ENGINEERING STATEMENT

For Type Certification of

Midland Consumer Radio

Model No: F-12
FCC ID: MMAF12

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 model F-12 transceiver. These tests 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. The data verifies that the above mentioned transceiver meets FCC requirements and Type Certification is requested.

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Rowland S. Johnson

Dated: April 26, 2001

A. INTRODUCTION

The following data are submitted in connection with this request for type certification of the model F-12 transceiver in

accordance with Part 2, Subpart J of the FCC Rules.

The model F-12 is a portable, battery operated, UHF, frequency modulated transceiver intended for 12.5 kHz channel family radio service applications in the 462.5625-467.7125 MHz band. It operates from a nominal 4.5 Vdc battery supply. MFR rated output power is 0.5 watts ERP(d)

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: MMAF12

   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. 11k0F3E emission
   b. Frequency range: 462.5625 - 467.7125 MHz.
   c. Operating power of transmitter is fixed at the factory at less than 0.5 W ERP(d)
   d. Maximum power permitted is 0.5 watts, and the model F-12 fully complied with that power limitation.
   e. The dc voltage and dc currents at final amplifier:

      Collector voltage: 4.4 Vdc
      Collector current: 0.67 A

   f. Function of each active semiconductor device is submitted as exhibit 1.
   g. Complete schematic diagram is submitted as a separate exhibit.
   h. A draft instruction manual is submitted as a separate exhibit.
   i. The transmitter tune-up procedure is submitted as a separate exhibit.

B. GENERAL INFORMATION (continued)

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

5. Data for 2.985 through 2.997 follow this section.

C. RF Power Output (Paragraph 2.985(a) of the Rules)

The model F-12 has a permanently attached built-in antenna without provisions for a coaxial connector.

Therefore RF power was determined by substitution.

TABLE 1

Operating Freq., MHz	Power watts into a dipole antenna
462.5625	0.48

D. MODULATION CHARACTERISTICS

1. A curve showing frequency response of the transmitter is shown in Figure 1. Reference level was audio signal output from a Boonton 8220 modulation meter with one kHz deviation. Audio output was measured with an Audio Precision System One integrated test system.

2. Modulation limiting curves are shown in Figure 2, using a Boonton 8220 modulation meter. Signal level was established with a Audio Precision System One integrated test system. The curves show compliance with paragraphs 2.987(b).

3. Figure 3 is a graph of the post-limiter low pass filter which provides a roll-off of 60Logf/3 dB where f is audio frequency in kHz. Measurements were made following EIA RS-152B with an Audio Precision System One integrated test system on the Boonton 8220 modulation meter audio output.

