



# Model 5402 Dante® Leader Clock with GNSS Synchronization

## Key Features

- Dedicated Leader clock for Dante audio-over-IP, AES67, ST 2110-30, and DDM applications
- High-performance IEEE 1588 PTPv1 and PTPv2 servers
- Integral GNSS (satellite) receiver for nanosecond-level timing accuracy (multi-band antenna included)
- Supports major constellations, including GPS (USA), Galileo (Europe), and BeiDou (China)
- Precision word clock output
- Eight configurable audio tone signals
- Three Gigabit Ethernet interfaces support independent redundant Dante and management networks
- Webpage management and USB flash drive software updating
- AC mains and 12 volts DC powering
- Lightweight enclosure, single rack-space (1U) mounting

## Overview

The Model 5402 Dante Leader Clock with GNSS Synchronization provides precise timing signals for applications that utilize the Dante audio-over-IP (AoIP) media networking technology. The unit implements a high-performance IEEE® 1588 precision time protocol (PTP) server, compatible with the requirements of Dante and capable of simultaneously supporting the timing needs of up to hundreds of Dante-compatible devices. As expected, the Model 5402 provides the PTPv1 (IEEE 1588-2002) compatibility that's required by Dante. In addition, the unit supports PTPv2 (IEEE 1588-2008) for AES67 and ST 2110-30 applications. The unit includes an integrated GNSS (satellite) receiver to allow a precise timing reference to be acquired from the four major constellations: GPS, Galileo, BeiDou, and GLONASS. A multi-band GNSS antenna is included with each Model 5402.

In addition, a sync input connection allows the Model 5402's internal oscillator to be synchronized with a variety of external timing and reference signals. A word clock output provides a general-purpose timing reference for use by external devices.

The Model 5402 integrates with the Dante Domain Manager™ (DDM) software application. With DDM, support for AES67 and ST 2110-30 can take place alongside Dante audio.

As an additional resource, the Model 5402 generates eight sine wave audio tones on Dante transmitter (output) channels. These can be useful during audio and data network installation, maintenance, and operation.

The Model 5402 is suitable for use in fixed and mobile broadcast facilities, post-production studios, commercial and educational theater environments, and entertainment applications. Only power, a GNSS antenna, and one, two, or three Ethernet network connections are required for full operation. Using Dante's inherent capabilities two Model 5402 units can serve in primary and backup Leader clock roles for redundant operation.

The unit's three Gigabit Ethernet (GigE) network interfaces can be configured for use in a range of network implementations. For high-reliability audio applications two of the



Model 5402 Front and Rear Views

interfaces can support redundant Dante operation while the third can be used for accessing the management webpages.

Front-panel LED indicators, an LCD display, and pushbutton switches provide users with direct access to important operating parameters. An integrated web server allows fast and flexible monitoring and configuration of the unit's networking, clocking, and Dante performance. Using the STcontroller software application, key operating parameters can be monitored in real time. In addition, STcontroller allows direct access to the Model 5402's management webpages.

The Model 5402 can be powered by 100-240 V, 50/60 Hz mains or a source of 12 volts DC. Both can be simultaneously connected to provide redundant operation. The lightweight enclosure mounts in one space (1U) of a 19-inch equipment rack. Industry-standard connectors are used for Ethernet, GNSS antenna, DC power, and AC mains interconnections. Updating the Model 5402's operating software can be easily performed using a USB flash drive.

## **Applications**

Applications for the Model 5402 include broadcast and post-production facilities, college and university audio networks, arenas, stadiums, corporate installations, and virtually any application where substantial numbers of Dante-compatible devices are utilized. The Model 5402 will serve as a stable and consistent Leader clock for the entire Dante "network." And, as expected, the Model 5402 is compatible with all Dante devices, no matter what their function or whom their manufacturer. Applications that utilize devices compatible with AES67 and ST 2110-30 will also benefit from the Model 5402's resources.

