# Applications Guide
# BAC-5051E BACnet Router

**Includes installation, operation, and maintenance instructions**

# Copyrights and trademarks

# 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.



**NOTICE**

OBSERVE PRECAUTIONS
FOR HANDLING
ELECTROSTATIC
SENSITIVE DEVICES

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# Contents

# Section 1: **Introduction**

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

The KMC Controls BAC–5051E is a multi-port BACnet router. Router highlights are:

- Easy to install and simple to configure.
- Configured from internally served web pages.
- Internal network diagnostics and route status reports.

**Topics in this section**

## Specifications

Specifications are subject to change without notice.

### Communications

#### BACnet Ethernet and IP
10BaseT/100BaseT, RJ–45 connector

#### 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 micro B connection for temporary power

### Configuration and software
All configuration is through internal browser based configuration pages. Requires HTML 5 browser.

## Installation

| | |
|---|---|
| Supply voltage | 24 volts AC (−15%, +20%), 50-60 Hz, Class 2 only, non-supervised<br>5 volt DC from powered USB connection<br>Supply source automatically switches to highest available voltage<br>8VA required power |
| Weight | Approximately 5.3 ounces (149 grams) |
| Case material | Green and black flame retardant plastic |

## Processor and memory

| | |
|---|---|
| Processor | Processor 32-bit ARM® Cortex-M4 |
| 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 |
| 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-5051E 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
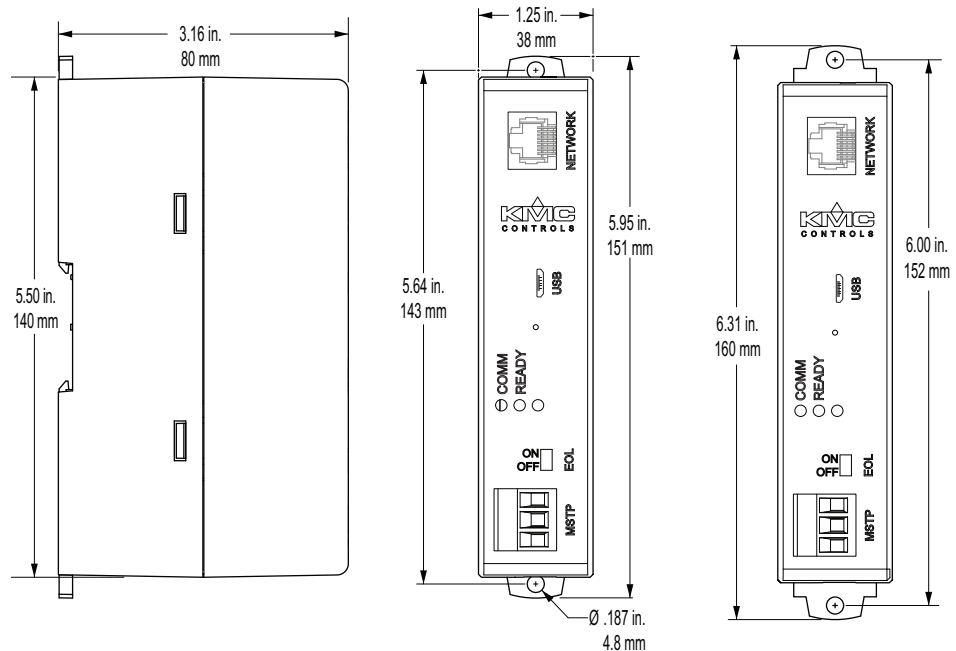


# Accessories and replacement parts

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 |

### Surge suppressors

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

### Cables

| | |
|---|---|
| HPO-5551 | Technicians cable kit—Conquest router tech cable kit Includes USB, Ethernet,and MS/TP to NetSensor 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**
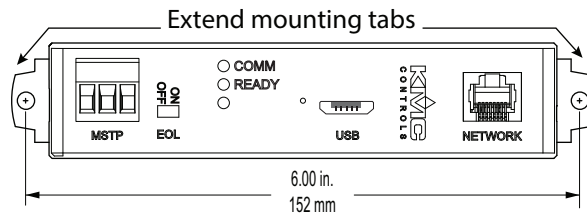


**DIN rail mounting** Mount the DIN rail and then do the following:

**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 router between 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 BAC-5051E behind a firewall.

**Illustration 1–2 Permanent installation**
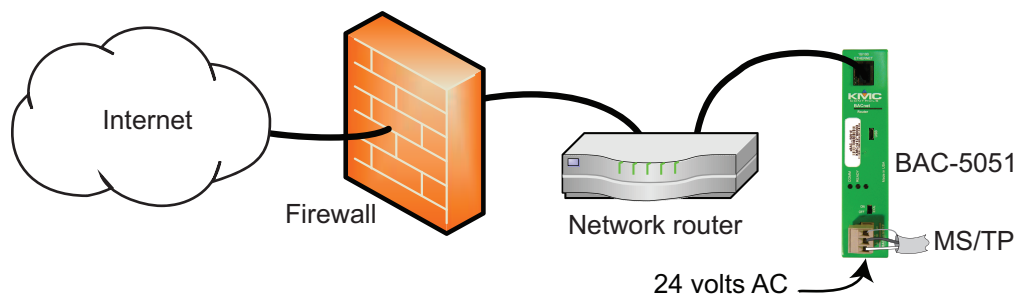


See also the following topics:

- *Mounting the router* on page 8
- *Connecting power* on page 9

## MS/TP network wiring

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

- Connect no more than 128 addressable BACnet devices to one MS/TP network. The devices can be any mix of controllers or routers.
- Use twisted pair, shielded cable with capacitance of no more than 51 picofarads per foot for all network wiring. Belden cable #82760 or equivalent meets the requirements.
- Connect the *-A* terminal in parallel with all other - terminals.
- Connect the *+B* terminal in parallel with all other + 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 4000 feet (1220 meters). Use no more than four repeaters per MS/TP network.
- Place a KMD−5567 surge suppressor in the MS/TP cable where it exits a building.

## MS/TP end of line termination switches

The controllers on the physical ends of the MS/TP wiring segment must have end of line termination added 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

The router requires a 24 volt, AC power source. Use the following guidelines when choosing and wiring transformers to the router. The router begins to operate when either power source is applied.

**Illustration 1−3 Power terminals**
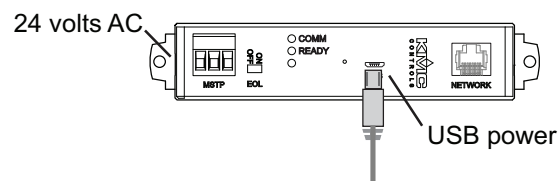


**For USB power** Connect the router to a powered USB port with a USB A to USB micro B cable. Typically the USB ports on laptop computers can supply power to the router. When connecting to a USB hub, verify the power specifications of the hub. See the topic *Specifications* .

**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 the USB and the network connection.

To use the USB for power and network communications, see the topic *Single-cable connection* on page 10.

**For 24 volt AC power** Connect a 24 volt AC power supply to the black power terminal block on the side of the router.

- Connect the ground side of the transformer to the ground terminal ⊥.
- Connect the AC phase to the phase terminal ∿.
- 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, AC power from within an enclosure to external devices.

## Single-cable connection

The BAC-50501E single-cable connection method connects the router to the 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 1–4 Single-cable connection as a service tool**
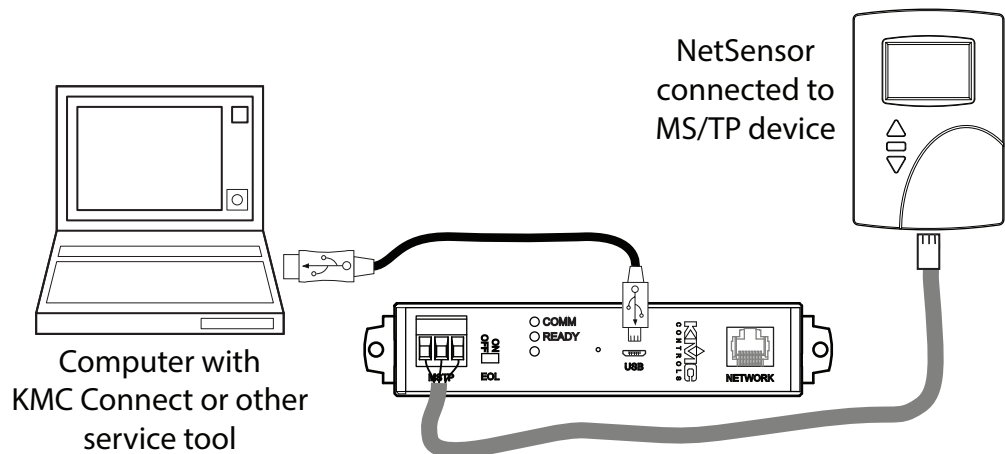


To set up a single-cable connection, do the following:

**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.

**3** Depending on the version of Windows, the first time the router is plugged into the computer, Windows will display a message that it is installing a new driver. Click on 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.

