ENGINEERING STATEMENT

For Type Certification of

Midland Consumer Radio

Model No: 75-785

FCC ID: MMA75785

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 75-785 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.

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Rowland S. Johnson

Dated: April 14, 2000

A. INTRODUCTION

The following data are submitted in connection with this request for type certification of the 75-785 transceiver in accordance with Part 2, Subpart J of the FCC Rules.

The 75-785 is a double sideband amplitude modulated transmitter/receiver combination intended for battery operated hand-held 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 CERTIFICATION (Paragraph 2.983 of the Rules)

1. Name of applicant: Midland Consumer Radio

2. Identification of equipment: FCC ID: MMA75785

   a. The equipment identification label is submitted as A separate exhibit.
   b. Photographs of the equipment are submitted as a separate exhibit.

3. Quantity production is planned.

4. Technical description:

   a. 6k00A3E emission
   b. Frequency range: 26.965 - 27.406 MHz
   c. Operating power of transmitter is fixed at the factory at less than 4 watts, and can be reduced 6 dB.
   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: 12.6 V
      Collector current: 610 mA @ 13.8 Vdc input.

   f. Function of each active semiconductor device: See Appendix 1.
   g. Complete circuit diagram is submitted as a separate exhibit.
   h. A user instruction book is submitted as a separate exhibit.
   i. The transmitter tune-up procedure is submitted as

a separate exhibit.

B. GENERAL INFORMATION...(C

j. A description of circuits for stabilizing frequency is included in Appendix 2.
k. A description of circuits and devices employed for suppression of spurious radiation and for limiting modulation is included in Appendix 3.
l. Not applicable.

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.) Power was measured with a supply voltage of 13.8 volts, and indicated:

Channel	Power, watts	
	HI	LO
1	4.0	1.0
21	3.9	1.0
40	3.8	0.9

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 Data Tech 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, 920, and 2500 Hz are shown using a Data Tech 209 modulation meter.

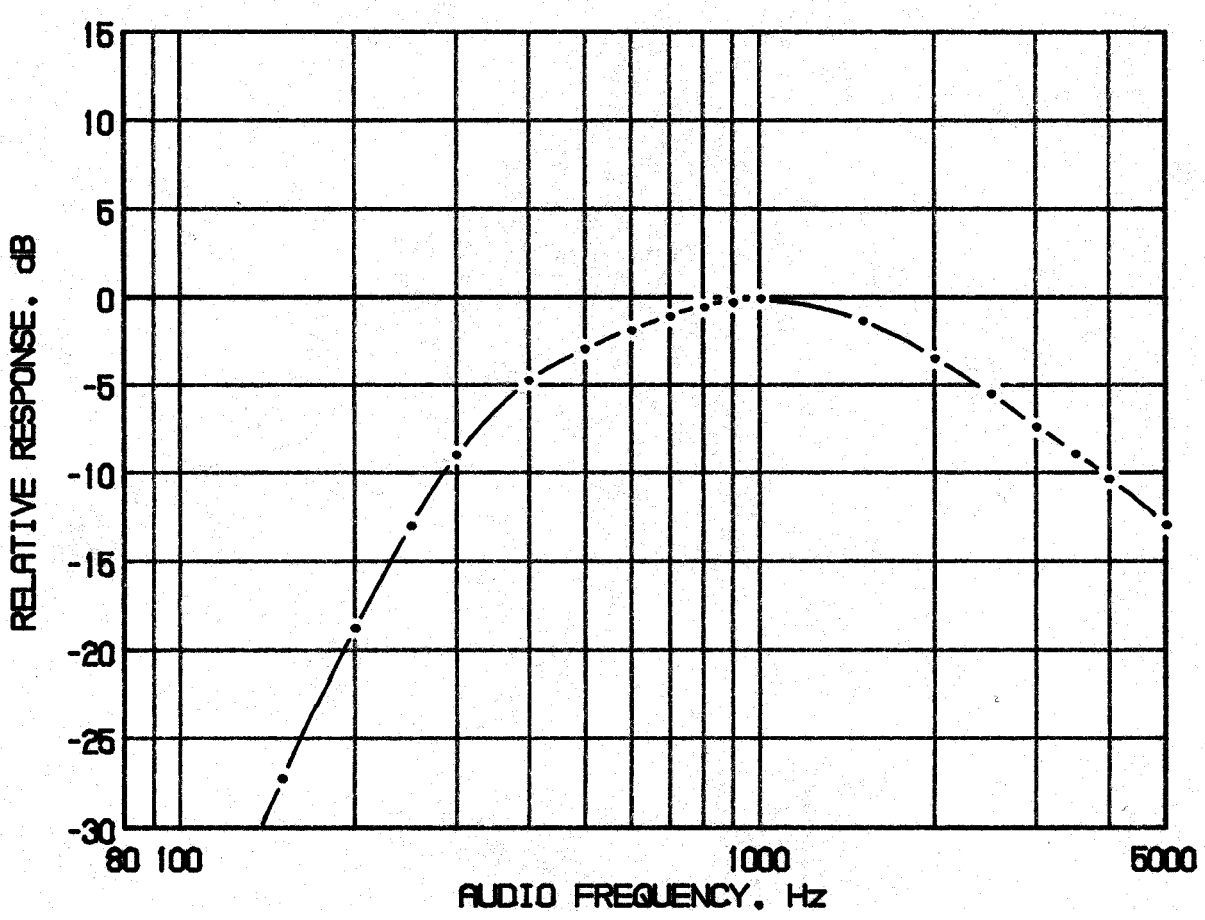
Signal level was established with a Audio Precision TRMS voltmeter and tracking generator. The curves show compliance with Paragraph 95.633(d) of the Rules.

