ARTISAN®
TECHNOLOGY GROUP

Your **definitive** source for quality pre-owned equipment.

Artisan Technology Group
(217) 352-9330 | sales@artisantg.com | artisantg.com

Full-service, independent repair center
with experienced engineers and technicians on staff.

We buy your excess, underutilized, and idle equipment
along with credit for buybacks and trade-ins.

Custom engineering
so your equipment works exactly as you specify.

- Critical and expedited services
- In stock / Ready-to-ship
- Leasing / Rentals / Demos
- ITAR-certified secure asset solutions

Expert team | Trust guarantee | 100% satisfaction

All trademarks, brand names, and brands appearing herein are the property of their respective owners.

Find the *Johnson Controls AS-EXP100-0 / EXP100* at our website: *Click HERE*

METASYS®

LABORATORY CONTROLS

Phoenix Interface (PHX200 or PHX600)

Introduction Page 3

- *About This Document* *3
- *Definitions* *4
- *Overview* *6
- *Selecting PHX and MIJ Models* *7
- *MIJ Features and Options* *8
- *Branch Certification* *9
- *Controller Specifications* *9
- *Point Counts* 10

Installation Procedures 11

- *Installation* 11
- *Tools Needed* 12
- *Physical Dimensions* 12
- *Environmental Information* *13
- *Mounting the PHX* 14
- *Mounting the MIJ* *15

Wiring Details 17

- *Wiring Guidelines* *17
- *Power Source* *18
- *Wiring the MIJ* *19
- *Wiring Sensors and Actuators* *25
- *Testing for Ground Loops* *30

* Indicates those sections where changes have occurred since the last printing.

© 1995 Johnson Controls, Inc.
Part No. 24-7678-3
Code No. LIT-5951020

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Networking the Controller--Installing the N2 Bus **Page *31**

- *N2 Bus Characteristics* *31
- *N2 Reference Lines* 32
- *N2 Earth Grounds* 32
- *End Of Line* *33
- *Setting the N2 Address* *39
- *Measuring Bus Voltage* *40
- *N2 Wiring to the Network Control Module* 43
- *N2 Wiring to Companion* *44

Networking the Controller--Zone Bus Communications **45**

- *Zone Bus Description* 45
- *Cable PRO Description* 45
- *Troubleshooting HVAC PRO for Windows* *47

Commissioning/Troubleshooting **49**

- *Commissioning/Troubleshooting* *49
- *Checking the Installation* 49
- *Configuring the Controller with HVAC PRO for Windows* *50
- *N2 Bus Troubleshooting Overview* 51
- *Troubleshooting Chart* 52
- *Testing the N2 Bus* 52
- *Test 2: Using the Oscilloscope* 54
- *Suppression Devices* 55
- *Diagnostic LEDs on EXP Boards* 56

Ordering Information **57**

- *Johnson Controls Code Numbers* *57
- *Vendor Code Numbers* *59

* Indicates those sections where changes have occurred since the last printing.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Introduction

About This Document

This document is designed to help the technician mount and wire the Johnson Controls, Inc. controller that connects a Phoenix Controls Corporation Makeup Air Controller to a Metasys® or Companion™ Network. This interface controller, when properly installed and commissioned, controls and monitors a wide variety of points relating to laboratory and fume hood airflow controls.

In addition to a brief overview of the product and its functions, the document provides detailed information regarding:

- installation procedures
- mounting a Johnson Controls lab and fume hood interface (PHX)
- mounting a Phoenix Controls makeup air controller interface (MIJ) to Johnson Controls, Inc.
- wiring details
- N2 Bus installation
- Zone Bus communications
- commissioning and troubleshooting
- ordering information

Notes: For information specific to Phoenix Controls Corporation, refer to their *Engineering Guide--Laboratory Airflow Controls*. The Phoenix Controls literature is available only to individuals who have completed certification courses with the Phoenix Controls Corporation.

If you require further information specific to Phoenix Controls Corporation and have not completed the certification courses, you must contact a Phoenix representative or the Phoenix Regional Sales Manager.

For information on configuring and commissioning the AS-PHX Controller, refer to the *Phoenix Lab and Fume Hood Interface* document in the *HVAC PRO for Windows User's Manual.*

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Definitions

Two devices connect the Phoenix system to Johnson Controls Metasys/Companion Facilities Management System. These devices are defined below.

Phoenix Lab and Fume Hood Interface Module (PHX)

The first device, the Phoenix Lab and Fume Hood Interface Module, is a monitoring device for the Phoenix Controls laboratory airflow controls. The module is manufactured by Johnson Controls, Inc. and referred to as **PHX200 or PHX600.**

Included with the PHX:

- The **EXP100** and the **FHI100-0** are included as necessary within the PHX200 or PHX600.
- The Expander (**EXP100**) is an analog to digital converter that monitors the analog and binary inputs from the Phoenix Controls Corporation MIJ board. The Fume Hood Interface (**FHI100-0**) collects data from up to two EXPs. The data is then communicated to the Metasys Network or Companion via the N2 Bus.

Makeup Air Controller Interface to Johnson Controls (MIJ)

The second device, the Phoenix Interface to Johnson Controls, controls the laboratory supply and exhaust airflow. All of the fume hoods and valves connect to this board. It is manufactured by Phoenix Controls Corporation and referred to as **MIJ400** (for up to two hoods) or **MIJ500** (for up to six hoods.)

How They Work Together

The PHX (made by Johnson Controls) is fully supported by Metasys Release 5.0 or greater, Companion 4.0, or greater, and the Zone Terminal (AS-ZTU100-1). The PHX monitors the various signals from the Phoenix Controls MIJ. The PHX also controls the thermal demand of the lab.

The MIJ (made by Phoenix Controls) controls all lab supply and exhausts for complete fume hood and lab pressurization control.

Both devices are factory calibrated. The MIJ board is purchased separately from Phoenix Controls Corporation. Together the devices communicate laboratory airflow conditions to each other and to the Metasys Network, thus providing a constant and safe laboratory and fume hood environment.

Note: The PHX is completely standalone and does not require the N2 Bus to control laboratory airflow.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

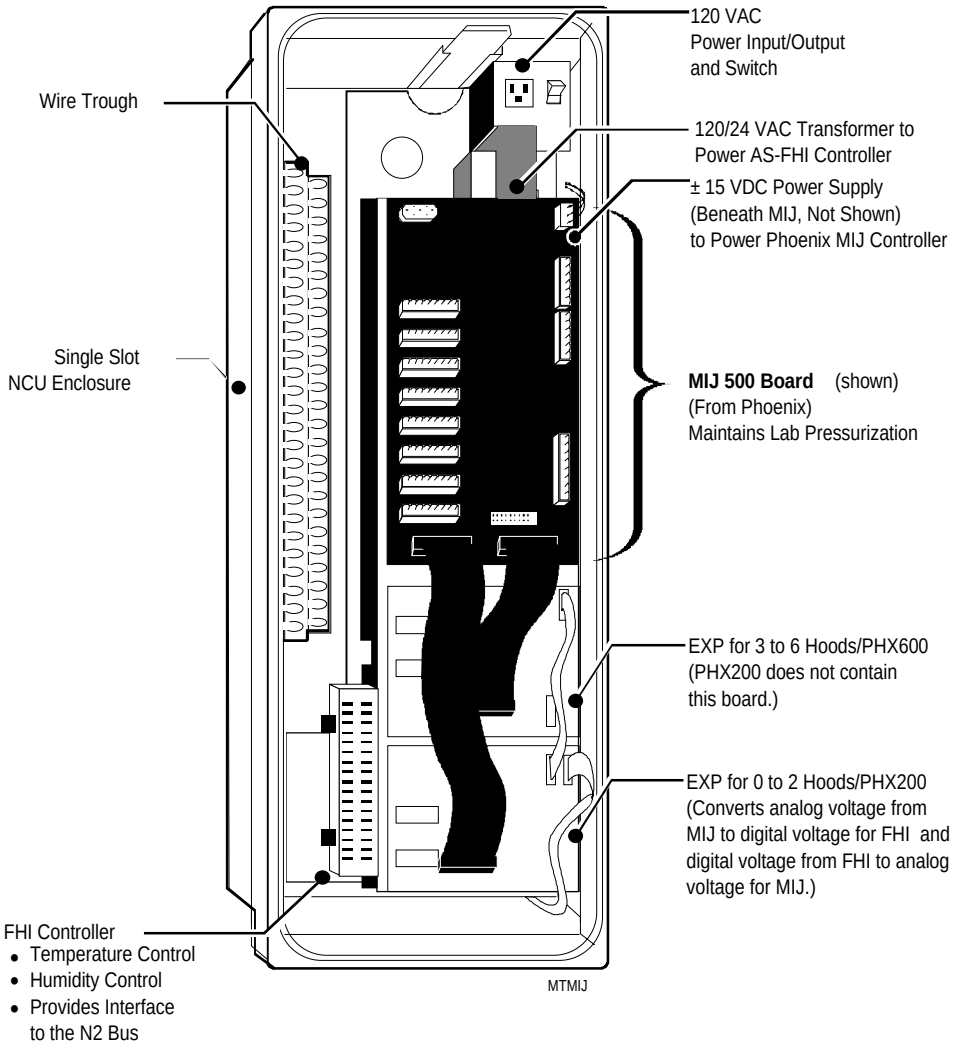


Figure 1: The PHX Lab and Fume Hood Interface Module

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Overview

The Phoenix Lab and Fume Hood Interface Module (PHX) is an input/output device for complete point monitoring and control of laboratory airflow control applications when used within a Metasys Network and Phoenix Controls Corporation MIJ.

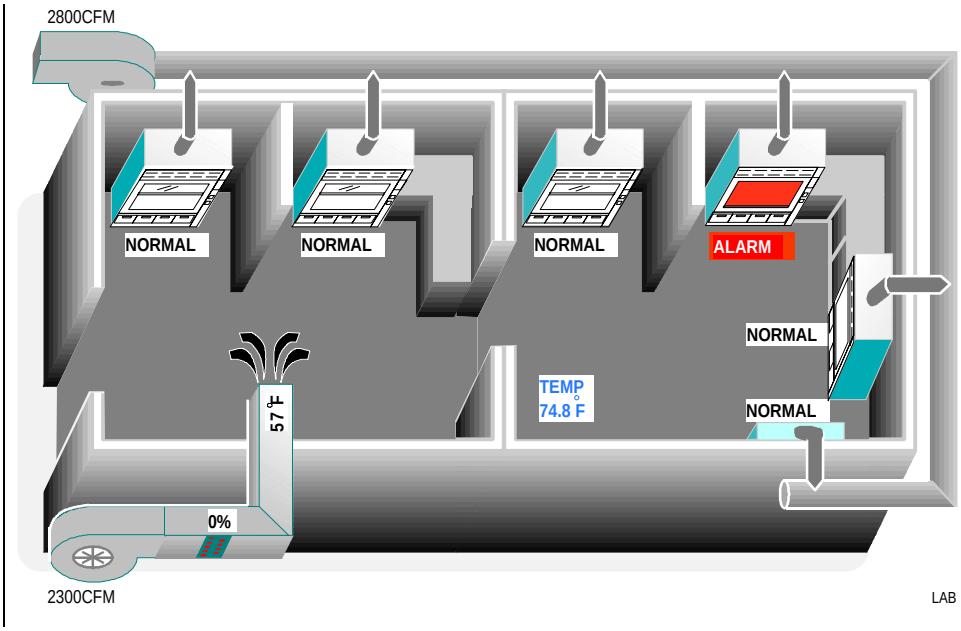


Figure 2: Lab with Six Fume Hoods

You can easily configure input and output points as well as software features using HVAC PRO for Windows™ Revision 4.0 or greater. Using HVAC PRO for Windows, the data base can be downloaded through a local thermostat or network-wide N2 Communications Bus. You can monitor not only laboratory controls, but also a wide variety of HVAC equipment. The PHX connects the Phoenix MIJ board to the Metasys Network through a Network Control Unit (NCU) or Companion.

When connected to the Metasys Network, the PHX provides point and control information to the rest of the network. The devices communicate through an N2 Bus. For a smaller facility, the PHX can function as a standalone controller with a Zone Terminal. Figure 3 illustrates the connectivity overview of the Metasys Network and the laboratory.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

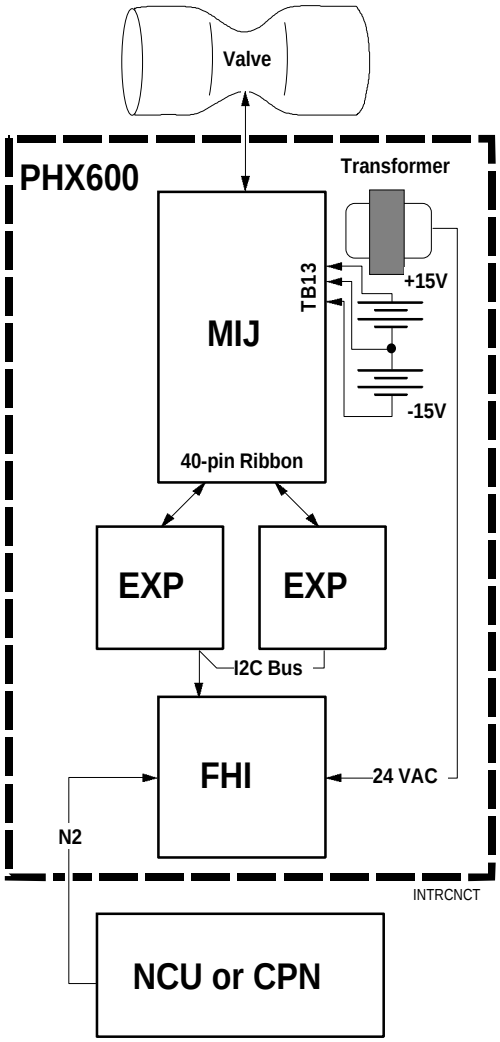


Figure 3: PHX Interconnection Diagram

Selecting PHX and MIJ Models

Use the PHX200 with a MIJ400 Controller if you have two hoods or less. The PHX200 used with a MIJ500 provides office switched and canopy hood control. Use the PHX600 with a MIJ500 when you have more than two hoods. Although you can use a PHX600 with a MIJ400, the additional points read by the PHX600 are not available for use on the MIJ400. Therefore, the additional cost of the PHX600 is unnecessary.

