MAINTENANCE MANUAL
136-174 MHz, DELTA-S NARROWBAND
TWO WAY FM RADIO
SERVICE SECTION

TABLE OF CONTENTS

DESCRIPTION

This section contains the information required to service the radio. It includes disassembly procedures for replacing Transistors, Integrated Circuits (IC's) and Chip Components. The section also includes alignment procedures, troubleshooting information, and Programming and Alignment tips.

The Programming and Alignment tips describe the procedures that must be followed after the EEPROMs in the radio have been re-programmed with new channel/frequency information.

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

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. Flat blade Screwdriver
2. TORX® Screwdriver with #8, #9, #15, and #30 tips.
3. #8 Nut Driver
4. 50 Watt Soldering Iron
5. Torque Wrench Kit -
   #8 TORX - 2.5 in. lbs.
   #9 TORX - 4 in. lbs.
   #15 TORX - 16 in. lbs.
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 #30 TORX screwdriver.

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 eleven #15 TORX retaining screws (A) (Figure 1) securing the circuit board to the main frame.
3. Remove two #9 TORX retaining screws (B) securing systems connector J601 to front casting.
4. Unsolder the two feed through capacitor terminals (E) on printed wire pattern.
5. 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 U702 and Q705 to the side of chassis.

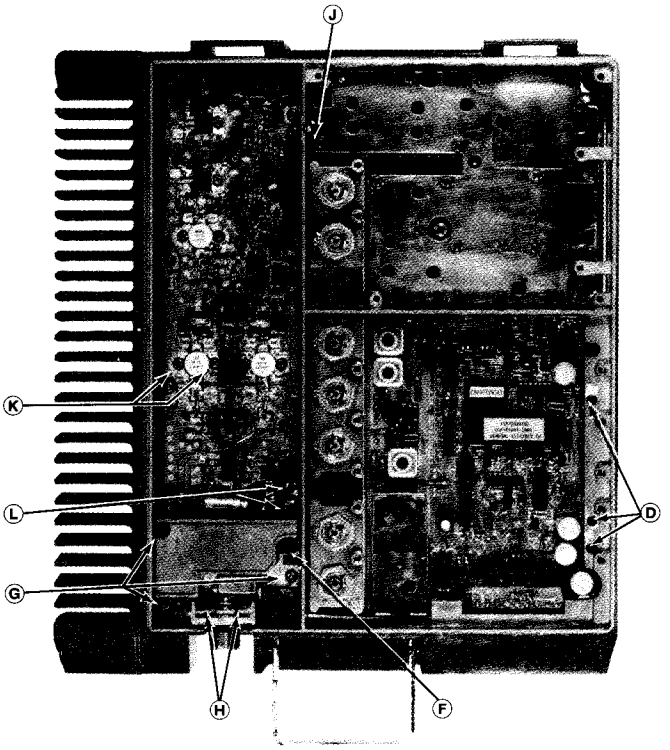


Figure 2 - Disassembly Procedure Top View

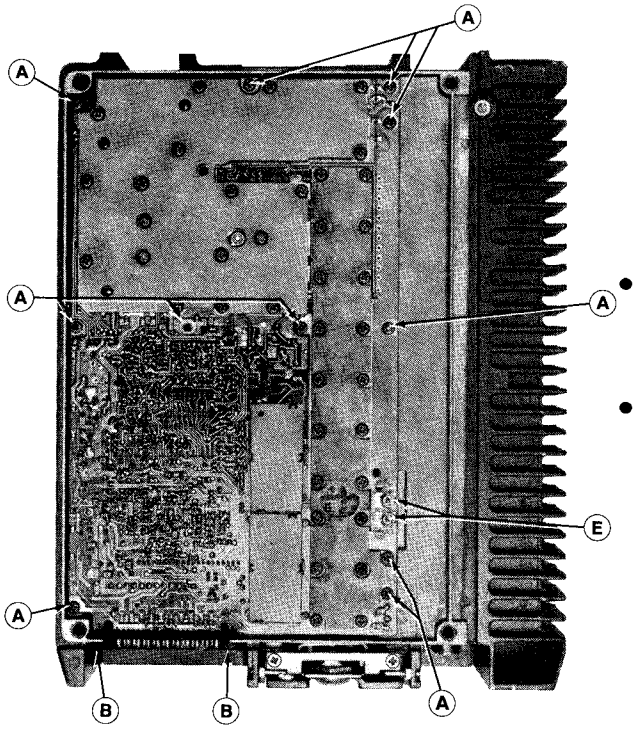


Figure 1 - Disassembly Procedure Bottom View

6. To remove the front end shield, remove the twenty #15 TORX retaining screws securing the shield to the front end casting and remove.
7. To remove the synthesizer shield, remove the seventeen #15 TORX retaining screws securing the shield to the synthesizer top casting.

- To replace TRS board:

1. Perform above procedures in reverse order.

- To remove the PA board:

1. Remove the three #15 TORX retaining screws (G) securing the PA filter cover to the main frame.
2. Remove the eight #15 TORX retaining screws (F) from around the edge of the PA board.
3. Remove the two #15 TORX retaining screws (H) securing the antenna connector to the main frame.

4. Loosen the #8 TORX retaining screw (J) securing the pass transistor to the side of the PA chassis compartment.
5. Remove the #8 TORX retaining screws (K) securing the PA transistors to the main frame.
6. Turn the radio over and remove the #8 nut and washer from the stud of PA transistor Q1.

NOTE

Torque #8 nut on Q1 to 6 inch lbs. when replacing.

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.

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 components 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. Heat each end of the chip using two soldering irons until solder flows, and then remove.
2. Remove excess solder with a vacuum solder extractor or Solder-wick®.
3. 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 compo-nent 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.

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

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, channel 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.

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. 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 FB5, CG DISABLE, ADVANCE CHANGE, and FB4 - FB2 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.

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

CAUTION

When using the radio with the S550, S950 or S990 control head, the ADVANCE CHANGE line should be disconnected from the control head by removing connector P3. Instead of keying the microphone, ground J602-8.

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:
   - Control head on channel one (1).
   - Key microphone while on hook. (Ground J602-8).
   - Apply A+ through a 10K resistor to J604-3.
   - Turn radio on. (Apply 13.8 VDC to J601-19).

NOTE

If any of these tests have failed, the microcomputer function is defective. Before replacing the microcomputer, exhaust all other possibilities. Check associated circuits for shorted or open printed wire runs and components.

ROM TEST

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

	D3	D2	D1	D0	ALERT TONE
ROM TEST FAILED	0	0	0	0	NONE
ROM TEST PASSED	0	0	0	1	NONE
ROM 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 test has passed. If the test has 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 the ROM 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 test is 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 J602-8). 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 J602-8. Port 1 and data bus lines all will go high.

2. Momentarily press and release the PTT switch J602-8. U705-34 and U705-19 will go low. All other outputs should be high.

3. Momentarily press and release the PTT switch J602-8. U705-33 and U705-18 will go low. All other outputs should be high.

4. Momentarily press and release the PTT switch J602-8. 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 J602-8. U705-31 and U705-16 will go low. All other outputs should be high.

6. Momentarily press and release the PTT switch J602-8. U705-30 and U705-15 will go low. All other outputs should be high.

7. Momentarily press and release the PTT switch J602-8. U705-29 and U705-14 will go low. All other outputs should be high.

8. Momentarily press and release the PTT switch J602-8. U705-28, 29 and U705-13 will go low. All other outputs should be high.

9. Momentarily press and release the PTT switch J602-8. U705-27 and U705-12 will go low. All other outputs should be high.

10. Momentarily press and release the PTT switch J602-8. Port 1 outputs will all be set high and data bus all pins high except pin 12.

NOTE

At this point the program advances to mirror the outputs FB5, CG DISBL, ADVANCE CHANGE, and FB4-FB2 onto the data bus U705-13 through U705-18.

11. Momentarily switch the following points while observing status of the associated data bus as indicated below. When switched via the chart below, the bus must switch either high or low.

