

BACnet Server for the Leviton Energy Monitoring Hub (EMH)

Product: Energy Monitoring Hub (EMH) **Article ID:** 013020-aa/tl

Date: 1/30/20

Summary: An overview of the BACnet functionality in the Leviton EMH (A7810, A8810, A8812)

- Information:** **Features**
- BACnet/IP server which automatically shares any supported meter connected to the EMH via **Modbus/485**, **Modbus/TCP** or **Modhopper** mesh network
 - Integrates with **Template Framework**, allowing user-definition of new or unusual meters
 - **No complex configuration required:** Simply connect a supported Modbus meter and it will be automatically detected and shared via BACnet
 - **Fast, guided setup:** Server identifies problems, guides you to solutions
 - Engineering units: Modbus registers are automatically translated to engineering quantities with proper units
 - Caching to manage limited Modbus bandwidth. Cache times are automatically tuned based on the units of the data point and history of queries.
 - Relay outputs supported, allowing complete control loops
 - Includes BBMD server, allowing your BACnet network to span IP subnets without extra hardware
 - BACnet discovery tools built-in, including detection of Device ID and Network Number conflicts
 - Detailed statistics to monitor performance
 - Allows **incoming Foreign Device Registration (FDR)**, simplifying remote diagnostics
 - Compatible with **EMH Remote Configuration**
 - Supported on A8812, A8810, A7810
 - Supports BACnet protocol version 1, revision 12
 - 64 BBMD entries are allowed
 - 64 FD entries are allowed

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Features

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BACnet Setup

Server's BACnet *object name*: Unique name of this server. Used as prefix for name of all data point objects. **Must be unique on BACnet network.** Automatically derived from server's current IP address if not specifically set.

Server's BACnet *base object ID (0-4194302)*: Unique object ID of this server and base of each meter's Object ID. **Must be unique on the BACnet network.** Automatically derived from server's current IP address if not specifically set. Use the Discover page to check for conflicts.

Server's virtual *network number (1-65534)*: The EMH assigns each meter it shares an address on a *virtual BACnet subnet*. This parameter sets the Network Number of that subnet. **The value is arbitrary but must be unique on the BACnet network.** Automatically derived from server's current IP address if not specifically set. Use the Discover page to check for conflicts.

Server's BACnet/IP *UDP port*: UDP port used for communication. The standard BACnet port is 47808 = 0xBAC0. May be changed to allow several independent BACnet networks to co-exist.

APDU timeout, APDU retries: Packet timeout and retry count *which BACnet peers should use when talking to this EMH*. We advertise these values. A warning is given if the timeout is less than the EMH's Modbus timeout. Use the Discover page to view the APDU timeout and APDU retries of other BACnet peers.

Note: bacnet.org's Interpretation, 135-2004-20 - January 27, 2007 clarifies the meaning of APDU_Timeout and APDU_Retries.

BBMD mode: The EMH can act as a BBMD, a protocol feature allowing BACnet networks to span IP subnets.

- **Allow incoming FDR (default):** By default, the EMH allows incoming Foreign Device Registration, which means BACnet peers on other subnets may use the EMH as a relay to join the local BACnet network. Up to 64 foreign devices may register simultaneously.
- **Full BBMD:** Select this option if you wish the EMH to distribute broadcasts to other IP subnets. Incoming FDR is also allowed. This option is only needed if:
 1. your BACnet network spans multiple IP subnets, and
 2. the local subnet doesn't already have a BBMD.
- **Disable all BBMD features:** Select this option to completely disable the BBMD service, including Foreign Device registration. This is not recommended but may be necessary to prevent *broadcast loops* or *broadcast storms* caused by other misbehaving or incorrectly configured BBMDs.

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*Note: BBMDs may also be used to join together two or more **virtual BACnet networks** which use different UDP ports, e.g., 47808 and 47809.*

Distribute broadcasts to: If **BBMD mode = Full BBMD** is selected, enter the list of IP addresses (and optional UDP ports) of other BBMD services on your BACnet network.

This list should be identical among all BBMDs -- you may safely include the EMH's own IP address in its list. You should have at most one BBMD per IP subnet. See How Do I... Span Subnets with a BBMD

BACnet debug information: Level of detail displayed in the EMH's Debugging Messages.

- **Errors & Summary (default):** Log only errors and summary info. Requires Debugging Messages be enabled.
- **Transitions:** Also log "transitions" such as changes to System_Status and Reliability Properties.
- **Full Debug:** Also log detailed debug info. This will slow the server significantly.
- **Full Debug (AREA):** Debug logging for AREA only.

*Note that **Full Debug** can significantly slow the BACnet server and should only be used until a problem is resolved.*

BACnet Device List

The **Device List** page shows the meters shared by the EMH as they appear in the BACnet world. [Uses of the Device List page:](#)

- Dump Object List of each meter to see how exactly how the EMH will present it to the BACnet network.
- View BACnet/IP address-info for each shared meter using [network] tab.
- Check for duplicate BACnet Device ID and Network Numbers.
- View per-meter statistics to verify operation and performance using [stats] tab.