The advantage of using the PHX600 with a MIJ400 is in consideration of future lab expansion. The PHX600 includes the additional EXP board and a larger power supply. If you plan to install additional hoods, office supplies, or additional supply or exhaust valves in the future you would only need to replace the MIJ400 with the MIJ500. This ensures a simple upgrade rather than replacement of the power supply and adding another EXP to the PHX panel.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

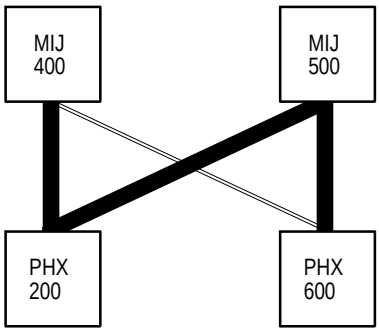


Figure 4: Selecting the PHX and MIJ Models

MIJ Features and Options

Table 1: MIJ Series 400/500 Features and Options

Features	MIJ400 Series	MIJ500 Series
Max Number of Fume Hoods	2	6
General Exhaust/Return Valve Control	YES	YES
Supply Valve Control	YES	YES
Dedicated Office Supply Valves	NO	YES
Dedicated Canopy, Snorkel, etc., Valve(s) Exhaust String	NO	YES
Switched Exhaust/Supply Input	NO	YES
Additional Exhaust/Supply Input	NO	YES
Emergency Exhaust Override Command (Vent/Purge)	YES	YES
Location	PHX200	PHX200 or PHX600
Options		
Exhaust Fan Control	YES	YES
Pneumatic Thermostat Input (-PTI)	YES	YES
Electronic Thermostat Input (-ETI)	YES	YES
Additional Override Control (-AOC)	YES	YES
Electronic Scaled Make-up Output and Input (-ESM)	NO	YES
TAC/Dual Duct Control (-TAC)	NO	YES
Single Exhaust Hood Inputs (1SE-6SE)	YES-2	YES-6

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Branch Certification

Commissioning the MIJ400 or MIJ500 Controller requires factory certification from Phoenix Controls. Only individuals who have successfully completed certification training at Phoenix Controls Corporation are qualified to install and commission Phoenix Controls MIJ Controllers. This manual does not replace Certification.

For information specific to Phoenix Controls Corporation, refer to their *Engineering Guide--Laboratory Airflow Controls*. The Phoenix Controls literature is available only to individuals who have completed certification courses.

If you require further information specific to Phoenix Controls Corporation and have not completed the certification courses, you must contact a Phoenix representative or the Phoenix Regional Sales Manager.

Note: You do not require certification from Phoenix Controls to install or commission the AS-PHX Controllers.

Controller Specifications

The table below lists the specifications for the FHI.

Table 2: FHI Specifications

Function	Resolution	Sample Time	Range	DC Input Impedance	Sensor or Load Impedance
AI-Voltage	14 BIT	1.5 sec	0 to 10 VDC	99K ohm	0 to 1K ohm
AI-Voltage	14 BIT	1.5 sec	0 to 2 VDC	470 K ohm	0 to 5K ohm
AI-Temp/Pot	14 BIT	1.5 sec	1K ohm Si, Ni, Pt, or 0 to 2K ohm pot	3540 ohm	0 to 2K ohm
ACCUM-AC	32 BIT	0.5 sec	0 to 24 VAC	370 K ohm	0 to 5K ohm
BI--AC 60 Hz	1 BIT	1.5 sec	0 to 24 VAC	370 K ohm	0 to 5K ohm
AO-Voltage	8 BIT	1.5 sec	0 to 10 VDC @ 10 mA max	N/A	1K to 10M ohm
BO-AC Triac*	1 BIT	1.5 sec	24 VAC @ 50 to 500 mA	N/A	48 to 480 ohm
DC Supply Out	N/A	N/A	15.6 to 17 VDC @ 90 mA	N/A	162 to 10M ohm

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Point Counts

The table below lists the point count for each PHX; i.e., PHX200 for up to two fume hoods and PHX600 for up to six fume hoods. Complete descriptions of all points are listed in the *HVAC PRO for Windows User's Manual*.

Table 3: Point Counts for PHX Interface Module

Point Type	PHX200 (2 Fume Hoods)	PHX600 (6 Fume Hoods)
Analog Inputs	22 Total (16) 0 to 10 VDC signals to the MIJ (6) RTD temperature elements (1000 ohm nickel, 1000 ohm platinum, or silicon) **or** 2K ohm setpoint potentiometers **or** 0 to 10 VDC transducers	38 Total (32) 0 to 10 VDC signals to the MIJ (6) RTD temperature elements (1000 ohm nickel, 1000 ohm platinum, or silicon) **or** 2K ohm setpoint potentiometers **or** 0 to 10 VDC transducers
Binary Inputs	20 Total (16) 0-12 VDC to the MIJ board (4) 24 VAC only (1) Momentary pushbutton from zone sensor for temporary occupancy mode BI 4 may be used as an accumulator input for frequencies less than 2 Hz.	36 Total (32) 0-12 VDC tied to the MIJ (4) 24 VAC input only (1) Momentary pushbutton from zone sensor for temporary occupancy mode BI 4 may be used as an accumulator input for frequencies less than 2 Hz.
Analog Outputs	5 Total 0 to 10 VDC @ 10 mA (3 used by MIJ)	5 Total 0 to 10 VDC @ 10 mA (3 used by MIJ)
Binary Outputs	6 Total (6) 24 VAC Triacs at 0.5 amps Low or High side common selectable	6 Total (6) 24 VAC Triacs at 0.5 amps Low or High side common selectable
N2 Bus	Isolated	Isolated
Zone Bus	8-pin phone jack on controller 6-pin phone jack at zone sensor	8-pin phone jack on controller 6-pin phone jack at zone sensor

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Installation Procedures

Installation

The PHX and its accessories are factory-mounted in an EWC100 and then field-mounted on the wall as described in this section. Analyze the proposed installation for the best mounting location for the PHX. You can find information on types of accessory devices available in the *Ordering Information* section of this document.

> CAUTION: You must understand and know who is responsible for all cutting into and installation of control devices in *contaminated* ductwork. Be sure to observe all site safety guidelines and procedures when visiting a retrofit site. Failure to do so may result in dangerous exposure to contaminants.

Decide where the PHX can be located with adequate mounting surface and reasonable access to installation and maintenance workers. Also of importance is the existence of power sources and communication lines. The PHX must be secured to a solid wall and not to vibrating surface.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Tools Needed

Tools you need for a typical installation include:

- HVAC PRO for Windows Revision 4.0 or greater software
- AS-CBLPRO-1 or -2
- AS-ZTU100-1 (optional)
- laptop computer
- two screwdrivers (1/8 in. and 1/4 in. flat-blade)
- drill or chassis punch for conduit
- Digital Multimeter (DMM)
- 100K ohm 1/4-watt resistor
- Double banana plug (optional; shown in Figure 5; available from local electronics store or ITT Pomona Stock No. 34F856 or 34F845, for earth ground voltage tests

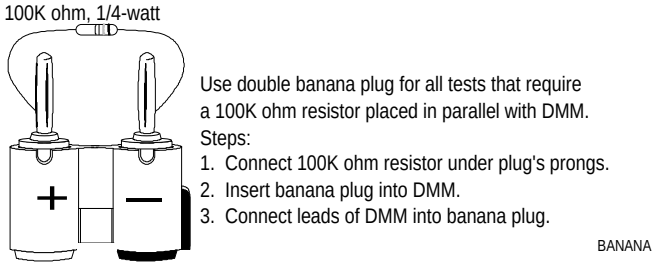


Figure 5: Double Banana Plug Used with 100K ohm Resistor

Physical Dimensions

The PHX requires a flat mounting surface area to match its dimensions of 28 x 10 x 8-5/8 in. (711 x 254 x 219 mm) H x W x D.

Allow enough room to install the enclosure and conduit for wiring terminations to the controller. Figure 6 shows a common mounting configuration for the PHX.

If the PHX must be installed in another enclosure, provide adequate ventilation to dissipate 100 watts from the +/- 15 VDC power supply.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Environmental Information

The installation site of the PHX must meet the following environmental standards.

- The atmosphere must be free of explosive vapors or escaping gases.
- A PHX can be mounted in an intrinsically safe area only when a separate barrier exists. Call Johnson Controls Technical Support--Milwaukee for information if required.
- The atmosphere must be free of exposure to corrosive chemical or salt vapors, which might damage electrical equipment.
- The temperature must be maintained between 32° to 125°F (0° to 52°C) with the relative humidity (non-condensing) maintained between 10 and 90 percent for vertical mounting and 32° to 113°F (0° to 45°C) for horizontal mounting.
- Door vents must be on the upper half of the unit for horizontal mounting. See Figure 6.

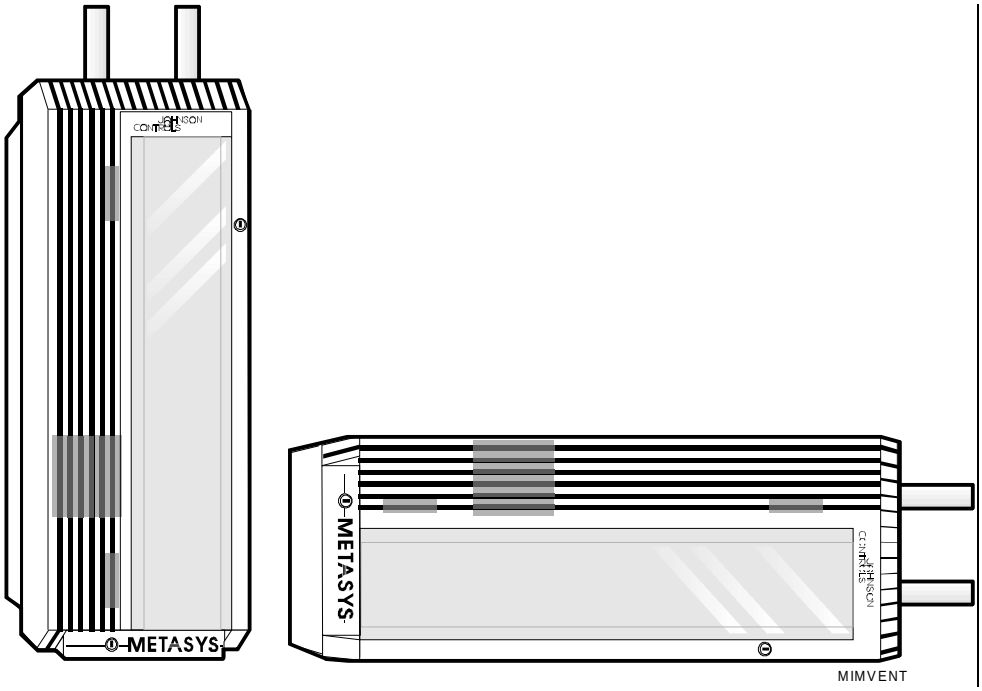


Figure 6: Vertical/Horizontal Mounting

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Mounting the PHX

Experimentally position the controller enclosure on the proposed mounting surface before installation to ensure the calculated mounting area is correct. You can make measurements for distance between controller terminals and sensor points and valves. Confirm electrical power source and conduit requirements at this time.

1. Secure the PHX enclosure to the wall using the keyhole and two other mounting holes on the back. See Figure 7.

   Position the PHX enclosure so that it rests firmly against the mounting surface. Use 1/4 inch diameter screws or bolts to hold 38 pounds (17.25 kg).

2. Using a hole saw or chassis punch, cut holes for the low voltage and line voltage conduits. When mounted vertically, the low voltage conduit is on the top left, and the line voltage is on the top right. See Figure 7. To pull wire with ease, use a minimum one inch conduit.

3. Use a grounded bushing on the line voltage conduit. Connect the ground bushing to the sheet metal base or the green ground wire.

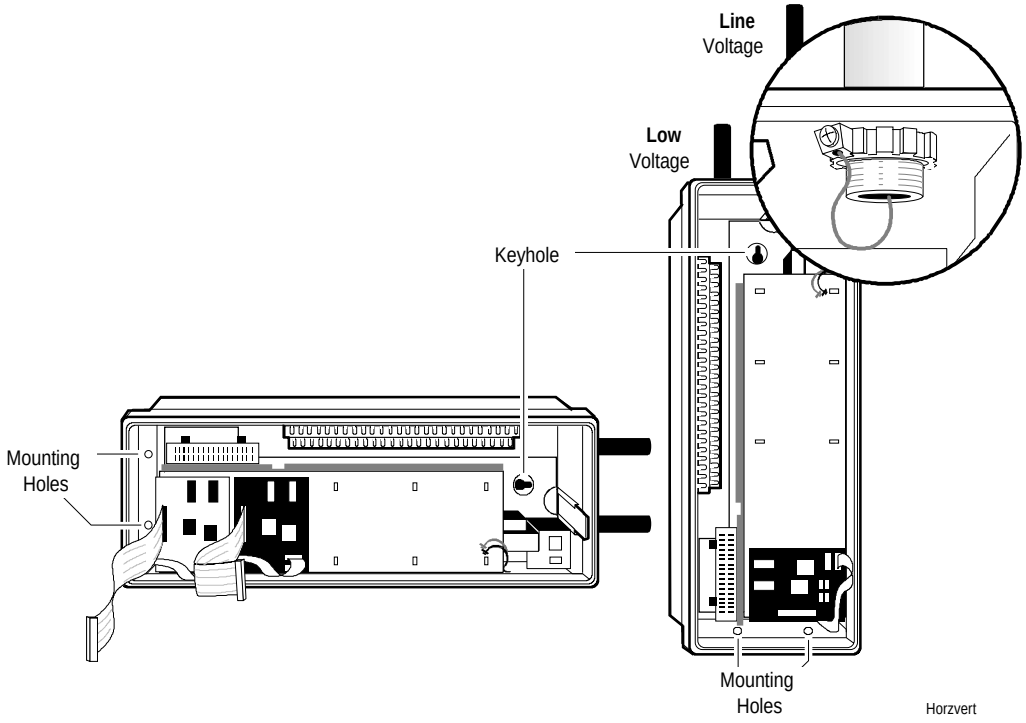


Figure 7: Mounting the PHX

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Mounting the MIJ

The MIJ400 and MIJ500 boards are purchased separately from Phoenix Controls Corporation. The MIJ board snaps into the upper half of the PHX enclosure. (See Figures 8 and 9.) Phoenix Controls factory calibrates and configures the MIJ board.

