



Application Guide BAC-5051AE router



Includes installation, operation and maintenance instructions

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Handling precautions

To prevent damage from electrostatic discharges, take reasonable precautions when handling, servicing, or installing the router. Discharge accumulated static electricity by touching your hand to a securely grounded object before working with the router.



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Section 1: Introduction

This section provides a description of the KMC Controls BAC-5051AE router. It also introduces safety information. Review this material before installing or operating the device.

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Specifications

Specifications are subject to change without notice.

Communication ports

Two 10BaseT/100BaseT, RJ-45 connectors

BACnet MS/TP

- One optically isolated MS/TP port, 9.6–115.2 kilobaud
- Removable three-screw terminal block, 12–22 AWG wire
- Switched end-of-line termination

USB

USB Type C connection for power and communications.

Configuration and software

All configuration is through internal browser-based configuration pages. This requires an HTML5 browser.

BACnet routing

BACnet IP—Two ports, each of which can be set up for any of the following protocols:

- Normal BACnet IP network routing
- BACnet broadcast management device (BBMD) with network and port address translation
- Foreign device registration with BACnet broadcast management devices (BBMDs)
- PAD (packet assembler/disassembler) routing

One BACnet Ethernet port

Installation

Supply voltage	24 VAC (50/60 Hz) or 24 VDC; –15%, +20%; Class 2 only; non-supervised (all circuits, including supply voltage, are power limited circuits) 5 volts DC from powered USB connection Supply source automatically switches to highest available voltage 8 VA required power
Weight	Approximately 5.4 ounces (154 grams)
Case material	Green and black flame retardant plastic

Processor and memory

Processor	Processor 32-bit ARM® Cortex-M7
Memory	Configuration parameters and diagnostics are stored in nonvolatile memory; auto restart on power failure

Regulatory and agency listings

BTL	Listed as BACnet Testing Laboratory profile B-RTR.
UL	UL 916 Energy Management Equipment UL 864 Smoke Control Equipment listed (UUKL), 10th edition. For smoke control applications, see Smoke Control Manual for KMC Conquest Systems , P/N 000-035-18.
RoHS	RoHS compliant (pending)
CE	CE compliant
FCC	FCC Class A, Part 15, Subpart B and complies with Canadian ICES-003 Class A This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Environmental limits

Operating Temperature 32 to 120° F (0 to 49° C)

Shipping Temperature -40 to 140° F (-40 to 60° C)

Humidity 0–95% RH, non-condensing

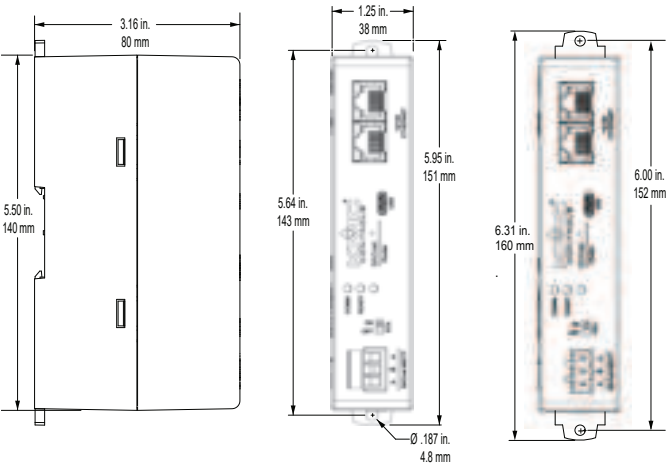
Timekeeping

The BAC-5051AE router is a BACnet time master device.

Update interval	Daily, weekly, or monthly
Time message type	UTC, local, or both
Setting time	Synchronized to SNTP server, set from computer time, or manually entered

Dimensions and mounting

Surface mount or 35 x 7.5 mm DIN rail mounting



Accessories and replacement parts

The following accessories and replacement parts are available from KMC Controls, Inc.

Power transformer

XEE-6111-50	Transformer, 120-to-24 VAC, 50 VA, single-hub
XEE-6112-50	Transformer, 120-to-24 VAC, 50 VA, dual-hub
XEE-6112-100	Transformer, 120-to-24 VAC, 96 VA, dual hub (approved for smoke control applications)

Surge suppressors

KMD-5567	EIA-485 surge suppressor for MS/TP networks
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Cables

HSO-9001	Ethernet cable, 50 feet
HSO-9011	Ethernet cable, 50 feet, plenum rated

Replacement parts

[HPO-9901](#)

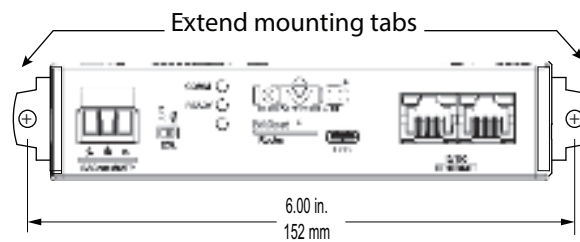
Controller replacement parts kit with terminal blocks and DIN clip

Mounting the router

For permanent installations, the router can be flush mounted or snapped to a 35 x 75 mm DIN rail. For router dimensions, see the topic [Specifications on page 5](#).

Surface mounting Extend the mounting tabs away from the router body and fasten with screws.

Illustration 1–1 Surface mounting the router



DIN rail mounting Mount the DIN rail and then do the following:

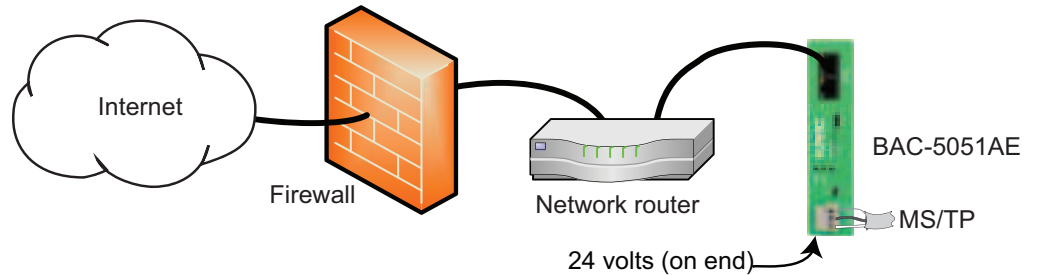
- 1 Extend the mounting tabs.
- 2 Place the bottom of the router over the DIN rail.
- 3 Push the mounting tabs back toward the router body to lock it to the rail.

Connecting for network routing

For permanent installations, connect the BAC-5051AE router to a network router or network switch and an MS/TP network. For permanent installations, the router is typically connected to a 24 volt transformer for power.

For installations that include Internet access, install the router behind a firewall.

Illustration 1–2 Permanent installation



See also the following topics:

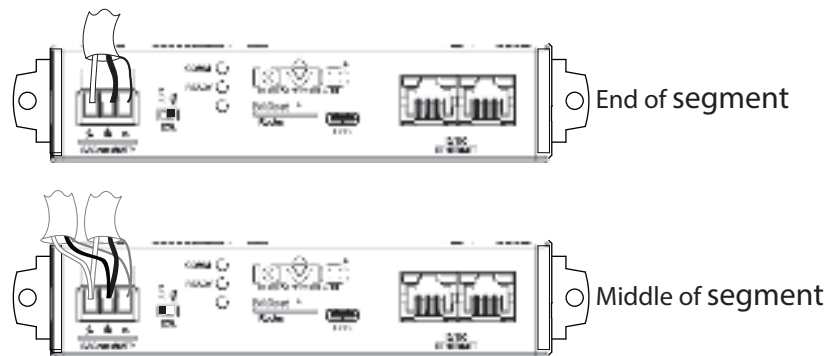
- [Mounting the router on page 8](#)
- [Connecting power on page 11](#)

MS/TP network wiring

Use the following principles when connecting the router to an MS/TP network:

- Connect no more than 128 BACnet devices to one MS/TP network. The devices can be any mix of masters, slaves, or routers.
- Use twisted pair, shielded cable with capacitance of no more than 51 picofarads per foot for all network wiring. See the bulletin *TB190529A, EIA-485 Network Wire Recommendations* available at kmcccontrols.com.
- Connect the $-A$ terminal in parallel with all other negative (-) terminals.
- Connect the $+B$ terminal in parallel with all other positive (+) terminals.
- Connect the shields of the cable together at each mid-line device. For KMC BACnet devices, use the S terminal.
- Connect the shield to an earth ground at one end only.
- Use a repeater between every 32 MS/TP devices or if the cable length exceeds 4,000 feet (1,220 meters). Use no more than four repeaters per MS/TP network.
- Connect a KMD-5567 surge suppressor to the MS/TP cable at the point where it exits a building.

Illustration 1–3 MS/TP wiring



MS/TP EOL (End-Of-Line) termination switches

Each controller at the physical end of an MS/TP wiring segment must have an end-of-line termination for proper network operation.

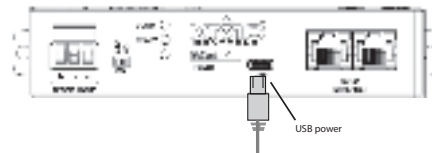
- If the router is at the end of the network segment, set the EOL switch to *ON*.
- If the router is in the middle of the network segment, set the EOL switch to *OFF*.

Connecting power

Power the BAC-5051AE router from a 24 volt power source, either AC or DC, or from a USB connection. The router begins to operate when a power source is applied. Use the following guidelines when choosing and wiring sources to the router.

For USB power Connect the router to a powered USB port with a USB-C cable. Typically, the USB ports on laptop computers can supply power to the router. When connecting to a USB hub, verify the power specifications of the hub. See the topic [Specifications on page 5](#).

Illustration 1–4 USB connection

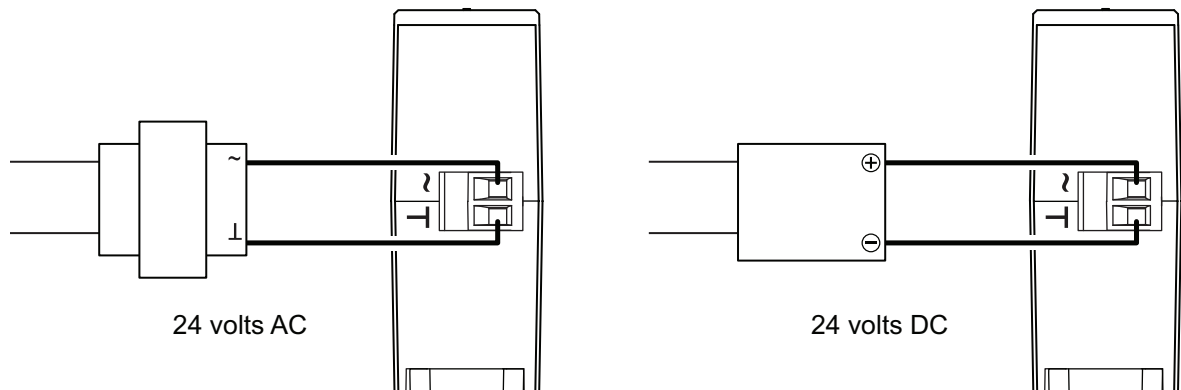


Note: When using USB connection for power and communications, use the USB cable from the HPO-5551 Technician's Router Cable Kit. The cable from the kit is specified to supply enough power for both the USB and the network connection.

To use the USB for power and network communications, see the topic [Single-cable connection on page 12](#).

For permanent installations, the router is usually powered from a 24 volt transformer or DC power supply.

Illustration 1–5 24 volt power connections



For 24 volt AC power Connect a 24 volt transformer to the black power terminal block on the end of the router.

- Connect the AC phase to the phase terminal ($\sim$).
- Connect the ground side of the transformer to the ground terminal ($\perp$).
- Use a Class 2 transformer of the appropriate size to supply power to the router.
- KMC Controls recommends powering the router from a dedicated transformer.
- Do not run 24 volt power from within an enclosure to external devices.

