

Model 5401

Dante™ Master Clock

User Guide

Issue Preliminary 4, May 2018

This User Guide is applicable for serial numbers M5401-00151 and later with application firmware 1.02 and later and Dante firmware 1.1.0 (Brooklyn II 3.10.2.2) and later

Copyright © 2018 by Studio Technologies, Inc., all rights reserved
www.studio-tech.com

This page intentionally left blank.

Table of Contents

Revision History	4
Introduction	5
Installation	Pending
Configuration	8
Operation	Pending
Technical Notes	Pending
Specifications	19
Appendix A—Sync Input Sources	21
Appendix B—Model 5401 Menu Structure	22
Appendix C—PTP v2 (IEEE-1588-2008) Characteristics	23

Revision History

Issue Preliminary 4, May 2018:

- Additional text and improvements.

Issue Preliminary 3, November 2017:

- Additional text and improvements.

Issue Preliminary 2, October 2017:

- Additional text and improvements.

Issue Preliminary 1, October 2017:

- Initial release.

Model 5401

DANTE MASTER CLOCK

Introduction

The Model 5401 Dante Master Clock provides precise timing signals for applications that utilize the Dante® audio-over-Ethernet 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 5401 provides the PTP v1 (IEEE® 1588-2002) compatibility that's required by Dante. In addition, the unit supports PTP v2 (IEEE 1588-2008) for AES67 applications. A word clock output provides a timing reference for use by external devices. The Model 5401 also generates up to eight sine-wave audio tones on Dante transmit (output) channels, useful during audio network installation, maintenance, and operation. A sync input connection allows the Model 5401's internal oscillator to synchronize with a variety of timing reference signals.

The Model 5401 is suitable for use in fixed and mobile broadcast facilities, post-production studios, commercial and educational theater environments, and entertainment applications. Only power and one or two Ethernet network connections are required for full operation. Using Dante's inherent

capabilities two Model 5401 units can serve in primary and secondary master clock roles for redundant operation.

An integral web server allows fast and flexible monitoring and configuration of the Model 5401's master clock, tone generation, and networking performance. Front-panel indicators, an LCD display, and pushbutton switches provide personnel with direct access to key operating parameters. Updating of the Model 5401's operating software can be easily performed using the integrated FTP (file-transfer protocol) client. The unit's dual Gigabit Ethernet ("GigE") network interfaces allow support for redundant Dante operation. All software files and configuration parameters are stored in non-volatile memory. The Model 5401 can be powered by 100-240 V, 50/60 Hz mains or a source of 12 volts DC. The lightweight enclosure mounts in one space (1U) of a standard 19-inch rack.

Applications

Applications for the Model 5401 include broadcast facilities, college and university audio networks, arenas, stadiums, and corporate installations — virtually any application where substantial numbers of Dante-compatible devices are utilized. The Model 5401 will serve as a stable and



Figure 1. Model 5401 Dante Master Clock front and back views

consistent master clock for the entire Dante “network.” And, as expected, the Model 5401 is compatible with all Dante devices, no matter what their primary function or manufacturer. Applications that utilize devices compatible with AES67 will also benefit from the Model 5401’s resources.

Why a Dedicated Dante Master Clock?

With Dante ubiquitous in fixed and mobile facilities of all sizes and types, the need arose for a cost-effective, purpose-designed, dedicated master clock. While an inherent strength of Dante networking is its carefully implemented use of IEEE 1588 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 master clock, but with the Model 5401 networked audio systems get the benefits of a high-performance “grandmaster” PTP server, 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 5401 can provide excellent master clock performance using its accurate and stable internal oscillator, which is temperature-controlled and exceeds the performance of standard Dante devices by at least an order of magnitude. While its standalone performance is excellent, the Model 5401 can also be “locked” to a variety of external signals for integration into facilities that

include a master timing reference. Compatible signals include word clock, video reference, and 10 MHz.

A word clock signal is often used as a timing reference in audio-only facilities. Several word clock rates, including 48 and 96 kHz, are compatible with the Model 5401’s sync input. Video reference (“sync”) signals are found in most broadcast and post-production facilities. The Model 5401 supports the most-common video format/rate combinations including “black burst,” bi- and tri-level HD, and several that are specifically intended for 4K applications. Industrial and commercial facilities often utilize a GPS-disciplined source of 10 MHz as a timing reference. This sine-wave signal is directly compatible with the unit’s sync input.

Word Clock Output

The Model 5401 generates a precise word clock output signal that can be used as a timing reference for related equipment. It’s specifically intended for “locking” audio equipment in applications that have Dante equipment whose timing reference signals are provided by a Model 5401. In this way all devices will share a common timing reference.

