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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: R006 (900MHz PA radio module)

FCC ID:	2AGSF-R006
APPLICANT:	Sensor Industries 601 Daily Drive, STE 300N Camarillo, CA 93010
TEST SITE(S):	National Technical Systems - Silicon Valley 41039 Boyce Road. Fremont, CA. 94538-2435
IC SITE REGISTRATION #:	2845B-3; 2845B-4, 2845B-5, 2845B-7
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REVISION HISTORY

Rev#	Date	Comments	Modified By
-	February 16, 2016	First release	
1.0	April 27, 2016	Added plots for compliance at bandedges. Additional data added for modified shield.	MEH

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SCOPE

An electromagnetic emissions test has been performed on the Sensor Industries model R006 (900MHz PA radio module), 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

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 Sensor Industries model R006 (900MHz PA radio module) 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 Sensor Industries model R006 (900MHz PA radio module) and therefore apply only to the tested sample. The sample was selected and prepared by Steve Smith of Sensor Industries.

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 (902 – 928 MHz)

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	535 kHz	>500kHz	Complies
15.247 (b) (3)	RSS 247 5.4 (4)	Output Power, 902 – 928 MHz	9.5 dBm (0.009 Watts) EIRP = 0.009 W Note 1	1Watt, EIRP limited to 4 Watts.	Complies
15.247(d)	RSS 247 5.2 (2)	Power Spectral Density	5.2 dBm/3kHz	8dBm/3kHz	Complies
15.247(c)	RSS 247 5.5	Antenna Port Spurious Emissions 30MHz – 9.28 GHz	All spurious emissions < -20dBc	< -20dBc	Complies
15.247(c) / 15.209	RSS 247 5.5 / RSS-GEN	Radiated Spurious Emissions 30MHz – 9.28 GHz	53.4 dBµV/m @ 2744.5 MHz (-0.6 dB)	Refer to the limits section (p19) for restricted bands, all others < -20dBc	Complies
Note 1: EIRP calculated using antenna gain of 0 dBi for the highest EIRP system.					

GENERAL REQUIREMENTS APPLICABLE TO ALL BANDS

FCC Rule Part	RSS Rule part	Description	Measured Value / Comments	Limit / Requirement	Result (margin)
15.203	-	RF Connector	EUT uses a permanently connected antenna	Unique or integral antenna required	Complies
15.207	RSS GEN Table 3	AC Conducted Emissions	34.7dBµV @ 0.46MHz (-12.0dB)	Refer to page 20	Complies
15.109	RSS GEN Table 2	Receiver spurious emissions	37.4 dBµV/m @ 38.83 MHz (-2.6 dB)	Refer to page 19	Complies
15.247 (b) (5) 15.407 (f)	RSS 102	RF Exposure Requirements	Refer to MPE calculations in separate exhibit	Refer to OET 65, FCC Part 1 and RSS 102	Complies
-	RSP 100 RSS GEN 6.6	Occupied Bandwidth	565 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 Sensor Industries model R006 (900MHz PA radio module) is a 900MHz radio module which is designed to communicate with other radios. Since the EUT would normally be floor-standing during operation, the EUT was treated as floor-standing equipment during testing to simulate the end-user environment. The electrical rating of the EUT is 3.3 Volts, 0.2 Amps.

The sample was received on December 11, 2015 and tested on December 11, 29, and 31, 2015. The EUT consisted of the following component(s):

Company	Model	Description	Serial Number	FCC ID
Sensor Industries	R006	PA Radio Module	15331507730235 (used for radiated measurements)	2AGSF-R006
Sensor Industries	R006	PA Radio Module	0192 (used for antenna port measurements)	2AGSF-R006

For AC conducted emissions per 15.207, the module was tested in a representative host system.

Company	Model	Description	Serial Number	FCC ID
Sensor Industries	UnitNode	Repeater	340	-

ANTENNA SYSTEM

The antenna system consists of 0dBi bent wire soldered to the pcb.

ENCLOSURE

The EUT has no enclosure. It is designed to be installed within the enclosure of a host system.

MODIFICATIONS

After all testing was completed, a sample with a modified shield was provided. A validation of the spurious emissions was performed.

SUPPORT EQUIPMENT

The following equipment was used as support equipment for testing:

Radiated Spurious and RF Conducted

Company	Model	Description	Serial Number	FCC ID
HP	Compaq nw8440	Laptop	CNU7212PXN	DoC
Texas Instruments	CC Debugger	USB to Serial adapter	-	-

For AC conducted emissions, no support equipment was used.

EUT INTERFACE PORTS

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

Radiated Spurious and RF Conducted

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
Laptop USB	CC Debugger	USB Cable – Multiconductor	Shielded	1.5
CC Debugger	EUT	Ribbon	Unshielded	15cm

AC Conducted

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
AC Port (Repeater)	AC Mains	3wire extension cable	Unshielded	0.8

EUT OPERATION

During radiated spurious and RF conducted testing, the EUT was configured for continuous transmission on the noted channel.

During AC conducted emissions, the repeater was operating as it would during normal usage with the radio transmitting.

TEST SITE

GENERAL INFORMATION

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

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

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

CONDUCTED EMISSIONS CONSIDERATIONS

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

RADIATED EMISSIONS CONSIDERATIONS

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

MEASUREMENT INSTRUMENTATION

RECEIVER SYSTEM

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

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

INSTRUMENT CONTROL COMPUTER

The receivers utilize either a Rohde & Schwarz EZM Spectrum Monitor/Controller or contain an internal Spectrum Monitor/Controller to view and convert the receiver measurements to the field strength at an antenna or voltage developed at the LISN measurement port, which is then compared directly with the appropriate specification limit. This provides faster, more accurate readings by performing the conversions described under Sample Calculations within the Test Procedures section of this report. Results are printed in a graphic and/or tabular format, as appropriate. A personal computer is used to record all measurements made with the receivers. The software used for radiated and conducted emissions measurements is NTS EMI Test Software (rev 2.10)

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

LINE IMPEDANCE STABILIZATION NETWORK (LISN)

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

FILTERS/ATTENUATORS

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

ANTENNAS

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

ANTENNA MAST AND EQUIPMENT TURNTABLE

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

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

INSTRUMENT CALIBRATION

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

TEST PROCEDURES

EUT AND CABLE PLACEMENT

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

CONDUCTED EMISSIONS

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

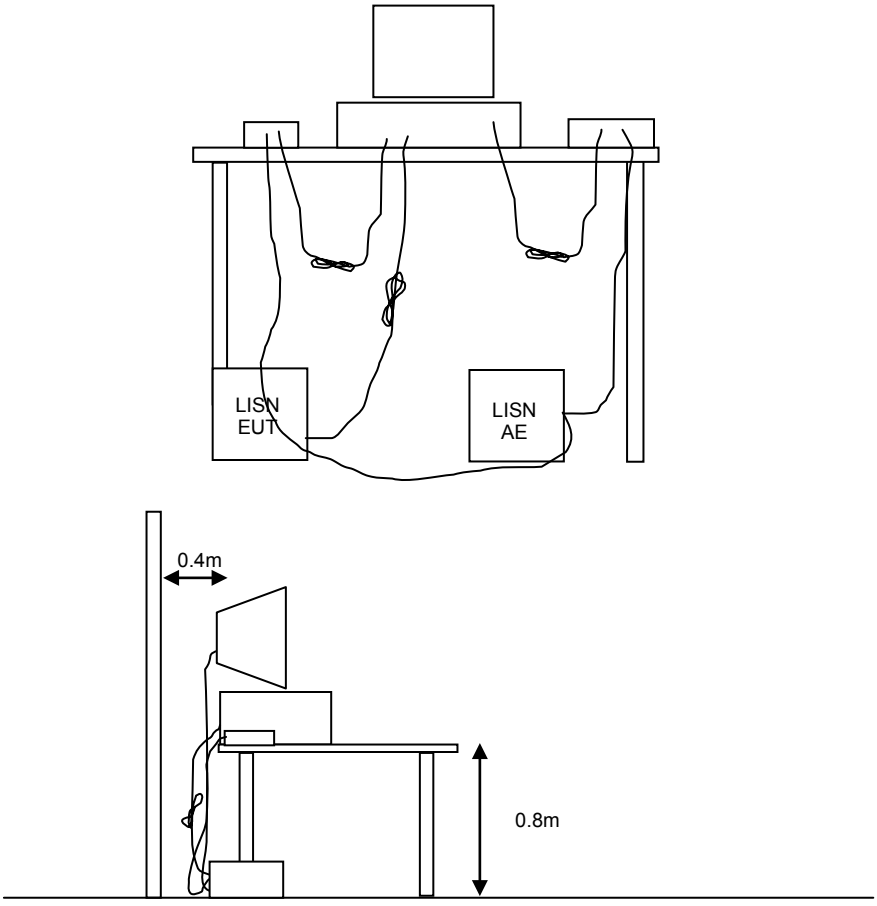


Figure 1 Typical Conducted Emissions Test Configuration

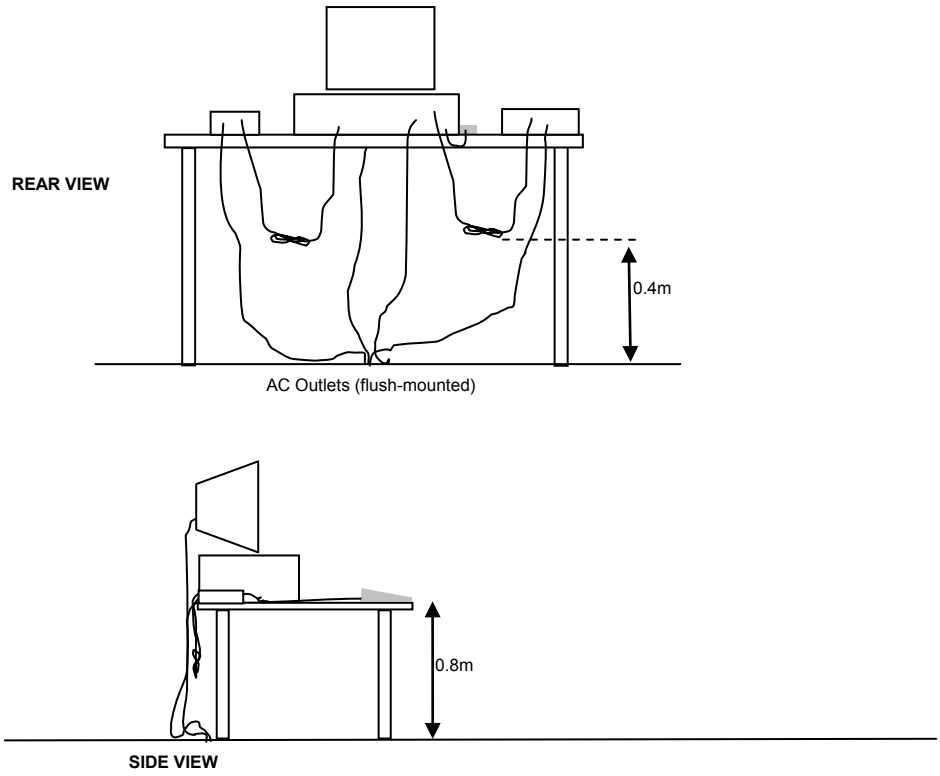
RADIATED EMISSIONS

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

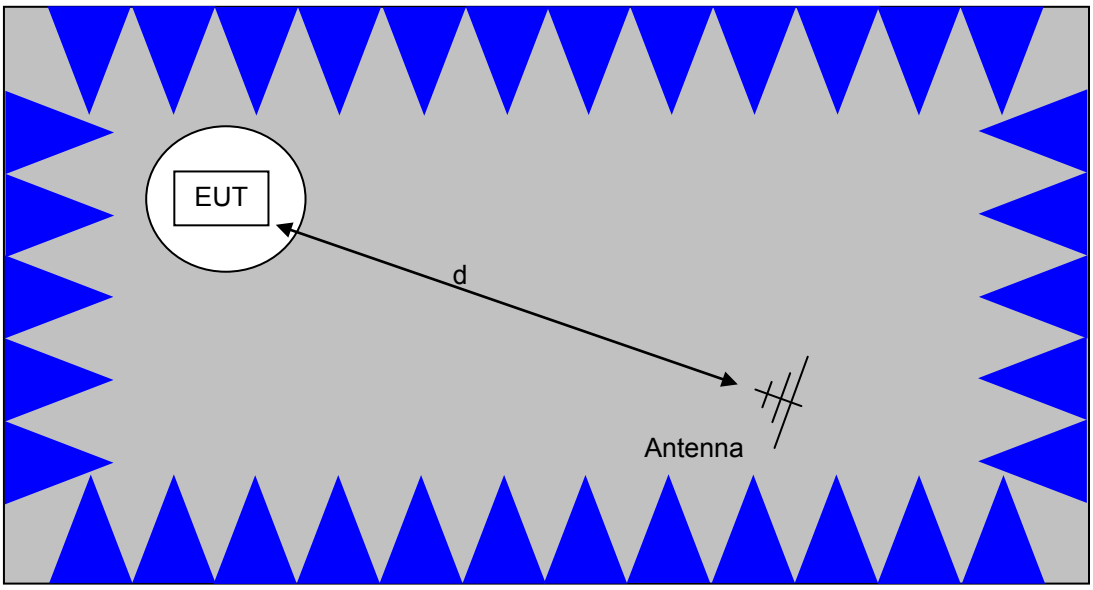
A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT.

