ValuPoint IoT
MODEL VP6-1470
IOT EDGE SERVER

CONTROL SOLUTIONS MINNESOTA

User Guide

Model VP6-1470
ValuPoint IoT
Edge Server for BACnet

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VP6-1470 User Guide Contents

ValuPoint IoT
Model VP6-1470
IoT Edge Server

Control Solutions Minnesota

1. Introduction

1.1 How to Use This Guide

This user guide provides background information on how the ValuPoint works, and an overview of the configuration process. There are several sections for groups of tabs found in the web interface in the ValuPoint which is accessed by opening a web browser and browsing to the IP address of the device.

You should at least read Sections 1 and 2 to gain an understanding of how the ValuPoint functions. You can use Sections 3 through 12 as reference material to look up as needed. You will need to read sections beginning at Section 13 to start to understand how to connect to the Amazon web servers. There is a "Quick Help" section at the bottom of each web page in the ValuPoint which is generally sufficient for quick reference in setting up the ValuPoint.

1.2 Important Safety Notice

Proper system design is required for reliable and safe operation of distributed control systems incorporating any Control Solutions product. It is extremely important for the user and system designer to consider the effects of loss of power, loss of communications, and failure of components in the design of any monitoring or control application. This is especially important where the potential for property damage, personal injury, or loss of life may exist. By using ANY Control Solutions, Inc., product, the user has agreed to assume all risk and responsibility for proper system design as well as any consequence for improper system design.

CAUTION: The lithium battery contained in this device may explode if mistreated. DO NOT recharge, disassemble, or dispose of in fire.

No action is required of the user to activate the battery that backs up the real time clock. Important: Replace battery with BR1225A only. Use of another battery may present a risk of fire or explosion.

1.3 Warranty

This documentation is provided "as is," without warranty of any kind, either expressed or implied, including, but not limited to, the implied warranties of fitness or merchantability for a particular purpose. Control Solutions may make improvements and/or changes in this documentation at any time. This documentation could include technical inaccuracies, typographical errors, and the like. Changes are periodically made to the information herein; these changes may be made without notice.

Product Warranty: All Control Solutions products are warranted against defects in materials and workmanship for a period of time from date of shipment from factory as follows: Two years on non-mechanical parts, one year on mechanical parts (e.g. relays). Defective units will be repaired or replaced, at manufacturer's discretion, at no cost to user except when negligence or improper use has resulted in damage. The express warranty stated herein is in lieu of all other warranties, express or implied, including without limitation any warranties of merchantability or fitness for a particular purpose and all other warranties are hereby disclaimed and excluded by Control Solutions, Inc.

Configuration errors made by customer are not covered under warranty. Damage caused by incorrect electrical connection is not covered under warranty. Removing circuit boards from their enclosures will void the warranty - the complete product with all of its original circuit boards and components must be returned for warranty consideration.

2. Connecting the ValuPoint

2.1 Overview of ValuPoint Operation

The ValuPoint connects physical I/O (e.g. sensors) to the Internet. In addition, the VP6-1470 turns any BACnet device into a Thing on the Internet of Things. Gain instant access to a wide range of machine learning and AI capabilities, a wide range of cloud based data storage and analytics, and a variety of cloud driven event handling and notification capabilities. All of this is made possible by the ValuPoint IoT Edge Server and the many features of Thingsboard.io, Amazon Web Services, or generic Mosquitto MQTT.

Are you not a fan of the "cloud"? No problem. The ValuPoint IoT Edge Server can provide you with many of the same capabilities on its own, without any cloud. You can take advantage of local data logging, local email client, and event notifications generated within just the ValuPoint itself.

An IoT Device typically has one or more of these functions:

- Monitoring something and collecting data for later analysis
- Controlling something according to some given algorithm or schedule
- Notifying somebody when something goes wrong

All of these functions are supported both for cloud based implementation and stand-alone implementation using the ValuPoint.

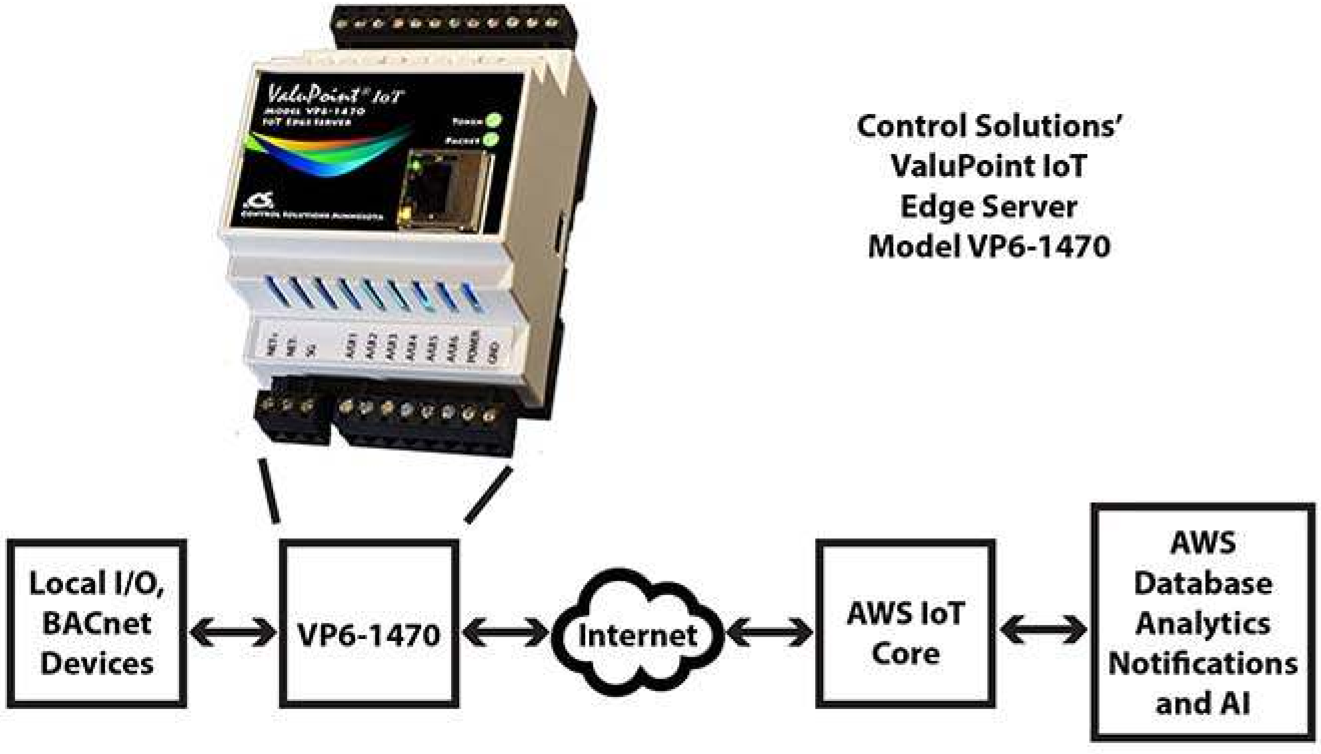
Hardware Features of Model VP6-1470

- 12 Analog/universal inputs, software selectable types
  - 0-10VDC, thermistor, discrete, dry contact, pulse
  - 0.1% reference,12-bit resolution
  - Non-volatile totalizing count inputs
  (to 2Hz on all channels, to 1kHz on 4 channels)
- 2 Discrete outputs
  - Form A relay
  - 2A @ 120VAC
  - 2A @ 30VDC
- Battery backed real time clock/calendar
- BACnet IP to MS/TP Router, IP over Ethernet 10/100BaseT
- Isolated BACnet MS/TP port, 9600, 19200, 38400, 76800 baud
- Powered by 18-30VDC or 24VAC 50/60 Hz Class 2, 0.3A max.
- DIN rail mounting, 100mm H x 70mm W x 60mm D
- Operating temperature -40°C to +80°C; Humidity 5% to 90%

- FCC Class A, CE Mark
- Listed to UL 916 and (Canadian) C22.2 No. 205-M1983

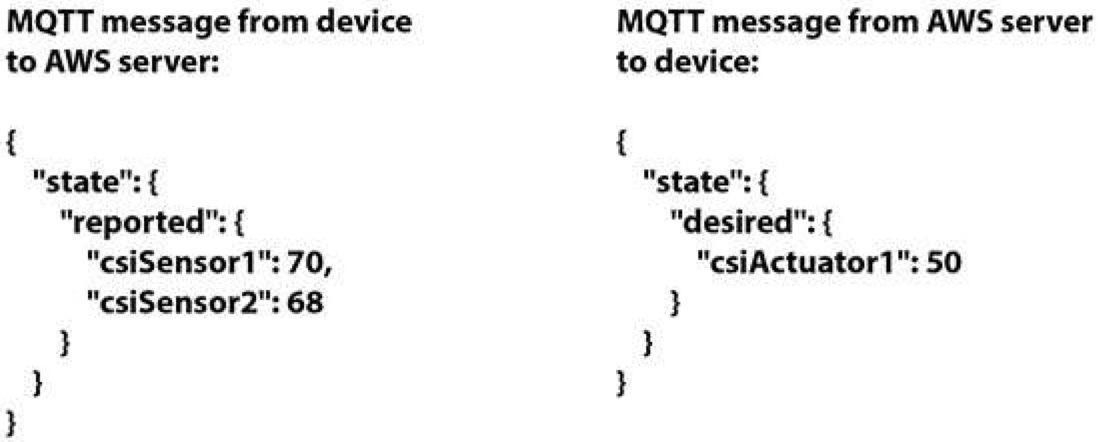
2.1.1 Cloud Based Application

Control Solutions chose to provide direct integration with Amazon Web Services simply because AWS offers the widest array of available capabilities at the best price. These capabilities have been scaled for large applications and are used by large corporations. At the same time, these capabilities are readily accessible for the much smaller enterprise with just a few devices to monitor. In fact, Amazon Web Services are affordable for using with just one device, unlike many of the IoT or MQTT enterprise solutions.



The ValuPoint will poll one or more BACnet devices, collecting data from the list of objects you provide. Based on rules you create, the ValuPoint will decide if and when to publish that data to the AWS server. You can also configure the ValuPoint to subscribe to data coming from the AWS server, which you can then write out to BACnet devices to manage setpoints and the like. AWS IoT is based on the MQTT protocol. Sending data to the AWS server and receiving data from the AWS server is all done in MQTT protocol using JSON to represent the data.

Examples of JSON formatted MQTT messages are as follows:



MQTT message from device to AWS server:

```
{
  "state": {
    "reported": {
      "csiSensor1": 70,
      "csiSensor2": 68
    }
  }
}
```

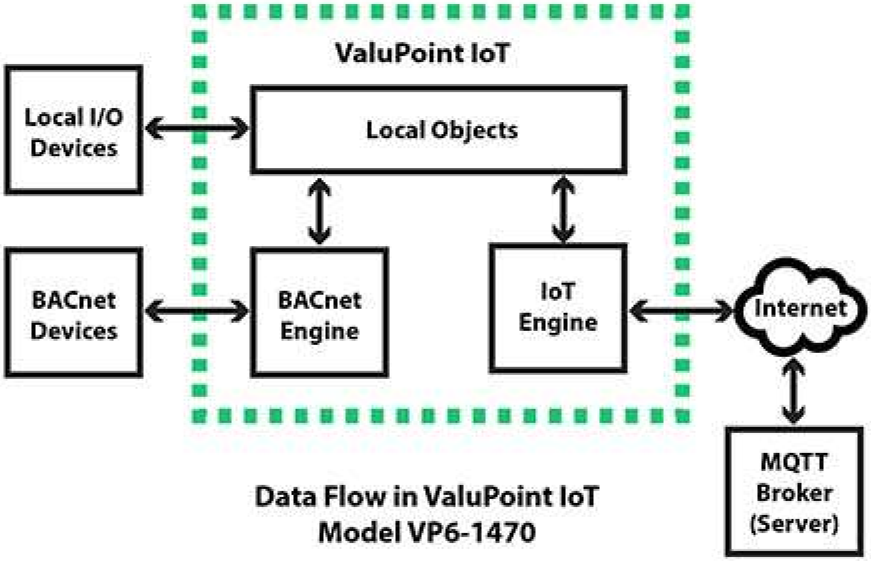
MQTT message from AWS server to device:

```
{
  "state": {
    "desired": {
      "csiActuator1": 50
    }
  }
}
```

The MQTT "publish" action, in controls terms, is most closely associated with sensors. Your hardware has collected sensor data, and you want to send that sensor data to a server or to other control devices. To send that data, you "publish" it.

