Model 5402
Dante® Leader Clock
with GNSS Synchronization

User Guide
Issue 7, December 2025

This User Guide is applicable for serial numbers:

M5402-02001 and later with
Main MCU Firmware (.bin) version 2.05 and later
Dante Firmware (.dnt) version 3.0.0 and later (Brooklyn 3 v4.3.1.8)
STcontroller version 4.04.11 (Windows) and later and
STcontroller version 4.04.02 (MacOS) and later

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Revision History

Issue 7, December 2025:

- Documents changes to Dante as it relates to AES67 and ST 2110-30.

Issue 6, November 2022:

- Documents ability to restore network and access settings.

- Removes all references of "Brooklyn II" as it can be either Brooklyn II or Brooklyn 3.

Issue 5, April 2022:

- Documents support for STcontroller software application.

- Miscellaneous corrections and clarifications.

Issue 4, August 2021:

- Documents change of Dante Controller default configuration setting. (Was Switched, changed to Switched+Mgmt.).

Issue 3, August 2021:

- Revises format of document. Incorporates menu page screen captures in-line with text and removes related appendix.

Issue 2, July 2021:

- Documents support for 176.4 and 192 kHz sample rates.

- Miscellaneous corrections and clarifications.

Issue 1, May 2021:

- Initial release.

Introduction

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 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.

Figure 1. Model 5402 Dante Leader Clock with GNSS Synchronization front and back views

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

Figure 2. An active, multi-band, high-precision antenna is included with each Model 5402

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, high-precision antenna is included with each Model 5402. The compact antenna is weather-resistant and includes a 5-meter (16.3 foot) cable with attached SMA plug. The antenna can be secured to the selected location using two machine screws or affixed magnetically to a metallic surface. Its performance is very good and many applications will find this antenna to be sufficient. But it's expected that alternate, installer-provided antennas 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.

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 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 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. 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.

Installation

In this section the Model 5402 will be mounted in one space (1U) of an equipment rack. In most cases, a GNSS (satellite) antenna will be connected. It's also possible that an synchronization source will be connected to the sync input BNC jack. If needed, a connection may be made to the word clock output BNC jack on the back panel. One or more Ethernet data connections will be made. AC mains and/or DC power will be connected to the Model 5402.

The interface cable associated with the included GNSS antenna will be connected to the SMA jack on the back panel of the Model 5402. Using a coaxial cable terminated with a BNC plug, an external source of synchronization may be connected to the sync input BNC jack. A word clock output is provided by way of a BNC jack and may be utilized by one or more pieces of equipment. Up to three Ethernet data connections will be made to the Model 5402 using standard RJ45 patch cables.

AC mains power can be connected to the Model 5402 by means of a detachable cord that is compatible with the unit's 3-pin IEC 320 C14 inlet connector. Some applications may warrant connection to a source of nominal 12 volts DC which can be made by way of a 4-pin XLR connector. A DC source can be used to power the Model 5402 as well as serving as a backup power source should AC mains not be present.

What's Included

The shipping carton contains a Model 5402 Dante Leader Clock, a GNSS antenna, and instructions on how to obtain an electronic copy of this guide. Also included in the shipping carton is a North-American-standard AC mains cord. For destinations outside of North America the local reseller or distributor should provide an appropriate AC mains cord.

Mounting the Model 5402

The Model 5402 Dante Leader Clock requires one space (1U) in a standard 19-inch (48.3 cm) equipment rack. Secure the unit into the designated equipment rack using two mounting screws per side. As the Model 5402 does not contain a fan or other noise-producing source it can be located within a room or other structure where audio monitoring is going to take place. But the priority when selecting a location is to ensure that the cable associated with the GNSS antenna can reach the SMA jack on the Model 5402's back panel. In addition, some or all of the connections involving the sync input BNC jack, the word clock output BNC jack, the Ethernet interface RJ45 jacks, and the AC mains and/or DC power connectors may be utilized.

The included GNSS antenna has an integral 5-meter (16.3 foot) nominal cable terminated with an SMA plug. It's possible that an extension cable or alternate antenna will be utilized which could expand the mounting location choices. Twisted-pair (UTC) Ethernet has a 100-meter (325-foot) interconnection cable limitation. But that can be overcome by using fiber-optic interconnections between the Model 5402 and the Ethernet switch or switches in the one or more associated local-area-networks (LANs).

Connecting the GNSS Antenna

A multi-band GNSS antenna is included with each Model 5402. This is not just a common low-cost single-band generic "GPS" antenna. This antenna, Studio Technologies' order code ANT-GNSS-01, is a premium-quality device that will support reception of all the satellite constellations that can be received by the Model 5402. The antenna must be located where an unobstructed "view" of the sky is available. The top of the antenna should face up so as to be within line-of-sight of overhead satellites. In most cases, an outdoor location will be optimal but selecting an indoor location that has minimal RF blockage can also be effectively used. The antenna is suitable for outdoor use and has an IP67 rating. This prevents dust from entering the unit. It also provides moisture protection, but the antenna should not be left submerged in water. It's possible that the antenna will work from inside a building, such as next to a window or beneath a skylight, but with reduced performance.

The antenna has an integral magnet such that it can self-affix to a ferrous surface. It also has two mounting holes, 68 millimeters apart center-to-center, that are optimized for use with M4 or number 8 screws. The antenna includes a 5-meter (16.3-foot) nominal length of miniature RG174 (50 ohm) coaxial cable terminated with an SMA plug. The plug must be securely affixed to the SMA jack on the Model 5402's back panel. The cable must not be crushed and sharp bends must be avoided. Do not secure the cable using cable ties such that the cable's mechanical characteristics are changed.

It's possible that the antenna's cable can be extended using a low-loss, 50-ohm nominal coaxial cable jumper assembly. These are commercially available from a variety of sources. The exact characteristics of an extension cable are difficult to define, however minimizing signal loss is critical. Testing the Model 5402 for proper GNSS reception with the antenna and proposed cable extender in place is really the only certain way of ensuring acceptable operation.

The Model 5402 can support the use of other multi-band GNSS antennas. Studio Technologies has tested several other antennas and they performed very well. Refer to the Technical Notes section for details.

Sync Input

An external synchronization source can be connected to the Model 5402's sync input BNC jack. Located on the back panel, this input allows the Model 5402's internal timing to be "locked" to an external reference. In most cases, utilizing the sync input won't be necessary as the unit's GNSS receiver will typically provide an equal or better timing reference.

Signals that are compatible with the Model 5402's sync input include word clock, bi-level video, tri-level video, and 10 MHz sine wave. A configuration setting in the Sync Input webpage defines what type of signal is going to be connected. Another setting defines if a termination impedance is applied to the sync input. Refer to the Specifications section for the general characteristics required of acceptable external sync signals.

A connected word clock signal must be a square wave with a rate that matches the Dante sample rate as defined in the Dante Controller application. The rate can be 44.1, 48, 88.2, 96, 176.4, or 192 kHz. If termination has been enabled for the sync input when it has been configured for word clock an impedance of 75 ohms will be applied.

A source of bi-level or tri-level video can also be connected to the sync input. Circuitry within the Model 5402 will decode many of the common video rates and formats, allowing them to serve as a timing reference. Refer to Appendix A for a list of compatible rates and formats. If the sync input is configured for video and termination has been enabled an impedance of 75 ohms will be applied.

A source of 10 MHz sine wave can be connected to the Model 5402's sync input. This type of signal is commonly used as a timing reference in industrial and instrumentation applications. An impedance of 50 ohms will be applied to the sync input if termination has been enabled and the source is selected for 10 MHz.

Word Clock Output

A word clock output signal is provided for use by other devices that want to be "timed" from the Model 5402. Available by way of a BNC jack located on the back panel, the square wave output has a frequency that matches the unit's configured Dante sample rate. Choices are 44.1, 48, 88.2, 96, 176.4, and 192 kHz. The exact frequency of the word clock output is based on the timing reference that has been selected for the Model 5402. If, for example, GNSS was selected as the unit's timing reference, then the word clock output would be "locked" to it.

The source impedance of the word clock signal is 75 ohms and its unterminated output level is 5 volts peak-to-peak (Vpp). When externally terminated with a 75 ohm load the word clock output level will drop to 2.5 Vpp.

Ethernet Connections

The Model 5402 provides three Gigabit Ethernet (GigE) ports for flexibility and compatibility with many networking implementations. Two ports are provided for interconnections with one or two local area networks (LANs) associated with Dante audio-over-IP networking schemes. They are labeled as PRI (primary) and SEC (secondary). The third Ethernet port, labeled MGMT, can be used to access the Model 5402 management resources. An internal web server function supports the Model 5402's management port's webpages. These webpages are used for configuration, monitoring, and maintenance of Model 5402 operation. Refer to Figure 3 for an overview of the Model 5402's three Ethernet ports and how they can operate.

Using the Dante Controller application, the three Ethernet ports can be configured to operate in one of four modes: Switched, Redundant, Switched+Mgmt, or Redundant+Mgmt. If configured for either the Switched or Redundant mode the management webpages are accessed by way of the management Ethernet port. When configured for the Switched+Mgmt mode the management webpages are accessed by way of either the primary or secondary Ethernet port. When configured for the Redundant+Mgmt mode the management webpages are accessed using an Ethernet connection made to the primary Ethernet port.

Dante Controller Network Switch Configuration	Model 5402 Ethernet Port		
	Pri	**Sec**	**Mgmt**
Switched	Dante		Management
Redundant	Dante Primary	Dante Secondary	Management
Switched+Mgmt	Dante and Management		Disabled
Redundant+Mgmt	Dante Primary and Management	Dante Secondary	Disabled

Figure 3. Model 5402 Ethernet Port Configuration and Operation

By providing three Ethernet ports and four configuration modes, the Model 5402 allows support for virtually all facilities, including those that utilize separate networks for Dante audio transport and equipment management. In this way, "production" networks that support transport of audio signals by way of a single LAN (Switched mode) or two LANs (Redundant mode) can be separate from an engineering network that is used by technical personnel for configuring and maintaining a facility or "plant."

Connections to the three Ethernet interfaces are made by way of standard RJ45 jacks that are located on the back of the Model 5402's enclosure. The Ethernet interfaces support auto MDI/MDI-X so that crossover cables are not required. Refer to Appendix B for examples of how the Model 5402's three Ethernet interfaces might be utilized. It's difficult to conceive of a network environment that the unit wouldn't be able to effectively support.

Dante Port Connections

At least one 1000BASE-T (GigE) Ethernet connection is required for Model 5402 Dante operation. It should be connected to the primary RJ45 jack. A second 1000BASE-T (GigE) connection can be made to the secondary RJ45 jack if Redundant Dante is desired. For this functionality to be active the Model 5402's network configuration must be set for the Redundant or Redundant+Mgmt mode within the Dante Controller software application. While technically 100BASE-TX (100 Mb/s) Ethernet can also be used for these Dante connections, it is not optimal. Additionally, it's important to note that 10BASE-T (10 Mb/s) Ethernet connections are not sufficient.

When configured in Dante Controller for the Switched or Switched+Mgmt modes the Model 5402's Dante secondary Ethernet connection can also be used as a "loop through" port such as would be provided by an Ethernet switch. Using the Dante secondary port in this manner for applications other than troubleshooting or "looping" to access the Model 5402's management port is not recommended. It will function reliably but "daisy chaining" Ethernet signals can limit flexibility and present a failure point; it's optimal if each Dante Ethernet interface connects directly to a separate port on an Ethernet switch.

Management Port Connection

If required by the needs of an application, the management webpages can be accessed using an Ethernet signal connected to the Model 5402's management Ethernet port. This requires that the network mode in Dante Controller be configured for Switched or Redundant. It's recommended that a 1000BASE-T (GigE) connection be made but a 100BASE-TX (100 Mb/s) connection is sufficient. (GigE will provide the best performance and it's assumed that all contemporary applications will support it.)

Access to the Model 5402's management webpages can also be obtained using the same network connection or connections that are being used for Dante audio. This requires that the network mode in Dante Controller be configured for Switched+Mgmt or Redundant+Mgmt. Appendix B provides example of how these network scenarios can easily be implemented.

Connecting Power

The Model 5402 requires a source of AC mains or nominal 12 volts DC for operation. Either source can be connected with the same result. Both can also be simultaneously connected if a redundant (backup) power scheme is desired.

Connecting AC Mains Power

The Model 5402 can operate directly from AC mains power of 100 to 240 volts, 50/60 Hz, 5 watts maximum. As a "universal mains input" device there are no

switches to set or jumpers to install. A 3-pin IEC 320 C14 inlet connector on the back panel mates with a detachable mains cord set.

All units are supplied from the factory with an AC mains cord that has a North-American (NEMA 5-15L) standard plug on one end and an IEC 320 C13 connector on the other end. Units intended for use in other destinations require that an appropriate mains cord be obtained. The wire colors in the mains cord should conform to the internationally recognized color code and be terminated accordingly:

Connection	Wire Color
Neutral (N)	Light Blue
Line (L)	Brown
Earth/Ground (E)	Green/Yellow

Because the Model 5402 does not contain a power on/off switch it will begin operation as soon as AC mains power is connected.

> **Safety Warning:** The Model 5402 does not contain an AC mains disconnect switch. As such, the AC mains cord plug serves as the disconnection device. Safety considerations require that the plug and associated inlet be easily accessible to allow rapid disconnection of AC mains power should it prove necessary.

Connecting DC Power

The Model 5402 can also operate from a source of 10 to 18 volts DC. The current required from a 12 volts DC source is 0.5 ampere (500 milliamperes) maximum. A 4-pin male XLR connector, located on the unit's back panel, is used to connect the source of DC. Prepare a mating connector (female) so that pin 1 is DC– and pin 4 is DC+. Pins 2 and 3 are not used and should remain unconnected. This connector type and pinout have become a broadcast DC power standard and should be familiar to many technical personnel. Because the Model 5402 contains no power on/off switch it will begin operation as soon as a DC power source is connected.

As previously mentioned, both an AC mains source and a DC source can be connected at the same time. If this is the implementation then the AC mains source will always power the Model 5402 with the DC source serving as a "hot standby." Only if the AC source fails will the unit draw power from the DC source. This will occur automatically with no interruption of Model 5402 operation. In this "standby" mode (when an AC mains source is connected) the Model 5402 draws less than 110 microamperes (uA) from a 12 volts DC input.

Dante Configuration

For audio and timing to correctly pass from the Model 5402 requires that several Dante-related parameters be configured. These configuration settings are stored in non-volatile memory within the Model 5402's Dante network interface circuitry. Configuration will typically be done with the Dante Controller software application, available for download free of charge at audinate.com. Versions of Dante Controller are available to support several operating systems. Refer to Appendix C for a list of the Model 5402's Dante Controller default configuration.

The Model 5402's Dante interface is compatible with the Dante Domain Manager (DDM) software application. Refer to DDM documentation, also available from Audinate, for details on which Model 5402 and related parameters may have to be configured.

Audio Routing

The Model 5402's eight Dante transmitter (output) channels can be assigned to the desired Dante receiver (input) channels on associated equipment. This will route the eight channels associated with the tone generator function. Within Dante Controller a "subscription" is the term used for routing a transmitter flow (a group of up to four output channels) to a receiver flow (a group of up to four input channels).

The Model 5402 uses a Brooklyn module to implement its Dante functionality. The number of transmitter flows associated with this module is 32 and, as such, typically no flow limitation should occur. These flows can either be unicast, multicast, or a combination of the two. Note, however, that when RTP mode is enabled in Dante Controller for AES67 or ST 2110-30 support the Dante transmitter (output) channels will only function in multicast; unicast is not supported.

Unit and Channel Names

The Model 5402 has a default Dante device name of **ST-M5402-** along with a unique suffix. The suffix identifies the specific Model 5402 that is being configured. The suffix's actual alpha and/or numeric characters relate to the MAC address of the unit's Brooklyn

module. The eight Dante transmitter (output) channels associated with the tone outputs have default names of **Tone 1** through **Tone 8**. Using Dante Controller, the device and channel names can be revised as appropriate for a specific application.

Device Configuration

The Model 5402 supports audio sample rates of 44.1, 48, 88.2, 96, 176.4, and 192 kHz with no pull-up/down options available. The digital audio data is in the form of 24-bit pulse-code modulation (PCM 24) samples. Clocking- and latency-related parameters can be adjusted if required in Dante Controller but the default values are typically correct.

Network Configuration – Dante

As has been covered previously, the Model 5402 allows connection of one, two, or three Ethernet signals using standard RJ45 jacks which are located on the back panel. In many applications two of the jacks will be used for Dante audio and the third for connecting to a network designated for device management purposes. It's also possible to access the Model 5402's management webpages using the Dante Ethernet ports. The Model 5402's Dante ports are labeled PRI and SEC indicating that they are typically used for the primary and secondary connections. The third Ethernet port is labeled MGMT, indicating that it is intended for use accessing the management webpages. How these three Ethernet ports function can be selected in the Network Config – Switch Configuration section of Dante Controller. The choices are *Switched*, *Redundant*, *Switched+Mgmt*, and *Redundant+Mgmt*.

If *Switched* is selected then the Model 5402 can establish one Dante audio connection with an Ethernet network. It doesn't matter which RJ45 jack is utilized, although for clarity this would typically be the primary jack. The secondary RJ45 jack can be used to interconnect with another piece of networked equipment. The management Ethernet port will be used to access the management webpages.

