ENGINEERING STATEMENT

For Type Certification of

Cobra Electronics Corporation

Model No: FRS 305
FCC ID: BBOFRS305

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 Cobra Electronics Corporation to make type certification measurements on the FRS 305 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 7, 2000

A. INTRODUCTION

The following data are submitted in connection with this

request for type certification of the FRS 305 transceiver in accordance with Part 2, Subpart J of the FCC Rules.

The FRS 305 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 6.0 Vdc battery supply. MFR rated output power is 0.5 watts ERP.

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

1. Name of applicant: Cobra Electronics Corporation

2. Identification of equipment: FCC ID: BBOFRS305

   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. Maximum power permitted is 0.5 watts, and the FRS 305 fully complied with that power limitation.
   e. The dc voltage and dc currents at final amplifier:

      Collector voltage: 5.9 Vdc
      Collector current: 0.50 A

   f. Function of each active semiconductor device: See Appendix 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.

   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.

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

The FRS 305 has a permanently attached built-in antenna without provisions for a coaxial connector.

Therefore RF power output was calculated, see Table 1. (The transmitter was tuned by the factory.)

TABLE 1

Operating Freq., MHz	Power watts into a dipole antenna
462.5625	0.495

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)

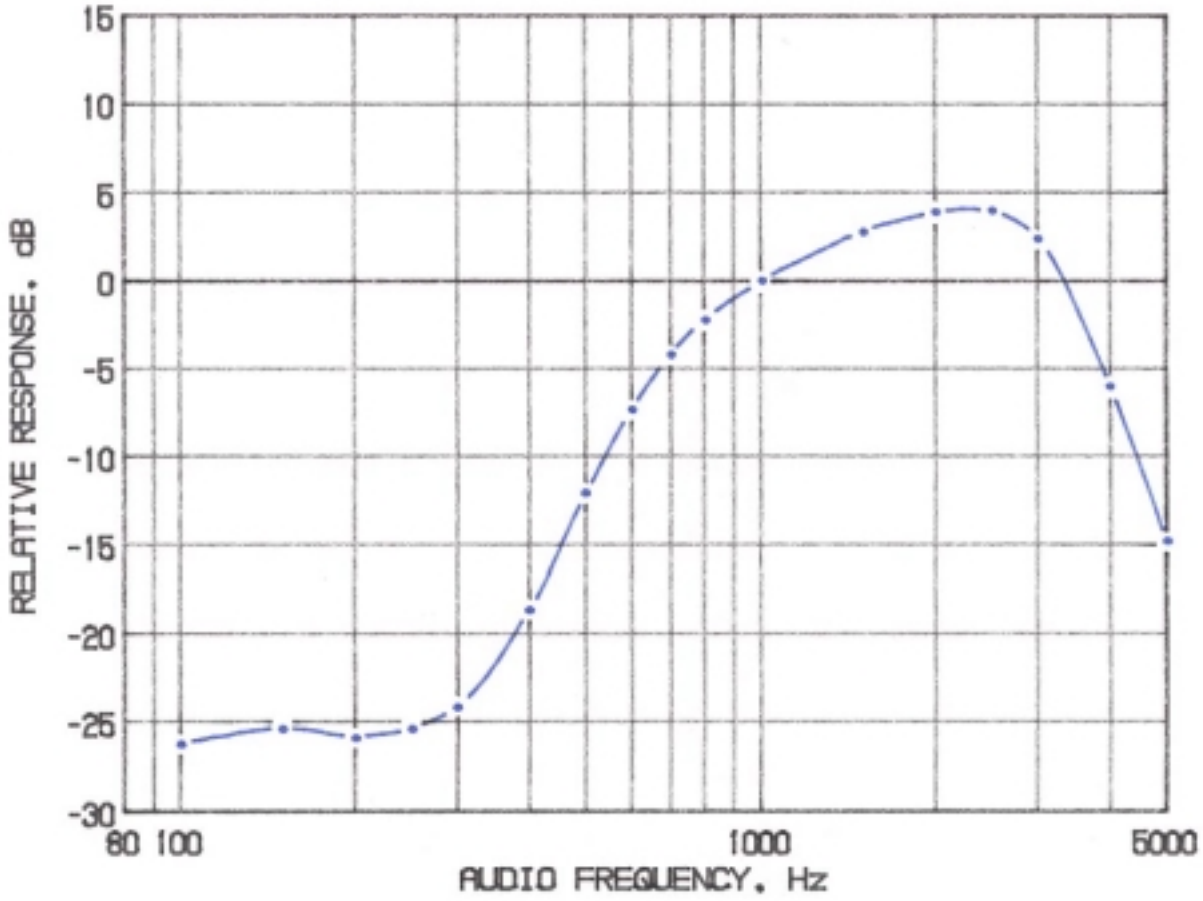
Figure 4 is a plot of the sideband envelope of the transmitter output taken with a Tektronix 494P spectrum analyzer. Modulation corresponded to conditions of 2.989(c)(1) and consisted of 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50% modulation at 2323 Hz, the frequency of maximum response. Measured modulation under these conditions was 1.9 kHz.

