



FCC PART 87

TEST AND MEASUREMENT REPORT For Mentor Radio, LLC

19601 Five Points Road,
Cleveland, OH 44135, USA

FCC ID: QQTM2115

Report Type: Original Report	Product type: Airport Ground Supporting Radio
Test Engineer: <u>Quinn Jiang</u> 	
Report Number: <u>R1111091-87</u>	
Report Date: <u>2012-01-16</u>	
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* This report may contain data that are not covered by the NVLAP accreditation and are marked with an asterisk “*” (Rev. 2)

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R1111091-87	Original Report	2012-01-16

1. General Information

1.1 Product Description for Equipment under Test (EUT)

The report has been prepared on behalf of *Mentor Radio, LLC* and their product FCC ID: QQTM2115, Model: M2115M, M2115B or the EUT as referred to in the rest of this report. The EUT is an airport ground support radio that operates in the 118-137 MHz band.

The EUT is an airport ground support radio that operates under FCC Part 87

Specifications	
Frequency Bands	118.025 - 136.975 MHz
Modulation Type	A3E
Emission Designator	6K00A3E
RF Output Power	10 Watts
Power Source	13 VDC

1.2 Mechanical Description

The EUTs measures approximately 18cm (L) x 19 cm (W) x 8.5 cm (H) and weighs approximately 1490.5g.

The test data gathered are from production sample, serial number: VI0077, assisgned by BACL.

1.3 Objective

This Type approval report is prepared on behalf of *Mentor Radio, LLC* in accordance with Part 87 of the Federal Communication Commissions rules.

The objective was to determine the RF output power, Occupied Bandwidth, Modulation Characteristics, Audio Frequency Response, Audio filter Response, Spurious Emissions, and Frequency Stability are in compliance with the FCC rules.

1.4 Related Submittal(s)/Grant(s)

None.

1.5 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 87 – Aviation Services

Applicable Standards: TIA603-C and ANSI 63.4-2003, American National Standard for Method of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz.

All emissions measurement was performed by Bay Area Compliance Laboratories Corp. The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

1.6 Measurement Uncertainty

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

Based on CISPR16-4-2: 2003, The Treatment of Uncertainty in EMC Measurements, the values ranging from ± 2.0 dB for Conducted Emissions tests and ± 4.0 dB for Radiated Emissions tests are the most accurate estimates pertaining to uncertainty of EMC measurements at BACL Corp.

1.7 Test Facility

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

The test site at BACL Corp. 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 have 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 test site also complies with the test methods and procedures set forth in CISPR 22:2008 §10.4 for measurements below 1 GHz and §10.6 for measurements above 1 GHz as well as ANSI C63.4-2003, ANSI C63.4-2009, TIA/EIA-603 & CISPR 24:2010.

The Federal Communications Commission and Voluntary Control Council for Interference have the reports on file and they are listed under FCC registration number: 90464 and VCCI Registration No.: R-3729, C-4176, G-469, and T-1206. The test site has been approved by the FCC and VCCI for public use and is listed in the FCC Public Access Link (PAL) database.

Additionally, BACL Corp. 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/Standards/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.

2.2 EUT Exercise Software

N/A

2.3 Equipment Modifications

No modifications were made to the EUT.