The **Device List** will also check for conflicting BACnet Device IDs and Network Numbers assigned to meters on this EMH and other BACnet devices.

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BACnet Discover

The **Discover** page allows you to use the EMH to scan the BACnet network.

Scan from (Device ID) _____, to (Device ID) _____: Enter a range of BACnet Device ID numbers or use the default. Narrowing the range is useful in large networks.

Wait _____ for response: Increase the amount of time to wait for responses if the network is very slow.

Scan Network : Click to begin scanning the network. The EMH will transmit a BACnet "Who-Is"

broadcast message every 5 seconds and will collect responses.

For each BACnet device discovered, the EMH will:

- Ping the device's IP address, printing either "alive" or "no response to ICMP ping".
- Query BACnet properties from the device.

The displayed information may be sorted by clicking on column headers.

Uses of the Discover page:

- See the Device IDs and Network Numbers already in use, to help choose these numbers for the EMH.
- See warnings if the EMH detects conflicts between *any* Device IDs or Network Numbers on your network.
- Verify BACnet communication between the EMH and other BACnet devices.
- Verify BACnet communication across subnets if using the BBMD or FDR features.
- Identify IP routing or firewall problems (the EMH automatically pings each BACnet device).
- Survey firmware versions of other BACnet devices on the network.

BACnet Discover → show: [network], [firmware], [stats]

- **show: [basic]**
Shows "basic" properties of the device.
- **show: [network]**
Shows network-level details (BACnet/IP address, network number, APDU timeouts and APDU retries). Useful for debugging timeout errors.
- **show: [firmware]**
Shows firmware versions. Useful for debugging compatibility problems.
- **show: [stats]**
Shows performance statistics:
 - **RP:** # of BACnet ReadProperty or ReadPropertyMultiple requests
 - **WP:** # of BACnet WriteProperty requests
 - **Dev Error:** Shows current error-code reported by the meter, or 0 if OK. Hover to see the error text.

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- **Data Age:** Shows current age of cached data. A * (asterisk) indicates an update is pending. If data is not requested, it will not be updated in the cache and so may appear very old.
- **Unit Issues:** Shows the number of points for which units could not be mapped to BACnet units.
- **Read Reqs / Errs:** # of read errors vs. total reads. A "read error" is counted if, when answering a BACnet RP or RPM request, the meter's data was not already cached and we failed to get a response from the meter in 65 seconds.
- **Write Reqs / Errs:** # of write errors vs. total writes. A "write error" is counted if we either timeout or get an error response when writing to a backend device.
- **I/O Response Time, Avg:** Moving average of response-time from this meter (reads or writes).
This differs from a meter's RTT in that it includes the effect of the overall load on the EMH, the communications to all other meters, logging activity, etc.
- **I/O Response Time, Worst** = worst-case (peak) response-time from this meter, over the last 63 requests (reads or writes).

BACnet Discover → Objects

Queries and displays the **object list** of the local or remote BACnet device.

Note:

- *BACnet's "Objects" are equivalent to Modbus's "Register blocks".*
- *BACnet's "Properties" are equivalent to Modbus's individual "Registers".*
- *See Comparison of BACnet vs. Modbus.*

Uses of the "Objects" link:

- See how the EMH will present a Modbus device to the BACnet world.
- Verify communication between the EMH and other devices on the BACnet network.
- General debugging and exploring.

BACnet Discover → EPICS

Note: "EPICS" is a file-format describing a BACnet device's features. See Terminology: PICS, EPICS and BIBBs.

Generates a template EPICS file for a BACnet device (local or remote).

Note that this EPICS file will need to be edited to fill in details.

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Uses of the "EPICS" link:

- Provide meter info in standard format to other BACnet tools.
- Assist in generating EPICS files for EMH meters, for Q/A testing with tools such as VTS or Visual Test Shell.

Background

Here is a comparison between BACnet and Modbus concepts and terms:

BACnet concept	Modbus concept
"Object"	Register block (group of related registers)
"Property"	Individual register
"Device Object" (DO)	Register block containing Meter name, firmware version, overall status flags, etc.
"Analog Input Object" (AI)	Register for individual data point
"Binary Value Object" (BV)	Register for individual relay output
"ReadProperty" (RP), "ReadPropertyMultiple" (RPM)	ReadCoilStatus, ReadHoldingRegister, ReportSlaveID, etc.
"WriteProperty" (WP)	PresetSingleRegister
MS/TP (BACnet over RS485)	Modbus/RTU (Modbus over RS485)
BACnet/IP (BACnet over UDP/IP, default port 47808)	Modbus/TCP (Modbus over TCP/IP, default port 502)

Background on "Device Objects"

A BACnet **Device Object** collects together information such as Description, Location or Firmware Version related to a single device, such as the EMH itself, or each meter shared by the EMH.

