ENGINEERING STATEMENT

For Type Certification of

Cobra Electronics Corporation

Model No: FRS 220
FCC ID: BBOFRS220B

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 220 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.

Rowland S. Johnson

Dated: January 5, 1999

A. INTRODUCTION

The following data are submitted in connection with this request for type certification of the FRS 220 transceiver in accordance with Part 2, Subpart J of the FCC Rules.

The FRS 220 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: BBOFRS220B

   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 220 fully complied with that power limitation.
   e. The dc voltage and dc currents at final amplifier:

      Collector voltage: 6.3 Vdc
      Collector current: 0.35 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.

B. GENERAL INFORMATION (continued)

   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 220 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	0.419

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. <u>Occupied_Bandwidth</u>
(Paragraphs 2.989(c) of the Rules)

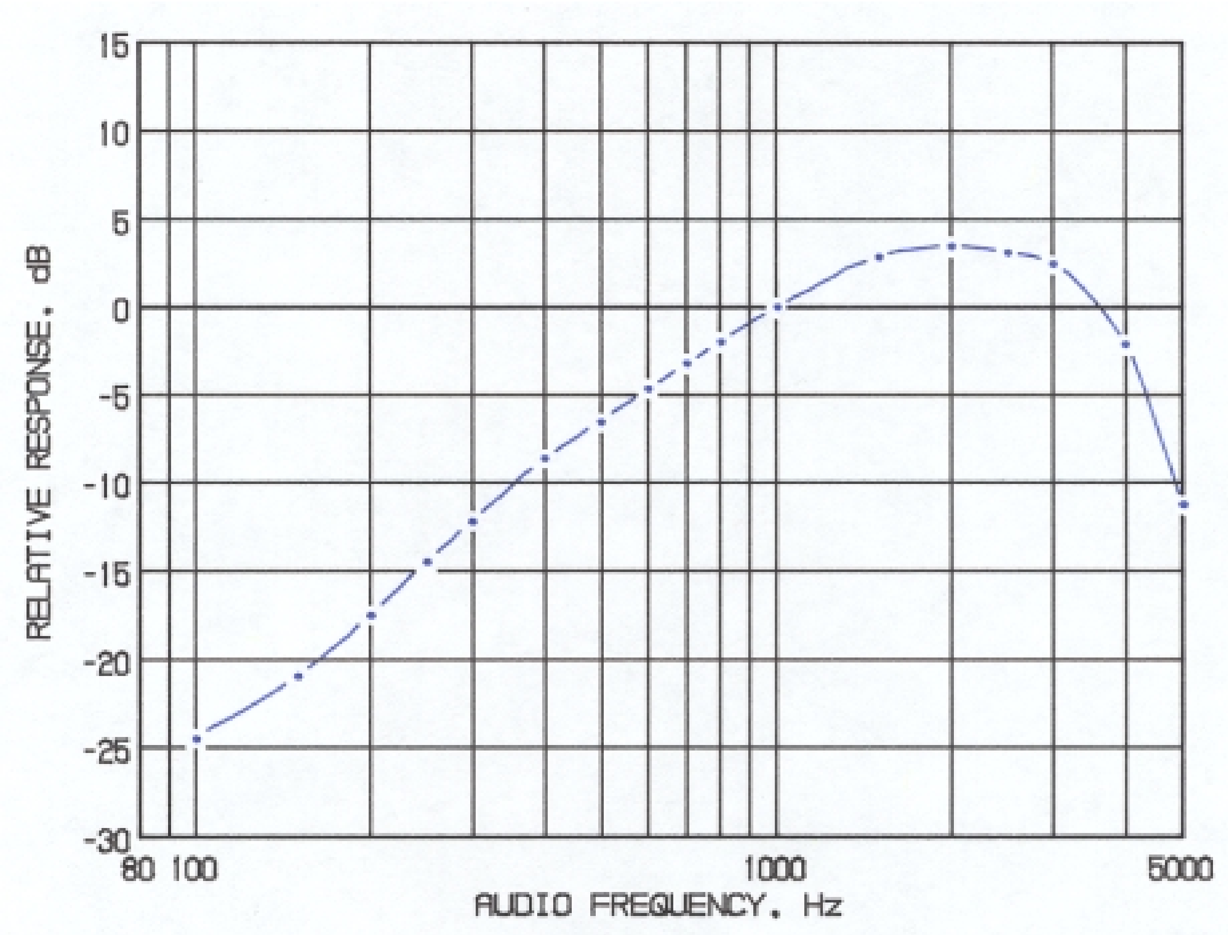
Figure 4 is a plot of the sideband envelope of the transmitter output taken with a Tektronix 494P spectrum analyzer. Modulation corresponded to conditions of 2.989(c)(1) and consisted of 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50% modulation at 2269 Hz, the frequency of maximum response. Measured modulation under these conditions was 1.3 kHz.

