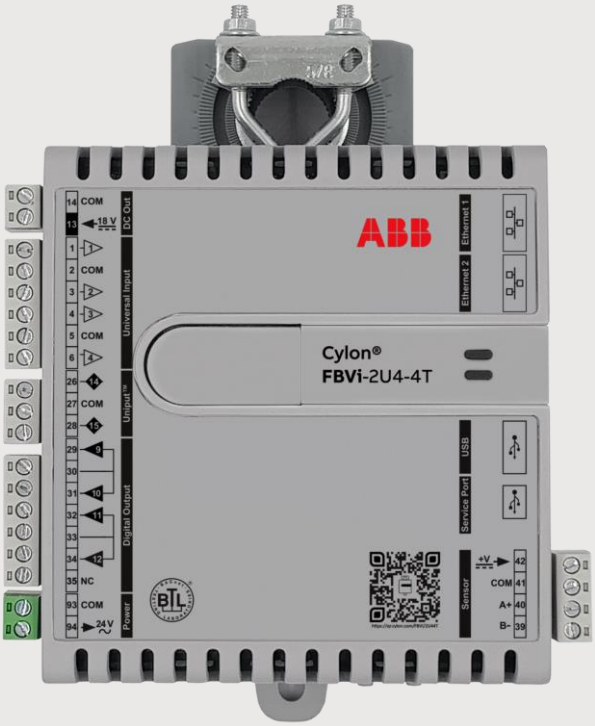
USER GUIDE

MAN0148 rev 11

FBVi-2U4-4T



Style conventions used in this document:

UI Text: Text that represents elements of the UI such as button names, menu options etc. is presented with a grey background and border, in Tahoma font which is traditionally used in Windows UIs. For example:

`Ok`

Standard Terms (Jargon): Text that is not English Language but instead refers to industry standard concepts such as Strategy, BACnet, or Analog Input is represents in slightly condensed font. For example:

BACnet

Code: Text that represents File paths, Code snippets or text file configuration settings is presented in fixed-width font, with a grey background and border. For example:

```
$config_file = c:\CYLON\settings\config.txt
```

Parameter values: Text that represents values to be entered into UI fields or displayed in dialogs is represented in fixed-width font with a shaded background. For example

`10°C`

Product Names: Text that represents a product name is represented in bold colored text. For example

INTEGRA™

Company Brand names: Brands that are not product names are represented by bold slightly compressed text:

ABB Active Energy

PC Keyboard keys: Text representing an instruction to press a particular key on the keyboard is enclosed in square brackets and in bold font. For example:

[Ctrl]+[1]

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1 The FBVi-2U4-4T

INTRODUCTION

The **FBVi-2U4-4T** is a freely programmable BACnet® Unitary Controller with native BACnet/IP communications support. The controller is BTL listed as BACnet Building Controller (B-BC) and is ideally suited for the control of Variable Air Volume zoning applications.

Part of Cylon's FLXeon Series of BACnet/IP field controllers, the FBVi-2U4-4T features 2 UniPuts™, 4 Universal Inputs and 3 Digital (Triac) Outputs, along with an integrated airflow sensor and a dedicated input for Cylon's CBT-STAT, FusionAir Smart Sensor, or other intelligent room sensors. The FBVi-2U4-4T model includes an integrated Belimo actuator.

FLXeon's scalable and modular architecture utilizes its embedded graphics and visualization engine FLXvue to get data from the #edge2cloud.

APPLICATION

The FBVi-2U4-4T is suitable for controlling single duct or fan assisted Variable Air Volume (VAV) applications. This controller also supports demand ventilation application, occupancy sensing or lighting control to further enhance energy savings.

Examples of typical VAV zoning applications include;

- Cooling only
- Cooling with Reheat
- Cooling with Reheat and Perimeter Radiation
- Series fan VAV
- Parallel fan VAV

The controller accommodates available pre-engineered strategies or can be tailored to custom applications using CXpro^{HD} programming software.

2 IP Networking

WHAT IS IP?

IP (Internet Protocol) is an agreed standard that defines how devices communicate over the Internet or other Internet-like Ethernet network.

IP is part of a 7-layer architecture consisting of

- Physical Layer (Layer 1)
- DataLink Layer (Layer 2)
- Network Layer (Layer 3)
- Transport Layer (Layer 4)
- Session Layer (Layer 5)
- Presentation Layer (Layer 6)
- Applications Layer (Layer 7)

PHYSICAL LAYER (LAYER 1)

This refers to the electrical impulses (or light signal or radio signals) carried on the cable (or fiber, air or other physical medium). For IP, the physical layer is usually Ethernet.

DATALINK LAYER (LAYER 2)

This is where data packets are translated to and from bits, which can be transferred on the Physical Layer

NETWORK LAYER (LAYER 3)

Layer 3 provides switching and routing to create paths for data to be transmitted from node to node within the network. This is the layer that gives IP its name.

TRANSPORT LAYER (LAYER 4)

This layer is responsible for end-to-end error recovery and flow control, enabling transparent transfer of data between hosts.

SESSION LAYER (LAYER 5)

The Session layer manages exchanges (conversations) between the “applications” on each host.

PRESENTATION LAYER (LAYER 6)

This layer translates between application and network formats, so that communication independent of data representation such as ASCII, GIF, JPEG etc.

APPLICATIONS LAYER (LAYER 7)

Everything at layer 7 is application-specific, such as Telnet, FTP, WWW browsers, HTTP etc.

IP ADDRESSING

Each device has at least one IP address, which uniquely identifies it from all other devices on the network.

There are several forms of IP addresses, but the most commonly used is IPv4, which consists of 4 numbers (between `0` and `255`) separated by dots e.g. `192.168.222.51`

DHCP (DYNAMIC HOST CONFIGURATION PROTOCOL)

The address can be set manually on the device itself, or else the device can be assigned one by a master controller on the network. This master controller is known as the Dynamic Host Configuration Protocol (DHCP) server.

To use an IP address, a device must know several pieces of data, including the IPv4 address that the device will use, the IP address of the Domain Name Server (DNS) where the device can find IP addresses of other devices, and the IP address of the Default Gateway device through which communications are routed.

Using DHCP means that all these pieces of information are set automatically avoiding the need for specialist knowledge of IP networking. If DHCP is available on your network is the most convenient way to configure your devices.

DHCP reservation

A DHCP server can be configured to always assign a particular IP address to a specific device. This is called a DHCP reservation and enables a user to access a device by IP address even if the device power-cycles and makes a new DHCP request.

SUBNETWORK (SUBNET)

A subnet is a logical division of a network – that is while it might be physically connected to other subnets, communications traffic from one subnet can be kept separate from comms origination on other subnets.

A group of the most significant bits of the IPv4 address (the numbers at the start of the address) specifies the address of a network or subnetwork. This is called the Network Prefix. The remainder specifies the host – the address unique to the specific device.

For example:

- on the `192.168` subnet, an IP address of `192.168.2.54` refers to device `2.54`.
- On the `55.231.77` subnet, IP address `55.231.77.3` refers to device `3`

The specific parts of the address that are in each portion is defined by the device's 'Subnet Mask'. This can be expressed as a "bitmask" that is applied by a bitwise AND operation – e.g. `255.255.0.0` means that only the last 2 segments of the address apply to the local subnet.

For example,

- if the address `192.168.2.54` has a subnet mask "`255.255.0.0`", that means that `192.168` is the subnet address, and `2.54` is the device address.
- if the address `55.231.77.3` has a subnet mask "`255.255.255.0`", that means that `55.231.77` is the subnet address, and `3` is the device address.

The network can also be identified by a decimal number following the first IP address on the network – e.g. `55.231.77.0/24`. This is called Classless Inter-Domain Routing (CIDR) notation. The decimal number represents the number of bits allocated for the Network Prefix.

Each segment of an IP address represents 8 bits,

i.e. `192.168.2.54` could also be written `11000000` . `10101000` . `00000010` . `00110110`

In CIDR notation, `/16` means that 16 of these bits represents the subnet, and the remainder specifies the host:

CIDR	192.168.2.54/16																														
IP Address decimal	192							.	168							.	2							.	54						
IP Address Binary	1	1	0	0	0	0	0	0	.	1	0	1	0	1	0	0	0	.	0	0	0	0	0	0	1	0	.	0	0	1	1	0	1	1	0
	16 bits representing the subnet																host														
Equivalent subnet mask	255							.	255							.	0							.	0						

CIDR	55.231.77.3/24																														
IP Address decimal	55							.	231							.	77							.	3						
IP Address Binary	0	0	1	1	0	1	1	1	.	1	1	1	0	0	1	1	1	.	0	1	0	0	1	1	0	1	.	0	0	0	0	0	0	1	1
	24 bits representing the subnet																								host						
Equivalent subnet mask	255							.	255							.	255							.	0						

DEFAULT GATEWAY

Devices on the same subnet can address IP packets to each other without using a router device.

To communicate with devices on another subnetwork, the traffic must be routed through a router device's WAN port. When a device needs to communicate with an IP address that is not on the same network, it sends the packet to the Default Gateway, which is usually the subnet's Router.

Note: Some BACnet services use "broadcasts" (e.g. "`Who-Is`"). On a LAN with standard routers, these broadcasts are "blocked". As a result, BACnet broadcasts are limited to the IP Subnet of the BACnet device. With a BACnet/IP network of 2 or more IP subnets, a device that can act as a BACnet/IP Broadcast Management Device (BBMD) must be used.

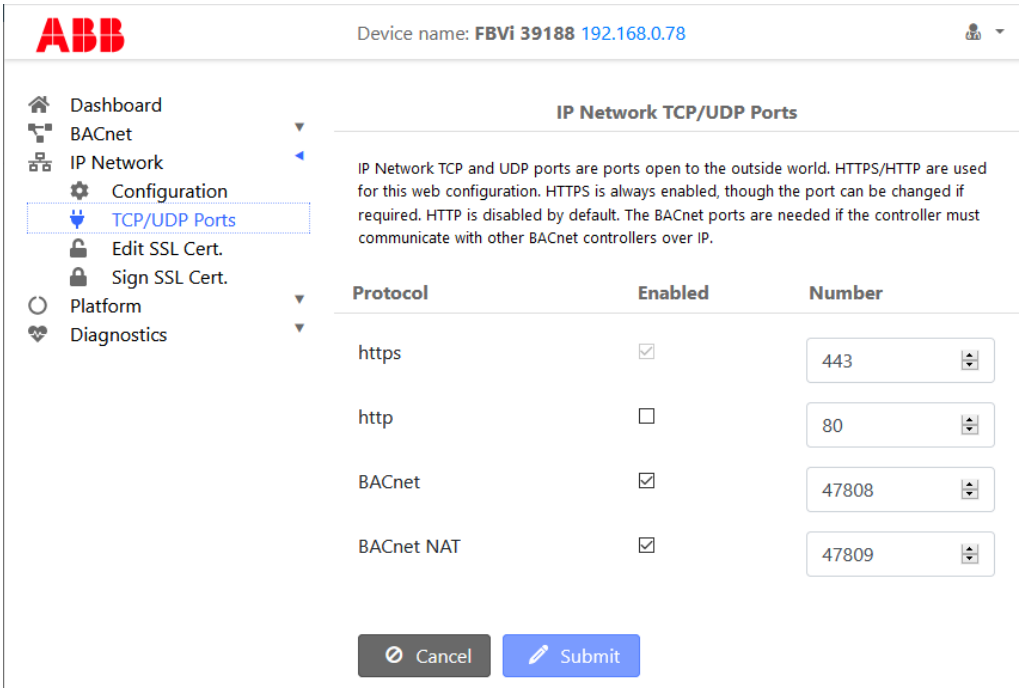
PORT NUMBERS

A “Port” on an IP device is a concept that allows traffic to be mapped within a device’s address to a specific process running in that device. A Port number forms part of a data packet’s IP address, but is often set by convention, depending on the protocol that the packet uses. For example, HTTP traffic by convention uses port `80`. If no port is specified in the IP address for HTTP traffic, port 80 will be assumed. If a port is specified (e.g. port `8080` as in the address `192.168.100.33:8080`), the specified port will be used instead. This allows the device to communicate on multiple protocols at the same time.

Some of the services associated with port numbers include:

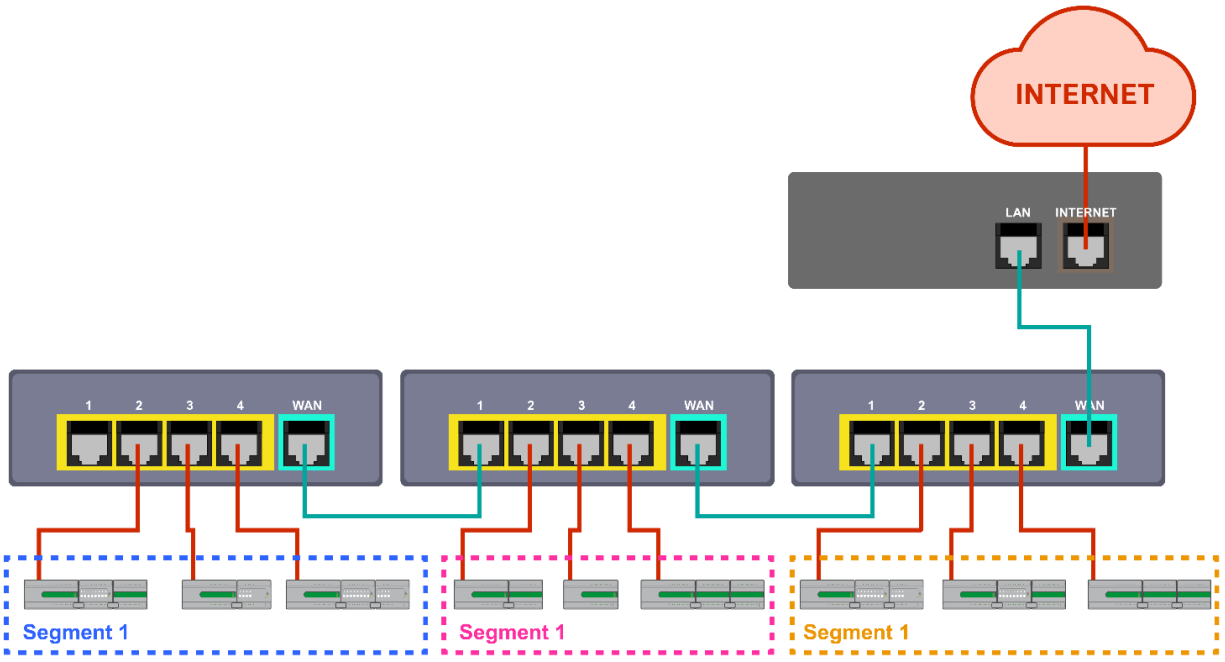
Service	Protocol	Default Port Number
SMTP	TCP	25
DNS	TCP, UDP	53
DHCP	UDP	67
HTTP	TCP	80
HTTPS	TCP	443
BACnet/IP	UDP	47808

Some of the port numbers recognized by **FBVi** are shown below. These can be changed in the controllers Web UI at IP Network > TCP/UDP Ports

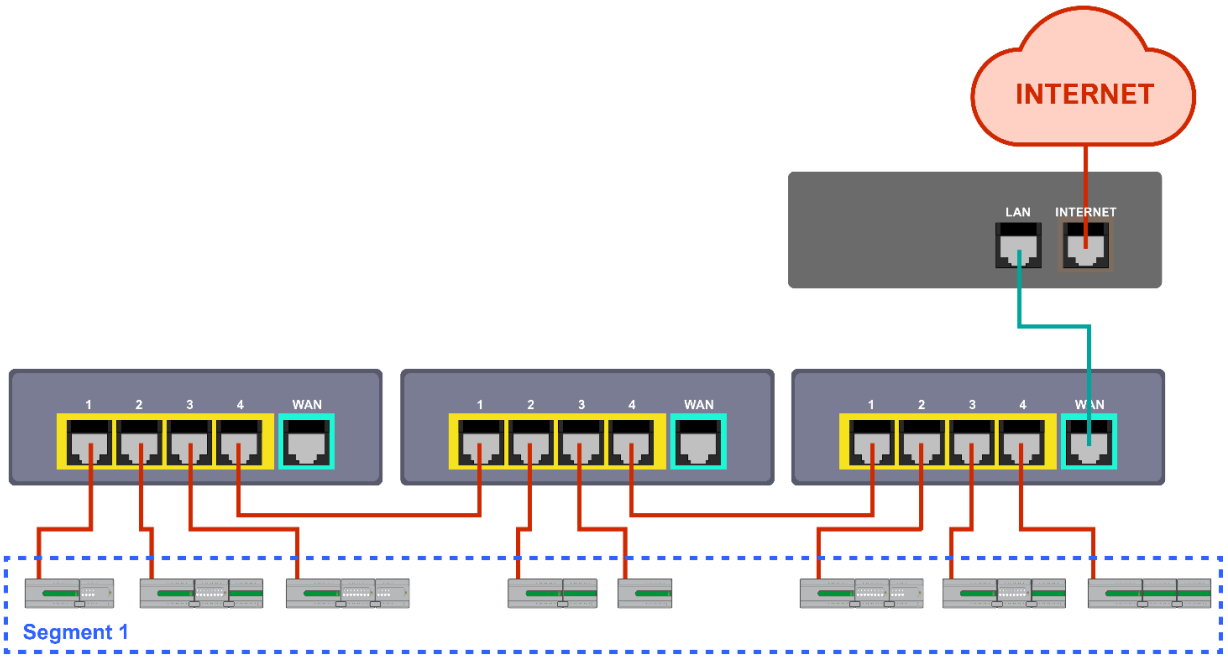


UPLINK/WAN AND SEGMENTATION

Physically splitting a network into different function groups is known as “Network segmentation”. This is done to improve performance (by reducing the amount of traffic on each segment) and to improve security. It is achieved by connecting Routers together by their “WAN” or “UPLINK” ports.



If routers are connected without using their “WAN” or “UPLINK” ports, the result is a single segment:



NETWORK ADDRESS TRANSLATION (NAT)

Network Address Translation is a function of a router or firewall, which maps multiple local IP addresses to a single public IP address. This is necessary because the number of IPv4 addresses is finite.

DOMAIN NAME SYSTEM (DNS)

When communicating on the wider Internet, it can be difficult to remember the numeric IP address for each device with which you want to communicate. The Domain Name System (DNS) was created to allow internet users to use a text-based Uniform Resource Locator (URL) with meaningful values such as “www.cylon.com” to connect to a site or device without having to know the server’s IP address. The DNS finds the URL in its distributed database and passes the corresponding numeric IP address to the requesting device. If a device’s IP address changes, the DNS server can be updated with its new IP address, ensuring that other networked devices can still find this device from its URL.

When setting a devices IP parameter manually, between one and three DNS IP address are usually provided. The second and third addresses are used if the first DNS becomes unavailable.

If you do not know the address of your DNS server(s), you can use publicly available DNS server addresses for example primary = `8.8.8.8` and secondary = `4.4.4.4`

3 BACnet Networking

WHAT IS BACNET?

BACnet is "a data communication protocol for building automation and control networks." This means it is a set of rules for exchanging BMS information between systems from different manufacturers.

The rules take the form of a written specification that spells out what is required to conform to the protocol

The key feature of BACnet is that the rules relate specifically to the needs of building automation and control equipment - for example, how to ask for the value of a temperature, define a fan operating schedule, or send a pump status alarm.

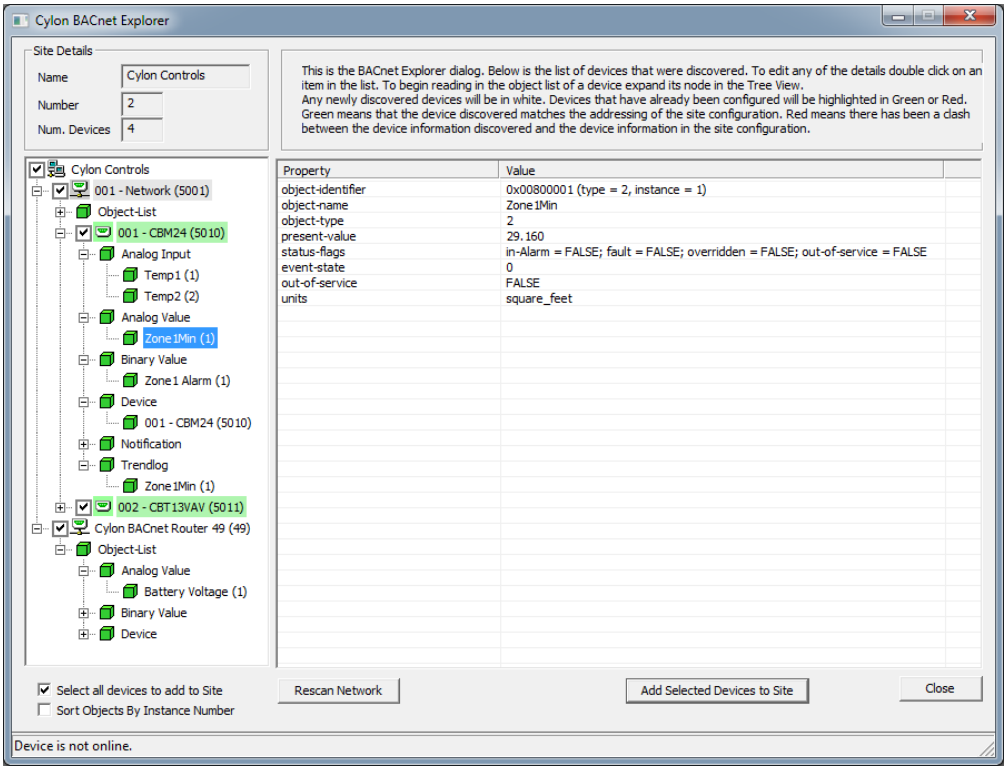
BACnet provides a standard way of representing the functions of any device - for example analog or binary inputs or outputs, schedules, control loops and alarms.

The standardized model of a device represents these common functions as collections of related information called objects

Each object has a set of properties that further describe it. Each analog input, for instance, is represented by a BACnet "Analog Input object", which has a set of standard properties such as 'Present Value', 'Sensor Type', 'Location', 'Alarm Limits' etc. Some of these properties are required, while others are optional.

The only required object in each BACnet controller is the Device object. This object contains the properties that define the controller's behavior on the network. Each controller's Device object has an associated number called the Device Instance. It is this unique number that allows all other BACnet devices to unambiguously access the controller.

Here is an illustration of BACnet objects:



BACNET OBJECT TYPES

The BACnet standard defines a number of standard object types, and this number is increasing over time. Cylon uses the following standard types (* indicates that the object is proprietary):

- Device
- Analog Input
- Analog Value
- Analog Output
- Binary Input
- Binary Value
- Binary Output
- Schedule
- Calendar
- Unitron Schedule *
- Notification Class
- File
- Trend Log
- Manufacturing Object *

BACNET SERVICES

The BACnet standard defines numerous services for interaction between BACnet devices. The following are supported by Cylon BACnet products:

- ReadProperty
- WriteProperty
- ReadPropertyMultiple
- WritePropertyMultiple
- Read Range
- WhoIs
- IAm
- WhoHas
- IHave
- UnconfirmedPrivateTransfer
- TimeSynchronization
- UTCTimeSynchronization
- DeviceCommunicationControl
- ReinitializeDevice
- AtomicWriteFile
- AtomicReadFile
- AcknowledgeAlarm
- GetAlarmSummary
- GetEventInformation
- ConfirmedEventNotification
- UnconfirmedEventNotification
- SubscriveCOV
- ConfirmedCOVNotification
- UnconfirmedOVNotification

BACNET'S CLIENT / SERVER NATURE

BACnet uses a “Client/Server" architecture. BACnet messages are called service requests. A Client machine sends a service request to a Server machine that then performs the service and reports the result to the Client.

Example:

A simple device such as a fixed function VAV controller would typically act as Server.

Front-end software running on a PC would act as a BACnet Client reading status values from the VAV and changing set-points.

Notes:

Server devices cannot initiate communication. Higher end embedded controllers generally include both server and client functionality. This allows them to share information such as outside temperature with each other or send alarms to a PC.

BACnet currently defines 35 message types that are divided into 5 groups or classes. For example, one class contains messages for accessing and manipulating the properties of the objects described above.

A common message type is the "`ReadProperty`" service request. This message causes the server machine to locate the requested property of the requested object and send its value back to the client.

Other classes of services deal with: alarms and events, file uploading and downloading, managing the operation of remote devices and virtual terminal functions.

NETWORK TYPES

BACnet messages can be carried over the following types of network:

- Ethernet
- ARCnet
- Master-Slave/Token-Passing (MS/TP)
- Point-to-Point (PTP)
- LON
- BACnet/IP

PIC STATEMENT

Every BACnet device is required to have a "protocol implementation conformance statement“ (PICS). A PICS is a BACnet specification sheet, containing a list of a device's BACnet capabilities.

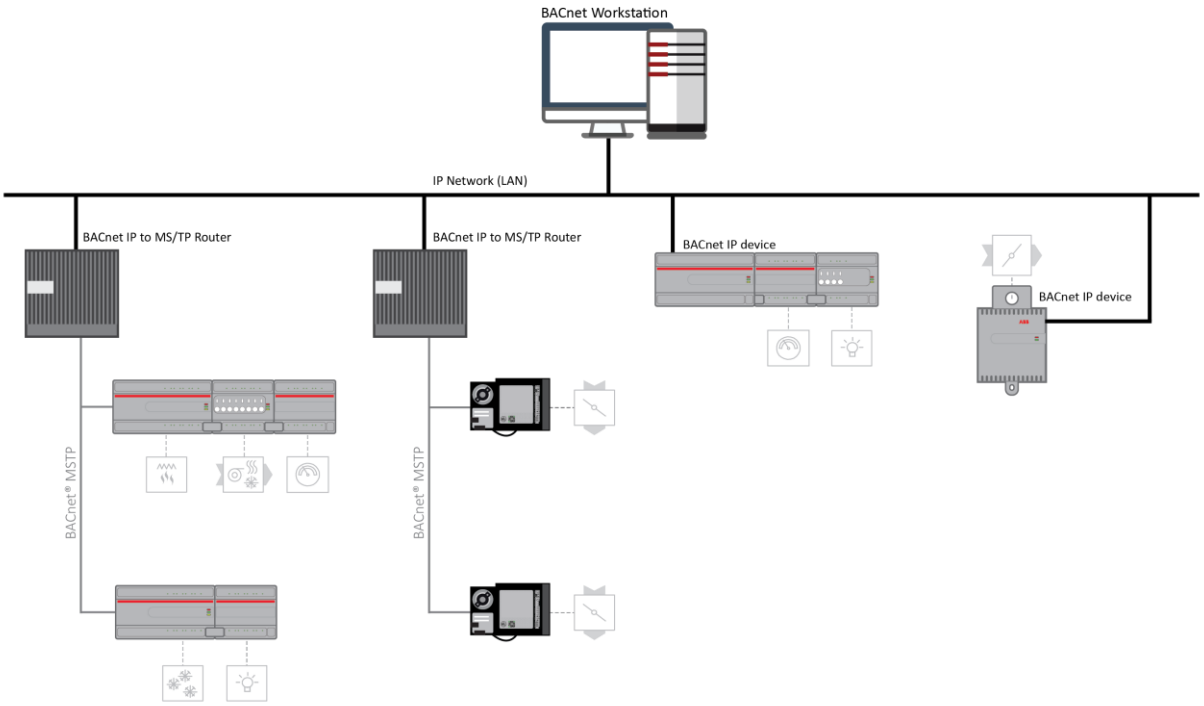
It contains:

- a general product description
- details of a product's BACnet capabilities
- which LAN options are available
- a few other items relating to character sets and special functionality

The PICS is the place to start to see what a device's capabilities are.

BACNET TOPOLOGY

A typical BACnet Network consists of devices connected to physical networks. Each device is a separate piece of hardware and has a physical connection to the network. Devices are given a unique Device Instance Number which can be a number between 0 and 4194302. BACnet MS/TP devices have additional addressing designations called MAC addresses. For most users it is the Device Instance Number which is used as a reference, but the combination of the Network Number and MAC address of an MS/TP device may be configured by a System Integrator to avoid any MAC address conflicts on the EIA-485 network.



BACNET IP

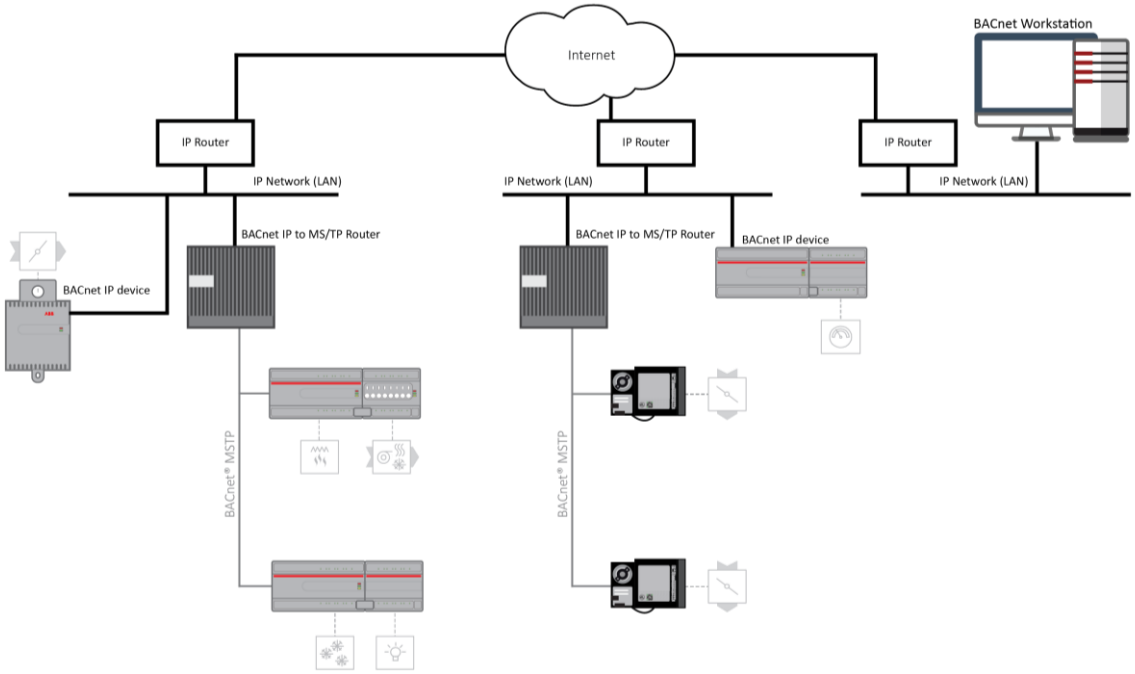
BACnet/IP uses the User Datagram Protocol (UDP) to send data packets. ASHRAE adopted BACnet/IP in annex j of the 135- 1995 standard.

BACnet/IP communicates using four methods.

- BACnet/IP to BACnet/IP (same subnet): Assuming that two devices know each other's IP addresses and the UDP ports they are using, i.e., their respective B/IP addresses, there is nothing that restricts them from communicating directly.
- BACnet/IP to BACnet/IP (different subnet): The location of the two devices is already known by the host and the message is routed to the device using switches and routers.
- Broadcast (same subnet): This is a standard Who is/ I am message sent across a local subnet for the BBMD to discover what the address are for the BACnet devices on the subnet.
- Broadcast (different subnet): This is a standard Who is/ I am message sent across a local subnet for the BBMD to discover what the address are for the BACnet devices on other subnets.