If the Model 5402's Dante network is configured for *Switched* ensure that only one of the two Dante RJ45 jacks on the back panel is connected to the LAN associated with the Dante network. If both of the Model 5402's Dante RJ45 jacks are routed to ports on the same LAN this will typically "crash" the network! (Although some of the latest/most-advanced Ethernet

switches will automatically detect and prevent such a "network bridging" issue from occurring.)

If *Switched+Mgmt* is selected the same issues as discussed in the previous two paragraphs would again apply. The only difference is that the management webpages would be accessed using the same Dante Ethernet port that is being used to access the Dante network. The management Ethernet port will be disabled.

If *Redundant* is selected then Dante's Redundant networking capability will be enabled. In this case, separate Ethernet LAN connections should be made to the Dante primary and Dante secondary RJ45 jacks. Again, the Model 5402's separate management Ethernet port will be used to access the management webpages.

If *Redundant+Mgmt* is selected in Dante Controller then the network connection made to the Dante primary Ethernet port will also be used to access the management web-pages. The Model 5402's separate management port will be disabled.

IP Addresses

When a Model 5402 has been configured for either the Switched or Switched+Mgmt network mode a single Dante IP address will be associated with the network connection that is made to either the Dante primary or the Dante secondary RJ45 jack. If the network configuration has been selected for Redundant or Redundant+Mgmt then separate IP addresses and related network parameters will be assigned to the Dante primary and Dante secondary Ethernet ports. No matter what network mode has been selected the Model 5402 will always have a separate management IP address.

Typically, the Model 5402's Dante IP address or addresses and related network parameters will be determined automatically using DHCP or, if that's not available, the link-local network protocol. If desired, the Dante Controller application does allow Dante IP addresses and related network parameters to be manually set to a fixed (static) configuration. While this is a more-involved process than simply letting DHCP or link-local "do their thing," if fixed addressing is necessary then this capability is available.

Note that if the Model 5402's network configuration has been set for Redundant or Redundant+Mgmt then the Dante primary and Dante secondary IP addresses and related parameters can be independently configured. This allows both Dante interfaces to be configured automatically, both interfaces to be configured manually, or one interface to be configured automatically and the other to be configured manually.

By default, the Model 5402's management IP address and related network parameters will be determined automatically using DHCP or link-local. A configuration option, accessible using the front-panel display and associated buttons or the management webpages, allows manual control of the management IP address, subnet mask, and gateway address values.

AES67 and ST 2110-30 Configuration – RTP Mode

Dante Controller allows a Model 5402 to be configured for AES67 or ST 2110-30 operation. This requires the RTP mode be configured for AES67 or ST 2110-30. As previously noted, if either AES67 or ST 2110-30 mode is enabled then PTPv2 will be utilized and the Dante transmitter (output) channels will use multicast. The sample rate will be selectable for 48 or 96 kHz.

Preferred Clock Source

By the very nature of its intended application, the Model 5402 will normally serve as the Leader Clock for all Dante-enabled devices. The unit has the ability to communicate with the Dante network, selecting itself as the Preferred Leader and causing the Enabled Sync to External function to be enabled. The status of these two parameters can be observed using the Clock Status function in Dante Controller.

Settings accessible using the Model 5402's management webpages allow extensive changes to the clock configuration. These are provided for use when troubleshooting or addressing special applications. In most cases, the Model 5402's default settings would be appropriate and should be utilized.

Model 5402 Configuration

Many Model 5402 Dante Leader Clock operating parameters can be configured using the management system's webpages that are provided by way of one of the unit's Ethernet ports. The specific port utilized for management will depend on the network configuration that is selected using the Dante Controller application. A standard web browser is all that is required to utilize the menu webpages.

Several key network configuration parameters can also be viewed and revised using the Model 5402's front-panel graphics display and associated push-button switches. Refer to Appendix D for details on which parameters can be revised in this manner. STcontroller can also be utilized to directly access the management webpages.

Management IP Address

It's easy to identify the Model 5402's management IP address by way of the front-panel display. If the screen saver function is active, as it will be in most situations, one of the six pages that will automatically show will have the current management IP address. As such, a user can simply observe the sequencing menu pages and watch for the one that shows the current management IP address. If it's desired that the current management IP address be continuously shown then the Enter pushbutton switch on the front panel should be pressed. This will stop the screen saver function and cause the current management IP address to show. It will also allow the various menu pages to be accessed using the up, down, left, and right pushbutton switches. Simultaneously pressing the left and right arrow buttons will cause the screen saver mode to begin again. The screen saver mode will also automatically start two minutes after the last press of any of the front-panel pushbutton switches.
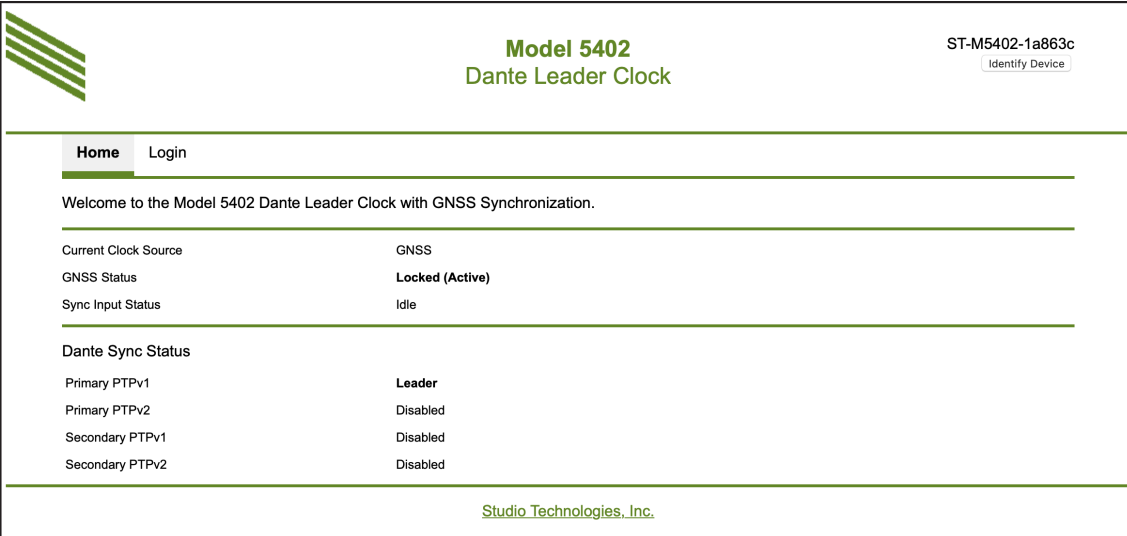
How the management Ethernet port obtains its IP address will depend on the management interface configuration setting. The default method is automatic so the Model 5402's management port will first try to obtain an IP address using DHCP. If that is not successful an IP address will be assigned using the link-local protocol. An address of 169.254.x.x will indicate that an IPv4 address was established using link-local. The Model 5402 may also have been configured to use a manual (fixed or static) IP address. The front-panel display and associated pushbuttons, or the Model 5402's management webpages, can be used to review and/or make changes to the management IP address and related parameters.

Accessing the Management Webpages

To access the Model 5402's home webpage, type the unit's management IP address into a browser's search bar. (It's possible that some browsers may require including the text *http://* followed by the IP address.) Alternately, the STcontroller software application can lead a user directly to the management webpages. This is described in detail in later sections. Of course, the computer associated with the browser must be on the same LAN and subnet as the Model 5402.

Home Menu

Once the Model 5402 menu system has been accessed the Home webpage will appear. It provides seven display-only fields along with a link to the Login menu webpage. The fields are similar to those provided in the Main menu configuration webpage. The current clock source field will show which timing source is actively being utilized by the Model 5402. The GNSS status field will indicate the current condition of the Model 5402's GNSS (satellite) receiver. The Sync Input status field shows the current operating condition of the sync input whose BNC jack is located on the unit's back panel. The four Dante sync status fields will show the role that the Model 5402 is actively playing as PTPv1 and PTPv2 timing resources for the devices connected to the associated network or networks. Details about these fields are provided in the Main menu paragraphs found later in this section.
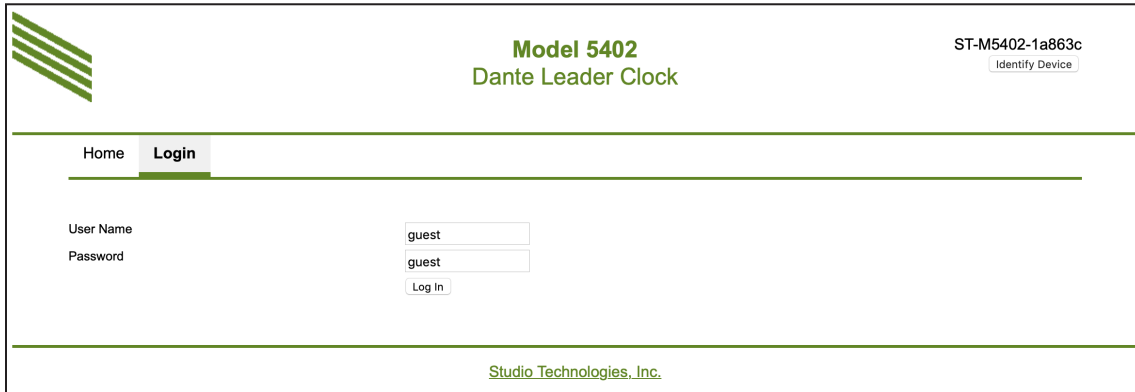
Login Menu

From the Home webpage click on the Login tab to access the Login menu webpage. Entry of a valid user name and password is required to access the additional configuration menus. The Model 5402 doesn't incorporate a sophisticated security implementation. The user name and password, as well as the underlying software, is intended to keep "honest" people from making unauthorized changes to the configuration of the Model 5402. It is not intended as a rigorous security system.

Should the applicable user name and/or password be misplaced, refer to the Technical Notes section and/or Appendix G for a recovery method.

User Name: Enter the Model 5402's user name into this field. It is case sensitive. The default user name is **guest**. If both the default user name and the default password are active then the user name will be shown in this field.

Password: Enter the Model 5402's password into this field. It is case sensitive. The default password is **guest**. If both the default user name and the default password are active then the password will be shown in this field.

Log In Button: Click on the Log In button to submit the entered user name and password. If the correct entries have been made the Main menu webpage will be shown. If an incorrect user name and/or password is entered then a login failed message will be shown.

Main Menu

Once the correct user name and password have been submitted the Main menu webpage will be shown. This menu provides the ability to select three important operating parameters as well as showing eight key real-time conditions. In addition, the menu system allows direct access to other menu webpages.

Main Clock Source: This is a configurable field with four choices: *Internal*, *GNSS*, *Sync Input*, and *Dante*.

This setting determines which source will be the main (normal) timing source that is used by the Model 5402's circuitry as its own "Leader" timing reference. This is the clock source that will be used by the Model 5402's PTPv1 and PTPv2 servers that are critical to the Model 5402's support of related Dante devices. When *Internal* is selected the Model 5402's temperature-stabilized, high-performance crystal oscillator is utilized. This will provide excellent timing accuracy and consistent long-term performance. This source is far superior to that provided by other standard Dante devices. This is the correct choice if GNSS is not going to be utilized or a high-quality external reference signal is not going to be connected to the sync input.

When *GNSS* is selected the timing reference that is derived from the selected satellite constellation or constellations will be used. This would be, assuming that a solid GNSS "lock" can be established, the most

accurate and consistent timing source. It's expected that GNSS will be selected in most Model 5402 applications.

When *Sync Input* is selected the Model 5402's sync input function will be utilized. Using a BNC jack, located on the Model 5402's back panel, an external source of word clock, video reference, or 10 MHz sine wave can be connected. Circuitry within the Model 5402 will "lock" (synchronize) the internal timing signals to the externally provided reference signal.

Selecting *Dante* will instruct the Model 5402 to use the clock signal provided by its Dante interface circuitry as its reference timing source. The Dante interface circuitry will either use its internal crystal oscillator or synchronize to another Dante device on the associated network. The actual clock source used by the Model 5402's Dante interface will depend on a setting in the Dante Controller application.

The Model 5402 includes the choice of Dante as the main clock source only for trouble-shooting or other factory-directed activities. It's not expected that this

selection will ever be used during normal Model 5402 operation. By selecting *Dante* the excellent timing performance that can be provided by the GNSS receiver, the sync input, or the internal oscillator would not be utilized.

Failover Clock Source: This is a configurable field with two choices: *Internal* and *Dante*.

This configuration choice selects which timing source will be used should the Model 5402's selected main clock source become unavailable. Specifically, the failover source will be used if a GNSS lock can't be obtained or a valid sync source is not connected to the sync input. If *Internal* is selected then the unit's crystal oscillator will be utilized as the Leader clock source should a valid GNSS or sync input signal not be available. If *Dante* is selected then the failover source will be the timing signal derived from the Model 5402's Dante interface.

From a performance standpoint it's preferable to select *Internal*. This ensures that the best clock performance can be obtained should the failover condition be active. However, selecting *Dante* would allow an interesting, albeit obscure, alerting feature to become active. In the Dante Controller application, a device such as the Model 5402 that has been selected as the Preferred Leader with an external source allowed will have an error condition occur if the Model 5402's Dante interface doesn't detect an external reference being applied. Losing the external reference is what the Model 5402's circuitry will do should failover be activated and *Dante* selected as the failover source. In this way, a Dante network user could be alerted to a clocking issue should the Model 5402 lose its important GNSS or external sync input source.

However, having an error condition reported in the Dante Controller application is probably not terribly important. The Dante SYNC LED, located on the Model 5402's front panel, will also offer a clear indication of a loss of a valid GNSS or external sync input signal. This LED will typically slowly flash green when the Model 5402 is functioning correctly as the Leader clock for the Dante network. However, should the unit be configured to use GNSS or an external sync input signal and a valid one is not present, the SYNC LED will flash orange to indicate this loss of lock and that the failover source is in use. In addition, the display will provide a text indication of this condition.

Force Preferred Leader: This is a configurable field with two choices: *Disabled* and *Enabled*.

This function impacts how the Model 5402 will control a Dante network's selection of which device is going to serve as the Leader clock. As the main reason for the Model 5402's existence is to serve as a Leader clock, in most applications the unit should be serving in that role. By forcing the Model 5402 to be a Preferred Leader clock it helps to ensure optimal Dante network operation. By enabling this configuration, users of the Dante Controller application will not be able to accidentally disable the Model 5402 as a Preferred Leader. One can observe exactly what is meant by the term Force Preferred Leader by unchecking the Model 5402's Preferred Leader check box in Dante Controller. After a short interval the box will automatically return to the enabled (checked) state.

How the Model 5402 handles forcing the Dante network to be a Preferred Leader clock and, if applicable, automatically supporting an external clock input is not trivial. This ability to control Dante network operation is part of the unit's "secret sauce." If the Model 5402's clock source is configured for Dante then the Model 5402 will force off (uncheck) the Enable Sync to External selection in Dante Controller. If the Model 5402's main clock source is configured for Internal, GNSS, or Sync Input then the Model 5402 will force on (check) the Enable Sync to External configuration in Dante Controller. This will apply as long as this specific Model 5402 is acting as Leader.

Submit: A Submit button is located below the Force Preferred Leader field. For any changes made to the three configurable fields on the Main menu webpage to be saved and acted upon the Submit button must be pressed.

Current Clock Source: This is a display-only field with choices of *Internal*, *Internal (Failover Active)*, *GNSS*, *Sync Input*, *Dante*, and *Dante (Failover Active)*.

The text *Failover Active* will be shown in red as a warning of an abnormal condition that warrants intervention. The current clock source field can also show --- which indicates a major hardware error and would warrant contacting the factory.

When *Internal* is shown it indicates that the Model 5402's internal temperature-stabilized oscillator is being used as its timing reference. When *Internal (Failover Active)* is shown an abnormal condition is occurring. In this case, the Model 5402 has been configured to use either GNSS or external sync signal as the main clock source but a valid one is not available; it is using its internal temperature-stabilized oscillator as the failover timing reference. If *GNSS* is shown then the Model 5402 is using a timing signal derived from the selected satellite constellation(s). If *Sync Input* is shown this indicates that an external timing reference signal is connected to the sync input BNC jack on the Model 5402's back panel and it is being used as the main clock source. If *Dante* is shown this indicates that the Model 5402 is using a timing reference derived from its Dante network interface. This is not an invalid condition but would typically only occur in a troubleshooting situation. If *Dante (Failover Active)* is shown an abnormal condition is occurring. In this case, the Model 5402 is using a timing reference derived from its Dante network interface. However, this is only occurring because the configured main clock source is not currently available.

GNSS Status: This display-only field will show *Locked (Active)*, *Locked (Standby)*, *Locking*, *Unlocked*, *Antenna Disconnected*, *Antenna Error*, and *Idle*. If *Locked (Active)* is shown this indicates that the GNSS receiver is "locked" to one or more satellites and the GNSS receiver is supplying the unit's timing reference. If *Locked (Standby)* is shown this indicates that the GNSS receiver is "locked," that the GNSS receiver is capable of serving as the unit's timing reference, but that it is not currently serving as the unit's main clock source. *Locking* means that the GNSS receiver is in the process of locking (or attempting to lock) to one or more of the possible satellite constellations. *Unlocked* means that the GNSS is not currently locked to a satellite constellation.

