ENGINEERING STATEMENT

For Type Certification of

Hong Jin Crown America Inc.

Model No: FRS-X2
FCC ID: KA9HJC-X2

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 Hong Jin Crown America Inc. to make type certification measurements on the model FRS-X2 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: January 19, 2001

A. INTRODUCTION

The following data are submitted in connection with this request for type certification of the model FRS-X2 transceiver in

accordance with Part 2, Subpart J of the FCC Rules.

The model FRS-X2 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 4.8 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: Hong Jin Crown America Inc.

2. Identification of equipment: FCC ID: KA9HJC-X2

   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 model FRS-X2 fully complied with that power limitation.
   e. The dc voltage and dc currents at final amplifier:

      Collector voltage: 4.7 Vdc
      Collector current: 0.58 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 model FRS-X2 has a permanently attached built-in antenna without provisions for a coaxial connector.

Therefore RF power 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. Occupied Bandwidth
(Paragraphs 2.989(c) of the Rules)

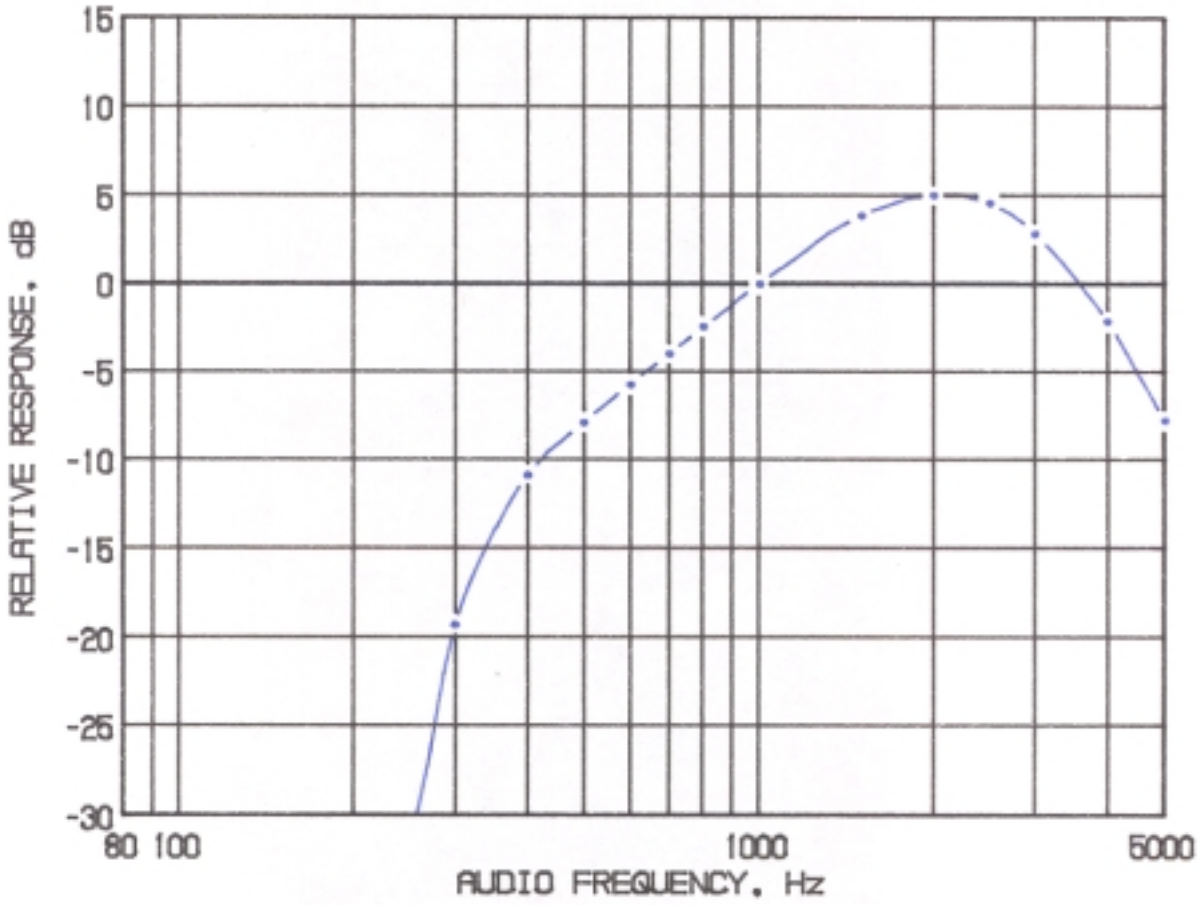
Figure 4 is a plot of the sideband envelope of the transmitter output taken with a Tektronix 494P spectrum analyzer. Modulation corresponded to conditions of 2.989(c)(1) and consisted of 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50% modulation at 2551 Hz, the frequency of maximum response. Measured modulation under these conditions was 2.3 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: KA9HJC-X2

