

SEL-3060

Ethernet Radio

Instruction Manual

20210715

SEL SCHWEITZER ENGINEERING LABORATORIES



*** P M 3 0 6 0 - 0 1 ***

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PM3060-01

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Preface

Manual Overview

The SEL-3060 Ethernet Radio manual includes the information needed to properly install and operate the product.

The scope of this manual includes specifications, installation, mechanical information, self-monitoring, and settings.

An overview of each manual section and topics follows.

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

Section 1: Introduction and Overview. Describes the basic features and functions of the SEL-3060, and lists the specifications.

Section 2: Getting Started. Describes how to initially connect to the SEL-3060 and how to link two radios.

Section 3: Installation. Describes how to mount and wire the SEL-3060; illustrates wiring connections for various applications.

Section 4: Settings and Commands. Describes settings and commands for use with the SEL-3060.

Section 5: Performance Monitoring, Testing, and Troubleshooting. Lists common operating and troubleshooting questions.


Appendix A: Firmware and Manual Versions. Details differences between firmware versions. Provides a record of changes made to the manual.

Appendix B: Firmware Upgrade Instructions. Provides instructions for upgrading the firmware in the SEL-3060.


Safety Information

Dangers, Warnings, and Cautions

This manual uses three kinds of hazard statements, defined as follows:

 **DANGER**

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

 **WARNING**










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

 **CAUTION**

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

Safety Symbols





The following symbols are often marked on SEL products.

	<div> CAUTION</div> <div>Refer to accompanying documents.</div>	<div> ATTENTION</div> <div>Se reporter à la documentation.</div>
	Earth (ground)	Terre
	Protective earth (ground)	Terre de protection
	Direct current	Courant continu
	Alternating current	Courant alternatif
	Both direct and alternating current	Courant continu et alternatif
	Instruction manual	Manuel d'instructions

Safety Marks

The following statements apply to this device.

<p>⚠ DANGER</p> <p>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.</p>	<p>⚠ DANGER</p> <p>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.</p>
<p>⚠ WARNING</p> <p>Atmospheric electrical charge accumulation can cause potential between the conductor and shield of the feedline, or cause lightning to strike an antenna. A lightning protector should be installed to prevent damage to equipment or injury to personnel.</p>	<p>⚠ AVERTISSEMENT</p> <p>L'accumulation de charges électriques de type atmosphérique peut être la cause d'une différence de potentiel entre le conducteur et le blindage de la ligne d'alimentation ou peut attirer la foudre sur l'antenne. Un parafoudre devrait être installé pour prévenir les dommages à l'équipement ou les blessures au personnel.</p>
<p>⚠ WARNING</p> <p>Have only qualified personnel service this equipment. If you are not qualified to service this equipment, you can injure yourself or others, or cause equipment damage.</p>	<p>⚠ AVERTISSEMENT</p> <p>Seules des personnes qualifiées peuvent travailler sur cet appareil. Si vous n'êtes pas qualifiés pour ce travail, vous pourriez vous blesser avec d'autres personnes ou endommager l'équipement.</p>
<p>⚠ WARNING</p> <p>Operator safety may be impaired if the device is used in a manner not specified by SEL.</p>	<p>⚠ AVERTISSEMENT</p> <p>La sécurité de l'opérateur peut être compromise si l'appareil est utilisé d'une façon non indiquée par SEL.</p>
<p>⚠ WARNING</p> <p>This device is shipped with default passwords. Default passwords should be changed to private passwords at installation. Failure to change each default password to a private password may allow unauthorized access. SEL shall not be responsible for any damage resulting from unauthorized access.</p>	<p>⚠ AVERTISSEMENT</p> <p>Cet appareil est expédié avec des mots de passe par défaut. A l'installation, les mots de passe par défaut devront être changés pour des mots de passe confidentiels. Dans le cas contraire, un accès non-autorisé à l'équipement peut être possible. SEL décline toute responsabilité pour tout dommage résultant de cet accès non-autorisé.</p>

<div> CAUTION</div> <div>Although the power level is low, concentrated energy from a directional antenna may pose a health hazard. Do not allow users to come closer than 23 cm (9 in) to the antenna when the transmitter is operating in indoor or outdoor environments.</div>	<div> ATTENTION</div> <div>Bien que le niveau de puissance soit bas, l'énergie concentrée d'une antenne directionnelle peut être un danger pour la santé. Ne pas autoriser les usagers à s'approcher à moins de 23 cm (9 po) de l'antenne quand l'émetteur est en opération dans un environnement intérieur ou extérieur.</div>
<div> CAUTION</div> <div>The radio contains devices 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.</div>	<div> ATTENTION</div> <div>La radio contient des circuits 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.</div>

Section 1

Introduction and Overview

Overview

The SEL-3060 is a license-free, digitally modulated Ethernet radio. The SEL-3060 is available at time of order as 900 MHz or 2.4 GHz.

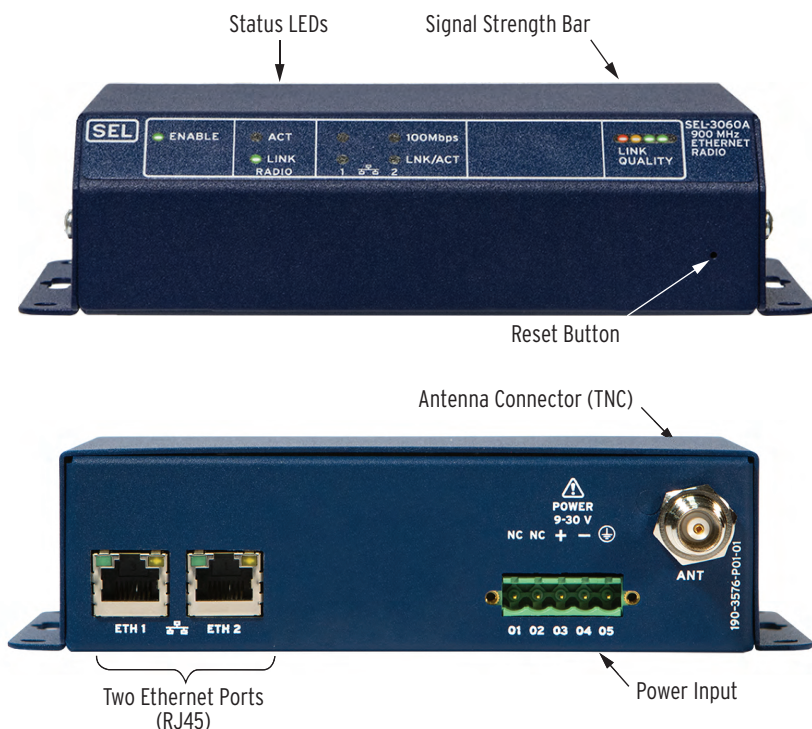


Figure 1.1 SEL-3060 Front- and Rear-Panel Features

The SEL-3060 prevents the need for expensive dedicated fiber transmitting over long distances. *Figure 1.2* shows two SEL-3060 radios creating a wireless communication link between two substations. The SEL-3060 makes it cost effective to provide secure remote communications without the need of trenching fiber, relying on unreliable phone networks, or network availability issues on cellular networks.

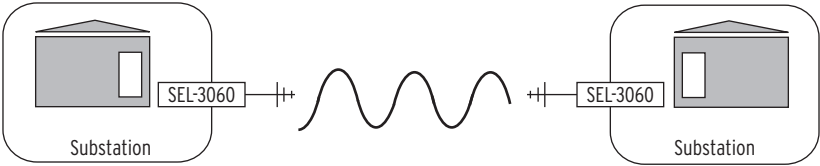


Figure 1.2 Point-to-Point Product Overview

Figure 1.3 shows the SEL-3060 in point-to-multipoint (P2MP) mode with an access point (AP) linked to five nodes. Figure 1.3 shows a typical recloser restoration scheme using SEL-651R Recloser Controls. The wireless link provides SCADA, Engineering access, and control to restore unfaulted sections of the line.

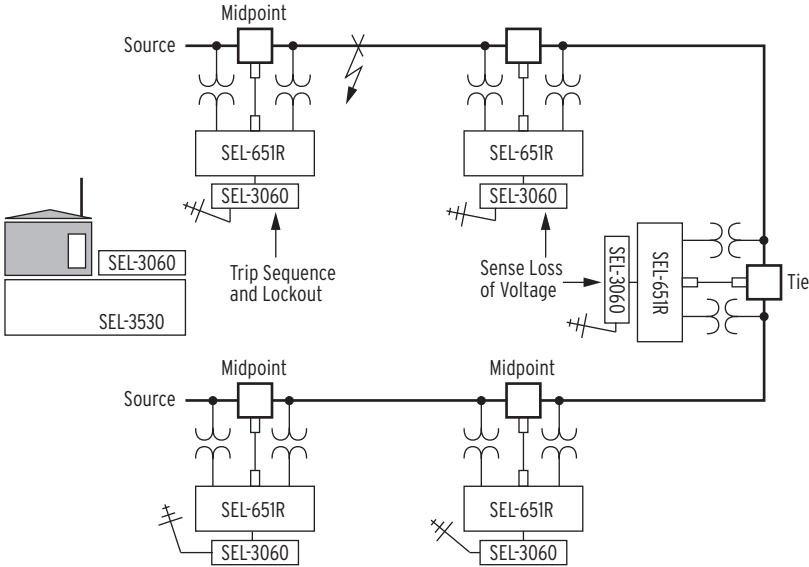


Figure 1.3 Point-to-Multipoint Product Overview

Features, Benefits, and Applications

- **LAN Extension Ethernet Radio.** Includes internal unmanaged switch with two 10/100BASE-T Ethernet ports. The SEL-3060A operates in the license-free 900 MHz ISM band, and the SEL-3060B operates in the 2.4 GHz license-free ISM band. The SEL-3060 includes a simple web interface for device configuration and file transfer. Upgrade firmware through local or wireless link. IP address discovery tool and wireless statistics report aid network analysis.
- **Fast Transfer for Time-Critical Messages.** Transfers time-critical IEC 61850 GOOSE messages in under 50 ms. Ideal for distribution automation and restoration schemes.
- **Point-to-Point and Point-to-Multipoint Operating Modes Provide Flexibility.** Gathers SCADA information from remote locations with point-to-multipoint radio operation or rapidly transfers control commands with low-latency point-to-point operation with a radio as far as 15 miles away (SEL-3060A) or 10 miles away (SEL-3060B).
- **Strong Security Thwarts Attackers.** Encrypts over-the-air data with AES 128-bit encryption. The network configuration can be locked to prevent tampering.
- **Supports Large Networks.** Enables creation of a point-to-multipoint network with one AP and as many as 63 subscriber nodes.
- **Tough Radio Operates in Extreme Conditions.** Designed, built, and tested for trouble-free operation in extreme temperatures of -40° to $+85^{\circ}\text{C}$ (-40° to $+185^{\circ}\text{F}$), electromagnetic interference, shock, and vibration conditions, per IEEE 1613 and IEC 61850-3 standards.
- **No Licensing Reduces Delays and Expenses.** Operates in the license-free ISM band for on-time, economical, on-budget projects.

