INSTRUCTION MANUAL

FOR

TRANSCEIVER

MODEL HT-1A

Radio industries
A SUBSIDIARY OF hallicrafters

5TH AND KOSTNER AVENUES • CHICAGO 24, ILLINOIS

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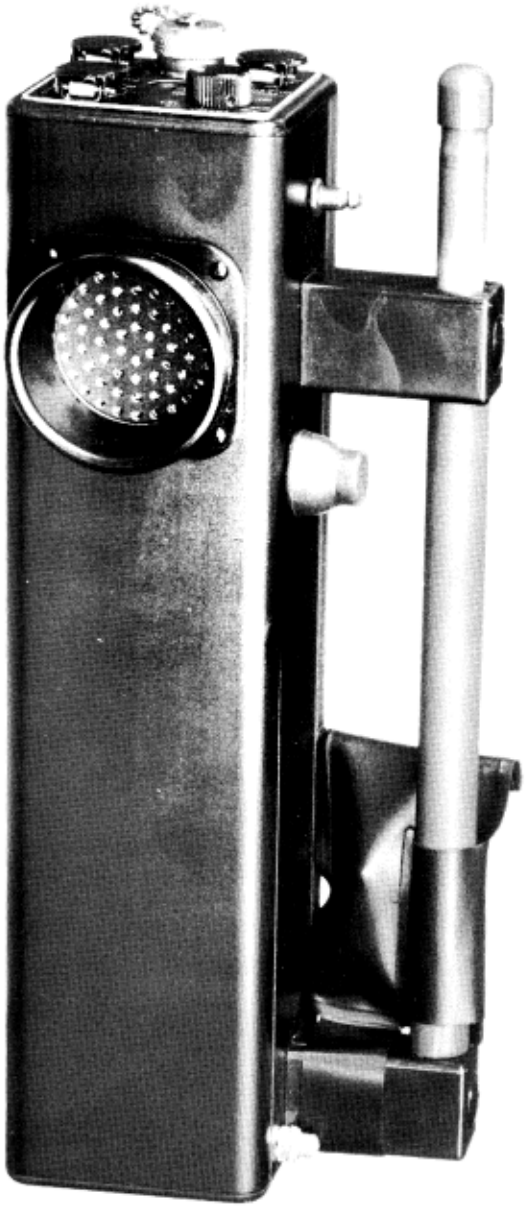


Figure 1. Model HT-1A Transceiver

SECTION I

INTRODUCTION

1. PURPOSE OF EQUIPMENT.

2. The Radio Industries Model HT-1A Transceiver is designed to transmit and receive AM (amplitude modulated) voice signals in the 30 to 40 megacycle frequency range. The equipment is a hand held portable transmitter and receiver unit. The frequency of operation and emission are compatible with that of the Village Radio Transceiver, Model TR-20 and when properly netted to the channel frequency may be used in conjunction with the model TR-20, to provide communications between the field and base units.

3. FUNCTIONAL DESCRIPTION.

4. The Model HT-1A Transceiver is designed for operation from self contained batteries providing 12 volts DC or an external 12-volt DC supply such as a storage battery for extended periods of operation. The circuits of the Model HT-1A Transceiver are completely transistorized to minimize current drain.

5. PHYSICAL DESCRIPTION.

6. The Model HT-1A Transceiver, shown in figure 1, is compact, lightweight, and rugged in construction. The sealed case prevents moisture damage to the equipment. No external connections are necessary to the equipment for normal field operation. However, when desired, connections for external antenna, headset, and external 12-volt DC supply are made at the top of the unit to the jacks provided. The Transceiver is equipped with hand and shoulder carrying straps. The unit is approximately 11-1/2 inches high, by 2-3/4 inches square excluding the telescoping antenna at the side. The antenna, when extended is approximately 74 inches in length. Weight of the unit is approximately 4-1/2 pounds, including batteries.

SECTION II

SPECIFICATIONS

7. Specifications applicable to the Radio Industries Model HT-1A Transceiver are presented in Table I. The transistor and diode complement are listed in Table II. The required fuses are listed in Table III. The dimensions and weight are given in preceding paragraph 6.

TABLE I – SPECIFICATIONS

GENERAL:

Input power — 12 volts DC, 0.180 amperes (transmit)
Transmit cycle (no limit)

TRANSMITTER:

Power output — 0.5 watts (minimum)
Emission — AM (amplitude modulated) voice
Frequency range — 30 to 40 megacycles
Number of channels — 1 (crystal controlled)
Frequency stability — ±0.005%
Output impedance — 50 ohms (nominal) to external antenna jack

TABLE I – SPECIFICATIONS (CONT)

RECEIVER:

Superheterodyne receiver circuit (transistorized) (double conversion)

Frequency range – 30 to 40 megacycles

Number of channels – 1 (crystal controlled)

Frequency stability – ±0.005%

Selectivity – 6 kilocycles at 6 DB down

Sensitivity – 1 microvolt for 10 DB $\frac{\text{Signal + Noise}}{\text{Noise}}$

1st Intermediate Frequency – 14.4 MC

2nd Intermediate Frequency – 455 kilocycles

Input impedance – 50 ohms (nominal) at external antenna jack

Audio output to speaker – 500 milliwatts (peak output)

Squelch – adjustable threshold type

Standby current – 20 milliamperes (no signal)

TABLE II – TRANSISTOR AND DIODE COMPLEMENT

Reference Symbol	Type	Function
	RECEIVER SECTION	
Q1	2N1745	RF Amplifier
Q2	2N1745	First Converter
Q3	2N1745	Second Converter
Q4	2N1790	First IF Amplifier
Q5	2N1790	Second IF Amplifier
Q6	SA536	Squelch Amplifier
D1	1N48A	Detector
D2	1N48A	Squelch Rectifier
	AUDIO AND MODULATION SECTION	
Q7	SA536	First Audio Amplifier
Q8	SA536	Driver Amplifier
Q9	2N2431	Audio Output and Modulator
Q10	2N2431	Audio Output and Modulator
	TRANSMITTER SECTION	
Q11	SM-1371	Transmitter Oscillator
Q12	2N2951	Transmitter Power Amplifier
	ACCESSORY CABLE, EXTERNAL POWER	
D101	1N91	Polarity Protection Diode

TABLE III – FUSE COMPLEMENT

Reference Symbol	Type	Function
F1	0.125 amp	Destruction Fuse
	ACCESSORY CABLE, EXTERNAL POWER	
F101	1 Amp	Equipment Protection, Accessory Power Cable

SECTION III

INSTALLATION AND ADJUSTMENT

8. UNPACKING.

9. The equipment may be shipped in either export or domestic packing cases. In either event, no special unpacking procedures are necessary. When new equipment is received, select a location where the cases may be unpacked without exposure to the elements.

10. PRELIMINARY PROCEDURES. Complete the following steps to prepare equipment for use:

a. Remove bottom coverplate by loosening the single screw at the center of plate.

b. Carefully slide front cover downward to expose the interior of the Transceiver. Inspect components for possible damage incurred in shipment. Report damages immediately to responsible personnel. DO NOT ATTEMPT TO PLACE DAMAGED EQUIPMENT IN SERVICE.

c. The equipment is normally received with crystals installed and ready for operation, requiring only battery installation given in step g below. Refer to paragraph 18, steps l and m, to check transmitter output using the field strength meter. In the event equipment is not pre-aligned complete the following steps d through g.

d. Refer to figure 3 and install crystal CR1 for the selected channel frequency in receiver section at the point shown. The crystal frequency is the operating frequency minus 14.4 Megacycles. Crystals are marked with channel frequency and preceded by the letter 'R' for receiver crystals.

EXAMPLE:

34.950 MC desired channel frequency
−14.400 MC difference frequency
20.550 MC crystal frequency (actual)

e. Refer to figure 3 and install crystal CR3 of the selected frequency in transmitter section at the point shown. The crystal frequency is the actual operation frequency desired for the selected channel. Crystals are marked with the channel frequency and preceded by the letter 'T' for transmitter crystals.

f. Refer to figure 6 and place the ON-OFF switch SW1 in the OFF position.

g. Do not replace front cover at this time. Observe battery installation decal or figure 2 and install eight (8) size 'D' cells as shown. Secure lower end plate in place temporarily with the single screw to secure batteries in place and complete the battery circuit.

NOTE

Follow battery installation diagram carefully. Improper battery installation will result in shortened battery life, improper or no voltage conditions. The battery case is designed to prevent reverse polarity battery installation, however, extreme care should be exercised.

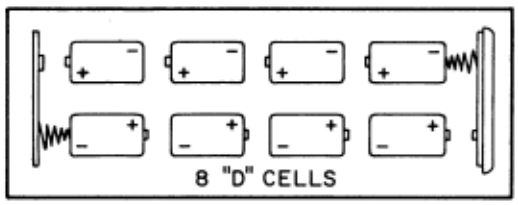


Figure 2. Battery Installation Diagram

11. TEST EQUIPMENT. The following test equipment, in addition to Model TS-20/35 Test Set and the Adapter Cable for the HT-1A Transceiver will be helpful in completing the adjustment procedures:

a. Signal Generator, covering the 455 kilocycle to 40 megacycle frequency range.

b. RF Wattmeter, or suitable dummy load with 50 ohm input impedance and provisions for metering the output.

c. Vacuum Tube Voltmeter or 20,000 ohm-per-volt Voltmeter.

d. Frequency Meter or similar frequency measuring equipment to check operating frequency.

e. Field Strength Meter FS-1 or similar meter for adjusting antenna loading for maximum radiated power.

