A. INTRODUCTION

The following data are submitted in connection with this request for type certification of the FRS 307 transceiver in accordance with Section 2, of FCC Rules.

The FRS 307 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 (Section 2.1033 of the Rules)

1. Name of applicant: Cobra Electronics Corporation

2. Identification of equipment: FCC ID: BBOFRS307C

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

      Collector voltage: 5.8 Vdc
      Collector current: 0.39 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 2.1046 through 2.1057 follow this section.

C. RF Power Output (Section 2.1046 of the Rules)

The FRS 307 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	0.285

D. MODULATION CHARACTERISTICS (Section 2.1047)

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 Section 2.1047 and 95.633(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
(Section 2.1047 and 95.629(a) 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 2.1049(c)(1) and consisted of 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50%

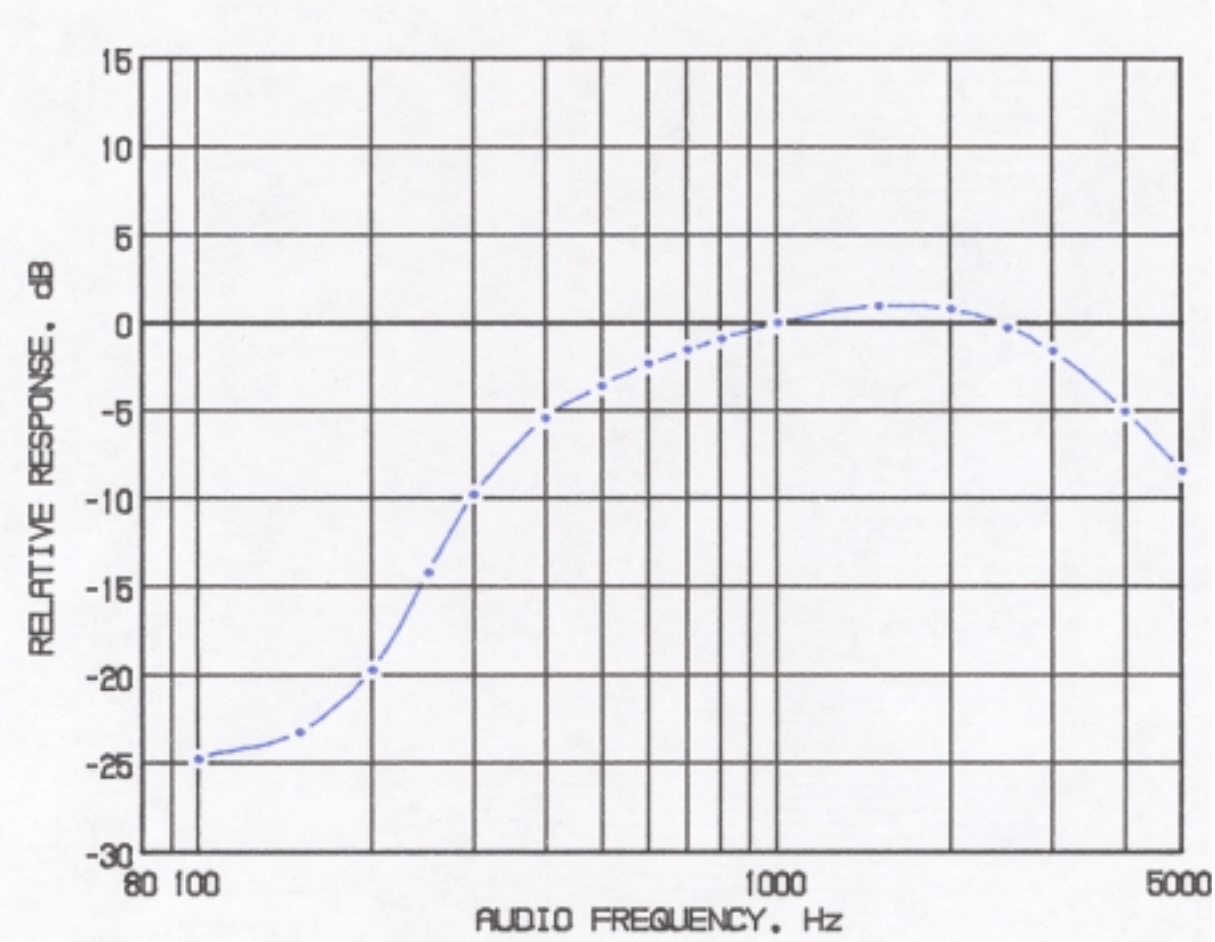
modulation at 1795 Hz, the frequency of maximum response. Measured modulation under these conditions was 1.8 kHz.

