

Model 544D Audio Interface

User Guide

Issue 2, April 2023

This User Guide is applicable for serial numbers
M544D-00151 and later with Application Firmware 1.0 and later
and STcontroller application version 3.10.15 and later.

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Revision History

Issue 2, April 2023:

- Miscellaneous corrections and clarifications.

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- Initial release.

Introduction

The Model 544D Audio Interface provides a simple yet high-performance means of interfacing two channels of analog line-level audio to and from applications that utilize Dante® audio-over-Ethernet media networking technology. Two Model 544D units can provide one-to-one signal paths, two in each direction, over a standard local area network (LAN). A Model 544D can work on its own to allow Dante-enabled products to interface with analog input and output signals. In addition, the unit supports transport of status signals or contact closures between Model 544D units and other compatible products. There are two general-purpose inputs (GPI) and two general-purpose outputs (GPO) on each Model 544D. The Model 544D can also provide a tone generator function. This allows sine-wave signals at a frequency of 1 kHz, 18 kHz, or 20 kHz to be output by way of the analog line-level and Dante digital interface channels.

The Model 544D is a fully professional product that offers the audio quality, features, and reliability required by 24-hour, on-air, and commercial applications. The two line-level analog audio inputs use standard 3-pin female XLR connectors for easy interfacing with balanced and unbalanced sources. The input audio signals are converted to 24-bit digital and then transported via the Dante interface. Two digital audio signals arrive into the Model 544D via the Dante interface and are then converted to analog. Two 3-pin male XLR connectors on the Model 544D's back panel provide balanced analog line-level outputs.

The Model 544D can serve as an analog-to-Dante bridge, linking analog audio interfaces found on devices such as matrix intercom systems, broadcast routers, and audio consoles to and from the Dante domain. An Ethernet connection is all that's required to make the Model 544D part of a sophisticated, networked audio system. Dante audio-over-Ethernet has found wide acceptance as an audio “backbone” due to its ease of use, high performance, strong interoperability, and wide adoption by a large number of equipment manufacturers. The Model 544D is a general-purpose “tool” that helps to expand Dante's capabilities to facilities and equipment that primarily supports signals in the analog domain.

Audio data is sent to the Model 544D 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 24 are supported. The two line-level input channels are converted to digital and then routed to transmitter (output) channels on the Dante interface. Two transmitter (output) channels from an associated Dante-enabled device can be assigned to the Model 544D's receiver (input) channels using the Dante Controller application. These are then converted into analog outputs.

Careful attention to circuit design and component selection ensures that excellent audio quality is maintained. Extensive filtering helps prevent damage or less-than-optimal performance should DC voltage, ESD (“static”), or strong RF signals be present on the associated analog signals.



Figure 1. Model 544D Audio Interface front and back views

The STcontroller software application is used to configure the Model 544D's wide range of operating parameters. These include the nominal signal levels and which sources are utilized for the analog and Dante digital channels. Versions of STcontroller are available that are compatible with the Windows® and macOS® operating systems. They are available, free of charge, from the Studio Technologies' website.

Using STcontroller, the nominal audio levels of the line input and line output functions can be independently selected. In this way, compatibility with SMPTE®, EBU, and “semi-pro” nominal signal levels is supported. Audio level meters provide confirmation of system performance during setup and operation. Two general-purpose input (GPI) and two general-purpose output (GPO) functions allow support for installer-selected applications, including party-line intercom call-light functions. LED indicators provide a direct indication of the status of the GPI and GPO functions.

The Model 544D can be powered by power-over-Ethernet (PoE) or an external source of 12 volts DC. Standard connectors are used for the analog line inputs and analog line outputs, Ethernet, GPI, GPO, and DC power interconnections. The Model 544D's enclosure has a “1/2-rack” 1U form factor and weighs less than two pounds, making it well suited for use in portable applications. Alternately, using one of the optional rack-mount front panels, one or two Model 544D units can be mounted in a single space (1U) of a standard 19-inch rack enclosure.

Applications

The most basic application for Model 544D is for transporting analog audio signals to and from one location to another using the data transport resources of a local area network — there's really no simpler means to getting high-quality audio from “point A to point B” and back. With standard connectors and PoE power, setup can be completed in just a few minutes. This makes Model 544D units effective in both fixed and portable applications.

The Model 544D can also find use when an application already supports Dante. For example, ports on a matrix intercom system that directly supports Dante, such as the RTS® ODIN® or ADAM® with OMNEO®, can be routed to a Model 544D's Dante transmitter (output) and receiver (input) channels. The Model 544D will then provide two analog line inputs and two

analog line outputs for use in a variety of applications. These can include interfacing with audio inputs and outputs associated with audio consoles, providing talent cueing (IFB) feeds, and interfacing with the audio outputs of aerial camera systems.

The GPI and GPO functions allow Model 544D units to transport contact closures using high-frequency audio tones that are embedded as part of the unit's audio channels. Two independent contact closures can be “repeated” across a network using Dante audio paths. Provided for installer-specified applications, having the ability to transport contact closures over significant distances can be a unique and valuable resource.

The Model 544D's tone generator capability enables the unit to create 1 kHz, 18 kHz, and 20 kHz sine-wave analog and Dante digital audio signals. The ability to generate precision 1 kHz sine-wave tones is intended for general-purpose audio use. The 18 kHz tone is provided as a resource when supporting remote-production (REMI) applications that use the Studio Technologies' Model 5422A Dante Intercom Audio Engine. This 18 kHz tone can be used by a matrix intercom system to facilitate creation of voice-with-tone interruptible foldback (IFB) signals. When routed to Model 5422A interrupt inputs, these specialized IFB interrupt signals will allow creation of excellent talent cueing channels.

The 20 kHz tone option is provided for use in applications where generation of a party-line call signal is desired. For example, the 20 kHz tone can be connected to a matrix intercom system which would be configured such that a button press will cause 20 kHz to be sent out an intercom channel. This can serve as a “trigger” signal for visual or audible alerting devices, such as the Studio Technologies' Model 391 Dante Alerting Unit.

Line Inputs

The Model 544D provides two analog line-level input channels. Two STcontroller configuration choices allow the nominal levels of each input to be +4 dBu, –2 dBu, or –10 dBu. When configured for +4 dBu the unit will be compatible with SMPTE applications where the nominal digital signal level is –20 dBFS. The –2 dBu configuration choice allows the line inputs to be optimized for EBU applications where the nominal digital signal level is –18 dBFS. The –10 dBu configuration is provided for “semi-pro” applications where

sources are typically unbalanced (single-ended). Using this selection, an analog signal with a level of -10 dBu will result in a Dante digital output signal with a level of -20 dBFS.

The electronically balanced (differential) input circuits are capacitor-coupled and ESD (static) protected for reliable operation in a variety of applications. They are also protected from damage should a moderate DC voltage be accidentally connected. Sources can include analog I/O cards on matrix intercom systems, audio consoles, wireless microphone receivers, and broadcast routers.

Line Outputs

The Model 544D provides two analog line-level output channels. As with the line inputs, STcontroller choices allow the audio source for each line output to be selected. Choices include the Dante receiver (input) channels, the line inputs, and three sine-wave tone sources. The nominal level of the line outputs can be selected in STcontroller to be $+4$, -2 , or -10 dBu. This allows compatibility in applications where SMPTE ($+4$ dBu = -20 dBFS) or EBU (0 dBu = -18 dBFS) standards may apply. The -10 dBu setting can be useful for “semi-pro” applications where a lower nominal level is necessary. The line outputs are electronically balanced, capacitor-coupled and ESD (static) protected. The outputs are compatible with virtually all balanced and unbalanced inputs with an impedance of 2 k ohms or greater.

Pro Audio Quality

The Model 544D’s audio circuitry was designed in the spirit of professional audio equipment rather than that found in typical broadcast or commercial audio gear. High-performance components are used throughout, providing low-distortion, low-noise, and high headroom. Care was taken so that signal integrity is maintained in both the analog and digital domains.

Audio Meters and Status LEDs

The Model 544D provides four 5-segment LED meters. The meters, located on the unit’s front panel, display the level of the audio signals associated with the two line inputs and two line outputs. At the time of installation and setup the meters are invaluable in helping to confirm correct operation. During normal operation the meters offer a real-time confirmation of the unit’s audio signal levels, helping to ensure that

optimal audio quality is maintained. Additional LED indicators are provided on the front panel, offering status indications of the incoming power, GPI, and GPO functions.

GPI and GPO Capability

The Model 544D allows the sending and receiving of status signals using high-frequency audio tones that are transported within the Dante audio channels. When two Model 544D units are interconnected using an Ethernet network and Dante, two status signals can be transported in each direction. The GPI (general-purpose input) functions are compatible with contact closures provided by equipment such as matrix intercom systems, video/audio routers, or tally systems. During operation, a closure on one Model 544D GPI will result in the closing (shorting) of a solid-state relay contact associated with the GPO on a second Model 544D unit. To assist in implementing specialized GPI and GPO applications a source of low-current DC power is also provided.

The GPI and GPO functions can be especially useful in party-line intercom applications where call-light signals are utilized. Contact closures on matrix intercom systems can be “repeated” by Model 544D units that are located anywhere on the same local area network (LAN). The Model 544D is also directly compatible with the call-light signal support provided by the Studio Technologies’ Model 545DC and Model 545DR Intercom Interface units. With a Model 544D appropriately interconnected with a matrix intercom system full call-light support can be provided to and from RTS and Clear-Com® party-line intercom circuits.

Tone Generator Mode

For special applications, the Model 544D can be configured to serve as an audio tone generator. Instead of functioning as an interface device, the Model 544D will generate low-distortion, frequency-accurate, sine-wave audio signals. STcontroller configuration choices allow the frequency of the tones to be 1 kHz, 18 kHz, or 20 kHz. The tone signals are available as line-level analog and Dante digital audio outputs. When selected to output a tone, the level on an analog line output will follow the configured nominal level. Using STcontroller, the choices are $+4$ dBu, -2 dBu, and -10 dBu. The tone level on the Dante transmitter (output) channels will be fixed at -20 dBFS.

The 1 kHz tone is provided for general-purpose audio use. This can serve as an audio reference for an entire audio “plant” or facility to access as needed. Having a continuous source of 1 kHz sine-wave in analog or Dante digital formats can be useful for installation, testing, and troubleshooting applications.

The 18 kHz tone is intended for use with matrix intercom systems that are used with the Studio Technologies’ Model 5422A Dante Intercom Audio Engine. This tone will be connected to a matrix intercom system using either analog or Dante inputs. The matrix intercom system will be configured such that it will combine voice audio with the 18 kHz tone to create specialized IFB interrupt signals. These voice-with-tone signals will be routed, by way of an audio transport system, to Model 5422A interrupt inputs associated with tone operated (TOX) IFB channels. The Model 5422A will detect the 18 kHz tone and “trigger” the associated IFB function. In this way, high-performance IFB functions can be implemented for REMI (remote-production) applications.

The 20 kHz tone is provided for use in applications where generation of in-band signals that are compatible with the call function on RTS TW-series party-line (PL) intercom channels is desired. One example would be for the 20 kHz tone to be connected to an analog or Dante receiver (input) channel on a matrix intercom system. The intercom system would be configured such that a button press on an intercom “key” panel would cause 20 kHz to be sent out an intercom channel. This would then serve as a call “trigger” for devices such as a Studio Technologies’ Model 391 Dante Alerting Unit. Another interesting example would be for the 20 kHz tone to be used to serve as an activation signal for contact closures. Using Dante subscriptions (routes), the intercom channel from the matrix interface would be connected to additional Model 544D units. When those units receive the 20 kHz tone signal they would enable their associated GPO contact closures.

