MOBILE RADIO

MAINTENANCE MANUAL
403-430 MHz & 450-512 MHz, DELTA-S
TWO WAY FM RADIO
SERVICE SECTION

TABLE OF CONTENTS

DESCRIPTION

This section contains the information required to service the radio. It includes disassembly procedures, procedures for replacing transistors, Integrated Circuits (IC's) and chip components. The section also includes alignment procedures and troubleshooting information (see Table of Contents).

PROGRAMMING

When programming with the 4EX22A10 Programmer, remove plug P706. Replace when programming is completed.

Jumper P707, when installed disables the EEPROM programming function. As shipped from the factory the jumper is not installed. In applications where an S950 control unit without download capability is used, it is recommended that jumper P707 be installed to prevent inadvertent program disruption.

INITIAL ADJUSTMENT

After the radio has been installed (as described in the Installation Manual), the following adjustments should be made by a certified electronics technician.

TRANSMITTER ADJUSTMENT

The adjustment for the transmitter includes measuring the forward and reflected power and adjusting the antenna length for optimum ratio, then setting the transmitter to rated power output. Next, measure the frequency and modulation and record these measurements for future reference. For the complete transmitter adjustment, refer to the Alignment Procedure (see Table of Contents).

RECEIVER ADJUSTMENT

The initial adjustment for the receiver includes tuning the input circuit to match the antenna. For receiver adjustment, refer to the Receiver Alignment Procedure (see Table of Contents).

MAINTENANCE

PREVENTIVE MAINTENANCE

To ensure high operating efficiency and to prevent mechanical and electrical failures from interrupting system operations, routine checks should be made of all mechanical and electrical parts at regular intervals. This preventive maintenance should include the checks as listed in the table of Maintenance Checks.

MAINTENANCE CHECKS	INTERVAL	
	6 Months	As Required
CONNECTIONS - Ground connections and connections to the voltage source should be periodically checked for tightness. Loose or poor connections to the power source will cause excessive voltage drops and faulty operation. When ground connections are not made directly to the battery, the connection from the battery to vehicle chassis must be checked for low impedance. A high impedance may cause excessive voltage drops and alternator noise problems.	X	
ELECTRICAL SYSTEM - Check the voltage regulator and alternator or generator periodically to keep the electrical system within safe and economical operating limits. Overvoltage is indicated when the battery loses water rapidly. Use of 1 or 2 ounces of water per cell per week is acceptable for batteries in continuous operation. A weak battery will often cause excessive noise or faulty operation.		X
MECHANICAL INSPECTION - Since mobile units are subject to constant shock and vibration, check for loose plugs, nuts, screws and parts to make sure that nothing is working loose.	X	
ANTENNA - The antenna, antenna base and all contacts should be kept clean and free from dirt or corrosion. If the antennas or its base should become coated or poorly grounded, loss of radiation and a weak signal will result.	X	
ALIGNMENT - The transmitter and receiver meter readings should be checked periodically, and the alignment "touched up" when necessary. Refer to applicable Alignment Procedure and Troubleshooting Procedure for typical voltage readings.		X
FREQUENCY CHECK - Check transmitter frequency and deviation. Normally, these checks are made when the unit is first put into operation, after the first six months and once a year thereafter.		X

DISASSEMBLY

EQUIPMENT REQUIRED

1. Flatblade Screwdriver
2. Phillips Head Screwdriver
3. Allen Wrench (5mm)
4. 50 Watt Soldering Iron
5. Torque Wrench Kit
6. X-Acto Knife
7. De-soldering Tool

- To gain access to the unit for servicing:
  1. Unlock the radio.
  2. Pull down the handle.
  3. Pull the radio forward and lift radio out of mounting place -- if desired.
  4. Pry up the front of top cover and lift the cover off.
  5. To gain access to the bottom side, pull the radio all the way out of the mounting frame and remove the four mushroom shaped feet using a 5mm allen wrench.

NOTE

With the top cover removed all components on the PA and TRS board are accessible for tuning. The PA, IF, and synthesizer/exciter covers must be removed to expose components.

- To remove the TRS board:
  1. Remove the bottom cover.
  2. Remove the nine retaining screws (Figure 1) securing the circuit board to the main frame.
  3. Remove two retaining screws (B) securing systems connector J601 to front casting.

4. Remove the two brass screws (C) securing the receiver RF shield to chassis.
5. Unsolder the two feed through capacitor terminals (E) at holes H13 and H14 on printed wire pattern.
6. Turn over the radio and remove the three retaining screws (D) (Figure 2) securing the audio bridge amplifier, U601 and U602, and the 5 and 9 volt regulators U701 and U702 to the side of chassis.
7. To remove the front end shield, remove the 20 retaining screws securing the shield to the backplate and remove.

NOTE

When replacing front end shield tighten all retaining screws to 1.75 Newton Meters (15.5 inch pounds).

8. To remove the synthesizer shield, remove the retaining screws securing the shield to the backplate.

- To replace TRS board:

1. Perform above procedures in reverse order.

- To remove the PA board:

1. Remove the eight retaining screws (F) from around the edge of the PA board.
2. Remove the three retaining screws (G) securing the PA filter cover to the main frame.
3. Remove the two retaining screws (H) securing the antenna connector to the main frame.
4. Loosen the retaining screw (J) securing the pass transistor to the side of the PA chassis compartment.
5. Remove the retaining screws (K) securing the PA transistors to the main frame.
6. Turn the radio over and remove the nut and washer from the stud of PA transistor Q1.
7. Unsolder the two power feed through capacitors at (L).
8. Carefully lift the PA board up off the pins extending upward from the TRS board.

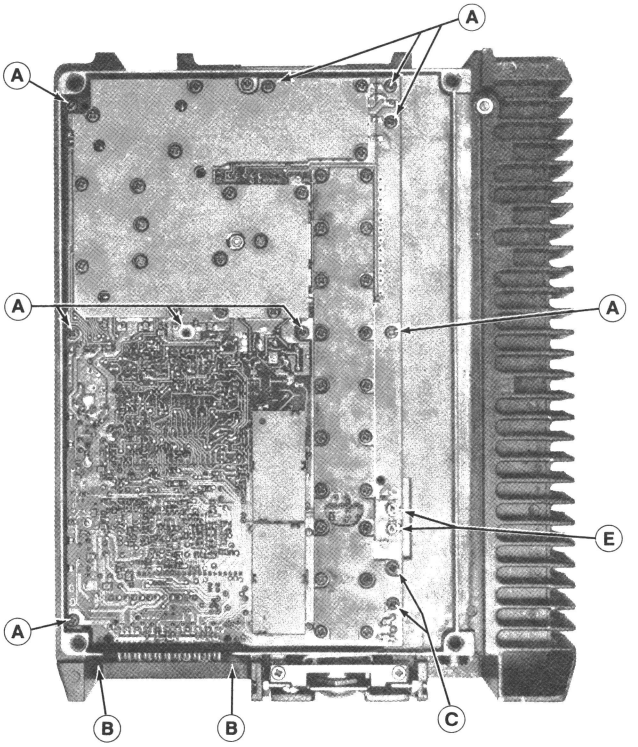

Figure 1 - Disassembly Procedure Bottom View

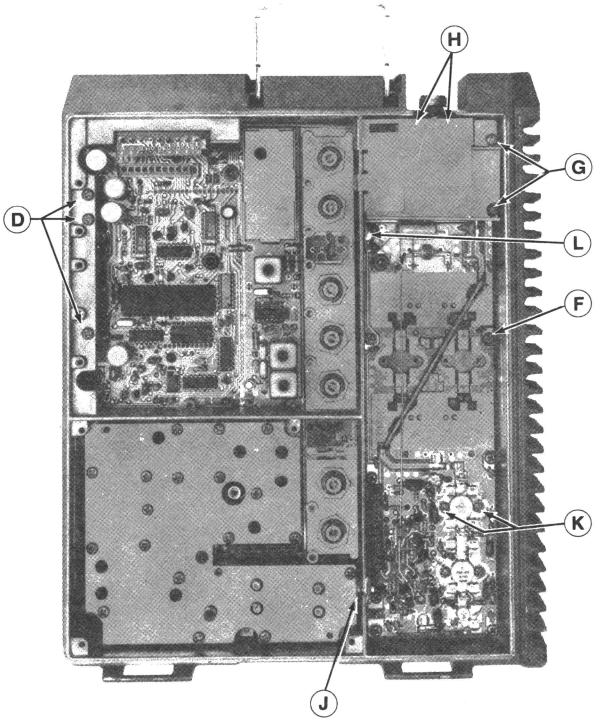

Figure 2 - Disassembly Procedure Top View

NOTE

Note the position of the copper washer spacer under transistor Q1. Be sure that this spacer is in place when replacing the board.

- To replace the PA board:

1. Perform the above procedures in reverse order, being careful to align all interconnecting pins and sleeves. Be sure the antenna gasket between the antenna jack and front casting is positioned properly.

PA TRANSISTOR REPLACEMENT

WARNING

The RF Power Transistors used in the transmitter contain Beryllium Oxide, a TOXIC substance. If the ceramic or other encapsulation is opened, crushed, broken or abraded, the escaping dust may be hazardous if inhaled. Use care in replacing transistors of this type.

- To replace the PA RF transistors:

1. Unsolder one lead at a time with a 50 watt soldering iron. Use a scribe or X-acto® knife to hold the lead away from the printed circuit board until the solder cools.
2. Remove retaining screws and lift out the transistor. Remove any old solder from the printed circuit board using a vacuum tool. Special care should be taken to prevent damage to the printed circuit board runs because part of the matching network is included in the base and collector runs.
3. Trim the new transistor leads (if required) to the lead length of the removed transistor. The letter "C" on the top of the transistor also indicates the collector.
4. Apply a coat of silicon grease to the transistor mounting surface. Place the transistor in the mounting hole. Align the leads as shown on the Outline Diagram. Then replace the transistor mounting screws using moderate torque.
5. Solder the leads to the printed circuit pattern. Start at the inner edge of mounting hole and solder the remaining length of transistor lead to the board. Use care not to use excessive heat that causes the printed wire board runs to lift up from the board. Check for shorts and solder bridges before applying power.

CAUTION

Failure to solder the transistor leads as directed may result in the generation of RF loops that could damage the transistor or may cause low power output.

REMOVING IC's

Removing IC's (and most other soldered-in components) can be easily accomplished by using a vacuum desoldering tool. To remove an IC, heat each lead separately on the solder side and remove the old solder with the desoldering tool.

CAUTION

The CMOS Integrated Circuit devices used in this equipment can be destroyed by static discharges. Before handling one of these devices, the serviceman should discharge himself by touching the case of a bench test instrument that has a 3-prong power cord connected to an outlet with a known good earth ground. When soldering or desoldering a CMOS device, the soldering iron should also have a 3-prong power cord connected to an outlet with a known good earth ground. A battery- operated soldering iron may be used in place of the regular soldering iron.

