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## **EMC Test Report**

### **Application for Grant of Equipment Authorization**

#### **FCC Part 15 Subpart C**

**Model: HR54-700**

FCC ID: PGRHR54

APPLICANT: Pace Americas Inc.  
310 Providence Mine Road  
Nevada City, CA 95959

TEST SITE(S): National Technical Systems - Silicon Valley  
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**REVISION HISTORY**

Rev#	Date	Comments	Modified By
-	August 3, 2015	First release	
1.0	August 6, 2015	Added AC Conducted Emissions results. Clarified radiated results below 1GHz. Updated duty cycle of transmissions during RF4CE (+wifi) radiated spurious testing.	Mark Hill

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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 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 National Technical Systems - Silicon Valley test procedures:

### ANSI C63.10-2013

### FCC DTS Measurement Guidance KDB558074

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.

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 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 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**

The following deviation was made from the published requirements listed in the scope of this report.

1. Power measurements were performed with an RBW=1MHz, VBW=3MHz, rather than 1-5% of the OBW.

## TEST RESULTS SUMMARY

### DIGITAL TRANSMISSION SYSTEMS (2400 – 2483.5MHz) – IEEE 802.11 Operation

FCC Rule Part	RSS Rule Part	Description	Measured Value / Comments	Limit / Requirement	Result
15.247(a)	-	Digital Modulation	Systems uses OFDM / DSSS techniques	System must utilize a digital transmission technology	Complies
15.247 (a) (2)	-	6dB Bandwidth	8.1MHz minimum	>500kHz	Complies
15.247 (b) (3)	-	Output Power (multipoint systems)	b: 20.3 dBm (0.107W) g: 20.1 dBm (0.102W) n20: 22.8 dBm(0.189W) n40: 21.2 dBm(0.099W)  EIRP = 0.423 W <sup>Note 1</sup>	1Watt, EIRP limited to 4 Watts.	Complies
15.247(e)	-	Power Spectral Density	b: 4.2 dBm/10kHz g: 1.2 dBm/10kHz n20: 4.3 dBm/10kHz n40: 4.2dBm/10kHz	8dBm/3kHz	Complies
15.247(d)	-	Antenna Port Spurious Emissions 30MHz – 25 GHz	All signals below -30dBc	< -30dBc <sup>Note 2</sup>	Complies
15.247(d) / 15.209	-	Radiated Spurious Emissions 30MHz – 25 GHz	53.7 dBμV/m @ 2483.5 MHz (-0.3 dB)	15.207 in restricted bands, all others <-30dBc <sup>Note 2</sup>	Complies

Note 1: EIRP calculated using antenna gain of 3.3dBi for the highest EIRP system.  
 Note 2: Limit of -30dBc used because the power was measured using the UNII test procedure (maximum power averaged over a transmission burst).

### DIGITAL TRANSMISSION SYSTEMS (2400 – 2483.5MHz) – RF4CE Operation

FCC Rule Part	RSS Rule Part	Description	Measured Value / Comments	Limit / Requirement	Result
15.247(a)	-	Digital Modulation	Systems uses DSSS techniques	System must utilize a digital transmission technology	Complies
15.247 (a) (2)	-	6dB Bandwidth	1.59MHz	>500kHz	Complies
15.247 (b) (3)	-	Output Power (multipoint systems)	-0.9 dBm (0.8mW)  EIRP = 2.5mW <sup>Note 1</sup>	1Watt, EIRP limited to 4 Watts.	Complies
15.247(e)	-	Power Spectral Density	-0.6 dBm/100kHz	8dBm/3kHz	Complies
15.247(d)	-	Antenna Port Spurious Emissions 30MHz – 25 GHz	All signals below -30dBc	< -30dBc <sup>Note 2</sup>	Complies
15.247(d) / 15.209	-	Radiated Spurious Emissions 30MHz – 25 GHz	47.5 dBμV/m @ 4924.0 MHz (-6.5 dB)	15.207 in restricted bands, all others <-30dBc <sup>Note 2</sup>	Complies

Note 1: EIRP calculated using antenna gain of 4.9 dBi for the highest EIRP system.  
 Note 2: Limit of -30dBc used because the power was measured using the UNII test procedure (maximum power averaged over a transmission burst).

**GENERAL REQUIREMENTS APPLICABLE TO ALL BANDS**

FCC Rule Part	RSS Rule part	Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.203	-	RF Connector	Antennas are internal to the device	Unique or integral antenna required	Complies
15.207	-	AC Conducted Emissions	46.1 dB $\mu$ V @ 0.443 MHz (-0.9 dB)	Refer to page 19	Complies
15.247 (b) (5) 15.407 (f)	-	RF Exposure Requirements	Refer to MPE calculations in separate exhibit	Refer to OET 65, FCC Part 1 and RSS 102	Complies

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



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

### **GENERAL**

The Pace Americas Inc. model HR54-700 is a set-top-box DVR that incorporates 802.11abgn 2x2 and 2.4GHz RF4CE 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 12 Volts DC, 4.0 Amps. The electrical rating of the EUT power adapter is 120 Volts, 60 Hz, 1.1 Amps.

The sample was received on June 19, 2015 and tested on June 19, 22, 25, 26, 28, July 1, 2, 8, 9, 10, 11, 14 and 16, 2015. The EUT consisted of the following component(s):

Company	Model	Description	Serial Number	FCC ID
Pace Americas, Inc.	HR54-700	DVR	G54DA5DN000024	PGR????
DirecTV	EPS44R3-16	AC/DC Adapter	DD44B1425A0039	N/A

### **ANTENNA SYSTEM**

The wifi and RF4CE 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 RF4CE antennas: 4.9 dBi (2.4GHz)

### **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
Dynex	DX-LCD19-09	Television	H8984JA055002	-
-	-	USB Memory Stick	None	-
Lacie	d2 Quadra	Sata Drive Enclosure	16551411120974GH B	

The following equipment was used as remote support equipment for emissions testing:

Company	Model	Description	Serial Number	FCC ID
Linksys	BEFSR41	Cable/DSL Router	687F749FC378	-

### **EUT INTERFACE PORTS**

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

Port	Connected To	Description	Cable(s)	
			Shielded or Unshielded	Length(m)
Power Input	AC Adpater	2 wire with ferrite	Shielded	0.7
SATA	Sata Drive	Multiwire	Shielded	1.2
USB	USB Memory Stick	4 wire	Shielded	1.2
Ethernet	Remote Switch	Cat 5	Unshielded	7
HDMI	Television	Multiwire with ferrite	Shielded	1.2
Coaxial	Television	Coax	Shielded	1.2
Digital Audio Out	Not connected (optical)	-	-	-
A/V Out	Television	Multiwire	Shielded	1.0
Satellite In	Unterminated	Coax	Shielded	7
Temporary Serial Programming box	CN1510 connection on PCB	Multiwire	Unshielded	0.3
Temporary Serial Programming box	Laptop	Multiwire	Shielded	1.5

### **EUT OPERATION**

During emissions testing the EUT was set to transmit continuously on the selected frequency, data rate, bandwidth, number of chains, power level and modulation as noted for each test using the serial port. The Ethernet port was in link state.

**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 3	US0027	2845B-3	41039 Boyce Road Fremont, CA 94538-2435
Chamber 4	US0027	2845B-4	
Chamber 5	US0027	2845B-5	
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.

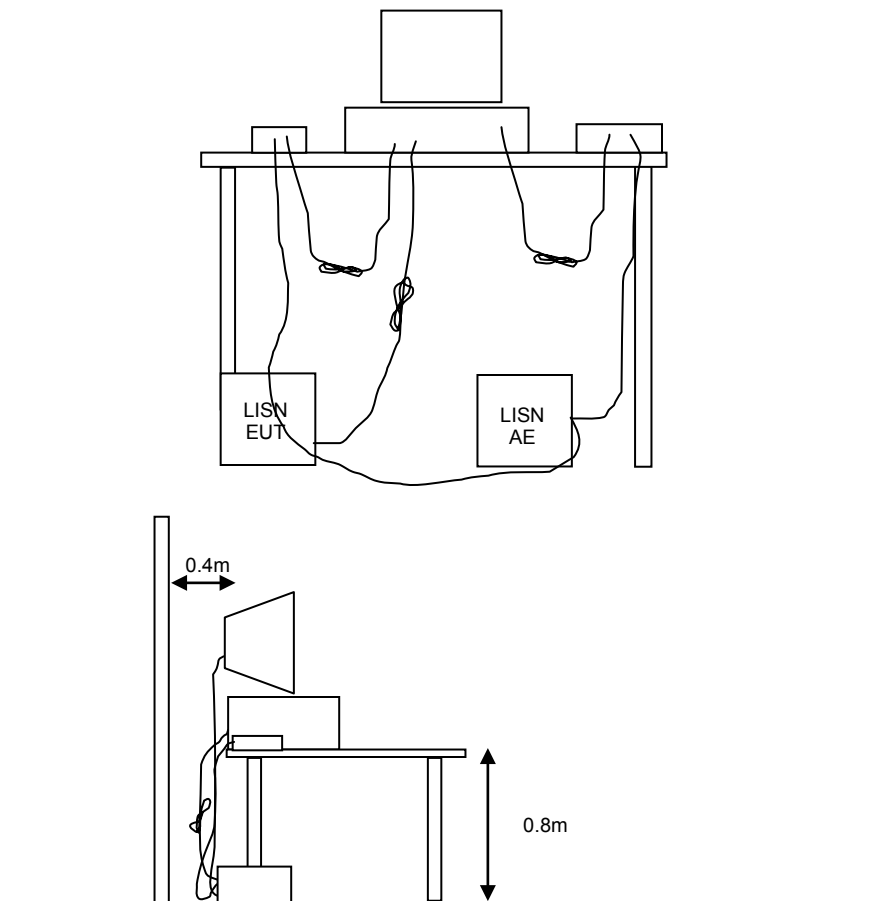


Figure 1 Typical Conducted Emissions Test Configuration

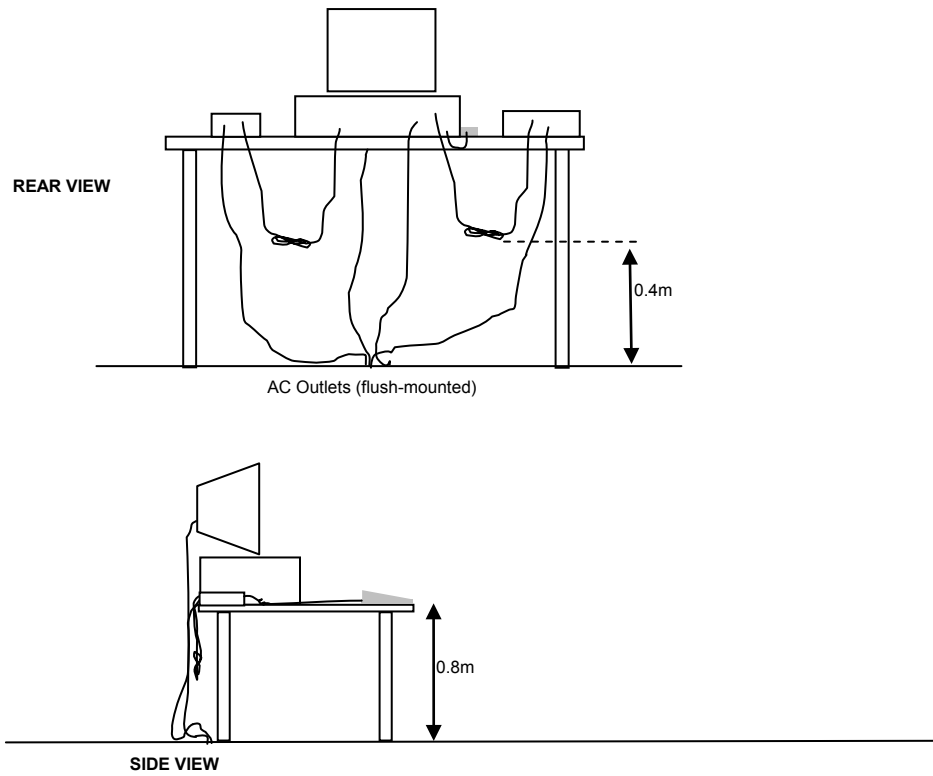
**RADIATED EMISSIONS**

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.

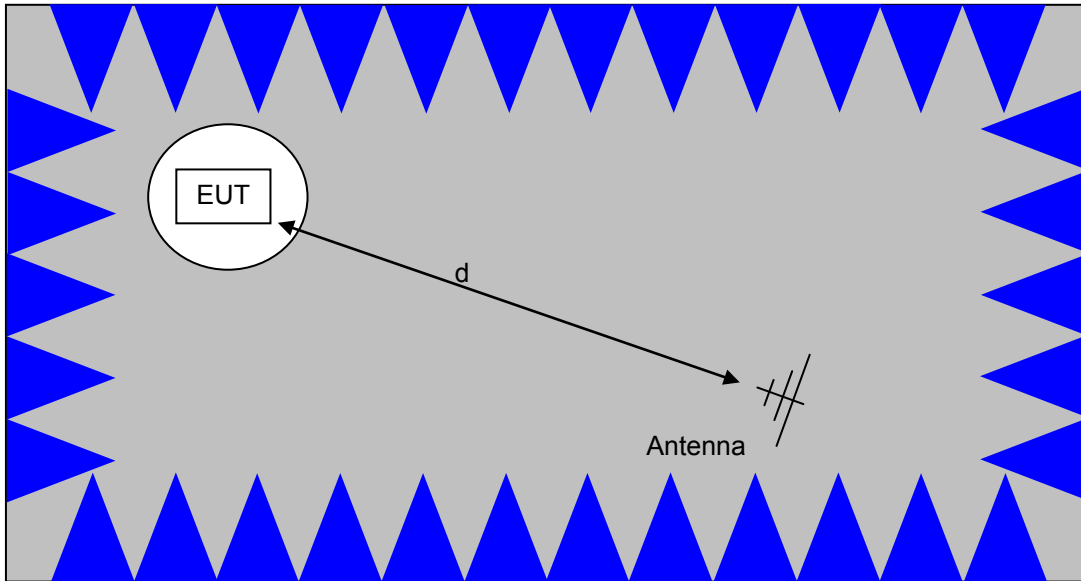
Final maximization is a phase in which the highest amplitude emissions identified in the spectral search are viewed while the EUT azimuth angle is varied from 0 to 360 degrees relative to the receiving antenna. The azimuth, which results in the highest emission is then maintained while varying the antenna 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 1 meter from the EUT and the antenna height is restricted to a maximum of 2.5 meters.



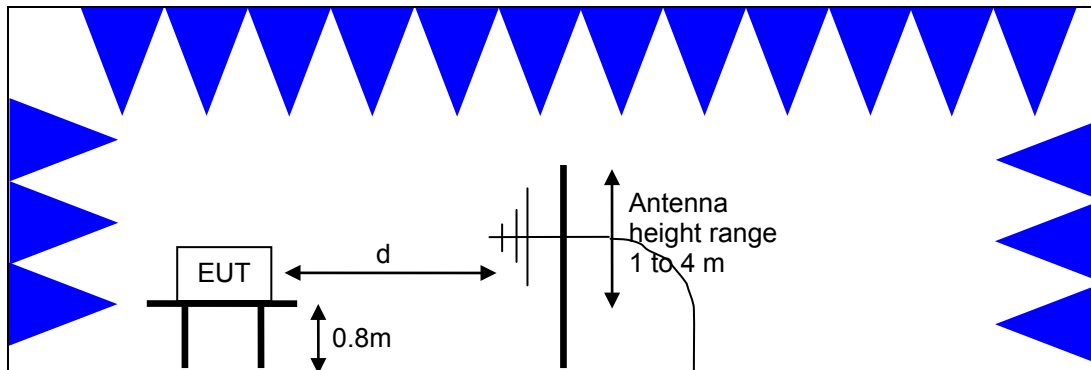
Typical Test Configuration for Radiated Field Strength Measurements





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.

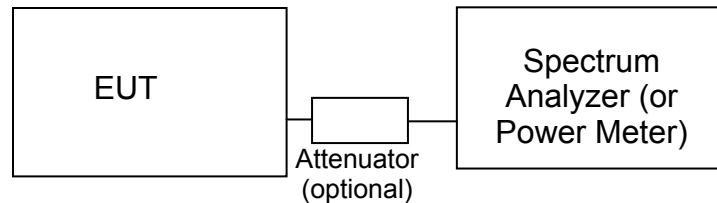
Floor-standing equipment is placed on the floor with insulating supports between the unit and the ground plane.



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 bands<sup>1</sup> (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 <sub>KHz</sub> @ 300m	67.6-20*log <sub>10</sub> (F <sub>KHz</sub> ) @ 300m
0.490-1.705	24000/F <sub>KHz</sub> @ 30m	87.6-20*log <sub>10</sub> (F <sub>KHz</sub> ) @ 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

### OUTPUT POWER LIMITS – DIGITAL TRANSMISSION SYSTEMS

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
902 – 928	1 Watt (30 dBm)	8 dBm/3kHz
2400 – 2483.5	1 Watt (30 dBm)	8 dBm/3kHz

The maximum permitted output power is reduced by 1dB for every dB the antenna gain exceeds 6dBi.

### TRANSMIT MODE SPURIOUS RADIATED EMISSIONS LIMITS – FHSS and DTS SYSTEMS

The limits for unwanted (spurious) emissions from the transmitter falling in the restricted bands are those specified in the general limits sections of FCC Part 15 and RSS 210. All other unwanted (spurious) emissions shall be at least 20dB below the level of the highest in-band signal level (30dB if the power is measured using the sample detector/power averaging method).

<sup>1</sup> 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:

$$F_d = 20 * \text{LOG}_{10} (D_m/D_s)$$

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:

$$F_d = 40 * \text{LOG}_{10} (D_m/D_s)$$

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:

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

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>
<b>Radiated Emissions, 1000 - 6,000 MHz, 19-Jun-15</b>					
EMCO	Antenna, Horn, 1-18 GHz	3115	1561	6/27/2014	6/27/2016
Rohde & Schwarz	EMI Test Receiver, 20 Hz-40 GHz	ESIB40 (1088.7490.40)	2493	1/23/2015	1/23/2016
<b>Radiated Emissions, 1000 - 6,000 MHz, 22-Jun-15</b>					
EMCO	Antenna, Horn, 1-18 GHz	3115	1561	6/27/2014	6/27/2016
Rohde & Schwarz	EMI Test Receiver, 20 Hz-40 GHz	ESIB40 (1088.7490.40)	2493	1/23/2015	1/23/2016
<b>Radiated Emissions, 1,000 - 6,500 MHz, 25-Jun-15</b>					
EMCO	Antenna, Horn, 1-18 GHz	3115	1561	6/27/2014	6/27/2016
Rohde & Schwarz	EMI Test Receiver, 20 Hz-40 GHz	ESIB40 (1088.7490.40)	2493	1/23/2015	1/23/2016
<b>Radiated Emissions, 1,000 - 18,000 MHz, 26-Jun-15</b>					
Hewlett Packard	Microwave Pre-amplifier, 1-26.5GHz	8449B	785	10/31/2014	10/31/2015
Hewlett Packard	SpecAn 9 kHz - 40 GHz, FT (SA40) Blue	8564E (84125C)	1393	5/2/2015	5/2/2016
Micro-Tronics	Band Reject Filter, 5725-5875 MHz	BRC50705-02	1682	7/15/2014	7/15/2015
Micro-Tronics	Band Reject Filter, 5470-5725 MHz	BRC50704-02	2240	9/16/2014	9/16/2015
Micro-Tronics	Band Reject Filter, 5150-5350 MHz	BRC50703-02	2251	10/3/2014	10/3/2015
EMCO	Antenna, Horn, 1-18 GHz	3115	2870	8/20/2013	8/20/2015
<b>Radiated Emissions, 1000 - 18,000 MHz, 28-Jun-15</b>					
Hewlett Packard	Microwave Pre-amplifier, 1-26.5GHz	8449B	785	10/31/2014	10/31/2015
Hewlett Packard	SpecAn 9 kHz - 40 GHz, FT (SA40) Blue	8564E (84125C)	1393	5/2/2015	5/2/2016
Micro-Tronics	Band Reject Filter, 5725-5875 MHz	BRC50705-02	1682	7/15/2014	7/15/2015
Micro-Tronics	Band Reject Filter, 5470-5725 MHz	BRC50704-02	2240	9/16/2014	9/16/2015
Micro-Tronics	Band Reject Filter, 5150-5350 MHz	BRC50703-02	2251	10/3/2014	10/3/2015
EMCO	Antenna, Horn, 1-18 GHz	3115	2870	8/20/2013	8/20/2015
<b>Radiated Emissions, 18 - 40 GHz, 01-Jul-15</b>					
Hewlett Packard	Head (Inc W1-W4, 3136) Purple		1772	6/19/2015	6/19/2016
A. H. Systems	Purple System Horn, 18-40GHz	SAS-574, p/n: 2581	2160	8/11/2014	8/11/2015
Hewlett Packard	SpecAn 9 kHz - 40 GHz, (SA40) Purple	8564E (84125C)	2415	3/7/2015	3/7/2016
<b>Radiated Emissions, 1000 - 6,000 MHz, 01-Jul-15</b>					
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1538	12/20/2014	12/20/2015
EMCO	Antenna, Horn, 1-18 GHz	3115	1561	6/27/2014	6/27/2016

<u>Manufacturer</u>	<u>Description</u>	<u>Model</u>	<u>Asset #</u>	<u>Calibrated</u>	<u>Cal Due</u>
<b>Bandedges, 1000 - 6,500 MHz, 02-Jul-15</b>					
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
EMCO	Antenna, Horn, 1-18 GHz	3115	1561	6/27/2014	6/27/2016
Micro-Tronics	Band Reject Filter, 5470-5725 MHz	BRC50704-02	2240	9/16/2014	9/16/2015
<b>Radiated Emissions, 1000 - 40,000MHz, 02-Jul-15</b>					
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	870	2/20/2015	2/20/2016
Hewlett Packard	Head (Inc flex cable, 1143, 2198) Red	84125C	1145	6/17/2014	7/17/2015
Hewlett Packard	SpecAn 30 Hz -40 GHz, SV (SA40) Red	8564E (84125C)	1148	9/20/2014	9/20/2015
EMCO	Antenna, Horn, 1-18 GHz	3115	1561	6/27/2014	6/27/2016
A. H. Systems	Blue System Horn, 18-40GHz	SAS-574, p/n: 2581	2159	9/2/2014	9/2/2015
<b>Radiated Emissions, 1,000 - 26,000 MHz, 08-Jul-15</b>					
EMCO	Antenna, Horn, 1-18 GHz	3115	487	7/29/2014	7/29/2016
Micro-Tronics	Band Reject Filter, 2400-2500 MHz	BRM50702-02	1683	8/4/2014	8/4/2015
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	2199	2/20/2015	2/20/2016
Hewlett Packard	SpecAn 9 kHz - 40 GHz, (SA40) Purple	8564E (84125C)	2415	3/7/2015	3/7/2016
<b>Radiated Emissions, 11000 - 25000 MHz, 09-Jul-15</b>					
EMCO	Antenna, Horn, 1-18 GHz	3115	487	7/29/2014	7/29/2016
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	785	10/31/2014	10/31/2015
Hewlett Packard	Head (Inc flex cable, (1742,1743) Blue)	84125C	1620	6/5/2015	6/5/2016
Micro-Tronics	Band Reject Filter, 2400-2500 MHz	BRM50702-02	1683	8/4/2014	8/4/2015
A. H. Systems	Spare System Horn, 18-40GHz	SAS-574, p/n: 2581	2162	7/24/2014	7/24/2015
<b>Conducted Emissions - AC Power Ports, 09-Jul-15</b>					
EMCO	LISN, 10 kHz-100 MHz	3825/2	1293	6/2/2015	6/2/2016
Rohde & Schwarz	Pulse Limiter	ESH3 Z2	1401	5/14/2015	5/14/2016
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1756	6/20/2015	6/20/2016
<b>Radiated Emissions, 1000 - 25,000MHz, 10-Jul-15</b>					
EMCO	Antenna, Horn, 1-18 GHz	3115	487	7/29/2014	7/29/2016
Micro-Tronics	Band Reject Filter, 5470-5725 MHz	BRC50704-02	1681	8/13/2014	8/13/2015
Micro-Tronics	Band Reject Filter, 2400-2500 MHz	BRM50702-02	1683	8/4/2014	8/4/2015
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	2199	2/20/2015	2/20/2016





<u>Manufacturer</u>	<u>Description</u>	<u>Model</u>	<u>Asset #</u>	<u>Calibrated</u>	<u>Cal Due</u>
Hewlett Packard	SpecAn 9 kHz - 40 GHz, (SA40) Purple	8564E (84125C)	2415	3/7/2015	3/7/2016
<b>Radio Antenna Port (Power and Spurious Emissions), 11-Jul-15</b>					
Agilent Technologies	PSA, Spectrum Analyzer, (installed options, 111, 115, 123, 1DS, B7J, HYX,	E4446A	2139	6/22/2015	6/22/2016
<b>Radio Antenna Port (Power and Spurious Emissions), 14-Jul-15</b>					
EMCO	Antenna, Horn, 1-18 GHz	3115	487	7/29/2014	7/29/2016
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1538	12/20/2014	12/20/2015

## **Appendix B Test Data**

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# EMC Test Data

Client:	Pace Americas, Inc.	Job Number:	J98591
Product:	HR54-700	T-Log Number:	T98678
System Configuration:		Project Manager:	Irene Radamacher
Contact:	Mark Rieger	Project Coordinator:	
Emissions Standard(s):	FCC 15.247, 15.407	Class:	N/A
Immunity Standard(s):		Environment:	Radio

## EMC Test Data

For The

**Pace Americas, Inc.**

Product

HR54-700

Date of Last Test: 7/21/2015



# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

## 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: 35 %

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

Run #	Mode	Channel	Power Setting	Test Performed	Limit	Result / Margin
1	b	1 - 2412MHz	20	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247( c)	45.0 dBµV/m @ 4824.0 MHz (-9.0 dB)
	b	6 - 2437MHz	20	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247( c)	38.9 dBµV/m @ 4874.0 MHz (-15.1 dB)
	b	11 - 2462MHz	20	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247( c)	41.4 dBµV/m @ 4923.9 MHz (-12.6 dB)
Scans on center channel in all OFDM modes to determine the worst case mode.						
2	g	6 - 2437MHz	20	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247( c)	35.6 dBµV/m @ 4277.0 MHz (-18.4 dB)
	n20	6 - 2437MHz	20	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247( c)	42.4 dBµV/m @ 4876.2 MHz (-11.6 dB)
	n40	6 - 2437MHz	20	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247( c)	35.0 dBµV/m @ 4264.7 MHz (-19.0 dB)
Measurements on low and high channels in worst-case OFDM mode.						
3	n20	1 - 2412MHz	20	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247( c)	36.9 dBµV/m @ 4269.8 MHz (-17.1 dB)
	n20	11 - 2462MHz	20	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247( c)	43.0 dBµV/m @ 4881.0 MHz (-11.0 dB)
40MHz - use if worse case from 2						
4	n40	3 - 2422MHz	20	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247( c)	42.4 dBµV/m @ 4896.0 MHz (-11.6 dB)
	n40	9 - 2452MHz	20	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247( c)	31.5 dBµV/m @ 4836.5 MHz (-22.5 dB)



# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radmacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A

### 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

Antenna: internal

### Test Notes

All testing performed with both chains trasnmitting at the note power setting

No emissions from the radio circuitry were observed below 1 GHz during preliminry tests.



# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radamacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	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	1Mb/s	0.98	Yes	2.737	0	0	10
11g	6Mb/s	0.98	Yes	1.423	0	0	10
n20	MCS0	0.99	Yes	1.33	0	0	10
n40	MCS0	0.98	Yes	1.33	0	0	10

## 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.



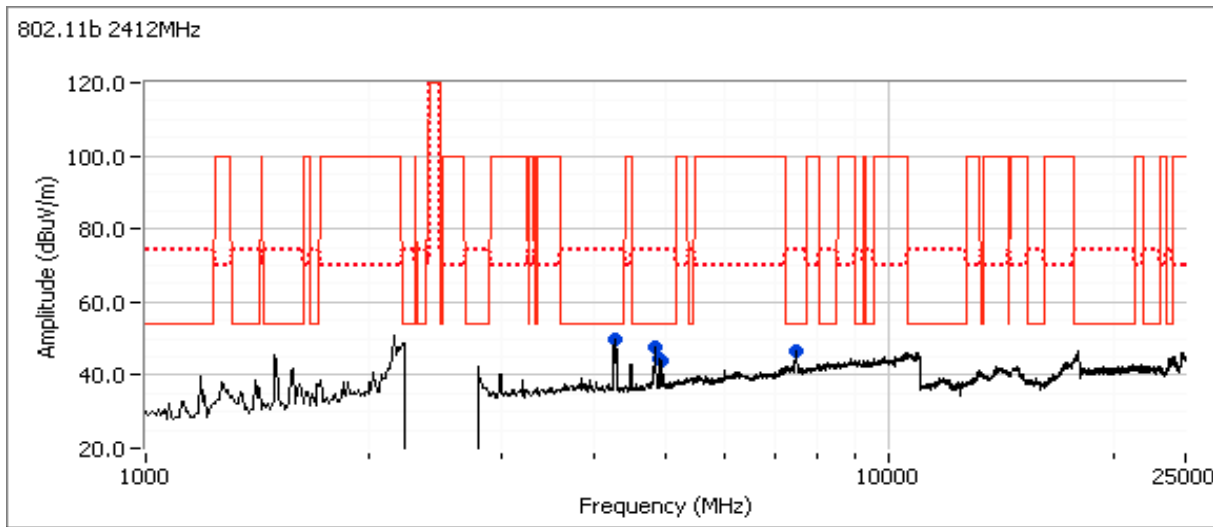
# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Run #1: Radiated Spurious Emissions, 1,000 - 25000 MHz. Operating Mode: 802.11b  
 Date of Test: 7/7/2015 Config. Used: #1  
 Test Location: Chamber #7 Test Engineer: Joseph Cadigal  
 EUT Voltage: 120V/60Hz

### Run #1a: Low Channel

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



Frequency MHz	Level dB $\mu$ V/m	Pol v/h	15.209 / 15.247		Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
			Limit	Margin				
4823.980	45.0	V	54.0	-9.0	AVG	27	1.6	RB 1 MHz;VB 10 Hz;Peak
4895.210	42.2	H	54.0	-11.8	AVG	8	1.6	RB 1 MHz;VB 10 Hz;Peak
4945.350	41.4	H	54.0	-12.6	AVG	8	1.9	RB 1 MHz;VB 10 Hz;Peak
4268.790	36.0	V	54.0	-18.0	AVG	284	2.5	RB 1 MHz;VB 10 Hz;Peak
4823.900	49.6	V	74.0	-24.4	PK	27	1.6	RB 1 MHz;VB 3 MHz;Peak
4945.720	44.2	H	74.0	-29.8	PK	8	1.9	RB 1 MHz;VB 3 MHz;Peak
4268.560	44.0	V	74.0	-30.0	PK	284	2.5	RB 1 MHz;VB 3 MHz;Peak
4895.750	43.8	H	74.0	-30.2	PK	8	1.6	RB 1 MHz;VB 3 MHz;Peak

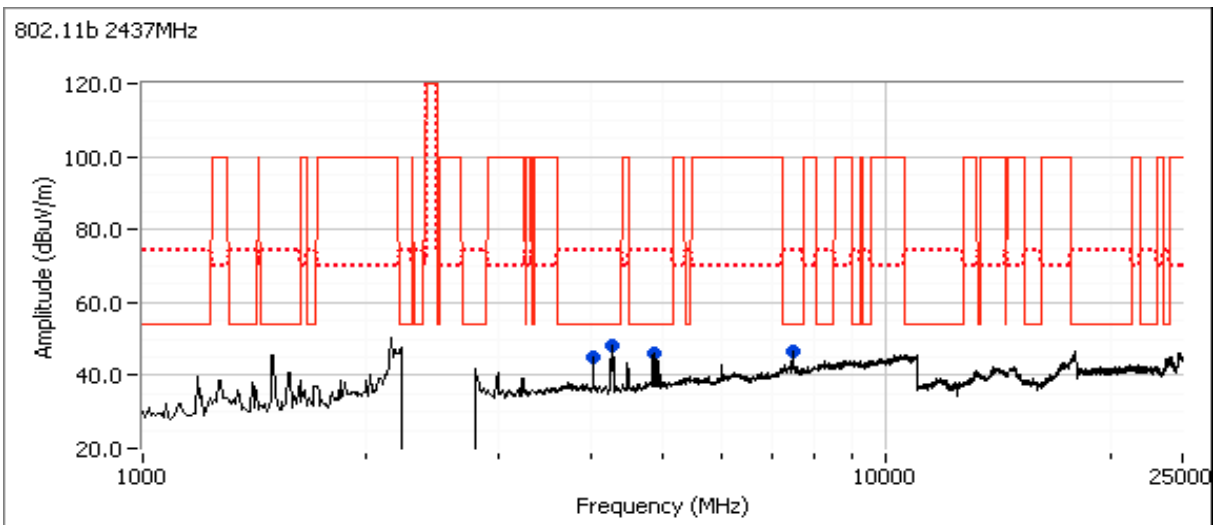
Note: Scans between 18 - 25 GHz performed with the measurement antenna moved around the card and its antennas 20-50cm from the device.

