

# SA-44 TONE ENCODER/DECODER SERVICE MANUAL

**LIMITED**

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# SECTION I

## GENERAL INFORMATION

### 1-1. INTRODUCTION

This service manual contains all the information normally required to install, operate, and service the Genave Model SA-44 subaudible-tone squelch encoder/decoder, commonly referred to as a "continuous-tone-controlled squelch system" (CTCSS).

### 1-2. DESCRIPTION

The Genave Model SA-44 is a subaudible-tone system, designed as an option for use with certain Genave business-band, FM transceivers. The SA-44 tone board is intended primarily for use in compact transceivers, such as handhelds or under-dash mobile units. An advantage of subaudible-tone squelch operation is that calls by other licensees sharing the channel will not be heard.

The decoder, in the optional SA-44 subaudible tone system, opens the audio circuitry between the receiver detector and audio output; thus, muting receiver until a signal continuously modulated by the proper subaudible tone is received. During "transmit" mode, an encoder on the SA-44 tone board supplies the assigned subaudible frequency to the transmitter modulator.

When equipped with SA-44 CTCSS option, the receiver must be switched manually to the "MONITOR" mode, prior to initiating a call, to insure that channel is NOT in use. This receiver switching is accomplished by a switch located on the transceiver case; refer to applicable transceiver Owner's Manual.

The SA-44 is a completely solid-state, miniature circuit which mounts inter-

nally in the associated transceiver. It consists of a tone-generating encoder and a tone-sensitive decoder. The SA-44 is capable of encoding and decoding any single tone within the 50 Hz to 300 Hz audio range.

A single printed-circuit board contains all circuitry for the SA-44. A pin and socket arrangement provides an easy method of securing the SA-44 PC board to transceiver main PC board, as well as completing the necessary connections between the two boards.

To retrofit earlier model transceivers, such as the GHT-6, with an SA-44 tone board, six (6) wires are required to connect SA-44 circuitry to transceiver PC board, since the transceiver board does NOT contain the necessary connecting pins.

### 1-3. SPECIFICATIONS

Over-all Dimensions:	2-1/8" L (53.5 mm); 1-9/16" W (40 mm); 7/16" H (11 mm)
Weight:	.75 Oz (21 grams)
Input Voltage:	9 to 12 volts
Frequency Range:	All EIA frequencies between 50 Hz and 300 Hz
Frequency Accuracy:	±0.4 Hz
Decode Sensitivity:	Typically less than .35 uV
Bandwidth:	±1% at 900 Hz deviation, min.

## 1-4. SUBAUDIBLE-TONE FREQUENCIES

The Electronic Industries Association (EIA) has compiled a list of CTCSS sub-audible-tones that are available for assignment. The frequencies are tabulated in two groups as shown in Table

1-1. Where possible, frequencies from only one group are assigned to a specific area, while adjacent areas are assigned frequencies from the other group to minimize possibility of interference.

TABLE 1-1

<u>Group A</u>		<u>Group B</u>	
<u>Freq Hz</u>	<u>EIA Code</u>	<u>Freq Hz</u>	<u>EIA Code</u>
67.0	- XZ	71.9	- XA
77.0	- XB	82.5	- YZ
88.5	- YB	94.8	- ZA
100.0	- 1Z	103.5	- 1A
107.2	- 1B	110.9	- 2Z
114.8	- 2A	118.8	- 2B
123.0	- 3Z	127.3	- 3A
131.8	- 3B	136.5	- 4Z
141.3	- 4A	146.2	- 4B
151.4	- 5Z	156.7	- 5A
162.2	- 5B	167.9	- 6Z
173.8	- 6A	179.9	- 6B
186.2	- 7Z	192.8	- 7A
203.5	- M1	210.7	- M2
218.1	- M3	225.7	- M4
233.6	- M5	241.8	- M6
250.3	- M7		



# SECTION II

## INSTALLATION MANUAL

### 2-1. INTRODUCTION

This manual section contains all the information normally required to install an SA-44 encoder/decoder in a Genave Business-Band, Handheld Transceiver. Installation instructions are given for current transceiver models, such as the ECOM-40 and ECOM-40U, as well as instructions for retrofitting the GHT-1 or GHT-6.