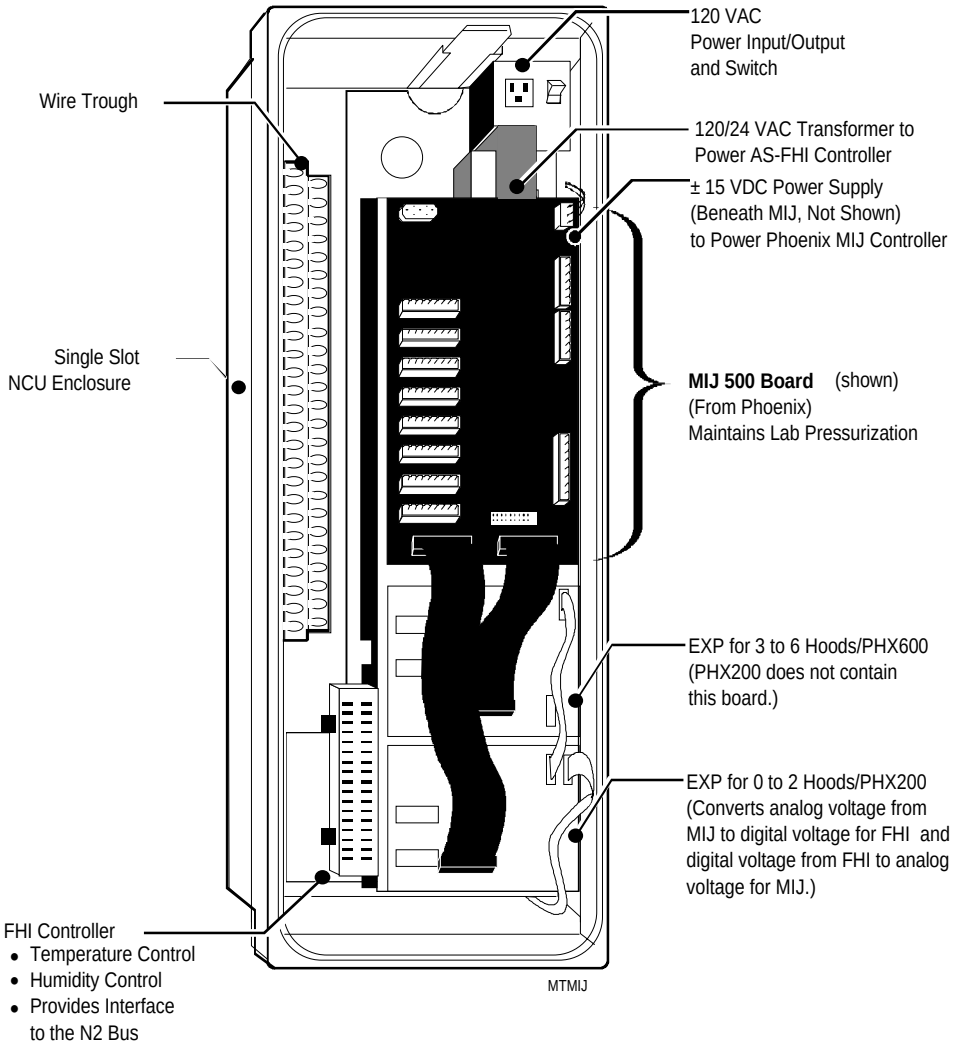


Figure 8: Mounting the MIJ500

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

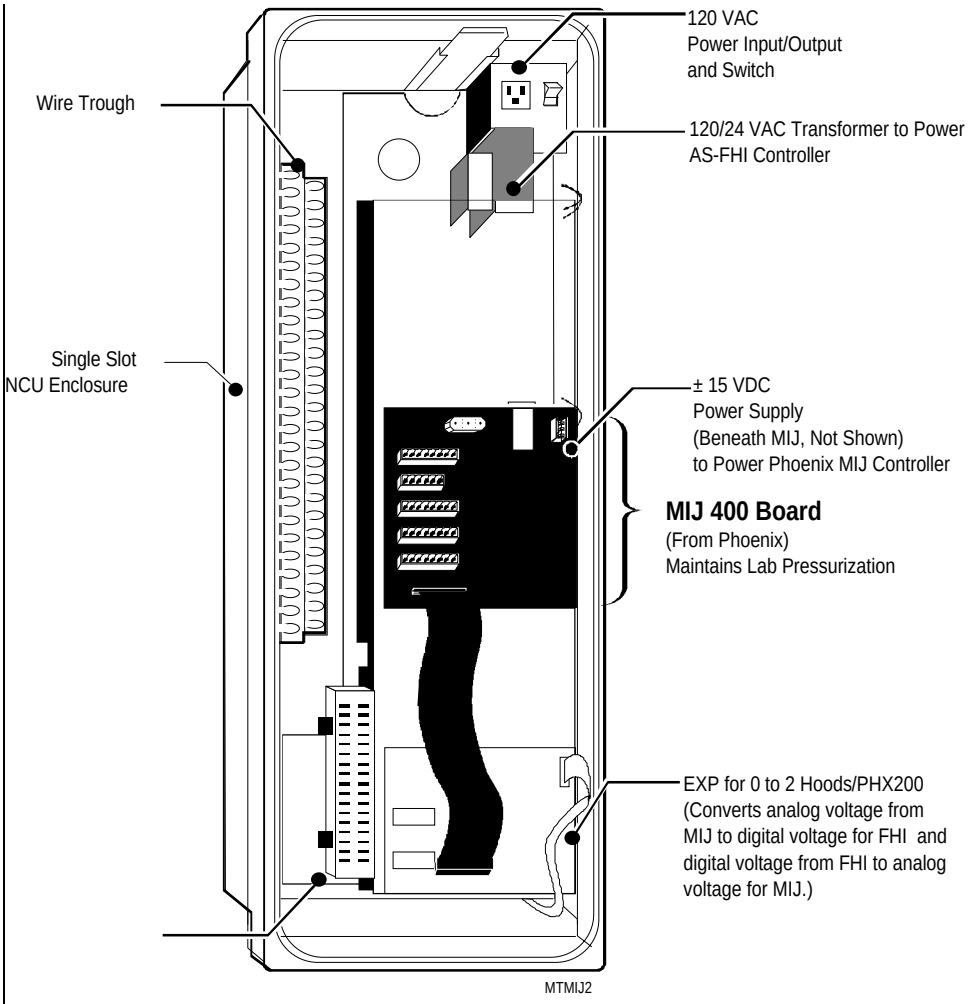


Figure 9: Mounting the MIJ400

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Wiring Details

Wiring Guidelines

Three to four printed wiring boards make up a PHX-MIJ lab control system. The MIJ is the lab controller from Phoenix Controls Corporation that connects to the supply/exhaust valves and fume hoods. The MIJ connects to one or two Expander (EXP) boards through 40-pin ribbon cables for a PHX200 or PHX600 respectively. The EXP boards connect to the Fume Hood Interface (FHI) board through a 6-pin cable.

Precautions

You need to take special precautions and follow good grounding procedures when installing the PHX.



CAUTIONS: To avoid possible electrical shock or damage to equipment, disconnect all power supplies to the system prior to wiring installation.

The CMOS circuits used in the controller are static sensitive. Use static protection (anti-static mats and/or grounding straps) when working on or near internal circuitry.

Touch conduit ground before handling any circuit boards to prevent static discharge.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Follow these guidelines:

- Make all wiring connections in accordance with the National Electrical Code as well as within local regulations.
- Locate equipment and route the N2 and field wiring so that signal wiring is separated from power wiring to the maximum extent possible (preferably two feet; however, six inches is the minimum separation). To establish tight, reliable electrical connections, use the correct wire sizes for the terminals (Table 12).

> **CAUTION:** If N2 or field wiring is run in the same conduit as line voltage wiring, the result is a loss of communications or analog input errors.

- Use copper conductors on all wiring connections. Use twisted pair wires for the FHI.
- Do not run N2 and field wiring in the same conduit as line voltage wiring (30 VAC or above) or near wiring that switches power to highly inductive loads (such as contactors, coils, motors, or generators).
- Daisy chain the N2 Bus without "Y" or "T" connections (unless a repeater is installed in the "T" tap).

Power Source

- Use a green ground wire on the line voltage conduit connected between the conduit bushing and the wire barrier or the green wire of the PHX outlet.
- Bring 120 VAC 60 Hz into top right portion of the PHX enclosure. Cut back the black (hot), white (neutral), and green (ground) wires on the outlet to six inches. Connect these to the line power using the same color code. See Figure 10 below. This powers the entire PHX system.

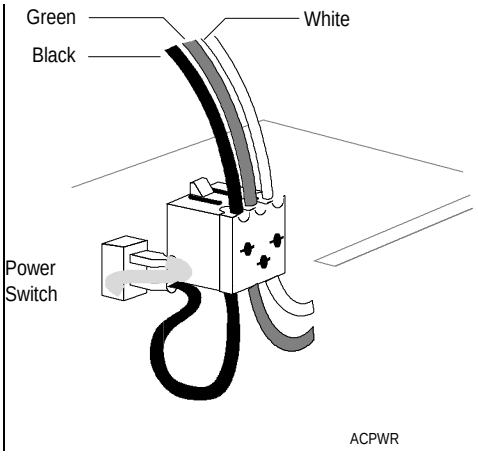


Figure 10: Wiring the Power Source

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Wiring the MIJ

This section deals only with wiring the MIJ board. Startup and commissioning must be performed by a Johnson Controls, Inc. branch that has been certified through Phoenix Controls Corporation. If the branch is not certified, you must seek assistance from a Phoenix Controls representative.

Typically, lab and fume hood wiring diagrams are produced by Phoenix Controls Corporation based on their internal room schedule sheet. These wiring diagrams detail the makeup air, exhaust, and fume hood valve wiring to the MIJ board. To minimize errors, Phoenix Controls uses a standard color code for the 8-conductor cable (Beldon 9421 or equivalent). See the following tables.

Panel Termination Points Lists

Fume Hood Exhaust Controller Terminal Points

The MIJ400 Fume Hood Exhaust Controller terminal points are located on terminal blocks TB1 and TB2. The MIJ500 Fume Hood Exhaust Controller terminal points are located on terminal blocks TB1, TB2, TB3, TB4, TB5, and TB6.

Table 4: Fume Hood Exhaust Controller Terminal Points

Pin	Description	Wire Color
1	+15V	White
2	GND	Orange
3	-15V	Black
4	Flow Command	Red
5	Flow Feedback	Green
6	Flow Alarm	Yellow
7	User Status	Blue
8	Sash Position	Brown

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

General Exhaust/Return Air Controller Terminal Points

The MIJ400 General Exhaust/Return Air Controller terminal points are located on terminal block TB3. The MIJ500 General Exhaust/Return Air Controller terminal points are located on terminal block TB7.

Table 5: General Exhaust/Return Air Controller Terminal Points

Pin	Description
1	+15V
2	GND
3	-15V
4	Flow Command
5	Flow Feedback
6	Flow Alarm
7	Minimum Electronic Clamp
8	Open

Ancillary Exhaust/Bypass Valve/Exhaust Fan Terminal Points

The MIJ500 Ancillary Exhaust/Bypass Valve/Exhaust Fan terminal points are located on terminal block TB8.

Note: The MIJ400 does not have these points.

Table 6: Ancillary Exhaust/Bypass Valve/Exhaust Fan Terminal Points

Pin	Description
1	+15V
2	GND
3	-15V
4	Ancillary Exhaust Flow Feedback
5	Ancillary Exhaust Flow Alarm
6	Scaleable Bypass/EFC Command
7	Bypass/EFC Flow Feedback
8	Exhaust Fan/Bypass Flow Alarm

The MIJ400 Exhaust/Bypass Valve/Exhaust Fan Interlock terminal points are located on terminal block TB5.

Table 7: Exhaust/Bypass Fan Interlock Terminal Points

Pin	Description
1	+12V
2	Emergency Override Input
3	GND
4	Bypass Air or Exhaust Fan
5	Bypass Air or Exhaust Fan Feedback
6	Bypass Air or Exhaust Fan Alarm

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Makeup Air Controller Terminal Points

The MIJ400 Makeup Air Controller terminal points are located on terminal block TB4. The MIJ500 Makeup Air Controller terminal points are located on terminal block TB9.

Table 8: Makeup Air Controller Terminal Points

Pin	Description
1	+15V
2	GND
3	-15V
4	Flow Command
5	Scaleable Flow Feedback
6	Flow Alarm
7*	Scaleable Flow Command
8*	Open

* These connections are only available on the MIJ500.

Ancillary Terminal Points

The MIJ500 Ancillary terminal points are located on terminal block TB11.

Note: The MIJ400 does not have these points.

Table 9: Auxiliary Terminal Points

Pin	Description
1	+12V
2	Emergency Override Input
3	Switched Flow Quantity
4	Hot Deck/TAC Command
5	Hot Deck/Flow Feedback
6	Hot Deck Alarm

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Office Supply Terminal Points

The MIJ500 Office Supply terminal points are located on terminal block TB12.

Note: The MIJ400 does not have these points.

Table 10: Office Supply Terminal Points

Pin	Description
1	+15V
2	GND
3	-15V
4	Open
5	Office Supply Flow Feedback
6	Office Supply Flow Alarm

Three Position Connector for Power

The MIJ400 Three Position Connector for Power terminal points are located on terminal block TB6. The MIJ500 Three Position Connector for Power terminal points are located on terminal block TB13.

Table 11: Three Position Connector for Power

Pin	Description	Wire Color
1	+15V	Red
2	GND	Black
3	-15V	White

Note: For startup and commissioning refer to Phoenix Controls Corporation *Operations and Maintenance Manual*.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

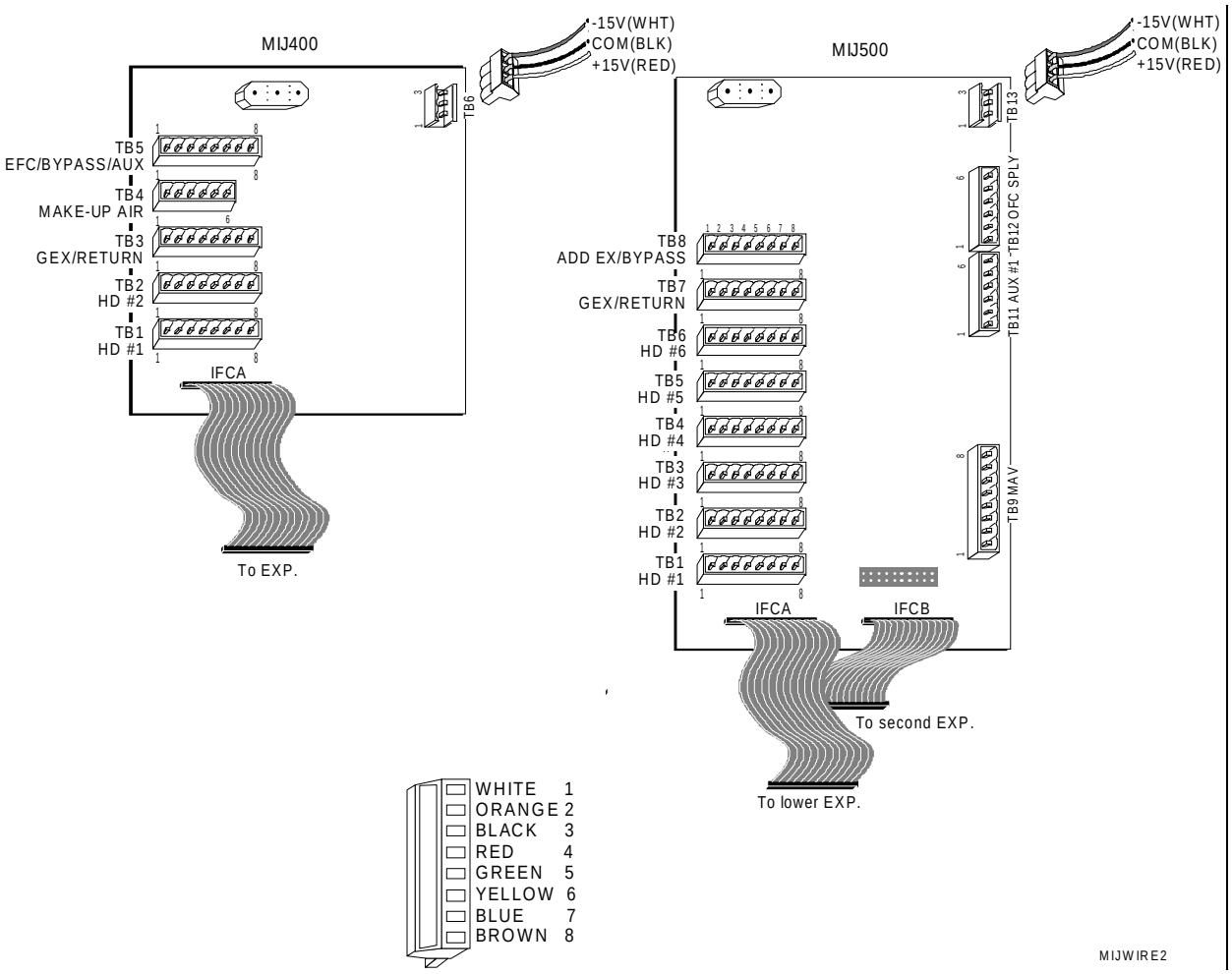


Figure 11: Wiring the MIJ400 and MIJ500

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

To wire the MIJ board:

1. Turn off the AC power switch. Run the 8-conductor cable to each fume hood and valve.
2. Using the color code, attach each wire to the connectors on TB1 through TB12. See Figure 11. Leave enough slack so that the cable for the fume hood and the makeup air valve reach the correct connectors at the bottom of the MIJ board. Label each connector.
3. Plug in each connector (TB1 through TB12) to the correct location on the MIJ board. (See Phoenix Controls drawings.) Do not connect the +/- VDC power at this time (TB13 of the MIJ500, TB6 of the MIJ400).
4. Plug the 40-pin ribbon cable from the lower EXP board to the lower left Interface Connector A (IFCA) on the MIJ board. See Figure 11.
5. If there are more than two fume hoods, plug the second 40-pin ribbon cable from upper EXP board to the lower right Interface Connector B (IFCB) on the MIJ board.
6. Before connecting the 3-conductor power connector to the MIJ, measure the voltage on this connector. Turn the AC power switch on and measure 15 +/- 0.1 VDC on the red wire referenced to the black wire. See Figure 11. Measure -15 +/- 0.1 VDC on the white wire referenced to the black wire. If these are correct, turn off the AC power switch and plug the 3-conductor connector onto the upper right connector (TB13) of the MIJ500, TB6 of the MIJ400). A Phoenix Controls trained technician/engineer may now start up the PHX Lab/Fumehood Controller.

