manager: Irene Rademacher
Standard: FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator: -
	Class: N/A

Run #5, Radiated Spurious Emissions, 1,000 - 40,000 MHz. Operation in the 5470-5725 MHz Band

Date of Test: 04/16/15

Test Location: Chamber #7

Test Engineer: M. Birgani

EUT Voltage: 120V/ 60Hz

Run #5a: Low Channel

Channel: 102

Mode: n40

Power: 20dBm

Tx Chain: 2x2

Data Rate: MCS0

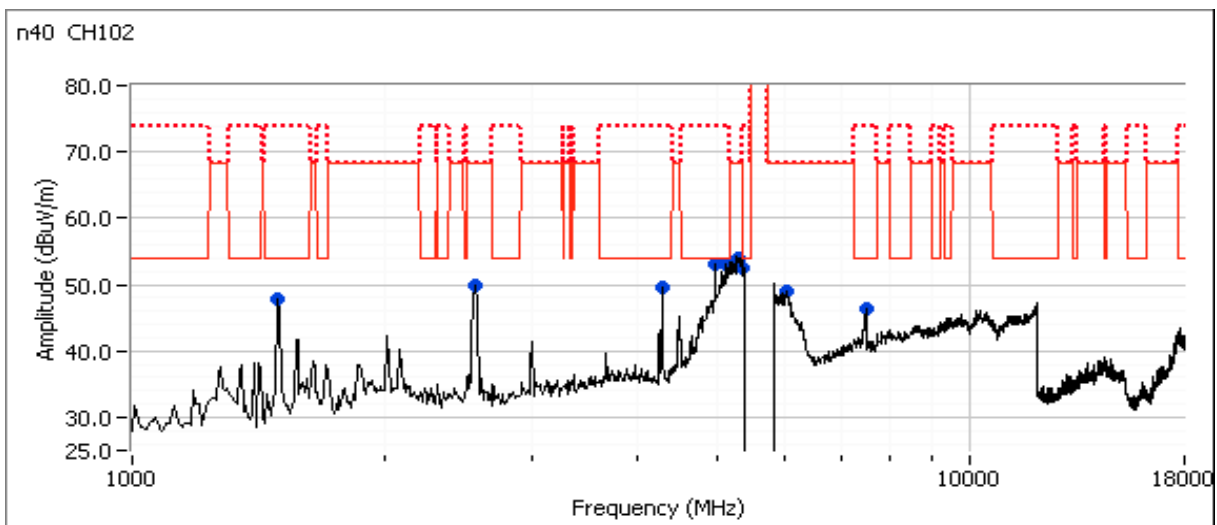
Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4283.330	49.7	V	54.0	-4.3	Peak	296	1.5	Note 4- PK reading with AVG limit
5120.140	48.7	H	54.0	-5.3	AVG	50	1.0	Note 4- RB 1 MHz;VB 10 Hz;Peak
1491.670	47.7	V	54.0	-6.3	Peak	31	2.0	Note 4- PK reading with AVG limit
7500.000	46.4	V	54.0	-7.6	Peak	96	1.5	Note 4- PK reading with AVG limit
5275.000	54.0	V	-	-	Peak	44	1.0	
5120.600	57.1	H	74.0	-16.9	PK	50	1.0	Note 4- RB 1 MHz;VB 3 MHz;Peak
2566.670	49.9	V	-	-	Peak	38	1.0	Note 4
6040.000	48.9	H	-	-	Peak	272	1.5	Emission in non restricted band

Note: Scans made between 18 - 40 GHz with the measurement antenna moved around the card and its antennas 20-50cm from the device indicated there were no significant emissions in this frequency range

Note 1: For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.

Note 4: Measured in run 1a. These emissions do not change with channel, so do not come from the Wi-fi module.

Note 5: Measured in run 3a. This emission does not change with channel, so does not come from the Wi-fi module.



Client: Pace Americas, Inc.	Job Number: J97945
Model: HR54-700	T-Log Number: T98161
Contact: Mark Rieger	Project Manager: Irene Rademacher
Standard: FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator: -
	Class: N/A

Run #5b: Center Channel

Channel: 110

Mode: n40

Power: 20dBm

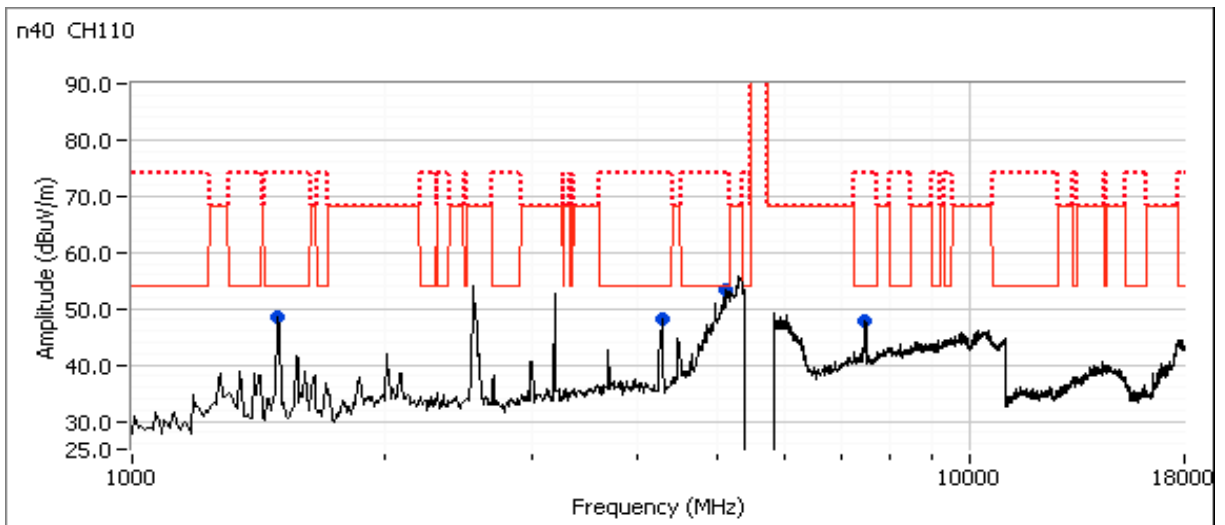
Tx Chain: 2x2

Data Rate: MCS0

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5105.620	48.0	H	54.0	-6.0	AVG	57	1.6	RB 1 MHz;VB 10 Hz;Peak
5091.220	60.2	H	74.0	-13.8	PK	57	1.6	RB 1 MHz;VB 3 MHz;Peak
7475.380	39.3	V	54.0	-14.7	AVG	356	2.2	RB 1 MHz;VB 10 Hz;Peak
1494.340	38.6	V	54.0	-15.4	AVG	19	2.2	RB 1 MHz;VB 10 Hz;Peak
7477.280	58.2	V	74.0	-15.8	PK	356	2.2	RB 1 MHz;VB 3 MHz;Peak
4252.450	56.3	V	74.0	-17.7	PK	240	1.3	RB 1 MHz;VB 3 MHz;Peak
4268.220	34.9	V	54.0	-19.1	AVG	240	1.3	RB 1 MHz;VB 10 Hz;Peak
1493.140	53.9	V	74.0	-20.1	PK	19	2.2	RB 1 MHz;VB 3 MHz;Peak

Note: Scans made between 18 - 40 GHz with the measurement antenna moved around the card and its antennas 20-50cm from the device indicated there were no significant emissions in this frequency range

Note 1: For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.



