

Model 5421

Dante Intercom Audio Engine

User Guide

Issue 2, September 2022

This User Guide is applicable for serial numbers M5421-00151 and later with Main Firmware version 1.03 and later, FPGA Firmware version 1.01 and later, and STcontroller application version 3.09.03 and later.

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Revision History

Issue 2, September 2022:

- Updated for clarity.

Issue 1, March 2020:

- Initial release of complete document.

Introduction

The Model 5421 Dante® Intercom Audio Engine is a high-performance, cost-effective, flexible solution for creating party-line (PL) intercom circuits. It's directly compatible with the Studio Technologies' range of 1-, 2-, and 4-channel Dante-enabled belt packs and other interface-related products. The unit is suitable for use in fixed and mobile broadcast facilities, post-production studios, commercial and educational theater environments, and entertainment applications.

Only a Gigabit Ethernet network connection with Power-over-Ethernet (PoE) support is required for the Model 5421 to provide a powerful resource in a variety of Dante applications. Front- and back-panel LEDs provide operating status indications. The Studio Technologies' STcontroller software application allows personnel to view and configure key operating parameters. The unit's lightweight "1/2-rack" enclosure can be used stand-alone or mounted in one space (1U) of a standard 19-inch rack enclosure with an optional rack-

mount installation kit. To meet the latest interoperability standard the Model 5421's Dante implementation meets the requirements of AES67 as well as supporting the Dante Domain Manager (DDM) application. Using DDM, compliance with ST 2110-30 may be possible.

The Model 5421 provides one 16-channel audio engine which can be configured to provide from one to four "virtual" intercom circuits. The term "audio engine" was selected to describe a set of audio input, processing, routing, and output resources that can be configured to support specific intercom requirements. Unlike general-purpose Dante digital matrix devices, the Model 5421 is optimized to allow direct support for theater, small broadcast, and general intercom applications.

Configuration and Functionality

Using the STcontroller software application a configuration choice selects how the Model 5421's 16-channel audio engine is segmented. This allows efficient use of the Dante channels to support the needs of specific applications. As all Dante intercom belt packs are essentially



Figure 1. Model 5421 Dante Intercom Audio Engine "throw down" front view



Figure 2. Model 5421 Dante Intercom Audio Engine back view

4-wire devices (having independent receiver (input) and transmitter (output) channels) “virtual” (simulated) party-line functionality must be created within the Model 5421’s digital processing resources. This requires that the maximum number of participants (users) on any one “party-line” be defined and an appropriate configuration be made.

The 16 channels offered by the Model 5421 are configured into what are called groups. Simple configuration choices are accessed using the STcontroller software application and allow the number of groups and their sizes to be selected. Group configuration can range from one group having 16 channels (a complete audio engine being used for a single group) to four groups each having four channels. The size of a group will dictate how many devices and associated users can be part of any one party-line. Five choices allow a range of group configurations to be selected with the default setting being two 8-channel groups.

Using the Dante Controller application, each group can be assigned a unique name. These names would typically reflect how each specific group is going to be utilized. Names such as Production, Lighting, Stage Manager, or Follow Spot would be typically used in theater-oriented intercom applications.

Technically, each group supports party-line operation by creating a series of unique “mix-minus” outputs, one for each channel in the group. These specialized outputs allow each intercom user assigned to that specific group (a “party-line”) to hear all members of that group except for themselves. (Thus comes the term “mix-minus” or a mix of all source but themselves.) By each user receiving a mix-minus signal precise control of each user’s local sidetone audio level and overall audio quality can be maintained.

Applications

The Model 5421 is compatible with many Dante-compliant devices including the extensive range of intercom beltpacks from Studio Technologies. These include the single-channel/dual-listen Model 372A and Model 373A, the 2-channel Model 370A and Model 371A, and the 4-channel Model 374A. The Model 5421 will also function directly with other Dante-supporting devices such as the Model 348 Intercom Station and Model 391 Dante Alerting Unit. In addition, the Model 5421 can function with matrix intercom systems, audio consoles, and wireless intercom base stations.

Dante Audio-over-Ethernet

Audio data associated with the Model 5421 is sent and received using the Dante audio-over-Ethernet media networking technology. Audio signals with a sample rate of 48 kHz and a bit depth of up to 16, 24, and 32 are supported. Up to 16 Dante receiver (input) and 16 transmitter (output) channels are available to implement virtual party-line (PL) intercom circuits.

AES67 and DDM

Using the Dante Controller software application, the Model 5421’s Dante interface can be configured to support, or not support, AES67 digital audio signals. The unit is also compliant with the Dante Domain Manager (DDM) software application. DDM offers an enhanced set of network control and monitoring features, making it ideal for security-conscious applications. This may also allow the Model 5421’s audio channels to support ST 2110-30.

Pro Audio Quality and Auto Mix

The Model 5421’s audio circuitry was designed to meet the demands of professional audio applications, far exceeding that of “typical” intercom products. Audio processing is performed in the digital domain using a high-speed field-programmable-gate-array (FPGA) integrated circuit.

The Model 5421's Auto Mix function utilizes a sophisticated FPGA-based algorithm to provide enhanced audio intelligibility. This feature is unique to party-line (PL) intercom applications and offers the opportunity for users to obtain the absolutely finest audio performance.

Status LEDs and Configuration

Two LEDs, located on the Model 5421's front panel, provide an indication of the Dante interface's status. LEDs associated with the back-panel R45 jack display the real-time status of the connected Ethernet signal. No pushbutton or configuration switches are provided. The Studio Technologies' STcontroller software application is used to configure the unit's operating parameters.