**4** From the Windows Control Panel, click **Network and Internet** and then **Networking Sharing Center**.

**5**   Once the center is open, click **Change Adaptor Settings**.

**6**   Identify the Local Area Connection that is associated with the BAC-5051E 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** and then click **Properties**.

**9**   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 192.168.1.252
- Set the subnet mask to 255.255.0.0.

**10**   When finished, click **OK** to save the work and then close all dialog boxes.

To test the connection, open a browser window and enter the address of the router. When the log in page opens, set up routing as described in the topic *Setting up routing* on page 23.

## Maintenance

The 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 router, KMC Controls provides the following assistance.

**The KMC Controls web site** Navigate to the support section on the KMC controls web site for the latest information for BAC-5051E and other KMC Controls products.

<div align="center">www.kmccontrols.com</div>

**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 to 5:00 PM Pacific time.

<div align="center">Toll-Free Technical Support: (866) 303-4562</div>

# Section 2: Configuring the router

This section provides important guidelines for configuring a KMC BAC-5051E router before it is placed on a network. Review this information carefully for proper installation.

The BAC-5051E can be fully configured either during initial configuration or after the router has an IP address assigned and is installed in its permanent location on a network.

**Topics in this section**

## Initial setup

The BAC-5051E is configured with an HTML 5 compatible web browser from 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 designer:

- Network numbers for each of the enabled networks.
- A MAC address for the MS/TP port.
- The highest MAC address used on the MS/TP network.
- The baud rate for the of the MS/TP networks.
- The address and port for a PAD router or BBMD to which the router will connect.

From the IT system administer:

- The IP address for the router.
- The IP subnet 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-A to USB-B micro cable or a 24 volt AC power source.

## Set up for configuration

To configure the router plug it into an Ethernet port. Typically this is a direct connection to a computer Ethernet connection which requires changing the computer IP address. See the procedure *Changing your computer's address* on page 17.

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 9.

**Illustration 2‑1 Connecting for configuration**
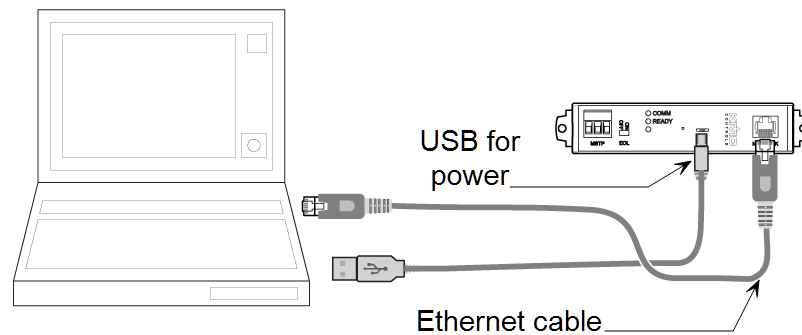


## Logging in

Use an HTML 5 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**.
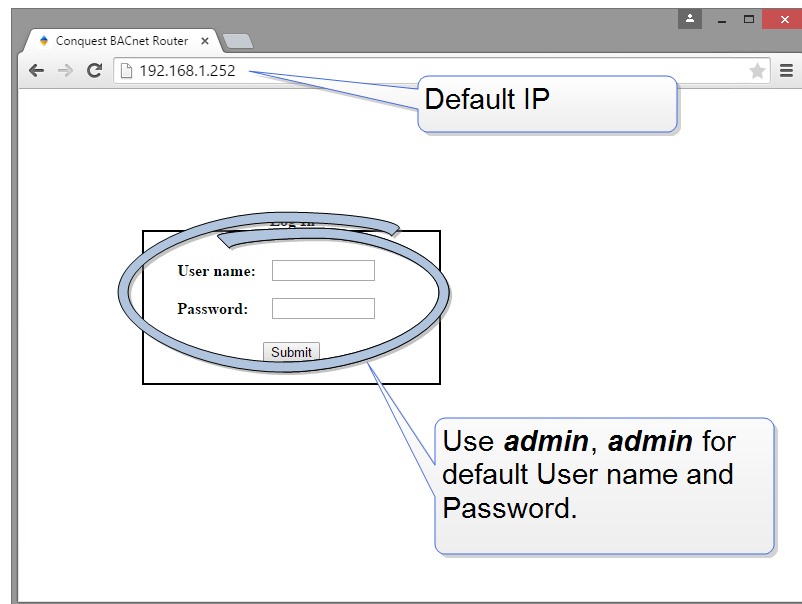


**5** At the log in window enter the following user name and password.

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

**6** Once the 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 page* on page 19.
- To set up BACnet routing, see the topic *Setting up routing* on page 23.
- To change passwords and add users, see the topic *Security page* on page 21.

**Note:** If you change the IP address, place the router on the new subnet and log in at the new address. Once the address is changed and saved the router will not respond to the old address.
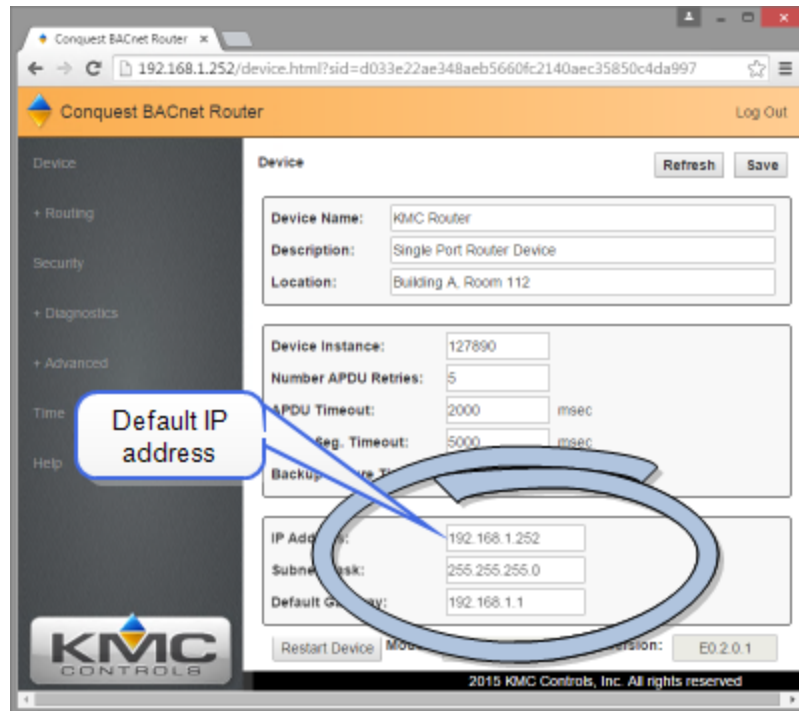
## Changing your computer's address

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.
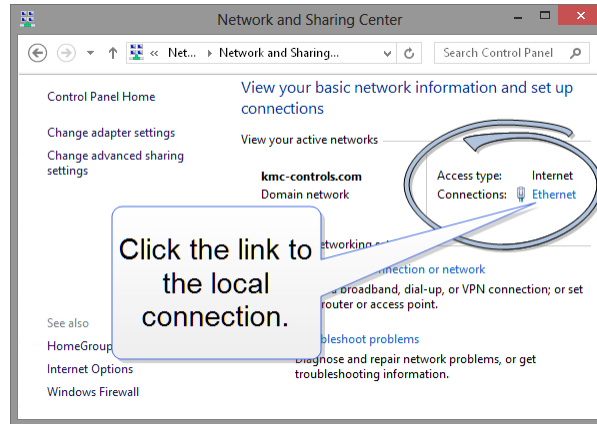