4. Occupied Bandwidth
(Paragraphs 2.989(c) of the Rules)

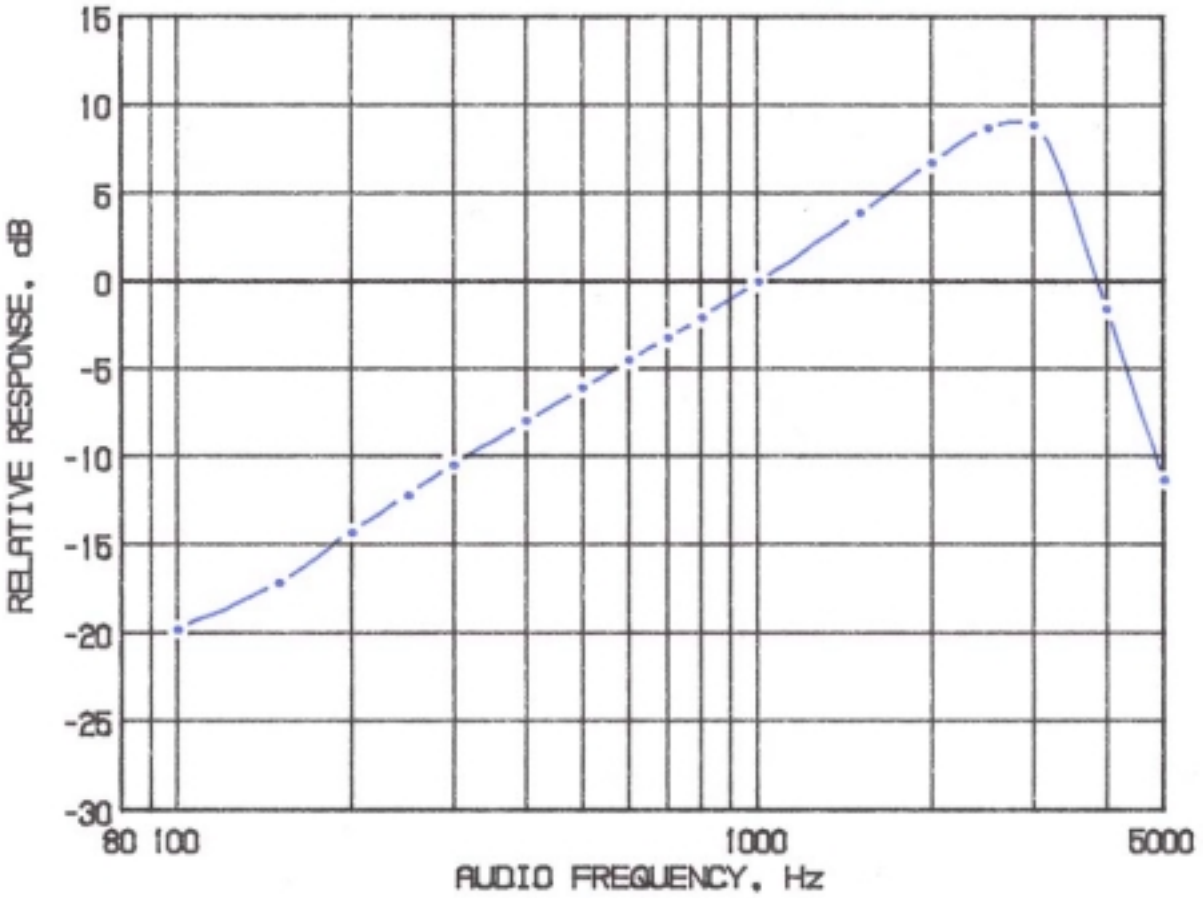
Figure 4 is a plot of the sideband envelope of the transmitter output taken with a Tektronix 494P spectrum analyzer. Modulation corresponded to conditions of 2.989(c)(1) and consisted of 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50% modulation at 2806 Hz, the frequency of maximum response.

Emission designator:

(2M + 2D) (2 x 3 kHz) + (2 x 2.5 kHz) = 11k0F3E

FIGURE 1

MODULATION FREQUENCY RESPONSE

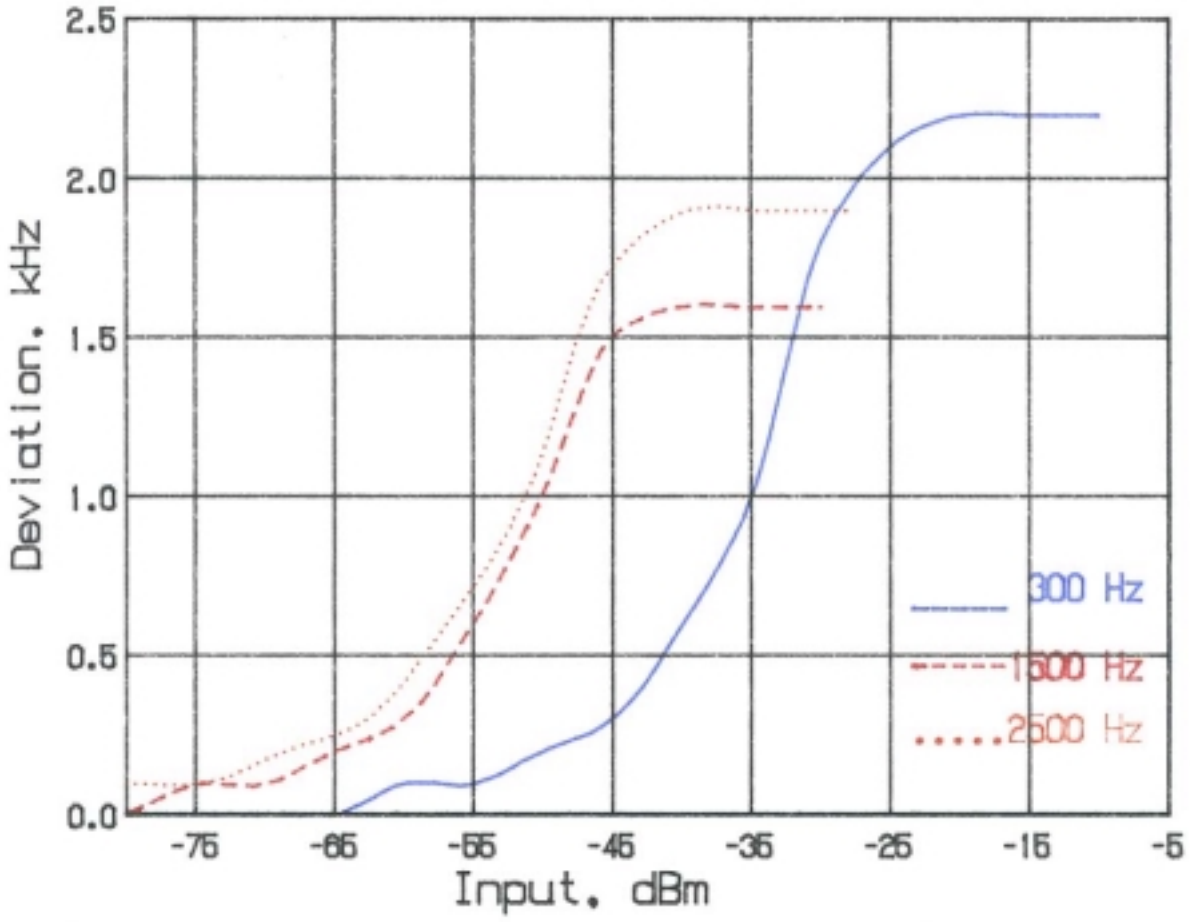


MODULATION FREQUENCY RESPONSE
FCC ID: MMAF12

FIGURE 1

FIGURE 2

AUDIO LIMITER CHARACTERISTICS

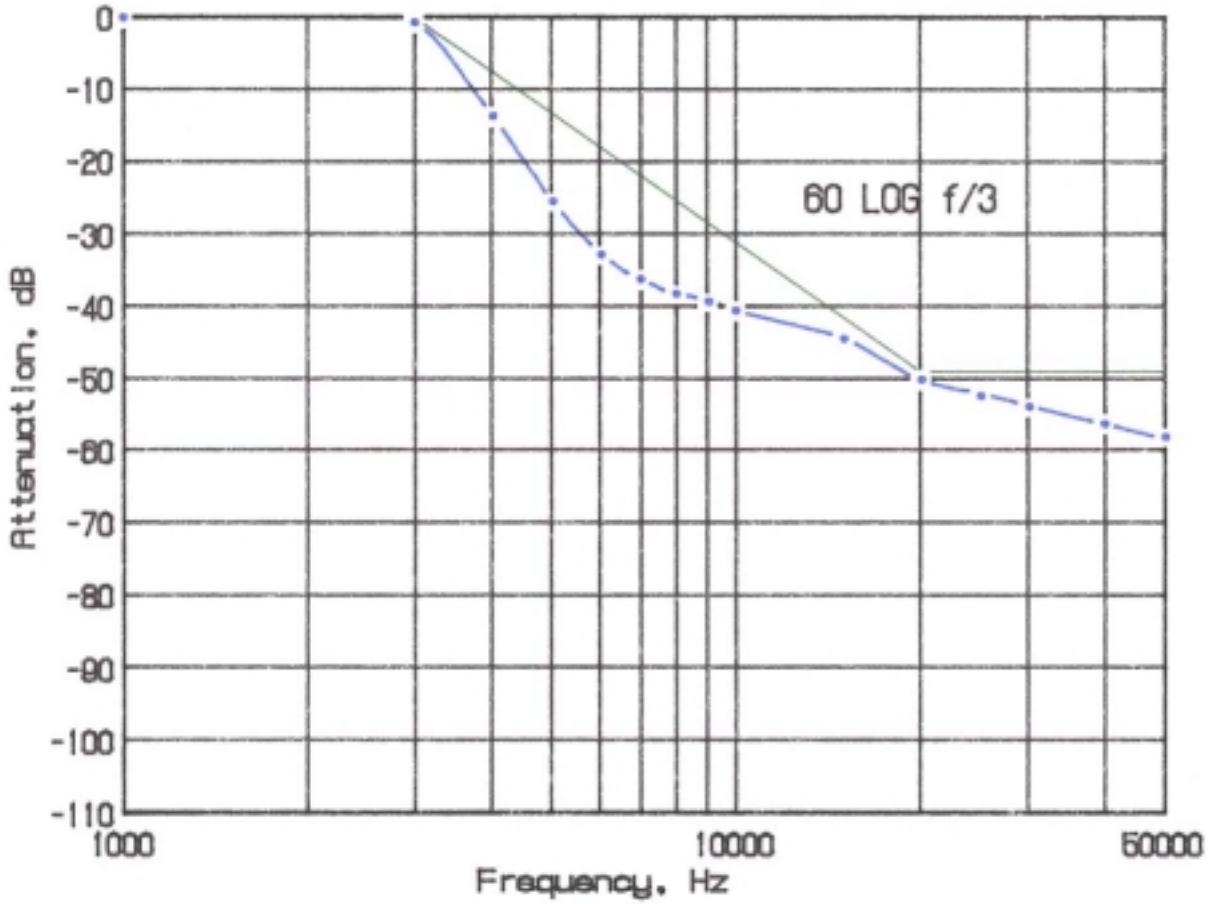


AUDIO LIMITER CHARACTERISTICS
FCC ID: MMAF12

FIGURE 2

FIGURE 3

AUDIO LOW PASS FILTER RESPONSE



AUDIO LOW PASS FILTER
RESPONSE
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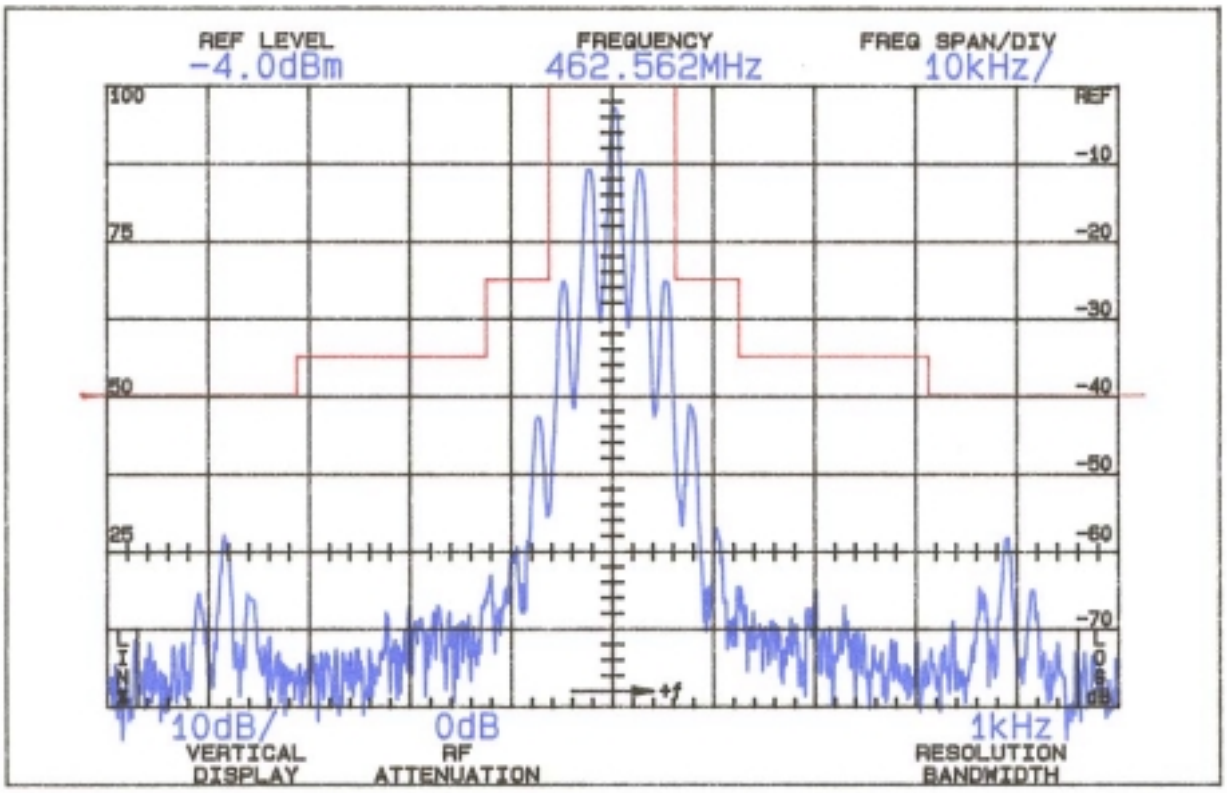
FIGURE 3

FIGURE 4

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, 12.5 kHz (6.25-12.5 kHz)	25
On any frequency more than 100%, up to and including 250% of the authorized bandwidth (12.5-31.25 kHz)	35
On any frequency removed from the assigned frequency by more than 250% of the authorized bandwidth (over 31.25 kHz)	43+10LogP = 40 (P = 0.48)

OCCUPIED BANDWIDTH
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FIGURE 4

D. MODULATION CHARACTERISTICS (Continued)

The plots are within FCC limits. The horizontal scale frequency) is 10 kHz per division and the vertical scale amplitude) is a logarithmic presentation equal to 10 dB per division.

