SEL-2488

Satellite-Synchronized Network Clock

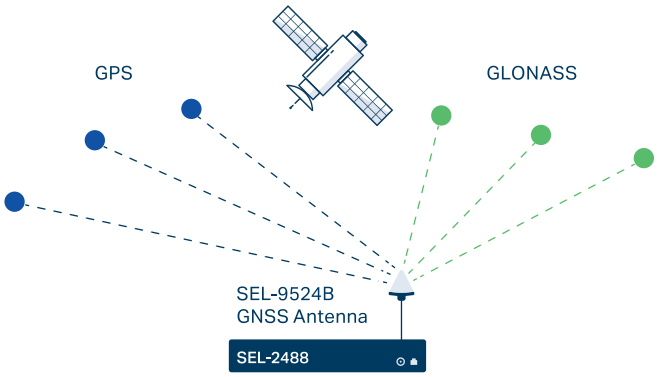
Provide advanced time synchronization using the most accurate, reliable, and secure clock in the industry

- Synchronize devices to within ±40 ns for demanding power utility applications, such as synchrophasors, IEC 61850-9-2 Sampled Values, and traveling-wave fault locating.
- Improve precise time resilience through multisource synchronization with GPS and the Precision Time Protocol (PTP).
- Distribute time to a broad range of end devices using IRIG-B, PTP, Network Time Protocol (NTP), and optional 10 MHz frequency outputs.
- Provide network resiliency using the Parallel Redundancy Protocol (PRP) or active-backup port bonding for Ethernet failover.
- Withstand Global Navigation Satellite System (GNSS) disruptions using the internal high-stability holdover oscillator with an accuracy of 2.5 µs after 24 hours.
- Secure and monitor time sources with Syslog, the acceptable master table (AMT), the Simple Network Management Protocol (SNMP), and the Lightweight Directory Access Protocol (LDAP).

Precise, Reliable Time Synchronization

Advanced Technology for Demanding/Critical Time Synchronization

The SEL-2488 Satellite-Synchronized Network Clock receives GNSS and optional PTP time signals and distributes precise time via multiple output protocols, including IRIG-B, optional PTP grandmaster as defined by IEEE 1588-2008, NTP, and 10 MHz frequency. The SEL-2488 sets a new standard for satellite-synchronized clocks by providing higher levels of accuracy, flexibility, dependability, and ease of use. The advanced capabilities of the SEL-2488 make it well-suited for critical infrastructure networks like emergency communications systems, for substations with multiple time-synchronization requirements, and for demanding power utility applications—like synchrophasors, Sampled Values, and traveling-wave fault locating.



Satellite signal verification—the SEL-2488 and SEL-9524B GNSS Antenna receive signals from two satellite constellations to validate GPS time signals, providing a layer of protection from GPS spoofing attacks.

Accurate

Synchronize with precise time accuracy within ±40 ns for critical applications. If GNSS time signals become unavailable, the clock switches into holdover with the standard temperature-compensated crystal oscillator (TCXO) holdover accuracy of 315 µs after 24 hours or one of several holdover options:

- Oven-controlled crystal oscillator (OCXO) holdover, accurate to 5 µs after 24 hours
- Double-oven-controlled crystal oscillator (DOCXO) holdover, accurate to 2.5 µs after 24 hours

Flexible

Distribute time from eight time outputs that are configurable for IRIG-B or time pulse outputs. The SEL-2488 also includes four independent Ethernet ports, which distribute time via NTPv4. With the PTP option, the SEL-2488 can act as a PTP grandmaster clock and profile translation device and can distribute time to up to four independent networks. And for interoperability with land mobile radio communications systems, you can configure the SEL-2488 with 10 MHz frequency outputs.

Dependable

The SEL-2488 provides an option for a second, redundant, hot-swappable power supply; operates from −40° to +85°C (−40° to +185°F); is certified to IEEE 1613 Class 2, IEC 61850-3, and IEC 60255; and is backed by our ten-year worldwide product warranty.

Simple Configuration

Easily access and modify system configurations through an intuitive and secure HTTPS web interface.

Enhanced Monitoring and Management

The SEL-2488 supports Syslog, LDAP, SNMP, and IEEE 1588e-2024 PTP Management Information Base (MIB) for real-time visibility, management, and fault detection.

