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EMC Test Report

Application for FCC Grant of Equipment Authorization

FCC Part 15 Subpart C

Model: RW2 Patch

FCC ID:	X7901913
APPLICANT:	Proteus Digital Health, Inc. 2600 Bridge Parkway Redwood City, CA 94065
TEST SITE(S):	National Technical Systems - Silicon Valley 41039 Boyce Road. Fremont, CA. 94538-2435
IC SITE REGISTRATION #:	2845B-5
REPORT DATE:	May 24, 2016
RE-ISSUED DATE:	August 26, 2016
FINAL TEST DATES:	May 2, 9 and 10, 2016
TOTAL NUMBER OF PAGES:	46

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A2LA ACCREDITED
Testing Cert #0214.26

REVISION HISTORY

Rev#	Date	Comments	Modified By
-	May 24, 2016	First release	
1	August 26, 2016	Corrected note on page 6 about method of power measurement, removed note 3 on page 27 about average measurement, removed conducted emissions procedure from page 12, added note about orientation tested on pages 32 and 36.	

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SCOPE

An electromagnetic emissions test has been performed on the Proteus Digital Health, Inc. model RW2 Patch, pursuant to the following rules:

FCC Part 15 Subpart C

Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in the following reference standards and as outlined in National Technical Systems - Silicon Valley test procedures:

ANSI C63.10-2013
FCC DTS Measurement Guidance KDB558074

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

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

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

OBJECTIVE

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

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

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

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

STATEMENT OF COMPLIANCE

The tested samples of Proteus Digital Health, Inc. model RW2 Patch complied with the requirements of the following regulations:

FCC Part 15 Subpart C

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

The test results recorded herein are based on a single type test of Proteus Digital Health, Inc. model RW2 Patch and therefore apply only to the tested samples. The samples were selected and prepared by Robert Leichner of Proteus Digital Health, Inc.

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		Description	Measured Value / Comments	Limit / Requirement	Result
15.247(a)		Digital Modulation	Systems uses GFSK modulation	System must utilize a digital transmission technology	Complies
15.247 (a) (2)		6dB Bandwidth	698 kHz	>500kHz	Complies
15.247 (b) (3)		Output Power (multipoint systems)	-10.9 dBm (0.00008 Watts) EIRP = 0.00012 W Note 1	1Watt, EIRP limited to 4 Watts.	Complies
15.247(e)		Power Spectral Density	-15.8 dBm/10kHz	8dBm/3kHz	Complies
15.247(d)		Antenna Port Spurious Emissions 30MHz – 25 GHz	All emission < -20dBc	< -20dBc Note 2	Complies
15.247(d) / 15.209		Radiated Spurious Emissions 30MHz – 25 GHz	44.3 dBµV/m @ 7440.0 MHz (-9.7 dB)	Refer to the limits section (p18) for restricted bands, all others < -20dBc Note 2	Complies

Note 1: EIRP calculated using antenna gains of 1.72 dBi for the highest EIRP system.
Note 2: Limit of -20dBc used because the power was measured using a peak power meter

GENERAL REQUIREMENTS APPLICABLE TO ALL BANDS

FCC Rule Part		Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.203		RF Connector	Integral antenna	Unique or integral antenna required	Complies
15.407 (b) (6)		AC Conducted Emissions	N/A - Battery powered only		
15.247 (i) 15.407 (f)		RF Exposure Requirements	Refer to calculations in separate exhibit, User Manual statements.	Refer to OET 65 and FCC Part 1	Complies

MEASUREMENT UNCERTAINTIES

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

Measurement Type	Measurement Unit	Frequency Range	Expanded Uncertainty
RF power, conducted (power meter)	dBm	25 to 7000 MHz	± 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
Radiated emission (field strength)	dBµV/m	25 to 1000 MHz	± 3.6 dB
		1000 to 40000 MHz	± 6.0 dB

EQUIPMENT UNDER TEST (EUT) DETAILS

GENERAL

The Proteus Digital Health, Inc. model RW2 Patch is a battery powered, body worn sensor patch that measures and records physiological parameters. It contains a Bluetooth low energy radio that transmits this data to any Bluetooth enabled device. The EUT was treated as tabletop equipment during testing to most closely simulate the end-user environment. The electrical rating of the EUT is 3 VDC, 20 mA.

The samples were received on April 28, 2016 and tested on May 2, 9 and 10, 2016. The following samples were tested:

Company	Model	Description	Serial Number	FCC ID
Proteus Digital Health	RW2 patch	Body worn sensor	31	X7901913
Proteus Digital Health	RW2 patch	Body worn sensor	762	X7901913
Proteus Digital Health	RW2 patch	Body worn sensor	1004	X7901913

OTHER EUT DETAILS

The following EUT details should be noted: the internal battery is not rechargeable. When depleted, the entire adhesive patch is thrown away. The RW2 patch is composed of the RW2 Pod p/n SPC-1913 and RW2 Strip p/n SPC-2005.

ANTENNA SYSTEM

The antenna system consists of integral 1.72 dBi antenna.

ENCLOSURE

The EUT enclosure is primarily constructed of plastic. It measures approximately 5.3 cm wide by 11 cm deep by .7 cm high.

MODIFICATIONS

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

SUPPORT EQUIPMENT

The following equipment was used as support equipment for testing:

Configuration #1

Company	Model	Description	Serial Number	FCC ID
Xantrex	XTS 7-6X	Linear DC power supply	65925	-
Dell	Latitude E6500	Laptop	B76FVL1	DoC

Configuration #2

Company	Model	Description	Serial Number	FCC ID
Xantrex	XTS 7-6X	Linear DC power supply	65925	-

No remote support equipment was used during testing.

EUT INTERFACE PORTS

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

Configuration #1

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
DC power	DC supply	2 wire	Unshielded	1
Control	Serial-USB adaptor	Multiwire	Shielded	2

Configuration #1 (Additional on Support Equipment)

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
USB (laptop)	Serial-USB adaptor	Direct plug-in	NA	NA

Configuration #2

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
DC power	DC supply	2 wire	Unshielded	1

EUT OPERATION

During emissions testing the EUT was transmitting a PRBS9 signal using a 37 byte packet, at the default power, on the channel called out in the individual test.

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

FILTERS/ATTENUATORS

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

ANTENNAS

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

ANTENNA MAST AND EQUIPMENT TURNTABLE

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

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

INSTRUMENT CALIBRATION

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

TEST PROCEDURES

EUT AND CABLE PLACEMENT

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

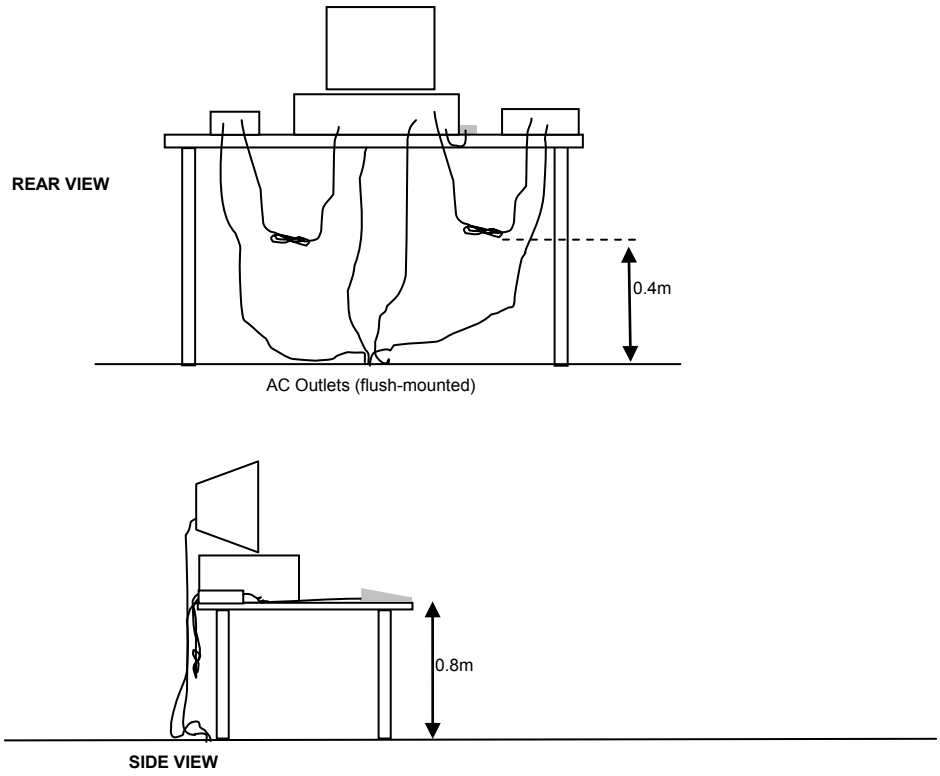
RADIATED EMISSIONS

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.

