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Comfort Controller 6400 CEPL130530-10-R

Guía de Instalación

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Comfort Controller

Installation and Start-up Manual

808-890 Rev. 9/05

Figures

Tables

Manual Revisions

The *Comfort Controller Installation and Start-up Manual* is catalog number 808-890, Rev. 9/05. It replaces the *Comfort Controller Installation and Start-up Manual* 808-890, Rev. 6/03.

The revisions are listed below.

Section/Chapter	Changes
Introduction	1. Removed reference to Appendix C, Smoke Control Applications. Appendix C has been removed from the manual as Carrier's listing for UL 864/UUKL expires effective 10/1/05. Renamed Appendix D to C.
	2. Pages 5 and 9 - Updated specifications to remove reference to UL 864 UDTZ and UUKL.
Installation and Wiring	3. Page 65 - At top of page, changed header from "Externally Powered 4-20mA Sensor Wiring" to read: "Internally Powered 4-20 mA Sensor Wiring (2-wire)". Same change made in Figure 47 caption.
	4. Page 70 - In Note at bottom of page, changed the sentence from "For example, on a Comfort Controller 1600, you must wire Channels 5-8 and Set Switch 1 to *Other* (Off)." to read: For example, on a Comfort Controller 1600, you must wire to Channel 7 or 8 and set Switch 1 or Switch 2 to *Other* (Off).
	5. In Table 4 on page 71, removed input type PT100.
Checkout	6. In Tables 8 and 9, corrected several degrees C conversions.

Introduction

Introduction

About this Manual

This manual is intended for use by Carrier Corporation technical representatives. It provides installation, start-up, and checkout procedures for the Comfort Controller 1600, and the Comfort Controller 6400 and its expansion module Comfort Controller 6400-I/O. It also provides installation instructions for the Local Interface Device (LID).

The manual is divided into three main sections.

Section One, Introduction, describes Comfort Controller 1600 and Comfort Controller 6400 Modules and their functions in the Carrier Comfort Network (CCN).

Section Two, Installation and Wiring, contains instructions for installing the optional cover on a Comfort Controller 1600, applying Carrier logos to all Comfort Controller modules, and step-by-step instructions for mounting and wiring all modules and the LID. It also contains sample installations of sensors and other devices and a pre-power-up checklist.

Section Three, Checkout, describes how to verify that the power supply is operating and that the modules are communicating with each other and on the CCN. It also contains instructions for calibrating input devices and tuning analog output control loops.

Appendix A contains wire lists for the Comfort Controller 1600, the Comfort Controller 6400, and the Comfort Controller 6400-I/O and sensor mounting and wiring instructions.

Appendix B provides instructions for clearing the Comfort Controller database.

Appendix C is a summary of product specifications and provides CCN product compatibility data.

This manual is written for world-wide use. Engineering measurements are in customary U.S. and metric units.

Installation and startup of all devices must be performed by Carrier qualified service technicians.

Overview

The Comfort Controller product family provides general purpose HVAC control and monitoring capability in a standalone or network environment using closed-loop, direct digital control. This product family can also control and monitor equipment such as lighting, pumps, and cooling towers. The Comfort Controller product family gives the Carrier Comfort Network (CCN) the capability to control and communicate with non-Carrier equipment and Carrier HVAC equipment not equipped with Product Integrated Controls (PICs).

You configure the Comfort Controller to contain a database of the algorithms, points, schedules, alarms, and system functions that are necessary to control and monitor the equipment at your site. You enter the configuration data using the following CCN operator interface devices:

- Network Service Tool III, IV
- Building Supervisor III, IV
- Local Interface Device (LID)
- ComfortWORKS

There are two types of Comfort Controllers, Comfort Controller 6400 and Comfort Controller 1600. Both controllers provide the same functions, such as:

- heating and cooling control
- proportional, integral, and derivative (PID) loop control
- scheduling
- custom programming

Comfort Controller 6400

You can connect 16 field points (8 inputs and 8 outputs) to the Comfort Controller 6400, also known as the *6400*. To connect additional field points, add optional input/output modules (8 inputs and 8 outputs per I/O module) to the *6400*. By using mutiple I/O modules, you can connect up to 48 additional points, giving you the capability to control and/or monitor a total of up to 64 field points. The appropriate number of I/O modules are selected for each control situation and simply installed along with the *6400* in your field selected NEMA-1 enclosure. This modular concept contributes to overall versatility and ease of installation.

8 Inputs

Numbers	Specifications
1 to 8	Discrete, analog, or temperature Discrete Dry Contact Pulsed dry contact Analog 4-20 mA (2 wire and 4 wire) 0-10 Vdc Temperature 5K & 10K ohm thermistors 1K ohm nickel RTD PT100

8 Outputs

Numbers	Specifications
1 to 8	Discrete or analog Discrete 24 Vdc@80 mA Analog 4-20 mA 0-10 Vdc

Specifications— Comfort Controller 6400 and Comfort Controller 6400–I/O

The Comfort Controller 6400 and Comfort Controller 6400-I/O support the following features and sensor and device types:

- Stand-alone control and monitoring of up to 16 field points, using proven algorithms.
- Support of the UT203 FID family of I/O modules for retrofit and upgrade applications.
- Compatibility with the following interface devices: Local Interface Device (LID), ComfortWORKS, Building Supervisor III, and Network Service Tool III.
- Three LEDs, conveniently located on the front of the module, indicated module status (red), CCN Communication Bus status (yellow) and I/O module communication status (green).

  Note: The yellow LED on the 6400-I/O Module is inactive.

- Ability to disable all inputs, all outputs, or disable both inputs and outputs by simply flipping a switch.

- Two-day backup of clock and data such as Data Collection and Runtime.

- Simplified field wiring using “plug type” terminals (two-pin connection for each input and output).

- Optional Comfort Controller 6400-HOA (Hand-Off-Auto) consisting of eight switches that provide you with the capability to manually override each discrete output point.

- Uses any standard, field-supplied 24 Vac, 60VA transformer.

Power Requirements .... 60VA@24 Vac$\pm$15%
Dimensions .... 13 in H x 2.75 in W x 5.5 in D
(33 cm x 7 cm x 14 cm)
Operating Temperature .... 32°F to 140°F
(0°C to 60°C)
Storage Temperature.. -40°F to 185°F
(-40°C to 85°C)
Operating Humidity .... 0 to 90%, non-condensing

Discrete Out Specifications
Output Signal .... 24Vdc@80 mA current limited

Analog Out Specifications
4-20 mA Milliamp Type
Load Resistance .... 0-600 ohms
Resolution .... 0.085 mA
Accuracy .... $\pm$2%

0-10 Vdc Voltage Type
Load Resistance .... >50,000 ohms
Resolution .... 50 mV
Accuracy .... $\pm$2%

Discrete In Specifications

Dry Contacts .... Switch Closure<3000 ohms

Pulsing Dry Contacts

  Repetition Rate .... 5 Hz max.

  Minimum Pulse Width .... 100 msec

Analog In Specifications

4-20 mA Milliamp Type

  Wire Type .... 2-wire or 4-wire

  Resolution .... 0.025 mA

  Accuracy .... ±1%

0-10 Vdc Voltage Type

  Resolution .... 0.0125 V

  Accuracy .... ±1%

5K Thermistor Type

  Nominal reading @5,000 ohms .... 77°F (25°C)

  Resolution .... 0.1°F

  Accuracy .... ±1°F

10K Thermistor Type

  Nominal reading @ 10,000 ohms .... 77°F (25°C)

  Resolution .... 0.1°F

  Accuracy .... ±1°F

Nickel RTD Type

  Nominal reading @ 1,000 ohms .... 70°F (21°C)

  Resolution .... 0.1°F

  Accuracy .... ±2°F

Electrical components are UL 916 PAZX, VDE, ULC, and CE Mark listed.

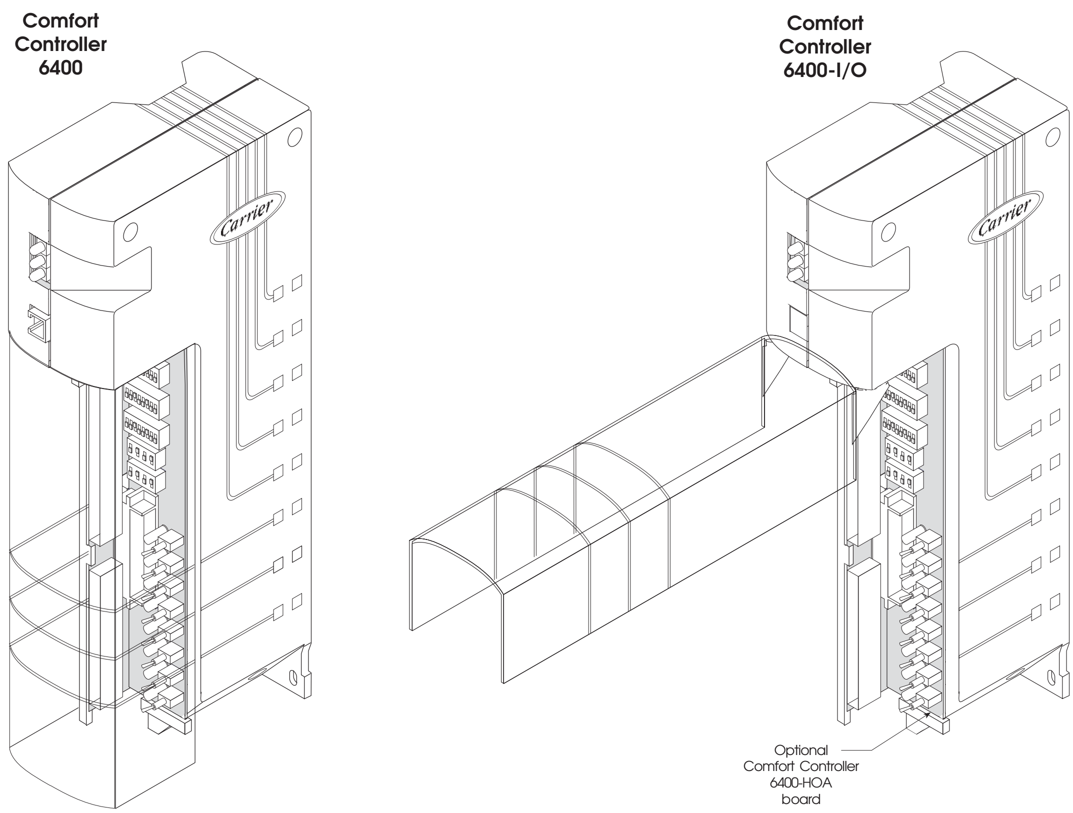
The Comfort Controller 6400 supports the UT203 FID family of I/O modules for retrofit applications:

- 8 Input
- 8 Output
- 4 Input/4 Output
- Low Voltage DSIO
- High Voltage DSIO*

*You must install High Voltage DSIO Modules in their own enclosure because they contain Class 1 wiring.

Figure 1 below shows Comfort Controller 6400 and 6400-I/O Modules.

Figure 1
Comfort Controller 6400 and 6400-I/O Modules

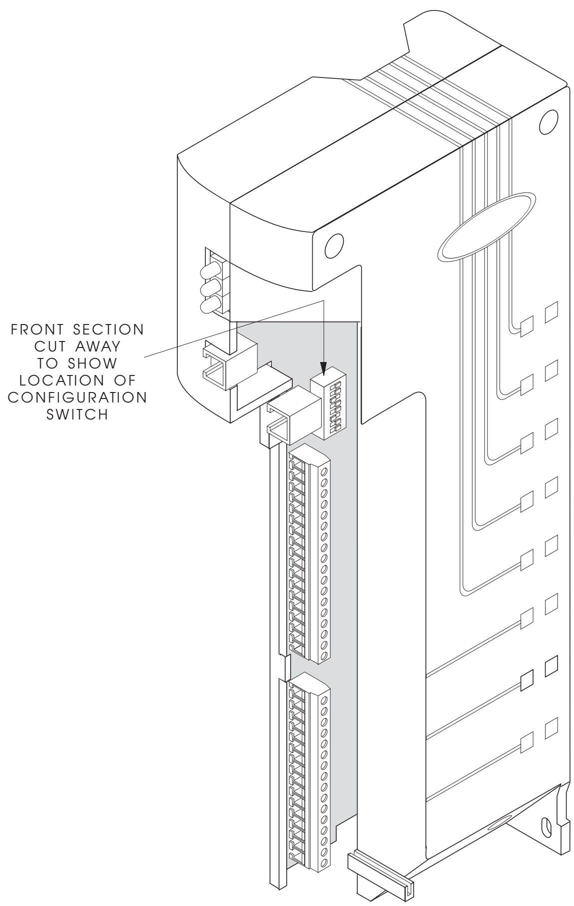


Comfort Controller 1600

The Comfort Controller 1600 supports the following features:

- Stand-alone control and monitoring of up to 16 field points (8 inputs and 8 outputs), using proven algorithms.
- Three LEDs, conveniently located on the front of the module, indicate module status (red), CCN Communication Bus status (yellow) and I/O module communication status (green).
- Two-day backup of clock and data such as Data Collection and Runtime.
- Uses any standard, field supplied 24 Vac, 60 VA transformer.

Figure 2
Comfort Controller 1600



8 Inputs

Numbers	Specifications
1 to 4	Discrete or analog (0-10 Vdc)
5 & 6	Temperature
7 & 8	Discrete, analog, or temperature
	Discrete
	Dry Contact
	Pulsed dry contact
	Analog
	4-20 mA (2-wire only)
	0-10 Vdc
	T-56 Slide bar
	Temperature
	5K & 10K ohm thermistors
	1K ohm nickel RTD

8 Outputs

Numbers	Specifications
1 to 4	Discrete
5 & 6	Analog
	4-20 mA
7 & 8	Discrete or analog
	Discrete
	24 Vdc@80 mA
	Analog
	4-20 mA
	0-10 Vdc

Specifications — Comfort Controller 1600

Power Requirements .... 60VA@24 Vac±15%
Dimensions .... 13 in H x 2.75 in W x 5.5 in D
(33 cm x 7 cm x 14 cm
Operating Temperature .... 32°F to 140°F
(0°C to 60°C)
Storage Temperature .... -40°F to 185°F
(-40°C to 85°C)
Operating Humidity .... 0 to 90%, non-condensing

Discrete Out Specifications

Output Signal .... 24Vdc@80 mA current limited

Analog Out Specifications

4-20 mA Milliamp Type

Load Resistance .... 0-600 ohms

Resolution .... 0.085 mA

Accuracy .... ±2%

0-10 Vdc Voltage Type

Load Resistance .... >50,000 ohms

Resolution .... 50 mV

Accuracy .... ±2%

Discrete In Specifications

Dry Contacts .... Switch Closure<3000 ohms

Pulsing Dry Contacts

Repetition Rate .... 5 Hz max.

Minimum Pulse Width .... 100 msec

Analog In Specifications

4-20 mA Milliamp Type

Wire Type .... 2-wire only

Resolution .... 0.025 mA

Accuracy .... ±1%

0-10 Vdc Voltage Type

Resolution .... 0.0125 V

Accuracy .... ±1%

5K Thermistor Type

Nominal reading @5,000 chms .... 77°F (25°C)

Resolution .... 0.1°F

Accuracy .... ±1°F

10K Thermistor Type

Nominal reading @ 10,000 chms .... 77°F (25°C)

Resolution .... 0.1°F

Accuracy .... ±1°F

Nickel RTD Type

Nominal reading @ 1,000 chms .... 70°F (21°C)

Resolution .... 0.1°F

Accuracy .... ±2°F

Electrical components are UL 916 PAZX, VDE, ULC, and CE Mark listed.

Installation and Wiring

Installation and Wiring

Required Tools and References

Drill with a #29 bit

Small needle nose pliers

Volt ohmmeter (VOM)

Wire cutter/stripper

1/8" blade screwdriver

1/4" and 5/16" nut drivers with 6" extension

Completed wire lists and configuration sheets for each Comfort Controller 6400 or 1600

Comfort Controller Overview and Configuration Manual (808-891)

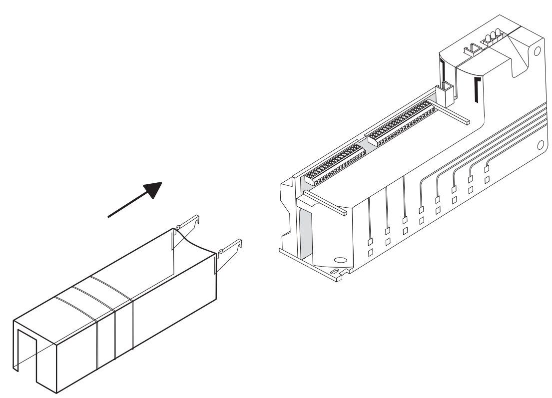
Installation instructions for all enclosures, power sources, and devices

Installing the Cover on a Comfort Controller 1600

The Comfort Controller 1600 is not sold with a cover. You can, however, order a cover as an option from Carrier. Follow the instructions below to install the optional cover.

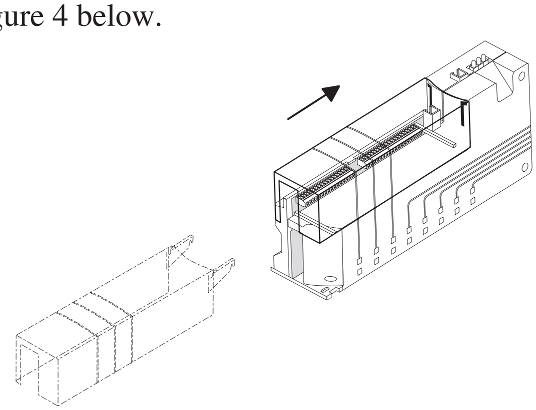
1. Lay the module on a flat surface, and position the cover as shown in Figure 3 below.

Figure 3
Positioning the Optional Cover on a Comfort Controller 1600



2. Gently slide the door forward until it snaps into place. Refer to Figure 4 below.

Figure 4
Snapping the Cover into Place



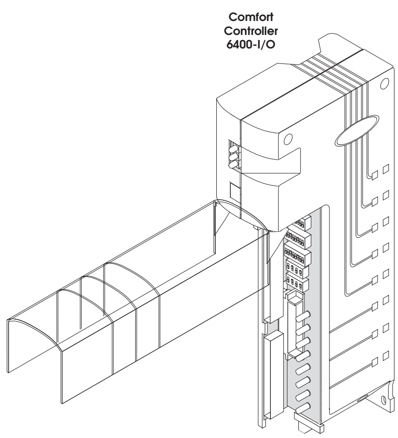
Installing the Optional Comfort Controller 6400-HOA

If desired, you can order from Carrier an optional configuration board for use with the Comfort Controller 6400 and Comfort Controller 6400-I/O. This board, which consists of eight hand-off-auto (HOA) switches, provides you with the capability to manually override each discrete output point.

Follow the instructions below to install the Comfort Controller 6400-HOA on either a *6400* or *6400-I/O*:

1. Verify that power is disconnected from the module.
2. Open the module cover as shown in Figure 5 below.

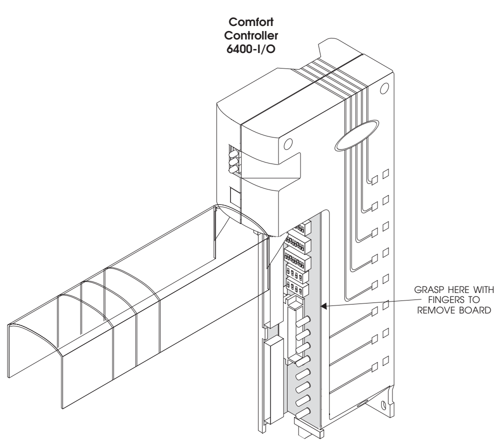
Figure 5
Comfort Controller with Cover Open



3. Remove the existing configuration board by pulling from the center of the board. Refer to Figure 6 below.

Caution: Be careful not to bend the board's LEDs. Do not use any tools to remove the board.

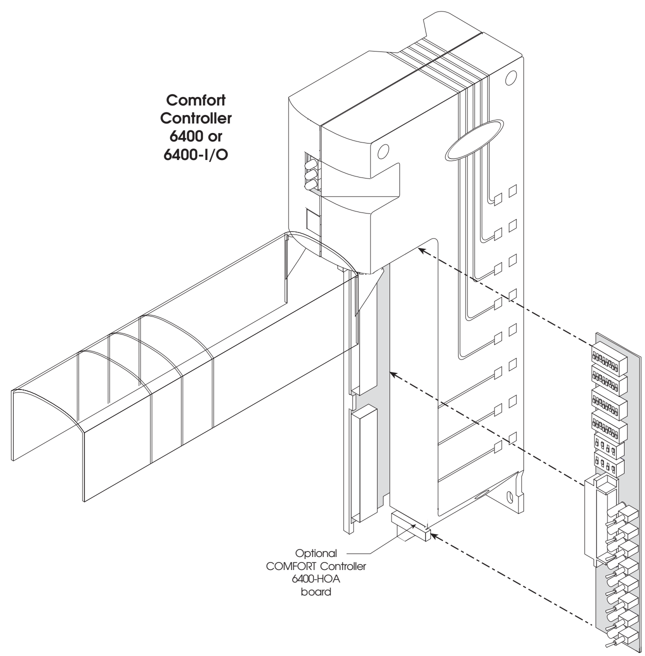
Figure 6
Removing the Old Configuration Board



4. Set Comfort Controller 6400-HOA SW1 through SW6 dip switches to match those on the configuration board removed in Step 3.

5. Install the Comfort Controller 6400-HOA as shown in Figure 7 below.

Figure 7
Installing the Comfort Controller 6400-HOA



Applying the Carrier Logos

Follow the instructions below to apply Carrier logos (labels) to the Comfort Controller. You must apply one Carrier-supplied logo to the side of the Comfort Controller 1600. You must apply two Carrier-supplied logos to the Comfort Controller 6400 and the Comfort Controller 6400-I/O — one on the door and one on the side.

1. Determine module installation orientation.
2. Affix the logo to the recessed area on the side of the module as shown in Figure 8 below.

   Note: Verify that the recessed area is clean and dry.

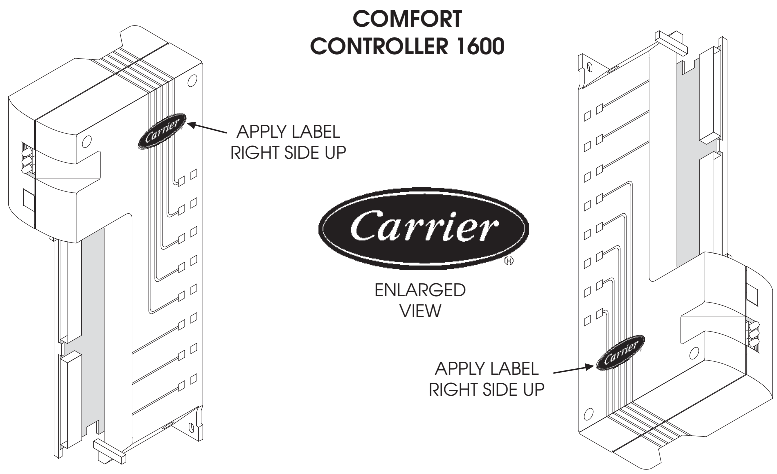


Figure 8
Applying Logo to Side of *1600* and *6400*

3. For Comfort Controller 6400 and Comfort Controller 6400-I/O Modules, affix the second logo to the recessed area on the module's door as shown in Figure 9 below.

   Note: Verify that the recessed area is clean and dry.

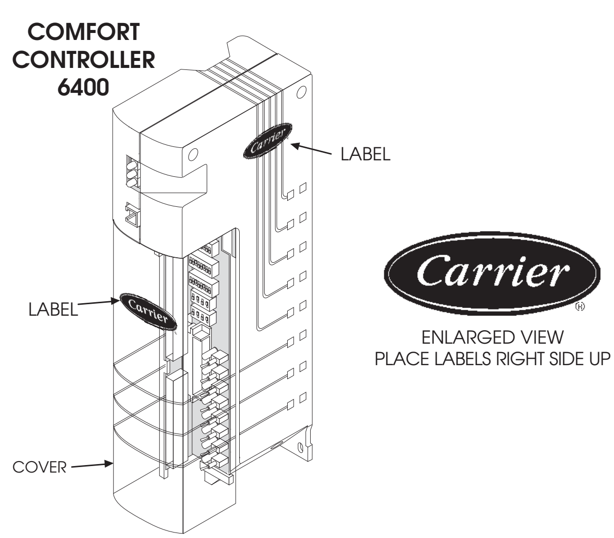


Figure 9
Applying Logo to Cover of *6400* and *6400-I/O*

Module Installation

Comfort Controller 6400, 6400-I/O, and 1600 Modules can be mounted in the following locations:

- Panel mounted in a NEMA Type 1 enclosure
- Rail mounted in a Carrier UT203 FID enclosure
- Wall mounted
- DIN rail mounted in an enclosure

Note: The mounting and wiring instructions in this manual apply to all module types except where noted.

Module dimensions are 13.25 in H x 5.575 in W x 2.75 in D (33.7 cm H x 15.2 cm W x 7 cm D). It is recommended that the modules be installed in a NEMA Type 1 enclosure for security purposes and to prevent damage.

Note: Minimum enclosure dimensions for one module are 20 in H x 9 in W x 8 in D (50.8 cm H x 22.9 cm W x 20.3 cm D). Estimate 2.75 in (7 cm) width for each added module.

The location of each enclosure or module is shown on the building layout drawings that have been approved by the customer. Ambient temperature in the enclosure should be 32 to 140°F (0 to 60°C), and humidity should be 0 to 90%, noncondensing.

Caution: Do not install these modules close to heaters, generators, power switching devices, or other equipment that generates electrical noise.

Before mounting the modules, install each enclosure in the designated area using the instructions provided by its manufacturer.

