

A. INTRODUCTION

The following data are submitted in connection with this request for type certification of the FR-460 transceiver in accordance with Part 2, Subpart J of the FCC Rules.

The FR-460 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. Output power rating is 0.5 watts ERP.

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

1. Name of applicant: Wireless Marketing Corporation
2. Identification of equipment: FCC ID: MGPFR-460
 - a. The equipment identification label is shown in Appendix 1.
 - b. Photographs of the equipment are included in Appendix 2.
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 FR-460 fully complied with that power limitation.
 - e. The dc voltage and dc currents at final amplifier:
Collector voltage: 4.4 Vdc
Collector current: 0.19 A
 - f. Function of each active semiconductor device:
See Appendix 3.
 - g. Complete circuit diagram is included in Appendix 4.
 - h. A draft instruction book is submitted as Appendix 5.
 - i. The transmitter tune-up procedure is included in Appendix 6.
 - j. A description of circuits for stabilizing frequency is included in Appendix 7.
 - k. A description of circuits and devices employed for suppression of spurious radiation and for limiting modulation is included in Appendix 8.
 - 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 FR-460 has a permanently attached built-in antenna without provisions for a coaxial connector.

Therefore RF power output was calculated as shown in Table 1. (The transmitter was tuned by the factory according to the procedure of Exhibit 4.)

TABLE 1

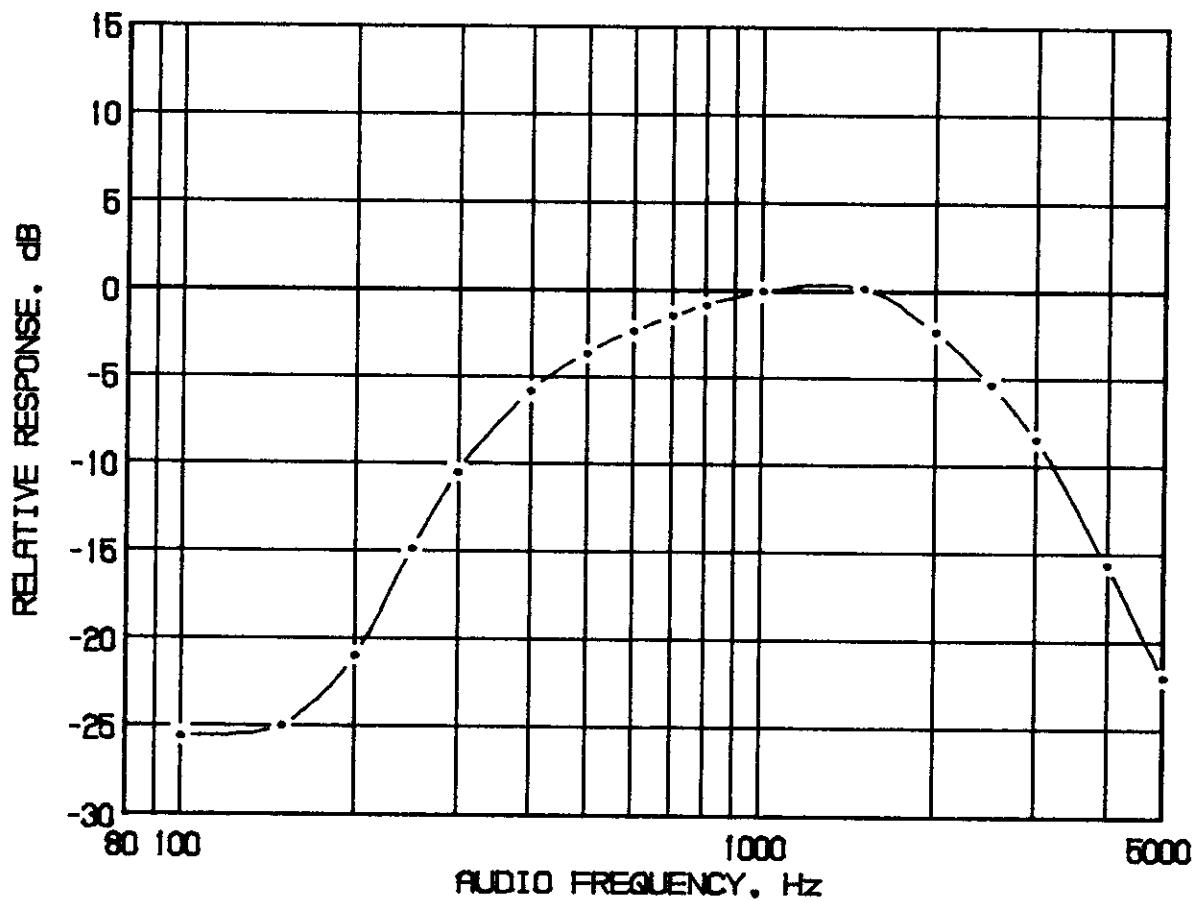
| Operating Freq., MHz | Power watts into a dipole antenna |
|----------------------|-----------------------------------|
| 462.5625 | 0.470 |