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

The model F-12 has a permanently attached antenna. There is no connector for an external antenna. Therefore, no antenna terminal conducted measurements were made.

F. DESCRIPTION OF RADIATED SPURIOUS MEASUREMENT FACILITIES

A description of the Hyak Laboratories' radiation test facility is a matter of record with the FCC. The facility was accepted for radiation measurements from 25 to 1000 MHz on October 1, 1976 and is currently listed as an accepted site.

G. MEASUREMENTS OF SPURIOUS RADIATION

Spurious emissions from the model F-12 were made by substitution with a Tektronix 494P spectrum analyzer using Singer DM-105 for the measurements to 1 GHz, and EMCO 3115 horn to 4.5 GHz.

The transmitter was located in an open field 3 meters from the test antenna. Supply voltage was a power supply with a terminal voltage under load of 4.5 Vdc.

The transmitter and test antennae were arranged to maximize pickup. Both vertical and horizontal test antenna polarization were employed.

Measurements were made from the lowest frequency generated within the unit to 10 times operating frequency. Data after application of antenna factors and line loss corrections are shown in Table 2.

TABLE 2

TRANSMITTER CABINET RADIATED SPURIOUS

462.5625 MHz, 4.5 Vdc, 0.48 watts

Spurious	dB Below

Frequency MHz	Carrier Reference[1]
462.563	0
1387.688	54V
2312.809	47V
2775.371	53V

Required: 43+10 Log(P) = 40

[1]Worst-case polarization, H-Horizontal, V-Vertical.

All other spurious from 21.25 MHz to the tenth harmonic were 20 dB or more below FCC limit.

H. FREQUENCY STABILITY
(Paragraph 2.995(a)(2))

Measurement of frequency stability versus temperature was made at temperatures from –20°C to +50°C. At each temperature, the unit was exposed to test chamber ambient a minimum of 60 minutes after indicated chamber temperature ambient had stabilized to within ±2° of the desired test temperature. Following the 1 hour 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 –20°C.

A Thermotron S1.2 temperature chamber was used. Temperature

was monitored with a Keithley 871 digital thermometer. The transmitter output stage was terminated in a dummy load. Primary supply was 4.5 volts. Frequency was measured with a HP 5385A frequency counter connected to the transmitter through a power attenuator. Measurements were made at 462.5625 MHz. No transient keying effects were observed.

TABLE 3

FREQUENCY STABILITY AS A FUNCTION OF TEMPERATURE
462.5625 MHz, 4.5 Vdc, 0.48 W

Temperature, °C	Output Frequency, MHz	p.p.m.
-19.4	462.562495	0.0
- 9.4	462.562555	0.1
0.5	462.562708	0.4
10.3	462.562756	0.6
20.3	462.562555	0.1
30.5	462.562294	-0.4
39.8	462.562144	-0.8
50.2	462.562330	-0.4
Maximum frequency error:	462.562144	
	462.562500	
	- .000356 MHz	

FCC Rule 95.627(b) specifies .00025% (2.5 p.p.m.) or a maximum of ±0.001156 MHz, which corresponds to:

High Limit	462.563656 MHz
Low Limit	462.561344 MHz

I. 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 frequency counter as supply voltage provided by an HP 6264B variable dc power supply was varied from ±15% above the nominal 4.5 volt rating to below the battery end point. A Fluke 197 digital voltmeter was used to measure supply voltage at transmitter primary input terminals. Measurements were made at 20°C ambient.

TABLE 4

FREQUENCY STABILITY AS A FUNCTION OF SUPPLY VOLTAGE

462.5625 MHz, 4.5 Vdc Nominal; 0.48W

Supply_Voltage		Output_Frequency,_MHz	p.p.m.
5.17	115%	462.562676	0.4
4.95	110%	462.562623	0.3
4.73	105%	462.562583	0.2
4.50	100%	462.562555	0.1
4.28	95%	462.562533	0.1
4.05	90%	462.562514	0.0
3.83	85%	462.562496	0.0
3.60	80%*	462.562480	-0.6

Maximum frequency error: 462.562480
462.562500

\- .000289 MHz

FCC Rule 95.627(b) specifies .00025% (2.5 p.p.m. or a maximum of ±0.001156 MHz, corresponding to:

High Limit	462.563656 MHz
Low Limit	462.561344 MHz

*Battery end point.