2.4 Local Support Equipment

N/A

2.5 Internal Configuration

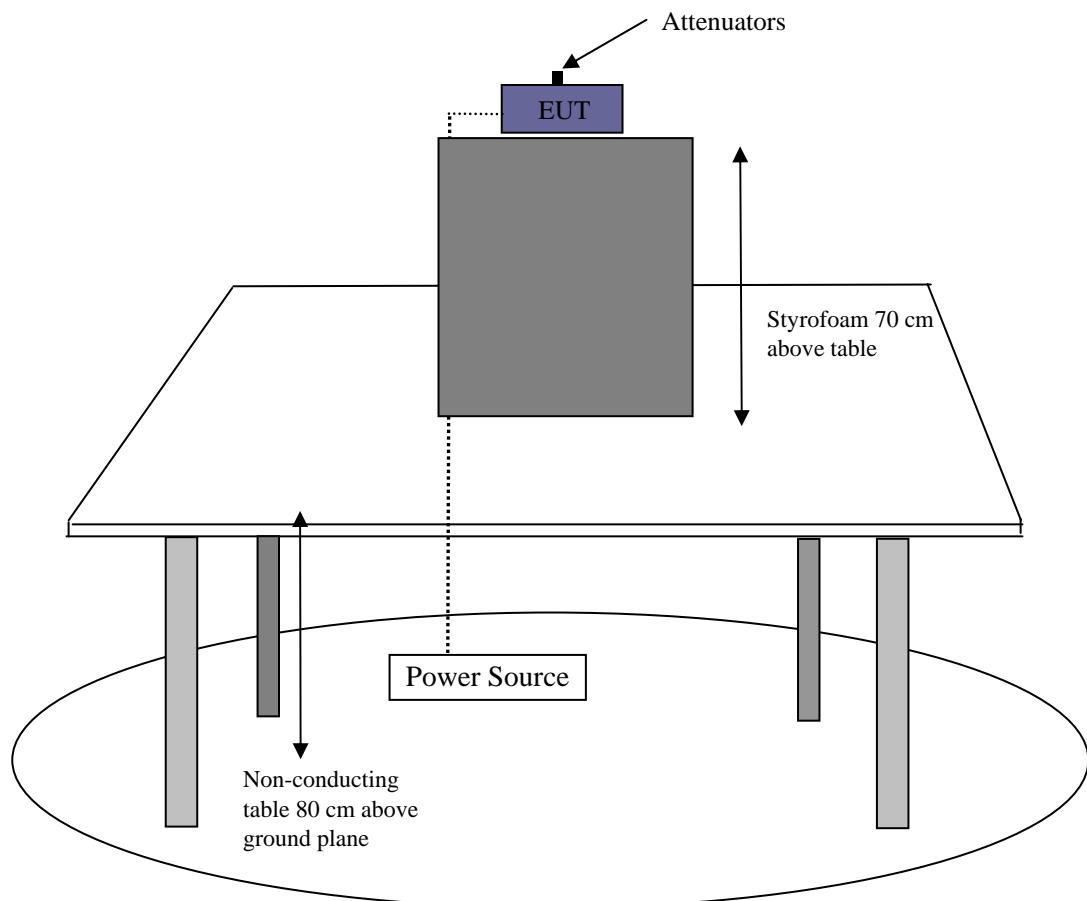
Manufacturer	Description	Model No.	Serial No.
Mentor Radio, LLC	RF Main PCB	MR-M2115-VHF Rev4-1	-
Mentor Radio, LLC	Digital PCB	-	-

2.6 Interface Ports and Cabling

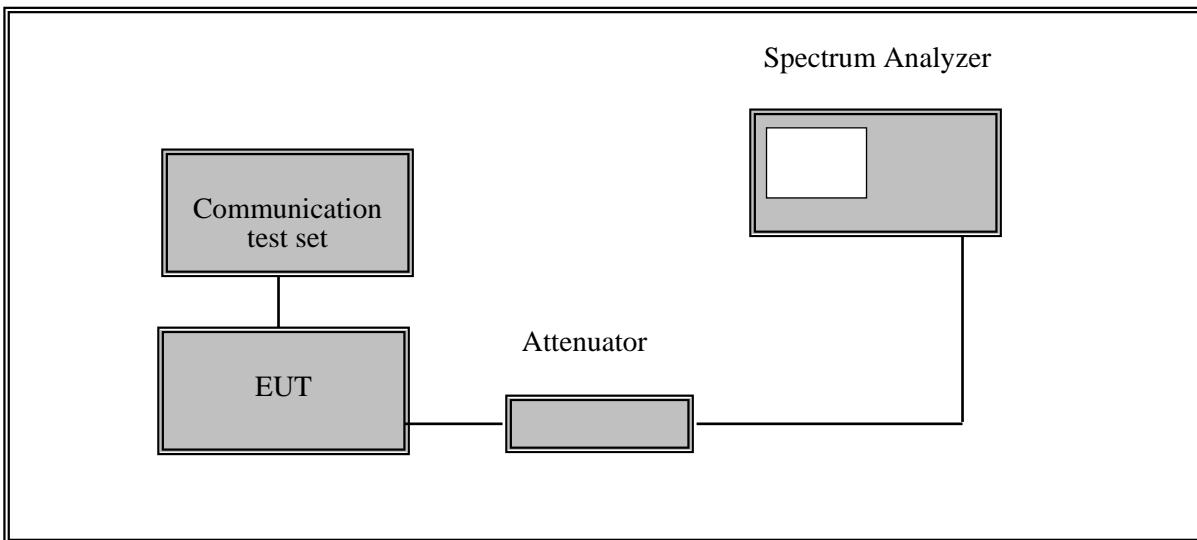
Cable Description	Length (m)	From	To
BNC	< 1	Communication test set	EUT
RF Cable	< 1	High Power Attenuator	EUT
RF Cable	< 1	High Power Attenuator	PSA