Panel Mounting

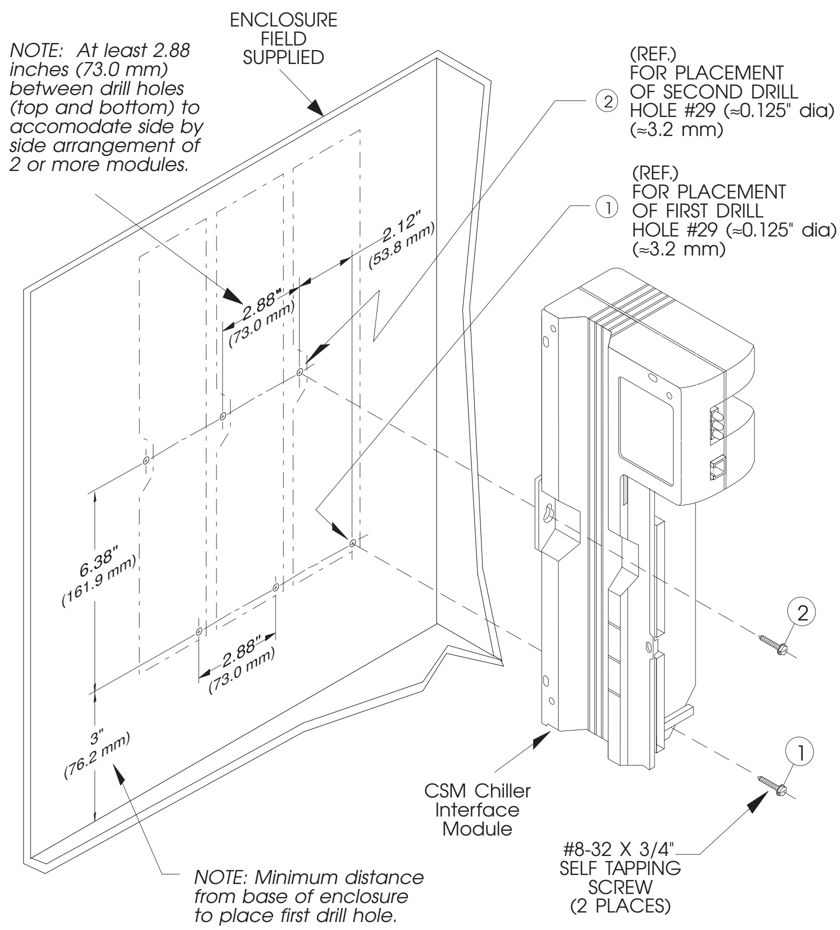
Modules can be panel mounted in any field-supplied standard NEMA Type 1 enclosure with a backplate.

1. Drill two holes for each module using a #29 bit. Refer to Figure 10 for mounting hole locations.

   Note: In Figure 10, the Comfort Controller 6400 has its door removed to better show the mounting components. You need only to open the door.

2. Partially attach two, 3/4 in, #8-32, self-tapping screws to the mounting surface.
3. Slide the screws into the holes.
4. If necessary, open the module door and tighten the screws to secure the module.

Figure 10
Panel Mount Installation Showing Mounting Hole



Rail Mounting in a UT203 FID Enclosure

You can rail mount modules in a Carrier UT203 FID enclosure.

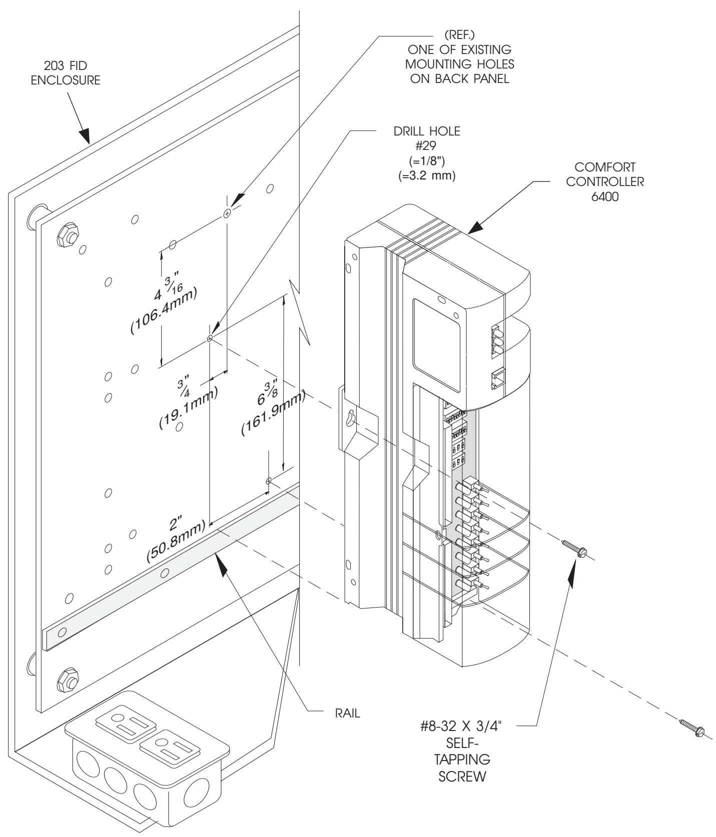
Note: All modules require two slots in the UT203 FID enclosure.

1. Using a #29 bit, module dimensions are 13.25 in H x 5.575 in W x 2.75 in D (33.7 cm H x 15.2 cm W x 7 cm D), drill one mounting hole using existing holes as a reference, as shown in Figure 11.

   Note: In Figure 11, the Comfort Controller 6400 has its door removed to better show the mounting components. You need only to open the door.

2. Partially attach the 3/4 in, #8-32, self-tapping screw provided in the keyhole on the module.
3. Slide the module into place on the rail.
4. If necessary, open the module door and tighten the screw to secure the module.

Figure 11
Rail Mounted in a UT203 FID Enclosure



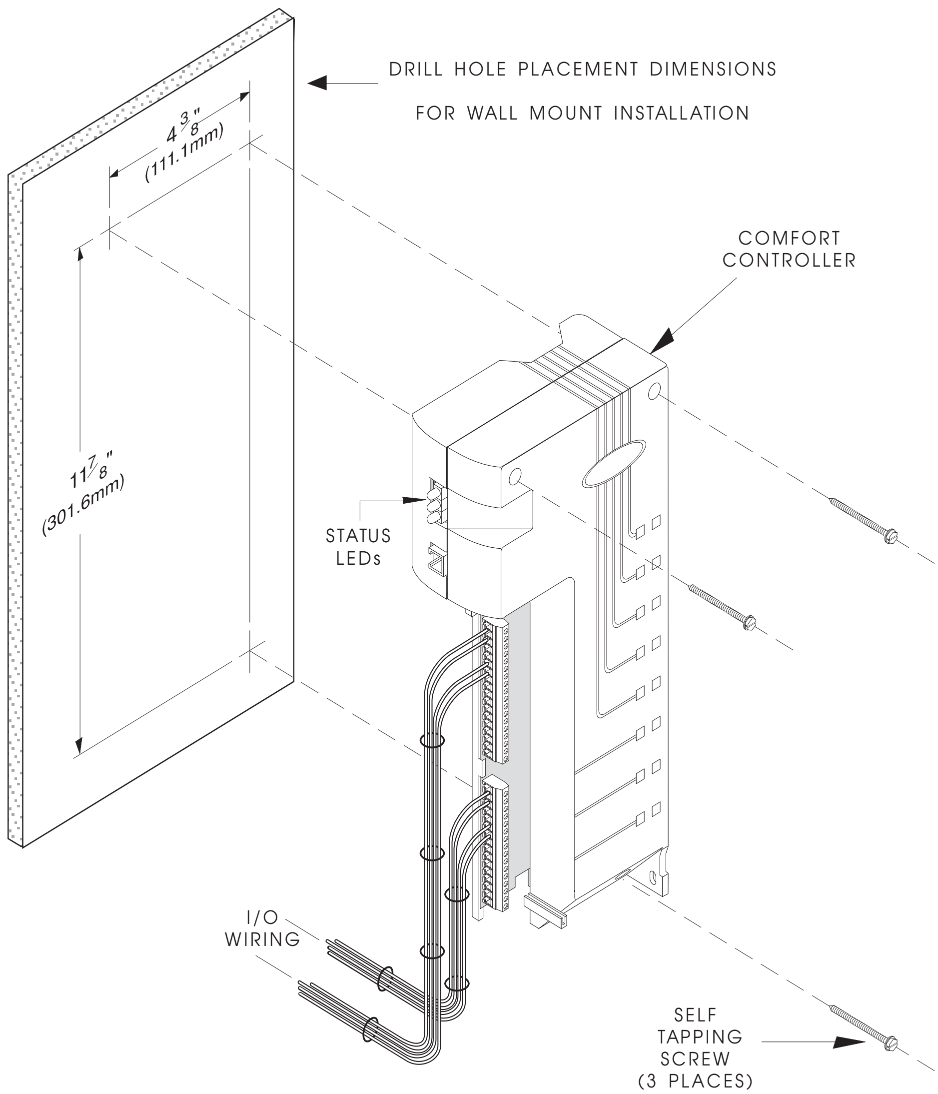
Wall Mounting

Modules should be flush mounted in a location where the enclosure depth is shallow, such as inside a control panel, or on the side of a unit, such as an air handler.

1. Using a #29 bit, drill three mounting holes as shown in Figure 12.
2. Attach the module using three, 1-1/2 in, #8-32, self-tapping screws.

Note: Orient the module so that you have access to the connectors and switches. Comfort Controller 6400 and 6400-I/O module covers should be clear of obstacles to operate properly.

Figure 12
Wall Mount Installation Showing Mounting Hole Locations



DIN Rail Mounting

Modules can be mounted on field-supplied DIN rails in an enclosure.

1. Install the DIN rails spaced as shown in Figure 13.

2. Partially attach two #8-32 screws on each module, one in the keyhole slot and one in the slotted hole on the bottom.

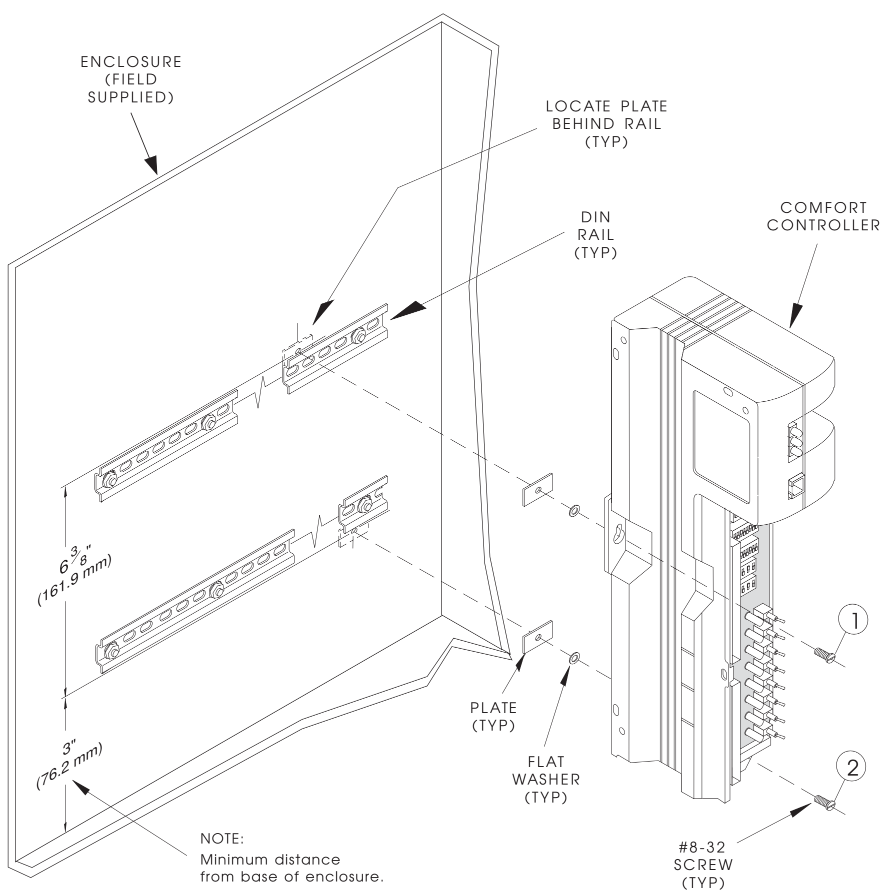
3. Attach the keyhole slot on the module to the mounting bracket on the top rail using a flat washer and plate as shown in the figure. Position the plate behind the rail.

4. Tighten the first screw, opening the module cover if necessary.

5. Fit the slotted hole on the bottom of the module to the mounting bracket below the bottom rail using a flat washer and plate as shown in the figure. Position the plate behind the rail.

6. Tighten the second screw to secure the module.

Figure 13
DIN Rail Mounted in an Enclosure Showing Rail Spacing



LID Installation

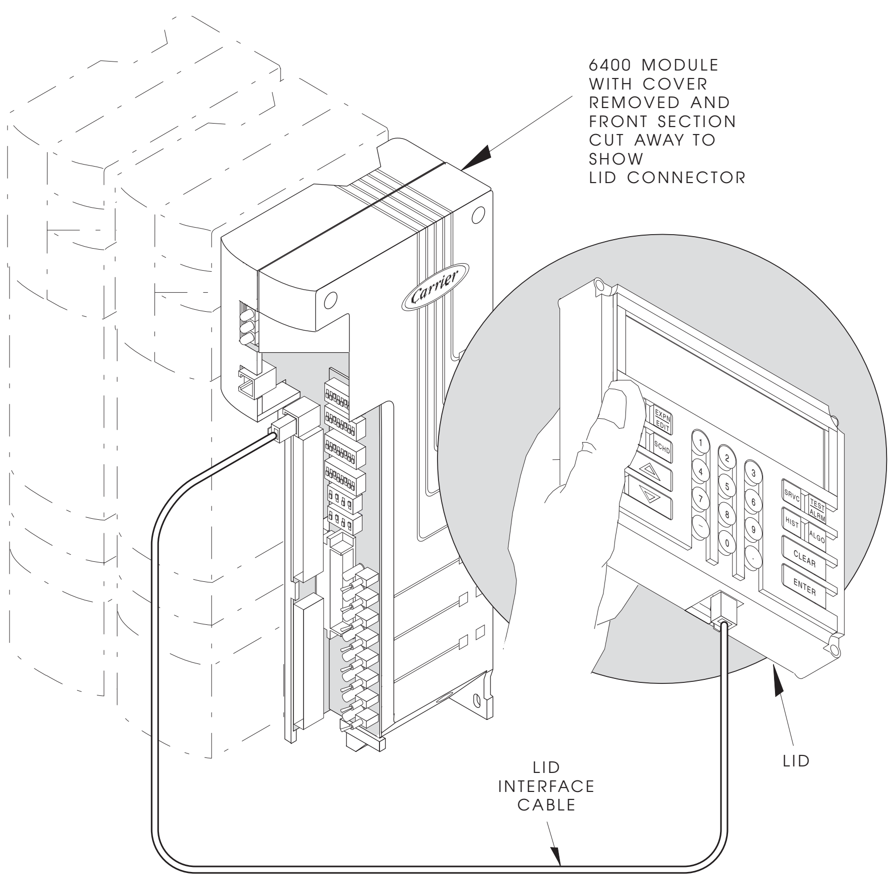
The LID can be hand held, wall mounted, or installed in the NEMA-1 enclosure door. Refer to Figure 14 for LID interface cable connections.

Hand Held

When you use the LID as a hand held device, you can connect it to either the Comfort Controller 6400, the Comfort Controller 1600, or any Comfort Controller 6400 I/O-Module.

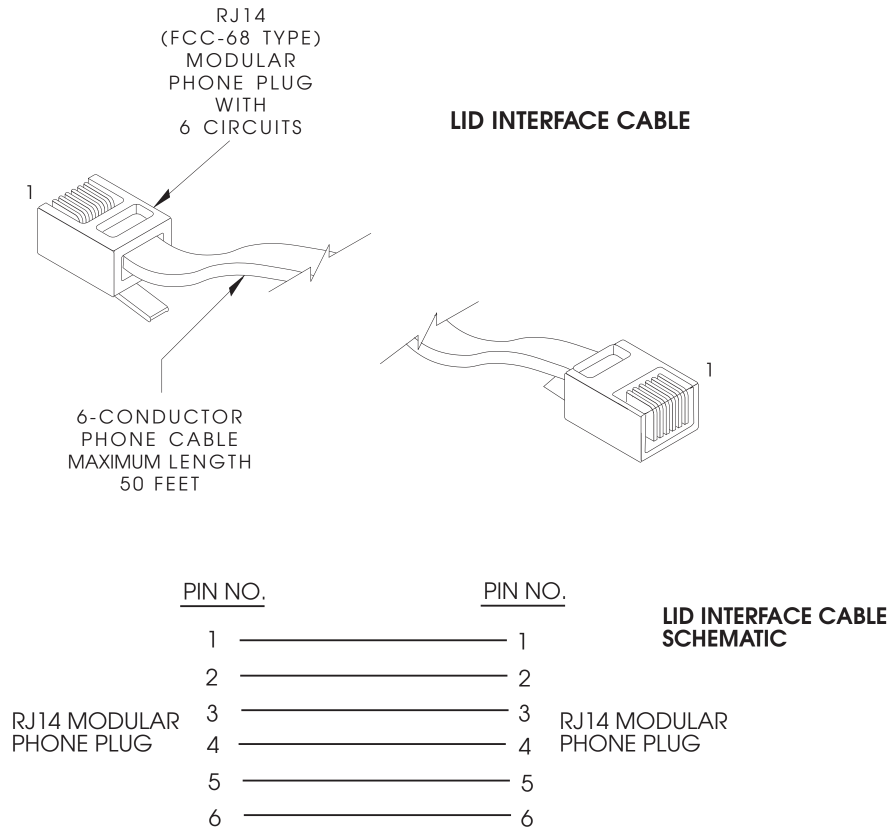
1. Connect the LID interface cable to the LID.
2. Connect the other end of the cable to the module as shown in Figure 14.

Figure 14
Connecting the LID as a Hand Held Device



The LID interface cable, shown in Figure 15, is a six-conductor phone cable with RJ14 type modular phone plugs attached to one or both ends.

Figure 15
The LID Interface Cable



Note: The LID interface cable is a “straight through” cable; there are no pin swaps from one RJ14 plug to the other.

Interface cable connections are shown in Table 1 below.

Table 1
Interface Cable Connections

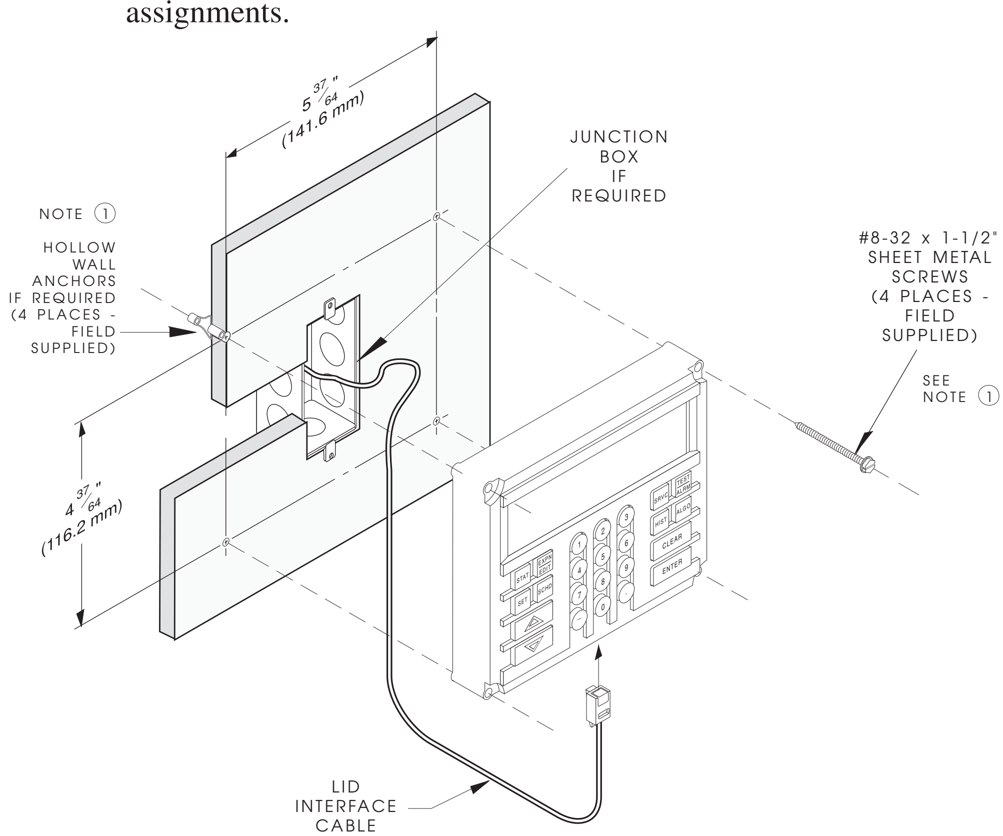
Pin	Function
1	24 Vdc
2	Comm (+)
3	Comm (gnd)
4	Gnd
5	Comm (-)
6	Gnd

Wall Mount

When you wall mount the LID, you can communicate with either one Comfort Controller 6400 with I/O Modules or one Comfort Controller 1600.

1. If required, install a junction box as shown in Figure 16.
2. If required, drill four holes for field-supplied wall anchors and install them.
3. Connect the LID interface cable to the LID.
4. Attach the LID to the wall with four #8 x 1-1/2 in sheet metal screws.
5. Wire the other end of the cable to the I/O Module Communication Bus. Refer to Table 1 on the previous page for pin assignments.

Figure 16
Wall Mounting the LID



Enclosure Mount

When you mount the LID in the NEMA-1 enclosure, it can communicate with either Comfort Controller 6400 with I/O Modules or one Comfort Controller 1600.

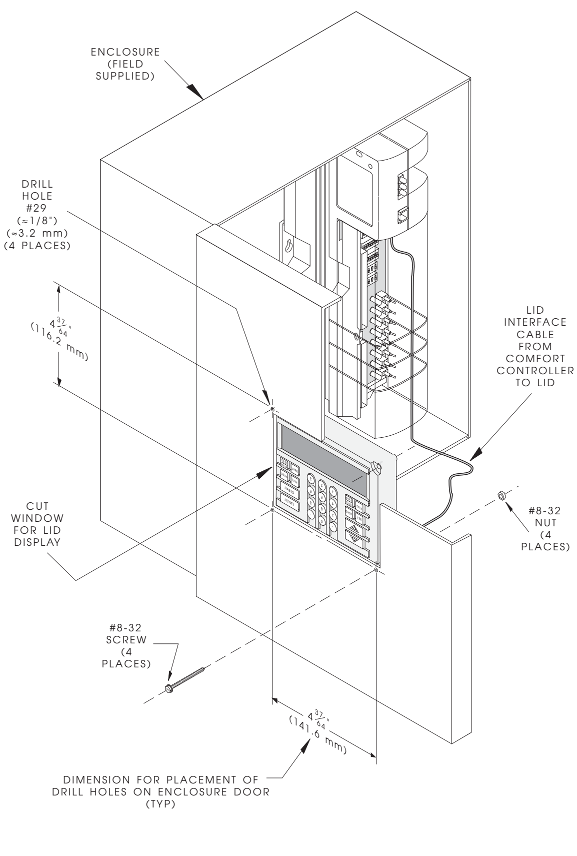
To flush mount the LID:

Follow the instructions for the wall mount, except use a #29 drill bit and four, 1-1/2 in, #8-32, self-tapping screws. Wire power and communications directly.

To door mount the LID:

1. Cut a rectangular hole 4 37/64 in x 5 37/64 in (116.2 mm x 141.6 mm) in the enclosure door as shown in Figure 17.
2. Drill four mounting holes.
3. Fit the LID into the opening and attach it using four, 1-1/2 in, #8-32 screws and nuts.
4. Connect the LID interface cable to the LID.
5. Connect the LID interface cable to the module as shown in Figure 14.

Figure 17
Mounting the LID in an Enclosure Door



Power Supply Installation

Comfort Controller 6400, 6400-I/O, and 1600 Modules use a field-supplied standard 24 Vac or 33 Vdc power source. Power requirements are the following:

Comfort Controller Module	Class 2 rated 24 Vac ± 15%	33 Vdc ± 15 %
1600, 6400, 6400-I/O	60 VA	1.5 A

All installation wiring must conform to the following requirements:

- Observe all applicable local codes, ordinances, and regulations.
- All module power wiring should be as short as possible.
- Do not run primary power wiring in the same conduit or Electrical Metallic Tubing (EMT) as the CCN Communication Bus, sensor field wiring, or device field wiring.

24 Vac Power Supply

The power supply should have minimum 60VA, Class II rated, or fused secondary. Install it according to the manufacturer's installation instructions.

The secondary winding of the power supply must be fused. A 3.3A slow blow fuse is recommended. Refer to the manufacturer's specifications.

Warning: Do not plug in or turn on the power supply at this time.

33 Vdc Power Supply

Install the power supply using the instructions provided by the manufacturer.

Warning: Do not plug in or turn on the power supply at this time.

Sensor and Device Installation

Install input and output field devices where specified in the building layout drawings. Refer to the manufacturer's installation instructions for each device. These instructions appear on the following pages.

Starter Enclosure Current Status Wiring

Purpose: The remote control of fans and pumps requires interfacing to an HOA (Hand Off Auto Switch) or push button switch for each fan or pump. The System Sheets define what devices are required at each starter. An S-1 indicates that the existing on/off switch must be replaced with a new HOA switch as shown on the following diagrams. An R-20 or R-21 indicates that a control relay must be added as shown on the following diagrams. An IR indicates that a status relay must be added as shown on the diagrams.

Installation Requirements:

- The components required for control of devices can be installed within existing motor control panel enclosures. The purchaser recommends this approach where practical with respect to cost/space considerations. Otherwise, it is recommended that separate NEMA 1 enclosures be installed by the Electrical Contractor.

- Existing HOA or push button switches can be used if other circuits are not affected, if the switch is rated for the application, and if the switch is in good condition.

- Control relays shall be wired in accordance with the System Sheets so that the fan or pump being controlled shall be turned on when the relay is de-energized (unless otherwise specified by purchaser).

- Control relays shall be wired in accordance with the System Sheets so that the fan or pump being controlled shall be turned on when the relay is de-energized (unless otherwise specified by purchaser).

- All status relay contacts will be defined by the purchaser. Normally open contact applications will be used.

- When retrofitting a system in an existing building, the electrical contractor shall tie into the circuit as defined by the project engineer. This is to ensure that each motor circuit that is to be cut and modified is verified before modifications are made. The added controls must not interface with existing fan shutdown panels associated with life safety, such as central fire alarm system or fire department override panels. The purchaser's project engineer will assist in defining existing control schemes.

Hardware Definition

The following devices shall be provided and installed by the electrical contractor per the Hardware Summary Consolidation Sheet.

R-20 Control Relay - SPDT Contact:
Contact voltage .... 600V maximum
Contact current ....10 Amps
Coil voltage.. 24 Vdc, 50 mA maximum
Reference .... P&B KUP
5 D15-24V with 27E
121 screw terminal socket or equivalent

R-21 Control Relay - DPDT Contacts:
Contact voltage .... 600V maximum
Contact current ....10 Amps
Coil voltage.. 24 Vdc, 50 mA maximum
Reference .... P&B KUP
5 D15-24V with 27E
121 screw terminal socket or equivalent

IR-1 Current Status Relays:
2-12 Amps

IR-2 Current Status Relays:
10-15 Amps

IR-3 Current Status Relays:
40-100 Amps

All required enclosures shall be supplied by the Electrical Contractor.

