

ENGINEERING STATEMENT

For Type Certification of
COBRA ELECTRONICS CORPORATION

Model No: FRS 110
FCC ID: BBOFRS110B

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 110 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: December 8, 1999

A. INTRODUCTION

The following data are submitted in connection with this request for type certification of the FRS 110 transceiver in accordance with Part 2, Subpart J of the FCC Rules.

The FRS 110 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. (Manufacturer's 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: BBOFRS110B
 - 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 110 fully complied with that power limitation.
 - e. The dc voltage and dc currents at final amplifier:

Collector voltage: 5.8 Vdc
Collector current: 0.37 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.

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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 110 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	0.492

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 $60\text{Log}f/3$ 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.

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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 2670 Hz, the frequency of maximum response. Measured modulation under these conditions was 2.1 kHz.

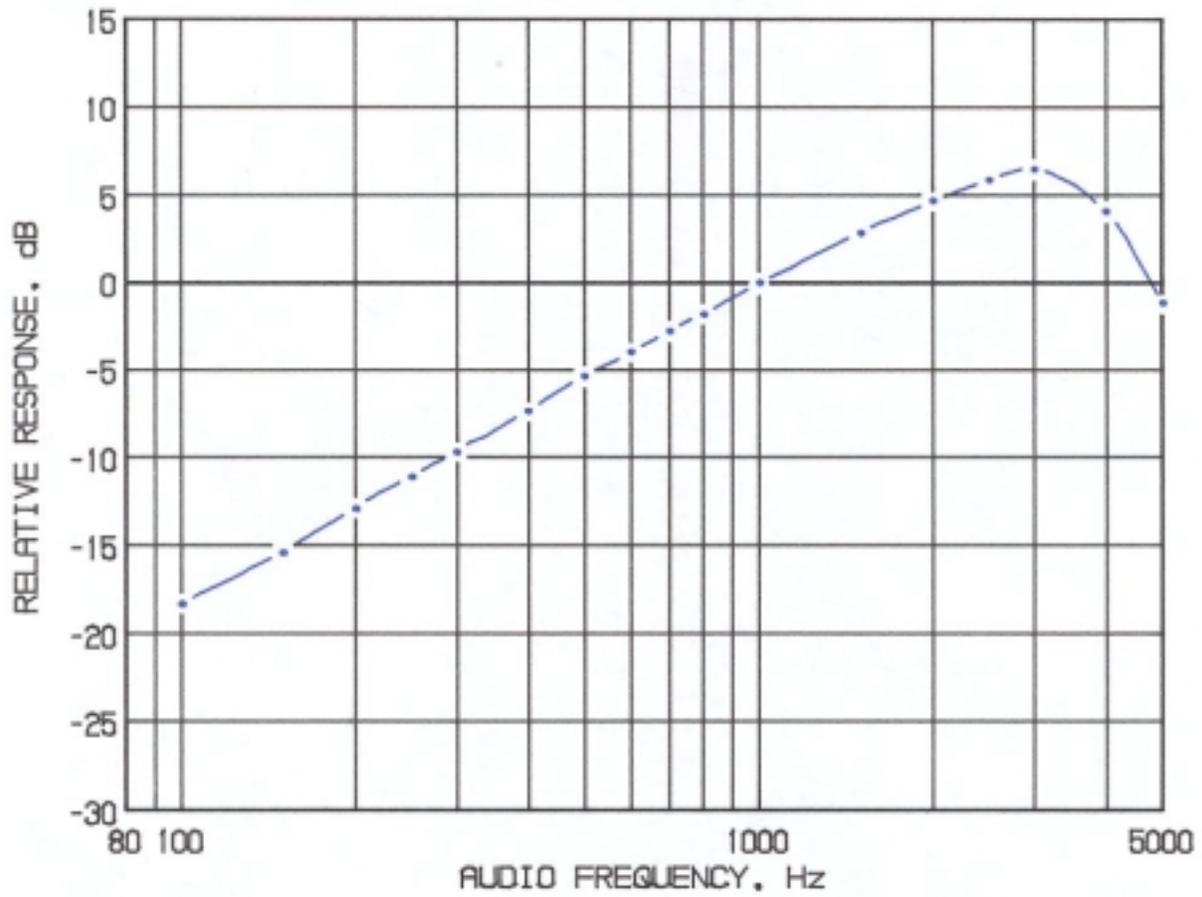
Emission designator:

$$(2M + 2D) (2 \times 3 \text{ kHz}) + (2 \times 2.5 \text{ kHz}) = 11k0F3E$$

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FIGURE 1

MODULATION FREQUENCY RESPONSE



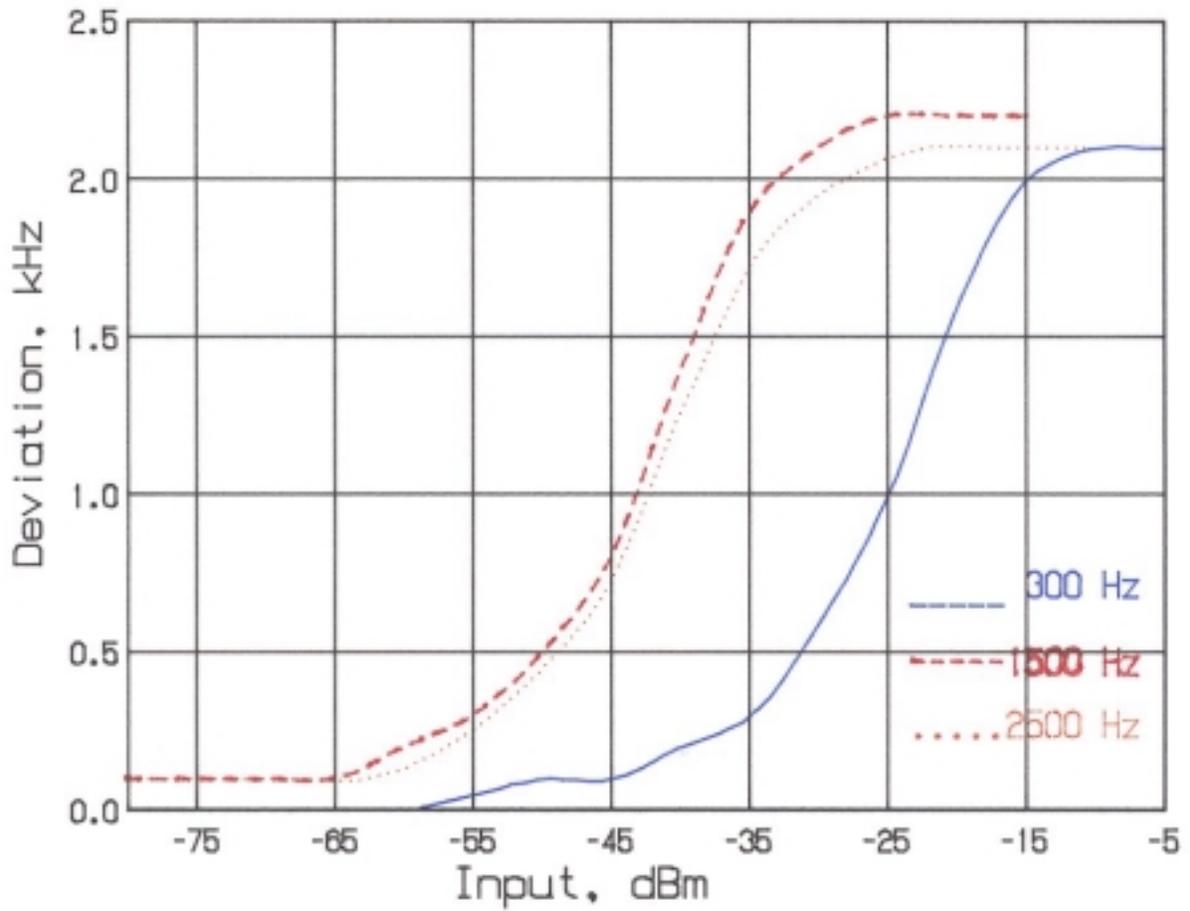
MODULATION FREQUENCY RESPONSE
 FCC ID: BBOFRS110B

