

*Electromagnetic Emissions Test Report  
for  
Radio Equipment  
Trimble Navigation  
Model: Apollo R8-M2 with 2.4GHz Module (RoHS Compliant)  
and SPS881 with 2.4GHz Module  
In Accordance With FCC Part 15.207 and RSS-Gen*


COMPANY: Trimble Navigation  
485 Potrero  
Sunnyvale, CA. 94086

TEST SITE: Elliott Laboratories, Inc.  
684 W. Maude Avenue  
Sunnyvale, CA 94085

TEST SITE: Elliott Laboratories, Inc.  
41039 Boyce Road.  
Fremont, CA. 94538-2435

REPORT DATE: July 17, 2007

FINAL TEST DATES: June 27, 2007

AUTHORIZED SIGNATORY:   
David W. Bare  
Chief Technical Officer



2016-01

Elliott Laboratories, Inc. is accredited by the A2LA, certificate number 2016-01, to perform the test(s) listed in this report. This report shall not be reproduced, except in its entirety, without the written approval of Elliott Laboratories, Inc.

---

**REVISION HISTORY**

Revision #	Date	Comments	Modified By
1	July 17, 2007	Initial Release	David Guidotti

**TABLE OF CONTENTS**

**COVER PAGE..... 1**

**REVISION HISTORY..... 2**

**TABLE OF CONTENTS..... 3**

**SCOPE..... 4**

**OBJECTIVE..... 4**

**STATEMENT OF COMPLIANCE..... 5**

**DEVIATIONS FROM THE STANDARDS..... 5**

**EMISSION TEST RESULTS ..... 6**

    CONDUCTED EMISSIONS (MAINS PORT).....6

    RADIATED EMISSIONS.....6

    MEASUREMENT UNCERTAINTIES.....6

**EQUIPMENT UNDER TEST (EUT) DETAILS ..... 7**

    GENERAL.....7

    ENCLOSURE.....7

    MODIFICATIONS.....7

    SUPPORT EQUIPMENT.....8

    EUT INTERFACE PORTS.....8

    EUT OPERATION.....8

**EMISSIONS TEST SITE..... 9**

    GENERAL INFORMATION.....9

    CONDUCTED EMISSIONS CONSIDERATIONS.....9

    RADIATED EMISSIONS CONSIDERATIONS.....9

**MEASUREMENT INSTRUMENTATION..... 10**

    RECEIVER SYSTEM.....10

    INSTRUMENT CONTROL COMPUTER.....10

    LINE IMPEDANCE STABILIZATION NETWORK (LISN).....10

    FILTERS/ATTENUATORS.....11

    ANTENNAS.....11

    ANTENNA MAST AND EQUIPMENT TURNTABLE.....11

    INSTRUMENT CALIBRATION.....11

**TEST PROCEDURES ..... 12**

    EUT AND CABLE PLACEMENT.....12

    CONDUCTED EMISSIONS (MAINS).....12

    RADIATED EMISSIONS.....12

**SAMPLE CALCULATIONS..... 13**

    SAMPLE CALCULATIONS - CONDUCTED EMISSIONS.....13

    SAMPLE CALCULATIONS - RADIATED EMISSIONS.....14

*APPENDIX A: Test Equipment Calibration Data..... 1*

*APPENDIX B: Test Data Log Sheets..... 2*

*APPENDIX C: Test Configuration Photographs..... 3*

---

**SCOPE**

Governments and standards organizations around the world have published requirements regarding the electromagnetic emissions of information technology equipment. Electromagnetic emissions testing has been performed on the Trimble Navigation model Apollo R8-M2 with 2.4GHz Module (RoHS Compliant), to establish compliance with these requirements.

The SPS881 with 2.4GHz Module is electrically identical to the R8-M2 with 2.4GHz Module. There are only cosmetic differences.

Electromagnetic emissions data has been taken pursuant to the following standards. Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with these specifications, test procedures, and measurement guidelines as outlined in Elliott Laboratories test procedures.

Standard	Title	Standard Date
FCC Part 15.207	Radio Frequency Devices – Conducted Limits	October 2006 as Amended
RSS-Gen Sections 6 and 7.2.2	General Requirements and Information for the Certification of Radiocommunication Equipment	Issue 2, June 2007

In order to demonstrate compliance with the requirements, the manufacturer or a contracted laboratory makes measurements and takes the necessary steps to ensure that the equipment complies with the appropriate technical standards.

**OBJECTIVE**

The objective of the manufacturer is to declare conformity for the Apollo R8-M2 with 2.4GHz Module (RoHS Compliant) and the SPS881 with 2.4GHz Module with the conducted emissions limits specified in the standards listed above.

---

**STATEMENT OF COMPLIANCE**

The tested sample of Trimble Navigation model Apollo R8-M2 with 2.4GHz Module (RoHS Compliant) complied with the requirements of:

Standard/Regulation	Equipment Type/Class	Standard Date
FCC Part 15.207	Radio	2006 as amended
RSS-Gen Section 7.2.2	Radio	2007

The test results recorded herein are based on a single type test of the Trimble Navigation model Apollo R8-M2 with 2.4GHz Module (RoHS Compliant) and therefore apply only to the tested sample. The sample was selected and prepared by Roy Urbach of Trimble Navigation.

Maintenance of compliance is the responsibility of the manufacturer. Any modification of the product that could result in increased emissions or susceptibility should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different enclosure, different line filter or power supply, harnessing and/or interface cable changes, etc.).

**DEVIATIONS FROM THE STANDARDS**

No deviations were made from the published requirements listed in the scope of this report.

**EMISSION TEST RESULTS**

The following emissions tests were performed on the Trimble Navigation model Apollo R8-M2 with 2.4GHz Module (RoHS Compliant). The measurements were extracted from the data recorded during testing and represent the highest amplitude emissions relative to the specification limits. The actual test results are contained in an appendix of this report.

**CONDUCTED EMISSIONS (MAINS PORT)**

June 27, 2007

Test	Standard/Section	Requirement	Measurement	Result	Compliance Status
CE, 0.15-30 MHz, 120V, 60Hz	FCC § 15.107(a) VCCI Table 4.2	0.15-0.5 MHz, 66-56 dB $\mu$ V QP 0.5-5.0 MHz, 56 dB $\mu$ V QP 5.0-30.0 MHz, 60 dB $\mu$ V QP 0.15-0.5 MHz, 56-46 dB $\mu$ V Av 0.5-5.0 MHz, 46 dB $\mu$ V Av 5.0-30.0 MHz, 50 dB $\mu$ V Av	43.1dB $\mu$ V @ 0.197MHz	-10.6dB	Complied

**RADIATED EMISSIONS**

Test	Standard/Section	Requirement	Measurement	Result	Compliance Status
RE, 30-1000 MHz	RSS-GEN	30 – 230, 30 dB $\mu$ V/m 230 – 1000, 37 dB $\mu$ V/m	29.0dB $\mu$ V/m @ 767.986MHz	-8.0dB	Complied
RE, 1000-7000 MHz	RSS-GEN	54.0 dB $\mu$ V/m Av 74.0 dB $\mu$ V/m Pk	51.0dB $\mu$ V/m @ 5600.0MHz	-3.0dB	Complied

**MEASUREMENT UNCERTAINTIES**

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below were calculated using the approach described in CISPR 16-4-2:2003 using a coverage factor of  $k=2$ , which gives a level of confidence of approximately 95%. The levels were found to be below levels of  $U_{cispr}$  and therefore no adjustment of the data for measurement uncertainty is required.

Measurement Type	Frequency Range (MHz)	Calculated Uncertainty (dB)
Conducted Emissions	0.15 to 30	$\pm 2.2$
Radiated Emissions	30 to 1000	$\pm 3.6$

**EQUIPMENT UNDER TEST (EUT) DETAILS****GENERAL**

The Trimble Navigation model Apollo R8-M2 with 2.4GHz Module (RoHS Compliant) is a radio with different plug-in radio modules. Since the EUT would be placed on a tabletop during operation, the EUT was treated as tabletop equipment during testing to simulate the end-user environment. The electrical rating of the EUT is 120/230 Volts, 50/60 Hz.