BACNET IP BROADCAST MANAGEMENT DEVICE (BBMD)

Some BACnet services use “broadcasts” (e.g. “`Who-Is`”). On a LAN with standard routers, these broadcasts are “blocked”. Thus, BACnet broadcasts are limited to the IP Subnet of the BACnet device. With a BACnet/IP network of 2 or more IP subnets, a device with BBMD can be used.



A BBMD located on an IP subnet monitors the origin of a broadcast message on that subnet and, in turn, constructs a “peer to peer” *message* in order to pass through an IP router. This “peer to peer” message is received by other BBMDs on other IP subnets and transmitted as a broadcast on their attached subnets.

Since the BBMD messages are directed messages, individual messages must be sent to each BBMD. Each BBMD device maintains a *Broadcast Distribution Table (BDT)*, the content of which is usually the same for all BBMDs within the network. BBMDs must know the IP address of all other BBMDs in the network.

It is possible to communicate to a device on a subnet that does not have a BBMD as in the BACnet Workstation example above. This type of device is called a foreign device since it resides on a different IP subnet from devices attempting to communicate with it.

Usually, in BACnet/IP, a foreign device is on a different subnet.

The foreign device (e.g. BOWS) registers with each BBMD, after which it can communicate with all other devices on the network. The BBMD then maintain a Foreign Device Table (FDT) which keeps track of foreign devices.

BACNET MS/TP

Note: FBVi is IP only, this section is provided for general information.

BACnet MS/TP (**M**aster-**S**lave **T**oken **P**assing) is an EIA-485 network layer intended for use with lower-level devices such as Unitary Controllers. In comparison to BACnet/IP and BACnet/Ethernet, MS/TP is more cost-effective to implement due to the lower cost of wiring. Given the MS/TP network is a serial-based network, devices may be configured to communicate at different baud rates specified by BACnet. Therefore, it is essential to know information regarding the BACnet network you are connecting to before installing.

TOKEN PASSING

BACnet MS/TP uses token passing to allow devices to communicate on the network. Token passing is controlled by each device, which contains an internal memory list of other MS/TP peers connected to the network. The token is passed in order of the MAC Address (Unit ID) from lowest to highest. In most MS/TP networks, each device is configured to be a master. Given all devices may be a master, MS/TP may appear and react slower than traditional building automation protocols. However, configuring your network for faster baud rates will help provide better bandwidth and transport speed of network messaging.

Token passing is a communications scheme that allows connected devices connected to intercommunicate with one another. A network “token” is passed from unit to unit on the network in a round-robin fashion by order of the MAC Address (lowest to highest) to provide a transport to access the network. When a unit possesses the token, it may perform any network activity for which it is responsible. When finished, the token is then passed onto the next device. At any time, the unit that possesses the token is the only device permitted to initiate communications with another device on the network or to request information from it. A device that receives the token may or may not need to perform network functions (e.g. read values from a remote device, broadcast information, etc.). If not, it will simply pass the token along the network.

If you are connecting devices to an existing MS/TP network consisting of third-party devices, consult third-party vendor documentation regarding MS/TP network considerations.

ADDRESSING

BACnet MS/TP devices contain two device addresses. One device address is known as a Device Instance, and the other is a MAC Address. The Device Instance is an address assignment that is used to identify the BACnet device on a global BACnet network. When a device is connected to a global BACnet network consisting of multiple data layers joined together using routers, the Device Instance is used to uniquely identify the device on a global basis. The valid range for the device instance in a BACnet device is 0 to 4,194,302. Devices must be configured for a unique, non-conflicting Device Instance. In the event that multiple devices are assigned the same Device Instance, both devices will simply not communicate on the BACnet network or could be subject to misdirected messaging (a message intended for Device-A may be routed to Device-B)

The MAC Address is an address assignment used within the BACnet MS/TP segment to permit a device to actively communicate on the BACnet MS/TP network. Valid MAC Address assignments range from 0 to 127 and are typically assigned in a logical and incremental order to permit faster token passing between devices. The MAC Address of a BACnet MS/TP device must be a unique, non-conflicting value that exists on the local MS/TP network. In the event that multiple devices are assigned with the same MAC Address, the effects can be far detrimental than that of a conflicting Device Instance; potentially resulting in a failure of the entire local MS/TP network. In the event that the unitary controller encounters a duplicate of its MAC Address, devices will inform the user that a duplicate MAC Address has been detected and will not perform client communications until resolved.

BAUD RATES

As a serial-based protocol, BACnet MS/TP supports the following four baud rates: 9.6kbps, 19.2kbps, 38.4kbps, and 76.8kbps. Devices can be configured for any of these baud rates, as well as native PC baud rates 57.6kbps and 115.2kbps which are currently not supported by the BACnet standard. Each device communicating on an MS/TP network must be configured for the same baud rate at all times

NETWORK OPTIMIZATION

In BACnet MS/TP devices, specific device properties are available to permit optimization. Network communications. By adjusting Device properties max-master and max-info-frames, users can adjust the token passing abilities of devices. The functionality of these two properties is described as follows:

- ***Max-Master*** - defines the highest unit ID of an MSTP master that is connected to the network. This value specifies to what address extent a token may pass. For example, if you have 64 devices addressed in a logical order, this value would be assigned to 64. This value should be set to the same value across all devices connected to an MSTP network.
- ***Max-Info-Frames*** - defines the number of data frames that an MSTP master can use the token before passing onto the next device. This value is typically set by the factory but can be modified if necessary. In the event a device does not need to keep the token for the number of frames specified, devices will automatically pass the token onto the next device.

BACNET MS/TP DEVICE LOADING

MS/TP (Master-Slave Token Passing) is a protocol where each device is wired in series and they take turns communicating, depending on which device currently holds a “token”. It is a robust design, and simpler/cheaper than IP though less flexible in terms of interoperability.

BACnet MS/TP is widely used in building automation, and usually uses RS-485 networking. As a result, the number of devices that can be connected together (on a “trunk” or “Fieldbus”) is limited by the electrical load the device puts on the network.

Unit Load is a concept created by the RS-485 specification to help determine how many devices can be connected to each fieldbus. The number of devices that can be connected depends on how much each device loads the fieldbus so the more a device loads the fieldbus, the fewer additional devices can be used. The total Unit Loads on a fieldbus must be 32 or less.

BACnet MS/TP allows 127 master device addresses, but the Unit Loading usually prevents that number of devices being active on a fieldbus.

READ PROPERTY MULTIPLE

A single BACnet request can contain a sequence of BACnet property references, each representing a single BACnet property. This allows multiple properties to be read with a single BACnet request.

By default, FBVi will read 5 properties at once.

BACNET PRIORITY ARRAY

BACnet uses a command prioritization scheme for objects that control equipment or software parameters that affect the operation of equipment connected to devices. The use of this command prioritization scheme (commonly referred to as Priority Array) allows a device to determine the order in which an object is controlled. Command Prioritization assigns unique levels of priority to the different types of devices that can write values to a device. There are 16 prioritization levels with Level 1 being highest and Level 16 the lowest. For example:

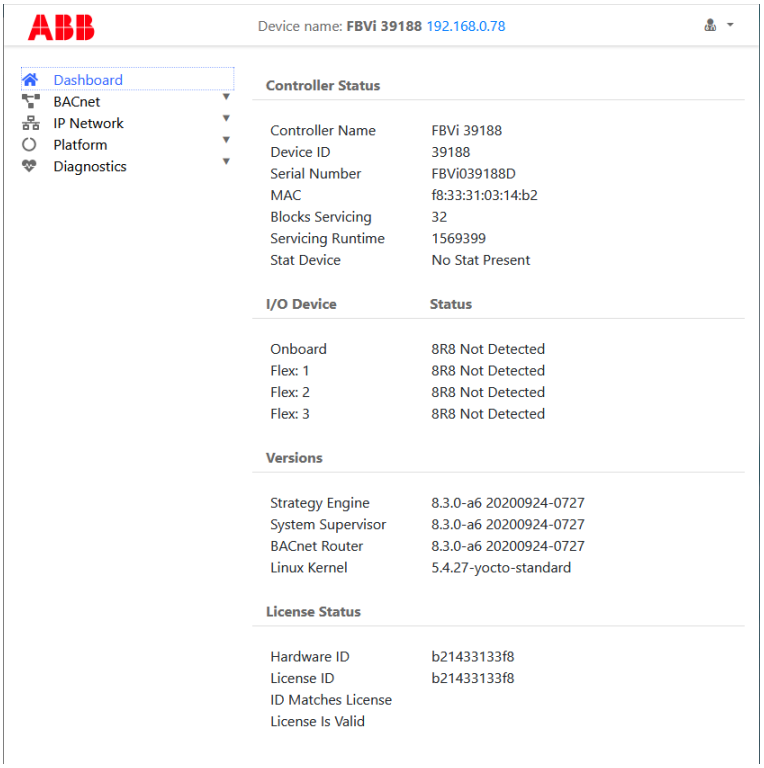
Priority Level	Application	Priority Level	Application
1	Manual-Life Safety	9	Available
2	Automatic-Life Safety	10	Available
3	Available	11	Available
4	Available	12	Available
5	Critical Equip. Control	13	Available
6	Minimum On/Off	14	Available
7	Available	15	Available
8	Manual Operator	16	Available

BACnet defines the types of objects that are either required or may optionally support the command prioritization scheme.

4 FBVi Web UI

SUMMARY DASHBOARD

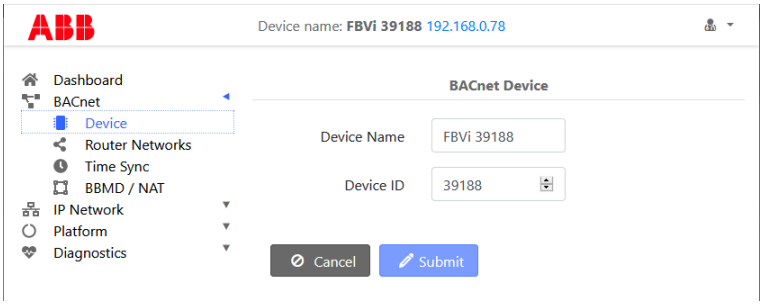
The Summary Dashboard displays the controller status including important information such as firmware versions and I/O status.



BACNET MENU

DEVICE

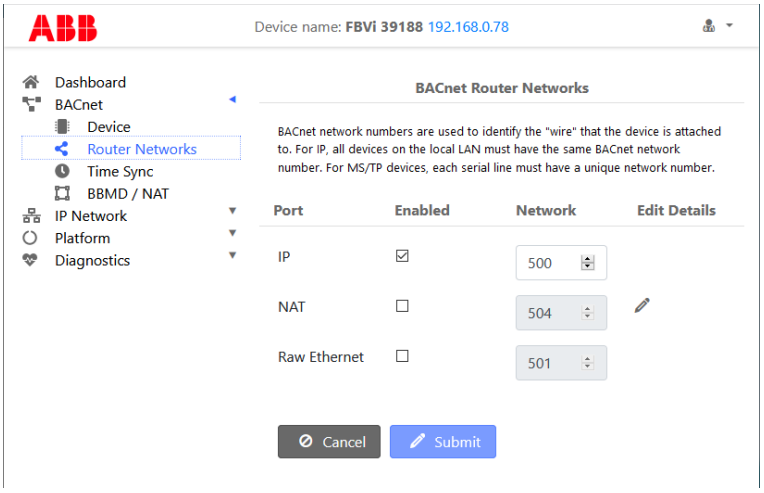
The BACnet Device Name and Device ID are set from this page.



ROUTER NETWORKS

BACnet Network numbers are used to identify the “wire” to which the device is attached.

- For IP, all devices on the local LAN must have the same BACnet Network number.
- For MS/TP devices, each serial bus line must have a unique BACnet Network number.

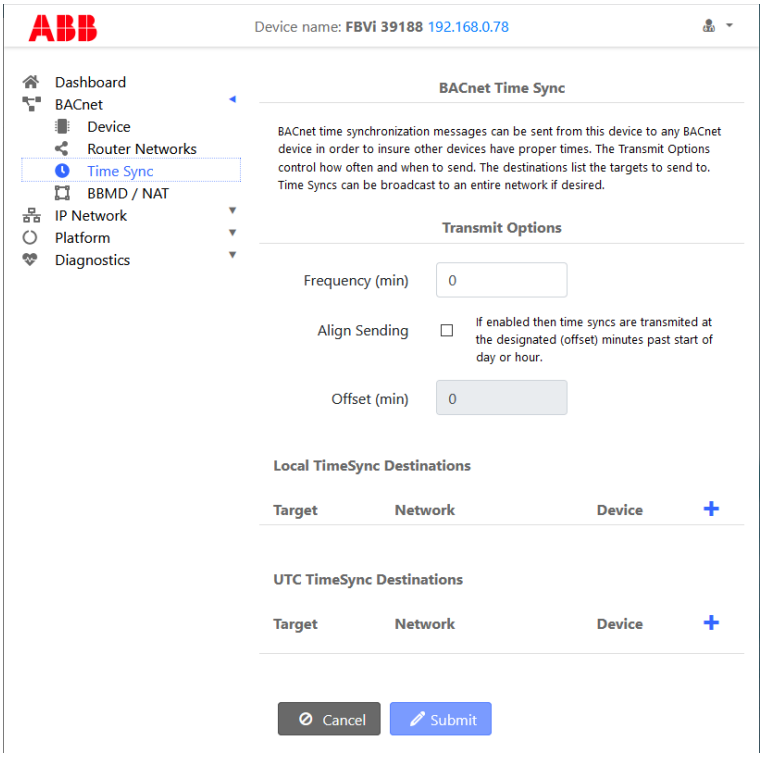


TIME SYNC

BACnet Time Synchronization messages can be sent from this device to any BACnet device in order to ensure that those devices have the correct times.

- The Transmit Options control how often and when to send.
- The Destinations list the targets to which the Time Sync messages will be sent.

Time Sync messages can be broadcast to an entire network if desired.



BBMD / NAT

BBMD connects BACnet IP networks that are not on the same local network (see *BACnet IP*

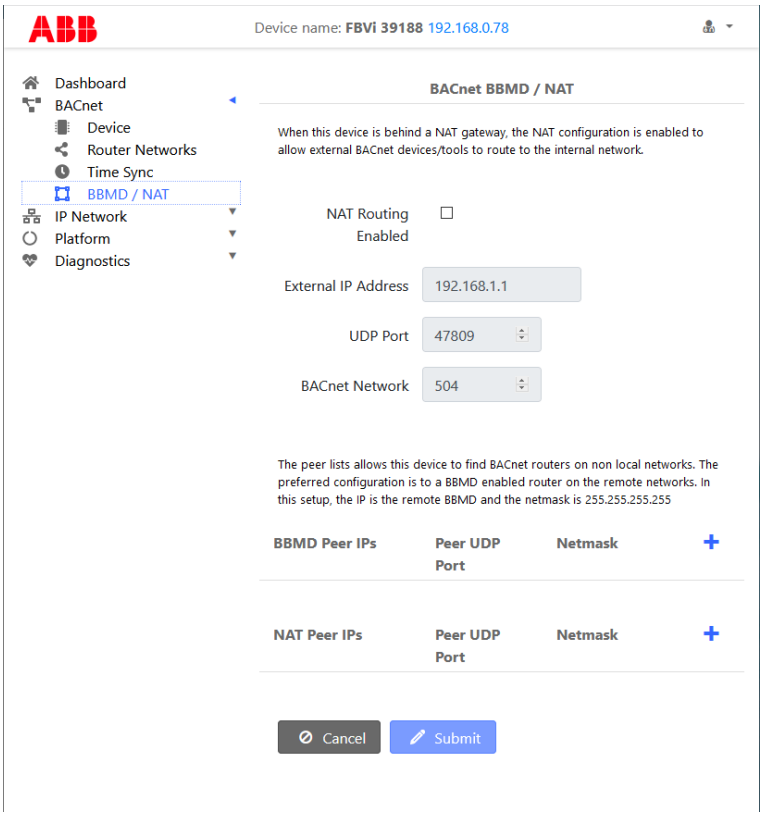
BACnet/IP uses the User Datagram Protocol (UDP) to send data packets. ASHRAE adopted BACnet/IP in annex j of the 135- 1995 standard.

BACnet/IP communicates using four methods.

- BACnet/IP to BACnet/IP (same subnet): Assuming that two devices know each other's IP addresses and the UDP ports they are using, i.e., their respective B/IP addresses, there is nothing that restricts them from communicating directly.
- BACnet/IP to BACnet/IP (different subnet): The location of the two devices is already known by the host and the message is routed to the device using switches and routers.
- Broadcast (same subnet): This is a standard Who is/ I am message sent across a local subnet for the BBMD to discover what the address are for the BACnet devices on the subnet.
- Broadcast (different subnet): This is a standard Who is/ I am message sent across a local subnet for the BBMD to discover what the address are for the BACnet devices on other subnets.

BACnet IP Broadcast Management Device (BBMD) on page 19 for details).

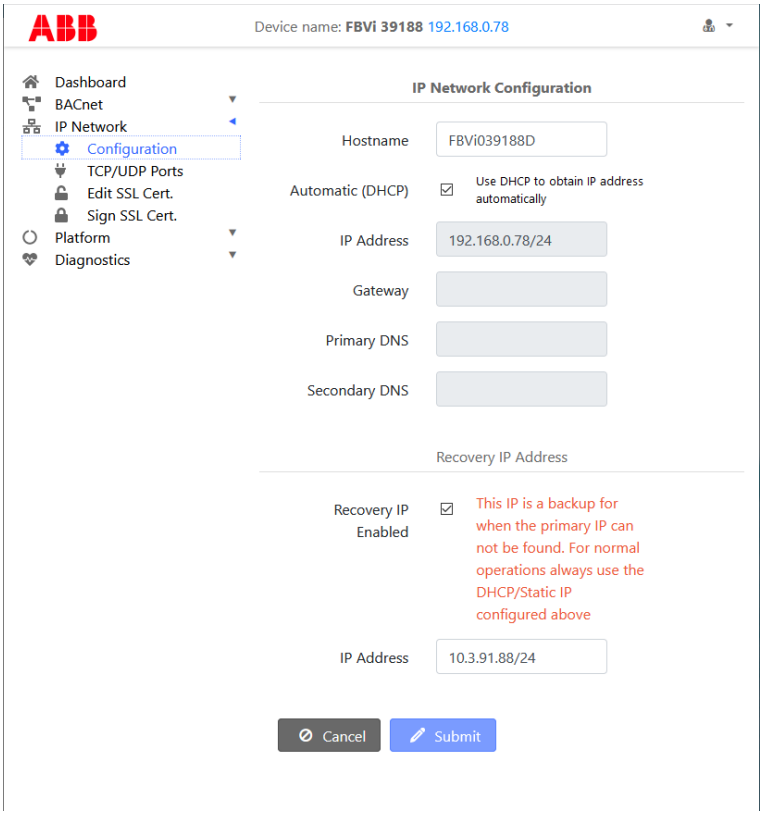
NAT connects sites where there is a NAT gateway between them.



IP NETWORK MENU

CONFIGURATION

This page allows basic IP configuration, identifying the current device on the IP network.



If your network has a DHCP server, click the Automatic (DHCP) box. You can then use BACnet discovery to list controllers along with their IP addresses, and can use the hostname to identify the IP address of a specific controller. By default, all FBVi devices leaving the factory are configured to use DHCP, and have a hostname set to "FBVi" followed by the controller's serial number – e.g. FBVi901004A

If your network does not have a DHCP server, then the FBVi controller will use a default IP address, which is made up as follows:

- The first byte of the IP address is set to 10
- The 6 digits of the numerical part of the serial number grouped into 3 sets of 2 digits to form the last 3 bytes of the IP address.

For example, FBVi with serial number 901001A will be allocated the default IP address of 10.90.10.01. See also *Configuring the IP connection* on page 37. The IP Address input is also used to specify the subnet mask in CIDR format. See *Subnetwork (Subnet)* on page 10 for a full explanation.

Recovery IP Address

If the primary IP cannot be reached – for example if the primary is set to automatic and there is no DHCP server available, then the user must use the Recovery IP Address to access the Web UI and properly configure the primary. The recovery is only designed for access to the web UI.

The factory default value is based on the serial number in the same way as the primary, but the Recovery IP Address should **not** be changed or disabled unless it interferes with other network operations.

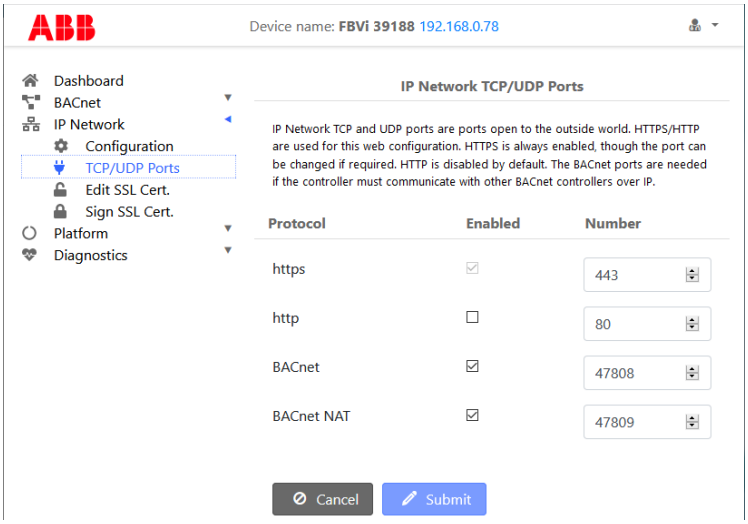
TCP/UDP PORTS

This page defines IP ports that are open to the outside world, and the protocols those ports expect to use.

HTTPS/HTTP are used for this web configuration.

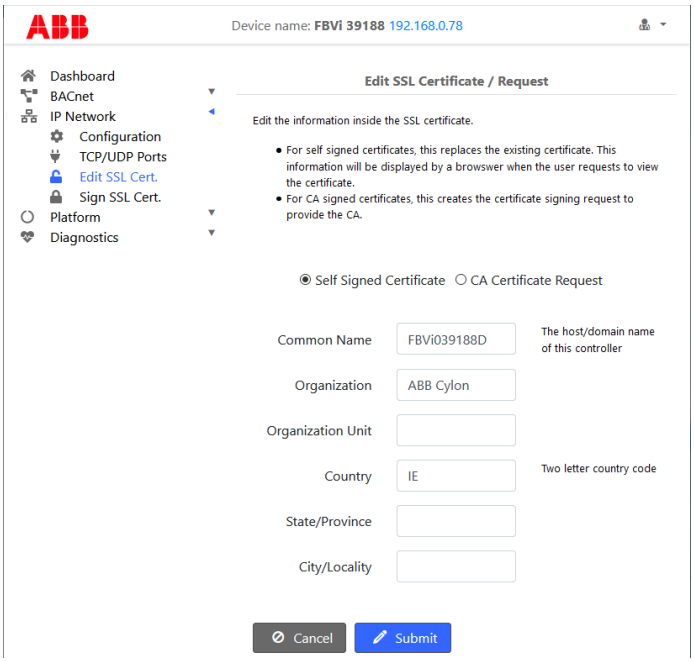
- HTTPS is always enabled, though the port can be changed if required.
- HTTP is disabled by default.

The BACnet ports are needed if the controller must communicate with other BACnet controllers over IP.

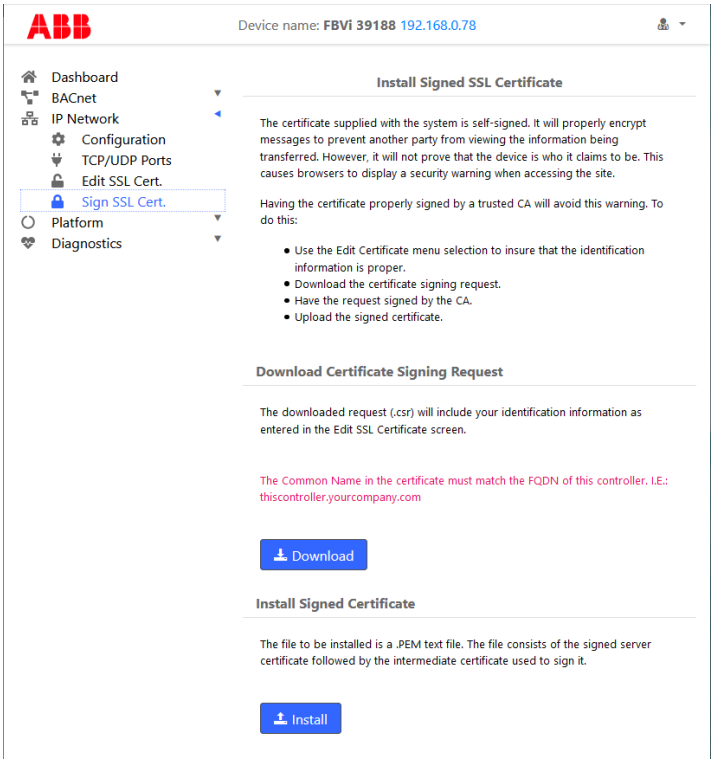


EDIT SSL CERT / SIGN SSL CERT

The IP Network > Edit SSL Cert page allows you to enter the details for an SSL certificate, which can be applied to the current FBVi as a self-signed certificate, or else these details can be used to generate a request for a 3rd-party SSL Cert on the IP Network > Sign SSL Cert page



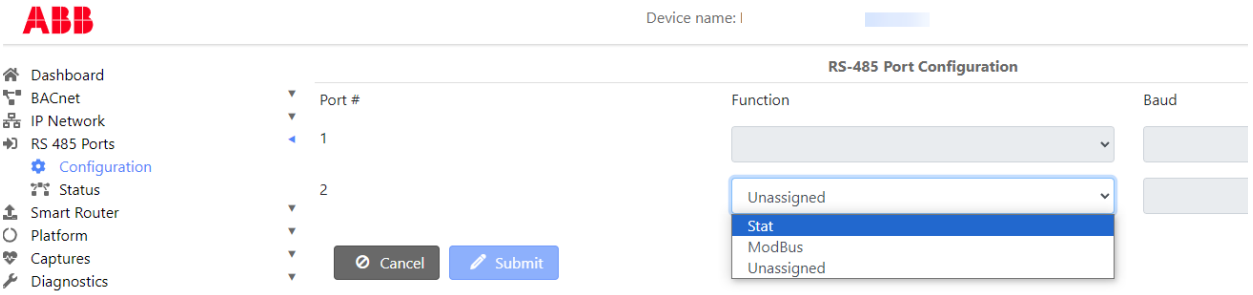
To install a 3rd-party SSL Cert, or to generate a request for a 3rd-party SSL Cert, use the IP Network > Sign SSL Cert page:



RS-485 PORT MENU

CONFIGURATION

The RS-485 “sensor” port is by default configured to communicate with a Room Sensor (e.g. FusionAir). However, it can be configured instead for `Modbus` on the RS 485 > Configuration page, and the baud rate can be set as appropriate. See ***Configuring a Modbus RTU connection*** on page 49 for more detail.



STATUS

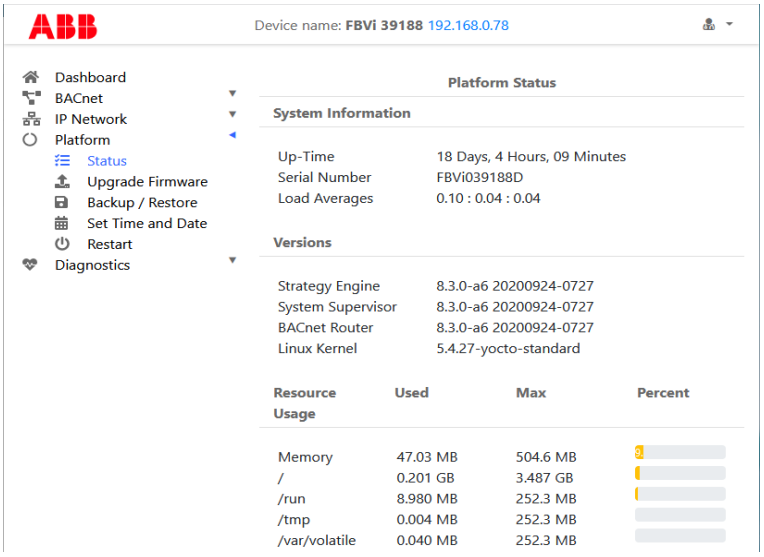
The status of the ports can be viewed on the RS 485 > Status page. It includes the number of characters transmitted (TX), and also received errors (FE), for each of the two RS-485 ports.

Note: If the FE value is a large percentage of the TX value (for example > `10` %), it may be beneficial to review your wiring for correct termination or unexpected line breaks.

PLATFORM MENU

STATUS REPORT

The Platform > Status page is useful for technical support and shows the Up-Time (running time) of the FBVi and its serial number, along with the versions of various software components of the FBVi. Memory usage is also displayed.

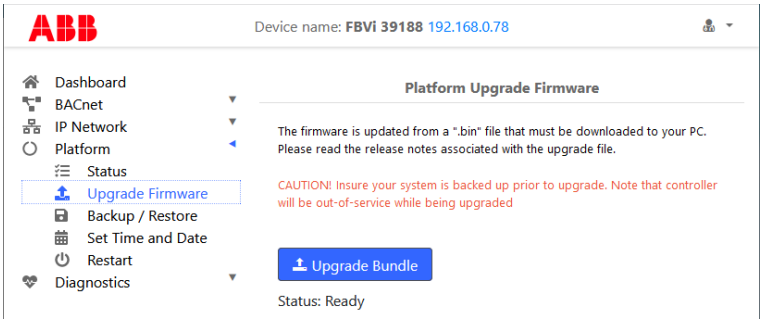


FIRMWARE UPGRADE UTILITY

With assistance from technical support, you may upgrade the firmware of the FBVi. Please be sure to back up your system before commencing the upgrade.

Note : The controller will be out of service while being upgraded.

To upgrade, click Platform > Upgrade Firmware and an Open File dialog will appear. Find the `.aam` file that you would like to upload. Once uploading has started, your system will be out of service. After approximately 30 seconds, your system will be online with the new firmware.

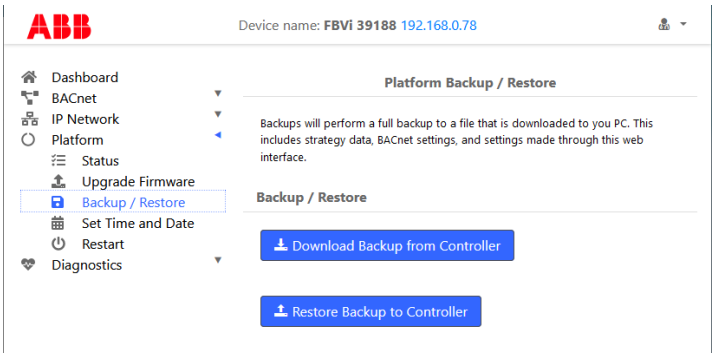


BACKUP/RESTORE UTILITY

You may perform a full backup to a file that can be downloaded to your PC. This includes Strategy data, BACnet settings and system settings configured via this web interface. Simply click the Download Backup from Controller button and save the backup to your PC.

