Calnex **Sentinel**

4G and 5G OTA / 1PPS / 100G / 25G / 10 G / 1G / 100 M

Calnex
Insight and Innovation

The dedicated synchronization tester

Now featuring 25/100G, 5G OTA and battery operation for OTA measurements

→ Verify phase, time and frequency synchronization

⊕ Monitor performance and diagnose synchronization issues on
3G/4G/5G mobile, data center, financial, power and other telecoms networks

Test Over-the-Air (OTA) synchronization in 4G and 5G mobile networks

How do you know if your Small Cells conform to 3GPP standards? With TDD and FDD systems implementing newer LTE features such as eICIC and CoMP, measuring the sync accuracy of a Small Cell/eNodeB is crucial. It's also quite a challenge, particularly when these network devices often lack a physical 1PPS output.

However, with Sentinel's non-invasive OTA test capability you can now measure, with precision, the Time Error between eNodeBs or gNodeBs and UTC to ensure they meet the 3GPP ≤3 μs phase alignment limit. Plus, with Sentinel's battery-powered option, you can make measurements in the field without requiring external power.
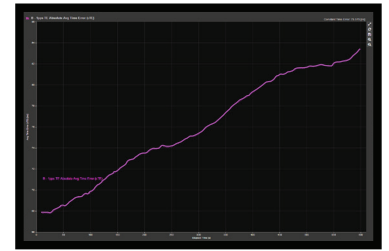
Evaluate OTA measurements using the Calnex Analysis Tool (CAT) for detailed insight into static and dynamic time and frequency synchronization.
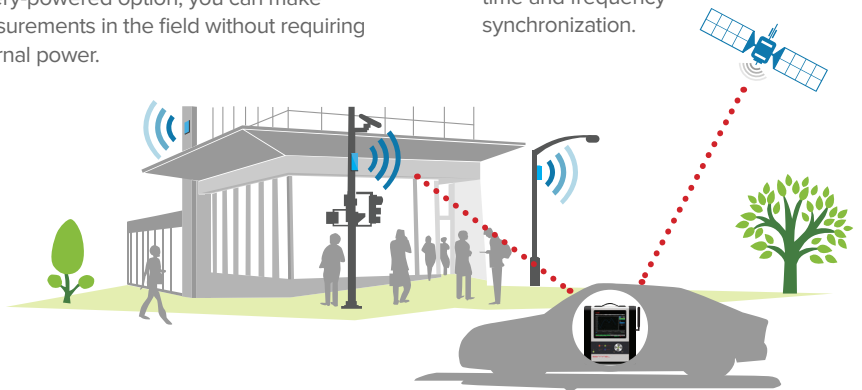
Test 3G/4G/5G and Small Cell deployments at various points in the network, including near to the GrandMaster (GM), and validate network performance to ITU-T limits.

Deliver the fast, stable services your customers can rely on
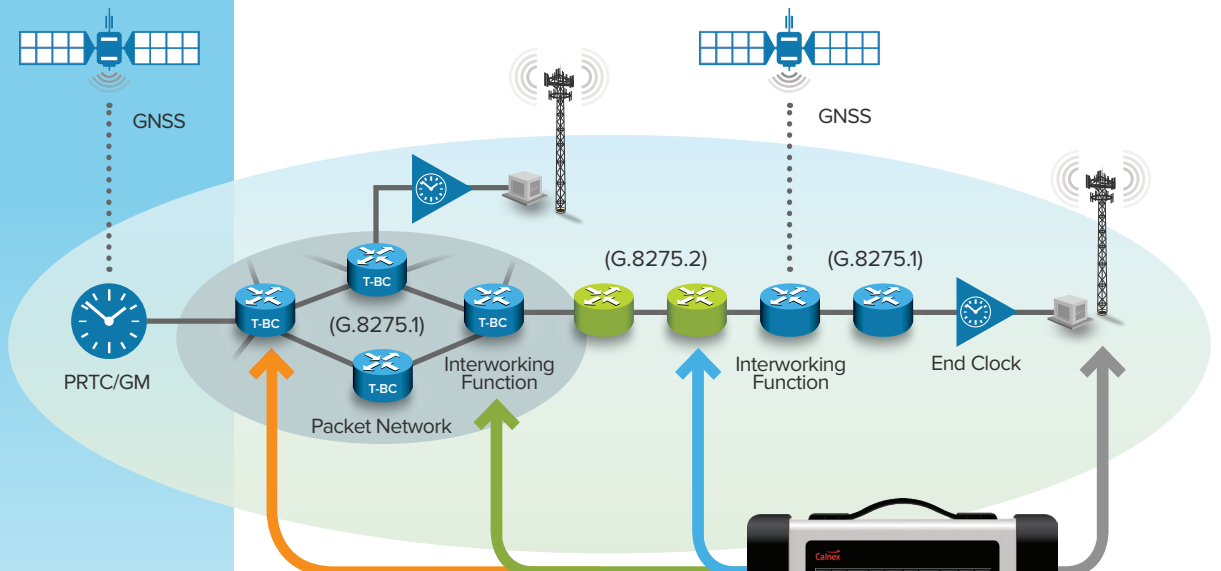
Use Sentinel to make long-duration, unattended measurements to identify slow variations in timing or sporadic transient behaviors.

