

HYAK LABORATORIES, INC.

7011 CALAMO STREET, SUITE 107
SPRINGFIELD, VIRGINIA 22150
(703) 451-1188
FAX (703) 644-7492

ENGINEERING STATEMENT

For Type Certification of
WIRELESS MARKETING CORPORATION

Model No: NR-150

FCC ID: MGPNR-150

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 Wireless Marketing Corporation to make type certification measurements on the NR-150 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: April 8, 1999

A. INTRODUCTION

The following data are submitted in connection with this request for type certification of the NR-150 transceiver in accordance with Part 2, Subpart J of the FCC Rules.

The NR-150 is both double-sideband amplitude modulated and single-sideband-suppressed-carrier transmitter/receiver combination intended for 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: Wireless Marketing Corporation
2. Identification of equipment: FCC ID: MGPNR-150
 - 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 or 4k00J3E emission
 - b. Frequency range: 26.965 - 27.406 MHz
 - c. Operating power of transmitter is fixed at the factory at less than 4 watts, AM; and 12 watts PEP.
 - d. Maximum power rating under 95.635(c) of the Rules is 4 watts, AM and 12 watts PEP.
 - e. The dc voltage and dc currents at final amplifier:

Collector voltage: 12.6 V
Collector current: 603 mA @ 13.8 Vdc input.
 - 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 volts, and indicated:

Channel	Power, watts		
	AM	LSB	USB
1	4.0	11.9	11.9
21	4.0	11.9	11.9
40	4.0	11.9	11.9

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

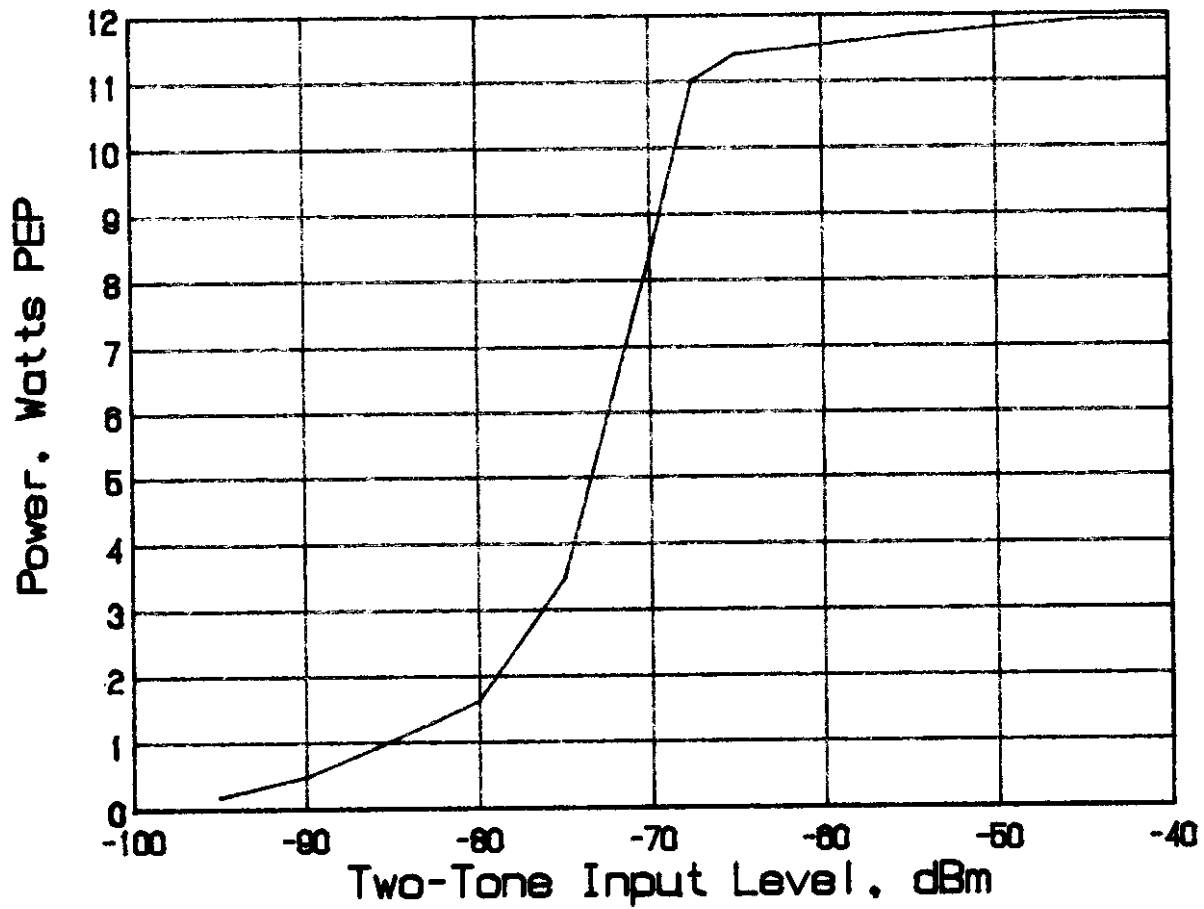
Curves of AM modulation limiting for both positive and negative peaks are shown in Figures 2a and 2b, respectively. Characteristics at 300, 1461, and 2500 Hz are shown using a Datatech 209 modulation meter. Signal level was established with a Audio Precision TRMS voltmeter and tracking generator. The 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, 1461 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

