SERVICE SECTION
FOR
MDX GE-MARC 800 MHz RADIO

TABLE OF CONTENTS

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LBI-38973

TABLE OF CONTENTS

DESCRIPTION

This Service Section contains the information necessary for aligning and troubleshooting the MDX GE-MARC 800 MHz Mobile Radio. In addition, information is provided for disassembling the radio and replacing surface mount components.

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 transmitter has been adjusted at the factory and should require no readjustment. However, the antenna length should be adjusted for optimum VSWR, and the frequency and modulation measured and recorded for future reference. For complete transmitter alignment, refer to the Alignment Procedures.

RECEIVER ADJUSTMENT

No initial adjustments to the receiver are required. Refer to the Receiver Alignment Procedure when service is required.

RE-INSTALLATION

The radio is designed to operate in 12 volt, negative ground vehicles only. If the mobile radio is moved to a different vehicle, always check the battery polarity of the new vehicle system.

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. Preventive maintenance should include the following checks.

CONNECTIONS

Ground connections to the voltage source should be periodically checked for tightness. Loose or poor connections to the power source 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 resistance. A high resistance may cause excessive voltage drops and alternator noise problems.

ELECTRICAL SYSTEM

Check the voltage regulator and alternator or generator periodically to keep the electrical system within safe operational limits. Overvoltage is indicated when the battery loses water rapidly. Usage of 1 or 2 ounces of water per cell per week is acceptable for batteries in continuous operation. A weak battery often causes excessive noise or faulty operation.

MECHANICAL INSPECTION

Since mobile units are subject to constant shock and vibration, check for loose plugs, nuts, screws and other parts to make sure that nothing is working loose.

ANTENNA

The antenna, antenna base and all contacts should be kept clean and free from dirt or corrosion. If the antenna or its base should become coated or poorly grounded, loss of radiation and a weak signal often results.

ALIGNMENT

The transmitter and receiver meter readings should be checked periodically and the alignment optimized when necessary. Refer to the Alignment Procedure.

FREQUENCY CHECK

Check transmitter frequency and deviation. Normally, these checks are made when the unit is first placed in operation, after the first six months, and once a year thereafter.

STATIC HANDLING PRECAUTIONS

This radio contains Metal Oxide Semiconductor (MOS) devices that are vulnerable to damage from Electrostatic Discharge (ESD). As a result, extra care must be taken when handling or testing the devices, modules, or the assemblies in which they are used.

LBI-38973

To prevent damage from ESD, observe the following precautions:

- Service the radio only at a static free work station or on a grounded mat.
- Perform diagnostics to isolate a faulty assembly or component. Do not use canned coolant for fault isolation.
- Discharge static voltage from your body by wearing a grounded antistatic wrist strap where possible. Where ground straps cannot be used, touch a grounded item prior to handling an open radio.
- Avoid touching any electrically conductive parts of circuit modules with your hands. When you must handle components, pick them up by the body and avoid touching the leads.
- Do not remove static sensitive devices from their protective packaging until you are ready to install them. Ground the package, to dissipate any accumulated charge, prior to removing the component.
- Ground all electrically powered test equipment. Ground test equipment leads prior to connecting to a circuit and connect the ground lead prior to connecting the test probe. Disconnect the probe before removing the ground lead.
- When soldering, be sure the soldering iron is grounded using a three prong cord connected to an outlet with a known good earth ground.
- Use only metallized or ESD protective vacuum-type desoldering tools.

NOTE

This symbol is used to identify circuitry using Electrostatic sensitive devices. Be sure to follow Static Handling Procedures when working near these devices.

DISASSEMBLY PROCEDURES

Disassembly procedures are provided to completely disassemble the radio. In general, reassembly is in the reverse order. Included are procedures to remove the top and bottom covers, RF board, Audio Board, Logic Board, System Board, and Front Cap Assembly, including the Audio Amplifier Board and Display Board. Refer to Assembly Diagrams located in the Combination Manual (LBI-38960) for this radio when assembling or disassembling the radio or replacing component boards.

NOTE

Remove power from the radio before servicing.

TO REMOVE BOTTOM COVER

1. Remove the four screws securing the bottom cover to the radio.
2. Gently lift the bottom cover from the radio.

TO REMOVE TOP COVER

1. Remove the bottom cover and slide the top cover up out of the casting.

NOTE

When replacing the covers check to see that the "O" ring gaskets are properly seated in the cover grooves. Also make sure the cables are pressed down in the inner wall slots so they will not be pinched during reassembly.

TO REMOVE RF BOARD

l. Remove the top and bottom covers from the radio.

2. Pry off the friction fit covers covering the RF board.

3. Gently pry interconnect plug P702 from the logic and RF boards using a small standard screwdriver.

4. Remove the two clips securing Q101 and U102 to the frame (on top side of board).

5. Remove the two M3.5-0.6 x 20 TORX screws (#15 drive) securing PA module U101 to the frame.

6. Remove the six M3.5-0.6 x 8 TORX screws (#15 drive) from the bottom side of the board.

7. Disconnect wires attached to J704, J705 and cables going to the PA Board.

8. Remove the six spring clips protruding through the RF board from the bottom side.

9. Gently push the RF board out of the radio casting.

TO REMOVE THE FRONT CAP ASSEMBLY

l. Remove the top and bottom covers of the radio.

2. Remove the four TORX screws (#10 drive) from top and bottom of the front cap assembly.

3. Gently pull the front cap assembly away from the radio.

4. Disconnect the ribbon cable from the rear of the assembly and disconnect the speaker leads from the system board. The front cap assembly can then be removed from the radio.

NOTE

When replacing the front cap assembly on the radio casting first check that the "O" ring gasket is seated in the casting groove. Carefully press the front cap over the gasket making sure the gasket remains in the groove. Reinstall the 4 TORX screws while applying pressure to seat the front cap against the casting.

TO REMOVE AUDIO AMPLIFIER BOARD

1. Remove the top and bottom covers.

2. Remove the Front Cap assembly.

3. Remove the four M3.5-0.6 x 8 TORX screws (#15 drive) securing the audio amplifier board to the radio casting.

4. Disconnect the interconnecting cable between the Audio Amplifier Board and the System and Display Boards.

5. Lift the Audio Amplifier Board out of the Front Cap assembly.

TO REMOVE THE AUDIO BOARD

1. Remove the top and bottom covers from the radio. Refer to the disassembly procedures for each.

2. Pull out the black clip protruding through the Audio Board that holds the Logic Board 5 volt regulator against the casting.

3. Remove the four M3.5-0.6 x 8 TORX screws (#15 drive) securing the Audio Board to the radio. Pry out the board using a screwdriver in the hole that was occupied by the clip.

TO REMOVE THE LOGIC BOARD

1. Remove the top cover, bottom cover, front cap assembly, and the Audio Board, from the radio. Refer to the disassembly procedures for each.

2. Remove interconnecting plug P702 from the RF and Logic Boards on the bottom of the radio.

3. Remove the four (4) M3.5-0.6 x 8 TORX screws (#15 drive) securing the Logic Board to the radio frame.

4. Carefully work the Logic Board out of the radio, being careful not to damage the plug going to the Front Cap Assembly.

TO REMOVE SYSTEM BOARD

1. Remove radio bottom cover.

2. Disconnect the speaker leads from J904.

3. Disconnect the ribbon cable from J902.

4. Disconnect the option cable, if used.

5. Remove the three M3.5-0.6 x 8 TORX screws (#15 drive) securing the system board to the frame.

6. Carefully work the board out of the radio, unplugging it from feed through assembly Z903.

TO REMOVE THE PA BOARD

1. Remove the top and bottom covers as instructed above.

2. Disconnect the cables to the RF Board.

3. Disconnect the cable at J151 on the PA Board.

LBI-38973

4. Remove the two M2.5-0.45 TORX screws (#8 drive) securing the PA transistor to the frame.

5. Remove the four M3.5-0.6 TORX screws (#15 drive) securing the board to the frame. Carefully work the board out of the radio, uplugging it from the feed through assembly Z903.

TO REMOVE THE DISPLAY BOARD

1. Remove the top and bottom covers and Front Cap Assembly as directed above.

NOTE
When installing the PA Board in the radio, tighten the screws securing the board to the casting to 15 inch-pounds. Then install the screws securing the transistor and torque to 4.5 inch-pounds.

