NTS Silicon Valley
www.nts.com
41039 Boyce Road
Fremont, CA 94538
510-578-3500 Phone
510-440-9525 Fax

EMC Test Report

Application for Grant of Equipment Authorization

Industry Canada RSS-Gen Issue 4 / RSS 247 Issue 1
FCC Part 15 Subpart C

Model: Vessyl

IC CERTIFICATION #:	20554-00001
FCC ID:	2AFM8-00001
APPLICANT:	Mark One Lifestyle 2475 3rd St. Apt 101 San Francisco, CA 94107
TEST SITE(S):	National Technical Systems - Silicon Valley 41039 Boyce Road. Fremont, CA. 94538-2435
IC SITE REGISTRATION #:	2845B-4
REPORT DATE:	September 23, 2015
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PROGRAM MGR / TECHNICAL REVIEWER:	QUALITY ASSURANCE DELEGATE / FINAL REPORT PREPARER:
Mark E Hill	David Guidotti
Staff Engineer	Senior Technical Writer

A2LA ACCREDITED
Testing Cert #0214.26

REVISION HISTORY

Rev#	Date	Comments	Modified By
-	September 23, 2015	First release	
1	October 1, 2015	Removed references to 15.E. Updated references to C63.10. Updated test dates. Clarified the spurious emissions measurement procedure. Updated bandwidth measurements	MEH
2	October 2, 2015	Fixed references to FCC Rule Part	MEH

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SCOPE

An electromagnetic emissions test has been performed on the Mark One Lifestyle model Vessyl, pursuant to the following rules:

Industry Canada RSS-Gen Issue 4
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 requirements

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.).

STATEMENT OF COMPLIANCE

The tested sample of Mark One Lifestyle model Vessyl complied with the requirements of the following regulations:

Industry Canada RSS-Gen Issue 4
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 Mark One Lifestyle model Vessyl and therefore apply only to the tested sample. The sample was selected and prepared by Jared Wolff of Mark One Lifestyle.

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 DSSS techniques	System must utilize a digital transmission technology	Complies
15.247 (a) (2)	RSS 247 5.2 (1)	6dB Bandwidth	503 kHz	>500kHz	Complies
15.247 (b) (3)	RSS 247 5.4 (4)	Output Power (multipoint systems)	2.3dBm (1.7mW) EIRP = 3.4mW Note 1	1Watt, EIRP limited to 4 Watts.	Complies
15.247(e)	RSS 247 5.2 (2)	Power Spectral Density	1.8 dBm / 30kHz	8dBm/3kHz	Complies
15.247(d)	RSS 247 5.5	Antenna Port Spurious Emissions 30MHz – 25 GHz	All emissions below the -30dBc limit	< -30dBc Note 2	Complies
15.247(d) / 15.209	RSS 247 5.5 / RSS-GEN	Radiated Spurious Emissions 30MHz – 25 GHz	52.7 dBµV/m @ 4804.0 MHz (-1.3 dB)	15.207 in restricted bands, all others <-30dBc Note 2	Complies

Note 1: EIRP calculated using antenna gain of 3 dBi for the highest EIRP system.
Note 2: Limit of -30dBc used because the power was measured using the UNII test procedure (maximum power averaged over a transmission burst).

GENERAL REQUIREMENTS APPLICABLE TO ALL BANDS

FCC Rule Part	RSS Rule part	Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.203	-	RF Connector	Antenna is internal	Unique or integral antenna required	Complies
15.207	RSS GEN Table 3	AC Conducted Emissions	33.7 dBµV @ 0.810 MHz(-12.3 dB)	Refer to page 18	Complies
15.247 (b) (5) 15.407 (f)	RSS 102	RF Exposure Requirements	Refer to SAR exclusion calculations in separate exhibit and RSS 102 declaration	Refer to OET 65, FCC Part 1 and RSS 102	Complies
-	RSP 100 RSS GEN 6.6	Occupied Bandwidth	894 kHz	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	± 0.52 dB
RF power, conducted (Spectrum analyzer)	dBm	25 to 7000 MHz	± 0.7 dB
Conducted emission of transmitter	dBm	25 to 26500 MHz	± 0.7 dB
Conducted emission of receiver	dBm	25 to 26500 MHz	± 0.7 dB
Radiated emission (substitution method)	dBm	25 to 26500 MHz	± 2.5 dB
Radiated emission (field strength)	dBµV/m	25 to 1000 MHz	± 3.6 dB
		1000 to 40000 MHz	± 6.0 dB
Conducted Emissions (AC Power)	dBµV	0.15 to 30 MHz	± 2.4 dB

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Mark One Lifestyle model Vessyl is a drinking vessel that utilizes a BLE radio. 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 5 Volts (DC), 0 Hz, 0.5 Amps.

The sample was received on August 25, 2015 and tested on August 24, 25, 27, 28, and October 1, 2015. The EUT consisted of the following component(s):

Company	Model	Description	Serial Number	FCC ID
Mark One	Vessyl	Drinking vessel with BLE radio	30T	2AFM8-00001
Mark One	Vessyl	PCB for antenna port measurements	15236039	2AFM8-00001
Mark One	LACA005	AC/DC Adapter	-	-
Mark One	Vessyl	Charging Coaster	-	-

OTHER EUT DETAILS

The EUT is recharged via a coaster, via physical connection. The docking station uses a USB connection to either an external charger or a computer. There is no data communicated over the USB connection.

ANTENNA SYSTEM

The antenna system consists of Molex, 2.4/5GHz stand alone antenna that is fixed mounted internally.

ENCLOSURE

The EUT enclosure is primarily constructed of plastic. It measures approximately 7.75 cm circumference by 18 cm high.

MODIFICATIONS

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

SUPPORT EQUIPMENT

The following equipment was used as local support equipment for testing:

Company	Model	Description	Serial Number	FCC ID
HP	Probook 6570b	Laptop Computer	NTS - 2641	
HP	-	AC/DC Adapter	1724299904	-
Mark One	-	Test Fixture	-	-

Note – for radiated spurious emissions and AC conducted emissions the support equipment was used to configure the radio and then removed during the actual test.

No remote support equipment was used during testing.

EUT INTERFACE PORTS

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

Antenna port measurements

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
EUT Contacts	Test Fixture	Direct Contact	-	-
Test Fixture	Laptop	USB	Shielded	0.3

AC Conducted Emissions

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
EUT Contacts	Charging coaster	Direct Contact	-	-
Charging Coaster (USB)	AC/DC Adapter	USB	Shielded	1.0

EUT OPERATION

During emissions testing the EUT was configured to transmit on the noted channel at the maximum output power. For radiated measurements, the spurious emissions were assessed with and without the test fixture, and the worse case (without fixture) is reported.

TEST SITE

GENERAL INFORMATION

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

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

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

CONDUCTED EMISSIONS CONSIDERATIONS

Conducted emissions testing is performed in conformance with ANSI C63.10. Measurements are made with the EUT connected to the public power network through a nominal, standardized RF impedance, which is provided by a line impedance stabilization network, known as a LISN. A LISN is inserted in series with each current-carrying conductor in the EUT power cord.

RADIATED EMISSIONS CONSIDERATIONS

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

MEASUREMENT INSTRUMENTATION

RECEIVER SYSTEM

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

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

INSTRUMENT CONTROL COMPUTER

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

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

LINE IMPEDANCE STABILIZATION NETWORK (LISN)

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

FILTERS/ATTENUATORS

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

ANTENNAS

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

ANTENNA MAST AND EQUIPMENT TURNTABLE

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

ANSI C63.10 specifies that the test height above ground for table mounted devices shall be 80 centimeters for measurements below 1GHz, and 1.5m for measurements above 1GHz. Floor mounted equipment shall be placed on the ground plane if the device is normally used on a conductive floor or separated from the ground plane by insulating material from 3 to 12 mm if the device is normally used on a non-conductive floor as specified in ANSI C63.4. During radiated measurements, the EUT is positioned on a motorized turntable in conformance with this requirement.

INSTRUMENT CALIBRATION

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

TEST PROCEDURES

EUT AND CABLE PLACEMENT

The regulations require that interconnecting cables be connected to the available ports of the unit and that the placement of the unit and the attached cables simulate the worst case orientation that can be expected from a typical installation, so far as practicable. To this end, the position of the unit and associated cabling is varied within the guidelines of ANSI C63.10, and the worst-case orientation is used for final measurements.

