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).

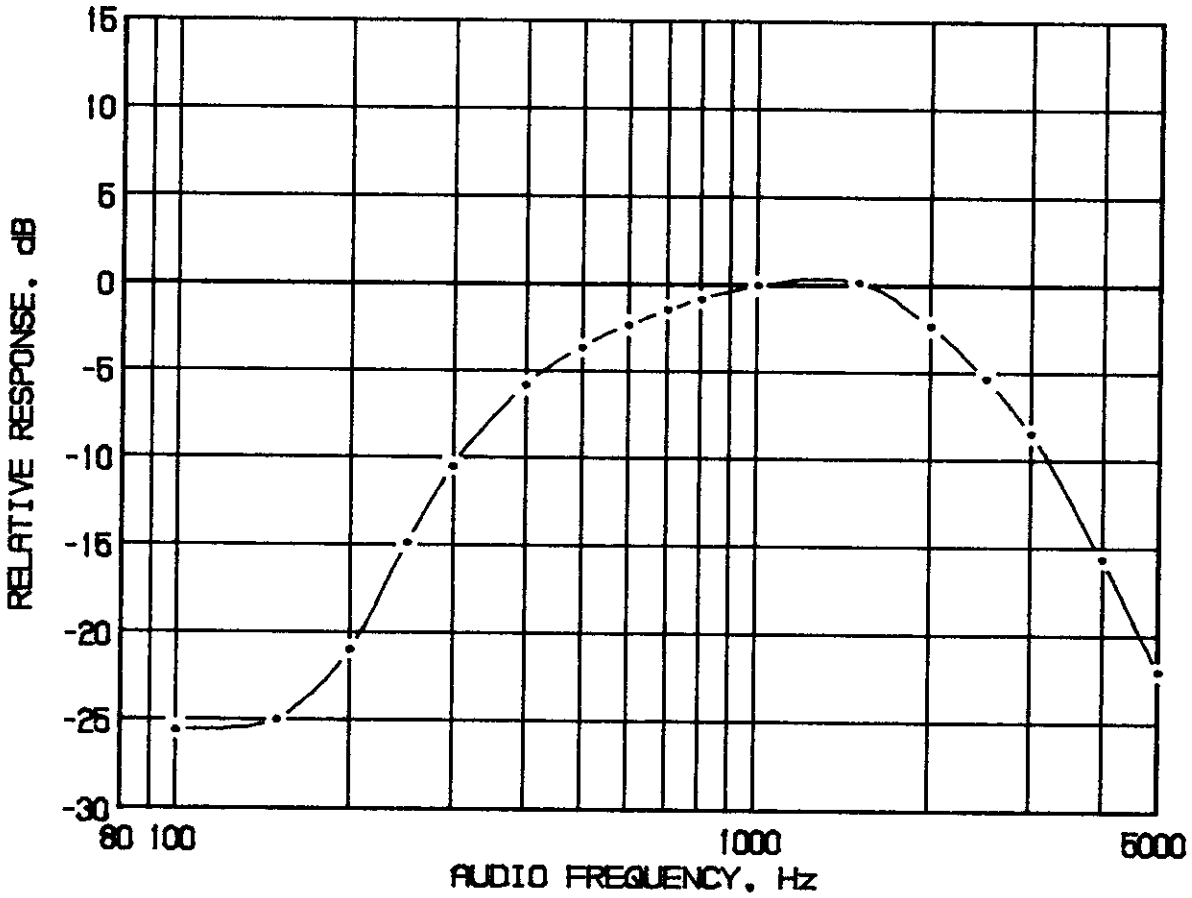
3. Figure 3 is a graph of the post-limiter low pass filter which provides a roll-off of 60Logf/3 dB where f is audio frequency in kHz. Measurements were made following EIA RS-152B with an Audio Precision System One integrated test system on the Boonton 8220 modulation meter audio output.

