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ENGINEERING STATEMENT

For Type Certification of

MIDLAND CONSUMER RADIO

Model No: 77-235ESP

FCC ID: MMA77235ESP

I am an Electronics Engineer, a principal in the firm of Hyak Laboratories, Inc., Springfield, Virginia. My education and experience are a matter of record with the Federal Communications Commission.

Hyak Laboratories, Inc. has been authorized by Midland Consumer Radio to make type certification measurements on the 77-235ESP transceiver. These tests were made by me or under my supervision in our Springfield laboratory.

Test data and documentation required by the FCC for type certification are included in this report. It is submitted that the above-mentioned transceiver meets all applicable FCC requirements.

Rowland S. Johnson

Dated: October 19, 1998

A. INTRODUCTION

The following data are submitted in connection with this request for type certification of the 77-235ESP transceiver in accordance with Part 2, Subpart J of the FCC Rules.

The 77-235ESP is a double-sideband amplitude modulated transmitter/receiver combination intended for mobile operation in the citizens radio service. The transmitter has 40-channel capability in the 26.965 - 27.405 MHz band utilizing phase locked loop (PLL) technology.

B. GENERAL INFORMATION REQUIRED FOR TYPE ACCEPTANCE (Paragraph 2.983 of the Rules)

1. Name of applicant: Midland Consumer Radio

2. Identification of equipment: FCC ID: MMA77235ESP

   a. The equipment identification label is shown in Appendix 1.
   b. Photographs of the equipment are included in Appendix 2.

3. Quantity production is planned.

4. Technical description:

   a. 6k00A3E emission
   b. Frequency range: 26.965 - 27.405 MHz
   c. Operating power of transmitter is fixed at the factory at less than 4 watts, AM.
   d. Maximum power rating under 95.635(c) of the Rules is 4 watts.
   e. The dc voltage and dc currents at final amplifier:

      Collector voltage: 13.7 V
      Collector current: 590 mA, 13.8 Vdc.

   f. Function of each active semiconductor device: See Appendix 3.
   g. Complete circuit diagram is included as Appendix 4.
   h. A draft instruction book is submitted as Appendix 5.
   i. The transmitter tune-up procedure is included in Appendix 6.
   j. A description of circuits for stabilizing frequency is included in Appendix 7.
   k. A description of circuits and devices employed for suppression of spurious radiation and for limiting modulation is included in Appendix 8.
   l. Not applicable.

B. GENERAL INFORMATION...(Continued)

5. Data for 2.985 through 2.997 follow this section.

6. RF Power Output (Paragraph 2.985(a),(b)(1) of the Rules)

RF power output in the AM mode was measured with a Bird 4421 RF power meter and a Narda 765-20 50 ohm dummy load. (The transmitter was tuned by the factory according to the procedure of Exhibit 4.) Power was measured with a supply voltage of 13.8 Vdc and indicated:

Channel	Power, watts
1	4.0
21	4.0
40	4.0

C. MODULATION CHARACTERISTICS

1. AF Frequency Response

A curve showing frequency response of the transmitter is shown in Figure 1. Reference level was taken as a 1 kHz tone with 50% modulation, as measured on a Datatech 209 modulation meter, using a Audio Precision TRMS voltmeter and tracking generator.