Ethernet Data and Power Source

The Model 5421 interconnects with a local-area-network (LAN) using a standard Gigabit (1000 Mb/s) twisted-pair Ethernet signal. The physical connection is made by way of a RJ45 receptacle. The Model 5421's operating power is provided by a Power-over-Ethernet (PoE)-compliant Ethernet signal. For network management purposes the unit's Ethernet interface will report to the power sourcing equipment (PSE) that it's a class 2 (low power) powered device (PD).

Simple Installation

The Model 5421 is housed in a rugged, light-weight aluminum enclosure that is designed to be "field tough." It can be used as a standalone portable unit, supporting what's known in the broadcast world as "throw-down" applications. Or it also can be directly placed upon on a rack-shelf or other flat surface. Optional rack-mount installation kits are available to allow one or two units to be mounted in one space (1U) of a standard 19-inch rack enclosure. As previously mentioned, the Model 5421 uses a standard RJ45 connector to allow fast and

convenient interconnection. Initial operation will commence when a Gigabit Ethernet signal with Power-over-Ethernet (PoE) capability is connected. Normal operation will take place after the unit "boots up." This process requires approximately 30 seconds.

Future Capabilities and Firmware Updating

The Model 5421 was designed so that its performance and capabilities can be enhanced in the future. A USB type A connector, accessible on the unit's back panel, allows the main firmware (embedded software) to be updated using a standard USB flash drive. To implement its Dante interface the Model 5421 uses Audinate's Broadway™ integrated circuit. The firmware in this integrated circuit can be updated via the unit's Ethernet interface, helping to ensure that the Dante performance remains up to date.

Getting Started

In this section, a location will be selected for the Model 5421 Dante Intercom Engine. A Gigabit Ethernet (GigE or GbE) connection that supports Power-over-Ethernet (PoE) will be made using a standard RJ45 patch cable. If desired, an optional rack-mount installation kit will be used to mount one or two Model 5421 units into a standard equipment rack.

System Components

Included in the shipping carton are a Model 5421 Dante Intercom Audio Engine and a printed copy of this guide. If one or two Model 5421 units are going to be mounted in a 19-inch equipment rack then an optional rack-mount installation kit is required. Specific kits are available for rack-mounting one or two Model 5421 units. If a rack-mount installation kit was purchased it would typically have been shipped in a separate carton.

Locating the Model 5421

The location of the Model 5421 will primarily depend on being within the 100-meter (325-foot) twisted pair Ethernet cable limitation. But the overall length limit can be overcome by using a fiber-optic interconnection between the Model 5421-related Ethernet switch and another Ethernet switch that's part of the application's local-area-network (LAN). With fiber interconnects there's no reason why a Dante-supported LAN can't be distributed over many miles or kilometers.

Protecting the Enclosure

The Model 5421 is shipped as a self-contained unit suitable for portable use or placement in a semi-permanent location. Installed on the bottom of the chassis are screw-on "bump on" protectors (also known as rubber "feet"). These are useful if the unit is going to be placed on surfaces where scratching of either the Model 5421's enclosure or the surface material could take place. However, if applicable the "feet" can be removed without the use of a tool, when rack- or custom-mounting the unit.

Making an Ethernet Connection

The Model 5421 has one RJ45 jack which is located on the unit's back panel. It requires connection with a Gigabit Ethernet (GigE or GbE) signal that also supports Power-over-Ethernet (PoE). This is typically provided by a port on a standard PoE-enabled Gigabit Ethernet switch. The required Gigabit Ethernet signal must follow the 1000BASE-T standard and meet the requirements of IEEE® 802.3af for PoE. To support power management functionality on the associated PoE switch (PSE) the Model 5421 enumerates itself as a PoE class 2 (low power) powered device (PD).

The Model 5421's Ethernet interface supports auto MDI/MDI-X and, as such, using a cross-over or "reversing" cable is not required. And while "Fast Ethernet" (100BASE-TX or 100 Mb)

may also function correctly, it's not recommended for maximum reliability.

Rack Mounting

For some applications it might be desirable to mount one or two Model 5421 units into one space (1U) of a 19-inch rack enclosure. Rack-mount installation kits, purchased separately, are available from Studio Technologies. The following sections provide details on how to use the rack-mount kits. Refer to Appendices B and C for graphical descriptions of how to attach the rack-mount kits.

Rack-Mounting One Model 5421 Unit

Rack-mount installation kit RMBK-11 is used to allow rack mounting of one Model 5421 unit. The kit contains one standard rack bracket, one long rack bracket, and four 6-32 thread-pitch Phillips-head machine screws. Refer to Appendix B for a visual explanation.

Begin the installation by removing the four "bump on" protectors from the bottom of the Model 5421's chassis. They can be removed using one's fingers to rotate them counter-clockwise; no tool is required. It's probably a good idea to store the four "bump on" protectors for possible later use.

With assistance from a #2 Phillips-tip screw driver, use the machine screws to attach the standard and long rack brackets to the sides of the Model 5421's enclosure. The screws will mate with the threaded fasteners that can be seen on the sides of the Model 5421's enclosure, near the front of the unit.

Mount the standard rack bracket to the left side of the Model 5421 (when viewed from the front) if the unit needs to be located on the left side of the rack enclosure. Then mount the long rack bracket to the right side of the Model 5421. Mount the brackets in the opposite orientation should the Model 5421 need to be located on the right side of the rack enclosure.