### 2-2. INSTALLATION - GENERAL

Installation of the SA-44 tone board in most transceiver models simply requires that the unit back cover be removed to provide access to foil-side of printed-circuit board.

Prior to installing SA-44 tone board in any model transceiver, be sure the foam tape or other insulating material is in place on the transceiver PC board to prevent foil side of SA-44 from shorting against foil side of transceiver PC board.

REMOVE JUMPER WIRE CONNECTED BETWEEN DETECTOR OUTPUT AND AUDIO AMPLIFIER INPUT. Refer to transceiver schematic in applicable transceiver maintenance manual for location of this wire. Then, the receptacles on SA-44 are carefully aligned with the corresponding pins on transceiver PC board. With insulating tape in place, push SA-44 tone board down until it fully seats on connecting pins.

Next, it is only necessary to set sub-audible levels, deviation, and the combined tone-voice deviation as outlined in Section 4 of this manual, and also in the applicable transceiver maintenance manual.

### 2-3. INSTALLATION IN GHT-1 OR GHT-6

All wires for the SA-44 encoder/decoder installation are provided in the existing transceiver wiring harness.

1. Remove transceiver rear cover by squeezing the two rear-cover locking buttons (on bottom plate) toward each other, while lifting the rear cover. Cover will hinge upward. See GHT-1 and GHT-6 Owner's Manual.

2. Lift battery pack from unit.

**CAUTION:** Failure to remove battery could result in serious damage to transceiver.

3. Remove six chassis-mounting screws shown in Figure 2-1 below.

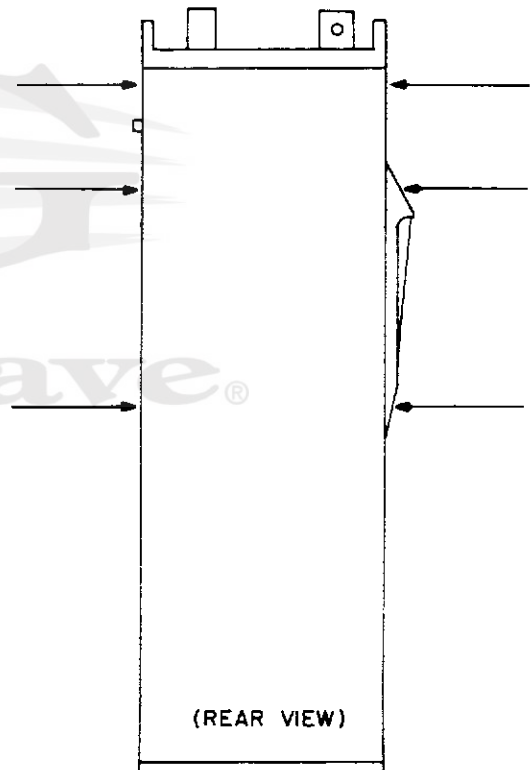


Figure 2-1. Chassis Removal

4. Flex side panel covering subaudible slide switch enough to allow switch to clear, and remove circuit-board chassis from the transceiver housing. Be careful not to damage the speaker or charging-jack leads.
5. Remove the five (5) receiver-board mounting screws, and secure receiver board in the open position (see Fig. 2-2 below).

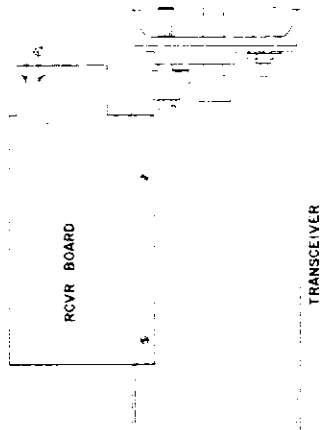


Figure 2-2. Receiver Board

6. Remove the solder connection between BLUE and YELLOW wires.
7. Refer to Figure 2-3, and make the following connections to the SA-44:
  - Brown wire -- Audio Output to Mod.
  - Blue wire --- Audio Input from Rec.
  - Red wire ---- Switched A+ (9.6 VDC)
  - Black wire -- Ground
  - Gray wire --- 9.6 VDC Xmit
  - Orange wire - Audio Output to Audio Amplifier
8. Install the SA-44 in its approximate location in circuit-board chassis.
9. Insert circuit-board chassis in the transceiver housing by flexing side panel to clear slide switch; then, replace the six (6) chassis-mounting