For 24 volt DC power Connect a 24 volt power supply to the black power terminal block on the end of the router.

- Connect the positive terminal (+) to the phase terminal ($\sim$).
- Connect the negative terminal (-) of the power supply to the ground terminal ($\perp$).
- Use a Class 2 power supply of the appropriate capacity to supply power to the router.
- KMC Controls recommends powering the router from a dedicated power supply.
- Do not run 24 volt power from within an enclosure to external devices.

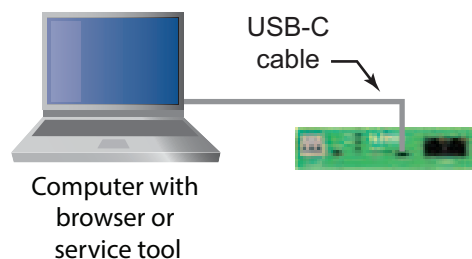
Single-cable connection

The single-cable connection method connects the BAC-5051AE router to a computer with a USB cable that supplies both power and communications. The USB port becomes a virtual network interface card (NIC) and establishes a network between the computer and the router.



Note: Use the USB cable from the HPO-5551 Router Technician's Cable kit for a single-cable connection. This cable meets the specification to supply the power and communications required by the router. Other cables may prevent routing on one or more ports.

Illustration 1–6 Single-cable connection



To set up a single-cable connection, do the following:

- 1 Plug the USB cable from the HPO-5551 cable kit into the router.

- 2 Plug the other end of the USB cable into the computer.

Depending on the version of Windows, the first time the router is plugged into a computer, Windows will display a message that it is installing a new driver. Click the message to see more details. Note the name of the device in the message because you will need this information in later steps. Allow the installation to finish and then close the dialog.

- 3 From the Windows Control Panel, click **Network and Internet**.
- 4 Click **Networking Sharing Center**.
- 5 Once the center is open, click **Change Adapter Settings**.
- 6 Identify the Local Area Connection that is associated with the router and click it to open the connection.
- 7 In the Local Area Connection status, click **Properties**.
- 8 When the next dialog opens, choose **Internet Protocol Version 4**.
- 9 Click **Properties**.
- 10 In the Properties dialog, select **Use the following IP address** and then enter a unique IP address and subnet mask.
 - The IP address must be unique and be part of the same subnet as the router's address.
 - If the router is still configured with the default address, use 192.168.1.10.
 - Set the subnet mask to 255.255.0.0.
- 11 When finished, click **OK** to save the work and then close all dialog boxes.

To test the connection, do the following:

- 1 Open a browser window.
- 2 Enter the address of the router.
- 3 When the log in page opens, set up the router as described in the topic
- 4 When the log in page opens, set up the router as described in the topic .

Maintenance

The BAC-5051AE router requires no routine maintenance. If necessary, clean with a damp cloth and mild soap.

If you encounter difficulty

If you experience difficulty with the BAC-5051AE router, KMC Controls provides the following assistance.

The KMC Controls web site Navigate to the support section on the KMC Controls website for the latest information for BAC-5051AE router and other KMC Controls products.

www.kmccontrols.com

KMC technical support Our distribution partners have unlimited and free access to our team of Technical Support representatives. We provide coast-to-coast and toll-free support from 8:00 AM Eastern Time to 5:00 PM Pacific Time.

Toll-Free Technical Support: (866) 303-4562

Safety considerations

KMC Controls, Inc. assumes the responsibility for providing you a safe product and safety guidelines during its use. Safety means protection to all individuals who install, operate, and service the equipment as well as protection of the equipment itself. To promote safety, we use hazard alert labeling in this manual. Follow the associated guidelines to avoid hazards.



Caution: Caution indicates potential personal injury or equipment or property damage if instructions are not followed.



Note: Provides additional information that is important but may be missed.



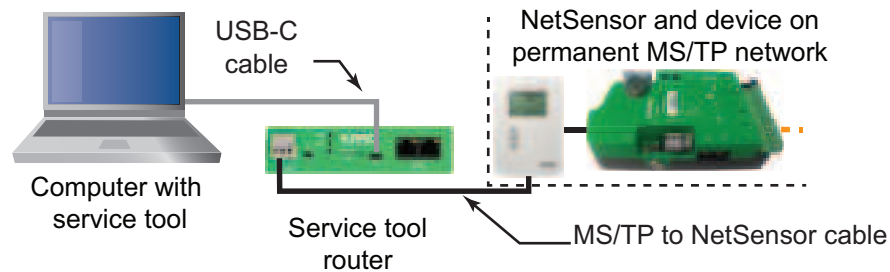
Tip: Provides programing tips and shortcuts that may save time.

Using the router as a technician's service tool

To use the BAC-5051AE router as a technician's service tool, connect it between a computer running a service tool program and a BACnet internetwork. Use the following cables from the HPO-5551 Router Technician's Cable kit to make the connections.

- The MS/TP to NetSensor cable
- The USB-C cable

Illustration 1–7 Router service tool connection



Computer requirements The computer running the service or configuration program must have a BACnet driver installed and be configured to match a port in the service tool router. The program also requires a unique Device Instance number assigned to the BACnet driver. The exact details for setting up the driver vary with each program.

Router setup Using the router for service connection requires that the router is set up with a unique Device Instance and network number between the computer and router. The network between the computer and router may be one of the IP protocols or the Ethernet protocol. Typically, the normal IP protocol is used when the router is connected between a computer and an MS/TP network.

- See the topic [on page 25](#) for details on configuring the router's ports for BACnet networks.
- Setting the device instance number is described in the topic [Device properties on page 21](#).

To set up the router for a service connection, do the following:

- 1 Set up the computer and router for a single-cable connection as described in the topic [Single-cable connection on page 12](#).
- 2 Connect the MS/TP to NetSensor cable between the router and the bottom of a NetSensor or STE-6000 sensor with a network port.
- 3 Assign a unique device instance number and network number to the service tool program.
- 4 Log in to the router using an HTML5 browser.
- 5 Assign a unique device instance number to the router.

- 6** Enable a port in the router for BACnet network.
 - The protocol for the port, either IP or Ethernet, in the router must match the protocol used by the service tool program.
 - The BACnet network number assigned to the port must be unique on the BACnet internetwork.
- 7** In the Router Core area, verify or select all of the following check boxes:
 - Route On Startup
 - Enable Routing
 - Use Learned Networks
- 8** Enable the MS/TP port in the service tool router.
 - Set the MS/TP MAC in the router that is unique on the MS/TP network.
 - Set the baud rate to match the baud rate of the building's MS/TP network.
- 9** Start the service tool program. The BACnet devices on the internetwork will be available for discovery. If it is a large internetwork, it may take a few minutes to discover all devices.

Section 2:

Configuring the BAC-5051AE router

This section provides important guidelines for configuring a router before it is placed on a network. Review this information carefully for proper installation.

The router must be configured as a network device. To prevent disrupting an existing network, configure the network address before connecting the router to the network. The BACnet device instance and other properties can be configured at the same time or after the IP address is assigned and the router is installed in its permanent location on a network.

Topics in this section

Initial setup	17
Device properties	21
Time	22
Security	23
Session timeout	24

Initial setup

Configure the BAC-5051AE router with an HTML5 compatible web browser using the web pages served from within the router. The router has the following default network address values.

- IP address—192.168.1.252
- Subnet mask—255.255.255.0
- Gateway—192.168.1.1

You will need the following information before you can configure a router.

From the BACnet system engineer:

- BACnet device instance for the router.
- Network numbers for each of the enabled networks.
- If applicable, the address and port for a PAD router or BBMD to which the router will connect.

From the IT system administrator:

- The IP address for the router.
- The IP subnetwork mask for the Ethernet LAN to which the router will connect.
- The IP address of the network gateway.
- If the router is part of a system that uses the Internet, you will also need the public IP address and port.

You will also need an HTML5-compliant browser, Ethernet cable, and a USB Type A-to-USB Type B micro cable or a 24 volt AC power source.

Setting up for configuration

To configure the router, plug it into an Ethernet port. Typically, this is a direct connection to a computer Ethernet connection that requires changing the computer IP address. See the procedure [Changing your computer's address on page 19](#).

In addition to the Ethernet connection, supply temporary power to the router with a USB cable. An alternative to the USB power connection is a 24 volt AC source. See [Connecting power on page 11](#).

Illustration 2–1 Connecting for configuration



Logging in

Use an HTML5 browser to log in and configure the router.

To log in, do the following.

- 1 Connect the router to an Ethernet port by doing one of the following.
 - Connect directly to the computer.
 - Connect to a subnet that recognizes address 192.168.1.252.
- 2 Connect the router to either USB or 24 volt AC power.
- 3 Open a new browser window.
- 4 Enter the address **192.168.1.252**.



- 5 At the log in window enter the following user name and password.
 - User name: **admin**
 - Password: **admin**

- 6 Once you have logged in, other parameters of the router can be changed from the Home page.
- To change the IP address, see the topic [Device properties on page 21](#).
 - To change passwords and add users, see the topic [Security on page 23](#).



Note: Once you change the IP address, place the router on the new subnet and log in using the new address. After the address is changed and saved, the router will not respond to the old address.



Changing your computer's address

To directly connect a computer to a router, you must set the IP address of the computer to be compatible with the IP address of the router.

- 1 From the Windows Control Panel, click **Network and Internet** and then **Networking Sharing Center**.
- 2 Choose the local connection for the LAN. Depending on the computer and version of Windows, the exact name for the connection may be *Ethernet*, *Local Area Connection*, or something similar.



3 In the Ethernet Status dialog, click **Properties**.



4 In the Ethernet Properties dialog, scroll and select **Internet Protocol Version 4 (TCP/IP)** and then click **Properties**.



5 In the Properties dialog, select **Use the following IP address** and then enter the following for the IP address, subnet mask, and Gateway.

- IP address—192.168.1.10
- Subnet mask—255.255.255.0
- Gateway—Leave empty or unchanged



6 When all information is correct, click **OK**.

Device properties

The Device page identifies the BAC-5051AE router for the Local Area Network (LAN). The IP Address, Subnet Mask, and Default Gateway values are supplied by the IT department system administrator.

The Device page also identifies the router as a BACnet device and sets BACnet communication properties. The default device instance for the router is .



Note: Once the window is saved, the router will use the new settings and will require you to log in at the new address. If the router is not on the same subnetwork as the network gateway router, it will not function correctly.



Device Name The name must be unique among all devices on the BACnet internetwork.

Description Optional information not included in the device name.

Location An optional value that describes the router's physical location.

Device Instance A number that identifies the router on the internetwork. The device instance must be unique on the internetwork and within the range of 0 to 4,194,302. The device instance is assigned by the BACnet system designer. The default device instance is 5051.

Number APDU Retries Indicates the maximum number of retries that an Application Layer Protocol Data Unit (APDU) packet is retransmitted.

APDU Timeout Indicates the time—in milliseconds—between retransmissions of an APDU packet requiring an acknowledgment for which no acknowledgment has been received.

APDU Seg. Timeout The Segment Timeout property indicates the time—in milliseconds—between the retransmission of an APDU segment.

Backup Failure Timeout The time—in seconds—that the router must wait before ending a BACnet backup or restore procedure.

IP Address The internal or private network address of the router.

Subnet Mask Mask determines which part of the IP address is used for a network identifier and which part is used for a device identifier. The mask must match the mask for the network gateway router and other devices on the subnet.

Default Gateway The address of the network gateway router. The BAC-5051AE router and gateway router must be part of the same LAN subnet.

Restart Device Restarts the router. Similar to restarting the router with a BACnet cold start from KMC Connect or TotalControl. A restart does not change properties or save changes not yet saved.

MAC The MAC (Media Access Control) address uniquely identifies the router on the local area network. This number is assigned by the manufacturer and cannot be changed.

