ENGINEERING STATEMENT

For Type Certification of

CLEARLINK COMMUNICATIONS LLC

Model No: C935
FCC ID: OKM935

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 ClearLink Communications to make type certification measurements on the C935 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: December 20, 1999

A. INTRODUCTION

The following data are submitted in connection with this request for type certification of the C935 transceiver in accordance with Part 2, Subpart J of the FCC Rules.

The C935 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. Manufacturer's 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: ClearLink Communications LLC

2. Identification of equipment: FCC ID: OKMC935

   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 C935 fully complied with that power limitation.
   e. The dc voltage and dc currents at final amplifier:

      Collector voltage: 4.4 Vdc
      Collector current: 0.32 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 C935 has a permanently attached built-in antenna

without provisions for a coaxial connector.

Therefore RF power output was calculated, see Table 1. (The transmitter was tuned by the factory.)

TABLE 1

Operating Freq., MHz	Power watts into a dipole antenna
462.5625	0.457

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 paragraph 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)

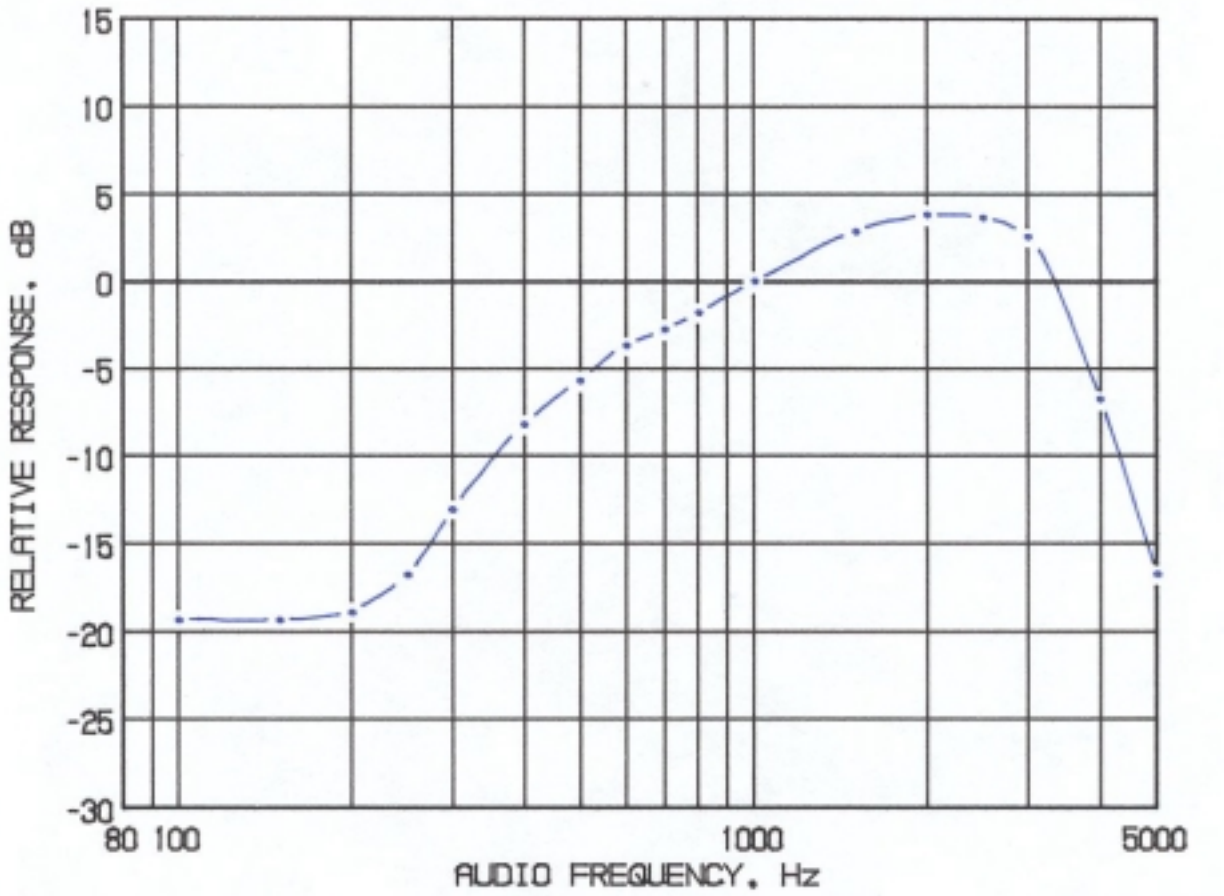
Figure 4 is a plot of the sideband envelope of the transmitter output taken with a Tektronix 494P spectrum analyzer. Modulation corresponded to conditions of 2.989(c)(1) and consisted of 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50% modulation at 2996 Hz, the frequency of maximum response. Measured modulation under these conditions was 1.6 kHz.

