ENGINEERING STATEMENT

For Type Certification of

Cobra Electronics Corporation

Model No: FRS 120
FCC ID: BBOFRS120B

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 120 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: February 26, 2001

A. INTRODUCTION

The following data are submitted in connection with this

request for type certification of the FRS 120 transceiver in accordance with Part 2, Subpart J of the FCC Rules.

The FRS 120 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.

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: BBOFRS120B

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

      Collector voltage: 4.4 Vdc
      Collector current: 0.56 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 120 has a permanently attached built-in antenna without provisions for a coaxial connector.

RF power output was determined by substitution.

TABLE 1

Operating Freq., MHz	Power watts into an ideal dipole antenna
462.5625	0.47

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)

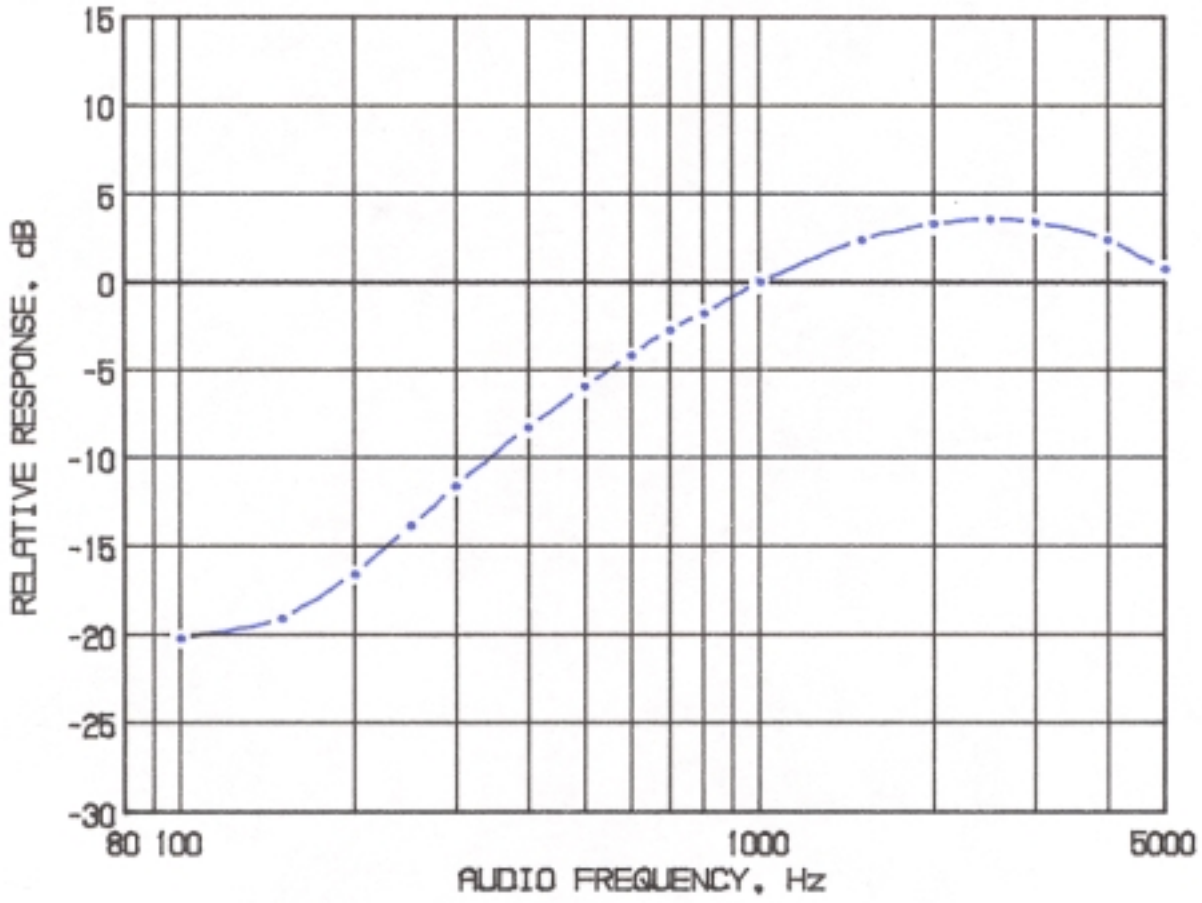
Figure 4 is a plot of the sideband envelope of the transmitter output taken with a Tektronix 494P spectrum analyzer. Modulation corresponded to conditions of 2.989(c)(1) and consisted of 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50% modulation at 2669 Hz, the frequency of maximum response. Measured modulation under these conditions was 1.8 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: BBOFRS120B

