



Test Report

Prepared for: Avalan Wireless Systems Incorporated

Model: MOD090-HP

Description: Wireless Ethernet Communication Radio

Serial Number: #2

FCC ID: R4N-AW900G2HP
IC: 5303A-AW900G2HP

To

FCC Part 15.247 DTS

And

IC RSS-247, Issue 2

Date of Issue: March 22, 2017

On the behalf of the applicant:

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Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	January 18, 2017	Kenneth Lee	Original Document
2.0	March 17, 2017	Kenneth Lee	Updated Cover page to show RSS-247 Issue 2 Updated the 15.247 section for the Conducted Spurious Emissions in the test summary table Updated the Band Edge detector used Updated Output Power test procedure
3.0	March 22, 2017	Kenneth Lee	Updated Output Power test name in the Test Summary Table and the Test procedure Updated Power Spectral Density Test Procedure



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

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Testing Certificate Number: **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 (°C)	Humidity (%)	Pressure (mbar)
24.3	43.8	968.7

EUT Description

Model: MOD090-HP

Description: Wireless Ethernet Communication Radio

Firmware: 1.10

Software: 1.10

Serial Number: #2

Additional Information:

1. The EUT was fully tested in two modulations, OFDM and OQPSK. The Spurious emissions' testing was done with the EUT transmitting a CW signal.
2. The data in this test report was taken with the 6 dBi antenna. The device can be sold with antennas that have a higher gain, in these cases; the power shall be reduced by 1 dB for every dB the antenna's gain exceeds 6 dBi.

EUT Operation during Tests

The EUT was set to transmit on the lowest, middle and the highest channel of operation, via software on a laptop computer.



Accessories:

Qty	Description	Manufacturer	Model	S/N
1	AC/DC Adapter	Foreland	FLD181-240075-U	N/A

Cables: None

Modifications:

1 Added filtering to the Pre-Amplifier in the transmit chain

15.203: Antenna Requirement:

_____ The antenna is permanently attached to the EUT

_____ The antenna uses a unique coupling

X The EUT must be professionally installed

_____ The antenna requirement does not apply



Test Results Summary

Specification	Test Name	Pass, Fail, N/A	Comments
15.247(b)	Fundamental Emission Output Power	Pass	
15.247(d)	Conducted Spurious Emissions	Pass	
15.247(d), 15.209(a), 15.205	Radiated Spurious Emissions	Pass	
15.247(d), 15.209(a), 15.205	Emissions At Band Edges	Pass	
15.247(a)(2)	Occupied Bandwidth	Pass	
15.247(e)	Transmitter Power Spectral Density	Pass	
15.207	A/C Powerline Conducted Emissions	Pass	



Fundamental Emission Output Power

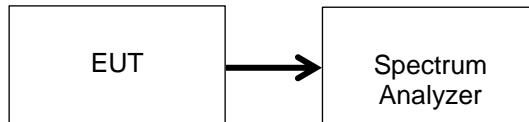
Engineer: Kenneth Lee

Test Date: 12/20/2016

Test Procedure

The EUT was connected directly to a spectrum analyzer input. The avg readings were taken and the result was then compared to the limit.

Test Setup



Fundamental Emission Output Power

OFDM

Tuned Frequency (MHz)	Measured Value (dBm)	Specification Limit	Result
904.4	29.92	1 W (30 dBm)	Pass
915.2	29.53	1 W (30 dBm)	Pass
926	29.18	1 W (30 dBm)	Pass

OQPSK

Tuned Frequency (MHz)	Measured Value (dBm)	Specification Limit	Result
904.4	29.46	1 W (30 dBm)	Pass
914	29.22	1 W (30 dBm)	Pass
926	29.59	1 W (30 dBm)	Pass



Conducted Spurious Emission

Engineer: Kenneth Lee

Test Date: 12/20/2016

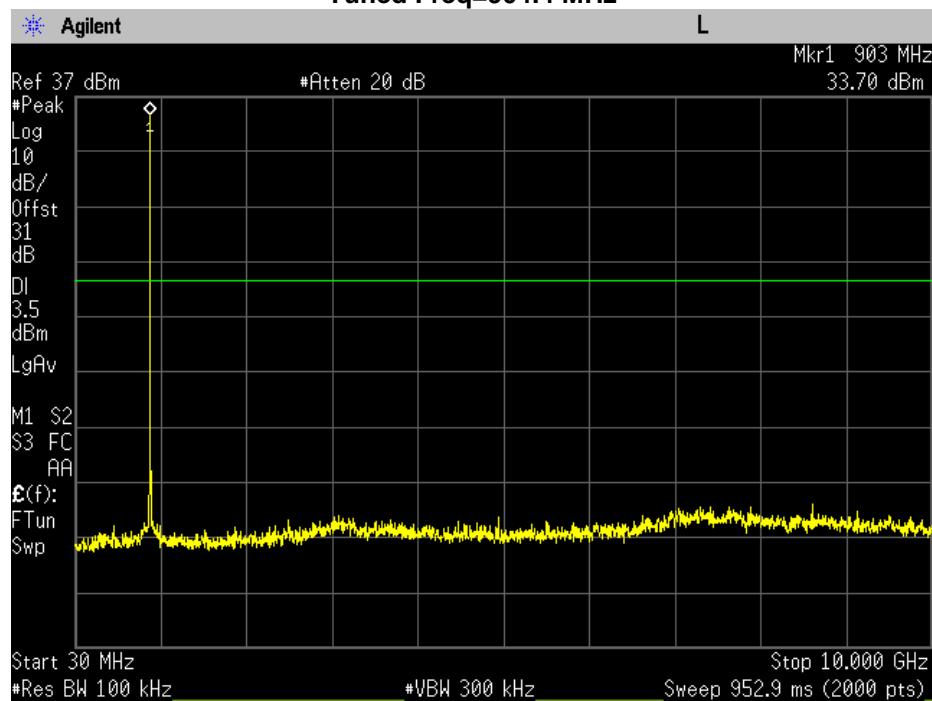
Test Procedure

The EUT was connected to a spectrum analyzer to verify that the EUT met the requirements for spurious emissions. The frequency range from 30 MHz to the 10th harmonic of the fundamental transmitter was observed. Only detectable spurious emissions were recorded and plotted. The peak output power is added to the recorded measurement to provide the corrected spurious level dBc.