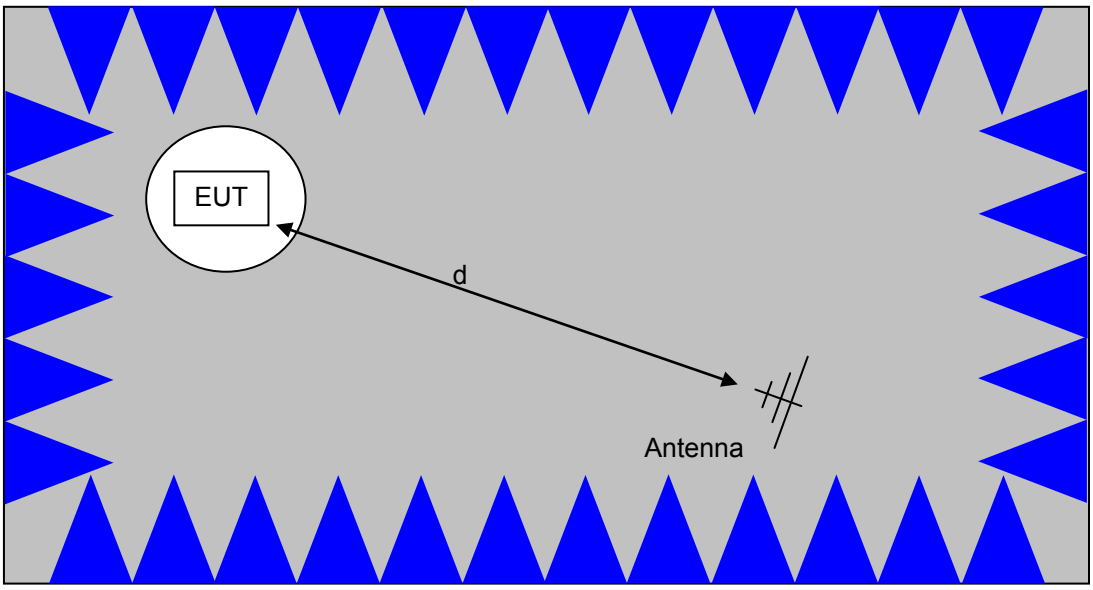
A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

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.

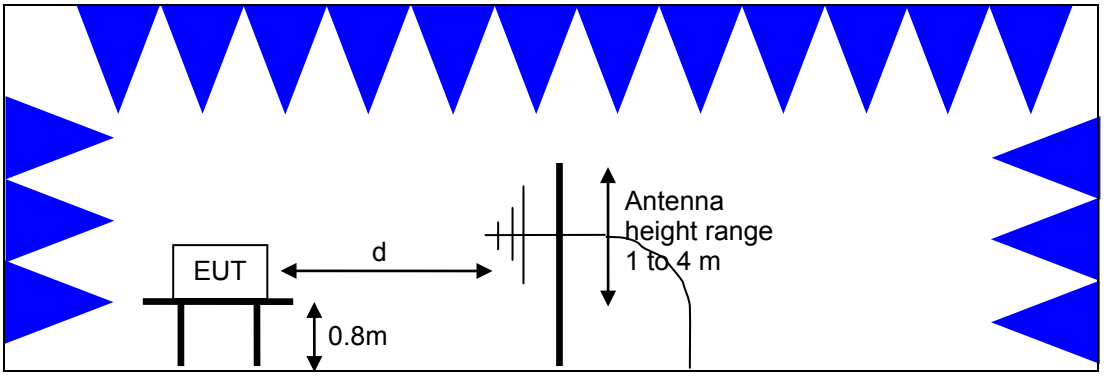


Typical Test Configuration for Radiated Field Strength Measurements



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.

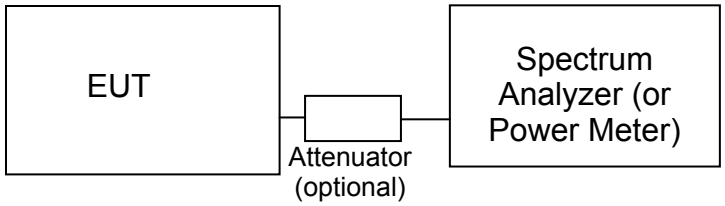
Floor-standing equipment is placed on the floor with insulating supports between the unit and the ground plane.



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

RECEIVER RADIATED SPURIOUS EMISSIONS SPECIFICATION LIMITS

The table below shows the limits for the spurious emissions from receivers as detailed in FCC Part 15.109 and RSS GEN Table 2. Note that receivers operating outside of the frequency range 30 MHz – 960 MHz are exempt from the requirements of 15.109 and receivers that are not stand-alone are exempt from the ISED Canada requirements per RSS-GEN.

Frequency Range (MHz)	Limit (uV/m @ 3m)	Limit (dBuV/m @ 3m)
30 to 88	100	40
88 to 216	150	43.5
216 to 960	200	46.0
Above 960	500	54.0

[1] 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-GEN. 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 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, 02-May-16

Manufacturer	Description	Model	Asset #	Calibrated	Cal Due
NTS	NTS EMI Software (rev 2.10)	N/A	0		N/A
NTS	NTS Capture Analyzer Software (rev 3.8)	N/A	0		N/A
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	870	1/21/2016	1/21/2017
Hewlett Packard	Spectrum Analyzer (SA40) Red 30 Hz -40 GHz	8564E (84125C)	1148	10/17/2015	10/17/2016
Micro-Tronics	Band Reject Filter, 2400-2500 MHz	BRM50702-02	1683	7/13/2015	7/13/2016
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1756	6/20/2015	6/20/2016
EMCO	Antenna, Horn, 1-18 GHz	3115	2733	11/18/2014	11/18/2016

Radio Antenna Port (Power and Spurious Emissions), 09-May-16

Manufacturer	Description	Model	Asset #	Calibrated	Cal Due
Rohde & Schwarz	Power Meter, Dual Channel	NRVD	1539	9/24/2015	9/24/2016
Agilent Technologies	PSA, Spectrum Analyzer, (installed options, 111, 115, 123, 1DS, B7J, HYX,	E4446A	2139	6/22/2015	6/22/2016
Rohde & Schwarz	Peak Power Sensor 100 uW - 2 Watts use with 20dB attenuator sn:1031.6959.00 only	NRV-Z32	3225	9/24/2015	9/24/2016

Appendix B Test Data

T101589 Pages 24 – 45

Client:	Proteus Digital Health	Job Number:	JD100869
Product	RW2 Patch	T-Log Number:	T101589
System Configuration:		Project Manager:	Deepa Shetty
Contact:	Robert Leichner	Project Coordinator:	
Emissions Standard(s):	FCC 15.247, RSS 247, EN 300 328	Class:	
Immunity Standard(s):	NA	Environment:	

EMC Test Data

For The

Proteus Digital Health

Product

RW2 Patch

Date of Last Test: 5/9/2016

Client:	Proteus Digital Health	Job Number:	JD100869
Model:	RW2 Patch	T-Log Number:	T101589
		Project Manager:	Deepa Shetty
Contact:	Robert Leichner	Project Coordinator:	-
Standard:	FCC 15.247, RSS 247, EN 300 328	Class:	N/A

