FCC PART 90 TYPE APPROVAL
EMI MEASUREMENT AND TEST REPORT

For

MIDLAND RADIO CORPORATION

1120 Clay Street
North Kansas City, MO 64116

FCC ID: MMASP200U2

2003-11-03

This Report Concerns:	**Equipment Type:**
☒ Original Report	Portable Radio

Test Engineer:	Ling Zhang
Report No.:	R0309223
Test Date:	2003-10-10
Reviewed By:	Ming Jing
Prepared By:	Bay Area Compliance Laboratory Corporation 230 Commercial Street Sunnyvale, CA 94085 Tel: (408) 732-9162 Fax: (408) 732 9164

TABLE OF CONTENTS

1 - GENERAL INFORMATION

1.1 Product Description for Equipment Under Test (EUT)

The *Midland Radio Corporation's* Model: *SP-230/250* or the "EUT" as referred to in this report is a portable radio which measured approximately 7.5"L x 2.5"W x 1.9"H.

The EUT operates at 440 – 470 MHz with maximum power of 37.00 dBm.

**The test data gathered are from production sample serial number B002 provided by the manufacturer.*

1.2 Objective

This type approval report is prepared on behalf of *Midland Radio Corporation* in accordance with Part 2, Subpart J, 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.

1.3 Related Submittal(s)/Grant(s)

No Related Submittals

1.4 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 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.

1.5 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.

2 - SYSTEM TEST CONFIGURATION

2.1 Justification

The EUT was configured for testing in a typical fashion (as normally used in a typical application).

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

2.2 Block Diagram

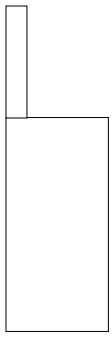
Please refer to Exhibit D.

2.3 Equipment Modifications

No modifications were necessary for the EUT to comply with the applicable limits and requirements.

2.4 Test Setup Block Diagram

The EUT is a standalone device.



EUT

3 - SUMMARY OF TEST RESULTS

FCC RULE	DESCRIPTION OF TEST	RESULT
§ 2.1046, § 90.205	RF power output	Compliant
§ 2.1047 § 90.205	Modulation Characteristics	Compliant
§ 2.1049 § 90.210	Emission, Occupied Bandwidth	Compliant
§ 2.1051 § 90.210	Spurious emissions at antenna terminals	Compliant
§ 2.1053 § 90.210	Field strength of spurious radiation	Compliant
§ 2.1055 § 90.213	Frequency stability vs. temperature Frequency stability vs. voltage	Compliant
§ 90.214	Transient Frequency Behavior	Compliant

4 - RF POWER OUTPUT

4.1 Applicable Standard

§2.1046
§90.205: Power dependent upon station's antenna HAAT and required service area and may be from 1 to 500 watts.

4.2 Test Procedure

1. The EUT was placed at 1.5m height turnaround table and in a position for normal use declared by the manufacturer.
2. The test antenna was oriented initially for vertical position with 3m away from EUT.
3. The output of the antenna was connected to the measuring receiver and the quasi-peak detector is used for the measurement.
4. The transmitter was turned on and the measuring receiver was tuned to the frequency of the transmitter under the testing.
5. The test antenna was raised and lowered through specified ranged of height until the maximum signal level was detected by the measuring receiver.
6. The transmitter was rotated through 360˚ in the horizontal plane until the maximum signal level was detected.
7. The transmitter was then replaced by a dipole which is a substitution antenna.
8. The substitution antenna was oriented for vertical polarization and then connected to a calibrated signal generator.
9. The input attenuator of measuring receiver was adjusted to increased the sensitivity.
10. The substitution antenna was raised and lowered to ensure the maximum signal level was detected.
11. The input signal to the substitution antenna was adjusted to the level to produce a level which was equal to the level noted while the transmitter radiated power was measured, corrected for the change of the input attenuator of the measuring receiver.
12. The input level to the substitution antenna was recorded as power level in dBm, corrected for any change of input attenuator of the measuring receiver.
13. The measurement was repeated with the test antenna and the substitution antenna oriented for horizontal polarization.
14. The measure of the radiated output power is the larger one of the two level recorded, at the input to the substitution antenna, corrected for gain of the substitution antenna if necessary.

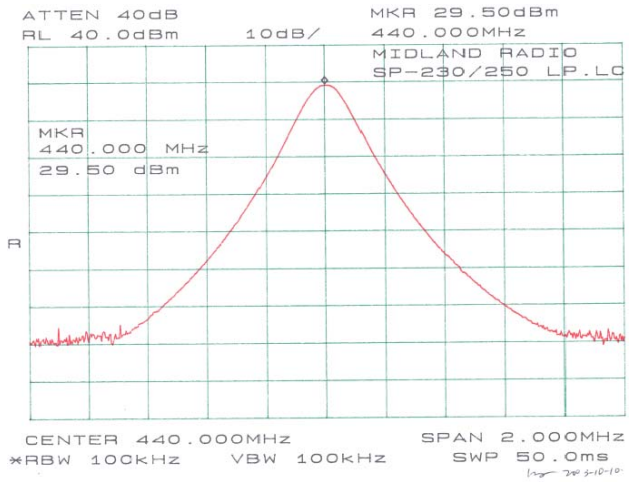
4.3 Test Equipment

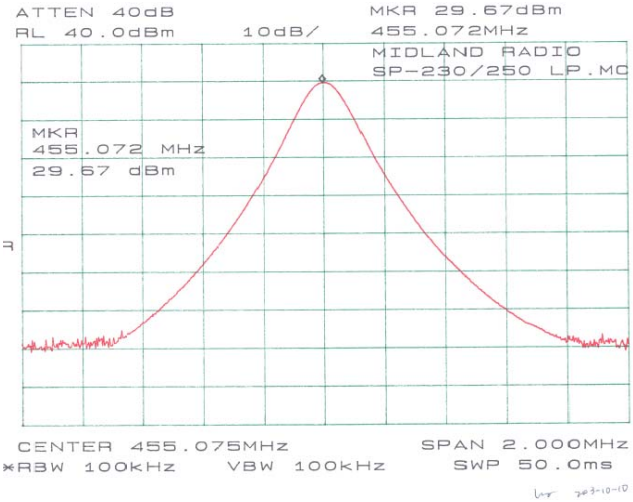
Hewlett Packard HP8566B Spectrum Analyzer
Hewlett Packard HP 7470A Plotter

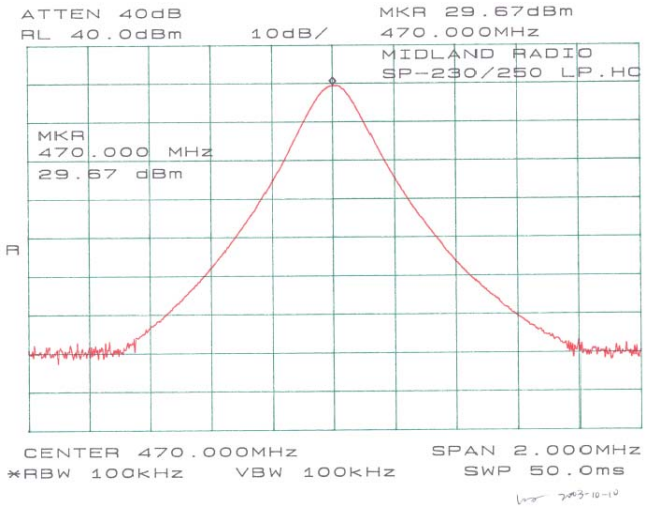
4.4 Test Results

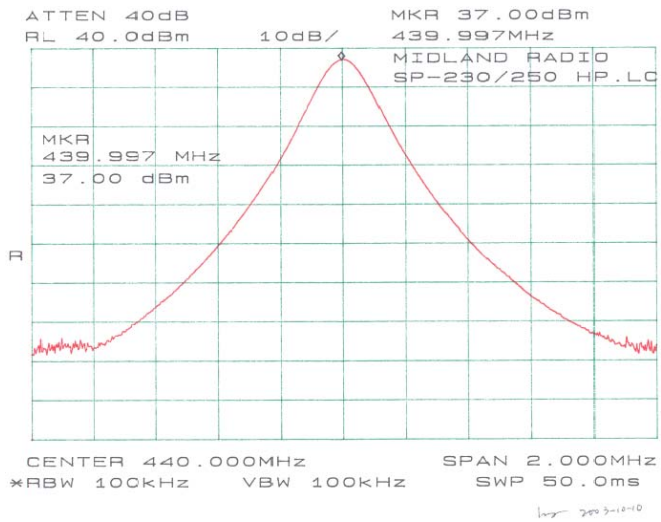
Power Level	Channel	Output Power in dBm	Output Power in W
Low Power	440.00	29.50	0.891
	455.08	29.67	0.927
	470.00	29.67	0.927
High Power	440.00	37.00	5.012
	455.08	37.00	5.012
	470.00	36.67	4.645