2. Remove the seven (7) M3.5-0.6 x 8 TORX screws (#15 drive) from the rear of the Front Cap Assembly to remove the two brackets and center of the Display Board.

3. Gently pull the control panel away from the front cap and disconnect the ribbon cable on the rear of the panel.

COMPONENT REPLACEMENT

SURFACE MOUNTED COMPONENTS

Surface mounted "Chip" components should always be replaced using a temperature controlled soldering system. The soldering tools may be either a temperature controlled soldering iron or a temperature controlled hot-air soldering station. A hot-air system is recommended for the removal of components on multi-layer boards. With either soldering system, a temperature of 700°F (371°C) should be maintained.

The following procedure outlines the removal and replacement of surface mounted components. If a hot-air soldering system is employed, see the manufacturer's operating instructions for detailed information on the use of your system.

CAUTION
Avoid applying heat to the body of any chip component when using standard soldering methods. Heat should be applied only to the metallized terminals of the components. Hot-air systems do not damage the components since the heat is quickly and evenly distributed to the external surface of the component.

CAUTION
This unit contains many static sensitive components, observe static handling precautions during any service procedure.

To Remove Surface Mounted Components

1. Grip the component with tweezers or small needle nose pliers.

2. Alternately heat the metallized terminal ends of the chip component with the soldering iron. If a hot-air system is used, direct the heat to the terminals of the component. Use extreme care with the soldering equipment to prevent damage to the printed wire board (PWB) and the surrounding components.

3. When the solder on all terminals is liquefied, gently remove the component. If all solder is not completely liquefied, the use of excessive force may cause the PWB pads to separate from the board.

4. It may be necessary to remove excess solder using a vacuum de-soldering tool or Solderwick®. Again, use great care when de-soldering or soldering on the printed wire boards. It may also be necessary to remove the epoxy adhesive that was under the chip component and any flux from the printed wire board.

To Replace Surface Mounted Components

1. "Tin" all terminal ends on the new component and on the pads of the PWB. Use as little solder as possible.

2. Place the component on the PWB pads, observing proper orientation for capacitors, diodes, transistors, etc.

3. Simultaneously touch the "tinned" terminal end and the "tinned" pad with the soldering iron. It may be necessary to slightly press the component down on the board. Repeat this procedure on all component terminals as necessary. Do not apply heat for an excessive length of time and do not use excessive solder.

   With a hot-air system, apply hot air until all "tinned" areas are melted and the component is seated in place. It may be necessary to slightly press the component down on the board. Touch-up the soldered connections with a standard soldering iron if needed. Do not use excessive solder.

4. Allow the component and the board to cool and then remove all flux from the area using alcohol or other EGE approved flux remover.

CAUTION
Some chemicals may damage the internal and external plastic and rubber parts of the radio.

To Replace Surface Mounted Integrated Circuits

Soldering and de-soldering techniques of the surface mounted IC's are similar to the procedures for the surface mounted chip components. Use extreme care and observe static precautions when removing or replacing the defective (or suspect) IC's. This will prevent damage to the printed wire board or the surrounding circuitry.

Replacement of the surface mounted IC's is best completed using a hot-air soldering system. See the manufacturers instructions for complete details on tip selection and other operating instructions unique to your system.

If a hot-air system is not available, the service technician may wish to clip the leads near the body of the defective IC and remove it. The leads can then be removed from the PWB using a standard soldering iron and tweezers. Install the new IC following the Chip Component Replacement procedures. It may not be necessary to "tin" the IC leads before the installation process.

TROUBLESHOOTING PROCEDURES

This section should help isolate a problem to a particular board or circuit. Block diagrams for power distribution, audio signal flow, and logic flow are located at the back of this manual. Refer to the appropriate LBI for additional circuit information for the Board suspected of having trouble.

The MDX GE-MARC 800 MHz mobile radio is divided into 6 Boards or assemblies. To aid in identifying the suspected board, major functions for each Board are given below. Refer to the appropriate LBI on each for more details.

- RF board A2: Synthesizer: generates all transmit and receive frequencies.

  Receiver: provides detected audio to the audio board.

  Transmitter: includes exciter and 10 watt PA Module.

  Power control circuitry for the transmitter.

  Pin diode TX/RX RF switch.

  Lowpass filter for the transmitter.

- PA Board: Power Amplifier: amplifies the 10 watt output of the RF board to 25 watts.

- Audio Board Analog to Digital and Digital to Analog conversion of the RX and TX audio.

  RX squelch - provides the CAS signal to the Logic Board.

  Conventional analog tone filtering and processing.

- Logic Board Routes signals between the RF, Audio, and Control Boards.

  Contains the EEPROM for the radio personality.

  Contains the main radio microprocessor.

  Accepts PTT from the microphone.

  Provides DPTT to turn on the transmitter.

LBI-38973

Provides synthesizer channel data to the RF Board.

Processes Rx and Tx audio using a digital signal processor.

Decodes tone data from the Audio Board.

Generates and detects the Channel Guard tones and data.

Controls all audio switches on the Audio Board.

Accepts the CAS squelch output from the Audio Board.

- System Board — A+ switching circuitry.

  Option connections.

- Front Cap Assembly

  Control Panel.

  Display Board includes microprocessor and display.

  Speaker.

Power On Self Diagnostic

The radio provides several self diagnostic checks when power is applied and informs the user of possible problems via messages on the front panel display. Messages and the reasons they are displayed are:

ERROR 1 — No personality. The radio has not been programmed with customer information.

ERROR 2 — Not used.

ERROR 3 — Synthesizer unlocked. The synthesizer is tested to verify that it can be locked in the proper time interval at various frequencies across the band.

ERROR 4 — EPROM program memory checksum error. If the microprocessor uses external memory, the EPROM has been corrupted or is malfunctioning.

SYMPTOMS AND CHECKS

SYMPTOMS	CHECKS
Blank display power up	Check for dc voltages to J707 on the on Display Board. Check for SW A+ and 8 volts on J702.
Radio does not en- go into test mode	The radio must be PC programmed to able the test mode. Enable it on the options screen of the PC programmer.
Low, distorted, or no Rx Audio	Check the receiver VOL/SQ HI output. The problem is most likely in the RF Board. If the synthesizer load commands are not correct, the problem may be on the Logic Board. If the audio is correct at VOL/SQ HI, check the Rx audio out. If improper, check the Audio, Logic, and/or Audio Amplifier Boards for proper unmute functions. Proper commands indicate a faulty Audio, Logic, or Audio Amplifier Board.
No Rx Alert Tone	Check the signalling tone output from the Audio or Logic Boards. Operate the volume control. If tones are not present, the Audio or Logic Boards may be faulty.
Poor Rx	Suspect the RF board. Check Sensitivity and receiver alignment. Refer to the RF board maintenance manual.
No Tx Power	Check the DPTT command to the RF board. If present, then the problem is likely on the RF board. If the DPTT is not present, the problem is likely on the Logic Board.
Low Tx Power	Check the transmit frequency. If it is not OK, check the synthesizer on the RF board to assure it load commands from the Logic board. If the commands are not present, a problem in the Logic board is likely. If the Tx frequency is correct, refer to the maintenance manual for the RF board and troubleshoot the transmitter.
No Tx Modulation	Check the Tx MOD input to the RF Board. If present, the RF Board may be faulty. If not present, determine what is missing: tone, voice, or both. Missing tones - Look for the signalling tone and busy tone on the Logic Board. If the tones are not present, the Logic Board may be faulty. Tones Present - Look for the proper unmute commands on the Logic Board. If the commands are not present, the Logic Board may be faulty. If the commands are present, the Audio Amplifier Board may be faulty. Missing Voice Signal - Check the mute commands on the Audio Amplifier Board and the Tx Audio input. If all signals are correct, the problem is likely a faulty Audio or Logic Board. If no signal is present at the Audio or Logic Boards, check the output from the Audio Amplifier Board and the microphone outputs.
Distorted Tx Audio	Check grounding between all boards and the casting. Check the Tx MOD input to the RF Board. If distorted, a faulty Audio or Logic Board is likely. Check the mute commands. If incorrect a faulty Audio or Logic board is likely. If the tones are distorted, check the tone generation circuitry on the Audio Board.
Transmitter Off Frequency	Suspect the RF board. Refer to "Frequency Set" procedure in the Transmitter Alignment section of this manual. Check the synthesizer load command. If the load command is wrong, a faulty Audio or Logic board is likely.
Calls Processed Incorrectly	Check personality PROM programming. Check for proper Tx and Rx operation. Refer to Tx and Rx Verification Procedures. If verification OK, determine if the problem is in the transmit or receive circuit. Rx decode check: Use the decode T test mode command. Modulate the generator with the correct tone sequence and busy tone. If the test fails, check the limited data output from the Audio or Logic Boards. If the data is not present, the Audio or Logic boards may be faulty. Tx encode check: Use the encode test. If the test fails, the Audio or Logic boards may be faulty. Look for the proper tones on the Audio and Logic boards and proper unmute commands. If all inputs are correct, the board(s) may be faulty.