FIGURE 1

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FIGURE 2

AUDIO LIMITER CHARACTERISTICS



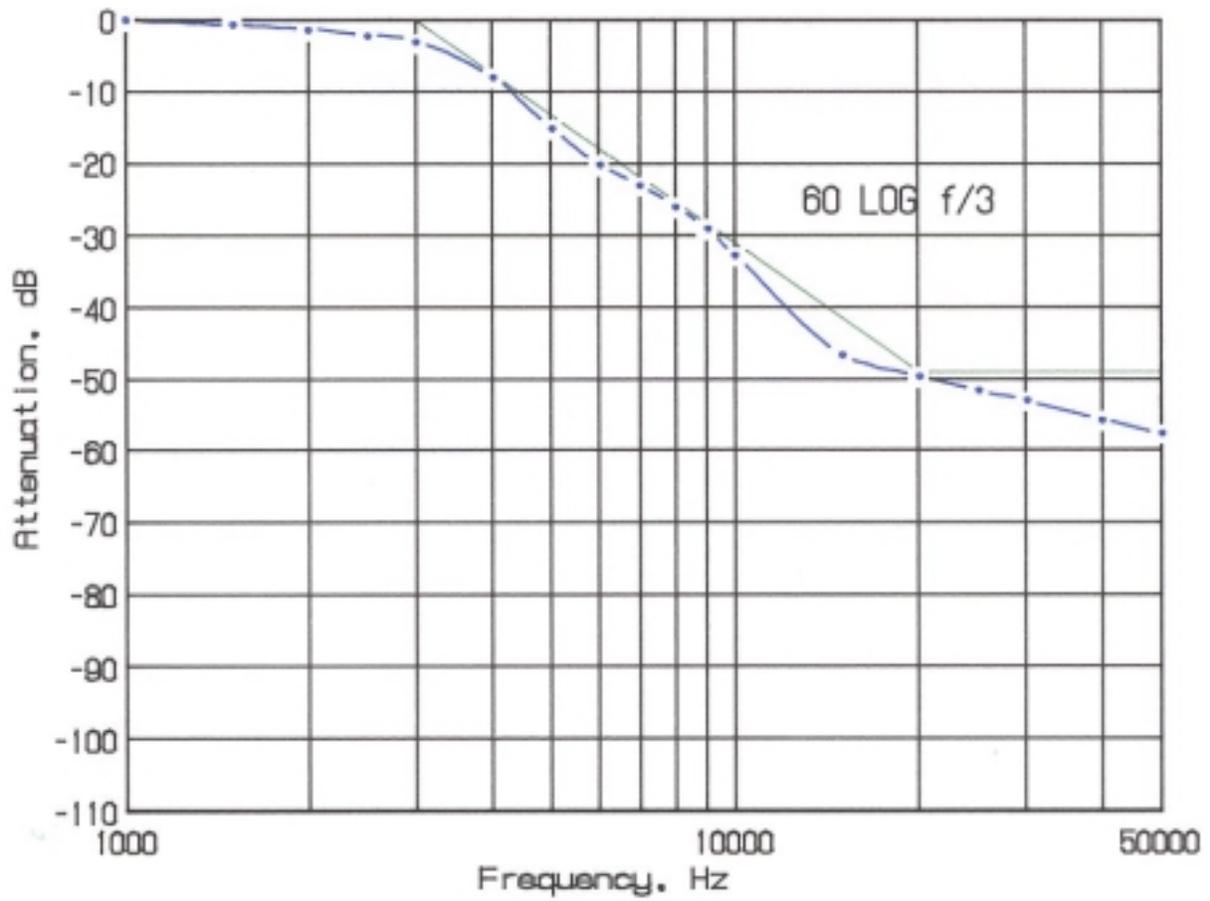
AUDIO LIMITER CHARACTERISTICS
 FCC ID: BBOFRS110B

