PRICE $2.50

SERVICE MANUAL

PACE SCAN 150
FM—VHF
SCANNING MONITOR
RECEIVER

(150-163 MHz)

PATHCOM INC.
PACE TWO-WAY RADIO PRODUCTS
24049 S. Frampton Ave., Harbor City, California 90710

PACE

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

SECTION I
GENERAL INFORMATION

1.1 GENERAL DESCRIPTION

This manual contains the necessary information to perform a detailed troubleshooting analysis and complete alignment on the PACE Model SCAN 150 Scanning Monitor Receiver.

The SCAN 150 is designed to cover one principal band of Public Safety and Land Mobile operation for two-way radios in the 150 to 163 MHz range. It is a pocket size scanner capable of scanning up to four crystal controlled channels in this band. Lockout switches are located on the control panel to provide additional control of each channel being scanned.

1.2 SPECIFICATIONS

Technical specifications for the PACE SCAN 150 Scanning Monitor are shown in Table 1-1.

1.3 CRYSTAL INFORMATION

Precision PACE crystals may be obtained from any authorized PACE Dealer. These PACE crystals will also provide better performance in many other brands of receivers utilizing 10.7 MHz IF. Check the local PACE Dealer for interchangeability information. When ordering crystals from other than the PACE Factory, be sure to specify the crystal formulas as shown in Table 1-2.

1.4 OTHER PERTINENT INFORMATION

This scanning monitor receiver is certified to comply with the necessary government requirements for receiver radiation. It is FCC Certified in compliance with Part 15. Each country and state has varying regulations concerning the application and use of monitor receivers in the Public Safety Service or other services. The user is required to be cognizant of these regulations for his area of operation.

Table 1-1
Technical Specifications

FCC Certified	Part 15C
Frequency Range	150 to 163 MHz, total spread of 7 MHz
Sensitivity	0.6 μV or better for 20 dB quieting
Squelch Sensitivity (Threshold)	0.5 μV
Selectivity	70 dB @ ± 20 kHz
Spurious Rejection	More than 50 dB
IF Frequency	1st IF 10.7 MHz; 2nd IF 455 kHz
Scanning Rate	4 channels per half/second typical
Power Source	5 V DC using 4 "AA" Nicad batteries
Dimensions	6" high x 2-5/8" wide x 1-3/16" deep
Weight	9 ounces including battery

Table 1-2
Crystal Specifications

Crystal Frequency	$= \frac{\text{Channel Frequency} - 10.7\text{ MHz}}{3}$
Frequency Tolerance	± .001% @ 25 °C
	± .005% @ -55 °C to +105 °C
Mode	Series resonance - 450 Hz
	3rd overtone
Impedance	35 Ω maximum
Holder	HC-25/U

SECTION II
INSTALLATION

2.1 BATTERY INSTALLATION

Open the back cover and remove the plastic battery holder. Install four "AA" size batteries observing polarity marked on the holder and see that the batteries are firmly seated.

CAUTION

Incorrect battery installation (reversed polarity) may seriously damage the receiver. Always insert the batteries as shown.

It is not necessary to remove the wires connected to the battery holder, but care must be taken not to break them.

2.2 CRYSTAL INSTALLATION

Up to four crystals may be installed at one time. When installing crystals, note that the socket for Channel 1 is nearest the top of the receiver and Channel 4 is toward the bottom of the receiver. A frequency trimming adjustment is provided for each channel, adjacent to the crystal socket, and should be adjusted for best reception on the desired channel frequency.

The SCAN 150 has been factory adjusted to receive channels on bands between 151.5 MHz and 158.5 MHz. Crystals used in the SCAN 150, within the above frequency range, may simply be plugged into the appropriate sockets and monitored. Any crystal used, other than this range, should be installed by a qualified licensed technician so that appropriate retuning can be accomplished for best performance.

To install crystals in the unit, loosen the center screw on the back cover and gently remove the front cover. Be careful not to break the speaker leads attached to the cover. Insert the crystals in the proper sockets. For convenience, a record should be kept of channel frequencies and channel numbers in which they have been installed.

NOTE

All crystals supplied for use in PACE 150 Scan Monitors have been individually checked for activity, proper frequency, and freedom from spurious and parasitic oscillations. Use of any crystals not supplied by PACE does not ensure against off frequency operation, spurious radiation, substandard performance, or temperature drift; nor will defects which in our opinion were caused by use of such crystals be corrected under warranty.

SECTION III
PRINCIPLES OF OPERATION

3.1 GENERAL

This section contains a general description of the SCAN 150 operating principles. Major circuit functions and system operation are discussed. A block diagram of the SCAN 150 is shown in Figure. 3-1.

3.2 CIRCUIT DESCRIPTION

3.2.1 Receiver Circuit

The receiver is a double conversion superheterodyne using crystal controlled oscillators. The first mixer (Q2) uses high-side injection from oscillator Q10. This results in a first IF frequency of 10.7 MHz. The second mixer (Q4) obtains injection from the 10.245 MHz oscillator Q11 which results in the second IF frequency of 455 kHz. The output of Q4 passes through ceramic filter FL1 to a four stage FM IF Amplifier/Limiter, Q5 through Q8. This limited FM IF signal is then coupled to the discriminator, D1 and D2, via discriminator driver Q9.

Audio output from the discriminator diodes is applied to audio pre-driver Q17 which drives the audio driver Q18. The output of Q18 is then applied to audio amplifiers Q19 and Q20, and on to the speaker via C59.

3.2.2 Squelch Circuit (Figure 3-2)

Noise is coupled from Q9 to noise amplifiers Q12 and Q13 via the 455 kHz trap T4. The amplified noise is detected in Q14 where it is rectified by C51 and R46 and coupled to squelch switch Q15. With increased squelch, switch Q15 is turned on resulting in decreased gain of the audio driver.