REPLACING CHIP COMPONENTS

Replacement of chip capacitors should always be done with a temperature-controlled soldering iron, using a controlled temperature of 700°F (371°C). However, do NOT touch black metal film of the resistors or the ceramic body of capacitors with the soldering iron.

NOTE

The metalized end terminations of the parts may be touched with the soldering iron without causing damage.

TO REMOVE CHIP COMPONENTS

1. Grip the component with tweezers or needle nose pliers.
2. Alternately heat each end of the chip in rapid succession until solder flows, and then remove and discard the chip.
3. Remove excess solder with a vacuum solder extractor or Solder-wick®.
4. Carefully remove the epoxy adhesive and excess flux to prevent damage to the printed board.

TO REPLACE CHIP COMPONENTS

1. Using as little solder as possible, "tin" one end of the component and one of the pads on the printed wiring board.
2. Place the "tinned" end of the component on the "tinned" pad on the board and simultaneously touch the component and the pad with a well "tinned" soldering iron while pressing the component down on the board.
3. Place the "tinned" soldering iron on the other end of the component and the pad simultaneously. Apply solder to the top of the end of the component until the solder starts to flow. Use as little solder as possible while getting a good joint.
4. After the component has cooled, remove all flux from the component and printed wiring board area with alcohol.

TEST AND TROUBLESHOOTING PROCEDURES

Maintenance of the radio is facilitated by use of the Self Test and Diagnostics routines and servicing techniques unique to this radio. Typical voltage readings are provided on the Schematic Diagram for reference when troubleshooting.

SERVICE TIP

When servicing the TRS board, relocating the Channel Guard board may be helpful.

CHANNEL GUARD BOARD

Both the Channel Guard board and Channel Guard extender may be removed and set aside during servicing. While servicing the radio install P608 to connect VOL/SQ/HI.

Microcomputer

When servicing the microcomputer/synthesizer circuitry it is sometimes desirable to force the microcomputer into specific operating modes. Following are some tips that allow you to initiate these modes.

- To force the microcomputer to continually try to reload the synthesizer. This mode will enable you to check the serial data, clock, advance change pulse and enable signals to the synthesizer. Grounding the lock detect line into the microcomputer at U703-8.
- To stop the microcomputer from running, disable the watchdog timer by shorting the collector and emitter of Q714 and ground the single step line at U705-5.

Microphonics

Synthesized radios tend to be sensitive to shock and vibration, creating microphonics. The construction of the DELTA-S, radio with its die cast aluminum frame, cast shields, and multiple board mounting screws, provides a high degree of immunity. When removing either printed circuit board or the shields, note the exact location and position of all mounting hardware including rubber padding and bracket (if included).

When servicing the radio be sure that no solder build-up has occured on the chassis or shield.

To assure a high degree of resistance to microphonics be sure to replace exactly, all hardware removed. Be sure that all mounting screws are properly torqued and shields in place. Refer to Mechanical Layout Diagram.

NOTE

Loose or rubbing parts, especially in the VCO area are particularly sensitive and can cause microphonics. Again be certain all hardware is properly installed and torqued.

MICROCOMPUTER DIAGNOSTICS

The microcomputer, in addition to operational programming, contains software for self diagnostic routines to aid in troubleshooting the radio. Since the radio can not function with a defective microcomputer, the self diagnostic routines include internal tests as well as input/output tests to verify proper operation. The internal tests include a

ROM test which verifies that the proper program is stored in the microcomputer and a RAM test which checks for proper data transfer to and from all memory locations. The input/output tests include a test which grounds one pin at a time on Port 1 and the data bus, and a test which mirrors the inputs PTT, FB5, CG DISABLE, ADVANCE CHANGE, and FB4 - FB1 onto the data bus. These tests assure proper operation of the ports and data bus, in addition to checking the input/output instructions of the microcomputer. When troubleshooting the radio, the diagnostic routines should be performed first before going on to the test procedures and alignment instructions.

VCO TIPS

The synthesizer has two VCO's or voltage controlled oscillators. The VCO frequency is directly related to a control voltage generated by the synthesizer circuitry and must remain within specified limits for the synthesizer to function properly.

The RX VCO typically will increase in frequency about 4 MHz when the control voltage moves from its lower limit to its upper limit. The TX VCO moves about 6 MHz for the same situation. By tuning the coil for the TX VCO or the capacitor in the RX VCO, the same control voltage frequency spread can be moved up or down through the full range of radio operating frequencies.

To maintain the excellent selectivity and hum and noise performance of the radio, the frequency range that the VCO's can be voltage tuned is kept to a minimum.

This requires that all the available voltage range be fully utilized. The alignment procedure, therefore, instructs the user to accurately set the control voltage to the upper limit of the voltage range at the highest frequency channel.

NOTE

Going too high with the voltage setting at the highest frequency channel may cause problems over temperature extremes as the VCO's will drift slightly. Set the voltage too low and you may not remain within the required lower voltage limit as you cover the radio's maximum two frequency spread.

If the required frequency spread is less than the maximum two frequency spread then there are no restrictions on setting the lowest and highest frequencies within the required voltage limits.

The minimum tuning requirement of the VCO's is to cover the proper frequency range. For instance, to cover 150.8 to 174 MHz the VCO must be tunable such that at 150.8 MHz the control voltage is at least greater than or equal to the lower voltage limit, and at 174 MHz the voltage must be less than the upper limit. If the control voltage can be tuned higher than the lower limit at 150.8 MHz, this simply means that you can program channels below 150.8 until you finally run into the lower voltage limit.

When tuning the VCO's to a channel close to 150.8 MHz, the control voltage may not reach the upper control voltage limit. This is normal for some radios and is due to the tolerances on the many capacitors in the VCO. Even though it takes very little change in capacitance to shift the VCO frequency range a few megahertz, this variation has been carefully compensated for by increased tuning range for the VCO. Therefore, if you tune to 150.8 MHz, you may not achieve the maximum control voltage for all radios, but you will always be greater than the lower voltage limit.

Note that the RX & TX VCO's have totally different tuning adjustment devices. The TX VCO will tune as any coil will by reaching a peak voltage setting at the 150.8 MHz frequency, assuming that the peak falls within the control voltage limits of the VCO. The RX VCO uses a multi-turn trimmer capacitor which lowers the VCO frequency linearly with clockwise turns of the screw-type slotted piston. Unlike the coil used in the TX VCO, the trimmer capacitor does not peak but simply reaches a maximum setting (lowest frequency is maximum setting).

The 150.8 MHz receive channel should have a control voltage greater than the lower limit. The trimmer cap is a very high quality device which allows the RX VCO to always have consistent state-of-the-art noise performance necessary for a high quality synthesized radio.

TEST EQUIPMENT REQUIRED

- 13.8 VDC supply, 500 mA (unless being tested in radio)
- DC Voltmeter (Data Tech 30L or equivalent)
- Oscilloscope (Tektronix 404 or equivalent)
- 10K resistor, 1/2 watt

TEST PROCEDURE

NOTE

This procedure assumes the TRS board is being tested in the radio. Alternate procedures for bench test are shown in parenthesis ().

1. Connect oscilloscopes to J601-18 (SPKR 1) and ground.
2. Enter the self diagnostic mode as follows:
   - Key microphone while on hook. (Ground J601-11).
   - Apply A+ through a 10K resistor to J604-3.
   - Turn radio on. (Apply 13.8 VDC to J601-19).

ROM AND RAM TESTS

Once power is supplied to the board, the microcomputer will jump to the self diagnostic test and immediately begin execution of the ROM and RAM tests. Upon completion of the ROM and RAM test (less than a second) the display, data bus, or alert tone will indicate if the tests have been passed, indicated as follows:

	D3	D2	D1	D0	ALERT TONE
ROM TEST FAILED	0	0	0	0	NONE
ROM TEST PASSED RAM TEST FAILED	0	0	0	1	NONE
ROM TEST PASSED RAM TEST PASSED	0	0	1	0	1 kHz

If the data bus is inaccessable then the alert tone can be used to indicate if the tests have passed. If the tests have passed there will be a 1 kHz tone on SPKR 1 and it will be heard on the speaker if the board is in a radio. If no alert tone is present, then either the ROM or RAM test has failed. If these tests have failed, the microcomputer function is defective. Before replacing the microcomputer, exhaust all other possibilities. Check associated circuits for shunted or open printed wire runs and components.

INPUT/OUTPUT TESTS

If the ROM and RAM tests are completed satisfactorily, release the PTT switch and remove A+ from J604-3. Note that the data bus will still indicate 02 (Hex), however, the 1 kHz tone should no longer be displayed on the scope or heard on the speaker.

The I/O test grounds one pin at a time on Port 1 and the data bus and is stepped through the test sequence by operating the PTT switch (momentarily grounding J601-11). Port 1 and the data bus can be monitored using a voltmeter. Port 1 consists of pins 27-34 on microcomputer U705. The data bus includes pins 12-19 on U705. Refer to schematic diagram for data bus and port identification for U705. For example: P17 = port 1 bit 7.

1. Momentarily press and release the PTT switch (J601-11) Port 1 and data bus lines all will go high.
2. Momentarily press and release the PTT switch (J601-11). U705-34 and U705-19 will go low. All other outputs should be high.
3. Momentarily press and release the PTT switch (J601-11). U705-33 and U705-18 will go low. All other outputs should be high.
4. Momentarily press and release the PTT switch (J601-11). U705-17 and U705-33 will go low. All other outputs should be high. Note that U705-32 will remain high. This is because this output switches the radio into the transmit mode when grounded. Thus the output is bypassed so that the radio will never go into the transmit mode during self test.
5. Momentarily press and release the PTT switch (J601-11). U705-31 and U705-16 will go low. All other outputs should be high.
6. Momentarily press and release the PTT switch (J601-11). U705-30 and U705-15 will go low. All other outputs should be high.
7. Momentarily press and release the PTT switch (J601-11). U705-29 and U705-14 will go low. All other outputs should be high.
8. Momentarily press and release the PTT switch (J601-11). U705-28 and U705-13 will go low. All other outputs should be high.

9. Momentarily press and release the PTT switch (J601-11). U705-27 and U705-12 will go low. All other outputs should be high.

10. Momentarily press and release the PTT switch (J601-11). Port 1 outputs will all be set high.

NOTE

At this point the program advances to mirror the outputs PTT, FB5, CG DISBL, ADVANCE CHANGE, and FB4-FB1 onto the data bus U705-12 through U705-19, respectively.

11. Momentarily apply ground to the following points while observing status of the associated data bus as indicated below. When ground is applied, the data bus should go low and then go high when ground is removed.

Momentarily Ground	Data Bus	Momentarily Ground	Data Bus
J604-1	U705-18	J601-13	U705-14
J601-10	U705-17	J601-2	U705-13
J604-3	U705-16	J601-1	U705-12
J601-4	U705-15	J601-11	U705-19

12. Exit the diagnostic routine by momentarily removing power to the radio.

TEST FREQUENCIES

If the EE PROM is not custom programmed to the customers specified personality (Option AO), then a standard test program is provided. The EE PROM is programmed on seven channels including tone and digital Channel Guard and carrier control timer. Table 1 in the Transmitter Alignment Procedure identifies the programmed test frequencies.