## **Why a Dedicated Dante Leader Clock?**

With Dante ubiquitous in fixed and mobile facilities of all sizes and types, the need arose for a cost-effective, purpose-designed, dedicated Leader clock. While an inherent strength of Dante networking is its carefully implemented use of the IEEE 1588 standard to ensure that all connected devices maintain a common timing reference, the actual performance can vary widely depending on the specific Dante devices in use and the overall number of devices on a network. There are many Dante-compatible devices that can provide adequate basic performance as a Leader clock, but with the Model 5402 networked audio systems get the benefits of a high-performance Primary Leader Clock, along with additional unique capabilities. The unit's feature set, along with the

associated internal hardware and software, was designed to provide optimum performance, flexibility, and system integrity.

## **Timing Sources**

The Model 5402 can provide excellent Leader clock performance using a timing reference that is based on signals provided by one or more GNSS (satellite) constellations. This will ensure accuracy and stability that exceeds the capability of standard Dante devices by at least an order of magnitude. A configuration choice is provided in a Model 5402 webpage to allow a failover source of timing to be selected should a valid GNSS signal become unavailable.

The Model 5402 will also provide strong Leader clock performance using its temperature-stabilized internal oscillator. While its standalone performance is excellent, it can also be "locked" to a variety of external signals for integration into facilities that already include a central or main timing reference. Compatible signals include word clock, video reference, and 10 MHz. Word clock is a square wave signal that is often used as a timing reference in audio-only facilities. Video reference ("sync") signals are found in most broadcast and post-production facilities. The Model 5402 supports the most-common video format/rate combinations including "black burst," bi- and tri-level HD, and several that are specifically intended for 4K applications. Industrial and commercial facilities often utilize a source of 10 MHz sine wave as a timing reference.

## **GNSS Support**

The Model 5402's internal time base can be synchronized to signals received from satellite-based timing systems. Most often referred to as GPS, satellite-based time and position data is more properly identified as being received from a GNSS (Global Navigation Satellite System). GPS (Global Positioning System) is just one set of satellites that can provide GNSS data. For maximum flexibility the Model 5402 contains an integral receiver that is compatible with the major worldwide GNSS constellations, including GPS (USA), Galileo (Europe), and BeiDou (China). In addition, the unit allows augmentation support for GPS as provided by QZSS (Japan). Configuration choices allow which constellations will be utilized by the Model 5402. This can range from one to all four constellations. Using these capabilities, the Model 5402 can achieve single-digit nanosecond timing accuracy. Multiple, geographically disbursed sites ("network nodes") can each use a Model 5402 to easily achieve a coordinated timing reference.

For general-purpose use the Model 5402's GNSS receiver will also report, by way of the front-panel display and/or the management webpages, the current date and time of day, as well as longitude and latitude parameters. In addition, the number of satellites currently "fixed" (locked) and the receiver input power can also be observed.

An active, multi-band [GNSS antenna](#) is included with each Model 5402. This antenna is compact, weather-resistant, and includes a 5-meter (16.3 foot) cable with attached SMA plug. The GNSS antenna can be secured to the selected location using two M4 machine screws or affixed magnetically to a metallic surface. Its performance is very good and many applications will find this antenna to be sufficient. It's expected that alternate, installer-provided GNSS antennas and associated cabling may also be utilized to meet the specific needs of various applications. This may involve supporting longer interface cables, using different mounting methods, or providing more-advanced weather-resistant properties. For additional details please refer to the Tech Note "[GNSS Cable Length and Antenna Notes.](#)"

### **Word Clock Output**

The Model 5402 generates a precise word clock output signal that can be used as a timing reference for related equipment. It's specifically intended for "locking" digital audio devices in applications that use the Model 5402 to provide timing reference signals for the associated Dante equipment. In this way, all devices in an installation will share a common timing reference.

