LSR a Laird Business ACCREDITED TESTING CERT #1255.01
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ENGINEERING TEST REPORT #: 316051 B
LSR JOB #: C-2393

Compliance Testing of:

Sterling-LWB

Test Date(s):

May 31st – June 16th, 2016

Prepared For:

Attn: Josh Bablitch
LS Research
W66 N220 Commerce Court
Cedarburg, WI 53012

This Test Report is issued under the Authority of:
Coty Hammerer, EMC Engineer

Signature: Coty Hammerer Date: 7-6-16

Quality Assurance by:	**Project Engineer:**
Adam Alger, Quality Systems Engineer	Coty Hammerer, EMC Engineer
Signature: Adam O Alger Date: 7-6-16	Signature: Coty Hammerer Date: 7-6-16

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LS Research, LLC in Review

As an EMC Testing Laboratory, our Accreditation and Assessments are recognized through the following:

TESTING CERT #1255.01

A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025: 2005 with Electrical (EMC) Scope of Accreditation
A2LA Certificate Number: **1255.01**

Federal Communications Commission (FCC) – USA

Listing of 3 Meter Semi-Anechoic Chamber based on Title 47 CFR – Part 2.948
FCC Registration Number: **90756**

Industrie Canada Industry Canada
Canada

Industry Canada

On file, 3 Meter Semi-Anechoic Chamber based on RSS-GEN – Issue 4
File Number: **IC 3088A-2**
On file, 3 Meter Semi-Anechoic Chamber based on RSS-GEN – Issue 4
File Number: **IC 3088A-3**

Product and General Information

Manufacturer:	LS Research
Date(s) of Test:	May 31st – June 16, 2016
Tested By:	Coty Hammerer, Kimberly Bay, Aidi Zainal, Shane Dock
Voltage:	3.3 VDC

Environmental Conditions in the Test Lab:
Temperature: 20-25° C
Atmospheric Pressure: 86 kPa - 106 kPa
Humidity: 30-60%

Introduction

Between May 31st to June 16th 2016, a series of emissions and immunity tests were performed on the Sterling-LWB Module henceforth referred to as the "*Equipment Under Test*" or "*EUT*". The emissions and immunity tests performed on the EUT are in accordance with **ETSI EN 301 489-17** and **ETSI EN 301 489-1** standards. The tests were performed to allow verification of the product to meet the EMC Directive 2014/30/EU.

Product Description

The Sterling-LWB is a multi-standard module with support for WLAN (802.11 b/g/n), and Bluetooth V2.1 and Bluetooth 4.0 & 4.1 with multiple antenna options.

Test Requirements

Product/Product Family		Application		
EN 301 489-17/EN 301 489-1		EMC for Radio Equipment, Specific conditions for Broadband DTS/EMC standard for radio equipment and services		
Basic Standards (Emissions)		**Port Tested**	**Test Descriptions**	**Results**
EN 55022		Enclosure	Radiated Emissions	**Pass**
		AC Power Ports	Conducted Emissions	**Pass**
IEC 61000-3-2	EN 61000-3-2	AC Power Ports	Harmonic Current Emissions (through Amendment 14 of IEC 61000-4-7)	Note 2
IEC 61000-3-3	EN 61000-3-3	AC Power Ports	Voltage Fluctuation and Flicker	Note 2
Basic Standards		**Port Tested**	**Test Specifications**	**Results**
IEC	**EN**			
IEC 61000-4-2	EN 61000-4-2	Enclosure	ESD, ±4kV Contact, ±8kV Air Discharge	**Pass**
IEC 61000-4-3	EN 61000-4-3	Enclosure	Radiated RF Immunity, 3 V/m, 80% AM @ 1kHz, 1% step of the previous frequency 80-2700 MHz	**Pass**
IEC 61000-4-4	EN 61000-4-4	AC Power Ports	EFT Burst: ±0.5 kV - ±2kV	Note 2
IEC 61000-4-4	EN 61000-4-4	Signal, Control & Telecomm and DC power ports	EFT Burst ±0.5kV	Note 3
IEC 61000-4-5	EN 61000-4-5	AC Input Ports	Surge ±1kV Differential Mode (line to line) ±2kV Common Mode (line to ground)	Note 2
IEC 61000-4-5	EN 61000-4-5	Telecommunication Ports	Surge ± 0.5kV Common Mode	Note 2
IEC 61000-4-6	EN 61000-4-6	AC Power Ports	Conducted RF Immunity: 3 V 80% AM modulation @ 1kHz	Note 2
IEC 61000-4-6	EN 61000-4-6	Signal, Control, Telecommunication and DC Power Ports (>3m)	Conducted RF Immunity: 3 V, 80% AM modulation @ 1kHz	Note 2
IEC 61000-4-8	EN 61000-4-8	Display & Magnetic Sensors	Magnetic Field Immunity 3 A/m	Not Required
IEC 61000-4-11	EN 61000-4-11	AC input ports	Voltage Dips and Short Interruptions at test Voltage level: 70%, 40% and 5% nominal for 10ms, 100ms and 5 sec (50Hz)	Note 2

Notes:

1. **See Appendix B for current test standard publication dates. EUT was tested per requirements of current standard publications.**
2. **Not applicable based on ETSI EN 301 489-1 v1.8.1 The EUT does not incorporate an AC Mains Port.**
3. **Not applicable based on ETSI EN 301 489-1 v1.8.1 The DC Input Port has a nominal input of 3.3 VDC, out of the range of 12 – 24 VDC.**

Summary of Test Report

DECLARATION OF COMPLIANCE

The EUT was found to **MEET** the requirements as described within the specifications of ETSI EN 301 489-17 V2.2.1 and ETSI EN 301 489-1 V1.8.1 for emissions and immunity tests.

The enclosed test results pertain to the sample(s) of the test item listed, and only for the tests performed on the data sheets. Any subsequent modification or changes to the test items could invalidate the data contained herein, and could therefore invalidate the findings of this report.

If some emissions are seen to be within 3dB of their respective limits, 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.

