Lab Code: 200167-0

FCC PART 15.247

MEASUREMENT AND TEST REPORT

For

Trimble Navigation Ltd.

935 Stewart Drive
Sunnyvale, CA 94085, USA

FCC ID: JUP-642356X-B1
Model: R8-M2(RoHS) with TNL450I 450 MHz radio

Report Type:	**Product Type:**
☒Original Submission: Supplemental Report	GPS Receiver with incorporated UHF and Bluetooth radios

Test Engineer:	Choon-Sian Ooi
Report Number:	R0710171-247
Report Date:	2007-11-12
Reviewed By:	James Ma, Test Engineer
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TABLE OF CONTENTS

1 GENERAL INFORMATION

1.1 Product Description for Equipment under Test (EUT)

The *Trimble Navigation Ltd.* product, FCC ID: JUP-642356X-B1, model: R8-M2(RoHS) with TNL450I 450 MHz Radio, or the "EUT" as referred to in this report, is a GPS receiver with integrated Bluetooth module, and is capable of being factory configured with various radio modules, which provide GPS corrections between a base station and a mobile unit. The Bluetooth enables the receiver to communicate with a handheld data collector. The TNL450I is a 450MHz radio which operates in three bands: 410-430MHz, 430-450MHz, and 450-470MHz. The R8-M2 was configured with the TNL450I radio (FCC ID: KEATNL450I) and Bluetooth (FCC ID: Q2331308) for testing.

** The test data gathered are from typical production samples provided by the customer with serial numbers as follows:*

- *R8-M2: Part Number: 60250-66; Serial Number RoHSA0001*
- *TNL450I Radio: Part Number: 64235-66; Serial Number: A02377 M02 0704 3001*

1.2 Antennae Description

Item Number	Model/Type	
GPS receiver antenna	Model:	Antenna Mobile
	Manufacturer:	SAS (Signal Antenna Systems, Inc.)
	Frequency Range:	Dual Frequency: 902-928 MHz; 2.4 – 2.5 GHz
	Maximum Antenna Gain:	2 dBi at 915 MHz; 2 dBi at 2.5 GHz
	Antenna Type	Monopole omni
	Measurement:	23 cmH

1.3 Mechanical Description of EUT

Trimble Navigation Limited's product, model: *R8-M2(RoHS)* or the "EUT" measures approximately 19 cmD x 25.5 cm H (including base stand).

1.4 EUT Photograph

Please refer to Exhibit C for more EUT photographs

1.5 Objective

This report is prepared on behalf of *Trimble Navigation* in accordance with Part 2, Subpart J, Part 15, Subpart C.

The objective of the manufacturer is to demonstrate compliance with the applicable FCC rules. The EUT has integrated into its design one UHF radio, and one FHSS radio module already tested for compliance and submitted to the FCC under FCC ID's KEATNL450I, and Q2331308 respectively; thus, the testing in this report concerns the compilation of these modules along with a GPS receiver into the device designated as FCC ID: JUP-642356X-B1. Only those tests affected by this assemblage (bold face type blow) are herein conducted and recorded; for all other test results please see those submission and reports mentioned in the following subsection.

Antenna Requirement
Conducted Emissions
Radiated Emissions
Hopping Channel Separation*
Channel Bandwidth*
Number of Hopping Frequencies Used*
Dwell Time of Each Frequency*
Maximum Peak Output Power*
100 kHz Bandwidth of Frequency Band Edge*
RF Exposure*
Spurious Emissions at Antenna Terminals*

**Please see related test reports for details*

1.6 Related Submittal(s)/Grant(s)

Please refer to FCC submissions FCC ID: KEATNL450I (BACL project number R0604242), and FCC ID: Q2331308 (BACL project number R0702082) for measurements and test results pertaining to the 450 MHz UHF radio and Bluetooth radio modules. Also, please refer to BACL report R0710171-90 for testing and results pertaining to the applicable FCC part 90 requirements for this device.

1.7 Test Methodology

All measurements contained in this report were conducted in accordance with ANSI C63.4-2003.

1.8 Measurement Uncertainty

All measurements involve certain levels of uncertainties, especially in field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

Based on NIS 81, The Treatment of Uncertainty in EMC Measurements, the values range from $\pm$2.0 for Conducted Emissions tests and $\pm$4.0 dB for Radiated Emissions tests are the most accurate estimates pertaining to uncertainty of EMC measurements at BACL.

Detailed instrumentation measurement uncertainties can be found in BACL report QAP-018.

1.9 Test Facility

The test site used by BACL Corp. to collect radiated and conducted emissions measurement data is located at its facility in Sunnyvale, California, USA.

The test sites at BACL have been fully described in reports submitted to the Federal Communication Commission (FCC) and Voluntary Control Council for Interference (VCCI). The details of these reports has been found to be in compliance with the requirements of Section 2.948 of the FCC Rules on February 11 and December 10, 1997 and Article 8 of the VCCI regulations on December 25, 1997. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.4-2003.

