ECOM-220

VHF-FM TRANSCEIVER

MAINTENANCE MANUAL

LIMITED

WARRANTY

General Aviation Electronics, Inc. (Genave) warrants this product to be free from material defects for a period of 90 days from the date of purchase, provided the warranty registration card properly filled out is returned by the purchaser to Genave within 10 days after purchase. This warranty is limited to the original retail purchaser and is not extended to second owners of the product.

Our obligation under this warranty is limited to replacement of any parts, except periodic maintenance items such as belts, fuses, etc.) which, upon our examination, appear to us to be defective in materials or workmanship. The parts will be replaced within 45 days after receipt of the unit, provided the unit is delivered to the Factory (Customer Service Dept., General Aviation Electronics, 4141 Kingman Drive, Indianapolis, Indiana 46226) within 90 days after the date of purchase, shipping prepaid. All shipping costs and labor charges shall be borne by the purchaser.

The owner may elect to have the unit serviced at any authorized Genave repair facility in which case Genave, within 45 days after receipt of the unit, will reimburse such shop therefor for parts returned shipping prepaid to the Factory (Customer Service Dept., General Aviation Electronics, 4141 Kingman Drive, Indianapolis, Indiana 46226). Purchaser shall bear time and all other costs including but not limited to labor, transportation and freight.

This warranty does not apply to defects, malfunction or breakage due to improper installation or to the servicing thereof by other than an authorized Genave dealer nor to units that have been damaged by lightning or other acts of God, excess current, or any units that have had serial number altered or removed. Abuse, misuse, tampering, submersion in water or willful destruction of the unit will also void this warranty.

This warranty gives you specific legal rights. You also have implied warranty rights. In the event of a problem with warranty service or performance, you may be able to go to a small claims court, a State court, or a Federal District court.

Genave offers this warranty in lieu of any and all other guarantees or warranties, either EXPRESSED or IMPLIED, including but not limited to warranties of merchantibility and/or fitness for a particular purpose. Any implied warranties are specifically and expressly limited to the 90-day period specified herein. Damages for breach of any warranties, either expressed or implied are limited to replacement of any defective parts as specified herein and any other incidental or consequential damages are expressly excluded.

General Aviation Electronics, 4141 Kingman Drive, Indianapolis, Indiana 46226 – Area 317 - 546-1111

4141 Kingman Drive, Indianapolis, Indiana 46226

AREA (317) 546-1111

Specifications subject to change without notice

Printed in U.S.A. Oct. 1977 (Rev. 1-23-80)

Tech. Pub. No. 0540052B

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SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION

This manual contains all the information normally required to license, install, and operate the Genave ECOM-220 VHF-FM transceiver.

The maintenance manual contains all the above information, in addition to unit schematics, alignment data, and parts lists.

1-2. DESCRIPTION

The ECOM-220 is designed to provide reliable, high-quality communications for various business radio services, such as: Public Safety, Industrial Radio, and Land Transportation. The radio was under strict quality control during its fabrication, and was thoroughly checked prior to shipment from the factory. It will provide many years of satisfactory operation, if given reasonable care and handling.

The ECOM-220 is a solid-state, VHF-FM transceiver designed for the transmission and reception of frequency modulated (16F3) radio signals on either of two possible channels within the VHF range from 143.9 to 173.4 MHz. Either frequency can be selected by use of a front-panel, two-position rotary switch.

The unit is complete with an attached hand microphone and internally-mounted speaker. All circuitry employed is the latest state-of-the-art design, using the latest in semiconductor and integrated circuit technology -- including a solid - state T/R switching circuit.

A 15-pin male plug mounted on rear panel of the ECOM-220 transceiver is designated as an "Accessory Connector," and mates with a 15-pin female connector to provide a convenient method of connecting power or optional accessories to the unit. Standard wiring of the accessory connector utilizes only five pins, leaving the remainder available for options or customized installation. See Section 2-10.

The transmitter RF output is typically 20 watts from 143.9 MHz to 160.0 MHz, and 15 watts minimum from 160.0 MHz to 173.4 MHz. The output impedance is 50-ohms using a standard UHF-type connector (83-1SP or PL259). An improved heat sink provides increased transmit-power stability.

The receiver is a crystal-controlled, dual-conversion superheterodyne employing a 4-pole monolithic crystal filter for good selectivity. A single integrated circuit performs limiting and detection functions. The 10.7 MHz 1st IF provides good image rejection, while the 455 kHz 2nd IF improves receiver stability.

The ECOM-220 transceiver is designed to operate on +13.75 volts DC primary power. The Genave PSI-10 power supply can be utilized when it is desired to operate the instrument from a 117 volt, 50-60 Hz source. For mobile operation, the source may be a battery or the vehicle electrical system (negative ground).

An easily-removed, two - piece plastic case protects the instrument from dirt and physical damage.

Provisions are made within each transceiver for the addition of an optional SA-1 Subaudible Tone Encoder-Decoder. This subaudible-tone system keeps the receiver squelched until a signal containing the proper subaudible, continuous tone is received. The SA-1 board generates the subaudible tone used to modulate the transmitter to activate the receivers in the system, and also decodes incoming signals. Note that all operating channels installed in the ECOM-220 must utilize the same tone

frequency -- there are no provisions for omitting (or changing) subaudible tone on one channel only. A ceramic resonator on the SA-1 printed-circuit board determines the frequency of subaudible tone being used.

NOTE: If subaudible-tone system is used, the carrier is automatically modulated by the subaudible tone during entire time that transmission is taking place. Also, the operating frequency must be monitored to ascertain that it is NOT in use prior to originating a call. This monitoring is accomplished automatically by removing the microphone from its hang-up bracket.

1-3. SPECIFICATIONS

GENERAL:

Front-Panel Size:	2-9/16" (6.50 cm) x 8-3/16" (20.79 cm)
Over-all Dimensions:	2-9/16" (6.50 cm) x 8-3/16" (20.79 cm) x 12-1/8" (30.79 cm)
Power Supply:	13.75 VDC, negative ground; min. 11.5V
Current Drain:	6.5 amps max. xmit; 0.2 amps receive
Frequency Range (MHz):	143.9 to 173.4; two-chan. separation 60 kHz min. and 1 MHz max.
Number of Channels:	Two
Temperature Range:	-30° to +60°C
Weight:	Approx. 5 lbs. (2.27 kg)

RECEIVER:

Sensitivity:	0.35 µV max. for 12 db SINAD - less than 0.55 µV for 20 dB quieting
Selectivity:	±7.5 kHz
Squelch Threshold:	Less than 0.35 µV
Modulation Acceptance Bandwidth:	More than 5 kHz
Adjacent Channel Rejection:	40 dB min. @ ±25 kHz (EIA); 55 dB for 20 dB quieting
Intermodulation Response:	60 dB minimum (EIA)
Image Response:	60 dB minimum (EIA)
Spurious Response:	60 dB minimum (EIA)
Audio Output Power:	5 watts; 4 watts at 15% distortion
Hum & Noise Level:	Better than 35 dB below rated output
Frequency Accuracy:	±500 Hz
Frequency Stability:	±.001%

TRANSMITTER:

Power Output:	20 watts, typical; 143.9 to 160.0 MHz 20 watts minimum; 160.0 to 173.4 MHz 15 watts minimum
Frequency Range (MHz):	143.9 to 173.4
Output Impedance:	50-ohms
Deviation:	4 kHz minimum; 5 kHz maximum
Frequency Accuracy:	±200 Hz Subaudible deviation, 1 kHz ±200 Hz Subaudible freq. tolerance, ±0.3 Hz
Frequency Stability:	.0005%
Transmitter Spurious:	-56 dB minimum

SECTION II

INSTALLATION MANUAL

2-1. INTRODUCTION

This section provides installation data and recommendations for fixed, mobile, or portable operation of the ECOM-220 VHF transceiver. For complete technical specifications of the unit, refer to Section 1-3 (Specifications) in this manual.

2-2. EQUIPMENT SUPPLIED

a. ECOM-220 Communications Transceiver with hand microphone and hang-up mounting clip.

b. Mounting Bracket with thumbscrews and washers.

c. Accessory Connector, 15-pin female.

2-3. EQUIPMENT REQUIRED, BUT NOT SUPPLIED

a. Vehicle or Base Antenna, 50 - ohm
b. Antenna Cable, RG-8A/U or RG-58A, as required.
c. Co-axial Connector, PL-259 (83-1SP)
d. Cabling for Power and Audio wiring, as required.

2-4. OPTIONAL EQUIPMENT AVAILABLE

a. SA-1 Subaudible-Tone PC board.
b. Remote Speakers, SP-5 or SP-6.
c. PSI-10, AC Power Supply.

2-5. PRE-INSTALLATION CHECK

Visually inspect the unit for any obvious external damage - such as broken knobs, dents, damaged mic or radio case. Any damage NOT related to shipping must be reported to General Aviation Electronics, Inc., 4141 Kingman Drive, Indianapolis, Ind., (46226), Telephone (317) 546-1111, as soon as possible.

If the packing case shows damage, make a notation to that effect on the express receipt or freight bill. Report to the transportation company any damage due to shipping, and file a claim promptly.

2-6. INSTALLATION PLANNING

The unit has been pre-aligned at the factory on transmit and receive frequencies listed on tag attached to the unit. If it should be necessary to change the transmit or receive frequency, alignment procedures contained in the ECOM-220 maintenance manual should be performed by an authorized technician, using proper test equipment; however, if new frequency differs from the factory-alignment frequency by not more than one half of maximum channel separation as listed in the Specifications (normally 1 MHz,) it will only be necessary to install and net the new crystals.

If ECOM-220 is equipped with optional SA-1 (Subaudible-Tone Squelch System), the subaudible-tone frequency will be listed on tag attached to the unit, and also on a label affixed to the inside of transceiver. If it should be necessary to readjust subaudible-tone frequency from factory-set value, refer to "Tone-Frequency Adjustment" procedure in this manual.

Before starting transceiver installation, determine desired mounting method and location; ascertain that required AC or DC power is available; determine location for antenna installation and routing of co-ax cable to transceiver.

NOTE: In choosing an operating location for the instrument, remember that F.C.C. Rules require that: "Each transmitter shall be so installed and protected that it is not accessible to or capable of operation by persons other than those duly authorized by the licensee," and, that "The operating position must be under the control and supervision of the licensee."

The transceiver may be mounted in any convenient position; unit performance is not affected by the mounting position. However, the unit should NOT be

mounted directly above a hot-air register or radiator.

2-7. FIXED OR MOBILE INSTALLATION

1. Refer to Figure 2-1. If mounting yoke has been installed on transceiver, remove yoke temporarily. For fixed operation, yoke may be repositioned on bottom side of unit to function as a supporting stand. For either fixed or mobile operation, the yoke may be secured in the desired location (under dash or shelf, on console or desk top, or overhead, etc.) with appropriate screws or bolts through two holes provided in the mounting yoke.

2. Connect color-coded power leads, terminated in the rear-panel 15-pin connector, to a power source. For fixed operation, the source may be a well - regulated, low-ripple AC power supply, such as the Genave Model PSI-10. For mobile operation, the source may be a battery or the vehicle's electrical system. This transceiver is designed to operate ONLY on a supply with neg. ground. Be SURE to connect RED power lead to +13.75 volts, and BLACK lead to -13.75 volts (ground). If it is necessary to extend power leads, use #14 or heavier gauge insulated copper wire.

   If supply polarity is reversed accidentally, the unit will be inoperative. In this event, check wiring polarity (RED to positive, and BLACK to negative), and check the protective fuse located on transceiver circuit board just below the rear-panel power connector. A blown fuse should be replaced ONLY with a type 3AG 7 amp fuse.

3. The ECOM-220 transceiver is equipped with an attached hand microphone; the microphone-mounting clip is attached to the desired mounting surface, using two small screws or bolts.

NOTE: If the SA-1 subaudible- tone option is included in transceiver, then mounting clip MUST be electrically connected to chassis ground of the transceiver in order to provide "hang-up" receiver squelching.

