

RADIO-RANGER

Wireless Fault Indication System

Instruction Manual



20070301



E. O. SCHWEITZER MANUFACTURING
A DIVISION OF SEL



* P M 8 3 0 0 - 0 1 *

⚠ CAUTION

Equipment components are sensitive to electrostatic discharge (ESD). Undetectable permanent damage can result if you do not use proper ESD procedures. Ground yourself, your work surface, and this equipment before removing any cover from this equipment. If your facility is not equipped to work with these components, contact SEL about returning this device and related SEL equipment for service.

⚠ DANGER

Disconnect or de-energize all external connections before opening this device. Contact with hazardous voltages and currents inside this device can cause electrical shock resulting in injury or death.

⚠ ATTENTION

Les composants de cet équipement sont sensibles aux décharges électrostatiques (DES). Des dommages permanents non-décelables peuvent résulter de l'absence de précautions contre les DES. Raccordez-vous correctement à la terre, ainsi que la surface de travail et l'appareil avant d'en retirer un panneau. Si vous n'êtes pas équipés pour travailler avec ce type de composants, contacter SEL afin de retourner l'appareil pour un service en usine.

⚠ DANGER

Débrancher tous les raccordements externes avant d'ouvrir cet appareil. Tout contact avec des tensions ou courants internes à l'appareil peut causer un choc électrique pouvant entraîner des blessures ou la mort.

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Preface

Manual Overview

The RADIORANGER™ Instruction Manual describes how to install, operate, and troubleshoot the RADIORANGER Wireless Fault Indication System.

An overview of each manual section and topics follows:

Preface. Describes the manual organization and conventions used to present information.

Section 1: Introduction and Specifications. Introduces the RADIORANGER system and lists specifications.

Section 2: SEL-8300 Wireless Interface Installation. Describes how to install, power, set, and test the underground Wireless Interface.

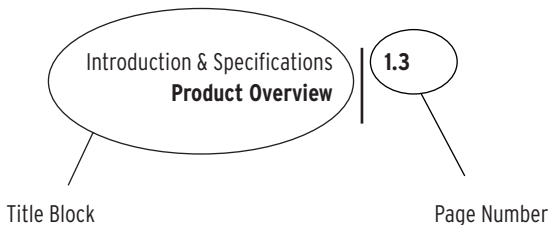
Section 3: SEL-8310 Remote Fault Reader Operation. Describes how to turn on, operate, and adjust the Remote Fault Reader. Descriptions and tables explain the various LED and audible indications.

Section 4: Testing and Troubleshooting. Describes how to test and troubleshoot products in the field.

Appendix A: Firmware and Manual Versions. Lists firmware and manual revision dates and a description of the modifications.

Page Numbering

This manual shows page identifiers at the top of each page; see the figure below.



Page Number Format

The page number appears at the outside edge of each page; a vertical bar separates the page number from the page title block. The page numbers of the RADIORANGER Instruction Manual are represented by the following building blocks:

- Section number
- Actual page number in the particular section

The section title is at the top of the page title block, with the main subsection reference in bold type underneath the section title.

Cross-References

Cross-references are formatted as described below in both the hard copy and electronic documentation for the RADIORANGER. In the electronic documentation, clicking with the mouse on cross-references takes you to the referenced location.

- References to figures, tables, examples, and equations include only the referenced item:
 - *Table 3.1* (3 indicates the section number)
 - *Figure 4.5* (4 indicates the section number)
- References to headings on another page include the heading title and the page number:
 - *Disconnect Monitoring on page 3.8*

Examples

This instruction manual uses several example illustrations and instructions to explain how to effectively operate the RADIORANGER. These examples are for demonstration purposes only; the firmware identification information or settings values included in these examples may not necessarily match those in the current version of your RADIORANGER.

Safety Information

This manual uses hazard statements, formatted and defined as follows:

CAUTION

Indicates a potentially hazardous situation that, if not avoided, may result in minor or moderate injury or equipment damage.

WARNING

Indicates a potentially hazardous situation that, if not avoided, **could** result in death or serious injury.

DANGER

Indicates an imminently hazardous situation that, if not avoided, **will** result in death or serious injury.

Section 1

Introduction and Specifications

Introduction

Locating faults in complex underground distribution systems has always proven challenging for electrical utilities. Troubleshooting often requires the time consuming and dangerous tasks of blocking traffic, opening, ventilating, draining, and accessing subsurface vaults in search of the fault location. SEL's RADIORANGER™ Wireless Fault Indication System allows utility personnel to have street-level access to the status of faulted circuit indicators (FCIs) installed below grade. This system dramatically reduces the need to access vaults during a patrol, which reduces fault-locating time and improves personnel safety.

This section covers the following areas:

- Product Overview
- Connections and System Diagram
- Accessories
- General Safety Information
- Specifications

Product Overview

The RADIORANGER is a wireless fault indication system for locating underground faults at street level, mitigating the need to access subsurface enclosures to retrieve FCI status. The RADIORANGER system consists of the SEL-8300 Wireless Interface (a subsurface radio), the SEL-8310 Remote Fault Reader (a handheld device), and SEL FCIs that connect to the Wireless Interface to convey FCI status, see *Figure 1.1*.

A variety of SEL FCIs can be ordered with a magnetic probe output in place of a visual display. The magnetic probe output connects to keyed ports on the SEL-8300 Wireless Interface. The SEL-8300 accepts up to 12 FCI magnetic probes, allowing a user to monitor up to four 3-phase circuits per installation. The SEL-8300 communicates via the unlicensed 900 MHz band to a handheld SEL-8310 Remote Fault Reader using a proprietary protocol. The design of the protocol makes communicating with or interfering with other devices unlikely. Utility personnel use the SEL-8310 to interrogate multiple Wireless Interface units to determine the status of FCIs installed in

subsurface vaults. The RADIORANGER system can dramatically reduce fault-locating times in dense metropolitan areas, reduce troubleshooting costs, improve reliability, and improve personnel safety.

