# RTU Open v5
## Integration Guide

Modbus

N2

BACnet
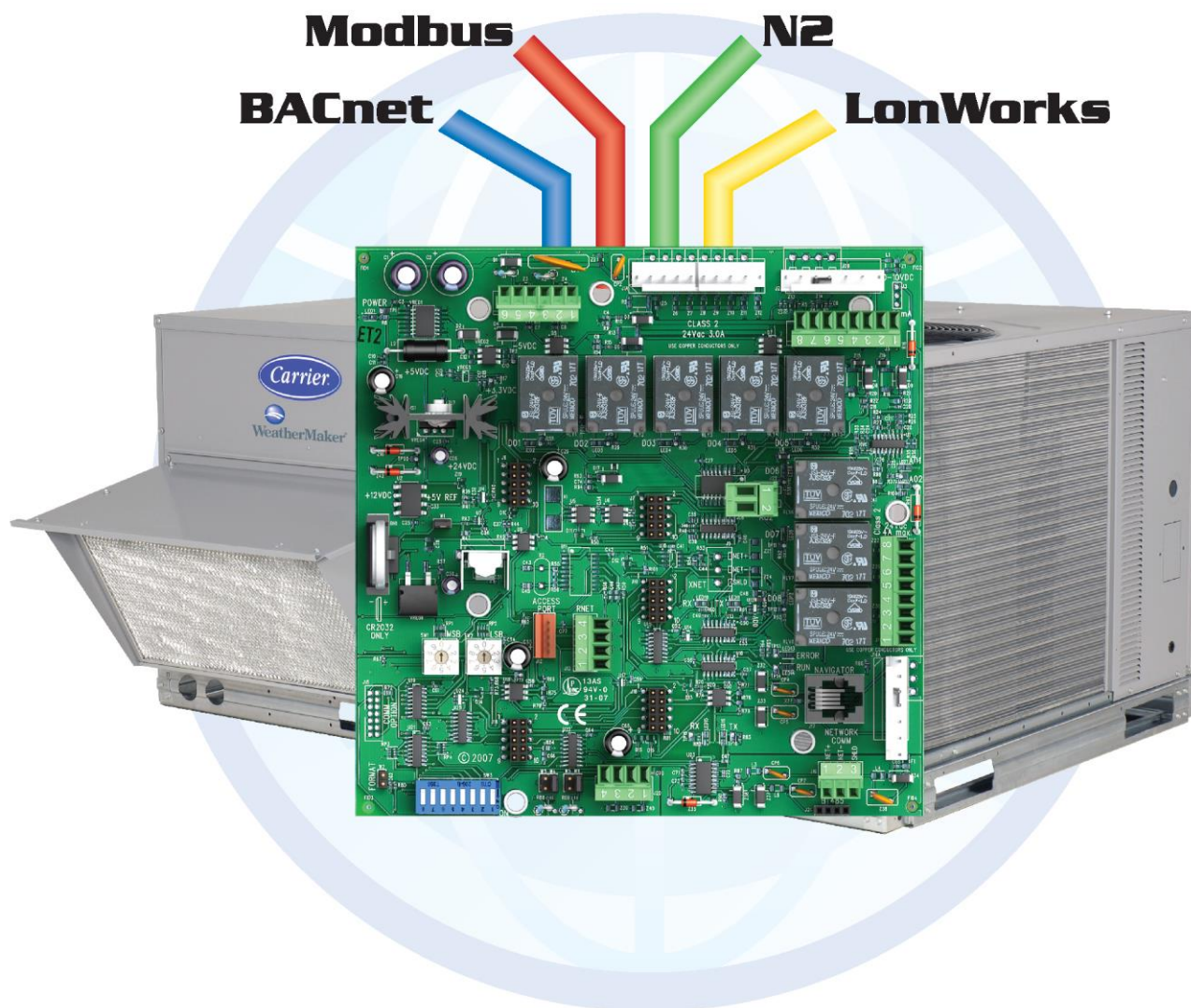
LonWorks

⚠️ 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 the RTU Open controller?

The RTU Open controller (part# OPN-RTUM2) is available as an integrated component of a Carrier rooftop unit, or as a field-installed retrofit product.

**NOTE** The RTU Open 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.

Its internal application programming provides optimum rooftop performance and energy efficiency. RTU Open enables the unit to run in 100% stand-alone control mode or it can communicate to the Building Automation System (BAS).

**The RTU Open supports the following:**

- **ZS and Carrier wireless sensors** - Models are available for monitoring space temperature, space relative humidity, and space IAQ/CO2. Sensors provide:
    - Space setpoint offset adjustment
    - Pushbutton override
    - Occupancy indicator

- **BACnet** and **third party protocols** - On-board DIP switches allow you to select the baud rate and choose one of the following protocols:
    - BACnet MS/TP
    - BACnet ARC156
    - Modbus
    - Johnson N2
    - LonWorks

- **Mixed systems** - Supports CCN air terminals using Linkage to BACnet RTU Open Air Source

- **California Title 24** - Includes advanced Fault Detection and Diagnostic Logic for Economizer Operation in accordance with California Title 24 requirements

- **Equipment Touch** - The Equipment Touch is a user interface that is a touchscreen device with a 4.3 in. color LCD display that you connect to the RTU Open (driver v6.00:082 or later) to view or change property values, equipment schedules, trends and alarms, and more, without having to access the system's i-Vu® server.

    The RTU Open's application supports detailed color graphics, status, properties, alarms, trends, performance, configuration, and Help on the Equipment Touch. In addition, an RTU Open Startup Wizard has specific screens to facilitate initial RTU Open configuration.

    For more details about the Equipment Touch, see the *Equipment Touch Installation and Setup Guide*.

**J1**

Blue Input-5 (SMK)
Red (also) Input-4 R terminal on RTU
Blue BO-5 Y1 terminal on RTU
Yellow BO-4 Y2 terminal on RTU
Orange BO-3 W1 terminal on RTU
Pink BO-2 W2 terminal on RTU
Green BO-1 G terminal on RTU
Brown 24 Vac Common C terminal on RTU
White Compressor Safety X on most RTU terminal boards
Red (also) 24 Vac R terminal on RTU
(Jumper to Input 4 Red, interrupt jumper for Fire Safety)

**J2**

Gray (also) Ext 24 Vac
Gray (also) Input-8 (Enthalpy)
Pink (also) AO-1
Pink (also) Gnd for OAT
Violet OAT
Brown Gnd for SAT
Orange SAT

**(AO-1)**
0-10 Vdc
4-20 mA (default - pins 2&3)

**J4**

+24 Vdc
Input-2 (CO2/RH)
Gnd
+24 Vdc
Input-1 (CO2/RH)
Gnd

Input-9
Ext 24 Vac
Input-8
Ext 24 Vac
Input-5
Ext 24 Vac
Input-3
Ext 24 Vac (Humidistat)
Ext 24 Vac

Power

Board power

RLY 1  RLY 2  RLY 3  RLY 4  RLY 5

J4    J1    J2    J3

J5    J5

VFD Output

RLY 6

J11
BO-6 (H)
(Humidimizer)
BO-7
(Reversing Valve/
High Speed Fan/Y3)
BO-8 (PE)
(Power Exhaust)

J22
RLY 7

RLY 8

ACCESS PORT
J13
RNET
+12 Vdc
Rnet-
Rnet+
Gnd
J12

Error
Run

J17

CR2032

MSB  LSB

SW1  SW2

Lonworks
Option Card
Port

COMM OPTION

J15

Do not use

Network
Comm
Net-
Net+
Shld

J14

Format

SW3

on

Example set for
Bacnet MS/TP
and 76.8k baud
(1,2, and 4 ON)
Recommended for all
i-Vu Open installations

Protocol and communications
baud rate selector DIP switches

WS6
WS4
WS3
WS5

RX  TX

J20
Gnd
Gnd

J19

BACnet/Modbus/Johnson N2
communication terminals

Input-10 (T-55 Accy)
Input-11 (Offset Potentiometer: T-56, 59)

# Safety considerations & handling warning

⚠ **WARNING**

When you handle the RTU Open:
- Do not contaminate the printed circuit board with fingerprints, moisture, or any foreign material.
- Do not touch components or leads.
- Handle the board by its edges.
- Isolate from high voltage or electrostatic discharge.
- Ensure that you are properly grounded.

# Communications wiring

## Protocol overview

Protocols are the communication languages spoken by the control devices. The main purpose of a protocol is to communicate information in the most efficient method possible. Different protocols exist to provide specific information for different applications.

In the BAS, many different protocols might be used, depending on manufacturer. Different protocols do not change the function of the controller, but they typically require the owner to change systems or components in order to change from one protocol to another. communicates different types of protocols.

The RTU Open can communicate 1 of 5 different protocols:

* *BACnet MS/TP* (page 5)

* *BACnet ARC156* (page 9)

* *Modbus* (page 11)

* *Johnson N2* (page 14)

* *LonWorks* (page 16)

The default setting is BACnet MS/TP. You set the protocol and baud rate using the **SW3** DIP switches. The rotary switches **MSB** (**SW1**) and **LSB** (**SW2**) set the board's network address. See table below for specific switch settings. The third party connects to the controller through port **J19** for BACnet MS/TP, BACnet ARC156, Modbus, and N2, and through **J15** for the LonWorks Option Card.

**NOTE**  You must cycle power after changing the rotary switches or after connecting the LonWorks Option Card to **J15**.

### SW3 DIP switch settings

|  |  | Unused | Comm Option port | Protocol | | | | Baud rate | |
|---|---|---|---|---|---|---|---|---|---|
|  |  | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| **BACnet MS/TP** (Default) | Master | N/A | Off | Off | Off | On | Off | Select Baud | Select Baud |
| **BACnet ARC156** |  | N/A | Off | Off | Off | Off | Off | N/A | N/A |
| **Modbus** | Slave | N/A | Off | Off | On | On | Off | Select Baud | Select Baud |
| **N2** | Slave | N/A | Off | Off | Off | On | On | Off | Off |
| **Lonworks** |  | N/A | On | On | Off | On | Off | Off | On |

### Baud DIP switch settings

| Baud Rate | DIP switch 2 | DIP switch 1 |
|---|---|---|
| 9,600 bps | Off | Off |
| 19.2 kbps | On | Off |

| | | |
|---|---|---|
| **38.4 kbps** | Off | On |
| **76.8 kbps** (Default) | On | On |

# BACnet MS/TP

## To set up the RTU Open for BACnet MS/TP

Refer to *Appendix B* (page 55) for the Protocol Implementation Conformance Statement, or download the latest from *BACnet International http://www.bacnetinternational.net/catalog/index.php?m=28*.

**NOTE** This controller counts as a full load on the MS/TP bus.
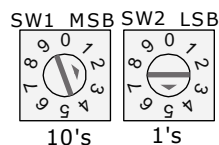
1   Turn **off** the RTU Open's power.

   **NOTE** Changes made to the switches when the controller is on will <u>not</u> take effect until the power is cycled!

2   Using the rotary switches **MSB** (**SW1**) and **LSB** (**SW2**), set a unique BACnet MS/TP MAC address for the RTU Open. Set the **MSB** (**SW1**) switch to the tens digit of the address, and set the **LSB** (**SW2**) switch to the ones digit. Valid addresses are 01-99.

   **NOTE** The rotary switches also determine the BACnet device instance of the controller on the BACnet network. The BACnet device instance is automatically generated based on the scheme 16101xx, where "16" is the BACnet vendor ID for Carrier Corporation, and xx equals the rotary switch address.

   **EXAMPLE** To set the controller's MS/TP MAC address to 01, point the arrow on the **MSB** (**SW1**) switch to 0 and the arrow on the **LSB** (**SW2**) switch to 1. Internally, the BACnet device instance is automatically generated as 1610101.



3   Set the **SW3** DIP switches **1** and **2** for the appropriate communications speed (9600, 19.2k, 38.4k, or 76.8k bps).

   **NOTE** Use the same baud rate and communication settings for all controllers on the network segment. The RTU Open is fixed at 8 data bits, No Parity, and 1 Stop bit for this protocol's communications.
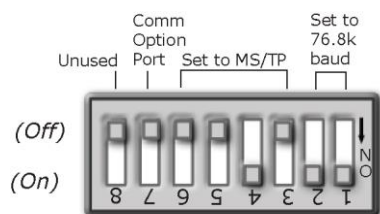
### Baud DIP switch settings

| Baud rate | 2 | 1 |
|---|---|---|
| 9,600 bps | Off | Off |
| 19.2 kbps | On | Off |
| 38.4 kbps | Off | On |
| 76.8 kbps | On | On |

**4** Set the remaining DIP switches as follows:

**BACnet MS/TP DIP switch settings**

| 8 | 7 | 6 | 5 | 4 | 3 |
|---|---|---|---|---|---|
| Off | Off | Off | Off | On | Off |

The following example shows the DIP switches set for 76.8k (Carrier default), and BACnet MS/TP.



**5** Connect the BACnet MS/TP network to the controller's **J19 Network Comm** port. Connect to **Net+**, **Net-**, and **SHLD**.
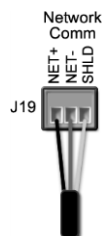


**Wire specifications**

○ A dedicated 22 AWG shielded twisted pair wire (EIA 485)

○ Maximum wire length 2000 feet (610 meters) or 32 nodes

○ Devices should be daisy-chained and not star-wired

○ Attach the drain/shield wire to both ends of the network segment and through every controller

**NOTE** Use the same polarity throughout the network segment.

**6** Turn **on** the RTU Open's power.

# Adjusting BACnet MS/TP properties using an Equipment Touch

You may need to adjust the following BACnet MS/TP protocol timing settings using the Equipment Touch.

**Max Masters** - defines the highest MS/TP Master MAC address on the MS/TP network.

For example, if there are 3 master nodes on an MS/TP network, and their MAC addresses are 1, 8, and 16, then Max Masters would be set to 16 (since this is the highest MS/TP MAC address on the network).

This property optimizes MS/TP network communications by preventing token passes and "poll for master" requests to non-existent Master nodes.

In the above example, MAC address 16 knows to pass the token back to MAC address 1, instead of counting up to MAC address 127. Each MS/TP master node on the network must have their Max Masters set to this same value. The default is 127.

**Max Info Frames** - defines the maximum number of responses that will be sent when the RTU Open receives the token. The default is 10 and should be ideal for the majority of applications. In cases where the RTU Open is the target of many requests, this number could be increased as high as 100 or 200.

**NOTES**

- BACnet MS/TP networks can be comprised of both master and slave nodes. Valid MAC addresses for master nodes are 0 – 127 and valid addresses for Slave nodes are 0 - 254.

- If the third party attempts to communicate to the controller but does not get a response, make sure the controller is set as a BACnet MS/TP (m) master. The BACnet software asks the controllers, "Who Is?" This is to auto-locate devices on the network. Only controllers set as masters will answer this request.

- See Appendix A for Network Points List.

- See *Appendix B* (page 55) for the BACnet Protocol Implementation Conformance Statement (PICS).

**To set the Device Instance number or adjust the Max Masters or Max Info Frames using an Equipment Touch**

**1** In the Equipment Touch interface, navigate to the **Properties Menu** screen and click **Login**.

**NOTE** The following graphic is generic and not specific to your system.
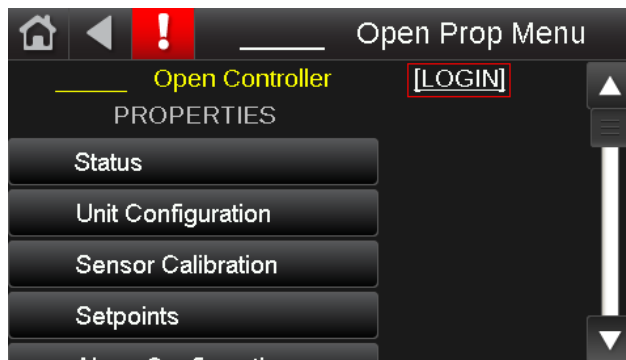


**2** Type **Touch** for the password and click **Done**.

**3**   On the **Properties Menu** screen, scroll to the bottom of the list and click **ET System**.

**4**   On the **ET System** screen, click **Setup**.

**5**   On the **Setup** screen, click **Module Setup**.

**6**   On the **Module Setup** screen, click **Communication**.



On the **Communication** screen, edit the fields as needed:

**7**   Click the property box next to **BACnet Device Instance**, type the new number, and click **Done**.

**8**   Click the property box next to **Max Masters** and/or **Max Info Frames**, type a new value (1-127), and click **Done**.