Each Device Object is assigned a Device ID number, from 0 to 4194302 (a 22-bit number, $2^{22}-2$), which must be unique across the BACnet network.

Each Device Object is also assigned a name.

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These two properties, Device ID and Device Name, are used to look up a device's BACnet address, much like a hostname is used to look up an IP address.

Background on "Analog Input Objects"

A BACnet **Analog Input Object** represents a single data point on a meter.

These are numbered starting from 1: AI1, AI2, AI3, ... where AI1 = Point 1, AI2 = Point 2, etc.

Unlike Modbus, where registers may have several formats (integer, unsigned, float, little-endian, big-endian, etc.), Analog Input Objects always provide data in a single IEEE float format.

Background on "Binary Value Objects"

A BACnet **Binary Value Object** represents a digital flag with a value of either 0 or 1.

If the meter has relay outputs, for each relay, the EMH creates one **Binary Value Object**. The name of the object is suffixed with " Relay".

See Relays.

Terminology: PICS, EPICS and BIBBs

PICS = BACnet "Protocol Implementation Conformance Statement". This is a "BACnet spec sheet" in a standard format.

EPICS = Electronic PICS. This is a more precise, machine-readable version of the PICS.

BIBB = BACnet Interoperability Building Block. This is a fancy way to describe a collection of related protocol features. Each class of BACnet device is expected to implement certain BIBBs in order to be certified.

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How Do I...

How Do I... Choose Device IDs and Network Numbers

Device Names and Device IDs are used to look up BACnet addresses just as hostnames are used to look up IP addresses.

EMH automatically generates these based on the current IP address.

Permanent Names

We recommend giving the EMH a permanent (custom) name and Device ID, or giving it a static IP address.

BACnet controllers will find the EMH by its Device Name or Device ID number, which are automatically derived from the IP address...

... if you use DHCP, the IP address could change causing your BACnet network to stop communicating.

Detecting Conflicts

Device names, Device IDs and Network Numbers **must be unique** across the BACnet network.

Use the Discover page to see what names and numbers are in use.

The Discover page will detect conflicts in Device ID and Network Number.

BACnet Network

Scan from (Device ID): to (Device ID): (*broadcasts Who-Is*)

 Duplicate ID(s) detected: Device:556249@10.55.70.132, Device:556249@10.55.78.3

How Do I... Choose Timeouts

The **APDU Timeout** setting tells the BACnet network how much time to allow the EMH to respond.

The EMH will recommend a timeout based on its Modbus configuration.

The **APDU Timeout** and **APDU Retries** may be increased for especially slow networks or networks with a high number of errors (e.g., wireless LANs).

How Do I... Optimize Response Time

The EMH monitors its configuration and the status of meters, and warns of situations causing poor performance:

Device status:  **WARNING: 8 meters shared, 2 meter errors. Meter errors will slow BACnet responses**

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To obtain the best possible response time:

- Fix any meter errors.
- If meter errors cannot be fixed, remove the meter from Modbus → Device List.
- Turn off **Debugging Messages** in System → System Log Files.
- Make sure **BACnet debug information** is not set to Full Debug.
- Make sure **Modbus debug information** is set to None in Modbus → Setup.
- Turn off **Search for Modbus Devices** option in Modbus → Setup.
- Increase the **Data logging period** in Modbus → Setup. Data logging takes priority over BACnet requests.
- Adjust your BACnet controller to poll at the minimum acceptable rate. See Optimize Polling.
- Increase the EMH's RS485 baud rate, especially if using meters with hundreds of points.

Use [stats] to find response problems. In particular:

- The **Data Age** column shows the age of cached data and shows a * (asterisk) when an update is pending. This provides a real-time view of update behavior. Generally, Data Age should increase up to the polling interval chosen by the BACnet client(s).
- The **I/O Response Time, Worst** column shows the worst response time of the last 63 updates.

How Do I... Optimize Polling

You may poll meters as fast as **once per second**.

We recommend choosing the **slowest acceptable polling rate** because the EMH's RS485 bandwidth is limited and much less than Ethernet bandwidth. This leaves the greatest amount of bandwidth for other purposes.

Whatever rate you choose, the EMH is optimized for **polling at a constant rate**.

Caching of Reads

The EMH caches data read from backend meters.

Writes (e.g., to relays) are never cached.

How Do I... Fix Unit Issues

EMH units (volts, amps, kWh, etc.) are automatically translated to the corresponding BACnet encoding.

Units & scaling status:  **WARNING: 1 meter has units which couldn't be converted to BACnet units, [View Log](#)**

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If non-standard unit abbreviations have been entered, the EMH will warn of **Unit Issues**.

Click "View Log" to see each unit issue; correct the units of the meter and point in question.

*Note: In all cases, **the value of the data point will be correct even if its units cannot be translated.***

Untranslatable units are encoded as dimensionless values (i.e., as a pure number).

