VVT Bypass Controller
Installation and Start-up Guide

Carrier
United Technologies
turn to the experts
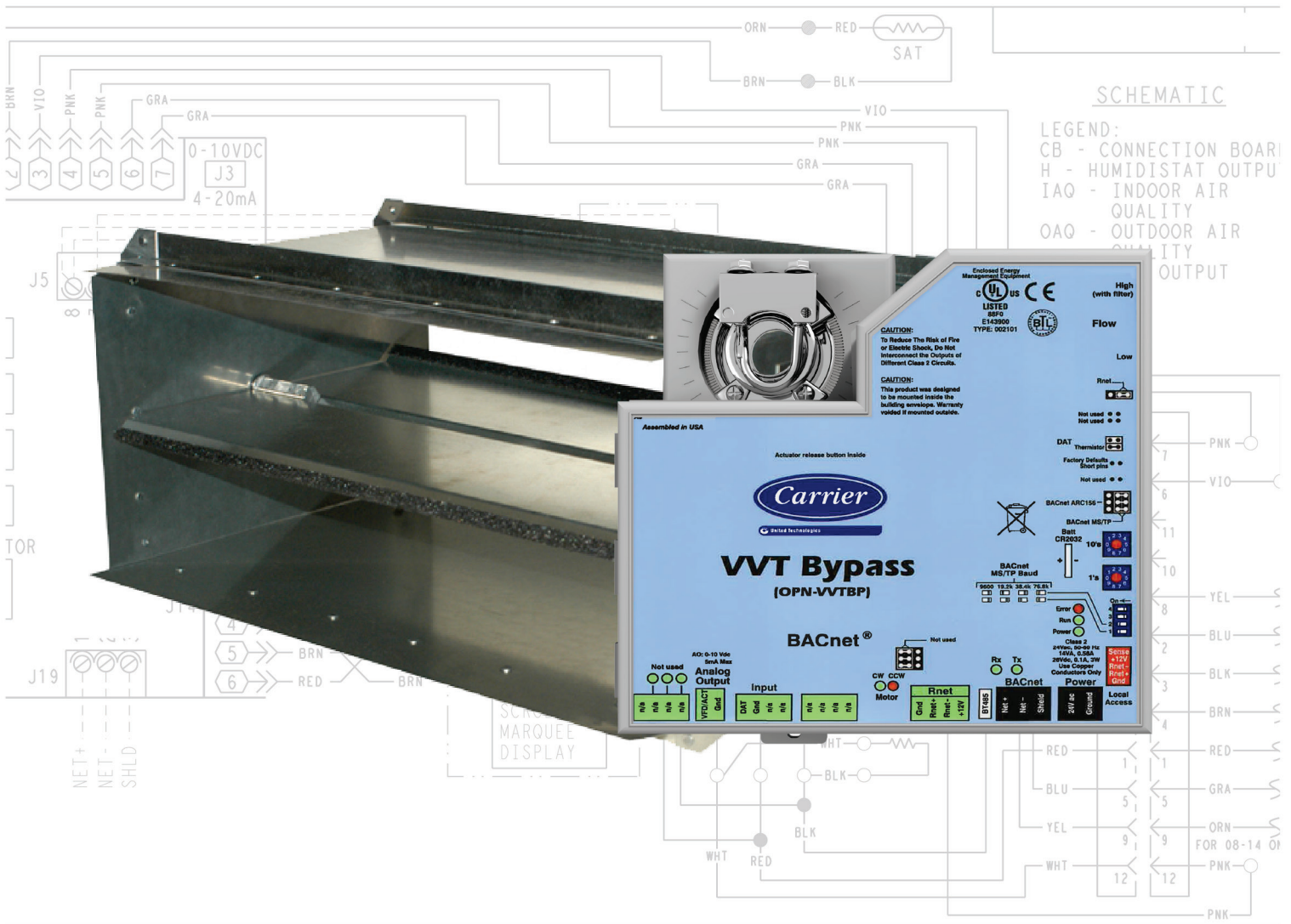
⚠ Verify that you have the most current version of this document from **www.hvacpartners.com** or your local Carrier office.

Important changes are listed in **Document revision history** at the end of this document.

Contents

Introduction

What is a VVT Bypass Controller?

The VVT Bypass Controller (#OPN-VVTBP), a component of the i-Vu® Control System, regulates the supply duct static pressure by controlling one of the following:

- The system's bypass damper
  The controller's built-in damper actuator provides 35 in/lbs (4 Nm) of torque. If the built-in actuator's torque is insufficient, the VVT Bypass Controller can be used to drive an external high-torque actuator. Or, the controller can drive multiple external damper actuators.

- The air source supply fan's variable frequency drive (VFD)

NOTE The VVT Bypass Controller controller is available in both English or Metric units. The metric version has (-M) appended to the part number. Everything in this document applies to both versions.

The i-Vu Control System uses linkage to exchange data between the zone terminals and their air source to form a coordinated HVAC system. The system's air source controller, zone controllers, and bypass controller are linked so that their data exchange can be managed by one zone controller configured as the VVT Master.

The following illustration shows the VVT Bypass Controller in a typical i-Vu® Control System.

Enclosed Energy
Management Equipment

c(UL)us
LISTED
88FO
E143900
TYPE: 002101

CE

BTL

High
(with filter)

Flow

Low

Rnet

Not used
Not used

CAUTION:
To Reduce The Risk of Fire
or Electric Shock, Do Not
Interconnect the Outputs of
Different Class 2 Circuits.

CAUTION:
This product was designed
to be mounted inside the
building envelope. Warranty
voided if mounted outside.

DAT Thermistor

Factory Defaults
Short pins

Not used

Assembled in USA

BACnet ARC156

BACnet MS/TP

Batt
CR2032

10's

1's

Actuator release button inside

Carrier

United Technologies

VVT Bypass

(OPN-VVTBP)

BACnet MS/TP Baud

9600 19.2k 38.4k 76.8k

On

4
3
2
1

Error
Run
Power

BACnet ®

Not used

Class 2
24Vac, 50-60 Hz
14VA, 0.58A
26Vdc, 0.1A, 3W
Use Copper
Conductors Only

Sense
+12V
Rnet-
Rnet+
Gnd

Local
Access

AO: 0-10 Vdc
5mA Max

Not used

Analog
Output

n/a n/a n/a n/a

VFD/ACT Gnd

Input

DAT Gnd n/a n/a

n/a n/a n/a

CW CCW

Motor

Rx Tx

Rnet

Gnd Rnet + Rnet - +12V

BACnet

BT485 Net + Net - Shield

Power

24V ac Ground

NOTE This document gives instructions for field-installation of a VVT Bypass Controller in an i-Vu® Control System.
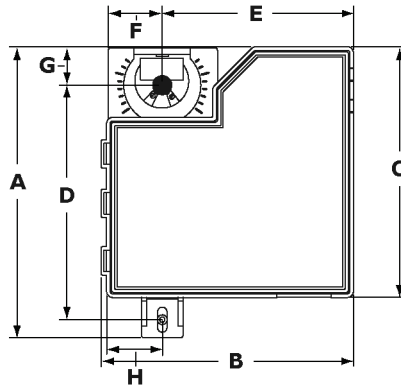
Specifications