Emission designator:

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

FIGURE 1

MODULATION FREQUENCY RESPONSE



MODULATION FREQUENCY RESPONSE
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FIGURE 1

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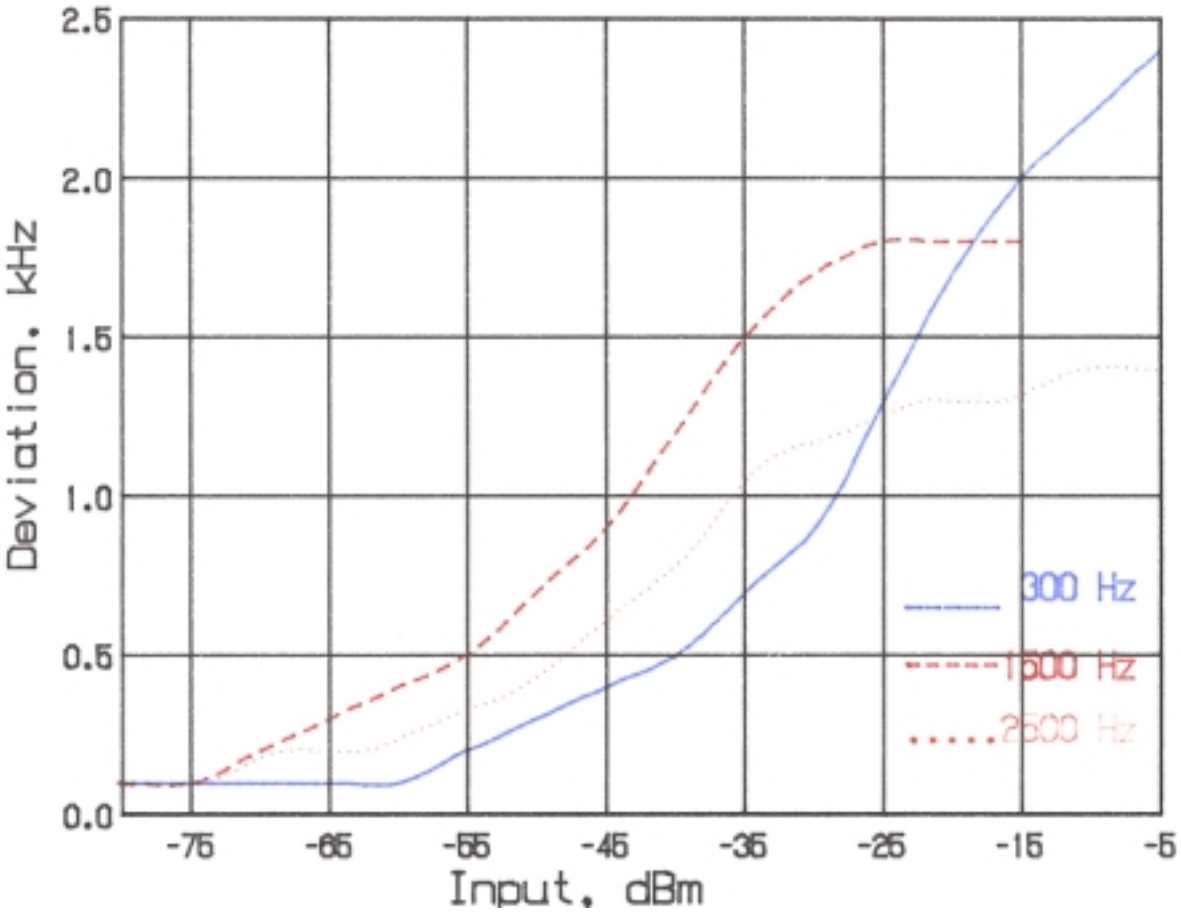
FIGURE 2

