SEL-3031 Serial Radio Transceiver

900-MHz Frequency-Hopping, Spread-Spectrum, Serial Encrypting Radio

Major Features and Benefits

➤ **Dual Radio Operating Modes Provide Flexibility.** Supports point-to-point radio operation for fast teleprotection, distribution automation, distributed generation, and economical backup protection. Provides point-to-multipoint (P2MP) radio operation for SCADA and other data gathering from remote locations.

➤ **Three Ports in One Radio Reduce Costs.** Simultaneously communicates with up to three independent ports and protocols.

➤ **Low Latency Enables Fast Control.** Transfers control commands with a typical 4.8-millisecond latency with SEL MIRRORED BITS® communications.

➤ **Strong Security Thwarts Attackers.** Protects critical data and repels malicious attacks with optional encryption card, using session authentication and strong 256-bit Advanced Encryption Standard (AES) technology.

➤ **Tough Radio Operates in Extreme Conditions.** Is designed, built, and tested for trouble-free operation in extreme temperature, electromagnetic interference, shock, and vibration conditions.

➤ **No Licensing Reduces Delays and Expenses.** Uses the license-free, 900-MHz ISM band for on-time, on-budget projects.

➤ **Mounting Options Simplify Installation.** Order your SEL-3031 in one of three different packages: rack-mount, wall-mount, and NEMA 3R prewired radio solution.

➤ **Multiple Protocols Satisfy Interconnection Requirements.** Communicate with industry-standardized byte-oriented protocols, such as DNP3, Modbus®, SEL MIRRORED BITS communications, IEEE C37.118 Synchrophasors, SEL Fast Messaging, and SEL ASCII.

➤ **Flexible Serial Port Options Match Integration Needs.** Order serial Port 1 as EIA-232, EIA-485, or optical fiber to easily connect to your existing devices.

➤ **Simple Settings Streamline Radio Commissioning.** Use ACSELERATOR QuickSet® SEL-5030 Software for all settings.

➤ **USB Management Port Conveniently Connects to PC.** Make settings changes, verify status information for proper installation, and verify radio performance without affecting the three serial channels.
Product Overview

With the SEL-3031, you no longer need three sets of radios or expensive dedicated fiber optics to transmit communications over long distances. The SEL-3031 provides three serial wireless interfaces on one device, making it the ideal solution for communications challenges. Figure 1 illustrates an application option, including DNP3 SCADA information, MIRRORED BITS control for reclosing coordination, and engineering access to the SEL-651R recloser control.

SEL-3031 Base Unit

Standard Features

➤ Three EIA-232 serial ports
➤ IRIG-B time-code input
➤ Power supply
  ➤ Wall mount 9–30 Vdc
  ➤ Rack mount 24/48 Vdc or 125/250 Vdc or Vac
  ➤ NEMA 3R enclosure 125/250 Vac or Vdc, optional backup battery
➤ Form B alarm contact
➤ ACSELERATOR QuickSet SEL-5030 Software
➤ +5 V pin 1 power for external transceivers
➤ Radio link statistics
➤ LEDs show protocol pass-through states per port on transmit and receive

Optional Features

➤ Rack mount with internal substation power supply
➤ EIA-485 Port 1
➤ Fiber-optic Port 1 (SEL-2812 and SEL-9220-compatible)
➤ SEL-3044 Encryption Card (256-bit AES encryption)
SEL-3031 Point-to-Point Applications

In a point-to-point application, SEL-3031 radios provide a direct connection between two devices. Figure 2 shows an example point-to-point application. In this application, the communications path is a single line-of-sight, making directional antennas the preferred solution.

Figure 2  Point-to-Point Communication

Point-to-point configurations are very useful when high-speed data are needed. The SEL-2100 processes and transfers all contact information passed through the SEL-2411 units and the SEL-2505.

Recloser Control Access

With three serial ports on the SEL-3031 you can poll SCADA data, operate or control reclosing remotely, and include engineering access to the oscillographic event reports (see Figure 3). Normally, it would require installing multiple radios at one location to have access to all this information as well as rapid operation speed. The SEL-3031 allows you to install one radio and choose the type of information and protocol necessary for the application.

Remote Access Application

Many existing substations have no outside communication or use expensive, unreliable communication over leased lines. Other connection methods are often cost prohibitive or have right-of-way issues. One alternative is to use the SEL-3031 to send information to a local substation that has existing backhaul communications. Figure 4 shows an example of how you can send information using the three serial ports on the radio. The SEL-3530 Real-Time Automation Controller (RTAC) concentrates all the data in the remote substation and using DNP3 or SEL Fast Messaging sends back data to the local substation. The first RTAC port has all of the SCADA data from the remote substation. Another serial port, also going into the SEL-3530, provides engineering access to obtain event reports or SER (sequential events recorder) from any of the relays. Use the third port to transfer synchrophasor messages back to the local substation. Synchrophasors are powerful tools to determine the phase angle and power flow between substations.