Test Setup

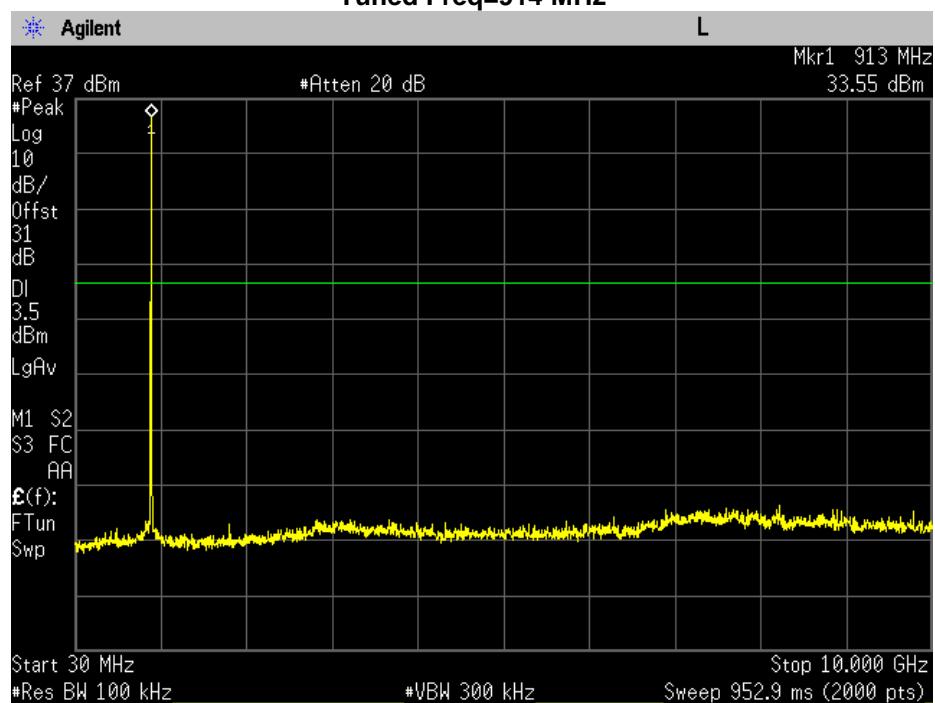


Conducted Spurious Emissions Tuned Freq=904.4 MHz

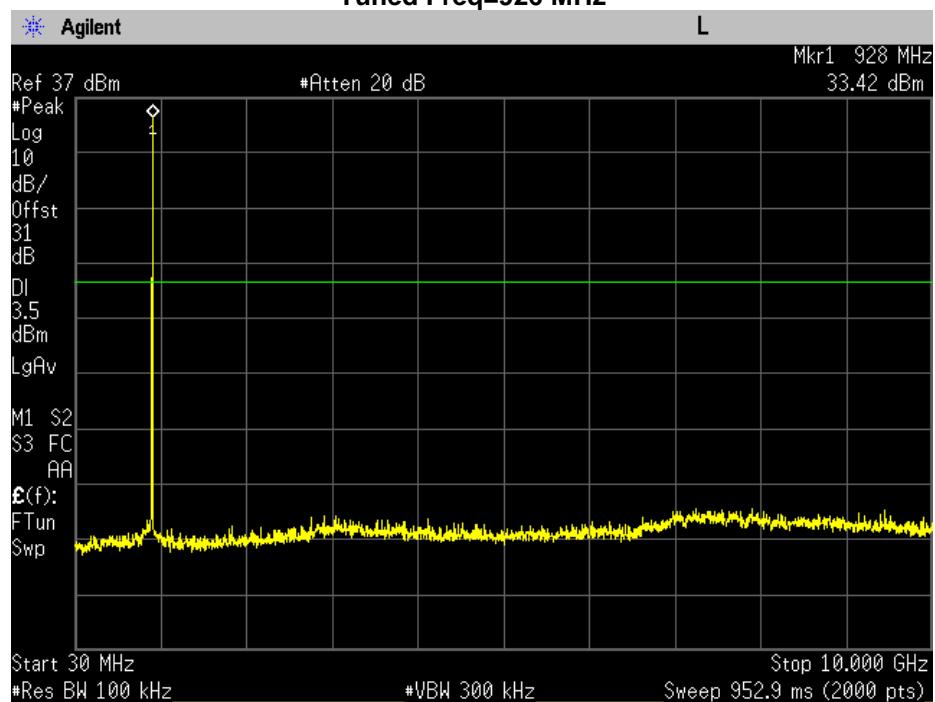




**Conducted Spurious Emissions
Tuned Freq=914 MHz**



**Conducted Spurious Emissions
Tuned Freq=926 MHz**





Radiated Spurious Emissions

Engineer: Kenneth Lee

Test Date: 12/20/2016

Test Procedure Radiated Spurious Emissions: 30 – 1000 MHz

The EUT was tested in a semi-anechoic test chamber set 3m from the receiving antenna. 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.

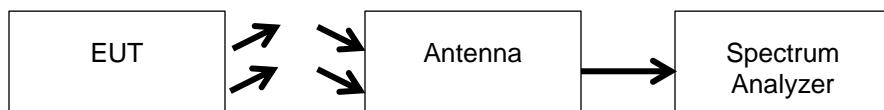
Correction factors were input into the spectrum analyzer before recording "Measured Level".

RBW = 100 KHz

VBW = 300 KHz

Detector – Quasi Peak

Test Setup



Test Procedure for Radiated Spurious Emissions above 1 GHz

The EUT was tested in a semi anechoic chamber set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Spurious Emissions. The antenna, band reject filter, amplifier and cable correction factors were input into the spectrum analyzer before recording the Measured Level to ensure accurate readings. The spectrum for each tuned frequency was examined to the 10th harmonic.

Test Setup



See Annex A for test data



Emissions at Band Edges

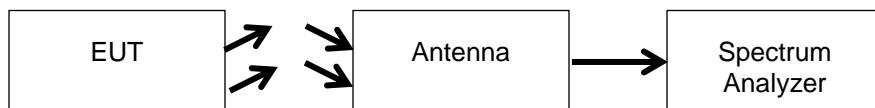
Engineer: Kenneth Lee

Test Date: 12/20/2016

Test Procedure

The EUT was tested in a semi-anechoic chamber set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for band edge and restricted band for both peak and average measurements. The cable and antenna correction factors were input into the analyzer as a reference level offset to ensure accurate readings. For the restricted band the amplifier and band reject filter correction factors were also input to the spectrum analyzer.

Band Edge Test Setup



Band Edge Emissions Summary - OFDM

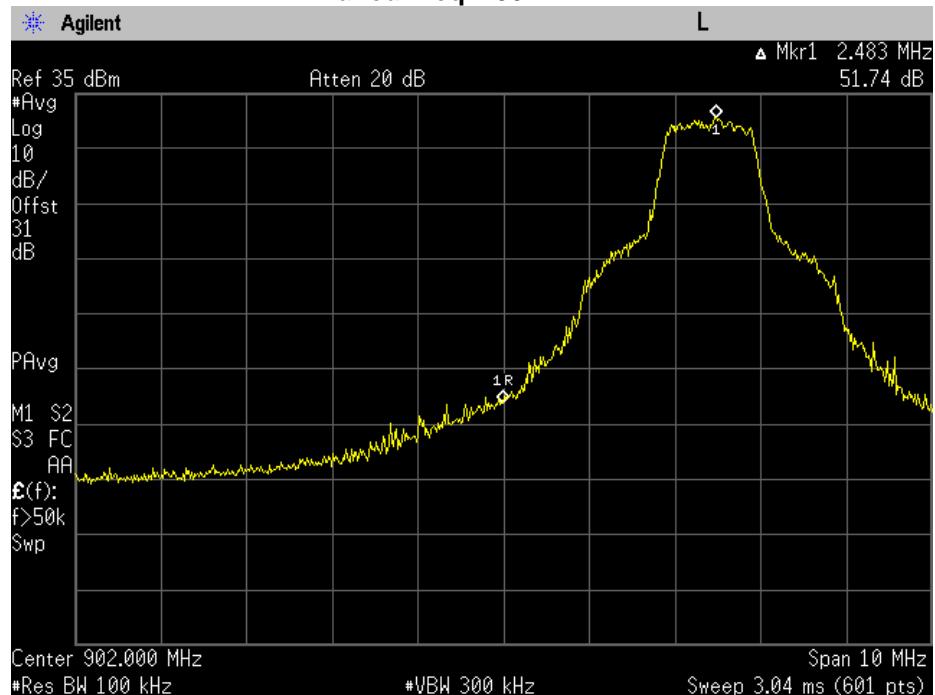
Tuned Frequency (MHz)	Emission Frequency (MHz)	Measured Value (dBc)	Detector	Limit (dBc)	Result
904.4	902	-51.74	Avg	-30dBc	Pass
926	928	-48.61	Avg	-30dBc	Pass