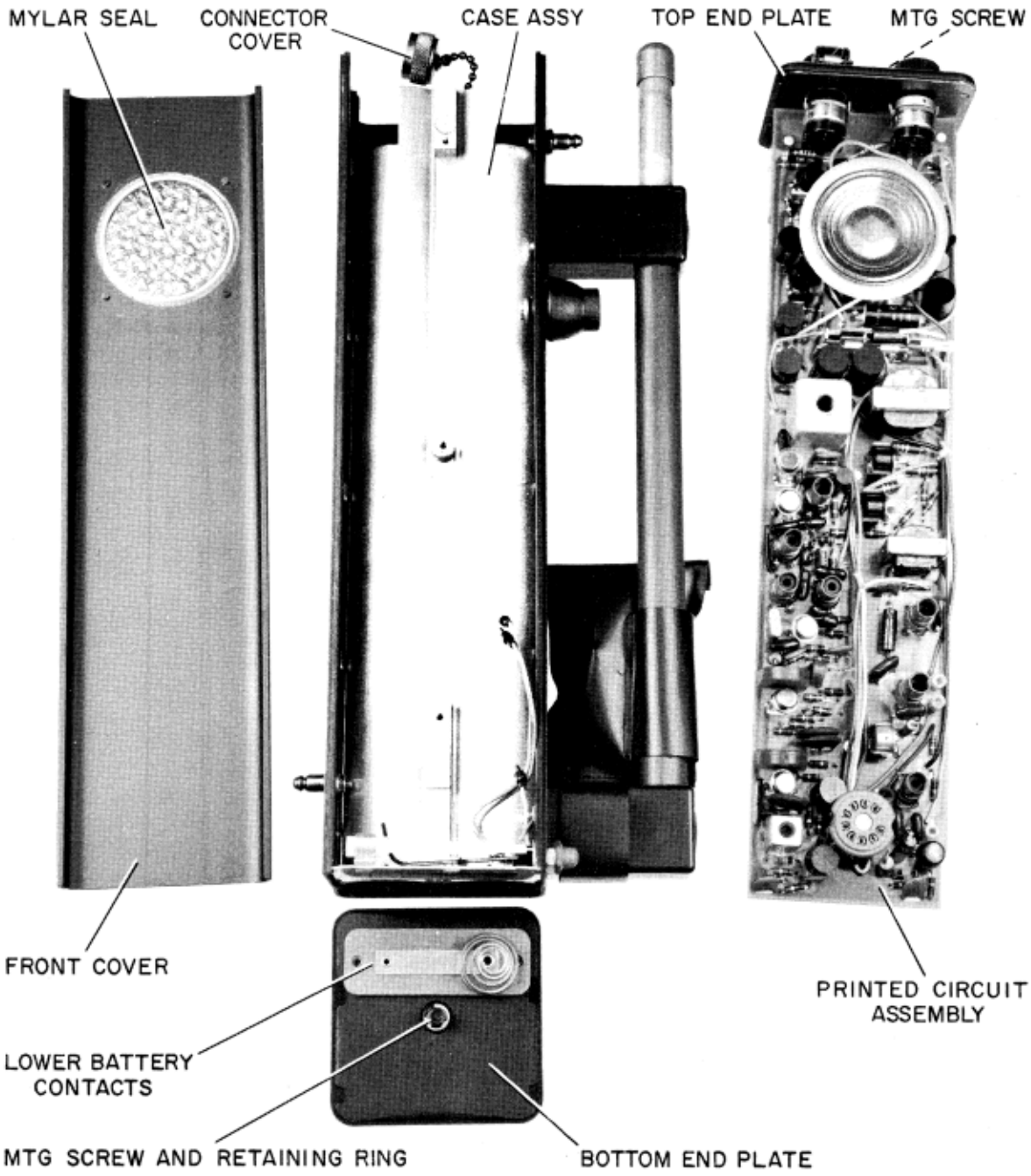


Figure 3. Model HT-1A, Interior View, Crystal, Adjustment Points, and Component Identification

12. TEST SET MODEL TS-20/35. The Radio Industries Model TS-20/35 Test Set, shown in figure 4, with Adapter Cable is designed for use with equipment of this type. The schematic diagram is shown in figure 11. The 500 microampere meter is provided with a special scale divided into red and green segments. The special scale permits rapid checking of equipment operation by semi-skilled operators. The Test Set checks the 5 circuits listed in Table IV by merely positioning a rotary selector switch. The green area is a target area unless otherwise specified. However, an indication slightly into the red area does not necessarily indicate that the transceiver is not functioning properly. When a large variation from the green area occurs, the transceiver should be checked by a skilled technician. The following steps describe Test Set connection and use:

a. Connect the eleven pin connector on Test Set to the mating connector of the Adapter Cable and the Adapter Cable Tip Plug to the pin jack located above Test Set selector switch.

b. The Test Set Adapter Cable connects to test socket S1 on the HT-1A Transceiver for completion of tune-up procedures and metering functions.

CAUTION

The TS-20/35 Test Set is a sensitive instrument. Use care in operation during alignment and measuring to prevent overload damage.

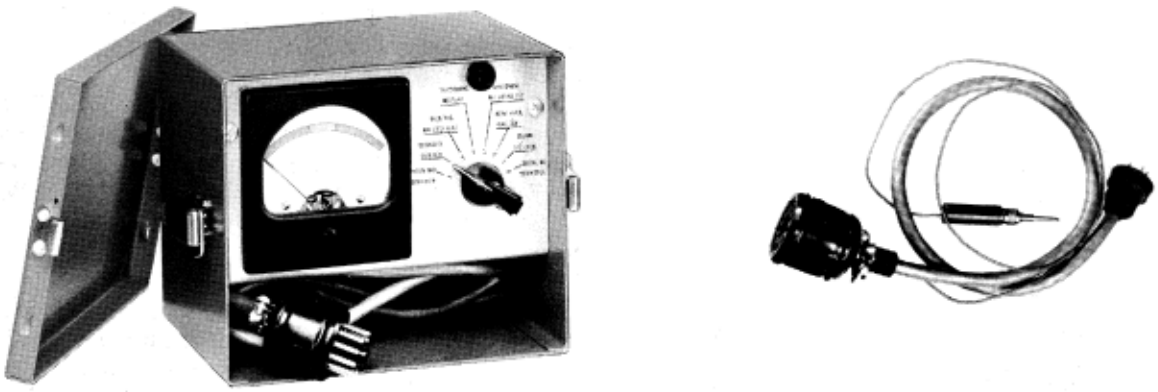


Figure 4. Model TS-20/35 Test Set and Adapter Cable

TABLE IV – TEST SET TS-20/35, SWITCH POSITIONING AND INDICATIONS

Position	Test Function	Indication
1	Battery voltage	Green
2	Not used	
3	AGC voltage	Note 1
4	Transmitter oscillator current	Green
5	Transmitter power amplifier current	Green
6	Not used	
7	Not used	
8	Modulator current	Note 2

NOTES

1. In position three, correct reading will be in the green area under no signal conditions, application of a signal causes the needle to deflect left indicating proper AGC operation.

2. In position eight, normal reading will be to the extreme left in the red area under no modulation conditions. Speaking into the microphone with PUSH-TO-TALK button depressed will cause the pointer to deflect into the green area on voice peaks.

13. FIELD STRENGTH METER MODEL FS-1. The Radio Industries Model FS-1 Field Strength Meter shown in figure 5 is designed for use with the Model HT-1A Transceiver and similar equipment in the 30 to 40 megacycle frequency range. The schematic diagram is shown in figure 11. The following steps will aid the user in obtaining optimum performance and results with the Field Strength Meter:

a. Extend the telescoping antenna and insert the plug on the antenna in the receptacle through top of case.

b. Place Field Strength Meter on the ground or table and set Tuning control to the approximate known frequency of operation.

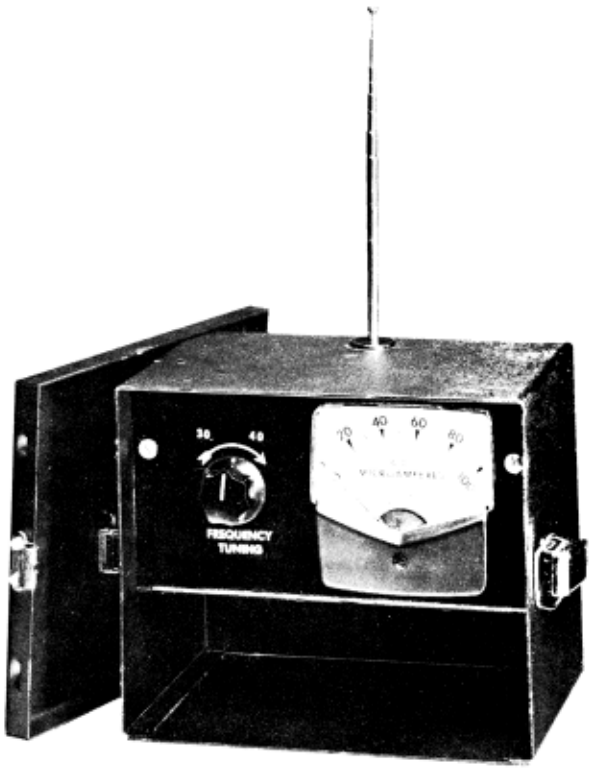


Figure 5. Model FS-1 Field Strength Meter

c. Moving a reasonable distance away from the Field Strength Meter with the Transceiver, observe Field Strength Meter and press push-to-talk button; meter should deflect upward indicating presence of the RF output.

d. Complete tune-up and adjustment procedures as specified tuning for maximum indication.

e. Sensitivity may be reduced by detuning the input circuit by positioning of the tuning control.

14. LOCATION AND FUNCTION OF CONTROLS.

15. Table V lists the reference designation, item name or marking, and the function of controls on the Model HT-1A Transceiver. Figure 6 shows their locations.