Models, Options, and Accessories

Standard Features

- P2P and P2MP operation modes
- Two 10/100BASE-T Ethernet ports
- Radio supports collocated antennas
- Power supply
 - Wall-mount: 9–30 Vdc <4 watts
 - NEMA enclosure: 24–48 Vdc, 125/250 Vac or Vdc (contact SEL for more information and customized options)
- Simple web-based interface for status and configuration

- Over-the-air firmware upgrades
- Upload/download configuration file for easy deployment
- Protocol pass-through support
 - TCP/IP
 - UDP
 - TELNET
 - DNP3 LAN/WAN
 - Modbus TCP
 - SEL Fast Messaging
 - SEL ASCII
 - IEC 61850 GOOSE
 - IEEE C37.118 Synchrophasors
 - HTTP webpage support
 - FTP

Accessories

Table 1.1 Radio Antenna and Cable Accessories (Sheet 1 of 2)

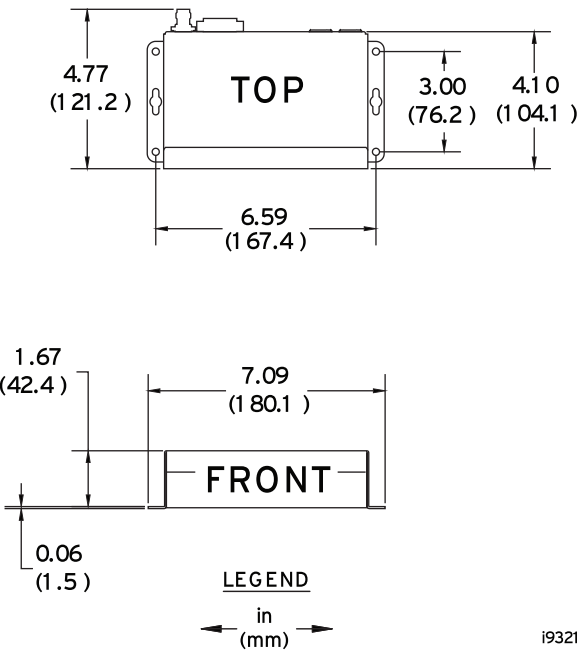
Description	Part Number
Feed Line	
LMR-400 TNC Male to N Male Cable	SEL-C966
LMR-400 N Male to N Male Cable	SEL-C968
7/8" Helix N Male to N Male Cable	SEL-C978
N Female to TNC Male Adapter	240-1809
900 MHz Antennas	
Low-Profile 3 dBi Gain Omnidirectional, N Female Connector	235-0003
Vertical 7.15 dBi Gain Omnidirectional, N Female Connector	235-0232
Vertical 9.15 dBi Gain Omnidirectional, N Female Connector	235-0233
Three-Element 8.15 dBi Gain Yagi, N Female Connector ^a	235-0009
Five-Element 11.1 dBi Gain Yagi, N Female Connector ^a	235-0220
Eleven-Element 14.15 dBi Gain Yagi, N Female Connector ^a	235-0222
Eighteen-Element 16.15 dBi Gain Yagi, N Female Connector	235-0224
Indoor 8" Vertical, TNC Male Connector	235-0108

Table 1.1 Radio Antenna and Cable Accessories (Sheet 2 of 2)

Description	Part Number
2.4 GHz Antennas	
Low-Profile 3 dBi Gain Omnidirectional, N Female Connector	235-0003
Vertical 10 dBi Gain Omnidirectional, N Female Connector ^a	235-0227
15 dBi Gain Enclosed Yagi, N Female Connector	235-0225
19 dBi Gain Panel, N Female Connector	235-0228
Indoor 8" Vertical, TNC Male Connector	235-0108
Antenna Mounting	
Vertical Omnidirectional Mount for 14" Maximum Diameter Poles	240-0103
Yagi Mount for 14" Maximum Diameter Poles	240-0104
Mast Mount for Large Omnidirectional Antennas (2.5" Maximum Diameter Antenna to 2.5" Maximum Diameter Mast)	240-0106
Mounting Bracket for Low-Profile Omnidirectional Radio Antennas (235-0003)	915900494
Surge Protection	
Radio Surge Protector With N Female Connectors	200-2004
Power Supply	
15 Vdc Power Supply	SEL-9322
120/230 Vac Power Input AC Adapter	240-0056
Plug Adapter Kit (UK, EU, AUS) for 240-0056	240-0055

a. Comes equipped with pipe-mounting hardware.

Product Diagrams



i9321b

Figure 1.4 SEL-3060 Dimensions

Specifications

Compliance

Designed and manufactured under an ISO 9001 certified quality management system
Also see *Table 1.2*.

General

Temperature Range

−40° to +85°C per IEC 60068-2-1 and 60068-2-2

Operating Environment

Pollution Degree: 2

Relative Humidity: 5%–95%, noncondensing

Maximum Altitude: 2000 m

Dimensions

Wall Mount: 151 mm x 2104 mm x 44 mm
(5.96 in x 4.08 in x 1.73 in)

Weight: 0.39 kg (0.86 lb)

Communications

Communications Ports

Ethernet Ports

Ports: 2 rear

Rate: 10/100 Mbps

Rear Connectors: RJ45

Standard: IEEE 802.3

Protocols

Modbus TCP, TCP/IP, UDP, FTP, DNP3 LAN/WAN, HTTP Webpage Support, Telnet, SEL ASCII and Compressed ASCII, SEL Fast Messaging, IEEE C37.118 Synchrophasors, IEC 61850 GOOSE

Typical Latency

Point-to-Point (IEC 61850 GOOSE)

500 Byte Packet: 12.5 ms

Point-to-Multipoint (IEC 61850 GOOSE)

500 Byte Packet: ~50 ms (4 nodes simultaneously transmit GOOSE)

Radio

Transmitter

Frequency Band

SEL-3060A: 902–928 MHz ISM band

SEL-3060B: 2.40000–2.46875 GHz ISM band

SEL-3060A3 (Brazil Firmware): 902.0–907.5, 915–928 MHz

Technology: Digital Modulation

Modulation: Frequency Shift Keying (FSK)

Operating Mode: Point-to-Point, Point-to-Multipoint (63 nodes)

RF Connector: TNC

Power Output

SEL-3060A: 20 dBm (100 mW)

SEL-3060B: 16 dBm ± 2 dBm (40 mW)

Number of Channels

SEL-3060A: 12

SEL-3060B: 26

Channel Bandwidth: 2 MHz

Receiver

SEL-3060A: −93 dBm ±2 dB at 1% packet error rate (PER)

SEL-3060B: −91 dBm ±2 dB at 5% PER

Distance

SEL-3060A Point-to-Point: 15 miles with 15 dB fade margin

SEL-3060A Point-to-Multipoint: 10 miles with 15 dB fade margin

SEL-3060B Point-to-Point: 10 miles with 15 dB fade margin

SEL-3060B	
Point-to-Multipoint:	7 miles with 10 dB fade margin
Error Detection:	16-bit CRC
Forward Error Correction (FEC):	4:16 block code

Data Rate

Aggregate Data Rate:	1 Mbps
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Encryption

AES 128-bit encryption for over-the-air data

Power Supply

Rated Supply Voltage:	12/24 Vdc
Input Voltage Range:	9–30 Vdc
Power Consumption:	<4 W

Type Tests

Communications Equipment Tests

IEEE 1613-2003	
Power Frequency Disturbances:	IEC 61850-3:2002

Environmental Tests

Vibration Resistance:	IEC 60255-21-1:1988 Class 2 Endurance Class 2 Response IEC 60255-21-3:1993 Class 2
Shock Resistance:	IEC 60255-21-2:1988 Class 1 shock withstand, bump Class 2 shock response
Cold:	IEC 60068-2-1:2007 –40°C, 16 hours
Damp Heat, Cyclic:	IEC 60068-2-30:2005 25°–55°C, 6 cycles, 95% relative humidity
Dry Heat:	IEC 60068-2-2:2007 +85°C, 16 hours

Dielectric Strength and Impulse Tests

Dielectric (HiPot):	IEC 60255-5:2000 IEEE C37.90–2005
Impulse:	IEC 60255-5:2000 0.5 J, 5 kV 2.4 kV on Ethernet Ports

RFI and Interference Tests

EMC Immunity

Standard:	IEEE 1613, Class 1
Electrostatic Discharge:	IEC 60255-2-2:2008 8 kV contact discharge 15 kV air discharge IEC 61000-4-2:2008 8 kV contact discharge 15 kV air discharge IEEE C37.90.3–2001 8 kV contact discharge 15 kV air discharge

Radiated RF Immunity:	IEC 60255-22-3:2007 10 V/m IEC 61000-4-3:2008 10 V/m IEEE C37.90.2–2004 35 V/m
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Fast Transient, Burst Immunity:	IEC 60255-22-4:2008 4 kV @ 5.0 kHz for power port 2 kV @ 5.0 kHz for communications ports IEC 61000-4-4:2011 4 kV @ 5.0 kHz for power port 2 kV @ 5.0 kHz for communications ports
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Power Frequency Magnetic Field:	IEC 61000-4-8:2009 1000 A/m for 3 s 100 A/m for 1 min
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Pulse Magnetic Field:	IEC 61000-4-9:2001 1000 A/m
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Damped Oscillatory Magnetic Field:	IEC 61000-4-10:2001 100 A/m
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Voltage Dips, Short Interruptions and Voltage Variations on DC Input Power Port:	IEC 60255-11:2008 IEC 61000-4-11:2004 IEC 61000-4-17:2002 IEC 61000-4-29:2000
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Surge Withstand Capability Immunity:	IEC 60255-22-1:2007 2.5 kV common-mode 1 kV differential-mode IEEE C37.90.1-2002 2.5 kV oscillatory 4 kV fast transient
Conducted RF Immunity:	IEC 60255-22-6:2001 10 Vrms IEC 61000-4-6:2008 10 Vrms
Digital Radio Telephone RF Immunity:	ENV 50204-1995 Severity Level: 10 V/m at 900 MHz and 1.89 GHz

EMC Emissions

Radiated Emissions

IEC 60255-25:2000

FCC Part 15.247; ICES-001; RSS-247

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, and
2. This device must accept any interference received, including interference that may cause undesired operation.

FCC Part 15, Class A

Note: This equipment has been tested and found to comply with the limits for a Class A 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.

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.

Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Section 15.21

Users manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Canada ICES-001(A) / NMB-001(A)

Table 1.2 Certifications by Country

Country	Authority	Reference
3060A		
Brazil	Anatel	0781-15-7001
Canada	IC	5303A-AW900MR
Mexico	IFETEL	RCPCSE14-0853
Trinidad and Tobago	TATT	2/2/1/1693/7
USA	FCC	R4N-AW900MR
3060B		
Australia	ACMA	RCM
Canada	IC	5303A-AW2400MR
Mexico	IFETEL	RCPCSE14-1847
New Zealand	Ministry of Economic Development	RCM
USA	FCC	R4N-AW2400MR

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Section 2

Getting Started

Introduction

This section includes the following information:

- *Connecting to the Device*
- *Creating a Point-to-Point Wireless Link*

Connecting to the Device

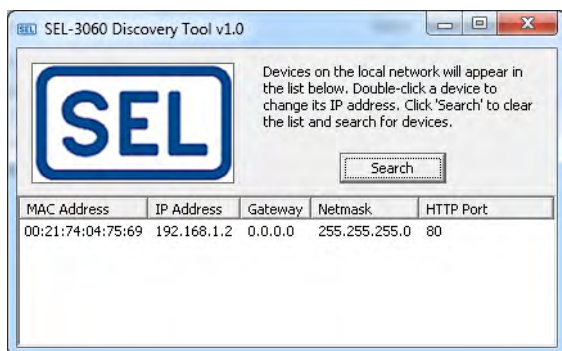
The SEL-3060 includes an HTTP web server for configuration and management functions. The web server can be accessed by a web browser by using either Google Chrome version 31 or higher or Microsoft Internet Explorer 9 or higher. SEL recommends using Google Chrome.

For the initial connection to a device, you will need to have the following:

- Computer with a wired Ethernet port
- SEL-3060
- One RJ45 Ethernet cable
- SEL-3060 Discovery Tool (available on the CD)

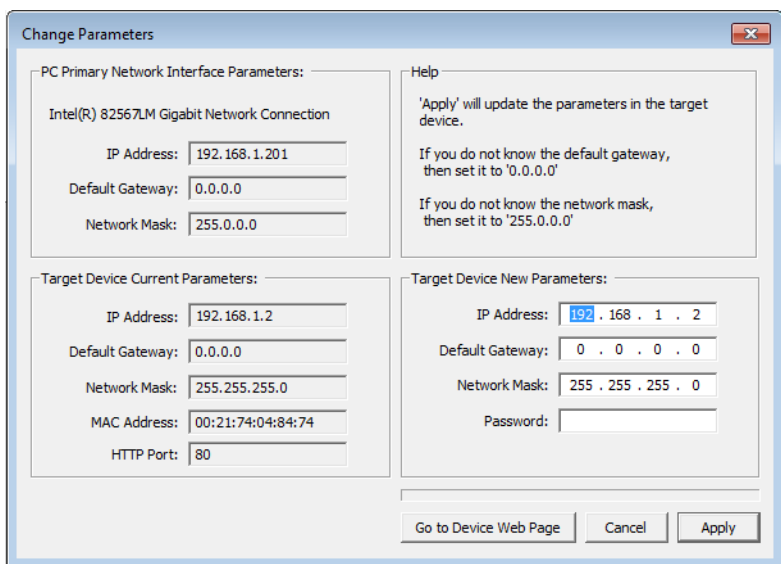
Configuration is handled by the SEL-3060 built-in web browser interface. The SEL-3060 should be turned on and connected directly to a computer Ethernet port using an RJ45 Ethernet cable.

- Step 1. Locate the SEL-3060 Discovery Tool on the CD provided with the product or download the program from selinc.com.
- Step 2. Double-click to run the SEL-3060 Discovery Tool and click **Search**.



Once you click **Search**, you should see the device appear with the default IP address of 192.168.1.2. If a device does not appear, then click **Search** to regenerate the list. If it still does not appear, you have a connection issue and need to examine the cabling, or you may have a firewall issue on your computer.

