

FCC PART 90 EMI MEASUREMENT AND TEST REPORT

For

Midland Radio Corporation

1120 Clay Street
North Kansas City, MO 64116

FCC ID: MMA710110C

2003-05-29

This Report Concerns: ☒ Original Report	Equipment Type: LAND MOBILE RADIO
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Report Number: R0305163	
Test Date: 2003-05-27	
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1 - GENERAL INFORMATION

1.1 Product Description for Equipment Under Test (EUT)

The *Midland Radio Corporation's* Model: 71-0110C or the "EUT" as referred to in this report is a land mobile radio which measures approximately 16.5"L x 19.2"W x 3.2"H. The EUT is comprised of separate module all housed within on 2RU equipment cabinet. The receiver, transmitter, and PA unit are each enclosed within their own die-cast housing. Each one is then mounted directly on the large upper heatsink. A microprocessor-controlled interface module controls the channel selection, LCD Display, timers, interfaces, and signaling features.

** The test data gathered is from typical production samples provided by the manufacturer.*

1.2 Objective

This report is prepared on behalf of *Midland Radio Corporation*. in accordance with Part 90 Subpart A, and Subpart I of the Federal Communication Commissions rules.

The objective of the manufacturer is to demonstrate compliance with FCC rules for effective radiated power, modulation characteristics, occupied bandwidth, radiated spurious emissions, and frequency stability.

1.3 Related Grant/Submission

No Related Submittals.

1.4 Test Methodology

Measurements contained in this report were also conducted with TIA/EIA Standard 603, Telecommunications Industry Association Land Mobile FM or PM Communications Equipment Measurement and Performance Standards.

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 C63.4-1992.

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, CISPR 22: 1997, and AS/NZS 3548: Electromagnetic Interference - Limits and Methods of Measurement of Information Technology Equipment test methods under NVLAP Lab Code 200167-0.

1.6 Test Equipment List

Manufacturer	Description	Model	Serial Number	Cal. Due Date
HP	Spectrum Analyzer	8568B	2517A01610	2003-10-30
HP	Spectrum Analyzer	8593A	29190A00242	2004-05-01
HP	Amplifier	8447E	1937A01054	2004-05-01
HP	Quasi-Peak Adapter	85650A	2521A00718	2004-05-01
Com-Power	Biconical Antenna	AB-100	14012	2004-05-01
Com-Power	LISN	LI-200	12005	2004-03-28
Com-Power	LISN	LI-200	12008	2004-03-28
Com-Power	Log Periodic Antenna	AL-100	16091	2004-05-01
Com-Power	Log Periodic Antenna	AB-900	15049	2004-05-01
Rohde & Schwarz	EMI Test Receiver	ESPI	1147 8007 07	2003-12-03
Agilent	Spectrum Analyzer (9KHz – 40GHz)	8564E	08303	2003-08-01
Agilent	Spectrum Analyzer (9KHz – 50GHz)	8565EC	06042	2004-05-03
HP	Amplifier (1-26.5GHz)	8449B	3147A00400	2004-03-14
A.H.System	Horn Antenna (700MHz-18GHz)	SAS-200/571	261	2003-05-31
JTW	Voltmeter	DT9205	N/A	Not Required

*** Statement of Traceability:** Bay Area Compliance Laboratory Corp. certifies that all calibration has been performed using suitable standards traceable to NATIONAL INSTITUTE of STANDARDS and TECHNOLOGY. (NIST)

1.7 Local Support Equipment

Manufacturer	Description	Model	Serial Number	FCC ID
Electro Impulse	1000W Attenuator	AX-1000-30	None	None
Condor	DC Power Supply	GPFC250	None	None

1.8 External I/O Cabling List and Details

Cable Description	Length (M)	From	To
BNC Cable	1.0	RF output port / EUT	Input port / Attenuator
BNC Cable	1.0	Output port/Attenuator	Attenuator

2 - SYSTEM TEST CONFIGURATION

2.1 Justification

The EUT was tested under typical operating modes to represent the worst-case results during the final qualification test.

2.2 EUT Test Configuration

The EUT was powered and fully operated by pushing PTT (Push To Talk) button and then change the channel to Low, Middle, and High by selecting the keypad on the EUT.

2.3 Special Accessories

As shown in section 2.7, interface cable used for compliance testing is shielded as normally supplied by customer and its respective support equipment manufacturers.

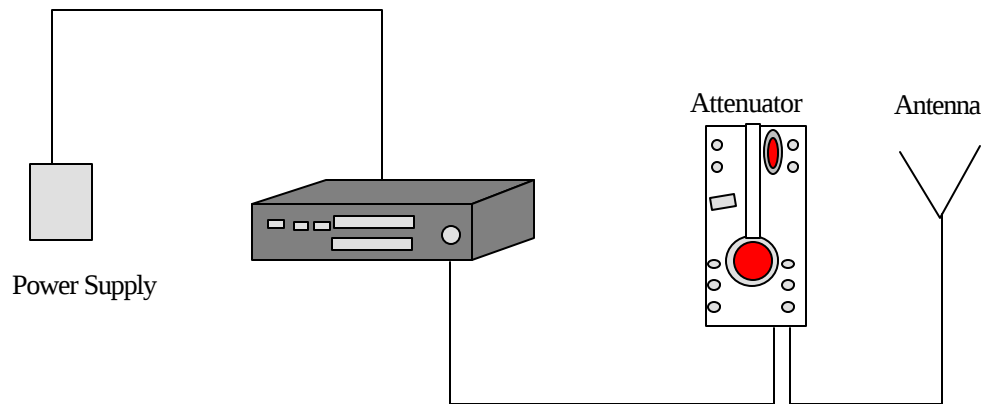
2.4 Schematics / Block Diagram

Please refer to Appendix D.