Figure 18
Current Status Relay Wiring IR-1, IR-2, IR-3 Based on the Application and Length of Wire Run. (The relay can be wired either from the starter enclosure, MCC enclosure, or from the motor.)

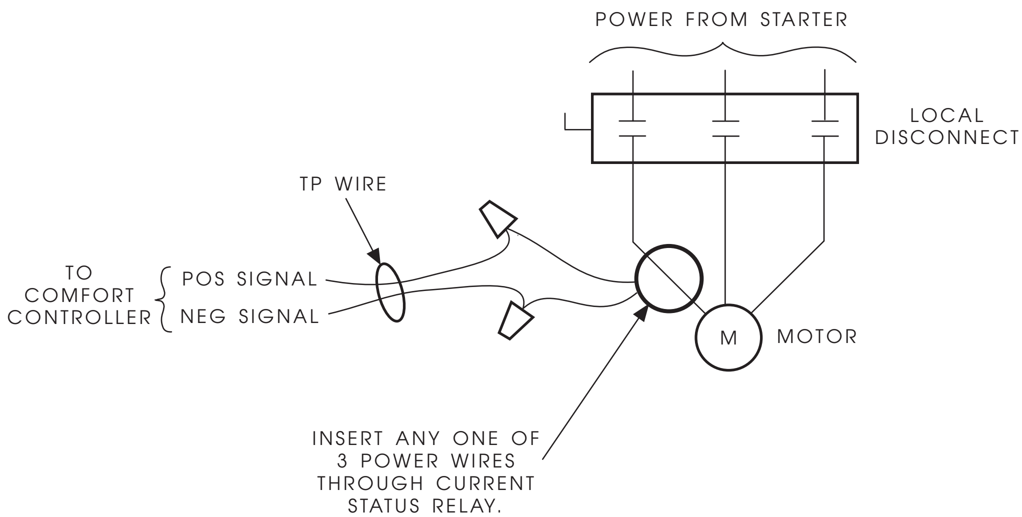
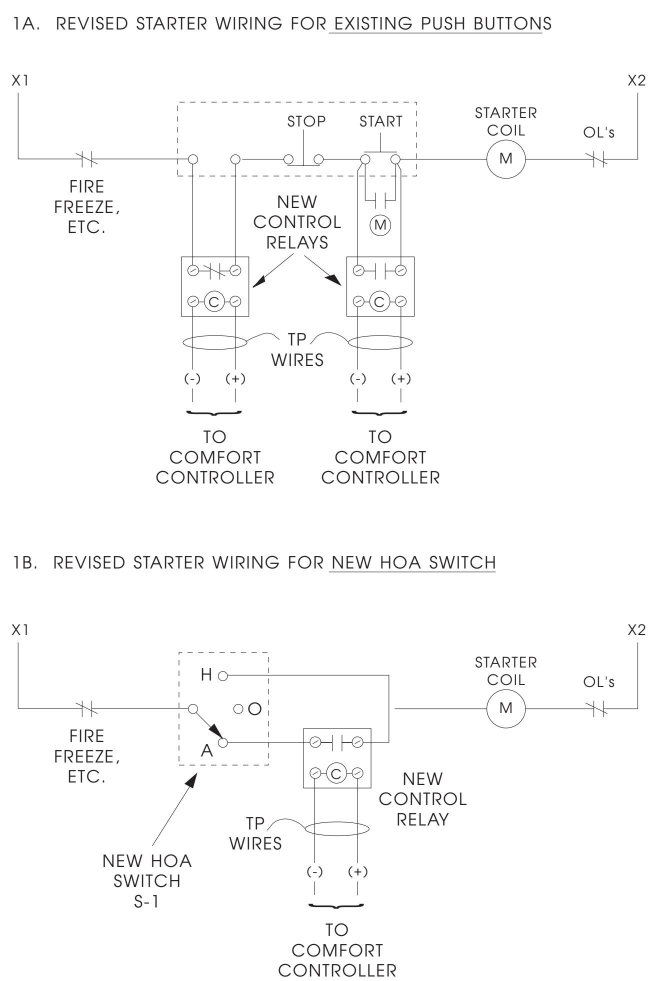


Figure 19
Existing Push Button Starter Wiring and Revised Starter Wiring



T-42S and T-42L Duct Air Temperature Sensors

The T-42 Duct Air Sensor (YSI 10K Thermistor) kits include the following components:

Component List:
- Duct Air Sensor mounted to utility box with attached gasket
- No. 10 Sheet Metal Screws
- Utility Box Cover
- No. 6-32 Machine Screws
- Wire Nuts

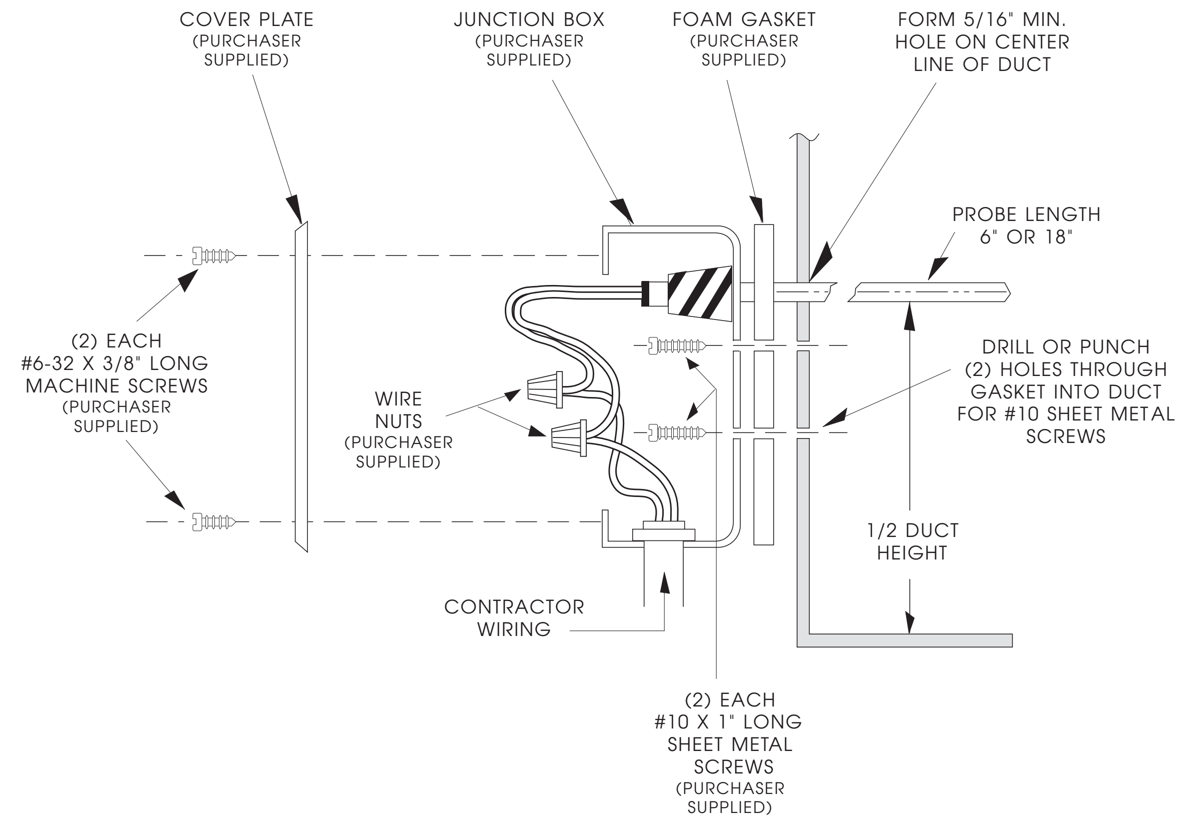
General Installation and Operation: The T-42 Series Duct Air Sensors are intended for air temperature measurement in any type of sheet metal HVAC duct work with mount hardware provided. Mounting is accomplished by providing a hole in the duct for sensor insertion and attaching the utility box to the outside of the duct with sheet metal screws.

Mounting Location: Punch or cut a 5/16 inch minimum diameter hole at a point approximately 1/2 of the duct height for the probe to be inserted. Remove one of the utility box knockouts in the desired position for system wire lead in. Insert the probe into the duct and position the box against the duct. (The long dimension of the box should be parallel to the axis of round ducts.) Match punch or drill 2 holes for No. 10 sheet metal screws into the duct through the utility box plus form gasket and mount the box. The duct air temperature sensor should be installed by connecting the thermistor leads to the sensor wire using wire nuts. (Polarity is not important.) If shielded sensor wire is provided, strip back the shield and tape to prevent contact. Attach the cover to the box with 6-32 machine screws.

General Precautions:
- Select sensor length such that tip is within center 1/3 of duct width.
- Mount sensor approximately on the side of the duct at 1/2 the duct height.
- Do not overtighten the sheet metal screws.

Generally installed and wired by electrical contractor.

Figure 20
T-42S and T-42L Duct Air Temperature Sensors



T-44S and T-44L Fluid Immersion Temperature Sensors

The T-44S and the T-44L Fluid Immersion Sensors (YSI 10K Thermistors) include the following components:

Component List:

- Fluid Immersion Sensor including sensor, thermowell, and weathertight junction box with cover plate, gasket, and 2 each 8-32 x 1/2 inch long machine screws.
- Hardware Kit consisting of 2 each wire nuts.

General Installation and Operation: The T-44S and the T-44L Fluid Immersion Sensors are designed to monitor internal pipe temperatures for use in energy management applications. This unit is designed with a removable temperature sensor to enable repair or replacement without interruping the fluid process. The T-44L is designed for insulated pipes with a 3 inch stand off. When mounted perpendicular to the flow, the T-44S and the T-44L fluid immersion sensors are designed to withstand a maximum pressure of 4000 PSI and a maximum velocity of 25'/second. If pressure and/or velocity is to exceed these two values, purchase an additional 3/4 inch NPT well and insert the T-44S or T-44L into the well.

This unit is designed with a removable temperature sensor to enable repair or replacement without interrupting the fluid process.

Mounting Location: Most installations are made by making a weld or cut in the line. Placement of this sensor should be as directed.

Orientation is not important; the unit may be mounted either horizontally or vertically. It is preferable to have the sensor tip extended into the line as close to half the diameter as possible. As an example, if a 4 inch pipe is being fitted, the sensor should enter into it a distance of 2 to 2 1/2 inches. On pipes with a diameter of 3 inches or less, the easiest way to obtain the correct insertion depth is by using nipple-union extensions and the threaded fitting on the sensor.

The sensor should be screwed in by hand until bottoming out and tightened an additional 1/8 of a turn (approx.) with a wrench.

Electrical connections are quite simple, as there is no polarity involved. The fluid immersion temperature sensor should be installed by connecting the thermistor leads to the sensor wiring using wire nuts. Install the gasket and cover plate.

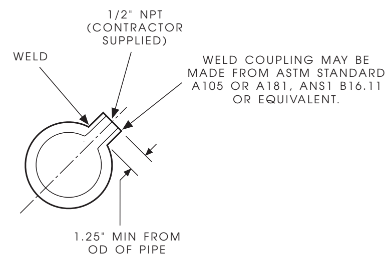
Figure 21
T-44S and T-44L
Fluid Immersion
Temperature Sensor

If shielded sensor wire is provided, strip back the shield and tape to prevent contact.

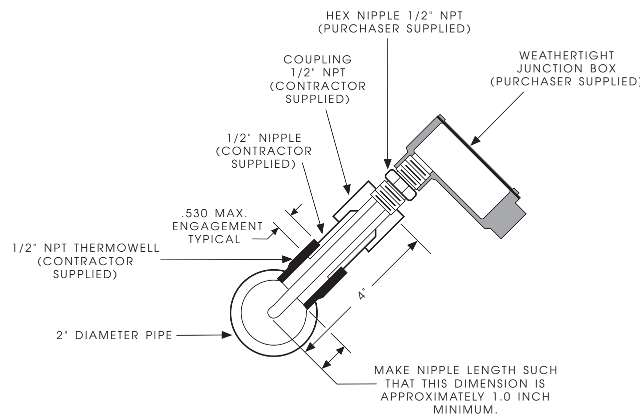
Generally installed and wired by electrical contractor.

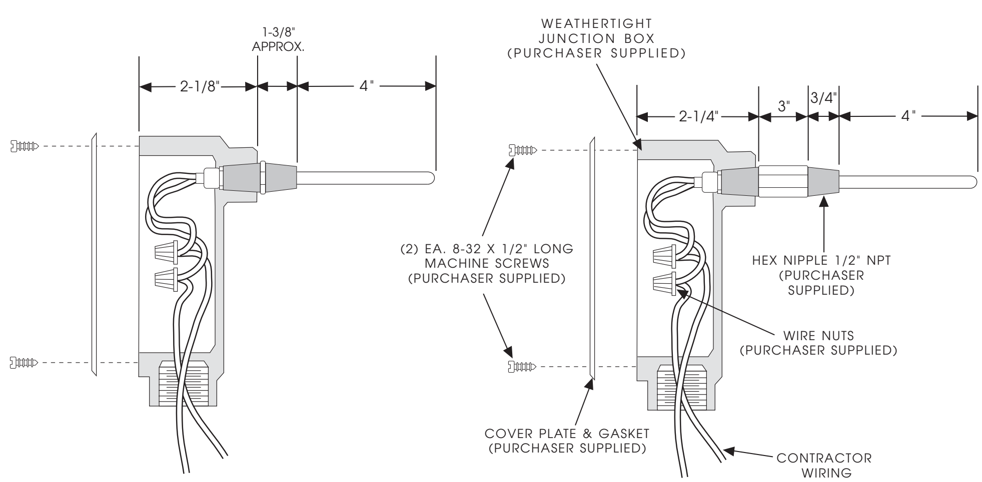
STANDARD PIPE INSTALLATION

1. If insulation is on pipe, remove a sufficient amount to allow installation welded coupling.
2. Drill or burn hole in process pipe to accept Threaded coupling. Align coupling square and perpendicular to axis of pipe and weld all around to provide a leak proof joint.
3. Thread device into weld coupling with thread sealant.



ADAPTER FOR SMALL DIAMETER PIPES





T-46 Outside Air Temperature Sensor

The T-46 Outside Air Sensor (YSI 10K Thermistor) includes the following components:

Component List:

- Outside Air Sensor
- Wire Nuts

General Installation and Operation: The T-46 Outside Air Sensor is designed to continuously monitor outdoor temperature. Its housing is constructed of PVC with an integral sensor shield to prevent ice formation on the sensitized portion and eliminate erroneous readings caused by solar radiation.

Mounting Location: The unit should be positioned with the sensor (slotted) end pointed downward. The housing is threaded to screw into a male 1/2 inch NPT EMT conduct adaptor so that the unit is mounted parallel to the building wall. This is not mandatory, as it can be installed on a roof or other location.

General Precautions: Successful operation of an energy management system relies on accurate knowledge of outside temperature. To obtain good readings, the sensor must not be subjected to extraneous sources such as the exhaust from air handling units, AC compressors or leakage drafts of indoor air. Landscaping such as shrubbery or trees can cause interference so the unit should be mounted away from any of these. Do not mount under direct water runoff as it will freeze around the sensor in winter and produce a false reading.

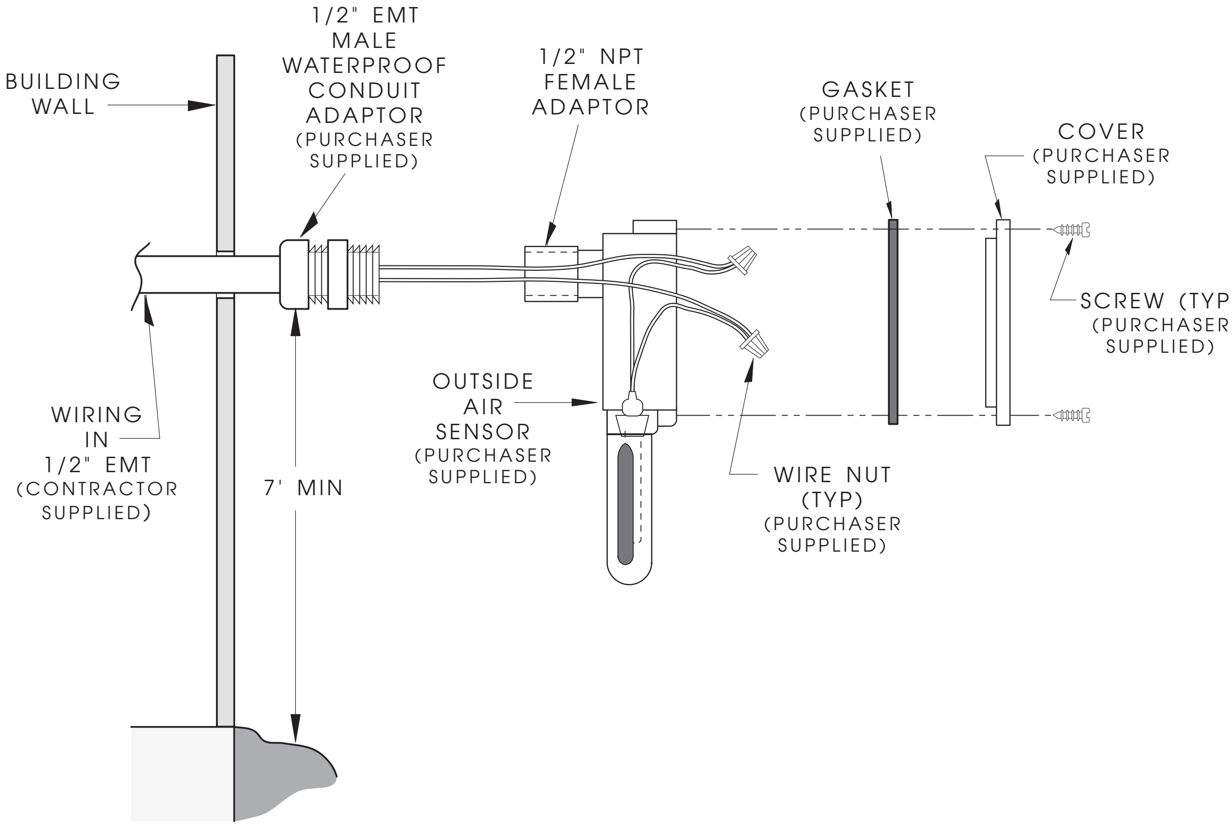
Because the sensing element is a thermistor, there is no polarity consideration.

The outside air temperature sensor should be installed by removing the box cover and connecting the thermistor leads to the sensor wiring using wire nuts.

If shielded sensor wire is provided, strip back the shield and tape to prevent contact.

Generally installed and wired by electrical contractor.

Figure 22
T-46 Outside Air Temperature Sensor



T-47S and T-47L Pipe Clamp Temperature Sensors

The T-47S and the T-47L Pipe Clamp Sensors (YSI 10K Thermistors) include the following components:

Component List:
- Pipe Clamp Sensor
- Wire Nuts

General Installation and Operation: The Model T-47 Pipe Clamp Sensor is available in two sizes to accommodate pipes of any diameter from 3 inches upward. This unit provides accurate temperature readings of liquids in a line if the pipe material is thermally conductive such as cast iron, stainless steel, or copper.

The Model T-47S Series Pipe Clamp Sensor is adjustable for 3.00' to 9.00'.

The Model T-47L Series Pipe Clamp Sensor is adjustable from 9.25' to 16.00'.

Mounting Location: This unit is mounted by placing the stainless steel clamp around the pipe and tightening it sufficiently so that no movement is possible. DO NOT overtighten it as this will strip the threads of the clamp. If desired, insulation can be placed around the clamp after mounting, as there is no need to remove the sensor once it is installed.

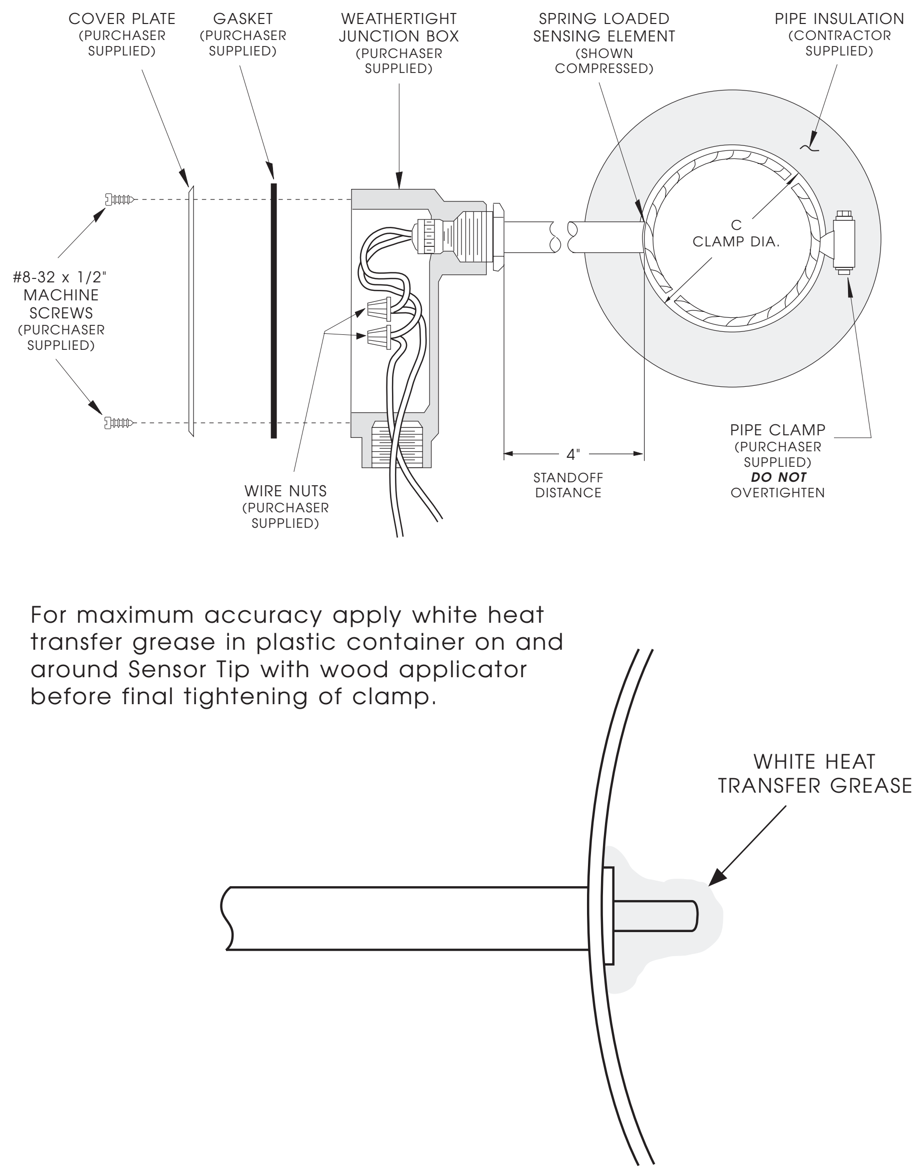
The pipe clamp temperature sensor should be installed by removing the cover and connecting the thermistor leads to the sensor wiring using wire nuts. Since this sensor uses thermistor elements, there is no polarity consideration.

General Precautions: If shielded sensor wire is provided, strip back the shield and tape to prevent contact.

- Pipe insulation must be removed before installation.
- Trim excess material from pipe clamp before installing insulation.

Generally installed and wired by electrical contractor.

Figure 23
T-47S and T-47L Pipe Clamp Temperature Sensors



T-48 Low Temperature Cutout Thermostat

Sensor Applications: The Low Temperature Cutout Thermostat consists of the following components:

Component List:
- Low Temperature Cutout Thermostat with cover, range adjusting screw, 20' (6.1m) sensing element, and manual reset button
- 8-32 x 1/4" binder heat terminal screws

General Installation and Operation: Used to sense the air temperature in air plenums where there is a possibility of air stratification. The sensor is wired to shut down the air system when the temperature becomes excessively low. The sensor responds to the lowest temperature at any point along its 20' sensing element. It may also be used to initiate a low temperature alarm.

Specifications:

Temperature range .... 15 to 55°F (-9 to 13°C)

Temperature differential .... 5°F, non-adjustable (2.8°C)

Contacts .... DPST
one contact opens on temperature drop,
second contact simultaneously closes

Contact Ratings
Main Contact ....120 Vac, 16.0 Full Load Amps
240 VAc. 8.0 Full Load Amps
24 to 600 Vac, 125 VA, pilot duty
Auxiliary Contact ....120 Vac, 16.0 Full Load Amps
240 VAc. 3.0 Full Load Amps
24 to 600 Vac, 125 VA, pilot duty

Component List: The T-48 Low Temperature Cutout Thermostat includes the following components:

- 17 ft. flexible Sensor
- General purpose galvanized steel utility junction box with cover plate
- Foam gasket
- Hardware kit consisting of 2 each wire nuts 2 each No. 10 sheet metal screws

General Description: The 17 ft. flexible averaging sensor is designed for use in plenums and large air ducts where there may be a wide range of temperatures. The sensor is designed to detect if the temperature becomes excessively low.

Duct Mounting: The copper tubing surrounding the sensor element can be bent to conform to the area of the duct, but must not be bent less than 2 1/2 inch diameter on any given turn. As a rule the sensor element should be evenly distributed over the entire cross-sectional area of the duct. Existing support structures for the element may be used so long as there is no metal-to-metal contact with the copper tubing and the mounting does not interfere with other functions or workmanship performed by other trades. Otherwise, a separate PVC support system must be supplied and installed by this contractor. Punch a 1.00" diameter hole in the duct, feed sensor element through and mount utility box. Form element as described above and secure.

If shielded sensor wire is provided, strip back the shield and tape to prevent contact.