How Do I... Use Relay Outputs

The following relays are supported:

- Leviton A8812 Internal I/O
- Leviton A8332-8FD Flex I/O
- Advantec, Adam 4068 and 4069
- Acromag, 902MB
- Coyote DataComm, Rio-9F
- Benjamin Electric, Power Panel Plus

Relays are modeled as BACnet **Binary Value** objects.

They are not "commandable" (i.e., they have no Priority_Array property).

In other words, the last write to the relay "wins".

Reading Present_Value of a Binary Value returns the state of the relay, which may be different than the last written value if the relay was changed by some means outside of BACnet (e.g., manual switch, Modbus, power cycling, etc.)

Note:

1. *Some controllers such as the Tridium JACE assume **Binary Value** objects are read-only. After discovering the relay's **Binary Value** object, you must change it to be of type "BinaryWritable" so the JACE will write to it.*
2. *Some controllers allow setting limits on how frequently a relay is changed. This feature of the controller can give the impression that the relay is not functioning.*

How Do I... Span Subnets with a BBMD

The **BBMD feature** lets you place the EMH on a IP subnet different from the one containing your BACnet controller. BBMD = **BACnet Broadcast Management Device**, a service which forwards BACnet broadcast messages from the local IP subnet to one or more remote IP subnets. BACnet/IP relies on broadcast messages, which are usually blocked by IP routers. When a BACnet network spans multiple IP subnets, a BBMD should be configured on each subnet with the IP addresses of all other BBMDs.

*Note: The BBMD feature **is not needed** if your BACnet network is contained in a single IP subnet, or if the subnet already has a BBMD. 64 BBMD entries are allowed.*

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How Do I... Span Subnets with Foreign Device Registration

FDR = **Foreign Device registration**, a service which allows a BACnet device not on the local IP subnet to relay its communications through the EMH.

No configuration is needed to use FDR. It is a service the EMH provides, which any BACnet device may use.

Typically, BACnet devices or tools supporting FDR will provide an input-field where you can enter the EMH's IP address and UDP port.

Uses of Foreign Device Registration:

1. Remote diagnostics. BACnet/IP relies on broadcast messages which typically are not forwarded by IP routers. BACnet scanning or management tools which support FDR may relay through the EMH to access all BACnet devices on the EMH's subnet.
2. Stand-alone BACnet meters which don't support full BBMD mode, may nevertheless support FDR. These meters can be configured to relay through an EMH to connect to a BACnet network spanning IP subnets.

Note: In the above cases, the EMH should be configured as a full BBMD if other BBMDs are present in the network. Otherwise, the "foreign device" relaying through the EMH will only be able to "see" the local subnet, not the entire BACnet network.

The FDR and BBMD features are compatible and may be used together. 64 FDR entries are allowed.

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PICS - Protocol Implementation Conformance Statement

BACnet Vendor Name:	Obvius
BACnet Vendor ID:	556
Product Name:	EMH, EMB, EMB Lite
Product Model Number:	A8812, A8810, A7810
Product Description:	"BACnet Server for EMH" is an add-on software module for Leviton "EMH" data acquisition server platform. The "EMH" is a Linux- based embedded controller with a web user-interface which automatically detects and recognizes a variety of power meters and sensors using a variety of protocols, chiefly Modbus/RTU and Modbus/TCP but also proprietary protocols. The "EMH" logs, stores and uploads data from these meters or sensors to a variety of databases and may also act as a real-time protocol gateway.
	The "BACnet Server for EMH" allows the EMH to represent each Modbus/TCP or Modbus/RTU meter or sensor it recognizes as a BACnet device, with data points represented as the appropriate BACnet objects. BACnet queries are answered from cached data, and proprietary algorithms are used to decide when to refresh this cached data via the backend (e.g., Modbus) protocols.
	The "BACnet Server for EMH" also includes features in its web user-interface to scan for and display information about other BACnet devices on the network, intended for to help the user through initial configuration and deployment of the product and in diagnosing problems.
	Only BACnet/IP (Annex J) is supported at this time.

1.1.1. BACnet Standardized Device Profile (Annex L)

X	BACnet Smart Sensor (B-SS).
X	BACnet Smart Actuator (B-SA).

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1.1.2. BACnet Interoperability Building Blocks (BIBBs) Supported (Annex K)

X	K.1.1 BIBB - Data Sharing - ReadProperty-A (DS-RP-A) [for network diagnostics]
X	K.1.2 BIBB - Data Sharing - ReadProperty-B (DS-RP-B)
X	K.1.3 BIBB - Data Sharing - ReadPropertyMultiple-A (DS-RPM-A) [for network diagnostics]
X	K.1.4 BIBB - Data Sharing - ReadPropertyMultiple-B (DS-RPM-B)
X	K.1.8 BIBB - Data Sharing - WriteProperty-B (DS-WP-B)
X	K.5.1 BIBB - Device Management - Dynamic Device Binding-A (DM-DDB-A)
X	K.5.2 BIBB - Device Management - Dynamic Device Binding-B (DM-DDB-B)
X	K.5.4 BIBB - Device Management - Dynamic Object Binding-B (DM-DOB-B)

1.1.3. Segmentation Capability:

None.