Definition of Performance Criteria

EUT setup during immunity and susceptibility testing:

The system was setup to have communication with the EUT:

1. WLAN radio: iperf test running. HyperTerminal program running on laptop connected to EUT causing EUT to transmit/receive. Other laptop connected to an AP with an external antenna. Client and server operations running to verify throughput.
2. Bluetooth radio: Throughput test running with 2 EUT samples. One acts as the Slave and the other as the Master both samples connected to the same PC and settings are set via the Test Tool Suite provided by the manufacturer.

- **Performance A:**

  No loss in communication link. A degradation of 10% from initial/starting average throughput is acceptable after the test.

- **Performance B:**

  A loss of communication link is allowed. Link shall be established manually due to the absence of application to automatically reconnect. After connection is re-established, a degradation of 20% from average throughput value before loss of link is acceptable.

- **Performance C**

  A loss of communication link is allowed. Link shall be established manually due to the absence of application to automatically reconnect. After connection is re-established, a degradation of 40% from average throughput value before loss of link is acceptable.

Radiated Emissions Test

Test Setup

The test setup was assembled in accordance with EN 55022 per requirements of ETSI EN 301 489-17.

Test Procedure

The frequency range from 30 MHz to 6000 MHz was investigated, and levels were manually noted at the various fixed degree settings of azimuth on the turntable and antenna height. The EUT was placed in the 3 Meter Semi-Anechoic Chamber, with the antenna mast placed such that the antenna was 3 meters from the test object. A Biconical Antenna was used to measure emissions from 30 MHz to 200 MHz, a Log Periodic Antenna was used to measure emissions from 200 MHz to 1000 MHz. Emissions between 1000 to 6000 MHz were measured using a double ridged horn antenna. The procedure for finding the maximum radiated RF emission for each scan was as follows: locating the antenna elevation (between 1 and 4 meters) that produced a peak emission. Next, the EUT was rotated on the turntable, obtaining the azimuth of the maximum signal level. These two steps were repeated until the maximum emission stayed at the same level. Individual scans were run using horizontal and vertical antenna polarities in the different frequency ranges.

Test Equipment Utilized

A complete list of test equipment can be found in Appendix A. Correction factors and cable loss factors 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, 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 and 1MHz for measurements above 1GHz.

Test Results

The EUT was found to **MEET** the Radiated Emissions requirements of the ETSI EN 301 489-17 standard. The frequencies with significant signals were recorded and plotted as shown in the Data Charts and Graphs.

Calculation of Radiated Emissions Limits

The following table presents the EN 55022 limits.

Frequency (MHz)	10 m Limit dBμV/m	3 m Limit dBμV/m
30 - 230	30	40.5
230 - 1000	37	47.5

Frequency (MHz)	Peak Limit (3m) dBμV/m	Average Limit (3m) dBμV/m
1000 – 3000	70	50
3000 - 6000	74	54

Sample conversion of limits between 10 meters and 3 meters:

3m limit (dBμV/m) – 10 dB = 10m limit (dBμV/m)
or
3m limit (dBμV/m) = 10m limit (dBμV/m) + 10.5 dB

from 30-230 MHz for example:

3m limit (dBμV/m) = 30.0 dBμV/m + 10.5 dB
40.5 dBμV/m = 30.0 dBμV/m + 10.5 dB

Radiated Emissions Data Chart

Manufacturer:	LS Research					
Date(s) of Test:	6/15/16					
Tested By:	Coty Hammerer, Shane Dock					
Voltage:	3.3 VDC					
Distance:	**X**	3 Meters		10 Meters		
EUT Power:		Single phase 120 VAC, 60Hz	**X**	DC Power Supply		
EUT Placement:	**X**	80cm non-conductive table		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

Environmental Conditions in the Lab:
Temperature: 20 – 25°C
Relative Humidity: 30 – 60 %

The table depicts the level of significant radiated emissions found:

Below 1000 MHz

Frequency (MHz)	Height (m)	Azimuth (degree)	Quasi Peak Reading (dBµV/m)	Quasi Peak Limit (dBµV/m)	Q.Peak Margin (dB)	Antenna Polarity	EUT orientation	Notes
197.90	1.00	0.00	27.40	40.50	13.10	V	Vert.	WLAN Chip: System Noise Floor
213.33	1.00	0.00	25.00	40.50	15.50	H	Vert.	WLAN Chip: System Noise Floor
466.71	1.45	103.25	31.30	47.50	16.20	V	Vert.	WLAN Chip: System Noise Floor

Frequency (MHz)	Height (m)	Azimuth (degree)	Quasi Peak Reading (dBµV/m)	Quasi Peak Limit (dBµV/m)	Q.Peak Margin (dB)	Antenna Polarity	EUT orientation	Notes
861.20	1.00	0.00	35.80	47.50	11.70	H	Vert.	Bluetooth Port Term.Noise Floor - Peak could not be recreated.
707.70	1.00	0.00	34.00	47.50	13.50	V	Vert.	Bluetooth Port Term. Noise Floor - Peak could not be recreated.
996.40	1.00	0.00	36.80	47.50	10.70	V	Vert.	Bluetooth Chip - Noise Floor
749.50	1.00	0.00	34.00	47.50	13.50	H	Vert.	Bluetooth Chip - Noise Floor - Peak could not be recreated
191.59	1.00	161.50	27.11	40.50	13.39	H	Vert.	Bluetooth Chip
37.68	1.00	157.75	34.10	40.50	6.40	V	Vert.	Bluetooth Chip - Power Supply
81.07	1.00	0.00	30.52	40.50	9.98	V	Vert.	Bluetooth Chip - Power Supply

Note:
1. Emissions seen above were determined NOT to be a function of the radio.

