JOHNSON CONTROLS

***TECHNICAL BULLETIN***

# Air Handling Unit (AHU) Controller



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

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# Introduction

In this document, Facility Management System (FMS) is a generic term that refers to the Metasys® Network, Companion™, and Facilitator™ supervisory systems. The specific system names are used when referring to system-specific applications.

**Table 1: Related Documents**

| Document Title | Code Number | FAN |
|---|---|---|
| ***ASC and N2 Bus Networking and Troubleshooting Guide Technical Bulletin*** | *LIT-6363003* | *636.3* |
| ***Controller and N2 Bus Networking and Troubleshooting Guide Technical Bulletin*** | *LIT-1628310* | *1628.2* |
| ***Auxiliary Gear Technical Bulletin*** | *LIT-6363080* | *636.3*<br>*1628.2* |
| ***N2 Communications Bus Technical Bulletin*** | *LIT-636018*<br>*LIT-6281120*<br>*LIT-1628120* | *636*<br>*628.1*<br>*1628.1* |
| ***Unitary (UNT) Controller Technical Bulletin*** | *LIT-6363081*<br>*LIT-1628320* | *636.3*<br>*1628.2* |
| ***Universal Packaging Module Technical Bulletin*** | *LIT-6363070*<br>*LIT-1628370* | *636.3*<br>*1628.2* |

## *Description*

The Johnson Controls Air Handling Unit (AHU) Controller is a complete digital control system for most common air handling configurations, including single zone, variable air volume, multi-zone, and dual duct. You may use the AHU as a standalone controller or connected to a FMS.

When connected to the FMS, the AHU provides all point and control information to the rest of the network. The devices communicate through an Opto-22® RS-485 N2 Bus.

Each AHU application uses a different sequence of operation, all of which are covered in the *HVAC PRO for Windows User's Manual (FAN 637.5* or *1637.5)*.

### Packaging

The AHU is available in the following packaging configurations:

- AHU103 in a triple UPM ( Universal Packaging Module) enclosure (EWC35) with special AHU door
- AHU102 individual controller board combined with the AHU100 individual termination board

Note: Johnson Controls Poteau Panel Unit facility can lay out, mount, and wire these enclosures to your requirements. Contact the Poteau Panel Unit at (918) 647-2195.

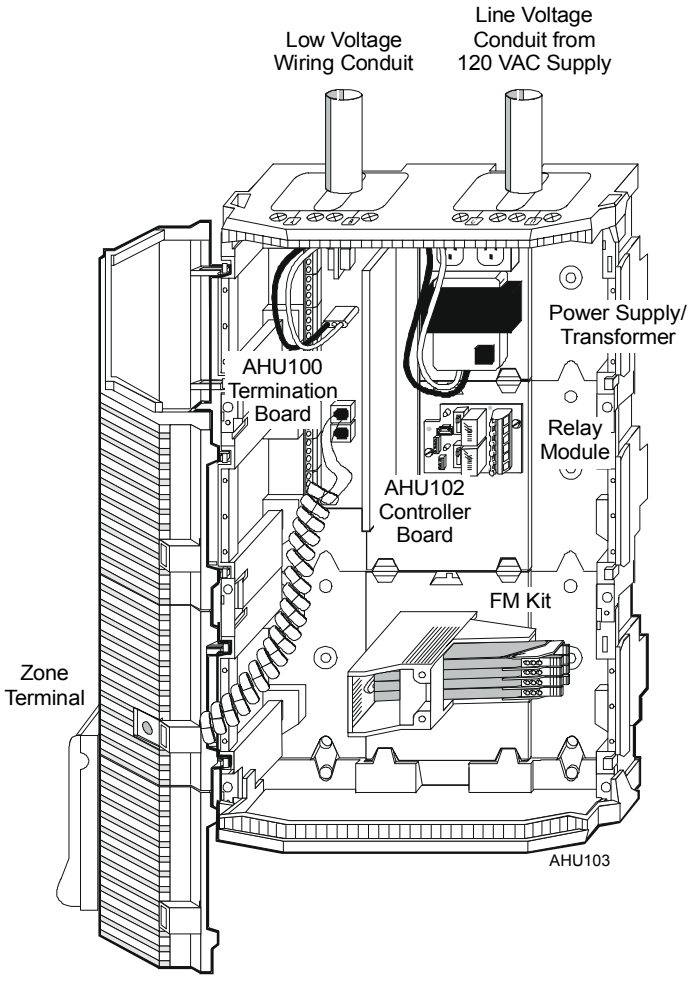



**Figure 1: AHU103 Example**

**AHU103**

The AHU103 consists of an AHU100-0 termination board, an AHU102 controller board, and a 92 VA transformer, packaged in a 3-high Universal Packaging Module (UPM). For details of the footprint and interior dimensions of the UPMs, refer to the *Universal Packaging Module Technical Bulletin (LIT-6363070)* in the *Metasys Applications Specific Controllers Technical Manual (FAN 636.3)* or *Universal Packaging Module Technical Bulletin (LIT-1628370)* in the *Facilitator Application Specific Controllers Technical Manual (FAN 1628.2)*. You can add UPMs to expand enclosure space. Refer to the *Ordering Information* section of this document for a listing of the appropriate part numbers.

## AHU Tower

The AHU Tower (Figure 26) configuration has been discontinued. For information about the tower configuration, refer to *Appendix A: AHU Tower* at the end of this document.

### Table 2: AHU Model Features

| Feature | AS-AHU103-300 or FA-AHU103-300 * |
|---|---|
| **Ambient Temperature Rating** | 0 to 50°C<br>(32 to 122°F) |
| **Analog Inputs** | 8<br>RTD temperature elements (1000 ohm nickel, platinum, or silicon)<br>2k ohm setpoint potentiometers<br>0 to 10 VDC or 0 to 2 VDC transmitters<br>0-20 mA |
| **Binary Inputs** | 8<br>Dry contacts<br>0 to 15 VDC<br>(2.5 VDC trigger) |
| **Analog Outputs** | 6<br>0/2 to 10 VDC, 0/4-20 mA |
| **Binary Outputs** | 10<br>24 VAC triacs switched<br>50-500 mA loads |
| **N2 Bus** | Isolated |
| **Zone Bus** | Discrete connections at controller<br>8-pin and 6-pin phone jacks on controller |
| **24 VAC Power Terminations** | J4 - 3-pin Molex to AS-XFR100 |
| **I/O Terminations** | Screw terminal (plug-in optional) |
| **N2 Terminations** | Fixed screw terminal block |

*AS indicates Metasys and FA indicates Facilitator.

## *Standards Compliance*

The AHU complies with the following standards:

- FCC Part 15, Subpart J, Class A
- IEEE 446, IEEE 472, IEEE 518
- IEEE 587 Category A/B
- UL 916 Safety
- UL 864 Smoke Control
- CSA C22.2 No. 205

# Installation Procedures

Application Specific Controllers (ASCs) are Direct Digital Controllers you configure for unique HVAC applications using HVAC PRO for Windows™. The type and number of components (sensors and actuators) selected for use with the AHU varies according to application. Analyze the proposed installation for logical location of these devices and draw up an inventory based on that study. Information on types of accessory devices is available in the *Ordering Information* section of this document.

## *Tools Needed*

Tools needed for a typical installation include:

- 1/4 inch bolts
- No. 8 Plastite™ screws [for maximum holding power of 90.7 kg (200 lb)].

  Note: No. 8 sheet metal screws, type A or AB are an alternative. However, these screws have a maximum holding power of 45.3 kg (100 lb).
- wrench and screwdriver appropriate to the bolt and screw heads
- Torx® screwdriver for T-20 recessed screws (needed for expanding the enclosure)
- drill

### Proximity

In the interest of efficiency, decide how close the AHU can be located to the air handling equipment—with adequate mounting surfaces, and reasonable access to installation and maintenance workers. Determining the location for the AHU depends on the existence of power sources and communication lines, and on which power sources and communication lines are to be used. The AHU must be secured to a solid wall and not to any vibrating surface.

Select a wall space or area with sufficient room to mount the enclosures and install conduits. The load-bearing capacity of the wall must be able to support the full configuration weight. Wood surfaces generally only require bolting the enclosure to the wall; dry wall surfaces require anchors for the bolts.

Due to the rigidity and strength of the molded plastic enclosure, the weight supported by an individual UPM section is probably higher than any application requirement. The pull-out value of the screw holes on the UPM backbone is 90.7 kg (200 lb). However, in securing a very heavy object, the best practice is to distribute the weight over a number of screws.

The weight resting on the bottom endcap must not exceed 22.6 kg (50 lb).

### Environment

The installation site of the AHU must meet the following environmental standards:

- The atmosphere must be free of explosive vapors or escaping gases.
- The atmosphere must be free of exposure to corrosive chemical or salt vapors that might damage electrical equipment.
- The temperature must be maintained between 0 to 50°C (32 to 122°F) with the relative humidity (non-condensing) maintained between 10 and 90 percent.
- The 120 VAC split-bobbin transformer (XFR) in the UPM provides transient immunity. Split-bobbin transformers have primary and secondary coils on separate, side-by-side bobbins. The power must be "clean" without electrical noise transients that are often present in industrial environments; otherwise, Metal Oxide Varistors (MOVs) must be added to the primary wires. Commercial and residential buildings typically have "clean" power, but may not, depending on the location, nearby equipment, etc. Refer to the *Power Line Wiring Transient Noise Precautions* section of this document.
- The UPM is for indoor use only. Avoid areas where water leakage may occur.

### *General Mounting*

The controller requires a mounting surface area to match its dimensions:

337.8 x 200.66 x 175.26 mm (13.3 x 7.9 x 6.9 in.)

Follow the steps below when mounting an enclosure:

1. Remove the cover (hinged on the left side) by opening it to a 90° angle and lifting it up and away.
2. Position the unit on the wall and mark the mounting slot location.
3. Drill a hole to accommodate a 1/4-inch bolt. Install the bolt, leaving 3/8 inch to 1/2 inch of thread exposed to hang the unit on.
4. Hang the backbone over the bolt. Plumb the box. Mark the appropriate mounting holes along the wiring channels.
5. Drill into the wall to accommodate the mounting holes (the units can be left in place or removed from the wall). Secure the unit with 1/4-inch bolts.
6. Mount the gear, using the No. 8 screws (seating torque should be 25 lb•in minimum) and replace the door.

### Window Expansion Kit

For those who want to monitor equipment such as gauges and LEDs (Light-Emitting Diodes), an optional full-window cover provides easy viewing while keeping the equipment securely locked away from unauthorized users. The Window Expansion Kit (EN-WIN101-0) includes a full-window cover, a backbone, and T-20 Torx screws (for fastening sections together).

### Expansion Kit Option

The Expansion Kit option provides additional storage capacity for equipment that does not need to be viewed. The Expansion Kit (EN-EXP101-0) includes a solid cover, a backbone, and T-20 Torx screws (for fastening sections together). You can order this kit to expand an existing enclosure at the job site or as part of an original configuration through the Johnson Controls Panel Unit.

### Adding Sections to Existing Units

You may add a backbone and cover to the bottom of an existing unit without having to rewire the original controls.

### Function Module Kit (AS-FMK102-0)

The Function Module Kit (FMK) provides the enclosure and termination board to connect up to four, single-slot function modules to the AHU. For more information on the use of the FMK, refer to the *Auxiliary Gear Technical Bulletin (LIT-6363080)* in *FAN 636.3* or *1628.2*.

### Relay Module (AS-RLY002-0)

The relay module is a self-contained relay device that provides an interface between the low voltage circuitry and line-voltage devices. Install the RLY in the desired location near the line-voltage wiring in the UPM. Position the RLY002 so the terminal for relay contacts is adjacent to the line-voltage wiring in the UPM. For more information on the use of the RLY, refer to the *Auxiliary Gear Technical Bulletin (LIT-6363080)* in *FAN 636.3* or *1628.2*.

### *Power Line Wiring Transient Noise Precautions*

The standard AHU, when powered by a split-bobbin transformer (XFR100) operates reliably in an electrical environment defined as Location Category "A" or "B" by the IEEE 587 Standard:

- IEEE 587 Location Category "A" power line surge/noise level is specified at 6 kV, 500 A (Ringwave).
- IEEE 587 Location Category "B" power line surge/noise level is specified at 6 kV, 3000 A (Ringwave and Exponential Wave).

For more information on noise prevention, refer to *Appendix A: Precautions for Rooftop Installations* section of the *Unitary (UNT) Controller Technical Bulletin* in *FAN 636.3* or *1628.2*.

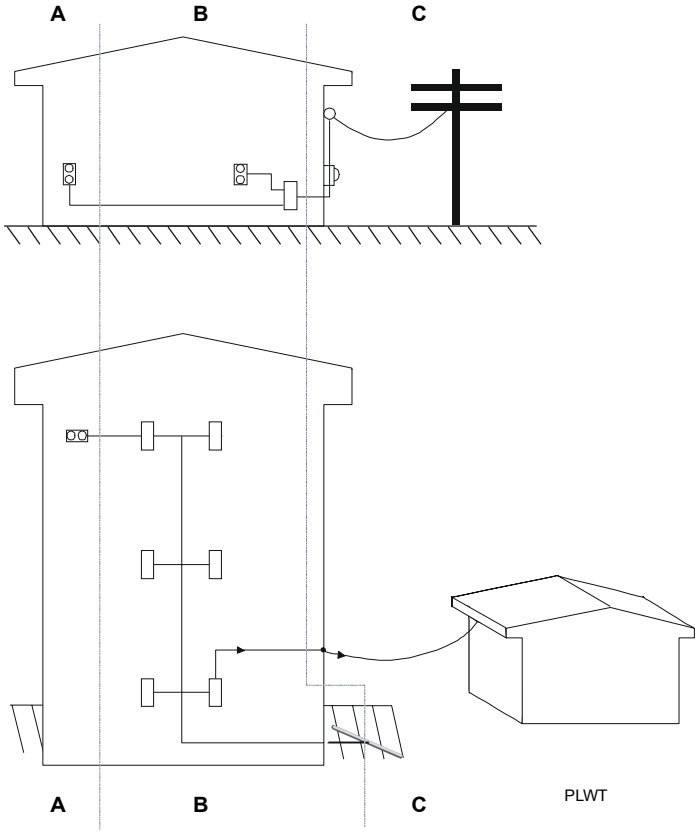



**Figure 2: Location Categories**

### *I/O and Communication Lines Wiring Transient Noise Precautions*

The I/O wiring and N2 Bus must be clean, without electrical noise transients from nearby lighting, heavy equipment switching, or inductive loads being driven. For more information on noise prevention, refer to *Appendix A: Precautions for Rooftop Installations* in the *Unitary (UNT) Controller Technical Bulletin* in *FAN 636.3* or *1628.2*.

In general, a proper AHU installation does not require a suppression device. If noise problems are encountered, 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-22-0 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). For more information, refer to the *N2 Communications Bus Technical Bulletin* in *FAN 636, 628.1*, or *1628.1*.

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 3, which were derived from Metal Oxide Varistors (MOVs).

**Table 3: Specifications for Suppression Devices (MOVs)**

| | Load Voltage | | | | |
|---|---|---|---|---|---|
| | **24 VAC** | **120 VAC** | **208-240 VAC** | **277 VAC** | **347 VAC** |
| **Minimum Continuous Voltage Rating** | 30 VRMS | 130-135 VRMS | 250-280 VRMS | 320 VRMS | 385 VRMS |
| **Minimum Energy Rating** | 8.5 Joules | 30 Joules | 55 Joules | 80 Joules | 85 Joules |
| **Minimum Peak Current (8 x 20 microsecond pulse)** | 1000 Amperes | 4000 Amperes | 4000 Amperes | 4000 Amperes | 4000 Amperes |
| **UL Recognized** | Optional | Required | Required | Required | Required |

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 AHU.