Band Edge Emissions Summary - OQPSK

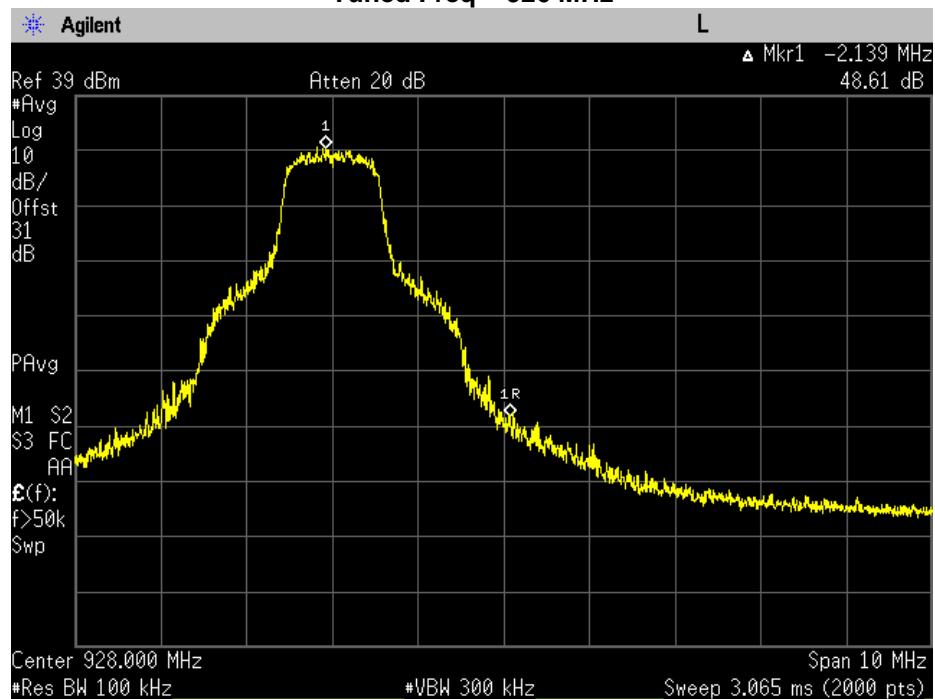
Tuned Frequency (MHz)	Emission Frequency (MHz)	Measured Value (dBc)	Detector	Limit (dBc)	Result
904.4	902	-49.57	Peak	-30dBc	Pass
926	928	-48.19	Peak	-30dBc	Pass



OFDM
Band Edge 902 MHz
Tuned Freq = 904.4 MHz

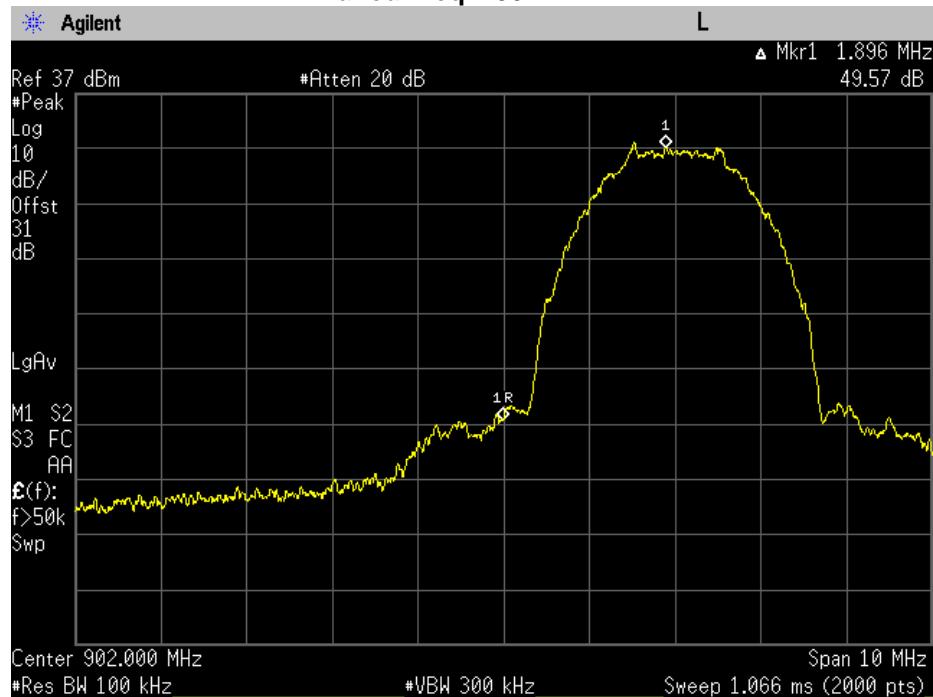


OFDM
Band Edge 928 MHz
Tuned Freq = 926 MHz

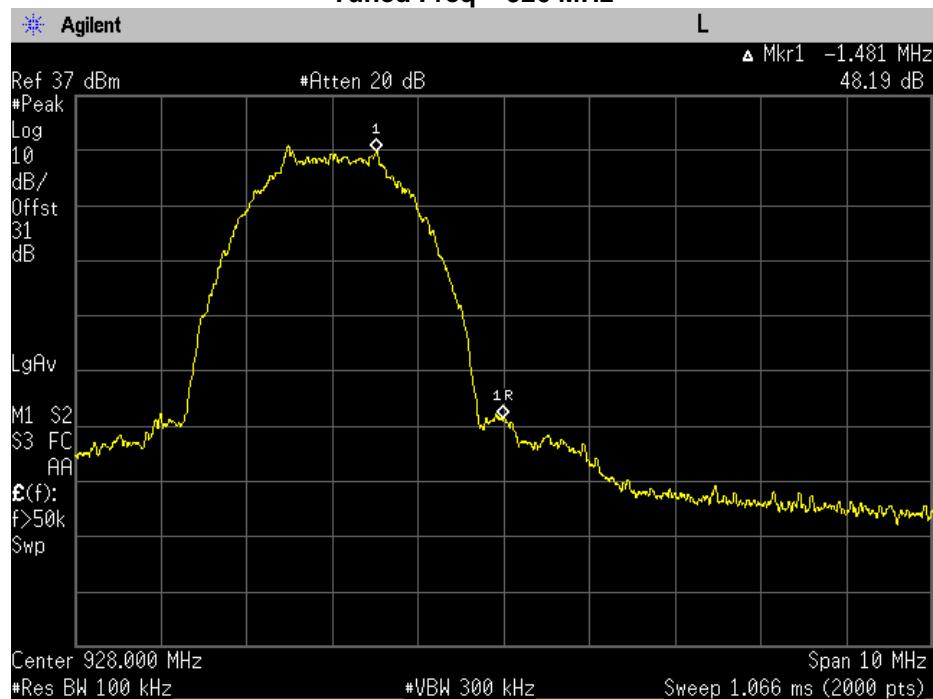




**OQPSK
Band Edge 902 MHz
Tuned Freq = 904.4 MHz**

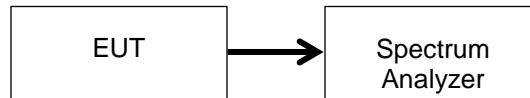


**OQPSK
Band Edge 928 MHz
Tuned Freq = 926 MHz**



**Occupied Bandwidth****Engineer:** Kenneth Lee**Test Date:** 12/20/2016**Test Procedure**

The EUT was connected directly to a spectrum analyzer. The Span was set wide enough to capture the entire transmit spectrum and the resolution bandwidth was set to at least 1% of the span. The analyzer was set to max hold and when the entire spectrum was captured the 6dB and 99% bandwidths were measured to verify the bandwidth met the specification.