MOMENTARILY GROUND	MOMENTARILY A+	DATA BUS
J601-2		U705-13
J601-3		U705-14
J601-4		U705-15
	J604-3	U705-16
J601-10		U705-17
J604-1		U705-18

12. Exit the diagnostics routines by momentarily removing power to the radio.

TEST FREQUENCIES

If the EEPROM is not custom programmed to the customers specified personality, then a standard test program is provided. The EEPROM is programmed on channels 1 through 16 including tone and digital Channel Guard and carrier control timer. Table 1 identifies the programmed test frequencies.

PROGRAMMING AND ALIGNMENT

The following procedure describes how to change the frequencies in the radio EEPROM(S) for new user frequencies, an alignment procedure guide is also provided to assist you in aligning the radio after the frequencies have been changed. The alignment procedure should be performed in the order given below and it must be performed prior to putting the radio back in service.

ALIGNMENT

After the radio has been programmed with new user frequencies, the radio realignment procedure is as follows:

Under Synthesizer and Transmitter Alignment Section

1. Check 9 volt regulator.
2. Adjust the synthesizer transmitter VCO.
3. Adjust the synthesizer receiver VCO.
4. Check the exciter. (No tuning required).
5. Adjust transmitter power amplifier.
6. Set the reference oscillator frequency (one setting for both TX and RX).
7. Set transmitter deviation.

Under Receiver Alignment Section

1. Tune local oscillator-buffer injection.
2. Tune front-end.
3. Tune IF selectivity.
4. Adjust FM detector/audio preamp.

PROGRAMMING

The Delta-S Highband narrowband radio must be programmed using either the TQ2310 or 4EX22A10 programmers. The procedures for using the programmers are covered in detail in LBI-31263 (TQ2310) and LBI-31305 (4EX22A10).

When programming the radio, consideration must be given to the individual band splits for the T/R/S board used in the radio, and the type of software in the radio microcomputer. The band splits and software group numbers are given below:

Band Split	T/R/S Board (Negative Ground Only)	T/R/S Board (Floating Ground)
150.8-174 MHz	19D901720G1,3	19D900951G1
136-153 MHz	19D901720G2,4	19D900951G2

MICROCOMPUTER SOFTWARE (U705)

19A703241G3 thru 7, 19A703244P10 -- Narrowband Software

19A703868G2 thru 4, 19A703244P21, P22 -- Wideband Software

PROGRAMMING TIPS

When using the TQ2310 suitcase programmer, jumper P707 (present on Negative Ground only T/R/S boards) must be removed. If programming the S950/S990 Control Unit connected to a radio, P703 on the rear of control unit must be disconnected to isolate the advance change pulse line.

When using the 4EX22A10 Hand Programmer, jumper P706 (Negative Ground T/R/S boards) must be removed (disconnects D720) or, one end of D720 must be disconnected on Floating Ground T/R/S boards.

MODIFICATION INSTRUCTIONS

When Public Address or DTMF Encode (option AP04) are present in the Control Unit or with the S950 Control Unit add P610 to the radio. P610 is part of Hardware Kit PL19A702024. See Mechanical Layout Diagram, page 15.

TABLE 1 - PROGRAM TEST FREQUENCIES

FREQ SPLIT	CHANNEL	TRANSMIT	RECEIVE	CG ENC	CG DEC	CCT
136-153 MHz	1A,1B	144.020	144.060	71.9	71.9	---
	2A,2B	146.770	145.060	023	023	---
	3A	144.020	144.060	---	---	30 SEC
150.8-174 MHz	1A,1B	156.015	156.060	71.9	71.9	---
	2A,2B	158.565	157.060	023	023	---
	3A	156.015	156.060	---	---	30 SEC

GE Mobile Communications
General Electric Company
Lynchburg, Virginia 24502
Printed in U.S.A.

SYNTHESIZER AND TRANSMITTER ALIGNMENT

TEST EQUIPMENT REQUIRED

1. Wattmeter, 50 ohm (capable of measuring 150 Watts & 1 Watt)
2. Digital Voltmeter
3. RF Frequency Counter
4. RF Voltmeter
5. Deviation Monitor
6. Audio Oscillator
7. Power Supply, 13.8 VDC regulated
8. GE Test Set, 4EX3A11 with Test Set Adapter 19C850590G1
9. Tuning Tool 19B800716P2

PRELIMINARY CHECKS AND ADJUSTMENTS

NOTE

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

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. Monitor J602-3 with a digital voltmeter and adjust R703.

ALIGNMENT PROCEDURE

SYNTHESIZER TX AND RX VCO

Check the positions of P201, P203, and P204 per the chart below:

	RADIO OPERATING FREQUENCY		RX VCO TUNING PLUG P201	TX VCO TUNING PLUGS P203 & P204
	150.8-174 MHz	136-153 MHz		
RX	150.8-159	136-145	IN	IN
	155-174	141-153	REMOVE	REMOVE
TX	150.8-167	136-149	IN	IN
	161-174	143-153	REMOVE	REMOVE

The TX and RX VCO voltage adjustments are described by the following Steps 1-5. After the lock detect light D713 goes out (Step 1 and 3) each VCO is adjusted after selecting the appropriate channel for the maximum reading indicated (below 7.5 VDC).

If the light is not out, all readings are meaningless.

As long as the highest operating frequency VCO voltage does not exceed the maximum meter reading (below 7.5 VDC) and the lowest operating frequency VCO voltage is not less than the minimum meter reading (above 3.0 VDC), the adjustment is proper.

When the two frequency spread is minimal it is acceptable to center tune the VCO voltage between the maximum and minimum meter readings.

If the highest operating frequency is at the low end of the frequency split (example 151.025 MHz on the 150.8-174 MHz split), the VCO reading may never reach the maximum. Therefore adjust the lowest operating frequency to VCO voltage above the minimum reading.

ALIGNMENT PROCEDURE (Continued)

STEP	METERING POSITION: GE TEST SET	METERING POSITION: MULTIMETER (- to J101-1)	TUNING CONTROL	METER READING	PROCEDURE
1.		LED D713	L209	LIGHT OUT	Select highest frequency transmit channel. Key the transmitter and tune L209 so that the lock detect indicator D713 goes out.
2.		J202	L209	BELOW 7.5 VDC	Monitor J202 with digital voltmeter. Tune L209 for 7.5 VDC maximum.
3.		LED D713	C220	LIGHT OUT	Unkey the transmitter. Select the highest frequency receive channel and tune C220 so that the lock detect indicator D713 goes out.
4.		J202	C220	BELOW 7.5 VDC	Monitor J202 with a digital voltmeter. Tune C220 for 7.5 VDC maximum.
5.		J202		ABOVE 3.0 VDC	Select the lowest frequency transmit and receive channel. Key the transmitter and check the TX VCO voltage. Unkey the transmitter and check the RX VCO voltage. Both readings should be above 3.0 VDC.
Test aid for TX and RX Injection					Monitor TX injection at J102 and RX injection at J451. TX injection +5 to +15 dBm RX injection +5 to +15 dBm

6.				250 mw	Key the transmitter. Connect a 0-1 watt wattmeter to J103-2,4 (exciter output). Meter should read 250 mw minimum. No tuning required. Typical output power is 350 mw.
	NOTE **The exciter can be isolated from the rest of the radio for test purposes, if desired. To isolate and set up, remove P102 and P103. Connect a (0-1 watt) wattmeter to J103-2,4. Apply a +7 dBm on frequency signal to J102-2,4.**				
7.	A (PA INPUT)			RATED OUTPUT POWER	Check exciter power output at both ends of the frequency spread. It should be equal to or greater than 250 mw. 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 Power Adjust control for maximum power (fully clockwise). Check the meter reading at both ends of the frequency spread. They should be approximately equal. Set RF Power Adjust for rated output power.
	REFERENCE OSCILLATOR 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 reference osc.**				
8.		J2	L352	CHANNEL OPERATING FREQUENCY	Key the transmitter while monitoring the frequency at the antenna connector J2. Adjust L352 for the assigned channel frequency. ±75 Hz for a 5 PPM (standard). ±30 Hz for a 2 PPM radio (optional). NOTE: The receiver injection frequency will automatically be correct.