# Wiring Details

## *Overview*

You need to take special precautions and follow certain grounding procedures when installing the AHU.

> CAUTION: **Possible Equipment Damage or Electrical Shock.** To avoid damaging equipment or electrical shock, ensure that all power supplies to the system have been disconnected prior to wiring installation. The circuits used in the controller are static sensitive. Use static protection (anti-static mats and/or grounding straps) or touch conduit ground before touching circuit boards when working on or near internal circuitry.

Follow these precautions:

- Make all wiring connections in accordance with the National Electrical Code (NEC) as well as with local regulations.
- The N2 Bus and signal wiring must be a twisted pair due to electric field and magnetic coupling. Locate equipment and route the N2 Bus and signal wiring so they are separated from power wiring by a minimum of one foot (two is preferred). If power wiring is in a grounded steel conduit, then the AHU and N2 signal wiring can be placed next to the conduit.
- Do not run N2 Bus and field wiring in the same conduit as line-voltage wiring (30 VAC or higher) or near wiring that switches power to highly inductive loads (such as contactors, coils, motors, or generators).
- Make all wiring connections to the AHU using only copper conductors of 24 to 18 AWG.
- The N2 must be daisy-chained without "Y" or "T" connections unless N2 repeaters are used. Refer to the *ASC and N2 Bus Networking and Troubleshooting Guide Technical Bulletin* in *FAN 636.3* or *Controller and N2 Bus Networking and Troubleshooting Guide Technical Bulletin* in *FAN 1628.2*.
- Use the recommended suppression devices on inductive loads, such as V11 solenoids and contactors/starters.

- Isolate all commons on the controller from earth ground, including the 24 VAC power supply.
- Shielded cable is not required for field wiring, but when used, hard ground the shield at the UPM enclosure and tape it back at the sensor or contact.

**Power Box and Transformer Location**

The power box and transformer can be located in different areas of the enclosure, depending on the requirements of the other installed equipment. There are four discrete locations for the power box, designated as A, B, C, or D on the outside of the endcap of the UPM enclosure. The power box is generally located in Area C. Set the power box on the inside of the unit over two bosses corresponding to one of the locations; A, B, C, or D. Position the transformer to within 12.7 mm (1/2 inch) of the power box.

Note: You must reconnect the ground wires if you move the power box.

**Landing Conduit**

We recommend that you use a hole-punch bit, or Greenlee® punch when drilling conduit holes.

> CAUTION: **Equipment Damage Hazard.** Do not use a spade bit to drill conduit holes. Using a spade bit damages the ground plane.

***Top Entry***

There are four 3-inch by 3-inch areas designated A, B, C, or D on the outside of the endcap for conduit entry into the power box. After noting the location of the power box, drill or punch a hole in the selected area to land the conduit.

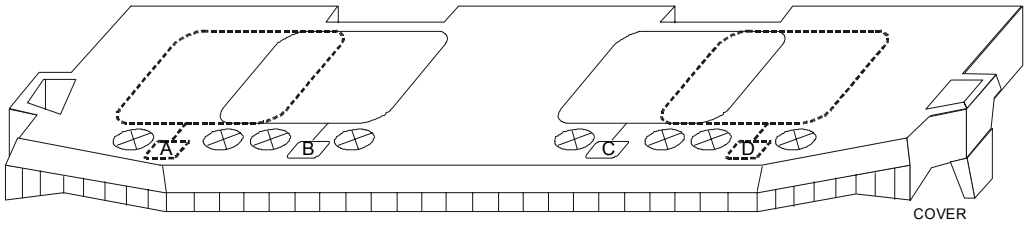



**Figure 3: Line-Voltage Conduit Entry from the Top of the Enclosure**

### *Side Entry*

A “guide” groove has been molded onto each side of the backbone section to help locate a drill point. Drill or punch a hole in the groove at the point that lines up with the conduit at the end of the enclosure.

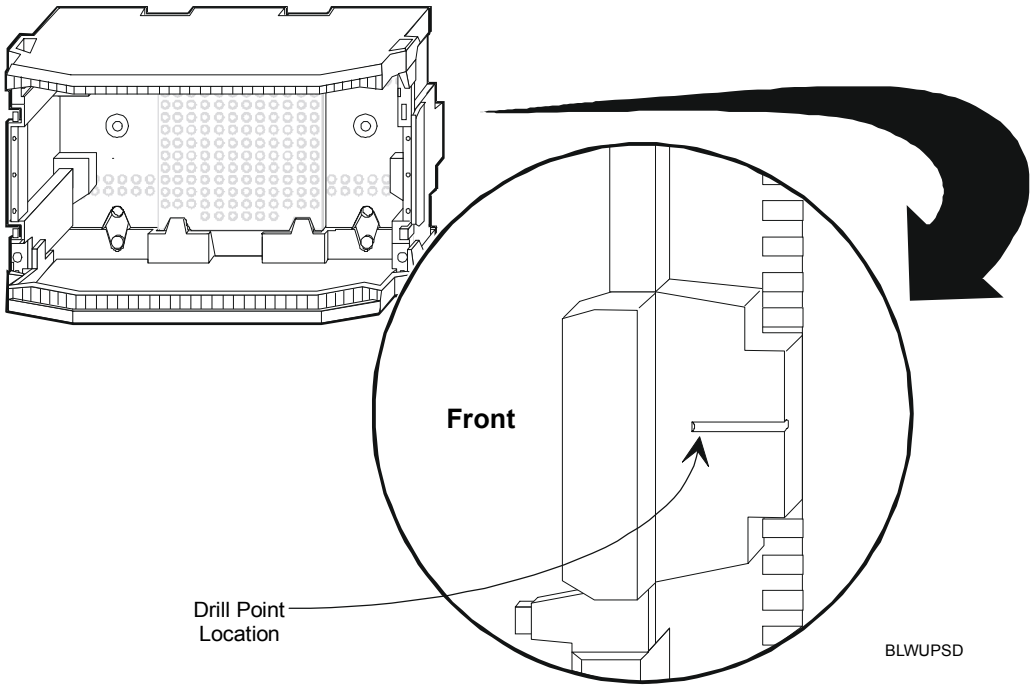



**Figure 4: Line-Voltage Conduit Entry from the Side**

**Power Connections**

Use wire nuts to connect the power source hot and neutral lines to the corresponding lines inside the power box. Use wire nuts to connect the **power source** ground wire to the green power box wire. This grounds the power outlets (which are internally connected to a ring terminal on the grounding screw). The **transformer** is already connected to the second ring terminal on the same grounding screw.

This connection completes the line-voltage wiring to the power outlets and the transformer. Internal connections to power outlets, switch, and ground are made at the factory. Switches control power to the transformer.

**Grounding and Bonding**

Installing the power box in any of the four designated positions locates one of the rear slots of the box over a grounding screw at the back of the endcap (each endcap has two grounding screws). The power box must be referenced (grounded) to a green-wire earth ground.

When bringing multiple conduits into one end of the enclosure, the standard conduit connectors automatically connect to the ground plane, grounding all conduits together. Attaching other devices to the opposite screw on the same endcap also grounds those devices via the aluminum ground plane.

To electrically bond the second endcap to the grounded endcap, attach a ground wire from the open screw of the power box endcap to either of the grounding screws of the second endcap.

**Table 4: Wire Selection Guide**

| **Incoming Service** | |
|---|---|
| **15 Ampere** | 14 AWG minimum (1.628 mm diameter) |
| **20 Ampere** | 12 AWG minimum (2.053 mm diameter) |
| **30 Ampere** | 10 AWG minimum (2.588 mm diameter) |

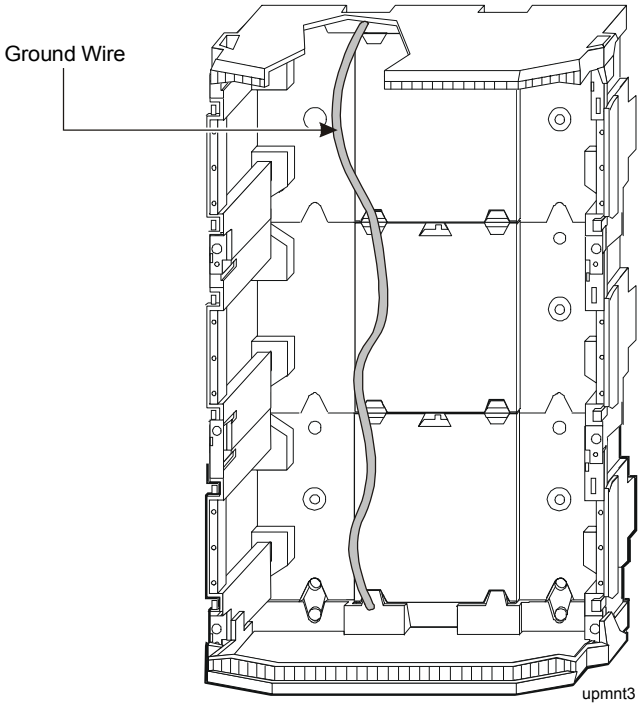



**Figure 5: Power and Grounding/Bonding Terminations**

WARNING: It is extremely important to separate line-voltage wiring and control/low voltage wiring and circuitry by a minimum of one inch. If this condition is not met, the installation may not comply with local code requirements.

### *Wiring the Termination Board (AS-AHU100-0)*

The AHU terminal designations that identify sensor and actuator connection points are illustrated below. Terminal functions are listed in Table 5. Use the HVAC PRO for Windows™ Configuration Tool to assign the inputs and outputs for a specific application.

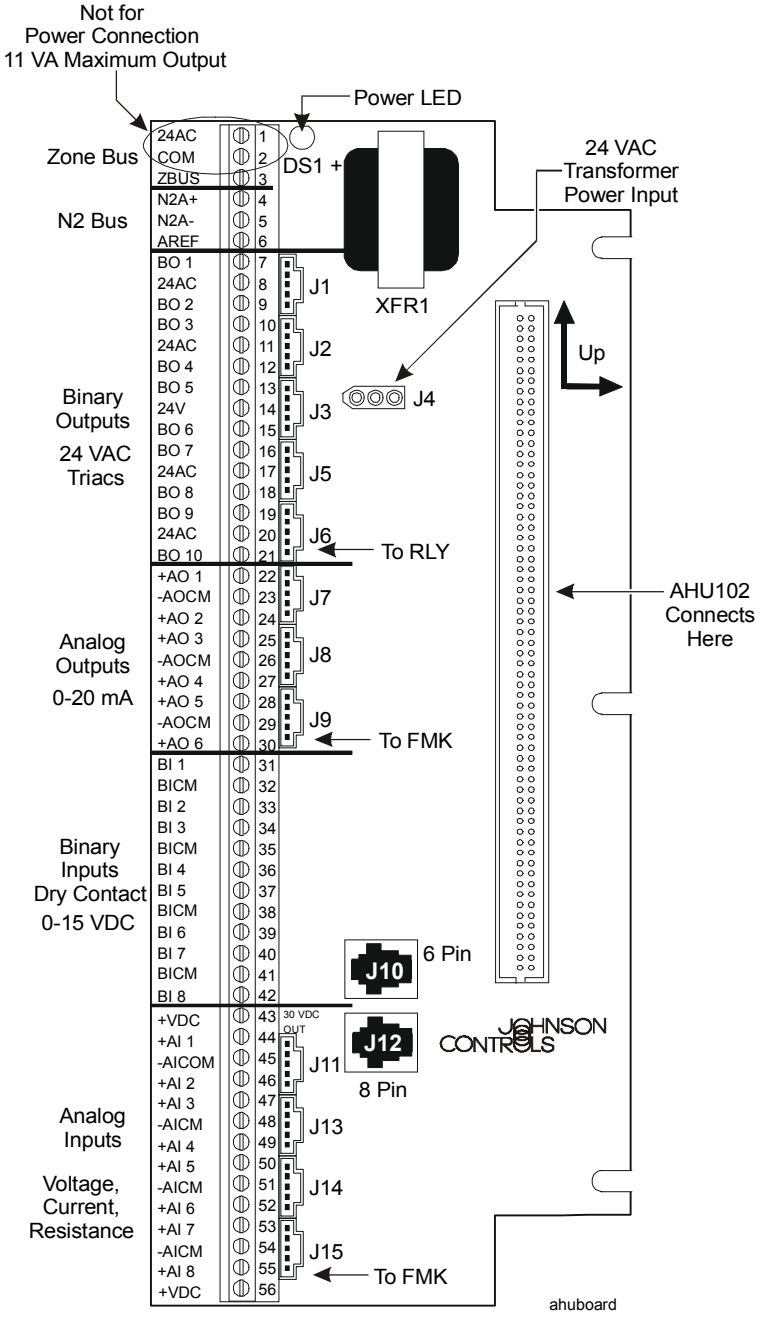



**Figure 6: AHU100 Terminal Assignments**

## Table 5: AHU100 Terminal Identification

| Terminal | No. | Description |
|---|---|---|
| **24 AC** | 1 | 24 VAC for Zone Bus Only |
| **COM** | 2 | Common |
| **ZBUS** | 3 | Zone Bus |
| **N2A+** | 4 | N2 Bus + |
| **N2A-** | 5 | N2 Bus - |
| **AREF** | 6 | N2 Reference |
| **BO 1** | 7 | Binary Output 1 |
| **24 AC** | 8 | 24 VAC |
| **BO 2** | 9 | Binary Output 2 |
| **BO 3** | 10 | Binary Output 3 |
| **24 AC** | 11 | 24 VAC |
| **BO 4** | 12 | Binary Output 4 |
| **BO5** | 13 | Binary Output 5 |
| **24 AC** | 14 | 24 VAC |
| **BO 6** | 15 | Binary Output 6 |
| **BO7** | 16 | Binary Output 7 |
| **24 AC** | 17 | 24 VAC |
| **BO 8** | 18 | Binary Output 8 |
| **BO 9** | 19 | Binary Output 9 |
| **24 AC** | 20 | 24 VAC |
| **BO 10** | 21 | Binary Output 10 |
| **+AO 1** | 22 | Analog Output 1 |
| **-AOCOM** | 23 | Analog Output Common |
| **+AO 2** | 24 | Analog Output 2 |
| **+AO 3** | 25 | Analog Output 3 |
| **-AOCOM** | 26 | Analog Output Common |
| **+AO 4** | 27 | Analog Output 4 |
| **+AO 5** | 28 | Analog Output 5 |

| Terminal | No. | Description |
|---|---|---|
| **-AOCOM** | 29 | Analog Output Common |
| **+AO 6** | 30 | Analog Output 6 |
| **BI 1** | 31 | Binary Input 1 |
| **BICM** | 32 | Binary Input Common |
| **BI 2** | 33 | Binary Input 2 |
| **BI 3** | 34 | Binary Input 3 |
| **BICM** | 35 | Binary Input Common |
| **BI 4** | 36 | Binary Input 4 |
| **BI 5** | 37 | Binary Input 5 |
| **BICM** | 38 | Binary Input Common |
| **BI 6** | 39 | Binary Input 6 |
| **BI 7** | 40 | Accumulator |
| **BICM** | 41 | Binary Input Common |
| **BI 8** | 42 | Accumulator |
| **+VDC** | 43 | + 30 VDC for Transducers |
| **+AI 1** | 44 | Analog Input 1 |
| **-AICOM** | 45 | Analog Input Common |
| **+AI 2** | 46 | Analog Input 2 |
| **+AI 3** | 47 | Analog Input 3 |
| **-AICOM** | 48 | Analog Input Common |
| **+AI 4** | 49 | Analog Input 4 |
| **+AI 5** | 50 | Analog Input 5 |
| **-AICOM** | 51 | Analog Input Common |
| **+AI 6** | 52 | Analog Input 6 |
| **+AI 7** | 53 | Analog Input 7 |
| **-AICOM** | 54 | Analog Input Common |
| **+AI 8** | 55 | Analog Input 8 |
| **+VDC** | 56 | + 30 VDC for Transducers |

Make connections to the AHU in one of two ways:

- either connect single wires to the individual screw terminals
- or, for Analog Inputs (AI), Analog Outputs (AO), and Binary Outputs (BO) within 36 inches of the controller, plug an AS-CBL100-0 Connector into the appropriate terminals between the controller and the relay enclosure, or function module kit.