The word clock output rate can be 44.1, 48, 88.2, 96, 176.4, or 192 kHz. The underlying timing source for the word clock output is derived from the Model 5402's main timing source. This will typically be one or more of the supported GNSS constellations. The main timing source is divided and processed by the Model 5402's logic circuitry to create the highly stable word clock output. This ensures that the word clock output is synchronized with the unit's PTPv1 and PTPv2 server functionality.

### **Audio Tone Generator**

The Model 5402 generates eight sine wave audio tones intended for general-purpose use. These audio tones are provided by the Model 5402 in the form of Dante transmitter (output) channels. They can be connected, using the Dante Controller application, to Dante receivers (inputs) on related equipment. The flexibility of being able to interconnect signals (create Dante "subscriptions") between all Dante devices



An active, multi-band, high-precision antenna is included with each Model 5402

on a network allows the audio tones to be used for a variety of purposes. Configuration choices allow the frequency and level of each sine wave tone to be optimized for use in specific applications.

### **Leader Clock Support for Dante Networks**

A core part of the technology underlying Dante audio-over-IP networking ensures that all connected devices follow a common timing reference. This is accomplished using the IEEE 1588-2002 (PTPv1) and 1588-2008 (PTPv2) precision time protocols. Any connected Dante device can be used as a Leader clock; there is no requirement that a dedicated Leader clock device be utilized to realize adequate functionality. However, the actual performance can vary widely depending on the specific Dante devices available and the overall number of Dante devices on a network.

Many Dante devices utilize the 2- or 4-channel Ultimo™ ULT or UXT integrated circuits to implement Dante connectivity. While Ultimo devices will fully support Dante audio transport, they are not well suited to serve as a Leader clock. Ultimo's PTP performance is limited and does not have the ability to synchronize with an external timing reference. Other Dante devices may use the Brooklyn II module or Broadway integrated circuit to support Dante connectivity. In some cases, these devices can provide good basic performance as a Leader clock.

However, problems and limitations may arise when these devices are called upon to perform "double duty," serving in both a primary function (such as analog-to-Dante interfacing or audio signal processing) as well as acting as a Leader clock. This is understandable as the main purpose of these devices is to serve functions other than acting as a primary synchronization reference. Specialized features, such as allowing a GNSS-derived time base are rarely, if ever, supported.

PTP performance can degrade when the computing power of a device is intended primarily for handling and manipulating digital audio signals. This can lead to the required PTP resources being in short supply when the number of Dante devices that need timing messages moves into the hundreds. Also, firmware updates, cabling changes, and other maintenance tasks typically associated with a general-purpose Dante device would impact the Leader clock functionality for an entire installation.

The Model 5402 was specifically designed to support a Dante-based audio or video system's Leader clock requirement. By utilizing GNSS, multiple Model 5402 units can be installed at independent locations while sharing a common timing reference. The unit's generation of audio tones and implementation of the word clock output utilize hardware circuitry that is separate from that associated with its PTP functionality. As such, this secondary functionality will not interfere with PTP operation. Unlike general-purpose Dante devices, once mounted in an equipment rack and the required interconnections made, the Model 5402 will perform its tasks without risk of interruption due to conflicting resource demands.

## **Flexible Networking Capability**

Using the Dante Controller application program, the Model 5402's three Ethernet ports can be selected to operate in one of four modes: Switched, Redundant, Switched+Mgmt, and Redundant+Mgmt. This should allow virtually any desired networking implementation to be easily achieved.

By using the Switched or Redundant network modes, separate network connections will be maintained for Dante audio and management purposes.

In the Switched mode a single Ethernet connection to either of the Model 5402's two Dante Ethernet ports will provide Dante Leader clock functionality. The remaining Dante Ethernet port will provide Dante network "loop-through" capability and can be used to interface with another piece of Ethernet-connected equipment. The management Ethernet port will be used to access the Model 5402's monitoring and configuration webpages.