CONDUCTED EMISSIONS

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

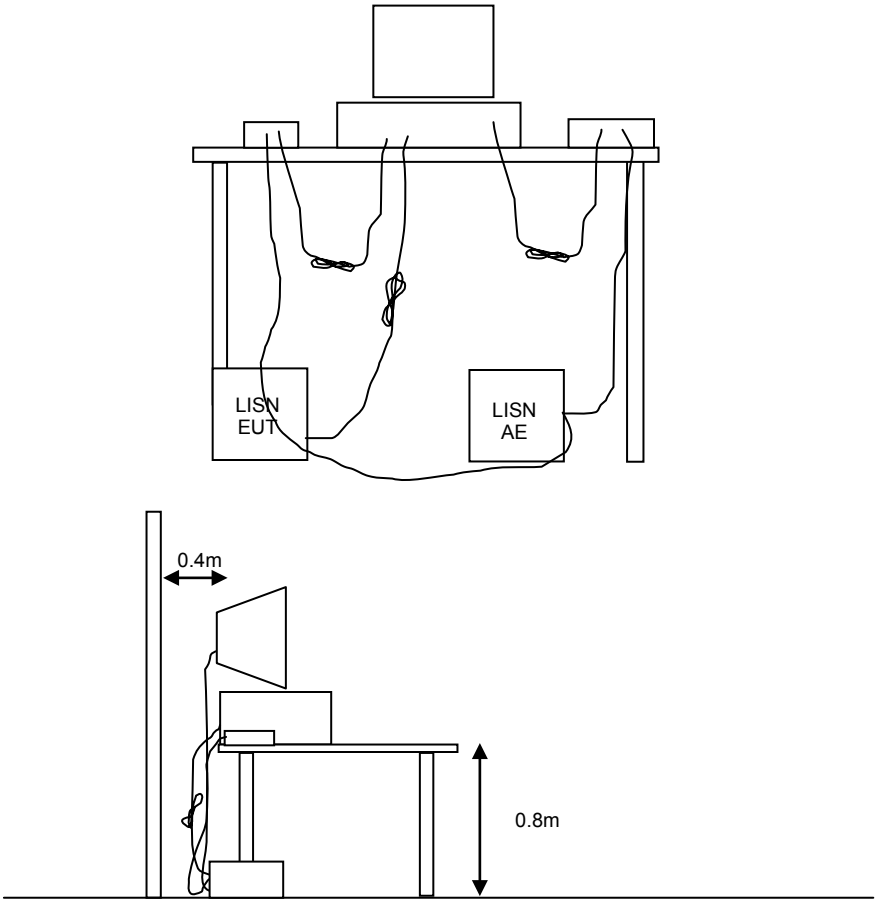


Figure 1 Typical Conducted Emissions Test Configuration

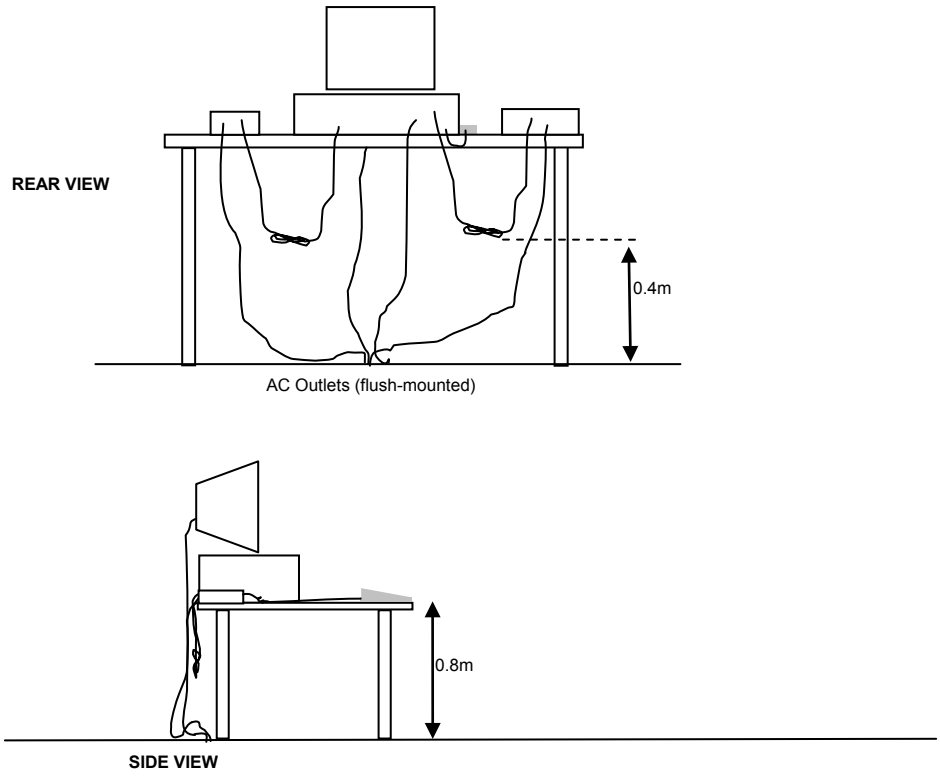
RADIATED EMISSIONS

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

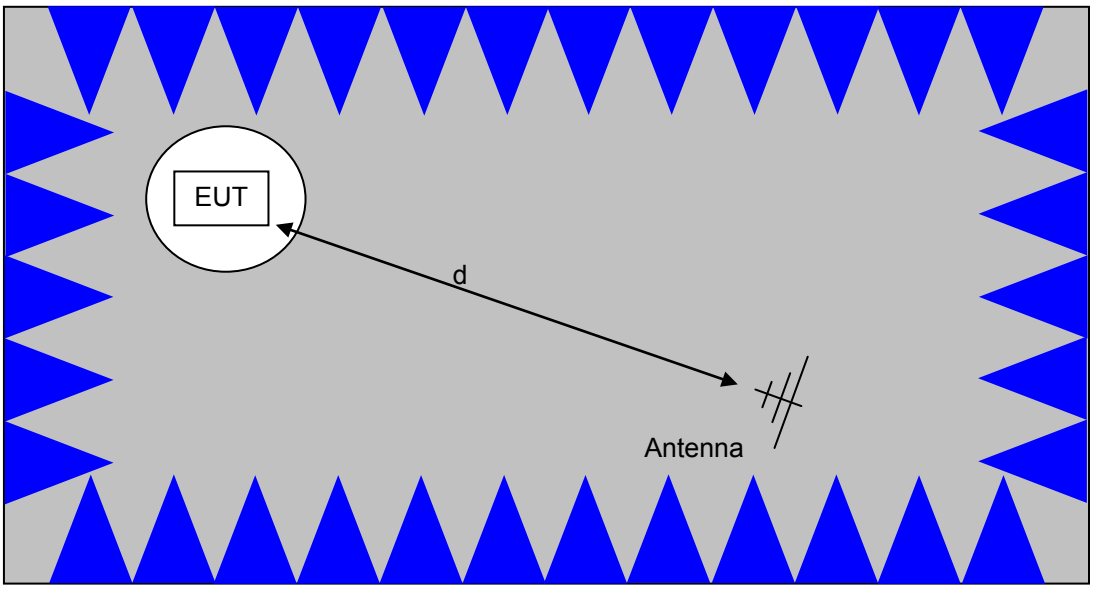
A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

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

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

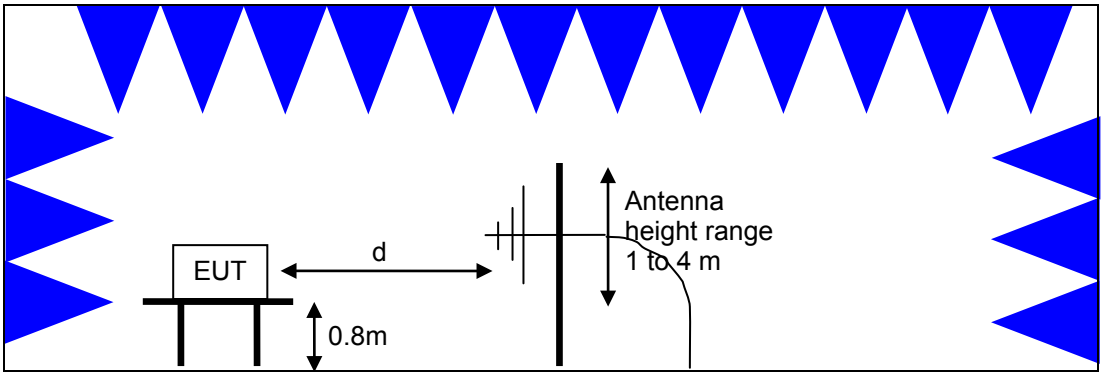


Typical Test Configuration for Radiated Field Strength Measurements



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

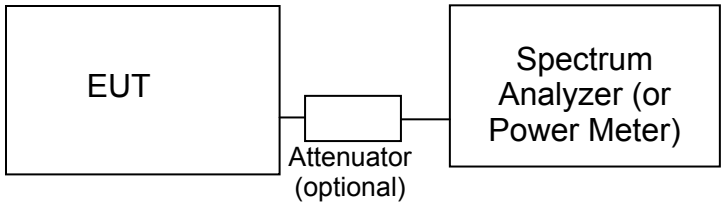
Floor-standing equipment is placed on the floor with insulating supports between the unit and the ground plane.



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

CONDUCTED EMISSIONS FROM ANTENNA PORT

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



Test Configuration for Antenna Port Measurements

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

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

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

BANDWIDTH MEASUREMENTS

The 6dB, 20dB, 26dB and/or 99% signal bandwidth are measured using the bandwidths recommended by ANSI C63.10 and RSS GEN.

SPECIFICATION LIMITS AND SAMPLE CALCULATIONS

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

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

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

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

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

GENERAL TRANSMITTER RADIATED EMISSIONS SPECIFICATION LIMITS

The table below shows the limits for the spurious emissions from transmitters that fall in restricted bands[1].

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

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

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

TRANSMIT MODE SPURIOUS RADIATED EMISSIONS LIMITS – FHSS and DTS SYSTEMS

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

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

SAMPLE CALCULATIONS - CONDUCTED EMISSIONS

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

$$R_r - S = M$$

where:

R_r = Receiver Reading in dBuV

S = Specification Limit in dBuV

M = Margin to Specification in +/- dB

SAMPLE CALCULATIONS - RADIATED EMISSIONS

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

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

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

where:

F_d = Distance Factor in dB

D_m = Measurement Distance in meters

D_s = Specification Distance in meters

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

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

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

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

$$R_c = R_r + F_d$$

and

$$M = R_c - L_s$$

where:

R_r = Receiver Reading in dBuV/m

F_d = Distance Factor in dB

R_C = Corrected Reading in dBuV/m

L_S = Specification Limit in dBuV/m

M = Margin in dB Relative to Spec

SAMPLE CALCULATIONS - FIELD STRENGTH TO EIRP CONVERSION

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

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

where P is the eirp (Watts)

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

Appendix A Test Equipment Calibration Data

Radiated Emissions, 1000 - 25,000 MHz, 25-Aug-15

Manufacturer	Description	Model	Asset #	Calibrated	Cal Due
EMCO	Antenna, Horn, 1-18GHz	3115	868	6/26/2014	6/26/2016
Hewlett Packard	High Pass filter, 8.2 GHz (Purple System)	P/N 84300-80039	1767	11/14/2014	11/14/2015
Hewlett Packard	Head (Inc 3136 Miteq + cable) Purple		1772	6/19/2015	6/19/2016
A. H. Systems	Spare System Horn, 18-40GHz	SAS-574, p/n: 2581	2162	7/29/2015	7/29/2017
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	2199	2/20/2015	2/20/2016
Micro-Tronics	Band Reject Filter, 2400-2500 MHz	BRM50702-02	2249	10/3/2014	10/3/2015
Hewlett Packard	SpecAn 9 kHz - 40 GHz, (SA40) Purple	8564E (84125C)	2415	3/7/2015	3/7/2016
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1630	7/6/2015	7/6/2016

Radiated Emissions, 30 - 1,000 MHz, 27-Aug-15

Manufacturer	Description	Model	Asset #	Calibrated	Cal Due
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1630	7/6/2015	7/6/2016
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	2237	8/29/2014	8/29/2016
Com-Power	Preamplifier, 1-1000 MHz	PAM-103	2885	10/22/2014	10/22/2015

Conducted Emissions - AC Power Ports, 27-Aug-15

Manufacturer	Description	Model	Asset #	Calibrated	Cal Due
EMCO	LISN, 10 kHz-100 MHz	3825/2	1292	7/24/2015	7/24/2016
Rohde & Schwarz	Pulse Limiter	ESH3 Z2	1401	5/14/2015	5/14/2016
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1630	7/6/2015	7/6/2016

Radio Antenna Port (Power and Spurious Emissions), 28-Aug-15

Manufacturer	Description	Model	Asset #	Calibrated	Cal Due
Agilent Technologies	3Hz -44GHz PSA Spectrum Analyzer	E4446A	2796	3/31/2015	3/31/2016

Radio Antenna Port (Bandwidth), 01-Oct-15

Manufacturer	Description	Model	Asset #	Calibrated	Cal Due
Agilent Technologies	3Hz -44GHz PSA Spectrum Analyzer	E4446A	2796	3/31/2015	3/31/2016

Appendix B Test Data

T99138 Pages 24 - 54

Client:	Mark One	Job Number:	JD98999
Product	Vessyl	T-Log Number:	T99138
System Configuration:	-	Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Emissions Standard(s):	FCC 15.247/RSS-247/LP0002	Class:	B
Immunity Standard(s):	-	Environment:	-