AUDIO LIMITER CHARACTERISTICS



AUDIO LIMITER CHARACTERISTICS
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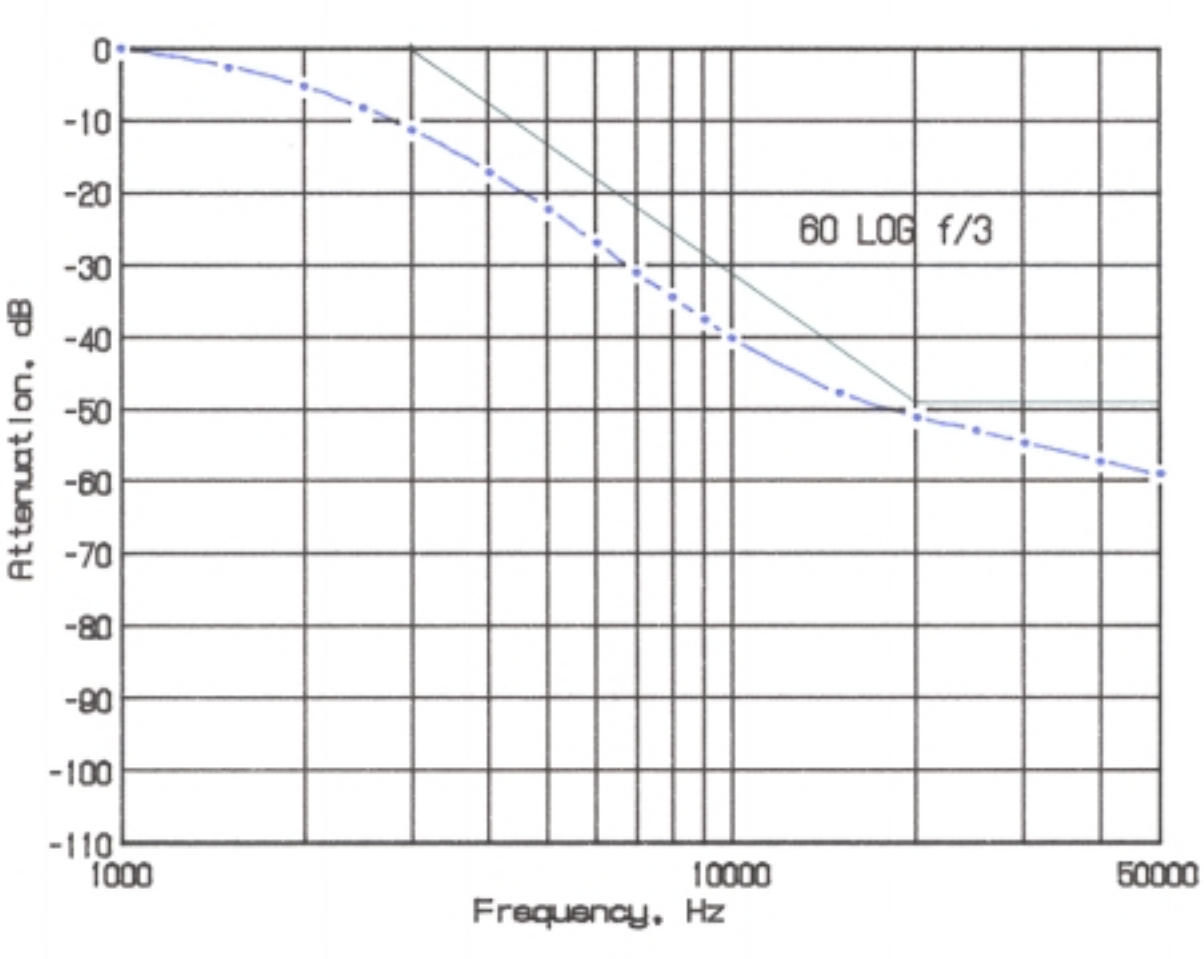
FIGURE 2