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, 920 Hz. The spectrum analyzer was tuned to upper and lower fourth-order sidebands in the time domain. Horizontal sweep of the analyzer was triggered in synchronism with the tone turn-on. 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: MMA75785

FIGURE 1

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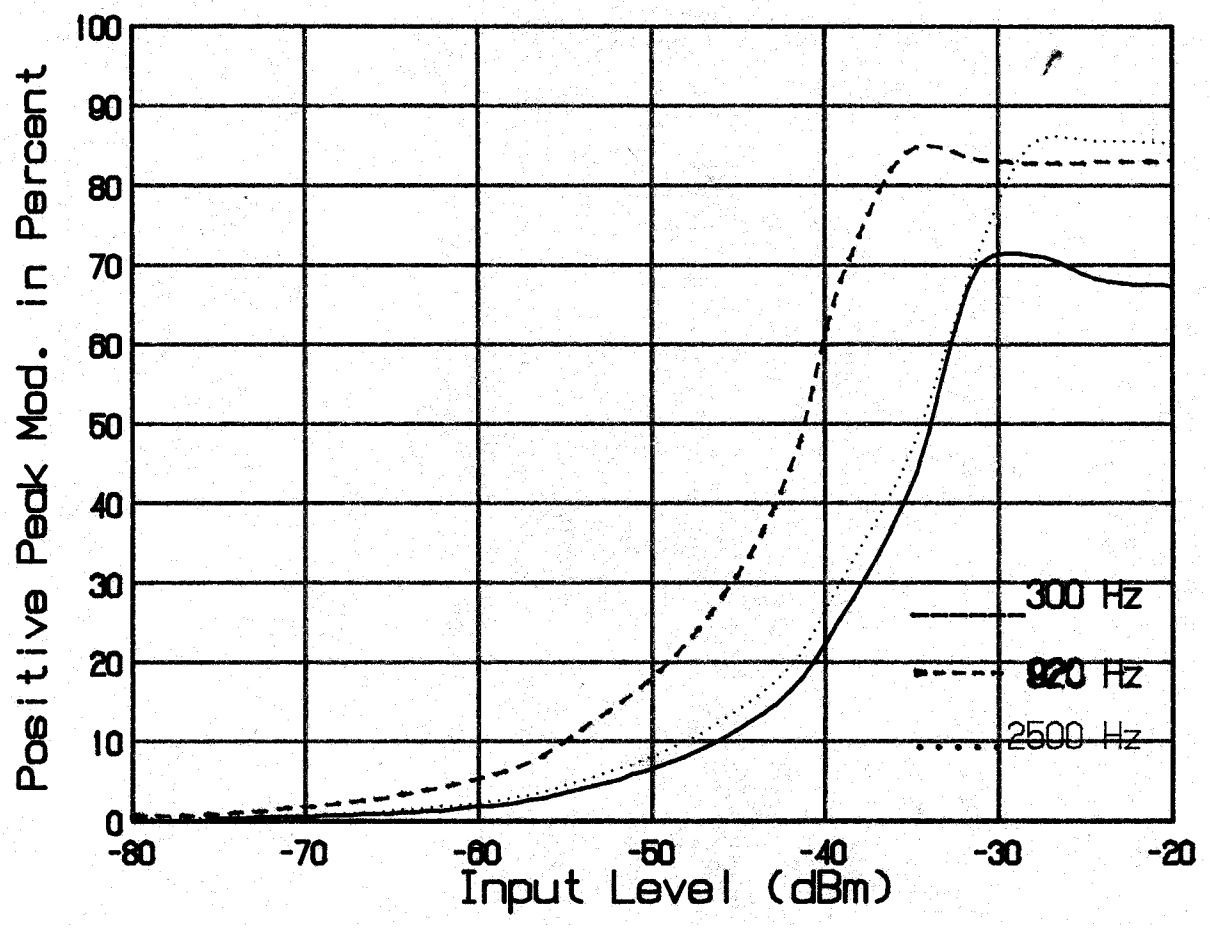
FIGURE 2a