ALIGNMENT PROCEDURE (Continued)

STEP	METERING POSITION: GE TEST SET	METERING POSITION: MULTIMETER (- to J101-1)	TUNING CONTROL	METER READING	PROCEDURE
***TRANSMITTER DEVIATION** STEP 9 COVERS RADIO WITHOUT CHANNEL GUARD STEPS 10 & 11 COVER RADIO WITH TONE CHANNEL GUARD STEPS 12, 13 & 14 COVER RADIO WITH DIGITAL (OR TONE AND DIGITAL) CHANNEL GUARD					
RADIO WITHOUT CHANNEL GUARD					
9.*			R237	4.5 KHz	Select a center frequency channel. Apply a 1 KHz tone at 1.0 VRMS to mic input jack (J602-5). Connect deviation monitor to antenna jack J2 through a 30 dB decoupler. Key the transmitter. Set deviation adjust R237 for 4.5 KHz deviation.
RADIO WITH TONE CHANNEL GUARD					
10.*			R237	3.75 KHz	Select a center frequency channel. Preset R22 on Channel Guard board to fully counterclockwise (minimum). Apply a 1 KHz tone at 1.0 VRMS to mic input jack (J602-5). Connect deviation monitor to antenna jack J2 through a 30 dB decoupler. Key the transmitter. Set deviation adjust R237 for 3.75 KHz devation.
11.*			R22	0.75 KHz	Remove 1 KHz tone modulation and adjust R22 for 0.75 KHz deviation.
RADIO WITH DIGITAL CHANNEL GUARD (OR TONE AND DIGITAL)					
12.*			R237	3.75 KHz	Select a center frequency channel. Preset R22 on Channel Guard board and R366 balance adjust on TRS board fully counterclockwise (minimum). Apply a 1 KHz tone at 1.0 VRMS to mic input jack (J602-5). Connect deviation monitor to antenna jack J2 through a 30 dB decoupler. Set deviation adjust R237 for 3.75 KHz deviation. Remove 1 KHz tone.
13.*			R366	2.0 KHz	Apply a 400 Hz tone through a 100 uF capacitor to J603-15 at a 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 for 2.0 KHz deviation. This setting adjusts the digital waveform balance. Remove generator.
14.*			R22	0.75 KHz or 0.65 KHz	Select a channel with Digital Channel Guard nearest the center frequency and adjust R22 on the Channel Guard board to 0.75 KHz deviation. If radio has Tone and Digital Channel Guard, set R22 on a Tone Channel Guard Channel to 0.65 KHz to maintain the Digital Code deviation at less than 1 KHz.

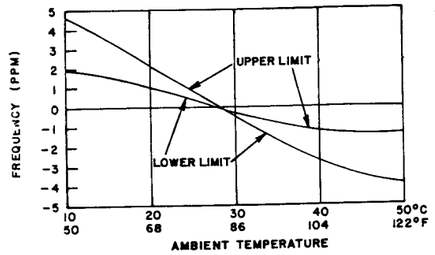


FIGURE 4 CORRECTION FACTOR IN FREQ. SETTING FOR 5 PPM OSCILLATOR

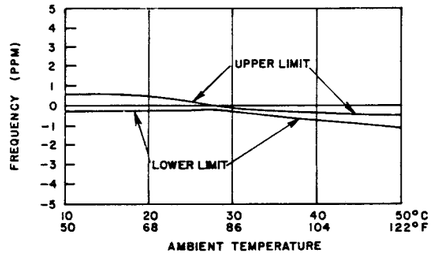


FIGURE 5 CORRECTION FACTOR IN FREQ. SETTING FOR 2 PPM OSCILLATOR

RC 4498

POWER AMPL METERING J1		
PIN	POS.	FUNCTION
10	A	RF DRIVE(EX OUT)
9	B	PWR CTL VOLT
8	C	TX A+ METER
7		
6	E	PA CURRENT (REF TX A+)
5	F	DRIVER CURRENT (REF TX. A+)
4		
3		
2		TX A+
1		TX A-

RF METERING-J101		
PIN	POS.	FUNCTION
10	A	AMPL 1 VOLT
9	B	AMPL 2 VOLT
8	C	AMPL 3 VOLT
7		
6		
5		
4	G	RX INJECTION
3	H	RX MIXER
2		A-
1		A-

SYSTEM METERING J602		
PIN	POS.	FUNCTION
10	D	IF AMPL
9		CG DISABLE
8		P.T.T.
7		SPKR 1
6		SPKR 2
5		MIC HI
4		
3	J	+9V
2	K	A+
1		A-

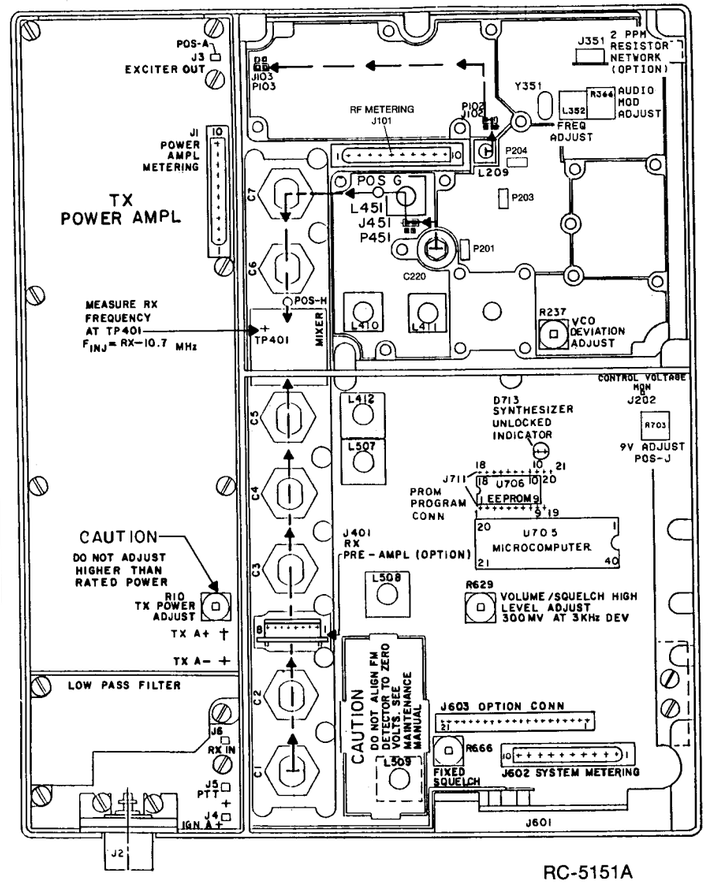


FIGURE 3 SYNTHESIZER AND TRANSMITTER ALIGNMENT

RECEIVER ALIGNMENT

TEST EQUIPMENT REQUIRED (Or Equivalent)

1. GE Test Set 4EX3A11, 4EX8K12, or 20,000 ohms-per-volt multimeter with 1 volt scale
2. AC Voltmeter
3. FM Deviation Monitor (138-175 MHz)
4. Digital Voltmeter (10 M ohms/volt)
5. VOM (20,000 ohms per volt)
6. RF Signal Generator (138-175 MHz)
7. Frequency Counter (150-175 MHz).
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 (in Transmitter Section) 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 C5 to maximum height above top of casting (10 mm).
3. Preset C6 and C7 as shown in Figure 6.
4. Preset L410, L411, L412, L507 and L508 to top of coil form and then turn clockwise 9 full turns.

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. Monitor J602-3 with a digital voltmeter and adjust R703.

