

FCC PART 80 & 90 TYPE APPROVAL EMI MEASUREMENT AND TEST REPORT

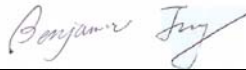
For

MIDLAND RADIO CORPORATION

1120 Clay Street
North Kansas City, MO 64116

FCC ID: MASP200V2

2003-11-14

This Report Concerns: ☒ Original Report	Equipment Type: Portable Radio
Test Engineer: Ming Jing / 	
Report No.: R0309222	
Test Date: 2003-10-02	
Reviewed By: Ling Zhang / 	
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GENERAL INFORMATION

Product Description for Equipment Under Test (EUT)

The *Midland Radio Corporation's* Model: *SP-220-240* or the "EUT" as referred to in this report is a portable radio which is measured approximately 9.8"L x 2.5"W x 2.0"H.

The EUT operates at 146-174 MHz with maximum power of 37.33 dBm (5.4W).

**The test data gathered are from production sample, serial number B003, provided by the manufacturer.*

Objective

This type approval report is prepared on behalf of *Midland Radio Corporation* in accordance with Part 2, Subpart J, Part 80, & Part 90 of the Federal Communication Commissions rules.

The objective of the manufacturer is to demonstrate compliance with FCC rules for output power, modulation characteristic, occupied bandwidth, spurious emission at antenna terminal, band edge, conducted and radiated margin.

Related Submittal(s)/Grant(s)

No Related Submittals

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 80 – Stations In the Maritime Service

Part 90 – Private Land Mobile Radio Service

Applicable Standards: TIA EIA 137-A, TIA EIA 98-C, TIA/EIA-603, ANSI 63.4-2001, 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.

Test Facility

The Open Area Test site used by Bay Area Compliance Laboratory Corporation to collect radiated and conducted emission measurement data is located in the back parking lot of the building at 230 Commercial Street, Sunnyvale, California, USA.

Test site at Bay Area Compliance Laboratory Corporation 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 C63.4-2001.

The Federal Communications Commission and Voluntary Control Council for Interference has the reports on file and is listed under FCC file 31040/SIT 1300F2 and VCCI Registration No.: C-1298 and R-1234. 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, Bay Area Compliance Laboratory Corporation is a National Institute of Standards and Technology (NIST) accredited laboratory, under the National Voluntary Laboratory Accredited Program (NVLAP). The scope of the accreditation covers the FCC Method - 47 CFR Part 15 - Digital Devices, IEC/CISPR 22: 1998, and AS/NZS 3548: Electromagnetic Interference - Limits and Methods of Measurement of Information Technology Equipment test methods under NVLAP Lab Code 200167.

SYSTEM TEST CONFIGURATION

Justification

The EUT was configured for testing according to ANSI C63.4-2001.

The final qualification test was performed with the EUT operating at normal mode.

Block Diagram

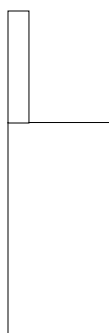
Please refer to Exhibit D.

Equipment Modifications

No modifications to the EUT.

Test Setup Block Diagram

The EUT is a standalone device.



EUT

SUMMARY OF TEST RESULTS

FCC RULE	DESCRIPTION OF TEST	RESULT
§ 2.1046, § 80.215 § 90.205	RF Power Output	Compliant
§ 2.1047 § 80.213 § 90.205	Modulation Characteristics	Compliant
§ 2.1049 § 80.211 § 90.210	Emission, Occupied Bandwidth	Compliant
§ 2.1051 § 80.211 § 90.210	Spurious Emissions at Antenna Terminals	Compliant
§ 2.1053 § 80.211 § 90.210	Field Strength of Spurious Radiation	Compliant
§ 2.1055(a) § 2.1055(d)(2) § 80.209 § 90.213	Frequency Stability vs. Temperature Frequency Stability vs. Voltage	Compliant
§ 90.214	Transient Frequency Behavior	Compliant

§2.1046, §80.215, & §90.205 - RF POWER OUTPUT

Applicable Standard

§2.1046

§80.215: <50Watts

§90.205: Power dependent upon station's antenna HAAT and required service area and may be from 1 to 500 watts.

Test Procedure

The RF output of the EUT was connected to a spectrum analyzer through appropriate attenuator.

Test Equipment

Manufacturer	Description	Model	Serial Number	Cal. Due Date
Hewlett Packard	Spectrum Analyzer	HP8565C	06042	2004-05-03
Hewlett Packard	Plotter	HP7470A	N/A	N/A

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

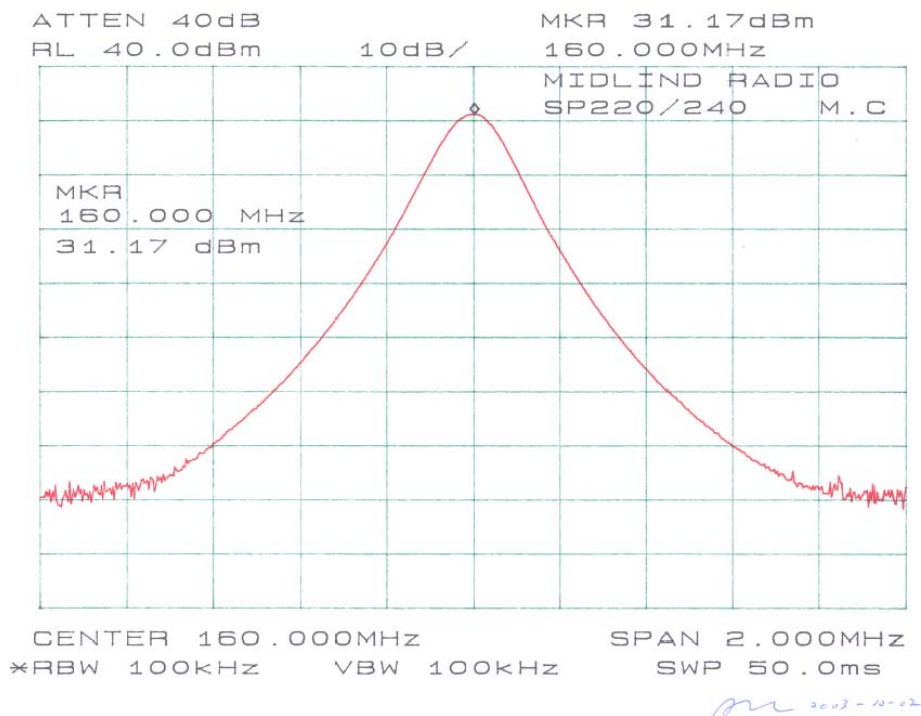
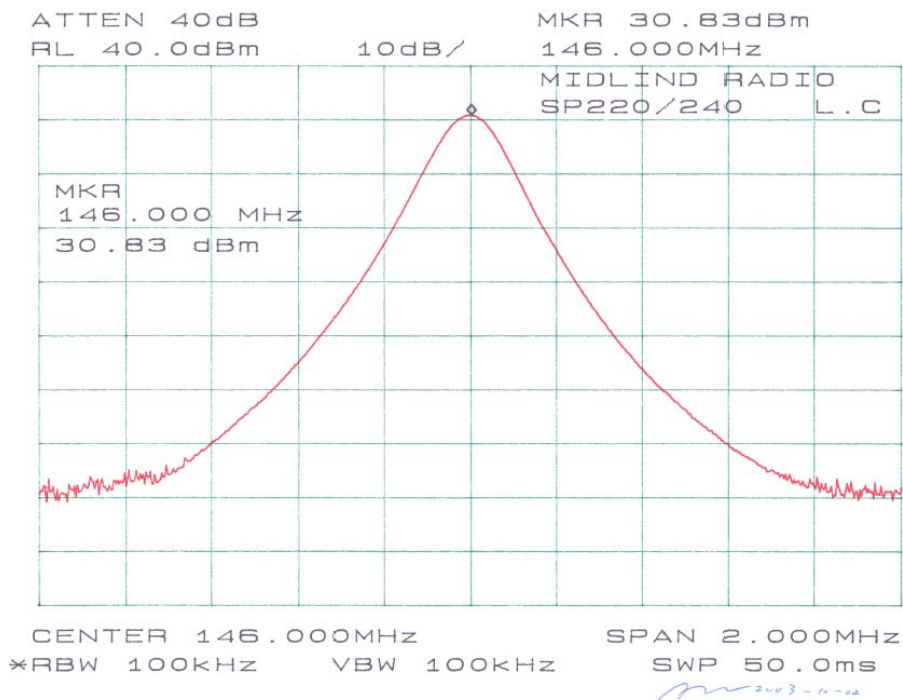
Environmental Conditions

