GENERAL:

This revision outlines changes that have occurred since the printing of your service manual. Use this information to correct your manual.

INSTRUCTION MANUAL AFFECTED:

6880904Z96-A  M1225 Mobile Radio Service Manual

REVISION DETAILS:

1. This supplement contains the new VHF, 10-25 W, 150-170 MHz radio models with new model charts, and revised specifications and theory of operation pages. In addition, the circuit board details, schematic diagrams and parts list have also been supplied. Please refer to the attached pages.

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# Model Charts

## M1225

**20-Channel VHF Mobile Radio**

150 - 170 MHz

10-25 Watts RF Power

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>X</td>
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<td>X</td>
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</tbody>
</table>

### Note:
Main board kits are not available separately for field replacement
M1225
4-Channel
VHF Mobile Radio
150 - 170 MHz
10-25 Watts RF Power

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Item</th>
<th>Item</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>HUD3253_ Radio, 12.5/25 kHz, 10-25 W</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>X</td>
<td>HMN3008_ Microphone</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>X</td>
<td>HLN9154_ Non-Locking Bracket</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>HKN4137_ Power Cable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>HLN9893_ M1225 4-Channel Manual Kit</td>
<td></td>
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**Note:** Main board kits are not available separately for field replacement.
# Specifications

## GENERAL

<table>
<thead>
<tr>
<th></th>
<th>VHF</th>
<th>UHF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model Series:</td>
<td>M33DGC</td>
<td>M43DGC</td>
</tr>
<tr>
<td>Frequency Range:</td>
<td>150-170 MHz</td>
<td>150-174 MHz</td>
</tr>
<tr>
<td>Channel Spacing:</td>
<td>12.5 kHz &amp; 20/25/30 kHz</td>
<td>12.5 kHz &amp; 20/25 kHz</td>
</tr>
<tr>
<td>Dimensions:</td>
<td>H 1.73&quot; X W 6.61&quot; X D 4.25&quot; (H 44mm X W 168mm X D 108mm)</td>
<td></td>
</tr>
<tr>
<td>Weight:</td>
<td>36 oz. (1.02kg)</td>
<td></td>
</tr>
<tr>
<td>Channel Capacity:</td>
<td>20 or 4 Channels</td>
<td></td>
</tr>
<tr>
<td>Freq. Separation:</td>
<td>24 MHz</td>
<td></td>
</tr>
<tr>
<td>Input Voltage:</td>
<td>13.6 ±10%</td>
<td></td>
</tr>
<tr>
<td>Current Drain:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standby</td>
<td>300 mA</td>
<td></td>
</tr>
<tr>
<td>Receive @Rated Audio</td>
<td></td>
<td>1.5 A</td>
</tr>
<tr>
<td>Transmit</td>
<td>7 A @ 25 W, 12.5 A @ 40 W</td>
<td>12.5 A @ 40 W</td>
</tr>
<tr>
<td>Squelch Capabilities:</td>
<td>Tone Coded, Digital Coded and/or Carrier Squelch</td>
<td></td>
</tr>
</tbody>
</table>

## TRANSMITTER

<table>
<thead>
<tr>
<th></th>
<th>VHF</th>
<th>UHF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freq. Stability (-30°C to +60°C):</td>
<td>±0.00025%</td>
<td></td>
</tr>
<tr>
<td>Spurs/Harmonics:</td>
<td>-23 dBm (5 μW)</td>
<td></td>
</tr>
<tr>
<td>Audio Response*</td>
<td>+1/-3 dB, relative to 6 dB/octave pre-emphasis, 300-3000 Hz (2550 Hz @ 12.5 kHz)</td>
<td></td>
</tr>
<tr>
<td>FCC Designation:</td>
<td>ABZ99FT3038, ABZ99FT3037</td>
<td>ABZ99FT4044, ABZ99FT3038</td>
</tr>
<tr>
<td>FCC Modulation:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20/25/30 kHz</td>
<td>16K0F3E</td>
<td>16K0F3E</td>
</tr>
<tr>
<td>12.5 kHz</td>
<td>11K0F3E</td>
<td>11K0F3E</td>
</tr>
<tr>
<td>Output Impedance:</td>
<td></td>
<td>50 ohms</td>
</tr>
<tr>
<td>Modulation Sensitivity:</td>
<td></td>
<td>80 mV rms for 60% deviation @ 1000 Hz</td>
</tr>
<tr>
<td>FM Noise:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20/25/30 kHz</td>
<td>45 dB</td>
<td>40 dB</td>
</tr>
<tr>
<td>12.5 kHz</td>
<td>40 dB</td>
<td>35 dB</td>
</tr>
<tr>
<td>Audio Distortion:</td>
<td></td>
<td>&lt;3% EIA (@1000 Hz, 60% of Rated Max. Deviation)</td>
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## RECEIVER

<table>
<thead>
<tr>
<th></th>
<th>VHF</th>
<th>UHF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freq. Stability (-30°C to +60°C):</td>
<td>±0.00025%</td>
<td></td>
</tr>
<tr>
<td>Sensitivity TIA @ 12 dB SINAD:</td>
<td>0.35 μV</td>
<td>0.30 μV</td>
</tr>
<tr>
<td>Squelch (internally pre-set):</td>
<td>10 dB SINAD</td>
<td></td>
</tr>
<tr>
<td>Selectivity TIA:</td>
<td>65 dB</td>
<td>75 dB</td>
</tr>
<tr>
<td>Intermodulation TIA*:</td>
<td>65 dB</td>
<td>75 dB</td>
</tr>
<tr>
<td>Spurious Rejection:</td>
<td>75 dB</td>
<td>70 dB</td>
</tr>
<tr>
<td>Image / Half IF Rejection:</td>
<td>70 dB</td>
<td></td>
</tr>
<tr>
<td>Audio Output:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 ohms (external)</td>
<td>7.5 W @ 5% distortion</td>
<td>4.0 W Nominal</td>
</tr>
<tr>
<td>16 ohms (internal)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Impedance:</td>
<td>50 ohms</td>
<td></td>
</tr>
<tr>
<td>TIA Usable Bandwidth:</td>
<td>1.2 kHz</td>
<td>2 kHz</td>
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</tbody>
</table>

* Local mode adds 10 dB protection against wideband interference.

## MILITARY STANDARDS 810 C, D & E FOR MOUNTING ACCESSORIES

<table>
<thead>
<tr>
<th>Applicable MIL-STD</th>
<th>Required Mounting Accessory</th>
<th>810C</th>
<th>810D</th>
<th>810E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibration:</td>
<td>Standard Non-Locking Bracket</td>
<td>514.2</td>
<td>8</td>
<td>514.3</td>
</tr>
<tr>
<td>Shock:</td>
<td>Standard Non-Locking Bracket</td>
<td>516.2</td>
<td>1, 3</td>
<td>516.3</td>
</tr>
<tr>
<td>Crash Hazard:</td>
<td>Any M1225 Mounting Accessory</td>
<td>516.2</td>
<td>3</td>
<td>516.3</td>
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</table>

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

MMR-128

(Page 6 is blank)
Section 2
Theory of Operation

Overview
This section provides detailed theory of operation for the components of the M1225 mobile radio.

Receiver Circuitry

VHF Receiver Front End

The received signal applied to the radio's antenna input connector is routed through the harmonic filter and PIN diode antenna switch. In the receive mode, PIN diodes CR2450 and CR2451 are both off, allowing the signal to pass unattenuated to the receiver front end filter. The insertion loss of the harmonic filter/antenna switch is less than 1 dB. The harmonic filter provides 19 dB attenuation for image protection at 240 MHz, with increased attenuation at higher frequencies.

The signal is routed to a fixed-tuned 4 pole capacitive-coupled resonator filter having a 3 dB bandwidth of 50 MHz and a 1 dB bandwidth of 45 MHz centered at 162 MHz. Insertion loss is 1.7 dB. Attenuation for image protection is 42 dB at 240 MHz, with increasing attenuation at higher frequencies.

The output of the filter is matched to the base of RF amplifier Q1, which provides 19 dB of gain and has a noise figure of 3 dB. Current source Q2 is used to maintain the collector current of Q1 constant at 30 mA. Transistors Q1 and Q2 are supplied from the 5R source. This source is switched by transistor Q412 which is controlled by U401-54. 5R is only present in the receive mode. This reduces dissipation in Q1 during transmit. Diode CR1 clamps excessive input signals, protecting Q1.

The output of Q1 is applied to a fixed-tuned 3 pole series-coupled resonator filter having a 3 dB bandwidth of 60 MHz and a 1 dB bandwidth of 45 MHz centered at 162 MHz. Insertion loss is 1.3 dB. Attenuation for image protection is 35 dB at 240 MHz, with increasing attenuation at higher frequencies.

A pin diode attenuator is located between the 3-pole filter and the first mixer. The bias current through this diode is switched by dual-composite transistor switch U2. In the Distance mode, U2 is turned on by a logic high at U2-4 from U401-57. CR2 is forward-biased which bypasses R11, and no loss is introduced. In the Local mode, U2 and CR2 are off (U401-57 is low), inserting 10 dB of attenuation due to R11. Because the attenuator is located after the RF amplifier, receiver sensitivity is reduced only by 5 dB, while the overall third order input intercept is raised by 15 dB. Thus, the Local mode significantly reduces the susceptibility to IM-related interference.

The first mixer, U1, is a passive, double-balanced type. This mixer provides all of the necessary rejection of the half-IF spurious response, since the improvement due to filter selectivity is negligible at 150 MHz. High-side injection at +6 dBm is delivered to the first mixer from the injection buffer, Q271, in the VCO/buffer circuit.

The mixer output is connected to a diplexer network which matches its output to the first two pole crystal filter, Y51A, at the IF frequency of 44.85 MHz, and terminates it in a 51 ohm resistor, R51, at all other frequencies.

UHF Receiver Front End

The received signal applied to the radio's antenna input connector is routed through the harmonic filter and PIN diode antenna switch. In the receive mode, PIN diodes CR2650 and CR2651 are both off, allowing the signal to pass unattenuated to the receiver front end filter. The insertion loss of the harmonic filter/antenna switch is less than 1 dB.

The signal is routed to a fixed-tuned 3 pole shunt resonator filter having a 3 dB bandwidth of 65 MHz and a 1 dB bandwidth of 40 MHz centered at 462 MHz. Insertion loss is 2.0 dB. Attenuation for image protection is 33 dB at 385 MHz, with increasing attenuation at lower frequencies.

The output of the filter is matched to the base of RF amplifier Q1, which provides 17 dB of gain and has a noise figure of 3 dB. Current source Q2 is used to maintain the collector current of Q1 constant at 30 mA. Transistors Q1 and Q2 are supplied from the 5R source. This source is switched by transistor Q412 which is controlled by U401-54. 5R is only present in the receive mode. This reduces dissipation in Q1 during transmit. Diode CR1 clamps excessive input signals, protecting Q1.

The output of Q1 is applied to a fixed-tuned 4 pole shunt resonator filter having a 3 dB bandwidth of 58 MHz and a 1 dB bandwidth of 40 MHz centered at 462 MHz. Insertion loss is 2.8 dB. Attenuation for
image protection is 43 dB at 385 MHz, with increasing attenuation at lower frequencies.

A pin diode attenuator is located between the 4 pole filter and the first mixer. The bias current through this diode is switched by dual-composite transistor switch U2. In the Distance mode, U2 is turned on by a logic high at U2-4 from U401-57. CR2 is forward-biased which bypasses R11, and no loss is introduced. In the Local mode, U2 and CR2 are off (U401-57 is low), inserting 10 dB of attenuation due to R11. Because the attenuator is located after the RF amplifier, receiver sensitivity is reduced only by 5 dB, while the overall third order input intercept is raised by 15 dB. Thus, the Local mode significantly reduces the susceptibility to IM-related interference.

The first mixer, U1, is a passive, double-balanced type. This mixer provides all of the necessary rejection of the half-IF spurious response, since the improvement due to filter selectivity is negligible at 474 MHz. Low-side injection at +6 dBm is delivered to the first mixer from the injection buffer, Q271, in the VCO/buffer circuit.

The mixer output is connected to a diplexer network which matches its output to the first two pole crystal filter, Y51A, at the IF frequency of 44.85 MHz, and terminates it in a 51 ohm resistor, R51, at all other frequencies.

**Receiver Back End**

Q51 amplifies the IF signal from Y51A by approximately 20 dB. The output of Q51 is matched to a second two pole crystal filter, Y51B. The overall 3 dB bandwidth of the crystal filters is 17 kHz. The signal from Y51B is applied to the input of the receiver system IC U51-13. Diode CR51 prevents overload of the second mixer in the receiver system IC.

Q52 is controlled by crystal Y52 which provides the low side injection second local oscillator signal applied to U51-12. The filtered and amplified 44.85 MHz first IF signal mixes with the second local oscillator signal at 44.395 MHz to produce a second IF signal at 455 kHz. The second IF signal is then filtered by switchable ceramic filter FL51 or FL53, amplified, then filtered by switchable ceramic filter FL52 or FL54 and applied to the audio detector. U401-53 controls the bandwidth select switch, Q53, to switch the narrower bandwidth ceramic filters FL51 and FL52 for 12.5 kHz channel spacing or the wider ceramic filters FL53 and FL54 for 20/25/30 kHz channel spacing.

The audio detector is a phase-locked loop type. The free-running oscillator frequency is determined by capacitor C61. Detected audio from U51-31 is routed via noise-peak limiting stage U552 to Rx IN and PL in ports on the audio filter IC (AFIC) U401 (pins 14 and 15 respectively), and also via CMOS switch U553B to op-amp U551B, where output is routed to the accessory connector J3-11 (see “Low-Level Rx Audio”).

U51 also contains the carrier-squelch circuitry. When an on-channel signal is present, the amount of high-frequency audio noise, at the detector, is reduced. This change in noise level is sensed to indicate the presence of an on-channel signal. The bandwidth of the sampled noise is determined by C64, C65, R59, R60, and R71 switched by Q54. U401-53 controls Q54 for 12.5 kHz or 20/25/30 kHz channel spacing operation. Squelch sensitivity is adjusted electronically by an attenuator in U402. Squelch noise is routed from U51-26 to U402-23, and the adjusted noise level is returned from U402-26 back to U51-23. This noise level is detected in U51 and compared to a preset threshold. Noise levels greater than a preset threshold, indicating weak or no signal present, cause U51-18 to go low. This is routed to microcomputer port PC5 (U401-55). When the noise level decreases below the threshold, due to on-channel quieting, U51-18 and therefore U401-55 go high. This indicates an on-channel signal is present, and the microcomputer unmutes the audio path.

Components R57, C68 and C69 determine squelch time constants as a function of the charging currents supplied by U51. These charging currents vary from weak to strong signal conditions, providing a variable squelch closing time-constant. For weak signals the time constant is long to minimize “chattering” or rapid muting and unmuting of the audio. For strong signals, where the carrier-absent to carrier-present conditions are substantial, the closing time-constant is shortened to minimize the length of the “squelch-tail”.

**Frequency Generation System**

The frequency generation system utilizes two IC’s, the Fractional-N Synthesizer (U201) and the VCO/Buffer (U251). Designed to maximize compatibility, the two IC’s provide many functions which would normally require additional circuitry.

The frequency generation circuitry is supplied from the analog 5 V supply regulated by U405. The synthesizer IC further filters this voltage (SUPPOUT, U201-18, 4.65 Vdc) and supplies it to the VCO/Buffer IC.