The Federal Communications Commission, Industry Canada, and Voluntary Control Council for Interference has the reports on file and is listed under FCC registration number: 90464, IC registration number: 3062A, and VCCI Registration Number: C-2463 and R-2698. The test site has been approved by the FCC, IC, and VCCI for public use and is listed in the FCC Public Access Link (PAL) database.

Additionally, BACL is a National Institute of Standards and Technology (NIST) accredited laboratory, under the National Voluntary Laboratory Accredited Program (Lab Code 200167-0). The current scope of accreditations can be found at http://ts.nist.gov/ts/htdocs/210/214/scopes/2001670.htm

2 SYSTEM TEST CONFIGURATION

2.1 Justification

The EUT was configured for testing according to ANSI C63.4-2003.

The EUT was tested in the engineering operating mode to represent *worst*-case results during the final qualification test.

2.2 EUT Exercise Software

During the conducted emissions tests, the EUT was searching for GPS satellites, and the 450 MHz radio was in receive mode. The Bluetooth radio was in listen mode. The EUT was continuously communicating with the laptop over the RS-232 connection. During the radiated emissions tests, the radio being tested was continuously transmitting in CW mode on the selected channel.

2.3 Equipment Modifications

No modifications to the EUT were made.

2.4 Special Accessories

As shown in following test block diagram, all interface cables used for compliance testing are shielded.

2.5 Local Support Equipment

Manufacturer	Description	Model	Serial Number
Dell	Laptop	DELL610	8273581345

2.6 Power Supply Lines

Manufacturer	Description	Model	Serial Number
AULT	AC/DC Adapter	PW174KA1802FXX	201

2.7 Internal Configuration

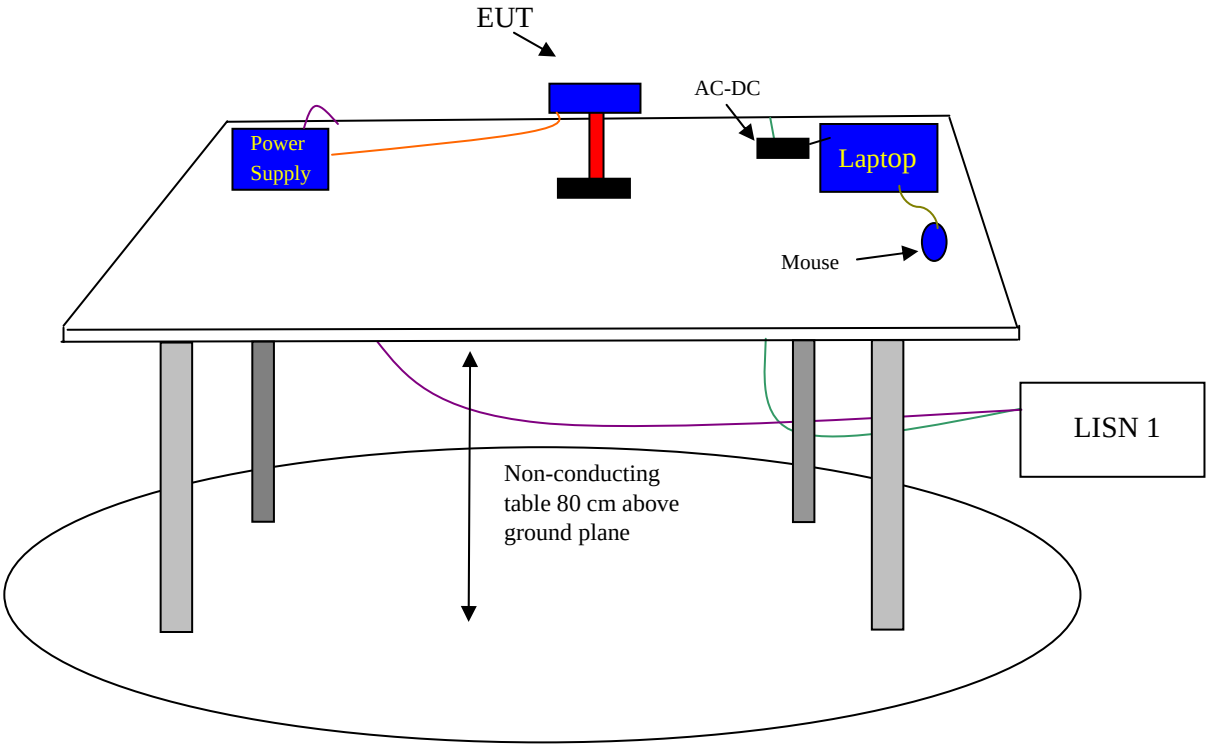
Manufacturer	Description	Part Number	Rev
Trimble Navigation	Control Board	53646-00-E	B
Trimble Navigation	Bluetooth Board	55155-00-D	1