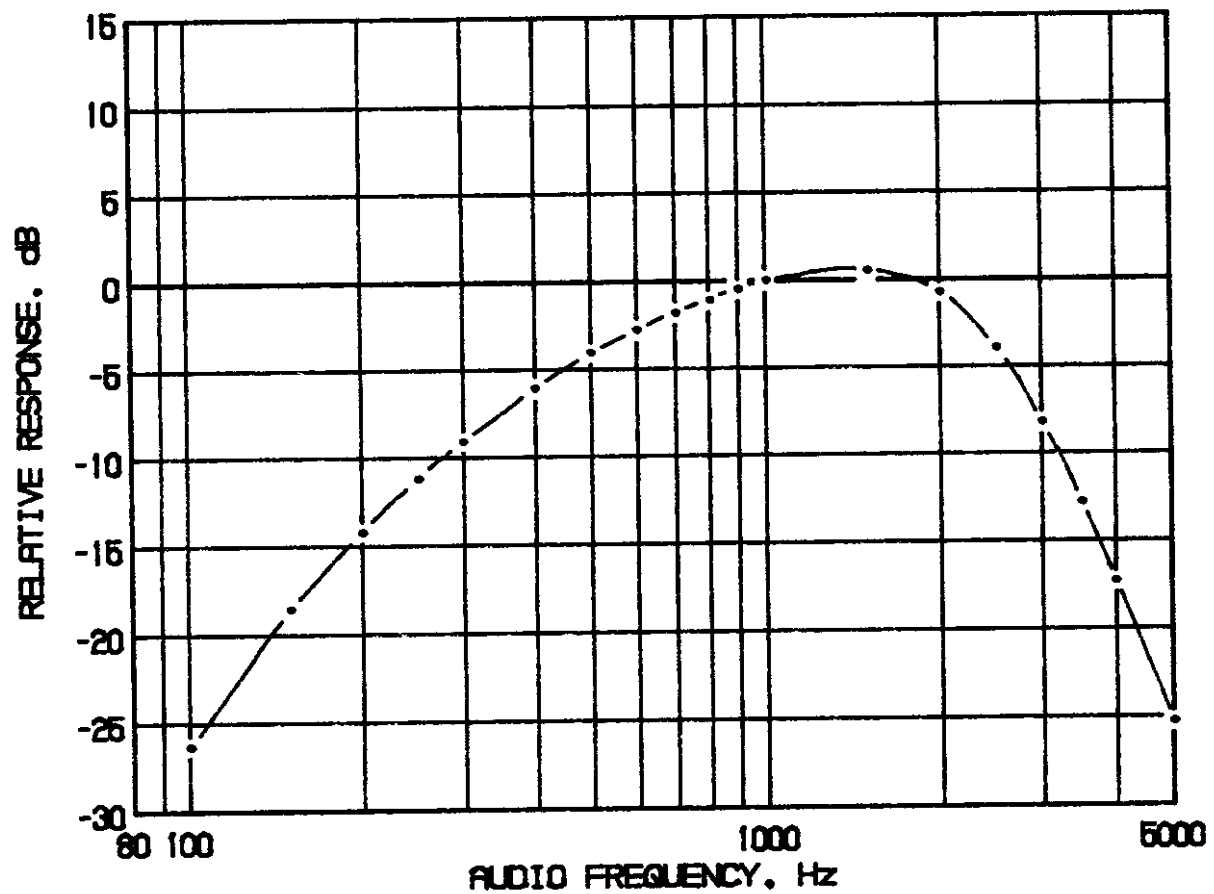
RF POWER OUTPUT VS AUDIO INPUT VOLTAGE
Two-Tone: 2400 + 500 Hz