Client: Pace Americas, Inc.	Job Number: J97945
Model: HR54-700	T-Log Number: T98161
Contact: Mark Rieger	Project Manager: Irene Rademacher
Standard: FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator: -
	Class: N/A

Run #5c: High Channel

Channel: 134

Mode: n40

Power: 20dBm

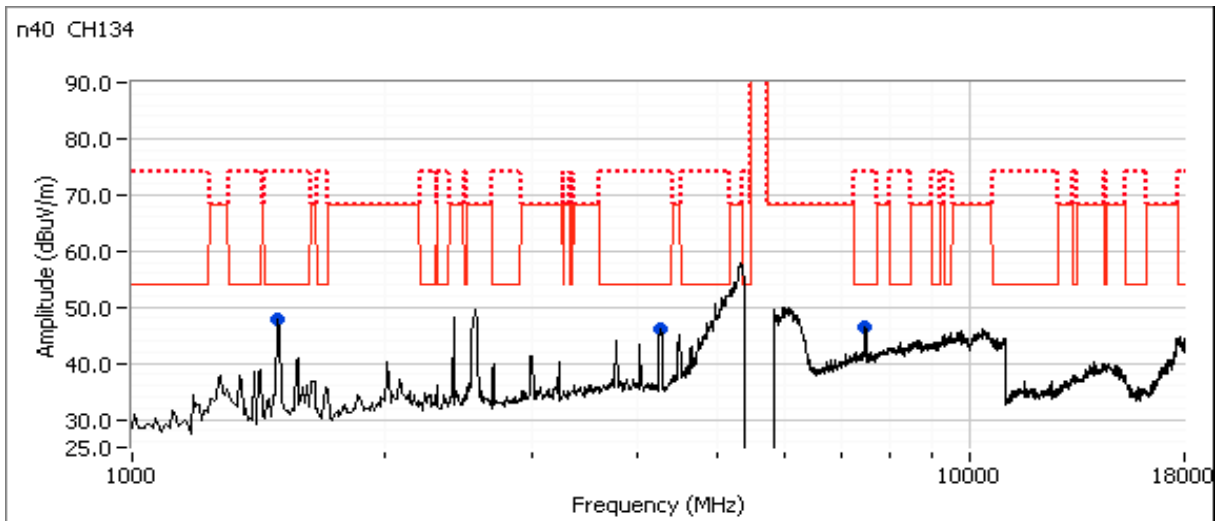
Tx Chain: 2x2

Data Rate: MCS0

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	PK/QP/Avg	degrees	meters	
7475.070	39.5	V	54.0	-14.5	AVG	34	1.6	RB 1 MHz;VB 10 Hz;Peak
7463.000	59.2	V	74.0	-14.8	PK	34	1.6	RB 1 MHz;VB 3 MHz;Peak
4281.000	58.6	V	74.0	-15.4	PK	308	1.9	RB 1 MHz;VB 3 MHz;Peak
1495.100	38.4	V	54.0	-15.6	AVG	134	1.6	RB 1 MHz;VB 10 Hz;Peak
4277.930	35.5	V	54.0	-18.5	AVG	308	1.9	RB 1 MHz;VB 10 Hz;Peak
1493.140	53.0	V	74.0	-21.0	PK	134	1.6	RB 1 MHz;VB 3 MHz;Peak

Note: Scans made between 18 - 40 GHz with the measurement antenna moved around the card and its antennas 20-50cm from the device indicated there were no significant emissions in this frequency range

Note 1: For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.



Client: Pace Americas, Inc.	Job Number: J97945
Model: HR54-700	T-Log Number: T98161
Contact: Mark Rieger	Project Manager: Irene Rademacher
Standard: FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator: -
	Class: N/A

Run #7, Radiated Spurious Emissions, 1,000 - 40,000 MHz. Operation in the 5725-5850 MHz Band

Date of Test: 04/16/15

Test Location: Chamber #7

Test Engineer: M. Birgani

EUT Voltage: 120V/ 60Hz

Run #7a: Center Channel

Channel: 149

Mode: n20

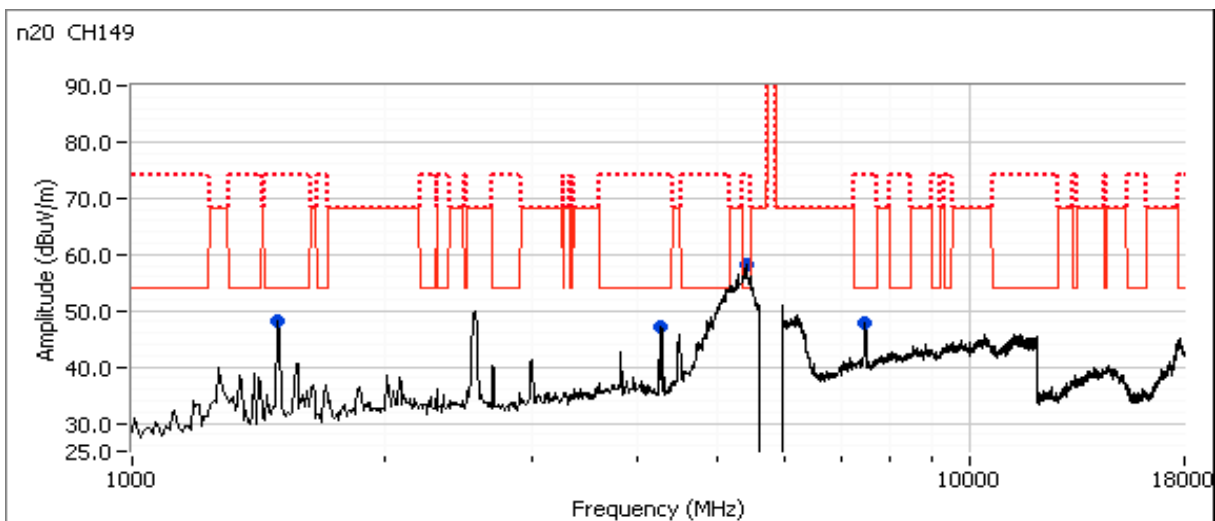
Power: 20

Tx Chain: 2x2

Data Rate: MCS0

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5410.200	44.8	H	54.0	-9.2	AVG	275	1.0	Note 6: RB 1 MHz;VB 10 Hz;Peak
5404.600	61.8	H	74.0	-12.2	PK	275	1.0	Note 6: RB 1 MHz;VB 3 MHz;Peak
7474.700	38.9	V	54.0	-15.1	AVG	33	1.6	RB 1 MHz;VB 10 Hz;Peak
7466.840	58.4	V	74.0	-15.6	PK	33	1.6	RB 1 MHz;VB 3 MHz;Peak
1494.170	37.9	V	54.0	-16.1	AVG	16	1.6	RB 1 MHz;VB 10 Hz;Peak
4267.740	34.7	V	54.0	-19.3	AVG	256	1.3	RB 1 MHz;VB 10 Hz;Peak
4269.800	54.7	V	74.0	-19.3	PK	256	1.3	RB 1 MHz;VB 3 MHz;Peak
1492.840	53.4	V	74.0	-20.6	PK	16	1.6	RB 1 MHz;VB 3 MHz;Peak

Note:	Scans made between 18 - 40 GHz with the measurement antenna moved around the card and its antennas 20-50cm from the device indicated there were no significant emissions in this frequency range
Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 2:	For emissions outside of the restricted bands the limit is -27dBm/MHz eirp (68.3dBuV/m). The measurement method required is a peak measurement (RB=1MHz, VB≥3MHz, peak detector).
Note 6:	Measured with band reject filter removed.



Client: Pace Americas, Inc.	Job Number: J97945
Model: HR54-700	T-Log Number: T98161
Contact: Mark Rieger	Project Manager: Irene Rademacher
Standard: FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator: -
	Class: N/A

Run #7b: Center Channel

Date of Test: 05/07/15

Test Engineer: M. Birgani

Test Location: Chamber #7

EUT Voltage: 120V/ 60Hz

Channel: 157

Mode: n20

Power: 23

Tx Chain: 2x2

Data Rate: MCS0

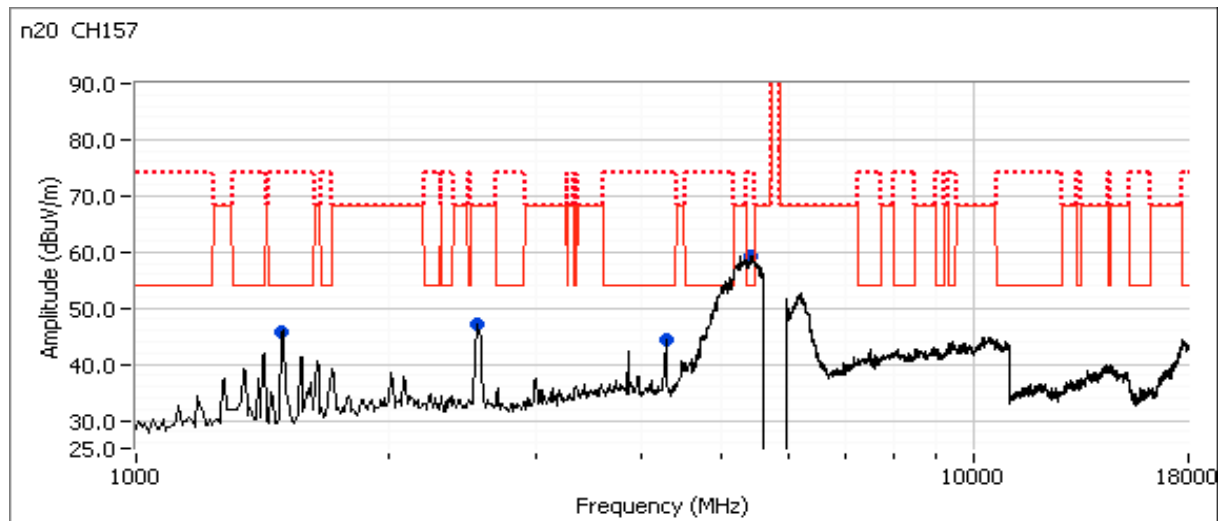
Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5418.920	52.7	H	54.0	-1.3	AVG	274	1.0	Note 6: POS; RB 1 MHz; VB: 10 Hz
1491.670	45.9	V	54.0	-8.1	Peak	194	1.5	PK reading w/ Avg limit
5419.830	64.5	H	74.0	-9.5	PK	274	1.0	Note 6: POS; RB 1 MHz; VB: 3 MHz
4291.670	44.4	V	54.0	-9.6	Peak	287	1.3	PK reading w/ Avg limit
2558.330	47.3	V	-	-	Peak	114	1.3	Note 4

