LS RESEARCH, LLC
WIRELESS PRODUCT DEVELOPMENT
ACCREDITED
Testing Cert. 1255.01
W66 N220 Commerce Court ● Cedarburg, WI 53012
Phone: 262.375.4400 ● Fax: 262.375.4248
www.lsr.com

TEST REPORT #: TR 314167 A
LSR Job #: C- 1964

Compliance Testing of:
Allegion AD 900MHz module V2

Test Date(s):
June 3rd to 17th 2014

Prepared For:
Attn: Mike Henney
11819 North Pennsylvania street,
Carmel, IN 46032

This Test Report is issued under the Authority of:
Khairul Aidi Zainal, Senior EMC Engineer

Signature: Date: 7/8/14

Test Report Reviewed by:	Project Engineer:
Adam Alger, EMC Engineer	Khairul Aidi Zainal, Senior EMC Engineer.
Signature: Date: 7-7-14	Signature: Date: 7/1/14

TABLE OF CONTENTS

EXHIBIT 1. INTRODUCTION

1.1 - Scope

References:	FCC Part 15, Subpart C, Section 15.247 RSS GEN issue 3 and RSS 210 issue 8 Annex 8
Title:	FCC : Telecommunication – Code of Federal Regulations, CFR 47, Part 15. IC : Low-power License-exempt Radio-communication Devices (All Frequency Bands): Category I Equipment
Purpose of Test:	To gain FCC and IC Certification Authorization for Low-Power License-Exempt Transmitters.
Test Procedures:	FCC KDB 558074 D01 DTS Measurement Guidance v03r02

1.2 – Normative References

Publication	Year	Title
FCC CFR Parts 0-15	2014	Code of Federal Regulations – Telecommunications
ANSI C63.4	2003	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
RSS-210 Annex 8	2010	Low-power License-exempt Radio communication Devices (All Frequency Bands): Category I Equipment
RSS-GEN Issue 3	2010	General Requirements and Information for the Certification of Radio Apparatus
ANSI C63.10	2009	American National Standard for Testing Unlicensed Wireless Devices
FCC KDB 558074 D01 DTS Meas Guidance v03r02	2014	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

1.3 - LS Research, LLC Test Facility

TESTING CERT #1255.01

LS Research, LLC is accredited by A2LA (American Association for Laboratory Accreditation) as conforming to ISO/IEC 17025, 2005 “General Requirements for the Competence of Calibration and Testing Laboratories”.

LS Research, LLC’s scope of accreditation includes all test methods listed herein, unless otherwise noted.

1.4 – Location of Testing

All testing was performed at the following location utilizing the facilities listed below, unless otherwise noted.

LS Research, LLC
W66 N220 Commerce Court
Cedarburg, Wisconsin, 53012 USA,

List of Facilities Located at LS Research, LLC:

Semi-Anechoic Chamber

1.5 – Test Equipment Utilized

A complete list of equipment utilized in testing is provided in Appendix A of this test report. Calibration dates are indicated in Appendix A. All test equipment is calibrated by a calibration laboratory accredited to the requirements of ISO/IEC 17025, and traceable to the SI standard.

EXHIBIT 2. PERFORMANCE ASSESSMENT

2.1 – Client Information

Manufacturer Name:	Allegion
Address:	11819 North Pennsylvania Street. Carmel, IN 46032
Contact Name:	Mike Henney

2.2 - Equipment Under Test (EUT) Information

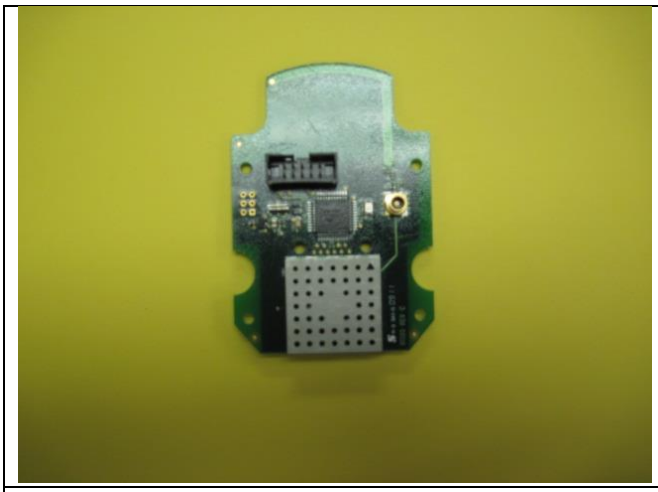
The following information has been supplied by the applicant.

Product Name:	AD 900MHz module V2
Model Number:	COMAD400V2
Serial Number:	LSR905141900033A (Trace antenna) LSR906141900046A (Antenna connector) LSR906141900037A (Antenna connector)

2.3 - Associated Antenna Description

There are multiple antennas associated with the product:

1. PCB trace antenna with a 5.7dBi maximum gain (measured over a conducting ground plane).
2. MA-CC60-60 Dual Beam Antenna with a 3.5dBi gain (Data sheet)
3. MA-CL67-15 multi band directional Panel antenna with 8.5dBi gain (Data sheet)
4. MA-CL92-5 Quasi-Omni Panel antenna with 4.5dBi gain (Data sheet)
5. MA-CM36-15 multi-band omni directional antenna with 2dBi gain (Data sheet).

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>1. Trace Antenna</td><td>4. MA-CM36-15 (Typical antenna installation)</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>2. MA-CL67-15 and MA-CL92-5 (Typical antenna installation)</td><td>3. MA-CC60-60 (Typical antenna installation)</td></tr>
</table>

2.4 - EUT'S Technical Specifications

EUT Frequency Range (in MHz)	906 MHz to 924 MHz
RF Power in Watts	☒ *Conducted Measurement* ☐ *EIRP*
Minimum:	0.0660 Watts
Maximum:	0.0724 Watts
Occupied Bandwidth	*6 dB: 564.8 kHz* *99%: 943.6 kHz*
Type of Modulation	BPSK
Emission Designator	565KG1D
Transmitter Spurious (worst case) at 3 meters	53.2dBµV/m at 7312MHz
Stepped (Y/N)	No
Step Value:	N/A
Frequency Tolerance %, Hz, ppm	Better than 100ppm
Transceiver/Microprocessor Model #	Atmel AT86RF212B-ZU# / Atmel ATMEGA644PA-AU
Antenna Information	
Detachable/non-detachable	Detachable and Non-detachable
Type	1. Trace antenna 2. Directional Panel antenna 3. Quasi Omni Panel antenna 4. Dual beam 'V' antenna 5. Dual beam 'Dome antenna'
Gain	1. Trace antenna = **5.7dBi** (measured over ground plane) 2. Directional Panel antenna = **8.5dBi** 3. Quasi Omni Panel antenna = **4.5dBi** 4. Dual beam 'V' antenna = **3.5dBi** 5. Dual beam 'Dome' antenna = **2.0 dBi**
EUT will be operated under FCC Rule Part(s)	*Title 47 part 15.247*
EUT will be operated under RSS Rule Part(s)	*RSS 210*
Modular Filing	☒ *Yes* ☐ *No*
Portable or Mobile?	Mobile

RF Technical Information:

Type of Evaluation (check one)		SAR Evaluation: Device Used in the Vicinity of the Human Head
		SAR Evaluation: Body-worn Device
	X	RF Evaluation

If RF Evaluation checked above, test engineer to complete the following:

Evaluated against exposure limits: ☒ General Public Use ☐ Controlled Use
Duty Cycle used in evaluation: 100 %
Standard used for evaluation: OET 65
Measurement Distance: 20cm
RF Value: **1.02** ☐ V/m ☐ A/m ☒ W/m^2
☐ Measured ☐ Computed ☒ Calculated

2.5 - Product Description

The communications module is a 900 MHz transceiver for electronic locks and non-lock devices. The communications module links the access device to the Access Control Management System, with feedback control to the Access Device via a wireless means. The module contains the embedded firmware implementing the radio physical and data layers. There are multiple antennas associated with the product:

1. PCB trace antenna with a 5.7dBi maximum gain (measured over a conducting ground plane).
2. MA-CC60-60 Dual Beam Antenna with a 3.5dBi gain (Data sheet)
3. MA-CL67-15 multi band directional Panel antenna with 8.5dBi gain (Data sheet)
4. MA-CL92-5 Quasi-Omni Panel antenna with 4.5dBi gain (Data sheet)
5. MA-CM36-15 multi-band omni directional antenna with 2dBi gain (Data sheet).

EXHIBIT 3. EUT OPERATING CONDITIONS & CONFIGURATIONS DURING TESTS

3.1 - Climate Test Conditions

Temperature:	70 -71° F
Humidity:	32-42%
Pressure:	728-741mmHg

3.2 - Applicability & Summary Of EMC Emission Test Results

FCC and IC Paragraph	Test Requirements	Compliance (Yes/No)
FCC : 15.207 IC : RSS GEN sect. 7.2.2	Power Line Conducted Emissions Measurements	Yes
FCC : 15.247 (a)(1) IC : RSS 210 A8.1 (a)	20 dB Bandwidth	N/A
FCC : 15.247(b) & 1.1310 IC : RSS 210 A8.4	Maximum Output Power	Yes
FCC : 15.247(i), 1.1307, 1.1310, 2.1091 & 2.1093 IC : RSS 102	RF Exposure Limit	Yes
FCC :15.247(d) IC : RSS 210 A8.5	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
FCC:15.247 (a)(2) IC: RSS 210 A8.2 (a)	6 dB Bandwidth of a Digital Modulation System	Yes
FCC:15.247 (d) IC: RSS 210 A8.2 (b)	Power Spectral Density of a Digital Modulation System	Yes
FCC : 15.247(c), 15.209 & 15.205 IC : RSS 210 A8.2(b), section 2.2, 2.6 and 2.7	Transmitter Radiated Emissions	Yes
The associated Radio Receiver has also been tested and found to comply with Part 15, Subpart B – Radio Receivers (RSS GEN and RSS 210 of IC). The Receiver Test Report is available upon request.		

3.3 - Modifications Incorporated In The EUT For Compliance Purposes

☒ None ☐ Yes (explain below)

3.4 - Deviations & Exclusions From Test Specifications

☒ None ☐ Yes (explain below)

EXHIBIT 4. DECLARATION OF CONFORMITY

The EUT was found to MEET the requirements as described within the specification of FCC Title 47, CFR Part 15.247, and Industry Canada RSS-210, Issue 8 (2010), Annex 8.

Note: If some emissions are seen to be within 3 dB of their respective limits; as these levels are within the tolerances of the test equipment and site employed, there is a possibility that this unit, or a similar unit selected out of production may not meet the required limit specification if tested by another agency.

LS Research, LLC certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specifications. The results in this Test Report apply only to the item(s) tested on the above-specified dates. Any modifications made to the EUT subsequent to the indicated test date(s) will invalidate the data herein, and void this certification.

EXHIBIT 5. RADIATED EMISSIONS TEST

5.1 - Test Setup

The test setup was assembled in accordance with Title 47, CFR FCC Part 15, RSS GEN and ANSI C63.4-2003. The EUT was placed on an 80cm high non-conductive pedestal, centered on a flush mounted 2-meter diameter turntable inside a 3 meter Semi-Anechoic, FCC listed Chamber. The EUT was operated in 100% duty cycle, continuous transmit mode for final testing using power as provided by bench DC supply. The unit has the capability to operate on 3 channels, controllable via instructions on proprietary test software.

The applicable limits apply at a 3 meter distance. The calculations to determine these limits are detailed in the following pages. Please refer to Appendix A for a complete list of test equipment. The test sample was operated on one of three (3) standard channels: low (906MHz), middle (914MHz) and high (924MHz) to comply with FCC Part 15.31(m).

5.2 - Test Procedure

Radiated RF measurements were performed on the EUT in a 3 meter Semi-Anechoic, FCC listed Chamber. The frequency range from 30 MHz to 10000 MHz was scanned and investigated. The radiated RF emission levels were manually noted at the various fixed degree settings of azimuth on the turntable and antenna height. The EUT was placed on a non-conductive pedestal in the 3 meter Semi-Anechoic Chamber, with the antenna mast placed such that the antenna was 3 meters from the EUT. A Biconical Antenna was used to measure emissions from 30 MHz to 300 MHz, and a Log Periodic Antenna was used to measure emissions from 300 MHz to 1000 MHz. A Double-Ridged Waveguide Horn Antenna was used from 1 GHz to 10 GHz. The maximum radiated RF emissions between 30MHz to 10 GHz were found by raising and lowering the sense antenna between 1 and 4 meters in height, using both horizontal and vertical antenna polarities.