EMC Test Data

For The

Mark One

Product

Vessyl

Date of Last Test: 8/28/2015

Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	Class:	N/A

Duty Cycle

Date of Test: 8/24/2015
Test Engineer: Mark Hill
Test Location: Lab #4

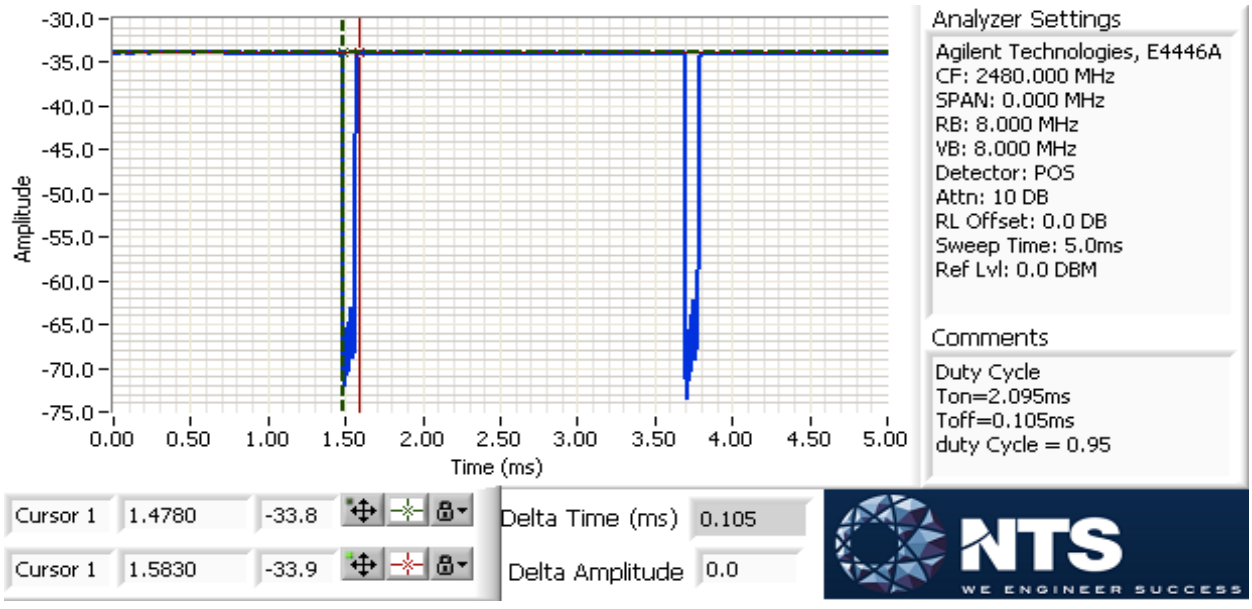
Sample Notes

Sample S/N: 30T
Driver: -

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

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
BLE	1Mb/s	0.95	Yes	2.095	0.21	0.42	477

* Correction factor when using RMS/Power averaging - 10*log(1/x)
** Correction factor when using linear voltage average - 20*log(1/x)
T = Minimum transmission duration



Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	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: 20.8 °C
Rel. Humidity: 37 %

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	2402MHz	-	0	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247(c)	52.0 dBµV/m @ 2368.4 MHz (-22.0 dB)
	BLE	2480MHz	-	0	Restricted Band Edge (2483.5 MHz)	FCC Part 15.209 / 15.247(c)	60.4 dBµV/m @ 2485.0 MHz (-13.6 dB)

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Sample Notes

Sample S/N: 30T
Driver:
Antenna: Internal

Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	Class:	N/A

Procedure Comments:

Measurements performed in accordance with FCC KDB 558074
Peak measurements performed with: RBW=1MHz, VBW=3MHz, peak detector, max hold, auto sweep time
Unless otherwise stated/noted, emission has duty cycle ≥ 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	1Mb/s	0.95	Yes	2.095	0.21	0.42	477

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

Note - worse case EUT orientation determined by preliminary measurements. For the side orientation, the EUT was rotated to determine worse case orientation.

Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	Class:	N/A

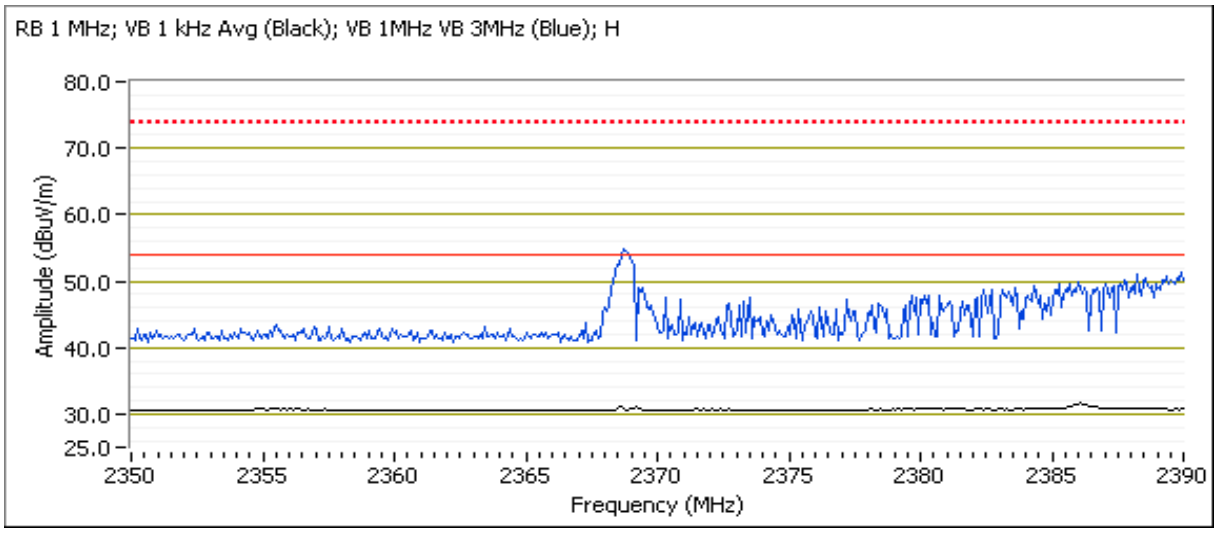
Run #1: Radiated Bandedge Measurements

Date of Test: 8/25/2015 0:00 Config. Used: 1
Test Engineer: Rafael Varelas Config Change: None
Test Location: FT Chamber #4 EUT Voltage: Battery

Channel: 2402MHz Mode: BLE Orientation: EUT Side w/o charger
Tx Chain: Main Data Rate: 1Mb/s

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2368.370	52.0	H	74.0	-22.0	PK	49	1.2	POS; RB 1 MHz; VB: 3 MHz
2372.520	29.5	H	54.0	-24.5	Avg	49	1.2	Note 4; RB 1 MHz; VB: 1 kHz
2388.000	47.0	H	74.0	-27.0	PK	49	1.2	POS; RB 1 MHz; VB: 3 MHz
2386.150	32.0	H	54.0	-22.0	Avg	49	1.2	Note 4; RB 1 MHz; VB: 1 kHz
2369.000	45.2	V	74.0	-28.8	PK	103	2.0	POS; RB 1 MHz; VB: 3 MHz
2386.420	31.2	V	54.0	-22.8	Avg	103	2.0	Note 4; RB 1 MHz; VB: 1 kHz

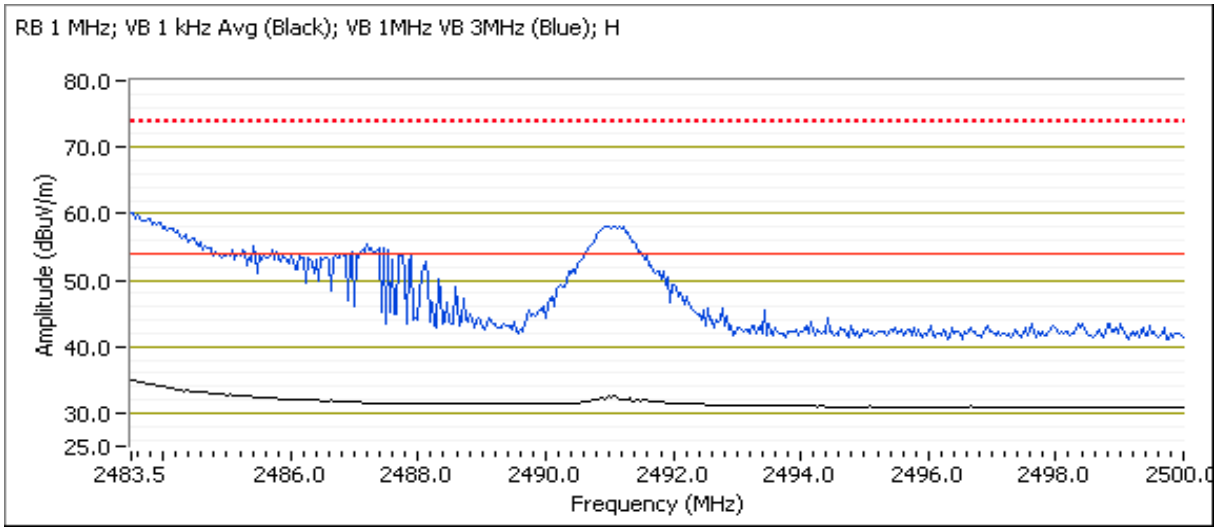


Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	Class:	N/A

Channel: 2480MHz Mode: BLE Orientation: EUT Side w/o charger
Tx Chain: Main Data Rate: 1Mb/s

Band Edge Signal Field Strength - Direct measurement of field strength

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2484.950	60.4	H	74.0	-13.6	PK	336	1.9	POS; RB 1 MHz; VB: 3 MHz
2483.570	35.3	H	54.0	-18.7	Avg	336	1.9	Note 4; RB 1 MHz; VB: 1 kHz
2491.570	57.2	V	74.0	-16.8	PK	240	1.0	POS; RB 1 MHz; VB: 3 MHz
2483.500	33.4	V	54.0	-20.6	Avg	240	1.0	Note 4:100; RB 1 MHz; VB: 1 kHz



Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	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: 20.8 °C
Rel. Humidity: 37 %

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	2402MHz	-	0	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247(c)	52.7 dBµV/m @ 4804.0 MHz (-1.3 dB)
	BLE	2440MHz	-	0	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247(c)	52.6 dBµV/m @ 4880.1 MHz (-1.4 dB)
	BLE	2480MHz	-	0	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247(c)	48.9 dBµV/m @ 4960.0 MHz (-5.1 dB)

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Sample Notes

Sample S/N: 30T
Driver:
Antenna: Internal

Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	Class:	N/A

Procedure Comments:

Measurements performed in accordance with FCC KDB 558074
Peak measurements performed with: RBW=1MHz, VBW=3MHz, peak detector, max hold, auto sweep time
Unless otherwise stated/noted, emission has duty cycle ≥ 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	1Mb/s	0.95	Yes	2.095	0.21	0.42	477

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:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	Class:	N/A