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

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

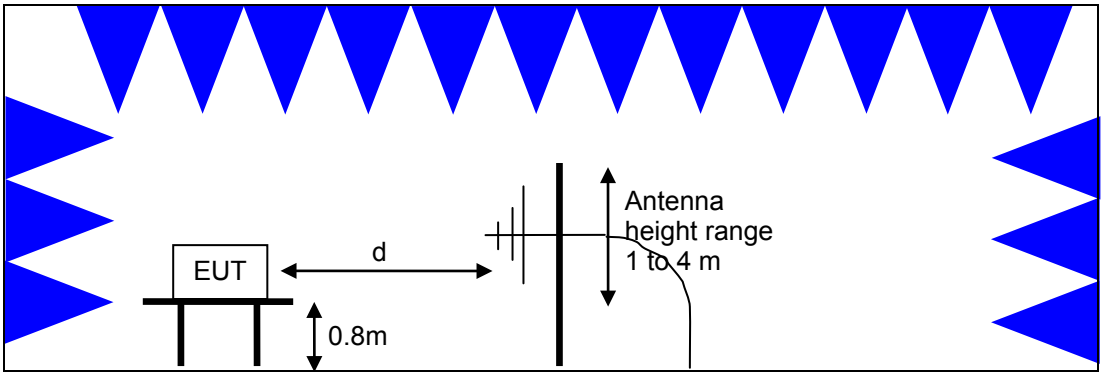


Typical Test Configuration for Radiated Field Strength Measurements



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

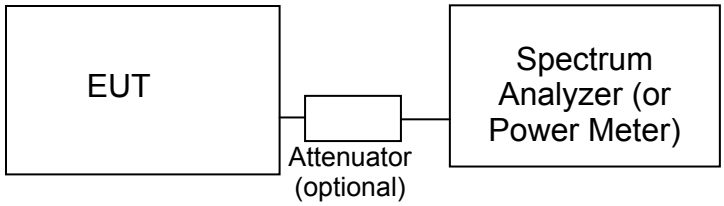
Floor-standing equipment is placed on the floor with insulating supports between the unit and the ground plane.



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

CONDUCTED EMISSIONS FROM ANTENNA PORT

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



Test Configuration for Antenna Port Measurements

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

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

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

BANDWIDTH MEASUREMENTS

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

SPECIFICATION LIMITS AND SAMPLE CALCULATIONS

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

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

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, RSS 210 Table 2, RSS GEN Table 1 and RSS 310 Table 3. Note that receivers operating outside of the frequency range 30 MHz – 960 MHz are exempt from the requirements of 15.109.

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

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.

[1] The restricted bands are detailed in FCC 15.205, RSS-GEN Table 3

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 247. 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

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

T100302

Manufacturer	Description	Model	Asset #	Calibrated	Cal Due
Radiated Spurious Emissions, 30 - 9300 MHz, 11-Dec-15					
NTS	NTS EMI Software (rev 2.10)	N/A	0		N/A
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	870	2/20/2015	2/20/2016
Hewlett Packard	Spectrum Analyzer (SA40) Red 30 Hz -40 GHz	8564E (84125C)	1148	10/17/2015	10/17/2016
EMCO	Antenna, Horn, 1-18 GHz	3115	1561	6/27/2014	6/27/2016
Hewlett Packard	High Pass filter, 1.5 GHz (Purple System)	P/N 84300-80037	1769	11/3/2015	11/3/2016
Radio Antenna Port (Power and Spurious Emissions), 11-Dec-15					
Rohde & Schwarz	Power Meter, Single Channel, +1795+1796	NRVS	1534	7/20/2015	7/20/2016
Rohde & Schwarz	Peak Power Sensor 100 uW - 2 Watts (w/ 20 dB pad, SN BJ5155)	NRV-Z32	1536	1/15/2015	1/15/2016
Agilent Technologies	PSA, Spectrum Analyzer, (installed options, 111, 115, 123, 1DS, B7J, HYX,	E4446A	2139	6/22/2015	6/22/2016
Radiated Emissions, 30 - 5,000 MHz, 31-Dec-15					
EMCO	Antenna, Horn, 1-18GHz	3115	868	6/26/2014	6/26/2016
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1538	12/19/2015	12/19/2016
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	1549	6/2/2015	6/2/2017
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	2199	10/9/2015	10/9/2016
Hewlett Packard	Spectrum Analyzer (SA40) Purple 9 kHz - 40 GHz,	8564E (84125C)	2415	3/7/2015	3/7/2016
Hewlett Packard	9KHz-1300MHz pre-amp	8447F	2777	3/4/2015	3/5/2016

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Conducted Emissions - AC Power Ports, 29-Dec-15					
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1538	12/19/2015	12/19/2016
Rohde & Schwarz	Pulse Limiter	ESH3 Z2	1594	5/14/2015	5/14/2016
Com-Power	9KHz-30MHz, 50uH, 15Aac, 10Adc, max CISPR 15	LI-215A	2672	6/26/2015	6/26/2016
Radiated Emissions, 30 - 26,500 MHz, 13-Apr-16					
EMCO	Antenna, Horn, 1-18GHz	3115	868	26-Jun-14	26-Jun-16
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1538	19-Dec-15	19-Dec-16
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	1549	02-Jun-15	02-Jun-17
Hewlett Packard	High Pass filter, 1.5 GHz (Purple System)	P/N 84300-80037	1769	03-Nov-15	03-Nov-16
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	2199	09-Oct-15	09-Oct-16
Hewlett Packard	Spectrum Analyzer (SA40) Purple 9 kHz - 40 GHz,	8564E (84125C)	2415	19-Mar-16	19-Mar-17
Hewlett Packard	9KHz-1300MHz pre-amp	8447F	2777	26-Jan-16	26-Jan-17

Appendix B Test Data

T100302 Pages 24 – 53
T100337 Pages 54 – 58

Client:	WateR8	Job Number:	JD100279
Product	R006 (900MHz radio module)	T-Log Number:	T100302
System Configuration:	-	Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Emissions Standard(s):	FCC 15.247	Class:	B
Immunity Standard(s):	-	Environment:	-

EMC Test Data

For The

WateR8

Product

R006 (900MHz radio module)

Date of Last Test: 4/13/2016

Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	Class:	N/A

Duty Cycle

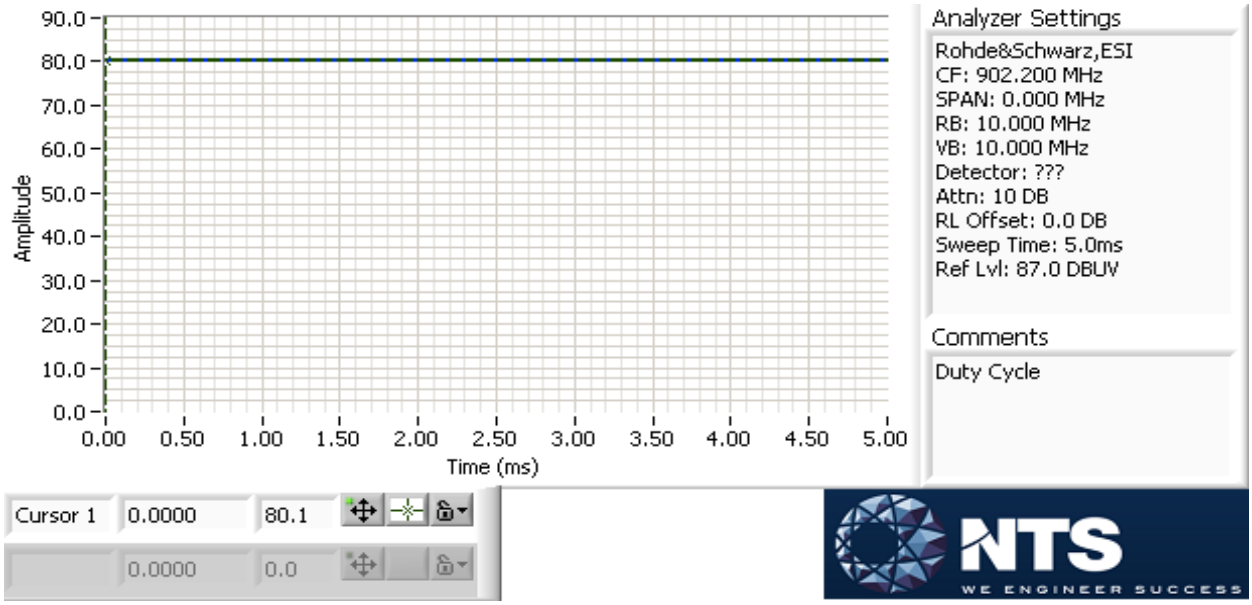
Date of Test: 12/11/2015
Test Engineer: Mark Hill
Test Location: FT Chamber #4

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

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

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
-	38.4 kHz	100.00	Yes	-	0	0	10

* 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:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	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 engineering evaluation testing of the EUT with respect to the specification listed above.

General Test Configuration

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

Ambient Conditions:

Temperature: 23 °C
Rel. Humidity: 38 %

Summary of Results - Device Operating in the 900 MHz Band

Run #	Mode	Channel	Target Power Setting	Passing Power Setting	Test Performed	Limit	Result / Margin
1a	Tx	902.6MHz	-5	-10	Radiated Emissions 30 MHz-9.3GHz	FCC Part 15.209 / 15.247(d)	47.7 dBµV/m @ 4507.5 MHz (-6.3 dB)
1b	Tx	915MHz	-5	-5	Radiated Emissions 30 MHz-9.3GHz	FCC Part 15.209 / 15.247(d)	53.4 dBµV/m @ 2744.5 MHz (-0.6 dB)
1c	Tx	927.4MHz	-5	-5	Restricted Band at 960 MHz	FCC Part 15.209 / 15.247(d)	23.3 dBµV/m @ 960.67 MHz (-30.7 dB)
			-5	-5	Radiated Emissions 30 MHz-9.3GHz	FCC Part 15.209 / 15.247(d)	87.6 dBµV/m @ 1854.5 MHz (-3.8 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.

Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	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.
Preliminary evaluation through three orientations performed to determine worse case (module flat). All results presented here performed in the worse case orientation.

