

**EMC Test Report****Application for FCC Grant of Equipment Authorization  
Canada Certification****Innovation, Science and Economic Development Canada  
RSS-Gen Issue 4 / RSS 247 Issue 1  
FCC Part 15 Subpart C****Model: ApexZ family of products**

FCC ID: 2AL8XAPEXZ

APPLICANT: Lighthouse Worldwide Solutions  
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IC SITE REGISTRATION #: 2845B-5

REPORT DATE: August 21, 2017

REISSUE DATE: September 18, 2017

FINAL TEST DATES: July 3, 6, 10, 11, 12 and 27 and August 4 and 5,  
2017

TOTAL NUMBER OF PAGES: 81



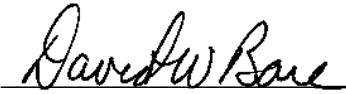
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**REVISION HISTORY**

Rev#	Date	Comments	Modified By
-	August 21, 2017	First release	
1	September 7, 2017	Revised report to correct Reviewer Name and Title	David Guidotti
2	September 18, 2017	Revised to correct EUT height, BLE channel numbers, update data summary table for spurious emissions and replaced measurements performed with incorrect BW settings.	David Bare

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## **SCOPE**

An electromagnetic emissions test has been performed on the Lighthouse Worldwide Solutions model ApexZ family of products, pursuant to the following rules:

RSS-Gen Issue 4 “General Requirements for Compliance of Radio Apparatus”

RSS 247 Issue 1 “Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSS) and Licence-Exempt Local Area Network (LE-LAN) Devices”

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.

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

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

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

Testing was performed only on model ApexZ family of products.

### **STATEMENT OF COMPLIANCE**

The tested sample of Lighthouse Worldwide Solutions model ApexZ family of products complied with the requirements of the following regulations:

RSS-Gen Issue 4 “General Requirements for Compliance of Radio Apparatus”

RSS 247 Issue 1 “Digital Transmission Systems (DTSS), Frequency Hopping Systems (FHSS) and Licence-Exempt Local Area Network (LE-LAN) Devices”

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 Lighthouse Worldwide Solutions model ApexZ family of products and therefore apply only to the tested sample. The sample was selected and prepared by Charley Abboud of Lighthouse Worldwide Solutions.

### **DEVIATIONS FROM THE STANDARDS**

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

## TEST RESULTS SUMMARY

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

FCC Rule Part	RSS Rule Part	Description	Measured Value / Comments	Limit / Requirement	Result
15.247(a)	RSS 247 5.2	Digital Modulation	Systems uses OFDM / DSSS techniques	System must utilize a digital transmission technology	Complies
15.247 (a) (2)	RSS 247 5.2 (1)	6 dB Bandwidth	BLE: 0.71 MHz 11b: 8.01 MHz 11g: 16.34 MHz n20: 17.58 MHz	>500 kHz	Complies
15.247 (b) (3)	RSS 247 5.4 (4)	Output Power (multipoint systems)	BLE: -0.5 dBm 11b: 13.1 dBm 11g: 10.7 dBm n20: 12.0 dBm	1 Watt, EIRP limited to 4 Watts.	Complies
15.247(e)	RSS 247 5.2 (2)	Power Spectral Density	BLE: -8.6 dBm/10 kHz 11b: -3.1 dBm/10 kHz 11g: -10.0 dBm/10 kHz n20: -10.3 dBm/10 kHz	8 dBm/3 kHz	Complies
15.247(d)	RSS 247 5.5	Antenna Port Spurious Emissions 30 MHz – 25 GHz	Signals below -30 dBc	< -30 dBc <sup>Note 2</sup>	Complies
15.247(d) / 15.209	RSS 247 5.5	Radiated Spurious Emissions 30 MHz – 25 GHz	43.1 dBμV/m @ 202.28 MHz (-0.4 dB)	Refer to the limits section (p20) for restricted bands, all others <-30 dBc <sup>Note 2</sup>	Complies
<p>Note 1: EIRP, if stated was calculated using maximum antenna gain of 1 dBi for the highest EIRP system.</p> <p>Note 2: Limit of -30 dBc used because the power was measured using the UNII test procedure (maximum power averaged over a transmission burst).</p>					

### GENERAL REQUIREMENTS APPLICABLE TO ALL BANDS

FCC Rule Part	RSS Rule part	Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.203	-	RF Connector		Unique or integral antenna required	Complies
15.407 (b) (6)	RSS-Gen Table 3	AC Conducted Emissions	37.1 dBμV @ 0.327 MHz (-12.4 dB)	Refer to page 19	Complies
15.247 (i) 15.407 (f)	RSS 102	RF Exposure Requirements	Refer to MPE calculations in separate exhibit, RSS 102 declaration and User Manual statements.	Refer to OET 65, FCC Part 1 and RSS 102	Complies
-	RSS-Gen 8.3	User Manual	Integral antenna	Statement for products with detachable antenna	Complies
-	RSP-100 RSS-Gen 6.6	Occupied Bandwidth (99%)	BLE: 1.07 MHz 11b: 10.60 MHz 11g: 17.12 MHz n20: 18.32 MHz	Information only	N/A

**MEASUREMENT UNCERTAINTIES**

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

Measurement Type	Measurement Unit	Frequency Range	Expanded Uncertainty
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 Lighthouse Worldwide Solutions model ApexZ family of products is a particle counter that is designed to detect air born particles. In addition, it incorporates Wi-Fi and Bluetooth 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 24 Vdc, 5.0 Amps. An AC Adapter (GST120A24-P1M) is provided with the product. The electrical rating is 100-240 Volts ,50,60 Hz,1.4 Amps Input. Output is 24Vdc, 5.0 Amps.

The sample was received on July 3, 2017 and tested on July 3, 6, 10, 11, 12 and 27 and August 4 and 5, 2017. The EUT consisted of the following component(s):

Company	Model	Description	Serial Number	FCC ID
Lighthouse Worldwide Solutions	ApexZ3	Particle Counter	1704141003	

**OTHER EUT DETAILS**

The following EUT details should be noted: Wi-Fi radio is 2.4 GHz b/g/n20 single antenna only. Wi-Fi and BT radios cannot transmit simultaneously.

**ANTENNA SYSTEM**

Integral antenna

**ENCLOSURE**

The EUT enclosure is primarily constructed of molded plastic. It measures approximately 32.41 cm wide by 15.82 cm deep by 22.55 cm high.

**MODIFICATIONS**

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

**SUPPORT EQUIPMENT**

Manufacturer	Model	Description	Serial Number	FCC ID
Mean Well	GST120A24	Power Supply	EB6BP05875	-

**EUT INTERFACE PORTS**

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

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
DC power	AC/DC power supply	Power cable	Unshielded	1.8
Ethernet 10/100 Base T	Router	CAT5	Shielded	10.0
Serial	Not connected	-	-	-
USB	Flash drive	USB	Shielded	3.0
Smart	Not connected	-	-	-
Micro USB	Not connected	-	-	-

**EUT OPERATION**

During testing, the EUT was transmitting with the highest RF power, with required modes and frequencies for each test case.

**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 5	US0027	2845B-5	41039 Boyce Road Fremont, CA 94538-2435

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**

Software is used to view and convert 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 software used for radiated and conducted emissions measurements is NTS EMI Test Software (rev 2.10)

### **LINE IMPEDANCE STABILIZATION NETWORK (LISN)**

Line conducted measurements utilize a 50  $\mu$ H Line Impedance Stabilization Network as the monitoring point. The LISN used also contains a 250  $\mu$ H 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 for tests below 1 GHz and 1.5 meters for tests above 1 GHz. 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.

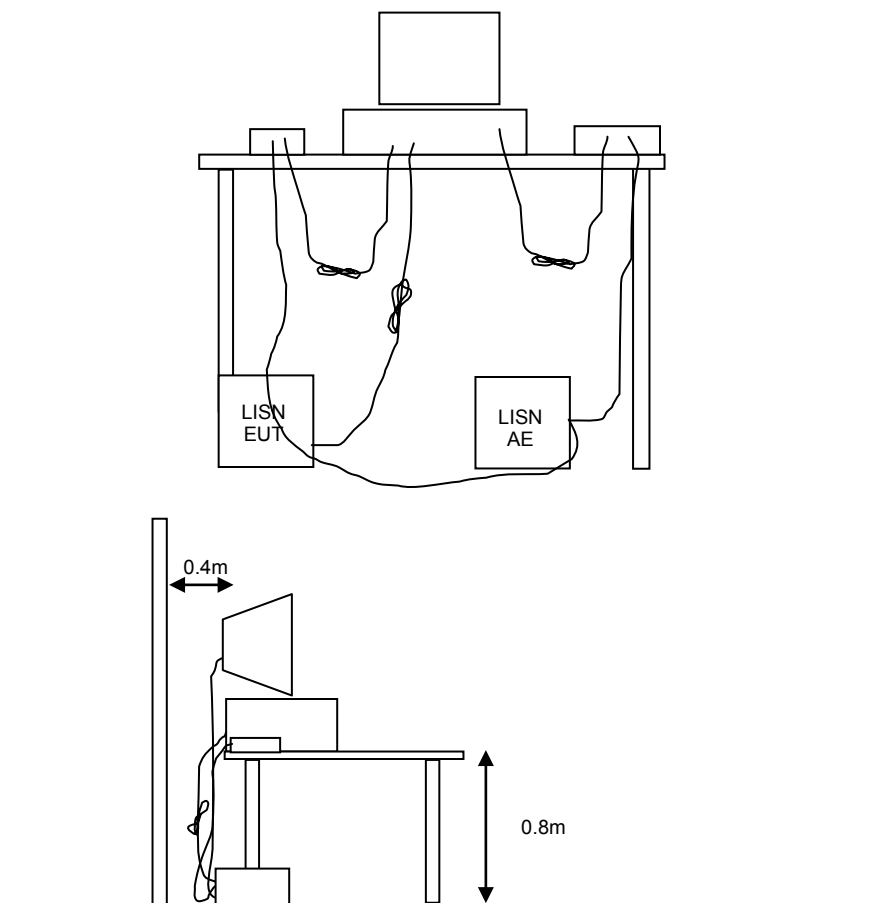
## TEST PROCEDURES

### 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**

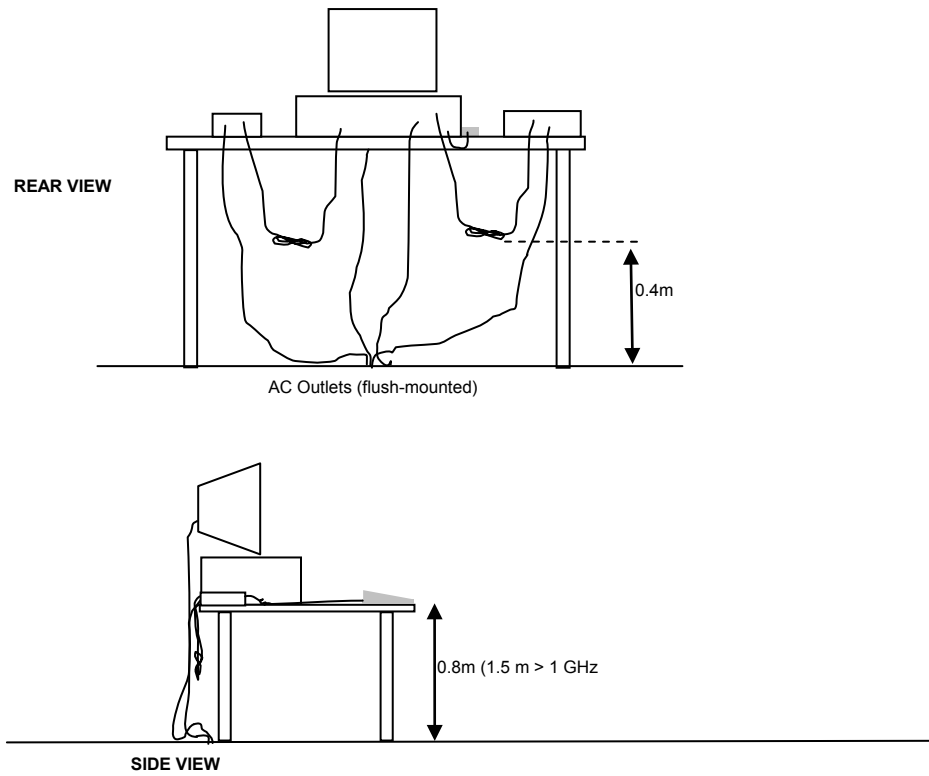
**RADIATED EMISSIONS**

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.

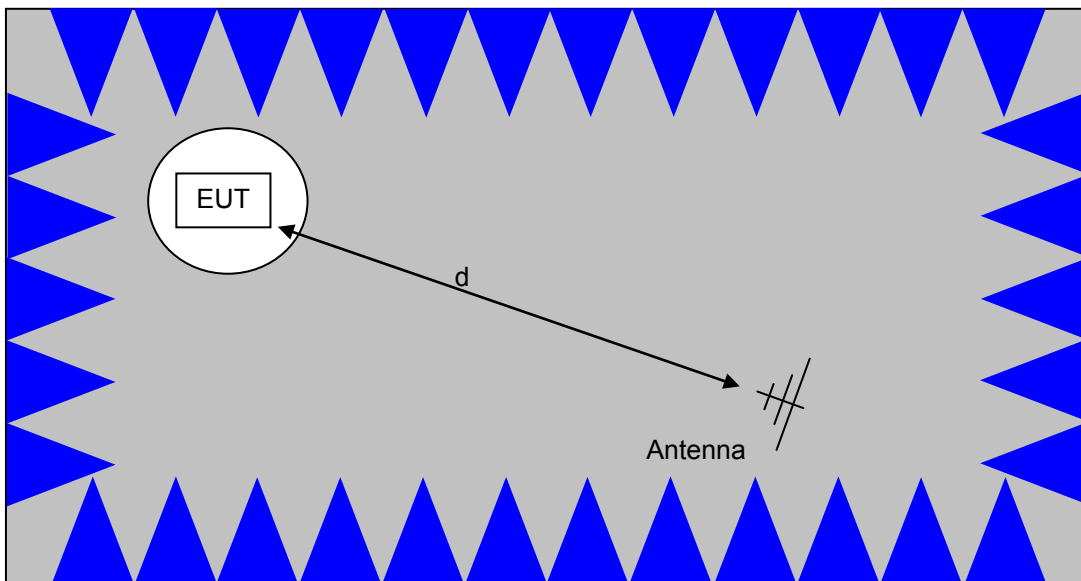
Final maximization is a phase in which the highest amplitude emissions identified in the spectral search are viewed while the EUT azimuth angle is varied from 0 to 360 degrees relative to the receiving antenna. The azimuth, which results in the highest emission is then maintained while varying the antenna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



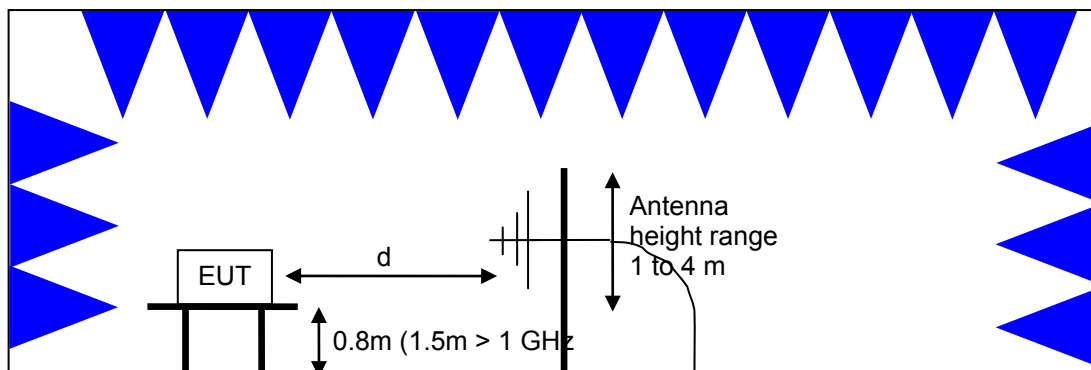
Typical Test Configuration for Radiated Field Strength Measurements





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.

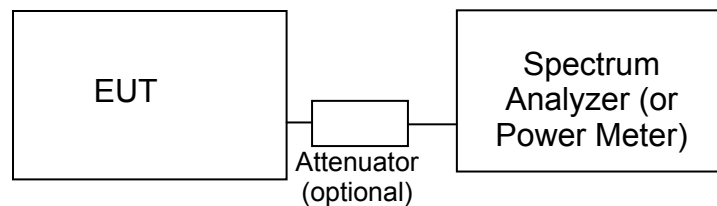
Floor-standing equipment is placed on the floor with insulating supports between the unit and the ground plane.



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 6 dB, 20 dB, 26 dB 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 (dB $\mu$ V)	Quasi Peak Limit (dB $\mu$ V)
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>.

Frequency Range (MHz)	Limit (μV/m)	Limit (dBμV/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

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<sup>1</sup> The restricted bands are detailed in FCC 15.205 and RSS-Gen Table 6

**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
5725 – 5850	1 Watt (30 dBm)	8 dBm/3kHz

The maximum permitted output power is reduced by 1dB for every dB the antenna gain exceeds 6dBi. Fixed point-to-point applications using the 5725 – 5850 MHz band are not subject to this restriction.

**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).

**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 dB $\mu$ V

$S$  = Specification Limit in dB $\mu$ V

$M$  = 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 dB $\mu$ V/m

$F_d$  = Distance Factor in dB

$R_c$  = Corrected Reading in dB $\mu$ V/m

$L_s$  = Specification Limit in dB $\mu$ V/m

$M$  = Margin in dB Relative to Spec

## 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, BE, 1,000 - 6,500 MHz, 03-Jul-17</b>					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
EMCO	Antenna, Horn, 1-18 GHz (SA40-Red)	3115	1142	9/29/2016	9/29/2018
Rohde & Schwarz	EMI Test Receiver, 20 Hz-40 GHz	ESI 40	2493	3/17/2017	3/17/2018
<b>Radiated Emissions, 1,000 - 26,500 MHz, 03-Jul-17</b>					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
EMCO	Antenna, Horn, 1-18 GHz (SA40-Red)	3115	1142	9/29/2016	9/29/2018
Hewlett Packard	Spectrum Analyzer (SA40) Blue 9 kHz - 40 GHz	8564E (84125C)	1393	4/10/2017	4/10/2018
HP / Miteq	SA40 B Head HF preAmplifier, 18-40 GHz (w/1393)	TTA1840-45-5P-HG-S	1620	2/13/2017	2/13/2018
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	1780	9/30/2016	9/30/2017
A. H. Systems	Spare System Horn, 18-40GHz	SAS-574, p/n: 2581	2162	7/29/2015	7/29/2017
Micro-Tronics	Band Reject Filter, 2400-2500 MHz	BRM50702-02	2249	5/17/2017	5/17/2018
<b>Radiated Emissions, 1,000 - 26,500 MHz, 06-Jul-17</b>					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
Hewlett Packard	Spectrum Analyzer (SA40) Blue 9 kHz - 40 GHz	8564E (84125C)	1393	4/10/2017	4/10/2018
EMCO	Antenna, Horn, 1-18 GHz	3115	1561	7/8/2016	7/8/2018
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	1780	9/30/2016	9/30/2017
Micro-Tronics	Band Reject Filter, 2400-2500 MHz	BRM50702-02	2249	5/17/2017	5/17/2018
<b>Radiated Emissions, 30 - 26,500 MHz, 10-Jul-17</b>					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
Hewlett Packard	Spectrum Analyzer (SA40) Blue 9 kHz - 40 GHz	8564E (84125C)	1393	4/10/2017	4/10/2018
EMCO	Antenna, Horn, 1-18 GHz	3115	1561	7/8/2016	7/8/2018
HP / Miteq	SA40 B Head HF preAmplifier, 18-40 GHz (w/1393)	TTA1840-45-5P-HG-S	1620	2/13/2017	2/13/2018
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	1780	9/30/2016	9/30/2017
A. H. Systems	Blue System Horn, 18-40GHz	SAS-574, p/n: 2581	2159	9/9/2015	9/9/2017
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	2197	9/9/2015	9/9/2017
Micro-Tronics	Band Reject Filter, 2400-2500 MHz	BRM50702-02	2249	5/17/2017	5/17/2018
Rohde & Schwarz	EMI Test Receiver, 20 Hz-40 GHz	ESI 40	2493	3/17/2017	3/17/2018

<u>Manufacturer</u>	<u>Description</u>	<u>Model</u>	<u>Asset #</u>	<u>Calibrated</u>	<u>Cal Due</u>
Com-Power	Preamplifier, 1-1000 MHz	PAM-103	2885	9/16/2016	9/16/2017
<b>Radiated Emissions, 1000 - 18,000 MHz, 11-Jul-17</b>					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
Hewlett Packard	Spectrum Analyzer (SA40) Blue 9 kHz - 40 GHz	8564E (84125C)	1393	4/10/2017	4/10/2018
EMCO	Antenna, Horn, 1-18 GHz	3115	1561	7/8/2016	7/8/2018
Micro-Tronics	Band Reject Filter, 2400-2500 MHz	BRM50702-02	1683	5/17/2017	5/17/2018
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	1780	9/30/2016	9/30/2017
<b>BE measurements for BT Basic &amp; EDR, 12-Jul-17</b>					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB 7	1538	2/11/2017	2/11/2018
EMCO	Antenna, Horn, 1-18 GHz	3115	1561	7/8/2016	7/8/2018
<b>Radiated Emissions, 18,000 - 25,000 MHz, 12-Jul-17</b>					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
Hewlett Packard	Spectrum Analyzer (SA40) Blue 9 kHz - 40 GHz	8564E (84125C)	1393	4/10/2017	4/10/2018
HP / Miteq	SA40 B Head HF preAmplifier, 18-40 GHz (w/1393)	TTA1840-45-5P-HG-S	1620	2/13/2017	2/13/2018
A. H. Systems	Red System Horn, 18-40GHz	SAS-574, p/n: 2581	2161	7/16/2015	7/16/2017
<b>Radiated Emissions, 30 - 1,000 MHz, 12-Jul-17</b>					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB 7	1538	2/11/2017	2/11/2018
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	2197	9/9/2015	9/9/2017
Com-Power	Preamplifier, 1-1000 MHz	PAM-103	2885	9/16/2016	9/16/2017
<b>Conducted Emissions - AC Power Ports, 27-Jul-17</b>					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
Rohde & Schwarz	Pulse Limiter	ESH3 Z2	1401	2/3/2017	2/3/2018
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB 7	1538	2/11/2017	2/11/2018
Fischer Custom Comm	LISN, 25A, 150kHz to 30MHz, 25 Amp,	FCC-LISN-50-25-2-09	2000	9/26/2016	9/26/2017
<b>Radiated Emissions, 30 - 1,000 MHz, 27-Jul-17</b>					
National Technical Systems	NTS EMI Software (rev 2.10)	N/A	0		N/A
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB 7	1538	2/11/2017	2/11/2018
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	2197	9/9/2015	9/9/2017
Com-Power	Preamplifier, 1-1000 MHz	PAM-103	2885	9/16/2016	9/16/2017





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<u>Manufacturer</u>	<u>Description</u>	<u>Model</u>	<u>Asset #</u>	<u>Calibrated</u>	<u>Cal Due</u>
Radio Antenna Port Agilent Technologies	(Power and Spurious Emissions), 04-Aug-17 & 05-Aug-17 3Hz -44GHz PSA Spectrum Analyzer	E4446A	2796	5/22/2017	5/22/2018

## **Appendix B Test Data**

T105297 Pages 27 – 80



## EMC Test Data

Client:	Lighthouse Worldwide Solutions	Job Number:	JD105241
Product	ApexZ3	T-Log Number:	T105297
System Configuration:		Project Manager:	Irene Radamacher
Contact:	Charley Abboud	Project Coordinator:	-
Emissions Standard(s):	FCC Part 15	Class:	B
Immunity Standard(s):		Environment:	Radio

## EMC Test Data

For The

**Lighthouse Worldwide Solutions**

Product

**ApexZ3**

Date of Last Test: 8/17/2017

Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

## RSS-247 and 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: 8/4/2017, 8/5/17  
 Test Engineer: Joseph Cadigal, YK Soo  
 Test Location: FT Lab#4A

Config. Used: 1  
 Config Change: none  
 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:            24 °C  
    Rel. Humidity:            38 %

### Summary of Results

Run #	Pwr setting	Avg Pwr	Test Performed	Limit	Pass / Fail	Result / Margin
1	default		Output Power	15.247(b)	Pass	BLE: -0.5 dBm 11b: 13.1 dBm 11g: 10.7 dBm n20: 12.0 dBm
2	default		Power spectral Density (PSD)	15.247(d)	Pass	BLE: -8.6 dBm/10kHz 11b: -3.1 dBm/10kHz 11g: -10.0 dBm/10kHz n20: -10.3 dBm/10kHz
3	default		Minimum 6dB Bandwidth	15.247(a)	Pass	BLE: 0.71 MHz 11b: 8.01 MHz 11g: 16.34 MHz n20: 17.58 MHz
3	default		99% Bandwidth	RSS GEN	Pass	BLE: 1.07 MHz 11b: 10.60 MHz 11g: 17.12 MHz n20: 18.32 MHz
4	default		Spurious emissions	15.247(b)	Pass	Signals below -30 dBc

Client:	Lighthouse Worldwide Solutions	Job Number:	JD105241
Model:	ApexZ3	T-Log Number:	T105297
Contact:	Charley Abboud	Project Manager:	Irene Radamacher
Standard:	FCC Part 15	Project Coordinator:	-
		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.

