

ENGINEERING STATEMENT  
For Type Certification of  
Midland Consumer Radio

Model No: F-10  
FCC ID: MMAF10

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 Midland Consumer Radio to make type certification measurements on the model F-10 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: May 3, 2001

A. INTRODUCTION

The following data are submitted in connection with this request for type certification of the model F-10 transceiver in

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

The model F-10 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(d)

B. GENERAL INFORMATION REQUIRED FOR TYPE CERTIFICATION  
(Paragraph 2.983 of the Rules)

1. Name of applicant: Midland Consumer Radio
2. Identification of equipment: FCC ID: MMAF10
  - 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)
  - d. Maximum power permitted is 0.5 watts, and the model F-10 fully complied with that power limitation.
  - e. The dc voltage and dc currents at final amplifier:  
  
Collector voltage: 4.4 Vdc  
Collector current: 0.69 A
  - f. Function of each active semiconductor device is submitted as exhibit 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.

2

B. GENERAL INFORMATION (continued)

- j. A description of circuits for stabilizing frequency is included in exhibit 2.
- k. A description of circuits and devices employed for suppression of spurious radiation and for limiting modulation is included in exhibit 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 F-10 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<br>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  $60\log f/3$  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.

3

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 2806 Hz, the frequency of maximum response.

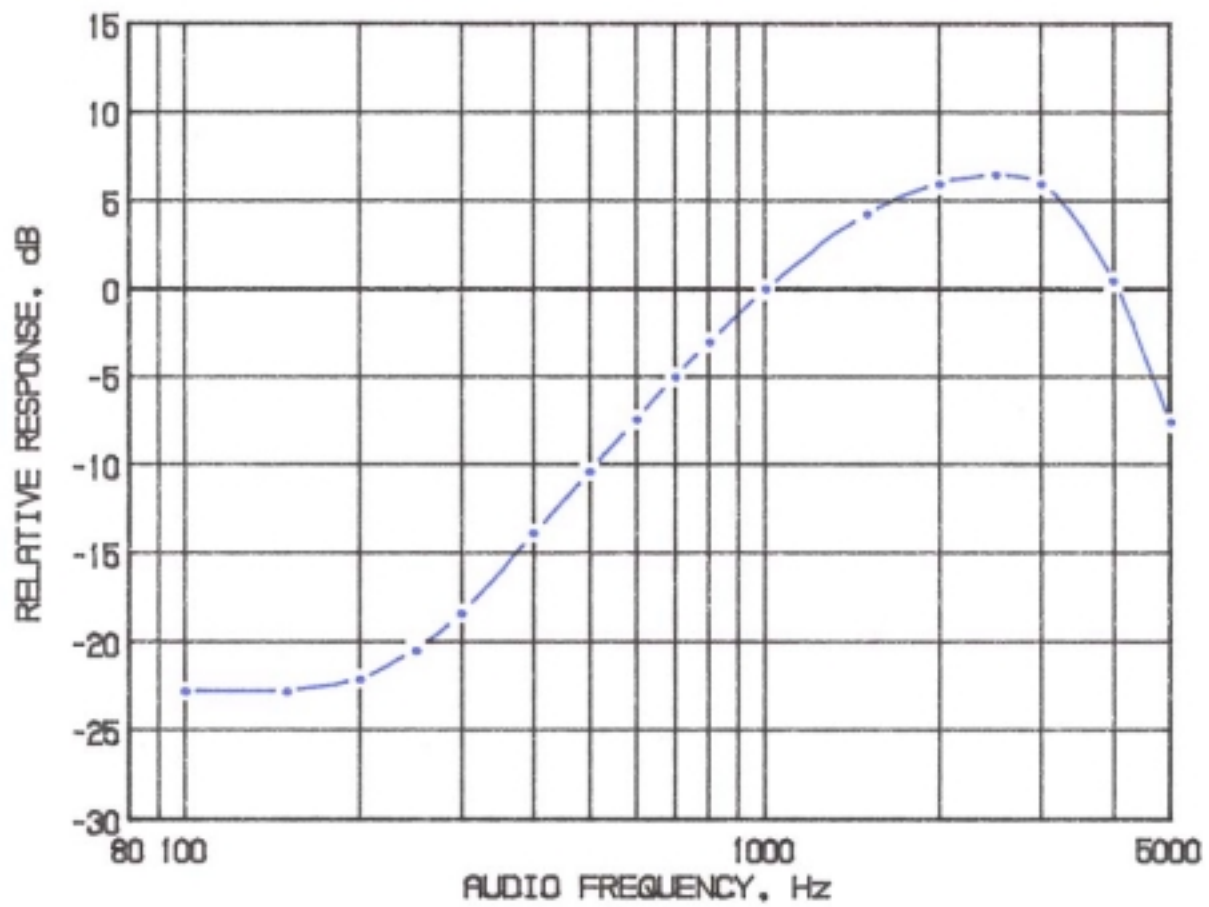
Emission designator:

$$(2M + 2D) (2 \times 3 \text{ kHz}) + (2 \times 2.5 \text{ kHz}) = 11\text{k0F3E}$$

4

FIGURE 1

MODULATION FREQUENCY RESPONSE



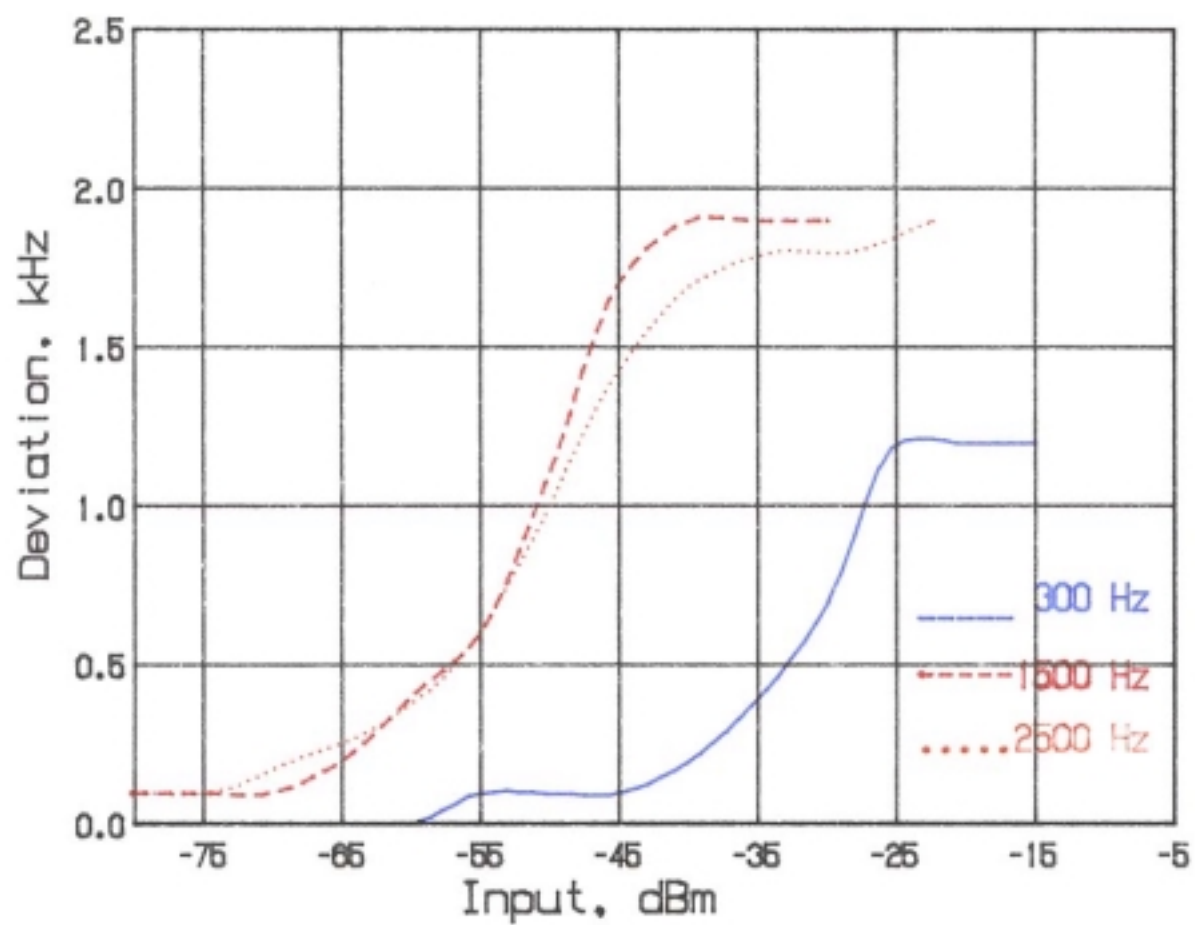
MODULATION FREQUENCY RESPONSE  
FCC ID: MMAF10