SIDEBAND MODE
RF POWER OUTPUT VS AUDIO INPUT
FCC ID: MGPNR-150

FIGURE 1

FIGURE 2
TRANSMITTER FREQUENCY RESPONSE

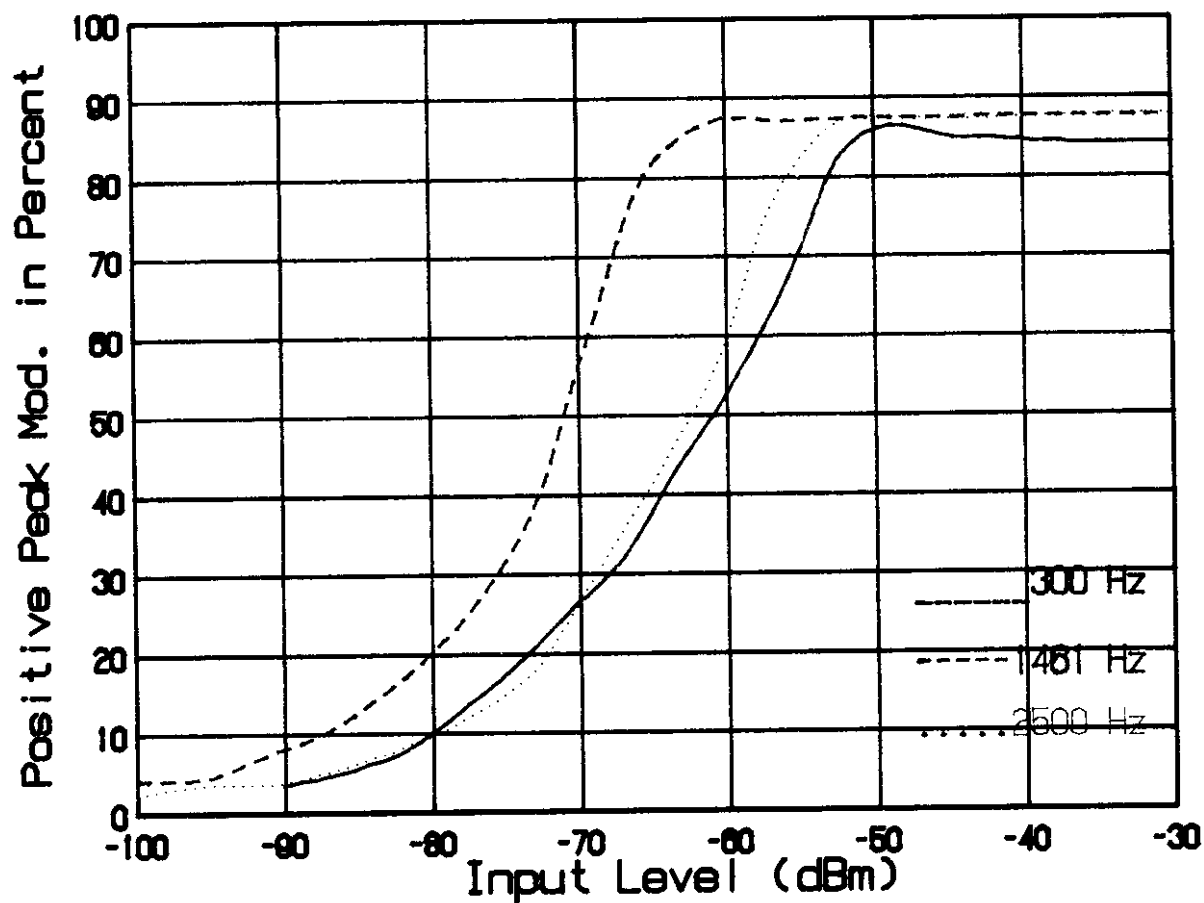


TRANSMITTER FREQUENCY RESPONSE
FCC ID: MGPNR-150

FIGURE 2

FIGURE 3a

AM MODULATION LIMITING - POSITIVE PEAKS



MODULATION LIMITING CHARACTERISTICS

Percent modulation as a function of input level at microphone jack in dBm for 300 Hz, 1461 Hz, and 2500 Hz tones.