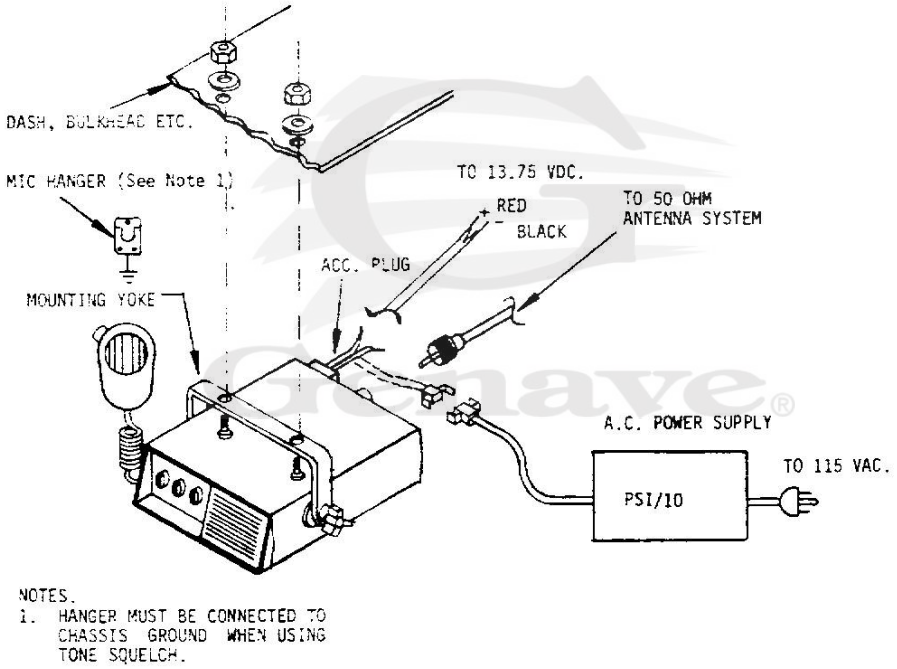


Figure 2-1. Typical Installation.

4. After any optional or custom wiring has been completed, replace transceiver in mounting yoke, and tighten both thumbscrews.

5. Connect 15-pin female receptacle to mating rear-panel plug. Secure the connecting wires at appropriate points.

6. Install co-axial connector on antenna cable as shown in Figure 2-2, and insert antenna connector into rear-panel mounted antenna receptacle.

NOTE: The transceiver is designed to match standard 50-ohm VHF communications antennas. In the interest of maximum efficiency, the antenna system should exhibit a low VSWR.

2-8. RESERVED

2-9. ANTENNA CONSIDERATIONS

Communications within the VHF-FM band are "line-of-sight;" thus, the higher the antenna is placed, the greater the operating distance. When considering characteristics of an antenna system, it is important to know that an antenna which provides good, effective transmitting gain will also provide the same relative gain when receiving.

In mobile installations, the antenna should be securely fastened to the vehicle, as far from the engine compartment as practicable, and all connections should be tight and weatherproof. Ideally, the antenna should be installed over a perfectly flat ground surface to assure omnidirectional radiation; therefore, the center of the auto roof is the best place to mount the VHF vertical antenna. The flat portion of the rear trunk deck can be used, but will result in a directional pattern.

For maximum efficiency, the antenna should be fed with low-loss 50-ohm co-axial cable. The loss per 100 feet at 144 MHz is shown in Table 2-1 for several popular types of co-ax cable:

Table 2-1.

Cable Type	Impedance	dB Loss
RG58/A-AU	53-ohms	5.7 dB
RG58 Foam	50-ohms	4.1 dB
RG8/A-AU	52-ohms	2.5 dB
RG8 Foam	50-ohms	2.2 dB

2-9-1. Antenna Connector Assembly

The procedure for installing a PL-259 (83-1SP) antenna connector is dependent upon type co-axial cable used - the PL-259 is installed directly on 0.405" OD cable such as RG8/A, whereas, the plug requires an adapter when used with the 0.195" OD cable such as RG58/A. The procedures for both cable types are given below, and shown in Figure 2-2.

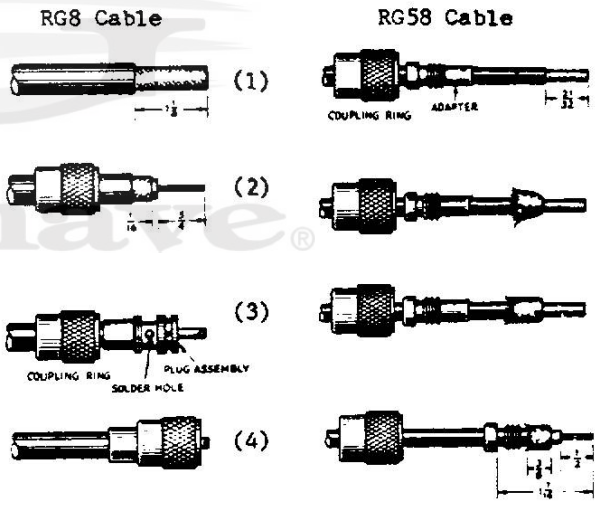


Figure 2-2. Connector Assembly

2-9-2. RG8 Cable Procedure

1. Trim end of cable flush, remove vinyl jacket from 1-1/8" of cable as shown in Figure 2-2(1). Do NOT nick braid.

2. Bare 3/4" of center conductor. Trim braided shield 1/16" and tin. Slide coupling ring on cable. See 2-2 (2) above.

3. Screw plug assembly on cable; solder plug assembly to braid through solder holes; solder center conductor to plug assembly center pin.

4. Screw coupling ring on assembly.

2-9-3. RG58 Cable Procedure

1. Trim end of cable flush; remove vinyl jacket from 21/32" of cable as shown in Figure 2-2 (1). Do NOT nick braid. Slide coupling ring and adapter on cable.

2. Fan braid slightly and fold back over cable. See Figure 2-2 (2).

3. Compress braid around cable, Figure 2-2 (3), and position adapter to dimension given in Figure 2-2 (4). Press braid over adapter sleeve and trim to dimension shown.

4. Bare 1/2" of center conductor as shown -- do NOT nick the conductor. Pre-tin exposed center conductor.

5. Screw plug assembly onto adapter sleeve, and solder the braid to plug assembly through solder holes. Next, solder center conductor to plug assembly center pin.

6. Screw coupling ring on plug assembly.

2-10. ACCESSORY CONNECTOR - P101

The 15-pin male plug mounted on rear panel of the ECOM-220 transceiver is designated as an "Accessory Connector," and mates with a 15-pin female connector to provide a convenient method of connecting power or optional accessories to the unit. Standard wiring of the accessory connector utilizes only five pins; therefore, ten of the pins are available for options or customized installation. Figure 2-3 illustrates standard wiring of the accessory connector, and the recommended connections for use with an external speaker.

NOTE: An external speaker (3.2-ohm) can be connected to pins 2 and 7 of the female connector or, a jumper can be connected between pins 2 and 10 to activate the internal speaker. Another suggestion is to use a SPDT switch to select either the internal or the external speaker at will.

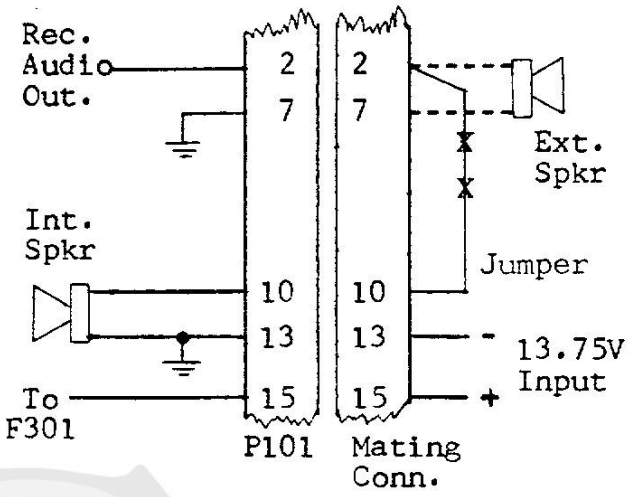


Figure 2-3. Accessory Connector

2-11. REMOVING INSTRUMENT TOP COVER

To gain access to the interior of unit remove plastic top cover by removing two 6/32 screws which secure rear of top cover to heatsink. Then, lift rear

of cover upward while sliding cover toward rear of instrument.

NOTE: If thumbscrews have not been removed from sides of transceiver, they must be loosened a few turns before attempting to remove unit covers.

2-12. TONE-FREQUENCY ADJUSTMENT

The SA-1 tone-squelch board is located at left-center of main PC board. If it is necessary to change tone frequency from the factory-set value, proceed as follows:

1. With top cover removed from transceiver, locate the Ceramic Resonator on subaudible - tone PC board. This Resonator determines the tone frequency; therefore, a different Resonator is required for each discrete subaudible - tone frequency.

2. Remove SA-1 subaudible-tone board from the transceiver by lifting the board up and off mating pins. Unsolder and remove Ceramic Resonator.

3. If subaudible-tone frequency is between 67 and 136.5 Hz, connect pin 8 of IC102 to pin 14 of IC101; but, if frequency is between 141.3 and 250.3 Hz, connect pin 8 of IC102 to pin 6 of IC101. Refer to Figure 2-4.

4. Solder new Resonator leads in place and carefully replace tone board in transceiver. Connect transceiver to its power source.

5. If another unit with the correct subaudible-tone frequency is available, it may be used for on-the-air testing; otherwise, set a signal generator to a 10 µV level on the appropriate operating frequency with ±1 kHz deviation at the desired subaudible - tone frequency.

6. With test signal applied to receiver, note that receiver unsquelches and operates normally.

7. The transmitter subaudible deviation should be checked. The deviation should be 1 kHz ±200 Hz.

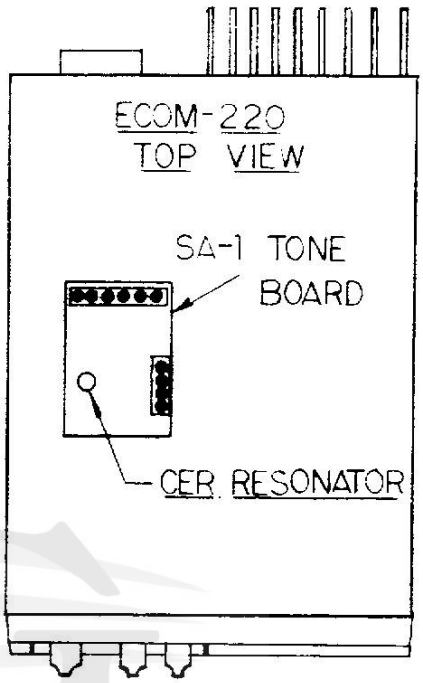
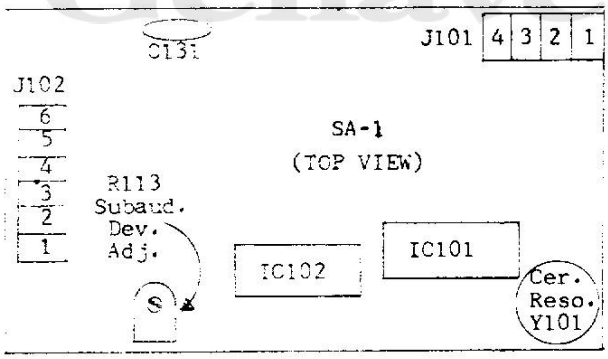
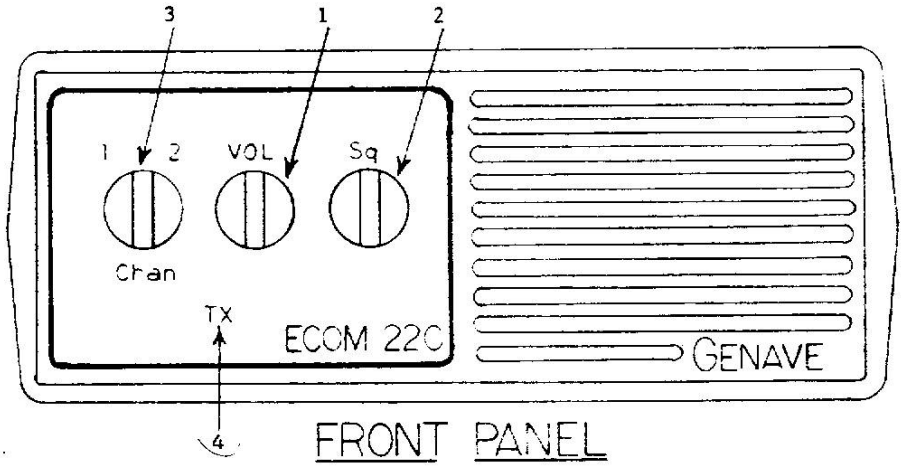


Figure 2-4. SA-1 Tone Board



SECTION III

OPERATING MANUAL



FRONT PANEL

3-1. OPERATING CONTROLS

For reliability and operating convenience, only essential operating controls are installed on the unit's front panel. The functions of these controls are as follows:

1. Volume control/On-Off switch
2. Squelch control
3. Channel-Selector switch
4. Transmit-Indicator lamp

The push-to-talk button on the microphone also functions as an operating control. Unit operation is quite simple, as explained below:

3-2. OPERATING INSTRUCTIONS

1. Turn VOLUME (#1) and SQUELCH (#2) controls fully counterclockwise.

2. Rotate CHANNEL SELECTOR (3) to desired operating frequency.

3. Rotate VOLUME control clockwise until switch clicks; this turns ON transceiver.

4. If transceiver is equipped with the SA-1 subaudible-tone option, it is necessary to deactivate tone-controlled squelch by removing microphone from its hanger. This breaks the "tone-enable" ground, and disables tone-squelch system.