The sample was received on June 26, 2007 and tested on and June 27, 2007. The EUT consisted of the following components:

Manufacturer	Model	Description	Serial Number	FCC ID
Trimble Navigation	R8-M2 with 2.4GHz Module	GPS/GNSS Receiver with a 2.4GHz data radio	SN: RoHS A00001 PN: 60250-24	-
Cirronet	2.4GHz Module	2.4GHz data radio	SN: WIT2410T-A-020001 PN: 62481-24	-
Ault	PW174KA180	AC Adapter for Radio	Date Code 0703 rev A RoHS	DoC
PCTEL	MaxRad Omni	2.4GHz Antenna	SN: Marked 408757 PN: MFB24008	-

**ENCLOSURE**

The EUT enclosure is primarily constructed of plastic. It measures approximately 19 cm wide by 19 cm deep by 10 cm high.

**MODIFICATIONS**

No modifications were made to the EUT in order to comply with the specifications.

**SUPPORT EQUIPMENT**

The following equipment was used as local support equipment for emissions testing:

Manufacturer	Model	Description	Serial Number	FCC ID
Dell	Lattitude D160	Laptop PC	Service Tag 3STVK81 Trimble #S-0002692	DoC
Dell	ADP-90AHB	AC Adapter for Laptop	CN-OC8023-48661-56S-1PT6	-
HP	Deskjet 5650	Printer	MY3883K42P	DoC

No remote support equipment was used during emissions testing.

**EUT INTERFACE PORTS**

The I/O cabling configuration during emissions testing was as follows:

June 26 and June 27, 2007

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)
<b>Interface Ports on EUT</b>				
7-Pin Serial/Power Port	Laptop PC DB9 Serial Port and External AC Adapter DC Output	Combo Serial/Power Cable	Shielded	Power = 2m Serial = 5m
Serial DB9	Not Cabled	-	-	-
Antenna	2.4 GHz Antenna	Coax	Shielded	5.1

Note: The Serial DB9 port was not connected during testing since the 7-Pin Serial/Power Port was already connected.

**EUT OPERATION**

During emissions testing the EUT was streaming data to the laptop and the radio was in hopping mode.



**EMISSIONS TEST SITE****GENERAL INFORMATION**

Final test measurements were taken on June 27, 2007 at the Elliott Laboratories Anechoic Chambers and/or Open Area Test Site(s) listed below. The test sites contain separate areas for radiated and conducted emissions testing. The sites conform to the requirements of 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 and CISPR 16-1:1999 - Specification for radio disturbance and immunity measuring apparatus and methods Part 1: Radio disturbance and immunity measuring apparatus. They are registered with the VCCI and are on file with the FCC.

In the case of Open Area Test Sites, ambient levels are at least 6 dB below the specification limits with the exception of predictable local TV, radio, and mobile communications traffic.

Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent requirements.

	Site	VCCI Registration #	FCC Registration #'s	Industry Canada Registration #'s	Location
	Chamber 3	R-1683	769238	IC 4549-3	41039 Boyce Road Fremont, CA 94538-2435
	Chamber 3	C-1795	-	-	

**CONDUCTED EMISSIONS CONSIDERATIONS**

Conducted emissions testing is performed in conformance with ANSI C63.4 and CISPR 22. Mains port measurements are made with the EUT connected to the public power network through nominal, standardized RF impedance, which is provided by a line impedance stabilization network, known as a LISN. A LISN is inserted in series with each current-carrying conductor in the EUT power cord. Telecommunication port measurements are made with the network cable connected through an ISN appropriate to the type of cable employed.

**RADIATED EMISSIONS CONSIDERATIONS**

The FCC has determined that radiated measurements made in a non-anechoic shielded enclosure are not suitable for determining levels of radiated emissions. Radiated measurements are performed in an Open Area Test Site or anechoic chamber, as defined in ANSI C63.4. The test site is maintained free of conductive objects within the CISPR defined elliptical area incorporated in ANSI C63.4 guidelines.

---

**MEASUREMENT INSTRUMENTATION****RECEIVER SYSTEM**

An EMI receiver as specified in CISPR 16-1 is used for emissions measurements. The receivers used can measure over the frequency range of 9 kHz up to 7 GHz. These receivers allow both ease of measurement and high accuracy to be achieved. The receivers have Peak, Average, and CISPR (Quasi-peak) detectors built into their design so no external adapters are necessary. The receiver automatically sets the required bandwidth for the CISPR detector used during measurements.

For measurements above the frequency range of the receivers, a spectrum analyzer is utilized because it provides visibility of the entire spectrum along with the precision and versatility required to support engineering analysis. Average measurements above 1000 MHz are performed on the spectrum analyzer using the linear-average method with a resolution bandwidth of 1 MHz and a video bandwidth of 10 Hz.

**INSTRUMENT CONTROL COMPUTER**

The receivers utilize either a Rohde & Schwarz EZM Spectrum Monitor/Controller or contain an internal Spectrum Monitor/Controller to view and convert the receiver measurements to the field strength at an antenna or voltage developed at the LISN measurement port, which is then compared directly with the appropriate specification limit. This provides faster, more accurate readings by performing the conversions described under Sample Calculations within the Test Procedures section of this report. Results are printed in a graphic and/or tabular format, as appropriate. A personal computer is used to record all measurements made with the receivers.

The Spectrum Monitor provides a visual display of the signal being measured. In addition, the controller or a personal computer runs automated data collection programs that control the receivers. This provides added accuracy since all site correction factors, such as cable loss and antenna factors are added automatically.

**LINE IMPEDANCE STABILIZATION NETWORK (LISN)**

Line conducted emission measurements utilize a fifty microhenry Line Impedance Stabilization Network as the monitoring point. The LISN used also contains a 250 uH CISPR adapter. This network provides for calibrated radio frequency noise measurements by the design of the internal low pass and high pass filters on the EUT and measurement ports, respectively.

---

**FILTERS/ATTENUATORS**

External filters and precision attenuators are often connected between the receiving antenna or LISN and the receiver. This eliminates saturation effects and non-linear operation due to high amplitude transient events.

**ANTENNAS**

A biconical antenna is used to cover the range from 30 MHz to 300 MHz and a log periodic antenna is utilized from 300 MHz to 1000 MHz. Narrowband tuned dipole antennas are used over the entire 30 to 1000 MHz frequency range for precision measurements of field strength. Above 1000 MHz, a horn antenna is used. The antenna calibration factors are included in site factors that are programmed into the test receivers.

**ANTENNA MAST AND EQUIPMENT TURNTABLE**

The antennas used to measure the radiated electric field strength are mounted on a non-conductive antenna mast equipped with a motor-drive to vary the antenna height.

ANSI C63.4 specifies that the test height above ground for table mounted devices shall be 80 centimeters. Floor mounted equipment shall be placed on the ground plane if the device is normally used on a conductive floor or separated from the ground plane by insulating material up to 12 mm thick if the device is normally used on a non-conductive floor. During radiated measurements, the EUT is positioned on a motorized turntable in conformance with this requirement.

**INSTRUMENT CALIBRATION**

All test equipment is regularly checked to ensure that performance is maintained in accordance with the manufacturer's specifications. All antennas are calibrated at regular intervals with respect to tuned half-wave dipoles. An appendix of this report contains the list of test equipment used and calibration information.

---

**TEST PROCEDURES****EUT AND CABLE PLACEMENT**

The standards require that interconnecting cables be connected to the available ports of the unit and that the placement of the unit and the attached cables simulate the worst case orientation that can be expected from a typical installation, so far as practicable. To this end, the position of the unit and associated cabling is varied within the guidelines of ANSI C63.4, and the worst case orientation is used for final measurements.