Measurements are graphed in real time allowing you to easily check the status of an ongoing measurement, and gives you confidence of the measurement integrity before you commit to a long term test.

Easily test the performance of your network's synchronization. Sentinel captures all data simultaneously enabling you to correlate timing performance at different points in the network, even between different timing architectures.

- PTP 2WayTE, SyncE, 1PPS TE
- 1PPS TE
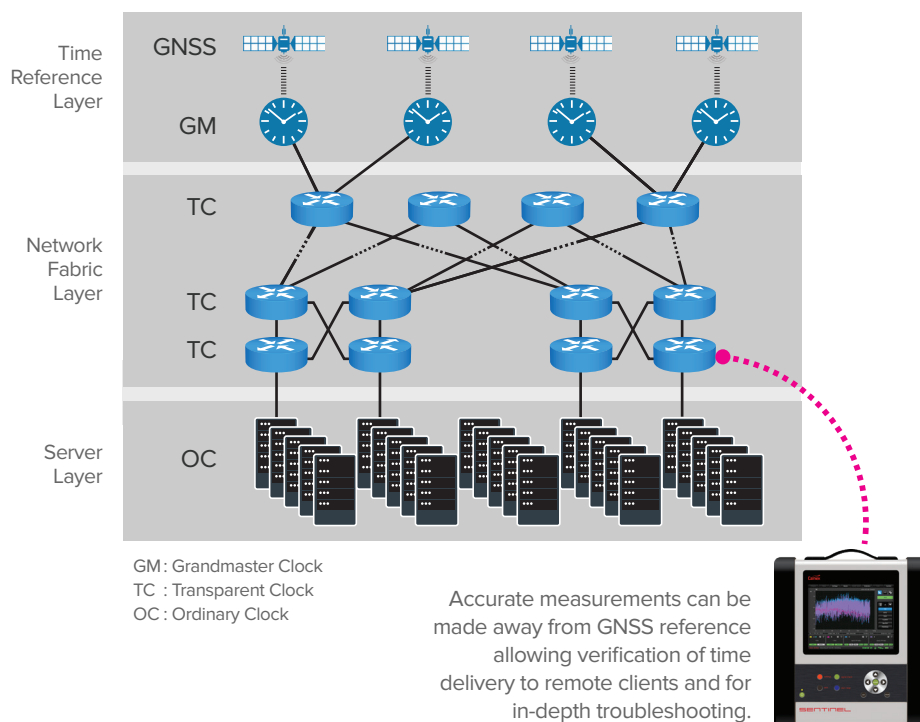- PTP pktSelected2wayTE, 1PPS TE
- Over-the-Air, TE

Test sPTP and NTP synchronization in data centers

Time synchronization is not new in data centers but the required accuracy is increasing. This is being driven by higher throughput, the need for lower latency, the movement of storage and computation to the network edge, and regulatory and standards body requirements.

While NTP was traditionally sufficient to maintain millisecond level synchronization, the need for synchronization to 100s or 10s of microseconds, and sometimes even tighter, is now required. Sentinel allows you to easily and thoroughly

verify and monitor the synchronization within your data center, and prove time/phase accuracy with microsecond precision.

What's more, Sentinel's holdover performance and transport mode allows you to move around your facility and test synchronization without having to maintain a reference GNSS or 1PPS signal. This makes Sentinel an indispensable tester for deployment, troubleshooting and network maintenance.


GM : Grandmaster Clock
TC : Transparent Clock
OC : Ordinary Clock

Accurate measurements can be made away from GNSS reference allowing verification of time delivery to remote clients and for in-depth troubleshooting.

