MAINTENANCE MANUAL

SERVICE SECTION
800 MHZ TRUNKED MOBILE RADIO

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DESCRIPTION

The Service Section contains the information necessary for aligning and troubleshooting the MDR Series mobile radio. In addition, information is provided for disassembling the radio and replacing chip 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 the complete transmitter alignment, refer to the Transmitter Alignment Procedure.

RECEIVER ADJUSTMENT

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

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.

PREVENTATIVE 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 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.

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.

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 may become coated or poorly grounded; loss of radiation and a weak signal will result.

ALIGNMENT

The transmitter and receiver meter readings should be checked periodically, and the alignment "touched up" when necessary. Refer to the Alignment Procedure in this manual.

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.

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, duplexer, RF board, Audio Board, Logic Board, Duplexer/Interface Board, System Board, and Front Cap Assembly including the Handset/Interface board. Refer to Figure 1, Radio Disassembly.

NOTE

Remove power from the radio before servicing.

TO REMOVE THE TOP COVER

l. Insert a small standard screwdriver under one side of the top cover and gently pry the side of the cover away from the frame releasing the locking tab.

2. Using the screwdriver, press in on the tabs on the rear of the radio and release the two locking tabs.

3. Insert the screwdriver under the other side of the radio top cover, releasing the remaining locking tab, and remove the cover from the radio.

TO REMOVE THE BOTTOM COVER

1. Remove the two screws securing the bottom cover to the radio. (Refer to Figure 1.) The bottom cover can then be removed from the radio.

TO REMOVE THE DUPLEXER ASSEMBLY

1. Remove the bottom cover of the radio.

2. Refer to Figure 2. Remove the single M3.0-0.8 X 20 (#10 drive) TORX screw "A", located on the rear of the radio, that secures the duplexer assembly to the casting.

3. The duplexer can now be removed by disconnecting the SMB connectors from the TX and RX inputs of the duplexer and disconnecting the TNC connector from the ANT port of the duplexer.

NOTE

Servicing the radio while the duplexer is not properly secured may cause electrical shorts. Special care must be taken to ensure that the duplexer does not make contact with any circuitry while power is applied to the radio.

TO REMOVE THE RF BOARD A2

l. Remove the top and bottom covers and the duplexer assembly from the radio (refer to the procedures above).