**9**   Click **Save**.

# Troubleshooting BACnet MS/TP communication

For detailed troubleshooting and a list of supported objects, get the controller's BACnet PICS from the *Carrier BACnet PICS website http://www.bacnetinternational.net/catalog/index.php?m=28*. You must get your BACnet Object list from the manufacturer.

The most common communication problems are the result of not properly following the configuration steps outlined in this manual. Review all of the steps and use the following list to check your settings.

**Verify accuracy of the following:**

**Hardware settings** for BACnet MS/TP (8 Data bits, No Parity, and 1 Stop bit):

- Baud rate DIP switches DS2 and DS1

- BACnet MS/TP protocol DIP switches DS3 - DS6

- Jumper set to EIA-485

- Proper connection wiring

- Unique rotary address switches 1 – 99. If controllers have duplicate addresses, network communication can be lost.

- Unique BACnet Device Instance numbers. Default is 16101XX, with the rotary address switches defining XX. If controllers have duplicate device instance numbers, network communication can be lost.

**NOTES**

- The controller recognizes physical changes (DIP switches, rotary switches, and jumpers) upon power up.

- If RX LED is solid, then the terminations are incorrect.

- If the network has greater than 32 devices or exceeds 2,000 feet, a Repeater should be installed.

- If a controller begins or ends a network segment, a terminating resistor may be needed.

# BACnet ARC156

## To set up the RTU Open for BACnet ARC156

The RTU Open's latest supported function codes and capabilities are listed on the associated Protocol Implementation Conformance Statement (PICS), *Carrier BACnet PICS website http://www.bacnetinternational.net/catalog/index.php?m=28*.

**1** Turn **off** the RTU Open's power.

**NOTE** Changes made to the switches when the controller is on will <u>not</u> take effect until the power is cycled!

**2** Using the rotary switches **MSB** (**SW1**) and **LSB** (**SW2**), set a unique BACnet MS/TP MAC address for the RTU Open. Set the **MSB** (**SW1**) switch to the tens digit of the address, and set the **LSB** (**SW2**) switch to the ones digit. Valid addresses are 01-99.

**NOTE** The rotary switches also determine the BACnet device instance of the controller on the BACnet network. The BACnet device instance is automatically generated based on the scheme 16101xx, where "16" is the BACnet vendor ID for Carrier Corporation, and xx equals the rotary switch address.

**EXAMPLE** To set the controller's MAC address to 01, point the arrow on the **MSB** (**SW1**) switch to 0 and the arrow on the **LSB** (**SW2**) switch to 1. Internally, the BACnet device instance is automatically generated as 1610101.
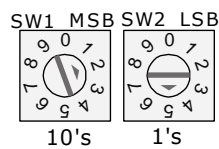


**3** Set the remaining DIP switches as follows:

**BACnet ARC156 DIP switch settings**

| 8 | 7 | 6 | 5 | 4 | 3 |
|---|---|---|---|---|---|
| Off | Off | Off | Off | N/A | N/A |

The following example shows the DIP switches set for BACnet ARC156.



**4** Connect the BACnet ARC156 network to the controller's **J19 Network Comm** port. Connect to **Net+**, **Net-**, and **SHLD**.
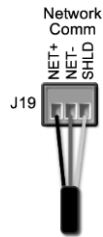


**Wire specifications**

○ A dedicated 22 AWG shielded twisted pair wire (EIA 485)
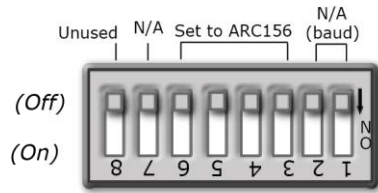
○ Maximum wire length 2000 feet (610 meters) or 32 nodes

○ Devices should be daisy-chained and not star-wired

○ Attach the drain/shield wire to both ends of the network segment and through every controller

**NOTE** Use the same polarity throughout the network segment.

**5** Turn **on** the RTU Open's power.

# Troubleshooting ARC156 communication

The most common communication problems result from not properly following the configuration steps outlined above in this manual. Review all of the steps and use the following list to check your settings.

**Verify accuracy of the following:**

• Protocol DIP switches DS3 - DS6

• Proper connection wiring

• Unique rotary address switches 1 – 99. If controllers have duplicate addresses, network communication can be lost.

• Unique BACnet Device Instance numbers. Default is 16101XX, with the rotary address switches defining XX. If controllers have duplicate device instance numbers, network communication can be lost.

**NOTES**

• The controller recognizes physical changes (DIP switches, rotary switches, and jumpers) upon power up.

• If RX LED is solid, then the terminations are incorrect.

- If the network has greater than 32 devices or exceeds 2,000 feet, a Repeater should be installed.

- If a controller begins or ends a network segment, a terminating resistor may be needed.

**Software settings** defined through the Equipment Touch device. To confirm settings, obtain a Modstat of the device. On the Equipment Touch, click the link to the Modstat.

# Modbus

## To set up the RTU Open for Modbus

Refer to *Appendix C* (page 56) for the Modbus Protocol Implementation Conformance Statement (PICS).

**1** Turn **off** the RTU Open's power.

   **NOTE** Changes made to the switches when the controller is on will <u>not</u> take effect until the power is cycled!

**2** Using the rotary switches, set a unique Modbus slave address for the RTU Open. Set the **MSB** (**SW1**) switch to the tens digit of the address, and set the **LSB** (**SW2**) switch to the ones digit. Valid Modbus slave addresses are 01-99.

   **EXAMPLE** To set the controller's Modbus slave address to 01, point the arrow on the **MSB** (**SW1**) switch to 0 and the arrow on the **LSB** (**SW2**) switch to 1.



**3** Set the **SW3** DIP switches **1** and **2** for the appropriate communications speed (9600, 19.2k, 38.4k, or 76.8k bps).

   **NOTE** Use the same baud rate and communication settings for all controllers on the network segment. The RTU Open is fixed at 8 data bits, No Parity, and 1 Stop bit for this protocol's communications.

   **Baud DIP switch settings**

| Baud rate | 2 | 1 |
|-----------|-----|-----|
| 9,600 bps | Off | Off |
| 19.2 kbps | On | Off |
| 38.4 kbps | Off | On |
| 76.8 kbps | On | On |

**4**    Set the remaining DIP switches as follows:

**Modbus DIP switch settings**

| 8 | 7 | 6 | 5 | 4 | 3 |
|---|---|---|---|---|---|
| Off | Off | Off | On | On | Off |

The following example shows the DIP switches set for 9600 baud and Modbus.
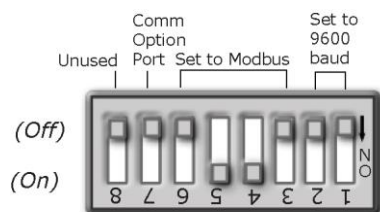


**5**    Connect the Modbus EIA-485 network to the RTU Open's **J19 Network Comm** port. Connect to **Net+**, **Net-**, and **SHLD**.
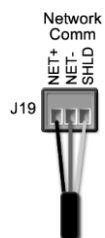


**Wire specifications**

○    A dedicated 22 AWG shielded twisted pair wire (EIA 485)

○    Maximum wire length 2000 feet (610 meters) or 32 nodes

○    Devices should be daisy-chained and not star-wired

○    Attach the drain/shield wire to both ends of the network segment and through every controller

**NOTE** Use the same polarity throughout the network segment.

**6**    Turn **on** the RTU Open's power.

# Troubleshooting Modbus communication

The most common communication problems result from not properly following the configuration steps outlined above in this manual. Review all of the steps and use the following list to check your settings.

**Verify accuracy of the following:**

**Hardware settings** for speaking Modbus (8 Data bits, No Parity, and 1 Stop bit):

•    Baud rate DIP switches DS2 and DS1

•    Protocol DIP switches DS3 - DS6

- Proper connection wiring

- Wiring specifications are 18 - 28 AWG; twisted pair, and 50 feet (15.4 meters) maximum

- Unique rotary address switches 1 – 99. If controllers have duplicate addresses, network communication can be lost.

  **NOTES**

- If RX LED is solid, then the terminations are incorrect.

- If the network has greater than 32 devices or exceeds 2,000 feet, a Repeater should be installed.

- If a controller begins or ends a network segment, a terminating resistor may be needed.

- The controller recognizes physical changes (DIP switches, rotary switches, and jumpers) upon power up.

**BAS must be:**

- Set for the same baud rate

- Sending requests to the proper address

- Reading or writing to the proper point addresses on the controller

- Set for the same communication settings (8 Data bits, No Parity, and 1 Stop bit)

- Speaking 2-wire 485 to the controller

**Software settings** defined through the Equipment Touch device. To confirm settings, obtain a Modstat of the device. On the Equipment Touch, click the link to the Modstat.

**NOTES**

- Refer to *Appendix A* (page 41) for the Network Points list.

- Refer to *Appendix C* (page 56) for the Protocol Implementation Conformance Statement.

**Modbus Exception Codes that might be returned from this controller**

| Codes | Name | Description |
| --- | --- | --- |
| 01 | Illegal Function | The Modbus function code used in the query is not supported by the controller. |
| 02 | Illegal Data Address | The register address used in the query is not supported by the controller. |
| 04 | Slave Device Failure | The Modbus Master has attempted to write to a non-existent register or a read-only register in the controller. |

# Johnson N2

## To set up the RTU Open for N2

Refer to *Appendix D* (page 58) for the N2 Protocol Implementation Conformance Statement (PICS).

**1** Turn **off** the RTU Open's power.

**NOTE** Changes made to the switches when the controller is on will <u>not</u> take effect until the power is cycled!

**2** Using the rotary switches, set a unique N2 slave address for the RTU Open. Set the **MSB** (**SW1**) switch to the tens digit of the address, and set the **LSB** (**SW2**) switch to the ones digit. Valid N2 slave addresses are 01-99.

**EXAMPLE** To set the N2 slave address to 01, point the arrow on the **MSB** (**SW1**) switch to 0 and the arrow on the **LSB** (**SW1**) switch to 1.
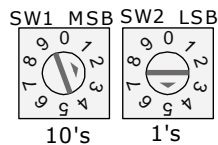


**3** Set the DIP switches **1** and **2** for 9600 bps baud.

**NOTE** Use the same baud rate and communication settings for all controllers on the network segment. The RTU Open is fixed at 9600 bps baud, 8 data bits, No Parity, and 1 Stop bit.

**4** Set the remaining DIP switches as follows:

### N2 DIP switch settings

| 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|---|---|
| Off | Off | Off | Off | On | On | On | On |

The following example shows the DIP switches set for 9600 baud and N2.
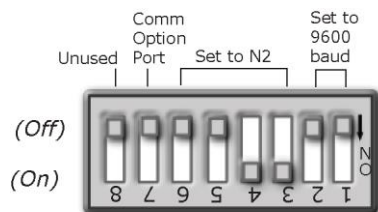
**5** Connect the N2 EIA-485 network to the controller's **J19 Network Comm** port. Connect to **Net+**, **Net-**, and **SHLD**.
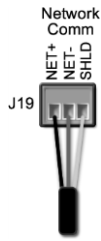
**Wire specifications**

○ A dedicated 22 AWG shielded twisted pair wire (EIA 485)

○ Maximum wire length 2000 feet (610 meters) or 32 nodes

○ Devices should be daisy-chained and not star-wired

○ Attach the drain/shield wire to both ends of the network segment and through every controller

**NOTE** Use the same polarity throughout the network segment.

**6** Turn **on** the RTU Open's power.

## Troubleshooting N2 communication

The most common communication problems result from not properly following the configuration steps outlined above in this manual. Review all of the steps and use the following list to check your settings.

**Verify accuracy of the following:**

**Hardware settings** for N2 (8 Data bits, No Parity, and 1 Stop bit):

• Baud rate DIP switches DS2 and DS1 set to 9600 bps

• Protocol DIP switches DS3 - DS6

• Jumper set to EIA-485

• Proper connection wiring

• Unique rotary address switches 1 – 99. If controllers have duplicate addresses, network communication can be lost.

• Unique BACnet Device Instance numbers. Default is 16101XX, with the rotary address switches defining XX. If controllers have duplicate device instance numbers, network communication can be lost.

**NOTES**

• If RX LED is solid, then the terminations are incorrect.

• If the network has greater than 32 devices or exceeds 2,000 feet, a Repeater should be installed.

• If a controller begins or ends a network segment, a terminating resistor may be needed.

• The controller recognizes physical changes (DIP switches, rotary switches, and jumpers) upon power up.

- Refer to *Appendix A* (page 41) for the Network Points list.

- Refer to *Appendix D* (page 58) for the Protocol Implementation Conformance Statement.

**Software settings** defined through the Equipment Touch device. To confirm settings, obtain a Modstat of the device. On the Equipment Touch, click the link to the Modstat.

# LonWorks

⚠ **WARNING**

When you handle the LonWorks Option Card:

- Do not contaminate the printed circuit board with fingerprints, moisture, or any foreign material.
- Do not touch components or leads.
- Handle the board by its edges.
- Isolate from high voltage or electrostatic discharge.
- Ensure that you are properly grounded.

Refer to *Appendix E* (page 60) for the LonWorks Protocol Implementation Conformance Statement (PICS).
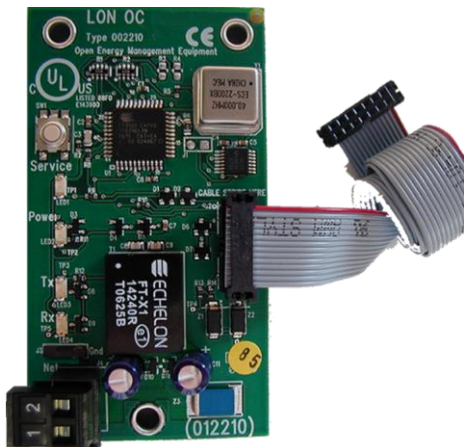
## To set up the RTU Open for the LonWorks Option Card (Part #LON-OC)

**1**  Turn **off** the RTU Open's power.

**NOTES**

- Changes made to the switches when the controller is on will <u>not</u> take effect until the power has been cycled!

- The controller's rotary address switches are not used when the LON-OC is installed. That's because each LON-OC has a 48-bit Neuron ID that makes it unique on the LonWorks network.

**2**  Set the SW3 DIP switches for LonWorks as follows:

| 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|---|---|
| Off | On | On | Off | On | Off | Off | On |
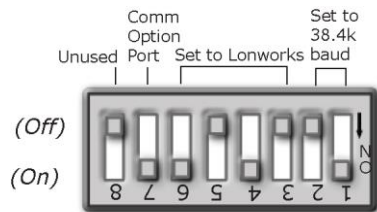


**3**  Plug the LonWorks Option Card's ribbon cable into Comm Option port **J15** on the controller.  See illustration below.

⚠ **CAUTION!** The controller must be **OFF** before being connected.
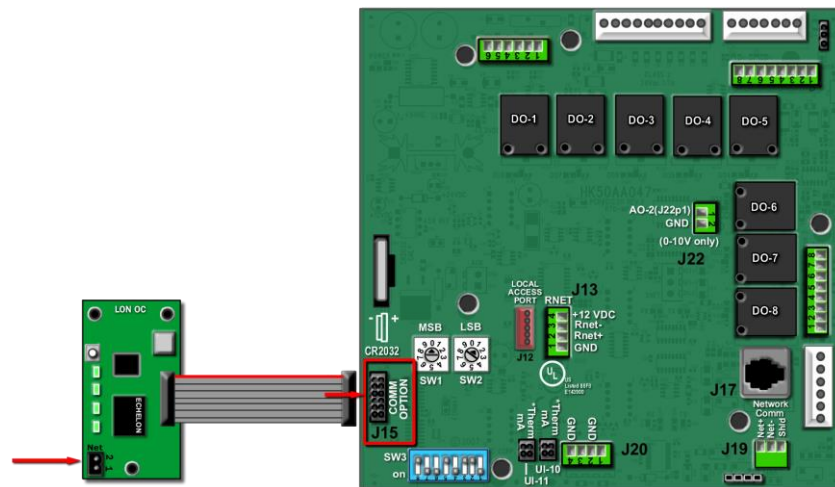


**4**  Connect the LonWorks network to the LonWorks Option Card's 2-pin **Net** port.

**NOTE**  The 2-pin **Net** port provides TP/FT-10 channel compatibility. The TP/FT-10 or "Free Topology" network type is **polarity insensitive**. Use 24 to 16 AWG twisted pair wire.