## 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)
BLE	1 Mb/s	93.2%	Yes	4.66	0.3058409	0.6116818	215
11b	1 Mb/s	96.9%	Yes	1.279	0.1370339	0.2740677	782
11g	6 Mb/s	96.0%	Yes	2.353	0.1754416	0.3508831	425
n20	MCS0	94.9%	Yes	1.293	0.2257858	0.4515717	773

## Sample Notes

Sample S/N: 1704141010

Driver:

Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

## Run #1: Output Power

Mode: BLE

Power Setting <sup>2</sup>	Frequency (MHz)	Output Power (dBm) <sup>1</sup>	mW	Antenna Gain (dBi)	Result	EIRP dBm	W	Output Power (dBm) <sup>3</sup>	mW
0	2402 (CH 37)	-0.6	0.9	-1.0	Pass	-1.6	0.001		
0	2440 (CH 17)	-0.5	0.9	0.0	Pass	-0.5	0.001		
0	2480 (CH 39)	-0.8	0.8	1.0	Pass	0.2	0.001		

Mode: 11b

Power Setting <sup>2</sup>	Frequency (MHz)	Output Power (dBm) <sup>1</sup>	mW	Antenna Gain (dBi)	Result	EIRP dBm	W	Output Power (dBm) <sup>3</sup>	mW
16	2412 (CH 1)	13.1	20.4	-1.0	Pass	12.1	0.016		
16	2437 (CH 6)	12.8	19.1	0.0	Pass	12.8	0.019		
16	2462 (CH 11)	12.4	17.4	1.0	Pass	13.4	0.022		

Mode: 11g

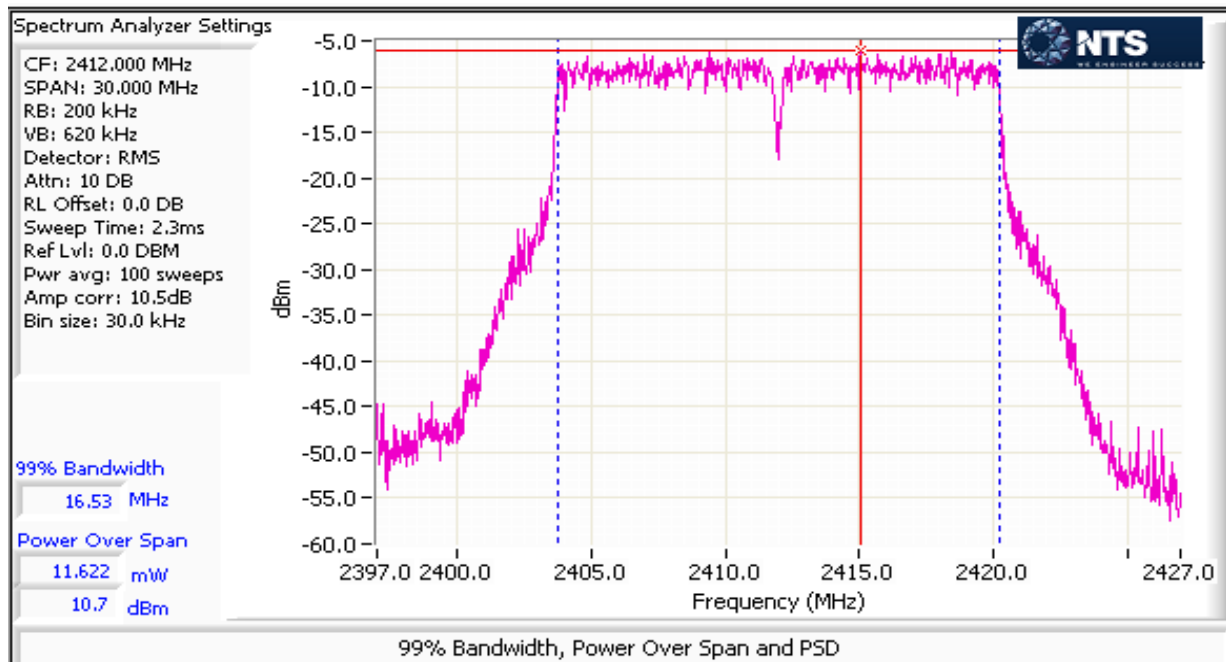
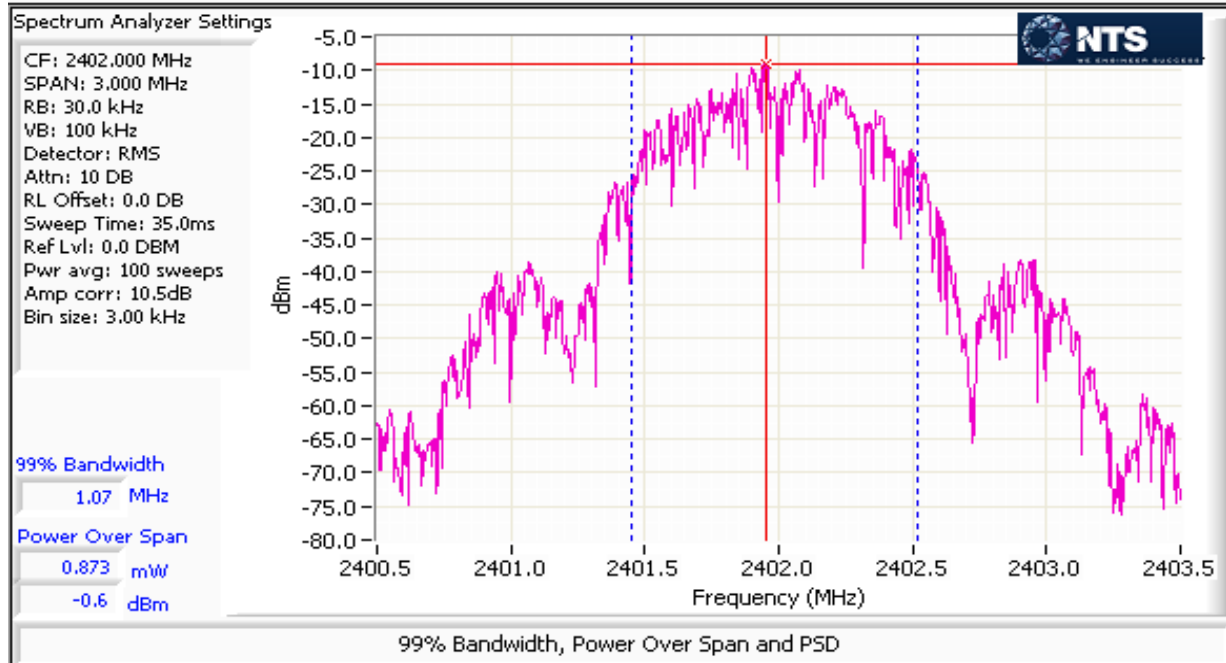
Power Setting <sup>2</sup>	Frequency (MHz)	Output Power (dBm) <sup>1</sup>	mW	Antenna Gain (dBi)	Result	EIRP dBm	W	Output Power (dBm) <sup>3</sup>	mW
15	2412 (CH 1)	10.7	11.7	-1.0	Pass	9.7	0.009		
15	2437 (CH 6)	10.3	10.7	0.0	Pass	10.3	0.011		
15	2462 (CH 11)	10.0	10.0	1.0	Pass	11.0	0.013		

Mode: n20

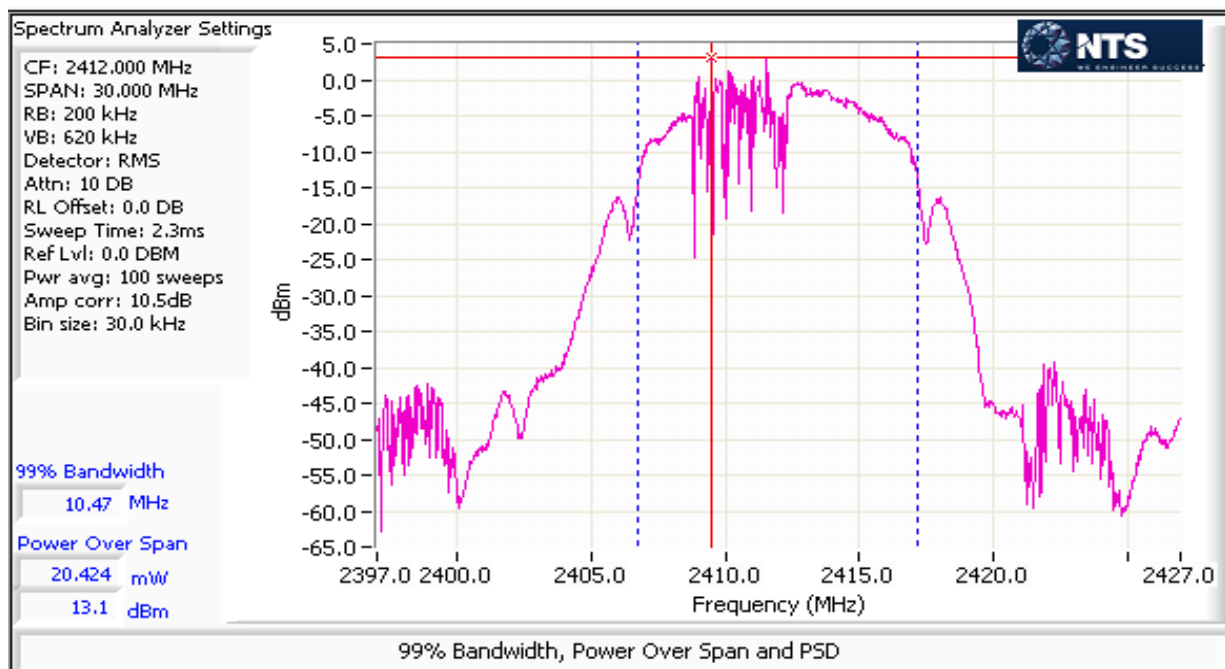
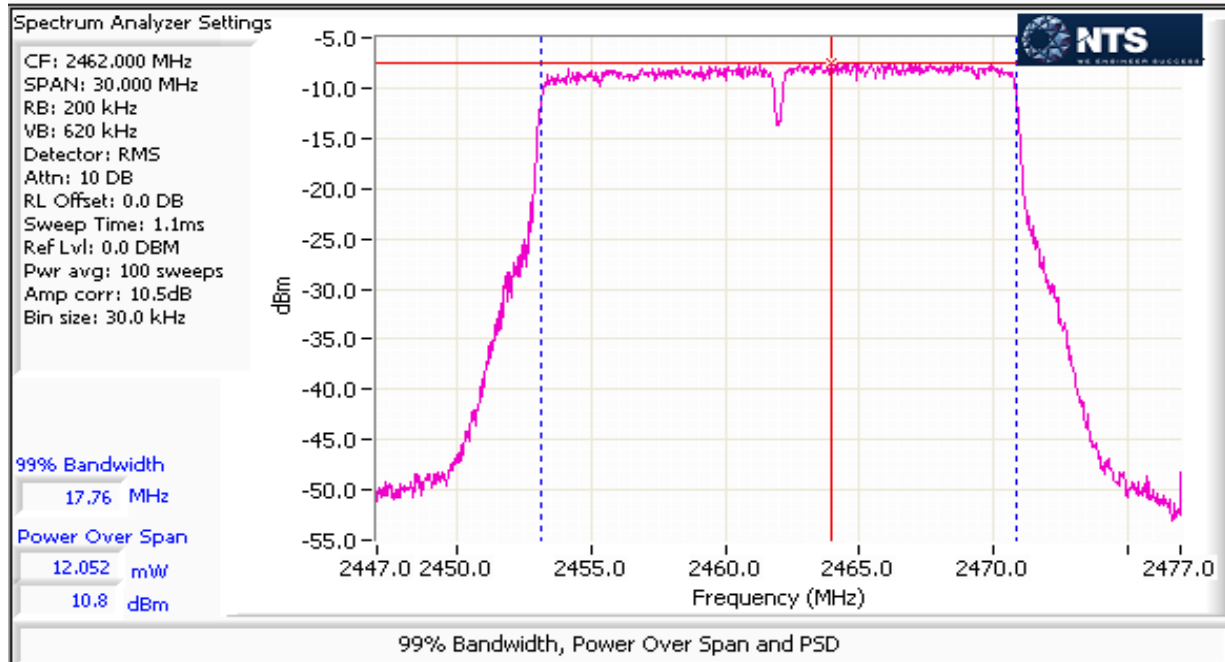
Power Setting <sup>2</sup>	Frequency (MHz)	Output Power (dBm) <sup>1</sup>	mW	Antenna Gain (dBi)	Result	EIRP dBm	W	Output Power (dBm) <sup>3</sup>	mW
14	2412 (CH 1)	9.6	9.1	-1.0	Pass	8.6	0.007		
14	2437 (CH 6)	9.2	8.3	0.0	Pass	9.2	0.008		
14	2462 (CH 11)	10.8	12.0	1.0	Pass	11.8	0.015		

- Note 1: Duty Cycle < 98%. Output power measured using a spectrum analyzer (see plots below) with RBW= 1-5% of OBW and  $\leq 1$  MHz, VB $\geq 3$ \* RBW, Span  $\geq 1.5$  of OBW, auto sweep time, RMS detector, power averaging on, GATING enabled, and power integration over the OBW, trace average 100 traces (option AVGSA-1 in C63.10). Spurious limit becomes -30dBc.
- Note 2: Power setting - the software power setting used during testing, included for reference only.
- Note 3: Power measured using average power meter (non-gated) and is included for reference only.

Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A



Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A





Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

## Run #2: Power spectral Density

Mode: BLE

Power Setting	Frequency (MHz)	PSD (dBm/10kHz) <sup>Note 1</sup>	Limit dBm/3kHz	Result
0	2402 (CH 37)	-8.9	8.0	Pass
0	2440 (CH 17)	-8.6	8.0	Pass
0	2480 (CH 39)	-9.0	8.0	Pass

Mode: 11b

Power Setting	Frequency (MHz)	PSD (dBm/10kHz) <sup>Note 1</sup>	Limit dBm/3kHz	Result
16	2412 (CH 1)	-3.1	8.0	Pass
16	2437 (CH 6)	-3.9	8.0	Pass
16	2462 (CH 11)	-4.1	8.0	Pass

Mode: 11g

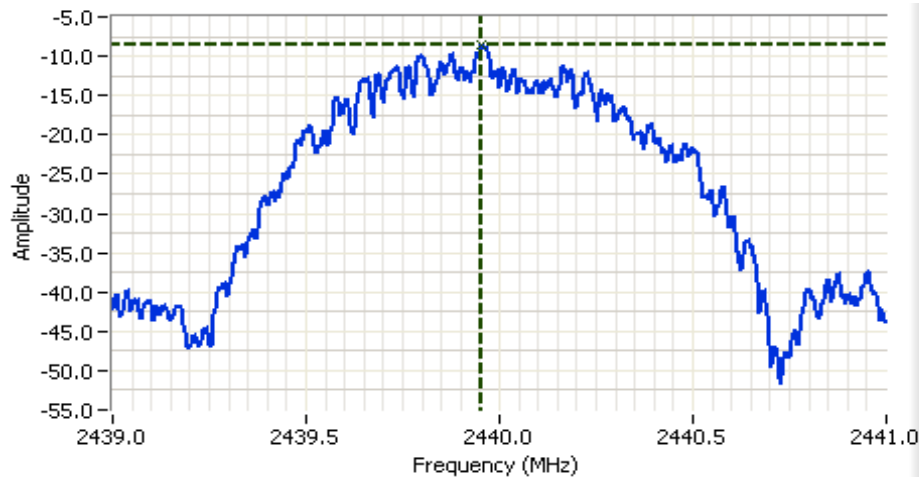
Power Setting	Frequency (MHz)	PSD (dBm/10kHz) <sup>Note 1</sup>	Limit dBm/3kHz	Result
15	2412 (CH 1)	-10.0	8.0	Pass
15	2437 (CH 6)	-10.2	8.0	Pass
15	2462 (CH 11)	-10.7	8.0	Pass

Mode: n20

Power Setting	Frequency (MHz)	PSD (dBm/10kHz) <sup>Note 1</sup>	Limit dBm/3kHz	Result
14	2412 (CH 1)	-10.8	8.0	Pass
14	2437 (CH 6)	-10.3	8.0	Pass
14	2462 (CH 11)	-10.9	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 =  $1.5*\text{DTS BW}$ , auto sweep time, max hold.

Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

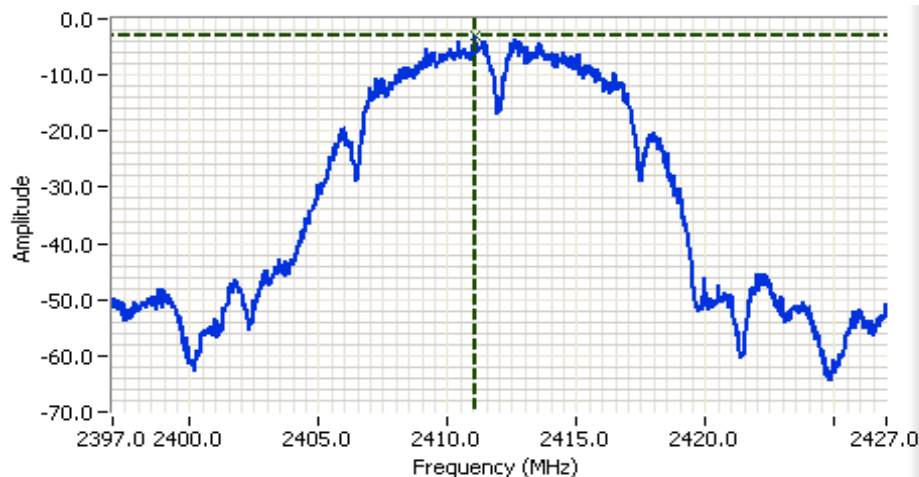
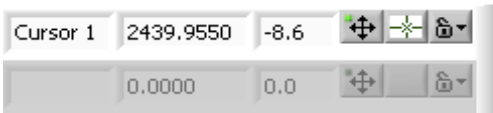


## Analyzer Settings

Agilent Technologies, E4446A  
 CF: 2440.000 MHz  
 SPAN: 2.000 MHz  
 RB: 10.0 kHz  
 VB: 30.0 kHz  
 Detector: POS  
 Attn: 20 DB  
 RL Offset: 10.5 DB  
 Sweep Time: 19.1ms  
 Ref Lvl: 10.5 DBM

## Comments

BLE  
 PSD = -8.6 dBm/10kHz

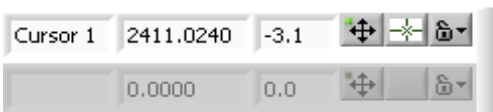


## Analyzer Settings

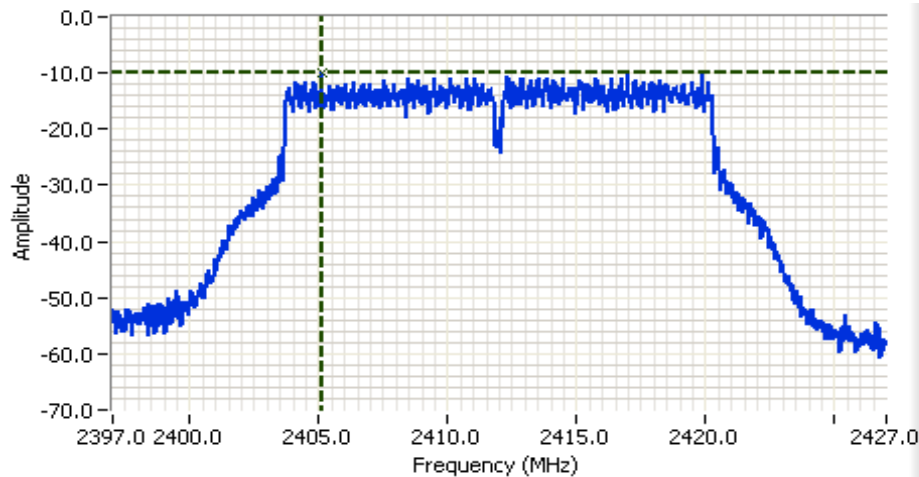
Agilent Technologies, E4446A  
 CF: 2412.000 MHz  
 SPAN: 30.000 MHz  
 RB: 10.0 kHz  
 VB: 30.0 kHz  
 Detector: POS  
 Attn: 20 DB  
 RL Offset: 10.5 DB  
 Sweep Time: 286.7ms  
 Ref Lvl: 10.5 DBM