When no signal is being received, noise from the discriminator driver is coupled to the base of noise amplifier Q12. Negative feedback from Q13 increases DC stability and attenuates audio frequencies. The filtered output is fed to squelch switch Q15, causing it to conduct. When Q15 is in conduction, voltage to the base of Q18 decreases. This cuts off the driver stage and prevents noise from passing on to the speaker.

3.2.3 Scan Circuit (Figure 3-3)

With no signal present, Q15 conducts, causing scanning keyer Q16 to cut off. This permits scanning pulse oscillator Q22 and Q23 to oscillate and supply pulses to binary counter IC1. Pulses from the counter are decoded in IC2, which produces a series of negative going pulses. These pulses are sequentially applied to each of the crystals in the oscillator.

When a signal is present, Q16 goes into full conduction. This causes the scanning pulse oscillator to turn off and the scanner locks in on that channel.

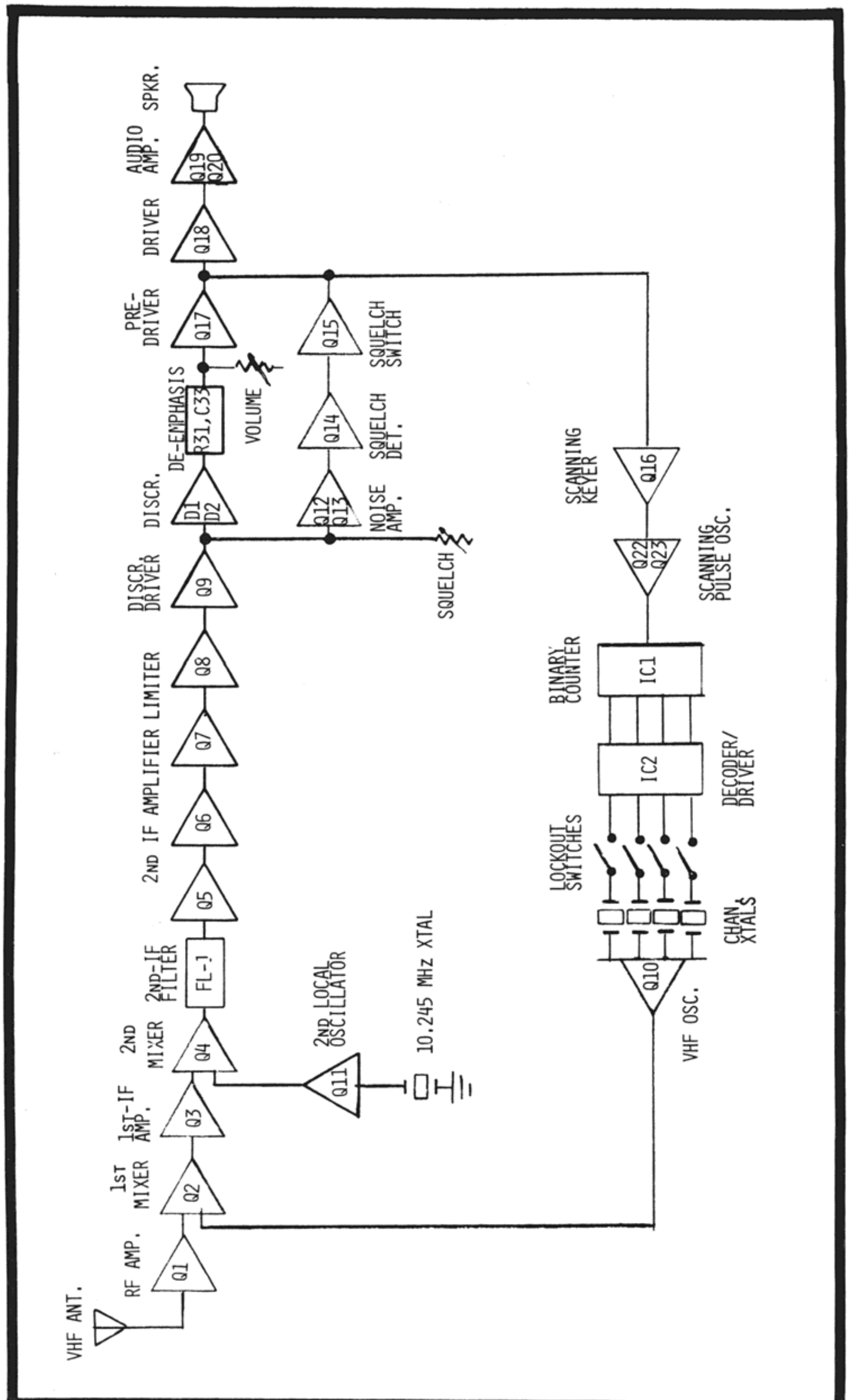

Figure 3-1. Model SCAN 150 Block Diagram

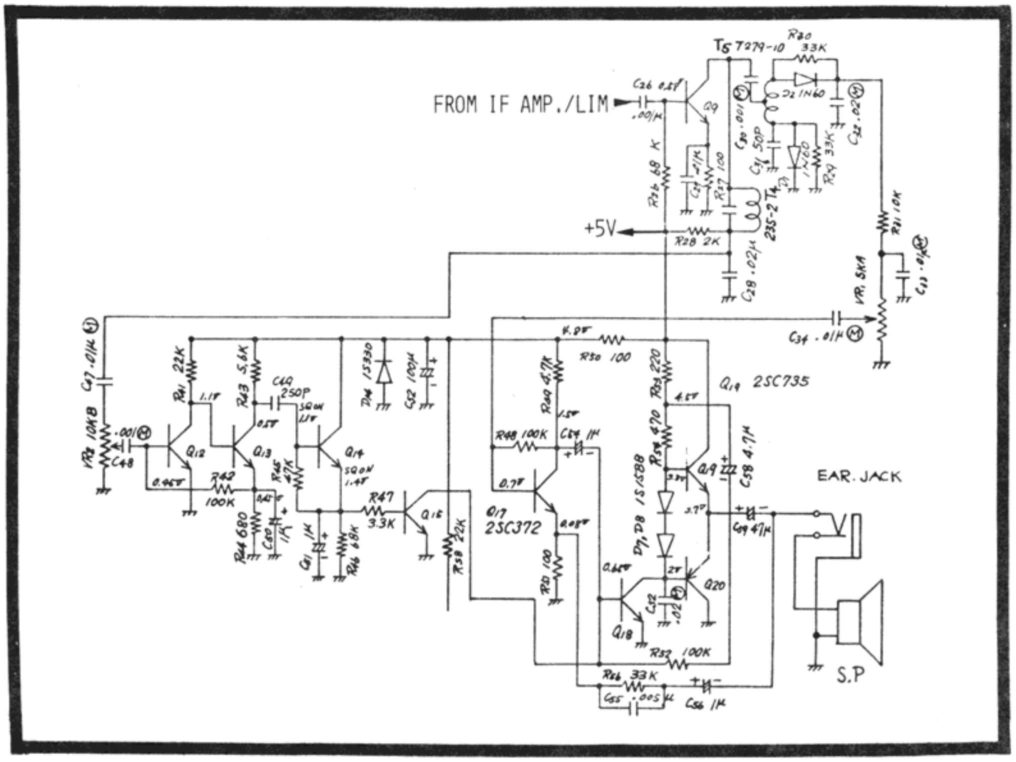

Figure 3-2. Squelch Circuit

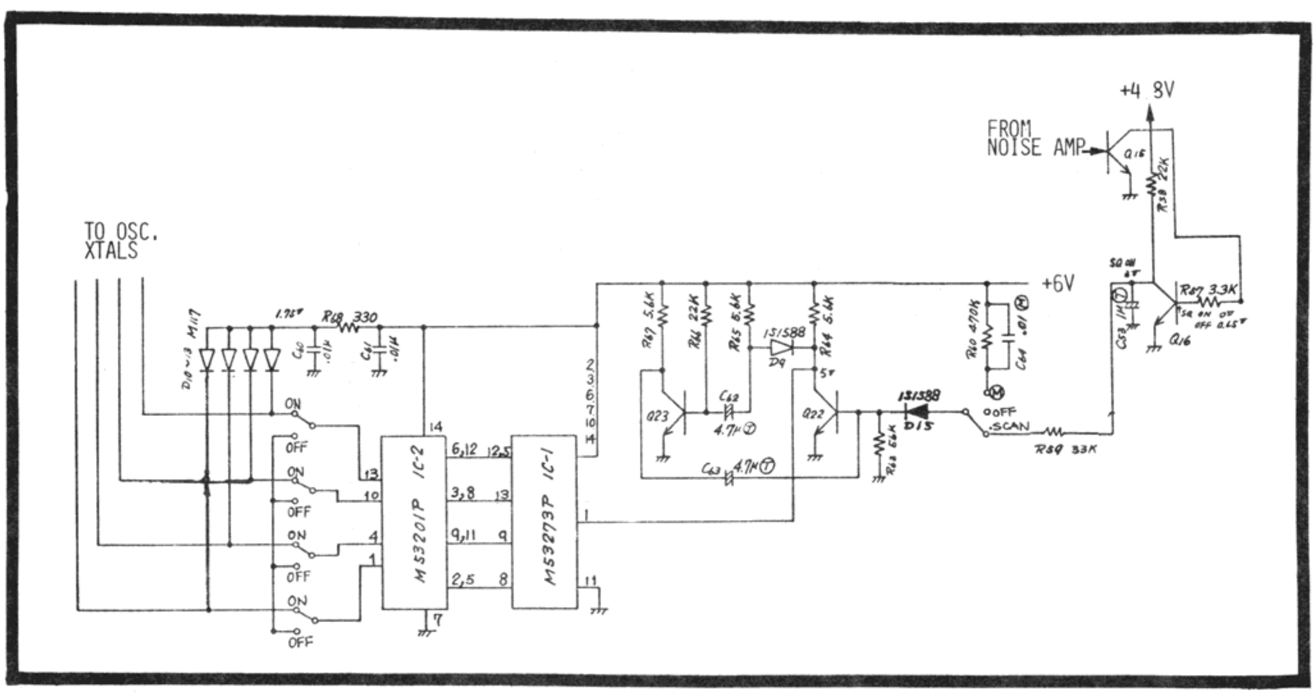

Figure 3-3. Scan Circuit

3.2.4 Oscillator Circuit (Figure 3-4)

Transistor Q10 is a crystal controlled oscillator which functions at the frequency determined by one of four crystals. The appropriate crystal is selected when a negative going pulse is applied from the decoder. Inductor L4 and capacitor C39, in the collector of Q10, triples the frequency of the oscillator. This tripled frequency is then applied to the base of first mixer Q2.