5. Now, rotate VOLUME control clockwise to adjust receiver volume to desired level.

6. Turn SQUELCH control clockwise until background noise just disappears. NOTE: Do NOT attempt to adjust SQUELCH control if a signal is being received.

7. To transmit, depress microphone pushbutton. If unit is equipped with subaudible-tone system, it is important to monitor channel before transmitting to insure that it is clear. The hand microphone circuitry is designed in such manner that receiver squelching is deactivated when microphone is removed from its hanger

8. The TRANSMIT-INDICATOR lamp (#4) will illuminate when transmitter is operating; then, hold microphone 3 to 6 inches from your mouth, and talk in a normal voice.

9. Release TRANSMIT pushbutton to listen.

NOTE: The squelch circuit, which is adjusted by front-panel control, quiets receiver in the absence of an incoming signal on the assigned operating frequency; however, any station in your vicinity, operating on this frequency, will be heard. With the tone-squelch system, however, only transmitted signals carrying the proper subaudible tone are heard, as explained previously.

3-3. LICENSING INFORMATION

Licensing requirements vary with the service for which this unit will be used; however, all services require the station transmitter to be licensed. Further, all transmitter adjustments or tests during or coincident with the installation, servicing, or maintenance of a radio station, which may affect the proper operation of such station, shall be made by or under the immediate supervision and responsibility of a person holding a first- or second-class commercial radio operator license, either radiotelephone or radiotelegraph, who shall be responsible for the proper functioning of the station equipment. Note, however, that in many services an unlicensed person, after having been authorized to do so by the station licensee, may operate from a control point a mobile, base, or fixed station or from a dispatch point a base or fixed station, during the course of normal rendition of service. The minimum class of operator authorization required for each specific classification of station is set forth in the appropriate F.C.C. rule part.

The following technical information is intended to aid ECOM-220 users in completing the application for radio station authorization. Only technical data pertaining to the transceiver are shown below; all other station particulars must be furnished by the licensee.

Transmitter Input Power:	45 watts
Transmitter Output Power:	20 watts
Type of Unit:	Transceiver
Type Acceptance/Model No:	T-7043200
Frequency Range (MHz);	143.9 to 173.4
Frequency Tolerance:	.0005%
Emission:	16F3
Approved under Rule Part Numbers:	21, 74, 81, 87, 89, 91, and 93

For additional information on filling out the appropriate application forms, consult the F.C.C. instruction sheet provided with that form. Note that some forms may be completed either by PRINTING IN INK, or by TYPING; whereas, TYPING is MANDATORY for certain F.C.C. Application forms. Two of the more common forms used to apply for a license for the ECOM-220 transceiver are F.C.C. forms 400 or 425, depending upon the usage and/or geographic location of the proposed station. To determine which form is required, contact nearest FCC Field Engineering Office as listed below -- they will also supply the appropriate forms.

The procedures for obtaining necessary licenses are found in the Federal Communications Commission Rules and Regulations. The services and the corresponding F.C.C. rule part numbers, under which the ECOM-220 can be used, are as follows:

Any of these volumes may be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Domestic Public Radio Services (Other than Maritime Mobile)
- F.C.C. Rules & Regulations, Volume VII, Part 21
  - Domestic Public Land Mobile Radio Service
  - Rural Radio Service

Experimental, Auxiliary, and Special Broadcast,
- F.C.C. Rules & Regulations, Volume III, Part 74
  - Remote Pickup Stations

Stations on Land in the Maritime Services
- F.C.C. Rules & Regulations, Volume IV, Part 81
  - Public Coast Stations
  - Marine Utility Stations
  - Fixed Stations Associated with the Maritime Mobile Service
  - Stations Operated in the Land Mobile Service for Maritime Purposes

Aviation Services
- F.C.C. Rules & Regulations, Volume V, Part 87
  - Civil Air Patrol Stations

Public Safety Radio Services
- F.C.C. Rules & Regulations, Volume V, Part 89
  - Local Government Radio Service
  - Police Radio Service
  - Fire Radio Service
  - Highway Maintenance Radio Service
  - Forestry-Conservation Radio Service
  - Special Emergency Radio Service

Industrial Radio Services
- F.C.C. Rules & Regulations, Volume V, Part 91
  - Power Radio Service
  - Petroleum Radio Service
  - Forest Products Radio Service
  - Motion Picture Radio Service
  - Relay Press Radio Service
  - Special Industrial Radio Service
  - Business Radio Service
  - Manufacturers Radio Service
  - Telephone Maintenance Radio Service

Land Transportation Radio Services
- F.C.C. Rules & Regulations, Volume V, Part 93
  - Motor Carrier Radio Service
  - Railroad Radio Service
  - Taxicab Radio Service
  - Automobile Emergency Radio Service

3-3-2. F.C.C. Field Engineering Offices

ALASKA, ANCHORAGE 99510
G-63 U.S.P.O. and Courthouse Bldg.
Box 644, 4th and F Streets

CALIFORNIA, LONG BEACH
Room 501
3711 Long Beach Blvd.

CALIFORNIA, SAN DIEGO 92101
Fox Theatre Bldg.
1245 7th Ave.

CALIFORNIA, SAN FRANCISCO 94111
323-A Customhouse
555 Battery St.

COLORADO, DENVER 80202
Suite 2925, The Executive Tower
1405 Curtis St.

DISTRICT OF COLUMBIA, WASHINGTON 20554
Room 411
1919 M St. NW.

FLORIDA, MIAMI 33130
Room 919
51 Southwest 1st Ave.

FLORIDA, TAMPA 33602
809 Barnett Office Bldg.
1000 Ashley Dr.

GEORGIA, ATLANTA 30309
440 Massell Bldg.
1365 Peachtree St. NE.

HAWAII, HONOLULU 96808
502 Federal Bldg.
Box 1021, 355 Merchant St.

ILLINOIS, CHICAGO 60604
3935 New Federal Bldg.
230 South Dearborn St.

LOUISIANA, NEW ORLEANS 70130
829 F. Edward Hebert Federal Bldg.
600 South St.

MARYLAND, BALTIMORE 21201
819 Federal Bldg.
31 Hopkins Plaza.

MASSACHUSETTS, BOSTON 02109
1600 Customhouse
165 State St.

MICHIGAN, DETROIT 48226
1054 Federal Bldg.
231 West LaFayette St.

MINNESOTA, ST. PAUL 55101
691 Federal Bldg. and U.S. Courthouse
316 North Robert St.

MISSOURI, KANSAS CITY 64106
1703 Federal Bldg.
601 East 12th St.

NEW YORK, BUFFALO 14202
1307 Federal Bldg.
111 West Huron St.

NEW YORK, NEW YORK 10014
201 Varick St.

OHIO, CINCINNATI 45231
8620 Winton Road

OREGON, PORTLAND 97204
1782 Federal Office Bldg.
1220 Southwest 3d Ave.

PENNSYLVANIA, PHILADELPHIA 19106
James A. Byrne Federal Courthouse
601 Market St.

PENNSYLVANIA, MONROEVILLE 15146
(Pittsburgh Area)
William Penn Highway

PUERTO RICO, HATO REY 00918
747 Federal Bldg.

TEXAS, DALLAS 75242
13E7 Earle Cabell Federal Bldg.
1100 Commerce St.

TEXAS, HOUSTON 77002
5636 New Federal Office Bldg.
515 Rusk Ave.

VIRGINIA, NORFOLK 23502
Military Circle
870 North Military Highway

WASHINGTON, SEATTLE 98174
3256 Federal Bldg.
915 2d Ave.

SECTION IV
MAINTENANCE MANUAL

4-1. INTRODUCTION

This Section of the maintenance manual contains theory of operation, alignment data, and schematics. Lists of replacement parts are given in Section 5 of this manual.

The Genave Model ECOM-220 transceiver is a VHF-FM unit designed to transmit and receive 16F3 emissions in the various land-mobile or business-radio services between 143.9 and 173.4 MHz. The instrument supplies a typical RF power output of 20 watts on either of two possible channels.

Basically, the receiver is a dual conversion superheterodyne employing a 4-pole monolithic crystal filter. A single integrated circuit performs the limiting and detection functions.

In conjunction with the following circuit description, refer to the appropriate transceiver main board schematic and the block diagram of Figure 4-1.

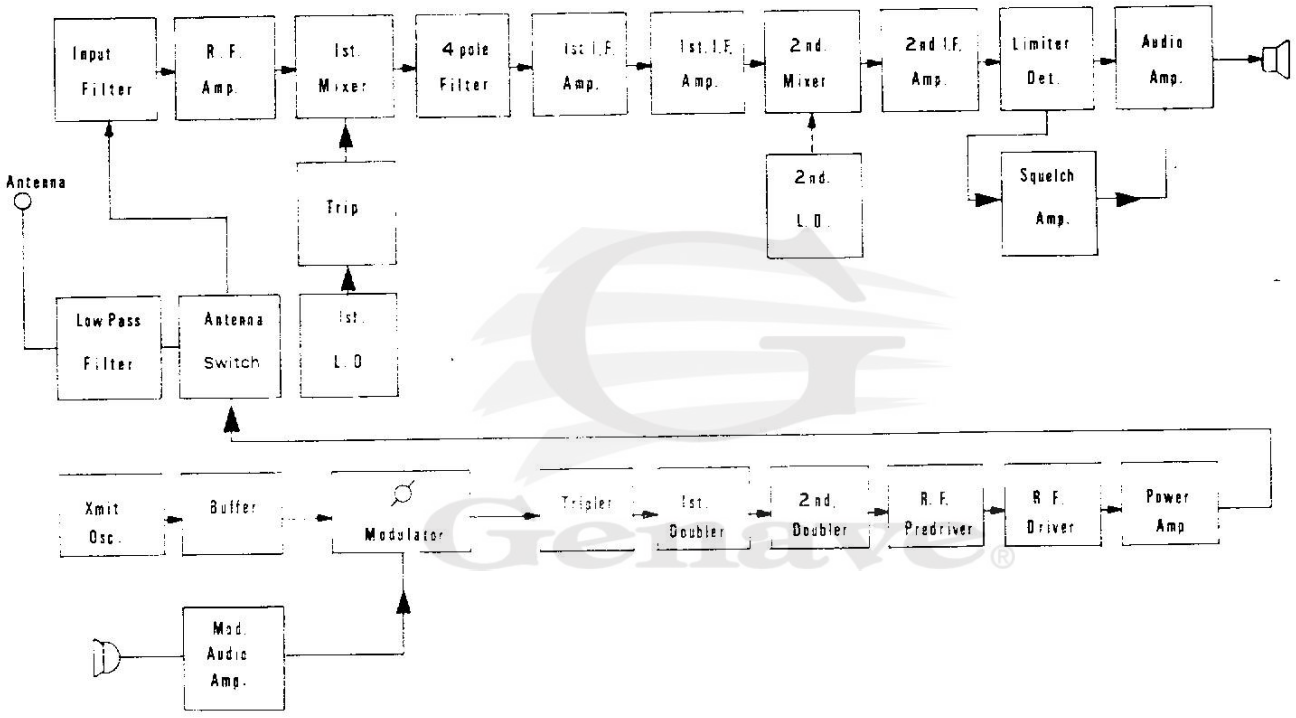


Figure 4-1. Block Diagram

4-2. THEORY OF OPERATION - RECEIVER

4-2-1. Low-Pass Filter

From antenna connector J301, the received signal is applied to a low-pass filter comprised of C387, L315, and C-386. In the "receive" mode, after the incoming signal leaves the low-pass filter, C446 and C447 feed the signal to the receiver input filter.

NOTE: The low-pass filter is utilized to filter both the received and the transmitted signals.

4-2-2. T/R Antenna Switch

The solid-state Transmit/Receive antenna switching circuit consists of a 1/4 wave lumped-constant line (C446, C447, and L316), CR308, C448, R348, and R-349.

A short applied to the far end of a quarter-wave line reflects high-impedance at the open end, while an open circuit at far end of line reflects a low-impedance (short) at the other end of quarter-wave line.

In transmit mode, the mic. PTT switch grounds CR308's cathode, thereby forward biasing diode, and applying a low-impedance (short) to end of quarter-wave line. Thus, an "open" circuit is reflected to input side of line effectively opening receiver input connection, and preventing full transmitter power from being applied to receiver.

In receive mode, R348 and R349 apply approx. 11 volts to CR308's anode. Now, with PTT switch open, 13 volts is applied to cathode of CR308. Thus, diode is back-biased and applies a high impedance to quarter-wave line; therefore a low-impedance is reflected to input side of line -- effectively connecting receiver input to low-pass filter and antenna.