TEST PREPARATION

To test the MDX GE-MARC radio, a test mode must be entered that disables the normal channel scanning mode for GE-MARC operation. This test mode function is normally disabled before shipment to the customer. The radio's personality must be PC programmed to access the test mode function. This function is found on the options screen in the PC programming software.

TMX Handset Option 19B801596P1 allows accessing the radio test mode functions for radio alignment and testing. Requires Test Point Adapter Option TQ2356 and an adapter cable 19B801417P12.

Test Point Adapter Option TQ2356 provides for connecting a TMX handset to the radio to access the test mode functions. The adapter also provides receive audio monitoring, transmit audio injection, and test points for all nine (9) pins of the microphone connector.

Service cable 19A704875P1 provides an extension between the Audio Board and the Logic Board. Both sides of the Audio Board are available for servicing using the cable.

Service cable 19B801348P4 provides a two (2) foot extension between the nine (9) pin "D" connectors (J701 and P701) on the Logic Board and Audio Amplifier Board.

To allow easier servicing of the Front Cap Assembly, service cable 19A705235P2, is available, and is a longer ribbon cable (2 feet) to connect the System Board and the Audio Amplifier Board.

LBI-38973

TEST MODE COMMANDS

Plug the handset and adapter cable into the test point box. Plug the other end of the adapter cable into the microphone connector of the radio.

With the radio power off, push and hold the VOLUME UP and CLR buttons on the radio control panel, and then turn on the radio power. After applying power, release the buttons. Test mode should appear in the radio display, followed by a similar display in the handset.

NOTE
The radio control panel buttons do not function while in test mode. Only the handset can control the radio.

When test mode is entered, the radio reverts to the following default conditions:

- Channel Number 730: 815.0125 MHz Tx
  860.0125 MHz Rx
- Volume Setting at minimum.
- All audio paths muted.

Channel Frequency Select

To select another channel frequency, press the CL key followed by a 2 to 4 digit channel number (10-1528) followed by CL. A channel number can be entered with or without leading zeros. The receive audio is turned on after entering the channel.

Example: For channel 12, enter CL 1 2 CL.

NOTE
To determine the channel number, use the following formula:

$$\text{CH. NO.} = \frac{\text{Tx Freq.} - 806.0125}{0.0125} + 10$$

Channel 10 is 806.0125 MHz and channel 1528 is 824.9875 MHz. Channel spacing is 12.5 kHz. A one MHz frequency increase or decrease corresponds to a channel number increase or decrease of 80.

Test Functions

Table 1 gives a summary of the important test functions. A complete description of all tests is given below.

Enter Test Mode	VOLUME UP and CLR (on radio)
Exit Test Mode	Turn radio power OFF
Select test channel frequency	CL (channel number) CL
Ramp volume UP/DOWN	VOLUME (on handset only)
Transmitter ON Transmitter OFF	S01 E
Receive Audio ON Receive Audio OFF	S02 S03
Transmit Audio ON Transmit Audio OFF	S04 S05
Transmit Busy Tone	S06
PTT switch enable	S16

Table 1 - Frequently Used Test Mode Functions

The test functions are enabled by first pressing the S key followed by a two digit number. Wait until the display is updated before pressing the next button (about ½ second).

TRANSMITTER TEST: **S 0 1 (ON)**
E (OFF)

The carrier is ON/OFF at the specified channel frequency. This function overrides the PTT switch. Receive audio is OFF.

RECEIVER AUDIO TEST: **S 0 4 (ON)**
S 0 3 (OFF)

The receiver audio path is ON (unmuted) or OFF (muted).

TRANSMITTER AUDIO TEST: **S 0 4 (ON)**
S 0 5 (OFF)

The transmitter audio path is ON (unmuted) or OFF (muted).

NOTE
The handset microphone is disabled in test mode. If desired, the radio's hand microphone can be plugged into the test box.

BUSY TONE TEST: **S 0 7 (ON)**
E (OFF)

The radio continuously transmits the 3051.6 Hz standard tone. This function overrides the alternate busy tone test.

ALTERNATE BUSY TONE TEST: **S 0 7 (ON)**
E (OFF)

The radio continuously transmits the 2918.7 Hz alternate busy tone. This function overrides the standard busy tone test.

TRANSMIT GE-MARC TONE TEST: **S 0 8 (tone 01-41)**

This function transmits the selected GE-MARC tone (01-41). Any key causes reset to the default conditions.

CHANNEL INCREMENT: **S 0 9**

This function increments the channel number and loads the synthesizer. The receive audio is on.

ACROSS BAND SWITCHING: **S 1 0**

This function continuously toggles the synthesizer across the band between 806.0125 and 825.9875 MHz. Any key causes reset to the defalult conditions.

TONE SET SELECT: **S 1 1 (tone set number 01-99)**

This function selects the tone sequence from the tone set number. The tone set must be programmed in the personality PROM. This function is used along with the Call Decode and Call Encode tests.

DTMF TONE TEST: **S 1 2 (DTMF tone 0-9,*, or #)**

This function transmits the selected DTMF tone. Any key causes reset to default conditions.

Key and DTMF tone combinations are as follows:

Key	Low Tone (Hz)	High Tone (Hz)
1	697	1209
2	697	1336
3	697	1477
4	770	1209
5	770	1336
6	770	1477
7	852	1209
8	852	1336
9	852	1477
*	941	1209
0	941	1336
#	941	1477

CALL DECODE TEST: **S 1 3**

This function looks for the tone sequence selected by the tone set function (S 1 1). The three (3) note alert tone is sounded and all handset indicators are displayed if the sequence is detected. Any key causes reset to default conditions.

CALL ENCODE TEST: **S 1 4**

This function initiates a call using the tone sequence selected by the tone set function (S 1 1). The three (3) note alert tone is sounded if the attempt is successful. The call is attempted at one (1) second intervals. Any key causes reset to default conditions.

ALERT TONE TEST: **S 1 5**

This function sounds the call initiated alert and the channels busy/error tone. Any key causes reset to default conditions.

PTT ENABLE: **S 1 6**

This function enables the PTT switch circuit; so that pressing the PTT switch turns ON activates the transmitter and releasing PTT turns the transmit circuit OFF. The function is disabled if another function activates the transmitter.

RELAY SWITCH TEST: **S 1 8**

This function toggles the relay line at a 1000 Hz rate for board level testing. Any key causes reset to default conditions.

PORT CHECK: **S 1 9**

This function is used to test the Logic Board microprocessor port pins. The pins toggle at the rate shown below (see next page). Any key causes reset to default conditions.

Port Check Pin Toggle Rate

Pin	Toggle Rate
4	5 kHz
5	2500 Hz
6	1250 Hz
8	312 Hz
9	156 Hz
14	78 Hz

SOFTWARE REVISION: **S 2 0**

This test displays the microprocessor software revision. Any key causes reset to default conditions.

DIRECT MODE TEST: **S 2 1**

This test pulls the band switch line of the VCO low. A channel can then be loaded to test the trransmit circuit at the high end of the band (channels 3610-5310).

CHECKSUM TEST: **S 2 2**

This test performs a checksum test on program memory. If the test passes, PROM OK is displayed. If the test fails, BAD PROM is displayed.