## Comments

802.11b  
 PSD -3.1 dBm/10kHz



Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

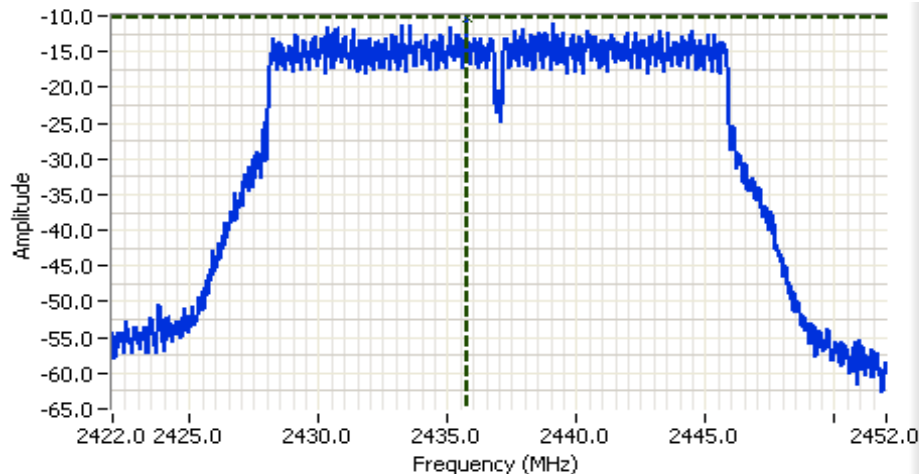


## Analyzer Settings

Agilent Technologies, E4446A  
 CF: 2412.000 MHz  
 SPAN: 30.000 MHz  
 RB: 10.0 kHz  
 VB: 30.0 kHz  
 Detector: POS  
 Attn: 20 DB  
 RL Offset: 10.5 DB  
 Sweep Time: 286.7ms  
 Ref Lvl: 10.5 DBM

## Comments

802.11g  
 PSD -10 dBm/10kHz



## Analyzer Settings

Agilent Technologies, E4446A  
 CF: 2437.000 MHz  
 SPAN: 30.000 MHz  
 RB: 10.0 kHz  
 VB: 30.0 kHz  
 Detector: POS  
 Attn: 20 DB  
 RL Offset: 10.5 DB  
 Sweep Time: 286.7ms  
 Ref Lvl: 10.5 DBM

## Comments

802.11n20  
 PSD -10.3 dBm/10kHz

Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

## Run #3: Signal Bandwidth

Mode: BLE

Power Setting	Frequency (MHz)	Bandwidth (MHz)		RBW Setting (MHz)	
		6dB	99%	6dB	99%
0	2402 (CH 37)	0.71	1.07	0.1	0.3
0	2440 (CH 17)	0.71	1.07	0.1	0.3
0	2480 (CH 39)	0.72	1.07	0.1	0.3

Mode: 11b

Power Setting	Frequency (MHz)	Bandwidth (MHz)		RBW Setting (MHz)	
		6dB	99%	6dB	99%
16	2412 (CH 1)	8.05	10.56	0.1	0.3
16	2437 (CH 6)	8.01	10.60	0.1	0.3
16	2462 (CH 11)	8.05	10.56	0.1	0.3

Mode: 11g

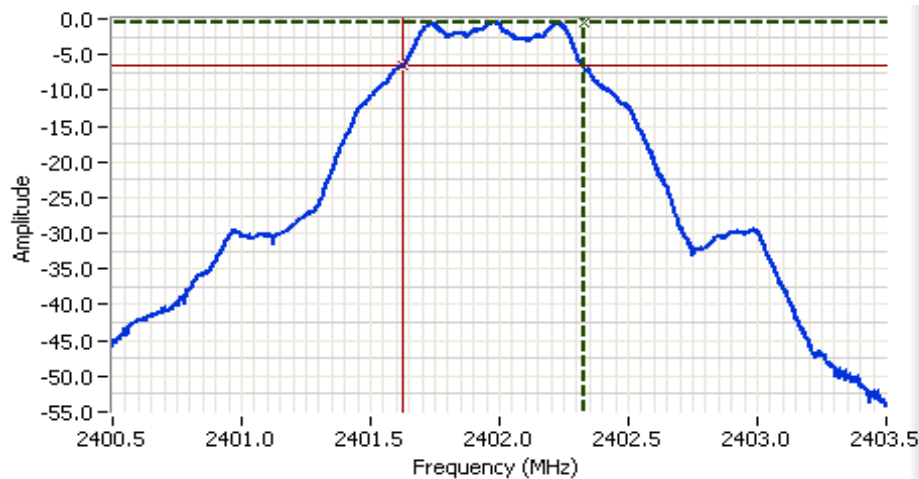
Power Setting	Frequency (MHz)	Bandwidth (MHz)		RBW Setting (MHz)	
		6dB	99%	6dB	99%
15	2412 (CH 1)	16.34	17.08	0.1	0.3
15	2437 (CH 6)	16.38	17.12	0.1	0.3
15	2462 (CH 11)	16.38	17.08	0.1	0.3

Mode: n20

Power Setting	Frequency (MHz)	Bandwidth (MHz)		RBW Setting (MHz)	
		6dB	99%	6dB	99%
14	2412 (CH 1)	17.62	18.24	0.1	0.3
14	2437 (CH 6)	17.58	18.24	0.1	0.3
14	2462 (CH 11)	17.58	18.32	0.1	0.3

Note 1: DTS BW: RBW=100kHz, VBW  $\geq 3 \times$  RBW, peak detector, max hold, auto sweep time, Span 2-5 times measured BW.  
 99% BW: RBW=1-5% of 99%BW, VBW  $\geq 3 \times$  RBW, peak detector, max hold, auto sweep time. Span 1.5-5 times OBW.

Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A



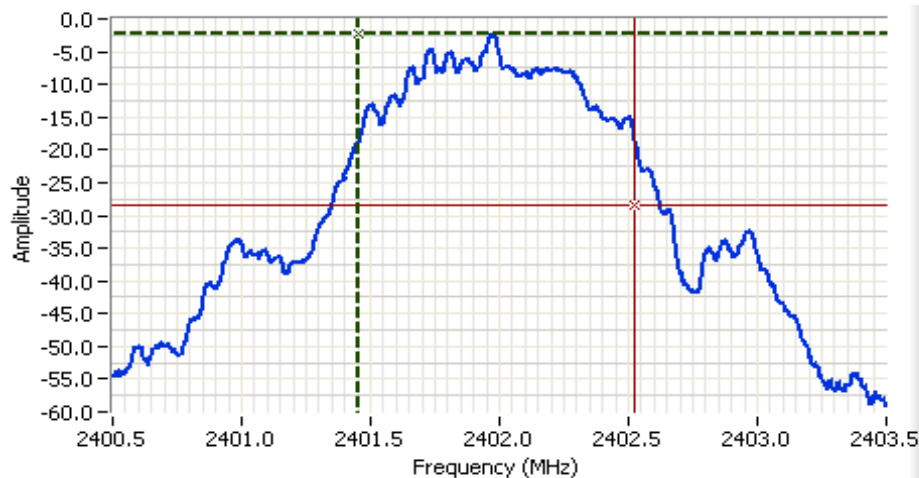
## Analyzer Settings

Agilent Technologies, E4446A  
 CF: 2402.000 MHz  
 SPAN: 3.000 MHz  
 RB: 100 kHz  
 VB: 300 kHz  
 Detector: POS  
 Attn: 20 DB  
 RL Offset: 10.5 DB  
 Sweep Time: 1.1ms  
 Ref Lvl: 10.5 DBM

## Comments

BLE  
 6dB BW: 706 kHz

Cursor 1	2402.3288	-0.5		Delta Freq.	706 kHz
Cursor 2	2401.6231	-6.5		Delta Amplitude	6.0



## Analyzer Settings

Agilent Technologies, E4446A  
 CF: 2402.000 MHz  
 SPAN: 3.000 MHz  
 RB: 30.0 kHz  
 VB: 100 kHz  
 Detector: POS  
 Attn: 20 DB  
 RL Offset: 10.5 DB  
 Sweep Time: 3.2ms  
 Ref Lvl: 10.5 DBM

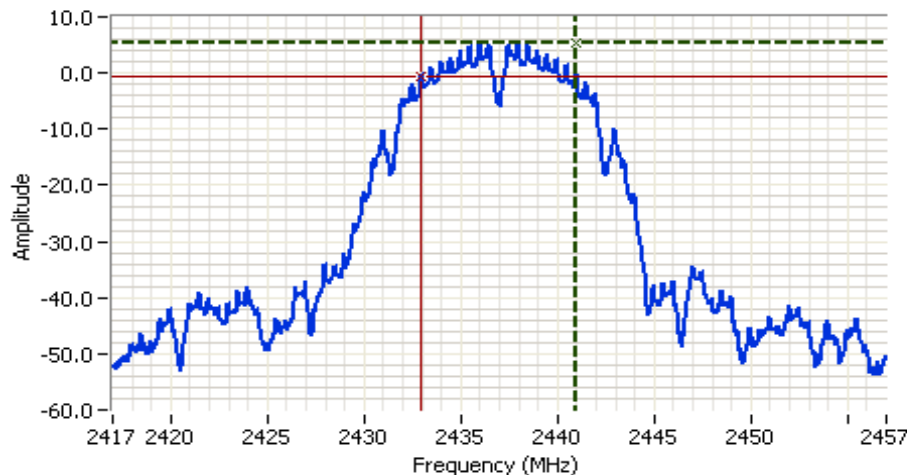
## Comments

BLE  
 99% power BW: 1.065 MHz

Cursor 1	2401.4570	-2.3		Delta Freq.	1.065
Cursor 2	2402.5220	-28.3		Delta Amplitude	26.0



Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A



## Analyzer Settings

Agilent Technologies, E4446A  
 CF: 2437.000 MHz  
 SPAN: 40.000 MHz  
 RB: 100 kHz  
 VB: 300 kHz  
 Detector: POS  
 Attn: 20 DB  
 RL Offset: 10.5 DB  
 Sweep Time: 3.9ms  
 Ref Lvl: 10.5 DBM

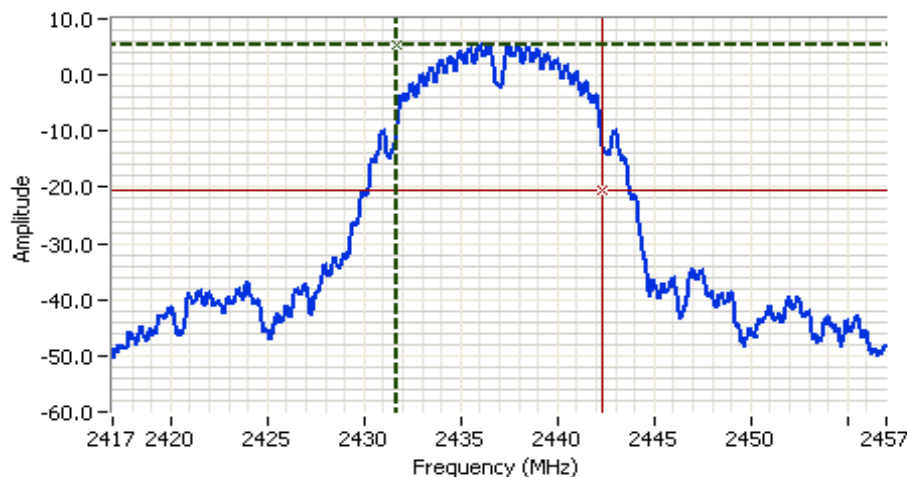
## Comments

11b  
 6dB BW: 8.008 MHz

Cursor 1 2440.9840 5.5  
 Cursor 2 2432.9760 -0.5

Delta Freq. 8.008

Delta Amplitude 6.0



## Analyzer Settings

Agilent Technologies, E4446A  
 CF: 2437.000 MHz  
 SPAN: 40.000 MHz  
 RB: 300 kHz  
 VB: 1.000 MHz  
 Detector: POS  
 Attn: 20 DB  
 RL Offset: 10.5 DB  
 Sweep Time: 1.1ms  
 Ref Lvl: 10.5 DBM

## Comments

11b  
 99% power BW: 10.600 MHz

Cursor 1 2431.6800 5.4  
 Cursor 2 2442.2800 -20.6

Delta Freq. 10.600

Delta Amplitude 26.0



Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A



## Analyzer Settings

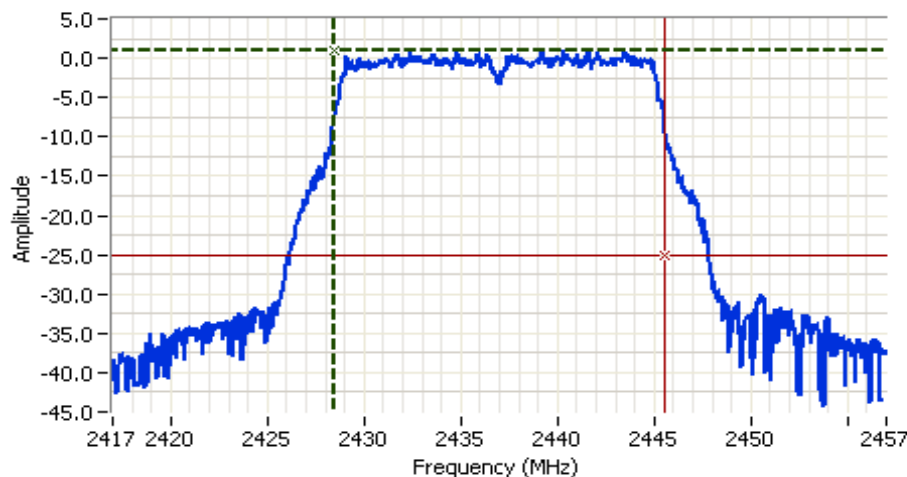
Agilent Technologies, E4446A  
 CF: 2412.000 MHz  
 SPAN: 40.000 MHz  
 RB: 100 kHz  
 VB: 300 kHz  
 Detector: POS  
 Attn: 20 DB  
 RL Offset: 10.5 DB  
 Sweep Time: 3.9ms  
 Ref Lvl: 10.5 DBM

## Comments

11g  
 6dB BW: 16.336 MHz

Cursor 1 2420.1481 -0.9  
 Cursor 2 2403.8118 -6.9

Delta Freq. 16.336  
 Delta Amplitude 6.0



## Analyzer Settings

Agilent Technologies, E4446A  
 CF: 2437.000 MHz  
 SPAN: 40.000 MHz  
 RB: 300 kHz  
 VB: 1.000 MHz  
 Detector: POS  
 Attn: 20 DB  
 RL Offset: 10.5 DB  
 Sweep Time: 1.1ms  
 Ref Lvl: 10.5 DBM

## Comments

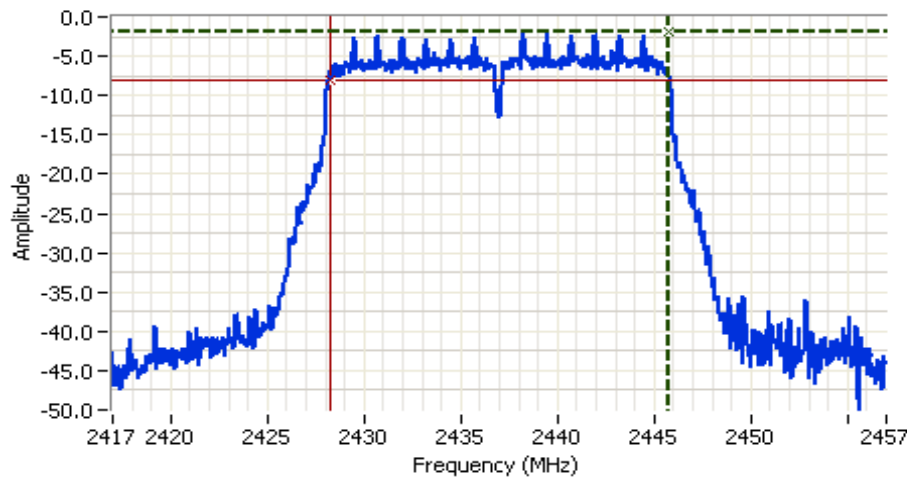
11g  
 99% power BW: 17.120 MHz

Cursor 1 2428.4400 1.0  
 Cursor 2 2445.5600 -25.0

Delta Freq. 17.120  
 Delta Amplitude 26.0



Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

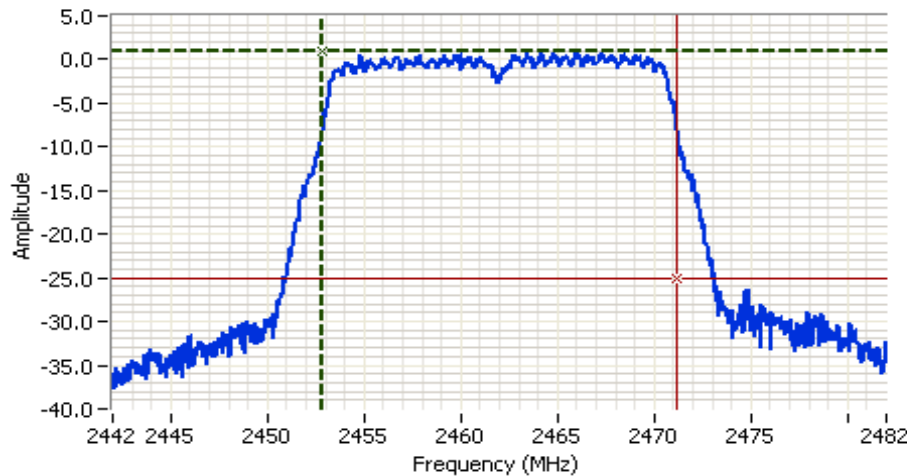


## Analyzer Settings

Agilent Technologies, E4446A  
 CF: 2437.000 MHz  
 SPAN: 40.000 MHz  
 RB: 100 kHz  
 VB: 300 kHz  
 Detector: POS  
 Attn: 20 DB  
 RL Offset: 10.5 DB  
 Sweep Time: 3.9ms  
 Ref Lvl: 10.5 DBM

## Comments

n20  
 6dB BW: 17.578 MHz



## Analyzer Settings

Agilent Technologies, E4446A  
 CF: 2462.000 MHz  
 SPAN: 40.000 MHz  
 RB: 300 kHz  
 VB: 1.000 MHz  
 Detector: POS  
 Attn: 20 DB  
 RL Offset: 10.5 DB  
 Sweep Time: 1.1ms  
 Ref Lvl: 10.5 DBM

## Comments

n20  
 99% power BW: 18.320 MHz





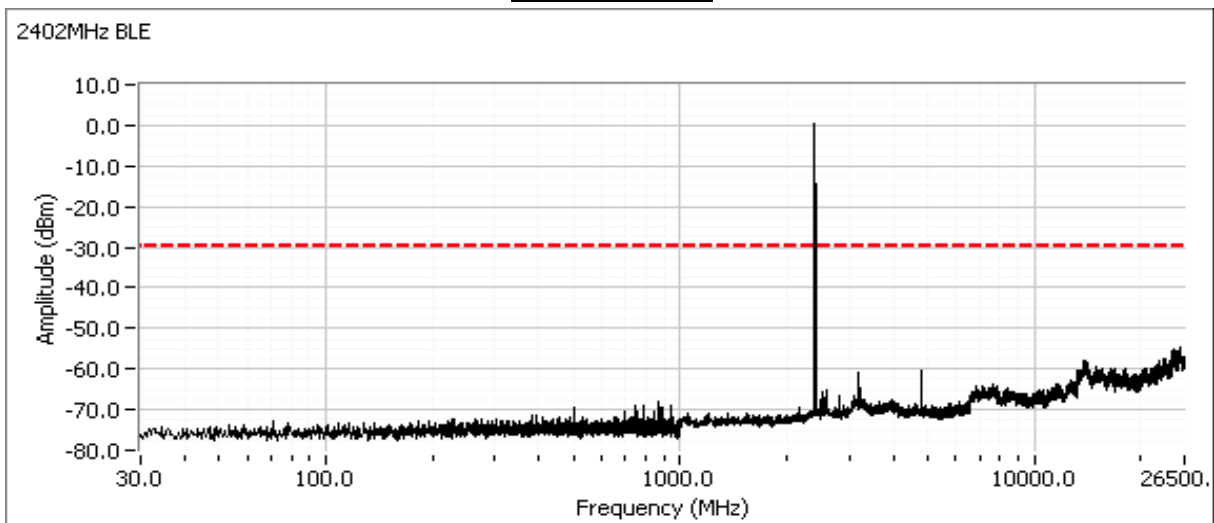
Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

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

Frequency (MHz)	Power Setting	Mode	Limit	Result
2402 (CH 0)	0	BLE	-30dBc	Pass
2440 (CH 19)	0	BLE	-30dBc	Pass
2480 (CH 39)	0	BLE	-30dBc	Pass
2412 (CH 1)	16	11b	-30dBc	Pass
2437 (CH 6)	16	11b	-30dBc	Pass
2462 (CH 11)	16	11b	-30dBc	Pass
2412 (CH 1)	15	11g	-30dBc	Pass
2437 (CH 6)	15	11g	-30dBc	Pass
2462 (CH 11)	15	11g	-30dBc	Pass
2412 (CH 1)	14	11n20	-30dBc	Pass
2437 (CH 6)	14	11n20	-30dBc	Pass
2462 (CH 11)	14	11n20	-30dBc	Pass

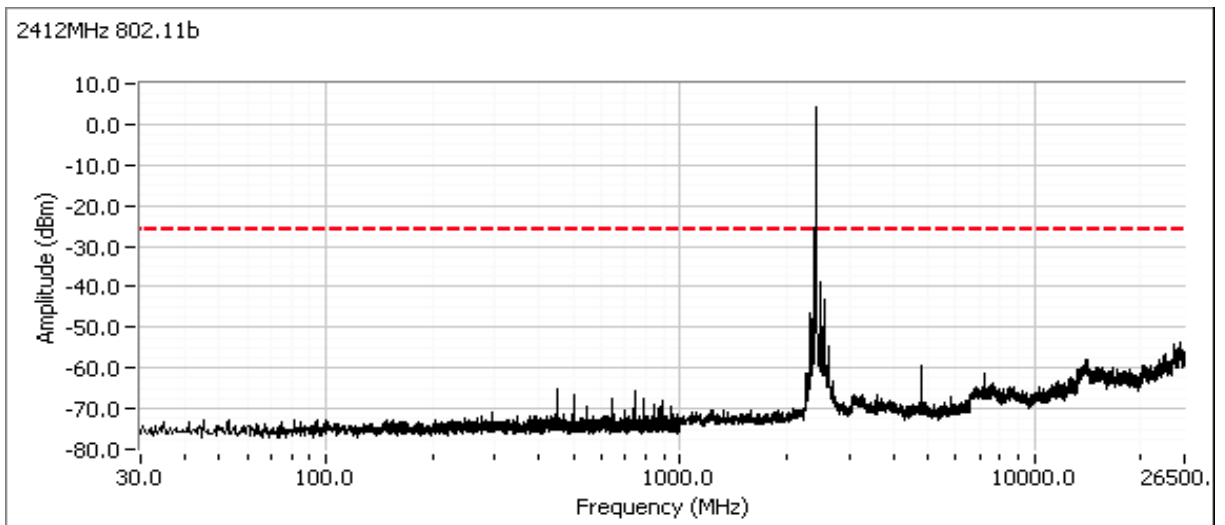
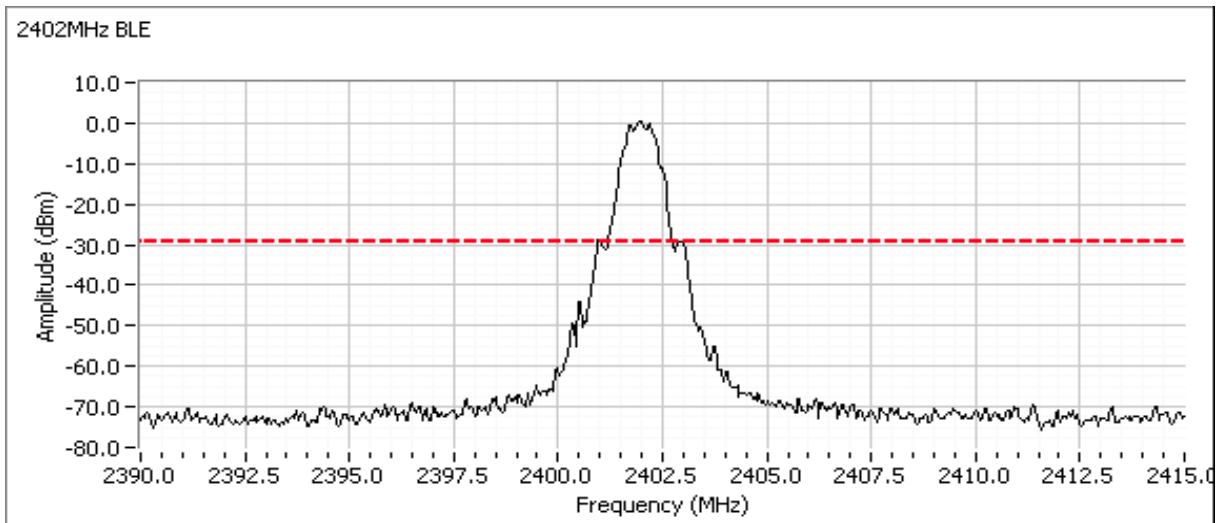
RBW = 100 kHz and VBW = 300 kHz for all plots.