2. Refer to Figure 3. Pry off the friction fit covers covering the RF Board.

3. Using a small standard screwdriver, gently pry the interconnect plug P702 from the Logic and RF Boards

4. Remove the two clips (Figure 4) 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.

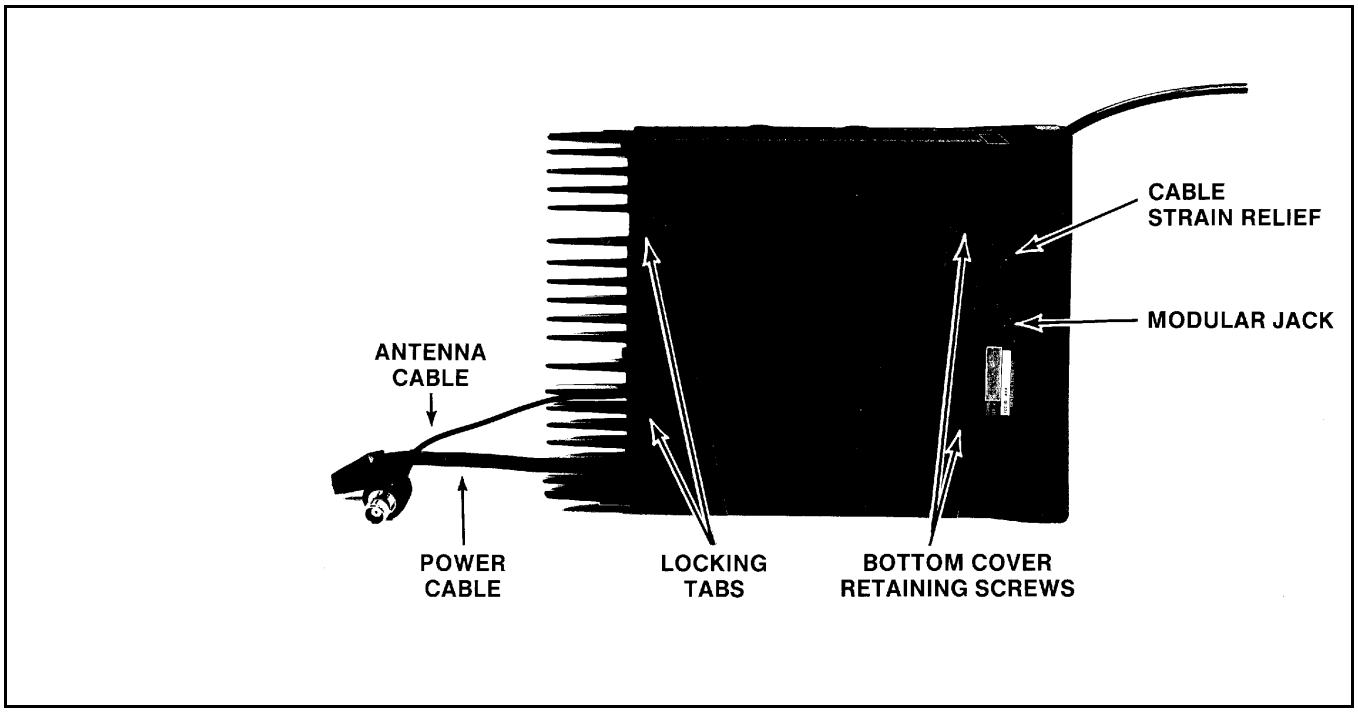

Figure 1 Radio Cover Removal

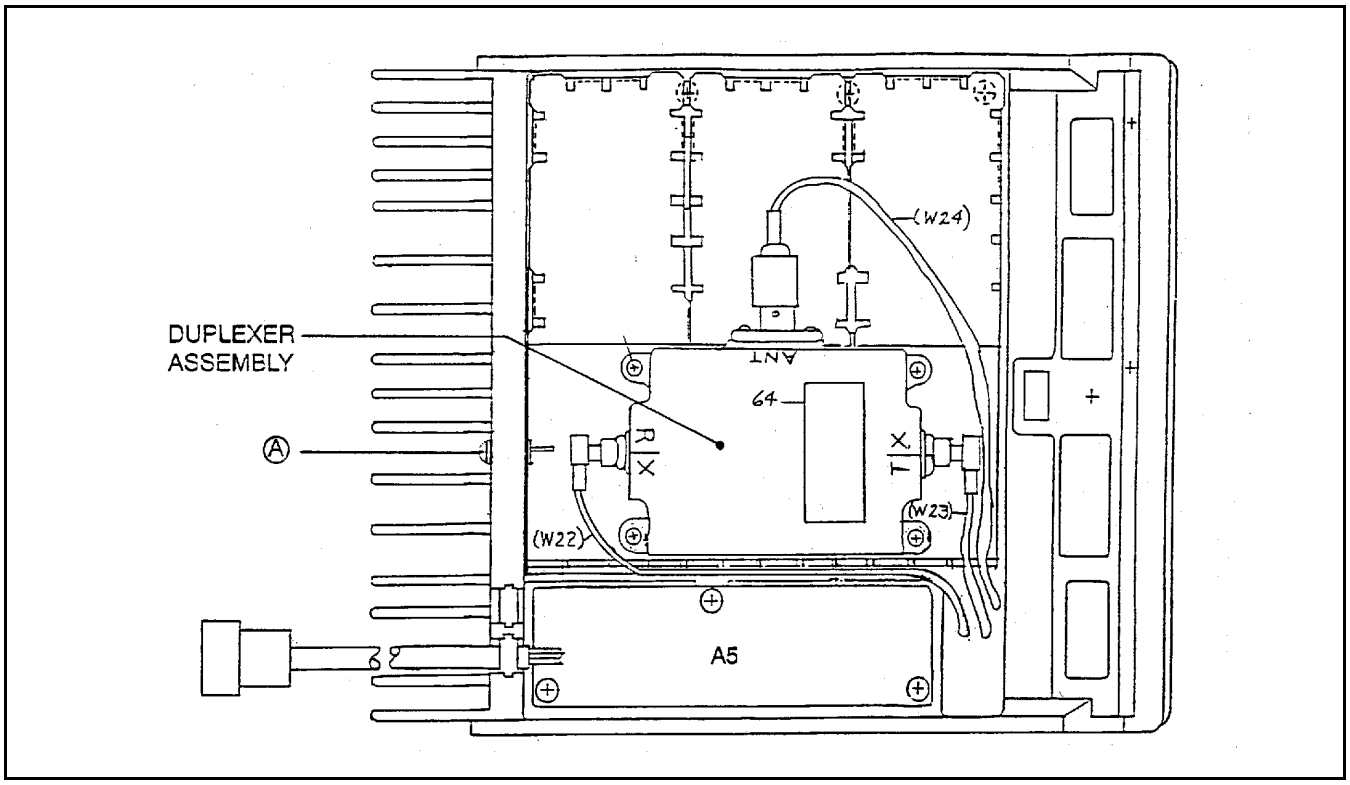

Figure 2 - Bottom View With Duplexer

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

7. Disconnect wires connected to J105, J704, J705 and the cables going to the Duplexer Interface 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 AUDIO BOARD A3

l. Pull out the black clip protruding through the Audio Board which holds the Logic Board 5-volt regulator against the casting.

2. Refer to Figure 4. 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 previously occupied by the clip.

TO REMOVE THE FRONT CAP ASSEMBLY

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

2. Remove the two M3.5-06 x 8 TORX screws (#15 drive) from both sides of the front cap and the TORX screw on the bottom of the front cap.

3. Gently pull the front cap assembly away from the radio exposing the ribbon cable on the rear of the assembly.

TO REMOVE THE LOGIC BOARD A1

l. Remove the top and bottom covers, Front Cap assembly and the Audio Board from the radio. Refer to the disassembly for each, in this section.

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

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

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

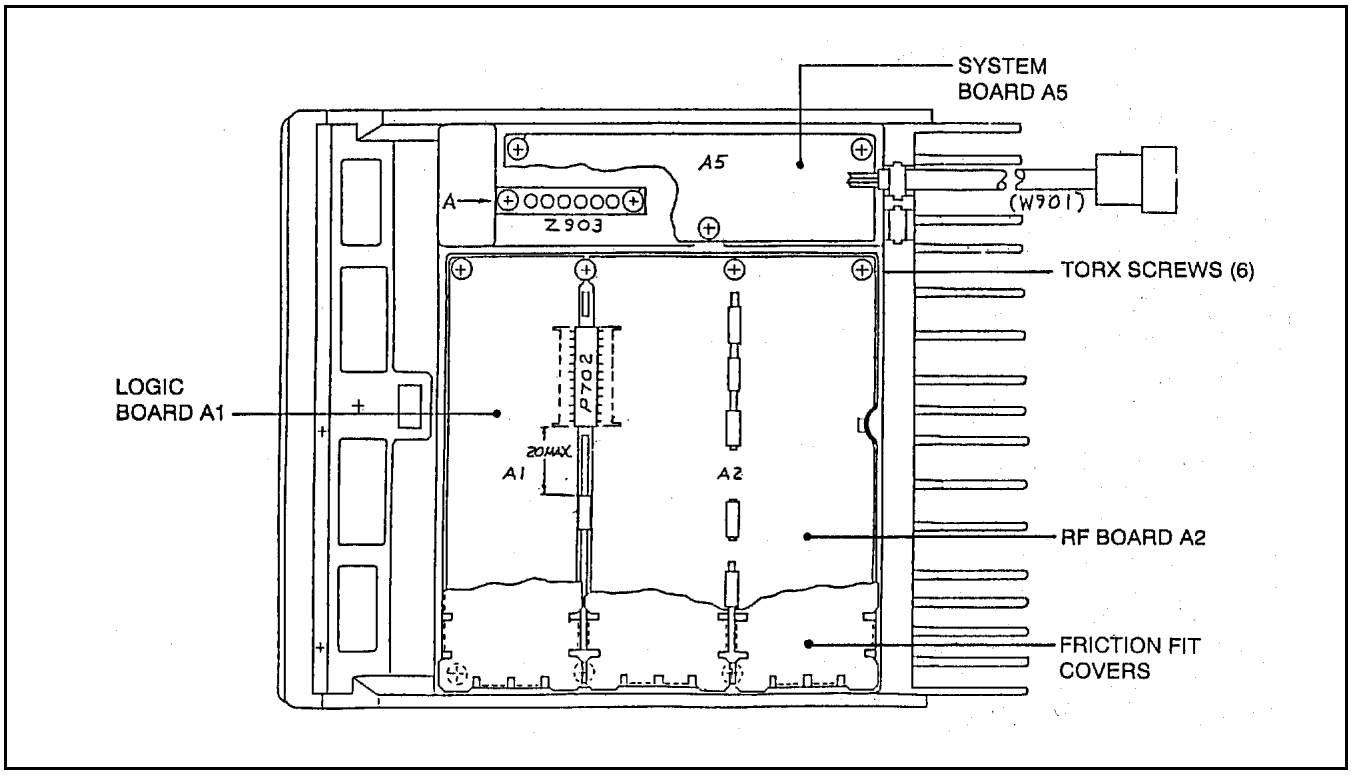

Figure 3 - Bottom View Without Duplexer

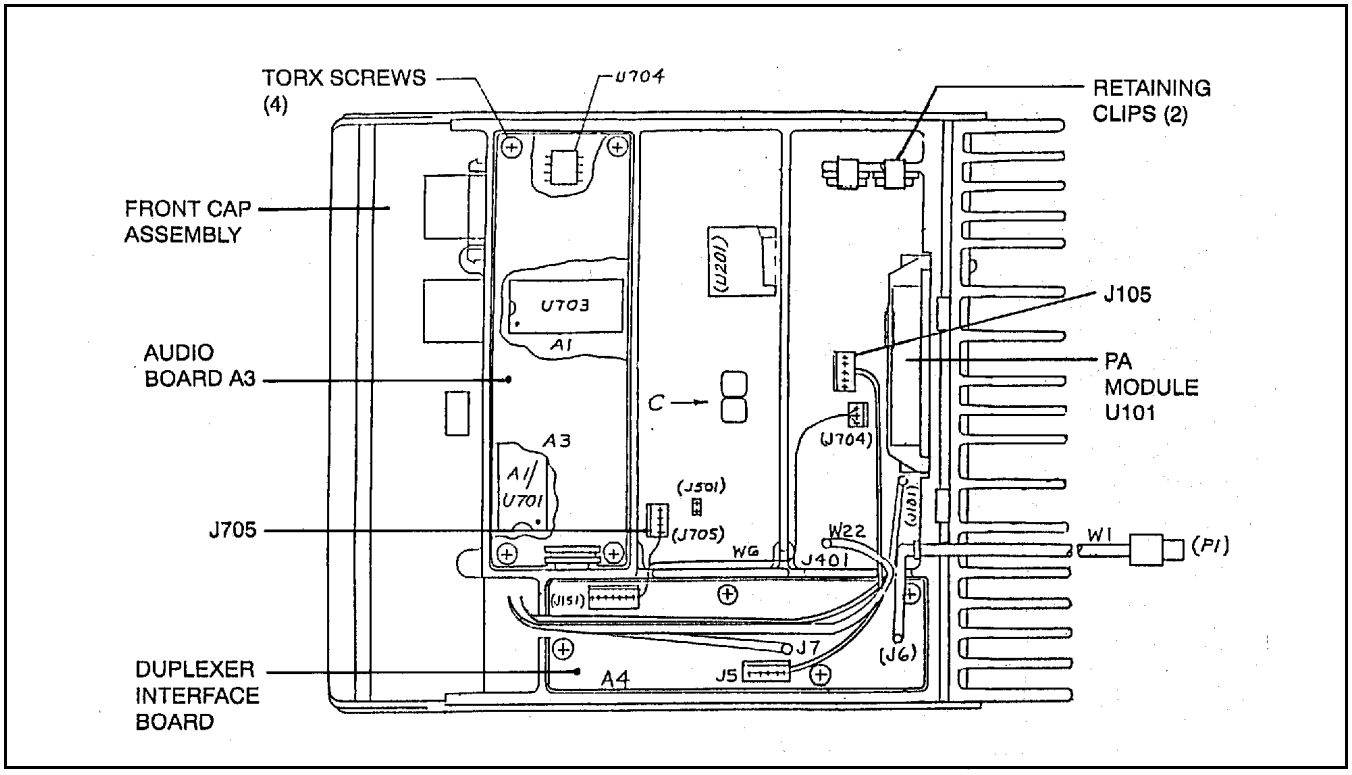

Figure 4 - Top View

TO REMOVE THE DUPLEXER INTERFACE BOARD A4

l. Remove the top cover of the radio. Refer to the procedure above.