1.1.4. Standard Object Types Supported:

X	Device.
X	Analog Input.
X	Binary Value.

1.1.5. Unsupported Properties and Restrictions:

None.

1.1.6. Data Link Layer Options:

X	BACnet IP, (Annex J).
---	-----------------------

1.1.7. Device Address Binding:

Not supported.

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1.1.8. Networking Options:

X	BACnet/IP Broadcast Management Device (BBMD). Max BDT slots: 64.
X	Registrations by Foreign Devices. Max FDT slots: 64.

1.1.9. Character Sets Supported:

Where support for multiple character sets is indicated, this does not imply that they can all be supported simultaneously.

X	ANSI X3.4/UTF-8
---	-----------------

1.1.10. Unsupported Functions of the BACnet Driver:

None.

1.1.11. Non-BACnet Equipment/Networks Supported:

If this product is a communication gateway, describe the types of non-BACnet equipment/networks(s) that the gateway supports

Various backend protocols, such as Modbus/TCP, Modbus/485, USB, Fronius, SMA, etc.
--

Wireshark Filters

WireShark Filter	What It Matches
udp.port == 47808	All BACnet packets on standard port
udp.port == 47808 or udp.port == 47809	BACnet packets on port 47808 or 47809
udp.port == 47808 and not ip.addr == 1.2.3.4	Exclude one "noisy" network node at 1.2.3.4
udp.port == 47808 and not bacapp.confirmed_service	Exclude Confirmed Services (such as ReadProperty and WriteProperty). Useful for debugging device and object discovery.
udp.port == 47808 and not (bacapp.confirmed_service == 12 or bacapp.confirmed_service == 14)	Exclude ReadProperty and ReadPropertyMultiple. Useful for debugging WriteProperty.
bacapp.confirmed_service == 15 and	BACnet WriteProperty packets to/from IP address 5.6.7.8

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ip.addr == 5.6.7.8	
bacapp.type > 4	BACnet Errors (type=5), Rejects (type=6) or Aborts (type=7)
bacapp.unconfirmed_service	BACnet Unconfirmed Service requests (Who-Is, I-Am, Who-Has, I-Have, etc.)
bacapp.unconfirmed_service == 8 or bacapp.unconfirmed_service == 0	BACnet Who-Is or I-Am packets (used for device discovery)
bacapp.unconfirmed_service == 7 or bacapp.unconfirmed_service == 1	BACnet Who-Has or I-Have packets (used for object discovery)
udp.port == 47808 and (bacnet.sadr_eth == 01:02:03:04:05:06 or bacnet.dadr_eth == 01:02:03:04:05:06)	BACnet requests to/from a particular meter (the address is the 6 byte "ADR" field shown in BACnet → Device List → show: [network])

Appendix A – Troubleshooting

This section lists many common problems and possible solutions in order of likelihood.

Symptom: Can't "Discover" the EMH?

If your BACnet Controller fails to "discover" the EMH, check the following:

1. Try "discovering" in the reverse direction: Can the EMH see your Controller or other BACnet devices? Login to the EMH and use BACnet à Discover.
2. Can you "discover" some objects on the EMH or none at all? Even if no meters are connected to the EMH, it should always share at least one BACnet Device Object (representing the EMH itself).
3. Basics: Check Ethernet cables, link-status LEDs, trying "pinging" ... Note that the EMH's "discovery" function will also ping each BACnet/IP device.
4. Same UDP port? Check that all BACnet/IP devices are using the same UDP port, by default 47808. The BACnet à Setup page will show the UDP port in use. Alternate UDP ports allow multiple distinct BACnet/IP networks to co-exist on a single LAN. Note: that the BBMD function may be used to bridge between BACnet/IP networks on distinct ports.
5. Same LAN subnet? Check that the EMH and your BACnet Controller are on the same IP subnet by comparing the IP addresses and subnet masks of each device. Note: just because you can "ping" the opposite device does not mean they are on the same IP subnet – they may be separated by an IP router, which will block BACnet broadcasts.
6. If not on same subnet, is there a properly configured BBMD on each LAN? Each BBMD must be configured with the IP-addresses (and UDP ports, if not the default) of all other BBMDs.

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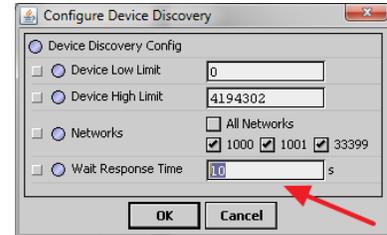
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7. Separated by NAT-router? Are the EMH and the BACnet Controller separated by a NAT-router? "NAT" stands for "Network Address Translation" and allows several devices to share a single IP address. Any NAT-router must specifically support the BACnet protocol.
8. Firewalls blocking UDP broadcasts? Check that there are no firewalls between the EMH and your BACnet Controller, or if there are, that they are not performing a NAT function and that they are configured to forward broadcasts. Alternately, configure the EMH as a BBMD.
9. Can your BACnet Controller wait longer for a "discovery" response? The EMH should respond within a few seconds to any discovery (Who-Is) request, but in large networks with many responding devices, the BACnet Controller may be overwhelmed with responses. Try increasing the amount of time your Controller waits to collect responses.



