



# Model 47A Interface

Dual 2-Wire Analog Audio to 4-Wire Analog Audio Interface

## Highlights

- Two 2-channel party-line intercom interfaces
- Four analog hybrids with auto null capability
- Input and output level metering
- Excellent audio quality
- 2-channel intercom power sources
- Direct support for broadcast SAP panel applications
- Standard audio connectors
- Universal input mains powered

The Model 47A is designed to interface 2-wire full-duplex party-line (PL) intercom circuits with 4-wire audio circuits associated with matrix intercom systems. Other specialized audio system interfacing applications can also be supported. The Model 47A provides two independent full-featured 2-channel interfaces. Each interface contains two hybrid circuits which include automatic nulling capability. The analog circuitry, under software control, provides excellent audio quality and high return-loss. The interfaces are compatible with powered and unpowered 2-wire party-line circuits. They are capable of supplying DC power to devices such as user belt-packs and user stations. Independent power sources are provided for both channels (pins 2 and 3) of each interface, allowing direct support for broadcast source assignment panel (SAP) applications. Configuration settings allow the 2-wire and 4-wire interface circuitry to be compatible with a range of nominal signal levels. Audio level meters provide user confirmation of system performance during setup and operation. Applications for the Model 47A include mobile and fixed television facilities, theme park and theater installations, and industrial testing environments. Standard audio connectors are used for all input and output signals. The Model 47A mounts in one space (1U) of a standard 19-inch rack enclosure and requires 100-240 volts, 50/60 Hz for operation.

## 2-Wire Interfaces

The Model 47A's 2-wire interfaces are optimized for direct connection with 2-channel party-line intercom circuits. In addition, single-channel party-line intercom circuits can also be connected. Many broadcast applications use the 2-channel TW-Series from RTS®, including their popular BP325 belt-pack. Other industry-standard single- and 2-channel PL intercom systems, including those from Clear-Com®, are also directly compatible. To provide optimal signal matching and interface performance the nominal level of the Model 47A's 2-wire interfaces can be selected. Using DIP switches, accessible on the front panel, the nominal levels can be selected to be either -10 or -14 dBu, settings that should allow compatibility with virtually all party-line systems.

The Model 47A's 2-wire interfaces can correctly function with powered ("wet") or unpowered ("dry") intercom circuits. Powered circuits have a DC voltage present, typically provided by power supplies such as the RTS PS20. This DC power, normally 30-32 volts, provides energy for connected devices such as user stations or belt-packs. In this type of application the Model 47A is configured to operate in its external 2-wire power source mode. In this mode the Model 47A's circuitry maintains the required high-impedance load and, as in all cases, draws no power from the party-line circuit. An auto-terminate function ensures that should a "wet" circuit not be connected, the Model 47A's interface circuitry will remain stable. This unique feature makes certain that objectionable audio signals, including oscillations and "squeals," will infrequently be sent to the connected 4-wire device.

A significant capability of the Model 47A's 2-wire interfaces is their ability to supply DC power and 200 ohm AC termination to both channels (pins 2 and 3) of the connected intercom circuits. Referred to as the Model 47A's internal 2-wire power source mode, the 30 volt outputs can power devices such as



user stations and beltpacks. With independent power sources provided for both pins 2 and 3 of each interface, applications that include flexible party-line intercom channel routing will be directly supported. As such, in applications that include both source assignment panel (SAP) and Model 47A units the need for external intercom power supplies can be eliminated. Besides reducing total system cost, this capability may also lower system weight, reduce required mounting space, and decrease the mains energy requirements.

With the Model 47A's 2-wire interfaces able to supply up to 315 milliamperes (mA) of current on each channel, a typical broadcast application that uses four sets of three BP325 beltpacks can easily be supported. And the sophisticated 30 volt DC intercom power sources ensure that applications that require long intercom cable runs will function correctly. The circuitry's output regulation is such that little change in the output voltage will occur over its entire rated output current. Also, the unique design of the power supply circuitry virtually eliminates the noise and "hiss" associated with typical intercom power supply performance. Under software control each of the four DC power sources is monitored for over-current and short-circuit conditions. This allows protective shut-down of individual DC outputs, as well as providing an alert by way of a visual indicator.

