

# EFJohnson<sup>®</sup>

## 5100 ES Models II/III Portable Radio Operating Manual

VHF / UHF / 700/800 / 800 MHz

Project 25 Conventional and Trunked  
Analog and Digital Conventional  
SMARTNET<sup>®</sup> / SmartZone<sup>®</sup>

7.2 VDC  
5 Watt (VHF), 4 Watt (UHF), 2.5 Watt (700 MHz), 3 Watt (800 MHz)

Part of Part Number 002-5100-70002CD  
March 2008



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March 2008



# EFJohnson®

## 5100 ES Models II/III Portable Radio Operating Manual

March 2008

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# Safety Requirements

## RF Energy Exposure Awareness and Control Information, and Operational Instructions for FCC Occupational Use Requirements

Before using your portable two-way Radio, read this important RF Energy Awareness And Control Information And Operational Instructions to ensure compliance with the FCC's RF exposure guidelines.

**Note** *This radio is intended for use in occupational/controlled conditions where users have full knowledge of their exposure and can exercise control over their exposure to meet FCC limits. This radio device is NOT authorized for general population, consumer, or any other use.*

This two-way radio uses electromagnetic energy in the radio frequency (RF) spectrum to provide communications between two or more users over a distance. It uses radio frequency (RF) energy or radio waves to send and receive calls. RF energy is one form of electromagnetic energy. Other forms include, but are not limited to, electric power, sunlight and x-rays. RF energy, however, should not be confused with these other forms of electromagnetic energy, which when used improperly can cause biological damage. Very high levels of x-rays, for example, can damage tissues and genetic material.

Experts in science, engineering, medicine, health and industry work with organizations to develop standards for exposure to RF energy. These standards provide recommended levels of RF exposure for both workers and the general public. These recommended RF exposure levels include substantial margins of protection. All two-way radios marketed in North America are designed, manufactured and tested to ensure they meet government established RF exposure levels. In addition, manufacturers also recommend specific operating instructions to users of two-way radios. These instructions are important because they inform users about RF energy exposure and provide simple procedures on how to control it. Please refer to the following web sites for more information on what RF energy exposure is and how to control your exposure to assure compliance with established RF exposure limits.

- <http://www.fcc.gov/oet/rfsafety/ef-faqs.html>
- <http://www.osha.gov/SLTC/radiofrequencyradiation/index.html>

## Federal Communications Commission Regulations

The FCC rules require manufacturers to comply with the FCC RF energy exposure limits for portable two-way radios before they can be marketed in the U.S. When two-way radios are used as a consequence of employment, the FCC requires users to be fully aware of and able to control their exposure to meet occupational requirements. Exposure awareness can be facilitated by the use of a product label directing users to specific user awareness

information. Your EFJohnson two-way radio has a RF exposure product label. Also, your EFJohnson user manual, or product manual, or separate safety booklet includes information and operating instructions required to control your RF exposure and to satisfy compliance requirements.

## Compliance with RF Exposure Standards

Your EFJohnson two-way radio is designed and tested to comply with a number of national and international standards and guidelines (listed below) for human exposure to radio frequency electromagnetic energy. This radio complies with the IEEE and ICNIRP exposure limits for occupational/controlled RF exposure environment at operating duty factors of up to 50% transmitting and is authorized by the FCC for occupational use only. In terms of measuring RF energy for compliance with the FCC exposure guidelines, your radio radiates measurable RF energy only while it is transmitting (during talking), not when it is receiving (listening) or in standby mode.