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 a 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.
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 2700 Hz, the frequency of maximum response. Measured modulation under these conditions was 2.5 kHz.

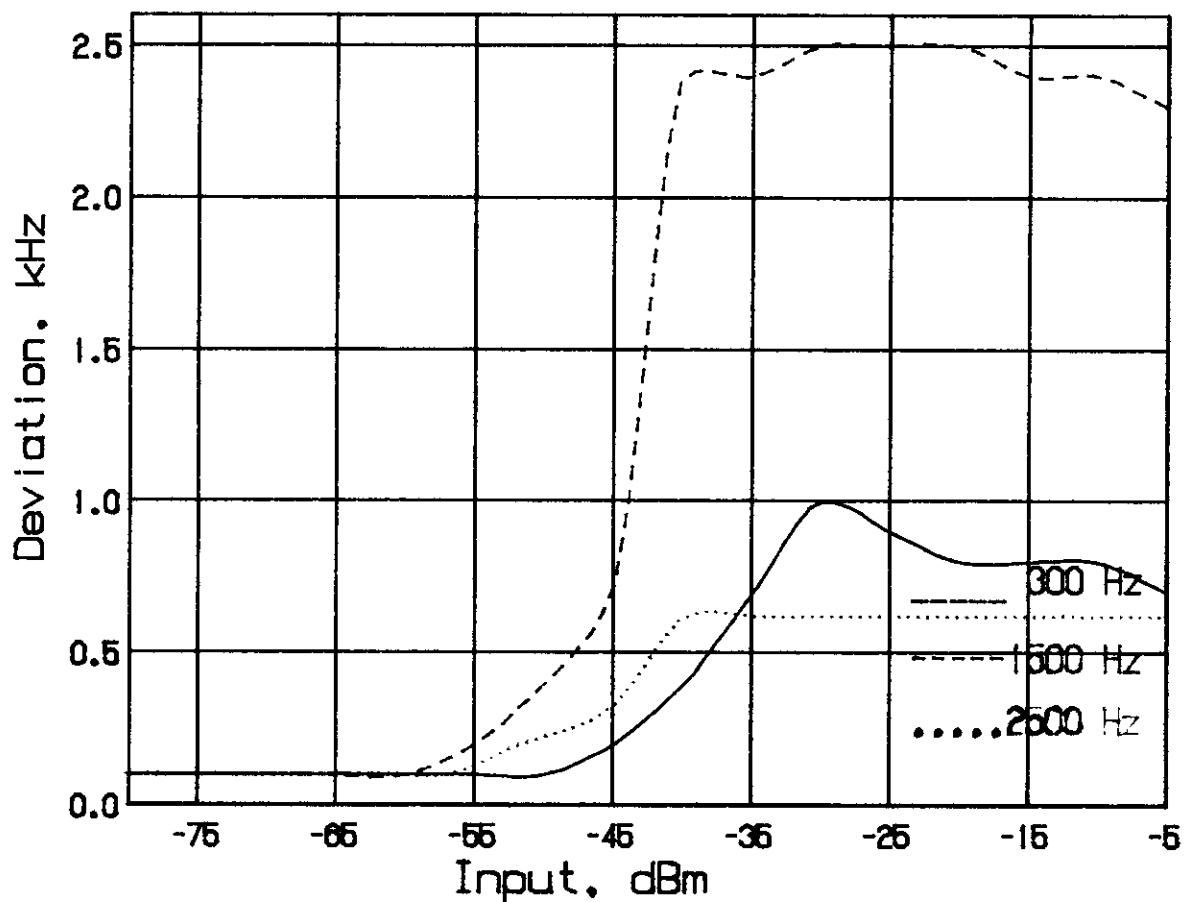
FIGURE 1