### **Analog Hybrids with Auto Nulling**

A key reason that the Model 47A's interfaces achieve excellent audio performance is the design of the 2-wire-to-4-wire hybrid circuits. They provide low noise and distortion, good frequency response, and high return-loss ("nulling"), even when presented with a wide range of 2-wire conditions. Unlike telephone-line ("POTS") oriented DSP-based hybrid circuits, the Model 47A's analog circuitry provides extended frequency response. With a pass band of 100 Hz on the low end and 8 kHz on the high end, natural-sounding voice signals can be sent to, and received from, the 2-wire party-line circuits.

A hybrid's ability to isolate the transmit signal from the receive signal in the 2-wire-to-4-wire interface is critical. The quality of this isolation, technically known as return-loss or trans-hybrid loss, is measured in dB. A high value is important, especially in applications where multiple 2-wire-to-4-wire interfaces are used together. Remote sports broadcast applications are especially sensitive to this requirement. The Model 47A's sophisticated auto nulling function uses analog circuitry under microprocessor control to achieve significant trans-hybrid loss. This return-loss "null" is achieved by making a series of adjustments to account for the resistive, inductive, and capacitive conditions that are present on the connected 2-wire party-line circuit. A party-line's condition is the sum of the impact made by the type and

quantity of cable, the connected user devices, and the intercom power source.

Whenever a user presses one of the Model 47A's auto null buttons digital circuitry adjusts the analog hybrids to rapidly achieve their maximum return-loss. The nulling process takes less than ten seconds for each channel of an interface. However, it's important to note that while the nulling process is automatic, it only takes place upon user request. This can lead to more stable and consistent audio performance when a hybrid is exposed to the varying 2-wire conditions often found in broadcast applications. The parameters obtained during the nulling process are stored in non-volatile memory; mains power interruptions won't require the auto nulling function to again be performed.

A sine-wave audio tone is generated for use during the auto nulling process. The frequency is software-controlled to maximize the ability of the hybrid circuits to reach a "deep" null. In addition, at the beginning of each auto null sequence a short period of 24 kHz tone is sent to the associated 2-wire party-line interface. This serves as a microphone disable ("mic kill") signal for user devices such as the RTS BP325. By automatically disabling "open" microphones the auto nulling process can achieve better performance.

### **4-Wire Interfaces**

Associated with the 4-wire portion of the Model 47A's interfaces are analog line-level inputs and outputs. These are intended to interconnect with a variety of 4-wire devices, including matrix intercom systems, audio-over-fiber transmission systems, and other specialized audio equipment. The input and output circuitry is transformer-coupled to minimize the chance of hum, noise, or ground "loop" issues. A key characteristic of the Model 47A's design is the ability to select the 4-wire input and output nominal levels. This helps to ensure compatibility with virtually all audio equipment. Front-panel-accessible DIP switches allow the nominal levels to be configured from among four choices: 0, +4, +6, or +8 dBu. The 0 dBu setting was specifically provided for compatibility with Clear-Com matrix intercom systems. The +4 dBu setting allows "standard" audio signals to be directly connected. Digital matrix intercom systems from Riedel® can be effectively connected using the +6 dBu setting. And the +8 dBu setting allows proper level matching with the popular ADAM®-Series of matrix intercom systems from RTS. This setting also applies to the related RVON-I/O VoIP product.

The Model 47A contains eight 5-segment LED level meters. Four of the meters are provided for each interface, with two displaying the level of the signal being received from the 4-wire source and two displaying the level being sent to the 4-wire output. During installation and setup the meters are invaluable in helping to

confirm that the nominal level DIP switch settings have been properly made. During normal operation the meters offer rapid confirmation of audio signal flow in and out of the unit. Additional LED status indicators are also provided, offering a clear view of the 2-wire DC power and auto null functions.

### **Pro Audio Quality**

The Model 47A's audio circuitry was designed in the spirit of professional audio equipment, rather than that found in typical party-line intercom gear. High-performance components are used throughout, providing low-distortion, low-noise, and high headroom. Using passive and active filters, the frequency response is limited to approximately 100 Hz to 8 kHz. This range was selected to provide excellent performance for human speech, while maximizing the ability of the hybrids to create substantial "nulls." When the Model 47A's internal DC power sources are selected to provide 2-wire party-line intercom power, enhanced audio performance can also be expected. The quality of the DC power sources is excellent, with very little noise, hum, or "hiss" being added to the 2-wire connections.