Strengthen Time Resilience With Zero-Trust Principles

The SEL-2488 applies zero-trust principles to provide secure and precise time synchronization across critical infrastructure. In the event of GNSS disruption, it can synchronize to alternate high-accuracy sources, such as the PTP Telecom Profile (ITU-T G.8275.1), providing redundancy and reducing dependence on any single point of failure.

For further security, the SEL-2488 incorporates satellite signal verification to detect and mitigate GNSS spoofing or jamming, validating the authenticity of satellite time signals before accepting them. Additionally, its PTP AMT restricts synchronization to explicitly approved PTP timeTransmitters, ensuring that only known and trusted sources can influence system time.

Powerful Features for Critical Applications

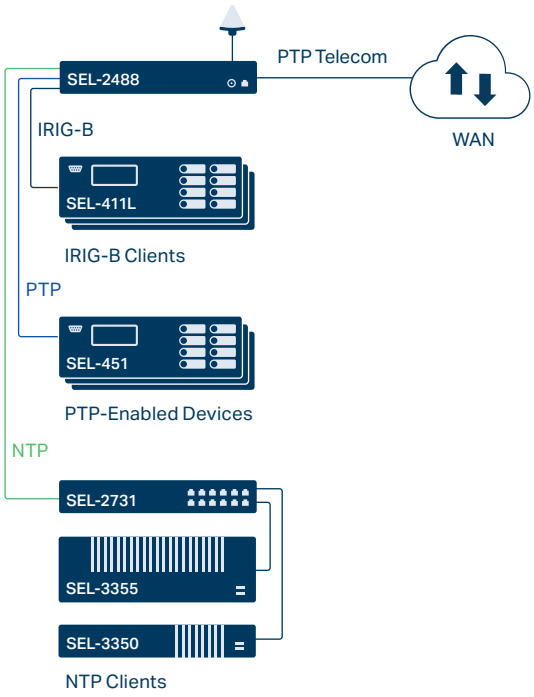
The SEL-2488 provides advanced time synchronization capabilities for demanding applications and larger substations with broad requirements for precise time.

Multisource Time Synchronization

The SEL-2488 supports synchronization from both GPS and optional PTP sources. A configurable priority list enables automatic failover between sources, ensuring continuous synchronization during GNSS disruptions. Supported PTP profiles include IEEE C37.238-2011/2017 (Power System), IEC/IEEE 61850-9-3:2016 (Power Utility Automation), and ITU-T G.8275.1 (Telecom).

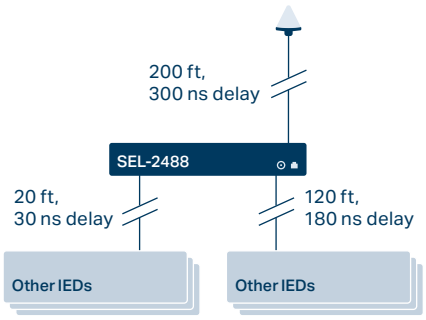
Time Distribution

The SEL-2488 has eight BNC ports, which can be configured for demodulated IRIG-B, time pulse, or modulated IRIG-B output (up to four ports). Demodulated IRIG-B ports provide time output for protection applications, synchronizing relays, phasor measurement units (PMUs), and other electronic devices to within ±40 ns average and ±100 ns peak accuracy to UTC. Six optional SMA ports can output 10 MHz frequency for interoperability with radio communications systems. Four Ethernet ports can distribute time using NTP to devices on the substation LAN, such as servers, computers, and other devices that set their time through NTP or the Simple Network Time Protocol (SNTP). The SEL-2488 can act as a Stratum 1 time server with typical client synchronization accuracy on a LAN of 0.5—2.0 ms. With the PTP option, the SEL-2488 can act as a PTP grandmaster clock (IEEE 1588-2008) with default (Annex J), power system (IEEE C37.238-2011/2017), and power utility automation (IEC/IEEE 61850-9-3:2016) profiles providing ±100 ns peak time stamp accuracy to UTC. The SEL-2488 can serve time via NTP and PTP to four independent networks.



Cable Delay Compensation

The SEL-2488 provides time delay compensation for antenna cables and output cables on a per-port basis to preserve accuracy. Antenna cable delay compensation is a global device setting, and output cable delay compensation can be individually configured at each BNC port with demodulated IRIG-B and pulse outputs. Cable delay compensation ensures high-accuracy time distribution in large facilities with dispersed electronic devices and/or in installations where antennas must be mounted high on towers.