2.8 Interface Ports and Cabling

Cable Description	Length (m)	From	To
Serial Cable	< 3m	EUT	Laptop

2.9 Test Setup Block Diagrams

Radiated Emissions and Conducted Emissions



3 SUMMARY OF TEST RESULTS FOR FCC PART 15

FCC RULES	DESCRIPTION OF TEST	RESULT
§15.203	Antenna Requirement	**Compliant**
§ 15.207 (a)	Conducted Emissions	**Compliant**
§15.205, §15.209 & §15.247(c)	Radiated Emissions	**Compliant**
§15.247 (a) (1)	Hopping Channel Separation	**Compliant**, Please refer to *FCC ID: **Q2331308** for Bluetooth 2.4 GHz*
§15.247 (a) (1) (i)	Channel Bandwidth	**Compliant**, Please refer to *FCC ID: **Q2331308** for Bluetooth 2.4 GHz*
§15.247 (a) (1) (iii)	Number of Hopping Frequencies Used	**Compliant**, Please refer to *FCC ID: **Q2331308** for Bluetooth 2.4 GHz*
§15.247 (a) (1) (iii)	Dwell Time of Each Frequency	**Compliant**, Please refer to *FCC ID: **Q2331308** for Bluetooth 2.4 GHz*
§2.106 §15.247 (b)(1)	Maximum Peak Output Power	**Compliant**, Please refer to *FCC ID: **Q2331308** for Bluetooth 2.4 GHz*
§ 15.247 (c)	100 kHz Bandwidth of Frequency Band Edge	**Compliant**, Please refer to *FCC ID: **Q2331308** for Bluetooth 2.4 GHz*
§2.1091 §15.247(e)(i)	RF Exposure	**Compliant**, Please refer to *FCC ID: **Q2331308** for Bluetooth 2.4 GHz*
§ 2.1051 §15.247(d)	Spurious Emissions at Antenna Terminals	**Compliant**, Please refer to *FCC ID: **Q2331308** for Bluetooth 2.4 GHz*

4 §15.203 - ANTENNA REQUIREMENT

4.1 Applicable Standard

According to § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §15.211, §15.213, §15.217, §15.219, or §15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

4.2 Result

The antennae, *Signal Antenna Systems, Inc.* model: *Antenna Mobile* utilized by this device is an external antenna with TNC (reverse polarity) connectors and a maximum gain of 2 dBi .

☒ **Compliant** ☐ **N/A**

5 § 15.207 – AC LINE CONDUCTED EMISSIONS

5.1 Applicable Standard

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of emission (MHz)	Conducted limit (dBµV)	
	Quasi-peak	Average
0.15–0.5	66 to 56*	56 to 46*
0.5–5	56	46
5–30	60	50

**Decreases with the logarithm of the frequency.*

5.2 EUT Setup

The conducted emissions tests were performed in the 10-meter chamber, using the setup in accordance with ANSI C63.4-2003 measurement procedures. The specifications used were in accordance with FCC Part 15 Standard, Class intentional radiator limits.

The spacing between the peripherals was 10 cm.

The external I/O cables were draped along the test table and bundled as required.

The EUT was tested connected LISN-1 which acted as an AC power source.

5.3 Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date
Solar Electronics Company	Line Impedance Network	TYPE 252-50-R-24-N	0511205	2007-07-07
Rohde & Schwarz	EMI Test Receiver	ESCI 3	100337	2007-02-24

****Statement of Traceability*:** BACL Corp. attests that all calibrations have been performed according to NVLAP requirements, traceable to the NIST.

5.4 Test Procedure

During conducted emissions testing, the power cord of the EUT was connected to the main outlet of the LISN-1.

Maximizing procedure was performed on the six (6) highest emission readings from the EUT.

All data was recorded in the peak detection mode, quasi-peak and average. Average readings are labeled "AV," and Quasi-peak readings are labeled "QP," in the test data hereinafter.