Antenna Disconnected would indicate that a GNSS antenna is not currently connected. The Model 5402 detects this by the absence of DC current being supplied by the circuitry associated with the GNSS antenna SMA jack. *Antenna Error* would typically indicate that too much DC current is being supplied by the circuitry associated with the GNSS antenna SMA jack. This could be indicative of a short circuit in the antenna's SMA plug or interconnecting cable. Idle would indicate that the GNSS receiver is not selected to be the main or failover clock source and is not currently locked to a satellite.

Sync Input Status: This is a display-only field with choices of *Locked (Active)*, *Locked (Standby)*, *Unlocked*, and *Idle*. As a warning of an abnormal condition the text *Unlocked* will be shown in red.

If *Locked (Active)* is shown this indicates that a valid signal is connected to the Model 5402's sync input and is serving as the unit's timing reference. If *Locked (Standby)* is shown this indicates that a valid signal is connected to the Model 5402's sync input and while it is capable of serving as the unit's main timing reference it is not currently serving as the main clock source.

If *Unlocked* is shown it can be the result of several conditions. It can be shown if a signal is connected to the Model 5402's sync input but is not being recognized as a valid timing reference. This can occur for multiple reasons. The most common would be due to a configuration mismatch, such as if a video reference is connected while the Model 5402's sync input is configured to support a word clock source. It might also indicate that a non-supported word clock rate or an incompatible video reference is connected. *Unlocked* could also be shown if no signal is connected to the sync input or if a connected signal is incorrectly terminated, e.g., no termination applied when one is required or if two terminations ("a double termination") were present.

Idle will be shown if the sync input has not been selected as the Model 5402's main clock source and a valid source has not been connected to the sync input. It simply indicates that the sync input circuitry is not actively receiving an external signal.

Primary Leader Clock: A display-only field will show the MAC (media access control) address of the Dante network's currently active Primary Leader Clock. Shown to the right of the MAC address will be an additional piece of information about what specific device is associated with the shown MAC address. If the MAC address is associated with this specific Model 5402 then the text will show *(This Device)*. If the MAC address is not for this specific Model 5402 the text will show *(Other Device)*.

A logical question to ask would be "so what is this Other Device?" Unfortunately, the Model 5402's firmware does not have the ability to know more about a specific Primary Leader Clock other than its MAC address. It can only determine if the MAC address matches this specific Model 5402 or not. If the address doesn't match then another device has to be serving as the Primary Leader. The Dante Controller may provide more detailed information about a Dante network's clocking. And network software or hardware tools may allow a MAC address to be associated with a specific device.

Note that the information provided in this field can be a bit confusing, even to the writer of this guide. But for a network maven it can be very useful when troubleshooting a complex network timing issue. Reviewing several related issues to Primary Leader Clock can be valuable. First of all, it's important to note that the reference to the word primary in "Primary Leader Clock" has nothing to do with the primary and secondary Ethernet interfaces! In this context Primary Leader Clock refers to the device that all other devices in a Dante network will follow.

In most cases, a Model 5402 will serve as the Primary Leader Clock. But there is no requirement that it must play this role. For example, a Model 5402 can serve as a Leader Clock while following the timing provided by another device that's serving as the Primary Leader Clock. For another example, one Model 5402 could serve as the Primary Leader Clock while several other Model 5402 units serve as PTP boundary clocks. These boundary clocks would, by way of a unicast PTP message, synchronize with the Primary Leader Clock. The boundary clocks could then provide PTPv1 and PTPv2 functionality (using multicast) with timing based on that derived from the Primary Leader Clock. This method may be used to provide Dante device timing across different subnets for complex or especially large applications. For more in-depth control of these clocking issues the Dante Domain Manager (DDM) software application can be very useful.

Dante Sync Status: The Model 5402 can simultaneously serve as a Leader clock for both Dante primary and Dante secondary networks and is capable of supporting both PTPv1 (IEEE 1588-2002) and PTPv2 (IEEE 1588-2008). As such, the unit is capable of acting as four independent Leader clocks: PTPv1 for Dante primary, PTPv2 for Dante primary, PTPv1 for

Dante secondary, and PTPv2 for Dante secondary. While the PTP processes are asymmetrical, they do share the same internal timing reference. The Model 5402 can also act as a PTPv1 and PTPv2 clock follower but that would typically be utilized only for test purposes. Standard and Redundant Dante (no AES67 or ST 2110-30 support) uses PTPv1 and that is always enabled in the Model 5402. AES67 and ST 2110-30 utilize PTPv2 clocking; if support for them is desired within the Dante environment an RTP mode must be enabled in the Dante Controller application.

The Model 5402's Main menu has four fields that show the real-time sync status of the PTPv1 and PTPv2 functions for the Dante primary and Dante secondary interfaces. If the network configuration in Dante Controller for this specific Model 5402 has been selected for Switched or Switched+Mgmt the clocking status of the Dante primary interface will be shown. In this situation, the Dante primary PTPv1 interface will show *Leader*, *Follower*, *Link Down*, or *Error* (with the latter showing in red text). If AES67 or ST 2110-30 support is enabled in Dante Controller then the same choices will also be shown in the primary PTPv2 field. If AES67 or ST 2110-30 support is not enabled then *Disabled* will show in the primary PTPv2 field. Since Dante secondary is not enabled then the secondary PTPv1 and secondary PTPv2 fields will show *Disabled*.

If the Model 5402's network configuration has been selected for Redundant or Redundant+Mgmt then both the primary PTPv1 and secondary PTPv1 sync status fields will be shown their respective sync status. They will show the same choices as described above: *Leader*, *Follower*, *Link Down,* or *Error* (with the latter showing in red text). If AES67 or ST 2110-30 support is enabled in Dante Controller then the same choices will also be shown in the primary PTPv2 and secondary PTPv2 fields. If AES67or ST 2110-30 support is not enabled then Disabled will show in both the primary PTPv2 and secondary PTPv2 fields.

Should *Leader* be shown in a specific field it would indicates that this specific Model 5402 is acting as the Leader clock for the Dante network and clock function associated with that field. If *Follower* is shown this indicates that this specific Model 5402 is obtaining its timing reference from another Dante device on the network. This would be shown if this specific Model 5402 was serving as a "hot" standby Dante Leader clock.

If *Link Down* is shown this will indicate that a valid Ethernet connection has not been made to the RJ45 jack associated with that field's Model 5402's Ethernet interface. The text *Error* shown would indicate that this specific Model 5402 is having a permanent or temporary issue with its internal circuitry. There may be occasions where the text *Error* would show for a few seconds while Model 5402 circuitry first becomes active.

GNSS Menu

The GNSS menu has a number of parameters that all relate to the Model 5402's GNSS receiver function. The first seven fields are display-only and show various conditions that are reported by the GNSS receiver. The last five parameters are used to configure which satellite constellations will be utilized by the GNSS receiver.

Lock Status: This display-only field will show *Locked*, *Locking*, or *Unlocked*. *Locked* means that the GNSS receiver is actively receiving a timing signal from one or more of the possible satellite constellations. *Locking* means that the GNSS receiver is in the process of locking (or attempting to lock) to one or more of the possible satellite constellations. *Unlocked* means that the GNSS is not locked to a satellite constellation. *Error* would indicate a problem with the Model 5402's circuitry being able to communicate with the GNSS receiver circuitry.

Antenna Status: This display-only field will show *Connected*, *Disconnected*, or *Error*. Connected indicates that DC current in the acceptable range is being drawn from the antenna input. No DC current is being drawn from the antenna input when Disconnected is shown. The text *Error* would be shown if too much DC current is being drawn from the antenna input. This would typically indicate a short circuit associated with the SMA plug and cable that is used to link the Model 5402 with the antenna.

Number of Satellites: This field shows the number satellites that the Model 5402's GNSS receiver is currently actively receiving. In theory only one satellite is required for the Model 5402 to be able to establish an accurate timing reference. But clearly a higher number is better as it gives the GNSS receiver more timing reference choices. The greater the number of supported constellations will also increase the possible number of satellites that can be received. In addition, the performance of the connected antenna will have a direct bearing on the number of satellites that the receiver is "tracking." This would not just be related to the capabilities of the antenna itself, but also its location, its "view" of the sky, and the length and type of interconnecting cable.

Signal Strength: This display-only field shows the energy that the Model 5402's GNSS receiver input section is receiving from the antenna. The larger the number the better the receiver is able to "lock" to satellites. This number will typically only be useful when troubleshooting a Model 5402 issue with the factory.

Longitude: This field shows the Model 5402's longitude, in degrees, as is calculated by the unit's GNSS receiver.

Latitude: This field shows the Model 5402's latitude, in degrees, as is calculated by the unit's GNSS receiver.

Time to First Fix: This field shows the time, in seconds, that the Model 5402's GNSS receiver required to establish a longitude and latitude position (a "fix") upon first receiving power or experiencing a reboot (restart). This parameter is provided for troubleshooting and general-interest purposes.

World Map and Location: A small world map graphic will also show on the GNSS menu webpage. A location dot, corresponding to the Model 5402's longitude and latitude, will provide a visual indication of the unit's position on the planet.

Supported Constellations: The Model 5402's GNSS receiver is able to support the planet earth's main satellite timing constellations. These include GPS (USA), Galileo (European Union), and BeiDou (China). By default, all the check boxes are enabled which directs the Model 5402 to use all of the constellations. This will provide the largest number of possible satellites that the GNSS receiver can utilize. This will maximize the chance that the receiver will always reliably "lock" to one or more satellites. However, unchecking one or more of the boxes will allow selection of the constellations that are desired for a specific application. There is no problem selecting even just one constellation as this will still typically allow adequate performance. Also, if a multi-band antenna is not available the constellation or constellations that match the antenna's capabilities can, and should, be selected.

QZSS Augmentation (Japan): QZSS is an abbreviation for the Quasi-Zenith Satellite System which was created to improve GNSS performance in the Asia-Oceania region, specifically Japan. It consists of a small set of satellites that serve to augment the precision that can be obtained from the GPS constellation. It can be enabled as desired for an application.

Date and Time Display: In the upper-right corner of the GNSS menu page is a line that will show "Last Updated" along with the date and time if the menu page was loaded when the GNSS sync status was locked. It will show the date in a DD-MMM-YYYY format and the time in UTC (Universal Coordinated Time). The Reload button can be used at any time to update the date and time information, along with the status of the twelve other parameters that are shown on this webpage.

Sync Input Menu

The Sync Input menu has parameters that are related to the Model 5402's sync input. This allows an external source of timing to be connected to the Model 5402 by way of a BNC jack that is located on the unit's back panel.

Lock Status: This is a display-only field that can show *Unlocked*, *Locked* followed by one of the word clock rates, *Locked* followed by one of the video rates, or *Locked (10 MHz)*. It's also possible that it could show *Error* which would indicate a Model 5402 hardware problem. This would be a rare occurrence and, in this case, contacting the factory would be recommended.

This field reflects the operation of the Model 5402's sync input circuitry. *Unlocked* will show if no signal source is connected or if the connected source doesn't match the selected sync input type. For example, *Unlocked* will show if Word Clock has been selected as the sync input type but a video sync signal has been connected. The detected rate will be shown following the term *Locked* whenever the sync input is locked to the connected signal. If this is a word clock signal then one of the six compatible rates will be shown: 44.1, 48, 88.2, 96, 176.4, or 192 kHz. If *Locked* is shown due to a video source being connected then the actual rate/format characteristics will also be shown. If the sync input is locked due to a 10 MHz signal being recognized then *Locked (10 MHz)* will show. The compatible sync input sources are listed in Appendix A.

Unlocked will be shown, in red text, if the sync input has been selected on the Main menu as the Model 5402's clock source but either no signal is connected to the sync input or a non-compatible signal is connected. A non-compatible signal would include a sync input type being selected for Word Clock and then a word clock signal at a different rate than the current

Dante sample rate is connected. For example, an incompatible situation would be where the current Dante sample rate is 48 kHz but the connected word clock signal is 96 kHz. Probably the most common non-compatible signal would be a situation where a video reference signal is connected to the sync input but the sync input type was left at the default (Word Clock) rather than being selected for Video.

Current Dante Sample Rate: This is a display-only field that can show 44.1 kHz, 48 kHz, 88.2 kHz, 96 kHz, 176.4 kHz, or 192 kHz. It can also show Error in the unlikely event that there is an issue with the Brooklyn module that provides the Model 5402's Dante interface.

This field shows the Model 5402's currently selected sample rate as used by the Model 5402's Dante transmitter (output) channels. The Dante transmitter (output) channels provide eight sine wave tones labeled **Tone 1** through **Tone 8**. Changes to the Dante sample rate are made using the Dante Controller software application.

Type: This is a configurable field with three choices: *Word Clock*, *Video*, and *10 MHz*.

If the Model 5402's clock source has been selected to Sync Input on the Main menu the type of connected source must be defined to match the application. If *Word Clock* is selected then a square wave source with a rate of 44.1, 48, 88.2, 96, 176.4, or 192 kHz needs to be connected. For proper operation, the

nominal unloaded level of the word clock source must be 5 volts DC peak-to-peak. Also, the connected word clock source must match the shown current Dante sample rate. This is a bit of a "chicken or the egg" situation since it can be confusing as to who is supposed to control the sample rate and who is supposed to follow the sample rate! The Dante Controller software application should be used to select the desired Model 5402 sample rate. This is the sample rate desired for the sine wave audio channels provided by the tone generator function. In most applications this will be 48 kHz. It's possible that in some audio-only applications 96 kHz or 192 kHz will be selected. Once the desired sample rate has been selected and/or confirmed, an external word clock source of the same rate should be connected. If the available external word clock source has a rate different than the current Dante sample rate then a review of the entire application must be performed and a common rate selected.

If *Video* is selected for the sync input type then a wide range of bi- and tri-level video reference signals can be connected to the sync input BNC jack. The Model 5402's circuitry will automatically decode many of the most common format/rate combinations. These include ubiquitous "black burst" signals as well as signals intended to support 4K video applications. Refer to Appendix A for a detailed list of compatible video sources.

If *10 MHz* is selected then the sync input is expecting connection of a sinusoidal source of 10 MHz. A signal of this type is typically associated with industrial or instrumentation applications. It may also be provided by a GPS (satellite) receiver.

If a choice of sync sources is available for a specific application it's recommended that a source of word clock be utilized. This is not because a word clock source is inherently better, but rather the recommendation is related to the Model 5402's circuit design. The unit's logic circuitry has to perform the least amount of processing with a word clock input signal as compared to that required to utilize a video reference or a 10 MHz signal. All compatible signals will work well but using a source of word clock requires the least logic "horsepower."

Termination: This is a configurable field with two choices: *Off* and *On*.

If desired, the Model 5402 can apply a terminating impedance to the sync input connection. The need for an input source to be terminated, or not, will depend on the source of the external sync signal. Typically, a source of sync should have one (and only one) termination applied. A timing reference source can generally be shared ("bused") to multiple devices with only the last connection on the "string" having an appropriate termination.

If the sync input termination is configured for *Off* then the sync input's impedance will be considered "high Z." If the sync input termination is selected to *On* and the sync input type is selected for Word Clock or Video the termination impedance will be 75 ohms. If *10 MHz* has been selected as the sync input type then a termination impedance of 50 ohms will be applied.

These termination values were selected to meet the technical requirements of industry-standard reference signals. Word clock should be a square wave with a source impedance of 75 ohms. Video is typically a complex analog signal with a source impedance of 75 ohms. And a 10 MHz reference is a normally a sine wave with a source impedance of 50 ohms.

Submit: A Submit button is located on the bottom of the Sync Input menu webpage. To save any changes made to fields on the Sync Input webpage requires that the Submit button be pressed. The Model 5402 will immediately incorporate operating changes as soon as the Submit button has been pressed.

Tone Generator Menu

The Model 5402's tone generator function is capable of creating eight precision sine wave tones with independent frequency and level configuration. The frequency range is 1 to 22000 hertz (Hz) and the level range is –99 to 0 dBFS.

The tone signals have Dante transmitter (output) default names of **Tone 1** through **Tone 8**. It's expected that most applications will only use a few of the tones. But having eight output channels provides flexibility in creating a set of tones with various frequency and level combinations. These can be useful in a range of applications including identifying individual channels in a multi-channel arrangement, e.g., stereo, 5.1, or 7.1.

Model 5402
Dante Leader Clock

ST-M5402-1a863c
Identify Device

| Main | GNSS | Sync Input | **Tone Generator** | Network | Access | System | | Log Out |

Channel	Frequency (Hz)	Level (dBFS)
Tone 1	100	-21
Tone 2	200	-22
Tone 3	300	-23
Tone 4	400	-24
Tone 5	500	-25
Tone 6	600	-26
Tone 7	700	-27
Tone 8	800	-28

Frequency range is 1 to 22000 Hz. Level range is -99 to 0 dBFS.   Submit

Studio Technologies, Inc.

Frequency (Hz): These eight fields reflect the Model 5402's currently selected sine wave tone generator frequencies. For each channel enter the desired frequency in full hertz. Don't use a suffix such as k or kHz, nor enter a comma or period to delineate thousands. Entering 1001 would be correct while 1,001 or 1.001 k would not be acceptable.