2. Disconnect the cables going back to the RF Board.

3. Disconnect the cables from the duplexer.

4. 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, unplugging it from the feed through assembly Z903.

TO REMOVE THE SYSTEM BOARD A5

1. Remove the bottom cover of the radio. Refer to the procedure above.

2. Disconnect the ribbon cable from J902.

3. Disconnect the option cable if used.

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

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

6. Disconnect the ribbon cable from the rear of the assembly. The Front Cap Assembly can then be removed from the radio.

TO REMOVE THE HANDSET INTERFACE BOARD A9

The Front Cap Assembly contains the Handset Interface Board. Remove the Handset Interface Board as instructed below.

1. Remove the clip securing the 3 watt PA (U801) to the front cap casting.

2. Remove the four M3.5-06 x 8 TORX screws (#15 drive) securing the board to the front cap casting. Lift the board out of the front cap.

CHIP COMPONENT REPLACEMENT

The procedure for removing chip components is given below. Replacement procedures for other unique components are located in the related board instruction manual where the component is used (PA module replacement is located in the RF Board manual).

Replacement of chip capacitors should always be done with a temperature controlled soldering iron, operating at 700F (371C). However, **DO NOT** touch black metal film of the resistors or the ceramic body of capacitors with the soldering iron. **NOTE:** The metallized end terminations of the parts may be touched with the soldering iron without causing damage.

CAUTION

The CMOS Integrated Circuit devices used in this equipment can be destroyed by static discharges. Before symbol handling one of these devices, the serviceman should discharge himself by touching the case of a bench 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.

To Remove Chip Components

l. Using two soldering irons simultaneously heat each end of the chip until solder flows, and then remove and discard the chip.

2. Remove excess solder with a vacuum solder extractor.

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 component down on the board.

3. Place the "tinned" soldering iron on the other end of the component and the pad simultaneously. Apply solder to the top of the end of the component until the solder starts to flow. Use as little solder as possible while making a good connection.

4. After the component has cooled, use alcohol to remove all flux from the component and printed wiring board.

TROUBLESHOOTING PROCEDURES

The following information should help isolate a problem to a particular board or circuit. Block diagrams for power distribution and signal flow are provided at the end of this service section. Refer to the appropriate instruction manual for more details.

The MDR radio contains six functionalized boards or assemblies. The major functions provided by each board are listed below to aid in identifying the suspect board.

- RF Board
  - Synthesizer: generates all transmit and receive frequencies
  - Receiver: provides detected audio to the Audio Board
  - Transmitter: includes exciter and 20 watt PA Module
  - Power control circuitry: for the transmitter
- Duplexer Interface or Optional Talk-Around Board
  - DC Power Distribution
  - RF Power Sensing
  - The talk around option also includes the ability to switch the transmitter output to the RX input of the duplexer when a talk-around frequency is selected.
- Audio Board
  - Analog to digital and digital to analog conversion of the RX and TX audio
  - CAS squelch output 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
  - 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 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 Audio Assembly
  - Contains the Handset/Interface Board and 3-watt Amplifier

SELF DIAGNOSTICS/ERROR MESSAGES

The radio performs several self diagnostic checks when power is applied and informs the user of a possible problem within the radio. These tests provide the following error messages on the display:

- PC PROG - No personality. The radio has not been programmed with customer information.
- ERROR 2 - Not used.
- UNLOCK - Synthesizer unlocked. The synthesizer is tested to verify that it will lock in the proper amount of time at various frequencies across the band.
- PROM BAD - EPROM program memory checksum error. If the microprocessor uses external memory, the EPROM has been corrupted or is malfunctioning.

SYMPTOMS AND CHECKS

SYMPTOMS	CHECKS
Handset Blank On Power Up	Check for filtered A+ to the handset on J701. If absent, refer to the power distribution block diagram.
Radio Will Not Go Into Test Mode Operation	The radio must be PC programmed to enable the test mode. Enable it on the options screen.
Low, distorted, or No Rx Audio	Check the receiver VOL/SQ HI output. If audio is improper, the problem is most likely on the RF Board. If 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 Board for proper unmute commands from the Logic Board. Proper commands indicate a a faulty Audio Board.
No Rx Alert Tone	Check the signalling tone output from the Logic board. Operate the volume control. If tones are not present, the Logic board may be faulty.
Poor Rx Sensitivity	Simplex operation: Suspect the RF Board. Check receiver alignment. Refer to the RF Board maintenance manual. Duplex operation: If receiver OK, check for proper grounding of top cover. Also, check lead placement on Duplexer/Talk-around Board.
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 its not OK, check the synthesizer on the RF Board and the synthesizer load commands from the Logic Board. If the commands are not present, a problem on 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 at the signalling tone and busy tone inputs to the Audio Board. If the tones are not present, the Logic Board may be faulty. Tones present - look for the proper unmute commands to the Audio Board from the Logic Board. If the commands are not present, the Logic Board may be faulty. If the commands are present, the Audio Board may be faulty. Missing Voice Signal - Check the mute commands from the Logic Board and the Tx Audio input to the Audio Board. If all signals are correct, the problem is likely a faulty Audio Board. If no signal is present at the Audio board, check the output from the Handset Interface board and handset outputs.

SYPTOMS AND CHECKS (CONTINUED)

SYMPTOMS	CHECKS
Radio Will Not Program When Plugged Into The TG3310 Interface Module	Radio must be turned "on" before programming. Connect the handset and press the on/off power switch.
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 board is likely. Check the mute commands, If incorrect, a faulty Logic board is likely. If the tones are distorted, check the tone generation circuitry on the Logic 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 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 FCN 1 and FCN 3 test mode commands. Modulate the generator with the correct tone sequence and busy tone. If the test fails, check the limited data output from the Audio board. If the data is present, the Logic Board may be faulty. If the data is not present, the Audio Board may be faulty. Tx encode check: Use FCN 08 for the encode test. If the test fails, the Audio or Logic Board may be faulty. Look for proper tones to the Audio Board and proper unmute commands from the Logic board. If all inputs are correct, the Audio board may be faulty. If all inputs are not correct, the Logic Board may be faulty. Tx/Rx/Encode/Decode OK: Check for proper synthesizer switching time. Use FCN 10 for the test. If the switching time is incorrect, the RF Board may be faulty.
Improper Direct Mode	Use the FCN 21 command and check the BANDSWITCH LINE. If the command is correct, the RF Board may be faulty. If the command is incorrect, the Logic board may be faulty. **CAUTION** The radio must be equipped with talk-around option for direct mode operation to work properly. DAMAGE to the radio may occur if the radio is placed in talk-around transmit mode without the talk-around option board installed.

TEST PREPARATION

To test the MDR radio, a test mode must be entered to disable the normal channel scanning mode for GE-MARC operation. The 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 located on the options screen in the PC programming software.

TEST MODE COMMANDS

The test mode enables the technician to exercise test functions in the field using the radio handset. Test mode is entered by pushing the FCN key and then pressing the "**A**" key. The PC Programmer can program the radio to prevent access to field test mode. If so programmed, the radio display will not change when the above sequence is entered.