The synthesizer also interfaces with the logic and AFIC circuitry. Synthesizer programming is accomplished through the SR DATA (U201-5), SR CLOCK (U201-6), and SYN LE (U201-7) lines by microcomputer U401. A serial stream of 98 bits is sent whenever the synthesizer is programmed. Synthesizer lock is indicated by a logic high at LOCK DET pin U201-2, and a logic low indicates out-of-lock.

In the transmit mode, modulation from the attenuators in the AFIC (U402-27 and 28) is resistively summed and applied to U201-8. The audio is digitized within U201 and applied to the loop divider to provide the low-port modulation. The audio is also routed through an internal attenuator for balancing of the high and
low port modulation, before being applied to the VCO from U201-28.

The AFIC employs switched-capacitor filters which require an external 2.1 MHz clock signal. This clock is generated in U201 by dividing the 16.8 MHz reference oscillator. The signal, at U201-11, is filtered, attenuated, and applied to U402-43 at a level of approximately 2 Vp-p.

**Synthesizer**

The Fractional-N synthesizer uses a 16.8 MHz crystal (Y201) to provide the reference frequency for the system. External components C201-3, R201-2, and CR201 are also part of the temperature-compensated oscillator circuit. The dc voltage applied to varactor CR201 is determined by a temperature compensation algorithm within U201, and is specific to each crystal Y201 based on a unique code assigned to the crystal.

The divided frequencies of the reference oscillator and the VCO signal (as applied to U201-20) are compared to generate the necessary correction voltage, or steering line voltage, which maintains the proper VCO frequency. The steering line voltage from U201-29 is filtered and applied to varactors CR241 and CR251 to control the frequencies of the receive and transmit VCOs respectively. To achieve fast lock time, an internal adaptive charge pump provides higher momentary current capability at U201-31 than in the normal steady-state mode. The normal and adaptive charge pumps receive their dc supply from a voltage-multiplier circuit which includes CR211, CR212 and associated capacitors C210-C216. By combining two 5 V square waves which are 180 degrees out-of-phase and adding this to the regulated 5 V supply, a source of approximately 12.6 Vdc is available at U201-32. The current for the normal mode charge pumps is set by R242. The pre-scaler for the loop is internal to U201 with the value determined by the frequency band of operation.

**VCO**

The VCO (U251) used in conjunction with the Fractional-N synthesizer (U201) generates an RF signal for both receive and transmit modes. The TRB line (U251-5) determines which oscillator and buffer is enabled, as described below. A sample of the RF signal from the enabled oscillator is routed from U251-23 to the pre-scaler input U201-20 via a matching network. After frequency comparison with the reference in the synthesizer, a resultant control voltage is applied to the varactors CR241 and CR251. This voltage, when locked, is between 3 and 10 V depending on VCO frequency.

In the receive mode, U251-5 is low, enabling the receive VCO and buffer in U251. The RF output signal at U251-2 is further amplified by Q271, low-pass filtered, and matched to the 50 ohm injection port of first mixer U1 at a level of +6 dBm.

During transmit, U251-5 is high, activating the transmit VCO and buffer. The RF output signal at U251-4 is low-pass filtered and matched into Q281 for further amplification before being applied to the RF power amplifier. A resistive attenuator (R284 through R286) isolates the VCO and buffer from impedance variations presented by the power amplifier for improved stability. The power output presented to the first stage (Q2610) of the RF power amplifier is +13 dBm.

**Transmit and Receive Audio Circuitry**

The majority of Rx and Tx audio processing is performed by U402, the Audio Filter IC (AFIC), which provides the following functions:

- Tone/Digital PL encoding and decoding
- PL rejection filter in Rx audio path
- Tx pre-emphasis amplifier
- Tx audio limiter
- Post-limiter (splatter) filter
- Tx deviation adjust digitally-controlled attenuators
- Programmable microphone gain attenuator
- Carrier squelch digitally-controlled attenuator
- Microcomputer output port expansion
- 2.5 Vdc reference source

The parameters of U402 which are programmable are selected by the microcomputer via the SR CLOCK (U402-39), SR DATA (U402-38) and chip enable (U402-41) lines.

**Rx Audio Path**

**Low-Level Rx Audio**

Detected audio from the IFIC U51-31 is routed via C553 to the switchable-gain limiter stage U552. The gain of limiter stage U552 is changed for 12.5 kHz or 25 kHz channels so that its output limits at slightly greater than full system deviation in either case. This limits the loudness of noise relative to voice during fading, weak signal conditions and squelch tails. Output is taken from this stage at two places. Pin 4, which is the (-) input, serves as an output which feeds AFIC ports Rx IN (pin 14) and PL IN (pin 15) via C551. The feedback around the op amp stage maintains the signal at U552-4 exactly equal to the signal applied to the (+) input, but the signal at U554-4 benefits from the selectable noise limiting threshold. Gain adjustments in the receive audio path for 12.5 or 25 kHz channels are then made in the AFIC. A second output from the limiter stage is taken at pin 1 and is affected by the gain change of U552 so that the level is a constant 840 mV rms at 60% deviation for either 12.5 or 25 kHz channels. This
level is attenuated 12 dB by R573, R579 and R580 and routed to the Detector Audio Send pin of the AdvantagePort™ connector (J13-16).

Detected audio from the IFIC U51-31 is also routed via a switchable-gain path (R577, R578 and U554A) to analog switch U553B (see "Accessory Connector Rx Audio Path").

The audio applied to the AFIC at U402-14 (Rx IN) is sharply high-pass filtered to remove all PL and DPL tones below 300 Hz. Audio is then routed through a digitally controlled attenuator which is set to approximately 6 dB attenuation. This attenuation is non-adjustable and maintains the output at U402-31 (Rx OUT) at a fixed and defined level of 450 mV rms for 60% deviation, since this level is applied to the AdvantagePort connector (J13-6). Receive volume adjustment is accomplished at a later point using the volume control R554. The internal de-emphasis characteristic within U402 is enabled, with the result that audio at U402-31 is de-emphasized but unmuted.

This audio signal is processed by the option board if present, or passed through resistor R551 if no option board is installed, and then fed to the expander portion of compander IC U555. The operation of the compander is described below. The output from the compander IC is routed through mute gate U554D, amplified by U551A and fed to the volume control, and also to handset audio buffer U551D (see "Handset Audio Path") and analog switch U553B (see "Accessory Connector Rx Audio Path").

Audio Power Amplifier

Audio from the wiper of the volume control is amplified by the audio power amplifier IC U501. This is a bridge amplifier delivering 7.8 V rms between pins 4 and 6 without distortion. This is sufficient to develop 7.5 watts of audio power into an external 8 ohm load, or approximately 4 watts of audio power into an internal 16 ohm speaker (under this condition, undistorted audio output voltage swing exceeds 8 V rms). The audio power amplifier is muted whenever speaker audio is not required, to reduce current drain and eliminate noise in the speaker. The audio amp is muted when U501-8 is low. This occurs if Q501 is saturated (U402-9 high) or when the radio is turned off. The current drain into supply pin U501-7 is negligible when U501-8 is low.

Because the power amplifier is a bridge-type, neither speaker terminal is grounded. Care should be taken that any test equipment used to measure the speaker audio voltage does not ground either speaker output terminal, otherwise damage to the audio power amplifier IC may result. If the test equipment input is not isolated from ground, voltage measurements may be made from one of the speaker output terminals (J3-1 or J3-16) to ground, in which case the voltage indicated will be one half of the voltage applied to the speaker or load resistor. When an 8-ohm load resistor is used, it should be connected across pins 1 and 16 of J13, never to ground.

Handset Audio Path

Rx audio from U551A-1 is amplified by op amp U551D and applied to the microphone connector J5-8 for use with a telephone-type handset. This audio is de-emphasized, and muted by U554D. It is also affected by any receive audio processing circuits on the option board, if installed, and by the compander, if enabled. When the radio has been programmed for handset operation, the audio power amplifier is muted whenever the handset is off-hook by a logic high from U402-9. This silences the speaker when the handset is in use.

Accessory Connector Rx Audio Path

Rx audio is amplified by stage U551B and is available at the accessory connector pin 11. This audio may be one of two types, depending on the R55 programming of analog switch U553B.

If U553B-10 is programmed high, the audio fed to U551B comes from the receiver's detector audio via a switchable-gain path using R577, R578 and U554A. In this case, audio at the accessory connector (J3-11) is "flat" (non-de-emphasized) and unmuted.

If U553B-10 is programmed low, the audio fed to U551B comes from U551A. Audio at J3-11 is de-emphasized and muted. This path will also be affected by any receive audio processing circuits on the option board, if installed, and by the compander, if enabled.

PL Decoder

Detected Rx Audio which has been limited by stage U552 is applied to the AFIC PL IN port (U402-15), where it first passes through the Tone PL filter or Digital PL filter, depending on the PL option selected for the current operating mode. Filtered PL is then coupled to the PL detector circuit, with detected output at U402-35. The detected PL signal is coupled from U402-35 to microcomputer port PA1 (U401-15) where algorithms perform the final PL decoding. Data for the tone PL frequency or Digital PL code for each mode is programmed through the Radio Service Software.

AdvantagePort™ Internal Option Board Rx Audio Path

De-emphasized, unmuted audio is available at J13-6 for use by an internally installed option board. If this audio is to be processed and returned to the radio's receive audio path, the processed audio will be returned from a low-impedance source on the option board to J13-8. The unprocessed audio through R551 is shunted due to the low source impedance of the option board at J13-8.
Since the gain of the AFIC is different for 12.5 or 25 kHz channels, the RX audio level at J13-6 is always 450 mV at 1 kHz and 60% deviation, regardless of the channel spacing. Similarly, audio returned to J13-8 from the option board should be supplied at a level of 130 mV rms at 60% deviation, regardless of the channel spacing.

Non-de-emphasized, unmuted audio is available at J13-16. Options requiring non-de-emphasized audio may use this, or may re-pre-emphasize the audio at J13-6, depending on the design of the option board. Because the gain of stage U552 is different for 12.5 or 25 kHz channels, the RX audio level at J13-16 is always 210 mV at 60% deviation, regardless of the channel spacing.

**Noise Squelch Attenuator**

The AFIC contains a 16 step programmable digital squelch attenuator whose input is U402-23 and output is U402-26. Noise squelch sensitivity is set using RSS, with open squelch at step 0 and maximum (tight) squelch at step 15.

**Tx Audio Path**

**Voice Path via Front Panel**

Microphone audio from the front panel mic jack J5-5 is attenuated from 80 mV rms (for 60% deviation at 1 kHz) to 65 mV by R658 and R659. When mic PTT is sensed from J5-6, CMOS gate U554C is enabled by a logic low at U402-5, which is inverted by Q651 to provide a logic high at U554C-6.

This audio is fed to the comander IC where it is amplified from 65 mV to 100 mV by an op amp gain stage (pins 7 and 6) and then applied to the compressor portion of the comander (pin 3). The output (pin 2) is attenuated back to the original 65 mV rms level by another op amp stage (pins 9 and 10) and applied as a low-impedance source to the Tx Audio Send pin of the AdvantagePort connector (J13-10).

**Voice Path via Accessory Connector**

Microphone audio from an accessory such as a desk set applied to External Mic Audio input J3-2 is attenuated from 80 mV rms (for 60% deviation at 1 kHz) to 65 mV by R666 and R665. When External Mic PTT is sensed at J3-3 (or from any programmable input to which Ext Mic PTT has been assigned), CMOS gate U554B is enabled by a logic high at U401-47.

This audio is fed to the comander IC and processed as described above for the Voice Path via Front Panel.

**AdvantagePort™ Internal Option Board Tx Audio Path**

Non-pre-emphasized microphone audio is available at J13-10 for use by an internally installed option board. If this audio is to be processed and returned to the radio's transmit audio path, the processed audio will be returned from a low-impedance source on the option board to J13-12 (Tx Audio Return). The unprocessed audio through R654 is shunted due to the low source impedance of the option board at J13-12. Since deviation is adjusted appropriately by the AFIC for 12.5 or 25 kHz channels, the TX audio level at J13-10 and J13-12 is always 65 mV for 60% deviation at 1 kHz, regardless of the channel spacing.

Some option boards must be able to modulate the transmitter with very low frequency data. The Post-Limiter Flat Tx Audio Return pin (J13-2) is used for this application. Audio from this pin is routed to the AUX Tx IN pin on the AFIC (U402-20) via summing op amp stage U551C. A level of 150 mV rms will produce 60% deviation regardless of channel spacing. This path bypasses the limiter stage in the AFIC, therefore the option board must provide the necessary amplitude limiting of this signal to prevent overdeviation. The AUX Tx IN path of the AFIC must be enabled via software control for this path to be active.

**Pre-emphasis of Microphone Audio Signals**

Pre-emphasis of the front panel or accessory microphone audio signal occurs after the AdvantagePort option board processing has occurred. Series capacitor C651 provides the pre-emphasis characteristic of audio applied to the Tx IN pin of the AFIC (U402-17). This pin is the summing junction of an inverting op-amp gain stage within U402. Audio processing, including limiting, splatter filtering, and level adjustment are performed within U402. The outputs of the two programmable deviation-adjustment attenuators (U402-27 and 28) are resistively summed and applied to the VCO modulation input of the frequency generation system.

**Flat (Non-Pre-Emphasized) Tx Audio Path via Accessory Connector**

Audio applied at J3-5 may be routed to the transmitter either before the limiter (PRE-LIM) or after (POST-LIM). This is programmed using RSS. The path is controlled by CMOS gate U553C, as controlled by U402-8 (low for PRE-LIM, high for POST-LIM). When the POST-LIM path is chosen, audio is routed via R671 and op amp U551C to the AUX TX INPUT (U402-20), therefore this input of the AFIC must be enabled via software control whenever an accessory connector PTT is sensed at J3-3 (or from any programmable input to which Accessory PTT has been assigned).
If the PRE-LIM path is chosen, audio is coupled by C655 and R670 to the summing input of an op amp within U402 (pin 17). Because R670 is significantly larger than R671, R669 provides a charging path for C655 when the PRE-LIM route is selected which is equivalent to the charging path via R671 in the POST-LIM path.

Audio present at J3-5 is muted during transmitter key-up until the frequency synthesizer has settled and locked on-frequency. This prevents unintentional frequency offset due to the presence of modulation while PTT is keyed. Muting occurs when U401-9 provides a low to U553A-11. While muted, R672 maintains the same dc bias on C655 to prevent switching transients.

**Tx Data Encoder (D/A Converter)**

Data such as MDC or DTMF signalling can be encoded into the TX audio path by generating the waveform at ports PA3, PA4 and PA5 of U401 (pins 13, 12 and 11 respectively). These outputs are resistively summed and weighted to allow either square waves or pseudosine waves to be encoded. Op amp U551C provides active summing and outputs the signal to the AUX Tx IN port of the AFIC (U402-20). Connection is also made to the AUX Rx IN port (U402-13) to allow true sidetones to be heard, for example when DTMF tones are encoded. The AUX Tx IN path of the AFIC may be enabled via software control when the data encoder is operating.

The data encoder circuit may not be utilized in all models.

