VCL-2156 NTP TIME SERVER

GPS / GLONASS / GALILEO / SBAS Primary Reference Clock

High Availability Multi-GNSS Time Synchronization System

A Strategic Necessity for Power Utilities, Defence, Financial Networks & Critical Infrastructure

Global Multi-Constellation Timing Solution

Advanced Dual-Band GNSS Synchronization

- L1 (1575.42 MHz): GPS, GLONASS, SBAS, Galileo
- L5 (1176.45 MHz): GPS, Galileo E5a, SBAS, NavIC
- Advanced Dual-Band Anti-Jamming & Anti-Spoofing Technology
- ITU-T G.811 / Stratum-1 Compliant Primary Reference Clock (PRC) when Locked to GNSS
- ITU-T G.812 Compliant OCXO Holdover Performance
- Flexible Timing Reference Inputs
    1. Dual-Band Multi-GNSS Input — GPS / GLONASS / SBAS / Galileo / NavIC (TNC)
    2. External 1PPS Reference Input — SMA Interface
    3. External NTP Synchronization Input — RJ45 Ethernet

STRATEGIC CONTEXT

The **VCL-2156 NTP Time Server** is an ITU-T G.811 compliant Primary Reference Clock designed for highly accurate and secure time synchronization in mission-critical infrastructure. It supports dual-band multi-constellation GNSS with L1 (GPS, GLONASS, SBAS, Galileo) and L5 (GPS, Galileo E5a, SBAS, NavIC) for enhanced accuracy, resilience, and high-availability synchronization.

Defence	**Power Utilities**	**Banking & Finance**
Oil & Gas	**Railways**	**Critical Infra**

The Timing Imperative: What's at Stake?

Power Grid Failure

A timing error of just microseconds can cause frequency deviation, phase mismatch and cascade failures across the national grid. SCADA systems require nanosecond-accurate synchronization.

Financial Fraud Risk

Stock exchanges, payment systems and banking networks require sub-millisecond timestamp accuracy. GPS spoofing can alter transaction timestamps enabling fraud.

Defence Vulnerability

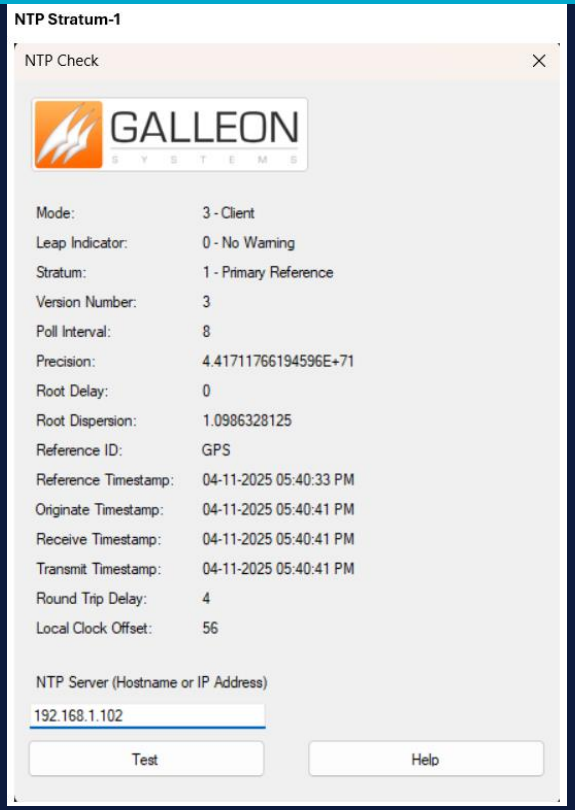
Military communications, radar systems and missile guidance require Stratum-1 timing. Reliance on foreign GPS creates a critical attack vector in conflict scenarios.

Critical Infrastructure

Telecom 5G networks, oil & gas pipelines, railway signalling and airports require precise time synchronization. Outages can cascade into national emergencies.