4-2-3. Input Filter and RF Amplifier

The receiver-input filter consists of a tuned circuit, L102 and C103, with the output tap on L102 coupled to RF amplifier Q101. The RF amplifier output is applied to a double-tuned circuit comprised of L103, C106, C109, and L104; then, the tap on L104 is coupled to a second RF amplifier, Q102. The output of Q102 is applied to another double-tuned circuit consisting of L105, C111, L106, and C114. The output tap on L106 routes the amplified signal to a dual-gate FET first-mixer, Q103.

4-2-4. 1st Local Oscillator & Tripler

The first local oscillator consists of Q109 and its associated circuitry. SW-301A selects the proper crystal in the 44.4 MHz to 54.2333 MHz range to produce the desired injection frequency. The collector circuit of Q109 is tuned to the crystal frequency by L107, and the output is coupled to the base of tripler Q110. The output of Q110 is tuned by C155 and the primary of T109 to cover the frequency range from 133.2 to 162.7 MHz; then, the secondary of T109 is connected to gate 2 of dual-gate first-mixer Q103. The first injection frequency is 10.7 MHz below the desired "receive" frequency.

4-2-5. 1st Mixer and 1st IF Amplifier

The 10.7 MHz difference signal produced in the first mixer is coupled by T101 to a 4-pole monolithic crystal filter consisting of FL101 and FL102. The output of the filter is transformer coupled by T102 to first stage Q104 of the first IF amplifier. The output of Q104 is coupled to second stage Q105 of the first IF amplifier by a double-tuned circuit comprised of T103 and T-104.

4-2-6. 2nd Mixer/Autodyne Converter

The output of Q105 is transformer coupled by T105 to the second mixer, Q106, which operates an an autodyne converter with crystal Y123 oscillating at 10.245 MHz to produce a second IF of 455 kHz.

4-2-7. Second IF Amplifier

Transformer T106 applies the resultant 455 kHz difference frequency to IC101, which functions as a high-gain 455 kHz IF amplifier.

4-2-8. Limiter, Detector, and Squelch

The output of IC101 is coupled by T107 to IC102 pins 1 and 2 -- IC102 performs the limiting and detection functions in the receiver. C130 sets the de-emphasis level in the detection circuitry, while T108, R121, and C131 form the quadrature detector. Detected audio on pin 8 of IC102 is fed through C132 and R122 to the audio amplification circuits via pin 14 on IC102. At the same time, detected audio from pin 8 is also applied to a noise amplifier consisting of Q107 and its associated circuitry. The amplified noise from Q107 is fed to the voltage-doubling detectors CR103 and CR104. The detected noise then charges C137 and biases the base of Q108. The Squelch control, R127, determines the authority of the detected-noise level on base of Q108 -- as Q108 turns ON, it pulls pin 6 of IC103 to ground. This action turns IC103 OFF, and completely silences the receiver.

4-2-9. Audio Amplifier

Volume control R131 sets the level of audio fed to audio amplifier IC103. R132 and C142 perform the frequency-response shaping of the audio amplifier while C144, C145, and C147 provide feedback to various stages within IC103. Audio output from pin 12 of IC103 is applied through C149 to the speaker.

NOTE: To quiet receiver audio during transmission, the microphone push-to-talk switch also grounds pin 6 of audio amplifier IC103 thru CR112.

4-3. THEORY OF OPERATION - TRANSMITTER

4-3-1. Microphone Amplifier/Limiter

The modulator audio amplifier in the unit is built around a single integrated circuit, IC301. This IC is a dual operational amplifier, and is shown on the schematic as IC301A and IC301B. Audio output of the ceramic microphone is amplified by IC301A -- a 6 dB per octave rising characteristic is given to the audio frequencies by loading the 1500 pF microphone capacitance with bias resistor R331. IC301 also provides the clipping function required for limiting modulation by saturating symmetrically against supply voltage and ground. Regulated-supply voltage for the modulator is obtained by applying 13.75 VDC primary power through R332 and across 6.8-volt zener diode CR305.

Output from IC301A is applied to IC301B which acts as an active, 2-pole, Chebyshev low-pass filter with a cutoff frequency of 3 kHz. R338 and C400 add a third pole to the filter, which gives the required -18 dB per octave rolloff above 3 kHz. R339 controls audio level applied to modulator varactor diodes, CR302 and CR311. C401 provides an audio return for R339.

4-3-2. Voice Modulator

CR302 and CR311 function as the phase modulators. DC bias for the modulation diodes is provided by IC301B through R338, R339, and R340, while R340 and C346 perform pre-emphasis of the audio applied to the phase-modulator circuitry.

A signal between 11.991 and 14.45 MHz from the "transmit" crystal oscillator is applied to CR302 and CR311 by tuned transformer T301. As an audio signal from the modulation amplifier is applied to the varactor diodes, the capacitance of the diodes changes -- thus varying the resonant frequency of tuned transformer T301. This results in phase modulation of the carrier signal.

4-3-3. Subaudible Tone Modulator

The circuitry composed of C449, C450, R350, R351, R352, CR310, L317, and C-451 is used to frequency modulate the transmit crystal oscillator when the subaudible-tone encoder is employed.

The amount of frequency modulation that results from the subaudible-tone input is limited by the applied-tone level. R351 is used to change the conduction angle of CR310 and, therefore, the symmetry of the subaudible modulation. This circuitry is used ONLY when the SA-1 Subaudible Tone Encoder/Decoder circuit board is installed in the unit.

4-3-4. Transmit Crystal Oscillator

Q301 and its associated circuitry form the "transmit" oscillator, which is a basic Colpitts circuit. SW301B selects the proper crystal to produce the desired output frequency. A variable capacitor is used in series with each crystal to allow exact setting of the generated frequency.

4-3-5. Crystal Oven

The circuitry comprised of R353, R354, RT301, and Q311 is used to provide heat to the "transmit" oscillator crystal. Thermistor RT301 controls transistor Q311 in a manner that causes resistor R354 to produce heat when the ambient temperature drops below 0°C. R354 is held in contact with the crystal case; thus, by heating the crystal, its frequency does not change as radio is subjected to colder temperatures.

-3-6. Buffer

.302 is a P-channel JFET which functions as a buffer to isolate "transmit" oscillator circuitry from the phase modulator.

4-3-7. Tripler

The output of the modulator is applied via C347 to base of Q303, which functions as an RF tripler. In this stage, for example, a modulated 13 MHz signal is multiplied to 39 MHz. The double-tuned transformer, T302, functions as a filter to reduce all harmonics and subharmonics of the desired 39 MHz output.

4-3-8 First Doubler

The filtered 39 MHz output from the secondary of T302 is applied to base of Q304, the first doubler. This Class C doubler stage multiplies the modulated 39 MHz output signal to a frequency in the 78 MHz range. The output circuit of Q304 is tuned by means of a double-tuned transformer, T303, which filters all undesired harmonics and subharmonics from the 78 MHz first doubler output.

4-3-9. Second Doubler

The 78 MHz signal from the first doubler is applied to the base of Q305, another Class C doubler stage. Here, the modulated 78 MHz RF signal is again doubled to the final output frequency in the 156 MHz range. The output of Q-305 is matched to the following amplifier stages by a resonant "L" section, consisting of L302 and C360. This circuit also provides suppression of any subharmonics of the desired output signal.

4-3-10. RF Predriver

The 156 MHz signal from the final multiplier stage is applied to base of Q-306, which functions as the first RF-power amplifier. This Class C amplifier increases RF-signal level from 50 mW to approximately 500 mW. The predriver output is coupled to following driver stage by means of a filter network consisting of L303, C365, C366, and L304. This circuit provides both filtering of any spurious responses, and impedance matching into driver stage.

4-3-11. RF Driver

Q307 and associated circuitry function as a Class C RF driver. L305, C368, L-306, C369, C370, and C371 form a frequency-selective matching network, that also reduces any spurious responses.

4-3-12. Final Power Amplifier

Q308 functions as the final RF-power amplifier, and typically develops approximately 20 watts of RF power. C373, C374, L309, and C402 comprise a resonant matching network, which matches output from Q308 to the 50-ohm antenna

impedance. The remainder of the components (up to C446 and L316) form an elliptic-function filter, which reduces the level of all spurious outputs to less than -13 dBm.

4-3-13. Transmit-Indicator Lamp

When transmitter is activated, RF voltage is coupled through C403 to diode detector CR309. The detected RF signal is then applied to base of Q309; thus, Q309 turns ON and allows current to flow through TX lamp DS301, indicating that RF power is being delivered.

4-3-14. Power Supply

Power to operate the ECOM-220 is obtained from an external 13.75 volt DC-power source via input connector P101, Fuse F301, and switch SW302.

Power is supplied to the transmitter driver and output stage whenever 13.75 volts are supplied to the unit's rear-panel power connector. These stages are controlled by applying drive from the previous stages. When mic. PTT switch is keyed, CR307 turns ON transistor switch Q310 which, in turn, supplies 13.75 volts to all transmitter stages, except driver and output stages.

Voltage to operate the "transmit" oscillator is regulated to 6.8 volts DC by R301 and CR301, prior to application to the oscillator circuit. R332 and CR-305 provide regulated 6.8 volts DC for the modulation amplifier.

Voltages for receiver oscillator/tripler, RF stages, 1st IF amplifiers, 2nd mixer, and 2nd IF amplifier are obtained from a zener-diode stabilized pass-transistor regulator, which consists of R151, R153, CR111, and Q115. The output of this regulator is approximately 9.5 volts DC.

The regulator is also used as a switching circuit to disable the above receiver voltages during transmission. The microphone push-to-talk switch disables the regulator by grounding the base of Q115 through R150 and CR110 while the P.T.T. switch is closed.

4-4. ALIGNMENT PROCEDURE - GENERAL

The transceiver is properly aligned before shipment from the factory, and realignment should not be necessary during normal life of the unit unless components within the instrument are replaced.

NEVER attempt to realign the transceiver circuits unless the test equipment specified for each section is available.

4-4-1. Disassembly

To gain access to interior of radio, remove plastic top cover by removing two 6/32 screws which secure rear of top cover to heatsink. Then, lift rear of cover upward while sliding cover toward rear of instrument. The bottom cover is removed in a like manner.

NOTE: If thumbscrews have NOT been removed from sides of transceiver, they must be loosened a few turns before attempting to remove unit covers.

4-5. RECEIVER ALIGNMENT

4-5-1. RF & Input Filter Alignment

1. Refer to Component Location Diagram in this Section for location of adjustments and test points.

2. Connect an FM Signal Generator to the transceiver antenna connector, and set generator to desired frequency with 1 kHz modulation at ±5 kHz deviation.

3. Turn radio ON and adjust C103, C-106, C109, C111, and C114 for best sensitivity (maximum quieting).

4-5-2. 1st Local Oscillator Alignment

1. Set the Channel-Selector switch to channel 1.

2. Preset L107 by setting top of slug flush with top of coil form, and then turning slug four turns into form.

3. Connect a VTVM RF probe to gate 2 of 1st mixer Q103.

4. Turn transceiver power switch ON and adjust slug in T109 for a maximum reading on VTVM.

NOTE: This is a preliminary adjustment; L107 and T109 will be touched up later for best quieting

5. Turn transceiver power switch OFF, and disconnect VTVM probe.

6. Connect frequency counter to gate 2 of mixer Q103.

7. Turn transceiver power switch ON, and note reading on the frequency counter. This reading should be within ±.001% of the L.O. injection frequency. The injection frequency can be found by subtracting 10.7 MHz from the channel, or operating, frequency. If the frequency is not within appropriate tolerance, adjust the associated crystal-netting trimmer capacitor, C171, located at left-front corner of main PC board. Repeat this step for the second channel, if used.

EXAMPLE: LO freq = 151.625 - 10.7
LO freq = 140.925
Tolerance = 140.925 x .00001
Tolerance = ±1409.25 Hz

8. Turn transceiver power switch OFF, and remove frequency-counter connection from mixer Q103.

4-5-3. 10.7 MHz & 455 kHz IF Alignment

1. Connect a high impedance detector (Figure 4-2) to drain of FET amplifier Q105; then, connect detector output to scope vertical input. Set scope vertical attenuator to its most sensitive position.

2. The connection point for the sweep-input signal depends upon frequency range of sweep generator being used: If generator covers 10.7 MHz, the sweep signal can be applied through a 39 pF capacitor to gate 1 of mixer Q103; however if generator covers operating frequency of the transceiver, the sweep signal can be applied directly to antenna input connector J301. Turn transceiver power switch ON.

NOTE: During alignment of monolithic crystal filters, keep sweep signal input level low enough to prevent overdriving the detector -- signal level at the detector should be approximately 10 - 20 mV. Set generator sweep width for approximately 25 kHz at a sweep rate of not more than 40 Hz.