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WORLD HEADQUARTERS • LYNCHBURG, VIRGINIA 24502 U.S.A.

GENERAL ELECTRIC
U.S.A.

TRANSMITTER QUICK CHECKS

EXCITER

RF METERING J101 EXCITER READINGS					PROBABLE CAUSE	
					METER READINGS	
TEST POS.	METERING JACK J101	FUNCTION	SCALE	TYPICAL READING	HIGH	LOW
A	J101-10	AMPL-1	0-1	0.2V	Q101 Shorted R101, 103 Open	Q101 Open R103, R105 Open L103 Open Oscillator/Buffer Defective
B	J101-9	TRIPLER	0-3	0.2V	Q102 Defective R107 Open	Q102 Shorted R110 Open L104, L05 and associated circuits, defective or improperly tuned.
C	J101-8	AMPL-3 REL PWR OUT	0-1	0.5V	Helical coil L114 shorted or mis-tuned	Q103 or Q104 defective. Check sistors, capacitors around Q103, Q104. Helical coils L107, L108 mis-tuned or defective. D101 and associated metering circuits defective.

TYPICAL PERFORMANCE INFORMATION

SIGNAL LEVELS

SIGNAL	INDICATION	VOLTAGE LEVEL
CAS	High Level	9.0 VDC
	Low Level	0.15 VDC
RUS	High Level (Rx Un-sq)	9.0 VDC
	Low Level (Rx Squelched)	0.15 VDC
	Low Level (Rx Mute/PTT pulled low, Rx unsquelched)	0.6 VDC
Sq Dis, Input	Logic Low (Sq. Dis)	0 VDC
	Logic High(Sq)	2.4 VDC
	Rx Un-Sq	0.14 VDC
CCT Sq Dis, Input	Logic Low	0.35 VDC
	Logic High	5.5 VDC
Tx Enable	Logic Low	2.0 VDC
	Logic High	9.0 VDC
PTT, Input	Logic Low	1.0 VDC
	Logic High	13 VDC

PA TROUBLESHOOTING PROCEDURE

When troubleshooting the transmitter check for typical meter readings at the exciter, J101, and the power amplifier, JACK, J1. Typical readings for the various test positions and test points are given in the following charts.

NOTE

Regulated +5 VDC and +9 VDC can be opened by P701 thru P705 to facilitate troubleshooting.

POWER AMPL METERING J1 PA JACK READINGS							METER READINGS	PROBABLE CAUSE
					80,90 100 W	35,40 50 W	65, 75 W		
TEST POS.	METERING POINT	FUNCTION MEASURED	SCALE	TYPICAL READING	TYPICAL READING	TYPICAL READING	HIGH	LOW
A	J1-10	RF DRIVE	0-1V	0.5V	0.5V	0.5V		Low exciter output. Realign or repair exciter.
B	J1-9	CONTROL VOLTAGE	0-15V	4V	4.5V	7.5V	Low exciter output.	High exciter output.
C	J1-8	Tx A+	0-15V	12.5V	12.5V	12.5V		Excessive voltage drop in power cable.
E	J1-6	PA CURRENT	0-30A	15A	---	11A	RF output excessively high. Be sure antenna is properly matched to 50 ohms.	RF output low.
F	J1-5	DRIVER CURRENT	0-15A	5A	8A	4A	100 Watt PA. Check A1Q5 and A1Q6. Be sure antenna is properly matched to 50 ohms. 40 Watt PA. RF output power is excessive. Be sure antenna is properly matched to 50 ohms.	100 Watt PA. A1Q5 and A1Q6 have excessive gain. RF output set too low. 40 Watt PA. Low RF output.

CURRENT REFERENCE CHART

SERVICE PLUG	FUNCTION	TYPICAL CURRENT/mA
P701	5V	75
P702	9V	70
P703	9V	Tx 90, Rx 80
P704	9V	Tx 45, Rx 75
P705	9V	Tx 40, Rx 55

TEST POINT DATA (Typical)

TEST POINT	VOLTAGE	CONTROL	DESCRIPTION
J602-3	9±0.05 VDC	R703	9 Volt Regulator
J602-2	13.2 VDC (A+)		
J202	3.0-7.5 VDC	C220	VCO Control Voltage (See Synth Align)
U703-9	Less than 1.0	L209	Frequency Lock Detector
J353	0.7 VPP		Reference Osc. Output (high impedance)
TP352	5.5 VDC (Nominal)	--	Compensation line voltage
J712	5.0 VDC	NONE	VCC to Microcomputer

RADIO CONNECTOR IDENTIFICATION	
Front Connector	J601
Systems Metering	J602
Option Connector	J603
PROM Program Plug	J711
RF Metering	J101
RX In.	P401
IF Input	P404
RX Inj.	P451
Exciter Input	P102
Exciter Output	P101, P103

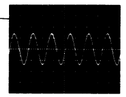
RECEIVER READINGS SYSTEM JACK, J602			
TEST POS	FUNCTION	SCALE	TYPICAL READING
D	IF AMP	1V	0.75
H	RX INJ	1V	0.55

SYMPTOM	PROCEDURE	ANALYSIS
Little or No RF Output	Key transmitter and check J1-10 (Pos A) for +0.5 V (exciter input).	Refer to Schematic Diagram and and verify voltage readings.
	Unkey transmitter and check Q105-C for +9.0 VDC	Verify +9.0 Volt supply. Check R124 and L117.
	Check DC voltages on Q101-Q105.	If voltages are incorrect, check L103, L106, L110, L112, L117 and all resistors for each stage. Check R106, R110, R114, R118, R119, and R124. Check Q101-Q105. Replace components if defective.
	Key transmitter and check for RF at tap of L210	No RF Present - Check DC voltages on Q201 and Q202. If voltages are incorrect check tuning of L205-L208, then check for +5.8 VDC at cathode of D217. Check R226, R231 and D217. Replace defective component. RF Present - Monitor J1-10 (Pos A) with multimeter and key and unkey the transmitter. Voltage should increase when the transmitter is keyed. If not, check L101, L102, and associated components. Also check C106-C108.
	Key transmitter and monitor voltage at J101-9 (Pos B Tripler). Voltage should increase.	If voltage does not increase check C116-C118, L104, L105, and associated components.
	Monitor J101-8 (Pos C) and key transmitter. Voltage should increase.	If voltage does not increase, check Q103, Q104 and associated components. Check D101 and associated metering circuitry. Finally, check both helical filters.
	Disconnect P101 from PA and measure RF input power from exciter. Should be 0.5 Watts or more.	If exciter output is low, check Q105 and associated circuitry. Also check 2nd helical filter including L114 and L115. Retune exciter if needed. If output power is correct be sure P101 is soldered securely and that it mates properly with the contact on the power amplifier.

SQUELCH CIRCUIT TEST WITH kHz SIGNAL

PRELIMINARY STEPS

1. Quiet receiver with 1000 uv modulated signal applied to antenna jack J2.
2. Squelch Adjust R666 to 8 dB SINAD.
3. Set modulation to 6 kHz.
4. Set deviation to 3 kHz.
5. Use 10 megohm probe.

A


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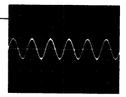
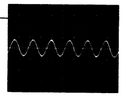
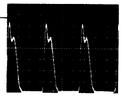
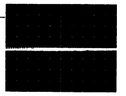


C
HOR .1 MSEC/DIV
VERT .2 V/DIV
(.36 V P-P)


D
HOR .50 uSEC/DIV
VERT .2 V/DIV
(1.2 V P-P)
BASE LINE = 0 VDC


E

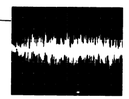

F


SQUELCH CIRCUIT CHECKS WITH NOISE

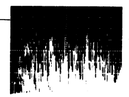
PRELIMINARY STEPS

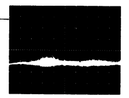
1. No input signal applied.
2. Squelch Adjust R666 set for 8 dB SINAD.
3. Use 10 megohm probe.

A
HOR .5 MSEC/DIV
VERT .1 V/DIV
(=4 V P-P)


B
HOR .5 MSEC/DIV
VERT .1 V/DIV
(=2 V P-P)


C
HOR .5 MSEC/DIV
VERT .5 V/DIV
(=1.5 V P-P)


D
HOR .5 MSEC/DIV
VERT .1 V/DIV
(=4 V P-P)
BASE LINE = 0 VDC


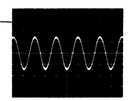
E
HOR .5 MSEC/DIV
VERT .2 V/DIV
(6 VDC)
BASE LINE = 0 VDC


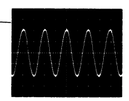
F
HOR .5 MSEC/DIV
VERT .2 V/DIV
(7.5 VDC)

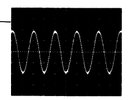

AUDIO CIRCUIT

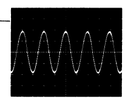
PRELIMINARY STEPS

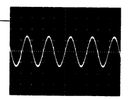
1. Apply 1000 uV on frequency signal with 1000 Hz modulation and 3 kHz deviation to antenna jack J2.
2. Output set to 12 Watts (6.93 VRMS) into 4-ohm load.
3. Use 1 megohm probe.

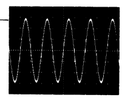
G
HOR .5 MSEC/DIV
VERT 50 MV/DIV
(140 MV P-P)


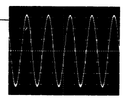
H
HOR .5 MSEC/DIV
VERT .2 V/DIV
(.84 V P-P)


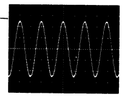
J
HOR .5 MSEC/DIV
VERT .1 V/DIV
(.4 V P-P)


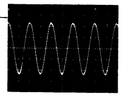
K
HOR .0.5 MSEC/DIV
VERT .1 V/DIV
(.4 V P-P)


L
HOR .5 MSEC/DIV
VERT .50 MV/DIV
(140 MV P-P)


M
HOR .5 MSEC/DIV
VERT .50 MV/DIV
(320 MV P-P)


N
HOR .5 MSEC/DIV
VERT .50 MV/DIV
(300 MV P-P)


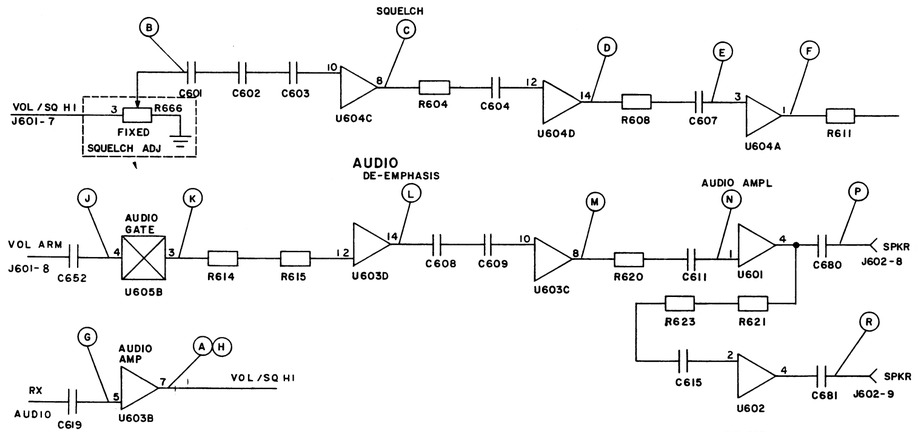
P
HOR .5 MSEC/DIV
VERT .2 V/DIV
(10 V P-P)