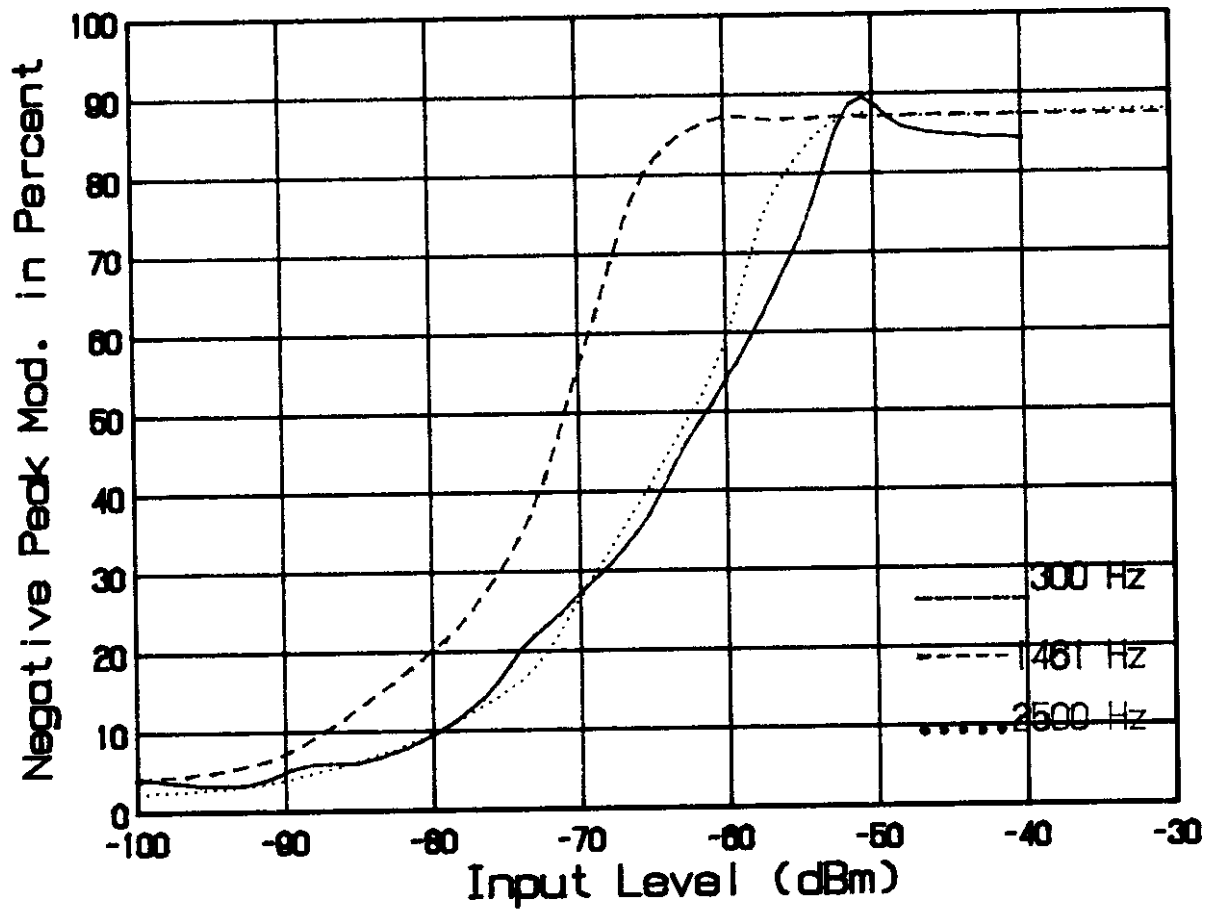
MODULATION LIMITING POSITIVE PEAKS

FCC ID: MGPNR-150

FIGURE 3a

FIGURE 3b

AM MODULATION LIMITING - NEGATIVE PEAKS



MODULATION LIMITING CHARACTERISTICS

Percent modulation as a function of input level at microphone jack in dBm for 300 Hz, 1461 Hz, and 2500 Hz tones.