±30ns GPS Accuracy **±20ns** GNSS Accuracy **±15ns** Compensated Accuracy **<9µs** Holdover (24hr)

VCL-2156 NTP Time Server: Product Overview



Standard
ITU-T G.811 Primary Reference Clock (Stratum 1)

Constellations
GPS, GLONASS, Galileo, SBAS, NavIC (Dual Band L1+L5)

NTP Performance
Up to 7,500 requests/sec | 40,000 NTP Slaves

Holdover
OCXO G.812 compliant — <9µs over 24 hours

Resilience
Anti-jamming, Anti-spoofing, 1+1 NTP Peering

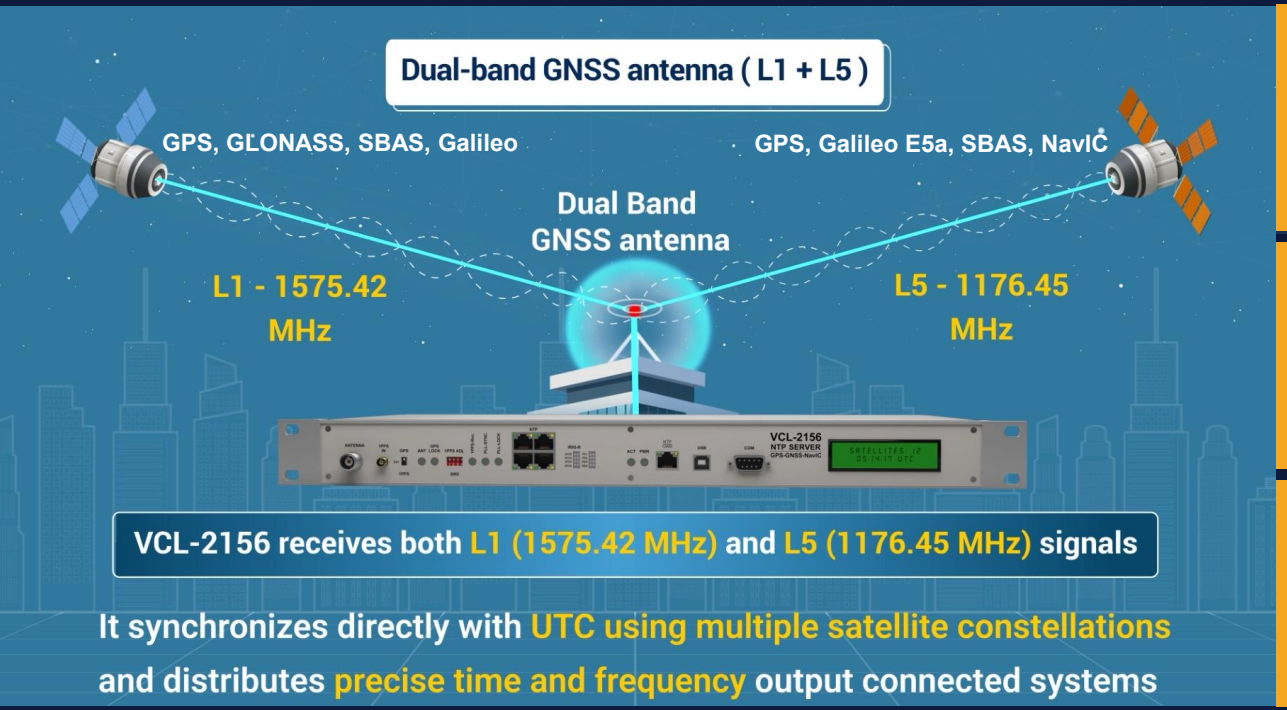
Ports
4+1 × 10/100BaseT Ethernet | IPv4/IPv6 dual stack

Supports upstream NTP input for synchronization from external time sources (e.g., (USA – NIST, NRC)

ITU-T G.811 Stratum 1 | MTBF ≥42 Years | IP20 Ingress Protection

Dual-Band GNSS: L1 + L5 with NavIC Support

Advantages of Dual Band constellations (L1+L5) in GNSS Clocks



High-Gain Dual-Band GNSS Antenna

Active dual-band L1/L5 GNSS antenna with RHCP polarization and integrated 40 dB amplification for reliable multi-constellation satellite reception.

