Precise Time Scale System

Fully Integrated, World-Class Timing System

Summary

Our Precise Time Scale System (PTSS) is a fully integrated, world-class timing system capable of providing timing accuracies comparable to the world's best national laboratories. It can combine up to eight high-performance cesium frequency standards or active hydrogen masers into a time scale that generates multiple signal outputs that can be distributed in a wide variety of formats. The PTSS often serves as the backbone for critical national infrastructure and as an authoritative time source for contribution to Coordinated Universal Time (UTC).

Key Features

- Fully integrated system capable of combining two to eight different types of clocks into a single time scale
- Multi-channel measurement system to provide clock time differences
- Ensemble and time scale algorithms to combine the clocks into one output
- Local realization of UTC and contribution to worldwide UTC calculated by the Bureau International des Poids et Mesures (BIPM)
- Distribution of 5 MHz, 10 MHz, 1 PPS, TOD, IRIG-B clock signals and packet timing including Network Time Protocol (NTP) and Precision Time Protocol (PTP)
- Measurements can be archived in a database for analytics
- User Interface to provide integrated system command and control
- Automatic generation of BIPM reports (clock, common view and TAIPPP)

Precise Time Scale System (PTSS)

UTC

UTC is the international timing standard that forms the basis for the coordinated dissemination of standard frequencies and timing signals. UTC is based on International Atomic Time (TAI), an international time scale that is computed by taking the weighted average of more than 300 atomic clocks located at laboratories around the world. Our 5071A Cesium Frequency Standard is the most widely used clock deployed in laboratories contributing to TAI.

UTC is based on TAI, but it is adjusted to account for the difference between the definition of the second per the International System of Units (SI) and the rotation of Earth. This correction keeps UTC in synchronization with various astronomical events, and it is the standard used for all general timekeeping applications.

The BIPM is an international organization responsible for establishing and distributing UTC and coordinating with laboratories around the world that help contribute to UTC. A laboratory's local/physical realization of UTC is referred to as UTC(k) where the letter "k" represents the laboratory.

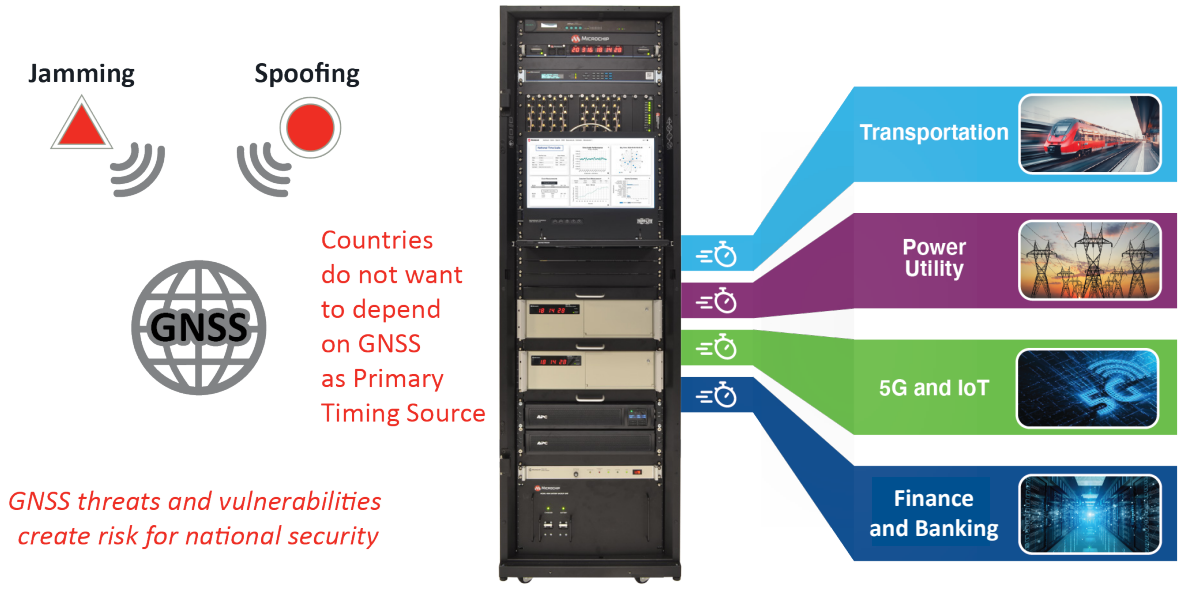
BIPM offers a monthly publication called *BIPM Circular T* that provides the offsets [UTC – UTC(k)] every five days for institutes that regularly contribute clock comparison data to the BIPM.