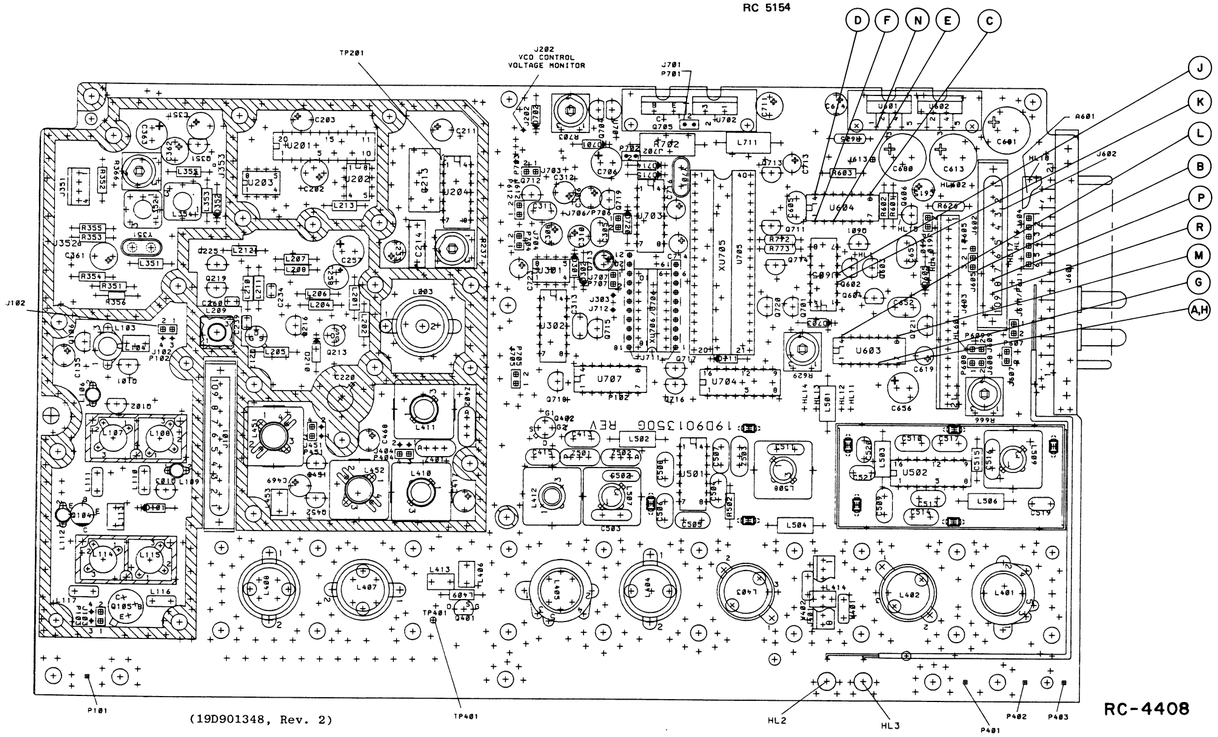
R
HOR .5 MSEC/DIV
VERT .2 V/DIV
(10 V P-P)


RECEIVER AUDIO AND SQUELCH WAVEFORM CHECKS

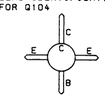
Issue 1

AUDIO AND SQUELCH WAVEFORMS





LEAD IDENTIFICATION
FOR Q104



TOP VIEW

NOTE: COLLECTOR LEAD MARKED AS SHOWN

LEAD IDENTIFICATION
FOR U701

TOP VIEW

LEAD IDENTIFICATION
FOR ALL TRANSISTORS
NOT OTHERWISE IDENTIFIED

IN-LINE
TOP VIEW

NOTE: CASE SHAPE IS DETERMINING FACTOR FOR LEAD IDENTIFICATION.

TEST PROCEDURES

These Test Procedures are designed to assist you in servicing a transmitter that is operating -- but not properly. Once a defect is pin-pointed, refer to the Transmitter Troubleshooting Procedure. Before starting, be sure that transmitter is tuned and aligned to the proper operating frequency.

CAUTION

Before bench testing the radio, be sure of the output voltage characteristics of your bench power supply.

To protect the transmitter power output transistors from possible instant destruction, the following input voltages must not be exceeded:

Transmitter unkeyed:	**20 Volts**
Transmitter keyed (50 ohms resistive load):	**18 Volts**
Transmitter keyed (no load or non-resistive load):	**14 Volts**

These voltages are specified at the normal vehicle battery terminals of the radio and take the voltage drop of standard cables into account. The voltage limits shown for a non-optimum load is for "worst case" conditions. For antenna mismatches likely to be encountered in practice, the actual limit will approach the 18 Volt figure.

Routine transmitter tests should be performed at EIA Standard Test Voltages (13.6 VDC for loads of 6 to 16 amperes; 13.4 VDC for loads of 16 to 36 amperes). Input voltages must not exceed the limits shown, even for transient peaks of short duration.

Many commonly used bench power supplies cannot meet these requirements for load regulation and transient voltage suppression. Bench supplies which employ "brute force" regulation and filtering (such as Lapp Model 73) may be usable when operated in parallel with a 12 Volt automative storage battery.

TEST PROGRAMMING

In DELTA-S radios, in which the EE PROM is not custom programmed, the EE PROM is programmed with the personality shown in Table 1 below.

FREQUENCY SPLIT	CHANNEL NO.	TRANSMIT FREQUENCY	RECEIVE FREQUENCY	CHANNEL GUARD ENC/DEC	CCT
450-470 MHz	1	461.025	461.050	71.9	---
	2	467.025	462.050	023	---
	3	461.025	461.050	---	30 SEC
	4	455.025	460.050	---	---
	5	450.000	460.025	---	---
	6	470.000	469.750	71.9	---
	7	461.000	460.750	---	---
470-494 MHz	1	483.8875	483.050	71.9	---
	2	489.8875	484.050	023	---
	3	483.8875	483.050	---	30 SEC
	4	477.8875	482.050	---	---
	5	470.000	470.050	---	---
	6	494.000	493.750	71.9	---
	7	485.000	484.750	---	---
494-512 MHz	1	503.000	502.975	71.9	---
	2	509.000	503.975	023	---
	3	503.000	502.975	---	30 SEC
	4	497.000	501.975	---	---
	5	494.000	501.975	---	---
	6	512.000	511.750	71.9	---
	7	503.000	502.750	---	---
403-430 MHz	1	413.025	413.050	71.9	---
	2	419.025	414.050	023	---
	3	413.025	413.050	---	30 SEC
	4	407.025	412.050	---	---
	5	403.000	403.050	---	---
	6	430.000	429.750	71.0	---
	7	414.000	413.750	---	---

TABLE 1 - PROGRAMED TEST FREQUENCIES

TRANSMITTER FREQUENCY ADJUSTMENT

First, check the frequency to determine if any adjustment is required. The frequency should be set with a frequency meter or counter with an absolute accuracy that is 5 to 10 times better than the tolerance to be maintained, and with the entire radio as near as possible to an ambient temperature of 25°C (77°F).

The oscillator frequency should be set at 25°C ambient temperature. In the range of 15°C to 40°C, if the frequency deviates more than ±1 PPM, it may be reset to ±1 PPM, respectively.

NOTE

Refer to Figures 4 and 5 Frequency Correction Factor.

Adjust L352 to set the transmit frequency while monitoring RF output jack J2 through a 30 dB decoupler.

SYNTHESIZER TRANSMIT DEVIATION ADJUSTMENT

The MOD ADJUST controls are adjusted to the proper setting before shipment and normally do not require readjustment. This setting permits approximately 75% modulation for the average voice level. The audio peaks which would cause overmodulation are clipped by the modulation limiter. The limiter, in conjunction with the de-emphasis network, instantaneously limits the slope of the audio wave to the modulator, thereby preventing over-modulation while preserving intelligibility.

TEST EQUIPMENT

1. An audio oscillator (GE Model 4EX6A10)
2. Deviation Monitor
3. An output meter or a VTVM
4. GE Test Set Model 4EX3A11 Test Cable 19C850590G1

PROCEDURE

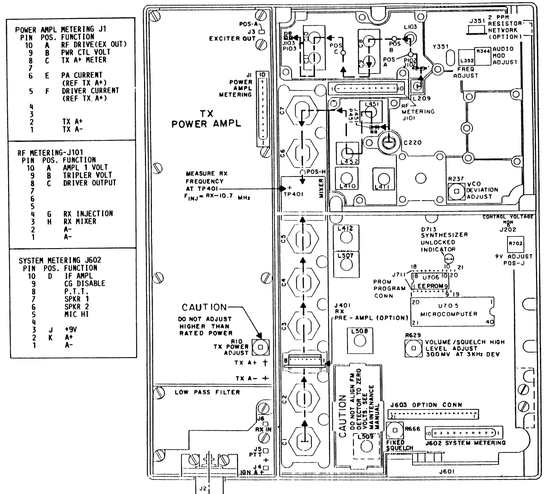
1. Select a center frequency channel. Disable Channel Guard if present.
2. Preset R366 fully counterclockwise and R22 on Channel Guard board (if present) to the center of its range.
3. Apply a 1 kHz tone at 1.0 VRMS to mic input jack J603-17. Connect deviation monitor to RF output jack J2 through a 30 dB decoupler. Set DEVIATION ADJUST R237 for rated deviation. ±3.75 kHz with Channel Guard or ±4.5 kHz without Channel Guard.
4. Apply a 400 Hz tone through a 100 uF capacitor to J603-15. Set output level to obtain a deviation of ±2.0 kHz. Note and maintain this voltage level while switching the output frequency to 10 Hz. Adjust REF OSC Deviation Control R366 starting from the fully clockwise position for ±2.0 kHz deviation. Remove modulation.
5. Select a channel with Channel Guard nearest the center frequency and adjust R22 on the Channel Guard option board to ±0.65 kHz (tone or digital Channel Guard).

ACCESSING CENTER TUNE FREQUENCY

NOTE

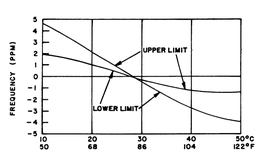
When a radio is factory programmed for less than 16 channels, channel 16 is programmed for transmit and receive center tune frequency. Under normal operation, the microcomputer will not access this channel. The following test accesses channel 16 to assure its availability for tuning purposes.

1. Apply +12 VDC through a 10K resistor to J604-3, then turn the radio on. This tells the microcomputer to always access channel 16.
2. To select the transmit center tune frequency, press the PTT switch (J601-11). Release the PTT switch to select the receive center frequency.
3. To exit this mode remove power from J604-3 and momentarily remove power from the radio.