The word clock output rate can be selected to be 44.1, 48, 88.2, or 96 kHz. The underlying timing source for the word clock output is derived from the Model 5401’s main timing source. As previously reviewed, the internal oscillator, if desired, can be “locked” to an external source. The main timing source is divided and processed by the Model 5401’s logic circuitry to create the highly stable word clock output. This ensures that the word clock output is synchronized with the unit’s PTP server functionality.

Audio Reference Signals

The Model 5401 generates eight sine-wave audio reference signals for general-purpose use. They are individually configurable in level and frequency. These audio “tones” are available on the Model 5401’s Dante transmitter (output) channels and can be connected, using the Dante Controller application, to Dante receivers (inputs) on related equipment. The flexibility of the available routes (Dante “subscriptions”) between all Dante devices on a network allows the reference signals to be used for a variety of purposes. Configuration choices allow the frequency and level of the sine-wave signals to be optimized for specific applications.

Master Clock Support for Dante Networks

A core part of the technology underlying Dante audio-over-Ethernet networking ensures that all connected devices follow a common timing reference. This is accomplished using the industry-standard IEEE 1588-2002 precision time protocol (PTP v1). Any connected Dante device can be used as a master clock; there is no requirement that a dedicated master clock device be utilized to realize adequate performance. However, the actual performance can range widely depending on the specific Dante devices available and the overall number of Dante devices on the network.

Many Dante devices utilize the 2- or 4-channel Ultimo™ integrated circuit to implement Dante connectivity. While Ultimo devices will fully support Dante audio transport they are not well suited to serve as a master clock. Ultimo’s PTP performance is limited and does not have

the ability to synchronize with an external timing reference. Other Dante devices use the Brooklyn II module to support Dante connectivity. In many cases these devices can provide good basic performance as a master clock including some that allow connection of an external source of word clock.

However, problems and limitations may arise when these devices are called upon to perform “double duty,” serving both a primary function (such as analog-to-Dante interfacing or audio signal processing) as well as acting as a master clock. This is understandable as the main purpose of these devices is to serve a function other than as a master clock. Timing related features, such as allowing connection of a video bi- or tri-level sync signal is rarely, if ever, supported. And PTP performance can degrade when the computing power of a device is intended primarily for handling and manipulating digital audio signals. This can lead to the required PTP resources being in short supply when the number of Dante devices that need timing messages moves into the hundreds. Also, firmware updates, cabling changes, and other maintenance tasks typically associated with a general-purpose Dante audio device would impact the master clock functionality for an entire installation.

The Model 5401 was specifically designed to support a Dante-based audio system’s master clock requirements. The unit’s generation of audio tones and implementation of the word clock output utilize hardware that is separate from that associated with PTP functionality. As such, this secondary functionality will not interfere with PTP operation. Unlike a general-purpose audio device, once mounted in an equipment

rack and the required interconnections are made, the Model 5401 will perform its tasks without risk of interruption due to conflicting resource demands.

Overall Networking Capability

Using the Dante Controller application program the Model 5401's two Gigabit Ethernet ports can be selected to operate in one of three modes: Switched, Redundant, and Pri Dante/Sec Mgmt. In the Switched mode a single Ethernet connection to either of the Model 5401's Ethernet ports will provide Dante master clock functionality as well as access to the Model 5401's management web pages. The remaining Model 5401 Ethernet port will provide network "loop-through" capability and can be used to interface with another piece of Ethernet-connected equipment. In the Redundant mode two independent Ethernet connections are made to the Model 5401's Ethernet ports, enabling Dante's redundant network capability. In this mode the Model 5401's primary Ethernet port will provide access to the management web pages. In the Pri Dante/Sec Mgmt mode, the Model 5401's primary Ethernet port will be used by the network associated with Dante while the secondary Ethernet port will be used to access the unit's management web pages. This allows separate networks to be maintained for Dante and maintenance and configuration purposes.

Operating Power

The Model 5401 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 a load be placed on the DC source. This allows a source of DC, typically an external power supply or broadcast-style battery, to serve in a backup capacity. With this arrangement normal operation can continue even if AC mains power is lost.

Future Capabilities

The Model 5401's main and logic (FPGA) embedded software (firmware) can be updated by way of its Ethernet network connection and the internet. Multiple versions of firmware are used to support the Dante interface hardware, user management menus, and audio generation capabilities. Each can be independently updated as required.