**3**   In the Ethernet Status dialog, click Properties.
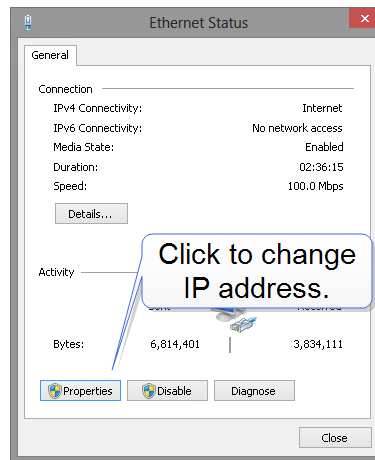
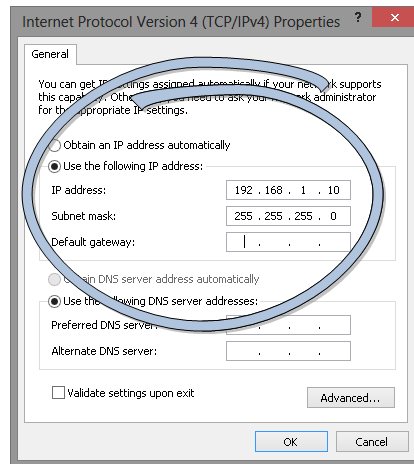**4**    In the Ethernet Properties dialog, scroll and select **Internet Protocol Version 4 (TCP/IP)** and then click **Properties**.
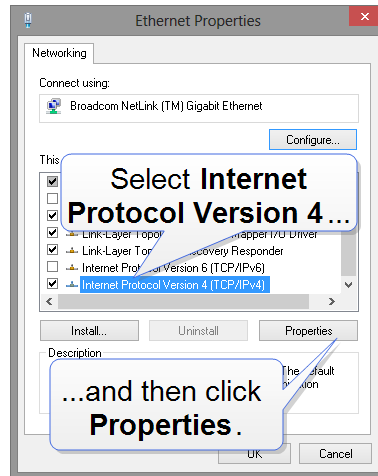


**5**    In the Properties dialog, select **Use the following IP address** and then enter the following for the IP address, subnet mask and Gateway.

- IP address—192.168.1.10

- Subnet mask—255.255.255.0
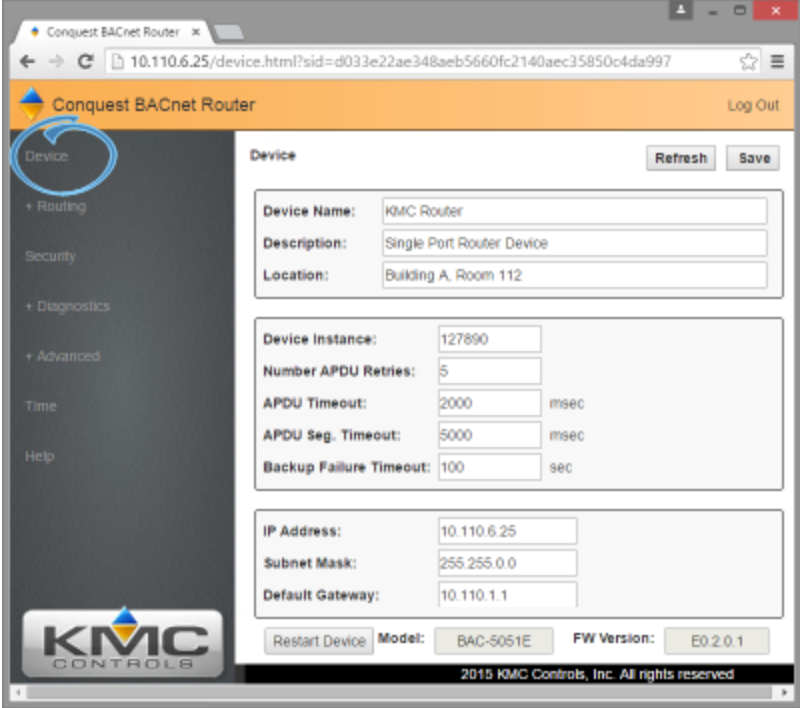
- Gateway—Leave empty or unchanged



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

# Device properties page

The Device window identifies the router as a BACnet device and sets BACnet communication properties. The default device instance for the router is 5051.

The Device window also configures the router for the Local Area Network (LAN). The IP Address, Subnet Mask, and Default Gateway values are supplied by the IT department system administrator.

**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 subnet 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 in the range from 0-4,194,302. 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 APDU is retransmitted.

**APDU Timeout** Indicates the time—in milliseconds—between retransmissions of an APDU 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 backup or restore procedure. Use a BACnet Operator Workstation such as KMC Connect or TotalControl to backup the router.

**IP Address** The internal or private network address of the router. For BACnet routing that requires a public IP address, see *Setting up routing* on page 23.

**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 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 coldstart from KMC Connect or TotalControl. A restart does not change properties or save changes not yet saved.

## Time page

Set up the router to be set as a BACnet time master device for any of the local networks.
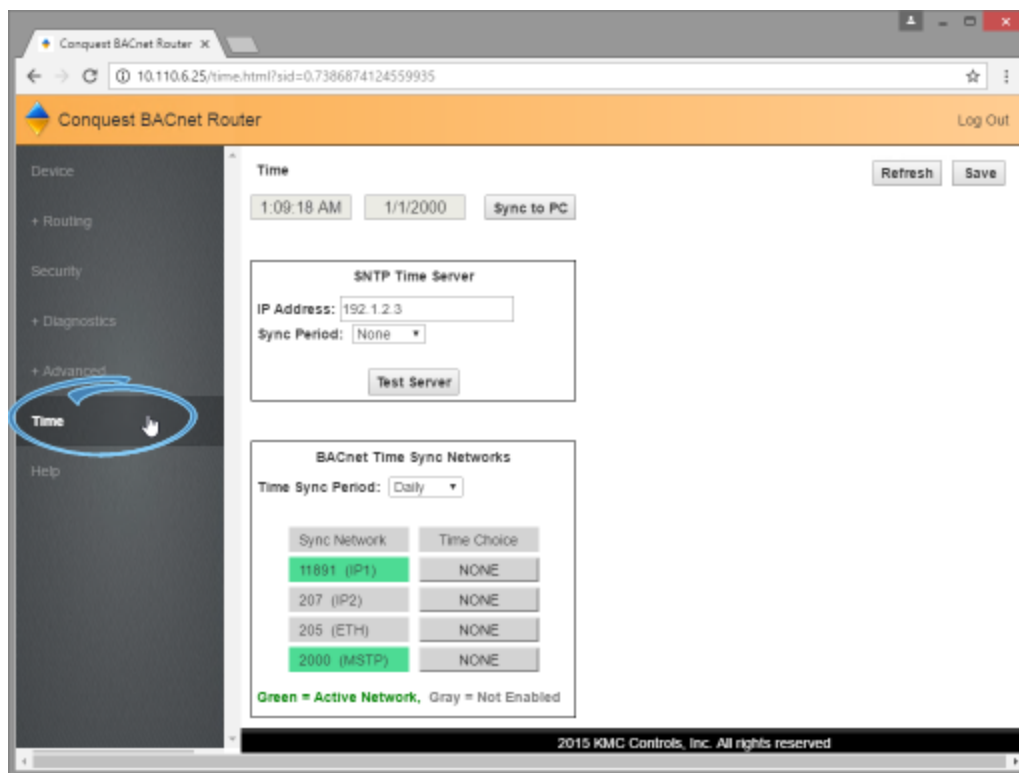


**Time** The local time and date maintained by the router. Time can be entered directly or synchronized to the time in the computer running the browser.

**SNTP Time Server** A Simple Network Time Protocol Server is a network device that maintains time for all devices, BACnet included, connected to a local area network. The BAC-5051E receives these time messages and rebroadcasts them as a BACnet time service message. The BACnet time messages can be sent hourly, daily, weekly, or monthly.

- **IP Address** The address of the SNTP server. This is supplied by the IT department.
- **Sync to PC** Click to transfer time maintained by the local computer to the router.