The default tone frequencies were selected in hundreds of hertz with the first digit matching the channel number: 100, 200, 300, etc. This can be useful when checking a series of channels as this pattern can be easily recognized either by ear or using equipment that can show the frequency in text. Some applications may need the common 1000 or 10000 Hz reference sine wave tones and there's no problem configuring these if desired.

Level (dBFS): These eight fields show the level of the Model 5402's sine wave tone outputs. The output level for each of the audio output channels is independently adjustable over a range of –99 to 0 dBFS. The level is selectable in 1-dBFS steps.

Enter the desired level in full dBFS with a hyphen as the prefix to indicate less than full scale. In applications that comply with the SMPTE® audio standards the typical nominal level will be –20 dBFS which can be thought of as 20 dB less than full scale or digital 0. In EBU applications the typical nominal level will be –18 dBFS. Some applications may benefit from a sine wave test tone that's 12 dB less than the reference level. This would equate to configuring an output to –34 dBFS (SMPTE) or –32 dBFS (EBU). These would typically be associated with a 1000 Hz tone.

The default tone levels were selected in a pattern that could help identify a specific channel. Dante transmitter (output) channel Tone 1 has a default level of –21 dBFS with the value of 1 being selected to reflect the channel number. Each subsequent channel then reduces its level by 1 dB. So, for example, the second

channel, Tone 2, has a level of –22 dBFS. While these level steps may not be readily discernible to human ears most test equipment or metering could easily be used to identify specific channels.

Submit: A Submit button is located at the bottom of the Level (dBFS) column on the Tone Generator menu webpage. To save any changes made to the level or frequency fields requires that the Submit button be pressed. Changes will be made immediately after pressing the Submit button.

Network Menu

Interfaces

There are twelve display-only fields that relate to the key parameters that are associated with the Dante and management interfaces. For clarity they are shown in the form of a simple table.

IP Addresses: These three display-only fields will show the current IP addresses associated with the Model 5402's Dante primary, Dante secondary, and management ports. The Dante primary and management fields will show either *Link Down* or an IP address. The Dante secondary field will show *Disabled*, *Link Down*, or an IP address. *Link Down* will show if an Ethernet connection has not been made to the appropriate RJ45 jack on the Model 5402's back panel. *Disabled* will show if Dante redundancy has not been enabled in the Dante Controller application. The 32-bit IP v4 addresses will be shown in what's known as dot-decimal notation (4 octets, each separated by a dot).

How the IP addresses are assigned will depend on the Model 5402's network configuration setting as performed using the Dante Controller application. Each IP address can be established automatically using a DHCP server or the IPv4 link-local protocol. An IP address assigned to the Dante primary interface by link-local will have a format of 169.254.x.x. An IP address assigned to the Dante secondary interface by link-local will have a format of 172.31.x.x. The Dante primary and secondary IP addresses can

also be individually set to a manual (static or fixed) IP addresses using the Dante Controller application.

If the network configuration is selected for switched the Dante primary IP address will be associated with a network connection made to either the Dante primary or Dante secondary RJ45 jack on the Model 5402's back panel. *Link down* will show if no connection is present. The IP address for the Dante secondary interface will show *Disabled* as it is not being utilized in this network mode. The management IP address will be associated with a network connection made to the management RJ45 jack on the Model 5402's back panel.

If the network configuration is selected for Redundant then the Dante primary IP address will be associated with the RJ45 jack labeled PRI on the Model 5402's back panel. *Link Down* will show if a valid Ethernet connection has not been made to the Dante primary Ethernet interface. The Dante secondary IP address will be associated with the RJ45 jack labeled SEC on the Model 5402's back panel. *Link Down* will show if a valid Ethernet connection has not been made with the Dante secondary Ethernet interface. The

management IP address with be associated with a network connection made to the RJ45 jack labeled MGMT on the Model 5402's back panel.

If the network configuration is selected in Dante Controller for Switched+Mgmt then the Dante primary IP address will be associated with a network connection made to either the Dante primary or the Dante secondary RJ45 jack on the Model 5402's back panel. The IP address field for the Dante secondary interface will show *Disabled* as it is not be utilized. The management IP address will be associated with a network connection made to either the Dante primary or Dante secondary connection.

If the network configuration is selected for Redundant+Mgmt then the Dante primary IP address will be associated with a connection made to the RJ45 jack labeled PRI on the Model 5402's back panel. *Link Down* will show if a valid Ethernet connection has not been made. The Dante secondary IP address will be associated with an Ethernet connection made to the RJ45 jack labeled SEC on the Model 5402's back panel. *Link Down* will show if a valid Ethernet connection has not been made with the Dante secondary Ethernet interface. The management IP address with be associated with a network connection made to the Dante primary RJ45 jack located on the Model 5402's back panel.

If the Model 5402's network configuration in Dante Controller is selected for Switched or Switched+Mgmt ensure that only one of the RJ45 jacks on the back panel is connected to the LAN associated with the Dante devices. The other RJ45 jack can be used to interconnect with another piece of networked equipment. But having both the Model 5402's Dante primary and Dante secondary RJ45 jack routed to ports on the same LAN will typically "crash" the network!

Subnet Mask: These three fields will show the subnet mask values associated with the Dante primary, Dante secondary, and management ports. They will show either *Link Down* or a subnet mask value. The subnet mask value will be shown in dot-decimal notation. When the IP address of the Dante primary or Dante secondary interfaces have been obtained using link-local the subnet mask value will always be 255.255.0.0.

Gateway Addresses: These three fields will show the gateway address associated with the Dante primary,

Dante secondary, and management ports. They will show either *Link Down*, ---, or a value in dot-decimal notation. A gateway address is usually obtained using DHCP or by way of a fixed (or static) stored value. When an IP address has been obtained using link-local then there will be no gateway address and --- will be shown. A Dante interface will typically only use a gateway address as a means of accessing an update server that's is located outside of the Dante network's LAN.

MAC Addresses: Three display-only fields will show the MAC (media access control) addresses associated with the network interface controller (NIC) devices used for the Dante primary, Dante secondary, and management ports. These are fixed hardware addresses assigned to Ethernet ports. Each is unique among all Ethernet ports and cannot be changed. The Model 5402 shows MAC addresses as six groups of two hexadecimal digits, separated by hyphens. No MAC address will be shown if an Ethernet interface has been disabled.

Switch Configuration: This is a display-only field that shows the Model 5402's network configuration as determined by a setting in the Dante Controller application. The term "Switch" refers to an Ethernet switching and routing integrated circuit that is part of the Model 5402's hardware. How this integrated circuit is configured determines the how the Model 5402's three GigE Ethernet ports function. The field will show Switched, Redundant, Switched+Mgmt, or Redundant+Mgmt. It will also show Error in the unlikely event that an error in the Dante interface circuit, provided by a Brooklyn module, has occurred.

Management Interface Configuration

There are four fields that relate to the Model 5402's management interface. They don't have any relation to the Dante primary and Dante secondary IP addresses and their associated network parameters.

IP Address Configuration: This is a configurable field with two choices: *Automatic* and *Manual*.

The selected configuration impacts how the Model 5402 obtains the IP address that is used for accessing the Model 5402's management web server and associated menu webpages. This setting has no impact on how the Model 5402 obtains IP addresses for the primary and secondary Dante IP interfaces.

Selecting the *Automatic* setting causes the Model 5402 to use the DHCP or, if DHCP is not available, the IPv4 link-local protocol to establish the IP address for the Model 5402's management port. When selected to use *Automatic*, upon establishing a connection to the configured Model 5402 RJ45 jack the DHCP protocol will request an IP address and related parameters. If obtaining an IP address in this manner is not successful then the IPv4 link-local protocol will be used. (If an IP address has the format of 169.254.x.x then it was assigned using IPv4 link-local.) Even if the IP address was established using link-local the DHCP protocol will remain active. In this case, approximately every 30 seconds the Model 5402's firmware will check for the presence of a DHCP server. If one becomes available then an IP address will be requested and, when obtained, will automatically replace the IP address that was previously established by link-local.

The *Manual* setting allows the desired IP address and related parameters to be manually entered. This can be useful when a fixed addressing scheme has been established. In this way, a static IP address can be entered along with the other important network parameters.

When selected for *Automatic* the fields for the manual IP address, subnet mask value, and gateway IP address will be "grayed out" (will have a gray background) to indicate that their values cannot be manually changed. In this condition they are display-only. Changing between *Automatic* and *Manual* and vice-versa will not impact the values stored in the manual IP address, manual subnet mask value, and manual gateway IP address fields.

Manual IP Address: This field shows the stored IP address associated with the management web server when the manual mode has been selected for the IP address configuration. This address has nothing to do with the IP address utilized by the primary and secondary Dante ports. When IP address configuration is selected for *Automatic* this field is grayed out and the value cannot be revised. Whenever the IP address configuration is selected for *Manual* the manual IP address can be modified as desired to meet the requirements of the application. After entering an IP address, using the standard dot-decimal notation, the Submit button at the bottom of the webpage must

be pressed for the changes to be stored. A system reboot is required for the revised manual IP address to be utilized. The Reboot function is available on the system webpage and the front panel.

Manual Subnet Mask: This field shows the stored subnet mask value associated with the management web server when the manual mode has been selected for the IP address configuration. When IP address configuration is selected for *Automatic* this field is grayed out and the value cannot be revised. When the IP address configuration is selected for *Manual* this field will not be grayed out and the value can be modified as desired to meet the requirements of the application. After entering a revised subnet mask value, using the standard dot-decimal notation format, the Submit button must be pressed for the change to be stored. A system reboot is required for the revised subnet mask value to be utilized.

Manual Gateway: This field shows the stored gateway value associated with the management web server when the manual mode has been selected for the IP address configuration. When IP address configuration is selected for *Automatic* the manual gateway field is grayed out and the value cannot be revised. When the IP address configuration is selected for *Manual* this field will not be grayed out and the value can be modified as desired. After entering a revised gateway value, using dot-decimal notation, the Submit button must be pressed for the change to be stored. A system reboot is required for the revised gateway value to be utilized.

Submit: The Submit button is located at the bottom of the Management Interface area of the Network menu webpage. To save any changes made to four fields in the Management Interface requires that the Submit button be pressed. To utilize those changes requires that a Model 5402 reboot to take place. That can occur by using the system Reboot function on the system webpage or a selection on the front panel's menus.

Access Menu

As a security method a user name and password must be entered before the configuration webpages can be accessed. (This is what you did to get this far!) These values can be changed as desired.

The Model 5402's access security method is in no way rigorous. The user name and password are sent to and received from the Model 5402 as plain text. They are also stored within the Model 5402 as plain text. There is no security method or encryption associated with these fields. Anyone "snooping" on the LAN that is transporting Model 5402 management data will see all values in plain text. The ability to select user name and password values is intended simply to provide a means of keeping "honest" users from easily changing the configuration of a Model 5402. If unauthorized access is of concern then it's recommended that the Model 5402's network configuration be selected for Switched or Redundant. And then an Ethernet connection to the Model 5402's management RJ45 jack should not be present except when access by authorized personnel is desired.

The default user name is **guest** and the default password is **guest**. These are case sensitive. If neither of the default entries are changed then they will show in the user name and password entry fields on the Login menu webpage. If the default user name and/or default password is changed then neither the user name nor the password will show upon accessing the Login menu webpage.

Management Log Credentials

User Name: In this field a revised user name can be entered. The user name must be a minimum of five characters, a maximum of 15 characters, and is case sensitive. All 95 of the printable ASCII characters can be used. These include upper and lower alphabetic characters, numbers, and standard punctuation marks.

New Password: In this field a revised password can be entered. The password must be a minimum of five characters, have a maximum of 15 characters, and is case sensitive. All 95 of the printable ASCII characters can be used. These include upper and lower alphabetic characters, numbers, and standard punctuation marks.

Confirm New Password: For a new password to be considered valid, enter it identically into this field.

Submit: The Submit button is located below the field for Confirm New Password. To save changes made to the User Name and/or New Password fields requires that the Submit button be pressed. Changes made will be effective upon the next attempt at logging into the Model 5402. Restoring the Model 5402 to its default values does not change the stored user name and password.

System Menu

This menu has seven display-only fields as well as functions that allow the default settings to be restored and the system to be rebooted (restarted).

One of the display-only fields shows the hardware serial number and the remaining six provide details about the firmware (embedded software) that is being actively utilized by the Model 5402.

Serial Number: This is a display-only field that shows the Model 5402's hardware serial number. This number has been assigned at the factory and cannot be changed.

Version Information: The version information section consists of six rows of information that provides details about the six firmware (embedded software) files that are being used by the Model 5402. These are display-only fields and will include a date if that is specified as part of the firmware release.

Main MCU Firmware: This display-only field shows the version number and associated release date of the Model 5402's Main MCU firmware. This firmware can be field-updated using a USB flash drive. Update details are provided in the Technical Notes section.

Main FPGA Firmware: This display-only field that shows the version number and associated date of the Model 5402's Main FPGA (field-programmable-gate-array) firmware. This firmware can be field-updated using a USB flash drive. Update details are provided in the Technical Notes section.

Sync FPGA Firmware: This display-only field shows the version number and associated date of the Model 5402's synchronization board FPGA (field-programmable-gate-array) firmware. This firmware can be field-updated using a USB flash drive. Update details are provided in the Technical Notes section.

Dante Product: This display-only field shows the product version number and associated date that's stored in and being utilized by the Dante interface. (The Dante interface is implemented using a Brooklyn module from Audinate.) This version number is

assigned by Studio Technologies as an identifier when a file is released that combines specific Model 5402 configuration information along with Dante operating firmware. The firmware for the Model 5402's Dante interface can be updated by way of an Ethernet connection using the Dante Updater software application that's provided as part of the Dante Controller software application.

Dante Firmware: This is a display-only field that shows the version number of the firmware associated with the Dante interface (Brooklyn module) that the Model 5402 utilizes for Dante interconnectivity. No date is associated with this file. The shown version number is assigned by Audinate and can't be changed by Studio Technologies. It is incorporated into the Dante Product (.dnt) file that is released by Studio Technologies' specifically for the Model 5402. As noted previously, this firmware, part of the Dante product firmware, can be updated by way of an Ethernet connection using the Dante Updater software application.

GNSS Firmware: This display-only field shows the version number of the firmware associated with the Model 5402's GNSS receiver circuitry. This firmware cannot be field updated.

Restore Default Configuration: There are two check boxes associated with the restore default configuration function. Either or both can be selected prior to pressing the Submit button. Enabling the Operational Settings check box allows all the Model 5402's configuration settings to be restored to their factory default values with the exception of the management interface and user access settings. The six configuration values associated with these two functions will not change. Enabling the Management Interface and Access Setting check box allows the Model 5402's configuration settings for the IP Configuration method, Manual IP Address, Manual Subnet Mask, Manual Gateway, User Name, and Password to be returned to their factory default values. Refer to Appendix E for a list of the these values.

System Reboot: The Reboot function is located on the bottom of the System menu webpage. It allows the Model 5402 to be rebooted (restarted) without having to perform a power cycle. (The function can be considered to invoke a "warm boot.") For a system reboot to take place the check box must be enabled prior to

pressing the Reboot button. During normal operation a system reboot will never be required. But after changes are made to any of the unit's management interface network configuration a reboot is required. A system reboot will cause the three Ethernet interfaces to go through a reconnection process, necessary should any of the management network parameters be revised. (These changes can be made by way of the Network menu choices or using the front-panel display and buttons.)

Webpage Inactivity Timer/ Automatic Log Out

Once a web browser has successfully logged into the Model 5402's menu system an inactivity timer will become active. If no configuration setting has been changed, a webpage refreshed, or a webpage newly accessed for 15 minutes, the user will automatically be logged out. Returning to the menu pages will require the login procedure to be successfully completed.

Menu Text and Links

The following provides details on some of the text and links that are presented on the Model 5402's webpages.

Device Name: In the upper-right corner of each Model 5402 webpage is the Dante device name. This name is unique to each device in a Dante deployment and is used as part of the Dante subscription (channel routing) process. The name can be changed from within the Dante Controller application.

Identify Device Link: In the upper-right corner of each webpage, directly below the device name, is a link called Identify Device. Clicking on it will cause the Dante identify action to commence on the specific Model 5402. The action will consist of the front-panel display's green backlight flashing five times. This command will help confirm that the web server on the desired Model 5402 is being accessed.

Company Name Link: On the bottom of each webpage is a link with the title Studio Technologies, Inc. Clicking on this link will cause the browser to open the Home webpage of the Studio Technologies website.

Log Out Link: In the upper-right corner of most of the Configuration menu webpages is a link called Log Out. It will cause the Model 5402's web server to end the session, logging out the user and returning

to the Home menu. To again access the configuration webpages requires that the user click on the Login tab and provide a valid user name and password.

Operation

Now that the Model 5402 is installed and configured it's ready for use. The unit is designed for continuous, unattended operation. However, there are a number of nuances in the unit's operation. This may make it worthwhile for personnel to spend some time reviewing this section.

Upon application of AC mains or DC power, the Model 5402 will go through a power-up sequence. The nine dual-color LEDs on the Model 5402's front panel will light green, then light red in a confirmation sequence. The unit's graphics display will show the Studio Technologies logo graphics image, followed by a menu page that shows the product name (Model 5402) and the Dante name. Then the version number of the Main MCU firmware will be shown. After a few seconds the screen saver mode, detailed later in this section, will begin operation.