Emission designator:

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

FIGURE 1

MODULATION FREQUENCY RESPONSE

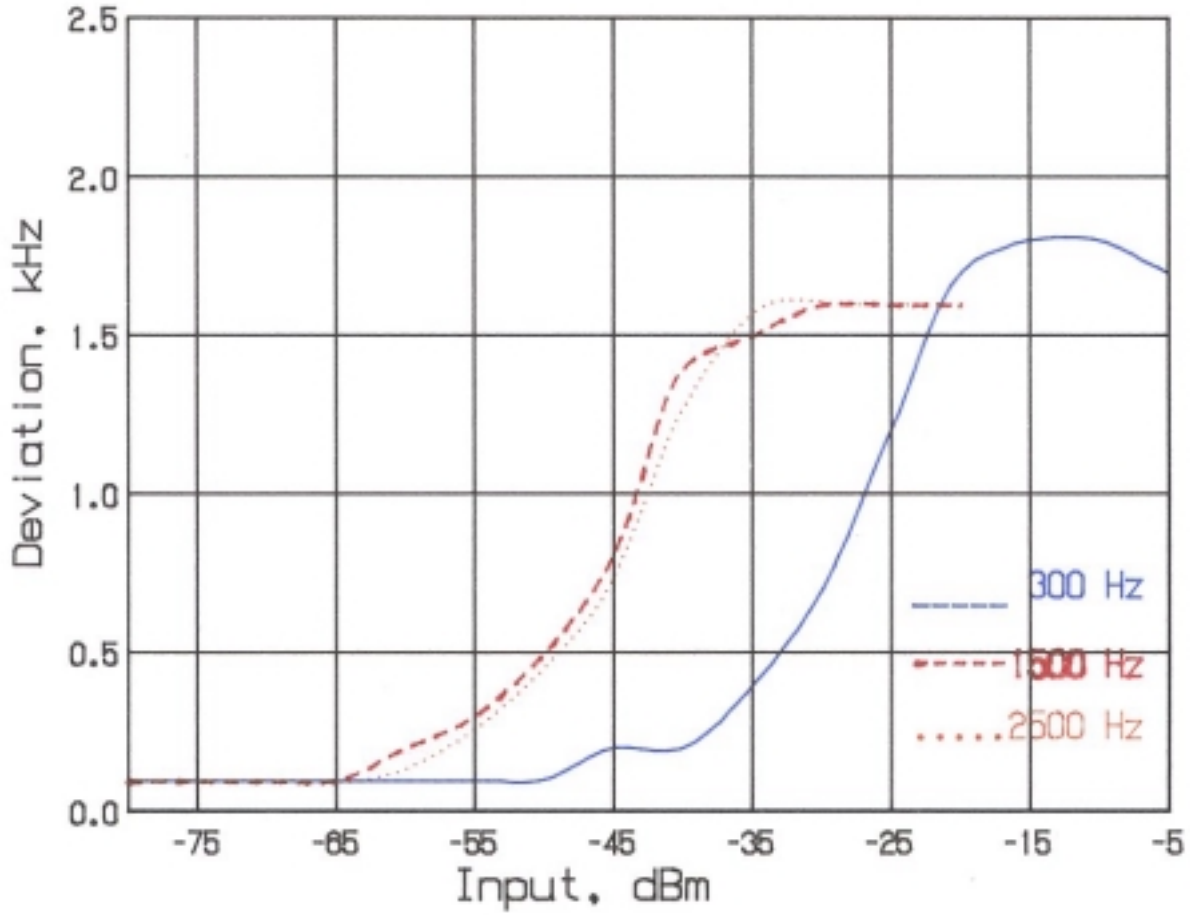


MODULATION FREQUENCY RESPONSE
FCC ID: OKMC935

FIGURE 1

FIGURE 2

AUDIO LIMITER CHARACTERISTICS

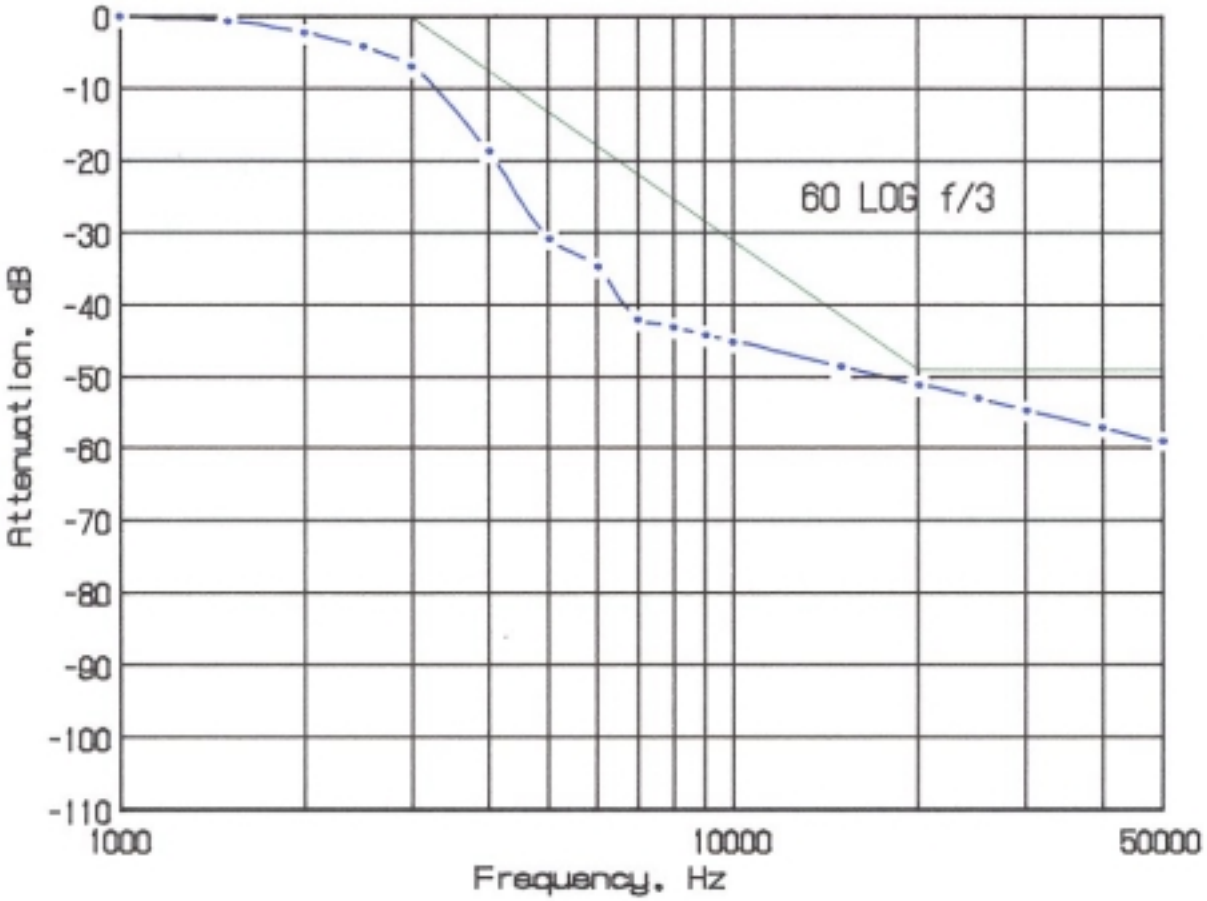


AUDIO LIMITER CHARACTERISTICS
FCC ID: OKMC935

FIGURE 2

FIGURE 3

AUDIO LOW PASS FILTER RESPONSE

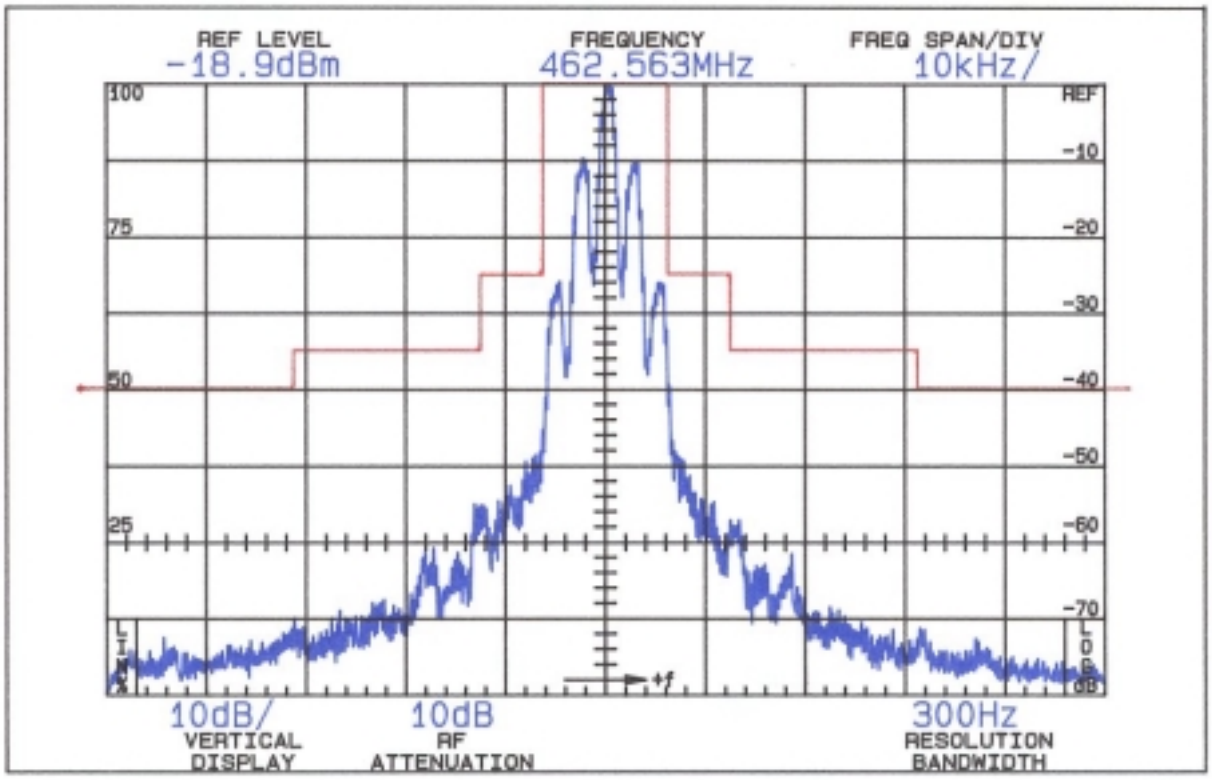


AUDIO LOW PASS FILTER
RESPONSE
FCC ID: OKMC935

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 = 0.457)

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 (Paragraph 2.991 of the Rules)

The C935 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. FIELD STRENGTH MEASUREMENTS OF SPURIOUS RADIATION

Field intensity measurements of radiated spurious emissions from the C935 were made 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.