Whatever your application, start testing in 3 easy steps

1 Connect to the network

2 Run 'Health Check' to auto-discover connections and check PTP protocol compliance

3 Start all measurements at the same time

Advanced capabilities and intuitive operation means engineers at all skill levels can use Sentinel with total confidence.


For detailed PTP Protocol Analysis, download data to Sentinel's on-board Packet Capture feature or by downloading data to the PTP Field Verifier (PFV) software.
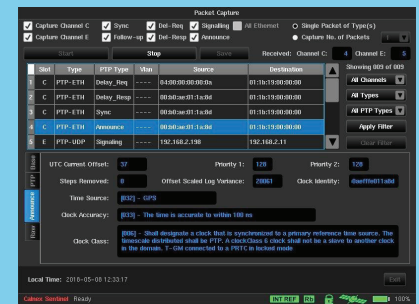
Packet Capture and Decode

Capture and decode Signaling, Sync, Del-Req, Del-Resp and Announce messages to help identify:

- Configuration issues – such as mismatch domain number configured for Master Clock and Subordinate Clock

- Protocol Implementation issues – such as the log interval of Del-Resp does not reflect the real packet rate as expected in multicast mode

- Protocol Signaling issues – such as signaling messages do not repeat after the negotiated contract period

- Capture and decode Announce messages – provides detailed information about the PTP GM which is fundamental to build up the Master-Subordinate clock hierarchy
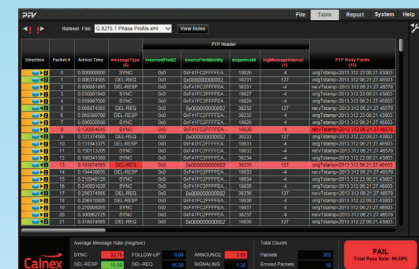
PTP Field Verifier

Analyze PTP protocol for conformance to standards or user-defined profiles.

- Automatic Pass/Fail indication – check captured PTP messages against a pre-defined set of rules, with clear Pass/Fail alerts

- Check transmitted PTP messages for compliance with ITU-T, IEEE and user-defined standards and rules – areas of non-conformance immediately visible

- Flexible XML rules allow full customization of pass criteria

- Full report generation capability
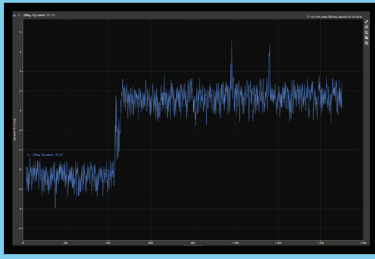
LTE-A/TDD LTE
- PTP/1PPS MaxlTEl
- PTP/1PPS dTE
- pktSelected2wayTE (APTS/PTS)

LTE-FDD/3G
- PDV FPP
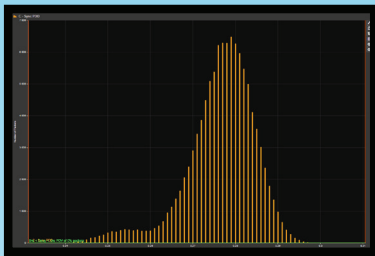- 16 ppb frequency wander
- MTIE/TDEV

Financial/Power Networks
- NTP PDV distribution
- NTP 2wayTE

SyncE
- E1/T1 wander
- MTIE/TDEV
- ESMC

TDM/Legacy
- E1/T1 wander
- MTIE/TDEV
- SSM

Get greater measurement insight with the Calnex Analysis Tool (CAT)

The CAT provides powerful insight into network and device performance. All your measurement results are now in one place, and you can view multiple graphs simultaneously for easier correlation of your results.

Enhanced graphics makes it easy to evaluate ITU-T metrics such as Time Error (cTE, dTE), MTIE and TDEV against ITU-T masks. While the customizable multi-graph window lets you rapidly select measurements and channels for detailed analysis.

CAT also provides one button generation of reports in PDF format including Pass/Fail statistics and details of failures. This allows you to share captures and results with vendors for fast, efficient and accurate troubleshooting.

Lab quality performance in an easy-to-use, portable package

No test port?
Use OTA measurements

Perform synchronization tests without physical connection to the network.
- 4G LTE-A
- 5G NR

No GNSS signal?
Use internal high-stability Rubidium (Rb) clock

Sentinel's built-in Rb clock is both highly stable and precise. Once disciplined, it has exceptional holdover performance allowing you to get to where you need to be and to make accurate measurements even when no reference 1PPS or satellite signal is available.