RC 5124

FIGURE 4 CORRECTION FACTOR IN FREQ. SETTING FOR 5 PPM OSCILLATOR



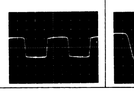
AUDIO CHECKS

TEST EQUIPMENT REQUIRED (or equivalent)

- Audio Oscillator
- Oscilloscope (Ballantine Model 1022A)
- AC Voltmeter (Triplett 310-C)
- Deviation Monitor (Cushman CE-50A)

AUDIO AC VOLTAGES

1. Connect audio oscillator output across J603-10 (MIC HI) and J603-16 (MIC LO).

		U301-7	C301-1
SCOPE SETTING	HORIZONTAL	200 U SEC/DIV	200 U SEC/DIV
	VERTICAL	2 VOLTS/DIV	2 VOLTS/DIV
SET AUDIO OSCILLATOR AT 1000 Hz WITH OUTPUT OF 1.0 VRMS. MODULATION ADJUSTED FOR 4.5 kHz DEVIATION. NOTE: AN RMS OR PEAK READING VOLTMETER WILL READ 1/2 TO 1/3 OF PEAK-TO-PEAK READINGS.			

AUDIO SENSITIVITY

1. Connect audio oscillator output across J603-10 (MIC HI) and J603-16 (MIC LO). Adjust output for 1000 Hz at 1.0 VRMS.
2. Reduce generator output until deviation falls to 3.0 kHz for radios without Channel Guard or to 2.25 kHz for radios with Channel Guard. Voltage should be less than 120 millivolts.

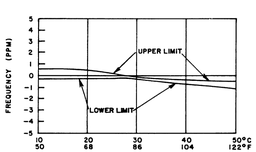
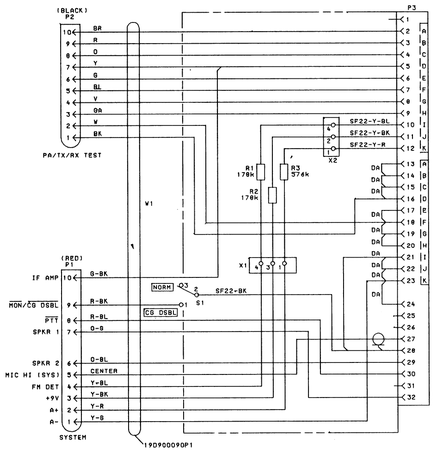


FIGURE 5 CORRECTION FACTOR IN FREQ. SETTING FOR 2 PPM OSCILLATOR

RC 4498

TEST CABLE 19C850590G1



ALL RESISTORS ARE 1/4 WATT UNLESS OTHERWISE SPECIFIED.
RESISTOR VALUES IN Ω UNLESS FOLLOWED BY MULTIPLIER K OR M.
CAPACITOR VALUES IN F UNLESS FOLLOWED BY MULTIPLIER µ,n OR P.
INDUCTANCE VALUES IN H UNLESS FOLLOWED BY MULTIPLIER m OR µ.

(19C850593, Rev. 4)

SYNTHESIZER AND TRANSMITTER ALIGNMENT

TEST EQUIPMENT REQUIRED

1. Wattmeter, 50 ohm (capable of measuring 150 Watts and 1 Watt)
2. DC Voltmeter, 20,000 ohms per volt
3. Digital Voltmeter
4. Oscilloscope
5. Power supply, 13.8 VDC regulated
6. GE Test Set, 4EX3A11 with Test Set Adapter 19C850590G1
7. Tuning Tool 19B800716P2

PRELIMINARY CHECKS AND ADJUSTMENTS

1. Connect black plug of GE Test Set to RF Metering jack J101. Connect red system metering plug to J602, system metering. Set polarity to "+" and voltage range to the 1 volt position (Test 1).

NOTE

Before aligning or making any adjustments to the transmitter, be sure that the output of the 9 Volt regulator is set for 9.0 ±0.05 VDC.

2. Apply power to the radio and monitor J602-3 with a digital voltmeter. If necessary, adjust R703 for 9.0 ±0.05 VDC.
3. Monitor voltage at J352 (compensation line voltage) and verify that voltage is approximately 5.5 volts DC.
4. Verify that reference oscillator frequency is within ±50 PPM of its tuned value (13.2 MHz Standard).

ALIGNMENT PROCEDURE

1. Preset the core of L352 and L354 to top of coil form and then turn clockwise two full turns.
2. Preset all four tuning screws in the exciter (C8-C11) so that the tops of the tuning screws are approximately 7 mm above the top of the casting.
3. Preset L103 so that the core is flush with the top of the coil form.

STEP	METERING POSITION: GE TEST SET	METERING POSITION: MULTI-METER (- to J101-1)	TUNING CONTROL	METER READING	PROCEDURE
			SYNTHESIZER		
					NOTE: Most tuning peaks will be quite broad with small changes in meter readings. Most dips will be sharper. Metering readings given are typical.
1.		U703-9	L209	<1.0 VDC	Select highest frequency transmit channel. Tune L209 so that lock detect indicator D713 goes out and the voltage at U703-9 is less than 1.0 VDC with no AC pulses present.
					NOTE: Steps 2 and 3 may not be possible if the highest channel frequency is in the low end of the split. When this occurs, tune for maximum voltage (while locked) and proceed to Step 4.
2.		J202	L209	7.5 VDC	Monitor J202 with digital voltmeter. Tune L209 for 7.5 VDC ± 50 mv.
3.		J202	C220	7.5 VDC	Select highest frequency receive channel (release PTT switch) and tune C220 for 7.5 VDC ±50 mv. at J202. Verify that lock indicator D713 goes out.
4.		J202		3.0-7.5 VDC	Select lowest frequency channel. Voltage should be between 3 - 7.5 VDC transmit and receive for the lowest and highest frequency channels.

ALIGNMENT PROCEDURE (Continued)

STEP	METERING POSITION: GE TEST SET	METERING POSITION: MULTIMETER (- to J101-1)	TUNING CONTROL	METER READING	PROCEDURE
			REFERENCE OSCILLATOR FREQUENCY		
5.		J102	L352	Channel Operating Frequency	NOTE: This step assumes the frequency is measured when the transmitter is first keyed. If delayed the rapidly rising ambient temperature must be taken into consideration. Figures 4 and 5 below show the temperature versus frequency correction curve for the 5 PPM and optional 2 PPM oscillators. Press the PTT switch while monitoring the Tx injection frequency at J102. Adjust L352 for the assigned channel frequency ±5 PPM or ±2 PPM when specified (Digit 11 = 'A'). Note: The receiver injection frequency will automatically be correct.
			EXCITER		
					NOTE: The exciter can be isolated from the rest of the radio for alignment purposes, if desired. To isolate and set up for alignment, remove P102 and P103. Connect a (0-1 watt) wattmeter to P103-2,4. Apply a +15 to 20 dBm on 1/3 carrier frequency signal to J102-2,1. If less than 6.0 MHz channel spacing is required, select the highest transmit RF frequency. If 6.0 to 12.0 MHz bandwidth is required, select center frequency. (Refer to "Accessing Center Tune Frequency" and complete Steps 7-14.)
6.	A (AMPL-1)	J101-10		0.25V	No tuning required.
7.	B (TRIPLER)	J101-9	L103	-0.45V	Tune L103 for maximum negative meter reading (switch voltmeter for negative reading.)
8.	B (TRIPLER)	J101-9	C8	-0.5V	Tune C8 for maximum meter reading.
9.	C (AMPL-3)	J101-8	C9	2.0V	Tune C9 for maximum meter reading. Stop when maximum is reached.
10.	C (AMPL-3)	J101-8	C10	0.01	Tune C10 for a dip, 0.01 volts typical. Note, after C11 is tuned, this voltage typically will be 0.5 volts.
11.	C		C11	0.5	Tune C11 for maximum exciter power output as indicated on the wattmeter, connected to J102-1,2. Exciter output is typically 600 mw.
12.	A (PA Input)	J1-10	C11	Rated Output Power	Check power output at both ends of the frequency spread. It should be equal to or greater than rated power. If wattmeter to measure exciter power is unavailable and the exciter is already connected to the PA, connect the meter to PA board J1. Connect a 150 watt wattmeter to antenna connector J2. Set the RF Adjust control for maximum power (fully clockwise). Tune C11 for maximum meter reading on J1, position A. Check the meter reading at both ends of the frequency spread. They should be approximately equal. If not adjust C11 accordingly. Set RF Power Adjust for rated output power.
13.	A (PA INPUT)		C11		NOTE: If more than 6.0 MHz channel spacing is required perform Steps 13 and 14. Select highest frequency channel. Key transmitter and adjust C11 so that output power is slightly above rated power.
14.			C10		Select lowest frequency channel. Key transmitter and adjust C10 so that output power is slightly above rater power. Switch to highest frequency channel and verify rated output power. If necessary repeat this step.

* Fo is the transmit output frequency at the antenna. The injection frequency is Fo at J102.

RECEIVER FREQUENCY ADJUSTMENT

(Refer to Transmit Frequency Adjustment, no adjustment of receive frequency is required)

ALTERNATE IF SWEEP ALIGNMENT

1. Attach an oscilloscope probe to IF AMP. MTR. (J602-10). (Refer to Figure 4).
2. Using an HP8640B signal generator, set with an on-channel frequency, feed a 20 Hz modulating frequency with 12 kHz of deviation into the radio at antenna jack J2.
3. Connect a coaxial cable between the AM output of the HP8640B and the external 10 trigger signal on the scope. Use NORMAL triggering.
4. DC couple the scope probe and adjust the controls for 0.1V per div. and 2 msec per div.
5. Adjust the AM output level to make sure the scope is triggering. Adjust the RF input signal level to keep the IF passband sweep pattern just below saturation (typ. 9 uV). After using the vertical and horizontal positioning controls to center the waveform, check for a scope pattern similar to the one below:

SERVICE NOTE: L410, L411, L412, L507, and L508 should be tuned to peak the IF passband, and any ripple should be minimized in the passband.

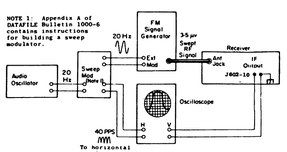


Figure 4 - Test Setup for 20 Hz Double-Trace Sweep Alignment

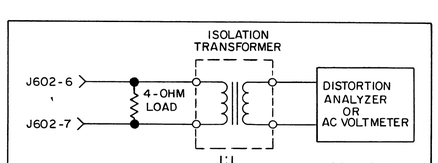


Figure 5 - Test Set-up, Audio Output Measurement

RECEIVER ALIGNMENT

TEST EQUIPMENT REQUIRED (Or Equivalent)

1. GE Test Set 4EX3A11, 4EX8K12, or 20,000 ohms-per-volt millimeter with 1 volt scale
2. AC Voltmeter
3. FM Deviation Monitor
4. Digital Voltmeter
5. VOM
6. RF Signal Generator (403-512 MHz)
7. Frequency Counter (Hewlett-Packard 5300B).
8. Oscilloscope
9. Audio Isolation Transformer (1:1) 19A116736P1 or equivalent.
10. 4 ohm 15 watt resistor.
11. Tuning Tool 19B800716P2

PRELIMINARY CHECKS AND ADJUSTMENTS

NOTE

Refer to Figure 3 or photo for location of tuning and adjustment controls.