Installation

— Pending —

Configuration

Sync Settings Menu

Force Preferred Master

This is a configurable field with two choices: *Disabled* or *Enabled*. The default factory selection is *Enabled*; restoring the Model 5401's factory defaults will return the selection to *Enabled*.

This function impacts how the Model 5401 will control a Dante network's selection of which device is going to serve as the master clock. As the main reason for the Model 5401's existence is to serve as a master clock, in most cases the unit should serve

Model 5401

DANTE MASTER CLOCK

in that role. By forcing the Model 5401 to be a preferred master it helps to ensure optimal Dante network operation. Users of the Dante Controller application will not be able to accidentally disable the Model 5401 as a preferred master. One can see exactly what is meant by the term “force preferred master” by unchecking the Model 5401’s preferred master check box in Dante Controller. After a short interval the box will automatically return to the enabled (checked) state.

How the Model 5401 handles forcing the Dante network to master clock operation and, if applicable, supporting an external clock input is not trivial. Reviewing some of the details can provide valuable insight: If the Model 5401’s clock source is configured for *Dante* the Model 5401 will always force the enable sync to external selection in Dante Controller to be off (unchecked). If the Model 5401’s clock source is configured for *Internal* then the Model 5401 will always force *Enable Sync to External* in Dante Controller to be on (checked) as long as the Model 5401 is acting as primary master, secondary master, or AES67 master. If the Model 5401’s clock source is configured for *Sync Input* the Model 5401 will always force the enabled sync to external in Dante Controller to be on (checked).

Clock Source

This is a configurable field with three choices: *Internal*, *Sync Input*, or *Dante*. The default factory selection is *Internal*; restoring the Model 5401’s factory defaults will return the selection to *Internal*.

This setting determines which timing source is used by the Model 5401’s circuitry as its own “master” timing reference.

This is the clock source that will be used by the Model 5401’s PTP server circuitry, the “heart” of the Model 5401’s support of related Dante devices. When *Internal* is selected the Model 5401’s temperature-stabilized, high-performance crystal oscillator is utilized. This will provide excellent timing accuracy and long-term consistent performance. This source is far superior to that provided by other standard Dante devices. This is the correct choice if a high-quality external reference signal is not going to be connected.

When *Sync Input* is selected the Model 5401’s external sync input connection will be active. Using a BNC connector, located on the Model 5401’s back panel, an external source of word clock, video reference, or 10 MHz sine wave can be connected. Circuitry with the Model 5401 will “lock” (synchronize) the internal timing signals to the externally provided reference signal. This is the recommended operating mode if a precision external reference is available. For example, in facilities that have equipment that supports video it’s typical to have a high-end master timing generator. And in audio facilities a “master” source of word clock may be available. In industrial or commercial settings a GPS receiver may be provided as a source of high-precision 10 MHz. But be aware that it is possible that an externally available reference signal may not be as “good” as the Model 5401’s internal oscillator. If that is the case then the internal source should be utilized. Other devices in a facility can then “lock” to the Model 5401’s word clock output. (This is available by way of a BNC connector located on the Model 5401’s back panel.)

Model 5401

DANTE MASTER CLOCK

Selecting *Dante* will instruct the Model 5401 to use the clock signal from its Dante interface circuitry as the timing source for the PTP server. The Dante interface circuitry will either use its internal crystal oscillator or synchronize to another Dante device on the network. The clock source the Model 5401's Dante interface uses will depend on a setting in the Dante Controller application. The Model 5401 includes the choice of *Dante* as a 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 5401 operation. By selecting *Dante* the excellent timing performance that the internal oscillator can provide or the benefits gained from synchronization with a "house" timing reference would not be utilized.

Sync Input Type

This is a configurable field with three choices: *Word Clock*, *Video*, or *10 MHz*. The default factory selection is *Word Clock*; restoring the Model 5401's factory defaults will return the selection to *Word Clock*.

If the Model 5401's clock source has been selected to *Sync Input* the type of connected source must be defined. If *Word Clock* is selected then a square wave source with a rate of 44.1 kHz, 48 kHz, 88.2 kHz, or 96 kHz can be connected. For proper operation the nominal level of the word clock source must be 5 volts DC. Also, the connected word clock source must match the displayed 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 5401 sample rate. This is the sample rate

desired for the eight channels of audio tone generator (Model 5401 Dante transmitter channels). In most applications this will be 48 kHz. It's possible that in some audio-only applications 96 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 connector. The Model 5401's circuitry will automatically decode 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 at the end of this guide for a detailed list of compatible video sources.

If a choice of sync sources is available the factory recommends that a source of word clock be utilized. This is because the Model 5401's clock circuitry has to perform the least amount of processing with a word clock input signal as compared to that required for a video or 10 MHz signal.