### *Power and Zone Bus Connections*

24 VAC input to the AHU100 plugs into the Molex connector (J4). This connector has a built-in line filter. Do not connect power to screw Terminals 1 and 2. This is filtered power out to Zone Bus devices.

Zone Bus may be hard-wired to the AHU instead of using the phone jack as described later in this technical bulletin. Terminal 3 (Figure 6) links the controller with Zone Bus. The Zone Bus provides 24 VAC, Common, and ZBUS. Terminals 1 and 2 are limited to 11 VA at 24 VAC.

The AHU controls input/output devices on the Zone Bus (e.g., six Master M100C series motors with unlimited slaves), the ZT, and laptop.

### *Analog Inputs*

The eight Analog Input (AI) terminals, their power supply, and their common points occupy Positions 43 through 56 of the terminal strip. These inputs may be of three types: resistive, voltage, or current. The AHU102 Logic Board processes and controls the configured control strategy. It reads the analog inputs through the analog input jumpers located on the lower right of the board. The type of analog input is selected through these jumpers (Figure 8). Table 6 shows each configuration.

**Table 6: Jumper Configurations on AHU102**

| AI Type | Range |
|---|---|
| **Current (C)** | 0-20 mA, 4-20 mA |
| **Voltage (V)** | 0-10 VDC, 0-5 VDC, 1-5 VDC |
| **Resistance (T) Temperature** | 1,000 ohm Nickel, Platinum, or Silicon, 0-2K ohm potentiometer |

Note: The AHU constantly resets if the jumper setting is voltage (V) or temperature (T) and the input signal is current. To correct this condition, set the AI jumper to the "C" position for the current input channel.

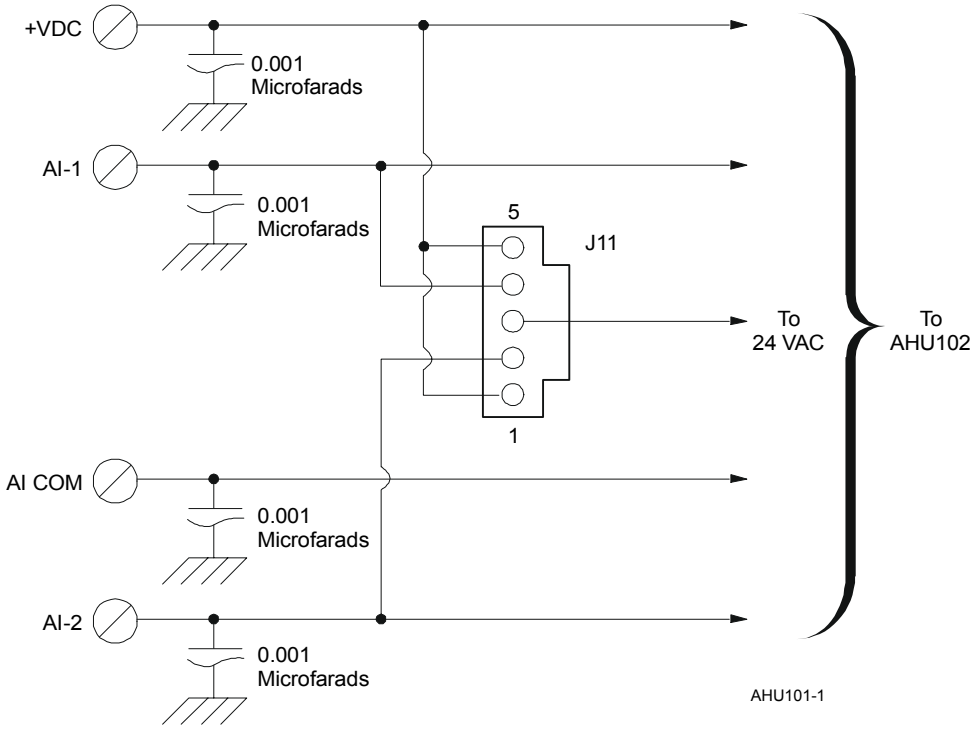



**Figure 7: AHU100 Analog Input Wiring Diagram for CBL100**

Figure 8 shows N2 hardware address switches and AI jumper positions. Use these switches to set the N2 Bus address. Boards without this switch must have the N2 address set through the HVAC PRO for Windows Configuration Tool.

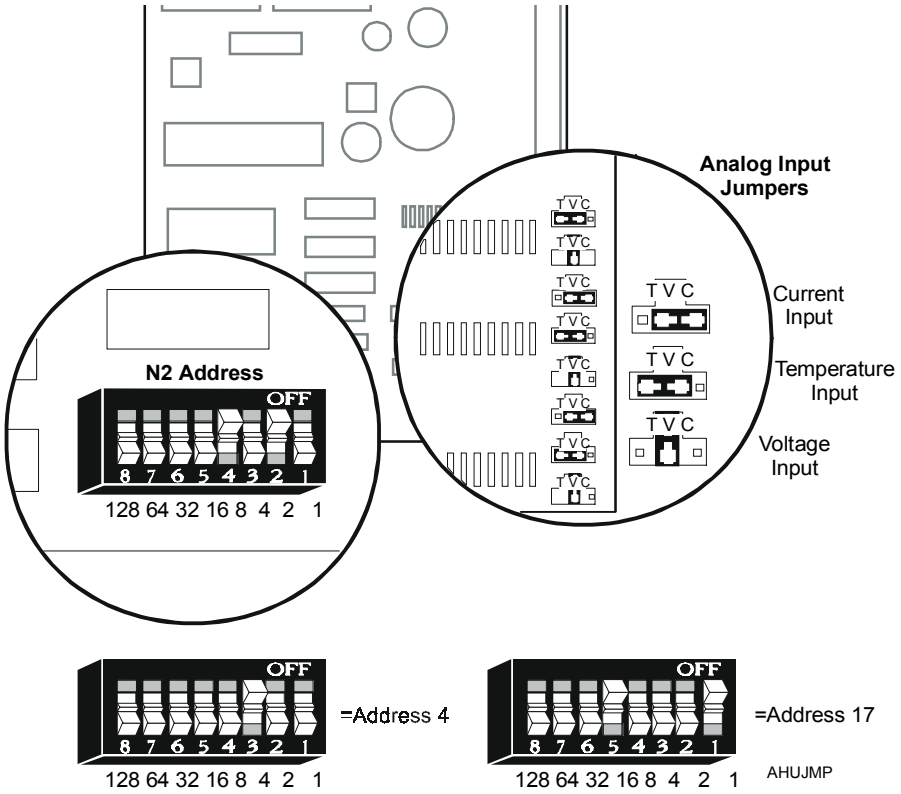



**Figure 8: N2 Address Switches**

### *Binary Inputs*

The eight Binary Input (BI) terminals and their common points occupy Positions 31 through 42 of the terminal strip. These inputs are of the dry contact type or 0 to 15 volt range with 2.5 VDC TTL thresholds.

### *Binary Outputs*

The ten Binary Output (BO) terminals and their 24 VAC points occupy Positions 7 through 21 of the terminal strip. Binary outputs are triacs on the controller hardware that can be directly connected to 24 VAC relays or solenoids. The binary outputs switch the common side of the power transformer (50 mA minimum to 500 mA maximum).

### *Analog Outputs*

The six Analog Output (AO) terminals and their common points occupy Positions 22 through 30 of the terminal strip. Analog outputs may be either a current (0/4 to 20 mA), or with a 499 ohm (1/2-watt) resistor, a voltage (0/2 to 10 VDC).

| IMPORTANT: | When connecting to Variable Frequency Drives, which are typically earth grounded, use 4-20 mA isolators. |
|---|---|

### Zone Bus

The Zone Bus allows you to connect an AS-CBLPRO-2 or the Zone Terminal to the AHU. With AS-CBLPRO-2 connected, use HVAC PRO for Windows for commissioning, downloading, and uploading. The Zone Bus is available for connections at a zone temperature sensor 6-pin and 8-pin phone jack.

### *Wiring the Zone Terminal*

For detailed information regarding wiring the Zone Terminal, refer to the *Zone Terminal Technical Bulletin (LIT-636014* or *LIT-1628330)* in *FAN 636.3* or *FAN 1628.2*.

### *Wiring Sensors*

Use 18 AWG (1.5 $mm^2$) twisted pair for all sensor and output wiring. Shielding is not required, but if used, earth ground the shield at the AS-XFR or the AS-RLY box. Use of 24 AWG (0.6 mm) wire may be desired in some applications; however, the recommended length of wire is reduced due to the resistance. To minimize sensor error caused by field wiring, the total resistive sensor wiring should be less than three ohms.

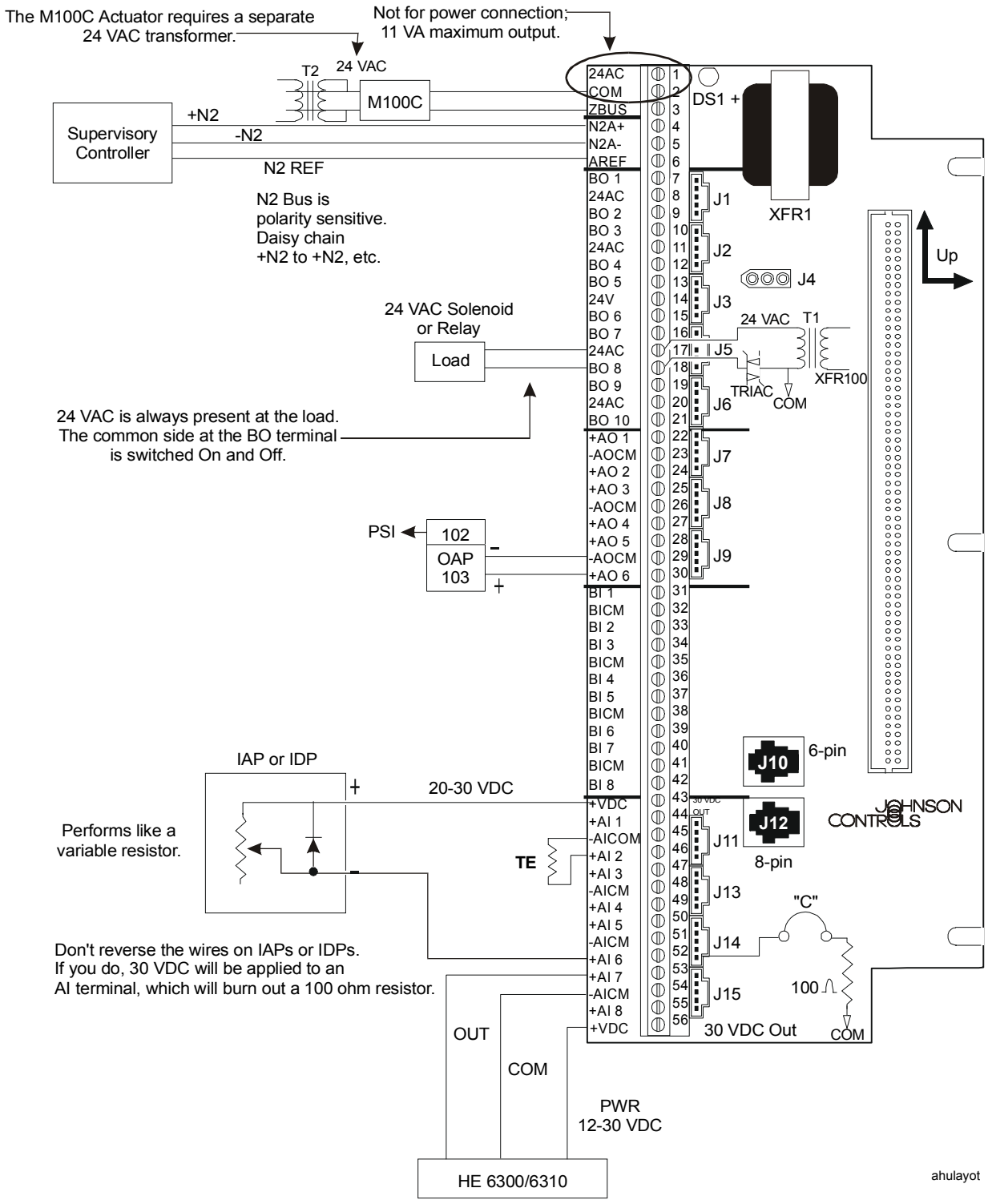



**Figure 9: Wiring Sensors**

CAUTION: **Possible Equipment Damage.** Do not run sensor wiring near line-voltage wiring.

### Table 7: ASC Wiring Guide

| Sensor Type | 18 AWG Wire Size Run Length in Meters (Feet) | 24 AWG Wire Size Run Length in Meters (Feet) |
|---|---|---|
| **AI Temperature (Resistive)** | 152.4 (500) | 30.5 (100) |
| **AI Voltage** | 152.4 (500) | 30.5 (100) |
| **AI Current** | 304.8 (1000) | 304.8 (1000) |
| **AO Voltage/Current (See note below.)** | 304.8 (1000) | 304.8 (1000) |
| **BI Voltage/Contact** | 152.4 (500) | 152.4 (500) |
| **Single BO at 0.1 ampere** | 152.4 (500) | 30.5 (100) |
| **Single BO at 0.5 ampere** | 30.5 (100) | 6.1 (20) |
| **Multiple BOs Using RLY100/050/002** | 152.4 (500) | 30.5 (100) |
| **Zone Bus** | 152.4 (500) | 15.2 (50) |
| **24 VAC Power (AS-XFR)** | 1.5 (5) | N/A |
| **20 VDC to 30 VDC Power Supply @ 160 mA (AHU only)** | 1000 (304.8) | 200 (61.0) |
| **15 VDC Power Supply @ 90 mA (VAV, UNT only)** | 1000 (304.8) | 200 (61.0) |
| **15 VDC Power Supply @ 200 mA (DX only)** | 1000 (304.8) | 200 (61.0) |

Note: For AO voltage, place resistor at the end of the line at the actuator or variable speed drive. Use a 499 ohm ± 1% 1/2-watt resistor for 0-10 VDC, or a 249 ohm ± 1% 1/2-watt resistor for 0-5 VDC.

## Humidity Sensor Connection

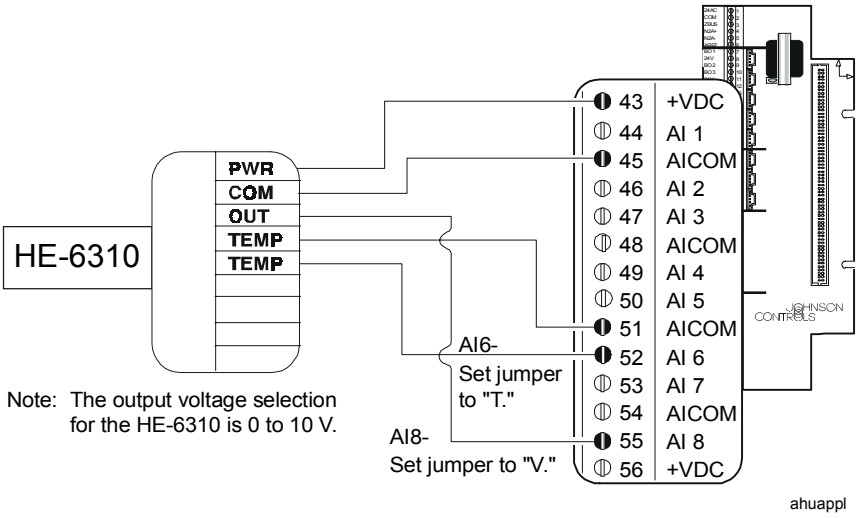



**Figure 10: Example of HE-6310 Humidity Sensor Connection to AHU**

To connect a humidity sensor:

1. Set the analog input jumper on the ASC Controller Board to V (voltage) for the humidity input. Set the temperature input to T (temperature).
2. Enter the range of the humidity sensor through HVAC PRO for Windows software (0 to 10 VDC is equal to 0-100% RH).