Note: The emissions at 4.5 and 7.5 GHz are not related to radio. After maximizing the signals; stopped the transmission and the signal level did not change.

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Run #1b: Center Channel

Channel: 6                      Mode: b  
 Tx Chain: Main/Aux            Data Rate: 1Mb/s



Frequency	Level	Pol	15.209 / 15.247	Detector	Azimuth	Height	Comments	
MHz	dB $\mu$ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4873.960	38.9	V	54.0	-15.1	AVG	35	1.6	RB 1 MHz;VB 10 Hz;Peak
4264.630	33.8	V	54.0	-20.2	AVG	334	2.5	RB 1 MHz;VB 10 Hz;Peak
4037.140	32.0	H	54.0	-22.0	AVG	342	1.6	RB 1 MHz;VB 10 Hz;Peak
4874.200	46.7	V	74.0	-27.3	PK	35	1.6	RB 1 MHz;VB 3 MHz;Peak
4039.170	44.0	H	74.0	-30.0	PK	342	1.6	RB 1 MHz;VB 3 MHz;Peak
4264.120	43.0	V	74.0	-31.0	PK	334	2.5	RB 1 MHz;VB 3 MHz;Peak

Note: Scans between 18 - 25 GHz performed with the measurement antenna moved around the card and its antennas 20-50cm from the device.

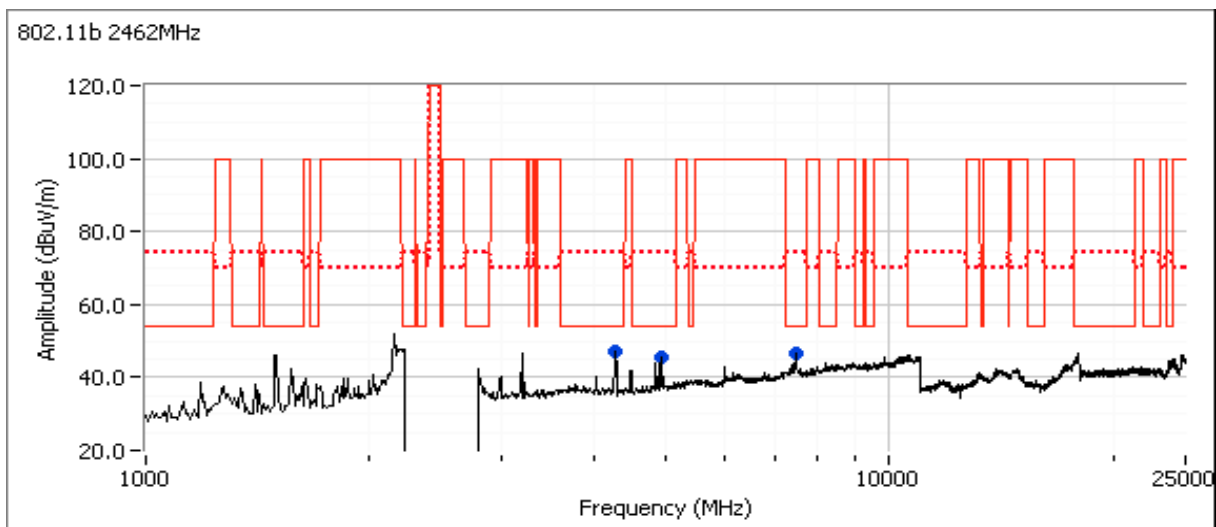
Note: The emissions at 4.5 and 7.5 GHz are not related to radio. After maximizing the signals; stopped the transmission and the signal level did not change.



Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

### Run #1c: High Channel

Channel: 11                      Mode: b  
 Tx Chain: Main/Aux            Data Rate: 1Mb/s



Frequency	Level	Pol	15.209 / 15.247	Detector	Azimuth	Height	Comments	
MHz	dB $\mu$ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4923.940	41.4	V	54.0	-12.6	AVG	344	1.6	RB 1 MHz;VB 10 Hz;Peak
4277.090	55.1	V	74.0	-18.9	PK	294	1.9	RB 1 MHz;VB 3 MHz;Peak
4275.440	35.0	V	54.0	-19.0	AVG	294	1.9	RB 1 MHz;VB 10 Hz;Peak
4924.100	47.7	V	74.0	-26.3	PK	344	1.6	RB 1 MHz;VB 3 MHz;Peak

Note: Scans between 18 - 25 GHz performed with the measurement antenna moved around the card and its antennas 20-50cm from the device.

Note: The emissions at 4.5 and 7.5 GHz are not related to radio. After maximizing the signals; stopped the transmission and the signal level did not change.



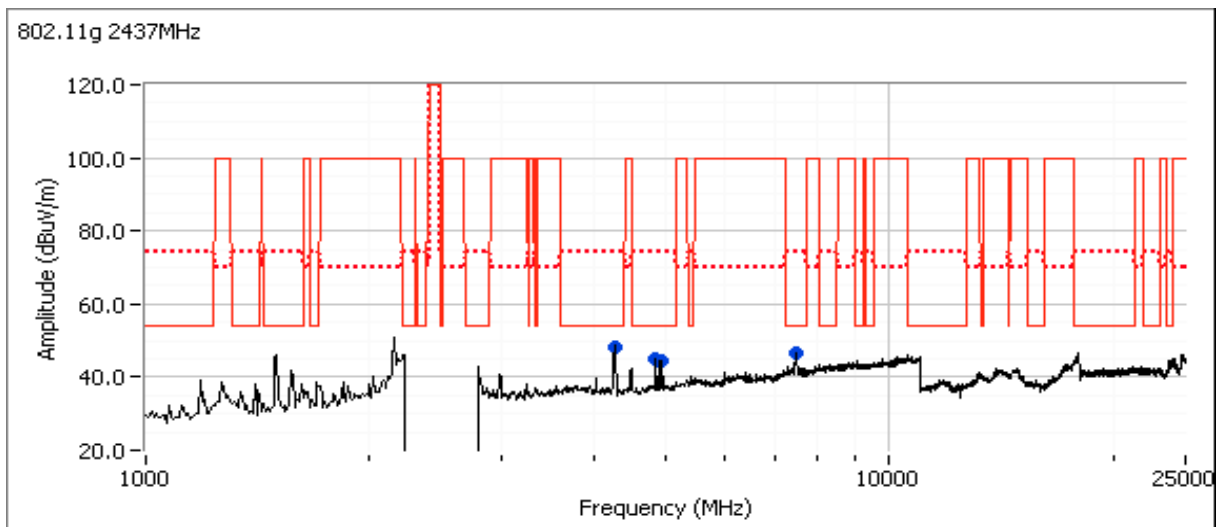
# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Run #2: Radiated Spurious Emissions, 1,000 - 25000 MHz. Operating Mode: OFDM  
 Date of Test: 7/7/2015 Config. Used: #1  
 Test Location: Chamber #7 Test Engineer: Joseph Cadigal  
 EUT Voltage: 120V/60Hz

Run #2a: Center Channel

Channel: 6 Mode: g  
 Tx Chain: Main/Aux Data Rate: 6Mb/s



Frequency	Level	Pol	15.209 / 15.247	Detector	Azimuth	Height	Comments	
MHz	dB $\mu$ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4276.950	35.6	V	54.0	-18.4	AVG	290	2.5	RB 1 MHz;VB 10 Hz;Peak
4877.080	32.9	H	54.0	-21.1	AVG	5	1.0	RB 1 MHz;VB 10 Hz;Peak
4839.230	32.8	H	54.0	-21.2	AVG	360	1.3	RB 1 MHz;VB 10 Hz;Peak
4846.030	48.0	H	74.0	-26.0	PK	360	1.3	RB 1 MHz;VB 3 MHz;Peak
4896.150	47.9	H	74.0	-26.1	PK	5	1.0	RB 1 MHz;VB 3 MHz;Peak
4276.620	44.3	V	74.0	-29.7	PK	290	2.5	RB 1 MHz;VB 3 MHz;Peak

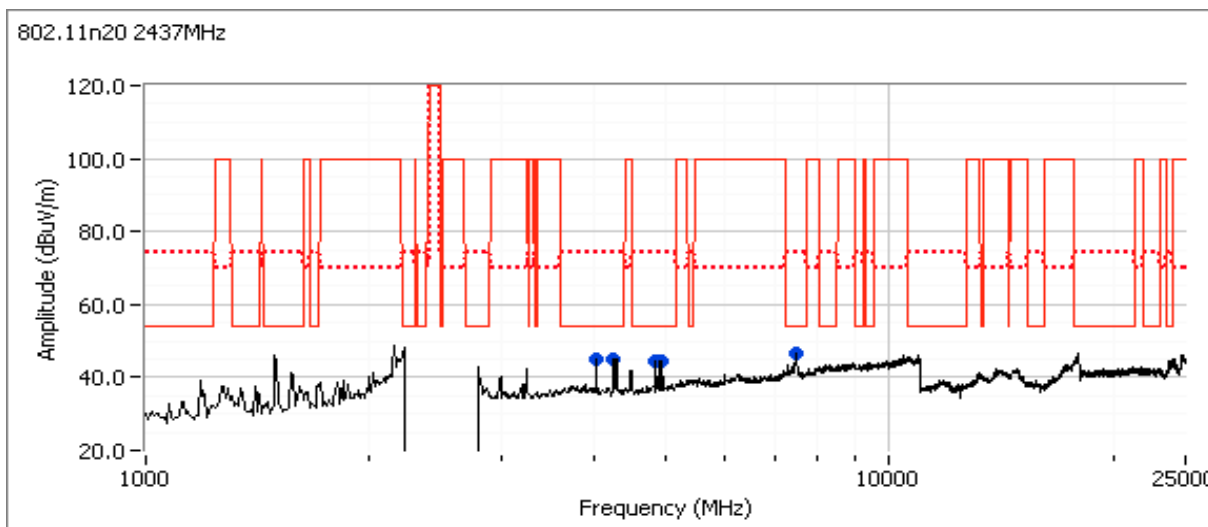
Note: Scans between 18 - 25 GHz performed with the measurement antenna moved around the card and its antennas 20-50cm from the device.

Note: The emissions at 4.5 and 7.5 GHz are not related to radio. After maximizing the signals; stopped the transmission and the signal level did not change.

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Run #2b: Center Channel

Channel: 6                      Mode: n20  
 Tx Chain: Main/Aux            Data Rate: MCS0



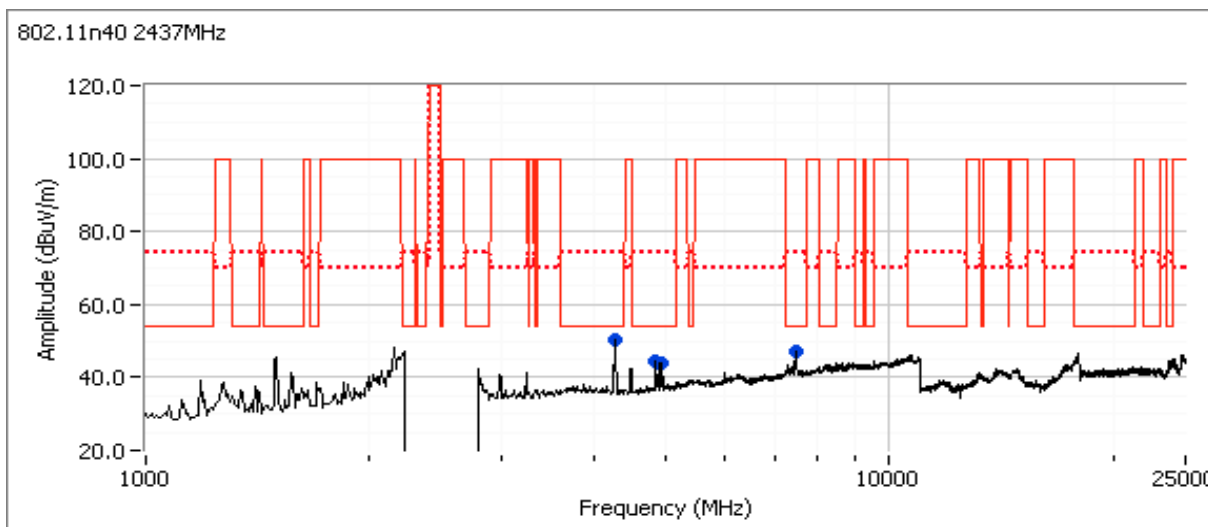
Frequency	Level	Pol	15.209 / 15.247	Detector	Azimuth	Height	Comments	
MHz	dB $\mu$ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4876.160	42.4	H	54.0	-11.6	AVG	45	1.0	RB 1 MHz;VB 10 Hz;Peak
4267.530	35.1	V	54.0	-18.9	AVG	277	1.0	RB 1 MHz;VB 10 Hz;Peak
4269.370	55.0	V	74.0	-19.0	PK	277	1.0	RB 1 MHz;VB 3 MHz;Peak
4957.120	32.9	H	54.0	-21.1	AVG	360	1.0	RB 1 MHz;VB 10 Hz;Peak
4868.670	32.8	H	54.0	-21.2	AVG	0	1.0	RB 1 MHz;VB 10 Hz;Peak
4946.120	47.9	H	74.0	-26.1	PK	360	1.0	RB 1 MHz;VB 3 MHz;Peak
4846.210	44.6	H	74.0	-29.4	PK	0	1.0	RB 1 MHz;VB 3 MHz;Peak
4878.100	44.1	H	74.0	-29.9	PK	45	1.0	RB 1 MHz;VB 3 MHz;Peak

- Note: Scans between 18 - 25 GHz performed with the measurement antenna moved around the card and its antennas 20-50cm from the device.
- Note: The emissions at 4.5 and 7.5 GHz are not related to radio. After maximizing the signals; stopped the transmission and the signal level did not change.

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

### Run #2c: Center Channel

Channel: 6                      Mode: n40  
 Tx Chain: Main/Aux            Data Rate: MCS0



Frequency	Level	Pol	15.209 / 15.247	Detector	Azimuth	Height	Comments	
MHz	dB $\mu$ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4264.680	35.0	V	54.0	-19.0	AVG	280	1.0	RB 1 MHz;VB 10 Hz;Peak
4864.960	33.6	H	54.0	-20.4	AVG	0	1.3	RB 1 MHz;VB 10 Hz;Peak
4262.540	53.4	V	74.0	-20.6	PK	280	1.0	RB 1 MHz;VB 3 MHz;Peak
4034.150	31.9	H	54.0	-22.1	AVG	347	1.6	RB 1 MHz;VB 10 Hz;Peak
4846.300	45.6	H	74.0	-28.4	PK	0	1.3	RB 1 MHz;VB 3 MHz;Peak
4032.840	42.9	H	74.0	-31.1	PK	347	1.6	RB 1 MHz;VB 3 MHz;Peak

Note: Scans between 18 - 25 GHz performed with the measurement antenna moved around the card and its antennas 20-50cm from the device.

Note: The emissions at 4.5 and 7.5 GHz are not related to radio. After maximizing the signals; stopped the transmission and the signal level did not change.



# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Run #3: Radiated Spurious Emissions, 1,000 - 25000 MHz. Operating Mode: Worse case from Run #2

Date of Test: 7/7/2015

Config. Used: #1

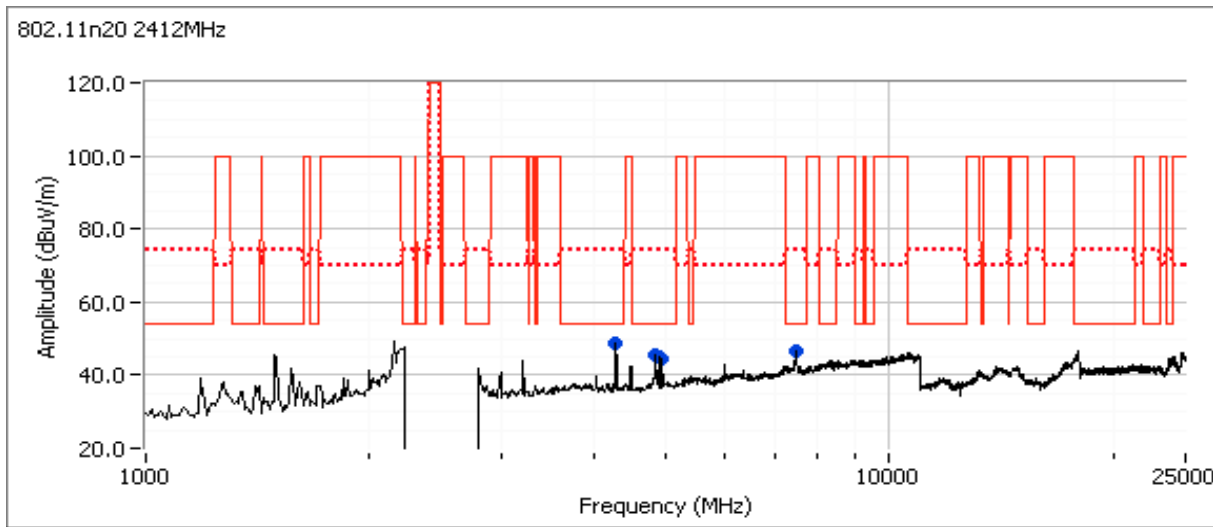
Test Location: Chamber #7

Test Engineer: Joseph Cadigal

EUT Voltage: 120V/60Hz

Run #3a: Low Channel

Channel: 1 Mode: n20  
 Tx Chain: Main/Aux Data Rate: MCS0



Frequency MHz	Level dB $\mu$ V/m	Pol v/h	15.209 / 15.247		Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
			Limit	Margin				
4269.750	36.9	V	54.0	-17.1	AVG	293	1.6	RB 1 MHz;VB 10 Hz;Peak
4836.280	35.5	H	54.0	-18.5	AVG	0	1.6	RB 1 MHz;VB 10 Hz;Peak
4962.560	32.9	H	54.0	-21.1	AVG	360	1.3	RB 1 MHz;VB 10 Hz;Peak
4877.500	32.8	H	54.0	-21.2	AVG	11	1.3	RB 1 MHz;VB 10 Hz;Peak
4846.220	46.3	H	74.0	-27.7	PK	0	1.6	RB 1 MHz;VB 3 MHz;Peak
4270.220	45.1	V	74.0	-28.9	PK	293	1.6	RB 1 MHz;VB 3 MHz;Peak
4895.030	44.3	H	74.0	-29.7	PK	11	1.3	RB 1 MHz;VB 3 MHz;Peak
4949.630	43.9	H	74.0	-30.1	PK	360	1.3	RB 1 MHz;VB 3 MHz;Peak

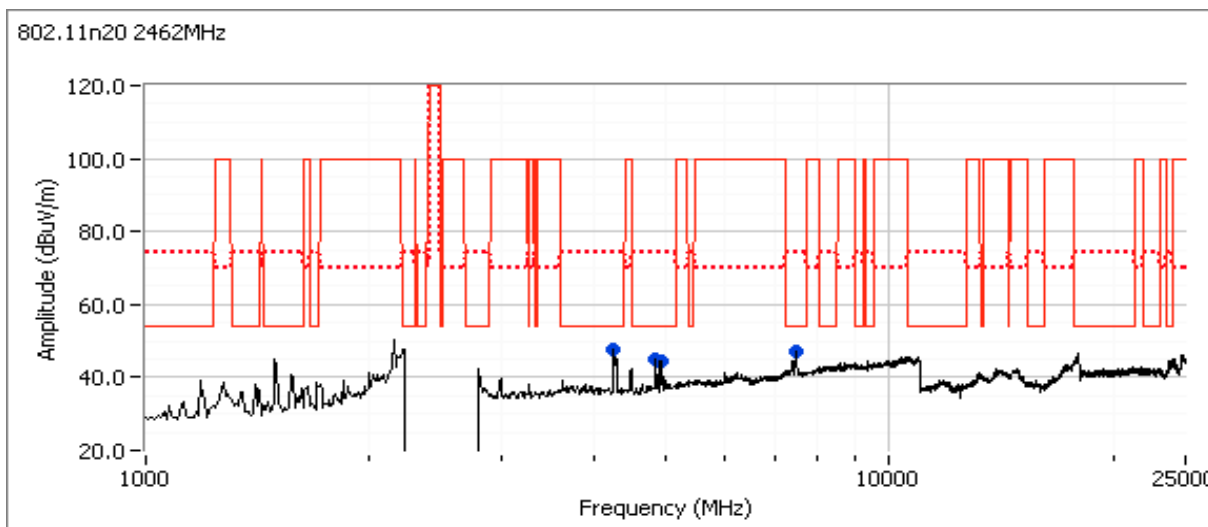
Note: Scans between 18 - 25 GHz performed with the measurement antenna moved around the card and its antennas 20-50cm from the device.

Note: The emissions at 4.5 and 7.5 GHz are not related to radio. After maximizing the signals; stopped the transmission and the signal level did not change.

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

### Run #3b: High Channel

Channel: 11                      Mode: n20  
 Tx Chain: Main/Aux            Data Rate: MCS0



Frequency	Level	Pol	15.209 / 15.247	Detector	Azimuth	Height	Comments	
MHz	dB $\mu$ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4880.970	43.0	H	54.0	-11.0	AVG	360	1.0	RB 1 MHz;VB 10 Hz;Peak
4946.110	40.7	H	54.0	-13.3	AVG	41	1.0	RB 1 MHz;VB 10 Hz;Peak
4256.550	33.6	V	54.0	-20.4	AVG	237	1.6	RB 1 MHz;VB 10 Hz;Peak
4837.570	32.8	H	54.0	-21.2	AVG	0	1.6	RB 1 MHz;VB 10 Hz;Peak
4890.910	47.8	H	74.0	-26.2	PK	360	1.0	RB 1 MHz;VB 3 MHz;Peak
4846.370	46.6	H	74.0	-27.4	PK	0	1.6	RB 1 MHz;VB 3 MHz;Peak
4932.460	45.4	H	74.0	-28.6	PK	41	1.0	RB 1 MHz;VB 3 MHz;Peak
4253.870	44.3	V	74.0	-29.7	PK	237	1.6	RB 1 MHz;VB 3 MHz;Peak

- Note: Scans between 18 - 40 GHz performed with the measurement antenna moved around the card and its antennas 20-50cm from the device.
- Note: The emissions at 4.5 and 7.5 GHz are not related to radio. After maximizing the signals; stopped the transmission and the signal level did not change.



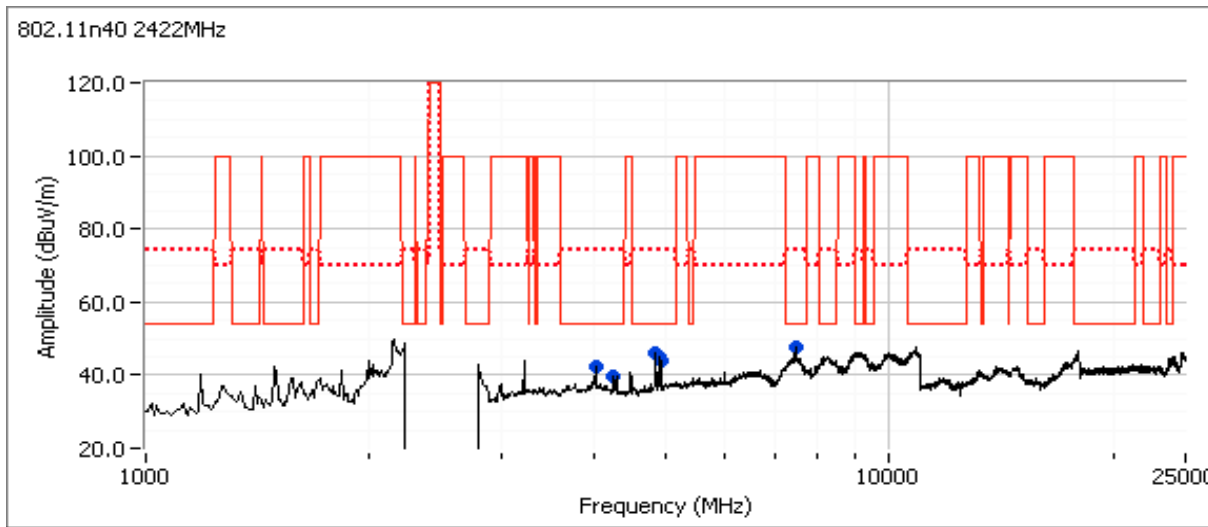
# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Run #4: Radiated Spurious Emissions, 1,000 - 25000 MHz. Operating Mode: 40MHz - use if worse case from 2  
 Date of Test: 7/7/2015 Config. Used: #1  
 Test Location: Chamber #7 Test Engineer: Joseph Cadigal  
 EUT Voltage: 120V/60Hz

### Run #4a: Low Channel

Channel: 3 Mode: n40  
 Tx Chain: Main/Aux Data Rate: MCS0



Frequency MHz	Level dB $\mu$ V/m	Pol v/h	15.209 / 15.247		Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
			Limit	Margin				
4895.980	42.4	H	54.0	-11.6	AVG	358	1.0	RB 1 MHz;VB 10 Hz;Peak
4032.050	34.2	V	54.0	-19.8	AVG	222	1.3	RB 1 MHz;VB 10 Hz;Peak
4261.780	30.9	H	54.0	-23.1	AVG	305	2.5	RB 1 MHz;VB 10 Hz;Peak
4835.030	30.3	H	54.0	-23.7	AVG	7	1.0	RB 1 MHz;VB 10 Hz;Peak
4030.160	42.3	V	74.0	-31.7	PK	222	1.3	RB 1 MHz;VB 3 MHz;Peak
4897.060	41.8	H	74.0	-32.2	PK	358	1.0	RB 1 MHz;VB 3 MHz;Peak
4260.760	41.6	H	74.0	-32.4	PK	305	2.5	RB 1 MHz;VB 3 MHz;Peak
4852.030	41.6	H	74.0	-32.4	PK	7	1.0	RB 1 MHz;VB 3 MHz;Peak

Note: Scans between 18 - 25 GHz performed with the measurement antenna moved around the card and its antennas 20-50cm from the device.

Note: The emissions at 4.5 and 7.5 GHz are not related to radio. After maximizing the signals; stopped the transmission and the signal level did not change.