LOGIC BOARD JUMPER TEST: **S 2 4**

This test returns the state of jumper P1 on J1 of the Logic Board. P1 is on J1-1 and 2 for radios with 45.0125 MHz IF offset (TMX-8825) and on J1-2 and 3 for radios with 45.3 MHz IF offset (MDX GE-MARC).

TEST PROCEDURE

The test described below can be performed (1) in the test mode, or (2) during normal operation on a conventional system/channel.

TRANSMITTER VERIFICATION

Transmitter Frequency

Key the transmitter on any channel and measure the transmit frequency. The measured frequency should be within 250 Hz of the assigned channel frequency.

Transmit Power

Select a channel and key the transmitter. Measured power should be 26 watts ±0.05 dB. Current should be less than eleven (11) amperes.

Audio Modulation Limiting

1. Apply a 1 kHz AC tone at 1.0 Vrms to the MIC HI input (Tx Audio).

2. Select a channel. Turn on Tx audio (no Channel Guard or Busy Tone). Measure and note deviation.

3. Select another channel. Measure the deviation. The highest measured deviation on the two channels should be 3.5 kHz ±0.2 kHz.

Busy Tone and Channel Guard Check

1. Check Tx audio with Busy Tone or Channel Guard. Tx audio deviation should be 4.2 kHz ±0.25 kHz (for Channel Guard) or 4.50 kHz ±0.25 kHz (for Busy Tone).

RECEIVER VERIFICATION

SINAD

1. Apply an on-channel RF signal to the antenna jack. Modulate the signal with a 1 kHz tone at 3 kHz deviation. Set the RF level to -116 dBm.

2. Check for greater than 12 dB SINAD on-channel at the RX Audio output.

3. Repeat the test for the band ends and the center channel frequency.

Audio Output

1. Apply a strong (-50 dBm) on-channel signal modulated with a 1 kHz tone at 3 kHz deviation.
2. Monitor option connector J905-2,9 and adjust volume for 10 watts output (6.3 Vrms into 4 ohms). Distortion should be less than 5%. **NOTE: The 10-watt audio PA has "balanced outputs" and must be tested with the test setup shown in Figure 1.**

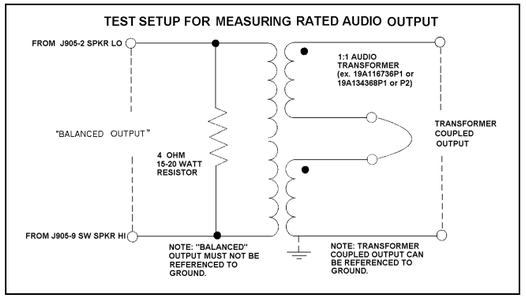


Figure 1 - Audio Output Test Setup

SERVICE AIDS

The following service aids are available to facilitate serviceing and adjustments.

- ST3712 Pin extractor Tool (11-03- 0038) - Allows removal of contacts from connector shell that mates with Option cable CC01. The option cable is required with all external options.

- ST2513 Alignment Tool - with two ceramic tips - used for squelch control and other adjustments.

- ST2617 Crimping Tool for field attachment of TNC - series male connectors 19A115903P1 to RG-58/U (and similar) coaxial cable.

LBI-38973

ALIGNMENT PROCEDURE

To align the radio, follow instructions in Transmitter and Receiver Alignment following this Figure. Refer to the Assembly Diagrams for board location and to this Figure for adjustment and test point locations.

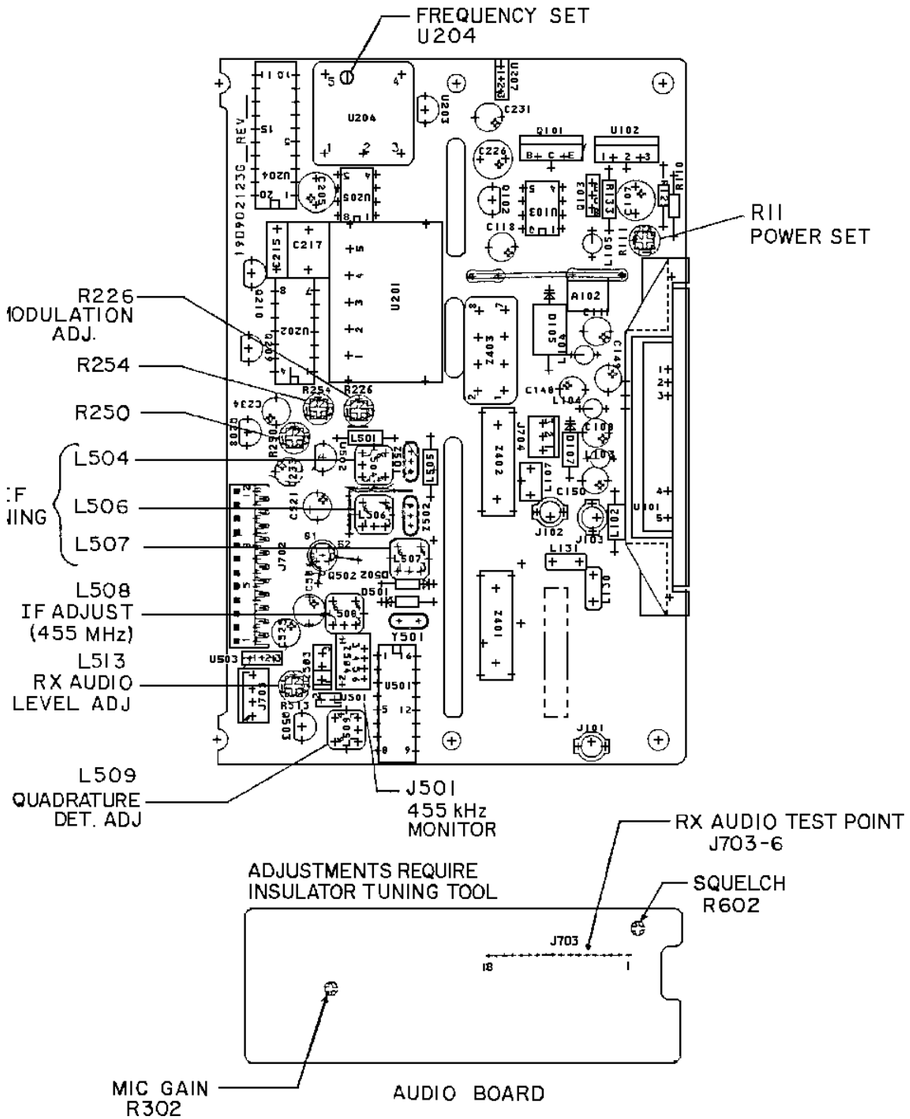


Figure 2 - Location of Controls and Adjustments, RF Board

TRANSMITTER ALIGNMENT

Frequency Set

Select any channel frequency. Key the transmitter and measure the transmit frequency. The frequency should be within ±250 Hz of the channel frequency. If it is not, adjust U204 to within ±100 Hz.

> **NOTE**
> The temperature should be 25° ±5° C. Ensure frequency counter calibration is better than ±0.1 PPM.

Audio Modulation Set

1. Apply a 1 kHz, 0.1 Vrms AC signal to the MIC HI input. Note that MIC HI has a DC voltage present.

2. Turn on the TX audio (with Channel Guard). Key the transmitter on a channel near the center of the frequency band (806-821). Adjust modulation control R254 for 4.25 kHz ±0.2 kHz deviation.

3. Key the transmitter on a channel near the center of the frequency band in the direct mode (851-866) and adjust R226 for 4.25 kHz ±0.2 kHz deviation.

Transmitter Power Set

1. Key the transmitter and adjust R111 in the power control circuit for 25 watts.

Channel Guard Check

1. Turn on the digital Channel Guard code 023. Verify TX modulation is 0.75 kHz ± 0.25 kHz. Adjust R250 for minimum deviation.

RECEIVER ALIGNMENT

Frequency Set

1. Verify that the transmitter is on frequency as described in the transmitter alignment procedure.

2. Inject a strong on-channel signal (-50 dBm) at the antenna input J101.

3. Monitor J501 with a frequency counter and adjust L508 for a reading of 455 kHz ±100 Hz.

IF Tuning

1. Monitor J501 pin 1 with an AC voltmeter (pin 2 is ground). Inject an on-channel signal at the antenna jack modulated with a 1 kHz tone at 3 kHz deviation.