Upon power being applied the green LED adjacent to the USB receptacle on the back panel will flash once to indicate that its associated circuitry is performing correctly. Also, upon power being applied to the Model 5402 the LEDs on the back panel associated with the unit's three Ethernet RJ45 jacks will briefly flash as a functional test.

After the Model 5402 has completed its power-up sequences the unit will begin operation. The nine front-panel LEDs will reflect the real-time status of the unit's major functions. The front-panel display will allow the viewing of over 25 menu pages showing status and configuration conditions. In addition, using the front-panel pushbutton switches some of the unit's configuration settings can be revised as required.

The following paragraphs will detail the operation of the front-panel LEDs.

Power LEDs

Two LEDs indicate the presence of incoming AC mains and nominal 12 volts DC power. They are labeled AC and DC and can light green or red. When a source of AC mains power is connected the AC LED will light green. (This is actually in response to

12 volts DC that is being generated by the internally located AC mains input/12 volts DC output power supply.) The LED labeled DC will light green whenever a connected DC source exceeds approximately 10 volts. The DC LED will light red when the DC input is between approximately 9 and 10 volts, indicating a low-voltage condition. Once the DC input is less than approximately 9 volts the DC LED will not light and the Model 5402 will no longer operate from the DC source.

Network LEDs

Three LEDs provide status indications related to the Model 5402's three Ethernet network interfaces. Two of the LEDs are associated with the Model 5402's Dante primary and Dante secondary Ethernet ports. They are labeled PRI and SEC. The third LED, labeled MGMT, is associated with the unit's management Ethernet port. The way in which the three Ethernet interfaces and their associated status LEDs function depend on the network configuration as selected using the Dante Controller application. The choices are Switched, Redundant, Switched+Mgmt, and Redundant+Mgmt.

Switched Network Operation

PRI LED: The PRI LED will light red when no Ethernet connection is present on the Dante primary or Dante secondary Ethernet ports. It will light green whenever a Gigabit Ethernet connection is present on either the Dante primary or the Dante secondary Ethernet port and a link has been established. It will light orange whenever a 100 Mb/s Ethernet connection is present on either the Dante primary or the Dante secondary Ethernet port and a link has been established.

SEC LED: The SEC LED will not light.

MGMT LED: When no Ethernet connection is present on the management Ethernet port the MGMT LED will not light. It will light green whenever a Gigabit or 100 Mb/s Ethernet signal is connected and a link has been established.

Redundant Network Operation

PRI LED: The PRI LED will light red when no Ethernet connection is present on the Dante primary Ethernet port. It will light green whenever a Gigabit Ethernet connection is present on the Dante primary Ethernet port and a link has been established. It will light orange whenever a 100 Mb/s Ethernet connection is present and a link has been established.

SEC LED: The SEC LED will light red when no Ethernet connection is present on the Dante secondary Ethernet port. It will light green whenever a Gigabit Ethernet connection is present on the Dante secondary Ethernet port and a link has been established. It will light orange whenever a 100 Mb/s Ethernet connection is present and a link has been established.

MGMT LED: When no Ethernet connection is present on the management Ethernet port the MGMT LED will not light. It will light green whenever a Gigabit or 100 Mb/s Ethernet connection is present and a link has been established.

Switched+Mgmt Network Operation

PRI LED: The PRI LED will light red when no Ethernet connection is present on the Dante primary or Dante secondary Ethernet ports. It will light green whenever a Gigabit Ethernet connection is present on the Dante primary or Dante secondary Ethernet ports and a link has been established. It will light orange whenever a 100 Mb/s Ethernet connection is present on either Ethernet port and a link has been established.

SEC LED: The SEC LED will not light.

MGMT LED: The MGMT LED will not light if an Ethernet connection is not present on the Dante primary or Dante secondary Ethernet ports. It will light green whenever a Gigabit or 100 Mb/s Ethernet connection is present on either the Dante primary or Dante secondary Ethernet port and a link has been established.

Redundant+Mgmt Network Operation

PRI LED: The PRI LED will light red when no Ethernet connection is present on the Dante primary Ethernet port. It will light green whenever a Gigabit Ethernet connection is present on the Dante primary Ethernet port and a link has been established. It will light orange whenever a 100 Mb/s Ethernet connection is present on the Dante primary Ethernet port and a link has been established.

SEC LED: The SEC LED will light red when an Ethernet connection is not present on the Dante secondary Ethernet port. It will light green whenever a Gigabit Ethernet connection is present on the Dante secondary Ethernet port and a link has been established. It will light orange whenever a 100 Mb/s Ethernet connection is present on the Dante secondary Ethernet port and a link has been established.

MGMT LED: The MGMT LED will not light if an Ethernet connection is not present on the Dante primary Ethernet port. It will light green whenever a Gigabit or 100 Mb/s Ethernet connection is present on the Dante primary Ethernet port and a link has been established.

Dante LEDs

Two LEDs are associated with the Model 5402's Dante interface. The system LED, labeled SYS, and the synchronization LED, labeled SYNC, will both light red as the Model 5402's Dante interface starts to function and awaits connection and full operation with one or two local area networks (LANs). (Two networks are utilized only when Dante redundancy is enabled.) The SYS LED will light red to indicate that the Dante interface is not ready to pass data to other devices. It will blink red if there is an issue communicating with the internal Dante Brooklyn module. It will light green when the Dante interface is operating normally and is ready to pass Dante data.

The SYNC LED will light red to indicate that the Model 5402's Dante interface has not established timing synchronization. The complete action of the SYNC LED will depend on the Switch configuration as set using the Dante Controller application. If Switched or Switched+Mgmt has been selected then the SYNC LED will slowly flash green if this specific Model 5402 is serving as the PTPv1 Leader clock for the associated Dante network. This will be a normal situation as usually this unit will be providing the timing reference for all of the other Dante devices. The SYNC LED slowly flashing green can be misconstrued as an error condition, but it is not. The SYNC LED slowly flashing green will mimic the action that other Dante devices will perform if they are acting as the Leader clock.

The SYNC LED will slowly flash orange if the Model 5402 is serving as the PTPv1 Leader clock for the Dante network and its failover mode is active. This would indicate that the unit was specified to utilize the GNSS receiver or the sync input, but is not able to do so. If the SYNC LED is lit solid orange then the Model 5402 is not acting as the PTPv1 Leader clock for the Dante network and the failover mode is active.

The SYNC LED lighting orange, whether solid or flashing, would typically indicate an error condition that should be resolved. The SYNC LED will light solid green when the Model 5402 is acting as the Follower

clock. In this case, the unit is using another Dante device on the network to provide its timing reference. This would not be a typical situation and might only occur while performing system testing or serving in a backup role.

If Redundant or Redundant+Mgmt has been selected then the SYNC LED will slowly flash green if this specific Model 5402 is serving as the PTPv1 Leader clock for either the Dante primary or Dante secondary network. The SYNC LED will slowly flash orange if this Model 5402 is serving as the PTPv1 Leader clock for the Dante primary network and its failover mode is active. This would indicate that the unit was specified to utilize the GNSS receiver or the sync input, but is not able to do so.

If the SYNC LED is lit solid orange then the Model 5402 is not acting as the PTPv1 Leader clock for the Dante primary network and its failover mode is active. The SYNC LED lighting orange, whether solid or flashing, would typically indicate an error condition that should be resolved.

The SYNC LED will light solid green when the Model 5402 is not acting as the PTPv1 Leader clock for the Dante primary and Dante secondary networks, unless the unit is locked to another Leader clock. In this case, the unit is using another Dante device to provide the timing reference for the Dante primary network. This would not be a typical situation and might only occur while performing system testing or serving in a backup role.

The management webpages should be utilized to observe the Model 5402's complete sync status. Using the Home and Main webpages, the status of the Dante primary and Dante secondary interfaces, including their support for PTPv1 and PTPv2, will be shown.

Note that it's possible that up to 30 or 40 seconds may be required for the SYNC LED to reach its final state after the Model 5402 powers up or performs a reboot (restart). Also, both the SYS and SYNC LEDs will flash red whenever the Model 5402's network configuration mode is changing. (This would be performed using the Dante Controller application.) After the revised network configuration has been established the SYS and SYNC LEDs will perform normally.

External Lock LEDs

Two LEDs, one labeled SYNC IN and the other labeled GNSS, are associated with the status of the Model 5402's two possible sources of external synchronization. If the unit has been configured to not utilize an external synchronization source connected to the BNC jack on the back panel then the SYNC IN LED will not be lit. If the unit's main clock source has been configured to utilize an external source of sync then the LED will light green if a valid source has been connected. The SYNC IN LED will light red if a valid signal has not been connected. This would typically indicate an error condition that should be investigated. If the Model 5402's main clock source has not been selected to use the sync input then the SYNC IN LED will function in a slightly different manner. It will light green whenever a valid source is connected to the sync input. It will not light if a valid source has not been connected.

The GNSS LED will not be lit if it has been configured to not act as a clock source and the function is not actively locked to a satellite constellation. The LED will light red if GNSS has been selected as the clock source for the Model 5402 but the unit has not established a locked condition with one of the selected satellite constellations. The GNSS LED will light green when the Model 5402 has locked onto a satellite constellation and a timing reference is being generated. The GNSS LED lighting red will typically indicate that an error condition is active and that further investigation is warranted.

RJ45 LED Indicators

On the Model 5402's back panel there are three RJ45 jacks that are provided for interfacing with the unit's three Ethernet ports. Two of the ports are typically used for Dante and the third for the management function. The Ethernet ports are labeled Dante PRI, Dante SEC, and MGMT. Associated with each RJ45 jack are two LEDs. One LED is labeled LINK and lights orange when a GigE Ethernet connection has been established with that specific port. The other LED is labeled ACT and flashes green to indicate activity, responding to Ethernet data traveling through the specific port.

The Model 5402's three Ethernet ports, as a group, can be configured, using the Dante Controller application, to operate in one of four network configuration

modes: Switched, Redundant, Switched+Mgmt, and Redundant+Mgmt. Details about the four network configuration modes are provided in later sections. The manner in which the LEDs associated with each RJ45 jack will light depends on the network configuration. The following sections detail the operation of the LEDs based on the specific network configuration.

Switched Network Mode
Dante PRI RJ45 LEDs:

LINK (Orange): Off if no Ethernet signal is connected or if a 100 Mb/s Ethernet signal is connected; lit if a GigE Ethernet signal is connected.

ACT (Green): Off if no data traffic; flashes to show data traffic.

Dante SEC RJ45 LEDs:
LINK (Orange): Off if no Ethernet signal is connected or if a 100 Mb/s Ethernet signal is connected; lit if a GigE Ethernet signal is connected.

ACT (Green): Off if no data traffic; flashes to show data traffic.

MGMT RJ45 LEDs:
LINK (Orange): Off if no Ethernet signal is connected or if a 100 Mb/s Ethernet signal is connected; lit if a GigE Ethernet signal is connected.

ACT (Green): Off if no data traffic; flashes to show data traffic.

Redundant Network Mode
Same as Switched.

Switched+Mgmt Network Mode
Dante PRI RJ45 LEDs:
LINK (Orange): Off if no Ethernet signal is connected or if a 100 Mb/s Ethernet signal is connected; lit if a GigE Ethernet signal is connected.

ACT (Green): Off if no data traffic; flashes to show data traffic.

Dante SEC RJ45 LEDs:
LINK (Orange): Off if no Ethernet signal is connected or if a 100 Mb/s Ethernet signal is connected; lit if a GigE Ethernet signal is connected.

ACT (Green): Off if no data traffic; flashes to show data traffic.

MGMT RJ45 LEDs:
LINK (Orange): Will not light.

ACT (Green): Will not light.

Redundant+Mgmt Network Mode
Same as Switched+Mgmt.

Front-Panel Display Page Descriptions
The following sections provide information about the Model 5402's front-panel menu pages. Additional details can be found in the Model 5402 Configuration section. Refer to Appendix D for the menu structure diagram.

Row One
There are six display pages associated with the top row which we'll refer to as row one. They relate to the timing status of the associated Dante primary PTPv1 network, the Model 5402's selected internal timing source, the status of the GNSS receiver, the parameters related to the external sync input, and the display of timing parameters that can be useful for factory troubleshooting.

Dante Sync Status Primary PTPv1: This menu page will show the PTPv1 sync status for the Dante primary interface. It will show *Leader*, *Follower*, *Link Down*, or *Error*. The management webpages should be utilized to observe the Model 5402's complete sync status. Using the Home and Main webpages, the status of the Dante primary and Dante secondary interfaces, including their support for PTPv1 and PTPv2, will be shown.

Current Clock Source: This menu page will show which timing source is actively being used by the Model 5402's circuitry. The possibilities are *Internal*, *Internal (Failover Active)*, *GNSS*, *Sync Input*, *Dante*, *Dante (Failover Active)*, and ---. Should the text *Failover Active* be present it will alternate on and off as a warning of an abnormal condition. This would typically warrant intervention.

GNSS Status: This menu page will provide information about the Model 5402's GNSS (satellite) receiver. The possibilities are *Locked*, *Locking*, *Unlocked*, *Antenna Disconnected*, *Antenna Error*, *Idle*, and *Error*. *Locked* means that the GNSS receiver is actively receiving a timing signal from one or more of

the possible satellite constellations. *Locking* means that the GNSS receiver is in the process of locking (or attempting to lock) to one or more of the possible satellite constellations. *Unlocked* means that the GNSS is not locked to a satellite constellation. *Antenna Disconnected* is self-explanatory. *Antenna Error* would be shown if an antenna-related error condition was present, such as too much DC current being drawn from the antenna input. *Idle* indicates that GNSS was not selected to be the Model 5402's timing source and the GNSS receiver is not actively locked to a constellation. *Error* would indicate a problem with the Model 5402's circuitry that prevents correct communication with the GNSS receiver circuitry.

Sync Input Type & Status: This display-only page shows two parameters. The top line will show the type of input that has been configured for the sync input. The possibilities are *Word Clock*, *Video*, and *10 MHz*. The bottom line will show the status of the external sync input circuitry. The possibilities are *Locked*, *Unlocked*, *Standby*, and *Idle*.

Sync Input Termination: This menu page will show the status of a terminating impedance being applied to the sync input BNC jack. The two possibilities are *Off* and *On*.

Phase Detector Deviation (Factory Use): This menu page will show two numbers related to how well the Model 5402's internal logic circuitry is "locking" to an external timing reference. (A configuration choice allows this reference to be either the GNSS receiver or a signal connected to the sync input.) The information on this menu page will only be relevant if the factory has been contacted in regards to a technical issue.

Row Two

Row two has four read-only front-panel menu pages that involve the GNSS (satellite) receiver circuitry and associated antenna.

Date and Time: The current date and time will be shown on this menu page. This information is from the GNSS receiver and should be quite accurate. On line one the date will show in a DD-MMM-YYYY format. The day of the month will be in the form of two numeric digits. The month will show as three alphabetic characters. The year will show as four numeric digits. On line two the time will be shown as HH:MM:SS in UTC (Universal Coordinated Time). If the GNSS receiver is

not locked to a constellation one of several messages will show These include *Waiting for GNSS Module*, *GNSS Sync Unlocked*, and *Not Available*.

Antenna Status: This menu page shows the current status of the GNSS antenna input. The possibilities are *Connected*, *Initializing*, *Disconnected*, and *Shorted*. The GNSS receiver depends on the connection of a compatible external multi-band antenna. One is provided with each Model 5402. Others can also be utilized if specialized characteristics are required. Any message but Connected would typically indicate a condition that needs investigation.

Number of Satellites and Signal Strength: This menu page will show details about the Model 5402's internal GNSS receiver. The value for the number of satellites is directly related to the total number of satellites that are currently being received. In factory testing of the Model 5402 the number of satellites that were concurrently being received ranged from 0 to 28. And it's possible that more than 28 could be received at the same time at some locations. The number of satellites will typically change over time. This is due to the fact that most navigation satellites will move in relation to the Model 5402 (MEO versus geosynchronous orbits). As such, the specific satellites that are locked with the Model 5402's GNSS receiver will often change over time.

The signal strength is shown in the form of five graphical bars of ascending height, left to right. The more bars that are shown the greater the received signal strength. And in this case, the more the better; an increase in received signal strength will typically lead to a more-reliable timing reference being obtained from the satellites associated with the selected constellation or constellations. If no antenna is connected the display will show either *Antenna Idle* or *Antenna Disconnected*. If a problem is detected on the antenna input then *Antenna Error* may show.

Time to First Fix (TTFF): This menu page shows the amount of time (in seconds) that elapsed between when the Model 5402 performed a bootup (restart) and when the GNSS receiver first established a fully locked condition. Subsequent reboots of the GNSS receiver will not cause a new TTFF value to be stored. Technically, time to first fix (TTFF) can be considered to be a measure of the time required for a

GNSS-based system to acquire satellite signals and navigation data. From that the receiver can calculate a position solution. (The position solution is called a "fix.") The TTFF value is typically only of use when troubleshooting an installation. In general, the lower the TTFF value the better. If no receiver lock has been established then **---** will show.