- Here's an example for the Tridium JACE:
10. Are there any Conflicts or Duplicate Device IDs or Network Numbers in your BACnet Network? BACnet requires that Device Names, Device IDs and Network Numbers should all be unique across the entire network. Your BACnet Controller may detect duplicates. If not, you can use the EMH's BACnet → Discover page. This will check for conflicts of Device IDs and Network Numbers across your entire network.



11. Device Name Conflicts? Duplicate Device Names are less likely to cause problems, but should still be corrected. To detect duplicate names with the EMH, use the BACnet → Discover page and click the "Device Name" column to sort by name, then look for any duplicates.

Your BACnet Controller can discover the EMH itself, **but not meters attached to the EMH**. The EMH acts as a BACnet "virtual router"... this means that each meter shared by the EMH will appear to be on a separate BACnet subnet. Some Controllers may require you to select "All Networks" or "Global Broadcast" when doing a discovery:



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Your Controller may also organize the BACnet devices **by network number**.

Symptom: “Discovery is Broken or Not Working” or “My Controller Doesn’t Support Discovery”?

It is possible to connect to BACnet devices by manually entering their BACnet address information into your Controller. This is useful if:

- Discovery fails (and cannot be fixed by any of the above means),
- If the Controller doesn’t support discovery, or
- You need to re-number your network.

The EMH displays everything you need in the show: [network] tab of the BACnet à Discovery page:

- The NET and ADR columns give the network number and address, and
- The B/IP MAC column gives the BACnet/IP MAC address.
- The “objects” link will display a device’s Object Instance Numbers.

Here is an example of entering or changing address information on the Tridium JACE.

Name	Type	Device ID	Netwk	MAC Addr	Enabled	Use Cov	Max Cov Subscriptions
AcquiSuite_70_5 Flex I/O	Bacnet Device	device:5016	35447	05 46 1B 10 BA C1	true	false	max

<input type="radio"/> Name	AcquiSuite_70_5 Flex I/O
<input type="radio"/> Type	Cannot edit
<input type="radio"/> Device ID	device 5016
<input type="radio"/> Netwk	35447 [0 - 65535]
<input type="radio"/> MAC Addr	05 46 1B 10 BA C1
<input type="radio"/> Enabled	<input checked="" type="radio"/> true
<input type="radio"/> Use Cov	<input type="radio"/> false
<input type="radio"/> Max Cov Subscriptions	max

OK Cancel

Symptom: BACnet Timeout or Communication Errors?

If your BACnet Controller fails to communicate after “discovery” is complete, or if it reports an unusually high number of communications or timeout errors, consider these possible causes:

1. **Recommended APDU Timeout in use?** The BACnet Server will recommend an APDU Timeout based on the EMH’s current Modbus configuration. This value is advertised to BACnet peers, but not all BACnet peers will use it. Verify the timeout on the BACnet Controller side.
2. **Review the EMH’s Modbus Timeout** (in Modbus → Setup). If the Modbus Timeout is incorrect for the meters being used, the recommended BACnet APDU Timeout will also be incorrect.

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3. **Segmentation not supported.** Verify the BACnet Controller isn't trying to use "Segmentation" when communicating with the EMH. Segmentation is not supported.
4. **Can ping? Both ways?** Verify you can ping the Controller from the EMH and vice-versa. Note: If you are spanning subnets with BBMDs, you might be able to discover devices that you cannot directly communicate with! This can happen if one BACnet device (on the remote network) has an incorrect default route. To guard against this unusual situation, the EMH will automatically ping each BACnet/IP device it discovers.
5. **Can ping with large packets?** Some types of network errors affect large packets more than small ones. The default size of packet used by "ping" is 64 bytes. Both Windows and Unix/Linux allow you to increase this default size when pinging to test the network's handling of large packets. For example, on Windows, the command is: ping -l SIZE HOSTNAME

```
C:\Users\mns>ping -l 1500 10.55.70.1

Pinging 10.55.70.1 with 1500 bytes of data:
Reply from 10.55.70.1: bytes=1500 time=36ms TTL=64
Reply from 10.55.70.1: bytes=1500 time=26ms TTL=64
Reply from 10.55.70.1: bytes=1500 time=3ms TTL=64
Reply from 10.55.70.1: bytes=1500 time=2ms TTL=64

Ping statistics for 10.55.70.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 2ms, Maximum = 36ms, Average = 16ms
```

6. **Other devices are BTL Listed?** Verify the other devices are BTL Listed. If not, check for firmware updates. The EMH's Discover → show: [firmware] tab will display the firmware versions of all devices.