**CONDUCTED EMISSIONS (MAINS)**

Conducted emissions are measured at the plug end of the power cord supplied with the EUT. Excess power cord length is wrapped in a bundle between 30 and 40 centimeters in length near the center of the cord. Preliminary measurements are made to determine the highest amplitude emission relative to the specification limit for all the modes of operation. Placement of system components and varying of cable positions are performed in each mode. A final peak mode scan is then performed in the position and mode for which the highest emission was noted on all current carrying conductors of the power cord. Emissions that have peak values close to the specification limit are also measured in the quasi-peak and average detection modes to determine compliance except when the amplitude of the emission when measured with the quasi-peak detector is more than 10 dB below the specification limit for average measurements. In this case only quasi-peak measurements are performed.

**RADIATED EMISSIONS**

Radiated emissions measurements are performed in two phases as well. A preliminary scan of emissions is conducted in which all significant EUT frequencies are identified with the system in a nominal configuration. At least two scans are performed from 30 MHz up to the frequency required by the regulation specified on page 1. One or more of these is with the antenna polarized vertically while the one or more of these is with the antenna polarized horizontally. During the preliminary scans, the EUT is rotated through 360°, the antenna height is varied and cable positions are varied to determine the highest emission relative to the limit. A speaker is provided in the receiver to aid in discriminating between EUT and ambient emissions. Other methods used during the preliminary scan for EUT emissions involve scanning with near field magnetic loops, monitoring I/O cables with RF current clamps, and cycling power to the EUT. Final maximization is a phase in which the highest amplitude emissions identified in the spectral search are viewed while the EUT azimuth angle is varied from 0 to 360 degrees relative to the receiving antenna. The azimuth that results in the highest emission is then maintained while varying the antenna height from one to four meters. The result is the identification of the highest amplitude for each of the highest peaks. Each recorded level is corrected in the receiver using appropriate factors for cables, connectors, antennas, and preamplifier gain. Emissions that have values close to the specification limit may also be measured with a tuned dipole antenna to determine compliance.

---

**SAMPLE CALCULATIONS****SAMPLE CALCULATIONS - CONDUCTED EMISSIONS**

Receiver readings are compared directly to the conducted emissions specification limit (decibel form). The calculation is as follows:

$$R_r - S = M$$

where:

$R_r$  = Receiver Reading in dBuV

$S$  = Specification Limit in dBuV

$M$  = Margin to Specification in +/- dB

---

**SAMPLE CALCULATIONS - RADIATED EMISSIONS**

Receiver readings are compared directly to the specification limit (decibel form). The receiver internally corrects for cable loss, preamplifier gain, and antenna factor. The calculations are in the reverse direction of the actual signal flow, thus cable loss is added and the amplifier gain is subtracted. The Antenna Factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements. A distance factor, when used for electric field measurements, is calculated by using the following formula:

$$F_d = 20 * \text{LOG}_{10} (D_m/D_s)$$

where:

$$F_d = \text{Distance Factor in dB}$$

$$D_m = \text{Measurement Distance in meters}$$

$$D_s = \text{Specification Distance in meters}$$

Measurement Distance is the distance at which the measurements were taken and Specification Distance is the distance at which the specification limits are based. The Antenna Factor converts the voltage at the antenna coaxial connector to the field strength at the antenna elements.

The margin of a given emission peak relative to the limit is calculated as follows:

$$R_c = R_r + F_d$$

and

$$M = R_c - L_s$$

where:

$$R_r = \text{Receiver Reading in dBuV/m}$$

$$F_d = \text{Distance Factor in dB}$$

$$R_c = \text{Corrected Reading in dBuV/m}$$

$$L_s = \text{Specification Limit in dBuV/m}$$

$$M = \text{Margin in dB Relative to Spec}$$

## **APPENDIX A: Test Equipment Calibration Data**

**Radiated Emissions, 30 - 7,000 MHz, 26-Jun-07**

**Engineer: Suhaila Khushzad**

<u>Manufacturer</u>	<u>Description</u>	<u>Model #</u>	<u>Asset #</u>	<u>Cal Due</u>
Hewlett Packard	Microwave Preamplifier, 1-26.5GHz	8449B	785	27-May-08
EMCO	Antenna, Horn, 1-18GHz	3115	868	26-Apr-08
Hewlett Packard	EMC Spectrum Analyzer, 9 KHz-26.5 GHz	8593EM	1141	29-Aug-07
Com-Power Corp.	Pre Amplifier, 30-1000 MHz	PA-103	1632	25-May-08
Sunol Sciences	Biconilog, 30-3000 MHz	JB3	1657	03-May-08

---

**Conducted Emissions, 0.150 - 30 MHz, 27-Jun-07**

**Engineer: Suhaila Khushzad**

<u>Manufacturer</u>	<u>Description</u>	<u>Model #</u>	<u>Asset #</u>	<u>Cal Due</u>
EMCO	LISN, 10 kHz-100 MHz	3825/2	1292	25-Jan-08
EMCO	LISN, 10 kHz-100 MHz	3825/2	1293	19-Jan-08
Rohde & Schwarz	Pulse Limiter	ESH3 Z2	1594	11-Apr-08
Rohde & Schwarz	EMI Test Receiver, 20 Hz-7 GHz	ESIB7	1630	11-Jan-08



***APPENDIX B: Test Data Log Sheets***

***ELECTROMAGNETIC EMISSIONS***

***TEST LOG SHEETS***

***AND***

***MEASUREMENT DATA***

T68420 17 Pages



## EMC Test Data

Client:	Timble Navigation	Job Number:	J68417
Model:	R8-M2 with 2.4GHz Module (RoHS Compliant)	Test-Log Number:	T68420
Contact:	Roy Urbach	Project Manager:	Dean Eriksen
Emissions Spec:	FCC Part 15 and EN 55022	Class:	B
Immunity Spec:	-	Environment:	-

# EMC Test Data

For The

## Timble Navigation

Model

**R8-M2 with 2.4GHz Module (RoHS Compliant)**

Date of Last Test: 7/13/2007



## EMC Test Data

Client:	Timble Navigation	Job Number:	J68417
Model:	R8-M2 with 2.4GHz Module (RoHS Compliant)	Test-Log Number:	T68420
Contact:	Roy Urbach	Project Manager:	Dean Eriksen
Emissions Spec:	FCC Part 15 and EN 55022	Class:	B
Immunity Spec:	-	Environment:	-

### EUT INFORMATION

*The following information was collected during the test sessions(s).*

#### General Description

The EUT is a GPS/GNSS Receiver with a 2.4GHz data radio that is designed to receive GPS signals and corrections. Since the EUT would be placed on a tabletop during operation, the EUT was treated as tabletop equipment during testing to simulate the end-user environment. The electrical rating of the EUT is 120/230 Volts, 60/50 Hz, 2 Amps.

#### Equipment Under Test

Manufacturer	Model	Description	Serial Number	FCC ID
Trimble Navigation	R8-M2 with 2.4GHz Module	GPS/GNSS Receiver with a 2.4GHz data radio	SN: RoHS A00001 PN: 60250-24	-
Cirronet	2.4GHz Module	2.4GHz data radio	SN: WIT2410T-A-020001 PN: 62481-24	-
Ault	PW174KA180	AC Adapter for Radio	Date Code 0703 rev A	DoC
PCTEL	MaxRad Omni	2.4GHz Antenna	SN: Marked 408757 PN: MFB24008	-

#### Other EUT Details

None

#### EUT Enclosure

The EUT enclosure is primarily constructed of plastic . It measures approximately 19 cm wide by 19cm deep by 10 cm high.

#### Modification History

Mod. #	Test	Date	Modification
1			
2			
3			

Modifications applied are assumed to be used on subsequent tests unless otherwise stated as a further modification.