Note: This backup cannot be used by CXpro^{HD} to edit a restored Strategy

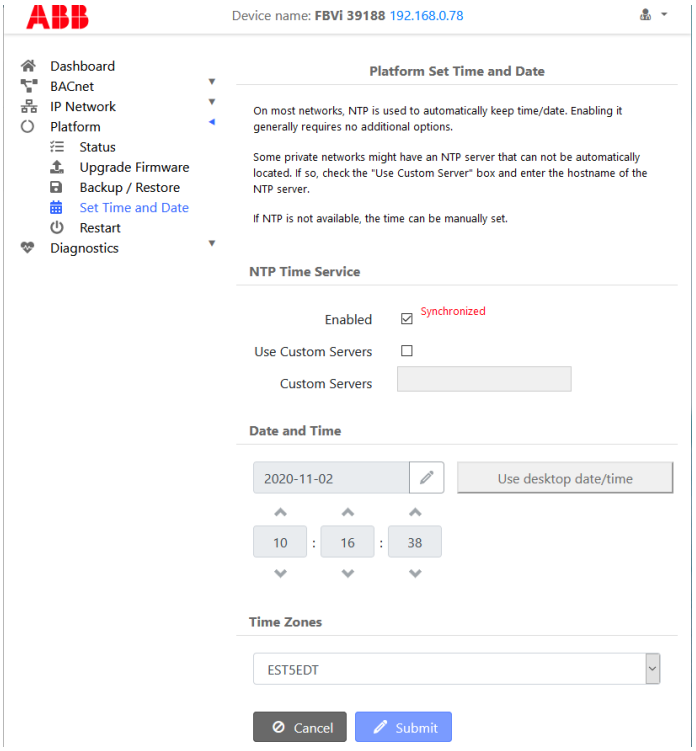
You may also restore a backup to the FBVi. By clicking the Restore Backup to Controller button. An Open File dialog will appear. Find the appropriate backup file and select it for restoring. After a few moments, the controller will restart with the new Strategy and data.



SET TIME AND DATE

On most networks, NTP is used to automatically keep the time and date correct. Enabling it generally requires no additional configuration.

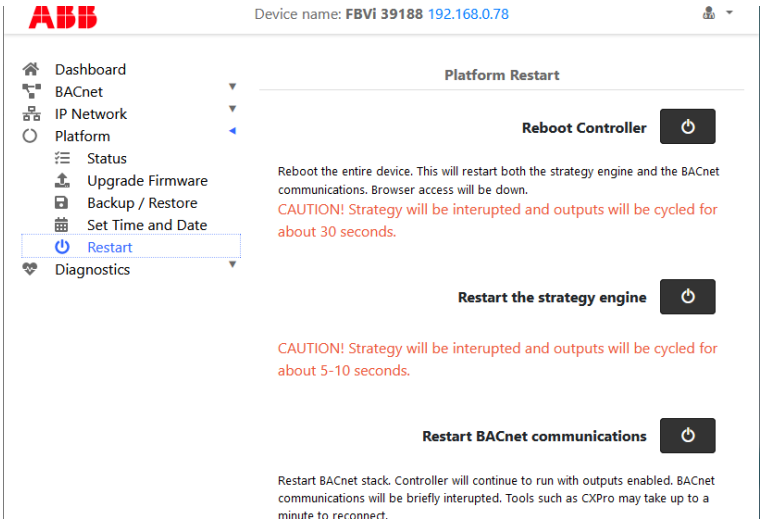
Some private networks may have an NTP server that cannot be automatically located. If so, check the Use Custom Server box and enter the hostname of the NTP server if available. If an NTP server is not available, the time can be manually set.



RESTART UTILITY

Several options are available for refreshing the **FBVi** platform, in case a condition has occurred which stopped a portion of the functionality of the **FBVi** and you do not wish to reboot the entire FBVi platform.

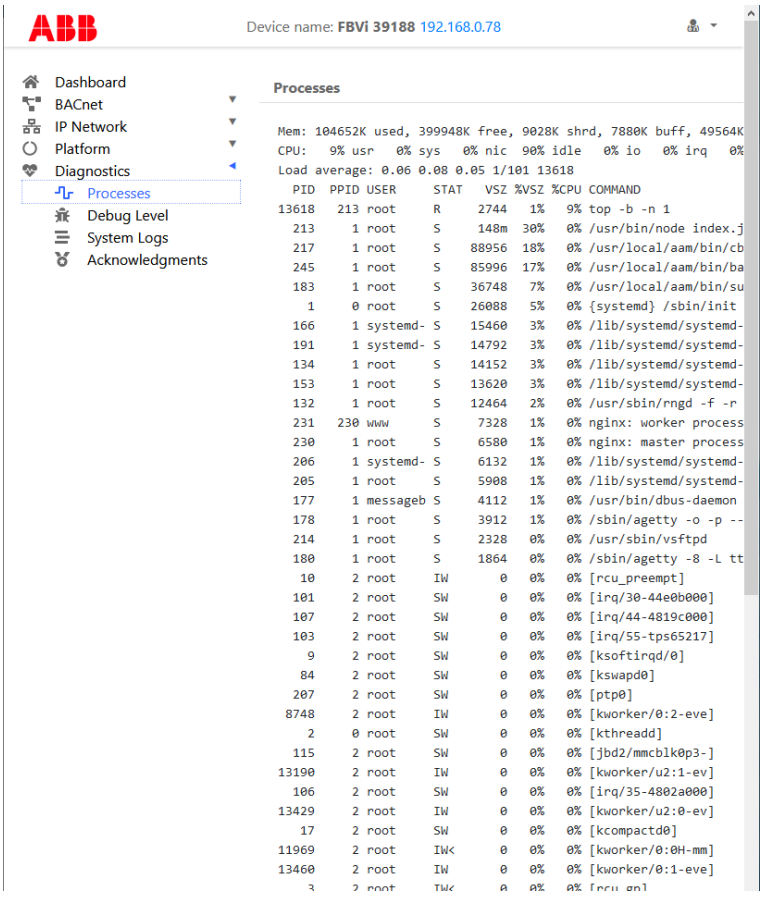
- Choose Reboot Platform to cleanly shutdown the **FBVi** and then restart it. This is equivalent to rebooting your PC.
- Choose Restart Strategy Engine to stop and restart the processing of the Strategy.
- Restart the BACnet Router and MSTP stops and restarts the internal BACnet Router and MS/TP network engine.



DIAGNOSTICS MENU

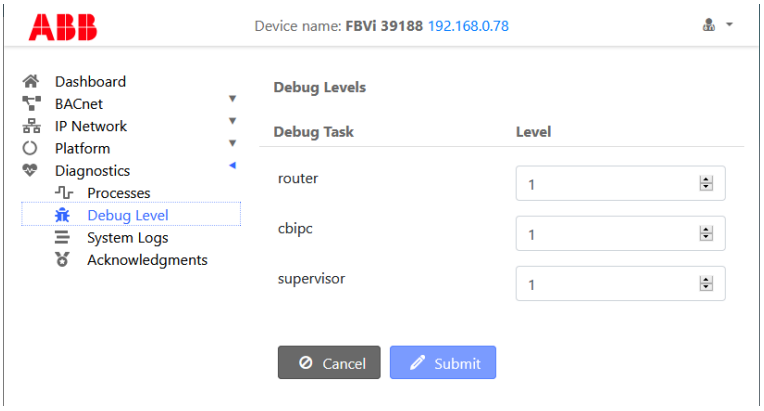
PROCESSES

The Diagnostic > Processes page displays a list of the processes that are running in the **FBVi**. If requested by Technical Support, a screenshot of this page can be useful in diagnosing certain types of problems.



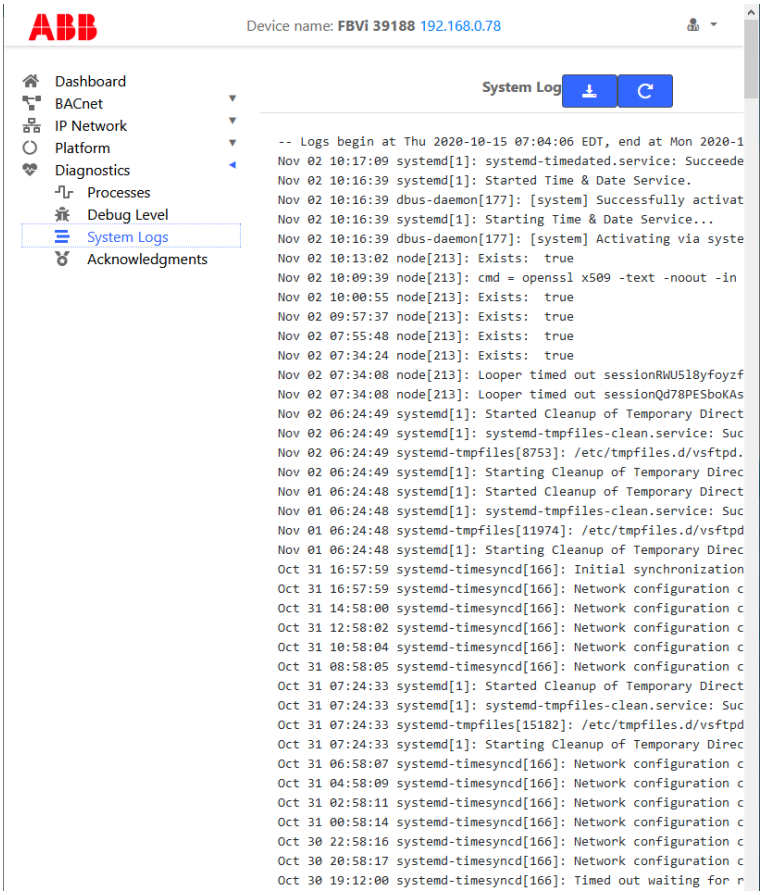
DEBUG LEVEL

If directed by Technical Support, you can change the debug levels to assist in troubleshooting difficult field problems should the need arise.



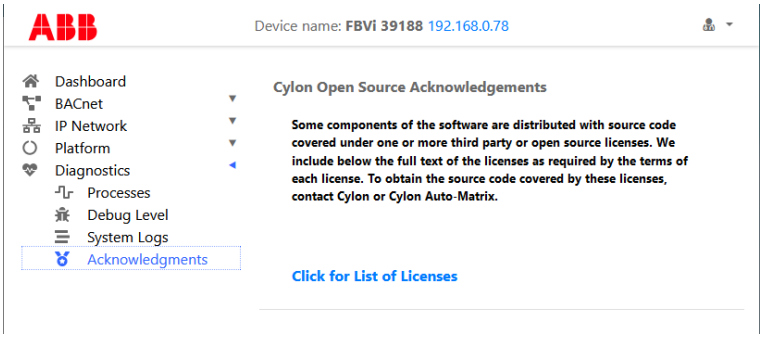
SYSTEM LOGS

If directed by Technical Support, a download of the system log may assist in troubleshooting difficult field problems should the need arise. The Download button will instruct you to save the file to your PC, from where you can email it to Technical Support.



OPEN-SOURCE ACKNOWLEDGMENT NOTICES

Some components of the software used in FBVi are distributed under one or more 3rd-party and open-source licenses. The licenses are listed on the Diagnostic > Acknowledgements page.



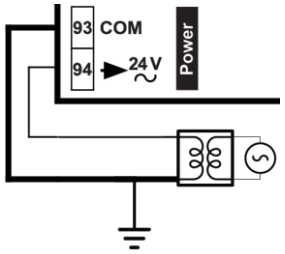
5 Installation

APPLY POWER TO THE FBVi-2U4-4T

For the initial configuration of the device, the controller must first be powered on.

Note: Service Port (USB connection) must not be connected until after the device is powered on.

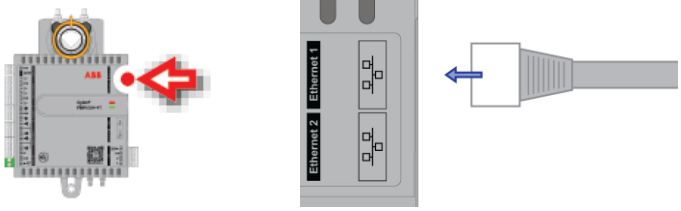
The FBVi-2U4-4T requires 24 V AC/DC supplied from an externally mounted power transformer. One conductor of the transformer must be grounded to an earth ground to avoid damage to the controller. This conductor will be wired to the COM (common) terminal of the controller. The wiring diagram is shown here:



Note: Ensure the 24 V AC/DC and Common wires are correctly connected to the controller. If the wires are swapped, it may cause damage to anything connected to the controller.

CONNECT THE FBVi TO AN IP NETWORK

Place an Ethernet cable from the Network's Ethernet switch into one of the 2 Ethernet ports on the top of the FBVi:

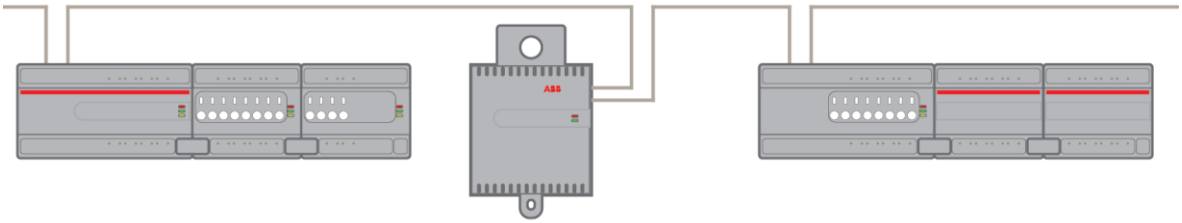


IP Cabling requirements

Cable	Standard patch cable, Cat 5e with 4 pairs of wires fitted with RJ-45 connectors
RJ-45 pin connections	Straight-through wiring
Characteristic impedance	100-130 Ohms
Distributed capacitance	Less than 100 pF per meter (30 pF per foot)
Maximum Cable length between IP devices	328 ft. (100 m) maximum

THE FBVi INTEGRATED ETHERNET SWITCH

The FBVi-2U4-4T includes an integrated Ethernet Switch, with 2 ports. This allows the device to forward IP packets from each port to the other, allowing FBVi, FBXi and CBXi devices to be connected in a Daisy-Chain topology:



It is recommended is that both ends of an FBXi / FBVi / CBXi daisy chain network are connected to a single switch that supports the Spanning Tree network switch protocol (STP). In this scenario a single line break or controller failure in the loop will allow all controllers to continue to communicate.

For example, if controllers A, B, C, D and E are daisy-chained, connected on both sides, with a single switch supporting Spanning Tree Protocol:

- If controller B loses power, controller A will be on one trunk, and C / D / E will be on another all communicating.
- If controllers B and D lose power, controllers A and E will communicate, but controller C will not.

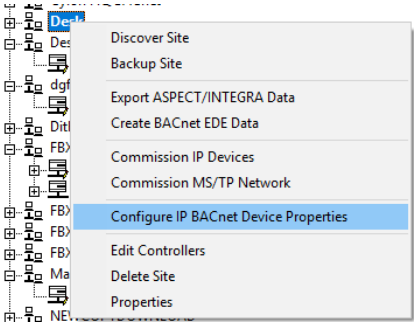
Note: The FBVi Series controller has a pass-through across its IP switches, such that if it loses power controllers 'downstream' will continue to be connected. Only the FBVi Series has this feature.

Note: If you plug both ends of the daisy chain network into a switch that does not support the Spanning Tree Protocol, it will flood the network with requests. The switch will send and receive the same messages over and over again, until something breaks.

CONFIGURING THE IP CONNECTION

Configuring the IP connection using CXpro^{HD}

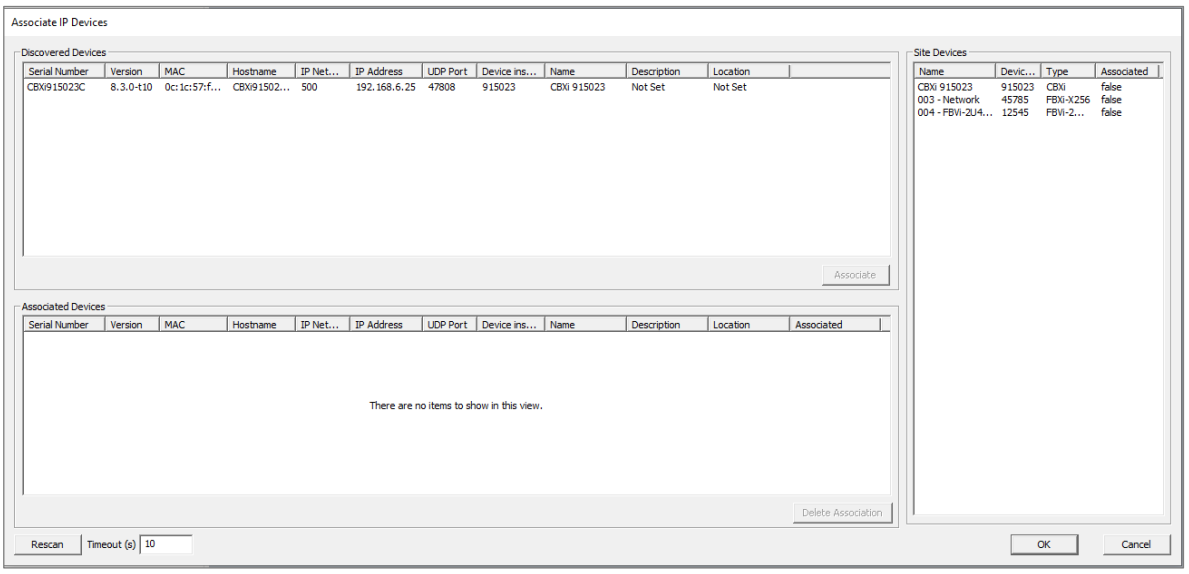
CXpro^{HD} includes a utility to quickly configure BACnet properties for IP devices. To launch this utility, right-click on a Site in the Site List and select Configure IP BACnet Device Properities



The utility will scan for all CBXi, FBXi and FBVi devices on the selected network.

Note: The devices must be configured within CXpro^{HD} before they can be accessed by this utility.

When scanning is complete, the Associate IP Devices dialog will open:



The Site Devices panel on the right lists all of the relevant IP devices configured in the CXpro^{HD} Site that have been successfully discovered on the BACnet network.

The Discovered Devices panel on the top left lists all of the relevant devices that have been discovered on the network

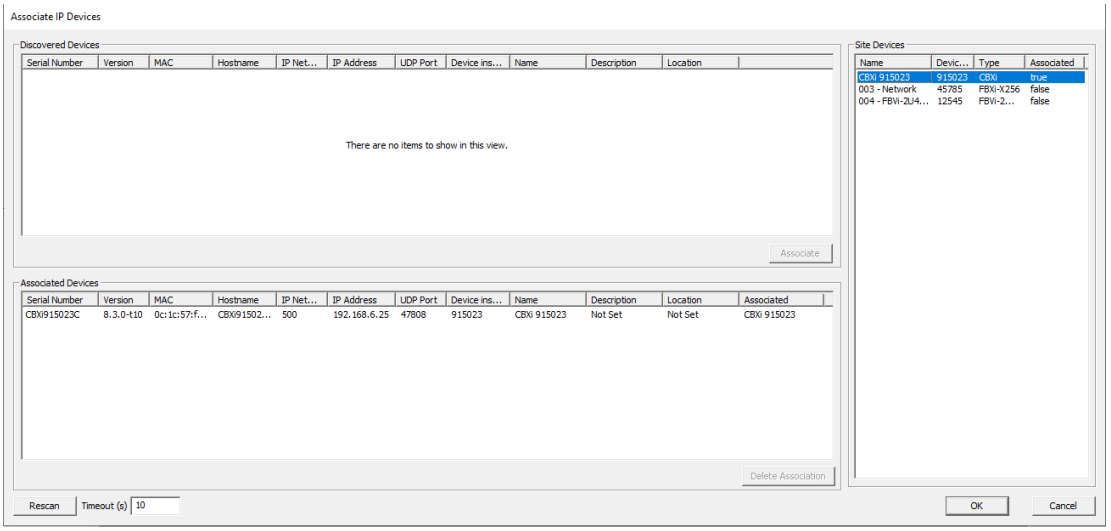
The Associated Devices panel on the bottom left lists any Discovered Device that has been associated with a configured Site Device.

How to Associate devices

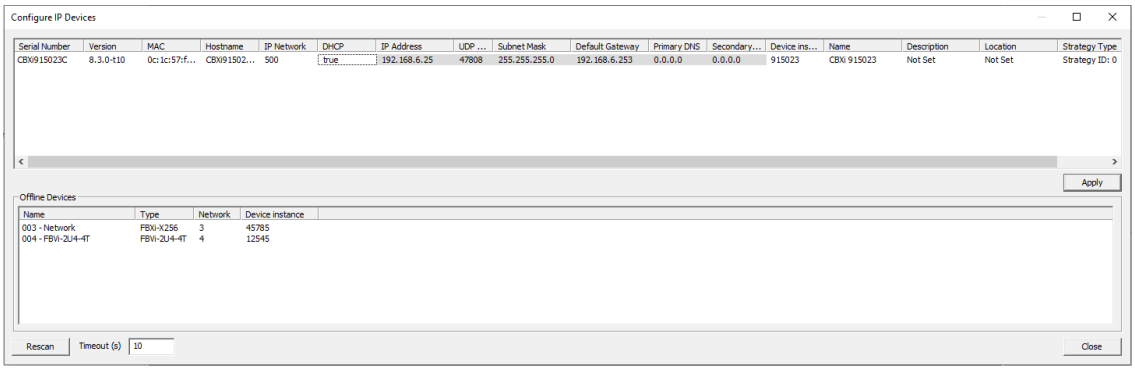
To associate a Discovered Device with a Site Device, select a device in the Site Devices list and a device in the Discovered Devices list and click the Associate button. Alternatively, you can drag the Site Device and drop it over a Discovered Device.

Once this is done, the discovered device is moved to the Associated Devices list. The device on the Site PC is updated with the Device Instance of the physical devices.

The MAC address will be stored in the site configuration as the key, so associations are maintained if the tool is run again.



When all required devices have been associated, click OK to open the Configure IP device dialog where the IP Properties of Associated devices can be edited.



The list on the bottom shows the unassociated or offline devices.

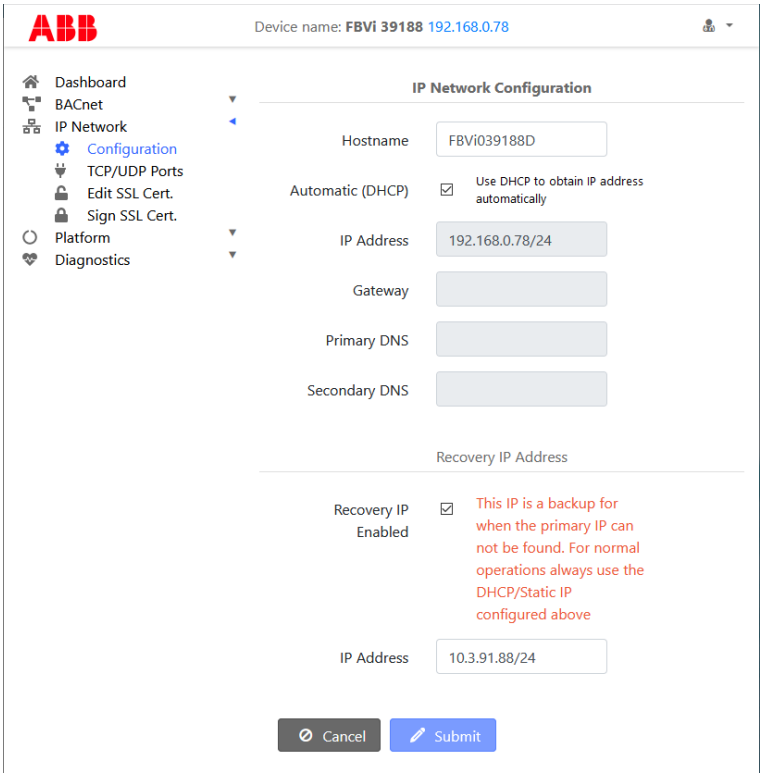
When the properties are set as required, click Apply to send the changes to that controller.

Configuring the IP connection without CXpro[HD]

If your network does not have a DHCP server, then the **FBVi** controller will use a Recovery IP address, which is made up as follows:

- The first byte of the IP address is set to 10
- The 6 digits of the numerical part of the serial number grouped into 3 sets of 2 digits to form the last 3 bytes of the IP address.

For example, a **FBVi** with serial number `039188D` will be allocated the Recovery IP address of `10.03.91.88`



Note: For a laptop (or PC) to communicate with a **FBVi** configured in this way, the IP address of the laptop's Ethernet port must be set to a subnet that is compatible with the **FBVi**'s IP address.

For example, if the **FBVi** has an IP address of `10.90.10.01`, the laptop could have an address something like `10.90.10.nn` with a subnet mask of `255.255.255.0`.

Note: If the default IP address is used on a network, it can cause an IP Address conflict if the network's subnet mask is `10.0.0.0/8` (see *Subnetwork (Subnet)* on page 10).

It may be possible to reach the FBVi over the network but BACnet messaging may fail.

In this case you may need to use a directly-connected laptop, or a different network to configure the **FBVi**. Alternatively you could change the **FBVi**'s subnet mask to `10.ss.ss.ss/24`, (where `ss` is the serial number) to reduce the size of the subnet that could give rise to conflicts. For example, a **FBVi** with serial number `901001A` should have a subnet mask of `10.90.10.01/24`.

Accessing the FBVi's Web UI

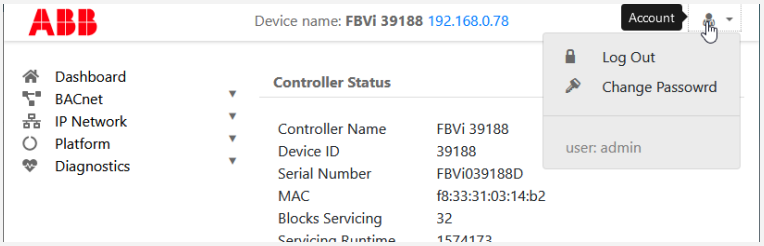
Point a web browser at the **FBVi** device's IP address, and log in to the Web UI.

Note: By default, all **FBVi** devices leaving the factory are configured with the following login:

username: `admin`

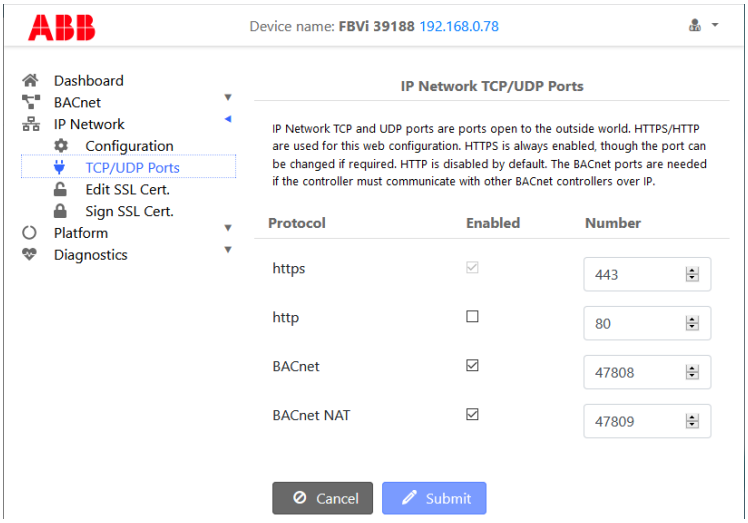
password: `cylonctl`

It is recommended that you change these credentials by clicking on the User icon in the top-right of the Web UI page and selecting Change Password.



Configuring IP Ports and IP security

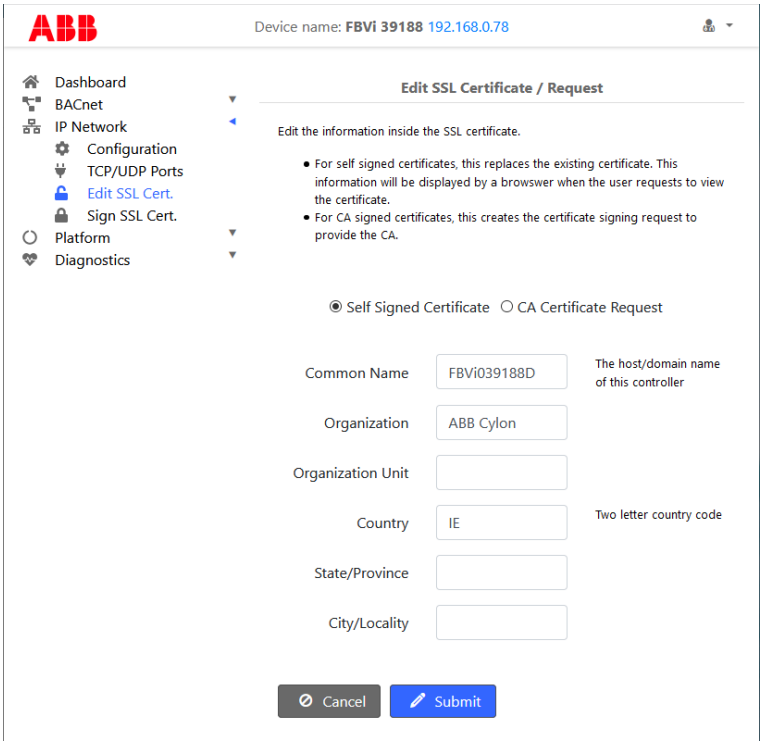
Specify the Ports for each protocol that the device will use, on the IP Network > TCP/UDP Ports page:



Note: BACnet NAT is used for accessing the BACnet device from the Internet, for example in the case of remote supervision. The Port Number set here should match the corresponding settings on the BACnet > BBMD/NAT page.

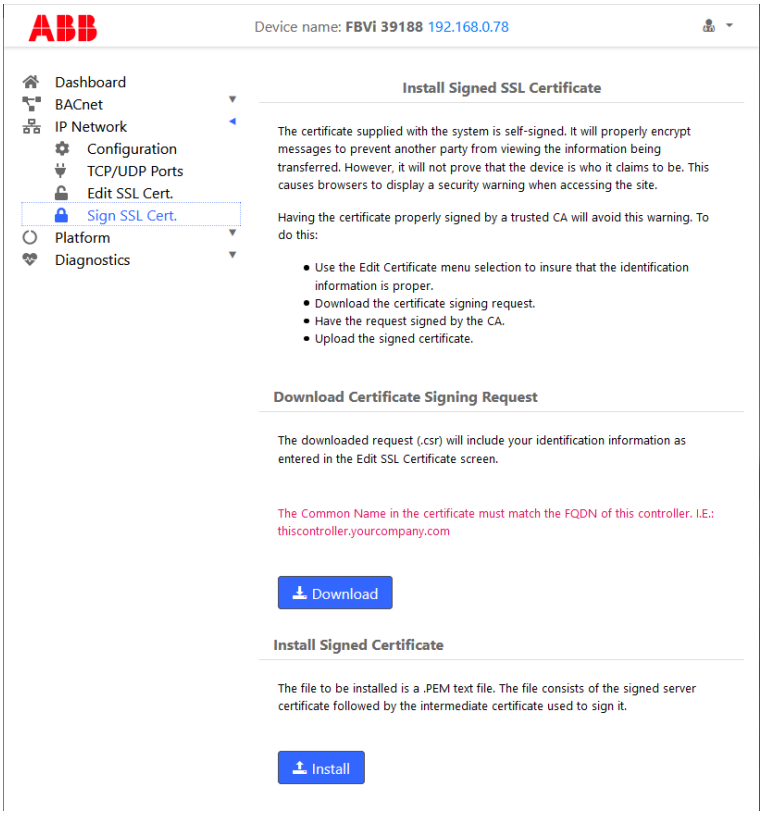
Warning: **Cylon recommend that controllers should not be exposed on the Internet without a VPN**. See *HT0038 Aspect, FBVi and CBXi System Network Security Best Practice* for detailed discussion of security issues.