Test Setup**6 dB Occupied Bandwidth Summary - OFDM**

Frequency (MHz)	Measured Bandwidth (MHz)	Specification Limit (kHz)	Result
904.4	1.083	≥ 500	Pass
915	1.102	≥ 500	Pass
926	1.075	≥ 500	Pass

99% Bandwidth Summary - OFDM

Frequency (MHz)	Measured Bandwidth (MHz)	Result
904.4	1.1937	Pass
915	1.1810	Pass
926	1.1745	Pass

6 dB Occupied Bandwidth Summary - OQPSK

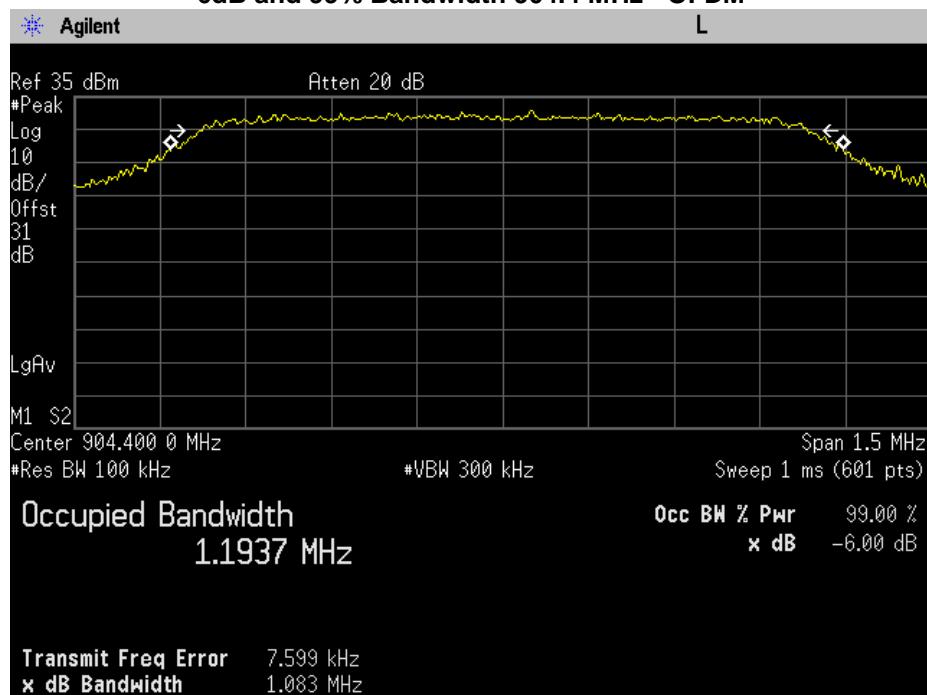
Frequency (MHz)	Measured Bandwidth (MHz)	Specification Limit (kHz)	Result
904	1.350	≥ 500	Pass
914	1.464	≥ 500	Pass
926	1.363	≥ 500	Pass

99% Bandwidth Summary - OQPSK

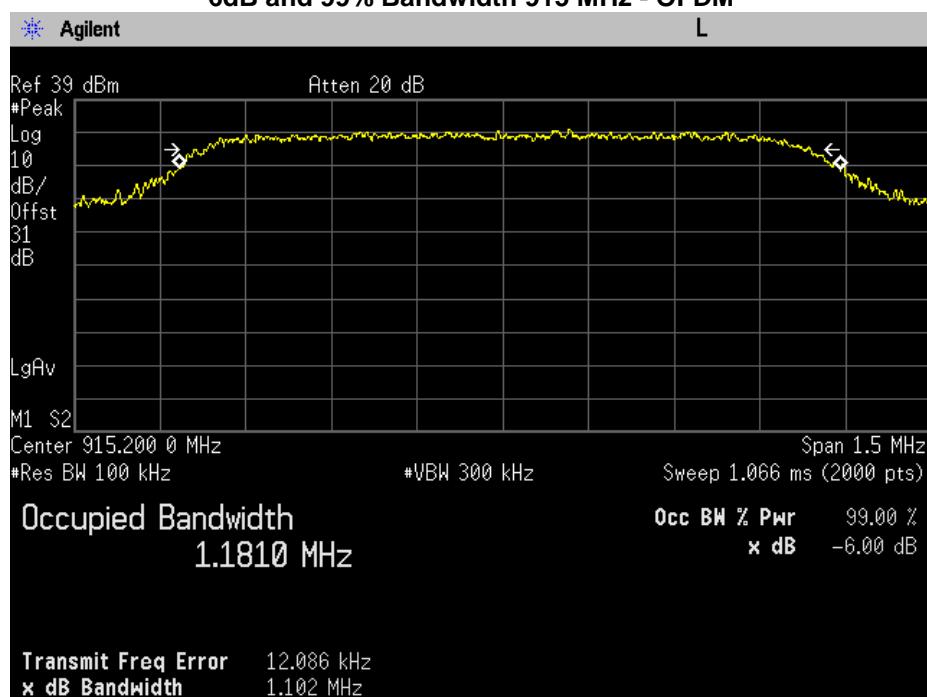
Frequency (MHz)	Measured Bandwidth (MHz)	Result
904	2.2194	Pass
914	2.2076	Pass
926	2.2139	Pass