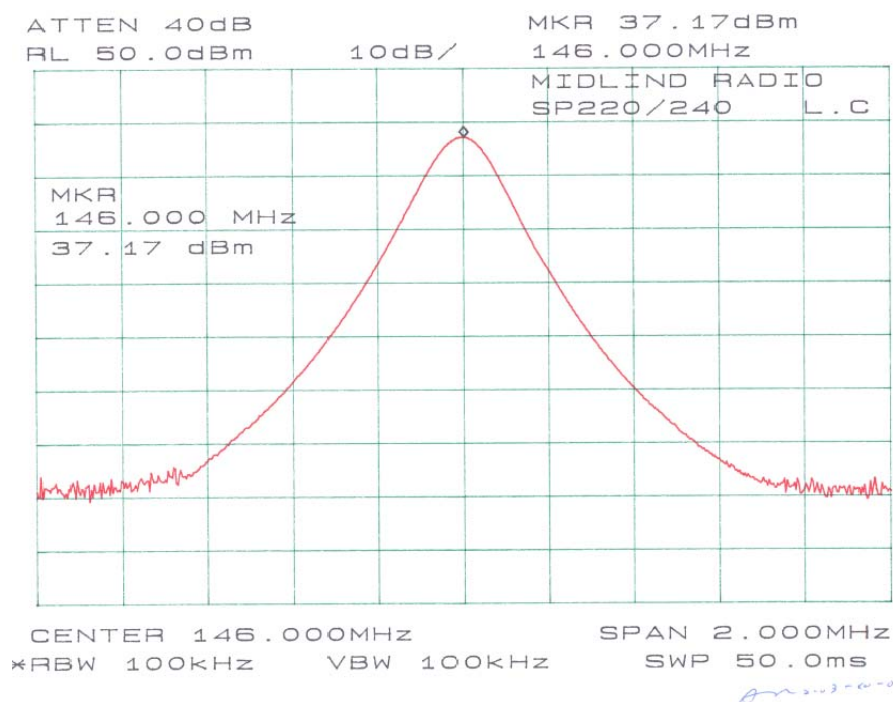
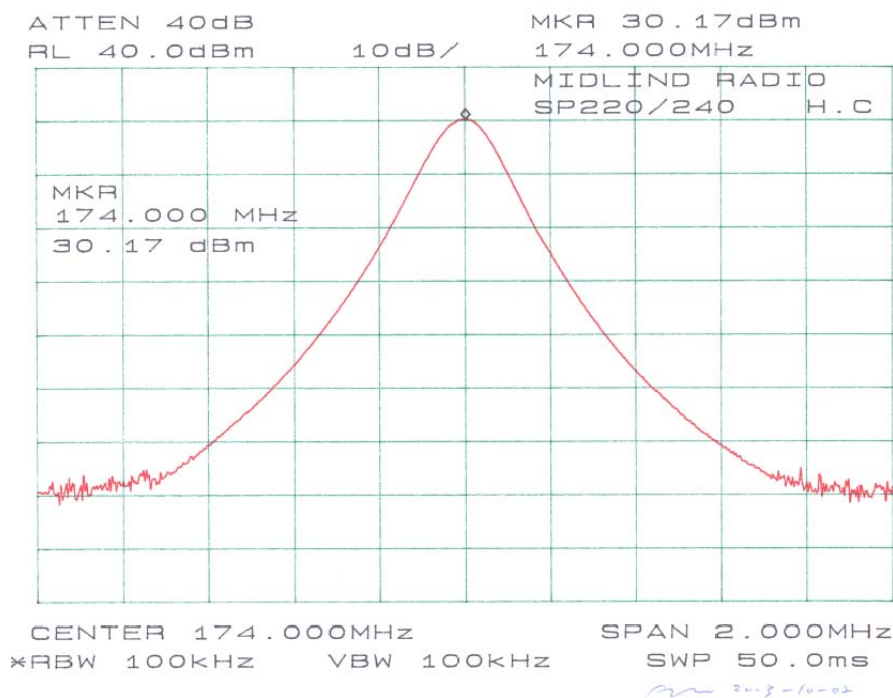
Temperature:	25°C
Relative Humidity:	52%
ATM Pressure:	1100mbar