The EUT was positioned in 3 orthogonal orientations when searching for peak emissions.

The restricted band spurious emissions were performed using two methods:

1. C63.10/ C63.4 radiated measurements. This procedure was used for the following EUT and antenna combination:
    a. Trace antenna
    b. MA-CL67-15 (Directional Panel antenna)

2. FCC KDB 558074 D01 DTS measurement guidance v03r02 section 12.2. (Antenna port conducted measurement and radiated cabinet/case measurement). This procedure was used for the following EUT and antenna combination:
    a. MA-CC60-60
    b. MA-CL92-5 Quasi-Omni Panel antenna
    c. MA-CM36-15

5.3 - Test Equipment Utilized

A list of the test equipment and antennas utilized for the Radiated Emissions test can be found in Appendix A. This list includes calibration information and equipment descriptions. All equipment is calibrated and used according to the operation manuals supplied by the manufacturers. All calibrations of the antennas used were performed at a calibration laboratory accredited to ISO 17025, and are traceable to the SI standard. In addition, the Connecting Cables were measured for losses using a calibrated Signal Generator and an EMI Receiver. The resulting correction factors and the cable loss factors from these calibrations were entered into the EMI Receiver database. As a result, the data taken from the EMI Receiver accounts for the antenna correction factor as well as cable loss or other corrections, and can therefore be entered into the database as a corrected meter reading. The EMI Receiver was operated with a resolution bandwidth of 120 kHz for measurements below 1 GHz (video bandwidth of 300 kHz), and a bandwidth of 1 MHz for measurements above 1 GHz (video bandwidth of 1 MHz).

5.4 - Test Results

The EUT was found to **MEET** the Radiated Emissions requirements of Title 47 CFR, FCC Part 15.247 and Canada RSS-210, Issue 8 (2010), Annex 8 for a DTS transmitter. The frequencies with significant RF signal strength were recorded and plotted as shown in the Data Charts and Graphs.

5.5 - Calculation of Radiated Emissions Limits and reported data.

Reported data:

For both fundamental and spurious emissions measurement, the data reported includes all necessary correction factors. These correction factors are loaded onto the EMI receiver when measurements are performed.

Reported Measurement data = Raw receiver measurement (dBµV/m) + Antenna correction Factor + Cable factor (dB) + Miscellaneous factors when applicable (dB) – amplification factor when applicable (dB).

Generic example of reported data at 200 MHz:

Reported Measurement data = 18.2 (raw receiver measurement) + 15.8 (antenna factor) + 1.45 (cable factor) = 35.45 (dBµV/m).

As specified in 15.247 (d) and RSS 210 A8.5, radiated emissions that fall within the restricted band described in 15.205(c) for FCC and section 2.2 of RSS 210 for IC, must comply with the general emissions limit.

The following table depicts the general radiated emission limits above 30 MHz. These limits are obtained from Title 47 CFR, Part 15.209, for radiated emissions measurements. These limits were applied to any signals found in the 15.205 restricted bands. The mentioned limits correspond to those limits listed in RSS GEN.

Frequency (MHz)	3 m Limit µV/m	3 m Limit (dBµV/m)	1 m Limit (dBµV/m)
30-88	100	40.0	-
88-216	150	43.5	-
216-960	200	46.0	-
960-24,000	500	54.0	63.5

Sample conversion of field strength (µV/m to dBµV/m):
dBµV/m = 20 $\log_{10}$ (100)= 40 dBµV/m (from 30-88 MHz)

5.6 - Radiated Emissions Test Data Chart

Manufacturer:	Allegion					
Date(s) of Test:	June 3rd to 17th 2014					
Project Engineer(s):	Khairul Aidi Zainal					
Test Engineer(s):	Aidi Zainal, Adam Alger, Mike Hintzke, Peter Feilen, Shane Rismeyer					
Voltage:	5.0 VDC					
Operation Mode:	Continuous transmit, modulated (100% duty cycle).					
Environmental Conditions in the Lab:	Temperature: 71° F Relative Humidity: 34%					
EUT Power:		Single Phase 120VAC		3 Phase ___VAC		
		Battery	X	Other: DC bench supply		
EUT Placement:	X	80cm non-conductive pedestal		10cm Spacers		
EUT Test Location:	X	3 Meter Semi-Anechoic FCC Listed Chamber		3/10m OATS		
Measurements:		Pre-Compliance		Preliminary	X	Final
Detectors Used:	X	Peak	X	Quasi-Peak	X	Average

Emissions other than transmitter harmonics:

Frequency (MHz)	Height (m)	Azimuth (degree)	Quasi Peak Reading (dBµV/m)	Quasi Peak Limit (dBµV/m)	Margin (dB)	Antenna Polarity	Notes
834.8	3.42	0	31.4	46.0	14.7	H	3
872.8	1.50	36	34.1	46.0	11.9	H	3
956.0	1.42	3	40.0	46.0	6.0	V	
956.0	2.00	63	39.9	46.0	6.1	H	
775.3	1.00	0	27.2	46.0	18.8	V	
998.7	1.00	0	28.3	54.0	25.7	H	
196.9	1.00	0	25.6	43.5	17.9	V	

Notes:

1. H: Horizontal, V: Vertical, S: Side, F: Flat.
2. Refer to exhibit 5.5 on explanation of how data is reported.
3. Emissions in the table above are those of the power supply used and not a function of the EUT.
4. Emission buried within noise floor.

A. MA-CL67-15 Panel (8.5 dBi) antenna radiated restricted band harmonics.

The following table depicts the level of radiated emissions of channel 906 MHz in the restricted band:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
2718	1.00	26	42.1	34.9	54.0	19.1	Horizontal	Vertical
3624	1.02	205	44.9	39.7	54.0	14.3	Horizontal	Vertical
4530				Note 3				
5436				Note 3				
8154	1.00	110	46.0	37.6	54.0	16.4	Vertical	Flat
9060	1.58	0	48.9	40.9	54.0	13.1	Vertical	Side

Notes:
1. H: Horizontal, V: Vertical, S: Side, F: Flat.
2. Refer to exhibit 5.5 on explanation of how data is reported.
3. Emission buried within noise floor.

The following table depicts the level of significant radiated emissions of channel 914 MHz in the restricted band:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
2742	1.22	342	43.7	35.8	54.0	18.2	Horizontal	Vertical
3656	1.04	122	48.3	41.9	54.0	12.1	Horizontal	Side
4570				Note 3				
7312	1.20	0	54.8	46.2	54.0	7.8	Vertical	Flat
8226	1.00	0	50.4	40.2	54.0	13.8	Vertical	Vertical
9140	1.77	46	53.7	45.7	54.0	8.3	Vertical	Side

Notes:
1. H: Horizontal, V: Vertical, S: Side, F: Flat.
2. Refer to exhibit 5.5 on explanation of how data is reported.
3. Emission buried within noise floor.

The following table depicts the level of significant radiated emissions of channel 924 MHz in the restricted band:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
2772	1.10	343	42.9	35.3	54.0	18.7	Horizontal	Vertical
3696	1.03	240	45.0	40.4	54.0	13.6	Horizontal	Side
4620	1.27	177	44.1	35.8	54.0	18.2	Horizontal	Vertical
7392	1.00	26	54.7	46.9	54.0	7.1	Vertical	Flat
8316	1.21	0	46.4	38.2	54.0	15.8	Vertical	Side

Notes:
1. H: Horizontal, V: Vertical, S: Side, F: Flat.
2. Refer to exhibit 5.5 on explanation of how data is reported.

B. Trace antenna radiated restricted band harmonics.

The following table depicts the level of radiated emissions of channel 906 MHz in the restricted band:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
2718	1.00	101	43.3	37.4	54.0	16.6	Horizontal	Flat
3624	1.16	167	46.7	41.3	54.0	12.7	Vertical	Side
4530	1.33	113	44.9	36.6	54.0	17.4	Horizontal	Vertical
5436				Note 3				
8154	1.12	191	49.7	42.5	54.0	11.5	Vertical	Vertical
9060	1.09	137	53.0	47.0	54.0	7.0	Vertical	Side

Notes:
1. H: Horizontal, V: Vertical, S: Side, F: Flat.
2. Refer to exhibit 5.5 on explanation of how data is reported.
3. Emission buried within noise floor.

The following table depicts the level of significant radiated emissions of channel 914 MHz in the restricted band:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
2742	1.05	57	46.1	38.0	54.0	16.0	Vertical	Vertical
3656	1.29	230	45.3	40.1	54.0	13.9	Horizontal	Flat
4570	1.00	172	45.0	38.3	54.0	15.7	Horizontal	Vertical
7312	1.23	140	61.3	53.2	54.0	0.8	Horizontal	Side
8226	1.20	207	49.1	41.5	54.0	12.5	Horizontal	Side
9140	1.38	14	50.3	42.2	54.0	11.8	Horizontal	Vertical

Notes:
1. H: Horizontal, V: Vertical, S: Side, F: Flat.
2. Refer to exhibit 5.5 on explanation of how data is reported.

The following table depicts the level of significant radiated emissions of channel 924 MHz in the restricted band:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
2772	1.18	354	46.6	38.7	54.0	15.4	Horizontal	Vertical
3696	1.05	133	49.3	43.8	54.0	10.2	Horizontal	Flat
4620	1.21	155	50.6	42.2	54.0	11.8	Horizontal	Vertical
7392	1.14	138	59.4	52.0	54.0	2.0	Horizontal	Side
8316	1.09	40	52.9	43.8	54.0	10.2	Horizontal	Vertical

Notes:
1. H: Horizontal, V: Vertical, S: Side, F: Flat.
2. Refer to exhibit 5.5 on explanation of how data is reported.

C. Cabinet radiation restricted band harmonics.

The data provided are radiated measurement data to accompany the conducted measurement data provided in the proceeding section (D).

The following table depicts the level of radiated emissions of channel 906 MHz in the restricted band:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
2718	1.00	120	45.0	35.5	54.0	18.5	Horizontal	Flat
3624	1.20	130	48.6	44.4	54.0	9.6	Horizontal	Side
4530				Note 3			Vertical	Flat
5436				Note 3				
8154	1.39	187	52.4	44.6	54.0	9.4	Vertical	Vertical
9060	1.09	192	52.7	44.6	54.0	9.4	Vertical	Vertical

Notes:

1. H: Horizontal, V: Vertical, S: Side, F: Flat.
2. Refer to exhibit 5.5 on explanation of how data is reported.
3. Emission buried within noise floor.

The following table depicts the level of significant radiated emissions of channel 914 MHz in the restricted band:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
2742	1.09	127	45.6	35.3	54.0	18.7	Horizontal	Flat
3656	1.10	174	50.2	46.2	54.0	7.9	Vertical	Side
4570	1.16	166	45.0	36.6	54.0	17.4	Vertical	Side
7312	1.62	192	54.1	46.2	54.0	7.8	Vertical	Side
8226	1.37	109	52.9	44.9	54.0	9.1	Vertical	Vertical
9140	1.00	229	52.3	44.0	54.0	10.0	Vertical	Side

Notes:

1. H: Horizontal, V: Vertical, S: Side, F: Flat.
2. Refer to exhibit 5.5 on explanation of how data is reported.

The following table depicts the level of significant radiated emissions of channel 924 MHz in the restricted band:

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)	Antenna Polarity	EUT orientation
2772	1.00	80	45.2	35.9	54.0	18.1	Horizontal	Flat
3696	1.13	184	50.5	46.9	54.0	7.1	Vertical	Side
4620				Note 3				
7392	1.06	154	51.6	44.5	54.0	9.5	Horizontal	Side
8316	1.00	201	51.2	43.5	54.0	10.5	Vertical	Vertical

Notes:

1. H: Horizontal, V: Vertical, S: Side, F: Flat.
2. Refer to exhibit 5.5 on explanation of how data is reported.
3. Emission buried within noise floor.