Plots for low channel



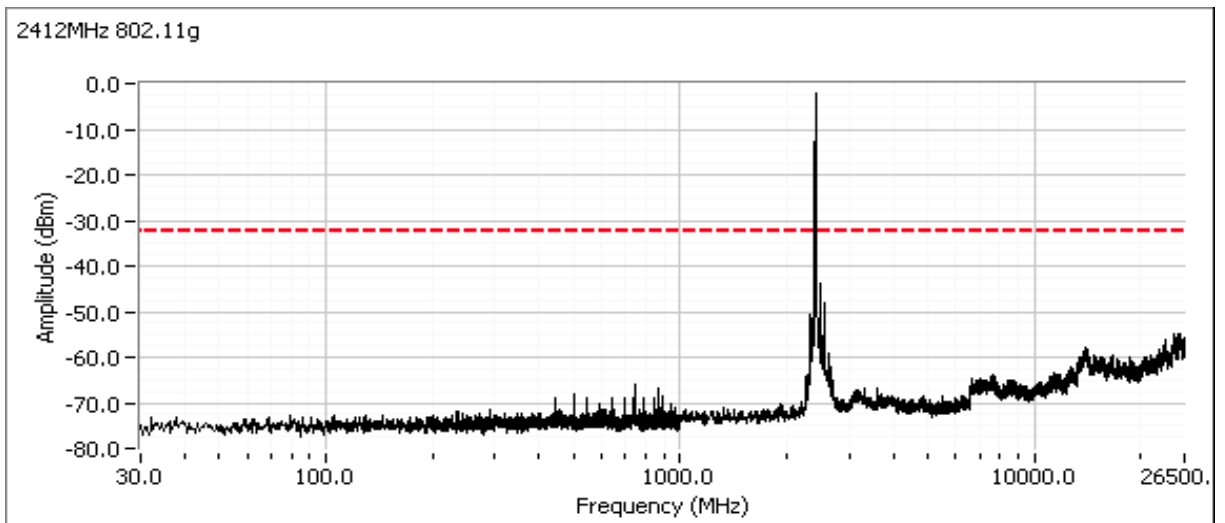
Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

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.



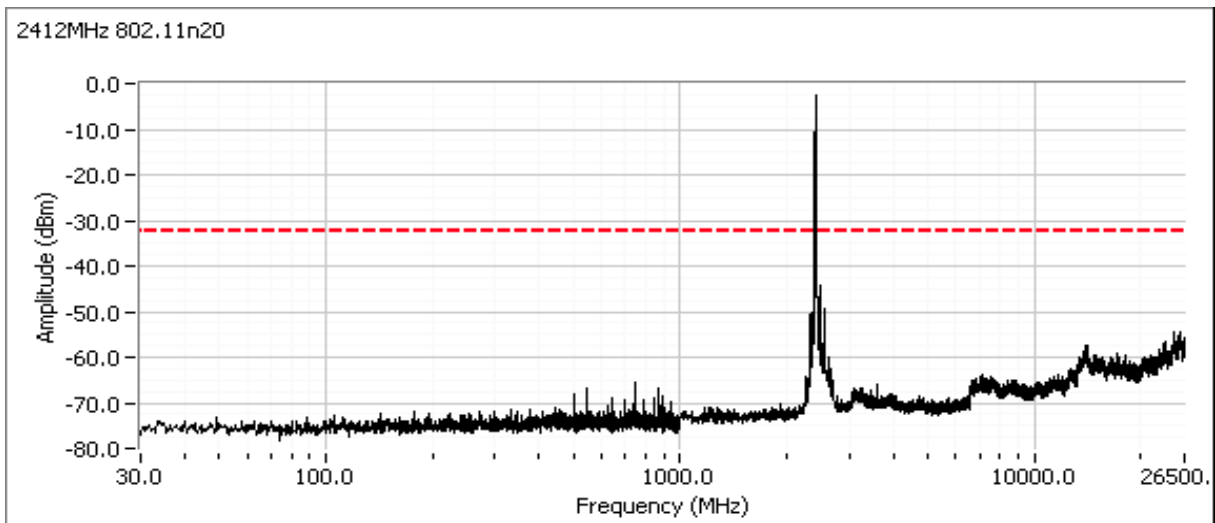
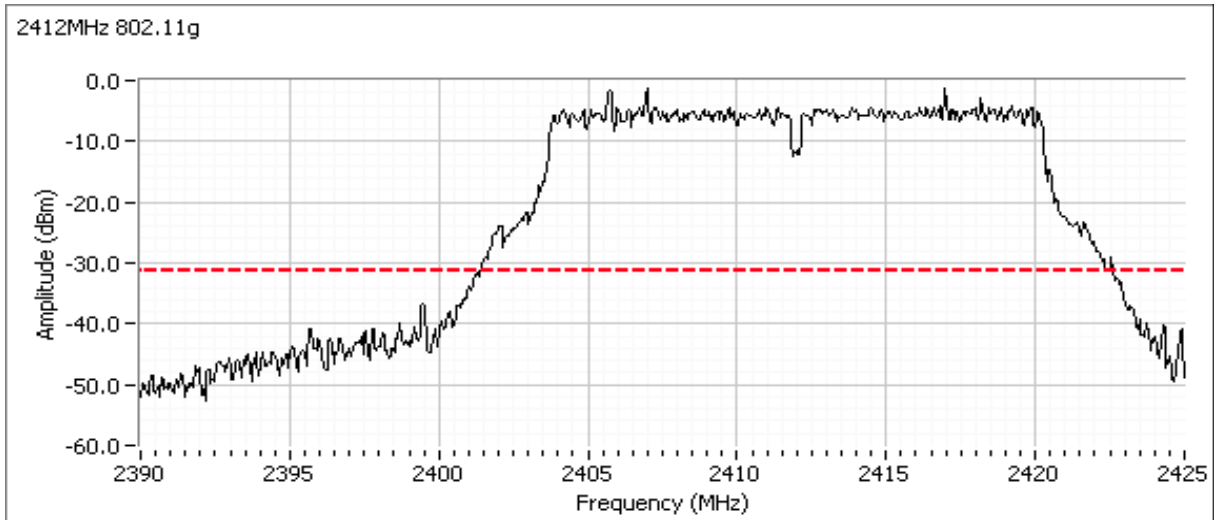
Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

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.



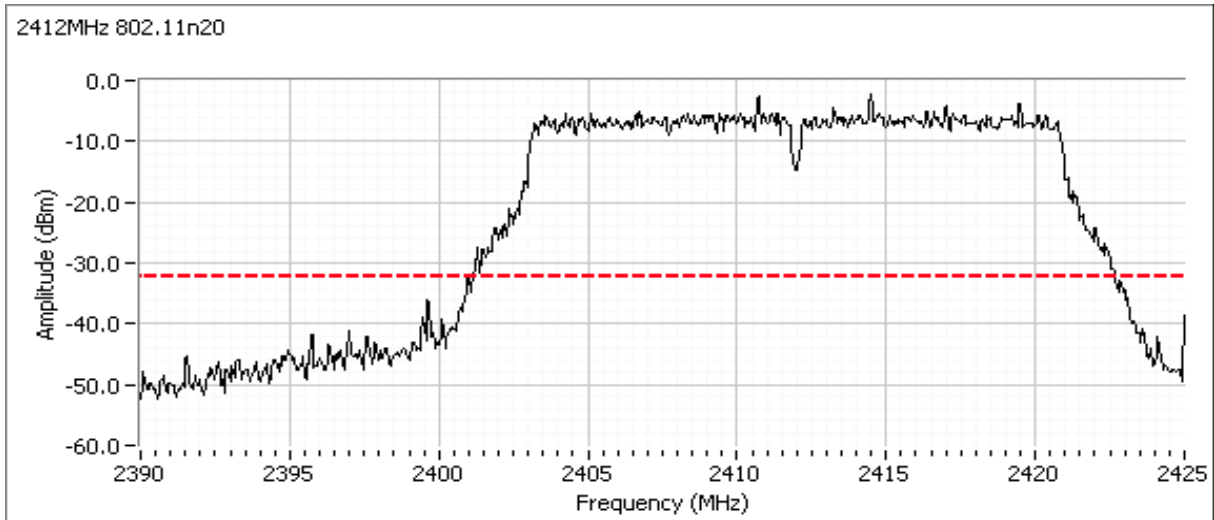
Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

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.

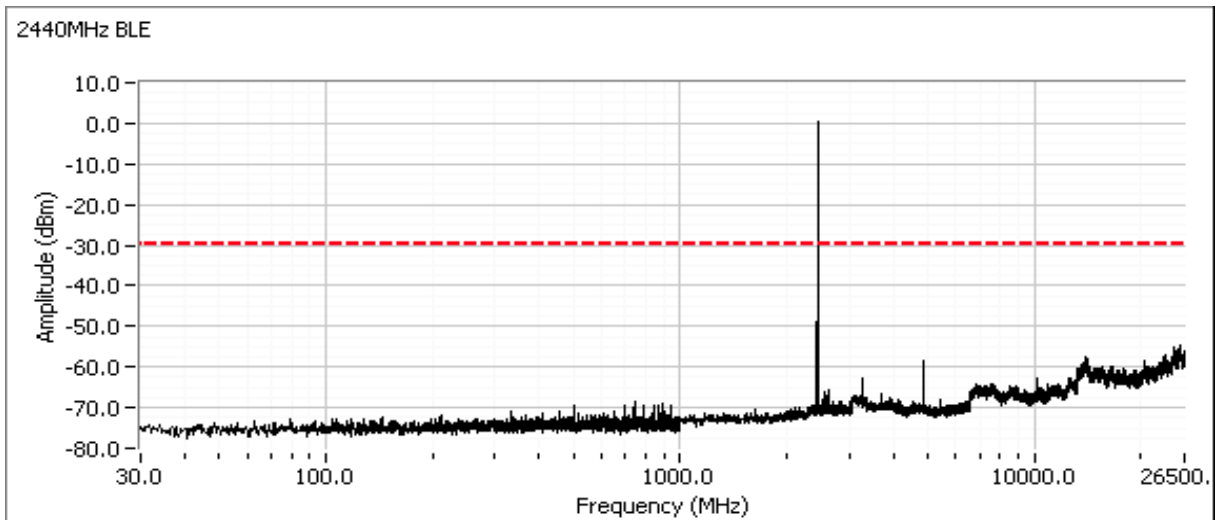


Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

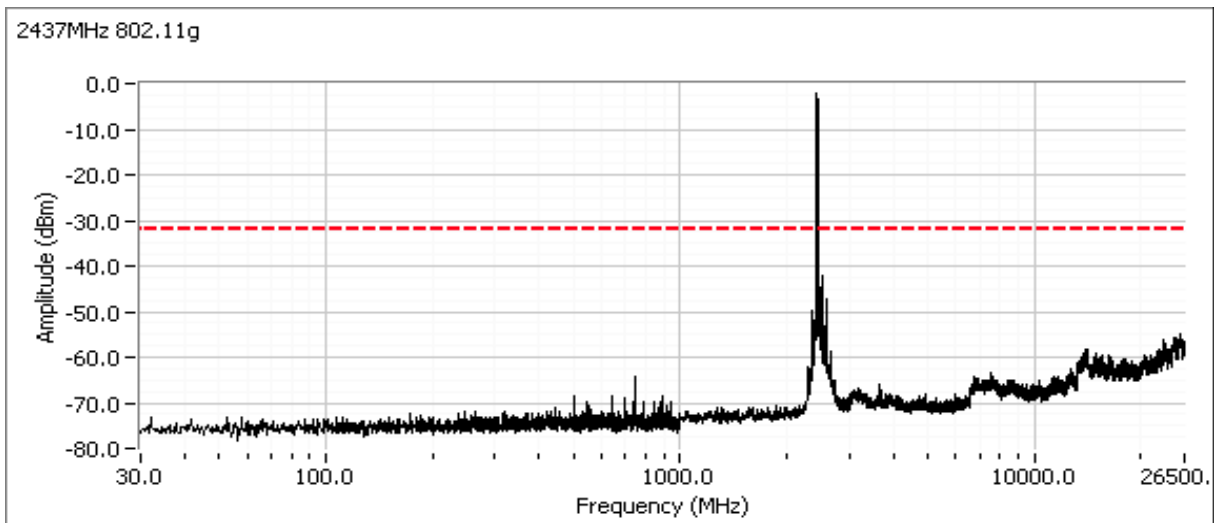
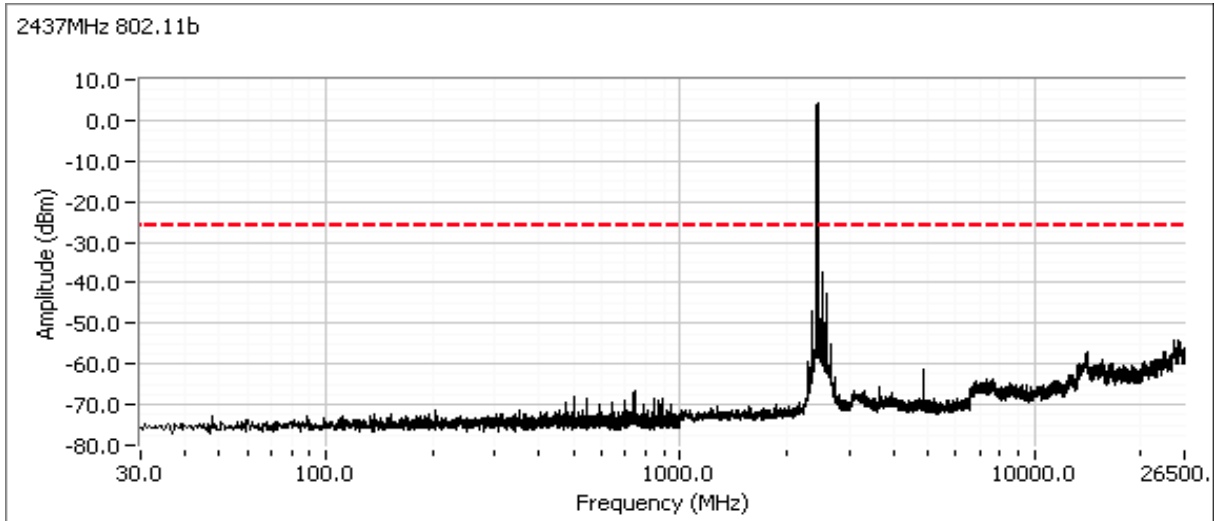
Additional plot showing compliance with -30dBc limit from 2390 MHz to 2400 MHz. Radiated measurements used to show compliance with the limits in the restricted band below 2390 MHz.



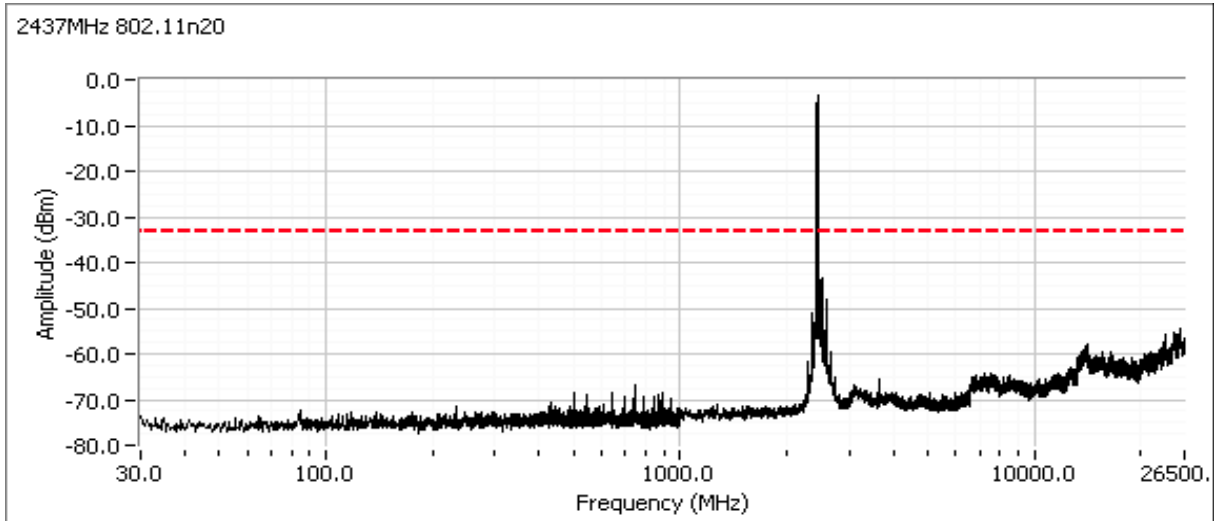
Plots for center channel



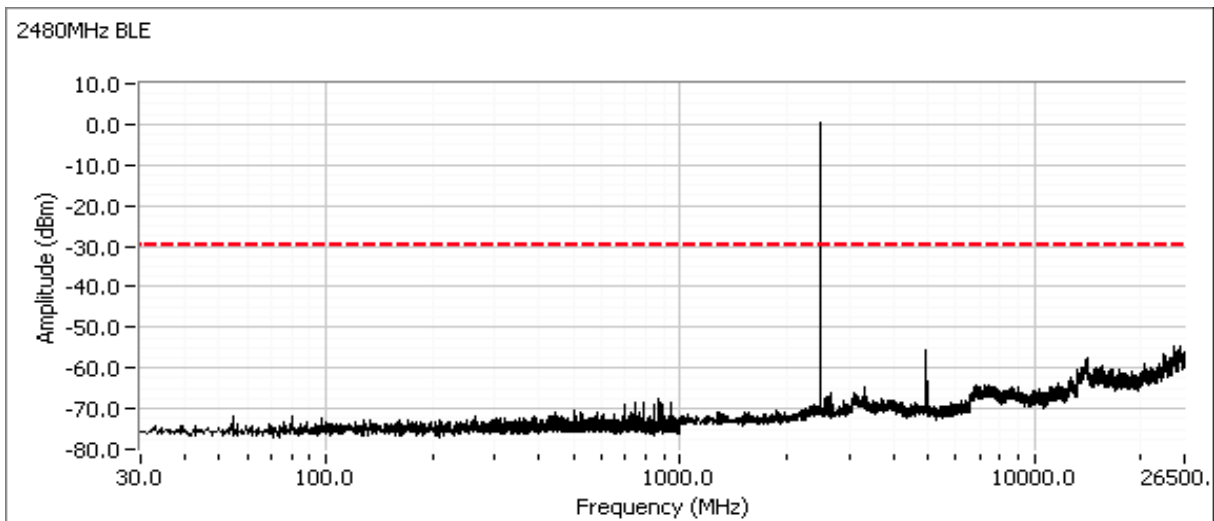
Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A



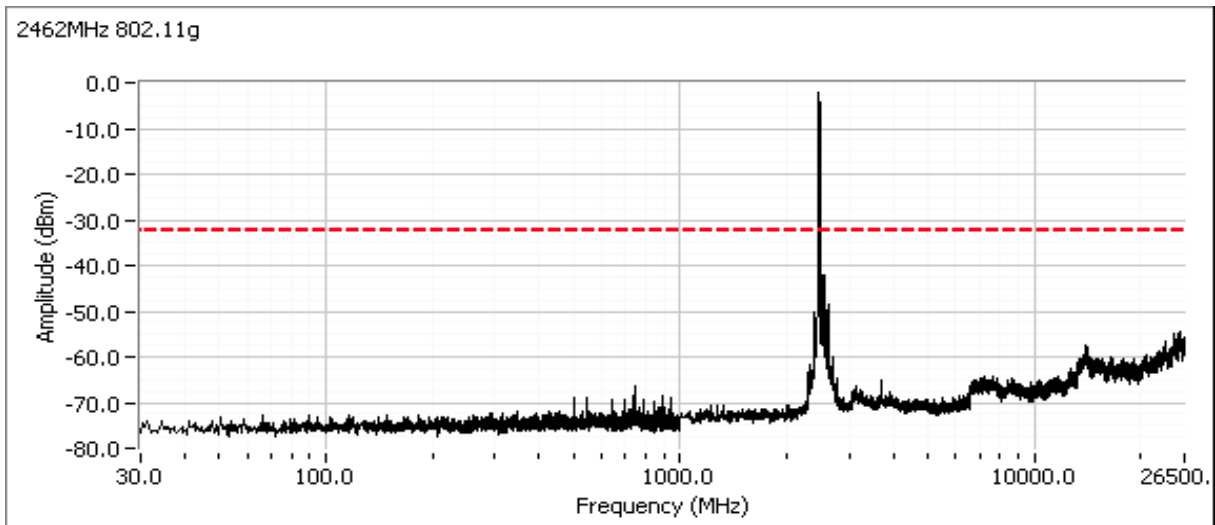
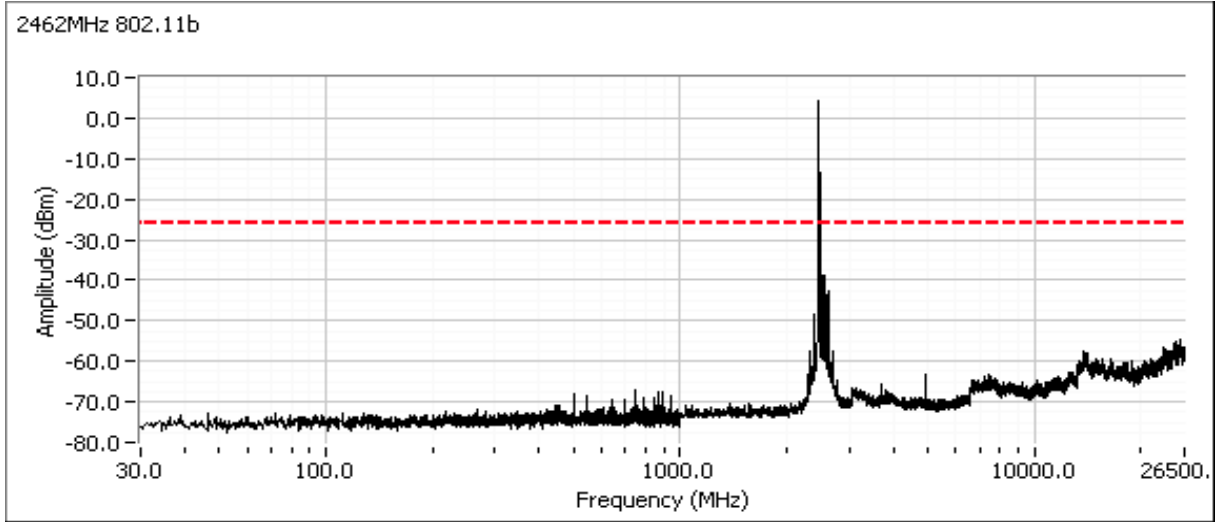
Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A



Plots for high channel

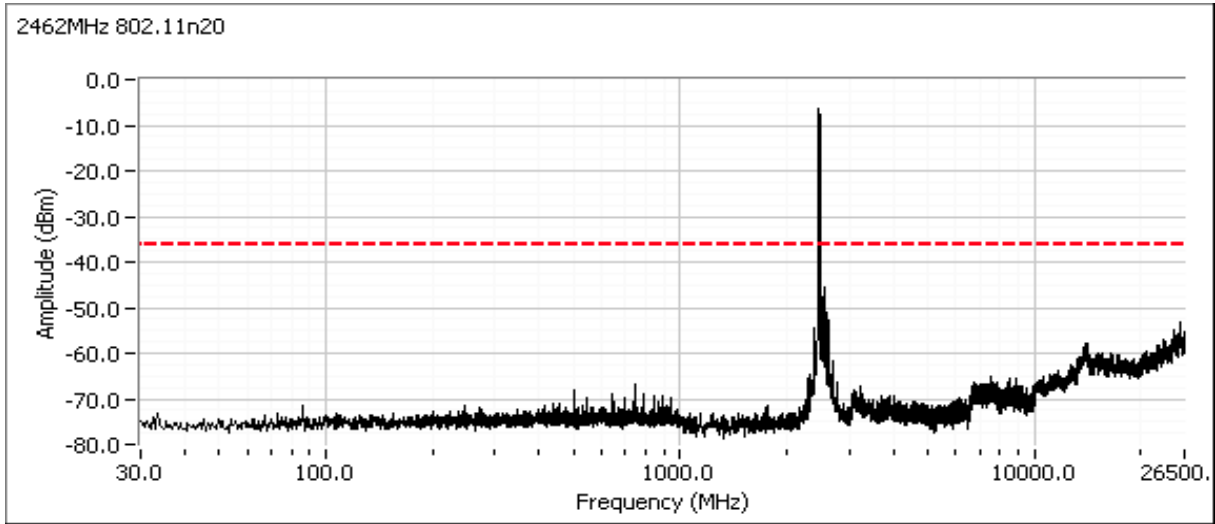


Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A





Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A



Client:	Lighthouse Worldwide Solutions	Job Number:	JD105241
Model:	ApexZ3	T-Log Number:	T105297
Contact:	Charley Abboud	Project Manager:	Irene Radamacher
Standard:	FCC Part 15	Project Coordinator:	-
		Class:	N/A

## RSS-247 and FCC 15.247 (DTS) Radiated Spurious Emissions

### Test Specific Details

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

### General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing.  
For radiated emissions testing the measurement antenna was located 3 meters from the EUT, unless otherwise noted.