Once the “bump on” protectors have been removed and the standard and long rack brackets have been installed the Model 5421 will be ready to be mounted into the designated equipment rack. One space (1U or 1.75 vertical inches) in a standard 19-inch equipment rack is required. Secure the unit into the equipment rack using two mounting screws per side.

Rack-Mounting Two Model 5421 Units

Rack-mount installation kit RMBK-12 is used to allow one-space (1U) rack mounting of two Model 5421 units. The kit can also be used to mount one Model 5421 and another product that is compatible with the RMBK-12 (such as the Studio Technologies’ Model 48D Dante Bridge). The kit contains two standard rack brackets, two joiner plates, eight 6-32 thread-pitch Phillips-head machine screws, and two 2-56 thread-pitch Torx T7 thread-forming machine screws. Refer to Appendix C for a visual explanation.

Begin installing the kit by removing the four “bump on” protectors from the bottom of each chassis. They can be removed using one’s fingers to rotate them counterclockwise; no tool is required. Store the eight “bump on” protectors for possible later use.

With assistance from a #2 Phillips-tip screw driver, use two of the 6-32 machine screws to attach one of the standard rack brackets to the left side (when viewed from the front) of one of the Model 5421 units. The screws will mate with the threaded fasteners that can be seen on the sides of the Model 5421’s enclosure, near the front of the unit. Using two more of the 6-32 machine screws, attach one of the joiner plates to the right side of that same Model 5421 unit.

Again using two of the 6-32 machine screws, attach the second standard rack bracket to the right side of the second Model 5421 or other compatible unit. Using the final two 6-32

machine screws, attach the second joiner plate to the left side of the second Model 5421 or other compatible unit with an orientation of 180 degrees from the way in which the first plate was installed.

To complete the assembly, “join” the units together by sliding each joiner plate through the other. The grooves in each joiner plate will carefully align with each other and form a relatively tight bond. Line up the two units so that the front panels form a common plane. With the aid of a Torx T7 driver, use the two 2-56 machine screws to secure the two joiner plates together. The screws should fit snugly into the small openings formed by the mating of the two joiner plates.

Once the “bump on” protectors are removed and the 2-unit assembly is created it is ready to be mounted into the designated equipment rack. One space (1U or 1.75 vertical inches) in a standard 19-inch equipment rack is required. Secure the assembly into the equipment rack using two mounting screws per side.

Dante Configuration

For audio to correctly pass to and from the Model 5421 requires that, at a minimum, several Dante-related parameters be configured. These configuration settings will be stored in non-volatile memory within the Model 5421’s circuitry. Configuration will typically be done with the Dante Controller software application which is available for download free of charge at audinate.com. Versions of Dante Controller are available to support Windows and OS X® operating systems. The Model 5421 uses the Broadway integrated circuit to implement the Dante functionality. The Model 5421 is compatible with the Dante Domain Manager (DDM) software application. This may allow ST 2110-30 routes to be established to and from the Model 5421’s audio channels.

Unit and Channel Names

The Model 5421 has a default Dante device name of **ST-M5421-** along with a unique suffix. The suffix identifies the specific Model 5421 that is being configured. The suffix's actual alpha and/or numeric characters relate to the MAC address of the unit's Broadway integrated circuit. By default, the 16 Dante receiver (Rx) and 16 Dante transmitter (Tx) audio channels are organized as two 8-channel groups. The channel default names are **A01-Group A** through **A08-Group A** and **B01-Group B** through **B08-Group B**. Using the Dante Controller application, the default device name and channel names can be revised as appropriate for the specific application.

Sample Rate, Encoding, Clocking, & Latency

The Model 5421 only supports an audio sample rate of 48 kHz with no pull-up/pull-down values available. Encoding choices are *PCM 24*, *PCM 16*, and *PCM 32*, but in virtually all cases the default selection of *PCM 24* would be appropriate. This is due to the processing within the Model 5421 being performed in 24-bit. Device Latency can be adjusted if required but the default value of 1.0 msec will typically be correct.

Network Configuration – Addresses

By default, the Model 5421's Dante IP address and related network parameters will be determined automatically using the DHCP protocol or, if not available as a network resource, the link-local protocol. If desired, Dante Controller allows the Model 5421's IP address 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. But in this case, it's highly recommended that a unit be physically marked, e.g., directly using a permanent marker and "console tape," noting its specific static IP address. If knowledge of a Model 5421's IP address has been misplaced there is no reset button or other simple method to identify and restore the unit to a default IP setting. Refer to the Technical Notes section for additional details.

AES67 Configuration – AES67 Mode

Using Dante Controller, the Model 5421 can be configured for AES67 operation. This requires that the AES67 Mode configuration choice to be set for Enabled. By default, the Model 5421 has this mode configured for Disabled.

Clocking

As is the case for all Dante devices, the Model 5421 can serve as a leader clock for a Dante network. But in many cases, the unit will receive "sync" from another device that's been selected as the "primary leader" for the application. As such, the check box for Preferred Leader associated with the Model 5421 would typically not be enabled. But for supporting a small to medium sized set of Dante devices there's no reason why the Model 5421 couldn't perform admirably as a leader clock. In this case, checking the box for Preferred Leader would be appropriate.

Audio Routing

Each Model 5421 Dante transmitter (Tx) output channel associated with a channel in an intercom group must be routed (subscribed) to the desired receiver channel on an associated piece of equipment. The receiver (Rx) input associated with the same channel in the same intercom group must also be routed (subscribed) to that same piece of equipment. One transmitter channel and one receiver channel always create a transmitter/receiver pair that is used as one channel in a party-line (PL) group.