FBVi controllers are shipped with a self-signed certificate. If a new self-signed certificate is required, then one can be created with the form on the IP Network > Edit SSL Cert page. If a signed certificate is required, then a signing request can be generated on the IP Network > Sign SSL Cert page, based on the information entered on the IP Network > Edit SSL Cert page.



The IP Network > Edit SSL Cert page allows you to enter the details for an SSL certificate, which can be applied to the current **FBVi** as a self-signed certificate, or else these details can be used to generate a request for a 3rd-party SSL Cert on the IP Network > Sign SSL Cert page.

To install a 3rd-party SSL Cert, or to generate a request for a 3rd-party SSL Cert, use the IP Network > Sign SSL Cert page:



WIRING THE IO

Wiring the Universal Inputs

The FBVI-2U4-4T comes with 5 universal inputs. `U/I-8` is dedicated to the internal airflow sensor. `U/I-1` through `U/I-4` is used for wiring in-room sensors, setpoint adjust, discharge air sensors, CO_2 sensors, relative humidity sensors, window, and motion sensors, depending on the application. The sequences for this wide range of applications are available within the preloaded strategy.

- **U/I – 1** will typically be where the room temperature sensor is wired. This input is pre-configured to support a 10K Type III thermistor.

Note: Room sensors that short the thermistor for push-button occupancy are supported with this controller.

- **U/I – 2** will typically be where the room setpoint adjusts is wired. This input is pre-configured to support a 5K POT. It can also be set up for an occupancy sensor or window sensor.
- **U/I – 3** is a dedicated input that has been configured to read a thermistor. In the pre-loaded strategy, this input is used for a discharge air temperature sensor.
- **U/I – 4** is configured as a voltage input. This input can be used for wiring in a CO_2 sensor or relative humidity sensor. It can also be set up for an occupancy sensor, window sensor, or a VAV fan status.

Note: For CO_2 or relative humidity sensors it must be a 0···10 Vdc sensor type. To change the span for the CO_2 sensor that is installed, adjust the following:

  - minCO2Range (A278) Low range of the sensor.
  - maxCO2Range (A280) High range of senor.

To adjust the span for the relative humidity sensor that is installed, adjust the following:

  - minHumidityRange (A251) Low range of the sensor.
  - maxHumidityRange (A305) High range of senor.

IO POINTS	DESCRIPTION
UI-01	Zone Temperature (with optional override button) occupancy, or window contact (all optional)
UI-02	Setpoint Adjustment (optional 5K slider) occupancy, or window contact (all optional)
UI-03	Discharge Temperature
UI-04	CO_2, Humidity, occupancy, fan status, or window contact (all optional)
UI-08	Flowrate Sensor

Wiring Analog and Digital Outputs

FBVI-2U4-4T has 4 digital outputs and 2 UniPuts™ (normally configured as analog outputs) for controlling a wide variety of possible elements of the VAV box. The FBVI-2U4-4T includes integrated damper control. It is possible to control single speed and variable speed fans (both parallel and series), electric heat, proportional heating valves, and tri-state heating valves depending on the application.

- **DO-09** can be configured for controlling first stage on-off electric heat or to open a tri-state heating valve.
- **DO-10** can be configured for controlling the second stage on-off electric heat or to close a tri-state heating valve.
- **DO-11** can be configured for controlling third stage on-off control.
- **DO-12** can be configured for constant volume series or parallel fan on-off control.
- **AO-14** can be configured for controlling any first stage modulating heating valves, SCR (Silicon Controlled Rectifier), or EMC (Electronic Modulating Control) type controls depending on the heating elements of the VAV box.
- **AO-15** can be configured for controlling any second stage modulating heating valves, SCR (Silicon Controlled Rectifier), or EMC (Electronic Modulating Control) type controls depending on the heating elements of the VAV box. This output can also be configured for variable speed fan control (series or parallel).

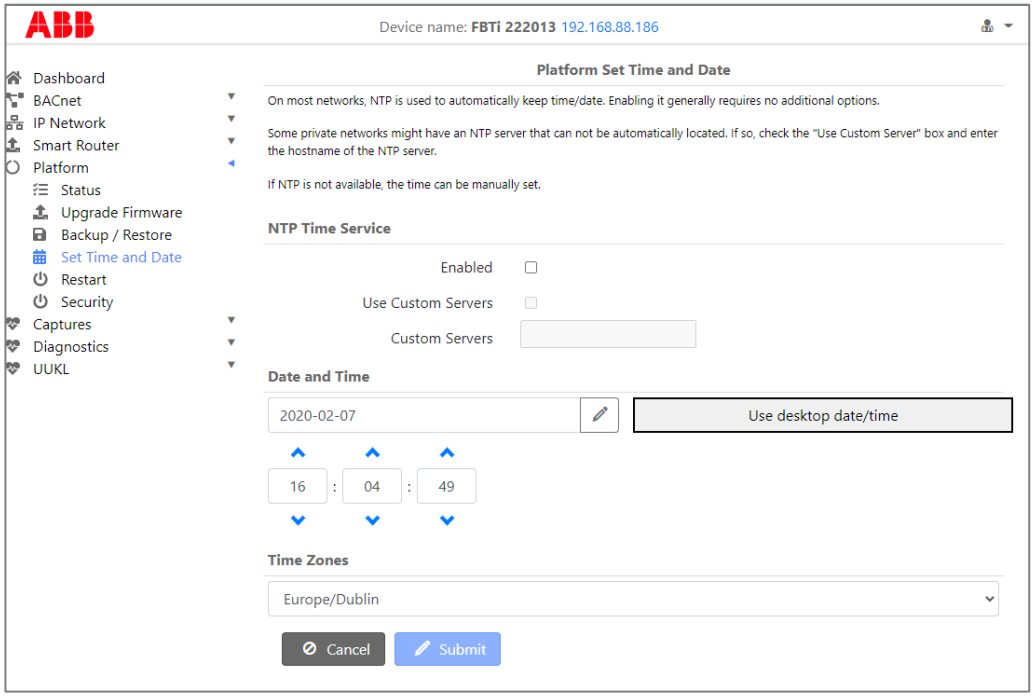
Note: `AO-14` and `AO-15` are preconfigured as a 0 ··· 10 V DC direct-acting output. During configuration, it is possible to configure either output or both outputs for reverse acting or 10 ··· 0 V DC. Either or both of these outputs can also be configured for 2 ··· 10 V DC or 10 ··· 2 V DC.

IO POINTS	DESCRIPTION
DO-09	1st Stage Electric Heat or Tri-State Heat Valve Open
DO-10	2nd Stage Electric Heat or Tri-State Heat Valve Closed
DO-11	3rd Stage Electric Heat
DO-12	Fan Command (Series or Parallel)
AO-14	1st Stage Modulating Heat Control
AO-15	2nd Stage Modulating Heat Control or Variable Fan Speed Control (Series or Parallel)

ADD THE CONTROLLER TO THE CXpro^{HD} SITE

SET CONTROLLER DATE AND TIME

The device should be set up as a Time Sync Master, so click the Enabled checkbox under Platform > Set Time and Date > NTP Time Service, and the controller time will be automatically updated.

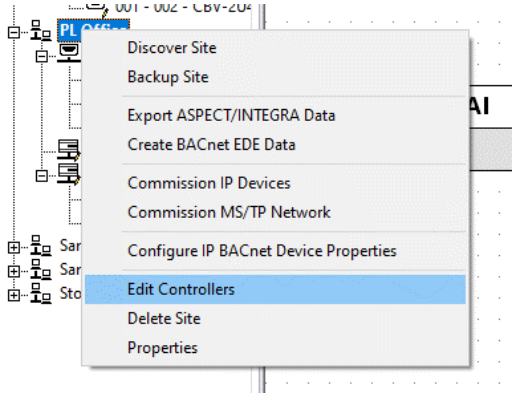


Note: The NTP Enabled checkbox is mirrored on the BACnet side with a proprietary property

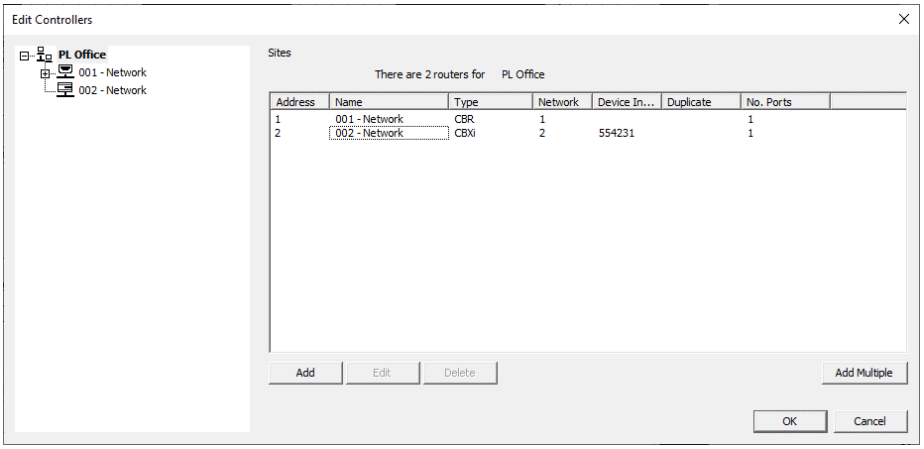
Note: If there is a local requirement not to use NTP, deselect the Enabled checkbox and use the inputs under Date and Time to set the controller's clock.

SET UP THE CONTROLLER IN A SITE IN CXpro^{HD}

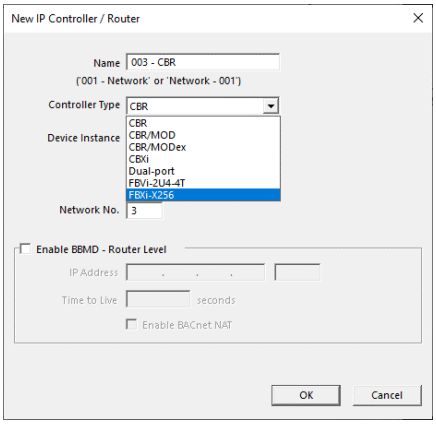
To add an **FBVi** to a side, right-click on the Site in the and select Edit Controllers:

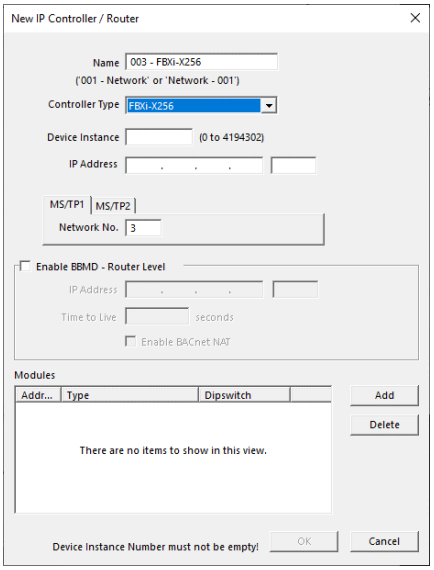


This opens the Edit Controllers dialog:



Click the Add button and select FBVi as the Controller Type in the New IP Controller / Router dialog:





Set the controller Name, Device Instance Number and IP Address : Port (for exporting to **ASPECT®** and **INTEGRA™**)

(IF REQUIRED) CONFIGURE A MODBUS CONNECTION

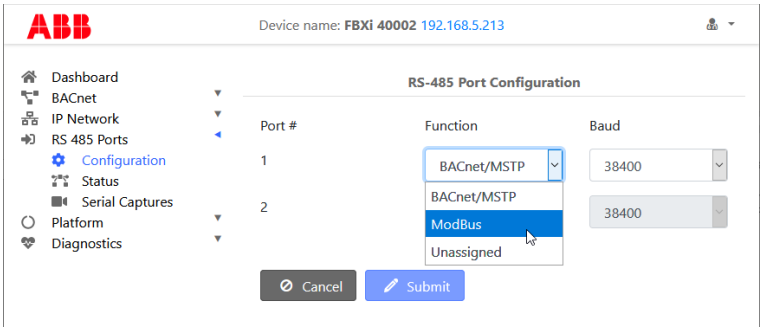
Modbus connections can be made directly to Modbus IP devices on an RTU trunk connected to the **FBVi**, or over IP to RTU devices attached to a separate router.

Note: An **FBXi** cannot have both BACnet MS/TP trunk and a Modbus RTU trunk simultaneously, but an **FBXi** controller that has an MS/TP subnet can read and write points to Modbus devices over IP.

Configuring a Modbus RTU connection

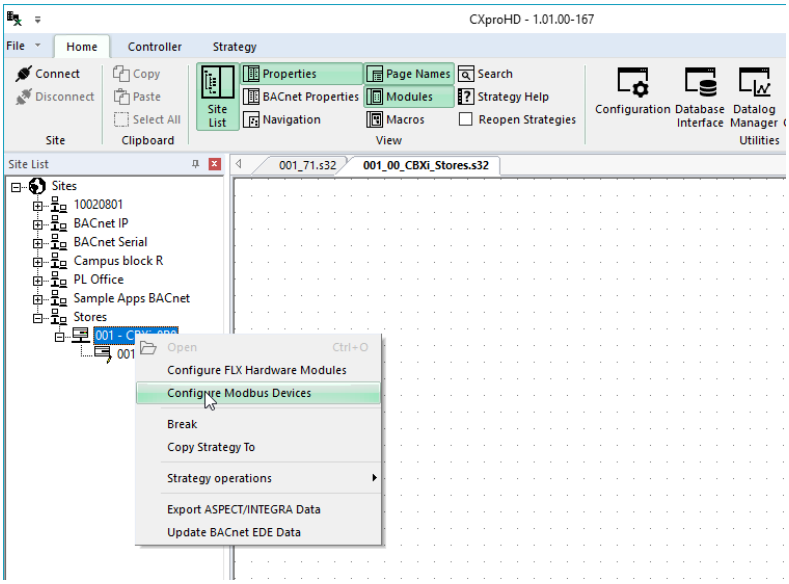
If a Modbus connection is to be through either of the RS485 Ports,

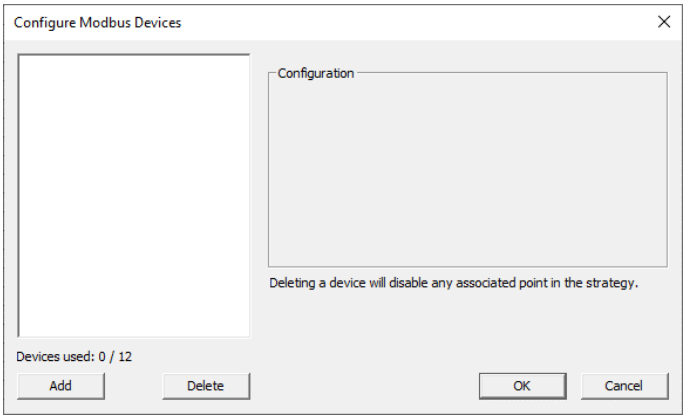
In the controller's `Web UI` > `RS 485 Port` > `Configuration` page, set `Protocol` of the required port to `Controller Modbus`:



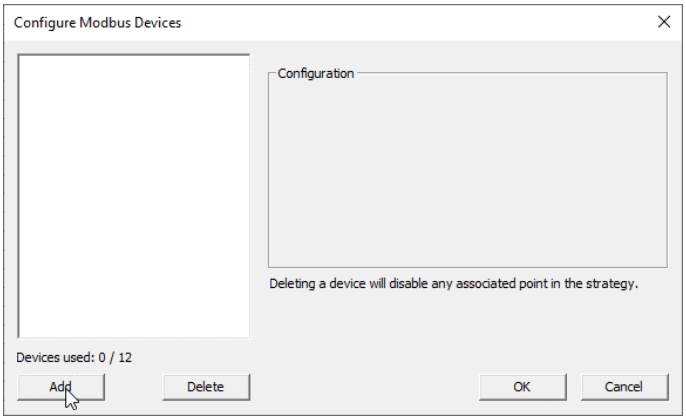
In CXpro^{HD}, open the Strategy drawing for the **FBVi**.

With the Strategy open, right-click on the **FBVi** in the `Site Tree`, and select `Configure Modbus Devices` to open the `Modbus Configuration` dialog:





Add a Modbus connection by clicking the Add button in the Configure Modbus Devices dialog

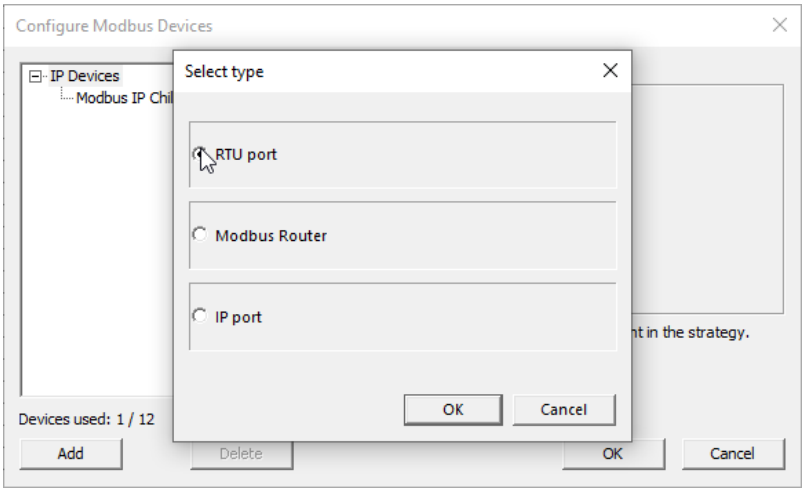


In FBXi controllers, each time you add a Modbus device you are offered the choice of adding

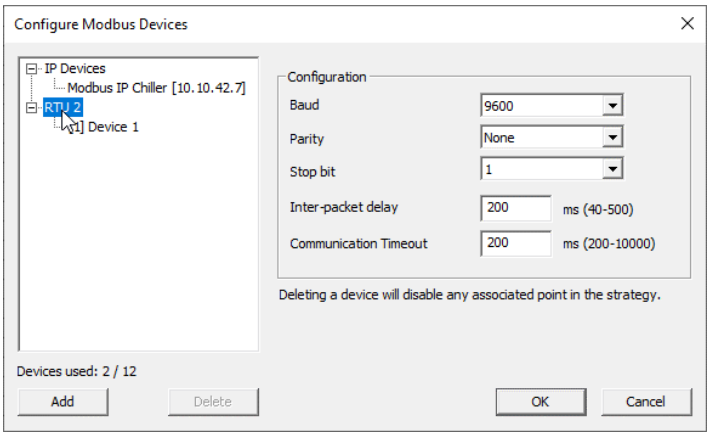
1. a Modbus RTU device connected to the FBXi's RTU port
2. a Modbus IP device
3. a Modbus RTU device connected to a separate IP Router

Connecting directly to a Modbus RTU device

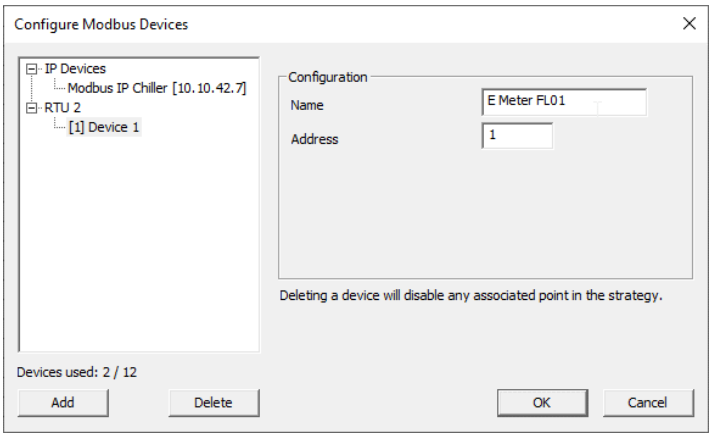
Select RTU Port and click OK,



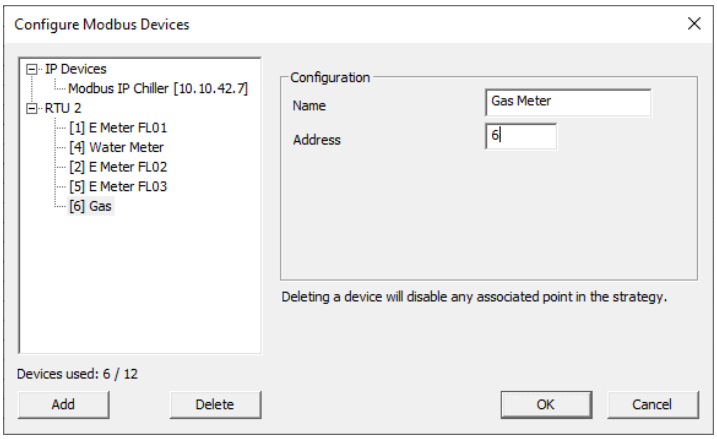
When the first Modbus RTU device is added, an entry for the RTU trunk itself is added. Select this trunk, and set the Baud rate, Parity and Stop Bit to match all other devices on the RS485 trunk:



Set a name and Modbus address for the device that was added along with the RTU trunk



For each additional device on the RTU trunk, click the Add button, select RTU and specify a name and RTU address.

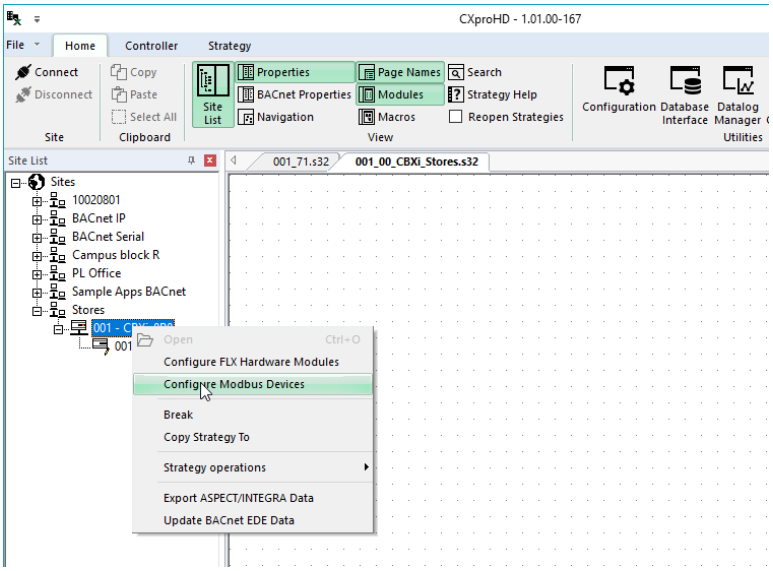


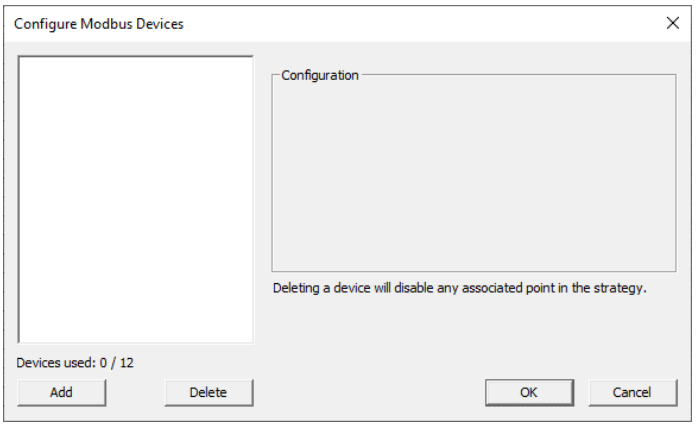
Configuring a Modbus IP connection

If a Modbus connection is to be over IP,

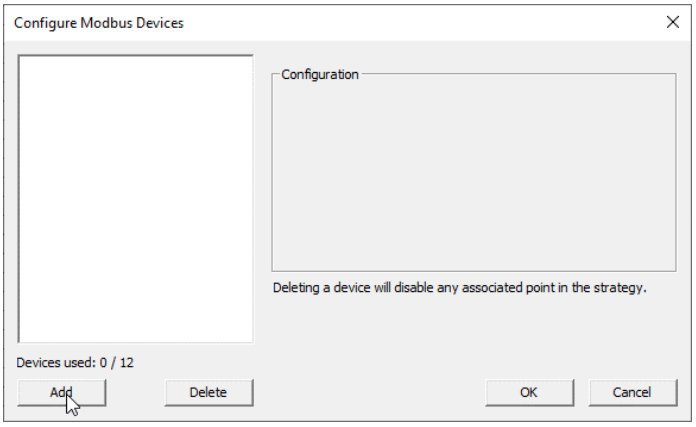
In **CXpro**^{HD}, open the Strategy drawing for the **FBVi**.

With the Strategy open, right-click on the **FBVi** in the Site Tree, and select Configure Modbus Devices to open the Configure Modbus Devices dialog:





Add a Modbus connection by clicking the Add button in the Configure Modbus Devices dialog

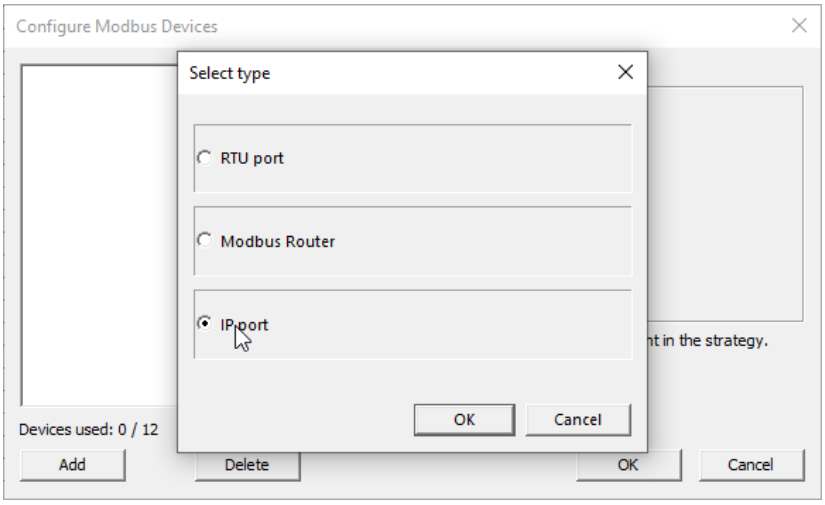


In FBVi controllers, each time you add a Modbus device you are offered the choice of adding

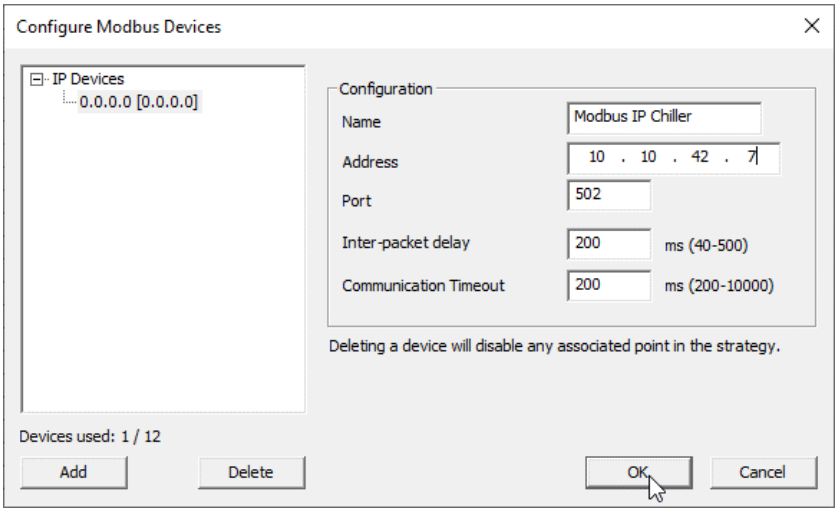
1. a Modbus RTU device connected to the FBXi's RTU port
2. a Modbus IP device
3. a Modbus RTU device connected to a separate IP Router

Connecting directly to an IP Modbus device

Select IP Port (device directly connected over IP) and click OK

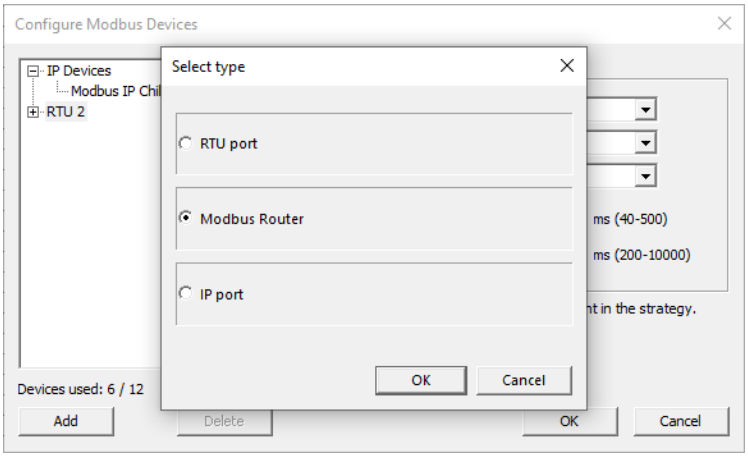


Set the Name and IP Address for the device and Click OK

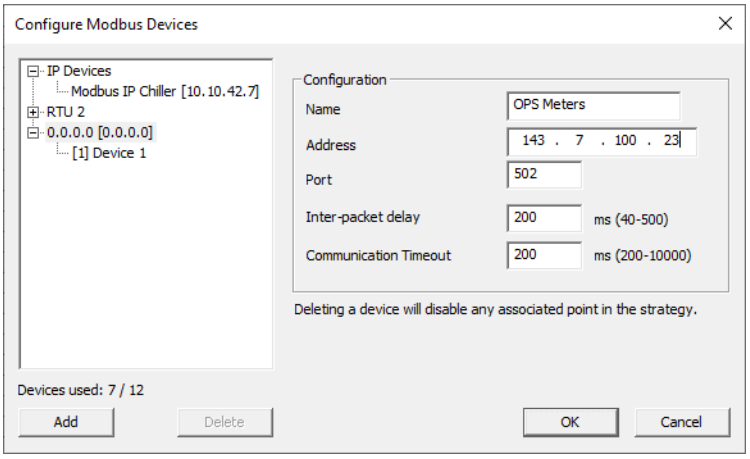


Connecting to a remote Modbus RTU device through an IP router

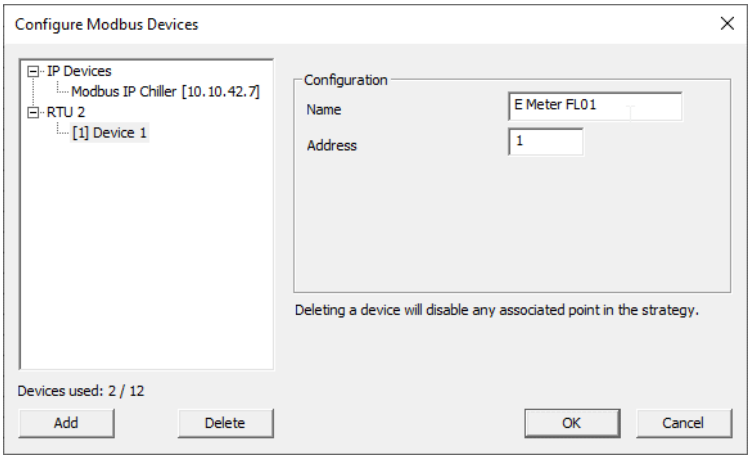
Select Modbus Router



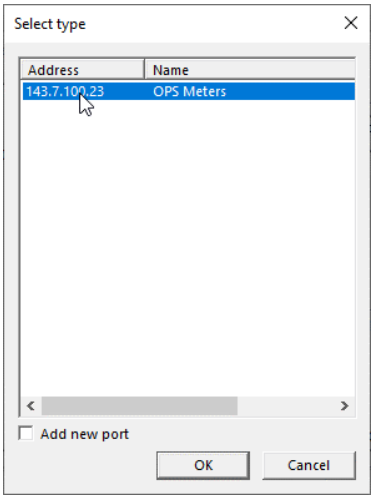
Set a Name, IP address and IP Port for the Router



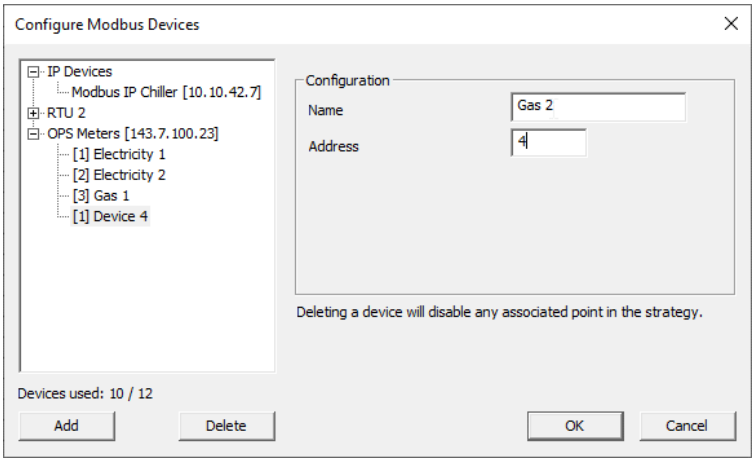
Set a name and Modbus address for the RTU device that was added along with the Router



For each additional device on the Router's RTU trunk, click the Add button, select Modbus Router, select the existing Router in the additional Select Type dialog that is displayed:



and specify a name and RTU address.