Connections and System Diagram

SEL fault indicators equipped with magnetic RADIORANGER Interface Probes communicate their status to the Wireless Interface. Utility personnel can quickly retrieve subsurface FCI status at street level via the wireless communications link between the Wireless Interface and Remote Fault Reader.



Figure 1.1 RADIORANGER System

Accessories

For the most effective performance of the RADIORANGER in a vehicle, use the optional accessory kit. The kit includes a windshield-mounting bracket for the Remote Fault Reader and a magnetically-mounted remote antenna terminated with the appropriate connector. The accessory kit comes in a hard carrying case for storage and portability. Please consult an SEL sales representative or www.eosmfg.com for more details.

General Safety Information

FCC Statements

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.

NOTE: This equipment generates, uses, and can radiate radio frequency energy. If not installed and used in accordance with the instruction manual, it may cause harmful interference to radio communications. Operation of this equipment in a residential area may cause harmful interference, in which case the user will be required to correct the interference at his own expense.

IMPORTANT: Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Specifications

Operating Temperature Range

-40° to +85°C (-40° to +185°F)
5 to 95% humidity (noncondensing)

Electromagnetic Compatibility

Electrostatic Discharge Immunity: IEC 60255-22-2: 1996 [EN 60255-22-2: 1997] IEC 61000-4-2: 1995 [EN 61000-4-2: 1995 + A1:1999 + A2:2001] IEEE C37.90.3: 2001 Severity Level: 2, 4, 6, 8 kV contact discharge; 2, 4, 8, 15 kV air discharge

Radio Frequency Interference Immunity: IEC 61000-4-3: 2002 [EN 61000-4-3: 2002] IEC 60255-22-3: 2000 [EN 60255-22-3: 2001] Severity Level: 10 V/m IEEE C37.90.2: 2004 Severity Level: 35 V/m

Power Frequency Magnetic Field Immunity: IEC 61000-4-8: 2001 [EN 61000-4-8: 1994 + A1:2001] Severity Level: 100 A/m (60 Sec), 1000 A/m (3 Sec), Level 5

Pulse Magnetic Field Immunity: IEC 61000-4-9: 1993: 2001 [EN 61000-4-9: 1994 + A1:2001] Severity Level: 1000 A/m, Level 5

Damped Oscillatory Magnetic Field Immunity: IEC 61000-4-10: 2001 [EN 61000-4-10: 1994 + A1:2001] Severity Level: 100 A/m, Level 5

Radiated Radio Frequency: (900 MHz and 1.89 GHz with modulation): ENV 50204: 1995, 10 V/m
Emissions: FCC Part 15, Class B

Environmental

Cold IEC 60068-2-1: 1990 + A1:1993 + A2:1994 [IEC 60068-2-1:1993 + A2:1995]

Temperature Shock on SEL-8310: MIL-STD-810F Method 503.4 -40°C (-40°F) and +70°C (158°F) with temperature stabilized inside the unit.
Dry Heat: IEC 60068-2-2: 1974 + A1:1993 + A2:1994 [EN 60068-2-2: 1993 + A1:1995]

Damp Heat, Cyclic: IEC 60068-2-30: 1980 + A1:1985 [EN 60068-2-30:1999]

Vibration Resistance: IEC 60255-21-1: 1988 [EN 60255-21-1: 1996 + A1:1996]

Vibration Endurance: Severity Class 1

Vibration Response: Severity Class 2

Shock Resistance: IEC 60255-21-2: 1988 [EN 60255-21-2: 1996 + A1:1996]

Bump Test: Severity Class 1

Shock Withstand: Severity Class 1

Shock Response: Severity Class 2

Seismic (Quake
Response):

IEC 60255-21-3: 1993
[EN 60255-21-3: 1995
+ A1:1995]
Severity Level: Class 2
IEC 60529: 2001
+ CRDG:2003
[BS EN 60529:1992
Protection Class
+ REAF:2004]
Severity Level: IP68
(4.5 m[15 feet])
SEL-8300 = IP54
SEL-8310 = IP58

Certifications

Listings:

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Section 2

SEL-8300 Wireless Interface Installation

Introduction

The SEL-8300 collects the status of up to 12 FCIs and communicates this data, upon request, to an SEL-8310 Remote Fault Reader. Connect SEL FCIs equipped with a magnetic probe output to the SEL-8300 via a keyed interface. Each magnetic probe assembly includes a permanent magnet, which activates a Hall-effect sensor inside the SEL-8300 to indicate the presence of an FCI probe, and two coils that deliver the FCI trip and reset signals.