Emission designator:

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

FIGURE 1

MODULATION FREQUENCY RESPONSE

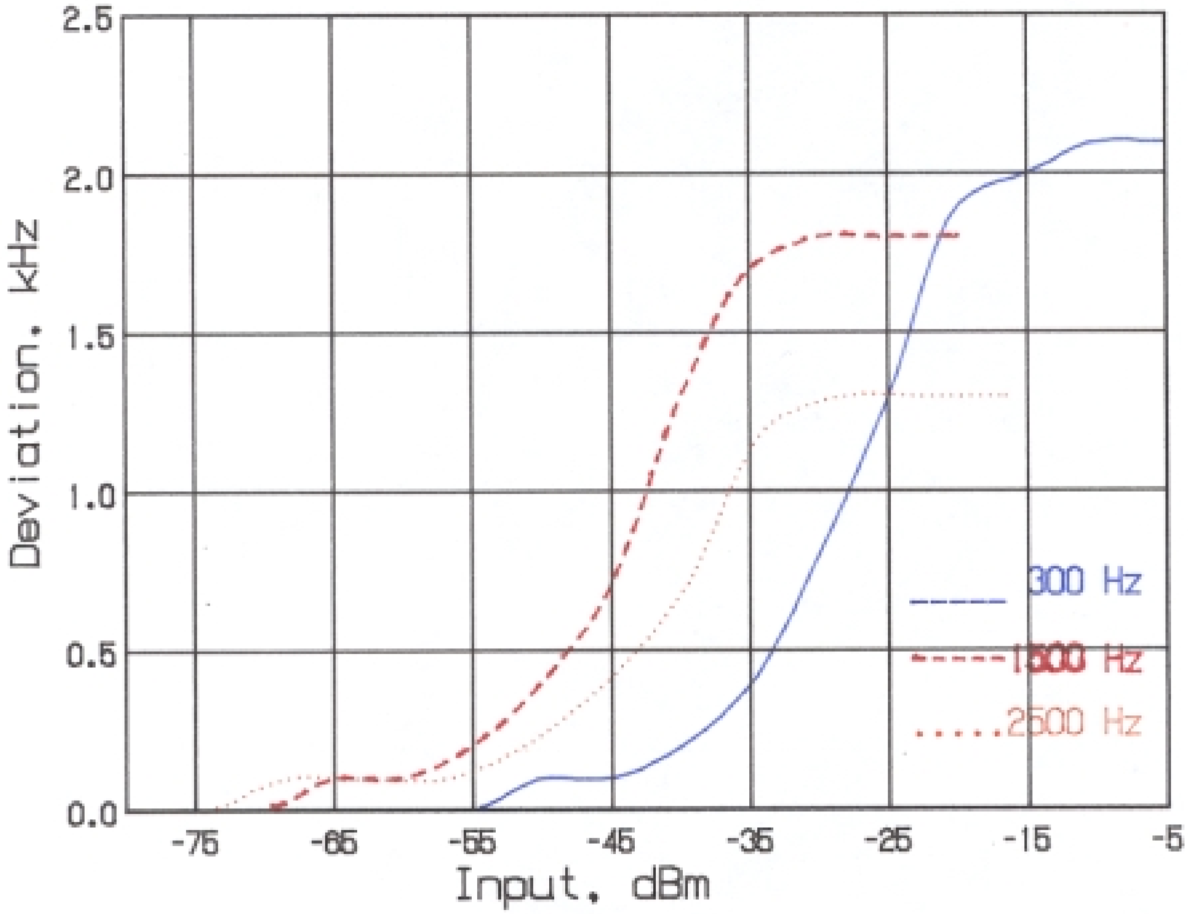


MODULATION FREQUENCY RESPONSE
FCC ID: BBOFRS220B

FIGURE 1

FIGURE 2

AUDIO LIMITER CHARACTERISTICS

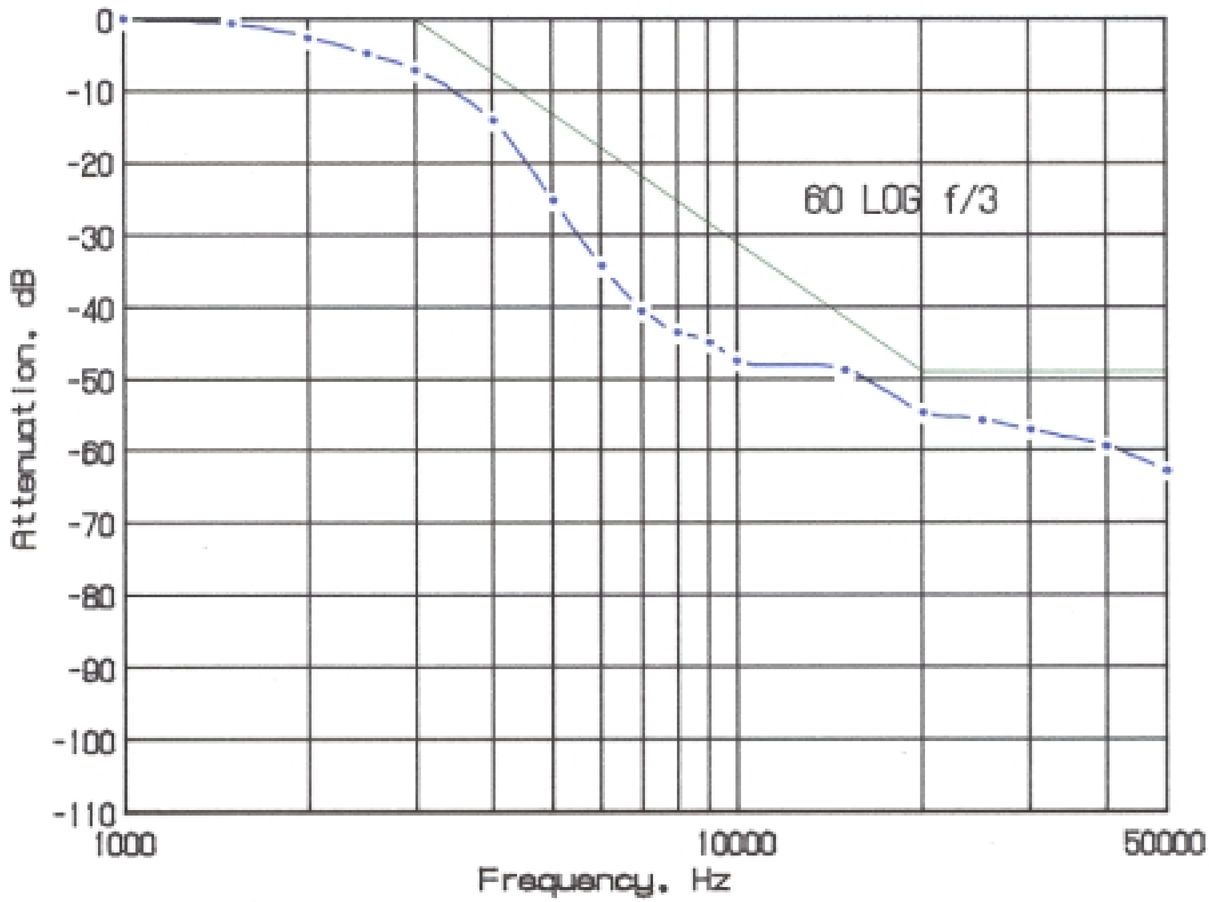