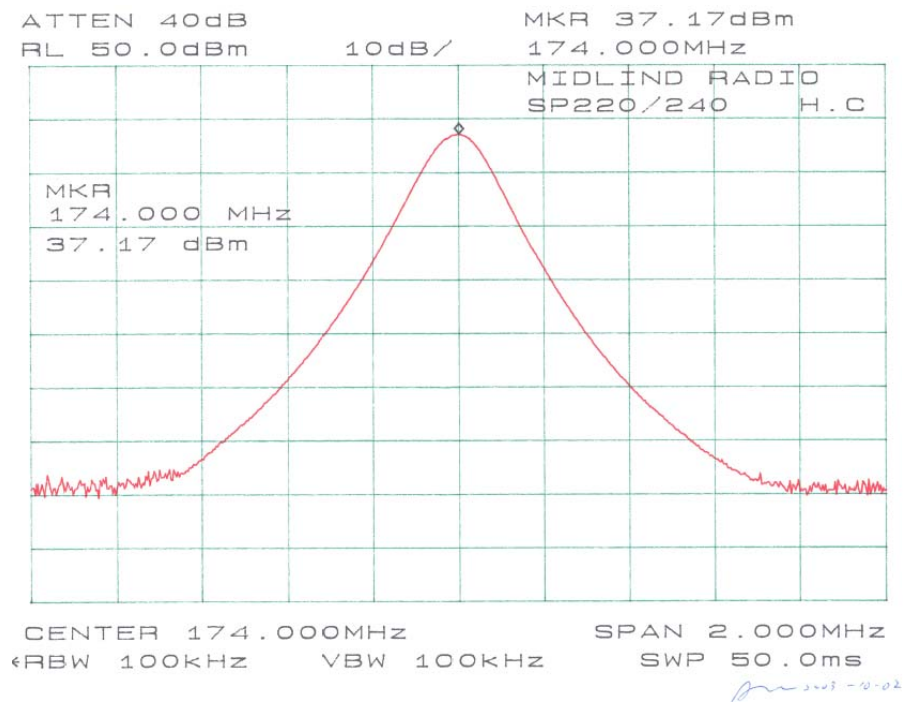
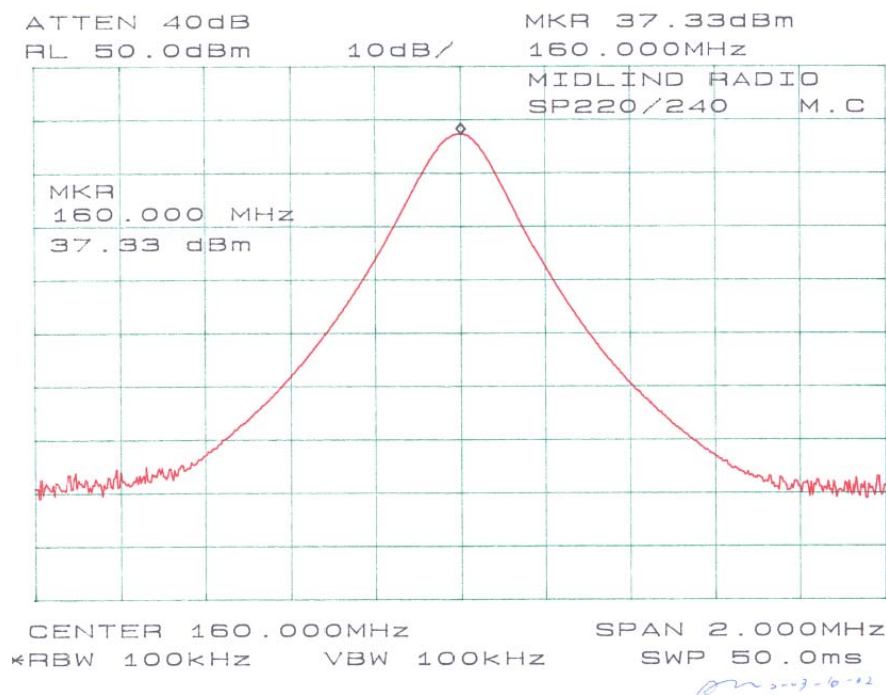
Test Results

Power Level	Channel	Frequency in MHz	Output Power in dBm	Output Power in W
Low Power	Low	146.00	30.83	1.211
	Middle	160.00	31.17	1.309
	High	174.00	30.17	1.040
High Power	Low	146.00	37.17	5.212
	Middle	160.00	37.33	5.408
	High	174.00	37.17	5.212

Note: The power output may depend on the intended use of the EUT. For all tests, the EUT was set to maximum conditions.







§2.1047, §80.213, & §90.205 - MODULATION CHARACTERISTIC

Applicable Standard

§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 5000Hz. 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.

§80.213:

- (a) When phase of frequency modulation is used in the 156-162MHz and 216-220MHz bands, the peak modulation must be maintained between 75 and 100 percent. A frequency deviation of ± 5 kHz is defined as 100 percent peak modulation.
- (b) Transmitters using F3E emission must have a modulation limiter to prevent any modulation over 100 percent.
- (d) Ship and coast station transmitters operating in the 156-162MHz and 216-220MHz bands must be capable of proper operation with a frequency deviation of ± 5 kHz.
- (e) Coast station transmitters operated in the 156-162MHz band must be equipped with an audio low-pass filter. The filter must be installed between the modulation limiter and the modulated radio frequency stage. At frequencies between 3 kHz and 20 kHz it must have an attenuation greater than at 1kHz by at least $60\log(f/3)$ dB. At frequencies above 20kHz the attenuation must at least 50 dB greater than at 1kHz.

§90.205

Transmitters utilizing analog emissions that are equipped with an audio low-pass filter must meet the emission limitations and must meet proper emissions mask of 90.210.

Test Procedure

Test Method: TIA/EIA-603 2.2.3

Test Equipment

Manufacturer	Description	Model No.	Serial No.	Calibration Due Date
Hewlett Packard	Spectrum Analyzer	HP8565EC	06042	2004-03-03
Hewlett Packard	Modulation Analyzer	8901A	2026A00847	2004-08-09