Row Three

Row three has five front-panel menu pages that involve the management IP address and related parameters. Two are display-only and three allow changes to be made.

Current Management IP Address: This menu page will show the IP address associated with the Model 5402's internal management web server. This address can be assigned automatically using the DHCP protocol or, if a DHCP server is not available, using the IPv4 link-local protocol. (An IP address that has the format of 169.254.x.x was assigned using IPv4 link-local.) The management IP address can also be manually assigned with a fixed or static IP address. If no Ethernet connection has been made the text *Link Down* will be shown.

If the Model 5402's network configuration in the Dante Controller application is selected for Switched or Redundant then this menu page will show the IP address that's associated with the connection made to the Model 5402's management RJ45 jack.

If the Model 5402's network configuration in the Dante Controller application is selected for Switched+Mgmt then the IP address that is shown will be associated with a connection that is made to either the Dante primary or Dante secondary Ethernet interface.

If the network configuration in Dante Controller has been selected for Redundant+Mgmt then the IP address that is shown will be associated with a connection that is made to the Dante primary Ethernet interface.

Current Management Subnet Mask: This menu page will show the subnet mask value that is active for the management interface and associated web server. If the IP address and related network parameters were obtained by way of DHCP then this field will show an IPv4 subnet mask value in dot-decimal notation. If the IP configuration mode is selected for

Automatic and the current IP address was obtained by way of link-local, then 255.255.0.0 will show. It's also possible that the subnet mask value was manually entered as part of a fixed or static IP address. Its value would show here.

Management IP Configuration: This menu page allows the display and revision of the method that the Model 5402 will use to obtain a management IP address and related parameters. The choices are *Automatic* and *Manual*. The selected configuration impacts how the Model 5402 obtains the IP address that is used for accessing the management web server and associated menu webpages. This setting has no impact on how the Model 5402 obtains IP addresses for the Dante primary and Dante secondary Ethernet interfaces.

An arrow icon will show in the upper-right corner of this menu page. This indicates that the setting can be changed. If the active method is not the desired one, press the Enter pushbutton switch located on the front panel. Use the left and right arrow buttons to select the desired method. Then again press the Enter button. The entry will be stored. To cause the Model 5402 to use a new setting requires that the unit be rebooted (restarted). This can be performed using one of three ways: another front-panel menu page, a selection in one of the management webpages, or by power cycling the unit.

Selecting the *Automatic* setting causes the Model 5402 to use DHCP or, if DHCP is not available, the IPv4 link-local protocol to establish the IP address for the management port. Even if the IP address was established using link-local the DHCP protocol will remain active. In this case, approximately every 30 seconds the Model 5402's firmware will check for the presence of a DHCP server. If one becomes available then an IP address will be requested and, when obtained, will automatically replace the IP address that was previously established by link-local.

The *Manual* setting allows the desired IP address and related parameters to be manually entered. This can be useful when a fixed or static addressing scheme has been established. In this way, a designated IP address can be entered along with the other necessary network parameters.

Manual Management IP Address: This menu page shows the stored IP address associated with the connection used to access the management web server. (This address has nothing to do with the IP addresses utilized by the Dante primary and Dante secondary Ethernet interfaces.) It will only be utilized when the manual mode has been selected for the management IP address configuration. When the IP address configuration has been selected for *Automatic* this field cannot be changed and a lock icon will show in the upper-right corner of the display.

Whenever the IP address configuration is selected for *Manual* the manual IP address can be modified as desired. This will be indicated by a circle with arrows icon that will show in the upper-right corner of the display. To start the process of changing the manual management IP address press the Enter pushbutton switch on the front panel. An icon with a wrench and screwdriver will show to indicate that an edit is in process. Press the left and right arrow pushbutton switches to select which specific digit of the IP address number is to be modified. Press the up and down arrow pushbuttons to select the desired number. The standard dot-decimal notation is used to display and revise the IP address. Once all the desired changes have been made press the Enter button to store the values.

To cause the Model 5402 to use a new setting requires that the unit be rebooted (restarted). This can be performed using one of three ways: another front-panel menu page, a selection in one of the management webpages, or by power cycling the unit.

Manual Management Subnet Mask: This menu page shows the stored subnet mask value associated with the connection used to access the management web server. (This value has nothing to do with the subnet mask values utilized by the Dante primary and Dante secondary ports.) It will be utilized only when the manual mode has been selected for the management IP address configuration. When the IP address configuration has been selected for *Automatic* this field cannot be changed and a lock icon will show in the upper-right corner of the display.

Whenever the IP address configuration is selected for *Manual* the manual management subnet mask value can be modified as desired. This will be indicated by a circle with arrows icon that will show in the upper-right corner of the display. To start the process of changing the subnet mask value press the Enter pushbutton switch on the front panel. An icon with a wrench and screwdriver will show to indicate that an edit is in process. Use the up and down arrow pushbutton switches to select the desired subnet mask value. Once the desired value has been selected press the Enter button to store it.

To cause the Model 5402 to use a new manual management subnet mask value requires that the unit be rebooted (restarted). This can be performed using one of three ways: another front-panel menu page, a selection in one of the management webpages, or by power cycling the unit.

Row Four

Row four has a total of six menu pages. Four of the menu pages relate to the Dante primary interface with three of these allowing both display and configuration changes to be made. The fifth menu page allows the configuration of the Ethernet switch integrated circuit to be shown. A sixth menu page allows the Dante interface to be rebooted (restarted).

Dante Device Name: The Dante device name is shown on this menu page. This name is unique to each device in a Dante deployment and is used as part of the Dante subscription (channel routing) process. The name can be changed from within the Dante Controller application. The text shown on this menu page is same as is shown in the upper-right corner of each Model 5402 management webpage.

Dante Primary IP Configuration: This menu page allows the display and revision of the method that the Model 5402's Dante interface will use to obtain the Dante primary IP address and related parameters. The choices are *Automatic* and *Manual*. This setting has no impact on how the Model 5402 obtains IP addresses for the Dante secondary interface and management interface webpages.

An arrow icon will show in the upper-right corner of this menu page. This indicates that the setting can be changed. If the active method is not the desired one, press the Enter pushbutton switch located on the front panel. Use the left and right arrow buttons to select the desired method. Then again press the Enter button. The entry will then be stored. To cause the

Model 5402 to use a new setting requires that the unit be rebooted (restarted). This can be performed using one of three ways: another front-panel menu page, a selection in one of the management webpages, or by power cycling the unit.

Selecting the *Automatic* setting causes the Model 5402's Dante interface to use DHCP or, if DHCP is not available, the IPv4 link-local protocol to establish the IP address used by the Dante primary interface. (An IP address that has the format of 169.254.x.x was assigned using IPv4 link-local.) Even if the IP address was established using link-local the DHCP protocol will remain active. In this case, the Model 5402's Dante interface will continue to check for the presence of a DHCP server. If one becomes available then an IP address will be requested and, when obtained, will automatically replace the IP address that was previously established by link-local.

The *Manual* setting allows the desired Dante primary IP address and related parameters to be manually entered. This can be useful when a fixed or static addressing scheme has been established. In this way, a designated IP address can be entered along with the other necessary network parameters.

To cause the Model 5402 to use a revised Dante primary IP address configuration method requires that the unit's Dante interface be rebooted (restarted). This can be performed using either the reboot Dante front-panel menu page or by rebooting the entire Model 5402. This latter action can be performed using one of three ways: another front-panel menu page, a selection in one of the management webpages, or by power cycling the unit.

Dante Primary IP Address: This menu page shows the IP address associated with the Dante primary interface. (This address has nothing to do with the IP addresses utilized by the Dante secondary and management interface ports.) It can be revised only when the manual mode has been selected for the Dante primary IP configuration. When the IP address configuration has been selected for *Automatic* this field cannot be changed and a lock icon will show in the upper-right corner of the display. If no Ethernet connection has been made the text *Link Down* will be shown.

If the network configuration is selected in the Dante Controller application for Switched or Switched+Mgmt then the Dante primary IP address will be associated with a network connection made to either the primary or the secondary RJ45 jack on the Model 5402's back panel. If the network configuration is selected for Redundant or Redundant+Mgmt then the Dante primary IP address will be associated with the RJ45 jack labeled PRI on the Model 5402's back panel.

Whenever the IP address configuration is selected for *Manual* the manual Dante primary IP address can be modified as desired. This will be indicated by a circle with arrows icon that will show in the upper-right corner of the display. To start the process of changing the Dante primary IP address press the Enter pushbutton switch on the front panel. An icon with a wrench and screwdriver will show to indicate that an edit is in process. Use the left and right arrow pushbutton switches to select which specific digit of the IP address number is to be modified. Press the up and down arrow pushbuttons to select the desired number. The standard dot-decimal notation is used to display and revise the Dante primary IP address. Once all the desired changes have been made press the Enter button to store them.

To cause the Model 5402 to use the new Dante primary IP address setting requires that the unit's Dante interface be rebooted (restarted). This can be performed using the reboot Dante front-panel menu page. Rebooting the entire the Model 5402 can also be utilized to cause a new Dante primary IP address to be used. This can be performed using one of three ways: another front-panel menu page, a selection in one of the management webpages, or by power cycling the unit.

Dante Primary Subnet Mask: This menu page shows the stored subnet mask value associated with the Dante primary interface. (This value has nothing to do with the subnet mask values utilized by the Dante secondary or management ports.) It will be utilized only when the manual mode has been selected for the Dante primary IP address configuration. When the IP address configuration has been selected for *Automatic* this field cannot be changed and a lock icon will show in the upper-right corner of the display.

Whenever the IP address configuration is selected for *Manual* the manual subnet mask value can be modified as desired. This will be indicated by a circle with arrows icon that will show in the upper-right corner of the display. To start the process of changing the subnet mask value press the Enter pushbutton switch on the front panel. An icon with a wrench and screwdriver will show to indicate that an edit is in process. Use the up and down arrow pushbutton switches to select the desired subnet mask value. Once the desired value has been selected press the Enter button to store it.

To instruct the Model 5402 to use the new Dante subnet mask value requires that the unit's Dante interface be rebooted (restarted). This can be performed using the reboot Dante front-panel menu page. Rebooting the entire Model 5402 can also be used to cause a new Dante primary subnet mask value to be used. This can be performed using one of three ways: another front-panel menu page, a selection in one of the management webpages, or by power cycling the unit.

Ethernet Switch Configuration: This display-only menu page shows the Model 5402's network configuration as determined by a setting in the Dante Controller application. The term "switch" refers to an Ethernet switching and routing integrated circuit that is part of the Model 5402's hardware. How this integrated circuit is configured determines the how the Model 5402's three Ethernet ports will function. The field will show Switched, Redundant, Switched+Mgmt, or Redundant+Mgmt. It will also show the text *Error* in the unlikely event that an error has occurred in the Brooklyn module that supports the Model 5402's Ethernet interfaces.

Reboot Dante: This menu page allows the Dante interface to be rebooted (restarted). This can be useful to force the Model 5402's Dante interface to utilize revised Dante primary IP address and related parameter configuration changes. It can also be useful when troubleshooting a Dante network issue. An arrow icon will show in the upper-right corner of the reboot Dante menu. To start the process of rebooting the Dante interface press the Enter pushbutton on the unit's front panel. This will lead to a confirmation page being shown. Use the left and right arrow pushbutton switches to select the desired action. The choices are

to cancel or to confirm. Press the Enter pushbutton switch to select the highlighted action.

Note that if the Dante interface is rebooted it may take 20 to 60 seconds for the Model 5402's operation to fully restore. During this time period the management Ethernet port will also disconnect and then reconnect.

Row Five
Row five contains six menu pages. Five of the pages provide information about the specific Model 5402, including its serial number and versions of the firmware (embedded software) that are in use. It also includes a menu page that allows the system to be rebooted (restarted).

Product Name & Serial Number: This menu page shows the name of the product (Model 5402) and the hardware serial number. The name and serial number, along with three MAC addresses associated with the Ethernet interfaces, are assigned at the factory and cannot be changed.

Main MCU Firmware Version: This menu page shows the version number of the Model 5402's Main MCU firmware. This firmware can be updated using a USB flash drive. Details regarding updating this firmware are provided in the Technical Notes section.

Main FPGA Firmware Version: This menu page shows the version number of the Model 5402's Main FPGA (field-programmable-gate-array) firmware. This firmware can be updated using a USB flash drive. Details regarding updating this firmware are provided in the Technical Notes section.

Sync FPGA Firmware Version: This menu page shows the version number Model 5402's internal synchronization board FPGA (field-programmable-gate-array) firmware. This firmware can be updated using a USB flash drive. Details regarding updating this firmware are provided in the Technical Notes section.

Dante Product Version: This menu page shows the product version number that's stored in and being utilized by the Dante interface. The Model 5402's Dante interface is implemented using a Brooklyn module from Audinate. This version number is assigned by Studio Technologies as an identifier when a file is released that combines specific Model 5402

configuration information along with Audinate-developed Dante operating firmware. The firmware for the Model 5402's Dante interface can be updated by way of an Ethernet connection using the Dante Updater software application that's provided as part of the Dante Controller software application.

Reboot System: This menu page allows the Model 5402 to be rebooted (restarted). This can be useful to force the Model 5402 to utilize any revised management and Dante interface configuration changes. An arrow icon will show in the upper-right corner of the reboot Dante menu. To start the process of rebooting the Model 5402 press the Enter pushbutton on the unit's front panel. This will lead to a confirmation page being shown. Use the left and right arrow pushbutton switches to select the desired action. The choices are to cancel or to confirm. Press the Enter pushbutton switch to select the highlighted action.

After performing a system reboot (restart), 20 to 60 seconds may be required for the Model 5402's operation to fully restore. During this time period both the Dante and management Ethernet ports will briefly disconnect and then reconnect.

Screen Saver

A "screen saver" mode will automatically activate two minutes after the last press of a front-panel pushbutton switch. When active, the screen saver mode will cause a continuous sequence of six menu pages to activate. Each menu page will be present for about three seconds before the next menu page will show.

When the screen saver mode is active pressing any of the five pushbutton switches on the front panel will cause it to stop and the current management IP address menu page to immediately be shown. To cause the screen saver mode to immediately start simultaneously press the left and right arrow pushbutton switches on the front panel.

There are six menu pages that will show when the screen saver mode is active. Details regarding the information provided in menu pages 2-6 were documented in previous sections. The menu pages consist of:

1. The Studio Technologies' company logo graphic.

2. The product name (Model 5402) and the Dante device name.

3. The current date and time (in UTC).

4. The Dante sync status.

5. The current clock source.

6. The current management IP address.

STcontroller Support

Several key Model 5402 operating parameters can be monitored in real-time using the STcontroller software application. In addition, the version numbers of the unit's firmware can be viewed. STcontroller also allows direct access to the Model 5402's management webpages.

Installing STcontroller

STcontroller is available free of charge on the Studio Technologies' website (studio-tech.com). Versions are available that are compatible with personal computers running selected versions of the Windows® and macOS® operating systems. If required, download and install STcontroller onto a designated personal computer. This personal computer must be on the same local area network (LAN) and subnet as the Model 5402 unit that is to be configured. Immediately after starting STcontroller the application will locate all the Studio Technologies' devices that it can control. The one or more Model 5402 units on the network will appear in the device list. Use the Identify command to allow easy recognition of a specific Model 5402 unit. Double-clicking on a device name will cause the associated configuration menu to appear. STcontroller does not allow any changes to be directly made to the Model 5402 configuration. It is intended to allow observation of a limited set of operating parameters. It also allows direct access to the Model 5402's web (HTML) pages without explicitly knowing the unit's management port IP address.
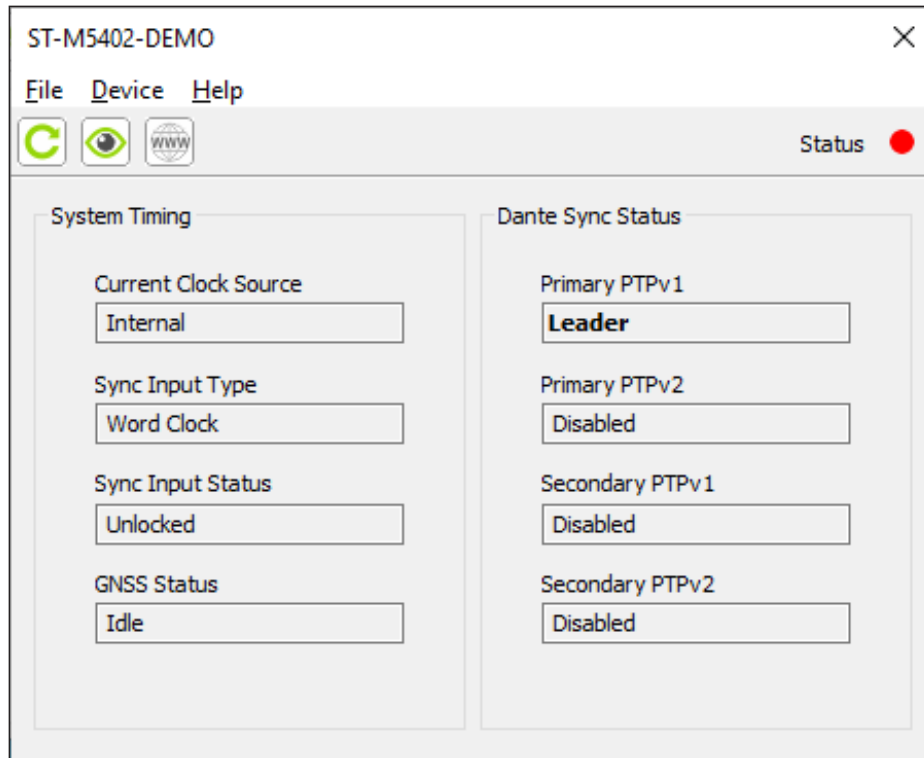
System Timing

This section has four display-only fields that show the current status of important Model 5402 operating parameters.