Time

Set the properties of the Time page to set up the router as a BACnet time master device.

Time The local time and date as maintained by the router is displayed at the top of the web page. Time and date can be entered directly or synchronized to the time in the computer running the browser.

Sync to PC Click to immediately transfer to the router the time and date maintained by the computer running the browser.

Refresh Clicking **Refresh** discards any changes and reloads router properties on the web page.

Save When finished making changes, click **Save** to make the changes permanent.



BACnet Time Sync Networks

Selects the interval and type of BACnet time message for each network.

Time Sync Period Sets the interval to send time synchronization to the selected BACnet networks. The choices are None, Daily, Weekly, Monthly, or Custom. The Custom interval is entered in minutes.

Interval Offset If Align Intervals is selected, the time synchronization messages are offset, in minutes, from the beginning of the hour or day.

Align Intervals If selected and a Time Sync Period is specified, time synchronization messages are sent at the start of the hour or day.

UTC Offset The UTC Offset property indicates the time offset—in minutes—between local standard time and Universal Time Coordinated. The value of the property ranges from -780 to +780 minutes. The time zones to the west of the zero degree meridian are positive values; those to the east are negative values. The value of the UTC Offset property is derived from the UTC received in a UTC Time Synchronization service request to calculate the correct local standard time.

Sync Network Enabled networks are indicated with a green background. To enable a network,

Time Choice Sets the type of time synchronization to NONE, UTC, LOCAL, or UTC & LOCAL. The router supports both UTC and local time synchronization.

- **UTC** The router sends time sync messages in Universal Time Coordinated (UTC). The devices on the network then apply an offset to calculate local time and date. UTC is the preferred method when the building automation system crosses time zones.
- **Local time** The router sends time sync messages in local time from which devices update their internal clock.

SNTP Time Server

A Simple Network Time Protocol (SNTP) server is a network device that synchronizes the time for devices connected to a local area network. The router receives these time messages and rebroadcasts them as BACnet time service messages.

IP Address Enter the address of the SNTP server. The address is supplied by the IT department.

Sync Period Select an hourly, daily, weekly, monthly, or a custom interval to send the time synchronization message. The custom period is set in minutes.

Test Server Click to test the connection to the network SNTP server.

Daylight Saving Time

DST Status This property indicates *ACTIVE* when Daylight Saving Time is in effect and *INACTIVE* when it is not in effect.

DST Enable Enables the router to change its time to Daylight Saving Time. The period of Daylight Saving Time is defined by DST Start Time and DST End.

DST Auto Calculation Selecting this check box sets the type of Daylight Saving Time calculation. When selected, the router uses a rules-based calculation for DST figured from the day of the month selected in the DST Start Time and in the DST End Time. When this check box is clear, DST is set to specific calendar dates.

DST Start Time Select the ordinal number, day, month and hour that starts Daylight Saving Time.

DST End Time Select the ordinal number, day, month and hour that ends Daylight Saving Time.

Security

- The user name list must include at least one name with Administrator privileges.
- User names and passwords are case sensitive.
- Only the Custom access level can be changed. To do so, select the check box next to each feature to which that role will be granted access. When finished, click **Save***.

The router is configured with the following default user name and password.

- User name: **admin**
- Password: **admin**



Note: Granting access to the Balancing function also includes access to the Zoning function.

Table 2–1 Security access levels

	Configure	Security
Administrator	Display Modify	Display Modify
View Only	Display	
Operator	Display Modify	
Custom	Display* Modify*	Display* Modify*

*Assigned as required.

Session timeout

The browser session will automatically close after 60 minutes of inactivity. After 58 minutes, the Reset Session Timer button appears on any open page. Click this button to reset the session timer.



Section 3:

This section provides important guidelines for configuring a KMC BAC-5051AE router for BACnet routing. Review this information carefully for proper installation. Choices for router configuration must be made to support the system plans for the designed BACnet internetwork.

The BAC-5051AE supports the following routing protocols.

- One MS/TP network
- One BACnet Ethernet
- Two IP networks that can be set up for any of the following protocols:
 - Normal BACnet IP network routing
 - BACnet broadcast management device with network and port address translation
 - Foreign device registration with BACnet broadcast management devices (BBMD)
 - PAD (packet assembly/disassembly) routing

Setting up routing can be performed either during initial configuration or after the router has an IP address assigned and is installed in its permanent location. See [Configuring the BAC-5051AE router on page 17](#) for initial configuration and log in procedures.

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BACnet IP routing

Either of the two IP ports can be configured for normal IP routing. The values to be used on this page are assigned by the BACnet system engineer.

For the log in procedure, see the topic [Initial setup on page 17](#).

- 1 Use an Internet browser to log in.
- 2 Click **Routing** .
- 3 Click **Configuration**.
- 4 Select **Enable** for one of the IP Ports.
- 5 Click ***Save**.
- 6 Select **Enable** for the IP Port.

- 7 From the list box, choose **IP (Normal)**.
- 8 Click ***Save**.
- 9 Set the Network and Port properties as needed, clicking ***Save** after making each change.

Note: Changes may not implement correctly if more than one at a time is made.

Note: The router will restart when a change is made and saved. To make additional changes, log in again.



Enable Select to enable the network. The port block turns green when enabled.

Port Assign a unique UDP port number to each of the enabled IP networks. The default port number is 47808.

Net Designates the BACnet network number for the port. Assign network numbers in the range from 1 to 65534.

Other IP routing protocols

BACnet Foreign device routing

A BACnet Foreign Device configuration can be useful for temporary network connections such as when using the router as a technician's diagnostic tool. For long-term network connections, KMC Controls recommends setting up a BACnet Broadcast Management Device (BBMD) configuration. Refer to [BACnet Broadcast Management Device routing](#).

Either of the two IP ports can be configured as a BACnet Foreign device. The values on this page are assigned by the BACnet system engineer.

For the log in procedure, see the topic [Initial setup on page 17](#).

- 1 Use an Internet browser to log in.
- 2 Click **Routing**.
- 3 Click **Configuration**.
- 4 Select **Enable** for the port.



Enable Select to enable the network. The port block turns green when enabled.

Net Designates the BACnet network number for the port. Assign network numbers in the range from 1 to 65534.

Port Assign a unique UDP port number to each of the enabled IP networks. The default port number is 47808.

Remote IP Enter the address of the remote BBMD. If network address translation (NAT) is used between the BAC-5051AE router and the BBMD, contact the network system administrator for the correct public IP address.

Remote Port Enter the port number of the remote BBMD. If port address translation (PAT) is used between the BAC-5051AE router and the BBMD, contact the network system administrator for the correct public UDP port.

Time To Live Sets the interval at which the router sends a registration message to the BBMD with which it is registered. The valid range is 1 to 65535 seconds.

BACnet Broadcast Management Device routing

For long-term network connections, KMC Controls recommends setting up a BACnet Broadcast Management Device (BBMD) configuration.

Either of the two IP ports can be configured as a BBMD. When configuring an IP port as a BBMD, keep in mind the following rules.

- Configure only one BBMD for a single IP subnetwork.
- Assign the same BACnet network number to all BBMDs on the internetwork.
- The BBMD can accept registration from BACnet foreign devices or perform BBMD-to-BBMD routing.

For more information about BBMDs, refer to the application guide [All About BACnet Broadcast Management Devices \(BBMD\)](#).

For the log-in procedure, see the topic [Initial setup on page 17](#).

To set up the router as a BBMD, do the following:

- 1 Use an Internet browser to log in.
- 2 Click **Routing**.
- 3 Click **Configuration**.
- 4 For the port, select **Enable**.
- 5 From the IP Port list box, choose **BBMD**.

- 6 Click **Table**.
- 7 Type entries in the Broadcast Distribution Table (BDT).

Net IP Address	Subnet Mask	Port
192.168.1.252	255.255.255.255	47808

- 8 Set other properties as needed and then click ***Save**.

Note: The router will restart. To make additional changes, log in again.



Enable Select to enable the network. The port block turns green when enabled.

Net Designates the BACnet network number for the port. Assign network numbers in the range from 1 to 65534.

Port Assign a unique UDP port number to each of the enabled IP networks. The default port number is 47808.

Network address translation

When using Network address translation, coordinate with the IT department to obtain a public IP address and a port exception in the firewall.

Use public address Select to enable network address translation and port forwarding.

Public address The static public IP address supplied by the IT department.

Public port The public UDP port supplied by the IT department. For security, use a port that is not in the typical range of BACnet ports.

Table

The items in Table define the Broadcast Distribution Table (BDT) for the BBMD. Enter the IP address, UDP port number and IP subnet mask of each BBMD that is part of the internetwork.

- If no BBMD uses a public IP address, then the BDT entries in every BBMD are the same.
- If the BBMD uses a public IP address, then the BDTs are different in every router. Each BDT will use its own private IP address, port number and subnetwork mask and the public IP address, port number and subnetwork mask for all of the other BBMDs on the internetwork.

To add or delete entries, do the following:

- Adding entries—Click **Add** and type entries as needed. When finished, click ***Save**.
- Deleting entries—Select **sel** and then click **Remove**.

Max FDT Table Entries Sets the maximum number of foreign devices that can register at one time. The range of values for MAX FDT Entries is 1 to 128.

Enable FD Service When selected, the BBMD permits foreign devices to register with the BBMD. The maximum number of devices is limited by the value in Max FDT Table Entries.

Accept Remote Configuration When selected, the BBMD will update the BDT with a table it receives from another BBMD.

PAD routing

Either of the two IP ports can be configured for PAD (packet assembler/dissassembler) routing to a companion PAD router located on a different subnetwork. The values on this page are assigned by the BACnet system engineer.

For the log in procedure, see the topic [Initial setup on page 17](#).

- 1 Use an Internet browser to log in.
- 2 Click **Routing** and then **Configuration**.
- 3 Select **Enable** for the port.
- 4 From the list box, choose **PAD**.
- 5 Set other properties as needed and then click ***Save**.

Note: The router will restart. To make additional changes, log in again.



A BACnet IP PAD router is a special type of router that connects two or more BACnet network segments that are separated by at least one IP-only router. The PAD router monitors network traffic for BACnet messages addressed to other subnetworks and then repackages the message so that it can pass through IP routers. In effect, this forms a “tunnel” between the two network segments. A companion PAD router unpacks and retransmits the message on the remote BACnet network.

Enable Select to enable the network. The port block turns green when enabled.

Net Designates the BACnet network number for the port. Assign network numbers in the range from 1 to 65534.

Port Assign a unique UDP port number to each of the enabled IP networks. The default port number is 47808.

Remote IP Enter the address of the remote PAD router. If network address translation (NAT) is used between the local router and the PAD router, contact the network system administrator for the correct public IP address.

Remote Port Enter the port number of the remote PAD router. If port address translation (PAT) is used between the BAC-5051AE router and the PAD or BBMD, contact the network system administrator for the correct public IP address.

Other IP routing protocols

- [BACnet Broadcast Management Device routing on page 27](#)
- [BACnet IP routing on page 25](#)
- [BACnet Foreign device routing on page 26](#)
- [Router Core properties on page 31](#)

BACnet Ethernet routing

Configure the Ethernet port in this page. The values on this page are assigned by the BACnet system engineer.

Enable Select to enable the network. The port block turns green when enabled.

Net Designates the BACnet network number for the port. Assign network numbers in the range from 1 to 65534.

MS/TP configuration

Configure the MS/TP network in this page. The values on this page are assigned by the BACnet system engineer.