Problem in the network?
Use Capture and Replay

Measure the network and send measurements back to the lab/vendor to replay and fix issues. Data can be transferred from Sentinel via a memory stick or via ftp to a remote PC. Plus, you can ftp results from ongoing measurements.

Actual network performance can also be downloaded to the Calnex Paragon to test individual network components.

# Enhanced monitoring and analysis with Calnex SyncSense

Calnex SyncSense is a sync-focused, highly scalable synchronization monitoring solution for both telecoms and data center networks. It is capable of continuously monitoring the sync performance of all the time-aware devices in your network to give you a clear view of your current network's sync state and any changes in the network that may cause timing errors.

Used in conjunction with Sentinel, it is also an effective way to manage long-term measurements to ensure your network's sync accuracy is maintained and for identifying and troubleshooting sync-related issues.

- Continuous monitoring of measurements being made by a remote Calnex Sentinel.
- Quick and easy way to check-in on the measurements.
- Easily manage the deployment of multiple Calnex Sentinels.
- Selectable alarm and notification thresholds.
- Multiple ways to contact you should there be an event.
- Ad hoc and automatic reporting.
- Automatic graphing and archiving of summarized measurement data.

By harvesting all available sync data (including ITU-T G.8275 Annex F) from multiple sources, SyncSense automatically creates a baseline so that you can benchmark and track changes, monitor trends, predict failures, and identify the cause of intermittent problems.
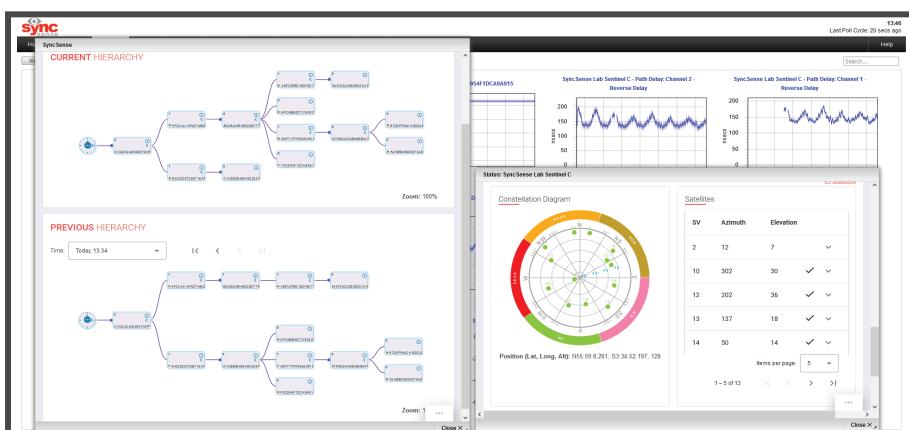
SyncSense can be ungraded to monitor additional time-aware devices in your network allowing total observability of your network's synchronization.

Specifications

Metrics and Masks

Test Modes
Masks or test limits can be applied to TE, 2wayTE, pktSelected 2wayTE, 2wayTEL, 2wayTEH, TIE, MTIE, and TDEV graphs.
PRC/SSU/SEC: Masks for G.811/G.812/G.813-clocks (ETSI 300 462-3).
Networks: According to G.823/G.824/G.8261/G.8261.1/G.8271.1/G.8271.2
SyncE: According to G.8261, G.8262
ANSI-standard: DS1 and OC-N masks.

Graph Display
Display modes: TE, 2wayTE, pktSelected 2wayTE, TIE, MTIE, TDEV, Path Delay, PDV, 2wayTEL, 2wayTEH, Distribution of PDV Selected PDV, Floor Packet Percentage, Maximum Average Frequency Error.
Number of Graphs: Up to 6 graphs of the same type can be over-laid on screen. Color coded.
Masks on Screen: Up to 6 MTIE and TDEV masks according to selected test mode. Pass/Fail result available for each mask.

Clock Module Specifications

Pre-defined Signal/Clock Types
- 1PPS (PTP Subordinate recovered clock).
- 8 kHz (frame clock).
- 64 kHz/64 kb/s (E0/DS0).
- 1.544 MHz/1.544 Mb/s (T1/DS1 clock/data).
- 2.048 MHz/2.048 Mb/s (E1 clock/data).
- 5 MHz/10 MHz (frequency reference).
- 25 MHz/125 MHz/156.25 MHz (SyncE clock rate).
- 34 Mb/s (E3), 45 Mb/s (DS3).
- 155.52 MHz/155 Mb/s (STM-1/STS-3 clock/data).