2.7 Test Setup Block Diagram

Radiated Test



Conducted Test



3 Summary of Test Results

FCC Rules	Description of Tests	Results
§1.1310, §2.1091	RF Exposure	Compliance
§2.1046, §87.131	RF Output Power	Compliance
§2.1047, §87.141	Modulation Characteristics	Compliance
§2.1049, §87.135	Occupied Bandwidth	Compliance
§2.1051, §87.139	Spurious Emissions at Antenna Terminals	Compliance
§2.1055, §87.133	Frequency Stability	Compliance
§2.1053, §87.139	Field Strength of Spurious Radiation	Compliance

4 FCC §2.1091 - RF Exposure

4.1 Applicable Standards

FCC §2.1091, (a) Requirements of this section are a consequence of Commission responsibilities under the National Environmental Policy Act to evaluate the environmental significance of its actions. See subpart I of part 1 of this chapter, in particular §1.1307(b).

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

Limits for Exposure

Frequency Range (MHz)	Electric Field Strength (V/m)	Magnetic Field Strength (A/m)	Power Density (mW/cm ²)	Averaging Time (minutes)
(A) Limits for Occupational/Controlled Exposures				
0.3-3.0	614	1.63	*(100)	6
3.0-30	1842/f	4.89/f	*(900/f ²)	6
30-300	61.4	0.163	1.0	6
300-1500	/	/	f/300	6
1500-100,00	/	/	1	6
(B) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	30
1.34-30	842/f	2.19/f	*(180/f ²)	30
30-300	27.5	0.073	0.2	30
300-1500	/	/	f/150	30
1500-100,000	/	/	1	30

f = frequency in MHz

* = Plane-wave equivalent power density

Note 1 to Table 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

Note 2 to Table 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

MPE Prediction

Predication of MPE limit at a given distance, Equation from 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

Maximum peak output power at antenna input terminal (dBm):	<u>39.90</u>
Maximum peak output power at antenna input terminal (mW):	<u>9772.372</u>
Prediction distance (cm):	<u>30</u>
Prediction frequency (MHz):	<u>127</u>
Maximum Antenna Gain, typical (dBi):	<u>0</u>
Maximum Antenna Gain (numeric):	<u>1.0</u>
Power density of prediction frequency at 30 cm (mW/cm ²):	<u>0.864067</u>
MPE limit for controlled exposure at prediction frequency (mW/cm ²):	<u>1.0</u>

Conclusion

The device complies with the MPE requirements by providing a safe separation distance of at least 30 cm between the antenna with unity gain, including any radiating structure, and any persons when normally operated.

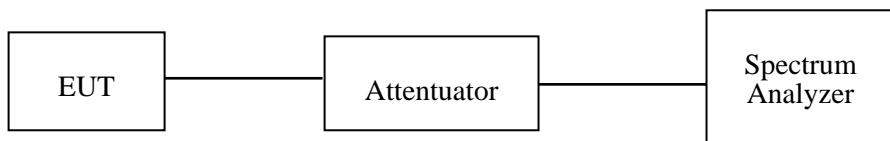
5 FCC §2.1046 & §87.131 – RF Output Power

5.1 Applicable Standard

According to FCC §2.1046 and §87.131, the Output power of Aviation support with A3E modulation is 50 Watts.

5.2 Test Procedure

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



5.3 Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date
Agilent	Spectrum Analyzer	E4440A	MY44303352	2011-05-10

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

5.4 Test Environmental Conditions

Temperature:	18-25 °C
Relative Humidity:	40-50 %
ATM Pressure:	101.2-102 kPa

The testing was performed by Quinn Jiang on 2011-11-30 to 2011-12-2 in the RF Site.