AUDIO LIMITER CHARACTERISTICS
FCC ID: BBOFRS220B

FIGURE 2

FIGURE 3

AUDIO LOW PASS FILTER RESPONSE

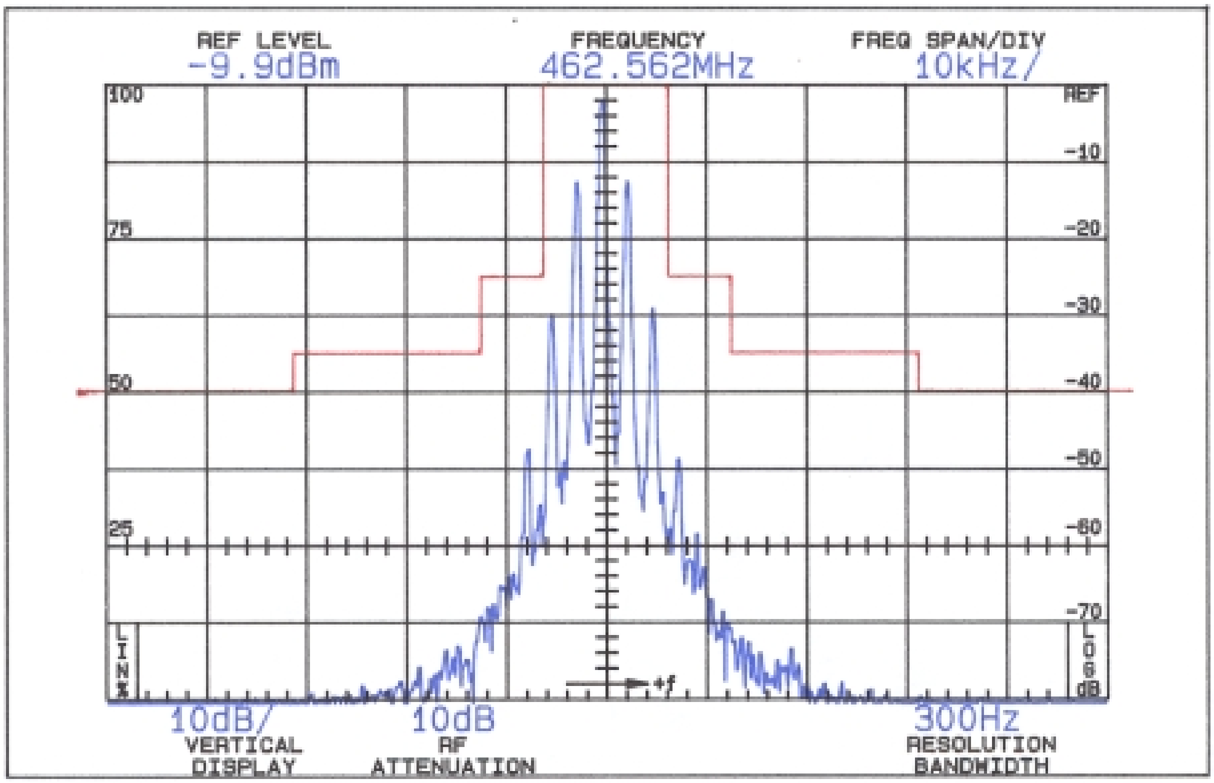


AUDIO LOW PASS FILTER
RESPONSE
FCC ID: BBOFRS220B

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 = 39 (P = 0.419)

OCCUPIED BANDWIDTH
FCC ID: BBOFRS220B

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 220 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 220 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 MHz), to 10 times operating frequency. Data after application of antenna factors and line loss corrections are shown in Table 3.