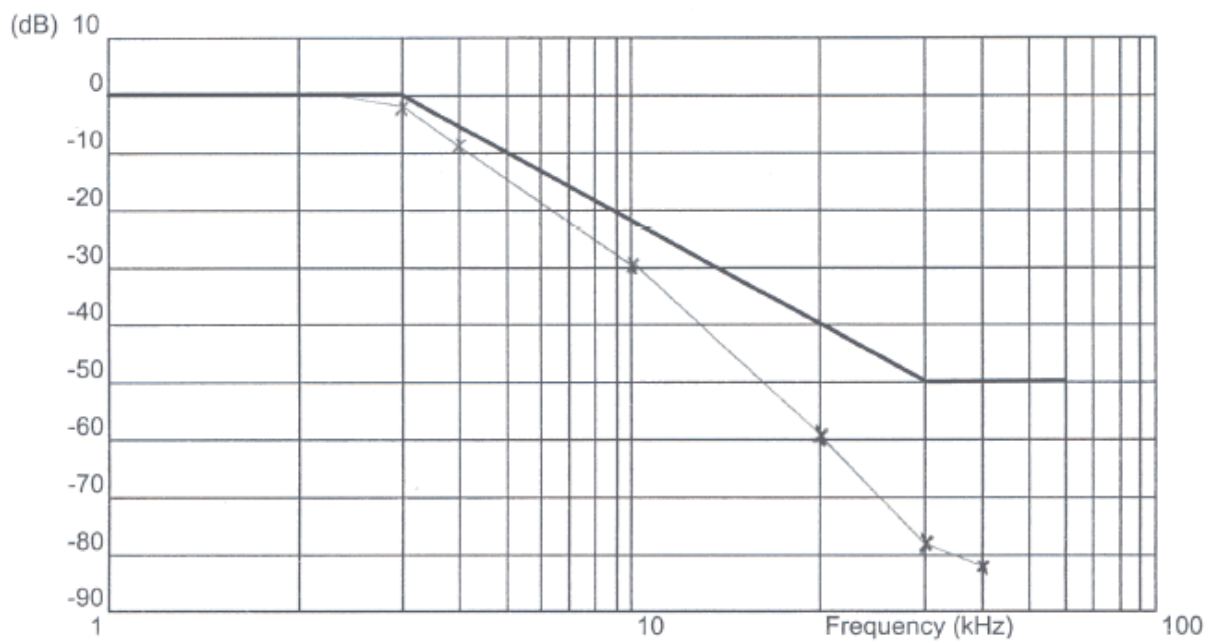
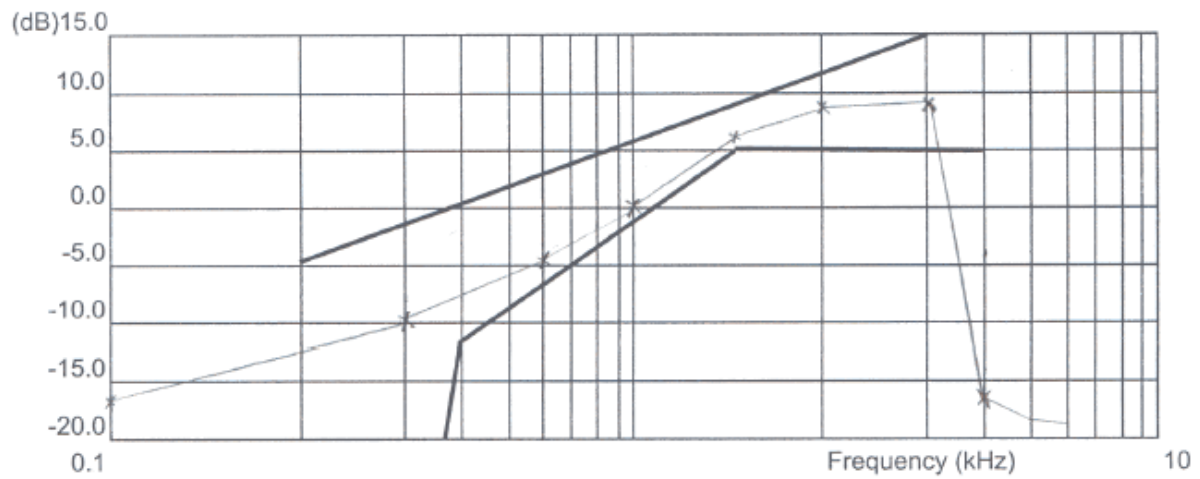
* **Statement of Traceability: BACL Corp.** certifies that all calibrations have been performed in accordance to NVLAP requirements, traceable to the NIST.

Environmental Conditions

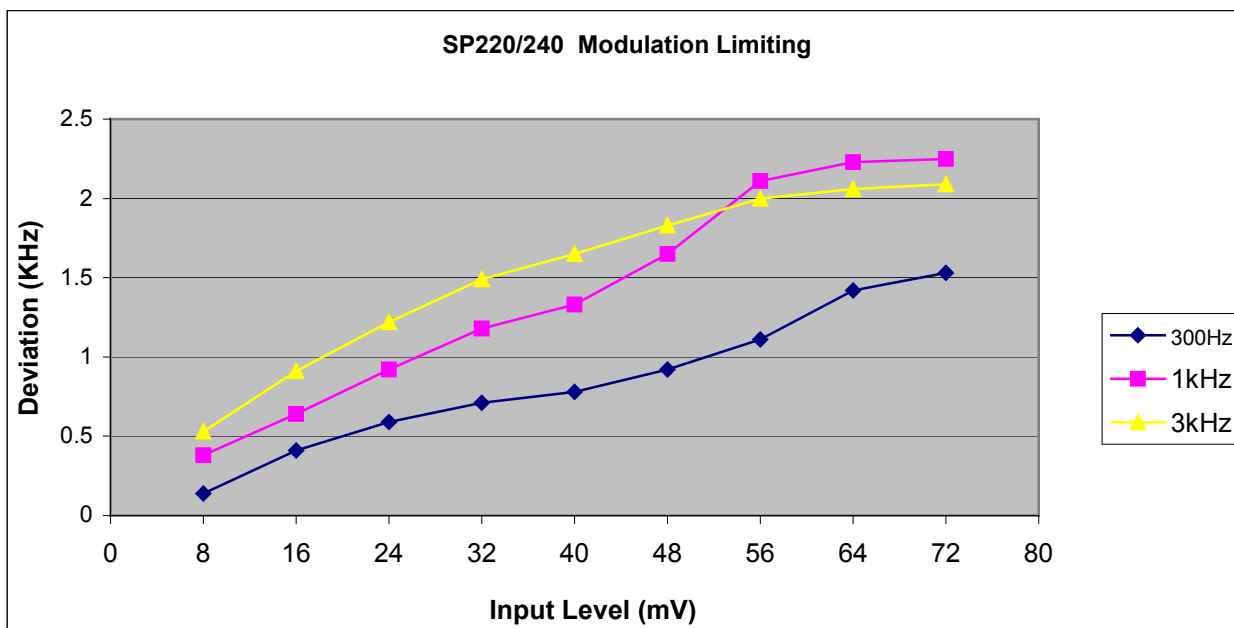
Temperature:	25°C
Relative Humidity:	52%
ATM Pressure:	1100 mbar

