Lab Code: 200167-0

# FCC PART 90
# TEST AND MEASUREMENT REPORT

For

## Pacific Crest Corporation

510 Deguigne Drive, Sunnyvale, CA 94085, USA

**FCC ID: KEAADLF**

**Model: ADLF**

| **Report Type:** | **Product type:** |
|---|---|
| Original Report | UHF Transceiver Module |

| | |
|---|---|
| **Test Engineer:** | Jack Liu |
| **Report Number:** | R0902238-90 |
| **Report Date:** | 2009-05-05 |
| **Reviewed By:** | Boni Baniqued<br>Sr. RF Engineer |
| **Prepared By:** **(84)** | Bay Area Compliance Laboratories Corp.<br>1274 Anvilwood Ave<br>Sunnyvale, CA 94085, U.S.A.<br>Tel: (408) 732-9162<br>Fax: (408) 732 9164<br>www.baclcorp.com |

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## DOCUMENT REVISION HISTORY

| Revision Number | Report Number | Description of Revision | Date of Revision |
|---|---|---|---|
| 0 | R0902238-90 | Original Report | 2009-05-05 |

# 1 General Information

## 1.1 Product Description for Equipment Under Test (EUT)

The report has been prepared on behalf of *Pacific Crest Corporation* and their product *FCC ID: KEAADLF, model: ADL Foundation* or the EUT as referred to in the rest of this report. The EUT is a radio modem transceiver module designed to provide data communication using UHF radio frequencies. The module supports GMSK/4FSK modulation schemes and is sold as an OEM product, to be incorporated into other equipment and used as a building block for the ADL product line or as an OEM product. Radio functions are controlled by a microprocessor under firmware control. Modem functions are performed by a proprietary ASIC. Table below is the General specification of the transceiver module

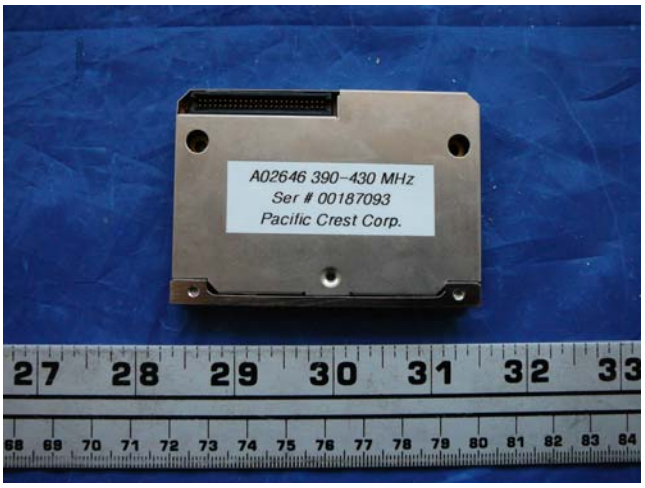
| **Technical Specifications** | |
|---|---|
| Frequency Band | 390 ~ 430 MHz<br>430~ 470 MHz |
| RF Output Power | 1Watt |
| Channel Spacing | 25 kHz; 12.5 kHz |
| Modulation | GMSK, 4FSK |

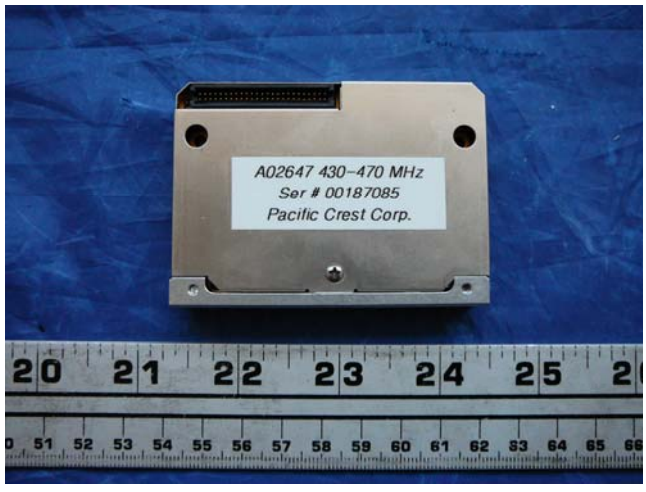
## 1.2 Mechanical Description

The EUT measures approximately 76.0 mm (L) x 54.0 mm (W) x 11.0 mm (H) and weighs 70 g.