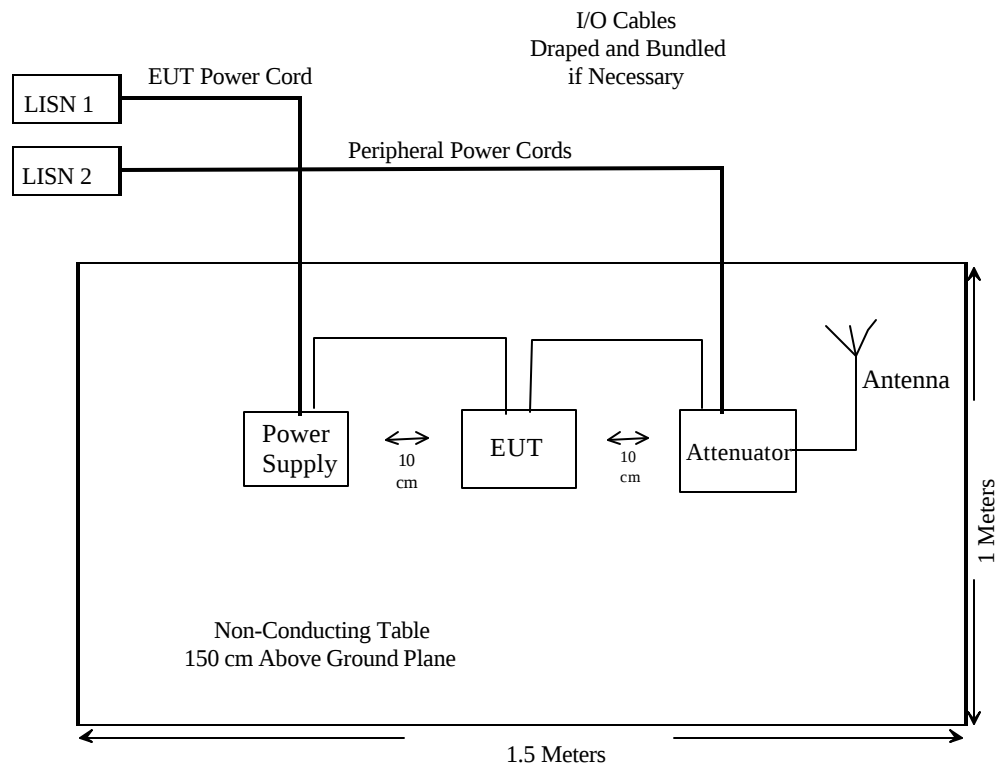
2.5 Equipment Modifications

No modification was made by BACL Corp. to make sure the EUT to comply with the applicable limits.

2.6 Configuration of Test System



2.7 Test Setup Block Diagram



3 - REQUIREMENTS OF PROVISIONS

3.1 Requirements and Test Summary

FCC Rules	Rules Description	Result
2.1046 90.205 (b)	RF Output Power	Complied
2.1047 90.207 90.210 (b)	Modulation Characteristics	Complied
2.1049 90.209 (b)(5) 90.210 (b)	Occupied Bandwidth	Complied
2.1053 90.210 (b)	Radiated Spurious Emission	Complied
2.1051 90.210 (b)	Spurious Emission at Antenna Port	Complied
2.1055 90.213	Frequency Stability Vs. Temperature Vs. Voltage	Complied
15.107	AC Line Conducted Emission	N/A

3.2 Labeling Requirement

Each equipment for which a type acceptance applications is filed on or after May 1, 1981, shall bear an identification plate or label pursuant to §2.295 (Identification of Equipment) and §2.926 (FCC identifier)

In August 1996 the Federal Communications Commissions (FCC) adopted RF exposure guidelines with safety levels for hand-held wireless devices.

Generally users manual contains a RF exposure statement to indicate compliance with FCC requirements.

The users manual should also contain required information and instruction pursuant to 95.653.

4 – CONDUCTED OUTPUT POWER

4.1 Provision Applicable

Per FCC §2.1046 and §90.205(b): the maximum transmitter output power is 300W for operating band within 25-50Mhz.