FIGURE 1

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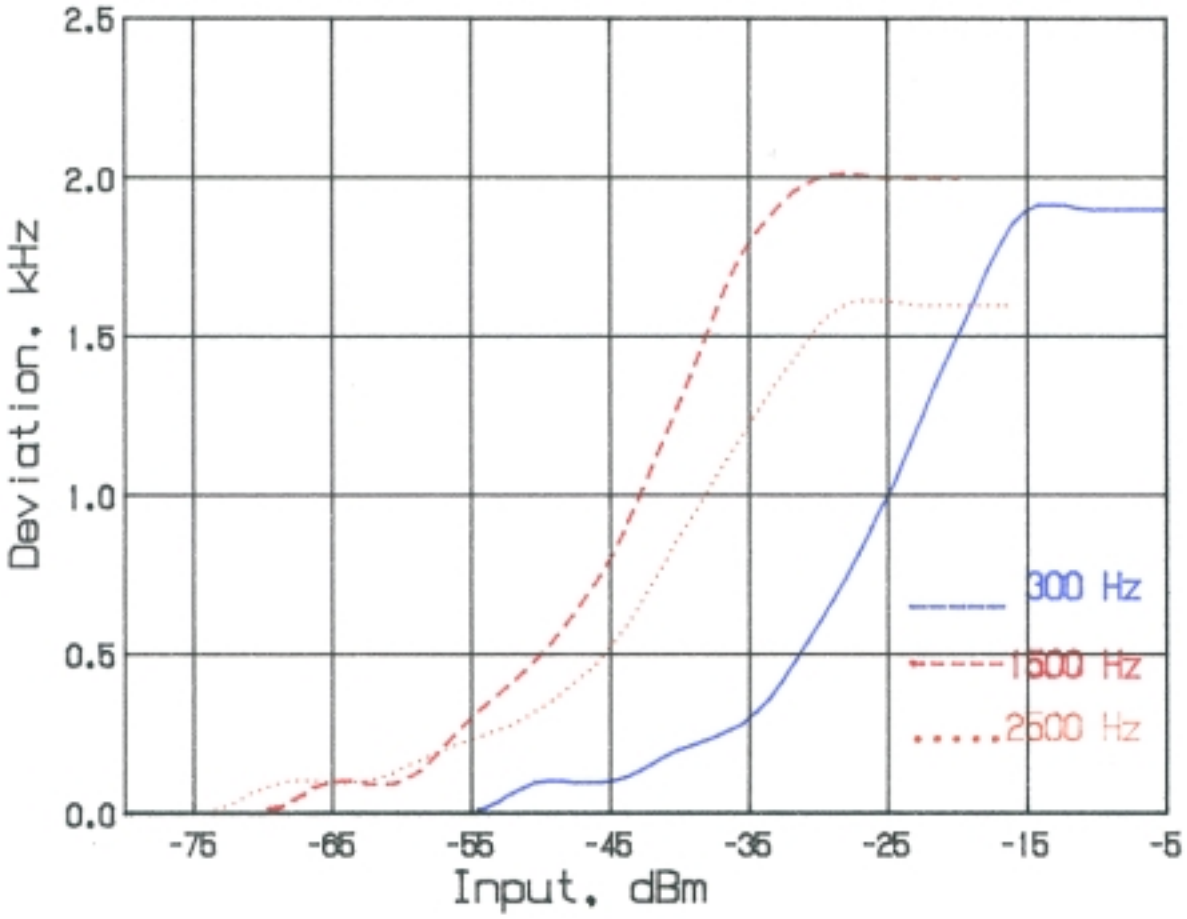
FIGURE 2