2. Adjust L504, L506, and L507 for a peak on the voltmeter. Adjust the level of the generator to keep the signal at J501 out of limiting (approximately -65 dBm).

3. Repeak the coils.

Quadrature Detector Adjustment

1. Inject a strong (-60 dBm) on-channel signal at the antenna jack modulated with a 1 kHz tone at 3.0 kHz deviation.

2. Monitor the VOL/SQ HI output at J705-3 with an AC voltmeter and adjust L509 for a peak indication on the meter.

Receiver Audio Level

1. Inject a strong on-channel signal at the antenna jack modulated with a 1 kHz tone at 3.0 kHz deviation.

2. Monitor VOL/SQ HI at J702-4 on the audio board with an AC voltmeter. Adjust R513 on the RF board for a reading of 200 ±20 mVrms.

Squelch Adjust

1. Select any channel. Apply a signal modulated with a 1 kHz tone at 3.0 kHz deviation to the antenna jack. Adjust the squelch pot on the Audio Board fully open.

2. While monitoring SPKR HI and LO, adjust the signal generator for 8 dB SINAD.

3. Adjust the squelch adjust potentiometer on the Audio Board until squelch opens.

POWER DISTRIBUTION

Refer to the Power Distribution Block Diagram for an understanding of the distribution of A+, SW A+, and the regulated voltages throughout the radio.

LBI-38973

A+

A+ (+13.8 volts nominal) enters the radio on the power cable and is connected to the system board. A+ feeds MOSFET switch Q903 providing SW A+ power to the audio amplifier board through J902 and J901. A+ is also applied to the display board through J707 and P707.

A+ leaves the system board on J903 and feeds the PA board and RF transistor Q151 through feedthru capacitor assembly Z903. D905 on the system board provides reverse polarity protection for the radio. D904 provides overvoltage positive spike protection on the system board A+ lead. A+ leaves the board on J151 and supplies power to PA module U101 and Q101 on the RF board. Q101 supplies the power control voltage to the PA module.

SW A+

Switched A+ (13.6 volts nominal) originates from the MOSFET switch on the system board. The Ignition Sense lead and the **POWER** push-button control the MOSFET switch. Fuse F901 protects the MOSFET and the radio from high current failures. SW A+ is supplied through J902 and J903 to the front cap assembly. It provides power to the 5 volt regulator, 10 watt audio PA, and the Front Cap Display Board. J903 provides SW A+ to the PA board which, in turn, passes SW A+ through J151 and J705 to the RF board.

SW A+ enters the RF board on J704 and J705 and supplies power to three 8-volt regulators and the transmitter power control circuitry. SW A+ leaves the RF board on J702 to supply power to 8-volt regulator U705 on the Logic Board. SW A+ also goes through J703 on the Audio Board to supply regulators U605, U606, and U607.

RF Board

8-volt regulator U502 provides power to the receiver. A separate 8.3-volt regulator U207 and 5-volt regulator U203 provide power to the synthesizer. 8 volt regulator U102 provides power to the transmitter. The output of U102 is switched to the exciter and the power control circuit. U503 powers the audio/logic board. U102 (TX 8-volt supply) and Q101 (power control output transistor) are mounted for heat sinking.

Logic Board

Requlator U705 receives SW A+ power and supplies 5 volt power to the logic devices on the board. SW A+ is routed to connector J701 to supply power to an option handset for test purposes.

Audio Board

Regulator U606 receives SW A+ power and generates 8 volt power for the audio devices on the board. The 8 volt power is further regulated to supply 5 volt bias and pull up supply. SW A+ is used to generate a negative supply (through Q602 and Q603) that supplies regulator U605 which generates -5 volts to supply power for audio devices.

Front Cap Assembly (Display Board)

A 5-volt regulator on the audio amplifier board powers the microprocessor logic display, icon LED's.

Audio Amplifier Board

A +5-volt regulator U727, is used for logic level pullups and to power the display board. SW A+ is used to power audio amplifier board U801, and display board backlighting control, Q850. An 8-volt regulator, U804, is used to power the operational amplifiers.

AUDIO SIGNAL FLOW

Refer to the Audio Signal Flow Block Diagram to see the distribution of RX and TX audio signals throughout the radio. Audio levels at important points are also shown.

Transmitter Audio

Microphone audio (MIC HI) is routed from the mic connector on the display board through the audio amplifier board to feed the Audio and Logic boards. After processing and summing the Channel Guard tones, the audio (TX MOD) is fed to the RF board. TX MOD is adjusted by Deviation Adjust R226 before feeding the modulation input to the synthesizer VCO U201.

Receiver Audio

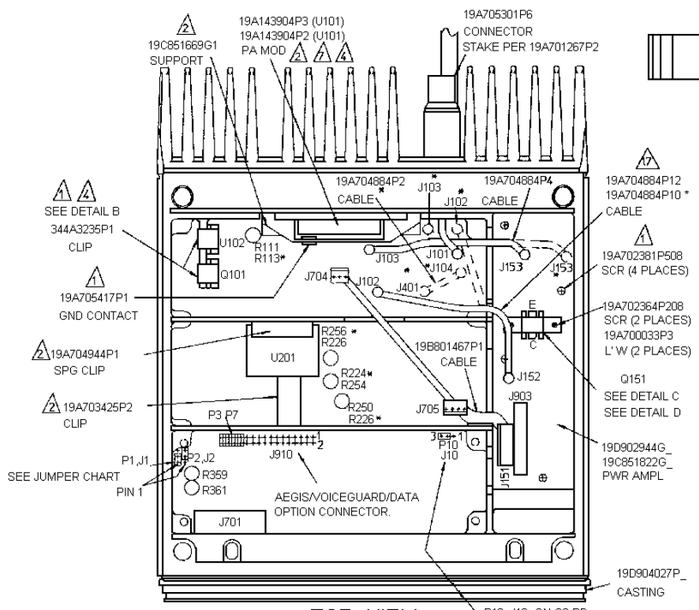
Discriminator audio is buffered by Q503 on the RF board and adjusted by R513. This audio (VOL/SQ HI) is routed to the Audio and Logic boards for audio processing, tone/code detection, and volume control.