- Step 3. Double-click on the listed device to configure it. The list of settings should appear.



The information on the left is the current status of the radio, and the lower right boxes allow you to change the IP network settings. It is important that the IP address of the SEL-3060 is on the same network as your computer. For example, if the network mask is 255.255.255.0, the first three number groups of the IP address must match.

- Step 4. Enter the desired network settings and password, then click **Apply**. The default password is **TAIL**.
- Step 5. Once you have changed the IP network settings, you can go to the SEL-3060 web interface by clicking on **Go to Device Web Page** or by directly entering the default IP address in your web browser. Your computer must be on the same network as the SEL-3060 to view the SEL-3060 login page.



The image shows the SEL-3060 web interface login page. It has a blue header with the SEL logo. The main content area is divided into two sections. The left section, titled 'User Login', contains a 'User Name:' field with '3060 User' entered, a 'Password:' field, and a 'Login' button. The right section, titled 'Web Access For Authorized Personnel Only', contains a disclaimer: 'This system is for the use of authorized users only. Individuals using this system without authority, or in excess of their authority, are subject to having all their activities on this system monitored and recorded by system personnel. Anyone using this system expressly consents to such monitoring and is advised that if such monitoring reveals possible evidence of criminal activity, system personnel may provide the evidence of such monitoring to law enforcement officials.'

User Login

User Name:
3060 User

Password:

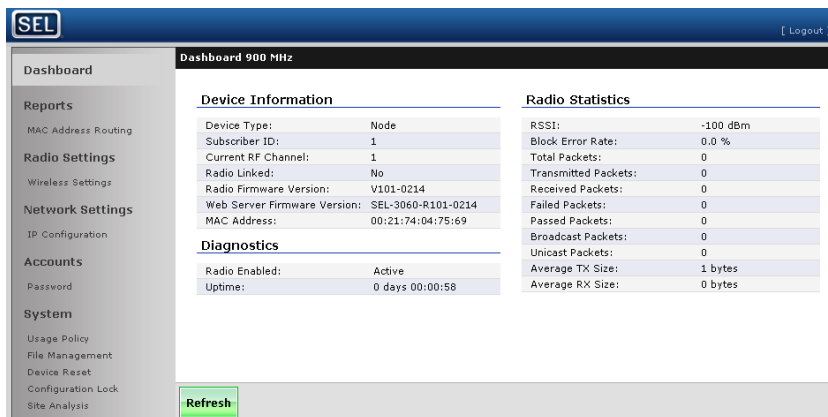
Login

Web Access For Authorized Personnel Only

This system is for the use of authorized users only. Individuals using this system without authority, or in excess of their authority, are subject to having all their activities on this system monitored and recorded by system personnel. Anyone using this system expressly consents to such monitoring and is advised that if such monitoring reveals possible evidence of criminal activity, system personnel may provide the evidence of such monitoring to law enforcement officials.

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- Step 6. Enter the device password (TAIL is the default password) and click **Login**.



The image shows the SEL-3060 web interface dashboard for 900 MHz. It has a blue header with the SEL logo and a 'Logout' link. The left sidebar contains a 'Dashboard' menu and a list of links: Reports, MAC Address Routing, Radio Settings, Wireless Settings, Network Settings, IP Configuration, Accounts, Password, System, Usage Policy, File Management, Device Reset, Configuration Lock, and Site Analysis. The main content area is titled 'Dashboard 900 MHz' and contains three sections: 'Device Information', 'Radio Statistics', and 'Diagnostics'. The 'Device Information' section shows: Device Type: Node, Subscriber ID: 1, Current RF Channel: 1, Radio Linked: No, Radio Firmware Version: V101-0214, Web Server Firmware Version: SEL-3060-R101-0214, and MAC Address: 00:21:74:04:75:69. The 'Radio Statistics' section shows: RSSI: -100 dBm, Block Error Rate: 0.0 %, Total Packets: 0, Transmitted Packets: 0, Received Packets: 0, Failed Packets: 0, Passed Packets: 0, Broadcast Packets: 0, Unicast Packets: 0, Average TX Size: 1 bytes, and Average RX Size: 0 bytes. The 'Diagnostics' section shows: Radio Enabled: Active and Uptime: 0 days 00:00:58. A green 'Refresh' button is located at the bottom left of the dashboard.

Dashboard

Reports

MAC Address Routing

Radio Settings

Wireless Settings

Network Settings

IP Configuration

Accounts

Password

System

Usage Policy

File Management

Device Reset

Configuration Lock

Site Analysis

Dashboard 900 MHz

Device Information

Device Type:	Node
Subscriber ID:	1
Current RF Channel:	1
Radio Linked:	No
Radio Firmware Version:	V101-0214
Web Server Firmware Version:	SEL-3060-R101-0214
MAC Address:	00:21:74:04:75:69

Radio Statistics

RSSI:	-100 dBm
Block Error Rate:	0.0 %
Total Packets:	0
Transmitted Packets:	0
Received Packets:	0
Failed Packets:	0
Passed Packets:	0
Broadcast Packets:	0
Unicast Packets:	0
Average TX Size:	1 bytes
Average RX Size:	0 bytes

Diagnostics

Radio Enabled:	Active
Uptime:	0 days 00:00:58

Refresh

Creating a Point-to-Point Wireless Link

The following steps show you how to quickly create a wireless point-to-point link with a pair of SEL-3060 radios. To perform these steps, you need to have access to the radio settings and to be connected to the device (see *Connecting to the Device*).

- Step 1. Connect an antenna to each of the radios before allowing them to link.
- Step 2. Open your browser and enter the SEL-3060 IP address to display the device webpage. You should see the dashboard screen as shown in Step 6 of *Connecting to the Device*.
- Step 3. On the left-hand side of the dashboard screen, click **Wireless Settings** under **Radio Settings**.

SEL

[Logout]

Dashboard

Reports

MAC Address Routing

Radio Settings

Wireless Settings

Network Settings

IP Configuration

Accounts

Password

System

Usage Policy

File Management

Device Reset

Configuration Lock

Site Analysis

Wireless Settings

Device Settings

RF Channel:

☒ Automatic Channel Mode

☐ 0 Manual Channel Mode

Operation Mode:

☒ Node

☐ Access point

Subscriber Node ID:

1

(decimal 1- 63)

Number of Subscriber Nodes:

(decimal 1- 63)

Encryption Settings:

Network Name:

0000-132a

(hexadecimal 0-F)

XXXX-XXXX

Encryption Key:

32c3-7a38-c5f8-9944-33c0-b82c-a05c-480b

(hexadecimal 0-F)

XXXX-XXXX-XXXX-XXXX-XXXX-XXXX-XXXX-XXXX

Submit

Cancel

- Step 4. There are four settings that must be made to link two or more radios.
- a. Under **Operation Mode**, set the first SEL-3060 radio to **Node**.
 - b. Set the **Subscriber Node ID** to 1.

NOTE: All nodes must have a unique ID and they must be numbered in sequence.

- c. The other two settings that must be set are the Encryption settings. Fill in the Network Name and Encryption Key settings with hexadecimal digits. The Network Name must have 8 hex digits and the Encryption Key must have 32 hex digits. Each configured radio must have the exact Network Name and Encryption Key or they will not link.
- Step 5. Once you complete setting the Wireless Settings page, click the **Submit** button, and then click **OK** to confirm.
- Step 6. Unplug the RJ45 Ethernet cable from the SEL-3060 node and connect it to the second SEL-3060.
- Step 7. Use the Discovery Tool to search for the new unit, configure the IP address to a different IP address than the Node, and then click **Apply**.
- Step 8. Open the login page of the SEL-3060 by clicking **Go to Device Web Page**.
- Step 9. Log in to the webpage and click **Wireless Settings** as done in *Step 3*.
- Step 10. For the second SEL-3060, you need to set the device to **Access Point**.
- a. Once you select **Access Point**, the setting **Number of Subscriber Nodes** will enable allowing a number entry.
 - b. In this case, set Number of Subscriber Nodes to 1. If you are doing a point-to-multipoint configuration, then you would set this to the maximum number of nodes you currently have in the network.
- Step 11. The Encryption Settings must exactly match what was entered on the node.
- a. If you still have the webpage open, you can copy/paste between radios.
 - b. Once completed, click the **Submit** button.
 - c. Click **OK** to confirm.

At this point the radios should link and the Link Quality should be active.

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Section 3

Installation

Overview

RF Exposure Notice

RF EXPOSURE The SEL-3060 transmitter module is approved for use only with specific antenna, cable, and output power configurations that have been tested and approved for use. Modifications to the SEL-3060, the antenna system, or to the power output that have not been explicitly specified by the manufacturer are not permitted and may render the radio noncompliant with applicable regulatory authorities. The radio equipment described in this manual emits radio frequency energy. Professional installation is required.



CAUTION

Although the power level is low, concentrated energy from a directional antenna may pose a health hazard. Do not allow users to come closer than 23 cm (9 in) to the antenna when the transmitter is operating in indoor or outdoor environments.

FCC Part 15 Notice

NOTE: Operation is subject to the following two conditions:
(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

This equipment has been tested and found to comply with the limits for Class A digital devices, pursuant to FCC Part 15 Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and radiates radio frequency energy, and if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential environment is likely to cause harmful interference, in which case the user will be required to correct the interference at his/her own expense.

Radio Path

Spread-spectrum radios operating in the 900 MHz and 2.4 GHz ISM band are limited by line-of-sight. Radio line-of-sight is longer than optical line-of-sight, because of the bending of the radio wave toward the surface of the earth. This radio horizon is typically 30 percent longer than the visual horizon. The longer the communications path, the taller the antennas must be to maintain the line-of-sight.

Obstructions in the line-of-sight will impact the performance of the radio, because the strongest radio signal is communicated directly along the radio line-of-sight.

The line-of-sight between two antennas is shaped like an ellipse (called the Fresnel zone). The point exactly halfway between the two antennas is the widest part of the ellipse, as shown in *Figure 3.1*. At 900 MHz and 1000 feet apart, the Fresnel zone has a 16-foot radius. At 20 miles apart, it has 170-foot radius. Anything within the Fresnel zone will obstruct and reduce signal strength and availability (the ground, buildings, vegetation, etc.). *Table 3.1* depict the maximum Fresnel zone radius and path loss for some typical path distances.

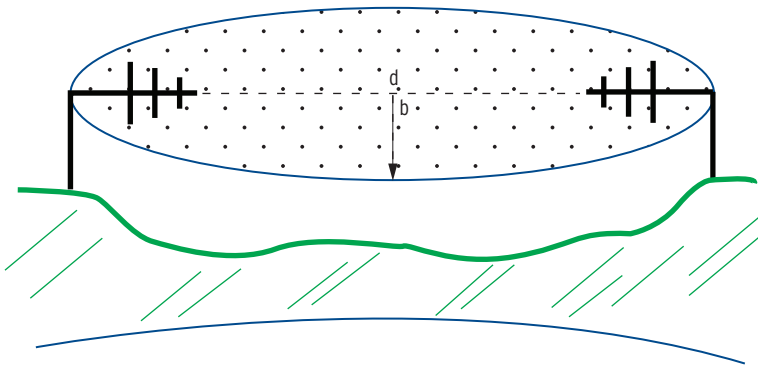


Figure 3.1 Fresnel Zone

The formula used to calculate the widest distance of the Fresnel zone is as follows:

$$b = 17.32 \sqrt{d/(4f)}$$

where:

b = radius of the Fresnel zone in meters

d = distance between transmitter and receiver in kilometers

f = frequency transmitted in GHz

Table 3.1 900 MHz Fresnel Zone Radius

Distance Between Antennas (d)	Fresnel Zone Radius (b)	Freespace Loss (dB)
300 m (1000 ft)	5 m (16 ft)	81
1.6 km (1 mi)	11.6 m (38 ft)	96
8 km (5 mi)	26 m (85 ft)	110
16 km (10 mi)	36.6 m (120 ft)	116
24 km (15 mi)	44.8 m (147 ft)	119
32 km (20 mi)	51.8 m (170 ft)	122

Table 3.2 2.4 GHz Fresnel Zone Radius

Distance Between Antennas (d)	Fresnel Zone Radius (b)	Freespace Loss (dB)
300 m (1000 ft)	3 m (10 ft)	90
1.6 km (1 mi)	7 m (23 ft)	104
8 km (5 mi)	16 m (52 ft)	118
16 km (10 mi)	22 m (72 ft)	124
24 km (15 mi)	27 m (89 ft)	128
32 km (20 mi)	32 m (105 ft)	130

Obstructions in the Fresnel zone may also cause multipath interference because of reflective or refractive signals that may arrive at the receiver out of phase with the desired signal. The Fresnel zone should be at least 60 percent clear of obstructions for reliable radio communications. Large objects outside the Fresnel zone can cause reflections that can also affect reliable radio operation.