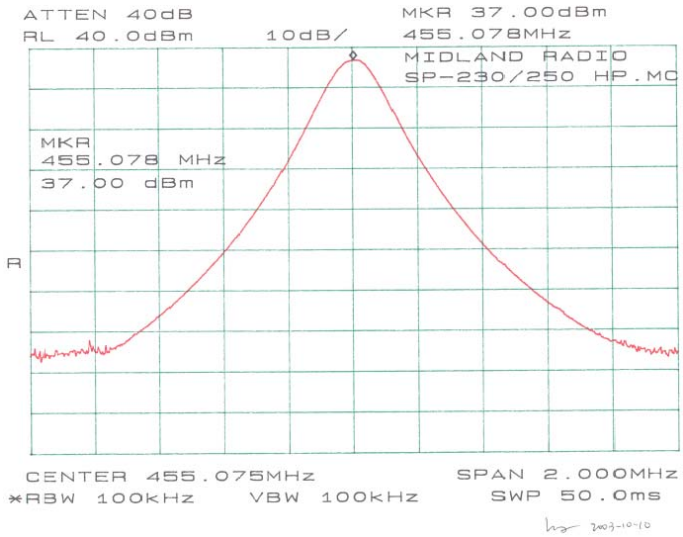
Note: The power output may depend on the intended use of the EUT. For all tests, the EUT was set to maximum conditions.

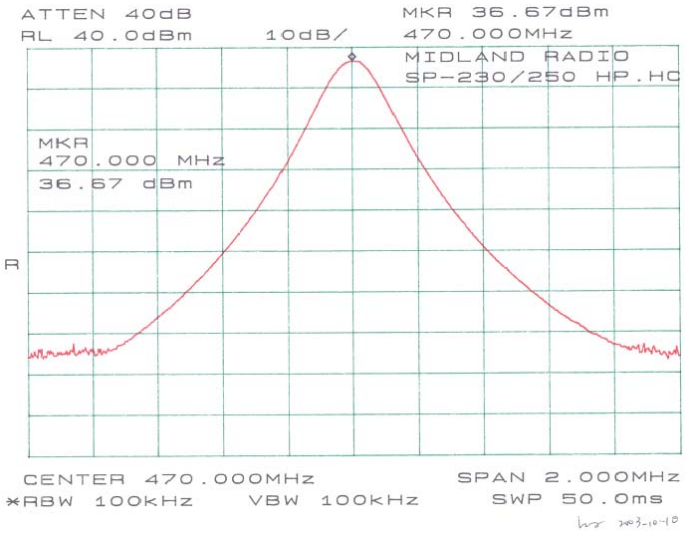

ATTEN 40dB
RL 40.0dBm
10dB/
MKR 29.50dBm
440.000MHz
MIDLAND RADIO
SP-230/250 LP.LC
MKR
440.000 MHz
29.50 dBm
CENTER 440.000MHz
SPAN 2.000MHz
*RBW 100kHz
VBW 100kHz
SWP 50.0ms


ATTEN 40dB
RL 40.0dBm
10dB/
MKR 29.67dBm
455.072MHz
MIDLAND RADIO
SP-230/250 LP.MC
MKR
455.072 MHz
29.67 dBm
CENTER 455.075MHz
SPAN 2.000MHz
*RBW 100kHz
VBW 100kHz
SWP 50.0ms


ATTEN 40dB
RL 40.0dBm
10dB/
MKR 29.67dBm
470.000MHz
MIDLAND RADIO
SP-230/250 LP.HC
MKR
470.000 MHz
29.67 dBm
CENTER 470.000MHz
SPAN 2.000MHz
*RBW 100kHz
VBW 100kHz
SWP 50.0ms


ATTEN 40dB
RL 40.0dBm
10dB/
MKR 37.00dBm
439.997MHz
MIDLAND RADIO
SP-230/250 HP.LC
MKR
439.997 MHz
37.00 dBm
A
CENTER 440.000MHz
SPAN 2.000MHz
*RBW 10CkHz
VBW 100kHz
SWP 50.0ms
2003-10-10


ATTEN 40dB
RL 40.0dBm
10dB/
MKR 37.00dBm
455.078MHz
MIDLAND RADIO
SP-230/250 HP.MC
MKR
455.078 MHz
37.00 dBm
A
CENTER 455.075MHz
SPAN 2.000MHz
*RBW 100kHz
VBW 100kHz
SWP 50.0ms
2003-10-10


ATTEN 40dB
RL 40.0dBm
10dB/
MKR 36.67dBm
470.000MHz
MIDLAND RADIO
SP-230/250 HP.HC
MKR
470.000 MHz
36.67 dBm
A
CENTER 470.000MHz
SPAN 2.000MHz
*RBW 100kHz
VBW 100kHz
SWP 50.0ms
2003-10-10

5 - MODULATION CHARACTERISTIC

5.1 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.

§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.