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
-	38.4 kHz	100.00	Yes	-	0	0	10

Sample Notes

Sample S/N: 15331507730235
Driver: -
Antenna: Bent Wire - 0dBi
Power setting = -5 dBm, unless noted otherwise.

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.

Sample S/N: 235 (30-1000MHz)

Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	Class:	N/A

Run #1: Radiated Spurious Emissions, 30 - 9300 MHz

Date of Test: 12/11/15 Config. Used: 1

Test Engineer: Mark Hill Config Change: -

Test Location: FT#4 EUT Voltage: 120V/60 - Host

Run #1a: Low Channel @ 902.6 MHz

Fundamental Signal Field Strength: Peak and average values measured in 1 MHz, and peak value measured in 100kHz

Measured at power setting -5

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
902.390	110.1	H	-	-	PK	109	1.0	POS; RB 2 MHz; VB: 3 MHz
902.390	110.0	H	-	-	PK	109	1.0	POS; RB 100 kHz; VB: 300 kHz
902.410	108.4	V	-	-	PK	61	1.5	POS; RB 100 kHz; VB: 300 kHz
902.289	108.4	V	-	-	PK	61	1.5	POS; RB 2 MHz; VB: 3 MHz

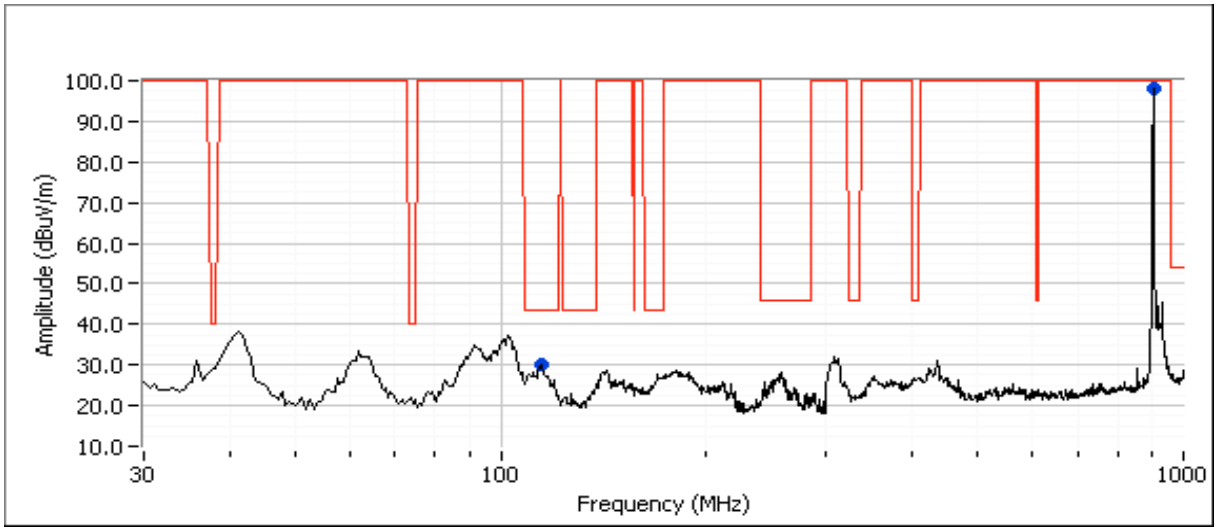
Fundamental emission level @ 3m in 100kHz RBW:	110.0 dBµV/m	
Limit for emissions outside of restricted bands:	90.0 dBµV/m	Limit is -20dBc (Peak power measurement)
Limit for emissions outside of restricted bands:	80.0 dBµV/m	Limit is -30dBc (UNII power measurement)

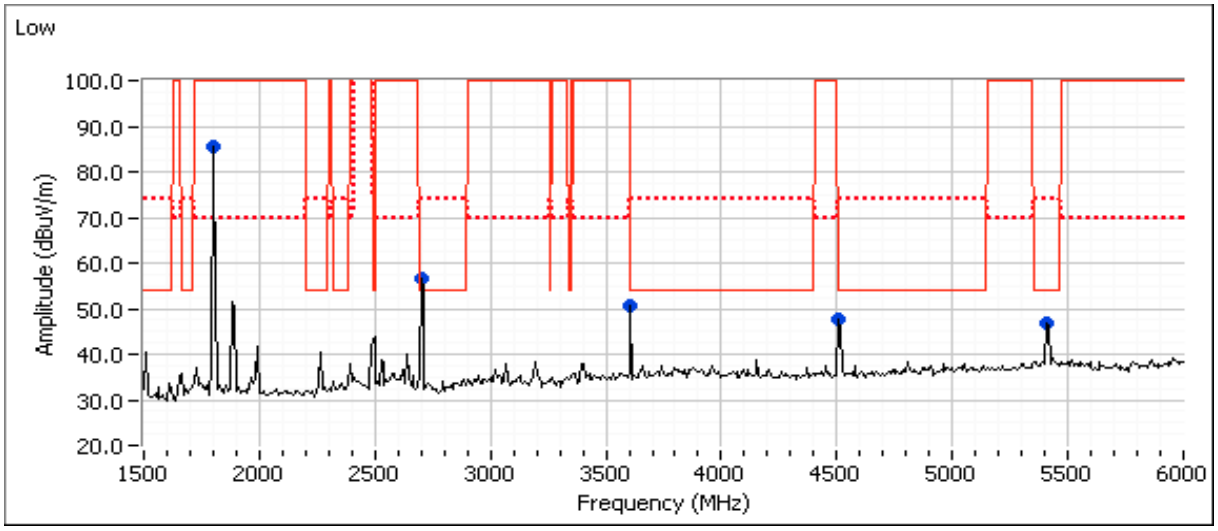
Other Spurious Emissions

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1804.870	88.1	V	-	-	Pk	87	1.06	Note 4, RB 100 kHz;VB 300 kHz;Pk
4507.500	47.7	H	54.0	-6.3	Peak	162	1.00	
2707.400	47.6	V	54.0	-6.4	AVG	140	0.99	Pwr setting = -10
5407.500	46.7	H	54.0	-7.3	Peak	342	1.00	
3609.630	38.8	H	54.0	-15.2	AVG	45	1.81	Pwr setting = -10
114.950	25.8	V	43.5	-17.7	QP	50	1.0	Pwr setting = -5
2707.330	51.3	V	74.0	-22.7	PK	140	0.99	Pwr setting = -10
3609.500	46.8	H	74.0	-27.2	PK	45	1.81	Pwr setting = -10

Note 3:	There was no signal within 1000 to 1500 MHz related to radio module.
Note 4:	Emission in a non-restricted band, refer to antenna port measurements.

Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	Class:	N/A





Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	Class:	N/A

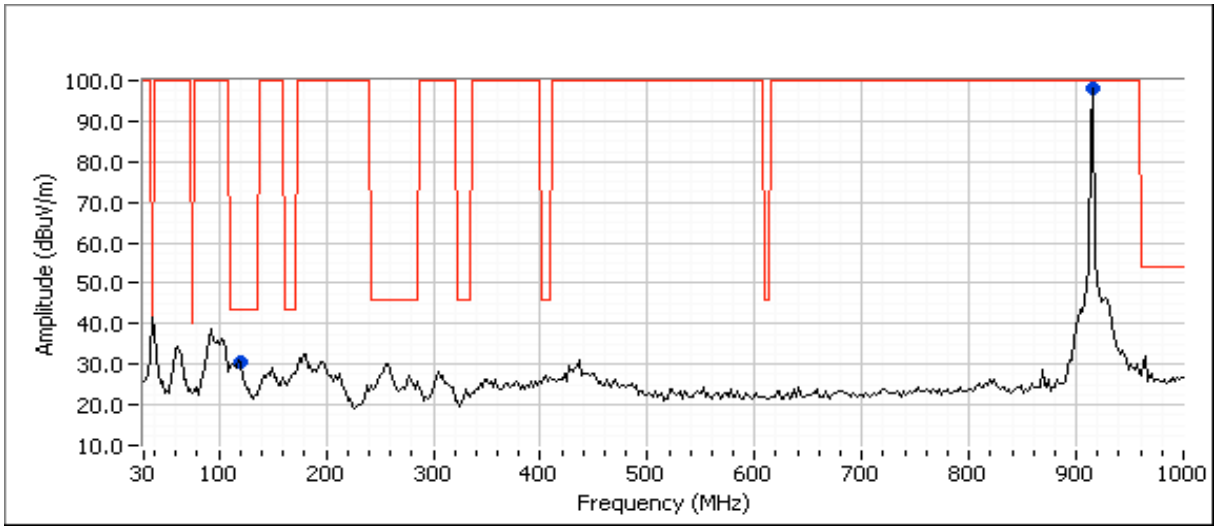
Run #1b: Center Channel @ 915 MHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
914.810	111.4	H	-	-	PK	115	1.0	POS; RB 2 MHz; VB: 3 MHz
915.130	111.4	H	-	-	PK	115	1.0	POS; RB 100 kHz; VB: 300 kHz
914.810	108.5	V	-	-	PK	112	1.0	POS; RB 1 MHz; VB: 3 MHz
914.810	108.5	V	-	-	PK	112	1.0	POS; RB 100 kHz; VB: 300 kHz

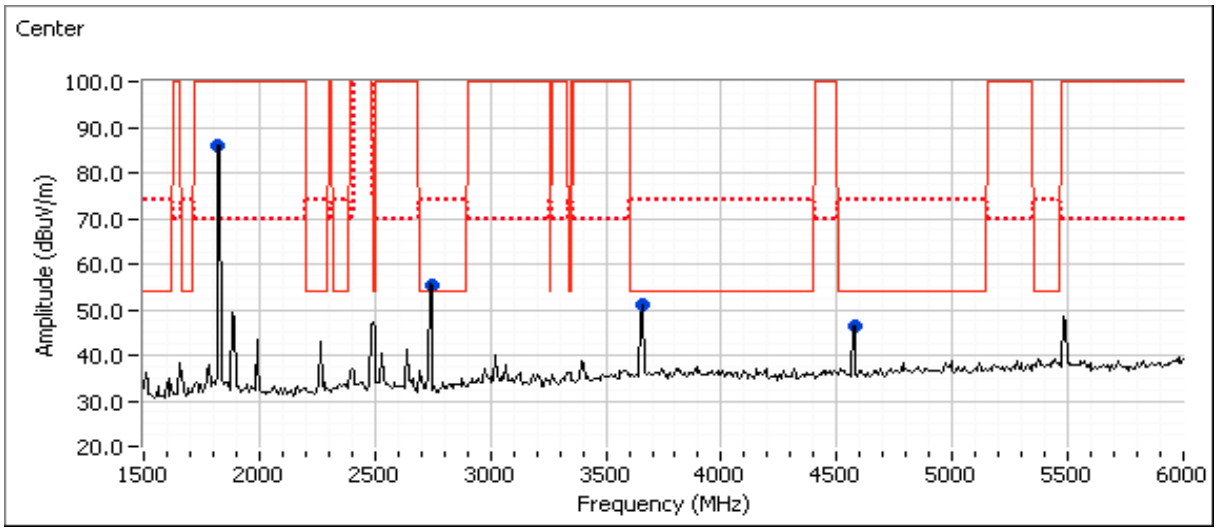
Fundamental emission level @ 3m in 100kHz RBW:	111.4 dBµV/m	
Limit for emissions outside of restricted bands:	91.4 dBµV/m	Limit is -20dBc (Peak power measurement)
Limit for emissions outside of restricted bands:	81.4 dBµV/m	Limit is -30dBc (UNII power measurement)

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2744.500	53.4	V	54.0	-0.6	AVG	307	1.27	
3659.250	49.4	V	54.0	-4.6	AVG	329	1.22	
1830.370	86.6	V	91.4	-4.8	Pk	89	1.02	RB 100 kHz;VB 300 kHz;Peak
119.419	26.9	V	43.5	-16.6	QP	246	1.0	QP (1.00s)
2744.570	55.9	V	74.0	-18.1	PK	307	1.27	
3659.170	53.5	V	74.0	-20.5	PK	329	1.22	

Note 3:	There was no signal within 1000 to 1500 MHz related to radio module.



Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	Class:	N/A



Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	Class:	N/A

Run #1c: High Channel @ 927.4 MHz.

Fundamental Signal Field Strength: Peak and average values measured in 1 MHz, and peak value measured in 100kHz

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
927.550	111.4	H	-	-	PK	225	1.0	POS; RB 100 kHz; VB: 300 kHz
927.550	112.2	H	-	-	PK	225	1.0	POS; RB 2 MHz; VB: 3 MHz
927.230	109.3	V	-	-	PK	58	1.0	POS; RB 2 MHz; VB: 3 MHz
927.550	109.1	V	-	-	PK	58	1.0	POS; RB 100 kHz; VB: 300 kHz

Fundamental emission level @ 3m in 100kHz RBW:	111.4 dBµV/m	
Limit for emissions outside of restricted bands:	91.4 dBµV/m	Limit is -20dBc (Peak power measurement)
Limit for emissions outside of restricted bands:	81.4 dBµV/m	Limit is -30dBc (UNII power measurement)

Band Edge Signal Field Strength - Direct measurement of field strength

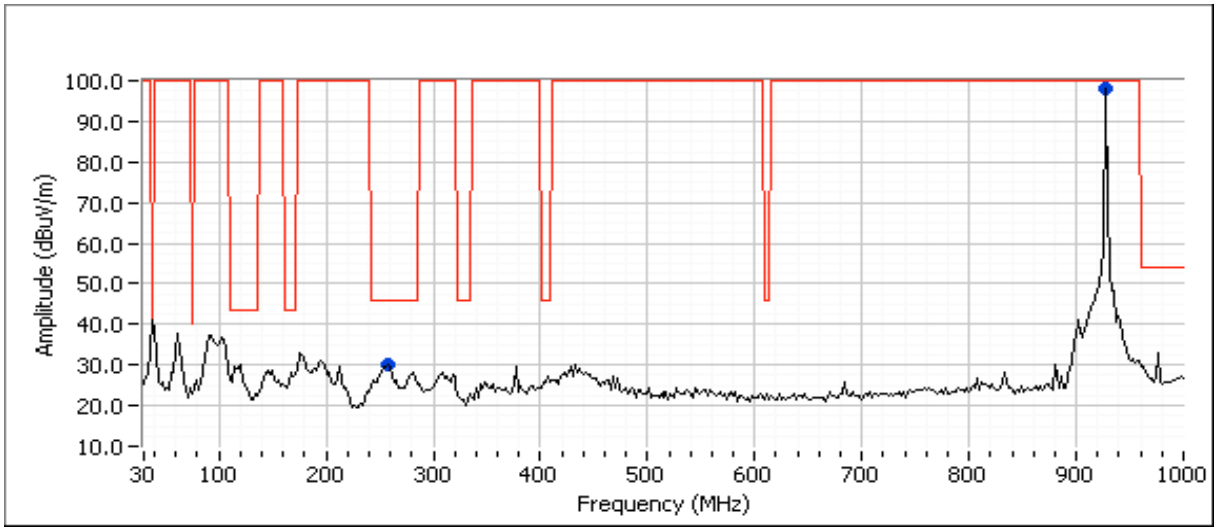
Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
960.669	23.3	V	54.0	-30.7	QP	8	1.0	QP (1.00s)
960.734	23.2	H	54.0	-30.8	QP	56	1.0	QP (1.00s)

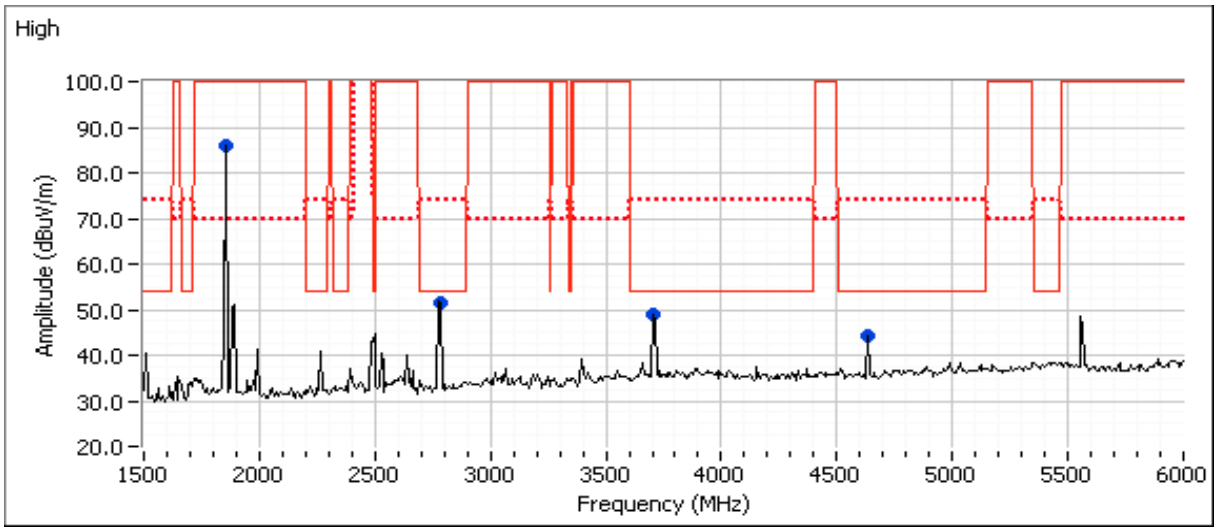
Other Spurious Emissions

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
1854.470	87.6	H	91.4	-3.8	Pk	93	1.00	RB 100 kHz;VB 300 kHz;Peak
2782.650	49.4	H	54.0	-4.6	AVG	37	1.00	
3708.850	48.6	H	54.0	-5.4	AVG	35	1.54	
4635.000	*44.1*	*H*	*54.0*	*-9.9*	*Peak*	*130*	*2.00*	
255.815	27.4	H	46.0	-18.6	QP	288	1.0	QP (1.00s)
3708.920	52.6	H	74.0	-21.4	PK	35	1.54	
2782.850	52.4	H	74.0	-21.6	PK	37	1.00	

Note 3:	There was no signal within 1000 to 1500 MHz related to radio module.

Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	Class:	N/A





Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	Class:	N/A

Receiver Radiated Spurious Emissions

Test Specific Details

Objective: The objective of this test session is to perform engineering evaluation 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: 15-18 °C
Rel. Humidity: 30-35 %

Summary of Results - Device Operating in the 900 MHz Band

Run #	Mode	Channel	Target Power Setting	Passing Power Setting	Test Performed	Limit	Result / Margin
1a	Rx	902.6MHz	-	-	Radiated Emissions 30 MHz-3GHz	FCC Part 15.109 (Class B)	37.0 dBµV/m @ 38.94 MHz (-3.0 dB)
1b	Rx	915.6MHz	-	-	Radiated Emissions 30 MHz-3GHz	FCC Part 15.109 (Class B)	37.4 dBµV/m @ 38.83 MHz (-2.6 dB)
1c	Rx	927.4MHz	-	-	Radiated Emissions 30 MHz-3GHz	FCC Part 15.109 (Class B)	35.2 dBµV/m @ 38.47 MHz (-4.8 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.

Procedure Comments:

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.
Preliminary evaluation through three orientations performed to determine worse case (module flat). All results presented here performed in the worse case orientation.

Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	Class:	N/A

Sample Notes

Sample S/N: 15331507730235
Driver: -
Antenna: Bent Wire - 0dBi

Measurement Specific Notes:

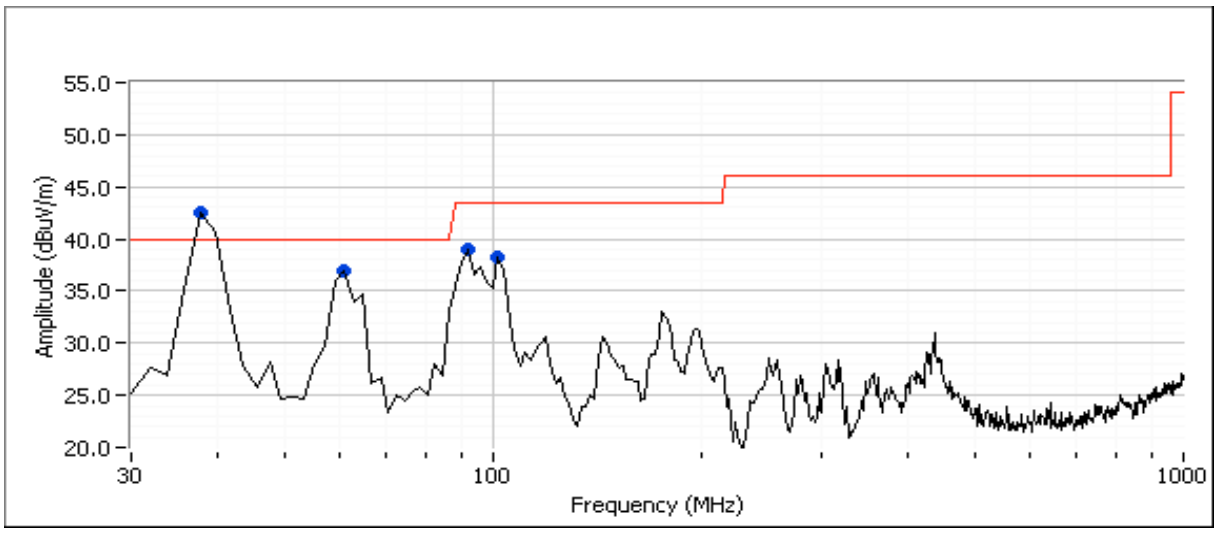
Note 1:	-

Run #1: Radiated Spurious Emissions, 30 - 9300 MHz

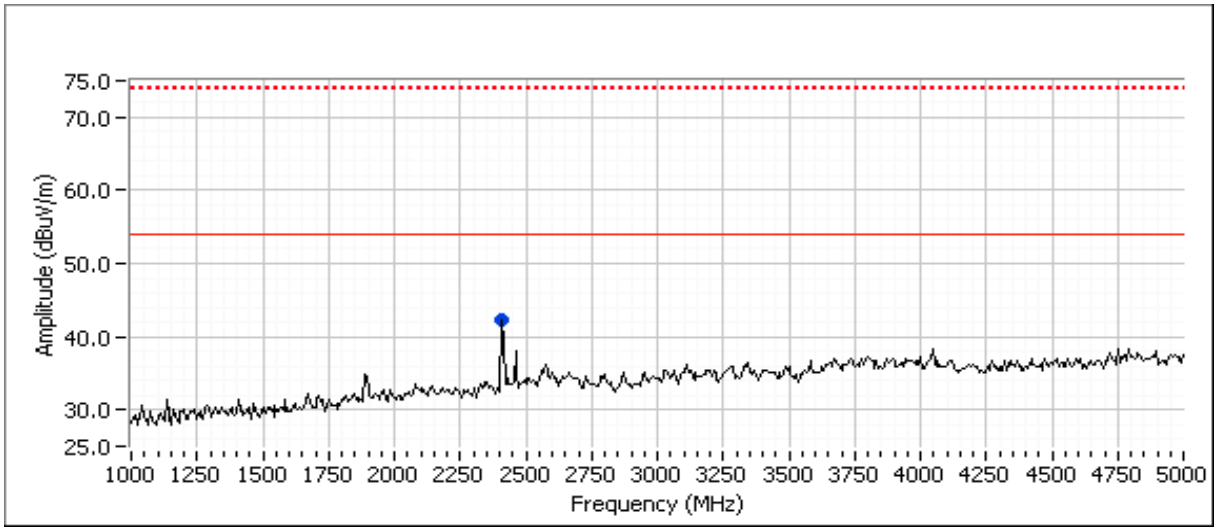
Date of Test: 12/31/15
Test Engineer: Mehran Birgani
Test Location: Chamber #7
Config. Used: 1
Config Change: -
Host EUT Voltage: 120V/ 60Hz

