FCC Certification 15.247 DTS
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NOTES

1) **ITEMS IN RED THROUGOUT THE REPORT ARE ITEMS THAT NEED TO BE ADDRESSED BY THE ENG AT THE TIME OF COMPLETION.**

Template Revision History

Revision	Date	Revised By	Authorized by: QM <initials>, Date	Reason for Revision
Rev 1.0	08/24/15	SM		Generated
Rev 2.0	12/6/17	AM		Updated ANSI dates and conducted spurious subsection designation

Compliance Testing, LLC
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EMI, EMC, RF Testing Experts Since 1963

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info@ComplianceTesting.com

Test Report

Prepared for: Axsys Automation Corp

Model: Zero Mass Water Sensor

Description: Solar Water Station

Serial Number: N/A

FCC ID: 2AO29200000700
IC: 23632-200000700

To

FCC Part 15.247
IC RSS-247, Issue 2

Date of Issue: April 12, 2018

On the behalf of the applicant:	**Axsys Automation Corp** **16043 N. 82nd St.** **Scottsdale, AZ 85260**
Attention of:	**Brad Carey** **Ph: (480)607-9183** **E-Mail: bcarey@axsysautomation.com**

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Project No: p1820009

Kenneth Lee
Project Test Engineer

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All results contained herein relate only to the sample tested.

Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	February 23, 2018	Kenneth Lee	Original Document
2.0	April 6, 2018	Kenneth Lee	Updated Antenna Gain to 6 dBi, added better explanations to the Peak Power and Power Spectral Density test methods. Updated FCC ID

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ILAC / A2LA

Compliance Testing, LLC, has been accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to the joint ISO-ILAC-IAF Communiqué dated January 2009).

The tests results contained within this test report all fall within our scope of accreditation, unless noted below.

Please refer to http://www.compliancetesting.com/labscope.html for current scope of accreditation.

Testing Certificate Number: **2152.01**

ACCREDITED
TESTING CERT
#2152.01

FCC Site Reg. #349717

IC Site Reg. #2044A-2

Non-accredited tests contained in this report:

N/A

The applicant has been cautioned as to the following

15.21 - Information to User

The user's manual or instruction manual for an intentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

15.27(a) - Special Accessories

Equipment marked to a consumer must be capable of complying with the necessary regulations in the configuration in which the equipment is marketed. Where special accessories, such as shielded cables and/or special connectors are required to enable an unintentional or intentional radiator to comply with the emission limits in this part, the equipment must be marketed with, i.e. shipped and sold with, those special accessories. However, in lieu of shipping or packaging the special accessories with the unintentional or intentional radiator, the responsible party may employ other methods of ensuring that the special accessories are provided to the consumer without an additional charge.

Information detailing any alternative method used to supply the special accessories for a grant of equipment authorization or retained in the verification records, as appropriate. The party responsible for the equipment, as detailed in § 2.909 of this chapter, shall ensure that these special accessories are provided with the equipment. The instruction manual for such devices shall include appropriate instructions on the first page of text concerned with the installation of the device that these special accessories must be used with the device. It is the responsibility of the user to use the needed special accessories supplied with the equipment.

Standard Test Conditions Engineering Practices

Except as noted herein, the following conditions and procedures were observed during the testing:

In accordance with ANSI C63.10-2013 and unless otherwise indicated in the specific measurement results, the ambient temperature of the actual EUT was maintained within the range of 10° to 40°C (50° to 104°F) unless the particular equipment requirements specified testing over a different temperature range. Also, unless otherwise indicated, the humidity levels were in the range of 10% to 90% relative humidity.

Measurement results, unless otherwise noted, are worst-case measurements.

Environmental Conditions		
Temperature (ºC)	**Humidity (%)**	**Pressure (mbar)**
18-29	22-38	966-972

EUT Description
Model: Zero Mass Water Sensor
Description: Solar Water Station
Firmware: N/A
Software: N/A
Serial Number: N/A
Additional Information: The EUT implements OQFSK modulation.
Antenna Gain: 6 dBi

EUT Operation during Tests
The EUT was set to transmit at the lowest, middle and highest channel of operation at the maximum available output power.

Accessories: None

Cables: None

Modifications: None

15.203: Antenna Requirement:

	The antenna is permanently attached to the EUT
X	The antenna uses a unique coupling
	The EUT must be professionally installed
	The antenna requirement does not apply

Test Results Summary

FCC 15.247 Specification	RSS-247 Specification	Test Name	Pass, Fail, N/A	Comments
15.247(b)	Section 5.4(d)	Peak Output Power	Pass	
15.247(d)	Section 5.5	Conducted Spurious Emissions	Pass	
15.247(d), 15.209(a), 15.205	Section 5.5	Radiated Spurious Emissions	Pass	
15.247(d), 15.209(a), 15.205	Section 5.5	Emissions At Band Edges	Pass	
15.247(a)(2)	Section 5.2(a)	Occupied Bandwidth	Pass	
15.247(e)	Section 5.2(b)	Transmitter Power Spectral Density	Pass	
15.207	RSS-GEN Section 8.8	A/C Powerline Conducted Emissions	N/A	EUT is DC Powered