FIGURE 1

5

FIGURE 2

AUDIO LIMITER CHARACTERISTICS

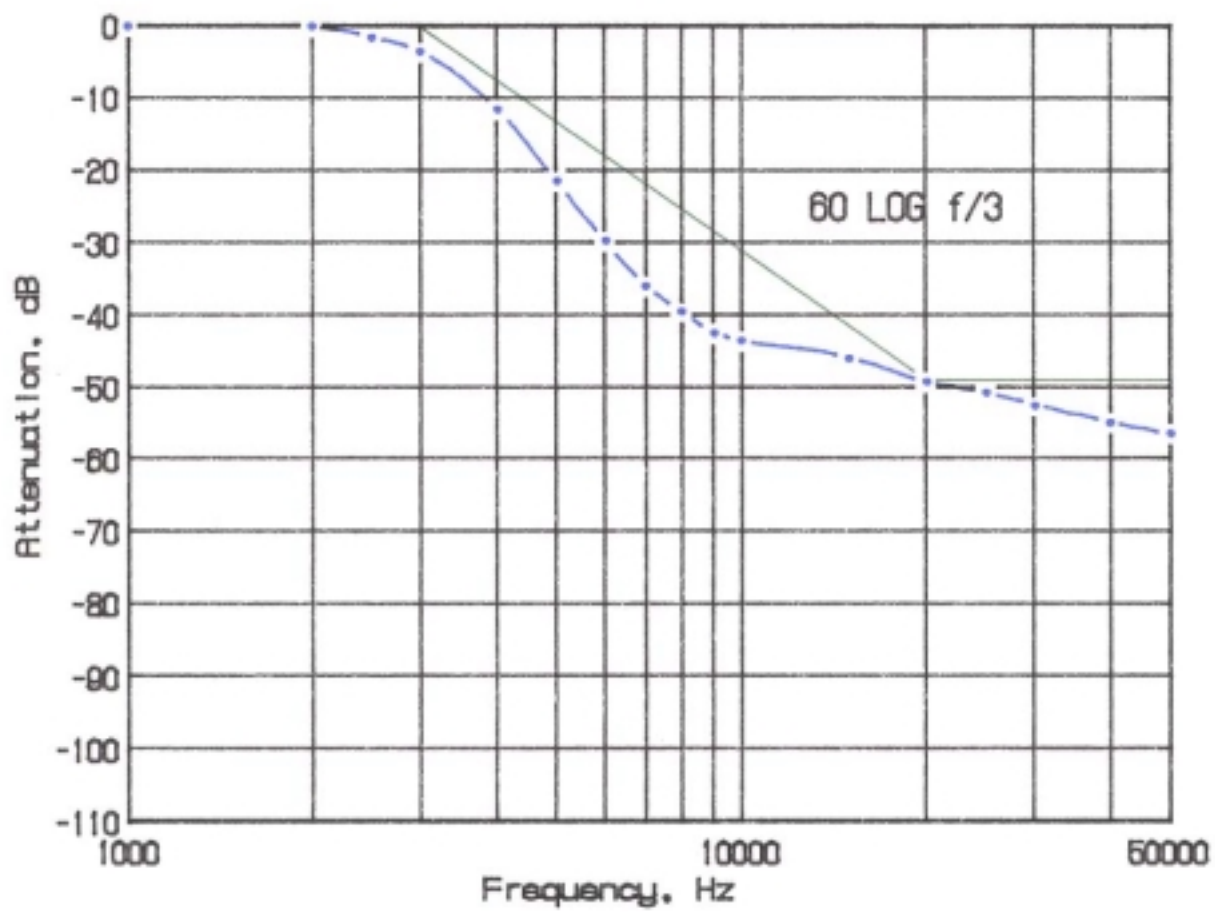


AUDIO LIMITER CHARACTERISTICS  
FCC ID: MMAF10

FIGURE 2  
6

FIGURE 3

AUDIO LOW PASS FILTER RESPONSE

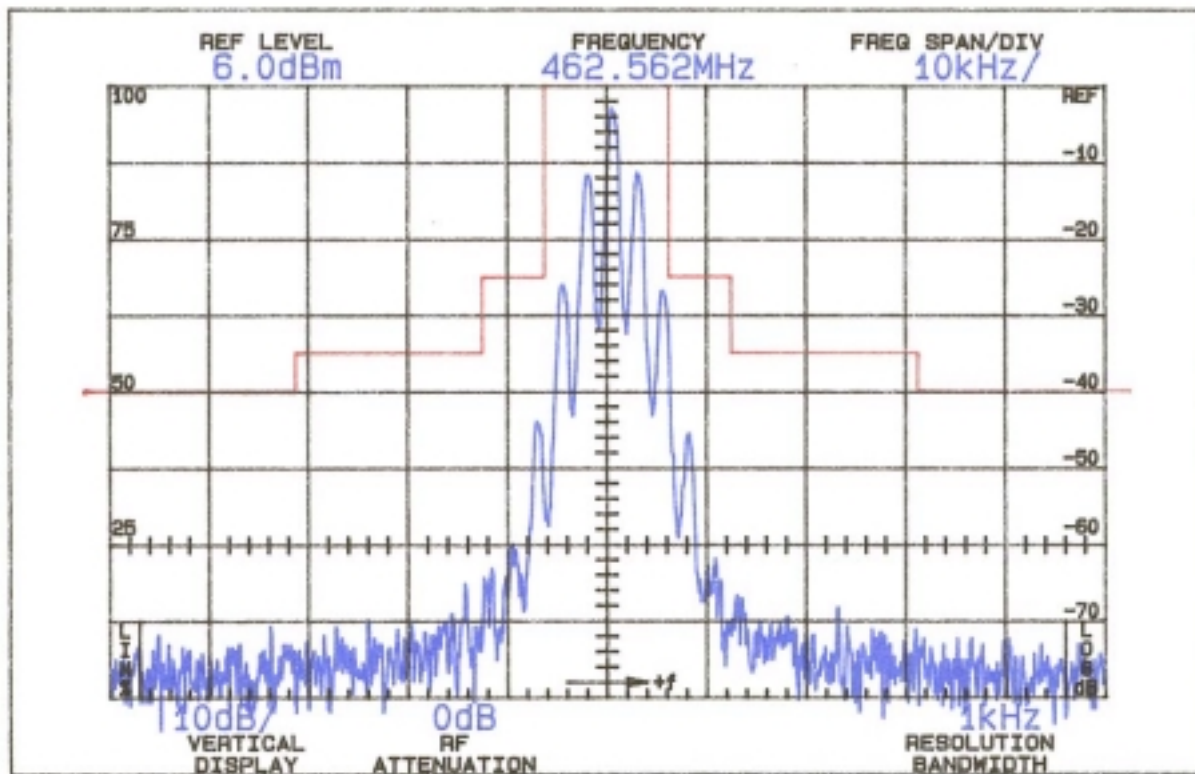


AUDIO LOW PASS FILTER  
RESPONSE  
FCC ID: MMAF10

FIGURE 3

7  
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)

$$43 + 10 \log P = 40$$

$$(P = 0.49)$$

OCCUPIED BANDWIDTH  
FCC ID: MMAF10

FIGURE 4

8

#### 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 F-10 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 F-10 were made by substitution with a Tektronix 494P spectrum analyzer using Singer DM-105 for the measurements to 1 GHz, and EMC0 3115 horn to 4.5 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 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, 0.49 watts

Spurious

dB Below

| <u>Frequency<br/>MHz</u> | <u>Carrier<br/>Reference<sup>1</sup></u> |
|--------------------------|------------------------------------------|
| 462.565                  | 0                                        |
| 2312.815                 | 55V                                      |
| 2775.377                 | 51V                                      |
| 3237.940                 | 57V                                      |
| 4625.627                 | 56H                                      |

Required:  $43+10 \log(P) = 40$

<sup>1</sup>Worst-case polarization, H-Horizontal, V-Vertical.