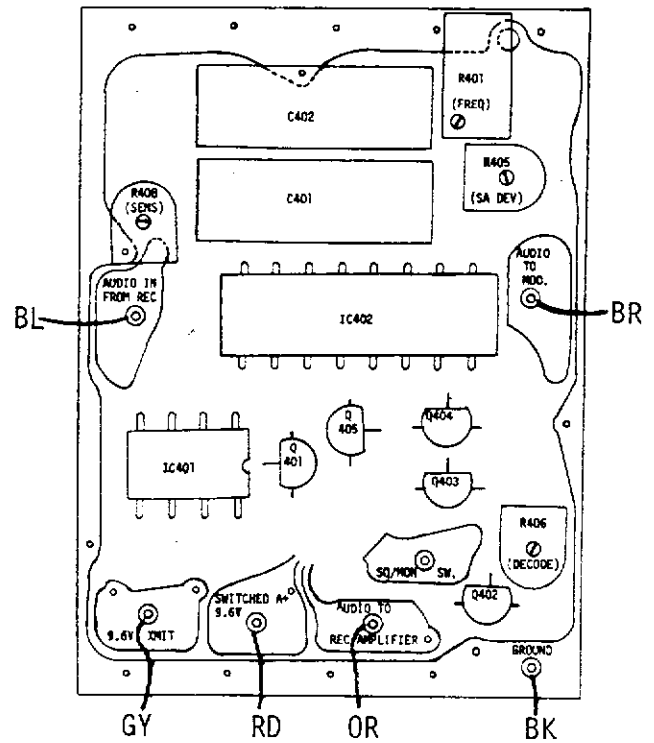


Figure 2-3. SA-44 Board

screws removed in step 3 above. The two LOWER screws are also used to secure SA-44 tone board in chassis.

**CAUTION:** Use care not to short battery charging connection lead.

10. Use #4-40 nuts on the LOWER two (2) mounting screws to secure SA-44 in place. See Figure 2-4.
11. Replace battery pack in transceiver as given in Owner's Manual.
12. Perform SA-44 adjustment procedures as given in Section 4 of this Service Manual.
13. Install receiver board in normal operating position on circuit-board chassis. Secure board with the five (5) screws removed in step 5 above.
14. Replace back cover on transceiver, and check for normal operation.

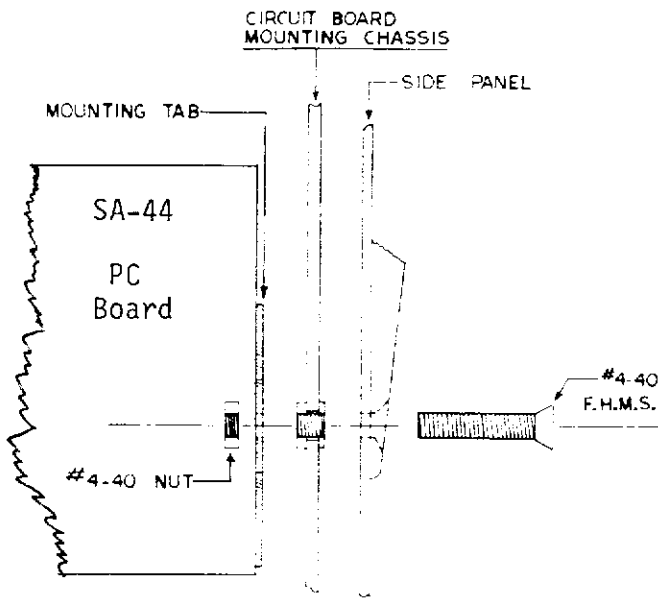


Figure 2-4. SA-44 Mounting

## 2-4. INSTALLATION IN ECOM-40/ECOM-40U

The ECOM-40 and ECOM-40U series units contain all components needed with the SA-44 tone encoder/decoder. Seven pins mounted on transceiver board mate with seven sockets on tone board to secure SA-44 in place, as well as completing electrical connections between the two PC boards.