**Screw Terminal TE-6400 Temperature Sensor**

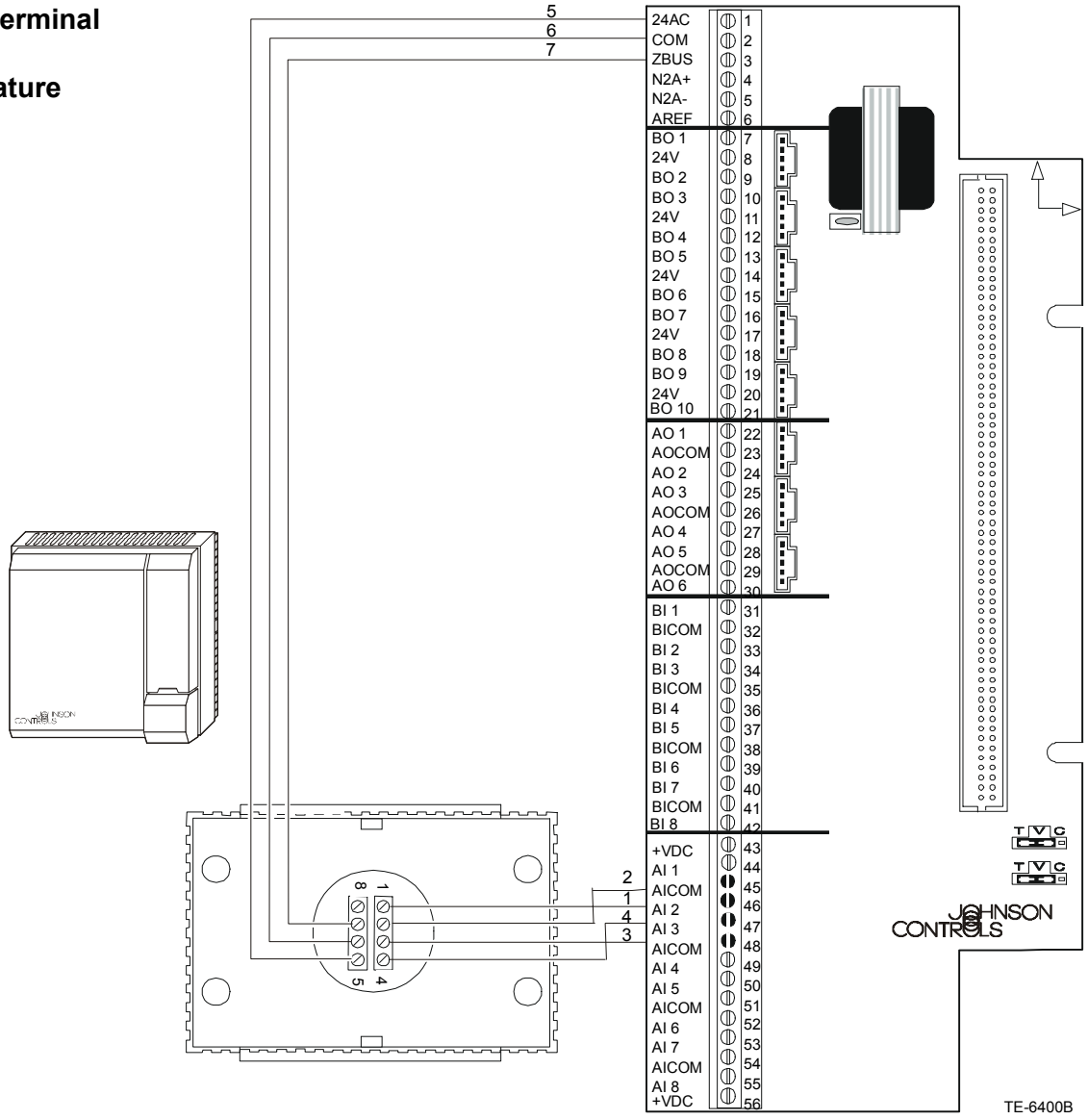



**Figure 11: TE-6400 Screw Terminals**

## Sharing a Sensor

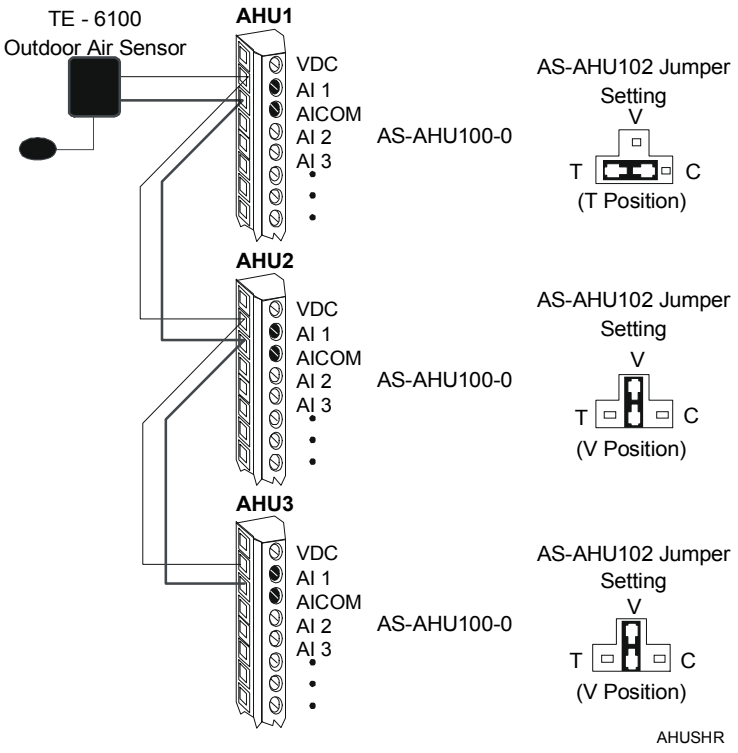



**Figure 12: Example of Sharing a Resistive Sensor Among AHU Controllers**

To share a single resistive sensor among multiple AHU Controllers:

1. Set the AHU102 analog input jumper located closest to the sensor to the T position.
2. Set all other AHU102 analog input jumpers to the V position.
3. Scale all inputs as a resistive temperature in each configuration of HVAC PRO for Windows.

Note: The maximum total wiring length is limited to 500 feet when using 18 AWG wire. There is a 1.5°F span error for each additional controller. The example illustrated in Figure 22 would have a 3°F error at the upper end of the sensor range.

| | |
|---|---|
| IMPORTANT: | If the master zone sensor uses the Zone Bus connection, only the master controller can be loaded and commissioned from the sensor connection. |

The AI offset feature in HVAC PRO for Windows can adjust the midpoint by 1°F at each AI to compensate for each additional controller sharing a sensor. For example, for two AHUs on one temperature sensor, the span shifts down by 1.5°F at 250°F, but only 0.5°F at -50°F for both controllers. An HVAC PRO for Windows offset of 1°F splits the error.

### *Wiring Actuators*

For detailed information regarding wiring actuators to the AHU, refer to the *Auxiliary Gear Technical Bulletin (LIT-6363080)* in *FAN 636.3* or *1618.2*.

### *Phone Jack Configuration*

Figure 13 illustrates the polarization of the 6-pin and 8-pin phone jacks on the AHU. Terminal 1 is to the extreme left as you face the jack opening, tab notch down.

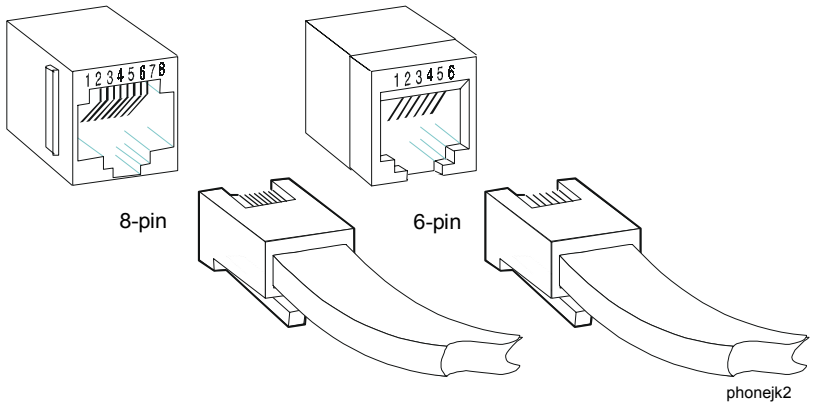



**Figure 13: Phone Jack Polarization**

Table 8 defines the pin usage for each jack.

Note: Phone jack terminals are hardware defined and cannot be changed through HVAC PRO for Windows.

**Table 8: Phone Jack Pin Identification**

| 8-pin Jack (AHU to TE-6400) | | 6-pin Jack (AS-CBLPRO-2 or Zone Terminal to Temperature Sensor) | |
|---|---|---|---|
| **Pin** | **Signal** | **Pin** | **Signal** |
| **1** | AI 8 Heating Setpoint | **1** | Not Used |
| **2** | AI 7 Cooling/Single Setpoint | **2** | 24 VAC |
| **3** | AI 4 Zone Temperature Sensor | **3** | 24 VAC and Zone Bus Common |
| **4** | Sensor Common | **4** | Not Used |
| **5** | 24 VAC | **5** | Zone Bus |
| **6** | 24 VAC and Zone Bus Common | **6** | Not Used |
| **7** | Setpoint Common | | |
| **8** | Zone Bus | | |

### *Remote Setpoint*

| | |
|---|---|
| IMPORTANT: | HVAC PRO for Windows defines the AHU remote setpoint path as AI8. This point must be moved to AI7 in the Analog Input Modify screen. |

### Fabricating an Interconnection Cable

You must construct any fabricated interconnection cable so the same color wire on both ends of the cable aligns with Pin 1 in the plug. This provides a consistent field assembly of the cable. Figure 14 illustrates the interconnection cable.

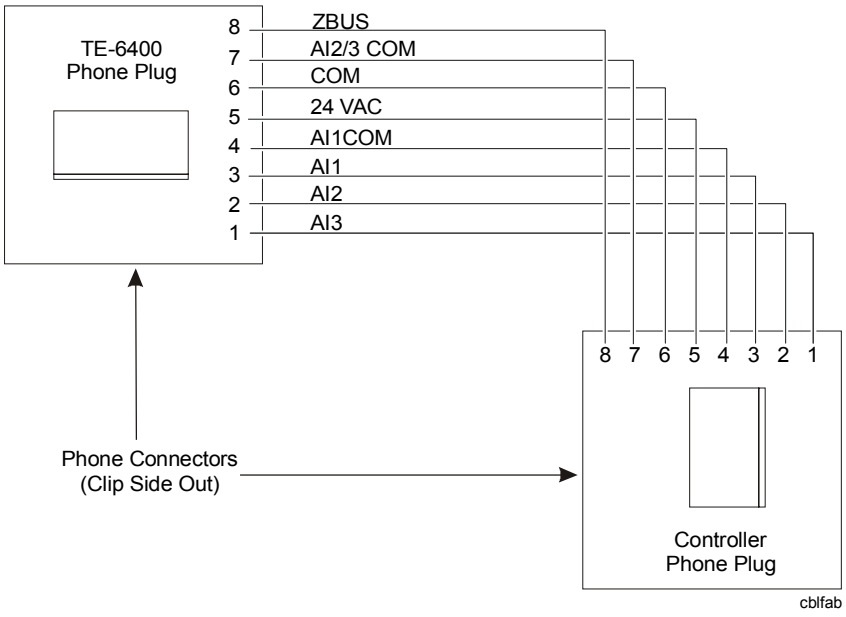



**Figure 14: Interconnection Cable**

Note: This is not typical of a pre-assembled phone cable purchased in retail stores. A telephone system cable is wired opposite the zone sensor requirements.

For information on cables, refer to the *Vendor Code Numbers* section in this technical bulletin.

# Networking the Controller

### *N2 Bus Characteristics*

When installed in an FMS Network, the AHU receives commands from the Network Control Module (NCM) or Companion/Facilitator on the N2 Bus and transmits status reports in return. The number of controllers on the N2 Bus is a database memory issue at the NCM, Companion, or Facilitator. Refer to the database generation documents in the *Metasys Companion Technical Manual (FAN 628.1),* or *Facilitator FMS Technical Manual (FAN 1628.1),* or *Metasys Network Technical Manual (FAN 636.0)* to determine practical limitations to the number of controllers on the N2 Bus.

The AHU N2 Bus connections are electrically isolated from other controller's circuitry to 500V by optical and magnetic coupling. An important feature of the AHU's N2 Bus is opto-isolation. Isolation on all three wires prevents interruption of all N2 Bus communication if any of the controllers on the bus become grounded.

The AHUs 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 less than 30 VDC/VAC between any two of the three N2 Bus terminals. 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 AHUs. For more detailed information about the N2 Bus, refer to the *N2 Communications Bus Technical Bulletin* in *FAN 636, 628.1,* or *1628.1*.

For more information on noise prevention, refer to *Appendix A: Precautions for Rooftop Installations* in the *Unitary (UNT) Controller Technical Bulletin* in *FAN 636.3* or *1628.2*.

Note: Do not run N2 Bus wiring in the same conduits as line-voltage wiring (30 VAC or above) or wiring that switches power to highly inductive loads (such as contactors, coils, motors, or generators).

### N2 Bus Capacity

You can connect up to 50 N2 devices (of which the AHU is one type) to one N2 Bus with a wiring run of up to 1,524 m (5,000 ft). Extending the N2 Bus capacity beyond 50 N2 devices, or the wiring run beyond 1,524 m (5,000 ft), requires the use of a bus repeater. Maximum wire length for an N2 network is 4,572 m (15,000 ft) with two repeaters. The N2 Bus is a daisy-chain system in which N2 devices can be connected to the Network Control Module (NCM), Companion, or Facilitator.

### 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 4572 m (15,000 ft) with two repeaters.

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

### N2 Earth Grounds

None of the wires on an AHU can be earth grounded, since it affects the noise immunity. When connecting to Variable Frequency Drives, which are typically earth grounded, use 4-20 mA analog output isolators.

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 Personal Computer (PC) power cord or via a printer connected to the computer, which in turn connects to the MM-CVT101. The Companion PC 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 AS-CBLPRO-0 or -1 only. If the laptop PC is earth grounded, the AS-CBLPRO-0 or -1 is grounded through the RS-232 common pin.

### End of Line

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

### *Installing the N2 Bus*

Set the N2 address and test for N2 voltage, polarity, and isolation before actually wiring the AHU Controller for operation. Refer to the *ASC and N2 Bus Networking and Troubleshooting Guide Technical Bulletin* in *FAN 636.3* or *Controller and N2 Bus Networking and Troubleshooting Guide Technical Bulletin* in *FAN 1628.2* for more information.

### *Setting the N2 Address*

The switches located on the AHU are set to the same number as was assigned to the module through software. The FMS uses this address for polling and commanding. The numbers are in binary format and vertically arranged with the least significant digit to the right.