Test Results

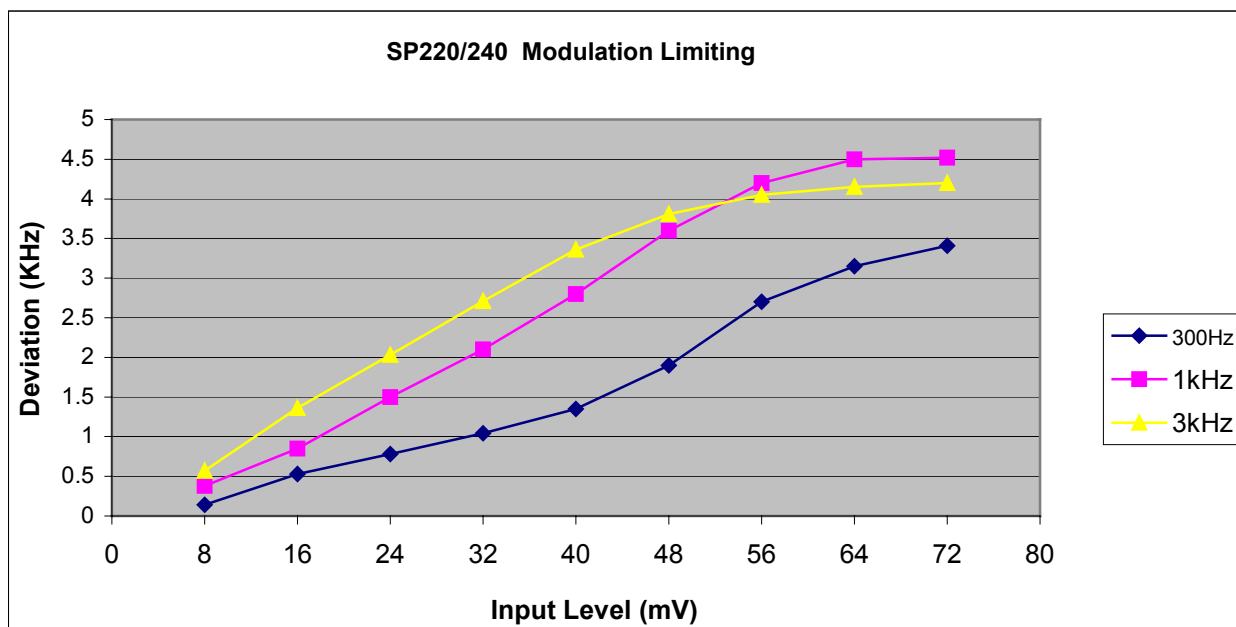
Please refer to the hereinafter plots.



Modulation for 12.5 kHz Channel Spacing



Modulation for 25kHz Channel Spacing



§2.1049, §80.211, & §90.210 - OCCUPIED BANDWIDTH

Applicable Standard

§2.1049, §80.211 and §90.210 (25kHz bandwidth only):

For any frequency removed from the center of the assigned channel by more than 50 percent up to and including 100 percent of the authorized bandwidth, at least 25 dB.

On any frequency removed from the center of the assigned channel by more than 100 percent up to and including 250 percent, at least 35 dB.

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

Low: $43+10\log P=43+10\log(4.4)=49.4\text{dB}$

Middle: $43+10\log P=43+10\log(4.1)=49.1\text{dB}$

High: $43+10\log P=43+10\log(3.9)=48.9\text{dB}$

The resolution bandwidth was 300Hz or greater for measuring up to 250kHz from the edge of the authorized frequency segment, and 30kHz or greater for measuring more than 250kHz from the authorized frequency segment.

§90.210 (12.5kHz bandwidth only)

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 ($f_d - 2.88\text{kHz}$) 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:

Low: $50+10\log P=50+10\log(4.4)=56.4\text{dB}$

Middle: $50+10\log P=50+10\log(4.1)=56.1\text{dB}$

High: $50+10\log P=50+10\log(3.9)=55.9\text{dB}$

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 KHz and the spectrum was recorded in the frequency band ± 50 KHz from the carrier frequency.

Test Equipment

Manufacturer	Description	Model No.	Serial No.	Calibration Due Date
Hewlett Packard	Spectrum Analyzer	HP8565EC	06042	2004-05-03
Hewlett Packard	Plotter	HP7470A	N/A	N/A
NAAYAN	Audio Generator	NY2201	00042	N/A

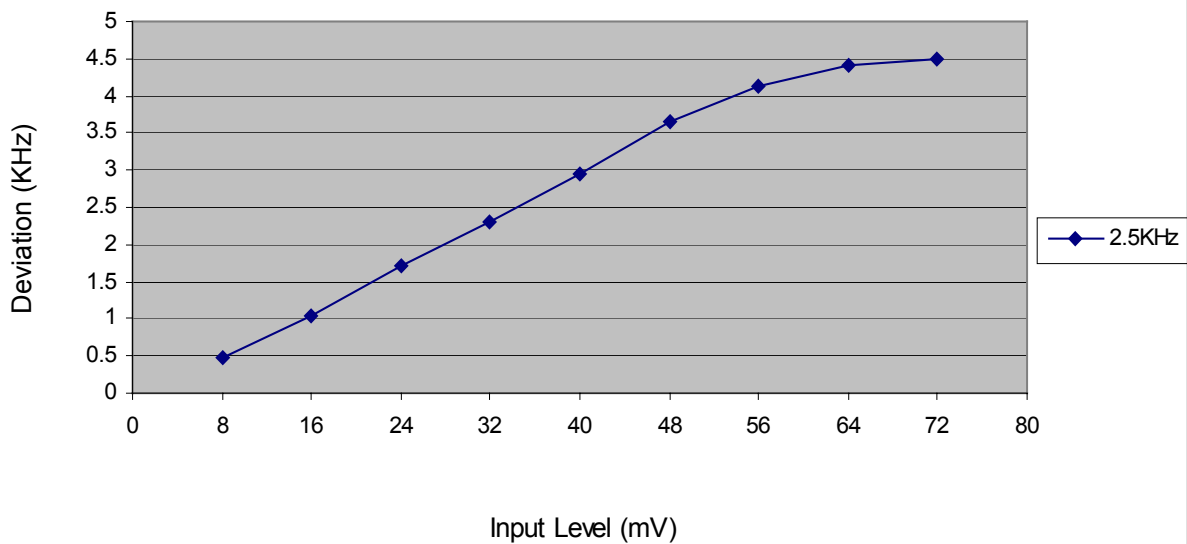
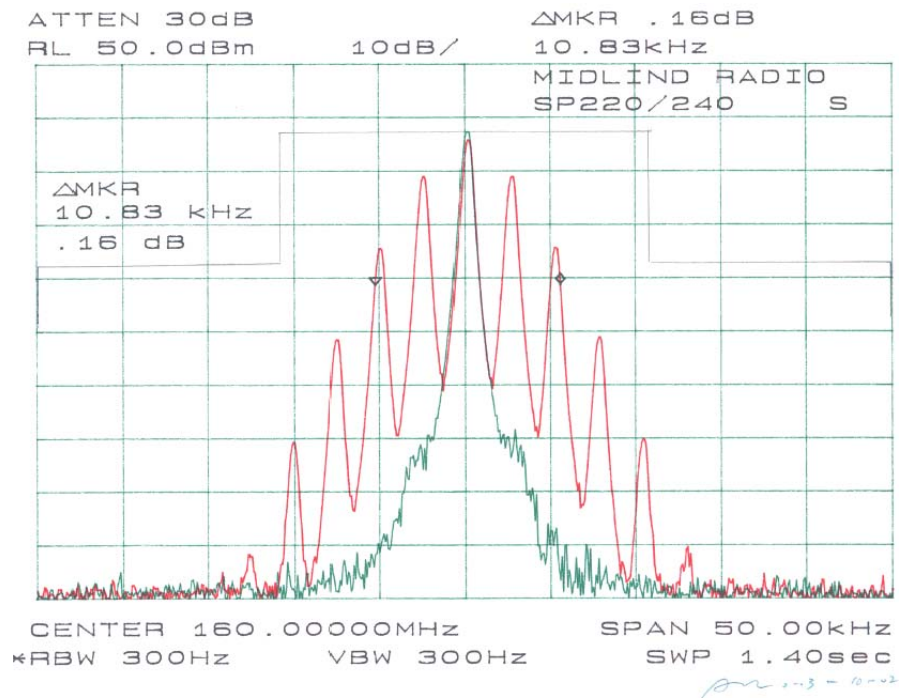
* **Statement of Traceability:** **BACL Corp.** certifies that all calibrations have been performed in accordance to NVLAP requirements, traceable to the NIST.