** The test data gathered are from production sample, serial number: A02646, A02647 provided by the manufacturer.*

## 1.3 EUT Photos




*Additional photos in Exhibit C*

## 1.4 Objective

This type approval report is prepared on behalf of *Pacific Crest Corporation* in accordance with Part 2 and Part 90 of the Federal Communication Commissions rules.

The objective of the manufacturer is to determine compliance with FCC rules, spurious radiated emissions.

## 1.5 Related Submittal(s)/Grant(s)

FCC Part 90 conducted test report provided by Pacific Crest

## 1.6 Test Methodology

All tests and measurements indicated in this document were performed in accordance with the Code of Federal Regulations Title 47 Part 2, Sub-part J as well as the following individual parts:

Part 90 – Private Land Mobile Radio Service

Applicable Standards: TIA/EIA-603-C, ANSI 63.4-2003, 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.

All radiated and conducted emissions measurement was performed at Bay Area Compliance Laboratory, Corp. The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

## 1.7 Test Facility

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

Test site at BACL has 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 have the reports on file and are listed under FCC file 31040/SIT 1300F2, IC registration number: 3062A, and VCCI Registration No.: C-1298 and R-1234. 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 TIA/EIA 603-C

The EUT was tested in the normal (native) operating mode to represent *worst*-case results during the final qualification test, the test software was provided by the client.

## 2.2 EUT Exercise Software

Software provided by the customer was used to exercise the system in a mode simulating normal operating conditions.

## 2.3 Equipment Modifications

No modifications were made to the EUT.

## 2.4 Local Support Equipment Power Supply and Line Filters

N/A

## 2.5 EUT Internal Configuration Details

| Manufacturers | Descriptions | Models | Serial Numbers |
|---|---|---|---|
| Pacific Crest Corporation | 390~430 MHz PCB Board | A02592 Rev. P4 | 00187093 |
| Pacific Crest Corporation | 430~470 MHz PCB Board | A02557 Rev. P8 | 00187085 |

## 2.6 Interface Ports and Cabling

| Cable Description | Length (m) | From | To |
|---|---|---|---|
| Power cable | 0.80 | Battery | EUT |

## 2.7 Power Supply Information

| Manufacturer | Description | Model | Serial Number |
|---|---|---|---|
| Genesis | Sealed Rechargeable LEAD-ACID Battery | NP112-12T, 12V, 12Ah | - |

# 3 Summary of Test Results

| FCC Rule | Description of Tests | Results |
|---|---|---|
| § 2.1046<br>§ 90.205 | RF Output Power | Compliant * |
| § 2.1047 | Modulation Characteristics | N/A |
| § 2.1049<br>§ 90.209 | Emission mask, Occupied Bandwidth | Compliant * |
| § 2.1051<br>§ 90.210 | Spurious emissions at antenna terminals | Compliant * |
| § 2.1053<br>§ 90.210 | Field strength of spurious radiation | Compliant |
| § 2.1055<br>§ 90.213 | Frequency stability vs. temperature<br>Frequency stability vs. voltage | Compliant * |
| § 90.214 | Transient Frequency Behavior | Compliant * |
| § 2.1091 | RF Exposure | Compliant * |

Note: * Please refer to the conducted test report (Report Number: ADLFFCC051309)

# 4 §2.1091 – RF Exposure

## 4.1 Applicable Standards

According to §2.1091 and §1.1307(b)(1), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines.

According to §1.1310 and §2.1091 RF exposure is calculated.

Limits for General Population/Uncontrolled Exposure

| Frequency Range (MHz) | Electric Field Strength (V/m) | Magnetic Field Strength (A/m) | Power Density ($mW/cm^2$) | Averaging Time (minutes) |
|---|---|---|---|---|
| **Limits for General Population/Uncontrolled Exposure** | | | | |
| 0.3-1.34 | 614 | 1.63 | *(100) | 30 |
| 1.34-30 | 824/f | 2.19/f | $*(180/f^2)$ | 30 |
| 30-300 | 27.5 | 0.073 | 0.2 | 30 |
| 300-1500 | / | / | f/1500 | 30 |
| 1500-100,000 | / | / | 1.0 | 30 |

f = frequency in MHz
* = Plane-wave equivalent power density

## 4.2 MPE Prediction

Predication of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$S = PG/4\pi R^2$

Where: S = power density
P = power input to antenna
G = power gain of the antenna in the direction of interest relative to an isotropic radiator
R = distance to the center of radiation of the antenna