In the Redundant mode two independent Ethernet connections are made to the Model 5402's two Dante Ethernet ports, enabling Dante's redundant networking capability. Again, the management Ethernet port will be used to access the Model 5402's monitoring and configuration webpages.

In the Switched+Mgmt mode a single Ethernet connection is used for both Dante Leader clock functionality as well as providing access to the Model 5402's management webpages. The remaining Dante Ethernet port will provide network "loop-through" capability and can be used to interface with another piece of Ethernet-connected equipment.

In the Redundant+Mgmt mode two independent Ethernet connections can be made to the Model 5402's two Dante Ethernet ports. This will enable Leader clock capability for redundant Dante applications. Access to the Model 5402's management webpages will be made by way of the Ethernet connection made to the Dante primary Ethernet port.

## **Operating Power**

The Model 5402 allows an AC mains source of 100-240 V, 50/60 Hz to be directly connected. It can also be DC powered using a 10-18 volt source that is connected via a broadcast-standard 4-pin XLR connector. If both AC and DC power sources are connected the unit will be powered by the AC mains supply. Only if the AC mains source fails will appreciable power be drawn from the DC source. This allows a source of DC, typically an external power supply, to serve in a backup capacity. With this arrangement normal operation can continue even if AC mains power is lost.

## **Future Capabilities**

The Model 5402 was designed so that its capabilities can be enhanced in the future. A USB receptacle, located on the unit's back panel, allows the three firmware files (embedded software) to be updated using a USB flash drive. The Model 5402's Dante firmware can be updated using one of the unit's Ethernet connections, helping to ensure that the Dante capabilities remain up to date. All software files and configuration parameters are stored in non-volatile memory.

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## Model 5402 Specifications

### Applications:

GNSS (satellite) time-referenced, high-performance Leader clock for Dante audio-over-IP applications. Also supports AES67 and ST 2110-30 applications. In addition, provides audio tones on Dante transmitter (output) channels for general-purpose use and a word clock synchronization output.

### Precision Time Protocol (PTP) Support:

PTPv1 (IEEE 1588-2002) for Dante; PTPv2 (IEEE 1588-2008) for AES67-2018 and ST 2110-30:2017

### Timing Reference:

Source: GNSS receiver, external sync input, internal time base, or via an existing Dante network, selectable

### GNSS Receiver Capability:

Type: multi-band GNSS, optimized for timing applications  
Constellations Supported: includes GPS (USA), Galileo (Europe), BeiDou (China), selectable  
Augmentation Support: QZSS (Japan, applies only to GPS), selectable  
Number of Concurrent Constellations: 4  
Time to First Fix: less than 40 seconds, typical  
Timing Accuracy: <5 ns (clear sky)  
Sensitivity: -148 dBm (cold starts), -166 dBm (tracking), typical  
Antenna Power Source: 5 Vdc, 100 mA maximum  
Antenna Requirement (for reception of four constellations): active, multi-band (L1, L2/E5b), terminated with SMA plug. (Antenna included with each Model 5402, see Included Accessories.)

### Sync Input:

Compatible Sources: word clock, bi-level video, tri-level video, 10 MHz  
Termination: 50 ohms (10 MHz), 75 ohms (word clock or video), or high Z (unterminated), selectable  
Word Clock Compatibility: square wave, 5 Vpp nominal unloaded, 44.1, 48, 88.2, 96, 176.4, or 192 kHz  
Video Signal Compatibility: bi- or tri-level, 1 Vpp nominal into 75 ohm load  
10 MHz Signal Compatibility: sine wave, 3 Vpp nominal into 50 ohm load

### Internal Time Base:

Type: 24.576 MHz temperature-stabilized crystal oscillator  
Initial Accuracy: 1 ppm (parts-per-million)  
Long-Term Accuracy: 1 ppm (parts-per-million) per year  
Temperature Stability:  $\pm 280$  ppb (parts-per-billion), 0-50 degrees C