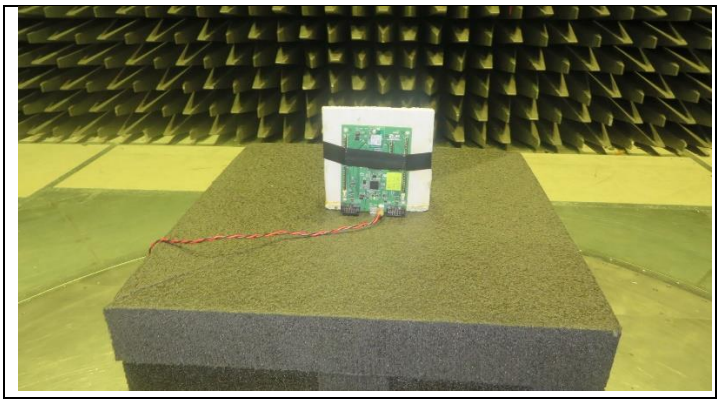
Above 1000 MHz

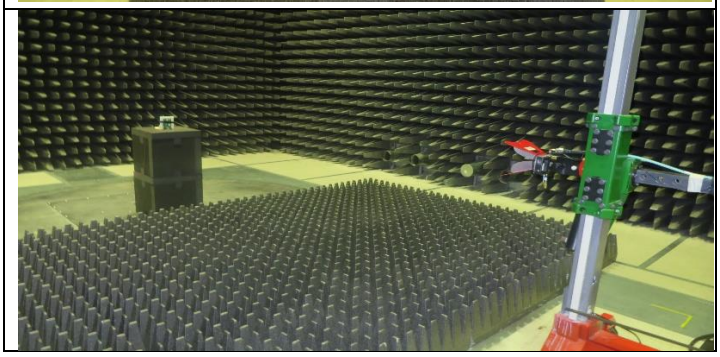
Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	Average Reading (dBµV/m)	Average Limit (dBµV/m)	Average Margin (dB)	Antenna Polarity	EUT orientation	Notes
3618.18	1.87	59.25	50.38	74.00	23.62	47.81	54.00	6.19	H	Vert.	WLAN Chip
3618.04	1.07	210.50	44.47	74.00	29.53	38.74	54.00	15.26	V	Vert.	WLAN Chip
3618.09	1.00	215.25	46.81	74.00	27.19	42.27	54.00	11.73	V	Vert.	WLAN Port Term.
3617.96	1.65	321.50	47.41	74.00	26.59	43.81	54.00	10.19	H	Vert.	WLAN Port Term.
3618.14	1.81	145.00	47.52	74.00	26.48	43.83	54.00	10.17	H	Hor.	WLAN Port Term.
3618.00	1.00	91.75	46.53	74.00	27.47	42.21	54.00	11.79	V	Hor.	WLAN Port Term.
3618.04	1.27	168.75	47.19	74.00	26.81	43.25	54.00	10.75	H	Flat	WLAN Port Term.
3618.09	2.01	213.25	47.24	74.00	26.76	43.33	54.00	10.67	V	Flat	WLAN Port Term.

Frequency (MHz)	Height (m)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Limit (dBµV/m)	Peak Margin (dB)	Average Reading (dBµV/m)	Average Limit (dBµV/m)	Average Margin (dB)	Antenna Polarity	EUT orientation	Notes
5995.2	1.00	0	42.6	74.0	31.42	29.6	54.00	24.41	H	Vert.	Noise Floor
5945.3	1.00	0	42.5	74.0	31.50	29.7	54.00	24.29	V	Vert.	Noise Floor
2409.6	1.00	177.5	42.8	70.0	27.21	26.4	50.00	23.59	V	Vert.	Bluetooth Port Term.
2409.2	1.00	181.25	42.9	70.0	27.10	26.5	50.00	23.50	V	Vert.	Bluetooth Chip

Photo(s) Taken During Testing

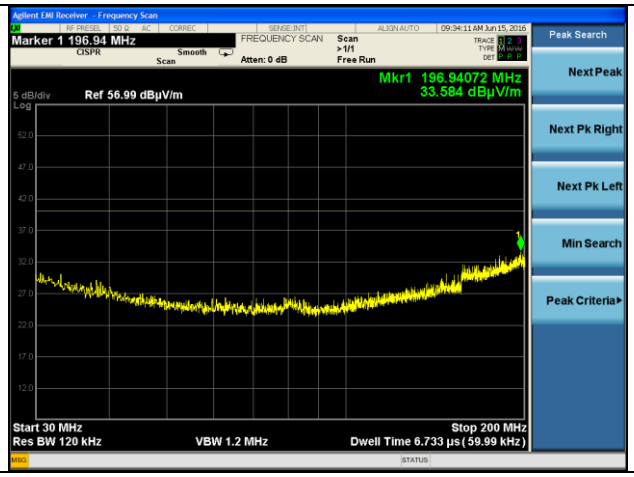
Setup for <u>Radiated Emissions</u> Test



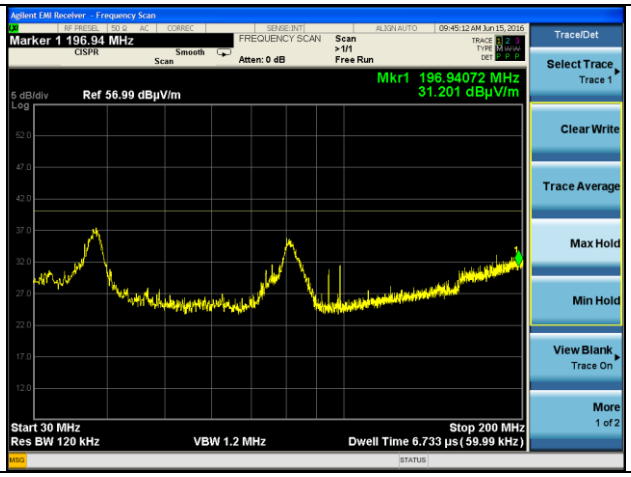


Graphs

Signature Scan of Peak Radiated Emissions
Displayed Below is Worst Case Emissions: WLAN Chip Antenna
30-200 MHz, at 3m