5.5 Test Results

Test Mode: Transmitting

Frequency (MHz)	Conducted Output Power (dBm)	Conducted Output Power (Watts)
118.025	39.56	9.04
127.000	39.90	9.77
136.975	39.67	9.27

6 FCC §2.1047 & §87.141 – Modulation Characteristic

6.1 Applicable Standard

FCC §2.1047:

- (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.

FCC §87.141:

- (a) When A3E emission is used, the modulation percentage must not exceed 100 percent. This requirement does not apply to emergency locator transmitters or survival craft transmitters.

6.2 Test Procedure

Test Method: TIA/EIA-603-C 2.2.3

6.3 Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date
Agilent	Spectrum Analyzer	E4440A	MY44303352	2011-05-10
HP	RF Communication test set	8920A	3438A05338	2010-05-18 ^{Note1}

Note 1: based on a two year calibration cycle

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

6.4 Test Environmental Conditions

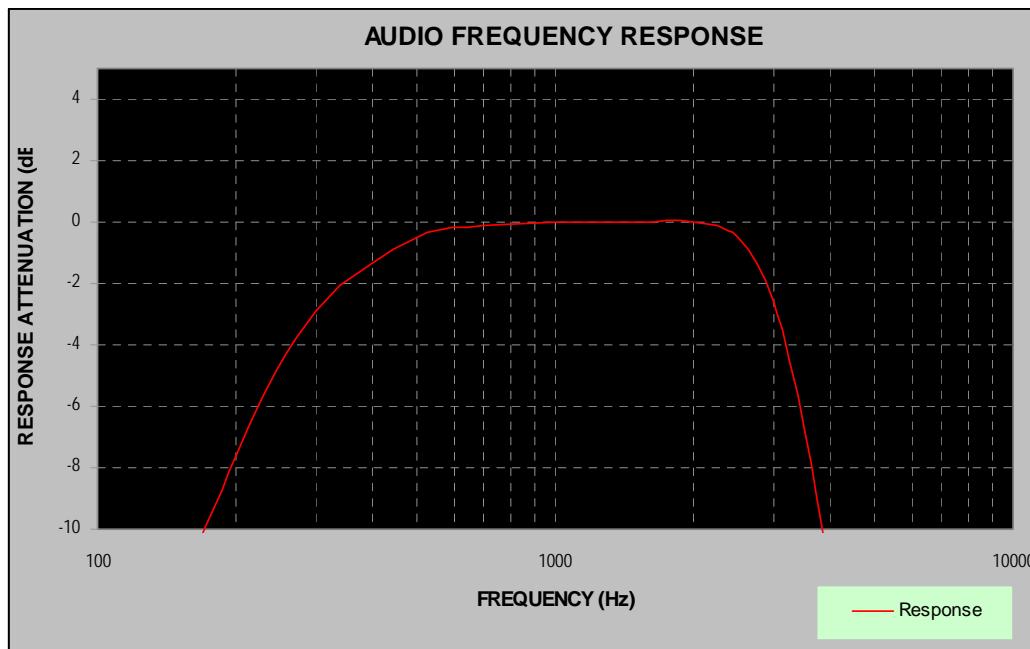
Temperature:	18-25 °C
Relative Humidity:	40-50 %
ATM Pressure:	101.2-102 kPa

The testing was performed by Quinn Jiang on 2011-11-30 to 2011-12-2 in the RF Site.

6.5 Test Results

Please refer to the plots hereinafter.

Audio Frequency Response



Audio Frequency (Hz)	Max Modulation Level (%)	Limit (%)
100	40	100
200	54	100
300	86	100
400	90	100
500	84	100
1000	78	100
2000	76	100
3000	68	100
4000	23	100
5000	1	100

7 FCC §2.1049, §87.135 & §87.137 – Occupied Bandwidth

7.1 Applicable Standard

FCC §87.137

A3E modulation with 6K00A3E emission designator: Authorized bandwidth is 25 kHz for transmitters approved after January 1, 1974 with 117.975-136 MHz operating band.

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 300 Hz and the spectrum was recorded in the frequency band \pm 250 kHz from the carrier frequency.