Spoofing Defence

Dual-frequency design makes it exponentially harder to simultaneously spoof both L1 and L5 bands.

Resilience

If one band is jammed, Dynamic Satellite Selection automatically switches to the other, maintaining lock.

VCL-2156 tracks up to 50 satellites simultaneously across both L1 and L5 bands

Power Utilities & Defence: Mission-Critical Timing

POWER UTILITIES

- Synchronization of Protection Relay Systems — prevents tripping cascades
- SCADA / IEC 61850 substation automation requires Stratum-1 timing
- Phasor Measurement Units (PMUs) need ≤1µs accuracy for wide-area monitoring
- Provides precise frequency synchronization with 2.048 MHz and 10 MHz outputs, along with 1PPS timing, ensuring accurate teleprotection and reliable frequency synchronization.
- EN61000-4-5 Level 3 — built for harsh electrical substation environments
- IRIG-B outputs for integration with protection and control systems

DEFENCE & SECURITY

- Air-gapped deployment: no reliance on external internet NTP sources
- GNSS-locked timing: 100% indigenous signal — cannot be denied by foreign entities
- Anti-jamming and anti-spoofing with Dynamic Satellite Selection
- IRIG-B for military communication and radar synchronization
- MD5/SHA1 authenticated NTP, SNMPv3 encrypted management
- RADIUS server authentication, SSH and clear-text protocol option

ADVANTAGE: Both sectors benefit from the VCL-2156's OCXO holdover capability — maintaining <9µs accuracy for 24 hours even during a complete GNSS blackout, with automatic failover to secondary NTP server.

Financial Systems & Critical National Infrastructure

Banking & Financial Exchanges

- ✓ Global financial exchanges require microsecond-level timestamp accuracy for secure and compliant trading operations. GNSS spoofing can compromise transaction integrity and audit traceability.
- ✓ Regulatory-compliant time-stamping ensures accurate trade records, audit trails, and synchronized financial transactions across critical trading networks.
- ✓ GNSS-locked NTP server provides sovereign time not subject to foreign manipulation
- ✓ 40,000 NTP slaves: supports entire bank network from a single appliance

Oil & Gas / Industrial

- ✓ Pipeline SCADA systems require synchronized timing for leak detection and safety valves
- ✓ Multi-Constellation GNSS technology delivers enhanced offshore reliability and extended oceanic coverage for mission-critical timing applications.
- ✓ 2.048 MHz and 2.048MBits E1 clock outputs for legacy telecom integration
- ✓ IP20 ingress protection and industrial Ethernet for harsh environments

Railways & Airports

- ✓ Train protection, signalling ATP/ATC systems require sub-millisecond time sync
- ✓ Platform systems, ticketing and public information boards all require NTP
- ✓ IRIG-B outputs for legacy signalling integration across rail networks
- ✓ Dual redundant power (AC and DC) for 24/7 mission-critical uptime

Security Architecture: Built for India's Threat Landscape

Signal Security

- Dual-band anti-jamming (L1+L5)
- Anti-spoofing with signal validation
- Automatically switches to the alternate band if one is jammed, ensuring continuous satellite lock.
- Dynamic Satellite Selection (DSS)
- Multi-Constellation Security

Network Security

- MD5 / SHA1 NTP authentication
- SSH encrypted management
- RADIUS server authentication
- Enable / Disable Telnet for NERC compliance

Access Control

- Encrypted password control
- Password strength monitoring
- Role-based access (GUI)
- SNMPv3 encrypted traps

Resilience

- 1+1 NTP Peering redundancy
- OCXO holdover
- Auto-failover to secondary NTP
- Dual redundant power supply

VCL-2156 is designed for air-gapped, isolated networks — no dependency on public internet or foreign NTP infrastructure

GNSS Threat Landscape: Jamming & Spoofing

Why Dual-Band Multi-Constellation Security is Essential for Critical Infrastructure

JAMMING

Deliberate radio-frequency interference that overwhelms or blocks GNSS signals across a region. Single-band receivers lose lock instantly. L1-band jammers are commercially available and widely used in conflict zones.