References	Description
CFR47, Part 15, Subpart B	Unintentional Radiators
CFR47, Part 15, Subpart C	Intentional Radiators
ANSI C63.10-2013	American National standard for testing Unlicensed Wireless Devices
ANSI C63.4-2014	Method and Measurements of Radio-Noise Emissions from low-Voltage Electrical and Electronic Equipment in the range 9kHz to 40GHz.
ISO/IEC 17025:2005	General requirements for the Competence of Testing and Calibrations Laboratories
KDB 558074 D01 v04	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating under §15.247

Conducted Output Power
Engineer: Kenneth Lee
Test Date: 2/23/2018

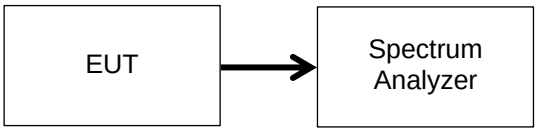
Test Procedure

The EUT was connected directly to a spectrum analyzer. The Spectrum Analyzer was set to the following:

RBW = RBW ≥ *DTS bandwidth*
VBW ≥ 3 x RBW
Span = ≥ 3 x RBW
Detector = Peak
Sweep = auto
Trace Mode = Max Hold

The EUT was set to transmit on the lowest, middle and highest frequencies at the maximum power level. The RF output power was measured using the spectrum analyzer's marker peak function, followed by a duty cycle correction per ANSI C63.10 Section 7.5.

Test Setup



Transmitter Output Power

Frequency (MHz)	Measured Data (dBm)	Duty Cycle Correction (dB)	Corrected Data (dBm)	Specification Limit (dBm)	Result
904	28.09	-8	20.08	1 W (30 dBm)	Pass
914	27.33	-8	19.33	1 W (30 dBm)	Pass
926	26.98	-8	18.98	1 W (30 dBm)	Pass

Radiated Spurious Emissions
Engineer: Kenneth Lee
Test Date: 2/21/2018

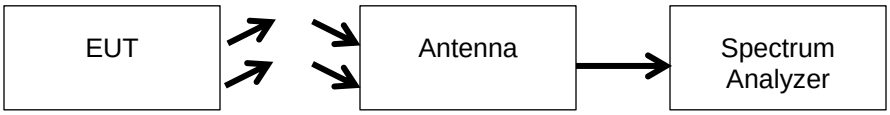
Test Procedure
Radiated Spurious Emissions: 30 – 1000 MHz

The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna. The EUT was set to transmit on the lowest, middle and highest frequencies at the maximum power level. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Emissions. The EUT was tested by rotating it 360° with the antennas in both the vertical and horizontal orientation and was raised from 1 to 4 meters to ensure the TX signal levels were maximized.

All emissions from 30 MHz to 1 GHz were examined.
Measured Level includes antenna and receiver cable correction factors.
Correction factors were input into the spectrum analyzer before recording "Measured Level".

RBW = 100 KHz
VBW = 300 KHz
Detector – Peak

Test Setup

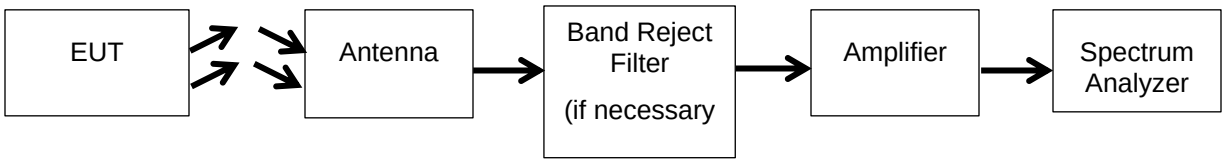


Test Procedure for
Radiated Spurious Emissions above 1 GHz

The EUT was setup in a semi-anechoic test chamber set 3m from the receiving antenna The EUT was set to transmit on the lowest, middle and highest frequencies at the maximum power level. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Emissions. The EUT was tested by rotating it 360° with the antennas in both the vertical and horizontal orientation and was raised from 1 to 4 meters to ensure the TX signal levels were maximized.

RBW = 1 MHz
VBW = 3 MHz
Detector – Peak

Test Setup



See Annex A for Test Data

Conducted Spurious Emissions

Engineer: Kenneth Lee

Test Date: 2/21/2018

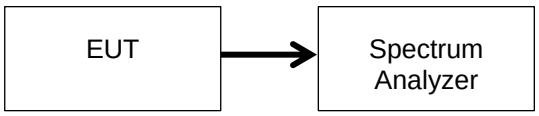
Test Procedure

The EUT was connected directly to a spectrum analyzer. The Spectrum Analyzer was set to the following:

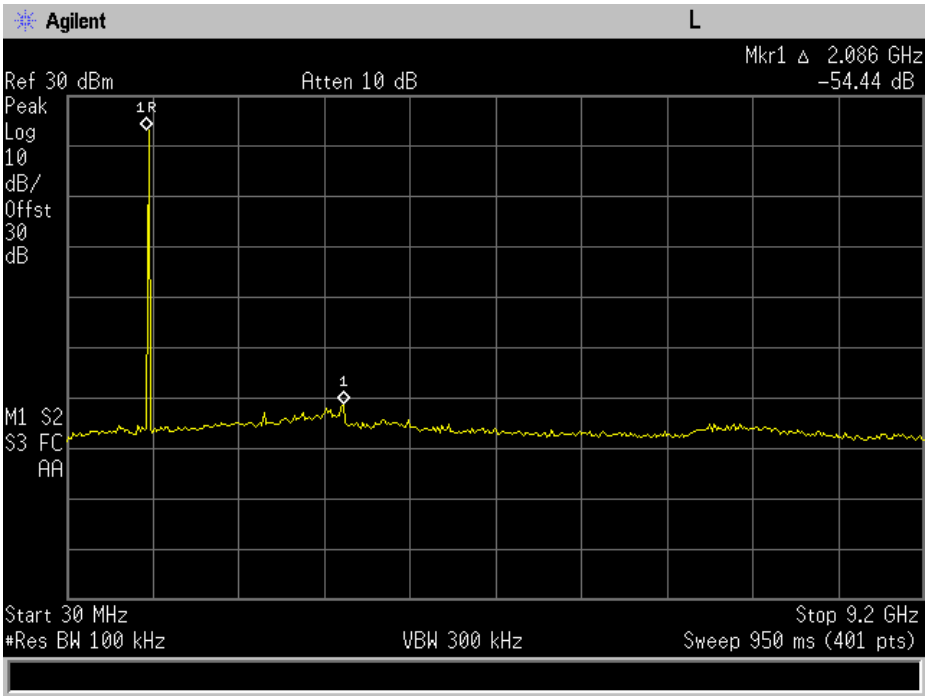
RBW = 100 kHz
VBW ≥ 3 x RBW
Peak Detector
Trace mode = max hold
Sweep = auto couple
Frequency Range = 30MHz – 10th Harmonic of the fundamental

The EUT was set to transmit on the lowest, middle and highest frequencies at the maximum power level. The trace was allowed to stabilize. All emission were investigated to insure they were attenuated from the peak fundamental by at least 20dB. If the average power levels were measured then the out-of-band emissions needed to be attenuated by 30dB.