7.3 Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date
Agilent	Spectrum Analyzer	E4440A	MY44303352	2011-05-10
HP	RF Communication test set	8920A	3438A05338	2010-05-18 ^{Note1}

Note 1: based on a two year calibration cycle

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

7.4 Test Environmental Conditions

Temperature:	18-25 °C
Relative Humidity:	40-50 %
ATM Pressure:	101.2-102 kPa

The testing was performed by Quinn Jiang on 2011-11-30 to 2011-12-2 in the RF Site.

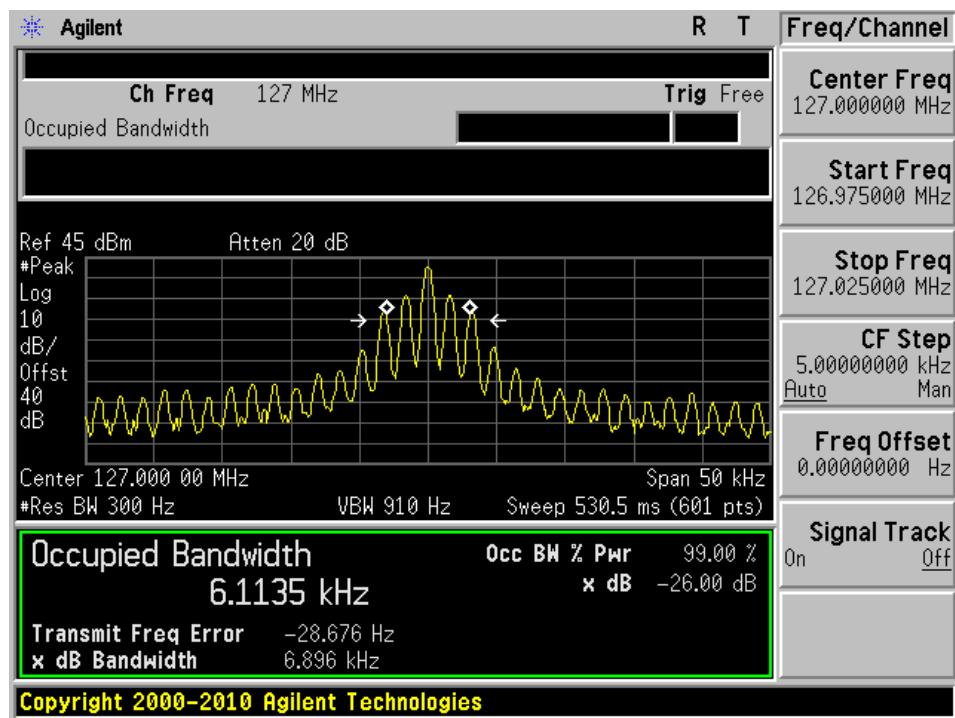
7.5 Test Results

Necessary BW Designator	Occupied Bandwidth (kHz)	Limit (kHz)
6K00	6.1135	6.0 < X < 25

Please refer to the plots hereinafter.

Occupied Bandwidth

Middle Channel – 127 MHz



8 FCC §2.1051 & §87.139 - Spurious Emissions at Antenna Terminals

8.1 Applicable Standard

FCC §87.139

Transmitters with an output power of 5 Watts or more must limit their emissions by at least $43 + 10 \log(P)$ dB on any frequency removed from the assigned frequency by more than 250% of the authorized bandwidth.

8.2 Test Procedure

The RF output of the transceiver was connected to a spectrum analyzer through appropriate attenuation. The resolution bandwidth of the spectrum analyzer was set at 10 kHz. Sufficient scans were taken to show any out of band emissions up to 10th harmonic.

8.3 Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date
Agilent	Spectrum Analyzer	E4440A	MY44303352	2011-05-10