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

FIGURE 1

MODULATION FREQUENCY RESPONSE

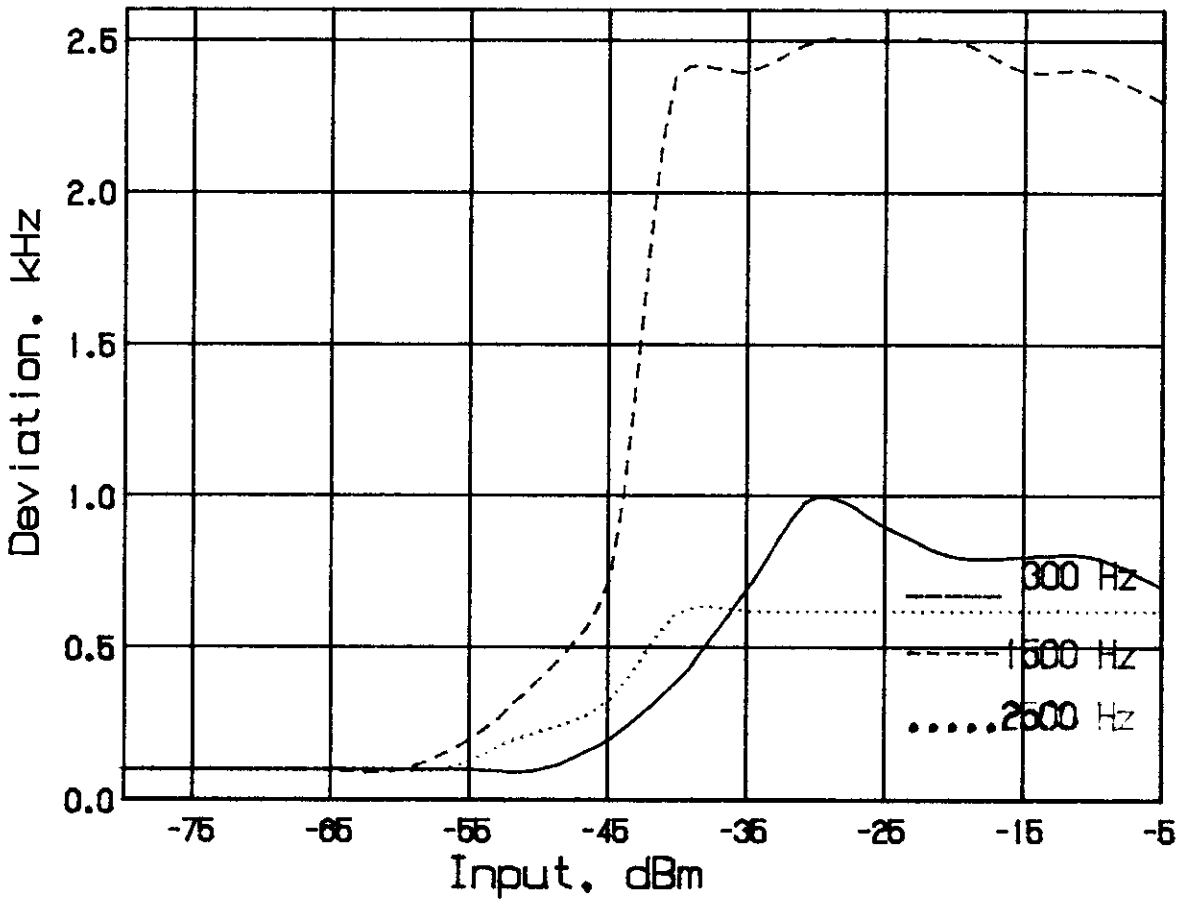


MODULATION FREQUENCY RESPONSE
FCC ID: MGPFR-460

FIGURE 1

FIGURE 2

AUDIO LIMITER CHARACTERISTICS

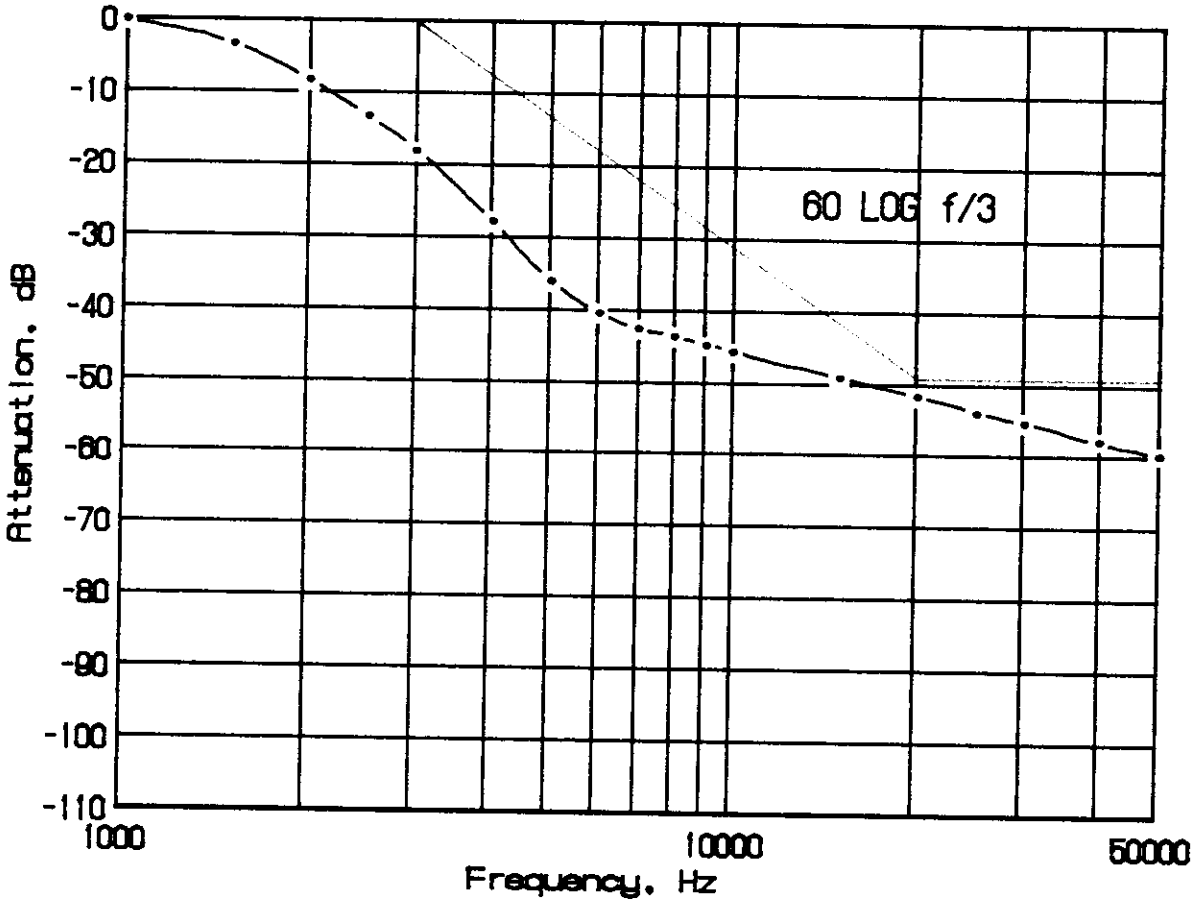


AUDIO LIMITER CHARACTERISTICS
FCC ID: MGPFR-460

FIGURE 2

FIGURE 3

AUDIO LOW PASS FILTER RESPONSE

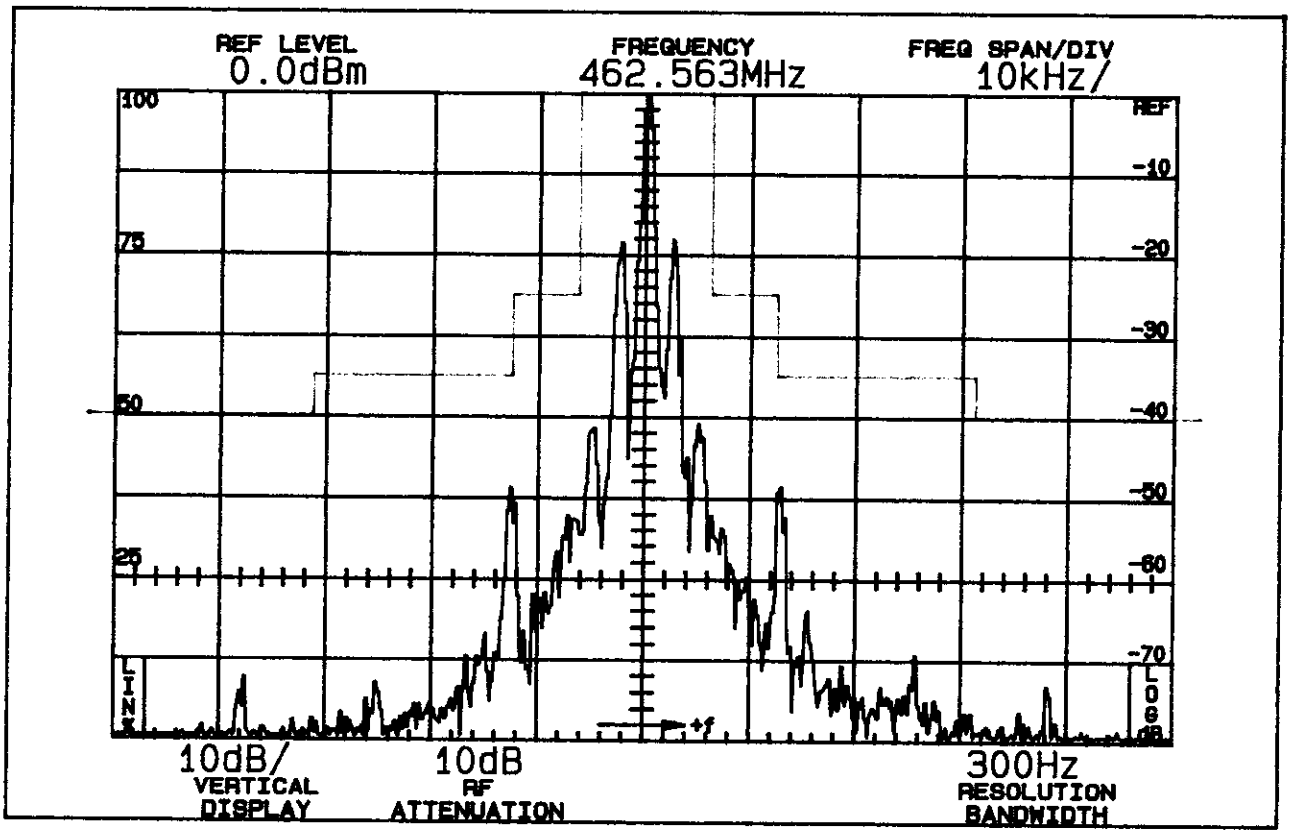


AUDIO LOW PASS FILTER
RESPONSE
FCC ID: MGPFR-460

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+10LogP = 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*

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 Calculation:

$$P = (FI*3)^2/49.2$$

$$= (1.6x3)^2/49.2$$

$$= 0.47 \text{ W}$$

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 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

Temperature, °C	Output Frequency, MHz	P.P.M.
-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
462.562222

- .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 ±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

Supply Voltage		Output Frequency, MHz	P.P.M.
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
462.562221

- .000279 MHz

FCC Rule 95.627(b) specifies .00025% (2.5 ppm) or a maximum of ± 0.001156MHz, 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

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)