Note: Scans made between 18 - 40 GHz with the measurement antenna moved around the card and its antennas 20-50cm from the device indicated there were no significant emissions in this frequency range

Note 4: Measured in run 1a. These emissions do not change with channel, so do not come from the Wi-fi module.

Note 5: Measured in run 3a. This emission does not change with channel, so does not come from the Wi-fi module.

Note 6: Measured with band reject filter removed.



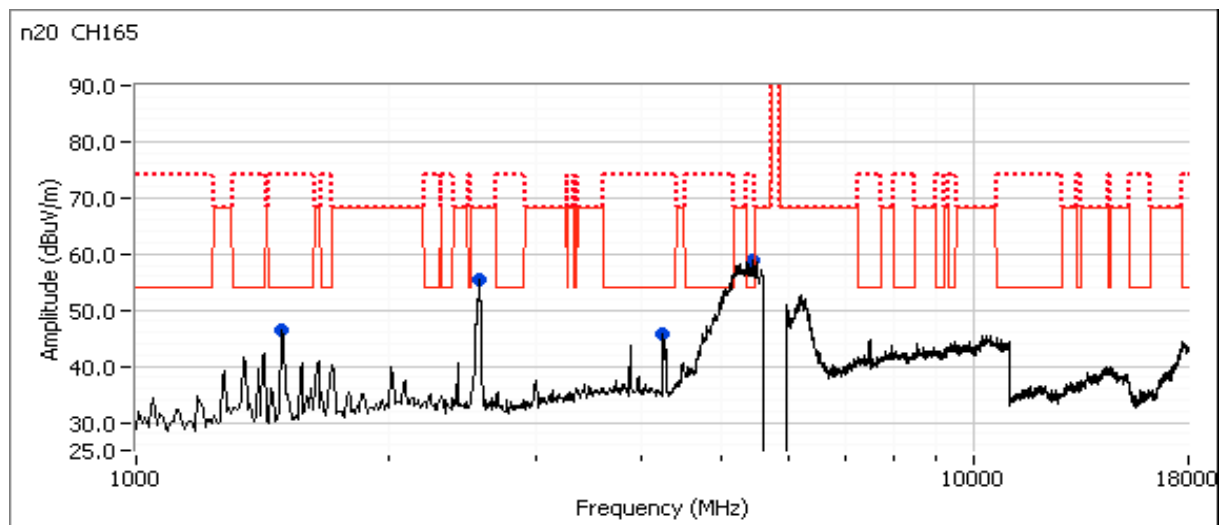
Client: Pace Americas, Inc.	Job Number: J97945
Model: HR54-700	T-Log Number: T98161
Contact: Mark Rieger	Project Manager: Irene Rademacher
Standard: FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator: -
	Class: N/A

Run #7c: Center Channel

Channel: 165 Mode: n20 Power: 23
 Tx Chain: 2x2 Data Rate: MCS0

Frequency	Level	Pol	15.209 / 15E		Detector	Azimuth	Height	Comments
MHz	dBμV/m	v/h	Limit	Margin	PK/QP/Avg	degrees	meters	
5425.340	51.4	H	54.0	-2.6	AVG	272	1.0	Note 6: POS; RB 1 MHz; VB: 10 Hz
1491.670	46.4	V	54.0	-8.4	Peak	204	2.0	PK reading w/ Avg limit
5427.380	65.0	H	74.0	-9.0	PK	272	1.0	Note 6: POS; RB 1 MHz; VB: 3 MHz
2566.670	55.4	V	-	-	Peak	105	1.0	Note 4
4250.000	45.8	V	54.0	-21.1	Peak	290	1.3	PK reading w/ Avg limit

Note:	Scans made between 18 - 40 GHz with the measurement antenna moved around the card and its antennas 20-50cm from the device indicated there were no significant emissions in this frequency range
Note 1:	For emissions in restricted bands, the limit of 15.209 was used which requires average and peak measurements.
Note 4:	Measured in run 1a. These emissions do not change with channel, so do not come from the Wi-fi module.
Note 6:	Measured with band reject filter removed.
Note 7:	Measured in run 7b.



Client: Pace Americas, Inc.	Job Number: J97945
Model: HR54-700	T-Log Number: T98161
Contact: Mark Rieger	Project Manager: Irene Rademacher
Standard: FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator: -
	Class: N/A

RSS-210 (LELAN) and FCC 15.407(UNII)

Antenna Port Measurements

Power, PSD, Peak Excursion, Bandwidth and Spurious 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.

Date of Test: 4/23/2015
 Test Engineer: M. Birgani
 Test Location: Lab #4A

Config. Used: Conducted
 Config Change: -
 EUT Voltage: 120V/60Hz

General Test Configuration

When measuring the conducted emissions from the EUT's antenna port, the antenna port of the EUT was connected to the spectrum analyzer or power meter via a suitable attenuator to prevent overloading the measurement system. All measurements are corrected to allow for the external attenuators and cables used.

Ambient Conditions:

Temperature:	18 °C
Rel. Humidity:	32 %

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.

Summary of Results

Run #	Test Performed	Limit	Pass / Fail	Result / Margin
1	Power, 5150 - 5250MHz	15.407(a) (1), (2)	PASS	n20: 22.3 dBm
1	Power, 5250 - 5350MHz	15.407(a) (1), (2)	PASS	n20: 22.4 dBm
1	Power, 5470 - 5725MHz	15.407(a) (1), (2)	PASS	n40: 22.5 dBm
1	Power, 5725 - 5850MHz	15.407(a) (1), (2)	PASS	n20: 25.5 dBm

Client:	Pace Americas, Inc.	Job Number:	J97945
Model:	HR54-700	T-Log Number:	T98161
Contact:	Mark Rieger	Project Manager:	Irene Rademacher
Standard:	FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator:	-
		Class:	N/A

Procedure Comments:

Measurements performed in accordance with FCC KDB 789033 D01 v01r03, dated April 8, 2013

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
11n20	MCS0	99%	Yes	1.312	0	0	762
11n40	MCS0	95%	Yes	0.343	0.23	0.47	2915

Sample Notes

Sample S/N: G54DA5DN000024
 Driver: 5.99 RC 188.10

Sample Notes

Only output power in the worse case spurious emissions mode was measured to compare to original approval
 For UNII1 - testing performed in worse case mode (n20) from C2PC testing/filing (J97522/R97561)
 For UNII2a - testing performed in worse case mode (n20) from original testing/filing (J87430/R89420)
 For UNII2c - testing performed in worse case mode (n40) from original testing/filing (J87430/R89420)
 For UNII3 - testing performed in worse case mode (n20) from C2PC testing/filing (J97522/R97561)
 Power measurements to show that the power used during the radiated measurements, met or exceeded the original approved power levels.

Note 1:	For 11n20 - Output power measured using a spectrum analyzer (see plots below). RBW=1MHz, VB=3 MHz, # of points in sweep $\geq 2 \times \text{span} / \text{RBW}$, RMS detector, power averaging on (transmitted signal was continuous) and power integration.
Note 1:	For 11n40 - Output power measured using a spectrum analyzer (see plots below). RBW=1MHz, VB=3 MHz, # of points in sweep $\geq 2 \times \text{span} / \text{RBW}$, RMS detector, trace average 100 traces, power averaging on (transmitted signal was not continuous) and power integration. As the duty cycle is <98%, the measurements were adjusted by adding the Pwr Cor factor.
Note 2:	Measured using the same analyzer settings used for output power.
Note 5:	For MIMO systems the total output power and total PSD are calculated from the sum of the powers of the individual chains (in linear terms). The antenna gain used to determine the EIRP and limits for PSD/Output power depends on the operating mode of the MIMO device. If the signals on the non-coherent between the transmit chains then the gain used to determine the limits is the highest gain of the individual chains and the EIRP is the sum of the products of gain and power on each chain. If the signals are coherent then the effective antenna gain is the sum (in linear terms) of the gains for each chain and the EIRP is the product of the effective gain and total power.