**BACnet Time Sync Networks** Selects the interval and type of BACnet time message for each network.

- **Sync Network** Networks in green indicates the network is enabled by the router. To enable a network, see *Setting up routing* on page 23.
- **Time Sync Period** Sets the interval to send time synchronization to None, Daily, Weekly, or Monthly.
- **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 (UTC). The devices on the network then apply an offset to calculate local time and date.
- **Local time** The router sends time sync messages in local time from which devices update their internal clock.
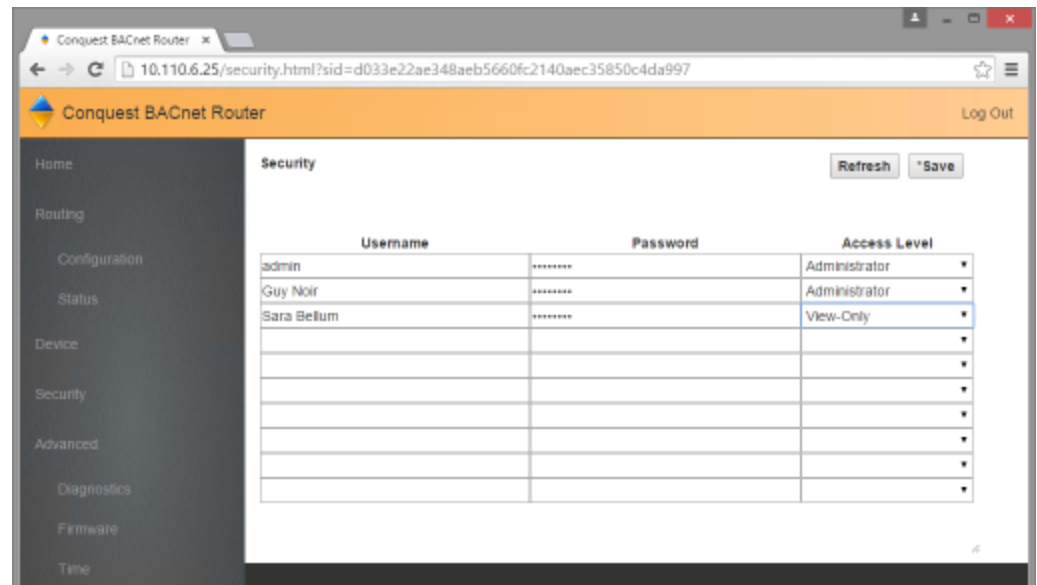
# Security page

The Security window sets user access to the router.

- The user name list must include at least one name with Administrator privileges.
- User names and passwords are case sensitive.

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

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



The router has two levels of user access.

- **Administrator** Full access to view and change all functions in the router.
- **View Only** The user can only view configuration, diagnostic, and status pages.

# Section 3: Setting up routing

This section provides important guidelines for configuring a KMC BAC-5051E router for BACnet routing. Review this information carefully for proper installation.

The BAC-5051E 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 assembling/disassembling) 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 router on page 13* for initial configuration and log in procedures.

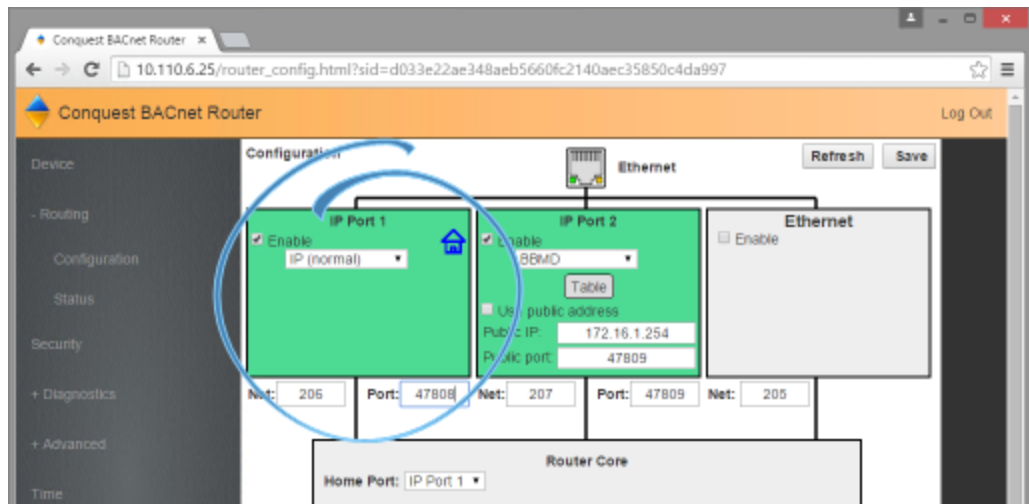**Topics in this section**

## BACnet IP routing

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

For the log in procedure, see the topic *Initial setup on page 13*.

**1** Use an Internet browser to log in.

**2** Click **Routing** and then **Configuration**.

**3** Select **Enable** for one of the IP Ports.

**4** From the list box, choose **IP (Normal)**.

**5**  Set the Network and Port properties as needed and then click **Save**.

**Note:** The router will restart. For 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 1-65534.

*Other IP routing protocols*

- *BACnet Broadcast Management Device routing* on page 26
- *BACnet PAD routing* on page 27
- *BACnet foreign device routing* on page 24
- *Router Core properties page* on page 30

## BACnet foreign 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.
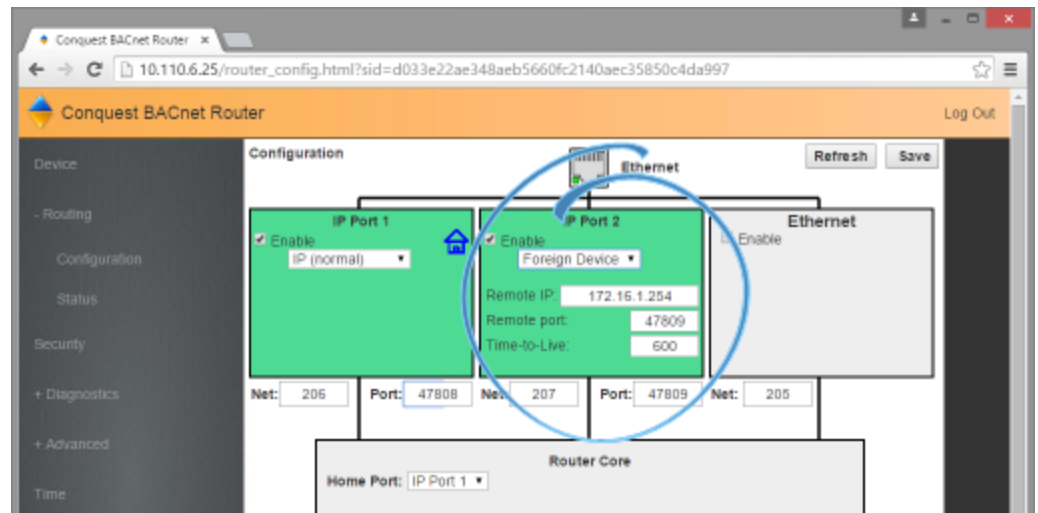
For the log in procedure, see the topic *Initial setup* on page 13.

**1**  Use an Internet browser to log in.

**2**  Click **Routing** and then **Configuration**.

**3**  Select **Enable** for one of the IP Ports.

**4**  From the list box, choose **Foreign Device**.

**5**    Set other properties as needed and then click **Save**.

     **Note:** The router will restart. For 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 1-65534.

**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 local 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 local 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 time range is 1-65535 seconds.

If the BBMD does not receive a registration message within the value of period set by Time To Live plus 30 seconds, the BBMD will remove the router from its foreign device table and will not send broadcast messages to the router.

*Other IP routing protocols*

- *BACnet IP routing* on page 23
- *BACnet Broadcast Management Device routing* on page 26
- *BACnet PAD routing* on page 27
- 
- *Router Core properties page* on page 30

# BACnet Broadcast Management Device routing

Either of the two IP ports can be configured as a BACnet Broadcast Management Device (BBMD). When configuring a router 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 foreign devices or perform BBMD-to-BBMD routing.

For the log in procedure, see the topic *Initial setup* on page 13.