APPENDIX 1

FUNCTION OF DEVICES
Model F-12

SEMICONDUCTORS AND FUNCTIONS

QF1	2SC4226	N.E.C	RX/TX VCO BUFFER
QV1	KRC104S	K.E.C	RX/TX VCO SWITCHING

QV2	2SC4226	N.E.C	O.S.C
QR1	2SC4226	N.E.C	RX RF AMP.
QR2	2SC4226	N.E.C	1'ST MIXER
QR3	KTC3880S	K.E.C	1'ST IF AMP.
QR5	KTC3875S	K.E.C	CTCSS DET.
QR6	KTA1504ST1(G)	K.E.C	AUDIO PATH SWITCH
QT1	2SC4226	N.E.C	TX BUFFER
QT2	2SC4226	N.E.C	TX POWER DRIVE AMP.
QT3	BLT70	PHILIPS	TX POWER FINAL AMP.
QF2	KRC104S	K.E.C	TX SWITCH
QS1	KRA105S	K.E.C	RX B+ SWITCHING
QS2	KRA105S	K.E.C	RX P/S SWITCHING
QS3	KRA105S	K.E.C	TX B+ SWITCHING
QS4	KRC104S	K.E.C	TX B+ SWITCHING
QS5	KRA105S	K.E.C	VOX OUT SWITCHING
QS7	KRA101S	K.E.C	PTT DETECTOR
QS8	KRA105S	K.E.C	LCD BACK LIGHT SWITCHING

IC1	DBL5018V	DAEWOO	2'ND MIXER,IF,AND FM DETECTOR
IC2	NJM2070	J.R.C	AUDIO POWER AMP.
IC3	KS57C21208	SAMSUNG	CPU
IC4	KB8825	SAMSUNG	PLL FREQUENCY SYSTHESIZER
IC5	TK71330	TOKO	REGULATOR
IC6	LM324	NATIONAL	PRE-EMPHASIS AND 300Hz HPF
IC7	24WC02J	HOLTEK	EEPROM
IC8	LM324	NATIONAL	CTCSS LOWPASS FILTER
IC9	LM324	NATIONAL	DE-EMPHASIS AND 300Hz HPF

APPENDIX 2

CIRCUITS AND DEVICES TO STABILIZE FREQUENCY

The PLL synthesizer of the signal loop PLL circuit with the reference of 6.25 kHz. The IC4 PLL IC includes all the function such as the reference oscillator, the driver, the phase detector, the lock detector, and the programmable divider.

At the reference oscillator, the 21.250 MHz TCXO of the TCXO-1 is connected to the pin 10,11 of the IC4 to oscillate the frequency of 21.250 MHz. The TCXO (21.250 MHz) is the temperature compensation circuit to maintain the frequency within the allowable error range even under a low temperature of -20•.

The phase detector send out the output power to the loop filter through 3 pin of the IC4. IF the oscillation frequency of the VCO is low compared to the referenced frequency, the phase detector sends out the output power in positive pulse. If the oscillation frequency of the VCO is high, phase detector send out can maintain the frequency set.

CIRCUITS AND DEVICES TO
STABILIZE FREQUENCY
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APPENDIX 2

APPENDIX 3

CIRCUITS TO SUPPRESS SPURIOUS RADIATION
AND LIMIT MODULATION

CIRCUITS TO SUPPRESS SPURIOUS RADIATION

The transmitted signal of approximately 7 mW, combined at the driver TR is supplied to the base of the QT2 amplifier. the transmitted signal amplified to 0.5 W here passes the TX LPF of the 2nd characteristic of the LT4 and the LT5, and RX/TX switching takes place by the DT2. After this, the signal is provided to the antenna the TX LPF of the 1st characteristics, consisted of the LT7.

CIRCUITS TO LIMIT MODULATION

The voice signal input from the microphone is pre-emphasized at the IC6D, and at the same time, the components below 300 Hz are reduce to minimize the influence to the CTCSS tone.
The signal which comes out of the IC6D is limited to a certain amplitude at the IC6C for the voice signal not to exceed the allowable band width assigned for transmission.

CIRCUITS TO SUPPRESS SPURIOUS
RADIATION AND LIMIT MODULATION
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APPENDIX 3