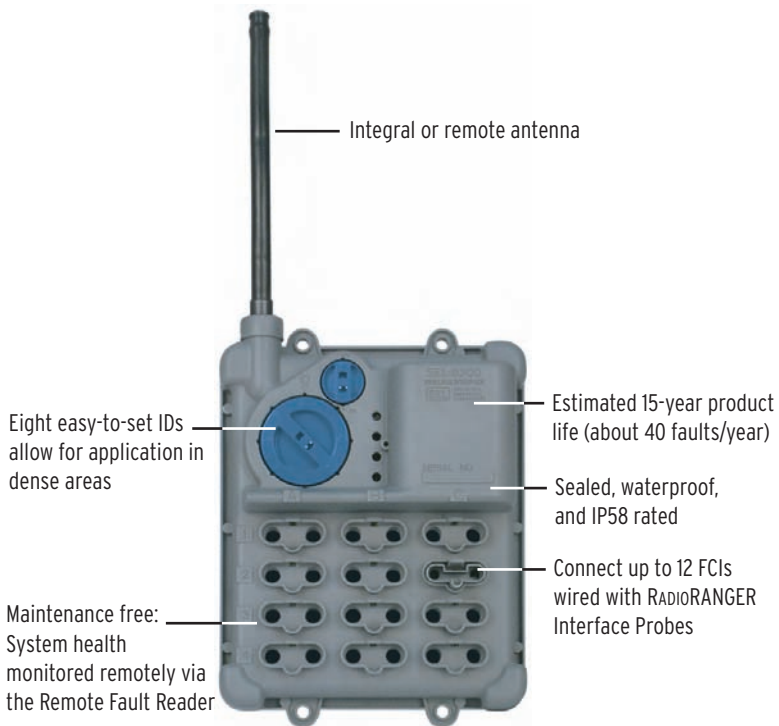
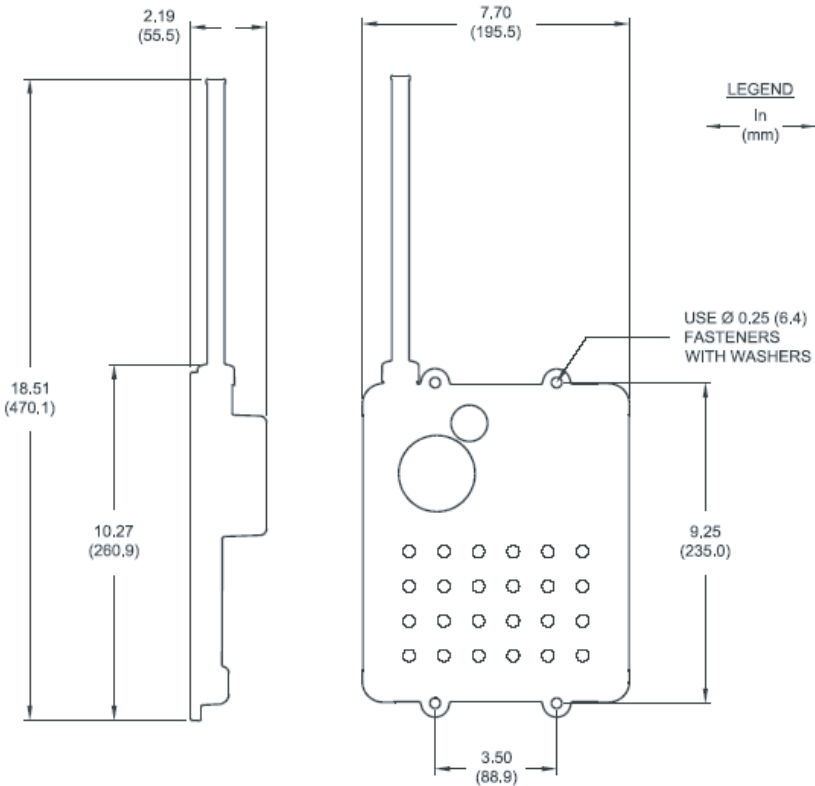


Figure 2.1 SEL-8300 Wireless Interface

SEL-8300 Installation

Securely mount the SEL-8300 using four 1/4 inch-sized (6.0 mm) fasteners (not included) designed for the surface to which the unit is being attached. To protect the polycarbonate material of the Wireless Interface, use a flat washer in conjunction with each fastener. We recommend that you install each fastener with a torque of 25 in/lbs not to exceed 50 in/lbs. Install the SEL-8300 vertically to ensure optimal integral antenna position and to maximize the life of the integral lithium battery.



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Figure 2.2 SEL-8300 Dimensional Diagram

Standard SEL FCI lead lengths for magnetic probe outputs are 12 feet. Additional lead lengths can be specified. Mount the SEL-8300 in a location that provides access to all FCI magnetic probes. The RADIORANGER system communicates via 900 MHz; to improve the range, install the SEL-8300 in locations with few RF impediments, such as below a grate, if possible. Additionally, RF performance will be compromised in vaults where flooding can occur. In vaults where flooding is common or where the FCI lead

length is insufficient for optimal installation, order SEL-8300 units with an optional remote antenna that provides an extra 15' of lead length. For best results, orient the omni-directional antenna vertically so that it points toward the surface.

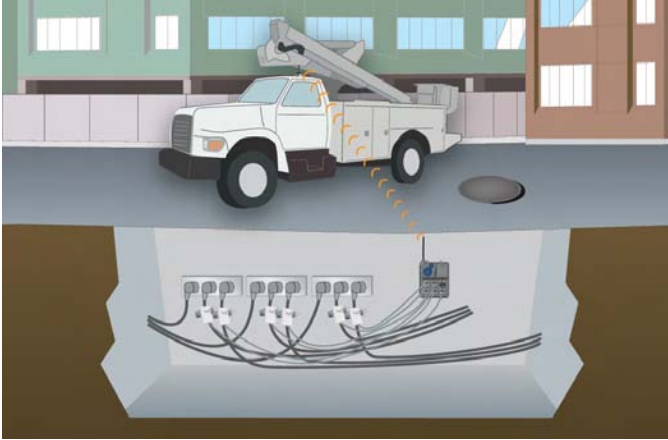


Figure 2.3 SEL-8300 Installed in Underground Vault

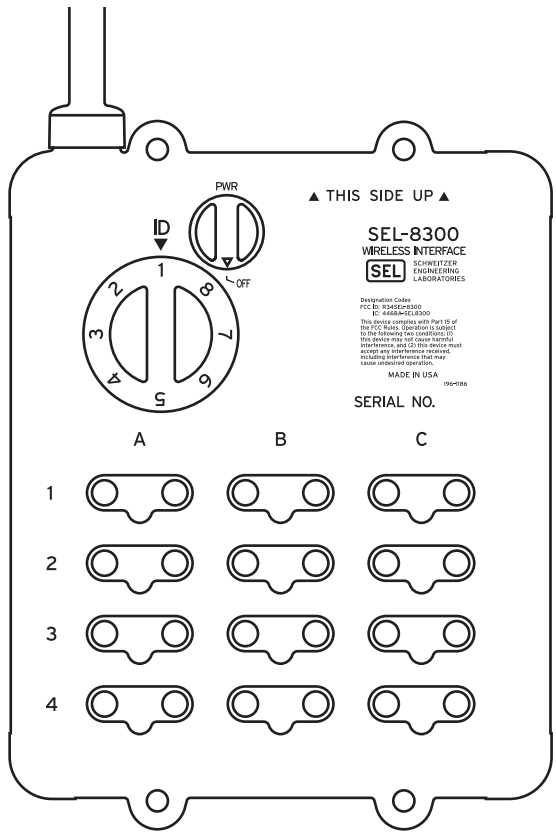
Power

The SEL-8300 is equipped with two dials: a power switch and an ID selector. The smaller dial, labeled **PWR**, controls the power and has two positions. When the arrow is pointing up, the SEL-8300 is on. When the arrow is pointing down, the unit is off. The unit is shipped in the off position to conserve battery energy. The SEL-8300 is powered by a 20-year shelf life lithium D cell. SEL designed the **RADIORANGER** system to optimize battery life without compromising RF range. As such, the SEL-8300 is expected to provide 15 years of service life under normal operating conditions.