Click OK when Modbus device configuration is complete.

CONFIGURING THE FBVi-2U4-4T CONTROLLER

The FBVi-2U4-4T has a pre-loaded strategy that is designed to be highly configurable for a wide variety of VAV sequences. The sequences can be selected by writing a value to the various input and output codes that are within the strategy. There are multiple ways to configure the FBVi-2U4-4T for a specific sequence. Users are able to set these configuration values through CXpro^{HD}.

Note: For VAV sequences to meet **ASHRAE** Standards, a discharge air sensor must be installed.

SETTING FBVi-2U4-4T BACNET COMMISSIONING CONFIGURATION CODES IN CXPRO^{HD}

When commissioning the FBVi, it is recommended to use the BACnet Commissioning option in CXpro^{HD}.

Input codes

By clicking into the field associated with each input users will notice that there are multiple options which can be selected:

- **UI-1** This input is typically going to be either local zone temperature or local zone temperature with push-button override. The push-button override option is the override button for occupying the VAV while in an unoccupied state. On some standard room sensors, this simply “shorts” the thermistor while the button is pushed. If a CBT-STAT or FusionAir Smart Sensor is being used, it can be configured as an occupancy sensor or window sensor.
- **UI-2** This input is typically going to be configured for set point slide adjust. This input will support a 5K POT to support room sensors. It can also be configured as an occupancy sensor or a window sensor.
- **UI-3** This input is used as the Discharge Air Temperature. There are no configurable options for this input.
- **UI-4** This input can be configured for a variety of different options. By default, it is configured for a CO_2 sensor. Other options are:
    - Humidity Sensor
    - Occupancy Sensor
    - Window Sensor
    - Fan Status

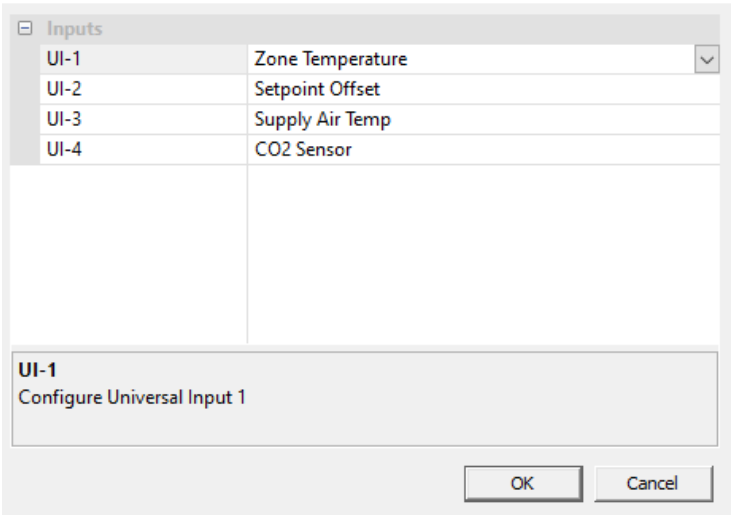
Output codes

By clicking into the field associated with each output, multiple options can be selected:

- **DO-09** can be configured for first stage heat on/off control or to open a tristate actuator.
- **DO-10** can be configured for second stage heat on/off control or to close a tristate actuator.
- **DO-11** is configured for third stage heat on/off control.
- **DO-12** can be configured for parallel or series constant volume fan
- **AO-14** can be configured for modulating heat control. By default, this will be first stage heat unless otherwise specified under options.
- **AO-15** can be configured for modulating heat control. By default, this will be second stage heat unless otherwise specified under options. This output can also be configured for parallel variable speed fan, or series variable speed fan.

INPUT CONFIGURATION

The inputs should be configured using the CXProHD BACnet commissioning tool. If changing the configuration in the field, use these values.



For UI1 Configuration, set UI1Config (A173) analog setpoint to the following:

- 0 = Zone Temperature (default)
- 1 = Occupancy Sensor
- 2 = Window Sensor

For UI2 Configuration, set UI2Config (175) analog setpoint to the following:

- 0 = Temperature Offset 0-5K Ohm (default)
- 1 = Occupancy Sensor
- 2 = Window Sensor

For UI3 Configuration, set UI3Config (A176) analog setpoint to the following:

- 0 = Discharge Air Temperature (default)
- 1 = No discharge Air Temperature

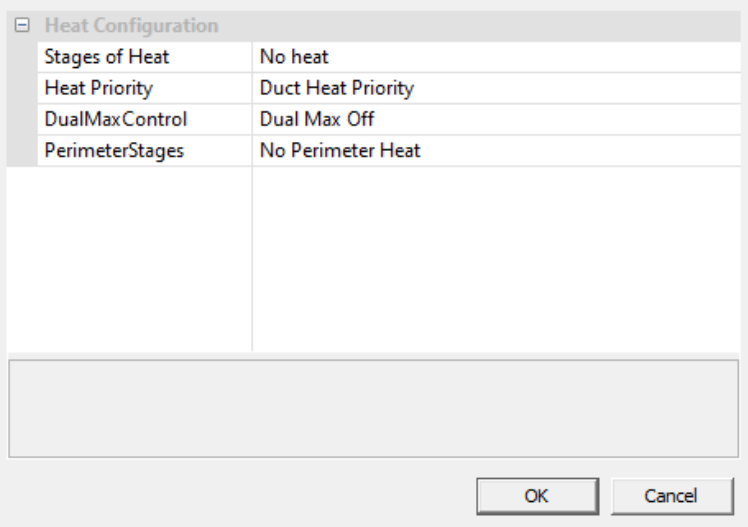
For UI4 Configuration, set UI4Config (A174) analog setpoint to the following:

- 0 = CO_2 Sensor (default)
- 1 = Humidity Sensor
- 2 = Occupancy Sensor
- 4 = Window Sensor
- 5 = Fan Status

HEAT SETUP

The FBVI-2U4-4T has 3 Digital Outputs (DO) to control heat stages, one dedicated digital output for a digital fan command, and 2 Analog Outputs (AO) to control modulating heat or fans. A tri-state heating valve may be configured using `DO-10` and `DO-11`.

The heatConfig (A4) analog setpoint will determine the stages of heat, heating priority, and if there is perimeter heat available. Using the CXProHD BACnet commissioning, the configuration number will be automatically calculated. If changing the values in the field, select each option, and add the numbers for the final number to enter into the heatConfig (A4) analog setpoint.



Options to select are:

- 0 = No Heat (default)
- 1 = One stage of Heat
  - Unit has one stage of heat.
- 2 = Two stages of Heat
  - Unit has two stages of heat.
- 4 = Three stages of Heat
  - Unit has three stages of heat.
- 16 = Is Duct heat or perimeter heat the priority
  - If Duct heat is the priority, the stages of duct heat will be enabled before the stages of Perimeter heat
  - If Perimeter heat is the priority, the stages of perimeter heat will be enabled before the stages of Duct heat.
- 32 = Operate both Duct heat and perimeter heat simultaneously
  - When both duct and perimeter heat are available, this will enable both the first stages of heat for both duct and perimeter heat at the same time.
- 64 = Use Dual Max Control
  - When the unit has a discharge air temperature sensor configured, this will enable the dual max heating sequence to be used for duct heating. See the control sequences section for dual max heating control details.

If Perimeter Heat is available, set the number of stages of Perimeter heat using the stagesOfPerimeterHeat (A75) analog setpoint.

HEAT ORDER

The Stages of heat will always operate in this order, with duct heat always wired as stages 1, 2, or 3. Perimeter/Baseboard heat is always be wired AFTER duct heat stages. If there is no duct heat, wire perimeter heat on stages 1, 2, or 3 instead.

For example, if there are 3 stages of heat, with 2 stages of duct heat and 1 stage of perimeter heat, wire duct heat on `DO-09` and `DO-10`, and wire perimeter heat on `DO-11`.

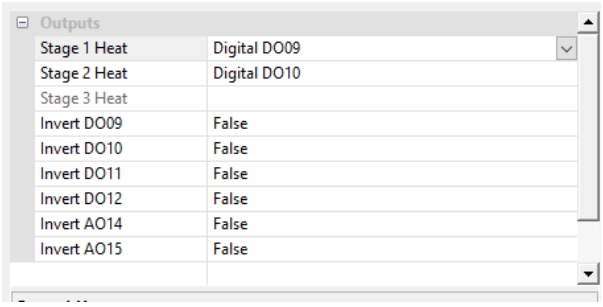
Priority order can be determined from the heatConfig (A4) setpoint.

If duct heat has priority with this example, `DO-09` and `DO-10` will be enabled before `DO-11`. If Perimeter heat has priority, `DO-11` will be enabled before `DO-09` and `DO-10`.

- `DO-09` = 1st stage of Heat (if tri-state is configured, the first stage is DO-10 and DO-11)
- `DO-10` = 2nd stage of Heat (not available Tri-State is selected for 1st stage)
- `DO-11` = 3rd stage of Heat (if tri-State is 1st stage, and a digital 2nd stage is needed, set heatConfig (A4) to 3 stages of heat)
- `DO-12` reserved for On/Off control for fan only.
- `AO-14` = 1st stage of Heat
- `AO-15` = 2nd stage of Heat (not available if a variable fan is configured)

DIGITAL HARDWARE OUTPUT CONFIGURATION

Each stage of heat requires the hardware output to be configured. The default setting for the heating outputs is digital on/off control on `DO-09, DO-10, DO-11`. `DO-12` is reserved for fan control only.



`DO-09` can be set with stg1OutType (A1) setpoint for:

- 0 = Digital on/off
- 1 = 0-10V
- 2 = 2-10V
- 3 = Tri-State
- 4 = Custom AO14 range

`DO-10` can be set with stg2OutType (A2) setpoint for:

- 0 = Digital on/off
- 1 = 0-10v
- 2 = 2-10v
- 4 = Custom AO15 range

`DO-11` is set for:

- Digital on/off

`DO-12` is set for:

- Digital on/off

DIGITAL OUTPUT DIRECT/REVERSE ACTION

In the FBVI-2U4-4T the digital outputs could also be set for reverse acting. This would be typically used for controlling normally-closed heating valves. The digital outputs are N.O. (normally open) operation.

To set digital outputs for N.C. (normally closed) operation:

- For DO09, set reverseDO09 (D198) digital setpoint to On
- For DO10, set reverseDO10 (D200) digital setpoint to On
- For DO11, set reverseDO11 (D202) digital setpoint to On
- For DO12, set reverseDO12 (D300) digital setpoint to On

ANALOG HARDWARE OUTPUT RANGE OPTIONS

AO14 and AO15 ranges can be selected with the stg1OutType (A1) or stg2OutType (A2) analog setpoints if both stages are set to heat. If AO15 is used for a variable fan, change the stg2OutType (A2) setpoint.

To customize the voltage ranges, use the following analog setpoints:

For the custom selection on AO14

- AO14_HiAOValue (A373) is 10V by default. This is adjustable.
- AO14_LowAOValue (A372) is 2V by default. This is adjustable

For the custom selection on AO15

- AO15_HiAOValue (A389) is 10V by default. This is adjustable.
- AO15_LowAOValue (A388) is 2V by default. This is adjustable

ANALOG OUTPUT DIRECT/REVERSE ACTION

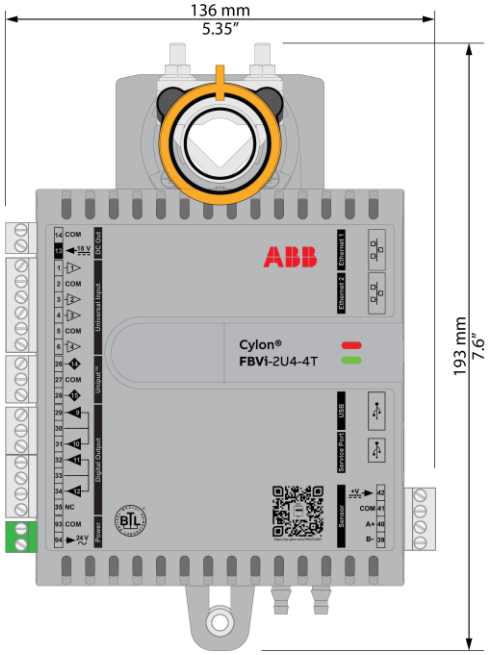
The analog outputs are set up to be direct-acting as default, or 0 to 100% = low value to high value.

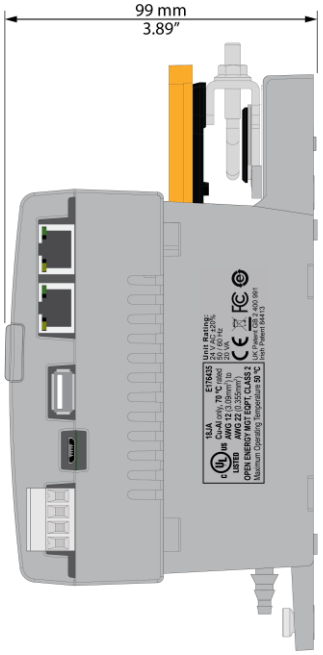
To set up for reverse acting, (0 to 100% = high value to low value)

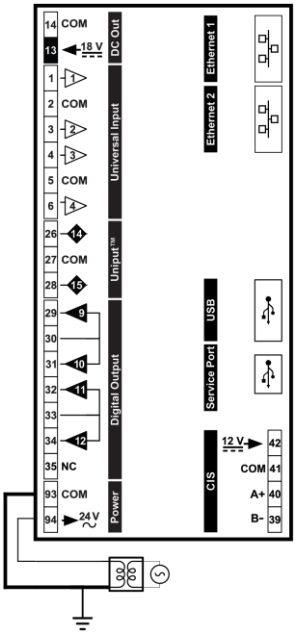
- For AO14, set reverseAO14 (D205) digital setpoint to On
- For AO15, set reverseAO15 (D206) digital setpoint to On

6 FBVi Operation

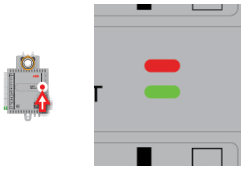
PHYSICAL LAYOUT



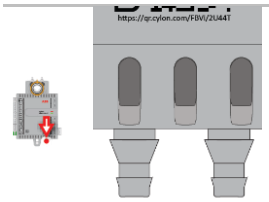




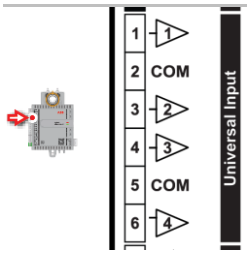
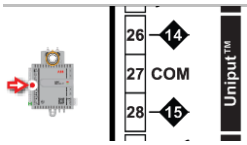
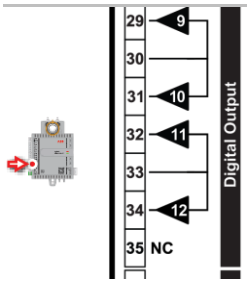
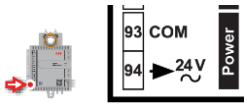
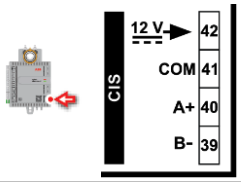
Description					
Indicator LEDs					
		Off	**On**	**Slow Blink**	**Fast blink**
	Red LED (Power)	Power is off	Power is on	—— Unit Rebooting ——	
	Green LED (Status)	Unit is not running	Strategy Loaded but no network connectivity	Strategy Loaded and device communicating on network	No Strategy loaded

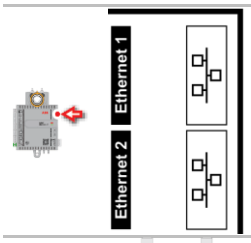
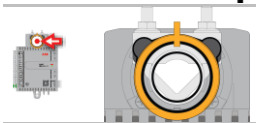
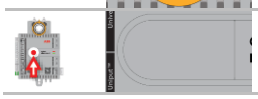


Note: During typical operation, the Red LED should be on, the Green LED should be blinking.



Bidirectional Airflow Sensor
External connection at bottom of housing

	Terminal Numbers	Description
	1, 3, 4, 6	Universal Inputs
	26, 28	UniPut™
	29, 31, 32, 34 30, 33	Triac Outputs Triac Common
	93, 94	Power 24 V AC **Important**: The common power connection (terminal 33) must be connected to Earth. ABB Cylon recommend that this is done at the 24 V AC transformer.
	41, 42 39, 40	Cylon® room sensor Power supply Cylon® room sensor RS485

	Description
	Ethernet
	Rotary Actuator
	Damper Manual Override

INPUTS AND OUTPUTS

Any of the UniPut terminals can be configured as an output.

INPUT MODES

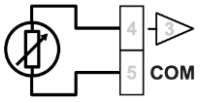
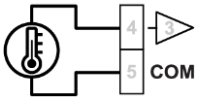
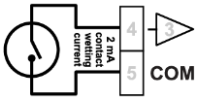
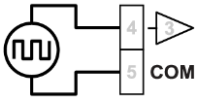
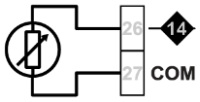
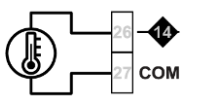
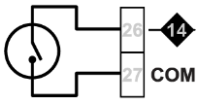
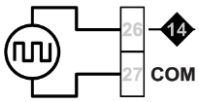
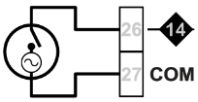
Universal Input terminals and UniPut™ terminals can be configured as inputs in almost identical fashion:

Measurement Mode	Universal Input	UniPut™ as Input:
Resistance	**Resistance measurement** Range: 0 ... 450 kΩ Accuracy: ±0.5% of measured resistance	
	Temperature measurement Range: -40 °C ... +110 °C Accuracy: 10k NTC sensors (e.g. 10k Type 2 (10K3A1) or 10k Type 3 (10K4A1): ±0.3 °C, -40 to 90 °C (-40°F to 194°F); ±0.4 °C > 90 °C (194°F)	
	Pulse counting (volt-free) up to 20 Hz, 25 ms – 25 ms	
	-	24 V AC Detect
Voltage	**Analog Input** Range: 0 ... 10 V @ **130 kΩ** Accuracy: ±0.5% full scale [50mV]	**Analog Input** Range: 0 ... 10 V @ **40 kΩ** Accuracy: ±0.5% full scale [50mV]
	Pulse counting (0 … 10 V) up to 20 Hz, 25 ms – 25 ms	
Current	**Current input** Range: 0 ... 20 mA @ 390 Ω Accuracy: ±0.5% full scale [100µA]	**Current input** Range: 0 ... 20 mA @ 390 Ω Note: Current Input requires user-supplied external 390 Ω resistance. Accuracy: depends on user supplied external resistor

Note: Inputs use on-board 16-bit analog to digital convertor.
Note: All inputs and outputs are protected against short circuit, as well as over-voltage up to 24 V AC.

Resistance Input mode (Passive Input)

Passive Inputs are all those devices that vary in resistance, including switch contacts.

	Resistance measurement	Temperature Measurement	Switch Contact	Pulse counting	24 V AC Detection
Universal Input					n/a
Uniput					

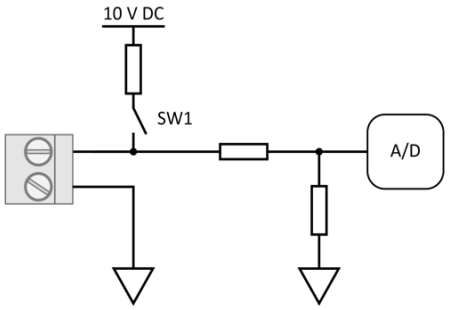
These all require a current supplied by the FLX terminal so that this resistance can be measured.

The passive sensor types supported by the FBVi-2U4-4T are:

- Pre-programmed Passive Temperature Sensors.
- Potentiometer (normally used as a 0 to 10 KΩ or a 1 KΩ to 11 KΩ variable resistor to give a 0 to 100 % output).
- Volt-Free Digital Input (the controller strategy measures the contact resistance and gives a `0` or `1` output).
- Straightforward Resistance measurement. This can be used with the `Make Linear` block to give a temperature output for temperature sensors that are not factory pre-programmed into the FBVi-2U4-4T.

In CXpro[HD] simply select '`Resistance`' sensor type in the `Point Module` and select `Pulsed` in the `Advanced` parameters (the Pulsed option increases accuracy by eliminating any self-heating in the passive temperature sensor, while the Continuous option can trade absolute accuracy for speed).

In Passive Input Mode the Uniputs™ and Universal Inputs configure like this:



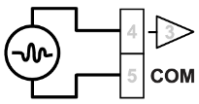
Note: The reference voltage can be pulsed or continuous, using the solid state switch.
A pulsed reference gives optimum accuracy by eliminating self-heating in the sensor, and this is the default setting.

UniPut™ 24 V AC Detection

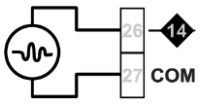
If 24 V AC is connected to a Uniput™ terminal, then the 24 V AC Detect circuit will detect this and will open switch `SW1`. `SW1` stays open for the duration of the 24 V AC state. When 24 V AC is removed from the Uniput™ terminal then the short circuit or open circuit states can again be detected.

Voltage input mode (Active Input)

Universal Input



Uniput

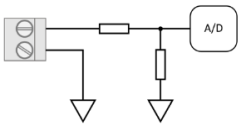


Note: Input Impedance for Universal Input terminals is 130 kΩ.
Input Impedance for Uniput™ terminals is 40 kΩ.

The 0 … 10 V input is used for Active analog and digital measurements. 'Active' means that there is no current supplied by the FLX for the sensor, as the signal is generated completely by the Sensor.

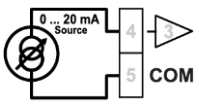
The '`mV`' sensor setting gives a value between `0` and `10,000`, which represents voltage in mV.

In `0 ... 10V Input` Mode, the Uniputs™ configure like this:

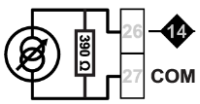


Current Input mode (Active Input)

Universal Input

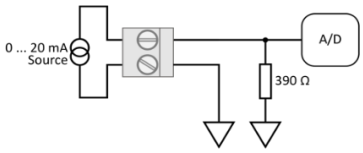


Uniput



The Current Input is used for `0 ... 20 mA` or `4 ... 20 mA` Active sensors.

`4 ... 20 mA` scaling can easily be achieved using CXpro[HD] by entering range values in the Point Module '`Advanced`' parameters.

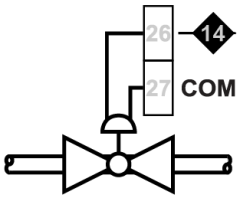


OUTPUT MODES

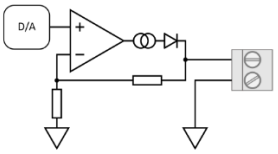
UniPut terminals can generate an output as follows:

- Analog Output 0 ... 10 V, 20 mA, 12-bit resolution
- Digital Output 0 ... 10 V, 20 mA
- Relay Contacts with ability to switch up to 24 V AC
  Maximum Load: 24 V AC, 2 (1) A resistive (inductive) for all relay contacts

Analog 0 … 10 V output mode

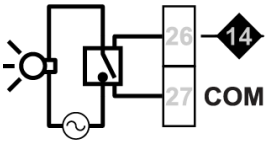


In `Analog 0 ... 10 V output` Mode, the Uniputs configure themselves like this:

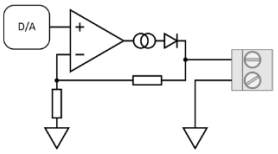


where the D/A is the digital to analog converter. All circuitry is fully protected against 24 V AC.

Digital 0 … 10 V output mode



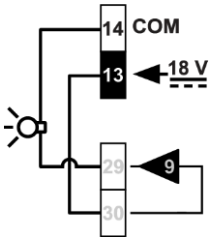
In `Digital 0 ... 10 V output` Mode, the Uniputs configure in the same way as for analog:



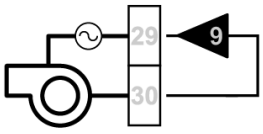
In this mode the output toggles between the voltages defined as "`ON`" and "`OFF`".

Triac Outputs

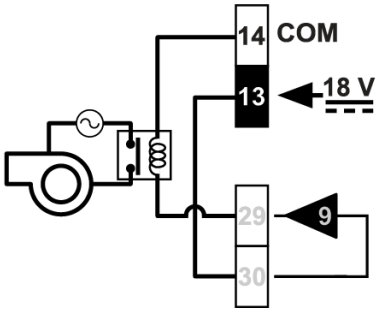
Triac Outputs can make use of the 24VAC Auxiliary Power outputs



But if more power is needed, a properly rated external power source must be used.

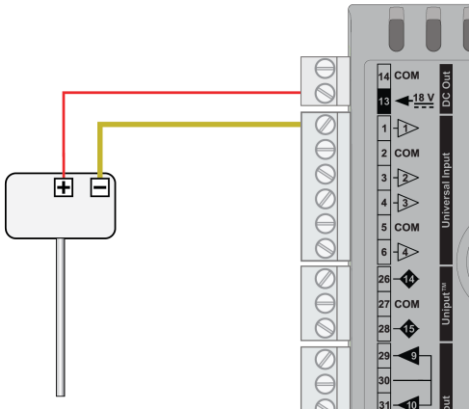


When wiring triacs, loads can be resistive or inductive. If your load requires more than 24 V or more than 500 mA, a properly sized intermediate relay must be used.

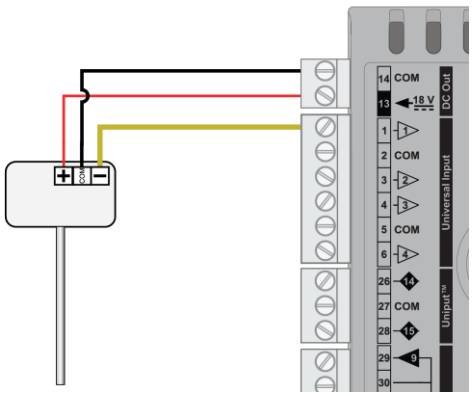


AUXILIARY POWER OUTPUT

FBVi-2U4-4T has one 18 V DC output, for I/O devices that require loop power.



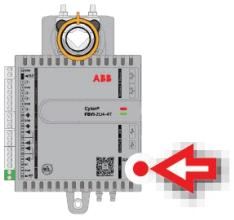
For 3-wire connections return can be through any COM terminal, but it is recommended that Auxiliary power wiring is through terminal 14, the COM between the two Auxiliary power terminals.

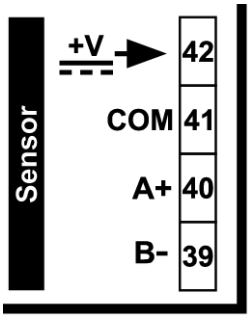


The DC output terminals provide a minimum of 18 V DC, but the load must remain below 60 mA.

USING A KEYPAD WITH THE FBVi

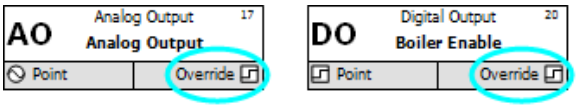
A CBT-STAT or FusionAir Smart Sensor can be connected to the FBVi at the Sensor port.





Note: CBT-STAT / FusionAir Smart Sensor can not be used to balance a VAV box.

The Controller Strategy can determine if an override is in place is by connecting to the Override point on the output module:



The value of the Override point will be '0' when the output is active and '1' when the point has been manually overridden. This allows the strategy to react to the fact that a point has been overridden.

Note: The corresponding terminal LED will indicate the override condition.

7 FBVI-2U4-4T Control Sequences

FBVI-2U4-4T COMMON CONTROL SEQUENCES

This section provides details of the typical control sequences used for most VAV applications. The sequences covered in this manual include the following:

- VAV Cooling only No Fan
- VAV Cooling only
- VAV Cooling only Variable Series Speed Fan
- VAV One to Three Stage Electric Reheat No Fan
- VAV One to Three Stage Electric Reheat Single Speed Fan
- VAV One to Three Stage Electric Reheat Variable Speed Fan
- VAV Modulating Hot Water Reheat No Fan
- VAV Modulating Hot Water Reheat Single Speed Fan
- VAV Modulating Hot Water Reheat Variable Speed Fan

VAV COOLING ONLY NO FAN

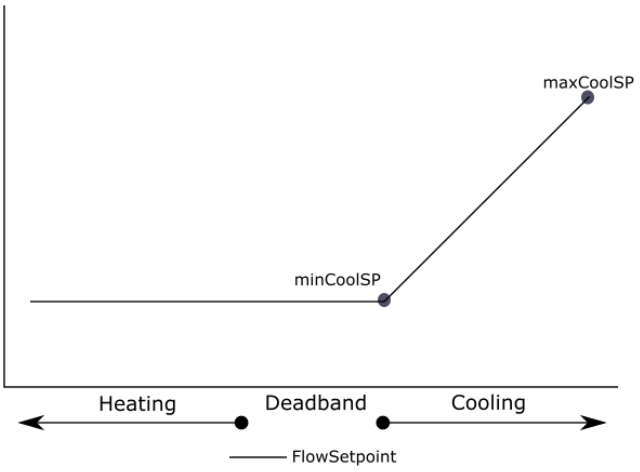
TEMPERATURE CONTROL

When the zone temperature is greater than the cooling temperature setpoint, the controller will enter the cooling mode. The primary airflow rate will be varied between its minCoolFlowStpt (A227), and its maximum Flowrate setpoint maxCoolFlowStpt (A228) as required to maintain the zone at the cooling temperature setpoint. Once the zone temperature falls below the cooling temperature setpoint, it will exit the cooling mode.