AM MODULATION LIMITING - POSITIVE PEAKS



MODULATION LIMITING CHARACTERISTICS

Percent modulation as a function of input level at microphone jack in dBm for 300 Hz, 920 Hz, and 2500 Hz tones.

MODULATION LIMITING POSITIVE PEAKS
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FIGURE 2a
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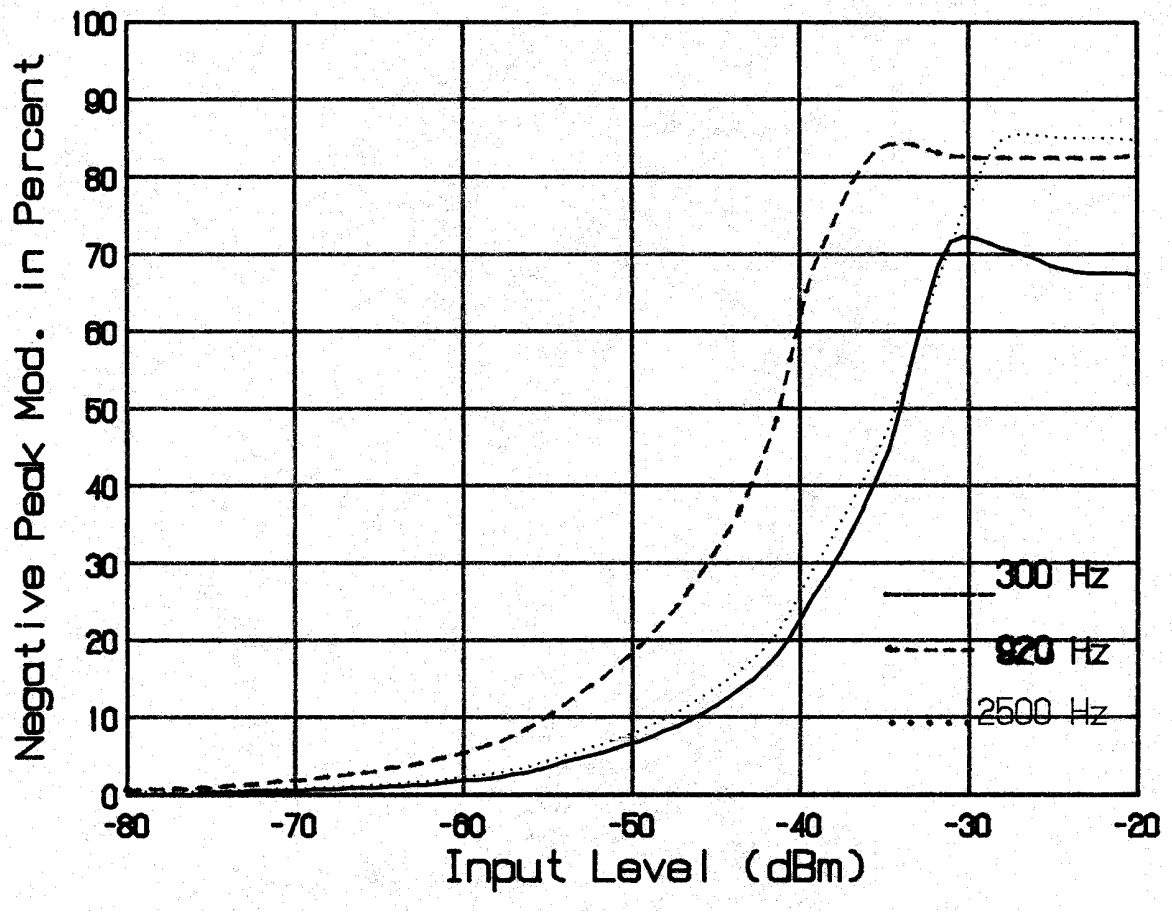
FIGURE 2b