The measurement system was capable of detecting signals 100 dB or more below the reference level. Measurements were made from the lowest frequency generated within the unit (12 MHz), to 10 times operating frequency. Data after application of antenna factors and line loss corrections are shown in Table 3.

TABLE 3

TRANSMITTER CABINET RADIATED SPURIOUS

462.5625 MHz, 4.5 Vdc, 0.457 watts

Spurious Frequency MHz	Radiated Field uV/m @ 3M	dB Below Carrier Reference[1]
462.563	1579901	0
925.126	1943	58V

1387.688	6430	48V
1850.251	10282	44V
2312.814	2003	58V
2775.377	3164	54V
3237.940	1310	62H*
3700.502	598	68H*
4163.065	705	67V*
4625.628	617	68H*

Required: 43+10 Log(P) = 40

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

*Reference data only, more than 20 dB below FCC limit.

All other spurious from 12 MHz to the tenth harmonic were 20 dB or more below FCC limit.

Power:

$P = (F.I.x3)^2/49.2$

$= (1.5799x3)^2/49.2$

$= 0.457$ W

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 4, 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 4

FREQUENCY STABILITY AS A FUNCTION OF TEMPERATURE
462.5625 MHz, 4.5 Vdc, 0.457 W

Temperature, °C	Output Frequency, MHz	p.p.m.
-19.4	462.562282	-0.5
- 9.5	462.562866	0.8
0.1	462.563324	1.8
9.8	462.563317	1.8
20.5	462.562923	0.9
29.8	462.562589	0.2
40.4	462.562485	0.0
50.2	462.562500	0.0

Maximum frequency error: 462.563324
462.562000
+ .000824 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 5

FREQUENCY STABILITY AS A FUNCTION OF SUPPLY VOLTAGE

462.5625 MHz, 4.5 Vdc Nominal; 0.457W

Supply Voltage	Output Frequency, MHz	p.p.m.