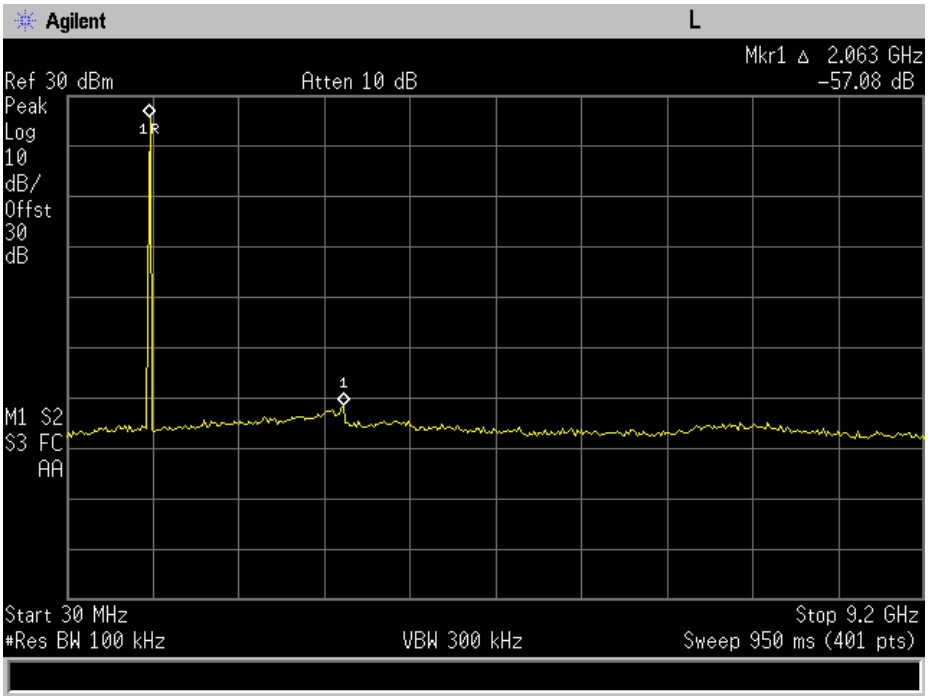
Test Setup



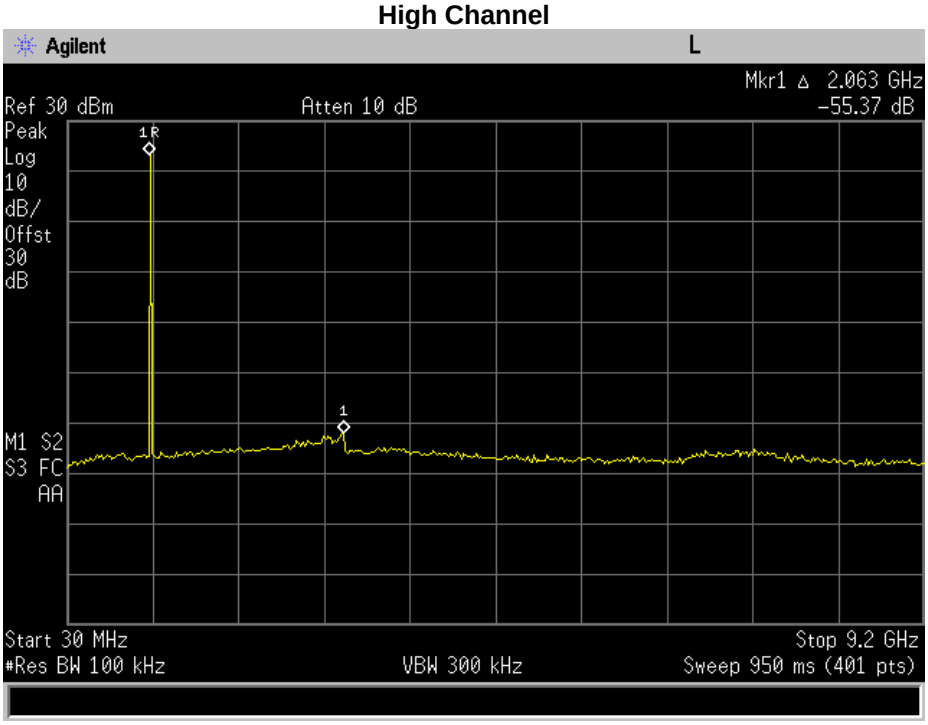
Low Channel



Middle Channel



High Channel



Emissions at Band Edges
Engineer: Kenneth Lee
Test Date: 2/21/2018

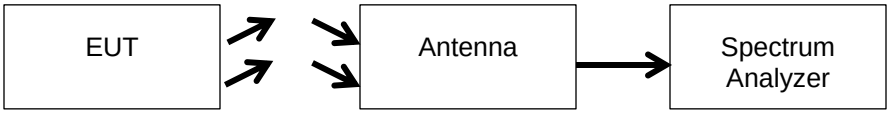
Test Procedure

The EUT was connected directly to a spectrum analyzer. The Spectrum Analyzer was set to the following:

RBW = 100 kHz
VBW ≥ 3 x RBW
Peak Detector
Trace mode = max hold
Sweep = auto couple

The spectrum analyzers marker delta function was used to ensure the emissions at the band edge were attenuated by at least 20 dBc or 30 dBc as necessary.