Emission designator:

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

FIGURE 1

MODULATION FREQUENCY RESPONSE



MODULATION FREQUENCY RESPONSE
FCC ID: BBOFRS305

FIGURE 1

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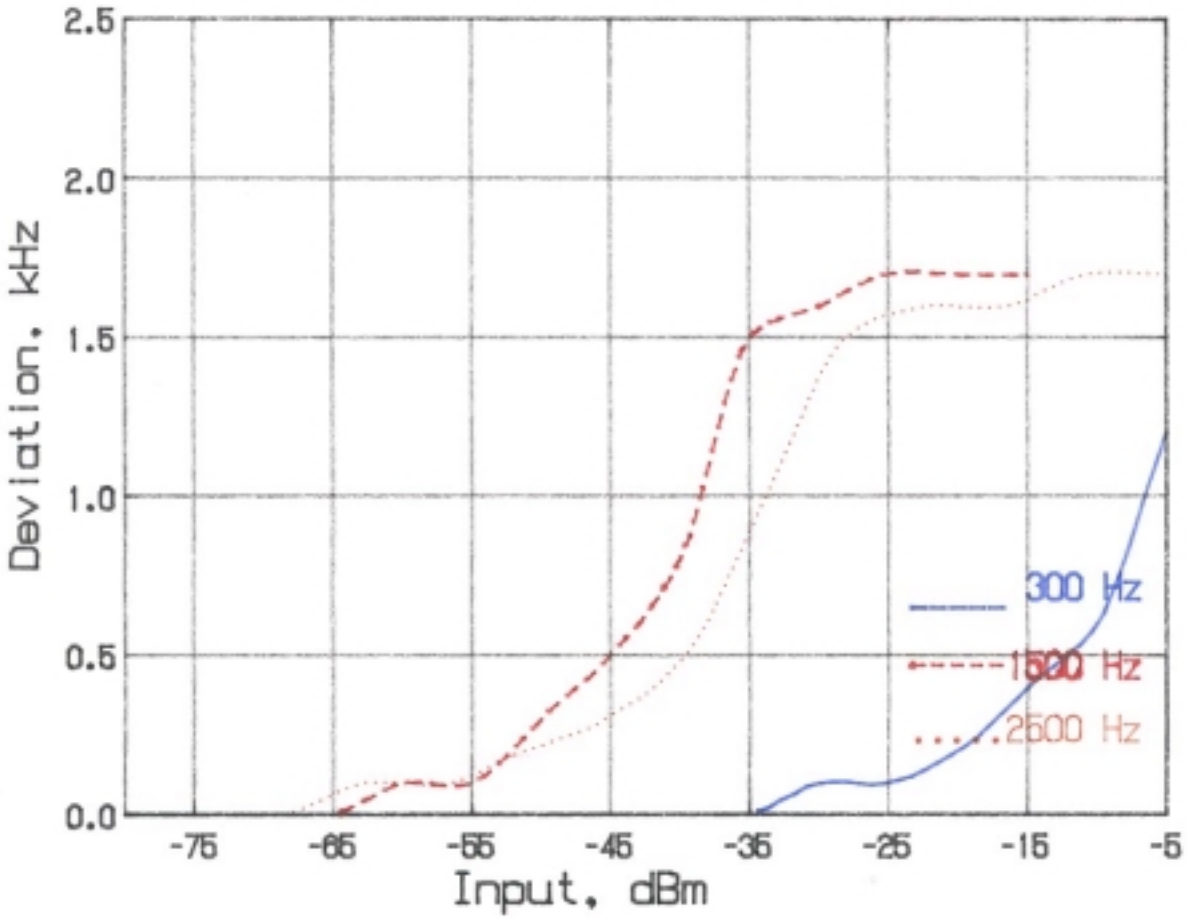
FIGURE 2