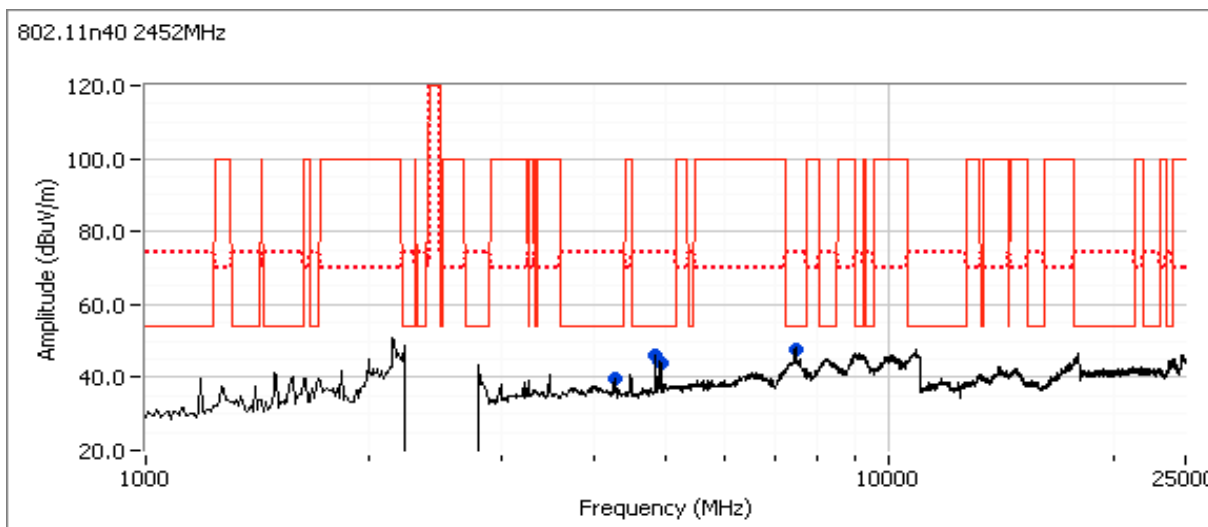


# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

## Run #4b: High Channel

Channel: 9                      Mode: n40  
 Tx Chain: Main/Aux            Data Rate: MCS0



Frequency	Level	Pol	15.209 / 15.247	Detector	Azimuth	Height	Comments	
MHz	dB $\mu$ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4836.460	31.5	H	54.0	-22.5	AVG	6	1.3	RB 1 MHz;VB 10 Hz;Peak
4262.330	30.5	H	54.0	-23.5	AVG	311	2.2	RB 1 MHz;VB 10 Hz;Peak
4898.150	29.5	V	54.0	-24.5	AVG	358	1.0	RB 1 MHz;VB 10 Hz;Peak
4941.670	29.2	H	54.0	-24.8	AVG	32	1.3	RB 1 MHz;VB 10 Hz;Peak
4261.430	42.3	H	74.0	-31.7	PK	311	2.2	RB 1 MHz;VB 3 MHz;Peak
4899.100	40.7	V	74.0	-33.3	PK	358	1.0	RB 1 MHz;VB 3 MHz;Peak
4941.870	40.5	H	74.0	-33.5	PK	32	1.3	RB 1 MHz;VB 3 MHz;Peak
4837.540	40.4	H	74.0	-33.6	PK	6	1.3	RB 1 MHz;VB 3 MHz;Peak

- Note: Scans between 18 - 40 GHz performed with the measurement antenna moved around the card and its antennas 20-50cm from the device.
- Note: The emissions at 4.5 and 7.5 GHz are not related to radio. After maximizing the signals; stopped the transmission and the signal level did not change.





# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

## 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 and 1.5 meters high, unless otherwise noted.

### Ambient Conditions:

Temperature: 21.8 °C  
Rel. Humidity: 35 %

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

Run #	Mode	Channel	Power Setting	Passing Setting	Test Performed	Limit	Result / Margin
1	b	1 - 2412MHz	20.0	20	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247( c)	47.3 dBµV/m @ 2389.8 MHz (-6.7 dB)
	b	11 - 2462MHz	20.0	20	Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247( c)	50.5 dBµV/m @ 2483.5 MHz (-3.5 dB)
2	g	1 - 2412MHz	17.5	17.5	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247( c)	72.8 dBµV/m @ 2388.6 MHz (-1.2 dB)
	g	2 - 2417MHz	19.5	19.5	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247( c)	70.4 dBµV/m @ 2389.8 MHz (-3.6 dB)
	g	10 - 2457MHz	19.0	19.0	Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247( c)	53.7 dBµV/m @ 2483.5 MHz (-0.3 dB)
	g	11 - 2462MHz	17.5	17.5	Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247( c)	73.5 dBµV/m @ 2483.9 MHz (-0.5 dB)



# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Run #	Mode	Channel	Power Setting	Passing Setting	Test Performed	Limit	Result / Margin
3	n20	1 - 2412MHz	17.5	17.5	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247( c)	51.0 dBµV/m @ 2389.6 MHz (-3.0 dB)
	n20	2 - 2417MHz	19.0	19.0	Restricted Band Edge (2390 MHz)		50.4 dBµV/m @ 2390.0 MHz (-3.6 dB)
	n20	9 - 2457MHz	18.5	18.5	Restricted Band Edge (2483.5 MHz)		71.6 dBµV/m @ 2483.9 MHz (-2.4 dB)
	n20	10 - 2457MHz	18.5	17.5	Restricted Band Edge (2483.5 MHz)		73.6 dBµV/m @ 2484.0 MHz (-0.4 dB)
	n20	11 - 2462MHz	17.0	14.0	Restricted Band Edge (2483.5 MHz)		73.5 dBµV/m @ 2486.4 MHz (-0.5 dB)
4	n40	3 - 2422MHz	14.5	14.5	Restricted Band Edge (2390 MHz)		51.2 dBµV/m @ 2389.7 MHz (-2.8 dB)
		4 - 2427MHz	16.0	16.0			51.6 dBµV/m @ 2389.6 MHz (-2.4 dB)
		5 - 2432MHz	17.0	17.5			52.9 dBµV/m @ 2389.5 MHz (-1.1 dB)
		6 - 2437MHz	17.0	17.5			50.2 dBµV/m @ 2389.6 MHz (-3.8 dB)
		6 - 2437MHz	17.0	17.5	Restricted Band Edge (2483.5 MHz)		53.6 dBµV/m @ 2484.1 MHz (-0.4 dB)
		7 - 2442MHz	17.0	16.5			53.5 dBµV/m @ 2484.0 MHz (-0.5 dB)
		8 - 2447MHz	17.0	15.5		73.5 dBµV/m @ 2484.5 MHz (-0.5 dB)	
		9 - 2452MHz -	16.0	15.0		72.9 dBµV/m @ 2487.2 MHz (-1.1 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.

**Sample Notes**  
 Sample S/N: G54DA5DN000024  
 Driver: 5.99 RC 188.10  
 Antenna: Internal



# EMC Test Data

Client:	Pace Americas, Inc.	Job Number:	J98591
Model:	HR54-700	T-Log Number:	T98678
		Project Manager:	Irene Radmacher
Contact:	Mark Rieger	Project Coordinator:	-
Standard:	FCC 15.247, 15.407	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.

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
11b	1Mb/s	0.98	Yes	2.737	0	0	10
11g	6Mb/s	0.98	Yes	1.423	0	0	10
n20	MCS0	0.99	Yes	1.33	0	0	10
n40	MCS0	0.98	Yes	1.33	0	0	10

## Measurement Specific Notes:

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 6:	Plots of the average and peak bandedge do not account for any duty cycle correction. Refer to the tabular results for final measurements.



# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radamacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A

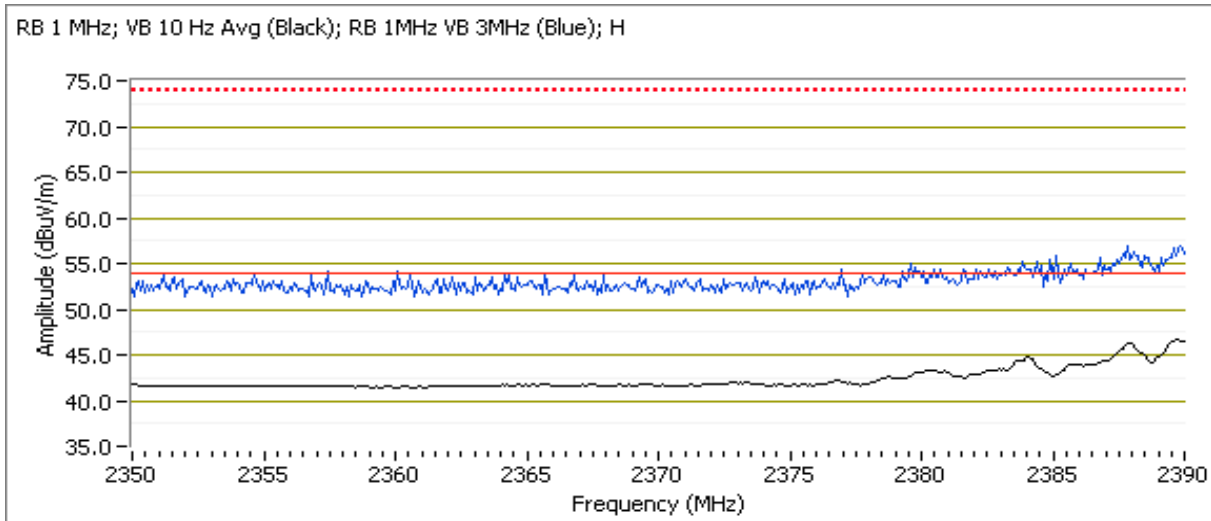
### Run #1: Radiated Bandedge Measurements

Date of Test: 6/19/2015 0:00      Config. Used: 1  
 Test Engineer: Rafael Varelas      Config Change: None  
 Test Location: FT Chamber #5      EUT Voltage: 120V/60Hz

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

### Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB $\mu$ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2389.760	47.1	H	54.0	-6.9	AVG	292	1.3	Note 3,POS; RB 1 MHz; VB: 10 Hz
2389.520	55.7	H	74.0	-18.3	PK	292	1.3	POS; RB 1 MHz; VB: 3 MHz
2389.200	38.3	V	54.0	-15.7	AVG	360	1.2	POS; RB 1 MHz; VB: 10 Hz
2388.880	48.2	V	74.0	-25.8	PK	360	1.2	POS; RB 1 MHz; VB: 3 MHz





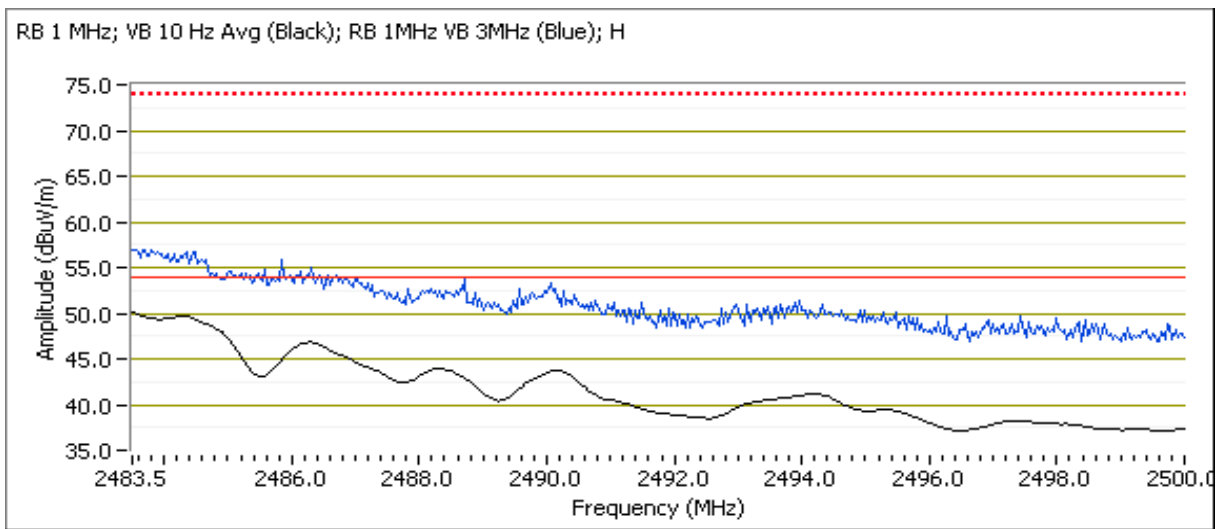
# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Channel: 11                      Mode: b  
 Tx Chain: Main/Aux            Data Rate: 1Mb/s

### Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB $\mu$ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2483.530	50.3	H	54.0	-3.7	AVG	39	2.2	Note 3,POS; RB 1 MHz; VB: 10 Hz
2483.960	56.5	H	74.0	-17.5	PK	39	2.2	POS; RB 1 MHz; VB: 3 MHz
2484.330	47.7	V	54.0	-6.3	AVG	360	1.0	POS; RB 1 MHz; VB: 10 Hz
2484.430	54.0	V	74.0	-20.0	PK	360	1.0	POS; RB 1 MHz; VB: 3 MHz





# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radamacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A

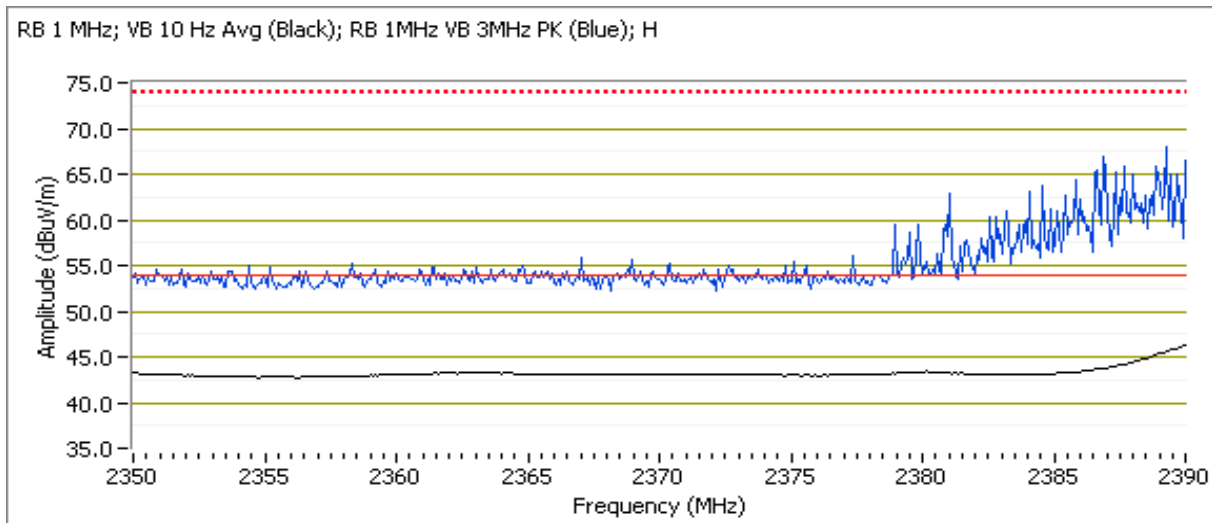
## Run #2: Radiated Bandedge Measurements

Date of Test: 6/19/2015 0:00      Config. Used: 1  
 Test Engineer: Rafael Varelas      Config Change: None  
 Test Location: FT Chamber #5      EUT Voltage: 120V/60Hz

Channel: 1      Mode: g  
 Tx Chain: 1 (0x01)      Data Rate: 6Mb/s

## Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB $\mu$ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2390.000	46.5	H	54.0	-7.5	AVG	66	1.3	Note 3,POS; RB 1 MHz; VB: 10 Hz
2388.560	72.8	H	74.0	-1.2	PK	66	1.3	POS; RB 1 MHz; VB: 3 MHz
2390.000	41.5	V	54.0	-12.5	AVG	240	2.6	POS; RB 1 MHz; VB: 10 Hz
2388.880	62.9	V	74.0	-11.1	PK	240	2.6	POS; RB 1 MHz; VB: 3 MHz





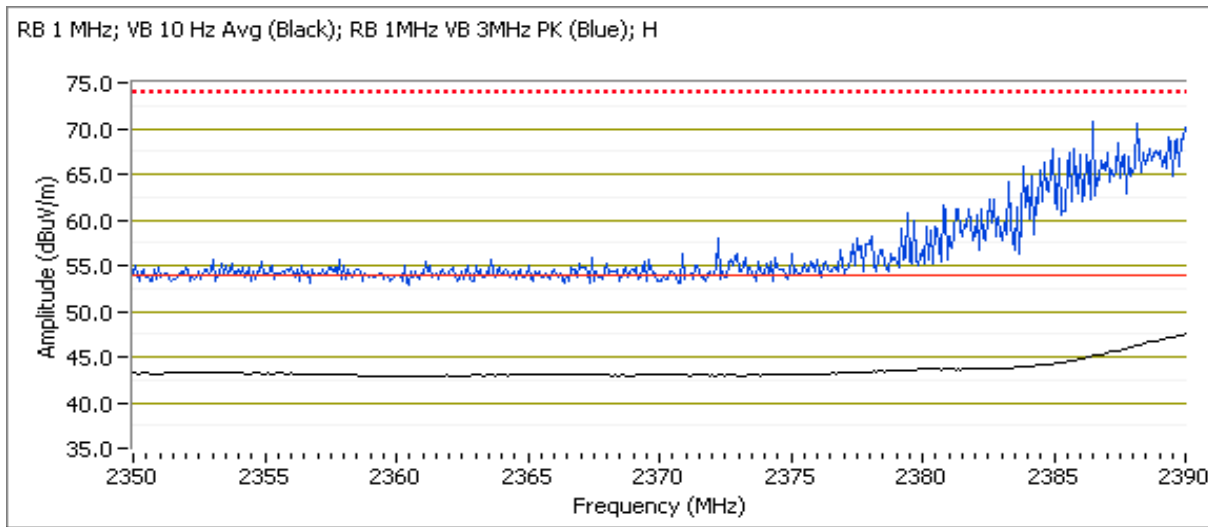
# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Channel: 2                      Mode: g  
 Tx Chain: 1 (0x01)            Data Rate: 6Mb/s

### Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB $\mu$ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2390.000	47.7	H	54.0	-6.5	AVG	75	1.1	Note 3,POS; RB 1 MHz; VB: 10 Hz
2389.760	70.4	H	74.0	-3.6	PK	75	1.1	POS; RB 1 MHz; VB: 3 MHz
2390.000	41.2	V	54.0	-12.8	AVG	246	1.0	POS; RB 1 MHz; VB: 10 Hz
2386.230	62.0	V	74.0	-12.0	PK	246	1.0	POS; RB 1 MHz; VB: 3 MHz





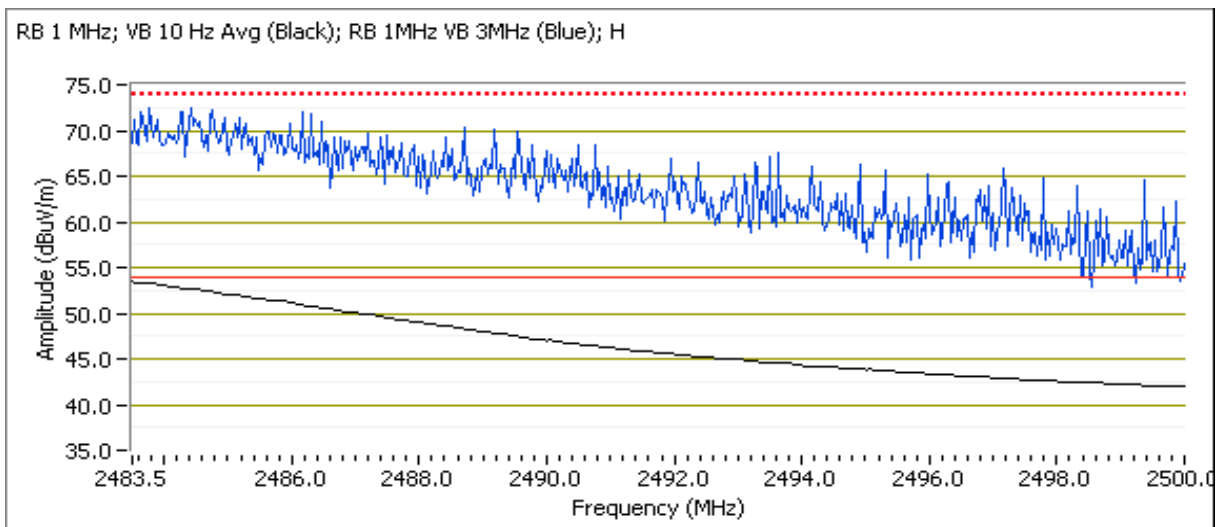
# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Channel: 10                      Mode: g  
 Tx Chain: 1 (0x01)            Data Rate: 6Mb/s

### Band Edge Signal Field Strength - Direct measurement of field strength

Frequency MHz	Level dB $\mu$ V/m	Pol v/h	15.209 / 15.247		Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
			Limit	Margin				
2483.500	53.7	H	54.0	-0.3	AVG	319	1.0	Note 3,POS; RB 1 MHz; VB: 10 Hz
2488.790	72.3	H	74.0	-1.7	PK	319	1.0	POS; RB 1 MHz; VB: 3 MHz
2483.570	48.1	V	54.0	-5.9	AVG	353	1.0	POS; RB 1 MHz; VB: 10 Hz
2484.190	61.7	V	74.0	-12.3	PK	353	1.0	POS; RB 1 MHz; VB: 3 MHz







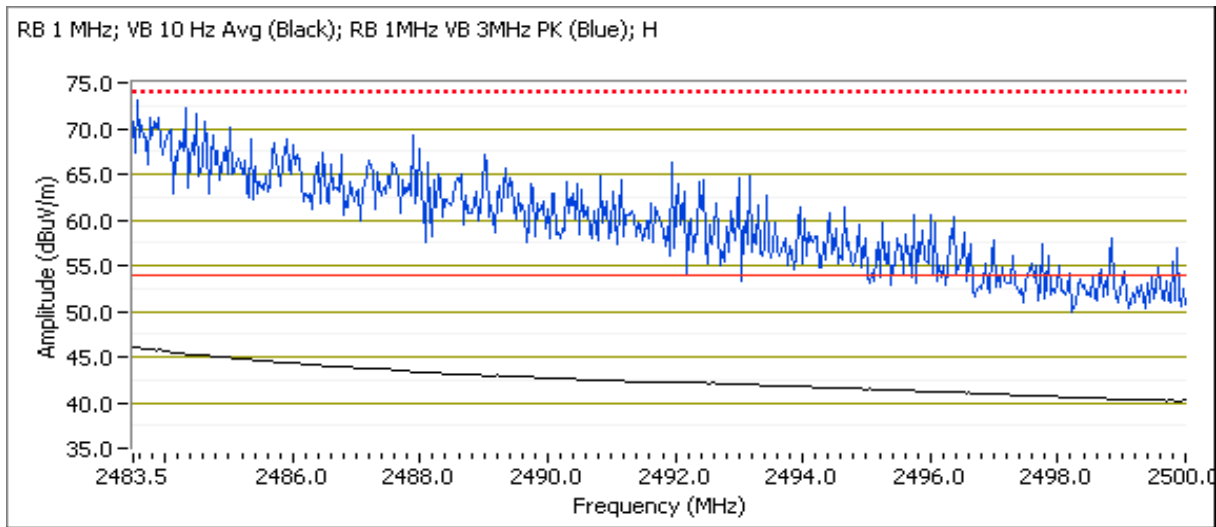
# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Channel: 11                      Mode: g  
 Tx Chain: 1 (0x01)            Data Rate: 6Mb/s

### Band Edge Signal Field Strength - Direct measurement of field strength

Frequency MHz	Level dB $\mu$ V/m	Pol v/h	15.209 / 15.247		Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
			Limit	Margin				
2483.500	46.4	H	54.0	-7.6	AVG	298	1.0	Note 3,POS; RB 1 MHz; VB: 10 Hz
2483.900	73.5	H	74.0	-0.5	PK	298	1.0	POS; RB 1 MHz; VB: 3 MHz
2483.500	42.6	V	54.0	-11.4	AVG	251	1.0	POS; RB 1 MHz; VB: 10 Hz
2483.500	70.1	V	74.0	-3.9	PK	251	1.0	POS; RB 1 MHz; VB: 3 MHz





# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

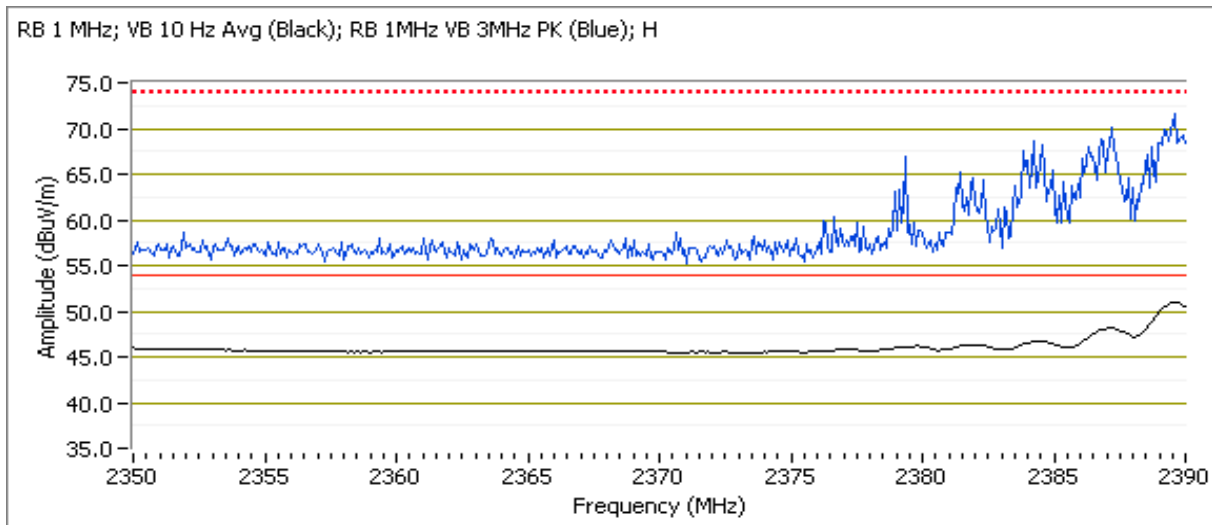
### Run #3: Radiated Bandedge Measurements

Date of Test: 6/19/2015 0:00  
 Test Engineer: Rafael Varelas  
 Test Location: FT Chamber #5  
 Config. Used: 1  
 Config Change: None  
 EUT Voltage: 120V/60Hz

Channel: 1 Mode: n20  
 Tx Chain: 2x2 Data Rate: MCS0

### Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB $\mu$ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2389.600	51.0	H	54.0	-3.0	AVG	74	1.3	POS; RB 1 MHz; VB: 10 Hz
2383.990	69.8	H	74.0	-4.2	PK	74	1.3	POS; RB 1 MHz; VB: 3 MHz
2390.000	42.7	V	54.0	-11.3	AVG	255	1.0	POS; RB 1 MHz; VB: 10 Hz
2389.840	61.0	V	74.0	-13.0	PK	255	1.0	POS; RB 1 MHz; VB: 3 MHz





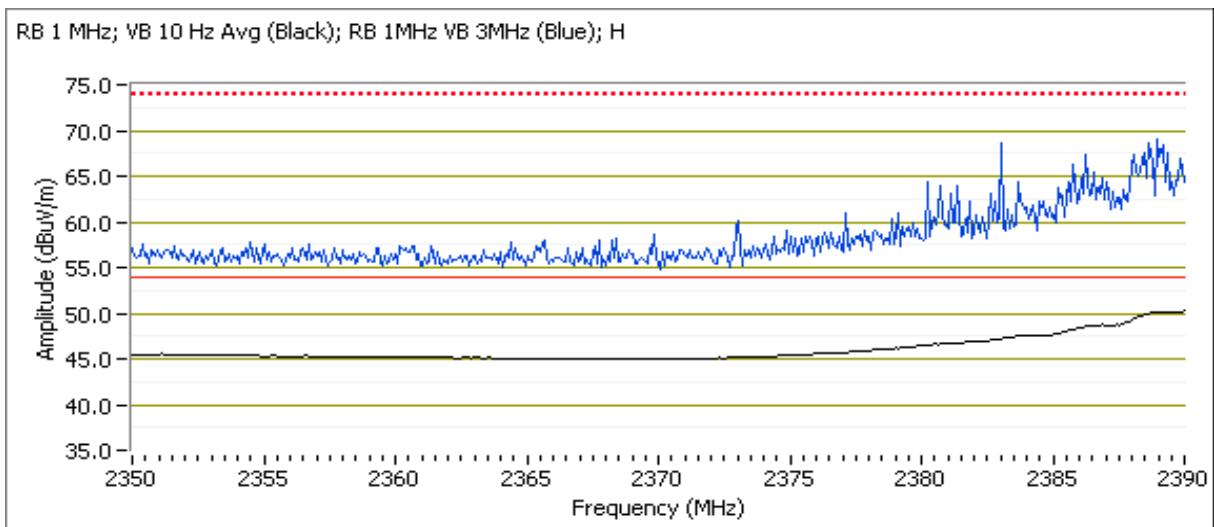
# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

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

### Band Edge Signal Field Strength - Direct measurement of field strength

Frequency MHz	Level dB $\mu$ V/m	Pol v/h	15.209 / 15.247		Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
			Limit	Margin				
2390.000	50.4	H	54.0	-3.6	AVG	297	1.3	POS; RB 1 MHz; VB: 10 Hz
2388.720	70.1	H	74.0	-3.9	PK	297	1.3	POS; RB 1 MHz; VB: 3 MHz
2390.000	45.8	V	54.0	-8.2	AVG	288	2.2	POS; RB 1 MHz; VB: 10 Hz
2386.070	62.6	V	74.0	-11.4	PK	288	2.2	POS; RB 1 MHz; VB: 3 MHz





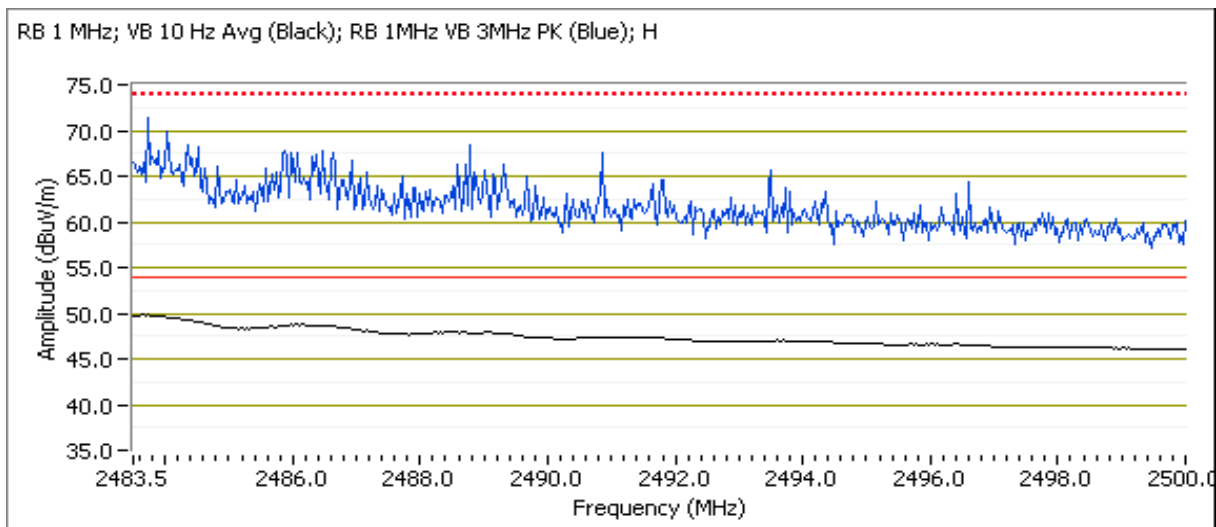
# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Channel: 9                      Mode: n20  
 Tx Chain: 2x2                Data Rate: MCS0

### Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB $\mu$ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2483.930	49.8	H	54.0	-4.2	AVG	303	1.2	POS; RB 1 MHz; VB: 10 Hz
2483.860	71.6	H	74.0	-2.4	PK	303	1.2	POS; RB 1 MHz; VB: 3 MHz





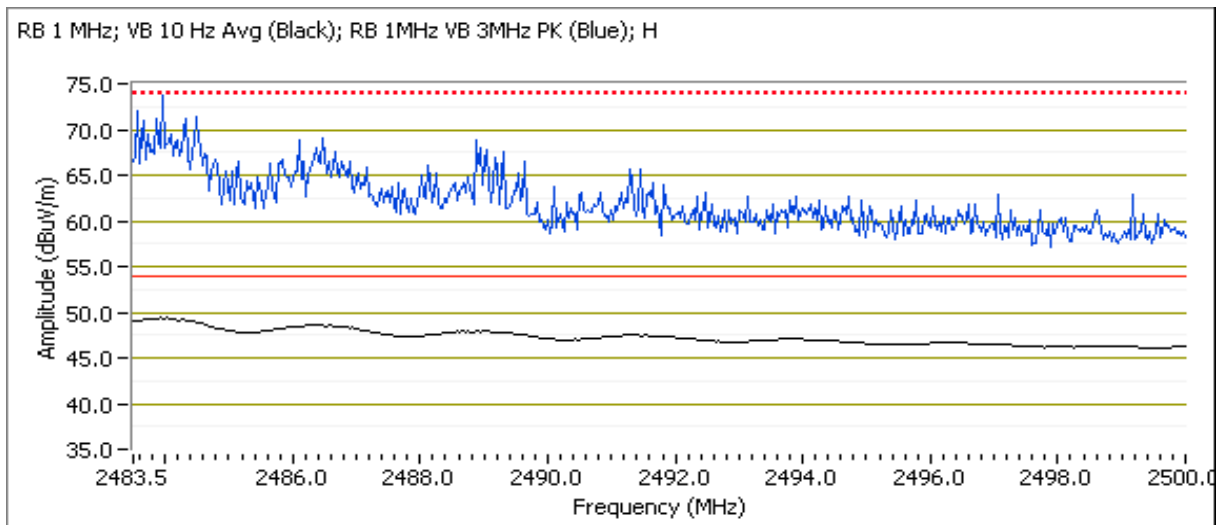
# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Channel: 10                      Mode: n20  
 Tx Chain: 2x2                      Data Rate: MCS0

### Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB $\mu$ V/m	v/h	Limit	Margin	PK/QP/Avg	degrees	meters	
Pwr setting = 17.5								
2483.700	49.5	H	54.0	-4.5	AVG	302	1.2	POS; RB 1 MHz; VB: 10 Hz
2484.030	73.6	H	74.0	-0.4	PK	302	1.2	POS; RB 1 MHz; VB: 3 MHz
2484.790	41.9	V	54.0	-12.1	AVG	251	1.0	POS; RB 1 MHz; VB: 10 Hz
2483.860	65.5	V	74.0	-8.5	PK	251	1.0	POS; RB 1 MHz; VB: 3 MHz





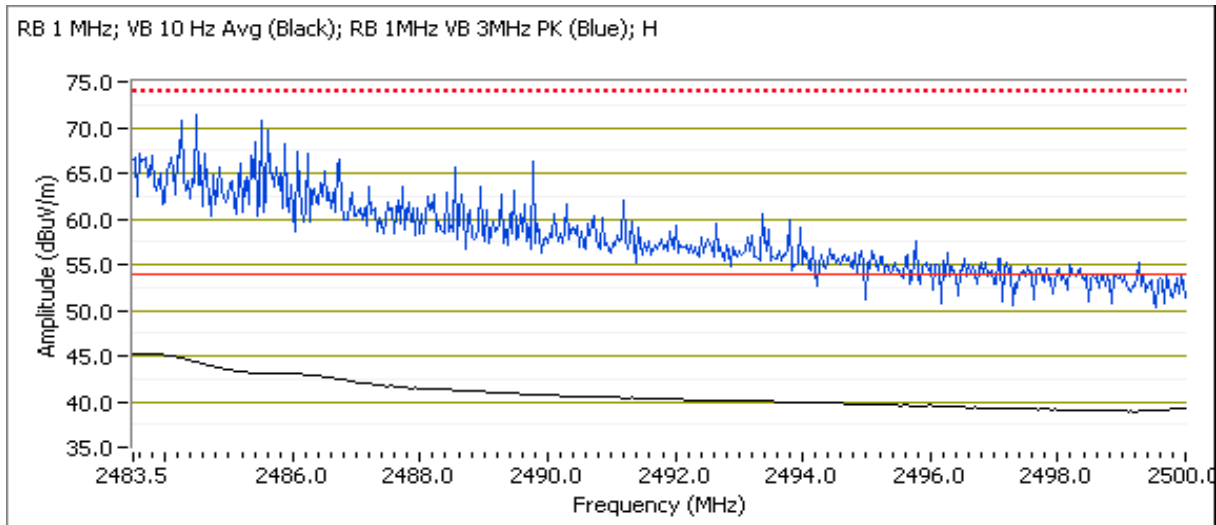
# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

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

### Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB $\mu$ V/m	v/h	Limit	Margin	PK/QP/Avg	degrees	meters	
Pwr setting = 14.0								
2483.690	45.4	H	54.0	-8.6	AVG	80	1.1	POS; RB 1 MHz; VB: 10 Hz
2486.360	73.5	H	74.0	-0.5	PK	80	1.1	POS; RB 1 MHz; VB: 3 MHz
2483.600	40.4	V	54.0	-13.6	AVG	250	2.2	POS; RB 1 MHz; VB: 10 Hz
2487.570	61.8	V	74.0	-12.2	PK	250	2.2	POS; RB 1 MHz; VB: 3 MHz





# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

## Run #4: Radiated Bandedge Measurements

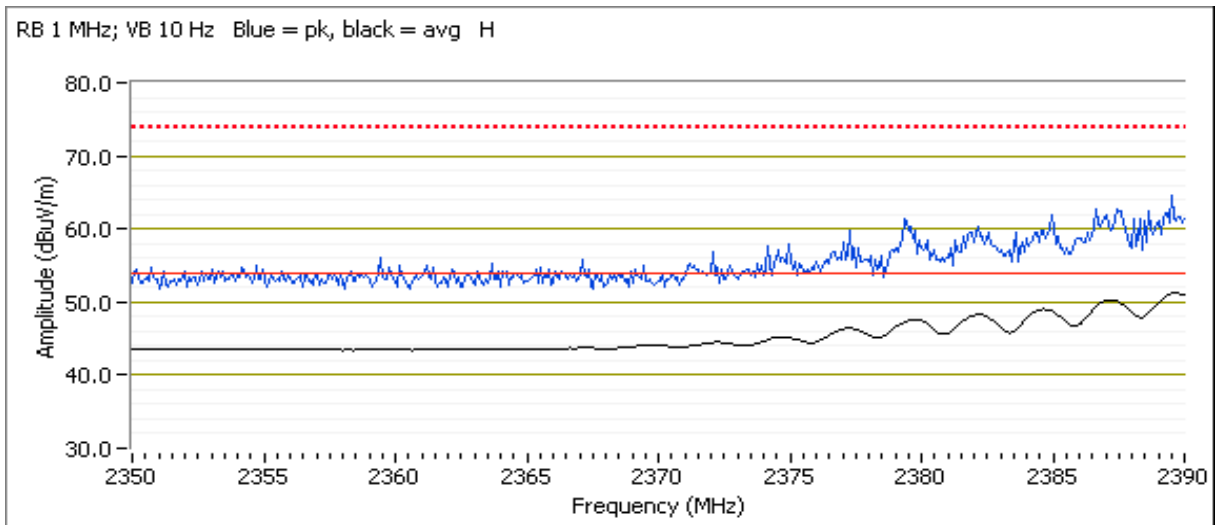
Date of Test: 6/22/2015 0:00  
 Test Engineer: John Caizzi  
 Test Location: Chamber 5

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

Channel: 3                      Mode: n40  
 Tx Chain: 2x2                 Data Rate: MCS0

### Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB $\mu$ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2389.680	51.2	H	54.0	-2.8	AVG	70	1.14	Setting = q58
2388.960	65.6	H	74.0	-8.4	PK	70	1.14	Setting = q58





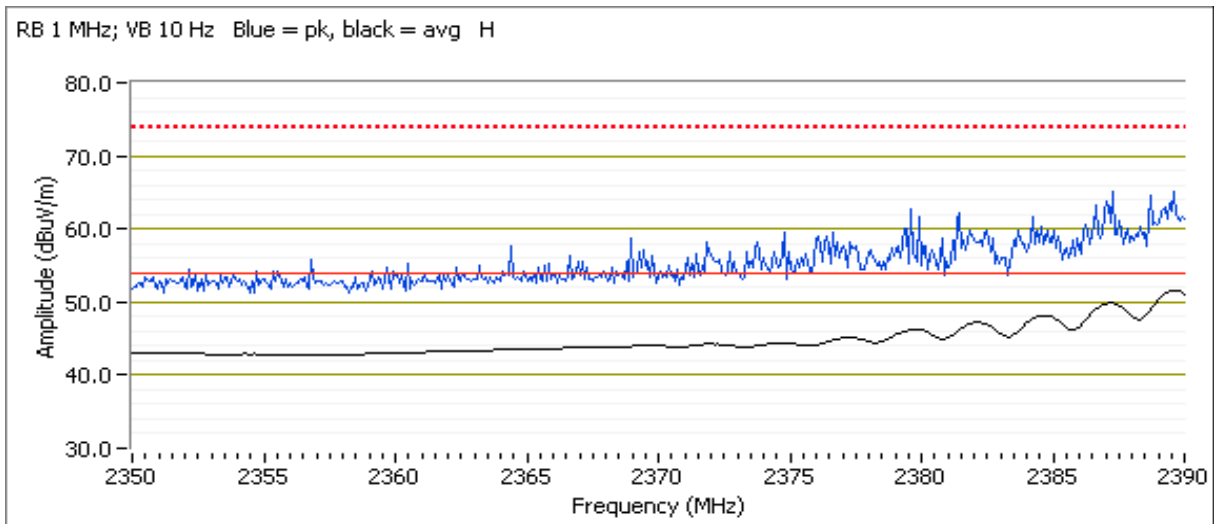
# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Channel: 4                      Mode: n40  
 Tx Chain: 2x2                Data Rate: MCS0

### Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB $\mu$ V/m	v/h	Limit	Margin	PK/QP/Avg	degrees	meters	
2389.600	51.6	H	54.0	-2.4	AVG	68	1.32	Setting = q64
2379.740	66.1	H	74.0	-7.9	PK	68	1.32	Setting = q64







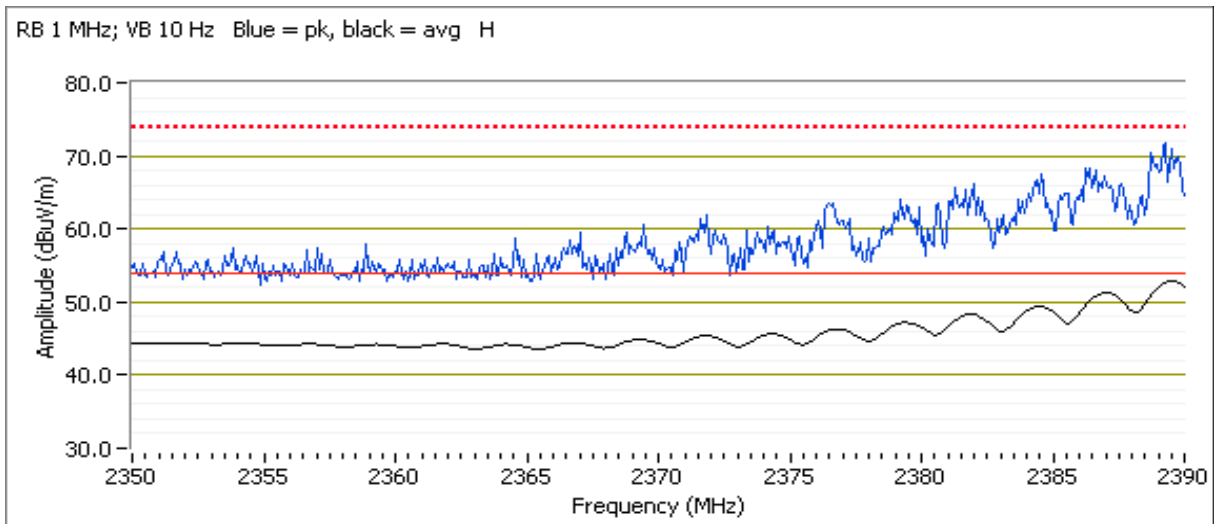
# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Channel: 5                      Mode: n40  
 Tx Chain: 2x2                Data Rate: MCS0

### Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB $\mu$ V/m	v/h	Limit	Margin	PK/QP/Avg	degrees	meters	
2389.520	52.9	H	54.0	-1.1	AVG	292	1.35	Setting = q70
2384.150	71.7	H	74.0	-2.3	PK	292	1.35	Setting = q70





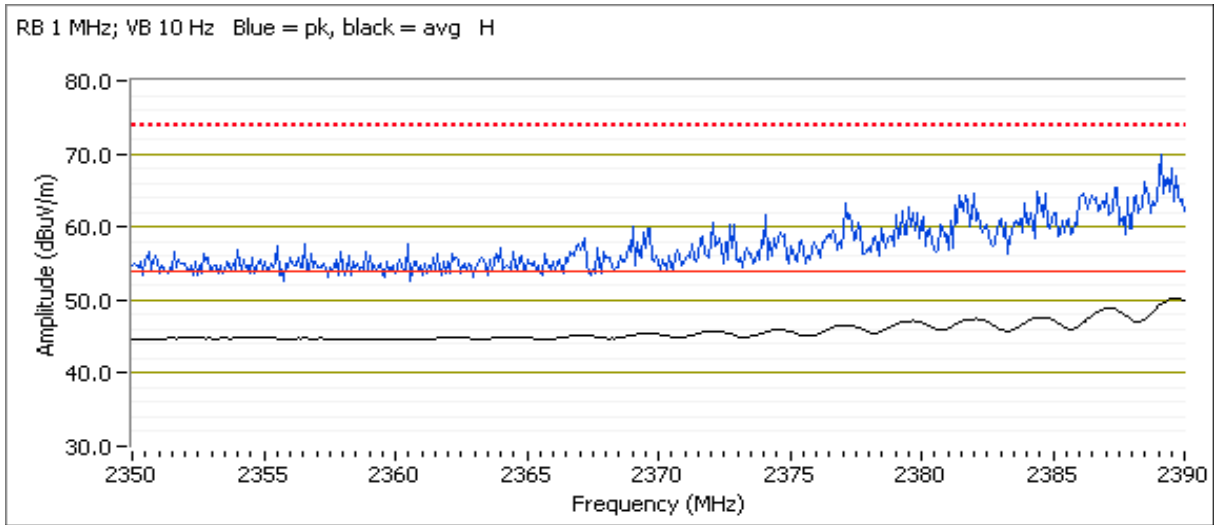
# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Channel: 6                      Mode: n40  
 Tx Chain: 2x2                Data Rate: MCS0

### Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB $\mu$ V/m	v/h	Limit	Margin	PK/QP/Avg	degrees	meters	
2389.600	50.2	H	54.0	-3.8	AVG	72	1.15	Setting = q70
2386.470	67.9	H	74.0	-6.1	PK	72	1.15	Setting = q70





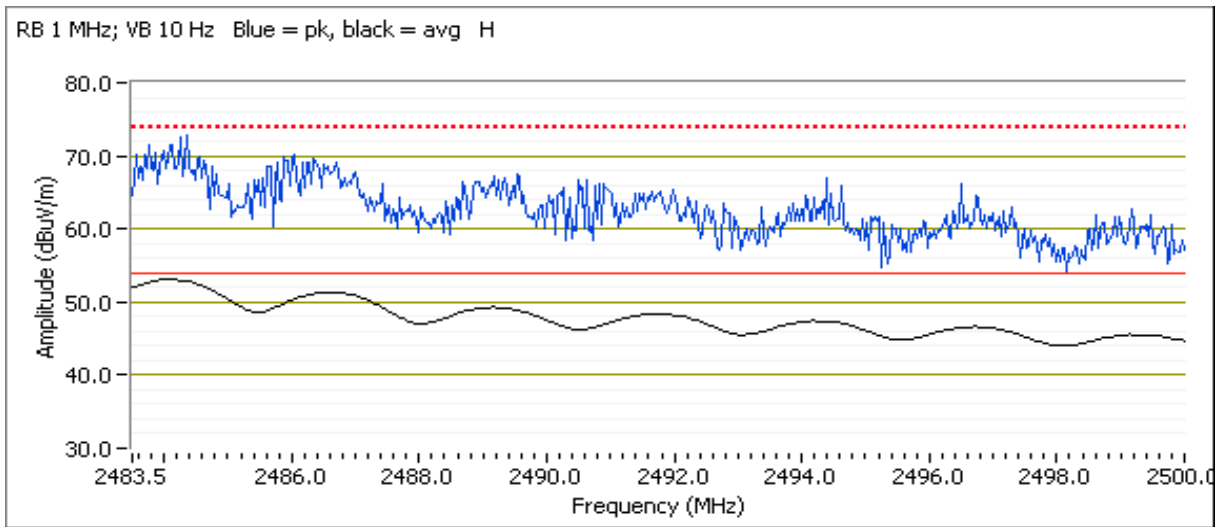
# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Channel: 6                      Mode: n40  
 Tx Chain: 2x2                Data Rate: MCS0

### Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB $\mu$ V/m	v/h	Limit	Margin	PK/QP/Avg	degrees	meters	
2484.100	53.6	H	54.0	-0.4	AVG	295	1.03	Setting = q69
2483.860	73.5	H	74.0	-0.5	PK	295	1.03	Setting = q69





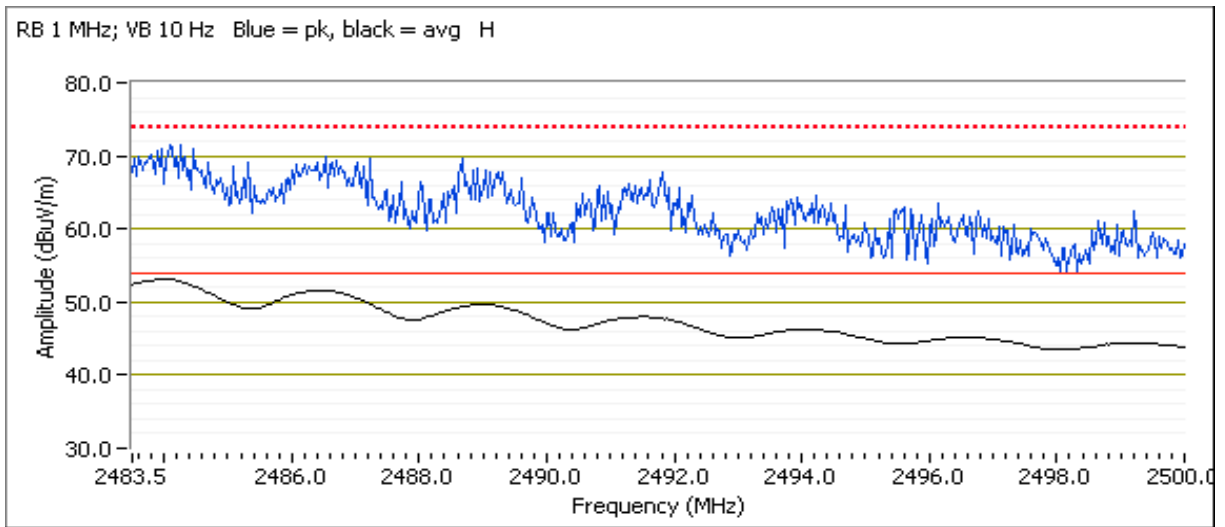
# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Channel: 7                      Mode: n40  
 Tx Chain: 2x2                Data Rate: MCS0

### Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB $\mu$ V/m	v/h	Limit	Margin	PK/QP/Avg	degrees	meters	
2484.000	53.5	H	54.0	-0.5	AVG	286	1.04	Setting = q66
2484.100	73.1	H	74.0	-0.9	PK	286	1.04	Setting = q66





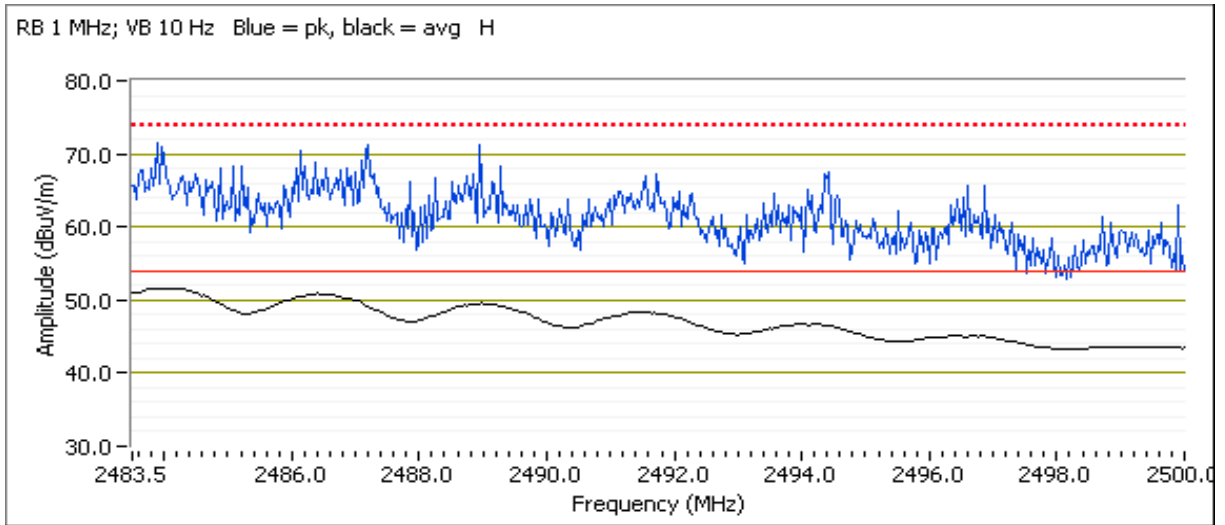
# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radamacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A

Channel: 8                      Mode: n40  
 Tx Chain: 2x2                Data Rate: MCS0

### Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB $\mu$ V/m	v/h	Limit	Margin	PK/QP/Avg	degrees	meters	
2483.960	52.3	H	54.0	-1.7	AVG	293	1.39	Setting = q62
2484.460	73.5	H	74.0	-0.5	PK	293	1.39	Setting = q62





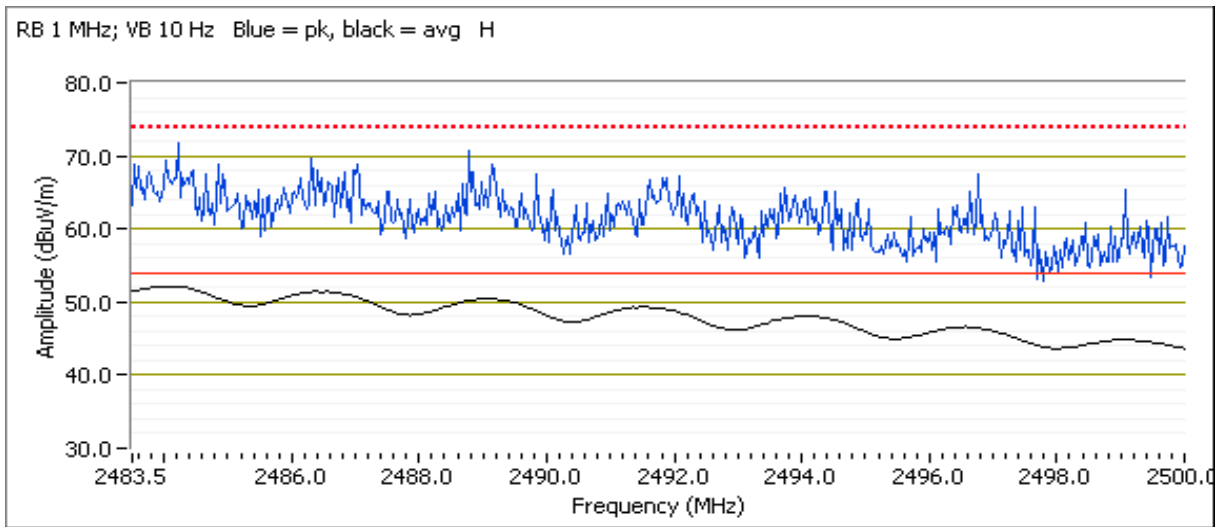
# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Channel: 9                      Mode: n40  
 Tx Chain: 2x2                Data Rate: MCS0

### Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB $\mu$ V/m	v/h	Limit	Margin	PK/QP/Avg	degrees	meters	
2484.100	52.4	H	54.0	-1.6	AVG	292	1.06	Setting = q60
2487.170	72.9	H	74.0	-1.1	PK	292	1.06	Setting = q60





# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radamacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A

## FCC 15.247 (DTS) Antenna Port Measurements MIMO and Smart Antenna Systems Power, PSD, 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: 7/10/2015  
Test Engineer: M. Birgani / J. Cadigal

Test Location: Lab 4A  
EUT Voltage: 120V/60Hz

### General Test Configuration

The EUT was connected to the spectrum analyzer or power meter via a suitable attenuator. All measurements were made on a single chain.

All measurements have been corrected to allow for the external attenuators used.

**Ambient Conditions:** Temperature: 20-22 °C  
Rel. Humidity: 30-35 %

### Summary of Results

Run #	Pwr setting	Avg Pwr	Test Performed	Limit	Pass / Fail	Result / Margin
1	-		Output Power	15.247(b)	Pass	b: 20.3 dBm (0.107W) g: 20.1 dBm (0.102W) n20: 22.8 dBm(0.189W) n40: 21.2 dBm(0.099W)
2	20		Power spectral Density (PSD)	15.247(d)	Pass	b: 4.2 dBm/10kHz g: 1.2 dBm/10kHz n20: 4.3 dBm/10kHz n40: 4.2dBm/10kHz
3	20		Minimum 6dB Bandwidth	15.247(a)	Pass	8.1MHz minimum
3	20		99% Bandwidth	RSS GEN	N/A	-
4	see data below		Spurious emissions	15.247(b)	Pass	All signals below -30dBc

### Modifications Made During Testing

No modifications were made to the EUT during testing

### Deviations From The Standard

Power measurements were performed with an RBW=1MHz, VBW=3MHz, rather than 1-5% of the OBW.



# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radamacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A

## Sample Notes

Sample S/N:  
 Driver: 5.99 RC 188.10  
 Antenna: internal

## Test Notes

Legacy modes (802.11 b/g) are single chain only

## Procedure Comments:

Measurements performed in accordance with FCC KDB 558074

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
11b	1 Mb/s	99.9%	yes	8.43	0	0	119
11g	6 Mb/s	98.3%	yes	1.41	0	0	707
n20	MCS 0	99.2%	yes	1.33	0	0	752
n40	MCS 0	98.4%	yes	1.33	0	0	752

## Antenna Gain Information

Freq	Antenna Gain (dBi) / Chain				BF	MultiChain Legacy	CDD	Sectorized / Xpol	Dir G (PWR)	Dir G (PSD)
	1	2	3	4						
2.4-2.4835 GHz	3.3	3.3			No	No	Yes	No	3.3	6.3

## For devices that support CDD modes

Min # of spatial streams:  
 Max # of spatial streams:

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; Dir G (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 KDB 662911 D01, v02.





# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radamacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A

## Run #1: Output Power

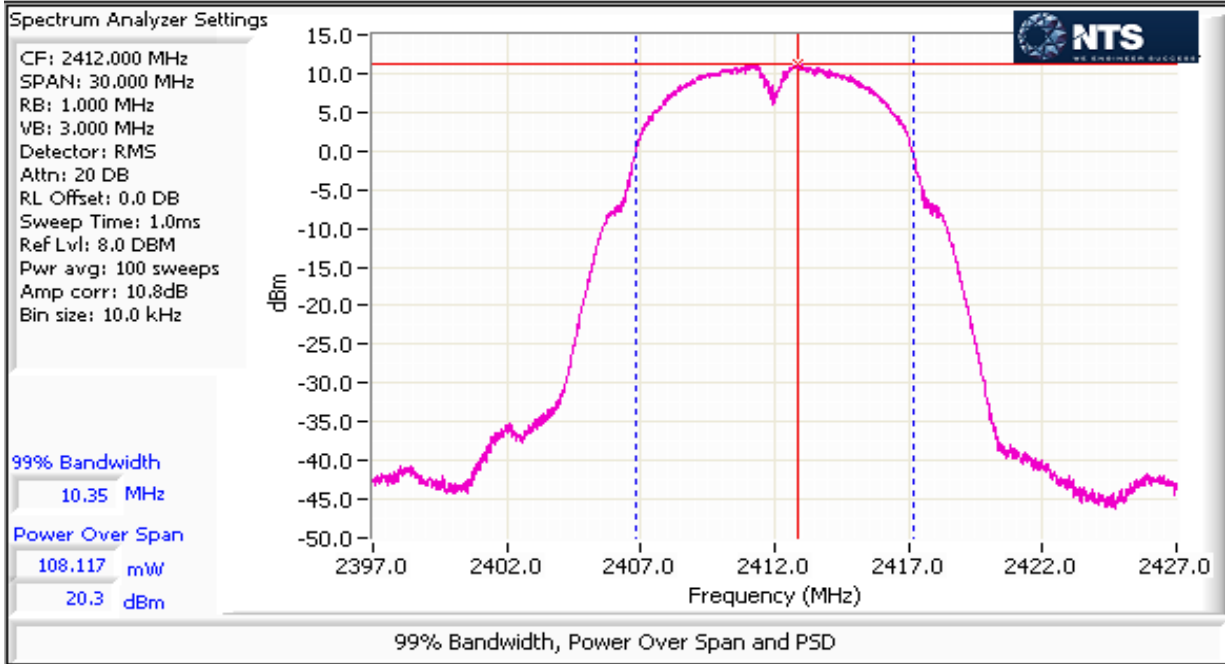
Note 1: Duty Cycle  $\geq 98\%$ . Output power measured using a spectrum analyzer (see plots below) with RBW= 1-5% of OBW, VB $\geq 3^*$  RBW, RMS detector, power averaging on, and power integration over the OBW, trace average 100 traces. Spurious limit becomes -30dBc.