5.2 Test Procedure

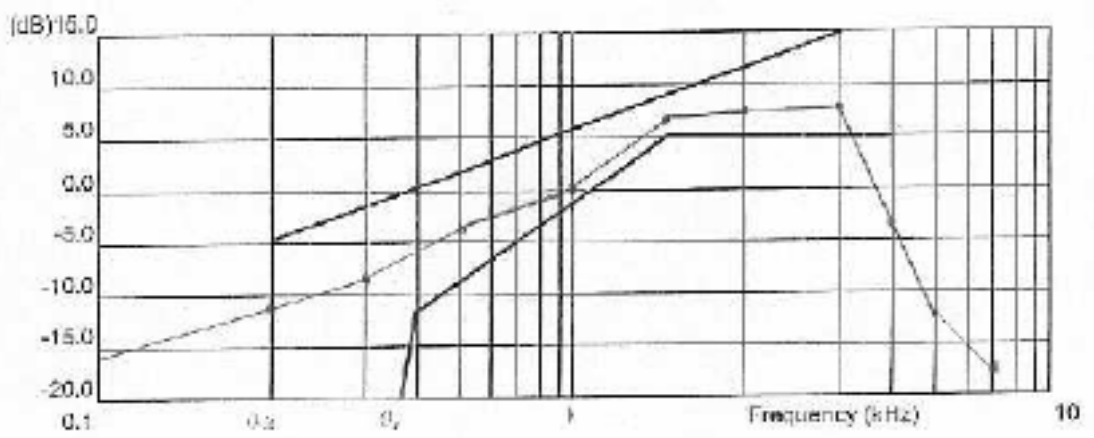
Test Method: TIA/EIA-603 2.2.3

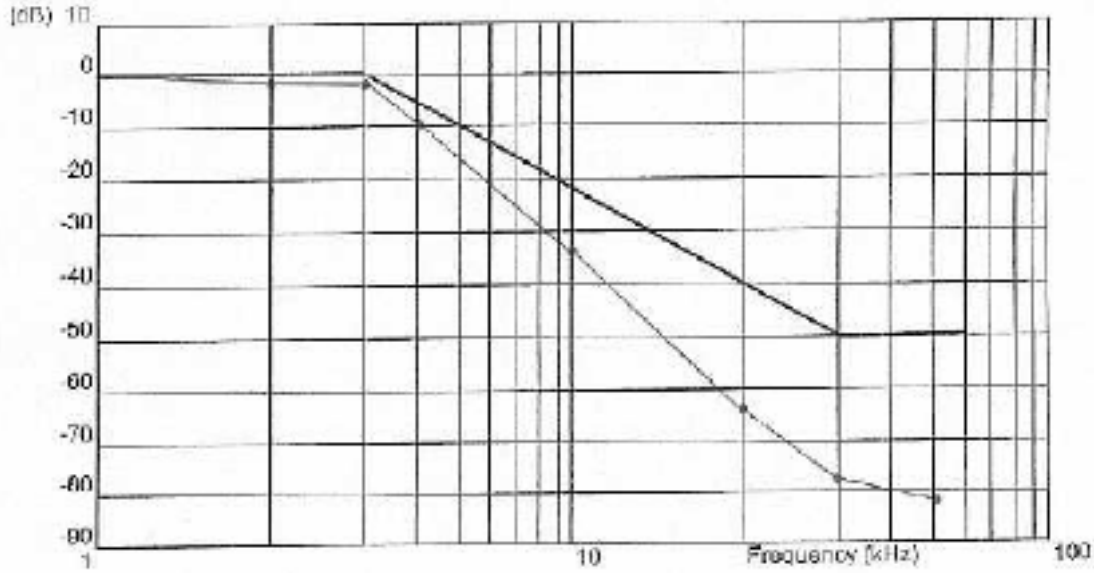
5.3 Test Equipment

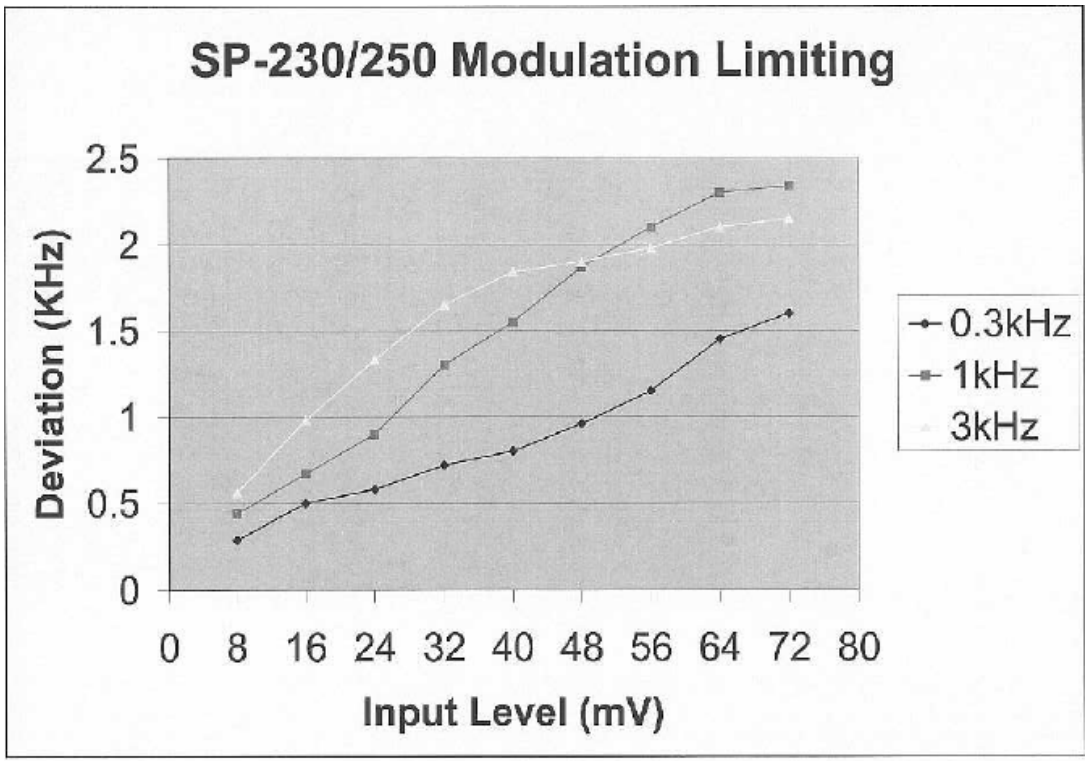
Hewlett Packard HP8566B Spectrum Analyzer

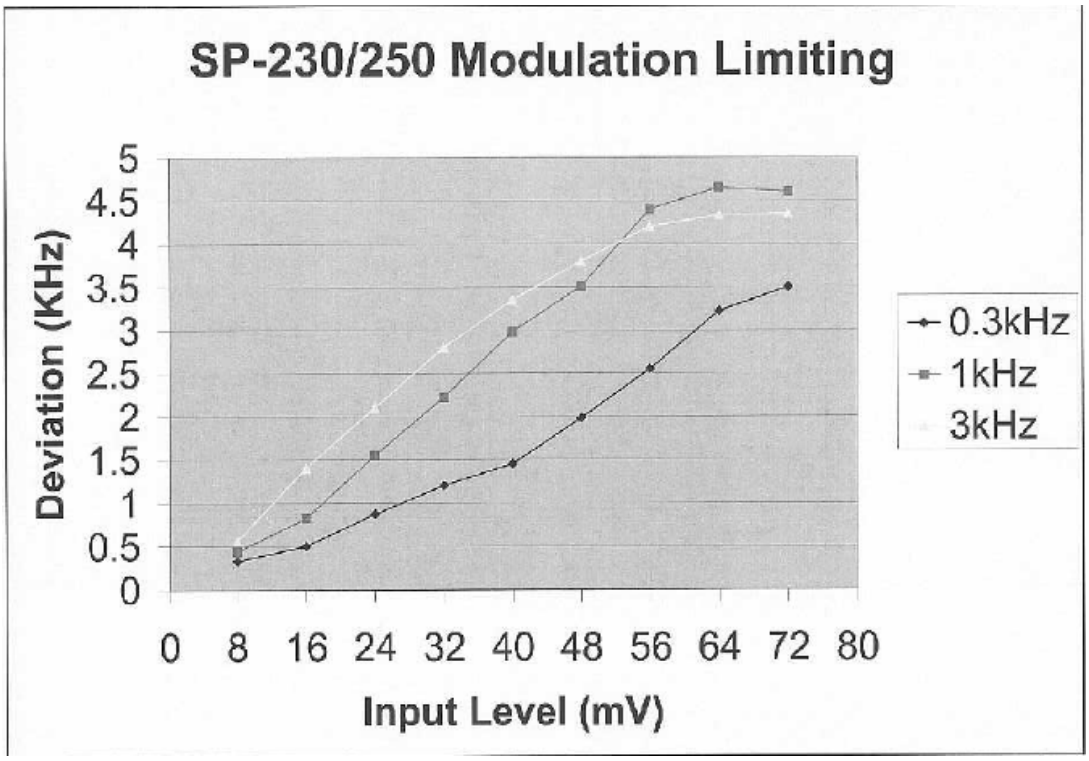
5.4 Test Results

Please refer to the hereinafter plots.