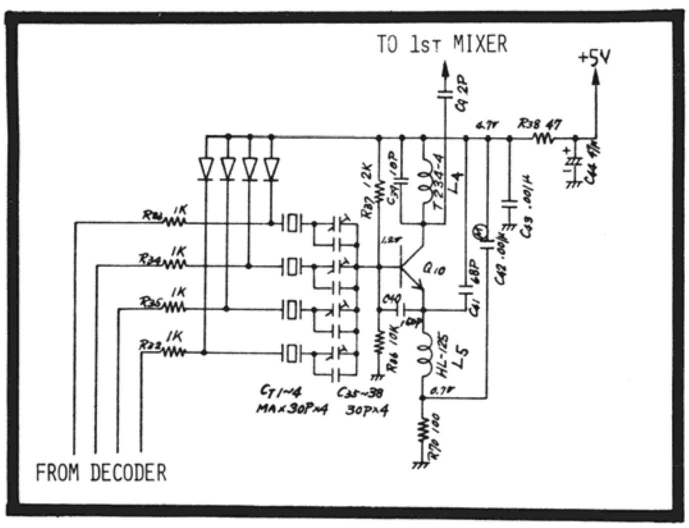

Figure 3-4. Oscillator Circuit

SECTION IV
MAINTENANCE

4.1 GENERAL

This section contains maintenance instructions for the PACE Model SCAN 150 Monitor. The procedures given in this section assume a general knowledge of communications, FM type receivers and a familiarization with transistors and ICs.

4.1.1 Tools and Techniques

A list of recommended tools and test equipment required for maintenance operations is presented in Table 4-1. Aside from the items listed, hand tools and equipment commonly used in the maintenance of electronic equipment are sufficient for maintenance operations.

It is recommended that maintenance adjustments and repairs be performed only by experienced personnel familiar with the equipment. In some cases, minor changes in voltage levels may be corrected by adjusting trim potentiometers located in the affected circuits. Standard practices in the electronic industry should be observed in checking and/or replacing system components.

4.1.2 Parts Identification

For printed circuit board (PCB) assembly component location, refer to illustrations and schematics in Section VI.

4.2 PREVENTIVE MAINTENANCE

The receiver requires minimal maintenance due to the nonmechanical nature of the equipment. However, a preventive maintenance program consisting of electrical checks is recommended as an aid in obtaining maximum operating efficiency from the system.

Table 4-1
Test Equipment Required

Item	Model or Description
VOM	Simpson 260 or equivalent
AC VTVM	Simpson 715 or equivalent
RF Voltmeter	Boonton 91H or equivalent
Signal Generator	Singer-Gertsch FM-10 or equivalent
RF Probe for VOM	If none available for instrument, one may be fabricated as shown in Fig. 4-1
Oscilloscope	RCA WO-505A or equivalent

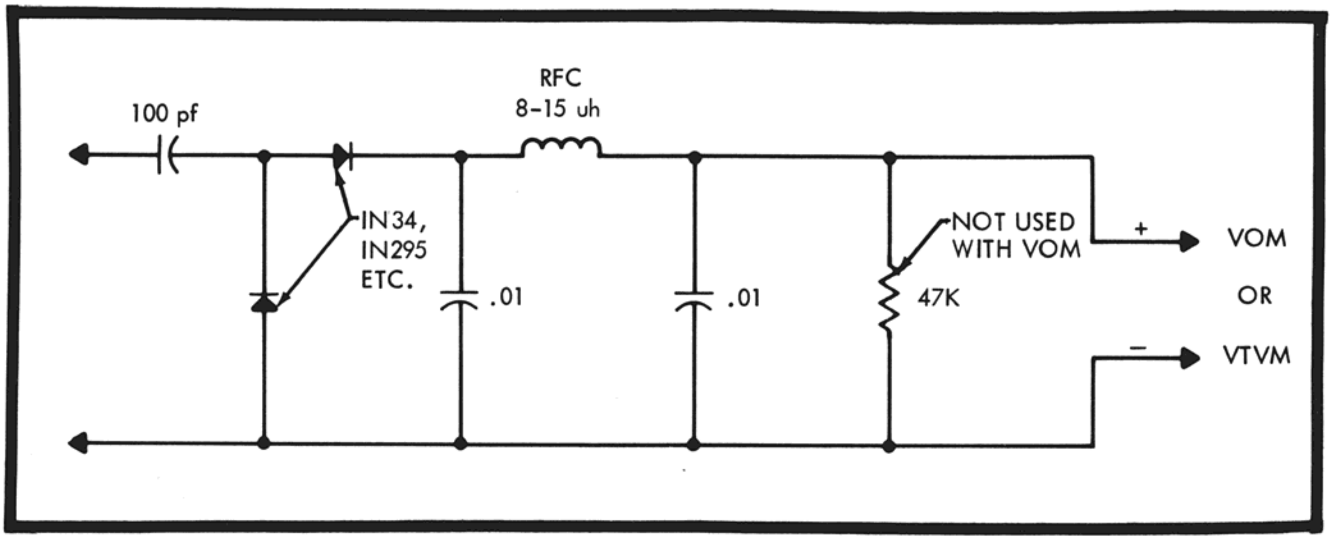

Figure 4-1. RF Probe

4.2.1 Maintenance Check

The purpose of this maintenance check is to verify the general operational status of the receiver. If consists of a visual inspection of the unit and a general cleaning of all potentiometers, switches, plugs, and jacks. To conduct the semi-annual maintenance check, proceed as follows:

1. Visually inspect the PCB for evidence of overheated components, excessive dirt, foreign material, or other physical damage. Inspect all connectors for dust corrosion or foreign material.

NOTE

Replacement or repair of the PCB is recommended if any of the components show evidence of overheating, thus preventing possible failure during system operation.