4.2 Test Procedure

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

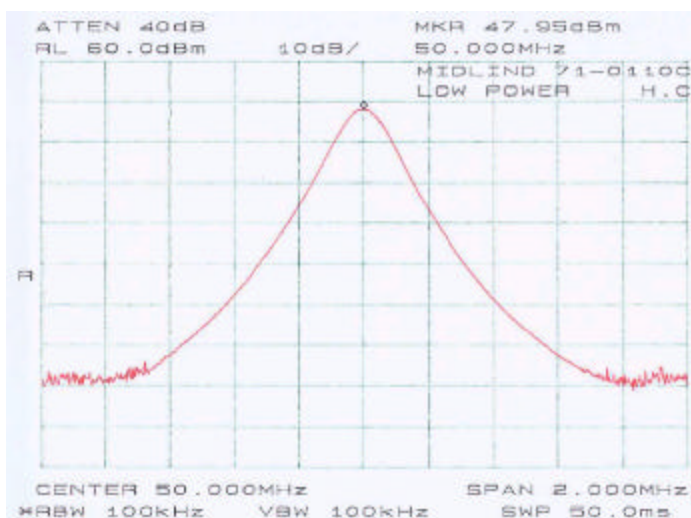
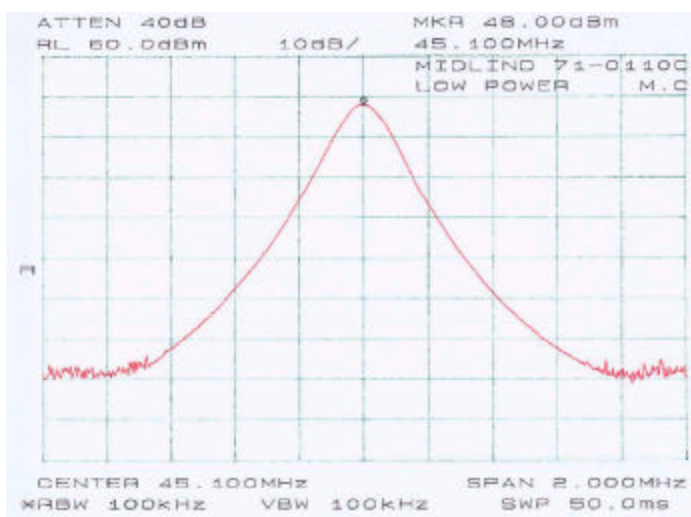
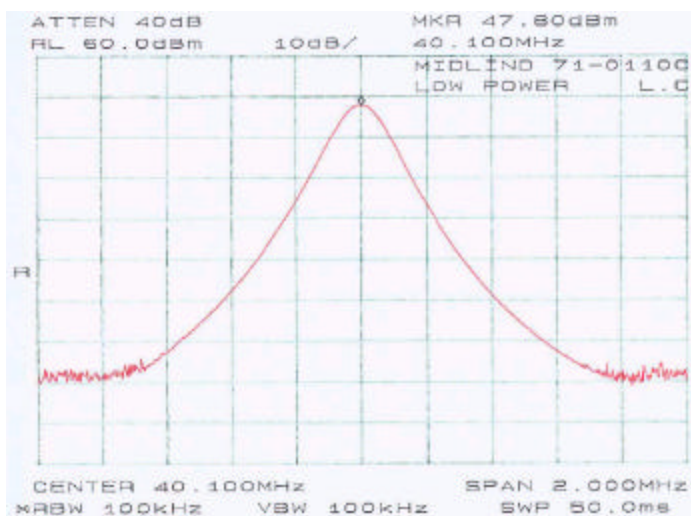
4.3 Test Equipment

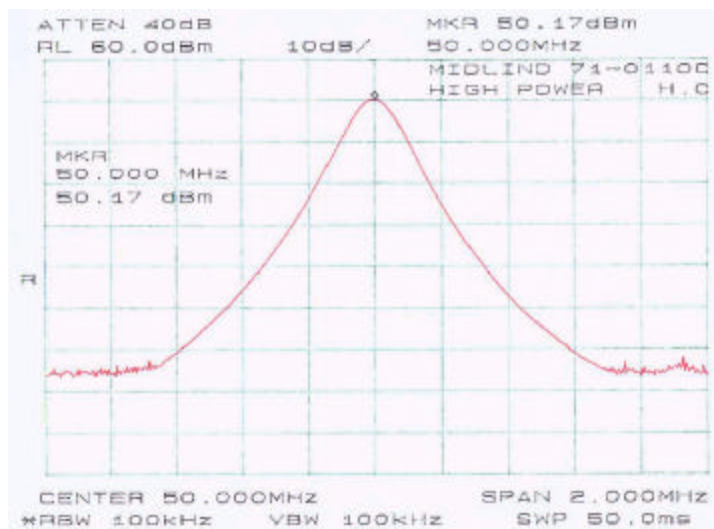
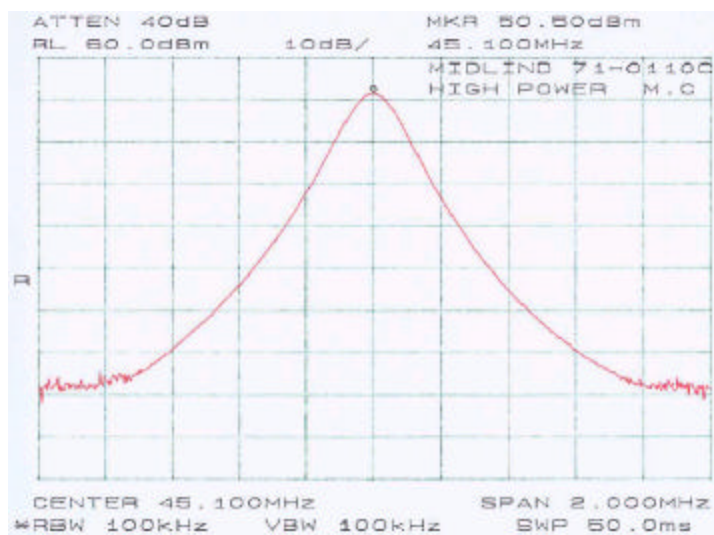
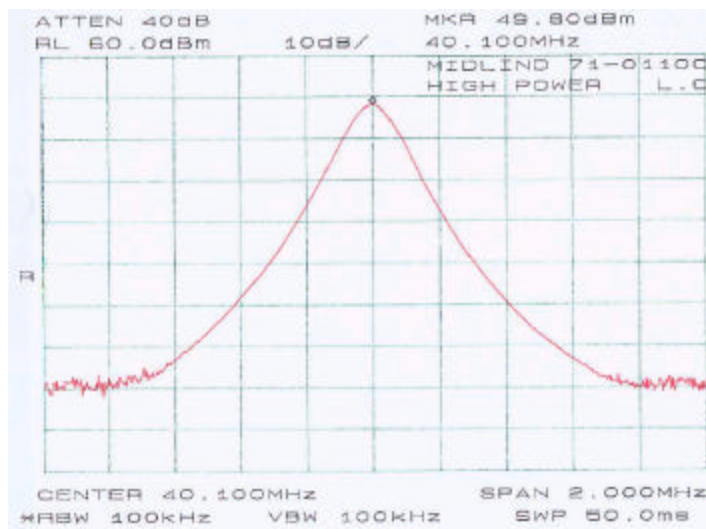
Hewlett Packard HP8565E Spectrum Analyzer
Hewlett Packard HP 7470A Plotter
HP8920A RF Communications Test Set
Electro Impulse AX-1000-30 1000W Attenuator