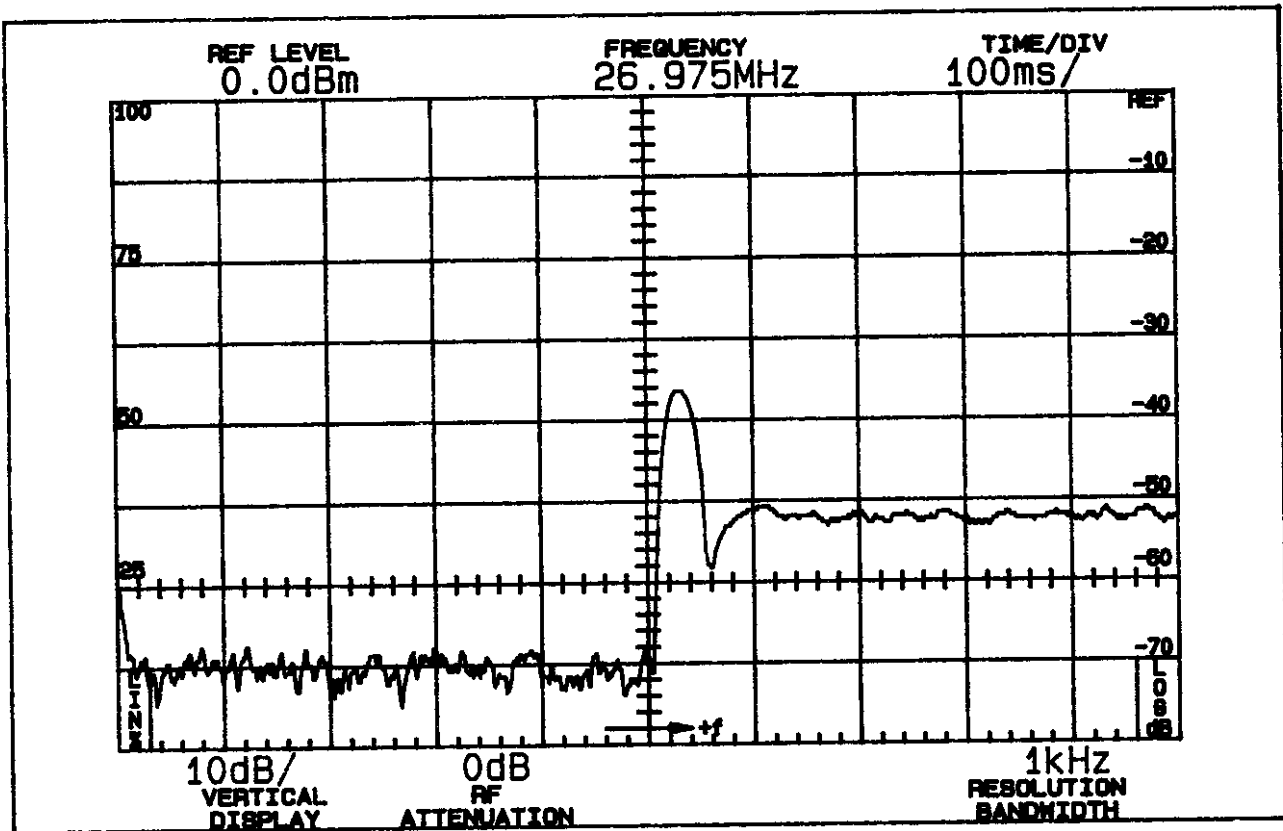
MODULATION LIMITING NEGATIVE PEAKS

FCC ID: MGPNR-150

FIGURE 3b

FIGURE 4a

MODULATION LIMITER ATTACK TIME



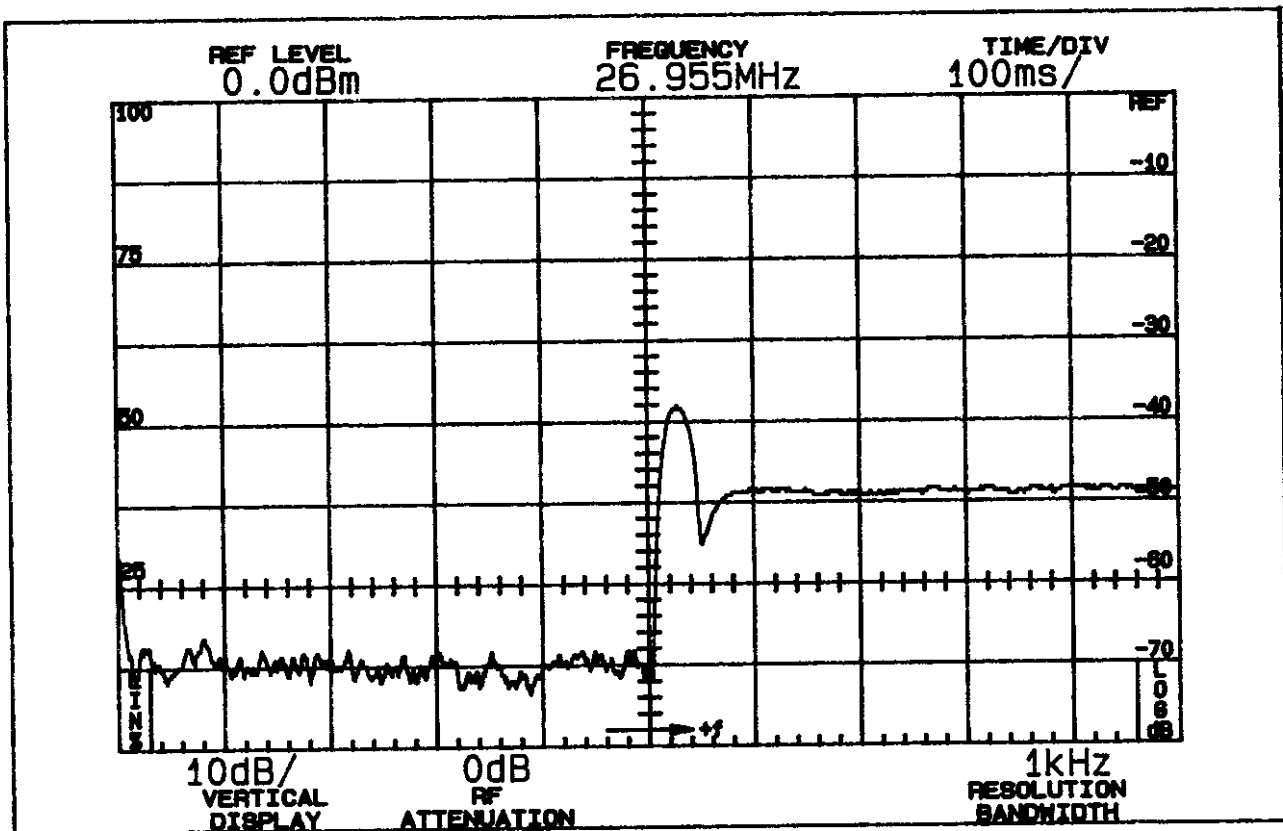
Measurement Conditions: 16 dB over 50% modulation level at 1461 Hz with 2500 Hz tone, upper fourth order sideband; horizontal scale 100 ms/div.

UPPER FOURTH-ORDER SIDEBAND
LIMITER ATTACK TIME
FCC ID: MGPNR-150

FIGURE 4a

FIGURE 4b

MODULATION LIMITER ATTACK TIME



Measurement Conditions: 16 dB over 50% modulation level at 1461 Hz with 2500 Hz tone, lower fourth order sideband; horizontal scale 100 ms/div.

LOWER FOURTH-ORDER SIDEBAND
LIMITER ATTACK TIME
FCC ID: MGPNR-150

FIGURE 4b

C. MODULATION CHARACTERISTICS (Continued)

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

Figure 5 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 1461 Hz, the frequency of maximum response. Measured modulation under these conditions was 88%.

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.