ALIGNMENT PROCEDURE

STEP	METERING POSITION		TUNING CONTROL	METER READING	PROCEDURE
	GE TEST SET	MULTIMETER			
LOCAL OSCILLATOR-BUFFER INJECTION					
1.	G (RX INJ)	J101-4	L451	Peak	Set Test Set to 1 volt scale and tune L451 for maximum reading on Test Set. Select desired channel on test frequency.
2.	H (RX MIX)	J101-3	C6, C7	Peak	Tune C6 and C7 for maximum reading on Test Set.
3.	H (RX MIX)	J101-3	C6, C7, L451	Peak	Repeak L451, C6 and C7. Sequentially retune L451, C6 and C7 until there is no further increase in meter reading.
FRONT END ALIGNMENT					
4.	D (IF AMP)	J602-10	C3	MAX	Connect RF signal generator to antenna jack J2. Set frequency to desired receive channel. 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).
5.	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.

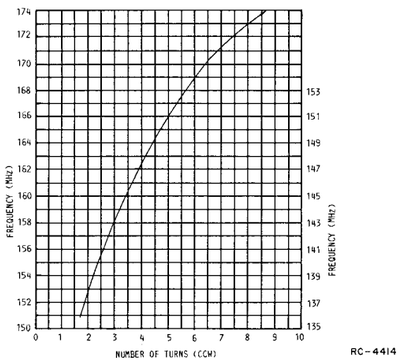


Figure 6 - 136-174 MHz Preset Tuning Chart

STEP	METERING POSITION		TUNING CONTROL	METER READING	PROCEDURE
	GE TEST SET	MULTIMETER			
IF SELECTIVITY					
					NOTE If the IF amplifiers have been aligned using the alternate sweep alignment method, proceed to Step 8.
6.	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. Repeat coils in sequence until no further improvement is noted.
7.	D (IF AMP)	J602-10	C1-C5		Repeak C1-C5.
FM DETECTOR/AUDIO PREAMPLIFIER					
8.			L509	0.35 - 0.5 VRMS	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. See Figure 8. Set R629 fully clockwise. Monitor the speaker outputs (J602-6,7) with an AC voltmeter. Tune quadrature coil L509 for a peak reading.
9.			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)					
10.			R666		Adjust fixed squelch control R666 fully clockwise (open squelch). Adjust input level of RF Signal Generator to produce a SINAD sensitivity reading of 9 dB. Turn R666 fully counterclockwise (maximum squelch position) to close squelch. Slowly readjust R666 to the position where the squelch just opens. Check that squelch opens at 8 dB (±1 dB).
MULTI-FREQUENCY CHANNEL SPACING (OMIT FOR SINGLE CHANNEL)					
11.	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.
12.	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.
13.	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.
14.		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 than 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 he high frequency channel. Readjust C5, if necessary, to keep the sensitivity at the band edges greater than or equal to 12 dB SINAD.

ALTERNATE IF SWEEP ALIGNMENT

1. Attach an oscilloscope probe to IF AMP. MTR. (J602-10). (Refer to Figure 7).

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. (Vertical) and 2 msec per div (Horizontal).

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 no ripple should be present in the passband.

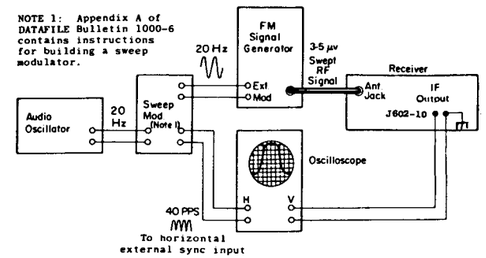


Figure 7 - Test Setup for 20 Hz Double-Trace Sweep Alignment

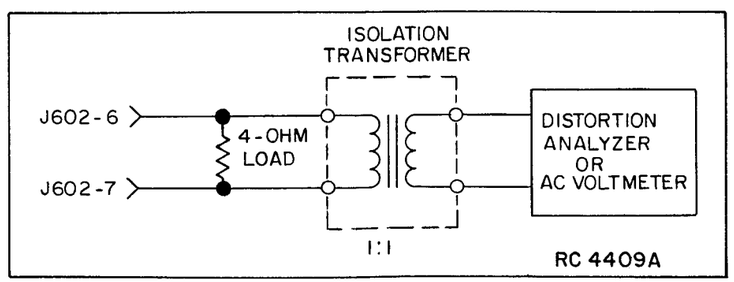


Figure 8 - Test Set-up, Audio Output Measurement

RECEIVER PERIODIC SERVICE PROCEDURE

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)

RECEIVER FREQUENCY ADJUSTMENT

(Refer to Transmit Frequency Adjustment, [Section 8.0] no receive frequency adjustment is required)

PRELIMINARY ADJUSTMENTS

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 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 8).

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 SENSATIVITY (12DB 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 (4.9 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.

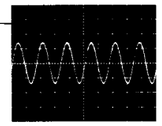
SERVICE CHECK

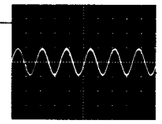
If the Modulation Acceptance Bandwidth test does not indicate the proper width check synthesizer frequency and then refer to the Alternate IF Alignment Procedure.

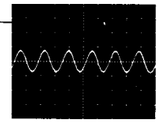
SQUELCH CIRCUIT TEST WITH 7 kHz SIGNAL

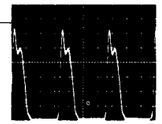
PRELIMINARY STEPS

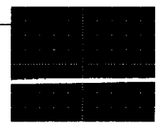
1. Quiet receiver with 1000 uv modulated signal applied to antenna jack J2.
2. Squelch Adjust R666 to 8 dB SINAD.
3. Set modulation to 6 kHz.
4. Set deviation to 3 kHz.
5. Use 10 megohm probe.

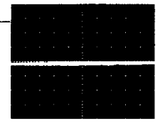
A

HORIZONTAL 0.2 MSEC/DIV
VERTICAL 0.2 V/DIV (0.5 V P-P)

B

HORIZONTAL 0.1 MSEC/DIV
VERTICAL 0.2 V/DIV (0.4 V P-P)

C

HORIZONTAL 0.1 MSEC/DIV
VERTICAL 0.2 V/DIV (0.36 V P-P)

D

HORIZONTAL μSEC/DIV
VERTICAL 0.2 V/DIV (1.2 V P-P)
BASE LINE = 0 VDC

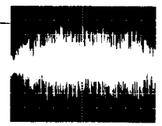
E

HORIZONTAL 1 MSEC/DIV
VERTICAL 0.3 V/DIV (0.3 VDC)
BASE LINE = 0 VDC

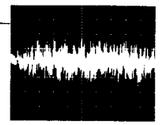
F

HORIZONTAL 1 MSEC/DIV
VERTICAL 1 V/DIV (5 VDC)
BASE LINE = 0 VDC

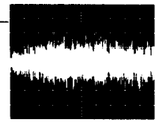
SQUELCH CIRCUIT CHECKS WITH NOISE

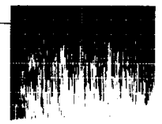
PRELIMINARY STEPS

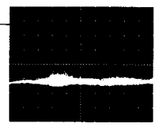
1. No input signal applied.
2. Squelch Adjust R666 set for 8 dB SINAD.
3. Use 10 megohm probe.