Refer to Appendix A for an example of Model 5421 routes (subscriptions) made using Dante Controller.

The most common Model 5421 configuration error occurs when the transmitter/receiver pair is not correctly routed: as a pair, to the same specific device and channel on the device. An intercom user device, such as a backpack from Studio Technologies, must have a talk and listen channel from the same channel routed to the same channel on the same intercom group from the Model 5421.

It's not necessary to route signals to and from all transmitter and receiver channels on a Model 5421 intercom group. There's no problem if channels are left as "spares" for future use. It is important to always remember that channels in a group always consist of a transmitter/receiver pair.

Flows

The number of receiver flows associated with the Model 5421's Broadway integrated circuit is 16. The same applies to the number of transmitter flows. Each flow can either be unicast, multicast, or a combination of the two. No receiver flow limitation will ever exist as there's one flow available for each of the 16 receiver channels. In most cases, 16 transmitter flows should prevent an issue of insufficient transmitter from occurring. When a Model 5421 is operating in the AES67 mode the transmitter (output) channels will always function in multicast. In AES67 unicast is not supported.

Note that within Dante Controller a "subscription" is the term used for routing a transmitter flow (a group of output channels) to a receiver flow (a group of input channels).

Model 5421 Configuration

The Studio Technologies' STcontroller software application is used to configure the way in

which the Model 5421 functions. No web pages or physical switch settings are used to configure the unit. This makes it imperative that STcontroller be available for convenient use on a personal computer that's connected to the related LAN.

Installing STcontroller

STcontroller is available free of charge on the Studio Technologies' website (studio-tech.com/stcontroller-application/) and is compatible with personal computers running Windows operating systems that are version 7 and later. STcontroller versions 2.06.00 and later are required to fully support the Model 5421. 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 5421 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 5421 units to be configured will appear in the device list. Use the Identify command to allow easy recognition of a specific Model 5421 unit. Double-clicking on a device name will cause the associated configuration menu to appear. Review the current configuration and make any changes that are desired. The Save Configuration and Load Configuration functions allow specific profiles to be saved and then loaded into one or more units as necessary.

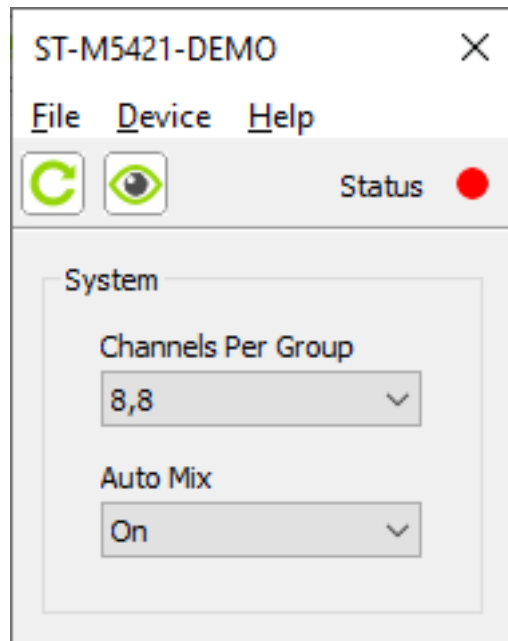
Using STcontroller's demo mode is an easy means of reviewing the configuration choices available for all compatible Studio Technologies' products. The demo mode also provides the ability to create and save configuration profiles without requiring the actual units to be present. These saved configuration profiles can then be loaded into actual units when they become available on the related network.

Configurable Parameters

The Model 5421 allows configuration of two functions. They are:

- System – Channels Per Group
- System – Auto Mix

Changes made using STcontroller will be immediately reflected in the unit's operation; no Model 5421 reboot is required. Each time a change is made the two LEDs on the Model 5421's front panel will flash orange four times to indicate that a command from STcontroller has been received.



The following two sections provide details on the configurable parameters.

System – Channels Per Group

Choices are 16; 12, 4; 8, 8; 8, 4, 4; and 4, 4, 4, 4.

The Model 5421's 16 Dante receiver (input) and 16 transmitter (output) channels can be configured to function in one of five available group arrangements. These groups define the maximum number of Dante device talk/listen channels that can join together to form a virtual party-line (PL). The configuration choices range from 16 which creates one large (16-channel) PL to selecting 4, 4, 4, 4 which creates four independent PL groups

of four channels each. As should be evident, adding together the size of each group will always equal 16. What configuration choice is optimal for an application will depend on the maximum number of independent PL "circuits" that need to be established. A simple review of an application should lead to the desired group configuration.

Inside the Model 5421 each group is isolated from each other, ensuring that there is no audio crosstalk. (This is to be expected as all Model 5421 audio inputs, outputs, and processing is performed within the digital domain.) Each member of a group is assigned its own mix-minus channel, meaning that the audio that it supplies to the group is routed

to all other members of the group but not to itself. A user receives confirmation audio from their own microphone by way of its local sidetone function and not from the group's mixing and distribution functions that create the multiple mix-minus buses.