Current Clock Source

This field will show the clock source that is currently in use. The choices possible will include *Internal*, *Internal (Failover Active)*, *GNSS*, *Sync Input*, *Dante*, and *Dante (Failover Active)*. The current clock source field can also show --- which indicates a major hardware error and would warrant contacting the factory.

When *Internal* is shown it indicates that the Model 5402's internal temperature-stabilized oscillator is being used as its timing reference. When *Internal (Failover Active)* is shown an abnormal condition is occurring. In this case, the Model 5402 has been

configured to use either GNSS or external sync signal as the main clock source but a valid one is not available; it is using its internal temperature-stabilized oscillator as the timing reference. If *GNSS* is shown then the Model 5402 is using a timing signal derived from the selected satellite constellation(s). If *Sync Input* is shown this indicates that an external timing reference signal is connected to the sync input BNC jack on the Model 5402's back panel and it is being used as the main clock source. If *Dante* is shown this indicates that the Model 5402 is using a timing reference derived from its Dante network interface. This is not an invalid condition but would typically only occur in a troubleshooting situation. If *Dante (Failover Active)* is shown an abnormal condition is occurring. In this case, the Model 5402 is using a timing reference derived from its Dante network interface. However, this is only occurring because the configured main clock source is not currently available.

Sync Input Type

The field will show the type of signal that has been selected for the sync input. The choices include *Word Clock*, *Video*, and *10 MHz*.

If Word Clock is shown then a square wave source with a rate of 44.1, 48, 88.2, 96, 176.4, or 192 kHz needs to be connected for correction operation. If Video is shown as the sync input type then a wide range of bi- and tri-level video reference signals can be connected to the sync input BNC jack. The Model 5402's circuitry will automatically decode many of the most common format/rate combinations. If 10 MHz is selected then the sync input is expecting connection of a sinusoidal source of 10 MHz. A signal of this type is typically associated with industrial or instrumentation applications. It may also be provided by a GNSS (satellite-based timing) receiver.

Sync Input Status

This field will show Locked (Active), Locked (Standby), Unlocked, or Idle.

If Locked (Active) is shown this indicates that a valid signal is connected to the Model 5402's sync input and it is serving as the unit's timing reference. If Locked (Standby) is shown this indicates that a valid signal is connected to the Model 5402's sync input and while it is capable of serving in that role.

If Unlocked is shown it can be the result of several conditions. It can show if a signal is connected to the Model 5402's sync input but is not being recognized as a valid timing reference. This can occur for multiple reasons. The most common would be due to a configuration mismatch, such as if a video reference is connected while the Model 5402's sync input is configured to support a word clock source. It might also indicate that a non-supported word clock rate or an incompatible video reference is connected. Unlocked could also be shown if no signal is connected to the sync input or if a connected signal is incorrectly terminated, e.g., no termination applied when one is required or if two terminations ("a double termination") were present.

Idle will show if the sync input has not been selected as the Model 5402's main clock source and a valid source has not been connected to the sync input. It simply indicates that the sync input circuitry is not actively receiving an external signal.

GNSS Status

This field will show Locked (Active), Locked (Standby), Locking, Unlocked, Antenna Disconnected, Antenna Error, or Idle. If Locked (Active) is shown this indicates that the GNSS receiver is "locked" to one or more satellites and the GNSS receiver is serving as the unit's main timing reference. If Locked (Standby) is shown this indicates that the GNSS receiver is "locked" and that the GNSS receiver is capable of serving as the unit's timing reference, but that it is not currently serving as the unit's main clock source. Locking means that the GNSS receiver is in the process of locking (or attempting to lock) to one or more of the possible satellite constellations. Unlocked means that the GNSS is not currently locked to a satellite constellation and it is not attempting to do so.

Antenna Disconnected would indicate that a GNSS antenna is not currently connected. The Model 5402 detects this by the absence of DC current being supplied by the circuitry associated with the GNSS antenna SMA jack. Antenna Error would typically indicate that too much DC current is being supplied by the circuitry associated with the GNSS antenna SMA jack. This could indicate a short circuit condition in the antenna's SMA plug or interconnecting cable. Idle would indicate that the GNSS receiver is not selected to be the main or failover clock source and is not currently locked to a satellite constellation.

Dante Sync Status

The Model 5402 can simultaneously serve as a Leader clock for both Dante primary and Dante secondary networks and is capable of supporting both PTPv1 (IEEE 1588-2002) and PTPv2 (IEEE 1588-2008). As such the unit is capable of acting as four independent Leader clocks: PTPv1 for Dante primary, PTPv2 for Dante primary, PTPv1 for Dante secondary, and PTPv2 for Dante secondary. Standard and Redundant Dante (no AES67 or ST 2110-30 support) uses PTPv1 and that is always enabled in the Model 5402. AES67 and ST 2110-30 utilize PTPv2 clocking; if support for them is desired within the Dante environment an RTP mode must be enabled in the Dante Controller application.

STcontroller provides four fields that show the real-time sync status of the PTPv1 and PTPv2 functions for the Dante primary and Dante secondary interfaces. The range of choices include *Leader*, *Follower*, *Link Down*, *Error*, *Disabled*, *Internal*, *Starting*, *Initializing*, *Fault*, *Listening*, *Pre-Leader*, *Passive*, *Uncalibrated*, and *Standby*. However, typically only one from among the first five will show.

If the network configuration in Dante Controller for this specific Model 5402 has been selected for Switched or Switched+Mgmt the clocking status of the Dante primary interface will be shown. In this situation, the Dante primary PTPv1 interface will show *Leader*, *Follower*, *Link Down*, or *Error*. If AES67 or ST 2110-30 support is enabled in Dante Controller then the same choices will also be shown in the primary PTPv2 field. If AES67 or ST 2110-30 support is not enabled then *Disabled* will show in the primary PTPv2 field. Since Dante secondary is not enabled then the secondary PTPv1 and secondary PTPv2 fields will show *Disabled*.

If the Model 5402's network configuration has been selected for Redundant or Redundant+Mgmt then both the primary PTPv1 and secondary PTPv1 sync status fields will show their respective sync status. They will show the same choices as described above: *Leader*, *Follower*, *Link Down*, or *Error*. If AES67 or ST 2110-30 support is enabled in Dante Controller then the same choices will also be shown in the primary PTPv2 and secondary PTPv2 fields. If AES67 or ST 2110-30support is not enabled then *Disabled* will show in both the primary PTPv2 and secondary PTPv2 fields.

Should *Leader* be shown in a specific field it would indicate that this specific Model 5402 is acting as the Leader clock for the Dante network and clock function associated with that field. If *Follower* is shown this indicates that this specific Model 5402 is obtaining its timing reference from another Dante device on the network. This would be what is currently shown if this specific Model 5402 was serving as a "hot" standby Dante Leader clock.

If *Link Down* is shown this will indicate that a valid Ethernet connection has not been made to the RJ45 jack associated with that field's Model 5402's Ethernet interface. The text *Error* would indicate that this specific Model 5402 is having a permanent or temporary issue with its internal circuitry. There may be occasions where Error would show for a few seconds while Model 5402 circuitry first becomes active.

Identifying Hardware and Firmware

STcontroller allows detailed information about the Model 5402's hardware and firmware (embedded software) to be shown. From the **Device** tab, select **Version and Information** and a screen will appear. Review this screen for details.

Accessing the Management Webpages

STcontroller's Model 5402 support allows a user to directly access the management webpages. This can be useful, eliminating the need to know the management port's IP address. (The management IP address can only be conveniently identified by viewing one of the Model 5402's front-panel display pages.) A "www" icon is located directly to the right of the identify ("eyeball") icon. Use this icon to invoke the personal computer's browser and immediately connect to the home management webpage. The normal login process will then be used to access the various webpages.

Technical Notes
PTPv1, PTPv2, AES67, and ST 2110-30

For clock synchronization "native" Dante utilizes version 1 of the Precision Time Protocol (PTPv1). Technically, the applicable standard is IEEE 1588-2002, which is what the Model 5402 supports for applications that utilize both single and redundant Dante. When operating in the Redundant or

Redundant+Mgmt network modes, independent PTPv1 server functionality is supported, one instance provided for the Dante primary port and a second instance provided for the Dante secondary port.

Applications that utilize AES67 or ST 2110-30 require PTP version 2 (PTPv2) as covered under the standard IEEE 1588-2008. (And following details as specified in the SMPTE ST2059-2 profile.) The Model 5402 will provide support for PTPv2 if the AES67 or ST 2110-30 mode has been enabled in the Dante Controller application. This is in addition to PTPv1 support; both can function simultaneously. When an RTP mode has been enabled and Redundant or Redundant+Mgmt mode is selected, then both the Model 5402's Dante primary and Dante secondary Ethernet interfaces will provide independent PTPv2 server functionality. (And to highlight, this is in addition to PTPv1 functionality.)

In Dante-related AES67 or ST 2110-30 applications the Model 5402 can provide good PTPv2 functionality. But the Model 5402 can't serve as a general-purpose PTPv2 grandmaster clock. Limitations in Dante's AES67 or ST 2110-30 implementation restricts Studio Technologies' ability to adjust PTPv2 operating parameters, something that some applications may require. Refer to Appendix F for details on the default PTPv2 implementation that the Model 5402 provides.

Dante IP Addresses

If the Model 5402's Dante interface has been configured in the Dante Controller application for Switched or Switched+Mgmt operation, by default the Model 5402's Dante primary Ethernet interfaces will attempt to automatically obtain an IP address and associated settings using DHCP (Dynamic Host Configuration Protocol). If a DHCP server is not detected then an IP address will automatically be assigned using the link-local protocol. This protocol is known in the Microsoft® world as Automatic Private IP Addressing (APIPA). It is also sometimes referred to as auto-IP (PIPPA). Link-local will randomly assign a unique IP address in the IPv4 range of 169.254.0.1 to 169.254.255.254. In this way, multiple Dante-enabled devices will connect together and automatically function, whether or not a DHCP server is active on the LAN. Even two Dante-enabled devices that are directly interconnected using an RJ45 patch cord should correctly acquire IP addresses and be able to communicate with each other. As previously discussed, using

Dante Controller the Model 5402's Dante Ethernet IP address(es) and related network parameters can also be set for manual (fixed or static) operation.

If the Model 5402's Dante interface has been configured in Dante Controller for Redundant or Redundant+Mgmt operation then both the Model 5402's Dante primary and Dante secondary Ethernet interfaces will attempt to automatically obtain IP addresses and associated network settings using DHCP. If DHCP is not available then link-local IP addresses will be assigned. If automatic assignment of IP addresses is not desired each interface can be individually configured using Dante Controller to use a manual (fixed or static) IP address and related network parameters.

The specific IP address assigned to each of the Model 5402's Dante interfaces can be identified using several methods. The Dante Controller application will directly show the network parameters of the primary and, if utilized, secondary Ethernet interfaces. Another means is to utilize the Model 5402's network configuration webpage to directly show the IP addresses assigned to the primary and, if utilized, secondary Ethernet ports. The Model 5402's front-panel menu system can also be selected to show the Dante primary IP address.

Optimizing Dante Network Performance

For best Dante audio-over-IP performance a network that supports VoIP QoS (voice-over-internet-protocol quality of service) capability is recommended. This can typically be implemented on virtually all contemporary managed Ethernet switches. There are even specialized switches that are optimized for entertainment-associated applications. Also, it's recommended that IGMP snooping functionality on Ethernet switch ports associated with Dante devices be disabled. This can be important, allowing Dante-related multicast data traffic, including PTPv1, to be correctly supported. Refer to the Audinate website (audinate. com) for details on how to optimize a network for Dante applications.

Management IP Address and Configuration

It's easy to determine the active IP address being used by the Model 5402's management Ethernet port. The most direct method is to simply watch the

front-panel screens that are active in the "screen saver" mode. This mode will enable automatically two minutes after the last press of any of the front-panel buttons. The front-panel menu system also allows the management IP address to be shown and, if required, revised. A menu structure diagram is available in Appendix D. It's also available as a separate document on the Studio Technologies website.

By default, the Model 5402's management Ethernet interface address configuration is set for automatic. In this way, it will attempt to automatically obtain an IP address and associated settings using DHCP. If a DHCP server is not detected an IP address will automatically be assigned using the link-local protocol in the IPv4 range of 169.254.0.1 to 169.254.255.254. There are two ways that the management Ethernet IP address and related network parameters can be set to a manual (fixed or static) configuration. The first method uses the front-panel display and buttons to allow the management Ethernet network parameters to be viewed and revised as desired. An even easier method might be to use the network configuration webpage that is provided as part of the Model 5402's management webpages.

Model 5402 Firmware Update Procedure

It's possible that updated versions of the three firmware (embedded software) files that are utilized by the Model 5402's MCU (microcontroller) and two FPGA (field-programmable-gate-array) integrated circuits will be released to add features or correct issues. Refer to the Studio Technologies' website for the latest firmware files. The Model 5402 has the ability to load applicable firmware files into non-volatile memory by way of a standard USB flash drive. The Model 5402 implements a USB host function and provides access by way of a type A receptacle located on the back panel. The Model 5402 updates its firmware using three files. The Main MCU firmware is named **M5402v*XrXX*.stm**, the Main FPGA firmware is named **M5402Mv*XrXX*.stf**, and the Sync FPGA firmware is named **M5402Sv*XrXX*.stf**, where "*XrXX*" represents the revision level contained within the file.

The update process begins by preparing a USB flash drive. The flash drive doesn't have to be empty (blank) but must be in the personal-computer-

standard FAT32 format. One, two, or all three of the firmware files can be automatically loaded at essentially the same time. On the flash drive's root folder, save the desired new firmware files, ensuring that the required names are specified. The file name for the Main MCU firmware must be **M5402v*XrXX*.stm**. The file name for the Main FPGA firmware must be **M5402Mv*XrXX*.stf**. The file name for the Sync FPGA firmware must be **M5402Sv*XrXX*.stf**. Be certain to use the eject command to ensure that the file is correctly stored on the USB flash drive.

Studio Technologies will supply each firmware file inside a .zip archive file. While the firmware file inside of the zip file will adhere to the naming convention required by the Model 5402, the name of the zip file itself will include the file's version number. For example, a zip file named **M5402v2r01MCU.zip** would indicate that version 2.01 of the Main MCU firmware (**M5402v2r01.stm**) is contained within this zip file.

Once the prepared USB flash drive is inserted into the USB receptacle, located on the Model 5402's back panel, the Model 5402 must be powered off and then powered on again. At this point the file(s) stored on the USB flash drive will automatically load. The precise steps required will be highlighted in the following paragraphs.

To install one, two, or all three of the firmware files follow these steps:

1. Remove power from the Model 5402. This will entail removing the AC mains power connector or removing the connector associated with the external source of nominal 12 volts DC. (Both must be disconnected if dual powering has been implemented.)

2. Locate the USB receptacle on the Model 5402's back panel. It is labeled Firmware Update. Directly adjacent to the USB receptacle is a small hole that provides visual access to a green LED indicator.

3. Insert the prepared USB flash drive into the USB receptacle.

4. Apply power to the Model 5402. Power can be provided by connecting AC mains or a source of nominal 12 volts DC.

5. After a few seconds the Model 5402 will run a "boot loader" program that will automatically load and save the new firmware file(s) that are present on the USB flash drive. The update process can range from approximately 10 seconds to approximately 60 seconds, depending on which of the three files are going to be updated. While files are being loaded the green LED, located adjacent to the USB receptacle, will flash slowly. Once the entire loading process has completed the Model 5402 will reboot (restart) using the newly saved firmware.

6. At this time the Model 5402 is functioning with the newly loaded firmware and the USB flash drive can be removed.

7. It's a good idea to confirm that the desired Model 5402's Main MCU, Main FPGA, and Sync FPGA firmware versions are loaded and operating as expected. There are two methods for observing the Model 5402's firmware version numbers. The most direct is to use the front-panel display. Alternately, the System webpage from the management webpages can be utilized.

Note that no harm will occur if power is applied to the Model 5402 that has a USB flash drive connected that doesn't have relevant files in its root folder. Upon power up the green LED, located adjacent to the USB receptacle, will flash on and off rapidly for a few seconds to indicate that a valid file has not been found. After this warning, normal operation using the unit's existing firmware will begin.

Dante Firmware Update

As previously discussed, the Model 5402 implements Dante connectivity using the Brooklyn module from Audinate. The Dante Controller software application can be used to determine the version of the firmware (embedded software) that resides in the Brooklyn module. The System webpage provided by the Model 5402's management web server can also be used to identify the firmware version.

The firmware (embedded software) residing in the Brooklyn module can be updated using the Model 5402's Dante primary Ethernet port. Performing the update process is easily accomplished using an automated method called Dante Updater that's included as part of the Dante Controller software application.