AUDIO LIMITER CHARACTERISTICS

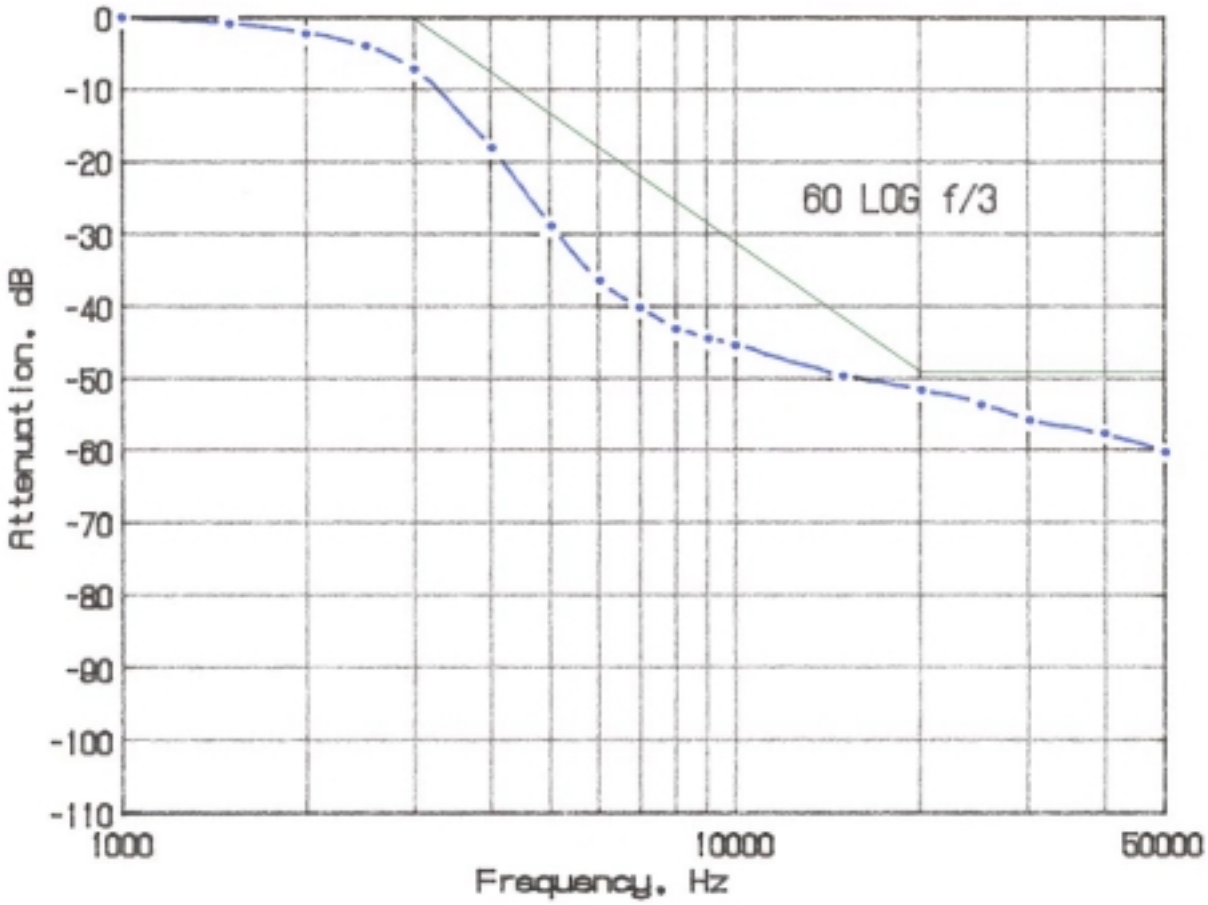


AUDIO LIMITER CHARACTERISTICS
FCC ID: BBOFRS305

FIGURE 2
 6

FIGURE 3

AUDIO LOW PASS FILTER RESPONSE

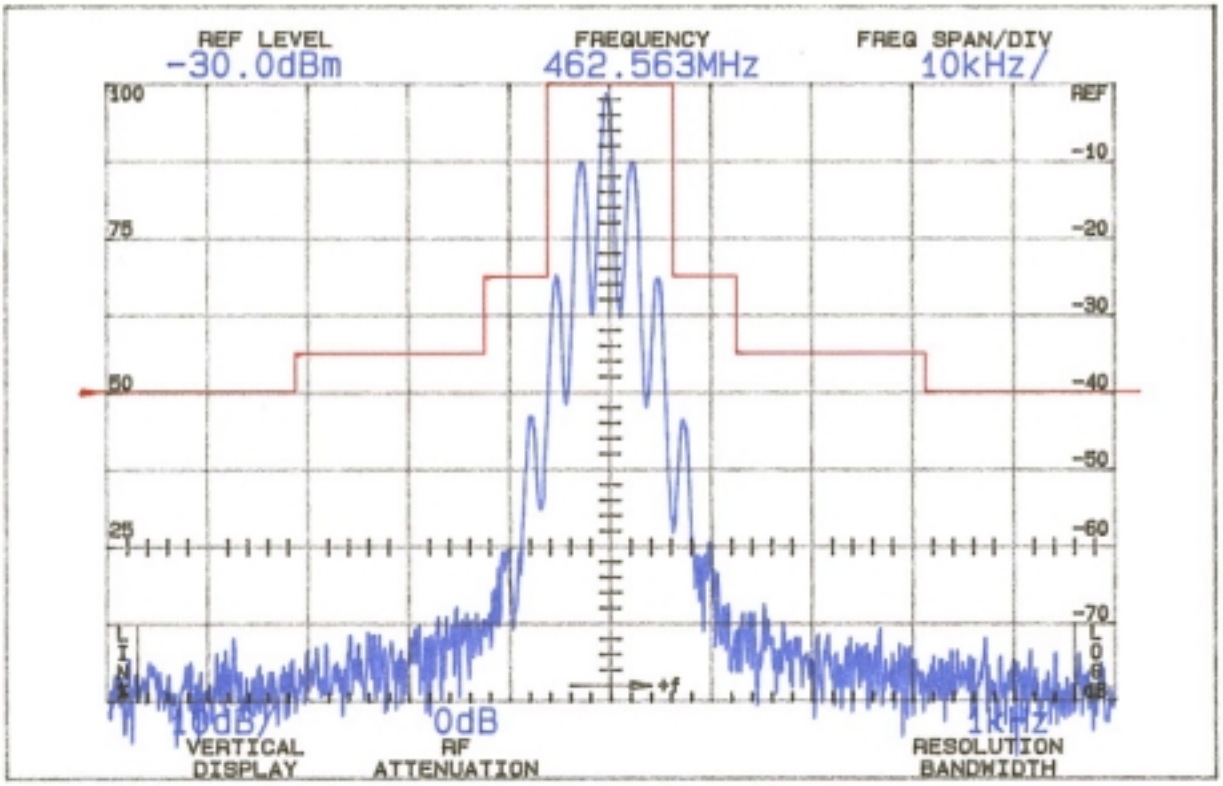


AUDIO LOW PASS FILTER
RESPONSE
FCC ID: BBOFRS305

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 = 0.495)

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 FRS 305 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. FIELD STRENGTH MEASUREMENTS OF SPURIOUS RADIATION

Field intensity measurements of radiated spurious emissions from the FRS 305 were made with a Tektronix 494P spectrum analyzer using Singer DM-105 for the measurements to 1 GHz, and EMCO 3115 horn to 4.8 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 6.0 Vdc.

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

The measurement system was capable of detecting signals 100 dB or more below the reference level. Measurements were made from the lowest frequency generated within the unit (12.8 MHz), 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, 6.0 Vdc, 0.495 watts

Spurious Frequency MHz	Radiated Field uV/m @ 3M	dB Below Carrier Reference[1]

462.563	1644864	0
