Elliott Laboratories Inc.
www.elliottlabs.com
684 West Maude Avenue
Sunnyvale, CA 94085-3518
408-245-7800 Phone
408-245-3499 Fax

# *Electromagnetic Emissions Test Report and Request for Class II Permissive Change pursuant to FCC Part 15, Subpart C Specifications for an Intentional Radiator on the Alien Technology Model: NanoScanner*

| | |
|---|---|
| FCC ID: | P65BHNPR001 |
| GRANTEE: | Alien Technology<br>18410 Butterfield Blvd, Ste 150<br>Morgan Hill, CA. 95037 |
| TEST SITE: | Elliott Laboratories, Inc.<br>684 W. Maude Avenue<br>Sunnyvale, CA 94086 |
| REPORT DATE: | May 23, 2003 |
| FINAL TEST DATE: | May 15 and May 16, 2003 |

AUTHORIZED SIGNATORY: _____

Juan Martinez
Sr. EMC Engineer

ACCREDITED

## *TABLE OF CONTENTS*

## *SCOPE*

An electromagnetic emissions test has been performed on the Alien Technology model NanoScanner pursuant to Subpart C of Part 15 of FCC Rules for intentional radiators. Conducted and radiated emissions data has been collected, reduced, and analyzed within this report in accordance with measurement guidelines set forth in ANSI C63.4-1992 as outlined in Elliott Laboratories test procedures.

The intentional radiator above has been tested in a simulated typical installation to demonstrate compliance with the relevant FCC performance and procedural standards.

Final system data was gathered in a mode that tended to maximize emissions by varying orientation of EUT, orientation of power and I/O cabling, antenna search height, and antenna polarization.

Every practical effort was made to perform an impartial test using appropriate test equipment of known calibration. All pertinent factors have been applied to reach the determination of compliance.

The test results recorded herein are based on a single type test of the Alien Technology model NanoScanner and therefore apply only to the tested sample. The sample was selected and prepared by Greg Katterhagenof Alien Technology

## *OBJECTIVE*

The primary objective of the manufacturer is compliance with Subpart C of Part 15 of FCC Rules for the radiated and conducted emissions of intentional radiators. Certification of these devices is required as a prerequisite to marketing as defined in Part 2 the FCC Rules.

Certification is a procedure where the manufacturer or a contracted laboratory makes measurements and submits the test data and technical information to the FCC. The FCC issues a grant of equipment authorization upon successful completion of their review of the submitted documents. Once the equipment authorization has been obtained, the label indicating compliance must be attached to all identical units subsequently manufactured.

## *STATEMENT OF COMPLIANCE*

The tested sample of Alien Technology model NanoScanner complied with the requirements of Subpart C of Part 15 of the FCC Rules for low power intentional radiators.

Maintenance of FCC compliance is the responsibility of the manufacturer. Any modification of the product which may result in increased emissions should be checked to ensure compliance has been maintained (i.e., printed circuit board layout changes, different line filter, different power supply, harnessing or I/O cable changes, etc.).

## *EMISSION TEST RESULTS*

The following emissions tests were performed on the Alien Technology model NanoScanner. The actual test results are contained in an exhibit of this report.

### *LIMITS OF CONDUCTED INTERFERENCE VOLTAGE*

The proposed change would not influence the data submitted during the original application for this device.

### *LIMITS OF ANTENNA CONDUCTED POWER*

The proposed change would not influence the data submitted during the original application for this device.

### *LIMITS OF RADIATED INTERFERENCE FIELD STRENGTH*

The EUT tested complied with the limits detailed in FCC Rules Part 15 Section 15.247 and 15.209 in the case of emissions falling within the frequency bands specified in Section 15.205.

The following measurement was extracted from the data recorded during the radiated electric field emissions scan and represents the highest amplitude emission relative to the specification limit. The actual test data and any correction factors are contained in an exhibit of this report.

| Frequency MHz | Level dBuV/m | Pol v/h | FCC Class A Limit | FCC Class A Margin | Detector Pk/QP/Avg | Azimuth degrees | Height meters | Comments |
|---|---|---|---|---|---|---|---|---|
| 4574.913 | 53.4 | V | 54.0 | -0.6 | Avg | 30 | 1.0 | Restricted Band |

***LIMITS OF POWER AND BANDWIDTH***

The maximum power output was verified to be 29.7 dBm (0.93 Watts) on channel 1, within 0.4dB of the output power reported to the FCC for the original device (29.3dBm, 0.85 Watts). The actual test data and any correction factors are contained in an exhibit of this report.

