ENGINEERING STATEMENT

For Type Certification of

Cobra Electronics Corporation

Model No: FRS 225
FCC ID: BBOFRS225C

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: November 28, 2000

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: BBOFRS225C

   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: 4.3 Vdc
      Collector current: 0.54 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. 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	0.495

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)

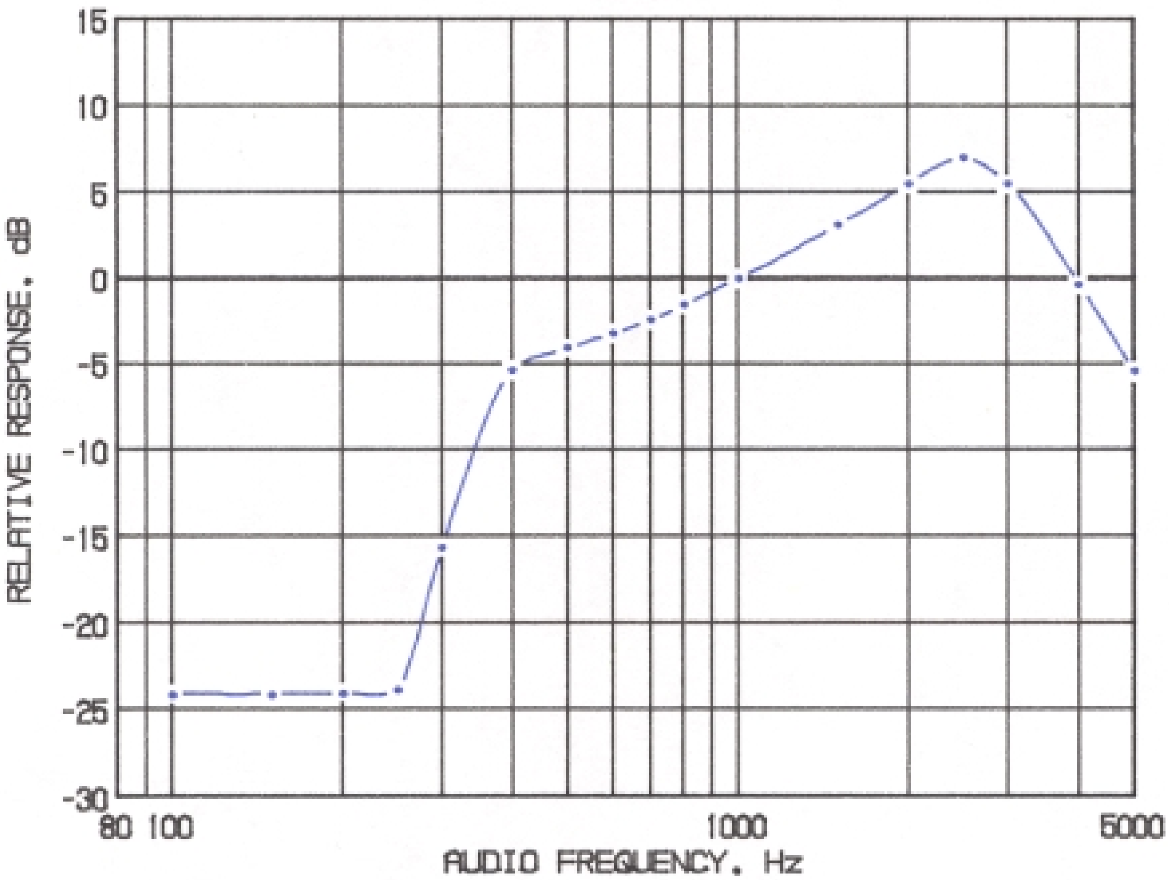
Figure 4 is a plot of the sideband envelope of the transmitter output taken with a Tektronix 494P spectrum analyzer. Modulation corresponded to conditions of 2.989(c)(1) and consisted of 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50% modulation at 2926 Hz, the frequency of maximum response. Measured modulation under these conditions was 1.9 kHz.