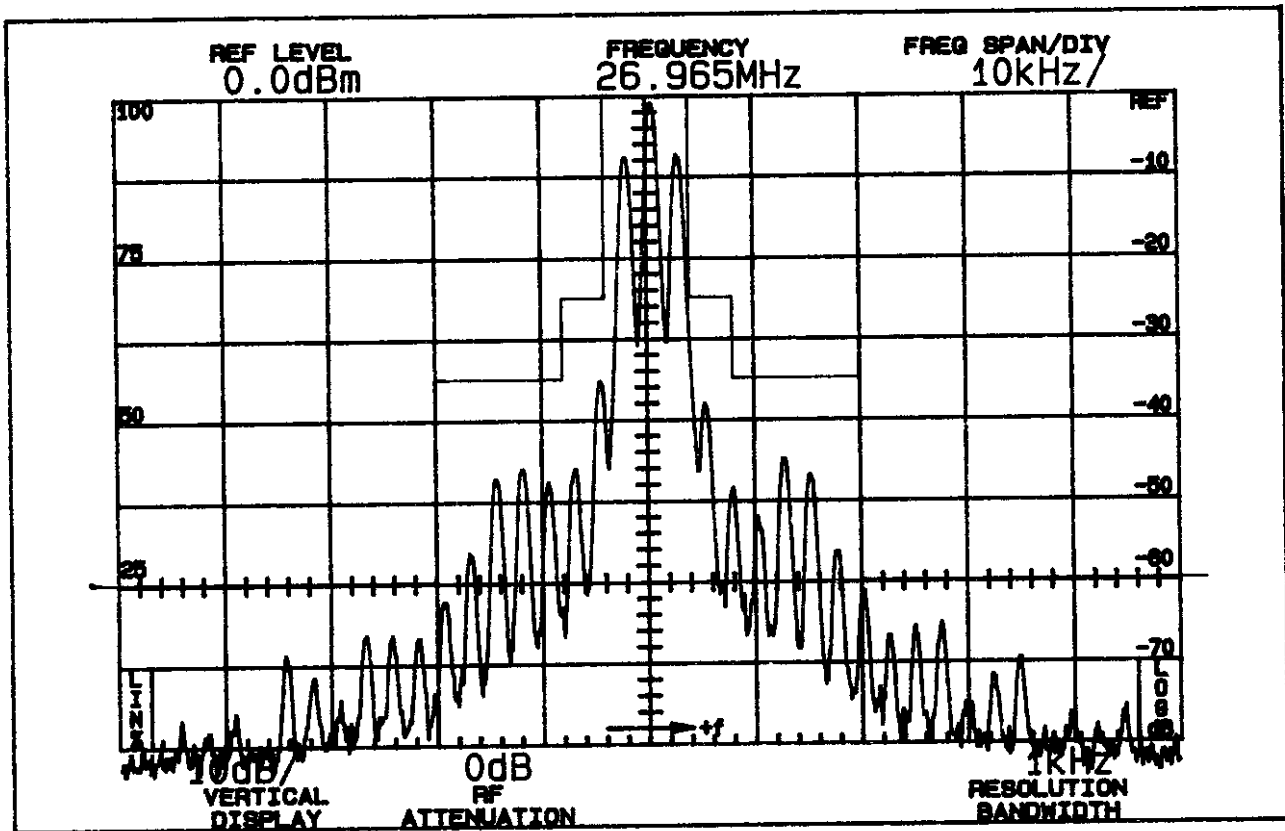
5. Occupied Bandwidth - SSB

Figures 6a and 6b are plots of the sideband envelopes of the transmitter for USB/LSB taken from an Advantest P3361A spectrum analyzer. Modulation corresponded to an input level 10 dB above reference modulation per 2.989(c). The modulation is two tones at frequencies of 500 Hz and 2400 Hz applied simultaneously at levels to produce equal magnitude sidebands before the onset of limiting per 2.989(c)(2). The reference modulation level to produce reference peak envelope power was established per OCE 43.

Each sideband is 3 dB below 0 dB reference.

The plots are within the limits imposed by Paragraphs 95.631(b)(2,4) for single sideband modulation. The horizontal scale, frequency, is 5 kHz per division and the vertical scale, amplitude, is 10 dB per division.