When test mode is first entered [FSxx #01] appears in the display where xx is the 2 digit number designation of the frequency set that was being scanned and 01 represents the first frequency in that set. If the PTT is pressed, the radio will transmit microphone audio only, and no tone detection will take place because the default tone is OO. When the PTT is released, the radio will "look" for a carrier on the selected channel. If a tone frequency is selected, the selected tone will be transmitted when the PTT is depressed, and if a carrier is received the selected tone will be detected. If the selected tone is detected, the audio to the handset and the external speaker (if installed) will be turned on.

When the on channel carrier is detected the indicator bars will be active and will not be active if an on channel carrier is not present.

Default Conditions

The radio, upon entering test mode, will revert to the first programmed channel in the frequency set that was being scanned when test mode was entered.

NOTE

Test mode cannot be entered from a conventional area. The volume will be set to the level saved after the most recent power down during normal operation. The Tone number is defaulted to 00. [TONE00] All speaker audio paths are unmuted.

Channel Frequency Select

To select a channel other than the frequencies in the current trunked set, press CLR followed by a 2 to 4 digit channel number (10-1208) followed by **"CLR".** The channels can be entered without leading zeros.

For example to select channel 12, enter: **"CLR 12 CLR"** or **"CLR 012 CLR"** or **"CLR 0012 CLR"**

To determine the channel, number use the following formula:

desired frequency = 805.8875 + .0125 ∗ channel number

or channel number = (frequency - 805.8875)/ .0125

= (816.2625 - 805.8875)/ .0125= 830

CAUTION

For channels in the talk-around band 851.0125 thru 865.9875 MHz (ch 3610 - 4808), the bandswitch line must be low (see FCN 21) and the talk around option must be installed.

Operating the transmitter in talk-around mode without the talk-around option board installed can cause damage to the radio.

TEST MODE COMMANDS AND FUNCTIONS

All functions have a 1 or a 3 key entry format. The single entry tests are similar to Classic II. The 3 key entry tests are similar to TMX-8712. The single digit tests use the numeric keypad 1, 3, 4, 6, 7, 9, ∗ & #. The 3 digit entry tests use the "FCN" key followed by the 2 digit test number. Pressing the key or key sequence initiates the action.

The single key commands and their functions are listed below. These commands are invoked using the keypad. A complete description of all commands and their functions follows this listing.

CLR = Start and end delimiter for channel number

END = Turns the transmitter off

RCL	= Reset to default conditions
FCN	= Invoke a new function
STO	= Exit test mode
VOLUP	= Ramp volume up
VOLDN	= Ramp volume down
*	= Frequency set select prompt
1	= Increment to next frequency in set
4	= Decrement to previous frequency in set
7	= Resets to first frequency in set
#	= GEMARC Tone number select prompt
3	= Increments tone number
6	= Decrements tone number
9	= Resets to tone number 00
PTT	= Keys the transmitter

SINGLE KEY TESTS

Frequency Select (CLR)

Select a frequency by entering "**CLR**" followed by a channel number (0000 - 4808), normal band (3610-1208), talk around band, followed by "**CLR**". This function allows the synthesizer to be placed on a channel that is not programmed in the radio. A channel number can be entered with or without leading zeroes.

Stop Transmitter (END)

This **END** key unkeys the transmitter. It **DOES NOT** change the state of the bandswitch line.

Default Conditions (RCL)

RCL key resets the Digital Signal Processor to the do nothing state (i.e RX and TX audio off), sets the microprocessor ports back to default state, resets to the beginning of the frequency set, sets the bandswitch line to the normal band, and displays [FSxx #01].

Mode (STO)

STO returns the radio to the power-up state. I.e. [PASSED] appears in the display and the radio returns to the normal mode of operation.

Volume Up (VOLUP)

The **VOLUP** command causes the radio to increment the volume setting by one step. There are 16 possible steps. The volume setting affects the receive audio and the audible user tones. A visual prompt is seen in the display of the new volume setting ranging from 00 through 15, for example [VOL - 04].

Volume Down (VOLDN)

The **VOLDN** command decrements the volume setting. A visual prompt is seen in the display as described above.

Frequency Set Select (*)

The (*****) command allows the user to select a particular frequency set that is programmed in the radio and set the synthesizer to that channel. The prompt [FSET?] is displayed and the user must enter the two (2) digit index number of the frequency set. This index number is the 2 digit number obtained from the PC programmer printout of the frequency set table. If a frequency set is specified that is greater than the number of frequency sets programmed in the radio, [ERROR] will appear in the display and 3 short beeps will be heard. The first frequency in the frequency set specified is always the default when a new frequency set is selected, for example [FS03 #01] would indicate frequency set 03 and the number 01 element of that set is currently active.

Increment Frequency (1)

The (**1**) command increments the radio to the next frequency in the selected frequency set. If the highest frequency in the frequency set is being displayed the first frequency in the frequency set will be "wrapped around" and displayed.

Decrement Frequency (4)

The (**4**) command decrements the radio to the previous frequency in the selected frequency set. If the active frequency is already the first frequency in the set the radio will wrap around to the highest frequency in the set.

Reset To Frequency 1 (7)

The (**7**) command resets the radio to frequency 1 of the selected frequency set.

Tone Select (#)

The (**#**) command allows any GEMARC tone to be selected. When the key is pressed the prompt [TONE?] is displayed. The user can then enter any number from 00 through 42. Tone numbers 1 through 42 are valid tone numbers. If selected, these tone numbers will be generated when the PTT is depressed, and will be detected when an on channel carrier is received. Tones 1 through 34 are the standard signalling tones. Tones 35 through 38 are the lowest frequency tones. Tone 39 is the acquisition tone. Tones 40 and 41 are standard and alternate busy tones respectively. Tone 42 is the dial tone detect/all channels busy tone. Tones 1 through 39 are transmitted at a high deviation level, while tones 40 through 42 are generated at a low deviation level.

NOTE

Tone 00 means that no tone is encoded and the radio does not look for a tone to decode.

GEMARC TONE TABLE

All GEMARC tones numbers and their respective frequencies are provided in Table 1 below.

Increment Tone (3)

The (**3**) command increments the tone number to the next GEMARC tone. If tone 42 is displayed then the tone wraps around to 00.

Table 1 - GEMARC Tones

NUMBER	FREQUENCY	NUMBER	FREQUENCY
01	604.2 HZ	22	1556.7HZ
02	631.5 HZ	23	1628.3HZ
03	662.3 HZ	24	1717.1HZ
04	693.0 HZ	25	1795.6HZ
05	727.1 HZ	26	1877.5HZ
06	761.3HZ	27	2051.6HZ
07	795.4 HZ	28	2143.8HZ
08	832.9 HZ	29	2239.4HZ
09	870.5 HZ	30	2341.8HZ
10	911.5 HZ	31	2447.6HZ
11	952.4 HZ	32	2556.9HZ
12	996.8 HZ	33	2672.9HZ
13	1041.2HZ	34	2792.4HZ
14	1089.0HZ	35	508.6 HZ
15	1140.2HZ	36	529.1 HZ
16	1191.4HZ	37	553.0 HZ
17	1246.0HZ	38	576.9 HZ
18	1304.0HZ	39	1962.9HZ (acq)
19	1362.1HZ	40	2918.7HZ (alt)
20	1423.5HZ	41	3051.9HZ (std)
21	1488.4HZ	42	466 HZ

Decrement Tone (6)

The (**6**) command decrements the tone number to the previous GEMARC tone. If tone zero is displayed then the tone wraps around to 42.

Reset To Tone 00 (9)

The (**9**) command resets the tone number to 00.

Push-To-Talk (PTT)

When the Push-To-Talk button on the side of the handset is pressed a serial character is sent to the radio. The handset reports when PTT has been pushed and also when PTT has been released. PTT keys the radio.

THREE KEY FUNCTION TESTS

The following tests require that a three key format be entered.