**Note** *The approved batteries supplied with this radio are rated for a 5-5-90 duty factor (5% talk-5% listen - 90% standby), even though this radio complies with the FCC occupational RF exposure limits and may operate at duty factors of up to 50% talk.*

Your EFJohnson two-way radio complies with the following RF energy exposure standards and guidelines:

- United States Federal Communications Commission, Code of Federal Regulations; 47 CFR §§ 1.1307, 1.1310, 2.1091 and 2.1093
- American National Standards Institute (ANSI) / Institute of Electrical and Electronic Engineers (IEEE) C95. 1-1992
- Institute of Electrical and Electronic Engineers (IEEE) C95.1-1999 Edition

## RF Exposure Compliance and Control Guidelines and Operating Instructions

To control your exposure and ensure compliance with the occupational/controlled environment exposure limits, always adhere to the following procedures.

### Guidelines

- Do not remove the RF Exposure Label from the device.
- User awareness instructions should accompany the device when it is transferred to other users.
- Do not use this device if the operational requirements described herein are not met.



## Operating Instructions

- Transmit no more than the rated duty factor of 50% of the time. To transmit (talk), push the Push-To-Talk (PTT) button. To receive calls, release the PTT button. Transmitting 50% of the time, or less, is important because this radio generates measurable RF energy exposure only when transmitting (in terms of measuring for standards compliance).
- Hold the radio in a vertical position in front of face with the microphone (and the other parts of the radio, including the antenna) at least one inch (2.5 cm) away from the nose. Keeping the radio at the proper distance is important because RF exposures decrease with distance from the antenna. The antenna should be kept away from eyes.
- When worn on the body, always place the radio in an EFJohnson approved clip, holder, holster, case, or body harness for this product. Using approved body-worn accessories is important because the use of EFJohnson or other manufacturer's non-approved accessories may result in exposure levels which exceed the FCC's occupational/controlled environment RF exposure limits.
- If you are not using a body-worn accessory and are not using the radio in the intended use position in front of the face, then ensure the antenna and the radio are kept at least one inch (2.5 cm) from the body when transmitting. Keeping the radio at the proper distance is important because RF exposures decrease with increasing distance from the antenna.
- Use only EFJohnson approved supplied or replacement antennas, batteries, and accessories. Use of non-EFJohnson approved antennas, batteries, and accessories may exceed the FCC RF exposure guidelines.
- For a list of EFJohnson approved accessories, see the service manual or marketing accessory lists or contact the E.F. Johnson Company.

## Contact Information

Toll-Free: 1-800-328-3911

Fax: 972-819-0639

E-Mail: [customerservice@efjohnson.com](mailto:customerservice@efjohnson.com). You can also e-mail a person directly if you know their first initial/last name (example: [jsmith@efjohnson.com](mailto:jsmith@efjohnson.com)).

You may also contact the Customer Service Department by mail. Please include all information that may be helpful in solving your problem. The mailing address is as follows:

EFJohnson  
Customer Service Department  
1440 Corporate Drive  
Irving, TX 75038-2401

## Electromagnetic Interference

This device complies with Part 15 of the FCC rules. Operation is subject to the condition that this device does not cause harmful interference. In addition, changes or modification to this equipment not expressly approved by the E.F. Johnson Company could void the user's authority to operate this equipment (FCC Rules, 47CFR Part 15.19).

## Usage Compatibility

Do NOT operate it in areas that are sensitive to RF energy such as aircraft, hospitals, blasting sites, and fuel storage sites. Areas with potentially flammable atmospheres are usually, but not always, clearly posted. These may include gas stations, fuel and chemical storage and transfer stations, below deck on boats, and areas where the air contains flammable chemicals or particles such as grain dust or metal powders.

## Battery Disposal

Dispose of the nickel metal-hydride (NiMH) or Lithium-Ion (Li-Ion) battery used by this radio in accordance with local regulations. Do NOT dispose of it in fire because it can explode. Also, do not short the terminals because it may become very hot.

# Features

This manual is applicable to the 5100 ES Models II/III Portable radios, software 6.6.x or later. The availability of many of the following features is controlled by the model of your radio, factory coding of your radio, installed options, firmware version, and field programming. Refer to Section 8 for more information.

