# Application Note AN2013-22

# *Using the SEL-3031 in a Dual High-Speed Hop-Sync Ring*

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## INTRODUCTION

The SEL-3031 Serial Radio Transceiver has three serial ports that support three different simultaneous connections and protocols. By using SEL Hop-Sync™ technology, two radios are collocated to communicate back to back and exchange data as repeaters without interference. This application note explains the value and benefit of inexpensive and robust dual-ring communications among remote sites via SEL Hop-Sync technology in the SEL-3031. Pairs of SEL-3031 radios located at each site and connected via SEL Hop-Sync technology provide continuous peer-to-peer communications simultaneously in both directions around the ring. These radio pairs also support both a primary and failover supervisory control and data acquisition (SCADA) link for constant data acquisition and control, even in the event of a communications failure.

## PROBLEM

Many existing devices and applications use serial communications networks and protocols such as DNP3 or Modbus® to communicate between remote sites and a centralized SCADA system. These client-server protocols support data acquisition and commanded control messages from the centralized SCADA client to the remote devices via SCADA radios at each site. This client-server polling scheme traditionally requires that the SCADA radio at the client communicate directly with each remote SCADA radio, one at a time. The protocols support data acquisition and control status responses from the remote sites back to the SCADA client over the same radio pair. Due to the nature of these protocols, they cannot be used for bidirectional, high-speed automation and control purposes. High-speed, peer-to-peer, real-time data exchange requires one or more additional, separate communications paths for bidirectional monitoring and control. Traditionally, this peer-to-peer application requires a second pair of radios between sites, resulting in increased cost associated with installation and equipment (such as antennas, feed lines, and surge arrestors).

## SEL SOLUTION

Installing SEL-3031 radios in a ring topology enables reliable, bidirectional, high-speed communication for automation and control. The SEL-3031 has three serial links multiplexed over one radio channel. Each port can be configured to communicate a different protocol. These radios are installed in pairs at each site. The example in Figure 1 represents a typical setup for a dual high-speed Hop-Sync ring. In this example, one port is dedicated for SCADA control and monitoring using DNP3 protocol to an intelligent electronic device (IED) or remote device port. A second port is used for intersite, high-speed, peer-to-peer communication via MIRRORED BITS® communications to another IED port. These MIRRORED BITS communications links simultaneously transmit data in both directions between the radios. Because IEDs have multiple

ports that support MIRRORED BITS communications, data coming from one direction into a serial port are often passed through and published out the second MIRRORED BITS communications port. In this way, the IEDs and radios perform high-speed data repeating. In the case of radio repeater sites, a third port (Port 3) is interconnected between the local radio pair and performs conventional repeating of the received protocol messages among radios without passing the messages through the IEDs. This is accomplished using directional antennas at repeater sites, which improves the link range because the antennas are more effective than omnidirectional antennas used in nonrepeater applications.