MODULATION FREQUENCY RESPONSE



MODULATION FREQUENCY RESPONSE
FCC ID: MGPFR-460

FIGURE 1

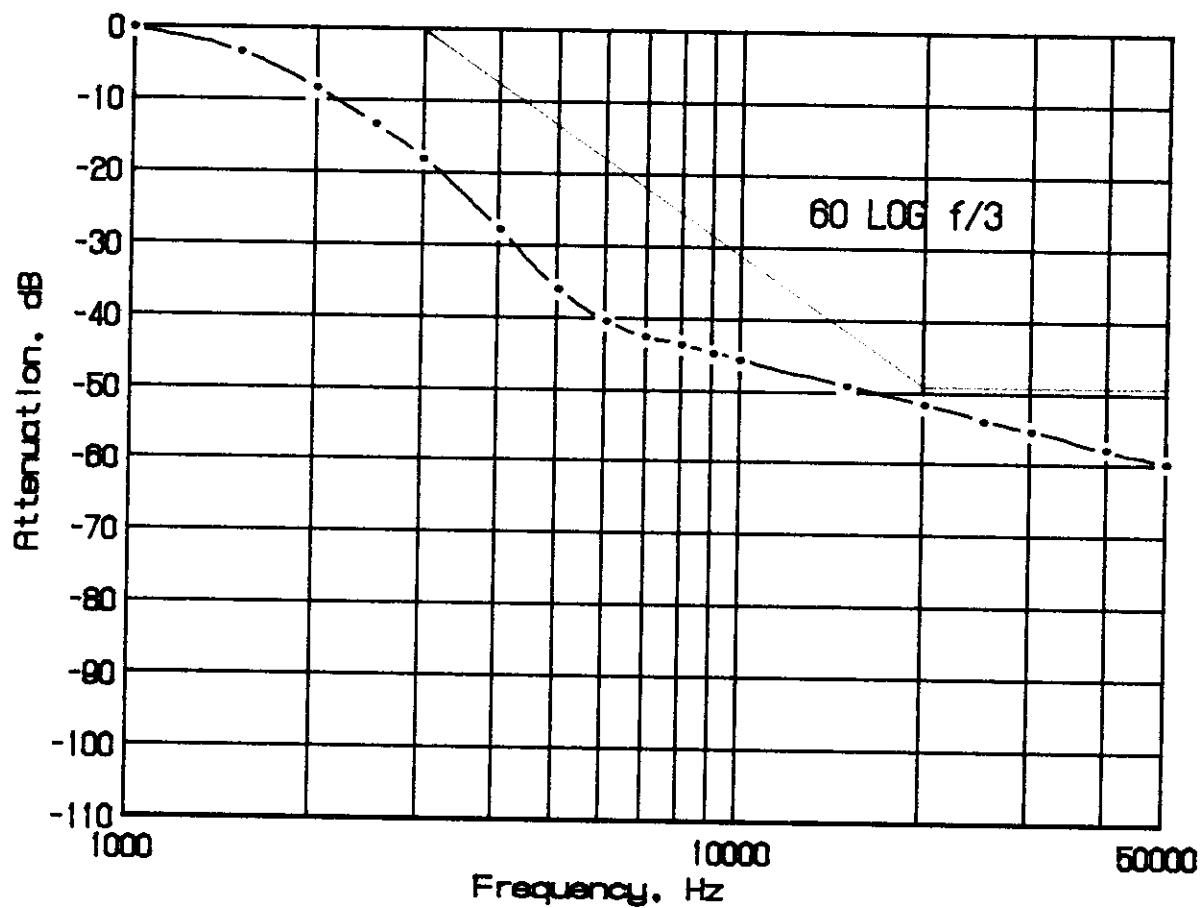
FIGURE 2
AUDIO LIMITER CHARACTERISTICS



AUDIO LIMITER CHARACTERISTICS
FCC ID: MGPFR-460

FIGURE 2

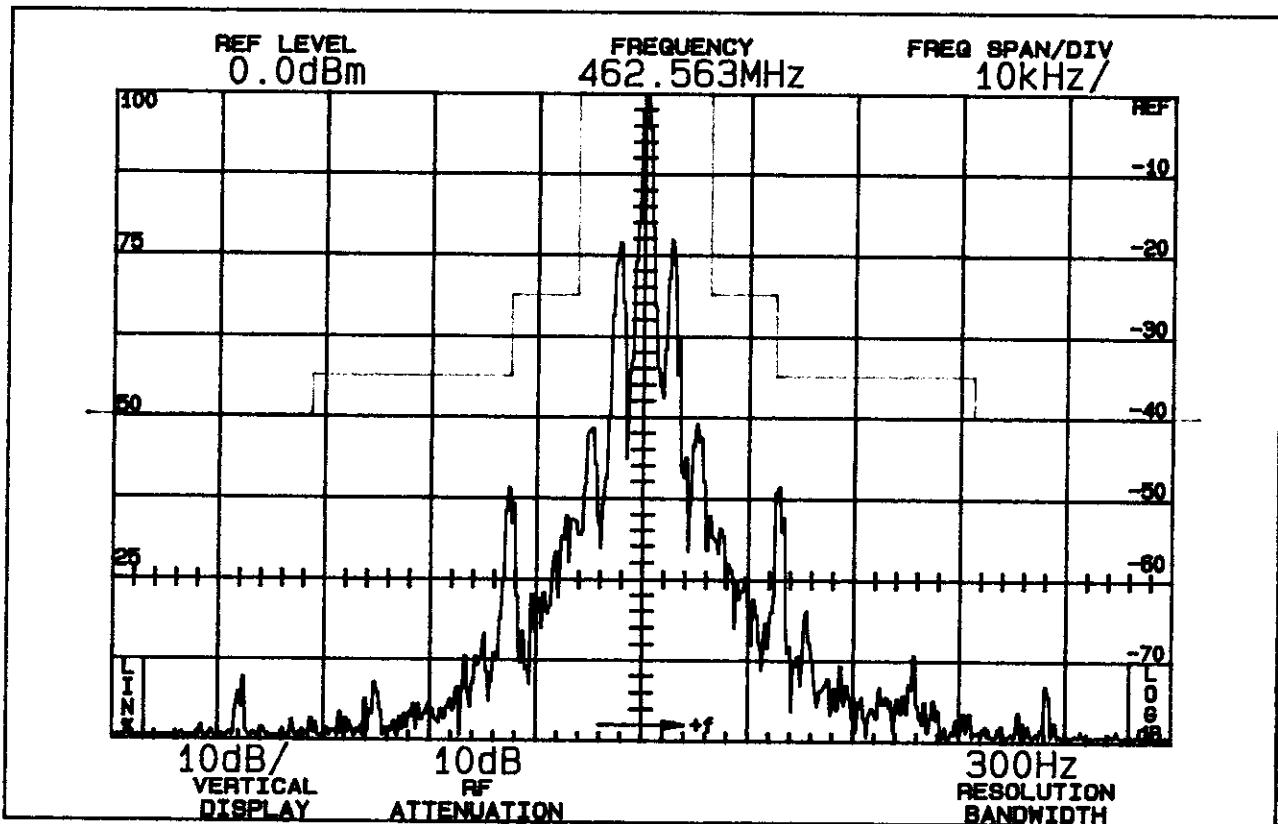
FIGURE 3
AUDIO LOW PASS FILTER RESPONSE



AUDIO LOW PASS FILTER
RESPONSE
FCC ID: MGPFR-460

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) $43 + 10 \log P = 40$
(P = 0.47W)

OCCUPIED BANDWIDTH
FCC ID: MGPFR-460

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 FR-460 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 FRS-465 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 2.