Symptom: Data Values are not Updating (not Refreshing)?

This section deals with the symptom of data values which are not updating (not refreshing) or which the Controller reports as "stale" or "down".

Database									6 objects
Name	Exts	Device ID	Status	Netwk	MAC Addr	Vendor	Model	Firmware Rev	
Obvius_TC50361 Internal I/O	   	device:55625	{down,alarm,unackedAlarm}	33399	03 46 1B FA BA C0	Obvius	Obvius, #1.11		FW
Obvius_TC50361 Thermostat	   	device:55600	{down}	33399	03 46 36 01 BA C0	Obvius	Veris Indl		GW
Obvius_TC50361 PowerMeter OK	   	device:55624	{down}	33399	03 46 4A F9 BA C0	Obvius	Obvius Pct		GW

1. From the BACnet Controller's point of view, are all devices "stale/down", or just some? All devices suddenly being "stale/down" suggests a networking problem between the Controller and the EMH. See the section above, Symptom: BACnet Timeout or Communication Errors.
2. Is meter data being updated (refreshed) on the EMH side? The Data Age column of the BACnet → Device List → show: [stats] tab will show how old each meter's data is, and the

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RP column (ReadProperty) will increment for each request. The Data Age column will also show an "*" (asterisk) when an update is pending but not yet completed. If the EMH is successfully completing requests, Data Age should periodically reset to 0. The length of time the "*" appears will let you visually gauge how fast the EMH is refreshing data.

3. If the problem appears to be on the EMH-side, see How Do I Optimize Response Time for solutions.
4. If the problem appears to be on the BACnet Controller side,
 - a. Check for Device Name, Device ID or Network Number conflicts.
 - b. Check if the Device ID of the EMH has simply changed. The most likely reason this could occur is because the EMH hasn't been assigned a permanent BACnet name and ID, and it is using DHCP, and its DHCP-assigned address has changed.

Finally, try re-discovering the EMH from the Controller.

Symptom: Can't Write (to Relays)?

If your BACnet Controller isn't able to write to relays shared by the EMH, consider these possible causes:

1. Supported relay type? Make sure the relay type is supported by the BACnet Server. If not, please contact Leviton to request support for the new relay.
2. Attempting to write to Binary Value object? The EMH represents each relay as a pair of objects – an Analog Input object and a Binary Value object. Only the Binary Value object may be written. The Binary Value object's name will be suffixed with "Relay". For example, here is how two relay points would appear to a Controller:

Name	Out	Object ID	Property ID	Index	Read	Write
Fan	0.00 {ok}	analogInput:41	Present Value	-1	Polled	readonly
Fan Relay	false {ok} @ 9	binaryValue:41	Present Value	-1	Polled	OK
Output 02	0.00 {ok}	analogInput:42	Present Value	-1	Polled	readonly
Output 02 Relay	true {ok} @ 9	binaryValue:42	Present Value	-1	Polled	OK

3. Meter communication errors (at Modbus level)? To verify that the EMH itself can successfully set or clear the relay, try changing the relay's state from the EMH's web UI. Login as "admin", navigate to Modbus → Device List, and click on the relay device. You should see a list of points. Locate the relay, and you should see buttons to turn it on or off, like so:

Fan	0	Turn On
Blinker	1	Turn Off

4. APDU Timeout too low? It possible, though unlikely, that the APDU Timeout is high enough to allow reads to succeed, but not writes. BACnet reads are satisfied very quickly from cache, while writes to relays always result in a Modbus write to the relay. This write must finish before the BACnet Server will reply with success. Assuming you've already verified the Modbus timeout is sufficient to write to the relay (above), try doubling the

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APDU Timeout.

- EMH's RS485 bus is overloaded? Each BACnet write to a relay's Present_Value will result in a Modbus/485 request on the EMH's RS485 port. If the RS485 port is simply overloaded (all bandwidth in use), requests will be delayed, and if this delay is great enough, it will exceed the BACnet Server's APDU Timeout. To diagnose this, navigate to BACnet → Device List → show: [stats] tab, and look at the "I/O Response Time, Worst-case" column (indicated by arrow).

BACnet Device List - Local Devices

Show: [\[basic\]](#) [\[network\]](#) [\[firmware\]](#) [\[stats\]](#) [\[all\]](#)

Device ID	Status	Device Name	RP	RP Cache Hits (%)	WP	Dev Error (if any)	Data Age	Unit Issues	Read Reqs / Errs	Write Reqs / Errs	I/O Response Time, Avg (ms)	I/O Response Time, Worst (ms)	Location
556000	alive, operational	Obvius_TC50361	0	0	0	0	0	0	0 / 0	0 / 0	0	0.0	
556001	alive, operational	Obvius_TC50361 Thermostat	40	0	0	0	53s	0	1 / 0	0 / 0	0	0.0	mb485-001
556249	alive, operational	Obvius_TC50361 Power Meter	40	0	0	0	53s	0	1 / 0	0 / 0	0	0.0	simulated
556250	alive, operational	Obvius_TC50361 Internal I/O	4601	100	2414	0	0*	0	4625 / 0	2414 / 0	215ms	1.5s	mb485-250