Wireless Interface ID Selection

The larger dial on the SEL-8300, labeled **ID**, allows the user to select one of eight wireless interface IDs. The Wireless Interface ID is part of the communications string between the SEL-8300 and SEL-8310 and identifies which ID(s) the Remote Fault Reader is communicating with. Therefore, the user should select different IDs if installing multiple SEL-8300 units within a 150-foot radius. Doing so prevents communications collisions with the SEL-8310, which could create a source of confusion for the operator. It is important to situate the ID selector within one of the eight detent positions in the SEL-8300 housing, to ensure proper ID selection.

Additionally, the ID could serve as a customer-specific naming convention to indicate the nature of certain installations. For example, certain IDs could represent specific vault configurations, voltages classes, etc. Another example of a naming convention is to have odd-numbered IDs represent circuits arranged in a North-South direction, and even-numbered IDs represent circuits arranged in an East-West direction.



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Figure 2.4 SEL-8300 Informational Diagram

SEL FCI Connections

The interface portion of the SEL-8300 is equipped with 12 FCI magnetic probe interface ports aligned in a 4 x 3 matrix. The rows represent Ways (of a multiway switch) 1, 2, 3, and 4, as read from top to bottom. The columns represent Phases A, B, and C, as read from left to right. For example, a probe installed in the top left position would correspond to Phase A of Way 1. The location of each FCI probe corresponds to how the probes are displayed on the SEL-8310 Remote Fault Reader.

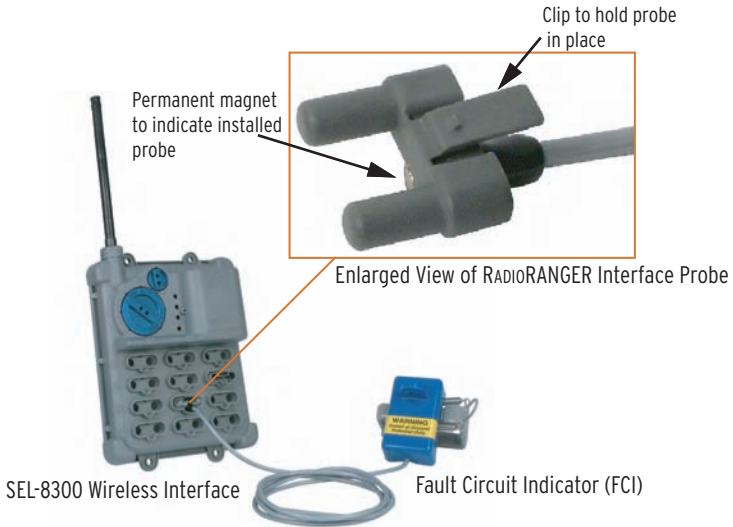


Figure 2.5 The Wireless Interface Has 12 Magnetic Probe Ports

Testing and Verifying Installation

After installing the SEL-8300 Wireless Interface, test its operation and verify the communications range.

Perform the following steps to make sure all FCIs are connected properly to the Wireless Interface.

- Step 1. On the SEL-8300, turn the **PWR** dial to the **ON** position.
- Step 2. Set the **ID** dial to any of the eight ID positions.
- Step 3. Turn on the SEL-8310 Remote Fault Reader.
- Step 4. Press the **{Scan}** button on the SEL-8310 and verify that it communicates with the SEL-8300.
- Step 5. Verify that the SEL-8310 display of the ID and FCI probes matches the SEL-8300. See *Section 3: SEL-8310 Remote Fault Reader Operation* for information on using the SEL-8310 Remote Fault Reader.
- Step 6. After the connection and status is correct, exit the subsurface vault and verify that the communications range is adequate. Remember to close the vault when determining communications range.

Testing and Verifying Installation

- Step 7. If the range is not adequate, move the SEL-8300 to a different location, possibly a higher point in the vault.
- Step 8. If moving the SEL-8300 does not provide adequate communications range outside of the vault, you may need to order the SEL-8300 with an external antenna. You can mount the external antenna near the top of the vault.

Section 3

SEL-8310 Remote Fault Reader Operation

Introduction

The SEL-8310 Remote Fault Reader provides a human-machine-interface (HMI) to utility personnel charged with locating and isolating faulted sections of circuits. The SEL-8310 is a handheld device that communicates wirelessly with any SEL-8300 Wireless Interface within range.



Figure 3.1 SEL-8310 Remote Fault Reader Front View

The SEL-8310 communicates the status of FCIs connected to any SEL-8300 within its range via LEDs and various audible tones. The front display section labeled **Fault Indication** has 12 LEDs arranged in a 4 x 3 matrix. The rows represent Ways 1, 2, 3, and 4, as read from top to bottom. The columns represent Phases A, B, and C, as read from left to right. For example, the status displayed in the top left position would correspond to an FCI monitoring Phase A of Way 1. Each LED corresponds to the position of each FCI probe installed in the SEL-8300.

Audio annunciation of FCI status is discussed in the manual sections, *DIP Switch Settings* and *Audio Indication*, which follow.

In addition to displaying FCI status, the SEL-8310 also displays its status (ON or OFF) and battery health through a **POWER LED**. The **INTERFACE LED** indicates the relative health of the SEL-8300, conveying any self-test problems and the lithium battery health.