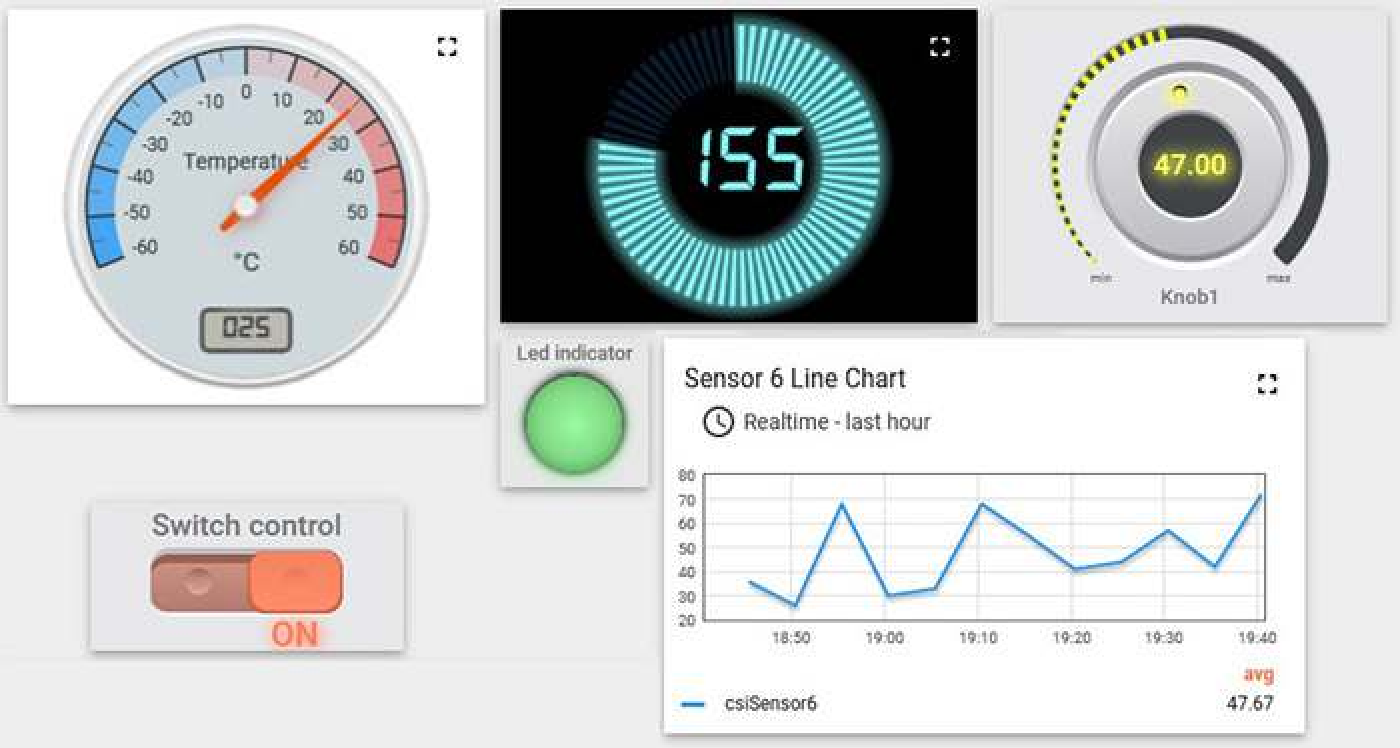
The MQTT "subscribe" action, in controls terms, is most closely associated with actuators. The "subscribe" action would also be associated with control setpoints. You can never force data into a device via MQTT. The device, in our case the ValuPoint, must subscribe to the source of data effectively asking to be informed of changes. Once you have subscribed to an MQTT source of data, then when received, you can use that data to control actuators or update setpoints.

The data flow in the ValuPoint is illustrated below. Data is collected from BACnet devices by the BACnet engine which stores that data in its objects. BACnet is collected according to a set of rules or "maps" created by the user. The BACnet data is automatically updated on a continual basis. Meanwhile, the IoT engine is looking at the data and its set of publish and subscribe rules to decide when to publish data from the local registers to the AWS server. These rules are also created by the user and data will be published according to the criteria set up by the user (you).



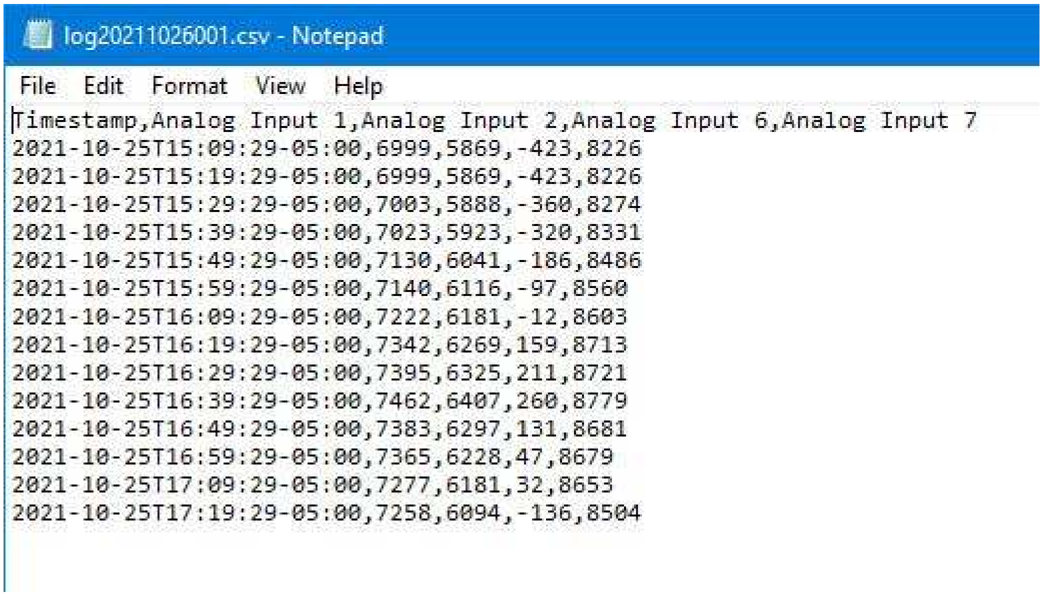
Data Flow in ValuPoint IoT
Model VP6-1470

The ValuPoint IoT Edge Server includes support for Thingsboard.io MQTT services. Thingsboard provides a number of capabilities including interactive real time dashboards with widgets such as gauges, knobs, buttons, and charts. Here is an example of a demo dashboard we built for test purposes.



2.1.2 Stand-Alone Application

The ValuPoint supports stand-alone data logging by logging selected data points to a local file in CSV format, and then automatically emailing that file to you from time to time. Once received, you can do anything with that data that you can normally do with any standard spread sheet program.

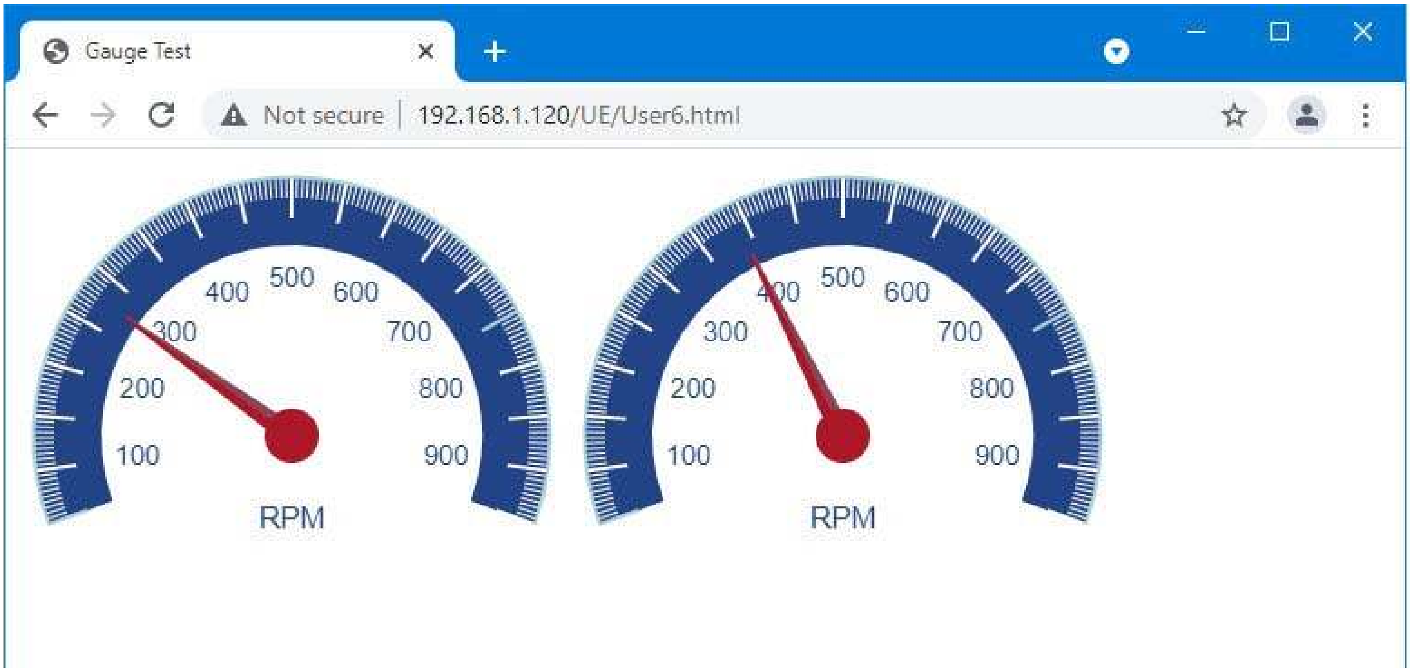

log20211026001.csv - Notepad

```
Timestamp,Analog Input 1,Analog Input 2,Analog Input 6,Analog Input 7
2021-10-25T15:09:29-05:00,6999,5869,-423,8226
2021-10-25T15:19:29-05:00,6999,5869,-423,8226
2021-10-25T15:29:29-05:00,7003,5888,-360,8274
2021-10-25T15:39:29-05:00,7023,5923,-320,8331
2021-10-25T15:49:29-05:00,7130,6041,-186,8486
2021-10-25T15:59:29-05:00,7140,6116,-97,8560
2021-10-25T16:09:29-05:00,7222,6181,-12,8603
2021-10-25T16:19:29-05:00,7342,6269,159,8713
2021-10-25T16:29:29-05:00,7395,6325,211,8721
2021-10-25T16:39:29-05:00,7462,6407,260,8779
2021-10-25T16:49:29-05:00,7383,6297,131,8681
2021-10-25T16:59:29-05:00,7365,6228,47,8679
2021-10-25T17:09:29-05:00,7277,6181,32,8653
2021-10-25T17:19:29-05:00,7258,6094,-136,8504
```

There are several features available for supporting control algorithms, and a real time scheduler is now included in the ValuPoint. Direct response control can sometimes be handled with just an event rule. You can also use a sequence of Calculate instructions for simple algorithms.

Notifications generated locally use event rules to detect when a condition exists. The local email client will email you or others to let you know what is going on.

The ValuPoint supports a customizable user interface so that you can have your own version of a "dashboard" for your device. With a little programming and a little help from JavaScript, you can display live gauges in your web browser.



2.2 Where to Start

• Start by connecting the ValuPoint as noted in the following section. Then set the IP address of your ValuPoint, and get familiar with the File Manager. You will find these covered in Section 3.

• Define your BACnet device and create some BACnet objects so you have a place to put data. Sections 4 and 6 talk about this.

• If you are going to interact with remote BACnet devices, section 7 talks about your VP6-1470 being a BACnet client. Section 8 talks about your VP6-1470 being a BACnet server.

• Are you interested in using Amazon Web Services? If so, start at section 13.

• Are you interested in local alarm monitoring? Event rules are where you will tell the ValuPoint what you want to watch for. These are covered in Section 9, and setting up the local email client to send you a notification about these events is covered in Section 10.

• Are you interested in local data logging? This is covered in Section 11.

- Are you interested in scheduling things that you want to happen? Take a look at the scheduler in Section 12.

- To get rolling with Amazon Web Services, start at Section 13 where we talk about setting up the ValuPoint to talk to AWS. Then move on to Sections 14 and 15 to cover the MQTT subscribe and publish configuration.

For using AWS, you will need to create an account at https://aws.amazon.com if you haven't already. Once there, you will find a seemingly endless source of documentation on AWS IoT as well as the many other related services available to you via AWS.

- You can install the open source Mosquitto MQTT broker on your own server. If you wish to use Mosquitto MQTT, refer to Section 16 to get started.

- Thingsboard.io offers a graphical dashboard for MQTT devices that is relatively straight forward to set up. Refer to Section 17 to get started with Thingsboard.