Duty Cycle

Date of Test: 5/2/2016
Test Engineer: John Caizzi
Test Location: Chamber 5

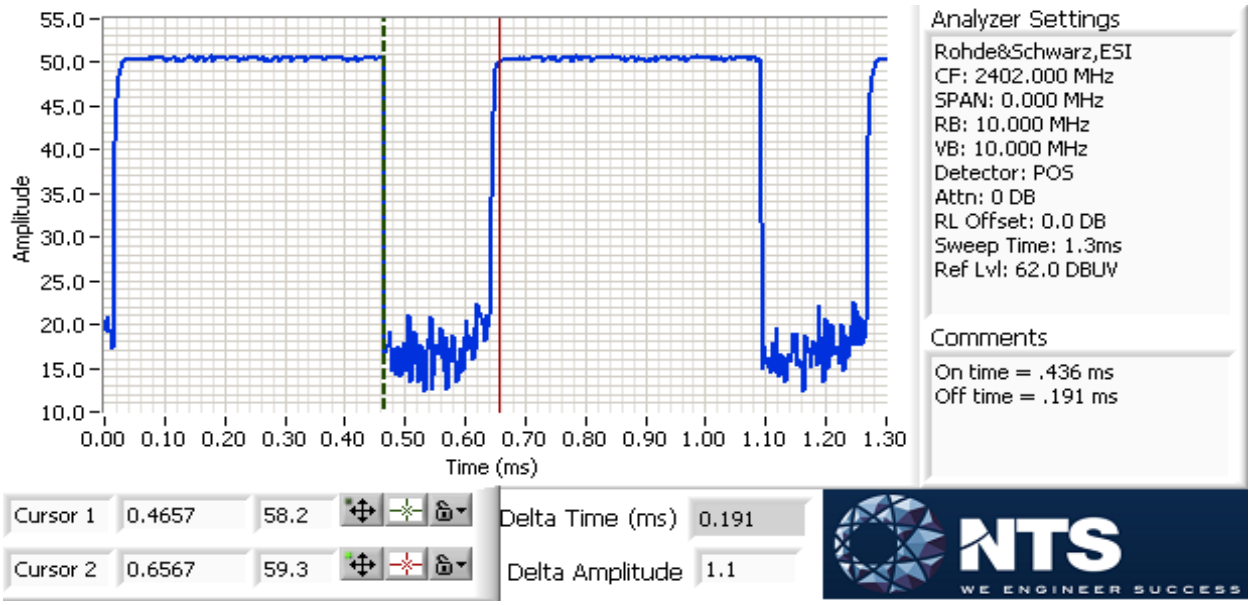
Sample Notes

Sample S/N: 762

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	1 Mbps	0.70	Yes	0.436	1.5778105	3.155621	2294

* 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:	Proteus Digital Health	Job Number:	JD100869
Model:	RW2 Patch	T-Log Number:	T101589
		Project Manager:	Deepa Shetty
Contact:	Robert Leichner	Project Coordinator:	-
Standard:	FCC 15.247, RSS 247, EN 300 328	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: 5/9/2016
Test Engineer: Mehran Birgani
Test Location: Fremont EMC Lab #4B

Config. Used: 1 (conducted)
Config Change: -
Host Unit Voltage 120V/60Hz

General Test Configuration

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

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

Ambient Conditions:

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

Summary of Results

Run #	Pwr setting		Test Performed	Limit	Pass / Fail	Result / Margin
1	Max		Output Power	15.247(b)	Pass	-10.9 dBm
2	Max		Power spectral Density (PSD)	15.247(d)	Pass	-15.8 dBm/10kHz
3	Max		Minimum 6dB Bandwidth	15.247(a)	Pass	0.698 MHz
3	Max		99% Bandwidth	RSS GEN	-	1.04 MHz
4	Max		Spurious emissions	15.247(b)	Pass	All emission < -20dBc

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:	Proteus Digital Health	Job Number:	JD100869
Model:	RW2 Patch	T-Log Number:	T101589
		Project Manager:	Deepa Shetty
Contact:	Robert Leichner	Project Coordinator:	-
Standard:	FCC 15.247, RSS 247, EN 300 328	Class:	N/A

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 Mbps	69.5%	Yes	0.436	1.58	3.16	2294

Sample Notes

Sample S/N: 1004

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)	Output Power mW
Max	2402	-10.9	0.08	1.72	Pass	-9.2	0.00012		
Max	2440	-11.4	0.07	1.72	Pass	-9.7	0.00011		
Max	2480	-12.4	0.06	1.72	Pass	-10.7	0.00009		

Note 1:	Output power measured using a peak power meter, spurious limit is -20dBc.
Note 2:	Power setting - the software power setting used during testing, included for reference only.

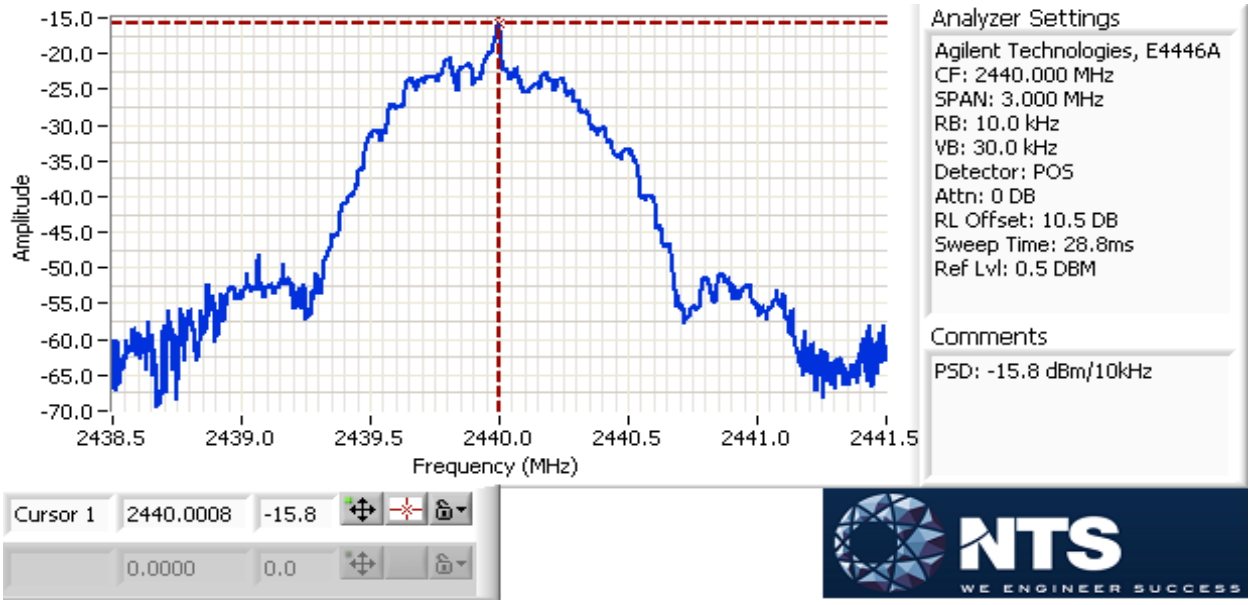
Run #2: Power spectral Density

Mode: BLE

Power Setting	Frequency (MHz)	PSD (dBm/10kHz) Note 1	Limit dBm/3kHz	Result
Max	2402	-16.2	8.0	Pass
Max	2440	-15.8	8.0	Pass
Max	2480	-16.0	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:	Proteus Digital Health	Job Number:	JD100869
Model:	RW2 Patch	T-Log Number:	T101589
		Project Manager:	Deepa Shetty
Contact:	Robert Leichner	Project Coordinator:	-
Standard:	FCC 15.247, RSS 247, EN 300 328	Class:	N/A