TABLE 3

TRANSMITTER CABINET RADIATED SPURIOUS

462.5625 MHz, 6.0 Vdc, 0.419 watts

Spurious Frequency MHz	Radiated Field uV/m @ 3M	dB Below Carrier Reference[1]
462.562	1513561	0
925.123	3702	52V
1387.685	1771	59V
1850.246	187	78V*

2312.808	152	80V*
2775.370	138	81V*
3237.931	128	81H*
3700.493	172	79H*
4163.054	256	75V*
4625.616	214	77H*

Required: 43+10 Log(P) = 39

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

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

All other spurious from 12 MHz to the tenth harmonic were 20 dB or more below FCC limit.

Power:

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

$= (1.513561)^2/49.2$

$= 0.419$ 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 4, 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 4

FREQUENCY STABILITY AS A FUNCTION OF TEMPERATURE
462.5625 MHz, 6.0 Vdc, 0.419 W

Temperature, °C	Output Frequency, MHz	p.p.m.
-19.7	462.561386	-2.4
- 9.6	462.561525	-2.1
0.4	462.562106	-0.9
10.1	462.562638	0.3
19.8	462.562593	0.2
30.1	462.562352	-0.3
39.9	462.562235	-0.6
50.2	462.562434	-0.1

Maximum frequency error: 462.561386
462.562500

\- .001114 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 5

FREQUENCY STABILITY AS A FUNCTION OF SUPPLY VOLTAGE

462.5625 MHz, 6.0 Vdc Nominal; 0.419W

Supply Voltage		Output Frequency, MHz	p.p.m.
6.9	115%	462.562623	0.3
6.6	110%	462.562615	0.2

6.3	105%	462.562601	0.2
6.0	100%	462.562593	0.2
5.7	95%	462.562587	0.2
5.4	90%	462.562579	0.2
5.1	85%	462.562570	0.2
4.8*	80%	462.562568	-0.4

Maximum frequency error: 462.562623
462.562500

\+ .000123 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 220

SEMICONDUCTOR AND FUNCTIONS

1.1) TR

Ref. No.	Description	Function		Manufacturer
		RX	TX	
Q1	2SC5084	RX AMP	-	TOSHIBA
Q2	2SC5084	RX 1ST MIXER	-	TOSHIBA
Q3	KTC3880	1ST IF AMP	-	K.E.C.
Q4	2SC5084	VCO	VCO	TOSHIBA
Q7	2SC5084	BUFFER AMP	BUFFER AMP	TOSHIBA
Q8	BFG135A	-	TX POWER TR	SIEMENS
Q8	BFG135	-	TX POWER TR	PHILIPS