Driver	drv_bpopen_x-xx-xxx
Power	24 Vac ±10%, 50–60 Hz 14 VA power consumption 26 Vdc (25 V min, 30 V max) Single Class 2 source only, 100 VA or less
BACnet port	For communication with the controller network using BACnet ARC156 (156 kbps) or BACnet MS/TP (9600 bps – 76.8 kbps)
Rnet port	For connecting an Equipment Touch
Local Access port	For system start-up and troubleshooting
Inputs	1 input for connecting the Duct air temperature sensor (#33ZCSENDAT)
Input resolution	10 bit A/D
Analog output	1 analog output, 0–10 Vdc (5 mA max) The controlled device must have a minimum of 2000 Ohms resistance measured from its input to ground and must share the same ground as the controller.
Output resolution	8 bit D/A
Integral airflow sensor	Precision low flow AWM series 0–2 in. H20 (0-.498 kPa), sensitive down to ±0.001 in. $H_2$0 (±.00025 kPa). Barbed tapered airflow connections accept 3/16 in. (4.75 mm) I.D. tubing. Allows for readings across the 0–2 in. $H_2$0 (0 - .498 kPa) range, accurate to ±5% of full flow at 2 in. $H_2$0 (.498 kPa).
Integral actuator	Brushless DC motor, torque 35 inch-pounds (4 Nm), runtime 205 seconds for 90 degree travel during control, or 25 seconds in high-speed test and balance mode
Battery	10-year Lithium CR2032 battery retains the following data for a maximum of 10,000 hours during power outages: control programs, editable properties, schedules, and trends.
Protection	Incoming power and network connections are protected by non-replaceable internal solid-state polyswitches that reset themselves when the condition that causes a fault returns to normal. The power, network, input, and output connections are also protected against transient excess voltage/surge events lasting no more than 10 msec.
BT485 connector	You attach a BT485 (not included) to a controller at the beginning and end of a network segment to add bias and to terminate a network segment.
Status indicators	LED's indicate status of communications, running, errors, power, and digital outputs
Environmental operating range	0 to 130°F (-18 to 54°C), 0 to 90% relative humidity, non-condensing
Storage temperature range	-24 to 140°F (-30 to 60°C), 0 to 90% relative humidity, non-condensing
Physical	UL94-5VA plenum rated enclosure for installation in plenum (or other space for environmental air) in accordance with NEC Section 300.22 (c) and (d)

Overall dimensions	A:	7 in. (17.8 cm)
	B:	6-1/32 (15.4 cm)
	C:	6 in. (15.24 cm)
Mounting dimensions	D:	5-5/8 in. (14.3 cm)
	E:	4-9/16 in. (24.3 cm)
	F:	1-5/16 in. (3.3 cm.)
	G:	7/8 in. (2.2 cm)
	H:	1-5/16 in. (3.3 cm)
Panel depth	2-1/2 in. (6.4 cm) minimum	
Shaft dimension	Minimum shaft diameter: 3/8 in. (.95 cm.)	
	Maximum shaft diameter: 1/2 in. (1.27 cm)	
	Minimum shaft length: 1 3/4 in. (4.45 cm)	
Weight	1.7 lbs (0.77 kg)	
BACnet support	Conforms to the BACnet Advanced Application Controller (B-AAC) Standard Device Profile as defined in ANSI/ASHRAE Standard 135-2012 (BACnet) Annex L, Protocol Revision 9	
Listed by	UL-916 (PAZX), cUL-916 (PAZX7), FCC Part 15-Subpart B-Class A, CE	

Safety Considerations

⚠️ **CAUTION**

Air conditioning equipment will provide safe and reliable service when operated within design specifications. The equipment should be operated and serviced only by authorized personnel who have a thorough knowledge of system operation, safety devices, and emergency procedures.

Good judgment should be used in applying any manufacturer's instructions to avoid injury to personnel or damage to equipment and property.

⚠️ **WARNING** **Electrical Shock Hazard**

Failure to follow this warning could cause personal injury, death, and/or equipment damage.

Disconnect all power to the unit before performing maintenance or service. Unit may automatically start if power is not disconnected.

⚠️ **WARNING** Follow all local, state, and federal laws regarding disposal of equipment containing hazardous materials such as mercury contactors.

Installing the VVT Bypass Controller

Duct
temperature
sensor

Supply
air

Bypass
damper

Bypass
controller
w/actuator

To
building

Duct static
pressure probe

Transformer

High pressure
tubing

Low pressure
open to space

Power
supply

To communication
bus

To install the VVT Bypass Controller:

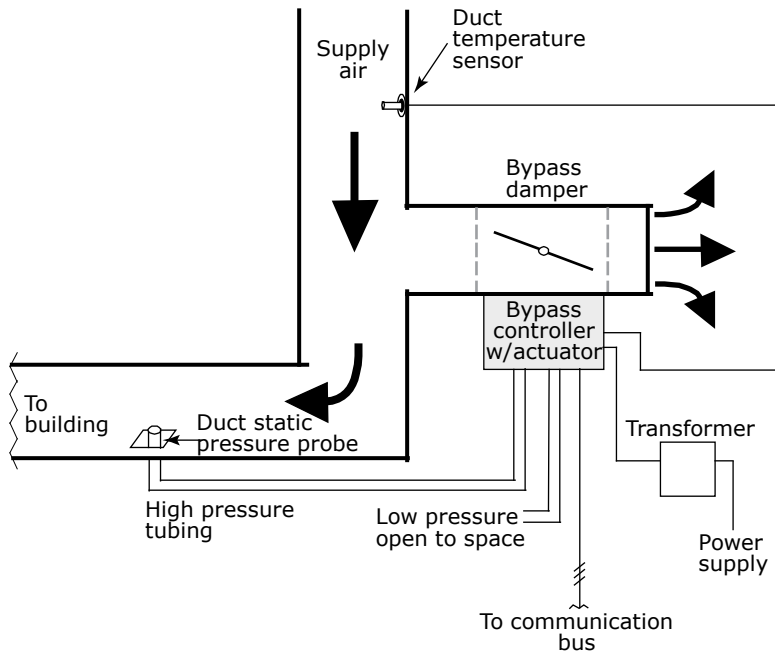**1** *Mount the controller* (page 7).

2 *Wire the controller for power* (page 9).

3 *Set the controller's address* (page 10).

4 *Wire the controller to the BACnet MS/TP or BACnet ARC156 network* (page 10).

**5** *Wire the inputs and outputs* (page 12).

Field-supplied hardware

Each VVT Bypass Controller installation requires the following field-supplied components:

- damper
- damper actuator (if high-torque actuator or slaved dampers are required)
- duct air temperature sensor
- transformer— 24 Vac, 40 Va
- wiring

Mounting the VVT Bypass Controller

Mount the VVT Bypass Controller on the bypass duct damper actuator shaft. For service access, allow at least 1 foot (.3 m) of clearance between the front of the controller and adjacent surfaces.

Allow 1 ft. (.3 m) clearance
for service access

2.5 in.
(6.35 cm)

Controller

End view inlet
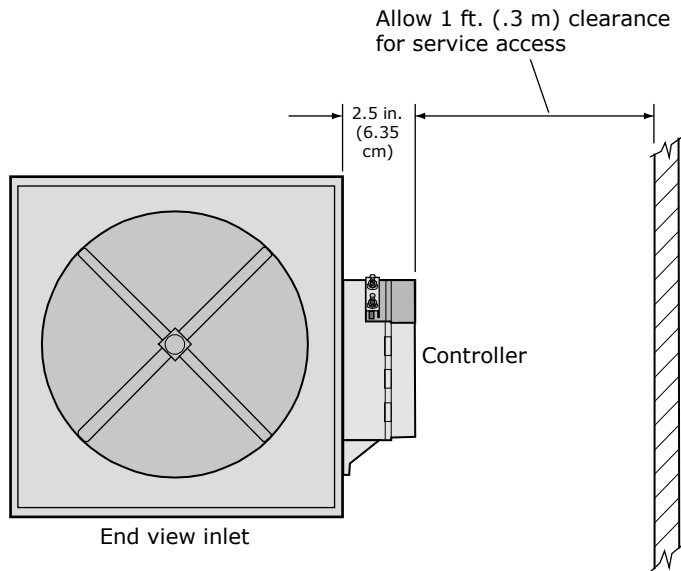
To mount the controller

1 Turn the damper shaft to fully close the damper.

2 Remove the controller's cover.

3 Mount the controller to the VVT box by sliding the clamp assembly onto the damper shaft.

VVT Box   Damper Shaft   Controller
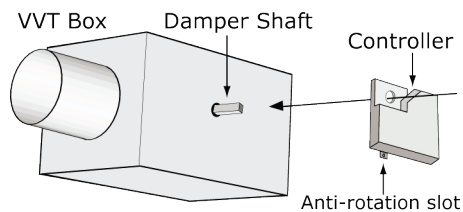
Anti-rotation slot

4 Secure the controller by installing the screw provided through the anti-rotation slot's bushing and o-ring.

Anti-rotation slot

O-ring   Bushing
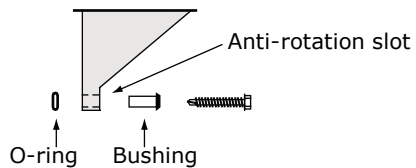
NOTE Center the bushing in the slot. Failure to do so may cause the actuator to stick or bind.