## EMC Test Data

Client:	Timble Navigation	Job Number:	J68417
Model:	R8-M2 with 2.4GHz Module (RoHS Compliant)	T-Log Number:	T68420
Contact:	Roy Urbach	Project Manager:	Dean Eriksen
Emissions Spec:	FCC Part 15 and EN 55022	Class:	B
Immunity Spec:	-	Environment:	-

### Test Configuration #1

*The following information was collected during the test sessions(s).*

#### Local Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
Dell	Lattitude D160	Laptop PC w/ BluetoothRadio	Service Tag 3STVK81 Trimble #S-0002692	DoC
Dell	ADP-90AHB	AC Adapter for Laptop	CN-OC8023-48661-56S-1PT6	-
HP	Deskjet 5650	Printer	MY3883K42P	DoC

#### Remote Support Equipment

Manufacturer	Model	Description	Serial Number	FCC ID
None	-	-	-	-

#### Cabling and Ports

Port	Connected To	Cable(s)		
		Description	Shielded or Unshielded	Length(m)

#### Interface Ports on EUT

7-Pin Serial/Power Port	Laptop PC DB9 Serial Port and External AC Adapter DC Output	Combo Serial/Power Cable	Shielded	Power = 2m Serial = 5m
Serial DB9	Not Cabled	-	-	-
Antenna	2.4 GHz Antenna	Coax	Shielded	5.1

#### EUT Operation During Emissions Tests

During emissions testing the EUT was streaming data to the laptop and the radio was set in hopping mode.

Client: Timble Navigation	Job Number: J68417
Model: R8-M2 with 2.4GHz Module (RoHS Compliant)	T-Log Number: T68420
	Account Manager: Dean Eriksen
Contact: Roy Urbach	
Standard: FCC Part 15 and EN 55022	Class: B

## Radiated Emissions FCC Part 15 and EN 55022 (Elliott Laboratories Fremont Facility, Semi-Anechoic Chamber)

### Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 6/26/2007	Config. Used: 1
Test Engineer: Suhaila Khushzad	Config Change: None
Test Location: Fremont Chamber #4	EUT Voltage: 120V/60Hz

### General Test Configuration

The EUT and any local support equipment were located on the turntable for radiated emissions testing. Any remote support equipment was located outside the semi-anechoic chamber. Any cables running to remote support equipment were routed through metal conduit and when possible passed through a ferrite clamp upon exiting the chamber.

The test distance and extrapolation factor (if applicable) are detailed under each run description.

Note, **preliminary** testing indicates that the emissions were maximized by orientation of the EUT and elevation of the measurement antenna. **Maximized** testing indicated that the emissions were maximized by orientation of the EUT, elevation of the measurement antenna, and manipulation of the EUT's interface cables.

**Ambient Conditions:**            Temperature:        23 °C  
    Rel. Humidity:        37 %

### Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	RE, 30 - 1000 MHz, Preliminary Scan	EN 55022, Class B	Pass	27.5dBµV/m @ 767.986MHz (-9.5dB)
2	RE, 30 - 1000 MHz, Maximized Emissions	EN 55022, Class B	Pass	29.0dBµV/m @ 767.986MHz (-8.0dB)
3	RE, 1000 - 7000 MHz, Maximized Emissions	FCC, Class B	Pass	51.0dBµV/m @ 5600.0MHz (-3.0dB)

### Modifications Made During Testing

No modifications were made to the EUT during testing

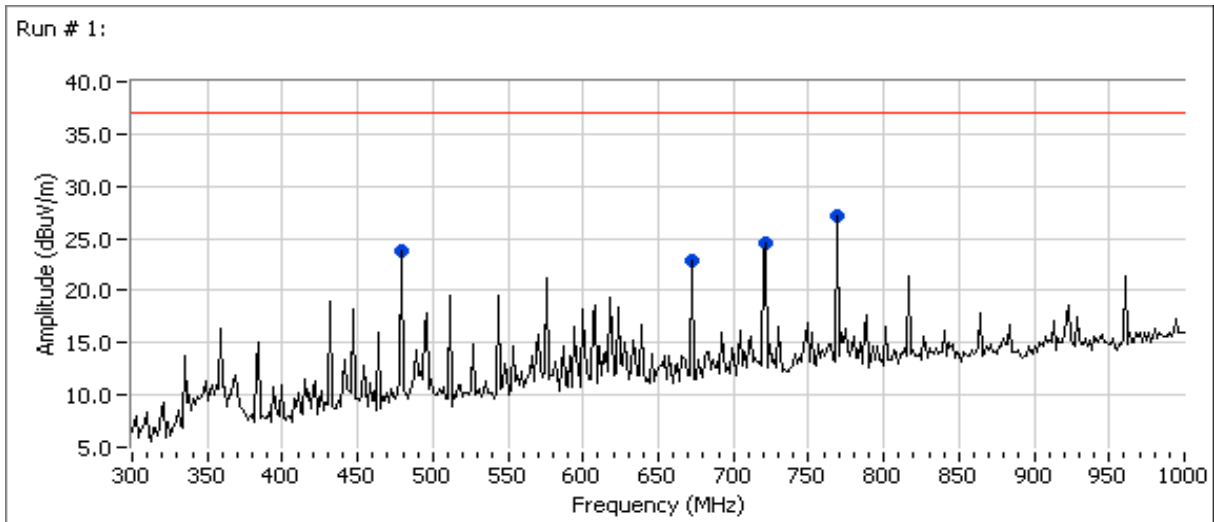
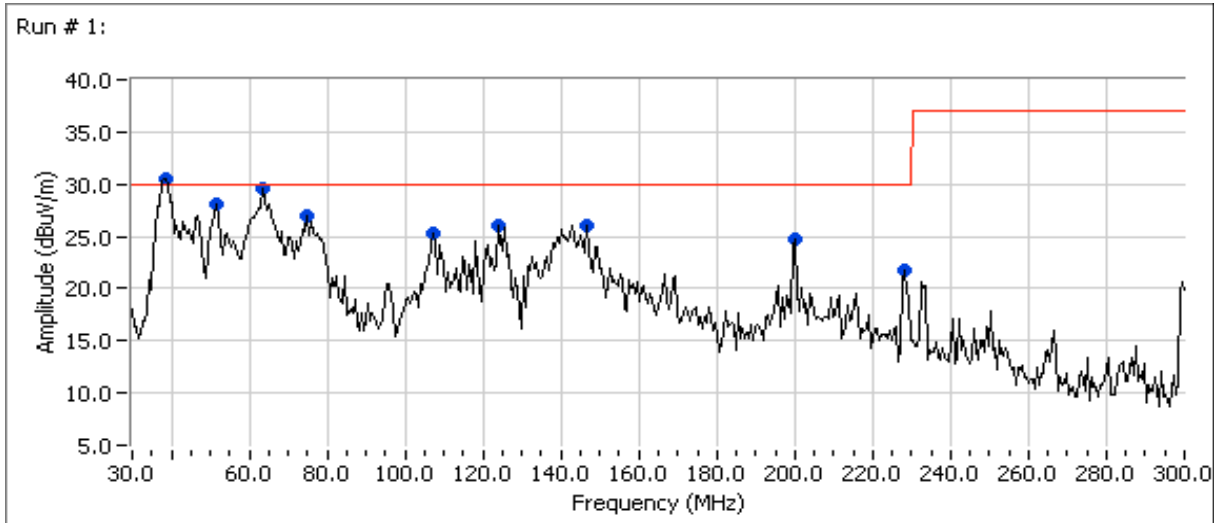
### Deviations From The Standard

No deviations were made from the requirements of the standard.