   If either of these voltages are incorrect, turn off AC power and remove the top metal plate. Remove the +/- 15 VDC power supply and adjust the appropriate potentiometer. Re-assemble.

Note: For startup and commissioning of the MIJ400 or the MIJ500 refer to the Phoenix Controls Corporation *Operations and Maintenance Manual*.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Wiring Sensors and Actuators

Remember, all air valves and fume hoods are wired directly to the MIJ. The temperature/humidity sensors and reheat valves are wired to the FHI.

Use 18 AWG twisted pair wire for all sensor and output wiring to the FHI. Shielding is not required, but if used, earth ground the shield at the metal plate. You may use 24 AWG wire in some applications. However, the length of wire is reduced due to the resistance. To minimize sensor error caused by field wiring, the total resistance of all sensor wiring should be less than three ohms.

> ⚠ CAUTION: Do not run AI, BI, AO, BO, ZBus, or N2 Bus wiring in the same conduit as line voltage wiring (30 VAC or above) or wiring that switches power to highly inductive loads (such as contactors, coils, motors, or generators).

Table 12: Sensor, Output, and Power Supply Wire Sizes and Lengths

Sensor Type	Wire Size	Length FT	(Meters)
AI Temperature/ Resistance	18 AWG	500	(150)
	24 AWG	100	(30)
Zone Thermostat	8-conductor phone cable	50	(15)
AI Voltage (0-10 VDC)	18 AWG	500	(150)
	24 AWG	100	(30)
BI Voltage / Contact	24 AWG to 18 AWG	500	(150)
Single BO at 0.1 amp	18 AWG	500	(150)
	24 AWG	100	(30)
Single BO at 0.5 amp	18 AWG	100	(30)
AO Voltage (0-10 VDC at 10 mA maximum)	18 AWG	1000	(300)
	24 AWG	200	(60)
14.6 to 17 VDC Power Supply at 15 mA each	18 AWG	1000	(300)
	24 AWG	200	(60)
Zone Bus	18 AWG	500	(150)
	24 AWG	50	(15)

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Analog Inputs

The FHI100-0 board, located under the metal plate, connects to the Metastat™, humidity transmitter, and reheat valve. The six analog input terminals, their power supply, and their common points occupy the upper left corner of the terminal strip of the FHI (Figure 12). These inputs may be of two types: resistive or voltage. The PHX processes and controls the configured control strategy. It reads the analog inputs through the analog input DIP switches located directly to the right of the analog input terminals.

You use these switches and HVAC PRO for Windows to select the type of analog input. Refer to *HVAC PRO for Windows User's Manual*. For temperature sensors and setpoint pots, set the DIP switch for T. For 3-wire voltage transmitters such as the HE-6300 Series, set the DIP switch for 10V and use the 15 VDC power supply terminals next to the inputs for AI 6. The following table shows each configuration.

Table 13: Analog Input Configurations

AI Type	Range	Switch Position-Set
Voltage (V)	0 to 2 VDC	SW1 to position V and set SW2 to position 2 V
Voltage (V)	0 to 10 VDC	SW1 to position V and set SW2 to position 10 V
Resistance Temperature (T)	1000 ohm Nickel, 1000 ohm Platinum or Potentiometer	SW1 to position T and set SW2 to position 2 V

The FHI has two sets of DIP switches. One set is for configuring the analog input points, and the other for setting the address of the controller. Use Table 14 to set the analog input DIP switches. Instructions for setting the N2 Address DIP switches are described in the next two sections called *Networking the Controller--Installing the N2 Bus* and *Networking the Controller--Zone Bus Communications*.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

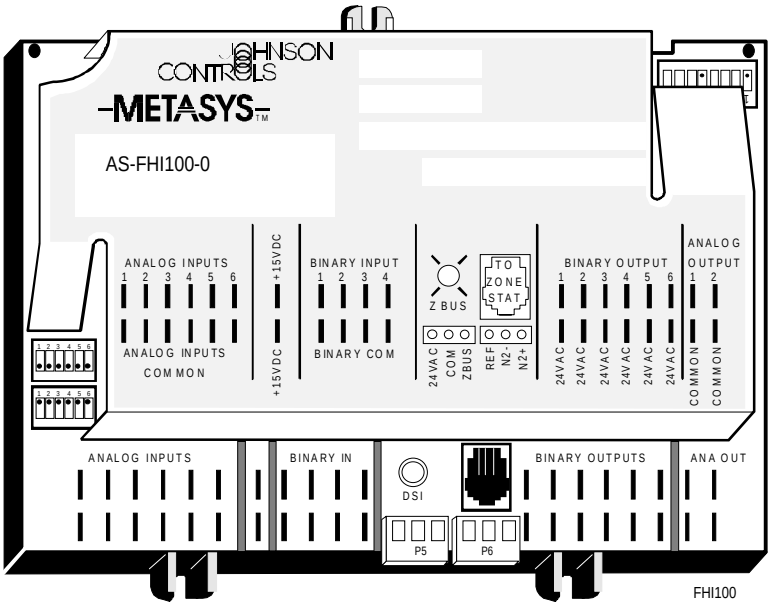


Figure 12: Setting Analog Input DIP Switches on the FHI

Use the following table to set the switches. For example, if you connect a 10 VDC input to AI 4, set SW1/4 to Off and SW2/4 to On.

Table 14: Analog Input DIP Switch Settings

Hardware Point	Temp / Resistive Input		2 VDC Input		10 VDC Input	
	SW1	SW2	SW1	SW2	SW1	SW2
AI 1	ON	OFF	OFF	OFF	OFF	ON
AI 2	ON	OFF	OFF	OFF	OFF	ON
AI 3	ON	OFF	OFF	OFF	OFF	ON
AI 4	ON	OFF	OFF	OFF	OFF	ON
AI 5	ON	OFF	OFF	OFF	OFF	ON
AI 6	ON	OFF	OFF	OFF	OFF	ON

To make all of the necessary wiring terminations between the PHX and TE-6400 Metastat or TE-6100-11 or -12 Zone Temperature Sensors, use phone cable that has pre-terminated 8-pin RJ-45 connectors. These cables are available from Anixter. Connect one end of the cable to the Zone Bus connector on the controller and the other end to the 8-pin connector on the back of the Metastat.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

In addition to the 8-pin RJ-45 connection, the TE-6100 and TE-6400 sensors also have a 6-pin RJ-12 connection under the cover. This allows remote connection of the Cable PRO (used during commissioning), or the Zone Terminal (used for system monitoring). For best results, mount the Zone Terminal on the outside of the laboratory to display alarms, hood flows, and lab pressurization. Use AS-CBLCON-0 to permanently connect a ZT to the PHX with a Metastat. See Figure 13.

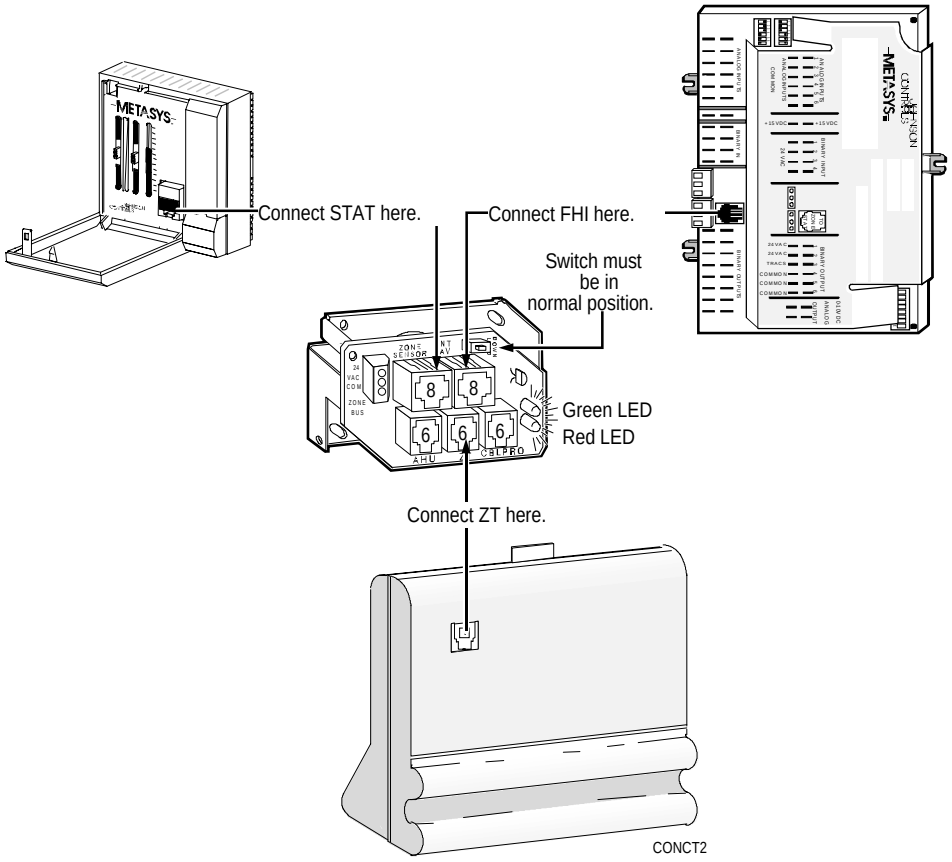


Figure 13: Example of a Permanent ZT Connection

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Phone Jack Polarization

Figure 14 illustrates the polarization of the 6-pin and 8-pin phone jacks on the FHI or Metastat. Terminal 1 is to the extreme left as you face the jack opening, tab notch down.

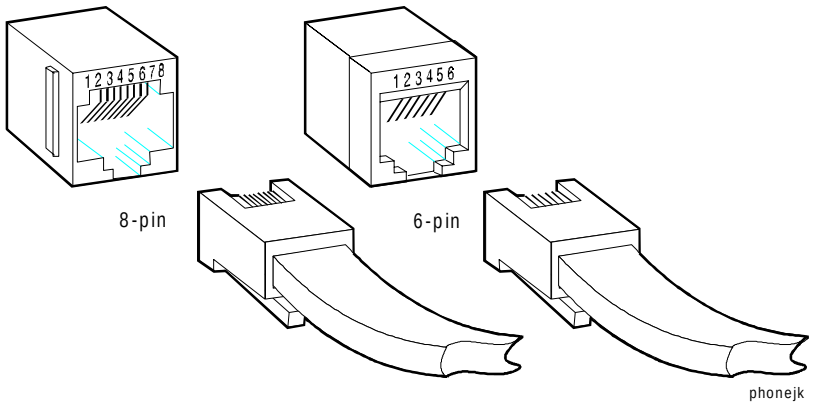


Figure 14: Phone Jack Polarization

The following table defines the pin usage for each jack.

Table 15: Phone Jack Pin Identification

8-Pin Jack (FHI to Temperature Sensor)		6-Pin Jack (Cable PRO or Zone Terminal to Temperature Sensor)	
Pin	**Signal**	**Pin**	**Signal**
1	AI 3 Unused	**1**	Not used
2	AI 2 Warmer, Cooler Setpoint	**2**	24 VAC
3	AI 1 Temperature Sensor	**3**	24 VAC/ZnBs Common
4	AI 1 Sensor Common	**4**	Not used
5	24 VAC	**5**	Zone Bus
6	24 VAC/ZnBs Common	**6**	Not Used
7	AI 2/3 Common		
8	Zone Bus		

Note: Refer to the *Vendor Code Numbers* section of this document for information on cables.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Testing for Ground Loops

A single earth ground connection on the analog common (black) TB13 wire is factory installed in the Phoenix MIJ. To test for a *single* earth ground, disconnect the 40-pin ribbon cables on the Phoenix MIJ to allow the rest of the Johnson Controls PHX electronics to float. Use a Digital Multimeter with a 100K ohm resistor across its inputs and measure the voltage from the +15 VDC terminal of the FHI100-0 to earth ground.

If you read less than 5 VDC/VAC, no ground loop exists. Reconnect the 40-pin ribbon cables. Testing is complete.

If you read 5 VDC/VAC or greater, the circuit is improperly isolated. Make sure the 40-pin ribbon cables are unplugged.

Note: Binary outputs are often the source of ground loops. Therefore, we recommend that you test the binary outputs of the FHI before testing other points.

Follow these steps:

1. Remove all the field wires and N2 Bus wires from the FHI, but leave the transformer wires attached. If you still read greater than 5 VDC/VAC, the transformer's secondary is earth grounded. Remove the earth ground on the transformer to the FHI and measure again. If the value is still 5 VDC/VAC or greater, make sure the 40-pin cables are disconnected and then replace the FHI.
2. With the Digital Multimeter still connected, reconnect each set of field wires one at a time until you read 5 VDC/VAC or greater. At this point, you have discovered one cause of the ground loop. Correct the problem by adding an isolation relay for BI or BO points or floating AI or AO points.
3. Continue to reconnect each set of field wires until all ground loops are found and corrected. You'll know that all grounds are corrected when you read less than 5 VDC/VAC on the DMM.