When setting the N2 Address, do not use address "0" which is an unavailable address, or "255" which is reserved for the Ethernet router on a Metasys Network.

| | |
|---|---|
| IMPORTANT: | If a Variable Air Volume Modular Assembly (VMA) exists on the N2 Network, do not use address "254." Address 254 is reserved in the VMA as a broadcast address that is used during code downloads from HVAC PRO for Windows. This allows multiple VMAs to receive the code download. |

### *N2 Wiring to the Network Control Module*

A hardware connection between the N2 Communications Bus and the NCM or Companion is required if the FMS is to communicate with N2 devices. Refer to Figure 15 for terminal locations and to the *N2 Communications Bus Technical Bulletin* in *FAN 636, 628.1,* or *1628.1* for termination and wiring restrictions.

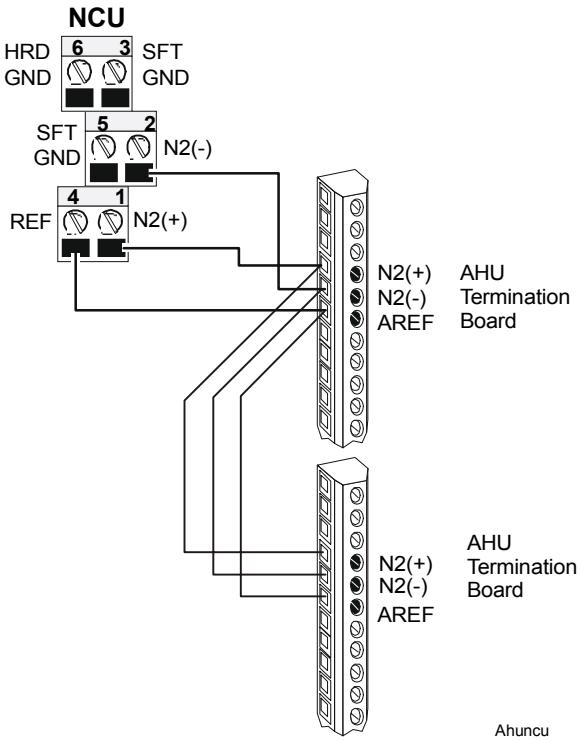



**Figure 15: Connecting the AHU to Metasys**

### *N2 Wiring to Companion or Facilitator*

A hardware connection between the N2 Communications Bus and the FMS is required to service N2 devices. A MM-CVT101-0 Communications Converter is required to network the PC Version Companion/Facilitator. Refer to Figure 16 for terminal locations. Refer to the *Auxiliary Gear Technical Bulletin (LIT-6363080)* in *FAN 636.3* or *1628.2* for information specific to the MM-CVT101-0.

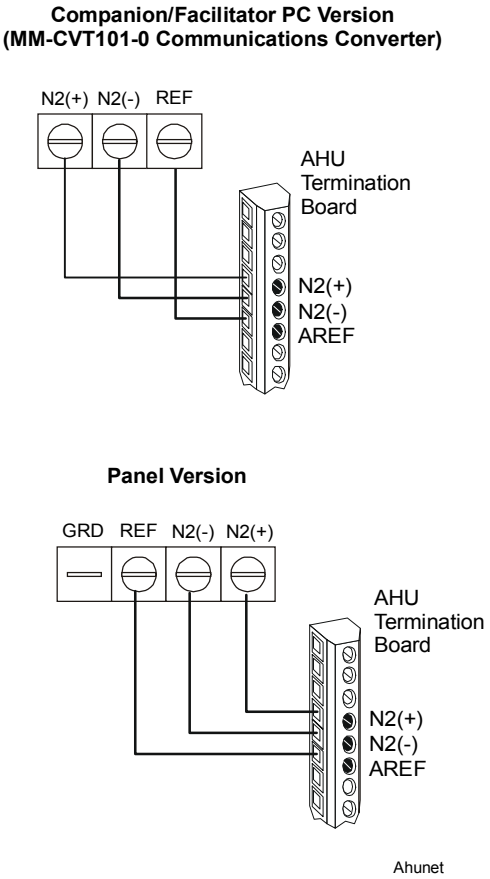



**Figure 16: Connecting the AHU to Companion/Facilitator**

### *Zone Bus Description*

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

To communicate with the AHU Zone Bus, each M100 Actuator must be equipped with an R81CAA-2 interface board. Refer to the *Auxiliary Gear Technical Bulletin* in *FAN 636.3* or *1628.2* for more information.

M100 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 9: Zone Bus Specifications**

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

# Downloading/Commissioning

### *Overview*

Commissioning an AHU 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 for Windows User's Manual* in *FAN 637.5* or *1637.5* for complete controller configuration information. A laptop PC with Configuration Tools is required to perform a complete system startup procedure.

### *Via Zone Bus*

Downloading and commissioning via the Zone Bus requires the use of the AS-CBLPRO-2 interface and a laptop or PC running the HVAC PRO for Windows software. Communication rate is 1200 baud over the Zone Bus.

### *Via N2 Bus*

HVAC PRO for Windows allows you to perform downloading and commissioning over the N2 Bus using a MM-CVT101-0 converter. Because the communication rate is 9600 baud, performing downloading and commissioning over the N2 Bus saves a great deal of time in loading the initial controller configuration files and parameters into the controller.

### *AHU Firmware*

In AHUs with firmware revisions C05 or older, some large configurations may overflow the amount of configuration space in the AHU memory. If an early DOS version of HVAC PRO™ is being used, the problem results in the AHU continually resetting after the download. If using HVAC PRO for Windows Release 5.1 or newer, a message appears stating that there is a configuration data overflow.

The C06 or newer firmware revisions to the AHU void this situation.

# Troubleshooting

## Checking the Installation

Inspect the mounted AHU to ensure proper installation. Refer to the appropriate illustrations in the *Installation Procedures* section, or *Appendix A: AHU Tower* of this document, or to the engineering drawings supplied for the individual site.

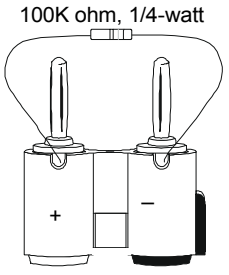
- Verify that the controller terminal connections are secure.
- Verify that the N2 connections are secure and labeled correctly.
- Verify that the AHU switches and jumpers are appropriately positioned. Refer to the section of this document titled *Wiring the Termination Board (AS-AHU100)*.

> CAUTION: **Equipment Damage Hazard.** Before starting, make sure power is switched off.

## Tools Needed

Tools needed for typical troubleshooting include:

- *ASC and N2 Networking and Troubleshooting Guide Technical Bulletin* in *FAN 636.3* or *Controller and N2 Bus Networking and Troubleshooting Guide Technical Bulletin* in *FAN 1628.2*
- Digital Multimeter (DMM)
- 100K ohm 1/4-watt resistor
- double banana plug (optional; shown in Figure 17; available from local electronics store or ITT Pomona Stock No. 34F856 or 34F845), for earth ground voltage tests




Use double banana plug for all tests that require a 100K ohm resistor placed in parallel with DMM.
Steps:
1. Connect 100K ohm resistor under plug's prongs.
2. Insert banana plug into DMM.
3. Connect leads of DMM into banana plug.

banana

**Figure 17: Double Banana Plug Used with 100K Ohm Resistor**

### Testing for Ground Loops

The AHU should be isolated from earth ground. A single earth ground occurs whenever you plug a 120 VAC powered laptop into the Zone Bus. This reduces the noise immunity of the circuitry, but is only temporary during commissioning.

Use a digital multimeter with a 100K ohm resistor across its inputs and measure the voltage from the +30 VDC terminal of the AHU to earth ground.

If you read less than 5 VDC/VAC, no ground loop exists. Testing is complete.

If you read 5 VDC/VAC or greater, the circuit is improperly isolated.

Note: Binary outputs or analog outputs to variable speed drives are often the source of ground loops. Therefore, we recommend that you test these before testing other points.

Follow these steps:

1. Remove all the field wires and Zone Bus wires from the AHU, 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 AHU or install a 24 VAC to 24 VAC 92 VA isolation transformer.
2. With the DMM 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 by using an isolator for 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.

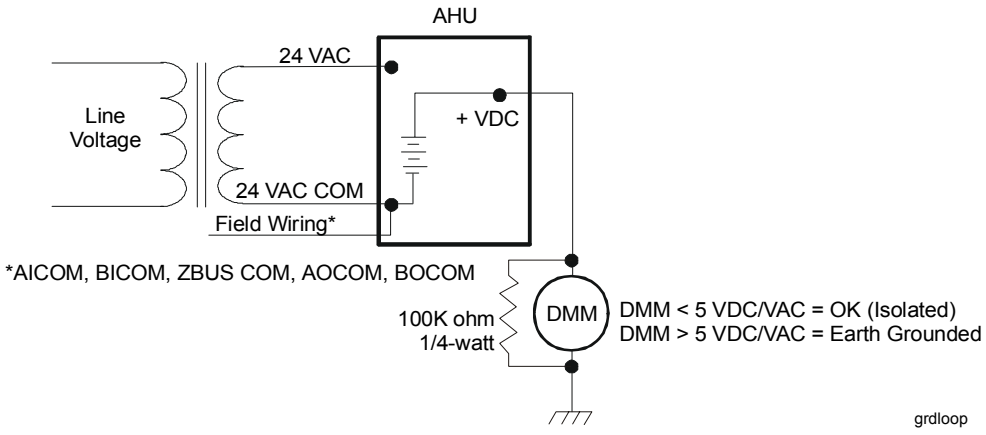



**Figure 18: Testing for Ground Loops**

## *HVAC PRO for Windows*

### Power Up Self-Test LED Sequence

The AHU runs through a series of self-tests when you first turn it on. The LEDs on the controller indicate the progress of the test sequence.

1. Both blink--power up initialization (AHU is resetting).
2. Top off and bottom on--running RAM, $E^2$PROM, and ROM diagnostics.
3. Both on--diagnostics complete.
4. Normal operation begins. (Refer to Tables 10 and 11.)

### Normal LED Operation

Table 10 and Table 11 describes the LED operations that may occur while using the HVAC PRO for Windows Commissioning Tool with the AHU over the Zone Bus. The cause of the error is often a loose or improper connection between the AS-CBLPRO-2, 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 an AHU to reset and resume communication after being downloaded.

**Table 10: Zone Bus LEDs**

| LED Operation | Description |
|---|---|
| **One Blink per Second** | One way communication. |
| **Two Blinks per Second** | Two way communication to M100Cs, a ZT, or HVAC PRO for Windows. |

**Table 11: N2 LEDs**

| LED Operation | Description |
|---|---|
| **No Blink** | No N2 Bus Communication. |
| **One Blink per Second** | N2 Bus is active but the controller is not mapped into the FMS. |
| **Two Blinks per Second** | Two way communication to the AHU. Controller is mapped into FMS. |

An effective troubleshooting technique is to use a CBLCON and observe its LEDs, which will indicate the problem. For more detailed information on the use of the CBLCON, please refer to the *Auxiliary Gear Technical Bulletin* in *FAN 636.3* or *1628.2*. 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 causing sporadic communication failures between the laptop and the AHU. Most often, noisy lines cause intermittent disruption, not total loss of communication.

For more information on the HVAC PRO for Windows, refer to the *HVAC PRO for Windows User's Manual*, *FAN 637.5* or *1637.5*.

**Table 12: Communication Errors on HVAC PRO for Windows Download or Commissioning**

| Error Message | Description | Solution |
|---|---|---|
| **Error 1**<br>**Undefined Command** | The device is being sent a message that contains an invalid command. | Check for missing N2 wire or tight and proper connections between the laptop PC, AS-CBLPRO-2, and the AHU. |
| **Error 5**<br>**Invalid Message Size** | The size of the message sent does not correspond to the type of message sent. | Try a different AS-CBLPRO-2 or use a CVT on the N2 Bus. |
| **Error 11**<br>**Invalid Command** | The command issued is not valid for the data type. | Check for tight and proper connections between the laptop PC, AS-CBLPRO-2, and the AHU. |
| **Error 14**<br>**Not Ready** | The AHU cannot process this message at this time. For example, the EEPROM is not functioning properly. | Cycle power on the AHU.<br>If problem persists, return AHU for repair or replacement. |
| **Error 15**<br>**Bad $E^2$ Write** | The AHU detected a problem with the EEPROM. | Return the AHU for repair or replacement. |
| **Error 16**<br>**No Communication** | Some hardware problem exists, such as a loose connection or a failed component. | Check for missing N2 wire or tight and proper connections between the laptop PC, AS-CBLPRO-2, and the AHU. |
| | 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. |
| **Error 17**<br>**Bad CRC** | 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, AS-CBLPRO-2, and the AHU. |
| **Error 18**<br>**InvalidResponse** | The message received is not what the HVAC PRO for Windows Load utility expected. | Check for tight and proper connections between the laptop PC, AS-CBLPRO-2, and the AHU. |
| **AI jumper improperly set to the "T" or "V" position.** | The power up sequence constantly repeats on the AHU. | Reset the AI jumper into the proper "C" position. |
| | Voltage to the AIs is greater than 10.3 VDC or less than -0.7 VDC. | Fix the voltage level. |

## *N2 Bus Overview*

You need to troubleshoot the N2 Bus if the FMS system is not properly communicating with the AHUs. Table 13 covers many AHU or N2 communication problems and suggests which actions to take.

**Table 13: N2 Bus Troubleshooting**

| Symptom | Possible Cause | Action |
|---|---|---|
| **AHU does not come online.** | Two or more AHUs have the same address. | Change each duplicate AHU address to a unique number. |
| | The address of the AHU was changed without its power being cycled afterward. | Cycle power on the AHU. |
| | The ten-minute delay after downloading the AHU has not yet expired (HVAC PRO Revision 1.0 or earlier). | Wait until the delay expires or cycle power on the AHU. |
| | A voltage greater than 10 VDC is on one of the Ais. | Jumper the AI to the "C" position for current. |
| **AHU cycles online and offline.** | A read-only point is defined in the Companion database 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 database. |
| **N2 Bus is offline.** | EOL jumpers and/or W3 jumper on MM-CVT101 or Companion Panel/*LTD* are not installed. | Install EOL jumpers and jumper W3 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. |

Before testing the N2 Bus, 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 AHU?
- Is the N2 polarity correct?
- Is the AHU powered and ready to respond?
- Are the end-of-line device settings correct on the NCM?
- Have you cycled power on an AHU after changing its address?
- Is the W3 loop back jumper on the Companion/Facilitator Panel/*LTD* fully pushed down on Pins 1 and 2?
- Are the AHUs configured properly with the correct number of points?
- Are there any ground loops as indicated by the +VDC test to earth ground?

CAUTION: **Possible electrical shock.** When troubleshooting, always measure the N2 REF to earth ground voltage with the Digital Multimeter (DMM). If line-voltage is measured, have a qualified electrician locate the fault.

## *Testing the N2 Bus*

You can use one of two methods to troubleshoot the N2 Bus. Both of these methods are 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 19:

1. If you have a Companion/Facilitator 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/Facilitator Panel/*LTD* Version or NCM, make sure the Panel/*LTD* is powered with 24 VAC and the NCM has 120 VAC. To avoid voltage fluctuation on the DMM, disable communications by selecting all N2 devices then performing a COMMDISABLE or by connecting a CVT in place of the NCM or Panel/*LTD*.

2. Connect the DMM across the N2+ and REF screws on the N2 terminal block. 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 19 shows the **same** test performed on three different terminal blocks.