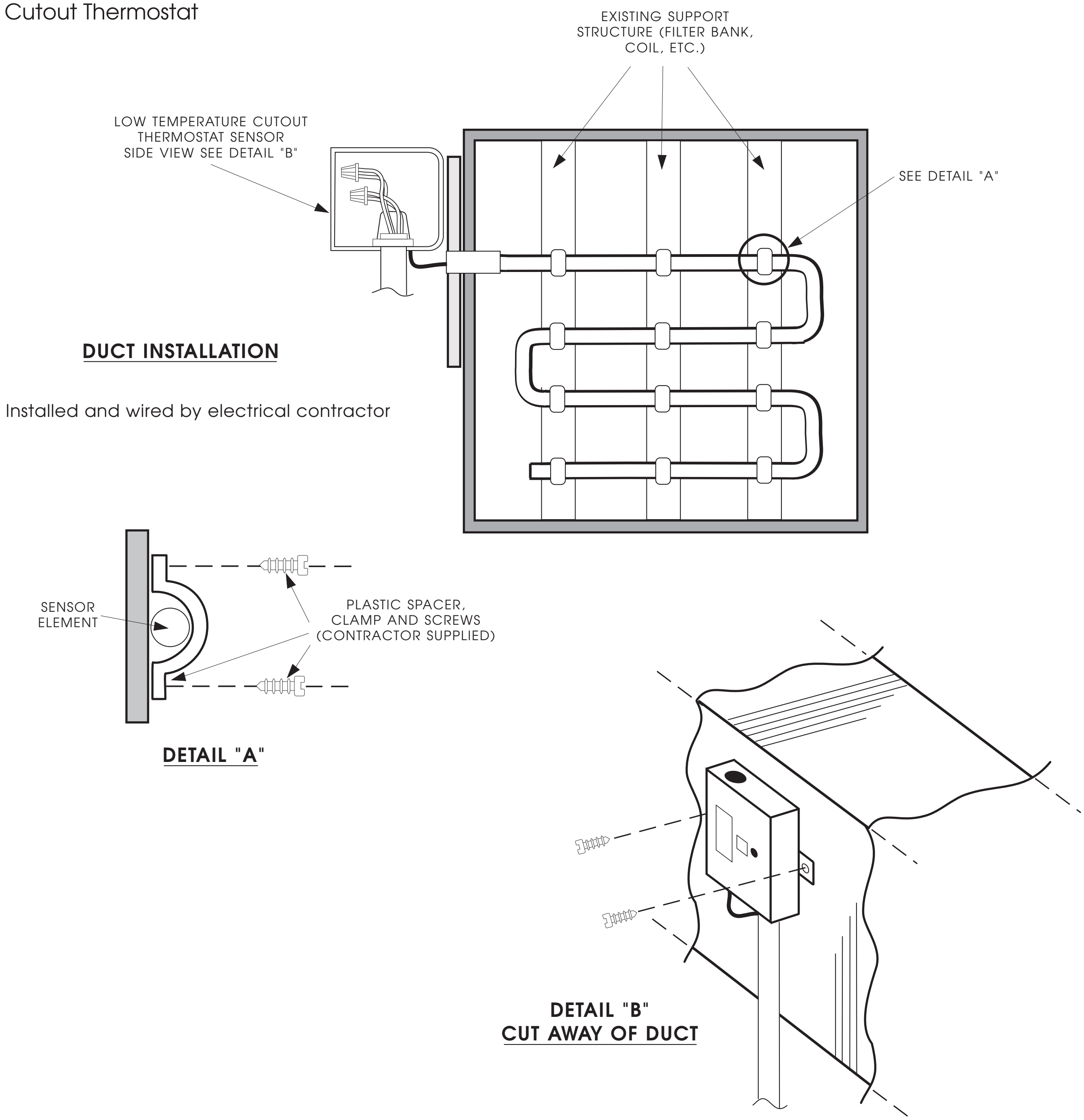
Inaccessible Duct: When space does not allow working inside the duct wrap element around 3/4" PVC. Cut holes near the center of the duct on either side, feed PVC with element through, secure and seal around PVC.

Important Notes:

- Avoid repeated bending of copper tubing as this will place stress on sensor element leading to eventual breakage.
- Do not fold or crimp copper tubing.
- Use care in forming and securing element.

Generally installed and wired by electrical contractor.

Figure 24
T-48 Low Temperature
Cutout Thermostat



T-49 Averaging Temperature Sensor

The T-49 Averaging Temperature Sensor (1K RTD Sensor) kit includes the following components:

Component List:
- 17 ft. flexible Sensor
- General purpose galvanized steel utility junction box with cover plate
- Foam gasket
- Hardware kit consisting of 2 each wire nuts 2 each No. 10 sheet metal screws

General Description: The 17 ft. flexible averaging sensor is designed for use in plenums and large air ducts where there may be a wide range of temperatures. The sensor is designed to detect the average temperature over its length.

Duct Mounting: The copper tubing surrounding the sensor element can be bent to conform to the area of the duct, but must not be bent less than 2 1/2 inch diameter on any given turn. As a rule the sensor element should be evenly distributed over the entire cross-sectional area of the duct. Existing support structures for the element can be used so long as there is no metal-to-metal contact with the copper tubing and the mounting does not interfere with other functions or workmanship performed by other trades. Otherwise, a separate PVC support system must be supplied and installed by this contractor. Punch a 1.00" diameter hole in the duct, feed sensor element through and mount utility box. Form element as described above and secure.

If shielded sensor wire is provided, strip back the shield and tape to prevent contact.

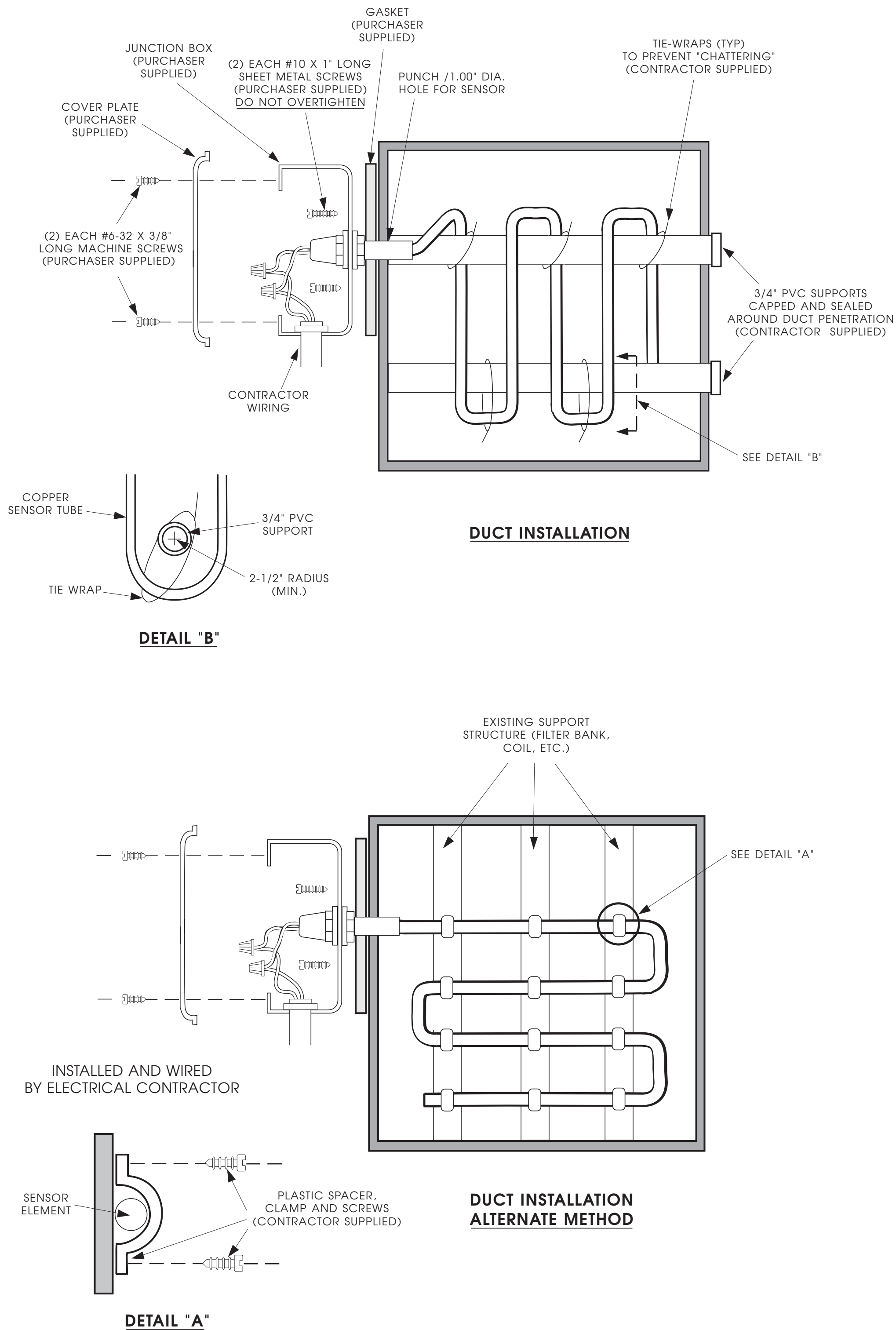
Inaccessible Duct: When space does not allow working inside the duct wrap element around 3/4" PVC. Cut holes near the center of the duct on either side, feed PVC with element through, secure and seal around PVC.

Important Notes:
- Avoid repeated bending of copper tubing as this will place stress on sensor element leading to eventual breakage.
- Do not fold or crimp copper tubing.
- Use care in forming and securing element.

Generally installed and wired by electrical contractor.

Figure 25

T-49 Averaging Temperature Sensor



T-55 Space Temperature Sensor with Override

The T-55 Space Temperature Sensor with Override (YSI 10K or MCI 10K Thermistor — jumper dependent) consists of the following components:

Component List:
- Space temperature sensor assembly
- Two No. 10 brass fillet head screws

General Instruction and Operation: The T-55 sensor is installed on interior walls to measure room space air temperature.

The T-55 sensor features an integral override button for initiating a timed override. Refer to the specific application literature to determine how the override function interacts with the application and how to use the override button.

The T-55 sensor's wall plate accommodates both the NEMA standard and the European 1/4 DIN standard. A junction box is recommended for installation, to accommodate the wiring. The T-55 sensor may be mounted directly on the wall when acceptable to local codes.

Note: Clean the sensor with a damp cloth only. Do not use solvents.

Selecting the Thermistor Curve: The T-55 is factory set to the MCI curve as a default. Before you install the sensor, the jumper should be between E2 and E3. See Figure 28.

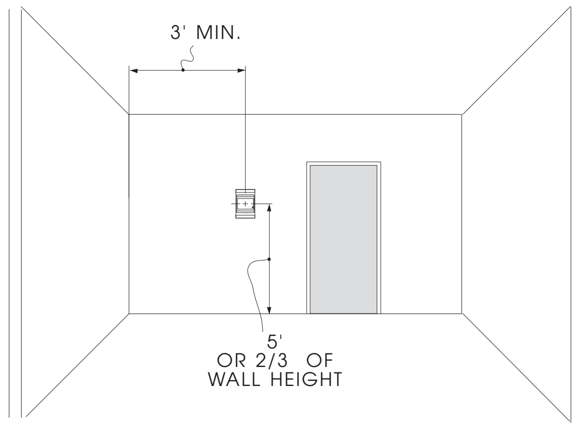
To remove the sensor cover, insert the blade of a small screwdriver into the sensor cover latch slot on the bottom of the sensor cover. Gently push upward on the screwdriver to release the cover latch and rotate the cover forward as the screwdriver is removed.

Locating the Sensor: Mount the T-55 sensor approximately five feet up from the floor, in an area that represents the entire zone being measured. See Figure 26 on the next page.

Never mount the sensor in drafty areas such as near heating or air conditioning ducts, open windows, fans or over heat sources such as baseboard heaters or radiators. These areas produce temperature extremes that cause inaccurate readings.

Avoid mounting the sensor in corner locations. Allow at least three feet between the sensor and any corner. Airflow near corners tends to be reduced, resulting in improper sensor readings.

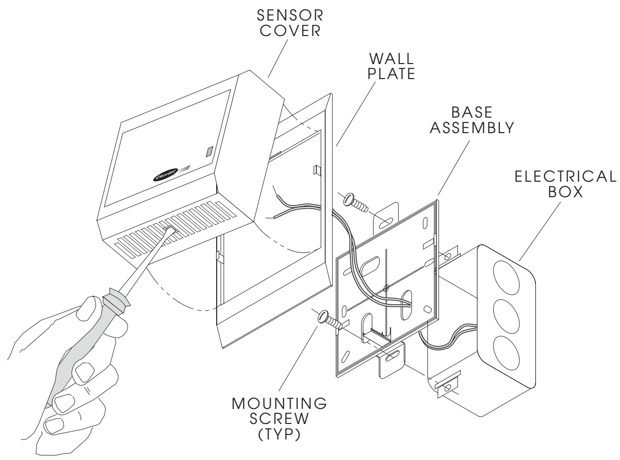
Figure 26
T-55 Sensor Location



To Install the T-55 Sensor:

1. Remove the sensor cover: using a small blade screwdriver, insert the blade into the sensor cover latch slot on the bottom of the cover. Gently push upward on the screwdriver to release the cover latch and rotate the cover forward as the screwdriver is removed.
2. Snap off the wall plate from the base assembly.
3. Feed the wires from the electrical box through the sensor base assembly.
4. Using two 6-32 x 5/8 inch screws, mount the sensor base assembly to the electrical box.
5. Dress the wires down and inside the perimeter of the sensor base.
6. Attach the wall plate by snapping it onto the sensor base assembly.
7. Replace the cover by inserting the top inside edge of the cover over the tab on top of the sensor base assembly and rotating the cover down. Snap the cover on.

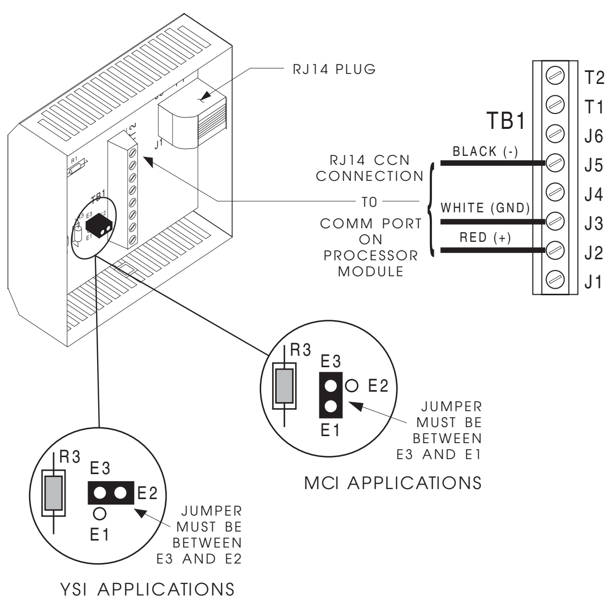
Figure 27
T-55 Sensor Installation



To Wire the Space Temperature Sensor:

1. Use a 20-AWG twisted pair conductor cable rated for the application.
2. Connect one wire of the twisted pair to terminal T1 and connect the other wire to terminal T2 of the terminal strip TB1 in the space temperature cover.
3. Refer to the installation instructions for your application to determine how to terminate the wires at the application end. This sensor must be configured/connected as a temperature Input, type 10K thermostat. Polarity of the wires does not matter.

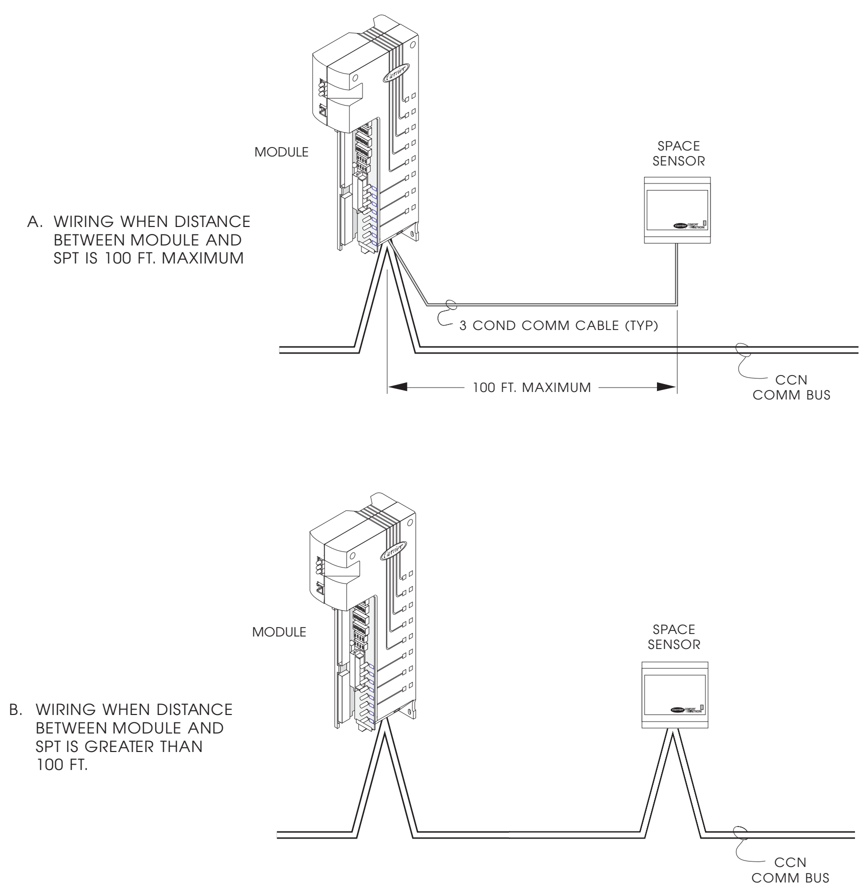
Figure 28
T-55 Space Temperature Sensor Wiring



To Wire the RJ14 Plug: The cable selected must be identical to the CCN Communication Bus wire used for the entire network. Refer to the application literature for communication bus wiring and cable selection. See Figure 28 for information about wiring the RJ14 plug.

1. Cut the CCN wire and strip the ends of the RED, WHITE, and BLACK conductors.
2. Insert and secure the RED (+) wire to pin J2 of the terminal strip TB1.
3. Insert and secure the WHITE (ground) wire to J3 of the terminal strip TB1.
4. Insert and secure the BLACK (-) wire to pin J5 of the terminal strip TB1.
5. The other end of the cable must be connected to a CCN communication bus on the Comfort Controller. Refer to the CCN Communication Wiring section of this manual.

Figure 29
Connecting the T-55 to the CCN Communication Bus



T-56 Space Temperature Sensor with Override and Setpoint Adjustment

The T-56 Space Temperature Sensor (YSI 10K or MCI 10K Thermistor — jumper dependent) with Override and Setpoint Adjustment consists of the following components:

Component List:

- Space temperature sensor assembly
- Two No. 10 brass fillet head screws

General Instruction and Operation: The T-56 Series Space Temperature Sensor with Override and Setpoint Adjustment is installed on interior walls to measure room space air temperature.

The T-56 sensor features an integral override button for initiating a timed override. The sensor also features an integral temperature slide switch that allows an occupant to adjust (bias) the heating and cooling setpoints upward and downward. Refer to the specific application literature to determine how the override function interacts with the application and how to use the override button.

The T-56 sensor's wall plate accommodates both the NEMA standard and the European 1/4 DIN standard. A junction box is recommended for installation, to accommodate the wiring. The T-56 sensor may be mounted directly on the wall when acceptable to local codes.

Note: Clean the sensor with a damp cloth only. Do not use solvents.

Selecting the Thermistor Curve: The T-56 temperature sensor is factory set to the MCI curve as a default. Before you install the sensor, the jumper should be between E2 and E3. See Figure 32.

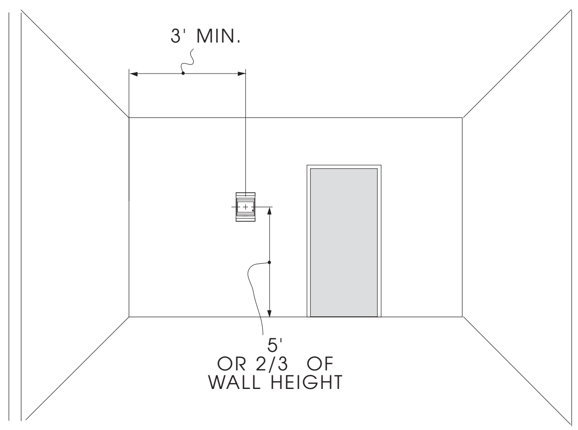
To remove the sensor cover, insert the blade of a small screwdriver into the sensor cover latch slot on the bottom of the sensor cover. Gently push upward on the screwdriver to release the cover latch and rotate the cover forward as the screwdriver is removed.

Locating the Sensor: Mount the T-56 sensor approximately five feet up from the floor, in an area that represents the entire zone being measured. See Figure 30 on next page.

Never mount the sensor in drafty areas such as near heating or air conditioning ducts, open windows, fans or over heat sources such as baseboard heaters or radiators. These areas produce temperature extremes that cause inaccurate readings.

Avoid mounting the sensor in corner locations. Allow at least three feet between the sensor and any corner. Airflow near corners tends to be reduced, resulting in improper sensor readings.

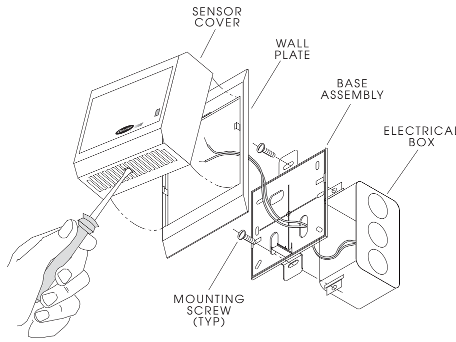
Figure 30
T-56 Sensor Location



To Install the T-56 Sensor:

1. Remove the sensor cover: using a small blade screwdriver, insert the blade into the sensor cover latch slot on the bottom of the cover. Gently push upward on the screwdriver to release the cover latch and rotate the cover forward as the screwdriver is removed.
2. Snap off the wall plate from the base assembly.
3. Feed the wires from the electrical box through the sensor base assembly.
4. Using two 6-32 x 5/8 inch screws, mount the sensor base assembly to the electrical box.
5. Dress the wires down and inside the perimeter of the sensor base.
6. Attach the wall plate by snapping it onto the sensor base assembly.
7. Replace the cover by inserting the top inside edge of the cover over the tab on top of the sensor base assembly and rotating the cover down. Snap the cover on.

Figure 31
T-56 Sensor
Installation



To Wire the T-56 Sensor:

1. Use a 20-AWG twisted pair conductor cable rated for the application.
2. Connect one wire to terminal TH and connect second wire to terminal COM of the terminal strip TB1 in the space temperature cover. Refer to the installation instructions for your application to determine how to terminate the wires at the application end. This sensor must be configured/connected as a 10K thermistor temperature sensor.

To Wire the RJ14 Plug: The cable selected must be identical to the CCN Communication Bus wire used for the entire network. Refer to the application literature for communication bus wiring and cable selection. See Figure 32 for information about wiring the RJ14 plug.

1. Cut one end of the CCN Communication Bus cable and strip the ends of the RED, WHITE, and BLACK conductors.
2. Insert and secure the RED (+) wire to pin CCN (+) of the terminal strip TB1.
3. Insert and secure the WHITE (ground) wire to CCN grd of the terminal strip TB1.
4. Insert and secure the BLACK (-) wire to pin CCN (-) of the terminal strip TB1.
5. The other end of the cable must be connected to the CCN Communication Bus on the Comfort Controller. Refer to CCN Communication Wiring later in this manual for wiring requirements.

Figure 32
T-56 Space Temperature Sensor Wiring

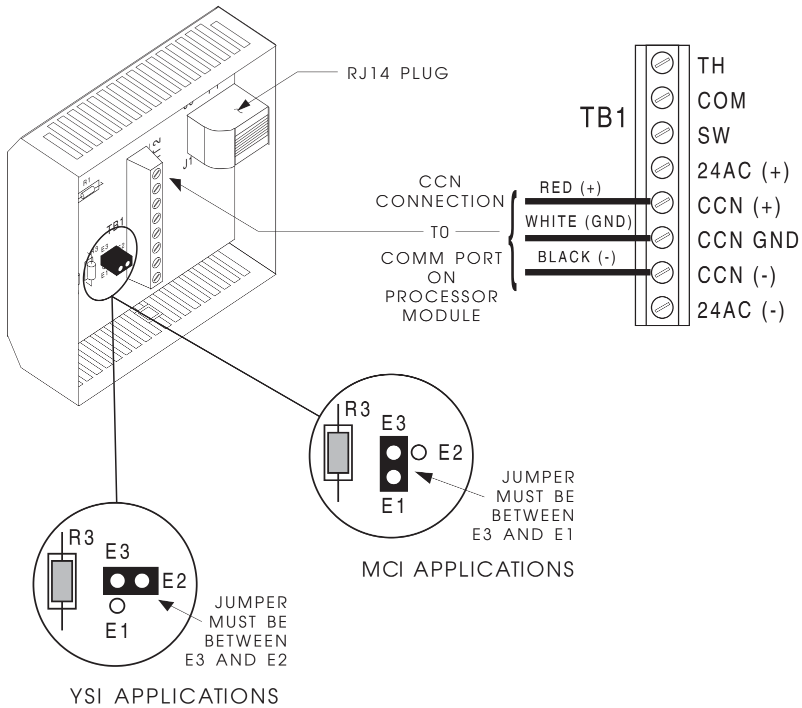
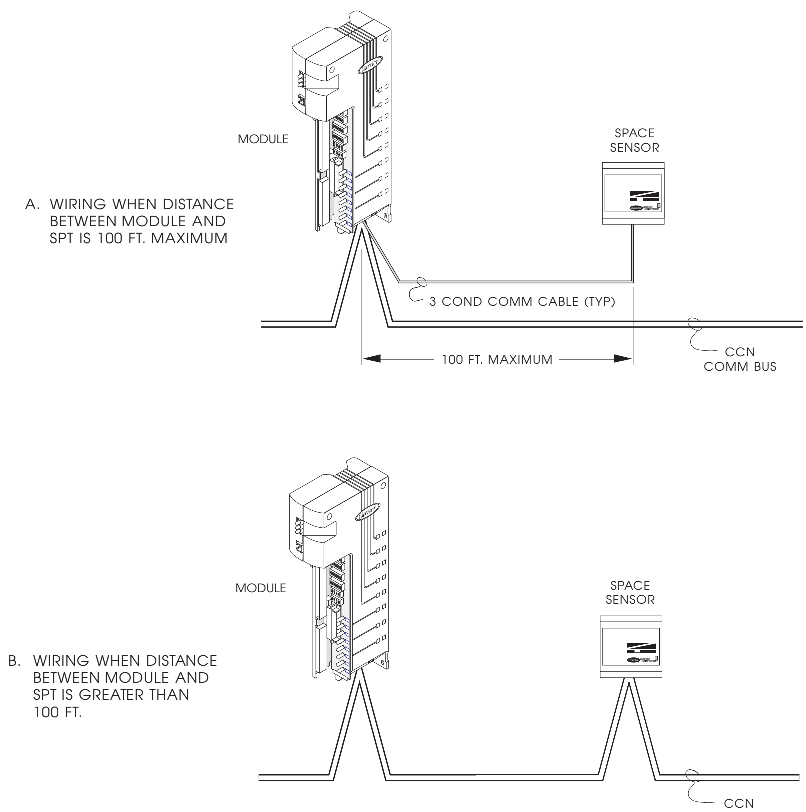


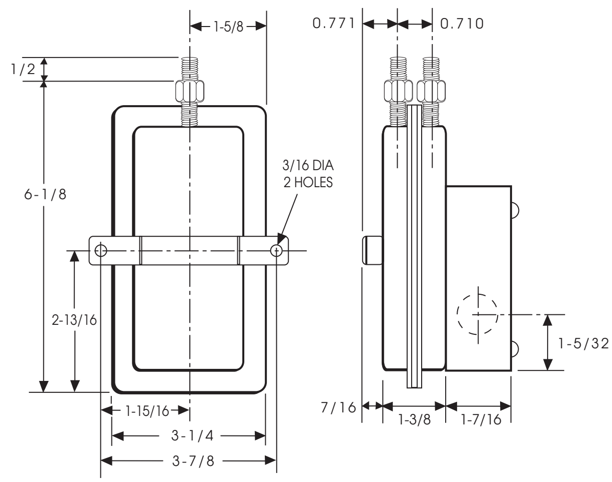
Figure 33
Connecting the T-56 to the CCN Communication Bus



P-23 Differential Air Pressure Switch

This sensor is equivalent to Cleveland Instruments, Cleveland #AFS 405 0-12" WG.