Q9	MMBR951	-	DRIVER AMP	MOTOROLA
Q10	KRA226S	-	TX B+ SWITCHING	K.E.C.
Q11	KRC104S	-	TX VCO SWITCHING	K.E.C.
Q12	KTC3875	B+ SWITCHING	B+ SWITCHING	K.E.C.
Q13	KRA105S	B+ SWITCHING	B+ SWITCHING	K.E.C.
Q14	KRA105S	RX B+ SWITCHING	-	K.E.C.
Q101	KTA1504S	AUDIO MUTE	-	K.E.C.
Q102	KTA1504S	AF SWITCHING	-	K.E.C.
Q103	KTA1504S	-	PTT CONTROL	K.E.C.
Q5	KRC112S	VOLUME CONTROL	-	K.E.C.
Q6	KRC112S	VOLUME CONTROL	-	K.E.C.
Q15	KRC112S	VOLUME CONTROL	-	K.E.C.
Q106	KRC104S	AUDIO MUTE	-	K.E.C.
Q107	KRC110S	LCDBACK LIGHTING	LCDBACK LIGHTIG	K.E.C.
Q108	KRC104S	RX B+ SWITCHING	-	K.E.C.
Q109	KRC104S	-	TX B+ SWITCHING	K.E.C.
Q110	KRC104S	-	TX B+ SWITCHING	K.E.C.
Q112	KRC104S	POWER CONTROL	POWER CONTROL	K.E.C.
Q113	KRA226S	POWER CONTROL	POWER CONTROL	K.E.C.
Q114	KTA1504S	BEEP/RING TONE CONTROL	-	K.E.C.
Q115	KRC104S	CTCSS NOISE LIMIT	CTCSS NOISE LIMIT	K.E.C.
Q116	KRC104S	CTCSS NOISE LIMIT	CTCSS NOISE LIMIT	K.E.C.

9.2) DIODE

Ref. No.	Description	Function		Manufacturer
		RX	TX	
D1	KDS181	DIODE SWITCHED	-	K.E.C.
D2	KDS226	DIODE SWITCHED	-	K.E.C.
D3	1SS314	-	PIN DIODE SWITCHED	TOSHIBA
D4	1SV229	VARICAP DIODE	VARICAP DIODE	TOSHIBA
D5	MMBV3401	DIODE SWITCHED	-	MOTOROLA
D6	MMBV3401	-	DIODE SWITCHED	MOTOROLA

D7	KDS160	-	DIODE SWITCHED	K.E.C.
D8	KDS181	DIODE SWITCHED	DIODE SWITCHED	K.E.C.
D9	1SS314	-	PIN DIODE SWITCHED	TOSHIBA
D10	1SS314	PIN DIODE SWITCHED	-	TOSHIBA
D11	KDS184	DIODE SWITCHED	DIODE SWITCHED	K.E.C.
D12	1SV229	VARICAP DIODE	VARICAP DIODE	TOSHIBA
D101	KDS226	DIODE SWITCHED	DIODE SWITCHED	K.E.C.
D301	KDS226	DIODE SWITCHED	-	K.E.C.

9.3) IC

Ref. No.	Description	Function		Manufacturer
		RX	TX	
IC2	TB31202FN	PLL IC	PLL IC	TOSHIBA
IC102	MC14053BD	ANALOG SWITCH	ANALOG SWITCH	MOTOROLA
IC103	KIA324F	DE-EMPHASIS,300Hz	-	K.E.C.
IC104	KIA324F	-	PRE-EMPHASIS,3KHz	K.E.C.
IC105	TK111XXM	4 V REGULATOR	4 V REGULATOR	TOKO
IC106	KS88C2416	CPU	CPU	SAMSUNG
IC107	KIA324F	SWITCHED CAPACITOR	SWITCHED CAPACITOR	K.E.C.
IC108	KS24C010	EEPROM	EEPROM	SAMSUNG
IC1	MC3361	2^{ND} MIXER AF DETECTOR	-	MOTOROLA
IC101	LM386	AUDIO AMP	-	NATIONAL

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

Output from the final RF power amplifier, Q5, and presented to a low-pass filter configured in a "pi" network consisting of L6, C611, L221, C613, L219, C616, C217, C617 and C619.

Circuitry to Limit Modulation and Audio Low Pass Filter

Microphone signal is amplitude limited to prevent deviation over 2.5 kHz, and applied to a 3 kHz low-pass filter configured around IC707.

CIRCUITS TO SUPPRESS SPURIOUS
RADIATION AND LIMIT MODULATION

FCC ID: BBOFRS220B
APPENDIX 3