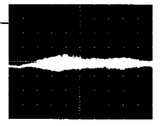
A

HORIZONTAL 5 MSEC/DIV
VERTICAL 1 V/DIV (≈ 4 V P-P)

B

HORIZONTAL 5 MSEC/DIV
VERTICAL 1 V/DIV (≈ 2 V P-P)

C

HORIZONTAL 5 MSEC/DIV
VERTICAL 0.5 V/DIV (≈ 1.5 V P-P)

D

HORIZONTAL 5 MSEC/DIV
VERTICAL 1 V/DIV (≈ 4 V P-P)
BASE LINE = 0 VDC

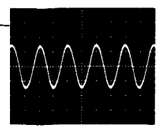
E

HORIZONTAL 5 MSEC/DIV
VERTICAL 0.2 V/DIV (0.6 VDC)
BASE LINE = 0 VDC

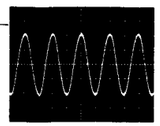
F

HORIZONTAL 5 MSEC/DIV
VERTICAL 2 V/DIV (7.5 VDC)

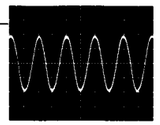
AUDIO CIRCUIT

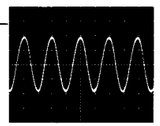
PRELIMINARY STEPS

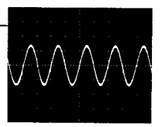
1. Apply 1000 uV on frequency signal with 1000 Hz modulation and 3 kHz deviation to antenna jack J2.
2. Output set to 12 Watts (9.8 VRMS) into 4-ohm load.
3. Use 1 megohm probe.

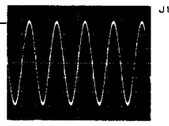
G

HORIZONTAL 0.5 MSEC/DIV
VERTICAL 50 MV/DIV (140 MV P-P)

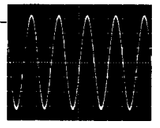
H

HORIZONTAL 0.5 MSEC/DIV
VERTICAL 0.2 V/DIV (0.84 V P-P)

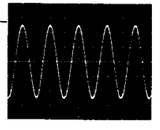
J

HORIZONTAL 0.5 MSEC/DIV
VERTICAL 0.1 V/DIV (0.4 V P-P)

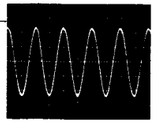
K

HORIZONTAL 0.5 MSEC/DIV
VERTICAL 0.1 V/DIV (0.4 V P-P)

L

HORIZONTAL 5 MSEC/DIV
VERTICAL 50 MV/DIV (140 MV P-P)

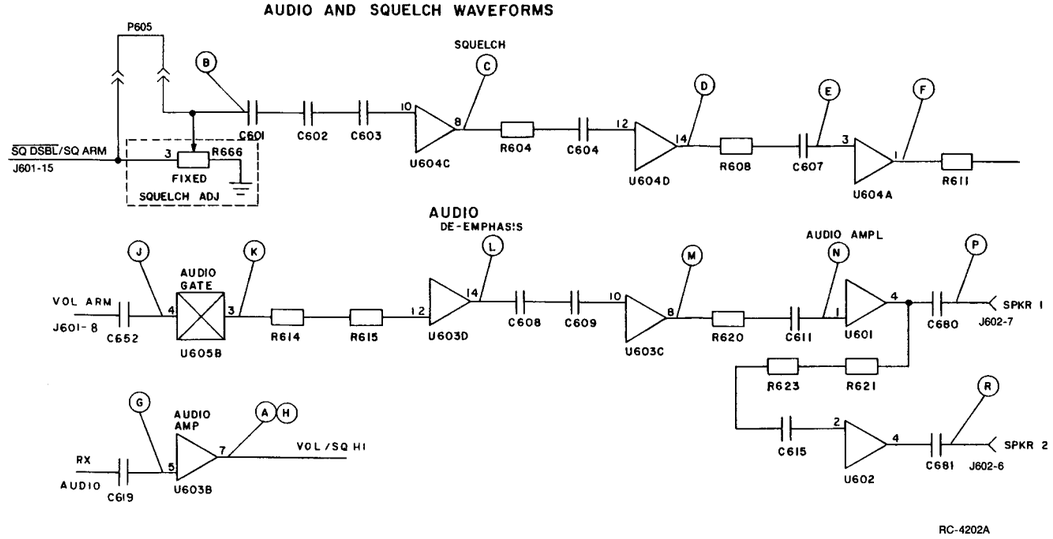
M

HORIZONTAL 0.5 MSEC/DIV
VERTICAL 50 MV/DIV (320 MV P-P)

N

HORIZONTAL 0.5 MSEC/DIV
VERTICAL 50 MV/DIV (300 MV P-P)

P

HORIZONTAL 0.5 MSEC/DIV
VERTICAL 2 V/DIV (10 V P-P)

R

HORIZONTAL 0.5 MSEC/DIV
VERTICAL 2 V/DIV (10 V P-P)

AUDIO AND SQUELCH WAVEFORMS



RC-4202A

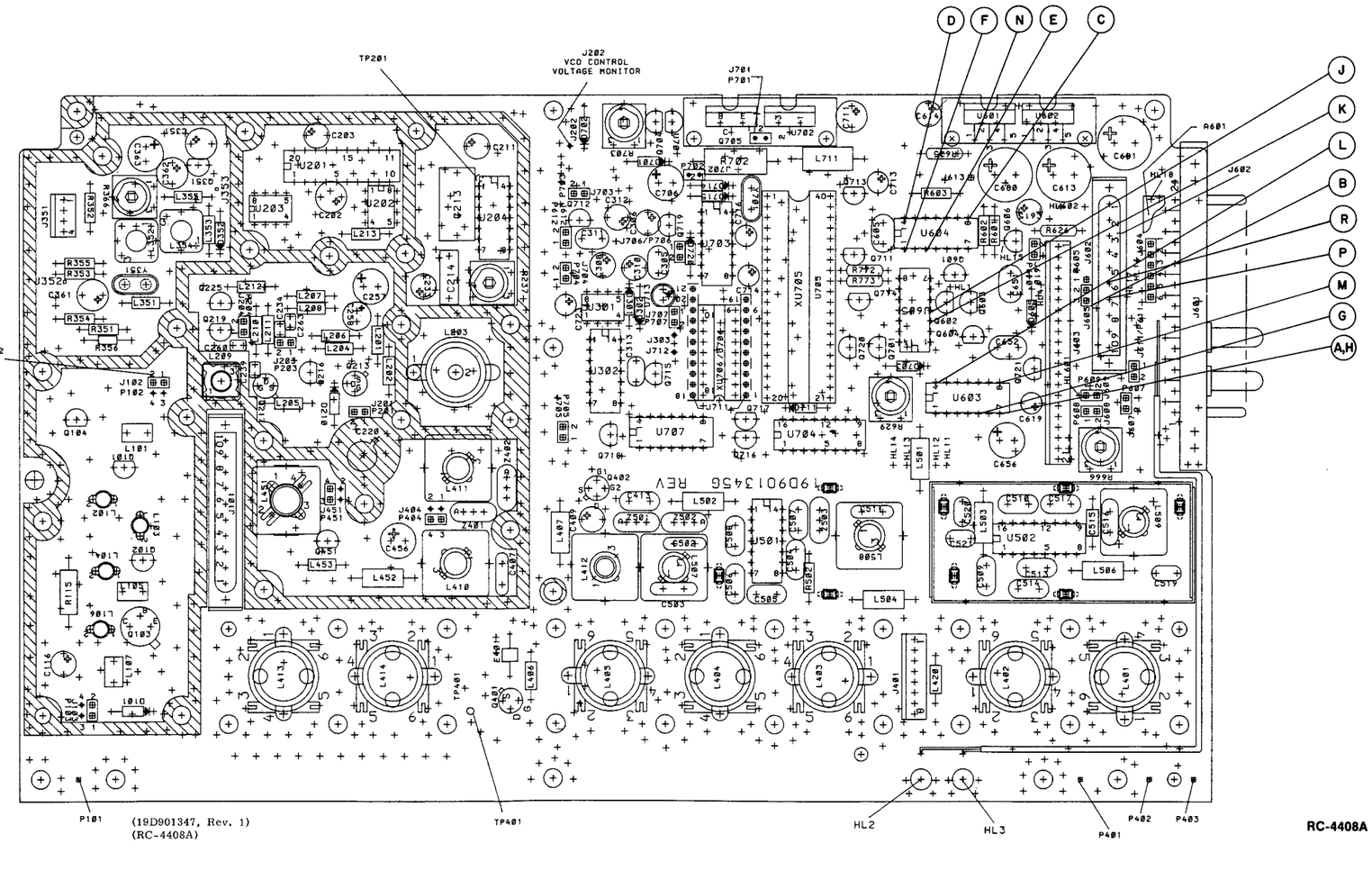
LEAD IDENTIFICATION FOR U701

TOP VIEW

LEAD IDENTIFICATION FOR ALL TRANSISTORS NOT OTHERWISE IDENTIFIED

IN-LINE
TOP VIEW

NOTE: CASE SHAPE IS DETERMINING FACTOR FOR LEAD IDENTIFICATION.