FIGURE 1

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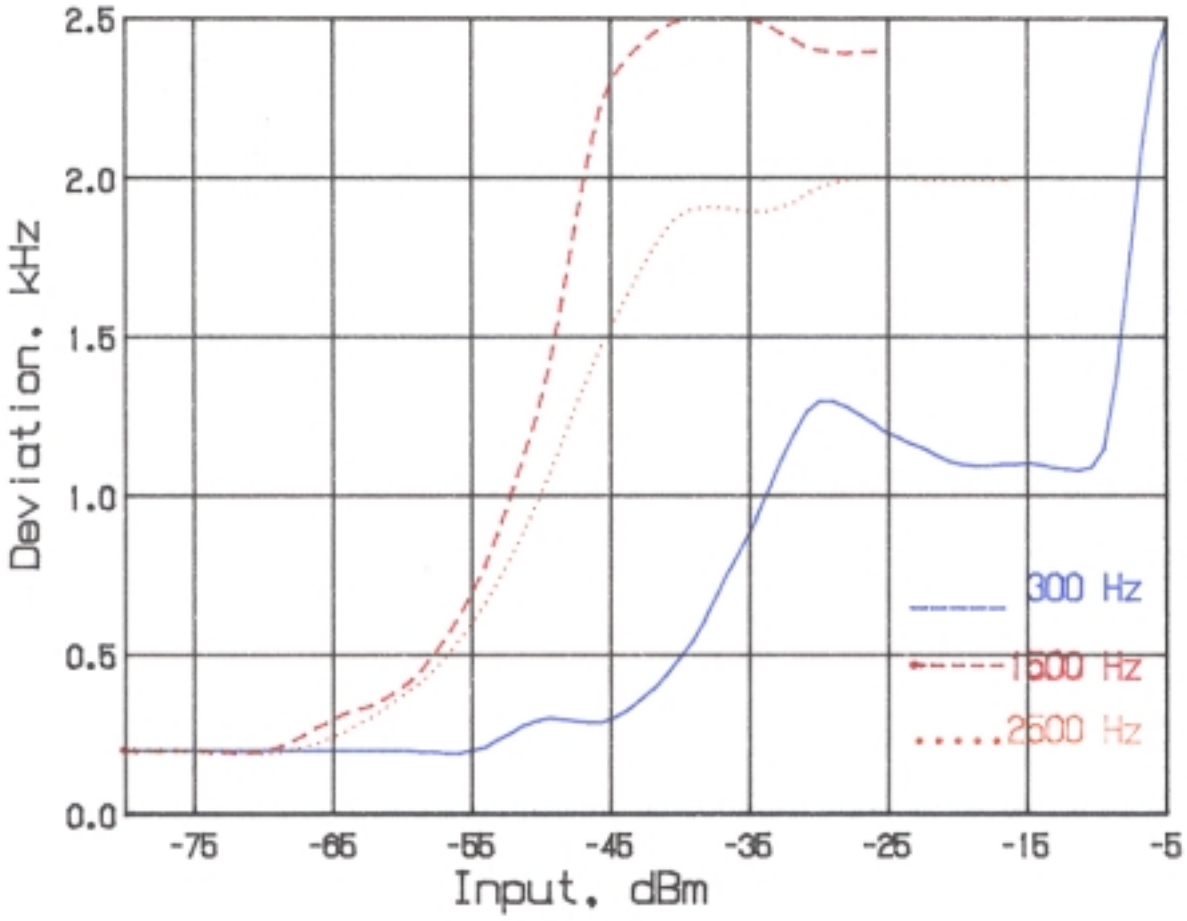
FIGURE 2

