

SEL-2488

Satellite-Synchronized Network Clock



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

- 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.
- Distribute time to a broad range of end devices using IRIG-B, the Precision Time Protocol (PTP), the 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 μ s after 24 hours.
- Validate GPS authenticity using Satellite Signal Verification to mitigate GPS vulnerabilities.
- Secure your time source with Syslog, the Simple Network Management Protocol (SNMP), the Lightweight Directory Access Protocol (LDAP), and an HTTPS web interface.

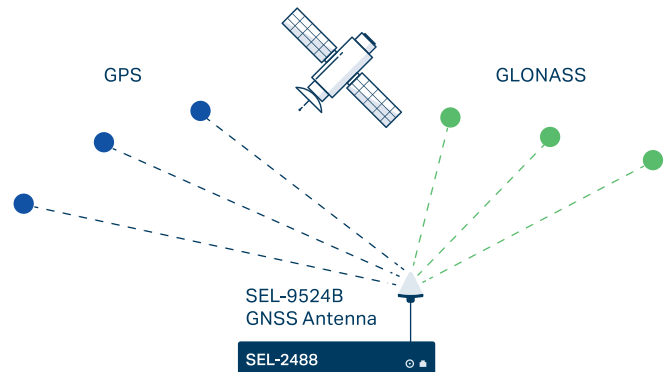




Precise, Reliable Time Synchronization

Advanced Technology for Demanding/Critical Time Synchronization

The SEL-2488 Satellite-Synchronized Network Clock receives GNSS time signals and distributes precise time via multiple output protocols, including IRIG-B; PTP grandmaster as defined by IEEE 1588-2008; NTP; and 10 MHz frequency. The SEL-2488 raises the bar 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 GPS/GLONASS 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 TCXO holdover accuracy of 315 μ s after 24 hours or one of several holdover options:

- OCXO holdover, accurate to 5 μ s after 24 hours
- DOCXO holdover, accurate to 2.5 μ s 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 can distribute time to four independent networks. And for interoperability with radio communication 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 $+85^{\circ}\text{C}$ (-40° to $+185^{\circ}\text{F}$); is certified to IEEE 1613 Class 2, IEC 61850-3, and IEC 60255; and is backed by our ten-year worldwide product warranty.

Secure and Simple

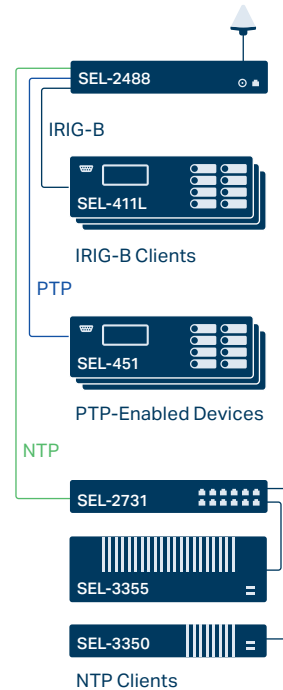
The SEL-2488 supports the Dynamic Host Configuration Protocol (DHCP) with a captive portal; LDAP; an HTTPS web interface; Syslog; and SNMP for easy and secure configuration and monitoring.

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.

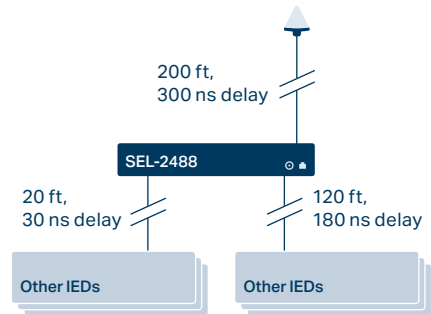
Time Distribution

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 IEDs 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 communication 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 IEDs 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.



Overview



SEL-2488 Specifications

General	
Time Accuracy	± 40 ns average, ± 100 ns peak for demodulated IRIG-B and 1 PPS (from BNC ports) ± 1 μ s modulated IRIG-B (peak) to UTC <100 μ s NTP time-stamp accuracy (typical) to UTC ± 100 ns PTP time-stamp accuracy (peak) to UTC
Time Sources	GPS GLONASS for verification
Holdover Accuracy After 24 Hours (Typical)	TCXO, 315 μ s (standard) OCXO, 5 μ s, 1E-10 (optional) DOCXO, 2.5 μ s, 5E-11 (optional)
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)
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): <ul style="list-style-type: none">- 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
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: <ul style="list-style-type: none">- 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 μ s accuracy
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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