The SEL-8300 is equipped with an ID selector dial that allows its radio to communicate via one of eight IDs. This allows the **RADIORANGER** system to be used in locations populated with multiple subsurface vaults within a small geographic area. The SEL-8310 can display information from up to eight different SEL-8300 units within range. The SEL-8310 identifies and differentiates each SEL-8300 within range via a series of LEDs corresponding to each Wireless Interface ID.

Power Requirements

The SEL-8310 is powered from three 1.5 Volt, AA batteries (alkaline or rechargeable). To open the battery cover, turn the fastener 1/4 turn counterclockwise. You can unhinge and remove the battery cover to access the battery holder, DIP switches, and programming header. Insert the batteries according to the polarity noted in the battery holder. To replace the battery cover, insert the two tabs of the cover under the hinge and lay the cover flat against the batteries. To secure the battery cover, turn the fastener 1/4 turn clockwise.

DIP Switch Settings

Access the eight-position DIP switch through the battery compartment. Refer to *Power Requirements* for instructions on opening the battery cover. DIP Switches 1 and 2 adjust the audio mode of the SEL-8310, while DIP Switches 3 and 4 allow the unit to operate on a single frequency. **Note:** Do not adjust DIP Switches 5, 6, 7, and 8. They should remain in the OFF position.

The SEL-8310 supports four audio modes, selectable via the DIP switch block located under the battery cover. *Table 3.1* describes the four audio modes and the DIP switch settings used to select them.

Table 3.1 Four Audio Modes Selectable With the DIP Switch Block

Audio Mode	DIP Switch 1	DIP Switch 2
Silent Mode	ON	ON
Summary Mode	ON	OFF
Morse Code Mode	OFF	ON
Row/Column Mode	OFF	OFF

The four audio modes are described briefly below. Refer to *Audio Indication*, for specific audio indications corresponding to each setting.

Silent Mode—Annunciates Process Status and Button Press information only.

Summary Mode—Annunciates Process Status, Button Press, and FCI Status Summary information only.

Morse Code Mode—Provides all audio indications. FCI Status Summary information is followed by FCI Detail information annunciated in Morse Code.

Row/Column Mode—Provides all audio indications. FCI Status Summary information is followed by FCI Detail information annunciated in Row/Column Mode.

All audio indications will be annunciated at the current volume control setting, with the exception of HMI Adjust Mode indications.

You can configure the SEL-8310 for single frequency operation to allow two SEL-8310 units to operate within the same area simultaneously, with each unit on a different frequency. *Table 3.2* shows the DIP switch settings that enable this functionality.

Table 3.2 DIP Switch Settings

Position of Switch	DIP Switch 3 Functionality	DIP Switch 4 Functionality
OFF	Single-Frequency Operation Disabled	Use Base Frequency
ON	Single-Frequency Operation Enabled	Use Offset Frequency

When DIP Switch 3 is in the ON position, DIP Switch 4 determines the single frequency to be used. If DIP Switch 3 is in the OFF position, then DIP Switch 4 has no effect. If using two SEL-8310 units in the same area, both units should have DIP Switch 3 set to ON and one of the units should have DIP Switch 4 set to ON.

Audio Indication

The SEL-8310 is equipped with a piezospeaker that produces four distinct audible tones to supplement LED indications. The tones are denoted as pitches P1, P2, P3, and P4 in this manual and are annunciated for either a short (50 ms) or long (150 ms) duration. The tones or sequence of tones are depicted in *Figure 3.2–Figure 3.14* and in *Table 3.5*.

There are four basic categories of audible annunciation: Process Status, FCI Status Summary, FCI Details, and Button Press. Additionally, a user can select from four audio modes: Silent, Summary, Row/Column, or Morse Code Mode. These audio modes are described in *DIP Switch Settings*.

Process Status

Process Status events are annunciated to provide feedback of SEL-8310 status. Each type of event is described below.

Power-Up

The Power-Up event is annunciated after a successful Power On Self-Test (POST) is completed. It is a series of four tones, three short tones followed by one long tone, increasing in pitch.



Figure 3.2 Power-Up Audio Indication in All Audio Modes

POST (Power On Self-Test) Fail

The POST Fail event is annunciated if any of the self-tests fail during power up. This is a single long tone as shown in *Figure 3.3*.



Figure 3.3 POST Fail Audio Indication in All Audio Modes

Scan Initiate

The Scan Initiate event is annunciated after the {Scan} button is pressed. It is a series of two short tones, increasing in pitch.



Figure 3.4 Scan Initiate Audio Indication in All Audio Modes

Scan Complete

The Scan Complete event is annunciated after a scan has completed. This is the same tone sequence that plays at power-up.



Figure 3.5 Scan Complete Audio Indication in All Audio Modes

FCI Status Summary

The FCI Status Summary tones provide feedback as to the status of the faulted circuit indicators connected to an SEL-8300 within range. The pitch and sequence of the tones indicate whether any or none of the connected FCIs are in the tripped state and no summary or detail sequence annunciation is already in progress.

Response Received

The Response Received tone will be annunciated during a scan whenever valid data are received from an SEL-8300 within range. This is a single short tone.



Figure 3.6 Response Received Audio Indication in All Audio Modes

FCI Status Summary–Tripped FCI(s)

The Tripped FCI(s) status will be annunciated if the SEL-8310 receives valid data from an SEL-8300 with at least one tripped FCI. This annunciation will occur following a press of the {Next} button, if the next ID contains at least one tripped FCI.



Figure 3.7 FCI Status Summary–Tripped FCI(s) Indication in Silent Mode



Figure 3.8 FCI Status Summary–Tripped FCI(s) Indication in Summary, Row/Column, or Morse Code Mode

Audio Indication

FCI Status Summary–No Tripped FCI(s)

The No Tripped FCI(s) status will be announced if the SEL-8310 receives valid data from an SEL-8300 with no tripped FCIs. This announcement will occur following a press of the {Next} button, if the next ID contains no tripped FCI(s). As indicated in Figure 3.9 and Figure 3.10, the announcement will vary for most audible modes.