Transmitter On (FCN 0 1)

The **FCN 0 1** function checks the lock detect line of the synthesizer and displays [UNLOCK] if the synthesizer is out of lock. Otherwise the radio displays [XMITON]. The transmitter is keyed at the specified frequency or channel regardless of whether the radio is in the "locked" condition. The transmitter will remain keyed and the IN USE status indicator displayed until any key is pressed. This function allows the user to not have to press the PTT button continuously during testing.

NOTE

During normal operation an UNLOCK condition prohibits the transmitter from being keyed.

Receive Audio On (FCN 0 2)

The **FCN 0 2** function displays [RXAUDON] and turns the received audio on regardless of the carrier or tone detect status.

Receive Audio Off (FCN 0 3)

The **FCN 0 3** function displays [RXAUDOF] and turns the receive audio off regardless of the carrier or tone detect status.

Microphone Audio On (FCN 0 4)

This **FCN 0 4** function displays [MICAUDON] and transmits the signal present on the mic audio path during transmit.

Microphone Audio Off (FCN 0 5)

The **FCN 0 5** function displays [MICAUDOF] and disables the mic audio path during transmit.

Transmit Standard Busy Tone (FCN 0 6)

The **FCN 0 6** function checks the lock detect line of the synthesizer and displays [UNLOCK] if the synthesizer is out of lock. Otherwise the radio will display [STDBSYON]. The transmitter is keyed regardless of an "unlock" condition and continuously transmits the 3051.6 HZ standard busy tone. Pressing any key unkeys the transmitter.

Transmit Alternate Busy Tone (FCN 0 7)

The **FCN 0 7** function checks the lock detect line of the synthesizer and displays [UNLOCK] if the synthesizer is out of lock. Otherwise the radio displays [ALTBSYON]. The transmitter is keyed regardless of an "unlock" condition and transmits the 2918.7 HZ alternate busy tone. Pressing any key unkeys the transmitter.

Transmit GEMARC Tone (FCN 0 8)

The **FCN 0 8** test prompts the user for the GEMARC tone to be transmitted with the [TONE?] prompt. The user then enters the number 00 - 42 of the GEMARC TONE (00 - 42). If the tone number specified is valid the radio checks the synthesizer lock and then immediately keys the transmitter and sends the tone (even if an "unlock" condition exists). If tone 00 is specified the radio will transmit microphone audio only. Pressing any key unkeys the transmitter.

Manual Channel Increment (FCN 0 9)

The **FCN 0 9** function increments the channel number and loads the synthesizer. The radio will then display the number of the channel loaded i.e. [CHAN0340] = channel 340

Across Band Switching (FCN 1 0)

The **FCN 1 0** function displays [SYNTOGLE] and continuously toggles the synthesizer between the first and last channels in the band (806.0125 MHz and 825.9875 MHz).

NOTE

Any key causes the radio to reset to default conditions.

Tone Set Select (FCN 1 1)

The **FCN 1 1** function allows the user to select a tone set that is programmed in the personality prom. It prompts the user with [TN SET?]. The user must then enter the 2 digit number of the tone set in the personality. The display will then verify the tone sequence selected: [02180000] or [23191724].

DTMF Tone (FCN 1 2)

The **FCN 1 2** function transmits the DTMF tone associated with the key pressed (0 - 9,*,#). The user is prompted with [TN PAIR?]. The user must enter the DTMF digit to be sent. (0-9,*,#).

The key and DTMF tone combinations are shown below.

Hz	1209	1336	1477
697	1	2	3
770	4	5	6
852	7	8	9
941	*	0	#
	keypad digit		

Each DTMF tone sequence consists of a LOW tone and a HIGH tone.

Decode Test (FCN 1 3)

The **FCN 1 3** function displays the message [DEC TEST] then begins the multi-group decode of the tone sets that are programmed in the selected area prior to entering test mode. As in the normal mode it will decode the individual decode tone set and the selected group, as well as groups 1, 2 & 3. If one of the tone sets is decoded, the display will be updated with the same name handle that the tone set has in trunked mode. The radio then sounds either the single (group decoded) or dual (individual decoded) note alert. The radio will then return to looking for the busy tone, PTT or another function to be selected. Mic audio will not be present if transmitting.

NOTE

Pressing any key causes the test to abort.

Encode Test (FCN 1 4)

The **FCN 1 4** function displays the tone set sequence that was either the selected group or the tone set selected by FCN 11. The radio will attempt calls on the selected channel. The channel can be selected using either programmed frequency sets or the CLR key method of channel selection. Attempts will not be made on a busy channel. The three note alert tone is sounded and the display will indicate [ENC COMP] if the attempt was successful. The radio will then return to looking for the busy tone, PTT or another function to be selected.Micaudio will not be present if transmitting.

NOTE

Pressing any key causes the test to abort.

Alert Tones (FCN 1 5)

The **FCN 1 5** function displays [ALERTONE] and then sounds the three note call alert tone and then the one second all-channels-busy tone and returns to looking for busy tone, PTT or another function to be selected.

Personality Prom Check (FCN 1 7)

The **FCN 1 7** test displays [PROMTEST] for one second an then displays a 30 second display count of when the test will complete. The test will conclude with [PROM OK] if the EEPROM is good. The test will end at any time a bad location is found and display the following message [PROM BAD]. This is a non-destructive test in that it does not alter the contents of any of the locations in the EEPROM.

Relay Switch (FCN 1 8)

The **FCN 1 8** function displays [RELYTOGL] and is used to toggle the relay (ext. alarm) line at a 1000 HZ rate for board level testing.

NOTE

Any key causes reset to default conditions.

Port Pin Check (FCN 1 9)

The **FCN 1 9** function displays [PORTTOGL] and is used to do a board level test operation of the microprocessor port pins. The port pins will toggle at the rates indicated in Table 2.

Table 2 - Port/Pin Identification

U701 Pin	RATE
2	20 Hz
3	10 kHz
4	5 Hz
5	2.5 kHz
6	1250 Hz
7	625 Hz
8	312 Hz
9	156 Hz
14	78 Hz
15	39 Hz

Software Revision (FCN 2 0)

The **FCN 2 0** test displays the microprocessor software revision. [MDR GRxx] where xx is the revision number in decimal format (i.e. 31 = 3.1)

Band Switch (Direct Mode) (FCN 2 1)

The **FCN 2 1** test displays [BSWCH-0] then pulls the bandswitch line of the VCO low. A talk around channel (3610-4808) must then be loaded using the channel load function (CLR). RCL must be pressed to reset the Bandswitch Line. Normal channels must then be loaded before the synthesizer will lock on channel.

CAUTION

The radio must be equipped with the Talk-Around option for proper direct mode function. Performing direct mode tests on a radio that is not equipped with the Talk-Around transmit option may damage the radio.

Checksum Test (FCN 2 2)

The **FCN 2 2** test performs a checksum test on the program memory. [PROM BAD] is displayed if the check sum fails. [PROM OK] is displayed if the test is successful.

TCXO Low Frequency Modulation Test (FCN 2 3)

The **FCN 2 3** function checks the lock detect line of the synthesizer and displays [UNLOCK] if the synthesizer is out of lock. Otherwise the radio displays [DCG ENC], keys the transmitter (even if an "unlock" condition exists) and continuously transmits a 10 HZ square wave useful in setting the low frequency compensation level to the TCXO (R250). Mic audio is also present. Pressing any key unkeys the transmitter.

Handset Self-Test (FCN 2 4)

The **FCN 2 4** test sends a command to the handset to cause it to go into the self-test mode. The handset will display [SELFTEST] then [RAM PASS] or [RAM FAIL] and then begin a pixel test of the multiplexed display. A test of the backlight [LITE ON] then [LITE OFF] will be performed. The call timer will begin running i.e.[000 00 0]. At this time the handset will display the name of any key (except END) that is pushed, eg. [KEY 4] indicates key 4 is pushed, [KEY STO] indicates the STO key is pressed, etc. Pushing the END key will terminate the self test. At this time [FSxx #01] will be displayed and the handset will return to test mode operation.

Tone Channel Guard Encode (FCN 2 5)

The **FCN 2 5** function checks the lock detect line of the synthesizer and displays [UNLOCK] if the synthesizer is out of lock. Otherwise the radio displays [CG ENC], keys the transmitter (even if an 'unlock' condition exists) and continuously transmits 150 Hz Channel Guard combined with mic audio. Pressing any key unkeys the transmitter.