390 ~ 430 MHz

| | |
|---|---|
| Maximum peak output power at antenna input terminal (dBm): | 29.9 |
| Maximum peak output power at antenna input terminal (mW): | 977.24 |
| Prediction distance (cm): | 27 |
| Prediction frequency (MHz): | 409.85 |
| Antenna Gain, typical (dBi): | 4.0 |
| Maximum Antenna Gain (numeric): | 2.512 |
| Power density at predication frequency and distance ($mW/cm^2$): | 0.268 |
| MPE limit for uncontrolled exposure at predication frequency ($mW/cm^2$): | 0.273 |

430 ~ 470 MHz Band

| | |
|---|---|
| Maximum peak output power at antenna input terminal (dBm): | 30.1 |
| Maximum peak output power at antenna input terminal (mW): | 1023.29 |
| Prediction distance (cm): | 27 |
| Prediction frequency (MHz): | 449.85 |
| Antenna Gain, typical (dBi): | 4.0 |
| Maximum Antenna Gain (numeric): | 2.512 |
| Power density at predication frequency and distance ($mW/cm^2$): | 0.281 |
| MPE limit for uncontrolled exposure at predication frequency ($mW/cm^2$): | 0.299 |

**Result**

The device is compliant with the requirement MPE limit for uncontrolled exposure. The maximum power density at the distance of 27 cm is 0.281$mW/cm^2$ (Limit 0.299 $mW/cm^2$)

# 5 §2.1046 – Conducted Output Power

## 5.1 Applicable Standards

Per FCC §2.1046 and §90.205: maximum ERP is dependent upon the station's antenna HAAT and required service area.

## 5.2 Test Procedure

TIA-603-C §2.2.1

## 5.3 Test Results

Please refer to Part 90 conducted test report provided by Pacific Crest (Report Number: ADLFFCC051309)

# 6 §2.1047 & §90.207 - Modulation Characteristic

## 6.1 Applicable Standard

§2.1047 & §90.207:

(a) Equipment which utilizes voice modulated communication shall show the frequency response of the audio modulating circuit over a range of 100 to 5000 Hz. for equipment which is required to have a low pass filter, the frequency response of the filter, or all of the circuitry installed between the modulation limited and the modulated stage shall be supplied.
(b) Equipment which employs modulation limiting, a curve showing the percentage of modulation versus the modulation input voltage shall be supplied.

## 6.2 Test Procedure

TIA-603-C §2.2.3

## 6.3 Test Results

N/A; There is no specific requirement for digital modulation; therefore modulation characteristic is not presented.

# 7 §2.1049 & § 90.209 – Occupied Bandwidth and Emission Mask

## 7.1 Applicable Standard

§2.1049, §90.210

12.5 kHz bandwidth:

For any frequency removed from the center of the authorized bandwidth $f_0$ to 5.625kHz removed from $f_0$, 0dB.

On any frequency removed from the center of the authorized bandwidth by a displacement frequency ($f_d$ in kHz) of more than 5.626kHz but no more than 12.5kHz, at least 7.27 ($f_d$ –2.88kHz) dB.

On any frequency removed from the center of the authorized bandwidth by a displacement frequency ($f_d$ in kHz) of more than 12.5kHz at least:

50+10logP or 70 dB

25 kHz bandwidth:

On any frequency removed from the center of the authorized bandwidth by a displacement frequency ($f_d$ in kHz) of more than 5kHz but not more than 10kHz, at least 83 Log ($f_d$ /5) dB.

On any frequency removed from the center of the authorized bandwidth by a displacement frequency ($f_d$ in kHz) of more than 10kHz but not more than 250% of the authorized bandwidth, at least 29 Log ($f_d^2$ /11) dB or 50 dB.

On any frequency removed from the center of the authorized bandwidth by more than 250% of the authorized bandwidth: least 43+ 10 Log (P).

## 7.2 Test Procedure

The RF output of the transmitter was connected to the input of the spectrum analyzer through sufficient attenuation.

The resolution bandwidth of the spectrum analyzer was set at 100 Hz and the spectrum was recorded in the frequency band ±50 KHz or $\pm$ 25 kHz from the carrier frequency.

## 7.3 Test Results

Please refer to Part 90 conducted test report provided by Pacific Crest (Report Number: ADLFFCC051309)

# 8 §2.1051 & §90.210 – Spurious Emissions at Antenna Terminals

## 8.1 Applicable Standard

§2.1051 and §90.210.