Figure 3  Product Overview

Figure 4  Remote Access Application
Short-Distance Wireless I/O Application

In large, new or existing substations it can be difficult and expensive to add wiring or communications links to sense and control remote I/O points. The SEL-3031 can be used in applications where you need to transfer I/O over a few hundred meters back to the control house. Figure 5 demonstrates how you can use three SEL-2505 Remote I/O Modules to transmit the status of 24 inputs and control 24 outputs. All of this information is transferred using SEL MIRRORED BITS to an SEL-3530 RTAC. Adding the SEL-3044 Encryption Card to the SEL-3031 adds encryption for MIRRORED BITS.
SEL-3031 Point-to-Multipoint Applications

Point-to-Multipoint (P2MP) offers flexibility when data gathering is needed from one central location. P2MP mode is designed to work with DNP3 or MODBUS to create a master/slave hierarchy where one master polls many slaves. P2MP configurations are useful when non-time critical data is needed from many locations.

Metering and Control Application

Figure 6 shows how a common P2MP system would work using the SEL-3530 Real-Time Automation Controller (RTAC) as a data concentrator and SEL-651R as the remote devices. The RTAC transmits data to Port 1 of the Master SEL-3031. This data is wirelessly transmitted and received by all remote SEL-3031 radios. Each remote SEL-3031 transmits this message through Port 1 to the connected SEL-651R. All SEL-651R devices will see this transmitted message. The SEL-651R that has the correct address contained in the transmitted message will communicate back to the RTAC.

Figure 6  P2MP DNP3 SCADA Gathering

Figure 7  P2MP SCADA Data and Control
SEL-3031 Features

Indication and Function

The SEL-3031 front panel has 10 LEDs, as shown in Figure 8.

The ENABLE and ALARM LEDs provide radio system status updates and alerts should any hardware or software errors occur.

The SEC LED is a multifunction LED that displays the status of the SEL encryption card (SEC). The LED indicates whether the encryption card is connected or enabled, and whether the card is properly set.

The LINK LED aids in installation and illuminates when the radio is properly linked.

The six TX/RX LEDs show communications activity on each of the three serial ports.

The rear-panel standard radio configuration is three EIA-232 ports, as shown in Figure 9.

Protocol Support

The SEL-3031 requires minimal settings to function with popular industry protocols. In P2P mode, each serial port can support a variety of protocols, including DNP3, Modbus, MIRRORED BITS, IEEE C37.118 Syncrophasors, and SEL ASCII. You can use different protocols on different ports simultaneously. In P2MP mode, only Port 1 is used and supports DNP3, MODBUS, or any other byte-oriented addressable protocol.

Encryption

The SEL-3031 can be ordered with an optional SEL encryption card. This card is a cryptographically-secure way to transmit sensitive data by radio in a P2P or P2MP network. Frequency-hopping, spread-spectrum communication is not sufficient to deter hackers. The encryption card provides 256-bit AES encryption. The card can be ordered with the SEL-3031, or added later as a field upgrade.

The serial port channel data speed is 19200 or 9600 bps when using the encryption card.
Configuration and Commissioning Software

The included ACSELERATOR QuickSet software program simplifies device configuration and supports the following commissioning and analysis functions for the SEL-3031:

➤ Accesses settings creation help online
➤ Organizes settings with the device database manager
➤ Loads and retrieves settings using a simple USB communications link
➤ Monitors radio signal strength and power output during installation
➤ Shows radio link and frequency zone availability statistics

Figure 11  ACSELERATOR QuickSet SEL-5030 Software
Mechanical Diagrams and Dimensions

Figure 12 SEL-3031 Rack-Mount Front Panel

Figure 13 SEL-3031 Rack-Mount Rear Panel

Figure 14 SEL-3031 Wall-Mount Front Panel

Figure 15 SEL-3031 Wall-Mount Rear Panel

RACK-MOUNT CHASSIS

WALL-MOUNT CHASSIS

Figure 16 Rack- and Wall-Mount Dimensions
Specifications

Compliance

Designed and manufactured under an ISO 9001 certified quality management system
UL Listed to U.S. and Canadian safety standards (File E220228; NRAQ, NRAQ7)
SEP (SEL-3044 encryption card): FIPS 140-2 Level 2 revalidation is pending
Also see Table 1.