Tone Channel Guard Decode (FCN 26)

When the **FCN 26** function is selected the radio displays [CG DEC] and looks for an on channel signal modulated with a 210.7Hz tone. If the tone is present the squelch is opened.

RADIO ALIGNMENT PROCEDURE

To align the radio, test mode operation must be used as described in the Test Preparation section. Refer to Figure 5 for location of adjustment controls. Refer to Figures 6, 7, and 8 for Troubleshooting, Control Signal, and Power Distribution Diagrams.

TEST EQUIPMENT AND SERVICE AIDS

The following list of test equipment and service aids is provided to facilitate servicing the radio.

- TQ0618 — Test Interface Box
- TQ3310 — PC Programming Adapter - includes 19D438367G1 Programming Interface Box w/LBI-31986, cable 19B235027P1 (interface to PC computer), and Power Supply 19B800850P2
- TQ3361 — Programming cable - interface to MDR Series radios
- 19A704875P1 — Service Cable - provides an extension between the audio and logic boards to permit servicing both sides of the audio board while powered up
- 19A705235P2 — Service Cable - provides an extension (two feet) between the System and Control Boards. Not required for most servicing if existing cable is not looped through the front of the radio assembly
- 19A801348P4 — Provides a two foot extension between the 9-pin "D" connectors on the Logic and Control boards. Permits servicing all assemblies in the Front Cap Assembly while power is applied
- 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

TRANSMITTER ALIGNMENT

Frequency Set

In test mode, key the transmitter (**FCN 0 1**) and measure the transmit frequency. The frequency should be within ±250 Hz of the test mode channel frequency. If not, adjust U204 to within ±100 Hz. (Push **END** to turn off the transmitter.)

NOTE

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

Normal Mode Modulation Set

1. Apply a 1kHz, 300 mVrms signal to the TX AUDIO input of the test box (TQ0618).
2. Select channel 649 (**CLR 6 4 9 CLR**) at 814.000 MHz. Turn on the TX audio (**FCN 0 4**). Turn on the Tone Channel Guard (**FCN 2 5**) which also keys the transmitter. Adjust the modulation pot R254 for 4.2 +0.1, -0.2 kHz deviation.

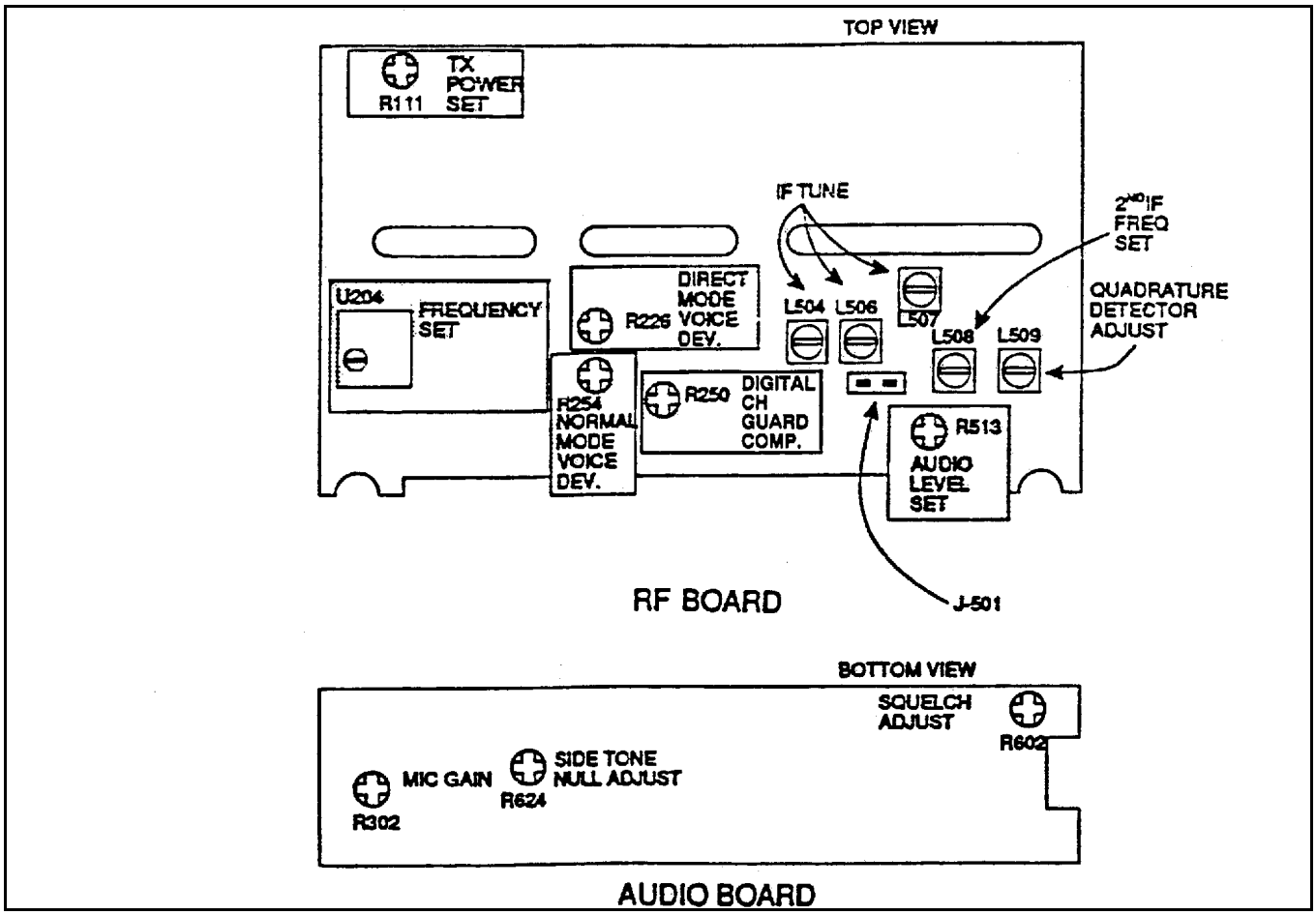

Figure 5 - Tuning and Adjustment Control Location

Direct Mode Modulation Set (for radios with the talk-around option installed)

1. Apply a 1kHz, 300 mVrms signal to the TX AUDIO input of the test box (TQ0618).
2. Set the Bandswitch line low (**FCN 2 1**).
3. Select a talk-around channel 4249 (**CLR 4 2 4 9 CLR**) at 859.000 MHz. Turn on the TX audio (**FCN 0 4**). Turn on the Tone Channel Guard (**FCN 2 5**) which also keys the transmitter. Adjust the modulation pot R226 for 4.2 +0.1, -0.2 kHz deviation.

NOTE

Pressing **RCL** resets the radio back to the first frequency in the frequency set and also sets the bandswitch line high.

Transmitter Power Set

1. While on channel 649, key the transmitter (**FCN 0 1**), and adjust R111 in the power control circuit for 11 watts.
2. Push **END** to unkey the transmitter.

RECEIVER ALIGNMENT

Frequency Set

1. Verify that the transmitter is on frequency as described in the transmitter alignment above.
2. Inject a strong, unmodulated on channel signal (-60dBm) 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 with an AC voltmeter and inject an on channel signal at the antenna jack modulated with a 60Hz ramp at 5 kHz deviation.

> **NOTE**
>
> A 1 kHz tone may be used if a 60Hz ramp is not available

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

3. Repeak the coils.

Quadrature Detector Adjustment

1. Inject a strong on channel signal at the antenna jack modulated with a 1 kHz tone at 3 kHz deviation.

2. Monitor the **VOL/SQ HI** output at J705-3 with an AC voltmeter and adjust L509 for a peak 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 kHz deviation.

2. Monitor **VOL/SQ HI** J705-3 with an AC voltmeter and adjust R513 for a reading of 150 mVrms. Alternatively, the RX AUDIO jack of the test box can be monitored when the Volume has been adjusted to VOL=10. R513 may be adjusted for a reading of 215 mVrms. A+ supply current should be less than 600 mA.