Ethernet Data, PoE, and DC Power Source

The Model 544D connects to a local area data network (LAN) using a standard 100 Mb/s twisted-pair Ethernet interface. The physical interconnection is made by way of a Neutrik etherCON RJ45 jack. While compatible with standard RJ45 plugs, an etherCON CAT5-compatible plug allows a ruggedized and locking

interconnection for harsh or high-reliability environments. The Model 544D’s operating power can be provided by way of the Ethernet interface using the Power-over-Ethernet (PoE) standard. This allows fast and efficient interconnection with the associated data network. To support PoE power management, the Model 544D’s PoE interface reports to the power sourcing equipment (PSE) that it is a class 1 (very low power) device. The unit can also be powered using an external source of 12 volts DC. For redundancy, both power sources can be connected simultaneously. Three LEDs on the unit’s back panel display the status of the network connection and the Dante interface. Two LEDs on the unit’s front panel provide a real-time indication of the connected power sources.

Simple Installation

The Model 544D uses standard connectors to allow fast and convenient interconnections. An Ethernet signal is connected using a Neutrik etherCON RJ45 jack. If Power-over-Ethernet (PoE) is available operation will commence immediately. An external 12 volts DC power source can also be connected by way of a 4-pin female XLR connector. Analog line-level input and output connections are made using 3-pin male and female XLR connectors. GPI, GPO, and auxiliary DC connections are made using a 9-pin female D-subminiature (DE-9F) connector. The Model 544D is housed in a rugged yet lightweight 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. Rack-mounting option kits are available that allow one or two Model 544D units to be mounted in one space (1U) of a standard 19-inch rack enclosure.

Future Capabilities and Firmware Updating

The Model 544D was designed so that its capabilities and performance can easily be enhanced in the future. A USB interface, located on the unit’s main circuit board (underneath the unit’s cover), allows the application firmware (embedded software) to be updated using a USB flash drive. To implement its Dante interface the Model 544D uses the UltimoX2™ integrated circuit from Audinate. The firmware in this integrated circuit can be updated via the Ethernet connection helping to ensure that its capabilities remain up to date.

Getting Started

In this section, a location will be selected for the Model 544D. If desired, an optional installation kit will be used to mount one or two units into a panel cutout, flat surface, or equipment rack. Signal interconnections will be made using the unit's back-panel connectors. An Ethernet data connection, which typically includes Power-over-Ethernet (PoE) capability, will be made using a cable-mounted etherCON CAT5-compatible plug or a standard RJ45 patch cord. A 4-pin XLR connector allows connection of an optional 12 volts DC power source. Connections to analog line-level input and output signals will be made using 3-pin male and female XLR connectors. Some applications may utilize the GPI and GPO functions which are accessible using a 9-pin female D-subminiature (DE-9F) connector.

What's Included

Included in the shipping carton are a Model 544D Audio Interface and instructions on how to obtain an electronic copy of this guide. An optional installation kit allows a Model 544D to be mounted in a rectangular opening in a tabletop or attached to a flat surface. If one or two Model 544D units are going to be mounted in a 19-inch equipment rack then having another of the optional rack-mount installation kits is required. If an installation kit was purchased it would typically have been shipped in a separate carton. As a device that can be powered by Power-over-Ethernet (PoE) or an external source of 12 volts DC, no power source is included. (A compatible power supply, the Studio Technologies' PS-DC-02, is available as an option.)

Locating the Model 544D

Where to locate a Model 544D will depend on being able to access the associated analog line input, analog line output, and, if utilized, GPI and GPO functions. The Model 544D is shipped as a self-contained "throwdown" unit suitable for portable use or placement in a semi-permanent location. Installed on the bottom of the chassis are screw-affixed "bump on" protectors (also known as rubber "feet"). These are useful if the unit is going to be placed on a surface where scratching of either the Model 544D's enclosure or the surface material could take place. However, if applicable the feet can be removed when installation in a panel cutout, onto a flat surface, or in a rack enclosure is going to be performed.

Once the unit's physical location has been established its assumed that the twisted-pair Ethernet cabling will be within 100-meters (325-feet) of the Ethernet port on an associated network switch. If this is not the case, then the overall length limit can be overcome by using a fiber-optic interconnection between the Model 544D's-related-Ethernet switch and another Ethernet switch that's part of the application's local-area-network (LAN). With a fiber interconnect there's no reason why a Dante-supporting LAN can't be distributed over many miles or kilometers.

Mounting Options

Panel Cutout or Surface Mounting One Model 544D Unit

Installation kit RMBK-10 allows one Model 544D to be mounted in a panel cutout or onto a flat surface. The kit contains two standard-length brackets 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 screw-on rubber feet from the bottom of the Model 544D's chassis. They can be removed using one's fingers to rotate them counterclockwise; no tool is required. Store the feet for possible later use.

To prepare the unit to mount in a cutout or other opening in a panel, use a #2 Phillips screwdriver and two 6-32 machine screws to attach one of the standard-length brackets onto the left side (when viewed from the front) of the Model 544D's enclosure. Orient the standard-length bracket such that its front is parallel to the Model 544D's front panel. The screws will mate with the threaded fasteners that can be seen on the side of the Model 544D's enclosure, near the front of the unit. Using two additional 6-32 machine screws, attach the other standard-length bracket onto the right side of the Model 544D's enclosure.

Once the two standard-length brackets have been installed the Model 544D will be ready to be mounted into an opening. Secure the unit into the top left and right edges of the opening using two mounting screws per side.

To prepare the unit to be mounted onto a flat surface simply requires the standard-length brackets be attached to the Model 544D at 90 degrees from how they are mounted for use in a panel cutout. Use a #2 Phillips screwdriver and two 6-32 machine screws

to attach one of the standard-length brackets onto the left side (when viewed from the front) of the enclosure. Orient the bracket such that its front is parallel with the top surface of the Model 544D's enclosure. The screws will mate with the threaded fasteners that can be seen on the side of the Model 544D's enclosure, near the front of the unit. Following the same orientation, use two additional 6-32 machine screws to attach the other standard-length bracket onto the right side of the Model 544D's enclosure.

Once the two standard-length brackets have been installed the Model 544D will be ready to be mounted onto a flat surface. Secure the unit to the surface using two mounting screws per side.

Left- or Right-Side Rack Mounting One Model 544D Unit

Installation kit RMBK-11 allows one Model 544D to be mounted in the left or right side of one space (1U) of a standard 19-inch rack enclosure. The kit contains one standard-length bracket, one long-length bracket, and four 6-32 thread-pitch Phillips-head machine screws. Refer to Appendix C for a visual explanation.

Begin the installation by removing the four screw-on rubber feet from the bottom of the Model 544D's chassis. They can be removed using one's fingers to rotate them counterclockwise; no tool is required. Store the feet for possible later use.

To prepare the unit to mount in the left side of a rack enclosure, use a #2 Phillips screwdriver and two 6-32 machine screws to attach the standard-length bracket onto the left side (when viewed from the front) of the enclosure. The screws will mate with the threaded fasteners that can be seen on the side of the Model 544D's enclosure, near the front of the unit. Using two additional 6-32 machine screws, attach the long-length bracket onto the right side of the Model 544D's enclosure.

To prepare the unit to mount in the right side of a rack enclosure, use a #2 Phillips screwdriver and two 6-32 machine screws to attach the long-length bracket onto the left side of the enclosure. Using two additional 6-32 machine screws, attach the standard-length bracket onto the right side of the Model 544D's enclosure.

Once the standard-length and long-length brackets have been installed the Model 544D 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 544D Units

Installation kit RMBK-12 is used to allow two Model 544D units to be mounted in one space (1U) of a standard 19-inch equipment rack. The kit can also be used to mount one Model 544D and one other Studio Technologies' product that is compatible with the RMBK-12, such as the Model 545DR Intercom Interface or the Model 5421 Dante Intercom Audio Engine. The RMBK-12 installation kit contains two standard-length 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 D for a visual explanation.

Begin the installation by removing the four screw-on rubber feet from the bottom of the Model 544D's chassis. They can be removed using one's fingers to rotate them counterclockwise; no tool is required. Store the feet for possible later use.

With assistance from a #2 Phillips screwdriver, use two of the 6-32 machine screws to attach one of the standard-length brackets onto the left side (when viewed from the front) of one of the Model 544D units. The screws will mate with the threaded fasteners that can be seen on the side of the Model 544D's enclosure, near the front of the unit. Using two more of the 6-32 machine screws, attach one of the joiner plates onto the right side of that same Model 544D unit.

Again using two of the 6-32 machine screws, attach the second standard-length bracket onto the right side of the second Model 544D or another compatible unit. Using the final two 6-32 machine screws, attach the second joiner plate onto the left side of the second Model 544D 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 screwdriver, use the two 2-56 Torx 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.

The 2-unit assembly is now 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.

Center Rack Mounting One Model 544D Unit

Installation kit RMBK-13 allows one Model 544D to be mounted in the center of one space (1U) of a standard 19-inch rack enclosure. The kit contains two medium-length brackets and four 6-32 thread-pitch Phillips-head machine screws. Refer to Appendix E for a visual explanation.

Begin the installation by removing the four screw-on rubber feet from the bottom of the Model 544D's chassis. They can be removed using one's fingers to rotate them counterclockwise; no tool is required. Store the feet for possible later use.

To prepare the unit to mount in the center of a rack enclosure, use a #2 Phillips screwdriver and two 6-32 machine screws to attach one of the medium-length brackets onto the left side (when viewed from the front) of the enclosure. The screws will mate with the threaded fasteners that can be seen on the side of the Model 544D's enclosure, near the front of the unit. Using two additional 6-32 machine screws, attach the other medium-length bracket onto the right side of the Model 544D's enclosure.

Once the two medium-length brackets have been installed the Model 544D 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.

Ethernet Connection with PoE

An Ethernet connection that supports 100BASE-TX (100 Mb/s over twisted-pair) is required for Model 544D operation. A 10BASE-T connection is not

sufficient; a 1000BASE-T (GigE) connection is not supported unless it can automatically "fall back" to 100BASE-TX operation. An Ethernet connection that supports Power-over-Ethernet (PoE) is preferred as it will also provide operating power for the Model 544D. To support Ethernet switches that include PoE power management capability the Model 544D will enumerate itself as a PoE class 1 device.

A 100BASE-TX Ethernet connection is made by way of a Neutrik etherCON RJ45 jack that is located on the back panel of the Model 544D. This allows connection by way of a cable-mounted etherCON CAT5-compatible or a standard RJ45 patch cord. A crossover cable will never be required as the Model 544D's Ethernet interface supports auto MDI/MDI-X. Per the Ethernet standard, the Ethernet Switch-to-Ethernet Device length limitation for twisted-pair cabling is 100-meters (325-feet).

External 12 Volt DC Input

An external source of 12 volts DC can be connected to the Model 544D by way of a 4-pin male XLR connector which is located on the back panel. While the requirement for the external source is nominally 12 volts, correct operation will take place with any source that has a range of 10 to 18 volts DC. The Model 544D requires 300 milliamperes maximum at 12 volts DC for correct operation. The DC source should be terminated to a 4-pin female XLR connector with pin 1 negative (–) and pin 4 positive (+). Purchased as an option, the compatible PS-DC-02 power supply is available from Studio Technologies. Its AC mains input allows connection of a 100-240 volts, 50/60 Hz source and its 12 volt DC, 1.5 amperes maximum output is terminated on a 4-pin female connector.

As previously discussed, an Ethernet connection that provides Power-over-Ethernet (PoE) can serve as the Model 544D's power source. Alternately, an external 12 volts DC source can be connected. For redundancy, both PoE and an external 12 volts DC source can be connected at the same time. If both PoE and an external 12 volts DC source are connected, power will be drawn only from the PoE supply. If the PoE source becomes inoperative the 12 volts DC source will provide the Model 544D's power with no interruption in operation. (Of course, if both PoE and Ethernet data support are lost that is a very different situation!)