Operating Mode: 802.11b  
 Directional Gain (dBi): 3.3

Max EIRP (mW): 229.1

Frequency (MHz)	Chain	Software Setting	Power <sup>1</sup>		Total		Max Power (W)	Limit dBm	Result	Power (dBm) <sup>3</sup>
			dBm	mW	mW	dBm				
2412	1	20.0	20.3	107.2	107.2	20.3	0.107	30.0	Pass	
	2									
	3									
	4									
2437	1	20.0	20.3	107.2	107.2	20.3	0.107	30.0	Pass	
	2									
	3									
	4									
2462	1	20.0	19.4	87.1	87.1	19.4	30.0	Pass		
	2									
	3									
	4									

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radamacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A





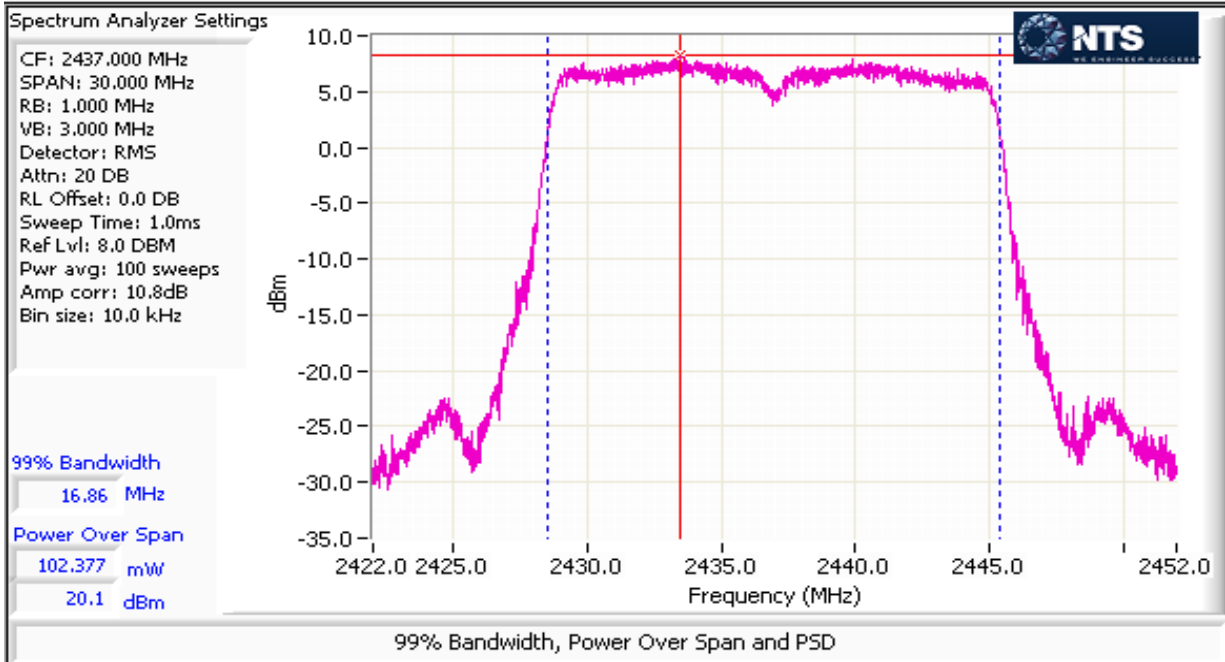
# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Operating Mode: 802.11g  
 Directional Gain (dBi): 3.3

Max EIRP (mW): 218.8

Frequency (MHz)	Chain	Software Setting	Power <sup>1</sup>		Total		Max Power (W)	Limit dBm	Result	Power (dBm) <sup>3</sup>
			dBm	mW	mW	dBm				
2412	1	17.5	17.1	51.3	51.3	17.1	0.102	30.0	Pass	
	2									
	3									
	4									
2437	1	20.0	20.1	102.3	102.3	20.1	0.102	30.0	Pass	
	2									
	3									
	4									
2462	1	17.5	16.3	42.7	42.7	16.3	30.0	Pass		
	2									
	3									
	4									





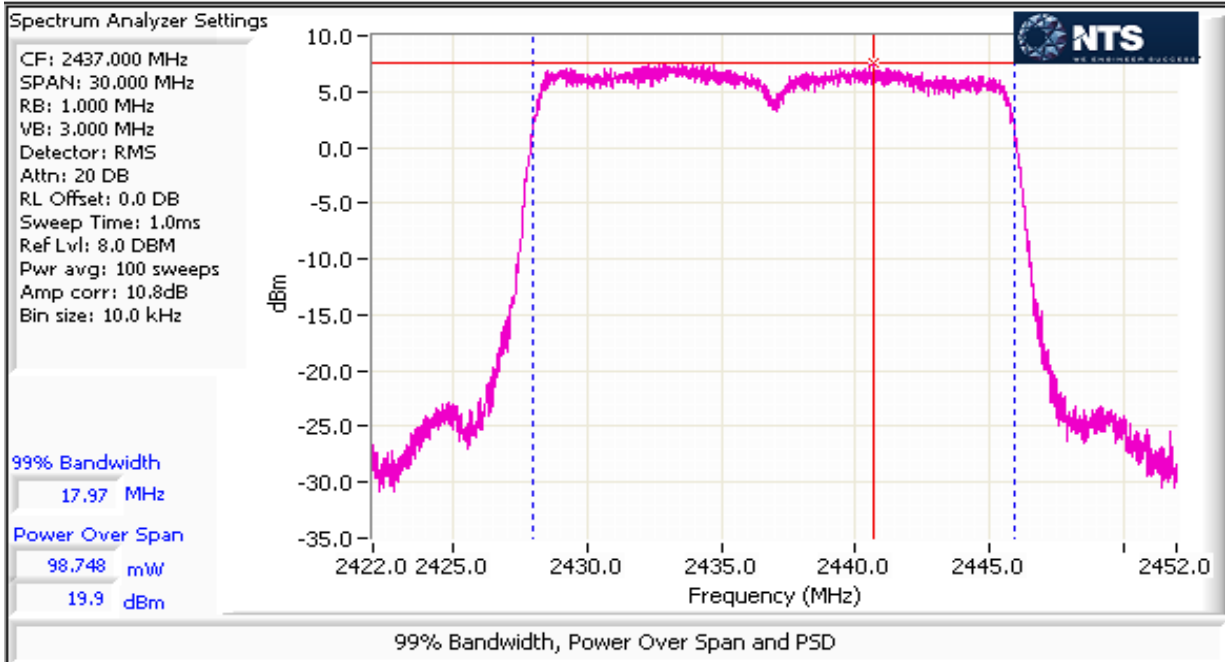
# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Operating Mode: 802.11n20  
 Directional Gain (dBi): 3.3

Max EIRP (mW): 403.9

Frequency (MHz)	Chain	Software Setting	Power <sup>1</sup>		Total		Max Power (W)	Limit dBm	Result	Power (dBm) <sup>3</sup>
			dBm	mW	mW	dBm				
2412	1	17.5	17.1	51.3	100.3	20.0	0.189	30.0	Pass	
	2		16.9	49.0						
	3		13.8	24.0						
2437	1	20.0	19.9	97.7	188.9	22.8	0.189	30.0	Pass	
	2		19.6	91.2						
	3		13.6	22.9						
2462	1	14.0	13.8	24.0	46.9	16.7	0.189	30.0	Pass	
	2		13.6	22.9						
	3		13.6	22.9						





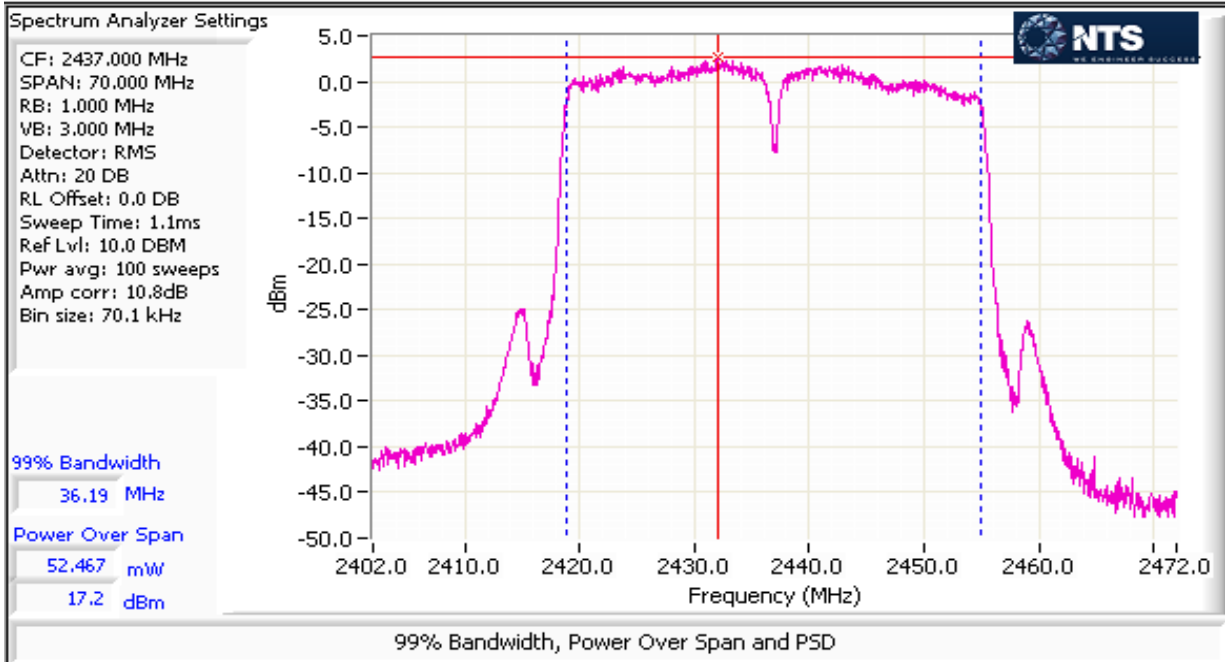
# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Operating Mode: 802.11n40  
 Directional Gain (dBi): 6.3

Max EIRP (mW): 423.4

Frequency (MHz)	Chain	Software Setting	Power <sup>1</sup>		Total		Max Power (W)	Limit dBm	Result	Power (dBm) <sup>3</sup>
			dBm	mW	mW	dBm				
2422	1	14.5	13.8	24.0	52.8	17.2	0.099	29.7	Pass	
	2		14.6	28.8						
	3		14.6	28.8						
2437	1	17.5	16.7	46.8	99.3	20.0				
	2		17.2	52.5						
	3		17.2	52.5						
2452	1	15.0	14.4	27.5	60.7	17.8				
	2		15.2	33.1						
	3		15.2	33.1						





# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

## Run #2: Power spectral Density

Mode: 11b

Power Setting	Frequency (MHz)	PSD (dBm/10kHz) <sup>Note 1</sup>				Total	Limit dBm/3kHz	Result
		Chain 1	Chain 2	Chain 3	Chain 4			
20	2412	3.8				3.8	8.0	Pass
20	2437	4.1				4.1	8.0	Pass
20	2462	4.2				4.2	8.0	Pass

Mode: 11g

Power Setting	Frequency (MHz)	PSD (dBm/10kHz) <sup>Note 1</sup>				Total	Limit dBm/3kHz	Result
		Chain 1	Chain 2	Chain 3	Chain 4			
20	2412	0.7				0.7	8.0	Pass
20	2437	1.2				1.2	8.0	Pass
20	2462	0.5				0.5	8.0	Pass

Mode: n20

Power Setting	Frequency (MHz)	PSD (dBm/10kHz) <sup>Note 1</sup>				Total	Limit dBm/3kHz	Result
		Chain 1	Chain 2	Chain 3	Chain 4			
20	2412	1.6	0.4			4.1	8.0	Pass
20	2437	0.9	1.6			4.3	8.0	Pass
20	2462	-0.4	0.1			2.9	8.0	Pass

Mode: n40

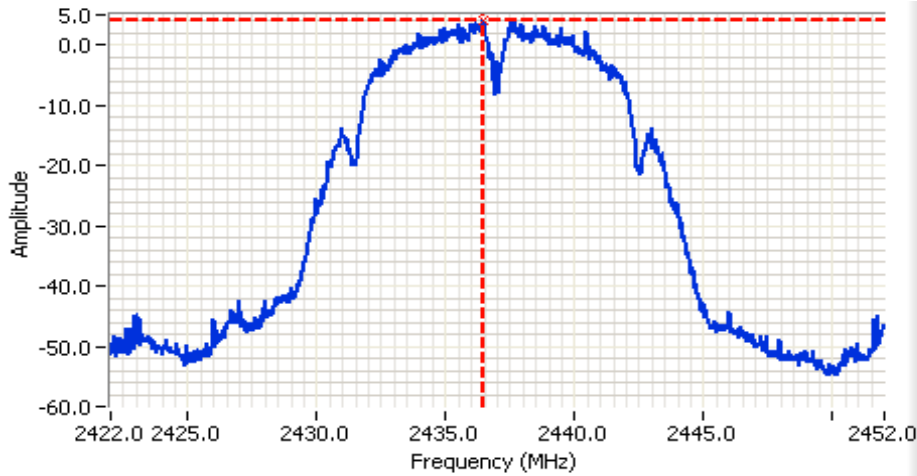
Power Setting	Frequency (MHz)	PSD (dBm/10kHz) <sup>Note 1</sup>				Total	Limit dBm/3kHz	Result
		Chain 1	Chain 2	Chain 3	Chain 4			
20	2422	-1.7	-2.0			1.2	8.0	Pass
20	2437	-2.1	-0.8			1.6	8.0	Pass
20	2452	-1.3	-3.1			0.9	8.0	Pass

Note 1: Test performed per method PKSPD, in KDB 558074. Power spectral density measured using:  $3\text{kHz} \leq \text{RBW} \leq 100\text{kHz}$ ,  $\text{VBW}=3*\text{RBW}$ , peak detector, span = 1.5\*DTS BW, auto sweep time, max hold.



# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A



**Analyzer Settings**  
 Agilent Technologies, E4446A  
 CF: 2437.000 MHz  
 SPAN: 30.000 MHz  
 RB: 10.0 kHz  
 VB: 30.0 kHz  
 Detector: POS  
 Attn: 10 DB  
 RL Offset: 10.8 DB  
 Sweep Time: 286.7ms  
 Ref Lvl: 7.8 DBM

**Comments**  
 802.11b Chain 1  
 PSD: 4.2 dBm/10kHz

Cursor 1 2436.4745 4.2

0.0000 0.0



Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radamacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A

### Run #3: Signal Bandwidth

Mode: 11b

Power Setting	Frequency (MHz)	Bandwidth (MHz)		RBW Setting	
		6dB	99%	6dB	99%
20	2437	8.1	10.1	100 kHz	200 kHz

Mode: 11g

Power Setting	Frequency (MHz)	Bandwidth (MHz)		RBW Setting	
		6dB	99%	6dB	99%
20	2437	16.4	16.9	100 kHz	200 kHz

Mode: n20

Power Setting	Frequency (MHz)	Bandwidth (MHz)		RBW Setting	
		6dB	99%	6dB	99%
20	2437	17.6	17.8	100 kHz	200 kHz

Mode: n40

Power Setting	Frequency (MHz)	Bandwidth (MHz)		RBW Setting	
		6dB	99%	6dB	99%
20	2437	35.7	36.3	100 kHz	510 kHz

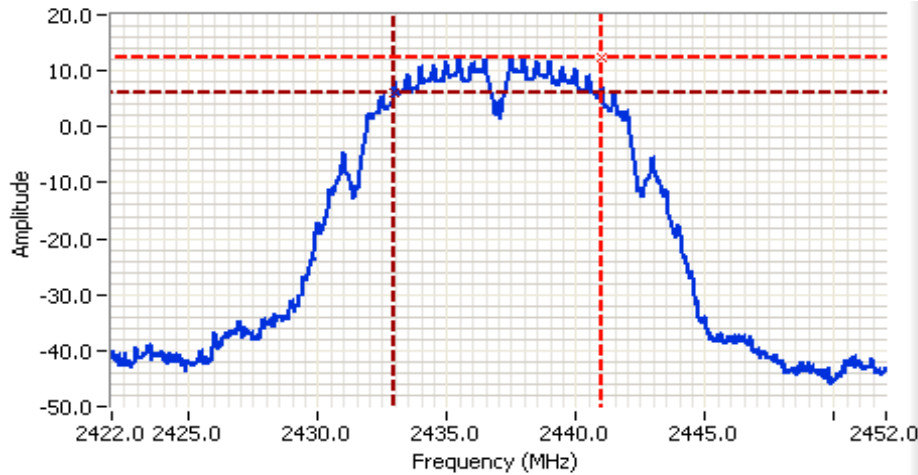
Note 1:	DTS BW: RBW=100kHz, VBW ≥ 3*RBW, peak detector, max hold, auto sweep time. 99% BW: RBW=1-5% of 99%BW, VBW ≥ 3*RBW, peak detector, max hold, auto sweep time.
Note 2:	Measurements performed on chain 1. Preliminary measurements showed that the 6dB BW and the 99%BW is consistent across the low, middle and high channels. Final measurements provided on the middle channel only for each mode.





# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A



**Analyzer Settings**  
 Agilent Technologies, E4446A  
 CF: 2437.000 MHz  
 SPAN: 30.000 MHz  
 RB: 100 kHz  
 VB: 300 kHz  
 Detector: POS  
 Attn: 20 DB  
 RL Offset: 10.8 DB  
 Sweep Time: 2.9ms  
 Ref Lvl: 16.8 DBM

**Comments**  
 802.11b chain 1  
 DTS BW: 8.1 MHz

Cursor 1	2441.0090	12.2	
Cursor 2	2432.9309	6.2	

Delta Freq.	8.078
Delta Amplitude	6.0



Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radamacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A

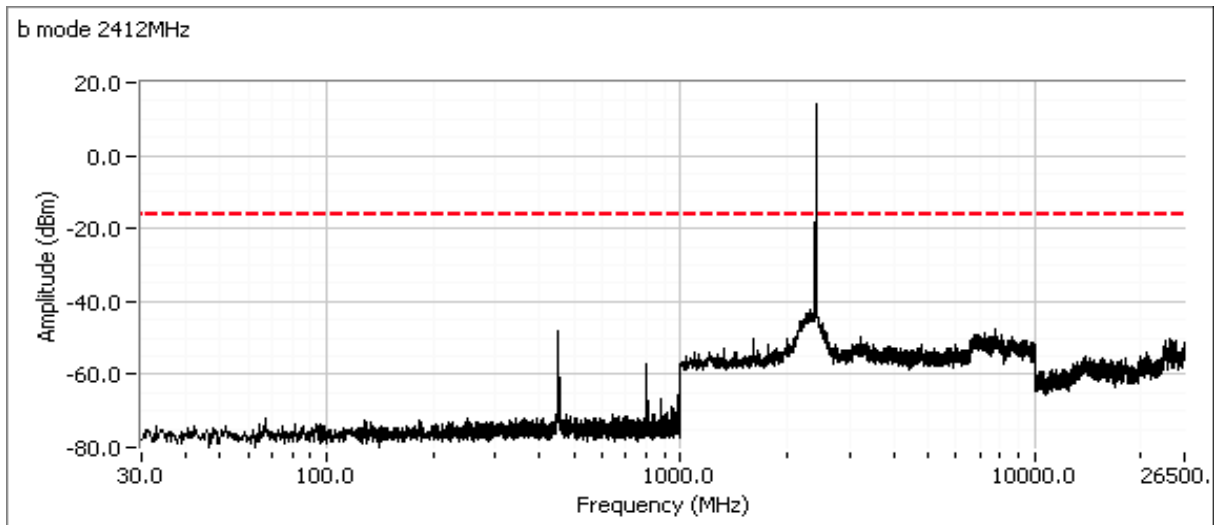
Run #4a: Out of Band Spurious Emissions

#1	Power Setting Per Chain			Mode	Frequency (MHz)	Limit	Result
	#2	#3	#4				
20				802.11b	2412	-30 dBc	Pass
20				802.11b	2437	-30 dBc	Pass
20				802.11b	2462	-30 dBc	Pass
18				802.11g	2412	-30 dBc	Pass
20				802.11g	2437	-30 dBc	Pass
18				802.11g	2462	-30 dBc	Pass
18	18			802.11n20	2412	-30 dBc	Pass
20	20			802.11n20	2437	-30 dBc	Pass
18	18			802.11n20	2462	-30 dBc	Pass
18	18			802.11n40	2422	-30 dBc	Pass
18	18			802.11n40	2437	-30 dBc	Pass
16	16			802.11n40	2452	-30 dBc	Pass

Note 1: Measured on each chain individually and compared to the in-band level on that chain per FCC KDB 662911 D01 3)b)

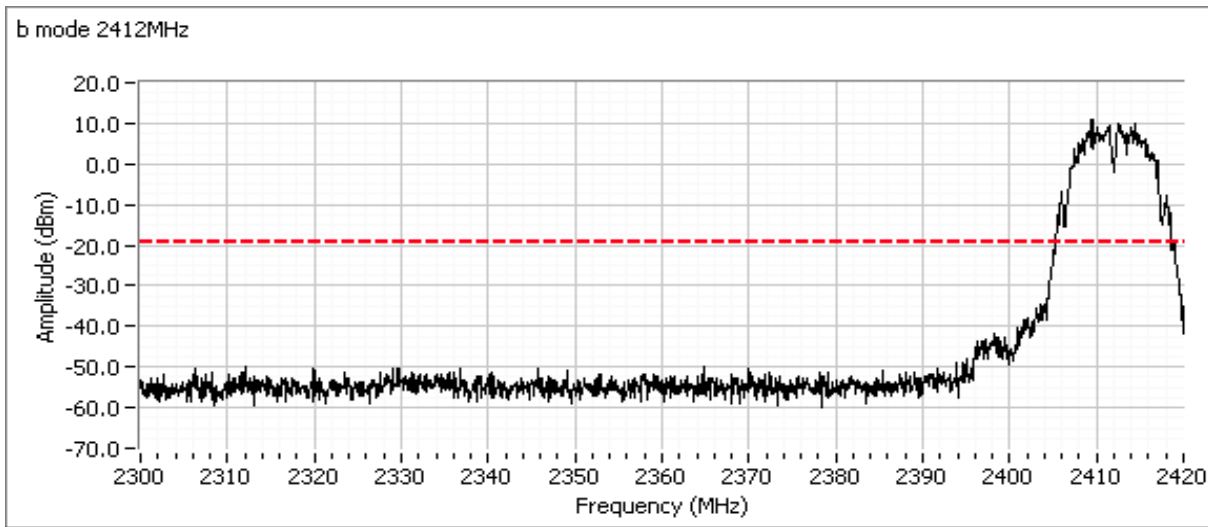
Note 2: All measurements performed with RBW=100kHz, VBW=300kHz, peak detector

Plots for low channel

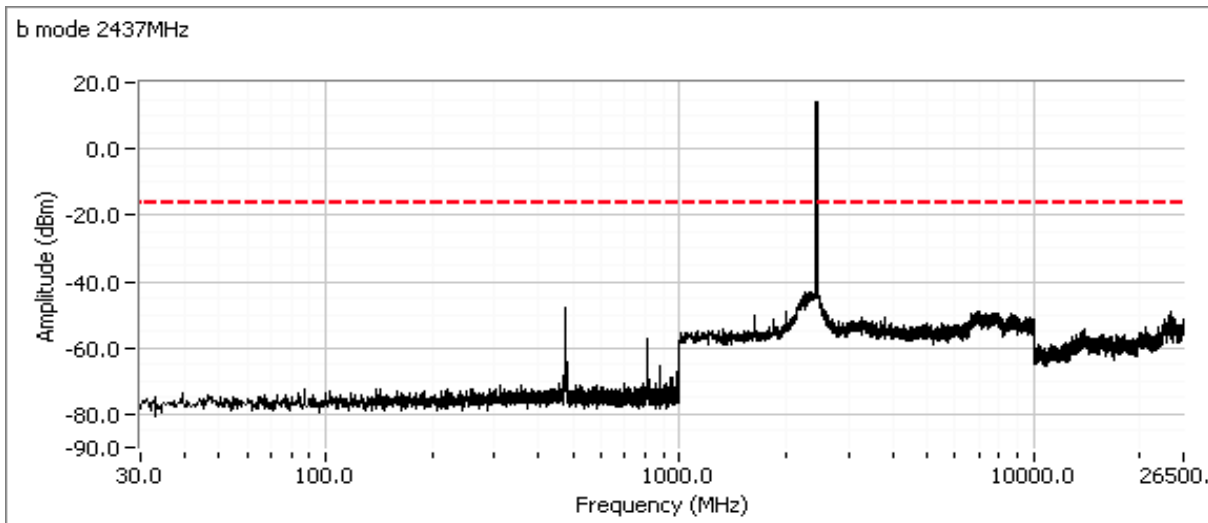


Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radmacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A

Additional plot showing compliance with -30dBc limit from 2390 MHz to 2400 MHz. Radiated measurements used to show compliance with the limits in the restricted band below 2390 MHz.

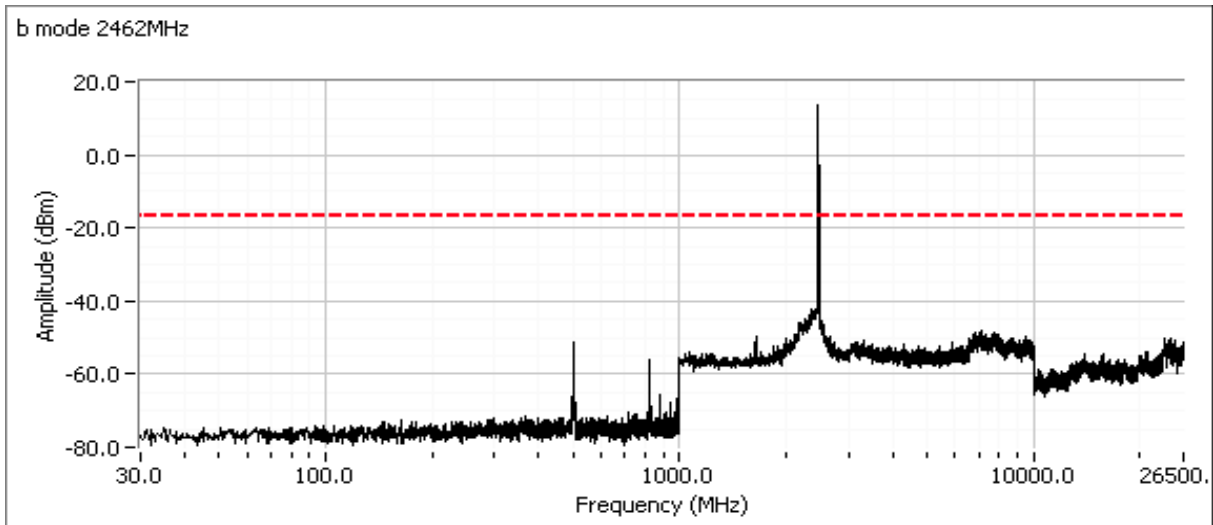


Plots for center channel

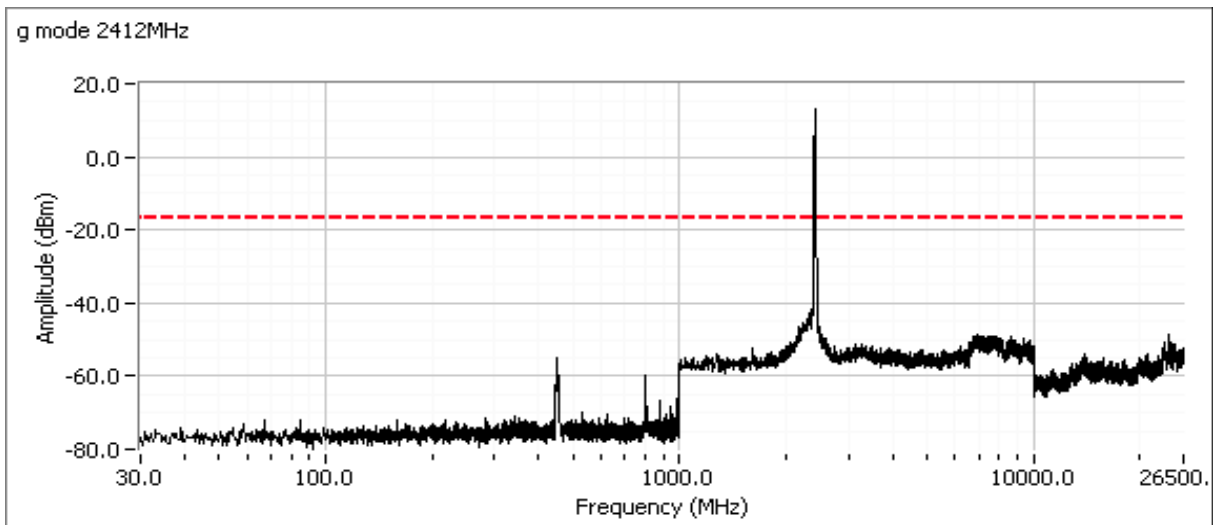


Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Plots for high channel

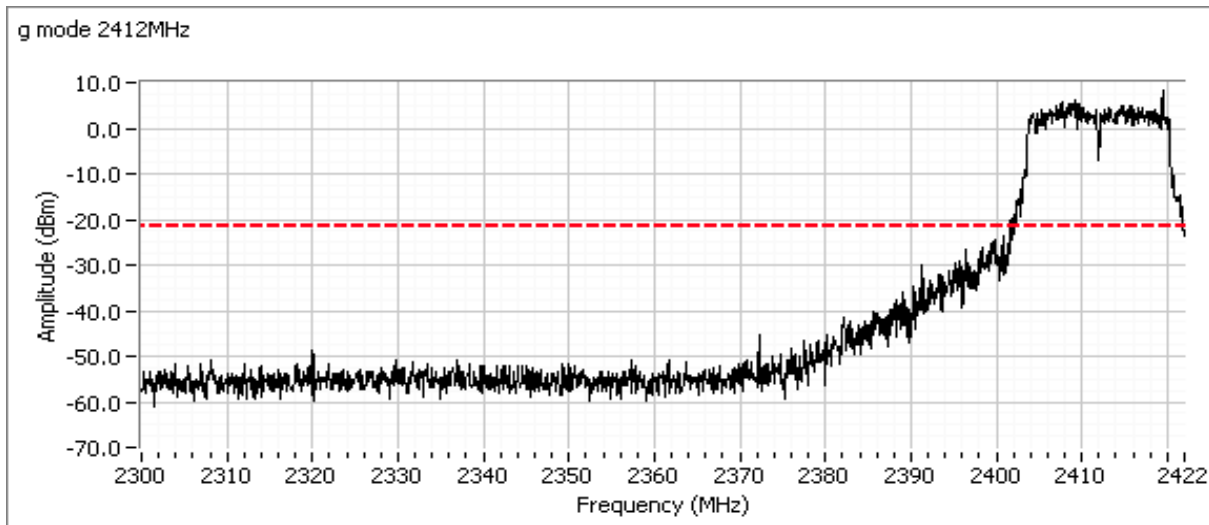


Plots for low channel

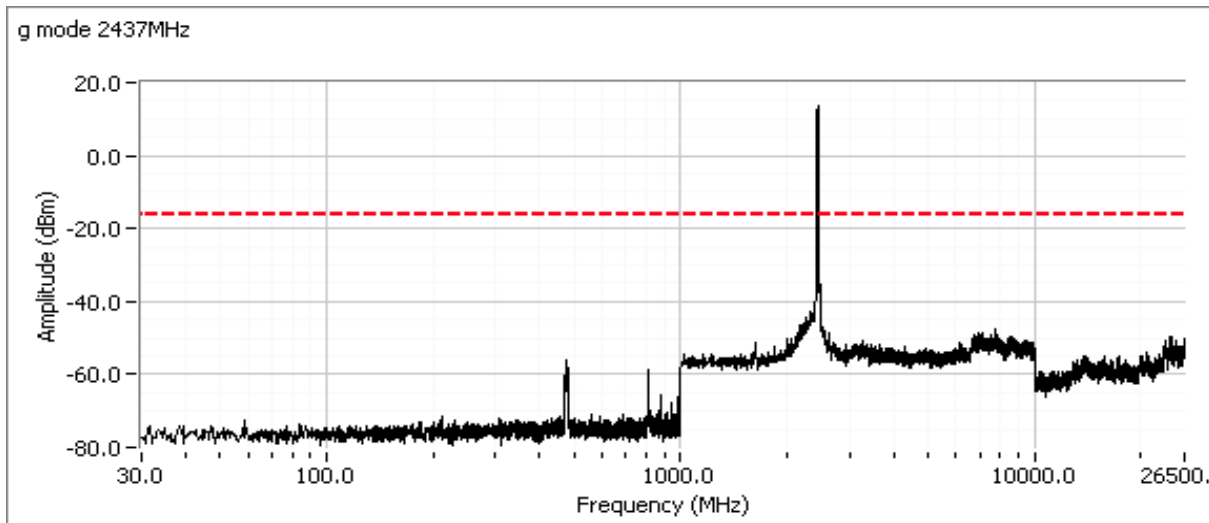


Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radamacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A

Additional plot showing compliance with -30dBc limit from 2390 MHz to 2400 MHz. Radiated measurements used to show compliance with the limits in the restricted band below 2390 MHz.