16. RECEIVER ADJUSTMENT. Complete the following steps to adjust receiver for use:

a. Refer to figure 3 and connect the TS-20/35 Test Set to Test Meter receptacle S1 using the Test Set Adapter Cable if not previously connected.

b. Place the eight position selector switch on the Test Set in the number one position (Battery Voltage). Refer to figure 6 and place the ON-OFF VOLUME Control SW1 in the ON position, and observe meter for proper indication of battery voltage (green target area).

c. Open the jack cover at SQUELCH control R32 and set control to the extreme clockwise position (squelch "open" condition). Place VOLUME ON-OFF control and switch, R31/SW1 in the extreme clockwise position (maximum volume).

d. RF coils L4 and L5 of 14.4 MC IF transformer normally do not require field adjustment. In the event difficulties are encountered, set the generator to a frequency of 14.4 MC and adjust output to approximately 10 millivolts. Couple the signal generator to L4 through a single turn link. Place the Test Set selector switch in the number three position (AGC voltage), and adjust for minimum meter reading, using an insulated alignment tool. Circuits are extremely sharp and require extreme care in alignment.

e. Remove the threaded cover on EXT ANT receptacle J2 and connect a signal generator to coaxial connector J2. Tune the generator to the desired channel frequency, reduce generator output to the point where a signal is just audible in the loudspeaker. FOR NO SIGNAL CONDITION REFER TO STEP g.

f. Refer to figure 3 and, using the insulated alignment tool provided, adjust RF input transformer L1, first converter transformer L2, and first converter oscillator coil L3. Adjust for maximum audio output at the loudspeaker.

g. In the event no audible signal is present in preceding step e or the signal stops abruptly during adjustments, readjust oscillator for proper operation. Adjust oscillator coil L3 until the signal is audible or a rushing noise is heard at the loudspeaker.

TABLE V – CONTROL FUNCTIONS, MODEL HT-1A TRANSCEIVER

Reference Designation	Item Name or Marking	Function
R31	VOLUME ON-OFF Control	Controls audio output level of receiver.
R32	SQUELCH Control	Establishes threshold of squelch circuit to mute receiver in absence of signal.
SW1	ON-OFF VOLUME Control	Applies or removes operating voltages to equipment.
SW2	Push-to-Talk Button	Switches operating voltage from receiver to transmitter circuits; switches antenna from receiver to transmitter; converts audio circuits to modulating circuits.
	(For units equipped with the destruct circuit.)	
SW3	Destruction Button	Equipment disabling. Functions only when push-to-talk switch is depressed, transmit condition.

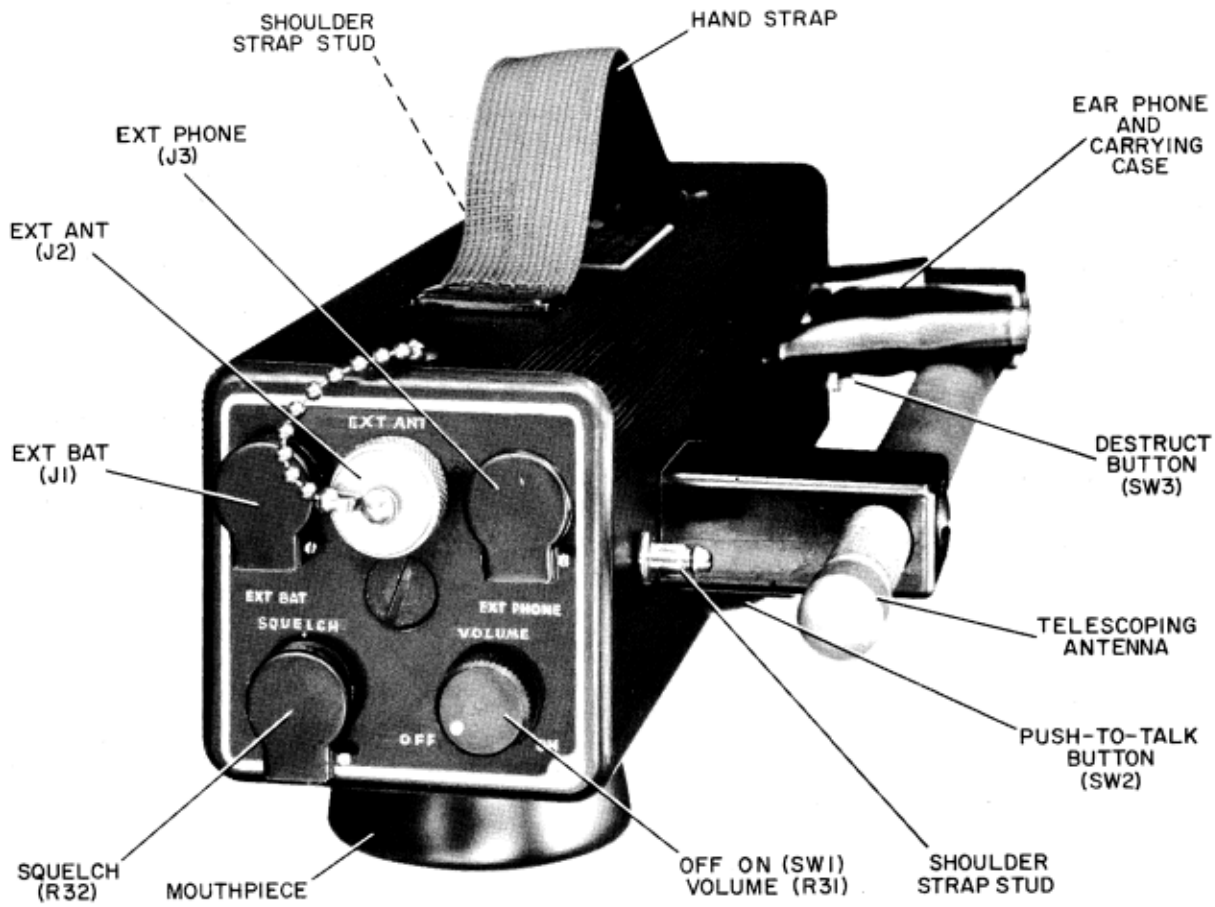


Figure 6. Model HT-1A, Location of Operating Controls and External Connection Points

h. Repeat adjustment procedures of step d, with the signal generator output reduced to approximately 1 microvolt output, tuning for minimum meter reading (left deflection, disregarding scale markings).

NOTE

Steps a through h are preliminary bench tune-up procedures and are based on operation from a 50-ohm antenna feed line. Optimum performance on the telescoping antenna is obtained by completing steps i through k.

i. Disconnect signal generator from EXT ANT receptacle and extend the telescoping antenna to maximum. Using the insulated alignment tool provided, refer to figure 3, and tune RF input transformer L1 for maximum output at the loudspeaker. The coil may be tuned for maximum background noise in the absence of a low level signal.

j. Squelch adjustment is accomplished under no signal conditions by rotating the SQUELCH control (counterclockwise) until the background noise at normal volume is just audible at the loudspeaker.

CAUTION

DO NOT operate transmitter for more than 5 seconds under the following conditions: Crystal CR3 removed from socket, improperly tuned oscillator, without a suitable antenna load, or the power amplifier severely detuned.

k. Operate the transmitter by pressing the push-to-talk button on the Transceiver and release. The receiver should return to operation immediately indicating correct oscillator starting; in the event receiver does not restart repeat step g. Observe cautions applicable to UNTUNED transmitter.

17. TRANSMITTER ADJUSTMENT. Complete the following steps to prepare the transmitter for use.

a. Connect an RF wattmeter or suitable dummy load with power measuring facilities to the EXT ANT receptacle J2 at top of case (figure 6).

b. Place the Test Set selector switch in position four (transmitter oscillator current).

c. Press the push-to-talk button on the Transceiver to operate transmitter and adjust oscillator to channel frequency by adjusting slug in coil L6 with an insulated alignment tool (figure 3). Observe Test Set meter for proper indication of current in or near green target area. The oscillator does not require peaking when adjusted to proper channel frequency by monitoring equipment. Release and press push-to-talk button several times to observe oscillator starting ability. Failure to start is normally attributed to improper adjustment such as attempting to peak the output.

d. Place the Test Set selector switch in position five (transmitter power amplifier current).

e. Refer to figure 3, operate transmitter and adjust coils L7 and L8 alternately to obtain the 0.5 watt power output indication on the RF wattmeter. The current indication on the Test Set meter must read in the green target area to prevent excess current conditions. The channel frequency should be checked on a frequency meter or receiver of known accuracy. Release and press push-to-talk button several times to check oscillator starting.

f. Place Test Set selector switch in position number eight (Modulator Current).

g. Operate the transmitter and speak distinctly and clearly into the microphone/speaker. The power indicated by the RF wattmeter will vary slightly and the Test Set meter will deflect from left to right towards the green target area on voice peaks.

h. Place ON-OFF switch SW1 in the OFF position, disconnect Test Set at Test Socket S1, and RF wattmeter from EXT ANT receptacle J2.

NOTE

Steps a through g are preliminary bench tune-up procedures. In the event the equipment is to operate into an external 50-ohm antenna no further adjustments are necessary. Steps i through p must be performed to prepare the equipment for operation using the telescoping antenna.

i. Using a Field Strength Meter complete the following steps.

j. Place the ON-OFF switch SW1 in the ON position and extend the telescoping antenna to full height.

k. Operate transmitter and adjust coils L7 and L8 for maximum output as indicated on the Field Strength Meter. Avoid overcoupling the transmitter antenna with the antenna on the Field Strength Meter to prevent erroneous indication.

l. Operate transmitter and speak into the microphone/speaker and note deflection of meter indicating presence of modulation.

m. Reconnect Test Set to Test Socket S1. Recheck transmitter oscillator current position four and transmitter power amplifier current position five.

n. Place ON-OFF switch SW1 in the OFF position, retract telescoping antenna, and disconnect the Test Set from test socket S1.

o. Remove bottom cover plate held in place by the single screw and slide front cover carefully into place. The edge of the speaker should be protected from damage by placing a small flat card or similar object over the edge while sliding the cover into position. Remove card when speaker is past the first edge of the retaining ring.

p. Replace bottom cover plate and secure, replace threaded cover on EXT ANT receptacle J2, completing tune-up procedures.