1. Remove transceiver rear cover by removing two screws, and lifting cover off as given in Section 4-5 of ECOM-40 Maintenance Manual.
2. Remove the battery pack from unit.

**CAUTION:** Failure to remove battery could result in serious damage to transceiver.

3. Refer to PC Board Component Layout drawing in Sec. 4 of applicable transceiver Maint. Manual. Locate and remove jumper wire connected between "Det. Audio" and "Audio to Vol. Cont." points.

**NOTE:** On the first several units produced, this jumper was installed on COMPONENT side of transceiver PC board and thus required removal of instrument FRONT cover also, but on next production run, the jumper was placed on FOIL side of board so all subaudible servicing of transceiver could be done by removing only REAR cover of unit.

4. Note that phenolic insulator is in position on foil side of the Tone Board; then align the seven socket pins on tone board with the corresponding male pins on transceiver main board. Push tone board down on pins until phenolic insulator rests against the transceiver main PC board.
5. Replace battery pack in transceiver as given in Section 4-6 of the ECOM-40() Maintenance Manual.
6. Adjust SA-44 tone freq. (R401), dev. level (R405), input sensitivity (R408), and decode level pot. (R406) as given in Section 4 of this manual.
7. Set transceiver tone/voice deviation for  $\pm 5$  kHz, as given in ECOM-40() Maintenance Manual Section 4.
8. Check transmit frequency for each crystal, as shown in Section 4 of ECOM-40() Maintenance Manual.
9. Check component side of tone board for a block of foam material designed to press against unit BACK cover to hold SA-44 in place.
10. Replace BACK cover on transceiver and check for normal operation.

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# **SECTION III**

# **OPERATING MANUAL**

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# SECTION IV MAINTENANCE MANUAL

## 4-1. INTRODUCTION

The SA-44 is a solid-state, subaudible-tone squelch encoder/decoder designed for mounting in the associated transceiver. The unit is capable of encoding and decoding any single tone between 50 Hz and 300 Hz.

## 4-2. THEORY OF OPERATION

The basic circuitry of the SA-44 tone encoder/decoder consists of an active bandpass filter, an amplifier, and detection/switch circuitry. A single, integrated circuit resistor package, IC-402, contains most of the necessary resistor values for the encoder/decoder circuitry. In this circuit description, as well as on the schematic of Figure 4-2, a designation such as R<sub>3-4</sub> indicates a resistor, within the integrated circuit package, connected between pins 3 and 4.

In the ENCODING mode, JFET switch Q401 connects active bandpass filter IC401A, and amplifier IC401B, in a closed loop. Thus, the circuitry now operates as a stable oscillator. The relationship between C401, C402, R<sub>1-2</sub>, and R401 determines the frequency of the active bandpass filter and, therefore, the oscillation frequency. R401 adjusts the filter to exact frequency in the 50 Hz to 300 Hz range. Tone output of the ENCODER appears across pot. R405 which applies a portion of this tone to the subaudible modulator in the associated transceiver. The setting of R405 determines the subaudible deviation.

In the DECODING mode, JFET switch Q401 opens; thus breaking the oscillatory loop and stopping oscillation. The receiver audio appears across sensitivity

control R408, which applies a portion of this audio to inverting input of amplifier, IC401B. R<sub>12-13</sub> connects amplifier output to input of the active filter. If proper subaudible tone is present in the receiver audio, the active bandpass filter will pass the tone via R404 and C406 to the detection circuitry. Q402 is a variable-gain amplifier in which R406 adjusts amplifier gain and sets bias level for Q403; the setting of R406 determines the decode level (detection threshold).

When the incoming subaudible tone exceeds the decode level, this causes the switching preamplifier Q403 to turn ON; CR402 improves switching characteristics of Q403. As Q403 turns ON, Q404 ceases to conduct, which causes JFET switch Q405 to turn ON.

The decoded tone from the active filter (shifted 180 degrees in phase) is applied to the resistive summing network formed by R<sub>2-4</sub> and R<sub>4-13</sub>. Then audio from amplifier IC401B is also applied to this summing network, resulting in cancellation of the decoded tone at the source of JFET Q405. When the decoder is activated by receipt of its assigned tone, JFET switch Q405 turns ON and the output (at drain of Q405) consists of the receiver audio, with the subaudible tone suppressed. This audio is then applied to the audio output stage in the transceiver.