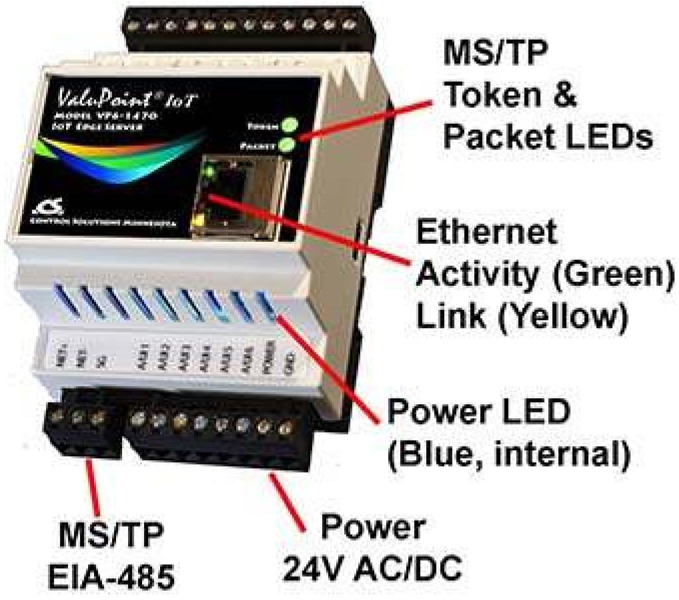
- Last but not least are a couple of advanced topics. If you want to create your own custom web pages to be served by the ValuPoint's internal server, that is covered in Section 18. If you have an external server with an application that can use a REST API to query devices, the REST API is covered in section 19.

- Various details are covered in Appendix A through G. Be sure to look at the first 3 sections of Appendix A which cover hardware details you will need to be aware of. You can save the rest of the reference information for when you need it.

2.3 Connectors and Indicators

Follow these steps to make the initial connection to the VP6-1470.

(a) Connect power. Apply +12 to +24VDC or 24VAC to the terminal marked “POWER”, and common or ground the terminal marked “GND”.


MS/TP Token & Packet LEDs
Ethernet Activity (Green) Link (Yellow)
Power LED (Blue, internal)
MS/TP EIA-485
Power 24V AC/DC
ValuPoint IoT
MODEL VP6-1470
IoT EDGE SERVER

(b) Connect a CAT5 cable between the RJ-45 jack on the ValuPoint, and your network switch or hub. You cannot connect directly to your PC unless you use a “crossover” cable.

(c) Apply power.

A blue LED inside the case should light indicating power is present.

If the link LED on the RJ45 jack is not on, check your Ethernet cable connections. Both link and activity LEDs on the RJ45 jack will be on solid for a short time during boot-up. The entire bootup process will take about 20 seconds, during which time you will not be able to connect with a browser.

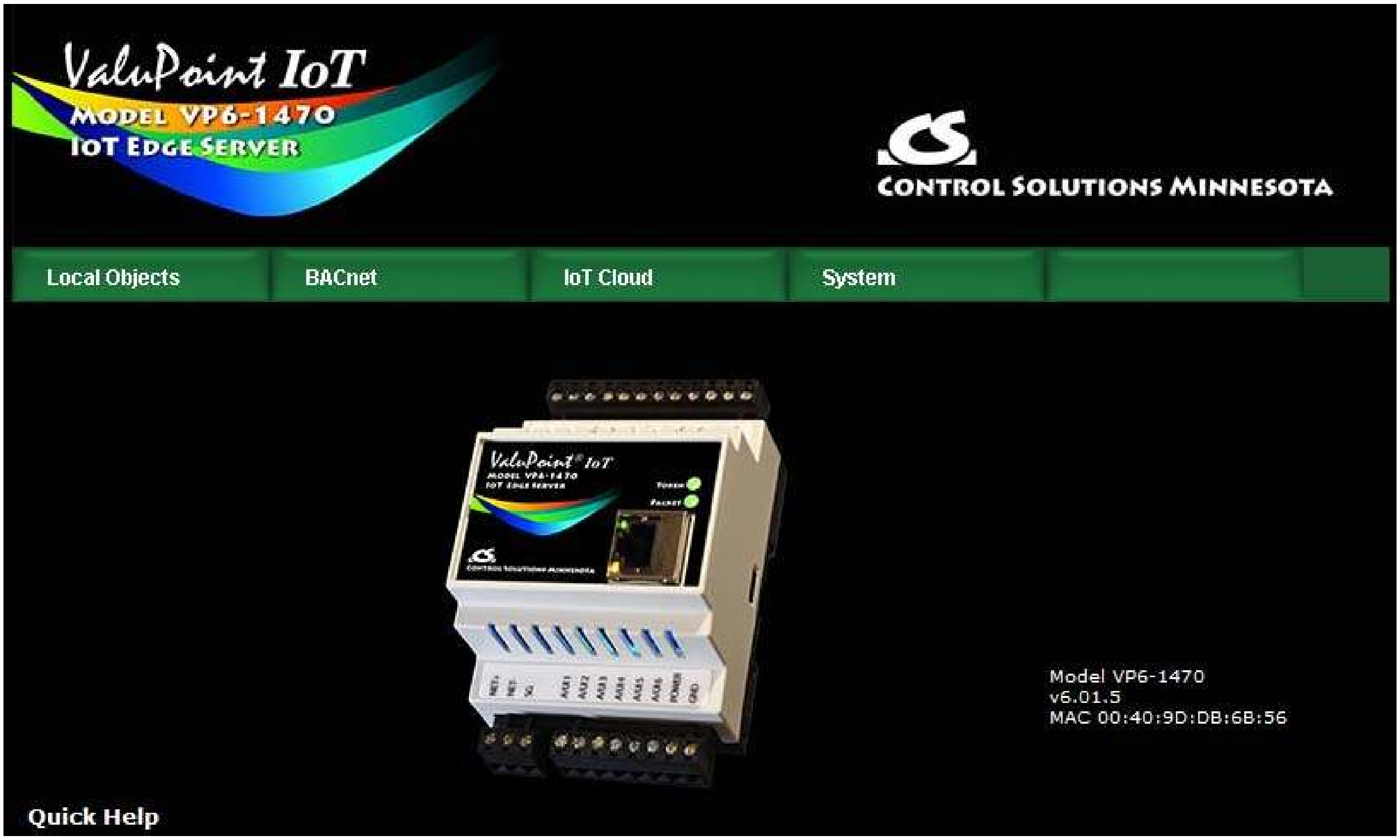
Ethernet link LED is the yellow LED integrated into the CAT5 connector. Ethernet activity LED is the green LED integrated into the CAT5 connector.

Refer to Appendix A for additional detail pertaining to connections and indicators as well as optional internal jumper settings.

2.4 Open Web User Interface

The default IP address as shipped is 10.0.0.101. Enter http://10.0.0.101 in your browser's address window. Newer computers should be able to connect directly to that IP address. Older computers required that the PC be on the same subnet first, or that you add a route to your network configuration.

This generally works, but if this fails, you will need to temporarily change your computer’s IP address to a fixed address that starts with 10.0.0. and ends with anything but 101.

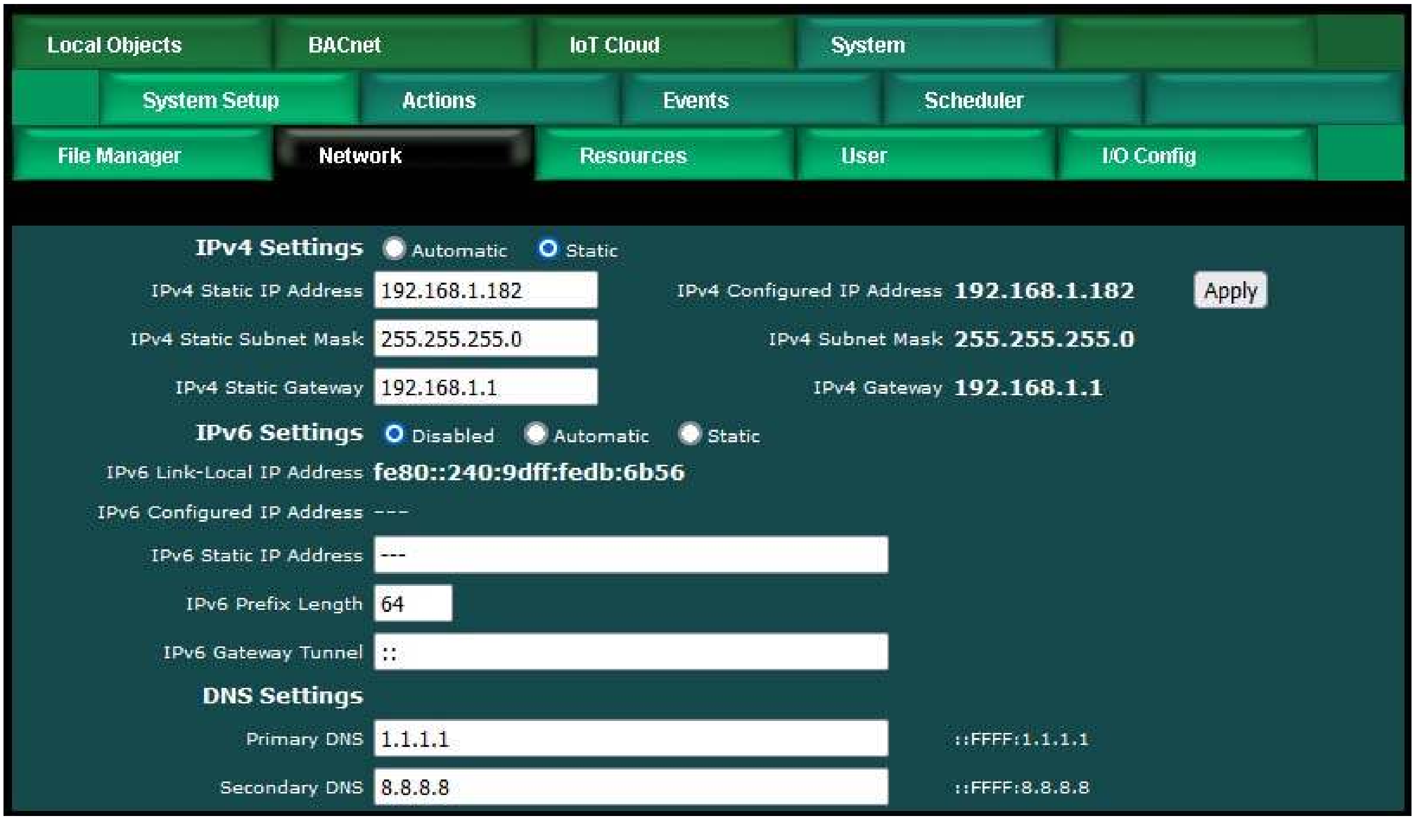


Model VP6-1470
v6.01.5
MAC 00:40:9D:DB:6B:56

Open your browser, and enter “http://10.0.0.101/” in the address window. You should see a page with the “ValuPoint” header shown above. From this point, you will find help on each page in the web site contained within the product.

When you click on any of the page tabs such as System, you will be asked for a user name and password. The only default login as shipped is “root”. The password is different for every ValuPoint shipped, and unique to your ValuPoint. Look for the root password document and/or label that was shipped with your device. If you have lost your root password, you will need to open a support ticket at https://ticket.csimn.com and provide the MAC address shown so that your original default password can be recovered. Or you can follow the procedure described in Appendix section A.6.

To change the IP address of the ValuPoint, go to the Network page under System :: System Setup. The following page should appear (only top portion illustrated here). Change the IP address, and subnet mask and ValuPoint if applicable. Click Change IP to save the changes. The process of programming this into Flash takes around half a minute. The new IP address only takes effect following the next system restart or power cycle.



IPv4 Settings ○ Automatic ● Static

IPv4 Static IP Address 192.168.1.182 IPv4 Configured IP Address **192.168.1.182**

IPv4 Static Subnet Mask 255.255.255.0 IPv4 Subnet Mask **255.255.255.0**

IPv4 Static Gateway 192.168.1.1 IPv4 Gateway **192.168.1.1**

IPv6 Settings ● Disabled ○ Automatic ○ Static

IPv6 Link-Local IP Address **fe80::240:9dff:fedb:6b56**

IPv6 Configured IP Address ---

IPv6 Static IP Address ---

IPv6 Prefix Length 64

IPv6 Gateway Tunnel ::

DNS Settings

Primary DNS 1.1.1.1 ::FFFF:1.1.1.1

Secondary DNS 8.8.8.8 ::FFFF:8.8.8.8

Most changes are stored in an XML configuration file in the device’s Flash file system. Only a few are stored differently, and the IP address is one of those. Normally, clicking Update on any configuration page only stores that configuration information to a temporary RAM copy of the configuration file. To make your changes other than IP address permanent, you must execute Save XML Config File on the File Manager page (System :: System Setup :: File Manager). Refer also to section 3.1.