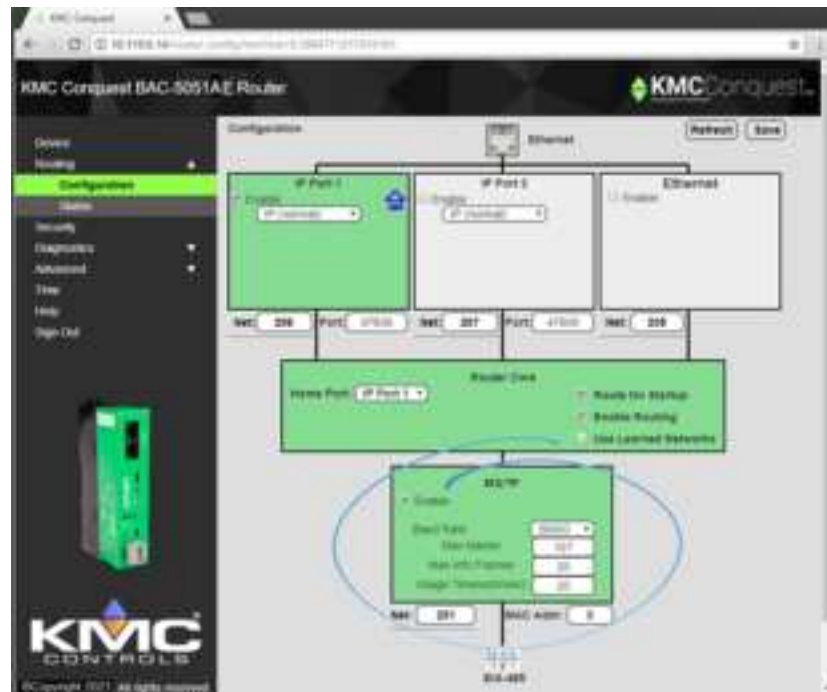
For the log in procedure, see the topic [Initial setup on page 17](#).

- 1 Use an Internet browser to log in.
- 2 Click **Routing**.
- 3 Click **Configuration**.
- 4 Select **Enable** for the MS/TP port.
- 5 Enter the Network number and a MAC address for the router.

6 Set Baud Rate. All devices on the MS/TP network must use the same Baud.

7 When finished, click ***Save**.

Note: The router will restart. To make additional changes, log in again.



Enable Select to enable the network. The port block turns green when enabled.

Net Designates the BACnet network number for the MS/TP port. Assign a network number that is in the range from 1 to 65534.

Baud Rate Select the baud rate from the drop-down list. The baud rate for the router and all devices connected to the MS/TP network must be the same.

Max Master Set to 127 or no lower than the highest MAC address on the network. See [Device Status on page 40](#).

Usage Timeout Sets the maximum time the router will wait on a response from a master device before passing the token.

MAC Address The MAC (Media Access Control) address assigned to the router for the MS/TP network. This must be unique on the MS/TP network and in the range from 0 to 127. Typically, the MAC address for a router is zero (0).

Router Core properties

The Router Core properties are general properties that apply to all routing protocols. The properties consist of the Home Port selection and the Routing properties.

Home port

Because the router is a BACnet device, it must be connected to one of the BACnet networks by setting the Home Port property. The home port:

- is designated on a router port by the Home Port icon .
- sets the network on which the router is connected. In operator workstations, the router appears on the network designated as the home port network.
- can be assigned to an enabled network only.



Caution: Using the MS/TP network reduces the APDU size and significantly increases network traffic. KMC Controls recommends that one of the IP ports or the Ethernet port is designated as the home port.



Routing properties

Route On Startup When selected, the router will immediately begin routing after a power cycle or BACnet cold start. This includes restarting the router on the [Device properties on page 21](#). The router will also select the Enable Routing check box during the reset or power up procedure.

Enable Routing When this check box is cleared, routing on all ports is disabled, but the router remains an active device on the BACnet Internetwork. The MS/TP diagnostic and Routing Status pages are still active. When routing is not enabled, the background of the Router Core box is gray. When routing is enabled, the background is green. Routing can also be enabled or disabled on the [Routing Status on page 35](#).

Use Learned Networks When selected, the router will attempt to learn the network number that is being using on a port. This works only in the event that there is at least one other router on the network that responds to a BACnet *What-Is-My-Network-Number* request. If available, the router will use the learned network. Otherwise, the router will use the configured network number.

Illustration 3–1 Routing properties



Section 4: Status and diagnostics

Topics in this section cover status and router diagnostic functions.

The BAC-5051AE router includes several status and function pages for diagnosing problems and improving the efficiency of the connected networks.

- The topic [Routing Status](#) applies to all connected networks.
- The topics [Device Status](#), [MS/TP Metrics](#), and [Token Use](#) apply to the MS/TP network.

Topics in this section

Routing Status	35
Device Status	40
Token Use	42
MS/TP Metrics	43
MS/TP Capture	47
Ping	49

Routing Status

The BAC-5051AE router includes BACnet routing functions. References to the router and routing in this topic refer to the BACnet routing functions and networks, including the BACnet virtual network, within the router. The status of the KMDigital networks, controllers, or points are not included on this page.

The Routing Status page contains a network status list and command buttons to update the display and networks. The page consists of three major parts.

- Send commands to the router with the [Routing Status buttons on page 36](#).
- View the status of networks in the [Route Status list on page 37](#).
- Clear selected networks by [Purging the Route Status list on page 39](#).

Enable Routing When this check box is clear, routing on all ports is disabled but the router remains an active device on the BACnet internetwork. The MS/TP diagnostic and Routing Status pages are still active. Routing can also be enabled or disabled on the [Router Core properties on page 31](#).



Note: Enable Routing will not remain selected after a restart if Route On Startup is not selected on the [Router Core properties on page 31](#).

Refresh Click to refresh the Route Status list. To automatically refresh the list every 10 seconds, select the **Auto Refresh** check box.

KMC Conquest BAC-5051AE Router

Routing Status

Enable Routing ☒ Auto Refresh ☐ Refresh

Send I-Am-Router-To-Network Clear Direct Network Status Purge Remote Networks

Send Who-Is-Router-to-Network Clear Remote Network Status Send Sequence (Purge, Clear, I-Am-Router-To-Network)

Legend	Status	Net	Destination/Discovered	Next Router	Time	Idle Time	
			Net	Addr			
(S)	Sole Master	2500	N/A	Directly Connected	Not Applicable	00:02:12	00:00:00 Select Routes
(G)	Active	11891	N/A	Directly Connected	Not Applicable	00:02:15	00:00:02 Select Routes
(G)	Active	205	N/A	11891	10.110.2.204.47801	00:02:15	00:01:33 Select
(G)	Active	1104	N/A	11891	10.110.2.204.47801	00:01:33	00:01:33 Select
(G)	Active	1106	N/A	11891	10.110.2.206.47801	00:01:33	00:01:33 Select
(G)	Active	1107	N/A	11891	10.110.2.207.47801	00:01:33	00:01:33 Select
(G)	Active	2000	N/A	11891	10.110.6.13.47801	00:02:02	00:01:33 Select
(G)	Active	3000	N/A	11891	10.110.6.12.47801	00:02:09	00:01:33 Select
(G)	Active	18895	N/A	11891	10.110.6.13.47801	00:01:33	00:01:33 Select

of Networks Displayed 9 (Actual 9) Purge

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Routing Status buttons

The Route Status buttons are useful for diagnosing routing and network problems.

Send I-Am-Router-To-Network Broadcasts to all networks that the router is connected to the network. This can trigger updates throughout the network.

Clear Direct Network Status Forces the status of all direct networks to Active. If a network problem continues after clearing the direct networks, the networks with problems will return to a status other than Active.

Purge Remote Networks Removes all remote routes from the network table.

Send Who-Is-Router-to-Network Initiates a query to other routers that results in the discovery of other networks. Other routers respond with a BACnet I-Am-Router-To-Network message.

Clear Remote Networks Forces the status of all remote networks to Active. If a problem continues with a remote network, it will return to a status other than Active.

Send Sequence Sequentially broadcasts the three commands Purge, Clear and Send I-Am-Router-To-Network.

Route Status list

The Routing Status list is a diagnostic display of all networks known to the router. Both direct and remote networks are listed.

- Direct (or local) networks are connected directly to the router.
- Remote networks are on the other side of one or more remote routers. The path to a remote network always includes at least one directly connected network.

Each of the columns lists information about local or remote networks.



Tip: If a directly connected network is shown to have a problem, the remote networks that connect to it will also show problems. Correct directly connected network problems before troubleshooting remote network problems.

Status The status of each network known to the router. See the table [Route status conditions](#) for a description of each condition.

Net The columns under Net will change modes depending on the setting of Use Learned Networks on the [Routing Status on page 35](#).

Destination The Destination is always the network number the router is using.

- If Use Learned Networks is enabled, this is the learned network number.
- If Use Learned Networks is not enabled, this is the network number entered for the port on the Configuration page.

Configured (Use Learned Networks enabled) The network number that is configured for the port on the Configuration page. If this number is different than the Destination network, the network number displays in red.

Discovered (Use Learned Networks not enabled) The learned network number at a port. If this network number is different than the network number on the Configuration page the number is in red and the status will be other than Active. Other networks are listed as N/A.

Next Router A list of each network connected to the router's ports that will be used to route a message to the next router.

- **Network** The BACnet network number to the next router.
- **Address** The MAC address of the next router.

Time The time elapsed since the status update.

Idle Time The time elapsed since the router last passed traffic to the network.

Table 4–1 Route status conditions

Status	Icon	Description	Action
Active		The network is functioning correctly and is capable of passing traffic.	None required.
Busy		The amount of network traffic is high enough that no new traffic can be accepted.	A temporary condition that does not require intervention.
Down Gone		The network is not functional and is rejecting traffic.	Most likely will require manual intervention. Conditions that cause a network to be down may include either LAN or BACnet router problems.
No Status		The router is searching for the network.	Usually a temporary condition. Does not require intervention.
Duplicated Network		Two networks are using the same network number. A router cannot pass traffic on a duplicated network.	Usually requires intervention to locate and change the duplicated network number. Multiple duplicated networks are usually an indication of a network loop.
Duplicate MAC		The router has detected two MS/TP device using the same MAC address. Traffic is not routed.	Change the MST/TP MAC address in either the router or the device that contains the duplicated number.
Sole Master		The router is not detecting any master MS/TP devices on the local network.	Requires corrective action if master devices are known to be connected to the local MS/TP network.

Table 4–1 Route status conditions (continued)

Status	Icon	Description	Action
BBMD: Unknown		Indicates the router is receiving BBMD traffic from an unknown BBMD. This does not stop traffic from routing.	If appropriate, add the unknown BBMD to the local BDT. A possible cause of unknown traffic is an address issue because of network address translation.
BBMD: Multiple		Indicates the router has detected another BBMD in the same subnet as itself. Traffic is not routed.	Remove a BBMD from the network.
Foreign Device NAK		A foreign device is preventing the router's request to distribute messages. Initially, this will not block traffic. However, as additional registration requests are received, attempts speed up until traffic is stopped.	The remote device server cannot register additional devices. Increase the value of Max FDT Entries in the remote server or register with a different server.
Mismatched Network Number		The learned network does not match the configured network.	Select Use Learned Networks on the Configuration page or change the router's network number.

Purging the Route Status list

To clear old data from the Route list, select a network and then click **Purge**.

- Choose **Select** to remove a specific remote network from the table.
- Choose **Select Routes** to remove all of the remote routes related to a directly connected network.

The selected network or networks are then cleared from the list. As the router detects the actual networks in use, they are added back to the list.