**5**  Turn **on** the RTU Open's power.

**6**  Commission the controller for LonWorks communication. See instructions below.

# Commissioning the controller for LonWorks communication

Before a device can communicate on a LonWorks network, it must be commissioned. Commissioning allows the system integrator to associate the device hardware with the LonWorks system's network layout diagram. This is done using the device's unique Neuron ID.

A network management tool such as Echelon's LonMaker is used to commission each device, as well as, to assign addressing. Specific instructions regarding the commissioning of LonWorks devices should be obtained from documentation supplied with the LonWorks Network Management Tool.

When a new device is first commissioned onto the LonWorks network, the system integrator must upload the device's External Interface File (XIF) information. LonWorks uses the XIF to determine the points (network variables) that are available from a device. The RTU Open has a set of predefined network variables. These variables can be bound or accessed by the Network Management Tool.

The **Browse** feature of the Network Management Tool allows you to read real-time values from the RTU Open. The Network Management Tool allows you to test integration prior to binding the controller's network variables to other LonWorks nodes.

# Troubleshooting LonWorks communication

The most common communication problems result from not properly following the configuration steps outlined above in this manual. Review all of the steps and use the following list to check your settings.

**Verify accuracy of the following:**

**Hardware settings** for speaking LonWorks (8 Data bits, No Parity, and 1 Stop bit):

- Baud rate DIP switches 1 and 2 set to 38.4 kbps

- Protocol DIP switches DS3 - DS6

- LON network terminated on LonWorks Option Card pins 1 and 2

- The BAS is connected properly to the LonWorks Option Card's 2-wire TP/FT-10 Net port, which is polarity insensitive. The BAS may have to configure jumper or DIP switches on their end to support TP/FT-10.

**NOTES**

- If RX LED is solid, then the terminations are incorrect.

- If the network has greater than 32 devices or exceeds 2,000 feet, a Repeater should be installed.

- If a controller begins or ends a network segment, a terminating resistor may be needed.

- The RTU Open must be properly commissioned onto the LonWorks network. See *Commissioning the controller for LonWorks communication* (page 18).

- The BAS must be connected properly to the LonWorks Option Card's 2-wire TP/FT-10 Net port, which is polarity insensitive.

**Software settings** defined through the Equipment Touch device. To confirm settings, obtain a Modstat of the device. On the Equipment Touch, click the link to the Modstat.

# 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 - <br> Runs on a laptop that connects to controller's Local Access port [1] | Temporary interface |
| **Equipment Touch** device - <br> Connects to controller's Rnet port [2] | Temporary or permanent interface |
| **I-Vu®** application <br> Available for BACnet systems only | Permanent interface |
| **System Touch** device <br> Available only for BACnet MS/TP systems. <br> 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.

# Sequence of Operation

The RTU Open supports various types of constant volume and Staged Air Volume (SAV) air source configurations:

- Standard heat/cool unit types with up to 2-stages of mechanical cooling and gas or electric heating

- Heat pump units utilizing a reversing valve output for heating and cooling control

- Heat pump unit (Carrier) with an OEM defrost control board

- Economizer, CO2, Demand Limiting, and RH control strategies are available for appropriately equipped units

- LC WeatherExpert™ unit with 3-stage compressor control and SAV variable speed supply fan control

- SAV energy saving operation which utilizes a standard heat/cool rooftop unit with a fan equipped with a VFD that provides variable speed fan control in both heating and cooling modes. This operation provides variable air flow but not VAV operation and does not provide duct static pressure control. It must be used with standard constant volume duct systems or VVT.

The RTU Open may operate as part of a VVT system using Airside Linkage or as a stand-alone controller.

# Occupancy

The RTU Open's operation depends upon its occupancy state (**Occupied/Unoccupied**). The RTU Open operates continuously in the **Occupied** mode until you configure an occupancy schedule.

An occupancy schedule may be:

- A local schedule configured in the controller using an Equipment Touch or Field Assistant

- A BACnet schedule configured for the RTU Open in the i-Vu® application.

- A BACnet or local schedule configured in the VVT Zones that are subordinate to the RTU Open and employing Linkage

To set up occupancy schedules, see the documentation for your user interface.

**NOTE** A BACnet schedule, downloaded from the i-Vu® application will overwrite a local schedule that was set up with an Equipment Touch or Field Assistant.

**Occupancy Source** - the following settings determine occupancy.

Options:

- **Always Occupied** – (default) Controller operates continuously, regardless of any configured schedule

- **BACnet Schedule** – Uses a local BACnet occupancy schedule configured within the controller

- **BAS On/Off** – Occupancy is set over the network by another device or a third party BAS. Refer to the *RTU Open Integration Guide* for additional instructions in communication protocols.

- **Remote Occ Input** – Controller monitors an input contact connected to one of the available binary inputs configured to receive it. You must set **Unit Configuration** > **Occupancy Source** to **Remote Occ Input** and one **Input Switch Configuration** to **Remote Occupancy**.

# Supply fan

The RTU Open supply fan may be configured for 1 of 3 **Fan Control modes**:

- **Single** - The fan operates at one speed only and provides on/off operation

- **Two Speed** - The fan operates at 1 of 2 speeds depending on the mode of operation and load conditions. During fan only or single stage cooling, the fan operates at low speed. During heating, second stage cooling, dehumidification, or if maximum economizer operation is required, the fan operates at high speed.

- **Variable Speed** - The fan operates at a variable speed to maintain the desired supply air conditions when heating or cooling are operating. Variable speed fan control provides Staged Air Volume (SAV) operation by maximizing energy savings and minimizing fan horsepower consumption. Fan speed is NOT controlled to maintain duct static pressure.

The RTU Open supply fan may be configured for 1 of 3 **Fan Modes**:

- **Auto** - The fan cycles on/off in conjunction with heating or cooling

- **Continuous** - The fan runs continuously during occupancy and intermittently during unoccupied periods with heating or cooling

- **Always On** - The fan runs continuously regardless of occupancy or calls for heating and cooling

Occupancy can be determined by Linkage, BACnet schedules, BAS schedules, or in response to a remote occupancy switch.

A **Fan Off Delay** allows the supply fan to continue operating after heating or cooling stops.

If the following alarms are active, the fan turns off immediately, regardless of the occupancy state or demand:
- **Fire Shutdown**
- **Safety chain**
- **Supply Air Temp Sensor** alarm
- **Space Temp Sensor** alarm

The RTU Open does not include smoke-control functions such as smoke-purge, zone-pressurization, or smoke-ventilation.

The RTU Open may be configured to accept a **Supply Fan Status** input to provide proof the supply fan is operating. When enabled, a loss or lack of fan status will stop heating and cooling operation.

A **Supply Fan Alarm Service Timer** function is available to track the number of supply fan run hours and generate an alarm when the accumulated runtime exceeds the set threshold.

**Vent / Fan Only mode** – When the space temperature is between the heating and cooling setpoints, the fan operates at the minimum VFD speed (**IDF Min Speed Voltage** / **Min VFD Output**) configured under normal operating conditions.
**NOTE** SAT must be above the **SA Vent / Temper Setpoint** if **SA Tempering** is disabled or SAT must be above the **SA Vent / Temper Setpoint -**7.5°F (-21.9°C) if **SA Tempering** is **Enabled** and OAT is below the **Minimum Cooling SAT**.

**Fan Only Override w/Variable Speed fan control** — The RTU Open monitors the SAT in fan only mode to ensure the SAT remains above an acceptable minimum value. Fan Override typically occurs when the outdoor air is cold in winter and the economizer increasingly opens at lower fan speeds to maintain a constant amount of outdoor air. **If SA Tempering** is disabled, then when the SAT drops below the **SA Vent / Temper Setpoint**, the fan speed increases up to the maximum configured speed (while at the same time, the economizer position will correspondingly decrease from the **Low Fan Econ Min Pos** toward the **Vent Dmpr Pos / DCV Min Pos**. The **Vent Dmpr Pos / DCV Min Pos** is used when the fan is at the configured maximum fan speed. The **Low Fan Econ Min Pos** is used when the fan is at the lowest speed and depends on which value, minimum vfd speed or heating speed, is set lower.

# Cooling

The RTU Open's application and configuration determines the specific cooling sequence. The RTU Open can control up to 2 stages of cooling with an additional output for a reversing valve (heat pump applications). The number of stages is configurable or is defined by unit type.

The following conditions must be true for the cooling algorithm to operate:

- **Outdoor Air Temperature**, if valid, is greater than the **Cooling Lockout Temperature** setpoint

- The indoor fan is on

- The unit has a valid **Supply Air Temperature** input

- The unit has a valid **Space Temperature** input

- Heat mode is not active and the 5-minute time guard between modes has expired

- Economizer is unavailable, or if the Economizer is active, mechanical cooling is available if the economizer is open > 90% for at least 7.5 minutes, the SAT and OAT > [**Minimum Cooling SAT** + 5Δ°F (2.7Δ°)] and SPT > [**Effective Cooling Setpoint** + 0.5Δ°F (.27Δ°C)].

The cooling relays are controlled by the Cooling Control PID Loop and Cooling Capacity algorithm. They calculate the desired number of stages needed to satisfy the space by comparing the **Space Temperature** to the:

- **Effective Occupied Cooling Setpoint** when occupied

- **Effective Unoccupied Cooling Setpoint** when unoccupied

When the cooling algorithm preconditions have been met, the compressors are energized in stages, as applicable. Anti-recycle timers are employed to protect the equipment from short-cycling. There are fixed 3 minute minimum on-times, and 5 minute off-times for each compressor output.

During compressor operation, the RTU Open may reduce the number of active stages if the rooftop supply air temperature falls below the **Minimum Cooling SAT Setpoint**. A compressor staged off in this fashion may be started again after the normal time-guard period has expired, if the **Supply Air Temperature** has increased above the **Minimum Cooling SAT Setpoint**.

**Compressor Service Alarm Timer** functions are available (1 for each stage of compression). This function tracks the number of compressor run hours and generates an alarm when the accumulated runtime exceeds the threshold set by the adjustable compressor service alarm timers.

**SAV Cooling Mode** - When the space temperature rises above the cooling setpoint and the cooling mode becomes active, the cooling capacity is calculated by the Cooling PID and the outputs are enabled as required. Initially, the fan runs at the configured minimum airflow (**IDF Min Speed Voltage / Min VFD Output**) and VFD speed as long as the SAT remains above the appropriate cooling stage setpoint (**Stage 'x' SAT Stpt**). As the SAT drops below the configured **Stage 'x' SAT Stpt**, the fan speed increases as required up to the configured maximum VFD speed (**IDF Max Speed Voltage / Max VFD Output**) to provide sufficient airflow across the coil and maintain the desired SAT setpoint. The number of setpoints displayed and used depends on the unit type and configuration.The specific setpoint used is based on how many stages of cooling are actively operating.

# Economizer

The RTU Open provides an analog economizer output for rooftop units with economizer dampers. Economizer dampers may be used to provide indoor air quality control and free cooling when outside air conditions are suitable.

The following conditions must be true for economizer operation:

- The **Outdoor Air Temperature** is less than the **Space Temperature** and less than the **Economizer High OAT Lockout Temp** setpoint

- The indoor fan is on

- The unit has a valid **Supply Air Temperature** input

- The unit has a valid **Space Temperature** input


If the RTU Open is configured for VFD or 2-speed fan, the economizer minimum position is adjusted to provide a constant amount of outdoor air. If the fan is on high speed or is configured for single-speed fan, the economizer minimum position will be set to the **Vent Dmpr Pos / DCV Min Pos** setpoint. If it is configured for VFD or 2-speed fan, and the fan is on low speed, the economizer minimum position will be set to the **Low Fan Econ Min Pos**.

If all preceding conditions are true, the economizer PID loop modulates the damper between the minimum position and 100% open.

The economizer will modulate to maintain the configured **Minimum Cooling SAT** limit when the unit is in an economizer only mode and will modulate closed only when the SAT drops below the **Minimum Cooling SAT** limit - 5Δ°F (-2.8Δ°C) when mechanical cooling is also operating.

**SAV Economizer Mode** - When the economizer mode becomes active, the fan runs at the configured minimum airflow (**IDF Min Speed Voltage / Min VFD Output**). The economizer algorithm will first modulate the economizer to lower the SAT until reaching the configured **Minimum Cooling SAT** limit, while maintaining the minimum fan airflow. If this alone is insufficient to maintain the space temperature, the RTU Open increases the fan speed to provide more OA for cooling. As necessary, the fan speed may increase up to the configured maximum VFD speed (**IDF Max Speed Voltage / Max VFD Output**) to provide the required cooling.

## Economizer Fault Detection & Diagnostics (FDD)

The RTU Open provides FDD (Fault Detection and Diagnostics) for economizer operation in compliance with California Title 24. The FDD logic detects 4 economizer faults:

- fails to close

- fails to open

- stuck fully open

- fails to fully open

Each condition causes an Economizer Operation alarm and displays the specific fault condition.

The following must be true to enable the FDD logic:

- RTU Open must be in Economizer mode

- 30 minutes must elapse since the last time heating or cooling was active

- OAT must be < (OAT economizer lockout - 15°F)

**Failed to Fully Open**

If the damper command is > 95%, the SAT must equal the OA temperature +/- 5°F, otherwise the **Full Open Fail** flag is set. If this condition continues for more than 30 minutes, the Economizer FDD alarm is active. This indicates that the damper failed to fully open when needed, since the SAT failed to reach the OA temperature +/- 5°F.

**Stuck Open**

If the damper is commanded to < 40% and the SAT is still equal to the OAT +/- 5°F, the **Stuck Open** flag is set. If this condition continues for more than 30 minutes, then the Economizer FDD alarm is active. This indicates the damper failed to close when needed, since the SAT failed to increase in temperature.

When the damper is modulating (MUST be above any minimum configured position) and between 25% and 100%, the FDD logic monitors the current and previous SAT, economizer-commanded position, and the OAT:

**Failed to Open**

If the FDD logic detects an increase in damper position, for example from 50% to 65%, it expects to also detect a decrease in SAT. If the SAT failed to decrease, or no change in SAT is detected, the FDD logic generates a **Failed to Open** alarm after 10 minutes.

**Failed to Close**

If the FDD logic detects a decrease in damper position, for example from 80% to 65%, it expects to also detect an increase in SAT. If the SAT failed to increase, or no change in SAT is detected, the FDD logic generates a **Failed to Close** alarm after 10 minutes.

# Power Exhaust

The RTU Open may enable and disable an exhaust fan, based on either the controller's occupancy or its economizer damper position. If the **Fan Control** is set to **Two Speed** or **Variable Speed**, the **Power Exhaust Setpoint** is automatically adjusted based on the fan's air delivery. The **Calculated PE Setpoint** used for control is displayed in the **Maintenance** section.

 If **Continuous Occupied Exhaust** is **Yes**, the **Power Exhaust** binary output (BO-8) is energized while the RTU Open is occupied and de-energized when unoccupied.

If **Continuous Occupied Exhaust** is **No**, the **Power Exhaust** binary output (BO-8) is energized when the economizer damper output exceeds the **Calculated Power Exhaust (PE) Setpoint** value. The output remains energized until the economizer output falls below the **Power Exhaust Setpoint** value by a fixed hysteresis of 10%.

# Pre-Occupancy Purge

**Pre Occupancy Purge** allows the rooftop equipment with an economizer damper to use outdoor air to purge the space of contaminants just prior to the beginning of the occupied period.

The following conditions must be true for pre-occupancy purge to operate:

- **Pre-Occupancy Purge** set to **Enable**

- **Economizer Exists** set to **Yes**

- A local time schedule is configured

- The local time schedule is currently unoccupied and the remaining time is less than the configured **Purge Time**

When the RTU Open schedule is unoccupied and the remaining unoccupied time is less than the purge time, the supply fan starts. The economizer damper opens to the configured **Economizer Purge Min Pos**. The RTU Open continues to operate in this mode until the occupied start time is reached. The **Pre-Occ Purge** state is displayed in the **Maintenance** section.

# Unoccupied Free Cooling

**Unocc Free Cool Enable** allows rooftop equipment with an economizer damper to use outdoor air for free cooling during unoccupied periods.