AUDIO LIMITER CHARACTERISTICS



NOTE: Deviation at 300 Hz did not exceed 2.5 kHz.

AUDIO LIMITER CHARACTERISTICS
FCC ID: KA9HJC-X2

FIGURE 2
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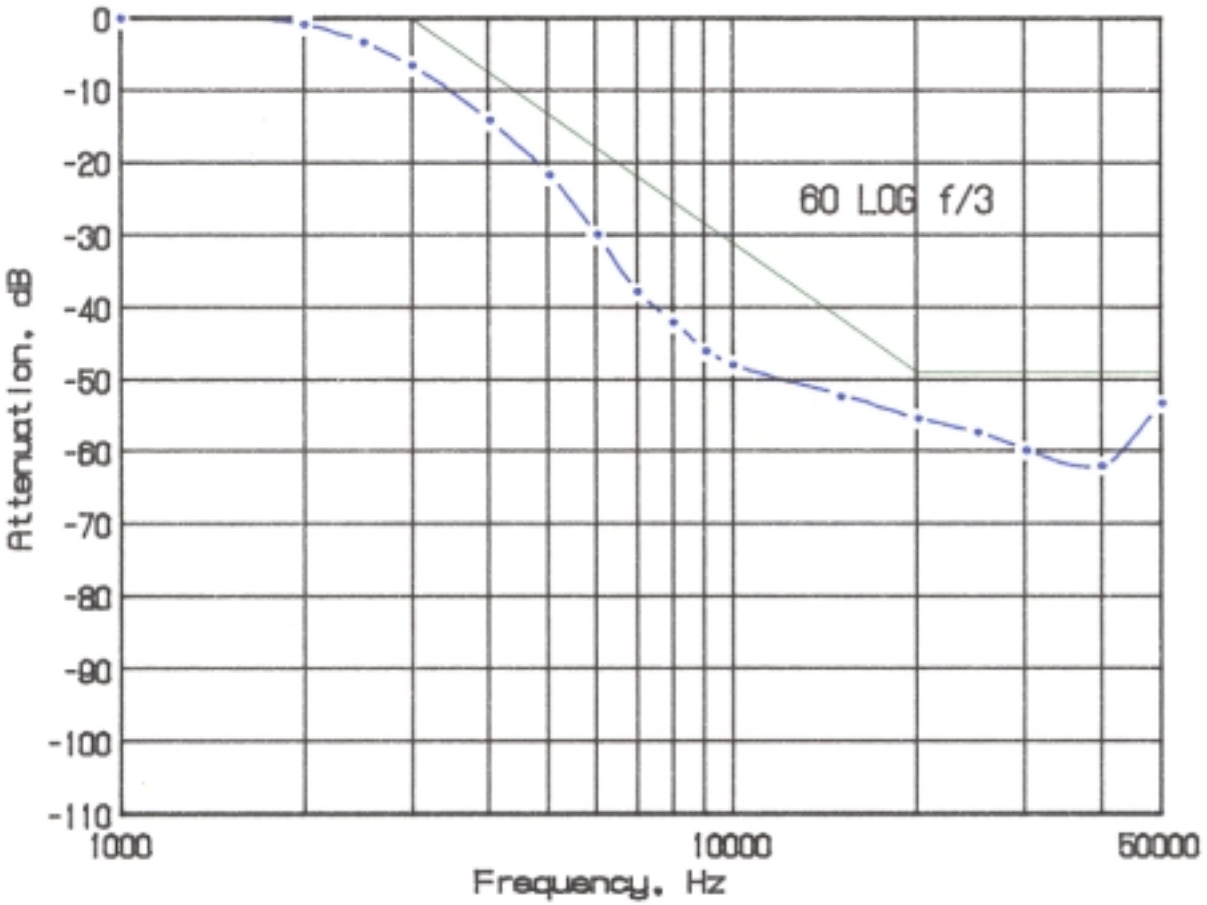
FIGURE 3