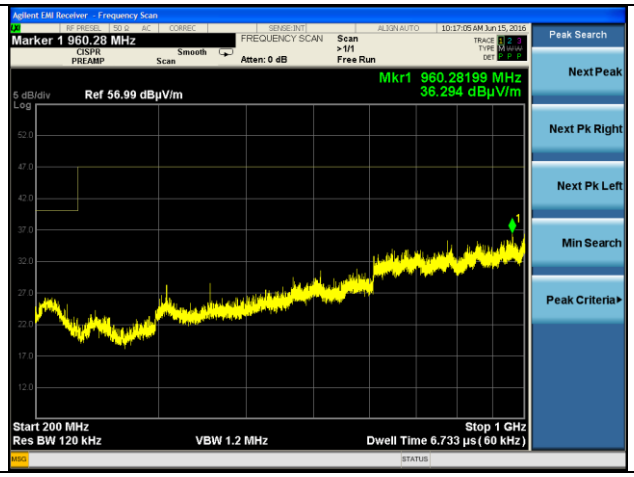


Horizontal

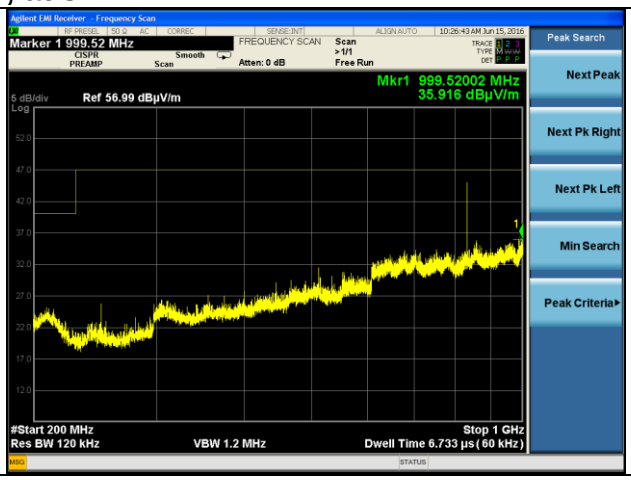


Vertical

200-1000 MHz, at 3m

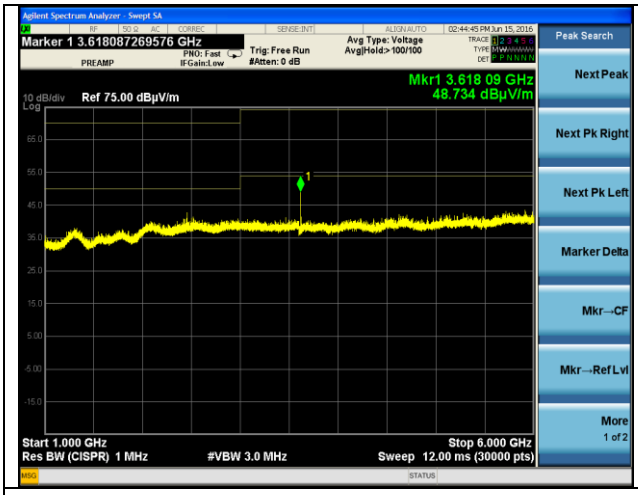


Horizontal

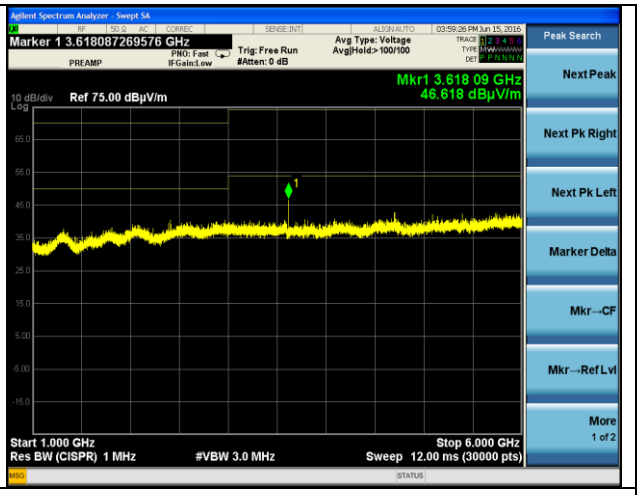


Vertical

1000 MHz – 6000 MHz



Horizontal



Vertical

Note: these screen captures represent Peak Emissions. For radiated emission measurements, a Quasi-Peak detector function is utilized when measuring frequencies below 1 GHz.

Electrostatic Discharge (ESD) Test

Test Setup

The ESD Immunity Test was setup in accordance with the IEC 61000-4-2 standard per the requirements of ETSI EN 301 489-17. The tests were performed with a Horizontal Coupling Plane (HCP) 1.6m x 0.8m placed on top of a table which is 80 cm height above the ground plane. A 0.5 mm thin sheet of non-conductive material was placed underneath the EUT for isolation of the Coupling Plane. The tests were performed using a Schaffner NSG438 Gun, which is compliant with the ESD standard IEC 61000-4-2, and was grounded to the ground reference plane through a 2-meter cable.

Test Procedure

The EUT was tested up to a level of ±4 kV Contact discharge, and a level of ±8 kV Air discharge, as required by ETSI EN 301 489-17 standard. Both Vertical Coupling Plane (VCP) and Horizontal Coupling Plane (HCP) discharges were applied at locations around the EUT.

Contact Discharge

The electrostatic discharges were applied to points of the EUT that were accessible during normal usage. The pointed tip of the ESD Gun was applied in contact mode to several key points on the EUT, and other accessible areas. The test voltage was increased from a minimum level of ± 2kV to a level of ± 4kV, in steps, to determine the EUT's susceptibility threshold. At least 10 single discharges were applied to selected points in both positive and negative polarities. The ESD Gun was held perpendicular to the surface of the discharge point to ensure repeatability of test results. During the ESD testing, the EUT continued to operate while it was monitored for any distortion caused by the ESD. The test sample showed no apparent failure during contact discharge from ±2 kV to ±4 kV. ESD contact discharges were also applied to a VCP spaced 10cm from the EUT, and a HCP around the EUT.

Air Discharge

The charged round tip of the ESD Gun was moved around various key points on the EUT to determine locations that would take a discharge. The tip was moved away from the EUT's surface after each discharge. This process was repeated until the discharges were completed from levels of ±2 kV to ±8 kV.

Test Equipment Utilized

A complete list of test equipment can be found in Appendix A.

Test Results

The EUT was found to **MEET** the ESD requirements of ETSI EN 301 489-17. Details of the test results can be found in the Data Charts.