Total devices: 4

Show: [\[basic\]](#) [\[network\]](#) [\[firmware\]](#) [\[stats\]](#) [\[all\]](#)

- This value should always be less than the APDU Timeout. If this is the problem, several solutions are possible:
 - Increase the APDU Timeout,
 - Optimize response time,
 - Reduce the load on the RS485 bus by reducing polling rates or reducing the EMH's
 - Data logging period,
 - Increase the RS485 bus bandwidth by reconfiguring your meters to operate at a higher baud rate.
- Does your Controller limit frequency of writes to protect equipment? As an example, the Tridium JACE's "Default Tuning Policy" for BACnet limits writes to once per hour.

Default Policy (Bacnet Tuning Policy)

Min Write Time [0ms - +inf]

Max Write Time [0ms - +inf]

Write On Start

Write On Up

Write On Enabled

Stale Time [0ms - +inf]

Poll Frequency

Use Cov

Use Confirmed Cov

Cov Subscription Lifetime min

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This feature is intended to protect equipment from too-frequent switching, so you should adjust it with care.

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Symptom: Relays Turn On When They Shouldn't?

This section deals with the symptom of relays turning on when they shouldn't, or turning on seemingly at random, or appearing to have "glitches".

All of these symptoms result from lack of **fail safe logic design**.

"**Fail safe logic design**" means designing your control logic so that if communication with a sensor fails for any reason, the logic outputs (to relays) go to the inactive (off) state, or at least remain unchanged.

The easiest way to ensure your logic design is "fail safe" is to test it by physically disconnecting sensors and observing the result.

Even in a properly working system, momentary communications failures are inevitable for these reasons:

1. The EMH gives priority to logging of data over responding to BACnet requests. At the start of each data logging cycle, the EMH will pause in servicing Modbus read-requests for approximately 10 seconds.
2. The response time of the EMH varies with the "load" on the RS485 bus, and this load may vary depending on the number of requests received over the network (from BACnet, from XML, from Modbus/TCP, etc.)
3. Electrical noise (such as lightning strikes) which disrupt Ethernet routers or switches or RS485 buses.
4. By default, the EMH checks for firmware updates. Installing an update means the EMH will reboot, causing a delay of approximately 1-2 minutes.

You can deal with these issues by:

- Properly setting your Controller's "Stale Timeout" (if it supports such a feature),
- Having your Controller monitor the **Status_Flags** and **Reliability** properties on objects shared by the EMH.
- Incorporating both above into your control logic.

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Setting a “Stale Timeout”

How you set a “stale timeout” is Controller-specific. For instance, the Tridium JACE has a “Stale Time” parameter in its BACnet Tuning Policy, which sets the maximum response delay before a data point is considered “stale” (see below). This should be set as follows:

Stale Time >= (APDU_Timeout * Number_of_APDU_Retries)

Default Policy (Bacnet Tuning Policy)

- Min Write Time: 00001h 00m 00s [0ms - +inf]
- Max Write Time: 00000h 00m 00s [0ms - +inf]
- Write On Start: true
- Write On Up: true
- Write On Enabled: true
- Stale Time: 00000h 00m 18s [0ms - +inf] ←
- Poll Frequency: Fast
- Use Cov: false
- Use Confirmed Cov: true
- Cov Subscription Lifetime: 15 min

How the EMH Signals Communications Failures

The BACnet Server for EMH will signal communications failures by updating the Status_Flags and Reliability properties of each data point’s Analog Input or Binary Value object, and by setting the System_Status property of each Device Object.

These properties may be monitored by the Controller. For instance, on the Tridium JACE, these properties may be “added” in the same way you would discover and “add” the Present_Value of an input (see below). These properties can then be used to “gate” your control logic.

Bacnet Discover Points

Discovered					
Object Name	Object ID	Property ID	Index	Value	Description
AcquiSuite_70_5 Flex I/O	device:5016	systemStatus		Operational	Flex I/O, SN=[001EC604020B]
Fan Temp	analogInput:1	presentValue		71.18	Fan Temp
Fan Temp	analogInput:1	objectIdentifier		analogInput:1	
Fan Temp	analogInput:1	objectName		Fan Temp	
Fan Temp	analogInput:1	objectType		Analog Input	
Fan Temp	analogInput:1	presentValue		71.24	
Fan Temp	analogInput:1	statusFlags		none	←
Fan Temp	analogInput:1	eventState		Normal	
Fan Temp	analogInput:1	outOfService		false	
Fan Temp	analogInput:1	units		Degrees Fahrenheit	
Fan Temp	analogInput:1	description		Fan Temp	
Fan Temp	analogInput:1	reliability		No Fault Detected	←

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