If proper subaudible tone is NOT present in the receiver audio, there will be no output from the bandpass filter. Thus Q403 is turned OFF, which turns Q404 ON and pulls gate of JFET switch Q405 down; thereby opening switch Q405. This opens audio path from transceiver detector to audio output stage, muting receiver.

## 4-3. ADJUSTMENT PROCEDURE

### 4-3-1. Test Equipment Required

a) FM Communications Test Set, with demodulated output available; for example: Cushman, Singer, Wavetek, or any equivalent.

b) Audio Generator, stable, 20 - 300 Hz (preferably digitally tuned).

NOTE: If item a) is not available, the following items can be substituted.

c) FM Generator, with EXT. MOD. input

d) Deviation Meter, with demodulated output.

### 4-3-2. Encoder Adjustment

Since the type of test equipment available will vary from Shop to Shop, only the basic steps necessary for encoder and decoder adjustment are given below.

1. With transceiver open and SA-44 adjustments accessible, connect DC power and antenna to unit; then, set frequency-selector to desired channel.
2. Set FM Test Set to same frequency as transceiver; connect a short antenna to Test Set Input.
3. Connect Audio Generator to "Horiz. Input" jack on Test Set scope. Set Horiz Input switch to "EXT." and place Vert. Input switch to "INT." Set frequency of audio generator to subaudible tone desired.

NOTE: When adjusting tone to proper frequency using this setup, a Lissajous pattern will be displayed on Test Set scope. The proper frequency is indicated by an almost stationary pattern, which may be a circle or a line depending upon the relative phase of the "demodulated audio tone" and the "audio generator tone." BE SURE pattern does NOT contain two or more loops in either the vertical or horizontal plane.

as this would indicate a tone freq. of either 1/2 or 2 times the desired frequency.

4. Key transceiver and adjust R401 (FREQ) on SA-44 tone board for the most stable pattern (1 loop or circle).

5. Adjust Test Set to read transmitter frequency deviation. Key the transceiver, and adjust R405 (S.A. DEV.) for +1 kHz deviation.

### 4-3-3. Decoder Adjustment

1. Connect RF output of Test Set to ant. jack on transceiver. If unit is not equipped with coax connector, solder a BNC connector to PC board temporarily.

2. Connect Audio Generator to modulate Test Set FM generator at the desired subaudible-tone frequency at +600 Hz deviation.

3. Set Test Set and transceiver to desired RECEIVE frequency.

4. Turn receiver squelch knob fully counterclockwise.

5. Rotate R406 (DECODE LEVEL) and R408 (SENS) on SA-44 tone board, to their approximate mid-positions, then rotate R406, if necessary, until audio is heard in receiver.

6. This step requires two slightly different procedures: One for the GHT-1/GHT-6, and the other for the ECOM-40/ECOM-40U.