2. Modulation Limiting

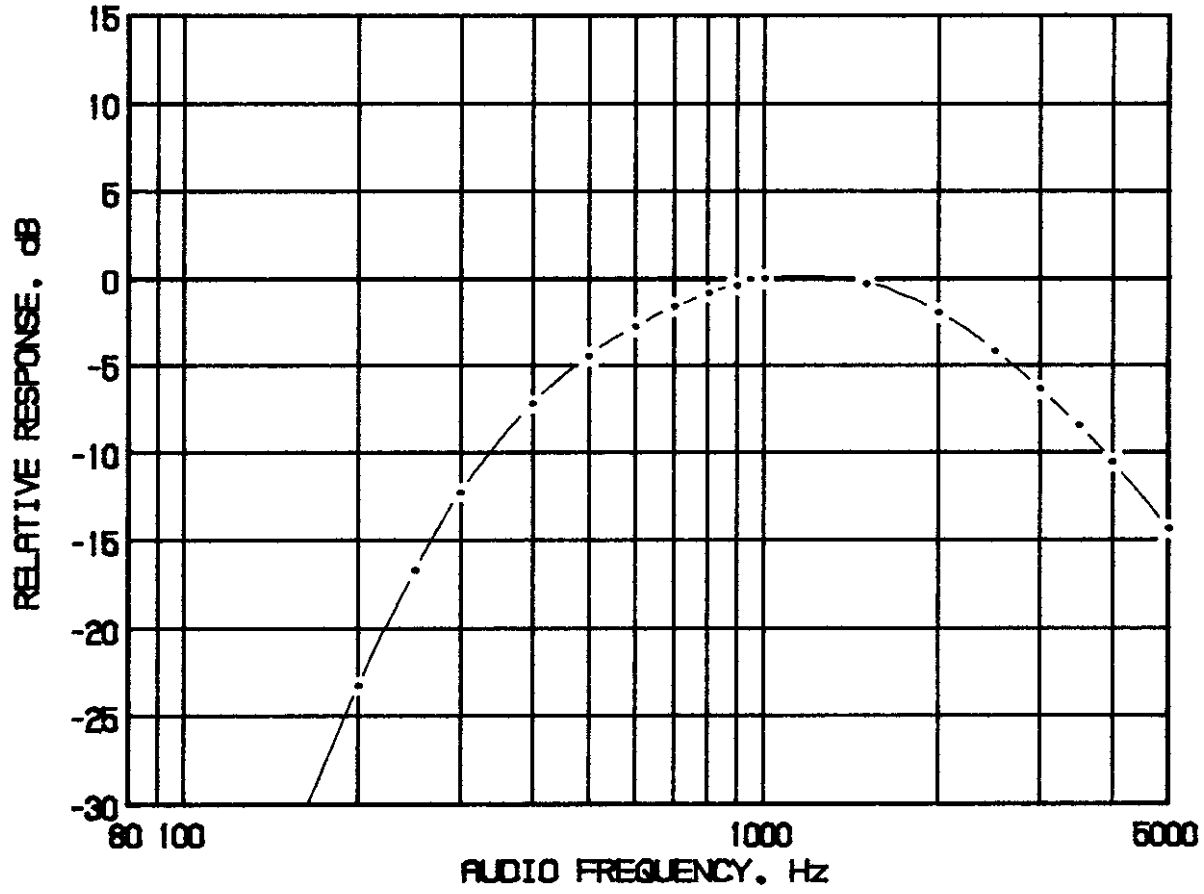
Curves of AM modulation limiting for both positive and negative peaks are shown in Figures 2a and 2b, respectively. Characteristics at 300, 1200, and 2500 Hz are shown using a Datatech 209 modulation meter. Signal level was established with a Audio Precision TRMS voltmeter and tracking generator. The curves show compliance with Paragraph 95.633(d) of the Rules.

3. Modulation Limiter Attack Time

Modulation limiter attack time was measured by applying to the microphone input terminals a pulsed tone at 2500 Hz, 16 dB above the level required for 50% modulation at the frequency of maximum response, 1200 Hz. The spectrum analyzer was tuned to upper and lower fourth-order sidebands in the time domain. Sweep speed was 100 milliseconds per division. Plots are included as Figures 3a and 3b. Any transients observed in excess of 33 dB attenuation as referenced to the carrier were less than 20 ms in duration.

