ENGINEERING STATEMENT

For Type Certification of

Cobra Electronics Corporation

Model No: FRS 104
FCC ID: BBOFRS104

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 104 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 10, 2002

A. INTRODUCTION

The following data are submitted in connection with this request for type certification of the FRS 104 transceiver in accordance with Part 2, Subpart J of the FCC Rules.

The FRS 104 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 (Paragraph 2.983 of the Rules)

1. Name of applicant: Cobra Electronics Corporation

2. Identification of equipment: FCC ID: BBOFRS104

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

      Collector voltage: 5.8 Vdc
      Collector current: 0.41 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 104 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 | 0.49 |

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 2791 Hz, the frequency of maximum response. Measured modulation under these conditions was 2.0 kHz.

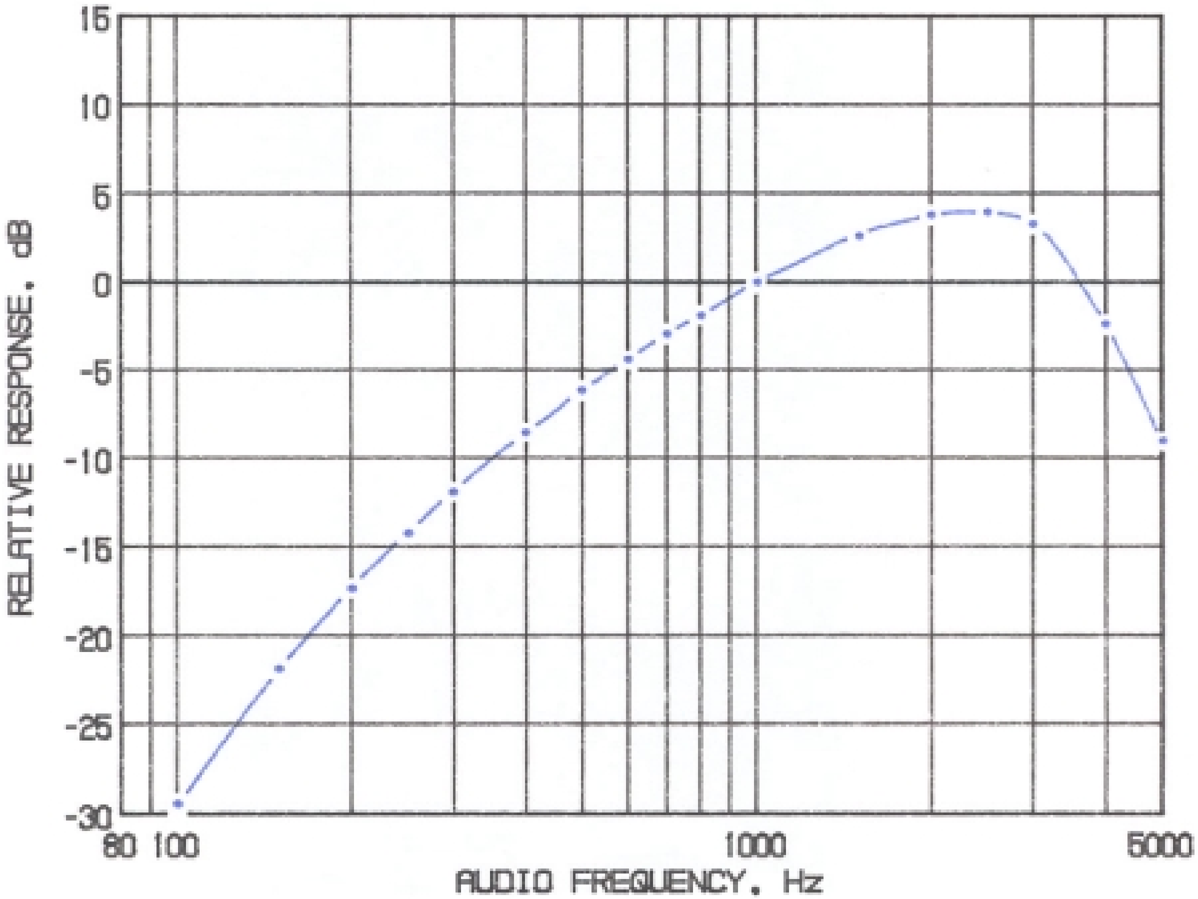
Emission designator:

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



FIGURE 1

MODULATION FREQUENCY RESPONSE



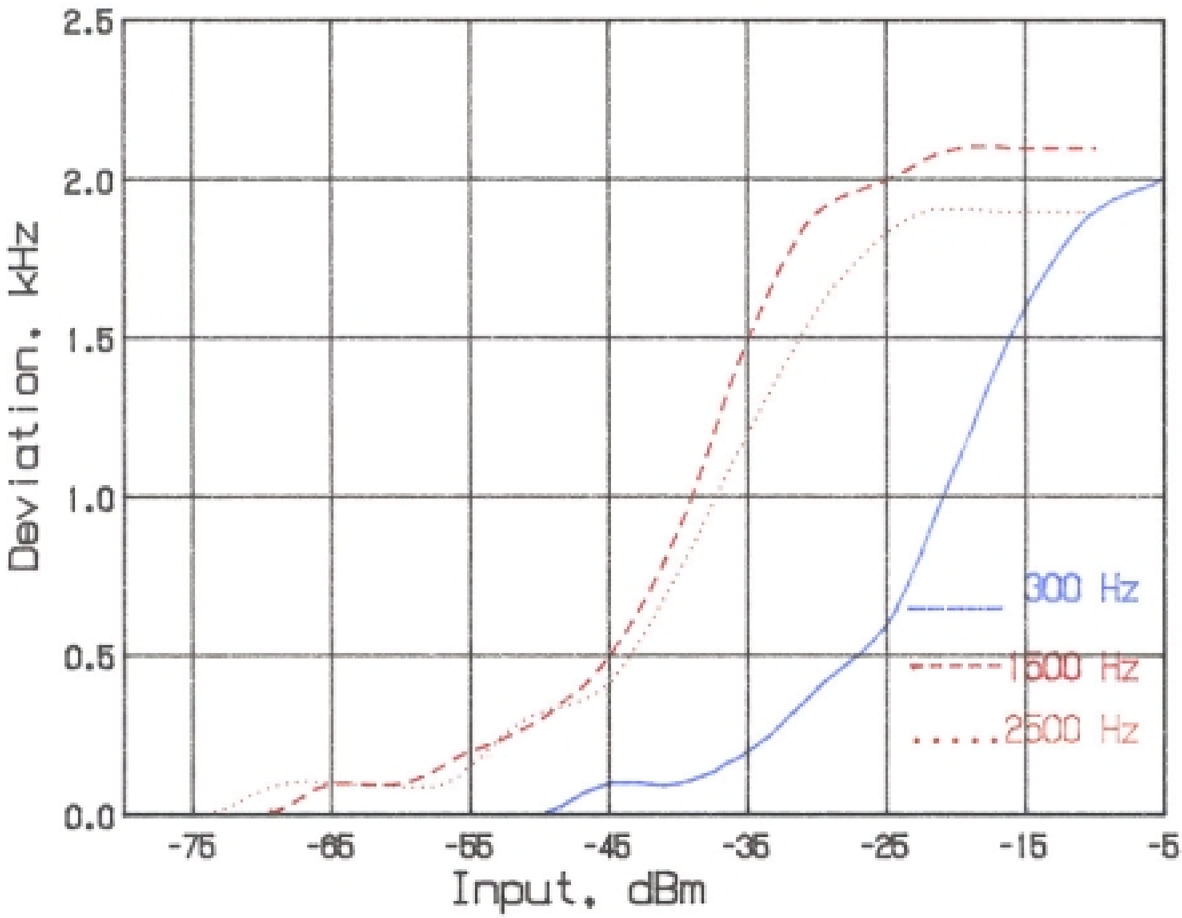

MODULATION FREQUENCY RESPONSE
FCC ID: BBOFRS104

FIGURE 1



FIGURE 2

AUDIO LIMITER CHARACTERISTICS

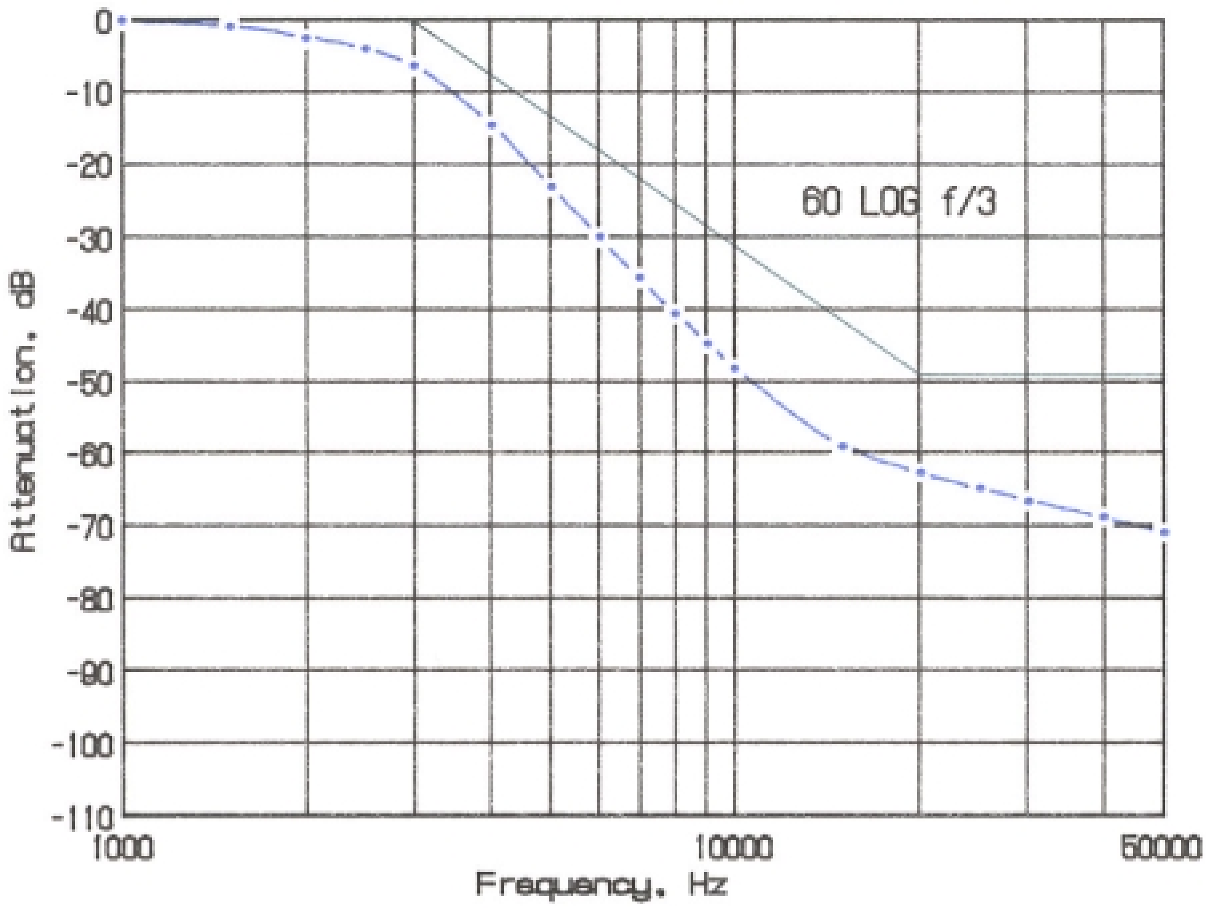



AUDIO LIMITER CHARACTERISTICS
FCC ID: BBOFRS104

FIGURE 2
6

FIGURE 3

AUDIO LOW PASS FILTER RESPONSE



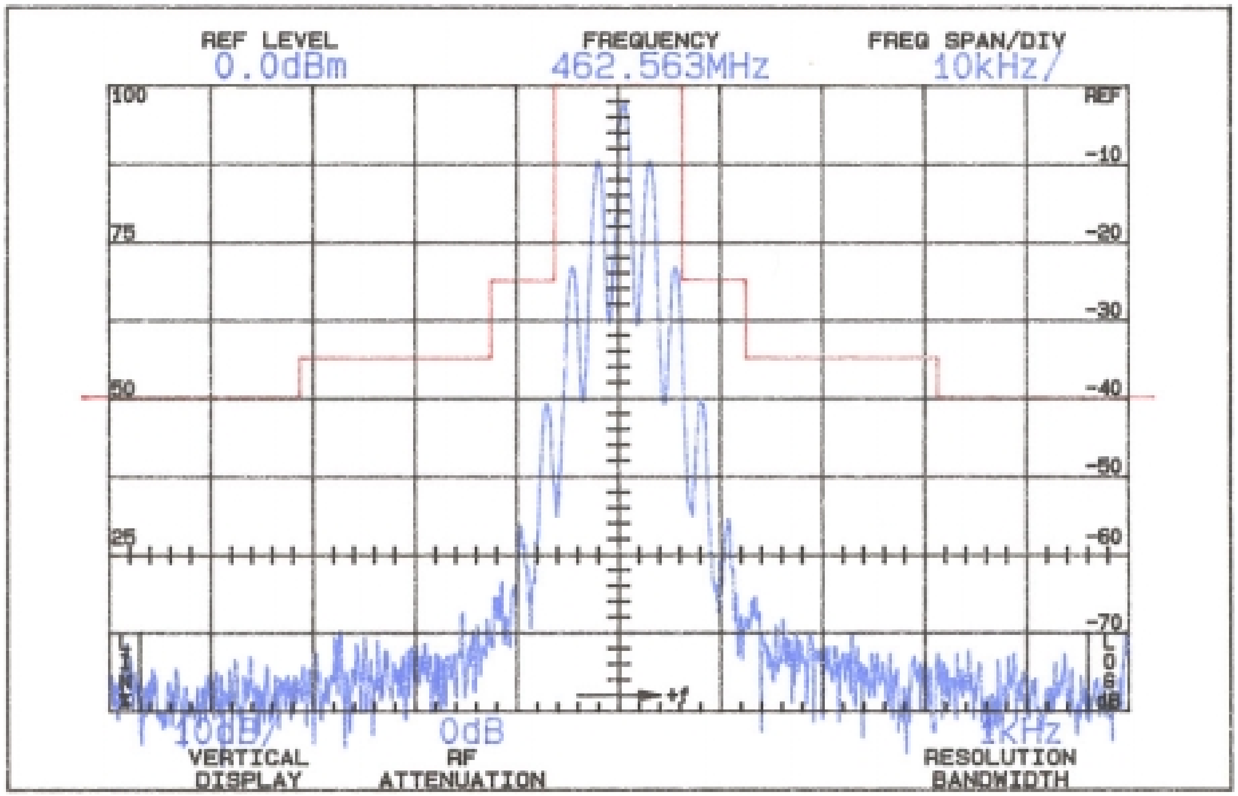

AUDIO LOW PASS FILTER
RESPONSE
FCC ID: BBOFRS104

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 = 0.49) |

OCCUPIED BANDWIDTH
FCC ID: BBOFRS104

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 104 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

Measurements of radiated spurious emissions from the FRS 104 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 (20.95 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, 0.49 watts

| Spurious Frequency | dB Below Carrier |
|---|---|

| MHz | Reference |
|---|---|
| 462.563 | 0 |
| 925.125 | 56V |
| 1387.688 | 56V |
| 1850.250 | 62H |
| 2312.813 | 56H |
| 2775.375 | 51H |
| 3237.938 | 43H |
| 3700.500 | 53H |
| 4163.063 | 53V |
| 4625.625 | 47H |

Required: 43+10 Log(P) = 40

All other spurious from 20.95 MHz to the tenth harmonic were 20 dB or more below FCC limit.