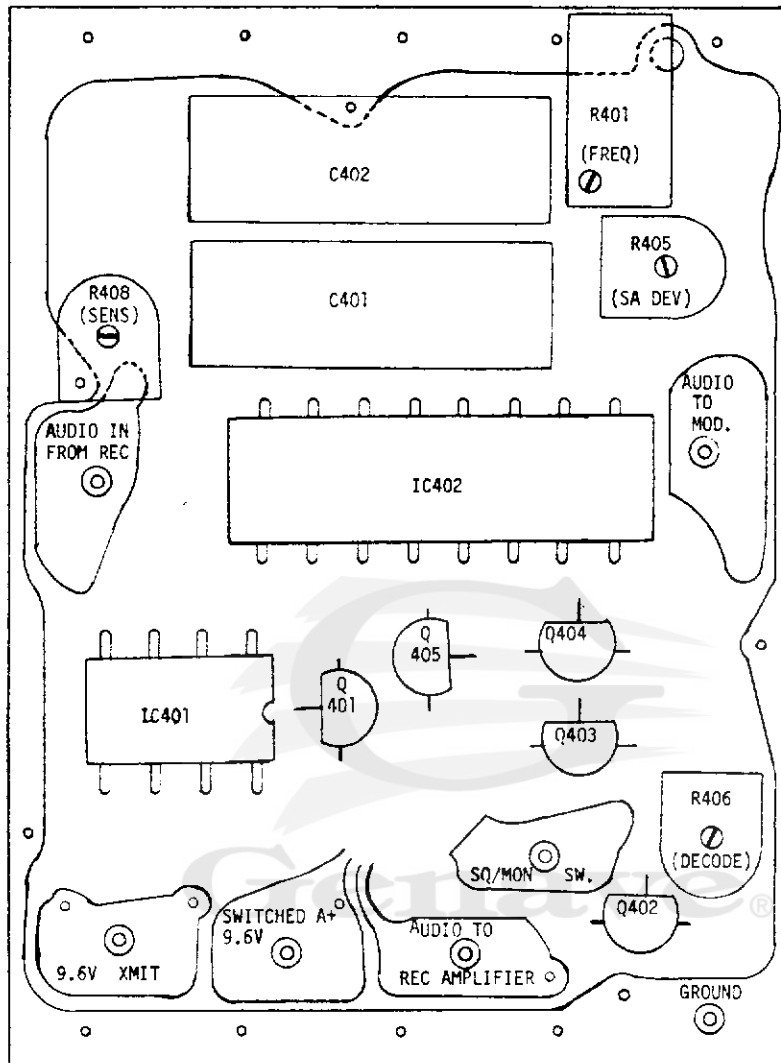
GHT-1/GHT-6 -- Slide SQUELCH/MONITOR switch on transceiver back and forth between the SQUELCH and MONITOR positions, while adjusting R408 (SENS) for the same audio level in either switch position.

ECOM-40/ECOM-40U - Adjust the R408 (SENS) control to approx. 1/3 of its resistance from ground end. If more audio is desired, the setting of R408 can be increased.

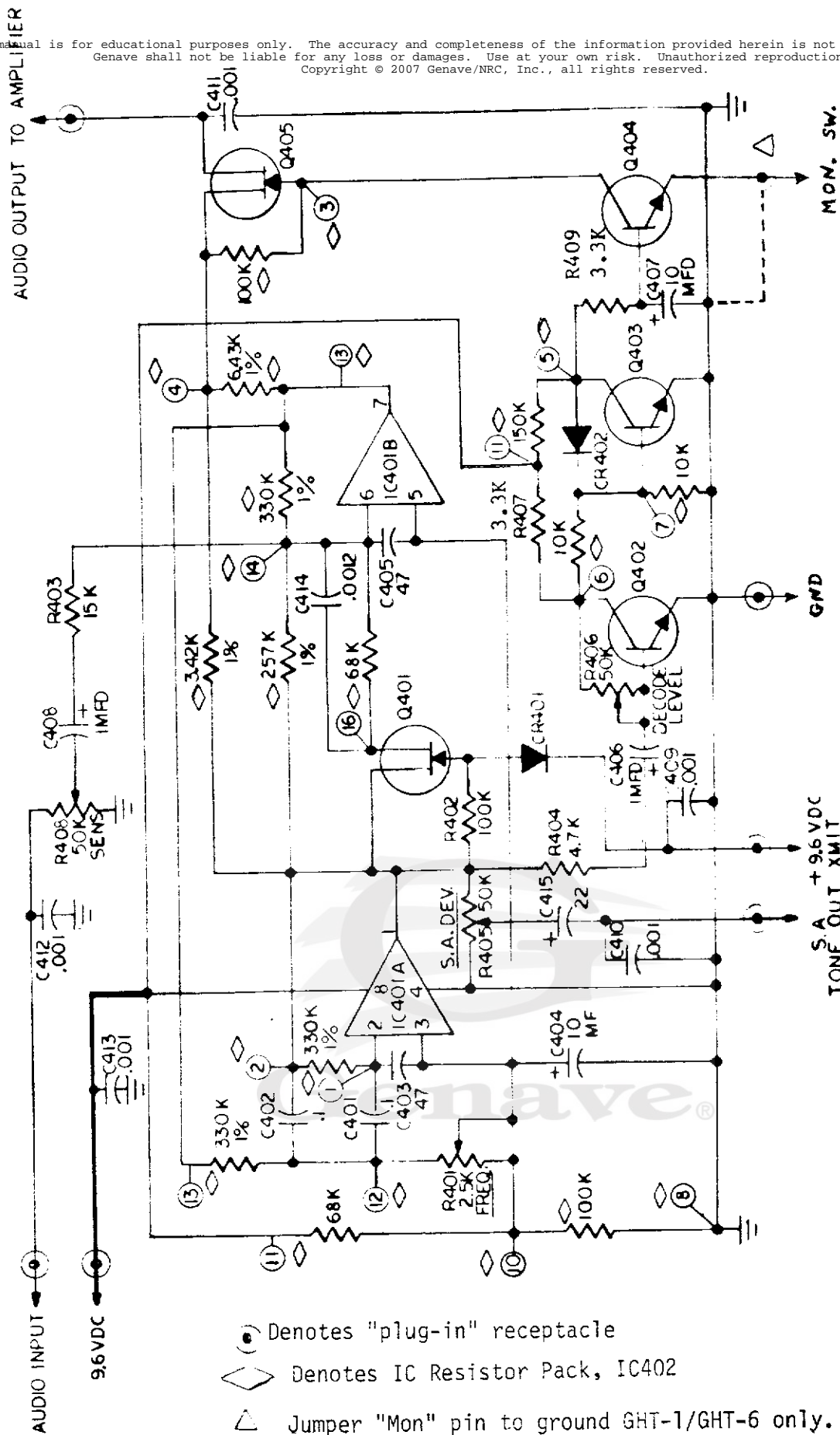
7. Place SQUELCH/MONITOR switch on transceiver case (see applicable Maintenance Manual) in its SQUELCH position.
8. Adjust R406 (DECODE LEVEL) until squelch opens.
9. Remove subaudible-tone modulation from Test Set, and note that receiver squelches.
10. GHT-1/GHT-6: Proceed with steps 13 and 14 in Section 2-3 of this Manual.  
ECOM-40/ECOM-40U: Perform steps 7 through 10 given in Section 2-4 of this Manual.