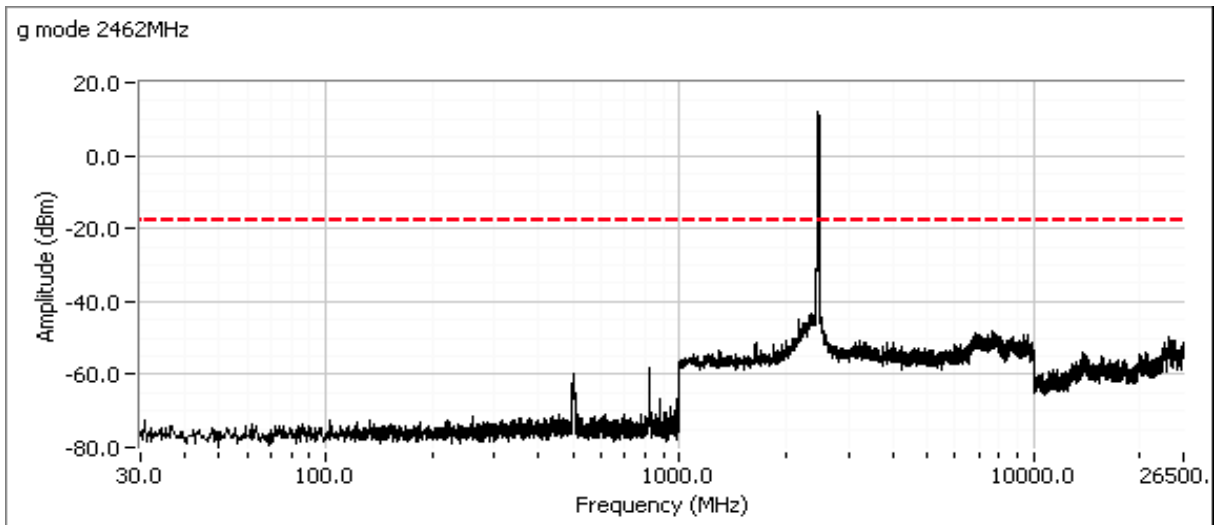


Plots for center channel

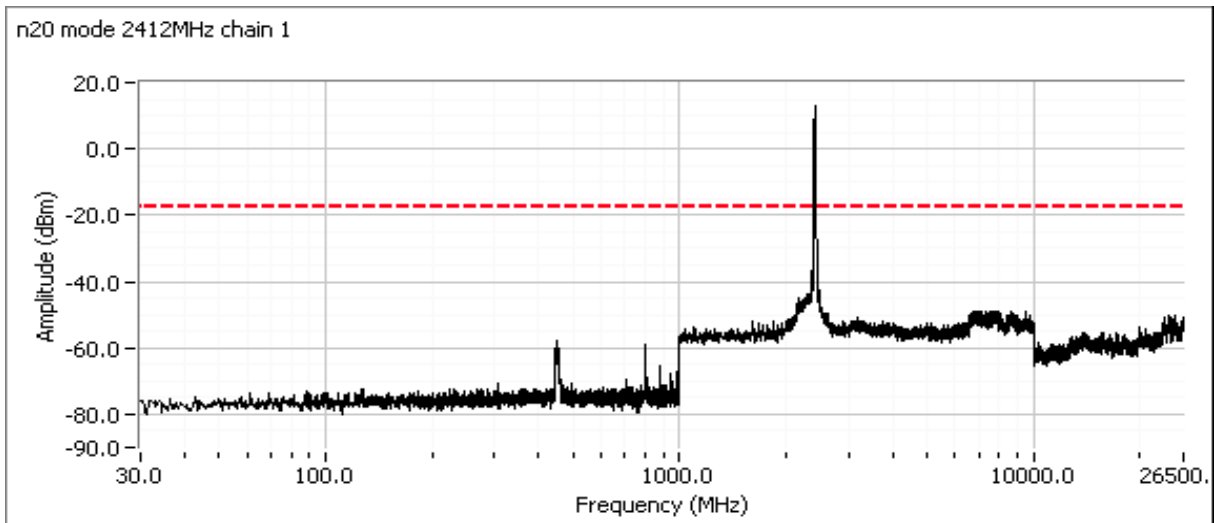


Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radamacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A

Plots for high channel

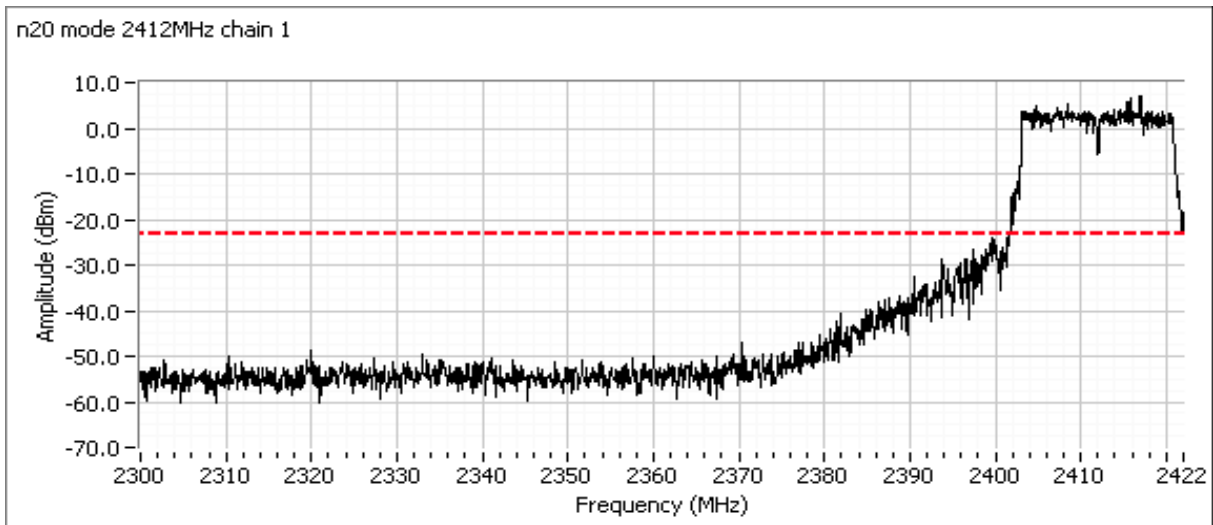


Plots for low channel, Chain 1

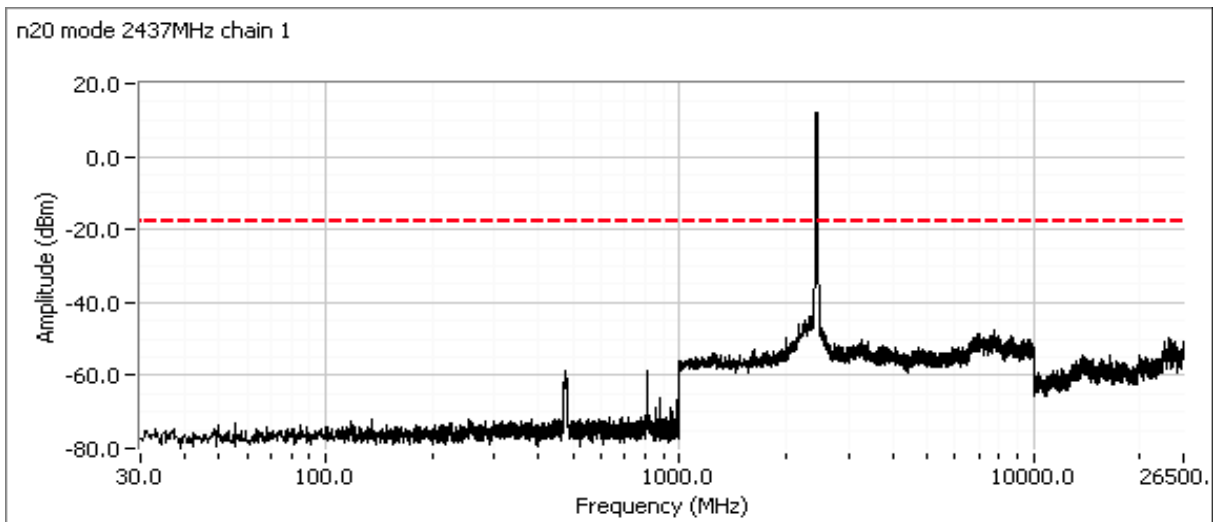


Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Additional plot showing compliance with -30dBc limit from 2390 MHz to 2400 MHz. Radiated measurements used to show compliance with the limits in the restricted band below 2390 MHz.

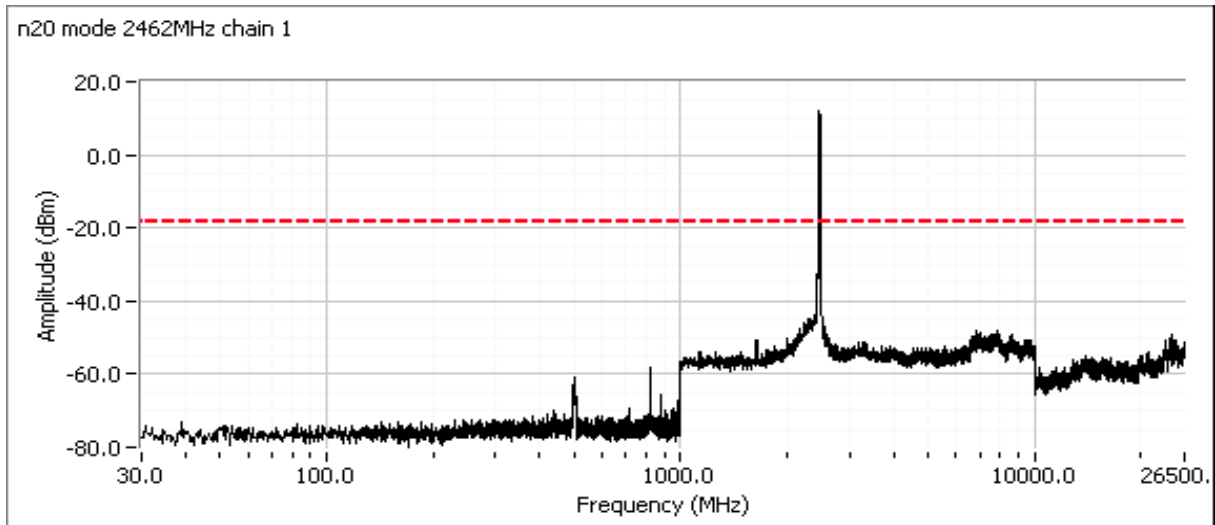


Plots for center channel, Chain 1

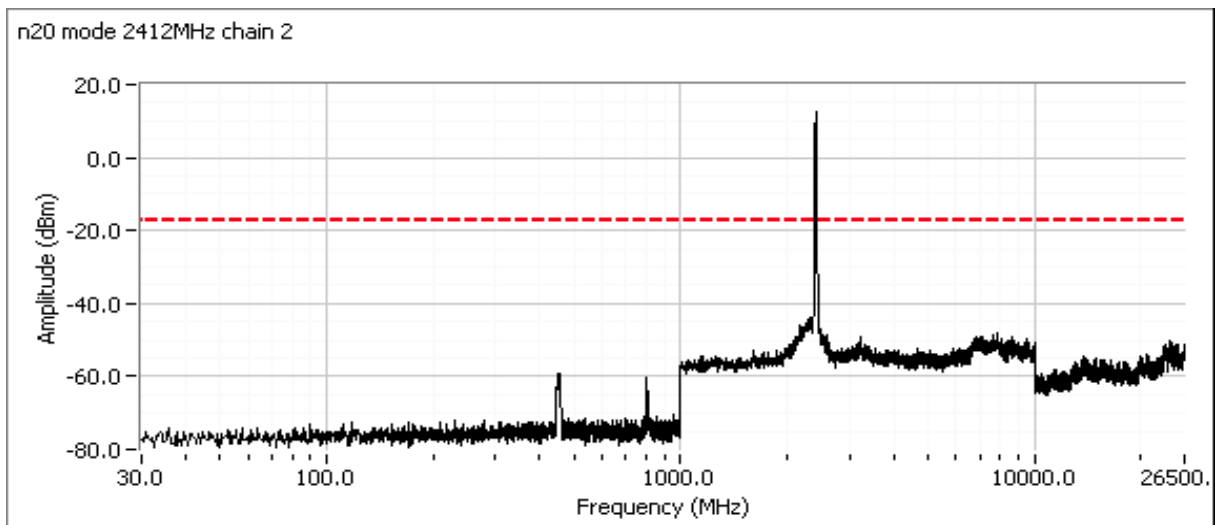


Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radamacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A

Plots for high channel, Chain 1



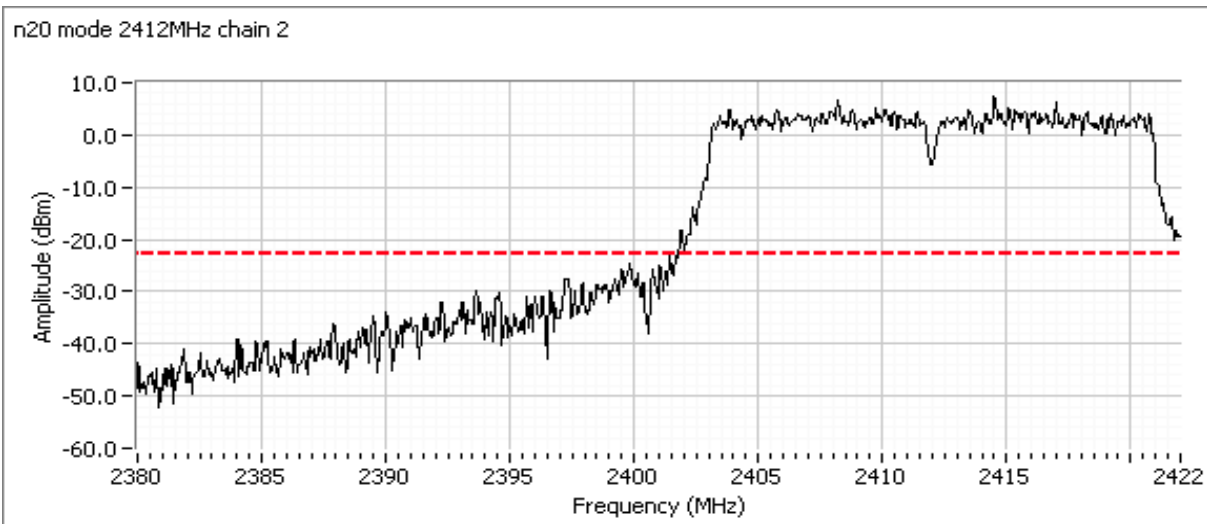
Plots for low channel, Chain 2



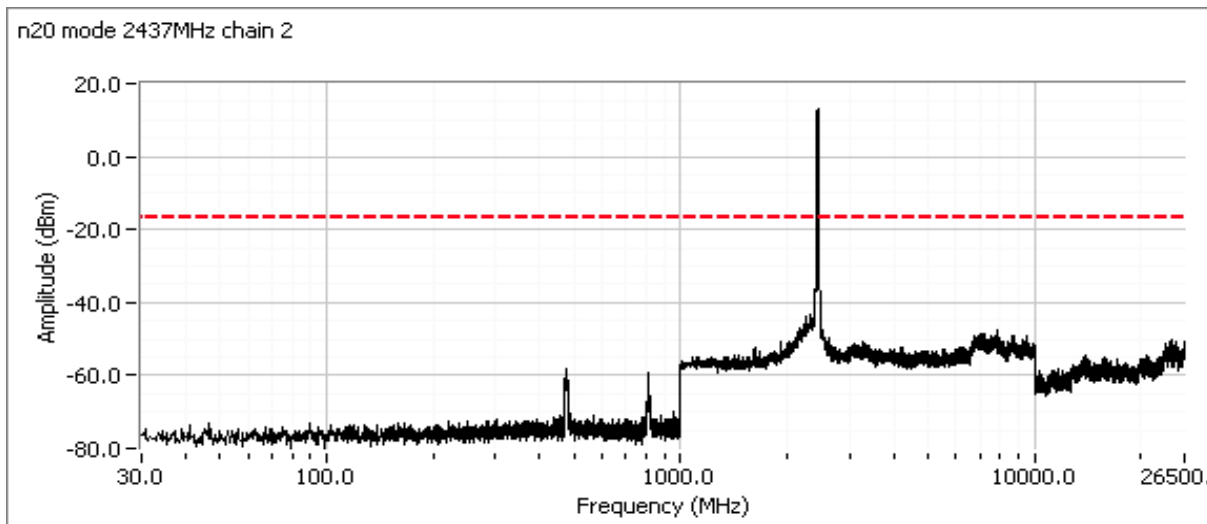


Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radamacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A

Additional plot showing compliance with -30dBc limit from 2390 MHz to 2400 MHz. Radiated measurements used to show compliance with the limits in the restricted band below 2390 MHz.

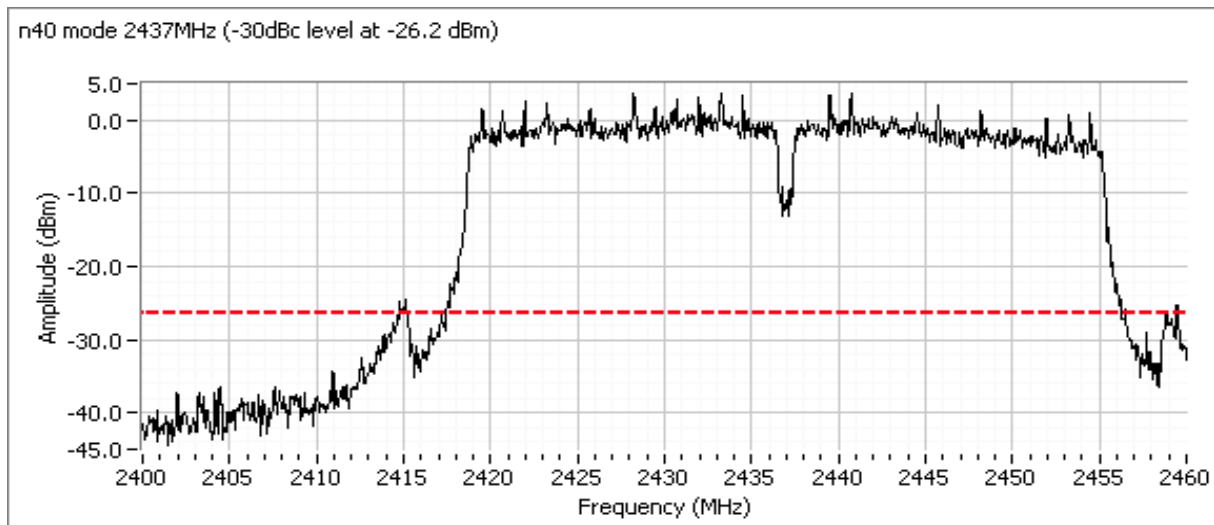
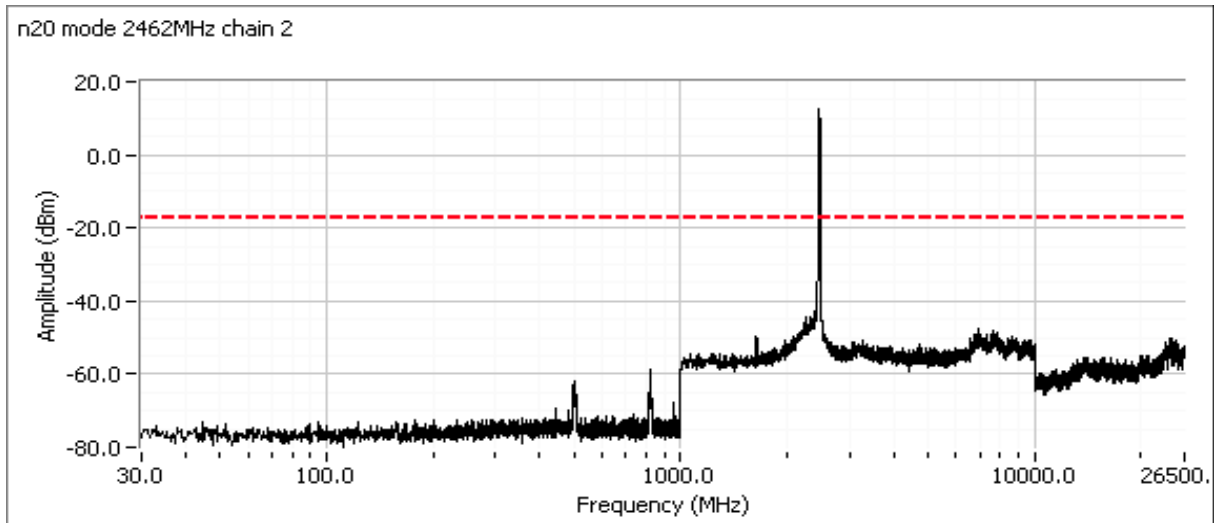


Plots for center channel, Chain 2



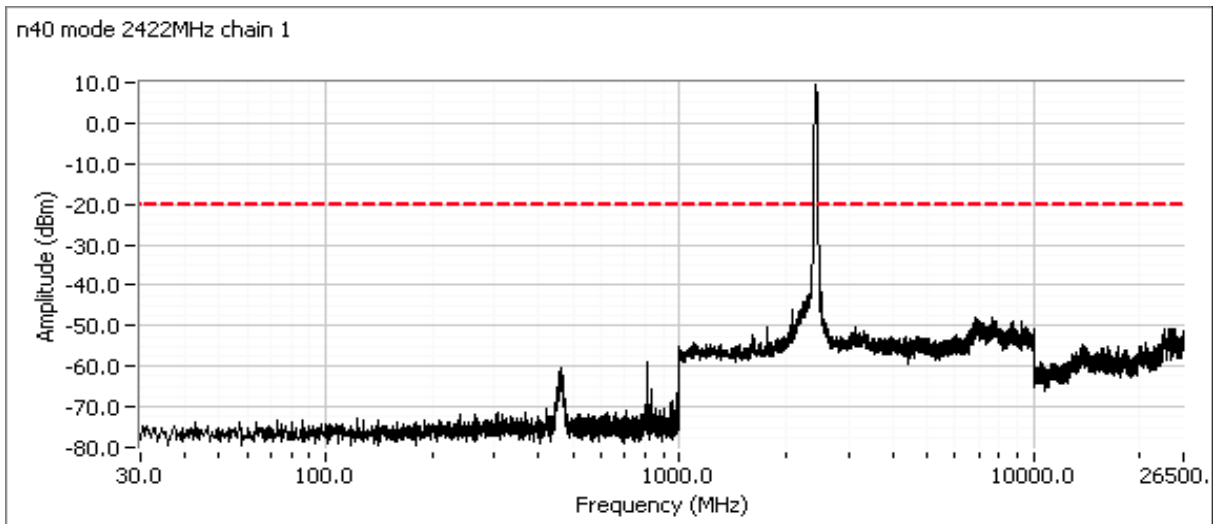
Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radmacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A

Plots for high channel, Chain 2

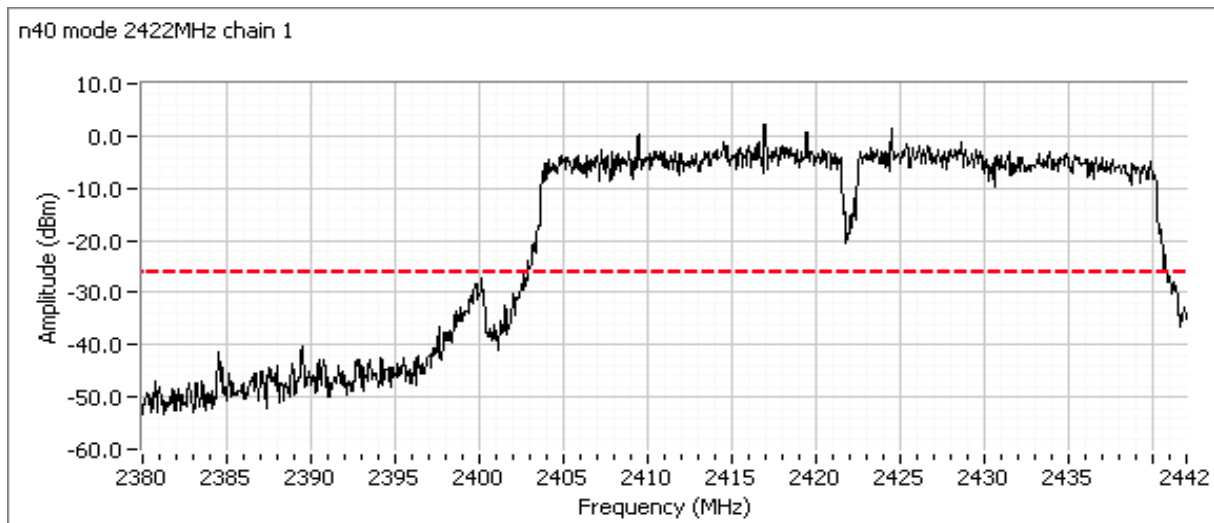


Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radmacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A

Plots for low channel, Chain 1

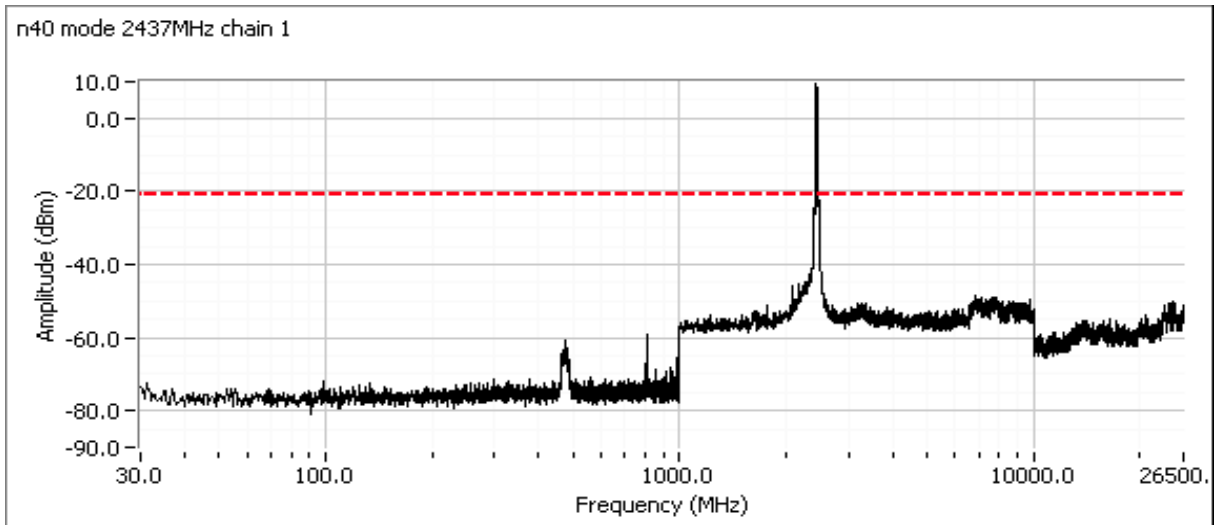


Additional plot showing compliance with -30dBc limit from 2390 MHz to 2400 MHz. Radiated measurements used to show compliance with the limits in the restricted band below 2390 MHz.