Emission designator:

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

FIGURE 1

MODULATION FREQUENCY RESPONSE

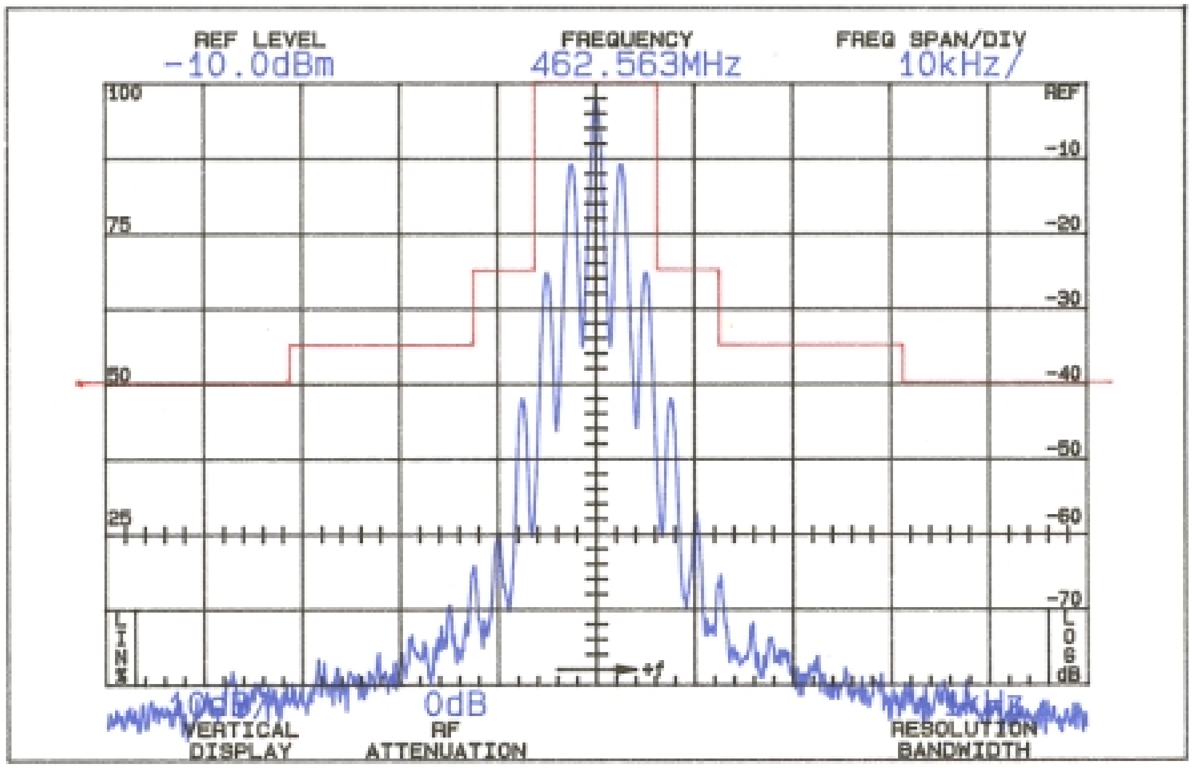


MODULATION FREQUENCY RESPONSE
FCC ID: BBOFRS225C

FIGURE 1

FIGURE 2

AUDIO LIMITER CHARACTERISTICS

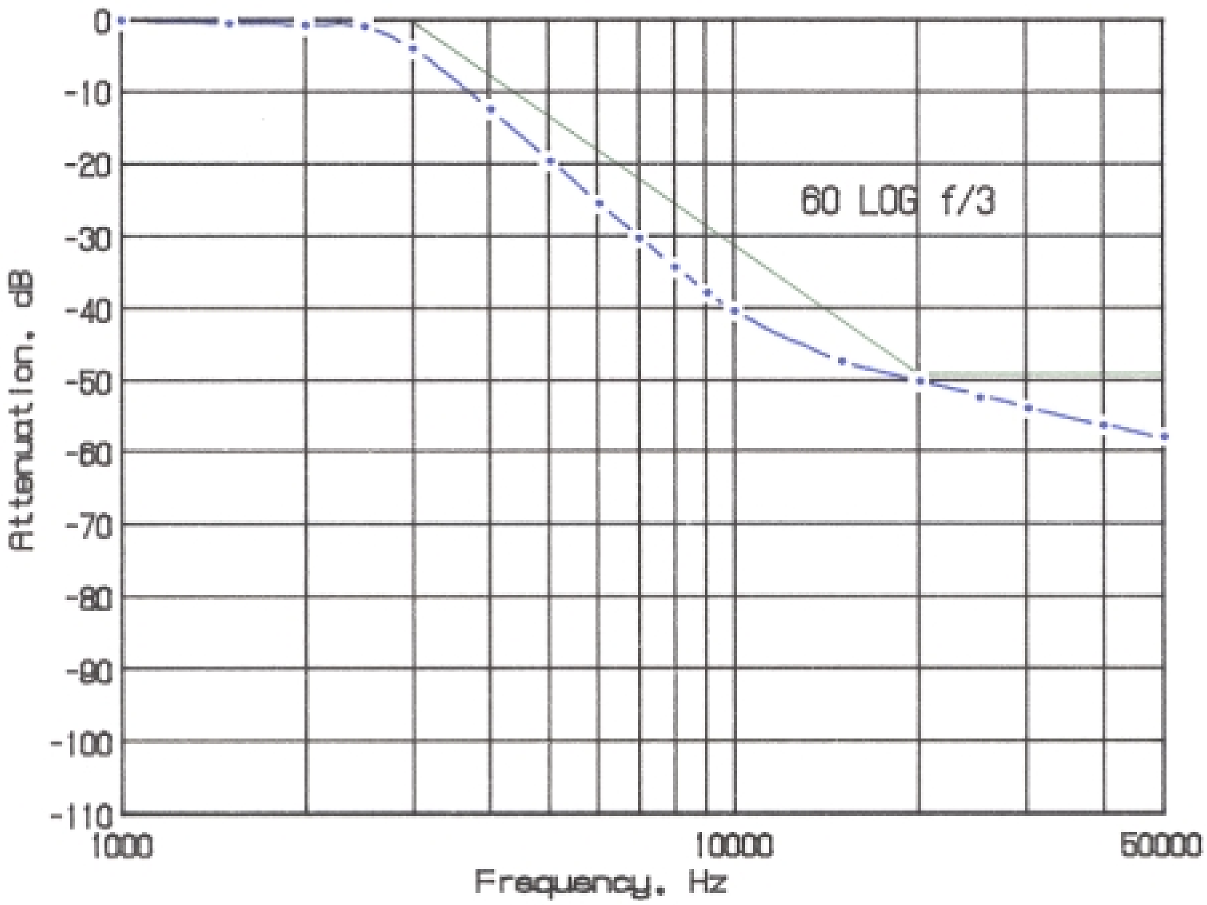


AUDIO LIMITER CHARACTERISTICS
FCC ID: BBOFRS225C

FIGURE 2

FIGURE 3

AUDIO LOW PASS FILTER RESPONSE

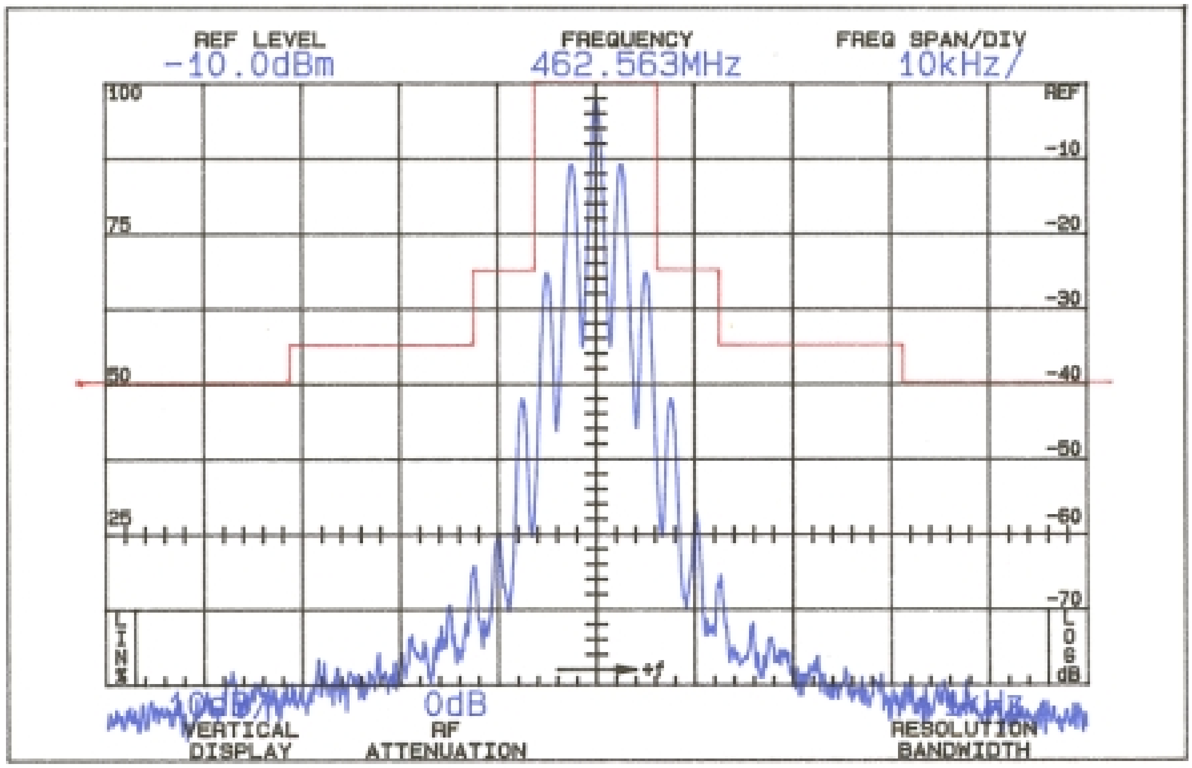


AUDIO LOW PASS FILTER
RESPONSE
FCC ID: BBOFRS225C

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 = 0.495)

OCCUPIED BANDWIDTH
FCC ID: BBOFRS225C

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, 0.495 watts

Spurious Frequency MHz	dB Below Carrier Reference

925.127	58
1387.690	49
1850.252	45
2312.817	53
3237.942	59
3700.502	57

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. 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, 0.495 W

Temperature, °C	Output Frequency, MHz	p.p.m.
-29.4	462.562829	0.7
-20.9	462.562868	0.8
-10.9	462.563290	1.7
- 0.1	462.563397	1.9
20.2	462.562664	0.4
29.1	462.561964	-1.2
39.9	462.561643	-1.9
49.9	462.561617	-1.9

Maximum frequency error:	462.563397
	462.562500
	+ .000897 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; 0.495W

Supply_Voltage		Output_Frequency,_MHz	p.p.m.
5.17	115%	462.562788	0.6
4.95	110%	462.562734	0.5
4.73	105%	462.562714	0.5
4.50	100%	462.562664	0.4
4.28	95%	462.562652	0.3
4.05	90%	462.562649	0.3
3.83	85%	462.562637	0.3
3.60*	80%	462.562634	-0.3