The proposed change would not influence the bandwidth data submitted during the original application for this device.

***CHANNEL SEPARATION, CHANNEL OCCUPANCY, AND NUMBER OF CHANNELS.***

The proposed change would not influence these parameters as submitted during the original application for this device.

***MEASUREMENT UNCERTAINTIES***

ISO Guide 25 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level and were calculated in accordance with NAMAS document NIS 81.

| Measurement Type | Frequency Range (MHz) | Calculated Uncertainty (dB) |
|---|---|---|
| Conducted Emissions | 0.15 to 30 | ± 2.4 |
| Radiated Emissions | 30 to 1000 | ± 3.2 |

## *EQUIPMENT UNDER TEST (EUT) DETAILS*

### *GENERAL*

The Alien Technology model NanoScanner is a radio which is designed to read RF ID tags. The radio is a frequency hopping spread spectrum device that uses 63 channels between 902.6MHz and 927.4 MHz. Normally, the EUT would be mounted to a wall during operation. For testing purposes the EUT was treated as table-top equipment during testing.

The sample was received on May 15, 2003 and tested on May 15 and May 16, 2003. The EUT consisted of the following component(s):

| Manufacturer/Model/Description | Serial Number |
|---|---|
| Alien Technology NanoScanner FHSS Radio | 11 |
| Alien Technology LP91501 Linearly polarized patch antenna | SN 00001 |

### *OTHER EUT DETAILS*

EUT operates in the 902 -928 MHz ISM band

### *ENCLOSURE*

The EUT enclosure is primarily constructed of machined aluminum.

### *MODIFICATIONS*

The EUT did not require modifications during testing in order to comply with the emission specifications.

### *SUPPORT EQUIPMENT*

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

| Manufacturer/Model/Description | Serial Number |
|---|---|
| Dell Latitude C600 Laptop | HQH9N01 |
| Hewlett Packard 2225C Printer | 2714540166 |

***EXTERNAL I/O CABLING***

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

| Port | Connected To | Cable(s) | | |
|---|---|---|---|---|
| | | Description | Shielded or Unshielded | Length(m) |
| RS-232 | PC | RS-232 | Shielded | 1 |
| Ethernet | PC | Cat-5 | Unshielded | 1 |
| I/O | Alarms | RS-232 | Shielded | 1 |
| Antenna 0 | Antenna | HF141 | Shielded | 2 |
| Antenna 1 | Teminated 50Ohms | - | - | - |
| Power | AC mains | Power cable | Unshielded | 1 |

***EUT OPERATION***

The EUT was in the interrogation mode (transmitting) during tests performed against 15.247. For measurements made on individual channels the unit was operating only on that channel.

For digital device emissions measurements, the unit was operating with the transmitter off, the receiver enabled and the EUT communicating to the PC.

## *PROPOSED MODIFICATION DETAILS*

### *GENERAL*

This section details the modifications to the Alien Technology model NanoScanner being proposed. All performance and construction deviations from the characteristics originally reported to the FCC are addressed

### *ANTENNA*

The proposed change to the existing device is to add a new Linearly polarized patch antenna with a gain of 6dBi.

## *TEST SITE*

### *GENERAL INFORMATION*

Final test measurements were taken on May 15 and May 16, 2003 at the Elliott Laboratories Open Area Test Site #1 located at 684 West Maude Avenue, Sunnyvale, California. The test site contains separate areas for radiated and conducted emissions testing. Pursuant to section 2.948 of the Rules, construction, calibration, and equipment data has been filed with the Commission.

The FCC recommends that ambient noise at the test site be at least 6 dB below the allowable limits. Ambient levels are below this requirement with the exception of predictable local TV, radio, and mobile communications traffic. The test site contains separate areas for radiated and conducted emissions testing. Considerable engineering effort has been expended to ensure that the facilities conform to all pertinent FCC requirements.

### *CONDUCTED EMISSIONS CONSIDERATIONS*

Conducted emissions testing is performed in conformance with ANSI C63.4-1992. Measurements are made with the EUT connected to the public power network through a nominal standardized RF impedance, 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.