Figure 34
P-23 Differential Air Pressure Switch

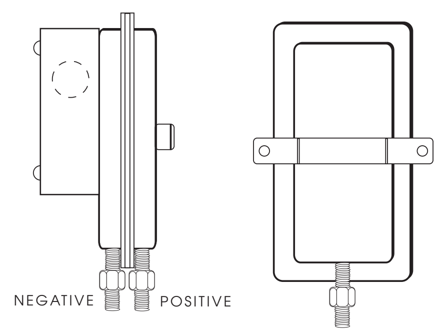


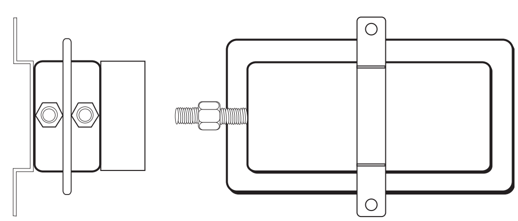
DIMENSIONS IN INCHES

SENSOR INSTALLED BY
Control Piping Contractor

SENSOR WIRE INSTALLED BY
Electrical Contractor

The sensor must be mounted with the diaphragm in a vertical plane as shown.





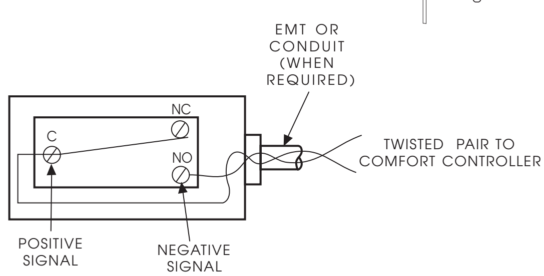
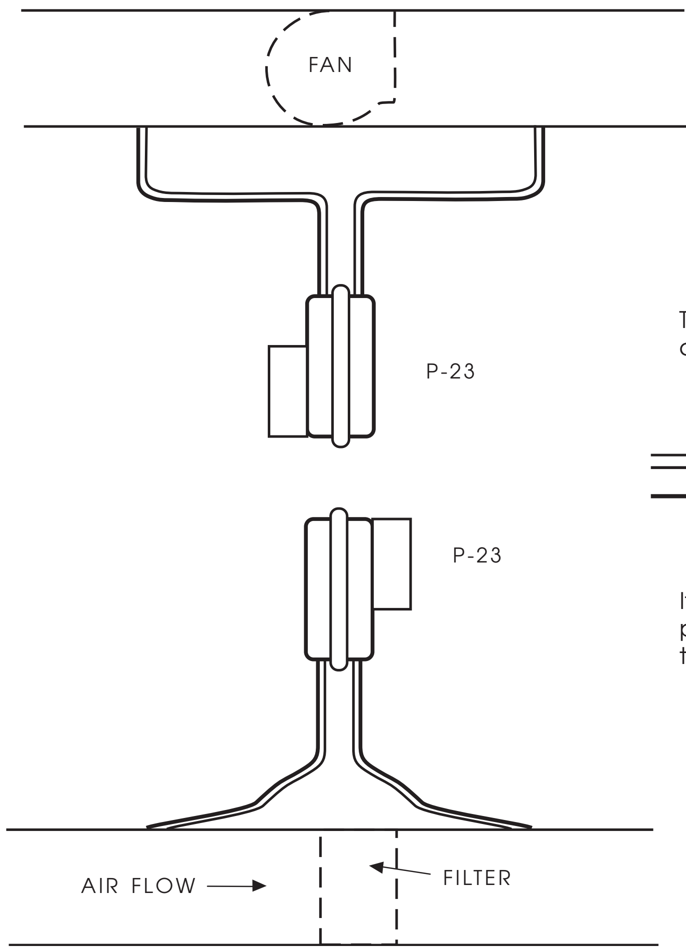


Figure 35

P-23 Differential Air Pressure Switch Typical Applications

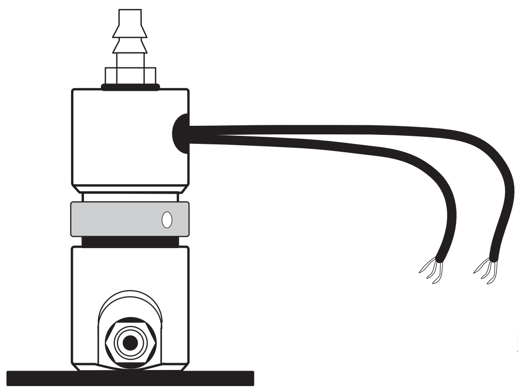


The tubing is to be neatly fastened to the duct and a 90° elbow is to be used to enter the duct work.

If there is insulation inside the duct, add a piece of polyethylene tubing just long enough to penetrate the insulation.

Low Wattage 3-Way Solenoid Valve V-5LW

Figure 36
Low Wattage 3-Way
Solenoid Valve V-5LW



MANUFACTURED BY: PRECISION DYNAMICS

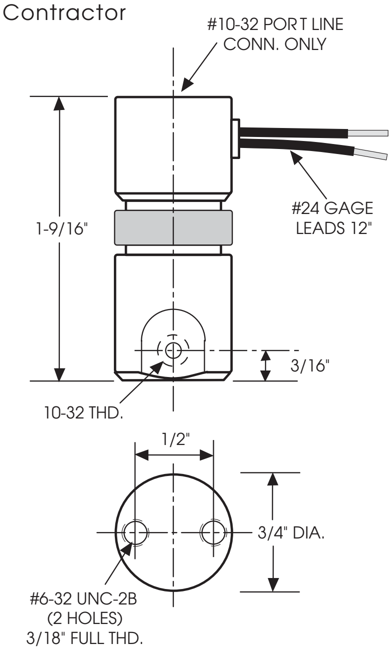
AVAILABLE THROUGH: REET CORP.
16 PROGRESS CIRCLE
NEWINGTON, CT 06111

VALVE INSTALLED BY:
Control Piping Contractor

VALVE WIRED BY:
Electrical Contractor

MODEL NUMBER: E3311-S14 24VDC

STANDARD



PORTS:
TOP-NORMALLY OPEN
BOTTOM (FACING)-NORMALLY CLOSED
BOTTOM (REVERSE SIDE)-COMMON

ORIFICE DIAMETER: 3/64" x 3/64"

PORT SIZE: 1/8"

NOTE: A higher volume solenoid with relay combination may be used if needed.

Power Wiring

Module power wiring can be completed only after all modules are installed in the enclosures. This section describes how to wire power connections to the Comfort Controller 6400, 6400-I/O, and 1600 Modules. It also describes how to wire power to High and Low Voltage DSIO Modules.

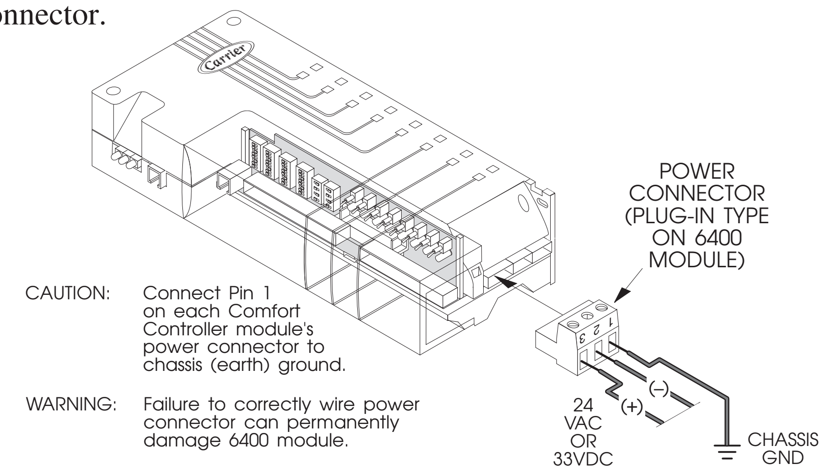
The *CCN Installation and Start-up Manual* (808-211) provides U.S. and international wire specifications for various applications and lists recommended wire vendors.

Warning: If using a 24 Vac power supply to power the Comfort Controller, do not use it to also power non-Comfort Controller devices, i.e., actuators.

6400 and *6400-I/O* Power Connector Location

The figure below shows the location of the power connector on the Comfort Controller 6400 and 6400-I/O and a detailed view of the connector.

Figure 37
Power Connector Location — *6400* and *6400-I/O*



1600 Power Connector Location

The figure below shows the location of the power connector on the Comfort Controller 1600 and a detailed view of the connector.

Figure 38
Power Connector Location —*1600*

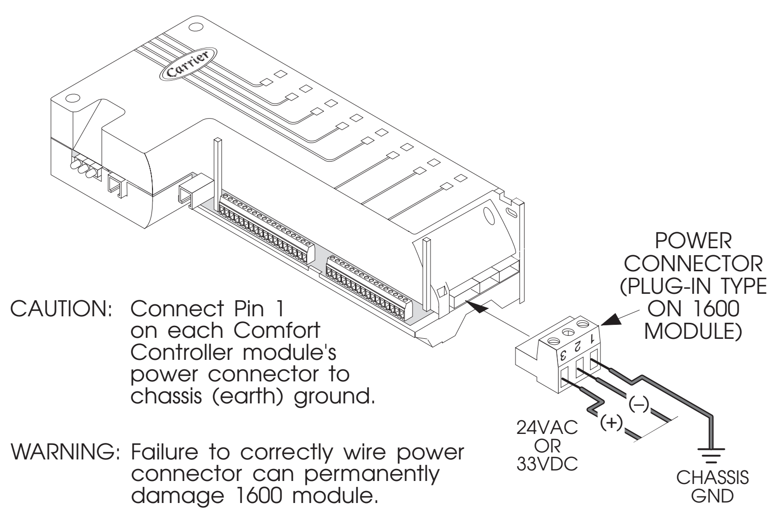


Table 2
Power Connector Pin Assignments

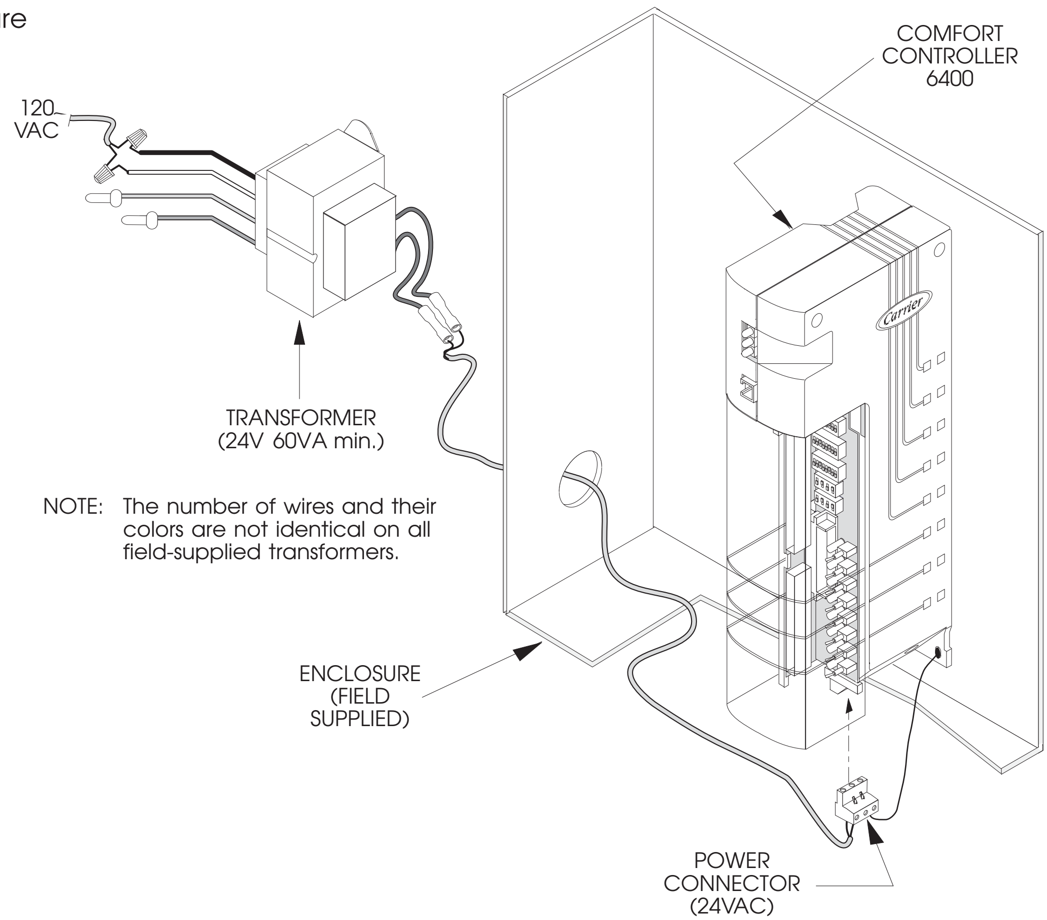
Comfort Controller Module	Pin Number	Power Connector
1600	3	24 Vac or 33 Vdc (+)
	2	24 Vac or 33 Vdc (-)
	1	Chassis ground
6400, 6400-I/O	3	24 Vac or 33 Vdc (+)
	2	24 Vac or 33 Vdc (-)
	1	Chassis ground

Wiring in a Typical Enclosure

On *6400* and *6400-I/O*, two pins are reserved for power and one is reserved for chassis ground.

The figure below shows power wiring within a typical enclosure for the power supply and the module.

Figure 39
Power Wiring in a Typical Enclosure

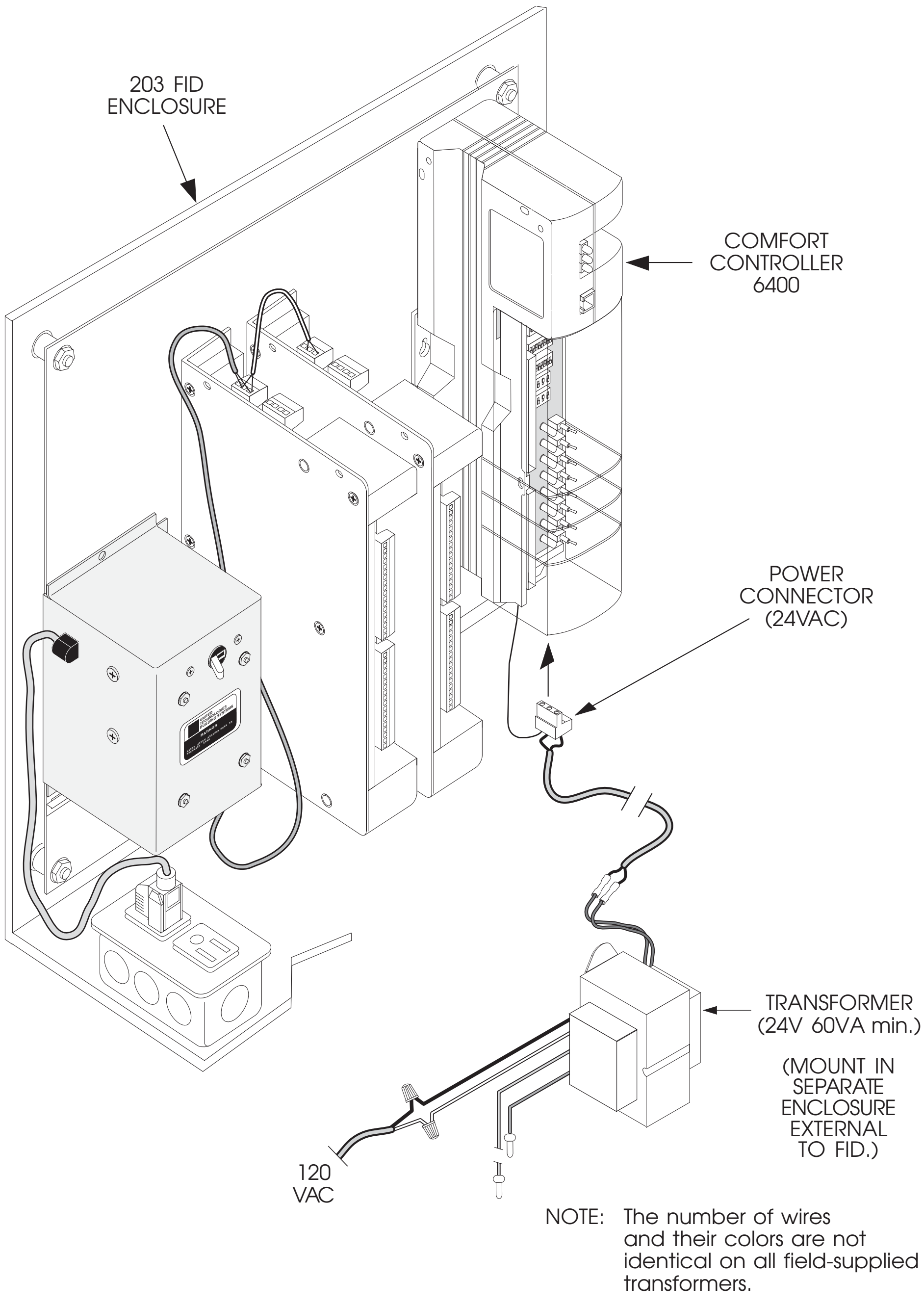


Typical Retrofit Installation

The figure below shows power wiring for a typical retrofit installation. There is an added power supply and a module.

Note: Daisy chain power wiring is not used for the Comfort Controller 6400/1600 Module because each module has its own power supply.

Figure 40
Retrofit Installation in a FID Enclosure



Communication Wiring

CCN and module communication wiring can be completed only after all modules are installed in the enclosures. This section describes how to wire CCN communication to the Comfort Controller 6400, Comfort Controller 1600, and Network Service Tool.

CCN Installation and Start-up Manual (808-211) provides U.S. and international wire specifications for various applications and lists recommended wire vendors.

The CCN Communication Bus conveys commands and data between the *6400* and any other element on the CCN. Physically, the CCN Communication Bus consists of three-conductor, shielded cable. System elements must be connected directly to the bus without the use of T-taps or spurs.

When connecting the CCN Communication Bus to a system element, each of the three conductors must be used for the same signal type throughout the entire CCN. That is:

- signal (+) terminals must always be wired to signal (+)
- signal ground terminals must always be wired to signal ground
- signal (-) terminals must always be wired to signal (-)

To achieve this consistancy, the following "color code" system is recommended:

Signal Type	Conductor Insulation Color/Pin #	
+	Red	(1)
Ground	White	(2)
-	Black	(3)

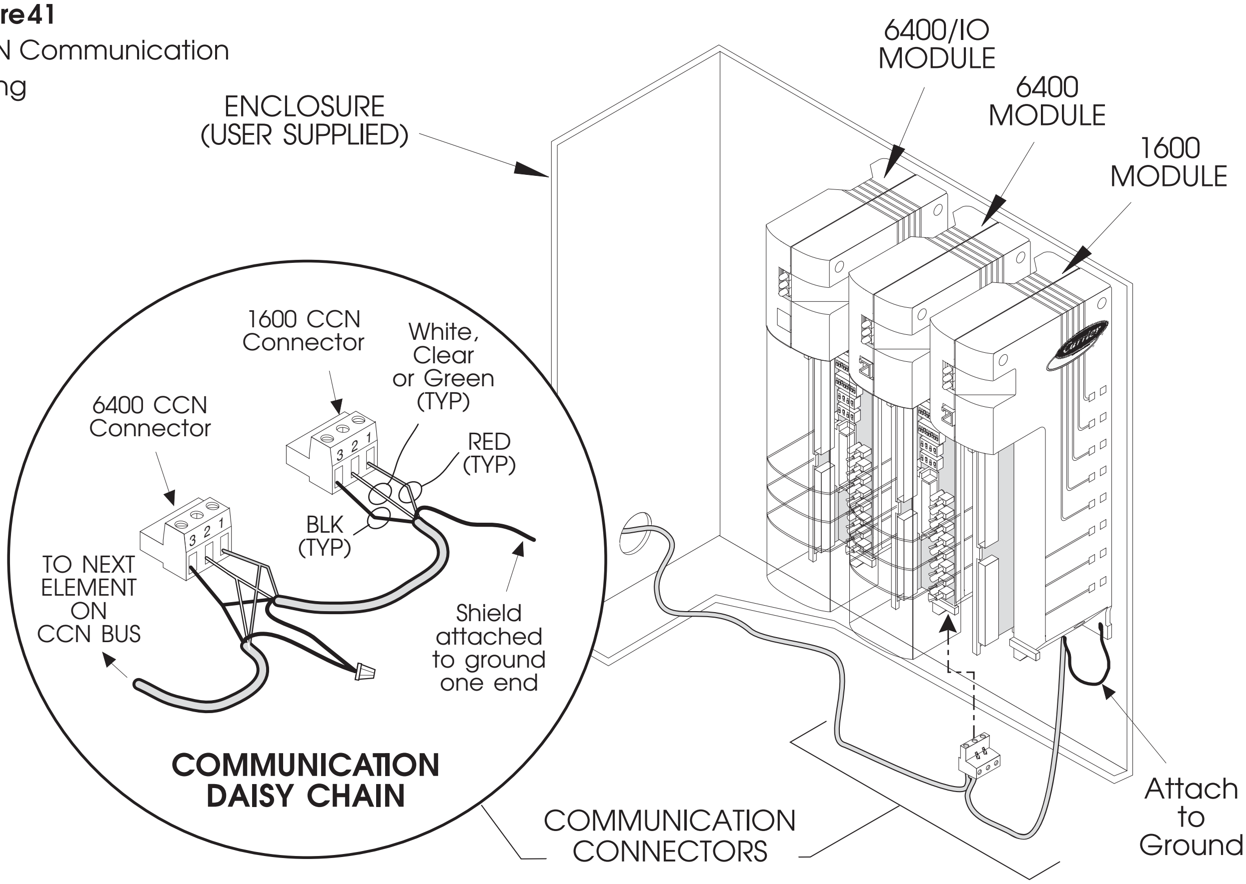
If a cable with a different color scheme is selected for the CCN Communication Bus, a similar color code system should be adopted to simplify installation and check out.

Grounding of Bus Shields

At each system element, the shields of its communication bus cables must be tied together. If the CCN Communication Bus is entirely within one building, the resulting continuous shield must be connected to ground at only one single point (refer to Figure 41). If the CCN Communication Bus exits from one enclosure and enters another, its shields shall also be connected to ground at a lightning suppressor in each building.

The specific shield connections are illustrated on the following pages in the wiring description for each system element type.

Figure 41
CCN Communication Wiring

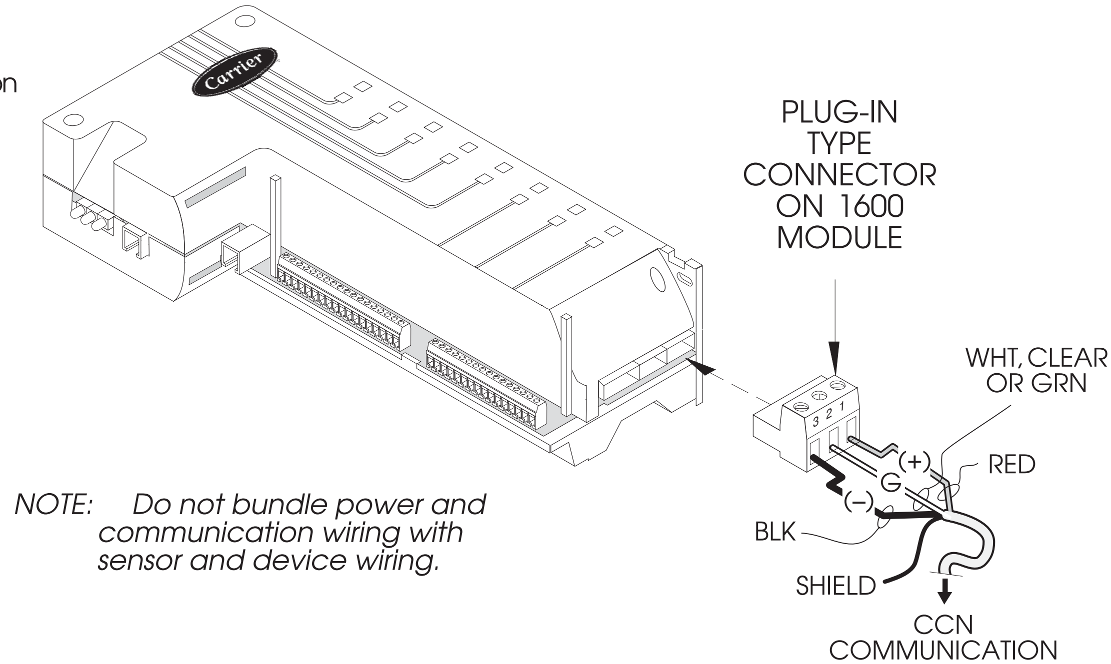


All buses, both primary and secondary, are composed of bus segments. A bus segment may be up to 1000 feet in length. A Repeater functions to join two bus segments. Up to three Repeaters can be used to form a bus, consisting of four segments.

1600 Communication Connector Location

The figure below shows the location of the CCN communication connector on the Comfort Controller 1600, and a detailed view of the connector.