Line Inputs

The Model 544D provides two analog line-level inputs that are intended for connection to balanced or unbalanced signal sources associated with professional audio and video equipment. It's expected that the nominal level of the analog sources will either be +4 dBu for SMPTE® applications, 0 or –2 dBu for EBU applications, or –10 dBu for “semi pro” applications. (Refer to a later section of this guide for analog line input nominal level configuration.) Commonly used sources could include analog I/O ports on broadcast matrix intercom systems, audio consoles, video storage and playback systems, wireless microphone receivers, and audio testing equipment. The circuitry associated with the line inputs is analog, electronically balanced, capacitor coupled, with a nominal impedance of 20 k ohms.

Two 3-pin female XLR connectors, located on the Model 544D's back panel, are used for interfacing with the source signals. Prepare 3-pin male XLR mating connectors such that pin 2 is signal high (+), pin 3 is signal low (–), and pin 1 is common/shield. It's also probable that unbalanced sources will interface correctly. With an unbalanced source begin by connecting signal high (+) to pin 2 and signal low/shield (–) to both pins 1 and 3. If this results in hum or noise, next try connecting signal high (+) to pin 2 and signal low/shield (–) only to pin 3; leave pin 1 unconnected (“floating”).

Line Outputs

The Model 544D provides two analog line-level outputs. These analog outputs are designed for general-purpose use which could include connecting to analog inputs on devices including matrix intercom systems, transmitters associated with wireless in-ear monitors, audio consoles, or amplified speakers. The circuitry associated with the line outputs is analog, capacitor-coupled, and has a nominal source impedance of 200 ohms. They will perform optimally when driving loads of 2 k (2000) ohms or greater. The nominal level of the line outputs is configurable to be either +4 dBu, –2 dBu, or –10 dBu, corresponding to the needs of SMPTE, EBU, or “semi-pro” applications. (Refer to a later section of this guide for analog line output level configuration.)

Two 3-pin male XLR connectors, located on the Model 544D's back panel, are provided for interfacing the line outputs with associated equipment. Prepare 3-pin female XLR mating connectors such that pin 2 is signal high (+), pin 3 is signal low (–), and pin 1 is common/shield. To connect to an unbalanced load use pin 2 as signal high (+) and pin 1 as low/shield; do not connect anything to pin 3. Do not short pin 3 to pin 1 as it will stress the output circuitry.

General-Purpose Inputs (GPI)

The Model 544D provides two general-purpose input functions that are referred to as GPI 1 and GPI 2. These functions allow transport of the status of relay contacts or open-collector logic signals. The Model 544D's GPI inputs use logic circuitry “pulled up” to 3.3 volts DC by way of resistors, which are active whenever they are brought to their logic low state. While the GPI input circuitry is protected from over-current and static discharge (ESD), care should be taken to minimize the chance that “nasty” signals can reach them.

The GPI inputs are active only when held in their low state; they can't be configured to change state (“latch”) in response to a logic pulse or momentary closure. Pins on a 9-pin female D-subminiature connector (DE-9F) are used for interfacing with the GPI inputs and system common connections. This connector is located on the Model 544D's back panel. A GPI is only active when its corresponding pin is connected to system common. GPI 1 is accessible on pin 3 and GPI 2 on pin 4. System common is available on pins 8 and 9. Refer to Figure 2 for connection details.

When a GPI is active, a 20 kHz sine-wave tone will be present on its respective Dante transmitter (output) channel.

General-Purpose Outputs (GPO)

The Model 544D provides two general-purpose output functions that are referred to as GPO 1 and GPO 2. These functions provide contact closures that respond to trigger signals transported over the Dante input (receiver) audio paths. The trigger signals are in the form of high-frequency audio tones (typically 18 or 20 kHz) that travel along with the normal audio signals (“in band” audio). The GPO functions can also change state in response to user activation using the

Pin	Function
1	GPO 1-A
2	GPO 2-A
3	GPI 1
4	GPI 2
5	Aux DC Out
6	GPO 1-B
7	GPO 2-B
8	COM
9	COM

Note:

Connector type on Model 544D is a 9-pin female D-subminiature (DE-9F). Installer must provide a 9-pin male D-subminiature (DE-9M). Connector uses 4-40 threaded inserts for locking with mating plug.

Figure 2. GPI, GPO, and Auxiliary DC Output connections

“virtual” on/off buttons accessible via the STcontroller application. The normally-open (not shorted) contact closures are isolated from system common. They are implemented using solid-state relay contacts which are intended to control low-voltage/low-current DC functions. The contacts are rated for use at up to 60 volts DC or AC with a maximum current of 400 milliamperes. They are not intended for direct connection to AC mains (high-voltage AC signals.).

Pins on a 9-pin female D-subminiature connector (DE-9F), located on the Model 544D’s back panel, allow interfacing with the GPO connections. Two connections are provided for each GPO, pins 1 and 6 for GPO 1 and pins 2 and 7 for GPO 2. Refer to Figure 2 for connection details.

Auxiliary DC Output

A source of low-voltage, low-current DC is available to support special applications that use the GPO functions. The auxiliary DC output is referenced to system common and can supply nominal 12 volts DC at a maximum current of 25 milliamperes. During normal operation the auxiliary DC output can range from 10 to 18 volts DC if an external power source is connected to the Model 544D and is providing operating power. The auxiliary DC output is accessible by way of pin 5 of the 9-pin female D-subminiature (DE-9F)

connector that’s located on the Model 544D’s back panel. System common is provided on pins 8 and 9. Refer to Figure 2 for connection details.

The exact use of the auxiliary DC output will depend on the needs of the specific applications and the capabilities of the installer. The auxiliary DC output can, for example, be connected in series with a GPO’s contact and used to directly light a status LED, enable an optical coupler, or provide a “GPO active” voltage output. Be careful to limit the load placed on the auxiliary output. Its circuitry will limit the current to approximately 25 milliamperes but keeping it from reaching that maximum value is a good idea.

Dante Configuration

To integrate the Model 544D into an application requires that a number of Dante-related parameters be configured. These configuration settings will be stored in non-volatile memory within the Model 544D’s Dante interface circuitry. Configuration will typically be done using the Dante Controller software application which is available for download free of charge at audinate.com. Versions of Dante Controller are available to support the Windows and macOS personal computer operating systems. The Model 544D uses the UltimoX2 2-input/2-output integrated circuit to implement its Dante interface. The Model 544D’s Dante interface is compatible with AES67 as well as the Dante Domain Manager™ (DDM) software application.

Audio Routing

Two Dante transmitter (output) channels on associated equipment should be routed (subscribed) to the Model 544D’s two Dante receiver (input) channels. The Model 544D’s two transmitter (output) channels should be routed (subscribed) to two Dante receiver (input) channels on associated equipment. This achieves audio interconnection of the Model 544D’s two input and two output channels with the Dante network and associated Dante device or devices. This will support the transport of human-understandable audio signals and/or tones associated with the GPI/GPO functions.

Within Dante Controller, a “subscription” is the term used for routing a transmitter channel or a flow (a group of up to four output channels) to a receiver

channel or a flow (a group of up to four input channels). The number of transmitter flows associated with an UltimoX2 integrated circuit is limited to two. These can either be unicast, multicast, or a combination of the two. If the Model 544D's transmitter (output) channels need to be routed using more than two flows it's possible that an intermediary device, such as the Studio Technologies' Model 5422A Dante Intercom Audio Engine, can be used to "repeat" the signals.

Model 544D units will be commonly utilized in one of two configurations: "point-to-point" or in association with other Dante-enabled equipment. The first configuration will utilize two Model 544D units that "work" together to link two physical locations. At each location there would typically be balanced or unbalanced analog audio (4-wire) signals. Alternately, or in addition to, there could be connections made to the unit's GPI and GPO functions. The two Model 544D units would operate "point-to-point," interconnecting the send and receive analog audio signals, and possible GPI/GPO signals, by way of the associated Ethernet network. To implement this application is very simple. The two transmitter (output) channels on each unit would be routed (subscribed) to the two receiver (input) channels on the other unit.

The other typical application will have one Model 544D connected to existing analog audio circuits and/or GPI/GPO functions. The unit's Dante audio channels would be routed (subscribed) to the Dante transmitter (output) and receiver (input) channels on associated Dante-enabled equipment. An example of this equipment could be the RTS ADAM matrix intercom system that provides Dante interconnection capability using its OMNEO interface card. The audio channels on the Model 544D would be routed (subscribed) to and from audio channels on the OMNEO card. Other equipment that supports Dante, such as audio consoles or audio interfaces (Dante-to-MADI, Dante-to-SDI, etc.), can have their audio channels routed (subscribed) to and from a Model 544D.

Device and Channel Names

The Model 544D has a default Dante device name of **ST-M544D-** followed by a unique suffix. The suffix identifies the specific Model 544D that is being configured. The suffix's actual alpha and numeric characters relate to the MAC (media access control)

address of the Ultimo integrated circuit that's present in the specific Model 544D. The two Dante receiver (input) channels have the default names of **Ch1** and **Ch2**. The two Dante transmitter (output) channels also have the default names of **Ch1** and **Ch2**. Using Dante Controller these names can be revised as appropriate for the specific application.

Device Configuration

The Model 544D 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. Clocking and Device Latency can be adjusted if required but the default values are typically correct.

Network Configuration – IP Address

By default, the Model 544D's Dante IP address and related network parameters will be determined automatically using DHCP or, if not available, the link-local network protocol. If desired, Dante Controller allows the IP address and related network parameters to be manually set to a fixed (static) configuration.

AES67 Configuration – AES67 Mode

The Model 544D can be configured for AES67 operation. This requires that the AES67 Mode be set for *Enabled*. By default, AES67 mode is set for *Disabled*. Note that in the AES67 mode the Dante transmitter (output) channels will function in multicast; unicast is not supported.

Model 544D Clocking Source

While technically the Model 544D can serve as a Leader clock for a Dante network (as can all Dante-enabled devices) in virtually all cases the unit will be configured to receive "sync" from another device. As such, the check box for Preferred Leader associated with the Model 544D would not want to be enabled.

Model 544D Configuration

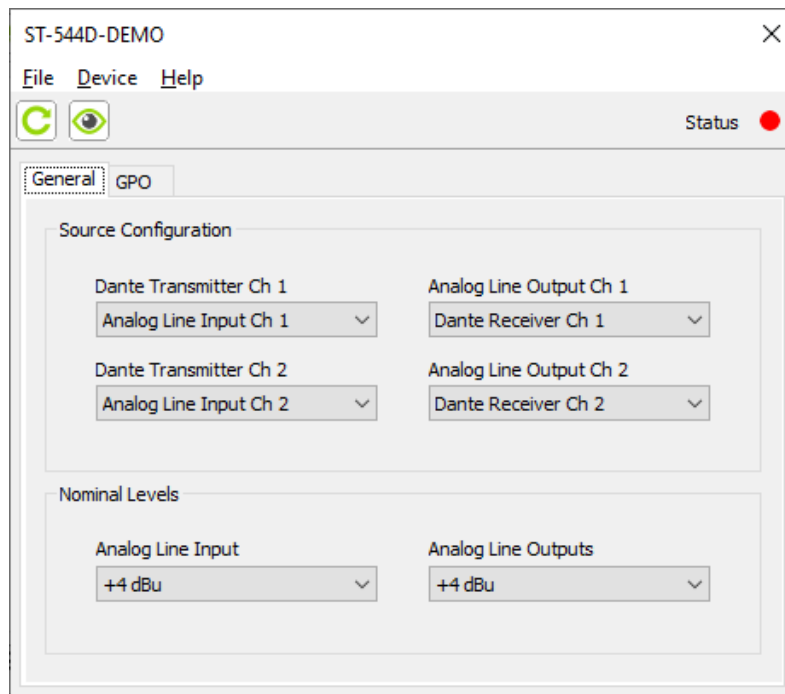
The STcontroller software application is used to configure a number of Model 544D operating functions. No DIP switch settings or other local actions are used to configure the unit. This makes it imperative that STcontroller be available for convenient use on a personal computer that's connected to the related LAN.