Electrostatic Discharge Data Chart

Manufacturer:	LS Research					
Date(s) of Test:	6/16/16					
Test Engineer:		Shane Dock	X	Coty Hammerer		Aidi Zainal
Voltage:	3.3 VDC					

A (X) indicates that a test specification has been observed.

Discharge Voltage Level:	X	Level 1	X	Level 2	X	Level 3		Other

Discharge Impedance:		150 Ohm/150pF	X	330 Ohm/150pF
Discharge Factor:	X	> 1 Second		Other – 5 Seconds
Number of Discharges:	X	> 10 Hits at all locations		Other – Hits at all locations

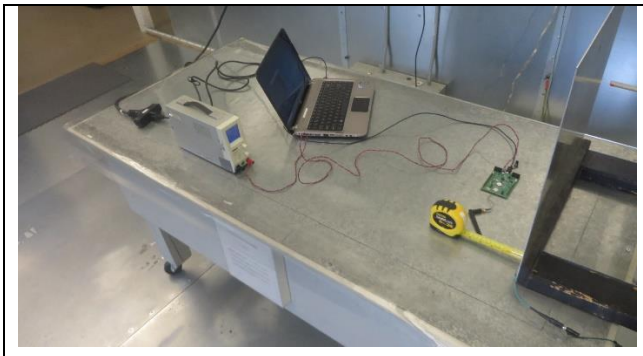
Performance Criterion:		Criterion A	X	Criterion B		Criterion C
Test Results:	X	Passed		Failed		

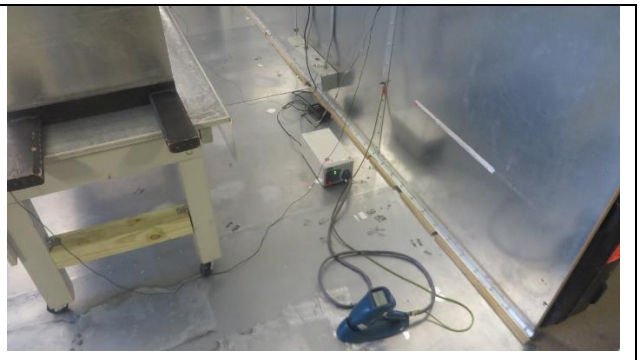
		Test Voltages						Discharge Type		Criteria Met
		+2kV	-2kV	+4kV	-4kV	+8kV	-8kV	Air	Contact	
Test Points	HCP	X	X	X	X				X	A
	VCP	X	X	X	X				X	A
	SMA Connector	X	X	X	X				X	A
	Antenna Joint	X	X	X	X	X	X	X		A

Note: The above test data is representative of exercising the Bluetooth and WLAN functionality of the module. The iperf test was run during ESD testing when evaluating WLAN and throughput testing via master/slave Bluetooth units was used to evaluate the Bluetooth functionality.

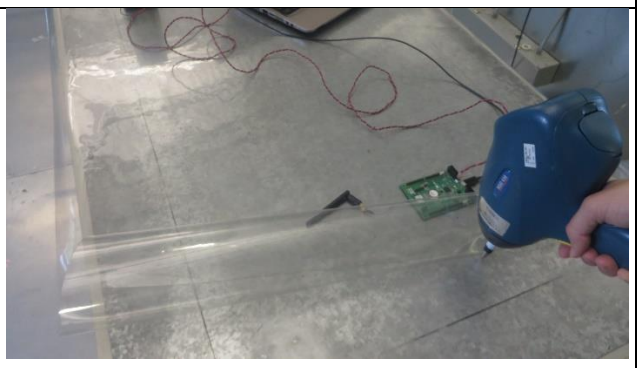
Photo(s) Taken During Testing

Setup for Electrostatic Discharge (ESD) Test





WLAN



Bluetooth

Radiated RF Immunity Test

Test Setup

The EUT was operated within the 3 Meter Semi-Anechoic Chamber during the Radiated RF Immunity Test. The test was performed in accordance with IEC 61000-4-3 per the requirements of ETSI EN 301 489-17. A level calibrated field was first determined by using the following steps. A transmitting antenna was placed 3 meters from the EUT's position, and 1.5 meters above the Ground Reference Plane. A swept carrier signal was then transmitted via the antenna, over a frequency range of 80 MHz to 1000 MHz. The resulting field intensity was monitored over a planar area of 1.5 m x 1.5 m, starting at 0.8 meters above the floor at the EUT position. A grid of 16 points within the 1.5 m x 1.5 m aperture area was measured using a Field Intensity Probe. The forward power required to create this field strength at each frequency step was measured with a Directional Coupler and stored in a calibration file. The Power Meter, Signal Generator, and Field Intensity Probe were all controlled and monitored by a laptop computer running the Teseq software program. This calibration was performed in both horizontal and vertical polarities. A similar setup and process was used to calibrate a 9 pt. grid for 1000 MHz to 2700 MHz. A Double Ridge Wave Guide Horn Antenna was used for the transmitting antenna. The calibration was conducted in both the vertical and horizontal antenna polarities.

Test Procedure

The EUT was placed on an 80 cm non-conductive table and the Antenna Mast was placed such that the antenna was 3 meters from the EUT. A Bilog Antenna was used from 80 MHz to 1000 MHz and a Double-Ridged Waveguide Horn Antenna was used from 1400MHz to 2700 MHz to transmit RF power to the EUT for both vertical and horizontal polarities. The transmitting antenna was placed at a fixed position above the Ground Reference Plane at a height of 1.5 meters for the lower frequency range and 1.3m for the higher frequency range. The field strength was monitored using a Field Sensor Probe placed on the test table near the EUT as a verification check. The intensity of the established field strength was checked prior to the actual testing. The Teseq software program was set to dwell for 3 seconds at each frequency and control the Signal Generator modulation of 1 kHz, 80% A.M. Each frequency was increased by 1% of the previous frequency in a logarithmic fashion. The test was repeated for each test configuration using both vertical and horizontal antenna polarities. The parameters of the RF Immunity testing for each sweep were set and automatically controlled and recorded in the Data Charts.