AM MODULATION LIMITING - NEGATIVE PEAKS



MODULATION LIMITING CHARACTERISTICS

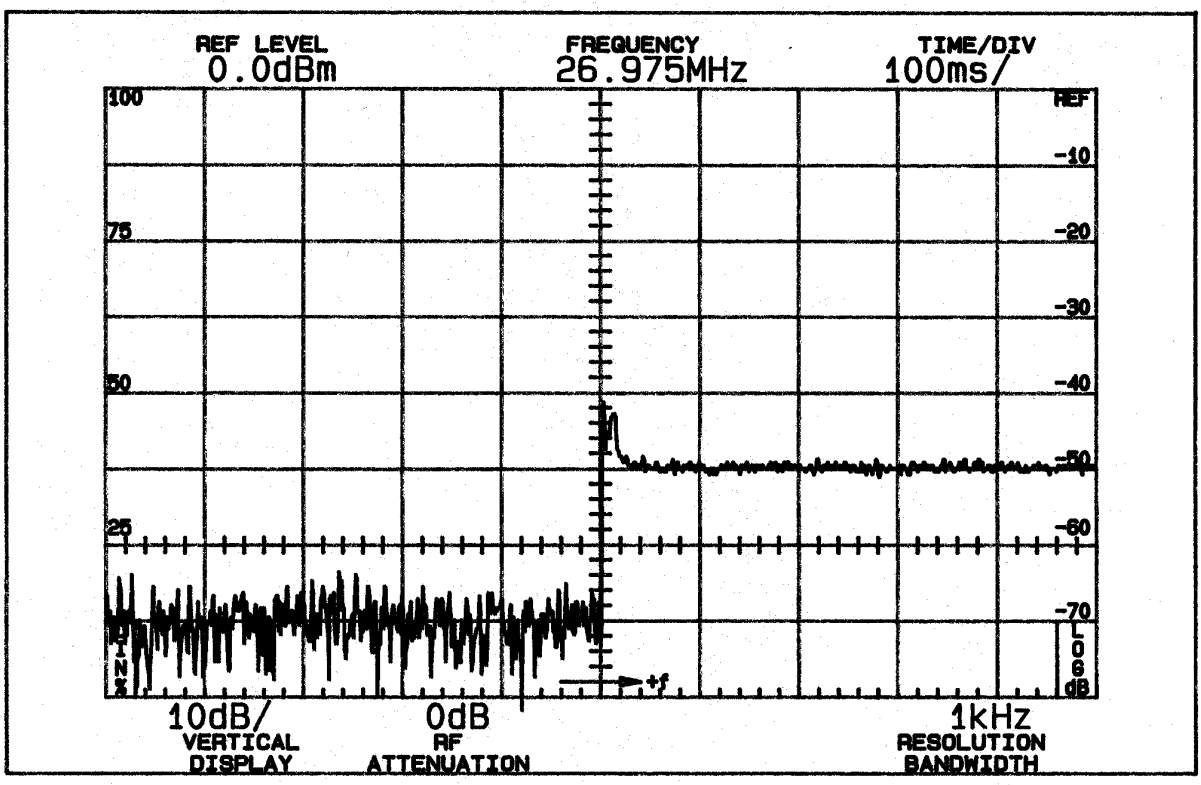
Percent modulation as a function of input level at microphone jack in dBm for 300 Hz, 920 Hz, and 2500 Hz tones.