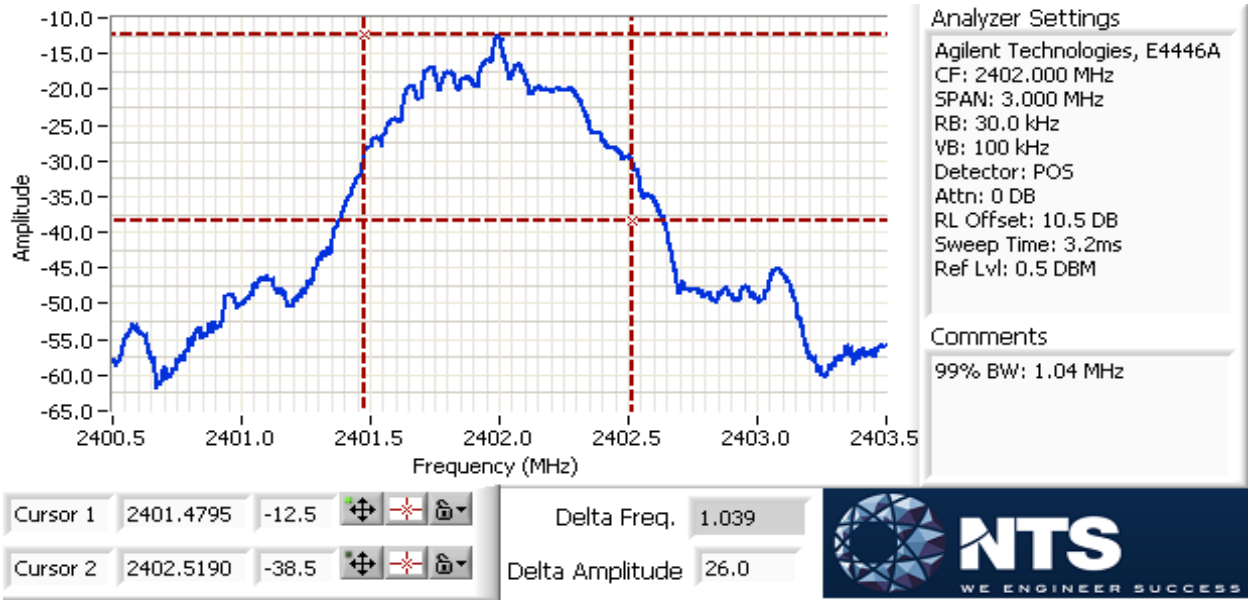
Run #3: Signal Bandwidth

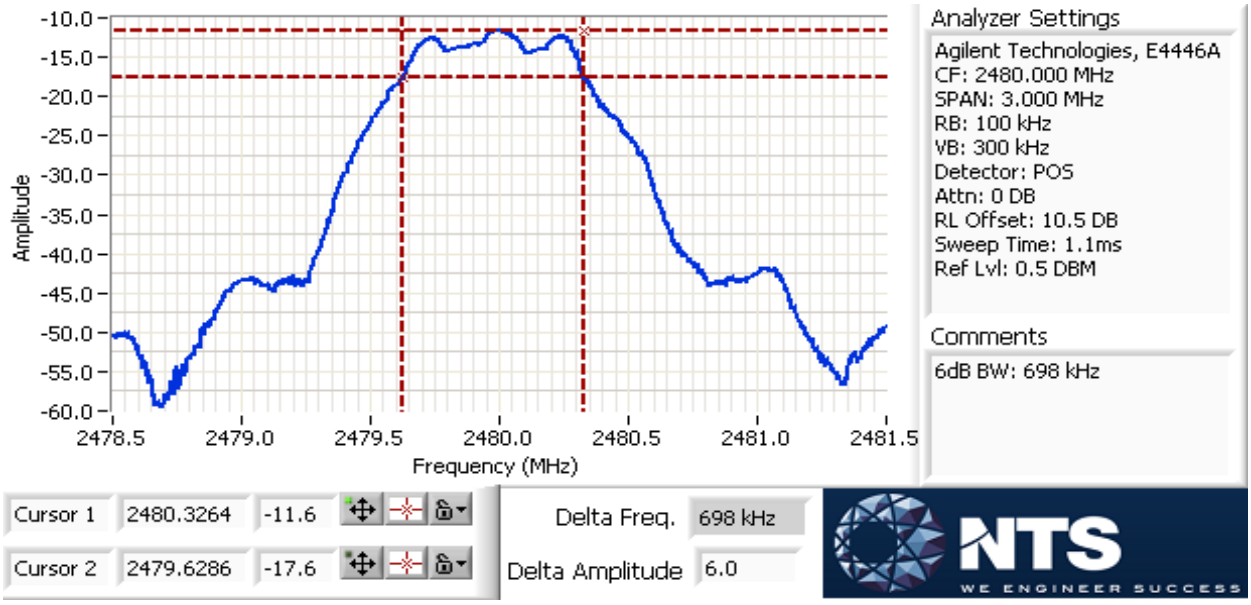
Mode: BLE

Power Setting	Frequency (MHz)	Bandwidth (MHz)		RBW Setting (kHz)	
		6dB	99%	6dB	99%
Max	2402	0.70	1.04	100	30
Max	2440	0.70	1.03	100	30
Max	2480	0.70	1.03	100	30

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:	Proteus Digital Health	Job Number:	JD100869
Model:	RW2 Patch	T-Log Number:	T101589
		Project Manager:	Deepa Shetty
Contact:	Robert Leichner	Project Coordinator:	-
Standard:	FCC 15.247, RSS 247, EN 300 328	Class:	N/A





Client:	Proteus Digital Health	Job Number:	JD100869
Model:	RW2 Patch	T-Log Number:	T101589
		Project Manager:	Deepa Shetty
Contact:	Robert Leichner	Project Coordinator:	-
Standard:	FCC 15.247, RSS 247, EN 300 328	Class:	N/A

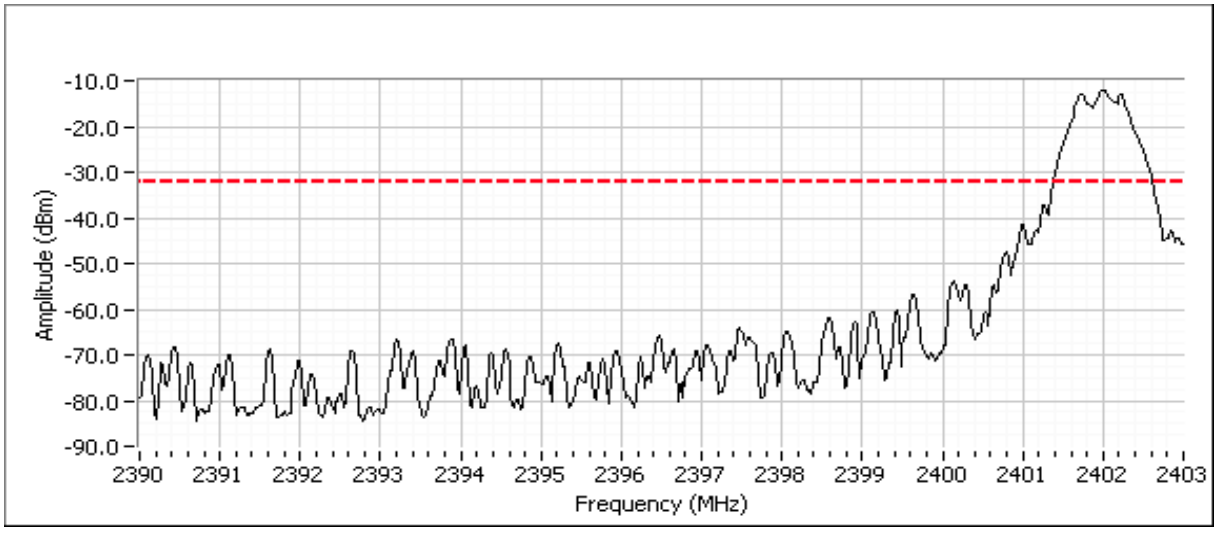
Run #4a: Out of Band Spurious Emissions

Frequency (MHz)	Power Setting	Mode	Limit	Result
2402	Max	BLE	-20dBc	Pass

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

Plot for low channel

Plot showing compliance with -20dBc limit from 2390 MHz to 2400 MHz. Radiated measurements are used to show compliance with the 15.209 limits for all other spurious emisisons per FCC KDB 558074.