TABLE 2
 TRANSMITTER CABINET RADIATED SPURIOUS
 462.5625 MHz, 4.5 Vdc, 0.470 watts

| Spurious Frequency MHz | Radiated Field uV/m @ 3M | dB Below Carrier Reference ¹ |
|------------------------------|--------------------------------|---|
| 462.563 | 1603245 | 0 |
| 925.126 | 2951 | 55V |
| 1387.689 | 575 | 69V* |
| 1850.252 | 184 | 79V* |
| 2312.814 | 733 | 67V* |
| 2775.377 | 160 | 80V* |
| 3237.940 | 127 | 82H* |
| 3700.503 | 143 | 81H* |
| 4163.066 | 100 | 84H* |
| 4625.629 | 43 | 91V* |

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

¹Worst-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 Calculation:

$$\begin{aligned}
 P &= (FI \times 3)^2 / 49.2 \\
 &= (1.6 \times 3)^2 / 49.2 \\
 &= 0.47 \text{ W}
 \end{aligned}$$

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 $\pm 2^\circ$ 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, 0.470W

| <u>Temperature, °C</u> | <u>Output Frequency, MHz</u> | <u>P.P.M.</u> |
|--------------------------|------------------------------|---------------|
| -19.2 | 462.562328 | -0.4 |
| - 9.7 | 462.562285 | -0.5 |
| 0.4 | 462.562241 | -0.6 |
| 10.1 | 462.562222 | -0.6 |
| 20.4 | 462.562264 | -0.5 |
| 30.4 | 462.562341 | -0.3 |
| 40.2 | 462.562464 | -0.1 |
| 50.1 | 462.562522 | 0.0 |
| Maximum frequency error: | 462.562500 | |
| | <u>462.562222</u> | |
| | - .000278 MHz | |

FCC Rule 95.627(b) specifies .00025% (2.5 ppm) 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 $\pm 15\%$ 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; 0.470W

| <u>Supply Voltage</u> | | <u>Output Frequency, MHz</u> | <u>P.P.M.</u> |
|--------------------------|------|------------------------------|---------------|
| 5.17 | 115% | 462.562221 | -0.6 |
| 4.95 | 110% | 462.562224 | -0.6 |
| 4.73 | 105% | 462.562252 | -0.5 |
| 4.50 | 100% | 462.562264 | -0.5 |
| 4.28 | 95% | 462.562272 | -0.5 |
| 4.05 | 90% | 462.562277 | -0.5 |
| 3.83 | 85% | 462.562278 | -0.5 |
| 3.74* | 83% | 462.562341 | -0.3 |
| Maximum frequency error: | | 462.562500 | |
| | | <u>462.562221</u> | |
| - .000279 MHz | | | |

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

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

*Battery end point.