AUDIO LIMITER CHARACTERISTICS

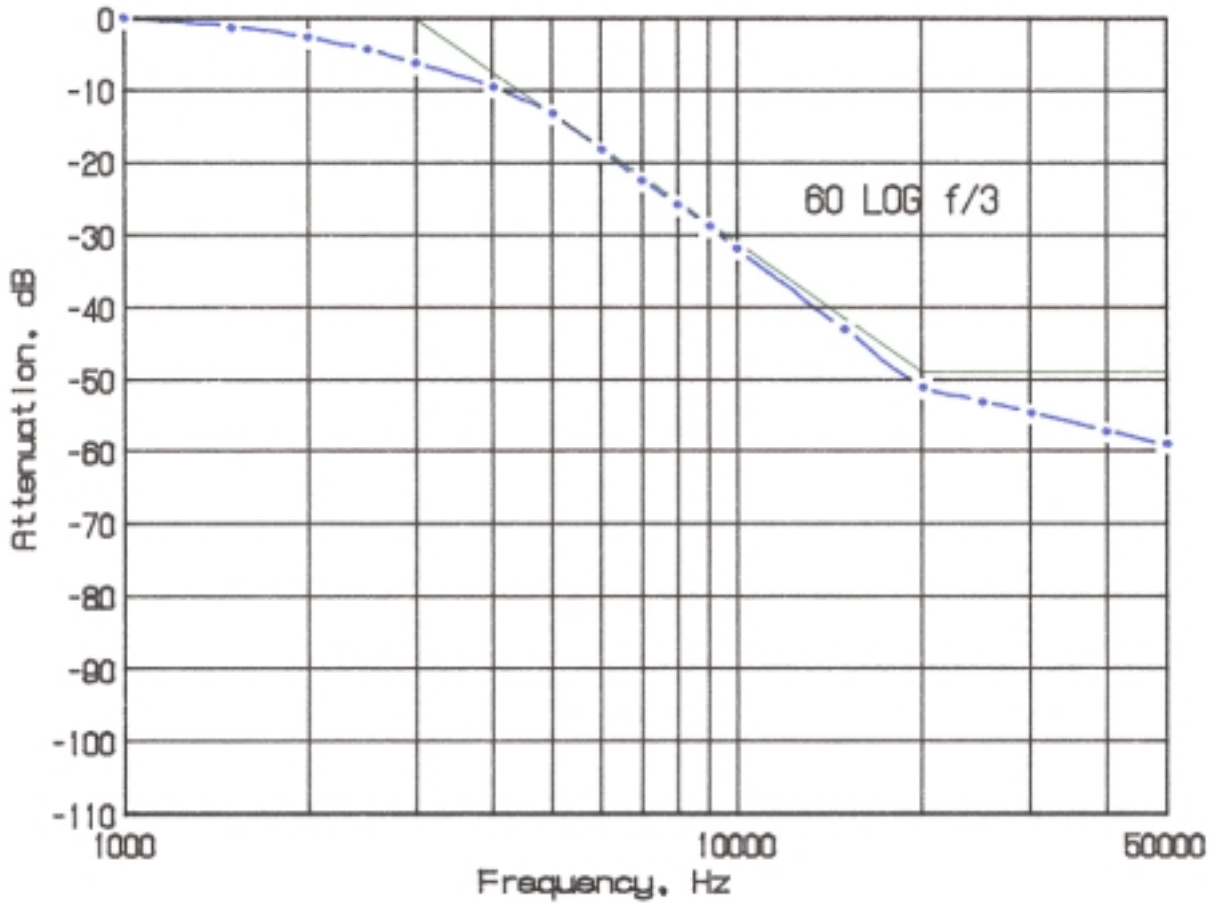


AUDIO LIMITER CHARACTERISTICS
FCC ID: BBOFRS120B

FIGURE 2

FIGURE 3

AUDIO LOW PASS FILTER RESPONSE

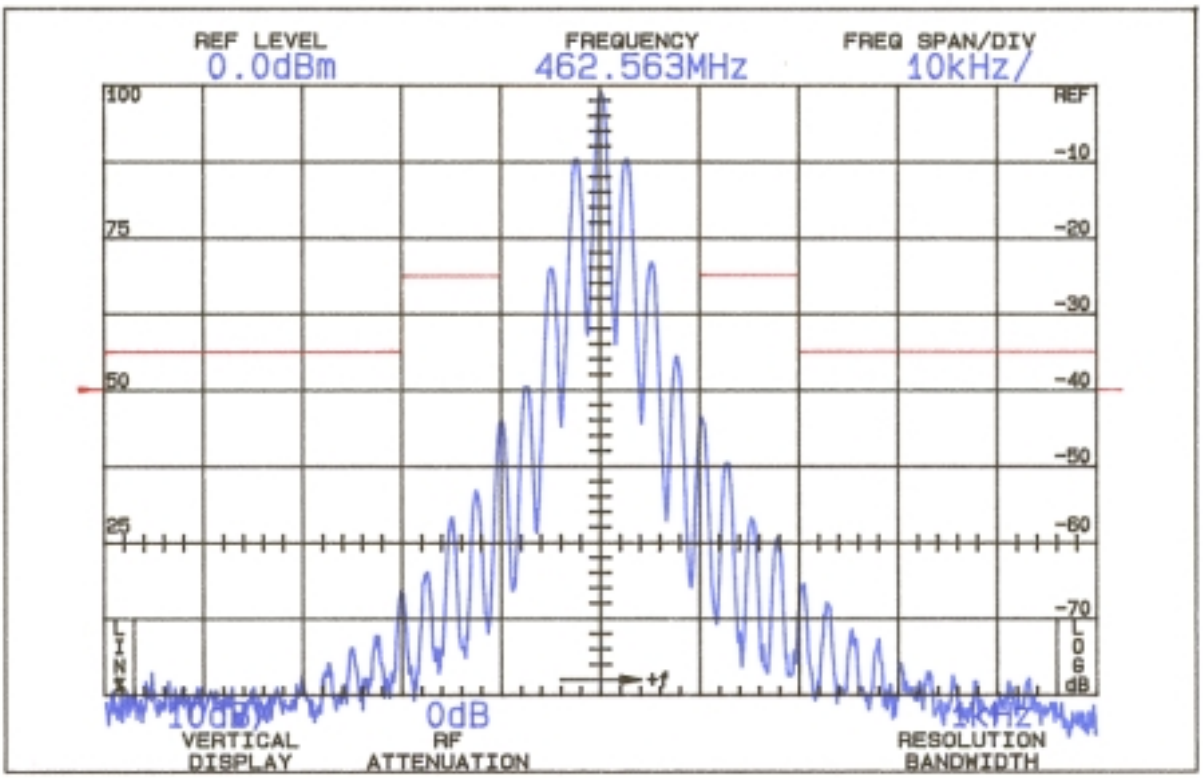


AUDIO LOW PASS FILTER
RESPONSE
FCC ID: BBOFRS120B

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 = 0.47)

OCCUPIED BANDWIDTH
FCC ID: BBOFRS120B

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 120 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

Measurements of radiated spurious emissions from the FRS 120 were made by substitution method 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 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 (12.8 MHz), to 10 times operating frequency. Data after application of antenna gain factors and line loss corrections are shown in Table 2.

TABLE 2

TRANSMITTER CABINET RADIATED SPURIOUS

462.5625 MHz, 4.5 Vdc, 0.47 watts

Spurious Frequency MHz	dB Below Carrier Reference

925.125	49
1387.690	57
1850.254	48
2312.817	51
2775.379	54
3700.504	53
4163.067	54

Required: 43+10 Log(P) = 40

All other spurious from 12.8 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, 0.47 W

Temperature, °C	Output Frequency, MHz	p.p.m.
-20.1	462.562288	-0.5
- 9.4	462.562383	-0.3
0.6	462.562379	-0.3
10.3	462.562507	0.0
20.5	462.562750	0.5
29.9	462.562443	-0.1