AUDIO LOW PASS FILTER RESPONSE

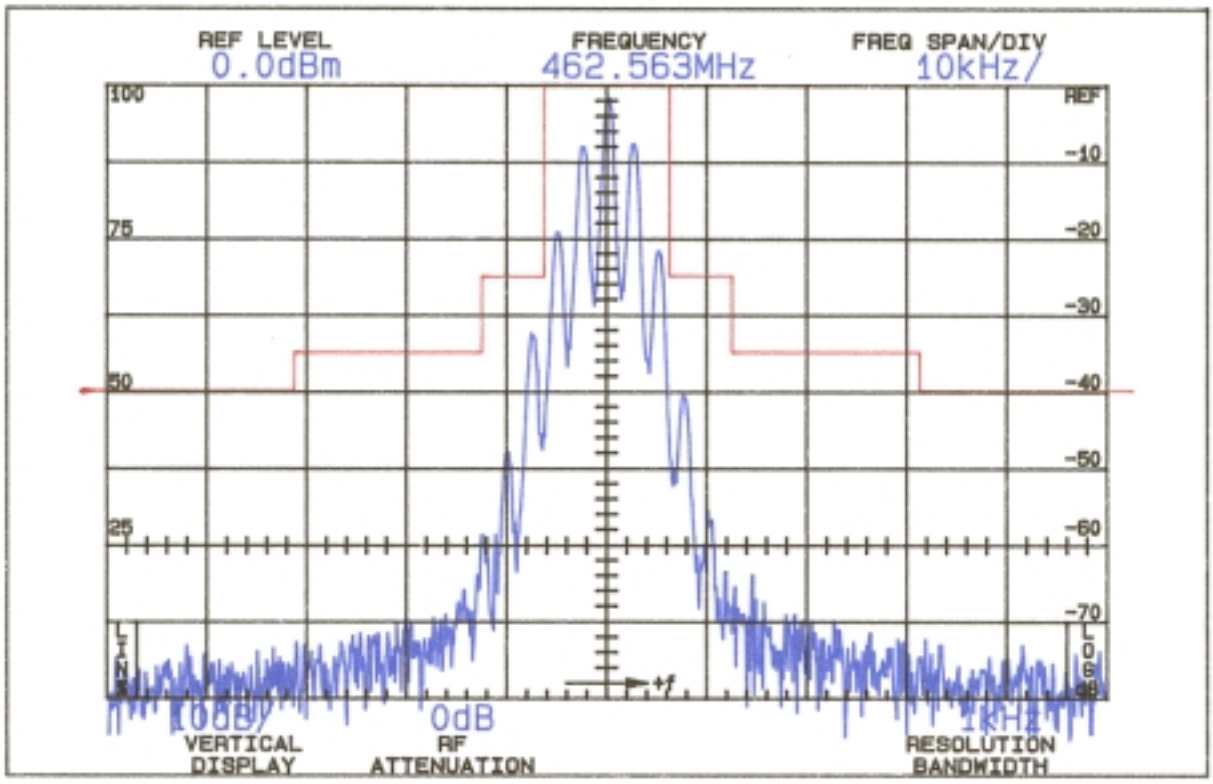


AUDIO LOW PASS FILTER
RESPONSE
FCC ID: KA9HJC-X2

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: KA9HJC-X2

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 model FRS-X2 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

Spurious emissions from the model FRS-X2 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 4.8 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 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, 4.8 Vdc, 0.45 watts

Spurious Frequency	dB Below Carrier

___MHz___	Reference[1]
462.563	0
925.125	51V
1387.690	53V
1850.253	53H
2312.815	52V
2775.378	51H
3237.941	53V
3700.505	59H
4163.067	52H
4625.630	57V
Required: 43+10 Log(P) =	40

[1]Worst-case polarization, H-Horizontal, V-Vertical.