Figure 3.9 FCI Status Summary–No Tripped FCI(s) Indication in Silent Mode



Figure 3.10 FCI Status Summary–No Tripped FCI(s) Indication in Summary, Row/Column, or Morse Code Mode

Data Collision

The Data Collision status will be announced if the SEL-8310 receives valid data from two SEL-8300 units set to the same ID. This announcement will sound after a scan when the ID containing multiple SEL-8300 units is selected after pressing the {Next} button. For more information on Data Collision see *Scanning for and Retrieving Data from SEL-8300 Units on page 3.10*. This is a set of long tones alternating between two pitches (high-low, high-low).



Figure 3.11 Data Collision Audio Indication in All Audio Modes

FCI Detail

If a user has configured the SEL-8310 for either Row/Column or Morse Code Modes, the FCI Detail tones will be announced after the FCI Status Summary (see *DIP Switch Settings on page 3.2* for more information). These tones will indicate all of the tripped phases on the lowest faulted Way. If more than one Way contains tripped FCIs, only the status of the lowest Way with tripped FCIs will be announced.

Morse Code Mode

If the current audio mode is Morse Code Mode, then the FCI Detail audio indication will consist of the lowest Way that contains one or more faults (1, 2, 3, or 4), followed by each faulted Phase in the Way (A, B, and C). The Morse Code dot-dash patterns for all possible Ways and Phases are shown in *Figure 3.12*.

Audio Indication

For example, in Row/Column Mode, the FCI Detail audio indication annunciated if Way 2 is the lowest Way containing a fault, and with Phases B and C faulted would be:



Button Press

The Button Press annunciation occurs under any of the following circumstances:

- Either the **{Scan}** or **{Next}** button is pressed in HMI Adjust Mode (see *HMI Adjust Mode on page 3.13* for more details)
- After the **{Next}** button is pressed in Normal Mode when there are no data to display
- The **{Next}** button is pressed in Silent Mode
- Either the **{Scan}** or **{Next}** button is pressed with the SEL-8310 in Low Power Mode












Figure 3.14 Button Press Audio Indication in all Modes

Table 3.5 Complete List of SEL-8310 Audio Indications (Sheet 1 of 2)

SEL-8310 Status	Audible Tones		
	Silent Mode	Summary Mode	Row/Column Mode
Power-Up			
POST Fail			
Scan Initiate			
Response Received			

Table 3.5 Complete List of SEL-8310 Audio Indications (Sheet 2 of 2)

SEL-8310 Status	Audible Tones			
	Silent Mode	Summary Mode	Row/Column Mode	Morse Code Mode
Scan Complete				
FCI Status Summary— Tripped FCIs				
FCI Status Summary—No Tripped FCIs				
NEXT (No Data to Display)				
Data Collision				
NEXT (HMI Adjust Mode)				
SCAN (HMI Adjust Mode)				

Operation

The **{Power}** button is located in the top left corner of the SEL-8310. Pressing the **{Power}** button causes the unit to enter a Power On Self-Test (POST) and alternates illuminating all LEDs in solid green, solid yellow, and solid red for 0.75 seconds each. Provided that the battery voltage is 3.0 Volts or above, it annunciates successful POST with a four-tone scan. If the battery voltage is below 3.0 Volts, the device will turn off to prevent damage to rechargeable batteries.

The **POWER** LED also indicates the relative battery life of the three 1.5 V (alkaline or rechargeable) AA batteries required to power the SEL-8310, as well as any internal RAM or Flash memory issues.

- A solid green LED indicates the voltage is above 3.2 Volts.
- A solid yellow LED indicates the voltage is at or below 3.2 Volts.
- A flashing red LED indicates that either the RAM or Flash memory self-check failed. Return any units exhibiting this annunciation to the factory for analysis.

Proper Orientation of the SEL-8310

The SEL-8310 is equipped with an integral dipole antenna. To achieve optimal range with SEL-8300 units mounted below grade, hold the SEL-8310 so that the antenna is on a parallel plane to the antenna of the SEL-8300, refer to *Figure 3.15*. If the SEL-8300 or its remote antenna is mounted properly, the SEL-8310 should be oriented vertically with the antenna pointing toward the sky. Because of the antenna radiation pattern, never point the SEL-8310 directly at a manhole or directly toward the location of the SEL-8300. Doing so will dramatically reduce the range of the radio system and result in poor performance.

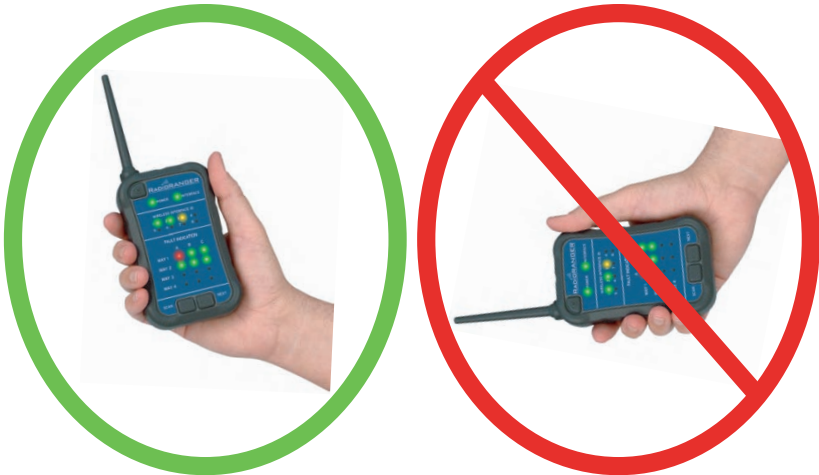


Figure 3.15 Correct and Incorrect Positioning of the Remote Fault Reader

Scanning for and Retrieving Data from SEL-8300 Units

The **{Scan}** and **{Next}** buttons are located near the bottom of the SEL-8310. After the unit is turned on and has successfully completed POST and memory tests, press the **{Scan}** button to initiate a scan for SEL-8300 units within range. The Scan Initiate annunciation, accompanied by pulsing yellow **WIRELESS INTERFACE ID** LEDs, indicates the scan sequence has begun.