(dB)15.0
10.0
5.0
0.0
-5.0
-10.0
-15.0
-20.0
0.1
Frequency (kHz)
10


(dB) 10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
1
10
Frequency (kHz)
100


SP-230/250 Modulation Limiting
Deviation (KHz)
2.5
2
1.5
1
0.5
0
0 8 16 24 32 40 48 56 64 72 80
Input Level (mV)
0.3kHz
1kHz
3kHz


SP-230/250 Modulation Limiting
Deviation (KHz)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0 8 16 24 32 40 48 56 64 72 80
Input Level (mV)
0.3kHz
1kHz
3kHz

6 - OCCUPIED BANDWIDTH

6.1 Applicable Standard

§2.1049 and §90.210

12.5kHz 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:

Low: 50+l0logP=50+10log(4.4)=56.4dB
Middle: 50+10logP=50+10log(4.1)=56.1dB
High: 50+10logP=50+10log(3.9)=55.9dB

25kHz bandwidth:
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+l0logP=43+10log(4.4)=49.4dB
Middle: 43+10logP=43+10log(4.1)=49.1dB
High: 43+10logP=43+10log(3.9)=48.9dB

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.

6.2 Test Procedure

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

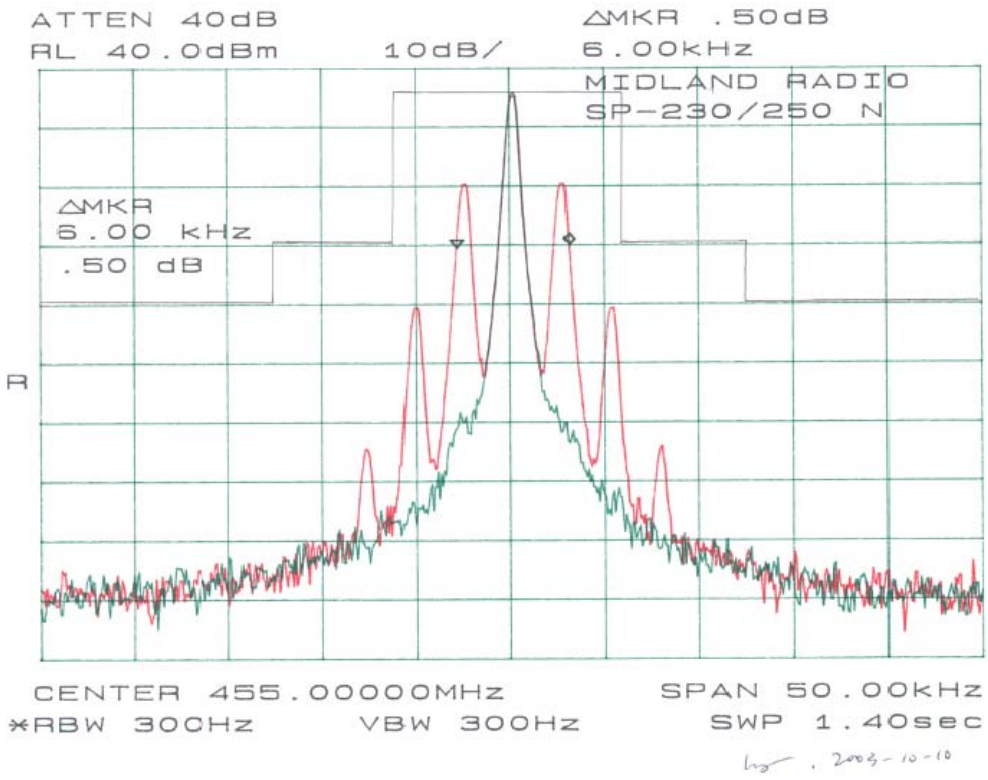
The resolution bandwidth of the spectrum analyzer was set at 30 KHz and the spectrum was recorded in the frequency band ±50 KHz from the carrier frequency.

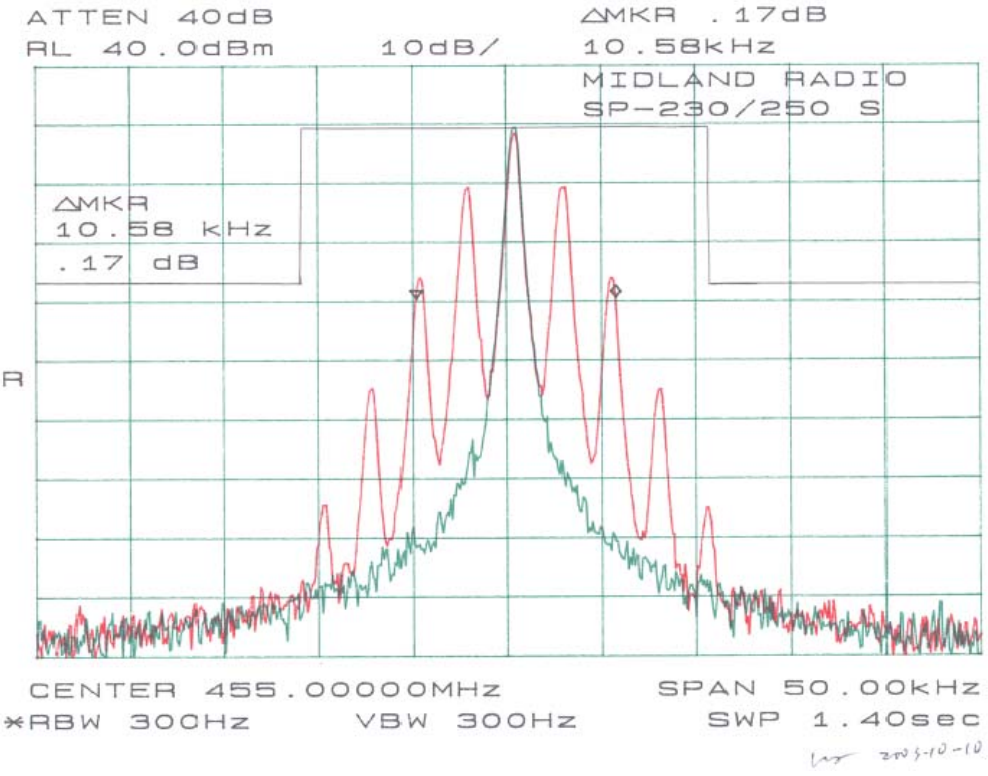
6.3 Test Equipment

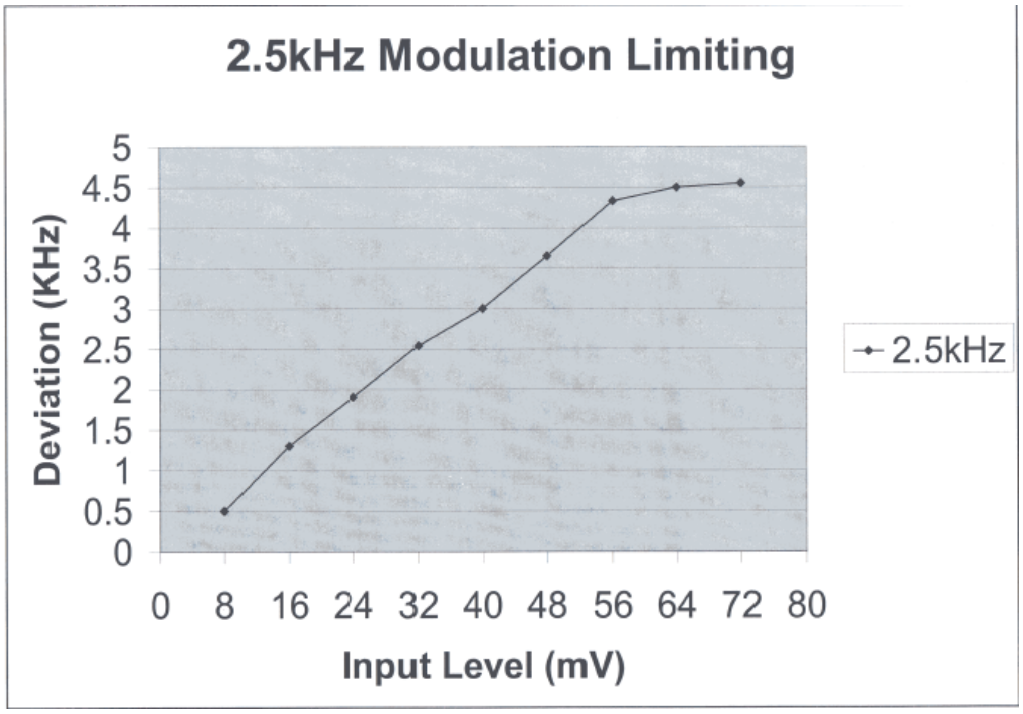
Hewlett Packard HP8566B Spectrum Analyzer
Hewlett Packard HP 7470A Plotter
HP8920A RF Communications Test Set (7/27/2003)
HP8561A Spectrum Analyzer (8/24/03)