5.17	115%	462.563108	1.3
4.95	110%	462.563040	1.2
4.73	105%	462.562979	1.0
4.50	100%	462.562923	0.9
4.28	95%	462.562884	0.8
4.05	90%	462.562856	0.8
3.83	85%	462.562836	0.7
3.60	80%	462.562817	-0.3

Maximum frequency error: 462.563108
462.562500
+ .000608 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
C935

SEMICONDUCTORS AND FUNCTIONS

Q3	KRA105S	K.E.C	RX POWER SAVEING SWITCHING
Q4	KRC104S	K.E.C	TX SWITCH
Q5	BFG135A	SIMENS	TX POWER FINAL AMP.
Q7	KTC3875S	K.E.C	CALL DET
Q11	KTC3880S	K.E.C	CTCSS DET.
Q12	KTA1504ST1(G)	K.E.C	MIC AMP. B+ SWITCHING
Q13	KRC104S	K.E.C	CALL MUTE
Q19	KTC3875S	K.E.C	CS OUTPUT AUDIO AMP.
Q20	KTC3875S	K.E.C	CD SWITCHING
Q31	KRC104S	K.E.C	RX/TX VCO SWITCHING
Q32	2SC5084	TOSHIBA	O.S.C
Q33	2SC5084	TOSHIBA	BUFFER
Q201	2SC5084	TOSHIBA	RX RF AMP.

Q202	2SC5084	TOSHIBA	1'ST MIXER
Q203	KTC3880S	K.E.C	1'ST IF AMP.
Q207	2SC5084	TOSHIBA	RX LOCAL OUTPUT
Q208	2SC5084	TOSHIBA	TX POWER DRIVE AMP.
Q209	2SC5084	TOSHIBA	TX BUFFER
Q306	KRA110S	K.E.C	LCD BACK LIGHT SWITCHING
Q311	KTA1504ST1(G)	K.E.C.	AUDIO PATH SWITCH
Q312	KRA105S	K.E.C	RX B+ SWITCHING
Q314	KRA105S	K.E.C	TX B+ SWITCHING
Q315	KRC104S	K.E.C	TX B+ SWITCHING
Q316	KRA101S	K.E.C	PTT DETECTOR
Q1	2SC5084	TOSHIBA	WX RF AMP
Q2	2SC5084	TOSHIBA	WX 1’st MIXER
Q14	KTC3880	K.E.C	WX 1’st IF AMP
Q9	2SC5084	TOSHIBA	WX O.S.C
Q8	2SC5084	TOSHIBA	WX VCO BUFFER
Q22	2SC5084	TOSHIBA	WX VCO AMP

IC1	24C02	HOLTEK	EEPROM
IC2	TA31101	TOSHIBA	COMPANDER
IC3	14066B	MOTOLORA	ANALOG SWITCHING
IC501	KA3361BD	SAMSUNG	2'ND MIXER,IF,AND FM DETECTOR
IC502	KB8825	SAMSUNG	PLL FREQUENCY SYNTHESIZER
IC701	TMP8721DF	TOSHIBA	CPU
IC702	TK71330	TOKO	REGULATOR
IC704	NJM2070	J.R.C	AUDIO POWER AMP.
IC707	LM324	NATIONAL	PRE-EMPHASIS AND 300Hz HFP.
IC708	LM358	NATIONAL	CALL DETECTOR
IC710	LM324	NATIONAL	DE-EMPHASIS AND 300Hz HPF.
IC711	LM324	NATIONAL	CTCSS LOWPASS FILTER

IC501	KA3361BD	SAMSUNG	WX 2'ND MIXER,IF,AND FM DETECTOR

FUNCTION OF DEVICES
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APPENDIX 1

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
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APPENDIX 2

APPENDIX 3

CIRCUITS TO SUPPRESS SPURIOUS RADIATION
AND LIMIT MODULATION

Circuitry to Suppress Spurious Emissions

Output from the final RF power amplifier, Q5, and presented to a low-pass filter configured in a "pi" network consisting of L5, C611, L221, C613, L219, C616, C217, C617, C619, L12 and C68.

Circuitry to Limit Modulation and Audio Low Pass Filter

Microphone signal is amplitude limited to prevent deviation over 2.5 kHz, and applied to a 3 kHz low-pass filter configured around IC707.

CIRCUITS TO SUPPRESS SPURIOUS
RADIATION AND LIMIT MODULATION

FCC ID: OKMC935
APPENDIX 3

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