EMC Test Data

Client:	Pace Americas, Inc.	Job Number:	J97945
Model:	HR54-700	T-Log Number:	T98161
Contact:	Mark Rieger	Project Manager:	Irene Rademacher
Standard:	FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator:	-
		Class:	N/A

Antenna Gain Information

Freq	Antenna Gain (dBi) / Chain				BF	MultiChain Legacy	CDD	Sectorized / Xpol	Dir G (PWR)	Dir G (PSD)
	1	2	3	4						
5150-5250	4.1	4.1			No	No	Yes	No	4.1	7.1
5250-5350	4.1	4.1			No	No	Yes	No	4.1	7.1
5470-5725	4.1	4.1			No	No	Yes	No	4.1	7.1
5725-5825	4.1	4.1			No	No	Yes	No	4.1	7.1

For devices that support CDD modes

Min # of spatial streams: 1
 Max # of spatial streams: 2

Notes:	BF = beamforming mode supported, Multichain Legacy = 802.11 legacy data rates supported for multichain transmissions, CDD = Cyclic Delay Diversity (or Cyclic Shift Diversity) modes supported, Sectorized / Xpol = antennas are sectorized or cross polarized.
Notes:	Dir G (PWR) = total gain (Gant + Array Gain) for power calculations; GA (PSD) = total gain for PSD calculations based on FCC KDB 662911. Depending on the modes supported, the Array Gain value for power could be different from the PSD value.
Notes:	Array gain for power/psd calculated per DKB 662911 D01, v01r02. Spatial Multiplexing with Nant=4, Nss=2, for worse case condition. Array gain = $10 \cdot \log(4/2) = 3\text{dB}$.
Notes:	For systems with Beamforming and CDD, choose one the following options: Option 1: Delays are optimized for beamforming, rather than being selected from cyclic delay table of 802.11; Array gains calculated based on beamforming criteria. Option 2: Antennas are paired for beamforming, and the pairs are configured to use the cyclic delay diversity of 802.11; the array gain associated with beamforming with 2 antennas (3dB), and the array gain associated with CDD with two antennas (3dB for PSD and 0 dB for power)

Client:	Pace Americas, Inc.	Job Number:	J97945
Model:	HR54-700	T-Log Number:	T98161
Contact:	Mark Rieger	Project Manager:	Irene Rademacher
Standard:	FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator:	-
		Class:	N/A

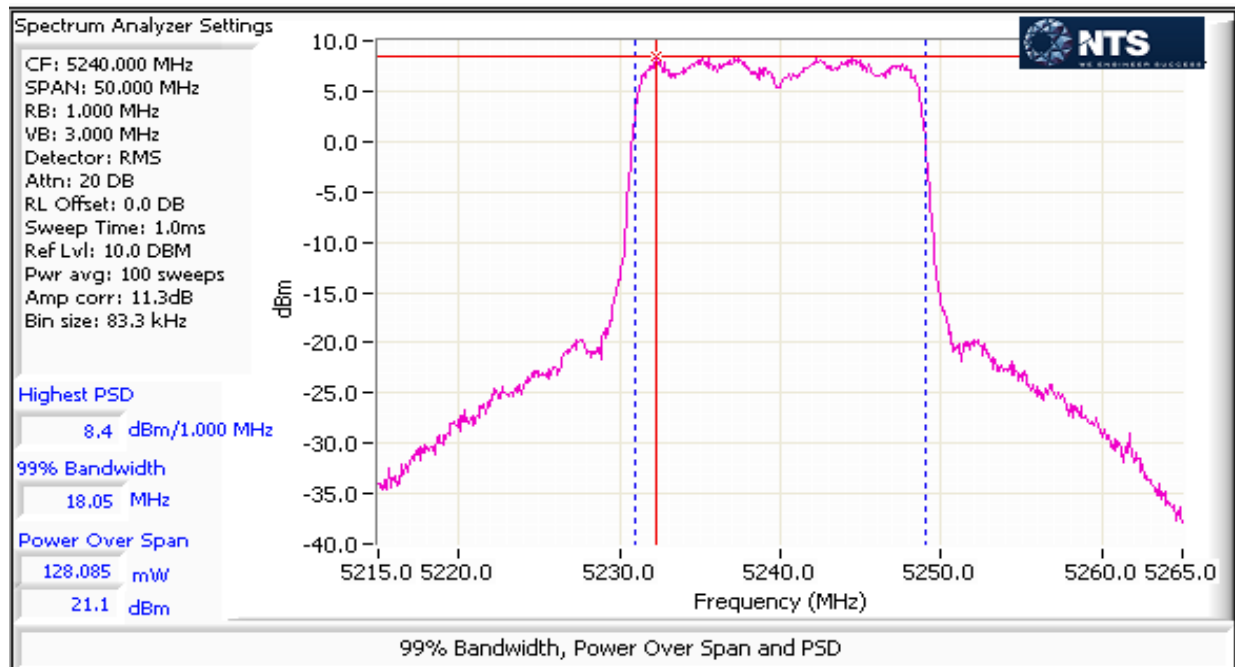
Run #1: Bandwidth, Output Power and Power Spectral Density - MIMO Systems

MIMO Device - 5150-5250 MHz Band - FCC

Mode: n20

Max EIRP (mW): 555.00324

Frequency (MHz)	Chain	Software Setting	26dB BW (MHz)	Duty Cycle %	Power ¹ dBm	Total Power		Orig. Pwr dBm	Max Power (W)	Result
						mW	dBm			
5180	1	19		100	18.8	145.0	21.6	21.8	0.216	-
	3									
	4									
	2				18.4					
5200	1	19		100	18.9	168.8	22.3	22.5		-
	3									
	4									
	2				19.6					
5240	1	19		100	19.4	215.9	23.3	22.5	-	
	3									
	4									
	2				21.1					



**NTS**

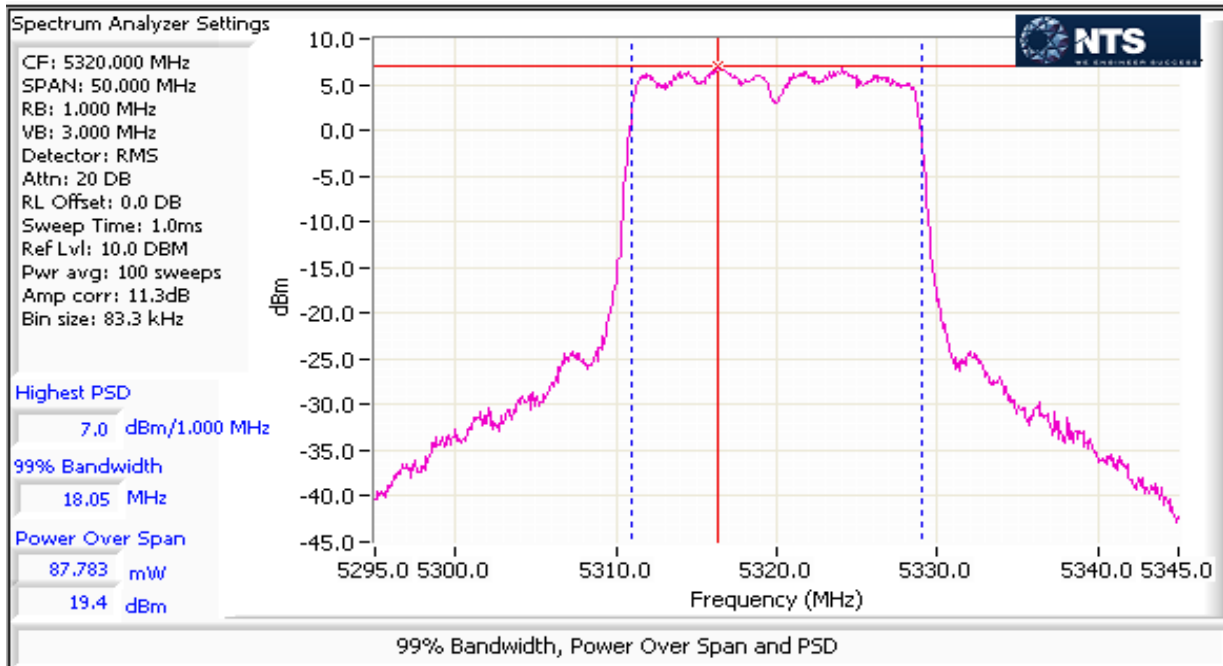
WE ENGINEER SUCCESS

EMC Test Data

Client:	Pace Americas, Inc.	Job Number:	J97945
Model:	HR54-700	T-Log Number:	T98161
Contact:	Mark Rieger	Project Manager:	Irene Rademacher
Standard:	FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator:	-
		Class:	N/A