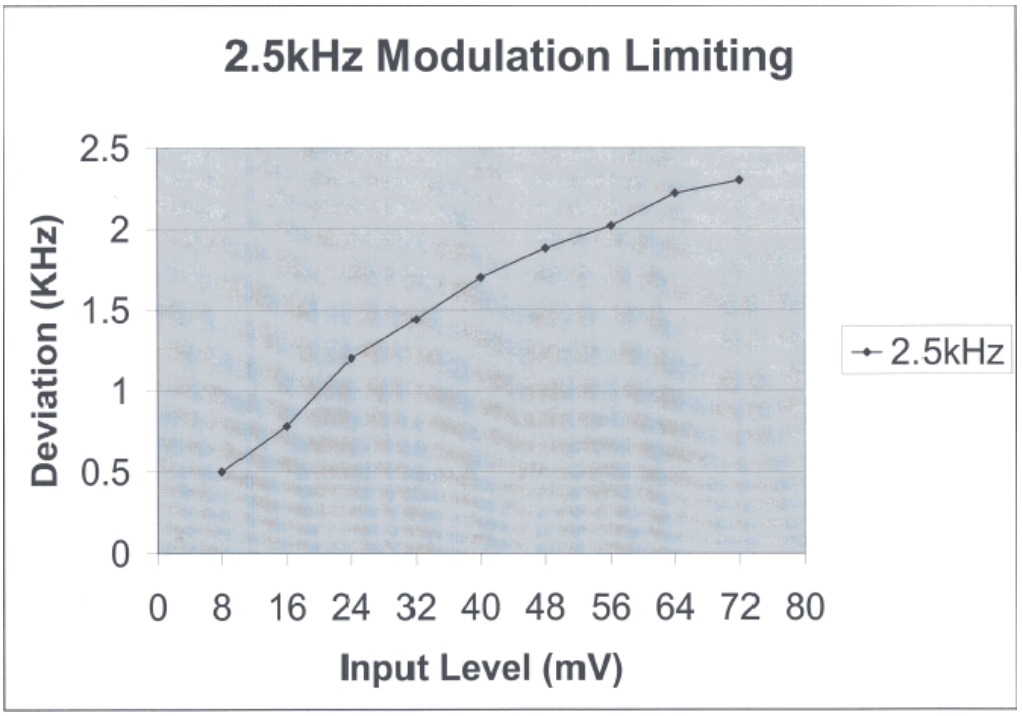
6.4 Test Results

Please refer to the hereinafter plots.


ATTEN 40dB
RL 40.0dBm
10dB/
ΔMKR .50dB
6.00kHz
MIDLAND RADIO
SP-230/250 N
ΔMKR
5.00 kHz
.50 dB
A
CENTER 455.00000MHz
SPAN 50.00kHz
*RBW 30CHz
VBW 300Hz
SWP 1.40sec
2003-10-10


ATTEN 40dB
RL 40.0dBm
10dB/
ΔMKR .17dB
10.58kHz
MIDLAND RADIO
SP-230/250 S
ΔMKR
10.58 kHz
.17 dB
A
CENTER 455.00000MHz
SPAN 50.00kHz
*RBW 30CHz
VBW 300Hz
SWP 1.40sec
2003-10-10


2.5kHz Modulation Limiting
Deviation (KHz)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0 8 16 24 32 40 48 56 64 72 80
Input Level (mV)
2.5kHz


2.5kHz Modulation Limiting
Deviation (KHz)
2.5
2
1.5
1
0.5
0
0 8 16 24 32 40 48 56 64 72 80
Input Level (mV)
2.5kHz

7 - SPURIOUS EMISSIONS AT ANTENNA TERMINALS

7.1 Test Procedure

§2.1051and §90.210 (25kHz bandwidth only)

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

Low: 43+l0logP=43+10log(4.4)=49.4dB
Middle: 43+10logP=43+10log(4.1)=49.1dB
High: 43+10logP=43+10log(3.9)=48.9dB

§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+l0logP=50+10log(4.4)=49.4dB
Middle: 50+10logP=50+10log(4.1)=49.1dB
High: 50+10logP=50+10log(3.9)=48.9dB

7.2 Test Procedure

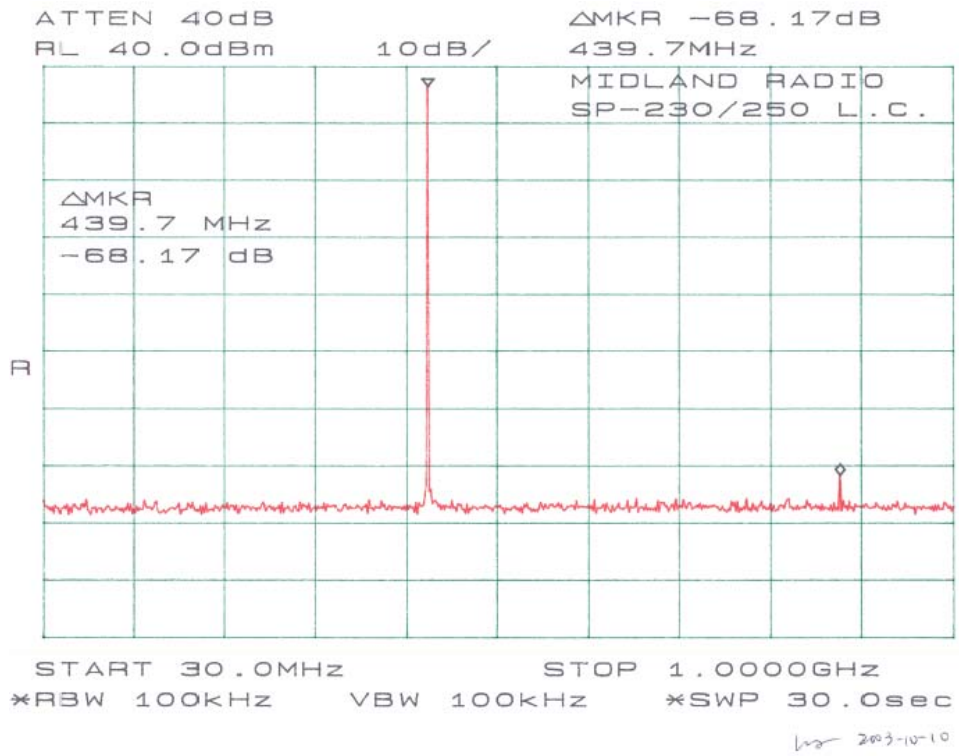
The RF output of the transceiver was connected to a spectrum analyzer through appropriate attenuation. The resolution bandwidth of the spectrum analyzer was set at 100 kHz. Sufficient scans were taken to show any out of band emissions up to 10^{th} harmonic.