Maximum frequency error: 462.562788
462.562500

+ .000288 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

Part List FRS225 2000/11/24

Description	Qty Reqd.	Schema
IC CMX808AE3------ SSOP20 ---RADIO.	1	IC201
CAP-CHIPTAN 10UF-- M 6V3 C1206	2	C17,C36
CAP-CHIP 100PF J 50V C0603 CH-	3	C49,C76,C202
CAP-CHIP 1NF-- K 50V C0603 B--	1	C59
CAP-CHIP 10NF- K 50V C0603 B--	11	C07,C09,C11,C67,C83,C30, C47,C46,C41,C62,C45
CAP-CHIP 100NF Z 16V C0603 F--	12	C14,C15,C16,C68,C80, C82,C27,C29,C28,C66,C203,C204
CAP-CHIP 1UF-- Z 25V C0805 F--	5	C72,C79,C81,C18,C73
CAP-CHIP 12PF- J 50V C0603 CH-	2	C56,C40
CAP-CHIP 1P5F- C 50V C0603 CH-	1	C34
CAP-CHIP 18PF- J 50V C0603 CH-	3	C52,C48,C31
CAP-CHIP 2PF-- C 50V C0603 CH-	1	C33
CAP-CHIP 22PF- J 50V C0603 CH-	2	C10,C43
CAP-CHIP 220PF J 50V C0603 CH-	1	C13
CAP-CHIP 2N2F- K 50V C0603 B--	2	C12,C206
CAP-CHIP 22NF- K 50V C0603 B--	6	C64,C70,C69,C63,C201,C205
CAP-CHIP 3PF-- C 50V C0603 CH-	7	C55,C54,C01,C60,C44,C53.C35
CAP-CHIP 3N3F- K 50V C0603 B--	1	C32
CAP-CHIP 4PF-- C 50V C0603 CH-	3	C39,C37,C06
CAP-CHIP 470PF J 50V C0603 CH-	2	C50,C75
CAP-CHIP 7PF-- D 50V C0603 CH-	5	C57,C58,C38,C08,C42
CAP-CHIP 5PF-- C 50V C0603 CH-	4	C02,C03,C04,C05
CAP-CHIP 560PF J 50V C0603 CH-	1	C78
CAP-CHIP 6N8F- J 50V C0603 B--	1	C77
CAP-CHIP 820PF K 50V C0603 B--	1	C71
DIODE SW- 1SS314-- SOD323 35V-	3	D04,D01,D06
DIODE SW- 1SS355-- SOD323 80V-	3	D02,D07,D08
DIODE VAR 1SV214-- SOD323 30V-	1	D03
CHIP INDUCTOR 12NH- +-5%- 0603	7	L01,L10,L11,L02,L03,L04,L06
CHIP INDUCTOR 18NH- +-5%- 0603	3	L13,L15,L05
INDUCTOR 2U2H- +-10% 0805----- LQG	1	L07
CHIP INDUCTOR 27NH- +-5%- 0603	2	L14,L12
THERMISTER 0220JBA A 22-- SMD-	1	TR01
RES-CHIP 10R- OHM J 1/16W 0603	1	R25
RES-CHIP 1K - OHM J 1/16W 0603	1	R36
RES-CHIP 10K- OHM J 1/16W 0603	4	R17,R34,R05,R41
RES-CHIP 100K OHM J 1/16W 0603	3	R48,R30,R202
RES-CHIP 1M-- OHM J 1/16W 0603	4	R13,R59,R40,R204
RES-CHIP 15K- OHM J 1/16W 0603	1	R31
RES-CHIP 22R- OHM J 1/16W 0603	1	R20
RES-CHIP 220R OHM J 1/16W 0603	3	R28,R63,R47
RES-CHIP 2K2- OHM J 1/16W 0603	2	R15,R18
RES-CHIP 22K- OHM J 1/16W 0603	6	R19,R39,R38,R46,R43,R08
RES-CHIP 270K OHM J 1/16W 0603	2	R10,R42
RES-CHIP 330R OHM J 1/16W 0603	2	R03,R54
RES-CHIP 33K- OHM J 1/16W 0603	2	R14,R49
RES-CHIP 3K9- OHM J 1/16W 0603	8	R23,R24,R16,R26,R21, R58,R37,R27
RES-CHIP 47R- OHM J 1/16W 0603	1	R35
RES-CHIP 4K7- OHM J 1/16W 0603	1	R11
RES-CHIP 47K- OHM J 1/16W 0603	10	R29,R45,R52,R201 R53,R51,R50,R01,R09,R44
RES-CHIP 470K OHM J 1/16W 0603	1	R06
RES-CHIP 5K6- OHM J 1/16W 0603	1	R56
RES-CHIP 100R OHM J 1/16W 0603	2	R22,R02
RES-CHIP 68K- OHM J 1/16W 0603	1	R32
RES-CHIP 680R OHM J 1/16W 0603	1	R04
RES-CHIP 820K OHM J 1/16W 0603	1	R07
RES-CHIP 8K2- OHM J 1/16W 0603	1	R57