APPENDIX 3

FUNCTION OF DEVICES
FR-460

ONE (1) PAGE DESCRIPTION OF ACTIVE COMPONENTS
FOLLOWS THIS SHEET

FUNCTION OF DEVICES
FCC ID: MGPFR-460

APPENDIX 3

7. Functional Description of active Components

| Parts Ref | Part Number | Part Description | Functions |
|-----------|--------------------|---------------------|---|
| D101 | MMBV3401LT1 | DIODE, SI, PIN | Antenna Switch Diodes for RX |
| D102 | HSM88ASIL | DIODE SW | Receiver Front End Protection |
| D201 | MMBV3401LT2 | DIODE, SI, PIN | Antenna Switch Diodes for TX |
| D401 | 1SV229T8 | DIODE VARICAP | Tuning Diodes for VCO (Frequency Channel) |
| D402 | MA862-TX | DIODE SW | Switching for VCO for RX Tuning Correction |
| D403 | 1SV229T9 | DIODE VARICAP | Tuning Diodes for VCO (Voice Modulation) |
| D404 | MA862-TX | DIODE SW | Switching for VCO Output for TX/RX |
| D501 | KDS184 | DIODE, SW | Switching - Power Button Operation Sensing |
| D502 | KDS184 | DIODE, SW | Protection - Over voltage protection |
| D503 | KDS184 | DIODE, SW | Switching - Power up reset |
| D504 | KDS184 | DIODE, SW | Protection - Over voltage protection |
| D505 | KDS184 | DIODE, SW | Switching - Bias for Microphone Power Supply |
| D601 | HSM88ASTL | DIODE, SW | RF Detector - Noise detector for squelch control |
| Q101 | BFQ67W-GS08 | TRANSISTOR RF | RF Amplifier - Receiver Front End |
| Q102 | BF998RA(MOR)GS0812 | TRANSISTOR RF | RF Amplifier - MOSFET 1st IF Mixer |
| Q103 | KTC3880SY | TRANSISTOR RF | RF Amplifier - IF Buffer Amp |
| Q201 | MRF9242T1(TE1) | TRANSISTOR RF | RF Amplifier - Transmitter Final Stage Power Amp |
| Q202 | 2SC3356(R25)-TIB | TRANSISTOR RF | RF Amplifier - Transmitter Driver Amp |
| Q203 | 2SC422612(R25) | TRANSISTOR RF | RF Amplifier - Transmitter Driver Amp |
| Q204 | KTC3875SGR | TRANSISTOR RF | Switching - Transmitter Output Power Control |
| Q205 | KRA102S | TRANSISTOR SW | Switching - Transmitter Final Stage Bias Control |
| Q401 | 2SC422612(R25) | TRANSISTOR RF | Oscillator - VCO |
| Q402 | 2SC422612(R25) | TRANSISTOR RF | Oscillator - VCO |
| Q403 | 2SC422612(R25) | TRANSISTOR RF | RF Amplifier - VCO Buffer Amp |
| Q501 | KTA1504SGR | TRANSISTOR SW | Switching - Power Supply ON/OFF Control |
| Q502 | KRC101S | TRANSISTOR SW | Switching - Power Supply ON/OFF Control |
| Q503 | KTA1504SGR | TRANSISTOR SW | Switching - Power Supply ON/OFF Control |
| Q504 | KTA1001-Y | TRANSISTOR SW | Switching - Audio Amplifier Power Supply Control |
| Q505 | KTA1504SGR | TRANSISTOR SW | Switching - Microphone Power Supply & PTT Sense |
| Q506 | KRA105S | TRANSISTOR SW | Switching - Receiver LED Indicator Control |
| Q507 | KRA105S | TRANSISTOR SW | Switching - Transmitter LED Indicator Control |
| Q508 | KRA105S | TRANSISTOR SW | Switching - LCD Panel Backlit Control |
| Q509 | KRA105S | TRANSISTOR SW | Switching - Key/Button Backlit Control |
| Q601 | KTC3875SGR | TRANSISTOR SW | RF Amplifier - Receiver Squelch Circuit BPF |
| Q602 | KRA102S | TRANSISTOR SW | Switching - Transmitter Enable |
| Q603 | KTA1504SGR | TRANSISTOR SW | Switching - Receiver Power Supply Switch |
| Q604 | KTC3875SGR | TRANSISTOR SW | Switching - VCO out of lock signal driver |
| Q605 | KTA1001-Y | TRANSISTOR SW | Switching - Transmitter Power Supply Control |
| U301 | U2781B | IC PLL SYNTH | Phase Lock Loop |
| U501 | 93C66S1-102T2.7 | IC MEMORY EEPROM | EEPROM to hold operational data |
| U502 | XC62SPR302MR | IC LINEAR REGULATOR | +3VDC Regulator |
| U503 | NJM2073M | IC LINEAR AMP | Audio Power Amplifier |
| U504 | LM2902D | IC LINEAR OP AMP | Filter Amplifier |
| U505 | FX828DS | IC ASP | Signaling Generator with volume control |
| U506 | UPD75P3018AKG-BE9 | IC CPU OTP | One Time Programmable CPU |
| U601 | MC3361BD | IC IF DETECTOR | IF Amplifier with FM Detector and Squelch Control |
| U602 | XC62SPR302MR | IC LINEAR REGULATOR | +3VDC Regulator |
| X301 | 5609A-ANT | OSC 12.8MHz | Temperature Controlled Crystal Oscillator (TCXO) |