SPOOFING

Transmission of counterfeit GNSS signals that deceive a receiver into reporting a false position or time. Can silently alter timestamps in power grids, financial exchanges or defence systems without triggering any alarm.

MEACONING

Re-broadcast of captured GNSS signals with deliberate delay, causing systematic time errors. Particularly dangerous for timing-sensitive infrastructure such as protection relays and trading platforms.

VCL-2156 GNSS SECURITY FRAMEWORK

✓ **Dual-Band L1 + L5**
Simultaneous tracking — cannot be jammed on both frequencies simultaneously

✓ **Dynamic Satellite Selection**
Real-time quality monitoring; auto-switches to uncompromised band under attack

✓ **T-RAIM Integrity Monitoring**
Time Receiver Autonomous Integrity Monitoring eliminates anomalous satellites algorithmically

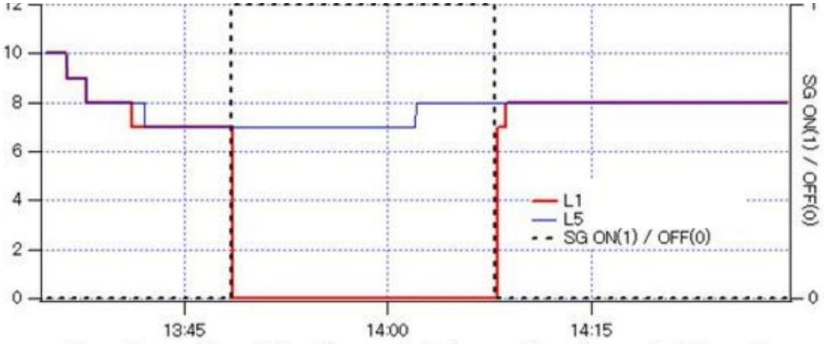
✓ **Signal Structure Verification**
Algorithm-driven validation of signal codes, structure and timing — detects spoofed signals

✓ **Multi-Constellation Tracking**
GPS + GLONASS + Galileo + SBAS + NavIC — an attacker would need to compromise all five constellations simultaneously to disrupt the timing solution.

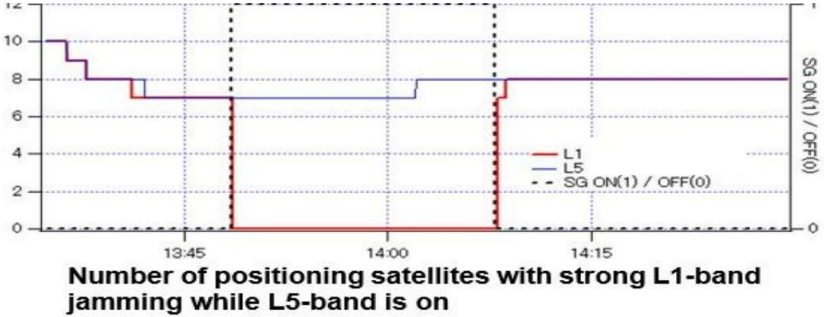
✓ **Inbuild GNSS Signal Monitoring**
Live C/N_0 monitoring and interference detection built into the GNSS management tool

Proven Anti-Jamming Performance: Live Test Data

Spectrum Analyser output from VCL-GNSS monitoring tool — strong L1-band jamming, L5-band active



Number of positioning satellites with strong L1-band jamming while L5-band is on



Number of positioning satellites with strong L1-band jamming while L5-band is on

L1 Band Jammed (Red Spike)

During simulated strong L1 jamming, L1 signal (red) drops to noise floor. The jammer is clearly visible as a large red interference spike in the C/N_0 spectrum.