The following conditions must be true for unoccupied free cooling to operate:

- **Unocc Free Cool Enable** set to **Enable**

- The system is unoccupied

- The outside air temperature is below the **Economizer High OAT Lockout Temp** setpoint

- The outside air temperature is less than the space temperature

- **Enthalpy** (if enabled) is **Low**

When the RTU Open schedule is unoccupied and the space temperature rises at least $1\Delta\,°F$ ($.5\Delta\,°C$) above the **Occupied Cooling Setpoint**, the supply fan starts. The economizer damper opens as necessary to cool the space. The RTU Open continues to operate in this mode until the space is satisfied or the outside air conditions are no longer suitable for free cooling.

# Optimal Start

The RTU Open may use either of 2 different **Optimal Start** methods. **Learning Adaptive Optimal Start** is used for heat pump applications and adjusts the effective setpoints to achieve the occupied setpoints by the time scheduled occupancy begins. This prevents or minimizes the need for auxiliary heat. The Optimal Start recovery period may begin as early as 4 hours prior to occupancy. The algorithm works by moving the unoccupied setpoints toward the occupied setpoints. The rate at which the setpoints move is based on the outside air temperature, design temperatures, and capacities.

The following conditions must be true for learning adaptive optimal start to operate:

- On the **Properties** page > **Control Program** tab > **Configuration** > **Setpoints** > **Optimal Start**, the default value is set to 1 and must be set greater than **0** (**0.00** disables **Optimal Start**) and less than or equal to **4**.

- The system is unoccupied

**NOTE**  If the controller does not have a valid outside air temperature, then a constant of 65°F (18.3°C) is used. This value is not adjustable.

The actual equation that the controller uses to calculate **Learning Adaptive Optimal Start** is nonlinear. An approximation of the result is shown below.

**NOTE**  The values in the graph below are Fahrenheit.
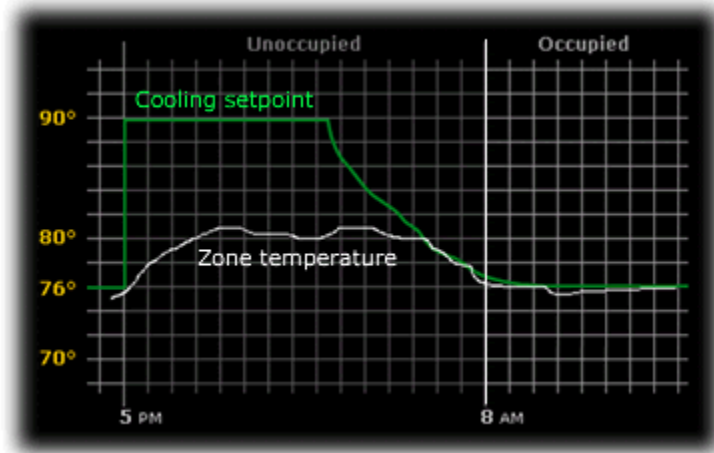


To change **Learning Adaptive Optimal Start** settings:

**1**    In the navigation tree, select the equipment that you want to change.

**2**    Click **Properties** page > **Control Program** tab >  **Configuration** > **Setpoints**.

**Temperature Compensated Optimal Start** is a second start method used for gas or electric heating applications. It switches from unoccupied to the occupied setpoints at a calculated time prior to occupancy. This minimizes the operation of the unit's fan. The Optimal Start recovery period may begin as early as 4 hours prior to occupancy. The time at which the setpoints move is based on the difference between the current space temperature and the desired setpoint, multiplied by the "K" factor, or recovery rate, for the required mode of operation.

The following conditions must be true for Temperature Compensated Optimal Start to operate:

- On the **Properties** page > **Control Program** tab > **Configuration** > **Setpoints** > **Optimal Start**, the default value is set to 1 and must be set greater than **0** (**0.00** disables **Optimal Start**) and less than or equal to **4**.

- The system is unoccupied

To change Temperature Compensated Optimal Start settings:

**1**    In the navigation tree, select the equipment that you want to change.

**2**    On the **Properties** page > **Control Program** tab > **Configuration** > **Setpoints**, click **Heat Start K factor** or **Cool Start K factor**. This defines the equipment's recovery rate in minutes / deg.

# Enthalpy control

You may use an enthalpy switch to indicate the suitability of outdoor air for economizer cooling. You can use either an outdoor air or differential enthalpy switch. A differential enthalpy switch has a sensing device in both the outdoor and return air streams. A differential enthalpy switch indicates when outside air is more suitable to be used than the return air and is available for economizer cooling. If no enthalpy switch is configured, a network point (Object Name: oae) is available. This point is displayed in the i-Vu® application and an Equipment Touch as **Enthalpy** (BACnet).

The sequence of operation for economizer cooling is the same with or without an enthalpy switch, except that an enthalpy switch imposes one more validation on the suitability of outside air for economizer cooling. An **Enthalpy Status** that is **High** disables the economizer and the outside air damper goes to its minimum position. An **Enthalpy Status** that is **Low** enables the economizer if a call for cooling exists and the remaining preconditions are met.

# Indoor Air CO2

**Indoor Air CO2** is controlled on rooftop equipment with an economizer. **Indoor Air CO2** sequence is enabled by installing an air quality (CO2) sensor. A CO2 sensor may be terminated at the RTU Open, or a subordinate zone controller, when part of a zoned system.

An outdoor air quality sensor may also be installed and terminated at the RTU Open, but it is not required. When an outdoor air quality sensor is not installed, the algorithm uses 400ppm as the fixed outdoor air CO2 level.

The following conditions must be true for the **Indoor Air CO2** algorithm to operate:

- The system is occupied

- The supply fan has been started for at least 30 seconds

- The CO2 sensor has a valid reading

As the air quality within the space changes, the minimum position of the economizer damper changes, which allows more or less outdoor air into the space, depending on the relationship of the indoor air CO2 level to the differential setpoint.

The **Indoor Air CO2** algorithm calculates a minimum position value using a PID loop. The CO2 minimum damper position is then compared against the **Vent Dmpr Pos / DCV Min Pos** setpoint and the greatest value becomes the final minimum damper position of the economizer output.

The degree to which the outside air damper may be opened by the **Indoor Air CO2** algorithm is limited by the **DCV Max Vent Damper Pos** setpoint, which is adjustable between zero and seventy-five percent (0 – 75%).

# Heating

The specific heating sequence is determined by the controller's application and configuration. The RTU Open controls up to 2 stages of gas or electric heating with an additional output for a **Reversing Valve** (Heat Pump applications).

The following conditions must be true for the heating algorithm to operate:

- The **Outdoor Air Temperature** is less than the **Heating Lockout Temperature** setpoint

- The indoor fan has been ON for at least 30 seconds

- The unit has a valid **Supply Air Temperature** input

- The unit has a valid **Space Temperature** input

- Neither Cool mode nor economizer are active and the time guard between modes has expired

The heating relays are controlled by the Heating Control PID Loop and Heating Stages Capacity algorithm, which calculate the desired number of stages to satisfy the space by comparing the **Space Temperature** to the:

- **Effective Occupied Heating Setpoint** when occupied

- **Effective Unoccupied Heating Setpoint** when unoccupied

When the heating algorithm preconditions have been met, the heating is energized in stages. Anti-recycle timers are employed to protect the equipment from short-cycling. There are fixed one minute minimum on and off times for each heating output.

During heating operation, the RTU Open may reduce the number of active stages if the rooftop **Supply Air Temperature** exceeds the **Maximum Heating SAT** setpoint. A heat stage turned off in this fashion may be started again after the normal time-guard period has expired, if the **Supply Air Temperature** has decreased below the **Maximum Heating SAT** setpoint.

**SAV Heating Mode** — When the space temperature is below the heating setpoint and the heating mode becomes active, the heating capacity is calculated by the Heating Control PID Loop and the outputs are enabled as required. Initially, the fan operates at the configured heat airflow (**IDF Heat Speed Voltage/Heating VFD Output**), whether higher or lower than the minimum VFD speed (**IDF Min Speed Voltage / Min VFD Output**), as long as the SAT remains below the **Maximum Heating SAT** minus 3°F (1.67°C). As the SAT increases above this value, the fan speed increases up to the configured maximum VFD speed (**IDF Max Speed Voltage / Max VFD Output**) to provide sufficient airflow across the coil and maintain the **Maximum Heating SAT** minus 3°F (1.67°C) setpoint. As the SAT exceeds the **Maximum Heating SAT**, the heat stages will be reduced or disabled.

# Supply Air Tempering

The RTU Open can provide supply air tempering to warm the discharge air under conditions where no heating or cooling is required, the outdoor air is cold, and the volume of outdoor air required for minimum ventilation causes the supply air temperature to fall below the adjustable **SA Vent / Temper Setpoint**.

To enable the tempering function, **SA Tempering** must be set to **Enable**.

The following conditions must be true for the algorithm to operate:

- The unit cannot be a heat pump type (**HP O/B Ctrl or HP Y1/W1 Ctrl**)

- The unit has been operating for at least 5 minutes

- The unit has a valid **Supply Air Temperature** input

- The unit is configured for gas or electric heat

- The Outdoor Air Temperature is less than the **Minimum Cooling SAT**

- The current operation mode is either **Fan Only**, **IAQ Override**,or **Pre-occ Purge**

- The fan status is True (if configured for the fan status option)

- The supply air temperature falls below the configured **SA Vent / Temper Setpoint**

When the algorithm preconditions above have been met, the first stage of heating is energized. The heating operates to maintain the desired **SA Vent / Tempering Setpoint** subject to the minimum on timer and anti-recycle timer to protect the equipment from short-cycling and ensure minimum burn time for gas heat. There are fixed one-minute minimum on and off times for the heating output.

# Heat Pump operation

The RTU Open can control heat pumps **HP O/B** and **Y1/W1**.

**HP O/B** provides a separate output (BO-7) to control a reversing valve. The reversing valve control may be configured to be energized with a call for heating **(B)**, or energized with a call for cooling (**O**).

The sequence of operations are as previously described for heating and cooling except that the **Y1** and **Y2** outputs are compressor outputs, energizing mechanical heating or cooling, depending on the state of the reversing valve. **W1** and **W2** are used for auxiliary heat. Up to 2 stages are available.

For heat pumps configured as **HP O/B**, the RTU Open provides a reverse cycle lockout that prevents reverse cycle operation when the OAT falls below the configured **HP Rev Cycle Lockout Temp**. Whenever the OA temperature is below this value, the RTU Open will immediately operate the auxiliary heat and disable the compressor operation whenever heating is required.

Select **Y1/W1** for heat pumps that do not require a **O** terminal to energize the reversing valve. The sequences of operations are as described for Heating and Cooling. The reversing valve output is not used in this application. **W2** is used for auxiliary heat. Up to 2 stages are available.

For all heat pump types, the RTU Open will prevent auxiliary heat operation whenever the OA temp is greater than the configured **HP Aux Heat Lockout Temp**. This allows the RTU Open to utilize the more efficient heating from the reverse cycle operation and prevents the operation of the auxiliary heat source.

**IMPORTANT!** All heat pump unit types **(HP O/B** and **Y1/W1**) require a valid OA Temperature value. This value may be a local sensor connected to the RTU Open or a value received from the network.

# Dehumidification

The RTU Open provides occupied and unoccupied dehumidification on units that are equipped with the Carrier Humidi-MiZer™ option from the factory. This requires a space relative humidity sensor or a humidistat for control.

The following conditions must be true for the dehumidification control to operate:

- The **Outside Air Temperature** is greater than the **Cooling Lockout Temperature** setpoint
- The **Indoor Fan** has been on for at least 30 seconds
- The unit has a valid **Supply Air Temperature** input
- The unit has a valid **Space Temperature** input
- The unit has a valid **Space Relative Humidity Sensor** or **Humidistat** input
- Heat mode is not active and the time guard between modes has expired

When using a relative humidity sensor to control dehumidification, occupied and unoccupied dehumidification setpoints are used.

When using a humidistat, the setpoints are not used. The humidistat indicates a high-humidity condition.

When a high indoor relative humidity condition is indicated and the above conditions are satisfied, the RTU Open enters the dehumidification mode, energizing the Humidi-MiZer™ output.

The mode continues until the space relative humidity falls below the active setpoint by a 5% fixed Hysteresis when a humidity sensor is used, or when there is no longer a call for dehumidification where a humidistat is used.

See the base unit / Humidi-MiZer™ operations manual for additional information.

# Demand Limiting

The RTU Open may employ a demand limit strategy. Demand limiting in the RTU Open works through setpoint expansion. The controller's heating and cooling setpoints are expanded in steps or levels. The degree to which the setpoints are expanded is defined by the **Demand Level Setpoints**.

Each **Demand Level** (1 through 3) adjusts the heating and cooling setpoints outwards. By default, **Demand 1** yields a 1Δ°F (.5Δ°C) expansion, **Demand 2** yields a 2Δ°F (1.1Δ°C) expansion, and **Demand 3** yields a 4Δ°F (2.2Δ°C) expansion.

The BACnet **Demand Limit** variable sets the desired level of setpoint expansion in the receiving controller. **Level 0** leaves the standard occupied and unoccupied heating and cooling setpoints in effect. Levels 1 through 3 expands occupied heating and cooling setpoints.

# Door switch

A **Door Contact** may be configured on any unused binary input. A typical application is a door or window contact mounted within the space served by a single zone rooftop. The **Door Contact** disables mechanical cooling and any heating, when active (an open door or window is detected). Economizer cooling, if available, continues to operate. The input provides a configurable alarm delay (60 second default) before heating and cooling is disabled.

# Remote Occupancy

**Remote occupancy** may be configured on any unused binary input channel. A typical application is a remote contact, controlled by a third party, or an occupancy sensor to set the controller's occupied mode. The **Remote Occupancy** function requires both an input configured for **Remote Occupancy**, and **Occupancy Source** set to **Remote Occ Input** to operate.

Once configured, the controller will operate in the occupied or unoccupied mode, as determined by the state of the **Remote Occupancy** input.

# Fire Shutdown

**Fire Shutdown** may be configured on Binary Input 5. A typical application involves a smoke detector or fire shutdown contact, which, when active, immediately shuts down equipment operation.

# Compressor Safety

**Compressor Safety** may be configured on Binary Input 3. A compressor safety tripped indicator circuit is available on most Carrier rooftop equipment.

A **Compressor Safety Alarm** is shown on **Properties** page > **Control Program** tab > **Alarms** and indicates that the equipment requires attention.

Cooling, heating, and supply fan outputs are not interrupted except where the RTU Open is configured for Heat Pump operation. When configured for Heat Pump, and in the heating mode, a compressor safety fault will cause the available stages of electric heating to be enabled in place of mechanical heating.

Normal operation resumes when the compressor safety circuit is de-energized.

# Fan Status

**Fan Status** may be configured on any unused binary input channel. A typical application would be an airflow switch, current sensing relay, or other device that provides a supply fan running verification.

Enabling this function displays the supply fan's status on the equipment graphic.

If the controller loses fan status during operation, heating and cooling are disabled, the economizer damper (if available) is closed, and an alarm for loss of status is indicated.

If the fan status is on when the controller is commanding the fan off, the unit remains in the off state. An alarm is generated indicating that the fan is running when it should be off.

# Filter status

**Filter** status may be configured on any unused binary input channel. A typical application is a differential pressure switch that senses the pressure drop across a filter bank.

When the pressure across the filter bank exceeds the setpoint of the differential pressure switch, the **Filter** status is displayed as **Dirty** on the controller graphic. An alarm indicates a dirty filter.

# Alarms

**NOTE** Some of the **Alarms** functions described in this section will only be visible on the **Properties** page > **Equipment** tab > **Alarms** when the appropriate inputs are configured. Alarms are not initiated when the input is not configured.

**Safety Chain** - You may use the RTU Open's safety chain circuit to shut down the unit for a safety condition. Examples: Low or High Temperature Cutouts (Freezestat / Firestat). This alarm indicates the safety chain circuit (Input 4) is open. Cooling, heating, and supply fan operation stop after appropriate time guards. Normal operation resumes when the safety chain circuit is complete.

**Fire/Smoke Shutdown** - You may configure the RTU Open to accept a **Fire Shutdown** contact on Input 5. Examples: Smoke detectors or fire shutdown relays. This alarm indicates this device (Input 5) has tripped. Cooling, heating, and supply fan operation immediately stop. Reset fire shutdown contact to resume normal operation.