FIGURE 5
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

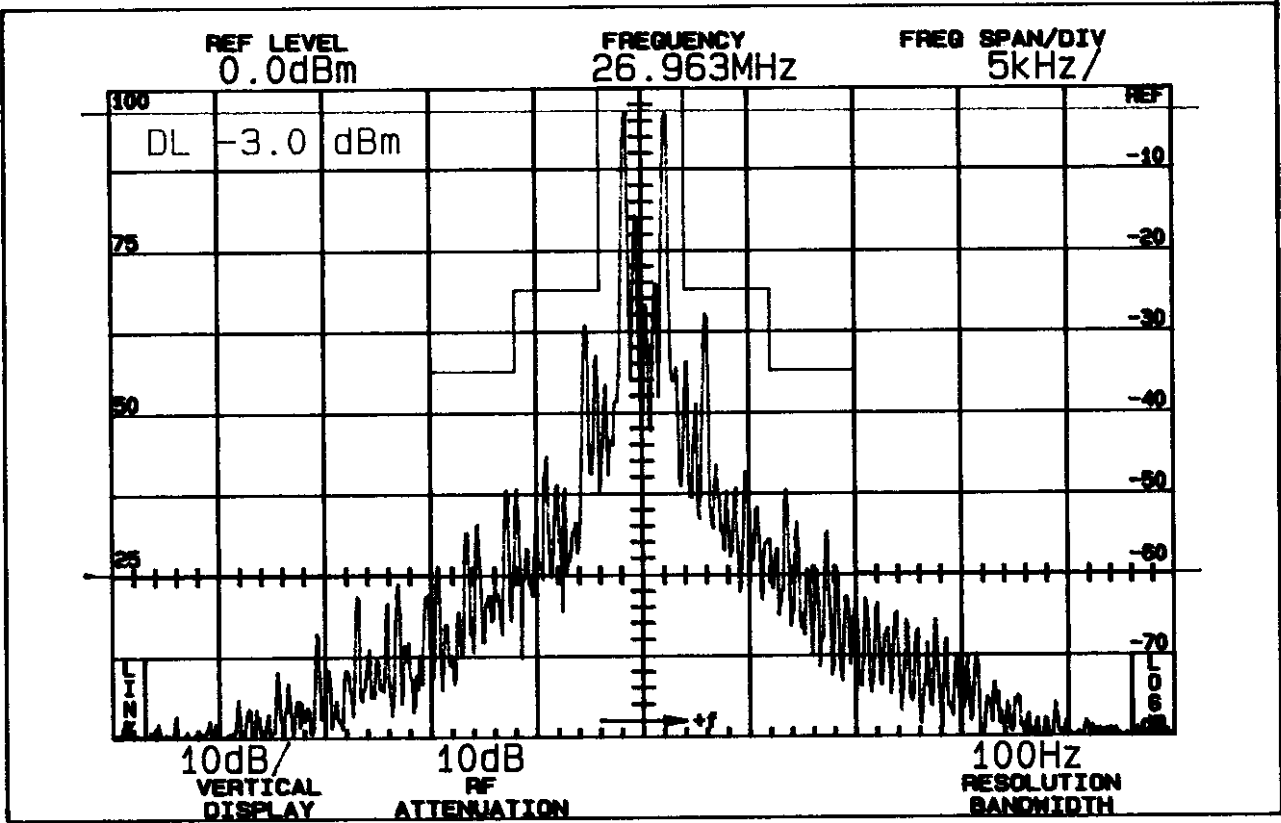
60

OCCUPIED BANDWIDTH - AM
FCC ID: MGP NR-150

FIGURE 5

FIGURE 6a

OCCUPIED BANDWIDTH - LSB



ATTENUATION IN dB BELOW
MEAN OUTPUT POWER
Required

On any frequency more than 50%
up to and including 150% from the
center of the authorized bandwidth,
4 kHz (2-6 kHz) 25

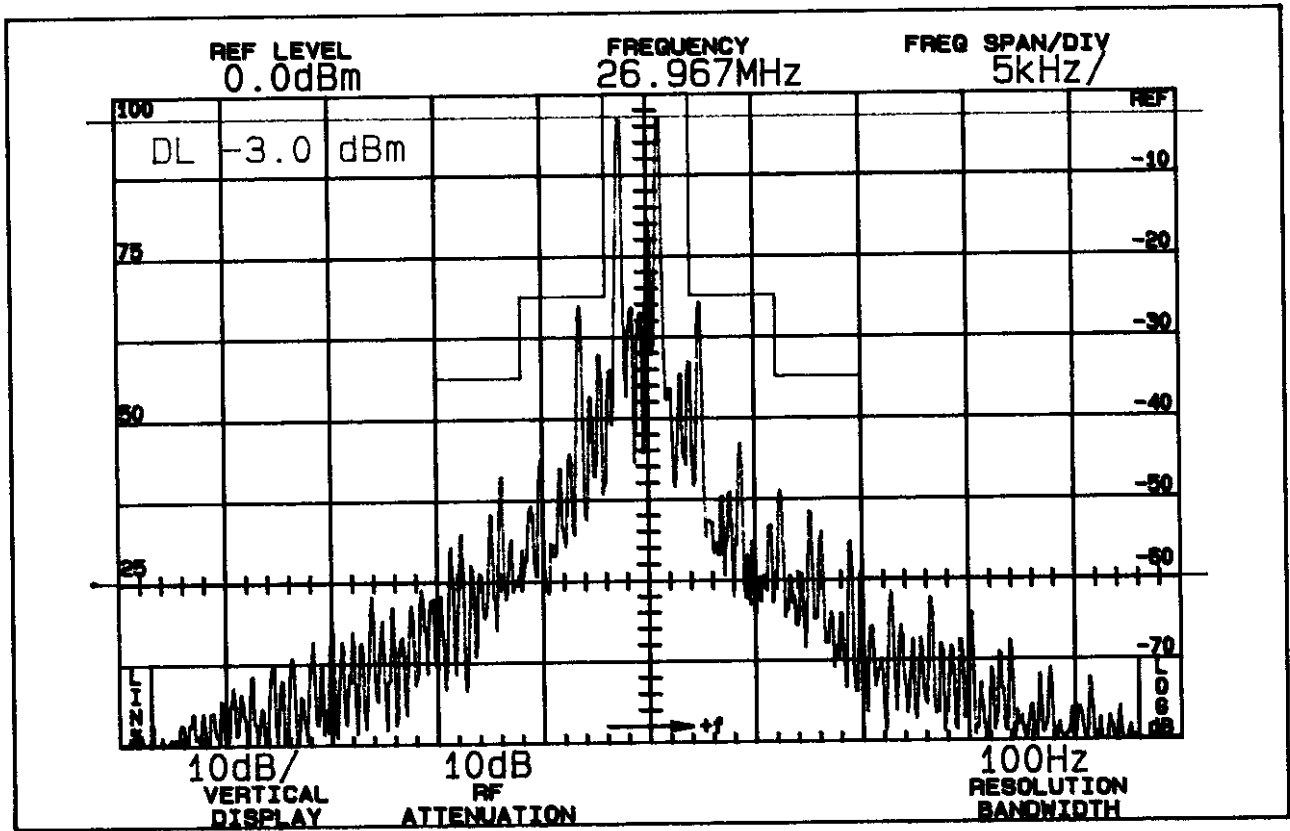
On any frequency more than 150%,
up to and including 250% from the
center of the authorized bandwidth,
4 kHz (6-10 kHz) 35