2. Blow out all dust from chassis and PCB components.

3. Clean and lubricate all potentiometer switches, plugs, and jacks.

4.3 CORRECTIVE MAINTENANCE

Corrective maintenance operations entail receiver checks and adjustments which are not part of preventive maintenance procedures. Operational malfunctions which require corrective maintenance may usually be corrected by an adjustment or PCB replacement. If necessary to make repairs at the component level, such repairs should be made by maintenance technicians who are familiar with the equipment and electronic repair techniques. Refer to Section V for alignment and adjustment procedures.

4.4 TROUBLESHOOTING

It is recommended that a functional analysis approach be used to locate the cause of the receiver malfunction. Troubleshooting can be simplified by reference to the schematic diagrams in Section VI.

Standard troubleshooting procedures, such as injection and signal tracing, should be used in locating faulty circuits. Once the trouble has been isolated to a particular circuit, the defective component can be localized by DC voltage and resistance measurements. Refer to voltage chart in Table 4-2.

Voltages at the various pins of integrated circuits IC1 and IC2 are shown in Tables 4-3 and 4-4, respectively. Their voltages are measured for each channel with the respective channel locked in.

NOTE

Voltages indicated are 5 V for a logical 1 (high) and 0 V for a logical 0 (low).

Voltages were measured with an ohmmeter having a 20,000 ohm/volt sensitivity, with fully charged Nicad batteries installed, all crystals removed, and squelch off (unless otherwise indicated). All voltages are positive and have a tolerance of ±10%.

Before proceeding with the troubleshooting procedures, the entire installation should be checked for defective antenna connections and loose or broken supply cables and plugs.

Table 4-2
Transistor Voltage Chart

Transistor	DC Voltage in Volts		
	Emitter	Base	Collector
Q1	0.85	1.5	4.5
Q2	0.4	3.75	4.5
Q3	0.7	1.3	4.6
Q4	0.9	1.6	3.2
Q5	0.0	2.0	1.4
Q6	2.5	3.0	3.7
Q7	0.0	0.6	1.4
Q8	2.5	2.3	3.75
Q9	0.15	0.35	2.0
Q10	0.8	1.5	4.3
Q11	1.6	0.6	4.75
Q12	0.0	0.4	1.1
Q13	0.55	1.1	0.65
Q14	SQ ON 4.0	2.0	4.8
	SQ OFF 0.0	0.0	4.8
Q15	SQ ON 0.0	0.8	0.0
	SQ OFF 0.0	0.0	0.6
Q16	SQ ON 0.0	0.0	4.6
	SQ OFF 0.0	0.55	0.0

Table 4-2
(continued)

Transistor	DC Voltage in Volts		
	Emitter	Base	Collector
Q17	0.05	0.7	1.5
Q18	0.0	0.6	2.0
Q19	3.0	3.5	4.75
Q20	3.0	2.0	0.0
Q22	0.0	0.0	4.75
Q23	0.0	0.6	0.0

Table 4-3
IC1 Voltage Chart*

Pin No.	DC Voltage in Volts			
	Channel 1	Channel 2	Channel 3	Channel 4
5	5	0	5	0
8	5	0	0	5
9	0	5	5	0
12	5	0	5	0
13	0	5	0	5

*Only output pins indicated.

Table 4-4
IC2 Voltage Chart

Pin No.	DC Voltage in Volts			
	Channel 1	Channel 2	Channel 3	Channel 4
1	5	5	5	0
2	5	0	0	5
3	0	5	0	5
4	0	5	5	5
5	5	0	0	5
6	5	0	5	0
7	0	0	0	0
8	0	5	0	5
9	0	5	5	0
10	5	0	5	5
11	0	5	5	0
12	5	0	5	0
13	5	5	0	5
14	6	6	6	6

SECTION V
ADJUSTMENTS AND ALIGNMENT

5.1 GENERAL

The PACE SCAN 150 Receiver is factory aligned to provide optimum performance. It will not normally require realignment unless major components have been replaced or if the receiver sensitivity has dropped below the specified 0.6 microvolts for 20 dB quieting, or if there is a malfunction of the receiver.

It is recommended that the receiver be returned to the factory for realignment. However, correct alignment procedures are given in the following paragraphs where this is not feasible.

5.2 TEST EQUIPMENT

The receiver alignment should not be undertaken unless precision equipment is available. Table 4-1 provides a list of recommended test equipment and tools.

5.3 PRELIMINARY SETUP

1. Set the front panel controls as follows:

Control	Setting
Squelch	Maximum CCW (squelch off)
Volume	Maximum CCW (minimum volume)
Power Switch ...	OFF

2. Make sure a fully charged set of Nicad batteries is installed in the unit.

3. Connect a DC voltmeter through an RF probe (Figure 4-1) to the collector of Q5. (This is designated as IF Test Point in Figure 5-1.)

4. Connect an oscilloscope and AC VTVM in parallel, directly across the speaker terminals. The external speaker jack may be used for this purpose.

5. Set the POWER switch to ON.

5.4 ALIGNMENT PROCEDURE

5.4.1 IF Alignment

1. Inductively couple an RF signal generator to the receiver's antenna. Set the frequency to the RF carrier frequency of the crystal installed in Channel 1 position (see Table 1-2). Check to see that the Channel 1 indicator lamp remains lit.

2. With no modulation of the signal, adjust the generator output control for an indication on the DC voltmeter of approximately 0.1 volts.

3. Tune T1, T2, and T3 for a maximum indication on the meter. Reduce the signal generator level, as required, to maintain approximately 0.1 volts (see Figure 5-1).

4. Repeat steps 2 and 3 with the generator output control set for a reading of approximately 0.05 volts.

5.4.2 RF Amplifier and Mixer Alignment

Continuing from 5.4.1, proceed as follows:

1. Turn the signal generator output down to zero, and adjust the receiver's volume control for a zero dB reference level on the AC VTVM.