**Gas Valve** – If configured for the IGC input function, the RTU Open will compare the state of this input with the requirement for heat (W1 or W2). If the IGC input, which detects an active flame in the gas heat section, is present 1 minute after any call for heating has ended, a gas valve failure alarm will occur, indicating a stuck gas valve.

**Compressor Status** – You may configure the RTU Open to monitor the base unit's compressor safety circuit. This alarm indicates the base unit's compressor safety circuit is energized. Cooling, heating, and supply fan outputs are not interrupted except when the RTU Open is configured for Heat Pump. Normal operation resumes when the compressor safety circuit is de-energized.

If the Heat Pump is a HP O/B Ctrl type and is in the heating mode, it will automatically replace the compressor stage(s) with the equivalent number of auxiliary heat stages, as available.

- If it's a Carrier Heat Pump HP Y1/W1 Ctrl, there is only 1 auxiliary heat stage output and the staging is done by the machine itself. The RTU Open control does not take any action.

- For a non-Carrier Heat Pump, when configured for 2 stages of aux heat and two compressors, Compressor 1 is replaced by Aux Heat Stage 1 and Compressor 2 is replaced by Aux Heat Stage 2.

The compressor output stays on when the safety alarm is present. For cooling, the alarm indicates the compressors are not operating. See Heat Pump operation for further information.

**Space Temperature** – This alarm indicates if the space temperature is outside the configured alarm limits. If active (Alarm), displays additional values for the space temperature when the alarm condition occurred and the alarm limit exceeded.

The following values are related to the **Space Temperature** alarm:

- **Alarming Temperature** – Displays the value of the space temperature that caused the alarm condition to occur and is only visible when the **Space Temperature** is in an alarm state.

- **Alarm Limit Exceeded** – Displays the value of the alarm setpoint that was exceeded by the alarming temperature and is only visible when the **Space Temperature** is in an alarm state.

**SPT Sensor** – This alarm indicates a communication failure of a connected SPT sensor that previously had been actively communicating. The alarm is reset when normal SPT sensor communications resume, if power is cycled to the controller, or if the **Shutdown** point is set to **Active**.

**ZS Sensor** – This alarm indicates a communication failure of a connected ZS sensor that had previously been actively communicating. The alarm is reset when normal ZS sensor communications resume, if power is cycled to the controller, or if the **Shutdown** point is set to **Active**.

**ZS Configuration** – This alarm indicates that at least 1 ZS sensor is configured in the Sensor Binder properties and is not communicating. The alarm is reset when the configured ZS sensor is communicating or the configuration is changed to reflect the sensor is no longer connected to the Rnet.

**Space Temp Sensor** – This alarm indicates an invalid sensor condition in a physically connected space temperature sensor (SPT Sensor/T5*).  Cooling, heating, and supply fan operation stop after the appropriate time guards. Normal operation resumes when the controller detects a valid sensor.

**Supply Air Temperature** – This alarm indicates that the supply air temperature is outside the configured alarm limits. The alarm is reset to normal when the supply air temperature returns within the configured alarm limits plus a $3\Delta\,°F$ $(1.6.\Delta\,°C)$ hysteresis. This alarm is inhibited until the fan has been running for 15 minutes to allow for system stabilization after startup.

**Supply Air Temp Sensor** – This alarm indicates a shorted or open circuit in the SAT input. Cooling, heating, and supply fan operation stops after the appropriate time guards. Normal operation resumes when the controller detects a valid sensor.

**Indoor Air Quality** – The RTU Open generates an **Indoor Air Quality** alarm if the $CO_2$ level exceeds the configured alarm limits. (This alarm is only shown when a valid indoor air quality sensor value is available).

**Indoor Air Quality Sensor** – The RTU Open generates an **Indoor Air Quality Sensor** alarm if a valid sensor value is no longer available. For locally connected sensors, the mA input at the associated channel falls below 3.5 mA or rises above 21 mA. For network sensors, the controller is no longer receiving a value from the network. Cooling, heating, and supply fan continue to operate. However, the controller's IAQ control function is disabled until the fault condition is corrected.

**Space Relative Humidity** – The RTU Open generates a **Space Relative Humidity** alarm if the space humidity level exceeds the configured low or high alarm limits. (This alarm is only shown when a valid relative humidity sensor value is available).

**Space Relative Humidity Sensor** – The RTU Open generates a **Space Relative Humidity Sensor** alarm if a valid sensor value is no longer available. For locally connected sensors, the mA input at the associated channel falls below 3.5 mA or rises above 21 mA. For network sensors, the controller is no longer receiving a value from the network.  Cooling, heating, and supply fan operation continues, however, the controller's Humidi-MiZer™ binary output is disabled until the fault condition is corrected.

**Filter** – If the RTU Open is configured to monitor the filter through a hardware input switch contact, it generates a **Filter** alarm if the associated input channel detects a dirty filter condition (opposite state of the **Input** "x" **Switch Configuration**). Otherwise, if no hardware switch monitoring is used, the RTU Open generates a filter alarm when the accumulated runtime exceeds the **Unit Configuration** > **Filter Service Alarm Timer** value (when not set to 0). This alarm is most commonly used to indicate a filter replacement is due. Reset the filter service runtime accumulator by setting the **Maintenance** > **Reset Filter Runtime Alarm** to **On**, back to **Off**, and clicking **OK** after each setting. Set **Unit Configuration** > **Filter Service Alarm Timer** value to **0** to disable the filter service alarm function.

**Local OAT Sensor** – This alarm indicates a shorted or open circuit in the locally connected OAT input.

**Outdoor Air Temp Sensor** – This alarm indicates a valid OAT sensor value is no longer available. An alarm condition can occur from a failed locally connected sensor or if a network OAT value is no longer being received by the controller. Cooling, heating, and supply fan operation continues. OAT lockouts will not operate while the sensor is in alarm. Normal operation resumes when the controller detects a valid sensor.

**Economizer Operation** – This alarm is active when an economizer fault is detected, as required by the CEC Title 24 Economizer FDD logic. Once detected, this alarm will stay active until the **Shutdown** input is set to **Active** or the fan is stopped.

**Economizer** – This point indicates the specific fault detected and announced by the Economizer Operation alarm above. Detected fault conditions include **Failed to Fully Open**, **Failed to Open**, **Failed to Close**, and **Stuck Open**.

**Outdoor Air Quality Sensor** – The RTU Open generates an **Outdoor Air Quality Sensor** alarm if the mA input at the associated channel falls below 3.5 mA or rises above 21 mA. For network sensors, the controller is no longer receiving a value from the network. Cooling, heating, and supply fan operation continues. However, the controller's IAQ control function uses 400ppm as the fixed outdoor air $CO_2$ level until the fault condition is corrected.

**Setpoint Slider** – The RTU Open generates this alarm when an open circuit is detected at Input 11 and the RTU Open **Configuration** > **Unit Configuration** > **Input Configuration** >  **Space Sensor Type** is set to T56. Note that only an open circuit results in an alarm. A short across this input offsets the setpoints negatively by the amount configured in the **Unit Configuration** > **Setpoint Adjustment Range**.

**Switch Configuration** - The RTU Open generates this alarm when any two of the **Unit Configuration** > **Input Functions 3**, **5**, **8,** or **9** are configured identically. Neither input may work reliably and downstream control may be affected, depending on the function duplicated. The alarm clears and normal control is restored when the input function duplication is corrected.

**Analog Input Configuration** - The RTU Open generates this alarm when the **Unit Configuration** > **Input Functions 1** and **2** are configured identically. Neither input may work reliably and downstream control may be affected, depending on the function duplicated. The alarm clears and normal control is restored when the input function duplication is corrected.

**Supply Fan Runtime** - The RTU Open generates a this alarm when the accumulated runtime exceeds the **Unit Configuration** > **Supply Fan Service Alarm Timer** value (when not set to 0). This alarm is most commonly used to indicate an equipment maintenance interval is due. The supply fan runtime accumulator may be reset by setting the **Maintenance** > **Reset Supply Fan Runtime Alarm** to **Clear**, and then back to **Run** – acknowledging each selection by clicking the **OK** button when it appears. Setting **Unit Configuration** > **Supply Fan Service Timer** value to **0** disables the supply fan runtime alarm function.

**Compressor 1 Runtime** - The RTU Open generates this alarm when the accumulated runtime exceeds the **Unit Configuration** > **Compressor 1 Service Alarm Timer** value (when not set to **0**). This alarm is most commonly used to indicate an equipment maintenance interval is due. The **Compressor 1 Runtime** accumulator may be reset by setting the **Maintenance** > **Reset Comp 1 Runtime Alarm** to **Clear**, and then back to **Run** – acknowledging each selection by clicking the **OK** button when it appears. Setting **Unit Configuration** > **Compressor 1 Service Timer** value to **0** disables the **Compressor 1 Runtime** alarm function.

**Compressor 2 Runtime** - The RTU Open generates this alarm when the accumulated runtime exceeds the **Unit Configuration** > **Compressor 2 Service Alarm Time**r value (when not set to **0**). This alarm is most commonly used to indicate an equipment maintenance interval is due. The Compressor 2 runtime accumulator may be reset by setting the **Maintenance** > **Reset Comp 2 Runtime Alarm** to **Clear**, and then back to **Run** – acknowledging each selection by clicking the **OK** button when it appears. Setting **Unit Configuration** > **Compressor 2 Service Timer** value to **0** disables the Compressor 2 runtime alarm function. Note that this function is unavailable if the **Service Configuration** > **Compressor States** value is not set to **Two Stages**.

**Airside Linkage Alarm** - An RTU Open may act as an air source in a zoned system. Carrier systems use a function called Linkage™ to pass data between a master zone and its air source over an MS/TP network connection. When the RTU Open is part of a linked system, it will indicate an airside linkage alarm if it loses communications with its linkage master or if it receives data from more than 1 master zone.

# Linkage

The RTU Open may serve as an air source to an Open Variable Volume Terminal (VVT) system. When the RTU Open is part of a VVT system and the controllers are wired together to form a network, the controllers may use a method of communication known as Linkage™. Linkage is a method by which an air source and its subordinate zone terminals exchange data 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 VVT Master gathers the following information from the slave zone controllers:

- occupancy status

- setpoints

- zone temperature

- relative humidity

- $CO_2$ level

- damper position

- optimal start data

The VVT Master performs mathematical calculations and algorithms on the data and then sends the composite information to the air source. The VVT Master receives information from the air source such as System Mode, Supply Air Temperature, and Outside Air Temperature (if available), and passes that information to all linked controllers.

The RTU Open is capable of operating in an SAV (Staged Air Volume) mode that is ideally suited to VVT systems. SAV requires the unit's fan be controlled by a VFD to provide variable speed fan operation. SAV operation is standard on the Carrier 3-stage LC Weather Expert units but can also be used with other 2-stage heat/cool units. To obtain SAV operation on those units, the **Fan Control** must be set to **Variable Speed**. In this mode, the fan runs at the lowest speed possible, saving energy and preventing excessive air from being bypassed during heating or cooling operation. Refer to the fan control and heating/cooling sequences for details on the specific operation. Note that using variable speed fan control does NOT eliminate the need for a Bypass damper.

**NOTE** The following paragraphs describe the interaction between the air source (RTU Open) and its subordinate zones. Additional information regarding Open Zoned Systems may be found in the *VVT Zone and VVT Bypass Controller Installation Guides*.

The VVT Master determines system operation by prioritizing heating and cooling requirements from all the zones based on their occupancy and demand. The VVT Master scans the system continuously to determine if any zones are occupied. Occupied zones are a higher priority than unoccupied zones. The VVT Master evaluates all the occupied zones' heating or cooling demands and sends a request to the air source (RTU Open) for:

- Cooling, if the number of occupied zones with cooling demands exceeds the number of occupied zones with heating demands, and the demand is greater than or equal to the number of configured **Linkage Callers**.
- Heating, if the number of occupied zones with a heating demand exceeds or is equal to the number of **Linkage Callers**.

If no zones are occupied or no occupied zones require heating or cooling, the VVT Master performs the evaluation described above for the unoccupied zones.

The VVT Master then gathers the following information and sends it to the air source (RTU Open):

- The setpoints and zone temperature from the zone with the greatest demand for the requested air source mode (heating or cooling). (This zone is called the reference zone.)
- The system occupancy status
- Most open damper position from any zone
- RH and CO2 values (if applicable)

The air source responds by sending the air source mode, supply air temperature, and outside air temperature. The air source verifies the mode by comparing its supply air temperature to the space temperature of the reference zone received through Linkage. See the air source documentation for operation and parameters used to verify its mode. This verification allows the VVT system to determine if the desired air source mode is actually being provided. For example, if the VVT Master sends a request for heating and the air source does not have heat or its heat has failed, the air source's actual mode indicates that and it's current mode is sent to the zones so that they can control accordingly.

The system remains in that mode until all zones of that demand are satisfied or until the system mode reselect timer (default 30 minutes) causes a forced re-evaluation of the system. If there is no demand for the opposite mode, the reselect timer starts again and the current mode continues until all zones are satisfied or until the reselect timer expires, repeating the process. If there is a demand for the opposite mode, the VVT Master sends the reference zone's space temperature and setpoints to the air source and restarts the reselect timer. The air source re-evaluates its demand based on the new information and goes to the Vent mode until the new mode can be verified as described above. The amount of time this takes is determined by the air source's operating parameters.

The VVT Master continuously evaluates the system and updates the air source with the most current system demand. Based on the evaluation, the reference zone can change from one zone to another. The evaluation process continues until there is no demand from any zone or the system mode reselect timer causes a re-evaluation of the system conditions.

If no heating or cooling is required or the current air source mode is satisfied, the VVT Master calculates the weighted average of the occupied and unoccupied heating and cooling setpoints. It also calculates a zone temperature that is midway between the setpoints (occupied or unoccupied based on the system's current occupancy status). This information, plus the occupancy status, is sent to the air source so that its current mode is disabled and the unit ceases heating or cooling operation. If the system is occupied, the air source fan and OA damper, if applicable, operate to maintain proper ventilation.

Linkage also provides a safety and system override function during any RTU heating mode. Whenever the RTU Open is in a heating mode, the control monitors the supply air temperature (SAT). Normally (and initially) during heating, the RTU sends the Linkage Heat mode which causes only those zones that require heat to modulate their dampers to utilize the heated primary air. If during heating the SAT increases and exceeds the Maximum Heating SAT plus $4\Delta°F$, Linkage transmits the Linkage Warm-up mode to all terminals. This allows more zones to utilize the heated primary air and attempts to prevent any further SAT increase. If this is insufficient, then the rooftop's heat stages cycle off and on, subject to the minimum on and off timers specific to the product and the type of heat provided.

⚠️ **CAUTION** It is important to properly set the value for the **Maximum Heating SAT** to match the value specified from the equipment product data recommendations. Many rooftops have heat capacity that provide a higher heat rise, resulting in an SAT in excess of the **Maximum Heating SAT** default value (120°F).

# Linkage 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. All zone dampers will open to 70% to facilitate the fan restarting. |
| **WARMUP** | Air source fan is on and typically used when providing the first cycle of heat when changing from unoccupied to occupied operation. It may also be used as a safety to increase airflow during a heating mode. All zones will modulate airflow to maintain the zone temperature at the midpoint between the occupied heat and occupied cool setpoints. |
| **HEAT** | Air source fan is on and providing heat. Equipment SAT is above the reference zone temperature and all zones modulate airflow to maintain the zone temperature at the appropriate (occ/unocc) heating setpoint. |

| | |
|---|---|
| **FREECOOL** | Air source fan is on and providing cooling using only the economizer and usually during an unoccupied period. All zones modulate airflow to maintain the zone temperature at the occupied cooling setpoint regardless of the zone's actual occupancy status. |
| **COOL** | Air source fan is on and providing cooling. Equipment SAT is below the reference zone temperature and all zones modulate airflow to maintain the zone temperature at the appropriate (occ/unocc) 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 a safety to increase airflow during a heating mode. All zones modulate airflow to maintain the zone's maximum cooling airflow. |
| **EVACUATION** | Air source supply fan is off usually as a result of a fire-life safety input being active. All zone dampers close and local terminal fans are disabled. |
| **VENT** | Air source fan is on and providing ventilation without heating or cooling. |

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

# Troubleshooting

The RTU Open controller acts as an intelligent embedded thermostat to the rooftop unit, but can be monitored and controlled from a third party network. For this reason, there are 3 distinct components for troubleshooting.