SECTION IV

OPERATION

18. GENERAL. The Radio Industries Model HT-1A Transceiver is assumed to be adjusted in accordance with the instructions contained in the preceding section.

19. OPERATION.

20. STARTING. Extend the telescoping antenna to its full height and place the ON-OFF switch VOLUME control in the ON position.

21. RECEIVER. The receiver is operative upon application of power, and requires only adjustment of audio level VOLUME control and adjustment of SQUELCH control to mute the receiver when a signal is not being received. The SQUELCH control will normally not require resetting unless attempting to receive an extremely weak signal of insufficient amplitude to break the squelch.

22. TRANSMITTER. Operate the transmitter by pressing the push-to-talk button at the side of the case and speak distinctly and clearly into the microphone/speaker. Figure 7 illustrates the proper method of operating and positioning equipment to properly modulate the output. Adjustments are not necessary on the transmitter during or preceding operation when previously pretuned and set in accordance with preceding instructions of Section III.

23. The receiver returns immediately to operation when push-to-talk button is released, antenna change-over and muting is accomplished by the switching action of push-to-talk button.

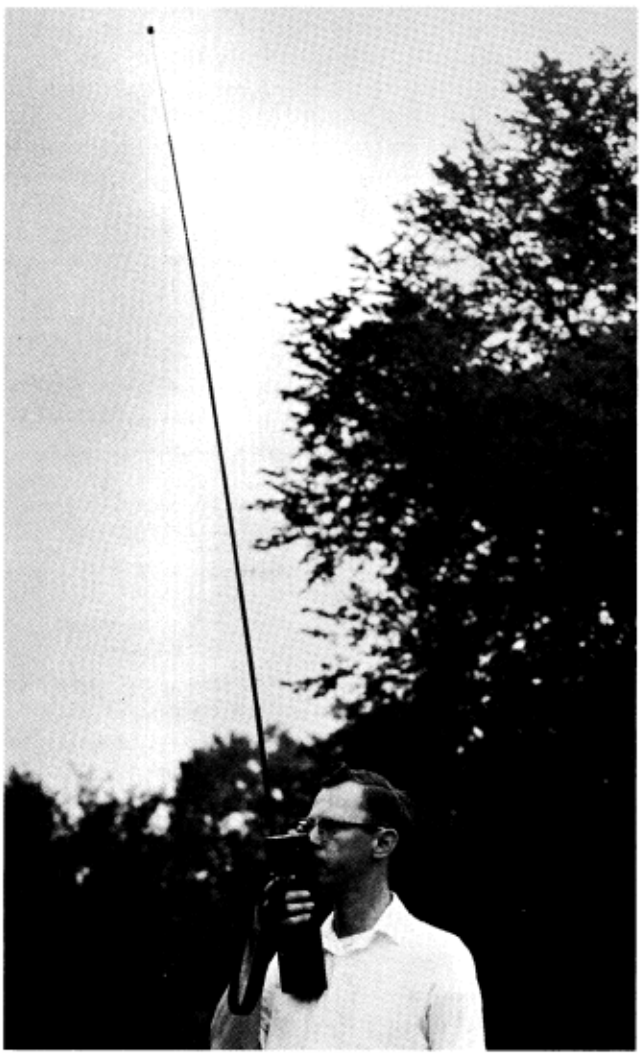


Figure 7. Proper Method of Operation

*24. DESTRUCTION TO PREVENT UNAUTHORIZED USE. The Transceiver is provided with destruct circuits which disable the equipment to prevent unauthorized use of the receiver and transmitter. Destruction is accomplished by pressing the destruct button near the lower antenna mounting block while the push-to-talk button is pressed to transmit and the ON-OFF switch is in the ON position. Accidental destruction is prevented by the interlocking action required and the accessibility of the destruct button to accidental contact.

* Applicable to units equipped with a destruct circuit.

25. The equipment is turned off when ON-OFF VOLUME control and switch is placed in the OFF position, extreme counter-clockwise position.

26. OPERATION CHECKS. The equipment requires no operating checks during or before operation when properly pre-aligned and tuned according to instructions in Section III. When operating checks are desired refer to the instructions covering the Model TS-20/35 Test Set and Adapter Cable and the Model FS-1 Field Strength Meter designed for use with the Model HT-1A Transceiver, paragraphs 13 and 14, Table IV.

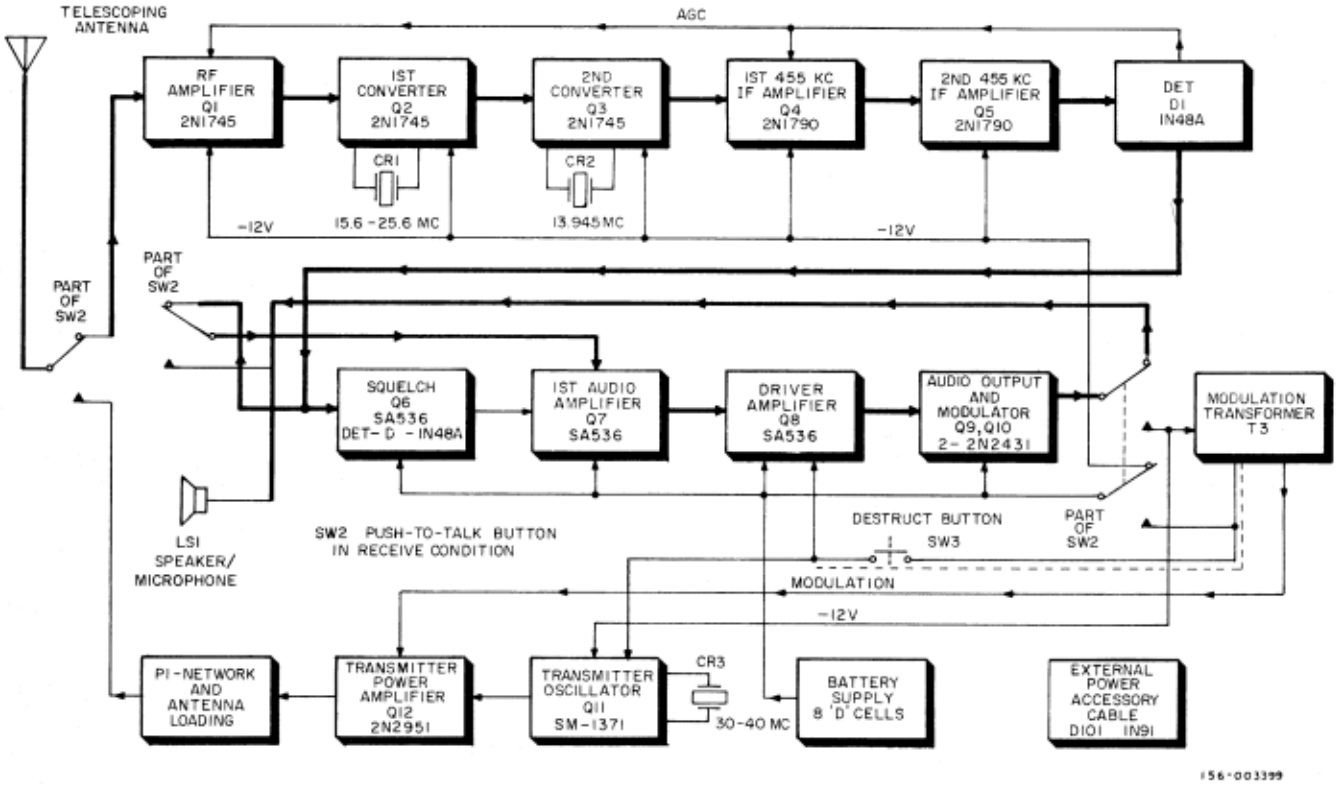


Figure 8. Model HT-1A Transceiver, Block Diagram

SECTION V

PREVENTIVE AND CORRECTIVE MAINTENANCE

27. INTRODUCTION.

28. The successful and rapid application of preventive and corrective maintenance procedures require a thorough understanding of the theory of operation of the Model HT-1A Transceiver. The following paragraphs must be studied carefully before preventive or corrective maintenance procedures are attempted.

29. THEORY OF OPERATION.

30. The Model HT-1A Transceiver consists of a transmitter and receiver in a single package with common audio circuits and self contained battery supply delivering 12-volts.

31. BLOCK DIAGRAM. The signal path through the Model HT-1A Transceiver is shown in the over-all block diagram figure 8. Paragraph 32 covers the signal path through the receiver circuits while paragraph 33 covers the transmitter signal path. For over-all circuit details refer to the schematic diagram shown in figure 11.