5 Hold down the controller's damper release button and rotate the actuator clamp in the same direction that closed the damper. Rotate the clamp until it stops, then rotate it back one notch.

6 Release the button.

7 Tighten the actuator clamp to the damper shaft by tightening the two M5 nuts.

8 Hold down the damper release button and rotate the damper from fully closed to fully open. If the damper traveled less than 90 degrees, do the following to set the actuator's fully open position:

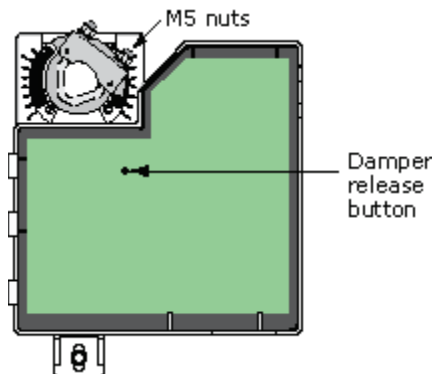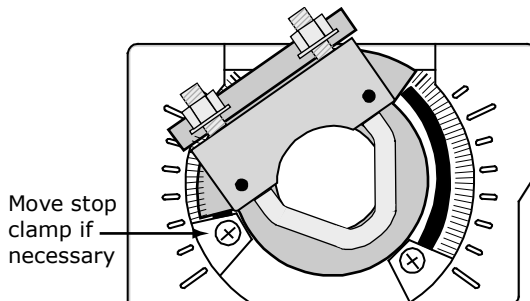   a) Loosen the appropriate stop clamp screw. See figure below.

    b) Move the stop clamp until it contacts the edge of the actuator cam.

    c) Tighten the screw.

9 Hold down the damper release button, rotate the damper to verify that it fully opens and closes, then release the button.

10 Connect the filter tube provided to the controller's **High** connector. See figure below. Using 1/4" poly tubing, connect the other end to a duct static pressure probe (part #39EK20462) located in the supply air duct downstream of the bypass damper, but before the first branching of ductwork. See diagram in *Installation* (page 6).

    NOTE Tubing should be at least 2 feet long for stable airflow measurement.

11 Leave the controller's **Low** connector open for plenum return or to a room space if using ducted return.

Tube installation

High

Low
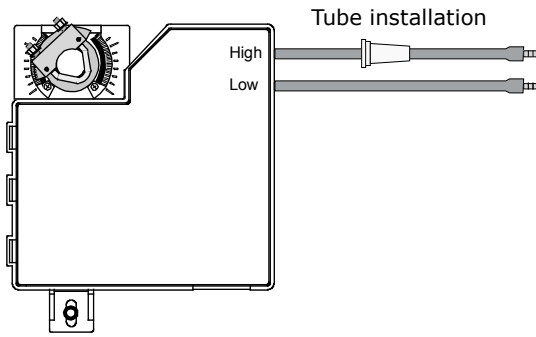
12   Replace the controller's cover.

Wiring the VVT Bypass Controller for power

⚠️ **WARNING**   Do not apply line voltage (mains voltage) to the controller's ports and terminals.

⚠️ **CAUTIONS**

- The VVT Bypass Controller is powered by a Class 2 power source. Take appropriate isolation measures when mounting it in a control panel where non-Class 2 circuits are present.

- Carrier controllers can share a power supply as long as you:
  - Maintain the same polarity.
  - Use the power supply only for Carrier controllers.

To wire the controller for power

1   Remove power from the power supply.

2   Pull the screw terminal connector from the controller's power terminals labeled **Gnd** and **24 Vac** or **Hot**.
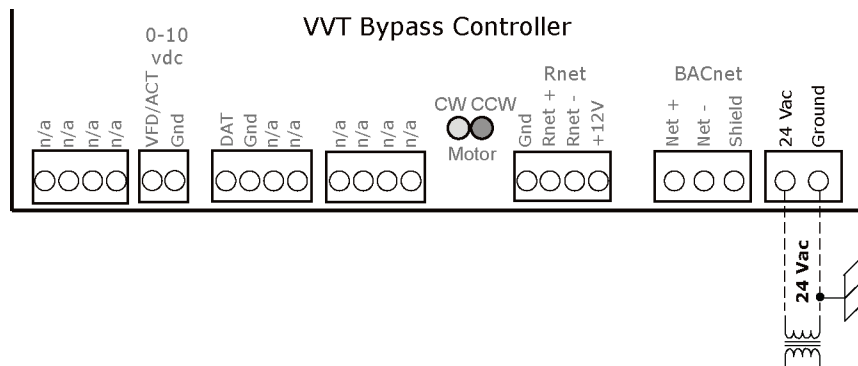
3   Connect the transformer wires to the screw terminal connector.

4 Apply power to the power supply.

5 Measure the voltage at the VVT Bypass Controller's power input terminals to verify that the voltage is within the operating range of 21.6–26.4 Vac.

6 Connect a 4-inch (10.2 cm) wire from **Gnd** to earth ground.

7 Insert the screw terminal connector into the VVT Bypass Controller's power terminals.

8 Verify that the **Power** LED is on and the **Run** LED is blinking.

Addressing the VVT Bypass Controller

You must give the VVT Bypass Controller an address that is unique on the network. You can address the VVT Bypass Controller before or after you wire it for power.

1 If the VVT Bypass Controller has been wired for power, pull the screw terminal connector from the controller's power terminals labeled **Gnd** and **24 Vac**. The controller reads the address each time you apply power to it.

2 Using the rotary switches, set the controller's address. Set the **Tens** (**10's**) switch to the tens digit of the address, and set the **Ones** (**1's**) switch to the ones digit.

EXAMPLE If the controller's address is 25, point the arrow on the **Tens** (**10's**) switch to 2 and the arrow on the **Ones** (**1's**) switch to 5.

10's

1's
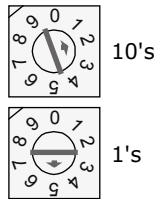
⚠️ **CAUTION** The factory default setting is **00** and must be changed to successfully install your VVT Bypass Controller.

Wiring for communications

The VVT Bypass Controller communicates using BACnet on the following types of network segments:

- MS/TP communicating at 9600 bps, 19.2 kbps, 38.4 kbps, or 76.8 kbps

- ARC156 communicating at 156 kbps

NOTE For more networking details, see the *Open Controller Network Wiring Installation Guide*.

Wiring specifications for BACnet MS/TP and ARC156

|	
Cable:	22 AWG or 24 AWG, low-capacitance, twisted, stranded, shielded copper wire
Maximum length:	2000 feet (610 meters)

⚠️ **WARNING** Do not apply line voltage (mains voltage) to the controller's ports and terminals.

To wire the controller to the BACnet network

1   Pull the screw terminal connector from the controller's power terminals labeled **Gnd** and **24 Vac**.

2   Check the communications wiring for shorts and grounds.

3   Connect the communications wiring to the controller's screw terminals labeled **Net +**, **Net -**, and **Shield**.

    NOTE Use the same polarity throughout the network segment.

4   Set the communication type and baud rate.

For...	Set BACnet ARC156 or MS/TP jumper to...	Set DIP switches 1 and 2 to...
ARC156	**ARC156**	N/A. Baud rate will be 156 kbps regardless of the DIP switch settings.
MS/TP	**MS/TP**	The appropriate baud rate. See the **BACnet MS/TP Baud** diagram on the controller.

    NOTE Use the same baud rate for all controllers on the network segment.

5   If the VVT Bypass Controller is at either end of a network segment, connect a BT485 to the VVT Bypass Controller.

6   Insert the power screw terminal connector into the VVT Bypass Controller's power terminals.

7   Verify communication with the network by viewing a Module Status report in the WebCTRL® interface.

Wiring inputs and outputs

⚠️ **WARNING** Disconnect electrical power to the VVT Bypass Controller before wiring it. Failure to follow this warning could cause electrical shock, personal injury, or damage to the controller.

⚠️ **CAUTION**

- Do not run sensor or relay wires in the same conduit or raceway with Class 1 AC or DC service wiring.
- Do not abrade, cut, or nick the outer jacket of the cable.
- Do not pull or draw cable with a force that may harm the physical or electrical properties.
- Avoid splices in any control wiring.