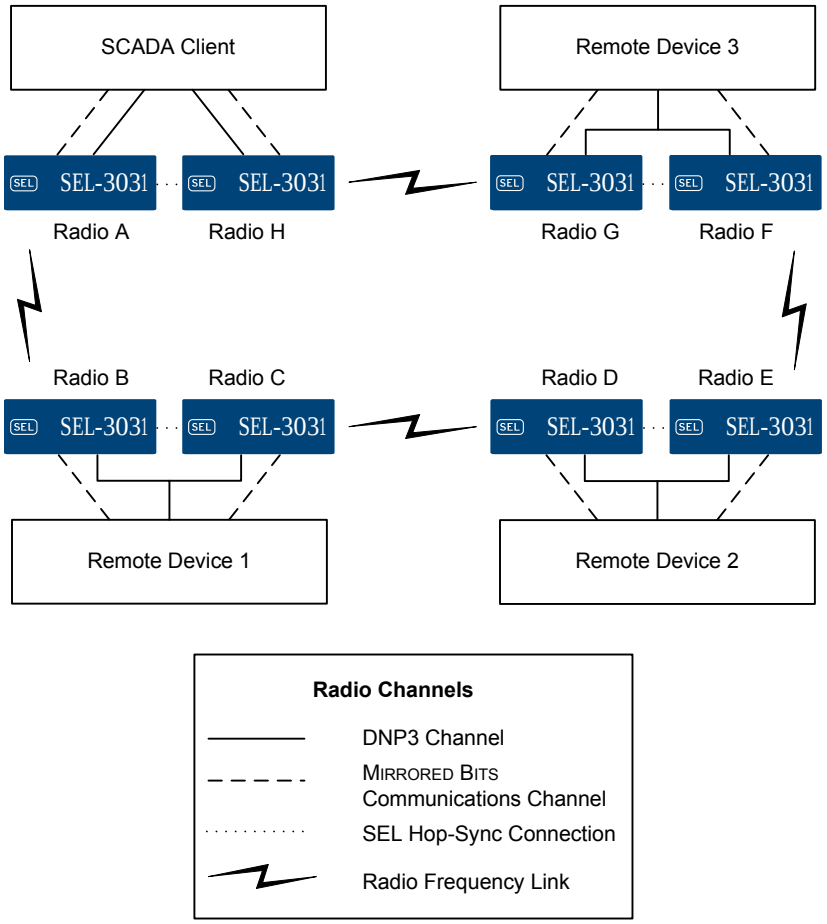


**Figure 1 SEL-3031 Hop-Sync Ring Example Diagram**

The connection between the Port 3 of each radio also performs radio hopping synchronization, referred to as SEL Hop-Sync technology, for minimum interference between the radios. This synchronization allows two radios to synchronize publications (called hops) to the next radio in the ring in order to prevent the radios from interfering with each other. This configuration allows continuous bandwidth at a lower latency compared with using another separate radio as a repeater and attempting to communicate through simultaneous receipts and publications. Hop-Sync technology in the SEL-3031 synchronizes all the radios in a looped network to one master radio and causes collocated radios to transmit and receive at the same time. This synchronized transmission minimizes the interference and maximizes the radio performance. In the ring topology, multiple channels between sites provide flexible topologies and allow the use of more than one protocol between the central SCADA system and remote sites, as well as between sites.

## Dual High-Speed Hop-Sync Ring Topology Advantages

A ring topology enables bidirectional data flow between sites. This allows messages to travel around the ring in both directions to remote sites by being repeated at each site along the way. It also supports peer-to-peer messages between sites in both directions. The multiple ports on the SEL-3031 support simultaneous MIRRORED BITS communications and SCADA protocols, such as DNP3, to multiple sites located far away from the central site. This simplifies site-to-site path studies, installation, and communication with sites that do not have a direct line-of-sight to the central site. The advantages of the dual high-speed Hop-Sync topology include the following:

- The dual-ring topology possible with the SEL-3031 supports redundant client-server connections via fast failover. This feature is possible if the client device such as an SEL-3530 Real-Time Automation Controller (RTAC) or SEL-2240 Axion® supports dual primary interrogation ports. This provides data flow redundancy of SCADA protocols for more reliable communications simultaneous with bidirectional MIRRORED BITS communications over the other channel.
- Every radio location has the ability to monitor SCADA and engineering access messages to and from every other site. Technicians can diagnose and troubleshoot communications problems from multiple locations.
- The data load between sites is shared over multiple channels for consistently enhanced performance of three separate IED communications channels.

Due to its ruggedness, longevity, and ability to transmit and repeat both peer-to-peer and centralized data acquisition and control communications, the SEL-3031 is a great fit for use in control and monitoring applications, especially for geographically distributed remote sites. Bidirectional data flow enables peer-to-peer data exchange to support rapid communications-assisted decision points at multiple remote sites. A dual high-speed Hop-Sync ring used for control and monitoring applications improves automation system operation, performance, and reliability because it allows the following to be done:

- Perform early detection of communications and process failures at each site and adjacent sites.
- Create and store typical process data in order to permit future comparisons to detect abnormalities.
- Use timely detection of abnormalities in the process to alert end users of channel failure and trigger condition-based maintenance.
- Automatically react to data from any site to trigger fail-safe or preventative actions.
- Improve troubleshooting and diagnostic calculations and reduce calculation time because data are shared between sites over multiple channels.
- Improve operational efficiency by decreasing the application downtime, and improve processes with system-wide situational awareness.