39.8	462.562087	-0.9
49.7	462.562063	-0.9
Maximum frequency error:	462.562063	
	462.562500	
	- .000437 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; 0.47W

Supply Voltage		Output Frequency, MHz	p.p.m.
5.17	115%	462.562754	0.5
4.95	110%	462.562756	0.6
4.73	105%	462.562752	0.5
4.50	100%	462.562750	0.5
4.28	95%	462.562747	0.5
4.05	90%	462.562743	0.5
3.83	85%	462.562740	0.5
3.60*	80%	462.562741	0.5

Maximum frequency error: 462.562796
462.562500

+ .000256 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/PARTS LIST
FRS 120

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	KRC104S	-	TX VCO SWITCHING	K.E.C.
Q5	KTA1504S	AF SWITCHING	-	K.E.C.
Q6	KTA1504S	BEEP/RING TONE CONTROL	-	K.E.C.
Q7	KRC104S	AUDIO MUTE	-	K.E.C.
Q8	KRA105S	-	TX VCO SWITCHING	K.E.C.
Q9	KRA226S	-	TX B+ SWITCHING	K.E.C.
Q10	KRA104S	-	TX B+ SWITCHING	K.E.C.
Q11	KRC104S	-	MIC MUTE	K.E.C.
Q12	KTA1504S	-	PTT CONTROL	K.E.C.
Q13	KRC104S	LCD BACK LIGHT	LCD BACK LIGHT	K.E.C.
Q14	KRC104S	RX B+ SWITCHING	-	K.E.C.
Q19	KRA226S	RX B+ SWITCHING	-	K.E.C.
Q31	KRC104S	-	TX VCO Switching	K.E.C.
Q32	2SC5084	VCO Pump Charge	VCO Pump Charge	TOSHIBA
Q33	2SC5084	VCO Pump Charge	VCO Pump Charge	TOSHIBA
Q34	2SC5084	Buffer Amp	-	TOSHIBA
Q35	2SC5084	-	BUFFER AMP	TOSHIBA
Q36	MMBR951	-	DRIVER AMP	MOTOROLA
Q38	BLT70	-	TX POWER TR	PHILIPS
Q38	DRF1401	-	TX POWER TR	DAEWOO