When the zone temperature is between the cooling and heating temperature setpoints, it will be in Deadband or Vent Mode. The controller will maintain the minCoolFlowStpt (A227).

When the zone temperature falls below the heating setpoint, the controller will enter the heating mode and the primary airflow rate will maintain the minCoolFlowStpt (A227). Once the zone temperature rises above the heating temperature setpoint, it will exit heating mode.

Cooling Only



INPUT / OUTPUT POINTS

VAV Cooling Only, no fan

IO POINTS	DESCRIPTION
UI-01	Zone Temperature (with optional override button) occupancy, or window contact (all optional)
UI-02	Setpoint Adjustment (optional 5K slider) occupancy, or window contact (all optional)
UI-03	Discharge Temperature
UI-04	CO_2, Humidity, occupancy, fan status, or window contact (all optional)
UI-08	Flowrate Sensor
DO-09	
DO-10	
DO-11	
DO-12	
AO-14	
AO-15	
AO-16	Damper Control

VAV COOLING ONLY CONSTANT SERIES SPEED FAN

TEMPERATURE CONTROL

When the zone temperature is greater than the cooling temperature setpoint, the controller will enter the cooling mode. The primary airflow rate will be varied between its minCoolFlowStpt (A227), and its maximum Flowrate setpoint maxCoolFlowStpt (A228) as required to maintain the zone at the cooling temperature setpoint. Once the zone temperature falls below the cooling temperature setpoint, it will exit the cooling mode.

When the zone temperature is between the cooling and heating temperature setpoints, it will be in Deadband or Vent Mode. The controller will maintain the minCoolFlowStpt (A227).

When the zone temperature falls below the heating setpoint, the controller will enter the heating mode and the primary airflow rate will maintain the minCoolFlowStpt (A227). Once the zone temperature rises above the heating temperature setpoint, it will exit heating mode.

DAMPER CONTROL

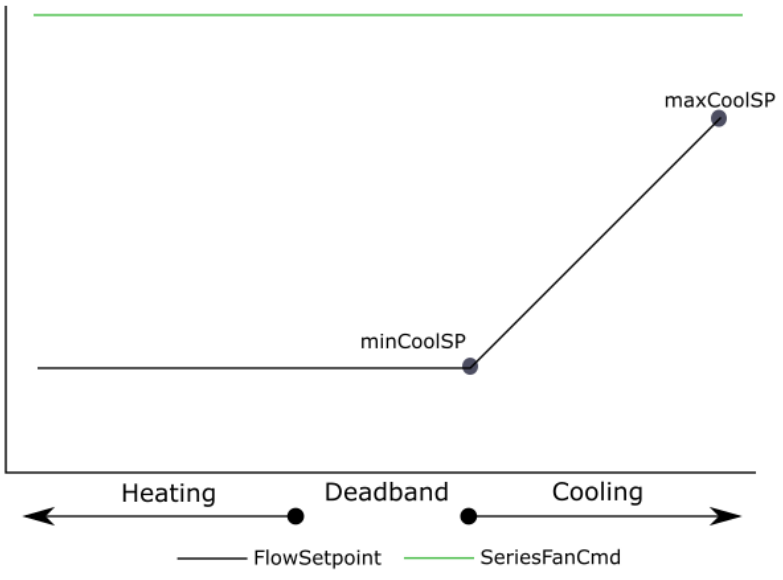
Before the series fan is enabled, the damper will close for 60 seconds to prevent the box fan from running backwards.

SERIES SINGLE SPEED FAN

The fan (DO 13) will operate continuously whenever the unit is in the occupied state, or if there is a request for heating or cooling. The fan control matrix is as follows:

MODE	COOLING	DEADBAND	HEATING
Occupied	On	On	On
Unoccupied	On	Off	On
Warm-up	N/A	On	On
Standby	On	On	On

Cooling with Constant Series Fan



INPUT / OUTPUT POINTS

VAV Cooling Only 1-speed fan

IO POINTS	DESCRIPTION
UI-01	Zone Temperature (with optional override button) occupancy, or window contact (all optional)
UI-02	Setpoint Adjustment (optional 5K slider) occupancy, or window contact (all optional)
UI-03	Discharge Temperature
UI-04	CO_2, Humidity, occupancy, fan status, or window contact (all optional)
UI-08	Flowrate Sensor
DO-09	
DO-10	
DO-11	
DO-12	Series Fan Cmd
AO-14	
AO-15	
AO-16	Damper Control

VAV COOLING ONLY VARIABLE SERIES SPEED FAN

TEMPERATURE CONTROL

When the zone temperature is greater than the cooling temperature setpoint, the controller will enter the cooling mode. The primary airflow rate will be varied between its minCoolFlowStpt (A227), and its maximum Flowrate setpoint maxCoolFlowStpt (A228) as required to maintain the zone at the cooling temperature setpoint. Once the zone temperature falls below the cooling temperature setpoint, it will exit the cooling mode.

When the zone temperature is between the cooling and heating temperature setpoints, it will be in Deadband or Vent Mode. The controller will maintain the minCoolFlowStpt (A227).

When the zone temperature falls below the heating setpoint, the controller will enter the heating mode and the primary airflow rate will maintain the minCoolFlowStpt (A227).

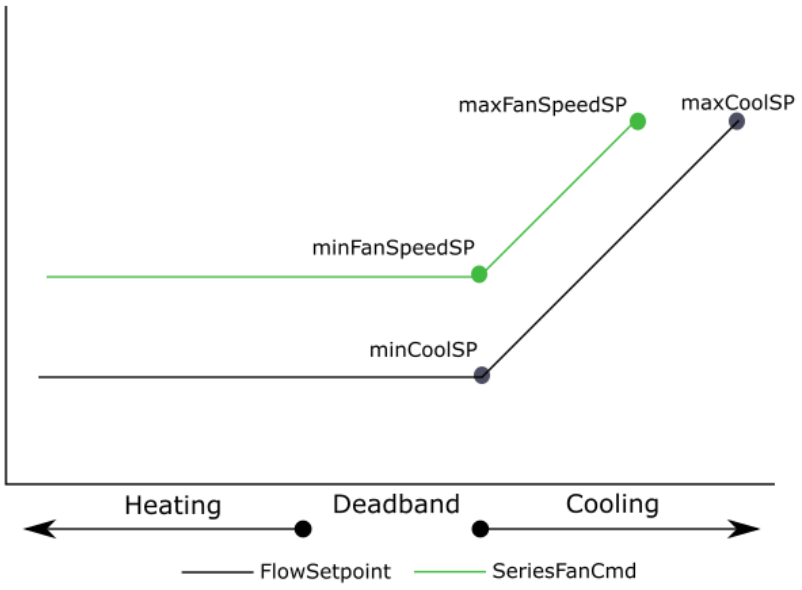
DAMPER CONTROL

Before the series fan is enabled, the damper will close for 60 seconds to prevent the box fan from running backwards.

SERIES VARIABLE SPEED FAN

The variable fan speed will be controlled by modulating AO 15 (default 0 ··· 10 Vdc). As more cooling is required, the fan speed will increase.

Cooling with Variable Series Fan



INPUT / OUTPUT POINTS

VAV Cooling Only with variable speed fan

IO POINTS	DESCRIPTION
UI-01	Zone Temperature (with optional override button) occupancy, or window contact (all optional)
UI-02	Setpoint Adjustment (optional 5K slider) occupancy, or window contact (all optional)
UI-03	Discharge Temperature
UI-04	CO_2, Humidity, occupancy, fan status, or window contact (all optional)
UI-08	Flowrate Sensor
DO-09	
DO-10	
DO-11	
DO-12	
AO-14	
AO-15	Series Fan Cmd
AO-16	Damper Control

VAV ONE TO THREE STAGE ELECTRIC REHEAT NO FAN

TEMPERATURE CONTROL

When the zone temperature is greater than the cooling temperature setpoint, the controller will enter the cooling mode. The primary airflow rate will be varied between its minCoolFlowStpt (A227), and its maximum Flowrate setpoint maxCoolFlowStpt (A228) as required to maintain the zone at the cooling temperature setpoint. Once the zone temperature falls below the cooling temperature setpoint, it will exit the cooling mode.

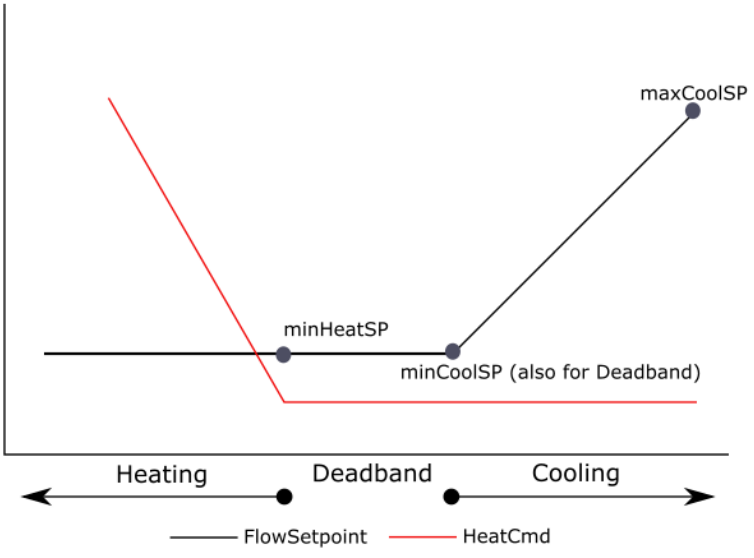
When the zone temperature is between the cooling and heating temperature setpoints, it will be in Deadband or Vent Mode. The controller will maintain the minCoolFlowStpt (A227).

If the activeAirflow (A250) is 50 cfm below the minHeatFlowStpt (A230), and the duct heat is digital, the heat will be disabled.

When the zone temperature falls below the heating setpoint, the controller will enter the heating mode.

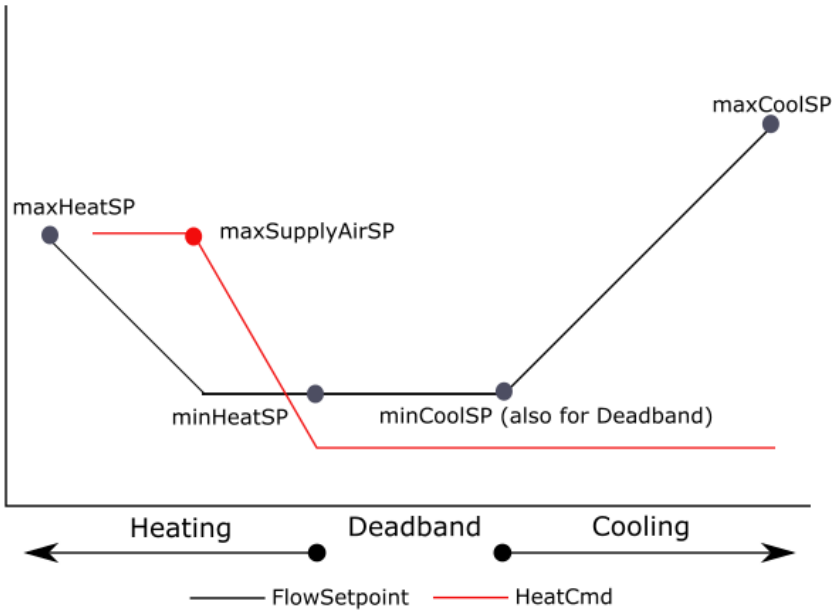
- If no discharge air temperature sensor is configured, or DualMax control is not enabled:
    - If there is no discharge air temperature sensor configured, as heating demand rises from 0-100%, the stages of heat shall be enabled to maintain zone temperature setpoints. Flow will maintain minHeatFlowStpt (A230) setpoint.
    - If a discharge air temperature sensor is configured, the discharge air temperature shall be reset upwards, displayed as dischargeAirTempStpt (A31) to a maximum set at maxDischargeAirTempStpt (A323). The stages of heat shall be enabled to maintain a discharge air temperature setpoint. Flow will maintain minHeatFlowStpt (A230) setpoint.

Cooling with Heat (no DualMax)



- If the discharge air temperature is configured and DualMax control is enabled:
    - As heating demand rises from 0-50%, the discharge air temperature shall be reset upwards, to a maximum of 20 deg above zone temperature. The stages of heat shall be enabled to maintain a discharge air temperature setpoint.
    - As heating demand rises from 51-100%, the airflow setpoint shall reset from the minHeatFlowStpt (A230) to the maxHeatFlowStpt (A229) flow.
    - The duct coil shall control the VAV discharge air temperature to the setpoint. The duct coil shall not directly control zone temperature.

Cooling with Staged Heat (DualMax)



INPUT / OUTPUT POINTS

VAV Electric Reheat, no fan

IO POINTS	DESCRIPTION
UI-01	Zone Temperature (with optional override button) occupancy, or window contact (all optional)
UI-02	Setpoint Adjustment (optional 5K slider) occupancy, or window contact (all optional)
UI-03	Discharge Temperature
UI-04	CO_2, Humidity, occupancy, fan status, or window contact (all optional)
UI-08	Flowrate Sensor
DO-09	Stage 1 Electric Heat
DO-10	Stage 2 Electric Heat
DO-11	Stage 3 Electric Heat
DO-12	
AO-14	
AO-15	
AO-16	Damper Control (**FBVI-2U4-4T** only)

VAV ONE TO THREE STAGE ELECTRIC REHEAT SINGLE SPEED FAN

TEMPERATURE CONTROL

When the zone temperature is greater than the cooling temperature setpoint, the controller will enter the cooling mode. The primary airflow rate will be varied between its minCoolFlowStpt (A227), and its maximum Flowrate setpoint maxCoolFlowStpt (A228) as required to maintain the zone at the cooling temperature setpoint. Once the zone temperature falls below the cooling temperature setpoint, it will exit the cooling mode.

When the zone temperature is between the cooling and heating temperature setpoints, it will be in Deadband or Vent Mode. The controller will maintain the minCoolFlowStpt (A227).

In heating mode, the controller will maintain the minHeatFlowStpt (A230).

If the activeAirflow (A250) is below the minHeatFlowStpt (A230), the heat will be disabled.

When the zone temperature falls below the heating setpoint, the controller will enter the heating mode.

- If no discharge air temperature sensor is configured is not enabled:
    - As heating demand rises from 0-100%, the stages of heat shall be enabled to maintain zone temperature setpoints.
- If discharge air temperature sensor is configured (this meets ASHRAE Standards):
    - As heating demand rises from 0-100%, the discharge air temperature shall be reset upwards, displayed as dischargeAirTempStpt (A31) to a maximum set at maxDischargeAirTempStpt (A323). The stages of heat shall be enabled to maintain a discharge air temperature setpoint.

DAMPER CONTROL

Before the series fan is enabled, the damper will close for 60 seconds to prevent the box fan from running backwards.

FAN CONTROL

Parallel Single Speed Fan Option

During the occupied mode, the intermittent single speed fan will typically be energized in the heating mode. The typical fan control matrix is as follows, although other options are possible:

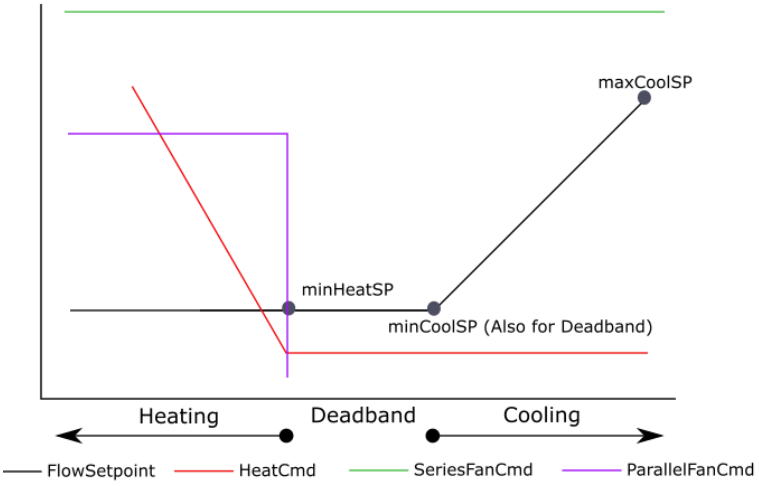
MODE	COOLING	DEADBAND	HEATING
Occupied	Off	Off	On
Unoccupied	Off	Off	On
Warm-up	Off	Off	Off
Standby	Off	Off	On

Series Single Speed Fan Option

The fan will operate continuously whenever the unit is in the occupied state, or another state and the cooling or heating mode. The fan control matrix is as follows:

MODE	COOLING	DEADBAND	HEATING
Occupied	On	On	On
Unoccupied	On	Off	On
Warm-up	N/A	On	On
Standby	On	On	On

Cooling with Staged Heat and Fan



INPUT / OUTPUT POINTS

VAV Electric Reheat with 1-speed fan

IO POINTS	DESCRIPTION
UI-01	Zone Temperature (with optional override button) occupancy, or window contact (all optional)
UI-02	Setpoint Adjustment (optional 5K slider) occupancy, or window contact (all optional)
UI-03	Discharge Temperature
UI-04	CO_2, Humidity, occupancy, fan status, or window contact (all optional)
UI-08	Flowrate Sensor
DO-09	Stage 1 Electric Heat
DO-10	
DO-1	
DO-12	Series or Parallel Fan Cmd
AO-14	
AO-15	
AO-16	Damper Control

VAV ONE TO THREE STAGE ELECTRIC REHEAT VARIABLE SPEED FAN

TEMPERATURE CONTROL

When the zone temperature is greater than the cooling temperature setpoint, the controller will enter the cooling mode. The primary airflow rate will be varied between its minCoolFlowStpt (A227), and its maximum Flowrate setpoint maxCoolFlowStpt (A228) as required to maintain the zone at the cooling temperature setpoint. Once the zone temperature falls below the cooling temperature setpoint, it will exit the cooling mode.

When the zone temperature is between the cooling and heating temperature setpoints, it will be in Deadband or Vent Mode. The controller will maintain the minCoolFlowStpt (A227).

If the activeAirflow (A250) is below the minHeatFlowStpt (A230), the heat will be disabled.

In heating mode, the controller will maintain the minHeatFlowStpt (A230).

When the zone temperature falls below the heating setpoint, the controller will enter the heating mode.

- If no discharge air temperature sensor is configured:
    - As heating demand rises from 0-100%, the stages of heat shall be enabled to maintain zone temperature setpoints.
    - As heading demand rises from 51%-100%, the fan speed setpoint shall reset from minFanSpeed (A237) to maxFanSpeed (A238)
- If discharge air temperature sensor is configured (this meets ASHRAE Standards):
    - As heating demand rises from 0-50%, the discharge air temperature shall be reset upwards, to a maximum of 20 deg above zone temperature. The stages of heat shall be enabled to maintain a discharge air temperature setpoint.
    - As the discharge air heating demand rises from 51-100%, the fan speed setpoint shall reset from the minFanSpeed (A237) to the maxFanSpeed (A238).
    - The duct coil shall control the VAV discharge air temperature to the setpoint. The duct coil shall not directly control zone temperature.

DAMPER CONTROL

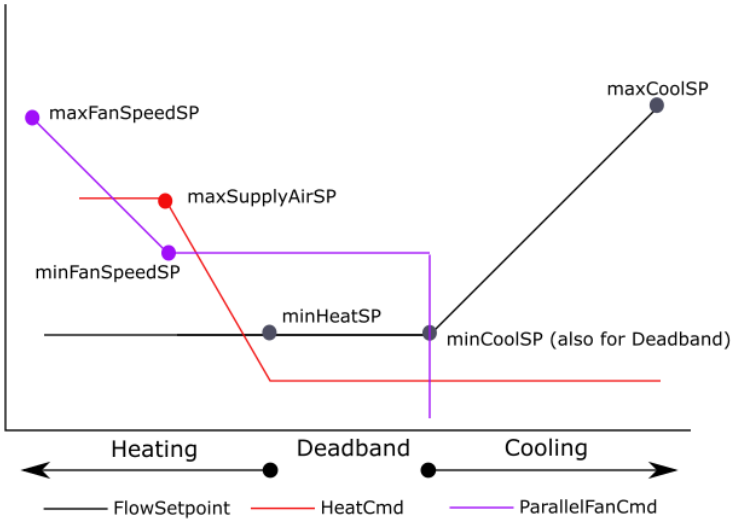
Before the series fan is enabled, the damper will close for 60 seconds to prevent the box fan from running backwards.

FAN CONTROL

Parallel Variable Fan Speed Option

The variable fan speed will be controlled by modulating `AO 15` (default 0 ··· 10 Vdc). The fan will run in heating mode only. As more heating is required, the fan speed will increase. As the heating demand increases, the variable fan command will increase from minFanSpeed (A237) setpoint to the maxFanSpeed (A238) setpoint.

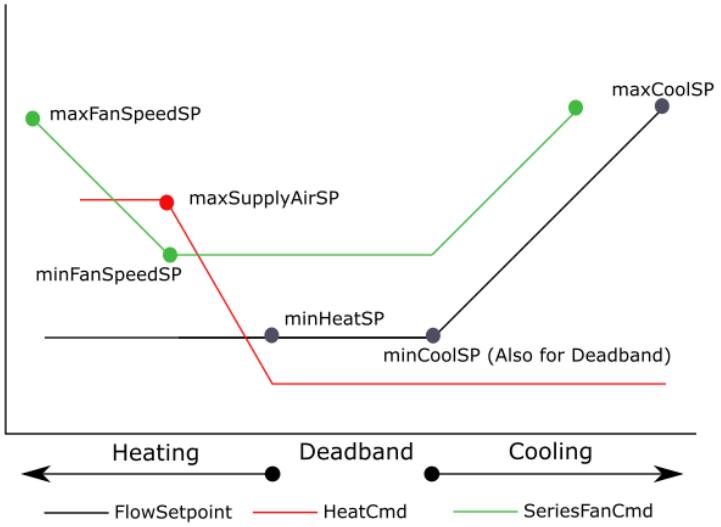
Cooling with Heat and Variable Parallel Fan



Series Variable Fan Speed Option

The variable fan speed will be controlled by modulating AO 15 (default 0 ··· 10 Vdc). In deadband mode, the fan will run at a slower speed. As the heating demand increases, the variable fan command will increase from minFanSpeed (A237) to the maxFanSpeed (A238). As the cooling demand increases, the variable fan command will increase from minFanSpeed (A237) to maxFanSpeed (A238).

Cooling with Heat and Variable Series Fan



Input / Output Points

VAV Electric Reheat with variable speed fan

IO POINTS	DESCRIPTION
UI-01	Zone Temperature (with optional override button) occupancy, or window contact (all optional)
UI-02	Setpoint Adjustment (optional 5K slider) occupancy, or window contact (all optional)
UI-03	Discharge Temperature
UI-04	CO_2, Humidity, occupancy, fan status, or window contact (all optional)
UI-08	Flowrate Sensor
DO-09	Stage 1 Electric Heat
DO-10	Stage 2 Electric Heat
DO-11	Stage 3 Electric Heat
DO-12	
AO-14	
AO-15	Series or Parallel Fan Cmd
AO-16	Damper Control

VAV MODULATING HOT WATER REHEAT NO FAN

TEMPERATURE CONTROL

When the zone temperature is greater than the cooling temperature setpoint, the controller will enter the cooling mode. The primary airflow rate will be varied between its minCoolFlowStpt (A227), and its maximum Flowrate setpoint maxCoolFlowStpt (A228) as required to maintain the zone at the cooling temperature setpoint. Once the zone temperature falls below the cooling temperature setpoint, it will exit the cooling mode.

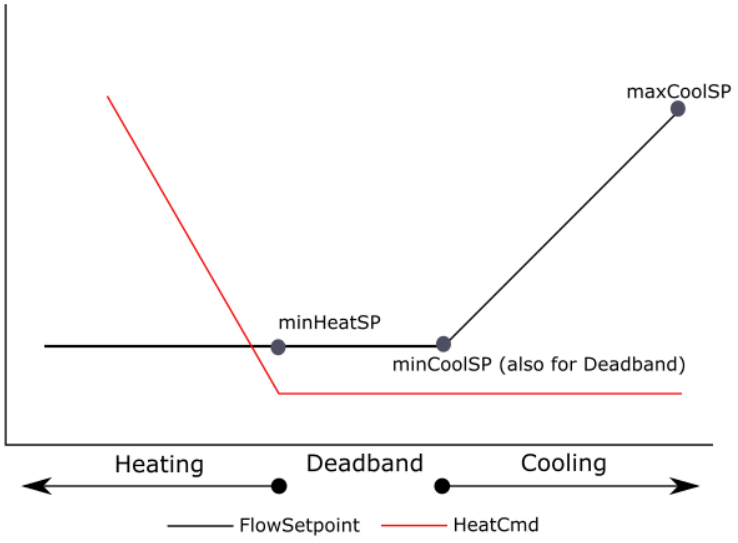
When the zone temperature is between the cooling and heating temperature setpoints, it will be in Deadband or Vent Mode. The controller will maintain the minCoolFlowStpt (A227).

If the activeAirflow (A250) is below the minHeatFlowStpt (A230), the heat will be disabled.

When the zone temperature falls below the heating setpoint, the controller will enter the heating mode.

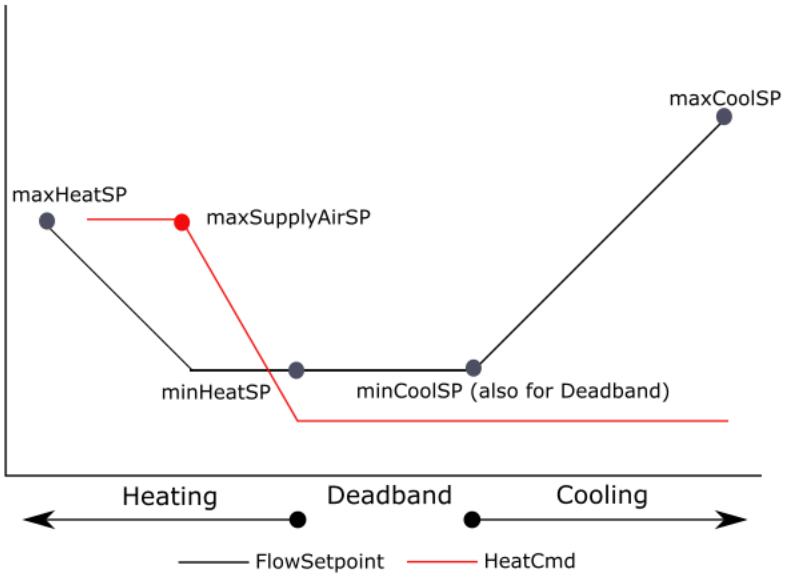
- If no discharge air temperature sensor is configured, or DualMax control is not enabled:
    - If there is no discharge air temperature sensor configured, as heating demand rises from 0-100%, the stages of heat shall be enabled to maintain zone temperature setpoints. Flow will maintain minHeatFlowStpt (A230) setpoint.
    - If a discharge air temperature sensor is configured, the discharge air temperature shall be reset upwards, displayed as dischargeAirTempStpt (A31) to a maximum set at maxDischargeAirTempStpt (A323). The stages of heat shall be enabled to maintain the discharge air temperature setpoint. Flow will maintain minHeatFlowStpt (A230) setpoint.

Cooling with Heat (no DualMax)



- If the discharge air temperature is configured and DualMax control is enabled:
    - As heating demand rises from 0-50%, the discharge air temperature shall be reset upwards, to a maximum of 20 deg above zone temperature. The stages of heat shall be enabled to maintain the discharge air temperature setpoint.
    - As heating demand rises from 51-100%, the airflow setpoint shall reset from the minHeatFlowStpt (A230) to the maxHeatFlowStpt (A229) flow.
    - The duct coil shall control the VAV discharge air temperature to the setpoint. The duct coil shall not directly control zone temperature.

Cooling with Modulating Heat (DualMax)



Typically, the modulating heating valve may be controlled by either `AO-14` or `DO-09` and `DO-10` in a tri-state control mode where `DO-09` drives the hot water valve open and `DO-10` drives it closed. There are additional options available such as having `AO-14` as the first stage modulating heat and `AO-15` as the second stage modulating heat.

INPUT / OUTPUT POINTS

VAV Modulating HW Reheat, no fan AO (0 ··· 10 Vdc)

IO POINTS	DESCRIPTION
UI-01	Zone Temperature (with optional override button) occupancy, or window contact (all optional)
UI-02	Setpoint Adjustment (optional 5K slider) occupancy, or window contact (all optional)
UI-03	Discharge Temperature
UI-04	CO_2, Humidity, occupancy, fan status, or window contact (all optional)
UI-08	Flowrate Sensor
DO-09	
DO-10	
DO-11	
DO-12	
AO-14	Stage 1 Modulating Heat
AO-15	
AO-16	Damper Control

VAV Modulating HW Reheat, no fan Tri-state

IO POINTS	DESCRIPTION
UI-01	Zone Temperature (with optional override button) occupancy, or window contact (all optional)
UI-02	Setpoint Adjustment (optional 5K slider) occupancy, or window contact (all optional)
UI-03	Discharge Temperature, occupancy, fan status, or window contact (all optional)
UI-04	CO_2, Humidity
UI-08	Flowrate Sensor
DO-09	Stage 1 Modulating Heat Valve Open
DO-10	Stage 1 Modulating Heat Valve Close
DO-11	
DO-12	
AO-14	
AO-15	
AO-16	Damper Control (**FBVI-2U4-4T** only)

VAV MODULATING HOT WATER REHEAT SINGLE SPEED FAN

TEMPERATURE CONTROL

When the zone temperature is greater than the cooling temperature setpoint, the controller will enter the cooling mode. The primary airflow rate will be varied between its minCoolFlowStpt (A227), and its maximum Flowrate setpoint maxCoolFlowStpt (A228) as required to maintain the zone at the cooling temperature setpoint. Once the zone temperature falls below the cooling temperature setpoint, it will exit the cooling mode.

When the zone temperature is between the cooling and heating temperature setpoints, it will be in Deadband or Vent Mode. The controller will maintain the minCoolFlowStpt (A227).

If the activeAirflow (A250) is below the minHeatFlowStpt (A230), the heat will be disabled.

In heating mode, the controller will maintain the minHeatFlowStpt (A230).

When the zone temperature falls below the heating setpoint, the controller will enter the heating mode.