FIGURE 1

TRANSMITTER FREQUENCY RESPONSE

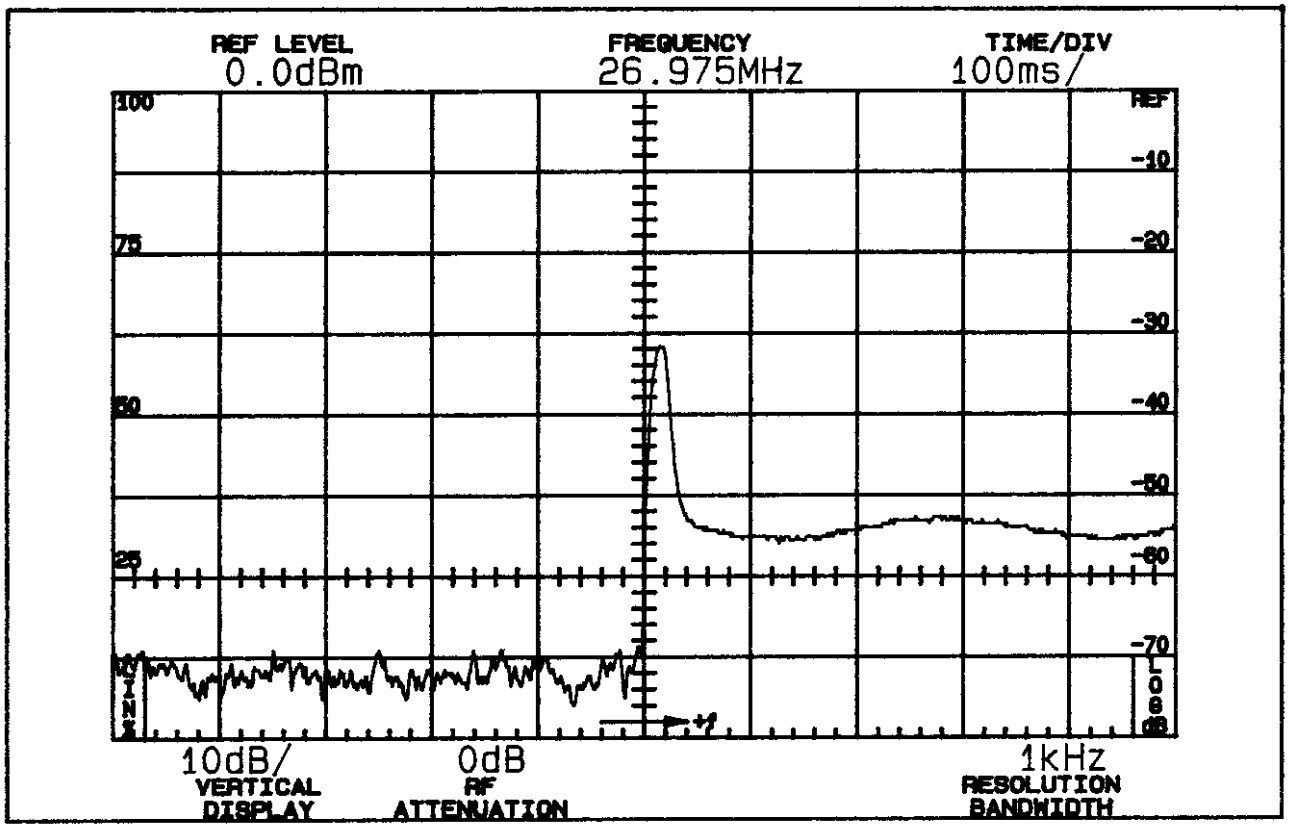


TRANSMITTER FREQUENCY RESPONSE
FCC ID: MMA77235ESP

FIGURE 1

FIGURE 3a

MODULATION LIMITER ATTACK TIME



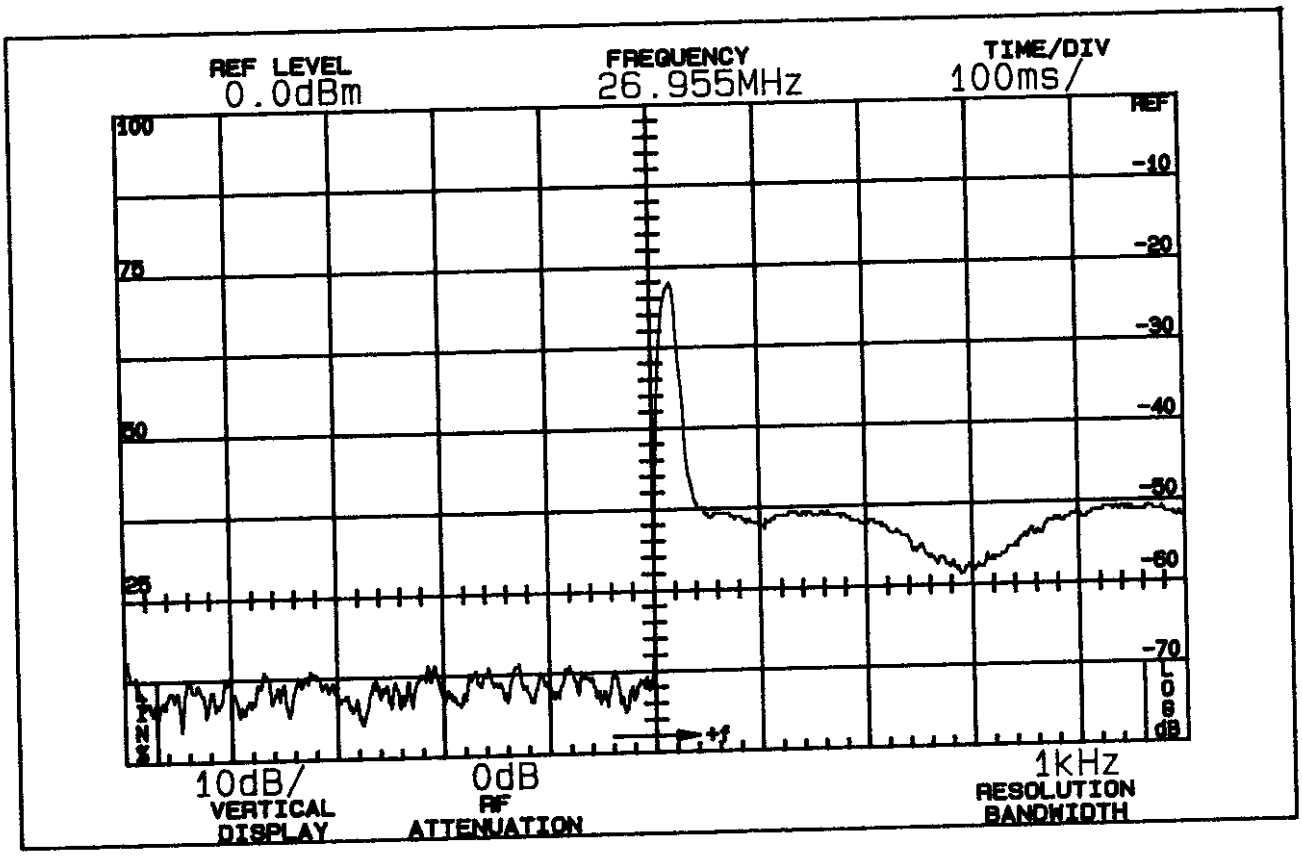
Measurement Conditions: 16 dB over 50% modulation level at 1200 Hz with 2500 Hz tone, upper fourth order sideband; horizontal scale 100 ms/div.

UPPER FOURTH-ORDER SIDEBAND
LIMITER ATTACK TIME
FCC ID: MMA77235ESP

FIGURE 3a

FIGURE 3b

MODULATION LIMITER ATTACK TIME



Measurement Conditions: 16 dB over 50% modulation level at 1200 Hz with 2500 Hz tone, lower fourth order sideband; horizontal scale 100 ms/div.

LOWER FOURTH-ORDER SIDEBAND
LIMITER ATTACK TIME
FCC ID: MMA77235ESP

FIGURE 3b

C. MODULATION CHARACTERISTICS (Continued)

4. Occupied Bandwidth - AM
(Paragraph 2.989(c) of the Rules)

Figure 4 is a plot of the sideband envelope of the transmitter taken from a Tektronix 494P spectrum analyzer. Modulation corresponded to conditions of 2.989(a) and consisted of 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50% modulation at 1200 Hz, the frequency of maximum response. Measured modulation at 1200 Hz was 86% positive, 85% negative.

The plot is within the limits imposed by Paragraph 95.631(b)(1,3) for double sideband AM modulation. The horizontal scale, frequency, is 10 kHz per division and the vertical scale, amplitude, is a logarithmic presentation equal to 10 dB per division.