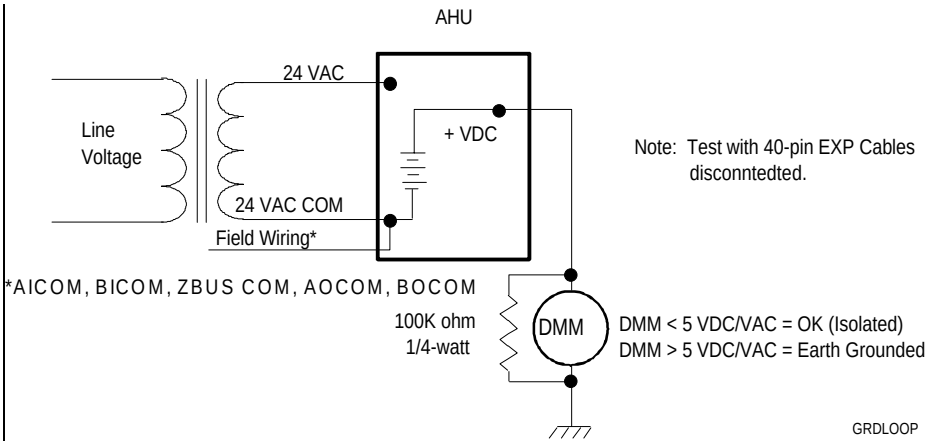


Figure 15: Testing for Ground Loops

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Networking the Controller-- Installing the N2 Bus

N2 Bus Characteristics

When installed in a Metasys Network, the PHX receives commands from the Network Control Unit (NCU) or Companion on the N2 Bus and transmits status reports in return. The maximum electrical limitation on the N2 Bus is 255 devices. However, the number of controllers on the N2 Bus is a data base memory issue at the NCU or Companion. Refer to the data base generation documents in either the *Metasys Companion Technical Manual (FAN 628.1)* or the *Operator Workstation User's Manual (FAN 634)* to determine practical limitations to the number of controllers on the N2 Bus.

The PHX N2 Bus connections are electrically isolated from other controller's circuitry to 500 V by optical and magnetic coupling. For runs of up to 5,000 feet, use 22 AWG twisted pair wire. Runs longer than 5,000 feet require a bus repeater. An N2 Network may be extended to a maximum length of 15,000 feet using two repeaters.

The N2 Bus is a "daisy chain" communications line. Essentially, it consists of three wires, which carry three signals: N2+, N2-, and REF. The N2+ and N2- lines carry the actual data signals. The REF line provides a common reference so that each connected device is capable of electrically receiving and transmitting data by creating a common voltage reference among all the devices connected together by the N2 lines. Three lines are required for optimum reliability. It is important that the N2+ and N2- lines *must be twisted pair lines*, which allows most induced noise (common-mode noise) from external sources to affect both lines equally, thereby canceling the noise.

Note: Do not run N2 Bus wiring in the same conduits as line voltage wiring (42 VAC or above) or wiring that switches power to highly inductive loads (such as contactors, coils, motors, or generators).

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

N2 Reference Lines

The Reference (REF) line helps to provide a common reference from which each device connected to the N2 line can discern the voltage levels, and hence, the data on the N2+ and N2- lines. The N2 lines may connect devices that are far apart, such as in two different buildings, by allowing line lengths of up to 15,000 feet with two repeaters.

IMPORTANT:	Connecting the earth ground of one building (or floor) to the earth ground in another building (or floor) can cause current to flow in the line that connects the two grounds together. Therefore, the N2 Bus wires must not be earth grounded.

Because of this, the Electrical Interface Association (EIA) Standard RS-485 (the N2 Bus) specification states:

> "Where circuit reference is provided by a third conductor, the connection between circuit common and the third conductor must contain some resistance (e.g., 100 ohms) to limit circulating currents when other ground connections are provided for safety."

For the Companion System, the 100 ohm resistor is located in the RS-232 to N2 Bus converter (MM-CVT101-0) or in the Companion Panel/*LTD* to earth ground. Other devices are totally isolated from earth ground.

An important feature of the PHX's N2 Bus is opto-isolation. Isolation prevents interruption of all N2 Bus communication if any of the controllers on the bus become grounded.

N2 Earth Grounds

Most N2 devices have isolated N2 communications power supplies. Therefore, there is no direct path to earth ground through any of the N2 lines. However, there are three exceptions in which an unwanted earth ground may be introduced into the system:

- from the MM-CVT101, which is not isolated. It is grounded through Pin 7 of the RS-232 connector. Earth ground often comes in from the ground pin on the PC's power cord or via a printer connected to the computer, which in turn connects to the MM-CVT101. The Companion PC itself is grounded.
- from a surge protection module (i.e., Transient Eliminator®) on the N2 Bus. It produces a small amount of leakage to earth ground when functioning properly, but may be a short to ground after a lightning strike.
- from the Cable PRO (CBLPRO-0 or -1 only). If the laptop PC is earth grounded, the Cable PRO would be grounded through the RS-232 common pin.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

A single ground will not cause communication problems unless another earth ground path exists in the system to complete a ground loop.

The PHXs also have electrical protection built into the N2 Bus transceiver circuit. It prevents the N2 Bus circuitry from being damaged if someone inadvertently connects a voltage source greater than 5 VDC/VAC between any two or the three N2 Bus terminals-up to 30 VAC. If connecting 24 VAC to the N2 Bus, self-resetting fuses and transient suppressers protect the circuitry.

In most installations, the N2 Bus works fine with unshielded cable. However, in noisy environments, such as near gas ignition devices and arc welders, shielded twisted wire must be used; otherwise, the noise disrupts N2 communications and the PHXs.

End Of Line

The PHX N2 Bus is self-terminating and has the bias voltage permanently applied to the N2+ and N2- lines through 100K ohm resistors. The PHX has opto-isolation of the N2 Bus to the earth ground. Refer to the *N2 Bus Troubleshooting Overview* section of this document for more details.

N2 EOL Termination

The N2 Bus uses End-of-Line (EOL) terminations through the use of jumpers on the Companion Panel/LTD, RS-232 to N2 Bus converter (MM-CVT101), and repeater. N2 Bus circuitry in the PHX is self-terminating. Figure 16 shows an electrical drawing of the end-of-line wiring for the MM-CVT101 and the Panel/*LTD* Version Companion.

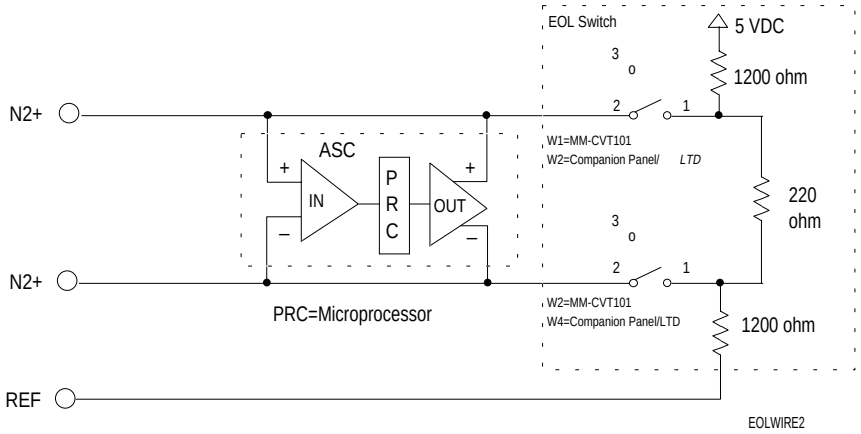


Figure 16: End-of-Line Wiring for MM-CVT101 and Panel/*LTD* Version Companion

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Figure 17 shows an electrical drawing of the end-of-line wiring for the PHX.

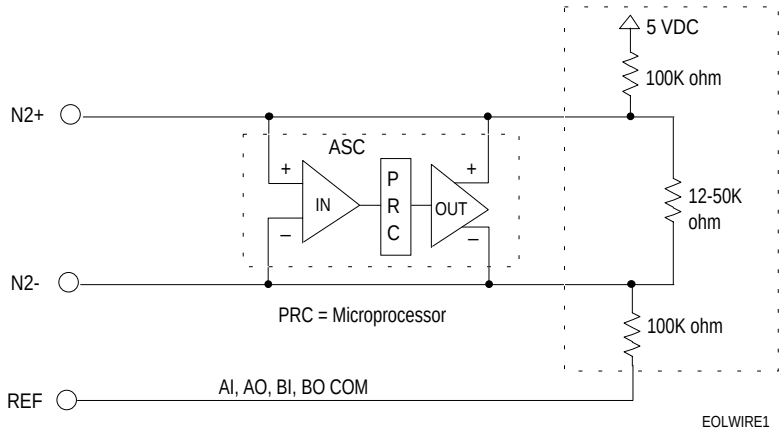


Figure 17: End-of-Line Wiring for PHX Interface

The EOL terminations on the MM-CVT101 and Panel/*LTD* Version Companion place a:

- direct current "bias" on the N2 wires
- 220 ohm resistor from the N2+ to the N2- lines to terminate them

The bias prevents the lines from "floating." If no communications are taking place and all the EOL jumpers are set to the Out position (2/3), the N2+ and N2- lines would "float." That is to say, the bus would have no definite voltage or signal. The receivers would interpret the floating N2 signal as "data," albeit bad data. To avoid this, and to provide some impedance termination, make one or two end-of-line terminations on each N2 Bus segment.

With the EOL jumpers set to the In position (jumper 1/2), a positive bias voltage is applied across the N2+ and N2- lines. This bias voltage is referenced to the REF line. The bias resistors and the 220 ohm termination resistors combine to form a voltage divider. By taking the tolerances on the resistors and the power supply variations into account, you should expect to see the following voltage levels on the N2 lines (MM-CVT101 is disconnected from the PC but still connected to the N2 Bus and powered up):

Voltage from N2+ to N2- = +0.36 to 0.92 VDC*
(DMM+ probe on N2+ terminal; DMM- probe on N2- terminal)

Voltage from N2+ to REF = +2.45 to 2.98 VDC
(DMM+ probe on N2+ terminal; DMM- probe on REF terminal)

Voltage from N2- to REF = +2.06 to 2.54 VDC
(DMM+ probe on N2- terminal; DMM- probe on REF terminal)

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

*If the difference from N2+ to N2- is greater than 0.36V, your system should be able to communicate.

If communication is taking place, voltage on the N2 Bus fluctuates and therefore the DMM will read these fluctuating voltages. An oscilloscope provides a more accurate reading.

Proper EOL Settings

Setting the EOL terminations correctly on the devices connected to the N2 Bus is crucial to proper and reliable communication. Follow these rules:

- Always set the EOL jumpers to In (position 1/2) for the Companion PC or Panel/*LTD*. This device is always set as end-of-line because all the ASCs controllers on the N2, and the PHXs, are self-terminating (they do not have EOL jumpers).
- If possible, terminate the two devices that are at the far ends of the N2 Bus.
- One device on the bus must be terminated. Jumper it as an end-of-line device.

During commissioning, visually check the N2 EOL jumpers at the NCM, Companion PC, or Panel/*LTD*. (Refer to the *PC Version Companion* and *Panel/LTD Companion Technical Bulletins* in the *Metasys Companion Technical Manual*.)

- For the NCM, DCM, or XM, a minimum of one end-of-line switch (per bus) must be set to IN.
- For the Panel/*LTD* version, the end-of-line jumpers are located on the Panel's circuit board (W2 and W4).
- For the PC version, the jumpers are located on the MM-CVT101 (W1 and W2).
- For the repeater, the jumpers are found under the top cover.

To illustrate different possible EOL terminations, consider the following examples in Figures 16 through 18.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Example One (Figure 18)

In this example, the N2 Bus begins at the PC/Panel/*LTD* Companion and connects several PHXs. This is the simplest network and requires only that the PC/Panel/*LTD* is set as the end-of-line device.

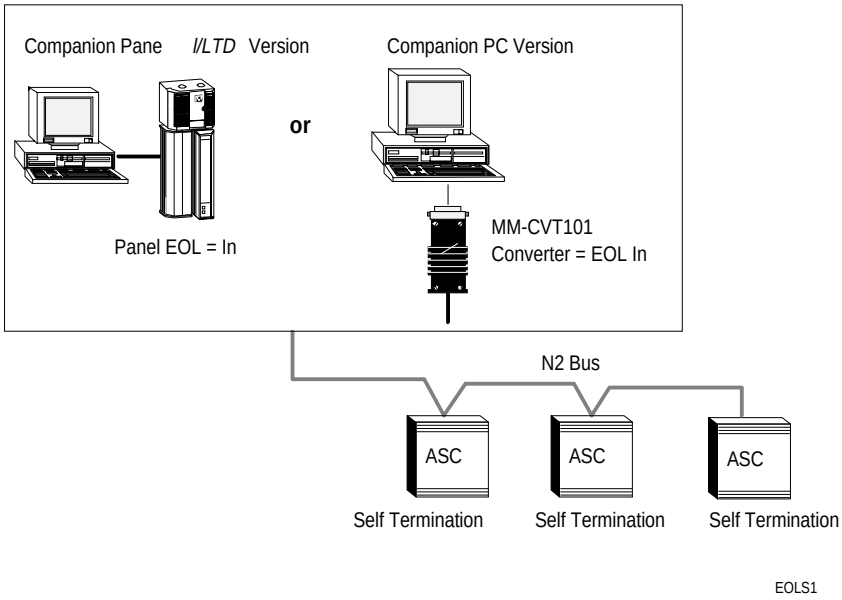


Figure 18: Example One: Companion PC/Panel/*LTD* Terminated

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Example Two (Figure 19)

In Figure 19, the N2 Bus has a row of PHXs. If the Companion PC or Panel/*LTD* is somewhere in the middle of the N2, it would have its EOL jumpers set to the In position, even though this device is not physically at the end-of-line. This is because at least one jumpered EOL is needed per bus.

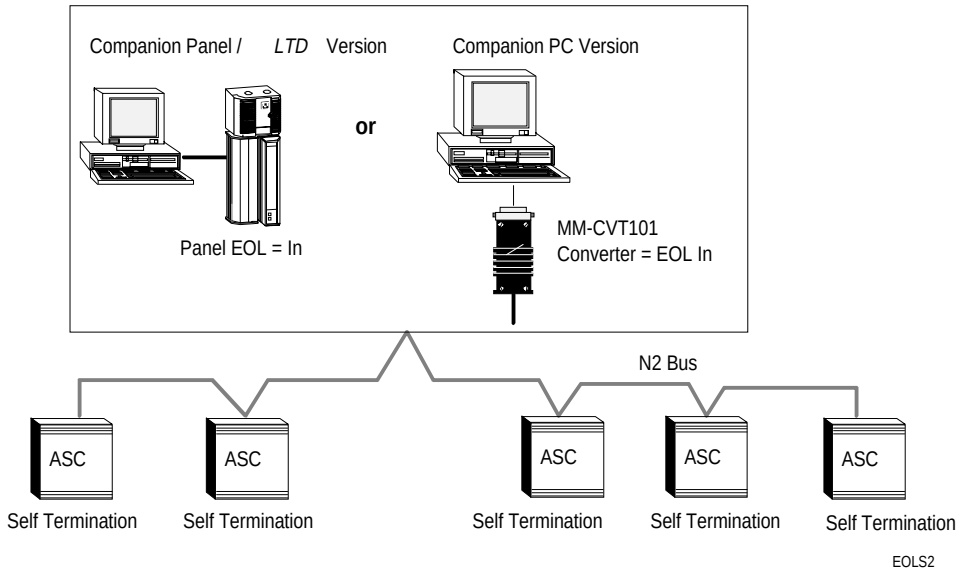


Figure 19: Example Two: Companion PC/Panel/*LTD* Terminated

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Example Three (Figure 20)

In the third example (Figure 20), a repeater is placed near the middle of the N2 Bus. Side A of the repeater has its EOL set to Out, but side B has its EOL set to In, since its segment needs a jumpered EOL. Also, the Companion PC or Panel/*LTD* has its EOL jumpers set to In.