Installing STcontroller

STcontroller is available free of charge on the Studio Technologies' website (studio-tech.com). Versions are available that are compatible with personal computers running selected versions of the Windows and macOS operating systems. If required, download and install STcontroller onto a designated personal computer. This personal computer must be on the same local area network (LAN) and subnet as the one or more Model 544D units that are to be configured. Immediately after starting STcontroller the application will locate all the Studio Technologies' devices that it can control. The Model 544D units that can be configured will appear in the device list. Use the Identify command to allow easy recognition of a specific Model 544D 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. Configuration changes made using STcontroller will be immediately reflected in the unit's operation; no Model 544D reboot is required. As an indication that a configuration change has been made the two LEDs associated with input power, labeled DC and PoE, on the Model 544D's front panel will flash in a distinctive pattern.

General Menu Page

The following configuration selections are available in the General menu selections tab.



Source Configuration – Dante Transmitter Ch 1

Choices are *Analog Line Input Ch 1*, *Analog Line Input Ch 2*, *Dante Receiver Ch 1*, *Dante Receiver Ch 2*, *1 kHz Tone*, *18 kHz Tone*, and *20 kHz Tone*.

This configuration choice determines the audio source that is utilized by Dante transmitter (output) channel 1. There are seven choices allowing a variety of applications to be supported.

Analog Line Input Ch 1: If this choice is selected, the analog source connected to the XLR connector associated with analog line input channel 1 will be routed to Dante transmitter (output) channel 1. This will be the typical setting for most applications.

Analog Line Input Ch 2: If this choice is selected, the analog source connected to the XLR connector associated with analog line input channel 2 will be routed to Dante transmitter (output) channel 1.

Dante Receiver Ch 1: When this choice is selected, the audio source associated with Dante receiver (input) channel 1 will be routed to Dante transmitter (output) channel 1. This is in essence a Dante digital “loop-back” function which can be useful for testing purposes.

Dante Receiver Ch 2: When this choice is selected, the audio source associated with Dante receiver (input) channel 2 will be routed to Dante transmitter (output) channel 1. This is in essence a type of Dante digital “loop-back” function which can be useful for testing purposes. But be careful, audio associated with Dante receiver (input) 2 will be output by way of Dante transmitter (output) channel 1!

1 kHz Tone: If this choice is selected, a digitally generated source of 1 kHz sine-wave tone will be routed to Dante transmitter (output) channel 1. The output level will be –20 dBFS.

18 kHz Tone: If this choice is selected, a digitally generated source of 18 kHz sine-wave tone will be routed to Dante transmitter (output) channel 1. The output level will be –20 dBFS.

20 kHz Tone: If this choice is selected, a digitally generated source of 20 kHz sine-wave tone will be routed to Dante transmitter (output) channel 1. The output level will be –20 dBFS.

Source Configuration – Dante Transmitter Ch 2

Choices are *Analog Line Input Ch 1*, *Analog Line Input Ch 2*, *Dante Receiver Ch 1*, *Dante Receiver Ch 2*, *1 kHz Tone*, *18 kHz Tone*, and *20 kHz Tone*.

This configuration choice determines the audio source that is utilized by Dante transmitter (output) channel 2. The available choices and associated actions are very

similar to that of Dante transmitter (output) channel 1. Refer to the previous paragraphs for details.

Source Configuration – Analog Line Output Ch 1

Choices are *Analog Line Input Ch 1*, *Analog Line Input Ch 2*, *Dante Receiver Ch 1*, *Dante Receiver Ch 2*, *1 kHz Tone*, *18 kHz Tone*, and *20 kHz Tone*.

This configuration choice determines the audio source that is utilized by analog output channel 1.

Analog Line Input Ch 1: If this choice is selected, the audio signal connected to the XLR connector associated with analog line input channel 1 will be routed to analog line output channel 1. This is an analog “loop-back” function that is provided for testing purposes.

Analog Line Input Ch 2: If this choice is selected, the analog signal connected to the XLR connector associated with analog line input channel 2 will be routed to analog line output channel 1. This is a form of analog “loop-back” that is provided for testing purposes. But be careful with this selection! Analog line input 2 will be output by way of analog line output 1.

Dante Receiver Ch 1: If this is selected, the audio source associated with Dante receiver (input) channel 1 will be routed to analog line output channel 1. This will be the typical setting for most applications.

Dante Receiver Ch 2: If this choice is selected, the audio source associated with Dante receiver (input) channel 2 will be routed to analog line output channel 1. Be careful with this setting! It's kind of a “channel cross.”

1 kHz Tone: When selected, a digitally generated source of 1 kHz sine-wave tone will be routed to analog line output channel 1. This is provided for general-purpose use. The level will be the selected nominal for the analog line outputs.

18 kHz Tone: If this choice is selected, a digitally generated source of 18 kHz sine-wave tone will be routed to analog line output channel 1. The level will be the selected nominal for the analog line outputs.

20 kHz Tone: If this choice is selected, a digitally generated source of 20 kHz sine-wave tone will be routed to analog line output channel 1. The level will be the selected nominal for the analog line outputs.

Source Configuration – Analog Line Output Ch 2

Choices are *Analog Line Input Ch 1*, *Analog Line Input Ch 2*, *Dante Receiver Ch 1*, *Dante Receiver Ch 2*, *1 kHz Tone*, *18 kHz Tone*, and *20 kHz Tone*.

This configuration choice determines the audio source that is utilized by analog line output channel 2. The actions of the configuration choices are the same as those available for analog line output channel 1. Details were provided in the previous paragraphs.

Nominal Levels – Analog Line Inputs

Choices are *+4 dBu*, *–2 dBu*, and *–10 dBu*.

This configuration choice determines the nominal level of the two analog line inputs. This equates to the signal level required to cause a Dante signal level of –20 dBu to be created on a Dante transmitter (output) channel. The configuration choice should be selected so as to best match the nominal level of the sources that are being connected to the Model 544D's line input XLR connectors.

The choice of *+4 dBu* would be compatible with most North American (SMPTE®-standard) applications where +4 dBu analog will equate to –20 dBFS digital. The choice of *–2 dBu* is intended for compatibility with signals that may be present in Europe (EBU-standard). In this case, an analog signal source with a level of 0 dBu will cause a digital output signal at a level –18 dBFS. The *–10 dBu* choice is provided for applications where semi-professional unbalanced sources are connected. They will typically have a much lower nominal signal level.

Nominal Levels – Analog Line Outputs

Choices are *+4 dBu*, *–2 dBu*, and *–10 dBu*.

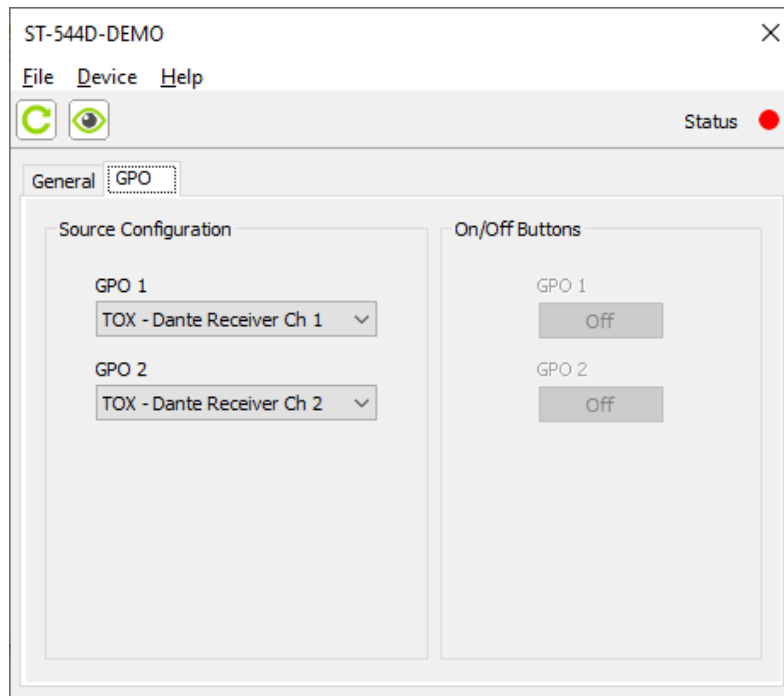
This configuration choice determines the nominal level of the Model 544D's two analog line outputs. The nominal level should be selected to best match the needs of inputs on equipment that will be utilizing these analog signal sources. The output level choices are all referenced to the designated signal source being a Dante receiver (input) with a level of –20 dBu.

When configured for *+4 dBu* the analog line outputs are configured such that a Dante input (receiver) channel with a signal level of –20 dBFS will result in an analog output signal having a level of +4 dBu. This

configuration would allow compatibility with SMPTE digital-to-analog level-relationship standards. When selected for *–2 dBu*, a Dante input (receiver) with a signal level of –18 dBFS will result in an analog output signal having a level of 0 dBu. This relationship would make the analog line outputs compliant with EBU standards. The *–10 dBu* selection is provided for applications where the analog line outputs might need a lower or “semi-pro” signal level. A signal on a Dante input (receiver) channel with a level of –20 dBu would result in an analog output level of –10 dBu.

GPO Menu Page

The following configuration selections are available in the GPO menu selections tab.



Source Configuration – GPO 1

Choices are *STcontroller On/Off Button*,
TOX – Dante Receiver Ch 1, and
TOX – Dante Receiver Ch 2.

The state (active or inactive) of GPO 1 can be controlled by the configuration selected from among three available sources.

STcontroller On/Off Button: When this choice is selected, the state of GPO 1 will be controlled by the virtual “button” that’s present in the On/Off Buttons click or keyboard key the GPO 1 On/Off button icon will cause the state of GPO 1 to change. This function can be useful during installation and configuration of the Model 544D and related signals. It can also be used as a means for an STcontroller user to control the state of GPO 1.

TOX – Dante Receiver Ch 1: This choice allows a high frequency signal that is present in Dante receiver (input) channel 1 to control the state of GPO 1. The acronym TOX has traditionally meant “Tone Operated Relay.” In the case of the Model 544D, it means that a

high-frequency tone (nominally 18 kHz or above) that is present in the audio channel (“in-band”) will be used as a control signal. GPO 1 will be active when a signal that meets the requirements for level and frequency is present on Dante receiver (input) channel 1.

Note that when this choice is selected, the high-frequency content on analog output channel 1 will be limited to nominally 10 kHz. This prevents a high-frequency tone present in Dante receiver (input) channel 1 that’s serving as a TOX signal from being output in analog output channel 1. This filtering function is accomplished by way of low-pass filtering sections within the digital domain.

TOX – Dante Receiver Ch 2: This choice allows a high frequency signal that is present in Dante receiver (input) channel 2 to control the state of GPO 2. The acronym TOX has traditionally meant “Tone Operated Relay.” In the case of the Model 544D, it means that a high-frequency tone (nominally 18 kHz or above) that is present in the audio channel (“in-band”) will be used as a control signal. GPO 2 will be active when a signal that meets the requirements for level and frequency is present in Dante receiver (input) channel 2.

Note that when this choice is selected, the high-frequency content on analog output channel 2 will be limited to nominally 10 kHz. This prevents a high-frequency tone present in Dante receiver (input) channel 2 that's serving as a TOX signal from being output in analog output channel 2. This filtering function is accomplishing by way of low-pass filtering sections within the digital domain.

Source Configuration – GPO 2

Choices are *STcontroller On/Off Button*,
TOX – Dante Receiver Ch 1, and
TOX – Dante Receiver Ch 2.