The three parts to the system are:

- The mechanical systems of the rooftop unit

- The RTU Open controller

- The third party network connected

Determining which component needs troubleshooting is the first step.

The RTU Open controller can be used to troubleshoot itself with service test, communicating LED's, and built-in alarms, which are discussed in the unit Controls and Troubleshooting instructions. Disconnecting the RTU Open from the unit control inputs can be valuable in determining whether the problem is related to the unit/equipment, the controller/equipment, or the controller/network. Generally, this should be the first step in troubleshooting operational problems. When disconnected from the unit control inputs, simple 24V signals can be used to activate the units G, Y1, Y2, W1, W2, etc. and verify proper unit operation.  If the problem occurs without the RTU Open connected, then the operator should begin troubleshooting the unit/equipment rather than the RTU Open or network.

Third party network may also help in troubleshooting the controller and rooftop unit. Third party network troubleshooting may also be required.

## LED's

The LED's indicate if the controller is speaking to the other devices on the network. The LED's should reflect communication traffic based on the baud rate set. The higher the baud rate, the more solid the LED's will appear.

The LED's on the RTU Open show the status of certain functions.

| If this LED is on... | Status is... |
| --- | --- |
| Power | The RTU Open has power. |
| Rx | The RTU Open is receiving data from the network segment |
| Tx | The RTU Open is transmitting data over the network segment |
| BO# | The binary output is active |

**NOTE**  If Tx is not lit, the MS/TP token is not being passed between controllers.

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 | Controller has just been formatted |
| 2 flashes per second | On | Two or more devices on this network have the same network address |

| If Run LED shows... | And Error LED shows... | Status Is.. |
|---|---|---|
| 2 flashes per second | On | Firmware halted after frequent system errors or control programs halted |
| 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 |
| On | On | Failure. Try the following solutions:<br>• Turn the RTU Open off, then on.<br>• Replace the RTU Open. |

# 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.

## 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.

## 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.

## Appendix A: Network Points List for RTU Open

## Third party access to BACnet points in a controller

BACnet system points in the i-Vu® Open controllers match physical I/O points to data, such as **Outside Air Temp**, to be written to the controller through the network, rather than by using a local hardwired sensor.

When a BACnet system point is written to, the controller uses the network value, even when there is a local sensor, as long as it is within the Min/Max refresh times noted below.

### BACnet writes to system points

The following table lists all of the writeable system points that could be present in an i-Vu® Open controller. The list of points is application-specific, therefore not all points are present in all i-Vu® Open controllers. This information applies whether the system point is being accessed by another i-Vu® Open controller or by a third party system.

| BACnet System Points Display Name | Valid Range | BACnet/ Modbus /N2 Default Value* | LonWorks Default Value* | Recommended Write Rrefresh Time (min/max) |
|---|---|---|---|---|
| System Space Temperature | -50 – 150°F | -999 | ~180°F | 1 min/5 min |
| System Space RH | 1 – 100% | -999 | -15.96 | 5 min / 10 min |
| System Space AQ | 200 – 9999 ppm | -999 | 64537 | 5 min / 10 min |
| System OA Temperature | -50 – 150°F | -999 | ~180°F | 5 min / 60 min |
| [OA] Enthalpy (BACnet) | High (0) / Low (1) | Low (1) | Low (1) | On change of state |
| System Outdoor AQ | 200 – 9999 ppm | -999 | -999 | 5 min / 60 min |
| System Water Temperature | -50 – 150°F | -999 | ~180°F | 5 min / 60 min |
| †System Fire/Smoke | Inactive (0) / Active (1) | Inactive (0) | N/A | On change of state |
| †System Pressurization | Inactive (0) / Active (1) | Inactive (0) | N/A | On change of state |
| Occupancy control configuration | 1 = Always Occupied<br>2 = BACnet Schedule (WebCTRL® only)<br>3 = BAS On/Off (third party control)*<br>4 = Remote Occ Input | 1 = Always Occupied<br><br>(Only available through BACnet) | N/A | N/A |
| BAS On/Off* (Occupancy)<br>Occupancy control configuration ust be set for 3 = BAS On/Off | 1=Inactive<br>2=Occupied<br>3=Unoccupied | Inactive (1) | Inactive (1) | On change of state |

In the i-Vu® interface, select the controller in the navigation tree and go to **Properties** > **BACnet Objects** tab. When an i-Vu® Open controller or a third party system writes to any of the system points, you must use **BACnet Priority Level 16** and the value **must** not be written to or refreshed more than once per minute (60 seconds).

⚠️ **CAUTION** If any other **Priority Level** is used, the value will not be recognized by the controller.

\* Modbus, N2, and LonWorks default values only apply to multi-protocol controllers.

† Points do not apply to multi-protocol controllers.

**Reading System Points**

To verify that the system point is being written to within the refresh time specified (value varies by point), the  i-Vu® Open controller clears any value that is written, once it has been processed by the controller and returned the system point to its default value. Therefore, a BAS should never read back the system point's value to confirm the commanded value was successfully received. To confirm a write, refer to the table below for the corresponding control point that should be read.

**NOTE**  A confirming "read" should take place at least 30 seconds following the "write" to verify that the write has been processed by the controller.

| Commanded Points | | | Control Points | | |
|---|---|---|---|---|---|
| **Display Name** | **Type / Instance** | **Object Name** | **Display Name** | **Type / Instance** | **Object Name** |
| **System Space Temperature** | av:1902 | system_spt | **Space Temperature - Prime Variable** | av:2007 | space_temp |
| **System Space RH** | av:1904 | system_rh | **Space Relative Humidity** | av:1011 | space_rh |
| **System Space AQ** | av:1903 | system_iaq | **Indoor Air Quality CO2 (ppm)** | av:1009 | iaq |
| **System OA Temperature** | av:1901 | system_oat | **Outdoor Air Temperature** | av:1003 | oa_temp |
| **[OA] Enthalpy (BACnet)** | bv:1901 | oae | **[OA] Enthalpy Status** | bv:1002 | enthalpy_status |
| **System Outdoor AQ** | av:1908 | system_oaq | **Outdoor Air Quality CO2 (ppm)** | av:1012 | oaq |
| **System Water Temperature** | av:1905 | system_water_temp | **Changeover Mode** | av:1014 | chgovr_mode |
| **†System Fire/Smoke** | bv:1907 | fire_shutdown | **Fire/Smoke Shutdown** | bv:7007 | fire_alarm |
| **†System Pressurization** | bv:1906 | press_override | **Pressurization** | bv:7038 | press_alarm |
| **BAS On/Off [Occupancy]** | msv:1001 | keypad_ovrde | **Occupancy Status** | bv:2008 | occ_status |

**†** Points do not apply to multi-protocol controllers.

# Network points list for BACnet and Modbus

| Point Name | Point Access | Units | Default Value | BACnet | | Modbus | |
|---|---|---|---|---|---|---|---|
| | | | | BACnet Point Name | BACnet Object ID | Modbus Register Type | Modbus Register # |
| SA Vent / Temper Setpoint | R/W | °F | 65 | tempering_stpt | AV:3032 | Holding Register (Float) | 174 |
| VFD Speed Config | R/W | %/V | % | vfd_spd_cfg | AV:1030 | | |
| Heating VFD Output | R/W | % | 100 | heat_vfd_spd | AV:3033 | | |
| Voltage Used to Set IDF VFD Heat Speed | R/W | V | 4.4 | ht_spd_volt | AV:83010 | | |
| Voltage Used to Set IDF VFD Maximum Speed | R/W | V | 10 | max_spd_volt | AV:83011 | | |
| Voltage Used to Set IDF VFD Minimum Speed | R/W | V | 5.2 | min_spd_volt | AV:83012 | | |
| Tempering Enable | R/W | | Disable | sa_tempering_en | AV:83016 | | |
| VFD Speed Test | R/W | V | 0 | vfd_spdv_test | AV:81003 | | |
| Supply Fan VFD Voltage | R | V | | vfd_volt_output | AV:2032 | | |
| VFD Analog Input Channel Type | R/W | Vdc | 2 to 10 | vfd_in_type | AV:91010 | | |
| Active Heat Stages | R | | | heat_run | AV:2003 | Input Register (Float) | 33 |
| Effective Cool Setpoint | R | °F | | eff_cl_stpt | AV:3005 | Input Register (Float) | 55 |
| High Space Temperature | R | 0=Normal 1=Alarm | | spt_hi_alarm | BV:7011 | Discrete Input | 35 |
| Low Space Temperature | R | 0=Normal 1=Alarm | | spt_lo_alarm | BV:7012 | Discrete Input | 39 |
| Input_6 | R | °F | | ai_6 | AI:1006 | | |
| Supply Fan Relay State | R | 0=Off 1=On | | sfan | BV:2001 | Discrete Input | 23 |
| Supply Fan Status | R | 0=Off 1=On | | sfan_status | BV:1003 | Discrete Input | 24 |
| Economizer Output | R | %Open | | econ_output | AV:2022 | Input Register (Float) | 51 |
| Outdoor Air Quality Sensor | R | 0=Normal 1=Alarm | | oaq_fail | BV:7006 | Discrete Input | 41 |
| DCV Max Vent Damper Pos | R/W | %Open | 50 | iaq_dpr_max | AV:9011 | Holding Register (Float) | 47 |
| Space Temperature - Prime Variable | R | °F | | space_temp | AV:2007 | Input Register (Float) | 107 |
| HP Rev Cycle Lockout Temp | R/W | °F | -3 | hp_rev_cycle_lockout | AV:9004 | Holding Register (Float) | 71 |
| System Outdoor Air Temperature | R/W | °F | -999 | system_oat | AV:1901 | Holding Register (Float) | 119 |
| Economizer Purge Min Pos | R/W | %Open | 40 | econ_purge_min | AV:9029 | Holding Register (Float) | 75 |
| Active Compressor Stages | R | | | comp_run | AV:2020 | Input Register (Float) | 31 |
| System Mode | R | 1=Off 2=Fan Only 3=Economizer Cooling 4=Cooling 5=Heating 6=Dehumidificati | | run_status | MSV:2002 | Input Register (Signed) | 1 |

| Point Name | Point Access | Units | Default Value | BACnet | | Modbus | |
|---|---|---|---|---|---|---|---|
| | | | | BACnet Point Name | BACnet Object ID | Modbus Register Type | Modbus Register # |
| | | on<br>7=Test<br>8=Shutdown<br>9=Unocc Free Cooling<br>10=Fire Shutdown<br>11=IAQ Override<br>12=Pre-occ Purge<br>13=IGC Override | | | | | |
| Supply Air Temperature | R | °F | | sa_temp | AV:1008 | Input Register (Float) | 109 |
| DCV Max Ctrl Setpoint | R/W | ppm | 650 | iaq_stpt_max | AV:3013 | Holding Register (Float) | 45 |
| Occ Relative Humidity Setpoint | R/W | %rh | 60 | occ_dehum_stpt | AV:3011 | Holding Register (Float) | 83 |
| Occupancy Status | R | 0=Unoccupied 1=Occupied | | occ_status | BV:2008 | Discrete Input | 18 |
| Optimal Start Type | R/W | 1=None 2=Temp Compensated 3=Learning Adaptive | 2 | start_type | MSV:2009 | Holding Register (Signed) | 154 |
| Setpoint | R/W | °F | | unocc_ht_stpt | AV:3004 | Holding Register (Float) | 17 |
| Economizer Test | R/W | %Open | 0 | econ_test | AV:81001 | | |
| Space Relative Humidity Sensor | R | 0=Normal 1=Alarm | | sprh_sensor_fail | BV:7022 | Discrete Input | 45 |
| Setpoint Adjustment | R | °F | | stpt_adj | AV:1006 | Input Register (Float) | 99 |
| Effective Heat Setpoint | R | °F | | eff_ht_stpt | AV:3006 | Input Register (Float) | 57 |
| Low Fan Econ Min Pos | R/W | %Open | 33 | econ_min_2 | AV:9030 | Holding Register (Float) | 89 |
| Fire / Smoke Shutdown | R | 0=Normal 1=Alarm | | fire_alarm | BV:7007 | Discrete Input | 32 |
| Reset Filter Alarm | R/W | 0=Off 1=On | Inactive (0) | filter_rntm_clr | BV:7517 | Coil | 22 |
| Setpoint | R/W | °F | | unocc_cl_stpt | AV:3003 | Holding Register (Float) | 15 |
| ZS Sensor Configuration | R | 0=Normal 1=Alarm | | zs_config_fail | BV:7055 | Discrete Input | 63 |
| Space Relative Humidity | R | %rh | | space_rh | AV:1011 | Input Register (Float) | 103 |
| Outdoor Air Temperature | R | °F | | oa_temp | AV:1003 | Input Register (Float) | 87 |
| Cooling Lockout Temperature | R/W | °F | 45 | oat_cl_lockout | AV:9002 | Holding Register (Float) | 43 |
| Power Exhaust Setpoint | R/W | %Open | 50 | pexh_stpt | AV:3010 | Holding Register (Float) | 97 |
| BAS On / Off | R/W | 1=Inactive 2=Occupied 3=Unoccupied | 1 | keypad_ovrde | MSV:1001 | Holding Register (Signed) | 133 |
| System Space AQ | R/W | ppm | -999 | system_iaq | AV:1903 | Holding Register (Float) | 149 |
| System Space RH | R/W | % | -999 | system_rh | AV:1904 | Holding Register (Float) | 151 |

| Point Name | Point Access | Units | Default Value | BACnet | | Modbus | |
|---|---|---|---|---|---|---|---|
| | | | | BACnet Point Name | BACnet Object ID | Modbus Register Type | Modbus Register # |
| Compressor Status | R | 0=Normal 1=Alarm | | comp_alarm | BV:7013 | Discrete Input | 30 |
| Filter Service Alarm Timer | R/W | hr | 600 | filter_service_hrs | AV:2019 | Holding Register (Float) | 67 |
| Indoor Air Quality Sensor | R | 0=Normal 1=Alarm | | iaq_sensor_fail | BV:7039 | Discrete Input | 37 |
| Heating Lockout Temperature | R/W | °F | 65 | oat_ht_lockout | AV:9003 | Holding Register (Float) | 69 |
| Dehumidification | R | 0=Inactive 1=Active | | dehum | BV:2006 | Discrete Input | 9 |
| Reversing Valve Relay State | R | 0=Off 1=On | | aux_1 | BV:2007 | Discrete Input | 20 |
| Password Protected Output Variable | R/W | | 0 | ppo | AV:90000 | | |
| Vent Dmpr Pos / DCV Min Pos | R/W | %Open | 20 | econ_min | AV:9005 | Holding Register (Float) | 131 |
| Filter | R | 0=Clean 1=Dirty | | filter_alarm | BV:7017 | Discrete Input | 31 |
| Safety Chain | R | 0=Normal 1=Alarm | | safety_alarm | BV:7024 | Discrete Input | 43 |
| Unocc Relative Humidity Setpoint | R/W | %rh | 95 | unocc_dehum_stpt | AV:3012 | Holding Register (Float) | 129 |
| Setpoint | R/W | °F | | occ_ht_stpt | AV:3002 | Holding Register (Float) | 19 |
| Supply Air Temp Sensor | R | 0=Normal 1=Alarm | | loc_sat_sensor_fail | BV:7020 | Discrete Input | 51 |
| Override Time Remaining | R | min | | ovrde_time | AV:2016 | Input Register (Float) | 93 |
| Setpoint Adjustment | R/W | 0=Disable 1=Enable | Active (1) | stpt_adj_enable | BV:1013 | Coil | 26 |
| System Space Temperature | R/W | °F | -999 | system_spt | AV:1902 | Holding Register (Float) | 123 |
| Space Temperature Offset Pot | R | °F | | stpt_adj_offset | AV:91006 | | |
| System Outdoor AQ | R/W | ppm | -999 | system_oaq | AV:1908 | Holding Register (Float) | 155 |
| Outdoor Air Temp Sensor | R | 0=Normal 1=Alarm | | oat_fail | BV:7029 | Discrete Input | 27 |
| SPT Sensor | R | 0=Normal 1=Alarm | | spt_sensor_fail | BV:7032 | Discrete Input | 38 |
| Fan / Speed | R | 1=Off 2=Low 3=Med 4=High 5=On | | fan_run | MSV:2004 | Input Register (Signed) | 175 |
| Setpoint Adjustment Range | R/W | °^F | 5 | stpt_adj_range | AV:9015 | Holding Register (Float) | 101 |
| Enthalpy (BACnet) | R/W | 0=High 1=Low | Active (1) | oae | BV:1901 | Coil | 6 |
| Optimal Start | R/W | hr | 1 | optm_start | AV:9026 | Holding Register (Float) | 147 |
| System Cooling Demand Level | R | | | cool_demand_level | AV:9006 | | |
| System Heating Demand Level | R | | | heat_demand_level | AV:9036 | | |
| System OAT Master | R | °F | | mstr_oa_temp | AV:80001 | | |