6dB and 99% Bandwidth 904.4 MHz - OFDM

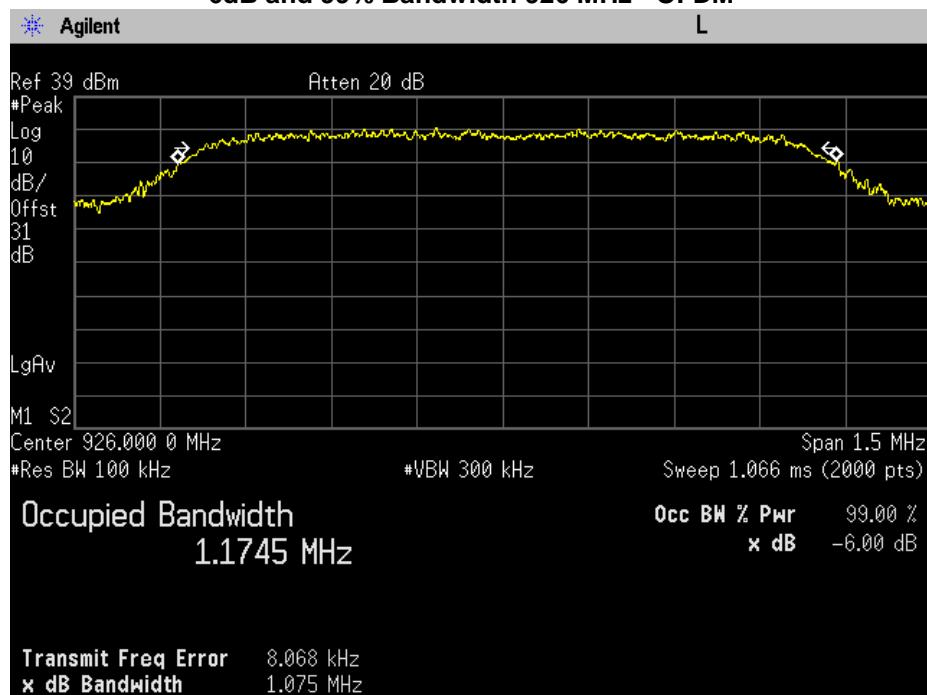


6dB and 99% Bandwidth 915 MHz - OFDM

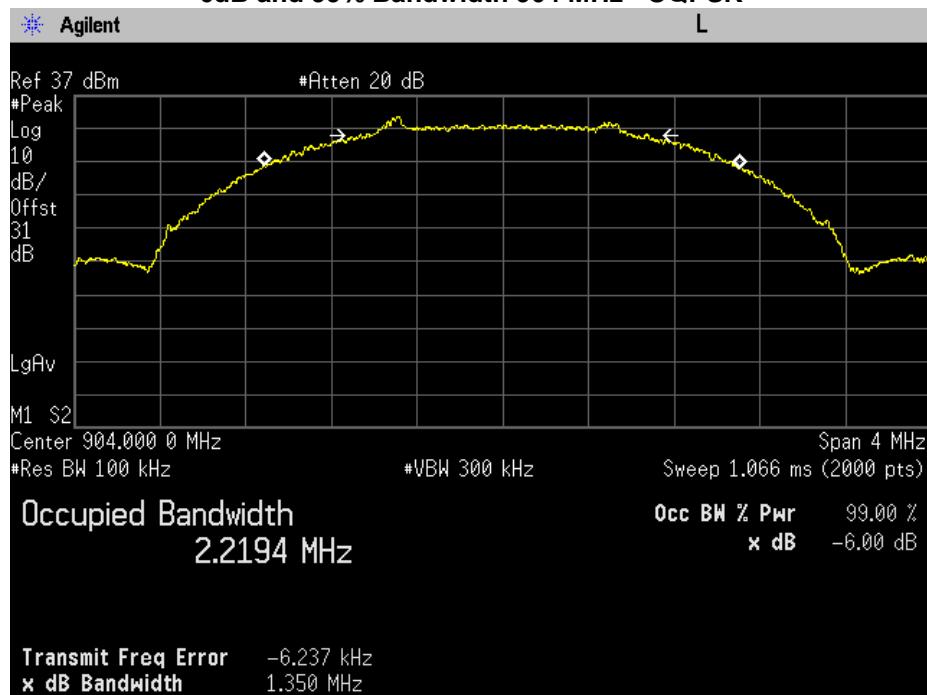




6dB and 99% Bandwidth 926 MHz - OFDM

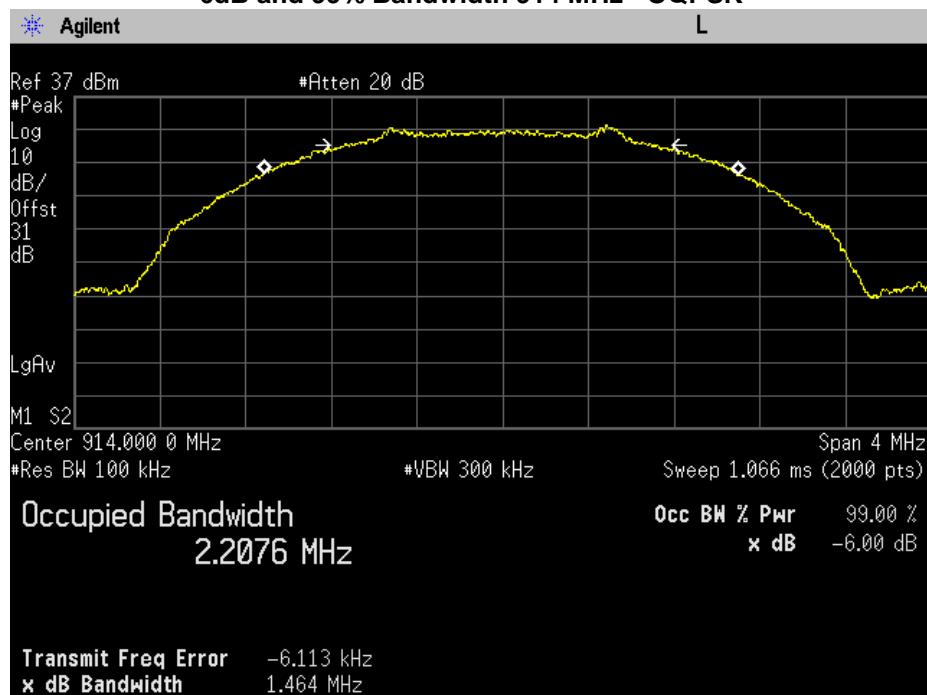


6dB and 99% Bandwidth 904 MHz - OQPSK

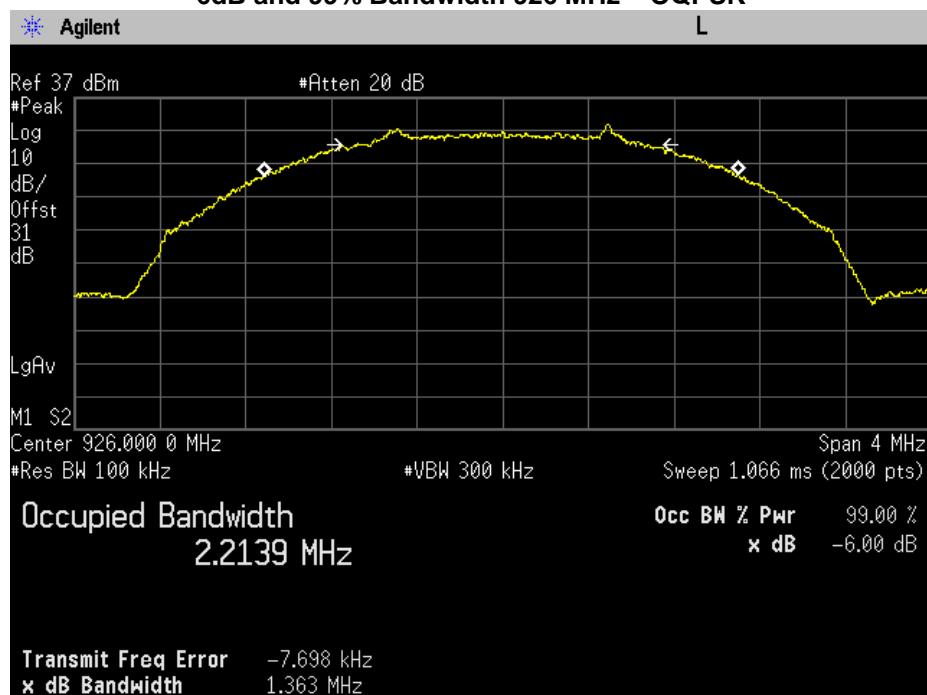




6dB and 99% Bandwidth 914 MHz - OQPSK



6dB and 99% Bandwidth 926 MHz – OQPSK





Transmitter Power Spectral Density (PSD)

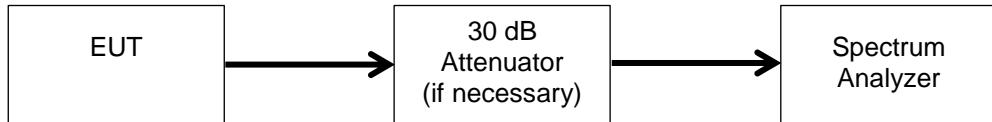
Engineer: Kenneth Lee

Test Date: 12/20/2016

Test Procedure

The EUT was connected directly to a spectrum analyzer. The test was performed per section 10.3 of KDB 558074 "Method AVGPSD-1 (trace averaging with EUT transmitting at full power throughout each sweep)"