5.5 Environmental Conditions

Temperature:	22.3 º C
Relative Humidity:	35.3 %
ATM Pressure:	102.5 kPa

**Testing was performed by Choon-Sian Ooi on 2007-10-17 to 2007-10-24.*

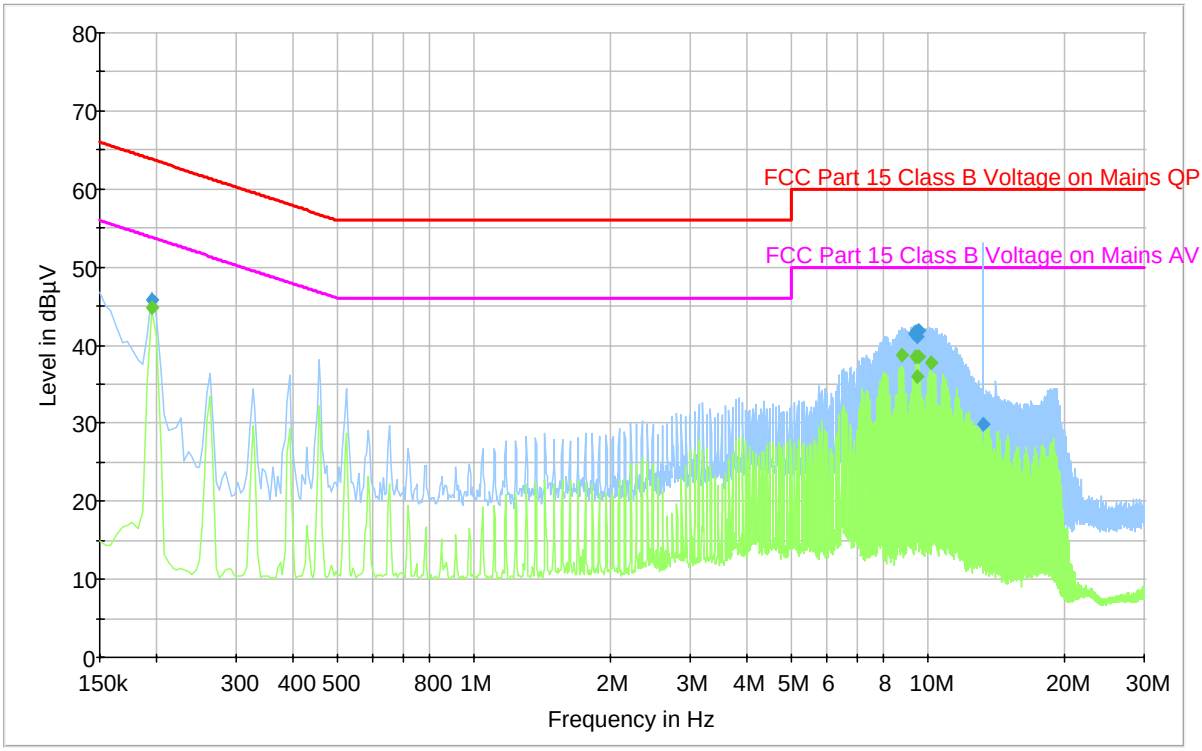
5.6 Summary of Test Results

According to the recorded data, the EUT complied with the limits presented in FCC §15.207 rules for intentional radiators, and had the worst margin reading of:

Margin (dB)	Frequency (MHz)	Conductor Mode (Hot/ Neutral)	Test Range
-6.9	0.195000	Hot	150 kHz to 30 MHz