4.4 Test Results

Transmitter	Channel	Frequency	Output Power in dBm	Output Power in W	Limit (W)
Low Power	Low	40.1	47.80	60.26	300
	Middle	45.1	48.00	63.10	300
	High	50	47.95	62.37	300
High Power	Low	40.1	49.80	95.50	300
	Middle	45.1	50.50	112.20	300
	High	50	50.17	103.99	300

Please refer to the following plots.





5 - MODULATION CHARACTERISTICS

5.1 Provision Applicable

Per FCC § 2.1047, § 90.207, and §90.210(b), modulation is required to report.

5.2 Test Procedure

5.2.1 Audio Frequency Response

The RF output of the transceiver was connected to the input of a FM deviation meter through sufficient attenuation so as not to overload the meter or distort the reading. An audio signal generator was coupled into the external microphone jack of the transceiver, or alternatively, the microphone element was removed the generator output was connected to the microphone connectors.

The audio signal input level was adjusted to obtain 20% of the maximum rated system deviation at 1 kHz, and recorded as DEVREF. With the audio signal generator level unchanged, set the generator frequency between 100 Hz to 5000 Hz. The transmitter deviations (DEVFREQ) were measured and the audio frequency response was calculated as

$$20\log_{10} [DEV_{FREQ} / DEV_{REF}]$$

5.2.2 Audio Low-Pass Filter Response

An audio signal generator and an audio spectrum analyzer were connected to the input and output of the post limiter low pass filter respectively. The audio signal generator frequency was set between 1000 Hz and the upper low pass filter limit. The audio frequency response at test frequency was calculated as

$$LEV_{FREQ} - LEV_{REF}$$

5.2.3 Modulation Limiting

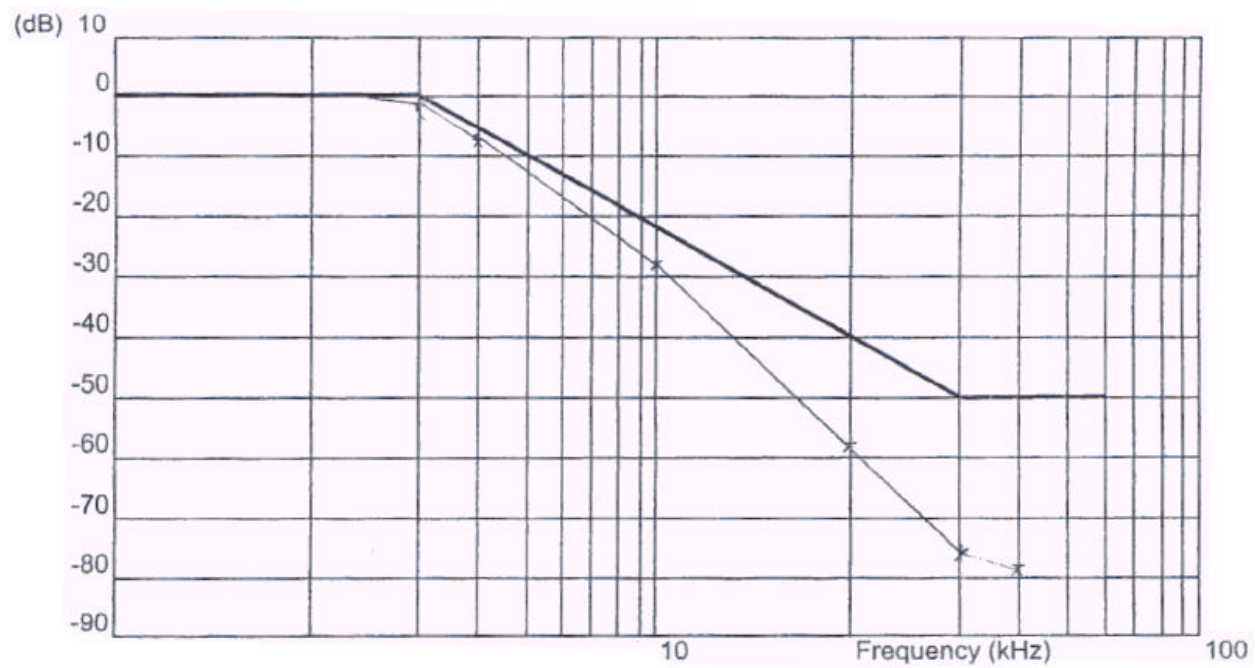
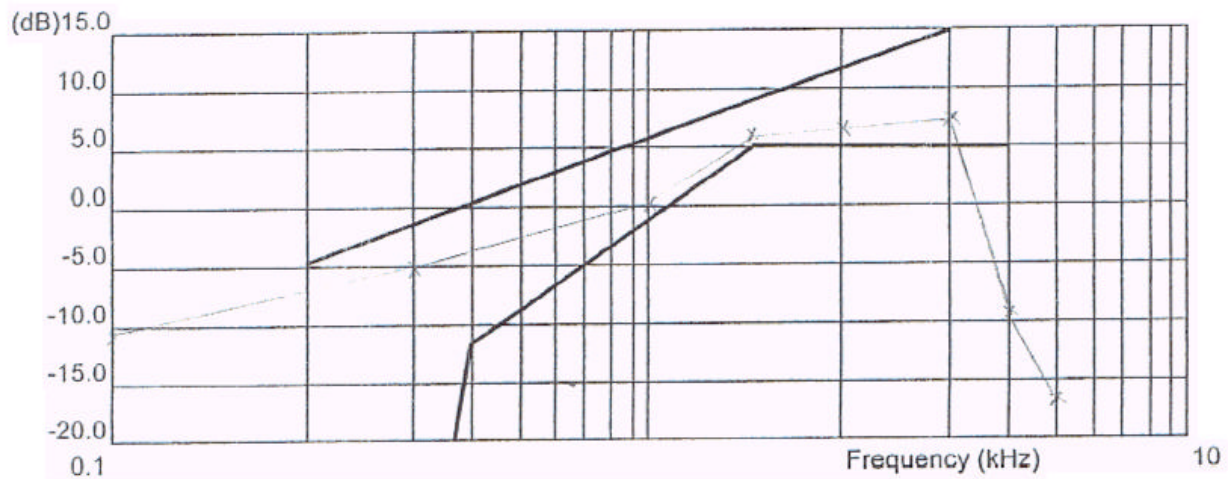
With the same setup as section 5.2.1 above, at three different modulating frequencies, the output level of the audio generator was varied and the FM deviation level was recorded.