BIPM's *Rapid UTC (UTCr)*, which is published weekly, provides daily values of [UTC – UTC(k)]. Laboratories that choose to participate in UTCr commit to submitting their data daily to the BIPM.

Visit the BIPM website to learn more about these resources.

The Role of National Time Scales for Critical Infrastructure

Time scale systems have traditionally been used by metrology labs to make measurements for purely scientific applications. However, with the global threat of GNSS vulnerability on the rise, the role of a country's national time scale is shifting from one of purely scientific applications to ensuring the fidelity and availability of secure time for critical national infrastructure. For many countries that cannot afford to launch their own GNSS constellations, owning and operating a time scale system within their borders that is synchronized and traceable to UTC is now a matter of national security and part of their cybersecurity strategy.



National Time Scale for Critical Infrastructure

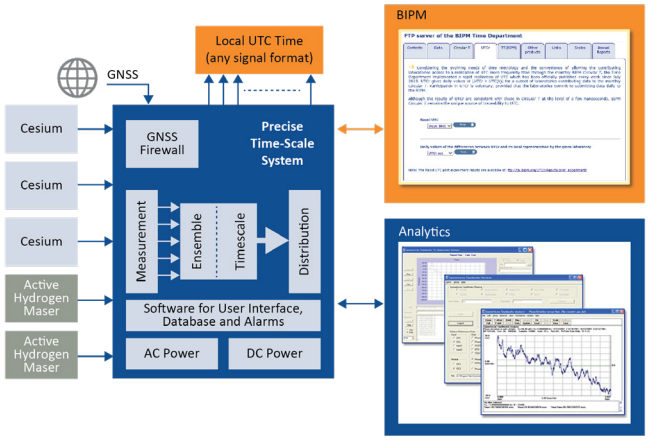
Laboratories that want to be a BIPM institute and potentially serve as a master source of time for critical infrastructure need a system with state-of-the art frequency stability, excellent phase noise and maximal operational availability.

To meet these evolving requirements, PTSS begins by incorporating any combination of our world-class frequency standards. The first option is the 5071A Cesium Frequency Standard, which constitutes approximately 70% of all physical UTC clocks contributing to UTC. Additionally, PTSS may include our MHM-2020 or MHM-2010, the world's most widely installed active hydrogen masers.

The PTSS product offers exceptional operational reliability, high quality, fast deployment, ease of use, low cost of ownership and a single point of contact for system support. Its unique set of features delivers the state-of-the-art functionality and performance necessary to establish a national timing reference aligned with UTC.

System Overview

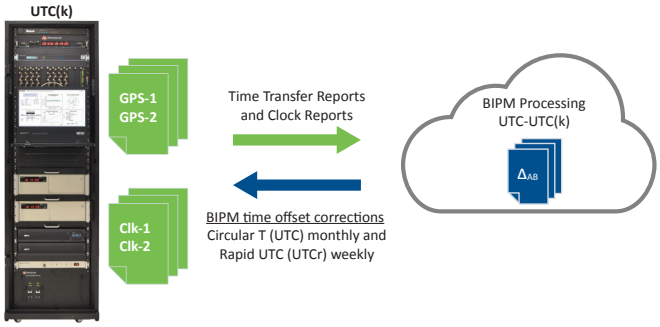
PTSS combines from two to eight cesium frequency standards or active hydrogen masers in order to create a system frequency output of superior stability. The component clocks themselves are not steered but operate as free-running frequency sources. A high-performance measurement system assesses and reports clock performance to the BIPM in accordance with its published method and format.



Precise Time Scale System

The core function of the PTSS is to generate a highly stable frequency reference that is steered in synchronization with UTC. Measurements of the relative differences between the independent clocks are used to generate the system frequency, which is superior in stability and accuracy to any of the component clocks. PTSS assigns weights to each of the component clocks that constitute the clock ensemble and intelligently combines them based on their respective level of performance. The measurement, ensemble and time scale capabilities are all part of the SyncSystem 4380A Time Scale Edition product (SyncSystem 4380A-TS). More details about this functionality can be found in its data sheet.