## 1.1 General Features

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- The following operating modes are programmable:
  - Conventional analog
  - Conventional APCO Project 25 (digital)
  - Trunked APCO Project 25 (digital)
  - SMARTNET™/SmartZone® trunked (analog or digital)
- 32 zones with 16 channels each (512 channels total) are standard. A maximum of 54 zones with 16 channels each (864 channels total depending on the option selected) may be enabled.
- Large graphic display with backlight
- 16-position channel select switch
- Three-position rotary option switch
- Up to nine (limited keypad) or 21 (DTMF keypad) programmable option switches
- Each option button programmable with a different function for each operating mode (Conventional, SMARTNET/SmartZone, Trunked P25)
- Menu mode

- AES 256-bit FIPS 140-2 approved encryption available on P25/digital channels
- DES 64-bit encryption available on analog channels, DES-OFB on digital channels (see Section 10)
- Emergency calls for high priority system access
- Priority (standard) and Radio Wide scan modes with user programmable scan lists
- User selectable high and low power output
- Surveillance mode
- Time-out timer
- Keypad lock to prevent accidental key presses
- Power up password to prevent unauthorized use.
- Programmable and user adjustable tone volume
- Programmable minimum volume level
- Soft power down to prevent accidental power off
- Operates on both wide and narrow band channels
- Adjust Contrast values of LCD display

## 1.2 Conventional Features

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- Up to 864 channels or talk groups programmable
- Repeater talk-around
- Carrier or Call Guard® (CTCSS/DCS) controlled squelch on analog channels, NAC and talk group IDs on P25 channels
- Normal/selective squelch selectable by option switch or menu
- Monitor mode selectable by option switch or menu
- Time out timer penalty and conversation timers
- Dual priority channel sampling when scanning (analog and digital channels)
- Busy channel lockout (transmit disable on busy)
- Unit calls on P25 channels
- Telephone calls on P25 channels with over dialing.
- Cloning capability using a cable or wireless connection (see Section 5.13)
- Emergency alarms and calls to alert a dispatcher of an emergency condition

- Single tone encoder controllable by user on analog channels
- Five tone encoder on analog channels
- Automatic Number Identification (ANI) on analog channels
- MDC1200 ANI and Emergency Alert support
- Call Alert™ on P25 channels (send and receive pages)
- Predefined messages (up to 16) can be sent to a dispatcher (P25 mode)
- Predefined status conditions (up to eight) can be sent to a dispatcher (P25 mode)
- Over-The-Air-Rekeying (OTAR) compatible (P25 channels).
- Keypad programming with password access (Federal Government users only)

### 1.3 SMARTNET / SmartZone Features

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- Up to 864 talk groups programmable (channels select talk groups)
- Group, Enhanced Private Conversation™, standard Private Conversation, and Telephone calls
- Emergency alarms to alert a dispatcher of emergency conditions
- Emergency calls for high priority system access
- Failsoft operation on a predefined conventional channel if trunked system fails
- Priority group calls detected while listening to other group calls when scanning
- Call Alert™ (send and receive pages)
- Predefined messages (up to 16) can be sent to a dispatcher
- Predefined status conditions (up to 8) can be sent to a dispatcher
- Dynamic regrouping (dispatcher can automatically gather users on a channel to receive a message)
- Roaming (SmartZone only)

### 1.4 Project 25 Trunked Features

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- Up to 864 talk groups programmable (channels select talk groups)
- Group and Unit Calls

## Features

- Telephone calls with over dialing
- Emergency alarms to alert a dispatcher of emergency conditions
- Emergency calls for high priority system access
- Failsoft operation on a predefined conventional channel if trunked system fails
- Priority group calls detected while listening to other group calls when scanning
- Call Alert™ (send and receive pages)
- Predefined status conditions (up to eight) can be sent to a dispatcher
- Dynamic regrouping (dispatcher can automatically gather users on a channel to receive a message)
- Roaming

## Controls and Display

### 2.1 Front Panel Controls

The location of these controls is shown in Figure 2.1.