Client: Timble Navigation	Job Number: J68417
Model: R8-M2 with 2.4GHz Module (RoHS Compliant)	T-Log Number: T68420
	Account Manager: Dean Eriksen
Contact: Roy Urbach	
Standard: FCC Part 15 and EN 55022	Class: B

### Run #1: Preliminary Radiated Emissions, 30 - 1000 MHz

Frequency Range	Test Distance	Limit Distance	Extrapolation Factor
30 - 1000 MHz	5	10	-6.0



Run # 1 Con't on Next Page



# EMC Test Data

Client: Timble Navigation	Job Number: J68417
Model: R8-M2 with 2.4GHz Module (RoHS Compliant)	T-Log Number: T68420
	Account Manager: Dean Eriksen
Contact: Roy Urbach	
Standard: FCC Part 15 and EN 55022	Class: B

## Run #1: Preliminary Radiated Emissions, 30 - 1000 MHz

Frequency Range	Test Distance	Limit Distance	Extrapolation Factor
30 - 1000 MHz	5	10	-6.0

### Preliminary peak readings captured during pre-scan

Frequency MHz	Level dB $\mu$ V/m	Pol v/h	EN 55022, Class B		Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
			Limit	Margin				
38.009	30.5	V	30.0	0.5	Peak	299	2.0	
63.622	29.5	V	30.0	-0.5	Peak	32	3.5	
51.383	28.1	V	30.0	-1.9	Peak	97	2.0	
75.079	26.9	V	30.0	-3.1	Peak	269	1.5	
123.630	26.1	V	30.0	-3.9	Peak	152	1.0	
147.200	26.0	V	30.0	-4.0	Peak	53	1.0	
108.162	25.3	V	30.0	-4.7	Peak	296	3.0	
200.505	24.7	H	30.0	-5.3	Peak	254	3.0	
227.401	21.7	V	30.0	-8.3	Peak	263	3.0	
767.986	27.1	H	37.0	-9.9	Peak	218	1.5	
719.988	24.5	H	37.0	-12.5	Peak	248	1.5	
480.001	23.8	V	37.0	-13.2	Peak	193	1.5	
671.991	22.8	H	37.0	-14.2	Peak	267	2.0	

### Preliminary quasi-peak readings (no manipulation of EUT interface cables)

Frequency MHz	Level dB $\mu$ V/m	Pol v/h	EN 55022, Class B		Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
			Limit	Margin				
767.986	27.5	H	37.0	-9.5	QP	227	1.5	
147.200	18.3	V	30.0	-11.7	QP	109	1.0	
480.001	25.1	V	37.0	-11.9	QP	190	1.5	
719.988	24.0	H	37.0	-13.0	QP	255	1.5	
671.991	23.3	H	37.0	-13.7	QP	264	2.0	
200.505	16.1	H	30.0	-13.9	QP	258	3.0	
108.162	15.6	V	30.0	-14.4	QP	301	3.0	
38.009	14.5	V	30.0	-15.5	QP	299	2.0	
75.079	13.7	V	30.0	-16.3	QP	251	1.5	
227.401	12.4	V	30.0	-17.6	QP	229	3.0	
63.622	11.4	V	30.0	-18.6	QP	36	3.5	
51.383	7.2	V	30.0	-22.8	QP	93	2.0	



# EMC Test Data

Client:	Timble Navigation	Job Number:	J68417
Model:	R8-M2 with 2.4GHz Module (RoHS Compliant)	T-Log Number:	T68420
		Account Manager:	Dean Eriksen
Contact:	Roy Urbach		
Standard:	FCC Part 15 and EN 55022	Class:	B

**Run # 2: Maximized Readings From Run # 1**  
**Maximized quasi-peak readings (includes manipulation of EUT interface cables)**

Frequency Range	Test Distance	Limit Distance	Extrapolation Factor
30 - 1000 MHz	5	10	-6.0

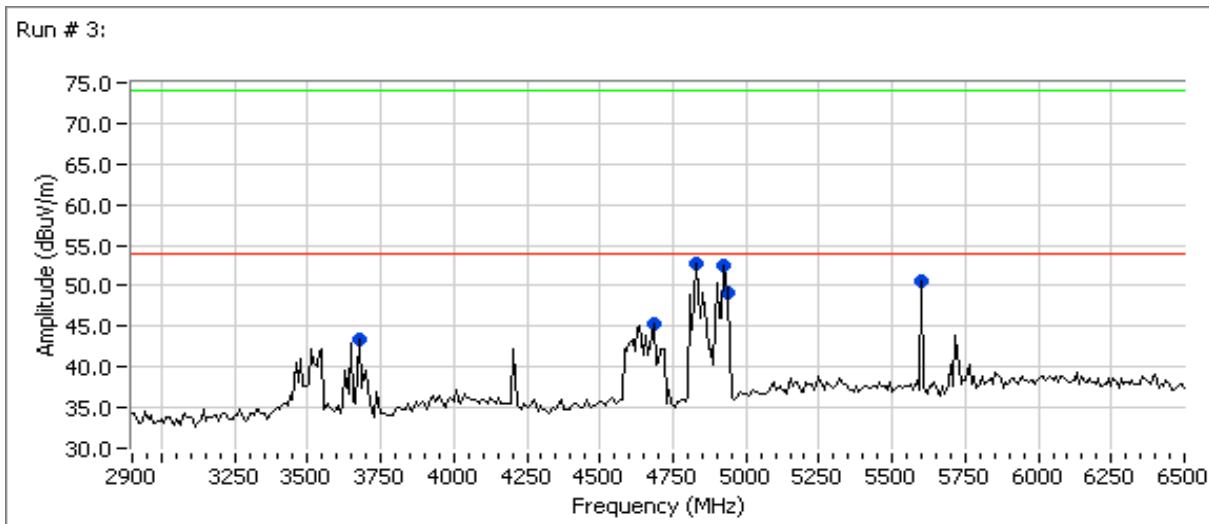
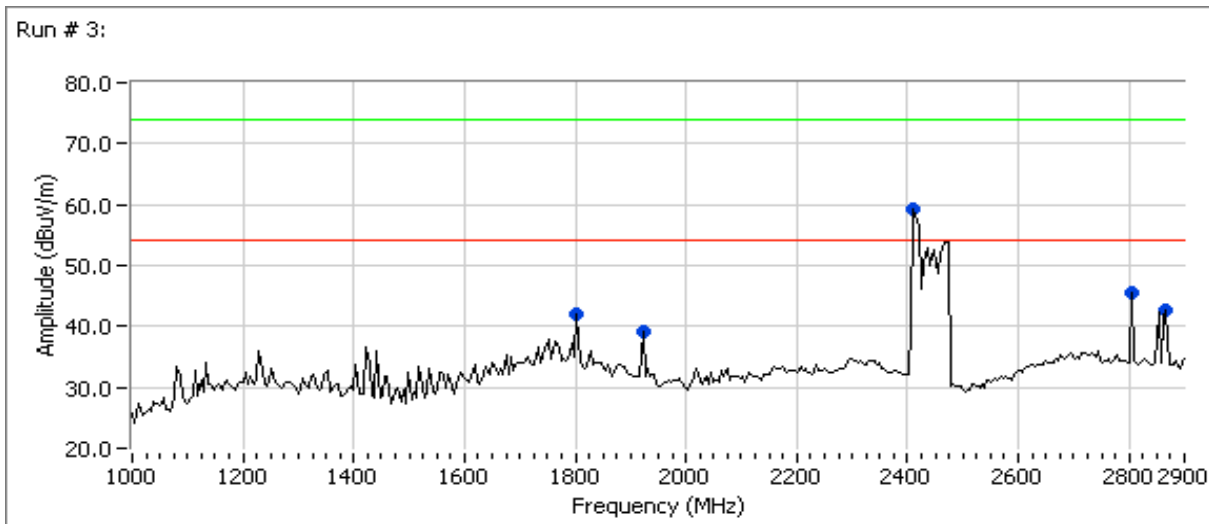
Frequency MHz	Level dB $\mu$ V/m	Pol v/h	EN 55022, Class B		Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
			Limit	Margin				
767.986	29.0	H	37.0	-8.0	QP	227	1.5	
719.988	26.8	H	37.0	-10.2	QP	254	1.4	
480.001	25.5	V	37.0	-11.5	QP	192	1.5	
147.200	18.3	V	30.0	-11.7	QP	70	1.0	
671.991	25.3	H	37.0	-11.7	QP	255	1.7	
200.505	16.1	H	30.0	-13.9	QP	253	2.7	