Time accuracy of ±40 ns is maintained with cable delay compensation.

Network Resiliency

The SEL-2488 supports as many as two Doubly Attached Node implementing PRP (DANP) interfaces or two active-backup port bonded interfaces for Ethernet failover. When PRP is enabled, all network traffic through the PRP interface will be duplicated across the two redundant LANs that form the PRP network. Active-backup port bonding logically combines two physical Ethernet ports into a single network interface with only one port active while the other serves as a failover backup.

Real-Time Clock (RTC) Mode

RTC mode increases time availability and supports continuous protection, monitoring, and control functions in critical infrastructure systems. It does this by using the internal RTC to provide a time output following power recovery until the primary reference source is reacquired. This feature is especially valuable for time-sensitive applications—such as IEC 61850 Sampled Values—that require precise local synchronization even when traceability to UTC is temporarily unavailable.

Overview

Multi-information LCD screen

Clock status LEDs

Status and activity LEDs

−40° to +85°C
−40° to +185°F

Local management port

Alarm and timer contact

Five optional 10 MHz sine-wave SMA output ports

Antenna TNC input port

Optional 10 MHz square-wave SMA output port

IRIG-B BNC input port (future)

Eight configurable BNC output ports (demodulated IRIG-B, modulated IRIG-B [T01—T04], and time pulse)

Four standard Ethernet ports

DB-9 output port (IRIG-B or time pulse)

Standard power supply

Optional redundant, hot-swappable power supply

SEL-2488 Specifications

General	
Time Accuracy	±40 ns average, ±100 ns peak for demodulated IRIG-B and PPS (from BNC ports) ±1 µs modulated IRIG-B (peak) to UTC <100 µs NTP time-stamp accuracy (typical) to UTC ±100 ns PTP time-stamp accuracy (peak) to UTC
Time Sources	GPS (standard) PTP IEEE 1588-2008 (optional) GLONASS (optional; for verification only)
Accuracy After 24 Hours in Holdover (Typical)	TCXO, 315 µs (standard) OCXO, 5 µs (optional) DOCXO, 2.5 µs (optional)
Frequency Stability After 24 Hours in Holdover (Typical)	OCXO: 1E-10 Hz/Hz DOCXO: 5E-11 Hz/Hz
Ports	1 front RJ45 Ethernet management port 8 rear BNC output ports 4 rear Ethernet ports in pairs of 10/100BASE-T, 100BASE-FX, or 100BASE-LX10 1 rear DB-9 port 1 rear BNC IRIG-B input port (supported in future firmware revision) 5 rear 10 MHz sine-wave SMA output ports (optional) 1 rear 10 MHz square-wave SMA output port (optional)
Input Protocols	PTP (IEEE 1588-2008) Profiles: - Default UDP (IPv4), 802.3 (Layer 2) - IEEE C37.238-2011/2017 (Power) - ITU-T G.8275.1 (Telecom) - IEC/IEEE 61850-9-3:2016 (Power Utility)
Output Protocols	Up to 9 demodulated IRIG-B (B002, B004), PPS, or kPPS Up to 4 modulated IRIG-B (B122, B124) NTPv4 server, broadcast, and multicast formats Supported profiles with the PTP option (IEEE 1588-2008): - Default UDP (Annexes D and J) - Default IEEE 802.3 (Annexes F and J) - IEEE C37.238-2011 Power System - IEEE C37.238-2017 Power System - IEC/IEEE 61850-9-3:2016 Power Utility Automation

General Specifications, Continued

Network Resiliency	Implements as many as two PRP (IEC 62439-3:2016) or active-backup port bonded interfaces using the following physical Ethernet port combinations: - ETH 1 and ETH 2 - ETH 3 and ETH 4 Supports PTP as a Doubly Attached Clock on ports where PRP is enabled.
Output Contact	Alarm contact, Form C Timer contact, Form A, 1 µs accuracy to UTC
Display	LED status indications LCD screen with backlight
Power Supply	24—48 Vdc 125—250 Vdc or Vac
Antenna	SEL-9524B GPS/GLONASS GNSS Antenna required for Satellite Signal Verification
Operating Conditions	—40° to +85°C (—40° to +185°F)

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