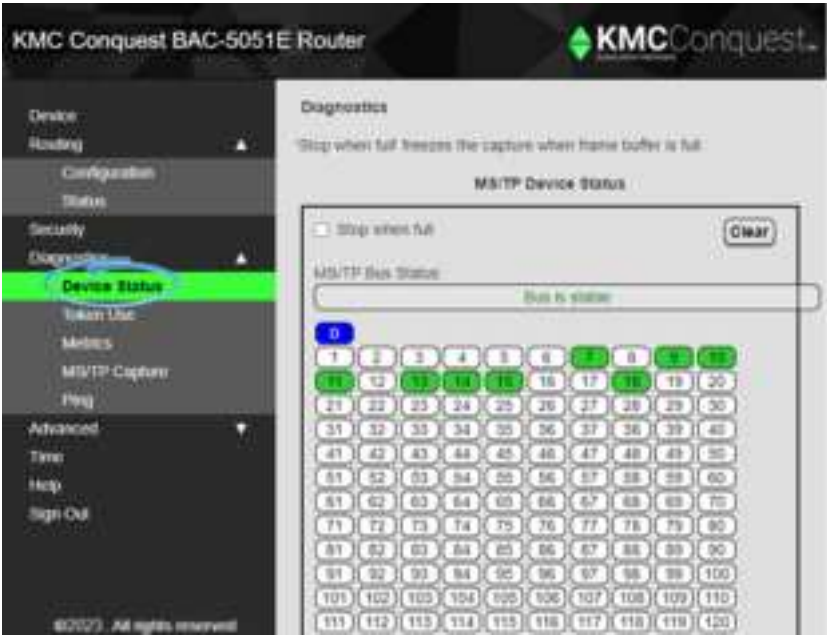
Device Status

The Device Status page is a color-coded status display and a list of metrics for the MS/TP network. The background color of each MAC address indicates its status.



Note: When the Diagnostics page opens, the router shows active network devices in green. After clicking Refresh, any device that was active but has stopped communicating within the last few seconds changes from green to gray.

See the topic [on page 25](#)



Operation

Stop when full When selected, freezes the capture when the frame buffer is full.

Clear When selected, deletes all current color indications in the MS/TP Device Status display and values in the metrics list and updates the window with the latest network status and metrics.

Table 4–2 Device status

Color	Icon	Description
White		No device is assigned to this MAC address.
Gray		A device was active with this MAC address but is no longer online.
Blue		The MAC address assigned to the router.
Green		The MAC address is assigned to an active device.
Red		Two devices are using the same MAC address.

If you encounter difficulty, click **Refresh** about every 10 seconds to observe how the Device Status changes.

- If a MAC is red, start disconnecting devices from the network and click **Refresh** as you disconnect until the red goes away. This will help find the device that has the same MAC address as the router.
- Gaps in the MAC addresses. MAC address gaps make the network less efficient because devices will continually search for devices in the gap. Small gaps between the router and the first device are acceptable, but try to eliminate gaps between devices by changing MAC addresses.
- Gray can indicate several issues. This means communications at or near the gray MAC address is intermittent. This can be caused by noise, loose wiring, and duplicate MAC addresses. It could mean the end-of-line termination is not set properly. It could mean a device has bad power and is resetting often. The problem is usually associated with the first device that is shown gray.
- Known devices are not green. This is usually caused by bad wiring, bad grounding, or not having the same baud-rate for the router and devices. To isolate the problem, start splitting the network by physically disconnecting wires until devices begin communicating.

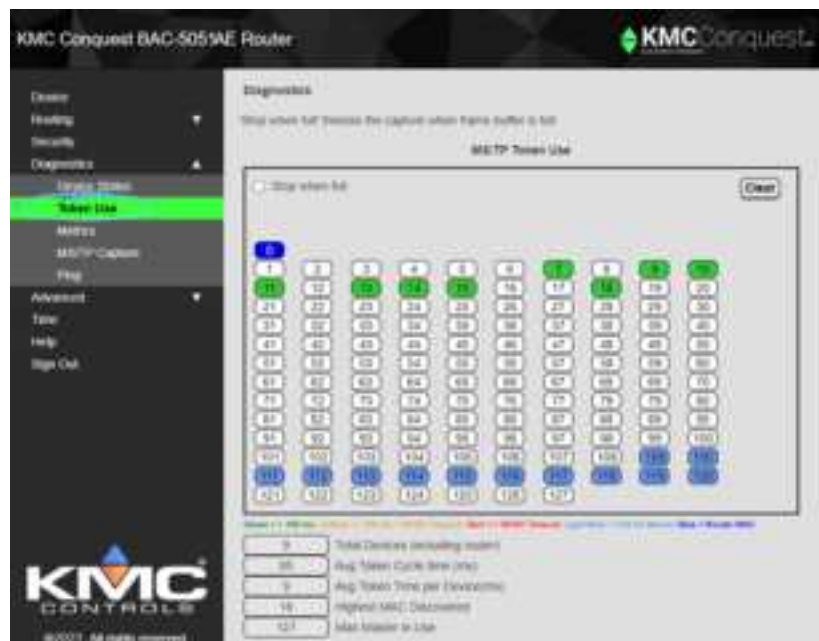
Network metrics are useful for evaluating overall network performance.

Network metrics

Metric	Description
Total Devices	The number of devices on the network including the router
AVG Token Cycle time	The time for the token pass to all controllers and return
AVG Token Time per device	Typically 10 ms or less
Last Master MAC Address	The highest MAC address found by the router.

Token Use

The Token Use page is a dynamic display of token passing on the network. The colors of each device indicate the speed of token passing.



Token use by color

Color	Description	Condition	Action
Blue	The MAC address assigned to the router.	Light traffic. Will change to green or yellow if traffic increases.	None required.
Green	Token passed in less than 100 ms.	Normal token passing.	None required.
Yellow	Token passed is more than 100 ms but less than the value of APDU Timeout.	Token passing is slow, but the device is still functional.	Indicates a potential bottleneck. No action is needed if the device returns to green.
Red	APDU Timeout	The device is retaining the token too long.	A bottleneck in network traffic. A typical cause is excessive or continuous polling for data in other controllers.
Light Blue	Poll for Master	A device is polling for a master device.	This is normal if there are gaps in the MAC addresses.

Operation

Stop when full When selected, Stop when full freezes the capture when the frame buffer is full.

Clear Removes data from the window and refreshes it with the current network status.

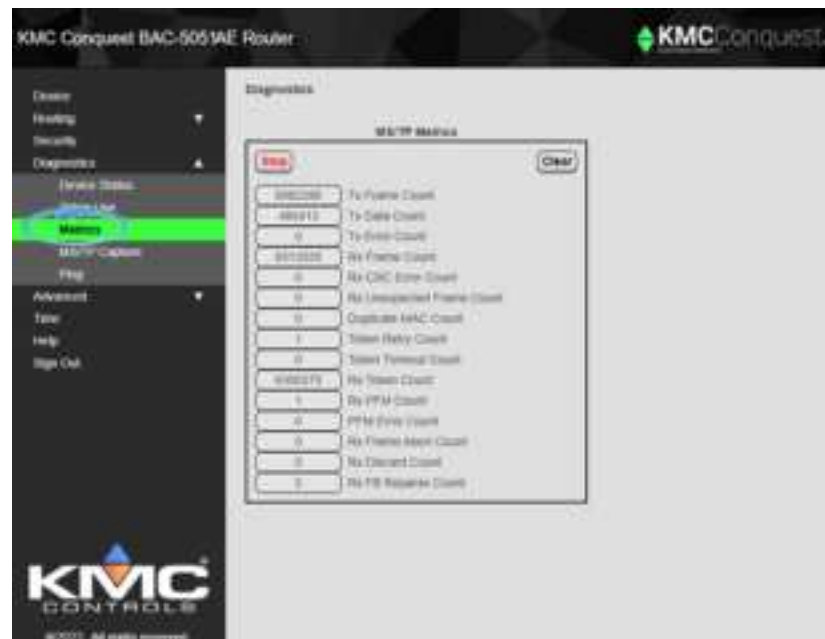
Network metrics are useful for evaluating overall network performance.

Network metrics

Metric	Description
Total Devices	The number of devices on the network including the router
AVG Token Cycle time	The time for the token pass to all controllers and return
AVG Token Time per device	Typically 10 ms or less
Last Master MAC Address	The highest MAC address found by the router.

MS/TP Metrics

Network metrics are useful for evaluating network performance and troubleshooting MS/TP network problems.



Operation

Stop When clicked, freezes the current values in the window. Clicking **Start** begins data collection again.

Clear Removes data from the window.

Interpreting the diagnostic data

Even the best designed and installed network will have minor or infrequent communications issues. The following tips will help determine the significance of the network metric as well as suggestions for improvement.

Tx and Rx Frame Counts The actual number of frame counts depends on the baud rate and number of network devices. The more connected devices, the slower the frame counts

grow. Unless the relative difference between the two counts is greater than 10%, the network is generally in good health. The reason the router sends more messages than it receives is primarily because of the small gap between its own MAC address and the next device.

Rx Frame Count greater than Tx Frame Count The greater the difference, the higher the probability of the following conditions.

- One or more devices somewhere in BACnet internetwork is sending a lot of broadcast messages.
- One or more devices on the router's MS/TP network is sending a lot of network unicast messages.

The usual cause is a device trying to find other devices that do not exist or are not communicating properly and are repeatedly sending BACnet WHO-IS messages. It is typical for this to be caused by a Control Basic program or a Notification Class object recipient list referring to a device that does not exist.

Rx Frame Count much less than Tx Count This may be accompanied by a device showing a gray, offline status. It usually means devices are not communicating reliably either because of noise or because they are inundated with network messages and cannot keep up.

Tx Data Count This is the number of messages that contain actual point data. Most other messages are just passing the token. In the previous example, the Data Count is only 0.1% of the Tx Frame Count. This means the network is passing a small number of points or trends. If this ratio is more than 30%, it may indicate a problem because it is likely that one or more devices or workstations are gathering more data than is really needed. This can mean the network will drop important messages.

Token Retry or Token Timeout This usually indicates a problem with the device next to the router in the MAC chain. The cause could be noise specific to the device or general network noise. This is not a problem unless there are more than 10 counts in a 24-hour period.

Rx PFM Count This indicates a problem between the router and the device just before it in the MAC chain, usually the one at the end. A few counts in a 24-hour period is not unusual.

All other metrics Other metrics typically do not indicate a problem unless a value exceeds 10 counts in a 24-hour period.

Description of the Metrics page

The following table describes each of the properties displayed on the MS/TP Metrics page.

Table 4–3 Diagnostic metrics

Metric	Description
Tx Frame Count	2.1.1. The number transmissions this device has made The number of transmissions sent by the router.
Tx Data Count	2.2.1. The number of transmissions that included data that this device made The number of transmissions sent by the router that included data.
Tx Error Count	2.3.1. The number of transmissions errors this device has taken The number of transmissions sent by the router that were in error.
Rx Frame Count	2.4.1. The number of frames meant for us The number of frames received by the router.
Rx CRC Error Count	2.5.1. The number of frames meant for us with bad CRCs The number of frames intended for the route with a bad Cyclic Redundancy Check (CRC).
Rx Unexpected Frame Count	2.6.1. The number of frames received where something unexpected went wrong The number of frames with an unexpected error that were received by the router.
Duplicate MAC Count	2.10.1. The amount of times this device received a message that it believed came from another device with the same mac The number of times the router received a message from another device with the same MAC.
Token Retry Count	2.13.1. The number of times this device has to retry passing the token The number of times the router had to retry passing the token.
Token Timeout Count	The number of times the token passing from the router to the next device failed.
Rx Token Count	The number of times the router received the token.
Rx PFM Count	The number of times the router received a poll-for-master message for its own MAC.

Table 4–3 Diagnostic metrics (continued)

Metric	Description
PFM Error Count	2.16.1. The number of times something unexpected came when this device thought it was receiving a poll to master. The number of times the router was expecting a poll-for-master message and did not receive it.
Rx Frame Abort Count	2.7.1. The amount of frames being received that were aborted do to timeout. The number of frames that were terminated because of a timeout error.
Rx Discard Count	2.8.1. The amount of frames discarded for mismatched timing or preambles. The number of frames rejected because of mismatched timing or preambles.
Rx FB Reparse Count	2.9.1. The amount of times we found more than one frame inside a frame buffer. The number of times more than one frame was found inside of the frame buffer.