The state (active or inactive) of GPO 2 can be controlled by the configuration selected from among the three available sources. The functionality of the three choices has previously been discussed for GPO 1.

On/Off Buttons

On the GPO page there is a section called On/Off Buttons which provides two software-implemented (virtual) pushbutton switches. These allow manual control of the state of the two GPO outputs when their respective source configuration has been selected for STcontroller On/Off Button. If this configuration choice has not been selected, the associated On/Off button will be “grayed out” and not available for use.

On/Off Buttons – GPO 1: This can be pressed, using a mouse click or keyboard key, to change the state of GPO 1 from inactive-to-active or active-to-inactive. This can prove useful during installation and testing of the Model 544D's GPO functions. It can also be used to manually control the state of GPO 1.

On/Off Buttons – GPO 2: This can be pressed, using a mouse click or keyboard key, to change the state of GPO 2 from inactive-to-active or active-to-inactive. It can find value during installation and testing of the Model 544D's GPO functions. It can also be used to manually control the state of GPO 2.

Operation

At this point, the Model 544D should have its Ethernet, line input, line output, and GPI/GPO connections implemented as desired for the application. Depending on the capabilities of the connected Ethernet signal, an external source of nominal 12 volts DC power may have also been connected. Using the Dante Controller software application, the two Dante receiver (input) channels and two Dante transmitter (output) channels should have been routed as desired. Normal operation of the Model 544D should now be occurring.

The Model 544D is designed for continuous operation with no adjustments required. Maintaining the correct signal levels coming into the line inputs and the Dante receiver (input) channels is important. This will ensure that proper signal levels are presented to the Model 544D's circuitry and associated equipment, leading to optimal audio performance. The audio level meters and GPO status LEDs will provide assistance in confirming that correct operation is taking place.

Initial Operation

The Model 544D will begin its initial functioning a few seconds after its power source is connected. As previously discussed, the unit's power source can be provided by Power-over-Ethernet (PoE) or an external source of 12 volts DC. If both are connected, the PoE source will power the unit. Should PoE power subsequently no longer be available, uninterrupted operation will continue using the external 12 volts DC source. (This will probably prove to be a "hollow" victory since a loss of PoE will probably also mean a loss of the required Ethernet data connection!)

Upon Model 544D power up, the status LEDs will light in various ways. The Dante and Ethernet status LEDs, located on the back panel, will light in various ways. On the front panel the input power, GPI and GPO status, and audio level meter LEDs will light in a test sequence. Once the sequence has completed the two columns of level meter LEDs associated with the line outputs will momentarily display the version number of the unit's application firmware (embedded software). Details on how to "read" the version number are provided in the Technical Notes section.

The Model 544D will now begin normal operation. The way in which the back-panel LINK/ACT, SYS, and SYNC LEDs light will depend on the characteristics of

the connected Ethernet signal and the configuration of the unit's Dante interface. Details will be covered in the next paragraph. The user is presented on the front panel with two input power status LEDs, two GPI status LEDs, two GPO status LEDs, and four 5-segment LED audio level meters. These resources are simple to understand and should prove to be useful as will be highlighted in the following paragraphs.

Power Status LEDs

Two power status LEDs are located on the left side of the Model 544D's front panel. When an Ethernet connection with power-over-Ethernet (PoE) has been connected the PoE LED will light. When an external source of nominal 12 volts DC is connected the DC LED will light. If both LEDs are lit then the Model 544D is being powered by the PoE connection.

Ethernet and Dante Status LEDs

Three status LEDs are located below the etherCON RJ45 jack on the Model 544D's back panel. The LINK/ACT LED will light green whenever an active data connection to a 100 Mb/s Ethernet network has been established. It will flash on and off in response to data packet activity. The SYS and SYNC LEDs display the operating status of the Dante interface and associated audio-over-Ethernet network. The SYS LED will light red upon Model 544D power up to indicate that the Dante interface is not ready. After a short interval, it will light green to indicate that it is ready to pass audio data with another Dante device. The SYNC LED will light red when the Model 544D is not synchronized with a Dante network. It will light solid green when the Model 544D is fully synchronized with a Dante network and an external clock source (timing reference) is being received. It will slowly flash green if this specific Model 544D is serving as the Leader clock for the Dante network. While technically possible, typically a Model 544D should not server as the Leader clock for a Dante application!

How to Identify a Specific Model 544D

Functions within the Dante Controller and STcontroller software applications allow specific Model 544D units to be identified. Each application provides an "eye-ball" icon that when clicked will activate the Identify function. When the Identify command is activated the associated software application will send a command

to a specific Model 544D unit. This will cause that unit's four audio level meters to light in a unique pattern. In addition, the SYS and SYNC LEDs, located directly below the RJ45 jack on the back panel, will slowly flash. After a few seconds the LED identification patterns will cease and normal Model 544D level meter and Dante status LED operation will resume. Audio, GPI, and GPO performance will not be impacted by the use of the Identify command. As such it's perfectly acceptable to use this command any time it would be useful.

Line Inputs

The Model 544D's two line-level inputs are electronically balanced (differential), capacitor coupled, with a nominal impedance of 20 k ohms. The nominal analog level of signals presented to the line inputs should match the Model 544D's configuration. (The configuration choices are +4 dBu, -2 dBu, and -10 dBu.)

The line input circuitry is protected from damage should a moderate DC voltage be accidentally connected. For example, no damage will occur if a powered analog party-line intercom circuit (typically 28 to 32 volts DC from 3-pin XLR pin 2 to pin 1) be accidentally connected. This protection would also be effective should P48 phantom power associated with a microphone signal be accidentally connected.

Line Outputs

The line outputs are electronically balanced (differential) and intended to be connected to various analog inputs with nominal impedances of 2 k (2000) ohms or greater. The nominal analog level of signals present on the line outputs will depend on the Model 544D's configuration. (The configuration choices are +4 dBu, -2 dBu, and -10 dBu.) No special precautions are necessary when using the line outputs in settings where a variety of signals are present. As with the line inputs, the line output circuitry is protected from damage. For example, no damage will occur if a powered analog party-line intercom circuit or a microphone signal with P48 phantom power present be accidentally connected.

The frequency response of each line output will depend on the configuration of its associated low-pass GPO function. If TOX is selected, then a low-pass filter function will be enabled and most energy above

10 kHz will be removed. This will have minimal impact for voice applications such as intercom or talent cueing (IFB).

Level Meters

The Model 544D contains four 5-segment LED level meters, two associated with the line inputs and two associated with the line outputs. The meters are provided as a support aid during installation, configuration, operation, and troubleshooting.

General

The meters are organized into two groups with one group representing the two line inputs and the second group representing the two line outputs. The two meters associated with the line inputs are calibrated in reference to the configuration of their nominal levels. When configured for +4 dBu nominal a meter's 0 LED lighting will indicate that an analog signal with a level of +4 dBu is present on the associated line input. This will translate to a transmitter (output) level of -20 dBFS being sent to the Dante network. When the line inputs are configured for -2 dBu nominal a meter's 0 LED lighting will indicate that a signal with a -2 dBu is present on the line input and the corresponding Dante transmitter (output) level will again be -20 dBFS. (As such, when an EBU-standard 0 dBu is presented to a line input it will result in a Dante output level of -18 dBFS.) When the line inputs are configured for -10 dBu nominal it follows that an input signal with a level of -10 dBu will result in a Dante digital output level of -20 dBFS.

Similar to the line inputs, the two meters associated with the line outputs are calibrated in reference to the configuration of the nominal level of the line outputs. When configured for +4 dBu nominal, a meter's 0 LED lighting will indicate that a Dante receiver (input) level of -20 dBFS is present along with a corresponding signal on the line output with a level of +4 dBu. When the line outputs are configured for a 0 dBu nominal level, a meter's 0 LED lighting will indicate that a Dante receiver (input) level of -18 dBFS is present. The corresponding analog output signal present on the line output will have a level of 0 dBu.

Each level meter contains four green LEDs and one yellow LED. The four green LEDs indicate audio signal levels at or below the selected nominal level (+4 dBu,

–2 dB, or –10 dBu). The top LED is yellow and indicates a signal that is 6 dB or greater than the selected nominal level. An audio signal that causes the yellow LED to light doesn't necessarily indicate an excessive level condition, but it does provide a warning that at some stage reducing the signal level of the source may be prudent. Typical operation with normal signal levels should find the meters lighting near their 0 point. Signal peaks may cause the yellow LEDs to flash. But a yellow LED that lights fully during normal operation will typically indicate excessive signal level and/or a configuration problem with associated Dante-enabled equipment.

Non-Optimal Signal Levels

If the meters consistently display levels that are lower or higher than 0, it's possible that a configuration issue exists. This would typically be related to an incorrect Model 544D line input or line output configuration or an incorrect setting on the equipment associated with the Model 544D. With a digital matrix intercom system providing the Dante input signal this problem could be due to an incorrect configuration having been made to its specific channel or port. For example, the RTS ADAM system has a published nominal level of +8 dBu, but it's not clear how this translates into a digital audio level on an associated OMNEO (Dante-compatible) port. Using its configuration software, it's most likely possible to set the nominal level of intercom key panels or ports to something different than +8 dBu. The best solution in this case would be to adjust the associated OMNEO (Dante-compatible) port such that it results in a nominal level that matches the Model 544D's configuration. So, for example, if the Model 544D is configured for +4 dBu nominal input levels then the associated OMNEO (Dante) transmitter channels should be set up to be the same. This should lead to the optimal performance of the Model 544D and the associated intercom system.

GPI and GPO

Whether or not the general-purpose input (GPI) and general-purpose output (GPO) functions are implemented will depend on the needs of the specific application. If the appropriate connections are made using the 9-pin female D-subminiature connector either or both functions can be utilized. No user action is required for the functions to be active. Two front-panel LEDs indicate the state of the GPI inputs.

Each LED will light green when their associated GPI is active. There are also two front-panel LEDs that light green when GPO 1 or GPO 2 are active.

A typical application might find two Model 544D units communicating with each other. For clarity, we'll call them Unit A and Unit B. An analog audio signal connected to input 1 on Unit A will be transported via Dante to Unit B and then sent out Unit B's line output 1. Signals connected to the line inputs on Unit B will end up on the line outputs of Unit A. How the GPI and GPO functions will be similar. Activating GPI 1 on Unit A will result in activation of Unit B's GPO 1. This condition will be noted by the GPI 1 lighting on Unit A and GPO 1 LED lighting on Unit B. Closures on Unit B's GPI 1 and GPI 2 will result in the GPI LED's lighting on Unit B and activation of Unit A's GPO outputs and associated LEDs.

Advanced applications may use a Model 544D unit to interface analog audio, GPI, and GPO signals associated with intercom or broadcast routers with Studio Technologies' Model 545DC or Model 545DR intercom interfaces. Since the three units (544D, 545DC, and 545DR) can use high-frequency (18 kHz and above) tones for signaling, direct compatibility between GPI, GPO, and party-line intercom call-light functions is possible.

Tone Generation

The Model 544D can be configured to produce sine-wave audio tones on the two analog line-level outputs and the two Dante transmitter (output) channels. These channels can be individually configured for tone generator operation with the frequency selected to be 1 kHz, 18 kHz, or 20 kHz. The level of the tone on the analog line-level outputs will follow the configured nominal level as set in STcontroller. (Choices are +4 dBu, –2 dBu, and –10 dBu.) The tone level on the Dante transmitter (output) channels is –20 dBFS.

Technical Notes

IP Address Assignment

By default, the Model 544D's Dante-associated 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 will, in most cases, correctly acquire IP addresses and be able to communicate with each other.