2. Adjust the generator output control for a -20 dB reading on the AC VTVM.

3. Adjust RF and mixer coils (L1 through L3) for a minimum indication on the AC VTVM (maximum sensitivity). During this procedure, decrease the generator output level (as required) to maintain the meter pointer at about the -20 dB position of the meter.

5.4.3 Oscillator Alignment

NOTE

Adjustable components in this circuit have been precisely set at the factory. Only the trimmer capacitors associated with the crystals should need adjustment when a new crystal is installed. All other adjustable components should not be readjusted unless one of the critical tuning components associated with them have been replaced.

Continuing from 5.4.2, proceed as follows:

1. Adjust oscillator coil L4 for a minimum indication on the AC VTVM. Decrease the generator output level, as required, to maintain the meter pointer at about the -20 dB position of the meter.

2. Adjust trimmer CT1 for a minimum indication on the AC VTVM. Decrease the generator output level, as required, to maintain the meter pointer at about the -20 dB position of the meter.

3. Set the frequency of the signal generator to the RF carrier frequency of the crystal installed in Channel 2 position. (Check to see that the Channel 2 indicator lamp remains lit.)

4. Adjust trimmer CT2 as indicated in step 2.

5. Repeat steps 3 and 4 for Channels 3 and 4, respectively, tuning CT3 and CT4.

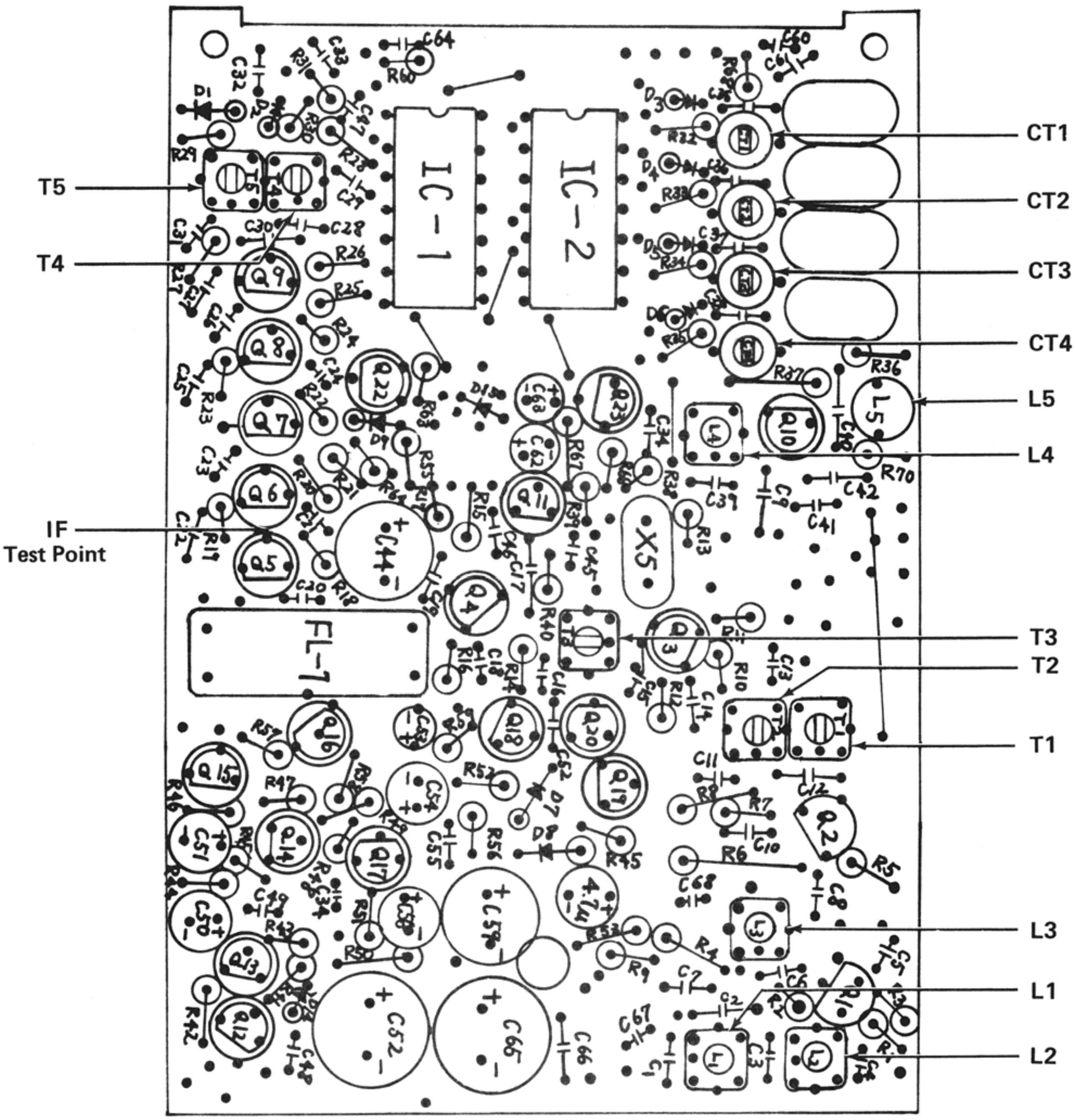

Figure 5-1. Adjustment Locations

5.4.4 FM Discriminator Alignment

1. Frequency modulate the RF carrier at 1 kHz with 3 to 5 kHz deviation.

2. Adjust discriminator transformer T5 for a linear sine wave display (at maximum amplitude) on the oscilloscope.

3. Adjust T4 for a linear sine wave display (at maximum amplitude) on the oscilloscope.

NOTE

The best setting for this transformer is completely counterclockwise (all the way out).