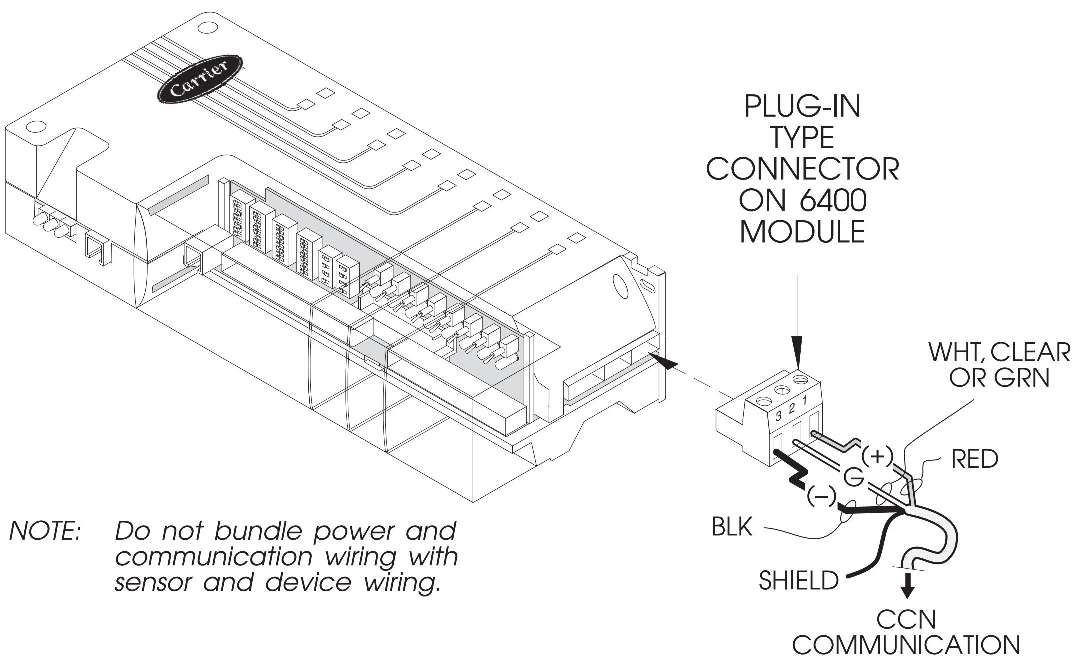
Figure 42
Communication Connector Location — *1600*



6400 Communication Connector Location

The figure below shows the location of the CCN communication connector on the Comfort Controller 6400, and a detailed view of the connector.

Figure 43
Communication Connector Location — *6400*



I/O Module Communication Wiring

The I/O Module Communication Bus conveys commands and data between the 6400 and the 6400 I/O or other I/O Modules. The LID can connect to any I/O module connected to the bus and communicate with the *6400* regardless of its physical locations.

Physically, the communication bus consists of three-conductor, shielded cable. System elements must be connected directly to the bus without the use of T-taps or spurs.

When connecting the I/O Module Communication Bus to an I/O Module, each of the three conductors must be used for the same signal type throughout the entire CCN. That is:

- signal (+) terminals must always be wired to signal (+)
- signal ground terminals must always be wired to signal ground
- signal (-) terminals must always be wired to signal (-)

To achieve this consistancy, the following "color code" system is recommended:

Signal Type	Conductor Insulation Color/Pin #	
+	Red	(1)
Ground	White	(2)
-	Black	(3)

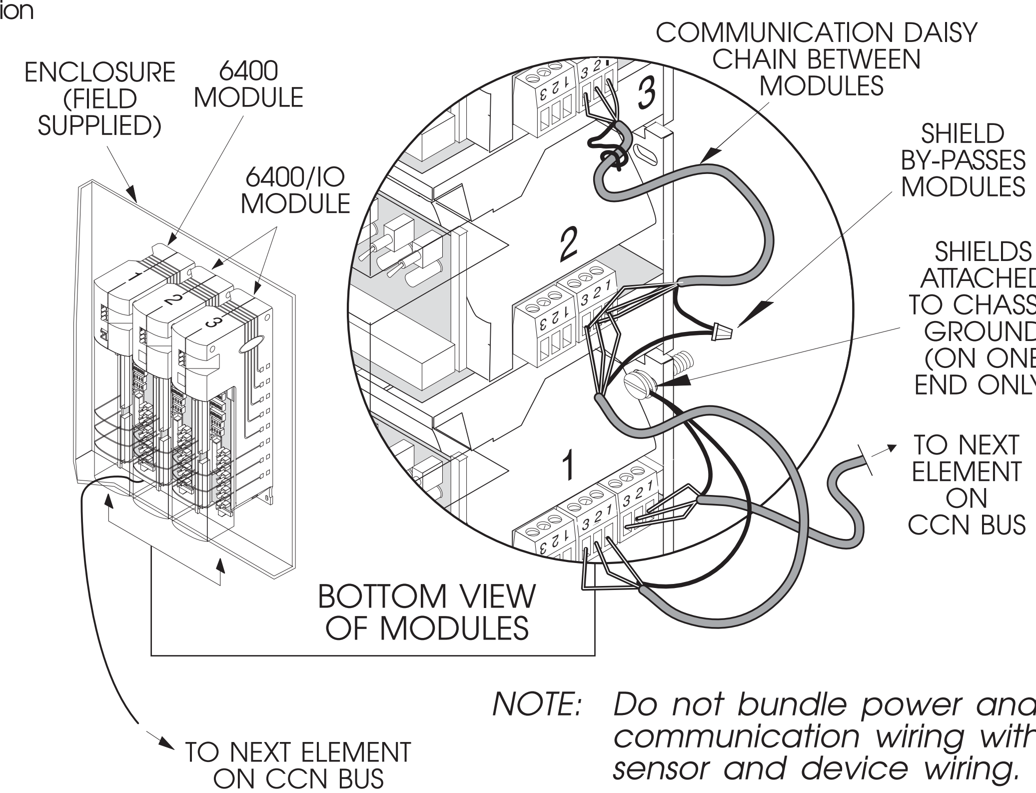
If a cable with a different color scheme is selected for the I/O Module Communication Bus, a similar color code system should be adopted to simplify installation and check out.

Grounding of Bus Shields: It is recommended that at each I/O Module, the shields of its communication bus cables be tied together. If the communication bus is entirely within one enclosure, the resulting continuous shield must be connected to ground at only one single point (refer to Figure 44). If the communication bus cable exits from one enclosure and enters another, its shields must be connected to ground in the enclosure with the *6400*.

The specific shield connections are illustrated on the following pages in the wiring description for each system element type.

The figure below shows communication connections between Comfort Controller 6400 and 6400-I/O Modules within an enclosure.

Figure 44
I/O Module Communication Wiring

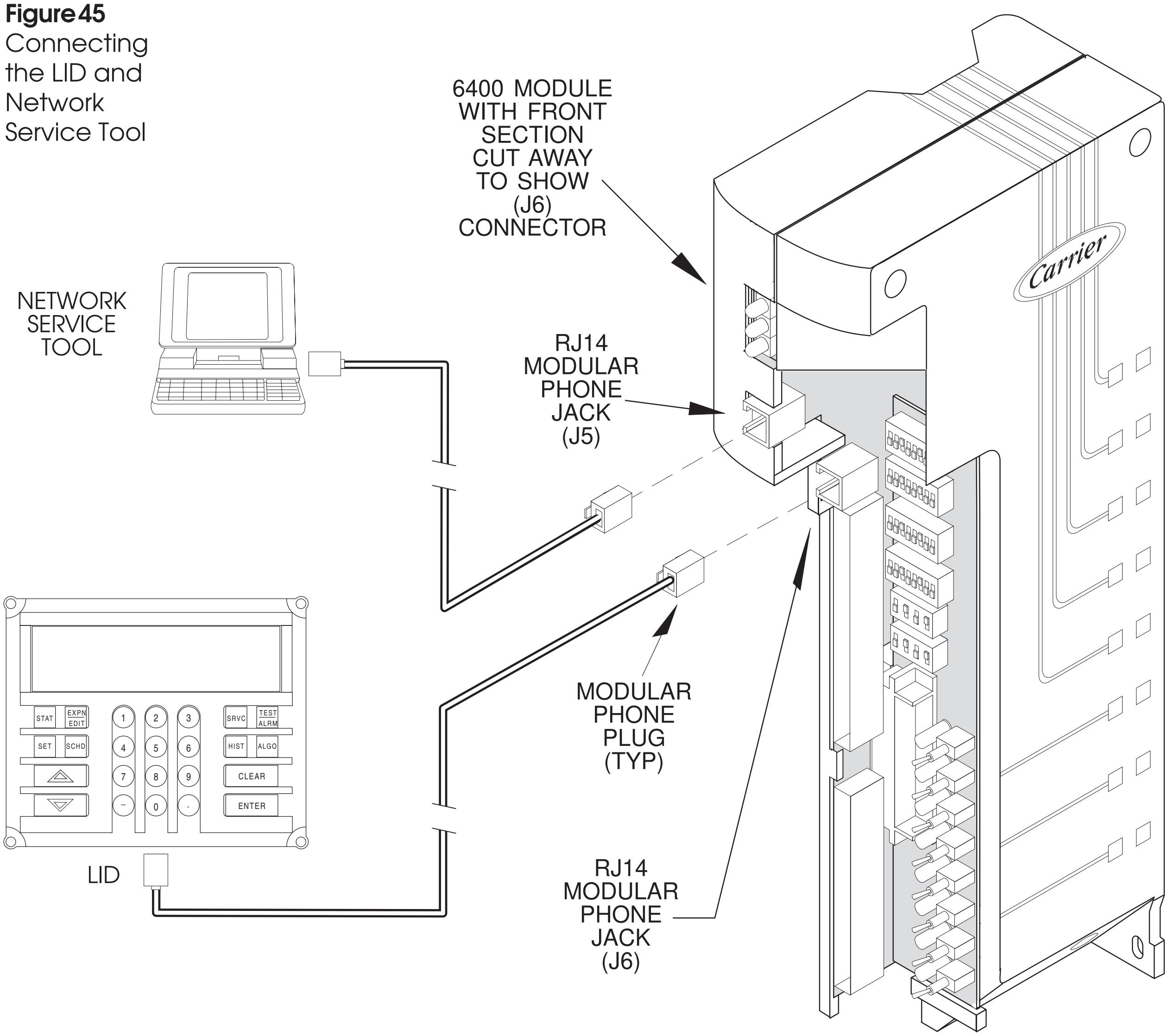


NOTE: Do not bundle power and communication wiring with sensor and device wiring.

LID and Network Service Tool Connection

The Comfort Controller 6400 and Comfort Controller 1600 provide two RJ14 modular phone jacks for LID and Network Service Tool cable connection, as shown in the figure below. The Comfort Controller 6400-I/O provides one jack for LID connection. The interface cable requires six conductors with an RJ14 style plug mounted at each end. Refer to the LID Installation section of this manual for a complete description of this assembly.

Figure 45
Connecting the LID and Network Service Tool



Sensor and Device Wiring

The following section lists general procedures and guidelines for wiring sensors and output devices. The *CCN Installation and Start-up Manual* (808-211) provides U.S. and international wire specifications for various applications and lists recommended wire vendors.

Appendix B of the *Comfort Controller Overview and Configuration Manual* lists the engineering units, ranges, resolutions, and accuracy for the standard input and output devices that the Comfort Controllers support.

Wiring Guidelines

Sensor and output device wiring is usually done in two stages. First, bring the wiring to the enclosure. Then terminate the wire to the module connectors.

1. Mark each wire with the cable number specified on the module wire list. Refer to Appendix A for a sample wire list.

2. Pull the sensor and device wiring into the enclosure. Route all sensor and device wiring through either the top or bottom of the enclosure.

   Note: Pulsed-type discrete input sensors require twisted shielded pair (tsp) wiring. Terminate the shield from the sensor to a forked type crimp connector, allowing enough wire so that this shield can be fastened under the module mounting screw.

   If the modules are not already installed, leave about 2 feet of wire in the enclosure before terminating the wire to the module connectors.

3. For the Comfort Controller 1600, refer to Field Wiring in the Checkout Section prior to terminating the wires.

4. Terminate the wires to the module I/O connectors, as shown in Figures 46 through 50 on the following pages.

Wire to the terminals designated on the wire list. Make final termination by stripping the end of each wire, inserting it into the connector, and tightening the adjacent screw. Refer to module I/O connectors below for more detailed information.

Note: If the modules are already installed, you can remove the connectors to facilitate wiring.

5. Bundle and dress all cables according to module and connector. Refer to Figure 50.

Caution: Bundle input and output cables separately.

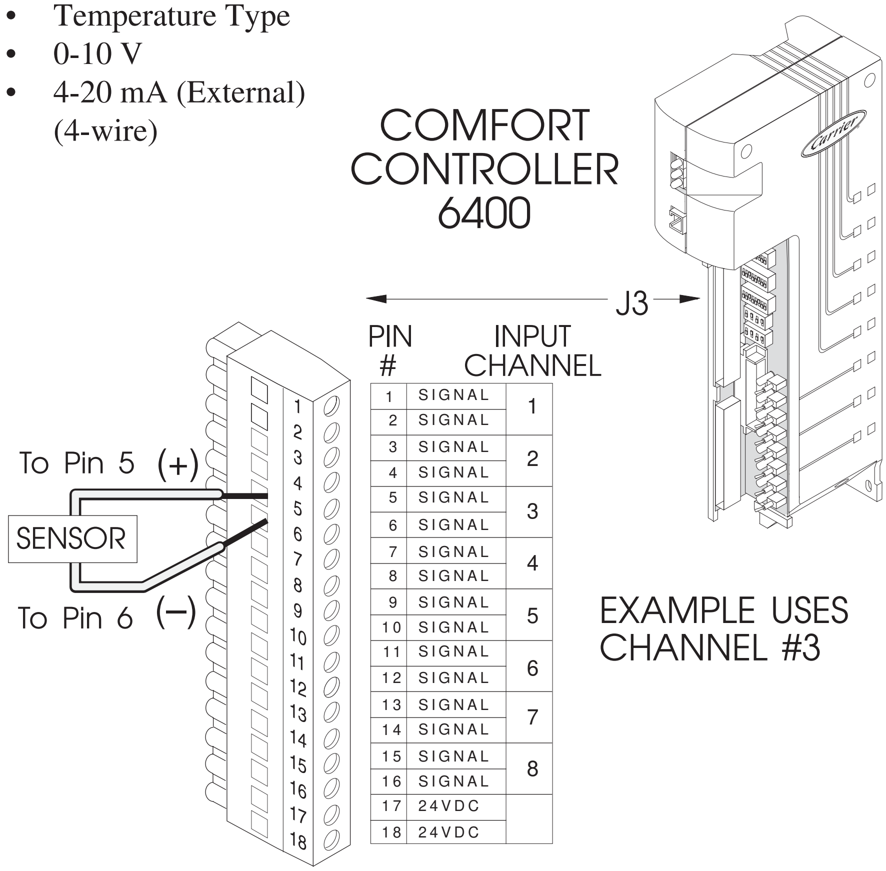
Note: Leave the connectors unplugged from the modules until you complete configuration.

6. Any input sensor or device located in another building structure must be equipped with a Carrier-approved lightning suppressor. It should be grounded to the Comfort Controller enclosure using 14 to 16 gauge wire no longer than 6 inches.

General Input Sensor Wiring

- Discrete Input
- Temperature Type
- 0-10 V
- 4-20 mA (External) (4-wire)

Figure 46
General Input Sensor Wiring

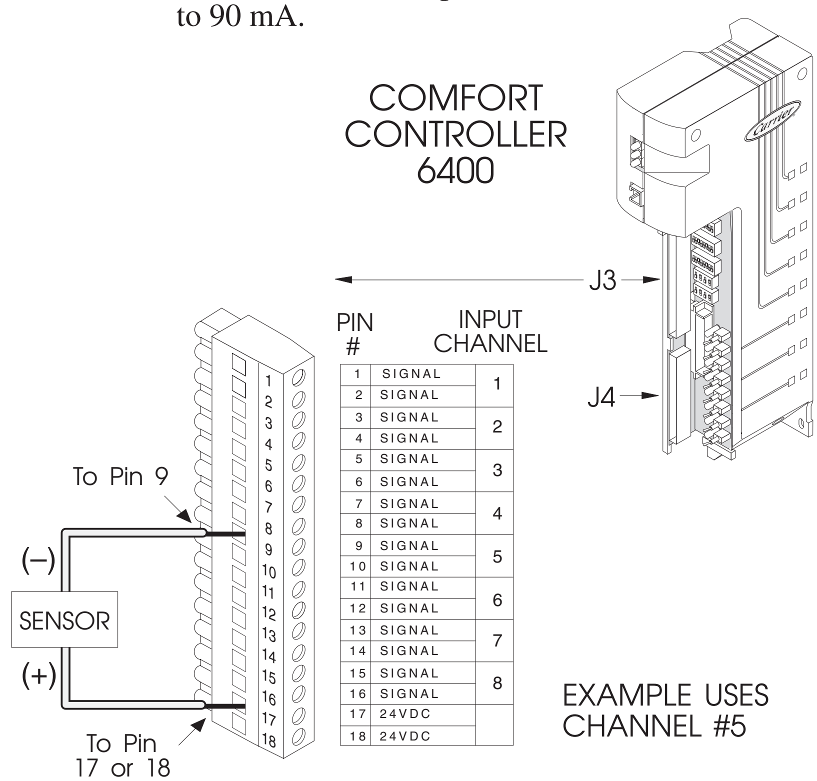


Internally Powered 4-20 mA Sensor Wiring (2-wire)

Note: Pin 17 is typically used for Channels 1-4,
Pin 18 is typically used for Channels 5-8.

Pins 17 and 18 each provide 24 Vdc current limited to 90 mA.

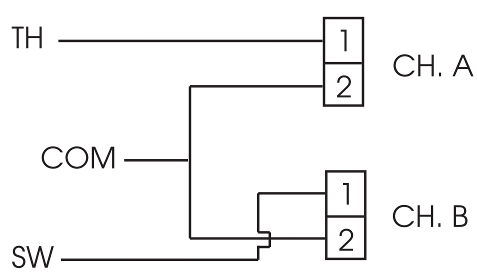
Figure 47
Internally Powered 4-20 mA Sensor Wiring (2-wire)



Note: On all modules, Pins 17 and 18 of Connector J3 are 24 Vdc sources for internally powered (2-wire) milliamp sensors. Each pin can provide power for up to four sensors maximum. Powering other devices could damage the Comfort Controller.

Wiring T-56 Space Temperature Sensor

For the Comfort Controller 6400, the T-56 can be wired to any two channels. For the 1600, it can be wired only to Channels 7 or 8.



Note: You should configure channel B as a voltage input, type 6, but set the switches on the 6400 for a 10 K thermistor.

Wiring ACI 10K-AN and 10K-CP Sensors

When wiring the Automation Components Inc. (ACI) 10K-AN (Carrier part number HH51BX006) or the 10K-CP (Carrier part number HH51BX005) sensor with slidebar, follow the guidelines below:

- Both sensor types require two Temperature Input hardware points on the Comfort Controller, one for the thermistor and one for the slidebar.
- Wire both inputs to the same controller, and run a 3-wire cable to the sensor.
- The ACI sensor has four terminals. The second SEN terminal (on left), and the first (SET) terminal (on right) should be jumpered (common wire).
- Since there is a common for both signals and both inputs wired to the same module, do not jumper the signal commons on the controller (pin 2 of both channels).

Wire the two Comfort Controller input terminals as shown below:

Comfort Controller	Sensor	
SPT 1	1st SEN terminal	
SPT 2	2nd SEN terminal	Common
Slider 1	2nd SET terminal	Common
Slider 2	No connection	

Configuration Guidelines

The Temperature Input for an ACI/10K-AN must be configured as a sensor type 1 (YSI 10K thermistor). The input for an ACI/10K-CP must be configured as a type 5 (MCI 10K thermistor temperature sensor). The slidebar input must always be configured as a sensor type 6 (T-56 Space Temperature Sensor with setpoint adjustment).

When using these sensors, you must configure the T56 Slider Bias (Setpoint Bias) and Setpoint Reference (Offset Low Value/Offset High Value) decisions on the AOSS or Linkage/AOSS function configuration screen. These functions contain the slidebar offset routine used to bias the setpoints.

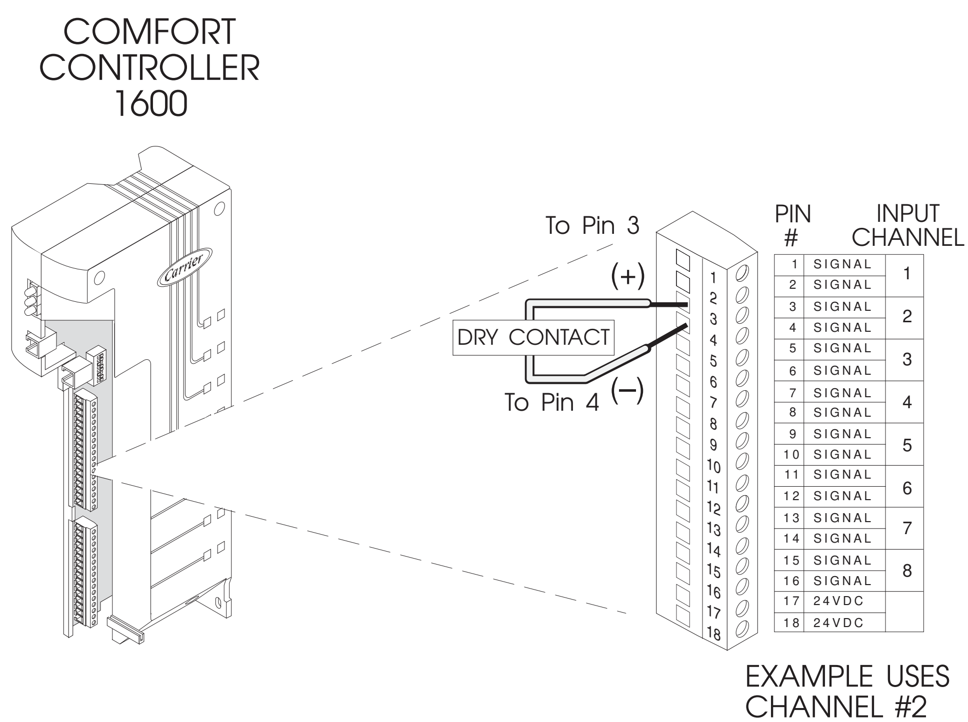
Note: It is not necessary to enable the AOSS or Linkage/AOSS function.

Enter the point name of the slidebar input in the AOSS or Linkage/AOSS T56 Slider Bias (Setpoint Bias) decision. Enter the name of the AOSS or Linkage/AOSS function in the Setpoint Schedule.

The actual biased setpoint is visible in the AOSS or Linkage/AOSS maintenance screen, based on the current slidebar position. The maintenance screen shows the occupied and unoccupied setpoint offset ranges.

The slidebar units are displayed as 0 to 100%, where 50% is the center (no setpoint bias) position, 0% is the full low (minus), and 100% is the full high (plus) setpoint bias position.

Figure 48
Discrete Input Sensor Wiring



General Output Device Wiring

- Discrete Output
- 0-10 V Actuators
- 4-20 mA

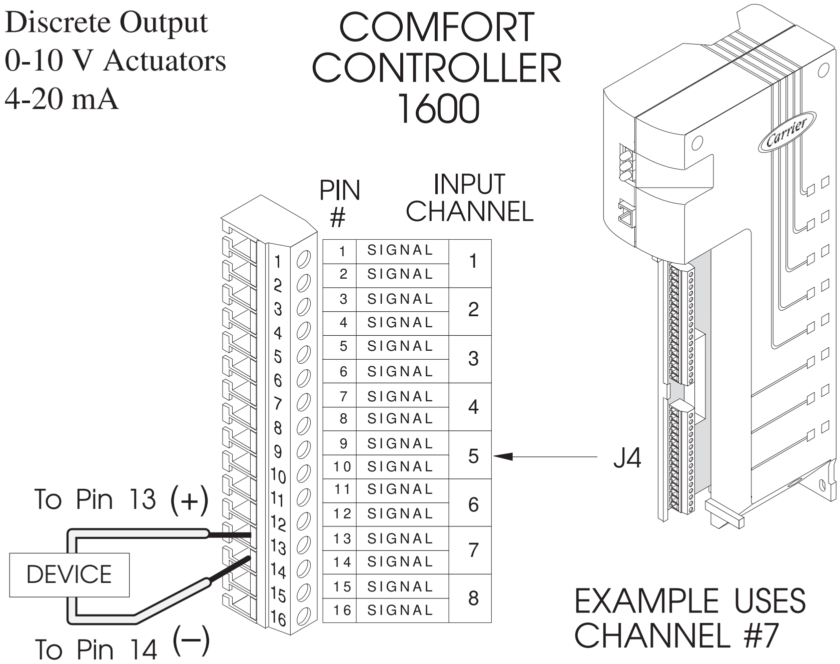


Figure 49
General Output Device Wiring

Bundling and Dressing Sensor and Device Wiring

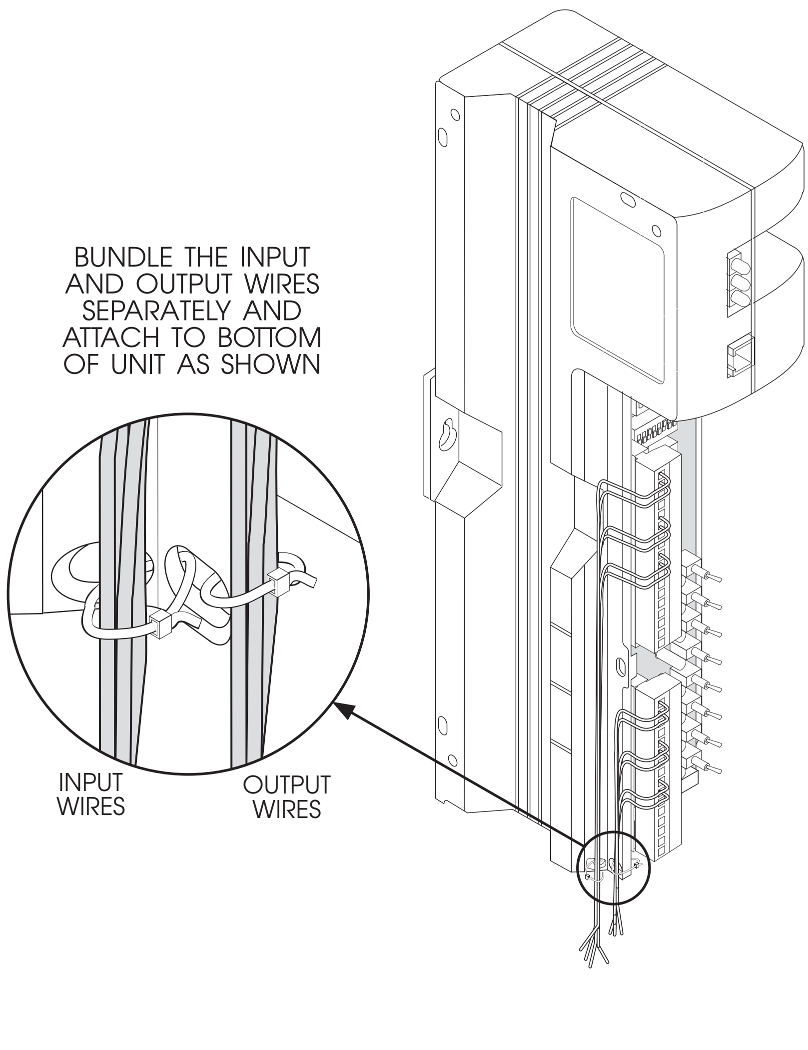


Figure 50
Bundling and Dressing Sensor and Device Wiring

Selecting Input and Output Types

This section describes the basic procedure for selecting the input or output device types required for your application.