Please see the plots hereinafter for detailed test results

5.7 Neutral Conductor Mode



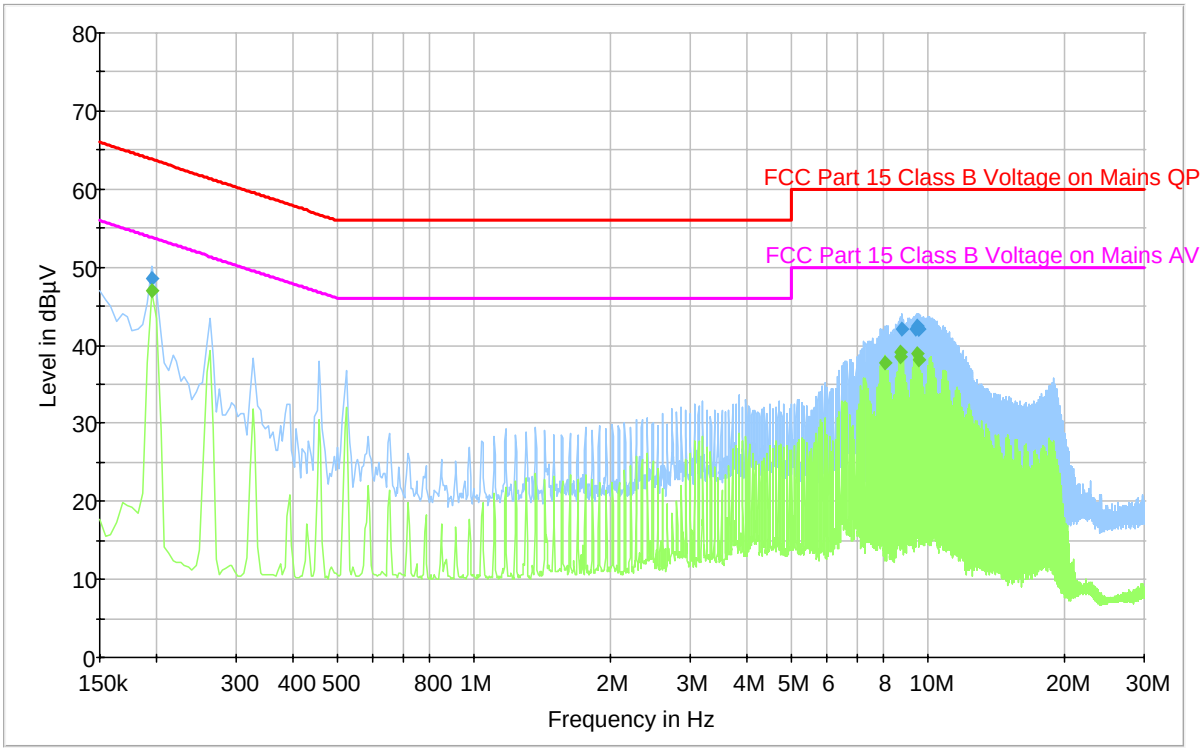
Quasi-peak Measurements

Frequency (MHz)	Quasi-peak (dBµV)	Conductor (Hot/Neutral)	Limit (dBµV)	Margin (dB)
0.195000	45.8	Neutral	63.8	-18.0
9.528000	41.8	Neutral	60.0	-18.2
9.397500	41.7	Neutral	60.0	-18.3
9.330000	41.5	Neutral	60.0	-18.5
9.465000	41.1	Neutral	60.0	-18.9
13.240500	29.9	Neutral	60.0	-30.1

Average Measurements

Frequency (MHz)	Average (dBµV)	Conductor (Hot/Neutral)	Limit (dBµV)	Margin (dB)
0.195000	44.9	Neutral	53.8	-8.9
8.745000	38.8	Neutral	50.0	-11.2
9.397500	38.6	Neutral	50.0	-11.4
9.528000	38.4	Neutral	50.0	-11.6
10.180500	37.8	Neutral	50.0	-12.2
9.465000	35.9	Neutral	50.0	-14.1

5.8 Hot Conductor Mode



Quasi-peak Measurements

Frequency (MHz)	Quasi-peak (dBµV)	Conductor (Hot/Neutral)	Limit (dBµV)	Margin (dB)
0.195000	48.5	Hot	63.8	-15.3
9.460500	42.4	Hot	60.0	-17.6
9.523500	42.1	Hot	60.0	-17.9
9.591000	42.1	Hot	60.0	-17.9
8.808000	42.0	Hot	60.0	-18.0
9.393000	42.0	Hot	60.0	-18.0

Average Measurements

Frequency (MHz)	Average (dBµV)	Conductor (Hot/Neutral)	Limit (dBµV)	Margin (dB)
0.195000	46.9	Hot	53.8	-6.9
8.740500	39.2	Hot	50.0	-10.8
9.460500	38.8	Hot	50.0	-11.2
8.677500	38.5	Hot	50.0	-11.5
9.591000	38.2	Hot	50.0	-11.8
8.025000	37.7	Hot	50.0	-12.3

6 §15.205, §15.209 & §15.247 - RADIATED EMISSIONS

6.1 Applicable Standard

FCC §15.205 Restricted bands of operation

(a) Except as shown in 15.205 paragraphs (d), only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	MHz	MHz	GHz	GHz
0.090 – 0.110	8.291 – 8.294	16.69475 – 16.69525	156.7 – 156.9	1435 – 1626.5	3.332 – 3.339	10.6 – 12.7
0.495 – 0.505	8.362 – 8.366	25.5 – 25.67	162.0125 –167.17	1645.5 – 1646.5	3.3458 – 3.358	13.25 – 13.4
2.1735 – 2.1905	8.37625 – 8.38675	37.5 – 38.25	167.72 – 173.2	1660 – 1710	3.600 – 4.400	14.47 – 14.5
4.125 – 4.128	8.41425 – 8.41475	73 – 74.6	240 – 285	1718.8 – 1722.2	4.5 – 5.15	15.35 – 16.2
4.17725 – 4.17775	12.29 – 12.293	74.8 – 75.2	322 – 335.4	2200 – 2300	5.35 – 5.46	17.7 – 21.4
4.20725 – 4.20775	12.51975 – 12.52025	108 – 121.94	399.9 – 410	2310 – 2390	7.25 – 7.75	22.01 – 23.12
6.215 – 6.218	12.57675 – 12.57725	123 – 138	608 – 614	2483.5 – 2500	8.025 – 8.5	23.6 – 24.0
6.26775 – 6.26825	13.36 – 13.41	149.9 – 150.05	960 – 1240	2690 – 2900	9.0 – 9.2	31.2 – 31.8
6.31175 – 6.31225	16.42 – 16.423	156.52475 – 156.52525	1300 – 1427	3260 – 3267	9.3 – 9.5	36.43 – 36.5
						Above 38.6

(b) Except as provided in 15.205 paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

(c) Except as provided in paragraphs (d) and (e), regardless of the field strength limits specified elsewhere in this Subpart, the provisions of this Section apply to emissions from any intentional radiator.

☒ **Compliant** ☐ **N/A**

FCC §15.209 Radiated emission limits, general requirements.