**Compander Operation**

The compander circuit of U555 is used to improve the signal-to-noise ratio of the voice communications path. This is accomplished by compressing the microphone signal during transmit by a ratio of 2:1 so that a 60 dB range of level changes at the microphone are reduced to only a 30 dB change before being transmitted. A complimentary expander circuit in the receiver audio path restores the 30 dB range of the received signal to its original 60 dB range before being applied to the speaker. Any noise occurring in the over-the-air transmission which is more than 30 dB below full deviation is reduced to greater than 60 dB below the peak voice level at the speaker, making such noise essentially inaudible.

The effectiveness of the compander system requires that both the transmitter and receiver utilize companding. It is possible to program the compander off on a per-channel basis using RSS, for use in systems with other radios that do not have the compander feature. The compander is active when U555-8 is low, and is bypassed when U555-8 is high. When in the bypass mode, the gain of the compressor (pin 3 in, pin 2 out) and expander (pin 14 in, pin 15 out) circuits is unity.

Q553 and C581 keep the compander turned off for approximately one second when the radio is turned on, to allow the compander circuits sufficient time to stabilize. At turn-on, U401-30 pulses low, which turns on Q553 and quickly charges C581 to 5 V, bypassing the compander. If the compander should be on, U401-30 stays high, and C581 discharges due to the internal resistance of U555-8. After one second, the voltage at U555-8 is low enough to enable the compander. If the compander should be off, U401-30 remains low, keeping Q553 on and U555-8 high.

Q554 and Q555 are used to increase the receive audio path gain by approximately 4 dB whenever the compander is turned on. This maintains the same subjective audio level for both compander and non-compander channels.

**Public Address Operation**

When the public address switch box and amplified speaker(s) accessories are used, and the radio has been programmed by RSS for public address, operation is as follows:

Turning on either the INT PA or EXT PA switches on the public address switch box provides a low at pin 14 of accessory connector J3. This enables public address operation of the radio. In this condition, radio receiver operation is unaffected, but keying of the transmitter is inhibited. If a MIC PTT is sensed from microphone jack J5-6, both the INT MIC ENABLE and EXT MIC ENABLE lines go high (U402-5 is low and U401-47 is high). This turns on both mic audio gates U554C and U554B, and allows audio from the microphone jack J5-5 to be routed directly to accessory connector J3-2. Mic audio from J3-2 is then routed to the selected public address amplified speakers by the public address switch box.

To prevent loading of the mic audio signal and loss of low frequency response, U651 senses that both INT MIC and EXT MIC enable lines are high and provides a low at its output, turning off U652 and removing the loading of R665 from the audio path. At all other times, U652 is on to provide microphone bias voltage to the external mic input via R665.

**Transmitter Circuitry**

**VHF 10-25 Watt Transmitter RF Power Amplifier**

The 10-25 watt VHF power amplifier is designed to cover the range of 150-170 MHz. It consists of three stages. The first stage, Q2410, operates in Class A with base bias supplied by the 8V source. The collector voltage is supplied from controlled B+. The output level of this stage (i.e. the gain of this device) is varied by changes in the controlled B+ voltage. The magnitude of
the control voltage depends on the PA output power, temperature and also antenna load mismatch.

The second stage of the PA, Q2430, is the driver which amplifies the output of low level amplifier to a level sufficient to drive the final stage device. This device operated in Class C delivers up to 3 watts output power. Collector voltage is supplied by UNSWB+.

The third stage, Q2440, is the final RF power amplifier, which operates in Class C directly from UNSWB+. It provides up to 30 watts output power.

A directional coupler, located between the final power amplifier and the harmonic filter, monitors the forward and reflected power. The sampled RF is rectified by diodes CR2480 (forward power) and CR2481 (reflected power) and the resulting dc voltage is routed to the power control circuit.

The antenna switch consists of two pin diodes, CR2450 and CR2451. L2452 and C2450, combined with the “on” inductance of CR2451, form a series resonant circuit to lower the shunt impedance presented by CR2451 when it is turned on. In the receive mode, both diodes are off. Signals applied at the antenna jack J1 are routed, via the harmonic filter, through L2451 and C2453 to the receiver input. In the transmit mode, 8T is present and both diodes are forward-biased into conduction. The transmitted RF from Q2440 via the directional coupler is routed through CR2450, and via the harmonic filter to the antenna jack. CR2451 conducts, shunting RF power and preventing it from reaching the receiver. L2451 is selected to appear as a 1/4 wave at VHF, so that the low impedance of CR2451 appears as a high impedance at the junction of CR2450 and the harmonic filter input. This provides a high series impedance and low shunt impedance divider between the power amplifier output and receiver input.

During transmit mode, 8T is present and both diodes are forward biased into conduction. The transmitted RF from Q2440 via the directional coupler is routed through CR2450, and via the harmonic filter to the antenna jack J1. The PIN diode CR2651 in the shunt-leg conducts, shunting RF power and preventing it from reaching the sensitive receiver front-end. The impedance inverter network contributes approximately 30 dB to transmit/receive isolation. Whereas, during receive mode, both the PIN diodes are non-conducting. Thus, the signal applied at the antenna jack J1 are routed via the harmonic filter, through C2658, L2652 and C2659 to the receiver input.

The harmonic filter is a seven pole 0.1 dB ripple Chebyshev low pass filter with a 3 dB frequency of approximately 200 MHz and less than 1 dB insertion loss in the passband.

VHF 40 Watt Transmitter RF Power Amplifier

The 40 watt VHF power amplifier is designed to cover the range of 150-174 MHz and has four stages. The first stage, Q2410, operates in Class A from the 8T source. It provides 13 dB of gain and an output of 400 mW.

The second stage, Q2420, has a nominal gain of 9.4 dB and power output of up to 3.5 watts. The output of this stage is adjusted by the controlled B+ voltage which supplies its collector. (VB+ max = 6.55 V).

The third stage, Q2430, operates in Class C with 8.1 dB gain and output power up to 22 watts. Collector voltage is directly from UNSW B+.

The fourth stage, Q2440, is the final RF power amplifier, which operates in Class C, is directly from UNSW B+. It provides up to 65 watts output.

A directional coupler, located between the final power amplifier and the harmonic filter, monitors the forward and reflected power. The sampled RF is rectified by diodes CR2480 (forward power) and CR2481 (reflected power) and the resulting dc voltage is routed to the power control circuit.

The antenna switch consists of two pin diodes, CR2450 and CR2451. L2452 and C2450, combined with the “on” inductance of CR2451, form a series resonant circuit to lower the shunt impedance presented by CR2451 when it is turned on. In the receive mode, both diodes are off. Signals applied at the antenna jack J1 are routed, via the harmonic filter, through L2451 and C2453 to the receiver input. In the transmit mode, 8T is present and both diodes are forward-biased into conduction. The transmitted RF from Q2440 via the directional coupler is routed through CR2450, and via the harmonic filter to the antenna jack. CR2451 conducts, shunting RF power and preventing it from reaching the receiver. L2451 is selected to appear as a 1/4 wave at VHF, so that the low impedance of CR2451 appears as a high impedance at the junction of CR2450 and the harmonic filter input. This provides a high series impedance and low shunt impedance divider between the power amplifier output and receiver input.

The harmonic filter is a seven pole 0.1 dB ripple Chebyshev low pass filter with a 3 dB frequency of approximately 200 MHz and less than 1 dB insertion loss in the passband.

UHF 10-40 Watt Transmitter RF Power Amplifier

The 40 watt UHF power amplifier is designed to cover the range of 450-474 MHz and has four stages. The first stage, Q2610, operates in Class A from the 8T source. It provides 11.8 dB of gain and an output of 300 mW.
The second stage, Q2620, has a nominal gain of 8.2 dB and power output of up to 2 watts. The output of this stage is adjusted by the controlled B+ voltage which supplies its collector.

The third stage, Q2630, operates in Class C with 8.1 dB gain and a power output of up to 13 watts. Collector voltage is directly from UNSW B+.

The fourth stage, Q2640, is the final RF power amplifier, which operates Class C directly from UNSW B+. It provides up to 30 watts output for low power and 50 watts output for high power.

A directional coupler, located between the final power amplifier and the harmonic filter, monitors the forward and reflected power. The sampled RF is rectified by diodes CR2680 (forward power) and CR2681 (reflected power) and the resulting dc voltage is routed to the power control circuit.

The antenna switch consists of two pin diodes, CR2650 and CR2651. L2652 and C2650, combined with the "on" inductance of CR2651, form a series resonant circuit to lower the shunt impedance presented by CR2651 when it is turned on. In the receive mode, both diodes are off. Signals applied at the antenna jack J1 are routed, via the harmonic filter, through L2651, C2653, and L2664 to the receiver input. In the transmit mode, 8T is present and both diodes are forward-biased into conduction. The transmitter RF from Q2640 via the directional coupler is routed through CR2650, and via the harmonic filter to the antenna jack. CR2651 conducts, shunting RF power and preventing it from reaching the receiver. L2651 is selected to appear as a 1/4 wave at UHF, so that the low impedance of CR2651 appears as a high impedance at the junction of CR2650 and the harmonic filter input. This provides a high series impedance and low shunt impedance divider between the power amplifier output and receiver input.

The harmonic filter is a seven pole 0.1 dB ripple Chebyshev low pass filter with a 3 dB frequency of approximately 600 MHz and less than 1 dB insertion loss in the passband.

**Power Control Circuit**

The power control circuit is a dc-coupled amplifier whose output is the controlled voltage applied to the second stage of the RF power amplifier (Q2420 in 40 W VHF, Q2410 in 25 W VHF, or Q2620 in UHF).

The input voltage to U451A-2 is a dc voltage from the directional coupler forward power detector, and is proportional to RF power output. This is compared to a dc voltage applied to U451A-3 which is proportional to the desired output power setting. Components R458, C467, R457 and C458 integrate the PWM pulses into a smooth dc voltage.

The power control loop varies the output of stage Q2420 or Q2620 as necessary to keep equal voltages at U451A pins 2 and 3, and thus maintains forward power at the adjusted setting.

Under conditions of poor antenna match resulting in high reflected power, the dc voltage at U451A-3 is reduced due to a lowering of the voltage at U451B-7. This is interpreted by the power control circuit as a lowering of the desired output power.

The temperature-sensing circuit protects the PA devices from excessively high temperatures. As the PA temperature increases, the resistance of thermistor R462 decreases. This causes Q453 to conduct, reducing the voltage at the base of Q452. This reduces the conduction of series pass device Q451, lowering the control voltage and therefore the output power.

Over-voltage protection prevents the control voltage from rising so high that the subsequent transmitter stages may be overdriven. Zener diode VR451 conducts when the control voltage exceeds 5.3 V in 40 W VHF models or 10.6 V in UHF models. This causes Q453 to conduct, lowering the control voltage as described earlier.

**PTT Circuits**

The logic system uses a single microcomputer A/D input port PE1 (U401-36) to distinguish between two different types of PTT information. This is done by assigning different voltage levels to the different PTT functions as follows:

- 0 to 2.1 Vdc (0.6 Vdc typ): Microphone PTT
- 2.2-3.6 Vdc (2.6 Vdc typ): Accessory PTT
- 4.75 to 5.0 Vdc (5.0 Vdc typ): Receive Mode

A microphone connected via the front panel jack J5 must present a low of less than approximately 2.0 V dc to be correctly interpreted as MIC PTT and cause the appropriate audio paths to be enabled. Similarly, an accessory whose PTT output is connected to J3-3 must present a low of less than approximately 2.0 V dc to be interpreted as an accessory PTT. This voltage is shifted to the range between 2.2 and 3.6 V by series resistor CR432.

Some accessories connected to J3 need to sense microphone PTT by looking for a low at J3-3. Diode CR408 causes J3-3 to be pulled low whenever microphone connector J5-6 is low.
Programmable I/O's

Pins 4, 6, 8, 9, 12, and 14 are programmable I/O's. They are used to control external accessories by the radio, or for control of radio functions by accessories.

Pin 4 is an output only. When U401-21 is high, Q901 and Q902 are on, and pin 4 is pulled high to the battery voltage. This is normally used to turn on a relay for activating the vehicle's horn or lights.

Pin 6 is an input only. Normally, R905 pulls pin 6 high, turning on Q903 and pulling U401-45 low. If pin 6 is pulled low, U401-45 goes high.

Pin 8 is an I/O (input and output). To function as an input, Q905 is turned off by keeping U401-20 low. Then, R907 pulls pin 8 high, turning on Q904 and pulling U401-44 low. If pin 8 is pulled low, U401-44 goes high. To function as an output, Q905 pulls pin 8 low whenever U401-20 is high.

Pin 9 is an input only. Normally, R909 pulls pin 9 high, turning on Q906 and pulling U401-46 low. If pin 9 is pulled low, U401-46 goes high. The emergency switch accessory, if used, is connected here.

Pin 12 is another I/O. To function as an input, Q909 is turned off by keeping U401-19 low. Then, R913 pulls pin 12 high, turning on Q908 and pulling U401-43 low. If pin 12 is pulled low, U401-43 goes high. To function as an output, Q909 pulls pin 12 low whenever U401-19 is high.

Pin 14 is also an I/O. To function as an input, Q911 is turned off by keeping U401-22 low. Then, R915 pulls pin 14 high, turning on Q910 and pulling U401-42 low. If pin 14 is pulled low, U401-42 goes high. To function as an output, Q910 pulls pin 14 low whenever U401-22 is high.

Zener diodes and bypass capacitors on each programmable I/O line prevent damage or abnormal operation due to ESD transients or RF fields.

The extent to which programmable I/O functions are supported may vary with different radio models. RSS allows the functions which are supported to be programmed.

DC Regulation and Distribution

Unswitched B+ supplies operating voltage directly to the RF power amplifier third and fourth stages, the power control series pass device Q451-E, the RAM keep-alive constant voltage supply to U401-62, the audio power amplifier supply pin U501-7 and, via fuse F401, to the on-off switch and external alarm switch transistor Q902-E. All of these circuits draw negligible current when the radio is turned off (less than 15 mA total).

When the on-off switch is "on," battery voltage is applied to 8 volt regulator U406, and via R502 to pin 8 of the audio power amplifier U501 which turns it on unless muted by Q501. The regulated output of U406 is routed to the display board for backlighting, to 8T transistor switch Q414, to U51 pins 16 and 17, to op amp U551 supply pin 4, and to the inputs of the 5 volt regulators U404 (digital) and U405 (analog). Separate analog and digital regulators are used to minimize microcomputer noise from being introduced into sensitive VCO and receiver circuits. The digital 5 V regulator includes a reset timer which holds the reset line U404-3 low for a predetermined time after the radio is turned on. Zener diodes on the 8 V and digital 5 V lines minimize susceptibility to ESD damage.

Ignition control of the radio is accomplished by removing fuse F401. The radio will only be able to turn on if battery voltage from the vehicles ignition switch is applied to accessory connector J3 pin 10. This voltage is routed to the on-off switch.

20-Channel LCD Front Panel Display Board

The 8-character display board contains back lighting LED’s, and an LCD that is driven by the LCD driver IC, U1101. When the LCD driver, U1101, is enabled via the CE (Chip Enable) input, the desired display information is then loaded serially via the SR Data line into U1101 from the microprocessor. U1101 also has a clock input that is connected to the main board SR Clock.

The back lighting for the 8-character display board can be toggled between two colors, amber and green per the users choice. This color choice for the LED’s is controlled by the microprocessor, which in turn gets its input from either the RSS setup, or one of the pushbuttons if so enabled. Each color of back lighting is produced by 12 pairs of LED’s, which are turned on by applying a ground to the cathodes of the 12 pairs of LED’s.