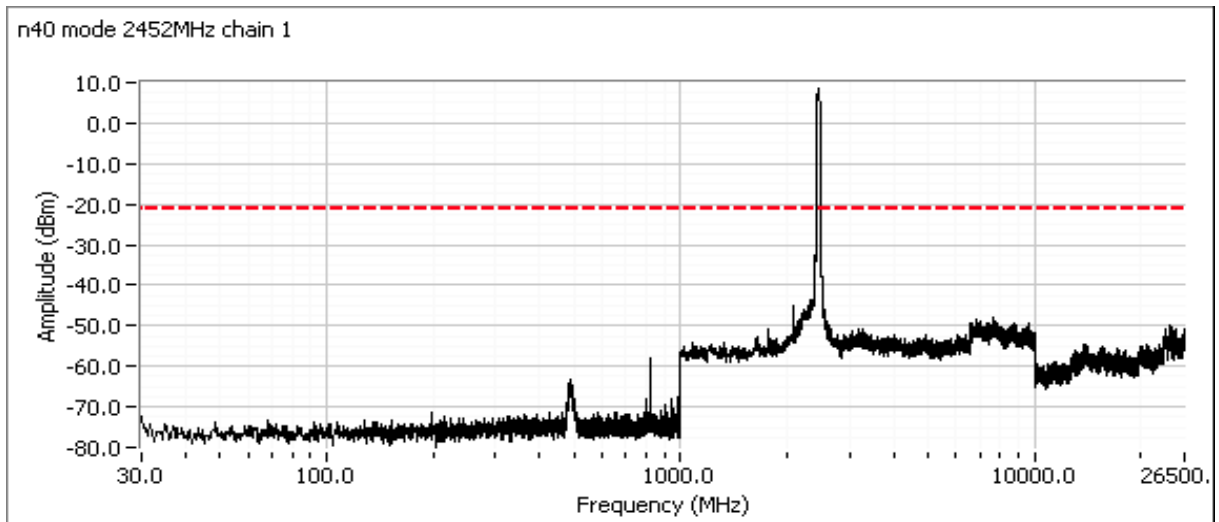


Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radamacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A

Plots for center channel, Chain 1

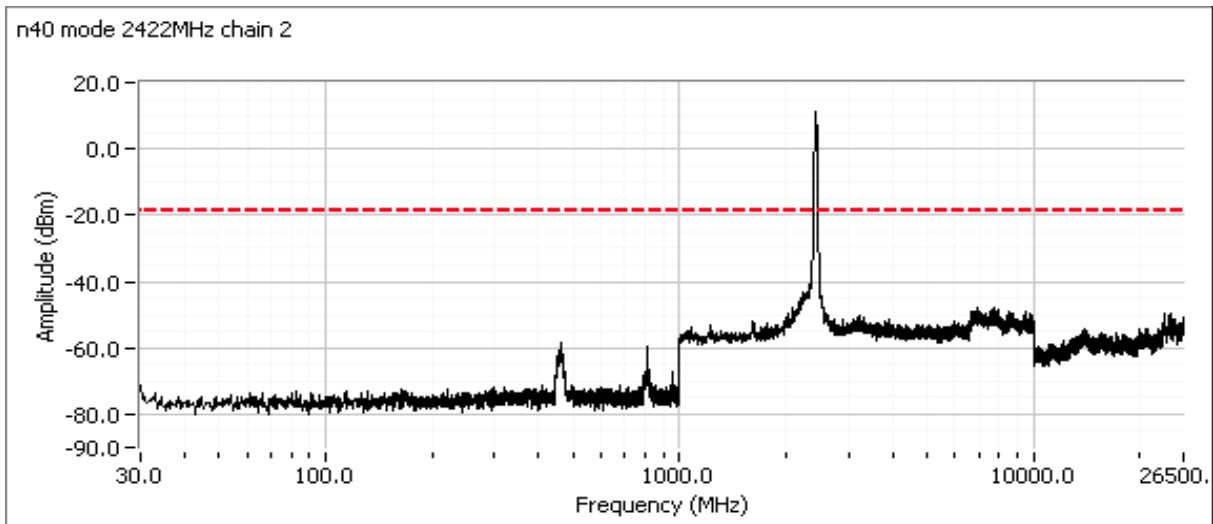


Plots for high channel, Chain 1

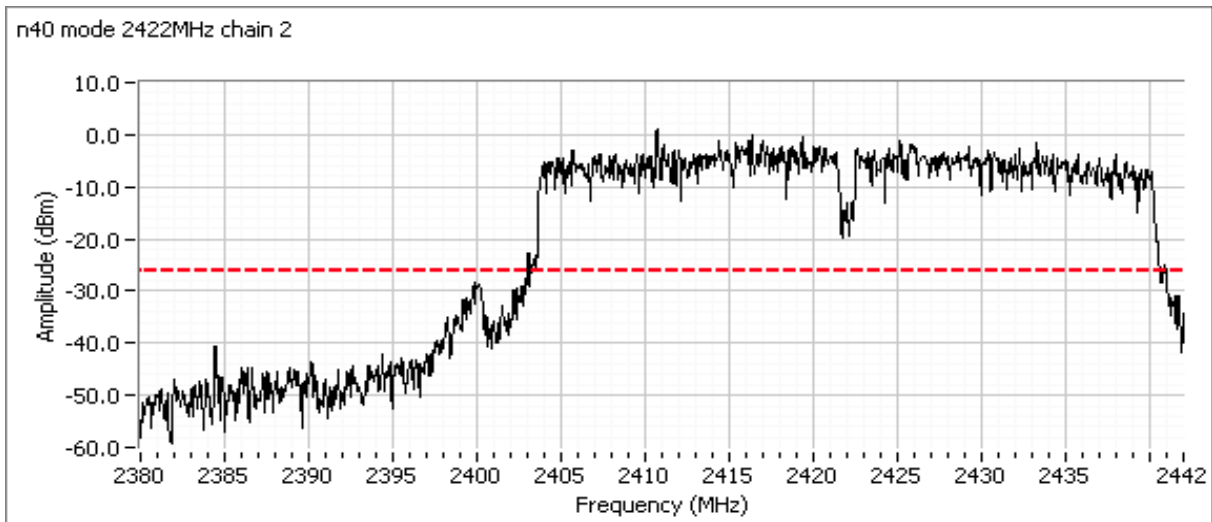


Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Plots for low channel, Chain 2

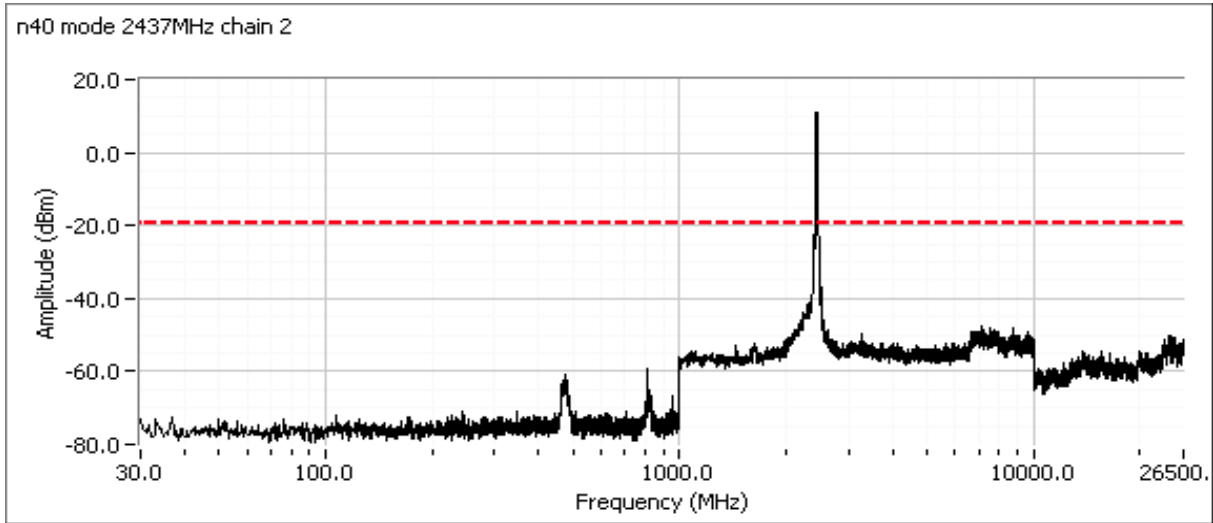


Additional plot showing compliance with -30dBc limit from 2390 MHz to 2400 MHz. Radiated measurements used to show compliance with the limits in the restricted band below 2390 MHz.

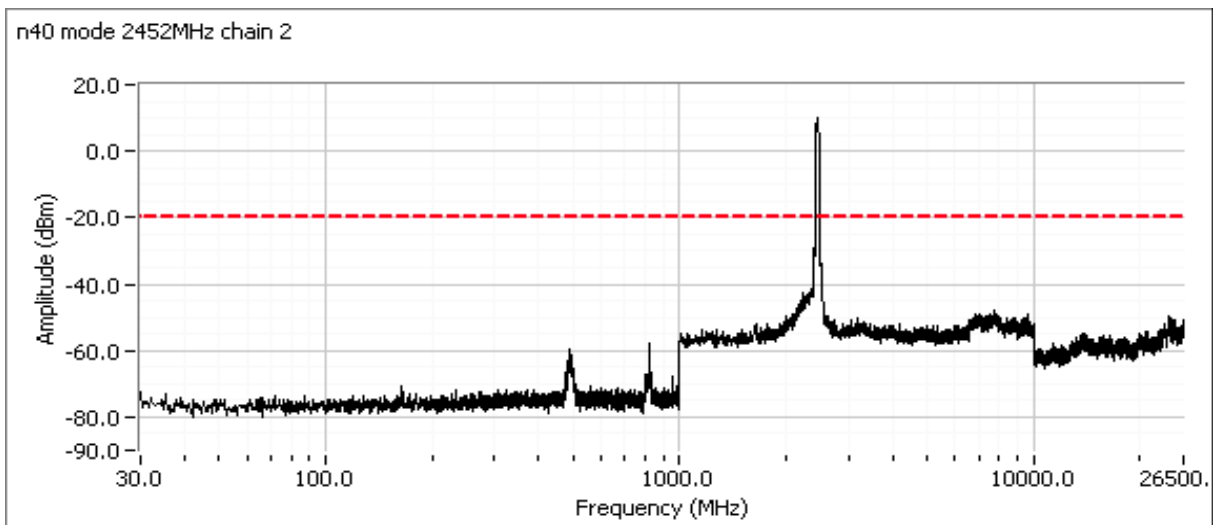


Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Plots for center channel, Chain 2



Plots for high channel, Chain 2





# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radamacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A

## 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: 35 %

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

Run #	Mode	Channel	Power Setting	Test Performed	Limit	Result / Margin
1a	RF4CE + WiFi	15 11	w3	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247( c)	31.3 dBµV/m @ 2376.9 MHz (-22.7 dB)
			w3 20	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247( c)	47.5 dBµV/m @ 4924.0 MHz (-6.5 dB)
1b	RF4CE + WiFi	20 100	w3 20	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247( c)	47.3 dBµV/m @ 5360.6 MHz (-6.7 dB)
1c	RF4CE + WiFi	25 1	w3	Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247( c)	42.4 dBµV/m @ 2484.0 MHz (-11.6 dB)
			w3 20	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247( c)	46.1 dBµV/m @ 4949.0 MHz (-7.9 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.



# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radamacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	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.

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
RF4CE	Fixed	100%	-	-	0	0	-
11b	1Mb/s	0.98	Yes	2.737	0	0	10
11a	6Mb/s	0.98	Yes	1.443	0	0	10

## Sample Notes

Sample S/N: G54DA5DN000024

Driver: 5.99 RC 188.10

Antenna: Internal

## 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.

## Test Notes

No emissions from the radio circuitry were observed below 1 GHz during preliminary tests.



Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radamacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A

**Run #1: Radiated Spurious Emissions, 1 - 25 GHz.**

Date of Test: 7/8/2015 0:00      Config. Used: 1  
 Test Engineer: Joseph Cadigal      Config Change: none  
 Test Location: FT Chamber#3      EUT Voltage: 120V/60Hz

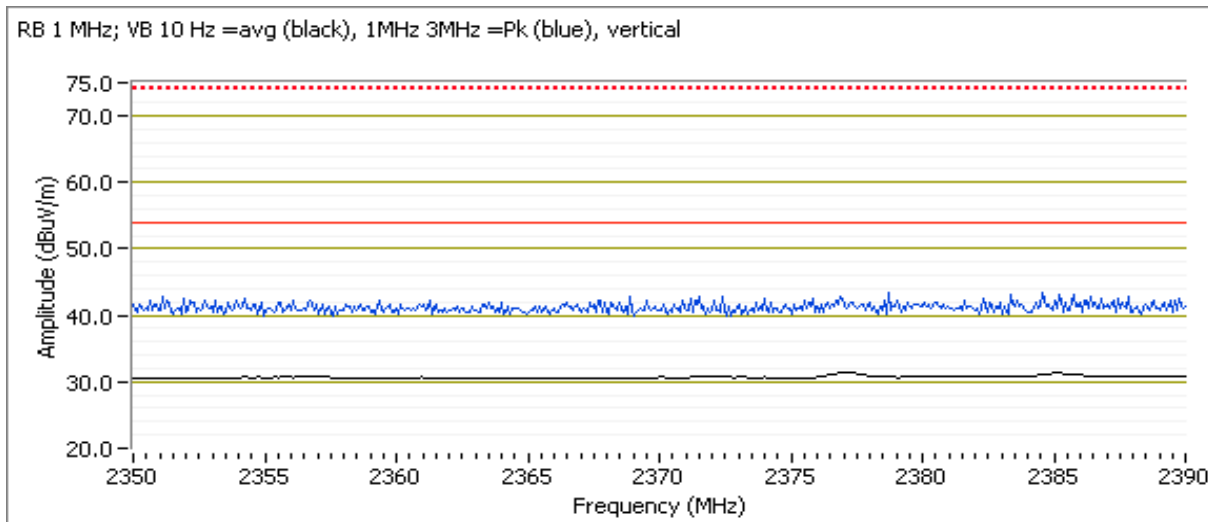
**Run #1a: Low Channel @ 2425 MHz**
**Fundamental Signal Field Strength: Peak value measured in 100kHz**

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB $\mu$ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2424.760	92.4	V	-	-	Pk	281	1.7	POS; RB 100 kHz; VB: 100 kHz
2425.090	95.3	H	-	-	Pk	337	1.6	POS; RB 100 kHz; VB: 100 kHz

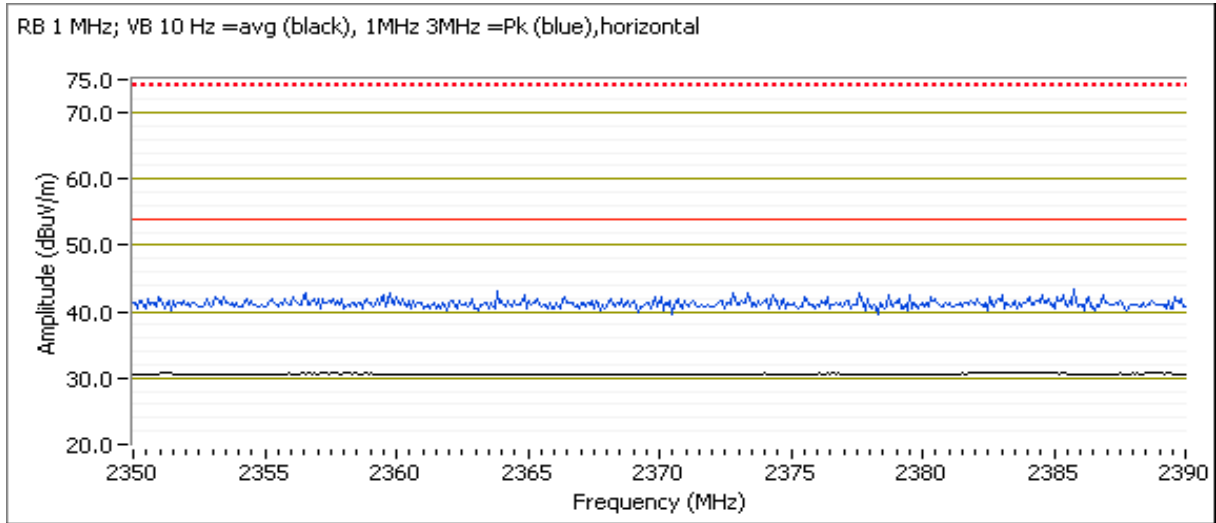
Fundamental emission level @ 3m in 100kHz RBW:	95.3	dB $\mu$ V/m	
Limit for emissions outside of restricted bands:	75.3	dB $\mu$ V/m	Limit is -20dBc (Peak power measurement)
Limit for emissions outside of restricted bands:	65.3	dB $\mu$ V/m	Limit is -30dBc (UNII power measurement)

**Band Edge Signal Field Strength - Direct measurement of field strength**

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB $\mu$ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2376.930	31.3	H	54.0	-22.7	AVG	337	1.6	POS; RB 1 MHz; VB: 10 Hz
2366.510	42.9	H	74.0	-31.1	PK	337	1.6	POS; RB 1 MHz; VB: 3 MHz
2385.110	30.8	V	54.0	-23.2	AVG	279	1.7	POS; RB 1 MHz; VB: 10 Hz
2377.170	42.0	V	74.0	-32.0	PK	279	1.7	POS; RB 1 MHz; VB: 3 MHz



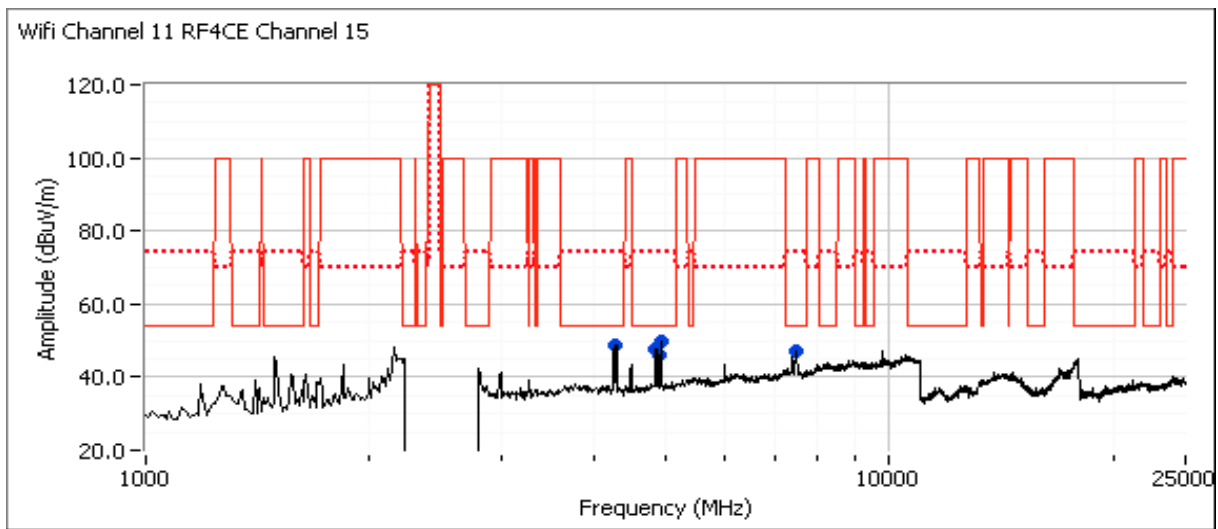
Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radmacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A



Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

### Other Spurious Emissions Low Channel @ 2425 MHz + Wifi Channel 11 802.11b

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB $\mu$ V/m	v/h	Limit	Margin	PK/QP/Avg	degrees	meters	
4924.010	47.5	V	54.0	-6.5	AVG	358	1.0	RB 1 MHz;VB 10 Hz;Peak
4923.940	51.3	V	74.0	-22.7	PK	358	1.0	RB 1 MHz;VB 3 MHz;Peak
4268.820	36.3	V	54.0	-17.7	AVG	282	2.5	RB 1 MHz;VB 10 Hz;Peak
4269.200	45.7	V	74.0	-28.3	PK	282	2.5	RB 1 MHz;VB 3 MHz;Peak
4885.730	44.1	V	54.0	-9.9	AVG	340	1.3	RB 1 MHz;VB 10 Hz;Peak
4887.480	51.5	V	74.0	-22.5	PK	340	1.3	RB 1 MHz;VB 3 MHz;Peak
4850.960	43.8	V	54.0	-10.2	AVG	347	1.6	RB 1 MHz;VB 10 Hz;Peak
4851.100	51.1	V	74.0	-22.9	PK	347	1.6	RB 1 MHz;VB 3 MHz;Peak



Note: Scans between 18 - 25 GHz performed with the measurement antenna moved around the card and its antennas 20-50cm from the device.

Note: The emissions at 4.5 and 7.5 GHz are not related to radio. After maximizing the signals; stopped the transmission and the signal level did not change.



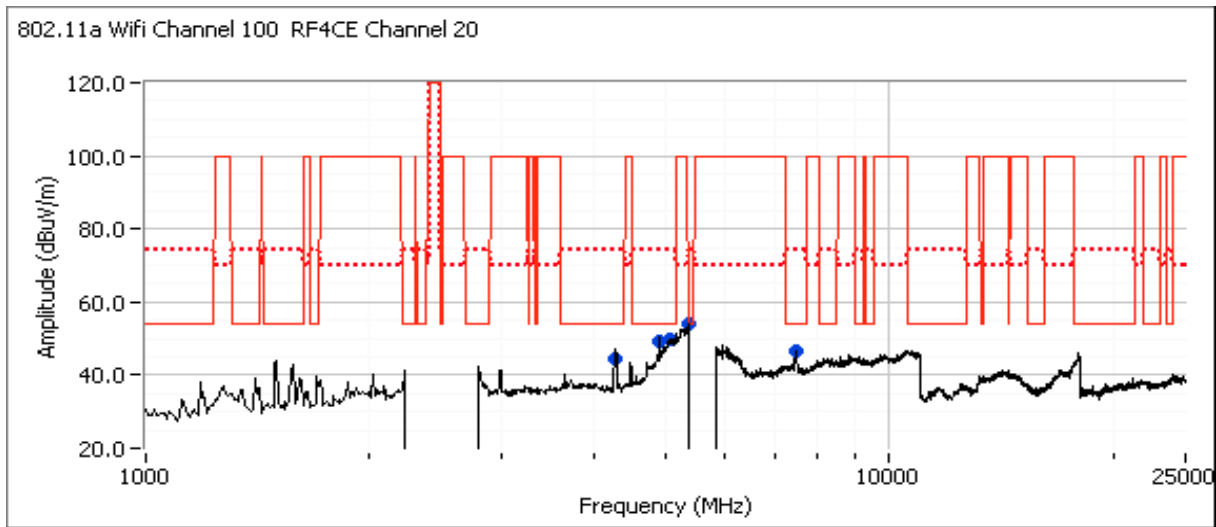
# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

Run #1b: Center Channel @ 2450 MHz + WiFi Channel 100 802.11a

Fundamental emission level @ 3m in 100kHz RBW:	95.7	dB $\mu$ V/m	
Limit for emissions outside of restricted bands:	75.7	dB $\mu$ V/m	Limit is -20dBc (Peak power measurement)
Limit for emissions outside of restricted bands:	65.7	dB $\mu$ V/m	Limit is -30dBc (UNII power measurement)

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB $\mu$ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
5360.560	47.3	H	54.0	-6.7	AVG	267	1.3	RB 1 MHz;VB 10 Hz;Peak
5360.520	59.3	H	74.0	-14.7	PK	267	1.3	RB 1 MHz;VB 3 MHz;Peak
4269.470	34.8	V	54.0	-19.2	AVG	318	1.9	RB 1 MHz;VB 10 Hz;Peak
4269.890	54.7	V	74.0	-19.3	PK	318	1.9	RB 1 MHz;VB 3 MHz;Peak
4900.960	45.3	V	54.0	-8.7	AVG	9	1.3	RB 1 MHz;VB 10 Hz;Peak
4901.000	53.0	V	74.0	-21.0	PK	9	1.3	RB 1 MHz;VB 3 MHz;Peak
5065.210	44.7	H	54.0	-9.3	AVG	291	1.0	RB 1 MHz;VB 10 Hz;Peak
5064.440	56.4	H	74.0	-17.6	PK	291	1.0	RB 1 MHz;VB 3 MHz;Peak



Note:	Scans between 18 - 25 GHz performed with the measurement antenna moved around the card and its antennas 20-50cm from the device.
Note:	The emissions at 4.5 and 7.5 GHz are not related to radio. After maximizing the signals; stopped the transmission and the signal level did not change.

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

**Run #1c: High Channel @ 2475 MHz**

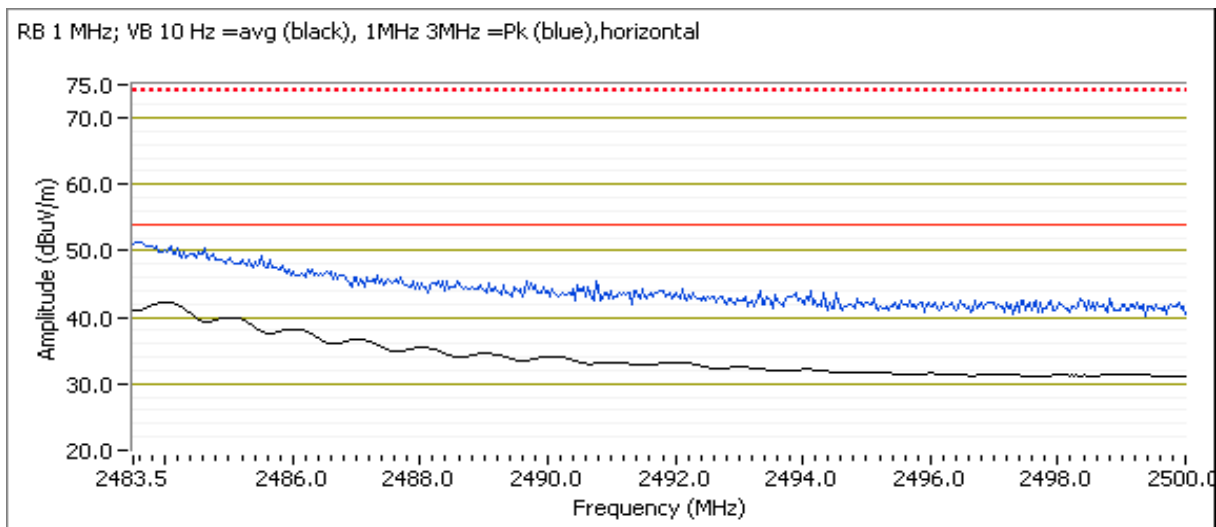
Fundamental Signal Field Strength: Peak value measured in 100kHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB $\mu$ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2474.910	92.2	V	-	-	Pk	293	1.3	POS; RB 100 kHz; VB: 100 kHz
2474.740	93.4	H	-	-	Pk	338	1.0	POS; RB 100 kHz; VB: 100 kHz

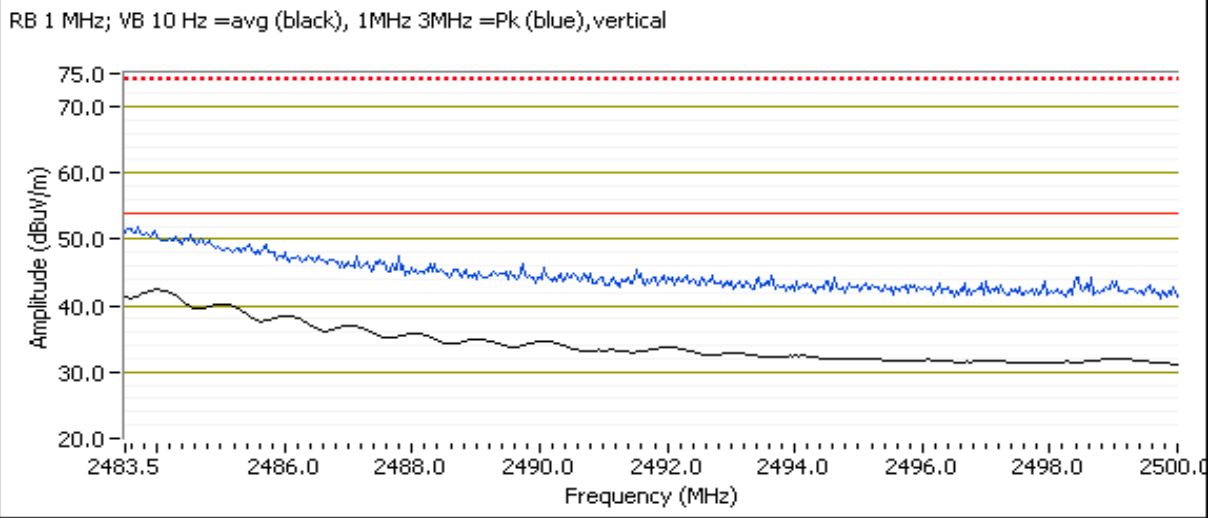
Fundamental emission level @ 3m in 100kHz RBW:	93.4	dB $\mu$ V/m	
Limit for emissions outside of restricted bands:	73.4	dB $\mu$ V/m	Limit is -20dBc (Peak power measurement)
Limit for emissions outside of restricted bands:	63.4	dB $\mu$ V/m	Limit is -30dBc (UNII power measurement)

**Band Edge Signal Field Strength - Direct measurement of field strength**

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB $\mu$ V/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2484.000	42.4	V	54.0	-11.6	AVG	291	1.3	POS; RB 1 MHz; VB: 10 Hz
2483.700	51.1	V	74.0	-22.9	PK	291	1.3	POS; RB 1 MHz; VB: 3 MHz
2484.000	42.3	H	54.0	-11.7	AVG	338	1.0	POS; RB 1 MHz; VB: 10 Hz
2483.960	50.3	H	74.0	-23.7	PK	338	1.0	POS; RB 1 MHz; VB: 3 MHz



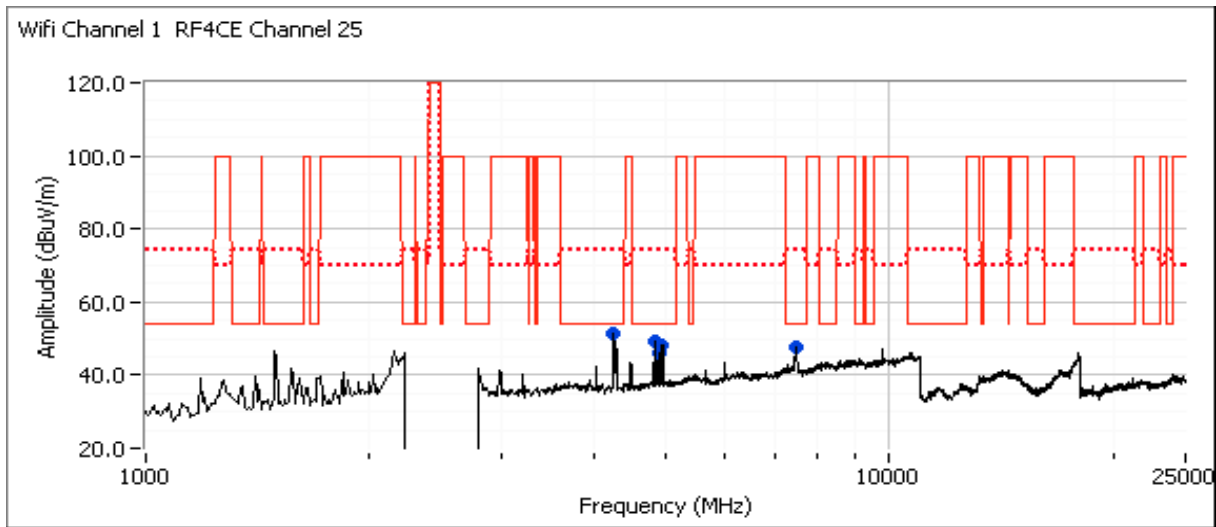
Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radamacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A



Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

### Other Spurious Emissions High Channel @ 2475 MHz + Wifi Channel 1 802.11b

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dB $\mu$ V/m	v/h	Limit	Margin	PK/QP/Avg	degrees	meters	
4949.000	46.1	V	54.0	-7.9	AVG	344	1.0	RB 1 MHz;VB 10 Hz;Peak
4948.850	54.1	V	74.0	-19.9	PK	344	1.0	RB 1 MHz;VB 3 MHz;Peak
4823.960	45.4	V	54.0	-8.6	AVG	22	1.3	RB 1 MHz;VB 10 Hz;Peak
4823.990	50.1	V	74.0	-23.9	PK	22	1.3	RB 1 MHz;VB 3 MHz;Peak
4264.750	36.1	V	54.0	-17.9	AVG	285	2.5	RB 1 MHz;VB 10 Hz;Peak
4264.900	44.8	V	74.0	-29.2	PK	285	2.5	RB 1 MHz;VB 3 MHz;Peak
4888.350	44.1	V	54.0	-9.9	AVG	357	1.0	RB 1 MHz;VB 10 Hz;Peak
4886.440	51.1	V	74.0	-22.9	PK	357	1.0	RB 1 MHz;VB 3 MHz;Peak



Note: Scans between 18 - 25 GHz performed with the measurement antenna moved around the card and its antennas 20-50cm from the device.