Reference carrier was set to 0 dB.

D. SPURIOUS EMISSIONS AT THE ANTENNA TERMINALS
(Paragraph 2.991 of the Rules)

The 77-235ESP transmitter was tested for spurious emissions at the antenna terminals while the equipment was modulated with a 2500 Hz signal, 16 dB above minimum input signal for 50% modulation at 1200 Hz, the frequency of highest sensitivity.

Measurements were made with Tektronix 494P spectrum analyzer coupled to the transmitter output terminal through Narda 765-20 50 ohm power attenuation.

In order to improve measurement system dynamic range, a series trap tuned to the carrier frequency was used on the Narda attenuator output. The trap, which had negligible shunt attenuation at the second harmonic and high frequencies, provided 26 dB attenuation of the fundamental. The trap was not used during close-in (within 10 MHz of the carrier) spurious measurements.

During the tests, the transmitter was terminated in the Narda 765-20 dummy load. Power was monitored on a Bird 43 Thru-Line wattmeter; supply was 13.8 Vdc throughout the tests.

Spurious emission was measured on Channels 1, 21, and 40 throughout the RF spectrum from 10 to 300 MHz. Any emissions that were between the 60 dB attenuation required and the noise floor of the spectrum analyzer were recorded. Data are shown in Table 1.