To enable the amber LED’s, a DC level of 5 V from the microprocessor is applied to the base of Q1108. This 5 V saturates Q1108 which connects a ground to the amber LED cathodes and also the base of Q1107. With the base of Q1107 grounded, the transistor operates in the cutoff mode which leads to the collector having a potential of ~8 V, which is also applied to the cathode of the green LED’s.

To enable the green LED’s, a DC level of 0 V (ground) to the base of Q1108 keeps Q1108 in cut-off mode which leads to the collector of Q1108 having a potential of 8 V. This 8 V potential on the collector of Q1108 is also applied to the base of Q1107 via R1125, thus saturating Q1107 and connecting the green LED’s to ground.

The six pushbuttons apply voltage to the bases of six digital transistors, Q1101 through Q1106. The appro-
appropriate transistor, in turn, grounds a tap on the series resistor ladders R1117 through R1122, producing a different DC level depending on which button is pressed. These DC levels are interpreted by an A/D input of the microprocessor (U401-37) and the corresponding function is enabled. The transistors ensure that the DC ladder voltage is consistent, although the series resistance of the keypad may vary.

4-Channel LED Front Panel Display Board

The LED display board contains back lighting LEDs for the keypad, channel indicator LEDs; and status indicators for transmit, monitor, and options. The channel and status display information is loaded serially into the shift register, U101. This information is then latched and turns on the LEDs, DS101 - DS105 and DS1012 - DS1014 via the driver transistors, Q1001 - Q1008.

The six pushbuttons apply voltage to the bases of six digital transistors, Q1009 through Q1014. The appropriate transistor, in turn, grounds a tap on the series resistor ladders R1017 through R1022, producing a different DC level depending on which button is pressed. These DC levels are interpreted by an A/D input of the microprocessor (U401-37) and the corresponding function is enabled. The transistors ensure that the DC ladder voltage is consistent, although the series resistance of the keypad may vary.
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<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parts List for UHF Main Boards, 450-474 MHz, 12.5 &amp; 25 kHz, 25-40 W</td>
<td>11</td>
</tr>
<tr>
<td>(Part of HUE3873C &amp; HUE3579A Radios)</td>
<td></td>
</tr>
<tr>
<td>Schematic Diagram for UHF Main Boards, 450-474 MHz, 12.5 &amp; 25 kHz, 10-25 W</td>
<td>13</td>
</tr>
<tr>
<td>(Part of HUE3871A &amp; HUE3580A Radios)</td>
<td></td>
</tr>
<tr>
<td>(Sheet 1 of 2)</td>
<td></td>
</tr>
<tr>
<td>Schematic Diagram for UHF Main Boards, 450-474 MHz, 12.5 &amp; 25 kHz, 10-25 W</td>
<td>14</td>
</tr>
<tr>
<td>(Part of HUE3871A &amp; HUE3580A Radios)</td>
<td></td>
</tr>
<tr>
<td>(Sheet 2 of 2)</td>
<td></td>
</tr>
<tr>
<td>Parts List for UHF Main Boards, 450-474 MHz, 12.5 &amp; 25 kHz, 10-25 W</td>
<td>15</td>
</tr>
<tr>
<td>(Part of HUE3871A &amp; HUE3580A Radios)</td>
<td></td>
</tr>
<tr>
<td>Circuit Board Details for HLN9644A 8-Character Display Board, 20-Frequency</td>
<td>17</td>
</tr>
<tr>
<td>Schematic Diagram, and Parts List for HLN9644A 8-Character Display Board, 20-Frequency</td>
<td>19</td>
</tr>
<tr>
<td>Circuit Board Details for HLN9887A Display Board, 4-Frequency</td>
<td>20</td>
</tr>
<tr>
<td>Schematic Diagram, and Parts List for HLN9887A Display Board, 4-Frequency</td>
<td>21</td>
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<td>22</td>
</tr>
<tr>
<td>for HMN3001/3008A Compact Microphone</td>
<td></td>
</tr>
<tr>
<td>Exploded Mechanical View and Parts List for HMN3001/3008A Compact Microphone</td>
<td>23</td>
</tr>
<tr>
<td>M1225 Radio Exploded Mechanical View and Parts List</td>
<td>24</td>
</tr>
</tbody>
</table>
Scope of Manual

This manual is intended for use by experienced technicians familiar with similar types of equipment. It contains all service information required for the equipment described and is current as of the printing date. Changes which occur after the printing date are incorporated by service manual revisions. These revisions are added to the manuals as the engineering changes are incorporated into the equipment.

How to Use This Manual

This manual contains introductory material such as model charts, accessories, and specifications, as well as four sections that deal with specific service aspects of the M1225 Mobile Radio. Refer to the Table of Contents for a general overview of the manual, or to the “Overview” paragraph in each section for a specific overview of the information in that section.

Other Documentation

Table 1 lists other documentation for the M1225 Mobile Radio.

<table>
<thead>
<tr>
<th>Information</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Use of Radio</td>
<td>M1225 20-Channel Operator Guide (6880904Z85)</td>
</tr>
<tr>
<td>Basic Use of Radio</td>
<td>M1225 4-Channel Operator Guide (6880906Z68)</td>
</tr>
<tr>
<td>Accessories</td>
<td>M1225 Accessory/Feature Sheet (6880904Z98)</td>
</tr>
<tr>
<td>Installation and Licensing</td>
<td>M1225 Installation/Licensing Guide (6880905Z15)</td>
</tr>
<tr>
<td>Programming</td>
<td>1225 Series RSS Getting Started (6880904Z93)</td>
</tr>
</tbody>
</table>

Technical Support

To obtain technical support, you may call Motorola’s Radius Product Services. When you call, we ask that you have ready the model and serial numbers of the respective radio or its parts.

Service Policy

If malfunctions occur within 30 days that cannot be resolved over the phone with Radius Product Services, a defective major component should be returned. You must obtain authorization from Radius Product Services before returning the component.

Ordering Replacement Parts

You can order additional components and some piece parts directly through your Radius price pages. When ordering replacement parts, include the complete identification number for all chassis, kits, and components. If you do not know a part number, include with your order the number of the chassis or kit which contains the part, and a detailed description of the desired component. If a Motorola part number is identified on a parts list, you should be able to order the part through Motorola Parts. If only a generic part is listed, the part is not normally available through Motorola. If no parts list is shown, generally, no user serviceable parts are available for the kit.

Radius 30-Day Warranty
Technical Support
Radius Product Services
1000 W. Washington St.
Mt. Pleasant, IA 52641 USA

Motorola Radio Support Center
Attention: Warranty Return
3760 South Central Avenue
Rockford, IL 61102 USA
1-800-227-6772 (U.S. & Canada)

Radius Major Component Repair
Motorola Radio Support Center
3760 South Central Avenue
Rockford, IL 61102 USA

Motorola Accessory & Aftermarket Division
Attention: Order Processing
1313 E. Algonquin Road
Schaumburg, IL 60196

Customer Service
1-800-422-4210
1-847-538-8198 (FAX)

Motorola Accessory & Aftermarket Division
Attention: International Order Processing
1313 E. Algonquin Road
Schaumburg, IL 60196

Parts Identification
1-847-538-0021
1-847-538-8194 (FAX)
# Model Charts

## M1225

**20-Channel VHF Mobile Radio**

**150 - 174 MHz**

**25-40 Watts RF Power**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X HUD3233_</td>
<td>Radio, 12.5/25 kHz, 25-40 W</td>
</tr>
<tr>
<td>X HMN3008_</td>
<td>Microphone</td>
</tr>
<tr>
<td>X HLN9154_</td>
<td>Non-Locking Bracket</td>
</tr>
<tr>
<td>X HKN4137_</td>
<td>Power Cable</td>
</tr>
<tr>
<td>X HLN9155_</td>
<td>M1225 20-Channel Manual Kit</td>
</tr>
</tbody>
</table>

**Note:** Main board kits are not available separately for field replacement.
**M1225**

**20-Channel**

**UHF Mobile Radio**

**450 - 474 MHz**

**10-25 Watts RF Power**

&

**25-40 Watts RF Power**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>HUE3873_ Radio, 12.5/25 kHz, 25-40 W</td>
<td>X X X</td>
</tr>
<tr>
<td>X</td>
<td>HUE3817_ Radio, 12.5/25 kHz, 10-25 W</td>
<td>X X X</td>
</tr>
<tr>
<td>X X</td>
<td>HMN3008_ Microphone</td>
<td></td>
</tr>
<tr>
<td>X X</td>
<td>HLN9154_ Non-Locking Bracket</td>
<td></td>
</tr>
<tr>
<td>X X</td>
<td>HKN4137_ Power Cable</td>
<td></td>
</tr>
<tr>
<td>X X</td>
<td>HLN9155_ M1225 20-Channel Manual Kit</td>
<td></td>
</tr>
</tbody>
</table>

*Note: Main board kits are not available separately for field replacement*
M1225
4-Channel
VHF Mobile Radio
150 - 174 MHz
25-40 Watts RF Power

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>HUD3251</td>
<td>X</td>
<td>X X X</td>
</tr>
<tr>
<td>X</td>
<td>HMN3008</td>
<td>X</td>
<td>Non-Locking Bracket</td>
</tr>
<tr>
<td>X</td>
<td>HLN9154</td>
<td>X</td>
<td>Power Cable</td>
</tr>
<tr>
<td>X</td>
<td>HLN9893</td>
<td></td>
<td>M1225 4-Channel Manual Kit</td>
</tr>
</tbody>
</table>

Note: Main board kits are not available separately for field replacement
M1225
4-Channel
UHF Mobile Radio
450 - 474 MHz
25-40 Watts RF Power
&
10-25 Watts RF Power

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>HUE3579_ Radio, 12.5/25 kHz, 25-40 W</td>
<td>X</td>
<td>X X X</td>
</tr>
<tr>
<td>X</td>
<td>HUE3580_ Radio, 12.5/25 kHz, 10-25 W</td>
<td>X</td>
<td>X X X</td>
</tr>
<tr>
<td>X X</td>
<td>HMN3008_ Microphone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X X</td>
<td>HLN9154_ Non-Locking Bracket</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>HKN4137_ Power Cable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X X</td>
<td>HLN9893 M1225 4-Channel Manual Kit</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Main board kits are not available separately for field replacement.
Accessories

Radius offers several accessories to increase communications efficiency. Many of the accessories available are listed below, but for a complete list, consult your Radius dealer.

Antennas:
- HAD4006_R: VHF 136-144 MHz, 1/4 Wave Roof Mount
- HAD4007_R: VHF 146-150 MHz, 1/4 Wave Roof Mount
- HAD4008_R: VHF 150-162 MHz, 1/4 Wave Roof Mount
- HAD4009_R: VHF 162-174 MHz, 1/4 Wave Roof Mount
- HAD4014_R: VHF 140-174 MHz, 3 dB Gain Roof Mount
- RAD4000_M: VHF 140-174 MHz, 3 dB Gain Magnetic Mount
- HAE4003_R: UHF 450-470 MHz, 1/4 Wave Roof Mount
- HAE4004_R: UHF 470-512 MHz, 1/4 Wave Roof Mount
- HAE4011_R: UHF 450-470 MHz, 3.5 dB Gain Roof Mount
- HAE4012_R: UHF 470-494 MHz, 3.5 dB Gain Roof Mount
- RAE4004_RB: UHF 450-470 MHz, 5 dB Gain Roof Mount
- RAE4004_M: UHF 440-470 MHz, 5 dB Gain Magnetic Mount
- HKN9557_R: PL259/Mini-U Antenna Adapter with 8 in. Cable
- HLN5282_R: Mini-U Connector
- HLN8027_R: Mini - UHF to BNC Adapter

Microphones:
- HNM1035_R: Heavy Duty Palm Microphone with 10.5 ft. Cord
- HMN3008_: Compact Microphone with Tx LED, 7 ft. Cord & Hang-up Clip
- HNM3001_: Compact Microphone with Tx LED, 10 ft. Cord & Hang-up Clip
- HNM3175_: Compact Touch-Code™ Microphone, 7 ft. Cord & hang-up Clip
- HNM3174_: Compact Microphone with Tx LED, 7ft. Cord & Hang-up Clip
- HNM3141_R: Handset with Hang-up Cup
- HLN9073_R: Microphone Hang-up Clip
- HLN9414_: Universal Hang-Up Clip
- HLN9560_R: 10.5 ft. Extended Coil Cord
- HLN9559_R: 7 ft. Coil Cord

Installation Accessories:
- HLN9162_: 5 in. Goose Neck Mounting Bracket
- HLN9227_: 8 in. Goose Neck Mounting Bracket
- HLN9408_: Goose Neck Decor Sleeve
- HLN9534_: Right Angle Mini-UHF Connector
- HLN9228_: Clam Shell Swivel Mounting Bracket
- HLN9617_: Key Lock Mounting Bracket
- HLN9154_: Non-Locking Mounting Bracket
- HLN9179_: Quick Release Mounting Bracket
- HLN9733_R: Shorting Plug
- HKN4137_: Low Power Cable to Battery

Control Station Accessories:
- HLN9226_: Mobile Holder
- HLN9886_: Grounding Kit
- HNM3000_: Black Desk Microphone
- HKN9018_: Control Station Cable
- HKN9019_: 16-pin Conductor Cable
- HPN8393_: Power Supply
- HPN9012_: Power Supply (25 W only)
- HKN9088_: Mini_U Antenna Adapter

Accessories / Kits Interfacing with the 16-Pin Connector:
- HKN9242_: 16-pin Accessory Kit with Expanded Connector
- HSN9008_: 16-pin External Speaker for Received Audio, 7.5 W
- HLN3145_R: Public Address Kit
- HSN1000_R: Amplified External Speaker, 6 W

April, 1999
## Accessories

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>HKN9327_R</td>
<td>16-pin Ignition Switch Cable</td>
</tr>
<tr>
<td>HLN9328_R</td>
<td>External Alarm Relay and Cable for Horn &amp; Lights</td>
</tr>
<tr>
<td>HKN9324_</td>
<td>15 ft. Public Address Speaker Cable</td>
</tr>
<tr>
<td>HKN9407_</td>
<td>Cigarette Lighter Adapter w/LED Indicator (25 W only)</td>
</tr>
</tbody>
</table>

## Manuals/Kits:

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1547A</td>
<td>DC Remote Adapter Manual</td>
</tr>
<tr>
<td>L1475A</td>
<td>Tone Remote Adapter Manual</td>
</tr>
<tr>
<td>6880904Z04</td>
<td>DTMF Microphone Operator's Instructions</td>
</tr>
<tr>
<td>6880904Z05</td>
<td>DTMF Microphone Service Manual</td>
</tr>
<tr>
<td>HLN9155</td>
<td>M1225 20-Channel Manual Kit</td>
</tr>
<tr>
<td>HLN9893</td>
<td>M1225 4-Channel Manual Kit</td>
</tr>
<tr>
<td>HVN9054</td>
<td>M1225 Radio Service Software Kit</td>
</tr>
</tbody>
</table>
# Specifications