On any frequency removed from the center of the authorized bandwidth by a displacement frequency ($f_d$ in kHz) of more than 12.5kHz at least:

50+10logP or 70 dB

On any frequency removed from the center of the assigned channel by more than 250 percent at least:

43+10log (P)

## 8.2 Test Procedure

TIA-603-C §2.2.13

## 8.3 Test Results

Please refer to Part 90 conducted test report provided by Pacific Crest (Report Number: ADLFFCC051309)

# 9 §2.1053 & §90.210 - Radiated Spurious Emissions

## 9.1 Applicable Standard

§2.1053 and §90.210

## 9.2 Test Procedure

TIA-603-C §2.2.12

The transmitter was placed on a wooden turntable, and it was transmitting into a non-radiating load which was also placed on the turntable.

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. The test was performed by placing the EUT on 3-orthogonal axis.

The frequency range up to tenth harmonic of the fundamental frequency was investigated.

Remove the EUT and replace it with substitution antenna. A signal generator was connected to the substitution antenna by a non-radiating cable. The absolute levels of the spurious emissions were measured by the substitution.

Spurious emissions in dB = 10 log (TX power in Watts/0.001) – the absolute level

Spurious attenuation limit in dB = 43 + 10 $Log_{10}$ (power out in Watts) for EUT with a 25 KHz channel bandwidth.

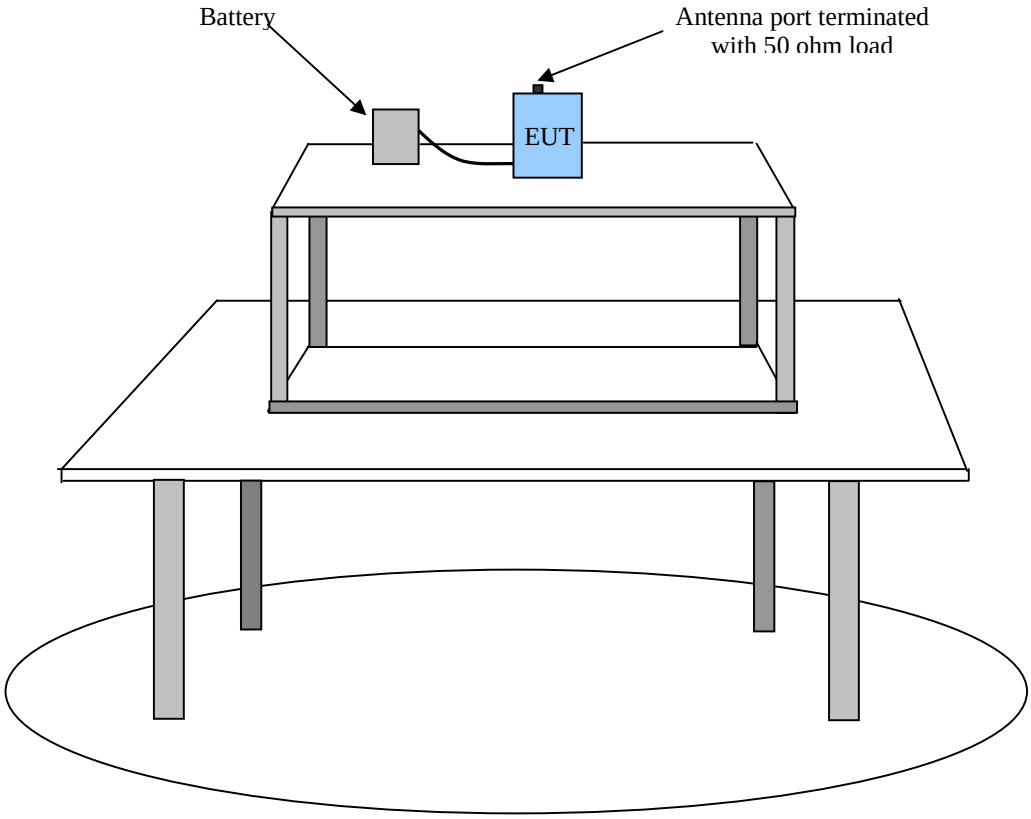
Spurious attenuation limit in dB = 50 + 10 $Log_{10}$ (power out in Watts) for EUT with a 12.5 KHz channel bandwidth.