TABLE 1

TRANSMITTER CONDUCTED SPURIOUS

Channel	Spurious Frequency MHz	dB Below Unmod Carrier Ref.
1	53.930	71
1	80.895	80
1	107.860	95
1	134.825	86
1	161.790	94
1	188.755	90
1	215.720	94
1	242.685	94
1	269.650	94
21	54.430	70
21	81.645	79
21	108.860	96
21	136.075	84
21	163.290	92
21	190.505	92
21	217.720	94
21	244.935	92
21	272.150	93
40	54.810	70
40	82.215	83
40	109.620	96
40	137.025	84
40	164.430	93
40	191.835	96
40	219.240	100
40	246.645	94
40	274.405	94
	Required:	60

All other spurious were over 20 dB below required 60 dB suppression.

E. FIELD STRENGTH MEASUREMENTS OF SPURIOUS RADIATION
(Paragraph 2.993(a)(b,2) of the Rules)

Field intensity measurements of radiated spurious emissions from the 77-235ESP transmitter were made with a Tektronix 494P spectrum analyzer and dummy load located in an open field 3 meters from the test antenna. Output power was 4.0 watts. The supply voltage was 13.8 Vdc. The transmitter and test antennae were arranged according to OCE 42 to maximize pickup. The unit has no accessory jacks. Both vertical and horizontal test antenna polarization were employed.

Measurements were made from 10 MHz to 10 times the maximum operating frequency of 26.965 or 270 MHz.

Reference level for the spurious radiations was taken as an ideal dipole excited by 4.0 watts, the output power of the transmitter according to the following relationship:*

$$E = \frac{(49.2 \times P_t)^{1/2}}{R}$$

where E = electric-field intensity in volts/meter

P_t = transmitter power in watts

R = distance in meters

for this case $E = \frac{(49.2 \times 4.0)^{1/2}}{3} = 4.7$ V/m

Since the spectrum analyzer is calibrated in decibels above one milliwatt (dBm):

4.7 volts/meter $= 4.7 \times 10^6$ uV/m

dBu/m $= 20 \text{ Log}_{10}(4.7 \times 10^6)$

$= 133$ dBu/m

Since 1 uV/m $= -107$ dBm, the reference becomes

$133 - 107 = 26$ dBm

Representing a conversion for convenience, from dBu to dBm. The measurement system was capable of detecting signals 100 dB or more below the carrier reference level. Data, including antenna factor and line loss corrections, are shown in Table 2.

*Reference Data for Radio Engineers, International Telephone and Telegraph Corporation, Sixth Edition.

G. FREQUENCY STABILITY (Continued)

TABLE 3

Temperature	Output Frequency, MHz
-29.8	27.064870
-20.0	27.065009
-10.2	27.065081
- 0.3	27.065094
10.5	27.065068
20.0	27.065023
30.2	27.064973
40.1	27.064930
50.0	27.064904
Maximum frequency error:	27.065000
	27.064870
	- .000130 MHz

FCC Rule 95.625(b) specifies .005% or a maximum of ± .001353 MHz.

G. FREQUENCY STABILITY AS A FUNCTION OF SUPPLY VOLTAGE (Paragraph 2.995(d)(2) of the Rules)

Oscillator frequency as a function of power supply voltage was measured with a HP 5385A digital frequency counter as supply voltage provided by Heath SP-5220 variable ac power supply was varied from ±15% above the nominal 13.8 Vdc. A Keithley 177 digital voltmeter was used to measure supply voltage at transmitter primary input terminals. Measurements were made at 20°C ambient. (See Table 4).

TABLE 4

Supply Voltage	Output Frequency, MHz
15.87	27.065024
15.18	27.065024
14.49	27.065023
13.80	27.065023
13.11	27.065022
12.42	27.065021
11.73	27.065020
Maximum frequency error:	27.065024
	27.065000
	+ .000024 MHz

FCC Rule 95.625(b) specifies .005% or a maximum of ± .0001353 MHz. No effects on frequency related to keying the unit were observed.

H. ADDITIONAL REQUIREMENTS FOR TYPE ACCEPTANCE
(Paragraph 95.665 of the Rules)

The 77-235ESP meets the applicable provision of 95.665(a).