Test Setup



PSD Summary – OFDM

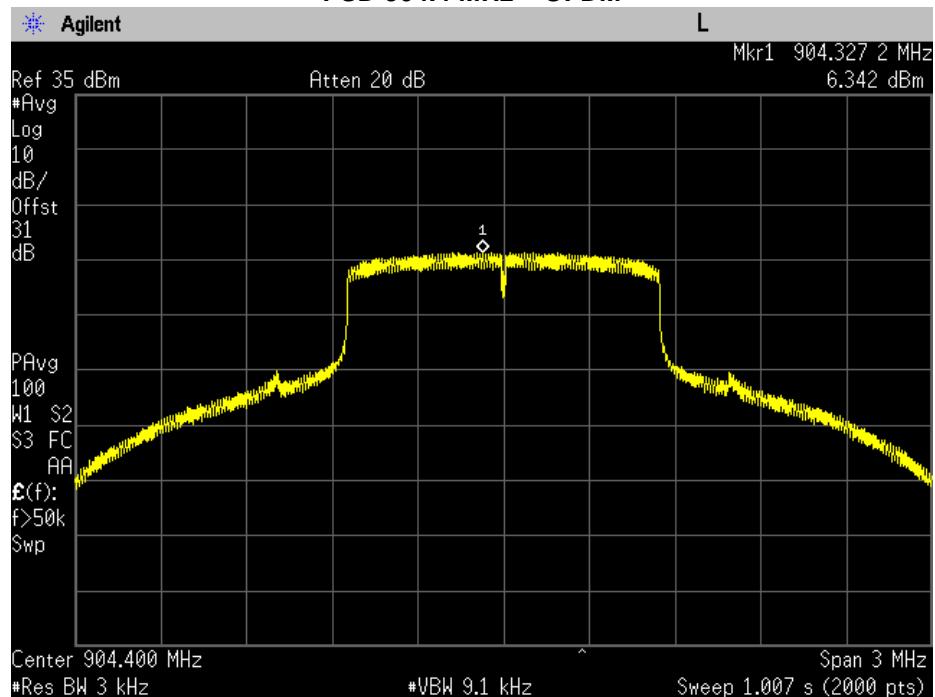
Frequency (MHz)	Measured Data (dBm)	Specification Limit (dBm)	Result
904.4	6.342	8	Pass
915	6.396	8	Pass
926	5-923	8	Pass

PSD Summary – OQPSK

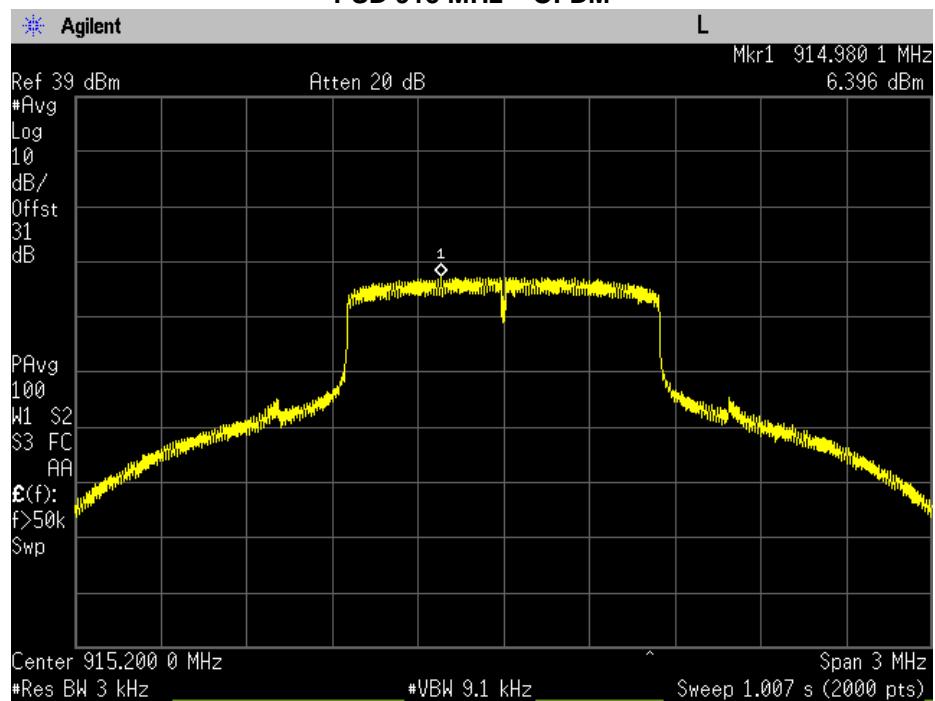
Frequency (MHz)	Measured Data (dBm)	Specification Limit (dBm)	Result
904	4.230	8	Pass
914	4.119	8	Pass
926	3.447	8	Pass