32. RECEIVER CIRCUITS. The receiver circuits operate from the 12-volt DC supply. The following sub-paragraphs cover the circuits in order of signal flow.

a. The RF amplifier stage Q1 in a common emitter circuit, utilizing a low noise transistor is designed to amplify a frequency in the 30 to 40 megacycle range. Output from the RF amplifier is coupled to the first converter stage through coil L2.

b. First converter stage, transistor Q2, functioning as both a mixer and a crystal controlled tickler coil oscillator is operating at a frequency of 14.4 megacycles below the incoming frequency. The output is coupled through bandpass coupler coils, L4 and L5, tuned to 14.4 megacycles to the input of the second converter stage.

c. Second converter stage, transistor Q3, is also a combination mixer/oscillator circuit. In this stage, the crystal operates in the fundamental mode in a crystal controlled Pierce oscillator circuit. The oscillator operating at 13.945 megacycles mixes with the 14.4 MC IF signal to develop a difference frequency of 455 KC for application to the first 455 KC IF amplifier through ceramic filter FL1.

d. First and Second 455 KC IF amplifiers, transistors Q4 and Q5 utilize ceramic filter coupling elements between stages. The first IF amplifier uses an additional ceramic filter in the emitter circuit to provide high selectivity. The output of second IF amplifier, transistor Q5 is developed across transformer T1. The developed output is detected by diode D1 and applied to the audio input, AGC circuit, and squelch amplifier circuit, transistor Q6. The audio is applied to first audio amplifier transistor Q7, through VOLUME control R31.

e. The AGC voltage developed at the output of detector diode D1 is applied through the decoupling and filter network to the receiver bias circuits.

f. The squelch amplifier, transistor Q6, is biased in a manner determined by the setting of squelch control R32, in the emitter circuit to permit turn-on and turn-off of the first audio amplifier. During the absence of a signal, transistor Q6 is in an "on" condition developing forward bias on diode D2 and biasing the first audio amplifier to cutoff. With the presence of a signal at the base of transistor Q6, the transistor turns "off" removing forward bias on squelch detector diode D2 and biasing the first audio amplifier permitting it to function in a normal manner.

g. The audio signal applied to first audio amplifier transistor Q7 is amplified and capacitively coupled to the driver amplifier transistor Q8 for further amplification. The output of the driver amplifier is transformer coupled to the audio output stage for amplification to the necessary level. The audio output modulator stage is functioning as a push pull class B output stage with each transistor conducting on alternate half cycles of the signal, for driving the loudspeaker or an external speaker connected to EXT PHONE receptacle J3.

33. TRANSMITTER CIRCUITS. The transmitter circuits operating from the self-contained 12-volt battery supply function as follows:

a. The transmitter oscillator, transistor Q11, in a common emitter grounded collector configuration, crystal controlled oscillator circuit develops the RF carrier across coil L6. The output is coupled to the base circuit of the transmitter power amplifier.

b. The transmitter power amplifier Q12 in a common emitter, grounded collector configuration amplifies the signal applied to the base. Modulation is applied through RF choke RFC1 in the emitter circuit. The output is developed across the Pi-network and coupled to the antenna circuit.

c. Audio amplification and modulation circuits in the transmit mode function as follows: Microphone/Speaker LS1 is capacitively coupled to the input of the first audio amplifier transistor Q7. The output is amplified through first audio amplifier transistor Q7, driver Q8 and applied to the audio output and modulator section. The output of the audio modulator is developed across modulation transformer T3 and applied to the emitter circuit of the transmitter power amplifier to provide a modulating signal to the transmitter circuit. On units equipped with a destruct circuit, pressing the destruct switch with the Transceiver operating in the transmit mode causes excess current to flow through fuse F1 in the emitter circuit of transistor Q8 and the ground return of transmitter oscillator transistor Q11, to blow the fuse preventing generation of a carrier and disabling the audio circuits in the transmit mode or audio output in the receive mode, rendering the equipment inoperative.

34. POWER SUPPLY. The power supply consisting of eight Size "D" cells develops 12 volts for operation of the equipment. The positive terminal of the battery is at ground while the negative terminal is the high side in this equipment. When using an external battery supply, such as a 12-volt automotive battery, or similar 12-volt DC supply source, external voltage is applied through EXT BAT receptacle J1 and accessory cable consisting of a polarity protect diode D101 and fuse F101. Observe battery polarity when connecting to an external battery.

35. CORRECTIVE MAINTENANCE.

36. GENERAL. Corrective maintenance involves two basic procedures: localization of trouble and isolation. Localization means tracing the trouble to the circuit responsible for abnormal operation. Isolation means tracing the trouble to the defective component. Quite frequently, the source of trouble can be isolated by inspection of components and wiring.

37. TROUBLE SHOOTING.

38. TROUBLE LOCALIZATION. The localization of trouble is most easily accomplished by performing the adjustment procedures of Section III and noting the results or indication for comparison with the normal condition. This will frequently locate the trouble.

CAUTION

Care must be exercised when using an ohmmeter in the testing of transistorized equipment. The application of ohmmeter test leads between emitter and base may damage the transistor due to reverse polarity voltage application from the meter. Check polarity of probes before testing if not known.

39. TROUBLE ISOLATION. The isolation of trouble to the defective part is most easily accomplished by the use of a vacuum tube voltmeter or volt-ohm-meter and normal transistor serving techniques. Reference to the voltage charts in Table VI facilitates rapid determination of the part at fault. During the process of isolation, continuous reference must be made to the schematic diagram to determine circuit configuration. The following sub-paragraphs cover basic tests for transistor circuits which may be performed in the isolation process.

a. Circuit Operation Checks. The circuit under question may be checked by voltage measurements based on Table VI. The transistor circuits of this equipment utilize PNP transistors in all functions with the exception of the Transmitter Oscillator and Power Amplifier which use NPN types. The voltages on all elements of the transistors will be negative with respect to ground in all cases. Voltages measured between the base and emitter circuits should reflect approximately .1 to .2 volt difference. No voltage, base to emitter, indicates possible transistor failure.

b. Operational Current Checks. Stage current is determined by measuring the voltage drop across either a resistor in the emitter or collector circuits. Calculate by Ohms Law E/R= I, to determine the current flowing. The current should not be below 0.5 milliamperes or above 3.0 milliamperes in low level stages. In the event calculated current does not fall within the range given, the resistance value across which the measurement was made should be checked, and other resistances in the circuit checked, before the transistor is replaced. This method is applicable to all circuits of the common emitter configuration whether they are amplifiers, oscillators, or converters. In checking high level push-pull stages it is desirable to use separate resistors in the emitter circuits to determine the balance of current through the two transistors, to insure equal gain and current flow during operation.

c. Transistor Current Gain Check. A rapid check of the transistors ability to control current flow is made by shorting the base to the emitter while measuring the voltage drop across a resistor in either the emitter or collector circuit. When the base is shorted to the emitter the transistor will be cut-off and the voltage across the resistor will be nearly zero. Failure of the transistor to cut-off, thus permitting current to flow, indicates that the transistor is defective and should be replaced.

d. Oscillator Check. Transistor oscillator circuits may be checked by either of two methods which follow:

(1.) Check for the presence of oscillation by using an RF probe with a sensitive vacuum tube voltmeter or volt-ohmmeter connected to the collector circuit.

(2.) Current measurement with the circuit operating versus the current measurement with the oscillator inoperative. Measuring the voltage drop across the collector resistor during normal operation a typical voltage drop could be 0.4 volt, with the oscillator inoperative by removing the crystal or shorting out the feedback path the typical voltage drop would nearly double in value.

40. PARTS REPLACEMENT AND ADJUSTMENT.

41. GENERAL. With the exception of the printed circuit board assembly, replacement of component parts in the Transceiver is completely orthodox and should be obvious to personnel who are generally familiar with electronic equipment. Before replacing any part, refer to Section VI of this manual and select only that item which is an exact replacement, (see figure 9 for component identification).

42. REMOVAL AND REPLACEMENT OF PRINTED CIRCUIT BOARD ASSEMBLY. In the event it is necessary to remove the printed circuit board or to make repairs to the board, the following steps should be completed to remove and replace the board (refer to figure 10):

a. With the bottom end plate removed, by loosening the single retaining screw, slide the front cover out of retaining channel, and remove.

b. Disengage push-to-talk button from push rod. It is not necessary to remove button assembly.

c. Disconnect the antenna lead, and two leads to the destruct switch (if so equipped) by a firm straight upward pull. Avoid bending or twisting to prevent board or connector pin damage.

d. Loosen and remove the three screws securing board to case. Remove ON-OFF VOLUME control knob with Allen wrench furnished in equipment.

e. Remove the top end plate by loosening the screw at center, and sliding assembly consisting of top end plate and board out at top end of case.

f. Remove top end plate from board by unsoldering wire connection to the rear of coaxial connector J2, and removing hardware securing connector to top end plate and bracket.

g. Install replacement board in the reverse order of sub-paragraphs a through f.

43. ADJUSTMENT AFTER REPAIRS. After repairs are made to the equipment, consideration should be given to the circuit or circuits that may be affected. When indicated, perform the applicable portion of adjustment or tune-up procedures given in Section III of this manual.