### 4-4. COMPONENT LAYOUT & SCHEMATIC



Component-side of PC Board



- ⊙ Denotes "plug-in" receptacle
- ◇ Denotes IC Resistor Pack, IC402
- △ Jumper "Mon" pin to ground GHT-1/GHT-6 only.

Figure 4-2. SA-44 Tone Board Schematic

# SECTION V

## PARTS LIST

<u>Reference Number</u>	<u>Part Number</u>	<u>Description</u>
<u>CAPACITORS C400</u>		
1, 2	1500060	Polycarbonate, .1 uF, 5%, 100V
3, 5	1520177	N2200 Disc, 47 pF, 20%
4, 7	1550007	Tant, 10 uF, 35VDC
6, 8	1550002	Tant, 1 uF, 35VDC
9 thru 13	1520196	Z5U Disc, .001 uF, 25V
14	1530011	Monolithic Disc, .0012 uF
15	1550001	Tant, .22 uF, 35VDC
<u>DIODES CR400</u>		
1	4810017	High-Speed Switching, FD1936
2	4810019	Hot Carrier, FH1100
<u>INTEGRATED CIRCUITS IC400</u>		
1	3130012	Dual Op-Amp, SN72558P
2	3130018	Resistor Package
<u>RESISTORS R400</u>		
1	4760047	Pot., 5K, Helitrim 68WR5K (FREQ)
2	4710038	Film, 100K, 5%, 1/4W
3	4710030	Film, 15K, 5%, 1/4W
4	4710025	Film, 4.7K, 5%, 1/4W
5, 6, 8	4760043	Pot., 50K, (DEV) (DECODE) (SENS)
7, 9	4710023	Film, 3.3K, 5%, 1/4W

<u>Reference Number</u>	<u>Part Number</u>	<u>Description</u>
<u>TRANSISTORS Q400</u>		
1, 5	4805458	N-Channel JFET, 2N5458
2, 3, 4	4805089	NPN Silicon, 2N5089

MISCELLANEOUS

---	1700080	Printed-Circuit Board
---	2510589	Shield
---	2100300	Receptacle, Berg VSTB 75302-001