Client:	Proteus Digital Health	Job Number:	JD100869
Model:	RW2 Patch	T-Log Number:	T101589
		Project Manager:	Deepa Shetty
Contact:	Robert Leichner	Project Coordinator:	-
Standard:	FCC 15.247, RSS 247, EN 300 328	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: 24 °C
Rel. Humidity: 33 %

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

Run #	Mode	Channel		Power Setting	Test Performed	Limit	Result / Margin
1	BLE	0 - 2402MHz		Max	Restricted Band Edge (2390 MHz)	FCC Part 15.209 / 15.247(c)	60.7 dBµV/m @ 2388.0 MHz (-13.3 dB)
		39 - 2480MHz			Restricted Band Edge (2483.5 MHz)		38.2 dBµV/m @ 2483.5 MHz (-15.8 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: 762
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 ≥ 98% and was measured using RBW=1MHz, VBW=10Hz, peak detector, linear average mode, auto sweep time, max hold.

Client:	Proteus Digital Health	Job Number:	JD100869
Model:	RW2 Patch	T-Log Number:	T101589
		Project Manager:	Deepa Shetty
Contact:	Robert Leichner	Project Coordinator:	-
Standard:	FCC 15.247, RSS 247, EN 300 328	Class:	N/A

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	0.70	Yes	0.436	1.5778105	3.155621	2294

Measurement Specific Notes:

Note 3:	Flat orientation used for tests based on prelimary test results.
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 8:	Plots of the average and peak bandedge do not account for any duty cycle correction. Refer to the tabular results for final measurements.

Client:	Proteus Digital Health	Job Number:	JD100869
Model:	RW2 Patch	T-Log Number:	T101589
		Project Manager:	Deepa Shetty
Contact:	Robert Leichner	Project Coordinator:	-
Standard:	FCC 15.247, RSS 247, EN 300 328	Class:	N/A

Run #1: Radiated Bandedge Measurements
Orientation: Flat

Date of Test: 5/2/2016 0:00
Test Engineer: John Caizzi
Test Location: Chamber 5

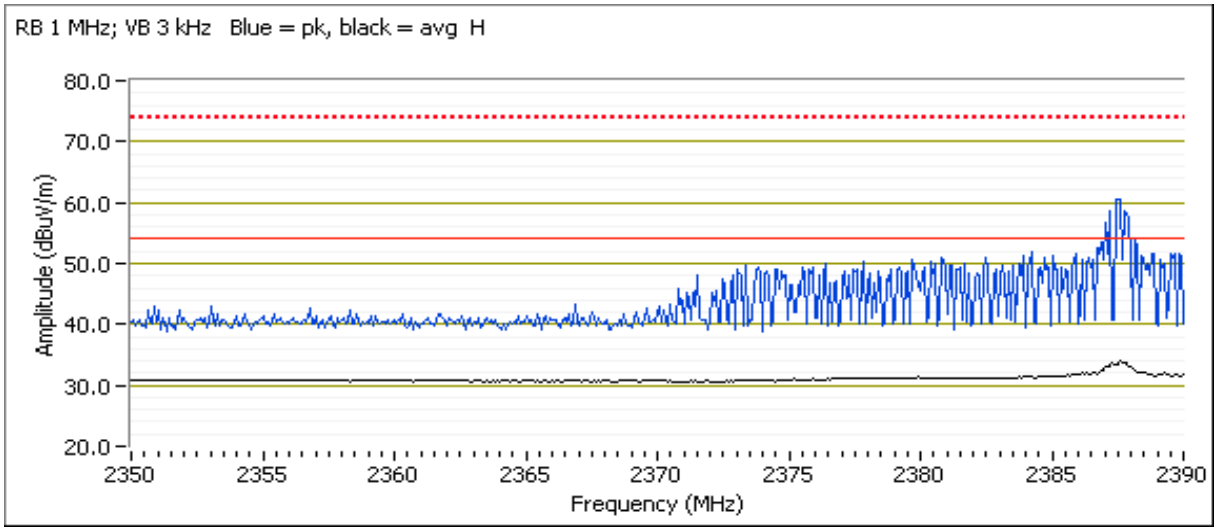
Config. Used: 2
Config Change: none
EUT Voltage: 3 VDC

Channel: 0
Tx Chain: NA

Mode: BLE
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	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2387.760	37.3	H	54.0	-16.7	Avg	235	1.81	Vavg:100; VB: 3 kHz, Note 4
2388.000	60.7	H	74.0	-13.3	PK	235	1.81	
2387.190	34.2	V	54.0	-19.8	Avg	360	2.51	Vavg:100; VB: 3 kHz, Note 4
2382.710	44.6	V	74.0	-29.4	PK	360	2.51	

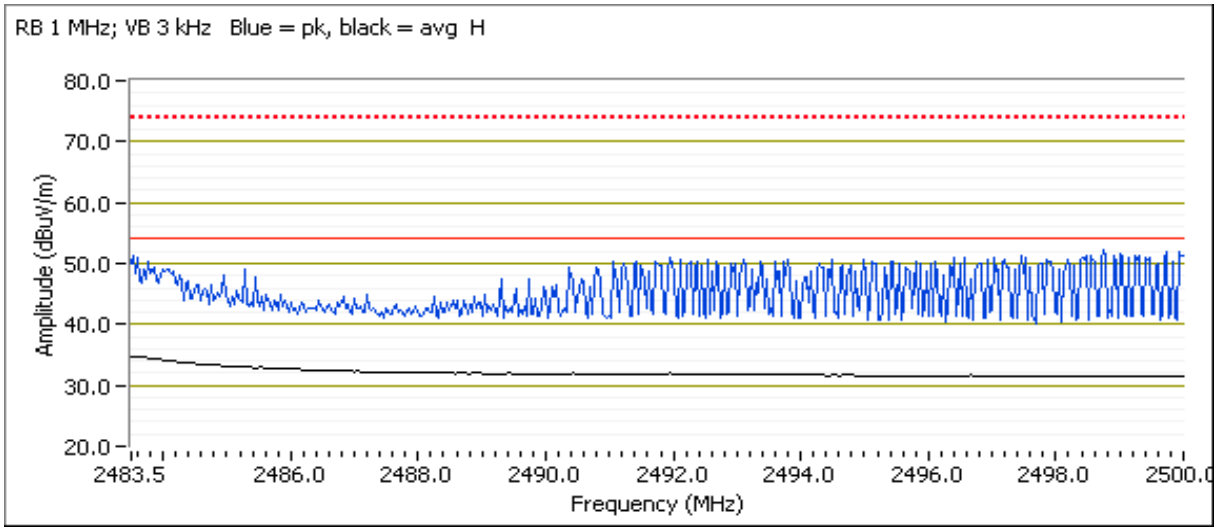


Client:	Proteus Digital Health	Job Number:	JD100869
Model:	RW2 Patch	T-Log Number:	T101589
		Project Manager:	Deepa Shetty
Contact:	Robert Leichner	Project Coordinator:	-
Standard:	FCC 15.247, RSS 247, EN 300 328	Class:	N/A

Channel: 39 Mode: BLE
Tx Chain: NA 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	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2483.530	35.0	V	54.0	-19.0	Avg	359	1.00	Vavg:100; VB: 3 kHz, Note 4
2496.260	43.8	V	74.0	-30.2	PK	359	1.00	
2483.500	38.2	H	54.0	-15.8	Avg	10	1.87	Vavg:100; VB: 3 kHz, Note 4
2499.470	51.9	H	74.0	-22.1	PK	10	1.87	



Client:	Proteus Digital Health	Job Number:	JD100869
Model:	RW2 Patch	T-Log Number:	T101589
		Project Manager:	Deepa Shetty
Contact:	Robert Leichner	Project Coordinator:	-
Standard:	FCC 15.247, RSS 247, EN 300 328	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: 31 %