Figure 2.1 Front Panel Controls



**Microphone** - The microphone is located behind the small opening shown in Figure 2.1. For best results, hold the radio 2-3 inches from your mouth and speak at a normal conversational level. Do not shout since it distorts your voice and does not increase range.

**Display** - This is a graphical LCD (Liquid Crystal Display). The display backlight can be programmed to turn on when any key is pressed or when the Backlight option switch is pressed or menu parameter selected (see Section 3.5).

**Up/Down Switch** - Selects zones when multiple zones are programmed (see Section 3.3). Pressing the upper part of the switch selects the next higher number and pressing the lower part selects the next lower number. This control also provides up/down select in the menu mode and in other modes when up/down select is required.

**<F1>** - In menu mode (see Section 4.3), functions as a step back and exit switch. If menu mode is not used, it is a programmable option switch.

**<F2>** - Selects the menu mode when that mode is enabled by programming. Also functions as an Enter or Select switch in the menu and other modes. If menu mode is not used, it is a programmable option switch.

**<F3>, <F4>** - Programmable option switches.

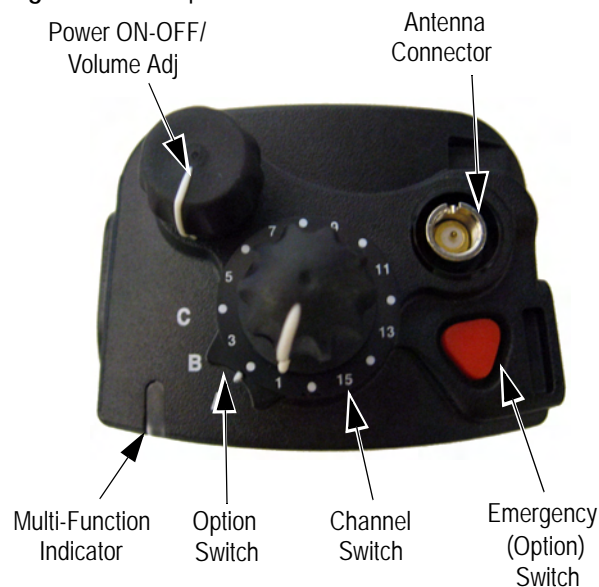
**DTMF Keypad** - The full keypad DTMF models include the 12 keys required to dial telephone and unit ID numbers.

**Speaker** - The radio speaker is located near the bottom of the front panel. When a speaker/microphone is used, it is automatically detected when the Opt Sel 1 line of the accessory connector is pulled low. The logic then automatically disables the internal speaker.



## 2.2 Top Panel Controls

Figure 2.2 Top Panel Controls



**Multi-Function Indicator** - Indicates the following conditions:

Table 2.1 LED Indicators

| LED Color | LED Duration                              | Description   |
|-----------|---|---|
| Red       | ON  | Tx: clear   |
| Red       | 125 ms ON 125 ms OFF                      | Tx: CLEAR with low battery Tx: trunking system busy |
| Red       | 125 ms ON 125 ms OFF 125 ms ON 750 ms OFF | Rx: Secure Group                                    |
| Red       | 750 ms ON 125 ms OFF                      | Rx: Secure individual call                          |
| Green     | ON  | Rx: clear conventional or trunking                  |
| Green     | 750 ms ON 125 ms OFF                      | Rx: clear individual call                           |
| Orange    | Continuous until Self Test complete       | Self Test state                                     |
| Orange    | ON  | Tx: Secure  |
| Orange    | 125 ms ON 125 ms OFF                      | Tx: SECURE with low battery                         |
| Orange    | Blinking (1 to 10 times)                  | Startup Failure. See Table 2.2 for details          |

**Note** *This indicator is disabled if the Surveillance mode is programmed (see Section 4.8).*

Certain failures encountered during radio startup are indicated by blinking of the Orange LED. The Type of failure is indicated by the number of times the LED blinks (1 to 10) as described in Table 2.2.