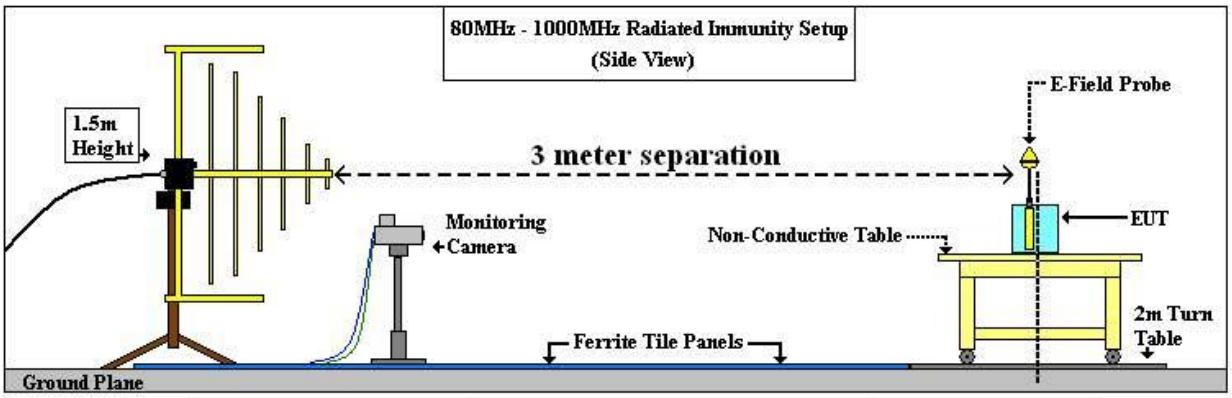
Test Equipment Utilized

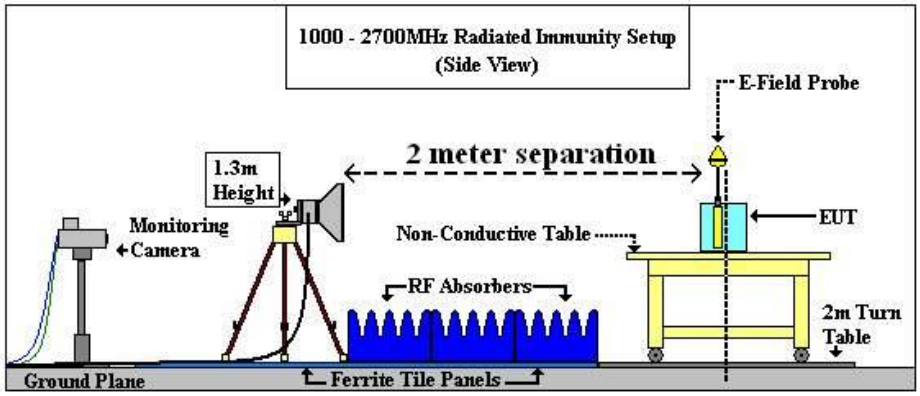
A complete list of test equipment can be found in Appendix A.

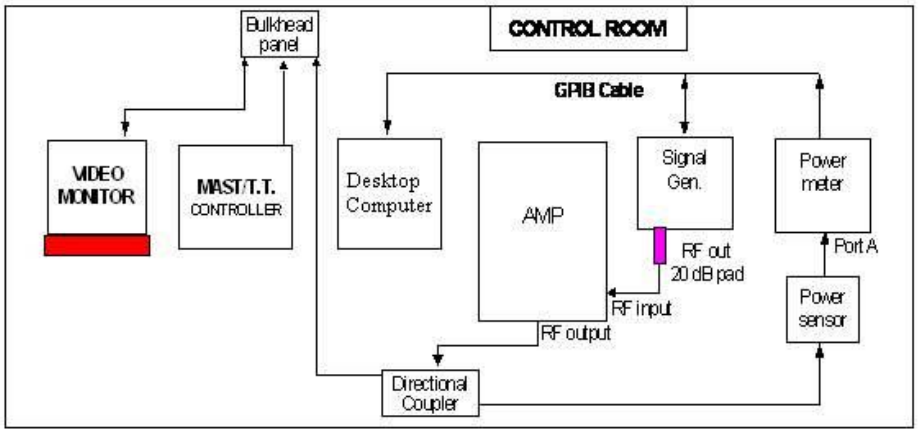
Test Results

The EUT was found to **MEET** the radiated immunity requirements of ETSI EN 301 489-17 The EUT was monitored remotely from the Control Room during the test.

RF IMMUNITY TEST CONFIGURATION







Radiated RF Immunity Test Data Chart

Manufacturer:	LS Research							
Date(s) of Test:	5/31/16 – 6/5/16							
Test Engineer:		Aidi Zainal	X	Kimberly Bay	X	Coty Hammerer		
Voltage:	3.3 VDC							
Areas Tested:	X	Front	X	Back				

Environmental Conditions in the Lab:
Temperature: 20 – 25° C
Atmospheric Pressure: 86 kPa – 106 kPa
Relative Humidity: 30 – 60%

A (X) indicates that a test specification has been observed.

Frequency Range:	X	1.4 – 2.7 GHz	X	80 MHz – 1000 MHz
		26 MHz – 80 MHz		900 ± 5 MHz
		27 MHz – 500 MHz		Other

Field Strength:		Level 1: 1 V/m		Level 3: 10 V/m
	X	Level 2: 3 V/m		Other

Antenna Range-EUT:	X	2 m	X	3 m

Antenna Polarity:	X	Horizontal	X	Vertical

Modulation:	X	AM: 80%, 1 kHz		Pulse 50% duty, 200 Hz
		AM: 80%, 0.5 Hz		Other: Pulse 50% duty, 1 Hz

Step:	X	1% of Fund. Freq., 3 Sec. Dwell		1 MHz Step, ___ Sec. Dwell

Performance Criterion:	X	Criterion A		Criterion B		Criterion C

Test Results:	X	Passed		Failed

Test Config
80-1000MHz
1% Frequency Increments
3 V/m Stress Level
3 sec. Dwell Time

→ → → → →

EUT Side	Polarity	Results	Criteria
Front	Horizontal	Pass	A
Front	Vertical	Pass	A
Rear	Vertical	Pass	A
Rear	Horizontal	Pass	A

Test Config
1400-2700MHz
1% Frequency Increments
3 V/m Stress Level
3 sec. Dwell Time

→ → → → →

Side	Polarity	Results	Criteria
Front	Horizontal	Pass	A
Front	Vertical	Pass	A
Rear	Vertical	Pass	A
Rear	Horizontal	Pass	A

Note: Above data is reflective of both WLAN and Bluetooth testing. The Bluetooth exclusion band ranges from 2280 – 2607.7 MHz and the WLAN exclusion band ranges from 2291.4 – 2595.6 MHz.