MIMO Device - 5250-5350 MHz Band - FCC**Mode:** n20**Max EIRP (mW):** 447.74423

Frequency (MHz)	Chain	Software Setting	26dB BW (MHz)	Duty Cycle %	Power dBm	Total Power ¹		Orig. Pwr dBm	Max Power (W)	Result
5260	1	20	20.6	100	19.0	164.5	22.2	22.0	0.174	-
	3									
	4									
	2				19.3					
5300	1	20	20.5	100	19.3	170.2	22.3	21.3		-
	3									
	4									
	2				19.3					
5320	1	20	20.8	100	19.4	174.2	22.4	22.0	-	
	3									
	4									
	2				19.4					

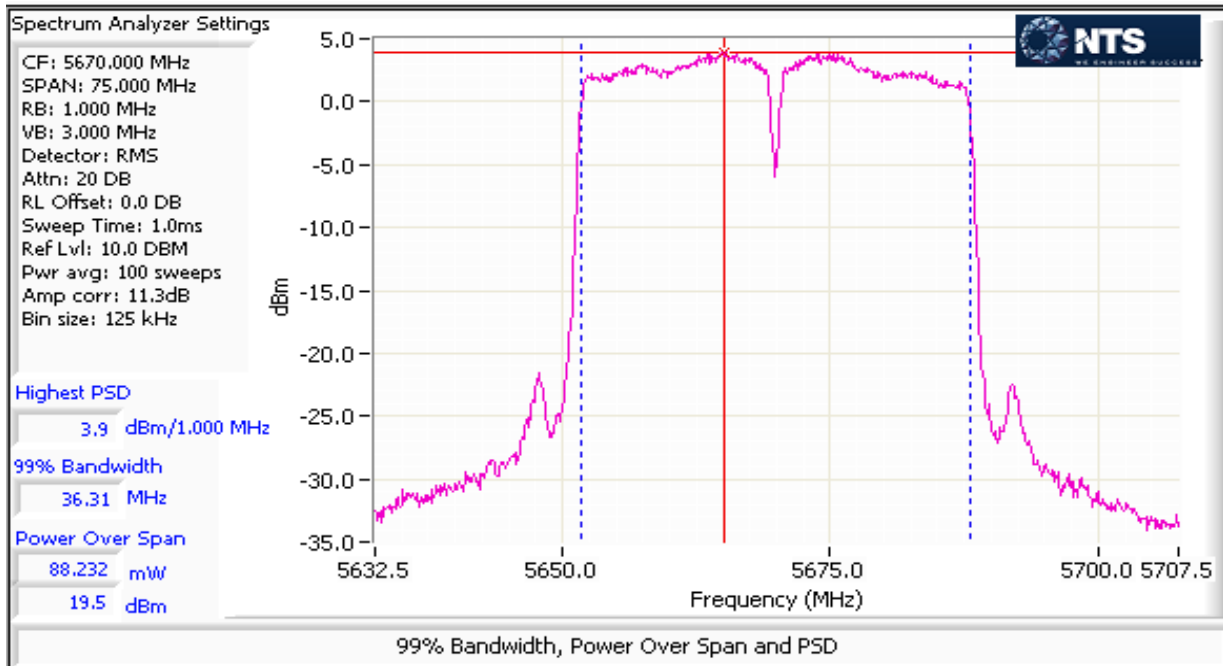


Client:	Pace Americas, Inc.	Job Number:	J97945
Model:	HR54-700	T-Log Number:	T98161
Contact:	Mark Rieger	Project Manager:	Irene Rademacher
Standard:	FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator:	-
		Class:	N/A

MIMO Device - 5470-5725 MHz Band - FCC
Mode: n40

Max EIRP (mW): 461.06987

Frequency (MHz)	Chain	Software Setting	26dB BW (MHz)	Duty Cycle %	Power dBm	Total Power ¹		Orig. Pwr dBm	Max Power (W)	Result
5510	1	20	42.5	95	18.7	150.9	21.8	20.0	0.179	-
	3									
	4									
	2				18.4					
5550	1	20	45.3	95	18.8	154.4	21.9	21.7		-
	3									
	4									
	2				18.5					
5670	1	20	44.9	95	19.5	179.4	22.5	21.8	-	
	3									
	4									
	2				19.1					



**NTS**

WE ENGINEER SUCCESS

EMC Test Data

Client:	Pace Americas, Inc.	Job Number:	J97945
Model:	HR54-700	T-Log Number:	T98161
Contact:	Mark Rieger	Project Manager:	Irene Rademacher
Standard:	FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator:	-
		Class:	N/A

MIMO Device - 5725-5850 MHz Band - FCC

Mode: n20

Max EIRP (mW): 915.1

Frequency (MHz)	Chain	Software Setting	26dB BW (MHz)	Duty Cycle %	Power ¹ dBm	Total Power		Orig. Pwr dBm	Max Power (W)	Result
					mW	dBm				
5745	1	20		100	18.8	159.0	22.0	21.3	0.356	-
	3									
	4									
	2				19.2					
5785	1	23		100	22.5	343.8	25.4	24.8		-
	3									
	4									
	2				22.2					
5825	1	23		100	22.3	356.0	25.5	24.1	-	
	3									
	4									
	2				22.7					

Spectrum Analyzer Settings

CF: 5825.000 MHz
 SPAN: 50.000 MHz
 RB: 1.000 MHz
 VB: 3.000 MHz
 Detector: RMS
 Attn: 20 DB
 RL Offset: 0.0 DB
 Sweep Time: 1.0ms
 Ref Lvl: 10.0 DBM
 Pwr avg: 100 sweeps
 Amp corr: 11.3dB
 Bin size: 83.3 kHz

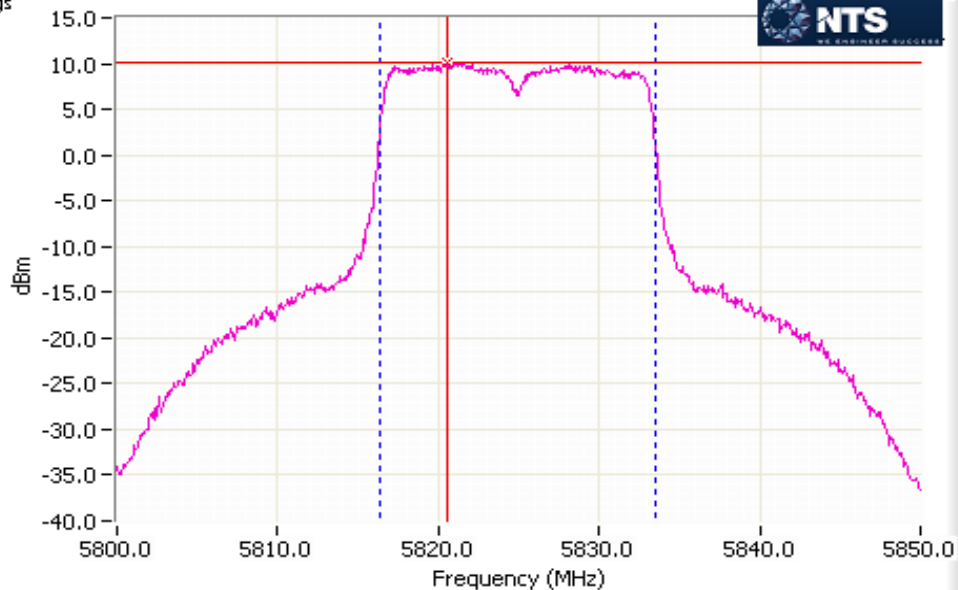
99% Bandwidth

17.14 MHz

Power Over Span

187.829 mW

22.7 dBm



99% Bandwidth, Power Over Span and PSD

Client:	Pace Americas, Inc.	Job Number:	J97945
Model:	HR54-700	T-Log Number:	T98161
Contact:	Mark Rieger	Project Manager:	Irene Rademacher
Standard:	FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator:	-
		Class:	N/A

RSS 210 and FCC 15.247 (DTS) Radiated Spurious 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 and all local support equipment were located on the turntable for radiated spurious emissions testing.