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

8.4 Test Environmental Conditions

Temperature:	18-25 °C
Relative Humidity:	40-50 %
ATM Pressure:	101.2-102 kPa

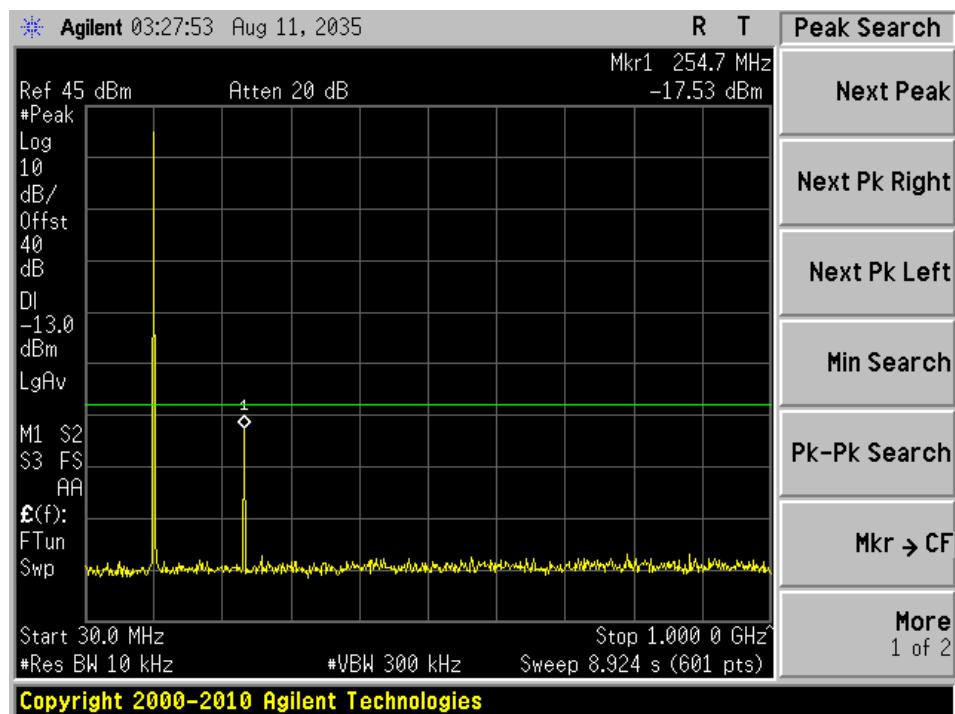
The testing was performed by Quinn Jiang on 2011-11-30 to 2011-12-2 in the RF Site.

8.5 Test Results

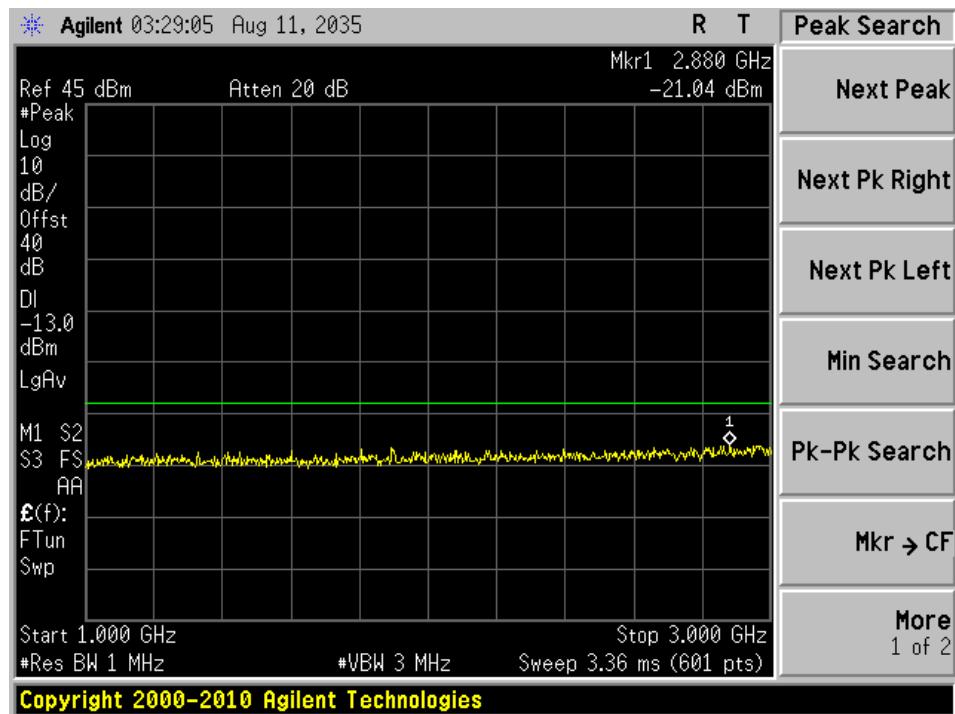
Please refer to the hereinafter plots.