Wiring a Duct Air Temperature sensor to an input

Part #33ZCSENDAT

The VVT Bypass Controller must be connected to a Duct Air Temperature (DAT) sensor that monitors the temperature of the air delivered by the air source.

NOTE This document gives instructions for wiring the sensor to the VVT Bypass Controller. For mounting and wiring the sensor, see the *Carrier Sensors Installation Guide*.

Wiring specifications

Cable from sensor to controller:	If <100 ft (30.5 meters) If >100 ft (30.5 meters)	22 AWG, unshielded 22 AWG, shielded
Maximum length:	500 feet (152 meters)	

To wire and mount the DAT sensor

1 Wire the sensor to the controller. See diagram below.

NOTE Sensor wiring does not have polarity. The wires can be connected to either terminal.

2 Using electrical tape, insulate any exposed wire to prevent shorting.
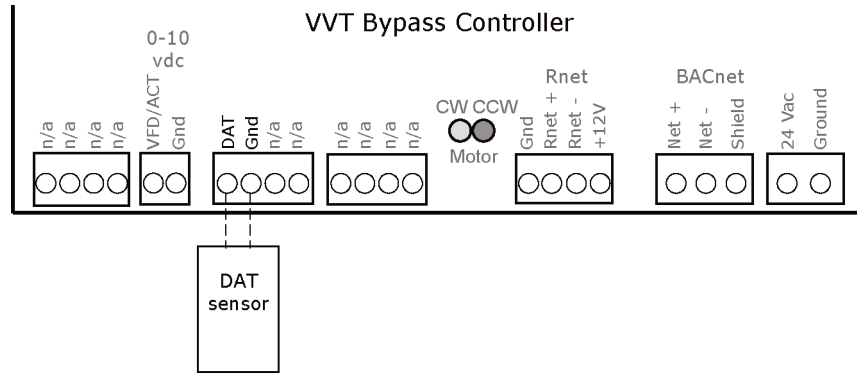
Wiring field-supplied actuators to the analog output

You can wire a high-torque actuator or parallel actuators to the controller's 0–10 Vdc analog output.

NOTE You cannot use the VVT Bypass Controller's built-in actuator if wiring external actuator(s) to the analog output.

High-torque actuators

You can wire one of the following Belimo actuators to the VVT Bypass Controller's analog output instead of using the controller's built-in, 35 in.-lb (4 Nm) actuator.

NMX24-MFT P-10028   90 in.-lb (10 Nm) actuator with 0–10 Vdc control and 0–10 Vdc feedback

AMX24-MFT P-10028   180 in.-lb (20 Nm) actuator with 0–10 Vdc control and 0–10 Vdc feedback

1 Install the actuator according to the manufacturer's instructions.

2 Wire the actuator to the controller using the diagram below.
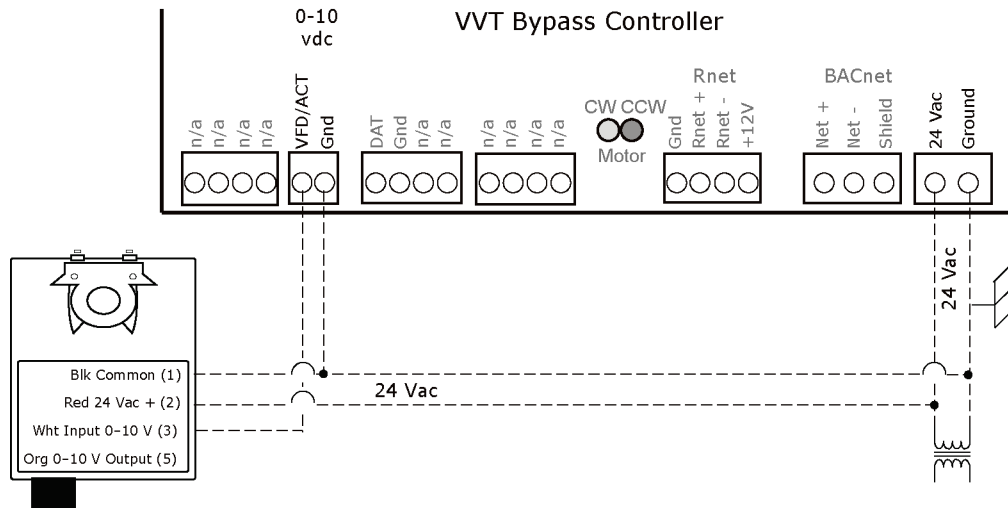
NOTE For proper operation and to prevent damage to the devices, use the same polarity for the actuator's power and the VVT Bypass Controller's power.

Linked actuators

You can wire up to 4 of the following Belimo actuators to the VVT Bypass Controller's analog output. Link actuators whose travel times and other parameters coincide.

LMX24-MFT P-10028	45 in.-lb (5 Nm) actuator with 0–10 Vdc control
NMX24-MFT P-10028	90 in.-lb (10 Nm) actuator with 0–10 Vdc control
AMX24-MFT P-10028	180 in.-lb (20 Nm) actuator with 0–10 Vdc control

1 Install the actuators according to the manufacturer's instructions.

2 Wire the actuators to the controller using the diagram below.

3 Set the direction rotation switch on each actuator to CW.
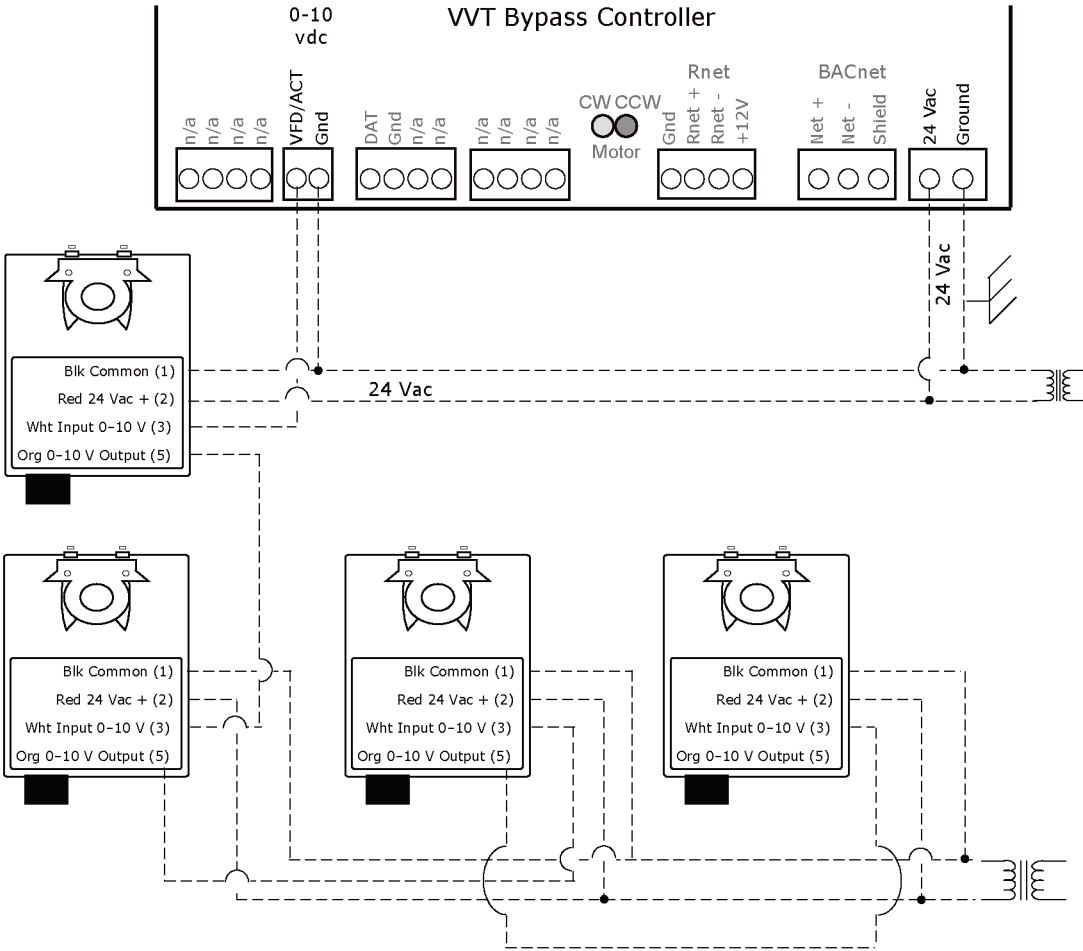
NOTE Maintain polarity if using the same power supply for more than one actuator.