### *RADIATED EMISSIONS CONSIDERATIONS*

The FCC has determined that radiation measurements made in a shielded enclosure are not suitable for determining levels of radiated emissions. Radiated measurements are performed in an open field environment. 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 2000 MHz. 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 1000MHz 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 and 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 run automated data collection programs which 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 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.

***POWER METER***

A power meter and thermister mount are used for all direct output power measurements from transmitters as they provide a broadband indication of the power output.

***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 range for precision measurements of field strength. Above 1000 MHz, a horn antenna is used. The antenna calibration factors are included in site factors, which 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 from 3 to 12 mm 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 exhibit of this report contains the list of test equipment used and calibration information.

## *TEST PROCEDURES*

### *EUT AND CABLE PLACEMENT*

The FCC requires 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*

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.

### *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 are 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 which 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 which have values close to the specification limit may also be measured with a tuned dipole antenna to determine compliance.

***CONDUCTED EMISSIONS FROM ANTENNA PORT***

Direct measurements are performed with the antenna port of the EUT connected to either the power meter or spectrum analyzer via a suitable attenuator and/or filter. These are used to ensure that the front end of the measurement instrument is not overloaded by the fundamental transmission.

## *SPECIFICATION LIMITS AND SAMPLE CALCULATIONS*

The limits for conducted emissions are given in units of microvolts, and the limits for radiated emissions are given in units of microvolts per meter at a specified test distance. Data is measured in the logarithmic form of decibels relative to one microvolt, or dB microvolts (dBuV). For radiated emissions, the measured data is converted to the field strength at the antenna in dB microvolts per meter (dBuV/m). The results are then converted to the linear forms of uV and uV/m for comparison to published specifications.

For reference, converting the specification limits from linear to decibel form is accomplished by taking the base ten logarithm, then multiplying by 20. These limits in both linear and logarithmic form are as follows:

***CONDUCTED EMISSIONS SPECIFICATION LIMITS, SECTION 15.207***

| Frequency Range (MHz) | Limit (uV) | Limit (dBuV) |
|---|---|---|
| 0.450 to 30.000 | 250 | 48 |

***RADIATED EMISSIONS SPECIFICATION LIMITS, SECTION 15.209***

| Frequency Range (MHz) | Limit (uV/m @ 3m) | Limit (dBuV/m @ 3m) |
|---|---|---|
| 0.009-0.490 | $2400/F_{KHz}$ @ 300m | $67.6-20*\log_{10}(F_{KHz})$ @ 300m |
| 0.490-1.705 | $24000/F_{KHz}$ @ 30m | $87.6-20*\log_{10}(F_{KHz})$ @ 30m |
| 1.705 to 30 | 30 @ 30m | 29.5 @ 30m |
| 30 to 88 | 100 | 40 |
| 88 to 216 | 150 | 43.5 |
| 216 to 960 | 200 | 46.0 |
| Above 960 | 500 | 54.0 |

***SAMPLE CALCULATIONS - CONDUCTED EMISSIONS***

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

$$R_r - B = C$$

and

$$C - S = M$$

where:

$R_r$ = Receiver Reading in dBuV

B = Broadband Correction Factor*

C = Corrected Reading in dBuV

S = Specification Limit in dBuV

M = Margin to Specification in +/- dB

* Broadband Level- Per ANSI C63.4, 13 dB may be subtracted from the quasi-peak level if it is determined that the emission is broadband in nature. If the signal level in the average mode is six dB or more below the signal level in the peak mode, the emission is classified as broadband.

***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:

$$F_d = 20*LOG_{10} (D_m/D_s)$$

where:

$F_d$ = Distance Factor in dB

$D_m$ = Measurement Distance in meters

$D_s$ = 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:

$R_r$ = Receiver Reading in dBuV/m

$F_d$ = Distance Factor in dB

$R_c$ = Corrected Reading in dBuV/m

$L_s$ = Specification Limit in dBuV/m

M = Margin in dB Relative to Spec

# *EXHIBIT 1: Test Equipment Calibration Data*

1 Page

**Radiated Emissions, 1 - 10 GHz, 15-May-03**
**Engineer: jgonzalez**

| Manufacturer | Description | Model # | Assett # | Cal interval | Last Calibrated | Cal Due |
|---|---|---|---|---|---|---|
| EMCO | Horn Antenna, D. Ridge 1-18GHz | 3115 | 1242 | 12 | 10/9/2002 | 10/9/2003 |
| Hewlett Packard | Microwave Preamplifier, 1-26.5GHz | 8449B | 870 | 12 | 1/10/2003 | 1/10/2004 |
| Narda West | High Pass Filter | HPF 180 | 821 | 12 | 8/7/2002 | 8/7/2003 |

**Conducted Emissions, 16-May-03**
**Engineer: Jay**

| Manufacturer | Description | Model # | Assett # | Cal interval | Last Calibrated | Cal Due |
|---|---|---|---|---|---|---|
| Rohde & Schwarz | Power Meter, Single Channel | NRVS | 1290 | 12 | 4/8/2003 | 4/8/2004 |
| Rohde & Schwarz | Power Sensor 100uW - 2 Watts | NRV-Z32 | 1536 | 12 | 3/20/2003 | 3/20/2004 |

# *EXHIBIT 2: Test Data Log Sheets*

**ELECTROMAGNETIC EMISSIONS**

**TEST LOG SHEETS**

**AND**

**MEASUREMENT DATA**

T51204 8 Pages

Elliott

# *EMC Test Data*

| | | | |
|---|---|---|---|
| Client: | Alien Technology | Job Number: | J47256 |
| Model: | NanoScanner | T-Log Number: | T47291 |
| | | Account Manager: | Rob Holt |
| Contact: | Rob Martin | | |
| Emissions Spec: | FCC15.247(FHSS), 15.109, | Class: | A |
| Immunity Spec: | | Environment: | |

# EMC Test Data

For The

## Alien Technology

Model

**NanoScanner**

Date of Last Test: 5/15/2003

| | | | |
|---|---|---|---|
| Client: | Alien Technology | Job Number: | J47256 |
| Model: | NanoScanner | T-Log Number: | T51204 |
| | | Account Mangager: | Rob Holt |
| Contact: | Rob Martin | | |
| Emissions Spec: | FCC15.247(FHSS), 15.109, 15.20 | Class: | A |
| Immunity Spec: | Enter immunity spec on cover | Environment: | |

# EUT INFORMATION

## General Description

The EUT is a radio which is designed to read RF ID tags. The radio is a frequency hopping spread spectrum device that uses 63 channels between 902.6MHz and 927.4 MHz. Normally, the EUT would be mounted to a wall during operation. For testing purposes the EUT was treated as table-top equipment during testing.

## Equipment Under Test

| Manufacturer | Model | Description | Serial Number | FCC ID |
|---|---|---|---|---|
| Alien Technology | NanoScanner | FHSS Radio | 11 | - |
| Alien Technology | LP91501 | linerally polarized patch antenna | SN 00001 | - |

## Other EUT Details

EUT operates in the 902 -928 MHz ISM band

## EUT Enclosure

The EUT enclosure is primarily constructed of machined aluminum.

## Modification History

| Mod. # | Test | Date | Modification |
|---|---|---|---|
| 1 | | | |

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

| | | | |
|---|---|---|---|
| Client: | Alien Technology | Job Number: | J47256 |
| Model: | NanoScanner | T-Log Number: | T47291 |
| | | Account Manager: | Rob Holt |
| Contact: | Rob Martin | | |
| Emissions Spec: | FCC15.247(FHSS), 15.109, 15.20 | Class: | A |
| Immunity Spec: | Enter immunity spec on cover | Environment: | |

# Test Configuration #1

## Local Support Equipment

| Manufacturer | Model | Description | Serial Number | FCC ID |
|---|---|---|---|---|
| Dell | Latitude C600 | Laptop | HQH9N01 | - |
| Hewlett Packard | 2225C | Printer | 2714540166 | - |

## Remote Support Equipment

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

## Interface Ports

| | | Cable(s) | | |
|---|---|---|---|---|
| Port | Connected To | Description | Shielded or Unshielded | Length(m) |
| RS-232 | PC | RS-232 | Shielded | 1 |
| Ethernet | PC | Cat-5 | Unshielded | 1 |
| I/O | Alarms | RS-232 | Shielded | 1 |
| Antenna 0 | Antenna | HF141 | Shielded | 2 |
| Antenna 1 | Teminated 50Ohms | - | - | - |
| Power | AC mains | Power cable | Unshielded | 1 |

## EUT Operation During Emissions

The EUT was in the interrogation mode (transmitting) during tests performed against 15.247. For measurements made on individual channels the unit was operating only on that channel. For channel occupancy measurements the unit was operating in hopping mode.