(a) Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100 **	3
88 - 216	150 **	3
216 - 960	200 **	3
Above 960	500	3

*** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.*

(b) In the emission table above, the tighter limit applies at the band edges.

☒ **Compliant** ☐**N/A**

FCC §15.247 Radiated emission limits.

(d) 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, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

☒ **Compliant** ☐**N/A**

6.2 Test Setup

The radiated emissions tests were performed in the 3-meter semi-anechoic chamber test site, using the setup in accordance with ANSI C63.4-2003. The specification used was the FCC 15 Subpart C limits.

6.3 Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date
Agilent	Analyzer, Spectrum	E4446A	US44300386	2007-04-26
HP	Amplifier, Pre	8447D	2944A10198	2007-01-08
A. H. Systems	Antenna, Horn, DRG	SAS-200/571	261	2007-06-07
Sonama Instrument	Pre- Amplifier	317	260407	N/R
Sunol Science	Broadband Antenna	JB3 Antenna	A020106-2	2007-04-05
Rohde & Schwarz	EMI Test Receiver	ESCI 3	100337	2007-03-08
Sunol Science	System Controller	SC99V	011003-1	N/R

*** Statement of Traceability: BACL Corp.** attests that all calibrations have been performed per the NVLAP requirements, traceable to the NIST.

6.4 Environmental Conditions

Temperature:	22-24 º C
Relative Humidity:	33-36 %
ATM Pressure:	104.5-106 kPa

** The testing was performed by Choon-Sian Ooi on 2007-10-17 to 2007-10-24.*

6.5 Test Procedure

Maximizing procedure was performed on the six (6) highest emissions to ensure EUT compliance is with all installation combinations.

All data were recorded in the peak detection mode. Quasi-peak readings was performed only when an emission was found to be marginal (within -4 dB of specification limits), and are distinguished with a "**QP**" in the data table.

Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain from the Amplitude reading. The basic equation is as follows:

Cord. Amp. = Indicated Reading + Antenna Factor + Cable Factor - Amplifier Gain

The "**Margin**" column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -7dB means the emission is 7dB below the maximum limit. The equation for margin calculation is as follows:

Margin = Cord. Amp. – Limit

Summary of Test Results

According to the data hereinafter, the EUT complied with the FCC Title 47, Part 15, Subpart C, section 15.205, 15.209 and 15.247 standard's radiated emissions limits for intentional radiators, and had the worst margin reading of:

Mode: Receiving			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Range**
-1.29	599.999	Horizontal	30-1000 MHz

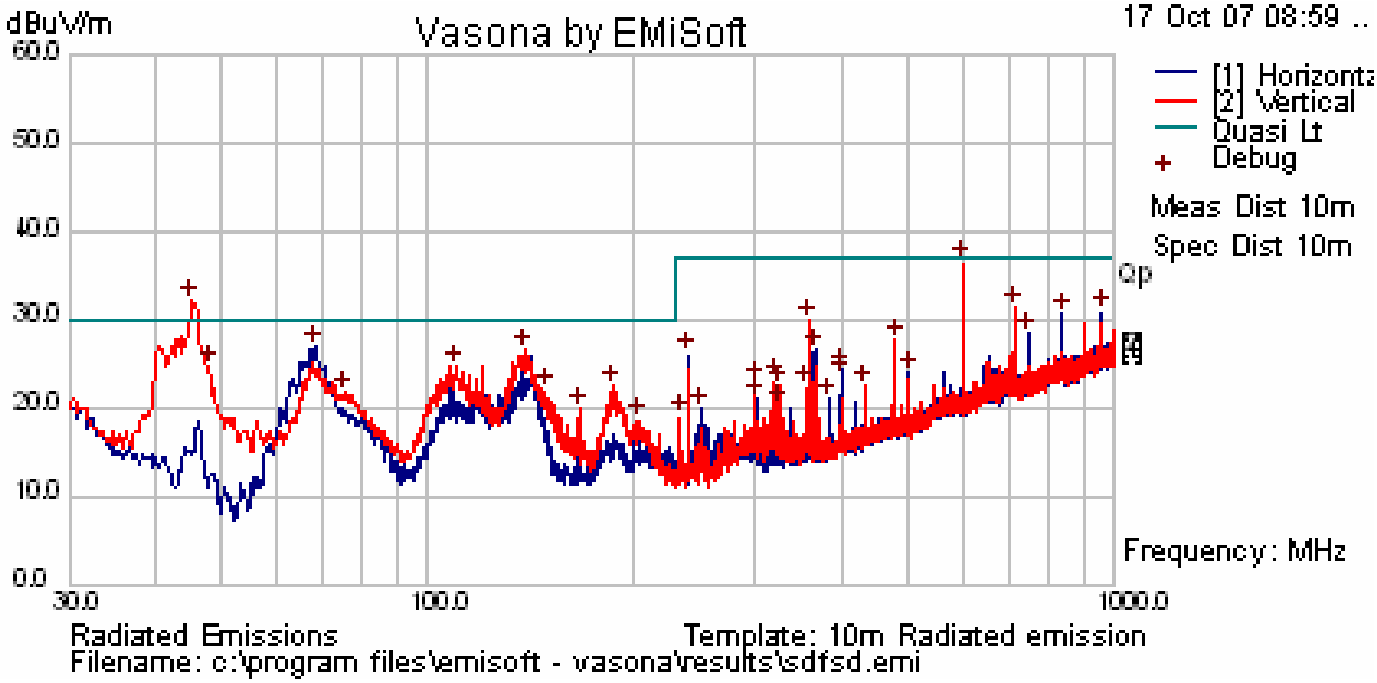
Mode: Receiving			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Range**
-4.63	5599.889	Horizontal	Above 1 GHz