### Ambient Conditions:

Temperature: 23 °C  
Rel. Humidity: 38 %

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

Run #	Mode	Channel	Target Power	Power Setting	Test Performed	Limit	Result / Margin
1	BLE	37 - 2402MHz		max	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247( c)	34.8 dBµV/m @ 2367.2 MHz (-19.2 dB)
	BLE	39 - 2480MHz		max	Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247( c)	35.2 dBµV/m @ 2490.7 MHz (-18.8 dB)
1	b	1 - 2412MHz		max	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247( c)	43.8 dBµV/m @ 2387.2 MHz (-10.2 dB)
	b	11 - 2462MHz		max	Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247( c)	45.4 dBµV/m @ 2483.5 MHz (-8.6 dB)
2	g	1 - 2412MHz		max	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247( c)	39.8 dBµV/m @ 2390.0 MHz (-14.2 dB)
	g	11 - 2462MHz		max	Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247( c)	61.2 dBµV/m @ 2483.7 MHz (-12.8 dB)
3	n20	1 - 2412MHz		max	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247( c)	44.2 dBµV/m @ 2389.8 MHz (-9.8 dB)
	n20	11 - 2462MHz		max	Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247( c)	65.0 dBµV/m @ 2484.6 MHz (-9.0 dB)

Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	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: 1704141003

Driver:

Antenna: internal

## 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 a 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)
BLE	1 Mb/s	0.93	Yes	4.66	0.3058409	0.6116818	215
11b	1 Mb/s	0.97	Yes	1.279	0.1370339	0.2740677	782
11g	6 Mb/s	0.96	Yes	2.353	0.1754416	0.3508831	425
n20	MCS0	0.95	Yes	1.293	0.2257858	0.4515717	773

## 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 4:	Emission has constant duty cycle $< 98\%$ , average measurement performed: RBW=1MHz, VBW $>1/T$ but not less than 10Hz, peak detector, linear averaging, auto sweep, trace average 100 traces, measurement corrected by Linear voltage correction factor

Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

## Run #1: Radiated Bandedge Measurements

Date of Test: 7/3/2017 0:00

Test Engineer: Joseph Cadigal

Test Location: FT Chamber#5

Config. Used: 1

Config Change: none

EUT Voltage: 120V/60Hz

Channel: 37

Mode: BLE

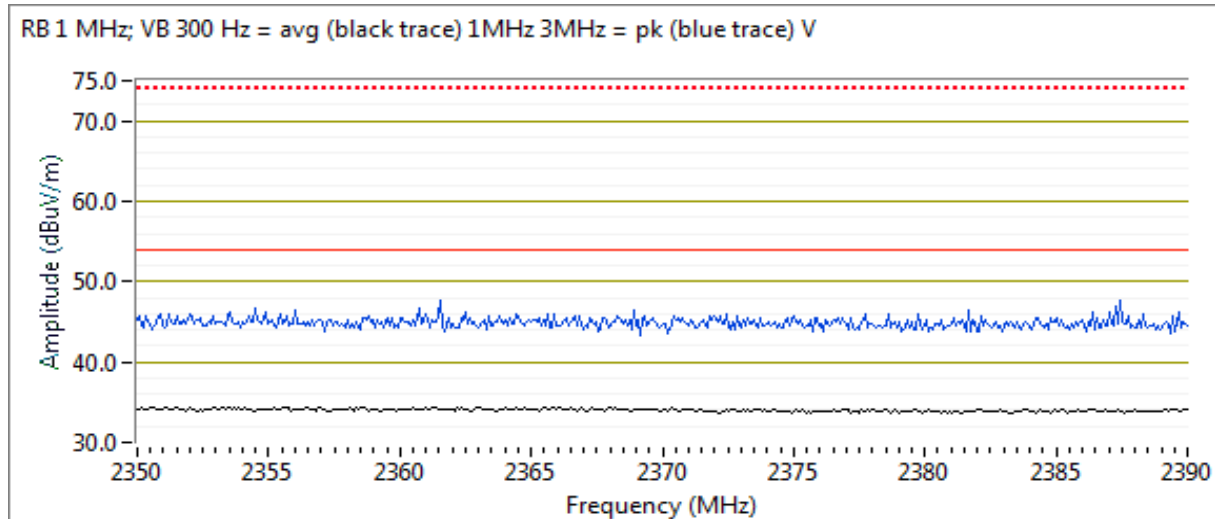
Tx Chain: 1

Data Rate: 1 Mb/s

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

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2367.230	34.8	V	54.0	-19.2	Avg	100	2.2	POS; RB 1 MHz; VB: 300 Hz
2377.090	46.8	V	74.0	-27.2	Pk	100	1.0	POS; RB 1 MHz; VB: 3 MHz
2368.600	34.6	H	54.0	-19.4	Avg	225	1.2	POS; RB 1 MHz; VB: 300 Hz
2364.910	46.5	H	74.0	-27.5	Pk	225	1.0	POS; RB 1 MHz; VB: 3 MHz

RB 1 MHz; VB 300 Hz = avg (black trace) 1MHz 3MHz = pk (blue trace) V

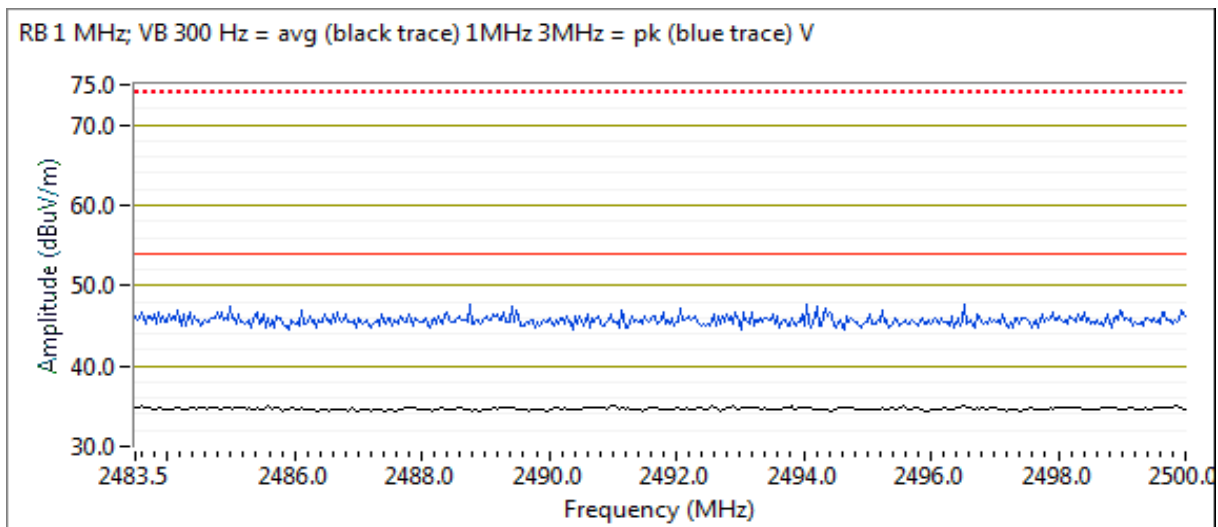


Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

Channel: 39      Mode: BLE  
Tx Chain: 1      Data Rate: 1 Mb/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	
2490.740	35.2	V	54.0	-18.8	Avg	164	2.3	POS; RB 1 MHz; VB: 300 Hz
2485.050	47.2	V	74.0	-26.8	Pk	164	1.0	POS; RB 1 MHz; VB: 3 MHz
2497.350	35.2	H	54.0	-18.8	Avg	216	1.0	POS; RB 1 MHz; VB: 300 Hz
2486.440	48.2	H	74.0	-25.8	Pk	216	1.0	POS; RB 1 MHz; VB: 3 MHz

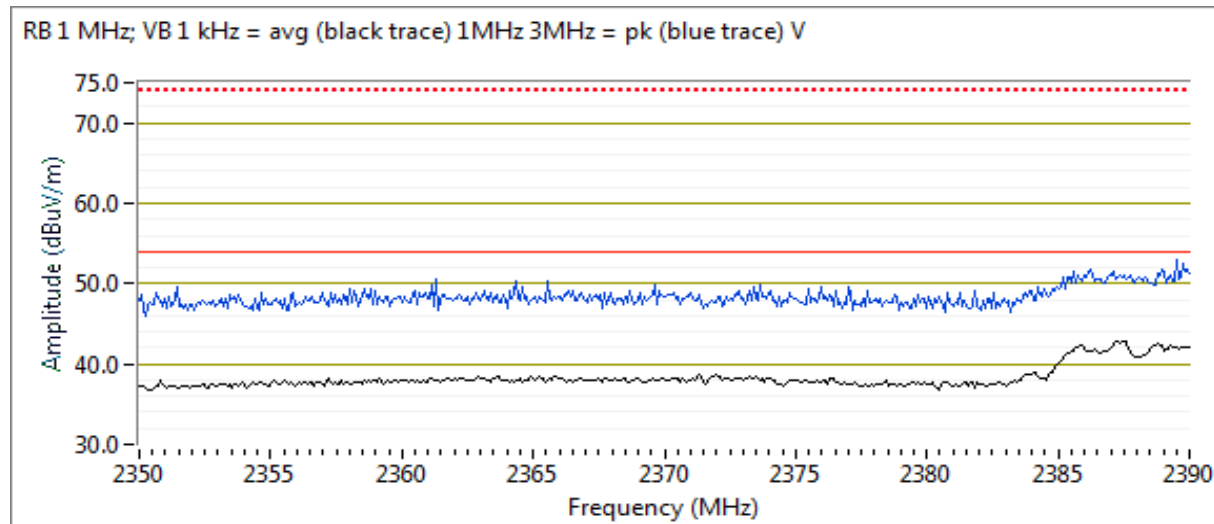


Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

Channel: 1 Mode: b  
 Tx Chain: 1 Data Rate: 1 Mb/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	
2387.190	43.8	V	54.0	-10.2	Avg	92	2.2	POS; RB 1 MHz; VB: 1 kHz
2374.450	49.7	V	74.0	-24.3	Pk	92	1.0	POS; RB 1 MHz; VB: 3 MHz
2387.350	39.3	H	54.0	-14.7	Avg	233	1.0	POS; RB 1 MHz; VB: 1 kHz
2386.070	49.1	H	74.0	-24.9	Pk	233	1.0	POS; RB 1 MHz; VB: 3 MHz

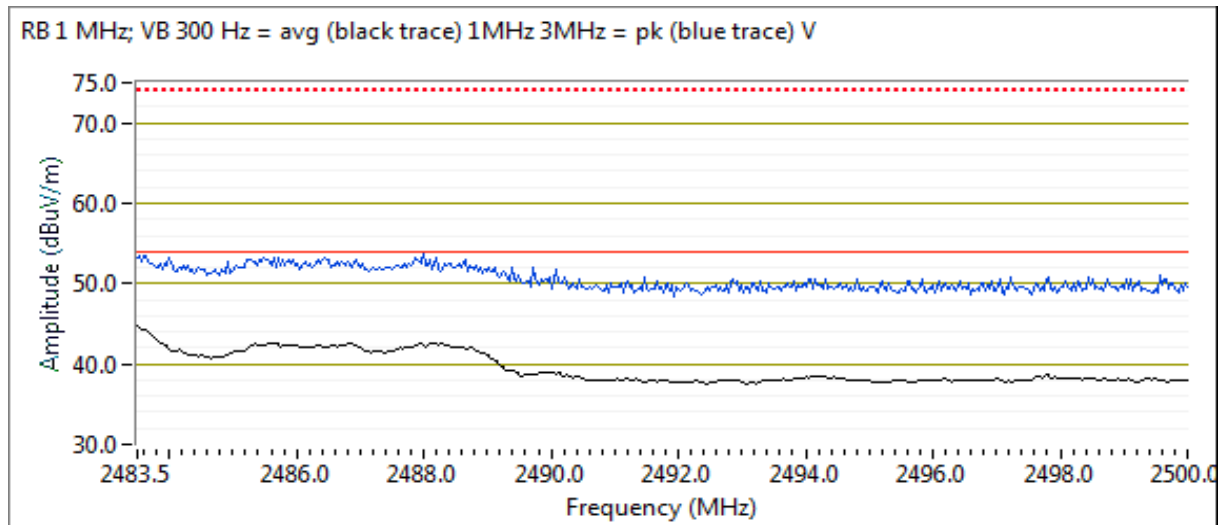


Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

Channel: 11      Mode: b  
Tx Chain: 1      Data Rate: 1 Mb/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	
2483.500	45.4	V	54.0	-8.6	Avg	126	2.2	POS; RB 1 MHz; VB: 1 kHz
2483.500	50.8	V	74.0	-23.2	PK	126	1.0	POS; RB 1 MHz; VB: 3 MHz
2483.630	37.5	H	54.0	-16.5	Avg	112	1.0	POS; RB 1 MHz; VB: 1 kHz
2488.390	49.0	H	74.0	-25.0	PK	112	1.8	POS; RB 1 MHz; VB: 3 MHz



Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

## Run #2: Radiated Bandedge Measurements

Date of Test: 7/3/2017 0:00

Test Engineer: Joseph Cadigal

Test Location: FT Chamber#5

Config. Used: 1

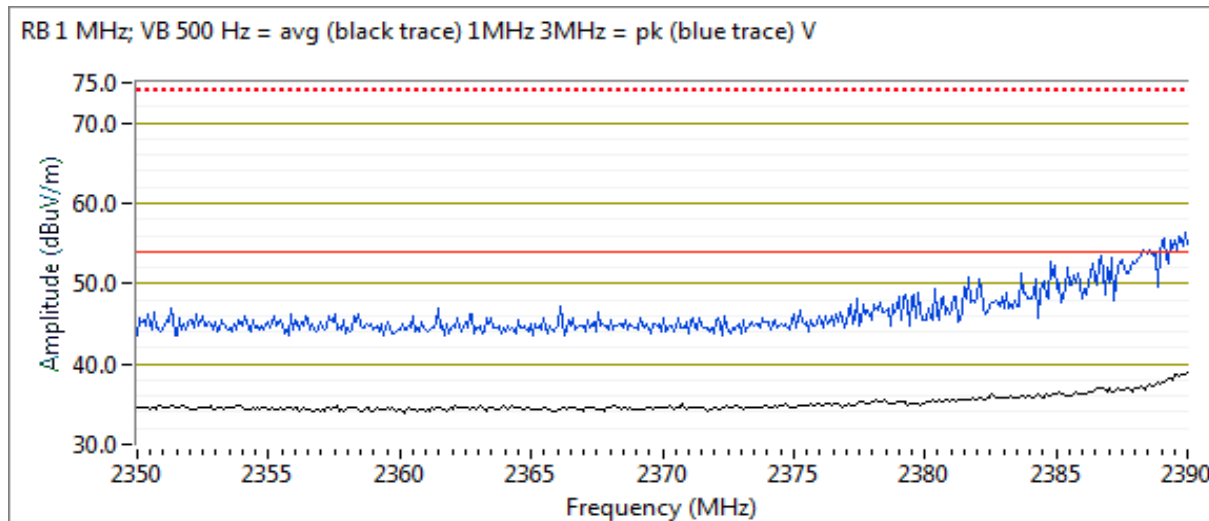
Config Change: none

EUT Voltage: 120V/60Hz

Channel: 1 Mode: g  
 Tx Chain: 1 Data Rate: 6 Mb/s

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

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2390.000	39.8	V	54.0	-14.2	Avg	227	1.0	POS; RB 1 MHz; VB: 500 Hz
2389.120	57.4	V	74.0	-16.6	Pk	227	1.0	POS; RB 1 MHz; VB: 3 MHz
2389.920	39.1	H	54.0	-14.9	Avg	0	1.0	POS; RB 1 MHz; VB: 500 Hz
2389.520	57.8	H	74.0	-16.2	Pk	0	1.0	POS; RB 1 MHz; VB: 3 MHz





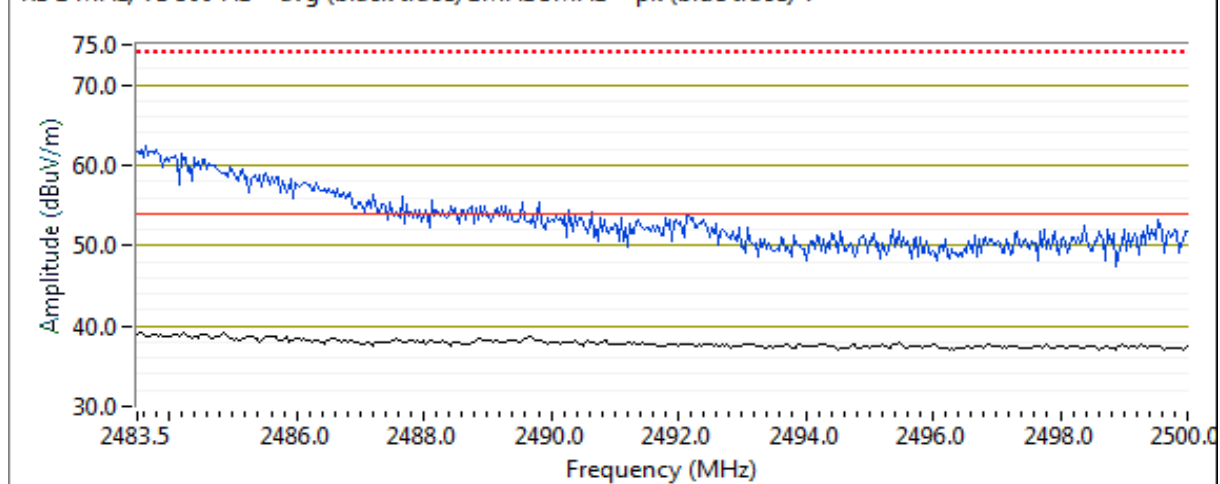
Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

Channel: 11 Mode: g  
 Tx Chain: 1 Data Rate: 6 Mb/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	
2483.700	61.2	V	74.0	-12.8	Pk	165	1.0	POS; RB 1 MHz; VB: 3 MHz
2483.570	39.6	V	54.0	-14.4	Avg	165	1.8	POS; RB 1 MHz; VB: 500 Hz
2483.600	36.2	H	54.0	-17.8	Avg	97	1.0	POS; RB 1 MHz; VB: 500 Hz
2484.490	54.5	H	74.0	-19.5	Pk	97	1.0	POS; RB 1 MHz; VB: 3 MHz

RB 1 MHz; VB 500 Hz = avg (black trace) 1MHz 3MHz = pk (blue trace) V



Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

## Run #3: Radiated Bandedge Measurements

Date of Test: 7/3/2017 0:00

Test Engineer: Joseph Cadigal

Test Location: FT Chamber#5

Config. Used: 1

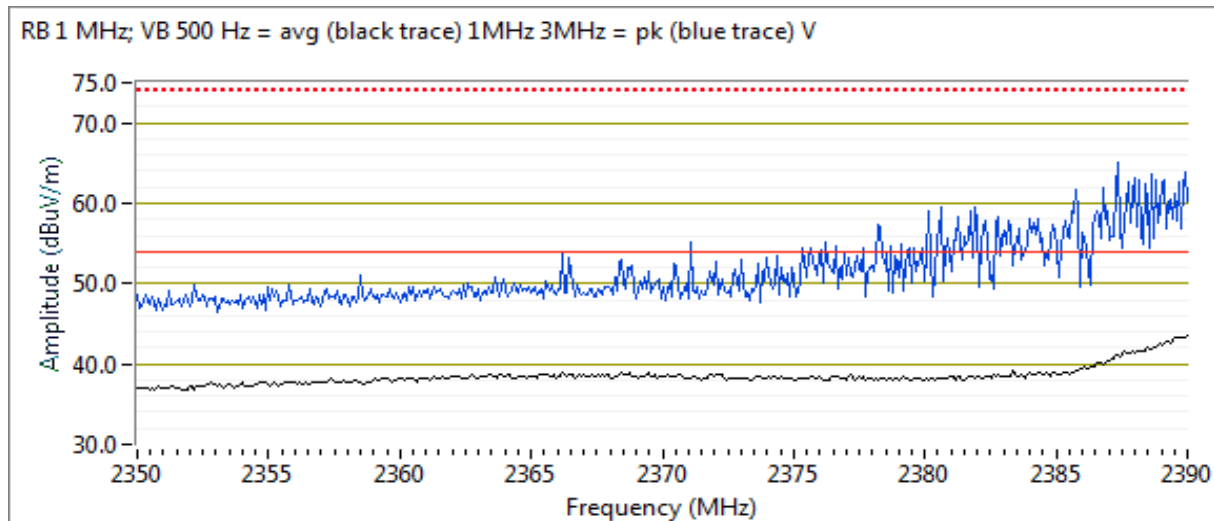
Config Change: none

EUT Voltage: 120V/60Hz

Channel: 1 Mode: n20  
 Tx Chain: 1 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	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2389.840	44.2	V	54.0	-9.8	Avg	96	2.2	POS; RB 1 MHz; VB: 1 kHz
2375.170	63.1	V	74.0	-10.9	Pk .	96	1.0	POS; RB 1 MHz; VB: 3 MHz
2389.440	39.3	H	54.0	-14.7	Avg	224	1.0	POS; RB 1 MHz; VB: 1 kHz
2389.360	60.4	H	74.0	-13.6	Pk .	224	1.0	POS; RB 1 MHz; VB: 3 MHz