User-defined Clock Types
From 0.5 Hz to 200 MHz in 0.5 Hz steps. Note: symmetrical, unipolar clock signals.

Measurement Ports
Number of Ports: 2 per module.
Connector: BNC.
Impedance: 75 Ω, VSWR <2:1 or 1 MΩ.
Voltage Range: ±5.00 V.
Sensitivity: min input voltage 60 mVpp, Signal Check voltages are for indication only.
Signal Type: Symmetrical pulse (clock signal); Unsymmetrical repetitive pulse (clock signal); HDB3-coded data (data signal); AMI B8ZS, B3ZS (data signal).
Frequency Measurement: TIE accuracy 1 ns.
1PPS: Constant TE measurement accuracy with reference to GNSS ±75 ns.

Relative Time Error
The accuracy with which Sentinel measures the phase difference between any two clock inputs ±5 ns.

Ethernet Specifications

Synchronous Ethernet
SyncE clock measurement.
Conformance to G.8261 masks (MTIE/TDEV).
Extract and graph ESMC message (SSM).
Generate and change ESMC.

PTP (1588) and NTP
Network 2-way TE, Forward (Sync) PDV, Reverse (DelReq) PDV and Network Delay.
Raw PDV (*vs* time and distribution graphs).
Selected Packet PDV (*vs* time and distribution graphs).
Cluster/band packet selection.
Pseudo-Subordinate Clock Mode or Monitor Mode.
1 ns resolution timestamp.
Captured PDVs can be replayed on Calnex Paragon-X for troubleshooting.

PTP (1588): Layer 2 Multicast and Layer 3 (UDP/IPv4, UDP/IPv6) Multicast/Unicast.
NTP: Layer 3 (UDP/IPv4/IPv6) Unicast.

Measurement Ports
Number of Ports: Maximum of 2.
Connectors: RJ45 for 100/1000 Base-T, SFP/SFP+ for 100M/1G/10G Optical, QSFP28 for 100G Optical, SFP28 for 25G Optical. (QSFP28 to SFP28 adapter supplied; optical transceivers not supplied.)

Accuracy
PTP/NTP constant TE measurement accuracy with reference to GNSS ±75 ns.

OTA Module Specifications

Measurement Accuracy	±100 ns.
Maximum input power	−20 dBm.
Operating Frequencies	Up to 6 GHz.
NR and LTE Bands	TDD and FDD.

Platform Specifications

Reference Clock	Built-in Rubidium reference or external reference input 1 MHz, 5 MHz or 10 MHz.
Internal Data Storage	Up to 32G.
External Data Storage	USB memory stick.
Start/Stop	Via START/STOP key.
Signal Check Parameters	Signal type (Clock, Data or Unknown); Frequency (for clock signals); Pulse width (for data signals).
Display	Color TFT, 8.4", 800 x 600 pixels, resistive touchscreen.

Specifications

Internal Rb Clock

Stability
Output frequency accuracy (7 mins to warmup): 1×10^{-9}
Ageing (1 day): $<1 \times 10^{-12}$
Ageing (1 year): $<5 \times 10^{-10}$

GNSS-disciplining

Built-in GNSS Module
12 channels, TRAIM GNSS receiver, high sensitivity. GPS, GLONAS, Beidou, Galileo.

Time Accuracy
±15 ns at 1σ after 24 hours lock.

Frequency Accuracy
2×10^{-12} averaged over 24 hours.

GNSS Disciplining Modes
Always disciplining, always in holdover, disciplining only between measurements.
Requires 6 hours discipling if disconnected from GNSS for <1 week; 12 hours if >1 week.
Requires 1 hour disciplining if using Cs quality 1PPS (from any state).

External References

Frequency Reference Input (std)
Input Frequency: 10 MHz, 5 MHz.
Voltage Range: 0.1 Vrms to 5 Vrms.
Impedance: Approx. 50 Ω.

External 1PPS Timing Input
Voltage Range: 0 V to 0.8 V (Low), 2 V to 3.3 V (High) into 50 Ω.
Required Accuracy: ±100 ns to UTC.

GNSS Timing Reference
Antenna Input: N-type connector.
DC-feed: +5 V on center pin to active GNSS antenna.