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

**1**   Use an Internet browser to log in.

**2**   Click **Routing** and then **Configuration**.

**3**   Select **Enable**.

**4**   From the list box, choose **BBMD** for one of the IP Ports.

**5**   **Click Table** and then add entries to the Broadcast Distribution Table (BDT).

**6**   Set other properties as needed and then click **Save**.

   **Note:** The router will restart. For additional changes, log in again.
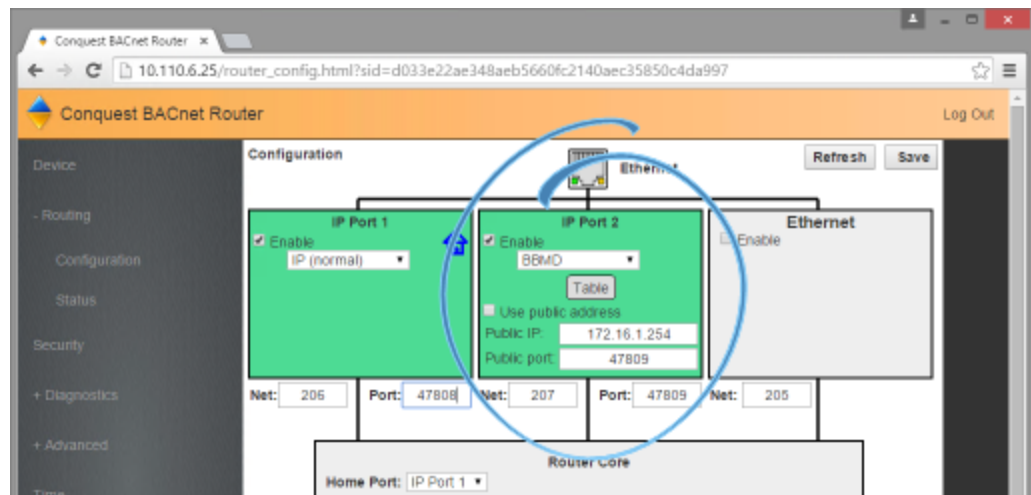


**Enable** Select to enable the network. The port block turns green when enabled.

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

**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 an IP address, UDP port number and IP subnet mask of each BBMD that is part of the internetwork.

- If none of the BBMDs are using a public IP address, the BDT entries in every BBMD are the same.
- If the BBMD uses a public IP address, the BDTs are different in everty router. Each BDT will use its own private IP address, port number,and subnet mask and the public IP address, port number, and subnet mask for allof the other BBMDs on the internetwork.

To add or delete entries, do the following.

- Adding entries—Click **Add** for additional entries.
- Deleting entries—Select **sel** and click **Delete**.

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

**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 Entries.

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

*Other IP routing protocols*
- *BACnet IP routing* on page 23
- *BACnet PAD routing* on page 27
- *BACnet foreign device routing* on page 24
- *Router Core properties page* on page 30

## BACnet PAD routing

Either of the two IP ports can be configured for PAD routing to a companion PAD router in different subnet. The values on this page are assigned by the BACnet system engineer.

For the log in procedure, see the topic *Initial setup* on page 13.

**1** Use an Internet browser to log in.

**2** Click **Routing** and then **Configuration**.

**3** Select **Enable** for one of the IP Ports.

**4** From the list box, choose **PAD**.

**5**   Set other properties as needed and then click **Save**.

**Note:** The router will restart. For additional changes, log in again.
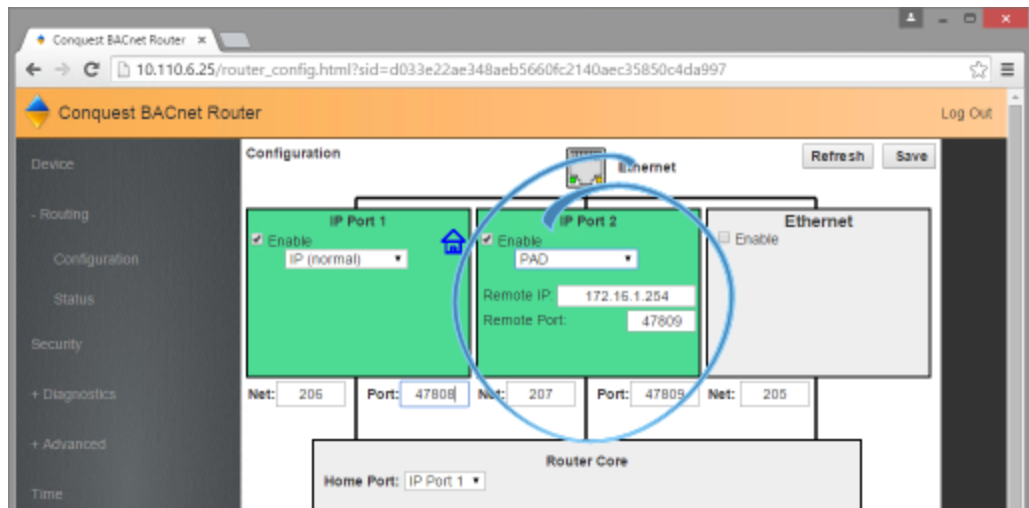


A BACnet IP PAD is a special type of router that connects two or more BACnet network segments that are separated by at least one IP-only router. The PAD router monitors network traffic for BACnet messages addressed to the other subnet and repackages the message that can pass through IP routers, in effect forming 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 1-65534.

**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 local 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 26
- *BACnet IP routing* on page 23
- *BACnet foreign device routing* on page 24
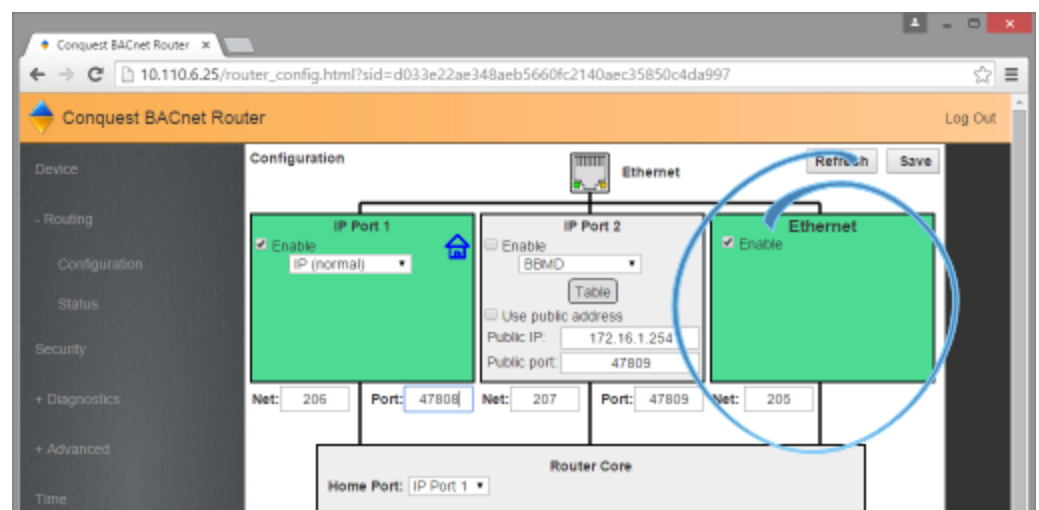- *Router Core properties page* on page 30

# BACnet Ethernet routing

Configure the Ethernet port 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 13.

1   Use an Internet browser to log in.

2   Click **Routing** and then **Configuration**.

3   Select **Enable** for the Ethernet port.

4   Enter the Network number and then click **Save**.

> **Note:** The router will restart. For 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 1-65534.