Run #1a: Low Channel @ 902.6 MHz

Frequency	Level	Pol	15.109 Class B		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
38.941	37.0	V	40.0	-3.0	QP	293	1.0	QP (1.00s)
60.398	33.9	V	40.0	-6.1	QP	132	1.0	QP (1.00s)
92.389	36.4	V	43.5	-7.1	QP	182	1.0	QP (1.00s)
101.155	32.5	V	43.5	-11.0	QP	212	1.0	QP (1.00s)
2408.000	35.7	H	54.0	-18.3	AVG	4	2.2	RB 1 MHz;VB 10 Hz;Peak
2406.990	44.0	H	74.0	-30.0	PK	4	2.2	RB 1 MHz;VB 3 MHz;Peak



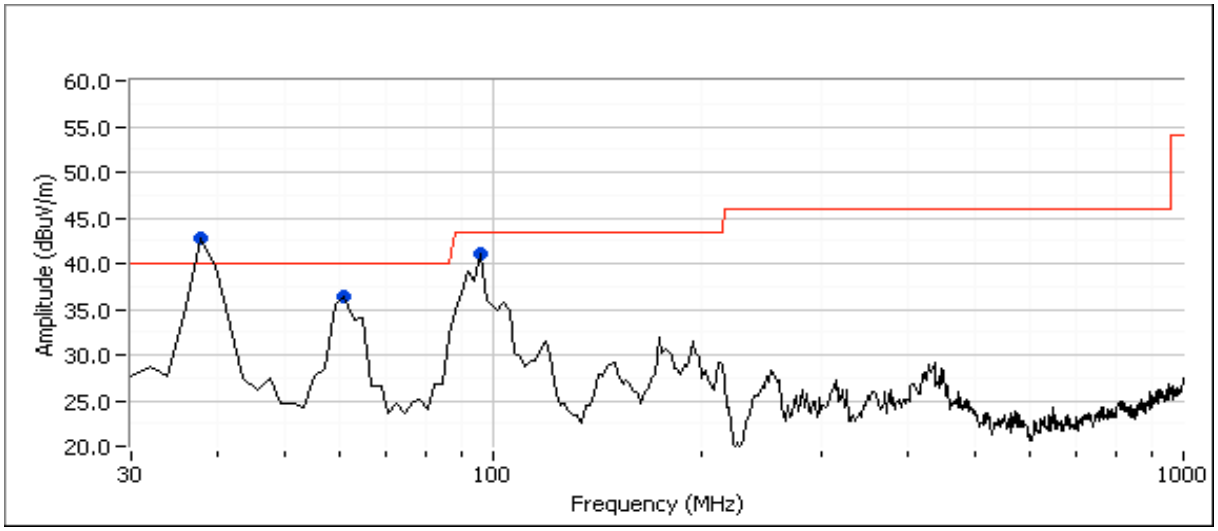
Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	Class:	N/A

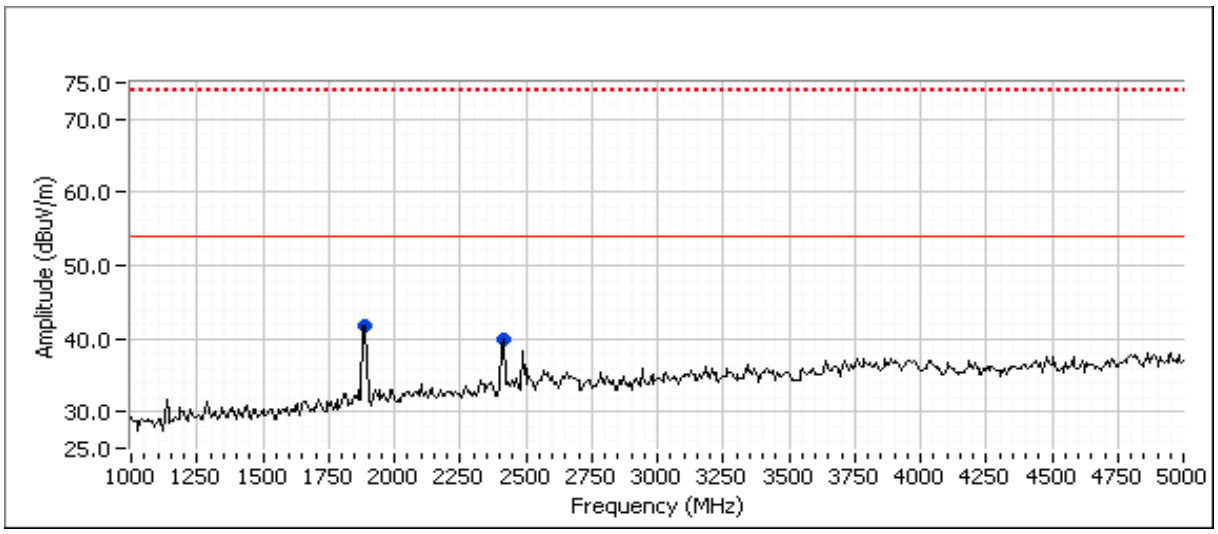


Run #1b: Center Channel @ 915 MHz

Frequency	Level	Pol	15.109 Class B		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
38.825	37.4	V	40.0	-2.6	QP	228	1.0	QP (1.00s)
95.991	36.2	V	43.5	-7.3	QP	122	1.0	QP (1.00s)
60.592	32.6	V	40.0	-7.4	QP	107	1.0	QP (1.00s)
2429.220	32.1	H	54.0	-21.9	AVG	284	1.0	RB 1 MHz;VB 10 Hz;Peak
1899.500	30.2	V	54.0	-23.8	AVG	11	1.9	RB 1 MHz;VB 10 Hz;Peak
2429.150	43.1	H	74.0	-30.9	PK	284	1.0	RB 1 MHz;VB 3 MHz;Peak
1899.790	42.0	V	74.0	-32.0	PK	11	1.9	RB 1 MHz;VB 3 MHz;Peak

Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	Class:	N/A

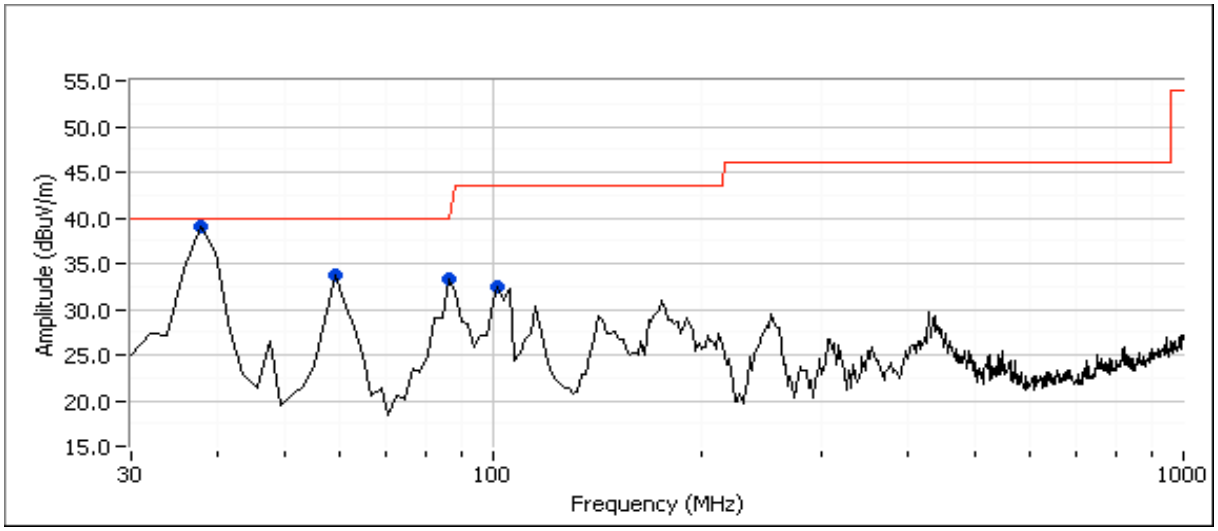




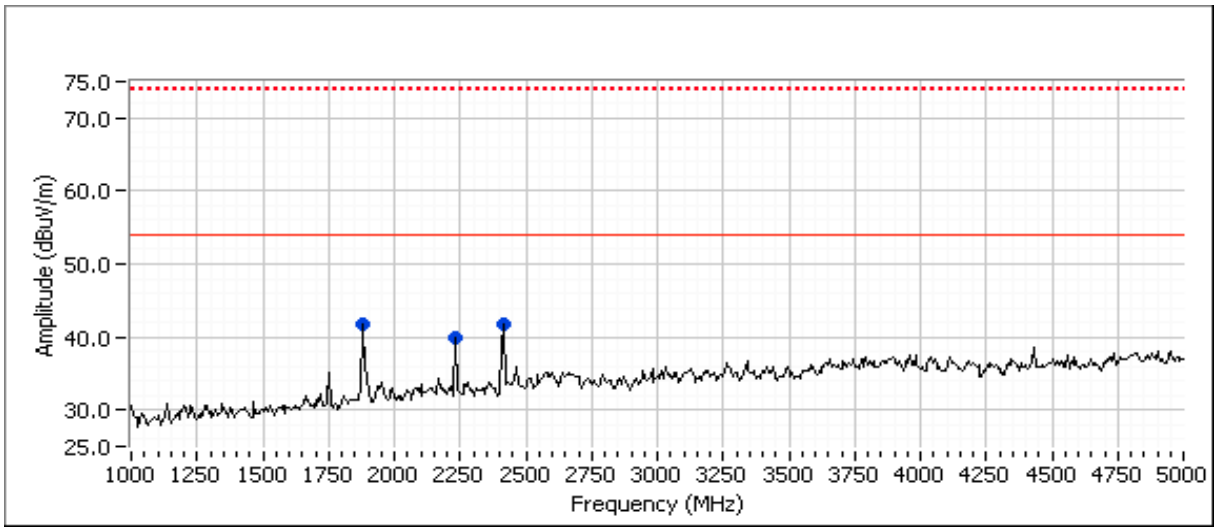
Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	Class:	N/A

Run #1c: High Channel @ 927.4 MHz.

Frequency	Level	Pol	15.109 Class B		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
38.474	35.2	V	40.0	-4.8	QP	333	1.0	QP (1.00s)
87.435	29.7	V	40.0	-10.3	QP	208	1.0	QP (1.00s)
59.687	26.8	V	40.0	-13.2	QP	192	1.5	QP (1.00s)
102.284	27.9	V	43.5	-15.6	QP	288	1.0	QP (1.00s)
2398.800	32.1	H	54.0	-21.9	AVG	300	2.5	RB 1 MHz;VB 10 Hz;Peak
2400.990	32.0	H	54.0	-22.0	AVG	300	2.5	RB 1 MHz;VB 10 Hz;Peak
2222.910	30.8	V	54.0	-23.2	AVG	142	1.6	RB 1 MHz;VB 10 Hz;Peak
2399.260	43.7	H	74.0	-30.3	PK	300	2.5	RB 1 MHz;VB 3 MHz;Peak
2399.170	43.6	H	74.0	-30.4	PK	300	2.5	RB 1 MHz;VB 3 MHz;Peak
2222.140	42.3	V	74.0	-31.7	PK	142	1.6	RB 1 MHz;VB 3 MHz;Peak



Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	Class:	N/A



Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	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 engineering evaluation testing of the EUT with respect to the specification listed above.