Transmitted Signal

According to FCC and IC regulations, the maximum transmitted power allowed out of an antenna is 36 dBm Equivalent/Effective Isotropically Radiated Power (EIRP) for 900 MHz and 2.4 GHz SEL-3060 radios. In addition to the 36 dBm limit, the FCC allows higher gain directional antennas for 2.4 GHz SEL-3060B radios. With 2.4 GHz directional antennas, for every 3 dB increase higher than 36 dBm, the radio transmit power must be reduced by 1 dBm from the 30 dBm limit. Because the SEL-3060B transmits at 17 dBm, higher gain antennas can be used, exceeding the 36 dBm limit. On 2.4 GHz radios, this allows much higher gain antennas to be used to propagate longer distances with a much narrower beam.

EIRP is the amount of equivalent power transmitted equally in all directions during use of a theoretical isotropic antenna. EIRP takes into account the power output of the radio, line feed losses, and the gain of the antenna.

$$\text{EIRP} = \text{SEL-3060 Power Output (dBm)} - \text{line-feed loss (dB)} + \text{antenna gain (dBi)}$$

Calculate the EIRP so you can verify that the SEL-3060 stays in compliance with FCC and IC regulations. Maximum power output from the antenna must not exceed 36 dBm. The SEL-3060A can transmit as high as 100 mW or 20 dBm from the antenna port. If the calculated EIRP exceeds 36 dBm, then you must use either a lower gain antenna or a higher loss/longer coaxial cable to reduce the power transmitted by the radio. The SEL-3060 transmit power is fixed and cannot be changed. With 2.4 GHz directional antennas, for every 3 dB increase higher than 36 dBm, the radio must be reduced by 1 dBm from the allowed 30 dBm. Because the SEL-3060B transmits at 17 dBm, higher gain antennas can be used. See feed line loss in *Table 3.8* and *Table 3.9*.

NOTE: This device has been designed to operate with the antennas listed in Table 3.3 and Table 3.4. Antennas not included in this list or having a gain greater than the same type of antenna found in the tables are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

For example, if you wanted to design a radio system to achieve a 32-km (15-mile) radio path and run at the highest allowed transmitted power, one way is to use the SEL-3060A with 15 meters (50 feet) of LMR-400, lightning arrestor, and the 5-Element Yagi with 16.15 dBi of gain. In this scenario, the radio would transmit 20 dBm, the feed line loss would be 1.95 dB, lightning arrestor loss would be 0.15 dB, and the antenna gain would be 16.1 dBi. The result would be 34 dBm, which is 2 dBm lower than allowed by the FCC.

NOTE: To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (EIRP) is not more than that permitted for successful communication.

Table 3.3 Antennas Permitted for Use With the SEL-3060A 900 MHz Radio

Antenna Type	Maximum Allowed Gain
Yagi antenna	16.15 dBi or less
Omnidirectional antenna	11.15 dBi or less

Table 3.4 Antennas Permitted for Use With the SEL-3060B 2.4 GHz Radio

Antenna Type	Maximum Allowed Gain
Yagi antenna	16.15 dBi or less
Omnidirectional antenna	15 dBi or less
Panel antenna	19 dBi or less

Fade Margin

The fade margin determines the allowable signal loss between the transmitter and receiver. The fade margin is a function of system gains (transmitter power, receiver sensitivity, and antenna gain) and system losses (free-space loss, losses because of Earth's curvature, and coaxial cable loss). Variations in temperature and the humidity of the atmosphere with elevation cause the signals to bend more or bend less, resulting in fading at the receiver. The longer the path, the more likely deep fades will occur, requiring a greater fade margin. The formula to calculate free-space loss is shown below.

$$\text{Free-Space Loss} = 92.4 + 20\log(f) + 20\log(d) \text{ dB}$$

where:

f = frequency in GHz

d = distance in km

Regional conditions also impact the probability of signal fade. Generally, mountainous terrain is more favorable, while tropical areas and those near large bodies of water are less favorable. One of the results from a site survey is the fade margin. A fade margin of 10 dB will yield adequate performance for noncritical communications while a fade margin of 15 dB will yield good radio performance for critical communications links.

Site Survey

A line-of-sight path provides the most reliable transmission in all cases. As the distance increases, the need for a clear path becomes more critical in creating a reliable, available radio link. If the radio path is short and the other end is visible without obstructions, a path study may not be needed. If you have a clear line-of-sight to the other location without obstructions to the Fresnel zone (see *Radio Path*) then a path study is generally not needed. Longer distances may require a path study, a visual path inspection, and a spectrum analysis of the area to give a good indication of how high the antenna needs to be and how good the radio link will be.

Radio Interference

The SEL-3060 shares a frequency spectrum with other services and FCC Part 15 (unlicensed) devices in ITU Region 2 (North, Central, and South America). This radio should not be used in Chile because of the regulations defining frequency allocation. Error-free communications may not be achievable in a given location, and some level of interference should be expected.

Consider the following points when setting up your system:

- Use directional antennas to help narrow the radio path and provide the best path to prevent adjacent interference.
- If you suspect interference from a nearby licensed system (such as a paging transmitter), it may be helpful to use horizontal polarization for all of the antennas in the network. Horizontal polarization can help improve signal availability but will likely increase the path loss. Horizontal polarization can provide an additional 20 dB of attenuation to interference because most other services use vertical polarization in these bands. *Figure 3.2* demonstrates antenna mounting for both vertical and horizontal polarization.

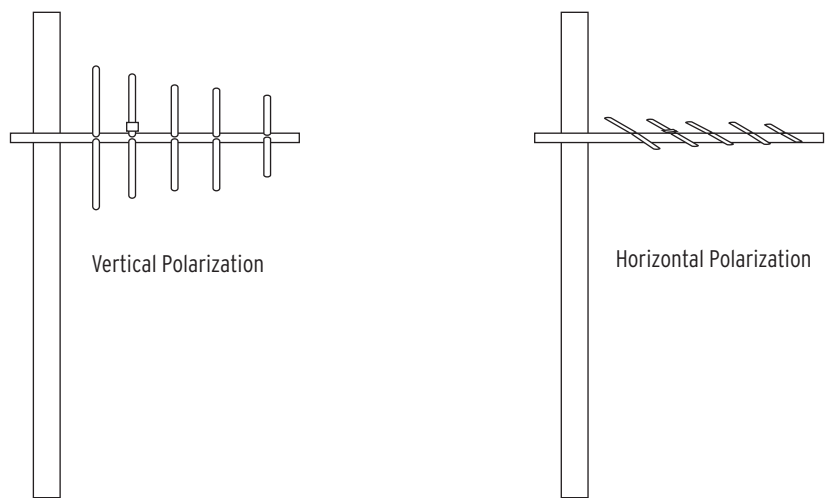


Figure 3.2 Antenna Polarization

Several SEL-3060 systems can coexist in close proximity with minimal interference by using manual channel settings that allow you to have collocated radios.

Table 3.5 SEL-3060A 900 MHz Channel Frequencies

Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6
903.125	905.20833	907.29167	909.37500	911.45833	913.54167
Channel 7	Channel 8	Channel 9	Channel 10	Channel 11	Channel 12
915.62500	917.70833	919.79167	921.87500	923.95833	926.04167

Table 3.6 SEL-3060A 900 MHz Channel Frequencies for Brazil (Part Numbers Starting With 3060A3)

Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6
903.125	905.20833	917.70833	919.79167	921.87500	923.95833
Channel 7					
926.04167					

Table 3.7 SEL-3060B 2.4 GHz Channel Frequencies

Channel 1	Channel 2	Channel 3	Channel 4	Channel 5	Channel 6
2.416667	2.418750	2.420833	2.422917	2.425000	2.427083
Channel 7	Channel 8	Channel 9	Channel 10	Channel 11	Channel 12
2.429167	2.431250	2.433333	2.435417	2.437500	2.439583
Channel 13	Channel 14	Channel 15	Channel 16	Channel 17	Channel 18
2.441667	2.443750	2.445833	2.447917	2.450000	2.452083
Channel 19	Channel 20	Channel 21	Channel 22	Channel 23	Channel 24
2.454167	2.456250	2.458333	2.460417	2.462500	2.464583
Channel 25	Channel 26				
2.466667	2.468750				

Feed Lines

The feed line used with the antenna is as important as the antenna. Coaxial cables should have low attenuation and be rated for outdoor use. Keep the feed line as short as possible to minimize signal loss between the radio and antenna. As a minimum, Times Microwave LMR-400 coax cables are preferred. If longer lengths or less loss is desired for the radio link, then a larger cable such as Andrew HELIAX can be used. *Table 3.8* and *Table 3.9* list the signal losses (in dB) for the indicated lengths of each cable type for each radio type.

Table 3.8 Length vs. Loss in Coaxial Cables at 900 MHz (Sheet 1 of 2)

Cable Type	3.05 meters (10 feet)	12.24 meters (50 feet)	30.48 meters (100 feet)	91.44 meters (300 feet)
LMR-400 (SEL-C966 or SEL-C968)	0.39 dB	1.95 dB	3.90 dB	Unacceptable Loss
1/2-inch HELIAX	Do not use	1.15 dB	2.29 dB	6.87 dB

Table 3.8 Length vs. Loss in Coaxial Cables at 900 MHz (Sheet 2 of 2)

Cable Type	3.05 meters (10 feet)	12.24 meters (50 feet)	30.48 meters (100 feet)	91.44 meters (300 feet)
7/8-inch HELIAX (SEL-C978)	Do not use	0.64 dB	1.28 dB	3.84 dB
1 1/4-inch HELIAX	Do not use	Do not use	0.95 dB	2.85 dB
1 5/8-inch HELIAX	Do not use	Do not use	0.80 dB	2.4 dB


Table 3.9 Length vs. Loss in Coaxial Cables at 2.4 GHz

Cable Type	3.05 meters (10 feet)	12.24 meters (50 feet)	30.48 meters (100 feet)	91.44 meters (300 feet)
LMR-400 (SEL-C966 or SEL-C968)	0.66 dB	3.3 dB	6.6 dB	Unacceptable Loss
1/2-inch HELIAX	Do not use	1.85 dB	3.7 dB	11.1 dB
7/8-inch HELIAX (SEL-C978)	Do not use	1.0 dB	2.0 dB	6 dB
1 1/4-inch HELIAX	Do not use	Do not use	1.6 dB	4.8 dB
1 5/8-inch HELIAX	Do not use	Do not use	1.4 dB	4.2 dB

Antenna System Ground

Antenna system grounding is not included in the scope of this manual. Please consult a radio systems engineer or other professional for advice on ground-system design. A well-designed system will minimize equipment damage and risk of electric shock to personnel.

Chassis Ground



Connect the grounding terminal labeled with the ground symbol (seen on the left) on the rear panel to a rack frame ground or main station ground for proper safety and performance. Use 4 mm² (12 AWG) or heavier wire less than 2 meters (6.6 feet) in length for this connection. The ground connection should be made before the power connections.

Connections

Rear-Panel Connections

The physical layout of the SEL-3060 connections is shown in *Figure 3.3*.

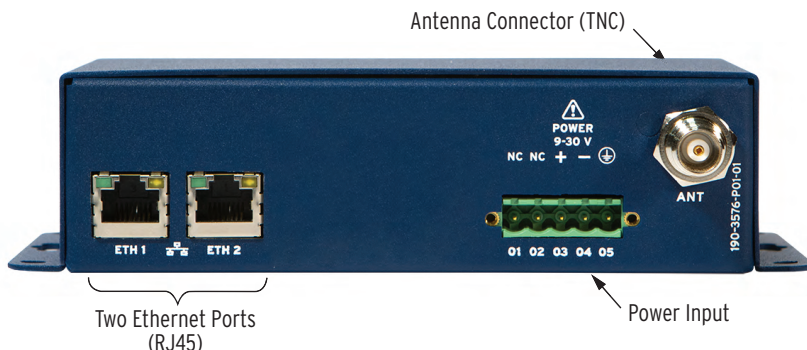


Figure 3.3 Wall-Mount Rear Connections

Power Connections

The **POWER** terminals on the rear panel (labeled + and -) must connect to the correct supply voltage. The supply voltage range is located on the serial label. The wall-mount configuration accepts only 9–30 Vdc. Check the serial label for power supply information.