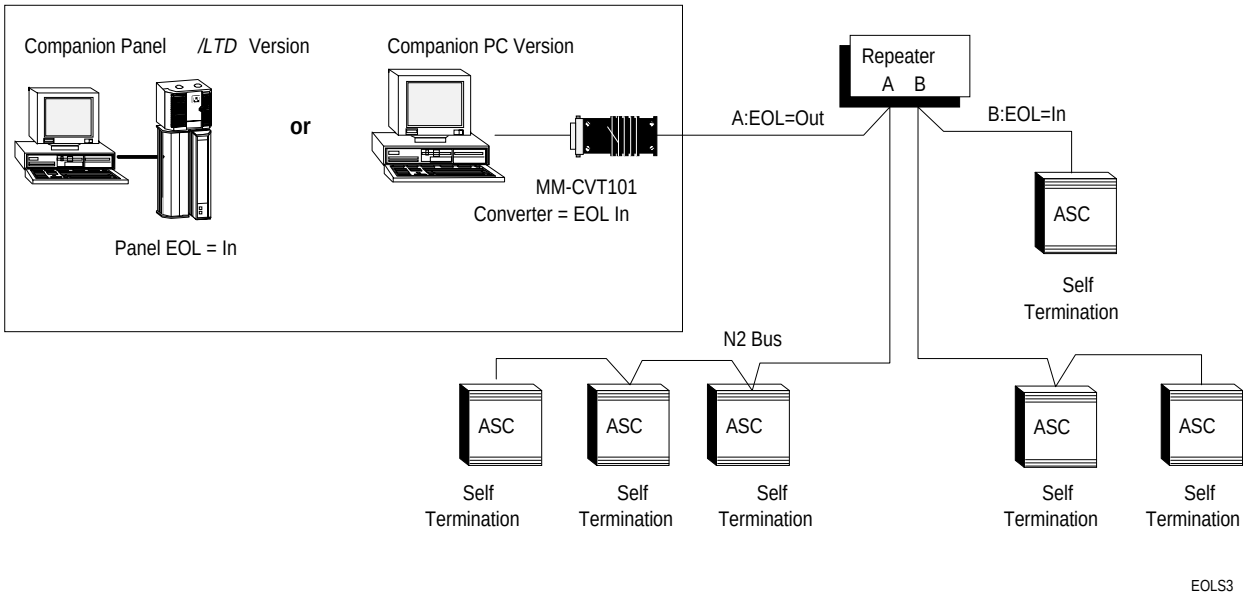


Figure 20: Example Three: Repeater Used on N2 Bus

N2 Bus Rules

The following table summarizes the rules and maximums allowed for installing the N2 Bus.

Table 16: N2 Bus Rules

Category	Rules/Maximums Allowed
General	Only one PC/Panel */LTD* Version Companion or NCU per N2 Bus
	Only daisy-chained devices
Maximum Number of Devices	100 devices per PC/Panel */LTD* Version Companion
	50 devices per repeater
	2 repeaters cascaded
Line Length and Type	5000 feet between repeaters
	15,000 feet from PC or Panel */LTD to* farthest PHX (3 segments of 5000 feet each)
	26 AWG twisted pair minimum (stranded 22 AWG or heavier recommended)
Terminations	1 switched EOL per segment (required)
	2 switched EOL per segment (preferred)

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Setting the N2 Address

You will need to set the N2 address and test for N2 voltage, polarity, and isolation before actually wiring the PHX-MIJ for operation.

The switches located in the lower right corner of the FHI are set to the same number as was assigned to the module through software. The Metasys (or Companion) Facility Management System (FMS) uses this address for polling and commanding. The numbers are in binary format and vertically arranged, with the least significant digit on the bottom.

For example, if the controller address is 17 (decimal), the binary representation is 00010001--Switches “1” and “16” must be set to the “On” (left) position (1 + 16 = 17), as shown in Figure 21.

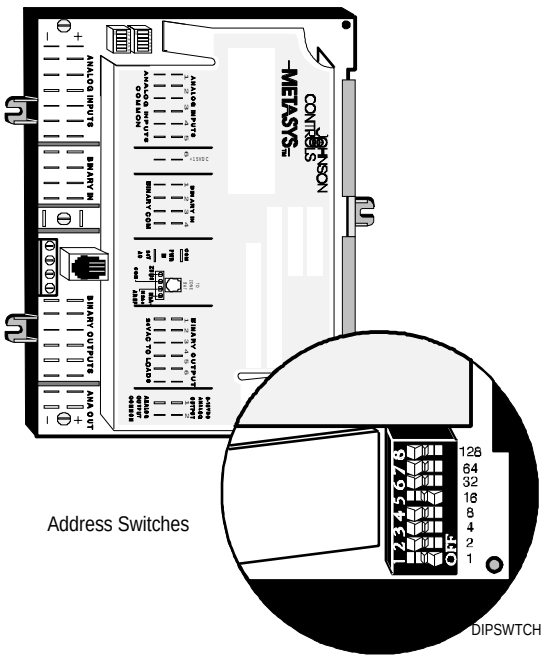


Figure 21: Setting the N2 Address DIP Switches

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Measuring Bus Voltage

This procedure allows you to test for proper voltage, polarity, and isolation of the following components:

- RS-232 to N2 Bus converter, MM-CVT101, (Steps 1 and 3)
- Panel/*LTD* Version Companion RS-485 N2 Bus converter or NCU (Steps 2 and 3)
- PHX N2 Bus (Step 4)
- N2 Bus wiring (Steps 5 and 6)

Follow the steps specific to your installation.

1. If you have a Companion PC Version, remove the 25-pin RS-232 connection from the MM-CVT101 converter. This removes the fluctuating voltage due to communications and allows you to read the DC bias voltage. Disconnect the N2 Bus wires. Wire the transformer to the MM-CVT101 and plug into a 120 VAC source.
2. If you have a Companion Panel/*LTD* Version or NCU, disconnect the N2 Bus wires from the Panel/*LTD*. Wire 24 VAC to the panel or power up the NCU.
3. Connect the DMM (without a 100K ohm resistor) across the N2+ and REF inputs on the N2 terminal block of the Companion/NCU (Figures 20 and 21). Write down the DC voltage reading. Repeat for N2- and REF, then for N2+ and N2-. Compare the voltages you read on the DMM to the following values:

   N2+ to REF = +2.45 to 2.98 VDC

   N2- to REF = +2.06 to 2.54 VDC

   N2+ to N2- = +0.36 to 0.92 VDC

   If your readings are not approximately within the ranges listed above, the N2 EOL device jumpers are probably set incorrectly. For the PC Version, ensure that Pins 1 and 2 on both W1 and W2 of the MM-CVT101 are jumpered (EOL=In). For the Panel/*LTD* Version, Pins 1 and 2 on both W2 and W4 of the Panel/*LTD* circuit board must be jumpered (EOL=In). If not, jumper them and repeat the DMM readings. If the voltages read are still not close to those above, and, after connecting the PHXs to the N2 Bus, the PHXs are still not communicating, replace the MM-CVT101 or Panel/*LTD* Version Companion.

   If your readings are approximately within the ranges listed above, the N2 EOL device jumpers are set correctly. Reconnect the wires and then go on to Step 4.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

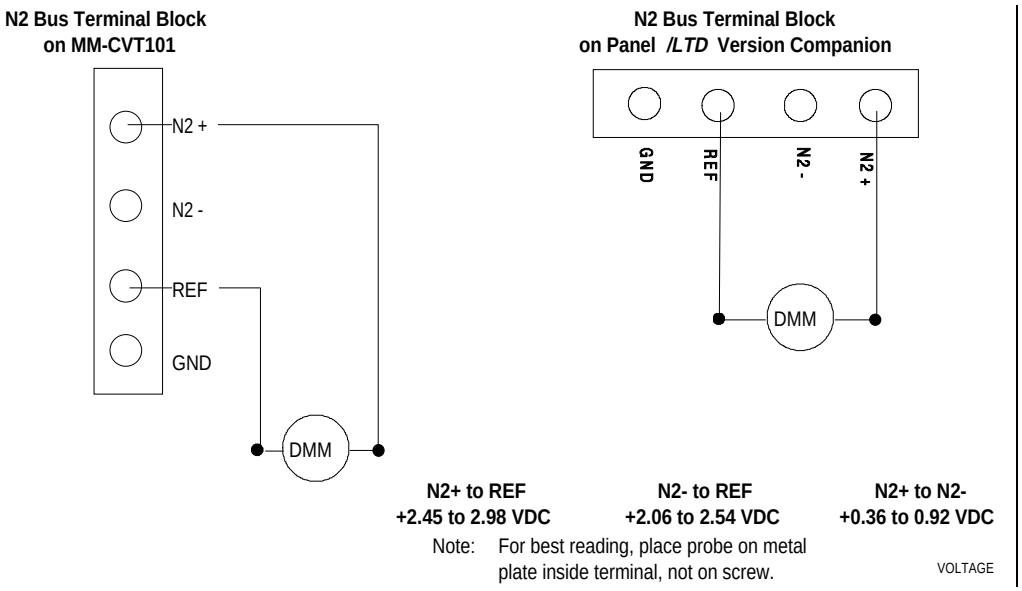


Figure 22: Measuring RS-485 N2 Bus Converter Circuitry

4. Power the PHX. Before connecting the N2 Bus at the FHI, check the voltage and polarity of the N2 DC bias voltages on the PHXs. Do so by connecting the DMM without the 100K ohm resistor across N2+ and REF (Figure 23). Write down the reading. Repeat for N2- and REF, then for N2+ and N2-. Compare the voltages you read to the following values:

   N2+ to REF = +2.45 to 2.98 VDC

   N2- to REF = +2.06 to 2.54 VDC

   N2+ to N2- = +0.36 to 0.92 VDC

   If your readings are not (approximately) at these values and the FHI does not communicate, check for power on the FHI then replace the FHI.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

If your readings are within these values, go on to Step 5.

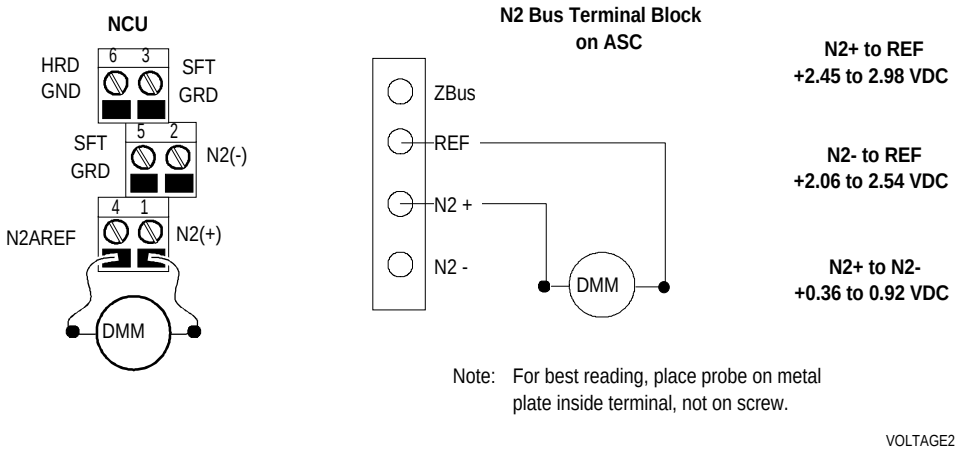


Figure 23: Measuring N2 Voltages at PHX

5. Before connecting the three N2 Bus wires to the PHX, identify the correct voltage and polarity of each wire with the DMM. The voltages should match the following:

   N2+ to REF = +2.45 to 2.98 VDC

   N2- to REF = +2.06 to 2.54 VDC

   REF to earth ground = ≤1.0 VDC/VAC, referenced to earth ground with 100K ohm resistor across the DMM

If the voltages are not within the above ranges, end-of-line termination may not be set correctly. Locate and fix the problem.

6. Connect the N2 Bus wires to the PHX and continue to the next PHX. Perform Steps 4 and 5 until you have connected each PHX to the N2 Bus.

These steps comprise the simplest and most thorough N2 Bus test.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

N2 Wiring to the Network Control Module

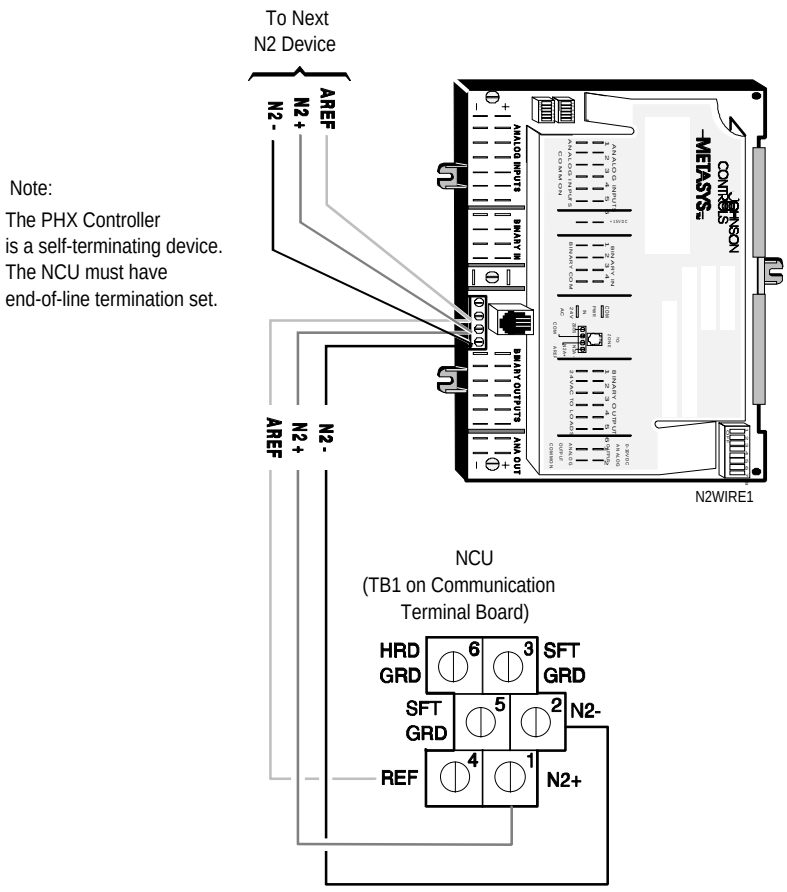


Figure 24: Connecting the PHX to an NCM

Table 17: Terminal Locations

TB2 Terminal Function	Number	PHX Connection
Chassis Ground	6	None
Soft Ground	5	None
N2B Ref. Ground	4	AREF
Soft Ground	3	None
-N2B Connection	2	N2 Bus: N2-
N2B Connection	1	N2 Bus: N2+

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

N2 Wiring to Companion

A hardware connection between the N2 Communications Bus and the Companion PC / Panel*/LTD* is required to service N2 devices. An MM-CVT101-0 Communications Converter is required to network to the PC Companion. See Figure 25 for terminal locations. Refer to the *Metasys Companion Technical Manual* for information specific to the CVT101 or Companion Panel*/LTD*. Set jumpers W1 and W2 in the 1-2 position.