General Test Configuration

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

Ambient Conditions:

Temperature: 23 °C
Rel. Humidity: 38 %

Summary of Results - Device Operating in the 900 MHz Band

Run #	Mode	Channel	Target Power Setting	Passing Power Setting	Test Performed	Limit	Result / Margin
1b	Tx	915MHz	-5	-5	Radiated Emissions 30 MHz-9.3GHz	FCC Part 15.209 / 15.247(d)	47.9 dBµV/m @ 2744.4 MHz (-6.1 dB)

Modifications Made During Testing

Modified shield

Deviations From The Standard

No deviations were made from the requirements of the standard.

Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	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.
Preliminary evaluation through three orientations performed to determine worse case (module flat). All results presented here performed in the worse case orientation.

Mode	Data Rate	Duty Cycle (x)	Constant DC?	T (ms)	Pwr Cor Factor*	Lin Volt Cor Factor**	Min VBW for FS (Hz)
-	38.4 kHz	100.00	Yes	-	0	0	10

Sample Notes

Sample S/N: 15331507730130
Driver: -
Antenna: Bent Wire - 0dBi
Power setting = -5 dBm, unless noted otherwise.

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.

Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	Class:	N/A

Run #1: Radiated Spurious Emissions, 30 - 9300 MHz

Date of Test: 04/13/16 Config. Used: 1
Test Engineer: M. Birgani Config Change: -
Test Location: Chamber #7 EUT Voltage: 120V/60 - Host

Frequency	Level	Pol	15.209 / 15.247		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
2744.430	47.9	V	54.0	-6.1	AVG	114	1.6	RB 1 MHz;VB 10 Hz;Peak
2744.410	46.1	H	54.0	-7.9	AVG	115	1.2	RB 1 MHz;VB 10 Hz;Peak
3660.540	45.5	V	54.0	-8.5	AVG	215	1.7	RB 1 MHz;VB 10 Hz;Peak
2745.380	53.0	V	74.0	-21.0	PK	114	1.6	RB 1 MHz;VB 3 MHz;Peak
3660.720	50.9	V	74.0	-23.1	PK	215	1.7	RB 1 MHz;VB 3 MHz;Peak
2744.440	50.2	H	74.0	-23.8	PK	115	1.2	RB 1 MHz;VB 3 MHz;Peak
1829.610	82.9	V	-	-	PK	156	1.8	Note 4; RB 100 kHz;VB 300 kHz

Note 3:	There was no signal within 1000 to 1500 MHz related to radio module.
Note 4:	Emission in a non-restricted band, refer to antenna port measurements.

Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	Class:	N/A

Receiver Radiated Spurious Emissions

Test Specific Details

Objective: The objective of this test session is to perform engineering evaluation 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: 15-18 °C
Rel. Humidity: 30-35 %

Summary of Results - Device Operating in the 900 MHz Band

Run #	Mode	Channel	Target Power Setting	Passing Power Setting	Test Performed	Limit	Result / Margin
1b	Rx	915.6MHz	-	-	Radiated Emissions 30 MHz-3GHz	FCC Part 15.109 (Class B)	37.0 dBµV/m @ 95.99 MHz (-6.5 dB)

Modifications Made During Testing

Modified shield

Deviations From The Standard

No deviations were made from the requirements of the standard.

Procedure Comments:

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.
Preliminary evaluation through three orientations performed to determine worse case (module flat). All results presented here performed in the worse case orientation.

Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	Class:	N/A

Sample Notes

Sample S/N: 15331507730130
Driver:
Antenna:

Measurement Specific Notes:

Note 1:	-

Run #1: Radiated Spurious Emissions, 30 - 9300 MHz

Run #1b: Center Channel @ 915.6 MHz

Date of Test: 04/13/16
Test Engineer: M. Birgani
Test Location: Chamber #7

Config. Used: 1
Config Change: -
EUT Voltage: 120V/60 - Host

Frequency	Level	Pol	15.109 Class B		Detector	Azimuth	Height	Comments
MHz	dBµV/m	v/h	Limit	Margin	Pk/QP/Avg	degrees	meters	
95.991	37.0	V	43.5	-6.5	QP	345	1.0	QP (1.00s)
38.825	24.7	V	40.0	-14.3	QP	345	1.0	QP (1.00s)

No other emissions observed

Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	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: 12/11/2015
Test Engineer: R. Varelas / M. Birgani
Test Location: FT Lab #4A

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

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: 18-20 °C
Rel. Humidity: 35-40 %

Summary of Results

Run #	Pwr setting	Avg Pwr	Test Performed	Limit	Pass / Fail	Result / Margin
1			Output Power	15.247(b)	Pass	9.5 dBm
2			Power spectral Density (PSD)	15.247(d)	Pass	5.2 dBm/3kHz
3			Minimum 6dB Bandwidth	15.247(a)	Pass	535 kHz
3			99% Bandwidth	RSS GEN	-	565 kHz
4			Spurious emissions	15.247(b)	Pass	All emissions are more than 10dB below the limit

Modifications Made During Testing

No modifications were made to the EUT during testing

Deviations From The Standard

No deviations were made from the requirements of the standard.

Sample Notes

Sample S/N: 0192
Driver:

Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	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)
-	38.4 kHz	100.00	Yes	-	0	0	10

Run #1: Output Power

HGM On and Manchester Mode

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
-10	902.6	9.5	8.9	0.0	Pass	9.5	0.009		
-10	915.0	8.4	6.9	0.0	Pass	8.4	0.007		
-10	927.4	6.8	4.8	0.0	Pass	6.8	0.005		

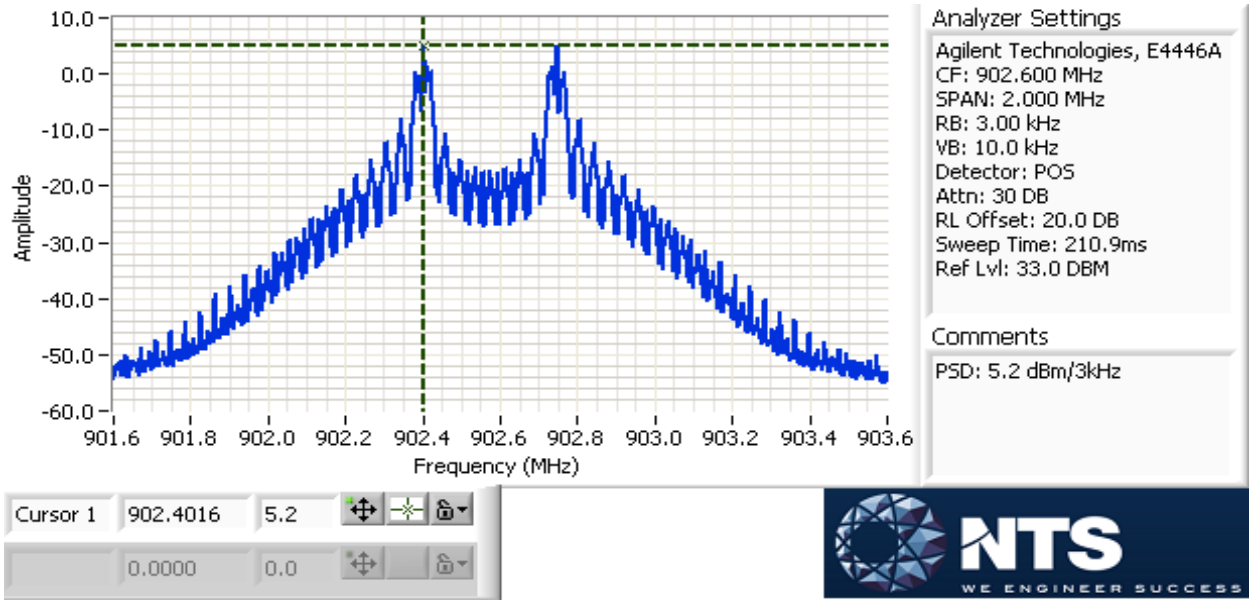
Note 1:	Output power measured using a peak power meter, spurious limit is -20dBc.
Note 2:	Power setting - the software power setting used during testing, included for reference only.

Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	Class:	N/A

Run #2: Power spectral Density
HGM On and Manchester Mode

Power Setting	Frequency (MHz)	PSD (dBm/3kHz) Note 1	Limit dBm/3kHz	Result
-10	902.6	5.2	8.0	Pass
-10	915.0	4.0	8.0	Pass
-10	927.4	2.5	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.



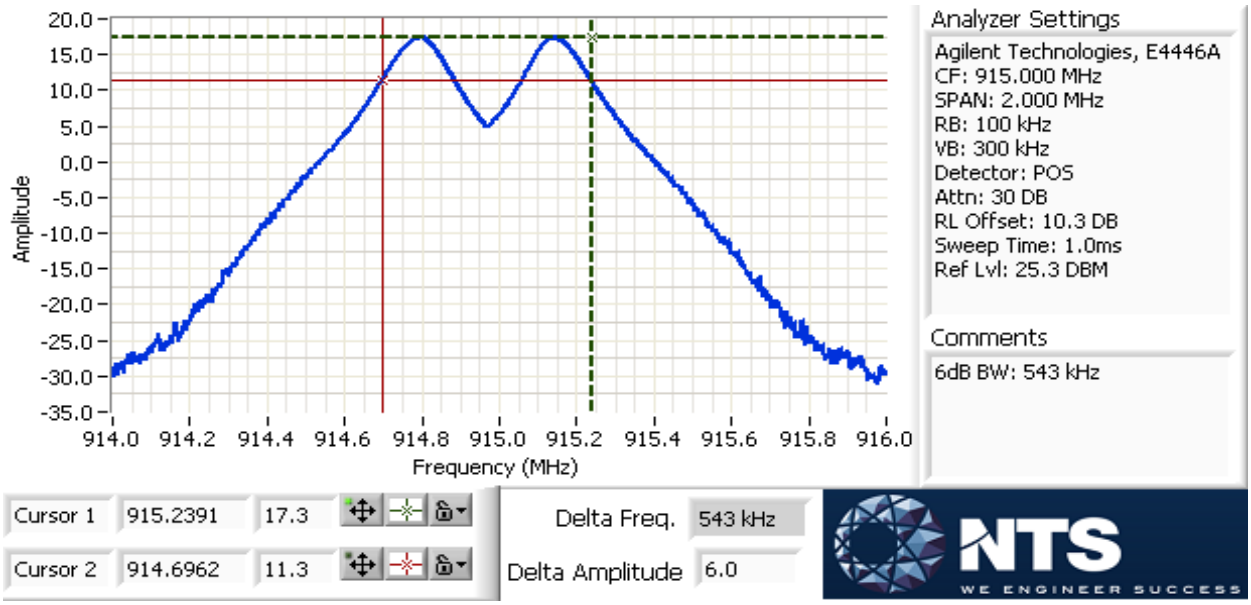
Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	Class:	N/A

