Model 5401A
Dante® Leader Clock

STUDIO TECHNOLOGIES INC.

Key Features

- Dedicated Leader clock for Dante audio-over-IP, AES67, and ST 2110-30 applications
- High-performance IEEE 1588 PTP v1 and v2 servers
- Internal temperature-stabilized frequency reference
- Compatible with external word clock, video sync, and 10 MHz sources
- Precision word clock output
- Eight configurable audio tone signals
- Three Gigabit Ethernet interfaces support independent 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 5401A Dante Leader Clock provides precise timing signals for applications that utilize the Dante audio-over-IP 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 5401A 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. A word clock output provides a general-purpose timing reference for use by external devices. The Model 5401A also generates eight sine wave audio tones on Dante transmitter (output) channels which can be useful during audio and data network installation, maintenance, and operation. A sync input connection allows the Model 5401A's internal oscillator to be synchronized with a variety of timing and reference signals.

The Model 5401A is suitable for use in fixed and mobile broadcast facilities, post-production studios, commercial and educational theater environments, and entertainment applications. Only power and one, two, or three Ethernet network connections are required for full operation. Using Dante's inherent capabilities two Model 5401A 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 interfaces can support Dante redundancy operation while the third is used for accessing the management webpages. To meet the latest interoperability standard the Model 5401A's Dante implementation supports AES67 and ST 2110-30. The unit also integrates with the Dante Domain Manager™ (DDM) software application.

Model 5401A Front and Rear Views

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 5401A's management webpages.

The Model 5401A 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, DC power, and AC mains interconnections. Updating the Model 5401A's operating software can be easily performed using a standard USB flash drive.

Applications

Applications for the Model 5401A 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 5401A will serve as a stable and consistent Leader clock for the entire Dante "network." And, as expected, the Model 5401A is compatible with all Dante devices, no matter what their function or manufacturer. Applications that utilize devices compatible with AES67 and ST 2110-30 will also benefit from the Model 5401A'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 5401A 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 5401A can provide excellent Leader clock performance using its temperature- stabilized internal oscillator, which exceeds the capability of standard Dante devices by at least an order of magnitude. While its standalone performance is excellent, the Model 5401A can also be "locked" to a variety of external signals for integration into facilities that 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. Several common word clock rates, including 48, 96 kHz, and the more-exotic 192 kHz, are compatible with the Model 5401A's sync input. Video reference ("sync") signals are found in most broadcast and post-production facilities. The Model 5401A 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 GPS-disciplined source of 10 MHz as a timing reference. This sine wave signal is typically compatible with the Model 5401A's sync input.

Word Clock Output

The Model 5401A 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 5401A 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 5401A's main timing source. As previously reviewed, the internal oscillator, if desired, can be "locked" to an external source. The main timing source is divided and processed by the Model 5401A'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 5401A generates eight sine wave audio tones intended for general-purpose use. These audio tones are available from the Model 5401A by way of Dante transmitter (output) channels and 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 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 PTPv1 (IEEE 1588-2002) and PTPv2 (IEEE 1588-2008) 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 a Brooklyn module or a 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. Timing related features, such as allowing connection of a video bi- or tri-level sync signal is rarely, if ever, supported. And 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 5401A was specifically designed to support a Dante-based audio system's Leader clock requirement. And 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 a general-purpose Dante device, once mounted in an equipment rack and the required interconnections are made, the Model 5401A will perform its tasks without risk of interruption due to conflicting resource demands.

Flexible Networking Capability

Using the Dante Controller application program, the Model 5401A'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 5401A'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 5401A's monitoring and configuration webpages.

In the Redundant mode two independent Ethernet connections are made to the Model 5401A's two Dante Ethernet ports, enabling Dante's redundant networking capability. Again, the management Ethernet port will be used to access the Model 5401A'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 5401A'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 5401A's two Dante Ethernet ports. This will enable Leader clock capability for applications that utilize Dante redundancy. Access to the Model 5401A's management webpages will be made by way of the Ethernet connection made to the Dante primary Ethernet port.

Operating Power

The Model 5401A 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 5401A 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 5401A'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.

Model 5401A Specifications

Applications:
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: internal time base, external sync input, or via an existing Dante network, selectable

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: ±280 ppb (parts-per-billion), 0-50 degrees C

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

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 5401A 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: 8, dual-color
Functions: provides indication of condition of incoming AC and DC power, status of three Ethernet interfaces, status of Dante connectivity, 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:
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

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.

Studio Technologies, Inc.
Skokie, Illinois USA

studio-tech.com