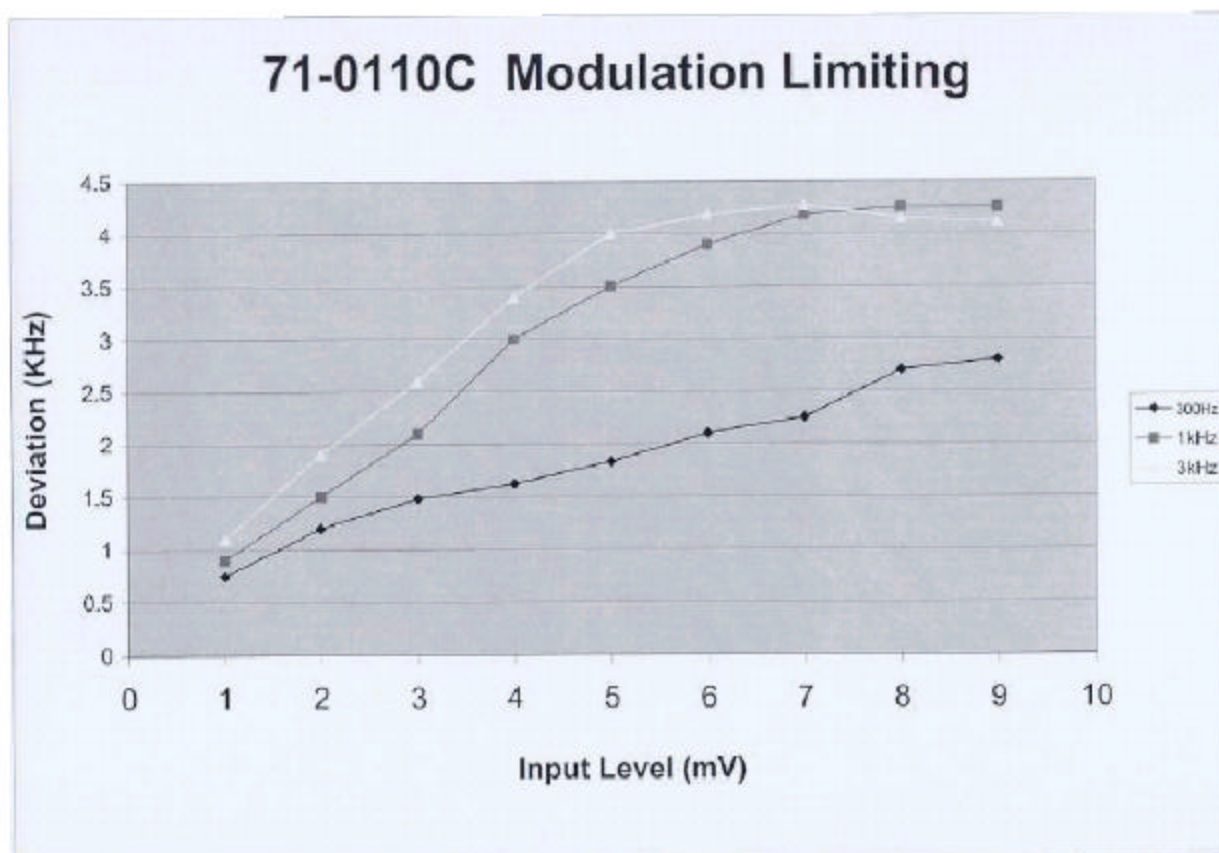
5.3 Test Equipment

Hewlett Packard HP8565E Spectrum Analyzer
Hewlett Packard HP 7470A Plotter
Hewlett Packard HP8901A Modulation Analyzer
Lecroy 9350A Oscilloscope
Nan Yan NY2201 Audio Generator

5.4 Test Results

The plot(s) of modulation characteristic is presented hereinafter as reference.