Do not apply power to the SEL-3060 without having a proper 50-Ω load on the antenna port. If you do not have the proper 50-Ω load connected, the radio antenna port can be damaged. The **POWER** terminals are not isolated from chassis ground. Use 2.5 mm² (14 AWG) size wire to connect to the **POWER** terminals. Place an external circuit breaker or switch no more than 3 meters (9.8 feet) from the equipment. The circuit breaker (or equivalent approved disconnect device appropriate for the country of installation) must comply with IEC 60947-1 and IEC 60947-3, be identified as the disconnect device for the equipment, and be located near the equipment. This disconnect device must interrupt both the positive (+) and the negative (-) power leads. The maximum current rating for the power disconnect circuit breaker or overcurrent device (fuse) must be 20 A. An internal power supply fuse protects the operational power supply. Be sure to use fuses that comply with IEC 60127-2.

Lightning Protection

WARNING

Atmospheric electrical charge accumulation can cause potential between the conductor and shield of the feed line, or cause lightning to strike an antenna. A lightning protector should be installed to prevent damage to equipment or injury to personnel.

Mount the antenna on an equipment building roof or tower to be safe, because the potential rise on the outside of either of these structures is approximately equal to the potential on the inside. You should use a lightning protector (Radio Surge Protector with N Female Connectors, SEL part number 200-2004) to equalize the difference in potential that can occur between the center conductor and the shield of the coaxial cable between the antenna and the radio. The higher you mount the antenna on a support structure, the greater the probability of equipment damage resulting from a lightning strike.

In all surge-protector applications, you should mount the surge protector at the building or enclosure entrance and ground the surge-protector body. Ground the radio to the same point as the surge-protector ground to avoid ground-rise-potential damage.

When using the surge protector, order an additional SEL-C966 cable and place this cable between the SEL-3060 and the surge protector. Because the distance varies from the SEL-3060 to the surge protector, be sure to specify this cable at approximately the correct length (plus 10 to 20 percent for installation variability).

Grounding (Earthing) Connections



You must connect the ground terminal labeled with the ground symbol (seen on the left) to a rack frame or switchgear ground for proper safety and performance. Use 2.5 mm² (14 AWG) wire less than 2 meters (6.6 feet) in length for the ground connection.

Ethernet Ports

Each of the rear-panel Ethernet ports has a pair of corresponding LED indicators on the front panel: a yellow indicator above a green one. *Table 3.10* shows how to interpret the states of these LED indicators. Note that the connector for each port on the rear panel has built-in status indicators. As with the front-panel indicators, these include one green and one yellow LED, and these indicate link status similarly. This simplifies detection of cabling errors when inserting and removing Ethernet cables from the rear of the unit.

Table 3.10 Ethernet Status Indicators

LED State	Ethernet
Solid green	Link up
Blinking green	Port activity
Solid yellow	Full-speed link (100 Mbps)
Blinking yellow	Collision
Extinguished yellow	Low-speed link (10 Mbps)

Reset Button

The front panel contains a pinhole reset button. If you forget the IP address or password, you can use this button to reset all the settings back to factory defaults. With the device turned on, insert a tool such as a straightened paper clip into the pinhole reset hole and press the recessed button. Hold the button depressed for five seconds. All front-panel indicators will illuminate to indicate the reset button is depressed. After releasing the button, the device will restart and all settings will be reset to factory default with the default password, **TAIL**.

Password

The SEL-3060 requires a password to access and set the radio. The password is for read and write access. The default password that is shipped with the SEL-3060 is shown in *Table 3.11*. Do not leave the factory-default password in the product. See *Password on page 4.8* for more information on setting passwords.

Table 3.11 Default Password

Access Level	Password
Read/Write	TAIL

Front-Panel Indicators

The SEL-3060 has 11 front-panel LED indicators. *Table 3.12* further describes these indicators that display the current status of the radio. The **LINK** LED indicates when the SEL-3060 has established a wireless connection to another SEL-3060.

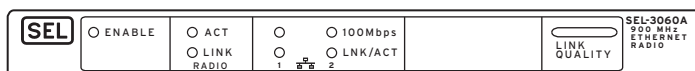


Figure 3.4 Front-Panel Status Indicator LEDs

Table 3.12 Front-Panel Status Indicator LEDs

Label	Color	Description
ENABLE	Green	All self-tests are passing and unit is operational
ACT	Green	Flashing: Radio data received or transmitted
LINK	Green	Communications link established between two or more radios
100Mbps	Amber	ON: Ethernet port connected at 100 Mbps OFF: Ethernet port connected at 10 Mbps
LNK/ACT	Green	ON: Ethernet port connected and active Flashing: Ethernet data activity on the port
LINK QUALITY	Multiple	Indicates the quality of the wireless link transitioning from red-amber-green where red is low quality and green is high quality

Communications

Ethernet Ports

Table 3.13 shows the physical interfaces of the SEL-3060.

Table 3.13 SEL-3060 Port Description

Port	Communications Interface	Location
Eth 1	10/100BASE-T	Rear
Eth 2	10/100BASE-T	Rear

Ethernet Port Connections

Table 3.14 shows the pin function of the Ethernet ports.

Table 3.14 SEL-3060 10/100 Mbps Ethernet Port Pinout (Sheet 1 of 2)

Pin	Description
1	A+
2	A–
3	B+
4	N/C
5	N/C

Table 3.14 SEL-3060 10/100 Mbps Ethernet Port Pinout (Sheet 2 of 2)

Pin	Description
6	B–
7	N/C
8	N/C

Cleaning

Use care when cleaning the SEL-3060. Perform the following steps:

- Step 1. Use a mild soap or detergent solution and a damp cloth to clean the chassis.
- Step 2. Be careful cleaning the front and rear panels because a permanent plastic sheet covers each panel.

Do not use abrasive materials, polishing compounds, or harsh chemical solvents (such as xylene or acetone) on any surface.

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Section 4

Settings and Commands

Introduction

This section explains the settings and commands in the SEL-3060.

Setup

Follow the steps outlined in *Section 2: Getting Started* to prepare the SEL-3060 for use. Perform the following steps to initiate communications:

- Step 1. Apply power to the SEL-3060.
- Step 2. Connect a standard RJ45 Ethernet cable (such as the SEL-CA605) between the SEL-3060 and the PC.
- Step 3. Open your local web browser and type in the SEL-3060 IP address.

Dashboard

When you first log in to the SEL-3060, the first page that appears is the Dashboard view. The dashboard lists device information, radio statistics, and diagnostic information. The dashboard is designed to give a quick view of the status of the SEL-3060 and the network it is connected to. The dashboard is automatically updated every 10 seconds, but you can click the **Refresh** button to update sooner.



Figure 4.1 Dashboard View

Device Information

The Device Information table gives a brief look at information about the radio, including if the radio is connected, the current state, and the firmware versions of the device.

Table 4.1 Dashboard Description (Sheet 1 of 2)

Name	Range	Description
Device Type	Access Point, Node	Identifies whether radio is set as an access point (AP) or node
Subscriptions Issued	1–63	(AP only) Displays number of nodes allowed to connect to an AP
Connected Subscribers	1–63	(AP only) Displays number of nodes that are actually connected to AP
Subscriber ID	1–63	(Node only) Uniquely identifies the node on the network
Current RF Channel	1–12 (SEL-3060A) 1–7 (SEL-3060A3 [Brazil Firmware]) 1–26 (SEL-3060B)	Current RF channel radio is operating on. See Table 3.3 and Table 3.4.
Radio Linked	Yes, No	Identifies if node is connected to AP or if AP is connected to one or more nodes
Radio Firmware Version	e.g., 099	Current radio firmware version

Table 4.1 Dashboard Description (Sheet 2 of 2)

Name	Range	Description
Web Server Firmware Version	SEL-3060-Rxxx-xxxx	Current web interface firmware version
MAC Address	e.g., 00:21:74:04:75:61	Unique MAC address of radio unit

Radio Statistics

The radio statistics column displays data about the radio link and statistical data about the payload data passing through the radio.

Table 4.2 Radio Statistics Description

Name	Range	Description
RSSI	-100 to 0 dBm	Received signal strength indication of the connected radio
Block Error Rate	0 to 100%	Percentage of received packets that fail averaged from the last 1000 data blocks
Total Packets	0 to $(4.29 \cdot 10^9)$	Total number of packets that have been transmitted and received by the radio
Transmitted Packets	0 to $(4.29 \cdot 10^9)$	Total number of packets transmitted out of the radio
Received Packets	0 to $(4.29 \cdot 10^9)$	Total number of packets received into the radio
Failed Packets	0 to $(4.29 \cdot 10^9)$	Number of packets that failed to get transmitted or received by the radio
Passed Packets	0 to $(4.29 \cdot 10^9)$	Number of packets successfully transmitted or received by the radio
Broadcast Packets	0 to $(4.29 \cdot 10^9)$	Number of broadcast packets sent or received by the radio
Unicast Packets	0 to $(4.29 \cdot 10^9)$	Number of unicast messages sent or received by the radio
Average TX Size	0 to 1536 bytes	Average size of payload data transmitted by the radio from the last 32 packets
Average RX Size	0 to 1536 bytes	Average size of payload data received by the radio from the last 32 packets

Diagnostics

The diagnostics section gives the current status of the radio and the amount of time it has been up and running.

Table 4.3 Diagnostics Description

Name	Range	Description
Radio Enabled	Active, Inactive, Standby	Displays if the radio is active in operation or inactive for a failure.
Uptime	0 days to ~4971 days, DDDD days, hh:mm:ss	The amount of time the device has been up and running.

Reports

The SEL-3060 includes reporting for the connected radios. In the AP under **Reports**, there is a report section called **MAC Address Routing**. This screen reports all of the connected SEL-3060 nodes to the AP, as well as all known MAC addresses of active devices connected to the node. This report is only available in the AP. The table automatically updates every 10 seconds. Press the **Refresh** button to refresh the screen sooner.

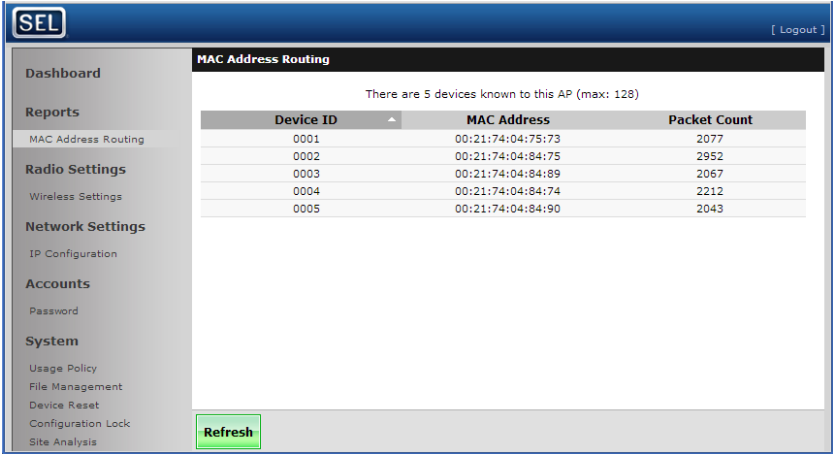


Figure 4.2 MAC Address Routing

The Device ID is the unique subscriber node identification of the node. As many as 63 nodes can be connected to one AP. The media access control (MAC Address) is a unique address given to the physical device on a network. There are no two identical MAC addresses for any network devices. This address uniquely identifies the radio on

the network. The third column shows the Packet Count. The Packet Count is the number of radio packets passed through the device. This value will reset if power is removed and then restored or if the device is reset.

Radio Settings

The main wireless settings for the SEL-3060 are located under the **Radio Settings** heading. *Figure 4.3* shows all the settings required to link radios in a point-to-point (P2P) or point-to-multipoint (P2MP) wireless network.

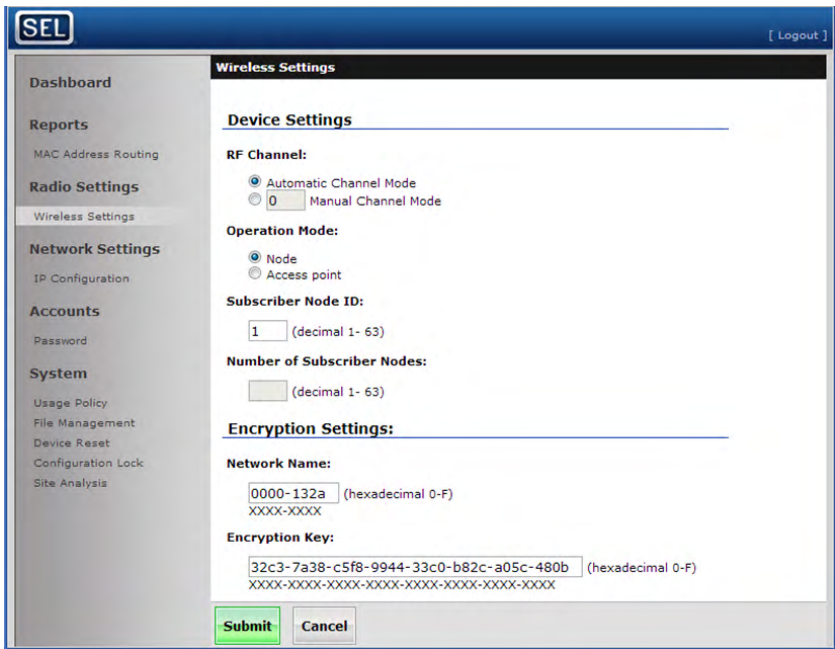


Figure 4.3 Wireless Device Settings

Table 4.4 describes the setting ranges and a brief description of how they are used.