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

10

#### 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, 0.49 W

| <u>Temperature, °C</u>   | <u>Output_Frequency, _MHz</u> | <u>p.p.m.</u> |
|--------------------------|-------------------------------|---------------|
| -20.1                    | 462.562331                    | -0.4          |
| - 9.9                    | 462.562344                    | -0.3          |
| - 0.8                    | 462.562390                    | -0.2          |
| 10.2                     | 462.562299                    | -0.4          |
| 20.2                     | 462.562588                    | 0.2           |
| 30.1                     | 462.562412                    | -0.2          |
| 40.2                     | 462.562169                    | -0.7          |
| 50.1                     | 462.562315                    | -0.4          |
| Maximum frequency error: | 462.562169                    |               |
|                          | <u>462.562500</u>             |               |
|                          | - .000331 MHz                 |               |

FCC Rule 95.627(b) specifies .00025% (2.5 p.p.m.) or a maximum of  $\pm 0.001156$  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  $\pm 15\%$  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; 0.49 W

| <u>Supply_Voltage</u> |      | <u>Output_Frequency, _MHz</u> | <u>p.p.m.</u> |
|-----------------------|------|-------------------------------|---------------|
| 5.17                  | 115% | 462.562331                    | -0.4          |
| 4.95                  | 110% | 462.562424                    | -0.2          |
| 4.73                  | 105% | 462.562525                    | 0.1           |
| 4.50                  | 100% | 462.562588                    | 0.2           |
| 4.28                  | 95%  | 462.562613                    | 0.2           |
| 4.05                  | 90%  | 462.562622                    | 0.3           |
| 3.83                  | 85%  | 462.562611                    | 0.2           |
| 3.60                  | 80%  | 462.562590                    | 0.2           |

Maximum frequency error: 462.562331  
462.562500

+ .000169 MHz

FCC Rule 95.627(b) specifies .00025% (2.5 p.p.m. or a maximum of  $\pm 0.001156$  MHz, corresponding to:

|            |                |
|------------|----------------|
| High Limit | 462.563656 MHz |
| Low Limit  | 462.561344 MHz |

\*Battery end point.

## APPENDIX 1

FUNCTION OF DEVICES  
Model F-10

## ΣΕΜΙΧΟΝΔΥΧΤΟΡΣ ΑΝΔ ΦΥΝΧΤΙΟΝΣ

## ΤΡΑΝΣΙΣΤΟΡ

|     |         |       |            |
|-----|---------|-------|------------|
| ΘΡ1 | 2ΣΧ4226 | N.E.X | ΡΞ ΡΦ ΑΜΠ. |
|-----|---------|-------|------------|

|     |          |        |                          |
|-----|----------|--------|--------------------------|
| ΘΡ2 | 2ΣΧ4226  | N.E.X  | 1ᅁΣΤ ΜΙΞΕΡ               |
| ΘΡ3 | KTX3880Σ | K.E.X  | 1ᅁΣΤ ΙΦ ΑΜΠ.             |
| ΘΡ4 | KPX110Σ  | K.E.X  | ΣΘΥΕΛΧΗ ΜΥΤΕ             |
| ΘΡ5 | KTX3875Σ | K.E.X  | ςΟΞ ΑΥΔΙΟ ΑΜΠ.           |
| ΘΤ1 | 2ΣΧ4226  | N.E.X  | ΤΞ ΒΥΦΦΕΡ                |
| ΘΤ2 | 2ΣΧ4226  | N.E.X  | ΤΞ ΠΟΩΕΡ ΔΡΙςΕ ΑΜΠ.      |
| ΘΤ3 | ΒΛΤ 70   | ΠΗΛΙΠΣ | ΤΞ ΠΟΩΕΡ ΦΙΝΑΛ ΑΜΠ.      |
| ΘΤ4 | KPX104Σ  | K.E.X  | ΡΞ Β+ ΣΩΙΤΧΗΙΝΓ ΑΤ ΤΞ    |
| ΘΣ1 | KPA105Σ  | K.E.X  | ΡΞ Β+ ΣΩΙΤΧΗΙΝΓ          |
| ΘΣ2 | KPA105Σ  | K.E.X  | ΠΟΩΕΡ ΣΑςΕ ΧΟΝΤΡΟΛ       |
| ΘΣ3 | KPA105Σ  | K.E.X  | ΤΞ Β+ ΣΩΙΤΧΗΙΝΓ          |
| ΘΣ4 | KPX104Σ  | K.E.X  | ΤΞ Β+ ΣΩΙΤΧΗΙΝΓ          |
| ΘΣ5 | KPA105Σ  | K.E.X  | ΜΙΧ ΑΜΠ Β+ ΣΩΙΤΧΗΙΝΓ     |
| ΘΣ7 | KPA101Σ  | K.E.X  | ΠΤΤ ΣΩΙΤΧΗΙΝΓ            |
| ΘΣ8 | KPX104Σ  | K.E.X  | ΒΑΧΚ ΛΙΓΗΤ ΛΕΔ ΣΩΙΤΧΗΙΝΓ |
| Θς1 | KPX104Σ  | K.E.X  | ΡΞ/ΤΞ ςΧΟ ΣΩΙΤΧΗΙΝΓ      |
| Θς2 | 2ΣΧ4226  | N.E.X  | Ο.Σ.Χ                    |
| ΘΦ1 | 2ΣΧ4226  | N.E.X  | ΡΞ ΒΥΦΦΕΡ                |