Middle Channel – 127 MHz

30 MHz – 1 GHz



1 – 3 GHz



9 FCC §2.1055 & §87.133 - Frequency Stability

9.1 Applicable Standard

FCC §2.1055, §87.133

Stations that operates in the 108-137 MHz band: Frequency tolerance is 20 ppm

9.2 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 the Spectrum Analyzer 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 Spectrum Analyzer.

Frequency Stability vs. Voltage: An external variable DC power supply Source. The voltage was set to 115% and 85% of the nominal value. The output frequency was recorded for each voltage.

9.3 Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date
Agilent	Spectrum Analyzer	E4440A	MY44303352	2011-05-10
ESPEC	Oven, Temperature	ESL-4CA	18010	2011-01-28

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

9.4 Test Environmental Conditions

Temperature:	18-25 °C
Relative Humidity:	40-50 %
ATM Pressure:	101.2-102 kPa

The testing was performed by Quinn Jiang on 2011-11-30 to 2011-12-2 in the RF Site.

9.5 Test Results

Frequency vs. Temperature

Test Condition		Reference Frequency (MHz)	Measured Frequency (MHz)	Frequency Error (ppm)	Limit (ppm)
Voltage (Vdc)	Temperature (°C)				
13	50	127	127.000021	0.165354	20
13	40	127	126.999977	-0.1811	20
13	30	127	126.999984	-0.12598	20
13	20	127	126.999987	-0.10236	20
13	10	127	126.999998	-0.01575	20
13	0	127	126.999995	-0.03937	20
13	-10	127	126.999996	-0.0315	20
13	-20	127	126.999997	-0.02362	20
13	-30	127	126.999992	-0.06299	20

Frequency vs. Voltage

Test Condition		Reference Frequency (MHz)	Measured Frequency (MHz)	Frequency Error (ppm)	Limit (ppm)
Voltage (Vdc)	Temperature (°C)				
11.05	20	127	127.000019	0.149606	20
14.95	20	127	126.99999	-0.07874	20

10 FCC §2.1053 & §87.139 – Field Strength of Spurious Radiation

10.1 Applicable Standard

FCC §87.139

Transmitters with an output power of 5 Watts or more must limit their emissions by at least $43 + 10 \log(P)$ dB on any frequency removed from the assigned frequency by more than 250% of the authorized bandwidth.

10.2 Test Procedure

The transmitter was placed on a Styrofoam with wooden turntable, and it was normal transmitting with 50ohm termination 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 = $10 \lg(TXpwr \text{ in Watts}/0.001)$ – the absolute level
Spurious attenuation limit in dB = $43 + 10 \log_{10}(\text{power out in Watts})$

10.3 Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date
Agilent	Spectrum Analyzer	E4440A	MY44303352	2011-05-10
Sunol Science Corp	System Controller	SC99V	122303-1	N/R
Sunol Science Corp	Combination Antenna	JB3	A020106-2	2011-08-10
Sunol Sciences	Horn antenna	DRH-118	A052704	2011-02-23
Hewlett Packard	Pre amplifier	8447D	2944A06639	2011-06-09
Mini-Circuits	Pre Amplifier	ZVA-183-S	570400946	2011-05-09
Hewlett Packard	Generator, Signal	83650B	3614A00276	2010-06-21 ^{Note 1}

Note 1: based on a two year calibration cycle

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

10.4 Test Environmental Conditions

Temperature:	20 °C
Relative Humidity:	46 %
ATM Pressure:	101.1 kPa

The testing was performed by Quinn Jiang on 2011-12-12 in 5 meter chamber -3.

10.5 Test Results

Middle Channel – 127 MHz

Indicated		Turntable Azimuth Degrees	Test Antenna		Substituted					Limit (dBm)	Margin (dB)
Freq. (MHz)	Amp. (dBuV)		Height (m)	Polar (H/V)	Freq. (MHz)	Level (dBm)	Antenna Cord. (dBi)	Cable Loss (dB)	Absolute Level (dBm)		
-	-	-	-	-	-	-	-	-	-	-	Note ¹

Note¹: All emission levels are at the noise floor and/or more than 20 dB below the limit.