Test Setup

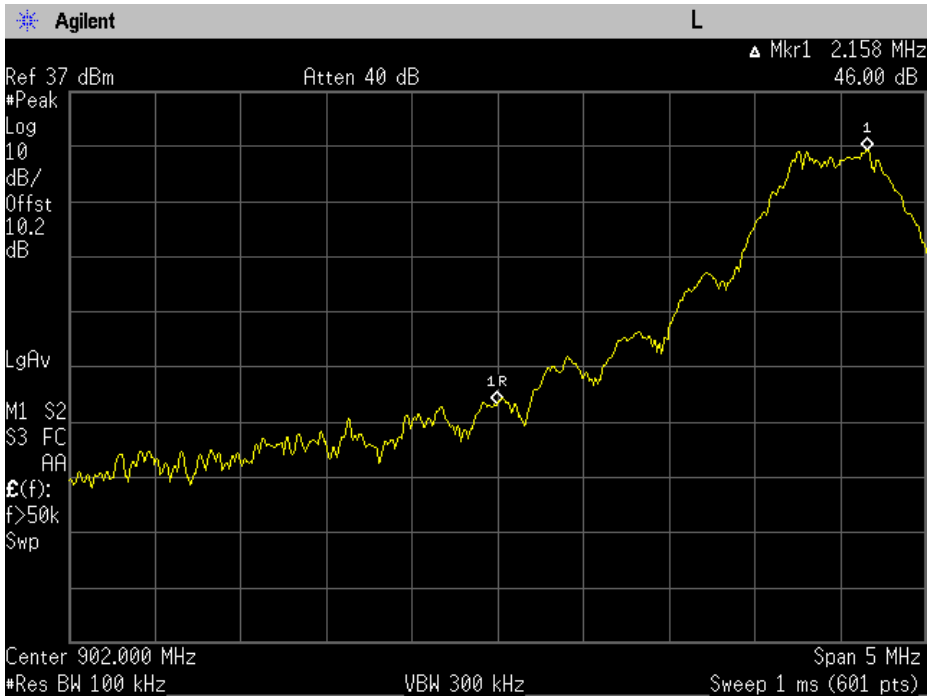


Band Edge Emissions Summary

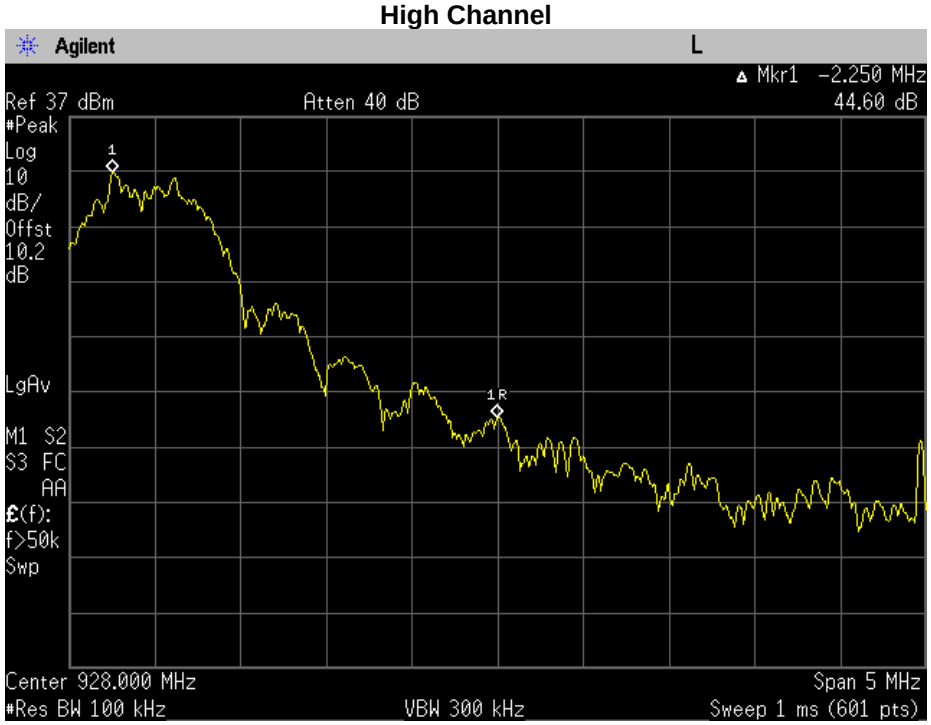
Tuned Frequency (MHz)	Emission Frequency (MHz)	Monitored Level	Detector	Limit	Result
904	902	-46 dB	Peak	-20 dBc	Pass
926	928	-44.6 dB	Peak	-20 dBc	Pass

Band Edge Plots

Low Channel



High Channel



DTS Bandwidth
Engineer: Kenneth Lee
Test Date: 2/23/2018

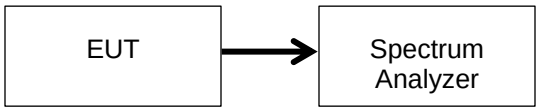
Test Procedure

The EUT was connected directly to a spectrum analyzer. The Spectrum Analyzer was set to the following:

RBW = 100 kHz
VBW ≥ 3 x RBW
Peak Detector
Trace mode = max hold
Sweep = auto couple
Span = 1.5 x EBW

The EUT was set to transmit at the lowest, middle and highest channels of the band at the maximum power levels. The maximum width of the emission that was determined by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that were attenuated by 6db and this value was used to determine the width of the carrier. Alternatively the spectrum analyzer's automatic bandwidth capability was used.

Test Setup



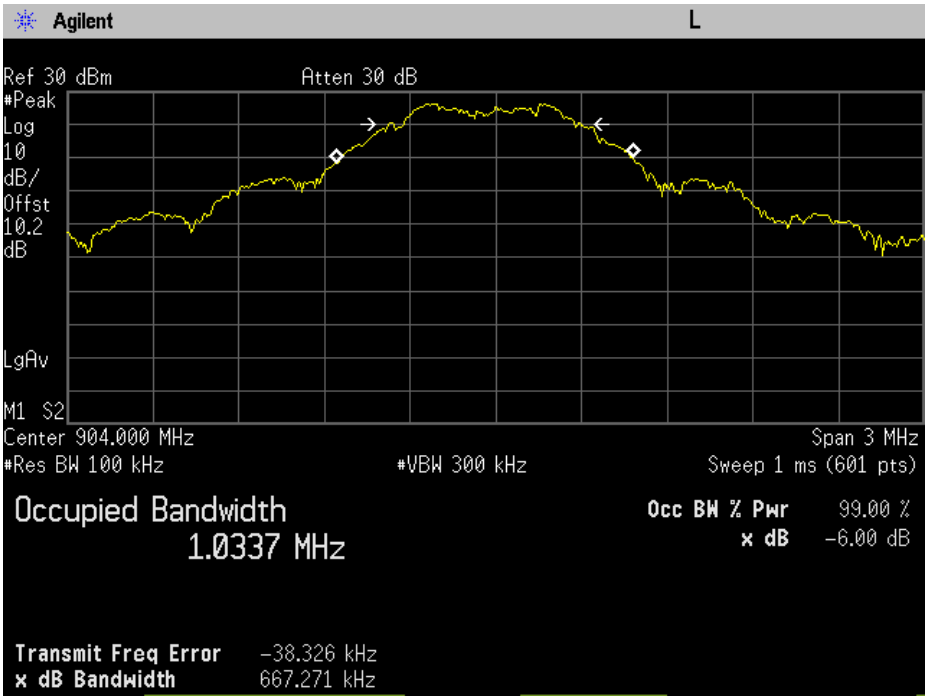
6 dB Occupied Bandwidth Summary

Frequency (MHz)	Measured Bandwidth (kHz)	Specification Limit (kHz)	Result
904	667.271	≥ 500	Pass
914	624.665	≥ 500	Pass
926	653.812	≥ 500	Pass