For radiated emissions testing the measurement antenna was located 3 meters from the EUT, unless otherwise noted.

Ambient Conditions:

Temperature: 25 °C
 Rel. Humidity: 31 %

Summary of Results - Device Operating in the 2400-2483.5 MHz Band

Run #	Mode	Channel	Target Power	Power Setting	Test Performed	Limit	Result / Margin
1	b	1 - 2412MHz	20	20	Radiated Emissions, 30 -1000 GHz	FCC Part 15.209 / 15.247(c)	34.9 dBµV/m @ 175.52 MHz (-8.6 dB)
	RF4CE - CH25	2475MHz	-	-	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247(c)	44.8 dBµV/m @ 4850.9 MHz (-9.2 dB)
2	n20	165 - 5820MHz	20	20	Radiated Emissions, 30 -1000 GHz	FCC Part 15.209 / 15.247(c)	35.2 dBµV/m @ 175.50 MHz (-8.3 dB)
	RF4CE - CH11	2405MHz	-	-	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247(c)	49.1 dBµV/m @ 5412.7 MHz (-4.9 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.

Sample Notes

Sample S/N: G54DA5DN000024
 Driver: 5.99 RC 188.10

Client:	Pace Americas, Inc.	Job Number:	J97945
Model:	HR54-700	T-Log Number:	T98161
Contact:	Mark Rieger	Project Manager:	Irene Rademacher
Standard:	FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator:	-
		Class:	N/A

Procedure Comments:

Measurements performed in accordance with FCC KDB 558074

Peak measurements performed with: RBW=1MHz, VBW=3MHz, peak detector, max hold, auto sweep time

Unless otherwise stated/noted, emission has duty cycle $\geq 98\%$ and was measured using RBW=1MHz, VBW=10Hz, peak detector, linear average mode, auto sweep time, max hold.

2.4GHz band reject filter used

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
11b	2Mb/s	1.00	Yes	4.23	0	0	236
11a	6Mbps	0.99	Yes	1.33	0	0	752
n20	MCS0	0.99	Yes	1.33	0	0	752
n40	MCS0	0.95	Yes	0.36	0.23	0.47	2762

Measurement Specific Notes:

Note 1:	Emission in non-restricted band, but limit of 15.209 used.
Note 2:	Emission in non-restricted band, the limit was set 30dB below the level of the fundamental and measured in 100kHz.
Note 2:	Emission has duty cycle $\geq 98\%$, average measurement performed: RBW=1MHz, VBW=3MHz, RMS, Power averaging, auto sweep, trace average 100 traces
Note 3:	Emission has duty cycle $< 98\%$, but constant, average measurement performed: RBW=1MHz, VBW=10Hz, peak detector, linear averaging, auto sweep, trace average 100 traces, measurement corrected by Linear Voltage correction factor
Note 4:	Emission has duty cycle $< 98\%$ and is NOT constant, average measurement performed: RBW=1MHz, VBW $> 1/T$, peak detector, linear average mode, sweep time auto, max hold. Max hold for $50 \cdot (1/DC)$ traces
Note 5:	Emission has duty cycle $< 98\%$, but constant, average measurement performed: RBW=1MHz, VBW=3MHz, RMS, Power averaging, auto sweep, trace average 100 traces, measurement corrected by Pwr correction factor
Note 6:	Plots of the average and peak bandedge do not account for any duty cycle correction. Refer to the tabular results for final measurements.

Client: Pace Americas, Inc.	Job Number: J97945
Model: HR54-700	T-Log Number: T98161
Contact: Mark Rieger	Project Manager: Irene Rademacher
Standard: FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator: -
	Class: N/A

Run #1: Radiated Spurious Emissions

Date of Test: 04/21/15

Test Engineer: M. Birgani

Test Location: Chamber 7

EUT Voltage: 120V / 60Hz

Run #1a: 30 - 1000MHz

WiFi:

Channel: 1

Mode: b

Tx Chain: Main

Data Rate: 2Mb/s

RF4CE:

Channel: 25

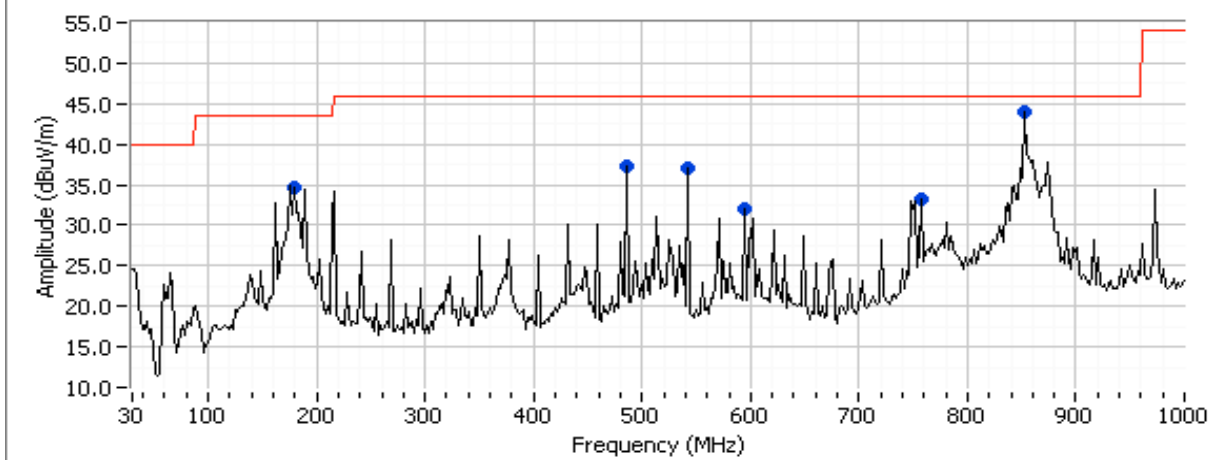
Mode: -

Tx Chain: -

Data Rate: -

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
175.515	34.9	H	43.5	-8.6	QP	303	1.5	QP (1.00s)
486.009	37.0	H	46.0	-9.0	QP	268	2.0	QP (1.00s)
540.017	36.7	H	46.0	-9.3	QP	288	1.5	QP (1.00s)
851.554	33.3	H	46.0	-12.7	QP	12	1.0	QP (1.00s)
755.976	31.8	H	46.0	-14.2	QP	323	2.0	QP (1.00s)
597.494	26.8	H	46.0	-19.2	QP	313	1.5	QP (1.00s)

RF4CE at 2475 MHz; 802.11b at 2412 MHz



Client:	Pace Americas, Inc.	Job Number:	J97945
Model:	HR54-700	T-Log Number:	T98161
Contact:	Mark Rieger	Project Manager:	Irene Rademacher
Standard:	FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator:	-
		Class:	N/A

Run #1b: 1 - 25 GHz

WiFi:

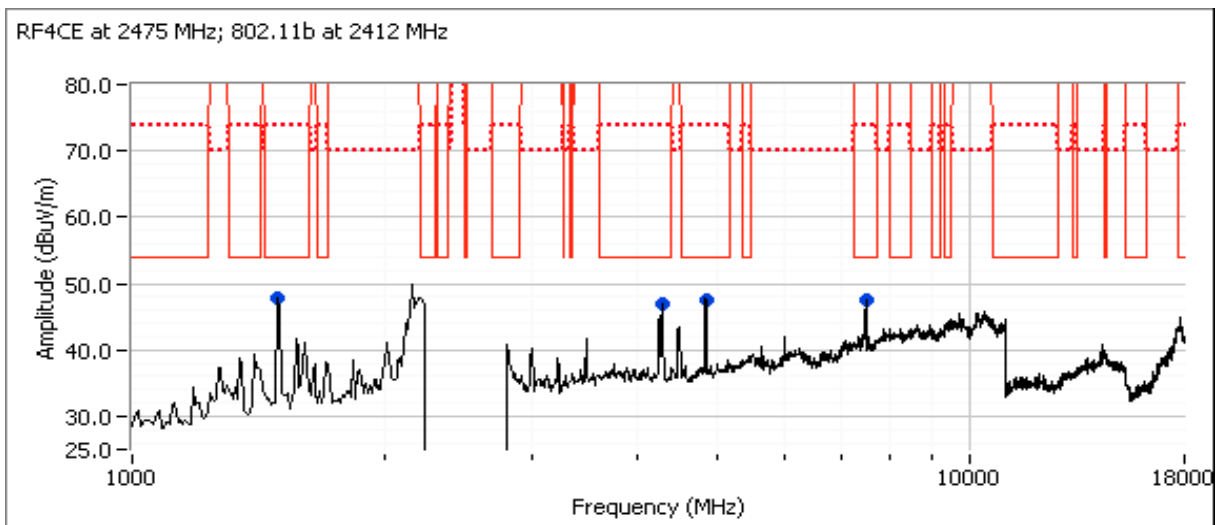
Channel: 1 Mode: b
 Tx Chain: Main Data Rate: 2Mb/s