Run #1: Radiated Spurious Emissions, 1,000 - 25000 MHz. Operating Mode: 802.11b

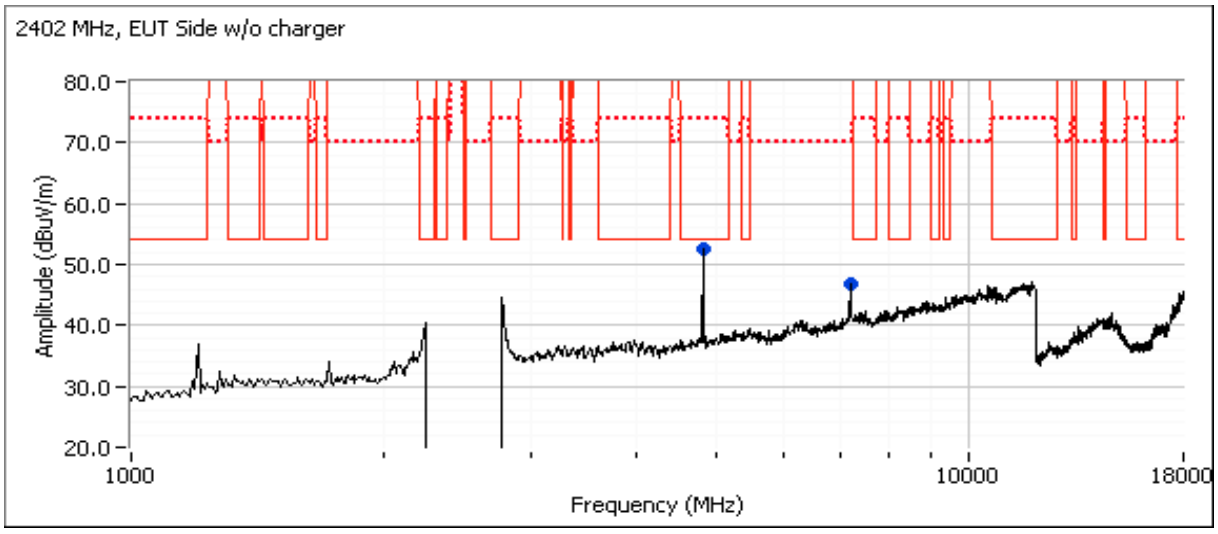
Date of Test: 8/25/2015 0:00 Config. Used: 1
Test Engineer: Rafael Varelas Config Change: None
Test Location: FT Chamber #4 EUT Voltage: Battery

Run #1a: Low Channel

Channel: 2402MHz Mode: BLE Orientation: EUT Side w/o charger
Tx Chain: Main Data Rate: 1Mb/s

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4804.020	52.7	H	54.0	-1.3	Avg	41	1.6	Note 4; RB 1 MHz; VB: 1 kHz
7205.970	43.8	V	54.0	-10.2	Avg	0	1.0	Note 1, 4; RB 1 MHz; VB: 1 kHz
4803.700	56.1	H	74.0	-17.9	PK	41	1.6	RB 1 MHz;VB 3 MHz;Peak
7206.520	52.4	V	74.0	-21.6	PK	0	1.0	Note 1,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



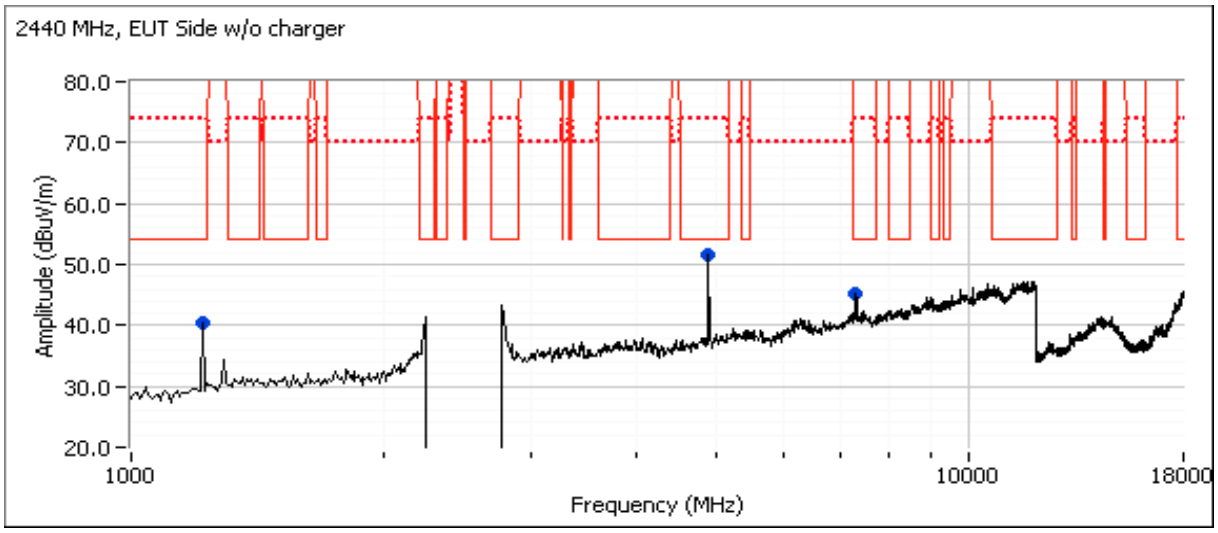
Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	Class:	N/A

Run #1b: Center Channel

Channel: 2440MHz Mode: BLE Orientation: EUT Side w/o charger
Tx Chain: Main Data Rate: 1Mb/s

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4880.070	52.6	H	54.0	-1.4	Avg	0	1.1	Note 4; RB 1 MHz; VB: 1 kHz
7320.170	43.0	H	54.0	-11.0	Avg	50	1.0	Note 4; RB 1 MHz; VB: 1 kHz
1219.980	40.8	H	54.0	-13.2	Avg	137	1.6	Note 4; RB 1 MHz; VB: 1 kHz
4879.770	55.4	H	74.0	-18.6	PK	0	1.1	RB 1 MHz;VB 3 MHz;Peak
7320.310	52.4	H	74.0	-21.6	PK	50	1.0	RB 1 MHz;VB 3 MHz;Peak
1220.120	44.7	H	74.0	-29.3	PK	137	1.6	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

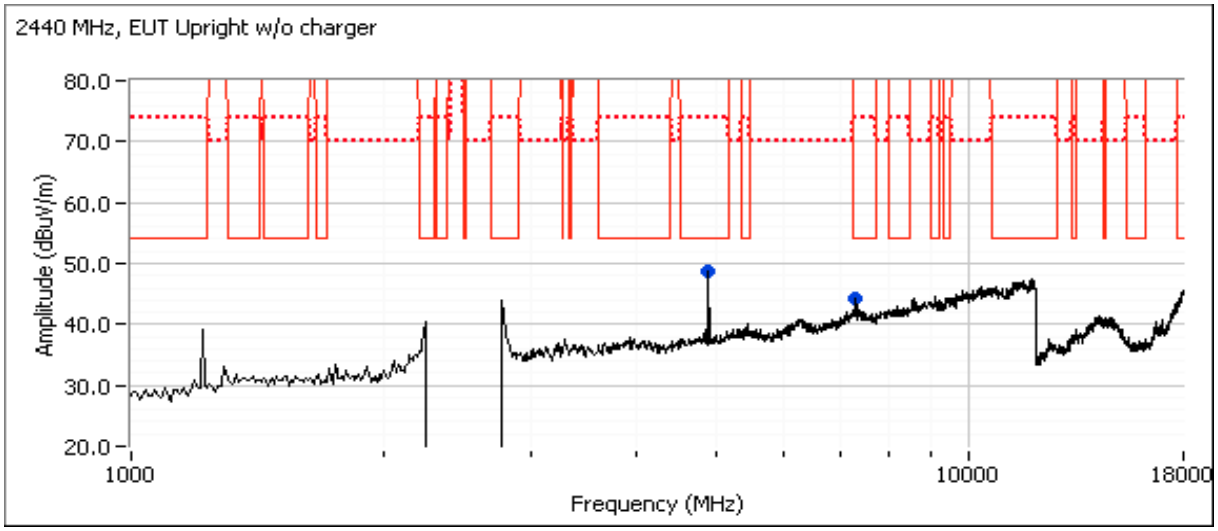


Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	Class:	N/A

Channel: 2440MHz Mode: BLE Orientation: EUT Upright w/o charger
Tx Chain: Main Data Rate: 1Mb/s

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4880.070	51.5	V	74.0	-22.5	PK	155	1.5	RB 1 MHz;VB 3 MHz;Peak
4880.040	47.4	V	54.0	-6.6	Avg	155	1.5	Note 4; RB 1 MHz; VB: 1 kHz
7319.800	52.4	V	74.0	-21.6	PK	339	1.7	RB 1 MHz;VB 3 MHz;Peak
7320.050	42.2	V	54.0	-11.8	Avg	339	1.7	Note 4; RB 1 MHz; VB: 1 kHz

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

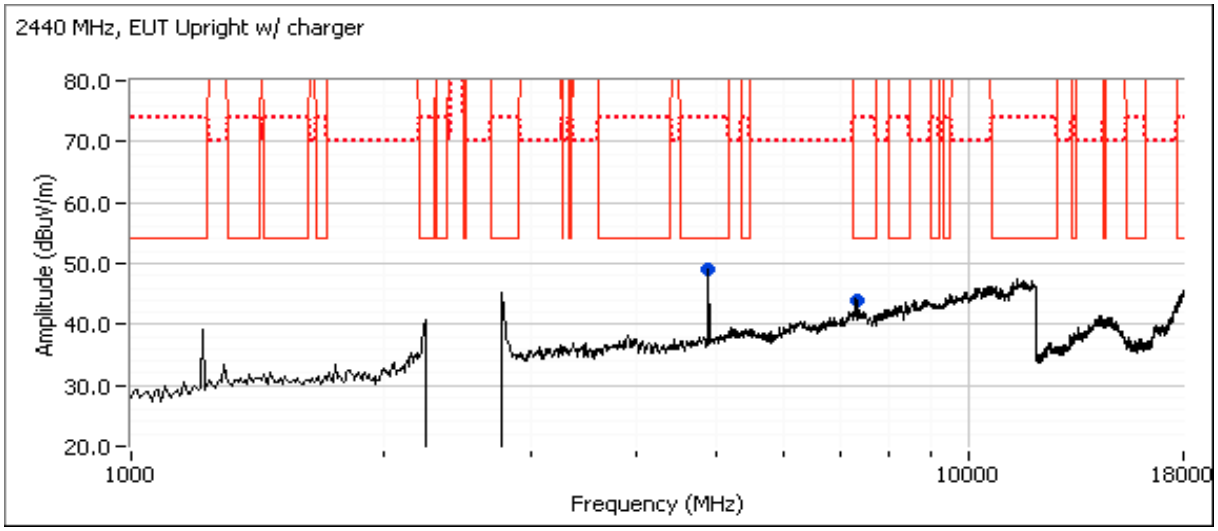


Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	Class:	N/A

Channel: 2440MHz Mode: BLE Orientation: EUT Upright w/ charger
Tx Chain: Main Data Rate: 1Mb/s

