ENGINEERING STATEMENT

For Type Certification of

Cobra Electronics Corporation

Model No: FRS 130
FCC ID: BBOFRS130D

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 130 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: November 13, 2001

A. INTRODUCTION

The following data are submitted in connection with this request for type certification of the FRS 130 transceiver in accordance with Part 2, Subpart J of the FCC Rules.

The FRS 130 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(d).

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: BBOFRS130D

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

      Collector voltage: 5.8 Vdc
      Collector current: 0.31 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. <u>RF Power Output</u> (Paragraph 2.985(a) of the Rules)

The FRS 130 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	0.45

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)

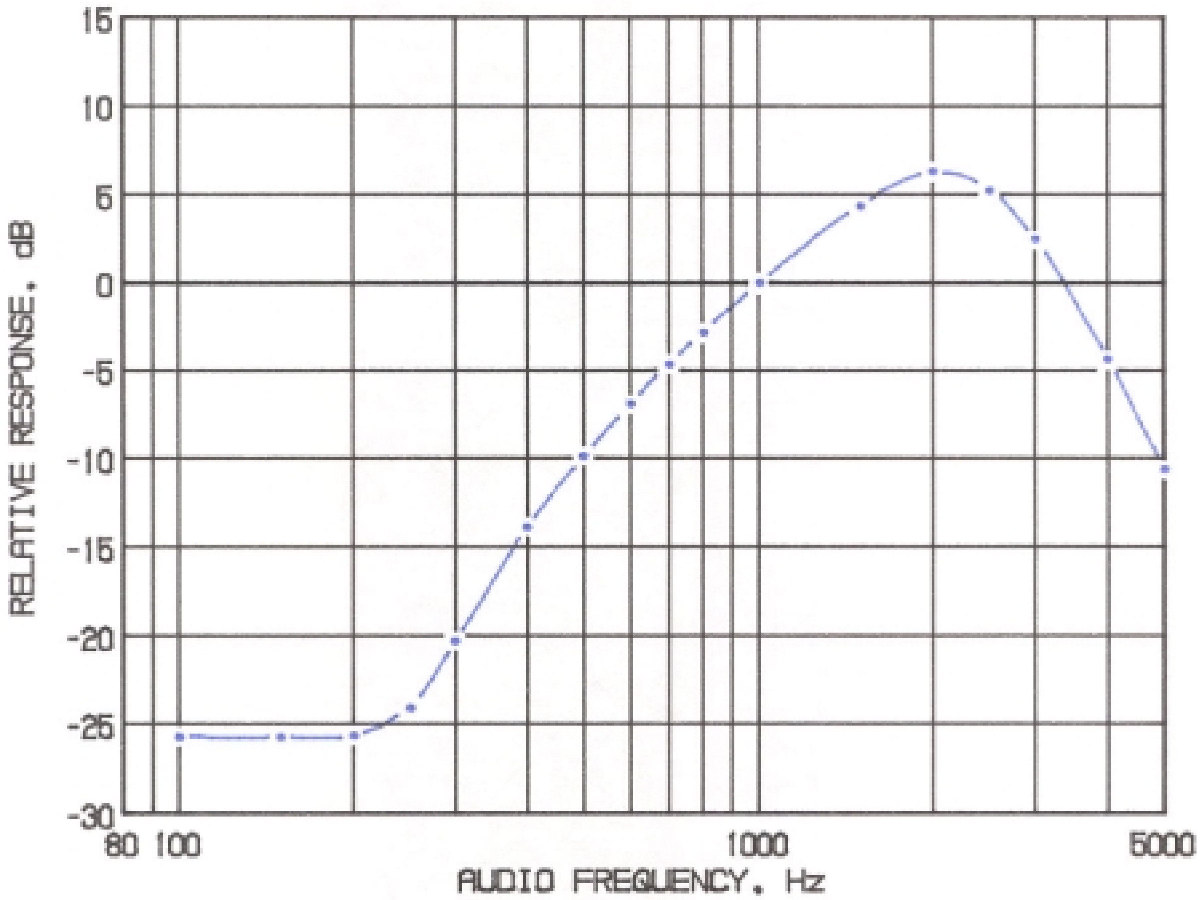
Figure 4 is a plot of the sideband envelope of the transmitter output taken with a Tektronix 494P spectrum analyzer. Modulation corresponded to conditions of 2.989(c)(1) and consisted of 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50% modulation at 2169 Hz, the frequency of maximum response. Measured modulation under these conditions was 1.9 kHz.