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

Run #	Mode	Channel		Power Setting	Test Performed	Limit	Result / Margin
1	BLE	0 - 2402MHz		Max	Radiated Emissions, 1 - 25 GHz	FCC Part 15.209 / 15.247(c)	43.8 dBµV/m @ 11266.4 MHz (-10.2 dB)
		19 - 2440MHz					44.2 dBµV/m @ 11905.7 MHz (-9.8 dB)
		39 - 2480MHz					44.3 dBµV/m @ 7440.0 MHz (-9.7 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: 762
Antenna: internal

Client:	Proteus Digital Health	Job Number:	JD100869
Model:	RW2 Patch	T-Log Number:	T101589
		Project Manager:	Deepa Shetty
Contact:	Robert Leichner	Project Coordinator:	-
Standard:	FCC 15.247, RSS 247, EN 300 328	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	0.70	Yes	0.436	1.5778105	3.155621	2294

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:	Flat orientation used for tests based on prelimary test results.
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:	Proteus Digital Health	Job Number:	JD100869
Model:	RW2 Patch	T-Log Number:	T101589
		Project Manager:	Deepa Shetty
Contact:	Robert Leichner	Project Coordinator:	-
Standard:	FCC 15.247, RSS 247, EN 300 328	Class:	N/A

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

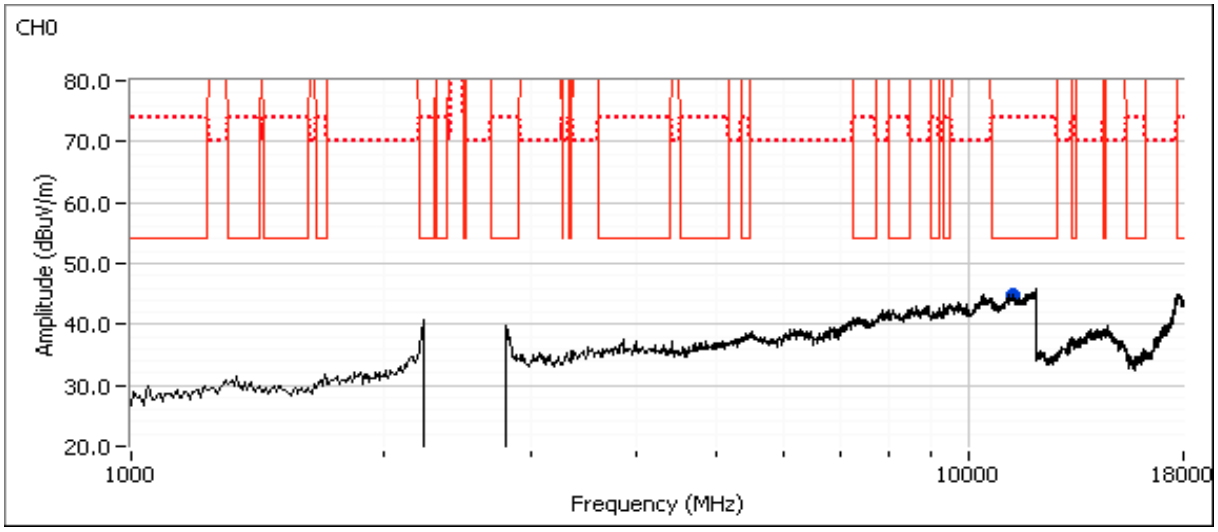
Date of Test: 5/2/2016 0:00
Test Engineer: John Caizzi
Test Location: Chamber 5

Config. Used: 2
Config Change: none
EUT Voltage: 3.0 VDC

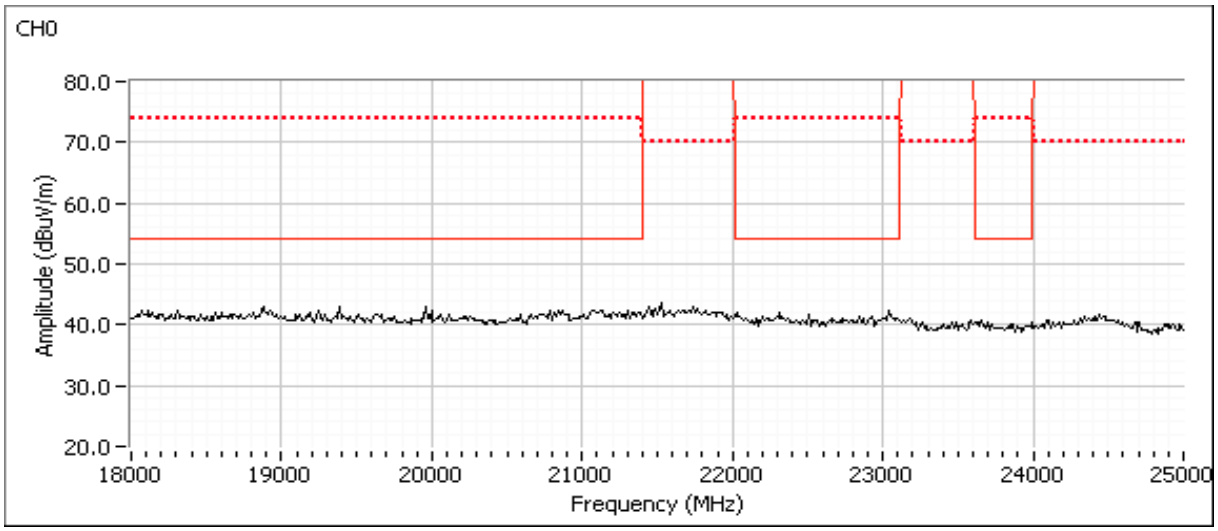
Run #1a: Low Channel
Orientation: Flat
Channel: 0
Tx Chain: NA

Mode: BLE
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	
11266.400	43.8	V	54.0	-10.2	Avg	360	1.50	VB 3 kHz, VAVG 100, Note 4
11265.050	52.6	V	74.0	-21.4	PK	360	1.50	



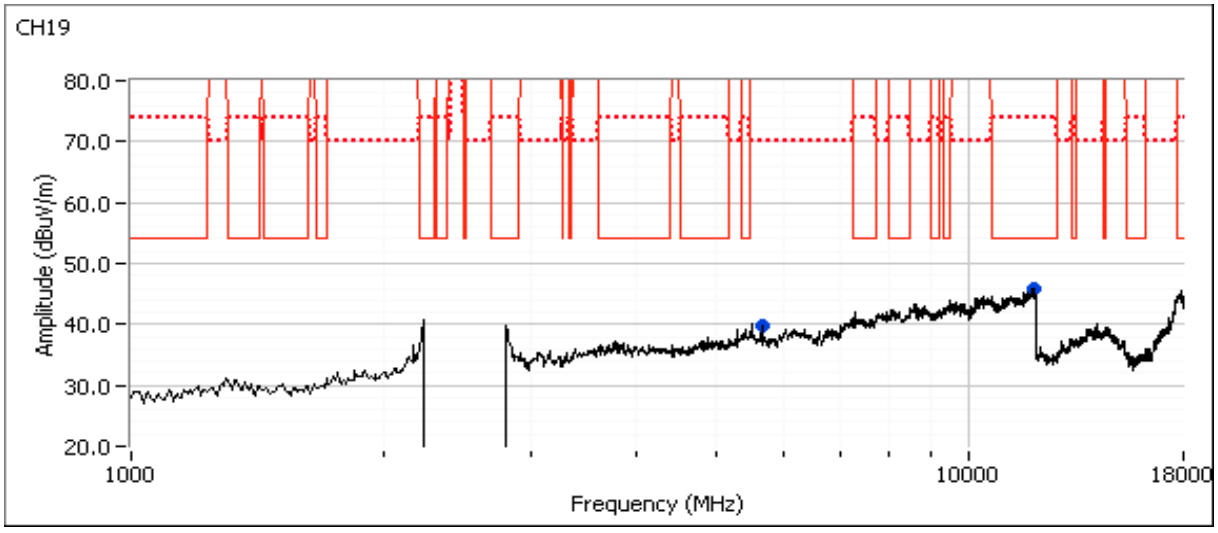
Client:	Proteus Digital Health	Job Number:	JD100869
Model:	RW2 Patch	T-Log Number:	T101589
		Project Manager:	Deepa Shetty
Contact:	Robert Leichner	Project Coordinator:	-
Standard:	FCC 15.247, RSS 247, EN 300 328	Class:	N/A