Mode: 2400 MHz (FHSS)			
Margin (dB)	**Frequency (MHz)**	**Polarization (Horizontal/Vertical)**	**Range**
-17.93	1799.608	Vertical	Above 1 GHz

Please refer to the following tables for full test results

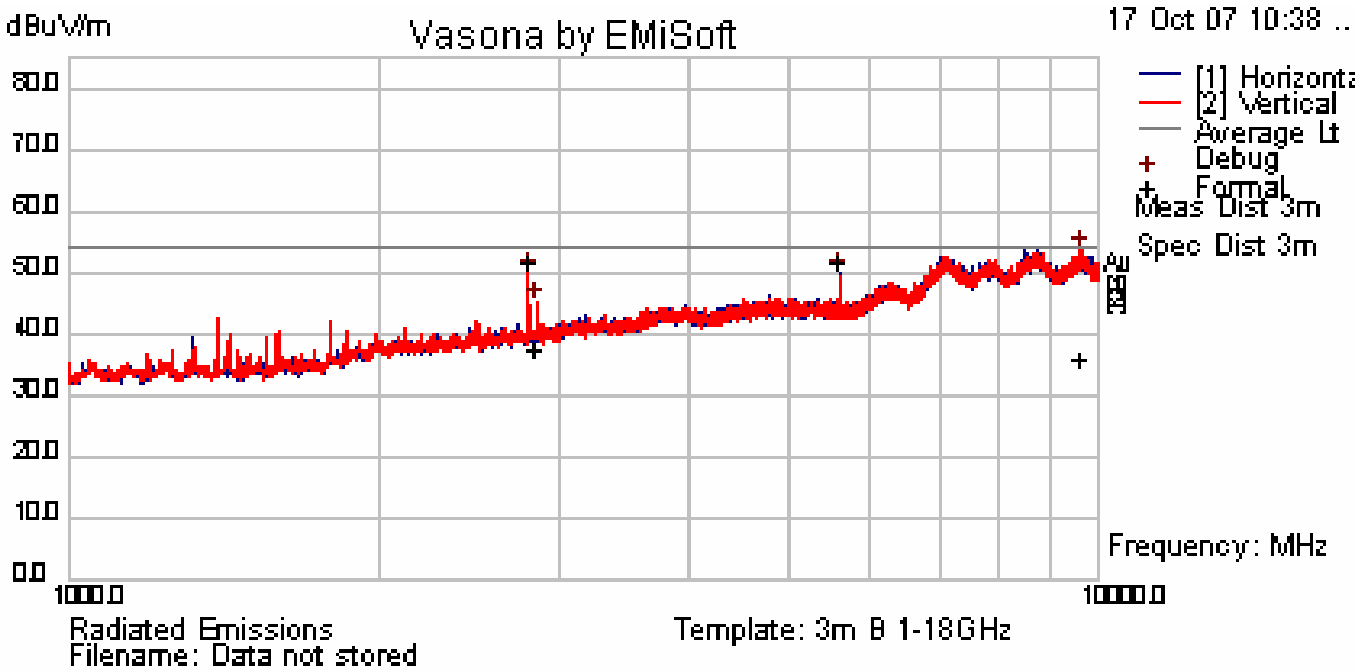
6.6 Spurious Radiated Emissions Test Data

Unintentional Radiated Emissions 30 MHz – 1000 MHz (Receiving Mode)