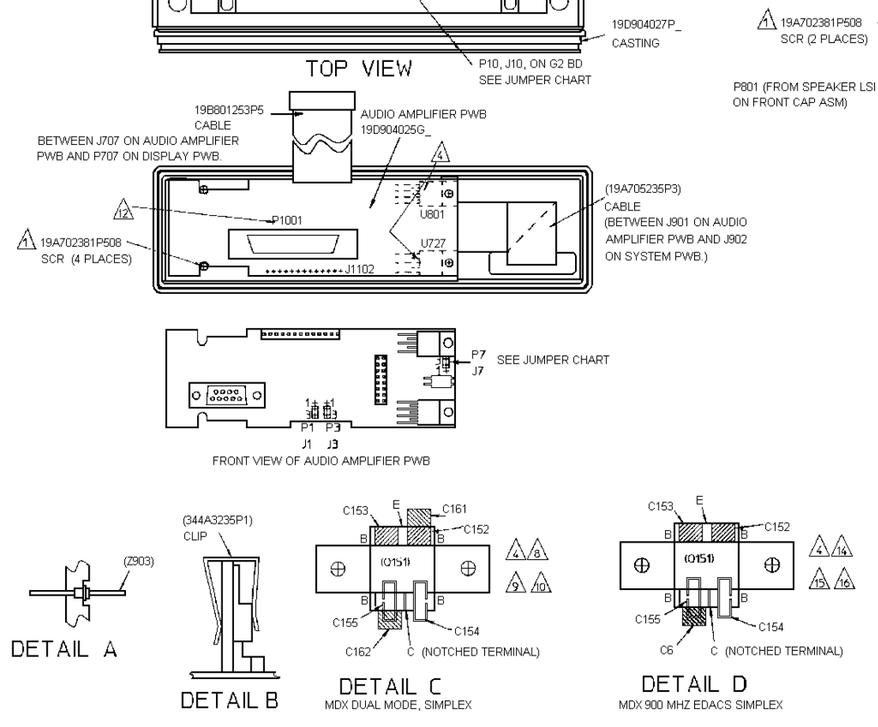
LOGIC SIGNAL FLOW

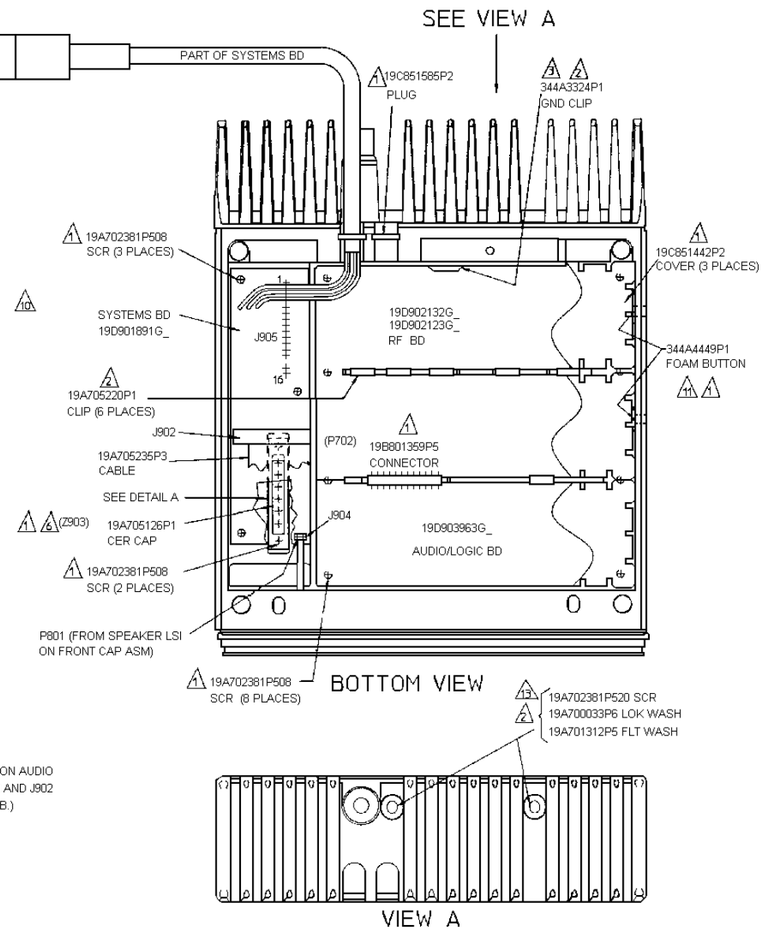
Refer to the Logic Signal Flow Block Diagram to see the distribution of logic signals throughout the radio.

APPENDIX A. GE-MARC TONES

Number	Frequency	Number	Frequency
01	604.2 Hz	22	1556.7 Hz
02	631.5 Hz	23	1628.3 Hz
03	662.3 Hz	24	1717.1 Hz
04	693.0 Hz	25	1795.6 Hz
05	727.1 Hz	26	1877.5 Hz
06	761.3 Hz	27	2051.6 Hz
07	795.4 Hz	28	2143.8 Hz
08	832.9 Hz	29	2239.4 Hz
09	870.5 Hz	30	2341.8 Hz
10	911.5 Hz	31	2447.6 Hz
11	952.4 Hz	32	2556.9 Hz
12	996.8 Hz	33	2672.9 Hz
13	1041.2 Hz	34	2792.4 Hz
14	1089.0 Hz	35	508.6 Hz
15	1140.2 Hz	36	529.1 Hz
16	1191.4 Hz	37	553.0 Hz
17	1243.0 Hz	38	576.9 Hz
18	1304.0 Hz	39	1962.9 Hz(acq)
19	1362.1 Hz	40	2918.7 Hz(alt)
20	1423.5 Hz	41	3051.9 Hz(std)
21	1488.4 Hz	42	466.0 Hz







AUDIO/LOGIC BD JUMPER CHART		
JUMPER	INSTALLATION	NOTES
P1	J1-1&2	BASE BOOST DISABLED
P2	J2-2&3	TX SIDETONE NEG. POLARITY
P3	J910-23 & 24	NO OPTION INSTALLED
P4	J910-25 & 26	NO OPTION INSTALLED
P5	J910-27 & 28	NO OPTION INSTALLED
P6	J910-29 & 30	NO OPTION INSTALLED
P7	J910-31 & 32	NO OPTION INSTALLED
P10	J10-2 & 3	MDX,EXCEPT 900 MHZ
P10	NOT INSTALLED	MDX, 900 MHZ

AUDIO AMPLIFIER BD JUMPER CHART		
JUMPER	INSTALLATION	NOTES
P1	J1-1&2	12V SW PW. CONTROLLED
P3	J3-1&2	MODE SELECT LOW
P7	J7-2&3	SWITCHED SPKR HI AUDIO

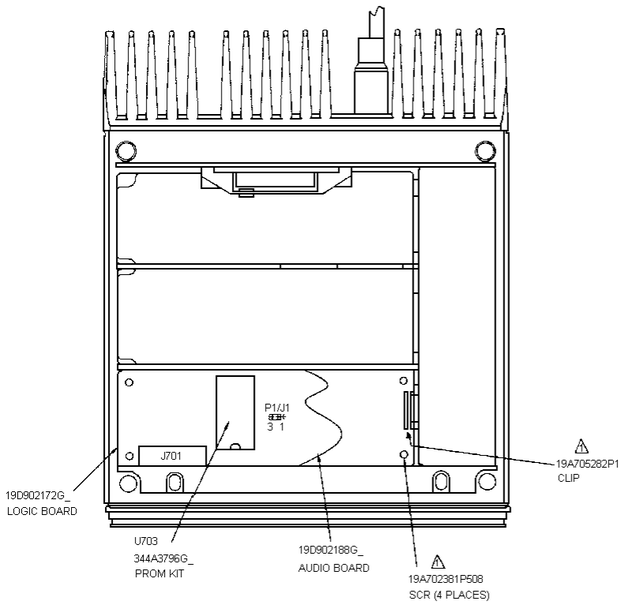
(1) MDX DUAL MODE, SIMPLEX
MDX 900 MHZ EDACS SIMPLEX

NOTES :

1. PART OF MDX MARRIAGE HARDWARE KIT 344A4253G1.
2. PART OF RF BD HARDWARE KIT 344A4255G6 (800MHZ).
   PART OF RF BD HARDWARE KIT 344A4255G8 (900MHZ).
3. INSTALL BETWEEN PWB AND CASTING. SOLDER TO PWB.
4. APPLY SILICONE GREASE (19A701337P1) TO PA MOD, Q101 AND U102 ON RF BD AND Q151 ON PA BD ALSO U801 AND U727 ON AUDIO AMPLIFIER BD.
5. DIP ENDS OF SCREWS THAT GO INTO CASTING IN GREASE (19A115204P1) BEFORE INSTALLING INTO CASTING. TORQUE TO 15 INCH-POUNDS.
6. LUBRICATE Z903 PINS WITH GREASE (19A704532P1).
7. INSTALL U101 FLUSH TO PWB AND FASTEN WITH SUPPORT TO CASTING BEFORE SOLDERING LEADS TO PWB. TOP OF U101 SHALL NOT EXTEND MORE THAN 0.25 ABOVE ADJACENT CASTING.
8. PRE-TIN AREA AROUND Q151 WHERE TRANSISTOR LEADS AND C152 - C155, C161 AND C162 ARE TO BE SOLDERED.
9. SOLDER Q151 LEADS WITH A MINIMUM OF SOLDER TO BD BEFORE INSTALLING CAPACITORS. SOLDER C152 - C155 AGAINST BODY OF Q151 ON TOP OF TRANSISTOR LEADS AS SHOWN BEFORE INSTALLING C161 AND C162 AGAINST C152 AND C155 AS SHOWN.
10. PART OF PA BD KIT 344A4256G10 (800MHZ).
    PART OF PA BD KIT 344A4256G12 (900MHZ).
11. APPLY OVER TWO HOLES ON INSIDE OF CASTING.
12. P1001 PART OF REMOTE MOUNT.
13. WEATHERPROOF HOLES AROUND SCREWS USING RTV162 (19A701648P2).
14. PRE-TIN AREA AROUND Q151 WHERE TRANSISTOR LEADS AND C152-C155 & C6 ARE TO BE SOLDERED.
15. SOLDER Q151 LEADS WITH A MINIMUM OF SOLDER TO BD BEFORE INSTALLING CAPACITORS. SOLDER C152 - C155 AGAINST BODY OF Q151 ON TOP OF TRANSISTOR LEADS AS SHOWN BEFORE INSTALLING C6 AGAINST C155 AS SHOWN.
16. PART OF PA BD KIT 344A4256G12.
17. ROUTE THE TWO PA CABLES AS SHOWN: J103-J153 CABLE THROUGH THE LARGE NOTCH NEAREST HEATSINK. J102-J152 CABLE THROUGH SMALL NOTCH.