1. Connect the black plug from the Test Set to the RF metering jack J101. Connect red system metering plug to J602, system metering. Set Test Set to 1 volt scale. A 20,000 ohms-per-volt multimeter may be used when the GE Test Set is not available.
2. Preset C1-C7 to maximum height above top of tuning nut (10 mm above casting).
3. Preset L509 to top of coil form and then turn clockwise 11 full turns.
4. Preset L451 to top of coil form, then turn 15 turns clockwise.
5. Preset L410, L411, L412, L507 and L508 to top of coil form and then turn clockwise 9 full turns.
6. Apply power to radio and monitor the regulated 9 volt supply at J602-3. Adjust R703 if necessary to obtain 9±0.01 VDC. Use a digital multimeter.

NOTE

Before aligning the receiver or making any adjustments to the radio be sure that the output of the 9 volt regulator is set for 9.0±0.1 VDC.

ALIGNMENT PROCEDURE

STEP	METERING POSITION: GE TEST SET	METERING POSITION: MULTIMETER	TUNING CONTROL	METER READING	PROCEDURE
			LOCAL OSCILLATOR INJECTION		
1.	G (RX INJ)	J101-4	L452	Peak	Select desired channel or center tune frequency. Set Test Set to 1 volt scale and tune L452 for maximum reading on Test Set.
2.	G (RX INJ)	J101-4	L451, L452	Peak	Tune L451 and L452 for maximum reading on Test Set.
3.	G (RX INJ)	J101-4	C7	Dip	Tune C7 for a dip in Test Set reading.
4.	H (RX MIX)	J101-3	C6, C7, L452	Peak	Tune C6 for maximum. Sequentially retune L452, C6 and C7 until there is no further increase in meter reading.
			FRONT END ALIGNMENT		
5.	D (IF AMP)	J602-10	C3	MAX	Connect RF signal generator to antenna jack J2. Set frequency to desired receive channel or center tune frequency. Set modulation frequency to 1 kHz and deviation to 3 kHz. Set input level to -10 dBm (70 mV). Tune C3 for maximum indication on meter while reducing the input level of the signal generator as required to keep the IF AMP reading from saturating. (0.6 V typical).
6.	D (IF AMP)	J602-10	C1, C5, C2, C4	Peak	Peak C1, C5, C2, C4 in sequence while reducing output level of signal generator to prevent saturation.

STEP	METERING POSITION: GE TEST SET	METERING POSITION: MULTIMETER	TUNING CONTROL	METER READING	PROCEDURE
			RF SELECTIVITY		
					NOTE If the IF amplifiers have been aligned using the alternate sweep alignment method, proceed to Step 9.
7.	D (IF AMP)	J602-10	L508, L507, L410, L411, and L412	Maximum (See Procedure)	Select a center frequency channel. Apply an on-frequency signal with 1 kHz modulation to antenna jack J2. Set deviation to 3 kHz. Reduce signal level to approximately 75% of saturated level shown on Test Set meter. While making the following adjustments keep the signal level below saturation. Tune L508, L507, L412, L411 and L410, in that order, for a peak reading. Repeak coils until no further improvement in meter reading is noted.
8.	D (IF AMP)	J602-10	C1-C5	Maximum	Repeak C1-C5.
			FM DETECTOR/AUDIO PREAMPLIFIER		
					NOTE The audio output is a balanced bridge circuit and requires all test equipment connected across the speaker leads to be both AC and DC isolated from ground. Connect test equipment as shown in Figure 5.
9.			L509	0.35 - 0.5 VRMS	Set signal generator output for 1000 u volts. Set R629 and volume control to the center position. Monitor the speaker outputs (J602-6,7) with an AC voltmeter. Tune quadrature coil L509 for a peak reading.
10.			R629		Adjust R629, audio preamplifier level for a nominal 300 mV RMS at VOL/SQ HI (J603-14).
			FIXED SQUELCH ADJUSTMENT (8 dB SINAD) (EARLIER MODELS)		
11.			R666		Adjust fixed squelch control R666 fully clockwise (open squelch). Adjust input level of RF Signal Generator to produce a SINAD sensitivity reading of 8 dB. Turn R666 fully counterclockwise (maximum squelch position) to close squelch. Slowly readjust R666 to the position where the squelch just opens. Verify that squelch opens at 8 ±1 dBm.
			MULTI-FREQUENCY SPREAD (Multi-Frequency radios) (Single Frequency Radio Proceed to Step 16.)		
12.	D (IF AMP)	J602-10	C1-C3		Select a center frequency channel. Apply an on-frequency signal with 1 kHz modulation to antenna jack J2. Set deviation to 3 kHz. Reduce signal level to approximately 75% of saturated level shown on Test Set meter. Detune C2 three turns clockwise or counterclockwise. Detune in direction that will not exceed maximum or minimum tuning screw height. Tune C1 for a peak. Increase or decrease signal generator level as required to maintain 75% of the saturated signal level. Detune C3 and then tune C2 for a peak. Detune C4 and then tune C2 for a peak.
13.	D (IF AMP)	J602-10	C4, C5		Detune C5 clockwise to minimum tuning screw height. Tune C4 for a peak. Then tune C5 to maximum tuning screw height. Tune C5 for a peak reading.
14.	H (RX MIX)	J101-3	C6		Select highest channel frequency and note meter reading. Select lowest channel frequency and note reading. Tune C6 slightly to equalize these two readings. If they cannot be equalized tune C6 to improve the channel with lowest reading.
15.		J2	C5		Adjust the frequency of the signal generator to the highest frequency channel. Apply a modulated signal at the 0.35 uV level. Measure the SINAD level in accordance with Step 2 of Receiver Test Procedures. If the SINAD reading is 12 dB SINAD or less, tune C5 counterclockwise until the SINAD reading is greater thatn 12 dB. Switch to the lowest frequency channel and set the signal generator to the lowest frequency channel. Measure the SINAD level on the distortion analyzer. If the SINAD reading is less than 12 dB, tune C5 clockwise until the SINAD reading is 12 dB. Recheck the sensitivity at the high frequency channel. Readjust C5, if necessary, to keep the sensitivity at the band edges greater than or equal to 12 dB SINAD.
16.	D (IF AMP)		C1-C5		Set signal generator for 12 dB SINAD level. Adjust C1-C5 for best sensitivity.

TEST PROCEDURES

These Test Procedures are designed to help you to service a receiver that is operating---but not properly. The problems encountered could be low power, poor sensitivity, distortion, limiter not operating properly, and low gain. By following the sequence of test steps starting with Step 1, the defect can be quickly localized. Once the defective stage is pin-pointed, refer to the "Service Check" listed to correct the problem. Additional corrective measures are included in the Troubleshooting Procedure. Before starting with the Receiver Test Procedures, be sure the receiver is tuned and aligned to the proper operating frequency.

TEST EQUIPMENT REQUIRED

- Distortion Analyzer
- Signal Generator
- 6 dB attenuation pad
- Audio Isolation Transformer
- 4 ohm resistor (15 watt minimum)

PRELIMINARY ADJUSTMENTS

NOTE

These procedures are written around the Heathkit Distortion Analyzer. If a Distortion Analyzer other than the Heath IM-12 is used, measure the sensitivity and modulation acceptance bandwidth in accordance with manufacturer's instructions.

1. Unsquelch the receiver.

STEP 1
AUDIO POWER OUTPUT AND DISTORTION

TEST PROCEDURE

Measure Audio Power Output as follows:

A. Apply a 1000 microvolt, on-frequency test signal modulated by 1,000 Hz with ±3.0 kHz deviation to antenna jack J2.

B. With 12 Watt Speaker

Disconnect speaker lead pins from J1A-36 and 37 on rear of control unit. Connect a 4.0 ohm, 15 Watt load resistor across system metering jack J602-6 and 7 on the TRS board.

Connect the isolation transformer input across the resistor. Connect the isolation transformer output to the Distortion Analyzer (See Figure 5).

C. Adjust the VOLUME control for 12 Watts output 6.93 VRMS using the Distortion Analyzer as a voltmeter.

D. Make distortion measurements according to manufacturer's instructions. Reading should be less than 3%. If the receiver sensitivity is to be measured, leave all controls and equipment as they are.

SERVICE CHECK

If the distortion is more than 3%, or maximum audio output is less than 12 Watts, make the following checks:

E. Battery and regulator voltage---low voltage will cause distortion. (Refer to Receiver Schematic Diagram for voltages.)

F. Audio Gain (Refer to Receiver Troubleshooting Procedure).

G. FM Detector Alignment (Refer to Receiver Alignment).

STEP 2
USABLE SENSITIVITY (12 DB SINAD)

If STEP 1 checks out properly, measure the receiver sensitivity as follows:

A. Apply a 1000 microvolt, on-frequency signal modulated by 1000 Hz with 3.0 kHz deviation to J601.

B. Place the RANGE switch on the Distortion Analyzer in the 200 to 2000 Hz distortion range position (1000 Hz filter in the circuit). Tune the filter for minimum reading or null on the lowest possible scale (100%, 30%, etc.)

C. Place the RANGE switch to the SET LEVEL position (filter out of the circuit) and adjust the input LEVEL control for a +2 dB reading on a mid range (30%).

D. Set signal generator output to 0.3 uV. Switch the RANGE control from SET LEVEL to the distortion range. Readjust Distortion Analyzer SET LEVEL as required until a 12 dB difference (+2 dB to -10 dB) is obtained between the SET LEVEL and distortion range positions (filter out and filter in).

E. The 12 dB difference (Signal plus Noise and Distortion to noise plus distortion ratio) is the "usable" sensitivity level. The sensitivity should be less than rated 12 dB SINAD specifications with an audio output of at least 6 Watts (49 Volts RMS across the 4.0 ohm receiver load using the Distortion Analyzer as a Voltmeter).

F. Leave all controls as they are and all equipment connected if the Modulation Acceptance Bandwidth test is to be performed.

SERVICE CHECK

If the sensitivity level is more than rated 12 dB SINAD, check the alignment of the RF stages as directed in the Alignment Procedure.