PSD 904.4 MHz – OFDM

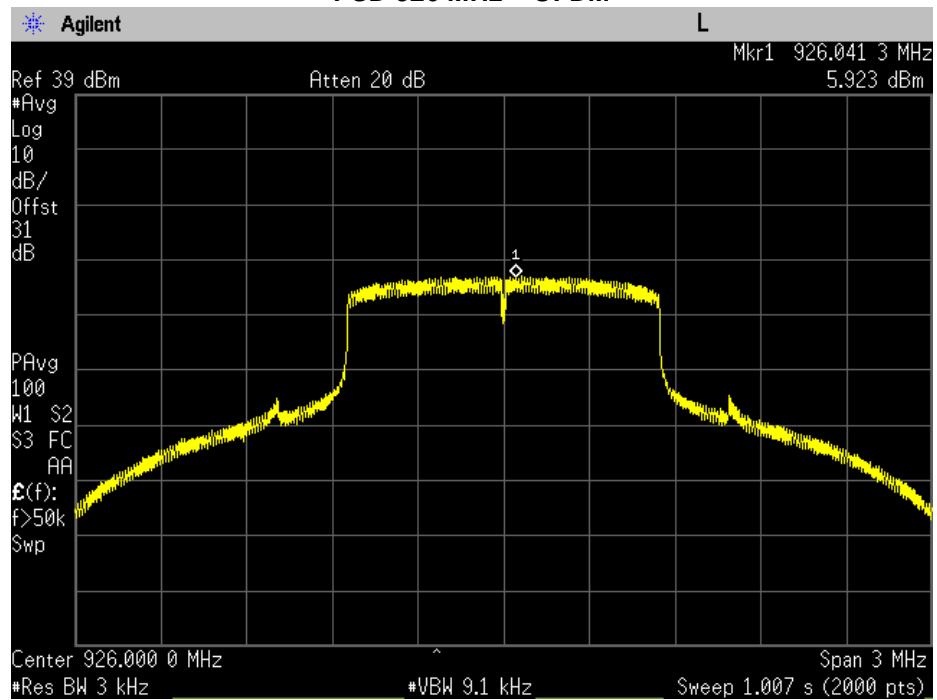


PSD 915 MHz – OFDM

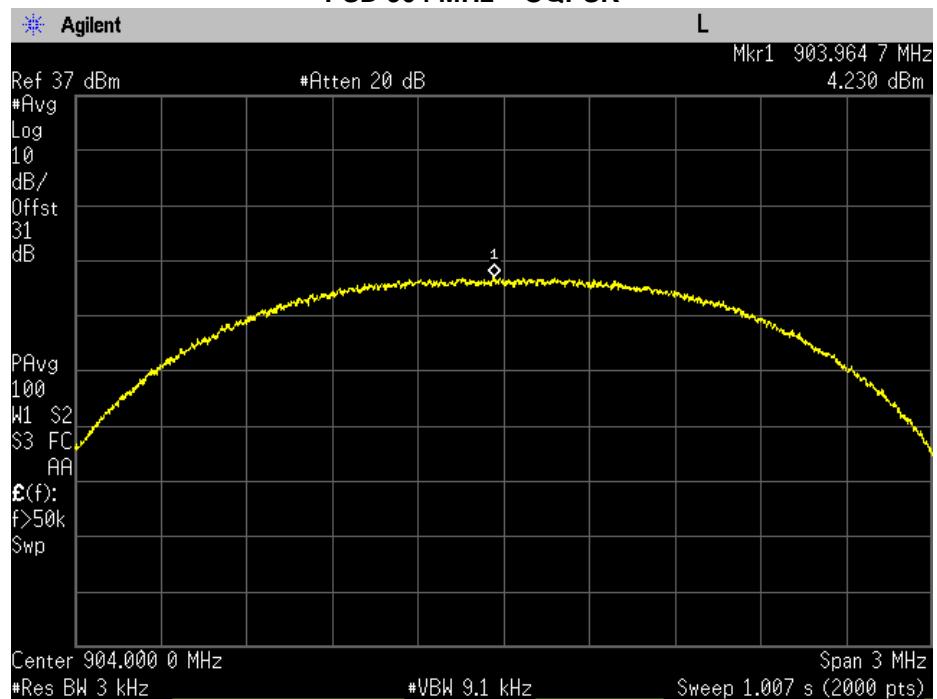




PSD 926 MHz – OFDM

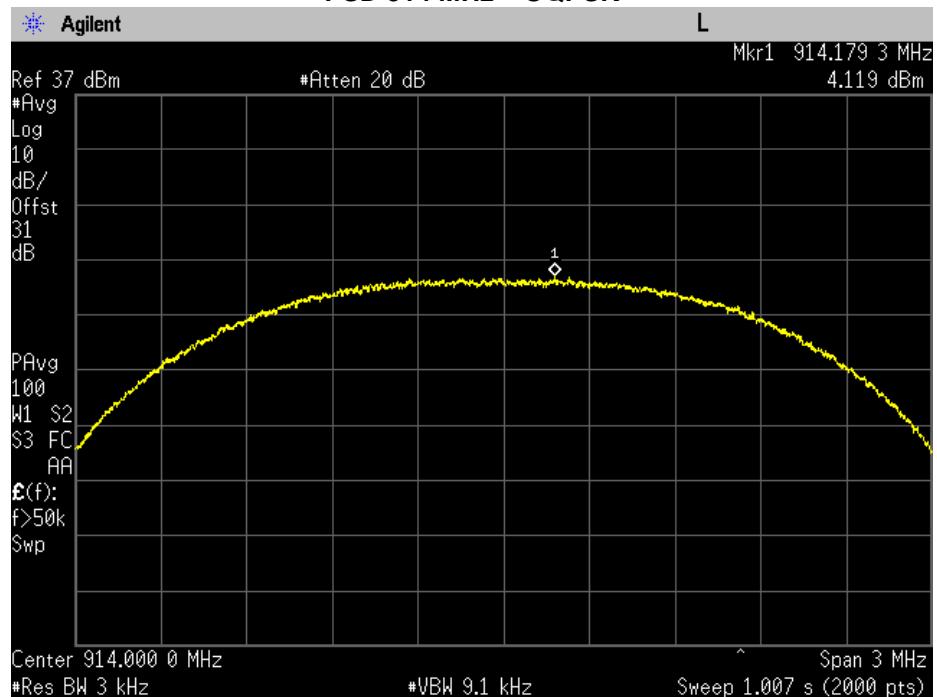


PSD 904 MHz – OQPSK

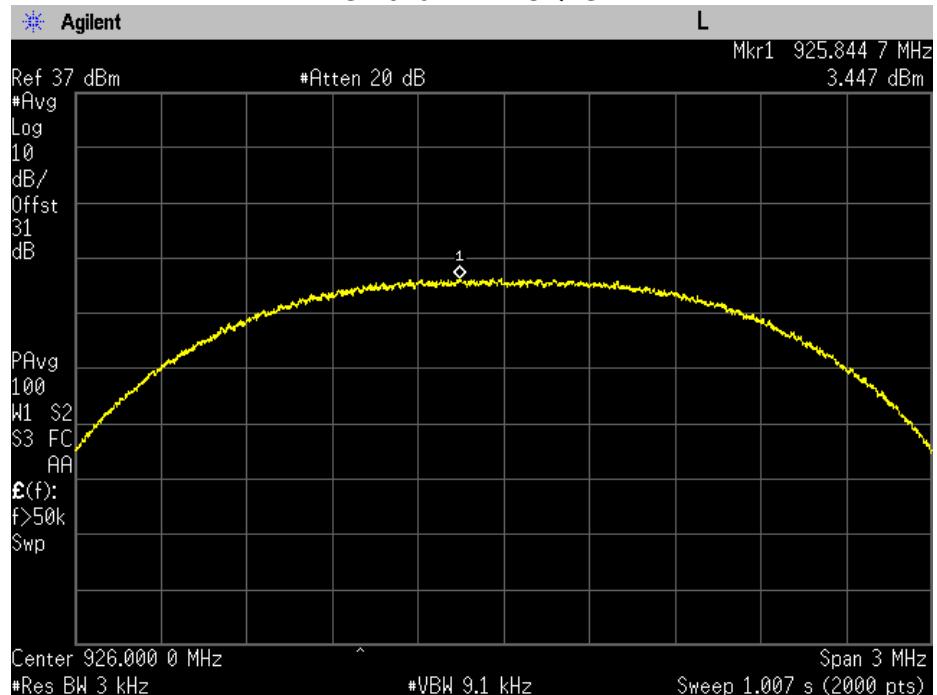




PSD 914 MHz – OQPSK



PSD 926 MHz – OQPSK





A/C Powerline Conducted Emission

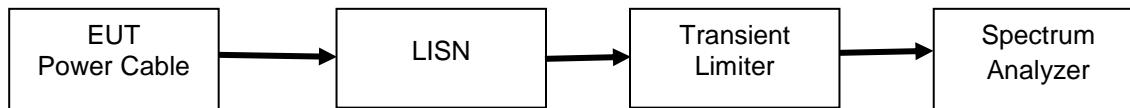
Engineer: Kenneth Lee

Test Date: 12/21/2016

Test Procedure

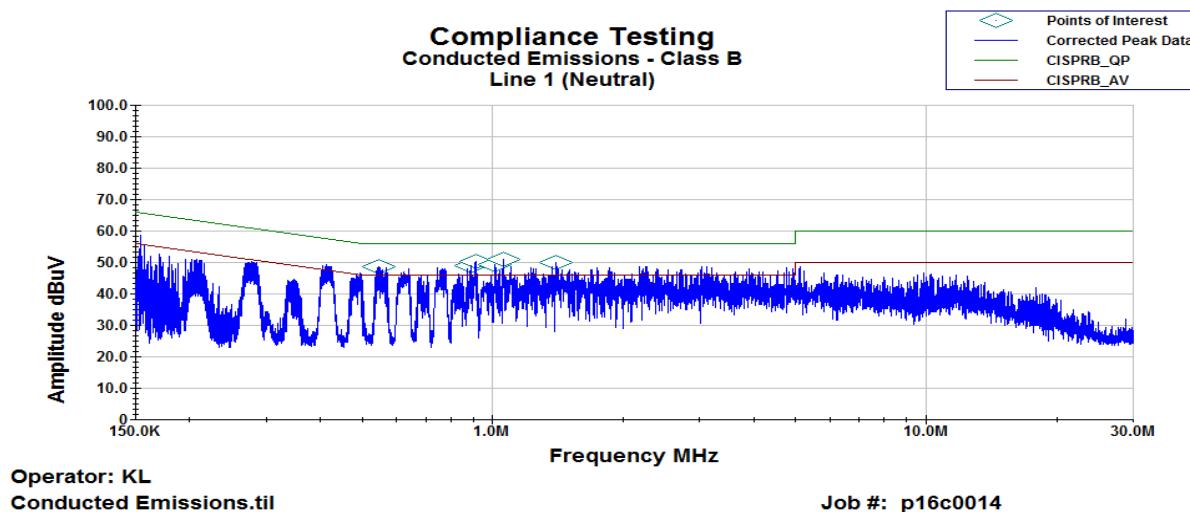
The EUT power cable was connected to a LISN and the monitored output of the LISN was connected to a transient limiter, which then connected directly to a spectrum analyzer. The conducted emissions from 150 kHz to 30 MHz were measured and compared to the specification limits.

Test Setup

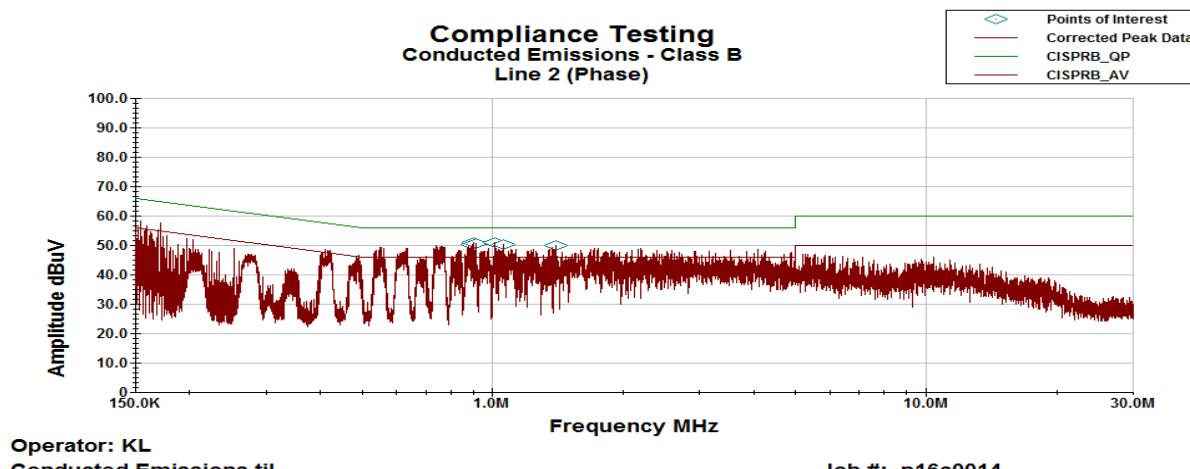


Conducted Emission Test Results

Line 1 Peak Plot



Line 2 Peak Plot





Line 1 Neutral Avg Detector

Frequency	Measured Value (dBuV)	LISN Correction Factor (dB)	Cable Loss (dB)	Transient Limiter (dB)	Final Data (dBuV)	Limit (dBuV)	Avg Margin (dB)
540.29 KHz	20.46	0.1	0.03	10.1	30.69	46	-15.31
907.11 KHz	20.62	0	0.04	10.1	30.757	46	-15.243
907.49 KHz	20.95	0	0.04	10.1	31.09	46	-14.91
1.0108 MHz	24.05	0	0.04	10.1	34.187	46	-11.813
1.0554 MHz	18.71	0	0.04	10.1	28.847	46	-17.153
1.3951 MHz	16.34	0	0.05	10.1	26.49	46	-19.51

Line 2 Phase Avg Detector

Frequency	Measured Value (dBuV)	LISN Correction Factor (dB)	Cable Loss (dB)	Transient Limiter (dB)	Final Data (dBuV)	Limit (dBuV)	Avg Margin (dB)
894.88 KHz	19.31	0	0.04	10.1	29.453	46	-16.547
903.67 KHz	19.48	0	0.04	10.1	29.623	46	-16.377
912.7 KHz	20.58	0	0.04	10.1	30.717	46	-15.283
1.0119 MHz	23.29	0	0.04	10.1	33.427	46	-12.573