3. System Configuration and Resources

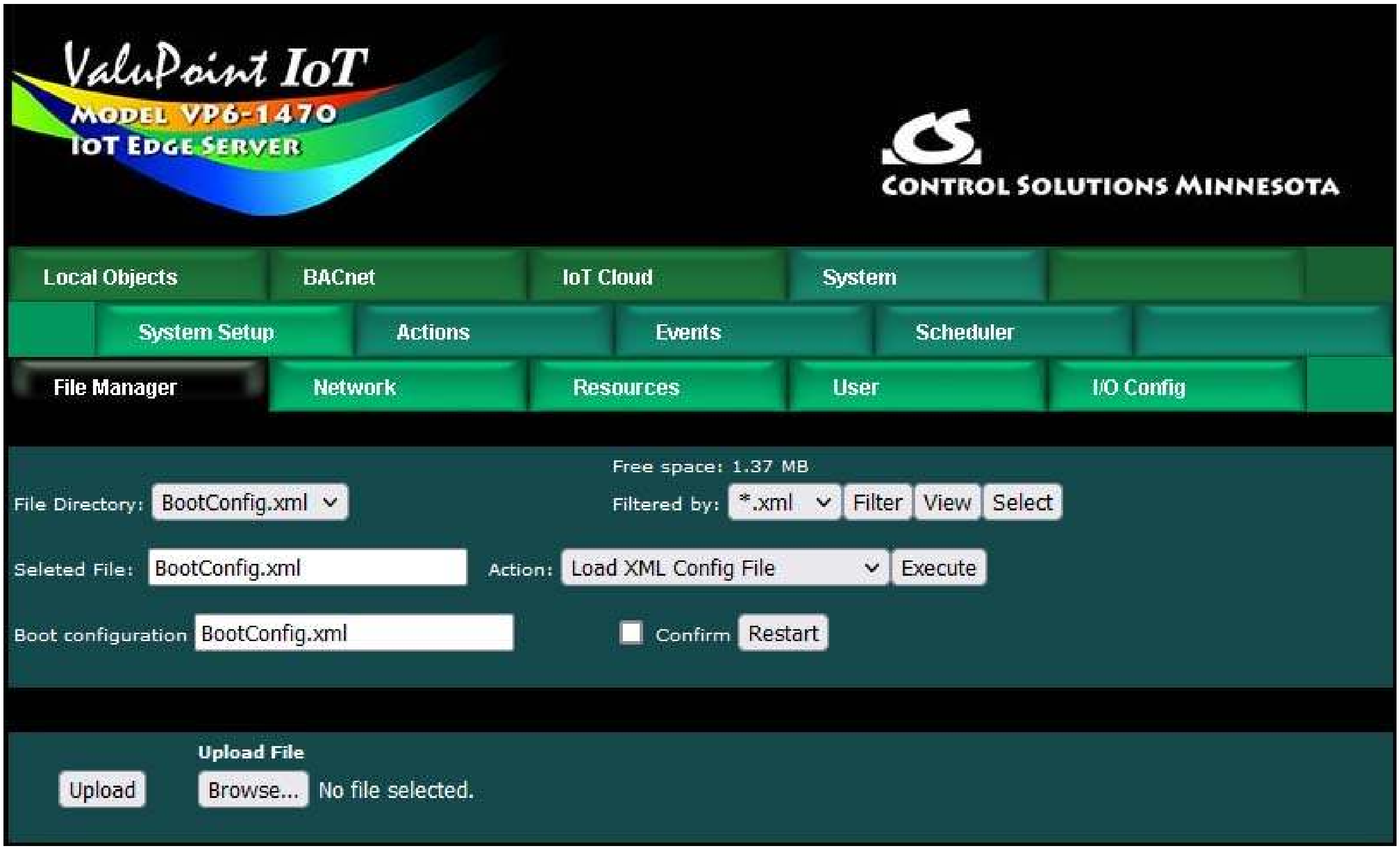
3.1 File Manager

The File Manager page is probably one of the most important pages to know about. Among other things, this is where you tell the ValuPoint to save all of the changes you have made. The various "Update" buttons on the many pages in the web user interface only copy your configuration from your PC's browser to temporary memory in the ValuPoint. To retain those changes indefinitely (i.e. through restart or power cycle), you need to tell the ValuPoint to save those changes in a configuration file.

The configuration files are stored in non-volatile (Flash) memory. The process of reprogramming the Flash takes a little time. It would be cumbersome to rewrite that file every time you made a minor change. Therefore, in the interest of being more responsive, and in the interest of extending the life of the Flash, configuration is only saved to Flash when you direct it to do so.

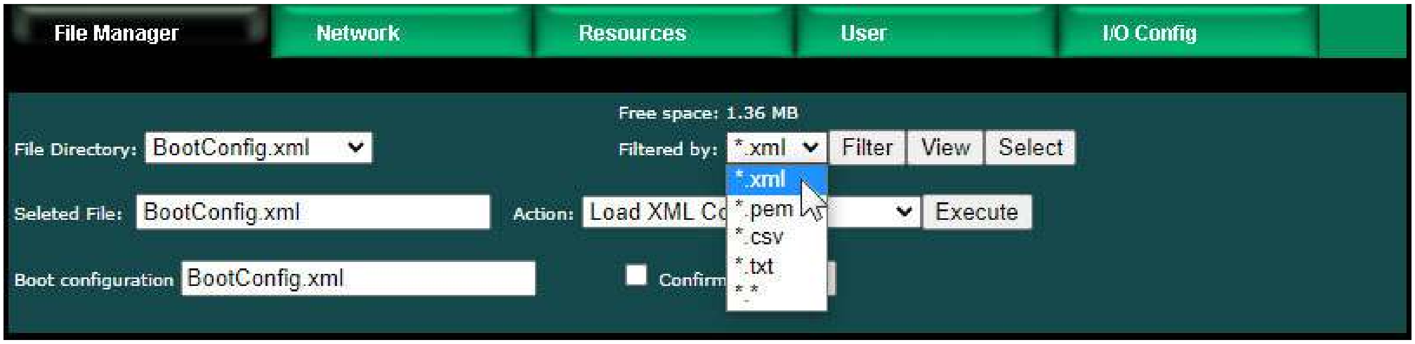
The File Manager is used in several other ways in addition to managing your XML configuration files. You upload SSL certificates here. You import CSV files for the BACnet Client configuration here. You upload text files used as email templates here.

Most configuration parameters are stored in the XML configuration file, but there are exceptions. The device's IP address, for one, is stored in a separate special area of non-volatile memory outside of the file system. Since you need to know the device's IP address in order to log in and upload a file, trying to have the IP address be one of the things you upload wouldn't make sense. In very general terms, the ValuPoint's job is defined by the XML file, and the ValuPoint's identity is stored outside of the file system.



Free space: 1.37 MB
File Directory: BootConfig.xml
Filtered by: *.xml
Seleted File: BootConfig.xml
Action: Load XML Config File
Boot configuration BootConfig.xml
☐ Confirm
No file selected.

The File Directory is a list of files that are currently stored in the ValuPoint's Flash file system. To filter files by type, select a type from the Filtered by list, and click Filter.



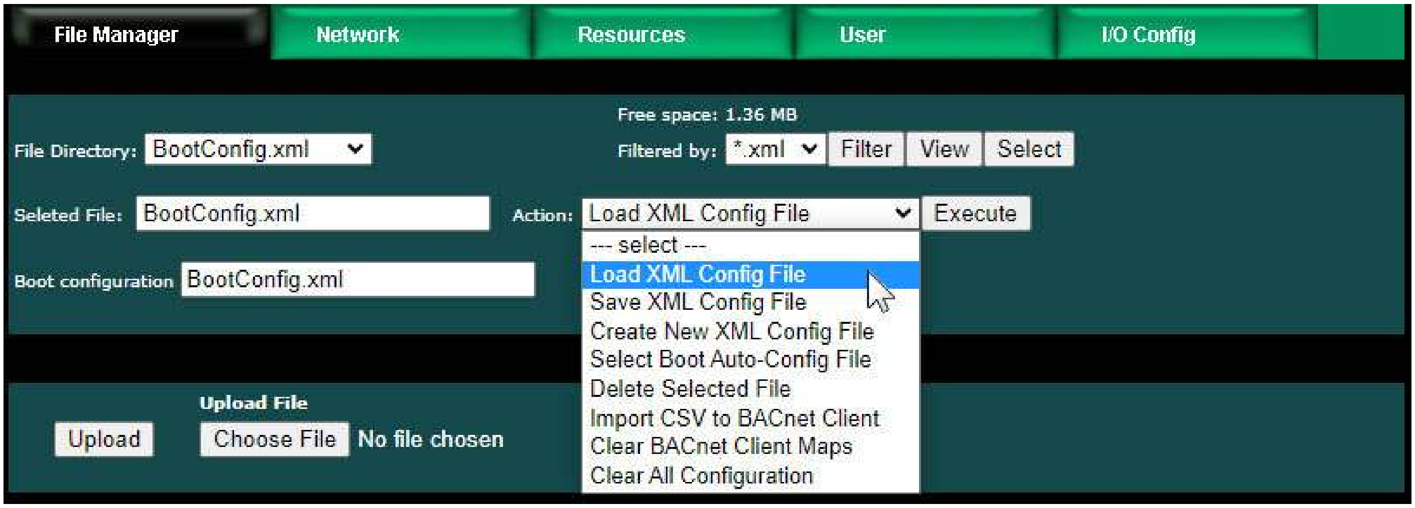
Free space: 1.36 MB
File Directory: BootConfig.xml
Filtered by: *.xml
Seleted File: BootConfig.xml
Action: Load XML Co
Boot configuration BootConfig.xml
☐ Confirm

File type filters are as follows:

*.xml	XML configuration files
*.pem	SSL certificates (for AWS IoT and/or HTTPS)
*.csv	CSV spreadsheet for Modbus register import
*.txt	Text file used as email message template
.	Display all files

There are several file related actions you may take. To take action with a certain file, select that file from the File Directory list, and click Select. That file should now show up in the Selected File window.

Once a file has been selected, choose your action from the Action list, and click Execute.



Free space: 1.36 MB

File Directory: BootConfig.xml

Filtered by: *.xml

Seleted File: BootConfig.xml

Action: Load XML Config File

Boot configuration BootConfig.xml

You must use the Select button to populate the Selected File window prior to executing any action from the list. Choose a file from the drop down list that shows all available files, then click the Select button. You may then act on that file.

You do not need to use the Select button to simply View a file. Clicking View will cause your browser to display the file chosen from the drop down list. If you attempt to View a CSV file, your PC will likely ask if you want to download the file or open it with your spread sheet program (e.g. Excel).

Upload File: To upload a file from your PC to this ValuPoint, use the Browse button to find the file on your PC, open the file in the PC's file dialog box, and then click Upload.

NOTE: If you get a message about directory needing synchronizing, click the browser's "back" button again to return to this page and click Upload again. This gets the browser and HTTP server back in sync, and this requirement generally happens only once or twice following power-up.

Restart: To restart the ValuPoint, check Confirm and click Restart. This is a hard reset that will accomplish the same thing as a power cycle without physically disconnecting and reconnecting power.

3.1.1 Load, Save, Create XML Configuration File

Load XML Config File: The configuration file shown in the "Boot configuration" window will be loaded automatically at startup. If you have uploaded a new configuration file and wish to use it without restarting, select that file and select this action.

HINT: If you are loading a file generated externally and you get "parameter out of range" errors pertaining to defining registers or "table full" errors while loading maps or rules, you might not have sufficient resources allocated. You may need to increase some counts on the Resources page.

Save XML Config File: Any time you have made configuration changes that you want to retain as permanent, you need to come here, select the file from the directory list, and execute this Save action.

Create New XML Config File: You have the option to a totally new configuration file. This is often suitable if you started with an existing configuration, made changes, and want to save your changes without replacing the original configuration. To create a new file, rather than selecting a file from the directory list, simply type a new name into the Selected file window. The name cannot contain spaces or special characters, and be sure to use the correct file suffix. Enter the name and execute this action.

3.1.2 Select Startup Configuration

Select Boot Auto-Config File: This is where you tell the ValuPoint what configuration to automatically load upon startup. To set the Boot configuration, select the XML file from the list, and execute this action. The name of the startup file, along with a few other important things like the ValuPoint's own IP address, are stored in a different area of Flash that is not part of the file system.

When selecting a new Boot configuration file, it is a good idea to select the file, and execute Load XML Config File. If there are errors, they will be displayed. If there are errors in the file but you do not fix them, then the ValuPoint will not fully start up the next time it restarts. The web user interface will be available, but it will not be talking to other devices.