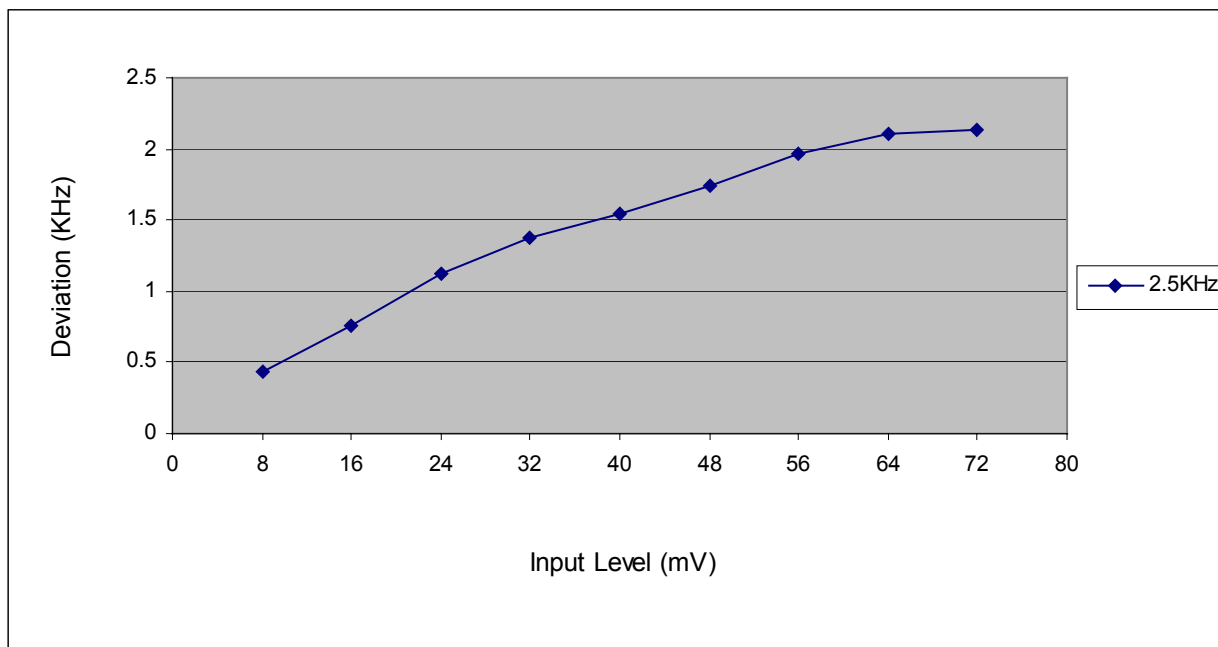
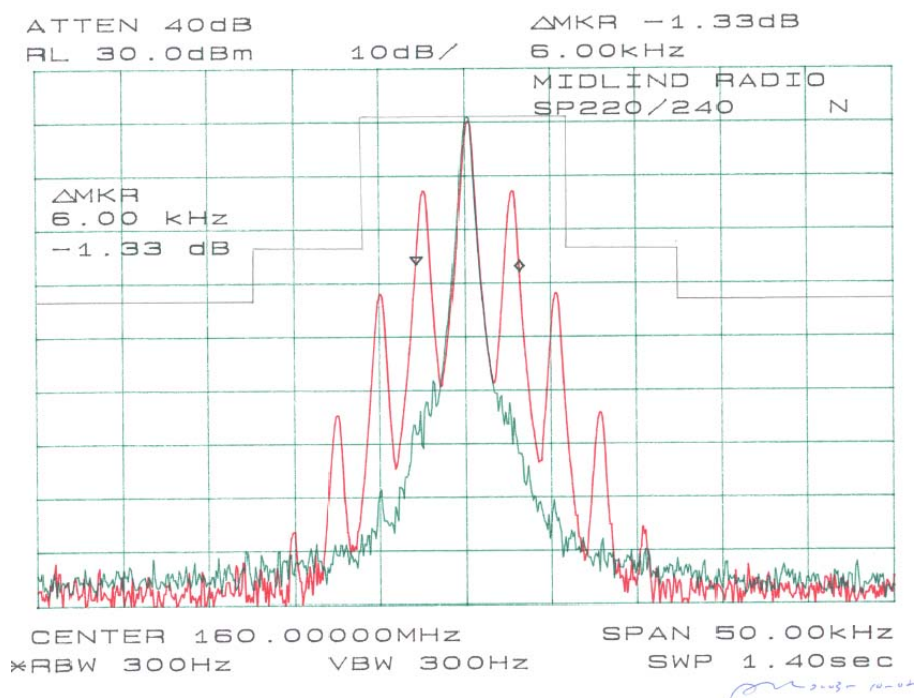
Environmental Conditions

Temperature:	25°C
Relative Humidity:	52%
ATM Pressure:	1100 mbar

Test Results

Please refer to the hereinafter plots.





§2.1051, §80.211, & §90.210 - SPURIOUS EMISSIONS AT ANTENNA TERMINALS

Standard Applicable

§2.1051, §80.211, and §90.210.

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

Low: $43+10\log P=43+10\log(4.4)=49.4\text{dB}$

Middle: $43+10\log P=43+10\log(4.1)=49.1\text{dB}$

High: $43+10\log P=43+10\log(3.9)=48.9\text{dB}$

§90.210 (12.5kHz bandwidth only)

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:

Low: $50+10\log P=50+10\log(4.4)=49.4\text{dB}$

Middle: $50+10\log P=50+10\log(4.1)=49.1\text{dB}$

High: $50+10\log P=50+10\log(3.9)=48.9\text{dB}$

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 100 kHz. Sufficient scans were taken to show any out of band emissions up to 10th harmonic.