MS/TP Capture

Use the MS/TP Capture page to monitor and save the BACnet traffic on the MS/TP network. The captured traffic can then be saved in a standard `.pcap` (Packet CAPture) file format. Once the data is saved, it can be analyzed with Wireshark or any other network analysis program that uses `.pcap` files.

To use the MS/TP Capture feature, the router must be connected directly to the monitored MS/TP network. This can be from either an existing router or a router temporarily connected as a service tool.

Illustration 4–1 MS/TP Capture page



Current State Shows the status of the capture. The status can be any of the following conditions.

- Idle
- Starting Capture
- Capturing
- Ending Capture
- Data Ready
- Error

Start Now Select this check box and then click **Save** to start a capture. The capture will continue until the length of time set in Max Time, the amount of data set in Max Length, or the maximum buffer size is reached.

Stop Now Select this check box and then click **Save** to end a capture. The data can then be saved by clicking **Download Capture**.

Start on Restart Select this check box and then click **Save**. The router will restart and capture MS/TP traffic until the Max Time or Max Length is reached or the buffer is full. The maximum amount of space to store captured data is 1 megabyte. The router will capture MS/TP traffic after every restart until Start on Restart is cleared.

Max Time Enter the length of time, in seconds, for a timed capture.

Max Length The amount of data, in bytes, to capture.

Last Start Time For information only. This is the time—as maintained by the clock in the router—when the last capture started.

Last End Time For information only. This is the time—as maintained by the clock in the router—when the last capture ended.

Capture Filled The percentage of available buffer space to store a capture. The maximum amount of space to store captured data is 1 megabyte.

Download Capture When this link is blue, captured data is ready to save to the computer on which the browser is running. Data is saved in the file format `.pcap` (Packet CAPture). The first capture is saved as `Capture.pcap`. Additional captures are saved with a number appended to the file name (`Capture (1).pcap`, `Capture (2).pcap`, etc.). Files are saved in the `Downloads` folder for the current Windows user.

Ping

Use the Ping page to transmit a minimal amount of data from the router to determine the connectivity of and response times from a network device.

To use the Ping feature, the router must be connected directly to the monitored MS/TP network. This can be from either an existing router or a router temporarily connected as a service tool.

A ping test is initiated manually and can be either a fixed series of four attempts or a continuous series of attempts that must be terminated manually.

Illustration 4–2 Ping page



Enter Destination Device Instance Type the device instance of the device to ping.

Continuous Ping? Select this check box and then click **Start** to initiate a continuous series of pings. The pings will continue until the **Stop** button is clicked.

Start Initiates a ping test. If the device is connected, a "success" message appears.

Stop Ends a Continuous Ping test.

Ping Results Displays a summary of the ping test with the following information.

Illustration 4–3 Ping Results report



- The time (in milliseconds) for the ping to travel from the router to the device and back
- The number of pings sent
- The number of pings received
- The number and percentage of pings lost
- The minimum length of round trip times in milliseconds
- The maximum length of round trip times in milliseconds
- The average length of round trip times in milliseconds

The Ping Results report is generated automatically after four ping attempts in a _ test or when the **Stop** button is clicked in a continuous ping test.

Using Ping data to optimize network performance

When using the ping feature to measure response times on MS/TP networks, it is important to understand that the MAC address and the Max Master configuration of devices have a noticeable effect. The following factors should be considered when interpreting the results of a ping test.

- The token cycle time increases as the number of devices on an MS/TP network increases. This leads to higher average response times.
- Even small amounts of ambient “useful” traffic (e.g., read-property or write-property messages) will have a significant effect on the time it takes for a token cycle to complete.
- MS/TP protocol dictates that missing devices (more specifically, unused MAC addresses) are polled periodically. Each poll takes a minimum of 20 milliseconds to complete. An unused range is called a “gap”. Every 50 token passes, the device before a gap will start a process that polls one “missing address” in the gap each token cycle. When there are multiple gaps, it is possible for all the devices before the gaps to “line up” and start polling the same token cycle. A variation of this is when multiple devices overlap while conducting a poll.
- Max Info Frames, which is used to control how much a device can use a token, contributes to network traffic rates when it is set to values greater than “1”. Values greater than “1” will slow down the token cycle in some situations.

The following are recommended practices for optimizing MS/TP network performance.

- Eliminate all gaps and set the Max Master correctly. This eliminates the polling process in normal situations.
- Keep the number of gaps small. The fewer the gaps, the less polling that occurs during a token cycle. For example, 10 gaps can equate to 200 milliseconds in a single token cycle.
- Keep the range of the gaps small. The greater the gap, the greater the number of cycles it takes to poll every MAC address within it. For example, a gap of 10 devices amounts to 200 milliseconds of processing time.
- The largest gap on many networks is between the highest MAC address used and the

MAX Master, which defaults to "127". Usually, this is done to allow for additional devices to be connected at a later time. However, setting the Max Master to a lower value can boost performance. For example, if the highest MAC used is 40, setting the MAX Master to 45 allows five devices to be added before having to reset the MAX Master. This also shortens the time it takes to poll.

- Consider dividing the MS/TP network into smaller MS/TP networks. For best results, divide the devices so that traffic flow is roughly balanced and apply the four points above.

Section 5: Advanced features

This section covers features for maintaining the router, balancing VAV controllers, and configuring zoning FlexStats.

Features in the Advanced group are for updating firmware in the router, backing up the router configuration, balancing VAV controllers, and configuring BAC-120063CW-ZEC zoning FlexStats.

- Recovering the IP address**—Discover an unknown network IP address.
- Firmware updates**—From time to time, KMC Controls issues updates to the firmware for the router. The updates can be added directly to the router from the browser pages.
- Configure from file**—Configuration properties for the router can be saved in a JSON (JavaScript Object Notation) file. The file can then be used as a backup file or to configure other routers with similar properties.
- Balancing**—Commands for balancing the airflow in BAC-8000 or BAC-9000 series controllers.
- Zone configuration**—Commands to set up a BAC-120063CW-ZEC zoning FlexStat.

Topics in this section

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Recovering the network address

If the network address of the router is lost or unknown, the router will respond to the default IP address for the first 20 seconds after power is applied.

- 1 Disconnect the router from the LAN and connect the router as described in the topic [Initial setup on page 17](#).
- 2 Unplug the router from the power source.
- 3 On the computer, open a browser window and enter the default address of 192.168.1.252.
- 4 Reconnect the router from the power source and immediately attempt to connect with the browser. The browser will respond with the router's IP address and subnet mask.

- Once the address is known, connect the router to the correct IP subnet for normal operation or router configuration.



Updating the firmware

The router firmware can be updated from the Firmware page in the Advanced group.



Note: The router firmware can also be updated with KMC Connect, TotalControl, or the Firmware Upgrade Tool. For instructions, see the help and other documentation for those programs.

Illustration 5–1 Firmware update page



To update the firmware, do the following:

- Download the new firmware from the KMC Partner Portal. A self-extracting executable file will install the firmware in the correct location.
- Run the downloaded file. This will place a .zip file in the folder at `C:\ProgramData\KMC Controls\Firmware Upgrade Manager\BACnet Family\BAC-5051AE`. Do not unzip this file.
- Use an Internet browser to log in to the router.

- 4** From the **Advanced** group, choose **Firmware**.
- 5** Click **Choose File** and browse to the following location: C:\ProgramData\KMC Controls\Firmware Upgrade Manager\BACnet Family\BAC-5051AE.
- 6** Locate and open the folder with the correct version of firmware.
- 7** Select the .zip file.
- 8** When the Proceed with download? dialog box opens, click **OK**.
- 9** When the download is finished, click **Commit**.
- 10** In the Restart Device? dialog box, click **OK**. The router will restart.

Configure from a file

Configuration properties for the BAC-5051AE router can be saved in a configuration file. The configuration file can then be used as a backup file or to configure other routers with similar properties.

- 1** Use an Internet browser to log in.
- 2** From the **Advanced** group, click **Choose File**.
- 3** Browse to the file location.
- 4** Choose the file.
- 5** Click **Open**.
- 6** When the Overwrite Router Configuration dialog opens, click **OK** to proceed.

Choose File Browse to the location and choose the configuration file.

Save Configuration Saves the router configuration in the file `config_5051AE.json`. The file type is JSON (Java Script Object Notation) and it is saved in the current Windows user's Downloads folder.

Illustration 5–2 Configure from File page



VAV balancing and configuration

Topics in this section are for control technicians or engineers who will be balancing the airflow in BAC-8000 or BAC-9000 series controllers. The BAC-5051AE includes the following features for balancing, configuring, and commanding airflow in a VAV controller.

- [VAV balancing on page 57](#)
- [Configuring VAV setpoints on page 59](#)
- [Commanding and monitoring airflow on page 60](#)

The VAV Balancing features are accessible through the Balancing/AFMS/ZEC tab on the router served web pages and are active only when a valid VAV controller has been discovered.

VAV balancing

The airflow balancing procedure described in this topic requires the following items.

- A flow hood or other accurate means to measure airflow
- The engineering design specifications for the minimum and maximum airflow setpoints
- A user name and password with permission to access the VAV balancing feature in the BAC-5051AE



Note: If the VAV unit is used for heat only or cooling only, the airflow setpoints for the unused mode must be set within the range of the mode in use. Failure to set the unused setpoints correctly will result in unpredictable or erroneous air balancing settings.



Note: Starting the balancing procedure erases all previous airflow correction factors. The airflow readings displayed on the VAV balancing page are the actual uncorrected airflow readings as measured by the controller.

- 1 Use an Internet browser to log in.
- 2 From the **Advanced** group, click **Balancing/AFMS/ZEC**.
- 3 Next to Instance Range, enter the device instance of the first SimplyVAV, followed in the second text box by the device instance of the last SimplyVAV controller to be balanced.



Note: If a value is entered in the first (start) text box only before clicking **Discover**, the router software will automatically add 49 device instances to that number and display the result in the second (end) text box.

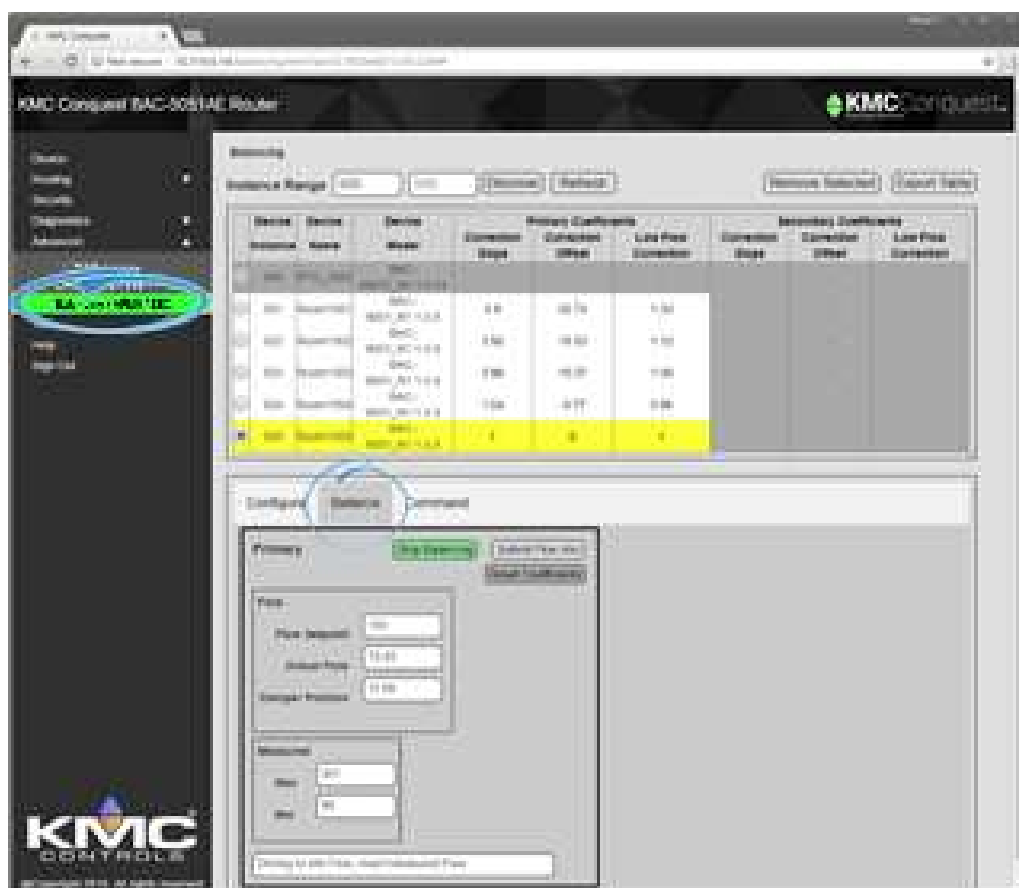
- 4 Click **Discover**. Up to 49 devices will be added to the list. VAV units can be identified as those with values shown under the Primary Coefficients heading in the list.