On any frequency more than 250% from
the center of the authorized
bandwidth 4 kHz (>10 kHz) 60

OCCUPIED BANDWIDTH - LSB
FCC ID: MGPNR-150

FIGURE 6a

FIGURE 6b
OCCUPIED BANDWIDTH - USB



ATTENUATION IN dB BELOW
MEAN OUTPUT POWER
Required

On any frequency more than 50%
up to and including 150% from the
center of the authorized bandwidth,
4 kHz (2-6 kHz)

25

On any frequency more than 150%,
up to and including 250% from the
center of the authorized bandwidth,
4 kHz (6-10 kHz)

35

On any frequency more than 250% from
the center of the authorized
bandwidth 4 kHz (>10 kHz)

60

OCCUPIED BANDWIDTH - USB
FCC ID: MGPNR-150

FIGURE 6b

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

The NR-150 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 1461 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; dc supply was 13.8 volts 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

<u>Channel</u>	<u>Spurious Frequency MHz</u>	<u>-AM- dB Below Unmod Carrier Ref.</u>	<u>dB Below Ref. PEP</u>	
			<u>-SSB- LSB</u>	<u>USB</u>
1	53.930	60	62	63
1	80.895	76	75	75
1	107.860	66	65	65
1	134.825	68	68	69
1	161.790	64	66	65
1	188.755	76	75	75
1	215.720	72	73	74
1	242.685	75	73	74
1	269.650	83	81	82
21	54.430	62	65	66
21	81.645	78	78	77
21	108.860	66	64	63
21	136.075	68	66	68
21	163.290	67	66	67
21	190.505	82	83	80
21	217.720	78	78	76
21	244.935	78	80	80
21	272.150	84	85	86
40	54.810	63	64	65
40	82.215	79	76	74
40	109.620	66	67	66
40	137.025	68	69	69
40	164.430	69	70	68
40	191.835	84	85	85
40	219.240	84	77	75
40	246.645	78	80	80
40	274.050	83	82	83
Required:		60	60	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 NR-150 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 volts. 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

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

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

$$\begin{aligned} 4.7 \text{ volts/meter} &= 4.7 \times 10^6 \text{ uV/m} \\ \text{dBu/m} &= 20 \text{ Log}_{10}(4.7 \times 10^6) \\ &= 133 \text{ dBu/m} \end{aligned}$$

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

$$133 - 107 = 26 \text{ dBm}$$

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.

F. FIELD STRENGTH MEASUREMENTS (Continued)

TABLE 2

TRANSMITTER CABINET RADIATED SPURIOUS
Channel 1, 26.965 MHz; 4.0 watts; 13.8 Vdc

<u>Frequency, MHz</u>	<u>dB Below Carrier Reference</u>		<u>Without Accessories</u>	
	<u>With Accessories</u>		<u>Vertical</u>	<u>Horizontal</u>
	<u>Vertical</u>	<u>Horizontal</u>	<u>Vertical</u>	<u>Horizontal</u>
53.930	80	99	87	99
80.895	68	76	70	74
107.860	75	81	81	82
134.825	75	75	75	74
161.790	75	61	77	61
188.755	88	83	94	88
215.720	84	80	93	86
242.685	97	93	97	98
269.650	98	88	96	86
FCC Limit:	60	60	60	60

Unlisted spurious were more than 80 below carrier reference from 10 to 270 MHz.

F. FREQUENCY STABILITY
(Paragraph 2.995(a)(1) of the Rules)

Measurement of frequency stability versus temperature was made at temperatures from -30°C to $+50^{\circ}\text{C}$ in 10° increments. At each temperature, the unit was exposed to the test chamber ambient a minimum of 60 minutes after indicated chamber temperature ambient had stabilized to within $\pm 2^{\circ}$ of the desired test temperature. Following a 30 minute soak at each temperature, the unit was turned on, keyed and frequency measured within 2 minutes. Test temperature was sequenced in the order shown in Table 3, starting with -30°C .

A Thermotron S1.2 temperature chamber was used. The transmitter output stage was terminated in a dummy load. Primary supply was 13.8 volts. Frequency was measured with a HP 5385A digital frequency counter connected to the transmitter through a power attenuator. Measurements were made on Channel 9, 27.065 MHz. No transient keying effects were observed. Data are shown in Table 3.

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

The NR-150 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 earphone/mike jacks
5. On-off switch (combined with receiver volume control)
6. Upper/lower sideband selector
7. Not applicable, no R3E emission
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 5, 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 NR-150 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 division ratio selection is BCD coded. All the 40 channels are mask programmed into the CPU and can not be changed.
3. Channel selection is controlled by the masked program of the CPU and has only 40 positions for use in the United States.
4. All the undedicated leads in the CPU and PLL integrated circuits are disabled and molded in epoxy, and is not serviceable by the user.
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.