6 - OCCUPIED BANDWIDTH OF EMISSION

6.1 Provision Applicable

Per FCC §2.1049, §90.209(b)(5), and §90.210 (b), the authorized bandwidth is 20kHz for operating band within 25-50 MHz.

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:

$$43 + 10 \log(P)_{\text{dB}}$$

6.2 Test Procedure

The RF output of the transmitter was connected to the input of the spectrum analyzer through sufficient attenuation. The RBW of the spectrum analyzer was set at 300Hz, and the spectrum was recorded in $\pm$ 50KHz from the carrier Frequency.

6.3 Test Equipment

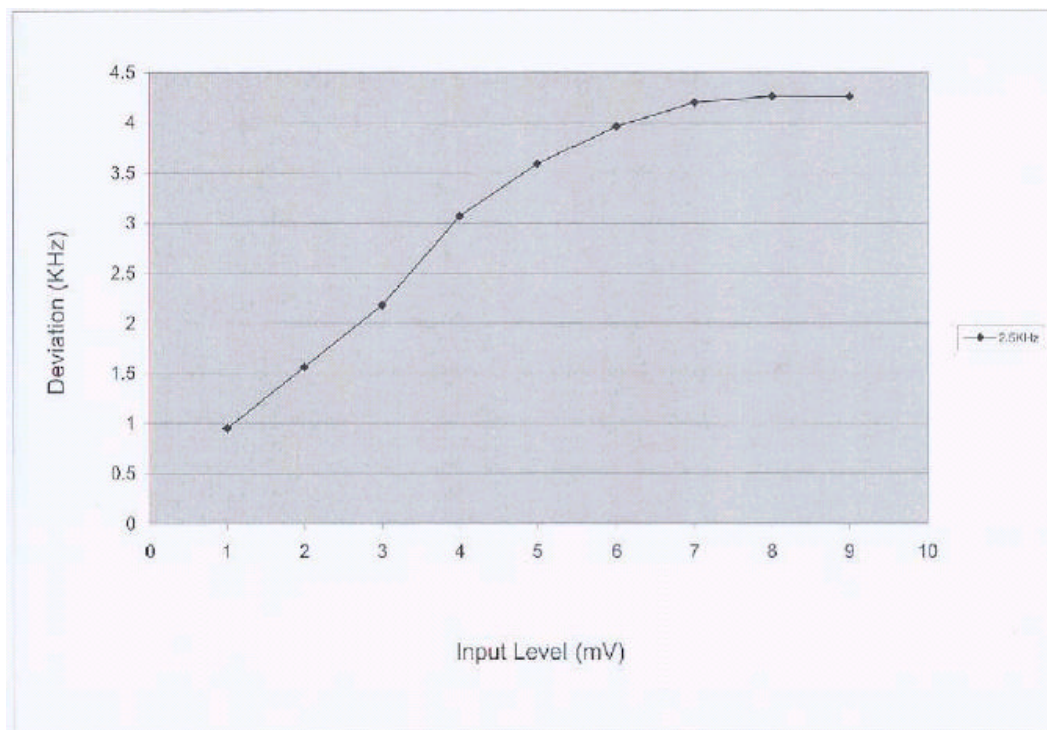
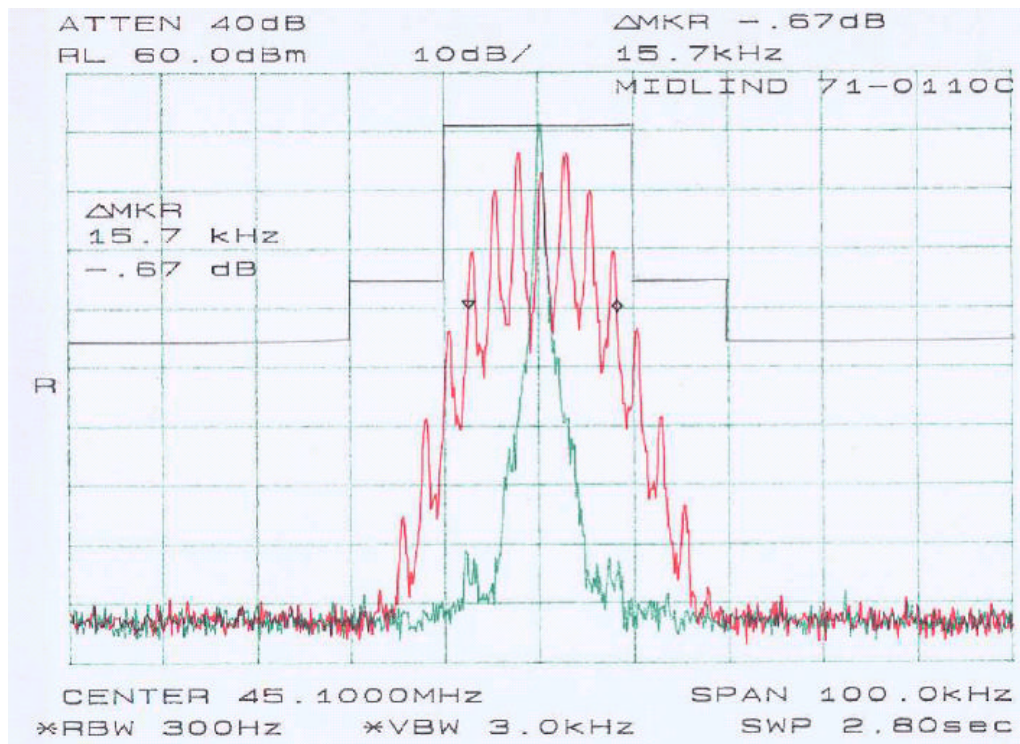
Hewlett Packard HP8565E Spectrum Analyzer
Hewlett Packard HP 7470A Plotter
Nan Yan NY2201 Audio Generator
Hewlett Packard HP8901A Modulation Analyzer

6.4 Test Results

Test Result: Pass
Please refer the following curve and plots.