For digital device emissions measurements, the unit was operating with the transmitter off, the receiver enabled and the EUT communicating to the PC.

Elliott

# EMC Test Data

| | | | |
|---|---|---|---|
| Client: | Alien Technology | Job Number: | J47256 |
| Model: | NanoScanner | T-Log Number: | T47291 |
| | | Account Manager: | Rob Holt |
| Contact: | Rob Martin | | |
| Spec: | FCC15.247(FHSS), 15.109, 15.207 | Class: | N/A |

## Radiated Emissions

### Test Specifics

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

Date of Test: 5/15 & 16/2003
Test Engineer: Juan Gonzalez/ JayD
Test Location: SVOATS #1 & 3mLab
Config. Used: 1
Config Change: None
EUT Voltage: 120V/60Hz

### General Test Configuration

The EUT and all local support equipment were located on the turntable for radiated spurious emissions testing.
For radiated emissions testing the measurement antenna was located 3 meters from the EUT.
When measuring the conducted emissions from the EUT's antenna port, the antenna port of the EUT was connected to the spectrum analyzer or power meter via a suitable attenuator to prevent overloading the measurement system. All measurements are corrected to allow for the external attenuators used.
Unless stated otherwise the EUT was operating such that it constantly transmitted on either the low, center or high channels.

### Ambient Conditions:

Temperature: 16 °C
Rel. Humidity: 30 %

### Summary of Results

| Run # | Test Performed | Limit | Result | Margin |
|---|---|---|---|---|
| 1a | RE, 30 - 10,000 MHz - Spurious Emissions | FCC Part 15.209 / 15.247( c) | Pass | -3.0dB @ 4512.9MHz |
| 1b | RE, 30 - 10,000 MHz - Spurious Emissions | FCC Part 15.209 / 15.247( c) | Pass | -0.6dB @ 4574.9MHz |
| 1c | RE, 30 - 10,000 MHz - Spurious Emissions | FCC Part 15.209 / 15.247( c) | Pass | -3.3dB @ 4636.9MHz |
| 2 | Output Power | 15.247(b) | Pass | -0.3dB @ 902.6MHz |

### 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.

Elliott

# EMC Test Data

| | | | |
|---|---|---|---|
| Client: | Alien Technology | Job Number: | J47256 |
| Model: | NanoScanner | T-Log Number: | T47291 |
| | | Account Manager: | Rob Holt |
| Contact: | Rob Martin | | |
| Spec: | FCC15.247(FHSS), 15.109, 15.207 | Class: | N/A |

**Run #1a: Radiated Spurious Emissions, Low Channel @ 902.6 MHz**

| | H | V |
|---|---|---|
| Fundamental emission level @ 3m in 100kHz RBW: | | |
| Limit for emissions outside of restricted bands: | -20 dBµV/m | |