| | | | | BACnet | | Modbus | |
|---|---|---|---|---|---|---|---|
| Point Name | Point Access | Units | Default Value | BACnet Point Name | BACnet Object ID | Modbus Register Type | Modbus Register # |
| T5x Override Duration | R/W | hr | 1 | ovr_dur | AV:9023 | | |
| VFD Speed Test | R/W | % | 0 | vfd_spd_test | AV:81002 | | |
| input_3 | R | 0=Off 1=On | | di_3 | BI:1003 | | |
| input_4 | R | 0=Off 1=On | | di_4 | BI:1004 | | |
| input_5 | R | 0=Off 1=On | | di_5 | BI:1005 | | |
| input_8 | R | 0=Off 1=On | | di_8 | BI:1008 | | |
| input_9 | R | 0=Off 1=On | | di_9 | BI:1009 | | |
| Airside Linkage | R | 0=Normal 1=Alarm | | air_linkage_fail | BV:7030 | | |
| Analog Input Configuration | R | 0=Normal 1=Alarm | | ai_cfg_alarm | BV:7026 | | |
| Compressor 1 Runtime | R | 0=Normal 1=Alarm | | comp1_rntm_alarm | BV:7014 | | |
| Compressor 1 Relay State | R | 0=Off 1=On | | comp_1 | BV:2005 | | |
| Compressor 1 Test | R/W | 0=Disable 1=Enable | Inactive (0) | comp1_test | BV:81005 | | |
| Compressor 2 Relay State | R | 0=Off 1=On | | comp_2 | BV:2004 | | |
| Compressor 2 Runtime | R | 0=Normal 1=Alarm | | comp2_rntm_alarm | BV:7015 | | |
| Compressor 2 Test | R/W | 0=Disable 1=Enable | Inactive (0) | comp2_test | BV:81004 | | |
| Compressor Safety Status | R | 0=Normal 1=Trouble | | comp_status | BV:1008 | | |
| Continuous Occupied Exhaust | R/W | 0=No 1=Yes | Inactive (0) | occ_exh | BV:9002 | | |
| DCV Control | R/W | | Inactive (0) | dcv_enable | BV:1027 | | |
| Dehumidification Test | R/W | 0=Disable 1=Enable | Inactive (0) | dehum_test | BV:81006 | | |
| Door Contact Status | R | 0=Off 1=On | | door_contact_status | BV:1010 | | |
| Economizer Exists | R/W | 0=No 1=Yes | Inactive (0) | econ_exist | BV:99001 | | |
| Enthalpy Status | R | 0=High 1=Low | | enthalpy_status | BV:1002 | | |
| Factory Test | R/W | 0=Off 1=On | Inactive (0) | fac_test_enable | BV:91000 | | |
| Factory Test Relay 1 Control | R/W | 0=Off 1=On | Inactive (0) | relay1_fac_test | BV:91001 | | |
| Factory Test Relay 2 Control | R/W | 0=Off 1=On | Inactive (0) | relay2_fac_test | BV:91002 | | |
| Factory Test Relay 3 Control | R/W | 0=Off 1=On | Inactive (0) | relay3_fac_test | BV:91003 | | |
| Factory Test Relay 4 Control | R/W | 0=Off 1=On | Inactive (0) | relay4_fac_test | BV:91004 | | |
| Factory Test Relay 5 Control | R/W | 0=Off 1=On | Inactive (0) | relay5_fac_test | BV:91005 | | |
| Factory Test Relay 6 | R/W | 0=Off | Inactive | relay6_fac_test | BV:91006 | | |

| | | | | BACnet | | Modbus | |
|---|---|---|---|---|---|---|---|
| Point Name | Point Access | Units | Default Value | BACnet Point Name | BACnet Object ID | Modbus Register Type | Modbus Register # |
| Control | | 1=On | (0) | | | | |
| Factory Test Relay 7 Control | R/W | 0=Off 1=On | Inactive (0) | relay7_fac_test | BV:91007 | | |
| Factory Test Relay 8 Control | R/W | 0=Off 1=On | Inactive (0) | relay8_fac_test | BV:91008 | | |
| Filter Status | R | 0=Clean 1=Dirty | | filter_status | BV:1004 | | |
| Fire Shutdown Status | R | 0=Run Enabled 1=Shutdown | | firedown_status | BV:1005 | | |
| Heat 1Test | R/W | 0=Disable 1=Enable | Inactive (0) | heat1_test | BV:81003 | | |
| Heat 2Test | R/W | 0=Disable 1=Enable | Inactive (0) | heat2_test | BV:81002 | | |
| Heat Stage 1 Relay State | R | 0=Off 1=On | | heat_1 | BV:2003 | | |
| Heat Stage 2 Relay State | R | 0=Off 1=On | | heat_2 | BV:2002 | | |
| Heat Type | R/W | 0=Electric 1=Gas | Inactive (0) | heat_type | BV:99002 | | |
| High Speed Fan Test | R/W | 0=Disable 1=Enable | Inactive (0) | hi_spd_test | BV:81010 | | |
| Humidistat Input Status | R | 0=High 1=Low | | humstat_status | BV:1006 | | |
| IGC Override | R | 0=Off 1=Active | | igcovr_status | BV:1022 | | |
| Local OAT Sensor | R | 0=Normal 1=Alarm | | loc_oat_sensor_fail | BV:7003 | | |
| Occupancy Contact | R | 0=Off 1=On | | occ_contact_status | BV:1007 | | |
| Power Exhaust Relay State | R | 0=Off 1=On | | pexh | BV:2010 | | |
| Power Exhaust Test | R/W | 0=Disable 1=Enable | Inactive (0) | pexh_test | BV:81008 | | |
| Reset Comp 1 Runtime Alarm | R/W | 0=Run 1=Clear | Inactive (0) | comp1_rntm_clr | BV:7514 | | |
| Reset Comp 2 Runtime Alarm | R/W | 0=Run 1=Clear | Inactive (0) | comp2_rntm_clr | BV:7515 | | |
| Reset Supply Fan Runtime Alarm | R/W | 0=Run 1=Clear | Inactive (0) | sfan_rntm_clr | BV:7510 | | |
| Reversing Valve Output | R/W | | Inactive (0) | rev_vlv_type | BV:1026 | | |
| RH Control | R/W | | Inactive (0) | rh_enable | BV:1025 | | |
| Safety Chain Feedback | R | 0=Off 1=On | | safety_status | BV:1009 | | |
| Schedule | R/W | 0=Unoccupied 1=Occupied | 0 | schedule | BV:8000 | | |
| Service Test | R/W | 0=Disable 1=Enable | Inactive (0) | test_enable | BV:81000 | | |
| Setpoint Slider | R | 0=Normal 1=Alarm | | slidepot_alarm | BV:7002 | | |
| Shutdown | R/W | 0=Inactive 1=Active | Inactive (0) | shutdown | BV:9001 | | |
| Supply Fan Failure | R | 0=Normal 1=Alarm | | sfan_fail_alarm | BV:7008 | | |
| Supply Fan in Hand | R | 0=Normal | | sfan_hand_alarm | BV:7009 | | |

| Point Name | Point Access | Units | Default Value | BACnet | | Modbus | |
|---|---|---|---|---|---|---|---|
| | | | | BACnet Point Name | BACnet Object ID | Modbus Register Type | Modbus Register # |
| | | 1=Alarm | | | | | |
| Supply Fan Runtime | R | 0=Normal 1=Alarm | | sfan_rntm_alarm | BV:7010 | | |
| Switch Configuration | R | 0=Normal 1=Alarm | | di_cfg_alarm | BV:7025 | | |
| System is shut down | R | 0=No 1=Yes | | shutdown_status | BV:2011 | | |
| Unocc Free Cool | R/W | 0=Disable 1=Enable | Inactive (0) | ntfc_ena | BV:80001 | | |
| Air Source Mode | R | 1=Off 2=Warmup 3=Heating 4=Cooling 5=Freecool 6=Pressure 7=Evac 8=Vent | | link_ahu_mode | MSV:2005 | | |
| Compressor Stages | R/W | 1=One Stage 2=Two Stages | 2 | comp_stages | MSV:91003 | | |
| Equipment Status | R | 1=Disabled 2=Test 3=Run | | mode_status | MSV:2001 | | |
| Fan Control | R/W | 1=Single Speed 2=Two Speed 3=Variable Speed | 3 | fan_type | MSV:9031 | | |
| Fan Mode | R/W | 1=Auto 2=Continuous 3=Always On | 2 | fan_mode | MSV:9032 | | |
| Input 1 Function | R/W | 1=No Sensor 2=IAQ Sensor 3=OAQ Sensor 4=Space RH Sensor | 1 | ai1_function | MSV:81001 | | |
| Input 2 Function | R/W | 1=No Sensor 2=IAQ Sensor 3=OAQ Sensor 4=Space RH Sensor | 1 | ai2_function | MSV:81002 | | |
| Input 3 Function | R/W | 1=No Function 2=Compressory Safety 3=Fan Status 4=Filter Status 5=Remote Occupancy 6=Door Contact | 2 | di3_function | MSV:81003 | | |
| Input 3 Switch Configuration | R/W | 1=NO 2=NC | 1 | di3_type | MSV:81013 | | |
| Input 5 Function | R/W | 1=No Function 2=Fire Shutdown 3=Fan Status 4=Filter Status 5=Remote Occupancy 6=Door Contact | 2 | di5_function | MSV:81005 | | |
| Input 5 Switch Configuration | R/W | 1=NO 2=NC | 1 | di5_type | MSV:81015 | | |
| Input 8 Function | R/W | 1=No Function | 2 | di8_function | MSV:81008 | | |

| Point Name | Point Access | Units | Default Value | BACnet | | Modbus | |
|---|---|---|---|---|---|---|---|
| | | | | BACnet Point Name | BACnet Object ID | Modbus Register Type | Modbus Register # |
| | | 2=Enthalpy Switch 3=Fan Status 4=Filter Status 5=Remote Occupancy 6=Door Contact | | | | | |
| Input 8 Switch Configuration | R/W | 1=NO 2=NC | 1 | di8_type | MSV:81018 | | |
| Input 9 Function | R/W | 1=No Function 2=HumidiStat 3=Fan Status 4=Filter Status 5=Remote Occupancy 6=Door Contact | 2 | di9_function | MSV:81009 | | |
| Input 9 Switch Configuration | R/W | 1=NO 2=NC | 1 | di9_type | MSV:81019 | | |
| Number Of Heat Stages | R/W | 1=1 2=2 3=0 | 2 | heat_stages | MSV:91004 | | |
| Occupancy Source | R/W | 1=Always Occupied 2=BACnet Schedule 3=BAS On/Off 4=Remote Occ Input | 1 | occ_source | MSV:1002 | | |
| Space sensor type | R/W | 1=T55 2=T56 3=SPT Sensor 4=None | 1 | spt_type | MSV:9001 | | |
| Space Temp Source | R | 1=Sensor Failure 2=SPT Sensor 3=T55 / T56 4=Network 5=Airside Linkage 6=Locked Value | | spt_status | MSV:2003 | | |
| Unit Type | R/W | 1=Heat / Cool 2=LC WeatherExpert 3=HP O/B Ctrl 4=HP Y1/W1 Ctrl | 2 | unit_type | MSV:9018 | | |
| ZS Temp Sensor | R | 0=Normal 1=Alarm | | zst_sensor_fail | BV:7051 | | |
| Economizer Operation | R | 0=Normal 1=Fault Detected | | econ_opr | BV:7054 | | |
| Space Temperature Alarm Status | R | 0=Normal 1=Alarm | | spt_alrm_status | BV:7056 | | |
| SPT Sensor | R | °F | | zone_temp_zone_temp | AI:1 | | |
| SPT Sensor | R | min | | zone_temp_override_time_remaining | AV:1 | | |
| input_10 | R | °F | | ai_10 | AI:1010 | | |
| Factory Test Analog 1 Control | R/W | % | 0 | ao1_fac_test | AV:91001 | | |
| Economizer High OAT Lockout Temp | R/W | °F | 75 | oat_ec_lockout | AV:9008 | | |
| Maximum Heating SAT | R/W | °F | 120 | sat_ht_max | AV:83004 | | |

| Point Name | Point Access | Units | Default Value | BACnet | | Modbus | |
|---|---|---|---|---|---|---|---|
| | | | | BACnet Point Name | BACnet Object ID | Modbus Register Type | Modbus Register # |
| Compressor 2 Runtime | R | hr | | comp2_rntm | AV:2018 | | |
| Linkage Max Damper Position | R | % | | link_max_dmpr | AV:2611 | | |
| Air Source Supply Air Temp | R | °F | | link_sat | AV:2608 | | |
| Max VFD Output | R/W | % | 100 | max_vfd_spd | AV:3026 | | |
| Dehum Min VFD Output | R/W | % | 100 | dehum_min_vfd | AV:3028 | | |
| Air Source Outdoor Air Temp | R | °F | | link_ahu_oat | AV:2609 | | |
| Stage 3 SAT Stpt | R/W | °F | 56 | stg_3_sat | AV:83010 | | |
| Stage 1 SAT Stpt | R/W | °F | 57 | stg_1_sat | AV:83008 | | |
| HP Aux Heat Lockout Temp | R/W | °F | 40 | oat_auxht_lockout | AV:3025 | | |
| input_1 | R | | | ai_1 | AI:1001 | | |
| Factory Test Analog 2 Control | R/W | V | 0 | ao2_fac_test | AV:91002 | | |
| Compressor 2 Service Alarm Timer | R/W | hr | 0 | comp2_service_hrs | AV:83007 | | |
| Compressor 1 Service Alarm Timer | R/W | hr | 0 | comp1_service_hrs | AV:83006 | | |
| Compressor 1 Runtime | R | hr | | comp1_rntm | AV:2017 | | |
| Min VFD Output | R/W | % | 40 | min_vfd_spd | AV:3027 | | |
| Stage 2 SAT Stpt | R/W | °F | 57 | stg_2_sat | AV:83009 | | |
| slidepot voltage reading | R | | | slidepot_volts | AI:1012 | | |
| Filter Runtime | R | hr | | filter_rntm | AV:2015 | | |
| Fan Off Delay | R/W | seconds | 90 | fan_delay_off | AV:9024 | | |
| input_7 | R | °F | | ai_7 | AI:1007 | | |
| input_11 | R | | | ai_11 | AI:1011 | | |
| input_2 | R | | | ai_2 | AI:1002 | | |
| Minimum Cooling SAT | R/W | °F | 50 | sat_cl_min | AV:83003 | | |
| Power Fail Restart Delay | R/W | seconds | 5 | start_delay | AV:9007 | Holding Register (Float) | 127 |
| Supply Fan Service Alarm Timer | R/W | hr | 0 | sfan_service_hrs | AV:83005 | | |
| Supply Fan Runtime | R | hr | | sfan_rntm | AV:2014 | | |
| Indoor Air Quality CO2 (ppm) | R | ppm | | iaq | AV:1009 | Input Register (Float) | 73 |
| Supply Fan VFD | R | % | | vfd_output | AV:2027 | | |
| Indoor Air Quality | R | 0=Normal 1=Alarm | | iaq_alarm | BV:7005 | Discrete Input | 33 |
| Supply Air Temperature | R | 0=Normal 1=Alarm | | sat_alarm | BV:7004 | Discrete Input | 47 |
| Space Relative Humidity | R | 0=Normal 1=Alarm | | sprh_hi_alarm | BV:7018 | Discrete Input | 34 |
| Space Temp Sensor | R | 0=Normal 1=Alarm | | spt_fail | BV:7001 | Discrete Input | 46 |
| Outdoor Air Quality CO2 (ppm) | R | ppm | | oaq | AV:1012 | Input Register (Float) | 85 |
| Gas Valve | R | 0=Normal 1=Alarm | | igc_alarm | BV:7050 | Discrete Input | 40 |
| Setpoint | R/W | °F | | occ_cl_stpt | AV:3001 | Holding Register (Float) | 9 |