3.1.3 Delete a File

Delete Selected File: Remove a file from the Flash file system by selecting it and executing this action.

3.1.4 Import CSV File

Import CSV to BACnet Client: You can configure BACnet client read and write maps in bulk by importing the maps as a CSV file that you created using a standard spreadsheet program. Refer to Appendix C for details about the CSV format. Note that maps will be added to the existing map list. If you want to replace existing maps with imported maps, execute Clear BACnet Client Maps first.

HINT: If you get "table full" errors while importing CSV files, you might not have sufficient resources allocated. You may need to increase some counts on the Resources page.

3.1.5 Clear Configuration

Clear BACnet Client Maps: Execute this action to clear (completely remove) all BACnet client read and write maps. The BACnet client device table will be left intact.

Clear All Configuration: Execute this action to completely wipe out all configuration. This includes all Modbus maps and devices, all IoT configuration, and all local registers. This will put you back to a "reset to factory" condition with the exception that your IP address is left unchanged. (See Appendix A, Section A.6, regarding forced hard configuration reset that includes IP address and root password.) If you want to make the now empty configuration permanent, select the file that is also selected as

Boot configuration, and execute the Save XML Config File action.

The other means of completely wiping out all saved configuration is to simple delete the file named as the Boot configuration file, and then restart or power cycle the ValuPoint. Upon restart, a new empty configuration file will be created automatically.

3.2 Configuration Files and Restoring Default Settings

There is a means of restoring the ValuPoint to "manufacturer's default settings". First of all, make sure that the Boot configuration file is set to "BootConfig.xml". Then, after selecting this file as the boot file, delete it. Now restart the ValuPoint. Upon restart, and upon finding that the boot configuration name is BootConfig.xml, and it does not exist, the ValuPoint will automatically create one with default parameters. The automatic creation of a default file will not occur with any other file name.

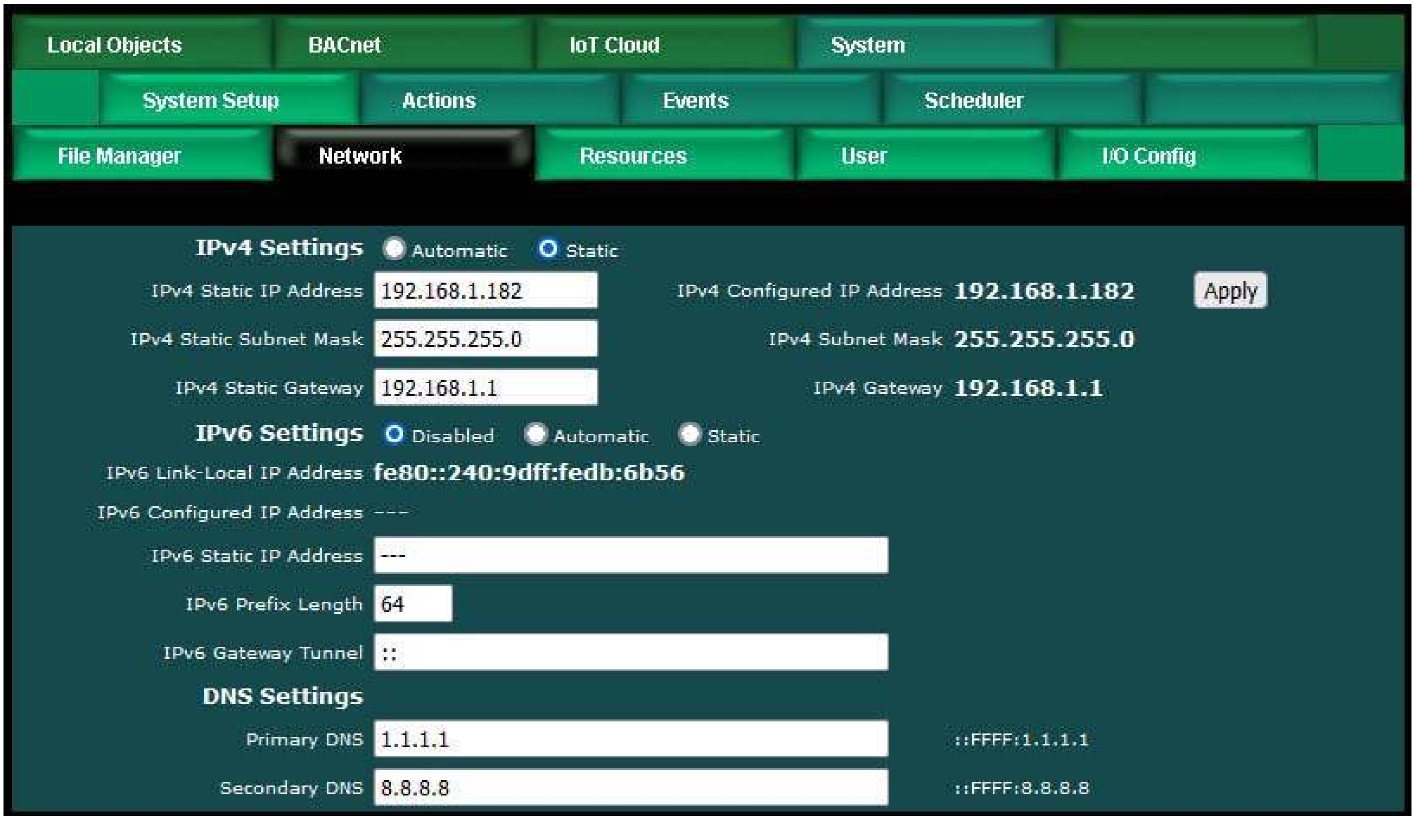
Manual Editing: It is possible to manually edit the XML file outside of the ValuPoint. However, doing so is very prone to errors. If there are errors in the XML file, it will not load successfully on startup. If the configuration does not load on startup, none of the scanners will begin scanning. Because they are all blocked by configuration failure, entering new configuration via the web pages will not result in functionality being restored. You must successfully load a configuration file before the ValuPoint will become functional. To check for errors, select the file here, select Load XML Config File, and click Execute. Error messages that would have been discarded by the automatic loading at startup will now be displayed on an error page if there are any.

Backup Copy of XML Config File: To save a copy of the configuration to your PC, select the file and click the View button. Your browser will now display the XML file. DO NOT do a text copy/paste to try to create an XML file - doing so will result in an invalid file format that cannot be loaded again. You must use the browser's "save as" or "save page" function. The browser should default to wanting to save a file with a .xml suffix. If correctly saved on your PC, you should be able to double click on the saved file and it will result in opening the file automatically in your browser. It was saved correctly if the browser does not give any error messages when displaying the XML (which should now look exactly as it did when you first clicked the View button). Saving the configuration file to your PC, and then uploading on a different device, is a quick and easy way to configure two ValuPoints the same way.

Note about caching: Your browser may cache files. If you view a file, make configuration changes, save the file, then view the file again, you may see the old file cached by the browser. To see the updated file, go to "Options" in your browser's tools menu, and delete temporary Internet files (or delete cache files). Also, if you upload a file, make changes on your PC, and re-upload the same file, the browser may send the old file. Again, you will need to find the button inside your browser options that lets you delete the cached files from your PC. To upload a configuration file from your PC to the ValuPoint, use the Browse button to find the file on your PC, open the file in the PC's file dialog box, and then click Upload.

3.3 Network Configuration

The Network Configuration page is where you set the ValuPoint's IP address as well as a few other important things.



IPv4 Settings ○ Automatic ● Static

IPv4 Static IP Address 192.168.1.182 IPv4 Configured IP Address 192.168.1.182

IPv4 Static Subnet Mask 255.255.255.0 IPv4 Subnet Mask 255.255.255.0

IPv4 Static Gateway 192.168.1.1 IPv4 Gateway 192.168.1.1

IPv6 Settings ● Disabled ○ Automatic ○ Static

IPv6 Link-Local IP Address fe80::240:9dff:fedb:6b56

IPv6 Configured IP Address ---

IPv6 Static IP Address ---

IPv6 Prefix Length 64

IPv6 Gateway Tunnel ::

DNS Settings

Primary DNS 1.1.1.1 ::FFFF:1.1.1.1

Secondary DNS 8.8.8.8 ::FFFF:8.8.8.8

3.3.1 IPv4, IPv6 Settings

To change the IP address(es) of this device, make the applicable entries and click Apply. The "automatic" selection means DHCP. Changes to the IPv4 IP address will take effect upon the next system restart.

If IPv6 is enabled, IPv6 will always have a Link-Local address, plus one configured address. The configured address will be either the static IP address, or an IPv6 address obtained from an IPv6 DHCP server. If no configured address appears, the DHCP server may have been unreachable.

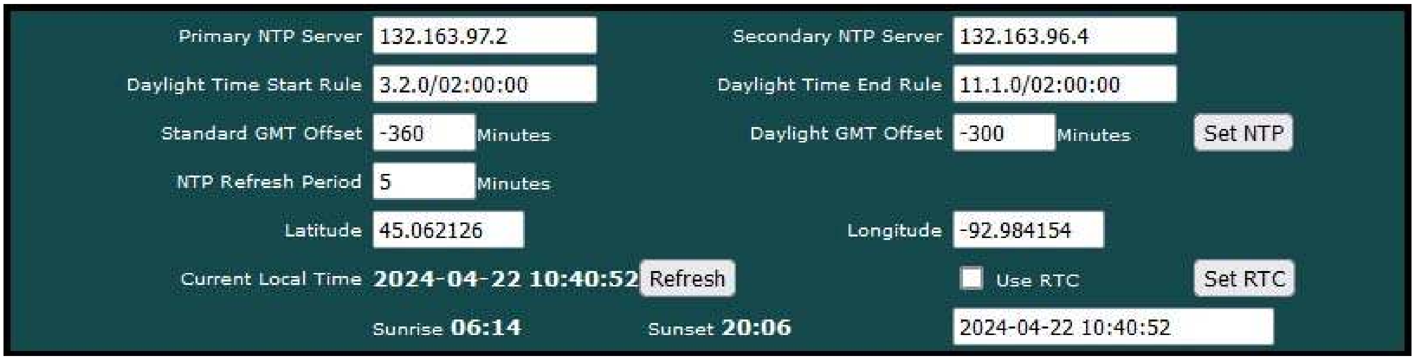
The IPv6 static IP address window is the configured static address. If "Static" is selected and a new IP address entered as the static address, this new address will not take effect until the next system restart.

The numbers shown to the right of the IPv4 input windows are the actual numbers currently in use. If static IP addresses have been entered but the ValuPoint has not been restarted yet, these numbers will not be the same.

You may use domain names instead of static IP addresses in several instances. If domain names are used, you must supply the IP address of at least one DNS server here. The DNS server must be at a static IP address. These changes take effect immediately. Note: If you are using DHCP, the DNS addresses will be supplied by the DHCP server and should be set to 0.0.0.0 here.

3.3.2 NTP Time Server Settings

The ValuPoint maintains time and date via SNTP services or its internal Real Time Clock/Calendar (RTC). The RTC can also be used as backup should SNTP be unavailable due to network disconnect.



Primary NTP Server 132.163.97.2
Secondary NTP Server 132.163.96.4
Daylight Time Start Rule 3.2.0/02:00:00
Daylight Time End Rule 11.1.0/02:00:00
Standard GMT Offset -360 Minutes
Daylight GMT Offset -300 Minutes
NTP Refresh Period 5 Minutes
Latitude 45.062126
Longitude -92.984154
Current Local Time 2024-04-22 10:40:52
□ Use RTC
Sunrise 06:14
Sunset 20:06
2024-04-22 10:40:52

NTP setup: Enter a primary and secondary IP address of NTP servers, such as those found at wwv.nist.gov (go to http://tf.nist.gov/tf-cgi/servers.cgi to find more). Enter daylight start/end rules, and offset from GMT for both standard and daylight time. Offset is a negative number in the western hemisphere. Enter an NTP update time in minutes. Do not set NTP to update too frequently or you risk being denied service by the NTP server. Click the Set NTP button after all settings have been made. The Flash update will take several seconds. The initial update of local time may take a minute or two. You may need to restart the ValuPoint if NTP had never before been initialized.

Daylight savings time start/end rules consist of "date/time" where the date (m.n.d) indicates the day when summer time starts or ends, and time (hour:min:sec) is the current local time when summer time starts/ends. The date portion of the rule is formatted as follows:

m indicates the month (1 <= m <= 12)

n indicates which week of the month (1 <= n <= 5). 5 = the last week in the month.

d indicates what day of the week (0 <= d <= 6). 0 = Sunday

For example: Start "4.1.0/02:00:00", end "10.5.0/02:00:00" means summer time starts at 2am on the first Sunday in April and ends at 2am on last Sunday in October. That was the old US rule. The new US rule is start "3.2.0/02:00:00" and end "11.1.0/02:00:00", which is start at 2am on the second Sunday in March, end at 2am on the first Sunday in November.