## 9.3 Test Equipment List and Details

| Manufacturer | Description | Model | Serial Number | Calibration Due Date |
|---|---|---|---|---|
| Agilent | Spectrum Analyzer | E4440A | US44303352 | 2009-05-31 |
| Sunol Sciences | Antenna | JB1 | A103105-3 | 2009-03-25 |
| A.R.A | Horn Antenna | DRG-118/A | 1132 | 2009-07-28 |
| A. H. Systems | Antenna, Horn, DRG | SAS-200/571 | 261 | 2009-07-01 |
| Ducommun | Pre-Amplifier | ALN-09173030-01 | 988251-03R | 2010-03-04 |
| HP | Pre-Amplifier | 8447D | 2944A06639 | 2010-03-06 |

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

## 9.4 Test Setup




## 9.5 Test Environmental Conditions

| | |
|---|---|
| **Temperature:** | 15~25 °C |
| **Relative Humidity:** | 20~32 % |
| **ATM Pressure:** | 100.9~101.1kPa |

** The testing was performed by Jack Liu on 2009-3-18 to 2009-4-6.*

## 9.6 Summary of Test Results

390~ 430 MHz Configuration 1 (With shielding on both side)
**-17.87 dB** at **3691.35 MHz** in the **Vertical** polarization

430~ 470 MHz Configuration 1 (With shielding on both side)
**-33.52 dB** at **1350.45 MHz** in the **Vertical** polarization

390~ 430 MHz Configuration 2 (Without shielding on top side)
**-17.2dB** at **3691.35 MHz** in the **Vertical** polarization

430~ 470 MHz Configuration 2 (Without shielding on top side)
**-20.22 dB** at **3289.65 MHz** in the **Vertical** polarization

## 9.7 Test Result

Test Mode: Transmitting mode

Note: Transmitter standby mode is not applicable to this device

**390~ 430 MHz Configuration 1 (With shielding on both side)**

Middle Channel (Channel spacing 12.5 kHz)

| Indicated | | Azimuth (degrees) | Test Antenna | | Substituted | | | | | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Frequency (MHz) | S.A. Amp. (dBuV) | | Height (cm) | Polar (H/V) | Frequency (MHz) | Level (dBm) | Ant. Cord. (dBi) | Cable Loss (dB) | Absolute Level (dBm) | | |
| 3691.35 | 54.78 | 267 | 124 | V | 3691.35 | -47.89 | 10.6 | 0.58 | -37.87 | -20 | -17.87 |
| 3281.2 | 53.12 | 266 | 157 | V | 3281.2 | -48.84 | 9.7 | 0.52 | -39.66 | -20 | -19.66 |

Middle Channel (Channel spacing 25 kHz)

| Indicated | | Azimuth (degrees) | Test Antenna | | Substituted | | | | | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Frequency (MHz) | S.A. Amp. (dBuV) | | Height (cm) | Polar (H/V) | Frequency (MHz) | Level (dBm) | Ant. Cord. (dBi) | Cable Loss (dB) | Absolute Level (dBm) | | |
| 3691.35 | 53.93 | 267 | 124 | V | 3691.35 | -48.74 | 10.6 | 0.58 | -38.72 | -13 | -25.72 |
| 3281.20 | 51.29 | 266 | 157 | V | 3281.20 | -50.67 | 9.7 | 0.52 | -41.49 | -13 | -28.49 |

**430~ 470MHz Configuration 1 (With shielding on both side)**

Middle Channel (Channel spacing 12.5 kHz)

| Indicated | | Azimuth (degrees) | Test Antenna | | Substituted | | | | | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Frequency (MHz) | S.A. Amp. (dBuV) | | Height (cm) | Polar (H/V) | Frequency (MHz) | Level (dBm) | Ant. Cord. (dBi) | Cable Loss (dB) | Absolute Level (dBm) | | |
| 1350.45 | 53.27 | 284 | 146 | V | 1350.45 | -61.2 | 8 | 0.32 | -53.52 | -20 | -33.52 |
| 1350.45 | 50.18 | 131 | 108 | H | 1350.45 | -64.05 | 8 | 0.32 | -56.37 | -20 | -36.37 |

Middle Channel (Channel spacing 25 kHz)

| Indicated | | Azimuth (degrees) | Test Antenna | | Substituted | | | | | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Frequency (MHz) | S.A. Amp. (dBuV) | | Height (cm) | Polar (H/V) | Frequency (MHz) | Level (dBm) | Ant. Cord. (dBi) | Cable Loss (dB) | Absolute Level (dBm) | | |
| 1350.45 | 51.28 | 284 | 146 | V | 1350.45 | -63.19 | 8 | 0.32 | -55.51 | -13 | -42.51 |
| 1350.45 | 48.55 | 131 | 108 | H | 1350.45 | -65.68 | 8 | 0.32 | -58.00 | -13 | -45.00 |