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
7320.190	52.1	V	74.0	-21.9	PK	341	1.8	RB 1 MHz;VB 3 MHz;Peak
7320.040	42.6	V	54.0	-11.4	Avg	341	1.8	Note 4; RB 1 MHz; VB: 1 kHz
4880.250	52.0	H	74.0	-22.0	PK	38	1.3	RB 1 MHz;VB 3 MHz;Peak
4879.960	47.3	H	54.0	-6.7	Avg	38	1.3	Note 4; RB 1 MHz; VB: 1 kHz

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



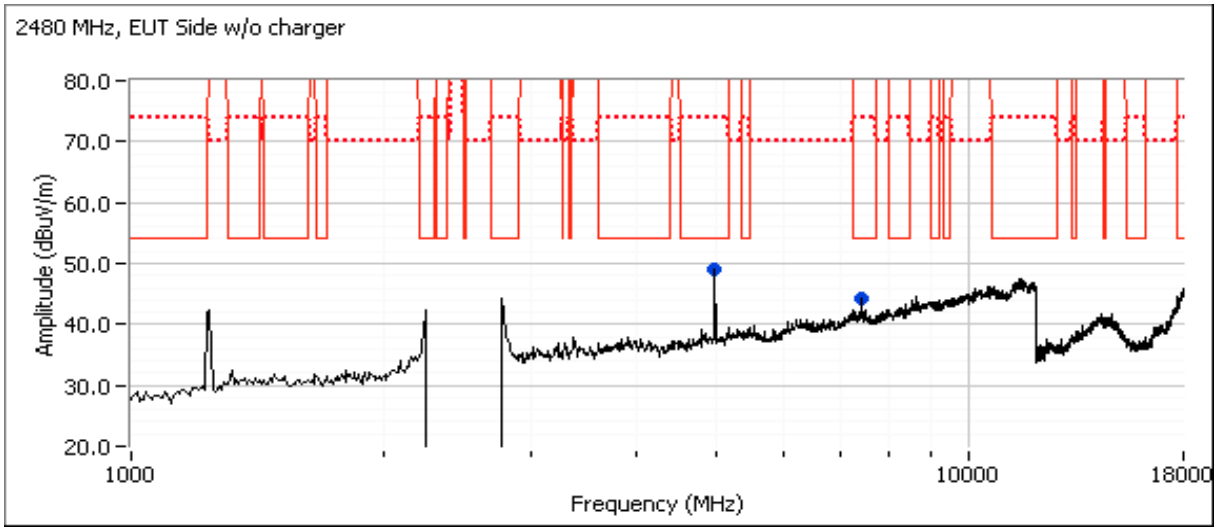
Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	Class:	N/A

Run #1c: High Channel

Channel: 2480MHz Mode: BLE Orientation: EUT Side w/o charger
Tx Chain: Main Data Rate: 1Mb/s

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
4959.970	48.9	H	54.0	-5.1	Avg	3	1.2	Note 4; RB 1 MHz; VB: 1 kHz
7440.000	41.6	V	54.0	-12.4	Avg	4	1.0	Note 4; RB 1 MHz; VB: 1 kHz
4959.720	52.6	H	74.0	-21.4	PK	3	1.2	RB 1 MHz;VB 3 MHz;Peak
7444.930	51.4	V	74.0	-22.6	PK	4	1.0	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:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	Class:	N/A

Radiated 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: 8/27/2015
Test Engineer: Rafael Varelas
Test Location: FT Chamber #4

Config. Used: 1
Config Change: None
Host Unit Voltage Battery

General Test Configuration

The EUT and any local support equipment were located on the turntable for radiated emissions testing.
The test distance and extrapolation factor (if applicable) are detailed under each run description.

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

Ambient Conditions:

Temperature:	22.7 °C
Rel. Humidity:	39 %

Summary of Results (ANSI C63.4:2009)

Run #	Test Performed	Limit	Result	Margin
1	Radiated Emissions 30 - 1000 MHz, Transmit	FCC 15.209	Pass	29.8 dBµV/m @ 838.68 MHz (-16.2 dB)
2	Radiated Emissions 30 - 1000 MHz, Receive	LP 0002	Pass	25.6 dBµV/m @ 375.75 MHz (-20.4 dB)

Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	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: 30T
Driver:
Antenna: Internal

Notes

Testing performed at 0.8m per C63.10

Procedure Comments:

Measurements performed in accordance with FCC KDB 558074
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	1Mb/s	0.95	Yes	2.095	0.21	0.42	477

Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	Class:	N/A

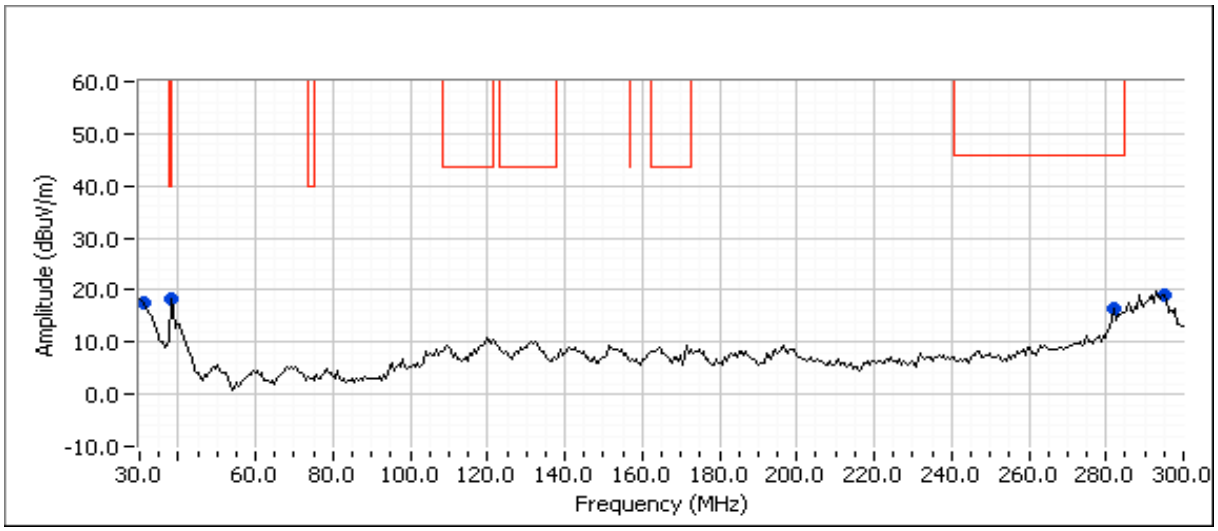
Run #1: Radiated Spurious Emissions, 30 - 1000 MHz

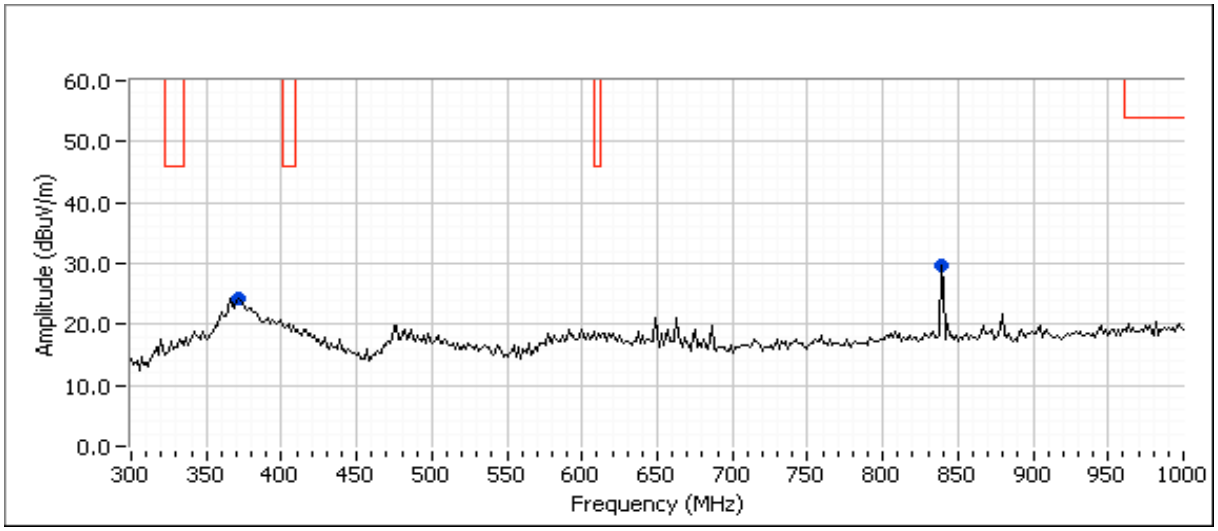
Test Parameters for Preliminary Scan(s)			
Frequency Range (MHz)	Prescan Distance (meters)	Limit Distance (meters)	Extrapolation Factor (dB, applied to data)
30 - 1000	3	3	0.0

Channel: 2440 Mode: BLE Antenna: Internal
Tx Chain: Main Data Rate: 1Mb/s

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
838.677	29.8	H	46.0	-16.2	Peak	243	1.0	Using restricted limit
31.082	17.7	H	40.0	-22.3	Peak	310	3.0	Using restricted limit
38.116	18.2	V	40.0	-21.8	Peak	100	1.0	
282.144	16.3	H	46.0	-29.7	Peak	98	1.0	
295.130	18.9	H	46.0	-27.1	Peak	89	1.0	Using restricted limit
371.543	24.3	H	46.0	-21.7	Peak	130	1.0	Using restricted limit

Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	Class:	N/A





Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	Class:	N/A

Run #2: Radiated Spurious Emissions, 30 - 1000 MHz

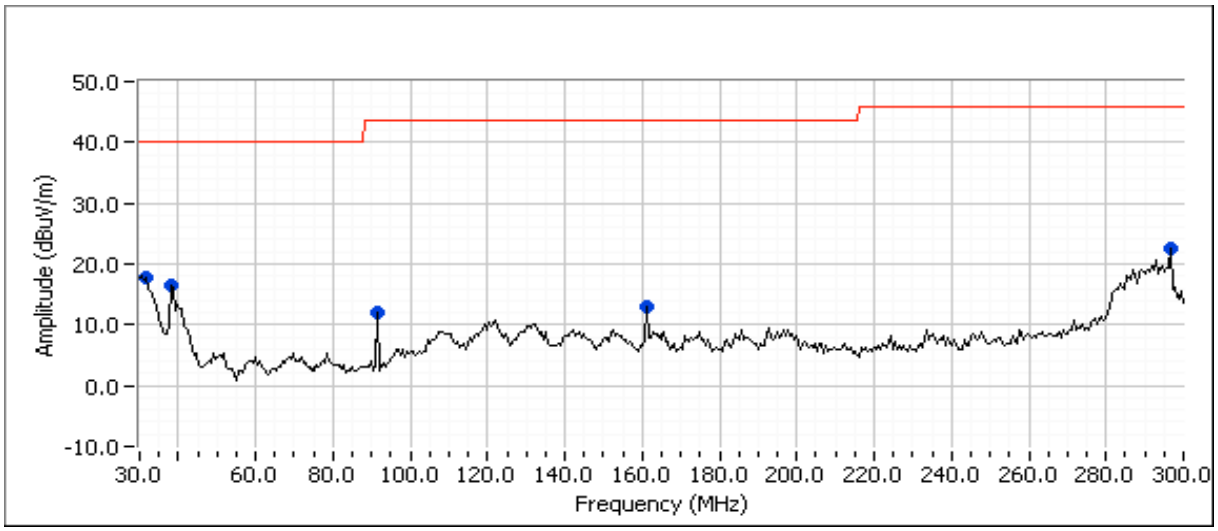
Test Parameters for Preliminary Scan(s)			
Frequency Range (MHz)	Prescan Distance (meters)	Limit Distance (meters)	Extrapolation Factor (dB, applied to data)
30 - 1000	3	3	0.0