## General

<table>
<thead>
<tr>
<th></th>
<th>VHF</th>
<th>UHF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model Series:</td>
<td>M43DGC</td>
<td>M44DGC, M34DGC</td>
</tr>
<tr>
<td>Frequency Range:</td>
<td>150-174 MHz</td>
<td>450-474 MHz</td>
</tr>
<tr>
<td>RF Output:</td>
<td>25-40 W</td>
<td>10-25 &amp; 25-40 WW</td>
</tr>
<tr>
<td>Channel Spacing:</td>
<td>12.5 kHz</td>
<td>20/25/30 kHz</td>
</tr>
<tr>
<td></td>
<td>12.5 kHz</td>
<td>20/25 kHz</td>
</tr>
<tr>
<td>Dimensions:</td>
<td>H 1.73&quot; X W 6.61&quot; X D 4.25&quot; (H 44mm X W 168mm X D 108mm)</td>
<td></td>
</tr>
<tr>
<td>Weight:</td>
<td>36 oz. (1.02 kg)</td>
<td></td>
</tr>
<tr>
<td>Channel Capacity:</td>
<td>20 or 4 Channels</td>
<td></td>
</tr>
<tr>
<td>Freq. Separation:</td>
<td>24 MHz</td>
<td></td>
</tr>
<tr>
<td>Input Voltage:</td>
<td>13.6 ±10%</td>
<td></td>
</tr>
<tr>
<td>Current Drain:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standby</td>
<td>300 mA</td>
<td></td>
</tr>
<tr>
<td>Receive @Rated Audio</td>
<td>1.5 A</td>
<td></td>
</tr>
<tr>
<td>Transmit</td>
<td>12.5 A @ 40 W</td>
<td>12.5 A @ 40 W</td>
</tr>
<tr>
<td>Squelch Capabilities:</td>
<td>Tone Coded, Digital Coded and/or Carrier Squelch</td>
<td></td>
</tr>
</tbody>
</table>

## Transmitter

<table>
<thead>
<tr>
<th></th>
<th>VHF</th>
<th>UHF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freq. Stability (-30C to +60C):</td>
<td>±0.00025%</td>
<td></td>
</tr>
<tr>
<td>Spurs/Harmonics:</td>
<td>-23 dBm (5 µW)</td>
<td></td>
</tr>
<tr>
<td>Audio Response*:</td>
<td>+1/-3 dB, relative to 6 dB/octave pre-emphasis, 300-3000 Hz (2550 Hz @ 12.5 kHz)</td>
<td></td>
</tr>
<tr>
<td>FCC Designation:</td>
<td>ABZ99FT3037</td>
<td>ABZ99FT4044, ABZ99FT3038</td>
</tr>
<tr>
<td>FCC Modulation:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20/25/30 kHz</td>
<td>16K0F3E</td>
<td>16K0F3E</td>
</tr>
<tr>
<td>12.5 kHz</td>
<td>11K0F3E</td>
<td>11K0F3E</td>
</tr>
<tr>
<td>Output Impedance:</td>
<td></td>
<td>50 ohms</td>
</tr>
<tr>
<td>Modulation Sensitivity:</td>
<td>80 mV rms for 60% deviation @ 1000 Hz</td>
<td></td>
</tr>
<tr>
<td>FM Noise:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20/25/30 kHz</td>
<td>45 dB</td>
<td>40 dB</td>
</tr>
<tr>
<td>12.5 kHz</td>
<td>40 dB</td>
<td>35 dB</td>
</tr>
<tr>
<td>Audio Distortion:</td>
<td>&lt;3% EIA (@1000 Hz, 60% of Rated Max. Deviation)</td>
<td></td>
</tr>
</tbody>
</table>

## Receiver

<table>
<thead>
<tr>
<th></th>
<th>VHF</th>
<th>UHF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freq. Stability (-30C to +60C):</td>
<td>±0.00025%</td>
<td></td>
</tr>
<tr>
<td>Sensitivity TIA @ 12 dB SINAD:</td>
<td>0.35 µV</td>
<td>0.30 µV</td>
</tr>
<tr>
<td>Squelch (internally pre-set):</td>
<td>10 dB SINAD</td>
<td></td>
</tr>
<tr>
<td>Selectivity TIA:</td>
<td>65 dB</td>
<td>75 dB</td>
</tr>
<tr>
<td>Intermodulation TIA*:</td>
<td>65 dB</td>
<td>75 dB</td>
</tr>
<tr>
<td>Spurious Rejection:</td>
<td>75 dB</td>
<td>70 dB</td>
</tr>
<tr>
<td>Image / Half IF Rejection:</td>
<td>70 dB</td>
<td>70 dB</td>
</tr>
<tr>
<td>Audio Output:</td>
<td></td>
<td>7.5 W @ 5% distortion</td>
</tr>
<tr>
<td>8 ohms (external)</td>
<td>4.0 W Nominal</td>
<td></td>
</tr>
<tr>
<td>16 ohms (internal)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input impedance:</td>
<td>50 ohms</td>
<td></td>
</tr>
<tr>
<td>TIA Usable Bandwidth:</td>
<td>1.2 kHz</td>
<td>2 kHz</td>
</tr>
</tbody>
</table>

* Local mode adds 10 dB protection against wideband interference.

## Military Standards 810 C, D & E for Mounting Accessories

<table>
<thead>
<tr>
<th>Applicable MIL-STD</th>
<th>Required Mounting Accessory</th>
<th>810C</th>
<th>810D</th>
<th>810E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vibration:</td>
<td>Standard Non-Locking Bracket</td>
<td>514.2</td>
<td>8</td>
<td>514.3</td>
</tr>
<tr>
<td>Shock:</td>
<td>Standard Non-Locking Bracket</td>
<td>516.2</td>
<td>1, 3</td>
<td>516.3</td>
</tr>
<tr>
<td>Crash Hazard:</td>
<td>Any M1225 Mounting Accessory</td>
<td>516.2</td>
<td>3</td>
<td>516.3</td>
</tr>
</tbody>
</table>

*SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE*
## Service Aids

The following table lists service aids recommended for working on the M1225 Mobile Radio.

<table>
<thead>
<tr>
<th>Motorola Part No.</th>
<th>Description</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>HLN9214</td>
<td>Radio Interface Box</td>
<td>Enables communication between the radio and the computer's serial communications adapter.</td>
</tr>
<tr>
<td>HSN9412</td>
<td>RIB Power supply</td>
<td>Used to supply power to the RIB.</td>
</tr>
<tr>
<td>HKN9216</td>
<td>Computer Interface cable</td>
<td>Connects the computer's serial communications adapter to the RIB.</td>
</tr>
<tr>
<td>HKN9215</td>
<td>AT to XT Computer adapter</td>
<td>Allows HKN9216 to plug into a XT style communications port.</td>
</tr>
<tr>
<td>HLN9390</td>
<td>Program Test Cable</td>
<td>RIB to Radio Cable</td>
</tr>
<tr>
<td>HKN9217</td>
<td>Power Supply Cable</td>
<td>Connects the power supply to the radio.</td>
</tr>
<tr>
<td>HVN9054</td>
<td>Radio Service Software</td>
<td>Software on 3-1/2 in. diskettes.</td>
</tr>
</tbody>
</table>

## Test Equipment

The following table lists test equipment required to service the M1225 Mobile Radio and other two-way radios.

<table>
<thead>
<tr>
<th>Motorola Model No.</th>
<th>Description</th>
<th>Characteristics</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>R2200, R2400, or R2001 with trunking option</td>
<td>Service Monitor</td>
<td>This monitor will substitute for items with an asterisk *</td>
<td>Frequency/deviation meter and signal generator for wide-range troubleshooting and alignment</td>
</tr>
<tr>
<td>*R1049</td>
<td>Digital Multimeter</td>
<td></td>
<td>Two meters recommended for ac/dc voltage and current measurements</td>
</tr>
<tr>
<td>*S1100</td>
<td>Audio Oscillator</td>
<td>67 to 200 Hz tones</td>
<td>Used with service monitor for injection of PL tones</td>
</tr>
<tr>
<td>*S1053, *SKN6009, *SKN6001</td>
<td>AC Voltmeter, Power Cable for meter, Test leads for meter</td>
<td>1mV to 300V, 10-Megohm input impedance</td>
<td>Audio voltage measurements</td>
</tr>
<tr>
<td>R1053</td>
<td>Dual-trace Oscilloscope</td>
<td>20 MHz bandwidth, 5mV/cm - 20V/cm</td>
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Overview
This section explains, step-by-step, how to disassemble and reassemble the M1225 radio.

Disassemble Radio

IMPORTANT
Before disassembling and reassembling the radio, wear a conducting wrist strap to prevent damage to any component on the main board from electrostatic discharge.

Remove Housing Cover
1. Pull the volume control knob straight off.
2. Remove the housing cover by sliding a flat bladed screwdriver under the cover latch (located bottom of radio) and gently pry upward until the latch disengages. (Figure 1-1.)
3. Slide the housing cover off of the heatsink rails.

Figure 1-1. Remove Housing

Remove Front Panel Display Board
1. Disconnect the flex connector cable from the black header on the main board by gently lifting upwards.
2. Remove the display board by tilting forward slightly and gently lifting upwards.

Remove Mechanical Components from Main Board
Refer to Figure 1-2 for steps 1 through 8 for the removal of the mechanical components from the main board. Refer to the exploded mechanical view diagram for more details.

Figure 1-2. Mechanical Components

1. Pull the 2-pin speaker cable connector upwards to disconnect from the main board.

CAUTION
In order to avoid damage to the speaker, Do Not grasp the speaker cone when removing the rubber gasket/speaker from the heatsink.

2. Grasp the speaker at both edges and slide the rubber grommet/speaker upwards to remove from the heatsink.
3. On the rear gasket, pry the plug out of the square pocket.
4. Lift up the accessory connector flap located on rear of heatsink.
5. Lift and peel off the rear gasket from the heatsink.
6. Disengage the power cable, from the double-D slot of the heatsink, by grasping and rotating the strain relief shoulder away from the PA shield (counterclockwise) and sliding upwards.

7. Remove the shroud by unsnapping the catch-tabs, located on the heatsink’s inside wall, using a flat bladed screwdriver and firmly pulling the shroud away from the heatsink.

8. Gently pry off the PA shield cover using a flat bladed screwdriver.

Remove Main Board

1. Remove the Hex nut from the bottom of the heatsink using a 5/16” nut driver.

2. Remove all 14 mounting screws from the main board using a T10 Torx® driver, being careful not to lose the display board support.

3. Loosen the antenna connection using a 1/2” nut driver.

4. To remove the main board grasp the edge of the main board, the antenna connector, the microphone connector, and the 16-pin accessory connector using both hands and lift upwards and away from the heatsink.

CAUTION
Make sure to avoid damaging the PA stud on the underside of the main board when lifting it upwards and away from the heatsink.

Reassemble Radio

Replace Main Board

1. Carefully place the main board into the heatsink, making sure that the PA stud clears the hole on the bottom of the main board.

NOTE
Make sure that the internal tooth washer and nut of the mini-U connector are on the outside of the heatsink wall.

2. Replace the 14 mounting screws and the display board support (refer to Figure 1-3) into the main board using a T10 Torx driver. Torque the 2 screws on the audio PA and the 2 screws on the transistor and regulator at 6-8 in-lbs. Torque the remaining 10 screws at 8-10 in-lbs.

3. Press down on the antenna connection and tighten using a 1/2” nut driver and torque at 20-24 in-lbs.

4. Rotate the strain relief shoulder away from the PA shield and insert into the double-D slot in heatsink

5. Press the strain relief shoulder downward and rotate (clockwise) toward the PA shield until it is fully seated.

CAUTION
The power cable should be routed around the components properly and gently pressed into position (Figure 1-3).

3. Insert the shroud into the heatsink and press the catch-tabs onto the snaps.

4. Place the rear gasket onto the heatsink, making sure it fits between the wall of the heatsink and the PA frame while firmly pressing the five ribs into the five teardrop indentations on the heatsink.

5. Press the plug of the rear gasket into the square pocket at the rear of the heatsink.

6. Attach the Hex nut to the bottom of the heatsink using a 5/16” nut driver and torque to 5 in-lbs.

7. Snap the PA shield cover into place on the PA shield frame, making sure not to pinch the rear gasket.
8. Slide the rubber grommet/speaker downwards onto the posts on the heatsink with the word TOP facing up.

**CAUTION**
The speaker cable should be routed in front of the 10-position black header on the main board to prevent the housing's rear hook from dislodging and damaging the speaker connector when replacing the housing (Figure 1-3).

9. Connect the speaker connector into the 2-pin jack on the main board.

**Replace Front Panel Display Board**

1. Insert the display board into the slide rails by gently tilting the board slightly forward and gently pushing down until fully seated.

**NOTE**
Check that the tab on the main board is locked into the slot on the display board.

2. Connect the flex connector cable to the black header on the main board.

**Replace Housing Cover**

1. Insert the keypad into the housing and press as shown in Figure 1-4. Check to see that all five buttons on the keypad are secured and protruding properly through the housing.

![Figure 1-4. Insert Keypad](image)

2. With the radio on a flat surface, place the housing approximately halfway on the heatsink guide rails (Figure 1-5).

3. Using both hands, press down on either side of the housing to assure that the heatsink and housing rails are aligned (Figure 1-5).

**NOTE**
*Do not* press on the keypad while sliding the housing onto the heatsink.

4. Slide the housing forward onto the heatsink rails, using both hands. Make sure that the power cord and the rear gasket clear the housing when the housing is flush with the rear of the heatsink.

5. Firmly press the housing cover and the heatsink together until the cover latch snaps into place (refer to Figure 1-6).

![Figure 1-5. Align Housing Cover to Heatsink Rails](image)

![Figure 1-6. Lock Housing Cover into Place](image)

**NOTE**
Verify that the outside corners of the gasket are properly inserted and aligned with the corners of the housing.

6. Insert the volume control knob by twisting the "D" shaft of the knob onto the volume control shaft while pushing inward.
Install an Advantage™ Board into the AdvantagePort™

The M1225 radio has been designed with an AdvantagePort interface that allows compatible Advantage Boards to be field installed.

IMPORTANT
Before disassembling and reassembling the radio, wear a conducting wrist strap to prevent damage to any component on the main board from electrostatic discharge.

Disassemble Radio

1. Refer to the "Remove Cover Housing” segment of this chapter to remove the cover housing.

2. Remove the three mounting screws from main board using a T10 Torx driver (Figure 1-7).

   Figure 1-7. Location of Mounting Screws

Insert Advantage Board

1. Insert the three standoff screws into the main board using a 5mm nut driver and torque at 4.5-5.5 in.-lbs.

   CAUTION
   Avoid excessive force when opening or closing the cover flaps of the 16-pin connectors on both the option and main boards. Damage to the connector’s could result!

2. Locate the 16-pin connector on the Advantage Board and gently lift the cover flap.

3. Locate the 16-pin connector on the main board and gently lift the cover flap.

4. With the component side of the option board facing up, insert and properly align the folded end (blue side up) of the flex connector cable into the 16-pin connector on the Advantage Board.

5. While holding the flex connector cable in place, gently close the cover flap.

6. Insert and properly align the other end (blue side up) of the flex connector cable into the 16-pin connector on the main board.

7. While holding the flex connector cable in place, gently close the cover flap.

8. Align the power cables over the main board so they lay flat.

9. With the component side of the option board facing down, position the holes of the Advantage Board over the standoff screws on the main board (Figure 1-8).

   NOTE
   Make sure that the flex connector cable of the front panel display board is underneath the Advantage Board.