FIGURE 2

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FIGURE 3

AUDIO LOW PASS FILTER RESPONSE



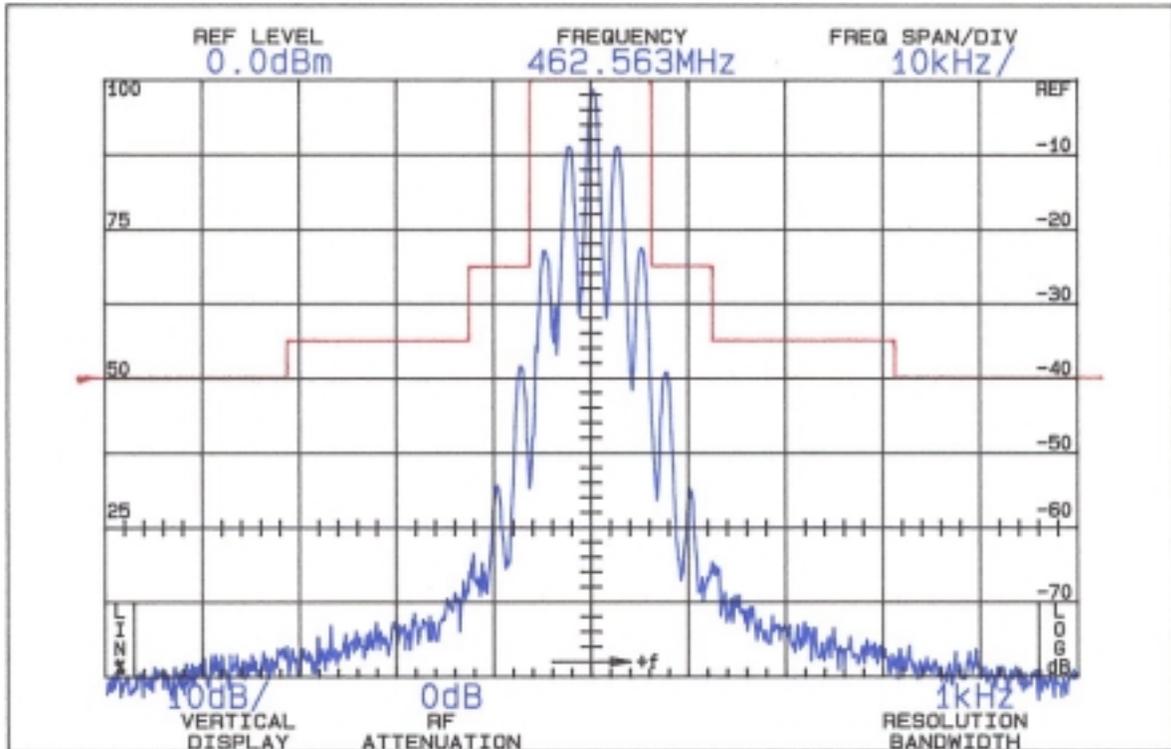
AUDIO LOW PASS FILTER
 RESPONSE
 FCC ID: BBOFRS110B

FIGURE 3

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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)

$$43 + 10 \log P = 40$$

$$(P = 0.492)$$

OCCUPIED BANDWIDTH
FCC ID: BBOFRS110B

FIGURE 4

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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 110B 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 110 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, 0.492 watts

<u>Spurious Frequency MHz</u>	<u>Radiated Field uV/m @ 3M</u>	<u>dB Below Carrier Reference¹</u>
462.562	1640590	0
925.123	7386	47
1387.685	8913	45

1850.246	8810	45
2312.808	5309	50
2775.370	1660	60
3237.931	3527	53
3700.493	1087	64
4163.054	614	69
4625.616	447	71