* 900 MHZ ONLY

(19D904183 Sh. 1, Rev. 2)



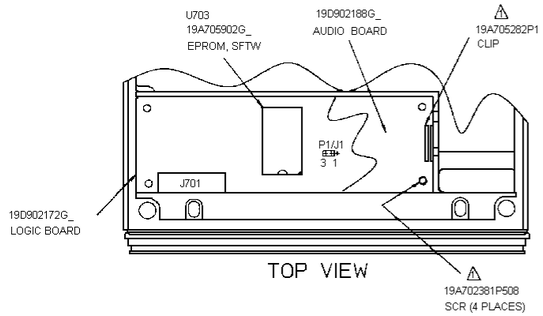
TOP VIEW

(3) MDR DUPLEX GE-MARC ONLY.
SAME AS PART 2 EXCEPT LOGIC BOARD (19D702172) IS ISUED INSTEAD OF THE AUDIO/LOGIC BOARD (19D903963) AND THE AUDIO BOARD (19D902188) IS INSTALLED ABOVE THE LOGIC BOARD AS SHOWN.

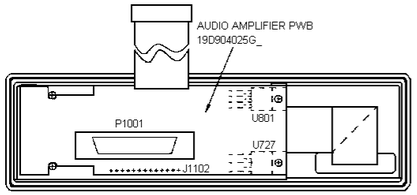
NOTES :

1. PART OF MDX MARRIAGE HARDWARE KIT 344A4253G1.
2. DIP ENDS OF SCREWS THAT GO INTO CASTING IN GREASE (19A115204P1) BEFORE INSTALLING INTO CASTING TORQUE TO 15 INCH-POUNDS.

LOGIC BD JUMPER CHART		
JUMPER	INSTALLATION	NOTES
P1	J1-2&3	DEFAULT POSITION



TOP VIEW



SEE JUMPER CHART

FRONT VIEW OF AUDIO AMPLIFIER PWB

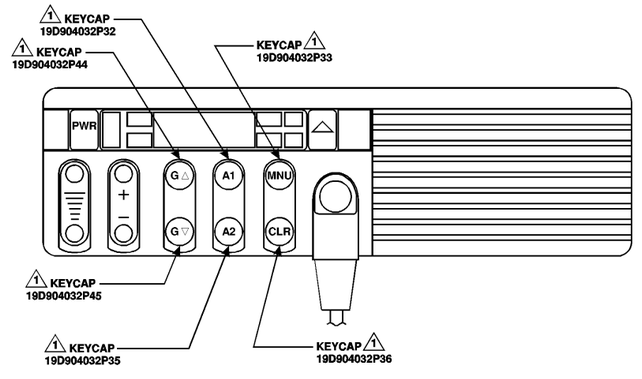
AUDIO AMPLIFIER BD JUMPER CHART		
JUMPER	INSTALLATION	NOTES
P1	J1-2&3	12V SW PW ON
P3	J3-2&3	MODE SELECT LOW
P7	J7-2&3	SWITCHED SPKR HI AUDIO

LOGIC BD JUMPER CHART		
JUMPER	INSTALLATION	NOTES
P1	J1-2&3	SELECT 45.3 MHZ RADIO IF OFFSET (VS 45.0125)

(4) MDX GE-MARC
SAME AS PART 1 (MDX DUAL MODE. SIMPLEX) EXCEPT AS SHOWN.

NOTES :

1. PART OF MDX MARRIAGE HARDWARE KIT 344A4253G1.
2. DIP ENDS OF SCREWS THAT GO INTO CASTING IN GREASE (19A115204P1) BEFORE INSTALLING INTO CASTING TORQUE TO 15 INCH-POUNDS.