Sync Input Termination

This is a configurable field with two choices: *Off* and *On*. The default factory selection is *On*; restoring the Model 5401's factory defaults will return the selection to *On*.

If desired, the Model 5401 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. The source can generally be shared (“bused”) to multiple devices with the last connection on the connection string applying an appropriate termination.

If sync input termination is configured for *Off* then the sync input’s impedance will be greater than 100 k ohms. 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.

Sync Input Failover Source

This is a configurable field with two choices: *Internal* or *Dante*. The default factory selection is *Internal*; restoring the Model 5401’s factory defaults will return the selection to *Internal*.

This configuration choice applies only if the Model 5401 has been configured to use the sync input. It specifies which clock source should be used by the Model 5401 if a valid sync source is not connected to the sync input. If *Internal* is selected then the precision crystal oscillator will be utilized as the master clock source should a valid signal not be connected to the sync input. If *Dante* is selected then the clock source derived from the Dante interface will be used.

From a performance standpoint it’s preferable to select *Internal*. This ensures that the best clock performance can be obtained should a valid external sync source not be present (sync input status unlocked). However, selecting *Dante* would allow an interesting alerting feature to

become active. In the Dante Controller application a device, such as the Model 5401, that has been selected as the preferred master with an external source allowed will have an error condition occur if the Dante interface doesn’t detect an external reference being applied. And losing the external reference is what the Model 5401’s circuitry will do should Dante be selected as the failure source. In this way a Dante network user could be alerted to an issue with the Model 5401 should it lose its very important external sync source.

Getting an error condition reported in Dante Controller is probably not terribly important. The sync LED on the Model 5401’s front panel will also offer a clear indication of a loss of an external sync signal. The LED will typically slowly flash green when the Model 5401 is functioning correctly as the clock master for the Dante network. However, should the unit be configured to use an external sync signal and a valid one is not present, the sync LED will flash orange to indicate the loss of lock to the sync input. In addition, the display will provide a text indication of this condition.

Sync Input Status

This is a display-only field that can show ---, *Unlocked*, or *Locked*.

This field reflects the status of the Model 5401’s sync input circuitry. If the Model 5401’s clock source has not been selected for *Sync Input* then the sync input status field will display ---. This simply indicates that the Model 5401 has not been configured to utilize an external sync source so there is no status associated with it.

Unlocked will be displayed if the sync input has been selected as the clock

Model 5401

DANTE MASTER CLOCK

source but either no signal is connected 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 being connected. For example, the situation 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*.

Locked will be displayed when a signal connected to the Model 5401's sync input is serving as the master timing reference. If the clock source configuration has been selected for *External* this is the desired condition. If *Locked* does not display then standard troubleshooting should be performed to remedy the issue. In most cases the problem will be resolved by ensuring that the sync input type configuration and the actual connected sync source are the same.

Detected Sync Input Format

This is a display-only field that can show ---, *Error*, 44.1 kHz, 48 kHz, 88.2 kHz, 96 kHz, one of the video format/rate combinations, or 10 MHz.

This field reflects the operation of the Model 5401's sync input circuitry. If the clock source is not set for *External* then the circuitry is not operational and --- will display. If *External* is selected then the field will display either *Error* or a detected rate. *Error* will display if the connected source doesn't match the selected sync input type. For example, if *Word Clock* has

been selected as the sync input type but a video sync signal has been connected. The detected rate will be displayed whenever the sync input status is locked. If this is a word clock signal then one of the four compatible rates will be displayed. If this is due to a video source being connected then the actual rate/format characteristics will be displayed. The compatible rate/format combinations are listed in Appendix A of this Guide. If locked is due to a 10 MHz signal being recognized then 10 MHz will display.

Current Dante Sample Rate

This is a display-only field that can show 44.1 kHz, 48 kHz, 88.2 kHz, or 96 kHz.

This field displays the Model 5401's currently selected sample rate as used by the Model 5401's Dante transmitter (output) channels. The transmitter channels, as of the initial firmware release, provide eight unique tone outputs labeled Tone01 through Tone08. From the factory the Model 5401's sample rate is selected to be 48 kHz. Changes to the sample rate are made using the Dante Controller software application. Restoring the Model 5401's factory defaults will not change the sample rate setting.

Submit

The *Submit* button is located on the bottom of the Sync Settings menu page. For any changes made to fields on the Sync Settings page to be saved and acted upon the *Submit* button must be pressed.