Note: The emissions at 4.5 and 7.5 GHz are not related to radio. After maximizing the signals; stopped the transmission and the signal level did not change.



# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radamacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A

## FCC 15.247 (DTS) Antenna Port Measurements Power, PSD, 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: 7/14/2015  
 Test Engineer: Mehran Birgani  
 Test Location: Chamber 7

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

### General Test Configuration

All measurements were performed radiated at 3m distance from the measurement antenna.

All measurements have been corrected for the measurement system used.

Ambient Conditions:                      Temperature:       20-22 °C  
   Rel. Humidity:     30-35 %

### Summary of Results

Run #	Pwr setting	Avg Pwr	Test Performed	Limit	Pass / Fail	Result / Margin
1	Max		Output Power	15.247(b)	Pass	-0.9 dBm (0.8mW)
2	Max		Power spectral Density (PSD)	15.247(d)	Pass	-0.6 dBm/100kHz
3	Max		Minimum 6dB Bandwidth	15.247(a)	Pass	1.59 MHz
3	Max		99% Bandwidth	RSS GEN	-	2.40 MHz
4	Max		Spurious emissions	15.247(b)	Pass	> -30dBc below limit

### 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.

### Procedure Comments:

Measurements performed in accordance with FCC KDB 558074

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
RF4CE	Fixed	100%	-	-	0	0	-





# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

## Sample Notes

Sample S/N:  
 Driver: 5.99 RC 188.10  
 Antenna: Intergrated

## Run #1: Output Power

Mode: RF4CE Chain 1

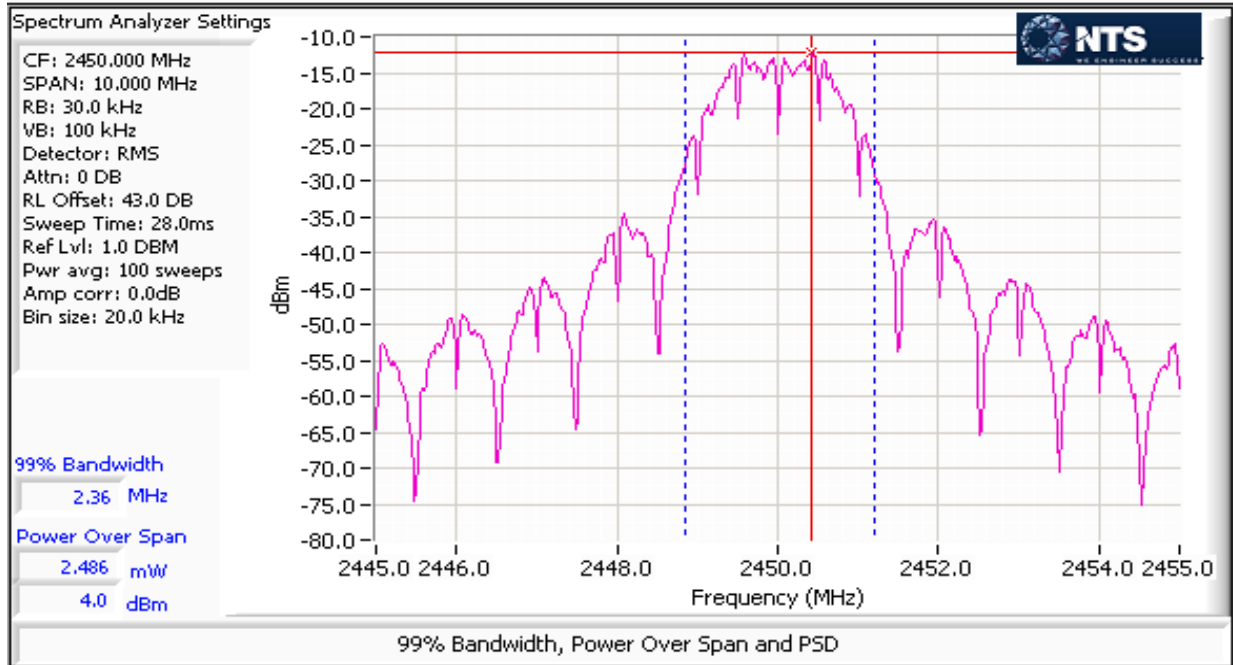
Power Setting <sup>2</sup>	Frequency (MHz)	Output Power (EIRP)		Antenna Gain (dBi)	Result	Power		Output Power	
		(dBm) <sup>1</sup>	mW			dBm	W	(dBm)	mW
Vertical									
Max	2425	-1.4	0.7	4.9	Pass	-6.3	0.0002		
Max	2450	1.9	1.5	4.9	Pass	-3.0	0.0005		
Max	2475	1.9	1.5	4.9	Pass	-3.0	0.0005		
Horizontal									
Max	2425	2.8	1.9	4.9	Pass	-2.1	0.0006		
Max	2450	3.7	2.3	4.9	Pass	-1.2	0.0008		
Max	2475	1.7	1.5	4.9	Pass	-3.2	0.0005		

Mode: RF4CE Chain 2

Power Setting <sup>2</sup>	Frequency (MHz)	Output Power (EIRP)		Antenna Gain (dBi)	Result	Power		Output Power	
		(dBm) <sup>1</sup>	mW			dBm	W	(dBm)	mW
Vertical									
Max	2425	1.0	1.3	4.9	Pass	-3.9	0.0004		
Max	2450	0.6	1.1	4.9	Pass	-4.3	0.0004		
Max	2475	-0.9	0.8	4.9	Pass	-5.8	0.0003		
Horizontal									
Max	2425	3.6	2.3	4.9	Pass	-1.3	0.0007		
Max	2450	4.0	2.5	4.9	Pass	-0.9	0.0008		
Max	2475	3.0	2.0	4.9	Pass	-1.9	0.0006		

Note 1: Duty Cycle  $\geq$  98%. Output power measured using a spectrum analyzer (see plots below) with RBW= 1-5% of OBW, VB $\geq$ 3\* RBW, RMS detector, power averaging on, and power integration over the OBW, trace average 100 traces. Spurious limit becomes -30dBc.

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radamacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A



Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

### Run #2: Power spectral Density

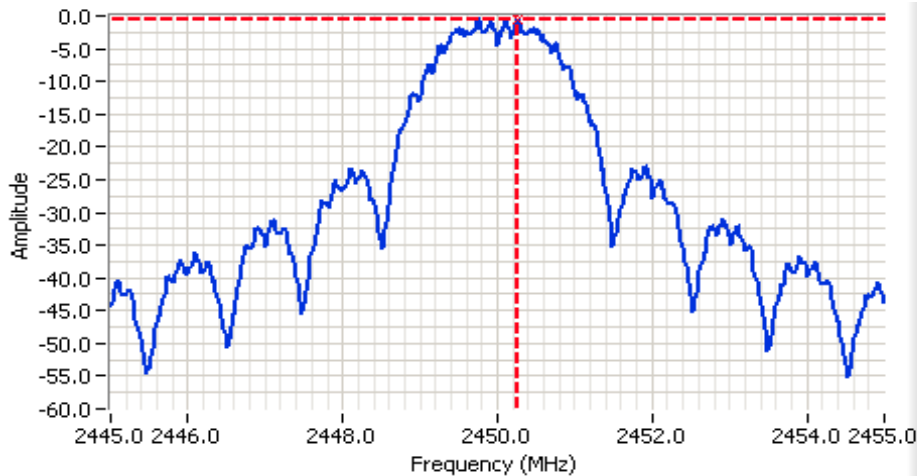
#### Mode: RF4CE Chain 1

Power Setting	Frequency (MHz)	PSD (eirp)	Ant Gain	PSD	Limit	Result
		(dBm/100kHz) <sup>Note 1</sup>		(dBi)		
Max	2425	-1.4	4.9	-6.3	8.0	Pass
Max	2450	-0.8	4.9	-5.7	8.0	Pass
Max	2475	-2.5	4.9	-7.4	8.0	Pass

#### Mode: RF4CE Chain 2

Power Setting	Frequency (MHz)	PSD (eirp)	Ant Gain	PSD	Limit	Result
		(dBm/100kHz) <sup>Note 1</sup>		(dBi)		
Max	2425	-0.7	4.9	-5.6	8.0	Pass
Max	2450	-0.6	4.9	-5.5	8.0	Pass
Max	2475	-1.5	4.9	-6.4	8.0	Pass

Note 1: Test performed per method PKSPD, in KDB 558074. Power spectral density measured using:  $3\text{kHz} \leq \text{RBW} \leq 100\text{kHz}$ ,  $\text{VBW}=3*\text{RBW}$ , peak detector, span =  $1.5*\text{DTS BW}$ , auto sweep time, max hold.



#### Analyzer Settings

Rohde&Schwarz, ESI  
 CF: 2450.000 MHz  
 SPAN: 10.000 MHz  
 RB: 100 kHz  
 VB: 300 kHz  
 Detector: POS  
 Attn: 0 DB  
 RL Offset: 43.0 DB  
 Sweep Time: 5.0ms  
 Ref Lvl: 1.0 DBM

#### Comments

PSD: -0.6 dBm/ 100kHz  
 Chain 2

Cursor 1 2450.2705 -0.56

0.0000 0.00

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

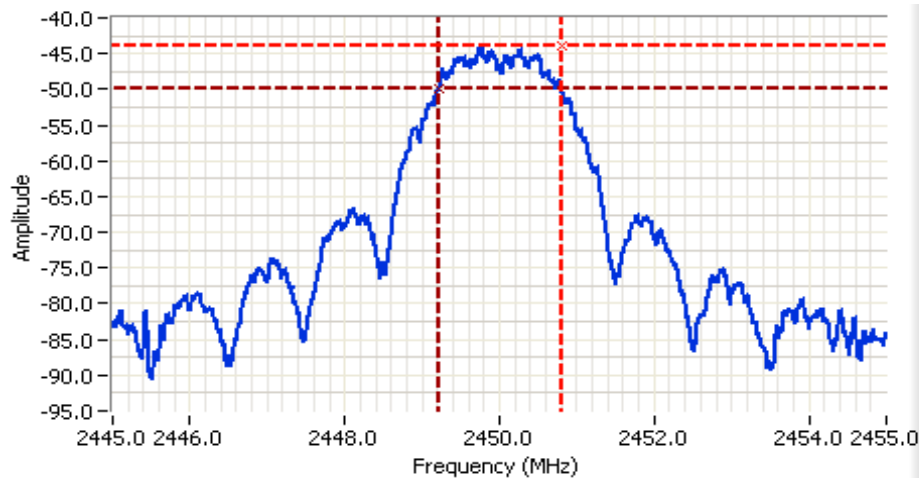
### Run #3: Signal Bandwidth

Mode: RF4CE

Power Setting	Frequency (MHz)	Bandwidth (MHz)		RBW Setting	
		6dB	99%	6dB	99%
w3	2450	1.59	2.40	100 kHz	30 kHz

Note 1: DTS BW: RBW=100kHz, VBW ≥ 3\*RBW, peak detector, max hold, auto sweep time.  
 99% BW: RBW=1-5% of 99%BW, VBW ≥ 3\*RBW, peak detector, max hold, auto sweep time.

Note 2: Measurements performed on chain 0



#### Analyzer Settings

Agilent Technologies, E4446A  
 CF: 2450.000 MHz  
 SPAN: 10.000 MHz  
 RB: 100 kHz  
 VB: 300 kHz  
 Detector: POS  
 Attn: 0 DB  
 RL Offset: 0.0 DB  
 Sweep Time: 1.0ms  
 Ref Lvl: -27.0 DBM

#### Comments

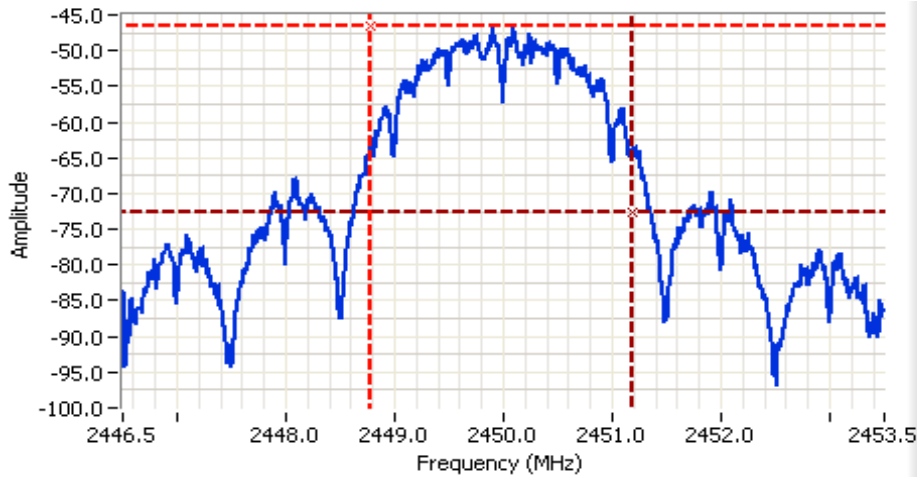
6dB BW: 1.585 MHz

Cursor 1	2450.8083	-44.0	
Cursor 2	2449.2233	-50.0	

Delta Freq.	1.585
Delta Amplitude	6.0



Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A



**Analyzer Settings**

Agilent Technologies, E4446A  
 CF: 2450.000 MHz  
 SPAN: 7.000 MHz  
 RB: 30.0 kHz  
 VB: 100 kHz  
 Detector: POS  
 Attn: 0 DB  
 RL Offset: 0.0 DB  
 Sweep Time: 7.5ms  
 Ref Lvl: -27.0 DBM

**Comments**

99% BW: 2.402 MHz

Cursor 1 2448.7768 -46.5 

Cursor 2 2451.1789 -72.5 

Delta Freq. 2.402

Delta Amplitude 26.0



### Run #4a: Out of Band Spurious Emissions

#1	Power Setting Per Chain			Mode	Frequency (MHz)	Limit	Result
	#2	#3	#4				
w3	w3			RF4CE	2405	-30 dBc	Pass
w3	w3			RF4CE	2450	-30 dBc	Pass
w3	w3			RF4CE	2475	-30 dBc	Pass

Note 1: Measured on each chain individually and compared to the in-band level on that chain per FCC KDB 662911 D01 3)b)

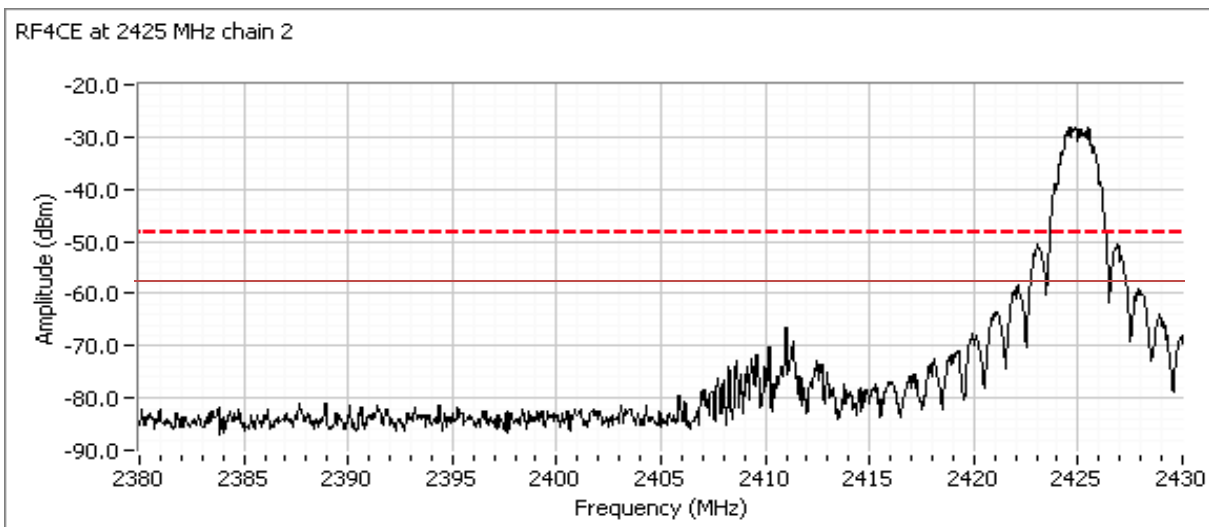
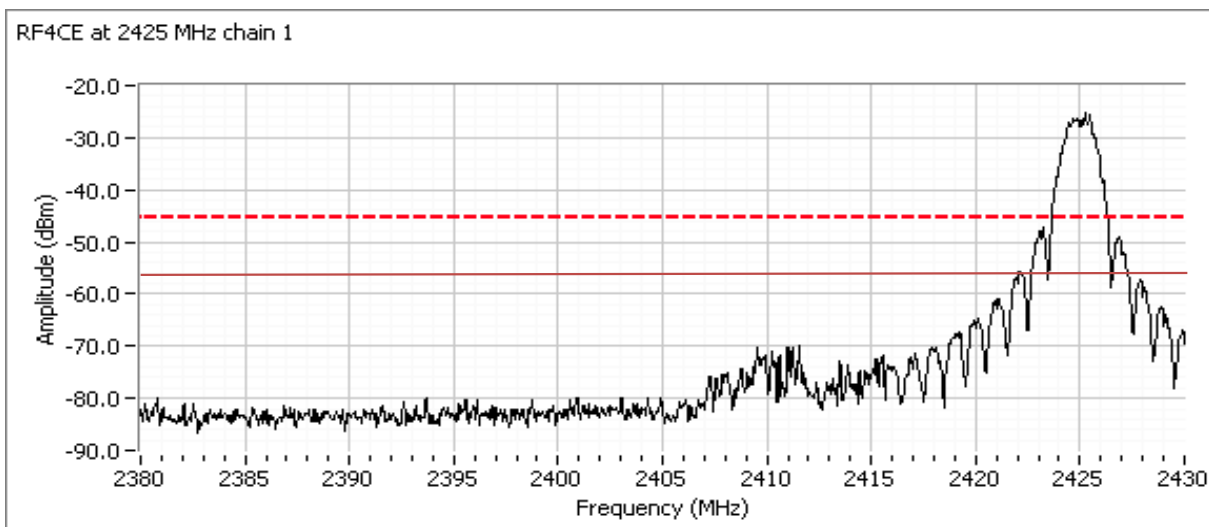
Note: Measured using a near field probe

Note: Measured using RBW=100kHz, VBW=300kHz, peak detector, max hold

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radamacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A

Plots for low channel, Chain 1

Additional plot showing compliance with -30dBc limit from 2390 MHz to 2400 MHz. Radiated measurements used to show compliance with the limits in the restricted band below 2390 MHz.



Note - solid line indicates -30dBc



# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radamacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A

## 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: 7/8/2015	Config. Used: 1
Test Engineer: Joseph Cadigal	Config Change: none
Test Location: FT Chamber#3	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.

<b>Ambient Conditions:</b>	Temperature:	25 °C
	Rel. Humidity:	31 %

### Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	CE, AC Power, 120V/60Hz	FCC 15.209	Pass	46.1 dBµV @ 0.443 MHz (-0.9 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.

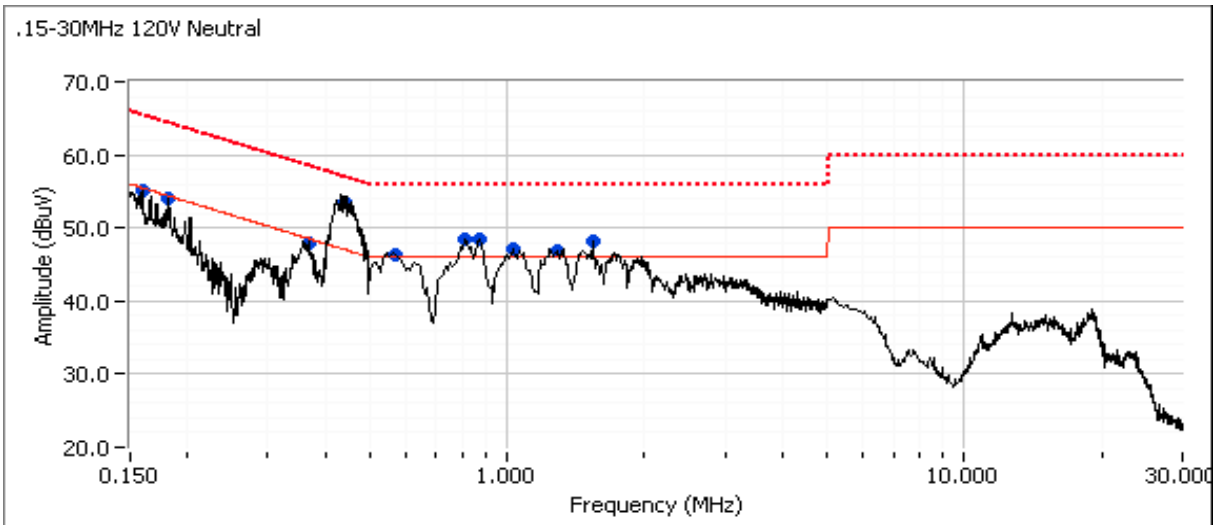
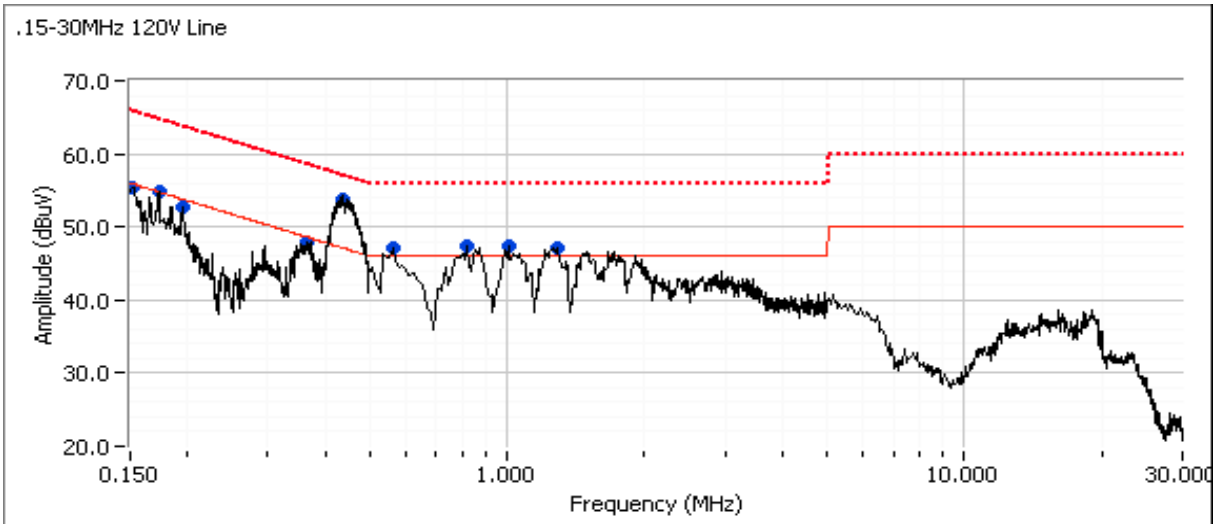
### Sample Notes

Sample S/N: G54DA5DN000024  
 Driver: 5.99 RC 188.10  
 Antenna: Internal

EUT configured to transmit on 802.11b, 1Mbps on channel 6 at maximum power and RF4CE on channel 15 at maximum power

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
Contact: Mark Rieger	Project Manager: Irene Radamacher
Standard: FCC 15.247, 15.407	Project Coordinator: -
	Class: N/A

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







# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radamacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A

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

Frequency MHz	Level dB $\mu$ V	AC Line	FCC 15.209		Detector QP/Ave	Comments
			Limit	Margin		
0.152	55.4	Line 1	55.9	-0.5	Peak	
0.173	54.8	Line 1	54.8	0.0	Peak	
0.196	52.7	Line 1	53.8	-1.1	Peak	
0.436	53.7	Line 1	47.1	6.6	Peak	
0.364	47.9	Line 1	48.6	-0.7	Peak	
1.277	47.0	Line 1	46.0	1.0	Peak	
1.010	47.4	Line 1	46.0	1.4	Peak	
0.814	47.4	Line 1	46.0	1.4	Peak	
0.566	47.0	Line 1	46.0	1.0	Peak	
0.160	55.1	Neutral	55.5	-0.4	Peak	
0.182	54.1	Neutral	54.4	-0.3	Peak	
0.368	48.0	Neutral	48.6	-0.6	Peak	
0.443	53.4	Neutral	47.0	6.4	Peak	
1.536	48.3	Neutral	46.0	2.3	Peak	
1.291	46.9	Neutral	46.0	0.9	Peak	
1.028	47.0	Neutral	46.0	1.0	Peak	
0.873	48.4	Neutral	46.0	2.4	Peak	
0.566	46.3	Neutral	46.0	0.3	Peak	
0.566	46.3	Neutral	46.0	0.3	Peak	
0.798	48.4	Neutral	46.0	2.4	Peak	

### Final quasi-peak and average readings

Frequency MHz	Level dB $\mu$ V	AC Line	FCC 15.209		Detector QP/Ave	Comments
			Limit	Margin		
0.443	46.1	Neutral	47.0	-0.9	AVG	AVG (0.10s)
0.436	46.1	Line 1	47.1	-1.0	AVG	AVG (0.10s)
0.436	52.1	Line 1	57.1	-5.0	QP	QP (1.00s)
0.443	51.7	Neutral	57.0	-5.3	QP	QP (1.00s)
0.566	39.2	Neutral	46.0	-6.8	AVG	AVG (0.10s)
1.277	38.9	Line 1	46.0	-7.1	AVG	AVG (0.10s)
1.028	38.9	Neutral	46.0	-7.1	AVG	AVG (0.10s)
0.566	38.8	Line 1	46.0	-7.2	AVG	AVG (0.10s)
0.814	38.7	Line 1	46.0	-7.3	AVG	AVG (0.10s)
1.010	38.6	Line 1	46.0	-7.4	AVG	AVG (0.10s)
1.291	38.5	Neutral	46.0	-7.5	AVG	AVG (0.10s)
1.536	37.8	Neutral	46.0	-8.2	AVG	AVG (0.10s)
0.364	40.1	Line 1	48.6	-8.5	AVG	AVG (0.10s)
0.368	39.3	Neutral	48.5	-9.2	AVG	AVG (0.10s)



# EMC Test Data

Client: Pace Americas, Inc.	Job Number: J98591
Model: HR54-700	T-Log Number: T98678
	Project Manager: Irene Radamacher
Contact: Mark Rieger	Project Coordinator: -
Standard: FCC 15.247, 15.407	Class: N/A

0.873	36.3	Neutral	46.0	-9.7	AVG	AVG (0.10s)
0.814	45.1	Line 1	56.0	-10.9	QP	QP (1.00s)
0.873	44.9	Neutral	56.0	-11.1	QP	QP (1.00s)
0.566	44.9	Neutral	56.0	-11.1	QP	QP (1.00s)
1.277	44.8	Line 1	56.0	-11.2	QP	QP (1.00s)
0.566	44.8	Line 1	56.0	-11.2	QP	QP (1.00s)
1.291	44.5	Neutral	56.0	-11.5	QP	QP (1.00s)
1.028	44.4	Neutral	56.0	-11.6	QP	QP (1.00s)
1.010	44.2	Line 1	56.0	-11.8	QP	QP (1.00s)
1.536	43.8	Neutral	56.0	-12.2	QP	QP (1.00s)
0.364	45.9	Line 1	58.6	-12.7	QP	QP (1.00s)
0.173	41.9	Line 1	54.8	-12.9	AVG	AVG (0.10s)
0.368	45.2	Neutral	58.5	-13.3	QP	QP (1.00s)
0.182	40.4	Neutral	54.4	-14.0	AVG	AVG (0.10s)
0.152	51.9	Line 1	65.9	-14.0	QP	QP (1.00s)
0.152	41.6	Line 1	55.9	-14.3	AVG	AVG (0.10s)
0.196	39.4	Line 1	53.8	-14.4	AVG	AVG (0.10s)
0.160	40.6	Neutral	55.5	-14.9	AVG	AVG (0.10s)
0.182	48.6	Neutral	64.4	-15.8	QP	QP (1.00s)
0.173	48.8	Line 1	64.8	-16.0	QP	QP (1.00s)
0.160	49.5	Neutral	65.5	-16.0	QP	QP (1.00s)
0.196	47.2	Line 1	63.8	-16.6	QP	QP (1.00s)

***End of Report***

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