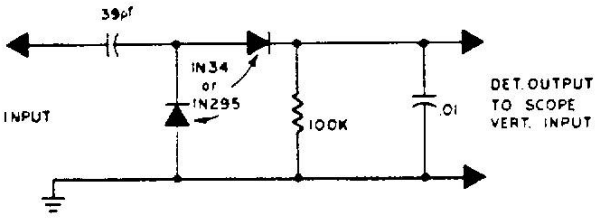


Figure 4-2. High - Impedance Detector

3. Adjust T101, T102, T103, T104, and T105 for a bandpass response similar to that shown below. The ripple should not exceed 2 dB, and in most cases will be 1 dB or less.

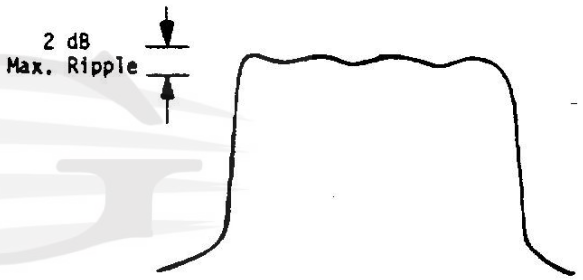


Figure 4-3. IF Response

4. Turn transceiver power OFF, and disconnect sweep generator, detector, and scope.

NOTE: After the 10.7 MHz crystal filters have been properly aligned using a swept signal, DO NOT change adjustments of T101 through T105.

5. Connect an AC voltmeter across unit speaker terminals; turn squelch and volume controls fully counterclockwise.

6. Apply a 10.7 MHz CW signal by either of the following methods:

   (1) Inject an accurate 10.7 MHz CW signal into gate 1 of mixer Q103 through a 39 pF capacitor. Short secondary of T109 to ground.

   (2) Connect a signal generator, set to desired "receive" frequency, to antenna connector J301, and connect a frequency counter to pin 1 of IF IC101. Turn instrument power switch ON, and increase generator output until 2nd IF is read on counter. "Fine-tune" signal generator until 2nd-IF frequency reads 455 kHz.

7. Disconnect RF generator from transceiver, and with transceiver power switch ON, adjust volume control for a 0.5-volt noise level on the AC voltmeter.

8. Reconnect signal generator to the transceiver, and increase unmodulated signal from signal generator until noise level drops to 0.25 VAC on voltmeter.

9. Now, adjust T106 and T107, in that order, for maximum quieting as indicated on the AC voltmeter.

   If using "Method #2," also adjust slugs in L107 and T109 for maximum quieting. Decrease RF input, as necessary, to maintain a usable reading on AC voltmeter during the alignment. Repeat step 9 until no further quieting is obtained.

10. Turn transceiver power OFF and disconnect AC voltmeter. Now, connect an oscilloscope across speaker terminals, and turn transceiver power switch ON.

11. FM modulate signal generator with a 1-kHz tone at ±5 kHz deviation. Adjust generator RF output to a 10-microvolt level and adjust scope-input sensitivity to cover about 3/4 of scope screen vertically with the 1-kHz tone.

12. Adjust T108 for maximum amplitude of the 1-kHz tone on scope screen.

13. If "Method #1" is used for alignment, turn transceiver power OFF and remove shorting jumper from the secondary of T109. Again connect an AC voltmeter across transceiver speaker terminals.

    Connect a signal generator, set to desired "receive" frequency, to antenna connector J301. Set receiver and generator levels as given in steps 7 and 8 above; then, adjust slugs in L107 and T109 for maximum quieting.

14. Turn transceiver power switch OFF, and disconnect all test equipment from unit.

4-5-4. RF Input for 20-dB Quieting

1. Turn FM signal-generator modulation OFF, and set generator RF attenuator for minimum output. Set transceiver and generator for desired channel.

2. Adjust transceiver volume control so that receiver background noise indicates -10 dB on AC VTVM connected across speaker terminals.

3. Slowly increase setting of FM signal generator RF attenuator, until AC VTVM indicates -30 dB. Note RF level shown on signal-generator attenuator. This is the RF input required to produce 20-dB receiver quieting; an input of -112 dBm (0.45 µV) will quiet receiver 20 dB. Check second channel, if used.

4-5-5. Squelch Operation

1. Set signal generator to desired "receive" frequency, and modulate gen-

erator with a 1 kHz tone at ±5 kHz deviation. Set RF attenuator for minimum RF output.

2. Turn squelch control fully clockwise. Receiver audio control should be set for maximum volume. Receiver is fully squelched, and should be completely silent.

3. Reduce DC-input voltage to approximately 11 volts, and note that receiver is still fully squelched. Return DC input to 13.75 VDC, set volume control at midrange, and adjust squelch control fully counterclockwise; then set squelch clockwise until receiver background noise just disappears.

4. Increase setting of signal-generator RF attenuator until the squelch just fully opens. The RF attenuator should show -121 dBm (0.2 µV) or better.

4-5-6. Audio-Output Power

1. Set FM signal generator on desired "receive" frequency, and modulate generator with a 1-kHz tone at ±5 kHz deviation. Set RF attenuator in the vicinity of 5 µV.

2. Turn volume control fully clockwise. The AC VTVM should indicate not less than 4 volts (4 watts).

3. Modulate generator with 500-Hz tone at ±5 kHz deviation, and note that AC VTVM indicates at least 4 volts with transceiver volume control fully clockwise.

4. Modulate signal generator with a 3-kHz tone at ±5 kHz deviation. Again AC VTVM indicates at least 4 volts with transceiver volume control fully clockwise.

5. Turn OFF transceiver power switch, and disconnect AC VTVM from transceiver speaker.

4-6-1. Equipment Required

To properly align the ECOM-220 transmitter, the following test equipment, or its equivalent, is required:

a) Power Meter: 50-watts @ 175 MHz, or relative output indicating device (Figure 4-4).

b) Dummy Load: For above, 50-ohm, 50-watts.

c) Frequency Counter: DC to 175 MHz; or other accurate frequency measuring device.

d) Deviation Meter: To read at least ±5 kHz.

e) VTVM: Any accurate instrument.

f) Oscilloscope: DC to 8 MHz, DC coupled, calibrated vertical attenuator.

g) Audio Generator: To supply 500 Hz, 1700 Hz, and 3,000 Hz.

h) Power Supply: Filtered, 13.75 VDC at 8 amps minimum.

4-6-2. Preparation for Alignment

1. Attach a 50-ohm dummy load to the transceiver RF - output connector through a power meter or relative output indicating device (Figure 4-4).

2. Preset the deviation potentiometer (R339) to its lowest setting (potentiometer rotated toward receiver side of mainboard). Refer to Component Layout Diagram in this section.

3. Connect instrument to a 13.75-volt DC power source.

4. Adjust subaudible symmetry potentiometer R349 (on main PC board) to its approximate midrange position.

NOTE: This potentiometer will require no further adjustment unless a Subaudible-Tone Encoder/Decoder is installed later. NEVER ADJUST THIS POTENTIOMETER AFTER NETTING "TRANSMIT" CRYSTALS.

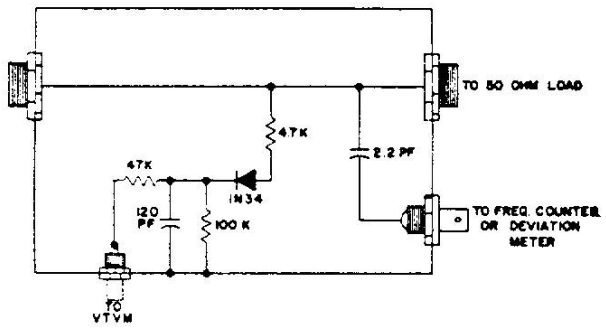


Figure 4-4. Relative Output Indicator

4-6-3. Frequency and Power Alignment

1. Rotate Channel-Selector dial to the desired channel.

   NOTE: The signal peak-voltage measurements in the following steps of this section are made with a VTVM and DC probe. Key transmitter ONLY while adjustments are being made.

2. Connect DC probe to emitter of Q303, key transmitter, and adjust slug in T301 for a peak at the fundamental frequency. Adjust VTVM attenuator for an on-scale reading. The peak should reach approximately 1.5 volts.

3. Move DC probe to emitter of Q304. Key transmitter, and adjust the two slugs in T302 for a peak, centered on third harmonic. Each slug should adjust between its associated winding and the outside end of the coil form. The signal should peak at approximately 0.2 volts.

4. Adjust T303 by connecting DC probe to emitter of Q305, keying transmitter, and adjusting the two slugs in T303 for a peak, centered on the third harmonic. Each slug should adjust between its associated winding and the outside end of coil form. The signal should peak at about 1.2 volts.

5. If relative output indicating device of Figure 404 is used, connect VTVM DC probe to the relative output terminal; otherwise, observe the wattmeter or other relative output indicator.

6. Preset C366 by tightening its adjustment screw down firmly; then, backing it off 1/2 turn.

7. Key tranmitter, and adjust C360, C365, C366, C368, C370, C374, and C402 for maximum relative output indication. This step may be repeated as necessary.

8. After unit has been on for approximately ten minutes to stabilize crystal oven, select channel 1, key transmitter, and adjust crystal-netting trimmer C421 for a correct frequency reading on the frequency counter or other frequency measuring device.

9. Repeat step 8 for second channel, if used. Refer to Main Board Component Location Diagram for location of "transmit" crystal-netting trimmers (C421 and C423).

4-6-4. Power-Measurement Procedure

1. Key transmitter, and note RF-power output readings. The power should be as follows: 143.9 to 160.0 MHz -- 20 watts minimum; 160.0 to 173.4 MHz --- 15 watts minimum.

4-6-5. Subaudible-Tone Deviation Adjustment (If Used)

1. Connect deviation meter to "Freq. Counter/Deviation Meter" output of the relative output indicating device.

2. Key transmitter and adjust "Subaudible-Tone Deviation Adjustment" (located on subaudible-tone board) to produce an output deviation of ±1 kHz, as indicated on the deviation meter. R351, the "Subaudible Symmetry Adjustment" (located on main PC board) should be adjusted simultaneously to produce identical + and - deviation.

NOTE: After any adjustment of R351, BE SURE TO PERFORM STEPS 8 AND 9 ABOVE TO ENSURE XMIT CRYSTAL IS NETTED TO PROPER FREQUENCY.

4-6-6. Carrier Deviation Adjustment

1. Feed an audio signal of 1700 Hz into transceiver microphone. Set mic. Gain potentiometer, R333, to maximum resistance (max. gain) by rotating its wiper toward receiver side of main circuit board. Do NOT key transmitter during this step. Connect vertical input lead of the oscilloscope to pin 1 of IC301 and adjust R331, the symmetry adjustment, until displayed waveform limits symmetrically on both top and bottom of the waveform.

2. Connect deviation meter to "Freq. Counter/Deviation Meter" output of the relative output indicating device.

3. Key transmitter, observe frequency deviation meter, and increase the microphone audio input until no further increase in deviation is indicated. The modulator stage is now saturated.

4. With frequency-deviation meter set to either + or - deviation, key the transmitter and adjust slug in T301 for a peak reading. The deviation potentiometer, R339, can be adjusted for an on-scale reading of the deviation meter.

5. Set deviation potentiometer, R339, as follows:

   Without subaudible tone: Set R339 for a deviation reading of ±5 kHz with the 1700 Hz tone applied to microphone.

   With subaudible tone: Set R339 for a combined subaudible and 1700 Hz tone deviation reading of ±5 kHz.

   Switch deviation meter to the + and - positions and check amount of deviation in each position.

6. If a difference exists between + and - deviation levels, adjust T301 by rocking its slug slightly until the two levels are brought into balance. The difference in deviation levels should not exceed 0.4 kHz.

7. For normal operation, the mic. gain potentiometer is set at maximum gain. If the unit is going to be operating in an area having a high acoustic noise level, the mic. gain can be reduced by rotating the gain pot. away from the maximum gain position. This will help reduce the amount of noise being transmitted along with the voice.

4-7. TONE-FREQUENCY ADJUSTMENT

If it becomes desirable to change tone frequency from the factory-set value, follow procedures given in Section 2-12 of this manual.

4-8. FREQUENCY CHANGES

Installation of new frequencies in this unit can be easily accomplished by performing the following steps:

NOTE: To aid in obtaining proper crystals for the ECOM-220, complete crystal specifications are given in Section 4-9 of this manual.

1. Remove top cover from instrument as explained in Section 4-4-1.

2. Install "receive" crystals in appropriate sockets at front left-hand corner of main PC board. Refer

to Main Board Component Location Diagram for receive crystal locations.