Identify Device

The *Identify Device* button is located in the upper-left corner of the Sync Settings main page, directly below the Dante device name display. Pressing the *Identify Device* button will cause the associated Model 5401

to flash its green backlight associated with the display five times.

Audio Generator Menu

The Model 5401's audio generator function is capable of creating eight precision sine-waves signals ("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 output signals have default names of *Tone01* through *Tone08*. It's expected that most applications will only use a few of the tones. But having eight output channels provides flexibility in creating a range of signals with various frequency and level combinations. These can be used for a range of applications including identifying individual channels in a multi-channel arrangement, e.g., stereo, 5.1, or 7.1.

Frequency (Hz)

These eight fields reflect the Model 5401's currently selected sine-wave 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 display 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 display the level of the Model 5401's eight sine-wave outputs. The output level for each of the eight audio generator output channels is independently adjustable over a range of -99 to 0 dBFS.

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.

The default tone levels were selected in a pattern that could help identify a specific channel. Channel *Tone01* 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, *Tone02*, 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

The *Submit* button is located on the bottom of the Audio Generator menu page. For any changes made to fields on the Audio Generator page to be saved and acted upon the *Submit* button must be pressed.

Identify Device

The *Identify Device* button is located in the upper left corner of the Audio Generator main page, directly below the Dante device name display. Pressing the *Identify Device* button will cause the associated Model 5401 to flash its green backlight on the display five times.

Network Configuration Menu

Dante IP Addresses

Primary

This is a display-only field that shows the IP address associated with the Model 5401's primary Dante data path. It will show either *No Ethernet Link* or an IP address. The IP address displayed in this field is not the IP address associated with the Model 5401's internal management web server. The 32-bit IP v4 address is displayed in what's known as dot-decimal notation.

How the IP address is determined depends on the Model 5401's network configuration setting as performed using the Dante Controller application. The IP address can be established automatically using a DHCP server or the IPv4 link-local protocol. An IP address assigned to the primary Dante port by link-local will have a format of 169.254.x.x. The primary IP address can also be set to a manual (static or fixed) IP address using Dante Controller.

If the network configuration is selected in Dante Controller for *Switched* (the factory default) then the primary Dante IP address will be associated with a network connection made to either the primary or the secondary RJ45 connections on the Model 5401's back panel. If the network configuration is selected for *Redundant* or

Pri Dante/Sec Mgmt then the primary Dante IP address will be associated with the RJ45 connection labeled Primary on the Model 5401's back panel. *No Ethernet Link* will display if a valid Ethernet connection has not been made with the primary RJ45 jack.

If the Model 5401's network configuration in Dante Controller is selected for *Switched* ensure that only one of the RJ45 connections on the back panel is connected to the LAN associated with the Dante devices. The other RJ45 connection can be used to interconnect with another piece of networked equipment. But having both of the Model 5401's RJ45 connections routed to ports on the same LAN will typically "crash" the network!

Secondary

This is a display-only field that shows the IP address associated with the Model 5401's secondary Dante data path. It will show *Disabled*, *No Ethernet Link*, or an IP address. The IP address displayed in this field is not the IP address associated with the Model 5401's internal management web server.

What is displayed and how a displayed IP address is determined depends on the setting of the Model 5401's network configuration using the Dante Controller application. If the network configuration is selected for *Switched* or *Pri Dante/Sec Mgmt* then a secondary Dante IP address will never be active and *Disabled* will be displayed.

If the network configuration is selected for *Redundant* then the secondary Dante IP address will be displayed. This is the Ethernet connection that is associated with RJ45 connection labeled Secondary on the

Model 5401's back panel. The IP address can be established automatically using a DHCP server or the IPv4 link-local protocol. An IP address assigned to the secondary Dante port by link-local will have a format of 172.31.x.x. The secondary IP address can also be set to a manual (static or fixed) number using the Dante Controller application. *No Ethernet Link* will display if a valid Ethernet connection has not been made with the secondary RJ45 jack.

Management Addresses

MAC Address

This is a display-only field that shows the Model 5401's MAC (media access control) address. This is a unique hardware identification number that is assigned to each specific Model 5401. No two Ethernet-connected devices should ever share a MAC address.

Current IP Address

This is a display-only field that shows the IP address associated with the Model 5401's internal management web server. This address can be assigned automatically via DHCP or IPv4 link-local. It can also be manually assigned with a fixed or static IP address. The Current IP Address is not associated with the Model 5401's primary or secondary Dante data connections.