Note: For dual-duct VAV systems, both the primary and secondary correction coefficients display.

- 5 Select a VAV unit from the list of discovered devices. The background of the selected unit changes to yellow.
- 6 Click the **Balance** tab.
- 7 Click **Start Balancing**. The router commands the controller to start the balancing function by positioning the damper for maximum airflow.
- 8 Wait for the value in Actual Airflow to stabilize.
- 9 With a flow hood, measure and note the airflow.
- 10 Enter the measured airflow in the **Measured Max** text box. The router then commands the VAV controller to position the damper for minimum airflow.
- 11 Again, wait for the value in Actual Airflow to stabilize.
- 12 With a flow hood, measure and note the actual airflow.
- 13 Enter the measured airflow in the **Measured Min** text box. The program in the controller calculates new airflow constants and returns the VAV controller to normal operation.

Illustration 5–3 VAV Balance page



Configuring VAV setpoints

Airflow setpoints in BAC-8000 or BAC-9000 series controllers can be changed from the Configure tab.

- 1 Log in and discover the VAV units as described in steps 1-5 in [VAV balancing](#).
- 2 At the bottom of the page, click the **Configure** tab.

The values shown are the actual values in the controllers. The values for Dual Minimum Flow and Secondary K Factor are active only if a dual-duct VAV controller is selected.

The following controls are available in the Configure tab.

Direction To Close Specifies the direction for the actuator to move toward the closed position. The default setting is clockwise (CW). Select **CCW** for counterclockwise.

Damper Calibration Trigger When activated, initiates a Control Basic sequence that modulates the damper to a completely open position and then to a completely closed position.

Secondary Damper Calibration Trigger When activated, initiates a Control Basic sequence that modulates a secondary damper to a completely open position and then to a completely closed position.



Note: The router monitors the damper position continuously so that if the damper reads as more than 100% open or less than 0% open, the program recalculates its position.

- 3 Make changes as needed.
- 4 Click **Save** when finished.

Device Instance	Device Name	Device Model	Correction Slope	Correction Offset	Low Flow Correction	Correction Slope	Correction Offset	Low Flow Correction
001	001_01.0.0.0	BAC	1	0	1			
002	002_01.0.0.0	BAC	1	0	1			
003	003_01.0.0.0	BAC	1	0	1			

Configure | Balance | Compare

Save | Refresh | Export | Load Configuration | Choose File | No file chosen

Max Cooling Flow: 400 | Min Cooling Flow: 400 | Primary K Factor: 100 | Dual Minimum Flow: 400 | Auxiliary Flow: 400 | Water Pressure: 2.5 | Max Heating Flow: 400 | Min Heating Flow: 400 | Secondary K Factor: 0 | Dual Minimum Flow: 400 | Direction To Close: ☒ CCW ☐ CW | Damper Calibration Trigger: ☒ Trigger ☐ Inactive | Secondary Damper Calibration Trigger: ☒ Trigger ☐ Inactive

Commanding and monitoring airflow

Command the airflow to a specific level to make adjustments or measurements that require a steady airflow.

- 1 Log in and discover the VAV units as described in steps 1-5 in [VAV balancing](#).
- 2 At the bottom of the page, click the **Command** tab.
- 3 To write a point, enter an airflow or damper position value.
- 4 Click **Command**. When any point is in manual override, the Command button changes to a green background.
- 5 To clear changes and return the device to its previous settings, click **Relinquish**.



Airflow Measurement System

Use the router Configure page to observe or change operating values in an Airflow Measurement System (AFMS). This is an alternative method to using an STE-9000 series NetSensor or KMC Workbench software. Refer to the *KMC Conquest Airflow Measurement System Application Guide* available from the [AFMS product page](#) at kmcccontrols.com for detailed information on setting up an Airflow Measurement System.

The AFMS features are accessible through the Balancing/AFMS/ZEC tab on the router served web pages and are active only when a valid AFMS controller has been discovered.

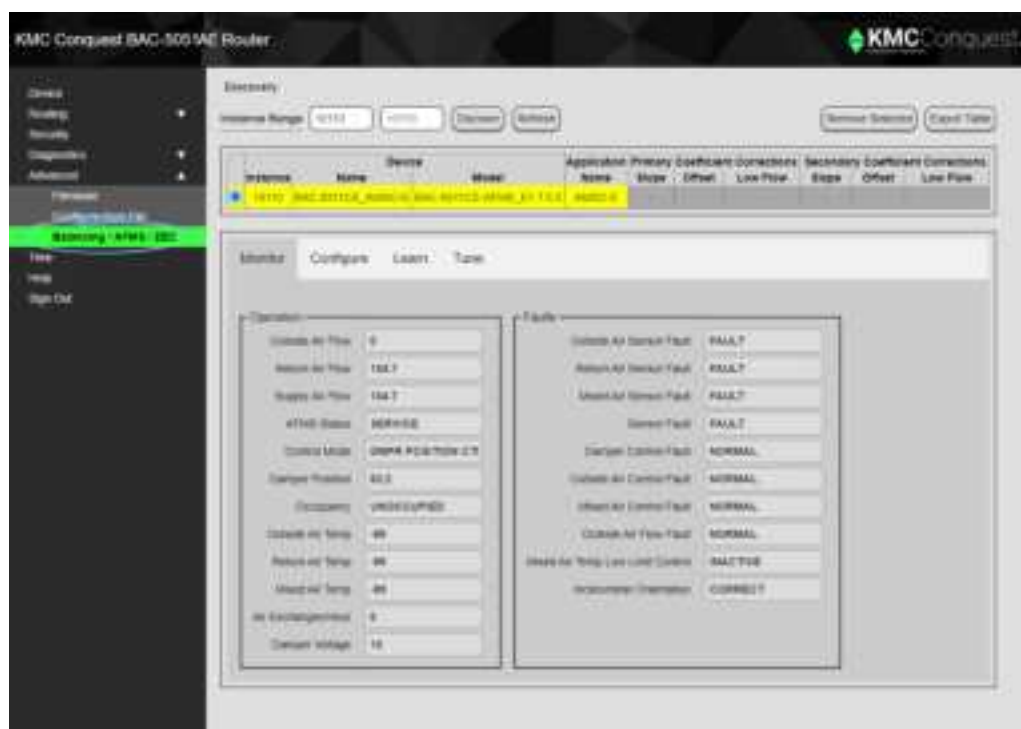
To open the AFMS features, do the following:

- 1 Use an Internet browser to log in.
- 2 From the **Advanced** group, click **Balancing/AFMS/ZEC**.
- 3 In the first blank text box beside **Instance Range**, type the device instance for the first AFMS controller, followed in the second text box by the device instance of the last AFMS controller to be discovered.



Note: If a value is entered in the first (start) text box only before clicking **Discover**, the router software will automatically add 49 device instances to that number and display the result in the second (end) text box.

- 4 Click **Discover**. Up to 50 AFMS devices will be added to the list.
- 5 Select an AFMS controller from the list of discovered units. The background of the selected unit changes to yellow and four tabs for AFMS parameters appear at the bottom of the page.
- 6 Select any of the tabs to make changes or observe operation.



Note: Use an STE-9000 series NetSensor to change from one application to the other (from English to metric or vice versa) before configuring other settings. Changing applications after configuration will restore most parameters to their default settings. For instructions on changing an application from its factory default, refer to the *KMC Conquest Airflow Measurement System Application Guide* available from the [AFMS product page](#) at [kmccontrols.com](#).

The following apply to entering and saving values in the AFMS tabs.

- Writable properties display in text boxes with white backgrounds.
- Read-only properties appear in text boxes with gray backgrounds and are for information only.
- Unsaved changed values appear in red text. When changes are complete, click **Save**. Saved values return to black text.

Monitor tab

The information in this tab is read only. To update values manually, click **Refresh**.

The following properties can be viewed from the Operation group.

- Outside Air Flow
- AFMS Status
- Control Mode
- Damper Position
- Occupancy
- Outside Air Temp
- Return Air Temp
- Mixed Air Temp

The following properties can be viewed from the Faults group.

- Outside Air Sensor Fault
- Return Air Sensor Fault
- Mixed Air Sensor Fault
- Sensor Fault
- Damper Control Fault
- Outside Air Control Fault
- Mixed Air Control Fault
- Outside Air Flow Fault
- Mixed Air Temp Low Limit Control

The screenshot shows the 'Monitor' tab interface with two main sections: 'Operation' and 'Faults'. Each section contains a list of properties and their current values.

Operation		Faults	
Outside Air Flow	127	Outside Air Sensor Fault	NORMAL
Return Air Flow	5.4	Return Air Sensor Fault	NORMAL
Supply Air Flow	127.4	Mixed Air Sensor Fault	NORMAL
AFMS Status	NORMAL	Sensor Fault	NORMAL
Control Mode	PASS THROUGH	Damper Control Fault	NORMAL
Damper Position	100	Outside Air Control Fault	NORMAL
Occupancy	OCCUPIED	Mixed Air Control Fault	NORMAL
Outside Air Temp	16.1	Outside Air Flow Fault	NORMAL
Return Air Temp	18	Mixed Air Temp Low Limit Control	INACTIVE
Mixed Air Temp	16.5	Indoor Air Operation	CORRECT
Air Exchanges/Hour	0		
Damper Voltage	0		

Configure tab

The properties in this tab are divided into General, Damper, and System Setup groups.

General

The General group contains the following properties.

- Supply Area - Click anywhere in the white box to type a value.
- Enable Low Limit - Select from the drop-down menu.
- Low Temp Limit - Click anywhere in the white box to type a value.
- Occupancy - Select from the items in the drop-down menu.

Damper

The Damper group contains the following properties.

- Stroke (in seconds) - Click anywhere in the white box to type a value.
- Damper Reverse Action - Select from the items in the drop-down menu.
- Actuator Volts - Select from the items in the drop-down menu.
- Learn Damper Span - Click **Start Span Mode** to activate the Learn Damper Span feature.
- Damper Span Learned - Read only

System Setup

The System Setup group contains the following properties.

- Control Mode - Click anywhere in the white box to type a value.
- Outside Air Flow Setpoint - Click anywhere in the white box to type a value.
- Outside Air Damper Setpoint - Click anywhere in the white box to type a value.
- Mixed Air Setpoint - Click anywhere in the white box to type a value.

The screenshot shows the 'Configure' tab of the KMC Controls software. The interface is divided into three main sections: General, Damper, and System Setup. The General section includes fields for Supply Area, Enable Low Limit, Low Temp Limit, Occupancy, Outside Air Calculation, and Outside Air Flow. The Damper section includes fields for Stroke Time, Damper Reverse Action, Actuator Voltage, Learn Damper Span, and Damper Span Learned. The System Setup section includes fields for Control Mode, Outside Air Flow Setpoint, Outside Air Damper Setpoint, and Mixed Air Setpoint. The interface also has tabs for Monitor, Configure, Learn, and Tune, and buttons for Refresh and Save.