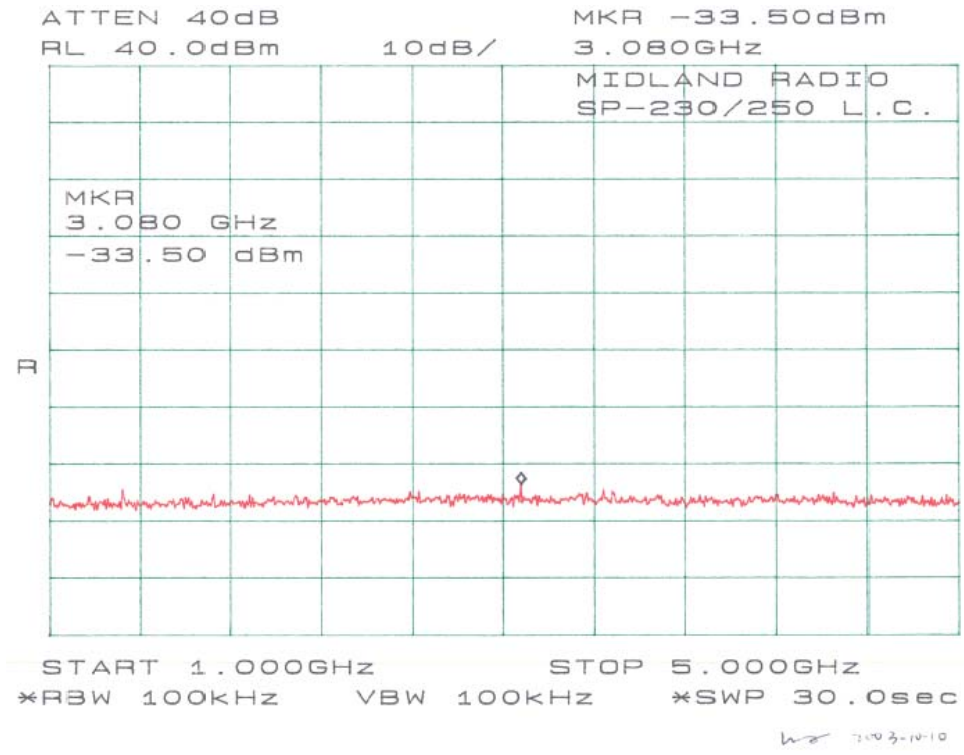
7.3 Test Equipment

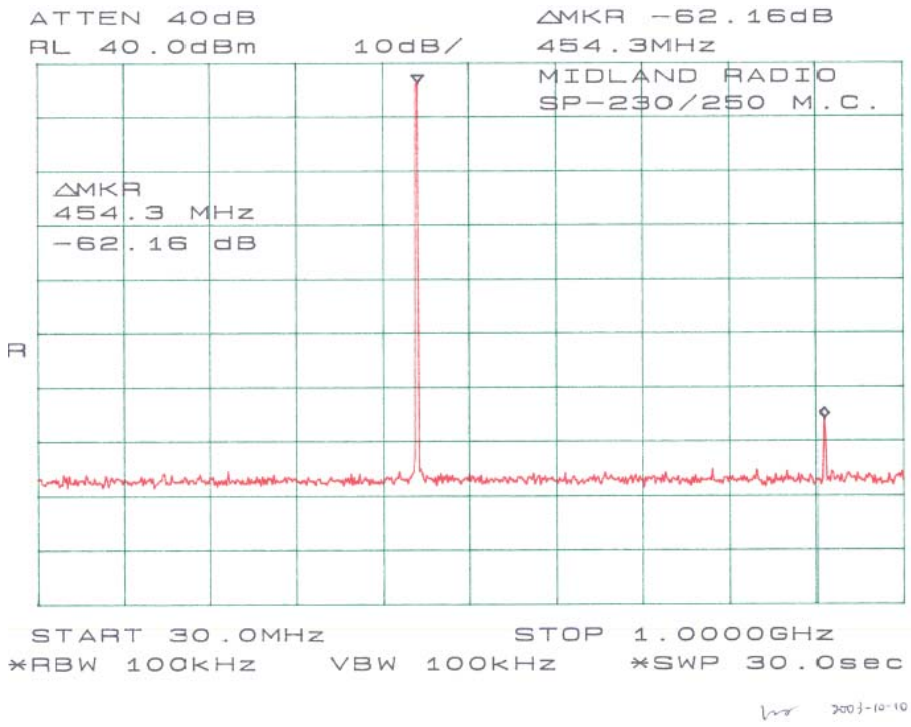
HP 8566B Spectrum Analyzer
Hewlett Packard HP8566B Spectrum Analyzer

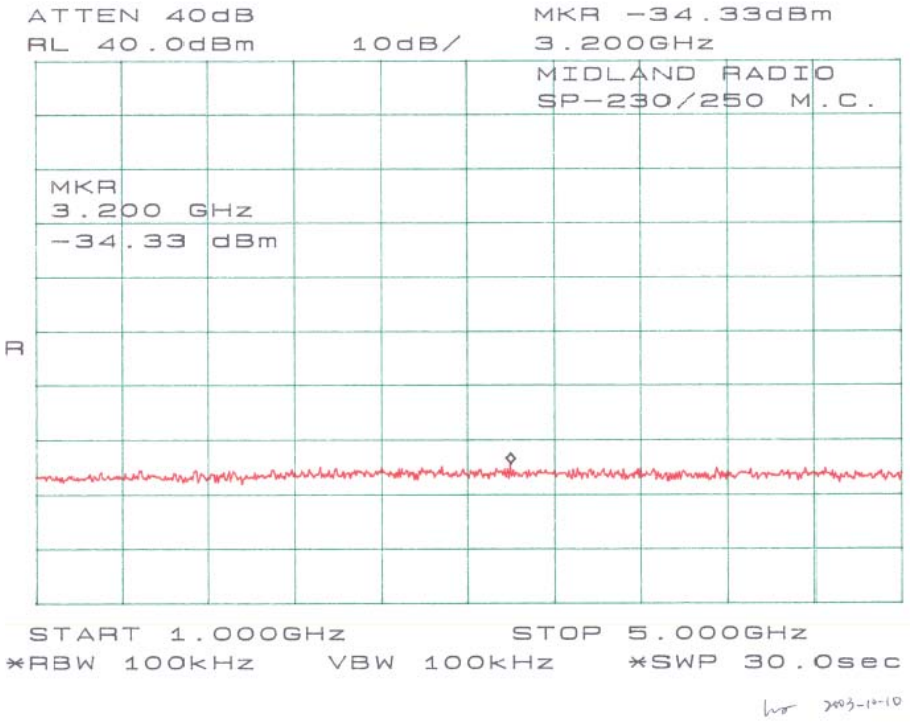
7.4 Test Results

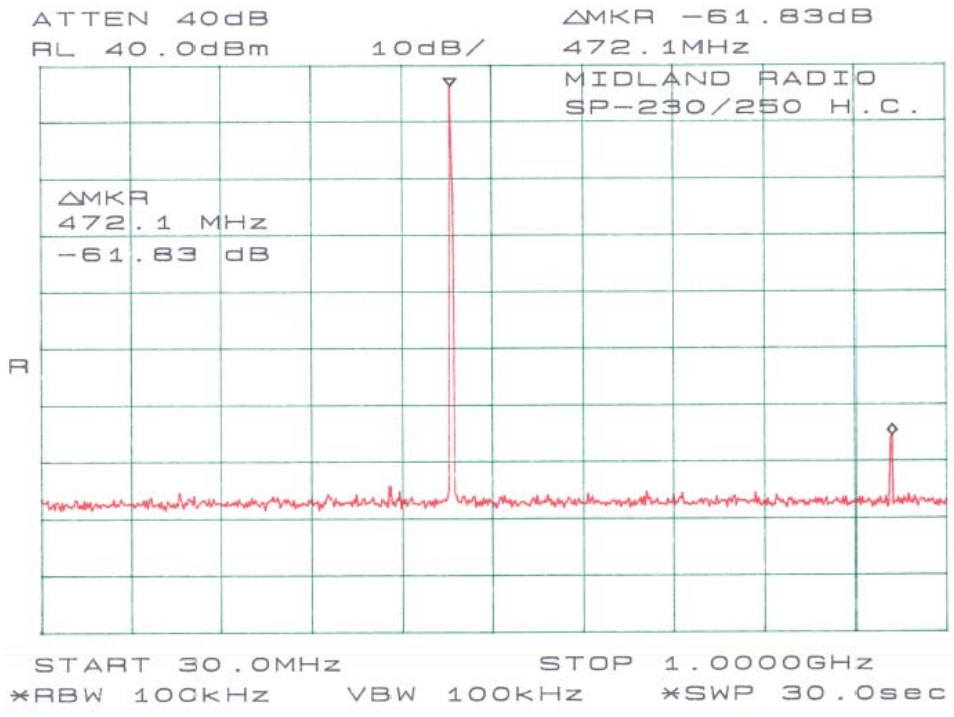
Please refer to the hereinafter plots.