Table 4.4 Wireless Settings (Sheet 1 of 2)

Setting	Setting Range	Default Setting
RF Channel	Auto, 1–12 (SEL-3060A), 1–7 (SEL-3060A3 [Brazil firmware]), 1–26 (SEL-3060B)	Auto
Operation Mode	Node, Access point	Node
Subscriber Node ID	1–63	Blank (node-only setting)

Table 4.4 Wireless Settings (Sheet 2 of 2)

Setting	Setting Range	Default Setting
Number of Subscriber Nodes	1–63	Blank (AP-only setting)
Network Name	8 digits in hexadecimal format	Random hex value loosely based upon MAC
Encryption Key	32 digits in hexadecimal format	Random hex value based upon MAC

RF Channel setting is used to set which channel of RF spectrum the radio should operate in. By default, RF Channel is set to Automatic and SEL recommends leaving it set to Automatic. In Automatic mode, the AP will monitor the block error rate of packets being sent and received. When the block error rate is high, it will automatically switch to a channel with less interference. In most applications, Automatic will yield the best performance. In cases where multiple collocated antennas are used, it may be necessary to manually set the channel. In this case, run the Site Analysis tool to check for available channels that are least noisy. Pick two or three channels that are the least noisy and have the largest spacing between the channels. For example, using the SEL-3060A 900 MHz radio, if you need to use two collocated antennas you would pick channels 1 and 12. If multiple radios are needed at the same location, it is best to use a mix of 900 MHz and 2.4 GHz where applicable.

Operation Mode sets how the radio operates on the wireless network. In a wireless network there can be one AP and as many as 63 nodes. If you have one AP and one node, then the wireless network is a P2P network. If there is more than one node on the network, then the wireless network is a P2MP network. In a P2P network all traffic is sent directly between the two points. In P2MP operation, all data are routed through the AP. The AP is typically placed at the head of a system or at the place of the SCADA Master. In P2MP configuration, two nodes are still allowed to communicate with each other. In this case, the data are routed through the AP in a two-hop sequence to reach the other node.

Subscriber Node ID is a unique identification of a node on the wireless network. Every node within the network must be set from 1–63 so that the AP can identify the node. The Node ID setting for each node should be set in sequential order, starting with 1 and as high as 63 for each node. Do not skip Node IDs and make sure the maximum Node ID used is equal to the number of subscriber nodes set in the AP.

Number of Subscriber Nodes is a setting only available in the AP. This setting tells the AP how many nodes are allowed to be part of the wireless network. For example, if you set the Number of Subscriber Nodes to 5 and you have a node set to 6 for the Node ID, the AP will not allow the node to join the network. In this scenario, the AP will only accept as many as five nodes, and they must all have Node IDs set between 1 and 5. If the number of Subscriber Nodes is set higher than the actual number of nodes, the AP will continually look for those nodes and you will lose some of the overall bandwidth.

NOTE: These settings assume the Network Name and Encryption Key are set identical on every radio operating on the network.

Network Name and **Encryption Key** settings go together in securing the wireless link. Both of these settings must be set identical on every radio operating on the same wireless network. Both settings allow the use of hexadecimal values, which are 0–9 and A–F for each digit. The Network Name is an 8-digit hex value that identifies the wireless network that all the radios relate to, with the head of the network being the AP. The Encryption Key is a 32-digit hex value that is used to encrypt all the wireless traffic between the AP and nodes.

Network Settings

The IP Configuration is found under **Network Settings**. The IP Configuration sets the wired and wireless local IP address so that the web interface can be accessed through the wireless and wired network.

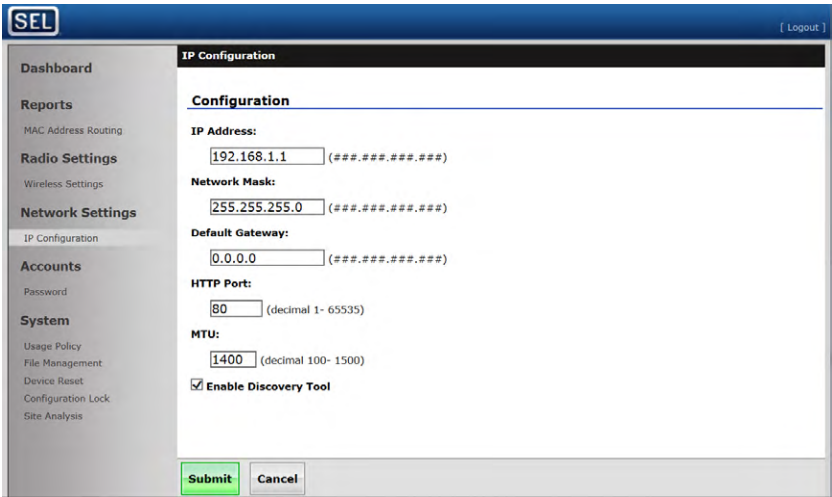


Figure 4.4 IP Configuration

Table 4.5 IP Configuration Settings (Sheet 1 of 2)

Setting	Setting Range	Default Setting
IP Address	(zzz.yyy.xxx.www) ^a	192.168.1.2
Subnet Mask	(yyy.yyy.xxx.www) ^a	255.255.255.0
Default Gateway	(zzz.yyy.xxx.www) ^a	000.000.000.000
HTTP Port	1–65535	80

Table 4.5 IP Configuration Settings (Sheet 2 of 2)

Setting	Setting Range	Default Setting
MTU	100–1500	1400
Enable Discovery Tool	Checked, not checked	Checked

^a zzz = 1-126, 128-223; yyy = 0-255; xxx = 0-255; www = 0-255.

IP Address is the local address of the web interface. This address must be unique from other devices on the same LAN. Both Ethernet ports on the SEL-3060 share the same IP address and act as an unmanaged, layer 2 switch. The default IP address is 192.168.1.2.

Subnet Mask is used to determine what network the radio resides on. If the address of a PC resides on a different subnet, the IP address is automatically routed through the default gateway. If two devices have different subnet masks, they might not be able to communicate with each other. The default subnet mask is 255.255.255.0.

Default Gateway is the IP address used to transfer packets to another network. The default gateway is typically a router configured to route device traffic over different subnets. If all the devices are on the same subnet, this setting does not need to be set.

HTTP Port is the port number used to access the web interface. The default is set to 80, which is the default port used on most webpages. If your company has different firewall rules they may use a different port number to access the web interface, which may require changing this value.

MTU is the Maximum Transmission Unit, which is the size of the largest network layer protocol data unit that can be communicated in a single network transaction. Its unit is in bytes, and the default is set to 1400 bytes. If your application uses a different MTU size, you may need to change this value.

Enable Discovery Tool allows the user to enable or disable the ability to have the SEL-3060 Discovery Tool discover the radio on the network. The default is checked.

Accounts

Password

The Password page allows a user to change the default password. The current password is never displayed on this page.

Table 4.6 Setting the Password

Setting	Setting Range	Default Password
New Password	8–32 numbers or letters	TAIL
Confirm Password	8–32 numbers or letters	TAIL

The default password on the device is TAIL. SEL strongly recommends that you change the password before putting the device into service. To enter a new password, you must enter it twice and the password must contain a minimum of eight characters. The characters consist of numbers or letters. No special characters are allowed. If the device password is forgotten, you can reset the device back to factory defaults. On the front of the SEL-3060 there is a pinhole to reset the device. See *Reset Button on page 3.11* for more information on how to reset the device to factory defaults.

System

Usage Policy

The initial webpage for accessing the SEL-3060 is the user login. The user login requires a password to access the device. On the right side of the login page is a usage policy.

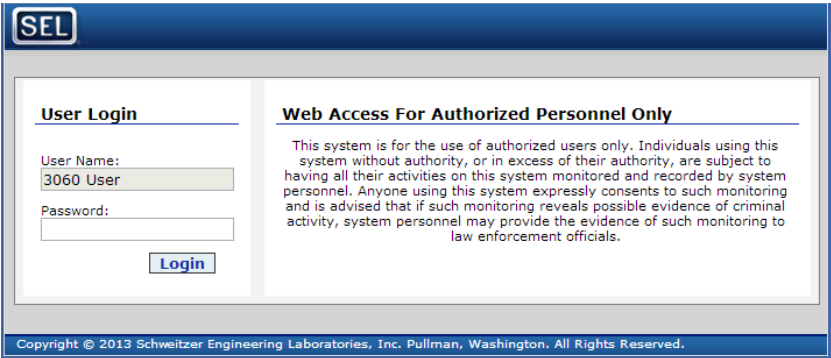


Figure 4.5 User Login Page

The usage policy is to make users aware when logging in that only authorized users are allowed. *Figure 4.5* displays the SEL-3060 default usage policy. If your company would like to use a different usage policy, you can customize it in the Usage Policy window.



Figure 4.6 Usage Policy

In *Figure 4.6*, the usage policy can be modified by entering a new usage policy and submitting the changes. You are allowed 400 characters to write a custom usage policy.

NOTE: Once you change the Usage Policy from the default usage policy to a customized usage policy, the only way to get the default usage policy back is by submitting a blank screen.

File Management

The file management interface allows you to upgrade the device and import/export settings configuration.

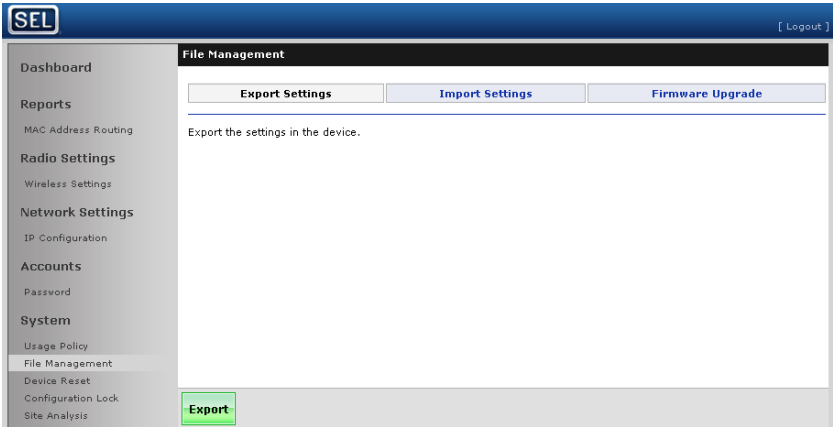


Figure 4.7 File Management

Figure 4.7 displays the interface for file management. The file management allows you to import/export a settings file or upgrade firmware.

Setting Import/Export

The SEL-3060 allows importing and exporting all settings files. The settings import function is available on the **File Management** tab.

Export Settings

The **Export Settings** page provides an interface to export settings to a single settings file. Perform the following steps to export a settings file:

- Step 1. Log in to the device and browse to the **File Management** page.
You should be on the **File Management** page shown in Figure 4.7.
- Step 2. Select the **Export Settings** tab.
- Step 3. At the bottom of the screen, click the **Export Settings** button.
- Step 4. The settings will be downloaded through the web interface. You will be prompted to save the file.

Import Settings

The **Import Settings** page provides an interface to import settings from a settings file. Perform the following steps to import a settings file:

- Step 1. Log in to the device and browse to the **File Management** page.
You should be on the **File Management** page shown in Figure 4.7.
- Step 2. Select the **Import Settings** tab.

- Step 3. Under **Settings File**, click on **Choose File** and browse to the location of the settings file you want to import.
- Step 4. Click the **Update** button.

Device Reset

The device reboot page allows the user to remotely restart the device.

The **Device Reboot** page is located under the **System** tab, as shown in *Figure 4.8*.