Wiring and mounting the Equipment Touch

⚠ **CAUTION** If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

See the *Equipment Touch Installation and Setup Guide* for more details.

Mounting

The Equipment Touch must be mounted within the building interior. You can mount the Equipment Touch:

- In a panel with the controller or on the panel door
- On a wall up to 500 feet from the controller

Wiring

- The Equipment Touch requires a 24 Vac power supply. It is not powered by the Rnet.

  ⚠ **CAUTION** The Equipment Touch can share a power supply with the Carrier controller as long as you:

  ○ Maintain the same polarity.

  ○ User the power supply only for Carrier controllers.

- You can also wire an external 10 kOhm, Type II thermistor (Carrier part number 33ZCT55SPT) to the Equipment Touch.

Wire the Equipment Touch directly to the controller's Rnet port as shown below.
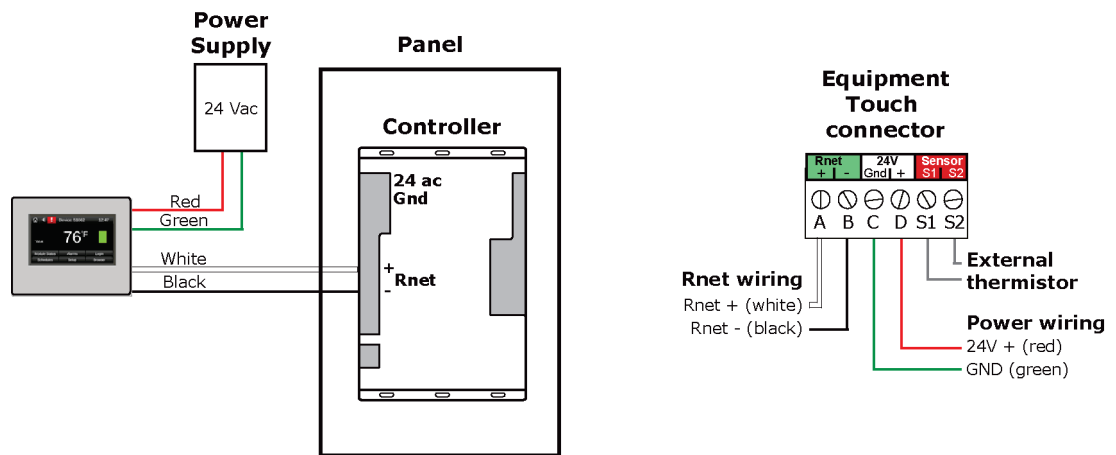
1 Turn off the VVT Bypass Controller's power.

2 Partially cut, then bend and pull off the outer jacket of the cable. Do not nick the inner insulation.
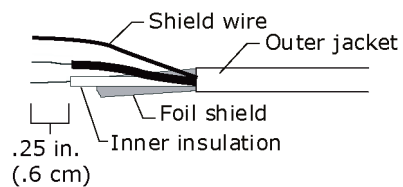
3 Strip about .25 inch (.6 cm) of the inner insulation from each wire.

4 Wire the VVT Bypass Controller's **Rnet+** and **Rnet-** terminals to the terminals of the same name on the Equipment Touch's connector.

   NOTE If using shielded wire, connect the shield wire and the ground wire to the **Gnd** terminal.

5 Turn on the VVT Bypass Controller's power.

6 Turn on the Equipment Touch.

   NOTE You do not need to set an address for the Equipment Touch.

Start-up

Use one of the following interfaces to start up, access information, read sensor values, and test the controller.

This interface...	Provides a...
Field Assistant application - Runs on a laptop that connects to controller's Local Access port [1]	Temporary interface
Equipment Touch device - Connects to controller's Rnet port [2]	Temporary or permanent interface
I-Vu® application Available for BACnet systems only	Permanent interface
System Touch device Available only for BACnet MS/TP systems. Wire to a BACnet MS/TP network connector and a 24 Vac power supply [3]	Temporary or permanent interface

[1] Requires a USB Link (Part #USB-L).
[2] See the *Equipment Touch Installation and Setup Guide* for detailed instructions.
[3] See the *System Touch Installation and Setup Guide* for detailed instructions.

⚠ **CAUTION**   If multiple controllers share power but polarity was not maintained when they were wired, the difference between the controller's ground and the computer's AC power ground could damage the USB Link and the controller. If you are not sure of the wiring polarity, use a USB isolator between the computer and the USB Link. Purchase a USB isolator online from a third-party manufacturer.

Configuring the VVT Bypass Controller's properties

To start up the VVT Bypass Controller, you must configure certain points and properties. *Appendix A* (page 29) is a complete list of all the points and properties, with descriptions, defaults, and ranges. These properties affect the unit operation and/or control. Review and understand the meaning and purpose of each property before changing it.

See *Appendix A* (page 29) for a complete list of the controller's points/properties.

NOTE Engineering units shown in this document in the defaults and ranges are strictly for reference. You must enter an integer only.

Performing system checkout

Bypass damper

1   Verify the VVT Bypass Controller is securely fastened to the bypass damper shaft and duct work.

2   Verify duct air temperature sensor is installed at the inlet of the damper or in the air source supply duct upstream of the bypass damper connection.

3   Verify that the high pressure tubing from the controller's airflow (pressure) sensor is connected to the duct static pressure probe downstream of the bypass damper. Then verify that the low pressure connector is not blocked.

4   Calibrate damper and pressure sensor:

a)   Disable the air source heating, cooling, and fan outputs using one of the following methods:

    • Physically disconnect the air source controller's output wiring to the unit.

    • In the i-Vu® or Field Assistant tree, select the RTU Open controller. Go to **Properties** > **Control Program** >
        Configuration > **Service Configuration** > **Service Test**, then enable **Service Test**. Make sure all other outputs under **Service Test** are disabled.

b)   Select the Bypass controller in the tree, then go to **Properties** > **Control Program** > **Unit Configuration** > **Bypass Control** > **Details** tab.

c)   Click **Damper Full Close**, then verify that the damper is fully closed.

d)   Click **Damper Full Open**, then verify that the damper is fully open.

e)   Click **Zero Cal** to close the bypass damper and zero the pressure sensor. When **Done** appears, click **Apply**.

f)   Enable the air source fan output using one of the following methods:

    • Physically connect the air source controller's fan enable wiring at the unit.

    • In the i-Vu® or Field Assistant tree, select the RTU Open controller. Go to **Properties** > **Control Program** >
        Configuration > **Service Configuration** > **Service Test**, then enable **Fan Test**. Make sure all other outputs under **Service Test** are disabled.

g)   Select the Bypass controller in the tree, then go to **Properties** > **Control Program** > **Unit Configuration** > **Bypass Control** > **Details** tab.

h)   After the static pressure has stabilized, make sure that **Target Damper Position** and **Duct Static Pressure** are not locked and that **Target Damper Position** is >0% and <100%. You may have to adjust the **Duct Static Pressure Setpoint** slightly to get the damper within this range.

i)   Using a branch-tee, connect a magnehelic gauge to the **High** connector on the controller's airflow sensor, then measure the static pressure. If the measured static pressure is different from the **Duct Static Pressure** by ±.05 in. (+.012 kPa), click **Pressure Sensor Cal**, enter the measured value next to the button, then click **Apply**.

j)   Remove the magnehelic gauge from the **High** connector, then reinsert the pressure tubing.

k)   Click **Automatic Control** to return the bypass to normal control.

l)   Enable the air source's heating and cooling outputs using one of the following methods:

   • Reconnect the air source controller's output wiring at the unit.

   • In the i-Vu® or Field Assistant tree, select the RTU Open controller. Go to **Properties** > **Control Program** >
      Configuration > **Service Configuration** > **Service Test**, then disable **Service Test** and **Fan Test**. Make sure all other outputs under **Service Test** are disabled.

CAUTION Pressing the actuator release button and moving the damper or disconnecting the actuator ribbon connector while the bypass controller is powered will cause the damper position to be out of calibration. To recalibrate the damper position, you must perform steps 4c and 4d above or power cycle the controller.