Comfort Controller 1600

Input and output types are the following:

Inputs
- Analog input type (4-20 mA internally powered only 0-10 Vdc)
- 5K, 10K thermistor, 1K ohm nickel RTD
- Dry contact discrete, pulsed

Outputs
- 24 Vdc 80mA discrete output
- Analog output type (mA or voltage)

If you are using the module's two universal input channels (7 & 8) and two universal output channels (7 & 8), you must now specify their input or output types.

You specify input or output type using switch SW1, which is located behind connector J6 on the module, as shown in Figure 51. The switch detail is shown in the figure below. Input and output type switch settings are listed in Table 3.

Figure 51 Comfort Controller 1600 Configuration Switch 1

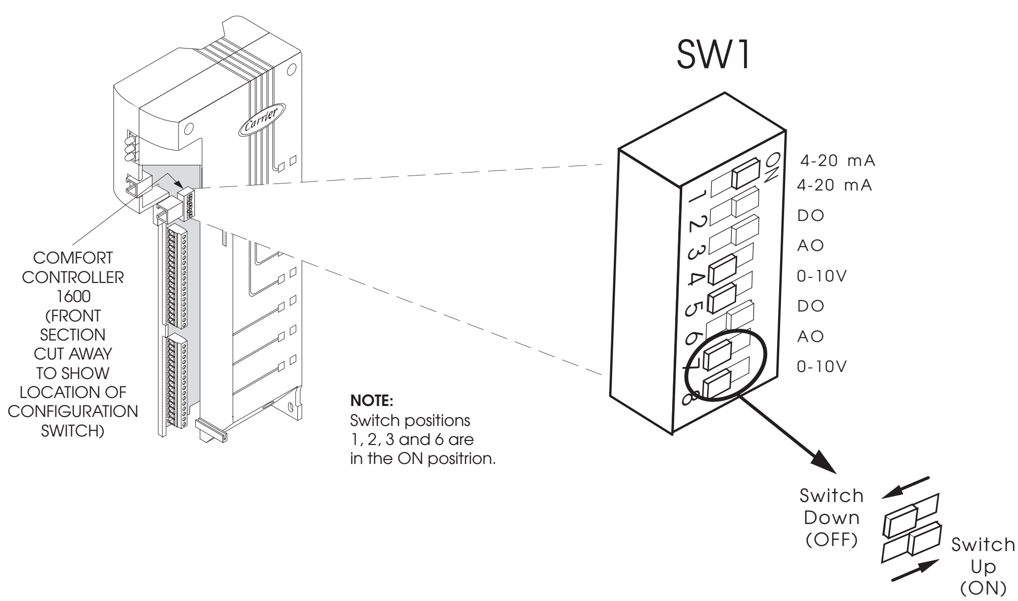


Table 3
Comfort Controller 1600 I/O Type Switch Settings

I/O Channel	Type	SW1 Position	Switch Setting
Input			
7	4-20 mA	1	ON
7	Other	1	OFF
8	4-20 mA	2	ON
8	Other	2	OFF
Output			
7	DO	3	ON
		4	OFF
		5	OFF
7	AO 4-20 mA	3	OFF
		4	ON
		5	OFF
7	AO 0-10 V	3	OFF
		4	ON
		5	ON
8	DO	6	ON
		7	OFF
		8	OFF
8	AO 4-20 mA	6	OFF
		7	ON
		8	OFF
8	AO 0-10 V	6	OFF
		7	ON
		8	ON

Note: If connecting a T-56 Space Temperature Sensor, or an ACI 10K-AN or 10K-CP sensor with slidebar, to a voltage input point, you must wire the sensor as a Temperature Input. For example, on a Comfort Controller 1600, you must wire to Channels 7 or 8 and set Switch 1 or Switch 2 to *Other* (Off).

Comfort Controller 6400 and Comfort Controller 6400-I/O

On Comfort Controller 6400 and Comfort Controller 6400-I/O, the following input types can be configured for input Channels 1 through 8 with switches SW2 and SW3 on the configuration board:

- Analog (0-10 Vdc)
- 4-20 mA (internal or external power)
- 5K, 10K, 1K ohm nickel RTD
- Dry contact discrete, pulsed

The following are user configurable output types for Channels 9 through 16 with switches SW4, SW5, and SW6:

- Output type (analog or discrete)
- Analog output type (mA or voltage)

Use the following procedure and Figure 52 to specify the input and output device types.

1. Set DIP switches on SW2 and SW3 for each input channel (1 through 8) according to input type. Settings for SW2 are INT (ON) and EXT (OFF). Settings for SW3 are 4-20 mA (ON) and OTHER (OFF). Switch settings for each input type are listed in Table 4.

Table 4
Input Type Switch Settings

Input Type	SW2	Analog In Type SW3
Int. mA	INT	4-20 mA
Ext. mA	EXT	4-20 mA
Dry contact DI	INT	OTHER
10K	INT	OTHER
5K	INT	OTHER
RTD	INT	OTHER
0-10 Vdc	INT	OTHER
T56	INT	OTHER

Note: If connecting a T-56 Space Temperature Sensor, or an ACI 10K-AN or 10K-CP sensor with slidebar, to a voltage input point, you must wire the sensor as a Temperature Input. For example, on a Comfort Controller 6400, you must set Switch 2 to *Int* and Switch 3 to *Other*.

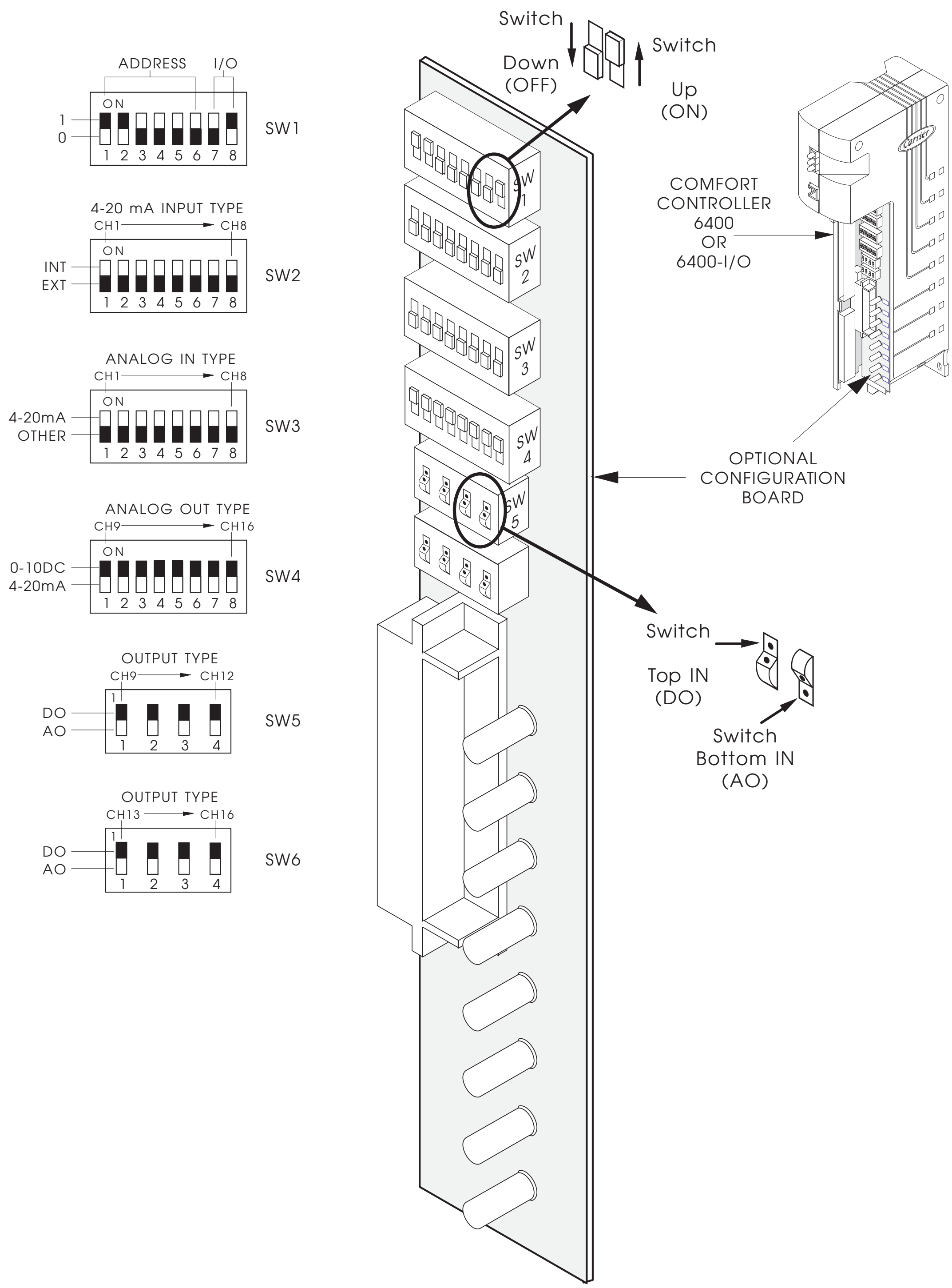
2. Set SW4 switches for output Channels 9 through 16. Settings

2. Set SW4 switches for output Channels 9 through 16. Settings are 0-10 DC (ON) and 4-20 mA (OFF). Set SW5 switches for output Channels 9 through 12; set SW6 switches for output Channels 13 through 16. Settings for these switches are AO and DO. Switch settings for each output type are listed in Table 5.

Table 5
Output Type Switch Settings

Output Type	Analog Out Type SW4	Output Type SW5	Output Type SW6
24 Vdc Discrete			
Outputs 9-12		DO	
Outputs 13-16			DO
4-20 mA			
Outputs 9-12	4-20 mA	AO	
Outputs 13-16	4-20 mA		AO
0-10 V			
Outputs 9-12	0-10 DC	AO	
Outputs 13-16	0-10 DC		AO

Figure 52
Comfort Controller 6400 and Comfort Controller 6400-I/O Configuration Board

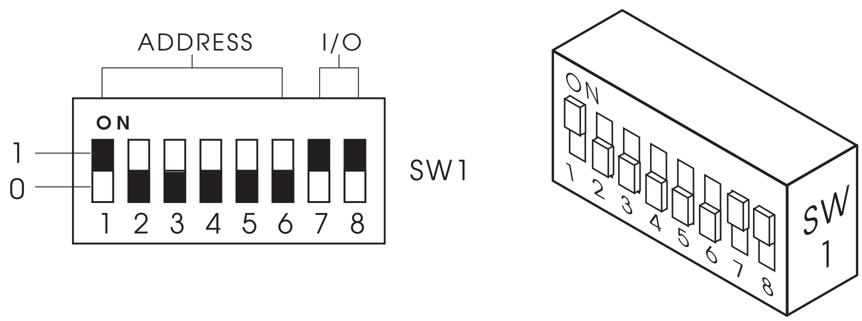


I/O Selecting and Setting Module Communication Addresses

The Comfort Controller 6400 and Comfort Controller 6400-I/O Modules each can support eight universal inputs and eight universal outputs. However, you can disable the inputs, disable the outputs, or disable I/O altogether using Switches 7 and 8 on SW1 on the Comfort Controller 6400 configuration board, shown in Figure 53 below.

Also, you can use the Comfort Controller 6400-I/O as a 4 Input/4 Output Module by setting Switches 7 and 8 on SW1 as if you were disabling all I/O. When the module is used in this way, the first four input channel connections (Terminals 1-8) and the first four output channel connections (Terminals 1-8) are used. The last four input and output channel connections on the module are unused.

Figure 53
Comfort Controller 6400 and Comfort Controller 6400-I/O Address Switch



Use the following procedure to set the switches:

1. Select I/O type or disable I/O using the switch settings in Table 6.

Table 6
I/O Switch Settings

I/O Select	SW1 Setting 7	8
No I/O – 6400	0	0
8 Inputs	1	0
8 Outputs	0	1
8 In/8 Out	1	1
4 In/4 Out – 6400-I/O	0	0*

*Using 4 in/4 out functionality requires 6400-I/O REV-03 or later.

2. If you selected 8 Inputs, 8 Outputs, or 8 In/8 Out, set the channel number of the first point of the module. Use Switches 1 through 6 on SW1. Table 7 lists the address settings.

Table 7
Comfort Controller 6400 and Comfort Controller 6400-I/O Addresses

First Channel No.	SW1 Address 1	2	3	4	5	6
1	1	0	0	0	0	0
2	0	1	0	0	0	0
3	1	1	0	0	0	0
4	0	0	1	0	0	0
5	1	0	1	0	0	0
6	0	1	1	0	0	0
7	1	1	1	0	0	0
8	0	0	0	1	0	0
9	1	0	0	1	0	0
10	0	1	0	1	0	0
11	1	1	0	1	0	0
12	0	0	1	1	0	0
13	1	0	1	1	0	0
14	0	1	1	1	0	0
15	1	1	1	1	0	0
16	0	0	0	0	1	0
17	1	0	0	0	1	0
18	0	1	0	0	1	0
19	1	1	0	0	1	0
20	0	0	1	0	1	0
21	1	0	1	0	1	0
22	0	1	1	0	1	0
23	1	1	1	0	1	0
24	0	0	0	1	1	0
25	1	0	0	1	1	0
26	0	1	0	1	1	0
27	1	1	0	1	1	0
28	0	0	1	1	1	0
29	1	0	1	1	1	0
30	0	1	1	1	1	0
31	1	1	1	1	1	0
32	0	0	0	0	0	1
33	1	0	0	0	0	1
34	0	1	0	0	0	1
35	1	1	0	0	0	1
36	0	0	1	0	0	1
37	1	0	1	0	0	1
38	0	1	1	0	0	1
39	1	1	1	0	0	1
40	0	0	0	1	0	1
41	1	0	0	1	0	1
42	0	1	0	1	0	1
43	1	1	0	1	0	1
44	0	0	1	1	0	1
45	1	0	1	1	0	1
46	0	1	1	1	0	1
47	1	1	1	1	0	1
48	0	0	0	0	1	1
49	1	0	0	0	1	1
50	0	1	0	0	1	1
51	1	1	0	0	1	1
52	0	0	1	0	1	1
53	1	0	1	0	1	1
54	0	1	1	0	1	1
55	1	1	1	0	1	1
56	0	0	0	1	1	1
57	1	0	0	1	1	1

Checkout

Checkout

This section describes basic checkout procedures that you should follow before and after you complete the installation.

Note: Because these procedures are interdependent, you should perform them in the order in which they are presented.

Power Supply

The first step in checking out an installation is to verify that the power supply is operating.

1. Apply 120 Vac or other line voltage to the primary side of the power supply.

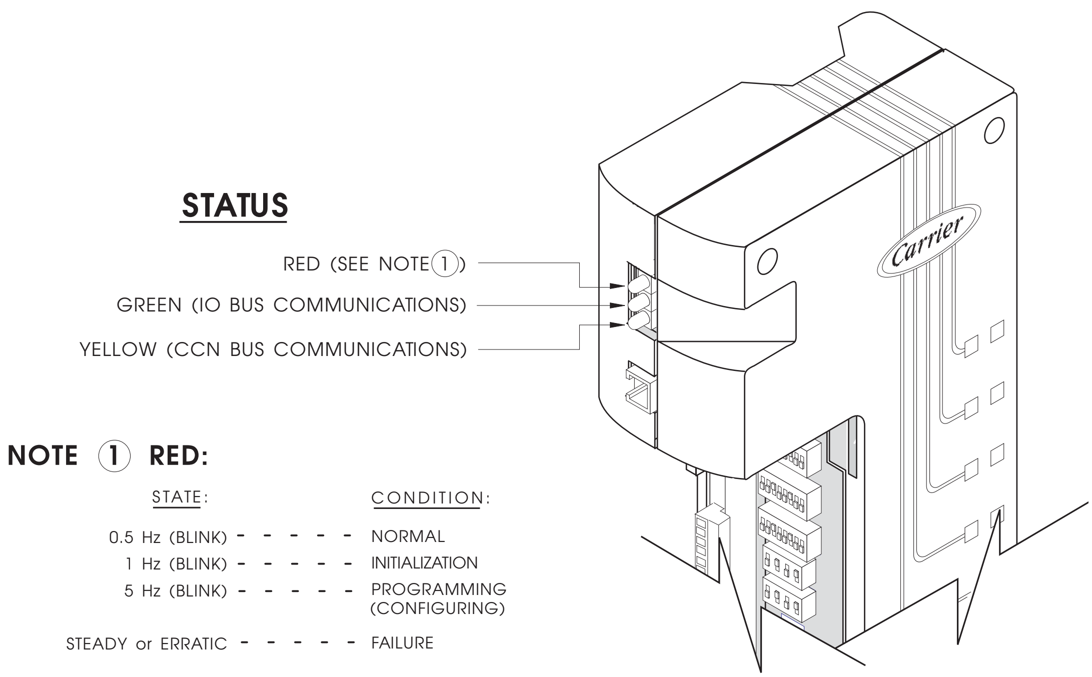
2. Ensure that 24 Vac $\pm$ 15% or 33 Vdc $\pm$ 15% is present on the power connector before you plug it into the module.

Modules

The Comfort Controller 6400 and Comfort Controller 1600 feature the diagnostic LEDs shown in the figure below.

Note: The yellow LED does not operate on the 6400-I/O Module.

Figure 54
Diagnostic LEDs



Follow the steps below to verify module operation.

1. Before applying power to the module, be sure that the I/O connectors are disconnected from the module.

2. Power the module. The red LED should flash at the "normal" 0.5 Hz rate. (On for 1 second, Off for 1 second).

3. Using the LID or the Network Service Tool, verify that the CCN address setting is correct.

Field Wiring

Follow this procedure to check the field wiring for stray voltage or resistance.

1. Turn module power off.

2. Verify that I/O connectors are removed from the module.

3. Using the wire list as a guide, locate the wiring pair associated with the point to be verified.

4. For the same point, go to the sensor or controlling relay and remove the wiring pair from the device terminals. Short the two wires together.

5. Return to the module and use a VOM to measure the resistance across the wiring pair described in Step 3 above. The reading should be less than 5 ohms.

6. Go to the sensor or controlling relay and remove the short described in Step 4 above. Do not reconnect the wires to the sensor at this time.

7. Return to the module and again use a VOM to measure the resistance across the wiring pair. The reading should measure an open, or infinite ohms.

8. If either of the resistances measured in Steps 5 and 7 above was incorrect, a problem exists in the wiring. Replace the wiring pair, or repair wiring if practical.

9. If both measurements were correct, continue with the next procedure.

External Devices

1. After you have determined that the wiring between the module and the sensor or controlling relay is correct, you should then determine if the device itself is functional.

2. If the device is a temperature sensor, verify that it is properly mounted at the correct location as shown in the installation drawings. Be sure that space sensors are not located near coffee pots, copying machines, or other sources of heat or cold.

3. If the device is a thermistor, a RTD, or a DO relay coil, use a VOM to measure resistance across the device terminals. Compare this measurement to Table 8. If the measurement is correct, reconnect all wiring between the device and the module. If the measurement is incorrect, replace the failed device and reconnect all wiring between it and the module.

4. If the device is a 2-wire, 4-20 mA type, there is no simple verification procedure. In this case, assume that it is functional until all device and module wiring, configuration decisions, and setpoint schedules are verified as correct. The 4-20 mA device should be replaced only after all other parameters have been checked thoroughly.

5. If the device is a motor current transducer CT-1, the verification procedure is as follows:

   Warning: Before servicing this device or any device inside a motor control panel, be sure to disconnect the high voltage supply.

   a. Verify motor current transducer CT-1 is installed and properly wired in the correct part of the starter circuit as shown in the installation drawings.

   b. Verify wiring from the module to CT-1 by following the External Devices procedure above, then reconnect the wiring pair at the device terminals.

c. Reconnect the high voltage supply to the motor control panel.

d. Return to the module. Do not connect the field wiring connector to the module.

e. Manually run the machine up to full load. Use a VOM to measure the voltage across the device wiring pair. The reading should be 1 to 5 Vdc. If the voltage is incorrect, replace motor current transducer CT-1.

6. After external wiring and devices have been determined to be functional, re-connect the field wiring connector to the module.

Table 8
Temperature to Resistance Conversion

Temperature		Resistance (ohms)		
°F	°C	5K YSI Thermistor	10K YSI Thermistor	1K Nickel RTD
-40	-40	168.3K	239.9K	693
-35	-37.2	140.1K	203.9K	
-30	-34.4	117.1K	173.7K	719
-25	-32	98.19K	148.5K	
-20	-29	82.60K	127.2K	745
-15	-26.1	69.72K	109.3K	
-10	-23.0	59.03K	94.17K	772
-5	-20.6	50.13K	81.31K	786.7
0	-17.8	42.70K	70.38K	799
5	-15.0	36.47K	61.07K	
10	-12.2	31.24K	53.11K	827
15	-9.4	26.84K	46.29K	
20	-6.7	23.12K	40.44K	854
25	-4.0	19.96K	35.41K	
30	-1.1	17.28K	31.06K	883
35	2.0	15.00K	27.31K	
40	4.4	13.05K	24.06K	912
45	7.2	11.38K	21.24K	926.5
50	10.0	9952	18.79K	940
52	11.1		17901	947.0
54	12.2		17058	952.8

(continued)

Table 8
Temperature to Resistance Conversion (Continued)

Temperature °F	°C	Resistance (ohms) 5K YSI Thermistor	10K YSI Thermistor	1K Nickel RTD
55	13.0	8720	16650	
56	13.3		16260	958.6
58	14.4		15504	964.5
60	15.6	7657	14780	970
62	16.7		14108	976.3
64	17.8		13464	982.2
65	18.3	6738	13150	
66	18.9		12852	988.1
68	20.0		12272	994.1
70	21.1	5942	11720	1000
72	22.2		11199	1006
74	23.3		10703	1012
75	24.0	5251	10460	
76	24.4		10231	1018
77	25.0		10000	1021
78	25.6		9783	1024
80	26.7	4649	9353	1031
85	29.4	4125	8377	1051
90	32.2	3666	7516	1062
95	35.0	3265	6754	1075
100	37.8	2913	6078	1093
105	41.0	2604	5479	
110	43.0	2331	4947	1125
115	46.1	2091	4475	
120	49.0	1878	4050	1157
125	52.0	1690	3672	
130	54.0	1523	3334	1190
135	57.2	1375	3032	
140	60.0	1243	2760	1223
145	63.0	1375	3032	
150	65.5	1021	2297	1257
155	68.3	927.0	2100	
160	71.1	843.0	1921	1290
165	73.8	767.8	1760	
170	76.6	700.2	1615	1325
175	79.4	639.4	1483	1337

(continued)

Table 8
Temperature to Resistance Conversion (Continued)

Temperature °F	°C	Resistance (ohms) 5K YSI Thermistor	10K YSI Thermistor	1K Nickel RTD
180	82.2	584.7	1363	1350
185	85.0	535.3	1255	
190	88.0	490.7	1156	1395
195	91.0	450.4	1067	
200	93.0	413.9	985.0	1430
205	96.1	380.8	910.5	
210	99.0	350.8	842.5	1466
215	102.0	323.5	780.3	
220	104.0	298.6	723.5	1503
225	107.2	276.0	671.4	
230	110.0	255.3	623.6	1540
235	113.0	236.4	579.8	
240	116.0	219.2	539.6	1677
245	118.3	203.4	502.6	
250	121.1	189.0	468.5	1615

Table 9
Additional Temperature to Resistance Conversions

Temperature °F	°C	Resistance (ohms) PT 100	10K MCI Thermistor
-40	-40.0	84.27	336000.0
-31	-35.0	85.25	242700.0
-22	-30.0	88.22	177000.0
-20	-29.0		
-15	-26.1		
-13	-25.0	90.19	130402.0
-10	-23.3		
-5	-21.0		
-4	-20.0	92.16	97060.0
0	-18.0		
5	-15.0	94.12	72940.0
10	-12.2		
14	-10.0	96.09	55319.0
15	-9.4		
20	-7.0		
23	-5	98.04	42324.0
25	-7.2	19.96	
30	-1.1		

(continued)

Table 9
Additional Temperature to Resistance Conversions (Continued)

Temperature ˚F	˚C	Resistance (ohms) PT 100	10K MCI Thermistor
32	0	100.00	32654.0
35	1.6		
40	4.4		
41	5.0	101.95	25396.0
45	9.2		
50	10.0	103.90	19903.0
55	13.0		
59	15.0	105.85	15714.0
68	20.0	107.79	12493.0
77	25.0	109.73	10000.0
86	30.0	111.67	8056.0
95	35.0	113.61	6530.0
104	40.0	115.54	5327.0
113	45.0	117.47	4370.0
122	50.0	119.40	3606.0
131	55.0	121.32	2986.0
140	60.0	123.24	2488.0
149	65.0	125.16	2083.0
158	70.0	127.07	1752.0
167	75.0	128.98	1480.0
176	80.0	130.89	1255.0
185	85.0	132.80	1070.0
194	90.0	134.70	915.0
203	95.0	136.60	787.0
212	100.0	138.50	680.0
221	105.0	140.39	592.0
230	110.0	142.29	517.0
239	115.0	144.17	450.0
246	118.8		401.0
248	120.0	146.06	
250	121.1		

Table 10
Additional Temperature to Resistance Conversions

Temperature ˚F	˚C	Resistance (ohms) 100K NTC Thermistor
77	25.0	100000.0
86	30.0	80548.8
95	35.0	65287.1
104	40.0	53234.5

(continued)

Table 10
Additional Temperature to Resistance Conversions (Continued)

Temperature ˚F	˚C	Resistance (ohms) 100K NTC Thermistor
113	45.0	43656.8
122	50.0	36000.1
131	55.0	29843.7
140	60.0	24866.2
149	65.0	20820.4
158	70.0	17514.9
167	75.0	14801.0
176	80.0	12562.2
185	85.0	10706.7
194	90.0	9162.3
203	95.0	7871.2
212	100.0	6787.4
221	105.0	5874.1
230	110.0	5101.4
239	115.0	4445.3
248	120.0	3886.3
257	125.0	3408.2
266	130.0	2997.5
275	135.0	2644.0
284	140.0	2339.0
293	145.0	2074.9
302	150.0	1845.6
311	155.0	1645.9
320	160.0	1471.5
329	165.0	1318.8
338	170.0	1184.7
347	175.0	1066.7
356	180.0	962.6
365	185.0	870.5
374	190.0	788.8
383	195.0	716.3
392	200.0	651.6
401	205.0	594.0
410	210.0	542.4
419	215.0	496.3
428	222.0	454.8
437	225.0	417.5
442	228.7	396.9

Configuration

At this point, you should refer to the *Comfort Controller Overview and Configuration Manual* for instructions on how to configure the newly installed Comfort Controller.