All other spurious from 12.8 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 4.8 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, 4.8 Vdc, 0.459 W

Temperature, °C	Output Frequency, MHz	p.p.m.
-19.5	462.562457	-0.1
- 9.9	462.562524	0.1
0	462.562573	0.2
10.2	462.562556	0.1
20.1	462.562454	-0.1
30.1	462.562363	-0.3
40.1	462.562322	-0.4
49.7	462.562302	-0.4

Maximum frequency error: 462.562302
462.562500

- .000198 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 4.8 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, 4.8 Vdc Nominal; 0.459W

Supply Voltage		Output Frequency, MHz	p.p.m.
5.52	115%	462.562469	-0.1
5.28	110%	462.562464	-0.1
5.04	105%	462.562459	-0.1
4.80	100%	462.562454	-0.1
4.56	95%	462.562453	-0.1
4.32	90%	462.562451	-0.1
4.08	85%	462.562449	-0.1
3.84*	80%	462.562446	-0.1

Maximum frequency error: 462.562446
462.562500

\- .000054 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
Model FRS-X2

PARTS LIST

(SMD/ INSERT)
MODEL : FRSX2 (RF B/D)
DATE :October.20.2000

NO	Parts Name	Specifications	manufacturer	Supplier	UNIT	Q'TY	Description
1	CAP,TANTAL,SMD,1U/25,A	25MCS105MATER	MARCON		EA	3	EC204,302,401
2	CAP,TANTAL,SMD,0.1U/35,A	35MCS104MATER	MARCON		EA	1	EC1
3	CAP,TANTAL,SMD,10U/10,A	10MCM106MATER	MARCON		EA	4	EC202,203,303,304
4	CAP,TANTAL,SMD,0.22U/35,A	35MCS224MATER	MARCON		EA	1	C317
5	CAP,TANTAL,SMD,47U/10,C	10MCM476MCTER	MARCON		EA	1	EC201
6	CAP-CER,1608,SMD	GRM39COG0R5C50PT	MURATA		EA	2	C205,308
7	CAP-CER,1608,SMD	GRM39COG020C50PT	MURATA		EA	2	C104,106
8	CAP-CER,1608,SMD	GRM39COG030C50PT	MURATA		EA	1	C223
9	CAP-CER,1608,SMD	GRM39COG040C50PT	MURATA		EA	3	C216,217,309
10	CAP-CER,1608,SMD	GRM39COG050C50PT	MURATA		EA	6	C207,211,222,301,305,306
11	CAP-CER,1608,SMD	GRM39COG070D50PT	MURATA		EA	2	C120,203
12	CAP-CER,1608,SMD	GRM39COG080D50PT	MURATA		EA	1	C221
13	CAP-CER,1608,SMD	GRM39COG090D50PT	MURATA		EA	2	C204,206
14	CAP-CER,1608,SMD	GRM39COG100D50PT	MURATA		EA	3	C119,121,310
15	CAP-CER,1608,SMD	GRM39COG150D50PT	MURATA		EA	6	C109,113,126,212,226,307
16	CAP-CER,1608,SMD	GRM39COG220J50PT	MURATA		EA	1	C229
17	CAP-CER,1608,SMD	GRM39COG270J50PT	MURATA		EA	3	C213,326,408
18	CAP-CER,1608,SMD	GRM39COG390J50PT	MURATA		EA	1	C327
19	CAP-CER,1608,SMD	GRM39COG470J50PT	MURATA		EA	3	C218,304,407
20	CAP-CER,1608,SMD	GRM39COG101J50PT	MURATA		EA	4	C208,210,302,402
21	CAP-CER,1608,SMD	GRM39COG221J50PT	MURATA		EA	1	C102
22	CAP-CER,1608,SMD	GRM39COG471J50PT	MURATA		EA	2	C404,405
23	CAP-CER,1608,SMD	GRM39X7R102K50PT	MURATA		EA	19	C107,117,118,122,124,125,202,209,215,220,225,228,303
							C311,320~324