- If no discharge air temperature sensor is configured is not enabled:
    - As heating demand rises from 0-100%, the stages of heat shall be enabled to maintain zone temperature setpoints.
- If discharge air temperature sensor is configured (this meets ASHRAE Standards):
    - As heating demand rises from 0-100%, the discharge air temperature shall be reset upwards, to a maximum of 20 deg above zone temperature. The stages of heat shall be enabled to maintain the discharge air temperature setpoint.

Typically, the modulating heating valve may be controlled by either `AO-14` or `DO-09` and `DO-10` in a tri-state control mode where `DO-09` drives the hot water valve open and `DO-10` drives it closed. There are additional options available such as having `AO-14` as the first stage modulating heat and AO 15 as the second stage modulating heat.

DAMPER CONTROL

Before the series fan is enabled, the damper will close for 60 seconds to prevent the box fan from running backwards.

FAN CONTROL

Parallel Single Speed Fan Option

During the occupied mode, the intermittent single speed fan will be energized in the heating mode. The fan control matrix is as follows:

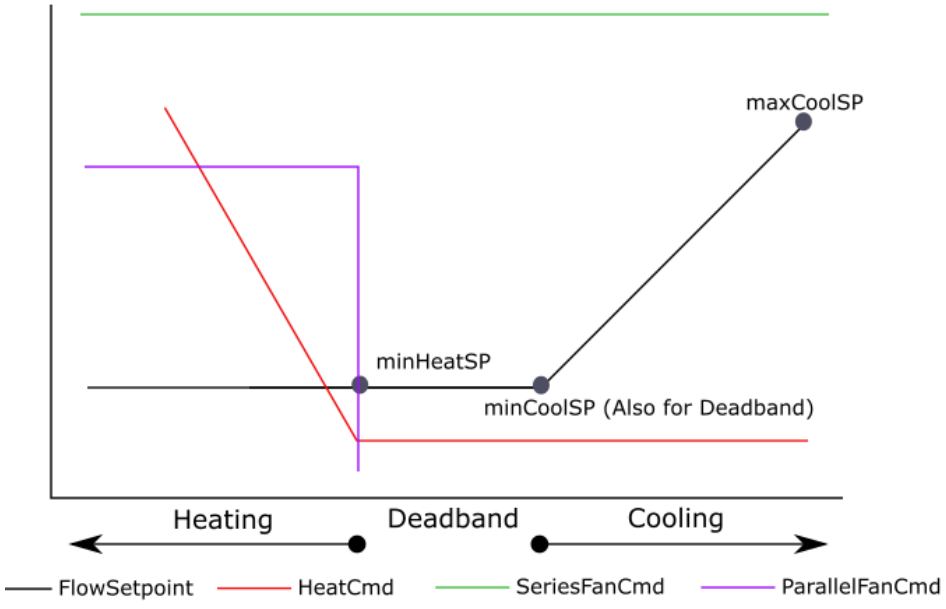
MODE	COOLING	DEADBAND	HEATING
Occupied	Off	Off	On
Unoccupied	Off	Off	On
Warm-up	Off	Off	Off
Standby	Off	Off	On

Series Single Speed Fan Option

The fan will operate continuously whenever the unit is in the occupied state, or in another state and in the cooling or heating mode. The fan control matrix is as follows:

MODE	COOLING	DEADBAND	HEATING
Occupied	On	On	On
Unoccupied	On	Off	On
Warm-up	N/A	On	On
Standby	On	On	On

Cooling with Modulating Heat and Fan



INPUT / OUTPUT POINTS

VAV Modulating HW Reheat with 1-speed fan `AO-14` (0 ··· 10 Vdc)

IO POINTS	DESCRIPTION
UI-01	Zone Temperature (with optional override button) occupancy, or window contact (all optional)
UI-02	Setpoint Adjustment (optional 5K slider) occupancy, or window contact (all optional)
UI-03	Discharge Temperature
UI-04	CO_2, Humidity, occupancy, fan status, or window contact (all optional)
UI-08	Flowrate Sensor
DO-09	
DO-10	
DO-11	
DO-12	Series or Parallel Fan Cmd
AO-14	Stage 1 Modulating Heat
AO-15	
AO-16	Damper Control

VAV Modulating HW Reheat with 1-speed fan Tri-state

IO POINTS	DESCRIPTION
UI-01	Zone Temperature (with optional override button) occupancy, or window contact (all optional)
UI-02	Setpoint Adjustment (optional 5K slider) occupancy, or window contact (all optional)
UI-03	Discharge Temperature
UI-04	CO_2, Humidity, occupancy, fan status, or window contact (all optional)
UI-08	Flowrate Sensor
DO-09	Stage 1 Modulating Heat Valve Open
DO-10	Stage 1 Modulating Heat Valve Close
DO-11	
DO-12	Series or Parallel Fan Cmd
AO-14	
AO-15	
AO-16	Damper Control

VAV MODULATING HOT WATER REHEAT VARIABLE SPEED FAN

TEMPERATURE CONTROL

When the zone temperature is greater than the cooling temperature setpoint, the controller will enter the cooling mode. The primary airflow rate will be varied between its minCoolFlowStpt (A227), and its maximum Flowrate setpoint maxCoolFlowStpt (A228) as required to maintain the zone at the cooling temperature setpoint. Once the zone temperature falls below the cooling temperature setpoint, it will exit the cooling mode.

When the zone temperature is between the cooling and heating temperature setpoints, it will be in Deadband or Vent Mode. The controller will maintain the minCoolFlowStpt (A227).

If the activeAirflow (A250) is below the minHeatFlowStpt (A230), the heat will be disabled.

In heating mode, the controller will maintain the minHeatFlowStpt (A230).

When the zone temperature falls below the heating setpoint, the controller will enter the heating mode.

- If no discharge air temperature sensor is configured:
    - As heating demand rises from 0-100%, the stages of heat shall be enabled to maintain zone temperature setpoints.
    - As heading demand rises from 51%-100%, the fan speed setpoint shall reset from minFanSpeed (A237) to maxFanSpeed (A238).
- If discharge air temperature sensor is configured (this meets ASHRAE Standards):
    - As heating demand rises from 0-50%, the discharge air temperature shall be reset upwards, to a maximum of 20 deg above zone temperature. The stages of heat shall be enabled to maintain the discharge air temperature setpoint.
    - As the discharge air heating demand rises from 51-100%, the fan speed setpoint shall reset from the minFanSpeed (A237) to the maxFanSpeed (A238).
    - The duct coil shall control the VAV discharge air temperature to the setpoint. The duct coil shall not directly control zone temperature.

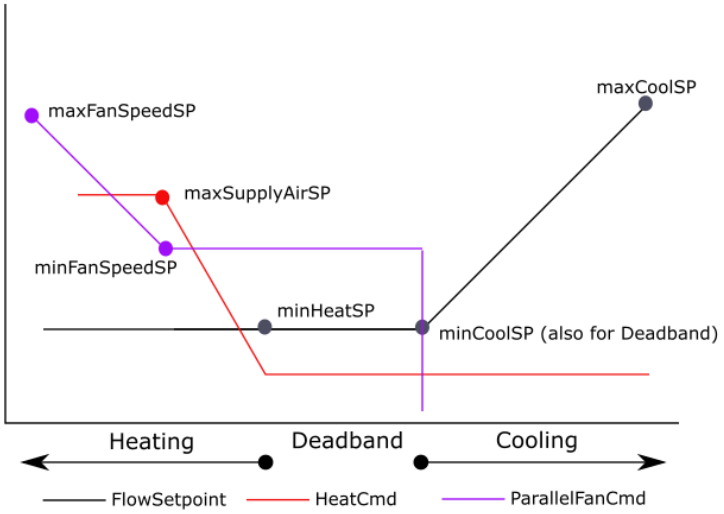
Typically, the modulating heating valve may be controlled by either `AO-14` or `DO-09` and `DO-10` in a tri-state control mode where `DO-09` drives the hot water valve open and `DO-10` drives it closed. There are additional options available such as having `AO-14` as the first stage modulating heat and AO 15 as the second stage modulating heat.

FAN CONTROL

Parallel Variable Fan Speed Option

The variable fan speed will be controlled by modulating `AO-15` (default 0 ··· 10 Vdc). The fan will run in heating mode only. As the heating demand increases, the variable fan command will increase from minFanSpeed (A237) to the maxFanSpeed (A238).

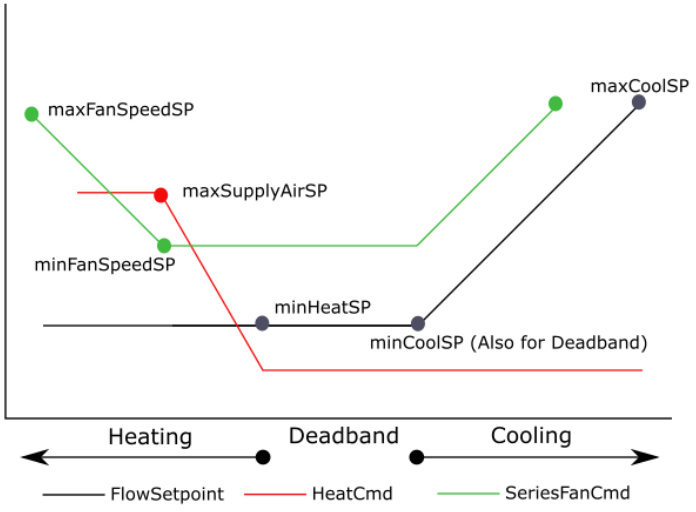
Cooling with Heat and Variable Parallel Fan



Series Variable Fan Speed Option

The variable fan speed will be controlled by modulating AO 15 (default 0 ··· 10 Vdc). In deadband mode, the fan will run at a slower speed. As the heating demand increases, the variable fan command will increase from minFanSpeed (A237) to the maxFanSpeed (A238). As the cooling demand increases, the variable fan command will increase from minFanSpeed (A237) to maxFanSpeed (A238).

Cooling with Heat and Variable Series Fan



INPUT / OUTPUT POINTS

VAV Modulating HW Reheat with variable speed fan AO 15 (0 ··· 10 Vdc)

IO POINTS	DESCRIPTION
UI-01	Zone Temperature (with optional override button) occupancy, or window contact (all optional)
UI-02	Setpoint Adjustment (optional 5K slider) occupancy, or window contact (all optional)
UI-03	Discharge Temperature
UI-04	CO_2, Humidity, occupancy, fan status, or window contact (all optional)
UI-08	Flowrate Sensor
DO-09	
DO-10	
DO-11	
DO-12	
AO-14	Stage 1 Modulating Heat
AO-15	Series or Parallel Fan Cmd
AO-xx	Damper Control

VAV Modulating HW Reheat with variable speed fan Tri-state

IO POINTS	DESCRIPTION
UI-01	Zone Temperature (with optional override button) occupancy, or window contact (all optional)
UI-02	Setpoint Adjustment (optional 5K slider) occupancy, or window contact (all optional)
UI-03	Discharge Temperature
UI-04	CO_2, Humidity, occupancy, fan status, or window contact (all optional)
UI-08	Flowrate Sensor
DO-09	Stage 1 Modulating Heat Valve Open
DO-10	Stage 1 Modulating Heat Valve Close
DO-11	
DO-12	
AO-14	
AO-15	Series or Parallel Fan Cmd
AO-16	Damper Control

8 Control Sequence Overview

This section provides an overview of the control features applicable to many of the FBVI-2U4-4T control sequences. The sections that follow go into more depth on each subject.

OCCUPANCY COMMANDS

OCCUPIED MODE

The default state of the controller is occupied. If set in this mode, the FBVI-2U4-4T will control to the occupied temperature setpoints. The Occupancy Command can be written by the master controller to the FBVI-2U4-4T. Set Occupied Mode by toggling analog setpoint occCmd (A269) = **1**

The master controller must write an occupancy state to each FBVI-2U4-4T or they will be left in the default occupied state at all times. If the unit is to operate stand-alone, an internal schedule is available. See Scheduling.

Standby Mode

This mode will be enabled only when occupancy sensors are used or on network command. Whenever the scheduled occupancy is `OCCUPIED`, and the occupancy sensor detects no occupants, this will offset the occupied heating and cooling setpoints for energy conservation. Once an occupant has been detected in the zone, the occupied heating and cooling setpoints will return to normal operation. Standby Mode can also be set manually by toggling analog setpoint occCmd (A269) = `2`.

Shed Mode

This mode will be enabled only when scheduled occupancy is `OCCUPIED`, and the netShedCmd (A310) analog setpoint is set to a value above `0`%. On a signal from `0` … `100`%, the occupied cooling and heating setpoints shall reset down to the occupied standby setpoints. Used for energy conservation.

UNOCCUPIED MODE

When indexed to the unoccupied state, the FBVI-2U4-4T will control to the unoccupied temperature setpoints. Set Unoccupied Mode by toggling analog setpoint occCmd (A269) = `0`. The damper will be closed.

Setup Mode

This mode will be enabled only when the scheduled occupancy is UNOCCUPIED. On a rise in zone temperature above the unoccupied cooling setpoint, the unit shall run in **Setup Mode,** and operate until the temperature falls below the unoccupied cooling setpoint. On a fall in zone temperature below the unoccupied cooling setpoint, the unit shall be disabled.

Setback Mode

This mode will be enabled only when the scheduled occupancy is UNOCCUPIED. On a fall in zone temperature below the unoccupied heating setpoint, the unit shall run in **Setback Mode,** and operate until the temperature rises above the unoccupied heating setpoint. On a rise in temperature above the unoccupied heating setpoint, the unit shall be disabled.

Occupied Override

During a scheduled unoccupied period, if the zone needs to be occupied for a short period of time, pressing a button can initiate a temporary period of occupancy. The amount of time for occupancy can be set in minutes at the occOvrTime (A167) analog setpoint.

- If a generic zone temperature sensor is wired to UI1, a “close” or “short” to UI1 will initiate the occupied override.
- If a CBT-STAT is used, pressing the right arrow button twice will initiate the occupied override.

BACNET HEARTBEAT COMMUNICATION STATUS AND STAND-ALONE OPERATION

The FBVI-2U4-4T can monitor its communication status with the master controller. If this feature is enabled, the box will be put into a failsafe mode if communications are lost.

To use this feature, set binary set point enableHeartbeat (D307) to `On` (default is set to `off`). The master controller must write a value of `On` to binary set point heartbeatPulse (D306) more frequently than the time delay setting in analog setpoint heartbeatTimer (A408) (do not use less than `5` minutes, default is `10` minutes).

After the time delay expires, if no writes are seen, commAlarm (D273) will be set to `On` indicating a communications loss.

During a communications loss state, the FBVI-2U4-4T will be set to the following:

- Occupied

HVAC MODES

By default, the HVACModeCmd (A287) is set to 0, for automatic operation. The VAV will heat and cool as configured. If the HVACModeCmd (A287) is set to any other value, it will operate as described below. (The occCmd (A269) will be disabled if any value other than Auto is selected).

- `0` = Auto (default)
- `1` = Morning Warmup
- `2` = Morning Cooldown
- `4` = Heat Only
- `8` = Cool Only
- `16` = Fire Stop
- `32` = Purge

WARM-UP/HEATING STATE

If the HVACModeCmd (A287) analog setpoint has been set for Morning Warm-up, or there has been hot air detected from the AHU supply air temperature, the unit will change to **Occupied Mode** and maintain the occupied heating setpoint. The mechanical heat (duct and perimeter heat) will be disabled. The damper will modulate to maintain the heating airflow setpoint, which will reset based on the heating demand.

The heating airflow setpoints will be substituted with the cooling airflow setpoints. On a call for more heat in an area, the airflow setpoint will reset up to the maximum cooling airflow setpoint, instead of the maximum heating airflow setpoint for maximum heat gain.

Once the room has met the setpoint, the airflow setpoint will return to the minimum heat setpoint.

COOL-DOWN/COOLING STATE

The unit will change to **Occupied Mode** and maintain the occupied cooling setpoint. The damper will modulate to maintain the cooling airflow setpoint, which will reset based on the cooling demand. Heating will be disabled.

HEAT ONLY

The unit will change to **Occupied Mode** and maintain the occupied cooling setpoint. The damper will modulate to maintain the heating airflow setpoint, which will reset based on the heating demand. Cooling will be disabled.

COOL ONLY

The unit will change to **Occupied Mode** and maintain the occupied cooling setpoint. The damper will modulate to maintain the cooling airflow setpoint, which will reset based on the cooling demand. Heating will be disabled.

FIRE STOP COMMAND

The unit will close the primary air damper and de-energize all fans and stages of heat and cooling.

PURGE COMMAND

The unit will set primary airflow setpoint to max Flowrate setpoint and de-energize all fans and stages of heat and cooling.

TEMPERATURE CONTROL

The FBVI-2U4-4T continuously compares the zone temperature with the active setpoints. Zone temperature is detected from UI1, a CBT-STAT or a FusionAir Smart Sensor.

Heating demand and cooling demand calculations are constantly updated. These calculations are expressed as 0···100% heating needed and 0···100% cooling needed.

Default temperature setpoints are 71 °F/ 75 °F for the occupied mode heating/cooling and 65 °F/ 85 °F for the unoccupied mode heating/cooling.

HEATING MODE

In the heating mode, stages of heat are energized, and/or valve positions are increased, as the heating demand increases. The primary supply air Flowrate is set to the current primary air heating flow setpoint. If the unit includes a fan, see the Fan Control section in Section 3.

In an OCCUPANCY state, on a fall in zone temperature below the occHeatStpt (A124), the heating demand will rise from 0% to 100%. If heat is available, the stages of heat will be enabled. The damper will modulate to maintain the activeAirflow (A250) to the activeFlowSetpoint(A236), and it will reset from minHeatFlowStpt (A230) to maxHeatFlowStpt (A229), depending on the VAV configuration. On a rise in zone temperature above the occHeatStpt (A124), the heating demand will fall from 100% to 0%. If heat is available, the stages of heat will be disabled.

The occHeatStpt (A124) setpoint can be affected by shed or standby modes. The active heating setpoint will be reflected by the activeHeatStpt (A188).

If the discharge air temperature is above the highDuctTempLockout setpoint (A34) of 180 °F (82 °C) the heat will be locked out until it falls below 120 °F (49 °C)

Note: While in warmup mode or hot air is present, accessory heat will not be commanded on.

In an UNOCCUPANCY state, on a fall in zone temperature below the unoccHeatStpt (A126), the heating demand will rise from 0% to 100%. If heat is available, the stages of heat will be enabled, and the unit will be in **Setback Mode**. The damper will modulate to maintain the activeAirflow (A250), and it will reset from minHeatFlowStpt (A230) to maxHeatFlowStpt (A229), depending on the VAV configuration. On a rise in zone temperature above the unoccHeatStpt (A126), the heating demand will fall from 100% to 0%.. If heat is available, the stages of heat will be disabled.

COOLING MODE

In the cooling mode, the primary air Flowrate setpoint is modulated toward maximum as the cooling demand increases. If the unit includes a fan, see the Fan Control section in Section 3.

In an OCCUPANCY state, on a rise in zone temperature above the occCoolStpt (A123), the cooling demand will rise from 0% to 100%. The damper will modulate to maintain the activeAirflow (A250) to the activeFlowSetpoint(A236), and it will reset from minCoolFlowStpt (A227) to maxCoolFlowStpt (A228). On a fall in zone temperature below the occCoolStpt (A123), the cooling demand will fall from 100% to 0%.

The occCoolStpt (A123) setpoint can be affected by shed or standby modes. The active heating setpoint will be reflected by the activeCoolStpt (A187).

In an UNOCCUPANCY state, on a rise in zone temperature above the unoccCoolStpt (A125), the cooling demand will rise from 0% to 100%. The unit will be in **Setup Mode**. The damper will modulate to maintain the activeAirflow (A250), and it will reset from minCoolFlowStpt (A227) to maxCoolFlowStpt (A228). On a fall in zone temperature below the unoccCoolStpt (A125), the cooling demand will fall from 100% to 0%.

Note: If the user tries to set the cooling setpoint occCoolStpt (A123) lower than the heating setpoint occHeatStpt (A124), the heating setpoint will be automatically lowered. If the user tries to set the heating setpoint occHeatStpt (A124) higher than the cooling setpoint occCoolStpt (A123), the heating setpoint will not change.

VENT MODE

In the DEADBAND mode, the unit is neither calling for heating or cooling during an OCCUPIED state. The zone temperature will be between the activeHeatStpt (A188) and activeCoolStpt (A187). The damper will modulate to maintain the minCoolFlowStpt (A227). If the unit includes a fan, see the Fan Control section in Section 3.

SETPOINT MODIFIERS

The Occupied setpoints can be modified in several different ways. HVACModeCmd (A287) must be in Auto.

- Slider Offset
  - If a generic Zone Temperature sensor is wired to UI1, UI2 can be setup to take a 0-5k potentiometer. The slider is enabled when binary setpoint SliderEnable (D95) is set to On. The analog setpoint SliderSpanStpt (A138) value will determine the upper and lower temperature range an end-user can set the sensor.
    - For example, if SliderSpanStpt (A138) is set to 4, that will allow a +2 to -2 range change for the heating and cooling setpoints. Let us say the occupied cooling setpoint (is 72F (22C) and the heating setpoint is 70F(20C). When UI2 value is 0 ohms, the activeCoolStpt (A187) and activeHeatStpt (A188) will offset 2 degrees down, so the activeCoolStpt (A187) will change to 70F(20C), and activeHeatStpt (A188) will change to 68F(18C). When the UI2 value is 5k ohms, the occupied activeCoolStpt (A187) and activeHeatStpt (A188) will offset 2 degrees up. Then the activeCoolStpt (A187) will change to 74(24C), and the activeHeatStpt (A188) will change to 72(22C).
- Standby Offset
  - If the unit is scheduled OCCUPIED and has an occupancy sensor on an input. When no occupancy is detected by the occupancy sensor after a set time, the occupied setpoints will offset to their standby setpoints, determined by the standbyOffset (A146) analog setpoint.
    - For example, let us say the standbyOffset (A146) is set to 3 deg, and the cooling setpoint is 72F(22C) and the heating setpoint is 70(20C). When no occupancy is detected by the occupancy sensor, the activeCoolStpt (A187) will change by +3 deg and change to 75F(25C). The activeHeatStpt (A188) will change by -3 deg and change to 67F(17C). Once there is occupancy detected, the cooling and heating setpoints will revert to their occupied setpoints.
- Shed Offset
  - If a value from 1-100% is sent to the netShedCmd (A310) analog point, the cooling and heating setpoints will reset from their occupied setpoints to their standby setpoints on a sliding scale.
    - For example, at 50% shed, and the activeCoolStpt (A187) was 72F(22C), and activeHeatStpt (A188) was 70F(20C), the new values will be 73.5F(23.5C) for activeCoolStpt (A187), and 68.5F(18.5C) for the activeHeatStpt (A188). At 100%, the cooling and heating setpoints will be equal to their standby setpoints.

CBT STAT (REQUIRES CBT-STAT STRATEGY)

Note: CBT-STAT/FusionAir Smart Sensor cannot be used to balance a VAV box.

If a CBT-STAT has been wired to the unit, the heating and cooling setpoints will be sent down to the CBT-STAT display. The strategy will automatically detect if the CBT-STAT is present and use zone temperature from the CBT-STAT and not UI1. On any mode change, the calculated setpoints will be sent down to the CBT-STAT, overriding any user adjustment for that period. Users can adjust the setpoints during occupied and unoccupied periods.

The CBTStatStptEnable (D164) digital setpoint can be used to lock out the ability of users to adjust the stat. If the unit is in Shed Mode, the CBT-STAT will also be locked out.

FUSIONAIR SMART SENSOR (REQUIRES FUSIONAIR STRATEGY)

If a FusionAir device has been wired to the unit, the heating and cooling setpoints will be sent down to the FusionAir device's display. The strategy will automatically detect if the FusionAir device is present and use zone temperature from the FusionAir device and not `UI1`. On any mode change, the calculated setpoints will be sent down to the FusionAir device, overriding any user adjustment for that period. Users can adjust the setpoints during occupied periods.

The FusionStatStptEnb (D164) digital setpoint can be used to lock out the ability of users to adjust the stat. If the unit is in Shed Mode, the FusionAir device will also be locked out.

CO_2 AND HUMIDITY

CO_2 CONTROL

A CO_2 sensor should be wired to UI4, and UI4Config (A174) is set to 0. If a FusionAir device is connected and is configured for CO_2, the CO_2 will be read from the sensor.

This will take a voltage signal from 0-10V.

To adjust the CO_2 reading dependent on altitude above sea level, enter the height in ft into the altitude (A215) analog setpoint.

- On a rise in zone CO_2 levels above the CO2_Stpt (A223), the VAV box flow will reset upwards to the maximum flow setpoint.
- To disable the CO_2 flow reset based on CO_2, set enableCO2_DCV (D270) to `FALSE`. This may be necessary on cooling only boxes with no supplemental heat.

The minimum CO_2 range in ppm is set using minCO2Range (A278), and the maximum CO_2 range is set using maxCO2Range (A280) analog setpoint.

HUMIDITY MONITORING

Humidity will be monitored by the CBT-STAT, the FusionAIr Smart Sensor or an external sensor if UI4Config (A174) is set to `1`, and a 0…10 V humidity sensor is wired.

WINDOW SENSOR AND FAN STATUS

WINDOW SENSOR

If an input has been configured for a window sensor, the input is N.O. when the window state is closed. When a window has been opened, the input will close. The status is read at windowOpen (D251).

When a window has been detected open:

- Heating and cooling are disabled.
- Damper is closed.
- Any VAV fans are disabled.

FAN STATUS

If UI 4 has been configured for fan status, the input is N.O. when the fan is off. When the fan is energized, the input will close. The fanConfig (A54) analog setpoint should be set for either parallel or series fan control. The status is read at fanStatus (D88).

- If the series or parallel fan has been commanded ON and no fan status has been detected within 30 seconds, a fan alarm will be generated.

DAMPER CONTROL

The FBVI-2U4-4T controller provides pressure-independent zone temperature control by calculating airflow rate setpoints based on the space temperature deviation from zone setpoint and the duration of deviation. The primary inlet airflow rate is measured and compared to this control point. Any error greater than the deadband setting will cause the primary air damper to be driven open or closed as required to reduce the error to within an adjustable Flowrate deadband.

The primary airflow setpoint is read from point activeFlowSetpoint (A236).

Specific details on airflow and airflow setpoints can be reviewed in Section 3 Control sequences.

TEST AND BALANCE

You can balance the box using Aero^{BT} (see *MAN0144 Aero^{BT} VAV Phone App*), or CXpro^{HD} (see *MAN0133 CXpro^{HD}*).

A point has been setup to allow test and balance commands to be sent to individual boxes, or groups of boxes, to set the primary air damper to max Flowrate, deadband Flowrate, fully open, fully closed, etc. These commands may be used to calibrate the airflow sensor and balance the boxes. Before balancing the box, the unit should be in occupied mode, and the HVACmodeCmd (A287) should be in Auto.

SETTING INITIAL BOX SIZE

Before balancing is available, an initial box size can be set to generate a starting K-factor. After balancing, this initial K-factor will be replaced with the balanced K-factor.

Set box size with the boxSize (A144) analog setpoint:

- 1 = 4" Box
- 2 = 5" Box
- 3 = 6" Box
- 4 = 8" Box
- 5 = 10" Box
- 6 = 12" Box
- 7 = 14" Box
- 8 = 16" Box

ZEROING AIRFLOW SENSOR

The FBVI-2U4-4T comes from the factory with the airflow sensor zeroed. To compensate for possible air leakage around the damper, users can zero the airflow sensor in the field. To zero the airflow sensor, users will need to do the following:

4. Drive damper to the closed position by setting flowOverride (A258) to 6 (fullClosed).
5. After the damper has fully shut, set zeroAirflow (D227) to ON. After 10 sec. it will record the offset.

After 10 seconds zeroAirflow (D227) will be automatically set back to off and the airflow sensor will now be zeroed. Be sure to set flowOverride (A258) to 0 (Auto) when finished with this step. The airflow offset calculation can be read at airflowOffset (A3).

AIRFLOW CALIBRATION PROCEDURE

K-factor settings can be manually entered:

6. For Single Point or the High K-factor, set balanceModeHi (D204) to `FALSE` and enter the K-factor in the KFactorFlowHI (A214) analog setpoint.
7. For the Low K-factor, set balanceModeLo (D45) to `FALSE` and enter the K-factor in the KFactorFlowLO (A245) analog setpoint.
8. The K-Factor that is used for flow will be displayed at activeKfactor (A293)
9. The current flow will be displayed at activeAirflow (A250)
10. To reset the K-factor back to the initial box size K-factor, enter 0 when manually entering both low and high K-factors.

Single Point Balancing

1. Set Max cfm at maxCoolFlowStpt (A228)
2. Set flowOverride (A258) to `1` (max cool flow)
3. Set balanceModeHi (D204) to `TRUE`
4. Allow activeAirflow (A250) to reach maxCoolFlowStpt (A228)
5. Enter the balancer's airflow in KFactorFlowHI (A214).
6. Again, allow activeAirflow (A250) to reach maxCoolFlowStpt (A228)
7. Repeat as necessary.
8. Calculated K factor can be read at activeKfactor (A293)
9. To exit balancing, set flowOverride (A258) to `0` (Auto)

Two-Point Balancing

2-point balancing with the minimum flow can also be achieved by doing the following:

1. Set Min CFM at minCoolFlowStpt (A227)
2. Set flowOverride (A258) to `2` (min cool flow)
3. Set balanceModeLo (D45) to `TRUE`
4. Allow activeAirflow (A250) to reach minCoolFlowStpt (A227)
5. Enter the balancer's airflow in KFactorFlowLO (A245).
6. Again, allow activeAirflow (A250) to reach minCoolFlowStpt (A227)
7. Repeat as necessary.
8. Calculated K factor can be read at activeKfactor (A293)
9. To exit balancing, set flowOverride (A258) to `0` (Auto)

Note: If the box has been 2-point balanced, the Active K Factor will reset between the low and high K Factors based on the active airflow.

Note: If you are using a 3rd party interface such as ASPECT® or INTEGRA™ for balancing boxes, make sure K Factor points are written to relinquish default, and not to the priority array.

SCHEDULING

There are two options available to schedule the box. Writing a value to occCmd (A269) through a network connection will set the box Occupied, Unoccupied, or Standby. If a network connection is not available, the FBVi can operate on a stand-alone internal schedule.

To select the internal schedule, set intScheduleEnb (D168) to `TRUE`. This will allow the internal BACnet schedule to command the unit Occupied or Unoccupied.

ALARMS

LOW AIRFLOW ALARM

If the activeAirflow (A250) is 30% below the activeFlowSetpoint (A236) for 5 minutes the lowAirFlowAlarm (D214) will be set to `TRUE`.

LOW DISCHARGE AIR TEMPERATURE ALARM

If the unit is configured for a discharge air temperature sensor and the discharge air is more than 15deg below the discharge air temperature setpoint, the lowDischAirTempAlarm (D217) will be set to `TRUE`.

ZONE AIR TEMPERATURE FAILURE

If the zone air temperature as detected on UI1 is below 20 or above 130 deg F, UI1_ZoneTemperatureFailure (D124) will be set to `TRUE`.

DISCHARGE AIR TEMPERATURE FAILURE

If the discharge air temperature is below 20 or above 130 deg F, UI3_DischargeTempFailure (D208) will be set to `TRUE`.

