

ENGINEERING STATEMENT

For Type Certification of  
Cobra Electronics Corporation

Model No: FRS 225  
FCC ID: BBOFRS225A

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 225 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 21, 2001

A. INTRODUCTION

The following data are submitted in connection with this

request for type certification of the FRS 225 transceiver in accordance with Part 2, Subpart J of the FCC Rules.

The FRS 225 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: BBOFRS225A
  - 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 225 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.

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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 225 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 a dipole antenna
462.5625	0.498

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 2996 Hz, the frequency of maximum response. Measured modulation under these conditions was 1.5 kHz.

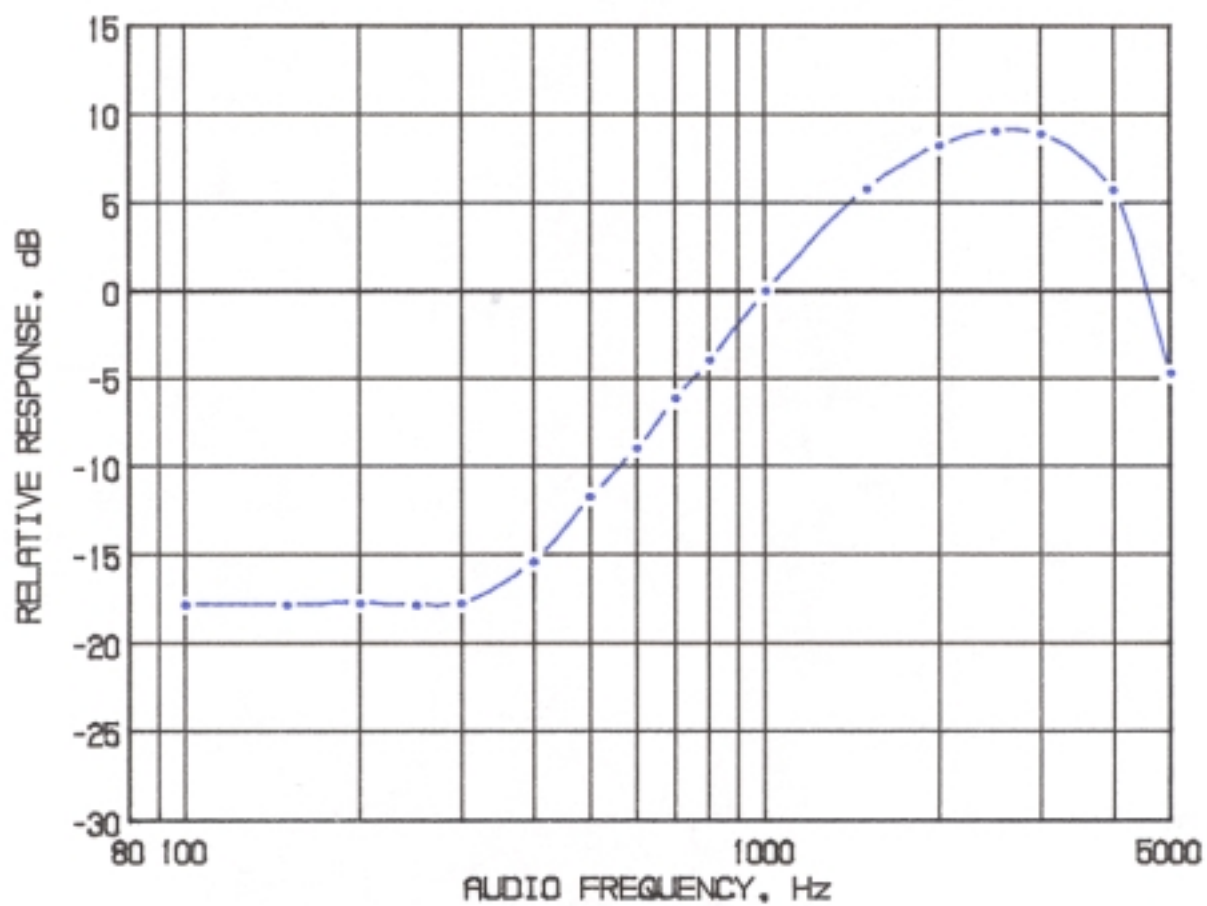
Emission designator:

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

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FIGURE 1

MODULATION FREQUENCY RESPONSE



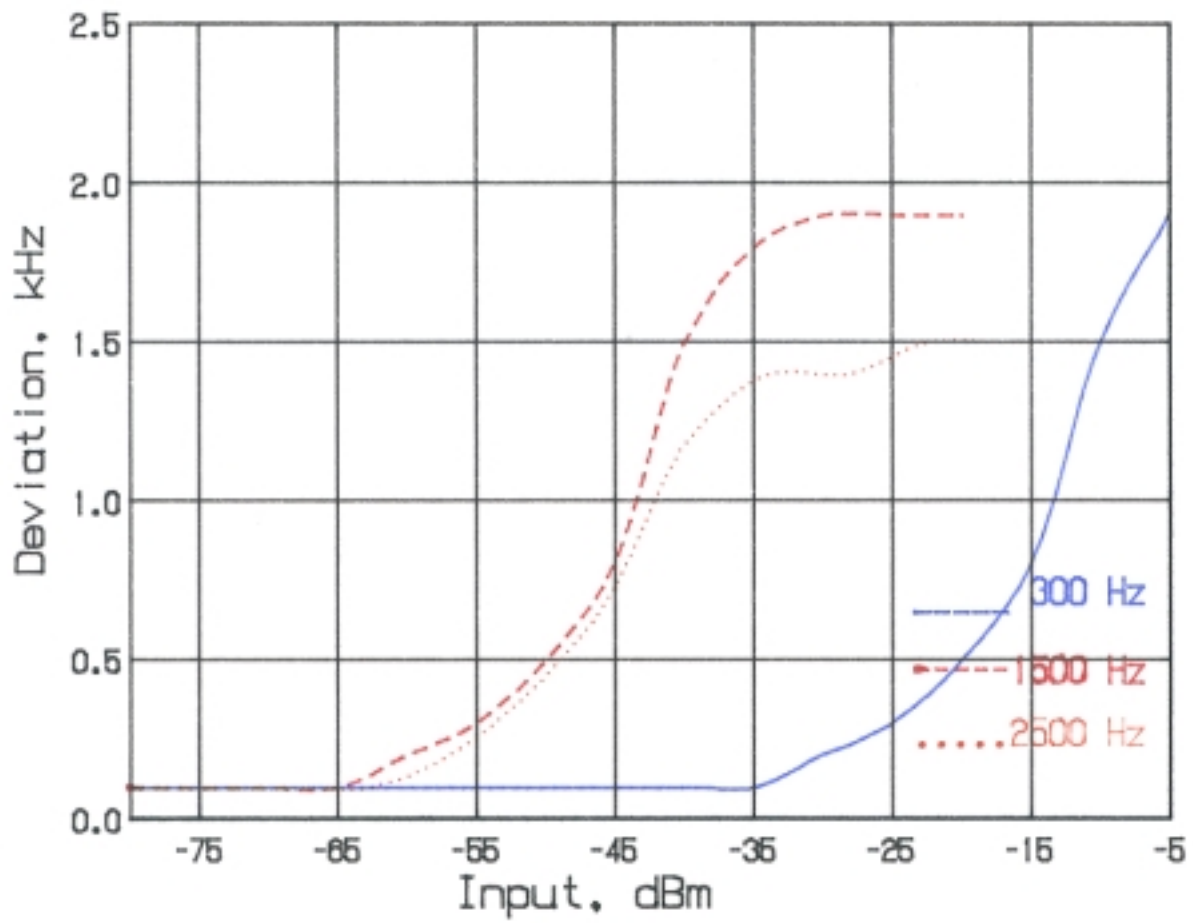
MODULATION FREQUENCY RESPONSE  
FCC ID: BBOFRS225A