External controls are limited to the following per 95.665(a):

1. Primary power connection
2. Microphone jack
3. RF output power connection
4. External speaker jack
5. On-off switch (combined with receiver volume control)
6. Not applicable, AM only
7. Not applicable
8. Transmitting frequency selector
9. Transmit-receive switch
10. Meter for monitoring transmitter performance
11. Meter/pilot lamp for RF output indication

The serial number of each unit will be implemented in accordance with 95.667.

A copy of Part 95, Subpart D, of the FCC rules for the Citizens Band Radio Service, current at the time of packing of the transmitter, must be furnished with each CB transmitter marketed per 95.669.

I. PLL RESTRICTIONS
(Per Public Notice of April 27, 1978)

The 77-235ESP meets the following conditions specified in the April 27, 1978 notice:

1. All frequency-determining elements, including crystals, PLL integrated circuits and channel selector switches are permanently wired and soldered in place.

2. The PLL integrated circuit has no more than six active leads and is BCD encoded.

3. The channel selection mechanism has only 40 positions.

4. The PLL integrated circuit has no "spare" or undedicated leads.

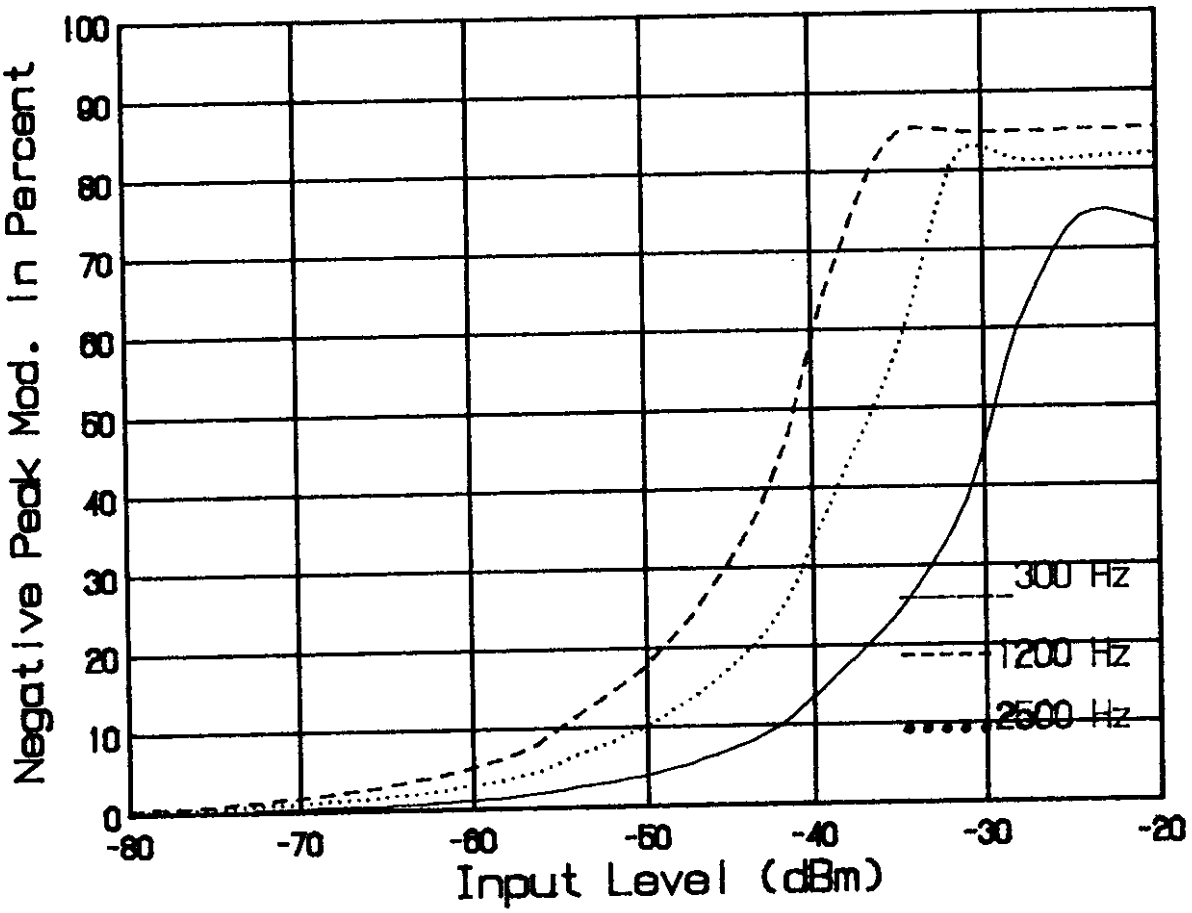
5. A copy of the PLL data sheet is shown in Appendix 9.