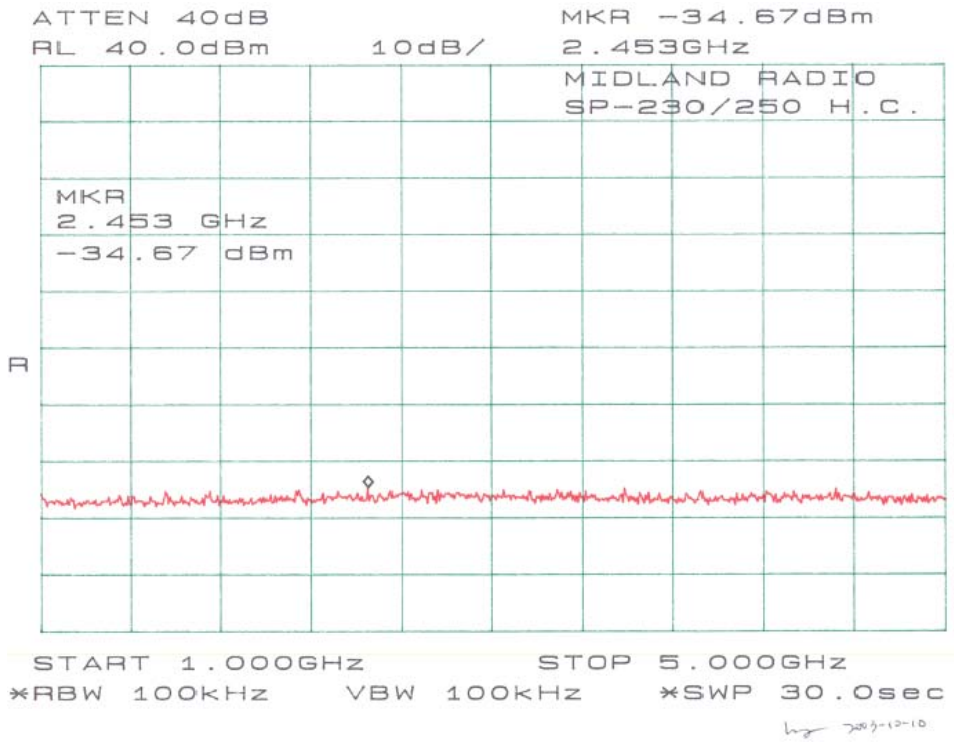

ATTEN 40dB
RL 40.0dBm
10dB/
ΔMKR -68.17dB
439.7MHz
MIDLAND RADIO
SP-230/250 L.C.
ΔMKR
439.7 MHz
-68.17 dB
R
START 30.0MHz
STOP 1.0000GHz
*RBW 100kHz
VBW 100kHz
*SWP 30.0sec
2003-10-10


ATTEN 40dB
RL 40.0dBm
10dB/
MKR -33.50dBm
3.080GHz
MIDLAND RADIO
SP-230/250 L.C.
MKR
3.080 GHz
-33.50 dBm
R
START 1.000GHz
STOP 5.000GHz
*RBW 100kHz
VBW 100kHz
*SWP 30.0sec
2003-10-10


ATTEN 40dB
RL 40.0dBm
10dB/
ΔMKR -62.16dB
454.3MHz
MIDLAND RADIO
SP-230/250 M.C.
ΔMKR
454.3 MHz
-62.16 dB
R
START 30.0MHz
STOP 1.0000GHz
*RBW 100kHz
VBW 100kHz
*SWP 30.0sec
2003-10-10


ATTEN 40dB
RL 40.0dBm
10dB/
MKR -34.33dBm
3.200GHz
MIDLAND RADIO
SP-230/250 M.C.
MKR
3.200 GHz
-34.33 dBm
R
START 1.000GHz
STOP 5.000GHz
*RBW 100kHz
VBW 100kHz
*SWP 30.0sec
2003-10-10


ATTEN 40dB
RL 40.0dBm
10dB/
ΔMKR -61.83dB
472.1MHz
MIDLAND RADIO
SP-230/250 H.C.
ΔMKR
472.1 MHz
-61.83 dB
R
START 30.0MHz
STOP 1.0000GHz
*RBW 10CkHz
VBW 100kHz
*SWP 30.0sec
2003-10-10


ATTEN 40dB
RL 40.0dBm
10dB/
MKR -34.67dBm
2.453GHz
MIDLAND RADIO
SP-230/250 H.C.
MKR
2.453 GHz
-34.67 dBm
R
START 1.000GHz
STOP 5.000GHz
*RBW 100kHz
VBW 100kHz
*SWP 30.0sec
2003-10-10

8 - RADIATED SPURIOUS EMISSION

8.1 Test Procedure

§2.1053 and §90.210 (25kHz bandwidth only)

8.2 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 (TXpwr in Watts/0.001) – the absolute level

Spurious attenuation limit in dB = 43 + 10 Log_{10} (power out in Watts)

8.3 Test Equipment

CDI B100/200/300 Biconical Antennas
EMCO Bi-logcon Antenna
EMCO 3115 Horn Antenna
HP 8566B Spectrum Analyzer
HP8640 Generator
Non-radiating Load

8.4 Test Result

Low Frequency: -13.6 at 880.000MHz
Mid Frequency: -18.9dB at 910.150MHz
High Frequency: -12.2dB at 940.000MHz

Run # 1 :Primary scan 400 - 5000 MHz , Low CH, high power

Indicated		Table	Test Antenna		Substituted			Antenna*	Cable	Absolute	Limit	Margin
Frequency MHz	Ampl. dBuV/m	Angle Degree	Height Meter	Polar H/V	Frequency MHz	Level dBm	Polar H/V	Gain Correction	Loss dB	Leval dBm	dBm	dB
440.000	116.17	270	2.1	v	440.000	35.8	v	0	0.1	35.7		
440.000	104.17	180	2.3	h	440.000	25.9	h	0	0.1	25.8		
880.000	58.17	300	2.0	v	880.000	-26.5	v	0	0.1	-26.6	-13	-13.6
880.000	51.33	180	2.0	h	880.000	-32.2	h	0	0.1	-32.3	-13	-19.3
1320.000	41.33	330	2.3	v	1320.000	-40.0	v	5	0.3	-35.3	-13	-22.3
1320.000	39.67	220	2.2	h	1320.000	-41.3	h	5	0.3	-36.6	-13	-23.6

Run # 2 :Primary scan 400 - 5000MHz , Mid CH, low power

Indicated		Table	Test Antenna		Substituted			Antenna*	Cable	Absolute	Limit	Margin
Frequency MHz	Ampl. dBuV/m	Angle Degree	Height Meter	Polar H/V	Frequency MHz	Level dBm	Polar H/V	Gain Correction	Loss dB	Leval dBm	dBm	dB
455.075	108.50	150	1.7	v	455.075	28.6	v	0	0.1	28.5		
455.075	97.33	180	1.8	h	455.075	20.5	h	0	0.1	20.4		
910.150	52.50	270	1.8	v	910.150	-31.8	v	0	0.1	-31.9	-13	-18.9
910.150	46.33	270	2.5	h	910.150	-35.6	h	0	0.1	-35.7	-13	-22.7
1365.225	40.67	220	2.0	v	1365.225	-40.6	v	5	0.3	-35.9	-13	-22.9
1365.225	39.17	270	1.7	h	1365.225	-42.0	h	5	0.3	-37.3	-13	-24.3