While the maximum number of talk/listen channels that can be assigned to a group is defined by the group size, this does not mean that all channels associated with a group have to be utilized. For example, if the Model 5421 is configured to provide two groups of eight channels, the first group could have five talk/listen channels routed to it while the second group could have just three talk/listen channels routed to it. The unused channels in a group don't contribute any noise or audio artifacts. They are simply "spare" and available for future use. They allow additional talk/listen channels to be routed to them as needed. Groups are just resources that allow talk/listen channels on compatible devices to be linked together. A group size just defines the maximum number of device channels that can be part of a set of users that can talk and listen among themselves.

As an example, if a group size of 16 is selected then a maximum number of 16 of talk/listen channels from Dante-compatible devices can be assigned (routed to or subscribed) to the group. This would equate to up to 16 of the Studio Technologies' Model 372A or Model 373A single-talk channel belt packs being able to function together in what to user's would be a party-line (PL) or shared communication channel or circuit. If, as another example, an application required that eight of the 2-channel Model 370A or Model 371A belt packs needed to work together to support two independent channels, then a Model 5421 configuration choice of 8, 8 would be appropriate.

When contemplating changing the group configuration it's important to note two things. The first is that Dante channel names may automatically change to reflect the revised group configuration. This is not necessarily a terrible thing but some re-editing of channel names may be required to achieve the desired implementation.

The second issue that could arise is that some or all existing Dante audio channel routes (subscriptions) may be removed upon a change in the group size. In this case, they will have to be re-established once the new group configuration has been selected and confirmed. Again, this is not a terrible thing to have occur. But it's possible that up to 32 Dante routes (subscriptions), consisting of 16 receiver/transmitter pairs, may have to be re-established.

In conclusion, these changes may be destructive as far as channel names and routes are concerned. A change of group configuration is "one way"; there's no method to go back to a previous group configuration and have the channel names and routes be automatically re-established.

System – Auto Mix

Choices are *Off* and *On*.

A special audio processing algorithm can be enabled to allow enhanced audio performance for party-line (PL) applications. This algorithm, implemented in the high-speed logic of the FPGA integrated circuit, will automatically adjust the contribution that each input signals makes to the group. This automatic mixing action will perform two tasks. It will help balance the audio level of each input that has a significant signal presented to its associated input. It will also reduce the contribution to the overall mix that each input signal will present if its level is determined to be below a fixed threshold. This helps ensure

that users who are actively talking on a PL circuit will be clearly heard while those who are not actively talking will have their background audio minimized.

In most cases leaving Auto Mix enabled will be appropriate. Special applications, such as using groups as unity gain digital mixers, may warrant turning off the Auto Mix function. Refer to the Technical Notes section for details on how a group could be used for a mixing, rather than in an intercom (PL), application.

Operation

At this point the Model 5421 should have a GigE PoE Ethernet connection made to the network interface jack. Using the STcontroller software application, the configuration parameters should have been reviewed and selected as desired. The Dante Controller software application allowed the network-related configuration settings to have been made. This included enabling AES67 support if needed. The Dante output (transmitter) and input (receiver) channel pairs should have been routed (subscribed) to create the desired party-line intercom virtual circuits.

Initial Operation

Typically, a Model 5421 will begin functioning within approximately 30 seconds of its Power-over-Ethernet (PoE) power source being connected. The two status LEDs that are part of the RJ45 jack have the names LINK and ACT. The LINK LED is orange and will light when a network connection has been established. The ACT LED is green and will flash whenever Ethernet data is passing through the interface.

Upon power being connected the Model 5421's microprocessor will start to function and initiate an LED test sequence. This will cause the green LED associated with the USB connector

on the back panel to flash once. In addition, the two bi-color LEDs on front panel, labeled SYS and SYNC, will first light green, then light red, to indicate that they are functional. After a few more seconds they will commence normal operation, reporting on the status of the associated Dante network. Both the SYS and SYNC LEDs will light red when their associated functions are not operational.

Dante Status LEDs

On the front panel the user is presented with two status LEDs. These resources are simple to understand and should prove to be useful during operation and troubleshooting. The SYNC LED will light red when the Ethernet interface is not synchronized with the Dante network. It will light solid green when the Ethernet interface is fully synchronized with the connected Dante network and an external clock source (timing reference) is being received. The SYNC LED will slowly flash green if the Model 5421's Dante interface is serving as the leader clock for the connected Dante network.

How to Identify a Specific Model 5421

The Dante Controller and STcontroller software applications offer an Identify command that can be used to help locate a specific Model 5421 device. When the Identify command is selected the SYS and SYNC LEDs on the front panel will flash. After a few seconds the identification patterns will cease and normal Model 5421 LED operation will resume. Audio performance will not be impacted by the use of the Identify command. As such, it's perfectly acceptable to use this command at any time.

Normal Operation

Normal operation should find the Dante status LEDs on the front panel lit. SYS should be solid green. SYNC should be solid green if an external clock source is providing timing.

It will slowly flash green if the unit is serving as Dante leader clock. The Model 5421 is designed for continuous operation. It uses low-power circuitry, consuming about 4 watts under normal conditions. No regular maintenance is required.

The STcontroller application is used to make any required configuration changes. It can also be used to find detailed information about the Model 5421's firmware (embedded software) and Dante interface. Application firmware updates will be made using the USB connector on the back panel. Dante interface firmware updates will be performed using the Ethernet connection. Details regarding firmware updates are provided later in this guide.