RF4CE:

Channel: 25 Mode: -
 Tx Chain: - Data Rate: -

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4850.940	44.8	V	54.0	-9.2	AVG	360	1.3	RB 1 MHz;VB 10 Hz;Peak
7497.900	39.2	V	54.0	-14.8	AVG	353	2.0	RB 1 MHz;VB 10 Hz;Peak
1494.660	39.0	V	54.0	-15.0	AVG	187	2.0	RB 1 MHz;VB 10 Hz;Peak
4267.520	58.6	V	74.0	-15.4	PK	43	1.0	RB 1 MHz;VB 3 MHz;Peak
7499.490	56.1	V	74.0	-17.9	PK	353	2.0	RB 1 MHz;VB 3 MHz;Peak
4270.980	35.3	V	54.0	-18.7	AVG	43	1.0	RB 1 MHz;VB 10 Hz;Peak
1492.880	55.1	V	74.0	-18.9	PK	187	2.0	RB 1 MHz;VB 3 MHz;Peak
4851.080	52.1	V	74.0	-21.9	PK	360	1.3	RB 1 MHz;VB 3 MHz;Peak

Note: Scans made between 18 - 25 GHz with the measurement antenna moved around the card and its antennas 20-50cm from the device indicated there were no significant emissions in this frequency range



Client: Pace Americas, Inc.	Job Number: J97945
Model: HR54-700	T-Log Number: T98161
Contact: Mark Rieger	Project Manager: Irene Rademacher
Standard: FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator: -
	Class: N/A

Run #2: Radiated Spurious Emissions

Date of Test: 04/21/15

Test Engineer: M. Birgani

Test Location: Chamber 7

EUT Voltage: 120V / 60Hz

Run #2a: 30 - 1000MHz

WIFI:

Channel: 165

Mode: n20

Tx Chain: 2x2

Data Rate: 2Mb/s

RF4CE:

Channel: 11

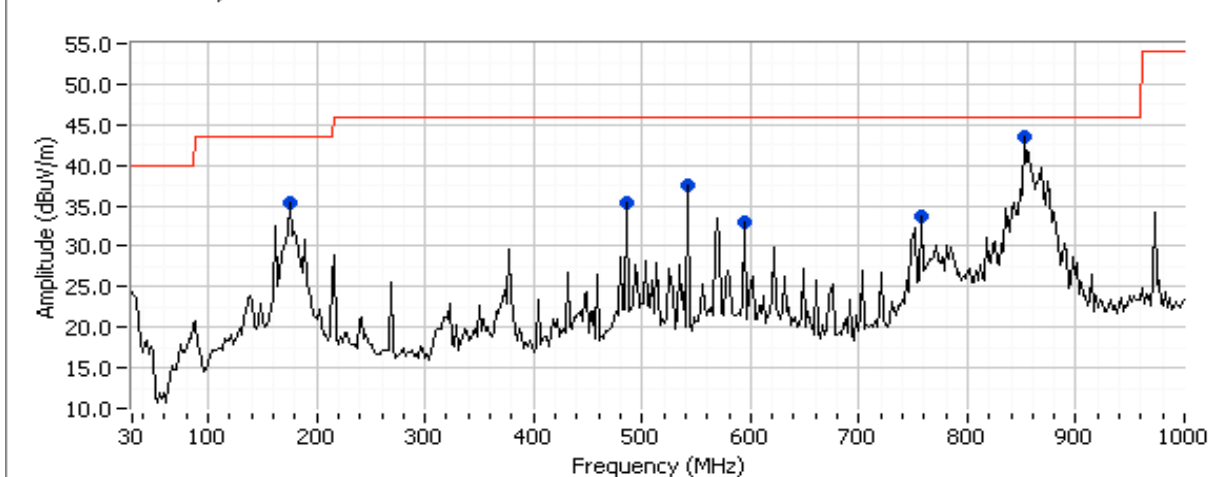
Mode: -

Tx Chain: -

Data Rate: -

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
175.500	35.2	H	43.5	-8.3	QP	116	2.0	QP (1.00s)
852.160	35.9	H	46.0	-10.1	QP	162	1.0	QP (1.00s)
540.017	35.9	H	46.0	-10.1	QP	314	1.5	QP (1.00s)
486.009	34.8	H	46.0	-11.2	QP	252	2.0	QP (1.00s)
755.999	34.5	H	46.0	-11.5	QP	308	2.0	QP (1.00s)
593.995	33.1	H	46.0	-12.9	QP	298	1.5	QP (1.00s)

RF4CE at 2405 MHz; 802.11n 20MHz at 5825 MHz



Client: Pace Americas, Inc.	Job Number: J97945
Model: HR54-700	T-Log Number: T98161
Contact: Mark Rieger	Project Manager: Irene Rademacher
Standard: FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator: -
	Class: N/A

Run #2b: 1 - 25 GHz

WiFi:

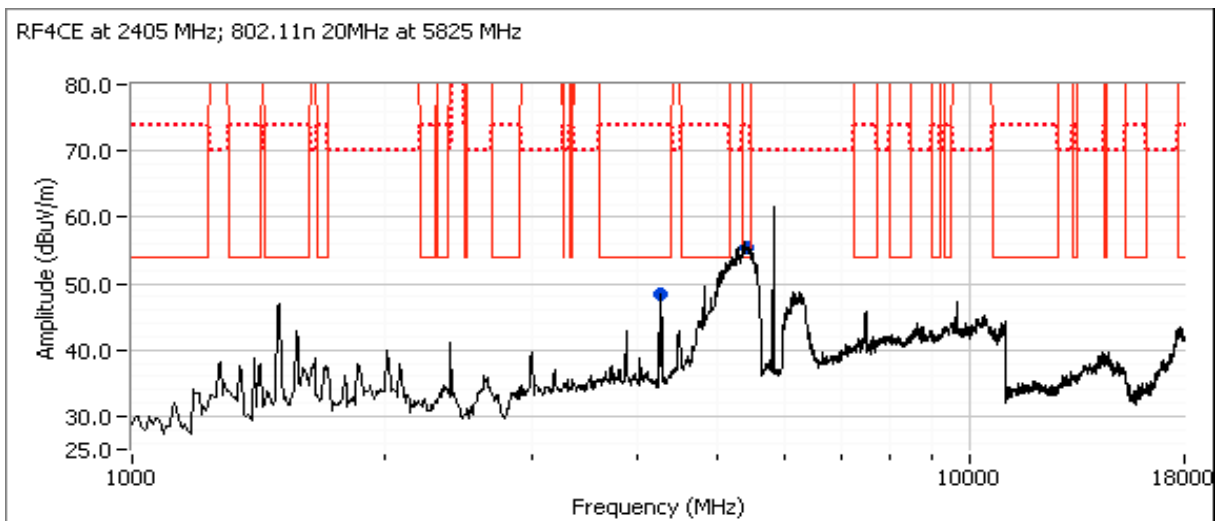
Channel: 165 Mode: n20
 Tx Chain: 2x2 Data Rate: 2Mb/s

RF4CE:

Channel: 11 Mode: -
 Tx Chain: - Data Rate: -

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB μ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5412.700	49.1	H	54.0	-4.9	AVG	280	1.4	RB 1 MHz;VB 10 Hz;Peak
5412.620	63.1	H	74.0	-10.9	PK	280	1.4	RB 1 MHz;VB 3 MHz;Peak
4273.870	59.1	V	74.0	-14.9	PK	284	2.0	RB 1 MHz;VB 3 MHz;Peak
7488.540	38.8	V	54.0	-15.2	AVG	24	1.6	RB 1 MHz;VB 10 Hz;Peak
7479.810	57.3	V	74.0	-16.7	PK	24	1.6	RB 1 MHz;VB 3 MHz;Peak
4273.300	35.7	V	54.0	-18.3	AVG	284	2.0	RB 1 MHz;VB 10 Hz;Peak

Note: Scans made between 18 - 25 GHz with the measurement antenna moved around the card and its antennas 20-50cm from the device indicated there were no significant emissions in this frequency range





EMC Test Data

Client: Pace Americas, Inc.	Job Number: J97945
Model: HR54-700	T-Log Number: T98161
Contact: Mark Rieger	Project Manager: Irene Rademacher
Standard: FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator: -
	Class: B

Conducted Emissions

(NTS Silicon Valley, 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: 4/22/2015
 Test Engineer: Joseph Cadigal
 Test Location: FT Chamber#4

Config. Used: 1
 Config Change: none
 EUT Voltage: 120V/60Hz

General Test Configuration

For tabletop equipment, the EUT was located on a wooden table inside the semi-anechoic chamber, 40 cm from a vertical coupling plane and 80cm from the LISN. A second LISN was used for all local support equipment. Remote support equipment was located outside of the semi-anechoic chamber. Any cables running to remote support equipment were routed through metal conduit and when possible passed through a ferrite clamp upon exiting the chamber.