An exception does arise when trying to directly interconnect two Dante-enabled devices that use Ultimo integrated circuits to implement Dante. The Model 544D uses an UltimoX2 “chip” and, as such, a direct one-to-one interconnection between it and another Ultimo-based product would typically not be supported. An Ethernet switch linking these units would be required to successfully interconnect the two Ultimo-based devices. The technical reason that a switch is required relates to the need for a slight latency (delay) in the data flow; an Ethernet switch will provide this. This wouldn’t typically prove to be an issue as the Model 544D uses Power-over-Ethernet (PoE) to provide its operating power. As such, in most cases a PoE-enabled Ethernet switch would be utilized to support Model 544D units.

Using the Dante Controller software application, the Model 544D’s IP address and related network parameters can be set for a manual (fixed or 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 every unit be physically marked, e.g., directly using a permanent marker or “console tape,” with its specific static IP address. If knowledge of a Model 544D’s IP address has been misplaced there is no reset button or other method to easily restore the unit to a default IP setting.

In the unfortunate event that a device’s IP address is “lost,” 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. The

simplest means of identifying an unknown IP address is to create a “mini” LAN with a small PoE-enabled Ethernet switch connecting a personal computer to the Model 544D. Then by using the appropriate ARP command the required “clues” can be obtained.

Optimizing Network Performance

For best Dante audio-over-Ethernet performance, a network that supports VoIP QoS capability is recommended. In applications that utilize multicast Ethernet traffic, enabling IGMP snooping can be valuable. (In this case, ensure that support for PTP timing messages is still available.) These protocols can 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 optimizing networks for Dante applications.

Application Firmware Version Display

A selection in the STcontroller software application allows the Model 544D’s application firmware version to be identified. This can be useful when working with factory personnel on application support and troubleshooting. To identify the firmware version, begin by connecting the Model 544D unit to the network (via Ethernet with PoE) and wait until the unit starts to function. Then, after starting STcontroller, review the list of identified devices and select the specific Model 544D for which you want to determine its application firmware version. Then select **Version and Information** under the **Device** tab. A page will then show that will provide lots of useful information. This includes the application firmware version as well as details on the Dante interface firmware.

Application Firmware Update Procedure

It’s possible that updated versions of the application firmware (embedded software) that is utilized by the Model 544D’s microcontroller (MCU) integrated circuit will be released to add features or correct issues. Refer to the Studio Technologies’ website for the latest application firmware file. The unit has the ability to load a revised file into its MCU’s non-volatile memory by way of a USB interface. The

Model 544D implements a USB host function that directly supports connection of a USB flash drive. The Model 544D's MCU updates its application firmware using a file named **M544DvXrXX.stm** where the Xs are decimal digits that represent the actual firmware version number.

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. The USB interface in the Model 544D is compatible with USB 2.0-, USB 3.0-, and USB 3.1-compliant flash drives. Save the new application firmware file in the root directory of the flash drive with a name of **M544DvXrXX.stm** where the XrXX is the actual version number. Studio Technologies will supply the application firmware file inside of a .zip archive file. The name of the zip file will reflect the application file's version number and will contain two files. One file will be the actual application file and the other a readme (.txt) text file. It's recommended that the readme (.txt) file be reviewed as it will contain details about the associated application firmware. The application firmware file inside of the zip file will adhere to the required naming convention.

To install the application firmware file, follow these steps:

1. Remove power from the Model 544D. This will entail removing the Ethernet connection if it is providing PoE power or removing the external source of 12 volts DC if that is being used. (Both must be disconnected if for some reason dual-power has been implemented.)
2. Remove the cover from the Model 544D's enclosure. Begin by removing the four 5/64 hex head screws and internal tooth lock washers, two per side. Be certain to save the screws and lock washers so that re-assembly will be fast and painless. Then carefully remove the cover. Locate the USB receptacle on the main circuit board. It's near the middle of the board. Also on the circuit board and adjacent to the USB receptacle is a very small LED indicator.
3. Insert the prepared USB flash drive into the USB receptacle.

4. Apply power to the Model 544D. Power can be provided by Power-over-Ethernet (PoE) associated with a connected Ethernet signal or from an external 12 volt DC source.
5. The Model 544D will run a "boot loader" program that will immediately load the new application firmware file (**M544DvXrXX.stm**). This process will take only a few seconds. During this time period, the LED adjacent to the USB receptacle will flash slowly on and off green. Once the entire loading process is over, taking approximately 10 seconds, the Model 544D will restart using the newly loaded application firmware.
6. At this time the Model 544D is functioning with the newly loaded application firmware and the USB flash drive can be removed. But to be conservative, remove the power first and then remove the USB flash drive.
7. Replace the cover and secure it using the previously removed screws and lock washers.
8. Using STcontroller, confirm that the desired application firmware version has been correctly loaded.

Note that upon power being applied to the Model 544D if the USB flash drive doesn't have the correct file (**M544DvXrXX.stm**) in the root folder no harm will occur. Upon power up the green LED adjacent to the USB receptacle will flash on and off rapidly for a few seconds to indicate that a valid file was not found and then normal operation using the unit's existing application firmware will begin.

Ultimo Firmware Update

As previously discussed, the Model 544D implements its Dante connectivity using the UltimoX2 integrated circuit from Audinate. The STcontroller or Dante Controller software applications can be used to determine the version of the firmware (embedded software) that resides in this integrated circuit. The firmware (embedded software) residing in the UltimoX2 can be updated by way of the Model 544D'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 544D firmware file, with a

name in the form of **M544DvXrXrX.dnt**, is 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 544D's Dante interface.

Restoring Factory Defaults

A command in the STcontroller software application allows the Model 544D's defaults to be reset to the factory values. From STcontroller, select the Model 544D for which you want to restore its defaults. Select the **Device** tab and then **Factory Defaults**. Click on the **OK** box. Refer to Appendix A for a list of the Model 544D's factory defaults.

Specifications

Power Sources:

Power-over-Ethernet (PoE): class 1 (very low power) per IEEE® 802.3af

External: 10 to 18 volts DC, 0.3 A max at 12 volts DC

Network Interface:

Type: 100BASE-TX, Fast Ethernet per IEEE 802.3u (10BASE-T and 1000BASE-T (GigE) not supported)

Power-over-Ethernet (PoE): Per IEEE 802.3af

Data Rate: 100 Mb/s (10 Mb/s and 1000 Mb/s not supported)

General Network Audio:

Type: Dante audio-over-Ethernet

AES67-2018 Support: yes, selectable on/off

Dante Domain Manager (DDM) Support: yes

Bit Depth: 16, 24, or 32

Sample Rate: 48 kHz

Dante Receiver (Input) Channels: 2

Nominal Level: –20 dBFS

Dante Receiver Audio Flows: 2

Dante Transmitter (Output) Channels: 2

Audio Sources: analog input Ch 1, analog input Ch 2, Dante receiver (input) Ch 1, Dante receiver (input) Ch 2, 1 kHz tone, 18 kHz tone, or 20 kHz tone

Nominal Level: –20 dBFS

Dante Transmitter Audio Flows: 2

Line Inputs: 2

Type: analog, electronically balanced, capacitor coupled

Impedance: 20 k ohms, nominal

Nominal Level: +4 dBu, –2 dBu, or –10 dBu, selectable

Maximum Level: +24 dBu when configured for +4 dBu nominal

Dynamic Range: >114 dB, A-weighted

Distortion (THDS+N): <0.002% (–95 dB), measured at –1 dBFS, 22 kHz bandwidth

Frequency Response: +0.0 dB/–0.5 dB, 20 Hz to 20 kHz

Line Outputs: 2

Audio Sources: Dante receiver (input) Ch 1, Dante receiver (input) Ch 2, analog input Ch 1, analog input Ch 2, 1 kHz tone, 18 kHz tone, or 20 kHz tone

Type: analog, electronically balanced, capacitor coupled, intended to drive balanced or unbalanced loads of 2 k ohms or greater

Source Impedance: 200 ohms

Nominal Level: +4 dBu, –2 dBu, or –10 dBu, selectable

Maximum Level: +24 dBu when configured for +4 dBu nominal

Dynamic Range: >114 dB, A-weighted

Distortion (THDS+N): 0.003% (–90 dB), measured at –1 dBFS, 22 kHz bandwidth

Frequency Response: ±0.1 dB, 20 Hz to 20 kHz, GPO low-pass filter disabled

GPO Low-Pass Filters: –3 dB @ 10 kHz, –55 dB @ 20 kHz

Tone Generator Function:

Type: sine-wave

Frequency: 1 kHz, 18 kHz, and 20 kHz, ±350 mHz

Analog Output Level: +4 dBu, –2 dBu, –10 dBu, nominal, selectable

Analog Output Distortion (THD+N): <0.003%

Digital Output Level (Dante transmitter (Output) channels): –20 dBFS

Digital Output Distortion (THD+N): <0.0001%

Meters: 4

Function: displays level of audio input and output channels

Type: 5-segment LED, modified VU ballistics

GPI: 2

Type: logic input, pulled up to +3.3 volts DC through 3.3 k (3300 ohm) resistor, pull input down to common connection to enable

Signaling Method: tone summed into Dante transmitter (output) audio path, 20 kHz, ±350 mHz

Status LEDs: 2

GPO: 2

Output Type: solid-state relay contact, form A (normally open, not shorted), isolated

Contact Rating: 400 mA, 60 volts AC/DC, maximum

Contact Resistance: 2 ohms, maximum

Activation Method: manual using STcontroller application or by monitoring Dante receiver (input) audio channel for presence of nominal 18 kHz and above tone. Digital low-pass filter limits the amount of tone audio that is sent to the associated analog line output.

Status LEDs: 2

Auxiliary DC Output:

Application: for use with GPO outputs

Type: 12 volts DC, nominal, 25 mA maximum

Connectors:

Line Inputs: 3-pin female XLR

Line Outputs: 3-pin male XLR

Ethernet: Neutrik etherCON RJ45 jack (compatible with Neutrik etherCON CAT5-compatible plug)

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

GPI/GPO/Aux DC: 9-pin female D-subminiature (DE-9F)

USB: type A receptacle (located inside Model 544D's enclosure and used only for updating application firmware)

Configuration: requires Studio Technologies' STcontroller software application

Software Updating: USB flash drive used for updating application firmware; Dante Updater application used for updating Dante interface firmware

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:

8.70 inches wide (22.1 cm)

1.72 inches high (4.4 cm)

8.30 inches deep (21.1 cm)

Weight: 1.7 pounds (0.77 kg); rack-mounting installation kits add approximately 0.2 pounds (0.09 kg)

Deployment: intended for tabletop applications.