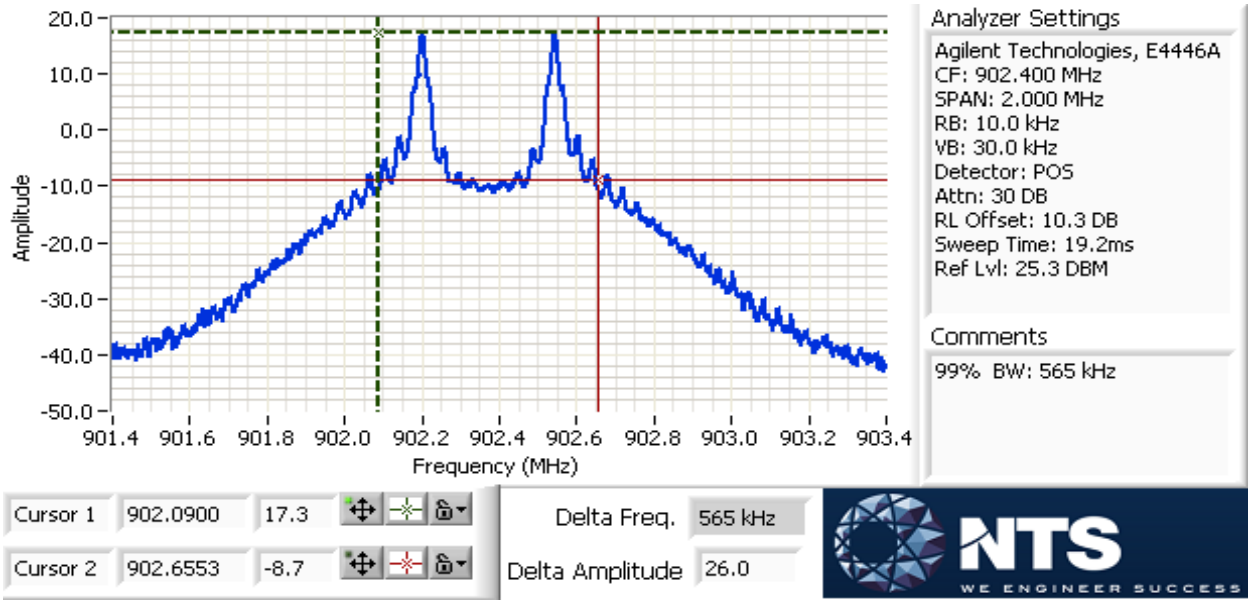
Run #3: Signal Bandwidth

Power Setting	Frequency (MHz)	Bandwidth (MHz)		RBW Setting (MHz)	
		6dB	99%	6dB	99%
-5	902.6	0.55	0.57	100kHz	10kHz
-5	915.0	0.54	0.56	100kHz	10kHz
-5	927.4	0.54	0.55	100kHz	10kHz

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:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	Class:	N/A





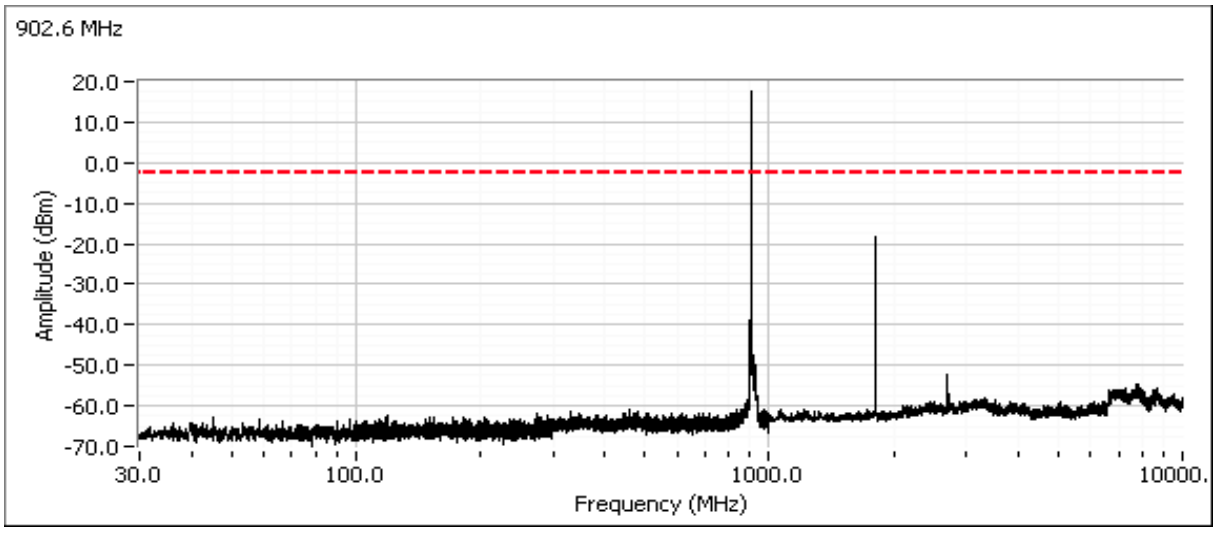
Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	Class:	N/A

Run #4a: Out of Band Spurious Emissions

Frequency (MHz)	Power Setting	Mode	Limit	Result
902.6	-5	-	-20dBc	Pass
915.0	-5	-	-20dBc	Pass
927.4	-5	-	-20dBc	Pass

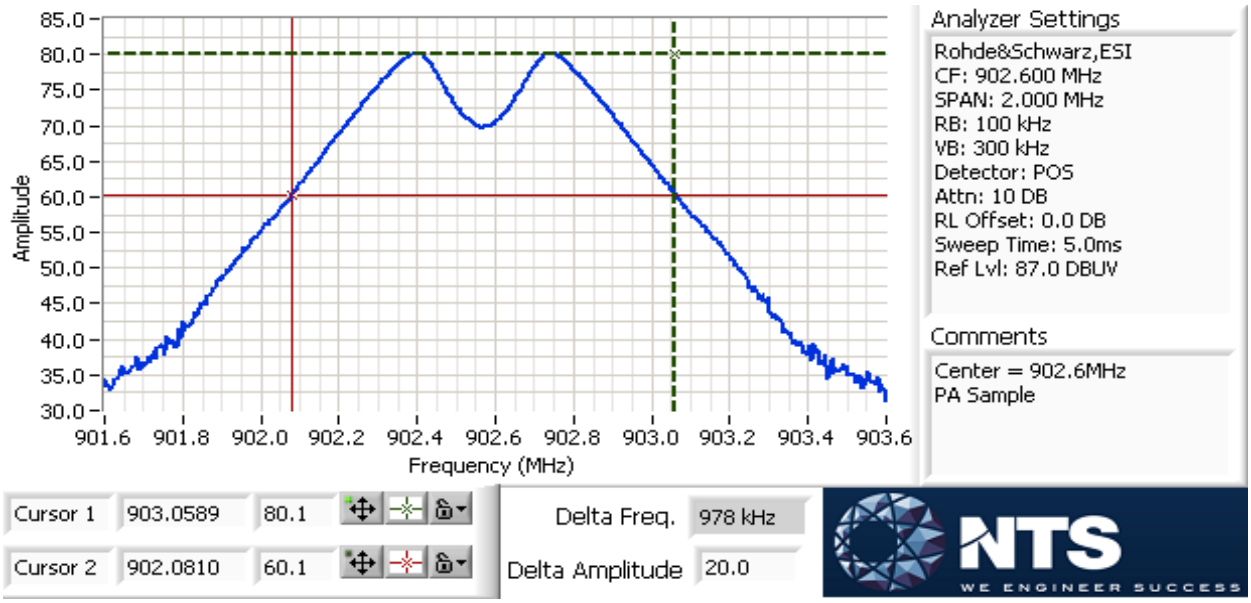
RBW = 100 kHz and VBW = 300 kHz for all plots.

Plots for low channel



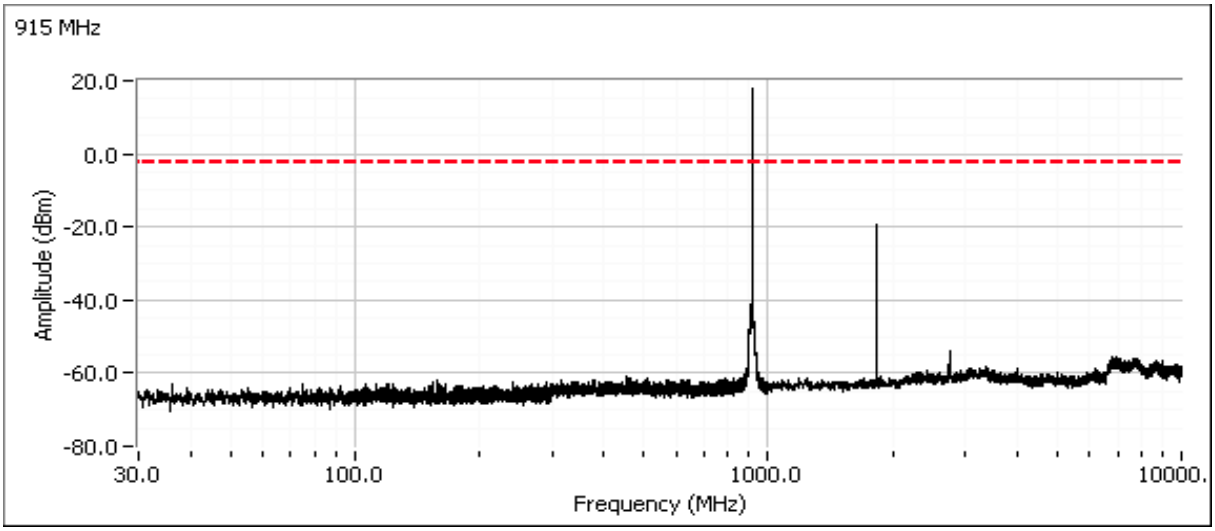
Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	Class:	N/A