925.125	370	73V*
1387.688	1170	63V*
1850.250	938	66H*
2312.813	1385	61V*
2775.377	302	75V*
3237.938	846	66V*
3700.502	3136	54V
4163.065	973	65V*
4625.629	309	75V*

Required: 43+10 Log(P) = 40

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

*Reference data only, more than 20 dB below FCC limit.

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

Power:

$P = (F.I.x3)^2/49.2$

$= (1.644864)^2/49.2$

$= 0.495$ W

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 6.0 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, 6.0 Vdc, 0.495 W

Temperature, °C	Output Frequency, MHz	p.p.m.
-19.1	462.561436	-2.3
-10.0	462.561501	-2.2
0.7	462.562066	-0.9
10.6	462.562599	0.2
20.7	462.562619	0.3
29.8	462.562522	0.0
39.9	462.562601	0.2
49.7	462.563177	1.5

Maximum frequency error: 462.561436
462.562500

- .001064 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 6.0 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, 6.0 Vdc Nominal; 0.495W

Supply Voltage		Output Frequency, MHz	p.p.m.
6.9	115%	462.562678	0.4
6.6	110%	462.562643	0.3
6.3	105%	462.562631	0.3
6.0	100%	462.562619	0.3
5.7	95%	462.562610	0.2
5.4	90%	462.562604	0.2
5.1	85%	462.562603	0.2
4.8 *	80%	462.562604	0.2