   Figure 1-8. Position of Advantage Board

10. Insert the three plastic screws into the Advantage Board using a straight edge screwdriver and torque at 0.7-0.9 in.-lbs.

11. Refer to the “Replace Housing Cover” segment of this chapter to reassemble the housing cover.
Section 2
Theory of Operation

Overview
This section provides detailed theory of operation for the components of the M1225 mobile radio.

Receiver Circuitry

VHF Receiver Front End
The received signal applied to the radio’s antenna input connector is routed through the harmonic filter and PIN diode antenna switch. In the receive mode, PIN diodes CR2450 and CR2451 are both off, allowing the signal to pass unattenuated to the receiver front end filter. The insertion loss of the harmonic filter/antenna switch is less than 1 dB. The harmonic filter provides 19 dB attenuation for image protection at 240 MHz, with increased attenuation at higher frequencies.

The signal is routed to a fixed-tuned 4 pole capacitive-coupled resonator filter having a 3 dB bandwidth of 50 MHz and a 1 dB bandwidth of 45 MHz centered at 162 MHz. Insertion loss is 1.7 dB. Attenuation for image protection is 42 dB at 240 MHz, with increasing attenuation at higher frequencies.

The output of the filter is matched to the base of RF amplifier Q1, which provides 19 dB of gain and has a noise figure of 3 dB. Current source Q2 is used to maintain the collector current of Q1 constant at 30 mA. Transistors Q1 and Q2 are supplied from the 5R source. This source is switched by transistor Q412 which is controlled by U401-54. 5R is only present in the receive mode. This reduces dissipation in Q1 during transmit. Diode CR1 clamps excessive input signals, protecting Q1.

The output of Q1 is applied to a fixed-tuned 3-pole series-coupled resonator filter having a 3 dB bandwidth of 60 MHz and a 1 dB bandwidth of 45 MHz centered at 162 MHz. Insertion loss is 1.3 dB. Attenuation for image protection is 35 dB at 240 MHz, with increasing attenuation at higher frequencies.

A pin diode attenuator is located between the 3-pole filter and the first mixer. The bias current through this diode is switched by dual-composite transistor switch U2. In the Distance mode, U2 is turned on by a logic high at U2-4 from U401-57. CR2 is forward-biased which bypasses R11, and no loss is introduced. In the Local mode, U2 and CR2 are off (U401-57 is low), inserting 10 dB of attenuation due to R11. Because the attenuator is located after the RF amplifier, receiver sensitivity is reduced only by 5 dB, while the overall third order input intercept is raised by 15 dB. Thus, the Local mode significantly reduces the susceptibility to IM-related interference.

The first mixer, U1, is a passive, double-balanced type. This mixer provides all of the necessary rejection of the half-IF spurious response, since the improvement due to filter selectivity is negligible at 150 MHz. High-side injection at +6 dBm is delivered to the first mixer from the injection buffer, Q271, in the VCO/buffer circuit.

The mixer output is connected to a diplexer network which matches its output to the first two pole crystal filter, Y51A, at the IF frequency of 44.85 MHz, and terminates it in a 51 ohm resistor, R51, at all other frequencies.

UHF Receiver Front End
The received signal applied to the radio’s antenna input connector is routed through the harmonic filter and PIN diode antenna switch. In the receive mode, PIN diodes CR2650 and CR2651 are both off, allowing the signal to pass unattenuated to the receiver front end filter. The insertion loss of the harmonic filter/antenna switch is less than 1 dB.

The signal is routed to a fixed-tuned 3 pole shunt resonator filter having a 3 dB bandwidth of 65 MHz and a 1 dB bandwidth of 40 MHz centered at 462 MHz. Insertion loss is 2.0 dB. Attenuation for image protection is 33 dB at 385 MHz, with increasing attenuation at lower frequencies.

The output of the filter is matched to the base of RF amplifier Q1, which provides 17 dB of gain and has a noise figure of 3 dB. Current source Q2 is used to maintain the collector current of Q1 constant at 30 mA. Transistors Q1 and Q2 are supplied from the 5R source. This source is switched by transistor Q412 which is controlled by U401-54. 5R is only present in the receive mode. This reduces dissipation in Q1 during transmit. Diode CR1 clamps excessive input signals, protecting Q1.

The output of Q1 is applied to a fixed-tuned 4 pole shunt resonator filter having a 3 dB bandwidth of 58 MHz and a 1 dB bandwidth of 40 MHz centered at 462 MHz. Insertion loss is 2.8 dB. Attenuation for
image protection is 43 dB at 385 MHz, with increasing attenuation at lower frequencies.

A pin diode attenuator is located between the 4 pole filter and the first mixer. The bias current through this diode is switched by dual-composite transistor switch U2. In the Distance mode, U2 is turned on by a logic high at U2-4 from U401-57. CR2 is forward-biased which bypasses R11, and no loss is introduced. In the Local mode, U2 and CR2 are off (U401-57 is low), inserting 10 dB of attenuation due to R11. Because the attenuator is located after the RF amplifier, receiver sensitivity is reduced only by 5 dB, while the overall third order input intercept is raised by 15 dB. Thus, the Local mode significantly reduces the susceptibility to IM-related interference.

The first mixer, U1, is a passive, double-balanced type. This mixer provides all of the necessary rejection of the half-IF spurious response, since the improvement due to filter selectivity is negligible at 474 MHz. Low-side injection at +6 dBm is delivered to the first mixer from the injection buffer, Q271, in the VCO/buffer circuit.

The mixer output is connected to a diplexer network which matches its output to the first two pole crystal filter, Y51A, at the IF frequency of 44.85 MHz, and terminates it in a 51 ohm resistor, R51, at all other frequencies.

**Receiver Back End**

Q51 amplifies the IF signal from Y51A by approximately 20 dB. The output of Q51 is matched to a second two pole crystal filter, Y51B. The overall 3 dB bandwidth of the crystal filters is 17 kHz. The signal from Y51B is applied to the input of the receiver system IC U51-13. Diode CR51 prevents overload of the second mixer in the receiver system IC.

Q52 is controlled by crystal Y52 which provides the low side injection second local oscillator signal applied to U51-12. The filtered and amplified 44.85 MHz first IF signal mixes with the second local oscillator signal at 44.395 MHz to produce a second IF signal at 455 kHz. The second IF signal is then filtered by switchable ceramic filter FL51 or FL53, amplified, then filtered by switchable ceramic filter FL52 or FL54 and applied to the audio detector. U401-53 controls the bandwidth select switch, Q53, to switch the narrower bandwidth ceramic filters FL51 and FL52 for 12.5 kHz channel spacing or the wider ceramic filters FL53 and FL54 for 20/25/30 kHz channel spacing.

The audio detector is a phase-locked loop type. The free-running oscillator frequency is determined by capacitor C61. Detected audio from U51-31 is routed via noise-peak limiting stage U552 to Rx IN and PL IN ports on the audio filter IC (AFIC) U401 (pins 14 and 15 respectively), and also via CMOS switch U553B to op-amp U551B, where output is routed to the accessory connector J3-11 (see "Low-Level Rx Audio"). U51 also contains the carrier-squelch circuitry. When an on-channel signal is present, the amount of high-frequency audio noise, at the detector, is reduced. This change in noise level is sensed to indicate the presence of an on-channel signal. The bandwidth of the sampled noise is determined by C64, C65, R59, R60, and R71 switched by Q54. U401-53 controls Q54 for 12.5 kHz or 20/25/30 kHz channel spacing operation. Squelch sensitivity is adjusted electronically by an attenuator in U402. Squelch noise is routed from U51-26 to U402-23, and the adjusted noise level is returned from U402-26 back to U51-23. This noise level is detected in U51 and compared to a preset threshold. Noise levels greater than a preset threshold, indicating weak or no signal present, cause U51-18 to go low. This is routed to microcomputer port FC5 (U401-55). When the noise level decreases below the threshold, due to on-channel quieting, U51-18 and therefore U401-55 go high. This indicates an on-channel signal is present, and the microcomputer unmutes the audio path.

Components R57, C68 and C69 determine squelch time constants as a function of the charging currents supplied by U51. These charging currents vary from weak to strong signal conditions, providing a variable squelch closing time-constant. For weak signals the time constant is long to minimize "chattering" or rapid muting and unmuting of the audio. For strong signals, where the carrier-absent to carrier-present conditions are substantial, the closing time-constant is shortened to minimize the length of the "squelch-tail".

**Frequency Generation System**

The frequency generation system utilizes two IC's, the Fractional-N Synthesizer (U201) and the VCO/Buffer (U251). Designed to maximize compatibility, the two IC's provide many functions which would normally require additional circuitry.

The frequency generation circuitry is supplied from the analog 5 V supply regulated by U405. The synthesizer IC further filters this voltage (SUPPFOUT, U201-18, 4.65 Vdc) and supplies it to the VCO/Buffer IC.

The synthesizer also interfaces with the logic and AFIC circuitry. Synthesizer programming is accomplished through the SR DATA (U201-5), SR CLOCK (U201-6), and SYN LE (U201-7) lines by microcomputer U401. A serial stream of 98 bits is sent whenever the synthesizer is programmed. Synthesizer lock is indicated by a logic high at LOCK DET pin U201-2, and a logic low indicates out-of-lock.

In the transmit mode, modulation from the attenuators in the AFIC (U402-27 and 28) is resistively summed and applied to U201-8. The audio is digitized within U201 and applied to the loop divider to provide the low-port modulation. The audio is also routed through an internal attenuator for balancing of the high and
low port modulation, before being applied to the VCO from U201-28.

The AFIC employs switched-capacitor filters which require an external 2.1 MHz clock signal. This clock is generated in U201 by dividing the 16.8 MHz reference oscillator. The signal, at U201-11, is filtered, attenuated, and applied to U402-43 at a level of approximately 2 Vp-p.

**Synthesizer**

The Fractional-N synthesizer uses a 16.8 MHz crystal (Y201) to provide the reference frequency for the system. External components C201-3, R201-2, and CR201 are also part of the temperature-compensated oscillator circuit. The dc voltage applied to varactor CR201 is determined by a temperature compensation algorithm within U201, and is specific to each crystal Y201 based on a unique code assigned to the crystal.

The divided frequencies of the reference oscillator and the VCO signal (as applied to U201-20) are compared to generate the necessary correction voltage, or steering line voltage, which maintains the proper VCO frequency. The steering line voltage from U201-29 is filtered and applied to varactors CR241 and CR251 to control the frequencies of the receive and transmit VCOs respectively. To achieve fast lock time, an internal adaptive charge pump provides higher momentary current capability at U201-31 than in the normal steady-state mode. The normal and adapt charge pumps receive their dc supply from a voltage-multiplier circuit which includes CR211, CR212 and associated capacitors C210-C216. By combining two 5 V square waves which are 180 degrees out-of-phase and adding this to the regulated 5 V supply, a source of approximately 12.6 Vdc is available at U201-32. The current for the normal mode charge pumps is set by R242. The pre-scaler for the loop is internal to U201 with the value determined by the frequency band of operation.

**VCO**

The VCO (U251) used in conjunction with the Fractional-N synthesizer (U201) generates an RF signal for both receive and transmit modes. The TRB line (U251-5) determines which oscillator and buffer is enabled, as described below. A sample of the RF signal from the enabled oscillator is routed from U251-23 to the prescaler input U201-20 via a matching network. After frequency comparison with the reference in the synthesizer, a resultant control voltage is applied to the varactors CR241 and CR251. This voltage, when locked, is between 3 and 10 V depending on VCO frequency.

In the receive mode, U251-5 is low, enabling the receive VCO and buffer in U251. The RF output signal at U251-2 is further amplified by Q271, low-pass filtered, and matched to the 50 ohm injection port of first mixer U1 at a level of +6 dBm.

During transmit, U251-5 is high, activating the transmit VCO and buffer. The RF output signal at U251-4 is low-pass filtered and matched into Q281 for further amplification before being applied to the RF power amplifier. A resistive attenuator (R284 through R286) isolates the VCO and buffer from impedance variations presented by the power amplifier for improved stability. The power output presented to the first stage (Q2610) of the RF power amplifier is +13 dBm.

**Transmit and Receive Audio Circuitry**

The majority of Rx and Tx audio processing is performed by U402, the Audio Filter IC (AFIC), which provides the following functions:

- Tone/Digital PL encoding and decoding
- PL rejection filter in Rx audio path
- Tx pre-emphasis amplifier
- Tx audio limiter
- Post-limiter (splatter) filter
- Tx deviation adjust digitally-controlled attenuators
- Programmable microphone gain attenuator
- Carrier squelch digitally-controlled attenuator
- Microcomputer output port expansion
- 2.5 Vdc reference source

The parameters of U402 which are programmable are selected by the microcomputer via the SR CLOCK (U402-39), SR DATA (U402-38) and chip enable (U402-41) lines.

**Rx Audio Path**

**Low-Level Rx Audio**

Detected audio from the IFIC U51-31 is routed via C553 to the switchable-gain limiter stage U552. The gain of limiter stage U552 is changed for 12.5 kHz or 25 kHz channels so that its output limits at slightly greater than full system deviation in either case. This limits the loudness of noise relative to voice during fading, weak signal conditions and squelch tails. Output is taken from this stage at two places. Pin 4, which is the (+) input, serves as an output which feeds AFIC ports Rx IN (pin 14) and PL IN (pin 15) via C551. The feedback around the op amp stage maintains the signal at U552-4 exactly equal to the signal applied to the (+) input, but the signal at U554-4 benefits from the selectable noise limiting threshold. Gain adjustments in the receive audio path for 12.5 or 25 kHz channels are then made in the AFIC. A second output from the limiter stage is taken at pin 1 and is affected by the gain change of U552 so that the level is a constant 840 mV rms at 60% deviation for either 12.5 or 25 kHz channels. This
The audio applied to the AFIC at U402-14 (Rx IN) is sharply high-pass filtered to remove all PL and DPL tones below 300 Hz. Audio is then routed through a digitally controlled attenuator which is set to approximately 6 dB attenuation. This attenuation is non-adjustable and maintains the output at U402-31 (Rx OUT) at a fixed and defined level of 450 mV rms for 60% deviation, since this level is applied to the AdvantagePort connector (J13-6). Receive volume adjustment is accomplished at a later point using the volume control R554. The internal de-emphasis characteristic within U402 is enabled, with the result that audio at U402-31 is de-emphasized but unmuted.

This audio signal is processed by the option board if present, or passed through resistor R551 if no option board is installed, and then fed to the expander portion of the compander IC U555. The operation of the compander is described below. The output from the compander IC is routed through mute gate U554D, amplified by U551A and fed to the volume control, and also to handset audio buffer U551D (see "Handset Audio Path") and analog switch U553B (see "Accessory Connector Rx Audio Path").

Audio Power Amplifier

Audio from the wiper of the volume control is amplified by the audio power amplifier IC U501. This is a bridge amplifier delivering 7.8 V rms between pins 4 and 6 without distortion. This is sufficient to develop 7.5 watts of audio power into an external 8 ohm load, or approximately 4 watts of audio power into an internal 16 ohm speaker (under this condition, undistorted output voltage swing exceeds 8 volts rms). The audio power amplifier is muted whenever speaker audio is not required, to reduce current drain and eliminate noise in the speaker. The audio amp is muted when U501-8 is low. This occurs if Q501 is saturated (U402-9 high) or when the radio is turned off. The current drain into supply pin U501-7 is negligible when U501-8 is low.