> **NOTE**
>
> The external speaker must be disabled otherwise higher supply currents will be measured.

Sidetone Adjustment

The following adjustment requires duplex operation. The RF signal generator must be isolated from the transmitter RF power by connecting a 15 watt 30dB attenuator or other isolation device in series with the RF signal generator.

1. Inject a strong on channel signal modulated by 1 kHz tone at 3 kHz deviation at the RF input.

2. Turn the RX audio on (**FCN 0 2**) and set the volume at maximum. Measure the RX audio output at the RX AUDIO jack of the test box (J701-5) which should be 215 mVrms.

3. Turn off the 1 kHz modulation while leaving on the RF generator signal.

4. Apply a 1 kHz tone to the TX Audio input at TX MOD jack of the test box (J701-4). Turn on the TX audio (**FCN 0 4**) and key the transmitter (**FCN 0 1**). Adjust the 1 kHz tone level for 3 kHz deviation.

5. Turn on the RX audio (**FCN 0 2**) and rekey (**FCN 0 1**). Measure the RX audio output and adjust R624 on the Audio Board for a null. The null should be less than 27 mVrms (< -18 dB down from the 215 mVrms reference taken above). Push **END** to unkey the transmitter.

TRANSMITTER VERIFICATION

Place the radio in the test mode for the following tests (**FCN A**).

Transmit Frequency

Key the transmitter (**FCN 0 1**) and measure the transmit frequency (default test mode channel is the first frequency in the trunk frequency set from which test mode was entered). The measured frequency should be within ±250 Hz. (Push **END** to unkey the transmitter.)

Transmit Power

Select channel 649 (**CLR 6 4 9 CLR**) at 814.0000 MHz. Key the transmitter (**FCN 0 1**). Power should be a minimum of 10 watts. (Push **END** to unkey the transmitter.)

Modulation Limiting

1. Apply a 1 kHz tone at 300 mVrms to the TX AUDIO input of the test box or J701-4.

2. Select channel 649 (**CLR 6 4 9 CLR**) at 814.0000 MHz. Turn on the TX audio (**FCN 0 4**). Turn on the channel guard tone (**FCN 2 5**) which also keys the transmitter.

3. The measured deviation should be 4.2 ±0.2 kHz. (Push **END** to unkey the transmitter.)

4. Select channel 649 (**CLR 6 4 9 CLR**) at 814.0000 MHz. Turn on the TX audio (**FCN 0 4**). Turn on the busy tone (**FCN 2 5**) which also keys the transmitter.

5. The measured deviation should be 4.5 ±0.2 kHz. (Push **END** to unkey the transmitter.)

Busy Tone Deviation

1. Select channel 649 (**CLR 6 4 9 CLR**) at 814.0000 MHz. Turn on the busy tone which also keys the transmitter (**FCN 0 6**).

2. The measured deviation should be 1 kHz +0.2, -0.3 kHz.

RECEIVER VERIFICATION

SINAD

1. Apply a RF generator to the antenna jack at 851.0125 MHz modulated with a 1 kHz tone at 3 kHz deviation. Set the RF level to -113 dBm.

2. Check for greater than 12 dB SINAD on channel 10 (**CLR 1 0 CLR**) at the RX AUDIO output J701-5.

3. Repeat the test for channel 649 at 859.0000 MHz and channel 1208 at 865.9875 MHz.

Audio Output

1. Apply a strong (-60 dBm) on channel signal modulated with a 1 kHz tone at 3 kHz deviation.

2. Set the volume at maximum. Monitor the RX AUDIO jack on the test box or J705-6. The output level should be approximately 215 mVrms with less than 5% distortion.

Duplex Receive Sensitivity

The following test requires a completely assembled radio with all covers in place. A calibrated attenuator pad (30 dB, 15 watts) must be placed between the radio's antenna jack and the RF signal generator to isolate the RF generator from the transmitter power.

1. Set the RF generator to 851.0125 MHz and the radio to channel 10 (**CLR 1 0 CLR**). Turn on 1 kHz tone at 3 kHz deviation. Adjust the RF level so -113 dBm will appear after the attenuator at the radio's antenna jack.

2. Turn on the transmitter (**FCN 0 1**). Measured SINAD should be greater than 12 dB.

3. Push **END** to unkey the transmitter. Repeat the above test for channel 649 at 859.0000 MHz and channel 1208 at 865.9875 MHz.

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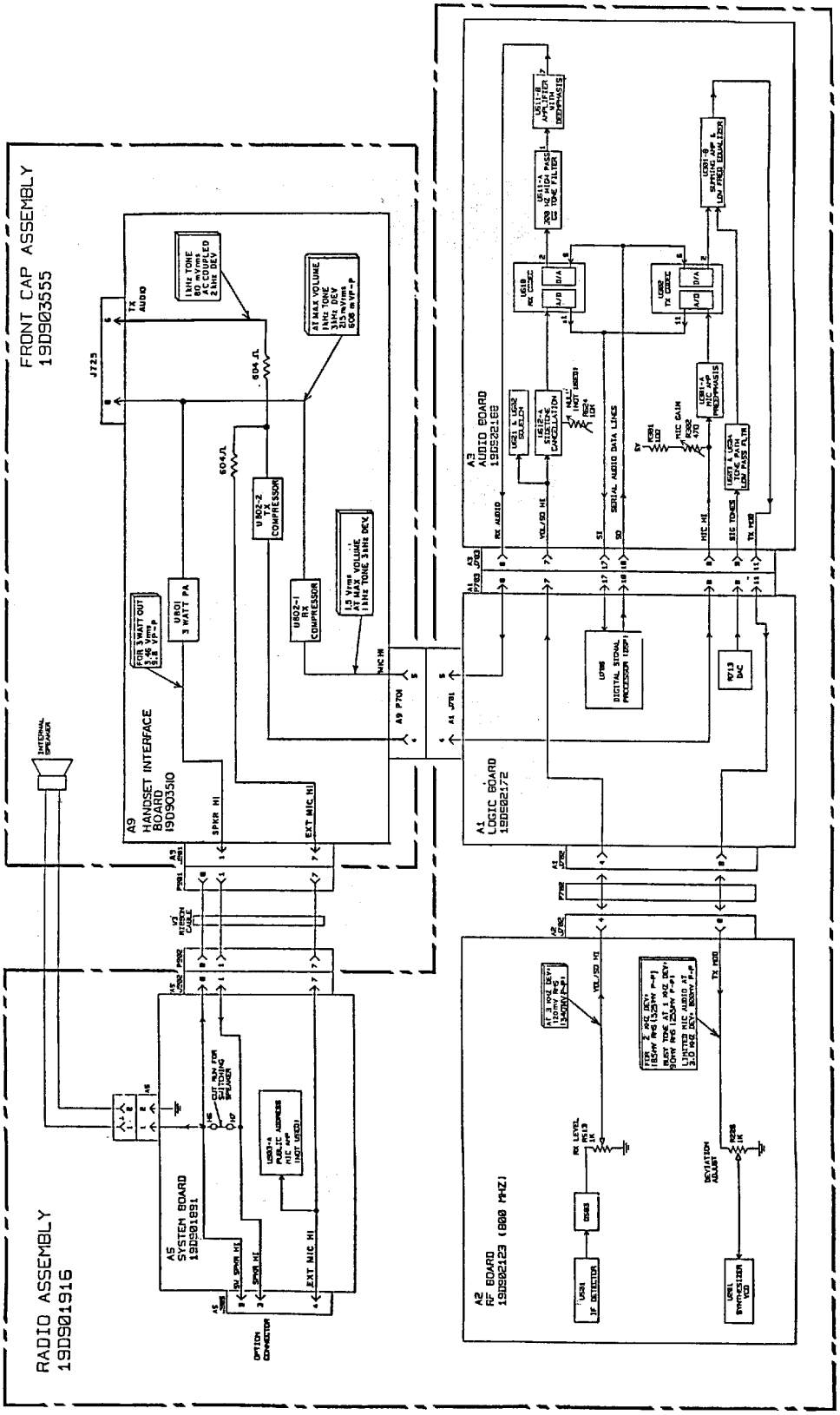