## Application Examples

In the following examples, the SEL-3031 Hop-Sync pairs are configured to work in a linear pass-through or ring topology with one master sending the synchronization signal to synchronize all the radios in the network. There are four sites with Hop-Sync radio pairs. Figure 2 shows Hop-Sync radio pairs used for a water flow control solution. Figure 3 shows a typical distribution automation system application using radios. In each figure, Radio A and Radio H are located at the SCADA client site and act as masters. The rest of the Hop-Sync pairs act as pass-through

repeaters to complete the ring. The radios that are using multiple channels can be set to communicate at a maximum data rate of 9600 bps with data encryption or a maximum data rate of 19200 bps without encryption.

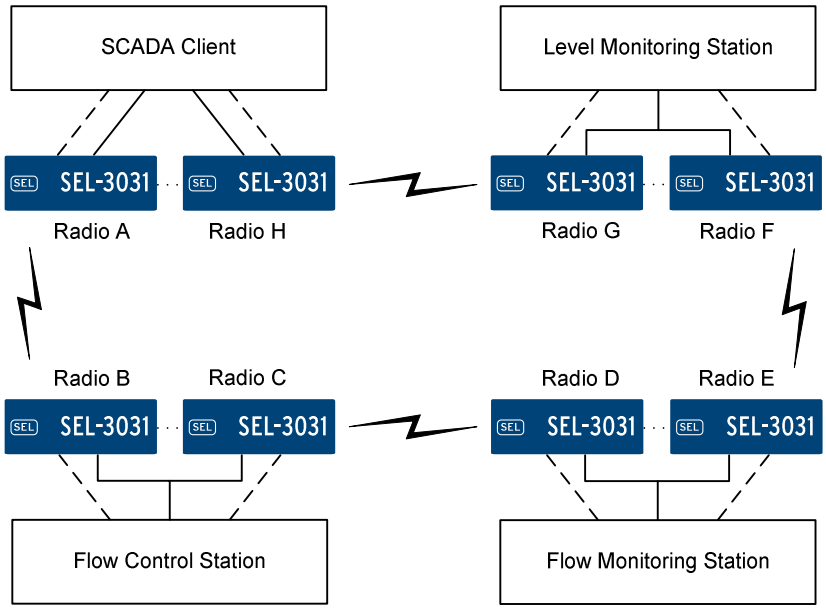


**Figure 2 Water Channel Flow Solution**

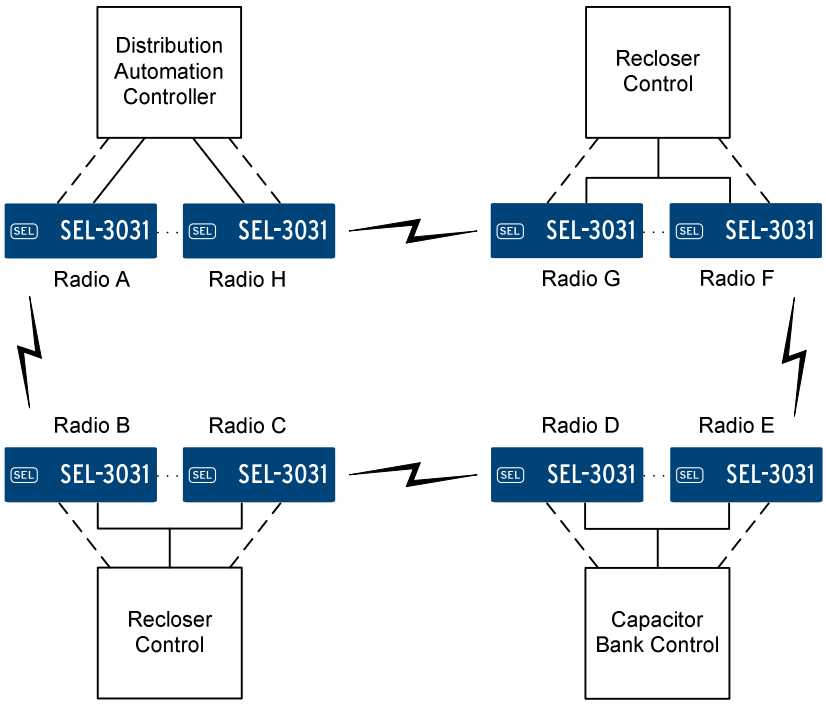


**Figure 3 Distribution Automation Solution**



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