(19D901347, Rev. 1)
(RC-4408A)

RC-4408A

RECEIVER AUDIO AND SQUELCH WAVEFORM CHECKS

TRANSMITTER PERIODIC SERVICE PROCEDURES

These 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.

ACCESSING CENTER TUNE FREQUENCY

When a radio is factory programmed for less than 16 channels, channel 16 is programmed for transmit and receive center tune frequency.

To access center tune frequency use available control unit and select channel 16.

NOTE

Under normal operation, in radios built prior to January 1989, the microcomputer will not access this channel. The following test acccesses 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 receiver center frequency.**
3. **To exit this mode remove power from J604-3 and momentarily remove power from the radio.**

NOTE

If the DELTA-S radio is used with the C800 or C900 Control, then the center tune frequency (Channel 16 Rx) is programmed to 100 MHz for proper scan operation.

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).

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

Refer to Step 8 of the Transmitter Alignment Procedure.

MODULATION LEVEL ADJUSTMENT

The MOD ADJUST controls are adjusted to the proper setting before shipment and normally do not required 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 modu-lator, thereby preventing over-modulation while preserving intelligibility.

Refer to Steps 9-14 of the Transmitter Alignment Procedures.

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 resistors, capacitors around Q103, Q104. Helical coils L107, L108 mis-tuned or defective. D101 and associated metering circuits defective.

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								
				80,90 100 W	35,40 50 W	65, 75 W	METER READINGS	PROBABLE CAUSE
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.

TEST AND TROUBLESHOOTING PROCEDURES

SYMPTOM	PROCEDURE	ANALYSIS
Little or No RF Output	Key transmitter and check J1-10 (Pos A) for +0.5 V (exciter output).	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.
	Disconnect P102 on exciter and measure RF output of synthesizer.	No RF present. See Synthesizer Troubleshooting Procedure. RF present, reconnect P102 and proceed to next step.
	Key transmitter and monitor voltage at J101-9 (Pos B Tripler). Voltage should increase.	If voltage does not increase check C116-C118, L106 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 P103 on Exciter and measure RF output 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.

SERVICE PLUGS CURRENT CHART

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

RADIO CONNECTOR IDENTIFICATION	
Front Connector	J601
Systems Metering	J602
Option Connector	J603
PROM Program Plug (Hand Programed)	J711
Exciter RF Metering	J101
RX Input	P401
IF Input	P404
RX Inj.	P451
Exciter Input	P102
Exciter Output	P101, P103
Hand Programmer Enable	P706
Program Disable	P707
TX PA Metering	J1
VG Interface	P612
Fixed Squelch	P605
Channel Guard	P608
Aux. Audio	P610
DPTT	P402
Ign. A+	P403
RX VCO Frequency Range	P201
TX VCO Frequency Range	P202
TX VCO Frequency Range	P204

	CHANNEL SELECTION TRUTH TABLE			
CHANNEL	FB1	FB2	FB3	FB4
1	0	1	1	1
2	1	0	1	1
3	0	0	1	1
4	1	1	0	1
5	0	1	0	1
6	1	0	0	1
7	0	0	0	1
8	1	1	1	0
9	0	1	1	0
10	1	0	1	0
11	0	0	1	0
12	1	1	0	0
13	0	1	0	0
14	1	0	0	0
15	0	0	0	0
16	1	1	1	1

FB5= 1= MODE A EE PROM CH 1-16
FB5= 0= MODE B EE PROM CH 17-32

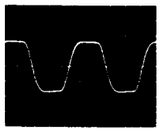
TRANSMITTER AUDIO CHECKS

TEST EQUIPMENT REQUIRED (or equivalent)

- Audio Oscillator
- Oscilloscope (BALLANTINE MODEL 1022A)
- AC Voltmeter (TRIPLETT 310-C)
- Deviation Monitor (CUSHMAN CE-50A)

TRANSMITTER 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.			

TRANSMITTER 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.

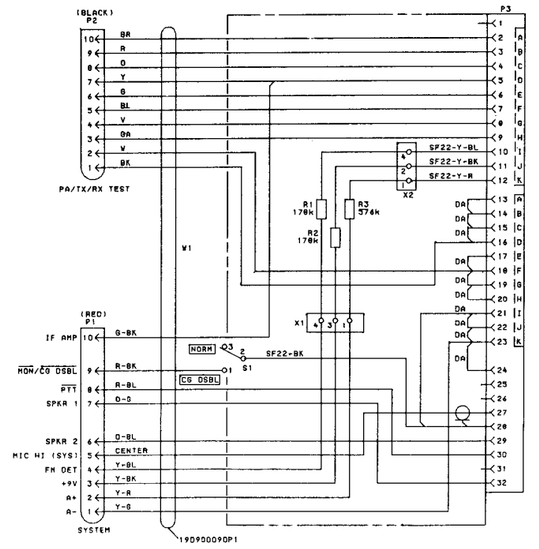
TEST POINT DATA (Typical)

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 (RX) L209 (TX)	VCO Control Voltage (See Synth Align)
J353	0.7 VPP		Reference Osc. Output (high impedance)
J352	5.5 VDC (Nominal)		Ref Osc Compensation Line Voltage
J712	5.0 VDC		VCC to Microcomputer

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	0 VDC
	Logic High	13 VDC



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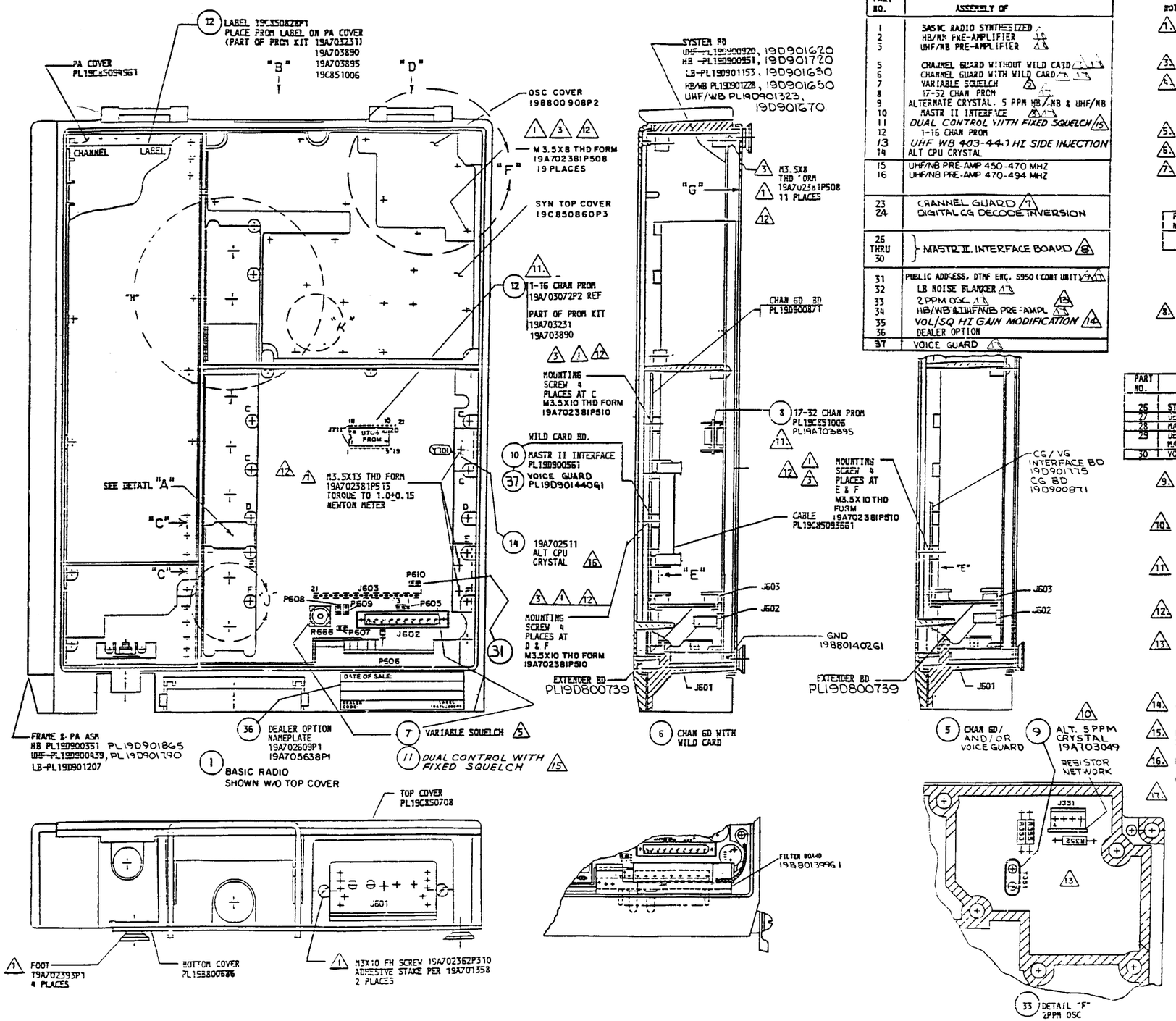