MODULATION LIMITING NEGATIVE PEAKS
FCC ID: MMA75785

FIGURE 2b

FIGURE 3a

MODULATION LIMITER ATTACK TIME



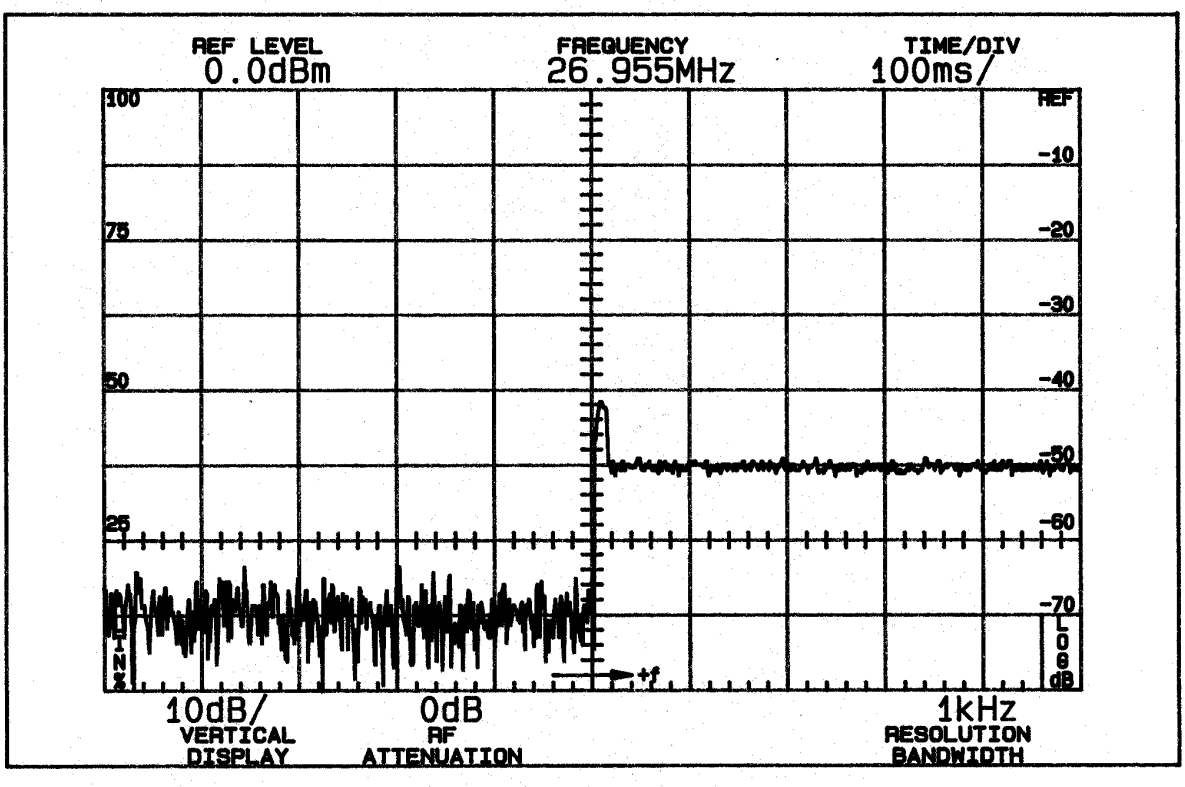
Measurement_Conditions: 16 dB over 50% modulation level at 920 Hz with 2500 Hz tone, upper fourth order sideband; horizontal scale 100 ms/div.

UPPER FOURTH-ORDER SIDEBAND
LIMITER ATTACK TIME
FCC ID: MMA75785

FIGURE 3a

FIGURE 3b

MODULATION LIMITER ATTACK TIME



Measurement_Conditions: 16 dB over 50% modulation level at 920 Hz with 2500 Hz tone, lower fourth order sideband; horizontal scale 100 ms/div.

LOWER FOURTH-ORDER SIDEBAND
LIMITER ATTACK TIME
FCC ID: MMA75785

FIGURE 3b

C. MODULATION CHARACTERISTICS (Continued)

4. Occupied_Bandwidth_-_AM
(Paragraph 2.989(c) of the Rules)

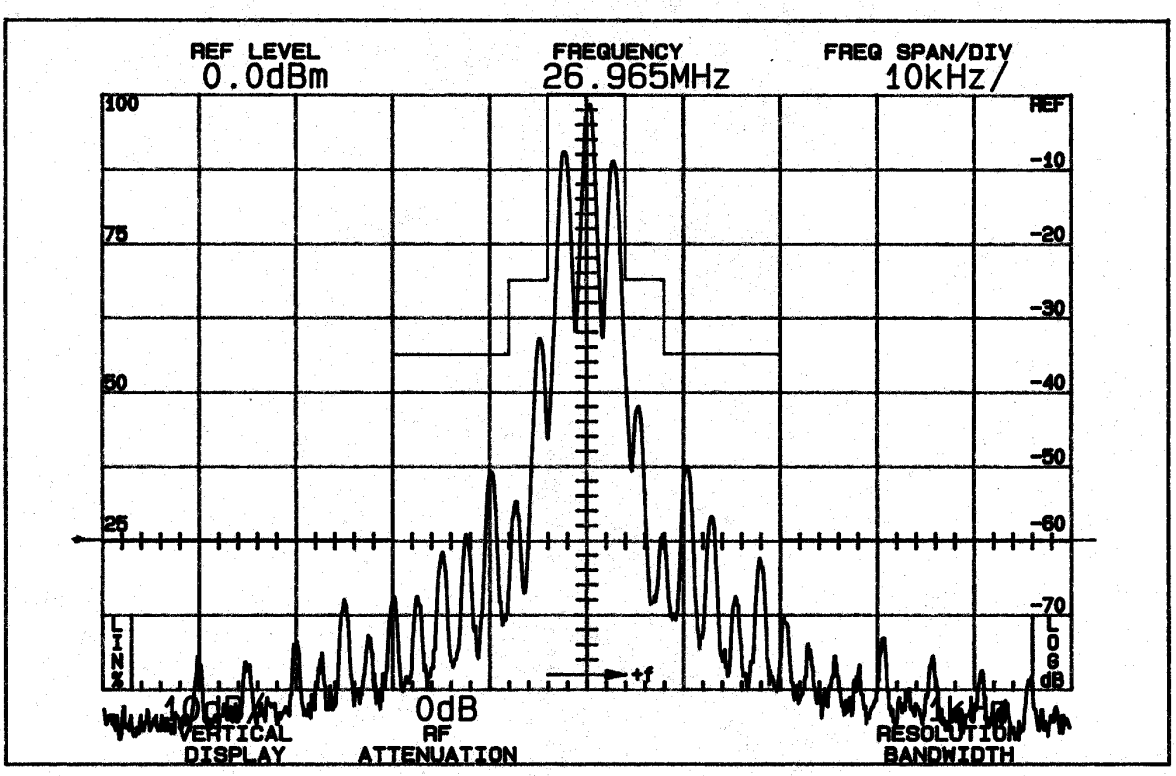
Figures 4a and 4b are plots of the sideband envelope of the transmitter at low and high power settings respectively taken from a Tektronix 494P spectrum analyzer. Modulation corresponded to conditions of 2.989(a) and consisted of 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50% modulation at 920 Hz, the frequency of maximum response. Measured modulation under these conditions was 87% positive, 85% negative.