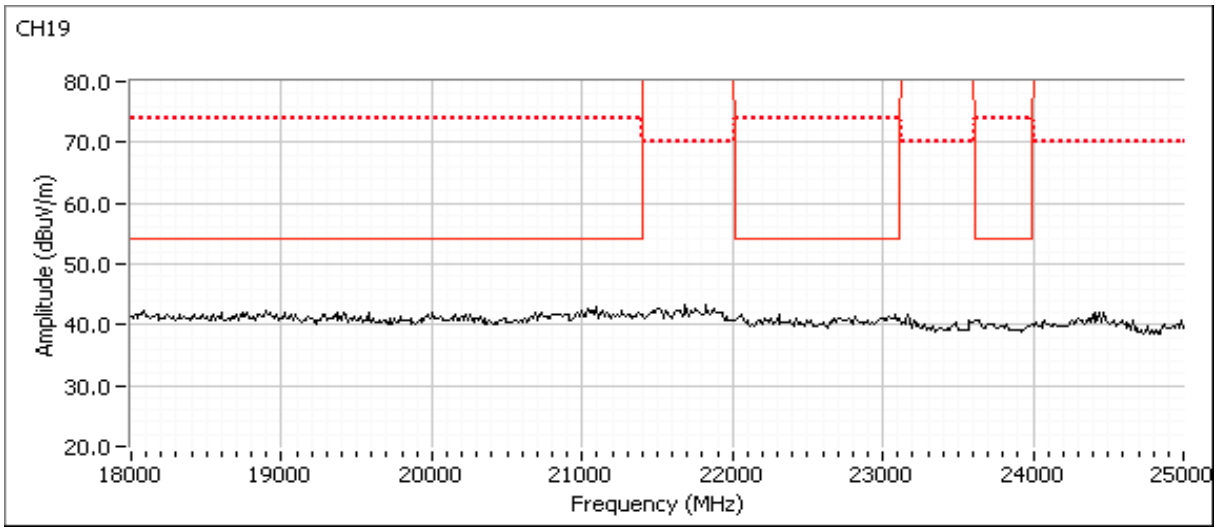
Client:	Proteus Digital Health	Job Number:	JD100869
Model:	RW2 Patch	T-Log Number:	T101589
		Project Manager:	Deepa Shetty
Contact:	Robert Leichner	Project Coordinator:	-
Standard:	FCC 15.247, RSS 247, EN 300 328	Class:	N/A

Run #1b: Center Channel
Orientation: Flat
Channel: 19 Mode: BLE
Tx Chain: NA 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	
11905.650	44.2	V	54.0	-9.8	Avg	0	1.99	VB 3 kHz, VAVG 100, Note 4
11906.080	52.8	V	74.0	-21.2	PK	0	1.99	
5650.000	39.7	H	54.0	-14.3	Peak	132	1.0	Note 1, peak compared to avg limit



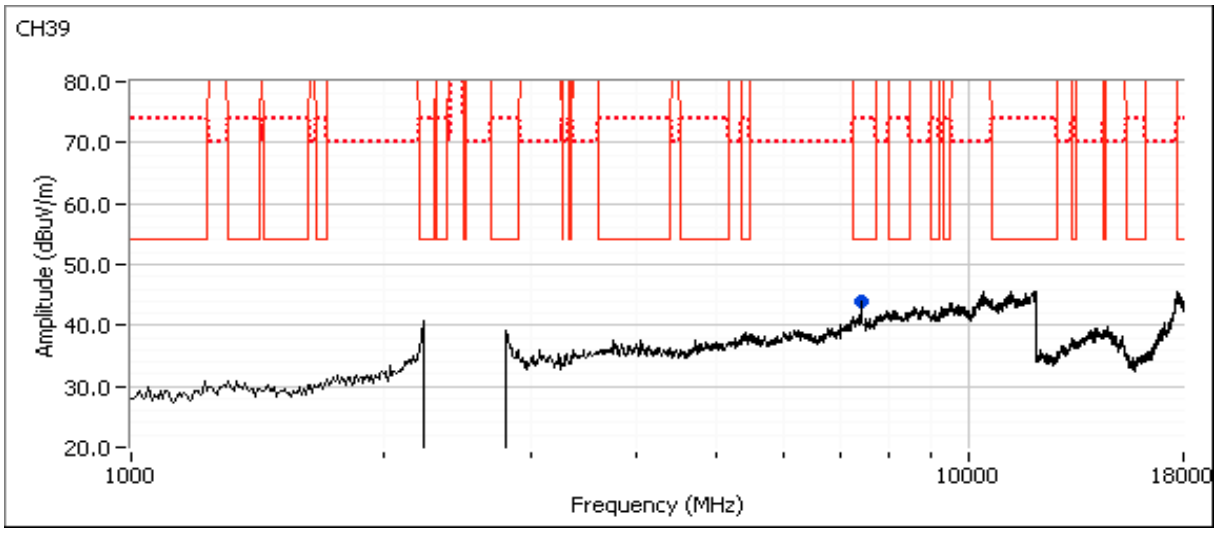
Client:	Proteus Digital Health	Job Number:	JD100869
Model:	RW2 Patch	T-Log Number:	T101589
		Project Manager:	Deepa Shetty
Contact:	Robert Leichner	Project Coordinator:	-
Standard:	FCC 15.247, RSS 247, EN 300 328	Class:	N/A



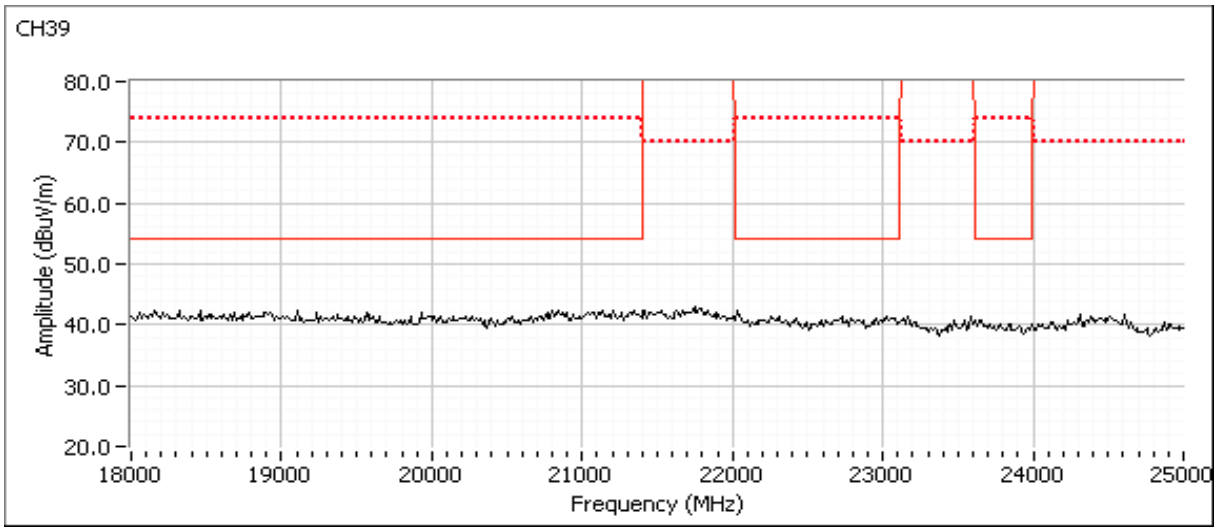
Client:	Proteus Digital Health	Job Number:	JD100869
Model:	RW2 Patch	T-Log Number:	T101589
		Project Manager:	Deepa Shetty
Contact:	Robert Leichner	Project Coordinator:	-
Standard:	FCC 15.247, RSS 247, EN 300 328	Class:	N/A