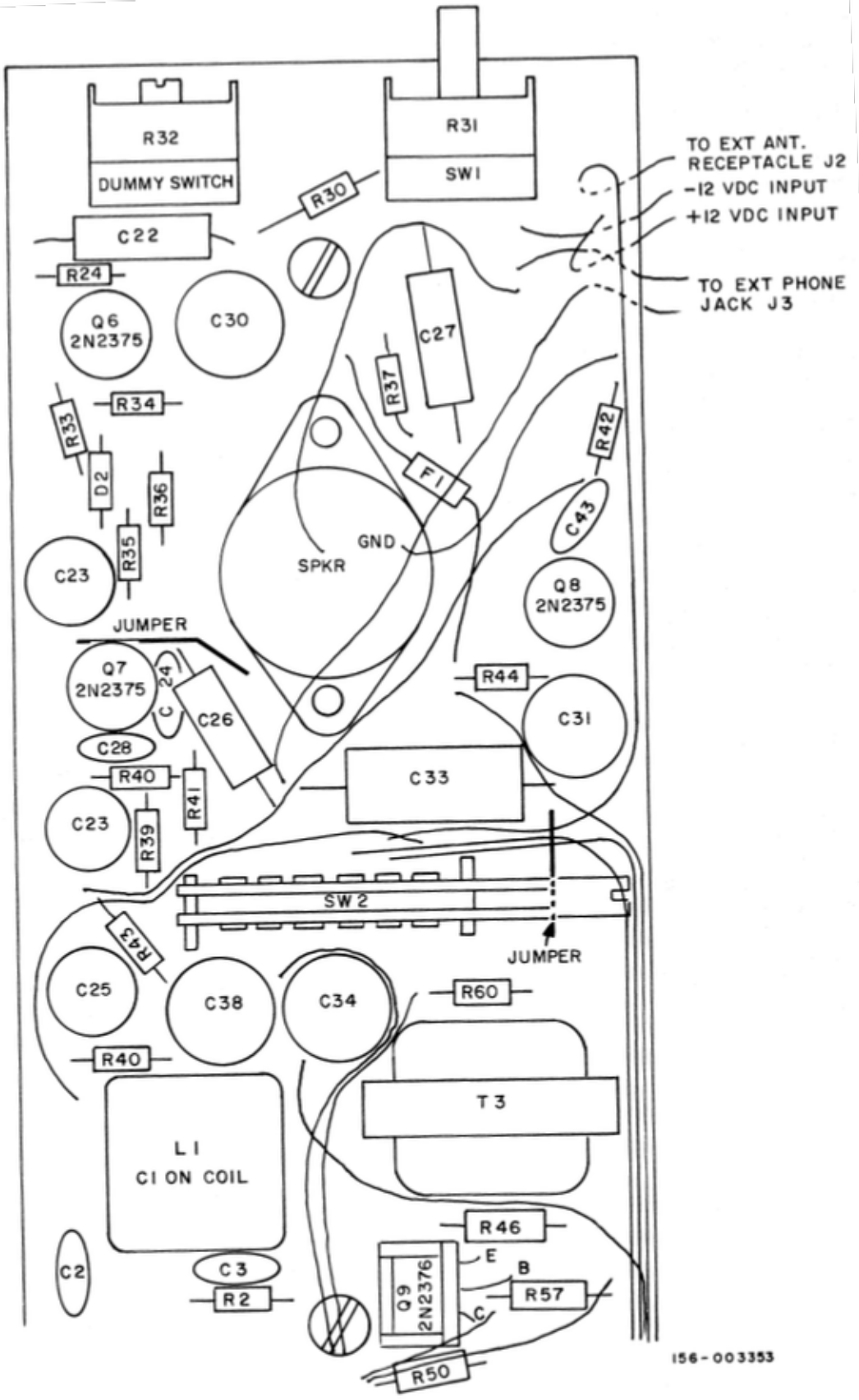


Figure 9. (Sheet 1 of 2) Model HT-1A, Printed Circuit Component Identification

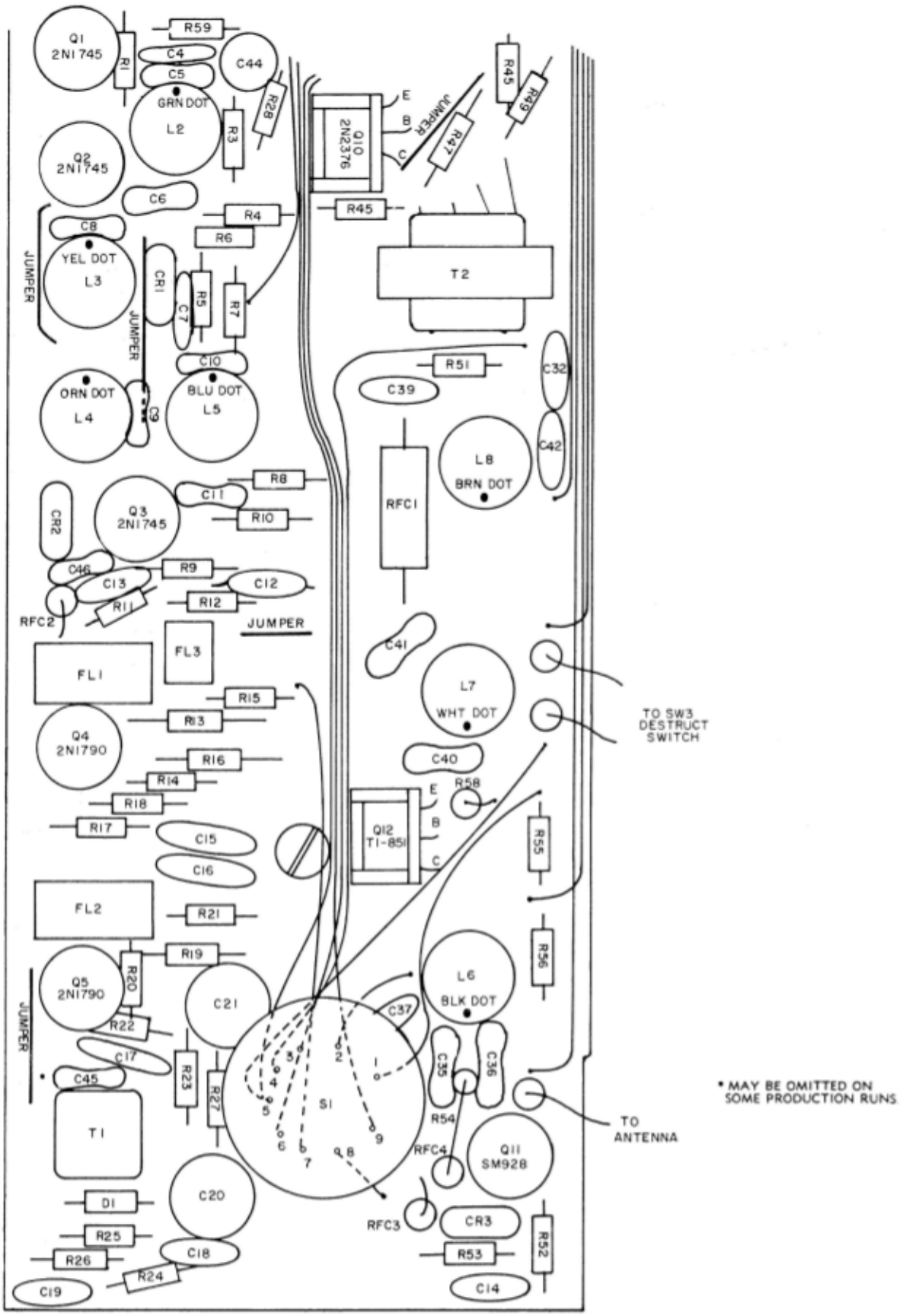


Figure 9. (Sheet 2 of 2) Model HT-1A, Printed Circuit Board Component Identification

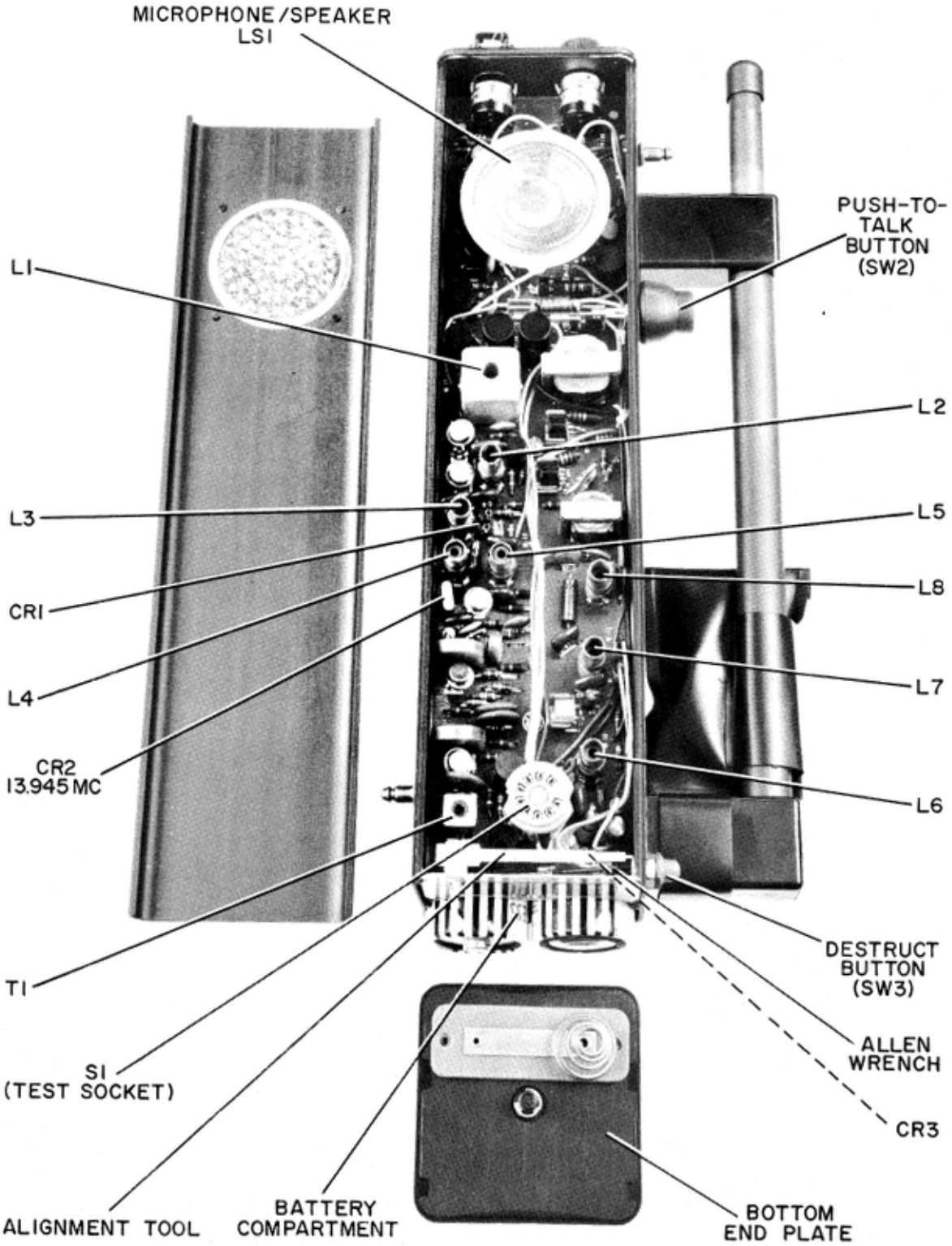


Figure 10. Model HT-1A Disassembly, Component Identification

TABLE VI – MODEL HT-1A TRANSCEIVER, VOLTAGE MEASUREMENTS

NOTE

The voltage measurements listed below were made with a Vacuum Tube Voltmeter. As readings may vary slightly from one unit to another they should be considered as approximate values. Measurements were made with the TS-20/35 Test Set disconnected and all controls in their normal receive condition (no signal), unless otherwise noted. All measurements between circuit ground (+) positive terminal of battery and point indicated, DC voltages.