FIGURE 3

AUDIO LOW PASS FILTER RESPONSE



AUDIO LOW PASS FILTER
RESPONSE
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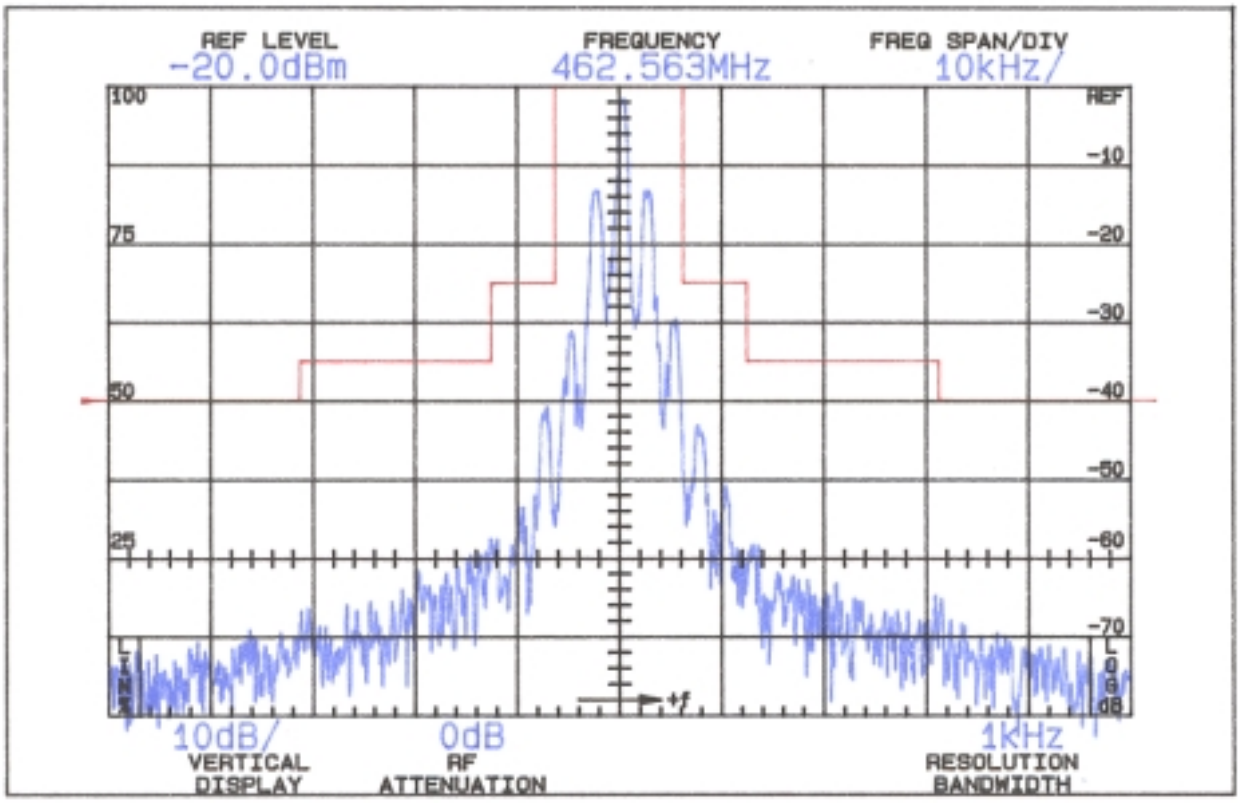
FIGURE 3

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 = 37 (P = 0.285

OCCUPIED BANDWIDTH
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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

The FRS 307 has a permanently attached antenna. There is no connector for an external antenna. Therefore, no antenna terminal conducted measurements were made.

F. MEASUREMENTS OF SPURIOUS RADIATION
(Section 2.1053, 95.635(b)(7) of the Rules)

Measurements of radiated spurious emissions from the FRS 307 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 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, 0.285 watts

Spurious Frequency	dB Below Carrier

___MHz___	Reference
462.563	0
925.127	40V
1387.689	52V
1850.252	45V

Required: 43+10 Log(P) = 37

All other spurious from 21.25 MHz to the tenth harmonic were 20 dB or more below FCC limit.

H. FREQUENCY STABILITY
(Section 2.1055 and 95.621(b) of the Rules)

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, 0.285 W

Temperature, °C	Output Frequency, MHz	p.p.m.
-19.3	462.562166	-0.7
- 9.8	462.562465	-0.1
0.6	462.562484	0.0
10.2	462.563219	1.6
19.9	462.562743	0.5
30.5	462.562391	-0.2
40.2	462.562245	-0.6
49.7	462.562830	0.7
Maximum frequency error:	462.563219	
	462.562500	
	+ .000719 MHz	

FCC Part 95 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
(Section 2.1055 and 95.621(b) 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; 0.285W

Supply Voltage		Output Frequency, MHz	p.p.m.
6.9	115%	462.563411	2.0
6.6	110%	462.562906	0.9
6.3	105%	462.562821	0.7
6.0	100%	462.562743	0.5
5.7	95%	462.562682	0.4
5.4	90%	462.562642	0.3
5.1	85%	462.562616	0.3
4.8*	80%	462.562603	0.2