D. Conducted measurements of restricted band harmonics.

The data provided are conducted measurement data using measurement procedure as outlined in FCC KDB 558074 D01 DTS Measurement Guidance v03r03 section 12.2

Low Channel	906 MHz										
Harmonic	Measured Restricted band emissions power (dBm)		Antenna Gain (dBi)	EIRP (dBm)		Calculated Field Strength (dBµV/m)		Limit (dBµV/m)		Margin (dB)		Notes
	Peak	Average		Peak	Average	Peak	Average	Peak	Average	Peak	Average	
2fo	N/A	N/A	5.0	N/A	N/A	N/A	N/A	74.0	54.0	N/A	N/A	
3fo	-44.8	-54.9	5.0	-39.8	-49.9	55.4	45.3	74.0	54.0	18.6	8.7	1
4fo	-54.8	-69.1	5.0	-49.8	-64.1	45.5	31.2	74.0	54.0	28.5	22.8	1
5fo	-60.8	-70.7	5.0	-55.8	-65.7	39.5	29.5	74.0	54.0	34.5	24.5	1
6fo	-61.0	-65.3	5.0	-56.0	-60.3	39.2	34.9	74.0	54.0	34.8	19.1	1
7fo	N/A	N/A	5.0	N/A	N/A	N/A	N/A	74.0	54.0	N/A	N/A	
8fo	N/A	N/A	5.0	N/A	N/A	N/A	N/A	74.0	54.0	N/A	N/A	
9fo	-57.7	-62.0	5.0	-52.7	-57.0	42.6	38.2	74.0	54.0	31.5	15.8	1
10fo	-44.4	-48.0	5.0	-39.4	-43.0	55.8	52.2	74.0	54.0	18.2	1.8	

Middle Channel	914 MHz										
Harmonic	Measured Restricted band emissions power (dBm)		Antenna Gain (dBi)	EIRP (dBm)		Calculated Field Strength (dBµV/m)		Limit (dBµV/m)		Margin (dB)		Notes
	Peak	Average		Peak	Average	Peak	Average	Peak	Average	Peak	Average	
2fo	N/A	N/A	5.0	N/A	N/A	N/A	N/A	74.0	54.0	N/A	N/A	
3fo	-45.2	-59.4	5.0	-40.2	-54.4	55.1	40.8	74.0	54.0	19.0	13.2	1
4fo	-54.3	-69.4	5.0	-49.3	-64.4	45.9	30.8	74.0	54.0	28.1	23.2	1
5fo	-55.0	-70.9	5.0	-50.0	-65.9	45.3	29.3	74.0	54.0	28.8	24.7	1
6fo	N/A	N/A	5.0	N/A	N/A	N/A	N/A	74.0	54.0	N/A	N/A	
7fo	N/A	N/A	5.0	N/A	N/A	N/A	N/A	74.0	54.0	N/A	N/A	
8fo	-51.2	-68.0	5.0	-46.2	-63.0	49.07	32.225	74.0	54.0	24.9	21.8	1
9fo	-52.3	-66.3	5.0	-47.3	-61.3	47.9	34.0	74.0	54.0	26.1	20.0	1
10fo	-43.7	-48.3	5.0	-38.7	-43.3	56.5	51.9	74.0	54.0	17.5	2.1	

High Channel	926 MHz										
Harmonic	Measured Restricted band emissions power (dBm)		Antenna Gain (dBi)	EIRP (dBm)		Calculated Field Strength (dBµV/m)		Limit (dBµV/m)		Margin (dB)		Notes
	Peak	Average		Peak	Average	Peak	Average	Peak	Average	Peak	Average	
2fo	N/A	N/A	5.0	N/A	N/A	N/A	N/A	74.0	54.0	N/A	N/A	
3fo	-45.1	-55.4	5.0	-40.1	-50.4	55.2	44.9	74.0	54.0	18.8	9.1	1
4fo	-56.6	-64.8	5.0	-51.6	-59.8	43.6	35.5	74.0	54.0	30.4	18.5	1
5fo	-58.0	-65.1	5.0	-53.0	-60.1	42.2	35.1	74.0	54.0	31.8	18.9	1
6fo	N/A	N/A	5.0	N/A	N/A	N/A	N/A	74.0	54.0	N/A	N/A	
7fo	N/A	N/A	5.0	N/A	N/A	N/A	N/A	74.0	54.0	N/A	N/A	
8fo	-54.0	-61.8	5.0	-49.0	-56.8	46.23	38.39	74.0	54.0	27.8	15.6	1
9fo	-53.9	-61.3	5.0	-48.9	-56.3	46.3	39.0	74.0	54.0	27.7	15.0	1
10fo	N/A	N/A	5.0	N/A	N/A	N/A	N/A	74.0	54.0	N/A	N/A	

Notes:

1. Measurement of system noise floor.

2. EIRP calculation:
   EIRP = Measured restricted band emissions power (dBm) + antenna gain (dBi)

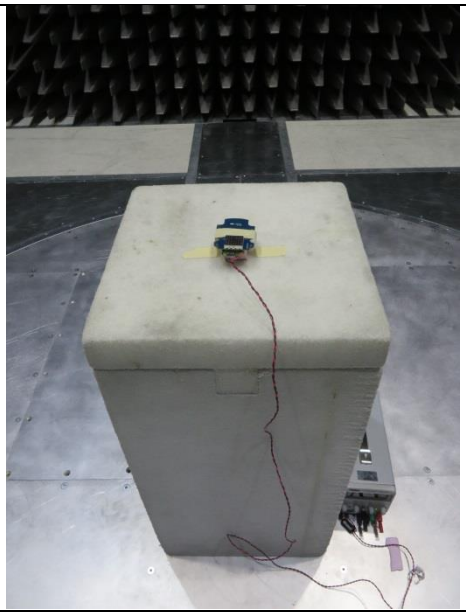
   Example:
   EIRP = -45.1dBm + 5.0dBi = -40.1dBm

3. Conversion from EIRP to equivalent field strength is based on KDB 558074 D01 v03r02 section 12.2.2 (e).
   E = EIRP – 20log D + 104.8; D=3m

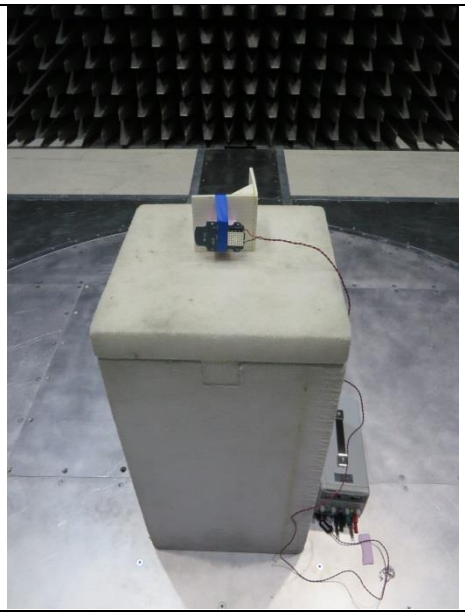
   Example:
   E= -40.1dBm -9.54+104.8 = 55.2dBµV/m

5.7 - Test Setup Photo(s) – Radiated Emissions Test

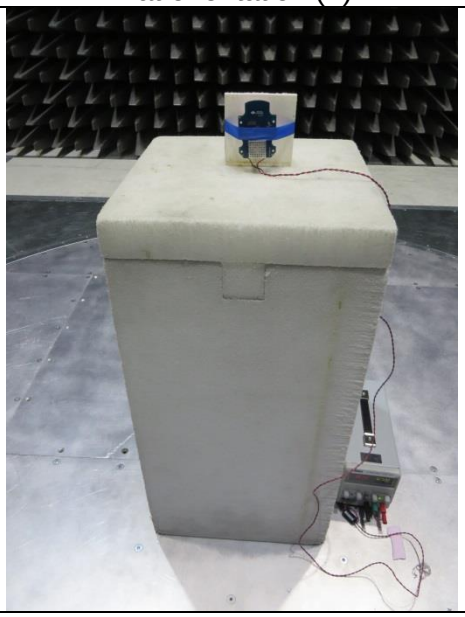
Trace antenna



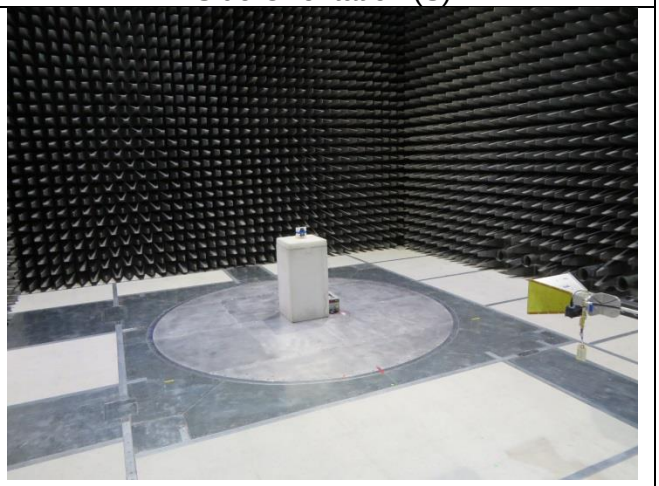
Flat orientation (F)



Side Orientation (S)

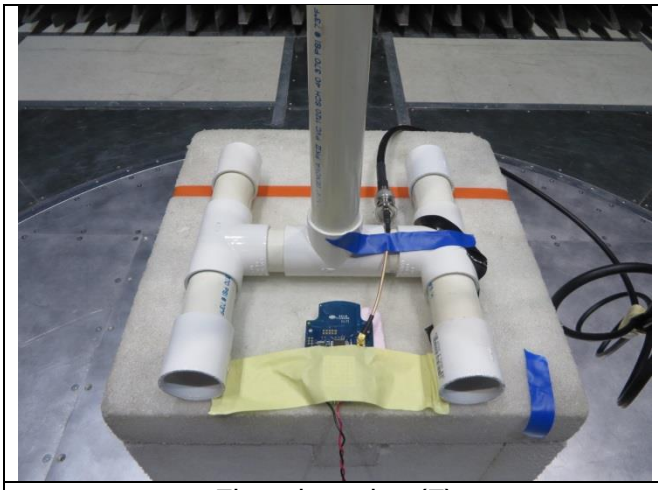
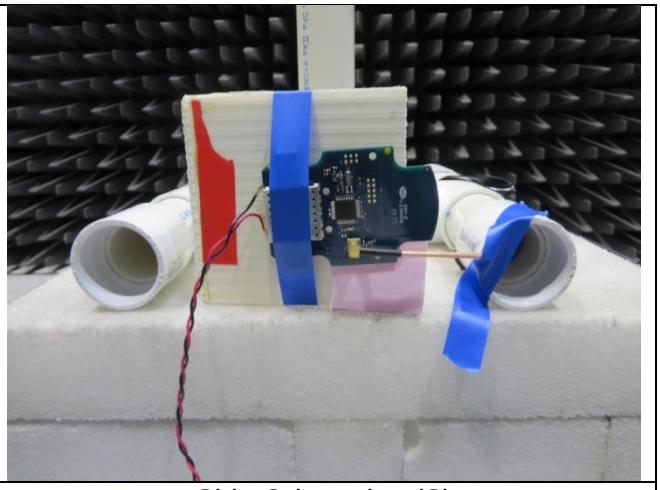
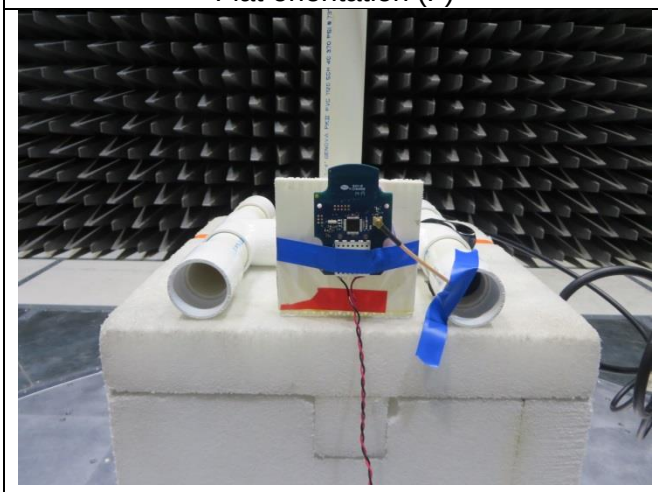
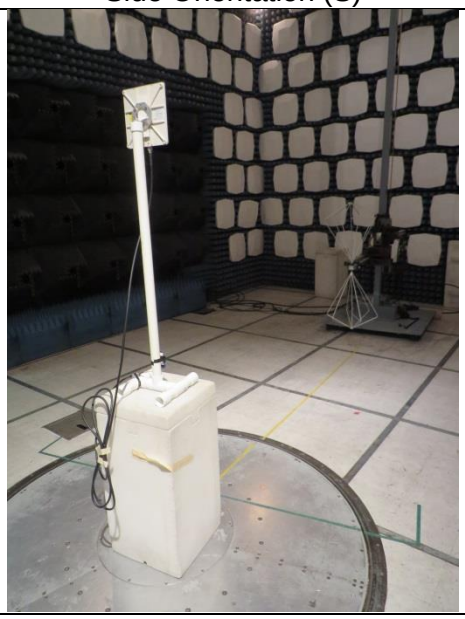