Additional plot showing -20dBc at 902MHz

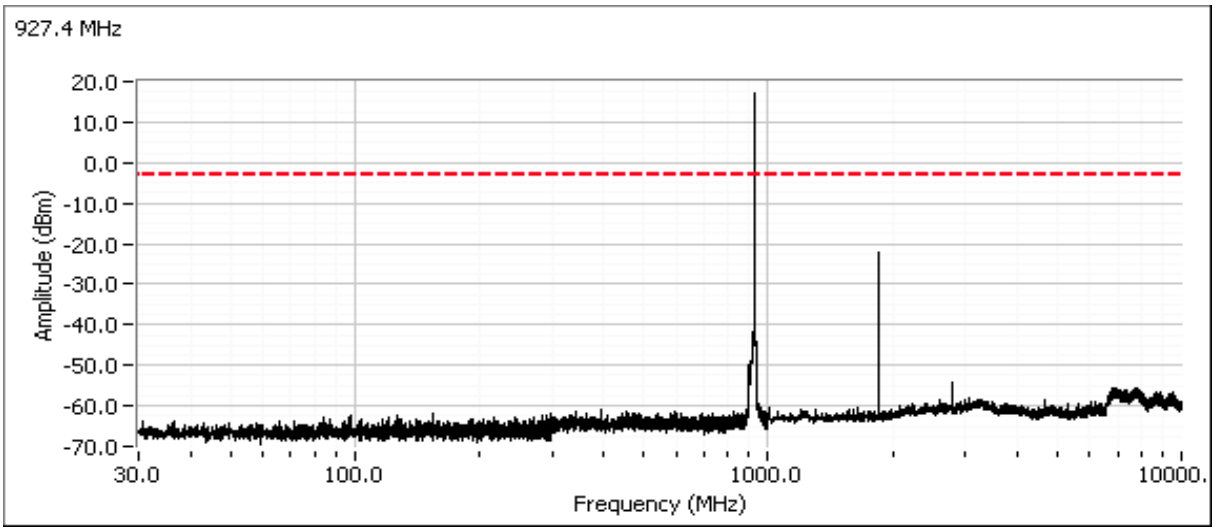


Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	Class:	N/A

Plots for center channel

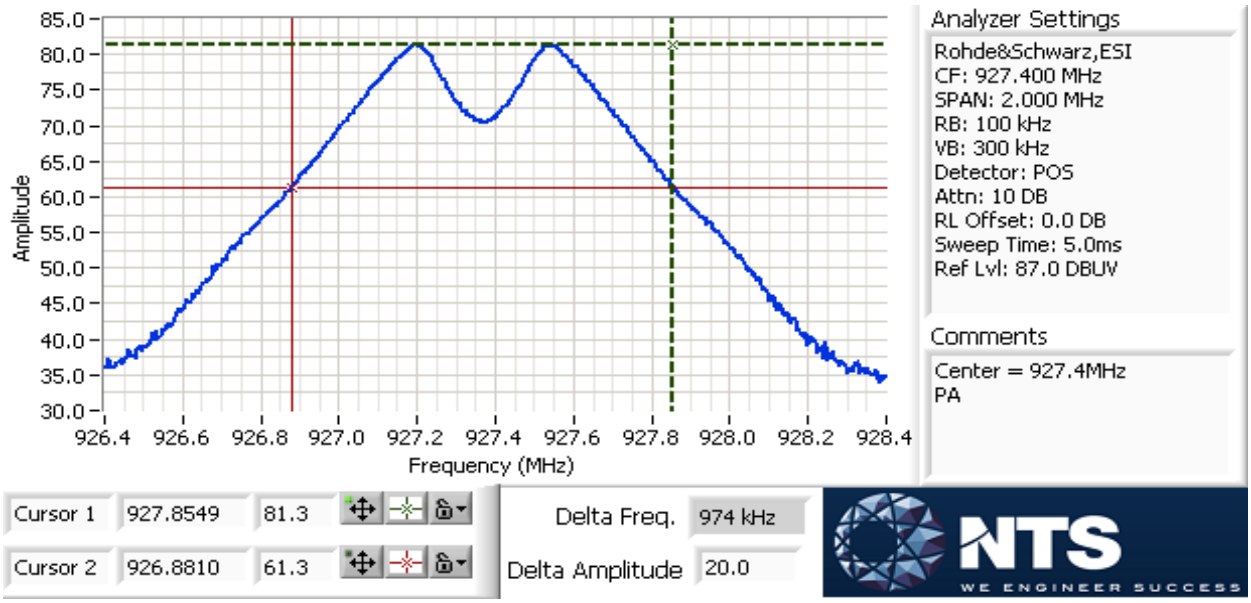


Plots for high channel



Client:	WateR8	Job Number:	JD100279
Model:	R006 (900MHz radio module)	T-Log Number:	T100302
		Project Manager:	Sheareen Jacobs
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.247	Class:	N/A

Additional plot showing -20dBc at 928MHz



Client:	WateR8	Job Number:	JD100279
Product	UnitNode (Repeater)	T-Log Number:	T100337
System Configuration:	-	Project Manager:	Christine Krebill
Contact:	Steve Smith	Project Coordinator:	
Emissions Standard(s):	FCC 15.B / EN 55022	Class:	B
Immunity Standard(s):	-	Environment:	-

EMC Test Data

For The

WateR8

Product

UnitNode (Repeater)

Date of Last Test: 2/11/2016

Client:	WateR8	Job Number:	JD100279
Model:	UnitNode (Repeater)	T-Log Number:	T100337
		Project Manager:	Christine Krebill
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.B / EN 55022	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: 12/29/2015
Test Engineer: Mehran Birgani
Test Location: Chamber #7
Config. Used: 1
Config Change: -
EUT Voltage: Refer to each run

General Test Configuration

The EUT was located on a non-conductive table inside the semi-anechoic chamber, 40 cm from a vertical coupling plane and 80cm from the LISN.

Ambient Conditions:

Temperature: 15-17 °C
Rel. Humidity: 30-35 %

Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	CE, AC Power,120V/60Hz	Class B	PASS	44.8dBµV @ 0.76MHz (-11.2dB)

Modifications Made During Testing

No modifications were made to the EUT during testing

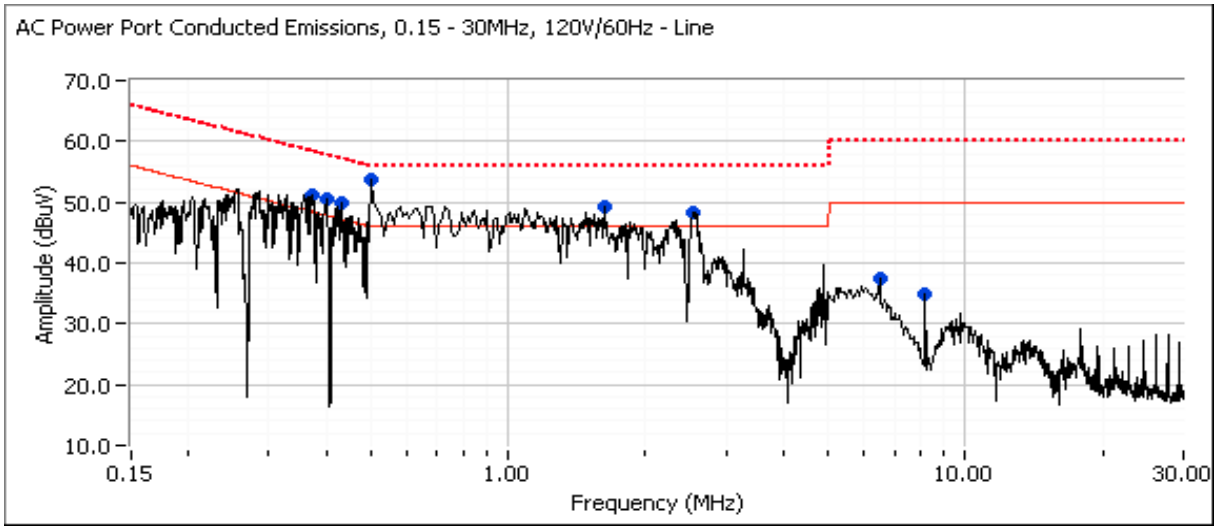
Deviations From The Standard

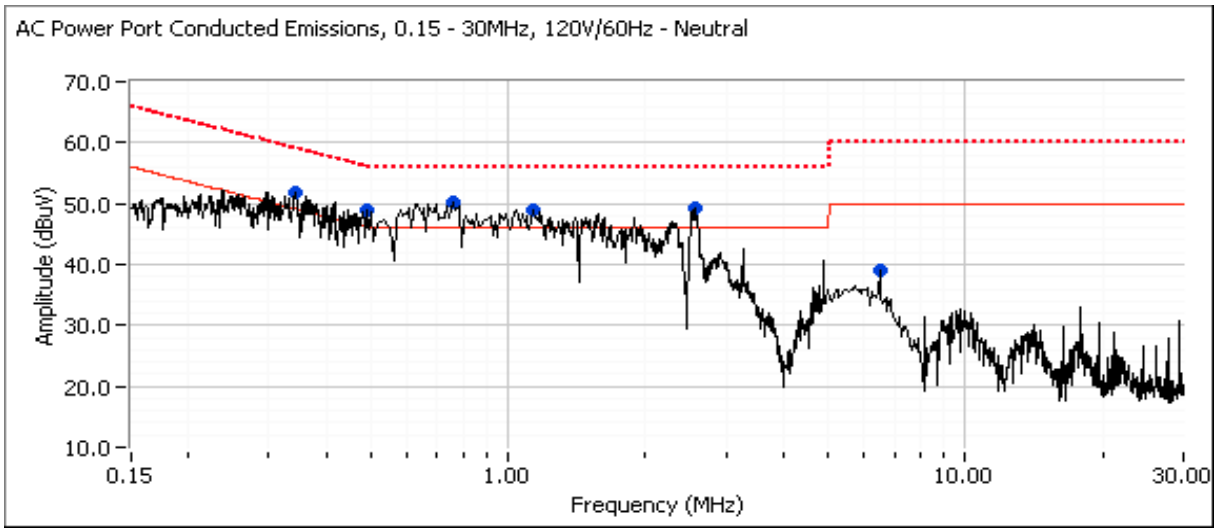
No deviations were made from the requirements of the standard.

Note: The unit was transmitting during testing and working in normal operation mode.

Client:	WateR8	Job Number:	JD100279
Model:	UnitNode (Repeater)	T-Log Number:	T100337
		Project Manager:	Christine Krebill
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.B / EN 55022	Class:	B

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





Client:	WateR8	Job Number:	JD100279
Model:	UnitNode (Repeater)	T-Log Number:	T100337
		Project Manager:	Christine Krebill
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.B / EN 55022	Class:	B

Run #1: AC Power Port Conducted Emissions, 0.15 - 30MHz, 120V/60Hz
Preliminary peak readings captured during pre-scan (peak readings vs. average limit)

Frequency	Level	AC	Class B		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
0.499	53.7	Line	46.0	7.7	Peak	
0.764	50.2	Neutral	46.0	4.2	Peak	
1.609	49.2	Line	46.0	3.2	Peak	
2.551	49.1	Neutral	46.0	3.1	Peak	
0.371	51.2	Line	48.4	2.8	Peak	
0.401	50.6	Line	47.8	2.8	Peak	
1.130	48.8	Neutral	46.0	2.8	Peak	
0.344	51.8	Neutral	49.1	2.7	Peak	
0.433	49.8	Line	47.2	2.6	Peak	
0.492	48.8	Neutral	46.2	2.6	Peak	
2.553	48.4	Line	46.0	2.4	Peak	
6.524	39.1	Neutral	50.0	-10.9	Peak	
6.425	37.6	Line	50.0	-12.4	Peak	
8.152	35.0	Line	50.0	-15.0	Peak	

Client:	WateR8	Job Number:	JD100279
Model:	UnitNode (Repeater)	T-Log Number:	T100337
		Project Manager:	Christine Krebill
Contact:	Steve Smith	Project Coordinator:	-
Standard:	FCC 15.B / EN 55022	Class:	B

Final quasi-peak and average readings

Frequency	Level	AC	Class B		Detector	Comments
MHz	dBµV	Line	Limit	Margin	QP/Ave	
0.764	44.8	Neutral	56.0	-11.2	QP	QP (1.00s)
0.499	44.4	Line	56.0	-11.6	QP	QP (1.00s)
2.553	44.0	Line	56.0	-12.0	QP	QP (1.00s)
2.551	44.0	Neutral	56.0	-12.0	QP	QP (1.00s)
1.130	43.8	Neutral	56.0	-12.2	QP	QP (1.00s)
0.401	45.4	Line	57.8	-12.4	QP	QP (1.00s)
0.371	46.1	Line	58.5	-12.4	QP	QP (1.00s)
0.433	44.4	Line	57.2	-12.8	QP	QP (1.00s)
0.491	43.3	Neutral	56.2	-12.9	QP	QP (1.00s)
0.344	46.0	Neutral	59.1	-13.1	QP	QP (1.00s)
1.609	42.5	Line	56.0	-13.5	QP	QP (1.00s)
6.524	30.3	Neutral	50.0	-19.7	AVG	AVG (0.10s)
2.553	22.9	Line	46.0	-23.1	AVG	AVG (0.10s)
2.551	22.8	Neutral	46.0	-23.2	AVG	AVG (0.10s)
0.371	24.8	Line	48.5	-23.7	AVG	AVG (0.10s)
6.524	36.3	Neutral	60.0	-23.7	QP	QP (1.00s)
0.433	23.2	Line	47.2	-24.0	AVG	AVG (0.10s)
0.764	20.8	Neutral	46.0	-25.2	AVG	AVG (0.10s)
1.130	20.4	Neutral	46.0	-25.6	AVG	AVG (0.10s)
0.401	22.1	Line	47.8	-25.7	AVG	AVG (0.10s)
0.499	20.0	Line	46.0	-26.0	AVG	AVG (0.10s)
1.609	19.8	Line	46.0	-26.2	AVG	AVG (0.10s)
0.491	19.8	Neutral	46.2	-26.4	AVG	AVG (0.10s)
8.152	33.2	Line	60.0	-26.8	QP	QP (1.00s)
8.152	23.2	Line	50.0	-26.8	AVG	AVG (0.10s)
0.344	21.7	Neutral	49.1	-27.4	AVG	AVG (0.10s)
6.425	28.7	Line	60.0	-31.3	QP	QP (1.00s)
6.425	12.3	Line	50.0	-37.7	AVG	AVG (0.10s)

End of Report

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