Attention to detail is a hallmark of the Model 47A's design. For example, during the brief auto nulling process an interface channel's 4-wire input and output signal is muted, preventing unwanted audio from reaching the connected equipment. Associated with the 2-wire interfaces is circuitry that, under software control, applies 200 ohm terminating impedances to the 2-wire party-line circuits. This, along with other circuitry that monitors DC voltages present on the 2-wire circuits, ensures that audio instability associated with unterminated circuits will rarely occur. As previously mentioned the Model 47A's 2-wire DC power sources offer a unique level of performance. Their ability to deliver power while maintaining audio quality is simply unmatched.

### **Special Applications**

While the Model 47A is designed to directly integrate into typical applications, it's ready to support the "one-in-a-million" situations, too. To accomplish this DIP switches, accessible on the back panel, allow some of the automatic features to be disabled. For example, one DIP switch allows the auto-terminate feature to be disabled. While this feature can help maintain audio quality, advanced users might need to disable it. This would allow full control over the Model 47A's four hybrid circuits, enabling them to be used completely independently. A second DIP switch changes the way in which the front-panel auto null pushbutton switches operate. Normally pressing one of the buttons begins the process of auto nulling both channels associated with an interface. The alternate switch mode allows each auto null sequence to be activated independently. One tap (a quick

press and release) of the auto null button will begin the auto null process for channel 1. Two taps of the button will begin the auto null process for channel 2. For installer-selected applications, three opto-coupled inputs allow selected Model 47A features to be remotely controlled. These features include remote auto nulling for each interface and remote "mic kill" activation.

### **Simple Installation**

The Model 47A uses standard 3-pin XLR connectors to allow convenient interconnection in most broadcast and general audio environments. For flexibility, access to the 2-wire party-line intercom interfaces can be made using the connectors provided on both the front and back panels. In permanent installations the back-panel connectors will typically be utilized. In other settings, such as field television production, front-panel access allows intercom beltpacks to be rapidly connected, without requiring access to the inside of a rack enclosure or necessitating the use of a secondary input/output (I/O) panel.

The Model 47A is housed in a rugged aluminum and steel enclosure that is designed to be "road tough." It mounts in one space (1U) of a standard 19-inch rack enclosure. The mains input source can range from 100 to 240 volts, 50/60 Hz allowing direct operation virtually anywhere in the world. A switch-mode power supply, contained within the Model 47A's enclosure, provides conversion of the mains input power into the DC voltage required by the party-line power supply circuits. Also contained within the unit is a DC-to-DC converter that creates the voltages required by the analog and digital circuitry. These efficient power supplies help to ensure cool, reliable operation in a variety of settings.

### **Design Philosophy**

While the "bits and pieces" that make up the Model 47A have been described in conventional terms, the real strength of the unit rests in how it integrates and performs in the "real world." Before beginning the Model 47A's design process, conversations with industry experts quickly made it apparent that installing and configuring existing 2-wire-to-4-wire interface units was invariably a time-consuming, aggravating process that required the talent of an expert to achieve reasonable results. And even under those constraints the resulting audio performance was often mediocre. Any new design had to look at the application in a different way. This led to the over-riding Model 47A design goal: create a "new breed of cat," fundamentally changing how broadcast 2-wire-to-4-wire interface equipment fit into actual applications.

An important first step was to eliminate the requirement that a senior technician, along with a screwdriver, be present during every installation. (It was universally acknowledged that their

time can be better spent elsewhere!) The need to adjust trim potentiometers, fabricate special cabling and connector straps, use nulling earpieces, etc., had to be eliminated. For example, in virtually all instances, input and output levels fall within just a few dB of their nominal values and, as such, could be supported with a limited number of configurable choices. In addition, it was acknowledged that in this application analog audio circuitry was capable of providing excellent audio performance, but that the required manual nulling process was operationally taxing. By adding digital control to the analog circuitry, automatic nulling could be performed—the best of both worlds!