FIGURE 1

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FIGURE 2

AUDIO LIMITER CHARACTERISTICS

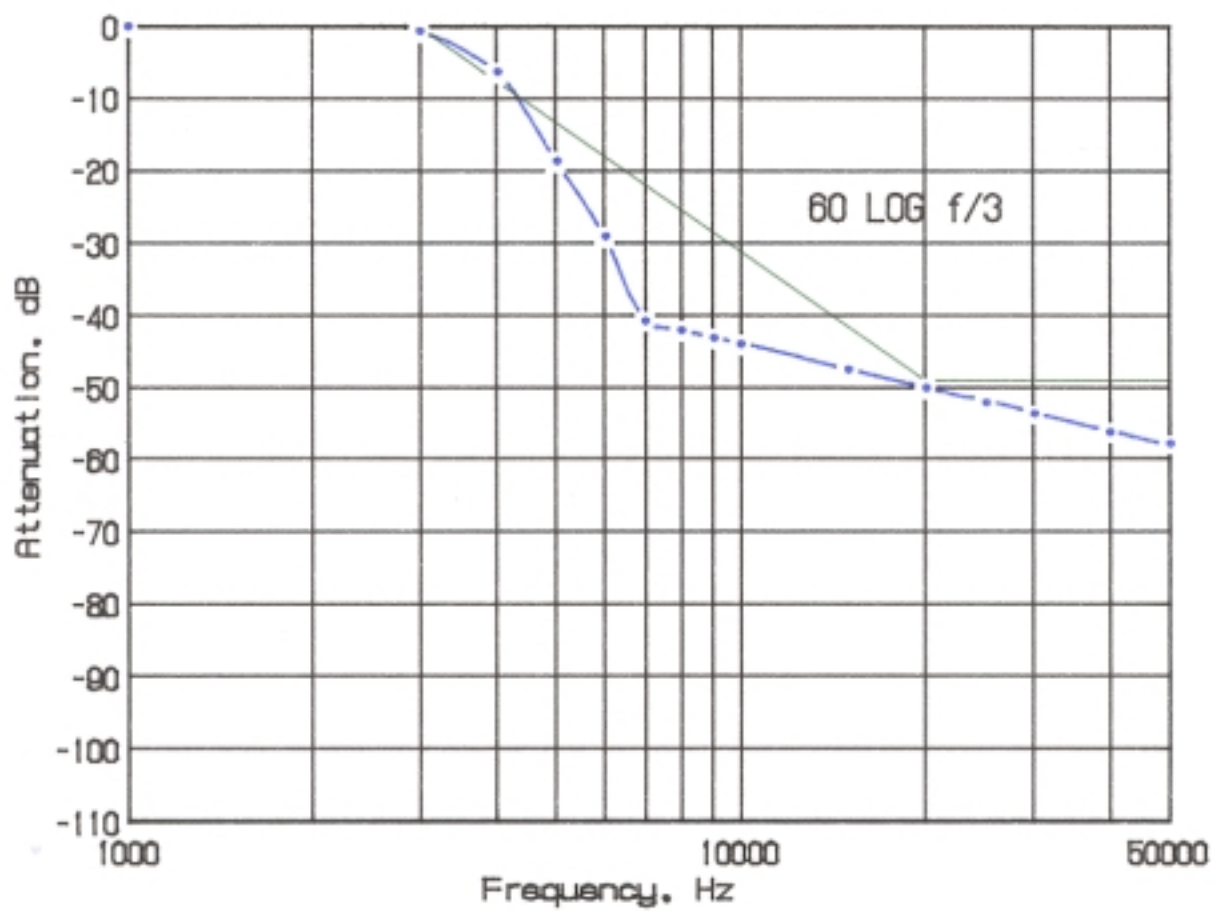


AUDIO LIMITER CHARACTERISTICS  
FCC ID: BBOFRS225A

FIGURE 2  
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FIGURE 3

AUDIO LOW PASS FILTER RESPONSE



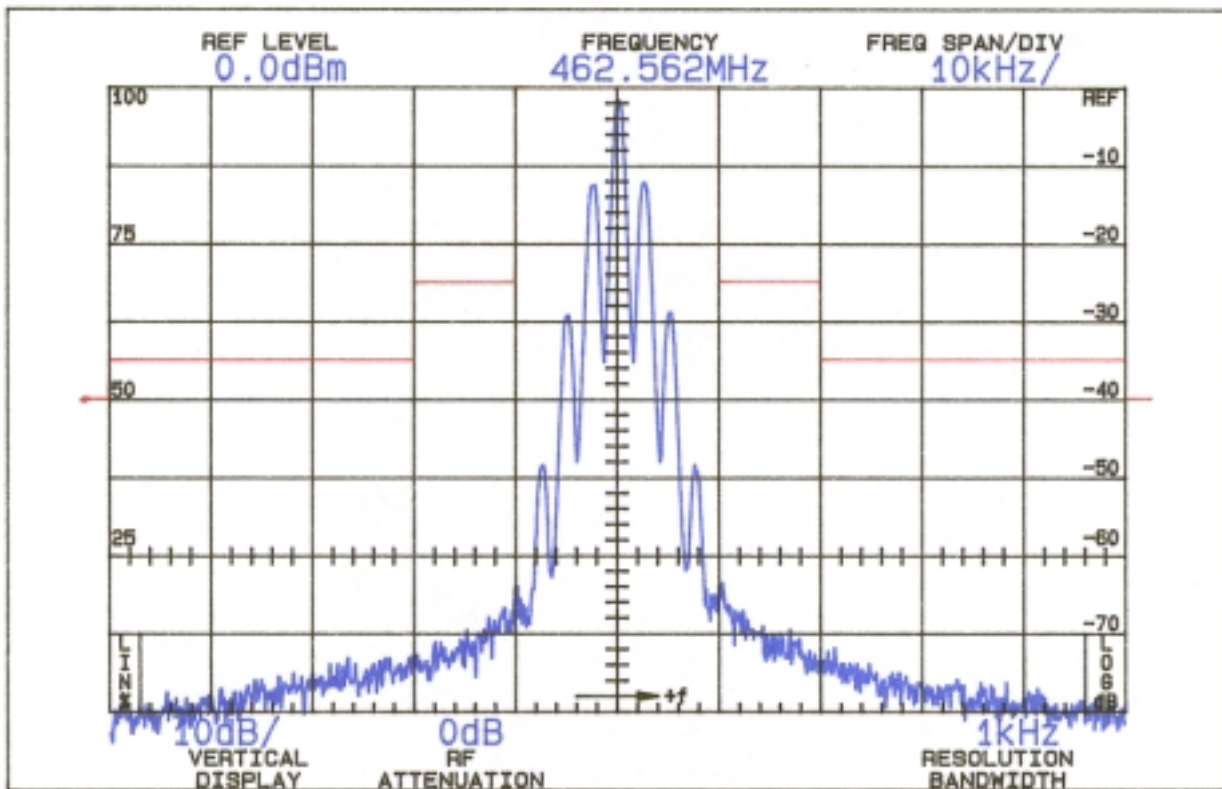
AUDIO LOW PASS FILTER  
RESPONSE  
FCC ID: BBOFRS225A