### Word Clock Output:

Type: square wave  
Rate: 44.1, 48, 88.2, 96, 176.4, or 192 kHz  
Source Impedance: 75 ohms  
Amplitude: 5 Vpp, unterminated; 2.5 Vpp, externally terminated with 75 ohms  
Jitter: 0.01 UI (using internal time base)

### Network Audio Technology:

Type: Dante audio-over-IP  
AES67-2018 Support: yes  
ST 2110-30:2017 Support: yes  
Dante Domain Manager™ (DDM) Support: yes  
Ethernet Interface Configuration: Switched, Redundant, Switched+Mgmt, or Redundant+Mgmt, selectable  
Clock Source: follows Model 5402 timing reference configuration  
Sample Rate: 44.1, 48, 88.2, 96, 176.4, or 192 kHz, selectable  
Bit Depth: 24  
Number of Dante Transmitter (Output) Channels: 8  
Number of Dante Transmitter Flows: 32

### Audio Tone Generator:

Type: continuous sine wave signals on Dante transmitter (output) channels  
Number of Channels: 8  
Frequency: 1 Hz to 22 kHz, individually configurable in 1-Hz steps  
Amplitude: 0 to -99 dBFS, individually configurable in 1-dB steps  
Distortion (THD+N): <0.0001% (<-121 dB), measured at 1 kHz, -1 dBFS

### Network Interfaces:

Qty: 3; Dante Primary, Dante Secondary, and Management  
Type: 1000BASE-T Gigabit Ethernet (GigE) per IEEE 802.3ab (100 Mb/s supported but not recommended for optimal performance; 10 Mb/s not supported)  
Ethernet Connection NIC Status LEDs: one link and one activity for each Ethernet interface

### Front-Panel Display: backlit LCD

### Front-Panel LEDs:

Qty: 9, dual-color  
Functions: provides indication of condition of incoming AC and DC power, status of three Ethernet interfaces, status of Dante connectivity, status of GNSS receiver, and status of sync input

### Software Updating:

USB flash drive supports updating of Main MCU, Main FPGA, and Sync FPGA firmware (embedded software); Dante interface updated via Ethernet interface

### Power Sources:

AC Mains: 100 to 240 V, 50/60 Hz, 5 W maximum  
DC: 10 to 18 V, 0.5 A max: 110 uA maximum with 12 volts DC and AC mains present, 190 uA maximum with 18 volts DC and AC mains present

### Connectors:

GNSS Antenna: SMA jack  
Sync Input, Word Clock Output: 2, BNC jack (female connector), per IEC 61169-8 Annex A  
Ethernet: 3, RJ45 jack  
USB: type A receptacle (used only for updating firmware)  
DC Input: 4-pin male XLR (pin 1 negative, pin 4 positive)  
AC Mains Input: 3-blade male, IEC 320 C14-compatible (mates with C13)

### STcontroller Support:

Status of select parameters can be monitored using Studio Technologies' STcontroller software application

### Included Accessories:

High-precision, multi-band GNSS antenna with 5-meter (16.3 foot) cable terminated with SMA plug. Mounts magnetically to metal surface or secured using two 4.5 mm pitch machine screws. (Hardware not included.)

### Environmental:

Operating Temperature: 0 to 50 degrees C (32 to 122 degrees F)  
Storage Temperature: -40 to 70 degrees C (-40 to 158 degrees F)  
Humidity: 5 to 95%, non-condensing  
Altitude: not characterized

### Dimensions (Overall):

19.00 inches wide (48.3 cm)  
1.72 inches high (4.4 cm)  
7.9 inches deep (20.1 cm)

**Mounting:** one space (1U) in a standard 19-inch rack

**Weight:** 3.0 pounds (1.4 kg)

Specifications subject to change without notice.

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## Studio Technologies, Inc.

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