The SyncSystem 4380A-TS includes a GNSS receiver capable of making measurements necessary to produce a Receiver Independent Exchange (RINEX) file that allows users to post-process GNSS data to determine the antenna position to within a few centimeters. The GNSS receiver also supports multi-constellation and multi-band satellite reception. The PTSS system utilizes the GNSS receiver in the 4380A-TS to generate GNSS common view reports, which may be delivered to BIPM to compute the site offset to UTC and steer the system on time. To monitor and ensure the fidelity of the GNSS signal, PTSS may be deployed with our BlueSky™ GNSS Firewall. The GNSS common view reports may be pulled directly from the SyncSystem 4380A-TS and are also automatically stored on the PTSS server to enable efficient interfacing with the BIPM.



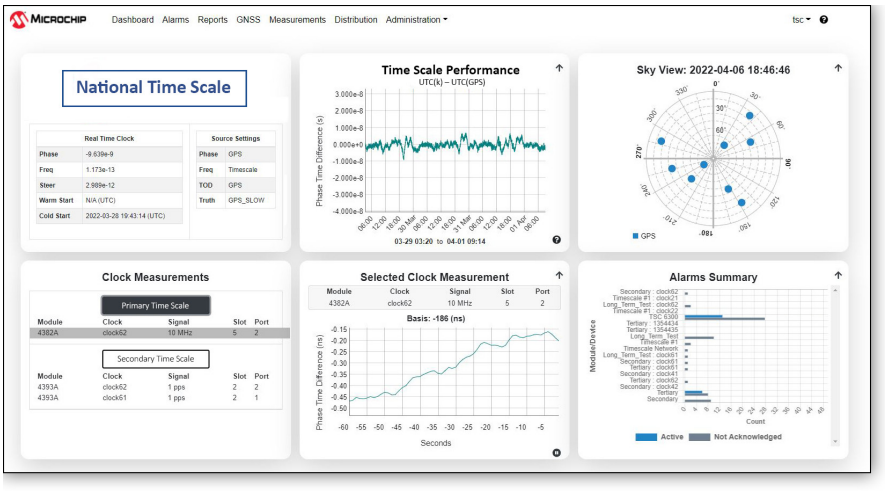
Interfacing with BIPM

Timing Signal Distribution

To deliver time scale system frequency and timing outputs, our 6300 Series distribution system can be wired into the rack to deliver traditional 10 MHz, 5 MHz, 1 PPS, TOD and IRIG signal outputs. The 6300 Series is an ultra-low phase noise distribution system with hot-swappable signal output modules and power supplies. In addition, our SyncServer® S650 or TimeProvider® 4100 products may be added to distribute packet timing signals from the PTSS. More information about the 6300 Series, SyncServer S650 and TimeProvider 4100 are available in their individual data sheets.

Time Scale Orchestrator Software

The PTSS is a system of systems that must work in an integrated manner. Included in the PTSS rack is a server with the Time Scale Orchestrator software installed providing integrated management, monitoring, alarming and reporting functions of the individual systems (products) of the PTSS. This ensures that the operator has a single pane of glass that provides a complete view of the entire time scale system performance and its management. An integrated database provides long-term storage of clock measurements for viewing and comparing clocks that are contributing to the time scale ensemble.

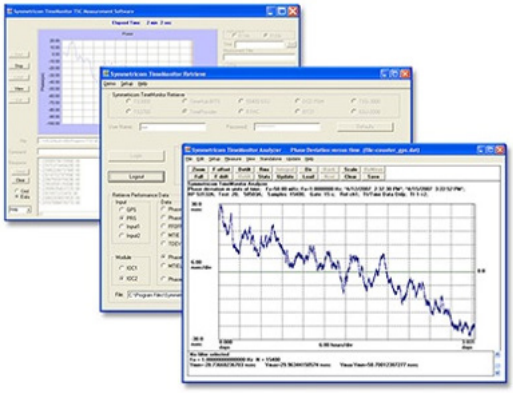


Time Scale Orchestrator Dashboard

The Time Scale Orchestrator includes several features to make interfacing with the BIPM for contribution to UTC a reliable and simplified process for the time scale operator. The software provides a web interface for clock configuration, viewing clock measurements, monitoring time scale performance and managing system reports, including common view reports, clock reports and TAIPPP reports. This unified system interface also includes alarm logging and management. Timing parameters can be entered through the GUI for steering the PTSS to the selected truth source, such as UTC. Please refer to the Time Scale Orchestrator data sheet for further details.