Emission designator:

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

FIGURE 1

MODULATION FREQUENCY RESPONSE

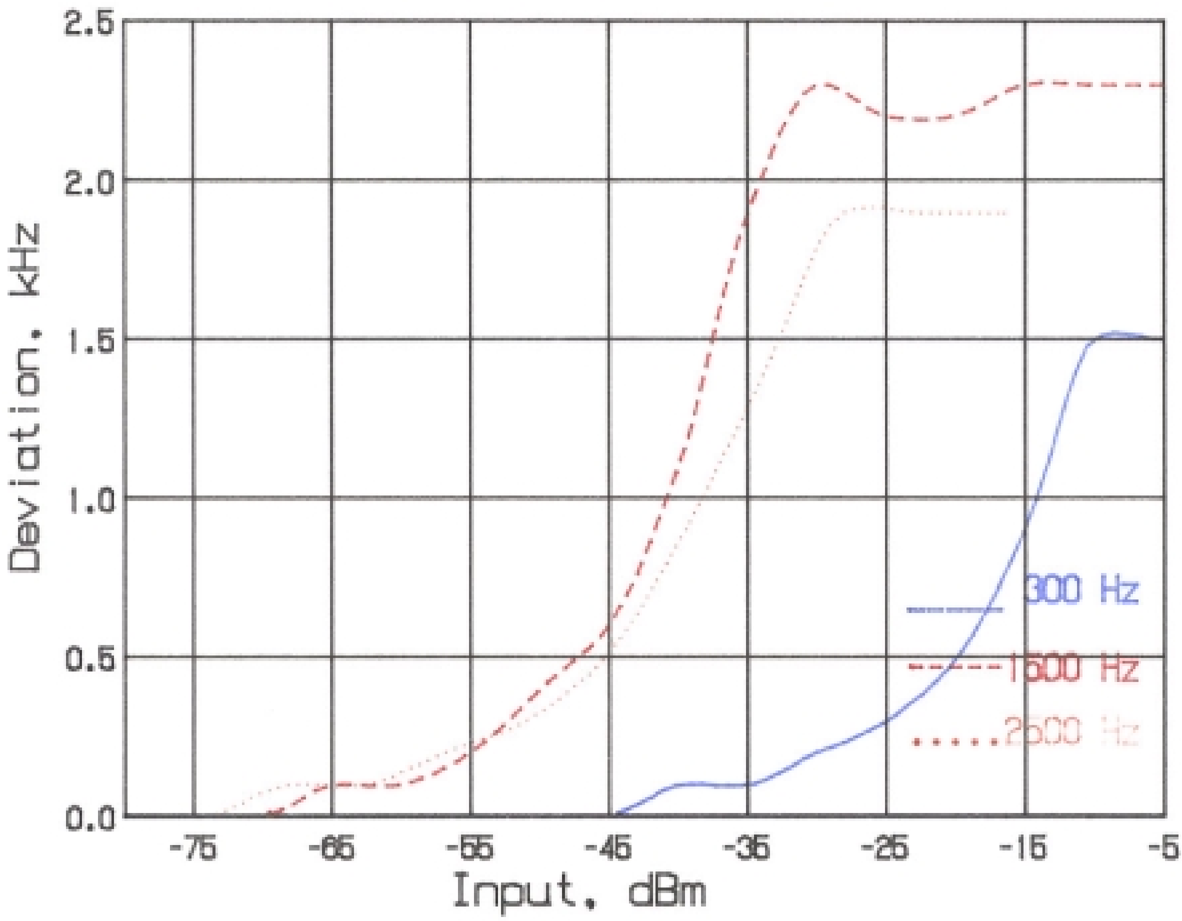


MODULATION FREQUENCY RESPONSE
FCC ID: BBOFRS130D

FIGURE 1

FIGURE 2

AUDIO LIMITER CHARACTERISTICS

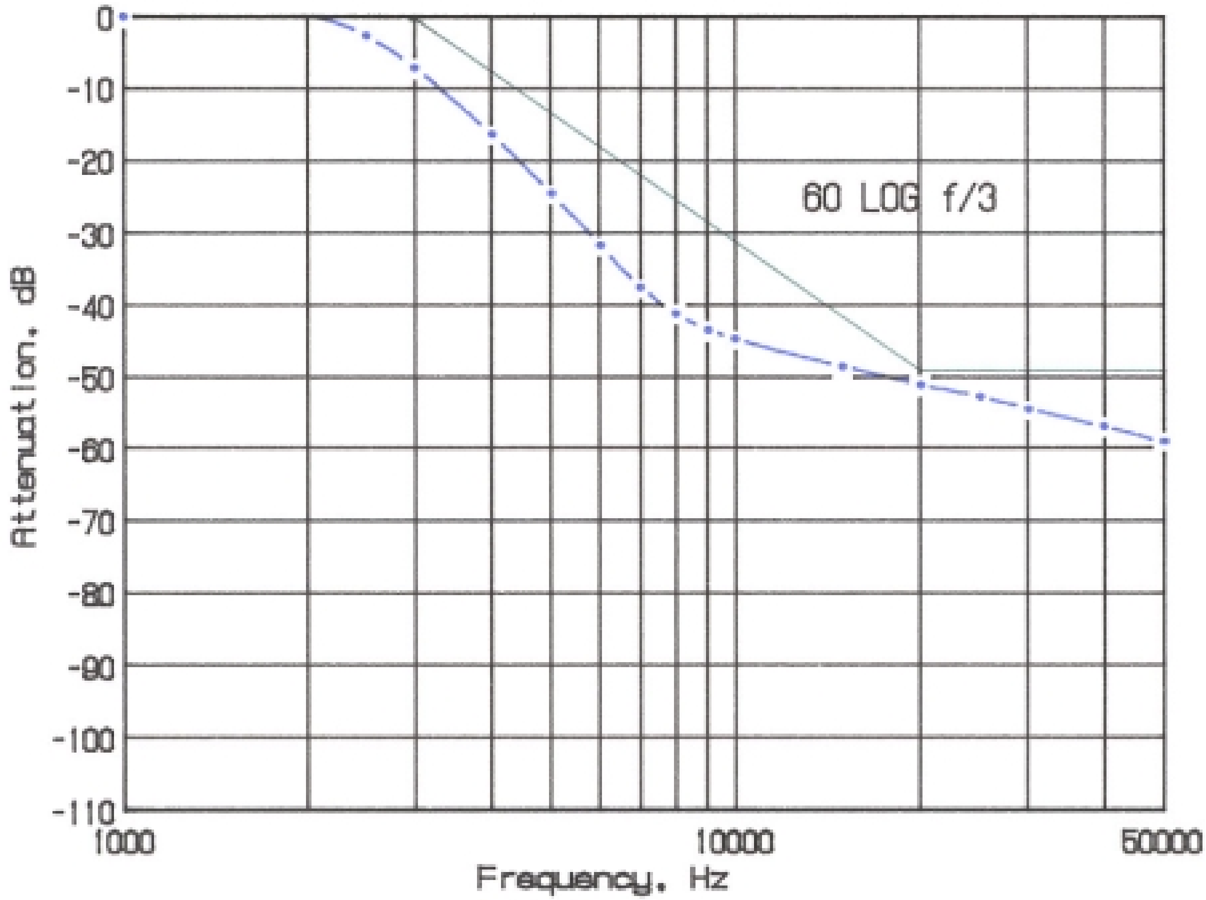


AUDIO LIMITER CHARACTERISTICS
FCC ID: BBOFRS130D

FIGURE 2

FIGURE 3

AUDIO LOW PASS FILTER RESPONSE

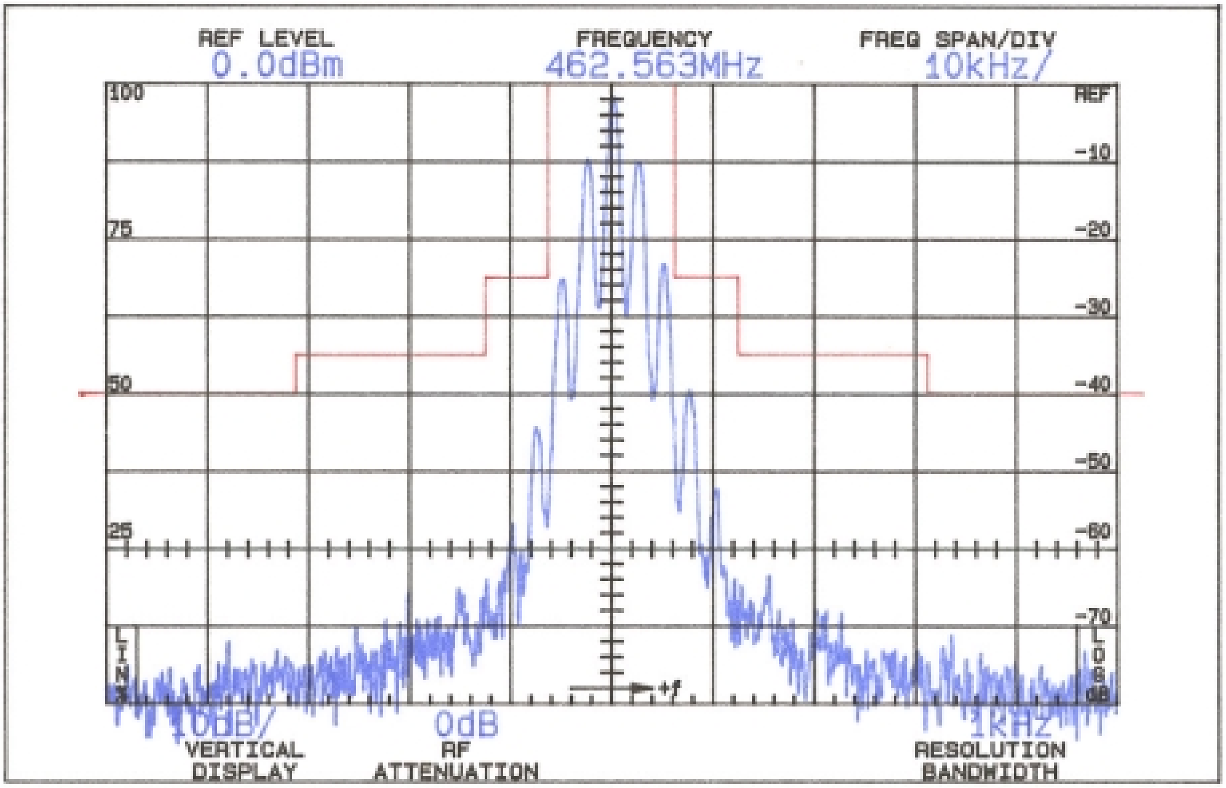


AUDIO LOW PASS FILTER
RESPONSE
FCC ID: BBOFRS130D

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 = 0.45)

OCCUPIED BANDWIDTH
FCC ID: BBOFRS130D

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 130 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 130 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 6.0 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 (21.250 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, 0.45 watts

Spurious Frequency	dB Below Carrier

MHz	Reference
462.563	0
925.125	55V
1387.688	51H
2312.813	49V
2775.375	55V
Required: 43+10 Log(P) =	40

All other spurious from 21.25 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. 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, 0.45 W

Temperature, °C	Output_Frequency,_MHz	p.p.m.
-20.3	462.562083	-0.9
- 9.9	462.562770	0.6
0.4	462.563283	1.7