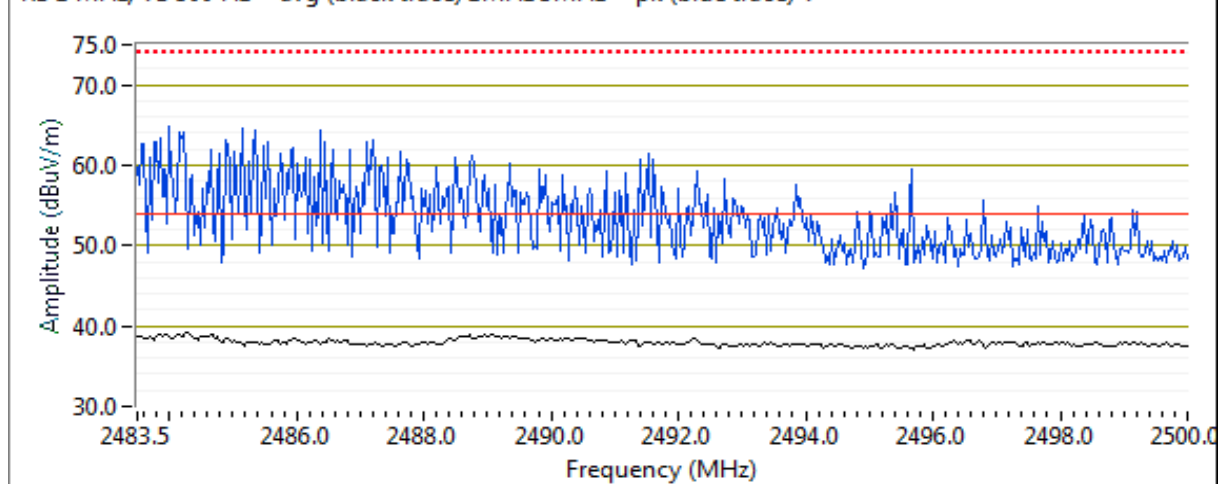
Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

Channel: 11 Mode: n20  
 Tx Chain: 1 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	
2484.590	65.0	V	74.0	-9.0	Pk	168	1.9	POS; RB 1 MHz; VB: 3 MHz
2488.820	39.6	V	54.0	-14.4	Avg	168	1.9	POS; RB 1 MHz; VB: 1 kHz
2486.150	36.0	H	54.0	-18.0	Avg	96	1.0	POS; RB 1 MHz; VB: 1 kHz
2487.070	56.5	H	74.0	-17.5	Pk	96	1.0	POS; RB 1 MHz; VB: 3 MHz

RB 1 MHz; VB 500 Hz = avg (black trace) 1MHz 3MHz = pk (blue trace) V



Client:	Lighthouse Worldwide Solutions	Job Number:	JD105241
Model:	ApexZ3	T-Log Number:	T105297
Contact:	Charley Abboud	Project Manager:	Irene Radamacher
Standard:	FCC Part 15	Project Coordinator:	-
		Class:	N/A

## RSS-247 and FCC 15.247 (DTS) Radiated Spurious Emissions

### Test Specific Details

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

### General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing.

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

### Ambient Conditions:

Temperature: 23 °C  
 Rel. Humidity: 38 %

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

Run #	Mode	Channel	Target Power	Power Setting	Test Performed	Limit	Result / Margin
1	BLE	37 - 2402MHz		max	Radiated Emissions, 30 MHz - 25 GHz	FCC Part 15.209 / 15.247( c)	46.7 dBµV/m @ 9217.3 MHz (-7.3 dB)
	BLE	17 - 2440MHz		max	Radiated Emissions, 30 MHz - 25 GHz	FCC Part 15.209 / 15.247( c)	38.0 dBµV/m @ 7511.8 MHz (-16.0 dB)
	BLE	39 - 2480MHz		max	Radiated Emissions, 30 MHz - 25 GHz	FCC Part 15.209 / 15.247( c)	30.8 dBµV/m @ 3544.6 MHz (-23.2 dB)
2	b	1 - 2412MHz		max	Radiated Emissions, 30 MHz - 25 GHz	FCC Part 15.209 / 15.247( c)	31.1 dBµV/m @ 3543.3 MHz (-22.9 dB)
	b	6 - 2437MHz		max	Radiated Emissions, 30 MHz - 25 GHz	FCC Part 15.209 / 15.247( c)	31.2 dBµV/m @ 3549.9 MHz (-22.8 dB)
	b	11 - 2462MHz		max	Radiated Emissions, 30 MHz - 25 GHz	FCC Part 15.209 / 15.247( c)	31.4 dBµV/m @ 3553.8 MHz (-22.6 dB)

Scans on center channel in both OFDM modes to determine the worst case mode.

3	g	6 - 2437MHz		max	Radiated Emissions, 30 MHz - 25 GHz	FCC Part 15.209 / 15.247( c)	31.1 dBµV/m @ 3543.5 MHz (-22.9 dB)
	n20	6 - 2437MHz		max	Radiated Emissions, 30 MHz - 25 GHz	FCC Part 15.209 / 15.247( c)	37.5 dBµV/m @ 3655.4 MHz (-16.5 dB)

Measurements on low and high channels in worst-case OFDM mode.

4	n20	1 - 2412MHz		max	Radiated Emissions, 30 MHz - 25 GHz	FCC Part 15.209 / 15.247( c)	35.1 dBµV/m @ 3618.0 MHz (-18.9 dB)
	n20	11 - 2462MHz		max	Radiated Emissions, 30 MHz - 25 GHz	FCC Part 15.209 / 15.247( c)	36.7 dBµV/m @ 3693.0 MHz (-17.3 dB)

Client:	Lighthouse Worldwide Solutions	Job Number:	JD105241
Model:	ApexZ3	T-Log Number:	T105297
Contact:	Charley Abboud	Project Manager:	Irene Radamacher
Standard:	FCC Part 15	Project Coordinator:	-
		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: 1704141003

Antenna: internal

## 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)	
BLE	1 Mb/s	0.93	Yes	4.66	0.3058409	0.6116818	215	300Hz
11b	1 Mb/s	0.97	Yes	1.279	0.1370339	0.2740677	782	1kHz
11g	6 Mb/s	0.96	Yes	2.353	0.1754416	0.3508831	425	1kHz
n20	MCS0	0.95	Yes	1.293	0.2257858	0.4515717	773	1kHz

## 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 3:	Emission has a duty cycle $\geq 98\%$ , average measurement performed: RBW=1MHz, VBW=3MHz, RMS, Power averaging, auto sweep, trace average 100 traces

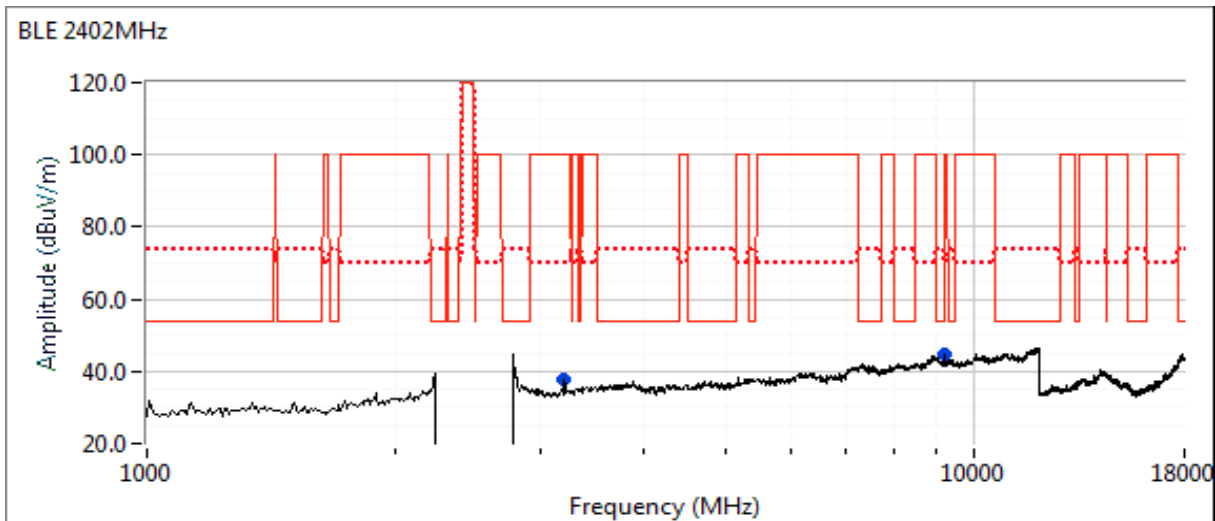
Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

Run #1: Radiated Spurious Emissions, 30 - 25,000 MHz. Operating Mode: BLE  
 Date of Test: 7/6/2017 0:00 Config. Used: 1  
 Test Engineer: Joseph Cadigal Config Change: none  
 Test Location: FT Chamber#5 EUT Voltage: 120V/60Hz

Run #1a: Low Channel

Channel: 37 Mode: BLE  
 Tx Chain: 1 Data Rate: 1 Mb/s

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBμV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
9217.290	46.7	V	54.0	-7.3	Pk	125	2.2	RB 1 MHz;VB 3 MHz;Peak
3202.890	43.8	V	54.0	-10.2	Pk	125	1.9	RB 1 MHz;VB 3 MHz;Peak



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

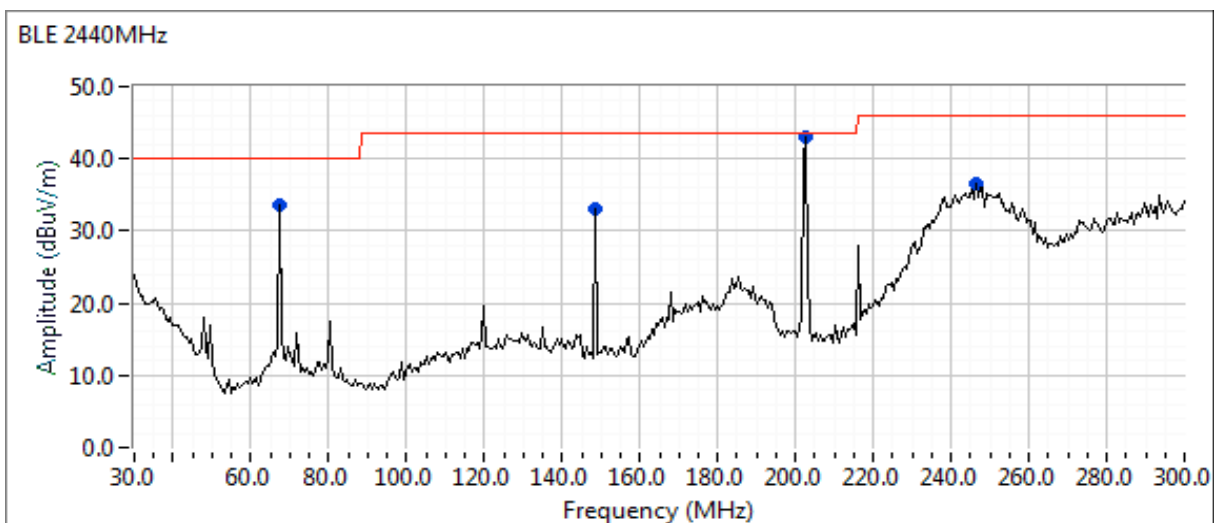
Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

## Run #1b: Center Channel

Channel: 17 Mode: BLE  
 Tx Chain: 1 Data Rate: 1 Mb/s

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
202.310	43.0	H	-	N/A	QP	137	1.5	Note 4
472.020	39.8	H	-	N/A	QP	170	1.5	Note 4
337.138	39.6	H	-	N/A	QP	128	1.0	Note 4
67.431	31.6	H	-	N/A	QP	42	4.0	Note 4
246.412	33.1	H	-	N/A	QP	159	1.0	Note 4
148.033	8.8	H	-	N/A	QP	128	3.0	Note 4
7511.750	38.0	H	54.0	-16.0	Avg	270	2.5	RB 1 MHz;VB 300 Hz;Peak
3555.470	30.8	V	54.0	-23.2	Avg	261	2.5	RB 1 MHz;VB 300 Hz;Peak
7509.460	50.1	H	74.0	-23.9	Pk	270	2.5	RB 1 MHz;VB 3 MHz;Peak
3554.710	43.5	V	74.0	-30.5	Pk	261	2.5	RB 1 MHz;VB 3 MHz;Peak

Note 4: These emissions are not from the radio. These emissions must meet the limits for commercial non radio equipment.

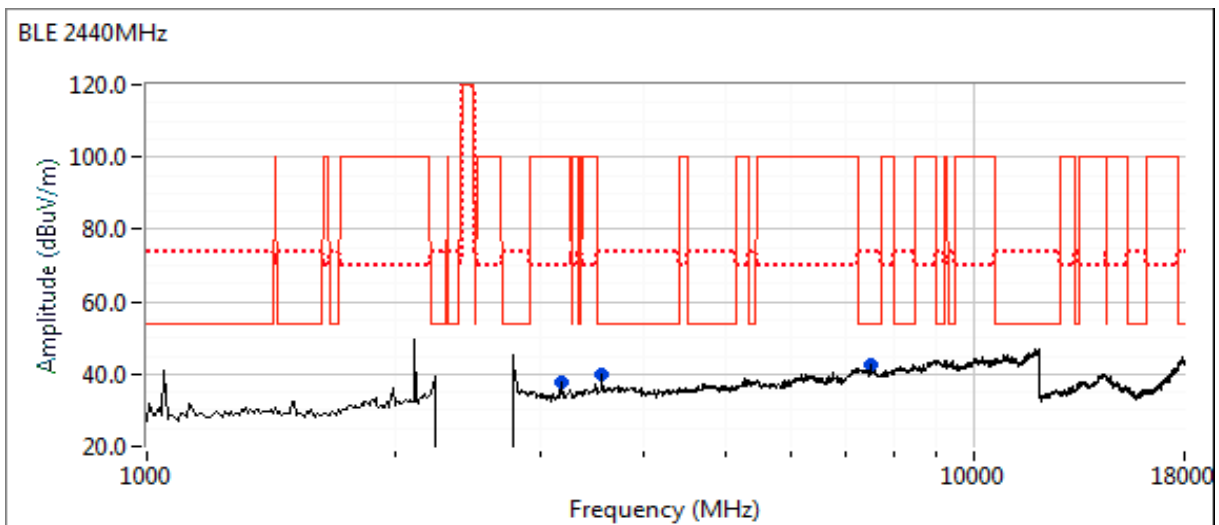
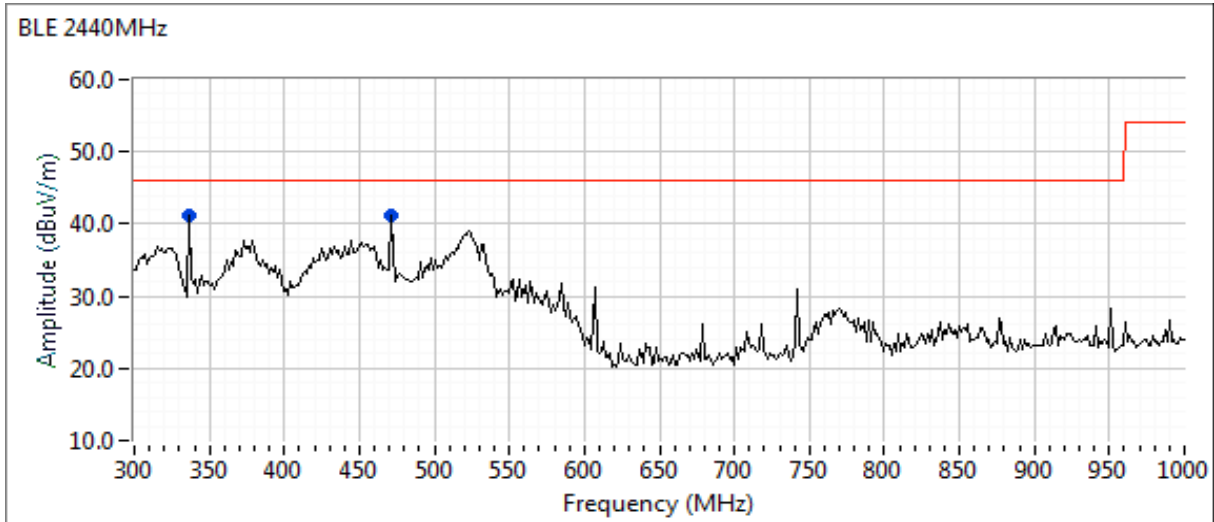


**NTS**

WE ENGINEER SUCCESS

## EMC Test Data

Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A



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

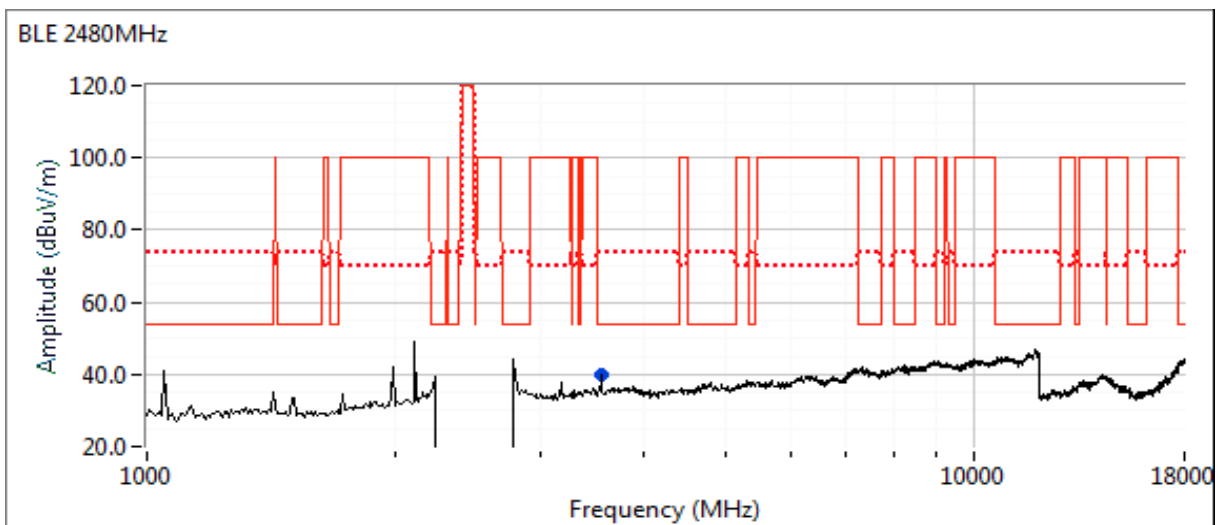


Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

## Run #1c: High Channel

Channel: 39 Mode: BLE  
 Tx Chain: 1 Data Rate: 1 Mb/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	
3544.550	30.8	V	54.0	-23.2	Avg	331	2.5	RB 1 MHz;VB 300 Hz;Peak
3545.370	42.9	V	74.0	-31.1	PK	331	2.5	RB 1 MHz;VB 3 MHz;Peak



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

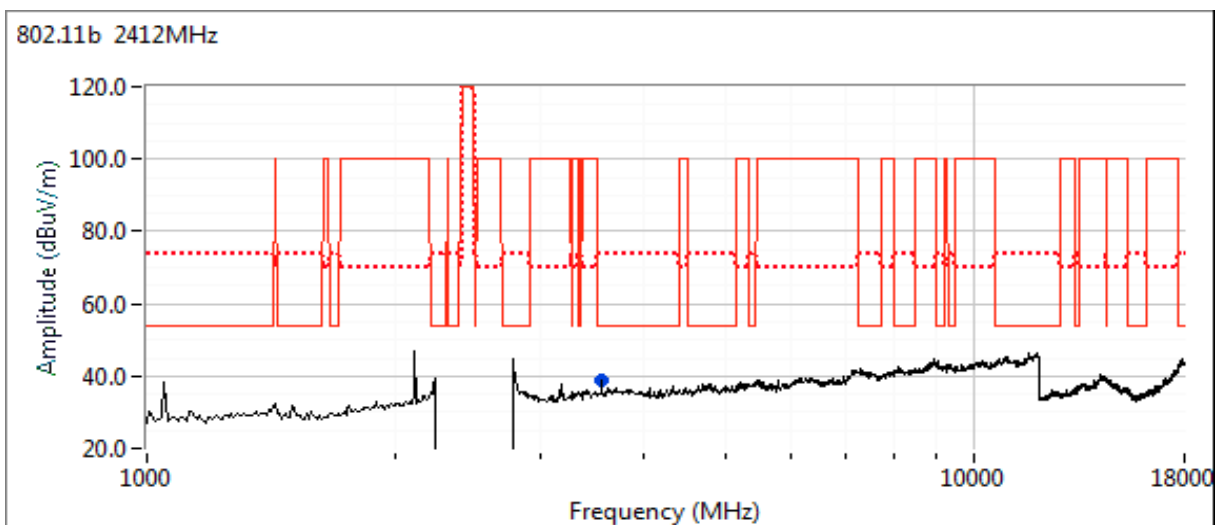
Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

Run #2: Radiated Spurious Emissions, 30 - 25,000 MHz. Operating Mode: 802.11b  
 Date of Test: 7/3/2017 0:00 Config. Used: 1  
 Test Engineer: Joseph Cadigal Config Change: none  
 Test Location: FT Chamber#5 EUT Voltage: 120V/60Hz

Run #2a: Low Channel

Channel: 1 Mode: b  
 Tx Chain: 1 Data Rate: 1 Mb/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	
3543.270	31.1	V	54.0	-22.9	Avg	9	2.5	RB 1 MHz;VB 1 kHz;Peak
3543.400	43.4	V	74.0	-30.6	Pk	9	2.5	RB 1 MHz;VB 3 MHz;Peak