Run # 3 :Primary scan 400 - 5000MHz , High CH, high power

Indicated		Table	Test Antenna		Substituted			Antenna*	Cable	Absolute	Limit	Margin
Frequency MHz	Ampl. dBuV/m	Angle Degree	Height Meter	Polar H/V	Frequency MHz	Level dBm	Polar H/V	Gain Correction	Loss dB	Leval dBm	dBm	dB
470.000	117.50	250	1.8	v	470.000	36.5	v	0	0.1	36.4		
470.000	105.20	150	2.5	h	470.000	26.4	h	0	0.1	26.3		
940.000	59.67	270	2.3	v	940.000	-25.1	v	0	0.1	-25.2	-13	-12.2
940.000	52.33	90	1.5	h	940.000	-31.3	h	0	0.1	-31.4	-13	-18.4
1410.000	42.15	100	2.2	v	1410.000	-39.1	v	5	0.3	-34.4	-13	-21.4
1410.000	40.50	150	2.0	h	1410.000	-40.5	h	5	0.3	-35.8	-13	-22.8

Note : No pre-amplifier for the test.
Dipole antenna for frequency below 1000MHz, Horn antenn for frequency above 1000MHz

9 - FREQUENCY STABILITY

9.1 Applicable Standard

§2.1055 (d)

§90.213
For output power > 2 watts, the limit is 2.5ppm.

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 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.

9.3 Test Equipment

Temperature Chamber -50^0 to $+100^0$C
Hewlett Packard 5383A Frequency Counter
Goldstar DC Power Supply, GR303

9.4 Test Results

Reference Frequency: 455.0000 MHz, Limit: 2.5 ppm			
Environment Temperature (°C)	Power Supplied (Vdc)	Frequency Measure with Time Elapsed	
		MCF (MHz)	PPM Error
60	7.5	454.9994	-1.32
50	7.5	454.9998	-0.44
40	7.5	454.9998	-0.44
30	7.5	455.0001	0.22
20	7.5	455.0000	0.00
10	7.5	455.0000	0.00
0	7.5	455.0001	0.22
-10	7.5	455.0002	0.44
-20	7.5	455.0004	0.88
-30	7.5	455.0005	1.10

Frequency Stability Versus Input Voltage

Reference Frequency: 455.0000 MHz, Limit: 2.5 ppm						
Power Supplied (Vdc)	Frequency Measure with Time Elapsed					
	2 Minutes		5 Minutes		10 Minutes	
	MHz	ppm	MHz	ppm	MHz	ppm
6.75	455.0001	0.22	455.0002	0.44	455.0002	0.44

Battery End Point: 6.75 Vdc

10 - TRANSIENT FREQUENCY BEHAVIOR

10.1 Test Method

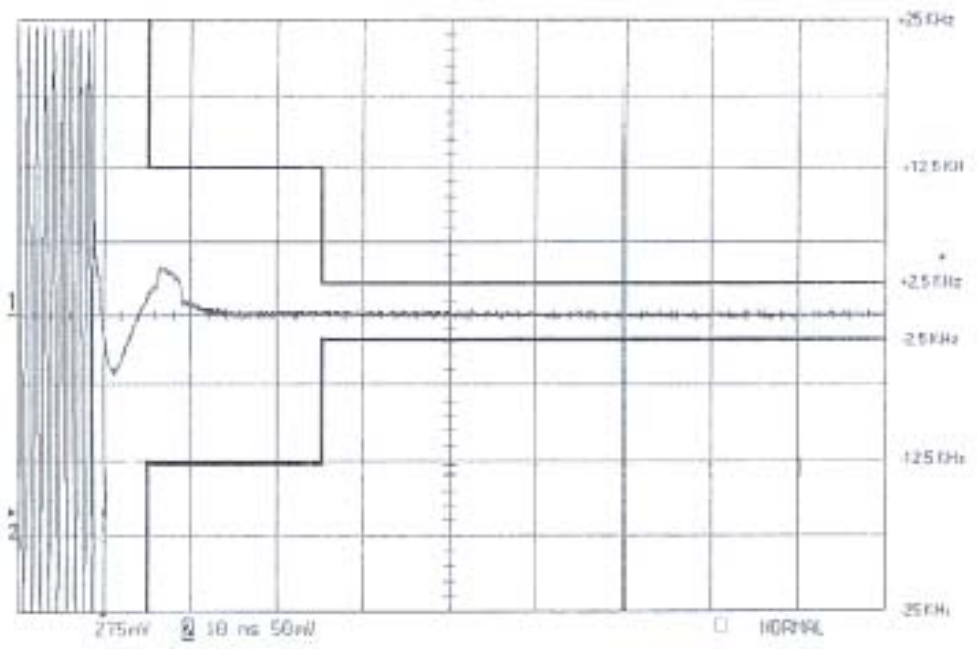
TIA/EIA-603 2.2.19

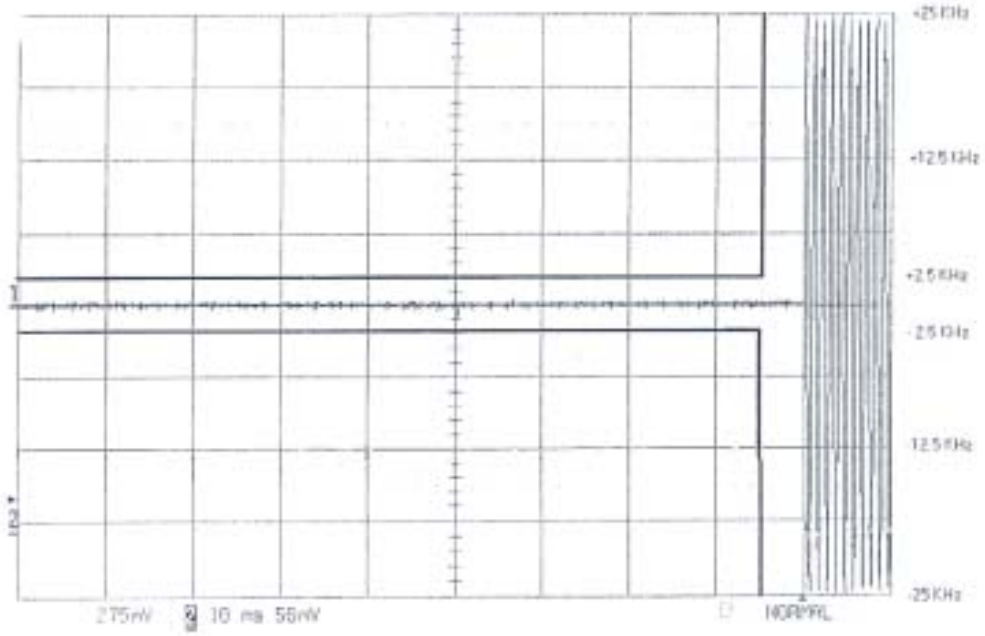
10.2 Test Equipment

Model	Calibration Due Date
HP8920A RF Communications Test Set	4/2/04
SME 02 Rhodes & Schwarz Signal Generator	3/21/04
LC334A Le Croy Digital Storage Scope	6/21/04

10.3 Test Result

Please refer to the plot hereinafter.


+25KHz
+12.5KHz
+2.5KHz
-2.5KHz
-12.5KHz
-25KHz
275mV
10 ms 50mV
NORMAL


+25KHz
+12.5KHz
+2.5KHz
-2.5KHz
-12.5KHz
-25KHz
275mV
10 ms 55mV
NORMAL