After the Comfort Controller is configured, use the LID to verify that each sensor or transducer works correctly.

Input and Output Device Connection

The final step in Comfort Controller 6400/1600 checkout is to connect the field devices to the module and check their operation. This requires physical inspection of the devices.

Input Devices

1. Plug the field wiring connector into the module.
2. Display each input channel.
3. Check each input's accuracy by comparing the data displayed on the LID with the actual temperature, status, pressure, etc., at the input device.

   Note: For AI points, verify the physical location of the sensor. For example, is the discharge sensor downstream from the coil? Is the space sensor in the correct space? Is the pressure sensor in a non-turbulent area?

4. If any input does not check out properly, verify its hardware and software configuration. Inputs that have slightly inaccurate readings can be trimmed.

Output Devices

Caution: You must correct inaccurate inputs before connecting output devices.

1. Force each output to a safe position.

Caution: This is recommended because the module will take control of the output devices as soon as you plug the field connectors into the module. The safe position ensures an orderly checkout procedure without disrupting normal building operation.

2. Plug the field connectors into the module.

Discrete Outputs

1. Display each discrete output.

2. Force the device on (or off) and verify its operation.

3. Force the device off (or on) and verify its operation.

4. Remove the force as each discrete out passes checkout. Observe proper algorithm control of each point before proceeding.

Tuning Control Loops

The sensitivity of most HVAC processes varies with changes in air temperature, water temperature, air volume, and other environmental conditions. Therefore, HVAC control loops periodically need recalibration or tuning to maintain a steady, stable response through seasonal changes.

Comfort Controller 6400 and Comfort Controller 1600 factory-set defaults are usually satisfactory for Proportional/Integral/Derivative (PID) adjustment of the gains.

However, should a loop require tuning, the most common indications are:

- Output oscillates wildly from maximum to minimum allowable value. The most likely cause is excessive proportional gain (P value).

- The controlled variable is away from the setpoint by more than about 2%, but output to the controlling device (valve, actuator, etc.) does not respond over a reasonable time period. The most likely cause is a smaller than acceptable integral gain (I value).

In some cases, the control loop tuning precision that can be attained depends on the application. For example, when a mixed air damper is used in a VAV application, the proportion of outside to return air for a given commanded position varies because of mechanical slop in the damper/actuator assembly. An AO–Mixed Air Damper VAV algorithm is considered to be well tuned if the mixed air temperature is stable within ± 1.0 ˚F.

Tuning can be more precise for constant volume applications, where this problem is normally suppressed by the lag between damper movement and temperature change in the controlled space.

You tune a control loop using the PID and submaster configuration decisions (PID_Master_Loop and P_Submaster_Loop). Refer to the *Comfort Controller Overview and Configuration Manual* or the *BEST++ Programmer's Reference Manual* for information on the software aspects of control loop tuning.

System Checkout

Before you begin tuning the loop, check out the system and verify the following:

1. There are no mechanical problems with the controls and the controlled equipment. Devices such as valves, dampers, and sensors must be operating properly.

2. Whether the actuators are direct acting or reverse acting to determine the correct polarity of the gains. In direct acting devices, the output increases as the controlled variable increases. In reverse acting devices, the output decreases as the controlled variable increases.

   Assuming that error is calculated as reference minus actual sensor value, the P term in dual loops and the P and I terms in single loops are negative for direct acting devices. The inverse is true for reverse acting devices. In all cases, the D term polarity should be the opposite of the P and I term polarity.

3. The system must be operating under actual load conditions. If conditions are atypical, the loop cannot be properly adjusted.

Determination of Throttling Range

Caution: You must determine the throttling range of the controlled device prior to attempting to tune the control loop.

You must differentiate between the throttling range and the spring range since the range over which the device (value, damper, etc.) produces a measurable effect (heat, cool, pressure, etc.) is almost surely to be less than the mechanical spring range. Once you determine the true throttling range, you can calculate the center value (or starting value, for single loops), which can be described as the center of the throttling range. This may be the mathematical center or it may not. For systems which have a very non-linear response, such as a steam valve which opens with a great rush of heat, the center value will be closer to the closed end than the middle.

It is usually helpful to force the valve to a position that should be somewhere in the middle, and confirm that it is neither fully open nor fully closed. As long as the entering process conditions are not atypical, any variance in the center value determination will be compensated for by the integral action of the control loop, assuming that no other tuning errors have occurred which could limit the output range of the algorithm. If tuning a dual loop, enter the center value in the P Submaster Loop's Center Value configuration decision of the algorithm controlling this device. If tuning a single loop, enter the starting value in the PID Master Loop's Starting Value configuration decision for the algorithm controlling this device.

Dual Loop PID Tuning

The following steps apply to Dual Loops only:

1. Verify the correct center value as outlined in Determination of Throttling Range.

2. Force the submaster reference to a value above or below the current value of the submaster sensor. This will cause the controlled device to operate in the middle portion of its range. Since we have already proven the accuracy of the center value, any problems with the submaster loop can be attributed to improper settings of submaster gain.

- If the submaster sensor and output oscillate wildly around the reference indicating an excessive amount of gain, reduce the gain in 50% increments until the oscillation subsides, and then bring it back up by half again. This should result in good stable control. It is possible to continue increasing the gain until the point of oscillation is again reached, then back it off by the smallest allowable increment below oscillation. However, this would likely result in the need to frequently re-tune if conditions change. The intent is to have a responsive loop, but not to the point of instability.

- If the output is stable but the submaster sensor is more than about 5% of reference away from the target reference, re-confirm the accuracy of the center value. If the center value is correct, bring up the gain in 50% increments to the point of instability, then back off slightly. Again, the intent is to stabilize as close to the reference as possible.

  This philosophy may require modification depending on the sensitivity of the controlled environment. Certain situations require a somewhat sluggish response as opposed to the utmost in system response, with borderline stability.

- If the output stabilizes with the sensor within about 5% of the reference, no action is usually needed, unless the user wants to increase the gain to the brink of oscillation, then back it down slightly. This will ensure the ultimate in response, but could result in oscillation if conditions change.

- If the output responds in reverse of what is expected, reverse the polarity of the Submaster Gain (+/-) or reverse the display type for the output device (0/100%). An example of the output responding in reverse of what you expect is when the reference requires heat, but the valve goes closed or moves towards closed. For example, a heating valve may display 100%, but the valve position is fully closed. After the required corrections are made, evaluate for the other possible conditions.

4. Adjust the master loop. At this point the submaster loop is stable and the gain has been adjusted for proper response. You may now adjust the master loop by removing the submaster force to allow the master loop mathematics to calculate a new submaster reference based on the amount of error between the master sensor and the setpoint. Start by adjusting the setpoint to a value about 3% away from the current conditions. At the controlling sensor this allows the equipment to operate with a legitimate load. Look for steady, gradual adjustment of the submaster reference in a measured response to the conditions in the controlled space.

5. Do one of the following based on the response of the output:

   - If the submaster reference swings wildly from its maximum to its minimum allowable value, the most likely cause is an excessive amount of Master Proportional Gain. Reduce the Master Proportional Gain in increments of 50% until stability results, then come back up by half again. Although adjustment may indeed be required, the default gains have been selected to produce satisfactory control in most situations.

   - If the output is stable but does not respond in a timely fashion to error conditions in the controlled space, the culprit is normally insufficient Master Integral Gain. The symptom would be that the controlled space is away from setpoint by a significant amount, but the output to the controlled device does not respond. The amount of adjustment to the Master Integral Gain is also done in 50% increments. However, in practice, as with the Master Proportional Gain, the factory defaults will generally work well.

   At this point the loop should be operating properly and the setpoint may be re-adjusted to an appropriate value.

6. Determine if your application requires a derivative term. The intent of the derivative term is to reduce or eliminate the overshoot in systems which have a very rapid rate of change.

Most HVAC applications that use a Master/Submaster approach do not respond this quickly, therefore the derivative is normally not necessary. As such, in the Comfort Controller, the default value for the derivative gain is zero. The actual purpose of the derivative term is to offset the action of the P and I terms. The derivative gain, when used, should have the same polarity as the P and I.

7. If your application does require a derivative term indicated by excessive overshoot, increase the Derivative Gain from zero by a small amount, perhaps 25% of the Proportional Gain, and re-test and re-adjust until overshoot is reduced to a satisfactory level.

Note: There are certain conditions when even the best control loop may not function precisely, may not be tunable to the last tenth of a degree, and perhaps even exhibit some oscillating in spite of the best efforts to stabilize it.

A common example of this condition would be mixed air dampers when used in a VAV application. The problems relate to the mechanical aspects of the damper, looseness in the linkages, etc., and their inherent non-repeatability. For a given commanded position, the proportions of outside and return air may vary due to the mechanical slop in the damper/actuator assembly. It would be reasonable to consider an AO–Mixed Air Damper VAV algorithm well tuned if the mixed air temperature is stable within +/-1.0 °F.

For constant volume applications, the conditions leading to these occurrences are normally suppressed by the lag between the air mix in the mixed air chamber, and the resulting temperature change in the controlled space, so tuning can be achieved more precisely.

Single Loop PID Tuning

The following tuning procedure assumes a 0 to 100% output. All Comfort Controller algorithms that are single loop in design (AO–Static Pressure, AO–Humidity Control, AO–Cooling VAV, etc.) utilize a single loop PID directly controlling the output device. The tuning process is similar to the master loop of a dual loop algorithm, with the following exceptions:

1. In a single loop PID, the center of the throttling range of the output device is referred to as the Starting Value, as opposed to the Center Value, as is the case in a dual loop.

2. The output of a single loop PID is expressed in the engineering units of the controlled device (%, psi, mAs, Volts, etc.) Since there is no submaster loop, there is no Submaster Reference.

As in the dual loop PID, the polarity of the gain must be correct for the installed actuator. In a single loop PID, loop direction is determined by the P and I terms, unlike in the dual loop, which uses the submaster loop gain for that purpose. As in the dual loop algorithms, the Derivative gain, if used, will be opposite that of the P and I gains.

The following steps are required to tune a single loop PID:

1. Verify the correct Starting Value as outlined in Determination of Throttling range.

2. Force the output to the controlled device to the fully closed position, so as not to produce a measurable result such as heating or cooling.

3. Adjust the setpoint to a value, about 3% of the current conditions at the controlling sensor, that will cause the control loop to modulate the output of the controlled device. The intent is to have a heating coil value open and produce heat, a cooling coil value open to cool the air stream, etc.

4. Remove the force from the output, and allow at least five minutes for the algorithm to stabilize. This allows the equipment to operate with a legitimate load. Look for steady, gradual adustment of the output at the controlling sensor in a measured response to the conditions in the controlled space.

5. Do one of the following based on the response of the output:

   - If the output swings wildly from its maximum to its minimum allowable value, the most likely cause is an excessive amount of Master Proportional Gain. Reduce the Master Proportional Gain in increments of 50% until stability results, then come back up by half again. Although adjustment may indeed be required, the default gains have been selected to produce satisfactory control in most situations.

   - If the output is stable but does not respond in a timely fashion to error conditions in the controlled space, the reason is normally insufficient Master Integral Gain. The symptom would be that the controlled condition is away from setpoint by a significant amount, but the output to the controlled device does not respond. As with the Master Proportional Gain, the factory defaults will generally work well.

6. Once the loop is operating properly, the setpoint should be returned to an appropriate value.

7. Determine if your application requires a derivative term. The intent of the derivative term is to reduce or eliminate the overshoot in systems which have a very rapid rate of change. Most HVAC applications do not respond this quickly, therefore the derivative is normally not necessary. Therefore, in the Comfort Controller, the default value for the derivative gain is zero. The actual purpose of the derivative term is to offset the action of the P and I terms. The derivative gain, when used, should have the same polarity as the P and I.

8. If your application does require a derivative term, indicated by excessive overshoot, increase the Derivative Gain from zero by a small amount, perhaps 25% of the Proportional Gain, and re-test and re-adjust until overshoot is reduced to a satisfactory level.

Troubleshooting

In determining whether a problem is within the module or in the external wiring or sensor, it is helpful to simulate the input to provide a known steady input to the controller. This test can be done for the thermistor, RTD, and discrete input types. You can simulate 4-20 mA inputs using an external current calibrator.

1. Turn the module power off.
2. Using the wire list as a guide, locate the terminal numbers for the wire to the input point.
3. Remove the wire pair to the input point using a small blade flathead screwdriver.
4. Select a comparable substitute for the input. For example:
   - A 1K ohm resistor can be substituted for a RTD type sensor. It will provide a reading of approximately 70˚F.
   - A 10K ohm resistor can be substituted for a thermistor type sensor. It will provide a reading of approximately 77˚F.

     Note: Due to manufacturing tolerances the actual resistances, and thus temperature readings, may vary. To get a more precise reading, measure the resistance of the resistor and use that value to check for temperature in Tables 8 - 10.
   - A short piece of #20 AWG wire can be substituted for a discrete input to provide an on (or off) reading.
5. Insert the leads of the substitute into the two terminals for the input points. Tighten the terminal screws to ensure good electrical contact.

6. Turn the module power on.

7. Read the input point status with the LID. Correct readings are:

   - For thermistor and RTD substitute readings, refer to Table 8.

   - On for a discrete input with straight logic, or off for inverted logic.

Appendixes

Appendix A

Wire Lists

This appendix contains a wire list for the Comfort Controller 1600. It also contains a wire list for the Comfort Controller 6400 and Comfort Controller 6400–I/O.

Carrier COMFORT NETWORK

Comfort Controller 1600 Wire List

PAGE______ OF______
REVISION____________
DATE______/____/_____

JOB: NAME ________________________________ NUMBER ______________

LOCATION: BUILDING________________________ FLOOR________________ AREA________________

ADDRESS: BUS #________________ ELEMENT#________________ CONTROLLER#________________

POINT/ CABLE#	J3 Pin # (+)	J3 Pin # (-)	✔	INPUT TYPE	SW1 Pin #	SW1 Pos.	POINT NAME	SENSOR CODE	WIRING DWG#	SYSTEM NAME
	1	2		Volt/DI						
	3	4		Volt/DI						
	5	6		Volt/DI						
	7	8		Volt/DI						
	9	10		Temp						
	11	12		Temp						
	18	13		mA	1	On				
	13	14		Other*		Off				
	18	15		mA	2	On				
	15	16		Other*		Off				

POINT/ CABLE#	J3 Pin # (+)	J3 Pin # (-)	✔	OUTPUT TYPE	SW1 Pin #	SW1 Pos.	SW1 Pin #	SW1 Pos.	SW1 Pin #	SW1 Pos.	POINT NAME	SENSOR CODE	WIRING DWG#	SYSTEM NAME
	1	2		DO										
	3	4		DO										
	5	6		DO										
	7	8		DO										
	9	10		mA										
	11	12		mA										
	13	14		DO	3	On	4	Off	5	Off				
				mA		Off		On		Off				
				Volt		Off		On		On				
	15	16		DO	6	On	7	Off	8	Off				
				mA		Off		On		Off				
				Volt		Off		On		On				

*Other = Volt, DI, or Temp

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Carrier COMFORT NETWORK

Comfort Controller 6400 and Comfort Controller 6400-I/O Wire List

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REVISION____________

DATE______/____/_____

JOB: NAME __________________________________ NUMBER ______________

LOCATION: BUILDING_________________________ FLOOR________________ AREA_______________

ADDRESS: BUS #_____________ ELEMENT#_________________ CONTROLLER#_______________

POINT/ CABLE#	J3 Pin #		✔	INPUT TYPE	SW2		SW3			POINT NAME	SENSOR CODE	WIRING DWG#	SYSTEM NAME
	(+)	(-)			Pin #	Pos.	Pin #	Pos.					
	17	1		2 wire		Int		mA					
	1	2		4 wire	1	Ext	1	mA					
	1	2		Other*		Int		Other					
	17	3		2 wire		Int		mA					
	3	4		4 wire	2	Ext	2	mA					
	3	4		Other*		Int		Other					
	17	5		2 wire		Int		mA					
	5	6		4 wire	3	Ext	3	mA					
	5	6		Other*		Int		Other					
	17	7		2 wire		Int		mA					
	7	8		4 wire	4	Ext	4	mA					
	7	8		Other*		Int		Other					
	18	9		2 wire		Int		mA					
	9	10		4 wire	5	Ext	5	mA					
	9	10		Other*		Int		Other					
	18	11		2 wire		Int		mA					
	11	12		4 wire	6	Ext	6	mA					
	11	12		Other*		Int		Other					
	18	13		2 wire		Int		mA					
	13	14		4 wire	7	Ext	7	mA					
	13	14		Other*		Int		Other					
	18	15		2 wire		Int		mA					
	15	16		4 wire	8	Ext	8	mA					
	15	16		Other*		Int		Other					

POINT/ CABLE#	J4 Pin #		✔	OUTPUT TYPE	SW4		SW5		SW6		POINT NAME	SENSOR CODE	WIRING DWG#	SYSTEM NAME
	(+)	(-)			Pin #	Pos.	Pin #	Pos.	Pin #	Pos.				
				DO		NA		DO						
	1	2		mA	1	mA	1	AO						
				Volt		Volt		AO						
				DO		NA		DO						
	3	4		mA	2	mA	2	AO						
				Volt		Volt		AO						
				DO		NA		DO						
	5	6		mA	3	mA	3	AO						
				Volt		Volt		AO						
				DO		NA		DO						
	7	8		mA	4	mA	4	AO						
				Volt		Volt		AO						
				DO		NA				DO				
	9	10		mA	5	mA			1	AO				
				Volt		Volt				AO				
				DO		NA				DO				
	11	12		mA	6	mA			2	AO				
				Volt		Volt				AO				
				DO		NA				DO				
	13	14		mA	7	mA			3	AO				
				Volt		Volt				AO				
				DO		NA				DO				
	15	16		mA	8	mA			4	AO				
				Volt		Volt				AO				

*Other = Volt, DI, or Temp

Note:

Switch	2	3	4	5	6
ON Pos.	Int	mA	Volt	DO	DO

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Appendix B

How to Clear the Comfort Controller Database

Follow the procedure below to completely erase the Comfort Controller database and return the unit to its factory default settings.

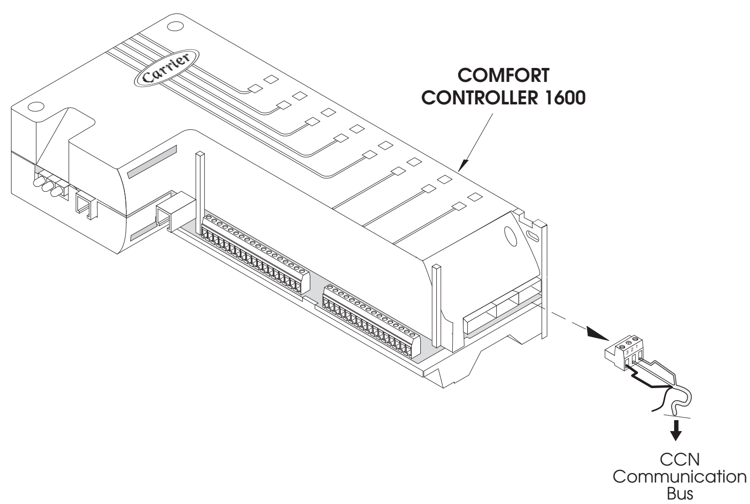
Caution: All data, i.e., 24-character names, algorithm selections, configuration decision entries, etc., will be erased.

1. If the Comfort Controller whose database you wish to clear is connected to the CCN, you must disconnect it. Refer to the figure below.

   To disconnect a Comfort Controller 1600 or 6400 from the CCN:

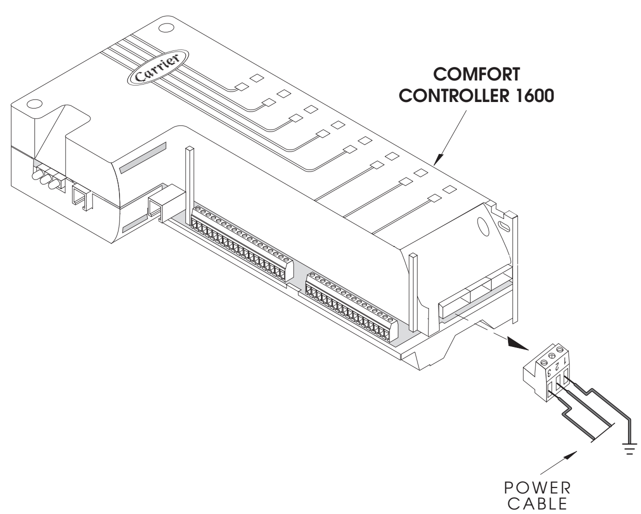
   Remove the CCN communication connector from the module.

Figure 55
Disconnecting the Comfort Controller from the CCN



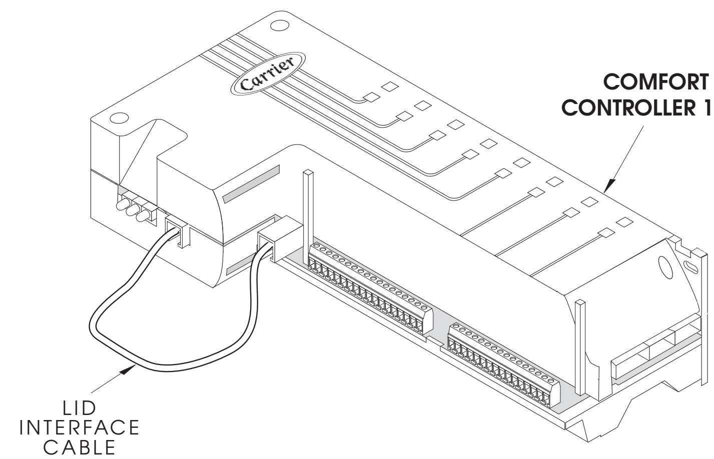
2. Disconnect power by removing the power connector from the module. Refer to the figure below.

Figure 56
Disconnecting Power from the Comfort Controller



3. Use the LID interface cable for this step of the process. Connect one end of the cable to the Comfort Controller's Network Service Tool interface connector and the other end to the LID interface connector, as shown in the figure below. For LID interface cable specifications, refer to LID Installation in the Installation and Wiring section of this manual.

Figure 57
Connecting the
LID Interface Cable



4. Re-connect power to the Comfort Controller. This begins the process of clearing the database.

   While the database is being cleared, the red LED on the Comfort Controller will blink at a two-second rate. Once the process is completed, the red LED will blink at a one-second rate, and the green LED will start to blink at a one-second rate. The entire process takes approximately eight seconds.

5. Disconnect the LID interface cable.

6. Re-connect the CCN Communication Bus to the Comfort Controller.

7. Upload the Comfort Controller and re-configure it as desired.

Appendix C

Quick Reference Guide

The following table is intended to be a summary of product specifications and CCN product compatibility data for the Comfort Controller.

Table C-1
Product Data

Item	Value	Comments
Baud Rate Data		
Default Baud Rate	9600	
Range of Baud Rates	9600-38400	38.4 requires 1.5 or higher
Address Data		
Default Address	0,1	
Valid Range of Addresses	1-239	
Address Setting Method		
NST	Yes	
ESU	Yes	
DIP Switch	No	
Ram Flush Procedure		
By Reset Jumper?	Yes	Clears only configuration
Software Reset by Config Decision?	No	
Address/Baud Rate Retention?	No/No	Reverts to address 0,1 @ 9600
Power Requirements		
AC Power		
(Volts and Va, +/-%)	24 Vac, 60 Va, +/- 15%	
DC Power		
(Volts and amps/milliamps, +/-%)	33 Vdc, 1.5a, +/- 15%	
Power Sharing (AC and DC)		
See Note #1 at end	Yes	Polarity MUST be maintained
Bus Communications		
38.4K Bridge Compatible	Yes	
8088 Bridge Compatible	Yes	
8052 Bridge Compatible	Yes	
# of Devices per Bus/Bus Segment		
(>= 19,400)	239	
# of Devices per Bus/Bus Segment		
(< 19,400)	239	

(*continued*)

Table C-1
Product Data
(continued)

Item	Value	Comments
User Interface Compatibility		
Building Supervisor IV	Yes	
Network Service Tool IV	Yes	
ComfortVIEW	Yes	
ComfortWORKS	Yes	
HSIO II (color buttons, white or black casing)	Yes	Direct comm to element only
LID1B	Yes	Cannot be 1st element
LID2B	Yes	Cannot be 1st element
Chiller Visual Controller (CVC)	Yes	Cannot be 1st element
Remote Enhanced Display (Display-only CVC)	Yes	Cannot be 1st element
Comfort Command Center	Yes	Display only//No configuration
Navigator	No	
Scrolling Marquee	No	
Option Module Compatibility		
APIM	Yes	
BACLink	Yes	
Data Collection I	Yes	
Data Collection III	Yes	
Data Collection IV	Yes	
Maintenance Management	Yes	
Timed Force	Yes	
Tenant Billing	Yes	
Loadshed	Yes	Version 1.6 or higher
Facility Time Schedule	Yes	
Cleaver Brooks	N/A	
Leibert Interface	N/A	
Simplex Interface	N/A	
Terminal System Manager II	Yes	
Terminal System Manager II Plus	Yes	
Chillervisor System Manager I	Yes	BEST++ access to CSM
Chillervisor System Manager II	Yes	BEST++ access to CSM
Chillervisor System Manager III	Yes	BEST++ access to CSM
Flotronic System Manager	Yes	BEST++ access to FSM

(*continued*)

Table C-1
Product Data
(continued)

Item	Value	Comments
Hydronic System Manager	Yes	BEST access to HSM
Hydro Hi-Q System Manager	Yes	BEST++ access to HHiQSM
Water System Manager	Yes	Heat sources only
Interoperability Interfaces		
DataPORT	Yes	
DataPORT II (dataLINK)	Yes	
BACLink	Yes	

Note#1 - It is strongly recommended that you use isolated, non-shared transformers to power this module. If power is to be shared with another device, you must maintain polarity (DC circuits) or phasing (AC circuits) of the power source between elements in question. Failure to maintain consistent polarity/phasing can result in irreparable damage to the modules.

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Document Name: ______________________ **Publication Date:** ______________________

Usefulness and Readability:

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Suggested Additions and Deletions:

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Errors and Omissions (Please give page numbers):

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