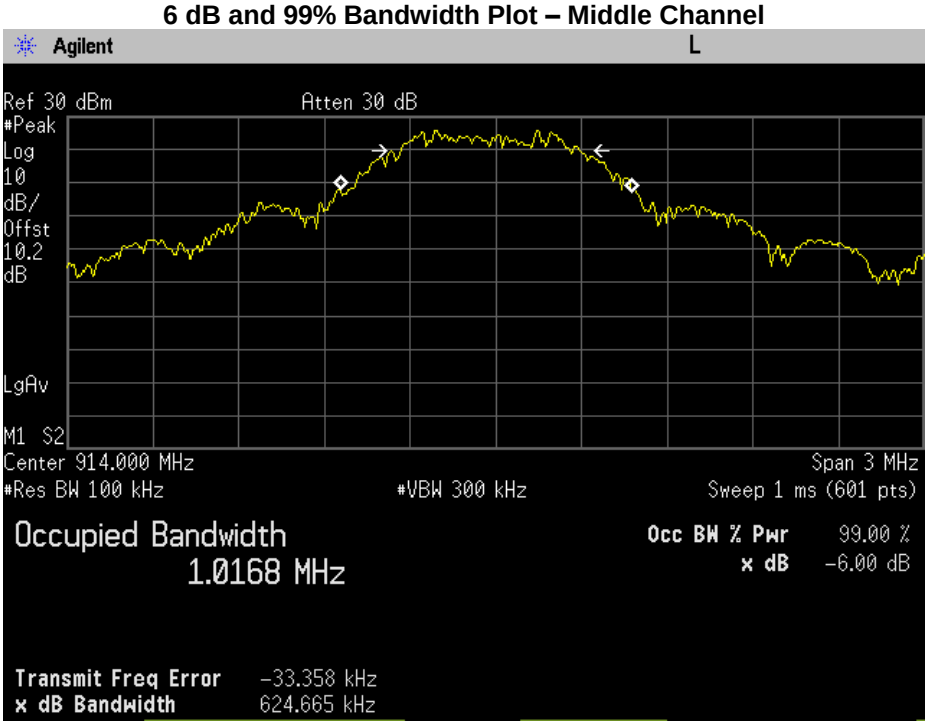
99% Bandwidth Summary

Frequency (MHz)	Measured Bandwidth (MHz)	Result
904	1.0337	Pass
914	1.0168	Pass
926	1.0496	Pass

6 dB and 99% Bandwidth Plot – Low Channel



6 dB and 99% Bandwidth Plot – Middle Channel



6 dB and 99% Bandwidth Plot – High Channel

Transmitter Power Spectral Density (PSD)

Engineer: Kenneth Lee

Test Date: 2/23/2018

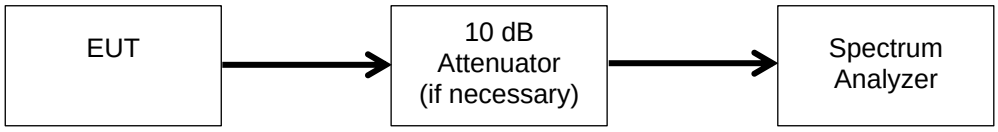
Test Procedure

The EUT was connected directly to a spectrum analyzer. The Spectrum Analyzer was set to the following:

DTS channel center frequency
Span 1.5 x DTS bandwidth
RBW =3 kHz ≤ RBW ≤ 100 kHz
VBW ≥ 3 x RBW
Peak Detector
Sweep time = auto couple
Trace mode = max hold

The EUT was set to transmit at the lowest, middle and highest channels of the band at the maximum power levels. The Power Spectral Density was measured using the spectrum analyzer's marker peak function, followed by a duty cycle correction per ANSI C63.10 Section 7.5.