Four optional mounting kits are also available:

RMBK-10 allows one unit to be mounted in a panel cutout or on a flat surface

RMBK-11 allows one unit to be mounted in the left- or right-side of one space (1U) of a standard 19-inch rack

RMBK-12 allows two units to be mounted in one space (1U) of a standard 19-inch rack

RMBK-13 allows one unit to be mounted in the center of one space (1U) of a standard 19-inch rack

DC Power Supply Option: Studio Technologies' PS-DC-02 (100-240 volts, 50/60 Hz, input; 12 volts DC, 1.5 A, output), purchased separately

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

Appendix A—STcontroller Default Configuration Values

General Menu Page:

Source Configuration – Dante Transmitter Ch 1: Analog Line Input Ch 1

Source Configuration – Dante Transmitter Ch 2: Analog Line Input Ch 2

Source Configuration – Analog Line Output Ch 1: Dante Receiver Ch 1

Source Configuration – Analog Line Output Ch 1: Dante Receiver Ch 2

Nominal Levels – Analog Line Inputs: +4 dBu

Nominal Levels – Analog Line Outputs: +4 dB

GPO Menu Page:

Source Configuration – GPO 1: TOX – Dante Receiver Ch 1

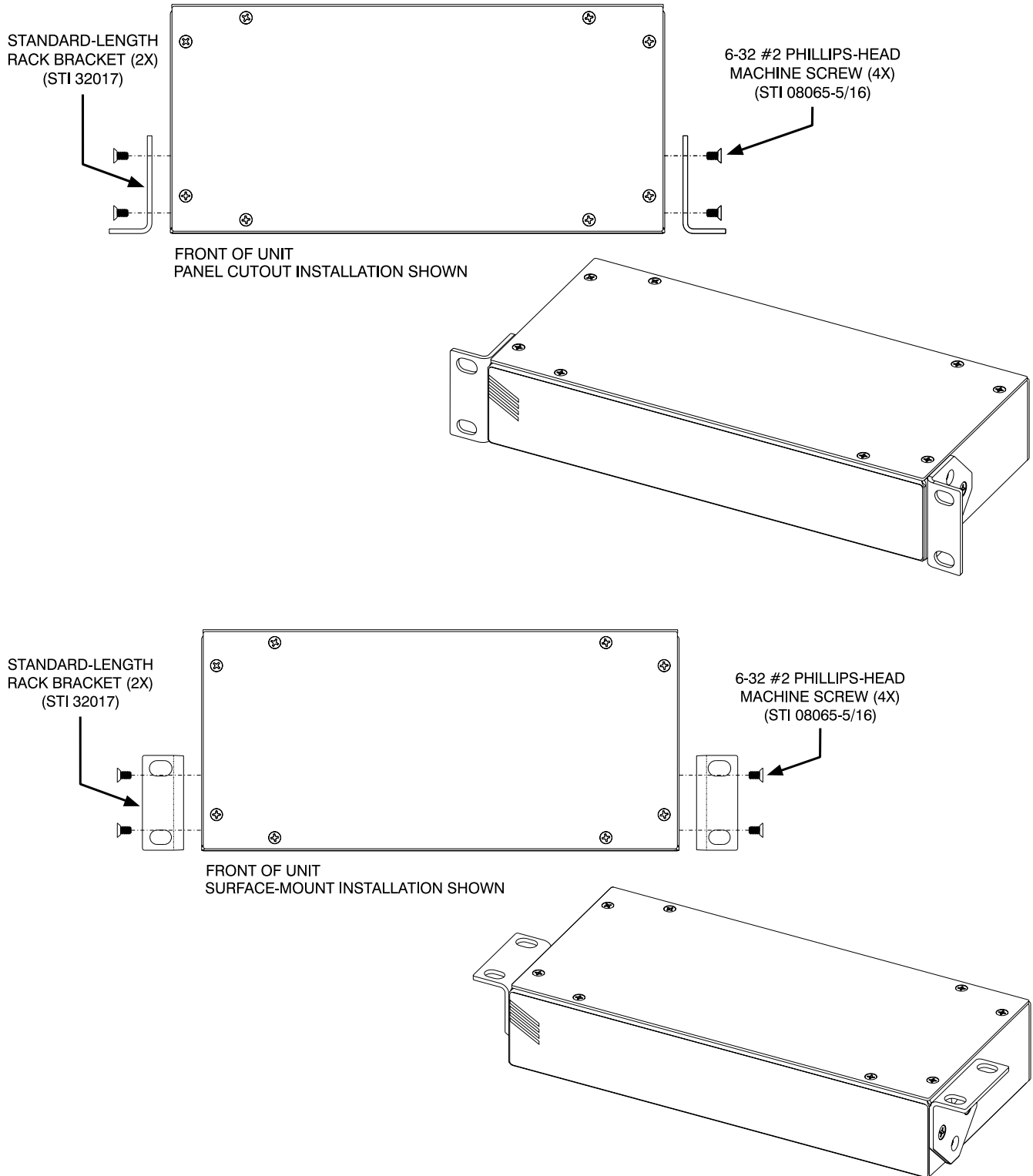
Source Configuration – GPO 2: TOX – Dante Receiver Ch 2

On/Off Buttons – GPO 1: No choice selected (field not active)

On/Off Buttons – GPO 2: No choice selected (field not active)

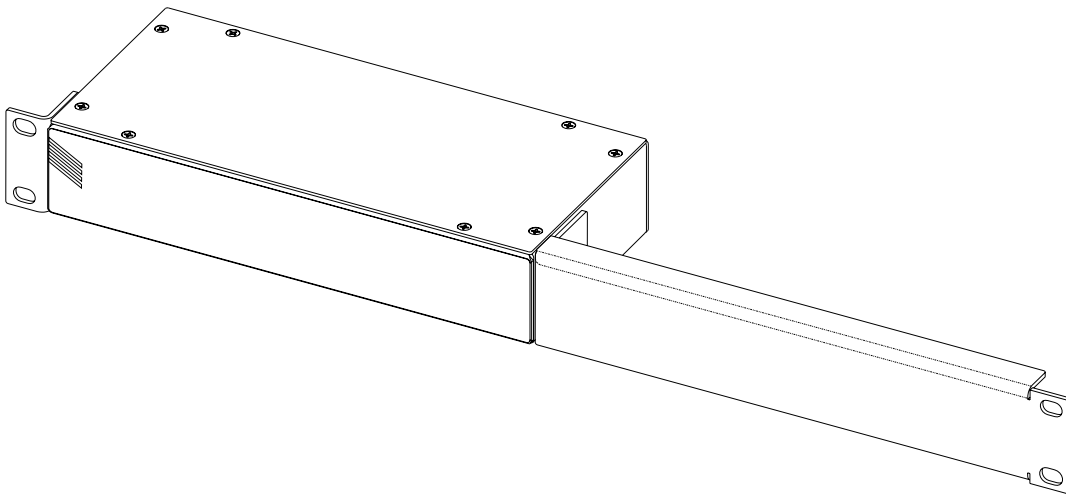
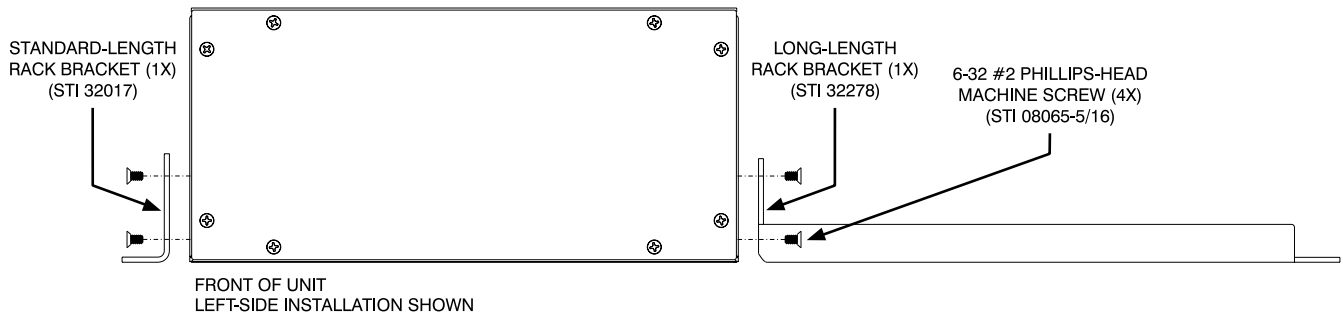
Appendix B—Graphical Description of the Installation Kit for Panel Cutout or Surface-Mounting Use (Order Code: RMBK-10)

This installation kit is used for mounting one Model 544D unit into a panel cutout or flat surface.



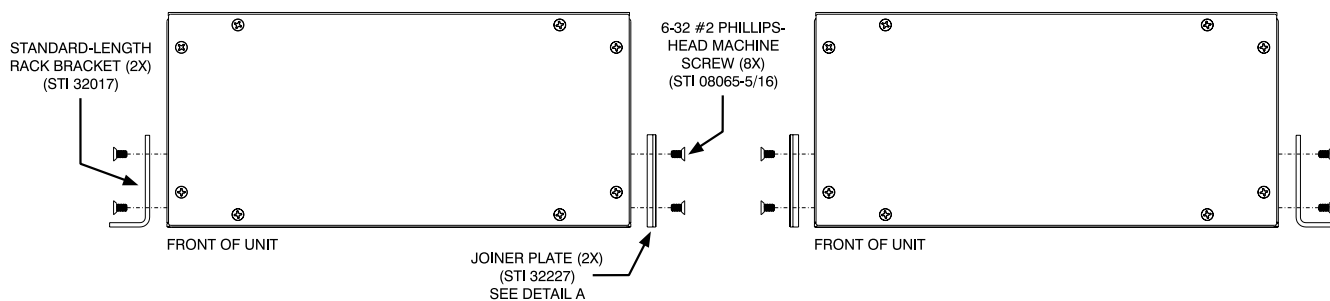
Appendix C—Graphical Description of Left- or Right-Side Rack-Mount Installation Kit for One “1/2-Rack” Unit (*Order Code: RMBK-11*)

This installation kit is used for mounting one Model 544D unit into one space (1U) of a 19-inch equipment rack. Unit will be located on the left- or right-side of the 1U opening.

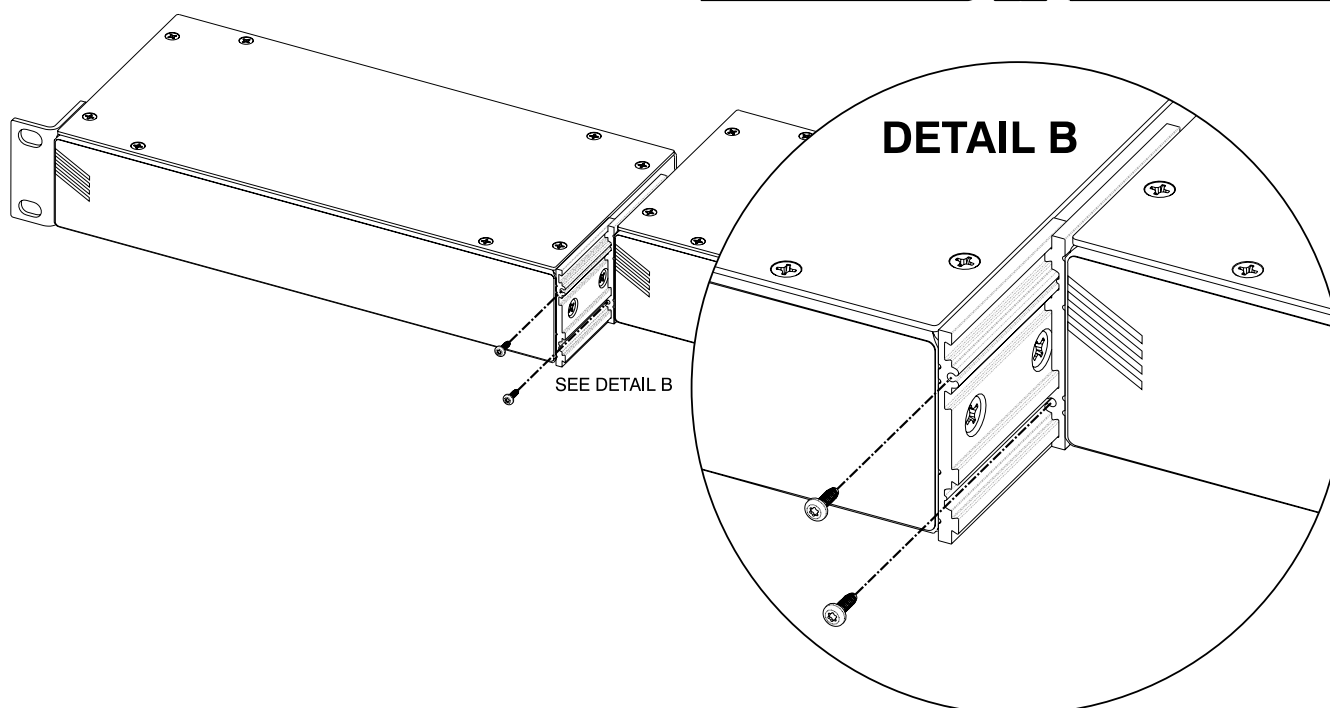
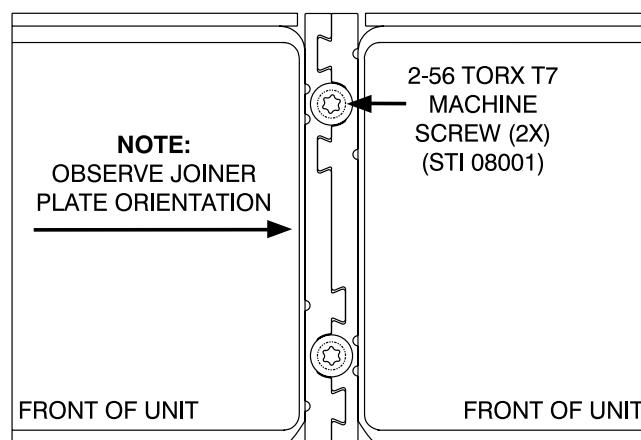


Appendix D—Graphical Description of Rack-Mount Installation Kit for Two “1/2-Rack” Units (Order Code: *RMBK-12*)

This installation kit can be used to mount two Model 544D units or one Model 544D unit and another product that is compatible with the RMBK-12 (such as the Studio Technologies’ Model 5421 Dante Intercom Audio Engine) into one space (1U) of a 19-inch equipment rack.