PART NO.	ASSEMBLY OF
1	BASIC RADIO SYNTHESIZED 1
2	HB/NB PRE-AMPLIFIER 4 13
3	UHF/NB PRE-AMPLIFIER 4 13
5	CHANNEL GUARD WITHOUT WILD CARD 1 13
6	CHANNEL GUARD WITH WILD CARD 1 13
7	VARIABLE SQUELCH 5
8	17-32 CHAN PROM
9	ALTERNATE CRYSTAL 5 PPM HB/NB & UHF/NB
10	MASTR II INTERFACE 9 13
11	DUAL CONTROL WITH FIXED SQUELCH 15
12	1-16 CHAN PROM
13	UHF WB 403-440 HI SIDE INJECTION
14	ALT CPU CRYSTAL
15	UHF/NB PRE-AMP 450-470 MHZ
16	UHF/NB PRE-AMP 470-494 MHZ
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 2 11
32	LB NOISE BLANKER 13
33	2 PPM OSC 13
34	HB/WB & UHF/NB PRE-AMPL 4 13
35	VOL/SQ HI GAIN MODIFICATION 14
36	DEALER OPTION
37	VOICE GUARD 11

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 FE05 TO J605-2 & 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	

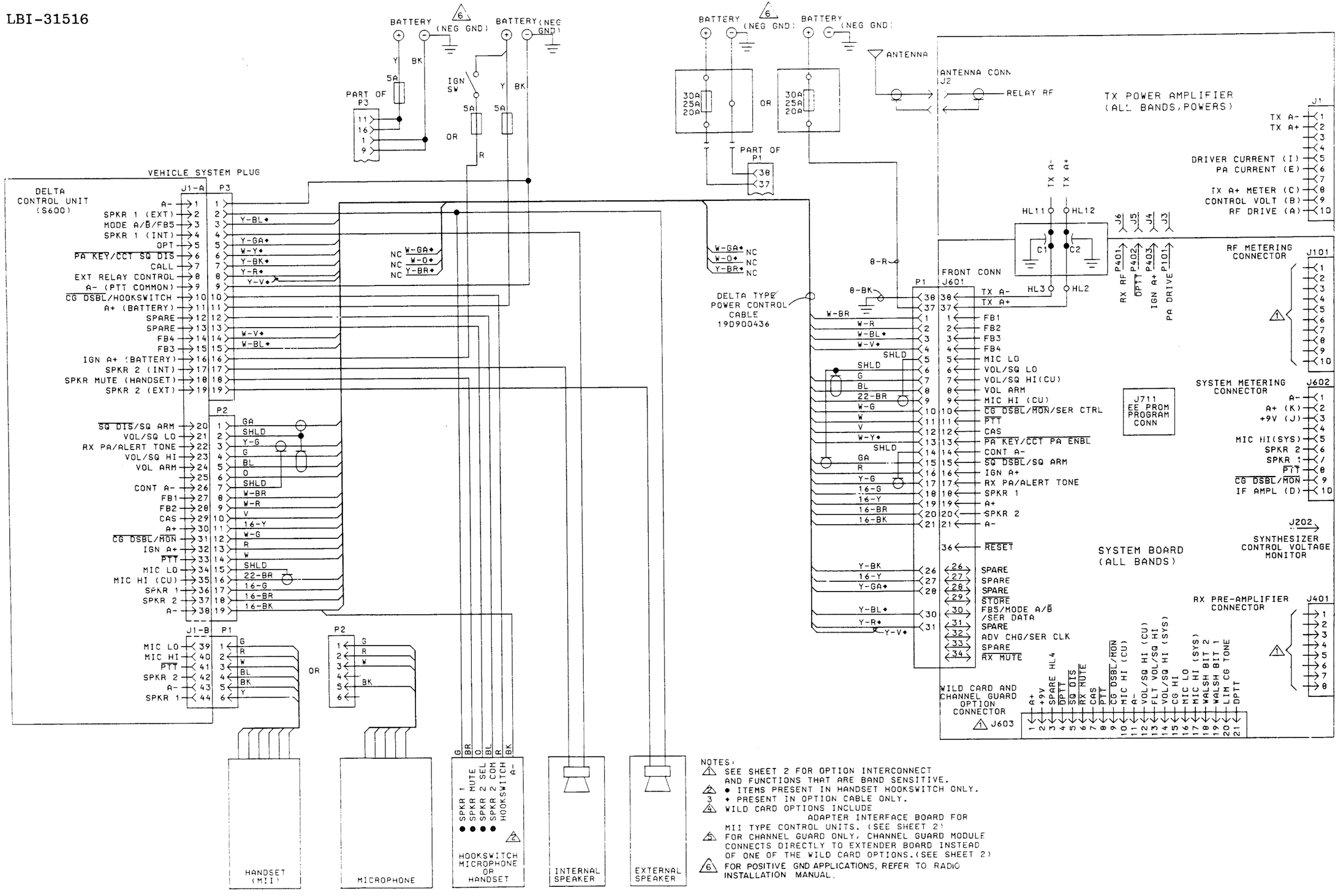
8. WHEN USING THE MASTR II INTERFACE BD. REMOVE P608 ON THE SYSTEM BD. THE MASTR II INTERFACE BOARD IS ASSEMBLED WITH ALL JUMPERS PRESENT. "X" INDICATES THAT THE JUMPER OR PART IS REMOVED. P3 IS LOCATED ON THE CHANNEL GUARD BOARD. P609 IS LOCATED ON THE SYSTEM BD.

PART NO.	APPLICATION	W1	W2	W3	W4	W5	W6	P3	P609
25	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.
17. LUBRICATE EACH CONTACT PER PGA-EAI22 IMMEDIATELY PRIOR TO MATING PINS WITH CONNECTOR FOR PARTS 2,3,5,6,8,10,31,32,33,34, & 37.

THIS DWG DUPLICATED ON RC4448

MECHANICAL LAYOUT DIAGRAM



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)
6. FOR POSITIVE GND APPLICATIONS, REFER TO RADIO INSTALLATION MANUAL.