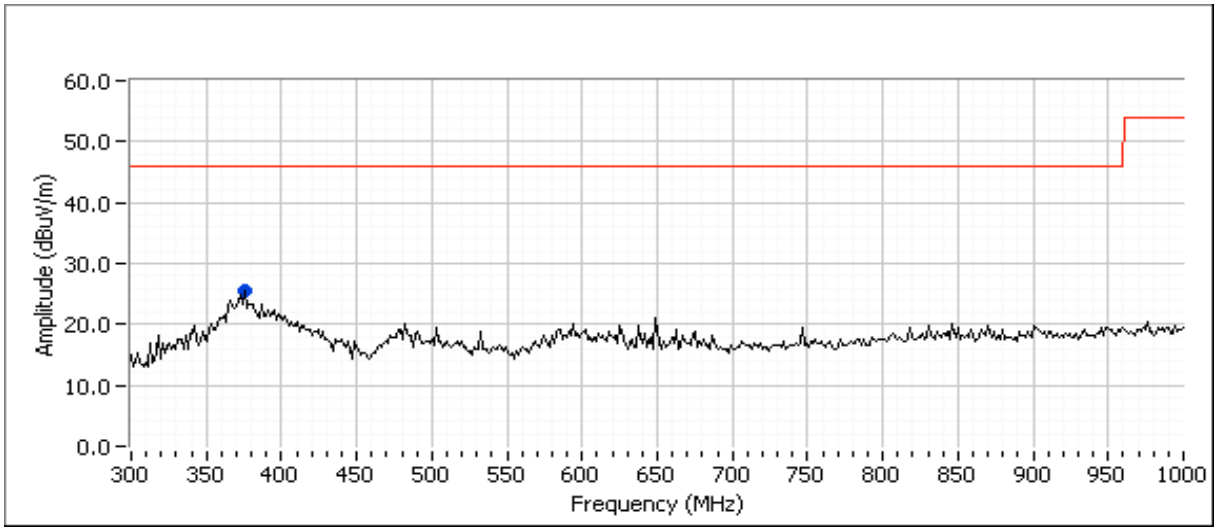
Channel: 2440MHz Mode: Rx Antenna: Internal
Tx Chain: Main Data Rate: N/A

Mazimized peak readings captured during pre-scan

Frequency	Level	Pol	LP0002 2.8		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
375.751	25.6	H	46.0	-20.4	Peak	150	1.0	
31.623	17.8	V	40.0	-22.2	Peak	265	2.5	
38.116	16.6	V	40.0	-23.4	Peak	63	1.0	
296.754	22.5	H	46.0	-23.5	Peak	86	1.0	
160.942	13.1	V	43.5	-30.4	Peak	18	2.5	
91.683	12.0	H	43.5	-31.5	Peak	360	4.0	

Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	Class:	N/A





Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	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: 8/28/2015
Test Engineer: Rafael Varelas
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: 21.6 °C
Rel. Humidity: 38 %

Summary of Results

Run #	Pwr setting	Avg Pwr	Test Performed	Limit	Pass / Fail	Result / Margin
1	-	-	Output Power	15.247(b)	Pass	2.3 dBm
2	-	-	Power spectral Density (PSD)	15.247(d)	Pass	1.8 dBm/30kHz
3	-	-	Minimum 6dB Bandwidth	15.247(a)	Pass	503 kHz
3	-	-	99% Bandwidth	RSS GEN	-	894 kHz
4	-	-	Spurious emissions	15.247(b)	Pass	All emissions below the -30dBc limit

Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	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	1Mb/s	0.95	Yes	2.095	0.21	0.42	477

Sample Notes

Sample S/N: 30T
Driver: -

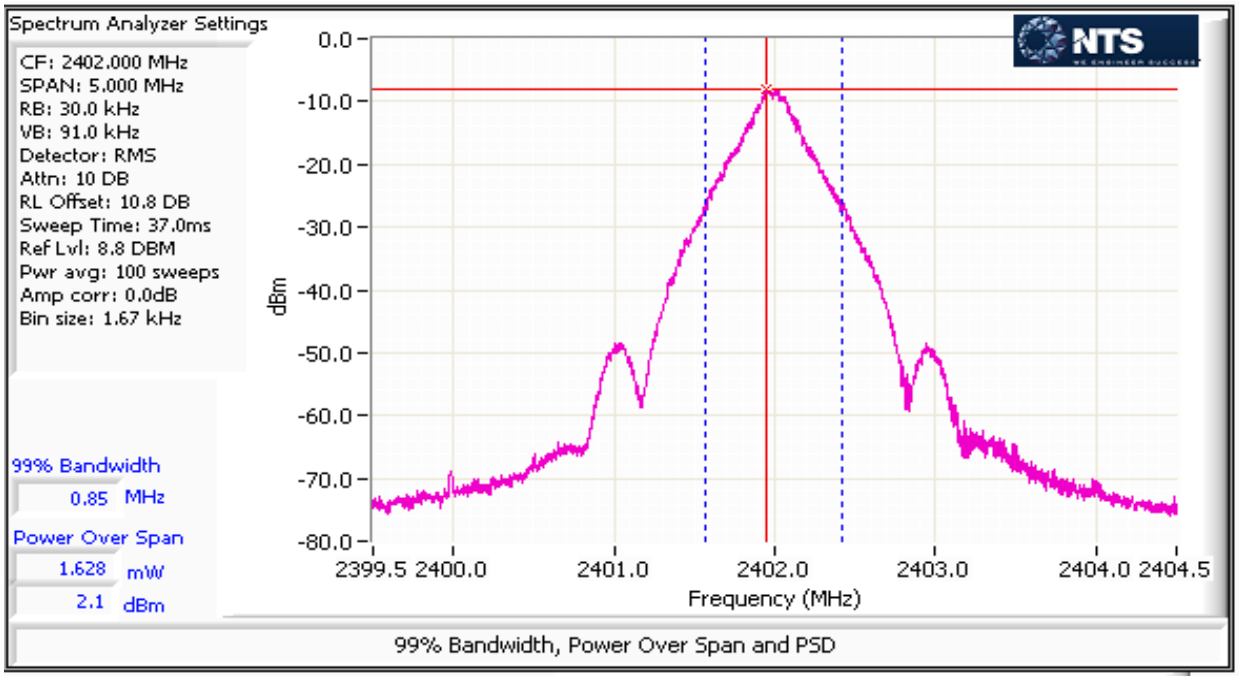
Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	Class:	N/A

Run #1: Output Power

Mode: BLE

Power Setting[2]	Frequency (MHz)	Output Power (dBm)[1]	Output Power mW	Antenna Gain (dBi)	Result	EIRP dBm	EIRP W	Output Power (dBm)[3]	Output Power mW
0	2402	2.3	1.7	3.0	Pass	5.3	0.0034	1.8	1.5
0	2440	2.1	1.6	3.0	Pass	5.1	0.0032	1.9	1.5
0	2480	2.0	1.6	3.0	Pass	5.0	0.0032	1.8	1.5

Note 1:	Duty Cycle < 98%, constant duty cycle. Output power measured using a spectrum analyzer (see plots below) with RBW= 1-5% of OBW, VB≥3* RBW, RMS detector, power averaging on, and power integration over the OBW, trace average 100 traces (option AVGSA-1, in KDB 558074). Measurement corrected by Pwr Cor Factor. 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.



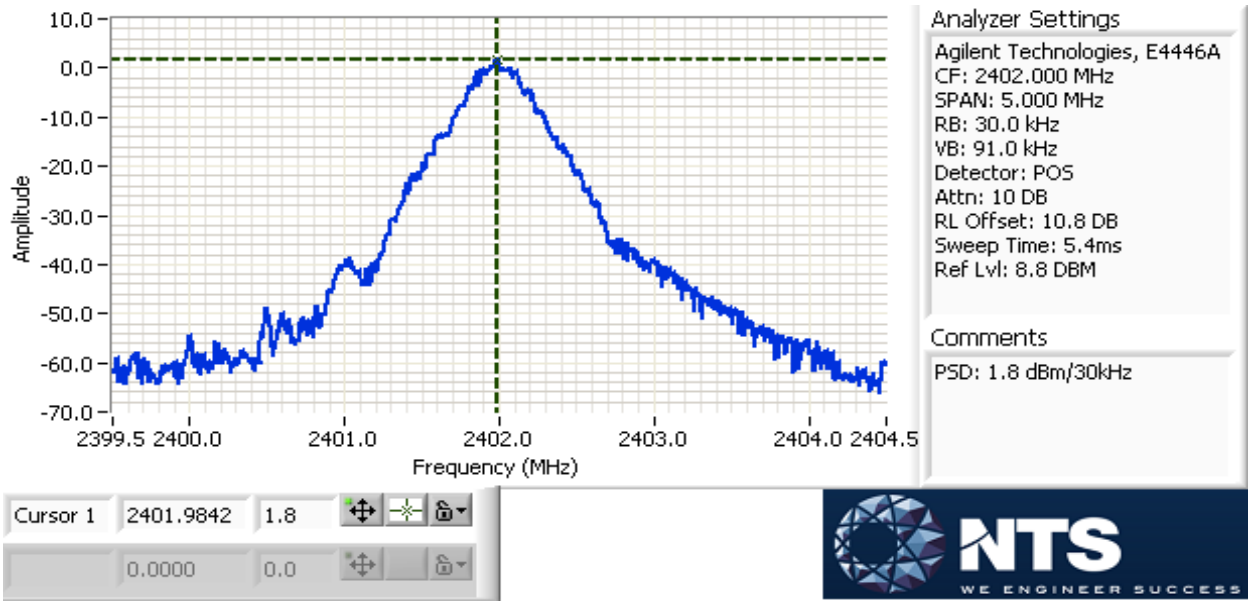
Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	Class:	N/A

Run #2: Power spectral Density

Mode: BLE

Power Setting	Frequency (MHz)	PSD (dBm/30kHz) Note 1	Limit dBm/3kHz	Result
0	2402	1.8	8.0	Pass
0	2440	1.7	8.0	Pass
0	2480	1.6	8.0	Pass