TimeMonitor Software

Many time scale operators are interested in analyzing the timing performance of individual clocks and the time scale system in detail. Measurement data stored in the Time Scale Orchestrator can also be easily imported into our TimeMonitor Software for more detailed analysis. This tool can display various performance metrics such as ADEV, TDEV and MTIE. Additionally, results from multiple measurements can be overlaid on the same graph enabling multiple clocks to be compared and analyzed together.

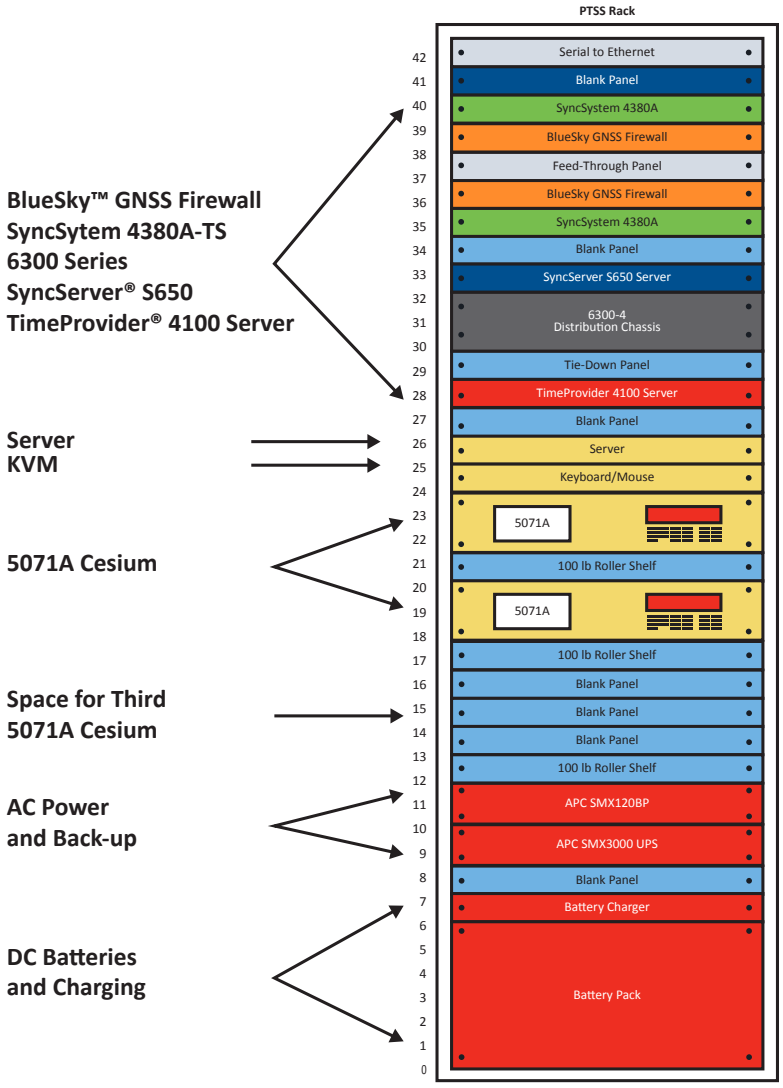


TimeMonitor Measurement Analysis

Baseline System Configuration

The baseline PTSS system operates in a single rack and includes two cesium clocks, one SyncSystem 4380A Time Scale Edition, our 6300 Series distribution system, a rack-mounted server with the Time Scale Orchestrator software installed and configured, a rack-mounted keyboard with trackpad and LCD monitor and a robust power supply system, including AC power backup and DC battery backup.

A key advantage of the system design is its modular architecture, which makes it easy to upgrade. The user can add cesium clocks into the rack and hydrogen masers later to further improve system performance. The modular configuration provides plug-and-play connection with additional clocks to eliminate the need for reconfiguring or expensive reengineering of the design.