J. FINAL AMPLIFIER DATA

1. A copy of the final RF amplifier data sheet is included in Appendix 10.

FIGURE 2b

AM MODULATION LIMITING - NEGATIVE PEAKS



MODULATION LIMITING CHARACTERISTICS

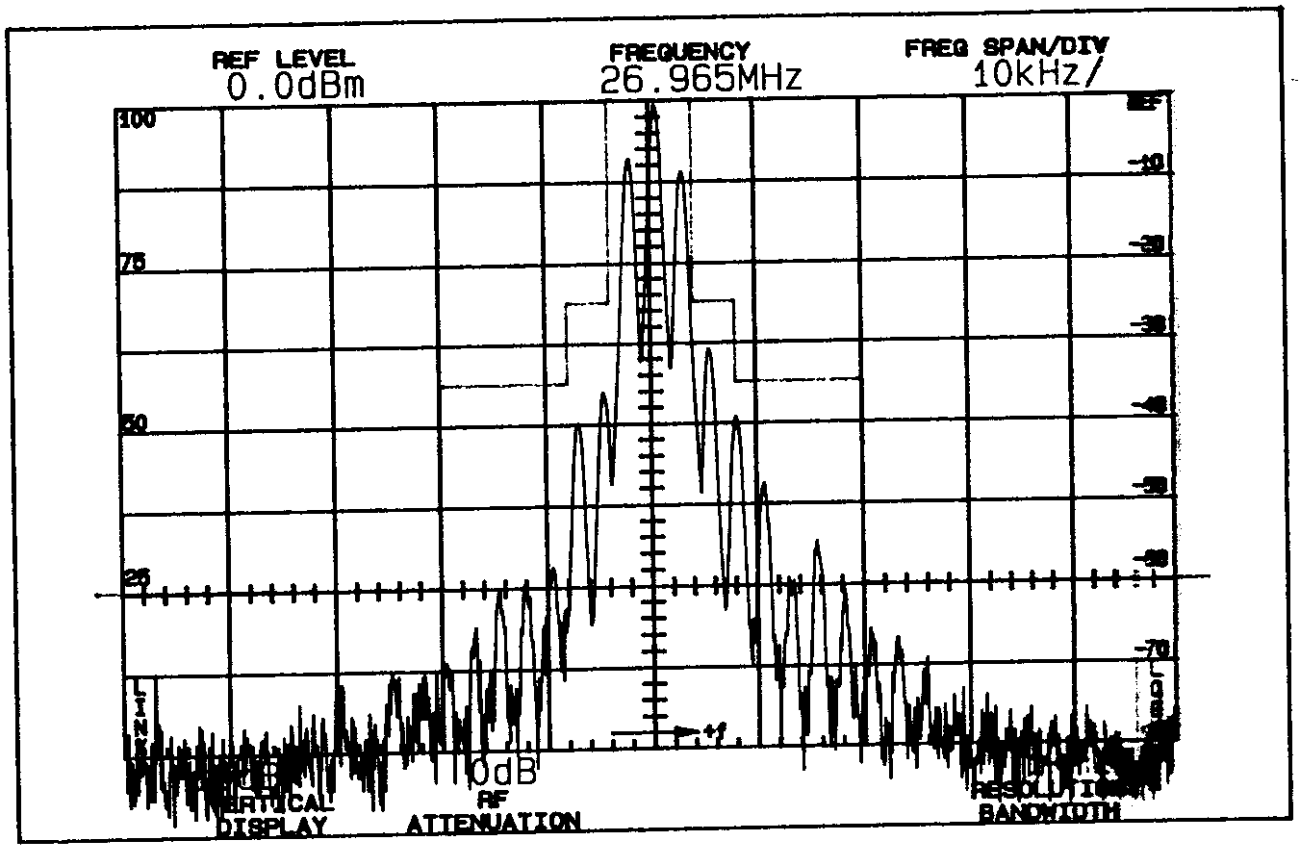
Percent modulation as a function of input level at microphone jack in dBm for 300 Hz, 1200 Hz, and 2500 Hz tones.