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



Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	Class:	N/A

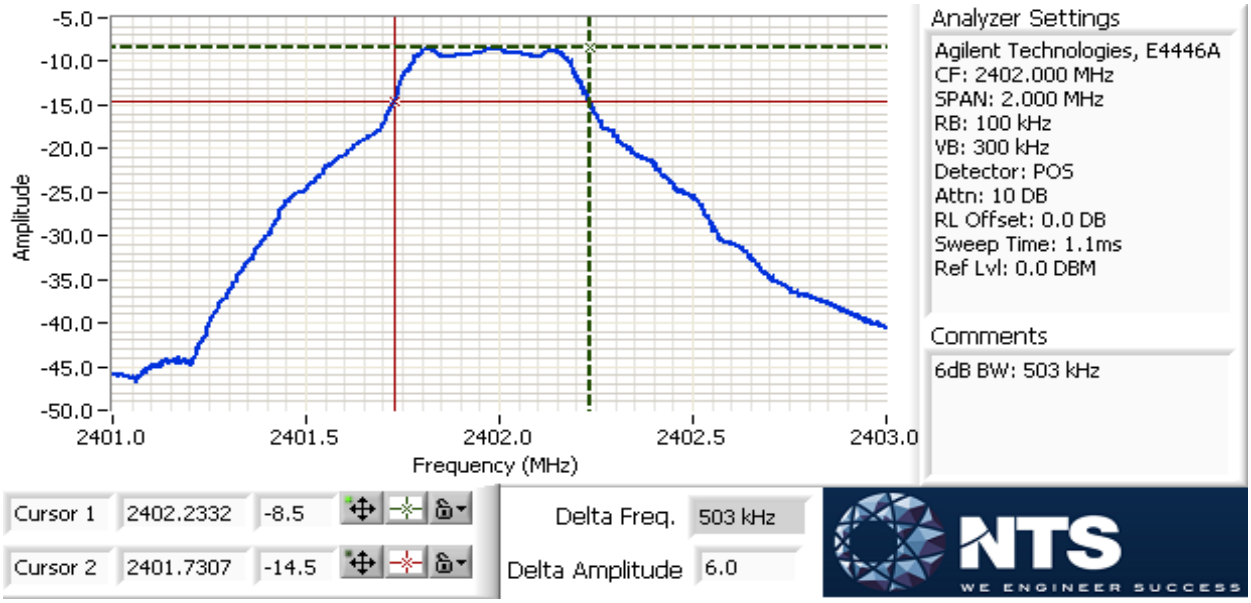
Run #3: Signal Bandwidth

Date of Test: 8/28/2015 Config. Used: 1
Test Engineer: Rafael Varelas Config Change: None
Test Location: FT Lab #4A EUT Voltage: 120V/60Hz

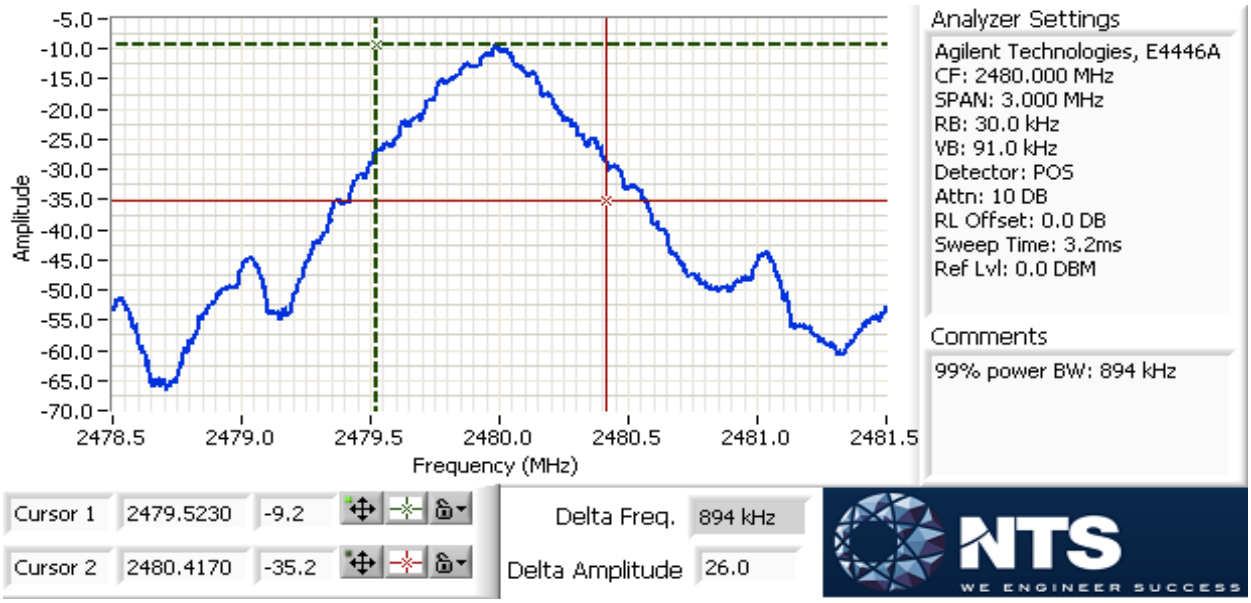
Mode: BLE

Power Setting	Frequency (MHz)	Bandwidth (MHz)		RBW Setting (MHz)	
		6dB	99%	6dB	99%
0	2402	0.503	0.885	0.1	0.03
0	2440	0.507	0.867	0.1	0.03
0	2480	0.513	0.894	0.1	0.03

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



Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	Class:	N/A

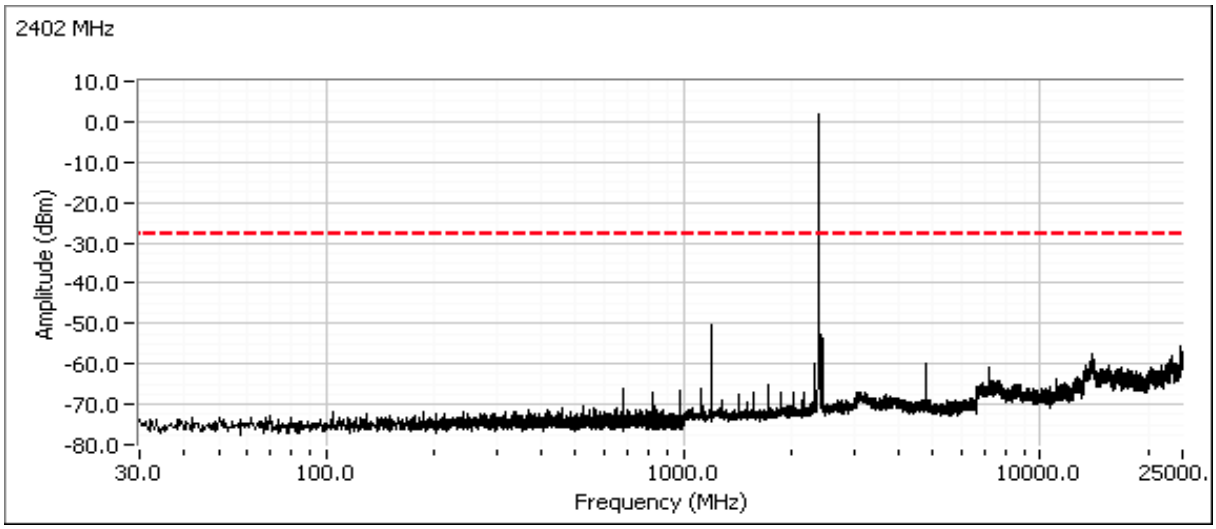


Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	Class:	N/A

Run #4a: Out of Band Spurious Emissions

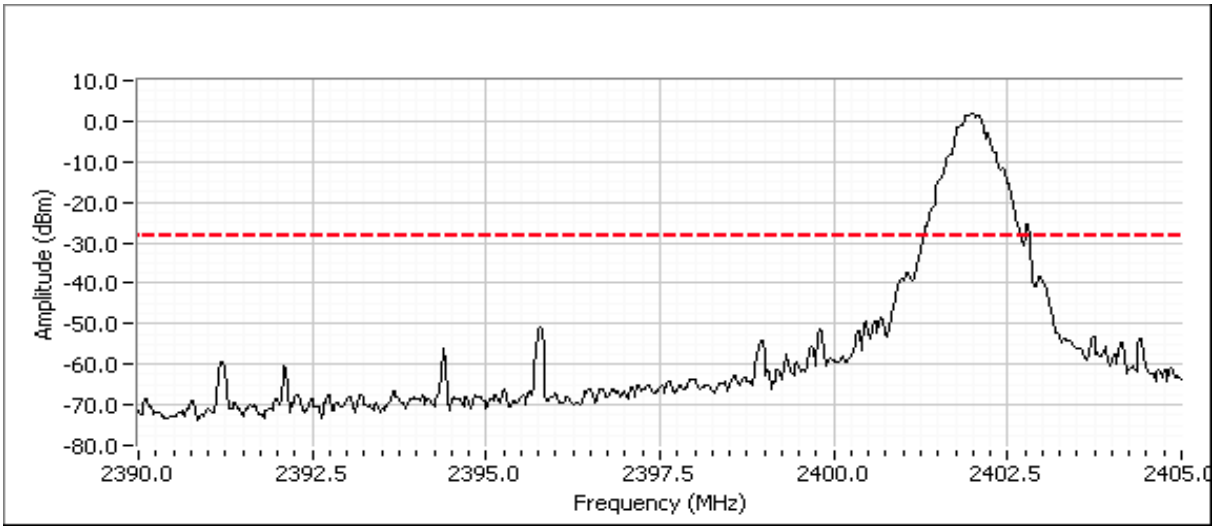
Frequency (MHz)	Power Setting	Mode	Limit	Result
2402	0	BLE	-30dBc	Pass
2440	0	BLE	-30dBc	Pass
2480	0	BLE	-30dBc	Pass

Plots for low channel

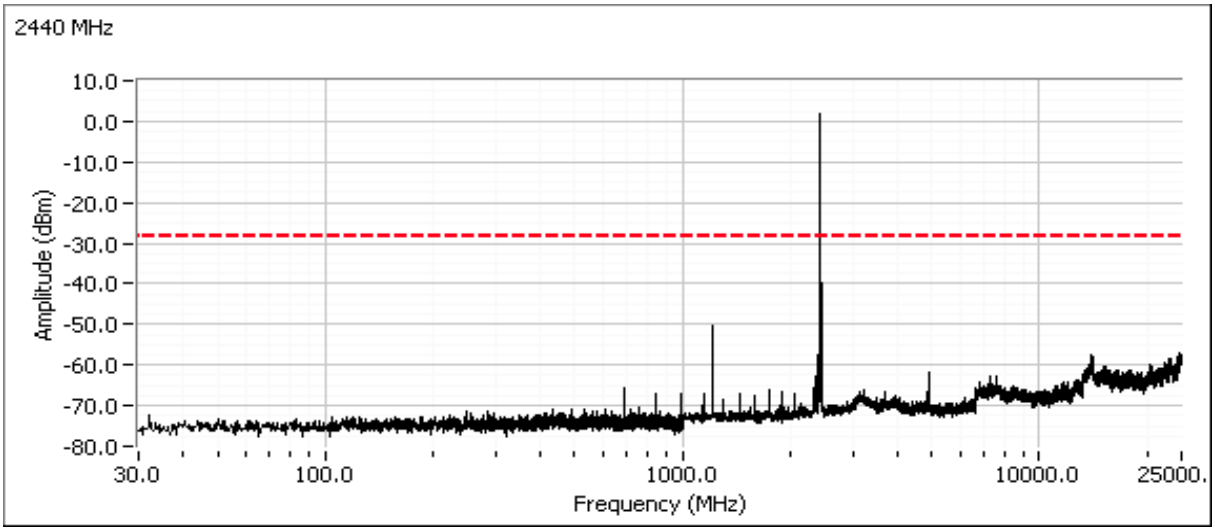


Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	Class:	N/A

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.