If the Model 5401's network configuration is selected in Dante Controller for *Switched* (the factory default) then the management IP address will be associated with a network connection made to either the primary or secondary RJ45 connections on the Model 5401's back panel. If the network configuration is selected for *Redundant* then the IP address will be associated with the network connection made to the RJ45 connection labeled Primary on the Model

5401's back panel. If the network configuration is selected for *Pri Dante/Sec Mgmt* then the IP address will be associated with network connection made to the RJ45 connection labeled Secondary on the Model 5401's back panel.

As previously mentioned, if the Model 5401's network configuration in Dante Controller is selected for *Switched* ensure that only one of the RJ45 connections on the back panel is connected to the LAN associated with the Dante devices. The other RJ45 connection can be used to interconnect the same LAN with another piece of networked equipment. But having both of the Model 5401's RJ45 connections routed to ports on the same LAN will typically "crash" the network!

IP Address Configuration

This is a configurable field with two choices: *Automatic* and *Manual*. The default factory selection is *Automatic*. To minimize the chance of losing access to the internal management web server restoring the Model 5401's factory defaults will not change the currently selected choice.

This configuration impacts how the Model 5401 obtains the IP address that is used for accessing the Model 5401's management web server and associated menu pages. This setting has no impact on how the Model 5401 obtains the primary and secondary IP addresses associated with the Dante Ethernet connections.

Selecting the *Automatic* setting will cause the Model 5401 to use DHCP or IPv4 link-local to establish the IP address of the Model 5401's management port. With this setting upon establishing a link to the appropriate Model 5401 RJ45 jack the DHCP protocol will request an IP address and

related parameters. If obtaining an IP address by way of the DHCP protocol is not successful then the IPv4 link-local protocol will be used. If an IP address that has the format of 169.254.x.x displays as the current IP address then it was assigned using IPv4 link-local. Even if the IP address was established using link-local the DHCP protocol will stay active. Approximately every 60 seconds the Model 5401'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 be used, replacing 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 manual IP address, subnet mask, gateway IP address, and DNS 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, subnet mask, gateway IP address, and DNS IP address fields.

Manual IP Address

This field is grayed out and will not display any text when the IP address configuration mode is selected for *Automatic*. When the IP address configuration is selected for *Manual* this field will display the IP address that is stored in the Model 5401. This is the IP address that is currently

being used, or will be used at the time of the next Ethernet connection reboot. It is the IP address that allows access to the Model 5401's management web server and associated menu pages. It has nothing to do with the IP address(es) associated with the Dante port(s). 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 format (4 octets separated by dots) the *Submit* button must be pressed for the changes to be stored. Restoring the Model 5401 default values will not change the stored IP address. A system reboot is required for the revised manual IP address to be utilized.

Subnet Mask

This field is grayed out when the IP address configuration mode is selected for *Automatic*. This field will be display-only in this instance and will display an IPv4 subnet mask in dot-decimal notation (4 octets separated by dots) if the current IP address and related network parameters were obtained by way of DHCP. This is the subnet mask that is being used by the internal management web server. If IP configuration mode is selected for *Automatic* and the current IP address was obtained by way of link-local then the associated subnet mask of 255.255.0.0 will be shown in this field.

When the IP address configuration is selected for *Manual* the field will not be grayed out. In this situation the stored subnet mask will be displayed and can be modified as desired to meet the requirements of the application. The displayed value is the subnet mask that is currently in use or will be used at the time of the next Ethernet connection reboot. After entering

an IP address using the standard dot-decimal notation format (4 octets separated by dots) the *Submit* button must be pressed for a change to be stored. A system reboot is required for the revised subnet mask value to be utilized. Restoring the Model 5401 default values will not change the stored subnet mask value.

Gateway IP Address

This field is grayed out when the IP address configuration mode is selected for *Automatic*. This field will be display-only in this instance and will display an IPv4 gateway IP address in dot-decimal notation (4 octets separated by dots) if the current IP address and related network parameters were obtained by way of DHCP. This is the gateway IP address that is being used by the Model 5401's management web server. If the IP configuration mode is selected for *Automatic* and the current IP address was obtained by way of link-local no gateway IP address will be shown in this field. This is because no gateway IP address is associated with link-local.

When the IP address configuration is selected for *Manual* the field will not be grayed out. In this situation the stored gateway IP address will be displayed and can be modified as desired to meet the requirements of the application. The displayed value is the gateway IP address that is currently in use, or will be used at the time of the next Ethernet connection reboot. After entering a gateway IP address using the standard dot-decimal notation format (4 octets separated by dots) the *Submit* button must be pressed for a change to be stored. A system reboot is required for the revised gateway IP address to be utilized. Restoring the Model 5401 default values will not change the stored gateway IP address value.