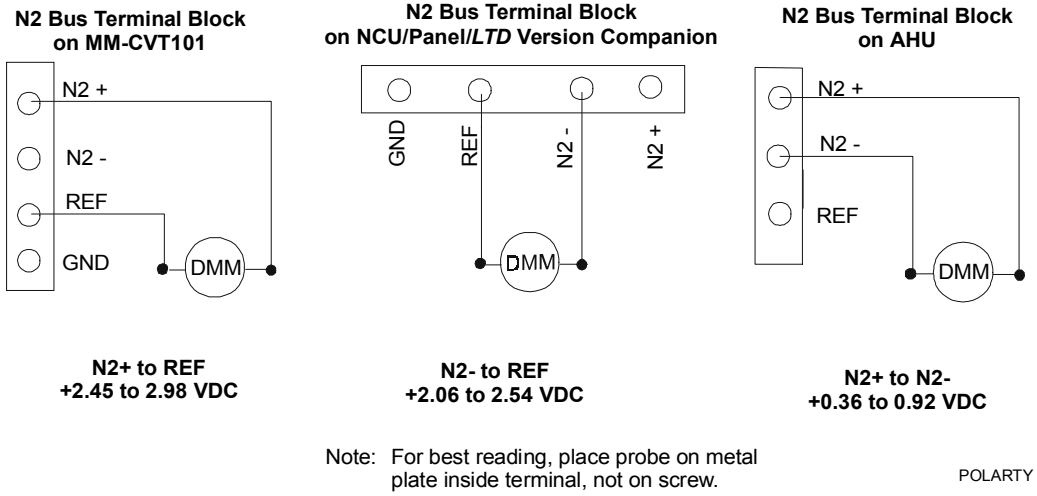



**Figure 19: Test for N2 Bus Shorts, Crossed Wires, and Grounds**

### Test 2: Using the Oscilloscope

You can use an oscilloscope to pinpoint communication faults over the N2 Bus. Refer to the *ASC and N2 Bus Networking and Troubleshooting Guide Technical Bulletin* in *FAN 636.3* or *Controller and N2 Bus Networking and Troubleshooting Guide Technical Bulletin* in *FAN 1628.2* for specific oscilloscope testing instructions.

# Configuring the Controller

### *Using HVAC PRO for Windows Configuration Tool*

You configure the AHU with a software program called HVAC PRO for Windows. This easy-to-use tool configures, commissions, and downloads the AHU's database. Figure 20 illustrates the HVAC PRO for Windows configuration process. Refer to the *HVAC PRO for Windows User's Manual (FAN 637.5* or *1637.5)* for specific information when configuring the AHU.

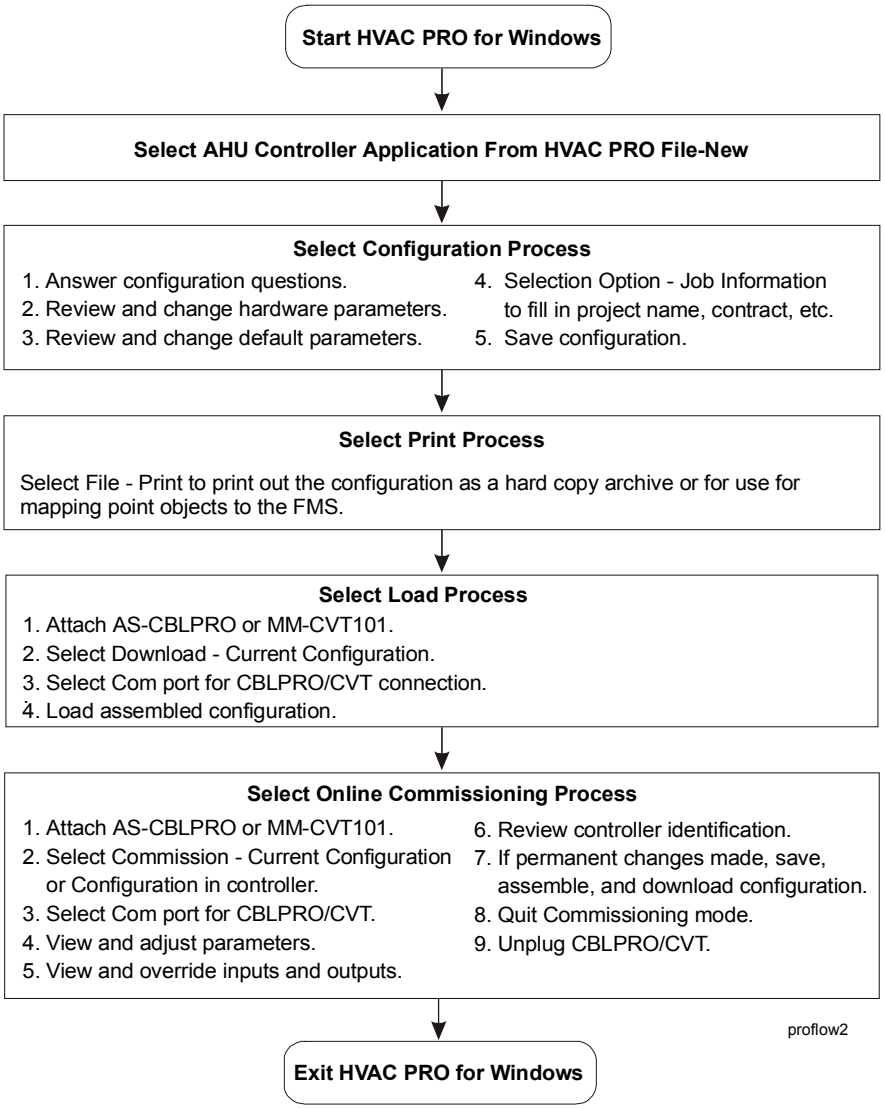



**Figure 20: Overview--Configuring an AHU**

Note: You can load and commission the controller either locally with the AS-CBLPRO-2 interface at the zone sensor or from a central location where the N2 has been pulled, controller's field hardware addressed, and an MM-CVT101-0 interfaced to the laptop.

### *Defining an AHU Control Device Object in Metasys Software*

Using a Metasys Network Control Module (NCM), you need to define an AHU Controller device object by entering data into the Attribute menu as seen on the Operator Workstation.

1. Go to the Network Map.
2. Double-click the system name in which you want to add the new AHU object.
3. Click New in the Item pull-down menu.
4. Click on Type: N2 devices in the Item New dialog box.

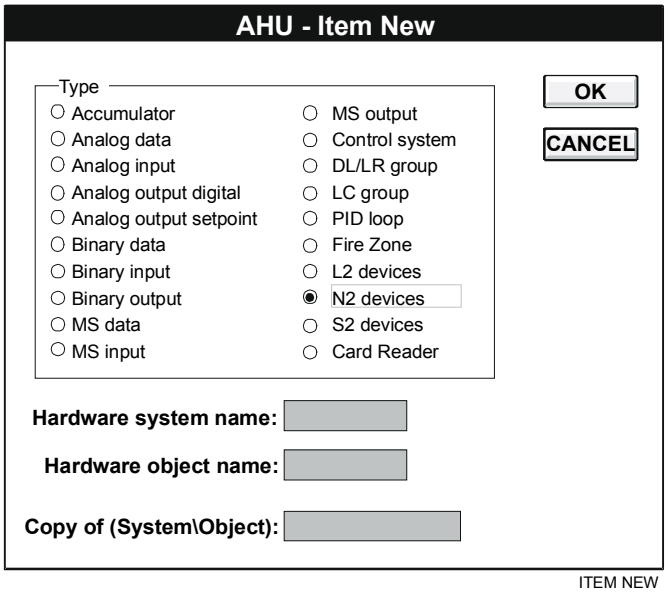



**Figure 21: Item New Dialog Box**

Note: The Hardware System and Hardware Object text fields are not used for this object type.

5. Click OK to display the Add N2 Device dialog box.

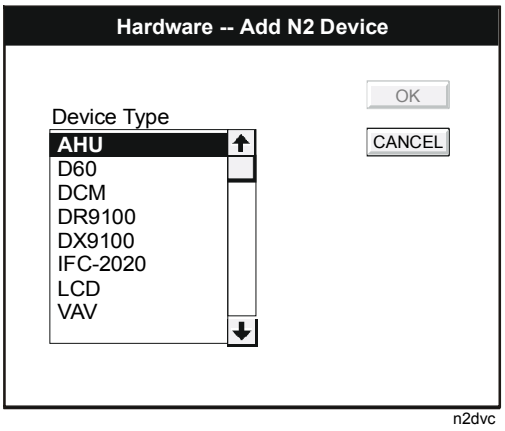



**Figure 22: Add N2 Device Dialog Box**

6. Highlight AHU.
7. Click OK to display the AHU Definition window (Figure 23).

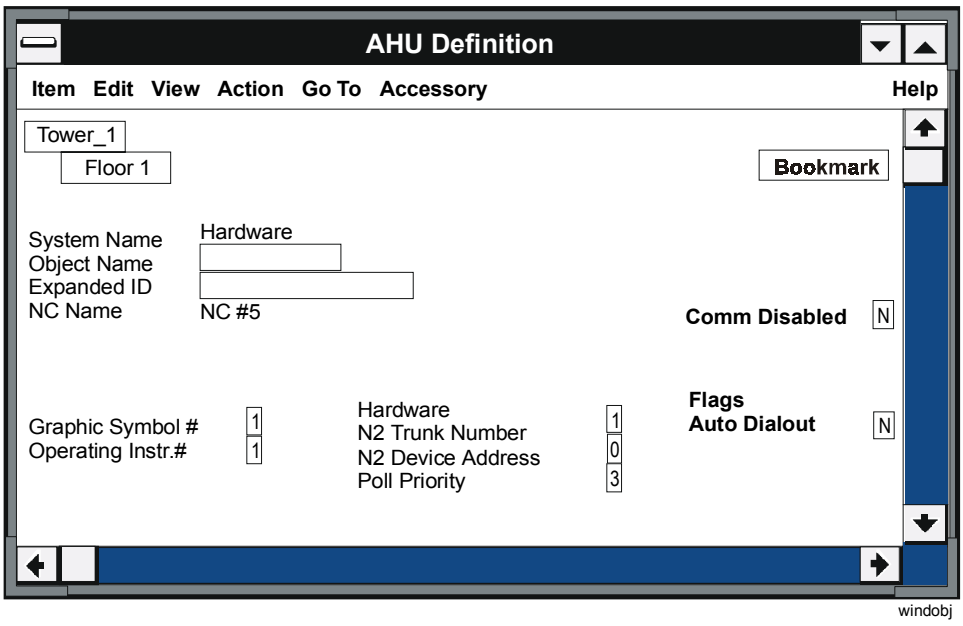



**Figure 23: AHU Definition Window**

Note that some of the fields in the window are blank and some are already filled in. You must fill in the blank attribute fields of required attributes. An N2 device address from 1 to 255 must also be specified. Attribute fields that are already filled in contain default values that may be accepted or changed.

Table 14 explains the blank attributes. The *Operator Workstation User's Manual (FAN 634)* describes the general procedures for entering and modifying data.

**Table 14: Blank AHU Object Attributes**

| Attribute | Description | Entry Values |
|---|---|---|
| **Object Name** | Identifies the object (i.e., ILC). The object name cannot be duplicated in the system. | 1 to 8 alphanumeric characters |
| **Expanded ID** | Further identifies the object (i.e., LC Device 1). | 0 to 24 alphanumeric characters (optional) |

8. To save the new AHU object, select Save from the Item pull-down menu. The object is added to the NCM database.
9. Upload the NCM to make an archive copy of the new object following the instructions in the *Operator Workstation User's Manual (FAN 634),* the *Advanced User's Guide* tab*,* the *Uploading and Downloading Databases* chapter, the *Uploading from the NCM* section.

### Modifying and Monitoring the AHU Object

Once you have defined the AHU object, you can modify or monitor its attribute values online using the AHU object Focus window. See the *Operator Workstation User's Manual (FAN 634)* for more information on using Focus windows.

### *Defining an AHU Control Device in Companion/ Facilitator Software*

To define a AHU control device in Companion, refer to the *Metasys Companion Technical Manual (FAN 628.1)*. To define a AHU control device in Facilitator, refer to the *Facilitator FMS Technical Manual (FAN 1628.1).*

# Ordering Information

## *Johnson Controls Code Numbers*

### Table 15: Metasys Controllers

| Code Number | Description |
|---|---|
| **AS-AHU103-300 or FA-AHU103-300** | AHU100-0, AHU102-0, and UPM with Transformer |
| **AS-AHU102-0 or FA-AHU102-0** | AHU Controller Board (only) |
| **AS-AHU100-0 or** | AHU I/O Termination Board |

Note: Code numbers beginning with *AS* are Metasys/Companion code numbers, and those beginning with *FA* are Facilitator code numbers.

### Table 16: Accessories

| Code Number | Description |
|---|---|
| **A-4000-137** | Pneumatic Replacement Filter Kit for FM-OAP102 |
| **AS-CBL100-0** | Cable Kit: RLY050/100/020 and FMK100 interconnect cables (bag of 10) |
| **AS-CBLCON-0** | Three 6-pin and Two 8-pin Phone Jacks with a Zone Terminal Block and ZT Download Switch |
| **AS-CBLZT66-0** | Replacement Cable for ZTU (6-pin to 6-pin) |
| **AS-CBLZT68-0** | Replacement Cable for ZTU (6-pin to 8-pin) |
| **AS-ENC100-0** | Utility Box: General purpose for expansion equipment needs |
| **AS-ENC101-0** | End Clamps: For equipment mounting on a DIN rail (bag of 10) |
| **AS-ENC102-0** | Bundle of 10 DIN Rails (2 meters long) |
| **AS-FMK102-0** | Function Module Kit for UPMs: Enclosure for FMs. Order FMs separately. |
| **AS-RLY002-0** | Relay Kit: Board with two relays only |
| **AS-RLY050-0** | Relay Kit: Metal enclosure and board with two relays |
| **AS-RLY100-1** | Relay Kit: Metal enclosure and board with four relays |
| **AS-XFR010-1** | 92 VA Split-bobbin Transformer without enclosure |
| **AS-XFR050-0** | 50 VA Split-bobbin Transformer without enclosure |
| **AS-XFR100-1** | Transformer Kit: Box-mounted 92 VA split-bobbin transformer for site power isolation of 120 VAC to 24 VAC, with cables, outlet, and power switch |
| **AS-ZTU100-1 or FA-ZTU100-1** | Metasys or Facilitator Zone Terminal Unit |
| **FM-IAP101-0** | Function Module--Input: 0 to 25 psi, 4 to 20 mA |
| **FM-IDP001-0** | Function Module--Input: 0 to 0.1 in. WC, 4 to 20 mA |
| **FM-IDP002-0** | Function Module--Input: 0 to 0.25 in. WC, 4 to 20 mA |
| **FM-IDP005-0** | Function Module--Input: 0 to 0.5 in. WC, 4 to 20 mA |
| **FM-IDP010-0** | Function Module--Input: 0 to 1 in. WC, 4 to 20 mA |
| **FM-IDP030-0** | Function Module--Input: 0 to 3 in. WC, 4 to 20 mA |
| **FM-IDP050-0** | Function Module--Input: 0 to 5 in. WC, 4 to 20 mA |
| **Continued on next page . . .** | |

| Code Number (Cont.) | Description |
|---|---|
| **FM-IDP100-0** | Function Module--Input: 0 to 10 in. WC, 4 to 20 mA |
| **FM-OAP102-0** | Function Module--Manual Override Kit Includes Pneumatic Air Line Filter Kit (requires FM-OAP103) |
| **FM-OAP103-0** | Function Module--Output: 0 to 20 mA/psi range, user variable |
| **FM-PCM101-0** | 10 Pack of Barbed Fitting for IDPs and IAPs |
| **HE-6400 Series** | Humidity Transmitters with Temperature Sensor |
| **M100C** | Zone Bus Damper Actuator |
| **MM-CVT101-0** | RS-232 to RS-485 converter for N2 Bus |
| **TE-6000 Series** | Temperature Sensors (Nickel, Platinum, or Silicon) (Resistance) |
| **TE-6300 Series** | Temperature Sensors (Nickel, Platinum, or Silicon) (Resistance) |
| **TE-6400 Series** | Zone Temperature Sensors (Nickel, Platinum) (Resistance) |

### *Vendor Code Numbers*

Table 17 and Table 18 list preconfigured cables and cable components available from Southwest Wire and Windy City Wire. These parts can be ordered through the Johnson Controls Preferred Supplier Program. Use Table 17 to order preconfigured cables.