Table 2.2 LED Startup Failure Indications

| Orange LED Blinks | Startup Failure Indicated | Description  |
|-------------------|---------------------------|--|
| 1                 | Incorrect Software        | Boot Loader is not the expected version  |
| 2                 | Bad File Format           | Parameter file version does not match radio's software                                     |
| 3                 | Parms Fail                | Invalid backup copy of parameters stored in SPI Flash device                               |
| 4                 | Bad Band                  | Radio band stored in parameter file does not match the radio band in the tuning parameters |
| 5                 | Corrupt Parms             | Parameters file contains an error, although parameters checksum is valid                   |
| 6                 | EEPROM Fail               | Self test timed out without successful read/verification of parameter file                 |
| 7                 | DSP Fail                  | PowerPC never received Power-up message from the DSP                                       |
| 8                 | Cycle Power               | Communication failure between DSP and back-end ADC on the RF Deck                          |
| 9                 | HC08 Init Fail            | HC08 was not initialized correctly and cannot be accessed                                  |
| 10                | Zone Fail                 | Number of zones exceeds the number of zones for which the radio was optioned               |

**ON-OFF/Volume** - Turning the knob clockwise turns power on and sets the volume level. Turning it counterclockwise to the detent turns power off. The minimum volume level can be set by programming. Soft power down can be programmed as described in Section 3.1.2, and the volume control can be disabled as described in Section 3.1.3.

**Channel Switch** - This 16-position switch selects up to 16 channels in the current zone. Additional zones can be programmed to allow up to 864 channels to be selected by this switch. This control can be disabled as described in Section 3.3.

**Rotary Option Switch** - This is a three-position switch that can be programmed to control various options. The “A” position is “on” and the “B” and “C” positions are “off” (see Section 4.1). When this switch is programmed to select zones, “A” selects Zone 1, “B” Zone 2, and “C” Zone 3 if applicable.


**Antenna Connector** - This is the connection point for the antenna. Make sure the antenna is tight before using the radio.

**Emergency Switch** - This switch or some other option switch can be programmed as an Emergency switch to alert a dispatcher of an emergency condition. Refer to Sections 5.9 and 6.9 for more information. This switch can also be programmed for other functions.

## 2.3 Side Controls

Figure 2.3 Side Controls and Jacks



**PTT (Push-To-Talk) Switch** - This switch is pressed to turn the transmitter on to transmit a message. It is then released to listen. Transmitting is indicated when the top panel indicator is constant red or  is displayed (surveillance mode only, see Section 4.8).

**Option Switches 1, 2, and 3** - Each of these switches can be programmed to control a specific function (see Section 4.1). In addition, they can be programmed for soft power down (see Section 3.1.2). These switches can also be temporarily disabled by the keypad lock feature (see Section 3.6) or permanently disabled.

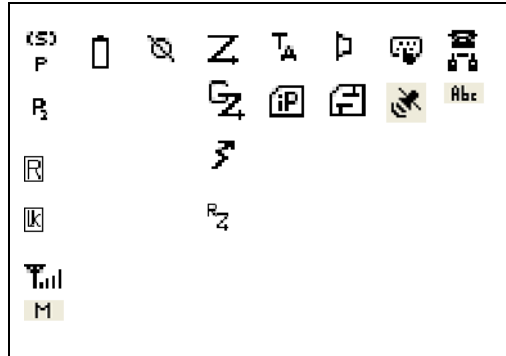
**Battery** - To remove the battery, press the release button on the bottom and pivot the bottom of the battery outward.

**Accessory Connector** - This is the connection point for optional accessories such as a speaker/microphone or earphone. It is also the connection point for the computer when programming the radio or for data equipment when the P25 Packet Data feature is used (see Section 5.14.10).

## 2.4 Display

The front panel display is shown below. Icons are typically shown in the upper part of the display and text messages in the lower part.