Technical Notes

Using a Group for Digital Mixing Purposes

A Model 5421 group creates party-line (PL) circuits which are actually a set of mix-minus buses, one per group member. Group sizes can range from four to 16 channels. So, as an example, a group size of eight will have eight mix-minus buses. The Model 5421 can be used as a general-purpose Dante unity-gain mixing device but with one limitation. The number of input signals allowed to be routed to the mix "bus" must be one less than the size of the group. This is because the group's channel used as the mix output must not have an input signal associated with it. Otherwise that input won't be present in the mix. (Remember, the Model 5421 creates mix-minus buses; each output has everything but its associated input!) In practice this means that by selecting different group size configurations the Model 5421 can be used as 15-, 11-, 7-, or 3-channel digital mixers. No input signal can be assigned to a group's channel that's being used as the output.

Users who are familiar with the Studio Technologies' Model 5422 Dante Intercom Audio Engine may recall that each of the unit's groups can be independently configured for a number of modes including intercom, IFB, and summing bus. The summing bus mode allows all channels of a group to be used for a mixing function. The Model 5421, as a more modest product, offers only intercom groups. But simply using one channel of a group as an output allows a mix function to be established.

Depending on the application the Auto Mix function may – or may not – be useful. In some situations, the Auto Mix function will be of sufficient importance to make it valid to use a Model 5421 just for this resource. Using it for general-purpose audio applications, and not just for intercom, may prove to be valuable.

IP Address Assignment

By default, the Model 5421's Ethernet interface will attempt to automatically obtain an IP address and associated settings using DHCP (Dynamic Host Configuration Protocol). If a DHCP server is not detected 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 can be connected 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, the Model 5421's Dante IP address and related network parameters can be manually set for a fixed (static) configuration using the Dante Controller software application. In the unfortunate event that a specific Model 5421's IP address is "lost" there are several techniques that may prove useful. It's possible that the Address Resolution Protocol (ARP) networking command can be used to "probe" devices on a network for this information. For example, in Windows OS the **arp -a** command can be used to display a list of LAN information that includes MAC addresses and corresponding IP addresses. (Within this list should be the Model 5421's statically assigned Dante IP address.) This method is most effective with a LAN that uses unmanaged Ethernet switches. Contemporary LANs that utilize managed switches may limit the ARP command's effectiveness.

In general, the simplest means of identifying an unknown IP address is to create a "mini" LAN with an unmanaged PoE-enabled Ethernet switch. Then by using the appropriate ARP command the required "clues" can be obtained. It's also possible to make an almost-direct connection between a personal computer and a Model 5421. The only additional piece of equipment required would be a PoE mid-span power supply for providing power to the Model 5421. From a data standpoint this implementation would provide a direct connection between the two Ethernet ports.

Optimizing Network Performance

For best Dante audio-over-Ethernet 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. Refer to the Audinate website (audinate.com) for

details on how to optimize a network for Dante applications.

Application Firmware Version Display

The STcontroller software application is used to display the version numbers of the Model 5421's two firmware (embedded software) components. These are the application firmware and the FPGA firmware. The application firmware is used by the unit's microcontroller integrated circuit to implement the Model 5421's general operating actions. The FPGA firmware is used by the field-programmable-gate-array integrated circuit which performs all audio processing functions.

To observe the firmware version numbers, begin by connecting the Model 5421's Ethernet port to a network. The unit will begin to function approximately 30 seconds after power is supplied. Start STcontroller, review the list of identified devices, and select the specific Model 5421 from which you want to determine its firmware versions. Then select **Version** under the **Device** tab. A dialog will then display that will provide a host of useful information. This will include the firmware versions as well as details on the Dante interface firmware.

Application Firmware Update Procedure

It's possible that updated versions of the two firmware (embedded software) files that are utilized by the Model 5421's microcontroller and FPGA (field-programmable-gate-array) integrated circuit will be released to add features or correct issues. Refer to the Studio Technologies' website for the latest firmware files. The unit has the ability to load revised files into non-volatile memory by way of a standard USB flash drive. The Model 5421 implements a USB host function and provides access by way of a type A receptacle located on the unit's back panel. The

Model 5421 updates its firmware using files named **M5421.bin** for the main firmware and **BWYA.bit** for the FPGA firmware.

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 or both of the firmware files can be automatically loaded and will be done sequentially. In the root directory save the desired new firmware file(s), ensuring that the required name or names are specified. For the application firmware the file name must be **M5421.bin** and for the FPGA firmware the file name must be **BWYA.bit**. 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 5421, the name of the zip file itself will include the file's version number. For example, a file named **M5421v1r00MCU.zip** would indicate that version 1.00 of the application firmware (**M5421.bin**) is contained within this zip file.

Once the USB flash drive is inserted into the USB type A receptacle, located on the back panel, the unit must be powered off and then powered on again. At this point the file(s) will automatically load. The precise steps required will be highlighted in the next paragraphs.

To install either or both of the firmware files follow these steps:

1. Remove power from the Model 5421 by disconnecting the Ethernet connection from the RJ45 jack on the back panel.
2. Locate the USB type A connector on the Model 5421's back panel, labeled Firmware Update. Directly to the right of the USB connector is a small hole that provides visual access to a green LED indicator.

3. Insert the prepared USB flash drive into the USB connector.
4. Apply power to the Model 5421 by reconnecting the Ethernet signal to the RJ45 jack.
5. After a few seconds the Model 5421 will run a "boot loader" program that will automatically read and then save the new firmware file(s) that are present on the USB flash drive. The update process can range from approximately 15 seconds to approximately 45 seconds, depending on which files are going to be updated. While the files are being loaded the green LED, located to the right of the USB connector, will flash slowly. Once the loading process has completed the Model 5421 will restart using the newly saved main firmware.
6. At this time the Model 5421 is functioning with the newly loaded firmware and the USB flash drive can be removed. But to be conservative, remove the power source first and then remove the USB flash drive.
7. If necessary, restart the Model 5421 by connecting the Ethernet with PoE signal to the RJ45 jack. Confirm that the desired firmware has been loaded and that the Model 5421's two firmware files are as desired. This is accomplished using the STcontroller software application. (Use the **Version** selection under the **Device** tab.)