STEP 3
MODULATION ACCEPTANCE BANDWIDTH (IF BANDWIDTH

If STEPS 1 and 2 check out properly, measure the bandwidth as follows:

A. Set Audio to 10% of rated output.

B. Set the Signal Generator output for twice the microvolt reading obtained in the 12 dB SINAD measurement.

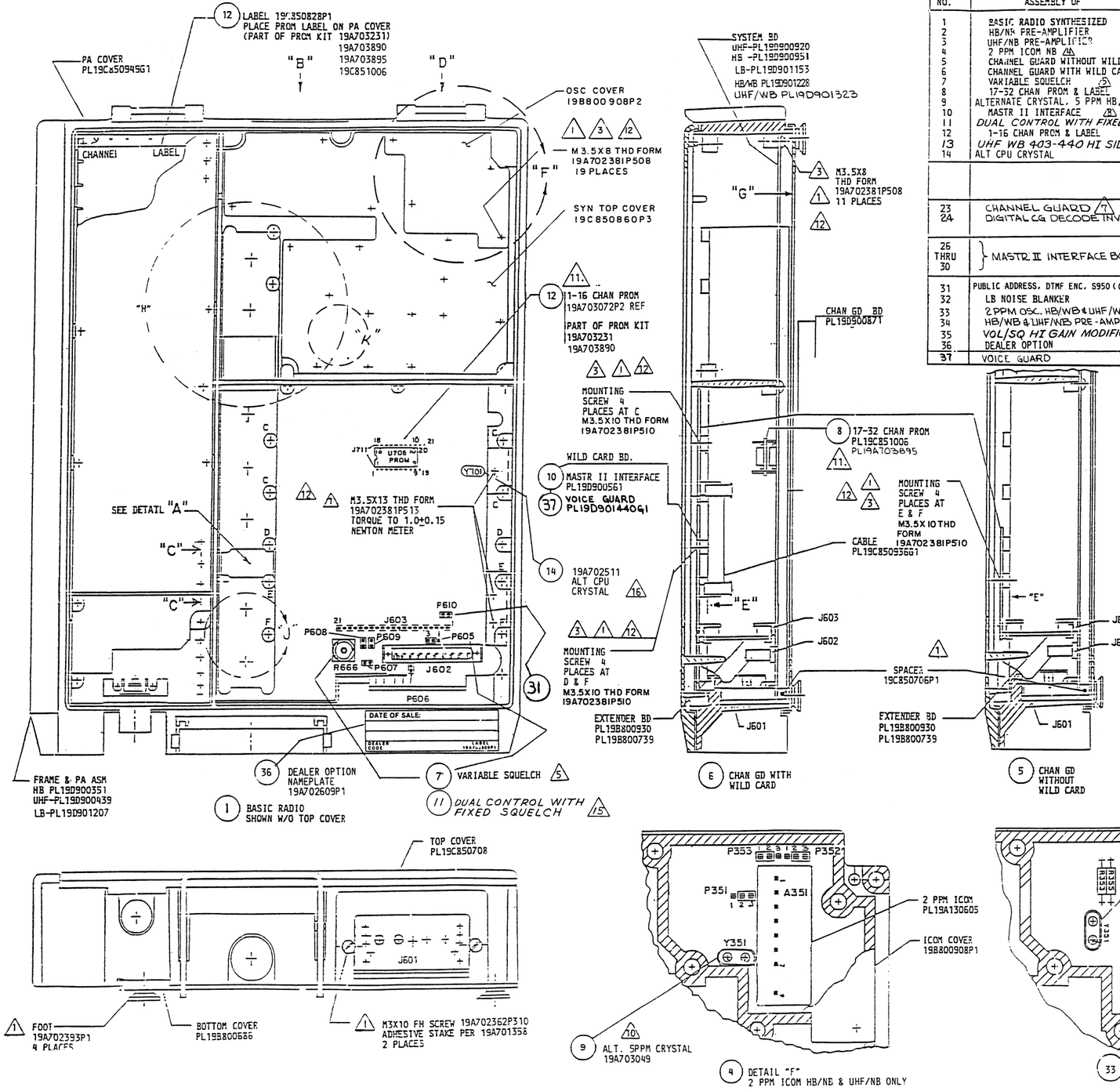
C. Set the Range control on the Distortion Analyzer in the SET LEVEL position (1000 Hz filter out of the circuit), and adjust the input LEVEL control for a +2 dB reading on the 30% range.

D. While increasing the deviation of the Signal Generator, switch the RANGE control from SET LEVEL to distortion range until a 12 dB difference is obtained between the SET LEVEL and distortion range readings (from +2 dB to -10 dB).

E. The deviation control reading for the 12 dB difference is the Modulation Acceptance Bandwidth of the receiver. It should be more than ±7.0 kHz.

SERVICE CHECK

If the Modulation Acceptance Bandwidth test does not indicate the proper width check synthesizer frequency and then refer to the Alternate IF Alignment Procedure.



PART NO.	ASSEMBLY OF
1	BASIC RADIO SYNTHESIZED
2	HB/NB PRE-AMPLIFIER
3	UHF/NB PRE-AMPLIFIER
4	2 PPM ICOM NB 4
5	CHANNEL GUARD WITHOUT WILD CARD 7
6	CHANNEL GUARD WITH WILD CARD 7
7	VARIABLE SQUELCH 5
8	17-32 CHAN PROM & LABEL
9	ALTERNATE CRYSTAL, 5 PPM HB/NB & UHF/NB
10	MASTR II INTERFACE 8
11	*DUAL CONTROL WITH FIXED SQUELCH* 15
12	1-16 CHAN PROM & LABEL
13	*UHF WB 403-440 HI SIDE INJECTION*
14	ALT CPU CRYSTAL
23	CHANNEL GUARD 7
24	DIGITAL CG DECODE INVERSION
26 THRU 30	MASTR II INTERFACE BOARD 8
31	PUBLIC ADDRESS, DTMF ENC, S950 (CONT UNIT) 9
32	LB NOISE BLANKER
33	2 PPM OSC. HB/WB & UHF/WB 13
34	HB/WB & UHF/NB PRE-AMPL
35	*VOL/SQ HI GAIN MODIFICATION* 14
36	DEALER OPTION
37	VOICE GUARD

NOTES:

1. PART OF HARDWARE KIT PL19A702024.

3. TORQUE M3.5 SCREWS TO 1.75 ± 0.15 NEWTON METER.

4. REMOVE EXISTING COVER 19B800908P2 AND RETURN TO STOCK. REMOVE 5 PPM CRYSTAL Y351 AND RETURN TO STOCK. MOVE P351, P352, P353 TO POSITION SHOWN IN DETAIL "F". PLUG-IN 2 PPM ICOM. INSTALL ICOM COVER USING EXISTING SCREWS: TORQUE SCREWS PER NOTE 3.

5. FOR VARIABLE SQUELCH, REMOVE POT R666 AND MOVE P605 TO J603 PINS 1, 2, 3.

6. PART OF UHF PRE-AMPL 19C850692.

7. P607 THRU P609 PLUGS ON SYSTEM BD. SHALL BE REMOVED WHERE "X" IS SHOWN BELOW.

PART NO.	DESCRIPTION	P607	P608	P609
23	CHANNEL GUARD		X	

8. WHEN USING THE MASTR II INTERFACE BD. REMOVE P608 ON THE SYSTEM BD. THE MASTR II INTERFACE BOARD IS ASSEMBLED WITH ALL JUMPERS PRESENT. "X" INDICATES THAT THE JUMPER OR PART IS REMOVED. P3 IS LOCATED ON THE CHANNEL GUARD BOARD. P609 IS LOCATED ON THE SYSTEM BD.

PART NO.	APPLICATION	W1	W2	W3	W4	W5	W6	P3	P609
26	STANDARD (NO OPTION PRESENT)		X	X			X		
27	DELTA CG	X		X			X		X
28	MASTR II CG ENCODER		X				X		
29	DELTA CG DECODER MASTR II CG ENCODER	X					X	X	X
30	VOICE OVER-RIDE	X		X	X	X			X

9. ADD P610 WHEN PUBLIC ADDRESS OR DTMF ENC OPTIONS ARE PRESENT IN CONTROL UNIT OR WITH S950 CONTROL UNIT. P610 IS PART OF HARDWARE KIT PL19A702024

10. REMOVE ICOM COVER, REMOVE EXISTING Y351 AND RETURN TO STOCK, AND INSTALL ALTERNATE CRYSTAL. INSTALL ICOM COVER USING EXISTING SCREWS: TORQUE SCREWS PER NOTE 3.

11. THE FOLLOWING ARE ELECTROSTATIC SENSITIVE DEVICES REQUIRING SPECIAL CARE PER 19A701294: U706 (1-16 CHANNEL PROM) AND U1 (17-32 CHANNEL PROM).

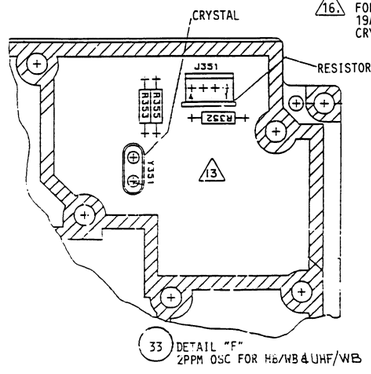
12. COAT ALL THD FORMING SCREWS WITH LUBRICANT 19A115204P1 BEFORE INSTALLING

13. REMOVE 5PPM CRYSTAL Y351 AND RETURN TO STOCK. REMOVE R352, R353, R355. PLUG-IN RESISTOR NETWORK AND CRYSTAL SUPPLIED IN KIT 19C851230.

14. FOR APPLICATIONS THAT REQUIRE VOL/SQ HI GAIN REMOVE W7 ON M11 INTERFACE BOARD. SEE SHEET 2.

15. FOR APPLICATIONS OF DUAL CONTROL WITH FIXED SQUELCH (NOT P7 VARIABLE SQUELCH) REMOVE P605.

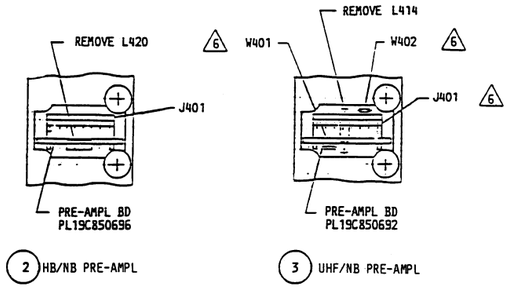
16. FOR APPLICATIONS THAT REQUIRE AN ALTERNATE CPU CRYSTAL, REMOVE 19A702511G3 CRYSTAL, RETURN TO STOCK, AND REPLACE WITH NEW GP CRYSTAL CALLED FOR ON STOCK SELECTION SHEET.