PARTS LIST

(SMD/ INSERT)
MODEL : FRSX2 (RF B/D)
DATE :October.20.2000

NO	Parts Name	Specifications	manufacturer	Supplier	UNIT	Q'TY	Description
24	CAP-CER,1608,SMD	GRM39X7R472K50PT	MURATA		EA	1	C403
25	CAP-CER,1608,SMD	GRM39X7R103K50PT	MURATA		EA	2	C315,316
26	CAP-CER,1608,SMD	GRM39Y5V104Z50PT	MURATA		EA	5	C214,219,401,406,409
27	CAP-CER,1608,SMD	GRM39Y5V224Z50PT	MURATA		EA	1	C319
28	RES,CF,5%,SMD	CR1/16W 000JV	HANRYUK		EA	1	R404
29	RES,CF,5%,SMD	CR1/16W 220JV	HANRYUK		EA	7	R112,207,212,302,320,321,401
30	RES,CF,5%,SMD	CR1/16W 470JV	HANRYUK		EA	1	R203
31	RES,CF,5%,SMD	CR1/16W 101JV	HANRYUK		EA	4	R104,113,301,305
32	RES,CF,5%,SMD	CR1/16W 471JV	HANRYUK		EA	2	R202,204
33	RES,CF,5%,SMD	CR1/16W 681JV	HANRYUK		EA	1	R303
34	RES,CF,5%,SMD	CR1/16W 102JV	HANRYUK		EA	4	R111,114,206,213
35	RES,CF,5%,SMD	CR1/16W 182JV	HANRYUK		EA	3	R317,318,403
36	RES,CF,5%,SMD	CR1/16W 332JV	HANRYUK		EA	3	R208,214,319
37	RES,CF,5%,SMD	CR1/16W 392JV	HANRYUK		EA	1	R304
38	RES,CF,5%,SMD	CR1/16W 472JV	HANRYUK		EA	4	R116,215,306,307
39	RES,CF,5%,SMD	CR1/16W 103JV	HANRYUK		EA	2	R109,407
40	RES,CF,5%,SMD	CR1/16W 223JV	HANRYUK		EA	2	R210,211
41	RES,CF,5%,SMD	CR1/16W 473JV	HANRYUK		EA	1	R102
42	RES,CF,5%,SMD	CR1/16W 104JV	HANRYUK		EA	3	R110,115,408
43	RES,CF,5%,SMD	CR1/16W 224JV	HANRYUK		EA	1	R406
44	RES,CF,5%,SMD	CR1/16W 334JV	HANRYUK		EA	1	R405
45	IC,IF DET,SMD	TA31136FN	TOSHIBA		EA	1	U401
46	IC,PLL,SMD	U2781B	TEMIC		EA	1	U301
47	FET,MIXER,SMD	BF998RA(MOR)GS0812	TEMIC		EA	1	Q102