Precise Time Scale System
Sample Rack Configuration

Services

Microchip, along with our global partners, provide a wide range of customer support services. We have over 40 years of experience designing timing solutions for mission-critical applications. Our facility in Boulder, CO, offers complete system integration and testing resources to ensure that you can successfully leverage all the features of the PTSS.

We offer these services:

- Site survey and verification
- Customer-witnessed factory acceptance testing
- On-site installation
- Remote installation support
- Training
- Extended hardware warranty and repair
- System spares program
- 24 × 7 technical support
- Consulting for contributing to BIPM

Summary

The Precise Time Scale System offers these key benefits for traditional metrology labs, site timing systems for satellite or related communications and national timing infrastructure:

- A highly robust and resilient architecture to serve as the backbone and primary time source for national timing of critical infrastructure
- Local realization of UTC(k) that is closely aligned with UTC as coordinated by the BIPM
- Contribution of clock data that is used by the BIPM for UTC computation
- UTC-class time, which can be constructed to specific customer requirements, deployed globally and supported with the highest level of customer service
- Flexible distribution of both traditional timing and packet timing signals
- Integrated management, monitoring, alarming and reporting functions for the entire time scale system

Specifications

Time Accuracy

- 10 ns (RMS)

Time accuracy is measured relative to UTC(USNO) at time of shipment

System Clocks

- Up to eight clocks can be included in the time scale ensemble
- No discontinuity in time scale during clock additions or deletions
- Recommended clock types
  - Microchip 5071A Frequency Standard
  - Microchip 5071A High Performance Frequency Standard
  - Microchip MHM 2020 Active Hydrogen Maser

GNSS Input

- Multi-Constellations: GPS, Galileo, GLONASS, BeiDou, QZSS
- GPS used for common view operation
- Multi-band (L1/L2) support
- BlueSky GNSS Firewall 2200 option for additional signal protection

Refer the BlueSky GNSS Firewall 2200 data sheet for further details

Signal Distribution

- 10 MHz, 5 MHz, 1 PPS, IRIG signal formats (provided using 6300 Series)
- Packet Timing distribution provided by SyncServer S650 and/or TimeProvider 4100

Refer to the respective data sheets for further details

Measurement Performance

- Supports measurements of atomic clocks for ensemble computation
- Supports signal formats of 10 MHz, 5 MHz, 1 PPS

Refer to the SyncSystem 4380A Time Scale Edition data sheet for further details

BIPM Reports

- BIPM Clock Reports
- BIPM GNSS Common View Reports
- TAIPP Precise Position Reports

Status and Alarm Reporting

- Alarms categorized by severity level
- Alarms identified by product, module, and system functions
- Alarm management including filtering, acknowledgement and clearing

User Interface and System Management

- Control and management through local GUI using keyboard, mouse and LCD (Refer to Time Scale Orchestrator data sheet for further details)
- Rack mounted 1U server (server options defined by user requirements) which includes installation and configuration of Time Scale Orchestrator

Power

- AC and/or DC power (overall power consumption dependent on configuration)
- All subsystems include redundant power supplies
- AC and DC power back-up (with batteries) included

Temperature

- 0 to 50°C (to achieve optimum performance, temperature variation should be controlled and maintained at ±0.25°C)

Additional Information

The Precise Time Scale System is a part of our larger product family of time scale and site timing system products. Please refer to the following for more information:

SyncSystem 4380A Time Scale Edition—The center piece of the Precise Time Scale System, this product generates an autonomous time scale derived from combining several highly accurate independent clocks. A multi-channel instrument for measuring high-performance cesium clocks or active hydrogen masers is built into the system.

Time Scale Orchestrator—This software provides a web interface for clock configuration, clock management, viewing of time scale performance and BIPM report storage (including common view reports, clock reports, and TAIPPP reports).

5071A Cesium Clocks and MHM 2020 Active Hydrogen Masers—Our atomic clocks provide accurate and stable frequencies that are continuously measured against each other to compute and generate the time scale frequency.

6300 Modular Distribution System—The 6300 system is a hot-swappable, modular distribution system that supports high-performance RF, 1 PPS and IRIG signal distribution. Designed for metrology applications, the 6300 Modular Distribution System delivers high-performance signal distribution without degradation.

TimeMonitor Software Suite—Performance metrics such as ADEV, TDEV, MTIE and many other calculations can be executed with a single push of a button and compared to a wide variety of industry performance masks.