Maximum frequency error: 462.562678
462.562500

\+ .000178 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
FRS 305

9. SEMICONDUCTORS AND FUNCTIONS

1) TRANSISTER

REF NO	TYPE	MANUFATURER	FUNCTION
Q1	2SC5084	TOSHIBA	RX RF AMP.
Q2	2SC5084	TOSHIBA	1'ST MIXER
Q3	KTC3880S	K.E.C	1'ST IF AMP.
Q4	KTC3875S	K.E.C	CALL DATA FILTER
Q5	KRC112S	K.E.C	VOLUME SWITCHING
Q7	KRC112S	K.E.C	VOLUME SWITCHING
Q8	KRC112S	K.E.C	VOLUME SWITCHING
Q15	KTC3875S	K.E.C	VIBRATOR SWITCHING
Q16	KRA226S	K.E.C	VCC IN TO VIBRATOR
Q101	KTA1504ST1(G)	K.E.C	AUDIO MUTE 1
Q102	KTA1504ST1(G)	K.E.C	AUDIO PATH
Q103	KTA1504	K.E.C	PTT DETECTOR
Q106	KRC104S	K.E.C	AUDIO SWITCHING 1
Q108	KRC105S	K.E.C	RX B+ SWITCHING
Q109	KRC104S	K.E.C	TX B+ SWITCHING 1
Q110	KRC104S	K.E.C	TX B+ SWITCHING 2
Q112	KRC104S	K.E.C	AUDIO SWITCHING 2
Q113	KRA226S	K.E.C	AUDIO MUTE 2
Q114	KRA104S	K.E.C	ROGER BEEP SWITCHING
Q115	KRC104S	K.E.C	LOW TONE SWITCHING
Q118	KRC104S	K.E.C	LOW TONE SWITCHING
Q222	KRC104S	K.E.C	BACK LIGHT SWITCHING
Q701	BFG135	SIEMENS	TX POWER FINAL AMP.
Q702	MMBR951	MOTOLOLA	TX POWER DRIVER AMP.
Q703	KRA226S	K.E.C	TX B+ PATH
Q704	2SC5084	TOSHIBA	BUFFER
Q705	2SC5084	TOSHIBA	O.S.C
Q706	KRC104S	K.E.C	V.C.O RX SWITCHING
Q707	KTC3875S	K.E.C	V.C.O NOISE FILTER
Q708	KRA105S	K.E.C	RX POWER SAVING SWITCHING
Q709	KRA105S	K.E.C	RX B+ SWITCHING

IC1	MC3361CD	MOTOLOLA	2'ND MIXER, IF, AND FM DETECTOR
IC7	KIA358A	K.E.C	CALL DATA FILTER
IC101	LM388	NATIONAL	AUDIO POWER AMP.
IC102	MC14053BD	MOTOLOLA	ANALOG SWITCH
IC103	KIA324F	K.E.C	DE-EMPHASIS AND 300Hz HPF
IC104	KIA324F	K.E.C	PRE-EMPHASIS AND 300Hz HPF.
IC105	TK11140	TOKO	REGULATOR
IC107	KIA324F	KEC	CTCSS TONE FILTER
IC108	KS24C010	SAMSUNG	EEPROM
IC301	KS88C2416	SAMSUNG	CPU
IC701	IB31202FN	TOSHIBA	PLL FREQUENCY SYNTHESIZER LIMITTER, 30HZ LPF

APPENDIX 2

CIRCUITS AND DEVICES TO STABILIZE FREQUENCY

SYNTHESIZER

A phase locked loop (PLL) circuit establishes and stabilizes operating frequency.

The data for producing necessary frequencies is established by the CPU on the digital board.

The frequency stability of the TX/RX is maintained by the TCXO, which generates a stable frequency of 12.8 MHz.

CIRCUITS AND DEVICES TO
STABILIZE FREQUENCY
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APPENDIX 2

APPENDIX 3

CIRCUITS TO SUPPRESS SPURIOUS RADIATION
AND LIMIT MODULATION

Circuitry to Suppress Spurious Emissions

The transmitted signal of approximately 16 dBm, combined at the PLL circuit is supplied to the base of the Q701 amplifier. The transmitted signal amplified to 27 dBm here passes the TX LPF of the 2^{nd} characteristic of the C703, L702, L701, L700 and TX/TX switching takes place by the D701. After this, the signal is provided to the antenna.

Circuitry to Limit Modulation and Audio Low Pass Filter

The voice signal input from the microphone is pre-emphasized at the IC104B, and at the same time, the components below 300 Hz are reduced to minimize the influence to the CTCSS tone. The signal which comes out of the IC104B is limited to a certain amplitude at the IC104A 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