**Table 17: Preconfigured Cables**

| Description | Cable Length | Southwest Wire Part Number | Windy City Wire Part Number |
|---|---|---|---|
| **RJ45 Straight-through Cable Assembly Plenum** | 7.62 m (25 ft) | CBL-STAT25-SW | CBL-STAT25-WC |
| • **Non-keyed Plugs** | 15.24 m (50 ft) | CBL-STAT50-SW | CBL-STAT50-WC |
| • **24 AWG** | 22.86 m (75 ft) | CBL-STAT75-SW | CBL-STAT75-WC |
| • **8 Conductor** | 30.48 m (100 ft) | CBL-STAT100-SW | CBL-STAT100-WC |
| • **Solid Wire** | | | |

Use Table 18 to order cable components available for creating your own cables.

**Table 18: Cable Components**

| Description | Southwest Wire Part Number | Windy City Wire Part Number |
|---|---|---|
| **304.8 m (1000 ft) Roll of Plenum Rated**<br>• **24 AWG**<br>• **8 Conductor**<br>• **Solid Wire** | CBL-24/8NAT-SW | CBL-24/8NAT-WC |
| **RJ45 Modular Plugs** | S100710 | S100710 |
| **Premium/Economy Crimp Tool** | S104012 | S104012 |
| **Twisted Pair Easy Strip** | S104020 | S104020 |

# Specifications

### Table 19: General Specifications

| | |
|---|---|
| **Product Name** | Air Handling Unit Controller (AHU) |
| **Supply Voltage** | 20-30 VAC at 50 or 60 Hz |
| **EEPROM size** | 8K bytes |
| **ROM/EPROM size** | 64K bytes |
| **RAM size** | 32K bytes |
| **Microprocessor** | Intel® 8051 |
| **Word Size** | 8 bit |
| **Clock Speed** | 11 MHz |
| **Power Consumption** | 16 VA maximum (relay and valve requirements not included) |
| **Ambient Operating Conditions** | 0 to 50°C (32 to 122°F) |
| **Ambient Storage Conditions** | -40 to 70°C (-40 to 158°F) |
| **Terminations** | Screw terminals |
| **Serial Interfaces** | 9600 baud N2 Bus and 1200 baud Zone Bus |
| **N2 Controller Addressing** | DIP switch set (1-255)<br>Note: 0, 255 are not available/reserved addresses. |
| **Mounting** | 1/4 inch bolts |
| **Dimensions (H x W x D)** | 584.2 x 406.4 x 190.5 mm (23 x 16 x 7.5 in.) |
| **Shipping Weight** | 7.7 kg (17 lb) |
| **Electrical Inputs** | Analog Inputs:<br>Nickel, Silicon, Platinum, (1K ohm) or temperature sensors,<br>2K setpoint potentiometer (2-wire)<br>Voltage Input for 0-10 VDC (humidity or dew point sensor)<br>Current input for 0-20 mA<br>Binary Inputs: dry<br>Refer to Table 20 for details. |
| **Outputs** | Binary Outputs, 24 VAC triac switched, 50-500 mA loads<br>Analog Output, 0-20 mA<br>Refer to Table 20 for details. |
| **Standards Compliance** | CSA C22.2 No. 205 FCC Part 15, Subpart J, Class A<br>IEEE 446 IEEE 472 IEEE 518 IEEE 587 Category A/B<br>UL 916 Safety UL 864 Smoke Control<br>Refer to the *Metasys Smoke Control Wiring Technical Bulletin LIT-636331* in *FAN 636* for details on smoke control compliance requirements. |

The performance specifications are nominal and conform to acceptable industry standards. For application at conditions beyond these specifications, consult the local Johnson Controls office. Johnson Controls, Inc. shall not be liable for damages resulting from misapplication or misuse of its products.

## Table 20: Input/Output Information

| Function | Reso-lution | Sample Time (Frequency) | Accuracy | Range | DC Input Impedance | Sensor/ Load Impedance | Noise Protection |
|---|---|---|---|---|---|---|---|
| **AI-Voltage** | 15 bit | 1.5 Seconds | ± 3mV | 0-2 VDC | 470K ohm | 0-5K ohm | NM ResCap + CM Cap |
| **AI-Voltage** | 15 bit | 1.5 Seconds | ± 18mV | 0-10 VDC | 470K ohm | 0-5K ohm | NM ResCap + CM Cap |
| **AI-Current** | 15 bit | 1.5 Seconds | ± 38 uA | 0-20 mA | 100 ohm | N/A | NM ResCap + CM Cap |
| **AI-Temp** | 15 bit | 1.5 Seconds | ± 0.4 F | 1000 ohm Si | 3540 ohm | 0-2K ohm | NM ResCap + CM Cap |
| **AI-Temp** | 15 bit | 1.5 Seconds | ± 0.6 F | 1000 ohm Ni | 3540 ohm | 0-2K ohm | NM ResCap + CM Cap |
| **AI-Temp** | 15 bit | 1.5 Seconds | ± 1.2 F | 1000 ohm Pt | 3540 ohm | 0-2K ohm | NM ResCap + CM Cap |
| **AI-Pot** | 15 bit | 1.5 Seconds | ± 0.1 F | 0-2K ohm Potentiometer | 3540 ohm | 0-2K ohm | NM ResCap + CM Cap |
| **ACCUM-DC** | 32 bit | 10 ms (100 Hz) | N/A | 0-15 VDC, 2.5V Trig | 47K ohm | 0-5K ohm | NM ResCap + CM Cap |
| **BI-DC sense** | 1 bit | 1.5 Seconds | N/A | 0-15 VDC, 2.5V Trig | 47K ohm | 0-5K ohm | NM ResCap + CM Cap |
| **AO-Current** | 8 bit | 1.5 Seconds | ± 1% | 0-20 mA @ 18 VDC maximum | N/A | 0-900 ohm | NM ResCap + CM ResCap |
| **BO-AC Triac** | 1 bit | 1.5 Seconds | N/A | 24 VAC @ 50-500 mA | N/A | 48-480 ohm | NM Cap + CM Cap |
| **DC Supply Out** | N/A | N/A | N/A | 20-30 VDC @ 160 mA | N/A | 125-10M ohm | NM Cap + CM Cap |
| **N2 Bus** | N/A | N/A | N/A | ±5 VDC | N/A | N/A | Opto + Transorb + CM Cap |
| **Zone Bus** | N/A | N/A | N/A | 0-5 VDC | N/A | N/A | Transorb + CM Cap |
| **Power Input** | N/A | N/A | N/A | 20-30 VAC @16 VA | N/A | N/A | CM Choke + CM Cap + NM MOV + NM Cap |
| State of Outputs During Power Fail = Disables when 24 VAC PWR drops below 18 VAC. | | | | | | | |
| State of Outputs After Power is Restored = Remain disabled for 10 seconds minimum, and then start per Restart Configuration. | | | | | | | |
| NM = Normal Mode, CM = Common Mode, Cap = Capacitor, Res = Resistor, Opto = Optical Isolation. | | | | | | | |

# Appendix A: AHU Tower

The AHU Tower has been discontinued because the AS-AHU101-1 or FA-AHU101-1 enclosure for the termination board is no longer produced. Table 21 lists the parts that can be ordered separately if needed.

The AHU Tower has been replaced with the AS-AHU103-300 or FA-AHU103-300 in the UPM enclosure (Figure 24). All the parts listed under the AS-AHU103-300 in UPM Enclosure, as shown in Figure 24, are included in the AS-AHU103-300 package. However, Item B, Termination Board (AS-AHU100-0), and Item C, Electronic Controller Board (AS-AHU102-0 or FA-AHU102-0), can be ordered separately if needed.

**Table 21: Replacement Parts Available**

| Item | Part Number | Order Number |
|---|---|---|
| **A** | Power/Supply Split-bobbin Transformer<br>(Pre-mounted in AS-ENC100-0 metal enclosure.) | AS-XFR100-1 |
| **B** | Termination Board<br>(without enclosure) | AS-AHU100-0 |
| **C** | Electronic Controller Board | AS-AHU102-0 or<br>FA-AHU102-0 |
| **D** | 92 VA Split-bobbin Transformer without enclosure | AS-XFR010-0 |

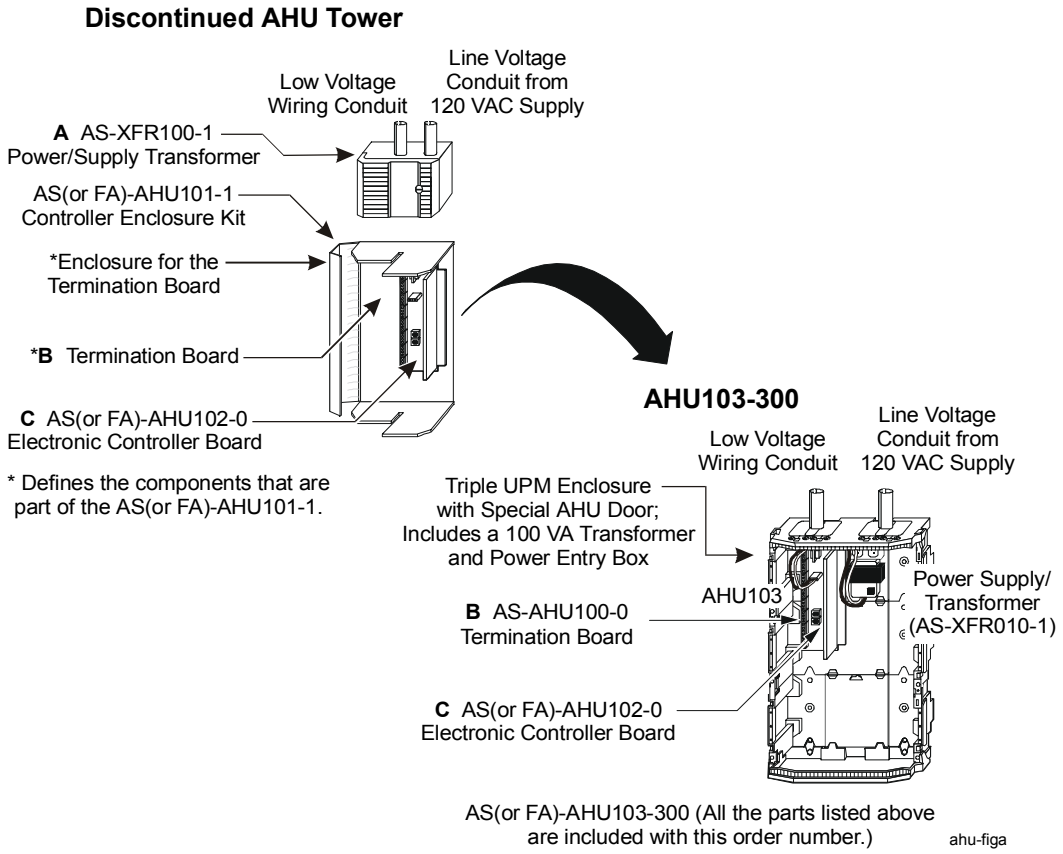



**Figure 24: AHU Tower Replaced by AHU103-300**

The replacement parts listed in Table 21 can also be ordered separately for custom enclosures (Figure 25).

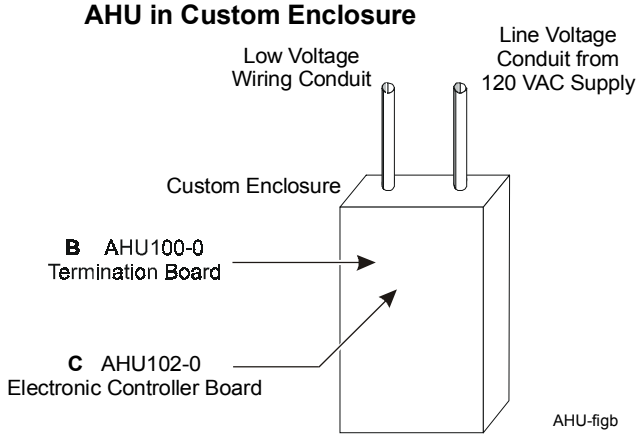



**Figure 25: AHU in Custom Enclosure**

## *Tower Installation*

The AHU Tower unit is no longer sold. However, *Appendix A: AHU Tower* includes the AHU technical bulletin information that could be needed for installed Tower units.

### General Mounting

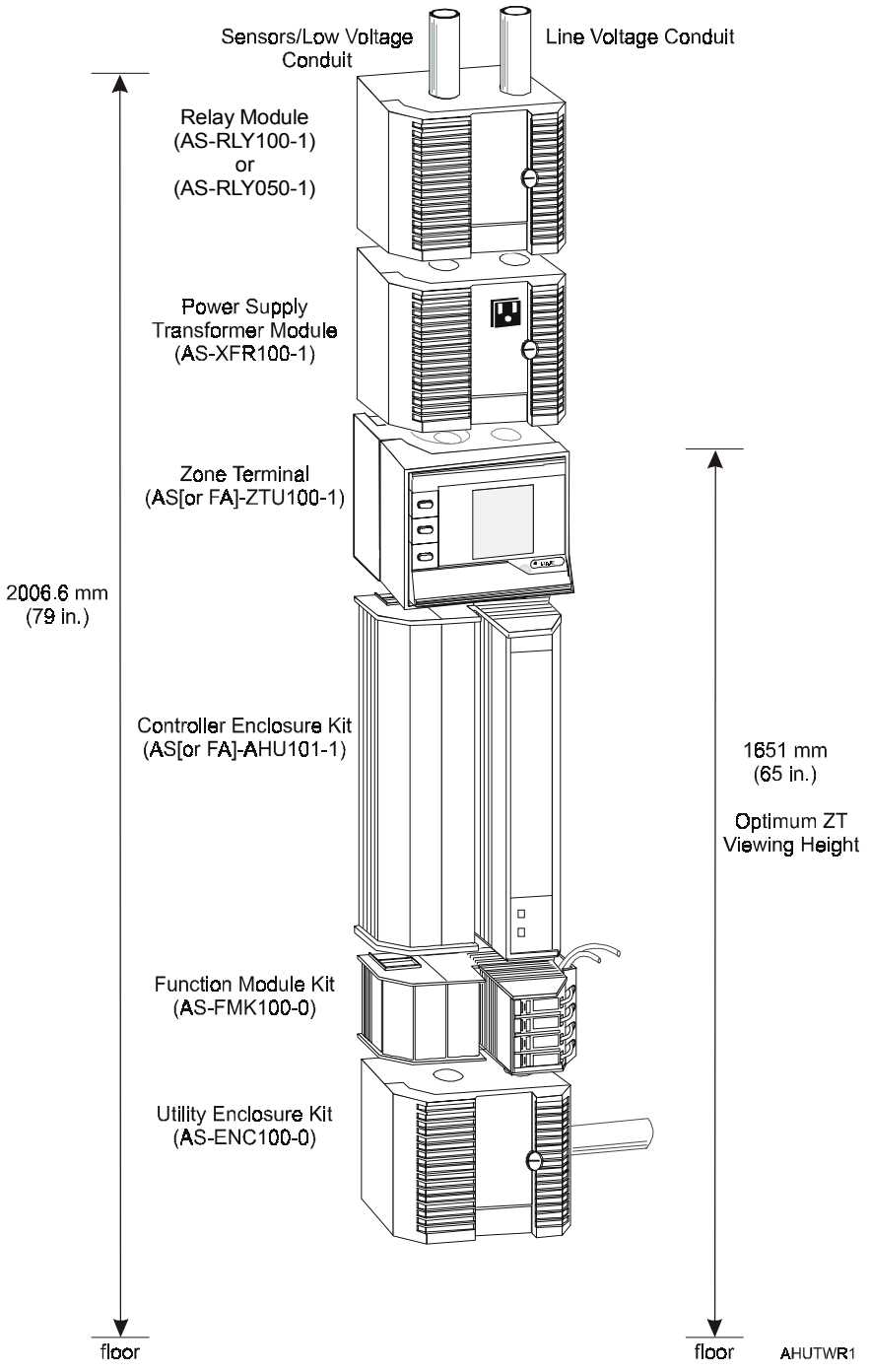



**Figure 26: AHU Tower**

Mount accessory devices on the DIN rail from top to bottom in this recommended order:

1. Relay Module Kit
2. Transformer
3. Zone Terminal Unit
4. AHU with Enclosure Kit
5. Function Module Kit
6. Utility Enclosure Kit for gauges/tubing

**Relay Module AS-RLY050-0/ AS-RLY100-1/ AS-RLY002-0**

The relay module is a self-contained relay device that provides an interface between the low voltage circuitry and line-voltage devices.