When a scan is initiated, the SEL-8310 clears any previously acquired data. If the **{Scan}** button is pressed while a scan is in progress, the SEL-8310 aborts the current scan and clears all acquired data. The SEL-8310 tests the battery voltage at the start of each scan and updates the **POWER LED** as required. The scan sequence ends when one of the following occurs:

- A valid response is received for all eight wireless interface IDs.
- The **{Scan}** button is pressed, which cancels the current scan and begins another.
- 15.2 seconds pass after the first valid response from an SEL-8300.
- The SEL-8310 enters the HMI Adjust Mode.
- 15 minutes pass after the **{Scan}** button is pressed and no valid responses have been received.

After a scan is complete, the number of SEL-8300 units within range is depicted on the SEL-8310 in the **Wireless Interface ID** section. The first valid SEL-8300 identified with at least one tripped FCI flashes yellow and its FCI status is depicted in the **Fault Indication** section of the SEL-8310. Use the **{Next}** button to cycle through and display the status of all SEL-8300 units within range, and their connected FCIs.

Unless multiple SEL-8300 units are installed within a 150-foot range, a user will probably only receive valid communications with one Wireless Interface per scan. In vault-dense areas or installations that require multiple SEL-8300 units, a user may be able to communicate with multiple SEL-8300 units, provided that the ID setting for each Wireless Interface is not identical. If multiple SEL-8300 units with the same ID setting are communicating to an SEL-8310, the SEL-8310 will display a collision notification (see *LED Legend—Wireless Interface ID Section*). To differentiate between two SEL-8300 units in this situation, users should move closer to the intended vault and/or orient themselves between the SEL-8310 and the adjacent vault to exit the range of, or block the signal of, the adjacent SEL-8300.

If two SEL-8310 Remote Fault Reader units are used in the same proximity, do not scan both units simultaneously or the communications channel may become unstable. In this situation, neither Remote Fault Reader may be able to properly communicate with SEL-8300 units within range. However, two Remote Fault Readers can be used simultaneously within the same range if the units are in Single Frequency Operation Mode and are not operating at the same frequency. Please see *DIP Switch Settings on page 3.2* for more information on how to enable this mode.

LED Legend—Wireless Interface ID Section

Green (solid) LED = Valid communication with an SEL-8300 set to the corresponding ID. All FCIs connected to that SEL-8300 are in the reset (unfaulted) position.

Yellow (flashing) LED = The SEL-8300 (corresponding to the ID) is being represented in the Fault Indication section of the SEL-8310.

Red (solid) LED = Valid communication with an SEL-8300 set to the corresponding ID. At least one FCI connected to that SEL-8300 is in the tripped (faulted) position.

Yellow/Red (toggling) LED = At least two SEL-8300 units are within range and are set to the same ID. The status of two SEL-8300 units will be displayed in this situation one when the yellow LED is flashing and the other when the red LED is flashing. The Interface and Fault Indication LEDs will display the corresponding SEL-8300 data accordingly.



Figure 3.16 Wireless Interface ID LED Color Descriptions

Table 3.6 Remote Fault Reader LED Indication Description (Sheet 1 of 2)

LED Label	Color	Representation
Power	Green	Good SEL-8310 Battery
	Yellow	Weak SEL-8310 Battery
	Red (Flashing)	Self-Test Error
Interface (corresponds to “Active” Wireless Interface ID)	Green	SEL-8300 in service < 12 years
	Yellow	SEL-8300 in service > 12 years
	Red (Flashing)	SEL-8300 imminent battery failure

Table 3.6 Remote Fault Reader LED Indication Description (Sheet 2 of 2)

LED Label	Color	Representation
Wireless Interface ID	Yellow (short pulse)	Scan in progress, no response received
	Yellow (flashing)	“Active” Wireless Interface ID
	Red (solid)	Indicates communication with an SEL-8300 with corresponding ID—connected to at least one tripped FCI
	Green (solid)	Indicates communication to an SEL-8300 with corresponding ID—connected to no tripped FCIs

FCI Data Display

The status of each FCI is communicated to the SEL-8300 via a keyed, wired magnetic probe interface. Each FCI will send either a Trip (faulted) or Reset (unfaulted) signal to the SEL-8300 through this magnetic probe interface. The SEL-8300 communicates the FCI data to the SEL-8310 via 900 MHz radio. The SEL-8310 then displays FCI status information under the **Fault Indication** section. A red LED indicates a tripped FCI, whereas a green LED indicates a reset FCI. By providing both tripped and reset indications, the RADIORANGER system allows the user to retrieve the status of the FCIs beyond the fault to validate the fault location.

Low Power Mode

To preserve the battery, the SEL-8310 will enter Low Power Mode one minute after scan termination or one minute after the last **{Next}** button press, whichever occurs later. When the SEL-8310 enters Low Power Mode, all address and FCI Status LEDs turn off. The **POWER** LED will emit short pulses, 2.25 seconds apart, in the color in which the **POWER** LED was illuminated prior to entering Low Power Mode. While the SEL-8310 is in Low Power Mode, pressing either the **{Scan}** or the **{Next}** button returns the device to the normal mode and displays the same data that was displayed prior to entering Low Power Mode. All the data received from the last scan is still available via the **{Next}** button. The SEL-8310 will reenter Low Power Mode one minute after Low Power Mode termination or one minute after the last **{Next}** button press, whichever occurs later.