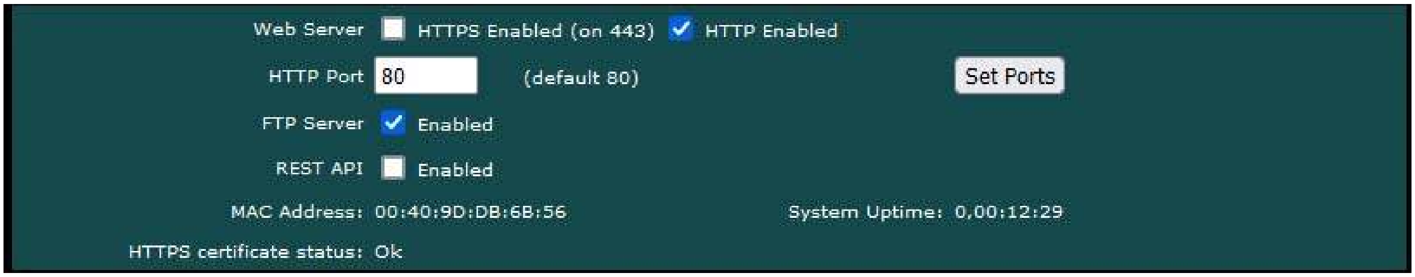
Latitude and longitude for the location of this device should be entered if you want to use the astronomical clock feature of the scheduler. Without latitude and longitude, the calculations for sunrise and sunset will be incorrect.

RTC (Real Time Clock) Setup: Check the "Use RTC" box, and enter the current date and time in the window below that box. Then click Set RTC. In order to use the scheduler without any SNTP, you do still need to enter Latitude and Longitude and click Set NTP. The RTC does not automatically adjust for daylight savings. If both NTP and RTC are enabled, then the RTC time/date will be updated from SNTP when available.

CAUTION: The lithium battery contained in this device may explode if mistreated. DO NOT recharge, disassemble, or dispose of in fire.

No action is required of the user to activate the battery that backs up the real time clock. Important: Replace battery with BR1225A only. Use of another battery may present a risk of fire or explosion.

3.3.3 Port Settings



Web Server □ HTTPS Enabled (on 443) ☑ HTTP Enabled

HTTP Port 80 (default 80)

FTP Server ☑ Enabled

REST API □ Enabled

MAC Address: 00:40:9D:DB:6B:56 System Uptime: 0,00:12:29

HTTPS certificate status: Ok

Secure browsing can be enabled here, and non-secure can be disabled. You cannot disable both, and a forced configuration reset will restore HTTP (non-secure) web browsing. In order to use HTTPS, you must first upload the necessary SSL certificates (see Appendix G) or allow the certificates to be self-generated by explicitly deleting existing certificates.

IMPORTANT: It is highly recommended that in making the transition from HTTP to HTTPS, you enable both until you confirm HTTPS is functional. If there is a problem with the SSL certificates provided for HTTPS, then HTTPS will not run and you will find an error message on the "HTTPS certificate status" line. If you disable standard HTTP without first verifying that HTTPS is functional, you may end up locked out and will then need to do a forced hard reset (Appendix A.6).

The HTTP port for browsing the user interface can be moved away from the default HTTP port 80. Select a different port, click Set Ports, and then restart the ValuPoint to make that new port take effect. Don't forget to append the port number to the ValuPoint's IP address when attempting to browse the web user interface if it has been moved from port 80.

FTP is enabled by default to allow firmware update uploads. It may be optionally disabled here. Just remember to enable it again before attempting a firmware update.

A REST API is available if you wish to query the ValuPoint and get replies to HTTP GET/ POST requests in JSON format. The API will be disabled by default, but you enable it here if desired. Refer to Section 20 for details about the API.

Any changes to this port numbers or enabling/disabling features requires restarting the ValuPoint before they will take effect.

3.4 Resource Allocation

Historically, Control Solutions devices had a fixed set of resources to work with. Invariably, there were always users that wanted less of this and more of that.

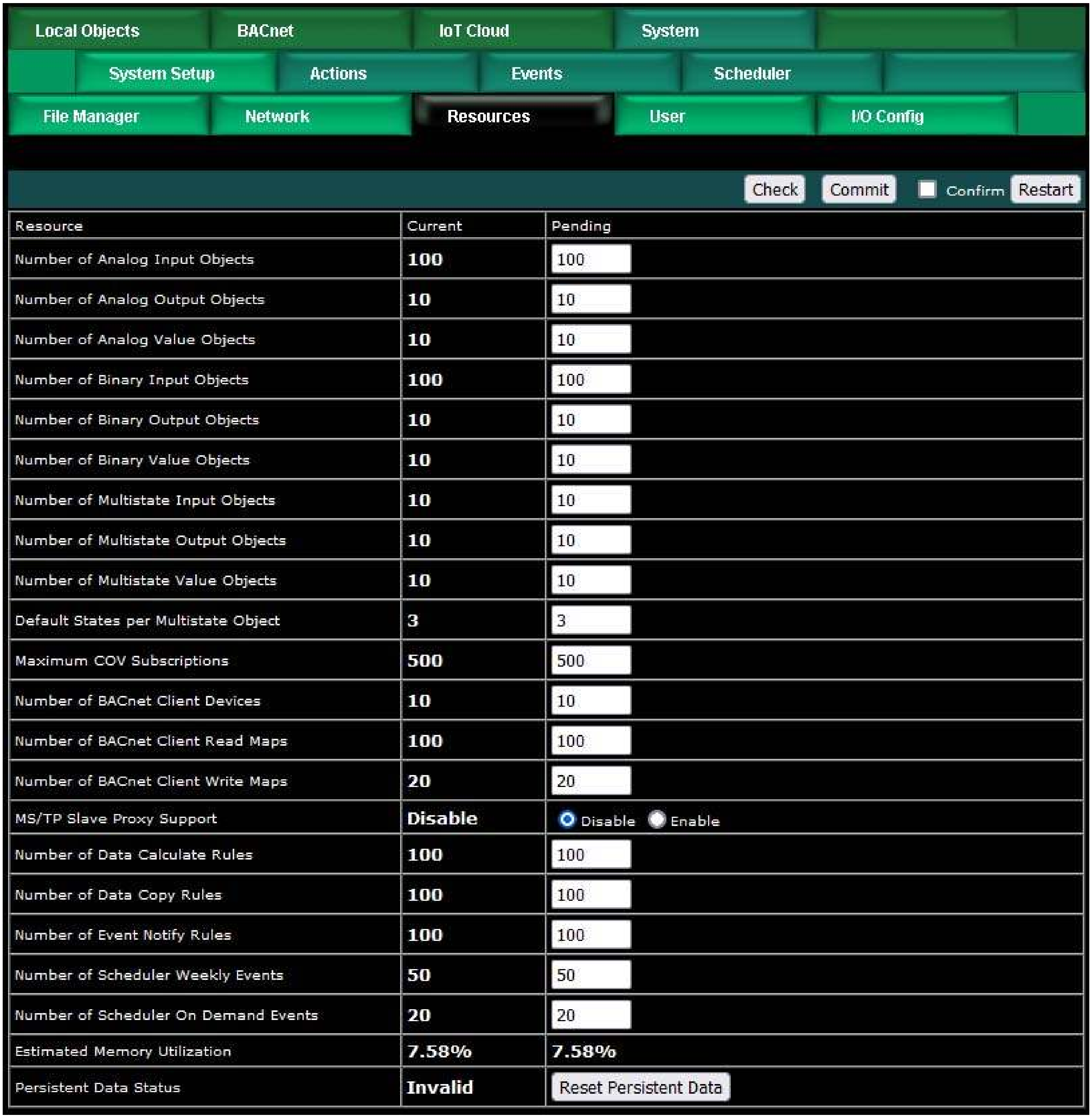
Therefore, while there are still maximums imposed, you can now shift resources around as best suits your application. An example is shown below.

The values in the Pending column are those found in the most recently loaded XML configuration file. When saving or creating a new XML file, the numbers in the Current column will be written to the file. To change the allocations, change numbers in the Pending column. When you are ready to commit these changes, click the Commit button. To cause the changes to go into use, you must restart the device since memory allocation can occur only once at startup.

You can click the Check button prior to Commit to see if the values you have entered will be accepted. If adjustments need to be made, the values in the Pending column will be updated.

The first time you visit this page, you will see the initial default values. Should you change any of them, minimums and maximums currently defined in firmware will be imposed. If you see a value smaller than what you entered, it may be that you had exceeded the internal limit.

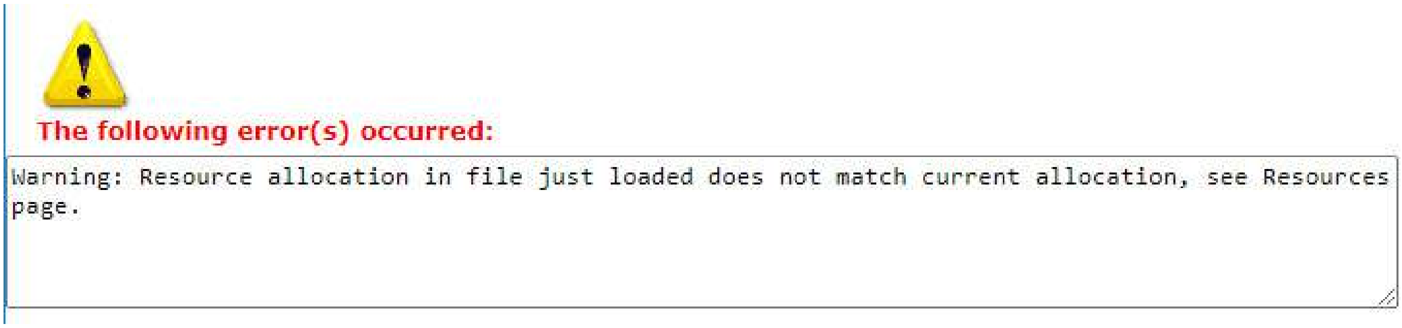
If you see that numbers toward the top of the list are large, and numbers near the bottom are all set to 1, it means the system has run out of free memory and you need to reallocate resources.



Resource	Current	Pending
Number of Analog Input Objects	100	100
Number of Analog Output Objects	10	10
Number of Analog Value Objects	10	10
Number of Binary Input Objects	100	100
Number of Binary Output Objects	10	10
Number of Binary Value Objects	10	10
Number of Multistate Input Objects	10	10
Number of Multistate Output Objects	10	10
Number of Multistate Value Objects	10	10
Default States per Multistate Object	3	3
Maximum COV Subscriptions	500	500
Number of BACnet Client Devices	10	10
Number of BACnet Client Read Maps	100	100
Number of BACnet Client Write Maps	20	20
MS/TP Slave Proxy Support	Disable	● Disable ○ Enable
Number of Data Calculate Rules	100	100
Number of Data Copy Rules	100	100
Number of Event Notify Rules	100	100
Number of Scheduler Weekly Events	50	50
Number of Scheduler On Demand Events	20	20
Estimated Memory Utilization	7.58%	7.58%
Persistent Data Status	Invalid	Reset Persistent Data

The estimated memory utilization shown at the bottom gives you an indication of how close you are to running out of memory. You will not be allowed to commit a resource allocation greater than 100%.

Any time you load an XML configuration file on the File Manager page, the system will compare the current resource settings to those found in the XML file. If they differ, you will see the message illustrated below. This does not necessarily constitute an error - it is just calling your attention to the fact that they are different. On the other hand, if there are other errors preceding this message, such as "table full", then the resource mismatch is indeed a problem and you should reallocate resources as shown in the Pending column (Pending allocations are what were found in the XML file).



The following error(s) occurred:

```
Warning: Resource allocation in file just loaded does not match current allocation, see Resources
page.
```

The Reset Persistent Data button is used to clear (zero) stored persistent data. Changing the local register pool size will clear persistent data. To clear data without changing any allocations, use this button. Local registers have the option of being configured as "persistent" which means the value contained in that register will be retained through restart or power cycle.