Maximum frequency error: 462.563411
462.562500

\+ .000911 MHz

FCC Part 95 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 Number	Description	Device Function	
		Receive Function	Transmit Function
Q1	2SC4226	1st RF Amplifier	
Q2	3SK320	1st Mixer	
Q3	DTA1431KA	Receive Vcc Switch	
Q4	DTA1431KA	Audio Muting	
Q5	2SC2712		Transmit Audio Amplifier
Q6	HN3C10FT	VCO	VCO
Q7	2SC4226		Transmit RF Driver
Q8	DTC114EKA	Volume Control	
Q9	DRF1401		Transmit RF Pwr Amp
Q10	DTA1431KA		Transmit Vcc Switch
Q11	DTA123EKA		External PTT Detect
Q12	MMBT3906	Audio PA Vcc Switch	
Q13	2SC4226		Transmit RF Buffer
Q14	2SC2712	CTCSS Lowpass Amp	
Q15	DTC114EKA	Modulator Muting	
Q16	DTC114EKA	Audio PA Vcc Driver	
Q17	DTA1431KA	Main Vcc Switch	Main Vcc Switch
Q18	DTC144EKA	Microprocessor Reset Driver	
Q19	DTC114EKA	CTCSS Filter Freq Sw	
Q20	DTC114EKA	CTCSS Filter Freq Sw	
Q21	2SC2712	CTCSS Lowpass Amp	
D1	1SS314		Antenna T/R Switch
D2	1SS314		Modulator
D3	1SV214		VCO Tuning Varactor
D4	KPA3010GR	LCD Backlight LED	
D5	1SS314		Antenna T/R Switch
D6	1SS367	Microprocessor Vcc Offset	
D7	KPA3010GR	LCD Backlight LED	
D9	BAS70-05		Modulation Limiter
D12	KDS226	CTCSS Limiter	
U1	S3F8235X	Control Microprocessor	
U2	LM324	CTCSS Filter & Detector	
U3	LM386	Audio Pwr Amp	
U4	AN6311FA	2nd Mixer/Low IF & Demod/PLL/Audio Processor	
U6	XC6021P402MR	4 Volt Series Regulator	

APPENDIX 2

CIRCUITS AND DEVICES TO STABILIZE FREQUENCY

Transmitter operating frequency is determined by a Phase Locked Loop (PLL) frequency synthesizer comprised of portions of integrated circuit U4 and the Voltage Control Oscillator (VCO) comprised of Q6, D3, D2 and associated passive components.

The quartz crystal X2 provides the reference frequency (20.950 MHz) for the PLL and is temperature compensated by the characteristics of capacitors C96, C99 and VC1.

Specific operating frequency is determined by data loaded to the programmable divider portion of the U4 PLL from the main control microprocessor via a serial data bus at pins 55 and 56 of U4. The charge pump portion of U4 will source or sink current at pin 46 to provide the bias voltage to VCO tuning varactor D3 required to establish a locked condition of the PLL.

When the PLL is locked, the VCO operating frequency stability is completely determined by the stability of the temperature compensated crystal oscillator at X2.

CIRCUITS AND DEVICES TO
STABILIZE FREQUENCY
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APPENDIX 2

APPENDIX 3

CIRCUITS TO SUPPRESS SPURIOUS RADIATION
AND LIMIT MODULATION

Microphone audio is amplified and pre-emphasized by portions of U4 and associated passive components.

Following amplification and pre-emphasis, the audio signal is passed to the base of amplifier Q5.

The amplified audio output from Q5 is sent to a series diode clipper comprised of D9, a common anode dual diode, and associated passive components. This clipper limits the peak to peak value of the audio signal to a fixed level determined by the values of R29, R31 and R49.

An adjustable fraction of the limited voltage is applied via variable resistor VR1 to the modulation input of the Voltage Controlled Oscillator (VCO) at the junction of R58 and R105. C145 and C32 in conjunction with R121 and R105 respectively provide low pass filtering of the limited audio signal to meet occupied bandwidth specifications.

CTCSS and system signaling tones are derived from the microprocessor and are inherently limited by the available VCC voltage and peak to peak output of the microprocessor. Controlled percentages of these signals are also applied to the modulation input at the R58/R105 node as determined by the control microprocessor and result in modulation values well below maximum legal levels with the design values shown. No additional limiting circuits are provided or required beyond the inherent limited peak to peak output signal of the microprocessor.

Q15 is non-functional during transmit and serves only to mute the modulation input in the receive mode.

CIRCUITS TO SUPPRESS SPURIOUS
RADIATION AND LIMIT MODULATION
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APPENDIX 3