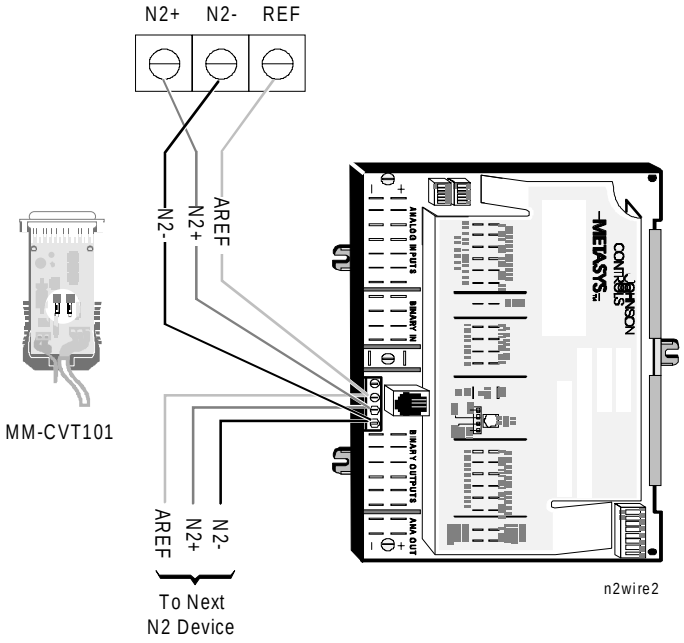


Figure 25: Connecting the PHX to Companion

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Networking the Controller-- Zone Bus Communications

Zone Bus Description

The Zone Bus is a 2-wire communications bus that allows a computer to communicate with the PHX to download the PHX's data base and to communicate with Zone Terminals and M100 Actuators. A third wire is used for 24 VAC power to the Cable PRO, Zone Terminal, and CBLCON. The bus interface sustains no damage in presence of fault voltages of 24 VAC.

M100C Actuators must be powered with separate transformers; therefore, only the Zone Bus and Common wires need to be pulled.

The Zone Bus has the following specifications:

Table 18: Zone Bus Specifications

Type	Multidrop serial communications bus
Speed	1200 baud (bits per second)
Recommended Cable Type	18 AWG with shield (Beldon 8760) or 24 AWG with no shield (unshielded telephone cable)
Maximum Bus Length	500 feet (150 meters) with 18 AWG cable or 50 feet (15 meters) with 24 AWG cable
Maximum Number of Devices	24 without Y500 repeater
Range of Addresses	0 to 63
Voltages **Logic High-Voltage** **Logic Low-Voltage**	 4 VDC minimum (approx.) 1 VDC maximum (approx.)
Data Transmission	1 Start Bit (low level) 8 Data Bits (least significant bit first) 1 Stop Bit (high level)

Cable PRO Description

The AS-CBLPRO is an interface device for use between a computer running HVAC PRO for Windows and PHXs. It is used for data base downloading, uploading, or commissioning via the Zone Bus communication port.

- When used with a Zone Bus device, such as the PHX or ZT, the Cable PRO is strictly an electrical interface between the serial RS-232 port of the computer and the Zone Bus. Cable PRO operates on 24 VAC drawn from a PHX over the wire used to make the Zone Bus connections. The data rate on both the RS-232 and the Zone Bus is 1200 baud.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

The connection to the RS-232 COM port of the computer is by means of a DB9 or DB25 connector supplied with the Cable PRO. After connecting it, make sure the Cable PRO is about a foot or more away from the computer monitor and system unit.

IMPORTANT:	In some cases, a computer monitor or PC will give off electromagnetic noise that may disturb Cable PRO communications. Therefore, do not position the Cable PRO near the monitor or PC.

Zone Bus communications to the PHX or ZT are monitored with an AS-CBLCON-0. This device has a red and green LED whose purposes are described in Table 19.

Table 19: CBLCON LEDs

Red LED--Power	Green LED--COMM	Cause
OFF	**OFF**	No power to PHX
ON	**OFF**	Zone Bus wire open
ON	**ON**	Zone Bus wire shorted to Common or CBLCON-0 switch in download position
ON	**Blinking**	Normal communications

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Troubleshooting HVAC PRO for Windows

Table 20 lists and describes the errors that may occur while using the HVAC PRO for Windows commissioning tool with the PHXs over the Zone Bus. The cause of the error is often a loose or improper connection between the Cable PRO (AS-CBLPRO), laptop PC, and the controller. A defective COM port on the laptop could also be at fault. Other times, a defective controller can cause an error.

Note: It takes ten seconds for a PHX to reset and resume communication after being downloaded.

An effective troubleshooting technique is to use a CBLCON and observe its LEDs, which will indicate the problem. You may also try exchanging the component that you believe is defective with a working component of the same type.

A noisy wire adjacent to the Zone Bus can also cause communication errors. Noise can be periodically induced into the Zone Bus, thereby causing sporadic communication failures between the laptop and the PHX. Most often, noisy lines cause intermittent disruption, not total loss of communication.

For more information on HVAC PRO for Windows, refer to the *HVAC PRO for Windows User's Manual (FAN 637).*

Table 20: Communication Errors on Zone Bus Download

Error Displayed	Description	Solution
Undefined command Error 1	The device is being sent a message that contains an invalid command.	Check for tight and proper connections between the laptop PC, Cable PRO, and the PHX.
Invalid message size Error 5	The size of the message sent does not correspond to the type of message sent.	
Invalid command Error 11	The command issued is not valid for the data type.	
Not ready Error 14	The PHX cannot process this message at this time. For example, the EEPROM is not functioning properly.	Cycle power on the PHX. If problem persists, return PHX for repair or replacement.
Bad E^2 Write Error 15	A known problem with the EEPROM exists.	Return the PHX for repair or replacement.
No communication Error 16	Some hardware problem exists, such as a loose connection or a failed component.	Check for tight and proper connections between the laptop PC, Cable PRO, and the PHX.
	Controller is still in reset mode. Resetting takes ten seconds after a download.	Wait ten seconds for the reset period to expire before trying to commission the controller.
Bad CRC Error 17	The Cyclical Redundancy Check of the message received is incorrect due to an error in transmission.	Check for tight and proper connections between the laptop PC, Cable PRO, and the PHX.
Invalid response Error 18	The message received is not what the HVAC PRO for Windows Load utility expected.	Retry.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Commissioning/Troubleshooting

Commissioning/ Troubleshooting

Commissioning a PHX begins after the unit is mounted, wired, and the control and hardware/software features have been defined through HVAC PRO for Windows. Refer to the *HVAC PRO Version 4.00 for Windows, Phoenix Lab and Fume Hood Interface* document for complete controller configuration information. A laptop PC with HVAC PRO for Windows for Windows Revision 4.0 or greater is required to perform a complete system startup procedure.

Checking the Installation

Review the mounted PHX to ensure proper installation. Refer to the appropriate illustrations in the section of this document titled *Installation Procedures* and to the engineering drawings supplied for the individual site.

- Ensure that the controller terminal connections are secure.
- Verify that the N2 connections are secure and labeled correctly.
- Verify that the FHI switches are appropriately positioned. Refer to the sections of this document titled *Wiring Sensors and Actuators*.
- Verify that there is a single earth ground connection to the PHX from the MIJ board following the procedures below. Disconnect the two 40-pin ribbon cables between the expander boards and the MIJ Panel.

  Use a voltmeter with a 100K ohm resistor wired across its inputs. Apply power and take AC and DC voltage measurements from the +15 VDC spade connector of the PHX to earth ground. Readings greater than 5 V indicate unwanted earth ground continuity to power, input, or output terminals of the controller. Locate the earth ground connection and either remove it or isolate it through relays for BIs or BOs.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Configuring the Controller with HVAC PRO for Windows

You configure the PHX 200/600 with a software program called HVAC PRO for Windows. This easy to use tool configures, commissions, and downloads the PHX's data base. Figure 26 illustrates the HVAC PRO for Windows configuration process. Refer to the *HVAC PRO for Windows User's Manual* for specific information when configuring the PHX.

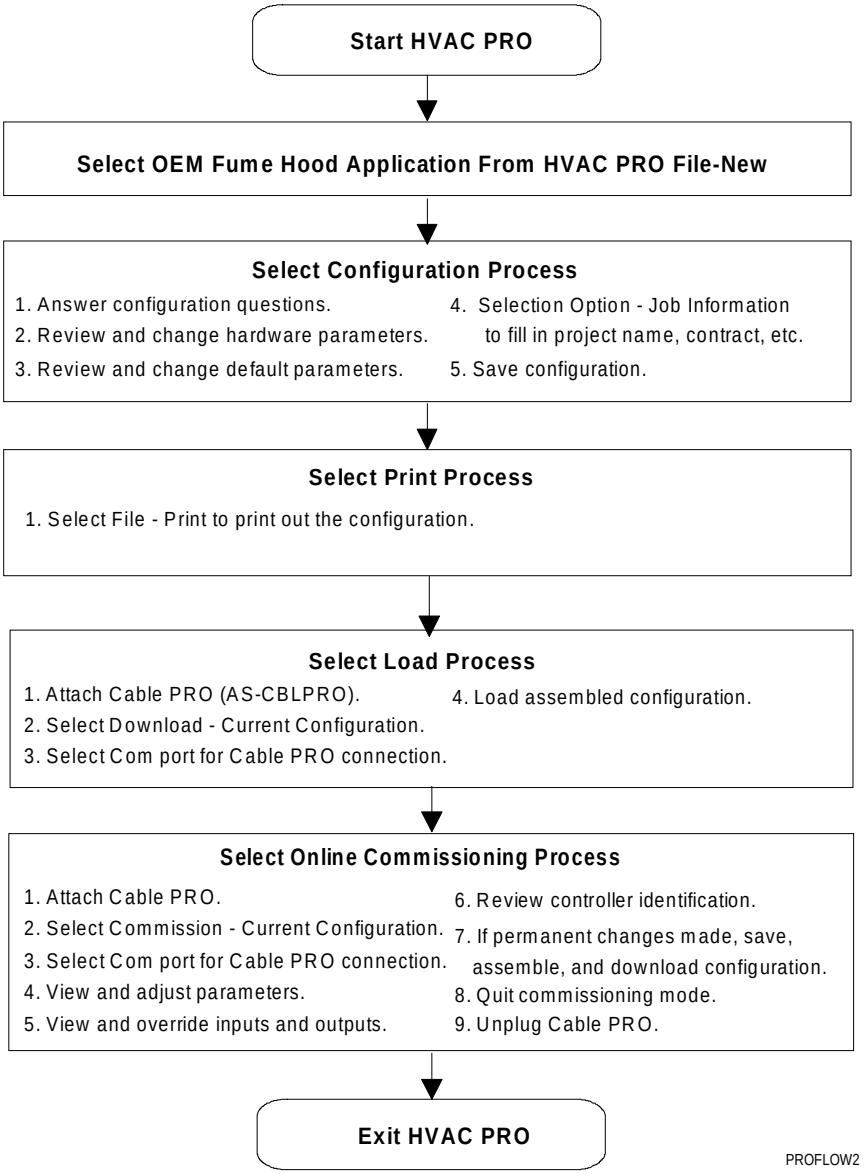


Figure 26: Overview--Configuring a PHX

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

N2 Bus Troubleshooting Overview

You need to troubleshoot the N2 Bus if the Companion system is not properly communicating with the PHXs. This section first presents a troubleshooting table. Table 21 covers many PHX or N2 communication problems and suggests which actions to take.

Second, specific troubleshooting tests are given. Before trying one of these tests, you may be able to determine the cause of the problem by asking yourself the following questions:

- Are the N2 Bus wires securely terminated to each FHI?
- Is the N2 polarity correct?
- Is the PHX powered and ready to respond?
- Are the end-of-line device settings correct?
- Have you cycled power on a PHX after changing its address?
- Is the W3 loop back jumper on the Companion Panel/*LTD* fully pushed down on Pins 1 and 2?
- Are the PHXs configured properly with the correct number of points?

Lastly, this section describes the diagnostic LEDs on the PHX.

> **CAUTION:** To avoid electrical shocks when troubleshooting, always measure the REF to earth ground voltage with the DMM. If line voltage is measured, have a qualified electrician locate the fault.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Troubleshooting Chart

Table 21: Troubleshooting

Symptom	Possible Cause	Action
N2 Bus is offline.	EOL jumpers and/or W3 jumper on MM-CVT101 or Companion Panel/*LTD* are not installed.	Install EOL jumpers and W3 jumper properly.
	MM-CVT101 is not plugged into PC or 9 VDC source.	Plug MM-CVT101 into PC or plug it into a 9 VDC source.
	N2 Bus polarity is incorrect.	Rewire N2 Bus wires for proper polarity.
PHX cycles online and offline.	A read-only point is defined in the Companion data base as a read/write point (AO or BO).	Delete the AO or BO point and read it as an AI or BI point to the Companion data base.
	A Companion process is using an unconfigured point (i.e., not listed in HVACPRO.SYM file).	Delete the use of the unconfigured point in the Companion process.
PHX does not come online.	Two or more PHXs have the same address.	Change each duplicate PHX address to a unique number.
	The address of the PHX was changed without its power being cycled afterward.	Cycle power on the PHX.
	The ten minute delay after down-loading the PHX has not yet expired (HVAC PRO Revision 1.0 or earlier).	Wait until the delay expires.
EXP does not come online.	The MIJ sets the address for each EXP.	Connect the 40-pin ribbon cables from the EXP to the MIJ.

Testing the N2 Bus

You can use one of two methods to troubleshoot the N2 Bus. Each of these methods is described in this section.

Test 1: Polarity, Shorts, Crossed Wires, Grounds

You'll need a DMM to perform this test. By connecting the DMM to each N2 Bus wire, you'll be able to detect polarity, shorts, crossed wires, and grounds.

Follow these steps, referring to Figure 27:

1. If you have a Companion PC Version, remove the 25-pin RS-232 connection from the MM-CVT101 converter. This removes the fluctuating voltage due to communications and allows you to read the DC bias voltage. Plug the converter's transformer into a 120 VAC source.