G. 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, 0.49 W

| Temperature, °C | Output Frequency, MHz | p.p.m. |
|---|---|---|
| -19.9 | 462.563163 | 1.4 |
| - 9.8 | 462.563462 | 2.1 |
| - 0.1 | 462.563466 | 2.1 |
| 10.2 | 462.563147 | 1.4 |
| 19.8 | 462.562636 | 0.3 |
| 30.4 | 462.562281 | -0.5 |
| 39.9 | 462.561908 | -1.3 |
| 50.3 | 462.561987 | -1.1 |

| | | |
|---|---|---|
| Maximum frequency error: | 462.563466 | |
| | 462.562500 | |
| | + .000966 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 |



H. 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; 0.49W

| Supply_Voltage | | Output_Frequency,_MHz | p.p.m. |
|---|---|---|---|
| 6.9 | 115% | 462.562765 | 0.6 |
| 6.6 | 110% | 462.562729 | 0.5 |
| 6.3 | 105% | 462.562681 | 0.4 |
| 6.0 | 100% | 462.562636 | 0.3 |
| 5.7 | 95% | 462.562597 | 0.2 |
| 5.4 | 90% | 462.562566 | 0.1 |
| 5.1 | 85% | 462.562543 | 0.1 |
| 4.8* | 80% | 462.562526 | 0.1 |

Maximum frequency error: 462.562765
462.562500

\+ .000265 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

## SEMICONDUCTOR AND FUNCTIONS

### 1 ) TR

| Ref. No. | Description | Function | | Manufacturer |
|---|---|---|---|---|
| | | RX | TX | |
| Q1 | 2SC5084 | RX AMP | - | TOSHIBA |
| Q2 | 2SC5084 | RX 1ST MIXER | - | TOSHIBA |
| Q3 | KTC3880 | 1ST IF AMP | - | K.E.C. |
| Q4 | KRC104S | - | TX VCO SWITCHING | K.E.C. |
| Q5 | KTA1504S | AF SWITCHING | - | K.E.C. |
| Q6 | KTA1504S | BEEP/RING TONE CONTROL | - | K.E.C. |
| Q7 | KRC104S | AUDIO MUTE | - | K.E.C. |
| Q8 | BFQ67W | - | TX POWER TR | PHILIPS |
| Q9 | KRA226S | - | TX B+ SWITCHING | K.E.C. |
| Q10 | KRA104S | - | TX B+ SWITCHING | K.E.C. |
| Q11 | KRC104S | - | MIC MUTE | K.E.C. |
| Q12 | KTA1504S | - | PTT CONTROL | K.E.C. |
| Q13 | KRC104S | LCD BACK LIGHT | LCD BACK LIGHT | K.E.C. |
| Q14 | KRA226S | RX B+ SWITCHING | - | K.E.C. |
| Q15 | KRC112S | VOLUMN CONTROL | VOLUMN CONTROL | K.E.C. |
| Q16 | KRC112S | VOLUMN CONTROL | VOLUMN CONTROL | K.E.C. |
| Q17 | KRC104S | AUDIO AMP CONTROL | - | K.E.C. |
| Q18 | BFQ67W | - | TX POWER TR | PHILIPS |
| Q19 | KRA105S | RX B+ SWITCHING | - | K.E.C. |
| Q20 | KRC104S | CPU RESET CONTROL | CPU RESET CONTROL | K.E.C. |
| Q21 | KRC110S | RX SWITCHING | - | |
| Q22 | KRC112S | - | TX B+ SWITCHING | K.E.C. |
| Q31 | KRC104S | - | TX VCO Switching | K.E.C. |
| Q32 | 2SC5084 | VCO Pump Charge | VCO Pump Charge | TOSHIBA |
| Q33 | 2SC5084 | VCO Pump Charge | VCO Pump Charge | TOSHIBA |
| Q34 | 2SC5084 | BUFFER AMP | - | TOSHIBA |
| Q35 | 2SC5084 | - | BUFFER AMP | TOSHIBA |
| Q36 | BFQ67W | - | DRIVER AMP | PHILIPS |
| Q38 | BFQ67W | - | TX POWER TR | PHILIPS |