Because the power amplifier is a bridge-type, neither speaker terminal is grounded. Care should be taken that any test equipment used to measure the speaker audio voltage does not ground either speaker output terminal, otherwise damage to the audio power amplifier IC may result. If the test equipment input is not isolated from ground, voltage measurements may be made from one of the speaker output terminals (J3-1 or J3-16) to ground, in which case the voltage indicated will be one half of the voltage applied to the speaker or load resistor. When an 8-ohm load resistor is used, it should be connected across pins 1 and 16 of J13, never to ground.

Handset Audio Path

Rx audio from U551A-1 is amplified by op amp U551D and applied to the microphone connector J3-8 for use with a telephone-type handset. This audio is de-emphasized, and muted by U554D. It is also affected by any receive audio processing circuits on the option board, if installed, and by the compander, if enabled. When the radio has been programmed for handset operation, the audio power amplifier is muted whenever the handset is off-hook by a logic high from U402-9. This silences the speaker when the handset is in use.

Accessory Connector Rx Audio Path

Rx audio is amplified by stage U551B and is available at the accessory connector pin 11. This audio may be one of two types, depending on the RSS programming of analog switch U553B.

If U553B-10 is programmed high, the audio fed to U551B comes from the receiver's detector audio via a switchable-gain path using R577, R578 and U554A. In this case, audio at the accessory connector (J3-11) is "flat" (non-de-emphasized) and unmuted.

If U553B-10 is programmed low, the audio fed to U551B comes from U551A. Audio at J3-11 is de-emphasized and muted. This path will also be affected by any receive audio processing circuits on the option board, if installed, and by the compander, if enabled.

PL Decoder

Detected Rx Audio which has been limited by stage U552 is applied to the AFIC PL IN port (U402-15), where it first passes through the Tone PL filter or Digital PL filter, depending on the PL option selected for the current operating mode. Filtered PL is then coupled to the PL detector circuit, with detected output at U402-35. The detected PL signal is coupled from U402-35 to microprocessor port PA1 (U401-15) where algorithms perform the final PL decoding. Data for the tone PL frequency or Digital PL code for each mode is programmed through the Radio Service Software.

AdvantagePort™ Internal Option Board Rx Audio Path

De-emphasized, unmuted audio is available at J13-6 for use by an internally installed option board. If this audio is to be processed and returned to the radio's receive audio path, the processed audio will be returned from a low-impedance source on the option board to J13-8. The unprocessed audio through R551 is shunted due to the low source impedance of the option
board at J13-8. Since the gain of the AFIC is different for 12.5 or 25 kHz channels, the RX audio level at J13-6 is always 450 mV at 1 kHz and 60% deviation, regardless of the channel spacing. Similarly, audio returned to J13-8 from the option board should be supplied at a level of 130 mV rms at 60% deviation, regardless of the channel spacing.

Non-de-emphasized, unmuted audio is available at J13-16. Options requiring non-de-emphasized audio may use this, or may re-pre-emphasize the audio at J13-6, depending on the design of the option board. Because the gain of stage U552 is different for 12.5 or 25 kHz channels, the RX audio level at J13-16 is always 210 mV at 60% deviation, regardless of the channel spacing.

Noise Squelch Attenuator

The AFIC contains a 16 step programmable digital squelch attenuator whose input is U402-23 and output is U402-26. Noise squelch sensitivity is set using RSS, with open squelch at step 0 and maximum (tight) squelch at step 15.

Tx Audio Path

Voice Path via Front Panel

Microphone audio from the front panel mic jack J5-5 is attenuated from 80 mV rms (for 60% deviation at 1 kHz) to 65 mV by R658 and R659. When mic PTT is sensed from J5-6, CMOS gate U554C is enabled by a logic low at U402-5, which is inverted by Q651 to provide a logic high at U554C-6.

This audio is fed to the compressor IC where it is amplified from 65 mV to 100 mV by an op amp gain stage (pins 7 and 6) and then applied to the compressor portion of the compressor (pin 3). The output (pin 2) is attenuated back to the original 65 mV rms level by another op amp stage (pins 9 and 10) and applied as a low-impedance source to the Tx Audio Send pin of the AdvantagePort connector (J13-10).

Voice Path via Accessory Connector

Microphone audio from an accessory such as a desk set applied to External Mic Audio input J3-2 is attenuated from 80 mV rms (for 60% deviation at 1 kHz) to 65 mV by R666 and R665. When External Mic PTT is sensed at J3-3 (or from any programmable input to which Ext Mic PTT has been assigned), CMOS gate U554B is enabled by a logic high at U401-47.

This audio is fed to the compressor IC and processed as described above for the Voice Path via Front Panel.

AdvantagePort™ Internal Option Board Tx Audio Path

Non-pre-emphasized microphone audio is available at J13-10 for use by an internally installed option board. If this audio is to be processed and returned to the radio's transmit audio path, the processed audio will be returned from a low-impedance source on the option board to J13-12 (Tx Audio Return). The unprocessed audio through R654 is shunted due to the low source impedance of the option board at J13-12. Since deviation is adjusted appropriately by the AFIC for 12.5 or 25 kHz channels, the TX audio level at J13-10 and J13-12 is always 65 mV for 60% deviation at 1 kHz, regardless of the channel spacing.

Some option boards must be able to modulate the transmitter with very low frequency data. The Post-Limiter Flat Tx Audio Return pin (J13-2) is used for this application. Audio from this pin is routed to the AUX Tx IN pin on the AFIC (U402-20) via summing op amp stage U551C. A level of 150 mV rms will produce 60% deviation regardless of channel spacing. This path bypasses the limiter stage in the AFIC, therefore the option board must provide the necessary amplitude limiting of this signal to prevent overdeviation. The AUX Tx IN path of the AFIC must be enabled via software control for this path to be active.

Pre-emphasis of Microphone Audio Signals

Pre-emphasis of the front panel or accessory microphone audio signal occurs after the AdvantagePort option board processing has occurred. Series capacitor C651 provides the pre-emphasis characteristic of audio applied to the Tx IN pin of the AFIC (U402-17). This pin is the summing junction of an inverting op amp gain stage within U402. Audio processing, including limiting, splatter filtering, and level adjustment are performed within U402. The outputs of the two programmable deviation-adjustment attenuators (U402-27 and 28) are resistively summed and applied to the VCO modulation input of the frequency generation system.

Flat (Non-Pre-Emphasized) Tx Audio Path via Accessory Connector

Audio applied at J3-5 may be routed to the transmitter either before the limiter (PRE-LIM) or after (POST-LIM). This is programmed using RSS. The path is controlled by CMOS gate U553C, as controlled by U402-8 (low for PRE-LIM, high for POST-LIM). When the POST-LIM path is chosen, audio is routed via R671 and op amp U551C to the AUX TX INPUT (U402-20), therefore this input of the AFIC must be enabled via software control whenever an accessory connector PTT is sensed at J3-3 (or from any programmable input to which Accessory PTT has been assigned).
If the PRE-LIM path is chosen, audio is coupled by C655 and R670 to the summing input of an op amp within U402 (pin 17). Because R670 is significantly larger than R671, R669 provides a charging path for C655 when the PRE-LIM route is selected which is equivalent to the charging path via R671 in the POST-LIM path.

Audio present at J3-5 is muted during transmitter key-up until the frequency synthesizer has settled and locked on-frequency. This prevents unintentional frequency offset due to the presence of modulation while PTT is keyed. Muting occurs when U401-9 provides a low to U553A-11. While muted, R672 maintains the same dc bias on C655 to prevent switching transients.

**Tx Data Encoder (D/A Converter)**

Data such as MDC or DTMF signalling can be encoded into the TX audio path by generating the waveform at ports PA3, PA4 and PA5 of U401 (pins 13, 12 and 11 respectively). These outputs are resistively summed and weighted to allow either square waves or pseudosine waves to be encoded. Op amp U551C provides active summing and outputs the signal to the AUX Tx IN port of the AFIC (U402-20). Connection is also made to the AUX Rx IN port (U402-13) to allow true sidetones to be heard, for example when DTMF tones are encoded. The AUX Tx IN path of the AFIC must be enabled via software control when the data encoder is operating.

The data encoder circuit may not be utilized in all models.

**Compadner Operation**

The compander circuit of U555 is used to improve the signal-to-noise ratio of the voice communications path. This is accomplished by compressing the microphone signal during transmit by a ratio of 2:1 so that a 60 dB range of level changes at the microphone are reduced to only a 30 dB change before being transmitted. A complimentary expander circuit in the receiver audio path restores the 30 dB range of the received signal to its original 60 dB range before being applied to the speaker. Any noise occurring in the over-the-air transmission which is more than 30 dB below full deviation is reduced to greater than 60 dB below the peak voice level at the speaker, making such noise essentially inaudible.

The effectiveness of the compander system requires that both the transmitter and receiver utilize companding. It is possible to program the compander off on a per-channel basis using RSS, for use in systems with other radios that do not have the compander feature. The compander is active when U555-8 is low, and is bypassed when U555-8 is high. When in the bypass mode, the gain of the compressor (pin 3 in, pin 2 out) and expander (pin 14 in, pin 15 out) circuits is unity.

Q553 and C581 keep the compander turned off for approximately one second when the radio is turned on, to allow the compander circuits sufficient time to stabilize. At turn-on, U401-30 pulses low, which turns on Q553 and quickly charges C581 to 5 V, bypassing the compander. If the compander should be on, U401-30 stays high, and C581 discharges due to the internal resistance of U555-8. After one second, the voltage at U555-8 is low enough to enable the compander. If the compander should be off, U401-30 remains low, keeping Q553 on and U555-8 high.

Q554 and Q555 are used to increase the receive audio path gain by approximately 4 dB whenever the compander is turned on. This maintains the same subjective audio level for both compander and non-comparator channels.

**Public Address Operation**

When the public address switch box and amplified speaker(s) accessories are used, and the radio has been programmed by RSS for public address, operation is as follows:

Turning on either the INT PA or EXT PA switches on the public address switch box provides a low at pin 14 of accessory connector J3. This enables public address operation of the radio. In this condition, radio receiver operation is unaffected, but keying of the transmitter is inhibited. If a MIC PTT is sensed from microphone jack J5-6, both the INT MIC ENABLE and EXT MIC ENABLE lines go high (U402-5 is low and U401-47 is high). This turns on both mic audio gates U554C and U554B, and allows audio from the microphone jack J5-5 to be routed directly to accessory connector J3-2. Mic audio from J3-2 is then routed to the selected public address amplified speakers by the public address switch box.

To prevent loading of the mic audio signal and loss of low frequency response, U651 senses that both INT MIC and EXT MIC enable lines are high and provides a low at its output, turning off U652 and removing the loading of R665 from the audio path. At all other times, U652 is on to provide microphone bias voltage to the external mic input via R665.

**Transmitter Circuitry**

**VHF 40 Watt Transmitter RF Power Amplifier**

The 40 watt VHF power amplifier is designed to cover the range of 150-174 MHz and has four stages. The first stage, Q2410, operates in Class A from the 8T source. It provides 13 dB of gain and an output of 400 mW.

The second stage, Q2420, has a nominal gain of 9.4 dB and power output of up to 3.5 watts. The output of this
stage is adjusted by the controlled B+ voltage which supplies its collector. (VB+ max = 6.55 V).

The third stage, Q2430, operates in Class C with 8.1 dB gain and output power up to 22 watts. Collector voltage is directly from UNSW B+.

The fourth stage, Q2440, is the final RF power amplifier, which operates in Class C, is directly from UNSW B+. It provides up to 65 watts output.

A directional coupler, located between the final power amplifier and the harmonic filter, monitors the forward and reflected power. The sampled RF is rectified by diodes CR2480 (forward power) and CR2481 (reflected power) and the resulting dc voltage is routed to the power control circuit.

The antenna switch consists of two pin diodes, CR2450 and CR2451. L2452 and C2450, combined with the “on” inductance of CR2451, form a series resonant circuit to lower the shunt impedance presented by CR2451 when it is turned on. In the receive mode, both diodes are off. Signals applied at the antenna jack J1 are routed, via the harmonic filter, through L2451 and C2453 to the receiver input. In the transmit mode, 8T is present and both diodes are forward-biased into conduction. The transmitter RF from Q2440 via the directional coupler is routed through CR2450, and via the harmonic filter to the antenna jack. CR2451 conducts, shunting RF power and preventing it from reaching the receiver. L2451 is selected to appear as a 1/4 wave at VHF, so that the low impedance of CR2451 appears as a high impedance at the junction of CR2450 and the harmonic filter input. This provides a high series impedance and low shunt impedance divider between the power amplifier output and receiver input.

The harmonic filter is a seven pole 0.1 dB ripple Chebyshev low pass filter with a 3 dB frequency of approximately 600 MHz and less than 1 dB insertion loss in the passband.

**UHF 10-40 Watt Transmitter RF Power Amplifier**

The 40 watt UHF power amplifier is designed to cover the range of 450-474 MHz and has four stages. The first stage, Q2610, operates in Class A from the 8T source. It provides 11.8 dB of gain and an output of 300 mW.

The second stage, Q2620, has a nominal gain of 8.2 dB and power output of up to 2 watts. The output of this stage is adjusted by the controlled B+ voltage which supplies its collector.

The third stage, Q2630, operates in Class C with 8.1 dB gain and a power output of up to 13 watts. Collector voltage is directly from UNSW B+.

The fourth stage, Q2640, is the final RF power amplifier, which operates Class C directly from UNSW B+. It provides up to 30 watts output for low power and 50 watts output for high power.

A directional coupler, located between the final power amplifier and the harmonic filter, monitors the forward and reflected power. The sampled RF is rectified by diodes CR2680 (forward power) and CR2681 (reflected power) and the resulting dc voltage is routed to the power control circuit.

The antenna switch consists of two pin diodes, CR2650 and CR2651. L2652 and C2650, combined with the “on” inductance of CR2651, form a series resonant circuit to lower the shunt impedance presented by CR2651 when it is turned on. In the receive mode, both diodes are off. Signals applied at the antenna jack J1 are routed, via the harmonic filter, through L2651, C2653, and L2664 to the receiver input. In the transmit mode, 8T is present and both diodes are forward-biased into conduction. The transmitter RF from Q2640 via the directional coupler is routed through CR2650, and via the harmonic filter to the antenna jack. CR2651 conducts, shunting RF power and preventing it from reaching the receiver. L2651 is selected to appear as a 1/4 wave at UHF, so that the low impedance of CR2651 appears as a high impedance at the junction of CR2650 and the harmonic filter input. This provides a high series impedance and low shunt impedance divider between the power amplifier output and receiver input.

The harmonic filter is a seven pole 0.1 dB ripple Chebyshev low pass filter with a 3 dB frequency of approximately 600 MHz and less than 1 dB insertion loss in the passband.

**Power Control Circuit**

The power control circuit is a dc-coupled amplifier whose output is the controlled voltage applied to the second stage of the RF power amplifier (Q2420 in VHF or Q2620 in UHF).

The input voltage to U451A-2 is a dc voltage from the directional coupler forward power detector, and is proportional to RF power output. This is compared to a dc voltage applied to U451A-3 which is proportional to the desired output power setting. This voltage is obtained by integrating a series of square wave pulses from port PH1 of the microprocessor (U401-26). The duty cycle of these pulses is varied in proportion to the desired output power setting. Components R458, C467, R457 and C458 integrate the PWM pulses into a smooth dc voltage.