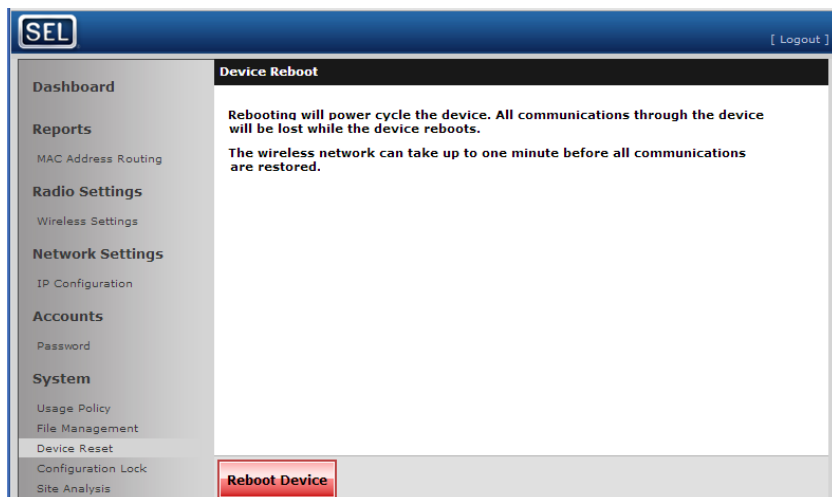


Figure 4.8 Device Reset

To remotely turn the SEL-3060 off and then back on from the Device Reboot page, click **Reboot Device**. The device will restart in a short period of time. Device Reboot does not reset the settings of the device; it only restarts the device and resets device statistics.

Configuration Lock

The SEL-3060 includes a feature that allows the user to lock down all access to the SEL-3060. The configuration lock, when selected, will restart the device and turn off all interfaces to the SEL-3060. Once the configuration lock is set, the SEL-3060 can only be used as a wired to wireless pass-through device. To regain access to the SEL-3060 you must physically be at the device and use the pinhole reset. This will reset all settings back to factory defaults. When the configuration lock is in effect, the settings, access, and encryption keys will never be exposed.

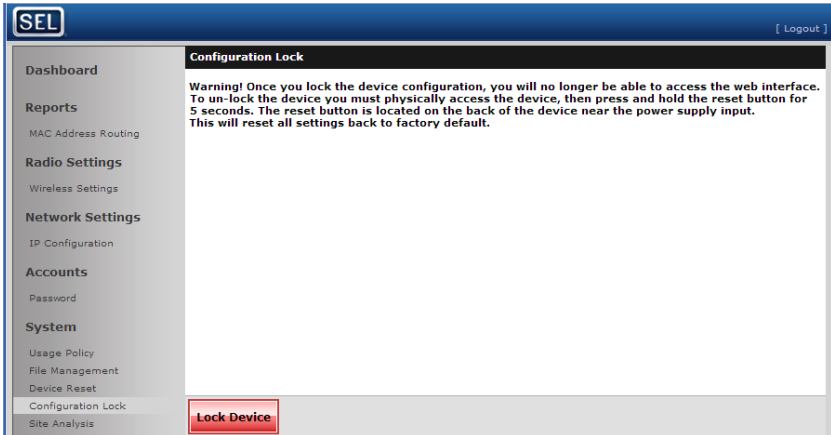


Figure 4.9 Configuration Lock

This mode of operation is valuable when setting up a wireless network where you do not want anyone to have access to view or change any settings. In this state, passwords no longer need to be maintained or changed in the SEL-3060.

Site Analysis

The site analysis page is designed to be used as a utility tool when the radio systems are experiencing large levels of interference. The site analysis tool allows you to view the current amount of noise levels in the operating spectrum. In most cases, setting the SEL-3060 RF channel to automatic will allow the radio to find the best spectrum to operate in. If the link is not working reliably or when you want to set up collocated SEL-3060 radios, this is a useful tool to get an idea of the current levels of RF in the surrounding area. If you are using Microsoft Internet Explorer 8, you will need to download the SVG plug-in. The screen will have a link to download the plugging at the bottom if it is needed.

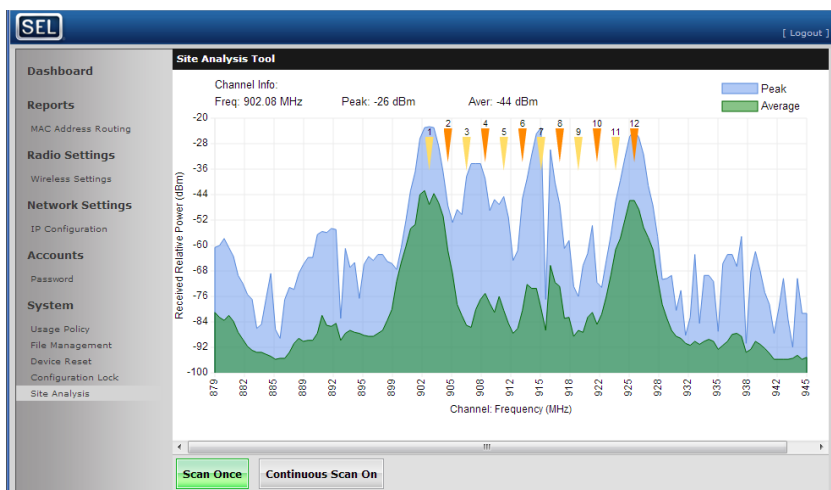


Figure 4.10 Site Analysis Tool

The site analysis tool can be run at the AP or any node in the network. The Site Analysis will temporarily turn off the radio link while it is scanning. After the scanning is finished it will link back to the existing system and send the scanned data.

To initiate the scan, click the button at the bottom labeled **Scan Once**, as shown in *Figure 4.10*. This will scan the RF spectrum and display the results on the screen once. If you would rather the SEL-3060 periodically scan, then click **Continuous Scan On**. The continuous scan works in approximately three second intervals.

When viewing the results of the scan, you want to find the lowest peak and average RF signal areas. In the case shown in *Figure 4.10*, it would be best to use Channel 5 or 9 to operate the radios.

Section 5

Performance Monitoring, Testing, and Troubleshooting

Overview

This section provides information on monitoring radio performance, testing, and troubleshooting. Because the SEL-3060 is equipped with self-tests, traditional periodic test procedures may be eliminated or greatly reduced.

Monitoring Radio Performance

This section describes the tools you can use to monitor and improve the radio performance. There are several items that you can use to optimize the radio link.

Monitoring and Improving Radio Link Performance explains how to optimize radio links.

Monitoring and Improving Radio Link Performance

This section assumes the radio link is up and running with sufficient link availability. If the radio link is either not working or has very low availability, see *Section 3: Installation* for information on properly installing and operating the radio.

Obtain access to any of the radios in the network with the set IP address. Access the device and go to the Dashboard screen. On the Dashboard screen under the Radio Statistics column, the first value is the receive signal strength indication (RSSI). This is the level of received level strength of the radio given in dBm. A good radio link should have 15 dB of margin to account for environmental conditions and signal fade. A fade margin of 10 dB will provide an adequate link for noncritical communications. The SEL-3060A receiver is rated down to -93 dBm at a 1 percent packet error rate (PER). If you observe a value of -78 dBm or greater then you are receiving a strong signal. If the value is less than -78 dBm, that does not mean the radio link will not work; it means that the performance and channel availability will be less and the radio network could have brief periods of link outages. To increase the signal or availability numbers you can adjust the radio antenna, replace the coaxial cable with a lower loss coaxial cable, or replace the antenna with a higher gain antenna. If you perform an initial path study and on-site path study, then most of these issues can be avoided. If none of these options improve radio link performance, you may want to set up a repeater site

Monitoring Radio Performance

between locations. A repeater site using two SEL-3060 radios will allow you to boost the signal, maintain full throughput, and use high-gain antennas to reach longer distances.

If you are using directional antennas, verify they have identical orientation. Both sides must be either polarized horizontally or vertically. Typically, a vertically polarized antenna will give better results than a horizontally polarized antenna. If the location of the radio antenna is shared with other antennas operating at the same frequency, then proper spacing and opposite polarization should be used on one set of the antennas. See *Section 3: Installation* for more information on antenna installation. Check the aiming of the antenna while viewing the Dashboard screen. The Dashboard automatically updates every ten seconds. To update faster you can click on the **Refresh** button. If the link is established, the Dashboard can be viewed on any linked radio. Adjusting the antenna will require two people, with one person moving the position of the antenna in small increments while the other is monitoring the RSSI. The antenna position must be rotated on both sides to obtain the highest signal strength. The RSSI must also be reviewed on each radio. The receive strength on one radio will likely be slightly different than the receive strength on the other radio.

The last step to check is the data availability of the radio link. The Dashboard will display the Block Error Rate. The Block Error Rate is the percentage of received packets that fail averaged from the last 1000 data blocks. It is ideal to see the Block Error Rate near zero. If you see a sustained high block error rate higher than 25 percent, there is either a great deal of interference or a low signal level. This is similar to the case with the RSSI, where to increase the availability you must either increase the strength of the signal or use the site analysis tool to manually change the radio to a region that is less occupied.

If the block error rate is still high and positioning the antenna does not help, then the radio link has a large amount of interference or there is an obstruction to the Fresnel zone that is causing reflection issues. The interference can be caused by a number of items. A path study is critical to determine how good the line-of-sight is and how high the antennas need to be. If the path study results do not match your actual results, you will need to make sure all of the parameters used to make the path study were correct. If the results still do not match, then there is an unaccounted obstruction in the path (either buildings or trees) that is causing the decrease in availability. See *Section 3: Installation* for more information on properly installing the antenna. If the availability of the radio is less than you need, then the problem is location, interference, or multipath radio issues. If the antenna tower is not located high enough and proper steps are not taken to detect noise floors or obstructions to the Fresnel zone, then the availability numbers may not reach those used in the path study.

Troubleshooting

Table 5.1 Troubleshooting Tips

Symptom	Probable Cause	Corrective Action
ENABLE LED is OFF	Radio recognized a status failure or incorrect power applied	Check that 9–30 Vdc is being applied to the input. Turn unit off, then on; see if the ENABLE LED is ON. Otherwise, return unit to the factory for repair.
Cannot open the webpage interface	Radio set to a different IP address or on a different subnet	Use the SEL-3060 Discovery Tool to find the device on the network and change to the correct IP settings. If you do not see the device with the Discovery Tool, make sure you are directly connected to radio. Otherwise, use the pinhole reset to reset the settings back to default.
Cannot log in	Invalid password	If you forget the password, you must reset the device by using the pinhole reset. This will reset the password back to the factory default.
The node will not link up to the access point (AP)	Radio address or encryption key is not set correctly	The master and remote radios must be set to the same network name and encryption key. The highest number of Node ID must be equal to or less than the AP number of subscriber units.
After the radios are linked, can no longer access devices on different radios	The radio/PC has learned MAC address routing tables, and switching locations prevents the devices from routing the traffic properly	Turn power to the AP and/or PC off, then on. This will reset the tables and cause the radio/PC to relearn the new routing tables.

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Appendix A

Firmware and Manual Versions

Firmware

The SEL-3060 contains two firmware versions, one for the radio firmware, the other for the web server. To find the version numbers of the firmware in your SEL-3060, go to the Dashboard screen on the web interface. The firmware revision number is located after the device information.

Table A.1 through Table A.3 list the firmware versions, revision descriptions, and corresponding instruction manual date codes. The most recent firmware version is listed first.

To avoid a loss of settings, read *Appendix B: Firmware Upgrade Instructions* before performing a firmware upgrade.

Table A.1 SEL-3060A Firmware Revision History

Firmware ID (FID) Number	Summary of Revisions	Manual Date Code
Radio Firmware Version: V102-0314 Web Server Version: SEL-3060-R104-0217	<ul style="list-style-type: none">➤ Added Maximum Transmission Unit (MTU) size.➤ Addressed an issue in all previous versions where maliciously crafted Ethernet packets could allow unauthorized access.	20170217
Radio Firmware Version: V102-0314 Web Server Version: SEL-3060-R103-1114	<ul style="list-style-type: none">➤ Enhanced MAC address table logging.	20141112
Radio Firmware Version: V102-0314 Web Server Version: SEL-3060-R102-0414	<ul style="list-style-type: none">➤ Enhanced RSSI calculation algorithm.➤ Fixed configuration file upload issues.	20140404
Radio Firmware Version: V099-0114 Web Server Version: SEL-3060-R100-0114	<ul style="list-style-type: none">➤ Initial version.	20140124

Table A.2 SEL-3060A3 Firmware Revision History

Firmware ID (FID) Number	Summary of Revisions	Manual Date Code
Radio Firmware Version: V102B-0814 Web Server Version: SEL-3060-R103B-1215	➤ Initial version.	20160113

Table A.3 SEL-3060B Firmware Revision History

Firmware ID (FID) Number	Summary of Revisions	Manual Date Code
Radio Firmware Version: V103-0314 Web Server Version: SEL-3060-R104-0217	➤ Added Maximum Transmission Unit (MTU) size. ➤ Addressed an issue in all previous versions where maliciously crafted Ethernet packets could allow unauthorized access.	20170217
Radio Firmware Version: V103-0314 Web Server Version: SEL-3060-R103-1114	➤ Enhanced MAC address table logging.	20141112
Radio Firmware Version: V103-0314 Web Server Version: SEL-3060-R102-0414	➤ Initial version.	20140404

Table A.4 and Table A.5 list the valid radio firmware and web server versions for the SEL-3060A and the SEL-3060B.