6.5 Emission Designator

$$2M + 2D = (2 \times 3 \text{ kHz}) + (2 \times 4.5 \text{ kHz}) = 15K0F3E$$



7 - RADIATED SPURIOUS EMISSION

7.1 Provision Applicable

Per FCC §2.1051 and FCC §90.210(b)

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

$$43 + 10 \log(P) \text{ dB}$$

7.2 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 = $10 \lg(\text{TXpwr in Watts}/0.001)$ – the absolute level

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

7.3 Test Equipment

CDI B100/200/300 Biconical Antennas
EMCO Bi-logcon Antenna
EMCO 3115 Horn Antenna
HP 8564E Spectrum Analyzer
Preamplifiers
HP8640 Generator
Non-radiating Load

7.4 Test Result

Low Frequency: -28.8 dB at 120.3 MHz
Middle Frequency: -27.9 dB 135.3 MHz
High Frequency: -28.9 dB at 150 MHz

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 DB	Level dBm	Limit dBm	Margin DB
Low Frequency												
40.1	95.7	320	2.2	v	40.1	39.7	v	0	0.1	39.6		
40.1	101.6	290	2.8	h	40.1	41.5	h	0	0.1	41.4		
120.3	47.1	110	1.5	h	120.3	-41.5	h	0	0.3	-41.8	-13	-28.8
80.2	45.8	130	1.5	h	80.2	-44.1	h	0	0.1	-44.2	-13	-31.2
160.4	40.1	210	1.8	h	160.4	-44.5	h	0	0.3	-44.8	-13	-31.8
120.3	40.7	15	1.8	v	120.3	-44.7	v	0	0.3	-45	-13	-32
80.2	42.2	60	1.5	v	80.2	-45.2	v	0	0.1	-45.3	-13	-32.3
160.4	36.4	250	1.5	v	160.4	-45.8	v	0	0.3	-46.1	-13	-33.1
Middle Frequency												
45.1	96.4	15	1.2	v	45.1	40.6	v	0	0.1	40.5		
45.1	103.2	270	1.8	h	45.1	44.1	h	0	0.1	44		
135.3	48.8	120	2	h	135.3	-40.6	h	0	0.3	-40.9	-13	-27.9
180.4	40.7	120	1.8	h	180.4	-43.2	h	0	0.3	-43.5	-13	-30.5
90.2	46.5	60	1.2	h	90.2	-43.8	h	0	0.1	-43.9	-13	-30.9
135.3	41.3	90	1.8	v	135.3	-44.2	v	0	0.3	-44.5	-13	-31.5
90.2	42.6	0	1.5	v	90.2	-44.7	v	0	0.1	-44.8	-13	-31.8
180.4	36.4	30	1.2	v	180.4	-45.8	v	0	0.3	-46.1	-13	-33.1
High Frequency												
50	93.3	250	2	v	50	38.8	v	0	0.1	38.7		
50	96.5	300	2.8	h	50	40.7	h	0	0.1	40.6		
150	47.1	120	2	h	150	-41.6	h	0	0.3	-41.9	-13	-28.9
200	40.2	310	1.5	h	200	-43.8	h	0	0.3	-44.1	-13	-31.1
100	45.5	15	1.8	h	100	-44.7	h	0	0.1	-44.8	-13	-31.8
100	41.8	90	1.6	v	100	-45.4	v	0	0.1	-45.5	-13	-32.5
150	40.4	160	1.8	v	150	-45.2	v	0	0.3	-45.5	-13	-32.5
200	36.2	0	1.5	v	200	-46.3	v	0	0.3	-46.6	-13	-33.6

Compliance Statement:

According to FCC Part 15, at 3-meter distance the emission from an intentional radiator shall not exceed the field strength level 40 dBuV/m within 30-88 MHz, 43.5 dBuV/m within 88-216 MHz, 46dBuV/m within 226-960 MHz, 54BuV/m above 960 MHz. The level of any unwanted emissions shall not exceed the level of the fundamental frequency.

The levels of unwanted emission of this device were below the above limits. This device was compliant with the FCC Part 15.

Result: Pass

8 - SPURIOUS EMISSION AT ANTENNA TERMINAL

8.1 Standard Applicable

Per FCC §2.1051 and FCC §90.210(b)