Figure 6 - Audio Signal Flow Diagram

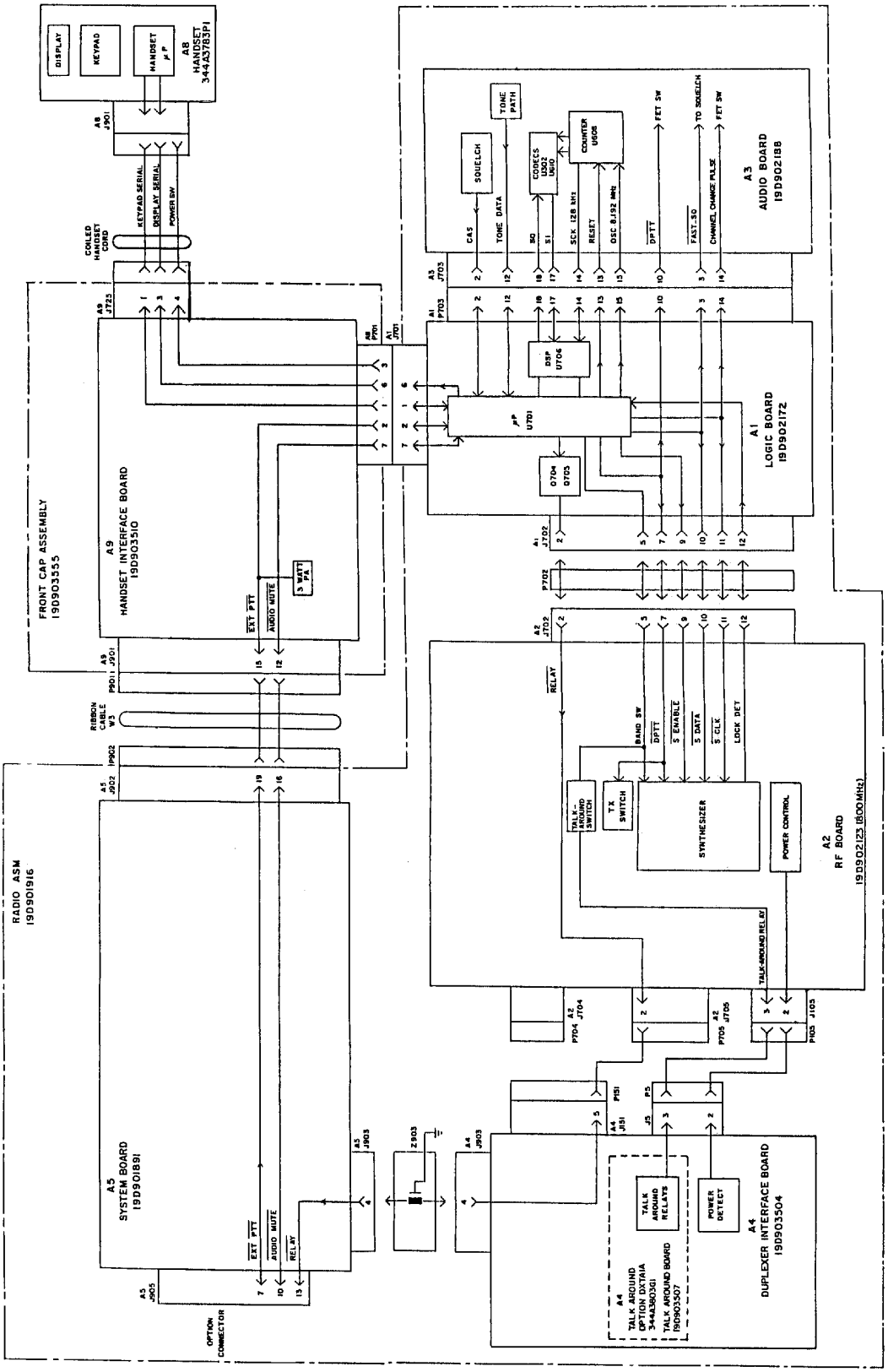

Figure 7 - Control Signal Flow Diagram

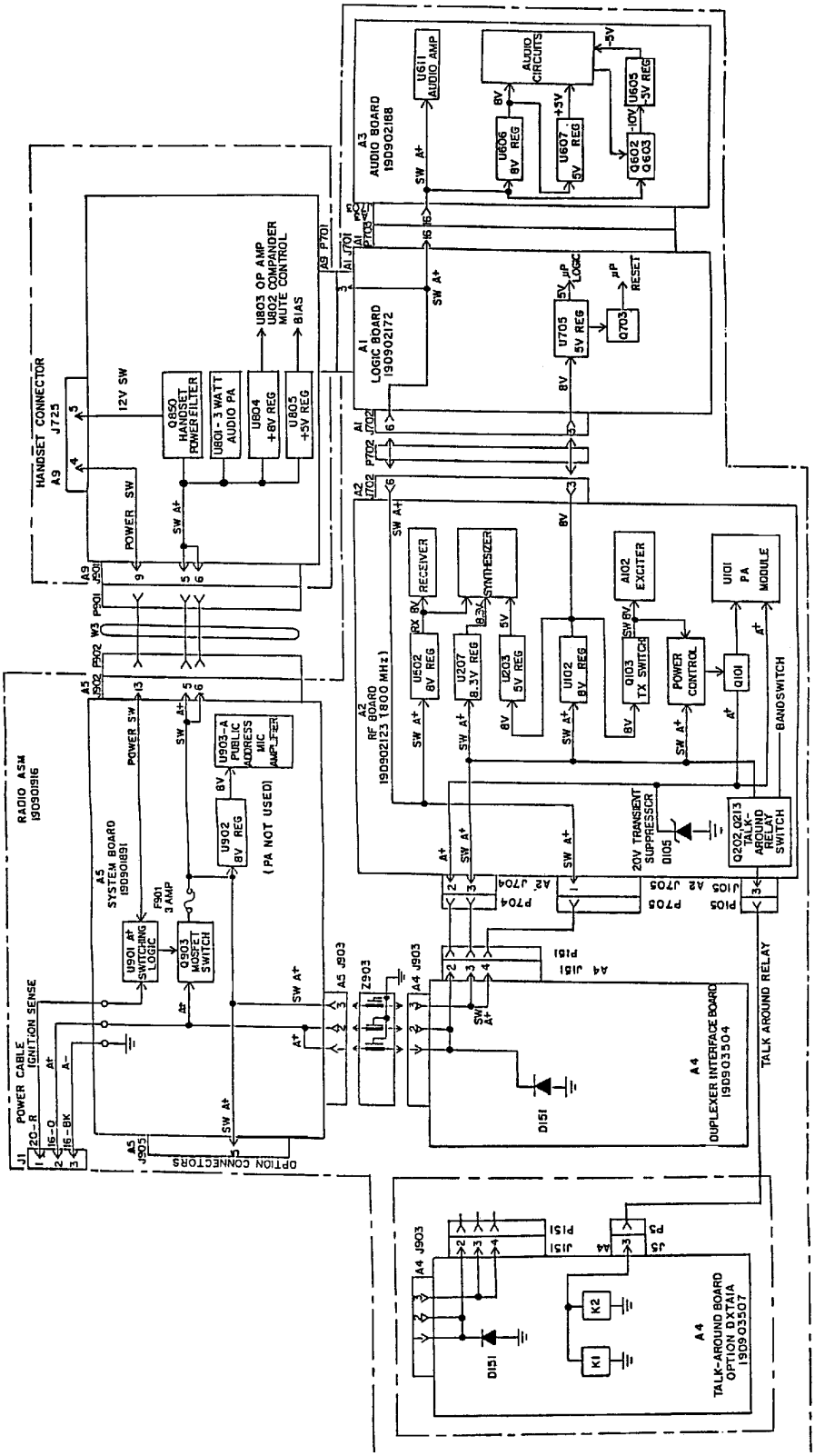

Figure 8 - Power Distribution Diagram