The plots are 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.

NOTE: Reference of 0 dBc is unmodulated transmitter power.

FIGURE 4a

OCCUPIED BANDWIDTH



ATTENUATION IN dB BELOW
MEAN OUTPUT POWER
Required

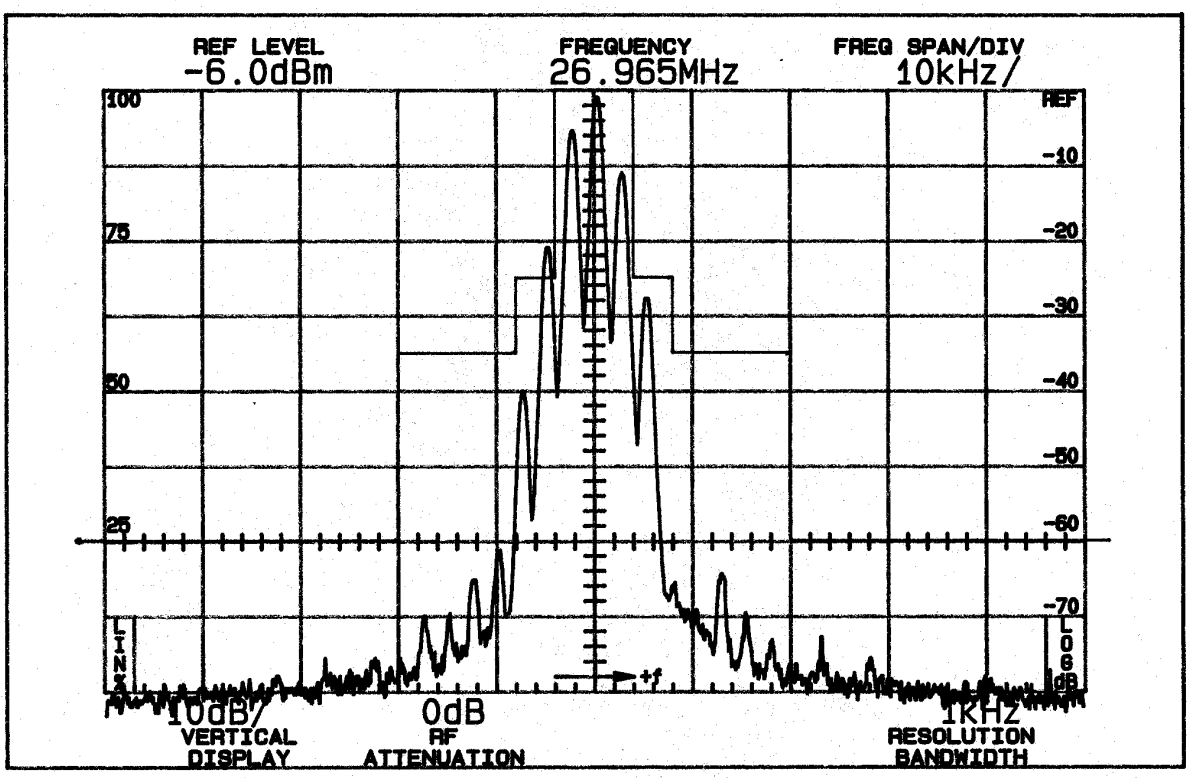
On any frequency more than 50% up to and including 100% of the authorized bandwidth, 8kHz (4-8kHz)	25
On any frequency more than 100%, up to and including 250% of the authorized bandwidth (8-20kHz)	35
On any frequency removed from the assigned frequency by more than 250% of the authorized bandwidth	60