Figure 2.4 Graphical Display













The icons are as follows:

Figure 2.5 5100 Icons

| Icon | Description   |
|------|---|
|      | Low Battery   |
|      | Keypad programming/edit mode – Displayed when the radio is in a mode where the user can edit radio parameters           |
|      | Monitor enabled   |
|      | Repeater talk-around enabled  |
|      | Scan enabled  |
|      | Security enabled  |
|      | The current channel is in the enabled scan list (only when scan is on or when in scan edit mode)                        |
|      | The current channel is the priority channel in the enabled scan list (only when scan is on or when in scan edit mode)   |
|      | The current channel is the priority 2 channel in the enabled scan list (only when scan is on or when in scan edit mode) |
|      | Interconnect mode enabled   |
|      | Private call mode enabled   |
|      | Roaming (only used with Multinet trunking)  |

Figure 2.5 5100 Icons

| Icon  | Description   |
|---|---|
|    | P25 Data Context enabled – Radio is ready for data operations   |
|    | P25 Data Channel Grant – Radio is operating on a data channel   |
|    | Site Lock (only used with Multinet trunking)  |
|    | Multinet trunking group scan enabled  |
|    | Transmit – Displayed while radio is transmitting while surveillance mode is enabled                   |
|    | Signal strength – indicates an acceptable site (only used with Multinet trunking)                     |
|    | GPS link active   |
|    | Call history – used in conventional call alert, unit call, or text messaging when selecting a unit ID |
|    | Text message mode active  |
|  | Radio Wide Scan Enabled   |

## 2.5 Signaling Tones


Information is communicated to users of the 5100 ES radio using signal tones and alerts and by LED signaling. Table 2.3 shows the information and signaling tones supported by the 5100 ES radio. If you are viewing a PDF of this manual on a computer equipped with a sound card, double-click on the Horn icon (  ) next to the Message Name to hear the tone.

Table 2.3 Tones for the 5100 ES Radios






| Message Name               | Message Description  | Audible Description  | Tone Category |
|----------------------------|--|--|---------------|
| Action Performed           |  An action has been performed such as selecting an item in List | One high pitched beep, one medium pitched beep and one high pitched beep | Keypress      |
| Alert                      |  TX Warning Timer for Group, Unit, and Interconnect Calls       | High Pitched Beep  | Action        |
| Alert Site Trunking        |  Radio is in Site Trunking                                      | High pitched beep  | Action        |
| Alert Tone Adjust          |  Used when adjusting the Volume for Alert Tones                 | Medium pitched tone  | Keypress      |
| Analog Signaling Side Tone |  Occurs during Conventional Analog Pre ANI Signaling            | Medium pitched continuous tone   | Action        |

Table 2.3 Tones for the 5100 ES Radios (Continued)