	DC Base Voltage	DC Collector Voltage	DC Emitter Voltage
RF Amplifier Q1	-1.8	-11	-1.7
1st Converter Q2	-1.95	-11.2	-1.85
2nd Converter Q3	-1.85	-10.5	-1.8
1st 455 KC IF Amplifier Q4	-2.4	-6.4	-1.95
2nd 455 KC IF Amplifier Q5	-1.8	-10.5	-1.6
*Squelch Amplifier Q6	-2.15	-10.15	-3.4
1st Audio Amplifier Q7	-4.5	-7	-4.4
Driver Amplifier	-1.25	-9.3	-1.2
Audio Output and Modulator Q9	-6.15	-11.9	-5.8
Audio Output and Modulator Q10	-0.01	-6	0
Transmitter Oscillator Q11	-11	0	-10.4
Transmitter Power Amplifier Q12	-11.6	0	-11.6

*Squelch control off Squelch "open" (extreme clockwise position).

Push-to-talk switch Pressed crystal CR3 removed from socket.

CURRENT MEASUREMENTS

Receiver, No Signal	25 milliamperes
Receiver, Average Input Signal, Max Audio Output	80 milliamperes
Transmitter Current, 0.5 watt Nominal Output Carrier Only	170 milliamperes
Transmitter Current, 0.5 watt Nominal Output with Peak Modulation	250 milliamperes

SECTION VI
PARTS LIST

NOTE

Components with reference designations from 1 to 99 are part of the removable printed circuit board. Components with reference designations from 101 to 199 are accessory items. Components with reference designations from 201 to 299 are part of the Test Set TS-20/35. Components with reference designations from 301 to 399 are part of Test Set adapter.

Components with asterisks may be values other than shown, when making replacement, use the part removed for reference and see page 21 parts list for alternates.

Reference Symbol	Description	Part Number
C1	CAPACITOR, Mica, 68pf, 5%, 300vdcw.	493-110680-227
C2	CAPACITOR, Ceramic, 0.002uf, 600vdcw.	047-001704
C3	CAPACITOR, Ceramic, 0.01uf, 50vdcw.	047-001703
C4	Same as C3.	
C5	CAPACITOR, Mica, 110pf, 5%, 300vdcw.	493-110111-228
C6	CAPACITOR, Mica, 120pf, 5%, 300vdcw.	493-110121-228
C7	Same as C3.	
C8	CAPACITOR, Mica, 100pf, 5%, 300vdcw.	493-110111-228
C9	CAPACITOR, Mica, 150pf, 5%, 300vdcw.	493-110151-228
C10	Same as C9.	
C11	CAPACITOR, Mica, 300pf, 2%, 300vdcw.	493-110301-328
C12	Same as C3.	
C13	Same as C3.	
C14	Same as C3.	
C15	CAPACITOR, Ceramic, 0.1uf, 25vdcw.	047-001705
C16	Same as C15.	
C17	Same as C15.	
C18	Same as C3.	
C19	Same as C3.	
C20	CAPACITOR, Electrolylic, 25uf, 12vdcw.	045-000949
C21	CAPACITOR, Electrolytic, 5uf, 12vdcw, non-pol.	045-000954
C22	CAPACITOR, Electrolytic, 5uf, 12vdcw.	045-000953
C23	CAPACITOR, Electrolytic, 5uf, 12vdcw.	045-000952
C24	Same as C3.	
C25	Same as C23.	
C26	Same as C22.	
C27	CAPACITOR, Mylar, 0.047 uf, 400vdcw.	046-001450
C28	Same as C2.	
C29	Same as C23.	
C30	CAPACITOR, Electrolytic, 25uf, 12vdcw.	045-000951
C31	Same as C30.	
C32	Same as C3.	
C33	CAPACITOR, Electrolytic, 50uf, 12vdcw.	045-00950
C34	CAPACITOR, Electrolytic, 100uf, 12vdcw.	045-000955
*C35	CAPACITOR, Mica, 82pf, 5%, 300vdcw.	493-110820-227
*C36	CAPACITOR, Mica, 18pf, 5%, 300vdcw.	493-110180-225
C37	Same as C3.	

Reference Symbol	Description	Part Number
C38	Same as C34.	
C39	Same as C3.	
C40	Same as C1.	
C41	CAPACITOR, Mica, 33pf, 5%, 300vdcw.	493-110330-227
C42	Same as C2.	
C43	Same as C2.	
C44	CAPACITOR, Electrolytic, 5uf, 20vdcw.	045-000990
C45	CAPACITOR, Mica, 130pf, 2%, 300vdcw.	047-001722
C46	CAPACITOR, Mica, 34pf, 2%, 300vdcw.	493-110340-327
CR1	CRYSTAL, Quartz, HC-6/u case-plug in, Receiver channel frequency desired-14.4 mc.	019-003040
CR2	CRYSTAL, Quartz, HC-6/u case, solder lugs, Mixer crystal 13.945 mc.	019-003038
CR3	CRYSTAL, Quartz, HC-6/u case, plug-in at operating frequency.	019-003039
D1	DIODE, Germanium. 1N48A	019-003001
D2	Same as D1.	
E1	ANTENNA, Telescoping, modified.	057-000433
F1	FUSE, Miniature pigtail type, 0.125 amp, 225V.	039-000751
FL1	FILTER, Ceramic, 455 Kc IF.	049-000246
FL2	Same as FL1.	
FL3	FILTER, Ceramic, 455 Kc.	049-000245
J1	CONNECTOR, Receptacle, male, phono, chassis mtg.	150-006210
J2	CONNECTOR, Receptacle, UHF coaxial type, single hole mtg.	010-002663
J3	CONNECTOR, Receptacle, female, miniature telephone type, W/NC contact.	036-000347
LS1	SPEAKER-MICROPHONE, 2 inch permanent magnet, 45 ohms.	085-000228
L1	TRANSFORMER, Rf input, 30 to 40 mc, (Red dot).	051-003638
L2	TRANSFORMER, Rf, coupling, (Green dot).	051-003637
L3	TRANSFORMER, 1st converter, (Yellow dot).	051-003636
L4	TRANSFORMER, Band-pass coupler, (Orange dot).	051-003635
L5	TRANSFORMER, 2nd converter, (Blue dot).	050-000904
L6	TRANSFORMER, Transmitter Oscillator, (Black dot).	050-001449
L7	COIL, Rf, pi-network, output, (Brown dot).	051-003640
L8	COIL, Rf, output coupling, (White dot).	051-003641
Q1	TRANSISTOR, Germanium, PNP, 2N1745.	112-000225
Q2	Same as Q1.	
Q3	Same as Q1.	
Q4	TRANSISTOR, Germanium, PNP, 2N1790.	112-000224
Q5	Same as Q4.	
Q6	TRANSISTOR, Germanium, PNP, SA536.	019-003346
Q7	Same as Q6.	
Q8	Same as Q6.	
Q9	TRANSISTOR, Germanium, PNP, 2N2431.	
Q10	Same as Q9.	
*Q11	TRANSISTOR, Silicon, NPN, SM-1371.	019-003343
*Q12	TRANSISTOR, Silicon, NPN, 2N2951/MM719.	019-003349
RFC1	CHOKE, Rf, 3.3 microhenry.	053-000667
RFC2	CHOKE, Rf, 15uh.	053-000688
*RFC3	CHOKE, Rf, 0.47.	053-000664

Reference Symbol	Description	Part Number
RFC4	CHOKE, Rf, 2.2uh.	053-100534
R1	RESISTOR, 10K ohms, 10%, 1/4w.	451-152103
R2	RESISTOR, 1,000 ohms, 10%, 1/4w.	451-152102
R3	RESISTOR, 470 ohms, 10%, 1/4w.	451-152471
R4	RESISTOR, 4.7K ohms, 10%, 1/4w.	451-152472
R5	RESISTOR, 22K ohms, 10%, 1/4w.	451-152223
R6	RESISTOR, 3.3K ohms, 10%, 1/4w.	451-152332
R7	Same as R3.	
R8	RESISTOR, 2.2K ohms, 10%, 1/4w.	451-152222
R9	Same as R1.	
R10	RESISTOR, 1.5K ohms, 10%, 1/4w.	451-152152
R11	Same as R8.	
R12	Same as R3.	
R13	Same as R6.	
R14	RESISTOR, 47K ohms, 10%, 1/4w.	451-152473
R15	RESISTOR, 8.2K ohms, 10%, 1/4w.	451-152822
R16	Same as R2.	
R17	Same as R8.	
R18	Same as R3.	
R19	Same as R6.	
R20	RESISTOR, 15K ohms, 10%, 1/4w.	451-152153
R21	Same as R2.	
R22	Same as R3.	
R23	Same as R4.	
R24	Same as R2.	
R25	Same as R2.	
R26	Same as R1.	
R27	Same as R6.	
R28	RESISTOR, 27K ohms, 10%, 1/4w.	451-152273
R29	Same as R2.	
R30	Same as R14.	
R31	RESISTOR, Variable, 10K ohms, 1/4w, audio taper, w/spst switch (SW1), 9/16 in.lg. shaft.	025-002162
R32	RESISTOR, Variable, 3K ohms, 1/4w, linear taper, 1/8 in.lg. slotted shaft. (w/dummy switch)	025-002163
R33	RESISTOR, 6.8K ohms, 10%, 1/4w.	451-152682
R34	Same as R1.	
R35	Same as R5.	
R36	Same as R28.	
R37	Same as R8.	
R38	Same as R4.	
R39	Same as R1.	
R40	Same as R1.	
R41	Same as R3.	
R42	Same as R8.	
R43	Same as R20.	
R44	Same as R3.	
R45	RESISTOR, 18 ohms, 10%, 1/4w.	451-152180