Output References

Reference Frequency Output
Reference Frequency: 10 MHz sine-wave.
Output Levels: 1 Vrms in 50 Ω.
Impedance: Approx. 50 Ω.

1PPS Output
Source: Internal Rubidium oscillator.
Output Logic Levels: TTL levels in 50 Ω.

E1/T1 Output
Connector: Clock: BNC.
Data: Isolated BNC.
Frequency: 2.048/1.544 MHz, 2.048/1.544 Mb/s.
Output Level: Accurate to G.703 ±1.2 V ±10% in 75 Ω.

Interfaces

USB Device Port
Connector: Std USB type B.
USB Version: 2.0

USB Host Port
Connector: Std USB type A.
Maximum Supply Current: 400 mA.
USB Version: 2.0

USB Charging Port
Input port only for charging Opt. 631 internal battery.
Connector USB type C. Supports 20 V, 5 A profile.

LAN/Management Port
Communication Port: RJ45, 10/100 Base-T.
Protocol: DHCP, FTP, web-based GUI (http/https) with authentication if required, WebDav. Supports VLAN.

Remote Operation
Remote operation via web-based GUI.
Event Log: On screen log of measurement start/stop, duration, alarms, loss of data, loss of communication link, etc.
Log can be saved as text file.
Report Generation: Printable, custom-designed measurement report in pdf format.
Security: Password secured access.

Environmental Data

Operating Temperature
0°C to 40°C. (30°C when charging Rb backup-battery.)

Storage
Temperature from 0 to 50°C and Humidity up to 90% non-condensing.

Safety
EN 61010-1: 2010.

EMC
EN 61326: 2013.

Power Supply
Line Voltage: 100 to 240 Vrms ±10%, 50 Hz to 60 Hz, <100 W.

Mechanical Data

Fold-out stand. Ruggedized casing.

Dimensions (w x h x d)
320 x 388 x 126 mm (12.6" x 15.3" x 5").

Weight
Net <7 kg (15 lb); Shipping with transport case <16 kg (35 lb). Weights are approximations based on varying configurations.

Specification is subject to change without notice.

Ordering Information

Calnex Sentinel Sync Analyzer with built-in GNSS receiver. Needs minimum of one measurement option (module/port).

Included with shipment: Calnex Analysis Tool (CAT), GNSS antenna, antenna cable (20 m), hard transport case, user manual on USB, line power cord, 1-year warranty and support.

Configurable Options

- Option 610: Clock module 1PPS/E1/T1, any clock from 0.5 Hz up to 200 MHz with 0.5 Hz step. (maximum two per instrument)

- Option 615: 100M/1G packet port (PTP/NTP/SyncE). Can order maximum of 2 x Option 615. Includes SyncE/ESMC analysis for 100M/1G optical and electrical rates. (maximum two – Option 615 and/or Option 616 per instrument)

- Option 616: 100M/1G/10G packet port (PTP/NTP/SyncE). Can order maximum of 2 x Option 616. Includes SyncE/ESMC analysis for 100M/1G/10G optical and electrical rates. (maximum two – Option 615 and/or Option 616 per instrument)

- Option 618: 100G interface ordered at same time as Sentinel mainframe or software upgrade enabling second 100G port

- Option 622: 25G interface ordered at same time as Sentinel mainframe or software upgrade enabling second 25G port

- Option 705: Over-the-Air (OTA) Time Error measurement module (maximum one per instrument)

Additional Options

- Option 620: PTP and NTP PDV measurement software (one license per instrument).

- Option 623: Return to factory upgrade of Sentinel with serial no. beginning 400. This is required when upgrading Sentinel with 25G and/or 100G interfaces. Options 618 and/or 622 must be ordered at the same time.

- Option 631. Battery Powered Operation. Provides three battery-powered functions:
  1. Transport Mode to maintain Rb accuracy in holdover mode during transportation.
  2. Uninterruptible Power Supply maintains operation if external power is interrupted.
  3. Measurements under battery power allows full operation of Sentinel without external supply.

- Option 812: One year extension of product warranty.

- Option 813: Two years extension of product warranty.

Optional Accessories

- Option 133: External 1PPS/ToD/Frequency Converter accessory.

- Option 511: Carry-on bag.

Calnex Solutions plc is a global leader in Test and Measurement solutions for next-generation telecom networks. For more information on the Calnex test equipment, and to take advantage of Calnex's extensive experience in Packet Sync and OAM testing technologies, contact Calnex today:

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Get quick assistance without international delays.