10.3	462.563105	1.3
19.9	462.562566	0.1
30.1	462.561956	-1.2
39.8	462.561474	-2.2
50.2	462.561385	-2.4

Maximum frequency error: 462.561385
462.562500

- .001115 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

APPENDIX 1 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; 0.45W

Supply_Voltage		Output_Frequency,_MHz	p.p.m.
6.9	115%	462.562670	0.4
6.6	110%	462.562627	0.3
6.3	105%	462.562618	0.3
6.0	100%	462.562566	0.1
5.7	95%	462.562495	0.0
5.4	90%	462.562448	-0.1
5.1	85%	462.562422	-0.2
4.8*	80%	462.562421	-0.2

Maximum frequency error: 462.562670
462.562500

\+ .000170 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

Reference	Type	Description
Q6	DRF1401	Final RF Amp
Q7	2SC4226	Driver
Q9	HN3C10FT	VCO
IC4	DL324V	L.P./H.P. Filter, Limiter
IC5	S1T8825	PLL

IC7	K557C2304	CPU

APPENDIX 2

CIRCUITS AND DEVICES TO STABILIZE FREQUENCY

PLL Frequency Synthesizer (IC5)

The PLL synthesizer of the signal loop PLL circuit with the reference of 3.125 kHz. The IC1 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 20.95 MHz crystal of the X2 is connected to the pin 11 of the IC5 to oscillate the frequency of 20.950 MHz. The TR1 resistor is the temperature compensation device the frequency within the allowable error range even under a low temperature of -30∝.

The phase detector sends out the output power to the loop filter through pin 3 of the IC5. If the oscillation frequency of the VCO is low compared to the referenced frequency, the phase detector sends out the output power in positive pulse. If the oscillation frequency of the VCO is high, phase detector send out can maintain the frequency set. The programmable divider maintains the desired frequency with control from the CPU. The dividing ration, “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/2)/003125 MHz = 74010
b) RX N = (462.5625 MHz –21.4 MHz)/2/0.003125 MHz = 70586

APPENDIX 3

CIRCUITS TO SUPPRESS SPURIOUS RADIATION
AND LIMIT MODULATION

Pre-emphasis and 300 Hz HPF. Limiter (IC4D, IC4C)

The voice signal input from the microphone is pre-emphasized at the IC4D, 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 IC4D, is limited to certain amplitude by D7 so that the voice signal will not exceed the allowable bandwidth assigned for transmission.

TX Power (Q6)

The transmitted signal of approximately 7 mW, combined at the driver TR is supplied to the base of the Q6 amplifier. The transmitted signal amplified to 0.5 W here passes the TX LPF of the 2^{nd} characteristic of the L13 and the L15, and TX/TX switching takes place by the D5. After this, the signal is provided to the antenna directly.