## ΙΝΤΕΓΡΑΤΕΔ ΧΙΡΧΥΙΤ

|     |            |         |                                        |
|-----|------------|---------|----------------------------------------|
| ΙΧ1 | ΔΒΛ5018ς   | ΔΑΕΩΟΟ  | 2ᅁΝΔ ΜΙΞΕΡ ΙΦ ΑΝΔ<br>ΦΜ ΔΕΤΕΧΤΟΡ       |
| ΙΧ2 | NᅁM2070    | ᅁ.P.X   | ΑΥΔΙΟ ΠΟΩΕΡ ΑΜΠ.                       |
| ΙΧ3 | KΣ88Χ21208 | ΣΑΜΣΥΝΓ | ΧΠΥ                                    |
| ΙΧ4 | KB8825     | ΣΑΜΣΥΝΓ | ΠΛΛ ΦΡΕΘΥΕΝΧΨ ΣΨΝΤΗΕΣΙΖΕΡ              |
| ΙΧ5 | TK71330    | ΤΟΚΟ    | ΡΕΓΥΛΑΤΟΡ                              |
| ΙΧ6 | ΔΒΛ358     | ΔΑΕΩΟΟ  | ΠΡΕ-ΕΜΠΗΑΣΙΣ ΑΝΔ ΜΙΧ ΑΜΠ,<br>ΛΙΜΙΤΤΕΡ. |
| ΙΧ7 | 24ΩΧΟ2ᅁ    | ΧΤΙ     | ΕΕΠΡΟΜ                                 |

## APPENDIX 2

### CIRCUITS AND DEVICES TO STABILIZE FREQUENCY

The PLL synthesizer of the F-10 consists of the signal loop PLL circuit with the reference of 6.25 KHz. The IC4 PLL IC

includes all the functions such as the reference oscillator, the driver, the phase detector, the lock detector and programmable divider.

At the reference oscillator, the 21.250 MHz TCXO of the TCX0-1 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.

The phase detector send out the output power to the loop filter through 3 pin of the IC4. IF the oscillation frequency of the VCO is low compared to the referenced frequency, the phase detector sends out the output power in positive pulse. If the oscillation frequency of the VCO is high, phase detector send out can maintain the frequency set.

CIRCUITS AND DEVICES TO  
STABILIZE FREQUENCY  
FCC ID: MMAF10

APPENDIX 2

APPENDIX 3

CIRCUITS TO SUPPRESS SPURIOUS RADIATION  
AND LIMIT MODULATION

CIRCUITS TO SUPPRESS SPURIOUS RADIATION

The transmitted signal of approximately 7mW, combined at the PLL module is supplied to the base of the QT3 amplifier. The transmitted signal amplified to 0.5 watts here passes the TX LPF of the 2<sup>nd</sup> characteristic of the LT4 and the LT5, and RX/TX switching takes place by the DT2. After this, the signal is provided to the antenna the TX LPF of the 1<sup>st</sup> characteristics, consisted of the LT6.

#### CIRCUITS TO LIMIT MODULATION

The voice signal input from the microphone is pre-emphasized at the IC6A. The signal which comes out of the DM1 is limited to a certain amplitude for the voice signal not to exceed the allowable bandwidth assigned for transmission.

CIRCUITS TO SUPPRESS SPURIOUS  
RADIATION AND LIMIT MODULATION  
FCC ID: MMAF10

#### APPENDIX 3