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

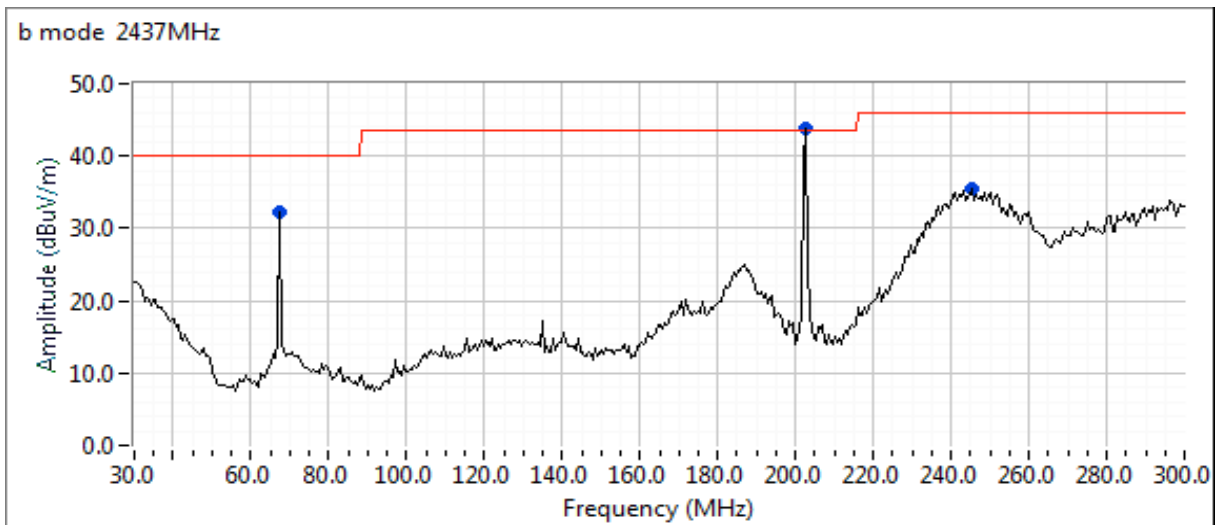
Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

## Run #2b: Center Channel

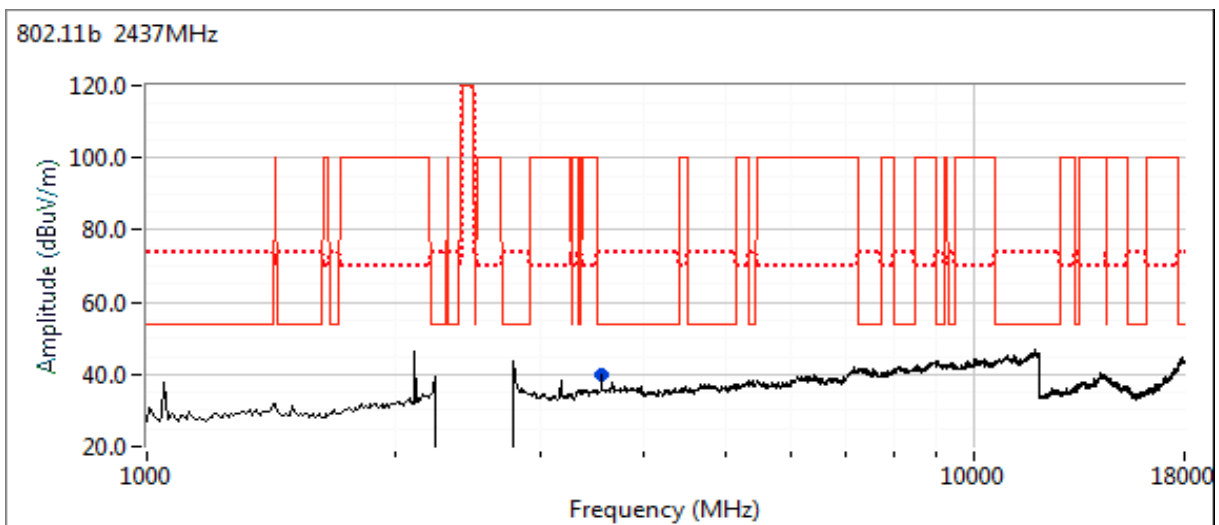
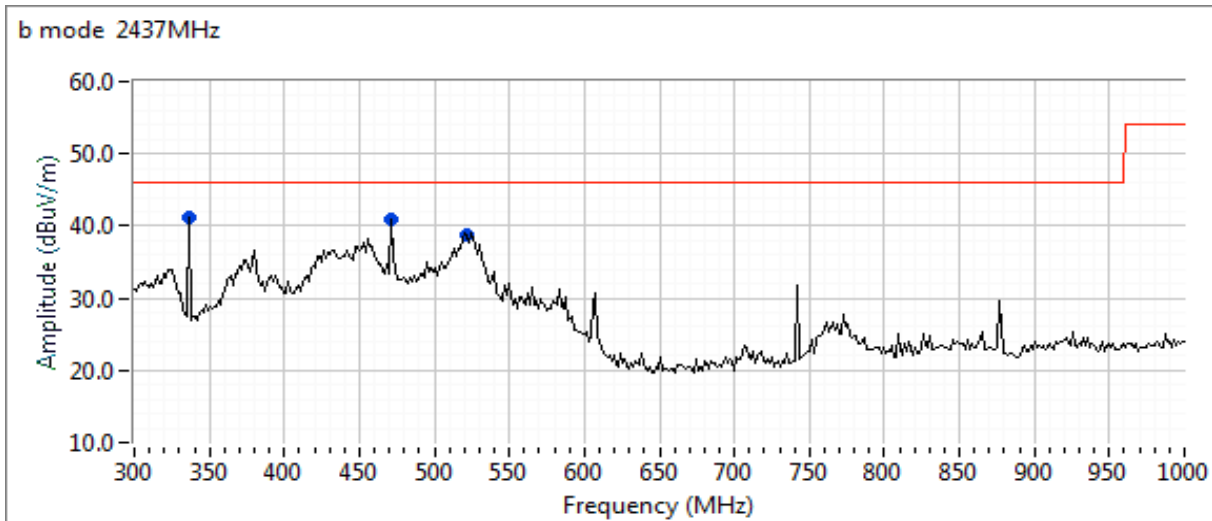
Channel: 6 Mode: b  
 Tx Chain: 1 Data Rate: 1 Mb/s

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
202.279	43.1	H	-	N/A	QP	134	1.5	Note 4
337.115	39.6	H	-	N/A	QP	128	1.0	Note 4
471.947	39.0	H	-	N/A	QP	187	2.0	Note 4
67.429	31.6	H	-	N/A	QP	39	4.0	Note 4
525.568	37.1	H	-	N/A	QP	142	1.5	Note 4
245.214	33.8	H	-	N/A	QP	157	1.0	Note 4
3549.910	31.2	V	54.0	-22.8	Avg	191	2.5	RB 1 MHz;VB 1 kHz;Peak
3549.160	43.5	V	74.0	-30.5	Pk	191	2.5	RB 1 MHz;VB 3 MHz;Peak

Note 4: These emissions are not from the radio. These emissions must meet the limits for commercial non radio equipment.



Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A



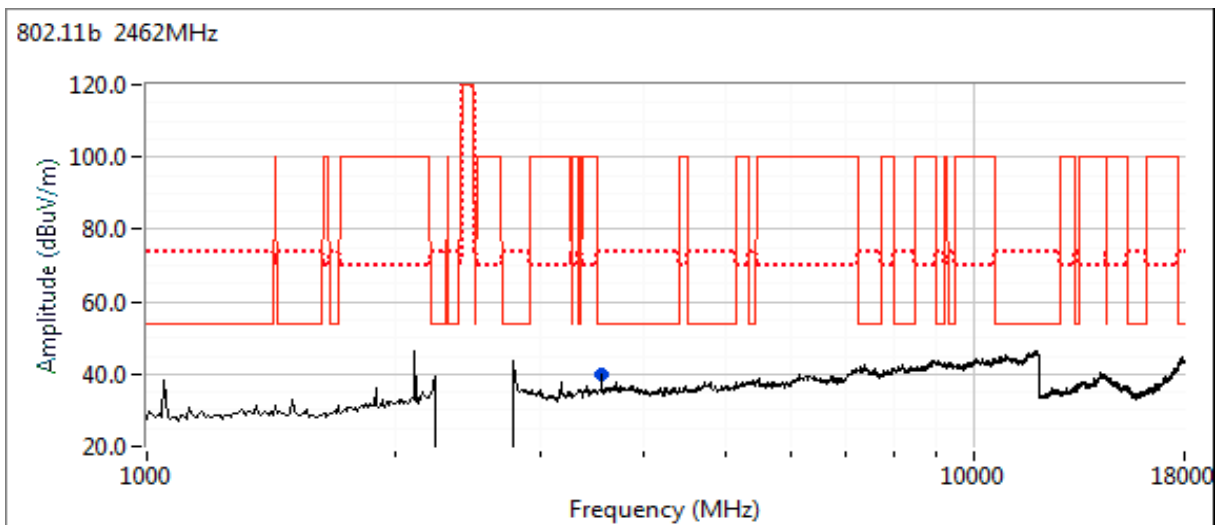
**Note:** Scans made between 18 - 25 GHz with the measurement antenna moved around the card and its antennas 20-50cm from the device indicated there were no significant emissions in this frequency range

Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

## Run #2c: High Channel

Channel: 11                      Mode: b  
Tx Chain: 1                      Data Rate: 1 Mb/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	
3553.790	31.4	V	54.0	-22.6	Avg	227	2.5	RB 1 MHz;VB 1 kHz;Peak
3554.270	42.9	V	74.0	-31.1	Pk	227	2.5	RB 1 MHz;VB 3 MHz;Peak



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

Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

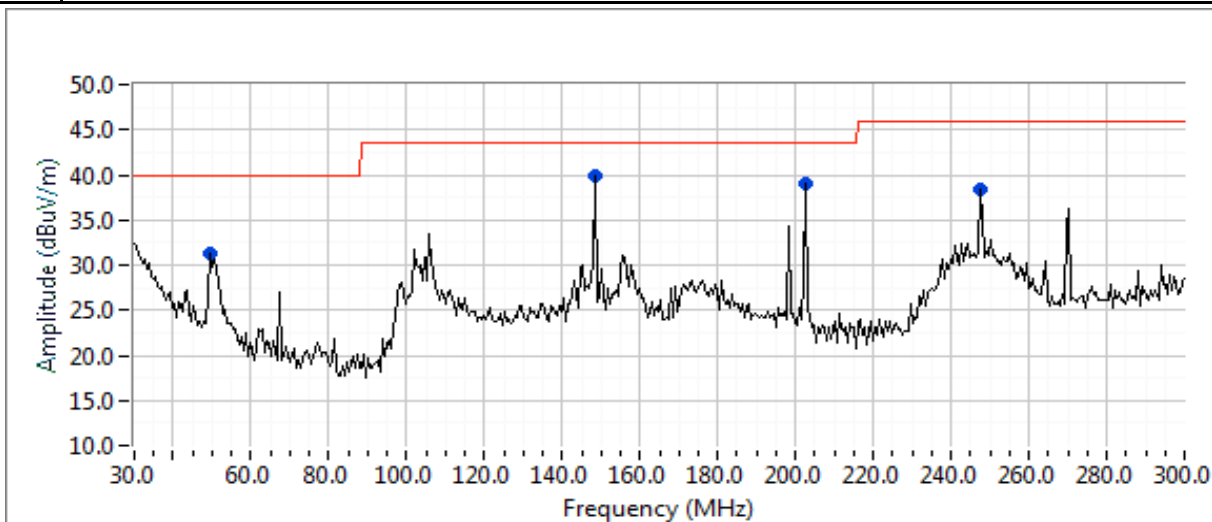
**Run #3: Radiated Spurious Emissions, 30 - 25,000 MHz. Operating Mode: OFDM**  
 Date of Test: 7/6/2017, 7/11/17 Config. Used: 1  
 Test Engineer: Joseph Cadigal, YK Soo Config Change: none  
 Test Location: FT Chamber#5 EUT Voltage: 120V/60Hz

## Run #3a: Center Channel

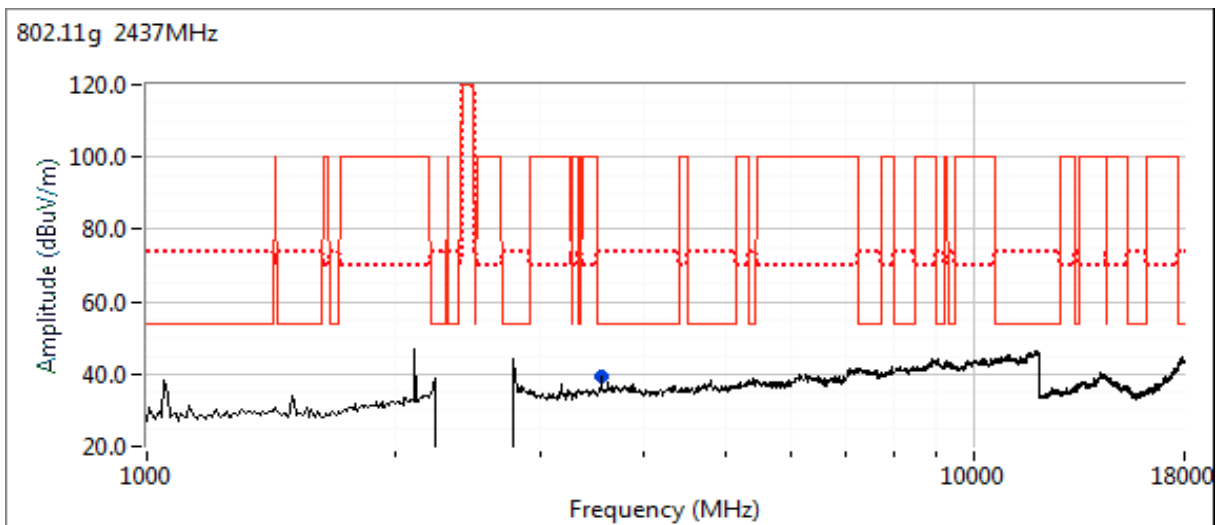
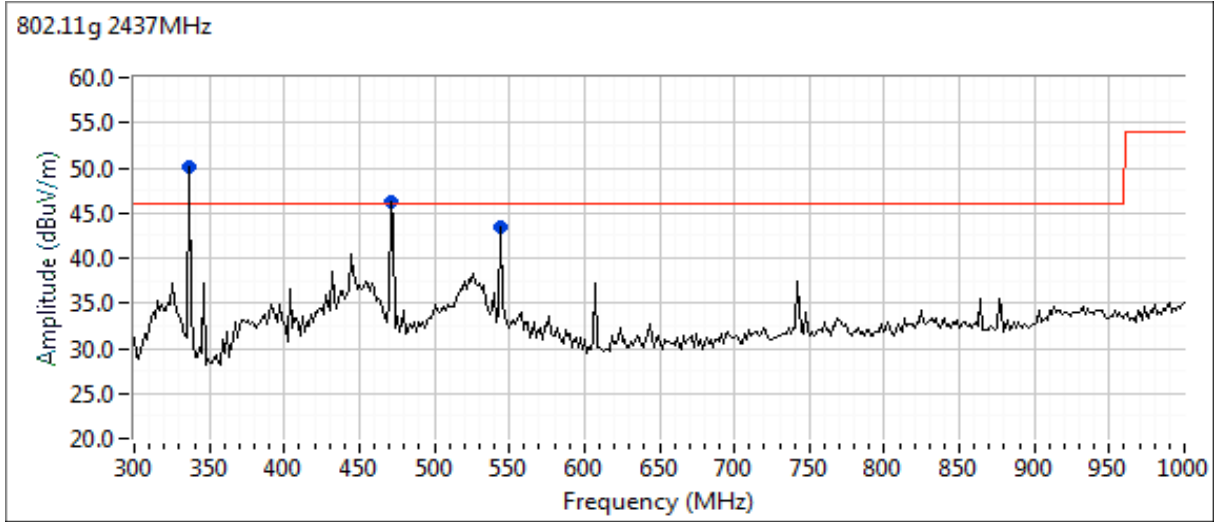
Channel: 6 Mode: g  
 Tx Chain: 1 Data Rate: 6 Mb/s

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
472.205	40.9	V	-	N/A	QP	131	1.0	Note 4
472.205	45.9	H	-	N/A	QP	36	1.0	Note 4
472.205	40.9	V	-	N/A	QP	131	1.0	Note 4
49.720	27.0	V	-	N/A	QP	9	1.0	Note 4
247.135	19.7	H	-	N/A	QP	18	2.0	Note 4
202.379	38.2	V	-	N/A	QP	76	1.0	Note 4
544.405	26.3	V	-	N/A	QP	275	1.0	Note 4
148.604	23.9	V	-	N/A	QP	339	1.0	Note 4
337.233	47.5	V	-	N/A	QP	334	1.0	Note 4
337.233	32.7	V	-	N/A	QP	258	1.0	Note 4
3543.460	31.1	V	54.0	-22.9	Avg	97	2.5	RB 1 MHz;VB 1 kHz;Peak
3541.500	42.7	V	74.0	-31.3	Pk	97	2.5	RB 1 MHz;VB 3 MHz;Peak

Note 4: These emissions are not from the radio. These emissions must meet the limits for commercial non radio equipment.



Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A



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

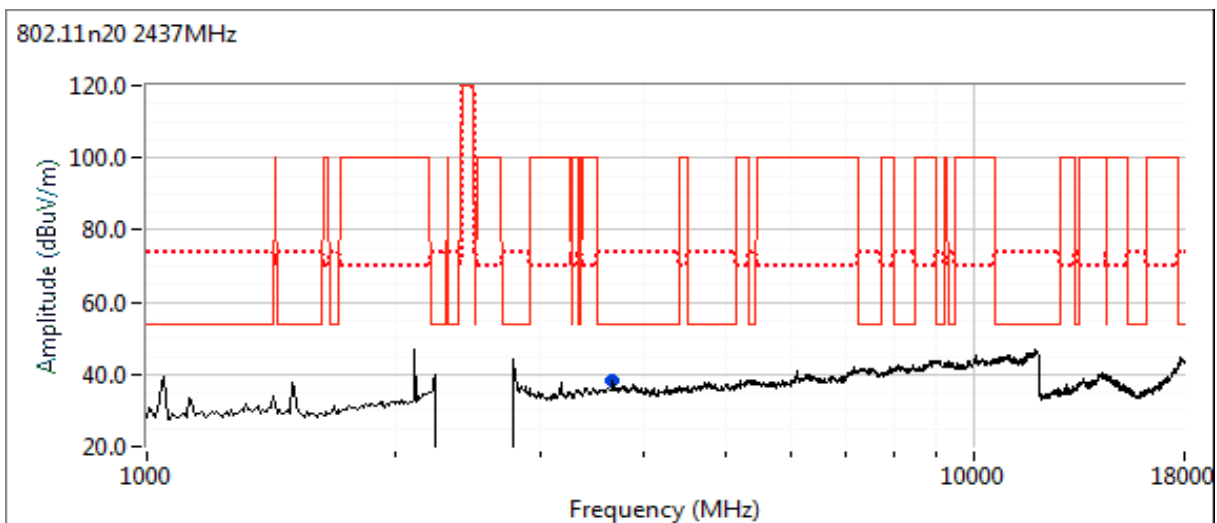
Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

## Run #3b: Center Channel

Channel: 6 Mode: n20  
 Tx Chain: 1 Data Rate: MCS0

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
472.087	41.3	H	-	N/A	QP	218	1.5	Note 4
430.806	35.6	H	-	N/A	QP	236	2.0	Note 4
443.858	34.7	H	-	N/A	QP	252	2.0	Note 4
542.862	26.0	H	-	N/A	QP	62	1.5	Note 4
67.442	17.9	V	-	N/A	QP	0	1.0	Note 4
202.325	20.3	H	-	N/A	QP	165	1.5	Note 4
3655.430	37.5	V	54.0	-16.5	AVG	122	1.9	RB 1 MHz;VB 1 kHz;Peak
3655.430	45.2	V	74.0	-28.8	PK	122	1.9	RB 1 MHz;VB 3 MHz;Peak

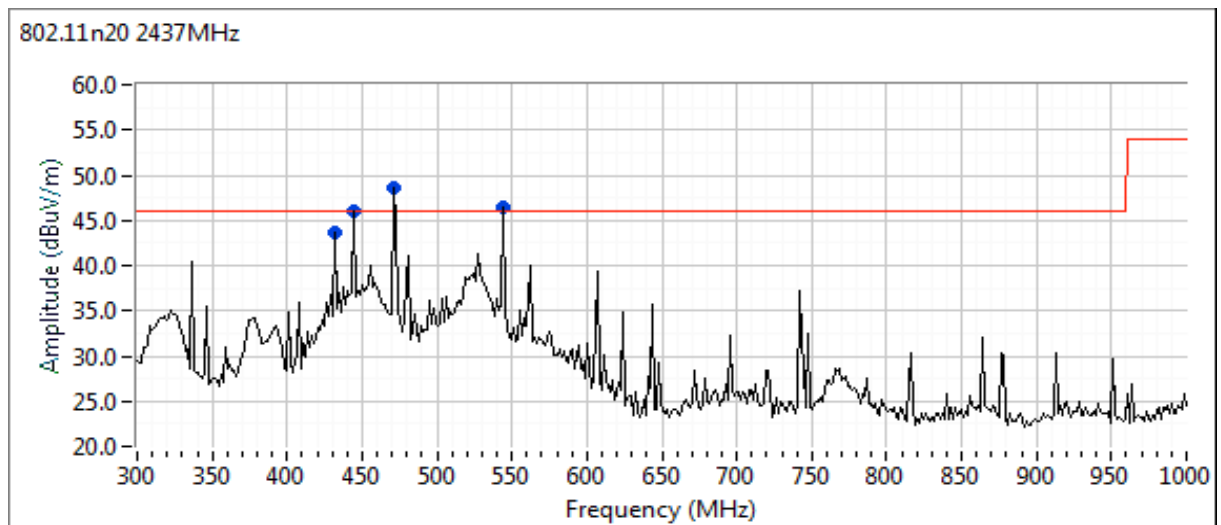
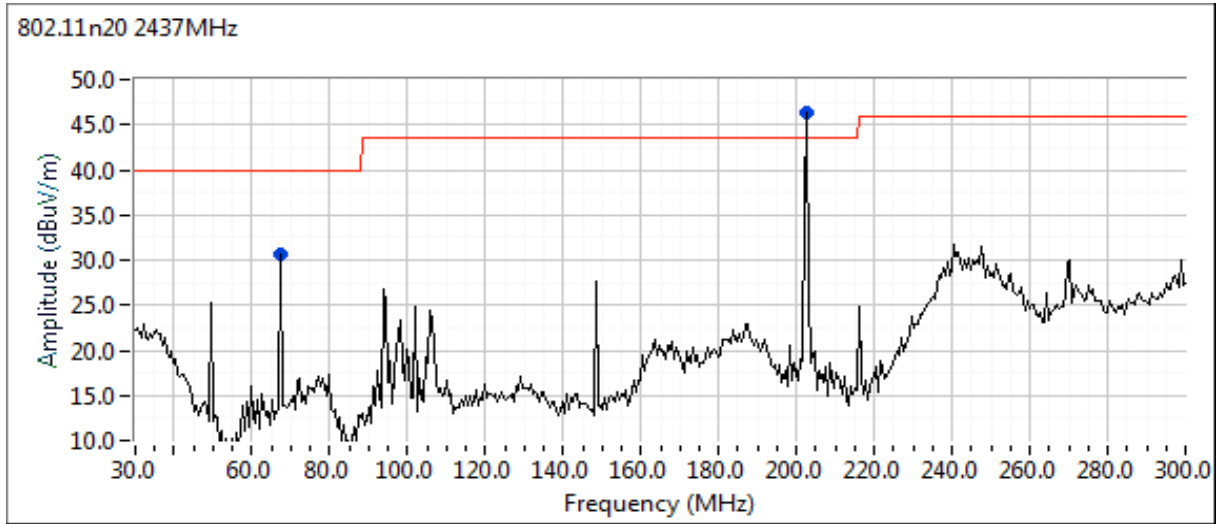
Note 4: These emissions are not from the radio. These emissions must meet the limits for commercial non radio equipment.