L5 Band Unaffected (Blue Line)

Throughout the L1 jamming event, the L5 band signal (blue) remains stable. The VCL-2156 NTP Time Server continues maintaining uninterrupted lock on GPS, Galileo and SBAS L5 signals, ensuring continuous synchronization performance.

Satellite Lock Maintained

The lower chart confirms 8–10 positioning satellites remain tracked on L5 throughout the jamming period. Time synchronization is never lost — Stratum-1 output continues.

T-RAIM Validated

T-RAIM integrity monitoring automatically flags and excludes the anomalous satellite signals, ensuring only verified, clean signals contribute to the timing solution.

How VCL-2156 Defeats Jamming & Spoofing

Multi-layer GNSS security architecture — algorithmic, hardware and protocol-level protection

1 Dual-Band Reception

L1 (1575 MHz) and L5 (1176 MHz) received simultaneously by a single dual-band antenna

2 C/N_0 Monitoring

Carrier-to-noise ratio monitored per satellite per band — live spectrum analyser detects interference spike

3 T-RAIM Screening

Anomalous satellite signals excluded algorithmically; only verified signals enter the timing solution

4 Band Fallback (DSS)

Dynamic Satellite Selection auto-switches to uncompromised band; alert raised. Timing never lost.

KEY TECHNOLOGIES: T-RAIM · Dual-Band L1/L5 · Multi-Constellation (GPS + GLONASS + Galileo + SBAS + NavIC) · Dynamic Satellite Selection (DSS)

6 USER-SELECTABLE MODES:

GPS only	GPS + GLONASS	GPS + NavIC	GPS + SBAS	GPS + Galileo	**All Constellations (50 Satellites)**

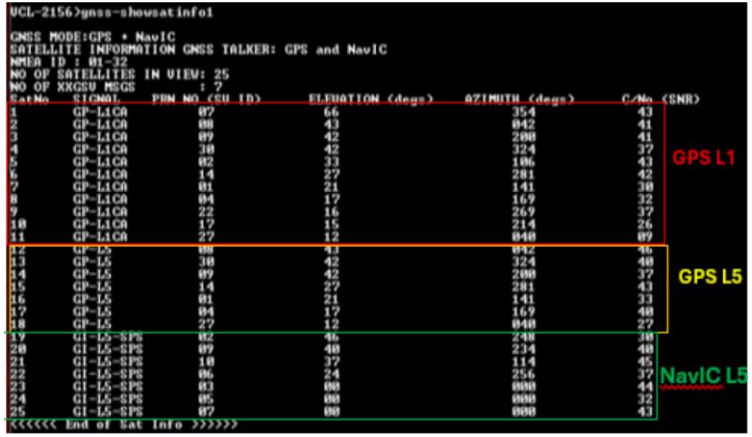
Indian Armed Forces PoC: Satisfactory Testing & Validation

VCL-2156 NTP Time Server — Proof of Concept with the Indian Armed Forces

PROOF OF CONCEPT — Validation of VCL-2156 NTP Server with Jamming and Spoofing Behaviour Analysis

- ✓ Jamming & Spoofing (L1 & L5 bands)— The VCL-2156 NTP Server and Clients demonstrated stable performance during jamming and spoofing testing. All operations recovered normally after the test conditions were removed.
- ✓ Army Headquarter NTP Client behaviour — During the jamming and spoofing tests, the time of the NTP clients remained stable and unchanged. The time and location information of the NTP clients were not compromised at any point during the PoC testing.
- ✓ Network Time Synchronization Test — PASSED: GPS-based NTP Server successfully synchronized all LAN devices. Stratum-1 output confirmed with GPS as Reference ID.
- ✓ NTP Security Authentication Test — PASSED: MD5 and SHA1 key-based authentication verified via GUI and CLI. Only authenticated clients able to synchronize — unauthenticated clients correctly rejected.