9.2) DIODE

Ref. No.	Description	Function		Manufacturer
		RX	TX	
D1	KDS226	DIODE SWITCHED	-	K.E.C.
D2	KDS181	DIODE SWITCHED	-	K.E.C.
D3	KDS226	DIODE SWITCHED	-	K.E.C.

D4	KDS181	DIODE SWITCHING	DIODE SWITCHING	K.E.C.
D5	KDS181	-	DIODE SWITCHING	K.E.C.
D9	KDS181	-	DIODE SWITCHED	K.E.C.
D10	MMBV3401	DIODE SWITCHED	-	MOTOROLA
D11	MMBV3401	-	DIODE SWITCHED	MOTOROLA
D201	KDV154	VARICAP DIODE	VARICAP DIODE	K.E.C.
D202	KDS114	PIN DIODE SWITCHED	-	K.E.C.

9.3) IC

Ref. No.	Description	Function		Manufacturer
		RX	TX	
IC1	KA3361	2^{ND} MIXER AF DETECTOR	-	SAMSUNG
IC2	NJM2070M	LOW VOLTAGE POWER AMP	-	JRC
IC4	TB31202FN	PLL IC	PLL IC	TOSHIBA
IC5	TK11130MCL	3 V REGULATOR	3V REGULATOR	TOKO
IC6	KIA4558F	-	DUAL LOW NOISE OP AMP	K.E.C.
IC100	KS57P21208	CPU	CPU	SAMSUNG
IC108	KS24C010	EEPROM	EEPROM	SAMSUNG

APPENDIX 2

CIRCUITS AND DEVICES TO STABILIZE FREQUENCY

PLL Frequency Synthesizer (IC4)

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 12.8 MHz TCXO of the TCXO is connected to the pin 11 of the IC4 to oscillate the frequency of 12.8 MHz. The TCXO (12.8 MHz) is the temperature compensation circuit to maintain the frequency within the allowable error rang even under a low temperature of -30° C. The phase detector send out the output power to the loop filter through 3rd pin of the IC4. If the oscillation frequency of the VCO is low compared to the reference frequency, the phase detector sends out output power in positive pulse. If the oscillation frequency of the VCO is high, phase detector send put can maintain the frequency set. The programmable divider maintain the desired frequency with control from the CPU. The dividing ratio, "N" to oscillate the desired frequency is as below :

N = VCO oscillation frequency / reference frequency

If the desired frequency is 462.5625 MHz

a) TX
N = 462.5625 MHz / 0.00625 MHz = 74010

b) RX
N = [462.5625 MHz – 21.4 MHz] / 0.00625 MHz = 70586

c) RX (WX)
N = [161.650 MHz – 21.4 MHz] / 0.00625 MHz = 22440

CIRCUITS AND DEVICES TO
STABILIZE FREQUENCY
FCC ID: BBOFRS120B

APPENDIX 2

APPENDIX 3

CIRCUITS TO SUPPRESS SPURIOUS RADIATION
AND LIMIT MODULATION

Circuitry to Suppress Spurious Emissions

The transmitted signal of approximately 7mW, combined at the driver TR is supplied to the base of the Q328 amplifier. The transmitted signal amplifier to 0.47 W here passes the TX LPF of the 2nd characteristics of the L25 and the L26, and RX/TX switching takes place by the D11. After this, the signal is provided to the antenna the TX LPF of the 1st characteristics consisted of the L27.

Circuitry to Limit Modulation and Audio Low Pass Filter

The voice signal input from the microphone is pre-emphasized at the IC6B. The signal which comes out of the IC6A is limited to a certain amplitude at the IC104A for the voice signal not to exceed the allowable bandwidth assigned for transmission.

CIRCUITS TO SUPPRESS SPURIOUS
RADIATION AND LIMIT MODULATION
FCC ID: BBOFRS120B

APPENDIX 3