Ambient Conditions:
 Temperature: 25 °C
 Rel. Humidity: 30 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	CE, AC Power, 120V/60Hz	15.207	Pass	43.1 dBμV @ 0.436 MHz (-4.0 dB)

Modifications Made During Testing

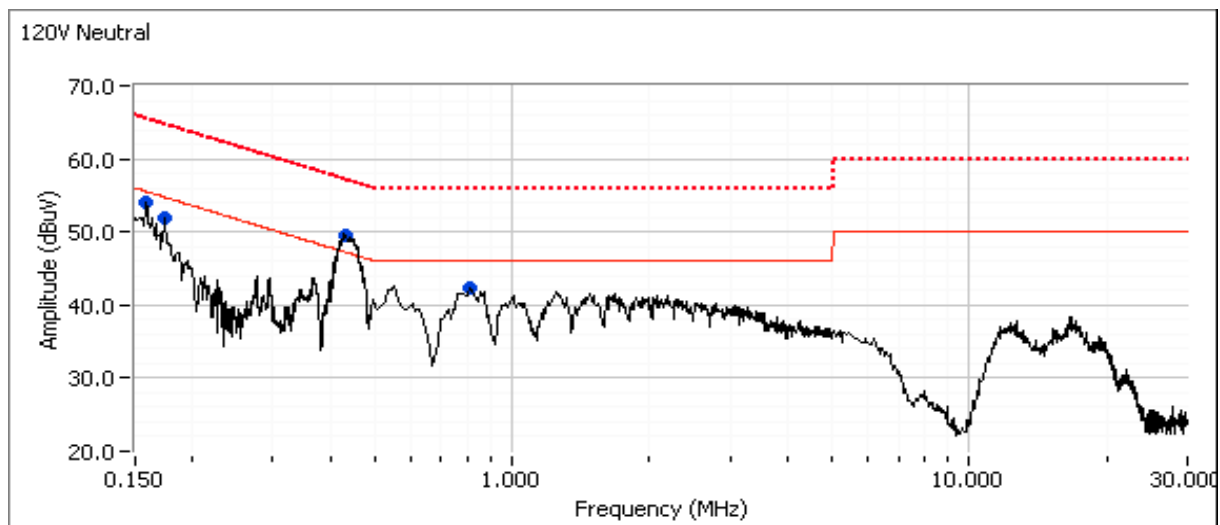
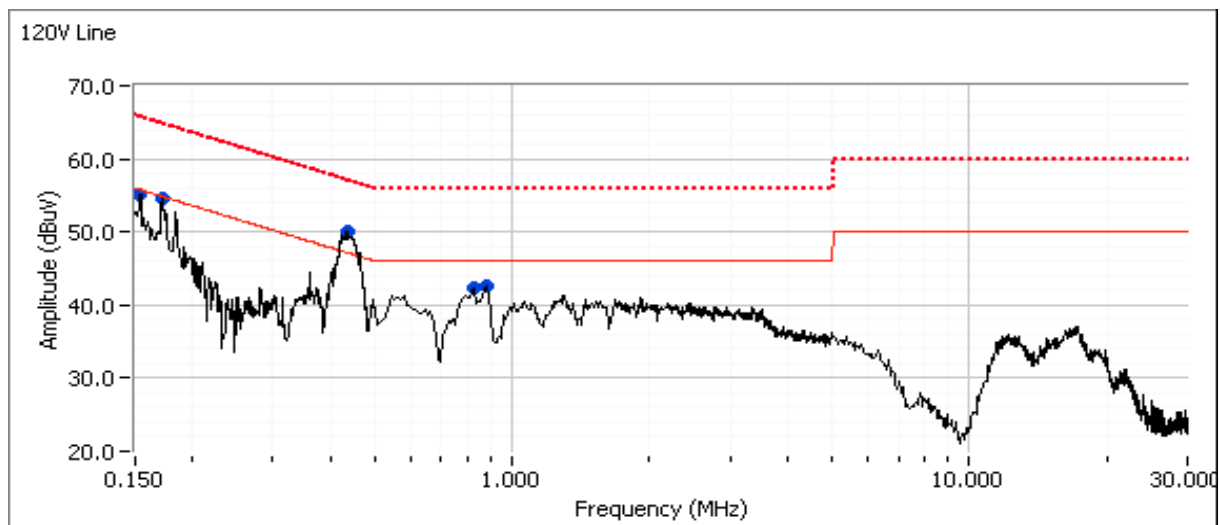
No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Client: Pace Americas, Inc.	Job Number: J97945
Model: HR54-700	T-Log Number: T98161
Contact: Mark Rieger	Project Manager: Irene Rademacher
Standard: FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator: -
	Class: B

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



EMC Test Data

Client:	Pace Americas, Inc.	Job Number:	J97945
Model:	HR54-700	T-Log Number:	T98161
Contact:	Mark Rieger	Project Manager:	Irene Rademacher
Standard:	FCC 15.247 / FCC 15.E (New Rules)	Project Coordinator:	-
		Class:	B

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

Frequency MHz	Level dB μ V	AC Line	15.207		Detector QP/Ave	Comments
			Limit	Margin		
0.436	50.0	Line 1	47.1	2.9	Peak	
0.172	54.6	Line 1	54.9	-0.3	Peak	
0.153	55.0	Line 1	55.8	-0.8	Peak	
0.830	42.4	Line 1	46.0	-3.6	Peak	
0.886	42.7	Line 1	46.0	-3.3	Peak	
0.174	51.8	Neutral	54.8	-3.0	Peak	
0.158	54.0	Neutral	55.5	-1.5	Peak	
0.434	49.4	Neutral	47.2	2.2	Peak	
0.798	42.3	Neutral	46.0	-3.7	Peak	

Final quasi-peak and average readings

Frequency MHz	Level dB μ V	AC Line	15.207		Detector QP/Ave	Comments
			Limit	Margin		
0.436	43.1	Line 1	47.1	-4.0	AVG	AVG (0.10s)
0.434	40.2	Neutral	47.2	-7.0	AVG	AVG (0.10s)
0.436	49.5	Line 1	57.1	-7.6	QP	QP (1.00s)
0.434	48.1	Neutral	57.2	-9.1	QP	QP (1.00s)
0.798	32.5	Neutral	46.0	-13.5	AVG	AVG (0.10s)
0.174	40.4	Neutral	54.8	-14.4	AVG	AVG (0.10s)
0.830	31.1	Line 1	46.0	-14.9	AVG	AVG (0.10s)
0.153	40.2	Line 1	55.8	-15.6	AVG	AVG (0.10s)
0.830	39.8	Line 1	56.0	-16.2	QP	QP (1.00s)
0.158	49.1	Neutral	65.6	-16.5	QP	QP (1.00s)
0.798	39.4	Neutral	56.0	-16.6	QP	QP (1.00s)
0.153	48.9	Line 1	65.8	-16.9	QP	QP (1.00s)
0.886	38.9	Line 1	56.0	-17.1	QP	QP (1.00s)
0.174	47.3	Neutral	64.8	-17.5	QP	QP (1.00s)
0.158	38.0	Neutral	55.6	-17.6	AVG	AVG (0.10s)
0.172	37.2	Line 1	54.9	-17.7	AVG	AVG (0.10s)
0.886	27.9	Line 1	46.0	-18.1	AVG	AVG (0.10s)
0.172	46.1	Line 1	64.9	-18.8	QP	QP (1.00s)

End of Report

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