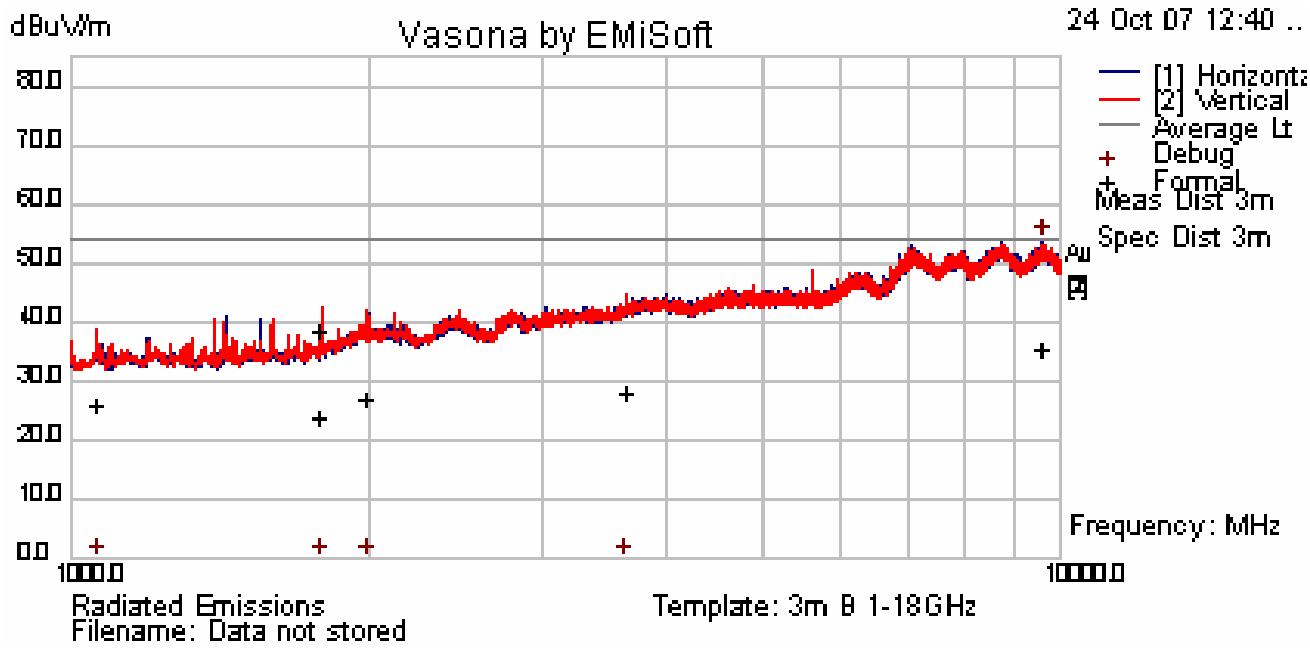
Frequency MHz	Reading (dBµV)	Azimuth Degrees	Height (cm)	Polar H / V	Antenna Loss dB	Cable loss dB	Corrected Reading dBuV/m	FCC Part 15 C		Comments
								Limit (dBuV/m)	Margin (dB)	
599.999	50.92	244	356	H	-19.64	4.44	35.71	37	-1.29	Quasi Peak
45.179	52.05	268	98	V	-27.54	0.75	25.26	30	-4.74	Quasi Peak
68.185	50.72	19	388	H	-30.16	0.79	21.35	30	-8.65	Quasi Peak
47.748	48.01	349	184	V	-28.86	0.77	19.93	30	-10.07	Quasi Peak
138.262	43.44	149	222	V	-24.98	1.06	19.52	30	-10.48	Quasi Peak
110.432	40.92	83	129	V	-24.88	1.06	17.1	30	-12.9	Quasi Peak

Unintentional Radiated Emissions Above 1GHz (Receiving Mode)



Frequency MHz	Reading (dBµV)	Azimuth Degrees	Height (cm)	Polar H / V	Antenna Loss dB	Cable loss dB	Corrected Reading dBuV/m	FCC Part 15 C		Comments
								Limit (dBuV/m)	Margin (dB)	
5599.889	47.79	114	104	H	-1.89	3.47	49.37	54	-4.63	Avg. Peak
2799.944	53.95	75	104	V	-7.03	2.4	49.32	54	-4.68	Avg. Peak
2847.517	39.24	78	112	V	-6.88	2.42	34.78	54	-19.22	Avg. Peak
9605.955	27.15	117	350	V	1.73	4.63	33.51	54	-20.49	Avg. Peak

Spurious Radiated Emissions – Bluetooth Radio (transmitting mode)



Frequency MHz	Reading (dBµV)	Azimuth Degrees	Height (cm)	Polar H / V	Antenna Loss dB	Cable loss dB	Corrected Reading dBuV/m	FCC Part 15 C		Comments
								Limit (dBuV/m)	Margin (dB)	
1799.608	45.08	160	98	V	-11.07	2.05	36.07	54	-17.93	Avg. Peak
9587.522	26.59	196	153	H	1.73	4.64	32.96	54	-21.04	Avg. Peak
3650.256	27.73	151	136	V	-5.2	2.75	25.28	54	-28.72	Avg. Peak
1993.656	31.16	54	122	V	-8.87	2.02	24.31	54	-29.69	Avg. Peak
1064.987	35.85	39	100	V	-13.87	1.53	23.5	54	-30.5	Avg. Peak
1798.102	30.19	7	106	V	-11.08	2.05	21.16	54	-32.84	Avg. Peak