   If you have a Companion Panel/*LTD* Version or NCU, make sure the Panel/*LTD* is powered with 24 VAC and the NCU has 120 VAC.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

2. Connect the Digital Multi-Meter across the N2+ and REF screws on the N2 terminal block (Figure 27). Write down the DC voltage reading. Repeat for N2- and REF, then for N2+ and N2-. Compare the voltages you read on the DMM to the following values:

   N2+ to REF = +2.45 to 2.98 VDC

   N2- to REF = +2.06 to 2.54 VDC

   N2+ to N2- = +0.36 to 0.92 VDC

   If your readings are not approximately within the ranges listed above, that particular wire is grounded, shorted, or crossed with another wire. Correct and measure again.

   If your readings are approximately within the ranges listed above, the bus is properly wired.

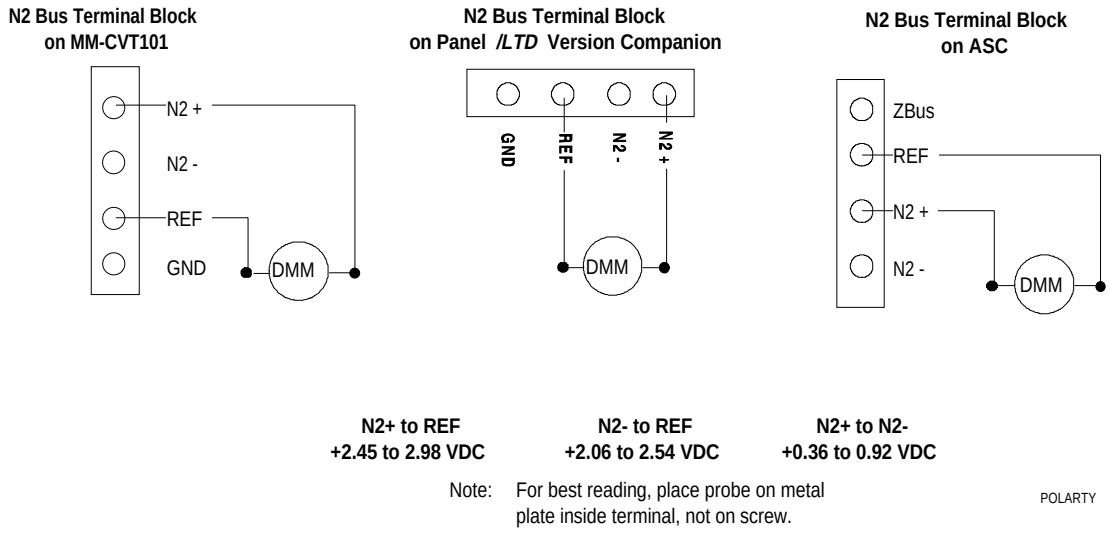


Figure 27: Test for N2 Bus Shorts, Crossed Wires, Grounds

3. Check the voltage and polarity of the N2 DC bias voltages at the FHI. Do so by connecting the DMM across N2+ and REF (Figure 27). Write down the reading. Repeat for N2- and REF, then for N2+ and N2-. Compare the voltages you read to the following values:

   N2+ to REF = +2.45 to 2.98 VDC

   N2- to REF = +2.06 to 2.54 VDC

   N2+ to N2- = +0.36 to 0.92 VDC

   If your readings are not (approximately) at these values, that particular wire is grounded, shorted, or crossed with another wire. Correct and measure again.

   If your readings are within these values, the bus is properly wired.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Test 2: Using the Oscilloscope

You can use an oscilloscope to pinpoint communication faults over the N2 Bus. The procedure requires a 2-channel scope with an A minus B function or an A plus B with B inverted function. Follow these steps:

1. Plug the scope into a grounded electrical outlet.
2. Set both channels to 2 volts per division. Both channels must have the same gain or volts per division setting.
3. With no signal applied, adjust each channel's vertical position at the same graticule on the screen (i.e., center screen).
4. Select the channel A minus B function. If your scope does not have this function, select the Add function (channel A ADDED to B then INVERT channel B).
5. Select the 0.5 mS horizontal range.

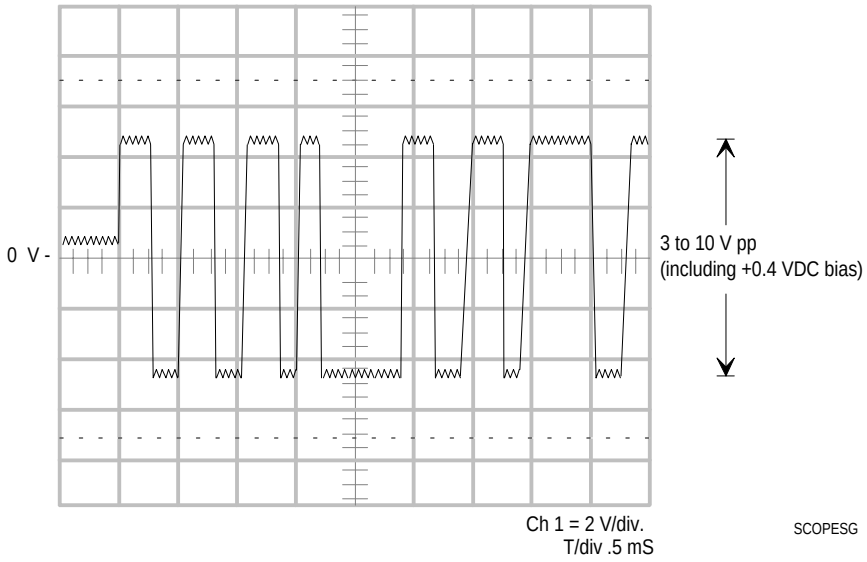


Figure 28: N2 Bus Signal as Measured with Oscilloscope

6. Connect channel B to the N2- wire and connect channel A to the N2+ wire. (Do not use the oscilloscope ground lead.)
7. Compare the signal you measure with the wave form in Figure 28. They should resemble the figure. A signal outside this range indicates that the N2 Bus is not functioning properly.

Note: At the dead time between messages, you can measure the bias voltage. In this figure, it is 0.4 VDC.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Factors that can cause improper signal levels are:

- N2 Bus wires are not polarized correctly (i.e., wires are reversed)
- N2 cable runs are too long
- PHX has malfunctioned
- N2 Bus is improperly terminated (e.g., EOL jumpers configured improperly)
- N2 Bus contains too many devices, loading down the bus
- N2 Bus wiring has "T" or "Y" connections installed

Check all wiring and devices to pinpoint the problem. Replace parts if necessary.

Suppression Devices

In general, a proper PHX installation will not require the use of a suppression device. If problems resulting from noise are encountered, you must identify the offending devices and install suppression devices. For example, the switching of inductive loads can generate transients that can be conducted and/or radiated into the circuits controlling those loads, as well as into other circuits nearby.

For inductive loads, the recommended suppression device is the ACC/22 for 12 to 120 VAC. For the N2 Bus, the recommended suppression device is the Transient Eliminator, model TE/JC04C12, made by Advanced Protection Technologies (APT).

Besides these recommended devices, you may find a different device that has the same capabilities. The device must meet or exceed the specifications in Table 22, which were derived from Metal Oxide Varistors (MOVs).

Table 22: Specifications for Suppression Devices (MOVs)

	Load Voltage				
	24 VAC	**120 VAC**	**208-240 VAC**	**277 VAC**	**347 VAC**
Min. Continuous Voltage Rating	30 VRMS	130-135 VRMS	250-280 VRMS	300 20 VRMS	385 VRMS
Min. Energy Rating	8.5 Joules	30 Joules	55 Joules	80 Joules	85 Joules
Min. Peak Current (8X20 sec pulse)	1000 Amps	4000 Amps	4000 Amps	4000 Amps	4000 Amps
UL Recognized	Optional	Required	Required	Required	Required

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

The most effective location for the suppression device is at the load, since it lessens the propagation of transient energy into connected wiring which, in turn, becomes a source of noise to adjacent wiring. Difficulties in getting access to the load, however, may sometimes make it necessary to locate the suppression device at the PHX.

Diagnostic LEDs on EXP Boards

Table 23: LED Operation on EXP

LED Prompt	Meaning
LED On solid	The expander failed a diagnostic test and after reporting the problem to the FHI; it should reset itself and try again.
LED Off, blinks On rapidly four times. Pauses for 1.5 seconds and then repeats.	The expander is in normal mode. Each blink On represents one message received from the FHI with its correct slave address. The first expander board receives four messages from the FHI and the second board receives three messages. (No AO data is sent to the second expander board.)
LED blinks 3 seconds On and 3 seconds Off.	The expander passed all diagnostic tests and is waiting for the first message to be received from the FHI with its correct slave address. You must connect the 40-pin ribbon cable to the MIJ to set the address then cycle power.
LED blinks 6 seconds On and 6 seconds Off	The expander passed all diagnostic tests and has, at one time, talked to a FHI but has not received a message with its slave address in at least five seconds. Verify the download file was for a PHX600 (both EXP's).
LED Off	No power to expander board. Check 6-conductor cable.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Ordering Information

Johnson Controls Code Numbers

The following is a list of code numbers and descriptions for the PHX and accessory equipment.

PHX Interface Modules

Code Number	Description
AS-PHX200-0 (2 fume hoods)	PHX connects to a Phoenix MIJ400 Controller
AS-PHX600-0 (6 fume hoods)	PHX connects to a Phoenix MIJ400 or MIJ500 Controller
MIJ500 for 0 to 6 fume hoods	One per PHX required--order from Phoenix Controls Corporation.
MIJ400 for 0 to 2 fume hoods	One per PHX required--order from Phoenix Controls Corporation.

Repair Parts or Upgrade

Code Number	Description
AS-FHI100-0	Controller
AS-EXP100-0	Expander Board

Sensors / Transmitters

Code Number	Description	Type
EP-8000-2	Electro-Pneumatic Transducer 0.5 to 19 PSIG	0 to 10 VDC, High Volume (relay)
HE-6300 Series	Wall Mount Humidity Transmitter	12-30 VDC Supply
HE-6310 Series	Duct Mount Humidity Transmitter	12-30 VDC Supply
TE-6100-961	Silicon Sensor	1035 ohms at 77°F (25°C)
TE-6100-11	Nickel Sensor without setpoint, phone cable connections	1000 ohms at 70°F (21°C)
TE-6100-12	Nickel Sensor with Warmer/ Cooler Pot, phone cable connections	1000 ohms at 70°F (21°C)
TE-64X0X-X0X0 **TE-64X1X-X0X0** **TE-64X3X-X0X0** **TE-64X5X-X0X0**	Nickel or platinum sensor, with or without setpoint, wall or surface mounting, with phone jack or terminal blocks, with or without thermometer	Nickel-1000 ohms at 70°F (21°C) Platinum-1000 at 32°F (0°C) Setpoint: warmer/cooler or graduated scale 65°F to 85°F (18°C to 30°C)
HE-6400 Series	Metastat Humidity Transmitter Nickel or platinum sensor, with or without setpoint, wall or surface mounting, with phone jack or terminal blocks, with or without thermometer	0-10 VDC Humidity Nickel-1000 ohms at 70°F (21°C) Platinum-1000 at 32°F (0°C) Setpoint: warmer/cooler or graduated scale 65°F to 85°F (18°C to 30°C)

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Dampers and Valve Actuators for Heating

Code Number	Description	Type
AV-8020 Series	Valve Actuator Assemblies 1/2 in.	24 VAC Triac/ Incremental
AV-8022 Series	Valve Actuator Assemblies 1/2 in.	0 - 10 VDC
AV-8050 Series	Valve Actuator Assemblies 1/2 in., 3/4 in., 1 in., and 1-1/2 in.	24 VAC Triac/ Incremental
AV-8051 Series	Valve Actuator Assemblies	24 VAC Triac/ Incremental/w Feedback
AV-8052 Series	Valve Actuator Assemblies	0 - 10 VDC
EDA-2040-6X	Damper Actuator (6 min)	24 VAC Triac/ Incremental
EDA-8x0x	Direct Mount Damper Actuator	24 VAC Triac/ Incremental or Proportional 0-10 VDC
AV-8090	Valve Actuator Assemblies 1-1/2 in. to 2 in.	24 VAC Triac/ Incremental
AV-8091	Valve Actuator Assemblies 1-1/2 in. to 2 in.	24 VAC Triac/ Incremental/w Feedback
AV-8092	Valve Actuator Assemblies 1-1/2 in. to 2 in.	0 to 10 VDC
M100C Series	Zone Bus Damper Actuators	Zone Bus Addressable
M100E Series	Standalone Economizer Actuators	Proportional Economizer Motor Actuator
M100G Series	Proportional Damper Actuators	0 to 10 VDC

Accessories

Code Number	Description	Type
AS-CBLPRO-1 or -2	HVAC PRO Cable	N/A
AS-CBLCON-0	ZT Adapter	Three 6-pin and two 8-pin with a ZT switch
WS-SWHPRO-004WINPRO-0	HVAC PRO for Windows Software, Software	N/A
WS-WINPRO -6	HVAC PRO for Windows Software Upgrade	N/A

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Vendor Code Numbers

The following is a list of code numbers and descriptions for PHX equipment requirements. All listed equipment is available from:

Anixter
2201 West Main Street
Evanston, IL 60202
1-800-792-1207
1-800-942-1664 (in Illinois)

Use the following information to order preconfigured cables from the factory.

Description	Cable Length	Part Number
RJ45 Straight-Thru Cable Assembly Non-plenum **- Non-keyed plugs** **- 24 Gauge** **- 8-conductor** **- Solid Wire**	25 feet	889158
	50 feet	889161
	100 feet	889166
RJ45 Straight-Thru Cable Assembly Plenum **- Non-keyed plugs** **- 24 Gauge** **- 8-conductor** **- Solid Wire**	25 feet	889315
	50 feet	889318
	100 feet	889324

Use the following table to order cable components for creating your own cables.

Description	Part Number
1000 Foot Roll of Non-plenum Rated **- 24 Gauge** **- 8-conductor** **- Solid Wire**	CM-00424BAG-3
1000 Foot Roll of Plenum Rated **- 24 Gauge** **- 8-Conductor** **- Solid Wire**	CMP-00424SAC-3
8 Position Non-keyed Plugs for Solid Cable (bag of 25)	074683 Stewart
Hand Tool with 8 Position Die Set for Solid 24 Gauge Wire	060612

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Notes

JOHNSON CONTROLS

Controls Group
507 E. Michigan Street
P.O. Box 423
Milwaukee, WI 53201

FAN 595.1
Laboratory Controls Manual
Printed in U.S.A.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

Artisan Technology Group is an independent supplier of quality pre-owned equipment

Gold-standard solutions

Extend the life of your critical industrial, commercial, and military systems with our superior service and support.

We buy equipment

Planning to upgrade your current equipment? Have surplus equipment taking up shelf space? We'll give it a new home.

Learn more!

Visit us at **artisantg.com** for more info on price quotes, drivers, technical specifications, manuals, and documentation.

Artisan Scientific Corporation dba Artisan Technology Group is not an affiliate, representative, or authorized distributor for any manufacturer listed herein.

We're here to make your life easier. How can we help you today?

(217) 352-9330 | sales@artisantg.com | artisantg.com

ARTISAN® TECHNOLOGY GROUP