# 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 13.

1   Use an Internet browser to log in.

2   Click **Routing** and then **Configuration**.

3   Select **Enable** for the MS/TP port.

4   Enter the Network number and a MAC address for the router.

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

**6** When finished, click **Save**.

**Note:** The router will restart. For additional changes, log in again.
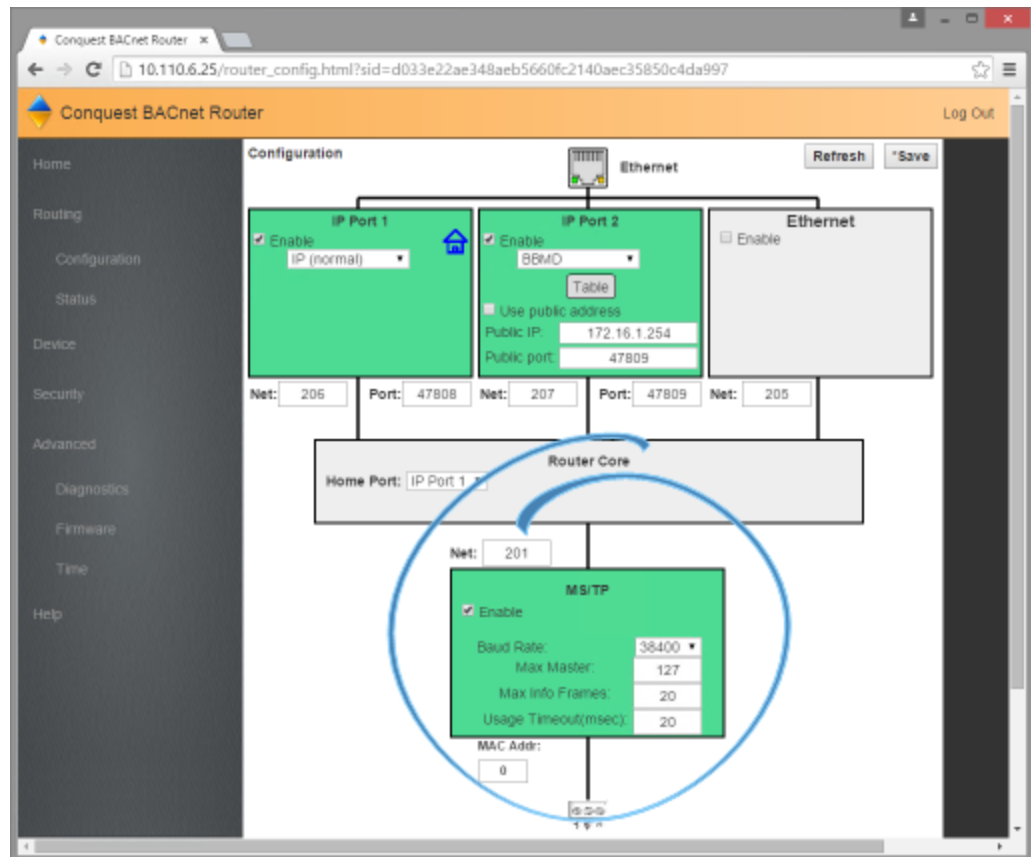


**Enable** Select to enable the network. The port block turns green when enabled.

**Net** Designates the BACnet network number for the MS/TP port. Assign network number in a range from 1-65534.

**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 use the same rate.

**Max Master** Set to 127 or no lower than the highest MAC address on the network. See *Device Status page* on page 39.

**Usage Timeout** Sets the maximum time the router will wait on a response from a master device before passing the token. The default value is 20 milliseconds.

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

# Router Core properties page

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 🏠.
- The home port sets the network on which the router is connected. In operator workstations, the router appears on the network designated as the home port network.
- The home port can be assigned only to an enabled network.

| ⚠️ **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. |

**Illustration 3−1 Router Home Port**
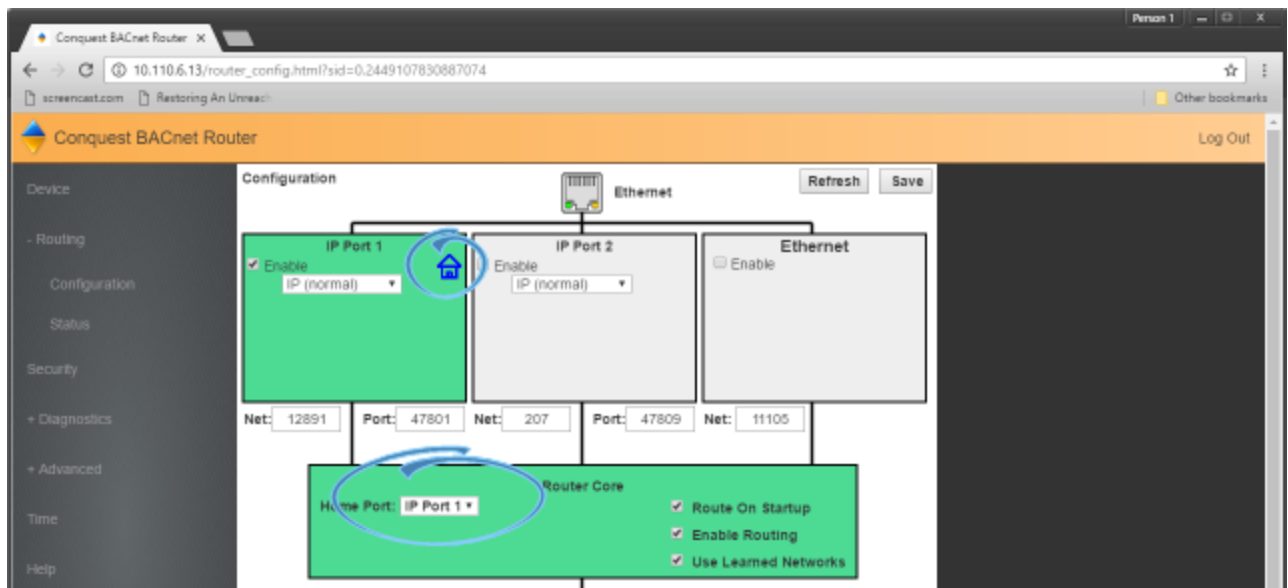


## Routing properties

**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 page on page 19*. The router will also select the Enable Routing check box during the reset or power up procedure.

**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. When routing is not enabled the background of Router Core is gray. When routing is enabled the background is green. Routing can also be enabled or disabled on the *Routing Status page on page 34*.

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

**Illustration 3–2 Routing properties**
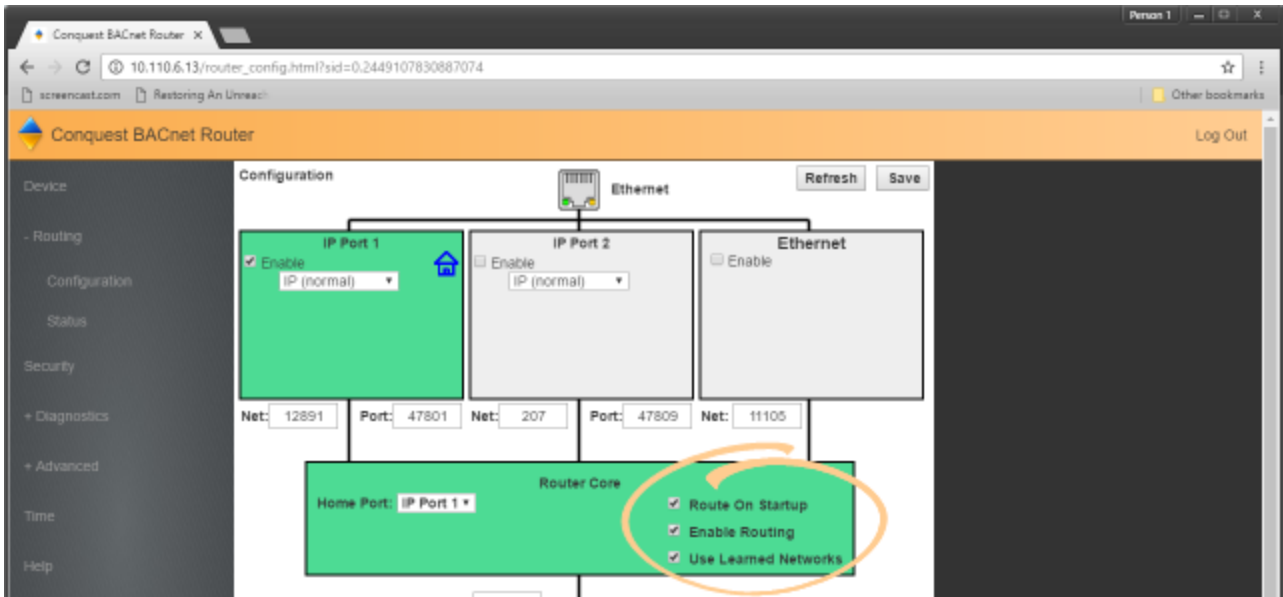
# Section 4: Diagnostics and status

Topics in this section cover the diagnostic and status functions of the BAC-5051E router.

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

- The topic *Routing Status page* applies to all connected networks.
- The topics *Device Status page*, *Metrics page*, and *Token Use page* apply to the MS/TP network.

**Topics in this section**

# Routing Status page

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

- Send commands to the router with the *Route Status buttons* on page 35.
- View the status of networks in the *Route status list* on page 35.
- Clear selected networks by *Purging the Route Status list* on page 38.

**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 page* on page 30.

**Note:** Enable Routing will not remain selected after a restart if Route On Startup is not selected on the *Router Core properties page* on page 30.