3.5 User Login Passwords

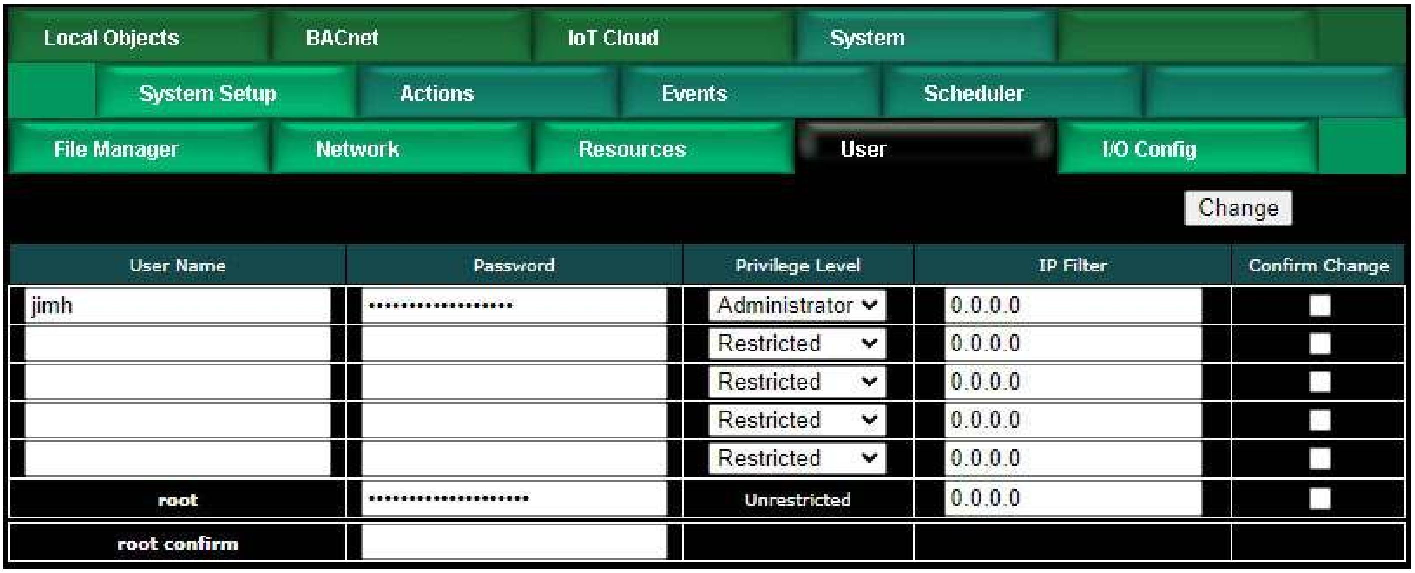
There is only one default login provided initially. That login is the username "root" and root's password is a unique password generated specifically for this particular ValuPoint. That unique password was provided for you in documentation included with the shipment. That unique password complies with California Consumer Privacy Act SB-327, which requires all Internet connected devices to have unique default passwords.

Once logged in as "root", you have the option of creating up to five additional logins.

The privilege level Administrator lets that user see and change anything. The privilege level Maintenance allows the user to log in and see (and change) values in the local registers via the Local Registers page, but cannot access any other pages. The Restricted level has no meaning in the ValuPoint (other than block access to everything) since it does not operate as a user defined web server.

You also have the option of IP filtering. If set, then the user can only access ValuPoint's web pages from that IP address. Leave set to 0.0.0.0 to disable filtering.

Only the root user will see this version of the User page. Other users will only be able to change their own password. To add or change a user, enter the name and credentials, check Confirm Change, and click Change. To delete a user, clear the name field, check Confirm Change, and click the Change button.

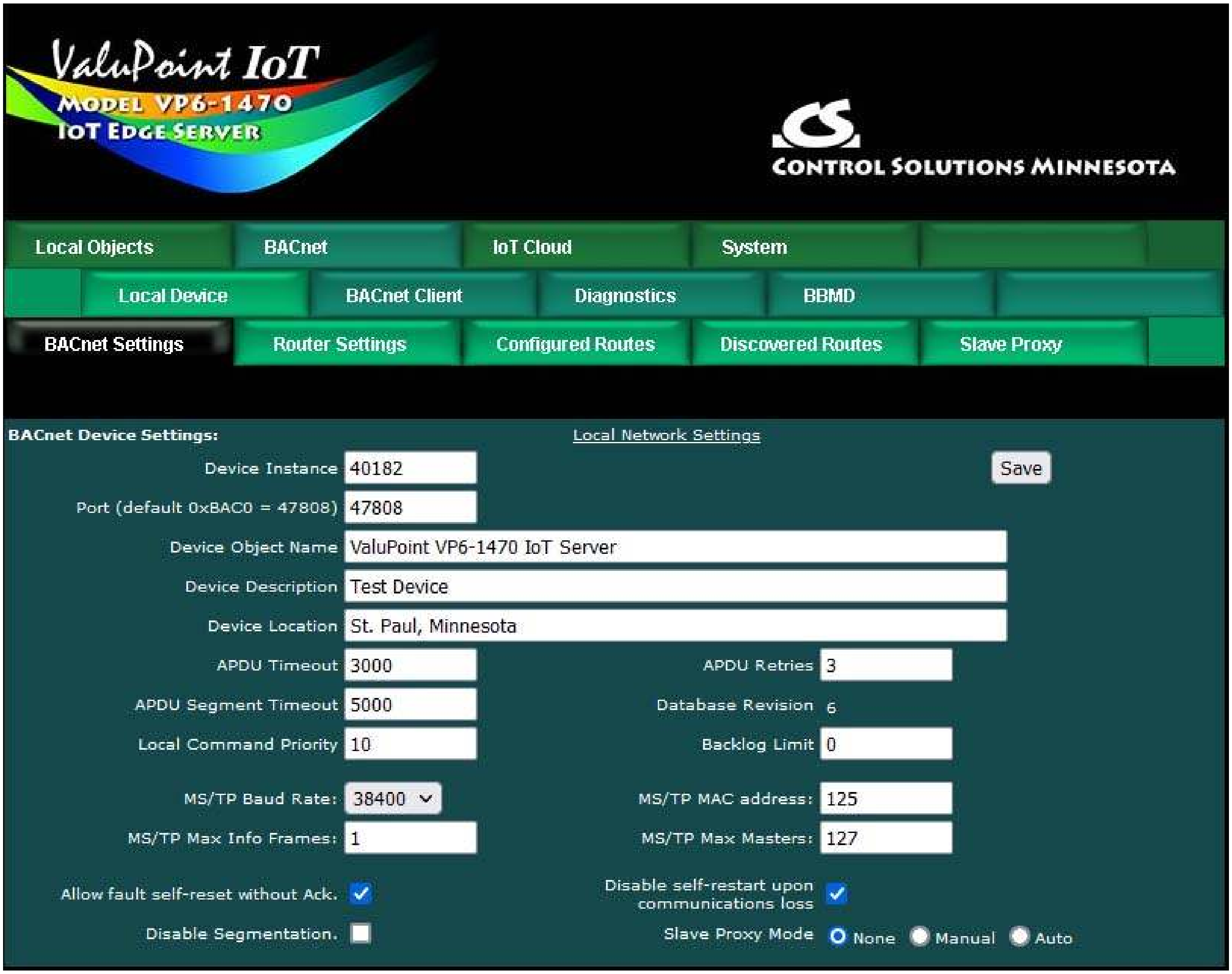


User Name	Password	Privilege Level	IP Filter	Confirm Change
jimh	••••••••••••••••••	Administrator	0.0.0.0	□
		Restricted	0.0.0.0	□
		Restricted	0.0.0.0	□
		Restricted	0.0.0.0	□
		Restricted	0.0.0.0	□
root	••••••••••••••••••••	Unrestricted	0.0.0.0	□
root confirm				

4. Configuring the BACnet Device

4.1 Device Object Parameters

The identity of the ValuPoint as a BACnet device is entered on this page, along with other device object parameters.



BACnet Device Settings:

Device Instance	40182		
Port (default 0xBAC0 = 47808)	47808		
Device Object Name	ValuPoint VP6-1470 IoT Server		
Device Description	Test Device		
Device Location	St. Paul, Minnesota		
APDU Timeout	3000	APDU Retries	3
APDU Segment Timeout	5000	Database Revision	6
Local Command Priority	10	Backlog Limit	0
MS/TP Baud Rate:	38400	MS/TP MAC address:	125
MS/TP Max Info Frames:	1	MS/TP Max Masters:	127
Allow fault self-reset without Ack.	☑	Disable self-restart upon communications loss	☑
Disable Segmentation.	□	Slave Proxy Mode	● None ○ Manual ○ Auto

Enter a device instance from 1 to 4,194,303. Enter a port number (note that 47808 is the standard port expected by most BIP devices).

The device object name, description, and location are entered here. The device object name is expected to be unique to the entire BACnet network. Standard BACnet timeout and retry values are also entered on this page. These values are stored in a special area of non-volatile memory rather than the XML configuration file.

Local command priority is used when the result of a Calculate or Copy rule is written to a commandable object. It is also used if the result of a client read map is saved to a local commandable object, although this would not be recommended. Output objects are commandable. Client read maps should store results in input or value objects, while client write maps take their data from value or output objects. In other words, output objects should not be used for input.

Backlog Limit refers to the number of outstanding requests that the BACnet client will be allowed to make. The client has the ability to generate requests faster than they can be sent even at the 100 megabit rate, and may send them faster than the receiving device can process them. The client will generate up to this number of requests before pausing to wait for replies. The limit will default to the maximum of 10.

The MS/TP port parameters are set on this page. The MAC address should be in the range of 0 to 127. Max master setting must equal or exceed the highest used MAC address, and this setting must be the same in all devices on the MS/TP network.

Check the "allow" check box to allow faults to self-reset. These faults are those conditions indicated by a non-zero reliability code in any of the data objects (see list on data objects pages). Normally an external client needs to read the realiability code to acknowledge the fault before it will automatically reset. By checking the "allow" check box, faults will automatically self-reset without acknowledgement. This is required any time the client does not periodically read reliability codes but does check fault status - a behavior known to be common to BMS front ends.

Check the "disable self-restart" box to disable self restart upon communication loss. If this box is not checked, this ValuPoint will restart itself in an attempt to auto-recover if communications with devices has started and then stopped.

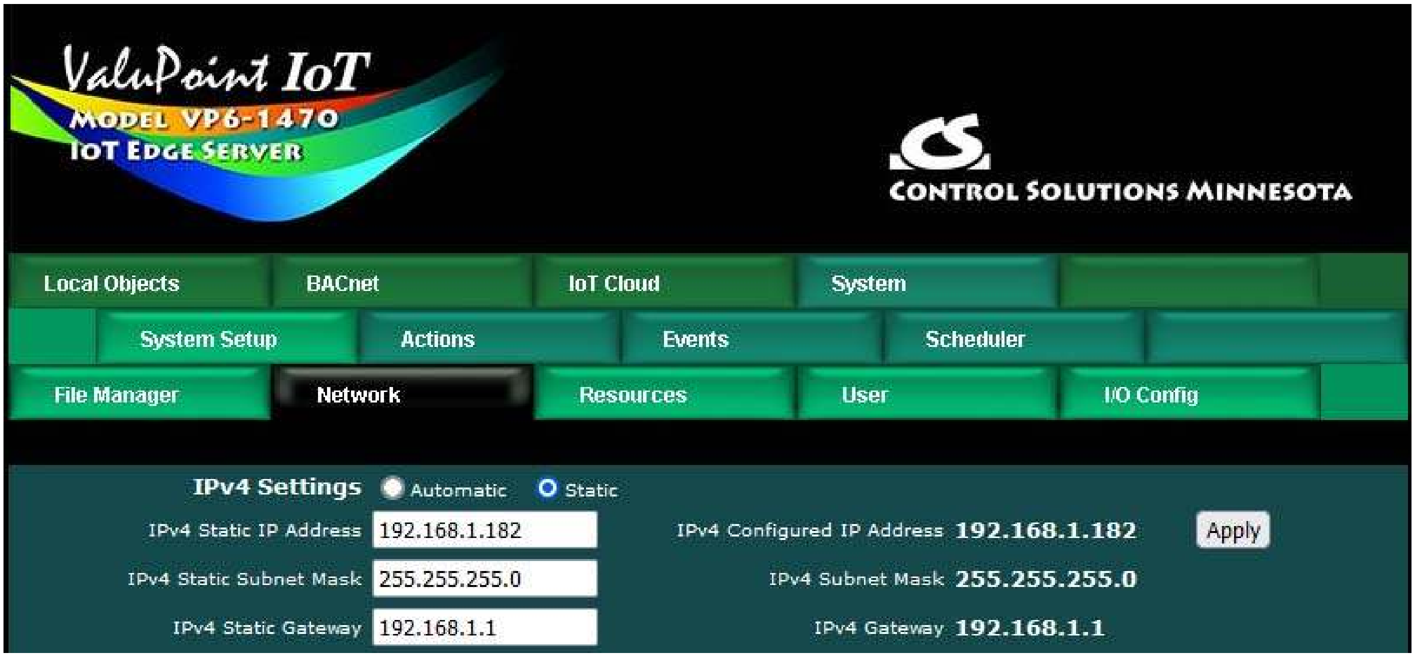
Segmentation can be disabled. This would only be valid when the ValuPoint is used as a gateway and the client does not support segmentation. As a router, this setting has no bearing on whether other devices may try to use segmentation.