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

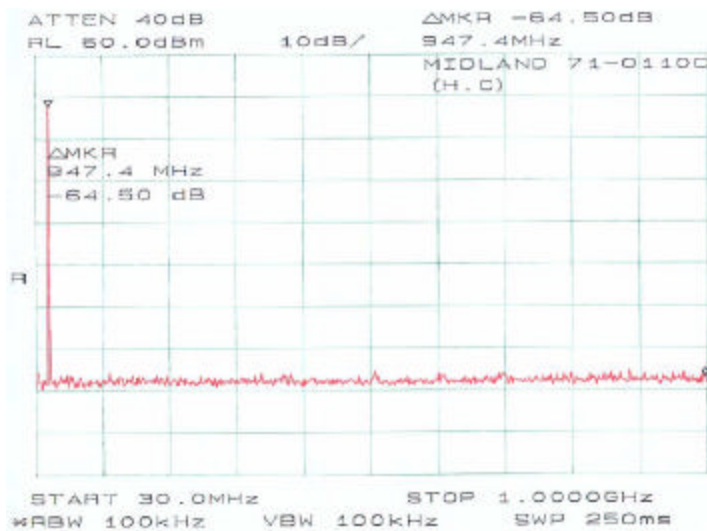
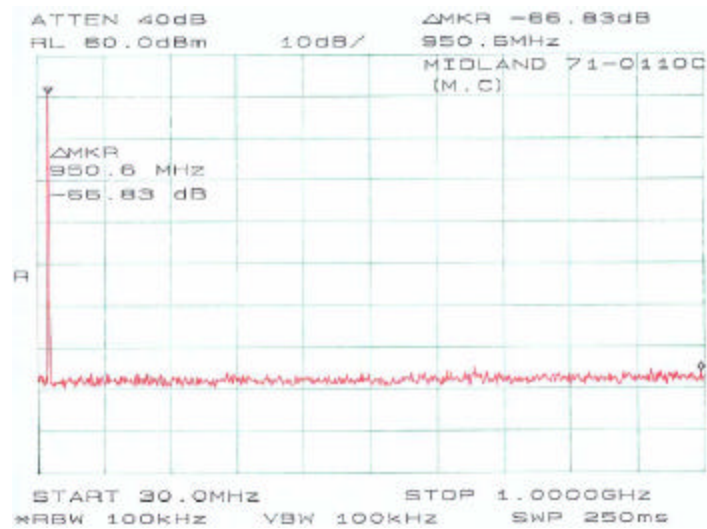
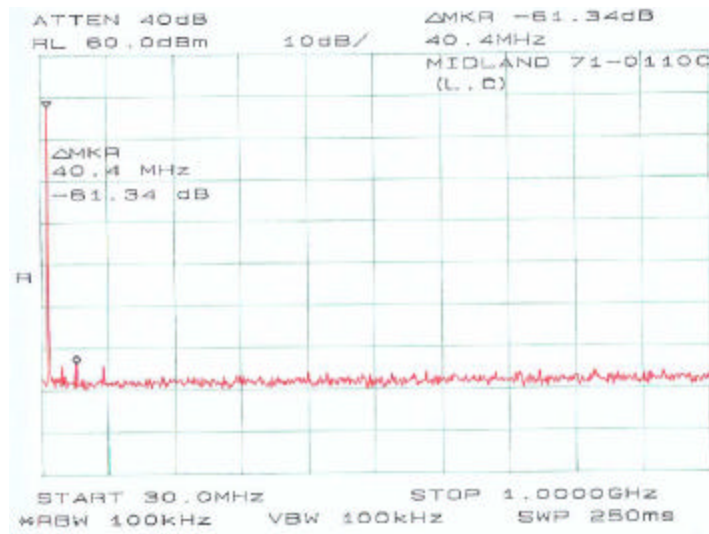
$43 + 10 \log(P)$ dB

8.2 Measurement 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.

8.3 Test Result

Please refer to following plots.



9 - AC LINE CONDUCTED EMISSIONS

9.1 Applicable Requirements

According to ANSI C63.4 and FCC §15.107, for equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is connected back onto the AC power line on any frequency or frequencies within the band 450 kHz to 30 MHz shall not exceed 250 microvolts. Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminals.

9.2 Test Equipment

HP 8566B Spectrum Analyzer
LISN

9.3 Test Results

Not applicable because of DC power supply.

10 - FREQUENCY STABILITY MEASUREMENT

10.1 Provision Applicable

According to §90.213, for operating band within 25-50MHz and output power > 2 watts, the frequency stability limit is 20 ppm.

10.2 Test Procedure

10.2.1 Frequency stability versus environmental temperature

The equipment under test was connected to an external DC power supply and the RF output was connected to a frequency counter via feedthrough attenuators. The EUT was placed inside the temperature chamber.

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

10.2.2 Frequency Stability versus Input Voltage

At room temperature ($25\pm 5^{\circ}\text{C}$), an external variable DC power supply was connected to the EUT. The frequency of the transmitter was measured for 115%, 100% and 85% of the nominal operating input voltage.

10.3 Test Equipment

Temperature Chamber, -50°C to $+100^{\circ}\text{C}$
Hewlett Packard HP8566B Spectrum Analyzer
Hewlett Packard HP 7470A Plotter
Hewlett Packard HP 5383A Frequency Counter
Condor Power Supply, GPFC250-12

10.4 Test Results

Reference Frequency: 45.1000 MHz, Limit: 20 ppm			
Environment Temperature (°C)	Power Supplied (Vdc)	Frequency Measure with Time Elapsed	
		MCF (MHz)	PPM Error
60	13.6	45.1007	17.4
50	13.6	45.1007	17.4
40	13.6	45.1005	12.4
30	13.6	45.1003	7.5
20	13.6	45.1000	0
10	13.6	45.1000	0
0	13.6	45.0998	-4.9
-10	13.6	45.0998	-4.9
-20	13.6	45.0997	-7.5
-30	13.6	45.0997	-7.5

Frequency Stability Versus Input Voltage

Reference Frequency: 45.1000 MHz, Limit: 20 ppm						
Power Supplied (Vdc)	Frequency Measure with Time Elapsed					
	2 Minutes		5 Minutes		10 Minutes	
	MHz	ppm	MHz	ppm	MHz	ppm
15.6	45.1000	0	45.1002	4.9	45.1002	4.9
13.6	45.1000	0	45.1000	0	45.0999	-2.5
11.5	45.1000	0	45.0999	-2.5	45.0997	-7.5

Conclusion: The EUT complied with the applicable Frequency Stability Limits.