PARTS LIST

(SMD/ INSERT)
MODEL : FRSX2 (RF B/D)
DATE :October.20.2000

NO	Parts Name	Specifications	manufacturer	Supplier	UNIT	Q'TY	Description
48	TR,RF,SMD	2SC3357	NEC		EA	1	Q202
49	TR,RF,SMD	2SC4226	NEC		EA	4	Q104,203,301,302
50	TR,RF,SMD	KRC404	KEC		EA	1	Q204
51	TR,SW,SMD	KTA1001	KEC		EA	1	Q205
52	TR,SW,SMD	KTC4080	KEC		EA	1	Q103
53	TR,RF,SMD	MRF9482			EA	1	Q201
54	DIODE,RF,SMD	MMBV3401	MOTOROLA		EA	2	D101,201
55	DIODE,SW,SMD	KDS226	KEC		EA	1	D102
56	DIODE,VVC,SMD	1SV270	TOSHIBA		EA	1	D302
57	DIODE,VVC,SMD	KDV154C	KEC		EA	1	D301
58	OSC,4ppm,SMD	12.8(-10~60/3ppm)	Nikko Den		EA	1	X301
59	DISCRIMINATOR	JTB455C24	DI		EA	1	X401
60	OSC,XTAL,수동	20.945M/15~30ppm	SEIKO		EA	1	X402
61	CERAMIC FILTER	CFWM455H,LTM455HT	MURATA,CQ		EA	1	FL401
62	Crystal Filter	21M08A	HZ		EA	1	XCF101
63	SEMI VR,3pi,SMD	EVM3YSX50B24(20K)	HOKURZK		EA	1	VR401
64	TRIMMER,SMD,10PF,3ø	TZC03Z100A110T00	MURATA		EA	2	VC101,301
65	CHIP,COIL,SMD,0805	0805AS-8R2J-01(8.2nH)	FASTRON		EA	1	L206
66	CHIP,COIL,SMD,0805	0805AS-012J-01(12nH)	FASTRON		EA	1	L102
67	CHIP,COIL,SMD,0805	0805AS-015J-01(15nH)	FASTRON		EA	1	L103
68	CHIP,COIL,SMD,0805	0805AS-018J-01(18nH)	FASTRON		EA	1	L210
69	CHIP,COIL,SMD,0805	0805AS-047J-01(47nH)	FASTRON		EA	1	L108
70	CHIP,COIL,SMD,0805	0805AS-022J-01(22nH)	FASTRON		EA	2	L209,301
71	CHIP,COIL,SMD,0805	0805AS-R33J-01(330nH)	FASTRON		EA	2	L205,303

PARTS LIST

(SMD/ INSERT)
MODEL : FRSX2 (RF B/D)
DATE :October.20.2000

NO	Parts Name	Specifications	manufacturer	Supplier	UNIT	Q'TY	Description
72	CHIP,COIL,SMD,1008	1008AS-3R3J-01(3.35uH)	FASTRON		EA	2	L107,108
73	COIL,AIR,SMD,11nH	300604L	STEWART		EA	2	L206,302
74	COIL,AIR,SMD,23nH	0.45-1.4-3TL	STEWART		EA	3	L202~204
75	COIL,AIR,SMD,26nH	0.45-1.4-6TL	STEWART		EA	2	L101,207
76	PCB	JHJC-FR8X2	DHAMYUNG		EA		

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
FCC ID: KA9HJC-X2

APPENDIX 2

APPENDIX 3

CIRCUITS TO SUPPRESS SPURIOUS RADIATION
AND LIMIT MODULATION

Circuitry to Suppress Spurious Emissions

Q201 provides approximately 4.8 V dc power source. Signals from Q201 is supplied through antenna switch D201 to a low-pass filter made up of L204, L203, L202 and C201-CC207, then applied to antenna jack.

Circuitry to Limit Modulation and Audio Low Pass Filter

Voice signal from the microphone is applied to microphone amplifier U506 contains a high-pass filer, low-pass filter that has a 6dB/oct response between 300 Hz and 3 kHz, and eliminates harmonics above 3 kHz. The pre-emphasized audio signal is applied to VR501 to adjust maximum frequency deviation.

CIRCUITS TO SUPPRESS SPURIOUS RADIATION AND LIMIT MODULATION

FCC ID: KA9HJC-X2
APPENDIX 3