The Dante Controller application is available, free of charge, from the Audinate website (audinate.com).

The latest Model 5402 firmware file, with an extension of .dnt, is available on the Studio Technologies' website as well being part of Audinate's product library database. The latter allows the Dante Updater software application that is included with Dante Controller to automatically query and, if required, update the Model 5402's Dante interface.

Restoring Model 5402's Default Settings

A command in the System Information webpage provided by the Model 5402's management web server allows most of the configuration settings to be restored to their default configuration values. For flexibility, this command allows the settings to be restored in two groups. One group covers the operational settings while the other group supports the management port and access settings. This can be useful but must be used with caution. Any customization made to the Model 5402's configuration will be lost. This can be offset in a positive way by returning the Model 5402 to a known configuration, a point that might aid in troubleshooting an issue. Refer to Appendix E for a list of the default values.

Lost User Name and/or Password

As is covered in detail in other sections, gaining access to the Model 5402's configuration menu webpages requires entering the correct user name and password. If the default entries, both of which are **guest**, are stored for use then they will show on the Login menu webpage. Pressing the Log In button on that webpage will then access the Main configuration webpage. If either or both the user name and the password have been configured to be something other than **guest** (the default) then nothing will show in the fields associated with the Login menu webpage.

If knowledge of the stored user name and/or password is "lost" then the Model 5402 includes a "back door" to allow access. But as a security measure physical access to the unit is required to utilize that access method; there is no means to access the unit via an Ethernet port without knowledge of the user name and password. The exact process of accessing the

Model 5402's configuration webpages without knowledge of the user name and/or password is detailed in Appendix G.

GNSS Antenna Choices

Each Model 5402 is shipped with an active multi-band GNSS (satellite) antenna. This antenna is from the Swiss firm u-blox and its data sheet can be found on the Studio Technologies website, associated with the Model 5402's Parts and Accessories documentation section. It's expected that this antenna will be useful in many, but not all, applications. At a minimum, the included antenna will ensure that an initial installation of a Model 5402 will offer GNSS performance without requiring an additional purchase.

The included antenna is of excellent quality but has possible application limitations. The first is that its integrated cable is just over 16 feet (5 meters) in length which precludes installation in many applications. An extension coaxial cable can be utilized but may not be optimal as the cable type is very small in diameter and loss could be expected when combined using coupling connectors. The second limitation is that while the included antenna is weather resistant it is not rated for continuous outdoor performance.

If the included antenna is not suitable, there is no reason why an alternate antenna can't be identified, purchased, and connected. As of the time of this writing, alternatives are readily available. By performing a web search Studio Technologies' factory personnel were able to locate several compatible antennas that had a range of interface connectors, environmental protection, and constellation support. Probably the source that had the most choices was eBay®, where compatible antennas ranged in price from about US$50 up to several thousand dollars!

When selecting an alternate antenna there are a number of parameters that have to be taken into account. The first is what frequency band or bands the antenna will support. That capability must be compared with what satellite constellations the Model 5402 is going to be configured to receive. The unit is capable of supporting four constellations which when all are selected requires a multi-band antenna. (Such as the antenna included with each Model 5402.) However, if for example only GPS support is needed then a more commonly available antenna can be utilized.

The alternate antenna's interface cable, typically purchased separately, must support compatible connections. One end would need to connect to the antenna and the other end to the Model 5402's SMA jack.

And finally, the selected alternate antenna must incorporate an integrated amplifier (be an "active" type) that can operate from the Model 5402's 5 volts DC power source. This power source is incorporated onto the center connection of the Model 5402's SMA jack. It is multiplexed with the radio frequency energy that is provided by the antenna.

The multi-band antenna included with each Model 5402 has a nominal gain of 28 dB. An alternate antenna should have at least that amount of gain. And some additional gain, up to about 6 or 8 dB, may be beneficial. But as the sophistication of an antenna, and the price, goes up the gain may well go up too. And the gain may be in excess of what the Model 5402's GNSS receiver can handle.

In conclusion, it's certainly possible to select and utilize an alternate GNSS antenna. But it's critical that both the new antenna and the Model 5402 be thoroughly tested together. Only a "reality check" over a period of a day or so will ensure proper operation.

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: ±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 and information contained in this User Guide subject to change without notice.

Appendix A–Compatible Sync Input Sources

The Model 5402's external sync input has been tested and confirmed for correct operation with the following signals:

Word Clock: Square wave signal with rate of 44.1, 48, 88.2, 96, 176.4, and 192 kHz

10 MHz: Sine wave signal with an amplitude of 1 Vrms, nominal, terminated with 50 ohms
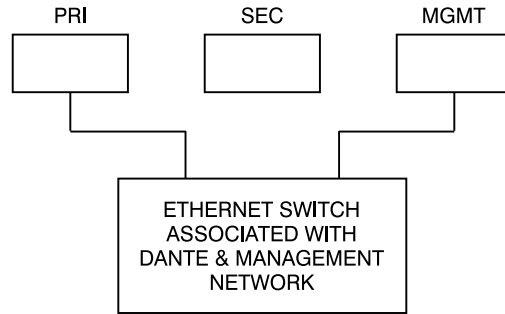
Bi-Level and Tri-Level Video: See table below

Video Format
NTSC ("Black Burst")
PAL ("Black Burst")
720p/50 Hz
720p/59.94 Hz
720p/60 Hz
1080psf/23.98 Hz
1080psf/24 Hz
1080i/50 Hz
1080i/59.94 Hz
1080i/60 Hz
1080p/23.98 Hz
1080p/24 Hz
1080p/25 Hz
1080p/29.97 Hz
1080p/30 Hz
1080p/50 Hz
1080p/59.94 Hz
1080p/60 Hz

Appendix B–Network Configuration Examples

ONE LAN – SWITCHED DANTE
MODEL 5402 NETWORK INTERFACE
CONFIGURED FOR SWITCHED OPERATION

PRI   SEC   MGMT

ETHERNET SWITCH
ASSOCIATED WITH
DANTE & MANAGEMENT
NETWORK

ONE LAN – SWITCHED DANTE
MODEL 5402 NETWORK INTERFACE
CONFIGURED FOR SWITCHED OPERATION

PRI   SEC   MGMT

PATCH CORD

ETHERNET SWITCH
ASSOCIATED WITH
DANTE & MANAGEMENT
NETWORK
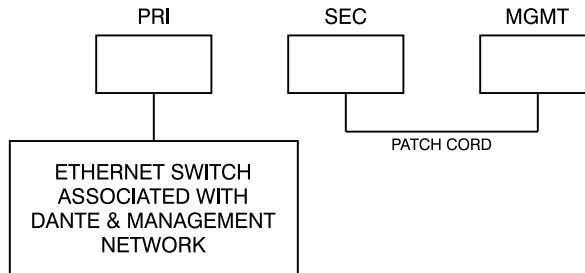
TWO LANs – SWITCHED DANTE
MODEL 5402 NETWORK INTERFACE
CONFIGURED FOR SWITCHED OPERATION
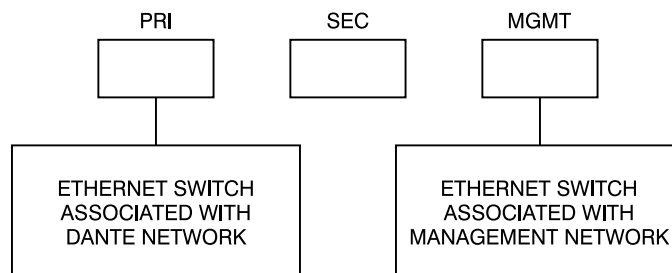
PRI   SEC   MGMT

ETHERNET SWITCH
ASSOCIATED WITH
DANTE NETWORK

ETHERNET SWITCH
ASSOCIATED WITH
MANAGEMENT NETWORK

TWO LANs – REDUNDANT DANTE

MODEL 5402 NETWORK INTERFACE
CONFIGURED FOR REDUNDANT OPERATION

PRI   SEC   MGMT

ETHERNET SWITCH
ASSOCIATED WITH
DANTE PRIMARY &
MANAGEMENT NETWORK

ETHERNET SWITCH
ASSOCIATED WITH
DANTE SECONDARY
NETWORK

TWO LANs – REDUNDANT DANTE

MODEL 5402 NETWORK INTERFACE
CONFIGURED FOR REDUNDANT OPERATION

PRI   SEC   MGMT

ETHERNET SWITCH
ASSOCIATED WITH
DANTE PRIMARY
NETWORK

ETHERNET SWITCH
ASSOCIATED WITH
DANTE SECONDARY &
MANAGEMENT NETWORK

THREE LANs – REDUNDANT DANTE

MODEL 5402 NETWORK INTERFACE
CONFIGURED FOR REDUNDANT OPERATION

PRI   SEC   MGMT

ETHERNET SWITCH
ASSOCIATED WITH
DANTE PRIMARY
NETWORK

ETHERNET SWITCH
ASSOCIATED WITH
MANAGEMENT
NETWORK

ETHERNET SWITCH
ASSOCIATED WITH
DANTE SECONDARY
NETWORK
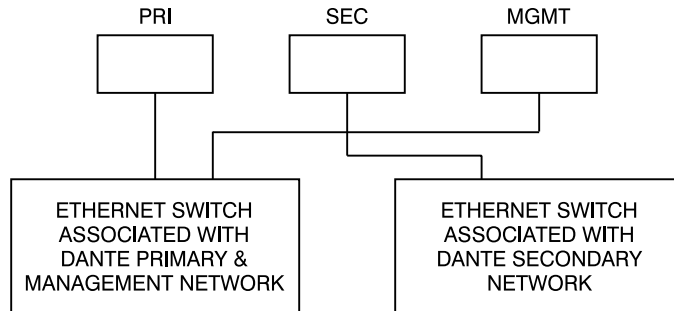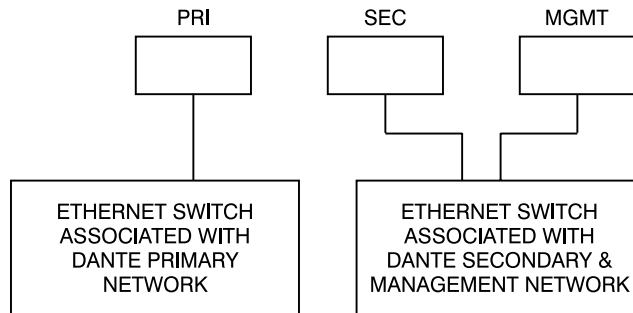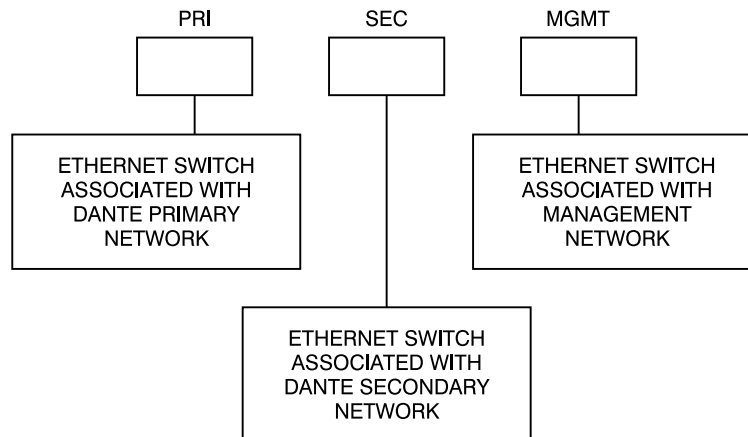
ONE LAN – SWITCHED+MANAGEMENT DANTE

MODEL 5402 NETWORK INTERFACE
CONFIGURED FOR SWITCHED+MGMT OPERATION

PRI   SEC   MGMT

ETHERNET SWITCH
ASSOCIATED WITH
DANTE & MANAGEMENT
NETWORK
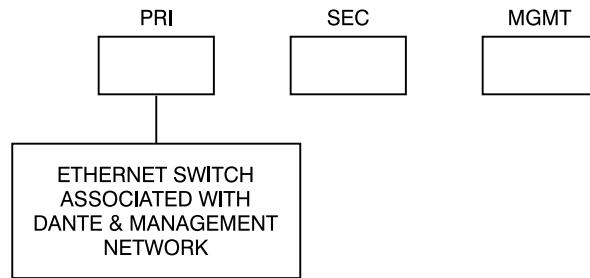
TWO LANs – REDUNDANT+MANAGEMENT DANTE

MODEL 5402 NETWORK INTERFACE
CONFIGURED FOR REDUNDANT+MGMT OPERATION

PRI   SEC   MGMT

ETHERNET SWITCH
ASSOCIATED WITH
DANTE PRIMARY &
MANAGEMENT NETWORK

ETHERNET SWITCH
ASSOCIATED WITH
DANTE SECONDARY
NETWORK
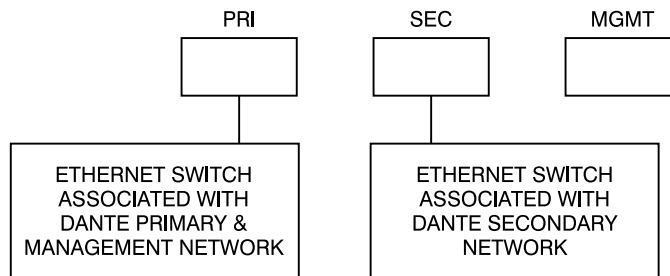
Appendix C–Dante Controller Default Settings

Default Device Configuration Screen

Default Network Configuration Screen

Appendix D–Front-Panel Menu Structure

Menu icon definitions:
↵ = Enter for info or editing
🔒 = Locked - No editing
✂ = Edit in process
↻ = Reboot for changes to take effect

Dante Sync Status Primary PTPv1 — Current Clock Source — GNSS Status — Sync Input Type & Status — Sync Input Termination — Phase Detector Deviation (Factory Use)

Date & Time — Antenna Status — No. of Satellites & Signal Strength — Time to First Fix (TTFF)

Current Management IP Address — Current Management Subnet Mask — Management IP Configuration * — Manual Management IP Address * — Manual Management Subnet Mask *

Dante Device Name — Dante Primary IP Configuration * — Dante Primary IP Address * — Dante Primary Subnet Mask * — Ethernet Switch Configuration * — Reboot Dante *

Product Name & Serial Number — Main MCU Firmware Version — Main FPGA Firmware Version — Sync FPGA Firmware Version — Dante Product Version — Reboot System *

Studio Technologies Logo — Product Name & Dante Device Name — Date & Time — Dante Sync Status — Current Clock Source — Current Management IP Address

Screen Saver (each screen active for approximately three seconds)

1. Screen saver automatically activates two minutes after last button press.
2. Press left and right buttons simultaneously to immediately enter screen saver mode.
3. Pressing Enter while screen saver is active goes directly to Current Management IP Address page.
4. This reflects operation for Model 5402 Main MCU firmware version 1.00 and later.

Appendix E–Model 5402 Default Operational Settings

Main Menu:
Main Clock Source: Internal
Failover Clock Source: Dante
Force Preferred Leader: Enabled

Sync Input Menu:
Type: Word Clock
Termination: On

Tone Generator Menu:
Tone 1: Frequency 100 Hz, Level –21 dBFS
Tone 2: Frequency 200 Hz, Level –22 dBFS
Tone 3: Frequency 300 Hz, Level –23 dBFS
Tone 4: Frequency 400 Hz, Level –24 dBFS
Tone 5: Frequency 500 Hz, Level –25 dBFS
Tone 6: Frequency 600 Hz, Level –26 dBFS
Tone 7: Frequency 700 Hz, Level –27 dBFS
Tone 8: Frequency 800 Hz, Level –28 dBFS

Network Menu, Management Interface:
IP Address Configuration: Automatic
Manual IP Address: 192.168.1.54
Manual Subnet Mask: 255.255.255.0
Manual Gateway: 192.168.1.1

Access Menu, Management Login Credentials:
User Name: guest
Password: guest

Appendix F–PTPv2 (IEEE® 1588-2008) Default Characteristics

With RTP Mode for AES67 Enabled

With RTP Mode for ST 2110-30 Enabled

Appendix G–Accessing the Unit when User Name and/or Password are Not Known

Follow this procedure to access the Configuration menu webpages if the user name and/or password is not known.

1. Remove power from the Model 5402.

2. Press and hold the left arrow and Enter buttons.

3. While continuing to hold the two buttons apply AC Mains or 12 volts DC power.

4. Continue to hold the two buttons and allow the Model 5402 to start. The Status LEDs on the front panel will first light green then light red in their start-up sequence.

5. Once the Status LEDs have completed their start-up sequence release the two buttons.

6. Use a web browser to access the Model 5402's Configuration menu webpages. The management port's IP address to use is shown in the current management IP address page on the front-panel display. Pressing the Enter button will cause the current management IP address page to immediately show on the front-panel display.

7. From the Home webpage select the Login menu webpage tab. Leave the user name and password fields empty and click the Log In button. This will allow access to the Configuration menu selections. At this point your web browser should show the Model 5402's Home webpage.

8. Navigate to the Access menu. From this webpage you will be able to view the stored user name. You will not be able to view the previously saved password. Enter and confirm a new password. Henceforth, to access the Model 5402's Configuration menu will require the use of the stored user name and password.