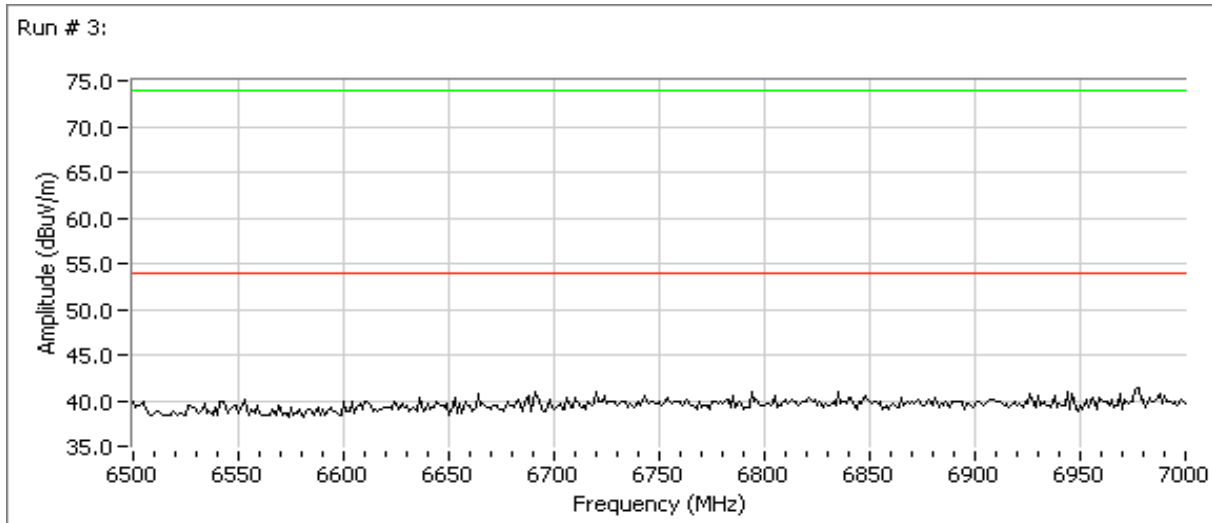
Client: Timble Navigation	Job Number: J68417
Model: R8-M2 with 2.4GHz Module (RoHS Compliant)	T-Log Number: T68420
	Account Manager: Dean Eriksen
Contact: Roy Urbach	
Standard: FCC Part 15 and EN 55022	Class: B

**Run # 3: Maximized Readings, 1000 - 7000 MHz**  
 Preliminary peak readings captured during pre-scan (peak readings vs. average limit)

Frequency Range	Test Distance	Limit Distance	Extrapolation Factor
1000 - 7000 MHz	3	3	0.0



Client: Timble Navigation	Job Number: J68417
Model: R8-M2 with 2.4GHz Module (RoHS Compliant)	T-Log Number: T68420
	Account Manager: Dean Eriksen
Contact: Roy Urbach	
Standard: FCC Part 15 and EN 55022	Class: B



**Run # 3: Maximized Readings, 1000 - 7000 MHz**

Preliminary peak readings captured during pre-scan (peak readings vs. average limit)

Frequency Range	Test Distance	Limit Distance	Extrapolation Factor
1000 - 7000 MHz	3	3	0.0

Frequency MHz	Level dBuV/m	Pol v/h	FCC Class B		Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
			Limit	Margin				
5600.070	50.7	V	54.0	-3.3	Peak	17	1.0	
4931.780	49.1	H	54.0	-4.9	Peak	296	1.9	
2800.020	45.4	V	54.0	-8.6	Peak	18	1.0	
2860.040	42.6	V	54.0	-11.4	Peak	18	1.0	
1799.980	42.1	V	54.0	-11.9	Peak	318	1.3	
1919.970	39.2	V	54.0	-14.8	Peak	106	1.0	

Run # 3 Con't on Next Page



# EMC Test Data

Client: Timble Navigation	Job Number: J68417
Model: R8-M2 with 2.4GHz Module (RoHS Compliant)	T-Log Number: T68420
	Account Manager: Dean Eriksen
Contact: Roy Urbach	
Standard: FCC Part 15 and EN 55022	Class: B

### Final peak and average readings

Frequency Range	Test Distance	Limit Distance	Extrapolation Factor
1000 - 7000 MHz	3	3	0.0

Frequency MHz	Level dB $\mu$ V/m	Pol v/h	FCC Class B		Detector Pk/QP/Avg	Azimuth degrees	Height meters	Comments
			Limit	Margin				
5599.950	51.0	V	54.0	-3.0	AVG	18	1.0	
2799.960	44.9	V	54.0	-9.1	AVG	19	1.0	
2860.000	41.8	V	54.0	-12.2	AVG	18	1.0	
1799.830	40.5	V	54.0	-13.5	AVG	315	1.3	
1919.970	37.2	V	54.0	-16.8	AVG	106	1.0	
5599.950	53.3	V	74.0	-20.7	PK	18	1.0	
2799.960	47.7	V	74.0	-26.3	PK	19	1.0	
2860.000	45.6	V	74.0	-28.4	PK	18	1.0	
1799.830	45.2	V	74.0	-28.8	PK	315	1.3	
1919.970	42.5	V	74.0	-31.5	PK	106	1.0	

Note 1:	Above 1 GHz, the FCC specifies the limit as an average measurement. In addition, the FCC states that the peak reading of any emission above 1 GHz, can not exceed the average limit by more than 20 dB.
Note 2:	2.4GHz, 3.6GHz, 4.6GHz, 4.8GHz, 4.9GHz are not included in the final result because they are from the Bluetooth and the Radio transmitter, therefore, they are covered under FCC Part 15.247. The 2.4GHz radio was mistakenly in transmit mode, hopping and sweeping each channel, during the test.

Client: Timble Navigation	Job Number: J68417
Model: R8-M2 with 2.4GHz Module (RoHS Compliant)	T-Log Number: T68420
	Account Manager: Dean Eriksen
Contact: Roy Urbach	
Standard: FCC Part 15 and EN 55022	Class: B

## Conducted Emissions

*(Elliott Laboratories Fremont Facility, Semi-Anechoic Chamber)*

### Test Specific Details

Objective: The objective of this test session is to perform final qualification testing of the EUT with respect to the specification listed above.

Date of Test: 6/27/2007	Config. Used: 1
Test Engineer: Suhaila Khushzad	Config Change: None
Test Location: Fremont Chamber #3	EUT Voltage: 120V/60Hz

### General Test Configuration

For tabletop equipment, the EUT was located on a wooden table inside the semi-anechoic chamber, 40 cm from a vertical coupling plane and 80cm from the LISN. A second LISN was used for all local support equipment.

**Ambient Conditions:**

Temperature:	20 °C
Rel. Humidity:	41 %

### Summary of Results

Run #	Test Performed	Limit	Result	Margin
1	CE, AC Power, 120V/60Hz	EN55022 Class B	Pass	43.1dBµV @ 0.197MHz (-10.6dB)
2	CE, AC Power, 230V/50Hz	EN55022 Class B	Pass	39.6dBµV @ 0.197MHz (-14.1dB)