| Frequency | Level | Pol | 15.209 / 15.247 | | Detector | Azimuth | Height | Comments |
|---|---|---|---|---|---|---|---|---|
| MHz | dBµV/m | v/h | Limit | Margin | Pk/QP/Avg | degrees | meters | |
| 4512.864 | 51.0 | V | 54.0 | -3.0 | Avg | 27 | 1.0 | Restricted |
| 7224.000 | 47.8 | V | 54.0 | -6.2 | Avg | 43 | 2.9 | Restricted |
| 2707.736 | 44.8 | V | 54.0 | -9.2 | Avg | 170 | 1.0 | Restricted |
| 9025.887 | 43.6 | V | 54.0 | -10.4 | Avg | 185 | 1.0 | Restricted |
| 9025.891 | 42.1 | H | 54.0 | -11.9 | Avg | 0 | 1.0 | Restricted |
| 8123.366 | 41.3 | V | 54.0 | -12.7 | Avg | 218 | 1.0 | Restricted |
| 8123.376 | 40.8 | H | 54.0 | -13.2 | Avg | 0 | 1.0 | Restricted |
| 5415.563 | 40.2 | V | 54.0 | -13.8 | Avg | 333 | 1.0 | Restricted |
| 7224.000 | 39.9 | V | 54.0 | -14.1 | Avg | 10 | 1.0 | Restricted |
| 5415.509 | 36.9 | H | 54.0 | -17.1 | Avg | 289 | 2.8 | Restricted |
| 9026.022 | 56.4 | V | 74.0 | -17.6 | Pk | 185 | 1.0 | Restricted |
| 7224.000 | 56.1 | V | 74.0 | -17.9 | Pk | 43 | 2.9 | Restricted |
| 4512.910 | 55.2 | H | 74.0 | -18.8 | Pk | 40 | 1.0 | Restricted |
| 4513.077 | 55.1 | V | 74.0 | -18.9 | Pk | 27 | 1.0 | Restricted |
| 9026.149 | 54.7 | H | 74.0 | -19.3 | Pk | 0 | 1.0 | Restricted |
| 3610.320 | 34.1 | V | 54.0 | -19.9 | Avg | 10 | 1.0 | Restricted |
| 2707.763 | 34.1 | H | 54.0 | -19.9 | Avg | 160 | 1.0 | Restricted |
| 3610.343 | 34.1 | H | 54.0 | -19.9 | Avg | 237 | 1.0 | Restricted |
| 8122.944 | 53.5 | H | 74.0 | -20.5 | Pk | 0 | 1.0 | Restricted |
| 8123.640 | 53.3 | V | 74.0 | -20.7 | Pk | 218 | 1.0 | Restricted |
| 7224.000 | 52.1 | V | 74.0 | -21.9 | Pk | 10 | 1.0 | Restricted |
| 4512.990 | 32.0 | H | 54.0 | -22.0 | Avg | 40 | 1.0 | Restricted |
| 5415.637 | 50.1 | V | 74.0 | -23.9 | Pk | 333 | 1.0 | Restricted |
| 2707.917 | 49.3 | V | 74.0 | -24.7 | Pk | 170 | 1.0 | Restricted |
| 5415.540 | 48.9 | H | 74.0 | -25.1 | Pk | 289 | 2.8 | Restricted |
| 3610.500 | 46.4 | H | 74.0 | -27.6 | Pk | 237 | 1.0 | Restricted |
| 3610.462 | 46.1 | V | 74.0 | -27.9 | Pk | 10 | 1.0 | Restricted |
| 2707.985 | 43.7 | H | 74.0 | -30.3 | Pk | 160 | 1.0 | Restricted |

| | |
|---|---|
| Note 1: | For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below the level of the fundamental. |

Elliott

# EMC Test Data

| | | | |
|---|---|---|---|
| Client: | Alien Technology | Job Number: | J47256 |
| Model: | NanoScanner | T-Log Number: | T47291 |
| | | Account Manager: | Rob Holt |
| Contact: | Rob Martin | | |
| Spec: | FCC15.247(FHSS), 15.109, 15.207 | Class: | N/A |

**Run #1b: Radiated Spurious Emissions, Center Channel @ 915 MHz**

| | H | V |
|---|---|---|
| Fundamental emission level @ 3m in 100kHz RBW: | | |
| Limit for emissions outside of restricted bands: | -20 dBµV/m | |