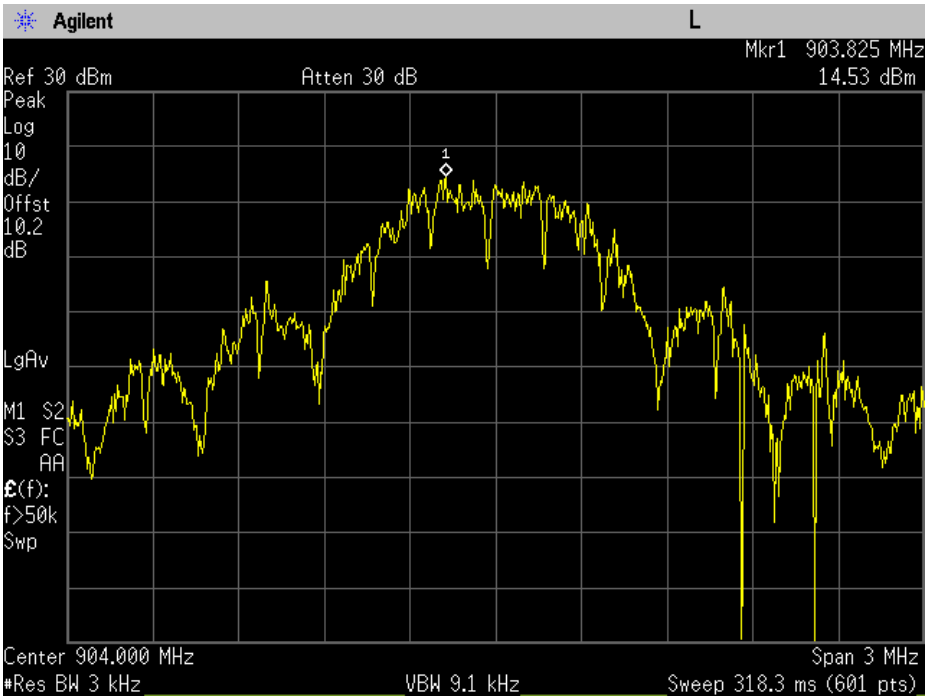
Test Setup



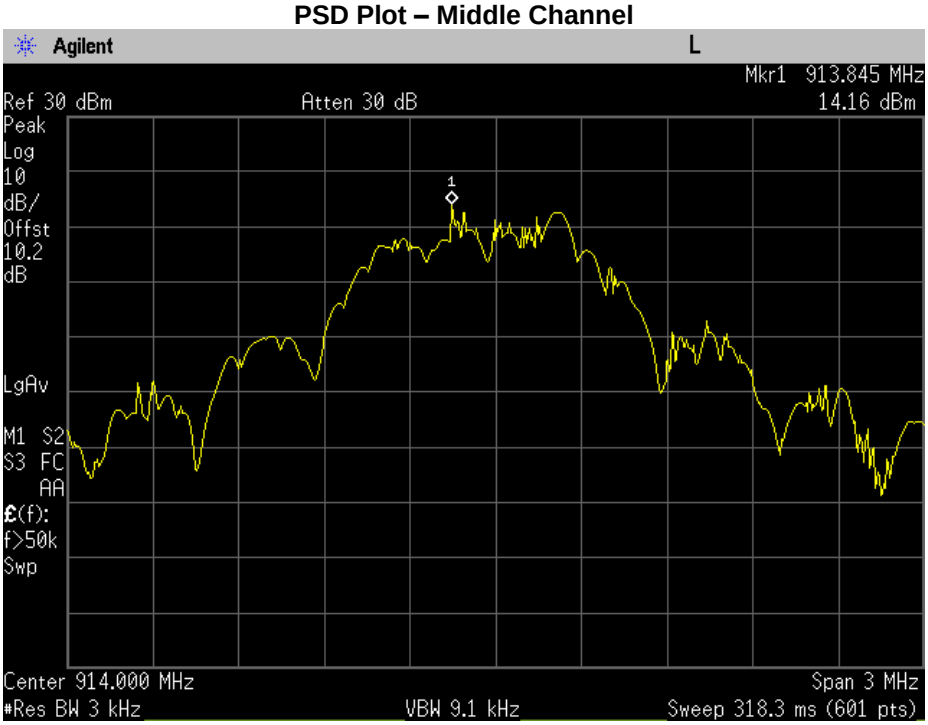
PSD Summary

Frequency (MHz)	Measured Data (dBm)	Duty Cycle Correction (dB)	Corrected Data (dBm)	Specification Limit (dBm)	Result
904	14.53	-8	6.53	8	Pass
915	14.16	-8	6.16	8	Pass
926	14.67	-8	6.67	8	Pass