### Modifications Made During Testing:

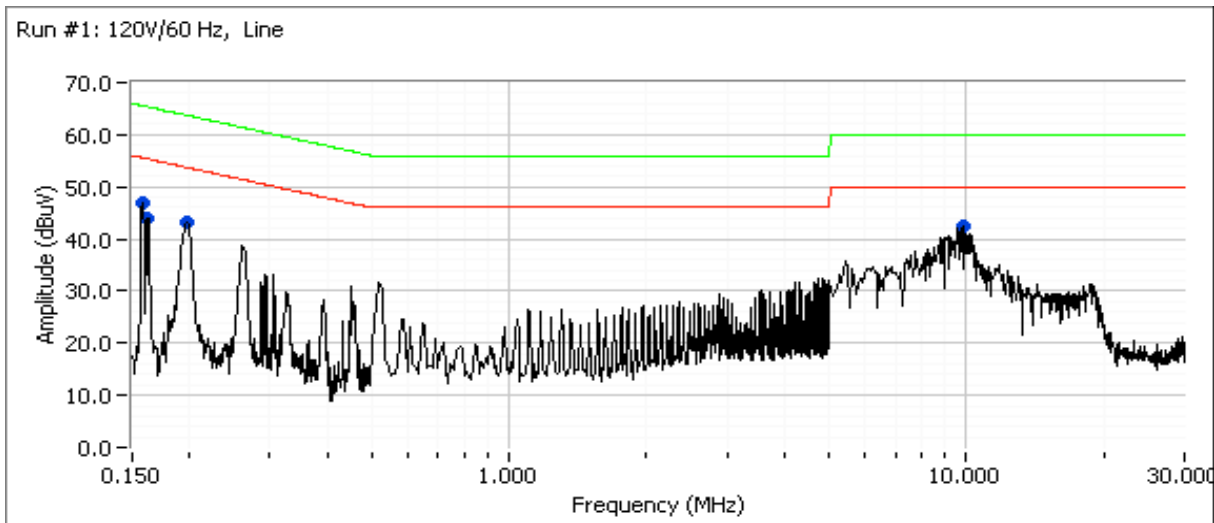
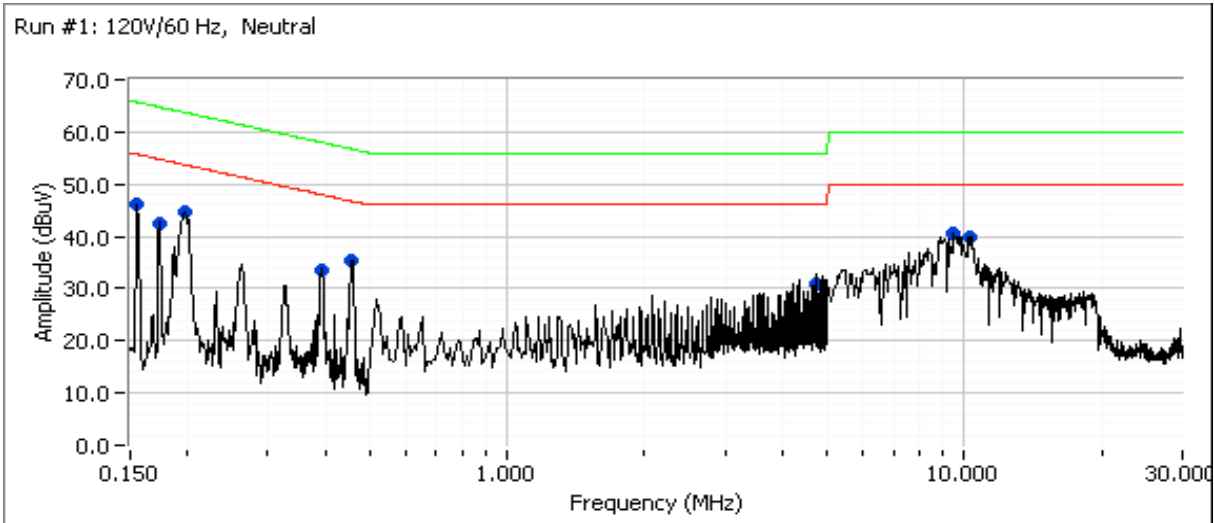
No modifications were made to the EUT during testing

### Deviations From The Standard

No deviations were made from the requirements of the standard.

Client: Timble Navigation	Job Number: J68417
Model: R8-M2 with 2.4GHz Module (RoHS Compliant)	T-Log Number: T68420
	Account Manager: Dean Eriksen
Contact: Roy Urbach	
Standard: FCC Part 15 and EN 55022	Class: B

### Run # 1: AC Power Port Conducted Emissions, 0.15 - 30MHz, 120V/60Hz



Run # 1 Con't on Next Page



# EMC Test Data

Client:	Timble Navigation	Job Number:	J68417
Model:	R8-M2 with 2.4GHz Module (RoHS Compliant)	T-Log Number:	T68420
Contact:	Roy Urbach	Account Manager:	Dean Eriksen
Standard:	FCC Part 15 and EN 55022	Class:	B

**Run # 1: AC Power Port Conducted Emissions, 0.15 - 30MHz, 120V/60Hz**

**Preliminary peak readings captured during pre-scan (peak readings vs. average limit)**

Frequency MHz	Level dB $\mu$ V	AC Line	EN55022 Class B Limit	Class B Margin	Detector QP/Ave	Comments
9.842	42.4	Line	50.0	-7.6	Peak	
9.903	42.4	Line	50.0	-7.6	Peak	
0.157	46.9	Line	55.6	-8.7	Peak	
0.197	44.7	Neutral	53.7	-9.0	Peak	
9.517	40.7	Neutral	50.0	-9.3	Peak	
0.154	46.2	Neutral	55.7	-9.5	Peak	
10.231	39.8	Neutral	50.0	-10.2	Peak	
0.197	43.1	Line	53.7	-10.6	Peak	
0.458	35.3	Neutral	46.7	-11.4	Peak	
0.162	44.0	Line	55.4	-11.4	Peak	
0.173	42.6	Neutral	54.8	-12.2	Peak	
0.393	33.5	Neutral	48.0	-14.5	Peak	
4.760	31.0	Neutral	46.0	-15.0	Peak	

Run # 1 Con't on Next Page



# EMC Test Data

Client: Timble Navigation	Job Number: J68417
Model: R8-M2 with 2.4GHz Module (RoHS Compliant)	T-Log Number: T68420
	Account Manager: Dean Eriksen
Contact: Roy Urbach	
Standard: FCC Part 15 and EN 55022	Class: B

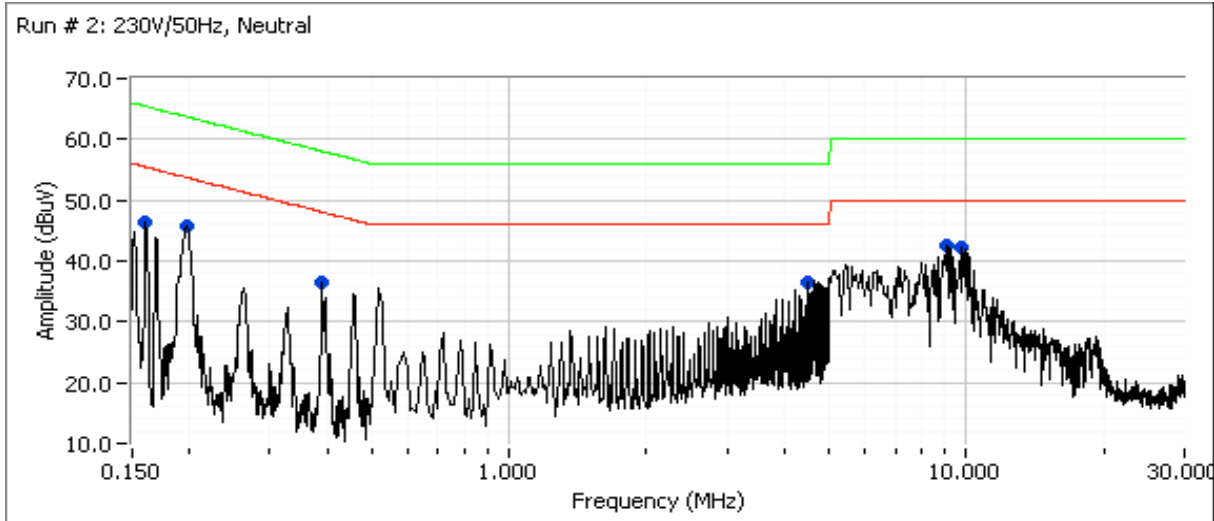
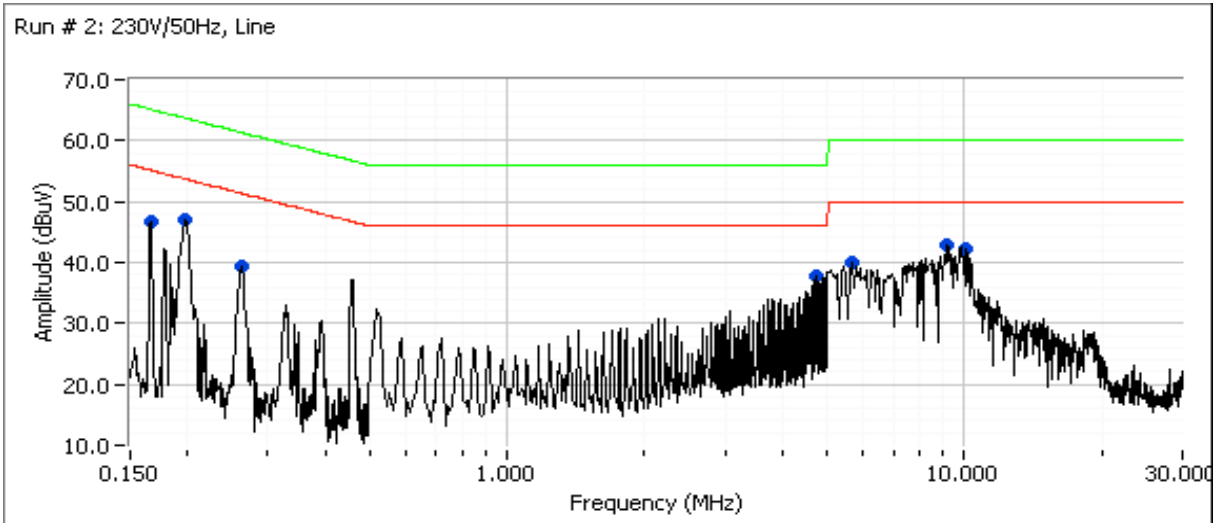
## Run # 1: AC Power Port Conducted Emissions, 0.15 - 30MHz, 120V/60Hz