1.053 MHz	15.99	0	0.04	10.1	26.133	46	-19.867
1.3963 MHz	19.62	0	0.05	10.1	29.773	46	-16.227

Line 1 Neutral QP Detector

Frequency	Measured Value (dBuV)	LISN Correction Factor (dB)	Cable Loss (dB)	Transient Limiter (dB)	Final Data (dBuV)	Limit (dBuV)	QP Margin (dB)
540.29 KHz	33.89	0.1	0.03	10.1	44.12	56	-11.88
907.11 KHz	34.15	0	0.04	10.1	44.29	56	-11.71
907.49 KHz	33.76	0	0.04	10.1	43.9	56	-12.1
1.0108 MHz	34.09	0	0.04	10.1	44.23	56	-11.77
1.0554 MHz	32.71	0	0.04	10.1	42.85	56	-13.15
1.3951 MHz	33.89	0	0.05	10.1	44.04	56	-11.96

Line 2 Phase QP Detector

Frequency	Measured Value (dBuV)	LISN Correction Factor (dB)	Cable Loss (dB)	Transient Limiter (dB)	Final Data (dBuV)	Limit (dBuV)	QP Margin (dB)
894.88 KHz	36.04	0	0.04	10.1	46.18	56	-9.82
903.67 KHz	35.86	0	0.04	10.1	46	56	-10
912.7 KHz	36.4	0	0.04	10.1	46.54	56	-9.46
1.0119 MHz	35.27	0	0.04	10.1	45.41	56	-10.59
1.053 MHz	34.03	0	0.04	10.1	44.17	56	-11.83
1.3963 MHz	33.19	0	0.05	10.1	43.34	56	-12.66

**Test Equipment Utilized**

Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
EMI Receiver	HP	8546A	i00033	3/29/16	3/29/17
Transient Limiter	Com-Power	LIT-153	i00123	Verified on: 12/21/16	
Horn Antenna	ARA	DRG-118/A	i00271	6/16/16	6/16/18
Humidity / Temp Meter	Newport	IBTHX-W-5	i00282	5/26/16	5/26/17
Bi-Log Antenna	Schaffner	CBL 6111D	i00349	8/3/16	8/3/18
AC Power Source	Behlman	BL 6000	i00362	Verified on: 12/21/16	
EMI Analyzer	Agilent	E7405A	i00379	2/11/16	2/11/17
3 Meter Semi-Anechoic Chamber	Panashield	3 Meter Semi-Anechoic Chamber	i00428	8/15/16	8/15/19
LISN	COM-Power	LI-125A	i00446	4/29/16	4/29/18
LISN	COM-Power	LI-125A	i00448	4/29/16	4/29/18
PSA Spectrum Analyzer	Agilent	E4445A	i00471	8/30/16	8/30/17
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