**390~ 430 MHz Configuration 2 (Without shielding on top side)**

Middle Channel (Channel spacing 12.5 kHz)

| Indicated | | Azimuth (degrees) | Test Antenna | | Substituted | | | | | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Frequency (MHz) | S.A. Amp. (dBuV) | | Height (cm) | Polar (H/V) | Frequency (MHz) | Level (dBm) | Ant. Cord. (dBi) | Cable Loss (dB) | Absolute Level (dBm) | | |
| 3691.35 | 55.45 | 267 | 124 | V | 3691.35 | -47.22 | 10.6 | 0.58 | -37.2 | -20 | -17.2 |
| 3691.35 | 51.22 | 237 | 100 | H | 3691.35 | -54.99 | 10.6 | 0.58 | -44.97 | -20 | -24.97 |

Middle Channel (Channel spacing 25 kHz)

| Indicated | | Azimuth (degrees) | Test Antenna | | Substituted | | | | | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Frequency (MHz) | S.A. Amp. (dBuV) | | Height (cm) | Polar (H/V) | Frequency (MHz) | Level (dBm) | Ant. Cord. (dBi) | Cable Loss (dB) | Absolute Level (dBm) | | |
| 3691.35 | 54.2 | 321 | 100 | V | 3691.35 | -48.47 | 10.6 | 0.58 | -38.45 | -13 | -25.45 |
| 3691.35 | 50.2 | 340 | 146 | H | 3691.35 | -56.01 | 10.6 | 0.58 | -45.99 | -13 | -32.99 |

**430~ 470 MHz Configuration 2 (Without shielding on top side)**

Middle Channel (Channel spacing 12.5 kHz)

| Indicated | | Azimuth (degrees) | Test Antenna | | Substituted | | | | | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Frequency (MHz) | S.A. Amp. (dBuV) | | Height (cm) | Polar (H/V) | Frequency (MHz) | Level (dBm) | Ant. Cord. (dBi) | Cable Loss (dB) | Absolute Level (dBm) | | |
| 3601.2 | 54.33 | 274 | 117 | V | 3601.2 | -49.85 | 10.2 | 0.57 | -40.22 | -20 | -20.22 |
| 3151.05 | 53.09 | 247 | 100 | V | 3151.05 | -51.09 | 9.3 | 0.51 | -42.3 | -20 | -22.3 |

Middle Channel (Channel spacing 25 kHz)

| Indicated | | Azimuth (degrees) | Test Antenna | | Substituted | | | | | Limit (dBm) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Frequency (MHz) | S.A. Amp. (dBuV) | | Height (cm) | Polar (H/V) | Frequency (MHz) | Level (dBm) | Ant. Cord. (dBi) | Cable Loss (dB) | Absolute Level (dBm) | | |
| 3601.20 | 53.17 | 274 | 117 | V | 3601.20 | -51.01 | 10.2 | 0.57 | -41.38 | -13 | -28.38 |
| 3151.05 | 52.75 | 247 | 100 | V | 3151.05 | -51.43 | 9.3 | 0.51 | -42.64 | -13 | -29.64 |

# §2.1055 & §90.213- Frequency Stability

## 10.1 Applicable Standard

§2.1055

§90.213 for output power < 2 watts, the limit is 5.0 ppm.

## 10.2 Test Procedure

Frequency Stability vs. Temperature: The equipment under test was connected to an external DC power supply and the RF output was connected to a frequency counter via feed-through attenuators. The EUT was placed inside the temperature chamber. The DC leads and RF output cable exited the chamber through an opening made for the purpose.

After the temperature stabilized for approximately 20 minutes, the frequency output was recorded from the counter.

Frequency Stability vs. Voltage: An external variable DC power supply was connected to the equipment under test. The voltage was set to 110% of the nominal value and was then decreased until the transmitter light no longer illuminated; i.e., the end point. The output frequency was recorded for each voltage.

## 10.3 Test Results

Please refer to Part 90 conducted test report provided by Pacific Crest (Report Number: ADLFFCC051309)

# 11 §90.214 – Transient Frequency Behavior

## 11.1 Standard Applicable

§90.214, Transmitters designed to operate in the 150–174 MHz and 421–512 MHz frequency bands must maintain transient frequencies within the maximum frequency difference limits.

## 11.2 Test Method

TIA/EIA-603 2.2.19

## 11.3 Test Result

Please refer to Part 90 conducted test report provided by Pacific Crest (Report Number: ADLFFCC051309)