Test Equipment

Manufacturer	Description	Model No.	Serial No.	Calibration Due Date
Hewlett Packard	Spectrum Analyzer	HP8565EC	06042	2004-05-03

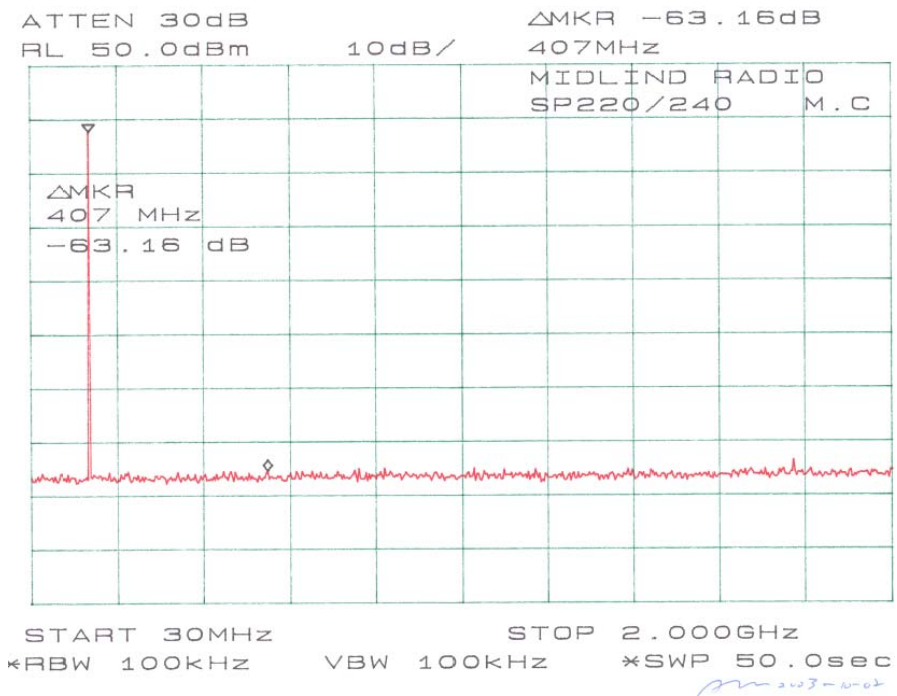
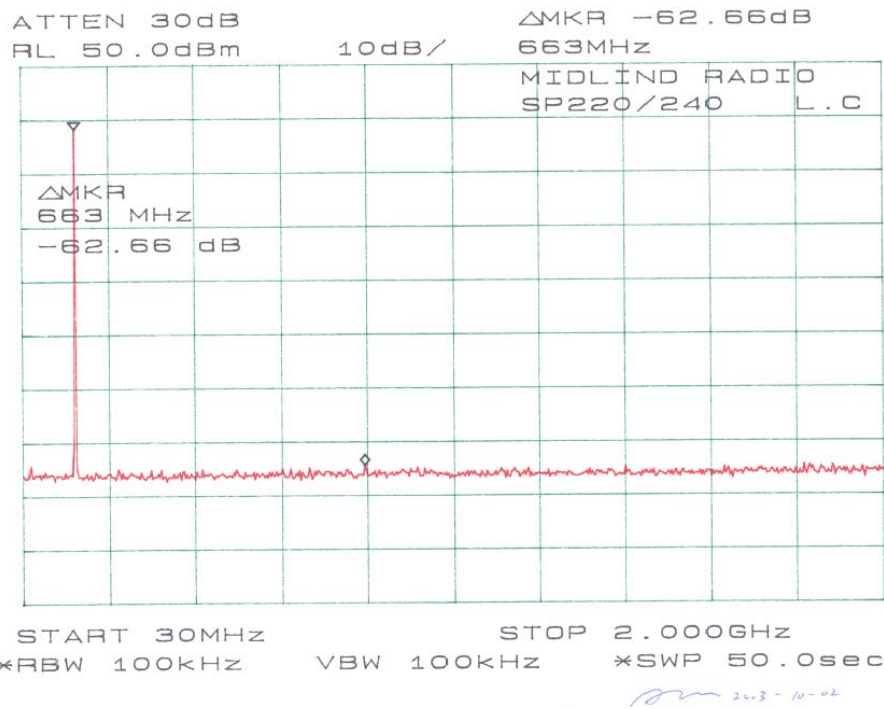
* **Statement of Traceability:** **BACL Corp.** certifies that all calibrations have been performed in accordance to NVLAP requirements, traceable to the NIST.

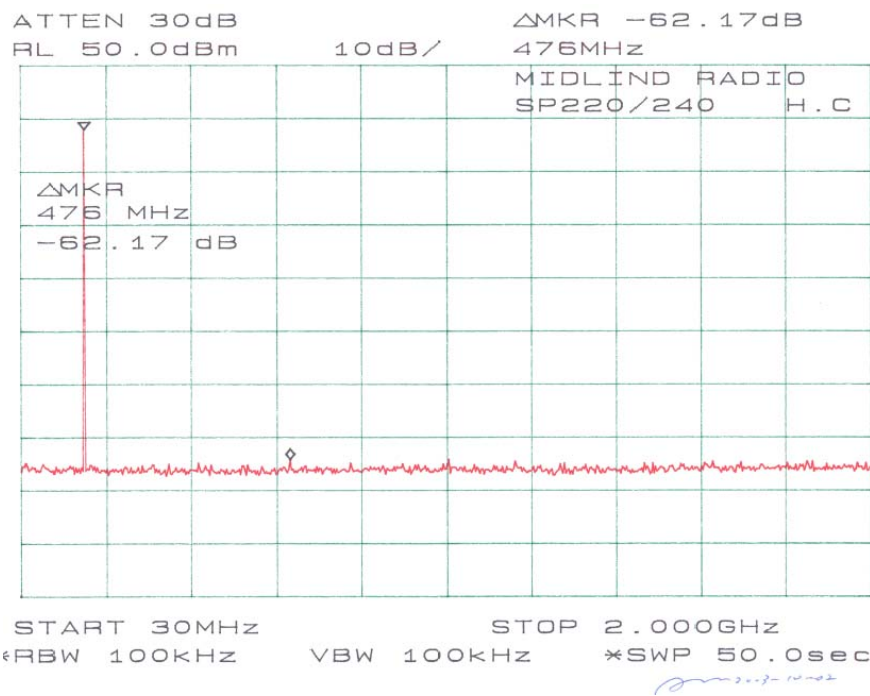
Environmental Conditions

Temperature:	25°C
Relative Humidity:	52%
ATM Pressure:	1100 mbar

Test Results

Please refer to the hereinafter plots.





§2.1053, §80.211, & §90.210 - RADIATED SPURIOUS EMISSION

Standard Applicable

§2.1053, §80.211, and §90.210.