3. Install "transmit" crystals in appropriate sockets at front right-hand corner of main PC board. Refer to Main Board Component Location Diagram for transmit crystal locations. Be sure that transmit and receive crystals are properly paired.

Channel	Receive Crystal	Transmit Crystal
1	Y101/C171	Y301/C421
2	Y102/C173	Y302/C423

4. To bring the receive crystal(s) "on frequency," perform steps 6 and 7 given in Section 4-5-2 of this manual.

5. To adjust transmit crystal(s) "on frequency," perform steps 8 and 9 given in Section 4-6-3 of this manual.

NOTE: If new frequencies differ appreciably from original alignment frequencies, it may be necessary to completely re-align transmitter and receiver circuits as detailed in Sections 4-5 and 4-6.

4-9. CRYSTAL SPECIFICATIONS

To change a transmit and/or receive operating frequency in a Model ECOM-220 transceiver requires that a new transmit and/or receive crystal be installed in the unit. The transceiver may also require some realignment to insure proper operation of the new frequency.

Crystals for the ECOM-series transceivers are available from the factory at nominal cost by calling the factory "Parts Department," and specifying the model number, desired operating frequency, and whether for transmit or receive. Crystals may also be obtained from other sources; therefore, the information necessary for ordering these crystals is given on following page.

4-9-1. Transmit Crystals

Parallel Mode:	C_p = 32 pfd.
Fundamental Cut Tolerance:	±.001% Max. Calibration Tolerance @ 25°C ±1°C. ±.0005% Max. Drift Over Temperature Range.
Temperature Range:	0° to +50° C.
Holder:	HC-25/U
Crystal Frequency:	$\frac{\text{Operating Frequency}}{12}$
Series Resistance:	25 ohms Maximum.
Genave Part Number:	2300211

4-9-2. Receive Crystals

Parallel Mode:	C_p = 32 pfd.
Third Overtone Tolerance:	±.001% Calibration Tolerance at 25°C ±1°C. ±.001% Max. Drift Over Temperature Range.
Temperature Range:	-30° to +60° C.
Holder:	HC-25/U
Crystal Frequency:	$\frac{\text{Operating Frequency - 10.7 MHz}}{3}$
Series Resistance:	40 ohms maximum.
Drive Level:	One mW
Genave Part Number:	2300226

4-10. SCHEMATICS AND COMPONENT LAYOUTS

This Section contains schematics and parts layout for the ECOM-220 VHF-FM transceiver.

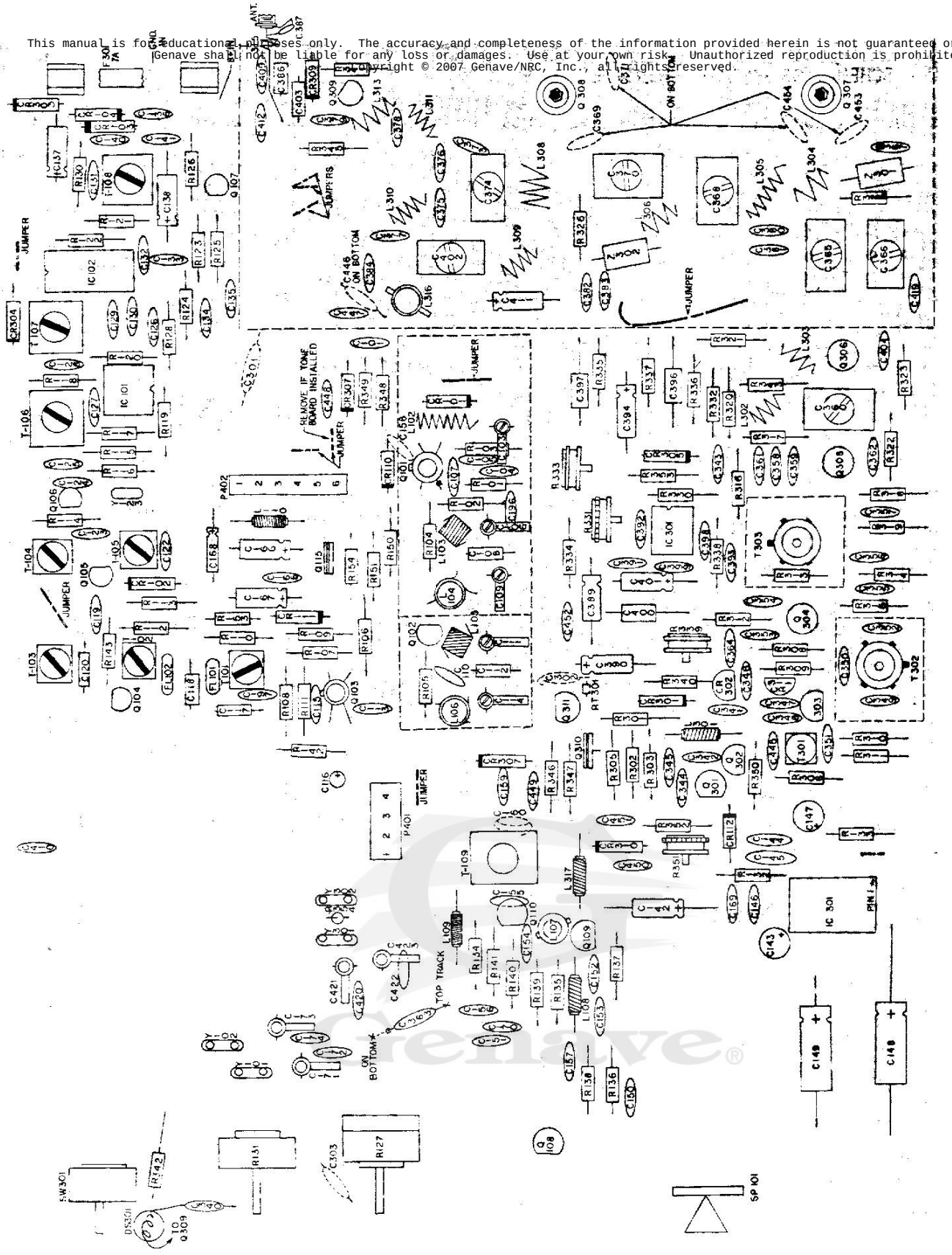
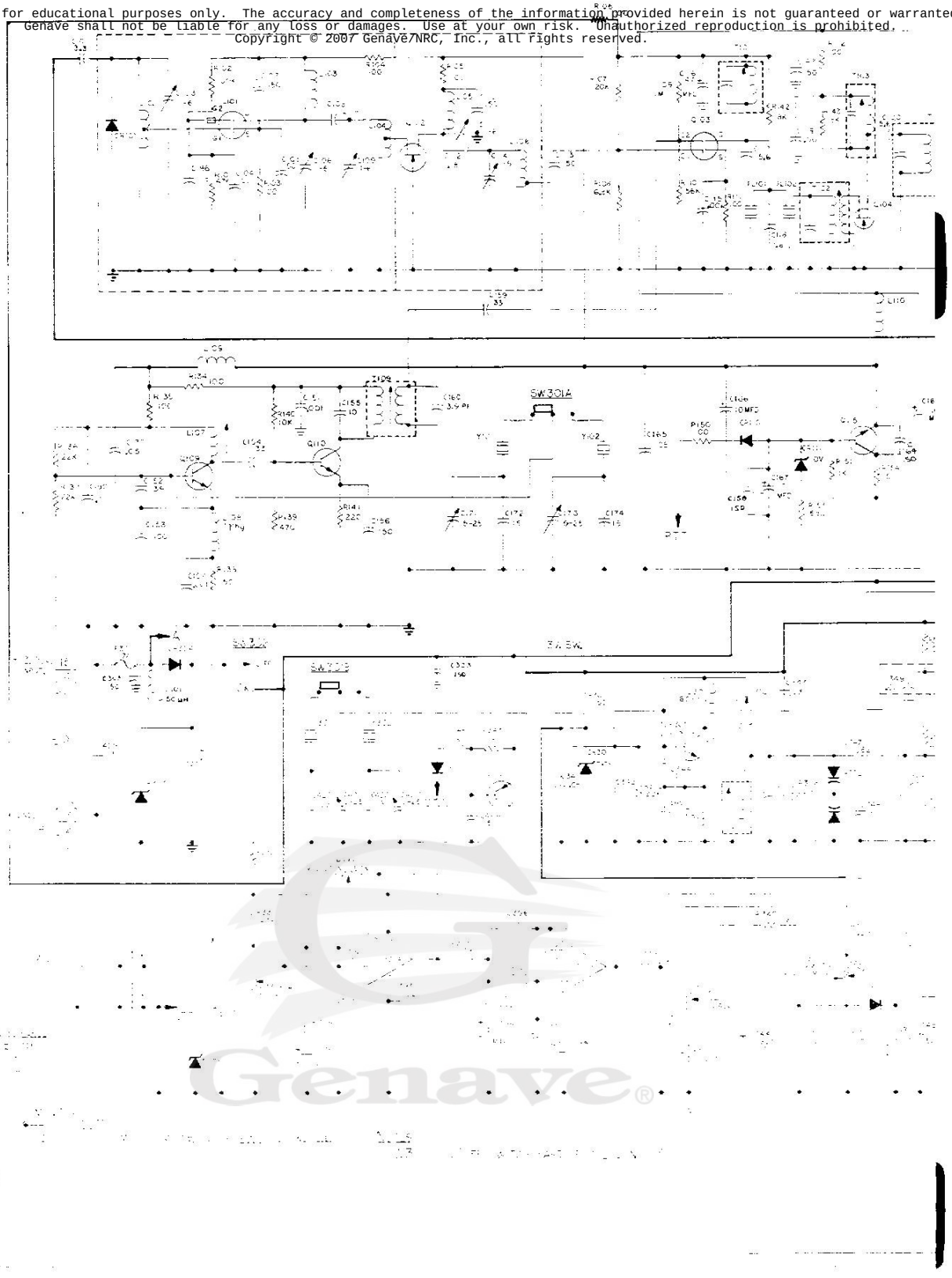


Figure 4-5. Main Board Component Layout (1-24-80)
(Top View)



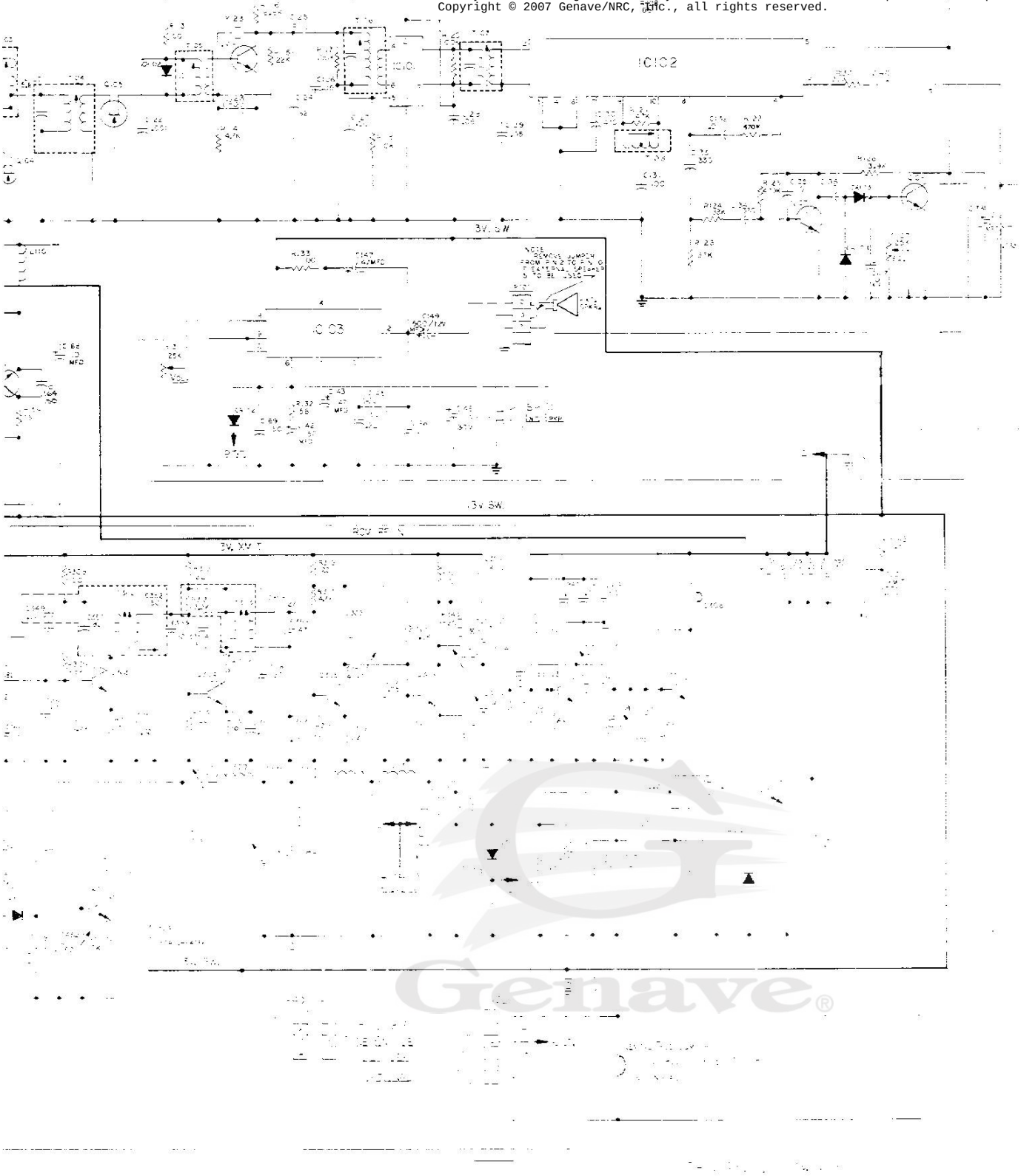


Figure 4-6. Main Board Schematic (1-24-80)

SECTION V
PARTS LIST

This section of the Maintenance Manual lists replacement electronic parts, as well as major mechanical components, for use in the ECOM-220 VHF-FM Transceiver.