The power control loop varies the output of stage Q2420 or Q2620 as necessary to keep equal voltages at U451A pins 2 and 3, and thus maintains forward power at the adjusted setting.

Under conditions of poor antenna match resulting in high reflected power, the dc voltage at U451A-3 is
reduced due to a lowering of the voltage at U451B-7. This is interpreted by the power control circuit as a lowering of the desired output power.

The temperature-sensing circuit protects the PA devices from excessively high temperatures. As the PA temperature increases, the resistance of thermistor R462 decreases. This causes Q453 to conduct, reducing the voltage at the base of Q452. This reduces the conduction of series pass device Q451, lowering the control voltage and therefore the output power.

Over-voltage protection prevents the control voltage from rising so high that the subsequent transmitter stages may be overdriven. Zener diode VR451 conducts when the control voltage exceeds 5.3 V in VHF models or 10.6 V in UHF models. This causes Q453 to conduct, lowering the control voltage as described earlier.

**PTT Circuits**

The logic system uses a single microcomputer A/D input port PE1 (U401-36) to distinguish between two different types of PTT information. This is done by assigning different voltage levels to the different PTT functions as follows:

- 0 to 2.1 Vdc (0.6 Vdc typ): Microphone PTT
- 2.2–3.6 Vdc (2.6 Vdc typ): Accessory PTT
- 4.75 to 5.0 Vdc (5.0 Vdc typ): Receive Mode

A microphone connected via the front panel jack J5 must present a low of less than approximately 2.0 V dc to be correctly interpreted as MIC PTT and cause the appropriate audio paths to be enabled. Similarly, an accessory whose PTT output is connected to J3-3 must present a low of less than approximately 2.0 V dc to be interpreted as an accessory PTT. This voltage is shifted to the range between 2.2 and 3.6 V by series resistor R432.

Some accessories connected to J3 need to sense microphone PTT by looking for a low at J3-3. Diode CR405 causes J3-3 to be pulled low whenever microphone connector J5-6 is low.

**Programmable I/O's**

Pins 4, 6, 8, 9, 12, and 14 are programmable I/O's. They are used to control external accessories by the radio, or for control of radio functions by accessories.

Pin 4 is an output only. When U401-21 is high, Q901 and Q902 are on, and pin 4 is pulled high to the battery voltage. This is normally used to turn on a relay for activating the vehicle's horn or lights.

Pin 6 is an input only. Normally, R905 pulls pin 6 high, turning on Q903 and pulling U401-45 low. If pin 6 is pulled low, U401-45 goes high.

Pin 8 is an I/O (input and output). To function as an input, Q905 is turned off by keeping U401-20 low. Then, R907 pulls pin 8 high, turning on Q904 and pulling U401-44 low. If pin 8 is pulled low, U401-44 goes high. To function as an output, Q905 pulls pin 8 low whenever U401-20 is high.

Pin 9 is an input only. Normally, R909 pulls pin 9 high, turning on Q906 and pulling U401-46 low. If pin 9 is pulled low, U401-46 goes high. The emergency switch accessory, if used, is connected here.

Pin 12 is another I/O. To function as an input, Q909 is turned off by keeping U401-19 low. Then, R913 pulls pin 12 high, turning on Q908 and pulling U401-43 low. If pin 12 is pulled low, U401-43 goes high. To function as an output, Q909 pulls pin 12 low whenever U401-19 is high.

Pin 14 is also an I/O. To function as an input, Q911 is turned off by keeping U401-22 low. Then, R915 pulls pin 14 high, turning on Q910 and pulling U401-42 low. If pin 14 is pulled low, U401-42 goes high. To function as an output, Q910 pulls pin 14 low whenever U401-22 is high.

Zener diodes and bypass capacitors on each programmable I/O line prevent damage or abnormal operation due to ESD transients or RF fields.

The extent to which programmable I/O functions are supported may vary with different radio models. RSS allows the functions which are supported to be programmed.

**DC Regulation and Distribution**

Unswitched B+ supplies operating voltage directly to the RF power amplifier third and fourth stages, the power control series pass device Q451-E, the RAM keep-alive constant voltage supply to U401-62, the audio power amplifier supply pin U501-7 and, via fuse F401, to the on-off switch and external alarm switch transistor Q902-E. All of these circuits draw negligible current when the radio is turned off (less than 15 mA total).

When the on-off switch is "on," battery voltage is applied to 8 volt regulator U406, and via R502 to pin 8 of the audio power amplifier U501 which turns it on unless muted by Q501. The regulated output of U406 is routed to the display board for backlighting, to 8T transistor switch Q414, to U51 pins 16 and 17, to op amp U551 supply pin 4, and to the inputs of the 5 volt regulators U404 (digital) and U405 (analog). Separate analog and digital regulators are used to minimize microcomputer noise from being introduced into sensitive VCO and receiver circuits. The digital 5V regulator includes a reset timer which holds the reset line U404-3 low for a predetermined time after the radio is turned on. Zener diodes on the 8V and digital 5V lines minimize susceptibility to ESD damage.
Ignition control of the radio is accomplished by removing fuse F401. The radio will only be able to turn on if battery voltage from the vehicles ignition switch is applied to accessory connector J3 pin 10. This voltage is routed to the on-off switch.

20-Channel LCD Front Panel Display Board

The 8-character display board contains back lighting LED's, and an LCD that is driven by the LCD driver IC, U1101. When the LCD driver, U1101, is enabled via the CE (Chip Enable) input, the desired display information is then loaded serially via the SR Data line into U1101 from the microprocessor. U1101 also has a clock input that is connected to the main board SR Clock.

The back lighting for the 8-character display board can be toggled between two colors, amber and green per the users choice. This color choice for the LED's is controlled by the microprocessor, which in turn gets its input from either the RSS setup, or one of the pushbuttons if so enabled. Each color of back lighting is produced by 12 pairs of LED's, which are turned on by applying a ground to the cathodes of the 12 pairs of LED's.

To enable the amber LED's, a DC level of 5 V from the microprocessor is applied to the base of Q1108. This 5 V saturates Q1108 which connects a ground to the amber LED cathodes and also the base of Q1107. With the base of Q1107 grounded, the transistor operates in the cutoff mode which leads to the collector having a potential of ~8 V, which is also applied to the cathode of the green LED's.

To enable the green LED's, a DC level of 0 V (ground) to the base of Q1108 keeps Q1108 in cut-off mode which leads to the collector of Q1108 having a potential of 8 V. This 8 V potential on the collector of Q1108 is also applied to the base of Q1107 via R1125, thus saturating Q1107 and connecting the green LED's to ground.

The six pushbuttons apply voltage to the bases of six digital transistors, Q1101 through Q1106. The appropriate transistor, in turn, grounds a tap on the series resistor ladders R1117 through R1122, producing a different DC level depending on which button is pressed. These DC levels are interpreted by an A/D input of the microprocessor (U401-37) and the corresponding function is enabled. The transistors ensure that the DC ladder voltage is consistent, although the series resistance of the keypad may vary.

4-Channel LED Front Panel Display Board

The LED display board contains back lighting LEDs for the keypad, channel indicator LEDs; and status indicators for transmit, monitor, and options. The channel and status display information is loaded serially into the shift register, U101. This information is then latched and turns on the LEDs, DS101 - DS105 and DS1012 - DS1014 via the driver transistors, Q1001 - Q1008.

The six pushbuttons apply voltage to the bases of six digital transistors, Q1009 through Q1014. The appropriate transistor, in turn, grounds a tap on the series resistor ladders R1017 through R1022, producing a different DC level depending on which button is pressed. These DC levels are interpreted by an A/D input of the microprocessor (U401-37) and the corresponding function is enabled. The transistors ensure that the DC ladder voltage is consistent, although the series resistance of the keypad may vary.
Overview

This section contains 5 troubleshooting tables for the following M1225 components:

- Receiver (all models)
- Transmitter (all models)
- Synthesizer (all models)
- Voltage Controlled Oscillator (VCO) (all models)
- Microprocessor (all models)
NO POWER OUTPUT AT ANTENNA

HIGH B+ CURRENT (>8A @ 25W POWERTSET) 
(>13A @ 40W POWERTSET)
B+ CURRENT DRAW?

LOW B+ CURRENT (<5A @ 25W POWERTSET) 
(<8A @ 40W POWERTSET)

CHECK REFLECTED POWER

CHECK B+ ON DRIVER AND FINAL STAGES

YES

REFLECTED POWER LEVEL GOOD? (<1.0 V)

NO

1.) CHECK FOR INCORRECT OR DAMAGED PARTS IN FINAL STAGES.
2.) VERIFY B+ FEED CIRCUIT INTEGRITY. (I.E. CONDITIONAL SHORTS.)

1.) CHECK PIN DIODES/BT BIAS.
2.) VERIFY CORRECT COMPONENTS IN HARMONIC FILTER.
3.) TROUBLESHOOT POWER CONTROL CIRCUITRY.

1.) CHECK FOR INCORRECT OR DAMAGED PARTS IN FINAL STAGES.
2.) VERIFY B+ FEED CIRCUIT INTEGRITY (I.E. CONDITIONAL OPENS.)

TROUBLESHOOT POWER CONTROL CIRCUIT AND/OR VERIFY POWERTSET USING RSS

VCONTROL LOW
(COLLECTOR Q451:<4.5V @ 25W/40W POWERTSET <3.5V @ 10W POWERTSET)

TROUBLESHOOT VCO

VCONTROL HIGH
(COLLECTOR Q451>10.0V)

VERIFY VCO OUTPUT (>13DBM)

YES

P.A. STAGE(S) BAD:
1.) VERIFY GAIN FROM INDIVIDUAL P.A. STAGES.
2.) REPLACE LOW/NO GAIN DEVICE(S).

NO

IS CONTROL VOLTAGE HIGH OR LOW?

VCO OUTPUT GOOD?
Troubleshooting Flow Chart for Synthesizer (All Models)
Section 4
Expanded Accessory Connector

General

The following is a description of the pin functions on the Expanded Accessory Connector for the M1225 mobile radio. Refer to Figure 1 for pin locations in the connector housing.

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>External Speaker (−)</td>
<td>Connect external 8-ohm speaker to pins 1 and 16. CAUTION: Bridge-type output. Neither pin 1 nor 16 is ground.</td>
</tr>
<tr>
<td>2</td>
<td>External Mic Audio</td>
<td>Input impedance: 500 ohms. 80 mV rms at 1 kHz for 60% deviation. This path is enabled when external mic PTT is keyed.</td>
</tr>
<tr>
<td>3</td>
<td>External Mic PTT</td>
<td>Pull this pin low (less than 1.8 V dc) to key transmitter and enable external mic audio path. This pin is pulled low via a diode when front panel mic PTT is pulled low to allow sensing of mic PTT by accessory. This pin is pulled high to 5 V dc via 9.6 k ohms.</td>
</tr>
<tr>
<td>4</td>
<td>Programmable Output</td>
<td>Defaults to External Alarm. Provides an active high to 13.8 V dc battery supply. Maximum current: 0.25 amps. Refer to “Programmable Pins” below.</td>
</tr>
<tr>
<td>5</td>
<td>Flat Tx Audio Input</td>
<td>Input impedance: 35k ohms. 150 mV rms for 60% deviation. May be programmed to bypass limiter using RSS.</td>
</tr>
<tr>
<td>6</td>
<td>Programmable Input</td>
<td>Refer to “Programmable Pin.”</td>
</tr>
<tr>
<td>7</td>
<td>Ground</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Programmable Input/Output</td>
<td>Defaults to COR carrier detect. Refer to “Programmable Pins.”</td>
</tr>
<tr>
<td>9</td>
<td>Programmable Input</td>
<td>Defaults to Emergency Switch. Refer to “Programmable Pins.”</td>
</tr>
<tr>
<td>10</td>
<td>Ignition Sense</td>
<td>Remove fuse F401 and connect this pin to vehicle ignition-controlled voltage source for ignition-controlled radio on-off. CAUTION: Accidentally shorting this pin to ground will blow internal fuse F401.</td>
</tr>
<tr>
<td>11</td>
<td>Rx Audio Output</td>
<td>330 mV rms (at 1 kHz if de-emphasized) at 60% deviation. Minimum load resistance: 5k ohms. Default is de-emphasized, muted. May be programmed for non-de-emphasized, unmuted using RSS.</td>
</tr>
<tr>
<td>12</td>
<td>Programmable Input/Output</td>
<td>Refer to “Programmable Pins.”</td>
</tr>
<tr>
<td>13</td>
<td>Switched A+ Sense</td>
<td>13.8 V dc source for accessories when radio is turned on. Maximum current: 0.5 amps. CAUTION: Accidentally shorting this pin to ground with radio turned on will blow internal fuse F401.</td>
</tr>
<tr>
<td>14</td>
<td>Programmable Input/Output</td>
<td>Refer to “Programmable Pins.”</td>
</tr>
<tr>
<td>15</td>
<td>Internal Speaker (+)</td>
<td>If jumper JU501 is removed, connect to pin 16 to enable internal speaker. NOTE: If the HLN3145 Public Address and Speaker A/B Switch kit is used, jumper JU501 must be removed if it is desired to mute the internal speaker when the switch is in position B.</td>
</tr>
<tr>
<td>16</td>
<td>External Speaker (+)</td>
<td>Connect external 8-ohm speaker to pins 1 and 16. CAUTION: Bridge-type output. Neither pin 1 nor 16 is ground.</td>
</tr>
</tbody>
</table>
Programmable Pins

Pins 4, 6, 8, 9, 12, and 14 are programmable I/O's. The functions of the pins can be assigned using RSS. Information on the available functions and how to program them is contained in the RSS help files in the Appendices section.

Pin 4 is an output only. It provides an active high to the 13.8 V dc battery supply (0.25 amps maximum), otherwise it is pulled low via 10k ohms.

Pin 6 and 9 are inputs only. They are normally pulled high to 5 V dc via 4.7k ohms. To activate the input, it should be pulled low to within 0.7 V dc of ground.

Pin 8, 12, and 14 may each be programmed as either an input or output. If programmed as an input, the pin is pulled high to 5 V dc via 4.7k ohms. To activate the input, it should be pulled low to within 0.7 V dc of ground. If programmed as an output, the pin is normally pulled high to 5 V dc via 4.7k ohms. When enabled, the output goes active low. Maximum sinking current is 50 mA.

Figure 4-1. Expanded Accessory Connector Pin Locations (viewed from rear of radio)
<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
<th>Quantity</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1234</td>
<td>Component A</td>
<td>5</td>
<td>each</td>
</tr>
<tr>
<td>2345</td>
<td>Component B</td>
<td>3</td>
<td>each</td>
</tr>
<tr>
<td>3456</td>
<td>Component C</td>
<td>7</td>
<td>each</td>
</tr>
<tr>
<td>4567</td>
<td>Component D</td>
<td>2</td>
<td>each</td>
</tr>
<tr>
<td>5678</td>
<td>Component E</td>
<td>4</td>
<td>each</td>
</tr>
<tr>
<td>6789</td>
<td>Component F</td>
<td>6</td>
<td>each</td>
</tr>
</tbody>
</table>
Note: The front cover of the HMN3008A microphone has holes and a "Motorola" name. The HMN3174 mike is identical, except that the front cover has horizontal slots and a "Radius" nameplate.