Required: $43+10 \text{ Log}(P) = 40$

¹Worst-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:

$$\begin{aligned}
 P &= (F.I.x3)^2/49.2 \\
 &= (1.6406)^2/49.2 \\
 &= 0.492 \text{ W}
 \end{aligned}$$

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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, 0.492 W

<u>Temperature, °C</u>	<u>Output_Frequency, _MHz</u>	<u>p.p.m.</u>
-20.3	462.561433	-2.3
- 9.9	462.561622	-1.9
- 0.8	462.561825	-1.5
10.2	462.562059	-1.0
20.3	462.562589	0.2
30.1	462.562755	0.6
40.4	462.562968	1.0
51.1	462.563514	2.2

Maximum frequency error: 462.561433
 462.562500

 - .001067 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; 0.492W

<u>Supply_Voltage</u>	<u>Output_Frequency, _MHz</u>	<u>p.p.m.</u>
6.9 115%	462.562473	-0.1

6.6	110%	462.562487	0.0
6.3	105%	462.562502	0.0
6.0	100%	462.562525	0.1
5.7	95%	462.562543	0.1
5.4	90%	462.562561	0.1
5.1	85%	462.562579	0.2
4.8*	80%	462.562596	-0.3

Maximum frequency error: 462.562596
462.562500
+ .000096 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 110B

SEMICONDUCTOR AND FUNCTIONS

Transistor

Ref. No.	Description	Function		Manufacturer
		RX	TX	
Q1	2SC5084	RX AMP	-	Toshiba
Q2	2SC5084	RX 1 ST MIXER	-	Toshiba
Q3	KTC3880S	1 ST IF AMP	-	K.E.C.
Q4	KRC104S	-	TX Switching	"
Q5	KTC3875S	Squelch Control	-	"

Q6	KTA1504S	Audio Mute	-	“
Q7	KRC104S	Audio Mute	-	“
Q9	KRA105S	-	TX B+ Switching	“
Q10	KRA104S	-	TX B+ Switching	“
Q11	KRC104S	-	MIC Mute	“
Q12	KTA1504S	-	TX B+ Switching	“
Q13	KRC104S	Lamp Switch	Lamp Switch	“
Q14	KRA226S	Audio Amp Control	-	“
Q15	KRC112S	Volume Control	-	“
Q16	KRC112S	Volume Control	-	“
Q17	KRC110S	Audio Amp Control	-	“
Q19	KRA105S	RX B+ Switching	-	“
Q31	KRC104S	-	TX VCO Switching	“
Q32	2SC5084	VCO Pump Charge	VCO Pump Charge	Toshiba
Q33	2SC5084	VCO Pump Charge	VCO Pump Charge	“
Q34	2SC5084	Buffer Amp	-	“
Q35	2SC5084	-	Buffer Amp	“
Q36	MMBR951	-	Driver Amp	Motorola
Q38	BFG135A	-	TX Power TR	Siemens
Q38	BFG135	-	TX Power TR	Philips
Q39	KRC112S	Volume Control	-	K.E.C.

IC

Ref. No.	Description	Function		Manufacturer
		RX	TX	
IC1	MC3361	2 ND MIXER AF DETECTOR	-	Motorola
IC2	LM386	Audio Amp	-	National
IC4	TB31202FN	PLL IC	PLL IC	Toshiba
IC5	TK11440MTR	4 V Regulator	4 V Regulator	TOKO
IC6A	KIA4558F	-	Audio Amp	K.E.C.
IC6B	KIA4558F	-	Pre-emphasis	“

IC100	KS57P21208	CPU	CPU	Samsung
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FUNCTION OF DEVICES
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APPENDIX 1

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, 38, and presented to a low-pass filter configured in a "pi" network consisting of L25, C311, L26, C312, C313, L27, C315 and C316.

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 IC6.

CIRCUITS TO SUPPRESS SPURIOUS
RADIATION AND LIMIT MODULATION

FCC ID: BBOFRS110B
APPENDIX 3