Variable frequency drive (VFD)

1   Verify that the controller's **VFD/ACT** output wiring is correctly connected to the VFD and that the VFD is configured for a 0-10 Vdc control signal.

2   In the i-Vu or Field Assistant tree, select the Bypass controller. Go to **Properties** > **Control Program** > **Unit Configuration**, then verify that **Control Device Type** is set to **VFD**.

3   Verify duct air temperature sensor is installed in the air source supply duct.

4   Verify that the high pressure tubing from the controller's airflow (pressure) sensor is connected to the duct static pressure probe downstream of the bypass damper. Then verify that the low pressure connector is not blocked.

5   Calibrate the VFD and pressure sensor:

   a)   Disable the air source heating, cooling, and fan outputs using one of the following methods:

      • Physically disconnect the air source controller's output wiring to the unit.

      • In the i-Vu® or Field Assistant tree, select the RTU Open controller. Go to **Properties** > **Control Program** >
         Configuration > **Service Configuration** > **Service Test**, then enable **Service Test**. Make sure all other outputs under **Service Test** are disabled.

   b)   Select the Bypass controller in the tree, then go to **Properties** > **Control Program** > **Unit Configuration** > **Bypass Control** > **Details** tab.

   c)   Click **Damper Full Open**, then verify the voltage at **VFD/ACT** and **Gnd** is 0 Vdc.

   d)   Click **Damper Full Close**, then verify the voltage at **VFD/ACT** and **Gnd** is 10 Vdc.

   e)   Click **Zero Cal** to zero the pressure sensor. When **Done** appears, click **Apply**.

   f)   Enable the air source fan output using one of the following methods:

      • Physically connect the air source controller's fan enable wiring at the unit.

      • In the i-Vu® or Field Assistant tree, select the RTU Open controller. Go to **Properties** > **Control Program** >
         Configuration > **Service Configuration** > **Service Test**, then enable **Fan Test**. Make sure all other outputs under **Service Test** are disabled.

   g)   Select the Bypass controller in the tree, then go to **Properties** > **Control Program** > **Unit Configuration** > **Bypass Control** > **Details** tab.

   h)   After the static pressure has stabilized, make sure that **Target Damper Position** and **Duct Static Pressure** are not locked and that **Target Damper Position** is >0% and <100%. You may have to adjust the **Duct Static Pressure Setpoint** slightly to get the damper within this range.

i) Using a branch-tee, connect a magnehelic gauge to the **High** connector on the controller's airflow sensor, then measure the static pressure. If the measured static pressure is different from the **Duct Static Pressure** by ±.05 in. (+.012 kPa), click **Pressure Sensor Cal**, enter the measured value next to the button, then click **Apply**.

j) Remove the magnehelic gauge from the **High** connector, then reinsert the pressure tubing.

k) Click **Automatic Control** to return the bypass to normal control.

l) Enable the air source's heating and cooling outputs using one of the following methods:

- Reconnect the air source controller's output wiring at the unit.

- In the i-Vu® or Field Assistant tree, select the RTU Open controller. Go to **Properties** > **Control Program** >
  Configuration > **Service Configuration** > **Service Test**, then disable **Service Test** and **Fan Test**. Make sure all other outputs under **Service Test** are disabled.

Sequence of operation

The VVT Bypass Controller maintains supply duct static pressure under all system operating conditions.

The controller can operate as part of a linked VVT system or as a stand-alone controller.

Duct static pressure control

The VVT Bypass Controller modulates a bypass damper or VFD to maintain the static pressure in the supply duct of the pressure-dependent VVT system. The controller has a built-in damper actuator that provides 35 in./lbs (4 Nm) of torque.

You can use the controller's 0–10 Vdc output to:

- Drive a larger actuator if the built-in actuator's torque is insufficient. The actuator must be installed so that 0 volts causes the bypass damper to fully open. See **NOTE** below and *High-torque actuator* (page 13).

- Drive multiple damper actuators from a single bypass controller. See **NOTE** below and *Linked actuators* (page 14).

- Control a VFD

NOTE You cannot use the built-in actuator if external actuator(s) are wired to the analog output.

If linkage is active, normal duct static pressure control is overridden if the linked air source is in either of the following modes:

- Fire shutdown or evacuation mode – The bypass damper will be fully open. If controlling a VFD, the VFD output will be at 0%.

- Pressurization mode – The bypass damper will be fully closed. If controlling a VFD, the VFD output will be at 100%.

LAT monitoring and limiting

To protect the air source from excessive supply air temperature conditions, the VVT Bypass Controller monitors the supply air temperature. If the temperature reaches either the **Minimum Cooling SAT** [45°F (7.2°C) default] or the **Maximum Heating SAT** [120° F (48.9°C) default], the Bypass controls to the **LAT Duct Static Pressure Setpoint** which increases airflow through the air source.

The amount of increase in airflow is related to the square root of the pressure increase. For example, a 25% increase in airflow at 1 in. (.249 kPa) of static pressure would require a 56% increase in duct static pressure [1 in.H_2O (.249 kPa) * 1.25^2 = 1.56 in. H_2O (.388 kPa)]. The default **LAT Duct Static Pressure Setpoint** of 0.8 in.H_2O (.199 kPa) provides a maximum 25% increase in airflow over the default Duct Static Pressure Setpoint of .5 in.H_2O (.125 kPa). [.5 in.H_2O (.125 kPa)* 1.25^2 = .75 [~.8] in.H_2O (.199 kPa)]. When the LAT exceeds the **Maximum Heating SAT** or **Minimum Cooling SAT**, the controller detects and indicates the excessive LAT condition and displays the **Controlling Pressure Setpoint** and the associated **LAT Airflow Increase** (%).

The Bypass does not resume normal control to the Duct Static Pressure Setpoint until the SAT drops 15Δ°F (8.3Δ°C) below the Maximum Heating Sat or rises 7Δ°F (3.9Δ°C) above the Minimum Cooing Setpoint.

If the supply air temperature exceeds the configured limits, a **Supply Air Temperature Alarm** is generated. If Linkage is active, the controller monitors the supply air temperature from the equipment rather than its own temperature input for faster response.

Equipment fan off detection

The VVT Bypass Controller continuously monitors its damper's position and the supply duct static pressure. If the pressure drops below 10% of the nominal setpoint and the bypass damper is fully closed (or VFD is commanded to maximum speed), after 1 minute the controller assumes that the equipment fan turned off. The bypass damper then modulates to 65% open and the VFD speed is commanded to 35% (3.5 volts) to facilitate a fan restart. The controller monitors the static pressure to determine when the equipment fan restarts. If it rises above 10% of the nominal pressure setpoint, the controller assumes the fan restarted and controls to maintain the duct static pressure setpoint. If Linkage is active, the air source mode is provided to the VVT Bypass Controller.

Supply Air Temperature Alarm

The VVT Bypass Controller generates an alarm if the supply air temperature remains above the configured **Maximum Heating SAT** or below the configured **Minimum Cooling SAT** for more than 5 minutes.

Airside linkage

When the VVT Bypass Controller is part of a linked system, it uses data received through Linkage (equipment SAT and mode) to detect excessive leaving air temperature (LAT) conditions at the equipment and equipment operating mode.

Air source mode determination

Linked air source modes – In a linked system, the air source determines its operating mode and qualifies that mode based on its own SAT. The following modes can be sent by the air source depending on its capability and configuration:

OFF	Air source fan is off. Terminal damper is positioned approximately 70% open to allow for system restart.
WARMUP	Air source fan is on and providing first cycle of heat when changing from unoccupied to occupied. It may also be used as an equipment safety to increase system airflow. The terminal's heating setpoint temporarily increases to the midpoint between the configured occupied heating and occupied cooling setpoints.
HEAT	Air source fan is on and providing heat. The terminal modulates its primary air damper to maintain the current heating setpoint.
FREECOOL	Air source fan is on and providing cooling using only the economizer and usually during an unoccupied period. The terminal modulates its primary air damper to maintain the midpoint between the configured occupied heating and occupied cooling setpoints.
COOL	Air source fan is on and providing cooling. The terminal modulates its primary air damper to maintain the current cooling setpoint.
PRESSURIZATION	Air source supply fan is on usually as a result of a fire-life safety input being active. It may also be used as an equipment safety to increase system airflow. The terminal modulates its primary air damper to provide the configured maximum cooling airflow.
EVACUATION	Evacuation is usually the result of a fire-life safety input at the air source being active. The terminal fully closes its primary air damper and disables its terminal fan, if equipped.
VENT	All terminals treat VENT mode the same as the COOL mode. For VVT terminals, VENT modes allows for an increase in airflow. VVT terminals use the greater of the configured Vent Damper Position or the Minimum Cooling Damper Position as the minimum during the VENT mode.