Vertical Orientation (V)

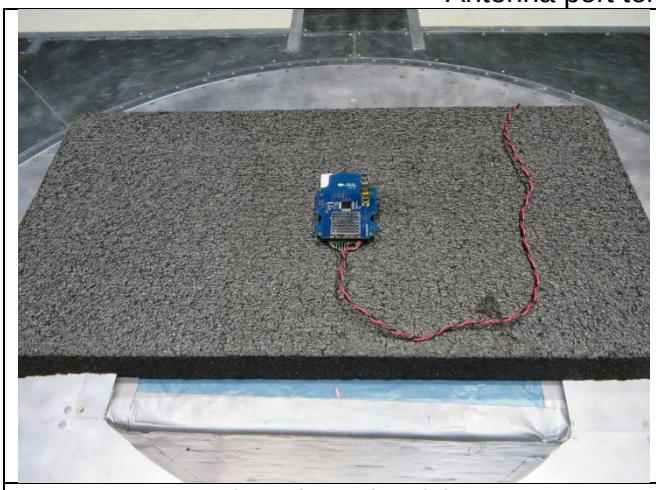


Chamber setup

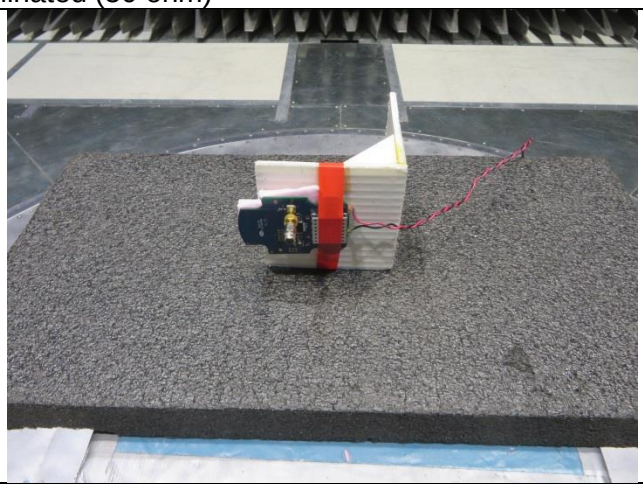
Directional Panel antenna

	
Flat orientation (F)	Side Orientation (S)
	
Vertical Orientation (V)	Chamber setup

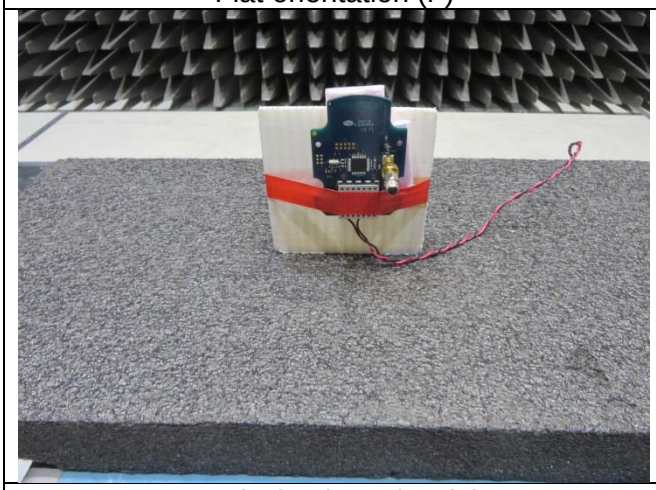
Antenna port terminated (50 ohm)



Flat orientation (F)



Side Orientation (S)



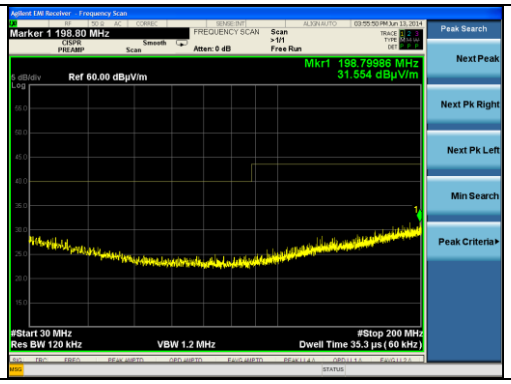
Vertical Orientation (V)

5.8 – Screen Captures.

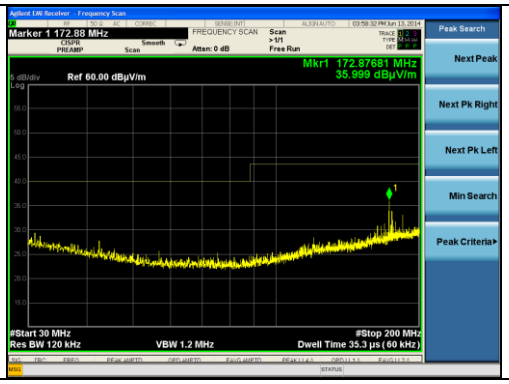
The plots included in this section are those of the EUT with the trace antenna option, representing all the configuration tested. Not all plots taken during testing is included.

The screen captures below are those of radiated emissions using the Peak detector of the analyzer.

30 to 200 MHz, 3m distance.



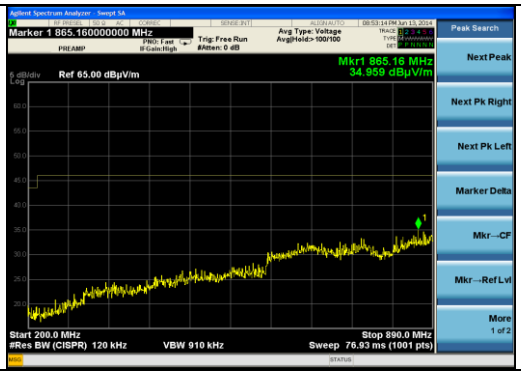
Horizontal



Vertical

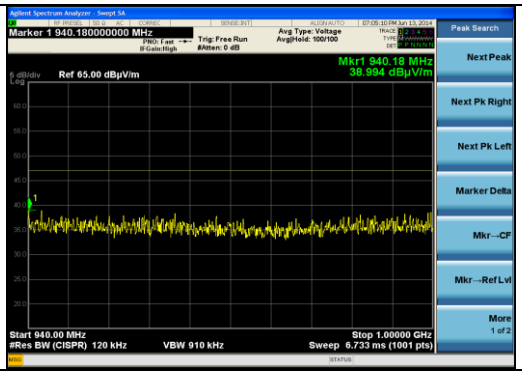
200 to 890 MHz, 3m distance.

Horizontal

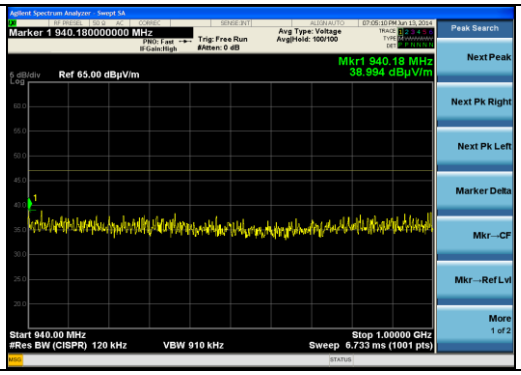


Vertical

940 to 1000 MHz, 3m distance.

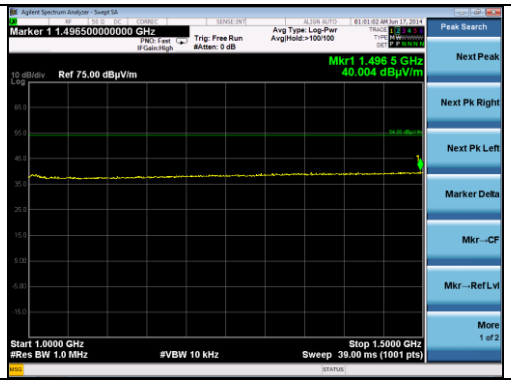
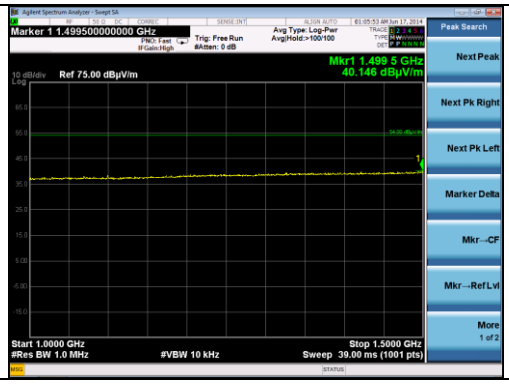


Horizontal



Vertical

1000 to 1500 MHz, 3m distance.

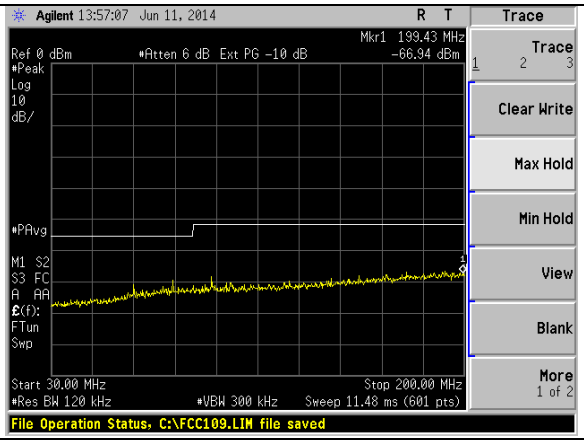
	
Horizontal	Vertical

1500 to 10000 MHz, 3m distance (reduced bandwidth).

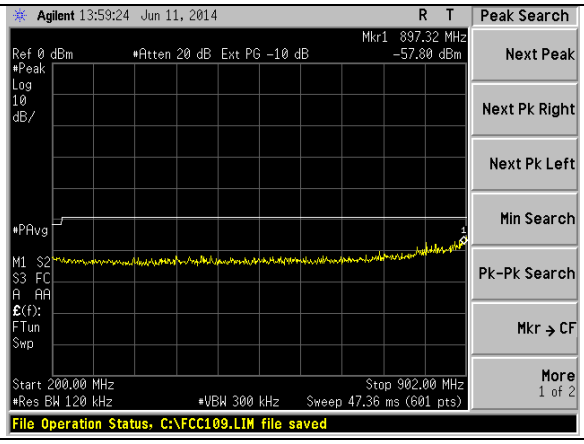
	
Horizontal	Vertical

The ranges of 890MHz to 902MHz and 928MHz to 960MH are in Exhibit 8, Band-edge measurements.

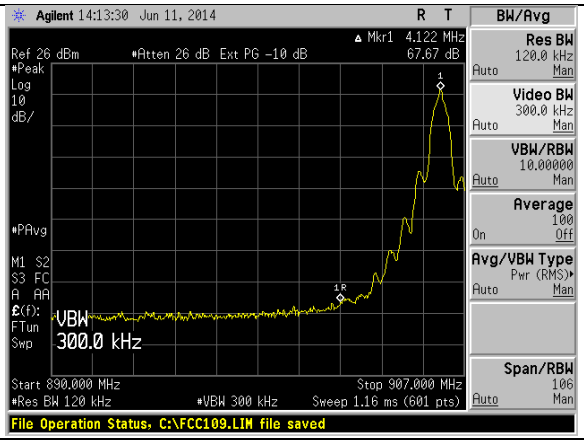
The screen captures below are those performed conducted using the Peak detector of the analyzer per FCC KDB 558074 D01 DTS Measurement Guidance v03r03 section 12.2.