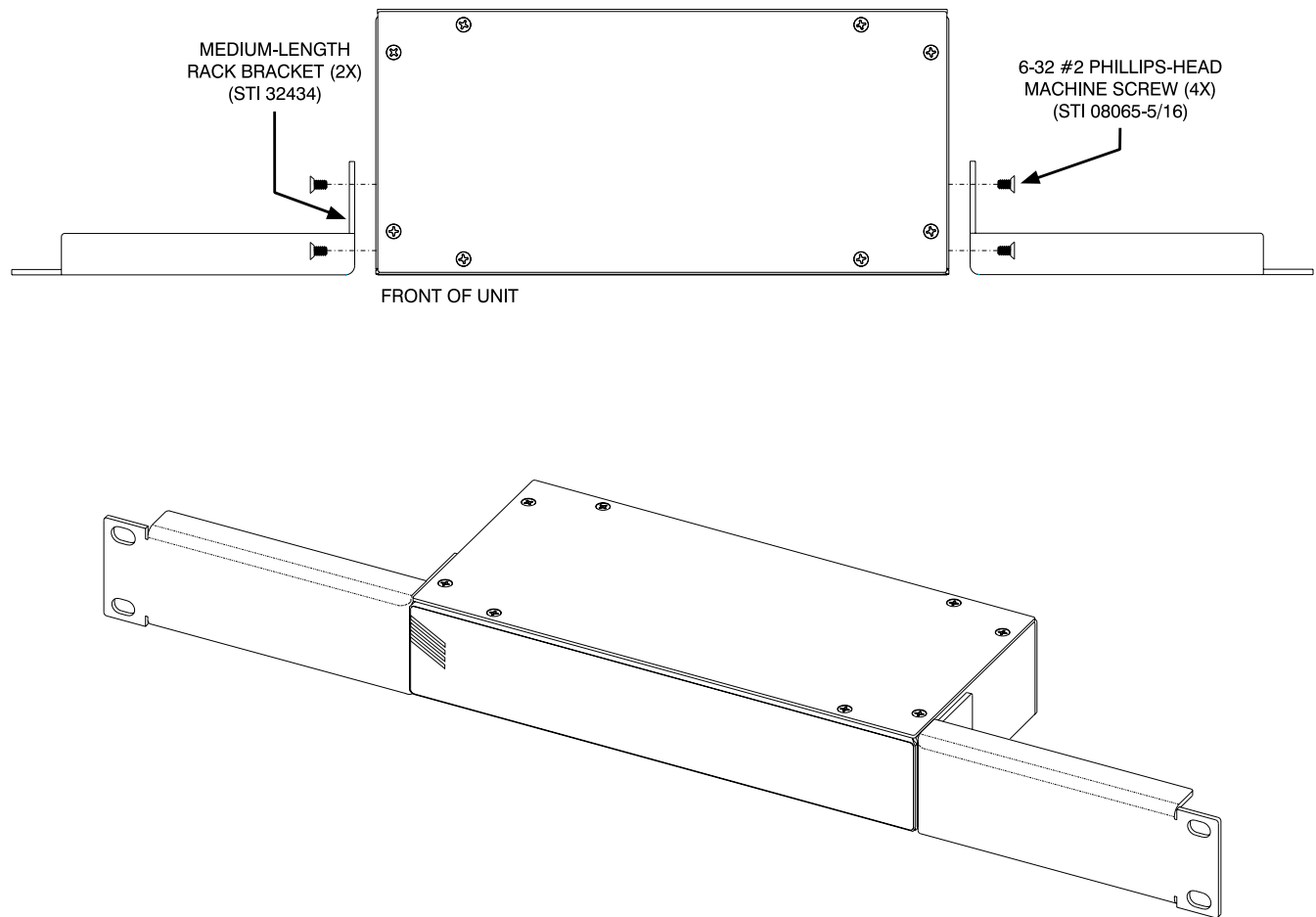


DETAIL A



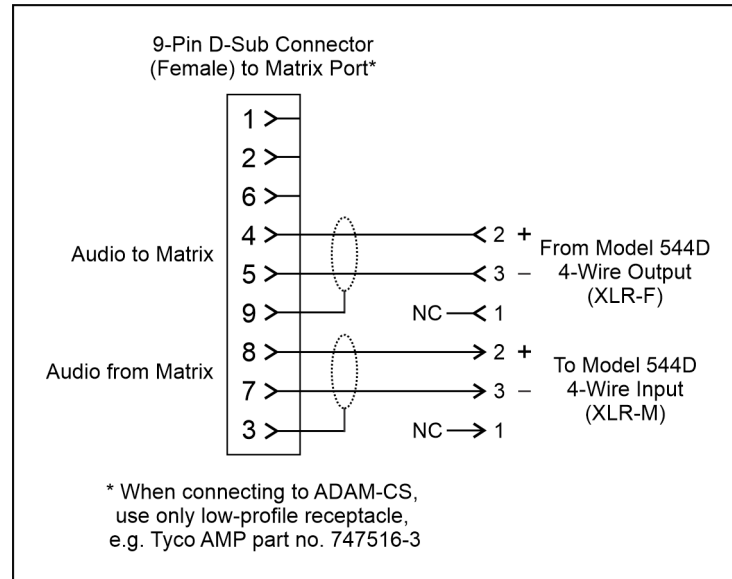
Appendix E—Graphical Description of Center Rack-Mount Installation Kit for One “1/2-Rack” Unit (*Order Code: RMBK-13*)

This installation kit is used for mounting one Model 544D unit into one space (1U) of a 19-inch equipment rack. Unit will be located in the center of the 1U opening.

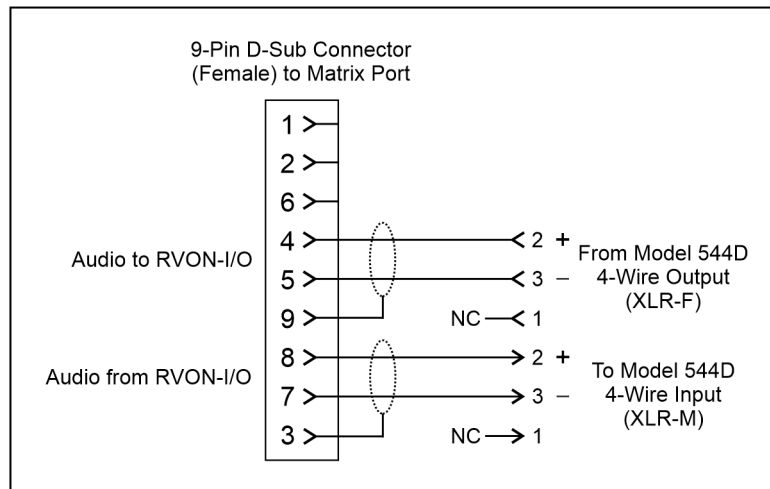


Appendix F—Interfacing RTS® Matrix Intercom Systems and RVON-I/O with the Model 544D Audio Interface

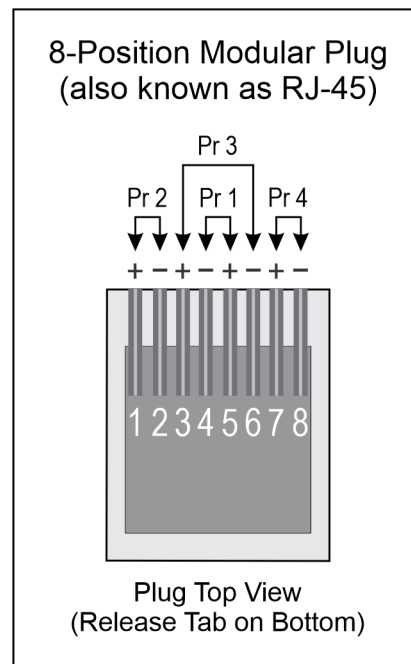
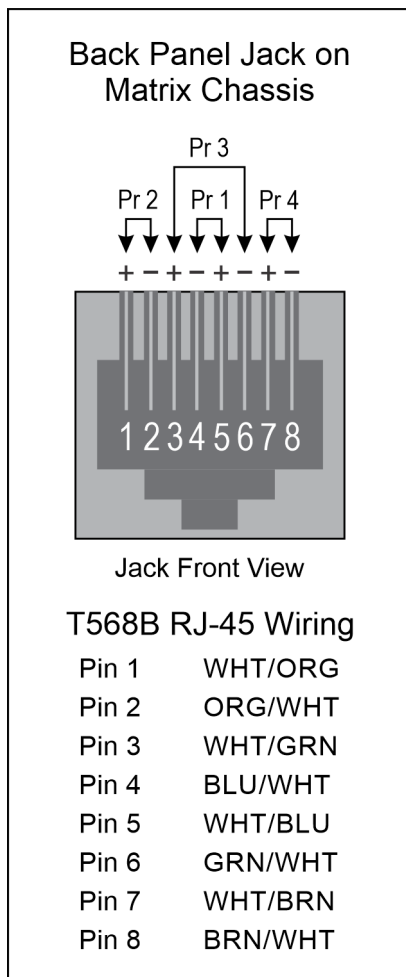
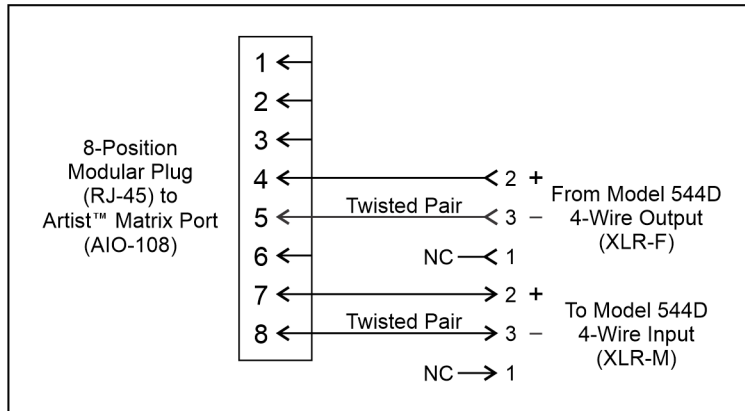
ADAM™ Matrix Intercom System Analog Ports to Model 544D Interface



RVON-I/O I/O Connections to Model 544D Interface



Appendix G—Interfacing Riedel® Artist™ Matrix Intercom System Analog Ports with the Model 544D Audio Interface



Appendix H—Interfacing Clear-Com® Matrix Intercom System Analog Ports with the Model 544D Audio Interface