Note that upon power being applied to the Model 5421 if the USB flash drive doesn't have the correct file(s) in its root folder no harm will occur. Upon power up the green LED, located below the USB connector, will flash on and off rapidly for a few seconds to indicate that a valid file has not been found. After this indicating sequence has completed then normal operation using the unit's existing application and FPGA firmware will begin.

Broadway Firmware Update

As previously discussed, the Model 5421 implements Dante connectivity using the Broadway integrated circuit from Audinate. The STcontroller software application can be used to identify the Dante firmware version. (Use the **Version** selection under the **Device** tab.)

The firmware (embedded software) residing in Broadway can be updated using the Model 5421's 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 application. This application is available, free of charge, from the Audinate website (audinate.com). The latest Model 5421 firmware file, with a name in the form of **M5421vXrXrX.dnt**, is always available on the Studio Technologies' website as well as 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 5421's Dante interface.

Restoring Factory Defaults

A command in the STcontroller software application allows the Model 5421's configuration selections to be reset to the factory values. From STcontroller select the Model 5421 for which you want to restore its defaults. Select the **Device** tab and then select the **Factory Defaults** feature. Then click on the **OK** box.

The two factory default values are:

System – Channels Per Group: 8, 8

System – Auto Mix: On

Specifications

Applications: designed to create from one to four virtual party-line (PL) circuits in Dante audio-over-Ethernet environments

Engine Group Options:

The following group sizes can be selected:

- 16 (one group)
- 12, 4 (two groups)
- 8, 8 (two groups)
- 8, 4, 4 (three groups)
- 4, 4, 4, 4 (four groups)

Audio Performance:

Internal Digital Audio Processing: 24-bit, fixed

Input-to-Output Audio Processing Latency: <100 uSec

Auto Mix: sophisticated FPGA-based algorithm provides enhanced party-line (PL) audio intelligibility (selectable on or off)

Network Audio Technology:

Type: Dante audio-over-Ethernet (also known as Dante audio-over-IP)

AES67-2018 Support: yes

Dante Domain Manager (DDM) Support: yes

Clock Source: Dante network or internal (can serve as leader clock)

Bit Depth: 16, 24, or 32

Sample Rate: 48 kHz

Number of Dante Receiver (Input) Channels: 16

Number of Dante Transmitter (Output) Channels: 16

Number of Dante Flows: 16 receiver, 16 transmitter

Network Interface:

Type: 1000BASE-T (Gigabit, GigE, or GbE) per IEEE 802.3ab, twisted-pair Ethernet, Power-over-Ethernet (PoE) supported

Data Rate: 1000 Mb/s (10 Mb/s not supported; 100 Mb/s supported but not optimal)

Auto MDI/MDI-X Support: yes

NIC Status LEDs: one link and one activity

Power Source:

Power-over-Ethernet (PoE): class 2 (low power, ≤6.49 watts) per IEEE® 802.3af

Configuration: requires Studio Technologies' STcontroller software application, version 2.06.00 and later

Connectors:

Ethernet: 1, RJ45

USB: type A receptacle (used only for updating application and FPGA firmware)

Software Updating: USB flash drive used for updating application and FPGA firmware; Dante Controller or Dante Firmware Update Manager applications can be used for updating Dante interface firmware

Front Panel LEDs: 2, dual-color

Functions: provides indication of status of Dante connectivity

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: 0 to 95%, non-condensing

Altitude: not characterized

Dimensions – Overall:

8.7 inches wide (22.1 cm)

1.72 inches high (4.4 cm)

8.3 inches deep (21.1 cm)

Mounting Options: single-unit (RMBK-11) and dual-unit (RMBK-12) rack-mount installation kits, purchased separately. Each uses one space (1U) in a standard 19-inch rack.

Weight: 1.3 pounds (0.59 kg); rack-mount installation kits add 0.2 pounds (0.09 kg)

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

Appendix A—Example of Model 5421 Routes (Subscriptions) made using Dante Controller