Test Procedure

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 = $10 \lg (\text{TXpwr in Watts}/0.001)$ – the absolute level

Spurious attenuation limit in dB = $43 + 10 \text{Log}_{10} (\text{power out in Watts})$

Test Equipment

Manufacturer	Description	Model	Serial Number	Cal. Due Date
Com-Power	Biconical Antennas	CDI B100/200/300	14012	2004-05-01
Com-Power	Bi-logcon Antenna	3110B	9603-2315	2004-10-11
A.H. System	Horn Antenna	SAS-200	2455	2004-08-02
Hewlett Packard	Spectrum Analyzer	HP8565EC	06042	2004-05-03
Rohde & Schwarz	Generator	SMIQ03	1048004	2004-08-01

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

Environmental Conditions

Temperature:	25° C
Relative Humidity:	52%
ATM Pressure:	1100 mbar

Test Result

Low Frequency: -31.1dB at 438.00 MHz
Mid Frequency: -30.9 dB at 480.00 MHz
High Frequency: -31.5 dB at 522.00 MHz

Test Data for High Power

EUT					Generator						Standard	
Indicated		Table	Test Antenna		Substitution			Antenna	Cable	Absolute	FCC	FCC
Frequency MHz	Ampl. dBuV/m	Angle Degree	Height Meter	Polar H/V	Frequency MHz	Level dBm	Polar H/V	Gain Corrected	Loss dBm	Level dB	Limit dBm	Margin DBm
Low Channel												
146	101.3	90	1.8	V	146	30.5	V	0	0.1	30.4		
146	91.8	180	2.2	H	146	23.7	H	0	0.1	23.6		
438	38.5	290	1.8	H	438	-43.8	H	0	0.3	-44.1	-13	-31.1
292	36.1	180	1.5	H	292	-45.9	H	0	0.1	-46.0	-13	-33.0
438	35.3	230	1.6	V	438	-46.5	V	0	0.3	-46.8	-13	-33.8
292	34.2	110	1.5	V	292	-47.3	V	0	0.1	-47.4	-13	-34.4
584	28.4	270	1.8	H	584	-51.9	H	0	0.3	-52.2	-13	-39.2
584	26.1	330	1.8	V	584	-54.1	V	0	0.3	-54.4	-13	-41.4
MIDDLE CHANNEL												
160	109.2	270	1.5	V	160	34.7	V	0	0.1	34.6		
160	108.7	310	1.5	H	160	32.6	H	0	0.1	32.5		
480	38.7	270	2.2	H	480	-43.6	H	0	0.3	-43.9	-13	-30.9
320	36.4	150	2.2	H	320	-45.8	H	0	0.1	-45.9	-13	-32.9
480	35.6	210	1.8	V	480	-46.3	V	0	0.3	-46.6	-13	-33.6
320	34.5	330	2	V	320	-47.2	V	0	0.1	-47.3	-13	-34.3
640	28.6	90	2.2	H	640	-51.6	H	0	0.3	-51.9	-13	-38.9
640	26.2	330	1.8	V	640	-53.9	V	0	0.3	-54.2	-13	-41.2
HIGH CHANNEL												
174	100.8	180	1.6	V	174	29.3	V	0	0.1	29.2		
174	91.5	110	1.6	H	174	23.4	H	0	0.1	23.3		
522	38.2	150	2.2	H	522	-44.2	H	0	0.3	-44.5	-13	-31.5
348	35.8	90	2.5	H	348	-46.1	H	0	0.1	-46.2	-13	-33.2
522	35.1	100	2.2	V	522	-46.9	V	0	0.3	-47.2	-13	-34.2
348	33.9	330	2.5	V	348	-47.6	V	0	0.1	-47.7	-13	-34.7
696	28.3	150	2.2	H	696	-51.9	H	0	0.3	-52.2	-13	-39.2
696	26.1	100	2.2	V	696	-54.2	V	0	0.3	-54.5	-13	-41.5

Note: No pre-amplifier for the test.

§2.1055(a), §2.1055(d)(2), §80.209, §90.213 - FREQUENCY STABILITY**Applicable Standard**

§2.1055 (a) and §2.1055(d)(2). The frequency stability shall be measured with variation of ambient temperature, and reduce supply voltage to the battery end point.

§80.209

For Coast Station and output power > 3 watts, the limit is 5.0ppm.

For output power ≤ 3 watts, the limit is 10 ppm.

§90.213

For output power > 2 watts, the limit is 5.0 ppm.

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 battery terminals of the equipment under test. The voltage was set to 115% of the nominal value and was then decreased until the transmitter light no longer illuminated; i.e., the battery end point. The output frequency was recorded for each battery voltage.

Test Equipment

Manufacturer	Description	Model	Serial Number	Cal. Due Date
Tenney	Temperature Chamber -50 ⁰ to +100 ⁰ C	Versa	12.222-193	2004-04-23
Hewlett Packard	Spectrum Analyzer	HP8565EC	06042	2004-03-03

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

Environmental Conditions

Temperature:	25° C
Relative Humidity:	52%
ATM Pressure:	1100 mbar

Test Results

Reference Frequency: 160.0000 MHz, Limit: 5.0 ppm			
Environment Temperature (°C)	Power Supplied (Vdc)	Frequency Measure with Time Elapsed	
		MCF (MHz)	PPM Error
60	7.5	159.9994	-3.7
50	7.5	159.9995	-3.1
40	7.5	159.9998	-1.2
30	7.5	160.0001	0.6
20	7.5	160.0002	1.2
10	7.5	160.0002	1.2
0	7.5	160.0002	1.2
-10	7.5	160.0003	1.8
-20	7.5	160.0004	2.5
-30	7.5	160.0004	2.5

Frequency Stability Versus Input Voltage

Reference Frequency: 160.0000 MHz, Limit: 5 ppm						
Power Supplied (Vdc)	Frequency Measure with Time Elapsed					
	2 Minutes		5 Minutes		10 Minutes	
	MHz	ppm	MHz	ppm	MHz	ppm
6.75	160.0002	1.2	160.0002	1.2	160.0002	1.2

Battery End Point: 6.75 Vdc

§90.214 - TRANSIENT FREQUENCY BEHAVIOR

Standard Applicable

§90.214. Transmitters designed to operate in 150-174MHz band must maintain transient frequencies within the maximum frequency difference limits.

Test Method

TIA/EIA-603 2.2.19

Test Equipment

Model	Calibration Due Date
HP8920A RF Communications Test Set	2004-04-02
SME 02 Rhodes & Schwarz Signal Generator	2004-03-21
LC334A Le Croy Digital Storage Scope	2004-06-21

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

Environmental Conditions

Temperature:	25° C
Relative Humidity:	52%
ATM Pressure:	1100 mbar

Test Result

Please refer to the plot hereinafter.