PoC TEST RESULT



Dual Band: Test on GPS L1 & L5, NavIC L5 band

Jamming: L1 and L5 band

Spoofing : Different coordinates

PoC Result: The time and location of the NTP clients was not compromised

CONCLUSION: The VCL-2156 NTP Time Server has successfully completed Proof of Concept testing with the Indian Armed Forces across all four test scenarios — Jamming & Spoofing (L1 & L5 bands), Army Headquarter NTP Client behaviour, Network Time Synchronization Test and Security Authentication — achieving satisfactory results in every test case.

VCL-2156: Technical Specifications

GNSS Receiver

- 62-channel GNSS + 50 satellites | L1 (1575.42 MHz) + L5 (1176.45 MHz)
- GPS, GNSS, GLONASS, Galileo, NavIC | Hot start: 1s | Cold start: 28s
- Tracking: -165 dBm | Antenna: TNC (Active, IP67, -40°C to +85°C)

Timing Accuracy

- ±30ns referenced to GPS | ±20ns referenced to GNSS
- ±15ns compensated (GPS+GNSS) | <9µs holdover over 24 hours
- OCXO stability: ±3ppb | 1-day aging: ±0.4ppb

NTP Performance

- Up to 7,500 NTP requests/second | 40,000 NTP Slaves | 250,000 SNTP Slaves
- NTP v2/v3/v4 (RFC 1119/1305/5905) | MD5/SHA1 authentication
- 1+1 NTP Peering | Unicast, Multicast, Broadcast | IPv4/IPv6 dual stack

Outputs

- 4 Independent NTP Servers | 1PPS, 2.048MHz, 10MHz, E1 2.048Mbits | IRIG-B (Modulated + Unmodulated)
- NMEA ToD, 1PPM/1PPH| Expansion chassis 2U: up to 16 additional PPS (Optical, BNC) and IRIG-B (DCLS RS485 / RS422, RS4232, Optical, BNC) outputs

Standards

- ITU-T G.811 (Stratum 1) | ITU-T G.812 Holdover | EN61000-4-5 Level 3
- CE 2014/30/EU | IEC 60950 | RoHS Compliant | MTBF ≥42 years (Telcordia)

Form Factor

- 1U rack mount (19/21/23 inch) | 44x482x228mm | <20W power | Convention cooled
- Dual redundant power: AC 100-240V or DC 24/48/110-220V | Reverse polarity protection

VCL-2156 NTP Server – Hardware Purchase Options

The NTP Server is available with **three GNSS configuration options**, allowing customers to select the most suitable model based on operational, security, and resilience requirements.

Option #1 – GPS (L1)

- ✓ Supported Satellite Constellation: **GPS only**
- ✓ Frequency Band: **L1**
- ✓ Suitable for standard timing applications where single-constellation GPS support is sufficient.

Option #2 – Dual-Band Multi-GNSS Clock with Jamming & Spoofing Detection

- ✓ Supported Satellite Constellations**: GPS, Galileo (E5a), SBAS, NavIC**
- ✓ Frequency Bands: **L1** (GPS, SBAS, Galileo) and **L5** (GPS, Galileo E5a, SBAS, NavIC).
- ✓ Features:
  GNSS jamming detection alerts
  GNSS spoofing detection alerts
- ✓ Suitable for critical infrastructure applications requiring enhanced reliability and signal monitoring.

Option #3 – Dual-Band Multi-GNSS Clock with Anti- Jamming & Anti-Spoofing

- ✓ Supported Satellite Constellations: **GPS, GLONASS, Galileo (E5a), SBAS, NavIC**
- ✓ Frequency Bands: **L1** (GPS, GLONASS, Galileo, SBAS) and **L5** (GPS, Galileo E5a, SBAS, NavIC).
- ✓ Features:
  Advanced anti-jamming protection
  Advanced anti-spoofing mechanisms
- ✓ Robust signal validation and interference detection
- ✓ Automatically switching to the other band if any one band is jammed to maintain satellite lock and provide the alert.
- ✓ **Designed for high-security and mission-critical environments requiring maximum GNSS resilience.**

Note: All NTP Server configuration options support the **same input and output interfaces, protocols, and timing outputs**. The differences between the options are limited **only to the supported GNSS constellations and security features**.

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