### Final quasi-peak and average readings

Frequency MHz	Level dBµV	AC Line	EN55022 Class B Limit	Class B Margin	Detector QP/Ave	Comments
0.197	43.1	Line	53.7	-10.6	AVG	
0.197	42.6	Neutral	53.7	-11.1	AVG	
9.517	34.7	Neutral	50.0	-15.3	AVG	
9.903	34.7	Line	50.0	-15.3	AVG	
10.231	34.5	Neutral	50.0	-15.5	AVG	
9.842	34.1	Line	50.0	-15.9	AVG	
0.458	30.3	Neutral	46.7	-16.4	AVG	
4.760	27.6	Neutral	46.0	-18.4	AVG	
0.197	45.2	Line	63.7	-18.5	QP	
0.197	43.9	Neutral	63.7	-19.8	QP	
9.903	39.7	Line	60.0	-20.3	QP	
0.393	27.6	Neutral	48.0	-20.4	AVG	
9.842	38.9	Line	60.0	-21.1	QP	
10.231	38.9	Neutral	60.0	-21.1	QP	
9.517	38.8	Neutral	60.0	-21.2	QP	
0.458	33.8	Neutral	56.7	-22.9	QP	
0.157	40.5	Line	65.6	-25.1	QP	
0.154	40.6	Neutral	65.8	-25.2	QP	
4.760	30.3	Neutral	56.0	-25.7	QP	
0.162	39.3	Line	65.4	-26.1	QP	
0.393	31.5	Neutral	58.0	-26.5	QP	
0.173	36.1	Neutral	64.8	-28.7	QP	
0.157	16.4	Line	55.6	-39.2	AVG	
0.154	16.4	Neutral	55.8	-39.4	AVG	
0.162	15.9	Line	55.4	-39.5	AVG	
0.173	15.1	Neutral	54.8	-39.7	AVG	

Client: Timble Navigation	Job Number: J68417
Model: R8-M2 with 2.4GHz Module (RoHS Compliant)	T-Log Number: T68420
	Account Manager: Dean Eriksen
Contact: Roy Urbach	
Standard: FCC Part 15 and EN 55022	Class: B

### Run # 2: AC Power Port Conducted Emissions, 0.15 - 30MHz, 230V/50Hz



Run # 2 Con't on Next Page





# EMC Test Data

Client:	Timble Navigation	Job Number:	J68417
Model:	R8-M2 with 2.4GHz Module (RoHS Compliant)	T-Log Number:	T68420
Contact:	Roy Urbach	Account Manager:	Dean Eriksen
Standard:	FCC Part 15 and EN 55022	Class:	B

## Run # 2: AC Power Port Conducted Emissions, 0.15 - 30MHz, 230V/50Hz

### Preliminary peak readings captured during pre-scan (peak readings vs. average limit)

Frequency MHz	Level dBµV	AC Line	EN55022 Class B Limit	Margin	Detector QP/Ave	Comments
0.197	46.9	Line	53.7	-6.8	Peak	
9.180	43.0	Line	50.0	-7.0	Peak	
9.049	42.6	Neutral	50.0	-7.4	Peak	
10.091	42.2	Line	50.0	-7.8	Peak	
0.197	45.9	Neutral	53.7	-7.8	Peak	
9.833	42.1	Neutral	50.0	-7.9	Peak	
4.754	37.9	Line	46.0	-8.1	Peak	
0.167	46.6	Line	55.2	-8.6	Peak	
0.161	46.3	Neutral	55.4	-9.1	Peak	
4.492	36.5	Neutral	46.0	-9.5	Peak	
5.664	40.0	Line	50.0	-10.0	Peak	
0.391	36.4	Neutral	48.1	-11.7	Peak	
0.262	39.3	Line	51.3	-12.0	Peak	

Run # 2 Con't on Next Page



# EMC Test Data

Client: Timble Navigation	Job Number: J68417
Model: R8-M2 with 2.4GHz Module (RoHS Compliant)	T-Log Number: T68420
	Account Manager: Dean Eriksen
Contact: Roy Urbach	
Standard: FCC Part 15 and EN 55022	Class: B

## Run # 2: AC Power Port Conducted Emissions, 0.15 - 30MHz, 230V/50Hz

### Final quasi-peak and average readings

Frequency MHz	Level dBµV	AC Line	EN55022 Class B Limit	Class B Margin	Detector QP/Ave	Comments
0.197	39.6	Line	53.7	-14.1	AVG	
0.197	37.4	Neutral	53.7	-16.3	AVG	
9.180	33.5	Line	50.0	-16.5	AVG	
4.754	29.4	Line	46.0	-16.6	AVG	
0.197	46.7	Line	63.7	-17.0	QP	
10.091	32.5	Line	50.0	-17.5	AVG	
9.049	32.5	Neutral	50.0	-17.5	AVG	
9.180	42.4	Line	60.0	-17.6	QP	
9.049	42.3	Neutral	60.0	-17.7	QP	
4.492	28.0	Neutral	46.0	-18.0	AVG	
10.091	41.6	Line	60.0	-18.4	QP	
9.833	31.4	Neutral	50.0	-18.6	AVG	
0.197	44.8	Neutral	63.7	-18.9	QP	
4.754	36.8	Line	56.0	-19.2	QP	
9.833	40.7	Neutral	60.0	-19.3	QP	
0.391	38.2	Neutral	58.0	-19.8	QP	
0.262	31.5	Line	51.4	-19.9	AVG	
0.391	27.9	Neutral	48.0	-20.1	AVG	
5.664	29.6	Line	50.0	-20.4	AVG	
4.492	35.5	Neutral	56.0	-20.5	QP	
5.664	38.9	Line	60.0	-21.1	QP	
0.262	38.3	Line	61.4	-23.1	QP	
0.161	36.8	Neutral	65.4	-28.6	QP	
0.167	35.7	Line	65.1	-29.4	QP	
0.161	16.4	Neutral	55.4	-39.0	AVG	
0.167	15.3	Line	55.1	-39.8	AVG	

## ***APPENDIX C: Test Configuration Photographs***

4 Pages