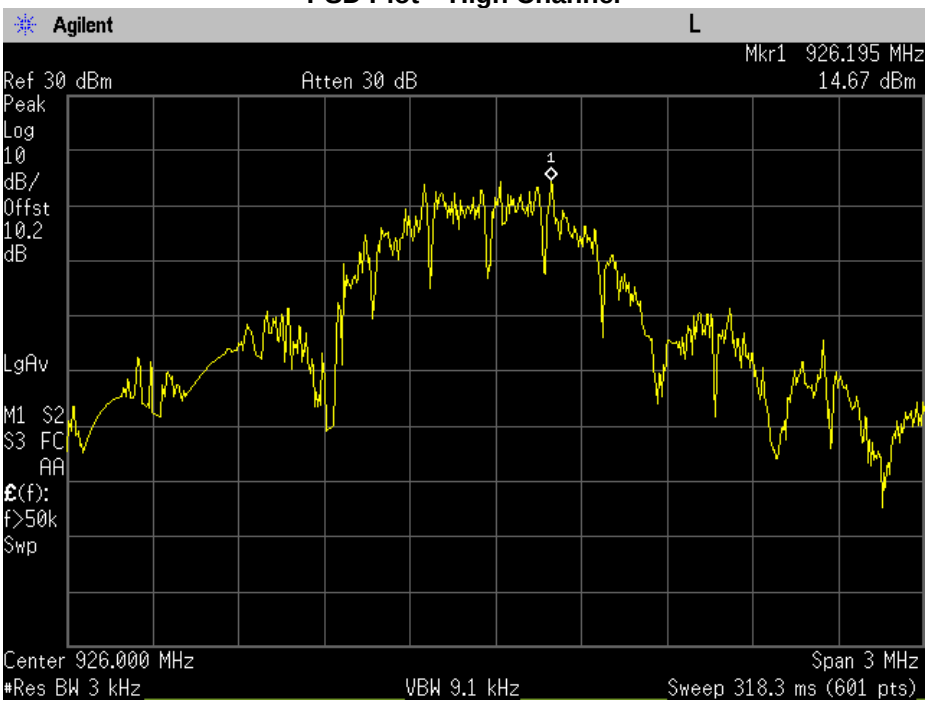
PSD Plot – Low Channel



PSD Plot – Middle Channel

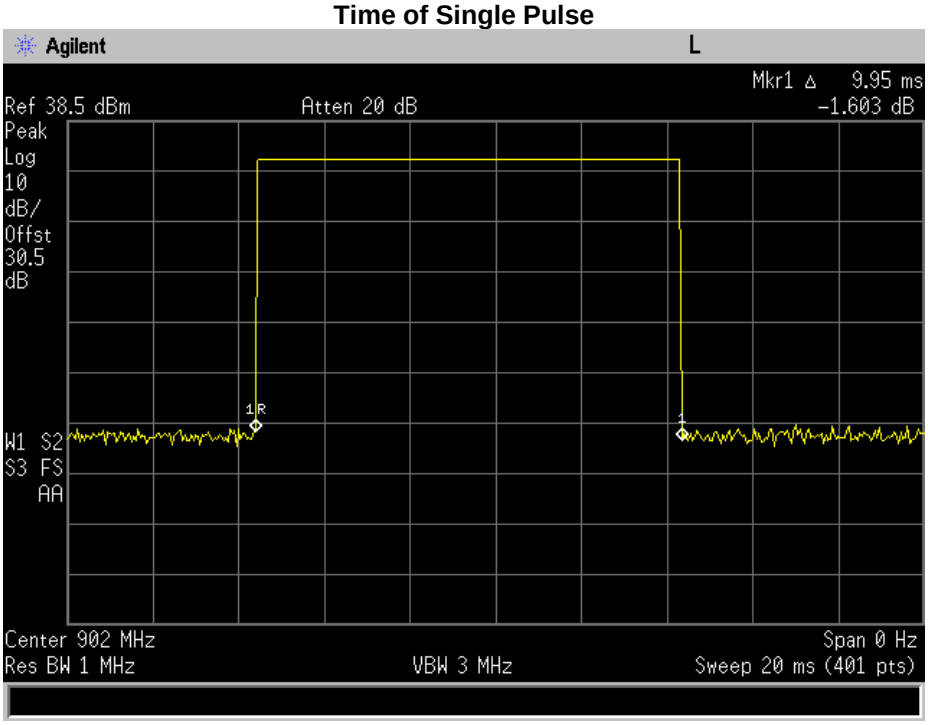


PSD Plot – High Channel

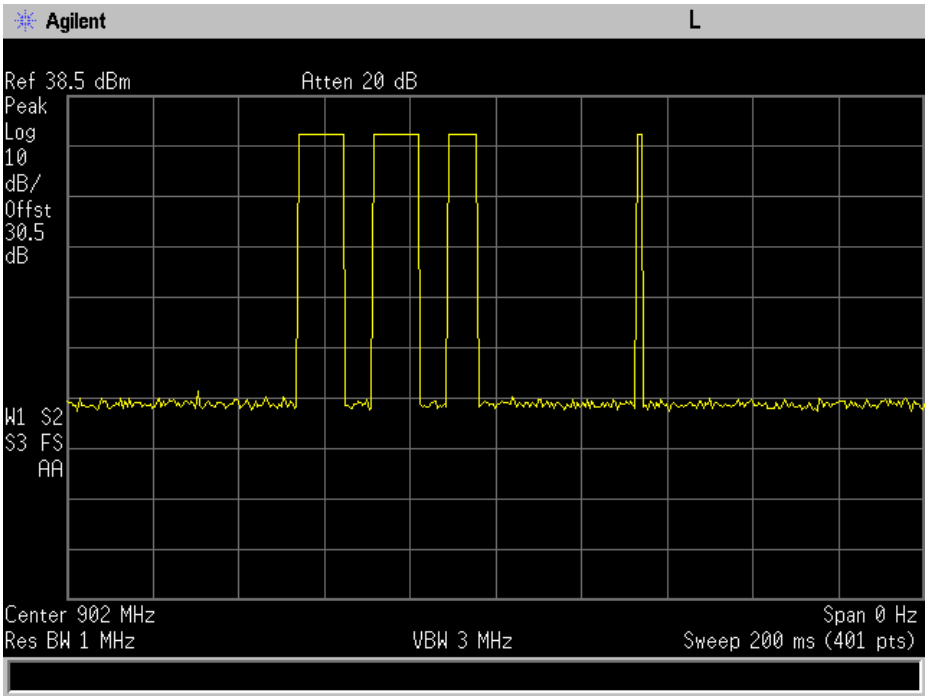


Duty Cycle Correction
Per ANSI C63.10:2013 Section 7.5

Time of Single Pulse



Number of Pulses in 200 ms



Time of Single Pulse = 9.95 ms
Number of Pulses in 100 ms = 4

$$\frac{39.8\ ms}{100\ ms} = 0.398$$

Duty Cycle Correction = 20 Log (0.398) = -8.002 dB

Test Equipment Utilized

Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
Horn Antenna	ARA	DRG-118/A	i00271	6/16/16	6/16/18
Humidity / Temp Meter	Newport	IBTHX-W-5	i00282	6/9/17	6/9/18
Bi-Log Antenna	Schaffner	CBL 6111D	i00349	8/3/16	8/3/18
EMI Analyzer	Agilent	E7405A	i00379	2/13/18	2/13/19
3 Meter Semi-Anechoic Chamber	Panashield	3 Meter Semi-Anechoic Chamber	i00428	8/15/16	8/15/19
PSA Spectrum Analyzer	Agilent	E4445A	i00471	9/6/17	9/6/18
Preamplifier for 1-18GHz horn antenna	Miteq	AFS44 00101 400 23-10P-44	i00509	N/A	N/A

In addition to the above listed equipment standard RF connectors and cables were utilized in the testing of the described equipment. Prior to testing these components were tested to verify proper operation.

END OF TEST REPORT