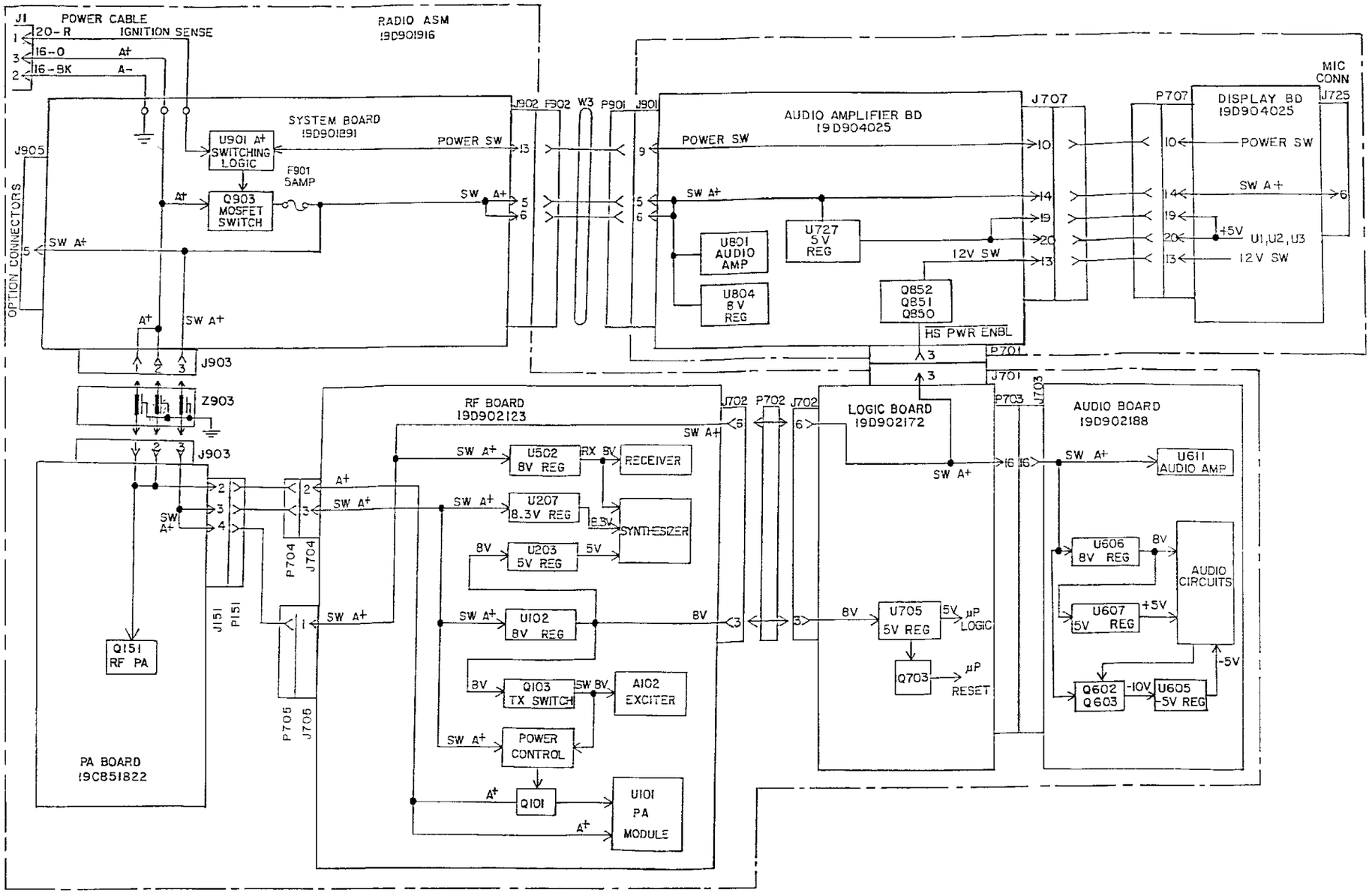


MDX GE-MARC SIMPLEX

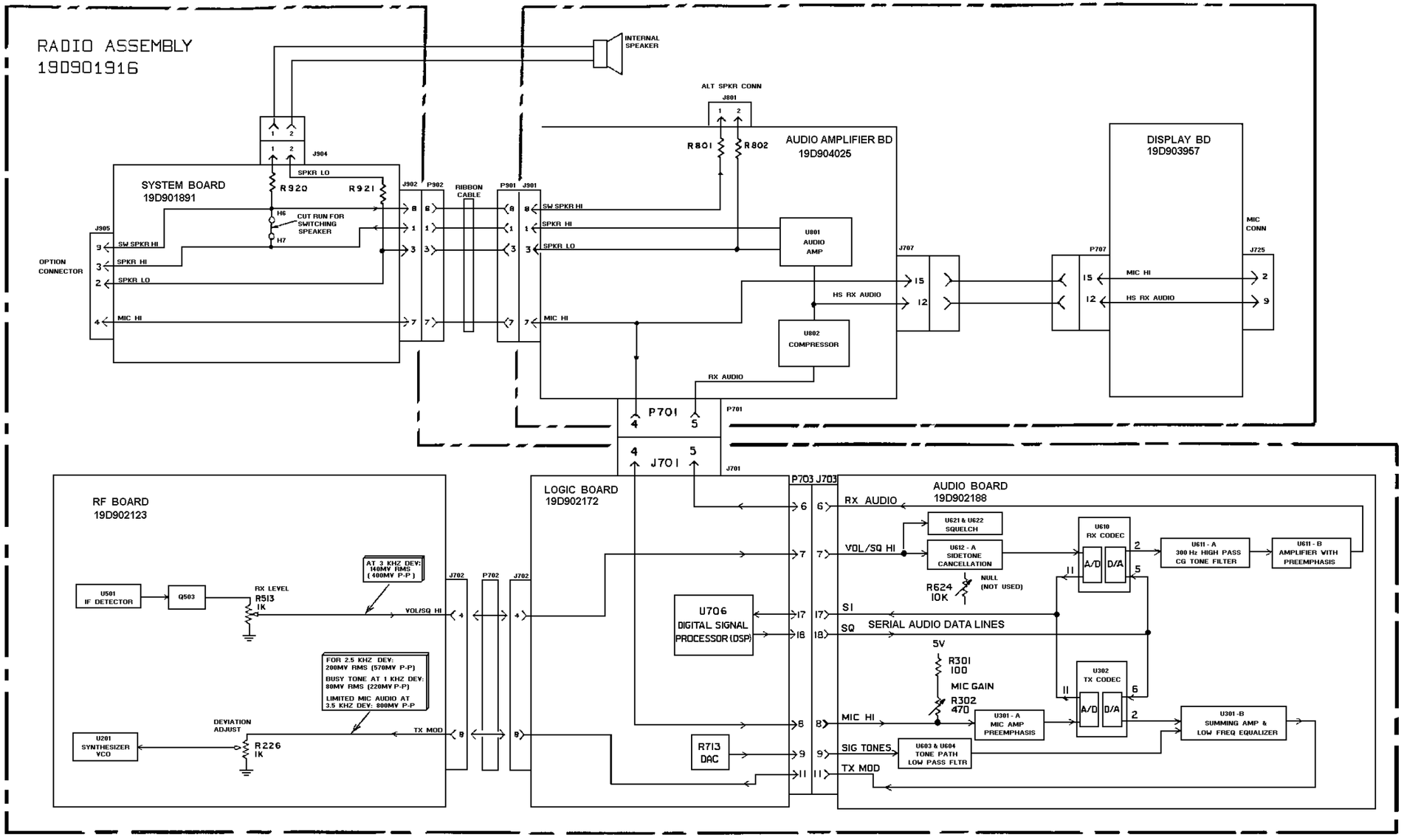
NOTES

1. PART OF KEYCAP KIT 344A4254G1

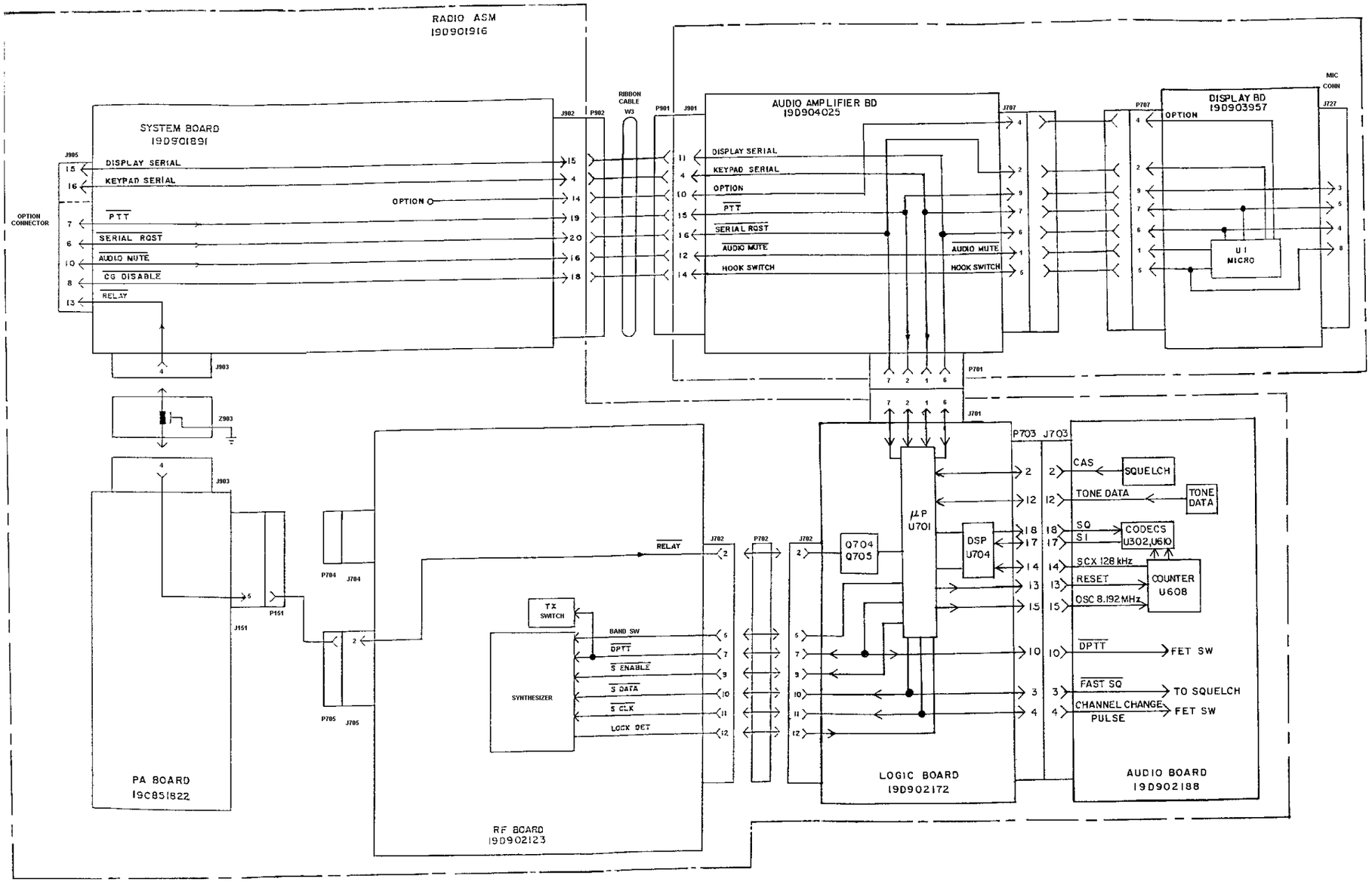
(19D904183 Sh. 5 & 6, Revs. 3 & 3)



MDX GE-MARC 800 MHz
Power Distribution Diagram



MDX GE-MARC 800 MHz
Audio Signal Flow



MDX GE-MARC 800 MHz
Data Control Diagram