Learn tab

Properties in the Learn tab that can be changed display in text boxes with white backgrounds.

The Learn tab contains the following properties.

- Minimum Delta T - Click anywhere in the white box to type a value. Delta-T is the difference between outside and return air temperatures.
- Auto Start Delta T - Click anywhere in the white box to type a value.
- Time Between Samples - Click anywhere in the white box to type a value in seconds.
- Date of Last Learn - Displays the month and date of the most recent Learn application.
- Outside Air Temperature When Learned - Displays the outside air temperature at the time of the most recent Learn application.
- Auto Learn Enable - Click **Enable Auto Learn** to activate the Auto Learn feature when the minimum delta-T criteria and Auto Start delta-T criteria are met. The controller will automatically start Learning Mode when the delta-T becomes greater than the Auto Start Delta Temp setpoint. The default Auto Start Delta Temp setpoint is a 20 degree Fahrenheit difference.
- Learning Mode - Click **Learning Mode** to enable the Learning Mode feature.



Note: Check the Learn Ready Status before manually starting Learn Mode. If Learn Ready Status shows not ready, enable the Auto Learn feature. Refer to **Checking Learn Ready Status** in the *Airflow Measurement System Application Guide*.

Monitor Configure **Learn** Tune

Refresh Save

Learn Parameters

Min Delta Temp	10
Auto Start Delta Temp	20
Outside Air Return Air Delta Temp	0.7
Time Between Samples	60
Date of Last Learn	0
Outside Air Temp When Learned	0
Learn Ready	NOT READY
Auto Learn Enable	OFF
Learning Mode	OFF

Tune tab

Properties in the Tune tab are divided into a Calibration group and an AFMS Table group.

Calibration

The Calibration group contains the following properties.

- Sampled Air Flow - Read only
- Offset - Click anywhere in the white box to type a value.
- Multiplier - Click anywhere in the white box to type a value.
- Outdoor Air Temperature - Click anywhere in the white box to type a value.
- Offset - Click anywhere in the white box to type a value.
- Return Air Temperature - Read only
- Offset - Click anywhere in the white box to type a value.
- Mixed Air Temperature - Read only
- Offset - Click anywhere in the white box to type a value.

AFMS Table

Values in the Standard column display outside airflow in cubic feet per minute at each damper position as a percentage toward 100 percent open.

Click anywhere in a white box to type a value.



Note: For AFMS controllers without Pressure Assist, the "With Pressure Assist" column is inactive.

The screenshot shows the 'Tune' tab interface with two main sections: 'Calibration' and 'AFMS Table'.

Calibration Section:

- Outside Air Flow: 0
- Outside Air Flow by Temp: -1
- Return Air Flow: 14.2
- Supply Diff. Pressure: 0
- Supply Air Flow: 14.2
- Offset: 0.5
- Multiplier: 1.5
- Outdoor Air Temp: -88
- Return Air Temp: -88
- Mixed Air Temp: -88

AFMS Table Section:

	Standard	With Pressure Assist
	OA Fraction	OA Fraction
Outdoor Air Closed	0	0
Outdoor Air 5	0	0
Outdoor Air 10	0	0
Outdoor Air 15	0	0
Outdoor Air 20	0	0
Outdoor Air 30	0	0
Outdoor Air 40	0	0
Outdoor Air 50	0	0
Outdoor Air 60	0	0
Outdoor Air 70	0	0
Outdoor Air 80	0	0
Outdoor Air 90	0	0
Outdoor Air 100	0	0

AFMS Pressure Assist (PA) Table

Values in the Standard column show outside airflow in cubic feet per minute at each damper position as a percentage toward 100 percent open.

Values in the With Pressure Assist column show pressure differential in inches of water column at each damper position as a percentage toward 100 percent open.

Click anywhere in a white box to type a value.

Monitor Configure Learn **Tune** Refresh Save

Calibration

Outside Air Flow: 128.8
 Outside Air Flow by Temp: -1
 Return Air Flow: 8.4
 Supply Diff Pressure: 0
 Supply Air Flow: 128.9
 Outside Air Temp: 76.6
 Return Air Temp: 79
 Mixed Air Temp: 76.2
 RAO Diff Pressure: 0.1

AFMS Table

	Standard SA Position	SA Flow	Diff Pressure
Return Air Closed	1	0	0
Return Air 5	1	0	0
Return Air 10	1	0	0
Return Air 15	1	0	0
Return Air 20	1	0	0
Return Air 30	1	0	0
Return Air 40	1	0	0
Return Air 50	1	0	0.5
Return Air 60	1	0	0
Return Air 70	1	0	0
Return Air 80	1	0	0
Return Air 90	1	0	0
Return Air 100	1	0	0

Zoning

Use the router zoning features to set up a BAC-120063CW-ZEC zoning FlexStat. This is an alternative and abbreviated method to using the interface on the FlexStat. The zoning features can also monitor the status for up to 16 SimplyVAV BAC-8000 series controllers for pressure-independent VAV control in their respective zones.

For additional information about the BAC-120063CW-ZEC and zoning, review the following documents that are available for the [BAC-120063CW-ZEC FlexStat](#) from the KMC Controls web site.

- BAC-120063CW-ZEC FlexStat Installation and Configuration Guide
- BAC-120063CW-ZEC FlexStat IoT and VAV Zoning Retrofits Application Guide
- BAC-120063CW-ZEC FlexStat Zoning Equipment Controller Data Sheet
- WHITE PAPER, VAV Zoning Made Easy

The zoning features are accessible through the Balancing/AFMS/ZEC tab on the router served web pages menu and are active only when a valid BAC-120063CW-ZEC zoning FlexStat has been discovered.

To open the zoning features, do the following:

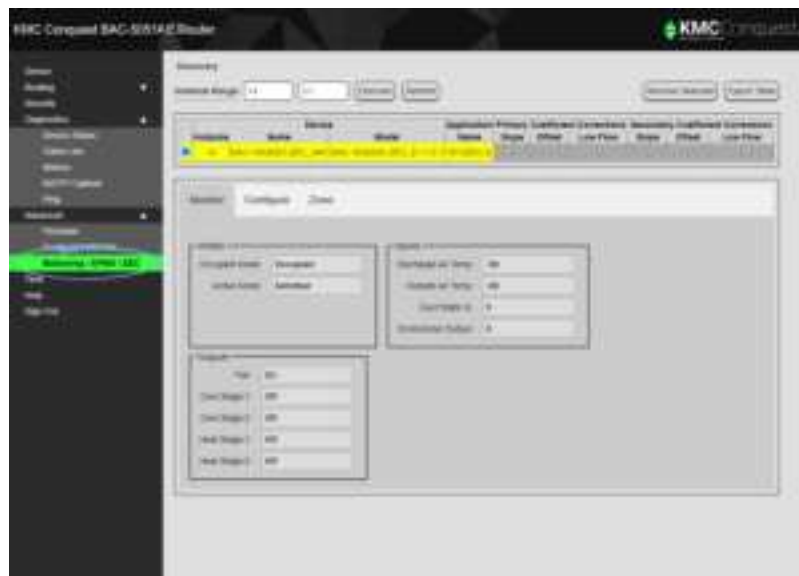
- 1 Use an Internet browser to log in.
- 2 From the **Advanced** group, click **Balancing/AFMS/ZEC**.

- 3 In the first blank text box beside **Instance Range**, type the device instance for the first ZEC controller, followed in the second text box by the device instance of the last ZEC controller to be discovered.



Note: If a value is entered in the first (start) text box only before clicking **Discover**, the router software will automatically add 49 device instances to that number and display the result in the second (end) text box.

- 4 Click **Discover**.
- 5 Select a ZEC FlexStat from the list of discovered units. The background of the selected unit changes to yellow and the Monitor, Configure, and Zone tabs appear in the lower portion of the page.
- 6 Select any of the tabs to make changes or observe operation.



Monitor tab

The property values in the Monitor tab are for information only and cannot be changed from the router page.

Modes The Modes group contains the System Mode property

Inputs The Inputs group displays values for the following properties.

- Discharge Air Temp
- Outside Air Temp
- Duct Static In
- Economizer Output

Duct Static Setpoint is the only property in the group that can be changed from the router page

Outputs The property values in the Outputs group are for information only and cannot be changed from the router page.

- Fan - Displays as On or Off.
- Cool Stage 1 - Displays as On or Off.
- Cool Stage 2 - Displays as On or Off.
- Heat Stage 1 - Displays as On or Off.
- Heat Stage 2 - Displays as On or Off.
- Zone Instance Range
- Zone Hysteresis
- Cooling DAT Setpoint
- Heating DAT Setpoint
- Duct Static Setpoint

Monitor	
Monitor Configure Zone	
Modes Occupied Mode: Occupied Active Mode: Satisfied Inputs Discharge Air Temp: -80 Outside Air Temp: -80 Duct Static In: 0 Economizer Output: 8 Outputs Fan: On Cool Stage 1: Off Cool Stage 2: Off Heat Stage 1: Off Heat Stage 2: Off	

Configure tab

The following properties can be set from the Configure tab. When changes are complete, click **Save**.

- First Zone Instance
- Last Zone Instance
- Zone Hysteresis
- Duct Static Setpoint
- ACT Cooling Setpoint
- ACT Heating Setpoint
- OCC Cooling Setpoint

The screenshot shows a software interface with three tabs: Monitor, Configure, and Zone. The Configure tab is active. In the top right corner of the Configure tab, there are two buttons: Refresh and Save. Below the tabs, there is a section titled 'General' which contains a list of configuration parameters, each with a corresponding input field:

Parameter	Value
First Zone Instance	101
Last Zone Instance	116
Zone Hysteresis	2
Duct Static Setpoint	0.5
ACT Cooling Setpoint	50
ACT Heating Setpoint	140
OCC Cooling Setpoint	50
OCC Heating Setpoint	140

Zone tab

The properties in the Zone tab display the following.

- Detected Zones
- Cooling Calls
- Heating Calls
- Zone Status for each of 16 zones

The information in this tab is for information only and cannot be changed from the router page.

The screenshot shows the 'Zone' tab interface. At the top, there are three tabs: 'Monitor', 'Configure', and 'Zone'. Below the tabs, there are three status indicators: 'Detected Zones: 0', 'Cooling Calls: 0', and 'Heating Calls: 0'. A 'Refresh' button is located to the right of these indicators. Below the status indicators is a section titled 'Zone Status' containing a 4x4 grid of 16 zone status indicators. Each indicator consists of a small square icon with a number inside, followed by the text 'NoCOMM'. The numbers 1 through 16 are arranged in the grid as follows:

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

Command tab

The properties in the Command tab are divided into four groups. Properties that can be changed display in text boxes with white backgrounds. Properties that cannot be changed display in text boxes with gray backgrounds and are for information only.

Groups with properties that can be changed also include Relinquish, Command, and Refresh buttons.

Command When clicked, the router writes changed values in the group to the BACnet Priority Array at Priority 8. Changed values are indicated with red text.

Relinquish When clicked, entries in the Priority 8 levels of the BACnet Priority Arrays are deleted and the Relinquish Default values for each of the properties are used. Relinquish Default values are set by the system engineer and cannot be altered from the router page.

Refresh Clicking the Refresh button clears any changes from the group and reverts to the original values.

Configure	Zone	Command
Modes		
System Mode		Relinquish Command Refresh
		AUTO ▼
Discharge Air Temp		
Current Temp		Relinquish Command Refresh
		95.35
Cooling Setpoint		45
Heating Setpoint		130
Duct Static		
Duct Static Setpoint		Relinquish Command Refresh
		1
Duct Static Input		-0.5
Outside Air Damper		0
Outputs		
Fan	ON	
Cool Stage 1	OFF	
Cool Stage 2	OFF	
Heat Stage 1	OFF	
Heat Stage 2	OFF	

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