Part List FRS225 2000/11/24

Description	Qty Reqd.	Schema
TRS SSB DTA143EKA---- SC59--- PNP	1	Q05
TRS SSB DTA123EKA---- SC59--- PNP	1	Q09
TRS SSB DTA143TKA---- SC59--- PNP	1	Q04
TRW SSB HN3C10FT NPN	1	Q06
TRS SSB 2SC2712GR---- SOT23-- NPN	1	Q10
TRS SSB 2SC4226R24 SOT23-- NPN	2	Q01,Q07
FET NC- 2SK3078------ SC62---	1	Q08
FET NC- 3SK320-------	1	Q02
IC DBL5018V------- SOP16- ----	1	IC01
IC DBL324V-------- SOP14- ----OPAMP	1	IC04
IC M64028AGP------ SSOP16 ---- PLL	1	IC02
IC S80820ANUP-EDHT2 SOT89- REEL :	1	IC07
IC LM386M-1------- SOIC8 ---- AUDIO PC	1	IC03
TRS SSB DTC114EKA---- SC59--- NPN	2	Q03,Q11
IC HT48C30-------- SOP28- ---- CPU	1	IC05
IC XC62FP3002PR--- SOT89- REEL 3V '	1	IC06
CAP-ELE 100UF- M 10V MINI--	1	C84
VAP-CAP 6P5 30PF TZC03P300A110	1	TC01
CRY FILTER 21M4HZ--- HC45/U	1	FLT02
CERFILTER 450KHZ---- LT450HT-- L8W	1	FLT03
IFT 700UH 8% L7.5W7.5H8-----	1	L08
IFT 105NH 8% L5.4W5.4H865---	1	L09
VR TRIMMER 5K-- N ---- EVND8Y	2	VR02,VR03
MICROPHONE -62DB 2V5- EM-926A- 6:	1	MIC01
TACT- SWITCH 1P1T KPT-1107V---	2	SW01,SW02
CER RESONATOR 4MH---Z L8W3H5.5	1	X02
CRYSTAL 20M95HZ- 5PPM-- HC45/U 15	1	X01
JACK MONO F DHOR ST-002------	1	J02
JACK MONO F DHOR ST-613------	1	J01
VR TRIMMER 5K-- N ---- RV091NS	1	VR01
SPEAKER- D36MM 8OHM-- 0.5W-	1	SP01
CAP-ELE 220UF- M 10V- MINI--	1	C51,C26,C65
CAP-CHIP 100NF Z 16V C0603 F--	1	C401
LED GREEN- ------- KPA-3010GR-	2	D401,D402
IC HT1621--------- DICE-- ---- LCD CONT	1	IC401
FLAT--- 340 12 P1.00	1	J201
HEATSEAL 010T L012 P1.80	1	J202
LCD TNG TTR5420DPFDN TNSF PLZR	1	LCD01
225 PANEL LENS, with printing	1	
BATTERY DOOR	1	
VOLUME RNOB	1	
ANTENNA CAP	1	
BATTERY DOOR LOCK	1	
FRONT CASE	1	
REAR CASE	1	
BELT CLIP	1	
BEZEL, SNAP ON COVER	1	
RF SHIELD CAN	1	
LOCK PIN	1	
ST SCREW 2.6 x 8, BB Head, Ni plated	2	
ST SCREW 3.0 x 8, BB Head, Ni plated	2	
SPEAKER NET DIA.35	1	
DOUBLE SIDE TAPE LIGHIGUIDE	1	
3 Keys keypad, black color	1	
PTT / Talk BUTTON	1	
JACK COVER	1	
Hand strip	1	
Dome, Dia = 6, Type no = 6BT- L	2	
BEZEL, SNAP ON COVER	0.5	
BEZEL, SNAP ON COVER	0.5	

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.

APPENDIX 3

CIRCUITS TO SUPPRESS SPURIOUS RADIATION AND LIMIT MODULATION

Circuitry to Suppress Spurious Emissions

The transmitted signal of approximately 16 dBm, combined at the PLL circuit is supplied to the base of the Q701 amplifier. The transmitted signal amplified to 27 dBm here passes the TX LPF of the 2nd characteristic of the C703, L702, L701, L700 and TX/TX switching takes place by the D701. After this, the signal is provided to the antenna.

Circuitry to Limit Modulation and Audio Low Pass Filter

The voice signal input from the microphone is pre-emphasized at the IC104B, 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 IC104B is limited to a certain amplitude at the IC104A for the voice signal not to exceed the allowable band width assigned for transmission.