The first column in the parts list contains component reference numbers as shown on schematics or wiring diagrams.

In general, 100-series numbers pertain to receiver components while 300-series and 400-series numbers are used for transmitter parts. Genave part numbers for replaceable items appear in the Part Number column, while a brief description for each part is shown in the Description column.

Reference Number	Part Number	Description
		CAPACITORS
C101	1520197	NPO, Disc, 3.3 pF ±10%
C102	---	Not Assigned
C103	1570120	Trimmer, 1-6 pF
C104	1520028	Y5E, Disc, 150 pF ±10%
C105	1520028	Y5E, Disc, 150 pF ±10%
C106	1570120	Trimmer, 1-6 pF
C107	1520028	Y5E, Disc, 150 pF ±10%
C108	1510027	NPO, Gimmick, 0.1 pF ±10%
C109	1570120	Trimmer, 1-6 pF
C110	1520028	Y5E, Disc, 150 pF ±10%
C111	1570120	Trimmer, 1-6 pF
C112	1510002	NPO, Gimmick, 0.18 pF ±10%
C113	1520028	Y5E, Disc, 150 pF ±10%
C114	1570120	Trimmer, 1-6 pF
C115	1520071	Z5P, Disc, .001 µF ±10%
C116	1541009	Tant., 47 µF, 16V
C117	1510026	NPO, Gimmick, 5.6 pF ±10%
C118	1510014	NPO, Gimmick, 1.8 pF ±10%
C119	1520071	Z5P, Disc, .001 µF ±10%
C120	1510026	NPO, Gimmick, 5.6 pF ±10%
C121	---	Not Assigned
C122	1520071	Z5P, Disc, .001 µF ±10%
C123	1530007	Silver Mica, 680 pF ±10%
C124	1520219	N330, Disc, 82 pF ±10%
C125	1520010	NPO, Disc, 18 pF ±10%
C126	1520054	M25, Disc, .05 µF, +80 -20%
C127	1520071	Z5P, Disc, .001 µF ±10%
C128	1520054	M25, Disc, .05 µF +80 -20%
C129	1520054	M25, Disc, .05 µF +80 -20%
C130	1520042	Y5E, Disc, 470 pF ±10%
C131	1520022	N220, Disc, 100 pF ±10%
C132	1520051	Y5U, Disc, .01 µF ±20%, 25V
C133	1520037	Y5E, Disc, 330 pF ±10%
C134	1520037	Y5E, Disc, 330 pF ±10%

CAPACITORS (Cont'd)

C135	1520007	NPO, Disc, 10 pF ±10%
C136	1520051	Y5U, Disc, .01 µF +20%, 25V
C137	1540014	Electrolytic, 10 µF, 25V
C138	1540014	Electrolytic, 10 µF, 25V
C139	---	Not Assigned
C140	1520055	Disc, .1 µF +80 -20%, 12V
C141	1520083	Y5T, Disc, .003 µF ±20%
C142	1540023	Electrolytic, 150 µF, 16V
C143	1541009	Tant., 47 µF, 16V
C144	1520057	Disc, .22 µF +80 -20%
C145	1500004	Mylar, .0015 µF ±10%, 630V
C146	1520055	Disc, .1 µF +80 -20%, 12V
C147	1541009	Tant., 47 µF, 16V
C148	1540038	Electrolytic, 1000 µF, 30V
C149	1540049	Electrolytic, 500 µF, 12V
C150	1520071	Z5P, Disc, .001 µF ±10%
C151	1520071	Z5P, Disc, .001 µF ±10%
C152	1520014	NPO, Disc, 39 pF ±10%
C153	1520024	N1500, Disc, 100 pF ±10%
C154	1520013	NPO, Disc, 33 pF ±10%
C155	1520007	NPO, Disc, 10 pF ±10%
C156	1520028	Y5E, Disc, 150 pF ±10%
C157	1520071	Z5P, Disc, .001 µF ±10%
C158	1520028	Y5E, Disc, 150 pF ±10%
C159	1520013	NPO, Disc, 33 pF ±10%
C160	1520003	NPO, Disc, 3.9 pF ±10%
C161	---	Not Assigned
C162	---	Not Assigned
C163	---	Not Assigned
C164	1520028	Y5E, Disc, 150 pF ±10%, 25V
C165	1520054	M25, Disc, .05 µF +80 -20%
C166	1540014	Electrolytic, 10 µF, 25V
C167	1540014	Electrolytic, 10 µF, 25V
C168	1540014	Electroyltic, 10 µF, 25V
C169	1520028	Y5E, Disc, 150 pF ±10%
C170	1520054	M25, Disc, .05 µF +80 -20%
C171	1570121	Trimmer, 5-25 pF
C172	1520010	NPO, Disc, 18 pF ±10%
C173	1570121	Trimmer, 5-25 pF
C174	1520009	NPO, Disc, 15 pF ±10%
C175	---	Not Assigned
C176	---	Not Assigned
C177	---	Not Assigned
C178	---	Not Assigned
C179	---	Not Assigned
C180	---	Not Assigned
C195	---	Not Assigned
C196	1520010	NPO, Disc, 18 pF ±10%
C197	1520028	Y5E, Disc, 150 pF ±10%
C301	1520028	Y5E, Disc, 150 pF ±10%
C302	1520028	Y5E, Disc, 150 pF ±10%
C303	1520028	Y5E, Disc, 150 pF ±10%
C340	1520028	Y5E, Disc, 150 pF ±10%

CAPACITORS (Cont'd)

C341	1520054	M25, Disc, .05 µF +80 -20%
C342	1520022	N220, Disc, 100 pF, ±10%
C343	1520054	M25, Disc, .05 µF +80 -20%
C344	1520022	N220, Disc, 100 pF ±10%
C345	1520022	N220, Disc, 100 pF ±10%
C346	1520014	NPO, Disc, 39 pF ±10%
C347	1520176	N330, Disc, 82 pF ±10%
C348	1520015	N1500, Disc, 47 pF ±10%
C349	1520051	Y5U, Disc, .01 µF ±20%, 25V
C350	1520176	N330, Disc, 82 pF ±10%
C351	1520053	M25, Disc, .02 µF ±10%, 25V
C352	1520028	Y5E, Disc, 150 pF ±10%
C353	1520028	Y5E, Disc, 150 pF ±10%
C354	1520009	NPO, Disc, 15 pF ±10%
C355	1520071	Z5P, Disc, .001 µF ±10%
C356	1520028	Y5E, Disc, 150 pF ±10%
C357	1520071	Z5P, Disc, .001 µF ±10%
C358	1520012	NPO, Disc, 27 pF ±10%
C359	1520015	N1500, Disc, 47 pF ±10%
C360	1560403	Trimmer, 40 pF, Arco PC403
C361	1520054	M25, Disc, .05 µF +80 -20%
C362	1520071	Z5P, Disc, .001 µF ±10%
C363	1520028	Y5E, Disc, 150 pF ±10%
C364	1520042	Y5E, Disc, 470 pF ±10%
C365	1560403	Trimmer, 40 pF, Arco PC403
C366	1560403	Trimmer, 40 pF, Arco PC403
C367	1520013	NPO, Disc, 33 pF ±10%
C368	1560406	Trimmer, 115 pF, Arco PC406
C369	1520022	N220, Disc, 100 pF ±10%
C370	1560406	Trimmer, 115 pF, Arco PC406
C371	1520022	N220, Disc, 100 pF ±10%
C372	---	Not Assigned
C373	1520018	N220, Disc, 56 pF ±10%
C374	1560406	Trimmer, 115 pF, Arco PC406
C375	1520011	NPO, Disc, 22 pF ±10%
C376	1520011	NPO, Disc, 22 pF ±10%
C377	1520030	N1500, Disc, 180 pF ±10%
C378	1520011	NPO, Disc, 22 pF ±10%
C379	1520011	NPO, Disc, 22 pF ±10%
C380	1520054	M25, Disc, .05 µF +80 -20%
C381	1520071	Z5P, Disc, .001 µF ±10%
C382	1520054	M25, Disc, .05 µF +80 -20%
C383	1520071	Z5P, Disc, .001 µF ±10%
C384	1520037	Y5E, Disc, 330 pF ±10%
C385	---	Not Assigned
C386	1510014	NPO, Gimmick, 1.8 pF ±10%
C387	1520011	NPO, Disc, 22 pF ±10%
C388	---	Not Assigned
C389	1540002	Electrolytic, 1 µF, 35V
C390	1540014	Electrolytic, 10 µF, 25V
C391	1520028	Y5E, Disc, 150 pF ±10%
C392	1520028	Y5E, Disc, 150 pF ±10%
C393	1520053	M25, Disc, .02 µF ±10%, 25V
C394	1540014	Electrolytic, 10 µF, 25V

Capacitors (Cont'd)

C395	---	Not Assigned
C396	1500018	Mylar, .01 µF ±10%, 100V
C397	1500013	Mylar, .0047 µF ±10%, 100V
C398	1520028	Y5E, Disc, 150 pF ±10%
C399	1520028	Y5E, Disc, 150 pF ±10%
C400	1500018	Mylar, .01 µF ±10%, 100V
C401	1540002	Electrolytic, 1 µF, 35V
C402	1560406	Trimmer, 115 pF, Arco PC406
C403	1510015	NPO, Gimmick, 2.2 pF ±10%
C404	1520071	Z5P, Disc, .001 µF ±10%
C405	---	Not Assigned
C406	---	Not Assigned
C407	---	Not Assigned
C408	---	Not Assigned
C409	1520028	Y5E, Disc, 150 pF ±10%
C410	1520051	Y5U, Disc, .01 µF ±20%, 25V
C411	1540002	Electrolytic, 1 µF, 35V
C412	1520028	Y5E, Disc, 150 pF ±10%
C413	1520028	Y5E, Disc, 150 pF ±10%
C414	---	Not Assigned
C419	1520028	Y5E, Disc, 150 pF ±10%
C420	1520013	NPO, Disc, 33 pF ±10%
C421	1570121	Trimmer, 5-25 pF
C422	1520013	NPO, Disc, 33 pF ±10%
C423	1570121	Trimmer, 5-25 pF ±10%
C424	---	Not Assigned
C425	---	Not Assigned
C426	---	Not Assigned
C427	---	Not Assigned
C428	---	Not Assigned
C444	1520028	Y5E, Disc, 150 pF ±10%
C445	1520010	NPO, Disc, 18 pF ±10%
C446	1520010	NPO, Disc, 18 pF ±10%
C447	1520010	NPO, Disc, 18 pF ±10%
C448	1520024	N1500, Disc 100 pF ±10%
C449	1550003	TANT., 3.3 µF, 35V
C450	1520051	Y5U, Disc, .01 µF ±20%, 25V
C451	1530002	Silver Mica, 120 pF ±10%
C452	1520028	Y5E, Disc, 150 pF ±10%
C453	1520018	N220, Disc, 56 pF ±10%
C454	1520218	N220, Disc, 56 pF ±10%
C455	---	Not Assigned

DIODES

CR101	4810017	High Freq. Switching, 1N4148
CR102	4810017	High Freq. Switching, 1N4148
CR103	4810021	1N34A
CR104	4810021	1N34A
CR105	---	Not Assigned
CR106	---	Not Assigned
CR107	---	Not Assigned