Photo(s) Taken During Testing

Prepared For: LS Research	**Model Number:** Sterling-LWB **Serial Number:** 15, 23, 26, 29, 32, 42, 47	**Report #:** TR 316051 B

Conducted AC Emissions

Test Setup

The test setup was assembled in accordance with EN 55022 per requirements of ETSI EN 301 489-17.

A generic AC/DC supply was used to power the EUT during testing.

Test Procedure

The EUT was investigated in continuous modulated 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.

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.

Test Results

The EUT was found to **MEET** the Radiated Emissions requirements of the ETSI EN 301 489-17 standard. The frequencies with significant signals were recorded and plotted as shown in the Data Charts and Graphs.

EN 55022 Class B 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	
Notes: Lower limit applies at transition frequencies. * The limit decreases linearly with the logarithm of the frequency in this range.			

CONDUCTED EMISSIONS TEST DATA CHART

Manufacturer:	LS Research					
Date(s) of Test:	4/14/16					
Project Engineer:	Coty Hammerer					
Test Engineer:	Coty Hammerer					
Voltage:	3.3 VDC					
Operation Mode:	Continuous Transmit – Worst Case					
Environmental Conditions in the Lab:	Temperature: 20-25◦ C Relative Humidity: 40%					
Test Location:	**X**	**AC Mains Test area**				**Chamber**
EUT Placed:	**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**

WLAN **3.3 VDC**

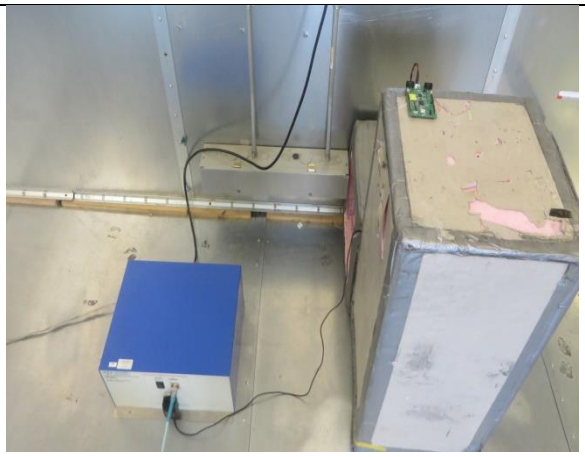
Line	Frequency (MHz)	Q-Peak Reading (dBµV)	Q-Peak Limit (dBµV)	Quasi-Peak Margin (dB)	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Notes
1	0.20	44.60	63.83	19.23	31.50	53.83	22.33	Tx
1	0.62	40.70	56.00	15.30	30.00	46.00	16.00	Tx
1	0.20	46.50	63.62	17.12	36.20	53.62	17.42	Tx
2	0.20	41.90	63.62	21.72	26.50	53.62	27.12	Tx
2	0.67	41.40	56.00	14.60	25.10	46.00	20.90	Tx
2	0.27	41.30	61.24	19.94	27.30	51.24	23.94	Tx

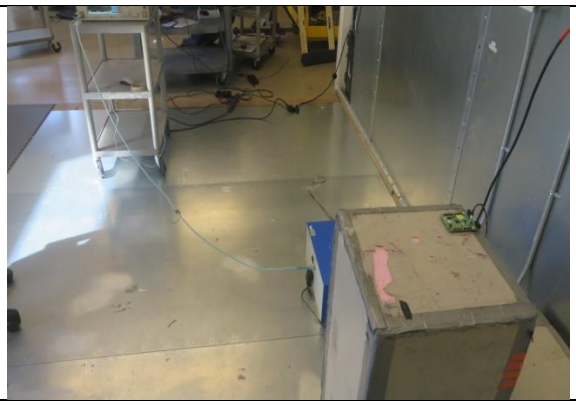
BLUETOOTH **3.3 VDC**

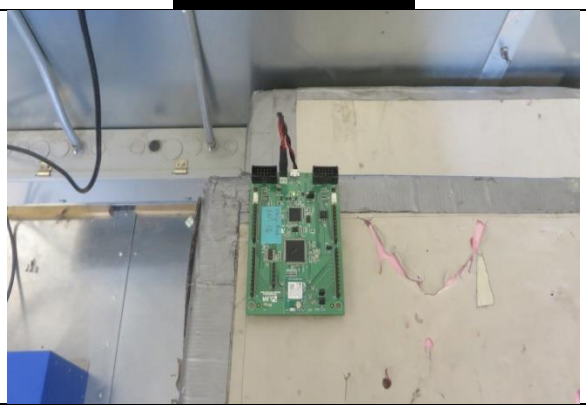
Line	Frequency (MHz)	Q-Peak Reading (dBµV)	Q-Peak Limit (dBµV)	Quasi-Peak Margin (dB)	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)	Notes
1	0.15	40.50	66.00	25.50	28.30	56.00	27.70	Tx
1	0.63	33.60	56.00	22.40	25.50	46.00	20.50	Tx
1	0.16	39.80	65.42	25.62	28.70	55.42	26.72	Tx
2	0.62	34.00	56.00	22.00	24.90	46.00	21.10	Tx
2	0.16	33.00	65.73	32.73	19.90	55.73	35.83	Tx
2	0.16	34.70	65.47	30.77	21.60	55.47	33.87	Tx

Note: Leveraging previous Transmitter data, represents worst case emissions.