HMI Adjust Mode

Adjust the SEL-8310 volume and brightness to accommodate user and situational preference. Pressing and holding both the **{Scan}** and **{Next}** buttons simultaneously for one second places the SEL-8310 in the HMI Adjust Mode. In this mode, the **FAULT INDICATION** LEDs are turned off. The **WIRELESS INTERFACE ID** LEDs will now

correspond to speaker volume and LED intensity. The SEL-8310 will exit the HMI Adjust Mode five seconds after the last button press or after pressing and holding both the **{Scan}** and **{Next}** buttons simultaneously for one second. Following HMI Adjust Mode termination, the SEL-8310 reenters Normal Mode. The same data displayed prior to entering HMI Adjust Mode will be available.

While the device is in the HMI Adjust Mode, the **{Scan}** button cycles through the four possible volume levels. The volume level is represented by solid yellow **WIRELESS INTERFACE ID** LEDs in a bar chart style from left to right. A single LED bar represents no volume; four LED bars represent maximum volume, which is the default. Each **{Scan}** button press selects the next highest volume level until it reaches the maximum volume level. At that point, pressing the **{Scan}** button again takes the unit back to the lowest volume level. When the SEL-8310 exits the HMI Adjust Mode, any adjustments made to the volume level are updated in the Flash memory and are active when the Normal Mode resumes.

While the device is in the HMI Adjust Mode, the **{Next}** button cycles through three possible LED brightness levels. The solid yellow LEDs that represent the volume level also adjust their brightness in response to presses of the **{Next}** button. Each **{Next}** button press selects the next highest brightness level until the maximum level is reached. At that point, pressing the **{Next}** button again selects the lowest brightness level. When the device exits the HMI Adjust Mode, any adjustments made to the brightness level are updated in the Flash memory and are active when the Normal Mode resumes.

Section 4

Testing and Troubleshooting

Introduction

This section provides guidelines for testing and troubleshooting the RADIORANGER system. Self-tests and troubleshooting procedures are included.

Self-Tests

The SEL-8300 and SEL-8310 perform periodic self-tests to verify proper operation. A self-test failure of either product is indicated via the Remote Fault Reader LED display. A flashing red **POWER** LED indicates an SEL-8310 self-test failure. A flashing red **INTERFACE** LED indicates an SEL-8300 self-test failure. Please contact the factory to service any device indicating a self-test failure.

Troubleshooting the SEL-8300

Troubleshooting issues related to the SEL-8300 are primarily related to system communication and battery life. *Table 4.1* lists common troubleshooting issues and causes/remedies.

Table 4.1 Troubleshooting the SEL-8300 (Sheet 1 of 2)

Issue	Possible Cause/Response
SEL-8300 is not identified after the SEL-8310 {Scan} button is pressed	Ensure the unit is turned on. Ensure ID selector is situated in a detent and rescan. Ensure antenna is oriented vertically and not submerged. Ensure the SEL-8310 is within proper range.
INTERFACE LED is solid yellow on the SEL-8310	Indicates the SEL-8300 has been in service for 12 years or longer.
INTERFACE LED is pulsing red on the SEL-8310	Indicates the SEL-8300 battery is weak. Order a replacement SEL-8300.

Table 4.1 Troubleshooting the SEL-8300 (Sheet 2 of 2)

Issue	Possible Cause/Response
INTERFACE LED is flashing red on the SEL-8310	If the LED is flashing red during a collision (i.e., SEL-8310 is communicating with two SEL-8300 units), this indicates the SEL-8300 battery is weak. If the LED is flashing red without a collision, it indicates that a self-test has failed. Please consult the factory.
Wireless ID is displayed, but FCI status is not	Ensure that probes are interfaced and mated correctly. Ensure the unit is turned on.
Wireless ID is displayed, but ID is inconsistent with ID setting	Ensure the unit is turned on. Ensure the ID selector is situated within 1 of the 8 detents. Ensure that the antenna is unobstructed.

Troubleshooting the SEL-8310

Troubleshooting issues related to the SEL-8310 are primarily related to system communication, battery life, and LED and audible indications. *Table 4.2* lists common troubleshooting issues and causes/remedies.

Table 4.2 Troubleshooting the SEL-8310 (Sheet 1 of 2)

Issue	Possible Cause/Response
Nothing happens after pressing the {Power} button	Check that batteries have sufficient voltage and are installed with correct polarity.
SEL-8310 illuminates all LEDs in green, yellow, and red sequence and then shuts off	Replace batteries.
POWER LED is yellow	Battery is weak.
POWER LED is flashing red	Self-test failure. Contact the factory for assistance.
LED brightness is not optimal	Adjust LED brightness in HMI Adjust Mode.
Volume level is not optimal	Adjust the volume level in HMI Adjust Mode.
Multiple ID and FCI data are displayed that are inconsistent with the actual system within range	Ensure that DIP Switches 5–8 are in the OFF position.
Audible annunciation is silent	Adjust volume level in HMI Adjust Mode.

Table 4.2 Troubleshooting the SEL-8310 (Sheet 2 of 2)

Issue	Possible Cause/Response
Audible annunciation contains a series of tones	Device may be in Morse Code or Row/Column Mode. Check DIP switch settings on positions 1 and 2.
Poor range between SEL-8300 and SEL-8310	Ensure the SEL-8300 antenna is unobstructed. Ensure the SEL-8310 is oriented properly (antenna is oriented vertically).

Factory Assistance

We appreciate your interest in SEL products and services. If you have questions or comments, please contact us at:

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Appendix A

Firmware and Manual Versions

Firmware

This manual covers the RADIORANGER system containing firmware bearing the firmware version numbers listed in *Table A.1*. This table also lists a description of modifications and the instruction manual date code that corresponds to firmware versions. The most recent firmware version is listed first.

Table A.1 Firmware Revision History

Firmware Identification (FID) Numbers	Description of Changes	Manual Date Code
SEL-8310-R100-V0-Z001001-D20070320	Original release	20070320
SEL-8300-R100-V0-Z001001-D20070320		

Instruction Manual

The date code at the bottom of each page of this manual reflects the creation or revision date.

Table A.2 lists the instruction manual release dates and a description of modifications. The most recent instruction manual revisions are listed at the top.

Table A.2 Instruction Manual Revision History

Revision Date	Summary of Revisions
20070320	Date of Initial Release.



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