See the air source's installation manual for more specific operation.

Troubleshooting

If you have problems mounting, wiring, or addressing the VVT Bypass Controller, contact Carrier Control Systems Support.

NOTE To help you troubleshoot, obtain a Module Status (Modstat) from the controller and review the System Error and Warning details.

LED's

The LED's on the VVT Bypass Controller show the status of certain functions. Verify the LED patterns by cycling power to the controller and noting the lights and flashes.

If this LED is on...	Status is...
Power	The VVT Bypass Controller has power
Rx	The VVT Bypass Controller is receiving data from the network segment
Tx	The VVT Bypass Controller is transmitting data over the network segment
CW	The actuator motor is turning clockwise
CCW	The actuator motor is turning counterclockwise

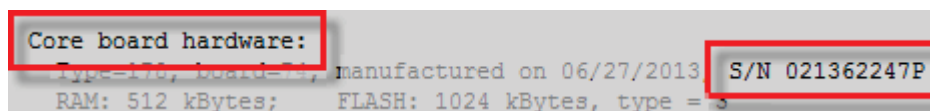The **Run** and **Error** LED's indicate controller and network status.

If Run LED shows...	And Error LED shows...	Status is...
2 flashes per second	Off	Normal
2 flashes per second	2 flashes, alternating with **Run** LED	Five minute auto-restart delay after system error
2 flashes per second	3 flashes, then off	The controller has just been formatted
2 flashes per second	1 flash per second	The controller is alone on the network
2 flashes per second	On	Exec halted after frequent system errors or control programs halted
5 flashes per second	On	Exec start-up aborted, Boot is running
5 flashes per second	Off	Firmware transfer in progress, Boot is running
7 flashes per second	7 flashes per second, alternating with **Run** LED	Ten second recovery period after brownout
14 flashes per second	14 flashes per second, alternating with **Run** LED	Brownout

If Run LED shows...	And Error LED shows...	Status is...
On	On	Failure. Try the following solutions: • Turn the VVT Bypass Controller off, then on. • Format the VVT Bypass Controller. • Download memory to the VVT Bypass Controller. • Replace the VVT Bypass Controller.

To get the serial number

If you need the VVT Bypass Controller's serial number when troubleshooting, the number is on:

• a sticker on the back of the main controller board
• a Module Status report (Modstat) under **Core** (or **Main**) **board hardware**


```
Core board hardware:
   Type=170, board=74, manufactured on 06/27/2013   S/N 021362247P
   RAM: 512 kBytes;    FLASH: 1024 kBytes, type = 3
```

To obtain a modstat in the WebCTRL® interface:

1   Select the VVT Bypass Controller in the navigation tree.

2   Right-click and select **Module Status**.

To restore factory defaults

⚠️ **CAUTION**   This erases all archived information and user-configuration settings. You will have to reconfigure all custom settings. It is recommended to restore the factory defaults only under the guidance of Carrier Control Systems Support.

To erase volatile memory data and restore factory default configuration settings:

1   Pull the screw terminal connector from the controller's power terminals labeled **Gnd** and **24 Vac**. Make sure the address switches are not set to 0, 0.

2   Short the **Factory Default Short pins** jumper's pins and maintain the short for steps 3 and 4.

3   Insert the power screw terminal connector into the VVT Bypass Controller's power terminals.

4   Continue to short the jumper until the **Error** LED flashes three times in sync with the **Run** LED.

5   Remove the short.

To replace the controller's battery

If the VVT Bypass Controller experiences a power outage and the control program stops functioning, replace the battery.

You need to replace the battery if the voltage measures below 2.9 volts when the controller is not powered.

1   Verify that the VVT Bypass Controller's power is on.

⚠ **CAUTION** If the controller's power is not **on** when replacing the battery, your date, time, and trend data will be lost.

2   Remove the VVT Bypass Controller's cover.

3   Remove the battery from the controller, making note of the battery's polarity.

4   Insert the new battery, matching the battery's polarity with the polarity indicated on the controller's cover.

5   Replace the VVT Bypass Controller's cover.

6   Download the VVT Bypass Controller.

To clean the airflow sensor orifice and replace the filter

In less than .02% of installations, small particulates (micron/submicron-level) can build up in the airflow sensor's internal orifice or clog the airflow filter, causing airflow restriction. Symptoms of airflow restriction are:

• Diffuser noise increases over time
• Space overcools at minimum airflow
• Frequency of dampers opening to maintain flow setpoint increases over time
• AHU fan speed increases over time

To check for these symptoms, set up trending of:

• Damper position to look for long term increase
• AHU fan speed for maintaining static pressure

If you see these symptoms, you should clean the flow sensor and replace the filter.

To clean the flow sensor

You can use a can of compressed air to clean the sensors while the controller is installed or on a repair bench.

1 Disconnect the **High** and **Low** flow sensor tubes.

2 Insert the compressed air straw 1/4" into the controller's **High** connector.
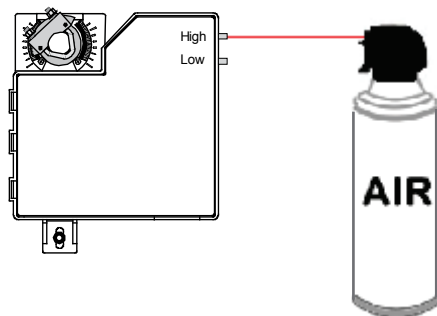
3 Press the air can's trigger twice for no more than 2 seconds each time.

4 Reconnect tubing to the **High** and **Low** flow sensor tubes.

To replace the filter

1 Order a replacement filter from Carrier.

2 Pull the tubing from both ends of the existing filter.
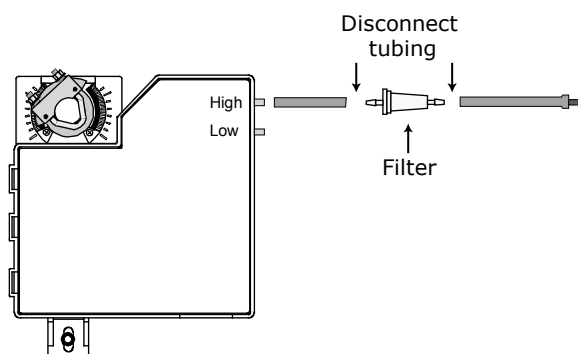
3 Attach tubing to the new filter.

Compliance

FCC Compliance

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

⚠ **CAUTION** Changes or modifications not expressly approved by the responsible party for compliance could void the user's authority to operate the equipment.

CE Compliance

⚠ **WARNING** This is a Class A product. In a domestic environment, this product may cause radio interference in which case the user may be required to take adequate measures.

BACnet Compliance

Compliance of listed products to requirements of ASHRAE Standard 135 is the responsibility of BACnet International. BTL® is a registered trademark of BACnet International.

Appendix A: VVT Bypass Controller Points/Properties

NOTE Engineering units shown in this document in the defaults and ranges are strictly for reference. You must enter an integer only.