DNS IP Address

This field is grayed out when the IP address configuration mode is selected for *Automatic*. This field is display-only in this instance and will display an IPv4 DNS IP address in dot-decimal notation (4 octets separated by dots) if the current IP address and related network parameters were obtained by way of DHCP. This is the DNS IP address that is being used by the Model 5401's management web server. If IP configuration mode is selected for *Automatic* and the current IP address was obtained by way of link-local no subnet mask will be shown in this field. This is because no DNS IP address is associated with link-local.

When the IP address configuration is selected for *Manual* the field will not be grayed out. In this situation the stored DNS IP address will be displayed and can be modified as desired to meet the requirements of the application. The displayed value is the DNS IP address that is currently being used, or will be used at the time of the next Ethernet connection reboot.

In most cases the Model 5401's default DNS IP address will be appropriate. It is 8.8.8.8 which is one of the two IPv4 recursive public name servers provided by Google®. But there's no issue entering a revised DNS IP address. Once it is entered, using the standard dot-decimal notation format (4 octets separated by dots), the *Submit* button must be pressed for a change to be stored. A system reboot is required for the revised gateway IP address to be utilized. Restoring the Model 5401 default values will not change the stored gateway IP address.

Submit

The *Submit* button is located on the bottom of the Network Configuration menu page. For any changes made to fields on the Network Configuration page to be saved and acted upon the *Submit* button must be pressed.

Identify Device

The *Identify Device* button is located in the upper-left corner of the Network Configuration main page, directly below the Dante device name display. Pressing the *Identify Device* button will cause the associated Model 5401 to flash its green backlight associated with the display five times.

Operation

— Pending —

Technical Notes

— Pending —

Specifications

Applications:

High-performance master clock for Dante audio-over-Ethernet applications. Also supports AES67-2013 applications. In addition provides audio reference signals (tones) for general-purpose use and a precision word clock sync output.

Precision Time Protocol (PTP) Support:

IEEE® 1588-2002 Version 1 (v1) for Dante; IEEE 1588-2008 Version 2 (v2) for AES67-2013

Timing Reference:

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

Internal Time Base:

Type: 24.576 MHz temperature-stabilized crystal oscillator

Initial Accuracy: 2 ppm (parts-per-million)

Long-Term Accuracy: 1 ppm (parts-per-million) per year

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

Sync Input:

Compatible Sources: word clock, bi-level video, tri-level video, 10 MHz

Termination: 50 ohms (10 MHz), 75 ohms (word clock or video), or high Z (unterminated), selectable

Word Clock Characteristics: square wave, 5 Vpp nominal unloaded, 44.1, 48, 88.2, or 96 kHz

Video Characteristics: bi- or tri-level, 1 Vpp into 75 ohm load

10 MHz Characteristics: sine wave, 3 Vpp into 50 ohm load

Word Clock Output:

Type: square wave

Rate: 44.1, 48, 88.2, or 96 kHz, selectable using Dante Controller application

Impedance: 75 ohms

Amplitude: 5 Vpp, measured unterminated

Jitter: measurement pending

Network Audio Technology:

Type: Dante audio-over-Ethernet

AES67-2013 Support: yes; selectable on/off

Dante Domain Manager (DDM) Support: yes

Ethernet Interface Configuration: Switched, Redundant, or Pri Dante/Sec Mgmt

Clock Source: follows overall Model 5401 configuration

Bit Depth: 24

Sample Rate: 44.1, 48, 88.2, or 96 kHz, selectable using Dante Controller application

Number of Dante Transmitter (Output) Channels: 8

Number of Dante Flows: 32

Audio Reference Signals:

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: 2, primary and secondary

Type: 1000BASE-T (Gigabit Ethernet ("GigE")) per IEEE 802.3ab (100 Mb/s also supported but not recommended for optimal performance)

NIC Status LEDs: one link and one activity for each Ethernet interface

Software Updating: internal FTP client supports updating of application, main FPGA, and sync FPGA software; process requires unrestricted access to the internet or a local FTP server

Front-Panel Display: LCD with LED backlighting

Front-Panel LEDs: 6, dual-color

Functions: provides indication of condition of incoming AC and DC power, status of Dante connections on Ethernet interfaces, and status of Dante connectivity

Power Sources:

AC Mains: 100 to 240 V, 50/60 Hz, 5 W maximum

DC: 10 to 18 V, 0.5 A max

Connectors:

Sync Input, Word Clock Output: BNC, per IEC 61169-8 Annex A

Ethernet: 2, RJ45

AC Mains Input: 3-blade, IEC 320 C14-compatible (mates with C13)