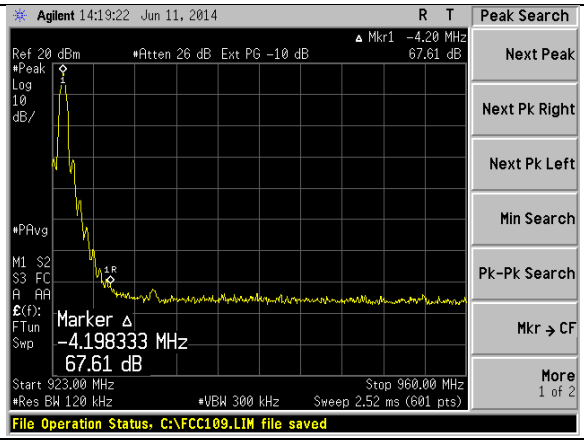
30 MHz to 200 MHz



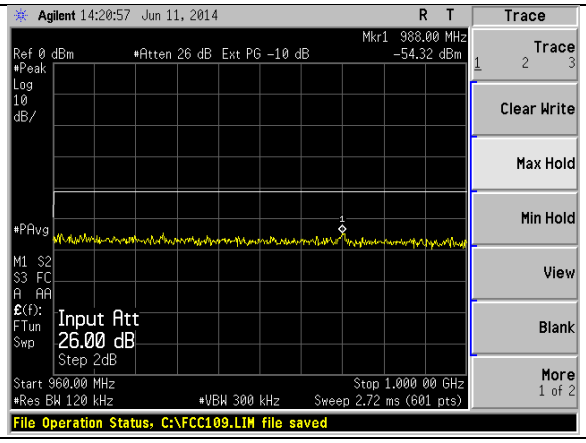
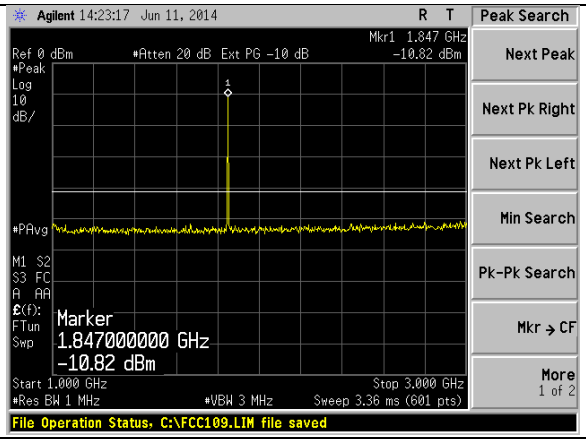
200 MHz to 902 MHz



890 MHz to 907 MHz



923 MHz to 960 MHz

	
960 MHz to 1000 MHz	1000 MHz to 3000 MHz

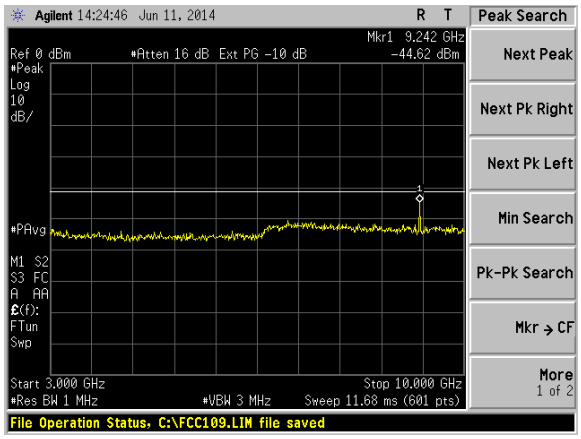


EXHIBIT 6. CONDUCTED EMISSIONS TEST, AC POWER LINE

6.1 Test Setup

The test area and setup are in accordance with ANSI C63.4 and with Title 47 CFR, FCC Part 15, Industry Canada RSS GEN. The EUT was placed on a non-conductive wooden table, with a height of 80 cm above the reference ground plane. The EUT's power was provided by an off the shelf AC to DC adaptor which was then plugged into a 50Ω (ohm), Line Impedance Stabilization Network (LISN). The AC power supply was provided via an appropriate broadband EMI Filter, and then to the LISN line input. Final readings were then taken and recorded. After the EUT was setup and connected to the LISN, the RF Sampling Port of the LISN was connected to EMI receiver System. The LISN used has the ability to terminate the unused port with a 50Ω (ohm) load when switched to either L1 (line) or L2 (neutral).

6.2 Test Procedure

The EUT was investigated in transmit mode for this portion of the testing. The appropriate frequency range and bandwidths were selected on the EMI Receiver, and measurements were made. The bandwidth used for these measurements is 9 kHz, as specified in CISPR 16-1, Section 1, Table 1, for Quasi-Peak and Average detectors in the frequency range of 150 kHz to 30 MHz. Final readings were then taken and recorded.

6.3 Test Equipment Utilized

A list of the test equipment and accessories utilized for the Conducted Emissions test is provided in Appendix A. This list includes calibration information and equipment descriptions. All equipment is calibrated and used according to the operation manuals supplied by the manufacturers. Calibrations of the LISN and Limiter were performed at an IEC/ISO 17025 accredited calibration laboratory, traceable to the SI standard. All cables are calibrated and checked periodically for conformance. The emissions are measured on the EMI System, which has automatic correction for all factors stored in memory and allows direct readings to be taken.

6.4 Test Results

The EUT was found to **MEET** the Conducted Emission requirements of FCC Part 15.207 and RSS GEN for Conducted Emissions. See the Data Charts and Graphs for more details of the test results.

6.5 FCC Limits of Conducted Emissions at the AC Mains Ports

Frequency Range (MHz)	Class B Limits (dBµV)		Measuring Bandwidth
	Quasi-Peak	Average	
0.150 -0.50 *	66-56	56-46	RBW = 9 kHz VBW ≥ 9 kHz for QP VBW = 1 Hz for Average
0.5 – 5.0	56	46	
5.0 – 30	60	50	
* The limit decreases linearly with the logarithm of the frequency in this range.			

6.6 CONDUCTED EMISSIONS TEST DATA CHART

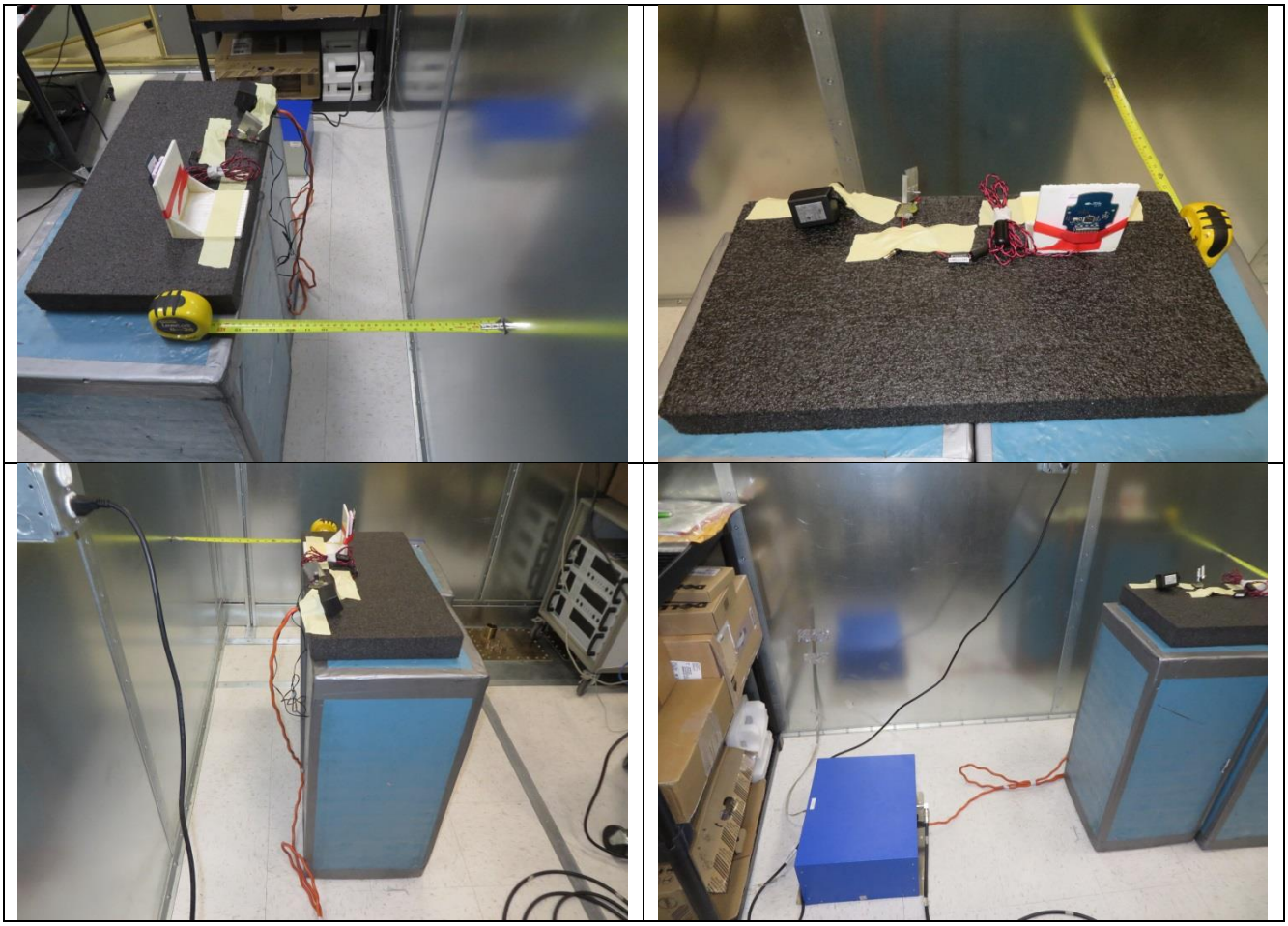
Manufacturer:	Allegion					
Date(s) of Test:	June 12th 2014					
Project Engineer:	Khairul Aidi Zainal					
Test Engineer:	Khairul Aidi Zainal					
Voltage:	120 VAC (supplying an AC to DC adapter)					
Operation Mode:	Transmit mode					
Environmental Conditions in the Lab:	Temperature: 23° C Relative Humidity: 48 %					
Test Location:	X	AC Mains Test area				Chamber
EUT Placed On:	X	40cm from Vertical Ground Plane				10cm Spacers
	X	80cm above Ground Plane				Other:
Measurements:		Pre-Compliance		Preliminary	X	Final
Detectors Used:		Peak	X	Quasi-Peak	X	Average

		Quasi-Peak			Average		
Frequency (MHz)	Line	Q-Peak Reading (dBµV)	Q-Peak Limit (dBµV)	Quasi-Peak Margin (dB)	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)
0.170	1	42.7	64.9	22.2	31.5	54.9	23.4
0.191	1	41.5	64.0	22.5	30.5	54.0	23.5
0.231	1	40.5	62.4	21.9	29.2	52.4	23.2
2.256	1	18.7	56.0	37.3	12.0	46.0	34.0
0.164	2	38.6	65.2	26.6	22.2	55.2	33.0
0.182	2	37.5	64.4	26.9	21.4	54.4	33.0
0.237	2	36.0	62.2	26.2	20.6	52.2	31.6

Notes:

1) The emissions listed are characteristic of the power supply used, and did not change by the EUT in either channels or in receive mode.

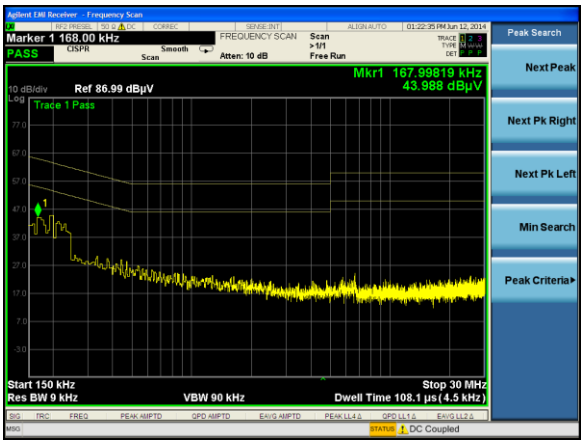
6.7 Test Setup Photo(s) – Conducted Emissions Test



6.8 Screen Captures – Conducted Emissions Test

These screen captures represent Peak Emissions. For conducted emission measurements, both a Quasi-Peak detector function and an Average detector function are utilized. The emissions must meet both the Quasi-peak limit and the Average limit as described in 47 CFR 15.107 and RSS GEN.