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)

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

$$(P = 0.498)$$

OCCUPIED BANDWIDTH  
FCC ID: BBOFRS225A

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 225 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 225 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 4.8 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 factors and line loss corrections are shown in Table 2.

TABLE 2

TRANSMITTER CABINET RADIATED SPURIOUS

462.5625 MHz, 4.5 Vdc, 0.498 watts

Spurious  
Frequency  
      MHz      

dB Below  
Carrier  
Reference

925.125  
3237.494

54V  
60V

Required:  $43 + 10 \log(P) = 40$

All other spurious from 20.95 MHz to the tenth harmonic were 20 dB or more below FCC limit.

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

Measurement of frequency stability versus temperature was made at temperatures from  $-20^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$ . 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  $\pm 2^{\circ}$  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  $-20^{\circ}\text{C}$ .

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, 0.498 W

<u>Temperature, °C</u>	<u>Output_Frequency, _MHz</u>	<u>p.p.m.</u>
-19.7	462.561818	-1.5
- 9.4	462.562063	-0.9
0.1	462.562570	0.2
9.9	462.562827	0.7
20.1	462.562607	0.2
30.2	462.562044	-1.0
39.9	462.561586	-2.0
50.2	462.561556	-2.0
Maximum frequency error:	462.561556	
	<u>462.562500</u>	
	- .000944 MHz	

FCC Rule 95.627(b) specifies .00025% (2.5 p.p.m.) or a maximum of  $\pm 0.001156$  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  $\pm 15\%$  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; 0.498W

<u>Supply_Voltage</u>		<u>Output_Frequency, _MHz</u>	<u>p.p.m.</u>
5.17	115%	462.562723	0.5
4.95	110%	462.562685	0.4
4.73	105%	462.562640	0.3
4.50	100%	462.562607	0.2
4.28	95%	462.562578	0.2
4.05	90%	462.562555	0.1
3.83	85%	462.562535	0.1
3.60*	80%	462.562517	0.0
Maximum frequency error:		462.562723	
		<u>462.562500</u>	
		+ .000223 MHz	

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

High Limit	462.563656 MHz
Low Limit	462.561344 MHz

\*Battery end point.

## APPENDIX 1

### FUNCTION OF DEVICES/CRITICAL COMPONENTS

U9	T0980	Power Amplifier
	2SC4226	RF transistor
LF1		Saw Filter
CF1		Crystal filter

## APPENDIX 2

### CIRCUITS AND DEVICES TO STABILIZE FREQUENCY

- a) U2 TB31202 PLL which is the main component to lock the TX carrier and provide stable output frequency.
- b) XL1 20.95 MHz is the main clock of PLL.

CIRCUITS AND DEVICES TO  
STABILIZE FREQUENCY  
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APPENDIX 2

APPENDIX 3

CIRCUITS TO SUPPRESS SPURIOUS RADIATION  
AND LIMIT MODULATION

- a) Op-amp, U4a, U4b, U4c, U4d, work as voice filter and limiter to suppress unwanted signal from MIC before sending to TX modulator.
- b) Q5, Q7, C29, C30, C87, VC2, D2, are the main components of VCO.
- c) D2 is variable diode which is the main component of modulation

in VCO.

CIRCUITS TO SUPPRESS SPURIOUS  
RADIATION AND LIMIT MODULATION  
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APPENDIX 3