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: 43.9 mm x 219.7 mm x 162.6 mm
(1.73 in x 8.66 in x 6.40 in)
Rack Mount: 43.7 mm x 482.6 mm x 160.0 mm
(1.72 in x 19.00 in x 6.3 in)

Time-Code Input

Port 2, Pins 4 and 6
Format: Demodulated IRIG-B
Input Impedance: 333 Ω
Accuracy: ± 5 milliseconds

Alarm Contact

Form B Contact
(open when energized and passes diagnostics)
Operating Voltage: 250 Vdc or 190 Vac
Dielectric Test Voltage: 500 Vrms
Continuous Carry: 6 A

Communications

Communications Ports

Serial Port 1
Data Speed Without Encryption Card: 38400 bps (disables Port 2), 19200 bps, or 9600 bps
Data Speed With Encryption Card: 19200 bps (disables Port 2) or 9600 bps
EIA-232, EIA-485 (ordering option)
Connector: 9-Pin Subminiature D
Fiber-Optic Ordering Option
Connectors: 2 ST (Tx and Rx)
Encoding SEL-2812/SEL-9220 Compatible
Wavelength: 850 nm multimode
Typical Tx Power: –13 dBm
Min. Rx Sensitivity: –29 dBm
Optical Budget: 16 dB
Compatible Fiber-Optic Core Diameter: 50, 62.5, or 200 μm

Serial Port 2, 3 Standard EIA-232
Data Speed Without Encryption Card: 19200 bps or 9600 bps
Data Speed With Encryption Card: 9600 bps
Connector: 9-Pin Subminiature D

Protocols

Modbus, DNP3, SEL Mirrored Bits Communications (MB8), acSELEntray QuickSet SEL-5030 Software Support, SEL ASCII and Compressed ASCII, SEL Fast Messaging, IEEE C37.118 Synchrophasors

Typical Latency

SEL-3031
Mirrored Bits: 8.9 ms at 9600 bps
5.6 ms at 19200 bps
4.8 ms at 38400 bps
Standard: 4.9 ms at 9600 bps
4.3 ms at 19200 bps
3.8 ms at 38400 bps

SEL-3031 With SEL-3044 Encryption Card
Mirrored Bits: 9.7 ms at 9600 bps
7.4 ms at 19200 bps
Standard: 5.7 ms at 9600 bps
5.3 ms at 19200 bps

Radio

Transmitter
Frequency Band: 902–928 MHz ISM band
Modulation: GFSK
Operating Mode: Point-to-Point
RF Connector: TNC
Power Output: 1 W (30 dBm) to 100 mW (20 dBm) in steps of 1 dBm
Channel Bandwidth: 250 kHz
Receiver
Sensitivity: –97 dBm, –104 dBi with ARQ on
Bit Error Rate (BER): <10⁻⁶ at –97 dBm
Distance: 20 miles, line of sight
Error Detection: 32-bit CRC

Power Supply

Rated Supply Voltage
Wall-Mount Model: 12/24 Vdc
Low-Voltage Model: 24/48 Vdc
High-Voltage Model: 125/250 Vdc
110/240 Vac, 50/60 Hz

Input Voltage Range
Wall-Mount Model: 9–30 Vdc
Low-Voltage Model: 18–60 Vdc
High-Voltage Model: 85–275 Vdc; 85–264 Vac

Power Consumption
Wall Mount: < 5 W
Rack Mount: < 7 W
**Power Consumption With SEL-3044 Card**
- Wall Mount: < 6 W
- Rack Mount: < 8 W

**Type Tests**

**Communications Equipment Tests**
- IEEE 1613-2003

**Environmental Tests**
- **Enclosure Protection:** IEC 60529:2001
- **Vibration Resistance:** IEC 60255-21-1:1988
  - Class 1 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
- **Impulse:** IEC 60255-5:2000
  - 0.5 J, 5 kV

**RFI and Interference Tests**
- **EMC Immunity**
  - **Standard:** IEEE 1613, Class 2
  - **Electrostatic Discharge:** IEC 61000-4-2:2008
    - Severity Level 4
    - 8 kV contact discharge
    - 15 kV air discharge
    - IEEE C37.90.3–2001
    - Severity Level 4
    - 8 kV contact discharge
    - 15 kV air discharge
  - **Radiated RF Immunity:** IEC 61000-4-3:2008
    - 10 V/m
    - IEEE C37.90.2–2004
    - 35 V/m
  - **Fast Transient, Burst Immunity:** IEC 61000-4-4:2004
    - 4 kV @ 2.5 kHz, and 5.0 kHz for communications ports, power supply, alarm contacts

**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 for communications ports, power supply, alarm contacts

**Conducted RF Immunity:** 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**
- **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; ICES-003
  - **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.

**Table 1 Government Approvals**

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