Table A.4 SEL-3060A Valid Firmware Combinations

Web Server Firmware File Name	Displayed Web Server Firmware Version	Radio Firmware File Name	Displayed Radio Firmware Version
Brutus_ARM_SEL_1.60.5074.webbin	SEL-3060-R104-0217	SEL_900_v102LN.bin	V102-0314
Brutus_ARM_SEL_1.60.4835.webbin	SEL-3060-R103-1114	SEL_900_v102LN.bin	V102-0314
Brutus_ARM_SEL_1.60.4822.webbin	SEL-3060-R102-0414	SEL_900_v102LN.bin	V102-0314
Brutus_ARM_SEL_1.60.4804.webbin	SEL-3060-R100-0114	SEL_900_v99LN.bin	V099-0114

Table A.5 SEL-3060B Valid Firmware Combinations

Web Server Firmware File Name	Displayed Web Server Firmware Version	Radio Firmware File Name	Displayed Radio Firmware Version
Brutus_ARM_SEL_1.60.5074.webbin	SEL-3060-R104-0217	SEL_2400_v103LN.bin	V103-0314
Brutus_ARM_SEL_1.60.4835.webbin	SEL-3060-R103-1114	SEL_2400_v103LN.bin	V103-0314
Brutus_ARM_SEL_1.60.4822.webbin	SEL-3060-R102-0414	SEL_2400_v103LN.bin	V103-0314

Instruction Manual

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

Table A.6 lists the instruction manual versions and revision descriptions. The most recent instruction manual revision is listed at the top.

Table A.6 Instruction Manual Revision History (Sheet 1 of 3)

Date Code	Summary of Revisions
20210715	Section 1 <ul style="list-style-type: none"> Updated <i>EMC Emissions in Specifications</i>.
20210511	Appendix A <ul style="list-style-type: none"> Added entry to R104 in <i>Table A.1: SEL-3060A Firmware Revision History</i> addressing an issue where maliciously crafted Ethernet packets could allow unauthorized access. Updated <i>Table A.2: SEL-3060A3 Firmware Revision History</i>. Added entry to R104 in <i>Table A.3: SEL-3060B Firmware Revision History</i> addressing an issue where maliciously crafted Ethernet packets could allow unauthorized access. Updated <i>Table A.4: SEL-3060A Valid Firmware Combinations</i>.
20200729	Section 1 <ul style="list-style-type: none"> Updated <i>Table 1.1: Radio Antenna and Cable Accessories</i>. Appendix A <ul style="list-style-type: none"> Added entry to R104 in <i>Table A.1: SEL-3060A Firmware Revision History</i> addressing a web interface security vulnerability. Added entry to R104 in <i>Table A.3: SEL-3060B Firmware Revision History</i> addressing a web interface security vulnerability.
20190214	Section 1 <ul style="list-style-type: none"> Updated <i>Table 1.1: Radio Antenna and Cable Accessories</i>.
20180906	Section 1 <ul style="list-style-type: none"> Updated <i>Table 1.1: Radio Antenna and Cable Accessories</i>. Updated <i>Specifications</i>.

Table A.6 Instruction Manual Revision History (Sheet 2 of 3)

Date Code	Summary of Revisions
20180829	Section 1 <ul style="list-style-type: none"> ➤ Updated <i>Specifications</i>.
20180613	Section 1 <ul style="list-style-type: none"> ➤ Updated <i>Table 1.1: Radio Antenna and Cable Accessories</i>.
20171005	Appendix A <ul style="list-style-type: none"> ➤ Added note to <i>Table A.1: SEL-3060A Firmware Revision History</i> regarding Web Server Version SEL-3060-R104-0217. Appendix B <ul style="list-style-type: none"> ➤ Updated <i>Firmware Upgrade</i>.
20170217	Section 3 <ul style="list-style-type: none"> ➤ Updated radius information in <i>Radio Path</i>. ➤ Changed the caption for <i>Table 3.1: 900 MHz Fresnel Zone Radius</i>. ➤ Changed the caption for <i>Table 3.2: 2.4 GHz Fresnel Zone Radius</i>. Section 4 <ul style="list-style-type: none"> ➤ Updated <i>Figure 4.1: Dashboard View</i>. ➤ Updated <i>Figure 4.4: IP Configuration</i>. ➤ Updated <i>Table 4.5: IP Configuration Settings</i>. ➤ Updated IP Address description in <i>Network Settings</i>. ➤ Added MTU description in <i>Network Settings</i>. ➤ Changed Enable IP Finder to Enable Discovery Tool in <i>Network Settings</i>. Appendix A <ul style="list-style-type: none"> ➤ Updated for web server version R104-0217.
20160829	Section 1 <ul style="list-style-type: none"> ➤ Updated <i>Specifications</i>. Section 3 <ul style="list-style-type: none"> ➤ Updated <i>Transmitted Signal</i>.
20160203	Section 1 <ul style="list-style-type: none"> ➤ Updated <i>Table 1.1: Radio Antenna and Cable Accessories</i>. ➤ Updated compliance information in <i>Specifications</i>. Section 3 <ul style="list-style-type: none"> ➤ Updated <i>Lightning Protection</i>.
20160113	Section 1 <ul style="list-style-type: none"> ➤ Added Brazil to <i>Table 1.2: Certifications by Country</i>. Section 3 <ul style="list-style-type: none"> ➤ Added <i>Table 3.6: SEL-3060A 900-MHz Channel Frequencies for Brazil (Part Numbers Starting With 3060A3)</i>.

Table A.6 Instruction Manual Revision History (Sheet 3 of 3)

Date Code	Summary of Revisions
	Section 4 <ul style="list-style-type: none"> Updated <i>Table 4.1: Dashboard Description</i>. Appendix A <ul style="list-style-type: none"> Updated for radio firmware version V102B-0814 and web server version R103B-1215.
20150211	Preface <ul style="list-style-type: none"> Updated <i>Safety Information</i>. Section 1 <ul style="list-style-type: none"> Renamed <i>Certifications</i> to <i>Compliance</i> and moved to the beginning of <i>Specifications</i>. Updated <i>Table 1.1: Radio Antenna and Cable Accessories</i>. Updated <i>Table 1.2: Certifications by Country</i>. Section 3 <ul style="list-style-type: none"> Updated <i>Table 3.7: Length vs. Loss in Coaxial Cables at 900 MHz</i>. Updated <i>Table 3.8: Length vs. Loss in Coaxial Cables at 2.4 GHz</i>.
20141126	Section 1 <ul style="list-style-type: none"> Updated surge protection information in <i>Table 1.1</i>. Section 3 <ul style="list-style-type: none"> Updated surge protection information in <i>Lightning Protection</i>.
20141112	Appendix A <ul style="list-style-type: none"> Updated for web server version R103-1114.
20140917	<ul style="list-style-type: none"> Added Australia, Trinidad and Tobago, and New Zealand to <i>Table 1.2: Certifications by Country</i>.
20140730	<ul style="list-style-type: none"> Added Mexico to <i>Table 1.2: Certifications by Country</i>.
20140404	<ul style="list-style-type: none"> Added SEL-3060B information throughout manual. Section 2 <ul style="list-style-type: none"> Updated screen shots. Section 4 <ul style="list-style-type: none"> Updated screen shots. Appendix A <ul style="list-style-type: none"> Updated for radio firmware version V102-0314 and web server version R102-0414. Added <i>Table A.2: SEL-3060B Firmware Revision History</i>, <i>Table A.3: SEL-3060A Valid Firmware Combinations</i>, and <i>Table A.4: SEL-3060B Valid Firmware Combinations</i>. Appendix B <ul style="list-style-type: none"> Added <i>Appendix B: Firmware Upgrade Instructions</i>.
20140124	<ul style="list-style-type: none"> Initial version.

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Appendix B

Firmware Upgrade Instructions

Introduction

SEL occasionally offers firmware upgrades to improve the performance of your device. The SEL-3060 stores firmware in nonvolatile memory. Opening the case or changing physical components is not necessary. These instructions give a step-by-step procedure to upgrade the device firmware by uploading a file from a personal computer to the device via the web interface. Firmware releases are enhancements to improve functionality that change the way your device is configured or maintained, and can be installed in increasing or decreasing order. All existing settings will be transferred to newer firmware (except if upgrading to R104; see *Upgrading to Version R104* for details). Settings may not be transferred to older firmware. After a firmware update, it is possible to revert to the previously installed firmware version.

To perform an upgrade, you will need the appropriate firmware upgrade file.

Firmware Files

SEL-3060 firmware upgrade files have a .bin file extension for the Radio Firmware or a .webbin file extension for the Web Server Firmware. SEL-3060A firmware files will always begin with “SEL_900,” and SEL-3060B firmware files will always begin with “SEL_2400.” The web server firmware “.webbin” is the same for both the SEL-3060A and SEL-3060B.

An example firmware filename is SEL_900_v101LN.bin (SEL-3060A radio firmware) or Brutus_ARM_SEL_1.60.4805.webbin (web server firmware).

NOTE: If the incorrect .bin firmware is loaded for the SEL-3060 radio, the firmware upgrade will complete with no error messages, but the radio will become inoperable until the correct firmware is loaded.

Firmware Upgrade

Upgrading to Version R104

Upgrading to SEL-3060-R104-0217 requires a factory-default reset after the firmware upload, and you must back up (export) device settings to a file before you upgrade the firmware and then restore (import) them after the upgrade process. Perform the following steps for the access point (AP) and for *each* node radio you are upgrading to SEL-3060-R104-0217:

- Step 1. Export the settings (see *Export Settings on page 4.11* for details).
For the node radios, this step can be done either locally or remotely.
For the AP, it must be done locally.
- Step 2. Perform the firmware upgrade as shown in *Standard Upgrade Process*.
For the node radios, this step can be done either locally or remotely.
For the AP, it must be done locally.
- Step 3. Perform a factory-default reset by pressing the pinhole reset button located on the front panel of the device. See *Reset Button on page 3.11* for details.
- Step 4. Access the web interface of the device via the default IP address (192.168.1.2). This step must be done locally through use of the Ethernet port.
- Step 5. Import the settings from the file you created in *Step 1* (see *Import Settings on page 4.11* for details).

Standard Upgrade Process

The SEL-3060 allows you to easily upgrade the device through the local interface or over the wireless interface. The SEL-3060 contains two firmware files, and both can be upgraded through the same interface. To upgrade the firmware, follow these steps:

- Step 1. Go to the **File Management** window located under the **System** tab and select **Firmware Upgrade**, as shown in *Figure B.1*.

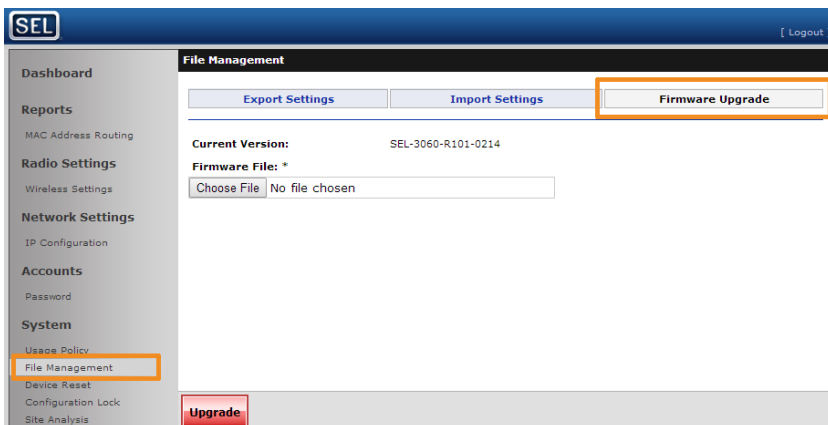


Figure B.1 File Management

- Step 2. Click **Choose File** and select the firmware file.
- Step 3. When you have selected the correct firmware file, click the **Upgrade** button. This will download the firmware file and restart the radio.

The settings will be maintained through the upgrade (except if upgrading to R104; see *Upgrading to Version R104* for details). The whole process should take under one minute.

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