The next step was to identify resources that would improve the installation process and make operation more reliable. This led to the inclusion of multiple LED level meters, allowing continuous monitoring of the input and output signals. It also

turned out that in many applications only a small number of user devices, such as beltpacks, are typically connected to 2-wire party-line intercom circuits. But power on both pins 2 and 3 of each interface was necessary for compatibility with SAP panel applications. By adding two DC power sources to each of the Model 47A's 2-wire interfaces, the need for external intercom power supplies could often be eliminated.

The final step was to create a physical package that would provide significant resources in a form that allowed simple and reliable integration with other equipment. This was accomplished by including two 2-channel interfaces in a 1U enclosure. Using standard 3-pin XLR audio connectors would enable rapid installation and troubleshooting. And by making the Model 47A “universally” powered, installation in any locale could be directly supported

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## Model 47A Specifications

### **General Audio:**

Frequency Response:  $\pm 2$  dB 100 Hz to 8 kHz

Distortion (THD+N):  $< 0.5\%$ , measured at 1 kHz, 4-wire input to 2-wire interface pin 2

Signal-to-Noise Ratio:  $> 55$  dB, measured at 1 kHz, 4-wire input to 2-wire interface pin 2

### **Connectors:**

Inputs from 4-Wire: 3-pin female XLR

Outputs to 4-Wire: 3-pin male XLR

2-Wire Party-Line Intercom: 3-pin male XLR

Remote Control: 10-pin header, requires user-provided 10-pin ribbon connector assembly

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

### **2-Wire Party-Line Intercom Interfaces: 2**

Type: 2-channel party-line (PL), unbalanced (pin 1 common; pin 2 channel 1 audio or DC with channel 1 audio; pin 3 channel 2 audio or DC with channel 2 audio)

Compatibility: single- and 2-channel intercom systems such as from RTS® and Clear-Com®

Impedance, External Power Mode:  $> 10$  k ohms

Impedance, Internal Power Mode: 200 ohms

Nominal Level:  $-10$  or  $-14$  dBu, selectable

“Mic Kill” Signal: square wave, 24 kHz,  $\pm 1\%$

### **2-Wire Party-Line Power Sources: 4, 2 per interface**

Rating: 30 volts DC nominal, 315 mA maximum, software monitored and controlled

### **Hybrids: 4, 2 per interface**

Topology: 3-section analog circuitry compensates for resistive, inductive, and capacitive 2-wire party-line loads

Nulling Method: automatic upon user initiation, processor implements digital control of analog circuitry; null settings stored in non-volatile memory

Nulling Line Impedance Range: 120-350 ohms

Nulling Cable Length Range: 0-3500 feet, typical

Trans-Hybrid Loss:  $> 40$  dB, typical at 800 Hz

### **4-Wire Inputs: 4, 2 per interface**

Type: transformer-coupled, capacitor isolated

Impedance: 13 k ohms

Nominal Level: 0, +4, +6, or +8 dBu, selectable in tandem with nominal output level

Maximum Level: +22 dBu

### **4-Wire Outputs: 4, 2 per interface**

Type: transformer-coupled, capacitor isolated

Impedance: 50 ohms nominal

Nominal Level: 0, +4, +6, or +8 dBu, selectable in tandem with nominal input level

Maximum Level: +20 dBu into 2 k ohms

### **Meters: 8**

Function: displays level of 4-wire inputs and outputs

Type: 5-segment LED, modified VU ballistics

### **Remote Control Inputs: 3**

Type: optically coupled

Input: 3-32 volts DC; 2 mA minimum for operation, 20 mA maximum

Functions: auto null interface 1, auto null interface 2, and “mic kill”

**AC Mains Requirement:** 100-240 volts ( $-15/+10\%$ ), 50/60 Hz, 60 watts maximum

### **Dimensions (Overall):**

19.0 inches wide (48.3 cm)

1.72 inches high (4.4 cm)

8.4 inches deep (21.3 cm)

**Mounting:** one space (1U) in a standard 19-inch rack

**Weight:** 4.7 pounds (2.1 kg)

Specifications subject to change without notice.

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