| Frequency | Level | Pol | 15.209 / 15.247 | | Detector | Azimuth | Height | Comments |
|---|---|---|---|---|---|---|---|---|
| MHz | dBµV/m | v/h | Limit | Margin | Pk/QP/Avg | degrees | meters | |
| 4574.913 | 53.4 | V | 54.0 | -0.6 | Avg | 30 | 1.0 | Restricted |
| 7319.899 | 51.8 | V | 54.0 | -2.2 | Avg | 60 | 1.3 | Restricted |
| 4574.904 | 51.4 | H | 54.0 | -2.6 | Avg | 38 | 1.4 | Restricted |
| 2744.893 | 48.0 | V | 54.0 | -6.0 | Avg | 0 | 1.0 | Restricted |
| 7319.916 | 46.7 | H | 54.0 | -7.3 | Avg | 297 | 1.0 | Restricted |
| 9149.884 | 45.2 | V | 54.0 | -8.8 | Avg | 60 | 1.0 | Restricted |
| 8234.945 | 44.9 | V | 54.0 | -9.1 | Avg | 340 | 1.5 | Restricted |
| 5490.000 | 43.6 | V | 54.0 | -10.4 | Avg | 330 | 1.0 | Restricted |
| 9149.889 | 43.3 | H | 54.0 | -10.7 | Avg | 0 | 1.0 | Restricted |
| 8234.900 | 42.9 | H | 54.0 | -11.1 | Avg | 310 | 1.4 | Restricted |
| 3659.938 | 42.6 | V | 54.0 | -11.4 | Avg | 350 | 1.7 | Restricted |
| 2744.953 | 40.0 | H | 54.0 | -14.0 | Avg | 233 | 1.0 | Restricted |
| 5490.000 | 39.0 | H | 54.0 | -15.0 | Avg | 286 | 2.4 | Restricted |
| 3659.887 | 38.2 | H | 54.0 | -15.8 | Avg | 332 | 1.0 | Restricted |
| 7319.377 | 58.1 | V | 74.0 | -15.9 | Pk | 60 | 1.3 | Restricted |
| 8235.037 | 57.0 | V | 74.0 | -17.0 | Pk | 340 | 1.5 | Restricted |
| 4574.788 | 56.1 | V | 74.0 | -17.9 | Pk | 30 | 1.0 | Restricted |
| 9149.968 | 56.0 | H | 74.0 | -18.0 | Pk | 0 | 1.0 | Restricted |
| 2744.893 | 55.9 | H | 74.0 | -18.1 | Pk | 233 | 1.0 | Restricted |
| 2745.185 | 55.6 | V | 74.0 | -18.4 | Pk | 0 | 1.0 | Restricted |
| 9149.668 | 55.5 | V | 74.0 | -18.5 | Pk | 60 | 1.0 | Restricted |
| 7320.103 | 55.1 | H | 74.0 | -18.9 | Pk | 297 | 1.0 | Restricted |
| 4574.715 | 54.7 | H | 74.0 | -19.3 | Pk | 38 | 1.4 | Restricted |
| 5490.000 | 51.9 | V | 74.0 | -22.1 | Pk | 330 | 1.0 | Restricted |
| 3659.800 | 50.0 | V | 74.0 | -24.0 | Pk | 350 | 1.7 | Restricted |
| 5490.000 | 50.0 | H | 74.0 | -24.0 | Pk | 286 | 2.4 | Restricted |
| 3660.445 | 47.7 | H | 74.0 | -26.3 | Pk | 332 | 1.0 | Restricted |
| 8234.923 | 46.4 | H | 74.0 | -27.6 | Pk | 310 | 1.4 | Restricted |

| | |
|---|---|
| Note 1: | For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below the level of the fundamental. |

Elliott

# EMC Test Data

| | | | |
|---|---|---|---|
| Client: | Alien Technology | Job Number: | J47256 |
| Model: | NanoScanner | T-Log Number: | T47291 |
| | | Account Manager: | Rob Holt |
| Contact: | Rob Martin | | |
| Spec: | FCC15.247(FHSS), 15.109, 15.207 | Class: | N/A |

**Run #1c: Radiated Spurious Emissions, High Channel @ 927.4 MHz**

| | H | V |
|---|---|---|
| Fundamental emission level @ 3m in 100kHz RBW: | | |
| Limit for emissions outside of restricted bands: | -20 dBµV/m | |