HIGH/LOW ZONE AIR TEMPERATURE ALARM

If the activeZoneTemp (A191) is 2 deg above the activeCoolStpt (A187) for more than 10 minutes, highZoneTempAlarm (D225) will be set to `TRUE`.

If the activeZoneTemp (A191) is 2 deg below the activeHeatStpt (A188) for more than 10 minutes, lowZoneTempAlarm (D196) will be set to `TRUE`.

AIRFLOW CALIBRATION ALARM

If the activeAirflow (A250) is 10% above the maxCoolFlowStpt (A228) for more than 10 minutes, airflowCalibrationAlarm (D219) will be set to `TRUE`.

LEAKING DAMPER ALARM

If the damperCmd (A261) is at 0% and the activeAirflow (A250) is above the minHeatFlowStpt (A230) for more than 10 minutes, leakingDamperAlarm (D221) will be set to `TRUE`.

LEAKING VALVE ALARM

If the stage 1 and 2 analog heating signals are at 0% and the discharge air temp is above 70 deg F, leakingValveAlarm (D223) will be set to `TRUE`.

FAN ALARM

If a fan status is configured, and it does not see a fan status for 30 seconds when the fan is commanded ON, fanAlarm (D127) will be set to `TRUE`.

HIGH CO_2 ALARM

If the CO_2 demand is over 50% for more than 10 minutes, highCO2Alarm (D194) will be set to `TRUE`.

NETWORK VARIABLES

There are network variables that are important to send information from the VAV to the AHU and from the AHU to the VAV.

NETWORK IN VARIABLES

There are two methods to send information to the VAV from the AHU.

- CXProHD BACnet Broadcast Module
  - The AHU strategy should contain a BACNet Broadcast Tx Module with each of these Broadcast names:
    - AHUFanStatus
    - AHUSupplyAir
    - OutsideAirTemp
    - netAHUMode
    - netOccCmd
    - GlobalShedCmd

- BACnet Points
  - BACnet point writes to the following variables:
    - netAHUFanStatus (D235)
    - netAHUSupplyAir (A304)
    - netOutdrAirTemp (A300)
    - HVACModeCmd (A287)
    - occCmd (A269)
    - netShedCmd (A310)

UNIT STATUS AND GRAPHIC POINTS

UNIT STATUS

For information on the current unit function, these points can be enumerated to display on graphic screens.

Occupancy status is displayed from occStatus (A316)

- 0=Unocc
- 1=Occ
- 3=Standby
- 4=SetbackMode
- 8=SetupMode

Unit status is displayed from unitStatus (A317)

- 1=CoolMode
- 2=VentMode
- 4=HeatMode

HVAC Mode status is displayed from HVACModeStatus (A295)

- 0 = Auto
- 1 = Morning Warm Up
- 2 = Morning Cool Down
- 4 = Heat Only
- 8 = Cool Only
- 16 = Shed
- 32 = Fire
- 64 = Purge

GRAPHIC POINTS

Extra points are available for use in graphic generation. These are optional and do not influence the operation of the unit. Used in Integra applications.

graphic_variableFanSignal (A315)

Use with analog graphics. If fanConfig (A54) is set up as a variable series fan or a variable parallel fan, and the signal from AO15 is greater than 0, the graphic will be enabled.

graphic_variableFanEnable (D266)

Use with a digital graphic. If fanConfig (A54) is set up as a variable series fan or a variable parallel fan, and the signal from AO15 is greater than 0, the graphic will be enabled.

graphic_digitalFan (D261)

Use with a digital graphic. If fanConfig (A54) is set up as an on/off series or on/off parallel fan, and digital output DO12 is On, the graphic will be enabled.

graphic_showPerimeterHeat (D265)

Use with a digital graphic. If stagesOfPerimeterHeat (A75) is greater than 0, enable the graphic.

graphic_Stg3HeatDigital (D264)

Use with digital graphics. If heatConfig (A4) is set for 3 stages of heat, and digital output DO11 is On, the graphic will be enabled.

graphic_Stg2HeatDigital (D268)

Use with digital graphics. If heatConfig (A4) is set for 2 stages of heat, and digital output DO10 is On, the graphic will be enabled.

graphic_Stg1HeatDigital (D267)

Use with digital graphics. If heatConfig (A4) is set for 1, 2, or 3 stages of heat, and digital output DO09 is On, the graphic will be enabled.

graphic_Stg2HeatSignal (A318)

Use with analog graphics. If heatConfig (A4) is set for 2 stages of heat, and digital output DO10 is On, and stg2OutType (A2) is a voltage signal, and fanConfig (A54) is not set for a variable fan, the graphic will be enabled.

graphic_Stg1HeatSignal (A327)

Use with analog graphics. If heatConfig (A4) is set for 3 stages of heat, and digital output DO10 is On, and stg2OutType (A2) is a voltage signal, the graphic will be enabled.

FAN CONTROL

PARALLEL FAN

The intermittent single speed fan will be energized when the FBVI-2U4-4T is in the heat mode. It will be off when not in the heat mode.

MODE	COOLING	DEADBAND	HEATING
Occupied	Off	Off	On
Unoccupied	Off	Off	On
Warm-up	Off	Off	Off
Standby	Off	Off	On

SERIES FAN

The terminal unit fan will operate continuously whenever the FBVI-2U4-4T is in the occupied state. It will also run whenever the FBVI-2U4-4T is in the unoccupied heating or unoccupied cooling mode. When initially powered up, or upon restoration of power after a power outage, the FBVI-2U4-4T controller executes a fan startup sequence to prevent reverse rotation. The fan startup sequence drives the primary air damper closed, waits 60 seconds, and then sets the fan speed output.

MODE	COOLING	DEADBAND	HEATING
Occupied	On	On	On
Unoccupied	On	Off	On
Warm-up	N/A	On	On
Standby	On	On	On

VARIABLE SPEED FAN

The terminal unit fan speed will be controlled through `AO-15` (0 ··· 10 V dc, or a custom range).

PARALLEL VARIABLE SPEED FAN

The Parallel Variable Speed fan will be energized when the FBVI-2U4-4T is in the heat mode and off when not in the heat mode. Speed will modulate between the Minimum and Maximum Setpoints as detailed in Section 3: Control Sequences.

SERIES VARIABLE SPEED FAN

When initially powered up, or upon restoration of power after a power outage, the FBVI-2U4-4T controller executes a fan startup sequence to prevent reverse rotation. The fan startup sequence drives the primary air damper closed, waits 60 seconds, and then sets the fan speed output.

The Series Variable Speed fan will operate continuously whenever the FBVI-2U4-4T is in the occupied state. It will also run whenever the FBVI-2U4-4T is in the unoccupied heating or unoccupied cooling modes. Speed will modulate between the Minimum and Maximum Setpoints as detailed in Section 3: Control Sequen

9 APPENDIX: List of FBVI-2U4-4T points

The FBVI-2U4-4T strategy is available in both Imperial and Metric units.

The tables in this Appendix list and describe the points in the Strategy and gives the units in each Strategy type along with the default value in that Strategy type.

HARDWARE POINTS (I/O)

ANALOG

POINT	POINT TYPE	OBJECTNAME	DESCRIPTION	IMPERIAL UNITS	METRIC UNITS
1	Analog Input	*UI01*	Room/Zone Temperature Sensor	° F	° C
2	Analog Input	*UI02*	Setpoint Adjust Potentiometer	Ohms	Ohms
3	Analog Input	*UI03*	Supply or Discharge Air Temperature	° F	° C
4	Analog Input	*UI04*	CO_2, Humidity, or Motion Detection	Volts	Volts
8	Analog Input	*UI08*	Flowrate Sensor	Pascals	Pascals
14	Analog Output	*AO14*	Modulating Heat Stage 1	%	%
15	Analog Output	*AO15*	Modulating Heat Stage 2 or Variable Fan Speed Control	%	%
16	Analog Output	*AO16*	Damper Commanded Position	%	%

DIGITAL

POINT	POINT TYPE	OBJECTNAME	DESCRIPTION	Active Text	Inactive Text
09	Digital Output	*DO09*	Heating Stage 1 or Tri-State Heating Valve Open	On	Off
10	Digital Output	*DO10*	Heating Stage 2 or Tri-State Heating Valve Close	On	Off
11	Digital Output	*DO11*	Heating Stage 3	On	Off
12	Digital Output	*DO12*	Series/Parallel On/Off Fan	On	Off

BACNET ANALOG VALUES

POINT	SETPOINT BLOCK	OBJECTNAME	DESCRIPTION	UNITS AND DEFAULT VALUES			
				IMPERIAL STG.		METRIC STG.	
1	Yes	*stg1OutType*	Output hardware setup for first stage of Heat 1 = 0-10V 2 = 2-10V 3 = Float 4 = Custom for AO14	0	no-units	0	no-units
2	Yes	*stg2OutType*	Output hardware setup for second stage of Heat 1 = 0-10V 2 = 2-10V 4 = Custom for AO15	0	no-units	0	no-units
3	No	*airflowOffset*	After zeroing airflow, calculated offset.		Pa		Pa
4	Yes	*heatConfig*	Configuration for the heat staging. Calculated with the CXPro Bacnet commission tool. Add values together for the total. 0 = no heat 1 = one stage heat 2 = two stages heat 4 = three stages heat 16 = perimeter heat primary 32 = duct hand perimeter simultaneous operation 64 = dual max control on	0	no-units	0	no-units
6	No	*terminalLoad*	The current terminal load. -100 to +100%		%		%
31	No	*dischargeAirTempStpt*	Calculated discharge air temperature setpoint. Minimum is 50°F (10°C)		°F		°C
34	Yes	*highDuctTempLockout*	If duct temperature is above setpoint, heat will be locked out until it falls below 120°F (49°C).	180	°F	82	°C
54	Yes	*fanConfig*	Configuration for fan control. 0 = No Fan 1 = On/Off Series Fan 2 = On/Off Parallel Fan 4 = Variable Series Fan 8 = Variable Parallel Fan	0	no-units	0	no-units
75	Yes	*stagesOfPerimeterHeat*	If the unit is configured for heat control with *heatConfig*, set the number of stages for perimeter heat. Perimeter heat will directly control zone temperature. Set 0…3 stages.	0	no-units	0	no-units
79	No	*Fusion_HeatingStpt*	The adjusted overridden offset + heating setpoint (FBVi-2U4-4T-FA-IMP / FBVi-2U4-4T-FA-SI only)	0	°F	0	°C
84	No	*Fusion_CoolingStpt*	The adjusted overridden offset + cooling setpoint (FBVi-2U4-4T-FA-IMP / FBVi-2U4-4T-FA-SI only)	0	°F	0	°C
92	Yes	*Fusion_altCO2Input (FusionAir strategy only)*	Bacnet point used when using 3rd party CO_2 sensor to be viewed at the Fusion Air Sensor. (FBVi-2U4-4T-FA-IMP / FBVi-2U4-4T-FA-SI only)	0	ppm	0	ppm
94	Yes	*Fusion_Offset (FusionAir strategy only)*	The allowable temperature range allowed between heating and cooling setpoints on the Fusion Air Sensor (FBVi-2U4-4T-FA-IMP / FBVi-2U4-4T-FA-SI only)	0	°F	0	°C
95	Yes	*Fusion_StptStepSize(FusionAir strategy only)*	The step amount per arrow press when overriding space temperature. (FBVi-2U4-4T-FA-IMP / FBVi-2U4-4T-FA-SI only)	.5	°F	.5	°C
97	Yes	*DamperDB*	Damper dead band. If the value of the active Airflow changes over this amount, allow the PI loop to continue.	25	cfm	12	L/s
98	Yes	*TriStateDegree*	Degrees of Damper actuator, used in calculation of floating-point position.	90	deg	90	deg
101	No	*TriStatePosition*	Calculated open position of a floating-point actuator	0	%	0	%
117	No	*netOccCmd*	Used for network assignment of the occCmd . Used when utilizing Tx modules. Not for BACnet use.		no-units		no-units
119	No	*netHVACMode*	Used for network assignment of the HVACMode. Used when utilizing Tx modules. Not for BACnet use.		no-units		no-units
123	Yes	*occCoolStpt*	Set the occupied Cooling Setpoint.	74	°F	23	°C
124	Yes	*occHeatStpt*	Set the occupied Heating Setpoint	72	°F	21	°C
125	Yes	*unoccCoolStpt*	Set the unoccupied Cooling Setpoint	80	°F	29	°C

POINT	SETPOINT BLOCK	OBJECTNAME	DESCRIPTION	UNITS AND DEFAULT VALUES			
				IMPERIAL STG.		METRIC STG.	
126	Yes	*unoccHeatStpt*	Set the unoccupied Heating Setpoint	65	°F	14	°C
133	Yes	*maxSliderRange*	When a potentiometer is used on UI2 for setpoint offset, the maximum Ohm range of the span.	5K	Ohms	5K	Ohms
138	Yes	*sliderSpanStpt*	The allowable temperature range for the potentiometer is used on UI2 . 4 = +2 deg and -2 deg from setpoint.	4	°F	4	°C
144	Yes	*boxSize*	Box size of the VAV. Sets an initial KFactor before balancing. Once the box is balanced, this value is replaced. 1 = 4"Box 2 = 5"Box 3 = 6"Box 4 = 8"Box 5 = 10"Box 6 = 12"Box 7 = 14"Box 8 = 16"Box	4	no-units	4	no-units
146	Yes	*standbyOffset*	When the unit is in Standby Mode, the occupied heating and cooling setpoints will be offset by this amount. Occupied cool stpt + offset Occupied heat stpt - offset	3	°F	3	°C
152	No	*CO2*	Raw CO_2 reading		ppm		ppm
154	No	*standbyCoolStpt*	Calculated standby cooling setpoint Occupied cool stpt + offset	77	°F	26	°C
155	No	*standbyHeatStpt*	Calculated standby heating setpoint Occupied heat stpt - offset	69	°F	18	°C
156	No	*shedCoolStpt*	Calculated shed cooling setpoint.		°F		°C
163	No	*CBTStat_Temperature*	CBT-Stat Temperature		°F		°C
164	No	*CBTStat_Humidty*	CBT-Stat Humidity		%rh		%rh
167	Yes	*occOvrTime*	When the unit is set to an occupied override state from either UI1 or the CBT Stat, the unit will stay occupied for this amount of time.	60	min	60	min
173	Yes	*UI1Config*	UI1 input configuration. 0 = ZoneTemperature 1 = Occ Sensor 2 = Window Sensor	0	no-units	0	no-units
174	Yes	*UI4Config*	UI4 input configuration. 0 = CO_2 Sensor 1 = Humidity Sensor 2 = Occ Sensor 4 = Window Sensor 8 = Fan Status	0	no-units	0	no-units
175	Yes	*UI2Config*	UI2 input configuration. 0 = Offset 1 = Occ Sensor 2 = Window Sensor	0	no-units	0	no-units
176	Yes	*UI3Config*	UI3 input configuration. 0 = Discharge Air Temp 1 = No Discharge Air Temp	0	no-units	0	no-units
179	Yes	*PIDTuneGain*	Tune loop gain for cooling and heating	3	no-units	3	no-units
180	Yes	*PIDTuneInt*	Tune loop integral for cooling and heating	60	no-units	60	no-units
182	No	*coolDemand*	Cooling demand from 0-100%		%		%
184	No	*heatDemand*	Heating demand from 0-100%		%		%
187	No	*activeCoolStpt*	The calculated cooling setpoint.	74	°F	23	°C
188	No	*activeHeatStpt*	The calculated heating setpoint.	72	°F	21	°C
190	Yes	*remoteZoneTemp*	If zone temperature is sent thru the network, use this point.	0	°F	0	°C
191	No	*activeZoneTemp*	The active zone temperature. Will show either UI1, remote temp, or CBT-Stat temperature.		°F		°C
199	No	*StrategyVer*	Current strategy version.		no-units		no-units
205	No	*ductHeatDemand*	The calculated duct heat demand		%		%

POINT	SETPOINT BLOCK	OBJECTNAME	DESCRIPTION	UNITS AND DEFAULT VALUES			
				IMPERIAL STG.		METRIC STG.	
214	Yes	*KFactorFlowHI*	Saved BACnet point for balanced Kfactor for single point, or the High Kfactor for 2-point. If Kfactor is known, write to this point. Set to.1 if not being used.	.1	no-units	.1	no-units
215	Yes	*altitude*	Approximate altitude for carbon dioxide reading adjustment.	500	ft	500	ft
223	Yes	*CO2_Stpt*	Carbon dioxide setpoint.	800	ppm	800	ppm
226	No	*CO2_Demand*	Percentage of CO_2 signal to override damper position to maintain		%		%
227	Yes	*minCoolFlowStpt*	Minimum cooling cfm flow setpoint	200	cfm	95	L/s
228	Yes	*maxCoolFlowStpt*	Maximum cooling cfm flow setpoint	800	cfm	378	L/s
229	Yes	*maxHeatFlowStpt*	Maximum heating cfm flow setpoint	150	cfm	70	L/s
230	Yes	*minHeatFlowStpt*	Minimum heating cfm flow setpoint	100	cfm	47	L/s
236	No	*activeFlowSetpoint*	Calculated active flow setpoint.		cfm		L/s
237	Yes	*minFanSpeed*	Minimum fan speed for variable speed fans.	20	%	20	%
238	Yes	*maxFanSpeed*	Maximum fan speed for variable speed fans.	80	%	80	%
245	Yes	*KFactorFlowLO*	Saved BACnet point for balanced Kfactor for low Kfactor for 2-point. If Kfactor is known, write to this point.	0	no-units	0	no-units
249	Yes	*paraFanLowCFMEnb*	If active airflow falls below this setpoint, enable the parallel fan.	50	cfm	23.5	L/s
250	No	*activeAirflow*	Current active airflow		cfm		L/s
251	Yes	*minHumidityRange*	Minimum humidity range		%rh		%rh
255	Yes	*damperGain*	Tune loop gain for damper	.8	no-units	.8	no-units
256	Yes	*damperIntegration*	Tune loop integration for damper	100	no-units	100	no-units
257	No	*HI_KFactor*	Calculated single point Kfactor, or Hi K factor when 2-point balancing.		no-units		no-units
258	Yes	*flowOverride*	Used to override flow setpoints, or to open or close damper. 0 = Auto 1 = MaxCoolFlowStpt 2 = MinCoolFlowStpt 3 = MaxHeatFlowStpt 4 = MinHeatFlowStpt 5 = Full Open 6 = Full Close (flow setpoint set to -1)	0	no-units	0	no-units
261	No	*damperCmd*	Damper demand 0-100%		%		%
265	No	*LO_KFactor*	Calculated Lo K factor when 2-point balancing.		no-units		no-units
268	No	*shedHeatStpt*	Calculated shed heating setpoint.		°F		°C
269	Yes	*occCmd*	Commands the box to occupied or unoccupied mode. 0 = Unoccupied Mode 1 = Occupied Mode 2 = Standby Mode	1	no-units	1	no-units
278	Yes	*minCO2Range*	Minimum CO_2 range for a 0…10 V input	0	ppm	0	ppm
280	Yes	*maxCO2Range*	Maximum CO_2 range for a 0…10 V input	2000	ppm	2000	ppm
283	Yes	*TriStateTravelTime*	The maximum amount of time for value travel from 0…100%	95	sec	95	sec
287	Yes	*HVACModeCmd*	Override the box to another control mode: 0 = Auto 1 = Morning Warm Up 2 = Morning Cool Down 4 = Heat Only 8 = Cool Only 16 = Fire 32 = Purge	0	no-units	0	no-units
289	Yes	*TriStateMinOnTime*	Step time for value. If *TriStateTravelTime* is 120 seconds and Min on time is 10 seconds, there are 12 equal steps between 0 and 100% for the valve.	2	sec	2	sec

POINT	SETPOINT BLOCK	OBJECTNAME	DESCRIPTION	UNITS AND DEFAULT VALUES			
				IMPERIAL STG.		METRIC STG.	
293	No	*activeKfactor*	Current active K factor		no-units		no-units
295	No	*HVACModeStatus*	Current HVAC mode status of the unit. 0 = Auto 1 = Morning Warm Up 2 = Morning Cool Down 4 = Heat Only 8 = Cool Only 16 = Shed 32 = Fire 64 = Purge		no-units		no-units
298	No	*UI4_InputConfig*	Used for input reset. Not for BACnet use.		no-units		no-units
300	Yes	*netOutdrAirTemp*	Network point to send outdoor air temperature to box.	0	°F	0	°C
304	Yes	*netAHUSupplyAir*	Network point to send AHU supply air temperature to box	0	°F	0	°C
305	yes	*maxHumidtyRange*	Maximum humidity range	100	%rh	100	%rh
307	No	*zoneHumidity*	Current zone humidity		%rh		%rh
308	No	*damperFeedback*	The current position of the damper		%		%
310	Yes	*netShedCmd*	The box will shed active setpoints based on a 0-100% signal.	0	%	0	%
314	No	*UI2_InputConfig*	Used for input reset. Not for BACnet use		no-units		no-units
315	No	*graphic_VariableFanSignal*	Used for graphics. Analog variable fan signal.				
316	No	*occStatus*	Shows current occupancy status. 0=Unocc 1=Occ 3=Standby 4=SetbackMode 8=SetupMode		no-units		no-units
317	No	*unitStatus*	Shows current heating/cooling status of the box: 1=CoolMode 2=VentMode 4=HeatMode		no-units		no-units
318	No	*graphic_Stg2HeatSignal*	Used for graphics. Analog variable heat signal.		no-units		no-units
323	Yes	*maxDischargeTempStpt*	Maximum temperature of duct discharge air temp setpoint when dual max control is off.	110	°F	43	°C
327	No	*graphic_Stg1HeatSignal*	Used for graphics. Analog variable heat signal.		no-units		no-units
329	No	*CO2_DemandVAV*	Available for AHU outdoor air reset of the damper.		%		%
335	Yes	*ductHeatPIDGain*	PID gain tuned for duct heat.	3	no-units	3	no-units
355	Yes	*perimeterHeatLockout*	The outdoor air temperature that the perimeter heat will be locked out.	65	°F	18	°C
361	No	*perimeterHeatDemand*	The calculated perimeter heat demand		%		%
372	Yes	*AO14_LowAOValue*	Custom low output voltage value for AO14 if *stg1OutType* set to 4	2	volts	2	volts
373	Yes	*AO14_HiAOValue*	Custom high output voltage value for AO14 if *stg1OutType* set to 4	10	volts	10	volts
388	Yes	*AO15_LowAOValue*	Custom low output voltage value for AO15 if *stg2OutType* set to 4	2	volts	2	volts
389	Yes	*AO15_HiAOValue*	Custom high output voltage value for AO15 if *stg2OutType* set to 4	10	volts	10	volts
408	Yes	*heartbeatTimer*	Time in minutes the digital heartbeat needs to change to maintain communication status.	10	min	10	min

BACNET BINARY VALUES

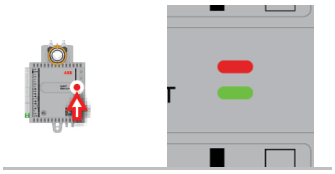
POINT	SETPOINT BLOCK	OBJECTNAME	DESCRIPTION	ACTIVE TEXT	INACTIVE TEXT	DEFAULT VALUES	
						IMP STG.	MET STG.
5	Yes	*TriStateReverse*	Reverses the on and off outputs for actuator control	On	Off	0	0
45	Yes	*balanceModeLo*	If set to TRUE, Flow will be recorded to LO_KFactor If set to FALSE, KFactor will be recorded to LO_KFactor	On	Off	0	0
79	Yes	*Fusion_OvrReset*	Resets FusionAir Sensor timed overrides (FBVi-2U4-4T-FA-IMP / FBVi-2U4-4T-FA-SI only)	On	Off	0	0
88	No	*fanStatus*	If UI4 is set up for a fan status, displays current fan status.	On	Off	0	0
95	Yes	*sliderEnable*	Enable the sliderSpanStpt (A138) to be used for UI2.	Enable	Disable	0	0
97	No	*occOvr*	When the occupied override is active.	On	Off	0	0
113	No	*coolMode*	Will be On if the unit is in cooling mode.	On	Off		
114	No	*heatMode*	Will be On if the unit is in heating mode.	On	Off		
117	Yes	*remoteZoneTempEnb*	Enable the remoteZoneTemp as the active zone temperature.	On	Off	0	0
118	No	*ventMode*					
120	No	*occMode*	Will be On if the unit is in occupied mode.	On	Off		
124	No	*UI1_ZoneTempFailure*	If UI1 is being used as the active zone temperature and the temperature reading is out of range, the alarm will be enabled.	On	Off	0	0
127	No	*fanAlarm*	If UI4 is used as the fan status, and the fan is commanded on and the fan status is open, the alarm will be enabled.	On	Off	0	0
161	No	*occSensorCmd*	If an input is set up for an occupancy sensor, the active status of the occupancy sensor.	On	Off	0	0
164	Yes	*CBTStatStptEnb*	CBT-Stat lockout that prevents user adjustment of setpoints. On = locked out. (FBVi-2U4-4T-IMP / FBVi-2U4-4T-SI only)	On	Off	0	0
164	Yes	*FusionStatStptEnb*	FusionAir Sensor lockout that prevents user adjustment of setpoints. On = locked out. (FBVi-2U4-4T-FA-IMP / FBVi-2U4-4T-FA-SI only)	On	Off	0	0
168	Yes	*intScheduleEnb*	Enable the internal BACnet schedule. Disables occCmd (A269).	On	Off	0	0
194	No	*highCO2Alarm*	If the CO_2 Demand is above 50% for more than 10 minutes, enable the alarm.	On	Off	0	0
196	No	*lowZoneTempAlarm*	If the active Zone Temperature is below the active heating setpoint for more than 15 minutes, enable the alarm.	On	Off	0	0
198	Yes	*reverseDO09*	Reverse the operation of digital output DO09	On	Off	0	0
200	Yes	*reverseDO10*	Reverse the operation of digital output DO10	On	Off	0	0
202	Yes	*reverseDO11*	Reverse the operation of digital output DO11	On	Off	0	0
204	Yes	*balanceModeHi*	If set to TRUE, Flow will be recorded to HI_KFactor If set to FALSE, KFactor will be recorded to HI_KFactor	On	Off	0	0
205	Yes	*reverseAO14*	Reverse the operation of analog output AO14	On	Off	0	0
206	Yes	*reverseAO15*	Reverse the operation of analog output AO15	On	Off	0	0
208	No	*UI3_DischargeTempFailure*	If UI3 is used as the active discharge air temperature and the temperature reading is out of range, the alarm will be enabled.	On	Off	0	0
214	No	*lowAirFlowAlarm*	If the active airflow is more than 30% below the active airflow setpoint for more than 5 minutes, enable the alarm.	On	Off	0	0
217	No	*lowDischAirTempAlarm*	If the discharge air temperature is more than 15 degrees below the discharge air temperature setpoint for more than 10 minutes, enable the alarm.	On	Off	0	0

POINT	SETPOINT BLOCK	OBJECTNAME	DESCRIPTION	ACTIVE TEXT	INACTIVE TEXT	DEFAULT VALUES	
						IMP STG.	MET STG.
219	No	*airflowCalibrationAlarm*	If the active airflow is more than 10% higher than the maximum cooling flow setpoint for than 10 minutes, enable the alarm.	On	Off	0	0
221	No	*leakingDamperAlarm*	If the damper command is at 0% and the active airflow is above the minHeatFlowStpt (A230) for more than 10 min, enable the alarm.	On	Off	0	0
223	No	*leakingValveAlarm*	If there is not a heating demand for the analog heat, and the discharge air temperature is above 70F for more than 15 minutes, enable the alarm.	On	Off	0	0
225	Yes	*highZoneTempAlarm*	If the active Zone Temperature is above the active cooling setpoint for more than 15 minutes, enable the alarm.	On	Off	0	0
227	Yes	*zeroAirflow*	Enable the airflow zeroing calculation.	On	Off	0	0
229	No	*damperOfflineAlarm*	If the communication between the damper and the control board is not working, this will be On.	On	Off		
235	Yes	*netAHUFanStatus*	Use as the network variable to send the AHU fan status down to the box. Used when the AHU does not use CXPro Tx modules.	On	Off	0	0
251	No	*windowOpen*	When an input is used for a window contact, shows the status if the window has been opened.	On	Off	0	0
256	No	*heatLockout*	Will be On if the heat is locked out.	On	Off	0	0
257	No	*damperStuckAlarm*	If the damper cannot go to the desired position, outside of the deadband.	On	Off	0	0
258	Yes	*reverseDamper*	Reverse the damper operation. On = Open is CCW. Off = Open is CW.	On	Off	0	0
264	No	*graphic_stg3HeatDigital*	Used for graphics. On when stage 3 heat is On	On	Off	0	0
265	No	*graphic_showPerimeterHeat*	Used for graphics. On when stagesOfPerimeterHeat (A75) is higher than 0.	On	Off	0	0
266	No	*graphic_variableFanEnable*	Used for graphics. On when the variable fan signal is above 0.	On	Off	0	0
267	No	*graphic_stg1HeatDigital*	Used for graphics. On when stage 1 heat is On.	On	Off	0	0
268	No	*graphic_stg2HeatDigital*	Used for graphics. On when stage 2 heat is On.	On	Off	0	0
270	Yes	*enableCO2_DCV*	Enable the CO_2 signal to reset airflow upwards. Can be disabled to prevent airflow reset.	On	Off	0	0
273	No	*commAlarm*	When the heartbeat communication is enabled, and the heartbeat pulse has not been toggled within the heartbeatTimer, enable the alarm.	On	Off	0	0
300	Yes	*reverseDO12*	Reverse the operation of digital output DO12	On	Off	0	0
304	Yes	*damperAdaptionReset*	When triggered, the damper will cycle between the two stop points and recalculate the 0 … 100% position based on them.	On	Off	0	0
306	Yes	*heartbeatPulse*	Point to toggle on and off when using the digital heartbeat. Must be toggled within the heartbeatTimer.	On	Off	0	0
307	Yes	*enableHeartbeat*	Enable heartbeat communication.	On	Off	0	0

10 APPENDIX: Troubleshooting

CONTROLLER STATE

LED LIGHT INDICATORS



		Off	On	Slow Blink	Fast blink
	Red LED (Power)	Power is off	Power is on	-------- Unit Rebooting -------	
	Green LED (Status)	Unit is not running	Strategy Loaded but no network connectivity	Strategy Loaded and device communicating on network	No Strategy loaded

COMM LOSS

Check that the wiring is correct.

Check that the device instance is not duplicated on the network.

WIRED SENSOR FAILURE

Check the device is wired correctly.

AIRFLOW FAILURE

Check that the airflow tubes are connected to the device from the airflow sensor.

Check that there are no airflow blockages on the airflow sensor.

Check that the damper is open, and the air handler is running.

DAMPER FAILURE

Check that the damperOfflineAlarm (D229) is not on. This would indicate a communication error with the damper.

Check the linkage connecting the damper to the device is tight.

Check that no debris is preventing the damper from opening or closing.

FAN FAILURE

Check that the unit configuration is set up for either On/Off or analog control of a fan.

Check that the correct output is controlling the fan, and it is wired correctly.

Check that no debris is preventing the fan from operating.

DUCT HEAT FAILURE

Check that the unit configuration is set up for either On/Off or analog control of the heat.

Check that the correct output is controlling the heating element, and it is wired correctly.

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