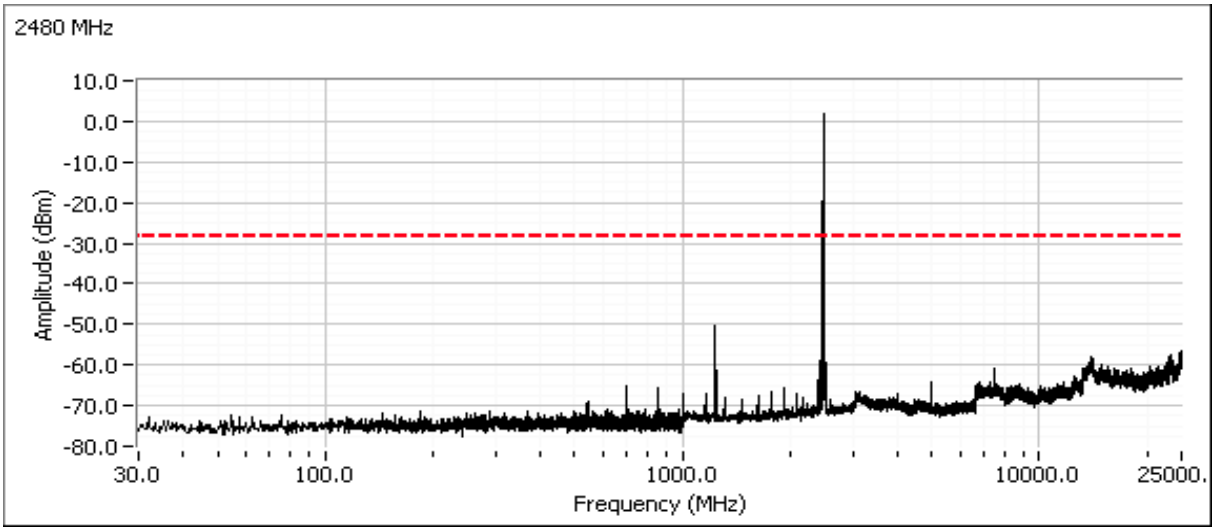


Plots for center channel



Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	Class:	N/A

Plots for high channel



Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	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: 8/27/2015
Test Engineer: Rafael Varelas
Test Location: FT Chamber #4

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

General Test Configuration

For tabletop equipment, the EUT and host system 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 where routed through metal conduit and when possible passed through a ferrite clamp upon exiting the chamber.

Ambient Conditions:

Temperature: 22.7 °C
Rel. Humidity: 39 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	CE, AC Power,120V/60Hz	FCC 15.207	Pass	33.7 dBµV @ 0.810 MHz(-12.3 dB)

Modifications Made During Testing

No modifications were made to the EUT during testing

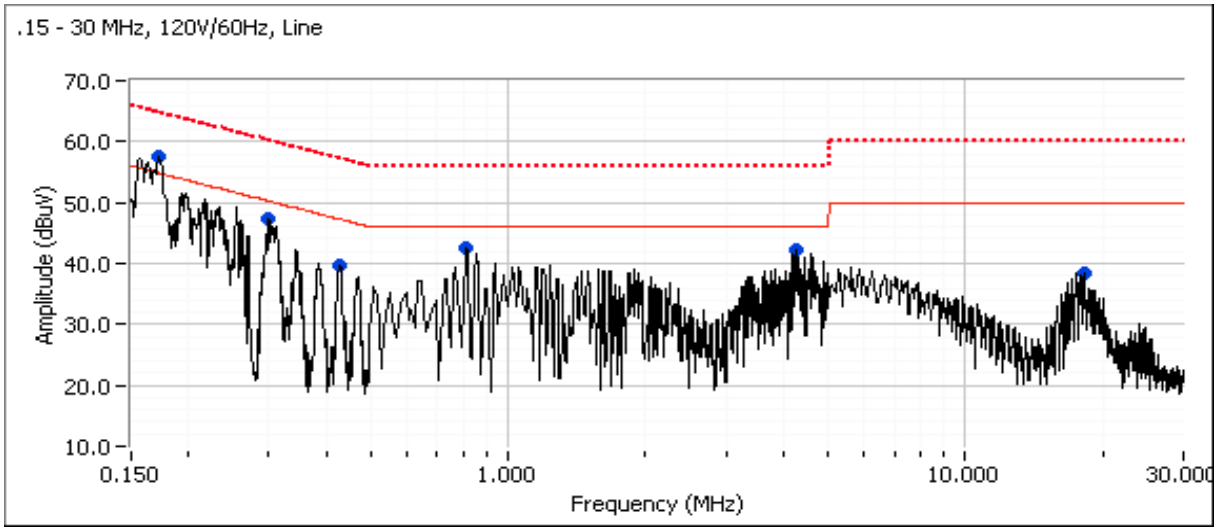
Deviations From The Standard

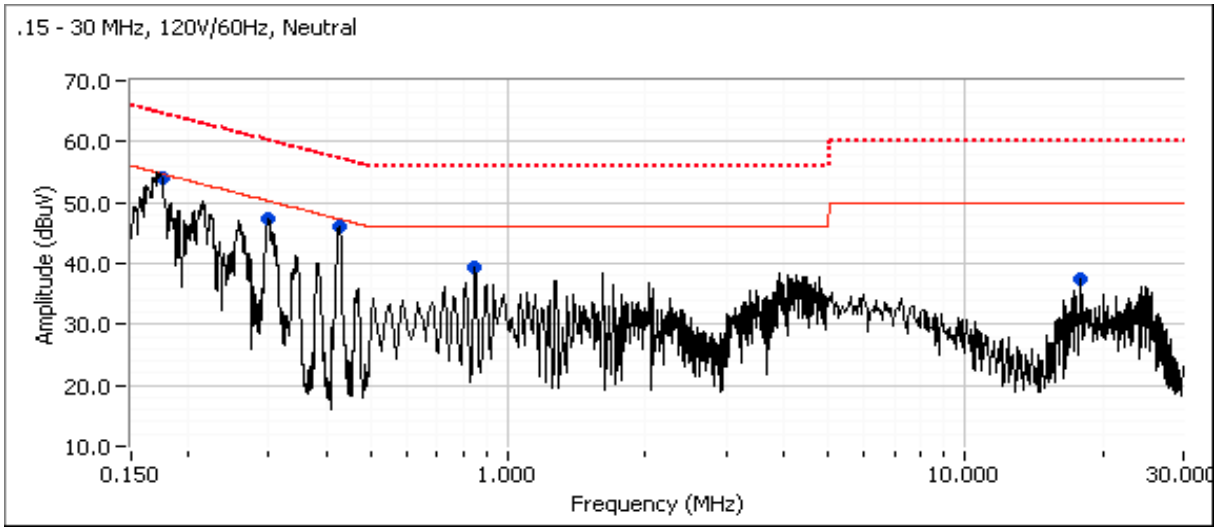
No deviations were made from the requirements of the standard.

Radio Operation: Continuous transmit at 2440MHz, maximum power

Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	Class:	B

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





Client:	Mark One	Job Number:	JD98999
Model:	Vessyl	T-Log Number:	T99138
		Project Manager:	Christine Krebill
Contact:	Jared Wolff	Project Coordinator:	-
Standard:	FCC 15.247/RSS-247/LP0002	Class:	B

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

Frequency	Level	AC	FCC 15.207		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
0.172	57.5	Line 1	54.8	2.7	Peak	
0.299	47.5	Line 1	50.2	-2.7	Peak	
0.428	39.8	Line 1	47.3	-7.5	Peak	
0.810	42.6	Line 1	46.0	-3.4	Peak	
4.262	42.3	Line 1	46.0	-3.7	Peak	
18.303	38.4	Line 1	50.0	-11.6	Peak	
0.174	54.0	Neutral	54.7	-0.7	Peak	
0.298	47.5	Neutral	50.3	-2.8	Peak	
0.425	46.1	Neutral	47.3	-1.2	Peak	
0.849	39.4	Neutral	46.0	-6.6	Peak	
17.780	37.3	Neutral	50.0	-12.7	Peak	

Final quasi-peak and average readings

Frequency	Level	AC	FCC 15.207		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
0.810	33.7	Line 1	46.0	-12.3	AVG	AVG (0.10s)
0.172	52.5	Line 1	64.9	-12.4	QP	QP (1.00s)
0.425	44.2	Neutral	57.3	-13.1	QP	QP (1.00s)
0.428	33.7	Line 1	47.3	-13.6	AVG	AVG (0.10s)
0.810	41.4	Line 1	56.0	-14.6	QP	QP (1.00s)
0.425	31.9	Neutral	47.3	-15.4	AVG	AVG (0.10s)
0.428	41.3	Line 1	57.3	-16.0	QP	QP (1.00s)
0.174	48.6	Neutral	64.8	-16.2	QP	QP (1.00s)
0.298	44.0	Neutral	60.3	-16.3	QP	QP (1.00s)
0.299	43.8	Line 1	60.3	-16.5	QP	QP (1.00s)
0.849	29.0	Neutral	46.0	-17.0	AVG	AVG (0.10s)
4.262	38.4	Line 1	56.0	-17.6	QP	QP (1.00s)
0.849	36.1	Neutral	56.0	-19.9	QP	QP (1.00s)
4.262	25.6	Line 1	46.0	-20.4	AVG	AVG (0.10s)
0.172	31.3	Line 1	54.9	-23.6	AVG	AVG (0.10s)
0.299	26.7	Line 1	50.3	-23.6	AVG	AVG (0.10s)
0.298	25.8	Neutral	50.3	-24.5	AVG	AVG (0.10s)
0.174	29.1	Neutral	54.8	-25.7	AVG	AVG (0.10s)
17.780	32.6	Neutral	60.0	-27.4	QP	QP (1.00s)
18.303	32.1	Line 1	60.0	-27.9	QP	QP (1.00s)
18.303	21.3	Line 1	50.0	-28.7	AVG	AVG (0.10s)
17.780	18.4	Neutral	50.0	-31.6	AVG	AVG (0.10s)

End of Report

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