RADIO INTERCONNECTION DIAGRAM

(19D900980, Sh. 1, Rev. 4)

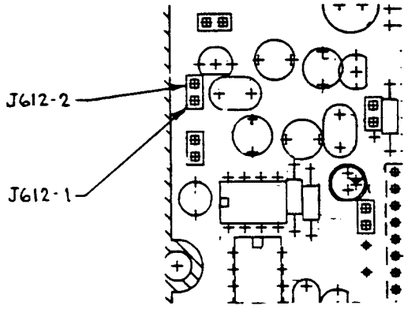
(37)

Hi BAND
DELTA RADIO WITH VOICE GUARD

SYSTEM BOARD ASM: 19D901345
LEVEL ONE ASM: 19D901720

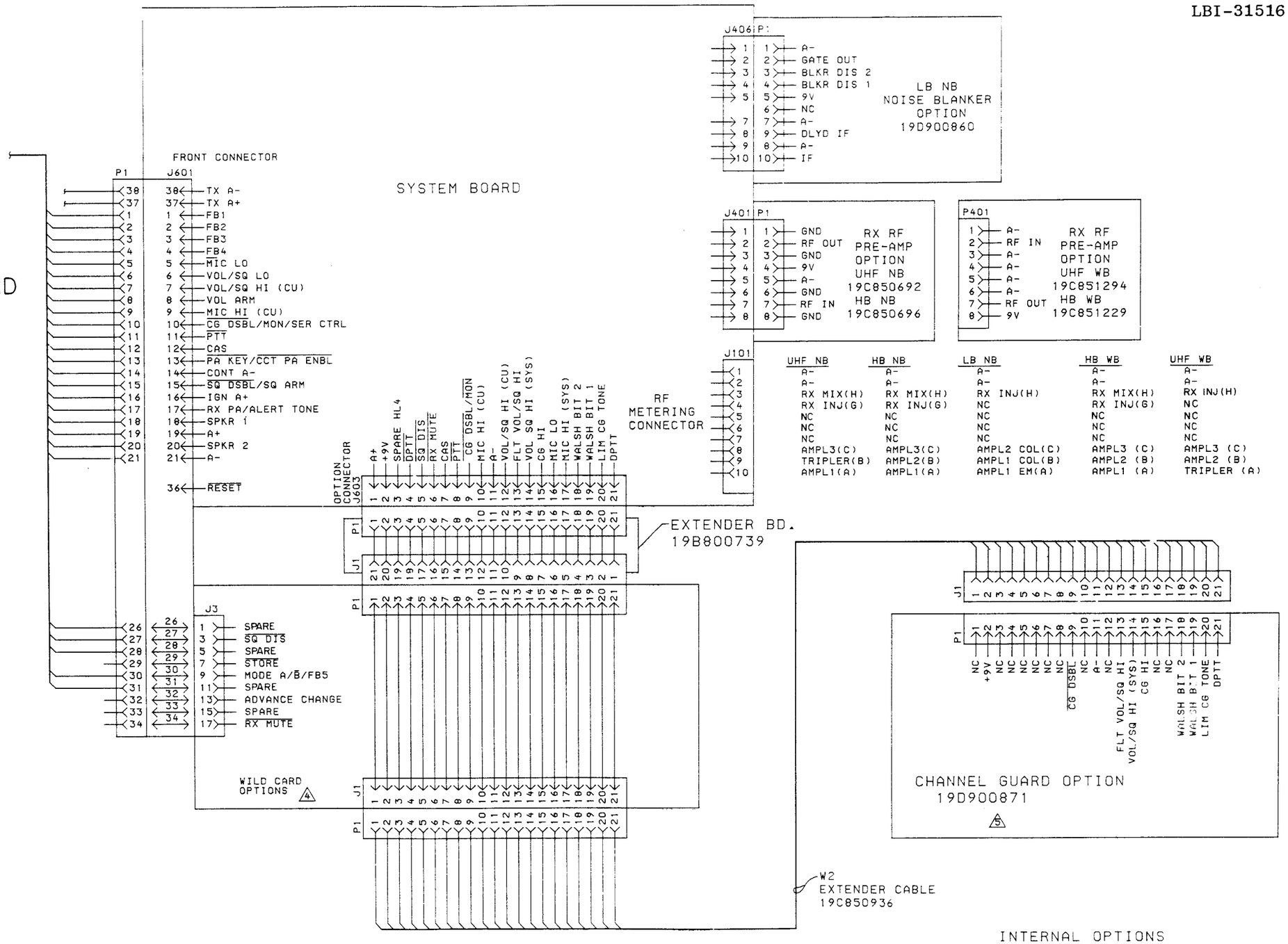
[1]

REMOVE P612
CONNECT BLACK WIRE
TO J612-1
CONNECT WHITE WIRE
TO J612-2



[2]

PLUG P3 OF W51 ONTO J53 OF V6 BOARD.



(19D900980, Sh. 2, Rev. 3)

INTERNAL OPTIONS

OPTION INTERCONNECTION DIAGRAM

ADDENDUM NO. 1 TO LBI-31516B
(PCN3)

This addendum to Maintenance Manual LBI-31516B includes important information concerning the use of the GE TEST SET to measure TX, PA, and EXCITER readings on the 136 - 174 MHz Delta-S Narrowband Two Way FM Radio.

The following changes to the text of LBI-31516B should be noted:

Page 10:

Under the section PRELIMINARY CHECKS AND ADJUSTMENTS, item #1 should read:

"1. Connect the black plug from the Test Set to the RF metering jack J101. Connect the red system metering plug to J602, system metering. Set Test Set to 1 volt **POSITION (TEST 1)**. ...."

Page 13:

TRANSMITTER QUICK CHECKS

EXCITER

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

RANGE POSITION	RF METERING J101 EXCITER READINGS					PROBABLE CAUSE METER READINGS	
	TEST POS.	METERING JACK J101	FUNCTION	METER SCALE	TYPICAL READING	HIGH	LOW
TEST 1	A	J101-10	AMPL-1	0-1	0.2V	Q101 SHORTED R101, 103 OPEN	Q101 OPEN R103,R105 OPEN L103 OPEN OSCILLATOR/BUFFER DEFECTIVE
TEST 1	B	J101-9	TRIPLER	0-1	0.2V	Q102 DEFECTIVE R107 OPEN	Q102 SHORTED R110 OPEN L104, L05 AND ASSOCIATED CIRCUITS DEFECTIVE OR IMPROPERLY TUNED.
TEST 1	C	J101-8	AMPL-3 REL PWR OUT	0-1	0.5V	HELICAL COIL L114 SHORTED OR MIS-TUNED	Q103 OR Q104 DEFECTIVE. CHECK RESISTORS, CAPACITORS AROUND Q103, Q104. HELICAL COILS L107, L108 MIS-TUNED OR DEFECTIVE. D101 AND ASSOCIATED METERING CIRCUITS DEFECTIVE.

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 in order to facilitate troubleshooting.

- Connect red system metering plug to J602, system metering.
- Connect black plug of GE Test Set to RF Metering jack J1 of the Power Amplifier, polarity to "+", and voltage range to the 1 volt position (Test 1).

RANGE POSITION	POWER AMPL METERING J1 PA JACK READINGS				80,90, 100 W	35,40, 50 W	65, 75 W	METER READINGS	PROBABLE CAUSE
	TEST POS.	METERING POINT	FUNCTION MEASURED	METER SCALE	TYPICAL READING	TYPICAL READING	TYPICAL READING	HIGH	LOW
TEST 1	A	J1-10	RF DRIVE	0-1V	0.5V	0.5V	0.5V		LOW EXCITER OUTPUT. REALIGN OR REPAIR EXCITER.
TEST 1	B	J1-9	CONTROL VOLTAGE	0-15V	4V	4.5V	7.5V	LOW EXCITER OUTPUT	HIGH EXCITER OUTPUT
TEST 1	C	J1-8	TX A+	0-15V	12.5V	12.5V	12.5V		EXCESSIVE VOLTAGE DROP IN POWER CABLE.
TEST 1	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
TEST 1	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

* **NOTE:** With High Sensitivity button depressed, polarity to "-".