# Network points list for N2 and LonWorks

| Point Name | Point Access | Units | Default Value | N2 N2 Network Point Type | N2 Network Point Address | Lonworks SNVT Type | SNVT Name |
|---|---|---|---|---|---|---|---|
| SA Vent / Temper Setpoint | R/W | °F | 65 | ADF | 77 | | |
| Active Heat Stages | R | | | ADF | 11 | SNVT_count_inc(9) | nvoHtStgs |
| Effective Cool Setpoint | R | °F | | ADF | 22 | SNVT_temp_p(105) | nvoEffCoolSP |
| High Space Temperature | R | 0=Normal 1=Alarm | | BI | 35 | SNVT_switch(95) | nvoHiSpTemp |
| Low Space Temperature | R | 0=Normal 1=Alarm | | BI | 39 | SNVT_switch(95) | nvoLoSpTmp |
| Supply Fan Relay State | R | 0=Off 1=On | | BI | 23 | | |
| Supply Fan Status | R | 0=Off 1=On | | BI | 24 | SNVT_switch(95) | nvoFanStatus |
| Economizer Output | R | %Open | | ADF | 20 | SNVT_lev_percent(81) | nvoEconOut |
| Outdoor Air Quality Sensor | R | 0=Normal 1=Alarm | | BI | 41 | SNVT_switch(95) | nvoOAQSensor |
| DCV Max Vent Damper Pos | R/W | %Open | 50 | ADF | 18 | SNVT_lev_percent(81) | nviDCVMaxPos |
| Space Temperature - Prime Variable | R | °F | | ADF | 48 | SNVT_temp_p(105) | nvoSpaceTemp |
| HP Rev Cycle Lockout Temp | R/W | °F | -3 | ADF | 30 | SNVT_temp_p(105) | nviHPRvClLk |
| System Outdoor Air Temperature | R/W | °F | -999 | ADF | 54 | SNVT_temp_p(105) | nviSysOAT |
| Economizer Purge Min Pos | R/W | %Open | 40 | ADF | 5 | SNVT_lev_percent(81) | nvoEcnPrgMin |
| Active Compressor Stages | R | | | ADF | 10 | SNVT_count_inc(9) | nvoCmpStages |
| System Mode | R | 1=Off 2=Fan Only 3=Economizer Cooling 4=Cooling 5=Heating 6=Dehumidification 7=Test 8=Shutdown 9=Unocc Free Cooling 10=Fire Shutdown 11=IAQ Override 12=Pre-occ Purge 13=IGC Override | | ADI | 13 | SNVT_count_inc(9) | nvoOpMode |
| Supply Air Temperature | R | °F | | ADF | 49 | SNVT_temp_p(105) | nvoSAT |
| DCV Max Ctrl Setpoint | R/W | ppm | 650 | ADF | 17 | SNVT_ppm(29) | nviDCVMaxPPM |
| Occ Relative Humidity Setpoint | R/W | %rh | 60 | ADF | 36 | SNVT_lev_percent(81) | nviOcRHSP |
| Occupancy Status | R | 0=Unoccupied 1=Occupied | | BI | 18 | SNVT_switch(95) | nvoOccStatus |
| Optimal Start Type | R/W | 1=None 2=Temp Compensated 3=Learning Adaptive | 2 | ADI | 20 | SNVT_count_inc(9) | nviOptStType |
| Setpoint | R/W | °F | | ADF | 8 | SNVT_temp_p(105) | nviUnoccHtSP |
| Space Relative Humidity | R | 0=Normal | | BI | 45 | SNVT_switch(95) | nvoSpRHSenr |

| Point Name | Point Access | Units | Default Value | N2 | | Lonworks | |
|---|---|---|---|---|---|---|---|
| | | | | N2 Network Point Type | N2 Network Point Address | SNVT Type | SNVT Name |
| Sensor | | 1=Alarm | | | | | |
| Setpoint Adjustment | R | °F | | ADF | 44 | SNVT_temp_p(105) | nvoSPAdjust |
| Effective Heat Setpoint | R | °F | | ADF | 23 | SNVT_temp_p(105) | nvoEffHeatSP |
| Low Fan Econ Min Pos | R/W | %Open | 33 | ADF | 32 | SNVT_lev_percent(81) | nviLwFnEcnMn |
| Fire / Smoke Shutdown | R | 0=Normal 1=Alarm | | BI | 32 | SNVT_switch(95) | nvoFrShtdwn |
| Reset Filter Alarm | R/W | 0=Off 1=On | Inactive (0) | BO | 22 | SNVT_switch(95) | nviRstFilAlm |
| Setpoint | R/W | °F | | ADF | 7 | SNVT_temp_p(105) | nviUnoccClSP |
| ZS Sensor Configuration | R | 0=Normal 1=Alarm | | BI | 63 | SNVT_switch(95) | nvoZsCfgFail |
| Space Relative Humidity | R | %rh | | ADF | 46 | SNVT_lev_percent(81) | nvoSpaceRH |
| Outdoor Air Temperature | R | °F | | ADF | 38 | SNVT_temp_p(105) | nvoOAT |
| Cooling Lockout Temperature | R/W | °F | 45 | ADF | 16 | SNVT_temp_p(105) | nviClLckTemp |
| Power Exhaust Setpoint | R/W | %Open | 50 | ADF | 43 | SNVT_lev_percent(81) | nviPwrExhSP |
| BAS On / Off | R/W | 1=Inactive 2=Occupied 3=Unoccupied | 1 | ADI | 1 | SNVT_count_inc(9) | nviBASOnOff |
| System Space AQ | R/W | ppm | -999 | ADF | 39 | SNVT_count_inc(9) | nviSysSpAQ |
| System Space RH | R/W | % | -999 | ADF | 40 | SNVT_lev_percent(81) | nviSysSpRH |
| Compressor Status | R | 0=Normal 1=Alarm | | BI | 30 | SNVT_switch(95) | nvoCmpSafety |
| Filter Service Alarm Timer | R/W | hr | 600 | ADF | 28 | SNVT_count_inc(9) | nviFltAlmTm |
| Indoor Air Quality Sensor | R | 0=Normal 1=Alarm | | BI | 37 | SNVT_switch(95) | nvoIAQSensor |
| Heating Lockout Temperature | R/W | °F | 65 | ADF | 29 | SNVT_temp_p(105) | nviHtLckTmp |
| Dehumidification | R | 0=Inactive 1=Active | | BI | 9 | | |
| Reversing Valve Relay State | R | 0=Off 1=On | | BI | 20 | | |
| Vent Dmpr Pos / DCV Min Pos | R/W | %Open | 20 | ADF | 60 | SNVT_lev_percent(81) | nviDCVMinPos |
| Filter | R | 0=Clean 1=Dirty | | BI | 31 | SNVT_switch(95) | nvoFilter |
| Safety Chain | R | 0=Normal 1=Alarm | | BI | 43 | SNVT_switch(95) | nvoSftyChain |
| Unocc Relative Humidity Setpoint | R/W | %rh | 95 | ADF | 59 | SNVT_lev_percent(81) | nviUnoccRHSP |
| Setpoint | R/W | °F | | ADF | 9 | SNVT_temp_p(105) | nviOccHeatSP |
| Supply Air Temp Sensor | R | 0=Normal 1=Alarm | | BI | 51 | SNVT_switch(95) | nvoSATSensor |
| Override Time Remaining | R | min | | ADF | 41 | SNVT_count_inc(9) | nvoOvrTmRem |
| Setpoint Adjustment | R/W | 0=Disable 1=Enable | Active (1) | BO | 26 | SNVT_switch(95) | nviSPAdjEnbl |
| System Space Temperature | R/W | °F | -999 | ADF | 56 | SNVT_temp_p(105) | nviSysSpTmp |
| System Outdoor AQ | R/W | ppm | -999 | ADF | 63 | | |
| Outdoor Air Temp Sensor | R | 0=Normal 1=Alarm | | BI | 27 | | |

| Point Name | Point Access | Units | Default Value | N2 | | Lonworks | |
| | | | | N2 Network Point Type | N2 Network Point Address | SNVT Type | SNVT Name |
|---|---|---|---|---|---|---|---|
| SPT Sensor | R | 0=Normal 1=Alarm | | BI | 38 | | |
| Fan / Speed | R | 1=Off 2=Low 3=Med 4=High 5=On | | ADI | 4 | | |
| Setpoint Adjustment Range | R/W | °^F | 5 | ADF | 45 | SNVT_count_inc(9) | nviSPAdjRng |
| Enthalpy (BACnet) | R/W | 0=High 1=Low | Active (1) | BO | 6 | SNVT_switch(95) | nviSysEnth |
| Optimal Start | R/W | hr | 1 | ADF | 61 | SNVT_count_inc(9) | nviOptmStart |
| Power Fail Restart Delay | R/W | seconds | 5 | ADF | 58 | SNVT_count_inc(9) | nviUntStrDly |
| Indoor Air Quality CO2 (ppm) | R | ppm | | ADF | 31 | SNVT_ppm(29) | nvoIAQ |
| Indoor Air Quality | R | 0=Normal 1=Alarm | | BI | 33 | SNVT_switch(95) | nvoIAQAlm |
| Supply Air Temperature | R | 0=Normal 1=Alarm | | BI | 47 | SNVT_switch(95) | nvoSATAlm |
| Space Relative Humidity | R | 0=Normal 1=Alarm | | BI | 34 | SNVT_switch(95) | nvoHiSPRHAlm |
| Space Temp Sensor | R | 0=Normal 1=Alarm | | BI | 46 | SNVT_switch(95) | nvoSPTmpSen |
| Outdoor Air Quality CO2 (ppm) | R | ppm | | ADF | 37 | SNVT_ppm(29) | nvoOAQ |
| Gas Valve | R | 0=Normal 1=Alarm | | BI | 40 | SNVT_switch(95) | nvoGasVlvAlm |
| Setpoint | R/W | °F | | ADF | 4 | SNVT_temp_p(105) | nviOccCoolSP |

# Appendix B:  BACnet Protocol Implementation Conformance Statement

The PIC statements are updated regularly. Please refer to the *BACnet website http://www.bacnetinternational.net/catalog/index.php?m=28* for the latest information.

## Appendix C: Modbus Protocol Implementation Conformance Statement

Date: 11/12/2013

Vendor Name: **Carrier**

Product Names: **RTU Open**

Product Model Number: **RTU Open**

### Protocol Description:

The RTU Open controller speaks the Modicon Modbus RTU/ASCII Protocol as described in the *Modicon Modbus Protocol Reference Guide, PI-MBUS-300 Rev.J*. Further details on the Modbus implementation are described below.

### Product Description:

The RTU Open is a factory-installed rooftop controller that is capable of speaking multiple protocols.

| Serial Transmission Mode: | Supported? |
|---|---|
| RTU | Slave only |
| ASCII | Not supported |

| Communication Types: | Baud rates: | Data Bits: | Parity: | Stop Bits: |
|---|---|---|---|---|
| 2-wire EIA-485, | 9600, 19200, 38400, 76800 | 8 | None | 1 |

| Function Codes: | Purpose: | Used with Register Numbers: |
|---|---|---|
| 01 – Read Coil Status | Read Discrete Outputs | 00001 - 65535 |
| 02 – Read Input Status | Read Discrete Inputs | 00001 - 65535 |
| 03 – Read Holding Registers | Read Holding Registers | 00001 - 65535 |
| 04 – Read Input Registers | Read Input Registers | 00001 - 65535 |
| 05 – Force Single Coil | Write Discrete Outputs (single) | 00001 - 65535 |
| 06 – Preset Single Register | Write Holding Registers (single) | 00001 - 65535 |
| 15 – Force Multiple Coils | Write Discrete Outputs | 00001 - 65535 |
| 16 – Preset Multiple Coils | Write Holding Registers | 00001 - 65535 |

| Register Type: | Range: | Function Codes Used with this Register Type: |
|---|---|---|
| Float Value (FLOAT) | Single-Precision IEEE floating point value | 3 – Read Holding Register<br>6 – Preset Single Register<br>16 – Preset Multiple Register |

| Unsigned Integer (UINT) | 0 - 65535 | 3 – Read Holding Register<br>6 – Preset Single Register<br>16 – Preset Multiple Register |
|---|---|---|
| Signed Integer (SINT) | -32768 - 32767 | 3 – Read Holding Register<br>6 – Preset Single Register<br>16 – Preset Multiple Register |
| Discrete Input (DI) | 0 = Off, 1 = On | 2 – Read Input Status |
| Discrete Output (DO) | 0 = Off, 1 = On | 1 – Read Coil Status<br>5 – Force Single Coil<br>15 – Force Multiple Coils |

## Appendix D:  Johnson N2 Protocol Implementation Conformance Statement

Vendor Name: **Carrier**

Product Names: **RTU Open**

Product Model Number: **RTU Open**

### Protocol Description:

N2 is not a standard protocol, but one that was created by Johnson Controls, Inc. that has been made open and available to the public. The speed of N2 network is limited to only 9600 baud. The N2 slave address can be set from 01 to 99.

### Product Description:

The RTU Open is a factory-installed rooftop controller that is capable of speaking multiple protocols. The RTU Open controller speaks the Johnson N2 Open Protocol as described in the *Metasys N2 System Protocol Specification (for Vendors) document*, revision 6/13/96.  Further details on the N2 supported implementation are described below.

| Communication Types: | Baud rates: | Data Bits: | Parity: | Stop Bits: |
|---|---|---|---|---|
| 2-wire EIA-485 | 9600 | 8 | None | 1 |

| Network Point Types: |
|---|
| Analog Inputs (AI) |
| Binary Inputs (BI) |
| Analog Outputs (AO) |
| Binary Outputs (BO) |
| Internal Floats (ADF) |
| Internal Integers (ADI) |
| Internal Bytes (BD) |

| Protocol Commands: |
|---|
| Identify Device Type |
| Sync Time |
| Poll Without Acknowledge |
| Poll With Acknowledge |
| Read Analog Input |
| Read Binary Input |
| Read Analog Output |
| Read Binary Output |
| Read Internal Parameter |
| Write Analog Input |
| Write Binary Input |
| Write Analog Output |

| |
|---|
| Write Binary Output |
| Write Internal Parameter |
| Override Analog Input |
| Override Binary Input |
| Override  Internal Parameter |
| Override Release Request |

## Appendix E:  LonWorks Protocol Implementation Conformance Statement

Date: 11/12/2013

Vendor Name: **Carrier**

Product Names: **RTU Open**

Product Model Number: **RTU Open**

### Product Description:

The RTU Open is a factory-installed rooftop controller that is capable of speaking multiple protocols. When the LonWorks Option Card (LON-OC), is installed in the field, it enables the RTU Open to communicate over a LonTalk network. The RTU Open does not conform to a standard LonWorks profile, but is self-documenting and any network management tool can manage and configure it over the network. An external interface file (.XIF), is also available so that any network management tool can design and configure the RTU Open prior to installation. Contact your Carrier representative for this .XIF file.

LonWorks is an open protocol that requires the use Echelon's Neuron microprocessor to encode and decode the LonWorks packets. In order to reduce the cost of adding the Echelon chip to every module, a separate LonWorks Option Card (LON-OC) was designed to connect to the RTU Open.

This accessory card must be ordered separately and is connected by attaching its ribbon cable into the **J15** connector on the RTU Open. The RTU Open's baud rate (**DS1** and **DS2** on **SW3**) must be set to 38.4k to communicate with the LON-OC. The address switches (**SW1** and **SW2**) are not used with LonWorks.

**Transceiver Type**: TP/FT 10

# 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* |
|------|-------|--------------------|-------|
| 11/19/19 | Appendix A: Network Points List > Third party access to BACnet points in a controller | New topic | C-TS-JN-E-RD |
| 8/29/19 | Indoor Air CO2 | Corrected DCV Max Vent Damper Pos percent | C-TS-RC-O |
| 2/5/19 | What is the RTU Open controller? | J1 Input 5 (SMK) wire color corrected from gray to blue | C-TS-RD-E-JA |

* For internal use only