1 ) TR (continue)

| Ref. No. | Description | Function | | Manufacturer |
|---|---|---|---|---|
| | | RX | TX | |
| Q39 | KRC112S | VOLUMN CONTROL | VOLUMN CONTROL | K.E.C. |
| Q40 | KTA1504S | VCO B+ SWITCHING | VCO B+ SWITCHING | K.E.C. |
| Q41 | KRC112S | - | PTT CONTROL | K.E.C. |

2 ) DIODE

| Ref. No. | Description | Function | | Manufacturer |
|---|---|---|---|---|
| | | RX | TX | |
| D1 | KDS226 | DIODE SWITCHED | - | K.E.C. |
| D2 | KDS181 | DIODE SWITCHED | - | K.E.C. |
| D3 | KDS226 | DIODE SWITCHED | - | K.E.C. |
| D4 | KDS184 | DIODE SWITCHING | DIODE SWITCHING | K.E.C. |
| D5 | KDS181 | - | DIODE SWITCHING | K.E.C. |
| D6 | KDV154 | VARICAP DIODE | VARICAP DIODE | K.E.C. |
| D8 | KDS184 | DIODE SWITCHED | DIODE SWITCHED | K.E.C. |
| D9 | KDS181 | - | DIODE SWITCHING | K.E.C. |
| D10 | MMBV3401 | DIODE SWITCHED | - | MOTOROLA |
| D11 | MMBV3401 | - | DIODE SWITCHED | MOTOROLA |
| D12 | KDS181 | DIODE SWITCHED | DIODE SWITCHED | K.E.C. |
| D14 | KDS184 | DIODE SWITCHED | DIODE SWITCHED | K.E.C. |
| D201 | KDV154 | VARICAP DIODE | VARICAP DIODE | K.E.C. |
| D202 | KDS114 | PIN DIODE SWITCHED | - | K.E.C. |

3 ) IC

| Ref. No. | Description | Function | | Manufacturer |
|---|---|---|---|---|
| | | RX | TX | |
| IC1 | MC3361 | 2ND MIXER AF DETECTOR | - | MOTOROLA |
| IC2 | IL386 | LOW VOLTAGE POWER AMP | - | SAMSUNG |
| IC4 | KB8825 | PLL IC | PLL IC | SAMSUNG |
| IC5 | TK11140MCL | 4 V REGULATOR | 4 V REGULATOR | TOKO |
| IC6 | KIA4558F | - | DUAL LOW NOISE OP AMP | K.E.C. |
| IC100 | KS57P21208 | CPU | CPU | SAMSUNG |

APPENDIX 2

CIRCUITS AND DEVICES TO STABILIZE FREQUENCY

The PLL synthesizer of the signal loop PLL circuit with the reference of 6.25 kHz. The IC4 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 21.25 MHz TCXO of the TCXO is connected to the pin 11 of the IC4 to oscillate the frequency of 21.25 MHz. The TCXO (21.25 MHz) is the temperature compensation circuit to maintain the frequency within the allowable error range even under a low temperature of -30°C. The phase detector sends out the output power to the loop filter through 3rd pin of the IC4. If the oscillation frequency of the VCO is low compared to the reference frequency, the phase detector sends out output power in positive pulse. If the oscillation frequency of the VCO is high, phase detector send out can maintain the frequency set.

# APPENDIX 3

## CIRCUITS TO SUPPRESS SPURIOUS RADIATION AND LIMIT MODULATION

### Pre-emphasis (IC6)

The voice signal input from the microphone is pre-emphasized at the IC6B. The signal which comes out of the IC6A is limited to a certain amplitude for the voice signal not to exceed the allowable band width assigned for transmission.

### TX Power (Q38, Q8, Q18)

The transmitted signal of approximately 7 mW, combined at the driver TR is supplied to the base of the Q38, Q8, Q18 amplifier. The transmitted signal amplifier to 0.47 W here passes the TX LPF of the 2$^{nd}$ characteristics of the L25 and the L26, and RX/TX switching takes place by the D11. After this, the signal is provided to the antenna the TX LPF of the 1$^{st}$ characteristics consisted of the L27.