**Power Supply/ Transformer Module (AS-XFR100-1)**

The Power Supply/Transformer Module (XFR100) provides 120 VAC to 24 VAC split-bobbin isolation, rated at 92 VA. It is a UL Class 2 transformer. It powers the AHU and all input and output loads.

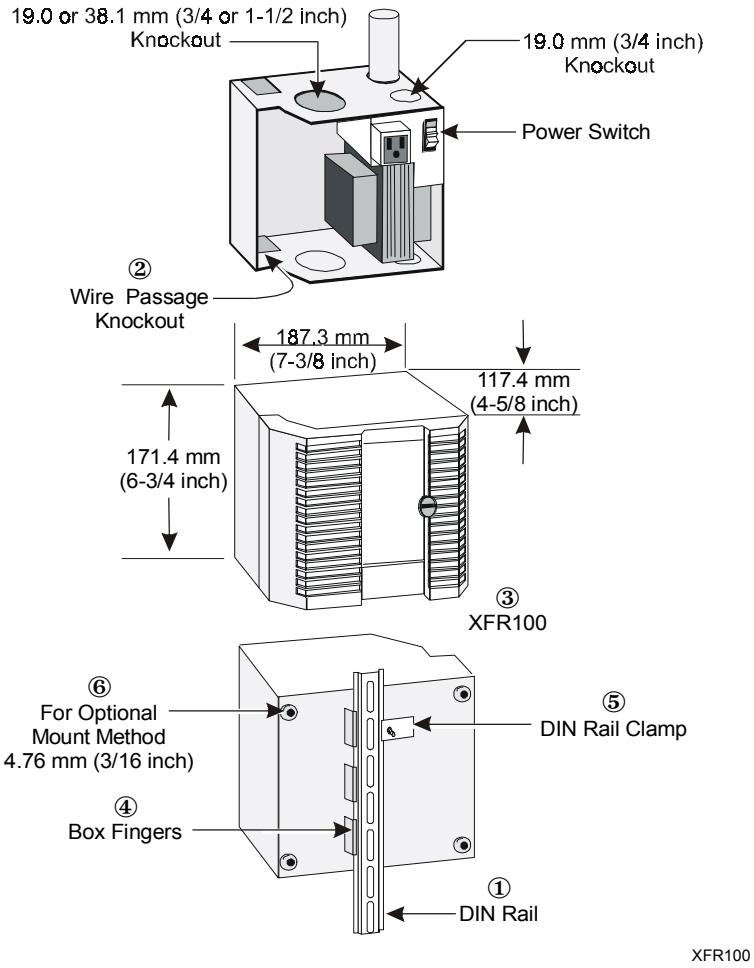



**Figure 24: Power Supply/Transformer Module (AS-XFR100-1)**

To mount the XFR100 on a DIN rail:

1. Fasten the DIN rail ① to the mounting surface. The recommended height for the rail gives the optimum line of vision to the ZT. Allow 152.4 mm (6 in.) to the left for the door and 254 mm. (10 in.) to the right of the DIN rail for poly tubing.
2. Using a flat-blade screwdriver and pliers, remove the necessary wire passage knockouts ②.
3. Position the XFR100 ③ so that it rests firmly against the surface of the DIN rail. Adjust the XFR100 vertically into its final location.
4. Hook the box fingers ④ over the DIN rail.

5. Slide the clamp ⑤ over the DIN rail and tighten.
6. Insert a sheet metal screw through one of the mounting feet ⑥ on the right to anchor the unit.

**Zone Terminal (AS-ZTU100-1) (FA-ZTU100-1**

For optimum viewing, mount the ZT 1651 mm (65 in.) from the floor to the top of the ZT unit.

For further explanation of Zone Terminal installation, refer to the *Zone Terminal Technical Bulletin (LIT-636014* or *LIT-1628330)* in *FAN 636.3 or 1628.2*.

**AHU Kit (AS-AHU101-1) and AHU Board (AS-AHU102-0) (FA-AHU102-0)**

The AHU101 housing is where all field and local terminations connect. The AHU102 Controller Board plugs into the AHU101 termination board and is temperature rated for equipment room applications.

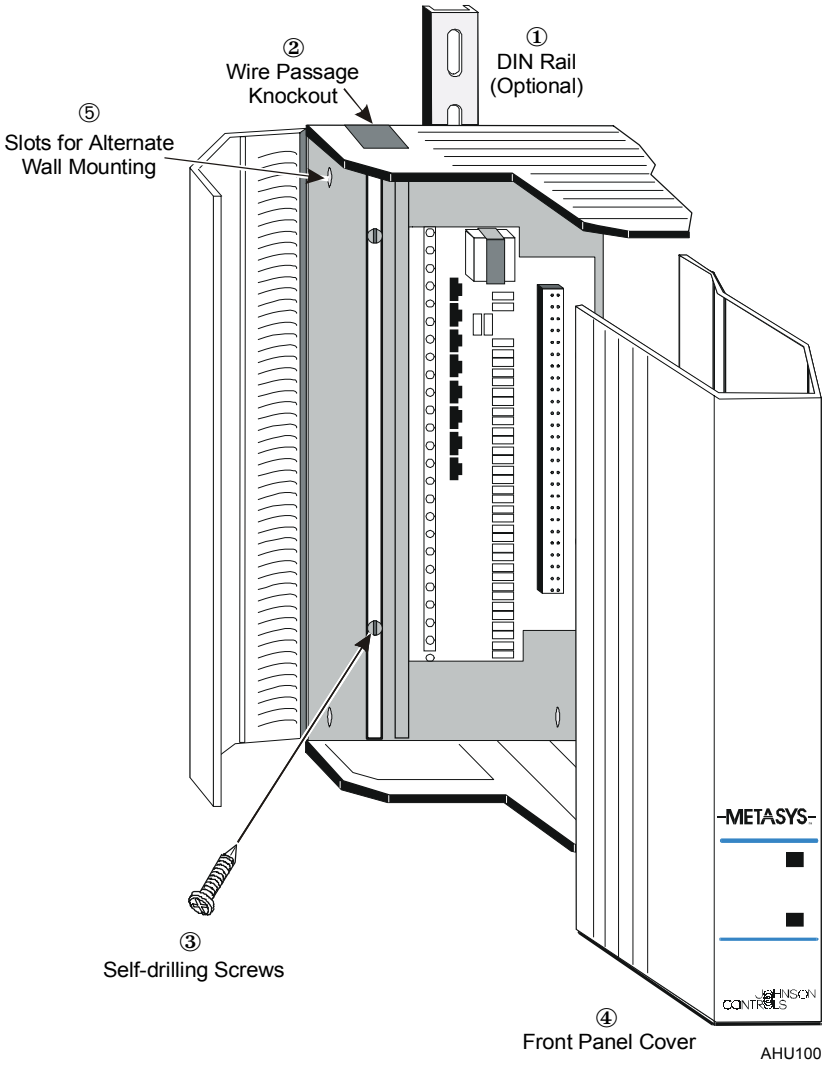



**Figure 25: AHU Enclosure**

Mount the AHU in any convenient location using the predrilled mounting holes. The controller should be mounted vertically on a wall or panel where it can be easily wired and adjusted through the front panel cover. The same instruction applies to remote location packages.

1. Position the AHU101 so that it rests firmly against the surface of the DIN rail ①. Allow 6 inches to the left and 10 inches to the right of the DIN rail for poly tubing. Adjust the AHU101 vertically into its final location.
2. Using a knife and pliers, remove the necessary wire passage knockouts ②.
3. Install self-drilling screws ③ to latch behind the DIN rail.
4. Insert a self-drilling screw in the lower right corner to stabilize the unit.
5. Remove the front panel cover ④ to install wiring.

For optional wall mounting, use alternate mounting holes ⑤ available in each corner.

**Function Module Kit (AS-FMK100-0)**

The Function Module Kit provides the enclosure and termination board to connect up to four, single slot function modules to the AHU.

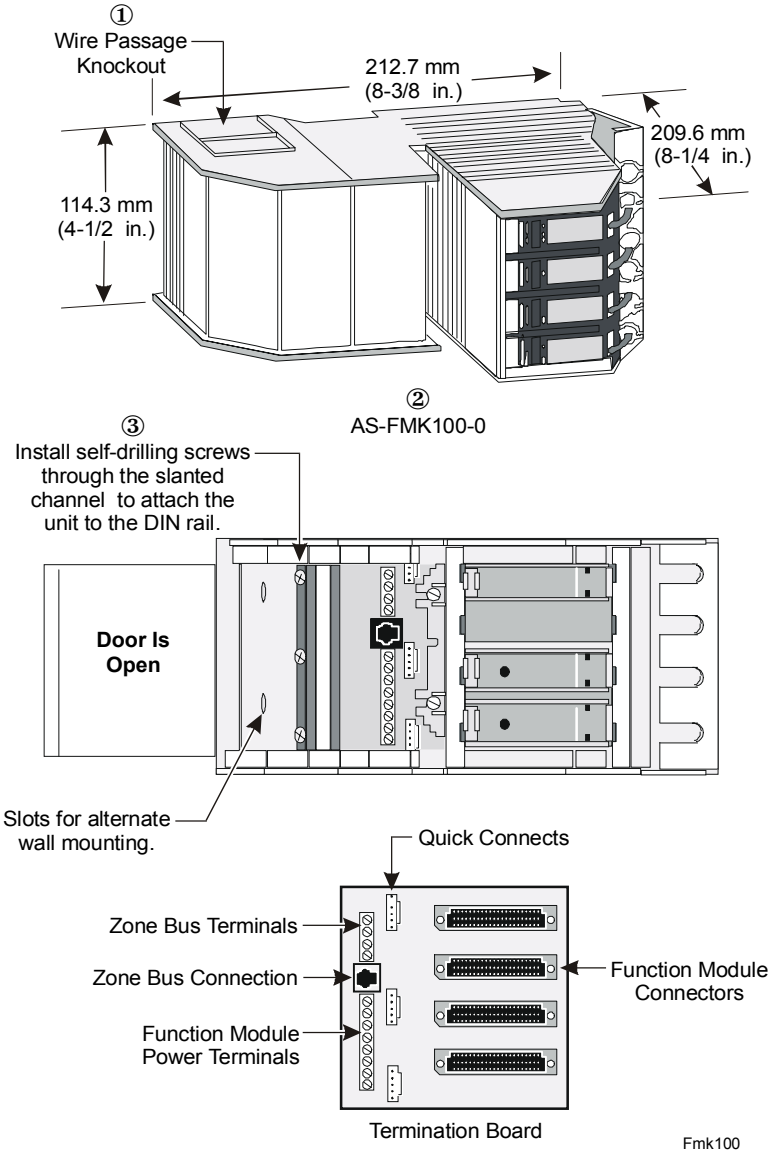



**Figure 26: Function Module Kit**

Follow these directions when installing a Function Module Kit:

1. Using a knife and pliers, remove the necessary wire passage knockouts ①.
2. Position the FMK100 ② so that it rests firmly against the surface of the DIN rail. Adjust the FMK100 vertically into its final location.
3. Install the provided self-drilling screws ③ into the angled slots, as shown above. The screws drill through the plastic and glide under the DIN rail.

### *Remote Function Module Kit*

The FMK100 has the same functional task as the local Function Module (FM) Kit. Use of a remote and/or local installation is optional.

### *Function Modules (FMs)*

The types of FMs provided for use in the FM Kit are:

- Input: The input FMs consist of the FM-IAP and various models of the FM-IDP modules. Each occupies one slot in the FM Kit.
- Output: The output FM (FM-OAP) has the same dimensions as the input FMs except it has twice the height. Therefore, the output FM occupies two slots in the FM Kit. An FM-OAP102 Pneumatic Manual Module must be ordered with each FM-OAP103 Electronic Module.

**AHU Tower Wiring Details**

For wiring details, refer to the *Wiring Details* section of this document.

***Pneumatic Connection***

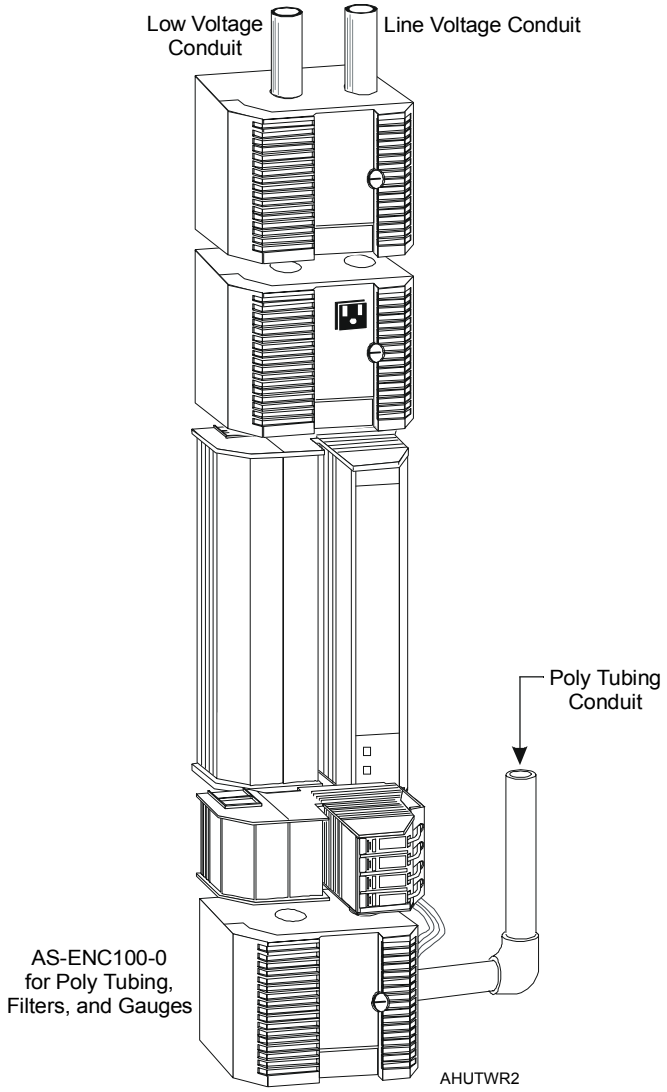



**Figure 27: Pneumatic Connection**

Connect pneumatic tubing into the AS-FMK100 Function Module Kit using conduit into the ENC100. Place the tubing to the right of the FMK100.

For complete information on installing pneumatic function modules, refer to the *Output Analog Pneumatic (OAP) Technical Bulletin (LIT-636045)* in the *Metasys Network Technical Manual (FAN 636)*.

# Notes

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Printed in U.S.A.
www.johnsoncontrols.com