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



Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A



Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

Run #4: Radiated Spurious Emissions, 30 - 25,000 MHz. Operating Mode: Worse case from Run #3

Date of Test: 7/10/2017 0:00

Config. Used: 1

Test Engineer: Joseph Cadigal

Config Change: none

Test Location: FT Chamber#5

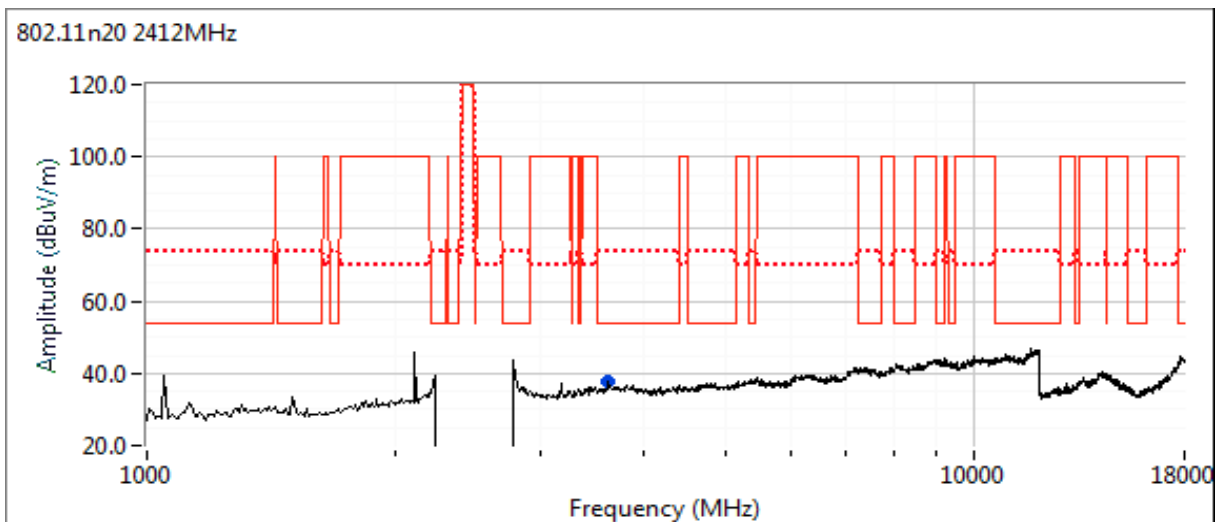
EUT Voltage: 120V/60Hz

Run #4a: Low Channel

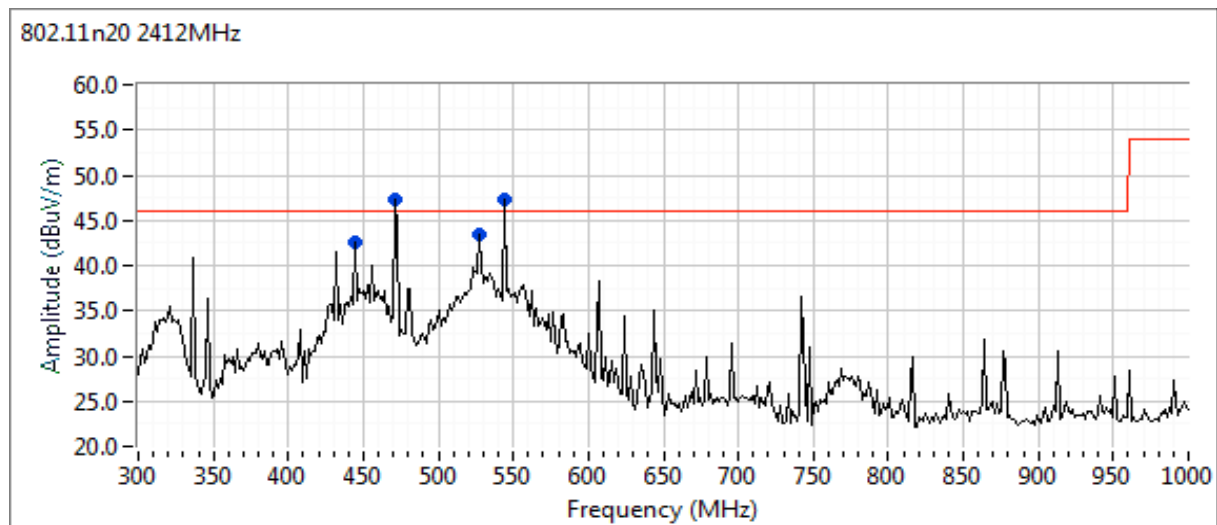
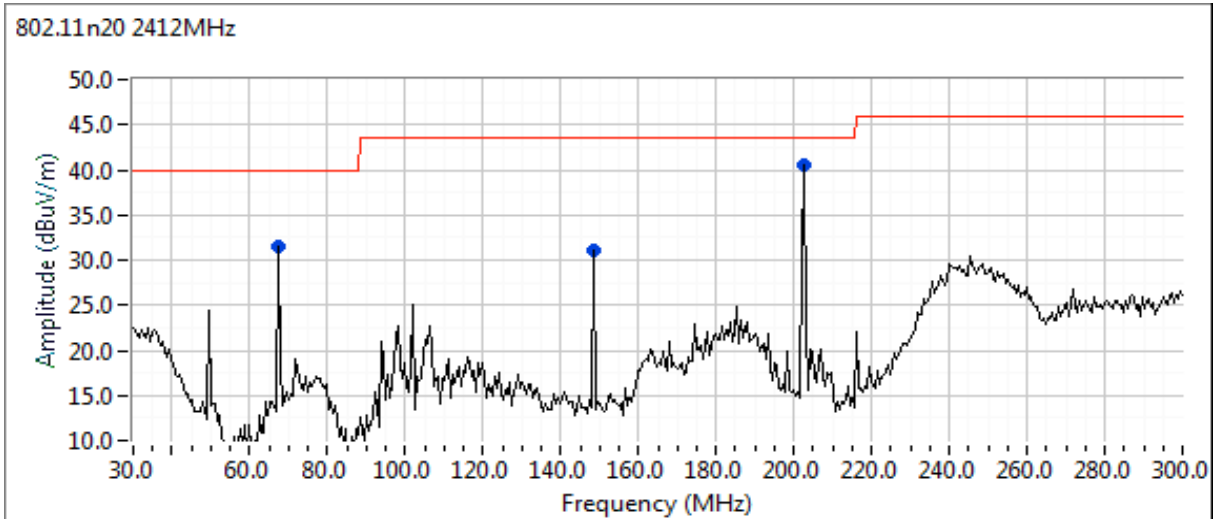
Channel: 1 Mode: n20  
 Tx Chain: 1 Data Rate: MCS0

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
527.999	41.0	H	-	N/A	QP	247	1.5	Note 4
445.496	39.2	V	-	N/A	QP	190	1.5	Note 4
202.320	35.9	V	-	N/A	QP	360	1.0	Note 4
472.110	37.8	H	-	N/A	QP	227	1.5	Note 4
472.110	46.3	H	-	N/A	QP	228	1.5	Note 4
148.500	27.1	V	-	N/A	QP	54	1.0	Note 4
67.442	22.5	V	-	N/A	QP	356	1.0	Note 4
544.489	23.1	H	-	N/A	QP	356	1.5	Note 4
3617.950	35.1	V	54.0	-18.9	AVG	100	2.5	RB 1 MHz;VB 1 kHz;Peak
3617.210	43.8	V	74.0	-30.2	PK	100	2.5	RB 1 MHz;VB 3 MHz;Peak

Note 4: These emissions are not from the radio. These emissions must meet the limits for commercial non radio equipment.



Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A



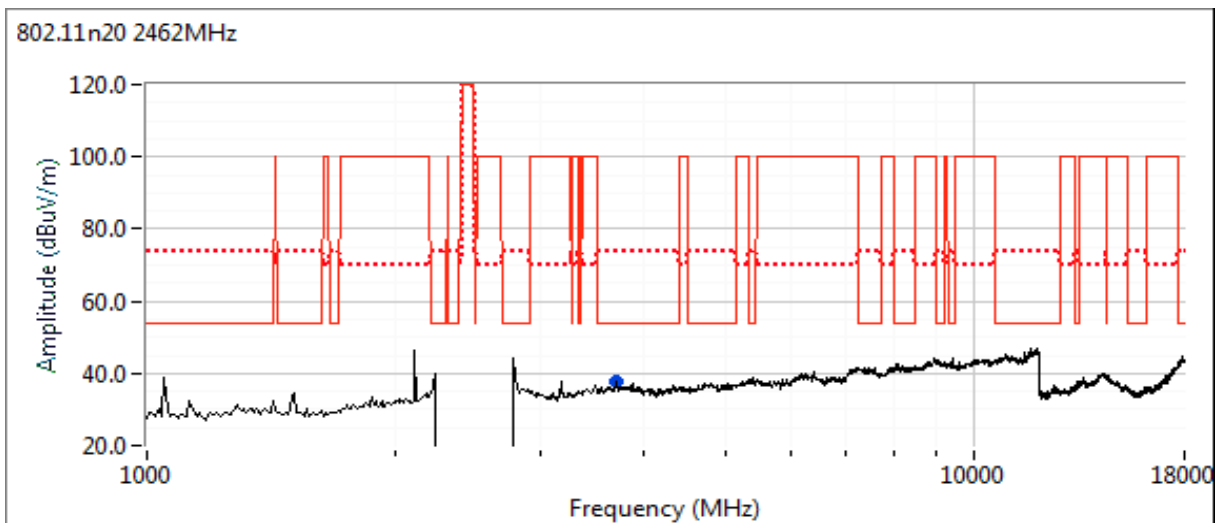
Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A

## Run #4b: High Channel

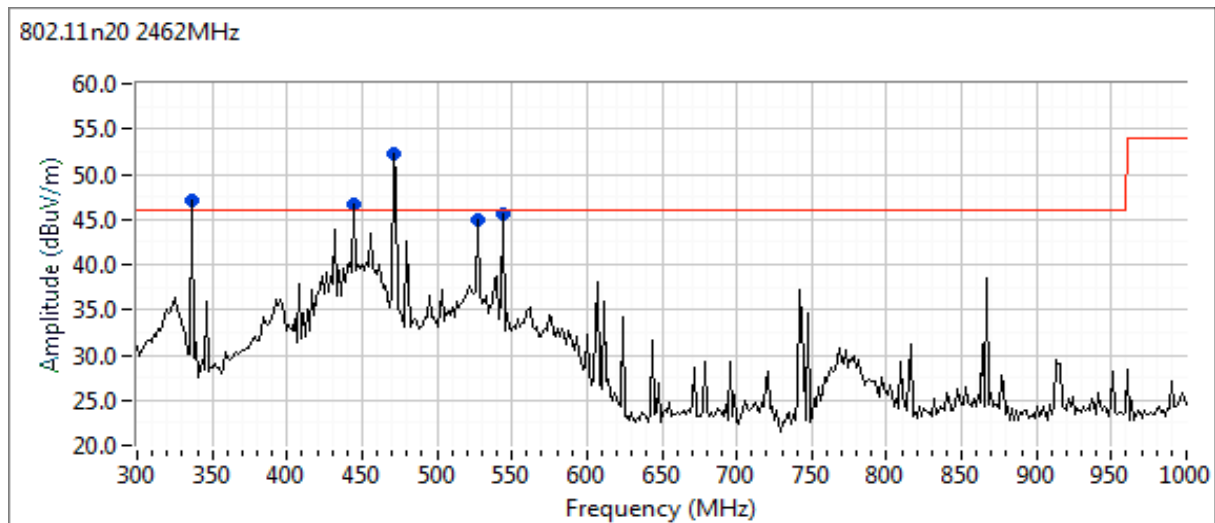
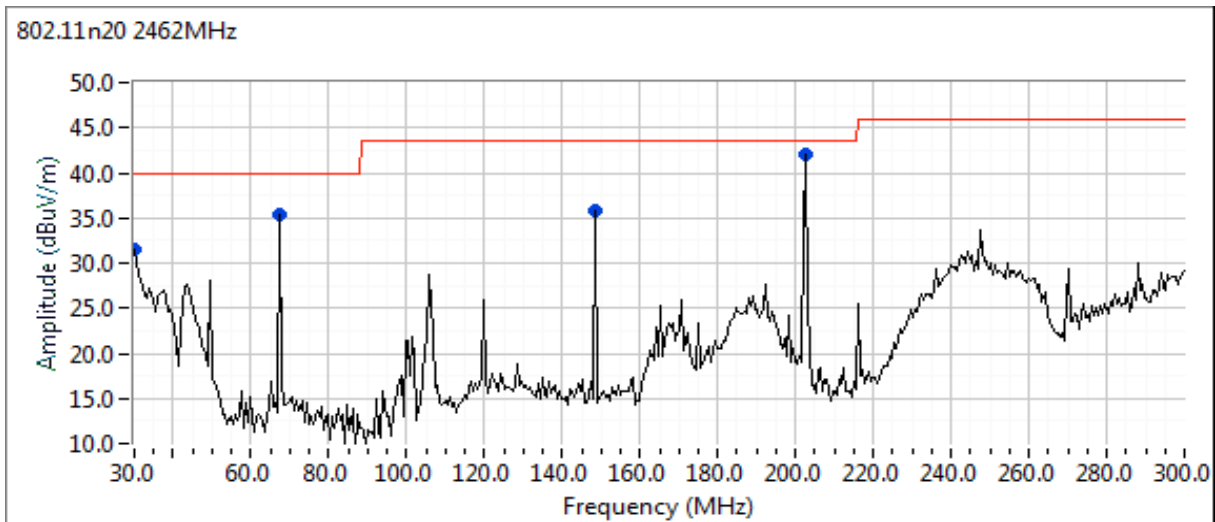
Channel: 11      Mode: n20  
 Tx Chain: 1      Data Rate: MCS0

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBuV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
30.239	29.7	V	-	N/A	QP	10	1.0	Note 4
148.818	10.4	H	-	N/A	QP	61	1.5	Note 4
543.221	21.1	V	-	N/A	QP	125	2.5	Note 4
337.188	46.8	H	-	N/A	QP	142	1.5	Note 4
67.444	23.3	V	-	N/A	QP	163	1.5	Note 4
472.015	51.8	H	-	N/A	QP	234	1.0	Note 4
526.304	26.3	H	-	N/A	QP	226	1.0	Note 4
202.310	41.9	H	-	N/A	QP	232	1.0	Note 4
443.914	34.9	H	-	N/A	QP	252	3.5	Note 4
3692.980	36.7	V	54.0	-17.3	AVG	130	2.2	RB 1 MHz;VB 1 kHz;Peak
3693.130	45.1	V	74.0	-28.9	PK	130	2.2	RB 1 MHz;VB 3 MHz;Peak

Note 4: These emissions are not from the radio. These emissions must meet the limits for commercial non radio equipment.



Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: N/A





## EMC Test Data

Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: B

### Conducted Emissions

(NTS Silicon Valley, Fremont Facility, Semi-Anechoic Chamber)

#### Test Specific Details

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

Date of Test: 7/27/2017  
 Test Engineer: Joseph Cadigal  
 Test Location: FT Chamber#5

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

#### General Test Configuration

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

Ambient Conditions:                      Temperature:                      23 °C  
    Rel. Humidity:                      38 %

#### Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	CE, AC Power, 120V/60Hz	15.207	Pass	37.1 dBμV @ 0.327 MHz (-12.4 dB)

#### Modifications Made During Testing

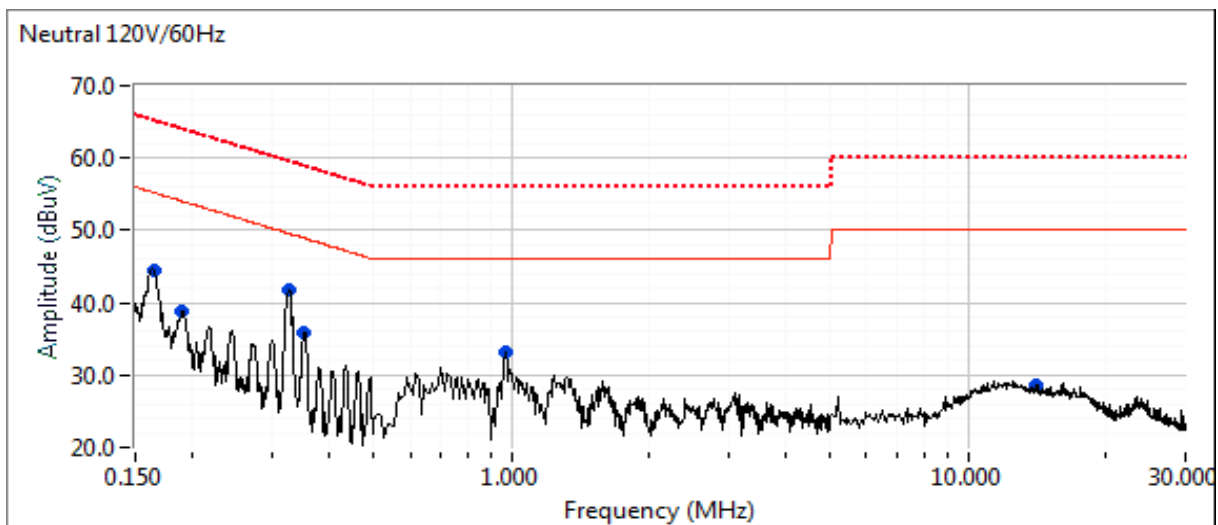
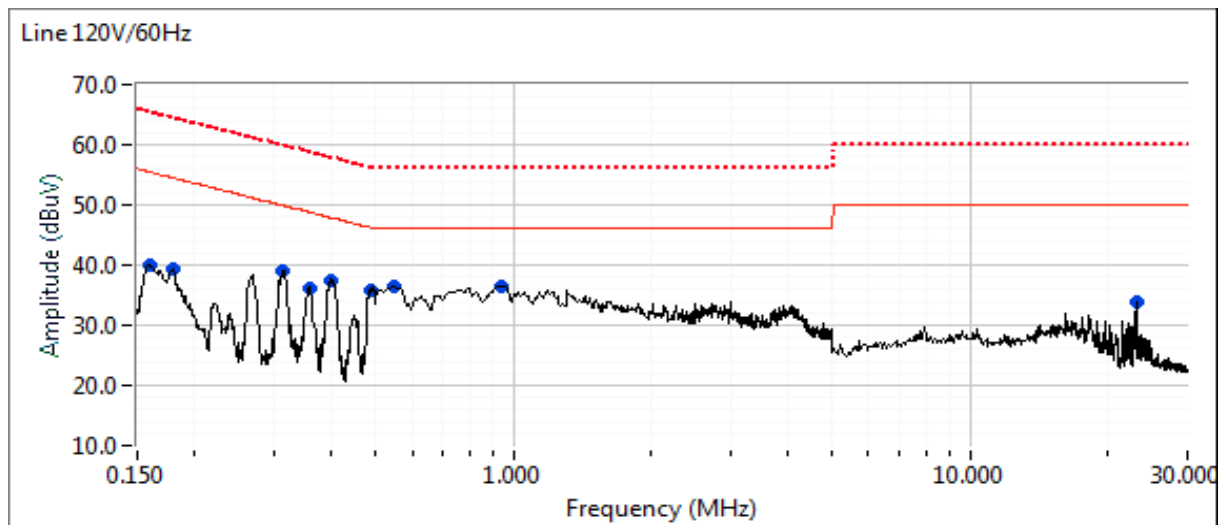
No modifications were made to the EUT during testing

#### Deviations From The Standard

No deviations were made from the requirements of the standard.

Client: Lighthouse Worldwide Solutions	Job Number: JD105241
Model: ApexZ3	T-Log Number: T105297
Contact: Charley Abboud	Project Manager: Irene Radamacher
Standard: FCC Part 15	Project Coordinator: -
	Class: B

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



Client:	Lighthouse Worldwide Solutions	Job Number:	JD105241
Model:	ApexZ3	T-Log Number:	T105297
Contact:	Charley Abboud	Project Manager:	Irene Radamacher
Standard:	FCC Part 15	Project Coordinator:	-
		Class:	B

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

Frequency MHz	Level dBμV	AC Line	Class B		Detector QP/Ave	Comments
			Limit	Margin		
0.401	37.5	Line 1	47.8	-10.3	Peak	
0.357	36.0	Line 1	48.8	-12.8	Peak	
0.313	38.9	Line 1	49.9	-11.0	Peak	
0.489	35.9	Line 1	46.2	-10.3	Peak	
0.160	40.0	Line 1	55.5	-15.5	Peak	
0.179	39.2	Line 1	54.5	-15.3	Peak	
0.938	36.5	Line 1	46.0	-9.5	Peak	
0.536	36.4	Line 1	46.0	-9.6	Peak	
23.128	33.8	Line 1	50.0	-16.2	Peak	
0.327	41.7	Neutral	49.5	-7.8	Peak	
0.165	44.5	Neutral	55.2	-10.7	Peak	
0.190	38.7	Neutral	54.0	-15.3	Peak	
0.352	35.9	Neutral	48.9	-13.0	Peak	
0.968	33.2	Neutral	46.0	-12.8	Peak	
14.082	28.7	Neutral	50.0	-21.3	Peak	

## Final quasi-peak and average readings

Frequency MHz	Level dBμV	AC Line	Class B		Detector QP/Ave	Comments
			Limit	Margin		
0.327	37.1	Neutral	49.5	-12.4	AVG	AVG (0.10s)
0.352	31.9	Neutral	48.9	-17.0	AVG	AVG (0.10s)
0.160	38.3	Line 1	55.5	-17.2	AVG	AVG (0.10s)
0.968	28.4	Neutral	46.0	-17.6	AVG	AVG (0.10s)
0.165	37.4	Neutral	55.2	-17.8	AVG	AVG (0.10s)
0.327	39.2	Neutral	59.5	-20.3	QP	QP (1.00s)
0.938	24.4	Line 1	46.0	-21.6	AVG	AVG (0.10s)
0.401	25.9	Line 1	47.8	-21.9	AVG	AVG (0.10s)
0.190	31.1	Neutral	54.1	-23.0	AVG	AVG (0.10s)
0.160	42.0	Line 1	65.5	-23.5	QP	QP (1.00s)
0.165	41.3	Neutral	65.2	-23.9	QP	QP (1.00s)
0.968	31.2	Neutral	56.0	-24.8	QP	QP (1.00s)
0.352	33.0	Neutral	58.9	-25.9	QP	QP (1.00s)
0.190	37.1	Neutral	64.1	-27.0	QP	QP (1.00s)
0.938	27.3	Line 1	56.0	-28.7	QP	QP (1.00s)
0.357	19.3	Line 1	48.8	-29.5	AVG	AVG (0.10s)
0.489	16.7	Line 1	46.2	-29.5	AVG	AVG (0.10s)
0.401	28.0	Line 1	57.8	-29.8	QP	QP (1.00s)
0.313	19.6	Line 1	49.9	-30.3	AVG	AVG (0.10s)



### ***End of Report***

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