Dante Controller - Network View
 Grand Master Clock: ST-M5421-d00062

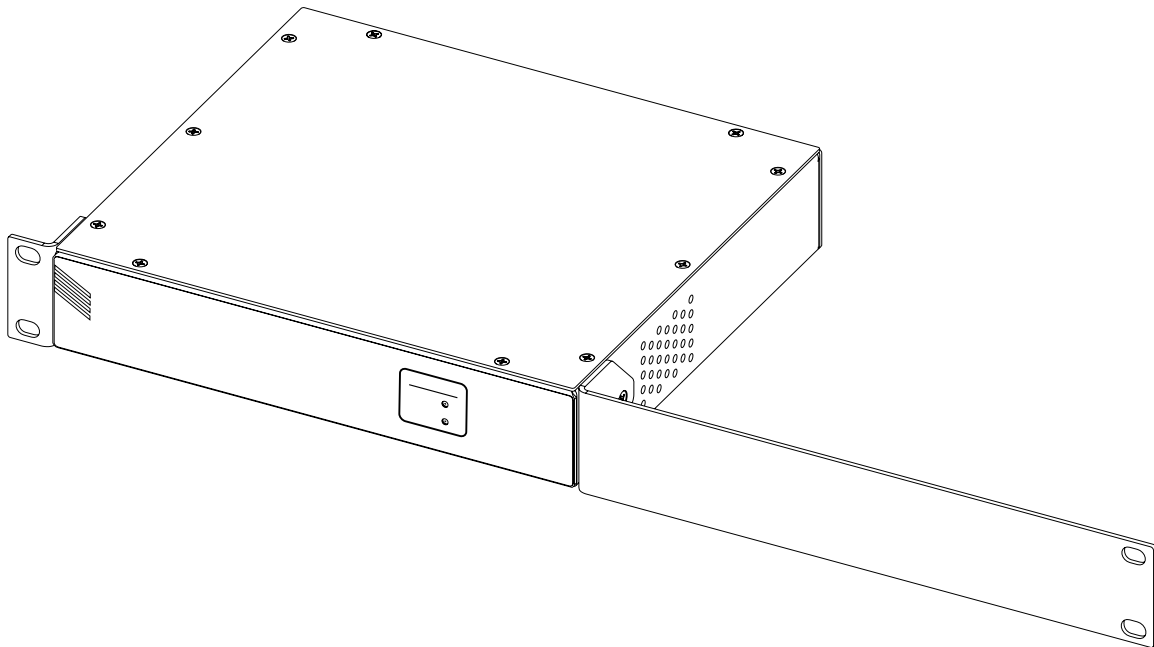
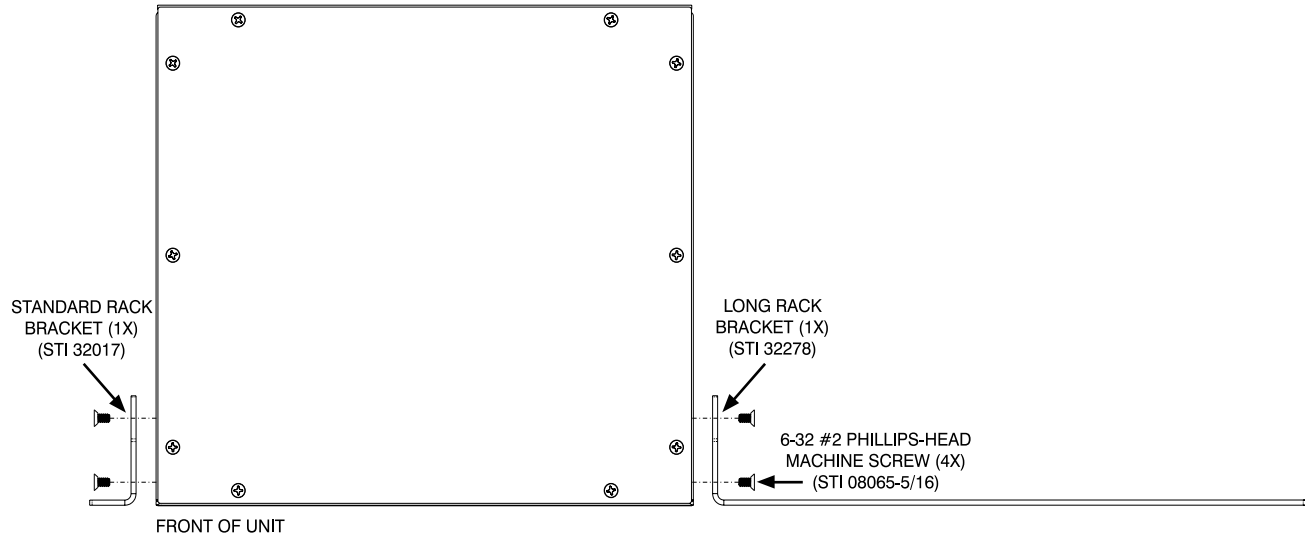
Routing | Device Info | Clock Status | Network Status | Events

Filter Transmitters:
 Filter Receivers:

Dante Transmitters	ST-M372A-81d7d0	ST-M372A-81d7d7	ST-M372A-81d7e0	ST-M372A-81d7e3	ST-M5421-d00062
Dante Receivers					
ST-M372A-81d7d0					
Headphone Ch1	✓				✓
Headphone Ch2					
ST-M372A-81d7d7					
Headphone Ch1	✓				✓
Headphone Ch2					
ST-M372A-81d7e0					
Headphone Ch1	✓				✓
Headphone Ch2					
ST-M372A-81d7e3					
Headphone Ch1	✓				✓
Headphone Ch2					
ST-M5421-d00062					
A01-Group A	✓				
A02-Group A		✓			
A03-Group A			✓		
A04-Group A				✓	
A05-Group A					✓
A06-Group A					
A07-Group A					
A08-Group A					
B01-Group B					
B02-Group B					
B03-Group B					
B04-Group B					
B05-Group B					
B06-Group B					
B07-Group B					
B08-Group B					

P: ■ Unmanaged Multicast Bandwidth: 0 bps Event Log: ■ Clock Status Monitor: ■

Appendix B—Graphical Description of Rack-Mount Installation Kit for One Model 5421 Unit (*Order Code: RMBK-11*)



Appendix C—Graphical Description of Rack-Mount Installation Kit for Two Model 5421 Units (*Order Code: RMBK-12*)

The kit can also be used to mount one Model 5421 and another product that is compatible with the RMBK-12 (such as the Studio Technologies' Model 48D Dante Bridge).