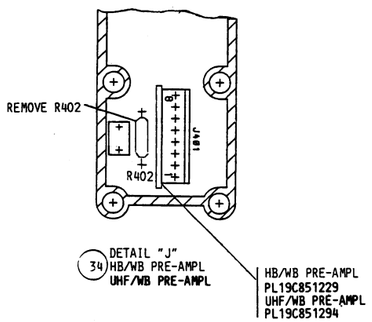
THIS DWG DUPLICATED ON RC4448

MECHANICAL LAYOUT

(19D900977, Sheet 1)

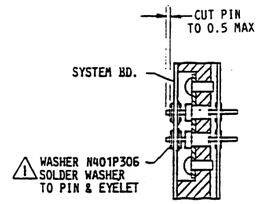


DETAIL "A"



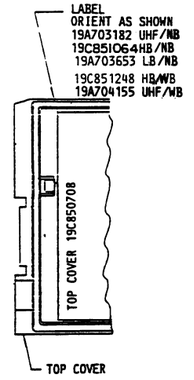
DETAIL "G"

VIEW "B"
ROTATED 180°



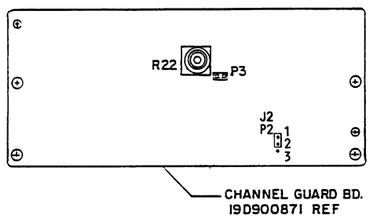
SECTION "C - C"

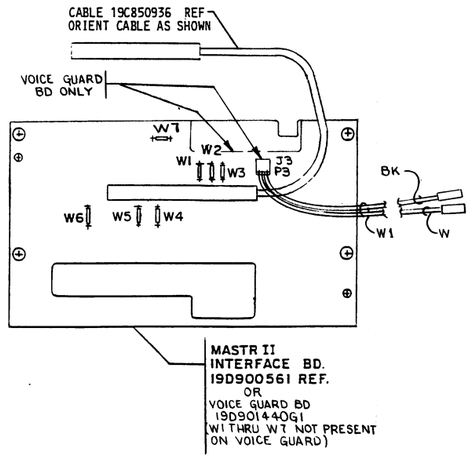
VIEW "D"
ROTATED 180°

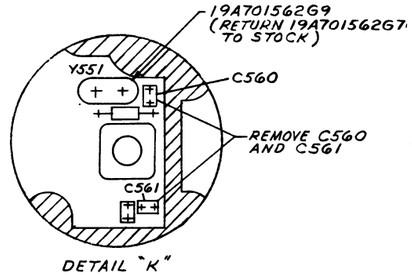


VIEW "E"
ROTATED 90°

24 DIGITAL CG DECODE INVERSION
MOVE P2 FROM J2-1 & 2 TO J2-2 & 3 ON CG BOARD.

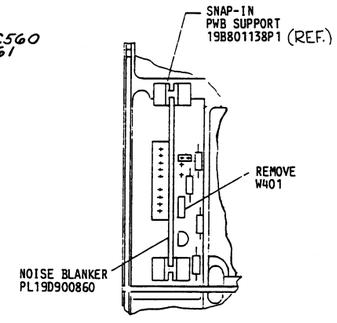






DETAIL "K"

13 UHF WB 403-440 HI SIDE INJECTION



32 DETAIL "H"
LB NOISE BLANKER

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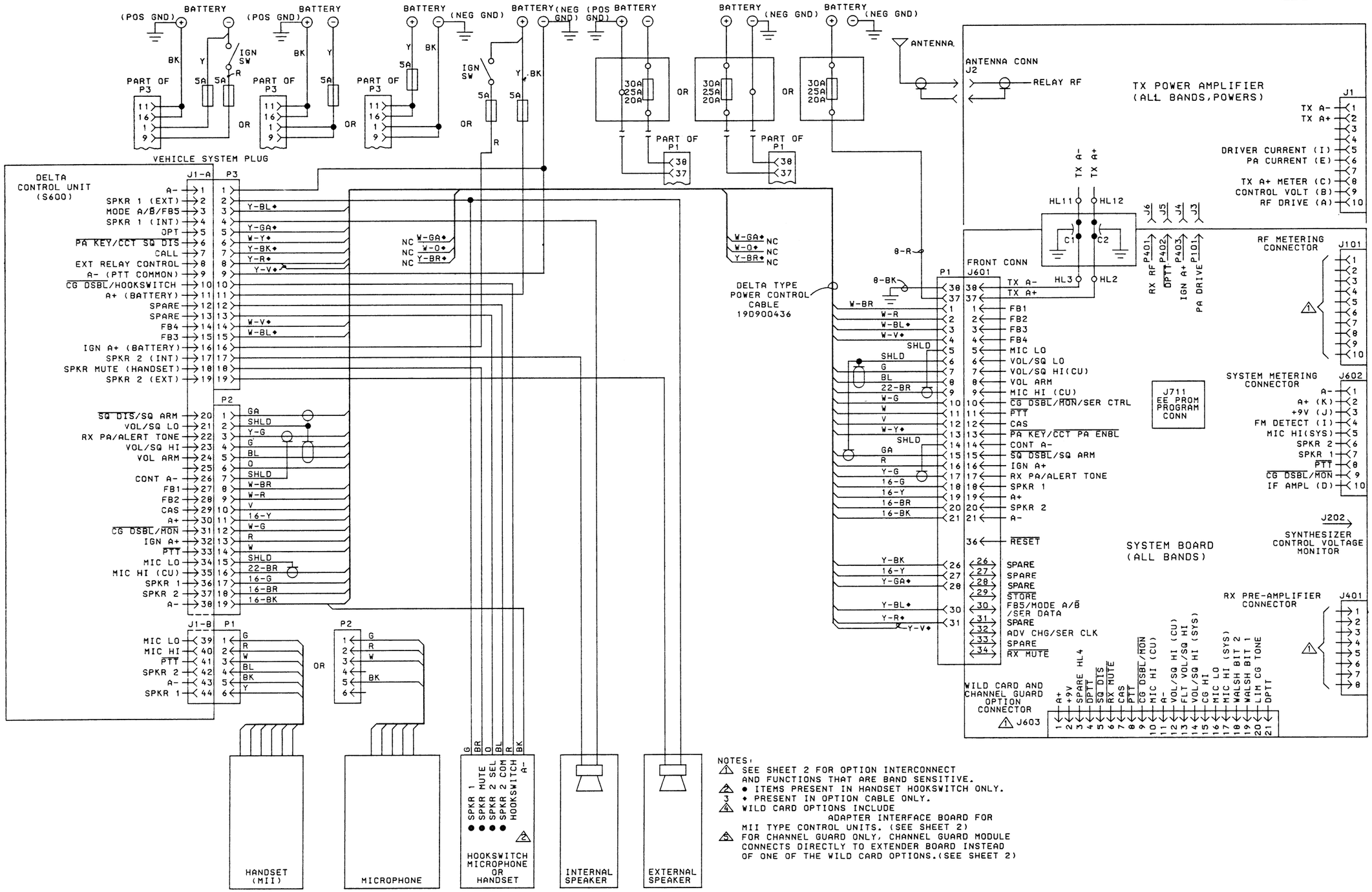
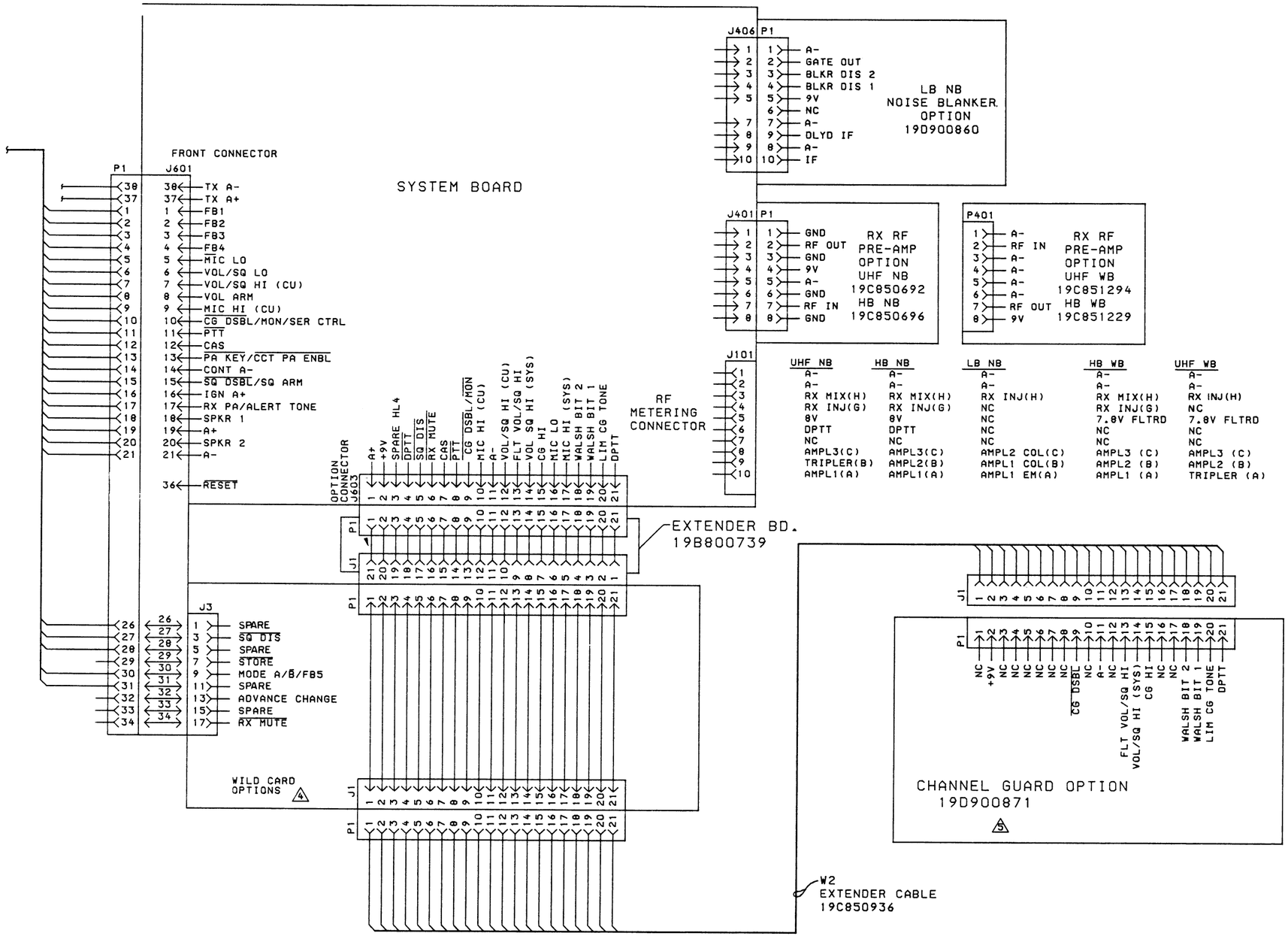
(19D900977, Sheet 2)



NOTES:
1. SEE SHEET 2 FOR OPTION INTERCONNECT AND FUNCTIONS THAT ARE BAND SENSITIVE.
2. ● ITEMS PRESENT IN HANDSET HOOKSWITCH ONLY.
3. ◆ PRESENT IN OPTION CABLE ONLY.
4. WILD CARD OPTIONS INCLUDE ADAPTER INTERFACE BOARD FOR MII TYPE CONTROL UNITS. (SEE SHEET 2)
5. FOR CHANNEL GUARD ONLY, CHANNEL GUARD MODULE CONNECTS DIRECTLY TO EXTENDER BOARD INSTEAD OF ONE OF THE WILD CARD OPTIONS.(SEE SHEET 2)

(19D900980, Sheet 1)

INTERCONNECTION DIAGRAM



(19D900980, Sheet 2)

INTERNAL OPTIONS

INTERCONNECTION DIAGRAM