DC Input: 4-pin male XLR (pin 1 negative, pin 4 positive)

Model 5401

DANTE MASTER CLOCK

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—Sync Input Sources

The Model 5401's sync input has been tested and confirmed for correct operation with the following sync signals:

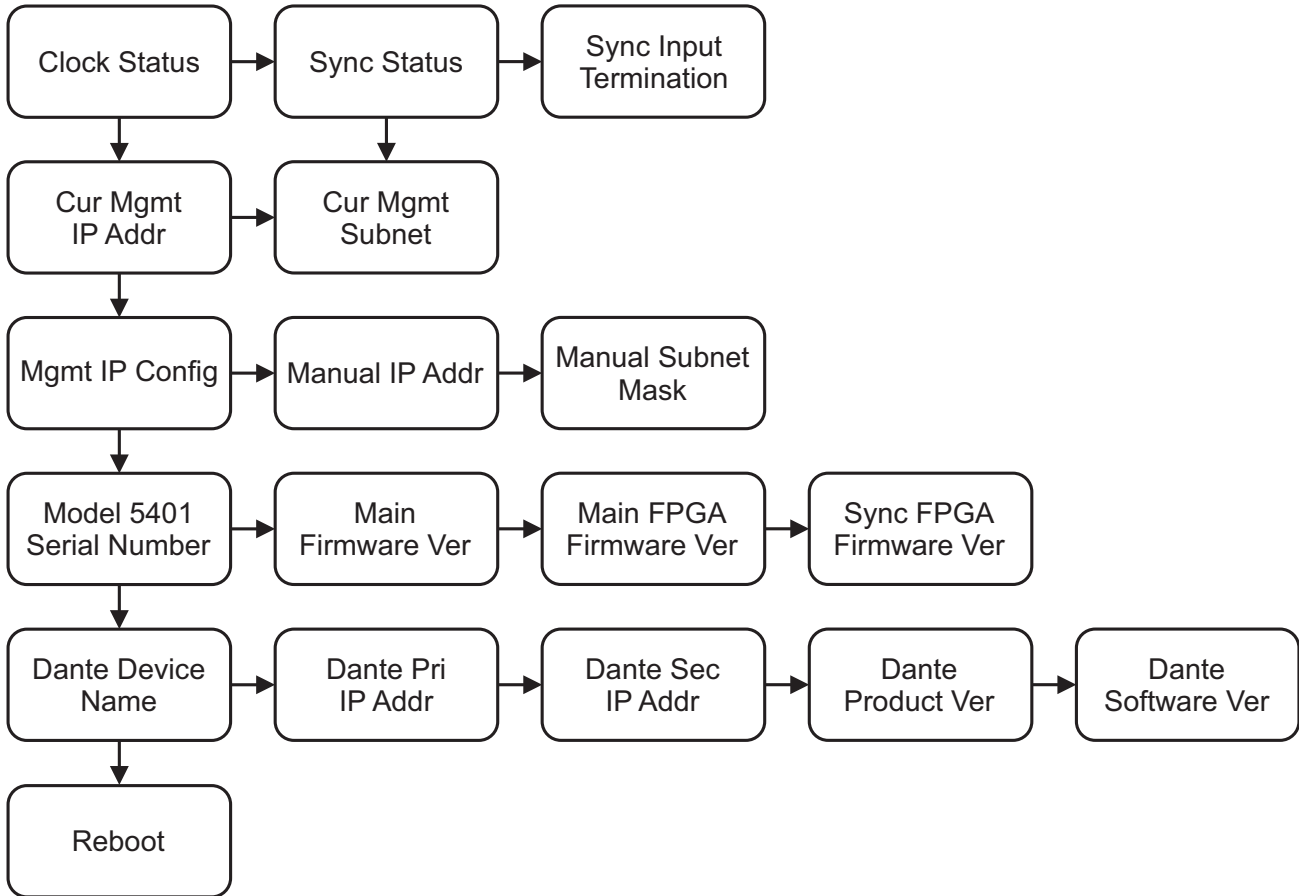
Word Clock: Square wave signal with rate of 44.1, 48, 88.2, or 96 kHz

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—Model 5401 Menu Structure



Appendix C—PTP v2 (IEEE-1588-2008)

Characteristics

Note: For Model 5401 PTP v2 support to be active AES67 Compatibility check box must be enabled in Dante Controller software application.

Domain: 0

Priority 1: 114

Clock Class: 248

Accuracy: Unknown (0xFE)

Variance: 61536

Priority 2: 112

Unique ID: 00:1D:C1:XX:XX:XX

DSCP: EF (46)