OCCUPIED BANDWIDTH
FCC ID: MMA75785

FIGURE 4a (Low Power)

FIGURE 4b

OCCUPIED BANDWIDTH



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
FCC ID: MMA75785

FIGURE 4b (High Power)

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

The 75-785 transmitter was tested in the AM mode 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 920 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 attenuator.

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 at both power settings on Channels 1, 21, and 40 throughout the RF spectrum from 10.24 to 300 MHz. Any emissions that were between the 60 dB attenuation required and the 100 dB 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. Low	dB Below Unmod Carrier Ref. High
1	53.930	90	84
1	80.895	93	90
1	107.860	89	84
1	134.825	82	83
1	161.790	100	103
1	188.755	104	91
1	215.720	83	82
1	242.685	78	74
1	269.650	73	71
21	54.430	89	83
21	81.645	92	89
21	108.860	90	84
21	136.075	80	82
21	163.290	100	107
21	190.505	101	92
21	217.720	82	83
21	244.935	79	74
21	272.150	74	71
40	54.810	88	86
40	82.215	92	85
40	109.620	90	85
40	137.025	81	82
40	164.430	104	108
40	191.835	101	92
40	219.240	86	85
40	246.645	80	75
40	274.050	76	72
	Required:	60	60

All other spurious were more than 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 75-785 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. Measurements were made with and without accessory cable. Both vertical and horizontal test antenna polarization were employed.

Measurements were made from 10.24 MHz to 10 times the maximum operating frequency of 26.965 or 269.650 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 = 4.7×10^6 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.

E. FIELD STRENGTH MEASUREMENTS (Continued)

TABLE 2

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

	dB Below Carrier Reference			
	With Accessories		Without Accessories	
Frequency, MHz	(V)	(H)	(V)	(H)
53.930	96	88	92	92
80.895	85	88	79	87
107.860	97	95	94	87
134.825	76	76	80	73
161.790	82	75	76	79
188.755	82	76	85	89
215.720	68	69	72	67
242.685	77	83	61	66
269.650	77	78	75	80
Required:	60	60	60	60

Any unlisted spurious were more than 80 below carrier reference from 10.24 to 269.65 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°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 ±2° 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.

F. FREQUENCY STABILITY (Continued)

TABLE 3

Temperature	Output Frequency, MHz
-29.4	27.065453
-19.7	27.065452
- 9.7	27.065433
- 0.1	27.065363
10.1	27.065253
19.9	27.065065
29.9	27.064953
40.4	27.064844
49.9	27.064749
Maximum frequency error:	27.065453 27.065000 + .000453 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 an HP 6264B variable dc power supply was varied ±15% from the nominal 13.8 volt rating. A Keithley 197 digital voltmeter was used to measure supply voltage at transmitter primary input terminals. Measurements were made at 20°C ambient.

TABLE 4

Supply Voltage	Output Frequency, MHz
15.87	27.065143
15.18	27.065122
14.49	27.065093
13.80	27.065065
13.11	27.065042
12.42	27.065024
11.73	27.065013

Maximum frequency error:

27.065143
27.065000
+ .000143 MHz

FCC Rule 95.625(b) specifies .005% or a maximum of ± .001353 MHz. No effects on frequency related to keying the unit were observed.

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

The 75-785 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
3. RF output power connection
4. External earpiece/mic jacks
5. On-off switch (combined with receiver volume control)
6. Not applicable, AM only
7. Not applicable, AM only
8. Transmitting frequency selector
9. Transmit-receive switch
10. See #1
11. Not applicable

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 75-785 meets the following conditions specified:

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 in to 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 US.