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

**Illustration 4–1 Routing Status page**
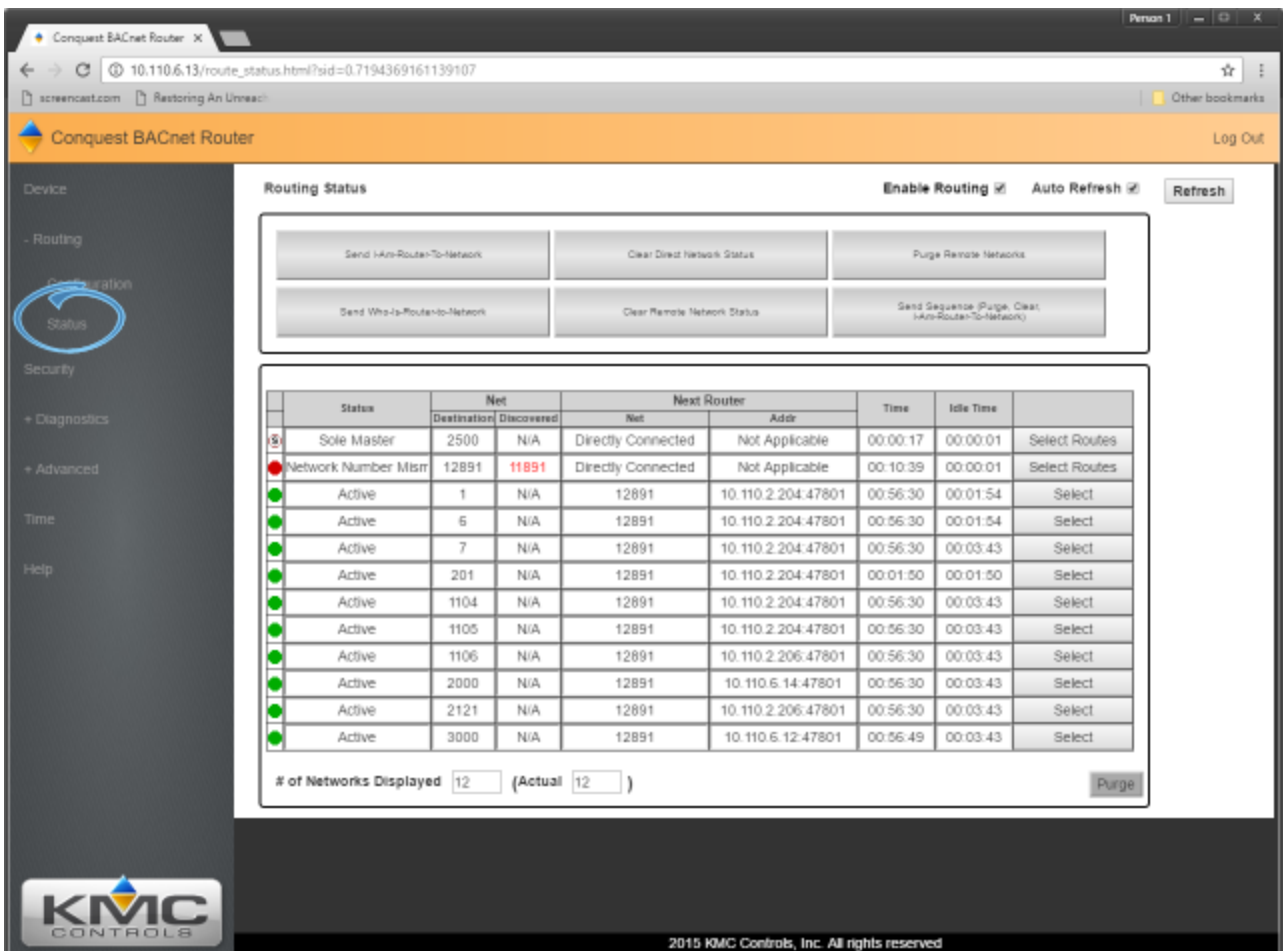
## Route Status buttons

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

**Send I-Am-Router-To-Network** Broadcasts to all networks that the router is on the network. This can trigger Internetwork wide updates.

**Clear Direct Network Status** Forces the status of all direct networks to Active. If a problem continues with a direct network, it 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 page* on page 34.

- **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 is 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 BACet network number to the next router.
- **Address** The MAC address of the next router.

**Time** The elapsed time since the status update.

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

Table 4-1 Route status conditions

| Status | Icon | Description | Action |
|--------|------|-------------|--------|
| Active | 🟢 | The network is functioning correctly and 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. |

Table 4-1 Route status conditions (continued)

| Status | Icon | Description | Action |
|---|---|---|---|
| Duplicated Network | (D) | 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 | (M) | 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 | (S) | The router is not detecting any master MS/TP devices on the local network. Slave devices however, may be present. | Requires corrective action if master devices are known to be connected to the local MS/TP network. |
| BBMD: Unknown | (B) | 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 | (B) | Indicates the router has detected another BBMD in the same subnet as itself. Traffic is not routed. | Remove a BBMD from the network. |

**Table 4-1 Route status conditions (continued)**

| Status | Icon | Description | Action |
|---|---|---|---|
| Foreign Device NAK | **F** | 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 page

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

**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 *Setting up routing* on page 23
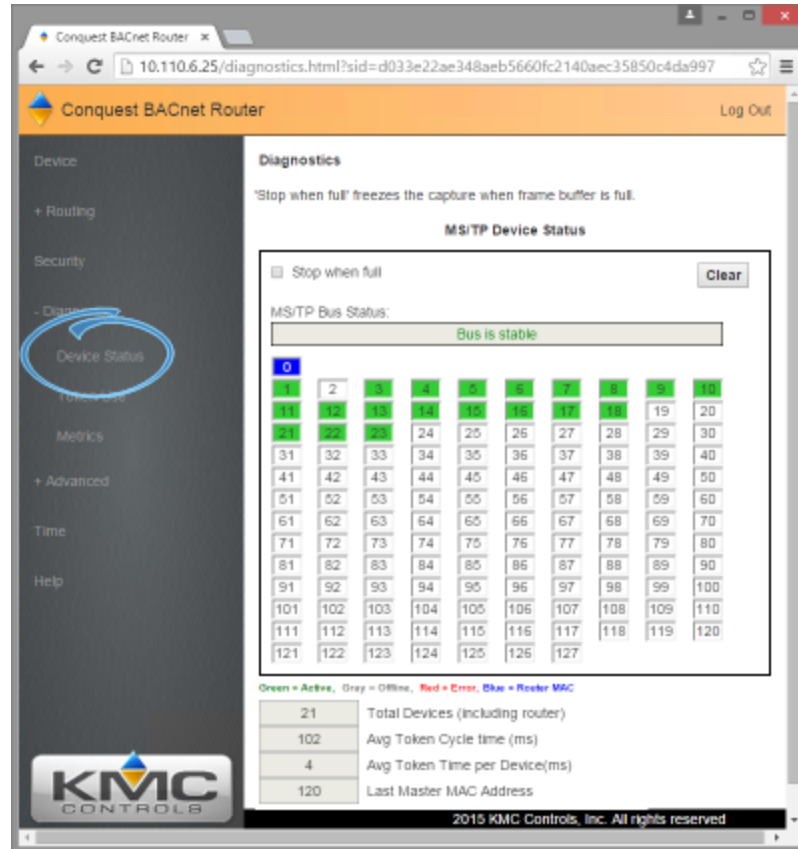


**Refresh** Updates the window with the latest network status.

**Clear** Deletes all current values in the MS/TP Status display and Metrics list.

**Table 4-2 Device status**

| Color | Icon | Description |
| --- | --- | --- |
| White | 5 | No device is assigned to this MAC address. |
| Gray | 16 | A device was active with this MAC address but is no longer online. |
| Blue | 0 | The MAC address assigned to the router. |
| Green | 5 | The MAC address is assigned to an active device. |
| Red | 6 | Two devices are using the same MAC address. |

If you encounter difficulty, click Refresh about every ten seconds to see 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 is okay, but you should 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.

The network metrics are useful for evaluating overall network performance.

**Network metrics**

| Metric | Description |
|---|---|
| Total Devices | 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 found by the router. |

# Token Use page

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.