MODULATION LIMITING NEGATIVE PEAKS
FCC ID: MMA77235ESP

FIGURE 2b

FIGURE 4

OCCUPIED BANDWIDTH - AM



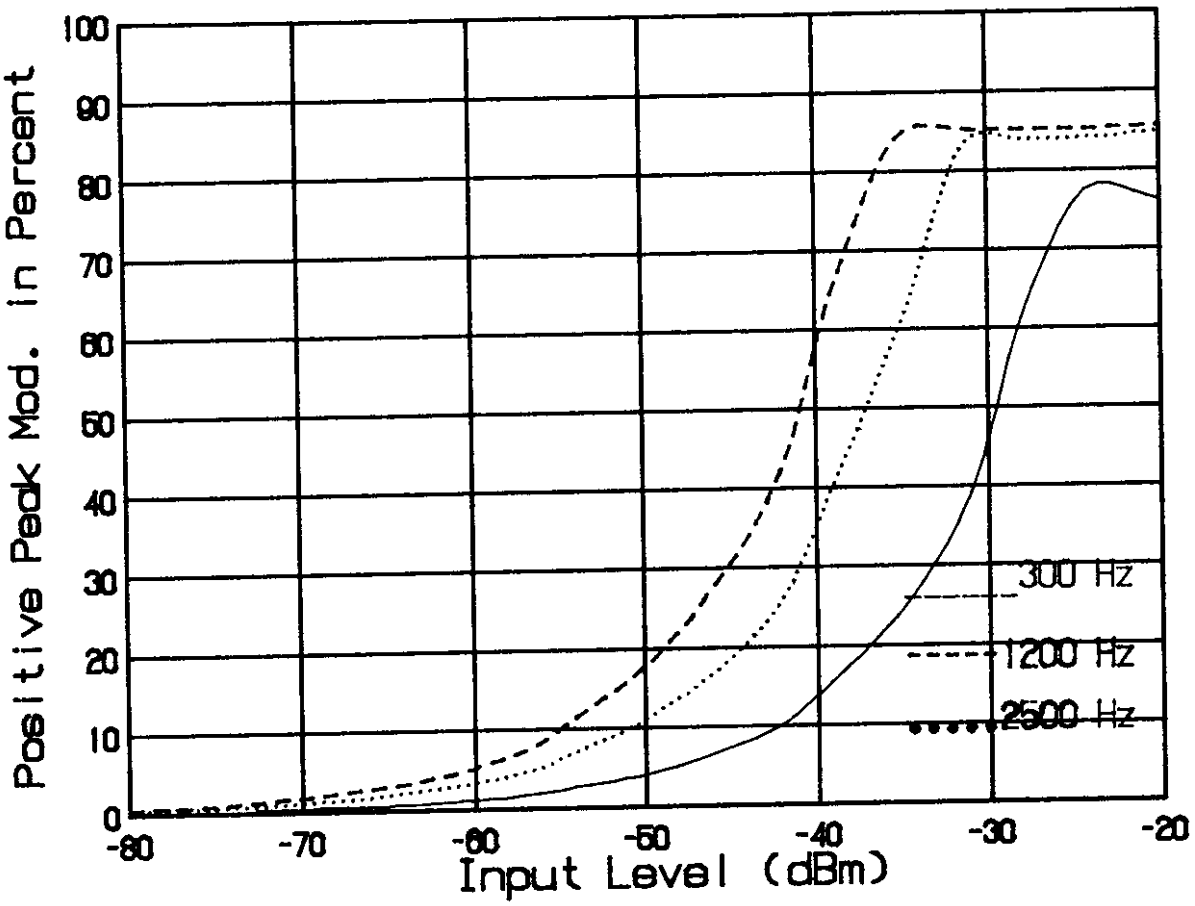
	ATTENUATION IN dB BELOW MEAN OUTPUT POWER Required
On any frequency more than 50% up to and including 100% of the authorized bandwidth, 8kHz (4-8kHz)	25
On any frequency more than 100%, up to and including 250% of the authorized bandwidth (8-20kHz)	35
On any frequency removed from the assigned frequency by more than 250% of the authorized bandwidth	60

OCCUPIED BANDWIDTH - AM
FCC ID: MMA77235ESP

FIGURE 4

FIGURE 2a

AM MODULATION LIMITING - POSITIVE PEAKS



MODULATION LIMITING CHARACTERISTICS

Percent modulation as a function of input level at microphone jack in dBm for 300 Hz, 1200 Hz, and 2500 Hz tones.

MODULATION LIMITING POSITIVE PEAKS
FCC ID: MMA77235ESP

FIGURE 2a