Test Setup Photo(s) – Conducted Emissions Test



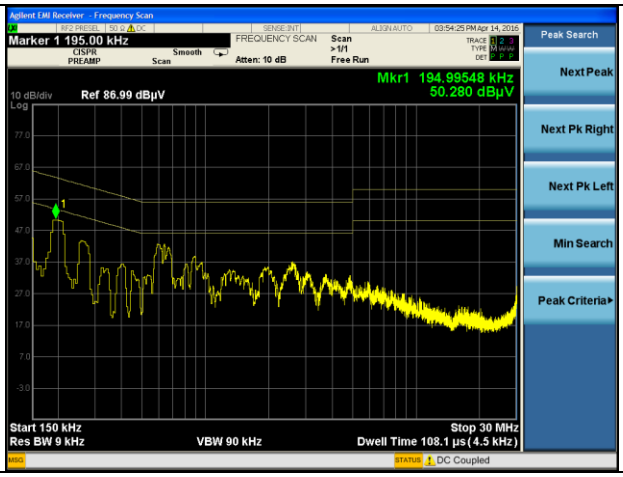




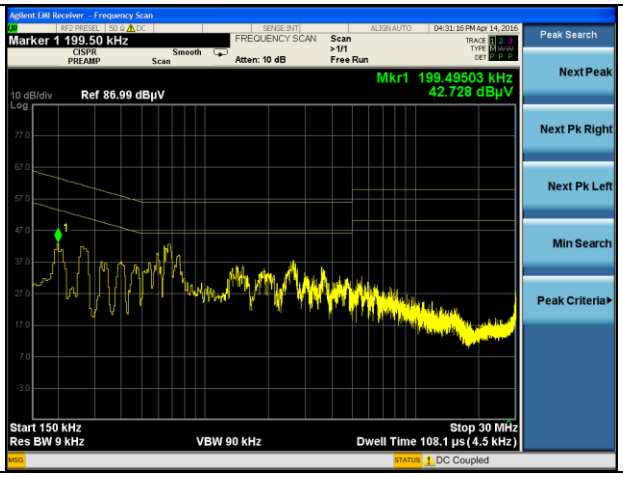
Screen Captures – Conducted Emissions Test

These screen captures represent Peak Emissions. For conducted emission measurements, both a Quasi-Peak detector function and an Average detector function are utilized.

WLAN



Line 1



Line 2

BLUETOOTH

Line 1

Line 2

Appendix A: Test Equipment List

LSR
a Laird Business

Date: 9-Mar-2016 Type Test: Radiated RF Immunity Job #: C-2393

Prepared By: Kim Customer: LSR Quote #: 316051

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960007	Double Ridge Horn Antenna	EMCO	3115	9311-4138	8/4/2015	8/4/2016	Active Calibration
2	EE 960052	Amplifier	AR	5S1G4	25582	Verification	Verification	System
3	AA 960164	3-axis Electric Field Probe (100kHz-6GHz; 0.5-80	ETS-Lindgren - Hc	HI-6005	102114	5/14/2015	5/14/2016	Active Calibration
4	EE 960165	Directional Coupler 10dB Attenuator 1-12.4GHz	narda	3202B-10	11558	2/17/2016	2/17/2017	Active Calibration
5	EE 960005	Dual Channel Power Meter	Gigatronics	8542C	1831450	12/28/2015	12/28/2016	Active Calibration
6	AA 960054	Power Sensor	Gigatronics	80301A	1830164	12/28/2015	12/28/2016	Active Calibration
7	CC 000314C	Vector Signal Generator	Agilent	E4438C	US 41469143	4/29/2015	4/29/2017	Active Calibration
8	AA 960050	Bilog Xwing Antenna	Chase	CBL6140A	1106	Verification	Verification	System
9	EE 960103	Power Amplifier	Milmega	80RF1000-250	1058468	Verification	Verification	System
10	EE 960077	DC Power Supply	GW Instek	GPS-3030DD	EJ810521	Verification	Verification	System

LSR
a Laird Business

Date: 9-Jun-2016 Type Test: Electrostatic Discharge Job #: C-2393

Prepared By: Coty Hammerer Customer: LSR Quote #: 316051

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960075	ESD Gun	Schaffner	NSG 438	569	8/18/2015	8/18/2016	Active Calibration

LSR
a Laird Business

Date: 15-Jun-2016 Type Test: Radiated Emissions Job #: C-2393

Prepared By: Coty Hammerer Customer: LSR Quote #: 316051

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	AA 960150	Biconical Antenna	ETS	3110B	0003-3346	2/1/2016	2/1/2017	Active Calibration
2	AA 960078	Log Periodic Antenna	EMCO	93146	9701-4855	2/17/2016	2/17/2017	Active Calibration
3	AA 960158	Double Ridge Horn Antenna	ETS Lindgren	3117	109300	2/4/2016	2/4/2017	Active Calibration
4	EE 960159	0.8 - 21GHz LNA	Mini-Circuits	ZVA-213X-S+	40201429	2/4/2016	2/4/2017	Active Calibration
5	EE 960085	N9038A MXE 26.5GHz Receiver	Agilent	N9038A	MY51210148	5/6/2015	5/6/2016	Active Calibration

LSR
a Laird Business

Date: 14-Apr-2016 Type Test: Conducted Emissions Job #: C-2391

Prepared By: Coty Hammerer Customer: LSR Quote #: 316050

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960162	LISN - 15A	COM-POWER	LI-215A	191969	7/24/2015	7/24/2016	Active Calibration
2	EE 960077	DC Power Supply	GW Instek	GPS-3030DD	EJ810521	Verification	Verification	System
3	EE 960088	8GHz MXE Spectrum Analyzer	Agilent	N9038A	MY51210138	2/24/2016	2/24/2017	Active Calibration

Project Engineer: Coty Hammerer Quality Assurance:

Appendix B: Applicable Referenced Standards.

Standard	Date	Am. 1	Am. 2
ETSI EN 301 489-17 V2.2.1	2012		
ETSI EN 301 489-1 V1.8.1	2008		

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
Radiated Immunity	3 Volts/Meter in 3-Meter Chamber	2.05 Volts/Meter
Conducted Immunity	3 Volts level	2.33 V
EFT Burst, Surge, VDI	230 VAC	54.4 V
ESD Immunity	Discharge at 15kV	3200 V
Temperature/Humidity	Thermo-hygrometer	0.64° / 2.88 %RH