This completes the alignment procedure.

5.5 QUIETING SENSITIVITY CHECK

After the receiver has been completely aligned, check the quieting sensitivity as follows:

1. Lock the scanner in on one of the channels.

2. Connect an AC VTVM on its 1 volt scale across the speaker terminals.

3. Turn the receiver squelch control fully counterclockwise (squelch off).

4. Adjust the volume control for a zero dB reference level on the AC VTVM.

5. Inductively couple an unmodulated FM signal generator to the receiver's antenna. The generator frequency should be set to the frequency of the locked-in channel.

6. Adjust the generator output level for a -20 dB indication on the AC VTVM. The level should be 0.6 microvolts or less. If greater than 0.6 microvolts, repeat Section 5.4.2.

SECTION VI
ILLUSTRATIONS AND PARTS LIST

6.1 GENERAL

The schematics and parts locators in this section are for the PACE Model SCAN 150 Scanning Receiver. Part numbers and descriptions are keyed to the schematic reference numbers and are listed for these components.

Table 6-1
Parts List

Reference Number	Description	Part Number
CAPACITORS*		
C32, 57	Mylar, 0.02 μF	IP 22-0017
C33, 34	Mylar, 0.01 μF	IP 22-0015
C42, 48	Mylar, 0.001 μF	IP 22-0014
C44, 59	Electrolytic, 47 μF	IP 22-0006
C50, 51, 53, 54, 56	Electrolytic, 1 μF	IP 22-0001
C52, 65	Electrolytic, 100 μF	IP 22-0008
C58, 62, 63	Electrolytic, 4.7 μF	IP 22-0003
PC1 thru 4	Trimmer, Ceramic, 30 pF	IP 22-0032
RESISTORS*		
VR1	Potentiometer, 5 k Ω	IP 24-0029
VR2	Potentiometer, 10 k Ω	IP 24-0030
DIODES, INTEGRATED CIRCUITS, AND TRANSISTORS		
D1, 2	Diode, 1N60P	IP 20-0016
D3 thru 9, 15	Diode, 1S1588	IP 20-0061
D10 thru 13	Diode, M117 (L.E.D.)	IP 28-0007
D14	Diode, 1S330	IP 20-0086
IC1	Integrated Circuit, M53273P	IP 20-0068
IC2	Integrated Circuit, M53201P	IP 20-0097
Q1, 2	Transistor, 2SC1047	IP 20-0065
Q3 thru 9, 11 thru 17, 21 thru 23	Transistor, 2SC372	IP 20-0039
Q10	Transistor, 2SC388A	IP 20-0088
Q18	Transistor, 2SC373	IP 20-0105
Q19	Transistor, 2SC735	IP 20-0041
Q20	Transistor, 2SA562	IP 20-0046

Table 6-1
(continued)

CHOKES, INDUCTORS, AND TRANSFORMERS

L1	Antenna, Loop*	
L2	Coil, RF, HL-123S	IP 21-0156
L3	Coil, IF, T-235-2	IP 21-0159
L4	Coil, IF, T-234-4	IP 21-0161
L5	Choke, HL-125	IP 21-0107
T1	Transformer, Antenna, HL-122S	IP 21-0155
T2	Transformer, RF Amplifier, HL-124S	IP 21-0157
T3, 4, 5	Transformer, IF, T-2531S	IP 21-0158
T6	Transformer, Detector, T279-10	IP 21-0160

MISCELLANEOUS

FL1	Filter, Ceramic	IP 31-0052
J1	Connector, Antenna	IP 26-0019
J2, 3	Connector, Earphone & PWR/CHGR	IP 26-0018
LS1	Speaker	IP 29-0014
S1 thru 4, 6	Switch, Slide	IP 25-0024
S5	Switch, Toggle	IP 25-0025
Y1 thru 4	Crystal (not supplied with unit)	
Y5	Crystal, 10.245 MHz	IP 31-0043
	Socket, Crystal	IP 34-0001
	Case, Battery	IP 34-0007
	Owners Manual	L2004

*Order all unlisted components by description and reference numbers.