| Message Name              | Message Description   | Audible Description  | Tone Category |
|---------------------------|---|--|---------------|
| Automatic Call Back       |  A Voice Channel is available from a previous request  | One high pitched beep, one medium pitched beep and one high pitched beep | Action        |
| Bad                       |  Invalid Key Presses, Inadequate Permissions / Self Test Fail  | Short Low Pitched Tone   | Action        |
| Call Alert ACK            |  Call Alert Acknowledgement has been Received  | Six medium pitched beeps   | Action        |
| Call Alert Received       |  Call Alert Page has been Received   | Six medium pitched beeps repeated every 6 seconds                        | Action        |
| Channel Busy              |  System is currently busy  | Group of 4 Low Pitched Tones   | Action        |
| Clear Alert Tone          |  Radio receives a Secure call while in a Clear Mode - PCC Option   | Medium Pitched Beep  | Action        |
| DTMF Keypress             |  DTMF Keypress   | Medium pitched continuous tone   | Action        |
| Dynamic Regrouping        |  Dynamically Regrouping Command has been received<br>• Talk Permit Tone while Dynamic Regrouped            | Gurgle   | Action        |
| Emergency Alarm ACK       |  Emergency Alarm Acknowledged Successful  | A group of 5 medium pitched tones  | Action        |
| Emergency Button Press    |  Emergency button has been Pressed   | Medium pitched long tone   | Action        |
| Emergency Canceled        |  Emergency is Canceled   | Medium pitched very long tone  | Action        |
| Enhanced Unit Call        |  Enhanced Unit Call is Received  | Three medium pitched tones repeated 4 times every 6 seconds              | Action        |
| Error                     |  Timeout States, Change Keypad Fail, TX Timeout, Attempt to TX Clear when Strapped Secure and vice versa | Low Pitched Continuous Tone  | Action        |
| Failsoft                  |  Trunking System has Failed  | Two medium pitched beeps repeated continuously                           | Action        |
| Feature OFF               |  Binary Feature has been Turned OFF  | Medium pitched beep followed by a lower pitched beep                     | Keypress      |
| Key Fail                  |  After channel change, Radio does not have the assigned key  | Six medium pitched long tones  | Action        |
| Key Fail PTT              |  After PTT, Radio is in Secure mode but does not have the assigned key                                   | Continuous medium pitched long tones                                     | Action        |
| Keyloader/Menu Enter Mode |  Enter Menu Mode, Keyloader Attached   | Medium Pitched Beep followed by a higher pitched beep                    | Keypress      |
| Keyloader/Menu Exit Mode  |  Exit Menu Mode, Keyloader Detached  | High pitched beep followed by a medium pitched beep                      | Keypress      |
| Low Battery               |  The battery strength is getting low. Charge or replace the battery immediately                          | Two medium pitched beeps   | Action        |
| Message / Status ACK      |  Message / Status Acknowledgement has been Received  | Six medium pitched beeps   | Action        |

Table 2.3 Tones for the 5100 ES Radios (Continued)

| Message Name                | Message Description  | Audible Description                                   | Tone Category |
|-----------------------------|--|---|---------------|
| Non-Enhanced Unit Call      |  Non Enhanced Unit Call is Received   | Two medium pitched beeps repeated every 6 seconds     | Action        |
| OTAR Acknowledgement        |  OTAR Hello Acknowledgement Received  | High Pitched Beep                                     | Action        |
| Out of Range                |  Trunking Radio is in an Out of Range State   | Low pitched, very long tone repeated                  | Action        |
| Priority Call Received      |  Radio has received a Priority Call   | Two low pitched beeps                                 | Action        |
| Radio Self-Test Pass        |  Self Test has Passed   | Medium Pitched Beep followed by a higher pitched beep | Keypress      |
| Return to Normal            |  Dynamic Regrouping has been Canceled<br><ul style="list-style-type: none"> <li>• Voltage has returned to Normal</li> <li>• Temperature has returned to Normal</li> <li>• Conventional: TX Penalty Timer has Expired</li> </ul> | Medium Pitched Beep followed by a higher pitched beep | Action        |
| Ring                        |  Radio has received an interconnect and is waiting for Unit Call target subscriber to respond   | Telephone Ringing                                     | Action        |
| System Retry                |  Tone that occurs after the 2nd ISP or ISW retry  | Continuous low pitched tone                           | Action        |
| Talk Permit Tone            |  (When PTT Button is Pressed) verifying that the system is accepting transmissions  | Three medium pitched beeps                            | Action        |
| Temperature Change          |  Temperature has changed from Normal to Hot or Too Hot  | Two medium pitched beeps                              | Action        |
| Unprogrammed Channel        |  Radio is turned to an Unprogrammed Channel   | Low Pitched Continuous Tone                           | Action        |
| Valid Keypress / Feature ON |  Valid Key Press or a Feature has been turned on  | Medium Pitched Short Tone                             | Keypress      |
| Volume Boundary             |  Volume boundary reached when adjusting the volume with Volume Up / Down Buttons  | Two medium pitched beeps                              | Action        |