4. All the undedicated leads in the CPU and PLL integrated circuits are disabled and not serviceable by the user.

5. PLL data sheet is submitted as a separate exhibit.

J. FINAL AMPLIFIER DATA

1. Final RF amplifier data sheet is submitted as a separate exhibit.

APPENDIX 1

FUNCTION OF DEVICES

75-785

SEMICONDUCTORS AND FUNCTIONS

1) IC

Ref. No.	Description	Function		Manufacturer
		RX	TX	
IC501	LC7185	PLL IC	PLL IC	SANYO
IC401	KIA7217AP	None	Audio Amp.	K.E.C.
IC551	LM386	Audio Amp.	None	National

2) TR

Ref. No.	Description	Function		Manufacturer
		RX	TX	
Q101	KTC3875S	AGC	-	K.E.C.
Q102	KTC3880S	RF Amp.	-	K.E.C.
Q103	KTC3880S	RX 1ST Mixer	-	K.E.C.
Q201	KTC3880S	RX 2ND Mixer		K.E.C.
Q202	KTC3880S	IF Amp.	-	K.E.C.
Q203	KTC3880S	IF Amp.	-	K.E.C.
Q204	KTA1504Y	ANL Clipping	-	K.E.C.
Q403	KTA1504S	-	ALC TR.	K.E.C.
Q404	KTC3875S	-	ALC	K.E.C.
Q500	KTC3198	Regulator	Regulator	K.E.C.
Q502	KTA1266	Digit Switching	Digit Switching	K.E.C.
Q503	KTA1266	Digit Switching	Digit Switching	K.E.C.
Q510	KTC3875S	PD Amp.	PD Amp.	K.E.C.

Q511	KTC3875S	PD Amp.	PD Amp.	K.E.C.
Q513	KRC101S	L/UL Switching	L/UL Switching	K.E.C.
Q550	KTC3875S	Control SQ.	-	K.E.C.
Q553	KTA1266	Control SQ.	-	K.E.C.
Q554	KRC101S	-	TX Switching	K.E.C.
Q555	KTC3875S	Control SQ.	-	K.E.C.
Q556	KRC110S	Control SQ.	-	K.E.C.
Q601	KTC3880S	Buffer	Buffer	K.E.C.
Q602	KTC3880S	-	TX VCO Switching	K.E.C.
Q603	KTC3880S	VCO	VCO	K.E.C.
Q701	KTC3880S	-	Double	K.E.C.
Q702	KTC3880S	-	PRE Amp.	K.E.C.
Q703	KTC1006	-	RF Driver Amp.	K.E.C.
Q704	KTC2078	-	Power Amp.	K.E.C.
Q900	KTC3198	Batt. Low	Batt. Low	K.E.C.
Q901	KTC3875S	Batt. Low	Batt. Low	K.E.C.
Q902	KTC3875S	Regulator	Regulator	K.E.C.
Q903	KRA102S	RX B+ Switching	-	K.E.C.
Q904	KRA102S	-	TX B+ Switching	K.E.C.
Q905	KRC110S	-	TX Switching	K.E.C.

FUNCTION OF DEVICES
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APPENDIX 1

APPENDIX 2

CIRCUITS AND DEVICES TO STABILIZE FREQUENCY

All 40 channels of transmitting, and receiving, frequencies are provided by PLL (Phase Locked Loop)circuitry.

The purpose of the PLL is to provide a multiple number of frequencies from a VCO (Voltage Controlled Oscillator) with quartz crystal accuracy and stability locked to crystal oscillator reference frequency.

The reference crystal oscillator frequency is 10.240 MHz.

CIRCUITS AND DEVICES TO
STABILIZE FREQUENCY
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APPENDIX 2

APPENDIX 3

1. Circuits_For_Suppression_Of_Spurious_Radiation

The tuning circuit between frequency synthesizer the final AMP Q704 and 3-stage "PI" network, C719, C721, C725, C722, L711, L712 and L713 in the Q704 output circuit serves to suppress spurious radiation. This network serves to impedance match Q704 to the antenna and to reduce spurious content to acceptable levels in the frequency systhesizer.

2. Circuits_For_Limiting_Modulation

The MIC input is fed to C.R. and then audio power IC401 which feeds modulation transformer T401. The audio output at the secondary of T401 is fed in series with the B+ voltage the diode D402 to the collectors of driver Q703 and final Q704 to collector modulate both these stages.

A portion of the modulating voltage is rectified by D402 which turns on Q404 which attenuates the MIC input to MIC AMP IC401 the resulting feeback loop-keeps the modulation from exceeding 100% inputs approximately 40 dB greater than that required to produce 50% modulation. The attack time is about 50 mS and the release time is about 300 mS.

3. Circuits_for_Limiting_Power

During factory alignment, the series base resistor of final Q704 (R711) is selected to limit the available power to slightly more than 4 watts. The tuning is adjusted so that the actual power is from 3.6 to 4.4 watts, there are no other controls for adjusting power.

DEVICES AND CIRCUITS TO SUPPRESS SPURIOUS RADIATION AND LIMIT MODULATION

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APPENDIX 3