Run #1c: High Channel
Orientation: Flat
Channel: 39 Mode: BLE
Tx Chain: NA 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	
7439.970	44.3	V	54.0	-9.7	Avg	206	1.03	VB 3 kHz, VAVG 100, Note 4
7440.730	51.0	V	74.0	-23.0	PK	206	1.03	



Client:	Proteus Digital Health	Job Number:	JD100869
Model:	RW2 Patch	T-Log Number:	T101589
		Project Manager:	Deepa Shetty
Contact:	Robert Leichner	Project Coordinator:	-
Standard:	FCC 15.247, RSS 247, EN 300 328	Class:	N/A



Client:	Proteus Digital Health	Job Number:	JD100869
Model:	RW2 Patch	T-Log Number:	T101589
		Project Manager:	Deepa Shetty
Contact:	Robert Leichner	Project Coordinator:	-
Standard:	FCC 15.247, RSS 247, EN 300 328	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: 4/28/2016
Test Engineer: John Caizzi
Test Location: Fremont Chamber #3
Config. Used: 2
Config Change: No power supply used
EUT Voltage: 3 VDC internal battery

General Test Configuration

The EUT was 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: 21 °C
Rel. Humidity: 34 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
2	Radiated Emissions 30 - 1000 MHz, Maximized	FCC 15.209	Pass	18.5 dBµV/m @ 30.13 MHz (-21.5 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: 31
Antenna: internal

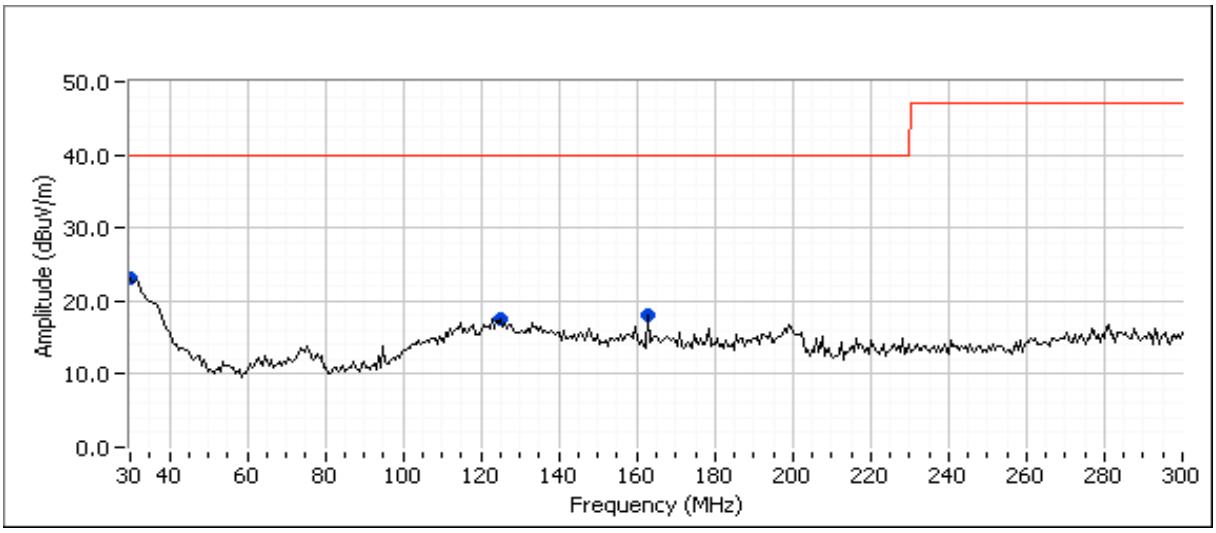
Test Notes

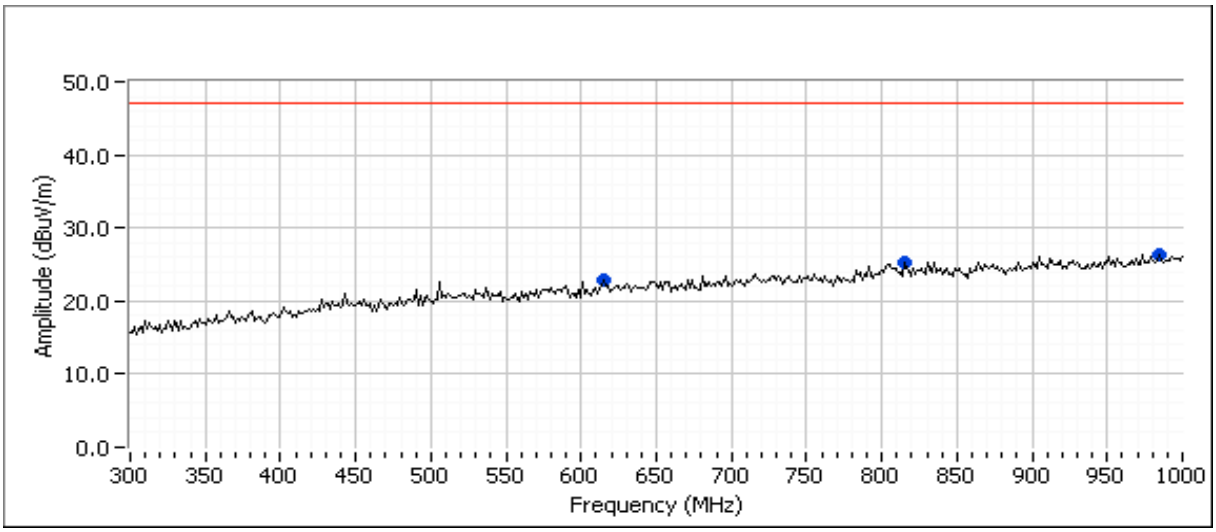
No emissions related to the Transmitter were observed, therefore testing was performed only with the radio set to channel 0.

Client:	Proteus Digital Health	Job Number:	JD100869
Model:	RW2 Patch	T-Log Number:	T101589
		Project Manager:	Deepa Shetty
Contact:	Robert Leichner	Project Coordinator:	-
Standard:	FCC 15.247, RSS 247, EN 300 328	Class:	N/A

Run #1: Preliminary Radiated 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





Client:	Proteus Digital Health	Job Number:	JD100869
Model:	RW2 Patch	T-Log Number:	T101589
		Project Manager:	Deepa Shetty
Contact:	Robert Leichner	Project Coordinator:	-
Standard:	FCC 15.247, RSS 247, EN 300 328	Class:	N/A

Preliminary peak readings captured during pre-scan

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
30.130	23.1	V	40.0	-16.9	Peak	330	3.5	
124.831	17.5	V	43.5	-26.0	Peak	114	4.0	
163.009	18.0	V	43.5	-25.5	Peak	347	1.0	
990.601	26.3	H	54.0	-27.7	Peak	360	4.0	
801.784	25.3	H	46.0	-20.7	Peak	145	2.5	
619.643	23.0	V	46.0	-23.0	Peak	155	1.0	

Preliminary quasi-peak readings (no manipulation of EUT interface cables)

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
990.601	21.9	H	54.0	-32.1	QP	360	4.00	
162.700	16.8	V	43.5	-26.7	QP	346	1.00	
30.130	18.5	V	40.0	-21.5	QP	328	3.50	
619.643	17.8	V	46.0	-28.2	QP	153	1.01	
801.784	20.4	H	46.0	-25.6	QP	144	2.50	
124.831	12.9	V	43.5	-30.6	QP	113	4.00	

Note 1: Limits shown on graphs are from CISPR 11.

Run #2: Maximized Readings From Run #1

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

Maximized quasi-peak readings (includes manipulation of EUT interface cables)

Frequency	Level	Pol	FCC 15.209		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
990.601	21.9	H	54.0	-32.1	QP	360	4.00	
162.700	16.8	V	43.5	-26.7	QP	346	1.00	
30.130	18.5	V	40.0	-21.5	QP	328	3.50	
619.643	17.8	V	46.0	-28.2	QP	153	1.01	
801.784	20.4	H	46.0	-25.6	QP	144	2.50	
124.831	12.9	V	43.5	-30.6	QP	113	4.00	

End of Report

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