**Illustration 4−2 MS/TP Token Use page**
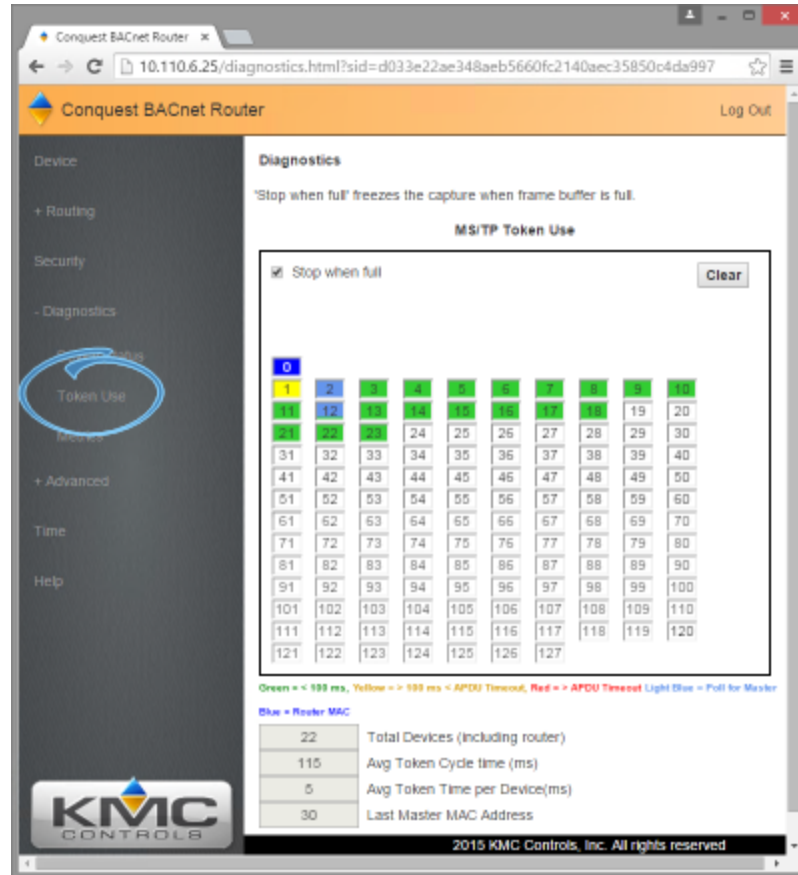


**Token use by color**

| 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 in 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 if device returns to green. |
| Red | APDU Timeout | The device is retaining the token too long. | A bottleneck in network traffic. Typical cause is excessive or continuous polling for data in other controllers. |

**Token use by color (continued)**

| Color | Description | Condition | Action |
| --- | --- | --- | --- |
| Light Blue | Poll for Master | A device is polling for a master device. | This is normal if there are gaps in the MAC addresses. |

**Stop when full** When selected full 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.

The network metrics are useful for evaluating overall network performance.

**Network metrics**

| Metric | Description |
| --- | --- |
| Total Devices | 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 found by the router. |

# Metrics page

The network metrics are useful for evaluating network performance and troubleshooting.

**Illustration 4–3 Diagnostic metrics**



It is normal for even the best designed and installed network to 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 generally okay. The reason is 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.

Typically a device is trying to find other devices that do not exist or are not communicating properly and are repeatedly sending WHO-IS messages. Usually this is 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** Will probably also see a device in a gray offline status. It usually means devices are not communicating reliably either because of noise or they 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 which just 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 workstation 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 this count is more than ten 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 ten counts in a 24-hour period.  If you encounter issues, see the topic *If you encounter difficulty* on page 11 to contact technical support.

# Section 5: Advanced features

This section covers features for updating and backing up the router.

Features in the Advanced group are for updating the firmware and backing up the router configuration.

**Firmware updates**—From time to time, KMC Controls issues updates to the firmware for the BAC-5051E router. The updates can be added directy to the router from the browser pages.

**Configure from file**—Router configuration properties 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.

**Recovering the IP address** Discover an unknown network IP address.

**Topics in this section**

## 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 13.

**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.

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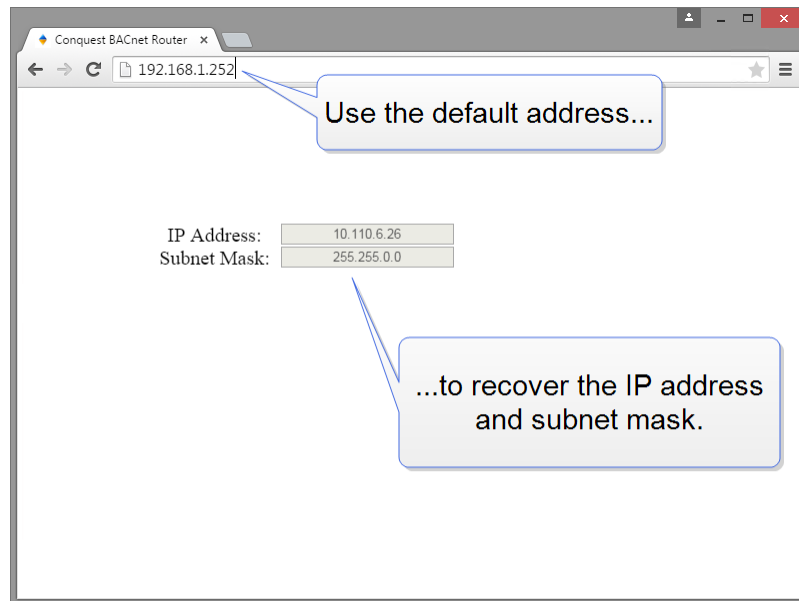


## Updating the firmware

The BAC-5051E 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**
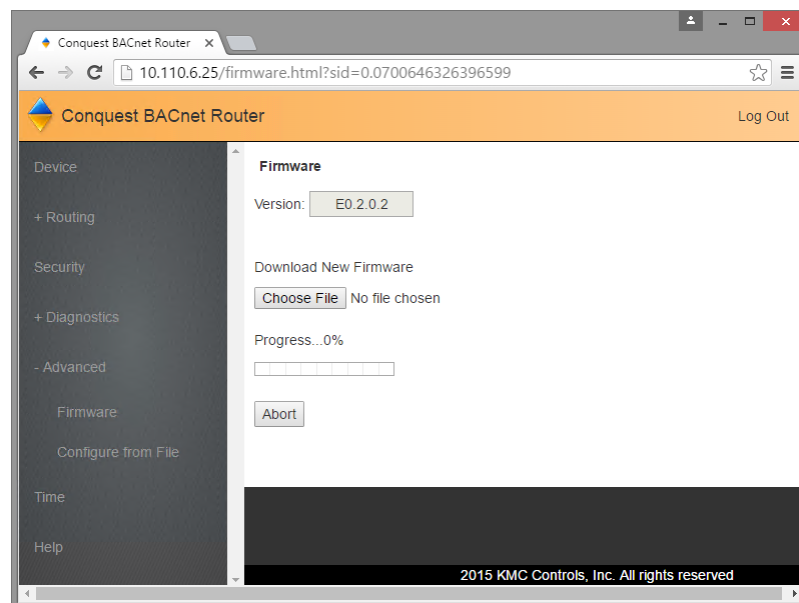


To update the firmware, do the following:

**1**   Download the new firmware from the KMC partner portal. The file is a self extracting executable file that will install the firmware in the correct location.

**2** Run the downloaded file. This will place a `.zip` file in the folder at `C:\ProgramData\KMC Controls\Firmware Upgrade Manager\BACnet Family\BAC-5051E.` Do not unzip this file.

**3** 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-5051E.`

**6** Locate and open the folder with the correct version of firmware and then select the `.zip` file.

**7** When the Proceed with Download dialog opens, click **OK**.

**8** When the download is finished, restart the router. The new firmware does not start running until the router is restarted.

## Configure from a file

Router configuration properties 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. The file format is JSON (JavaScript Object Notation) and it is stored in the download folder for the current user under the name `config_5051E.json`.

**1** Use an Internet browser to log in.

**2** From the **Advanced** group, click **Choose File**.

**3** Browse to the file location, choose the file, and then click **Open**.

**4** When the Overwrite Router Configuration dialog opens, click **OK** to precede.

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

**Save Configuration** Saves the router configuration in the file `config_5051E.json`. The file is saved to the downloads folder for the Windows user.

**Illustration 5−2 Configure from File page**

# Index