Line 1



Line 2

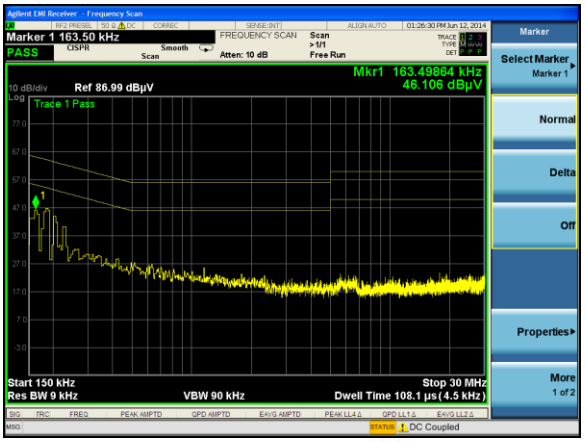


EXHIBIT 7. OCCUPIED BANDWIDTH

Test Engineer(s): Peter Feilen

7.1 - Limits

For a DTS system operating in the 902 to 928 MHz band, the minimum 6dB emission bandwidth limit is 500 kHz.

7.2 - Method of Measurements

Industry Canada (IC RSS GEN 4.6.1) also requires the measurement of the 99% bandwidth in addition to the 6dB emission bandwidth. For this portion of the tests, a direct measurement of the transmitted signal was performed at the antenna port of the EUT, via a cable connection to a spectrum analyzer. An attenuator was placed in series with the cable to protect the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings there by allowing direct measurements, without the need for any further corrections. The EUT was configured to run in a 100% duty cycle, continuous transmit mode, while being supplied with typical data as a modulation source. A bandwidth measurement function that is built into the spectrum analyzer was used to measure the 99 % and 6dB bandwidth.

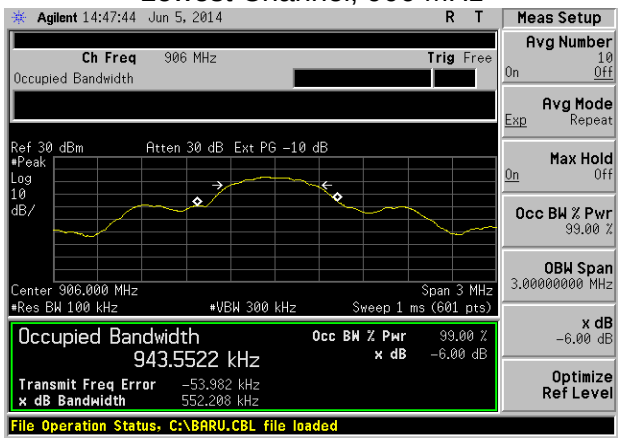
Measurement procedure: KDB 558074 D01 DTS Measurement Guidance v03r02 section 8

7.3 - Test Data

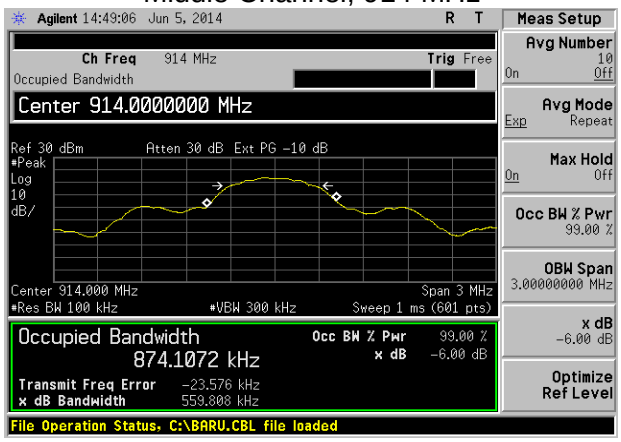
Frequency (MHz)	DTS/6dB BW (kHz)	99% BW (kHz)
906.0	552.2	943.60
914.0	559.8	874.10
924.0	564.8	843.70

7.4 – Screen Captures

Lowest Channel, 906 MHz



Middle Channel, 914 MHz



Highest Channel, 924 MHz

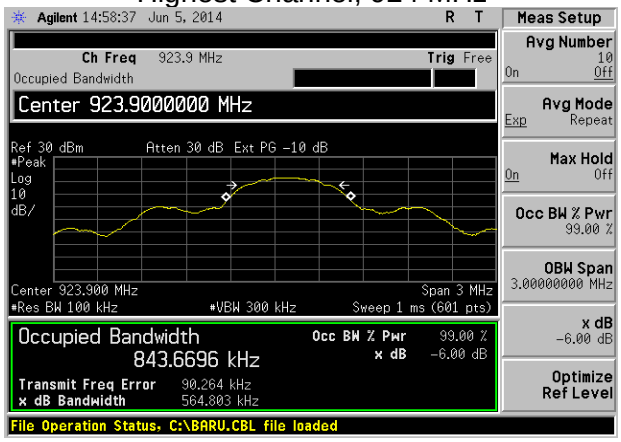


EXHIBIT 8. BAND EDGE MEASUREMENTS

Test Engineer(s): Aidi Zainal, Peter Feilen, Adam Alger and Mike Hintzke.

8.1 - Method of Measurements

FCC 15.247(d) require a measurement of spurious emission levels to be at least 20 dB lower than the fundamental emission level, in particular at the Band-Edges where the intentional radiator operates. Also, RSS 210 Section 2.2 requires that unwanted emissions meet limits listed in RSS GEN and also to the limits in the applicable annex. The following screen captures demonstrate compliance of the intentional radiator at the 902 - 928 MHz Band-Edges. The EUT was operated in 100% duty cycle continuous transmit mode with continuous modulation, with internally generated data as the modulating source. The EUT was operated at the lowest channel for the investigation of the lower Band-Edge, and at the highest channel for the investigation of the higher Band-Edge.

The Band-edge measurements were performed conducted and radiated. The measurement of band-edge was performed to satisfy FCC 15.247(d).

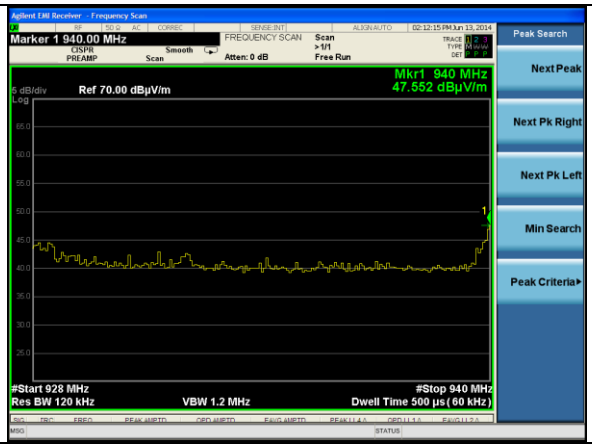
Conducted measurements of the spurious emission were performed with a measurement bandwidth of 100kHz.

8.2. Band edge captures.

Radiated Band-edge:

A. Continuously transmitting and modulated.

Lower band edge Peak

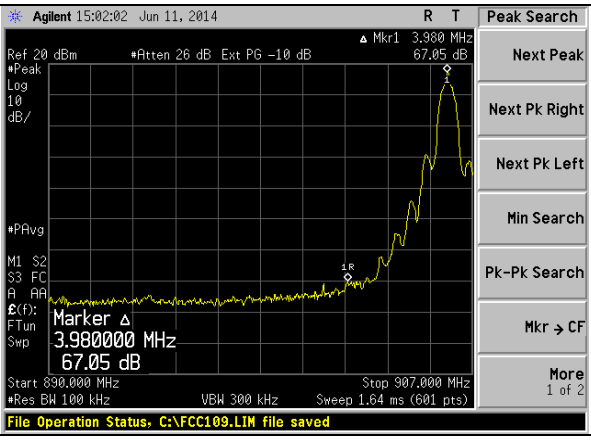


Upper band edge Peak

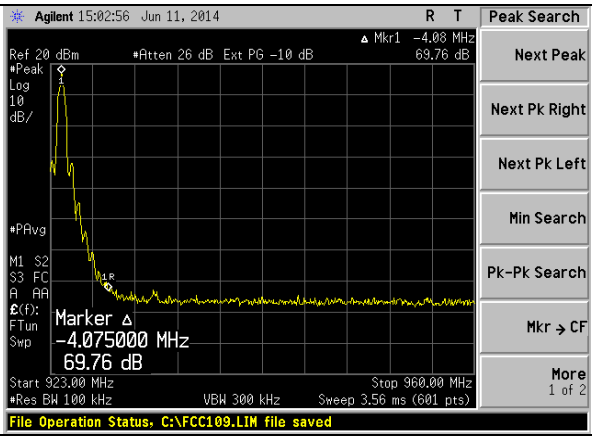
Note: The plots above chosen as representative of all the tested configurations.

Conducted Band-edge:

A. Continuously transmitting and modulated.



Lower band edge



Upper band edge

EXHIBIT 9. POWER OUTPUT (CONDUCTED)

Test Engineer(s): Peter Feilen

9.1 - Method of Measurements

The conducted RF output power of the EUT was measured at the antenna port using a short RF cable along with an attenuator as protection for the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings there by allowing direct measurements without the need for any further corrections. The unit was configured to run in a 100% duty cycle, continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with the appropriate resolution bandwidth, with measurements from a peak detector presented in the chart below.

Measurement procedure: KDB 558074 D01 DTS Measurement Guidance v03r02 section 9.1.1

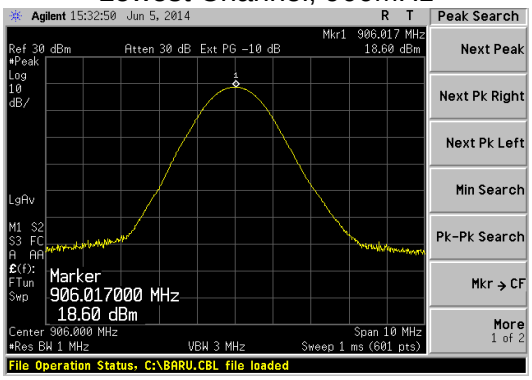
9.2 - Test Data

Frequency (MHz)	Power (dBm)	Limit (dBm)	Margin (dB)
906.0	18.6	27.5	8.9
914.0	18.5	27.5	9.0
924.0	18.2	27.5	9.3

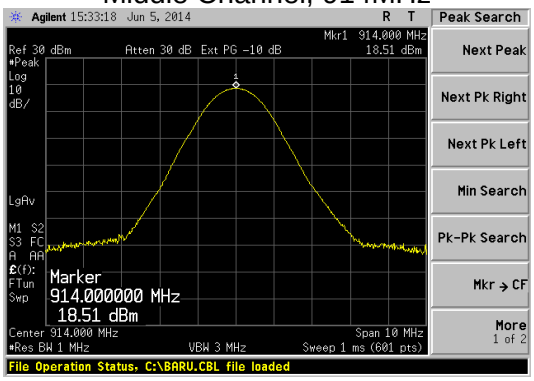
Note:
1. The limit was reduced by 2.5dB since the highest gain antenna associated with the EUT is an 8.5dBi panel antenna.

9.3 – Screen Captures.

Lowest Channel, 906MHz



Middle Channel, 914MHz



Highest Channel, 924MHz

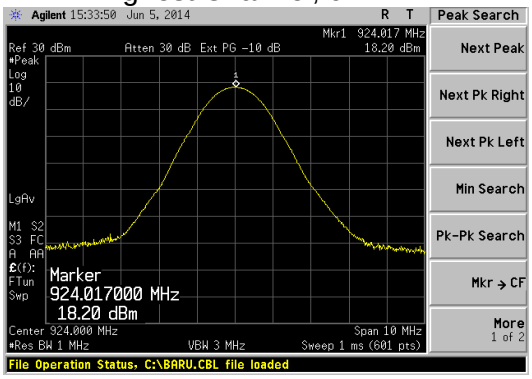


EXHIBIT 10. CONDUCTED SPURIOUS EMISSIONS

Test Engineer(s): Peter Feilen

10.1 - Limits

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 db below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

10.2 – Conducted Harmonic And Spurious RF Measurements

FCC Part 15.247(d) and IC RSS 210 A8.5 both require a measurement of conducted harmonic and spurious RF emission levels, as reference to the carrier level when measured in a 100 kHz bandwidth. For this test, the spurious and harmonic RF emissions from the EUT were measured at the EUT antenna port using a short RF cable along with an attenuator as protection for the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings, thereby allowing direct readings of the measurements made without the need for any further corrections. A spectrum analyzer was used with the resolution bandwidth set to 100 kHz for this portion of the tests. The unit was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source. The spectrum analyzer was used with measurements from a peak detector presented in the chart below. Screen captures were acquired and any noticeable spurious and harmonic signals were identified and measured.