Reference Symbol	Description	Part Number
R46	RESISTOR, 2.7 ohms, 10%, 1/2w.	451-152027
R47	Same as R2.	
R48	Same as R45.	
R49	Same as R2.	
R50	Same as R46.	
R51	RESISTOR, 2.7K ohms, 10%, 1/4w.	451-152272
R52	Same as R2.	
R53	Same as R15.	
R54	RESISTOR, 47 ohms, 10%, 1/4w.	451-152470
R55	RESISTOR, 330 ohms, 10%, 1/4w.	451-152331
R56	RESISTOR, 10 ohms, 5%, 1/4w.	451-151100
R57	Same as R46.	
R58	Same as R46.	
R59	Same as R28.	
R60	Same as R3.	
S1	SOCKET, Test, 9 pin min. female, noval, modified.	150-006181
SW1	SWITCH, SPST, p/o R-31.	
SW2	SWITCH, 4PST, push button, spring return.	060-002576
SW3	SWITCH, Push button, SPST, normally open.	060-002583
T1	TRANSFORMER, If output, 455 kc.	050-000930
T2	TRANSFORMER, Audio, modulation driver.	055-000488
T3	TRANSFORMER, Audio, modulation.	055-000487

ALTERNATE COMPONENTS

C35	CAPACITOR, Mica, 82pf, 5%, 500vdcw.	493-110820-233
C36	CAPACITOR, Mica, 18pf, 5%, 500vdcw.	493-110180-231
RFC3	CHOKE, R-f, 0.22uh.	053-000661
Q11	TRANSISTOR, Silicon, NPN, SM928.	112-000221
Q12	TRANSISTOR, Silicon, NPN, TI-851A	112-000220

P/O ACCESSORY ITEMS

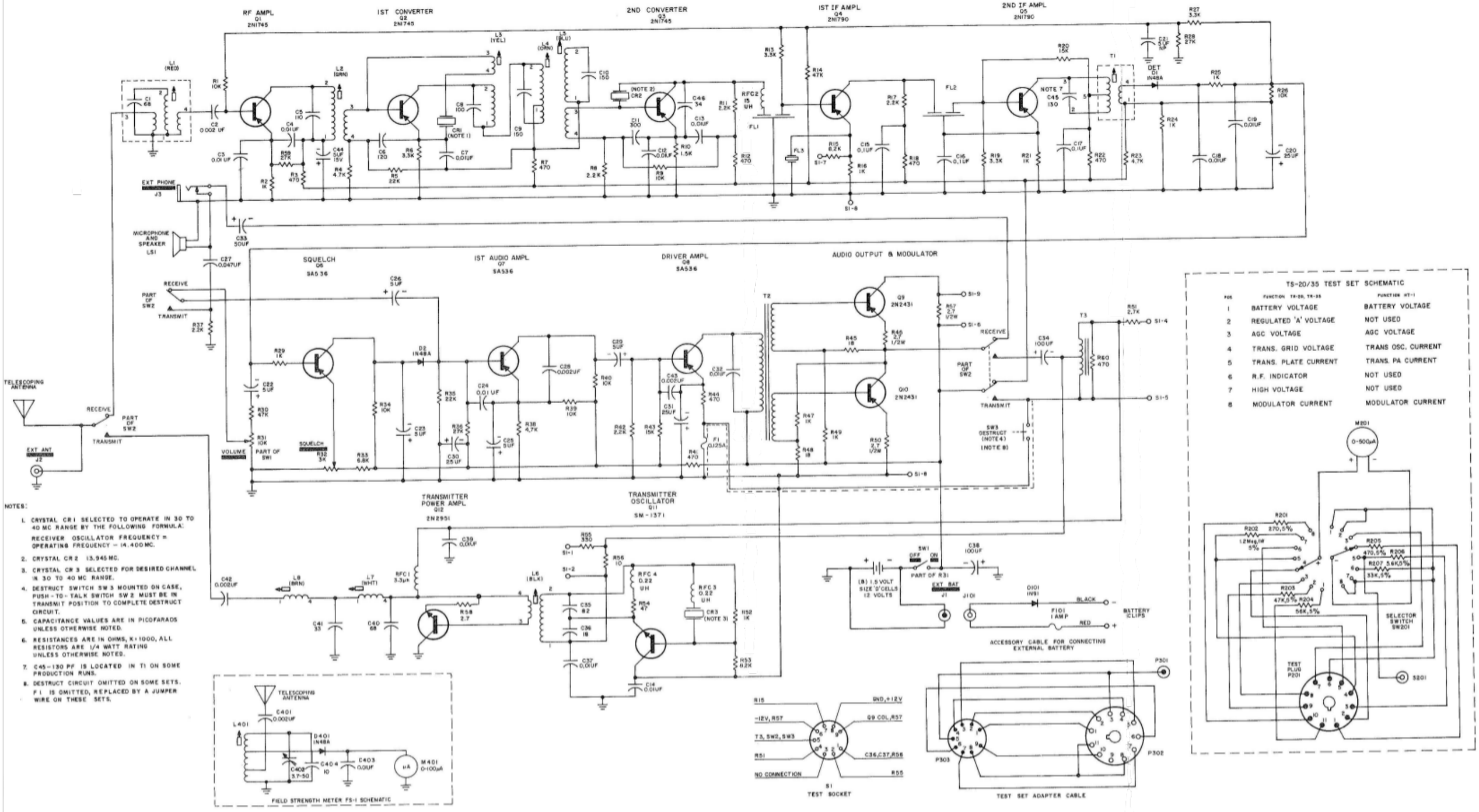
Reference Symbol	Description	Part Number
D101	DIODE, Germanium, power, 1N91.	019-001897
F101	FUSE, Cartridge, 1 amp, 3AG.	039-000306
J101	CONNECTOR, Receptacle, female, phono, chassis mtg.	010-002997

P/O TEST SET TS-20/35

P201	CONNECTOR, Plug, 11 pin, male, w/keyway.	006-001132
R201	RESISTOR, 270 ohms, 5%, 1/2w.	451-251271
R202	RESISTOR, 1.2 megohm, 5%, 1w.	451-351125
R203	RESISTOR, 39K ohms, 5%, 1/2w.	451-251393
R204	RESISTOR, 56K ohms, 5%, 1/2 w.	451-251563
R205	RESISTOR, 470 ohms, 5%. 1/2 w.	451-251471
R206	RESISTOR, 5600 ohms, 5%, 1/2w.	451-251562
R207	RESISTOR, 27K ohms, 5%, 1/2w.	451-251273
S201	CONNECTOR, Receptacle, female, pin jack type, chassis mtg.	036-000371
SW201	SWITCH, Rotary, 2 pole, 8 position.	060-002690

P/O TEST SET ADAPTER

P301	CONNECTOR, Plug, pin plug test lead type.	011-001433
P302	CONNECTOR, Plug. 11 pin female, with keyway.	010-002998
P303	CONNECTOR, Plug, male 9 pin, male, noval base.	150-006189



NOTES:

1. CRYSTAL CR1 SELECTED TO OPERATE IN 30 TO 40 MC RANGE BY THE FOLLOWING FORMULA:
   RECEIVER OSCILLATOR FREQUENCY = OPERATING FREQUENCY − 14.400 MC.
2. CRYSTAL CR 2 13.945 MC.
3. CRYSTAL CR 3 SELECTED FOR DESIRED CHANNEL IN 30 TO 40 MC RANGE.
4. DESTRUCT SWITCH SW 3 MOUNTED ON CASE, PUSH-TO-TALK SWITCH SW 2 MUST BE IN TRANSMIT POSITION TO COMPLETE DESTRUCT CIRCUIT.
5. CAPACITANCE VALUES ARE IN PICOFARADS UNLESS OTHERWISE NOTED.
6. RESISTANCES ARE IN OHMS, K=1000, ALL RESISTORS ARE 1/4 WATT RATING UNLESS OTHERWISE NOTED.
7. C45-130 PF IS LOCATED IN T1 ON SOME PRODUCTION RUNS.
8. DESTRUCT CIRCUIT OMITTED ON SOME SETS. F1 IS OMITTED, REPLACED BY A JUMPER WIRE ON THESE SETS.

TS-20/35 TEST SET SCHEMATIC

POS	FUNCTION TS-20, TS-35	FUNCTION HT-1
1	BATTERY VOLTAGE	BATTERY VOLTAGE
2	REGULATED 'A' VOLTAGE	NOT USED
3	AGC VOLTAGE	AGC VOLTAGE
4	TRANS. GRID VOLTAGE	TRANS OSC. CURRENT
5	TRANS. PLATE CURRENT	TRANS. PA CURRENT
6	R.F. INDICATOR	NOT USED
7	HIGH VOLTAGE	NOT USED
8	MODULATOR CURRENT	MODULATOR CURRENT

Figure 11. Model HT-1A Schematic Diagram.