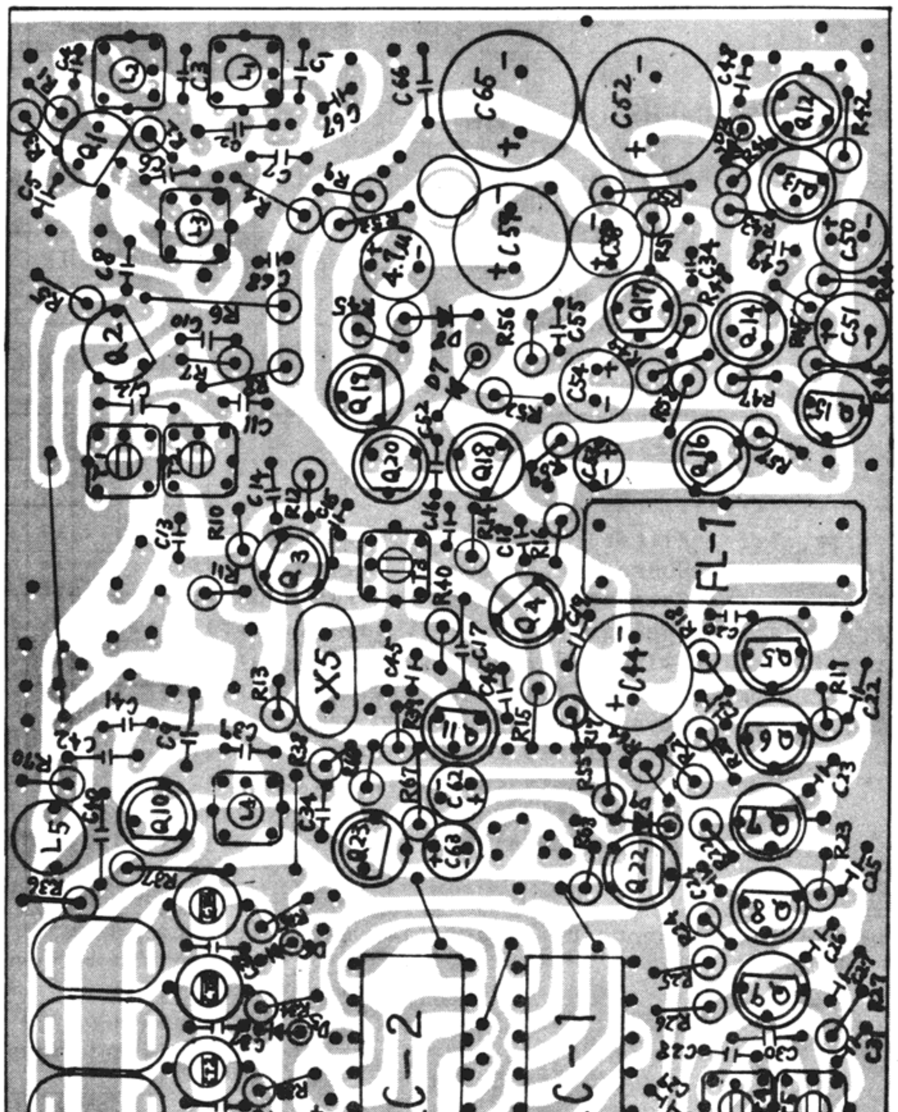

Figure 6-1. Parts Locator (Component Side)

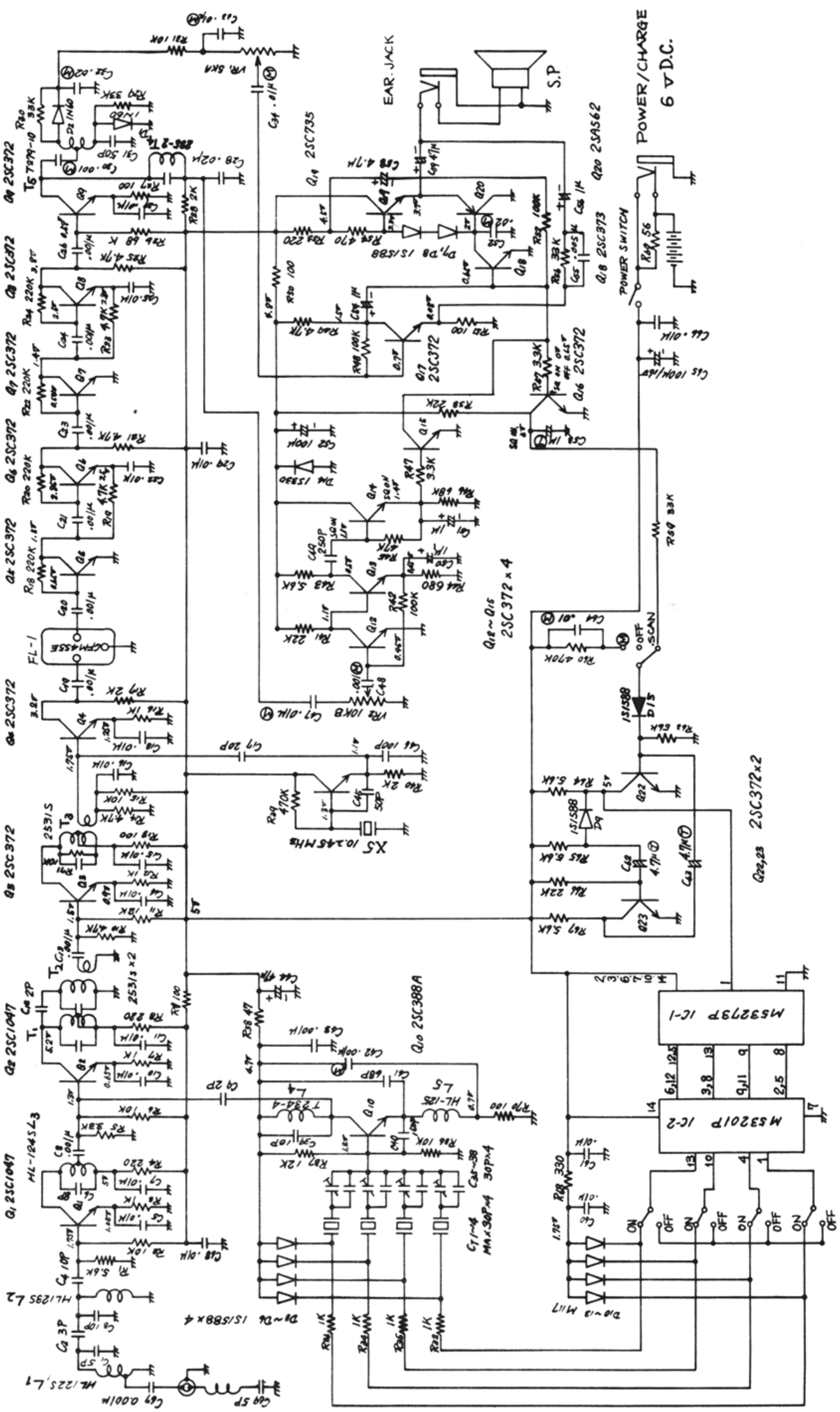

Figure 6-2. Schematic Diagram

PACE

TWO-WAY RADIO PRODUCTS
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