CR108	---	Not Assigned
CR109	---	Not Assigned
CR110	4810017	High Freq. Switching, 1N4148
CR111	4810008	Zener, 10V ±10%, ZS10A
CR112	4810017	High Freq. Switching, 1N4148
CR113	---	Not Assigned
CR114	---	Not Assigned
CR115	---	Not Assigned
CR301	4810007	Zener, 6.8V ±5%, 3/4W
CR302	4812109	Varicap, MV2109
CR303	4810011	Zener, 24V ±10%, 1W
CR304	4810013	General Purpose, 100 PRV, 1A
CR305	4810007	Zener, 6.8V ±5%, 3/4W
CR306	---	Not Assigned
CR307	4810017	High Freq. Switching, 1N4148
CR308	4810036	PIN, RF Sw, MPN3500
CR309	4810017	High Freq. Switching, 1N4148
CR310	4810017	High Freq. Switching, 1N4148
CR311	4812113	Varicap, MV2113

INTEGRATED CIRCUITS

IC101	3130017	MC1350P, IF Amplifier
IC102	3130024	CA3075, Quadrature Detector
IC103	3130020	CA810Q, Audio Amplifier
IC104	---	Not Assigned
IC105	---	Not Assigned
IC301	3130012	N5558, Dual Op-Amp
IC302	---	Not Assigned
IC303	---	Not Assigned
IC304	---	Not Assigned

INDUCTORS

L101	---	Not Assigned
L102	1800225	Coil, Rec. RF Amp.
L103	1800116	Coil, Rec. RF Amp.
L104	1800117	Coil, Rec. RF Amp.
L105	1800118	Coil, Rec. RF Amp.
L106	1800119	Coil, Rec. RF Amp.
L107	1800308	Coil, Rec. Osc.
L108	1800350	Coil, 1 µH Choke, ML10G
L109	1800332	Coil, 56 µH Choke
L110	1800332	Coil, 56 µH Choke
L111	---	Not Assigned
L112	---	Not Assigned
L113	---	Not Assigned
L114	---	Not Assigned

INDUCTORS (Cont'd)

L301	1800032	Coil, 80 µH Choke
L302	1800203	Coil, 3-1/2 T, LHH
L303	1800201	Coil, 2-1/2 T, LHH
L304	1800201	Coil, 2-1/2 T, LHH
L305	1800202	Coil, 3-1/2 T, RHH
L306	1800201	Coil, 2-1/2 T, LHH
L307	---	Not Assigned
L308	1800204	Coil, 4-1/2 T, LHH
L309	1800201	Coil, 2-1/2 T, LHH
L310	1800204	Coil, 4-1/2 T, LHH
L311	1800201	Coil, 2-1/2 T, LHH
L312	---	Coil etched on PC Board
L313	1800203	Coil, 3-1/2 T, LHH
L314	---	Coil etched on PC Board
L315	1800205	Coil, 2 T, LHH
L316	1800322	Coil, 4-1/2 T, RF Switch Circuit
L317	1800032	Coil, 80 µH Choke
L318	---	Not Assigned
L319	---	Not Assigned
L320	---	Not Assigned

TRANSISTORS

Q101	4800068	MOSFET, Dual Gate, 3N201 (SFE 801)
Q102	4805486	J-FET, N-Channel, 2N5486
Q103	4800068	MOSFET, Dual Gate, 3N201 (SFE 801)
Q104	4805484	J-FET, N-Channel, 2N5484
Q105	4805484	J-FET, N-Channel, 2N5484
Q106	4800026	NPN, Silicon, MPS-3693
Q107	4800028	NPN, Silicon, MPS-6514S
Q108	4800028	NPN, Silicon, MPS-6514S
Q109	4800026	NPN, Silicon, MPS-3693
Q110	4800024	NPN, Silicon, MPS-3563
Q111	---	Not Assigned
Q112	---	Not Assigned
Q113	---	Not Assigned
Q114	---	Not Assigned
Q115	4800018	NPN, Silicon, MPS-U01
Q301	4800033	NPN, Silicon, MPS-5172
Q302	4805461	J-FET, P-Channel, 2N5461
Q303	4800026	NPN, Silicon, MPS-3693
Q304	4804427	NPN, Silicon, 2N4427
Q305	4804427	NPN, Silicon, 2N4427
Q306	4804427	NPN, Silicon, 2N4427
Q307	4806080	NPN, Silicon, RF Power, 2N6080
Q308	4806082	NPN, Silicon, RF Power, 2N6082
Q309	4800051	NPN, Silicon, Darlington, MPS-A13
Q310	4800022	PNP, Silicon, MPS-U51
Q311	4800051	NPN, Silicon, Darlington, MPS-A13

RESISTORS

R101	4700045	47K, ±10%, 1/2 W
R102	4700049	100K, ±10%, 1/2 W
R103	4700013	100 ohm, ±10%, 1/2 W
R104	4700013	100 ohm, ±10%, 1/2 W
R105	4700013	100 ohm, ±10%, 1/2 W
R106	4700013	100 ohm, ±10%, 1/2 W
R107	4700050	120K, ±10%, 1/2 W
R108	4700035	6.8K, ±10%, 1/2 W
R109	4700058	1M, ±10%, 1/2 W
R110	4700046	56K, ±10%, 1/2 W
R111	4700013	100 ohm, ±10%, 1/2 W
R112	4700013	100 ohm, ±10%, 1/2 W
R113	4700013	100 ohm, ±10%, 1/2 W
R114	4700033	4.7K, ±10%, 1/2 W
R115	4700041	22K, ±10%, 1/2 W
R116	4700035	6.8K, ±10%, 1/2 W
R117	4700049	100K, ±10%, 1/2 W
R118	4700037	10K, ±10%, 1/2 W
R119	4700003	10 ohm, ±10%, 1/2 W
R120	4700049	100K, ±10%, 1/2 W
R121	4700045	47K, ±10%, 1/2 W
R122	4700057	470K, ±10%, 1/2W
R123	4700043	33K, ±10%, 1/2 W
R124	4700043	33K, ±10%, 1/2 W
R125	4700057	470K, ±10%, 1/2 W
R126	4700032	3.9K, ±10%, 1/2 W
R127	4760053	25K, Variable ±30% Linear, w/push-pull sw.
R128	4700011	68 ohm, ±10%, 1/2 W
R129	---	Not Assigned
R130	4700041	22K, ±10%, 1/2 W
R131	4760054	25K, variable ±30%, audio taper, with SW302
R132	4700010	56 ohm, ±10%,1/2 W
R133	4700013	100 ohm, ±10%, 1/2 W
R134	4700013	100 ohm, ±10%, 1/2 W
R135	4700013	100 ohm, ±10%, 1/2 W
R136	4700041	22K, ±10%, 1/2 W
R137	4700041	22K, ±10%, 1/2 W
R138	4700015	150 ohm, ±10%, 1/2 w
R139	4700021	470 ohm, ±10%, 1/2 W
R140	4700037	10K, ±10%, 1/2 W
R141	4700017	220 ohm, ±10%, 1/2W
R142	4700040	18K, ±10%, 1/2 W
R143	4700040	18K, ±10%, 1/2 W
R144	---	Not Assigned
R145	---	Not Assigned
R150	4700013	100 ohm, ±10%, 1/2 W
R151	4700025	1K ohm, ±10%, 1/2 W
R153	4710007	68 ohm, ±10%, 1/4 W
R154	4700004	15 ohm, ±10%, 1/2 W
R301	4700015	150 ohm, ±10%, 1/2 W
R302	4700041	22K, ±10%, 1/2 W
R303	4700041	22K, ±10%, 1/2 W
R304	---	Not Assigned
R305	4700023	680 ohm, ±10%, 1/2 W
R306	4700029	2.2K, ±10%, 1/2 W

R307	---	Not Assigned
R308	4700013	100 ohm, ±10%, 1/2 W
R309	4700047	68K, ±10%, 1/2 W
R310	4700033	4.7K, ±10%, 1/2 W
R311	4700016	180 ohm, ±10%, 1/2 W
R312	4700006	22 ohm, ±10%, 1/2 W
R313	4700031	3.3K, ±10%, 1/2 W
R314	4700017	220 ohm, ±10%, 1/2 W
R315	4700003	10 ohm, ±10%, 1/2 W
R316	4700006	22 ohm, ±10%, 1/2 W
R317	4700033	4.7K, ±10%, 1/2 W
R318	4700017	220 ohm, ±10%, 1/2 W
R319	4700006	22 ohm, ±10%, 1/2 W
R320	4700003	10 ohm, ±10%, 1/2 W
R321	4700029	2.2K, ±10%, 1/2 W
R322	4700015	150 ohm, ±10%, 1/2 W
R323	4700003	10 ohm, ±10%, 1/2 W
R324	---	Not Assigned
R325	4700009	47 ohm, ±10%, 1/2 W
R326	4700009	47 ohm, ±10%, 1/2 W
R327	---	Not Assigned
R328	---	Not Assigned
R329	---	Not Assigned
R330	4700045	47K, ±10%, 1/2 W
R331	4760039	500K, Variable, ±20%
R332	4700015	150 ohm, ±10%, 1/2 W
R333	4760021	50K, Variable, ±20%
R334	4700015	150 ohm, ±10%, 1/2 W
R335	4700037	10K, ±10%, 1/2 W
R336	4700035	6.8K, ±10%, 1/2 W
R337	4700043	33K, ±10%, 1/2 W
R338	4700034	5.6K, ±10%, 1/2 W
R339	4760021	50K, Variable, ±20%
R340	4700037	10K, ±10%, 1/2 W
R341	4700029	2.2K, ±10%, 1/2 W
R342	4700009	47 ohm, ±10%, 1/2 W
R343	4700024	820 ohm, ±10%, 1/2 W
R344	---	Not Assigned
R345	4700037	10K, ±10%, 1/2 W
R346	4700025	1K, ±10%, 1/2 W
R347	4700025	1K, ±10%, 1/2 W
R348	4700032	3.9K, ±10%, 1/2 W
R349	4700024	820 ohm, ±10%, 1/2 W
R350	4700026	1.2K, ±10%, 1/2 W
R351	4760019	10K, Variable, ±20%
R352	4700025	1K, ±10%, 1/2 W
R353	4710054	120K, ±5%, 1/4 W
R354	4700014	120 ohm, ±10%, 1/2 W
RT301	4760034	10K, Thermistor

Transformers

T101	5600098	10.7 MHz IF
T102	5600098	10.7 MHz IF

Transformers (Cont'd)

T103	5600098	10.7 MHz IF
T104	5600098	10.7 MHz IF
T105	5600046	10.7 MHz IF
T106	5600012	455 kHz IF
T107	5600012	455 kHz IF
T108	5600012	455 KHz IF
T109	5600048	Tripler - local oscillator
T301	5600072	Transmit oscillator
T302	5600082	Transmit Tripler
T303	5600083	Transmit First Doubler

Crystals

Y101	2300226	See Crystal Info, Section 4-9.
Y102	2300226	See Crystal Info, Section 4-9.
Y123	2300252	Second L.O., 10.245 MHz
Y301	2300211	See Crystal Info, Section 4-9.
Y302	2300211	See Crystal Info, Section 4-9.

Switches

SW301	5100128	Switch, 4P 2-Position, Rotary
SW302		ON-OFF, Part of R131

Chokes

Z101	1802678	50 µH Choke, Wilco ES2678
Z301	1800063	Ferrox Cube, VK-200-19-4B
Z302	1800063	Ferrox Cube, VK-200-19-4B
Z303	1870004	Core, Ceramic 57-1362
	1870003	Core, Ferrite 57-0180 (for G2 of Q101)

Miscellaneous

FL101, FL102	2303504	Crystal Filter, Monolithic, 10.7 MHz, Matched Pair
J101	2100252	Connector, Molex, 15-pin Female
	2100254	Terminal, Female, for J101
P101	2100255	Connector, Molex, 15-pin Male
	2100253	Terminal, Male, for P101
P401	2100070	Plug, 4-pin for Subaudible PC Board
P402	2100069	Plug, 6-pin for Subaudible PC Board
DS301	3900025	Bulb, #53
	2100062	Sockets, Crystal Pin
J301	2100256	Receptacle, Co-ax, Amphenol 83-878
F301	5140008	Fuse, 3AG 7 Amp
	5142068	Clip, Fuse, Littelfuse
SP101	1320025	Speaker, 3.2 ohm, 3.5"
	1325069	Microphone, Ceramic
	2510189	Front, Plastic
	2510192	Cover, Plastic (Top or Bottom); 1 assembled to "Front"

2510211	Positioner, Handle assembled to Cover
2510107	Bracket, Mounting
2400023	Knob, Thumbwheel
2510210	Knob, Channel
2510247	Heatsink
2510227	Bracket, Heatsink
2510226	Knob, Volume or Squelch
2510373	Bracket, Sw. Mtg.

2510210	Knob, Channel
7011200	SA-1 Jumper Bd (supplied when tone bd. not used)