Status

Navigation: i-Vu® / Field Assistant: **Properties** > **Control Program** > **Status**

Point Name/Description	Range	
Static Pressure - Prime Variable – The current supply duct static pressure. This value is shown on the default area graphic in i-Vu or Field Assistant.	R:	0 to 2.0 in. H_2O (0 to .498 kPa
Supply Air Temperature – If **Airside Linkage Status** is **Active**, this is the air source's current supply air temperature. If **Airside Linkage Status** is **Not Active**, this value is from the local SAT sensor.	R:	-56 to 245°F (-48.9 to 118.3°C)
Damper Position – If **Control Device Type** is **Actuator**, this is the current open damper position.	R:	0 to 100%
VFD output – If **Control Device Type** is **VFD**, this is the current VFD speed capacity.	R:	0 to 100%
LAT Control – The status of LAT Limit duct static pressure override control of the bypass.	R:	On/Off
LAT Airflow Increase – If **LAT Control** is **On**, this is the percent of increase in supply airflow that the overriding **LAT Duct Static Pressure Setpoint** will provide above the normal **Controlling Pressure Setpoint**.	R:	0 to 100%

Unit Configuration

Navigation: i-Vu® / Field Assistant: **Properties** > **Control Program** > **Unit Configuration**

Point Name/Description	Default/Range	
Control Device Type – The device the controller uses to control static pressure.	D:	Actuator
	R:	Actuator/VFD drive
Power Fail Restart Delay – How long the controller delays normal operation after the power is restored.	D:	60 seconds
	R:	0 to 600 secs
Automatic Deadband Adjustment – If using an actuator, set to Enable to automatically adjust the damper for full travel to correctly scale the damper position. If using a VFD drive, set to Disable.	D:	Enable
	R:	Enable/Disable

Point Name/Description	Default/Range
Maximum Heating SAT – The value that the SAT must exceed to cause the static pressure setpoint to be set to the **LAT Duct Static Pressure Setpoint**. This is also the **Supply Air Temperature Alarm**'s high limit.	D: 120°F (48.9°C) R: 40 to 180°F (4.4 to 82.2°C)
Minimum Cooling SAT – The minimum low limit value that the SAT must exceed to cause the static pressure setpoint to be set to the LAT Duct Static Pressure Setpoint. This is also the **Supply Air Temperature Alarm**'s low limit.	D: 45°F (7.2°C) R: 40 to 180°F (4.4 to 82.2°C)
Pressure Control Deadband – The amount that is added to and subtracted from the bypass controlling setpoint (Duct Static Pressure Setpoint or LAT Duct Static Pressure Setpoint). When the static pressure is within the controlling setpoint +/- this value, the output to the actuator or VFD drive maintains at its current position. When the static pressure is greater than the controlling setpoint +/- this value, the output modulates accordingly. **CAUTION** If this value is too low, the damper may oscillate to maintain the static pressure. This could cause the actuator to fail prematurely.	D: .05 in H_2O (.012 kPa) R: 0 to 2.0 in. H_2O (0 to .498 kPa
Bypass Control	
Direction Clockwise – Set this field to the damper's position when it rotates clockwise. (Only in the i-Vu®/Field Assistant applications)	D: Close R: Open/Close
Duct Static Pressure Setpoint – The normal static pressure setpoint the controller will maintain.	D: .5 in. H_2O (.125 kPa) R: .1 to 2.0 in. H_2O (.025 to .498 kPa)
LAT Duct Static Pressure Setpoint – The static pressure setpoint that the controller will maintain if the SAT exceeds the **Maximum Heating SAT** or **Minimum Cooling SAT** value. To disable this function, set this value less than or equal to the **Duct Static Pressure Setpoint**.	D: .8 in. H_2O (.199 kPa) R: .1 to 2.0 in. H_2O (.025 to .498 kPa)
Locks – ⚠️ **CAUTION** Overriding these values may damage equipment or ductwork. **Duct Static Pressure** – Lets you override the static pressure sensor input for testing and troubleshooting.	R: 0 to 2.0 in. H_2O (0 to .498 kPa
Target damper position – Allows you to override the normal control of the damper/VFD for the purpose of testing and troubleshooting.	R: 0 to 100%

Point Name/Description	Default/Range
Test and Balance **Zero Cal** – Closes the bypass damper and waits for the air source to go to the Off mode before zeroing out the static pressure sensor. This does not occur if the static pressure is > .05 in. H_2O (.0125 kPa) . **Pressure Sensor Cal** – Allows you to calibrate the pressure sensor after the Zero Cal has been performed. To enter a value here, neither the damper nor the pressure sensor can be locked, the bypass cannot be in LAT mode and the damper position must be >0% and <100%. The value entered will be the actual static pressure measured with an accurate static pressure measuring device. **Damper Full Open** – Overrides the damper to its full open position. **Automatic Control** – Returns the damper to its normal control routines. **This must be activated when you finish using any of the other Test and Balance commands.** **Damper Full Close** – Overrides the damper to its full closed position.	
Local Sensor Calibration	
Supply Air Temperature – Displays the current supply air temperature.	R: -56 to 245°F (-48.9 to 118.3°C)
Supply Air Temp Calibration – A calibration offset value to allow the supply air temperature sensor to be adjusted to match a calibrated standard measuring the temperature in the same location.	R: -20 to 20Δ°F (-11.1 to 11.1Δ°C)

Maintenance

Navigation: i-Vu® / Field Assistant: **Properties** > **Control Program** > **Maintenance**

Point Name/Description	Range
Static Pressure – The current supply duct static pressure.	R: 0 to 2.0 in. H_2O (0 to .498 kPa
Controlling Pressure Setpoint – The active static pressure setpoint that the bypass controls to.	R: .1 to 2.0 in. H_2O (.025 to .498 kPa)
Max Duct Pressure Setpoint – The Pressure Control Deadband that is added to the active static pressure setpoint.	R: 0 to 2.0 in. H_2O (0 to .498 kPa
Min Duct Pressure Setpoint – The Pressure Control Deadband that is subtracted from the active static pressure setpoint.	R: 0 to 2.0 in. H_2O (0 to .498 kPa

Alarms

Navigation: i-Vu® / Field Assistant: **Properties** > **Control Program** > **Alarms**

Point Name/Description	Range
Supply Air Temperature Alarm – Indicates if the supply air temperature exceeds the high temperature alarm limit or drops below the low temperature alarm limit.	R: Normal/Alarm
Airside Linkage Alarm – Indicates that it lost Linkage communications with the air source.	R: Normal/Alarm

Linkage

Navigation: i-Vu® / Field Assistant: **Properties** > **Control Program** > **Linkage**

Point Name/Description	Range
Air Linkage Status – If **Active**, the controller is part of a linked system. If **Not Active**, the controller is operating as a stand-alone device.	R: Active/Not Active
Air Source Mode – If **Airside Linkage Status** is **Active**, this is the current mode of the linked air source. If **Airside Linkage Status** is **Not Active**, this is the mode of the air source as determined by the zone controller's SAT sensor.	R: OFF WARMUP HEAT COOL FREECOOL PRESSURE EVAC VENT
Air Source Supply Air Temp – Shows the air source's SAT when **Airside Linkage Status** is **Active**. If **Airside Linkage Status** is **Not Active**, the controller's local DAT sensor value is displayed.	R: -56 to 245°F (-48.9 to 118.3°C)

I/O Points

Navigation: i-Vu® / Field Assistant: **Properties** > **I/O Points**

Point Name/Description	Range
Pressure Input – The current duct static pressure of the controller's integrated airflow sensor.	R: 0 to 2.0 in. H_2O (0 to .498 kPa

Point Name/Description	Range
SAT Sensor – The current duct air temperature sensor that is physically connected to the controller.	R: -56 to 245°F (-48.9 to 118.3°C)
AO Output – The current voltage on the controller's **VFD/ACT** output terminal.	R: 0 to 10 Vdc

Document revision history

Important changes to this document are listed below. Minor changes such as typographical or formatting errors are not listed.

Date	Topic	Change description	Code*
2/7/17	To wire the controller to the BACnet network	Added BACnet ARC156 connection information	C-D
	Wiring for communications	Changed from Wiring the VVT Bypass Controller to the MS/TP network	C-D
	Sequence of operation - Linkage modes and operation	Clarified reason and method for generating a particular mode. Evacuation/Shutdown changed to Evacuation.	C-AE-WB-E
	Specifications	Added ARC156.	C-D
	Cover What is the VVT Bypass Controller?	Updated picture	C-D
2/22/16	Start-up	Added USB Link wiring caution.	C-TS-RD-E-JH
		Removed all references to BACview	C-D
12/7/15	What is a VVT Bypass Controller?	Note on metric version.	C-AE-WB-E
	To mount the controller	Corrected the nut size to M5.	CA-AE-WB-E-RE
	To clean the airflow sensor orifice	New topic	AC-TS-TS-E
2/12/15	To mount the controller Variable frequency drive Bypass damper	Corrected the term "duct static pickup" to "duct static pressure probe". Added the part number.	C-TS-JN-E
6/19/14	Restore factory defaults	Added information on using the Factory Defaults Shorts pins	C-D-LJ-E-RD

* For internal use only

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