| Frequency | Level | Pol | 15.209 / 15.247 | | Detector | Azimuth | Height | Comments |
|---|---|---|---|---|---|---|---|---|
| MHz | dBµV/m | v/h | Limit | Margin | Pk/QP/Avg | degrees | meters | |
| 2782.150 | 38.4 | H | 54.0 | -15.6 | Avg | 163 | 1.0 | Restricted |
| 2782.327 | 53.3 | H | 74.0 | -20.7 | Pk | 163 | 1.0 | Restricted |
| 3709.545 | 45.4 | H | 74.0 | -28.6 | Pk | 336 | 1.0 | Restricted |
| 3709.591 | 33.6 | H | 54.0 | -20.4 | Avg | 336 | 1.0 | Restricted |
| 4636.125 | 47.5 | H | 54.0 | -6.5 | Avg | 335 | 1.0 | Restricted |
| 4636.447 | 52.1 | H | 74.0 | -21.9 | Pk | 335 | 1.0 | Restricted |
| 5564.000 | 38.1 | H | 54.0 | -15.9 | Avg | 331 | 1.0 | Restricted |
| 5564.000 | 41.5 | H | 74.0 | -32.5 | Pk | 331 | 1.0 | Restricted |
| 7419.137 | 41.3 | H | 54.0 | -12.7 | Avg | 331 | 1.0 | Restricted |
| 7419.251 | 53.5 | H | 74.0 | -20.5 | Pk | 331 | 1.0 | Restricted |
| 8346.494 | 54.1 | H | 74.0 | -19.9 | Pk | 200 | 1.0 | Restricted |
| 8346.565 | 41.8 | H | 54.0 | -12.2 | Avg | 200 | 1.0 | Restricted |
| 9273.477 | 56.1 | H | 74.0 | -17.9 | Pk | 0 | 1.0 | Non-Restricted |
| 9273.888 | 42.7 | H | 54.0 | -11.3 | Avg | 0 | 1.0 | Non-Restricted |
| 2782.157 | 55.4 | V | 74.0 | -18.6 | Pk | 360 | 1.0 | Restricted |
| 2782.173 | 44.6 | V | 54.0 | -9.4 | Avg | 360 | 1.0 | Restricted |
| 3709.478 | 50.2 | V | 74.0 | -23.8 | Pk | 40 | 1.0 | Restricted |
| 3709.512 | 40.0 | V | 54.0 | -14.0 | Avg | 40 | 1.0 | Restricted |
| 4636.435 | 54.5 | V | 74.0 | -19.5 | Pk | 20 | 1.5 | Restricted |
| 4636.876 | 50.7 | V | 54.0 | -3.3 | Avg | 20 | 1.5 | Restricted |
| 5564.000 | 45.4 | V | 54.0 | -8.6 | Avg | 15 | 1.0 | Restricted |
| 5564.000 | 52.5 | V | 74.0 | -21.5 | Pk | 15 | 1.0 | Restricted |
| 7419.127 | 54.7 | V | 74.0 | -19.3 | Pk | 360 | 1.7 | Restricted |
| 7419.187 | 49.8 | V | 54.0 | -4.2 | Avg | 360 | 1.7 | Restricted |
| 8346.524 | 41.6 | V | 54.0 | -12.4 | Avg | 82 | 1.0 | Restricted |
| 8346.572 | 54.9 | V | 74.0 | -19.1 | Pk | 82 | 1.0 | Restricted |
| 9273.998 | 42.7 | V | 54.0 | -11.3 | Avg | 0 | 1.0 | Non-Restricted |
| 9274.010 | 55.5 | V | 74.0 | -18.5 | Pk | 0 | 1.0 | Non-Restricted |

| | |
|---|---|
| Note 1: | For emissions in restricted bands, the limit of 15.209 was used. For all other emissions, the limit was set 20dB below the level of the fundamental. |

Elliott

# EMC Test Data

| | | | |
|---|---|---|---|
| Client: | Alien Technology | Job Number: | J47256 |
| Model: | NanoScanner | T-Log Number: | T47291 |
| | | Account Manager: | Rob Holt |
| Contact: | Rob Martin | | |
| Spec: | FCC15.247(FHSS), 15.109, 15.207 | Class: | N/A |

Date of Test: 5/16/2003
Test Engineer: Jay Dickinson
Test Location: 3mLab

Config. Used: 1
Config Change: None
EUT Voltage: 120V/60Hz

**Run #2: Peak Power Meter Measurement**

| Channel | Frequency (MHz) | Peak Output Power | Comments |
|---|---|---|---|
| Low | 902.6 | 29.7 dBm (0.93 W) | pass |
| Mid | 915 | 29.4 dBm | pass |
| High | 927.4 | 28.8 dBm | pass |

| | |
|---|---|
| Note 1: | Maximum antenna gain used for this antenna is 6dBi, therefore, maximum permitted power for a system utilizing more than 50 channels is 30dBm (1 Watt). Max output power originally reported to the FCC was 29.4dBm (0.85 Watts). |