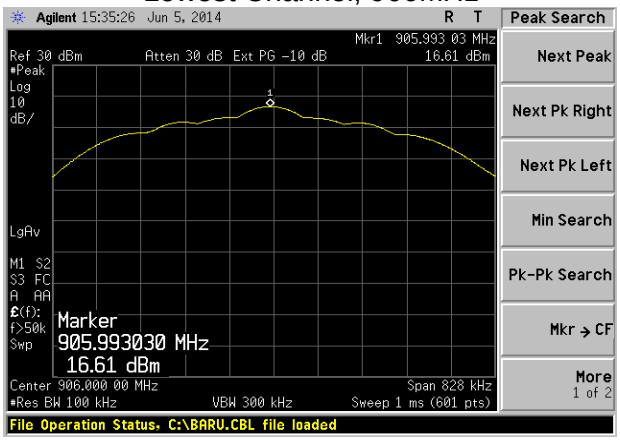
Measurement procedure: KDB 558074 D01 DTS Measurement Guidance v03r02 section 11

Note: Although measurements on all three channels were performed, plots included are those of low and high channels only.

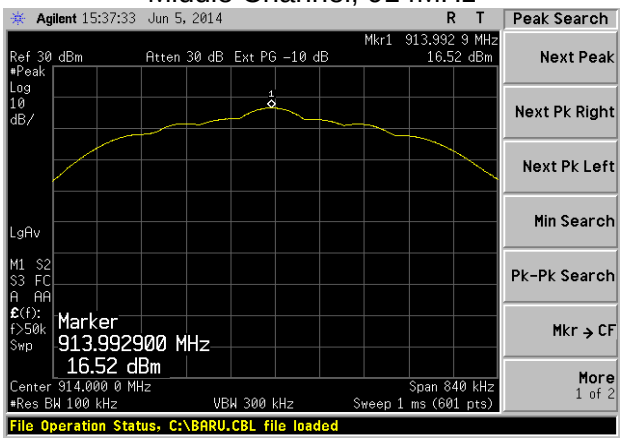
10.3 - Test Data

Reference level measurement:

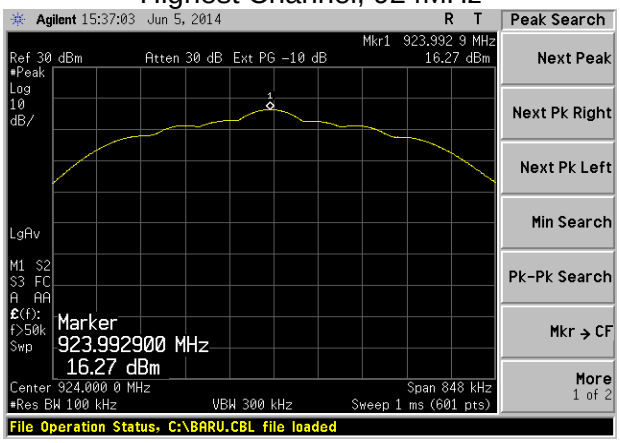
Lowest Channel, 906MHz



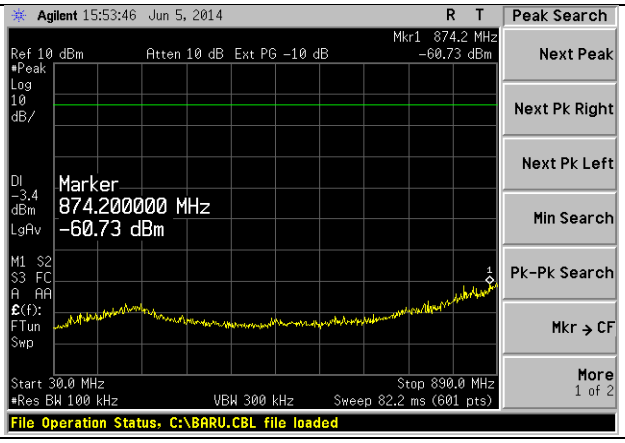
Middle Channel, 914MHz



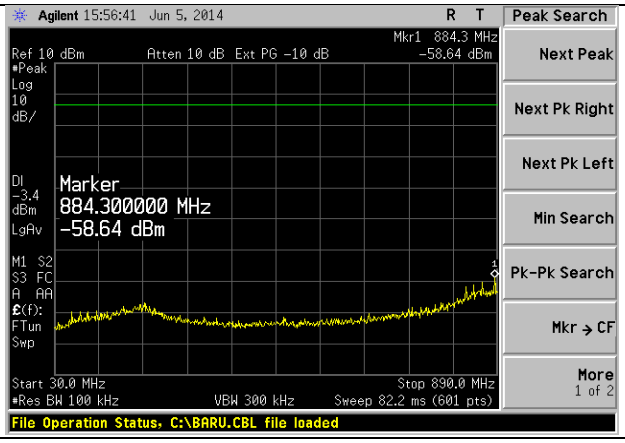
Highest Channel, 924MHz



30 MHz to 890 MHz

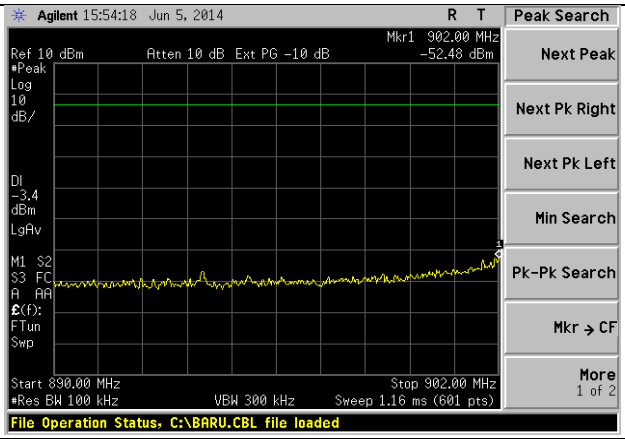


Low channel

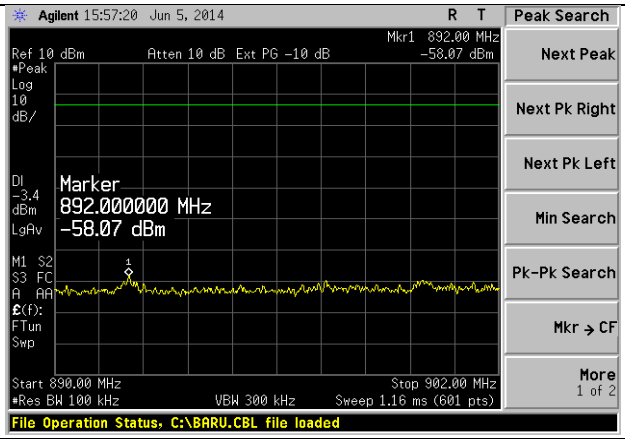


High channel

890 MHz to 900 MHz

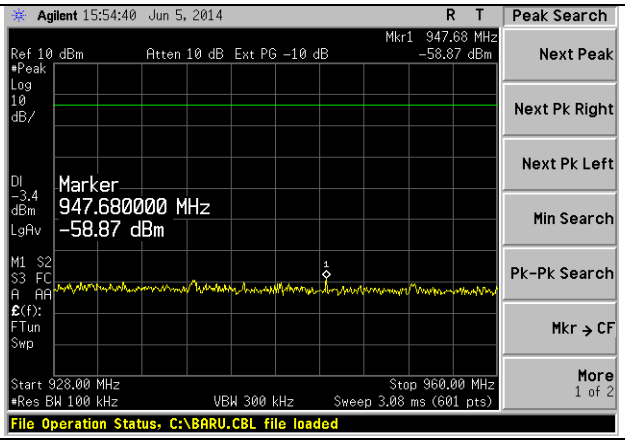


Low channel

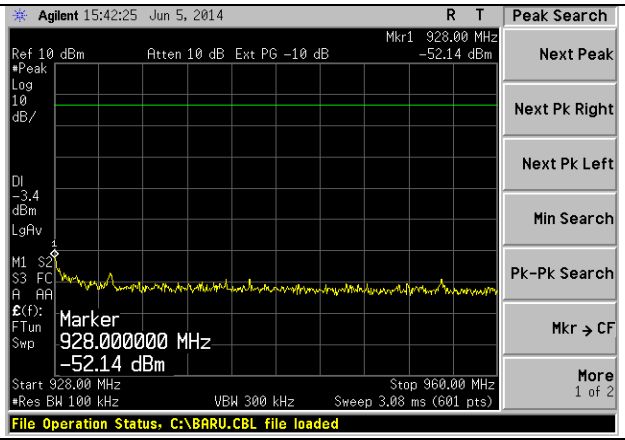


High channel

928 MHZ to 960 MHz

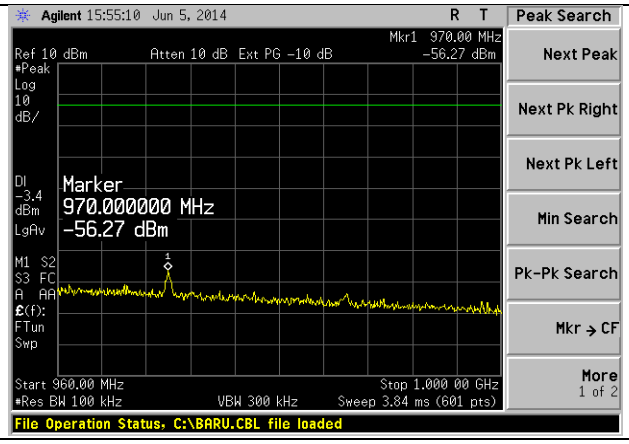


Low channel

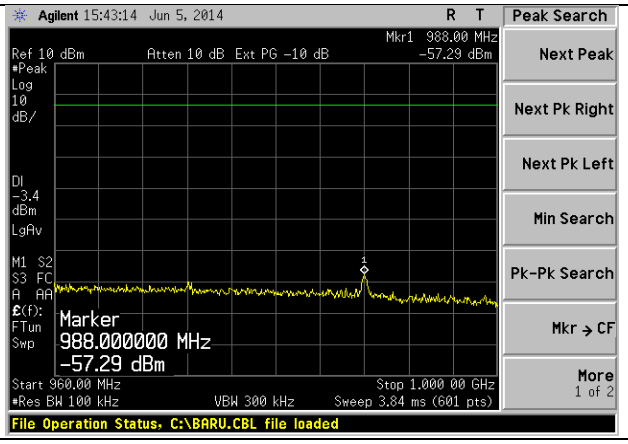


High channel

960 MHZ to 1000 MHz

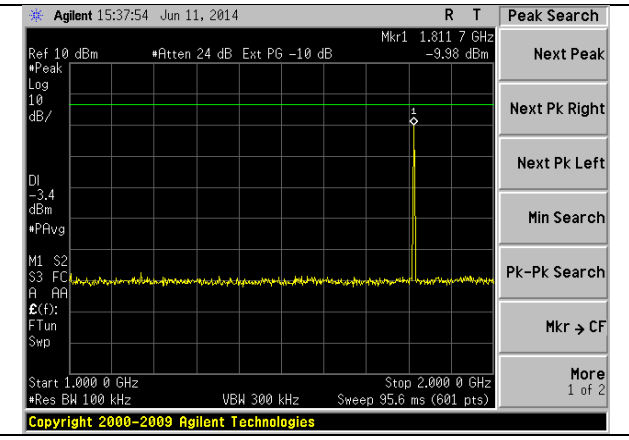


Low channel

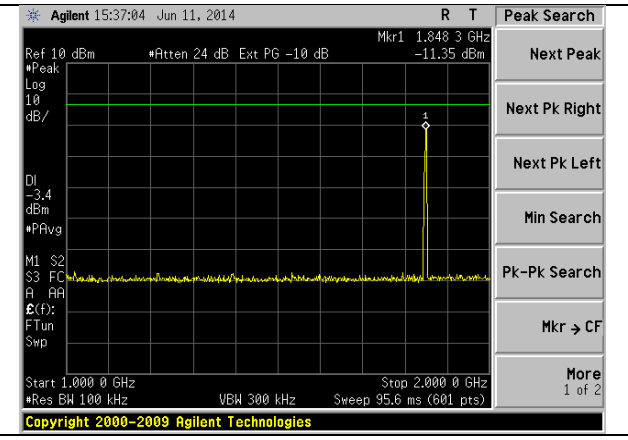


High channel

1000 MHZ to 2000 MHz

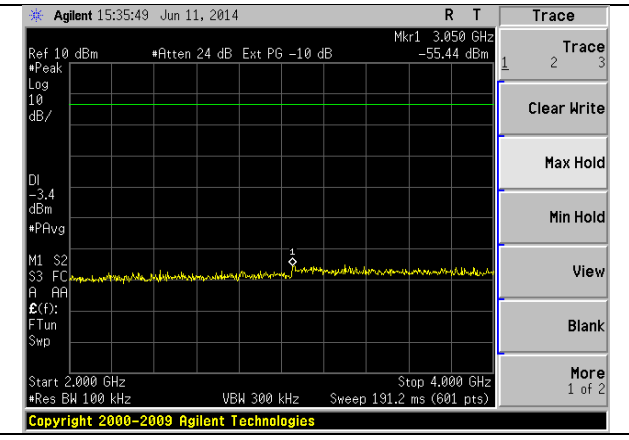


Low channel

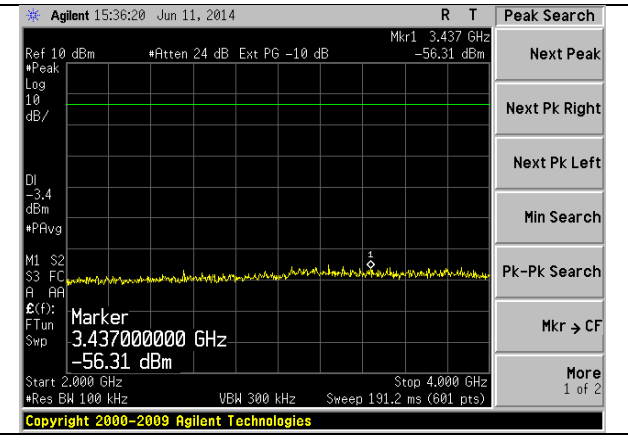


High channel

2000 MHZ to 4000 MHz

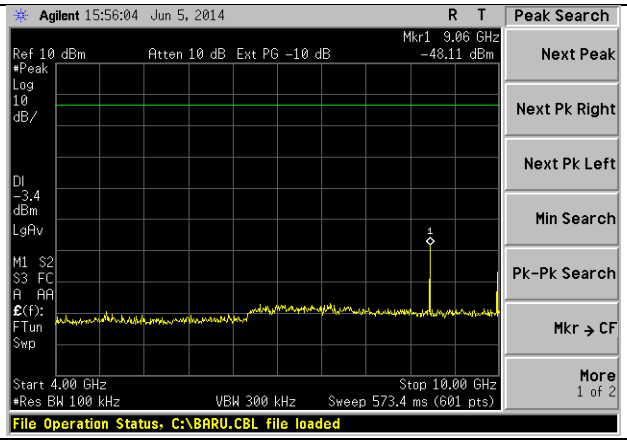


Low channel

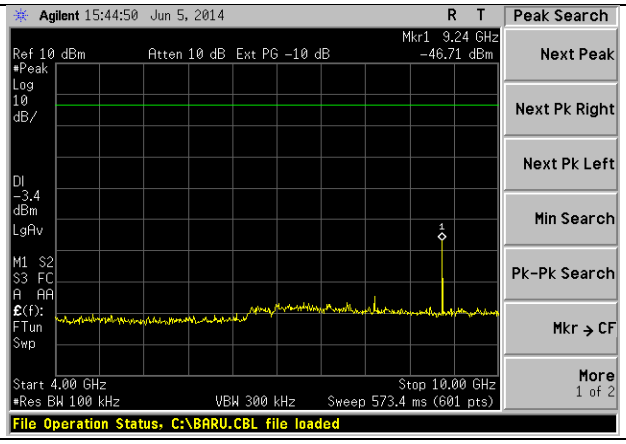


High channel

4000 MHZ to 10000 MHz



Low channel



High channel

EXHIBIT 11. POWER SPECTRAL DENSITIES: 15.247(e)

Test Engineer(s): Peter Feilen

11.1 Limits

For digitally modulate systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

Measurement procedure: KDB 558074 D01 DTS Measurement Guidance v03r02 section 10.2

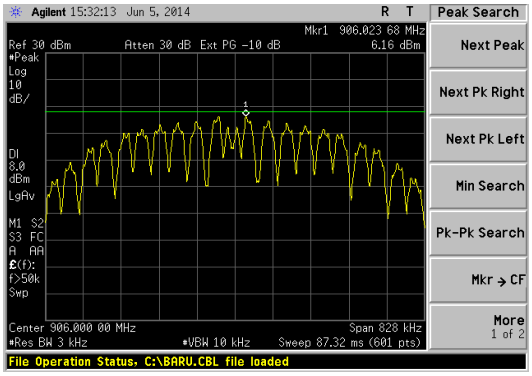
In accordance with FCC Part 15.247(e) and RSS 210 A8.2(b), the peak power spectral density should not exceed +8 dBm in any 3 kHz band. This measurement was performed along with the conducted power output readings performed as described in previous sections. The highest density was found to be no greater than 6.2dBm, which is under the allowable limit by 1.8 dB.

11.2 Test Data

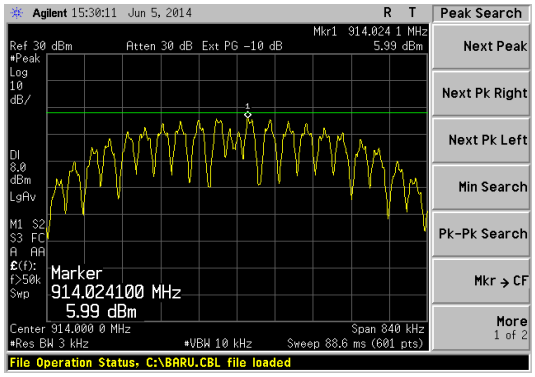
Frequency (MHz)	PSD/3kHz (dBm)	limit (dBm)	Margin (dB)
906.0	6.2	8.0	1.8
914.0	6.0	8.0	2.0
924.0	6.0	8.0	2.0

11.4 Screen Captures – Power Spectral Density

Low Channel



Middle Channel



High Channel

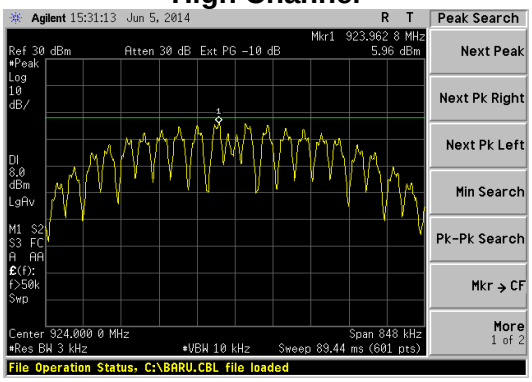


EXHIBIT 12. FREQUENCY & POWER STABILITY OVER VOLTAGE VARIATIONS

Test Engineer(s): Khairul Aidi Zainal

The power and frequency stability of the device was examined as a function of the input voltage available to the EUT. A Spectrum Analyzer was used to measure the power and frequency at the appropriate frequency markers. Power was supplied by an external bench-type DC power supply and was varied ±15% from the nominal.

4.25 VDC		5 VDC		5.75 VDC	
Power	Frequency	Power	Frequency	Power	Frequency
16.9	905894336	16.9	905894306	16.9	905894130
16.7	913894135	16.7	913894100	16.7	913894126
16.4	923894095	16.4	923894172	16.4	923894051

Channel	max	min	freq drift (Hz)
1	905894336	905894130	206
5	913894135	913894100	35
10	923894172	923894051	121

The EUT has better than 100 PPM frequency stability.

The power was then cycled On/Off to observe system response. No unusual response was observed, the emission characteristics were well behaved, and the system returned to the same state of operation as before the power cycle.

APPENDIX A – Test Equipment List

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 11-Jun-2014 Type Test : AC Mains Job # : C-1964

Prepared By: Aidi Customer : Allegion Quote #: 314167

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960085	N9038A MXE 26.5GHz Receiver	Agilent	N9038A	MY51210148	8/7/2013	8/7/2014	Active Calibration
2	EE 960089	LISN - 15A	COM-POWER	LI-215A	191943	2/26/2014	2/26/2015	Active Calibration

Project Engineer: Quality Assurance:

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 11-Jun-2014 Type Test : Conducted measurements Job # : C-1964

Prepared By: Aidi Customer : Allegion Quote #: 314167

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960144	Phaseflex	Gore	EKD01D010720	5800373	System	System	System
2	EE 960157	3Hz-13.2GHz Spectrum Analyzer	Agilent	E4445A	MY48250225	9/5/2013	9/5/2014	Active Calibration

Project Engineer: Quality Assurance: Peter Fiekin

LS RESEARCH LLC
Wireless Product Development
Equipment Calibration

Date : 11-Jun-2014 Type Test : Radiated measurements Job # : C-1964

Prepared By: Aidi Customer : Allegion Quote #: 314167

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960162	EM Series	MegaPhase	EM26-S1S1-120	12024301 001	System	System	System
2	EE 960087	44GHz EXA Spectrum Analyzer	Agilent	N9010A	MY53400296	10/27/2013	10/27/2014	Active Calibration
3	EE 960085	N9038A MXE 26.5GHz Receiver	Agilent	N9038A	MY51210148	8/7/2013	8/7/2014	Active Calibration
4	AA 960156	900MHz High Pass Filter	KWM	HPF-L-14185	unknown	7/22/2013	7/22/2014	Active Calibration
5	AA 960081	Double Ridge Horn Antenna	EMCO	3115	6907	2/25/2014	2/25/2015	Active Calibration
6	EE 960160	0.8-21GHz LNA	Mini-Circuits	ZVA-213X-S+	977711030	6/10/2013	7/10/2014	Active Calibration
7	AA 960007	Double Ridge Horn Antenna	EMCO	3115	9311-4138	6/10/2013	7/10/2014	Active Calibration
8	AA 960005	Biconical Antenna	EMCO	93110B	9601-2280	7/25/2013	7/25/2014	Active Calibration
9	AA 960078	Log Periodic Antenna	EMCO	93146	9701-4855	1/8/2014	1/8/2015	Active Calibration
10	EE 960088	8GHz MXE Spectrum Analyzer	Agilent	N9038A	MY51210138	11/19/2013	11/19/2014	Active Calibration

Project Engineer: Quality Assurance: Peter Fiekin

APPENDIX B – Test Standards: CURRENT PUBLICATION DATES RADIO

STANDARD #	DATE	Am. 1	Am. 2
ANSI C63.4	2003		
ANSI C63.10	2009		
FCC 47 CFR, Parts 0-15, 18, 90, 95	2014		
RSS GEN	2010		
RSS 210	2010		

APPENDIX C - Uncertainty Statement

Table of Expanded Uncertainty Values, (K=2) for Specified Measurements

Measurement Type	*Particular Configuration*	*Uncertainty Values*
Radiated Emissions	*3 – Meter chamber, Biconical Antenna*	*4.82 dB*
Radiated Emissions	*3-Meter Chamber, Log Periodic Antenna*	*4.88 dB*
Radiated Emissions	*3-Meter Chamber, Horn Antenna*	*4.85 dB*
Radiated Emissions	*10-Meter OATS, Biconical Antenna*	*4.32 dB*
Radiated Emissions	*10-Meter OATS, Log Periodic Antenna*	*3.63 dB*
Absolute Conducted Emissions	*Agilent PSA/ESA Series*	*1.38 dB*
AC Line Conducted Emissions	*Shielded Room/EMCO LISN*	*3.20 dB*
Temperature/Humidity	*Thermo-hygrometer*	*0.64° / 2.88 %RH*