If you have MS/TP devices on the local MS/TP link that are slave-only, i.e. do not respond to Who-Is, then you will want to enable Slave Proxy Mode. Use the Manual setting if you will enter those devices explicitly on the Slave Proxy page. Select Auto mode to attempt to auto-discover them.

Click Save to store. This store process will take a little while as these parameters are being saved to non-volatile memory. A change in port number will not take effect until the next system restart.

4.2 Network Settings

The two most important things that must be unique on the BACnet IP network are device instance, and IP address. The IP address is set on the Network page.



IPv4 Settings ○ Automatic ● Static

IPv4 Static IP Address 192.168.1.182 IPv4 Configured IP Address 192.168.1.182

IPv4 Static Subnet Mask 255.255.255.0 IPv4 Subnet Mask 255.255.255.0

IPv4 Static Gateway 192.168.1.1 IPv4 Gateway 192.168.1.1

Select either Static or Automatic for IPv4. To change the Static IP address of this device, enter the address, subnet mask, and gateway, then click Apply.
Select Automatic to specify that DHCP should be used to obtain an IP address upon power-up. IP address change will take effect upon next power cycle.

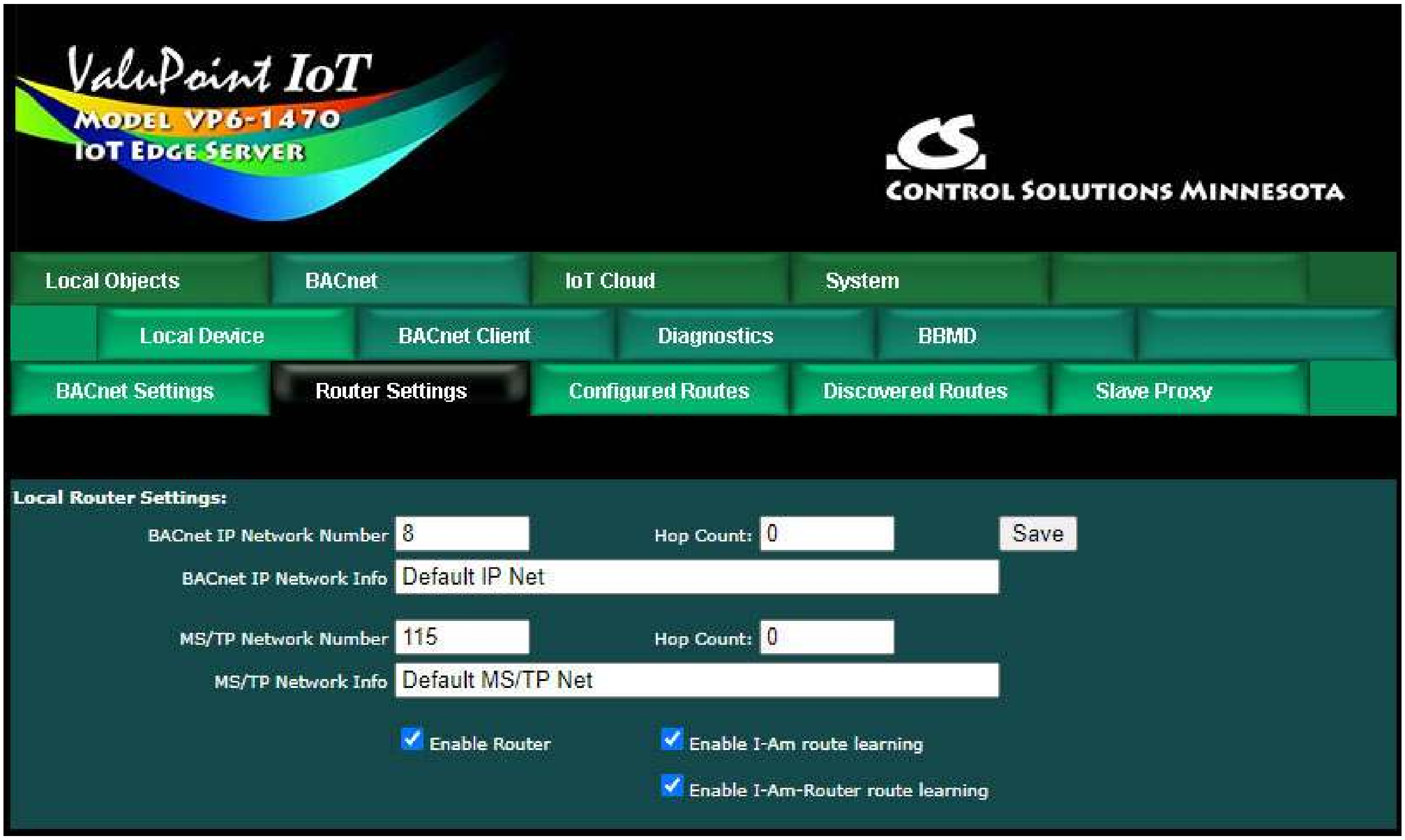
The above screen shot is only a portion of the Network setup page, and is the only part of the Network page that is required for BACnet IP. The remainder of the Network page is discussed in Section 3.3.

The Web User Interface is accessible via IPv6; however, the BACnet IP Client does not yet support IPv6. The only demonstrated version of BACnet IP over IPv6 does not use actual IPv6 addresses - it uses Virtual MAC addresses (VMAC) and address translation tables. The VMAC approach allows IPv6 to coexist with original IPv4 devices. As of development of this device, test specifications for BACnet IP over IPv6 were not available and thus IPv6 support is not included in this device.

5. Configuring the BACnet Router and BBMD

5.1 Router Settings

The local network numbers are set here.



Local Router Settings:

BACnet IP Network Number: 8 Hop Count: 0

BACnet IP Network Info: Default IP Net

MS/TP Network Number: 115 Hop Count: 0

MS/TP Network Info: Default MS/TP Net

☑ Enable Router ☑ Enable I-Am route learning

☑ Enable I-Am-Router route learning

Enter the network numbers for the networks directly connected to this router. These must be unique across the entire internetwork. These numbers will ultimately tell other routers how to find devices on these local networks.

The Info strings are strictly informational and have no bearing on functionality.

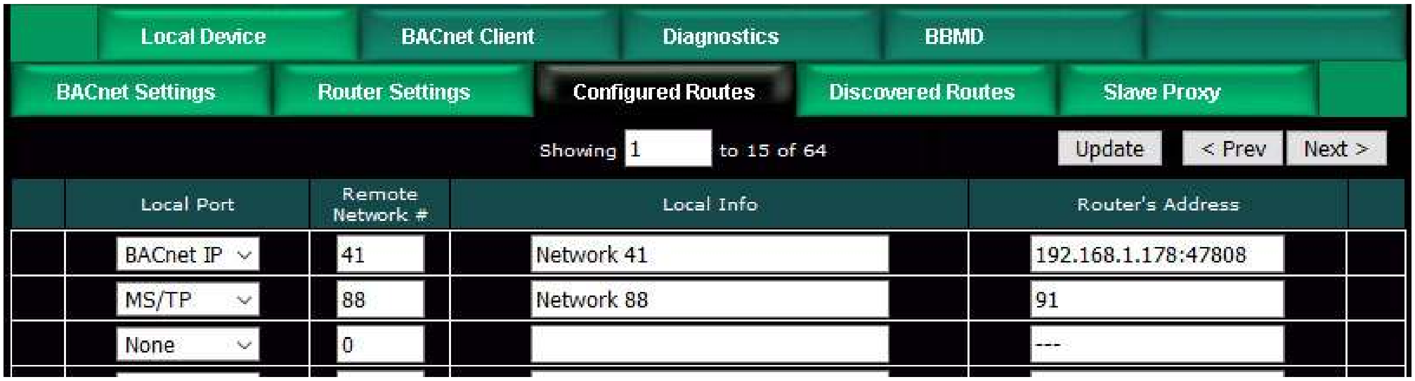
Hop count should be the maximum number of routers on the network. Hop count limits the number of times a packet is forwarded by a router. It should not be forwarded more times than there are routers, but if a router is misconfigured, a message may bounce back and forth until the hop count expires (hop count defaults to 255). By setting the hop count equal to the number of routers downstream, a message being bounced by misconfigured routers will expire sooner than later and not jam the network.

Router functionality can be disabled when the ValuPoint should operate only as a gateway or just an I/O device. Multiple routers across the same networks will cause network failure. Disable router functionality any time routing will not be used.

Networks can be configured or learned. To disable learning in conjunction with configuring network routes, make the applicable selections above.

5.2 Configured Routes

Networks and other routers can be automatically learned or they can be configured. If route learning is disabled, then you must provide routing information to other networks here.



Showing 1 to 15 of 64

	Local Port	Remote Network #	Local Info	Router's Address	
	BACnet IP	41	Network 41	192.168.1.178:47808	
	MS/TP	88	Network 88	91	
	None	0		---	

Enter the known remote network numbers and the ports via which they may be reached.

The Info strings are strictly informational and have no bearing on functionality.

The router's address is optional. If not given here, it will be searched for on the network using Who-Is-Router. You may enter the remote router's address as an MS/TP MAC address, or an IP address optionally with port number. If no port number is given, the ValuPoint's own local port number will be used. IP should be given in the form of 192.168.1.199:47808 (for example) or just 192.168.1.199.

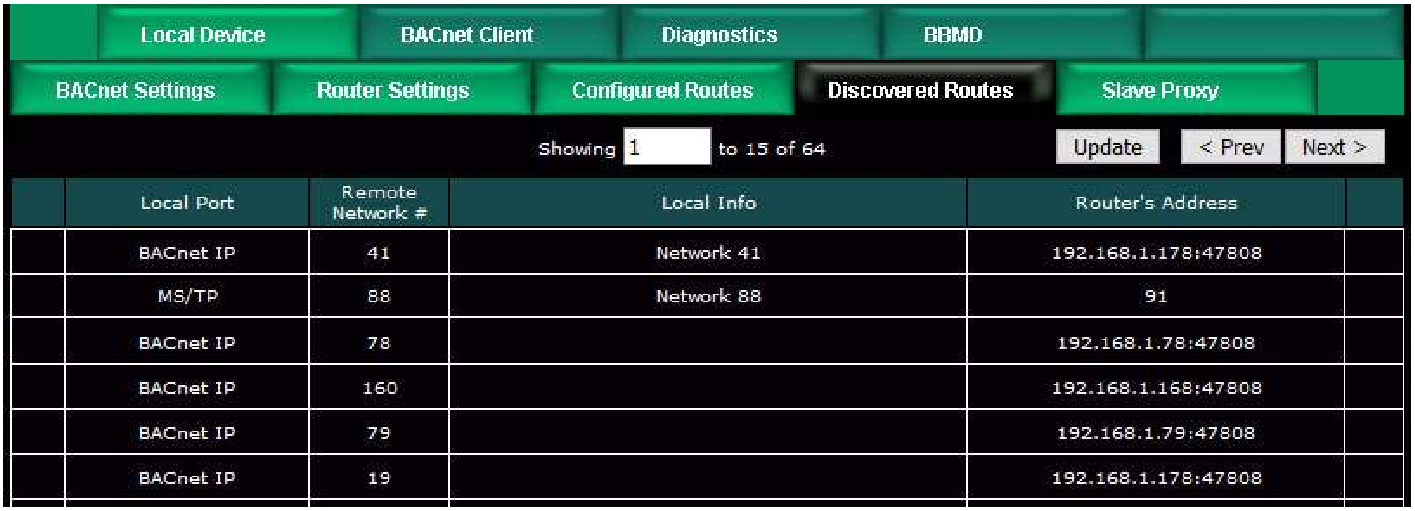
It should be noted that even if you do enter the router's address here, it will be replaced in the event an I-Am-Router message is received for the given network number but having a different router address.

It should also be noted that if some external BACnet network management tool sends a router table initialize message to this device, the entire page shown here will be replaced. After a delay of a few minutes, the new contents of this page will be auto-saved to the XML configuration file for subsequent reload. Thus, the router portion of this ValuPoint may be remotely managed.

If you leave this page completely empty, all routers needed for routing of traffic will be located using the Who-Is-Router broadcast to the network. Routers that are found this way, in addition to any listed here, will be listed on the Discovered page.

5.3 Discovered Routes

The summary of both learned and discovered routes is listed on this page.



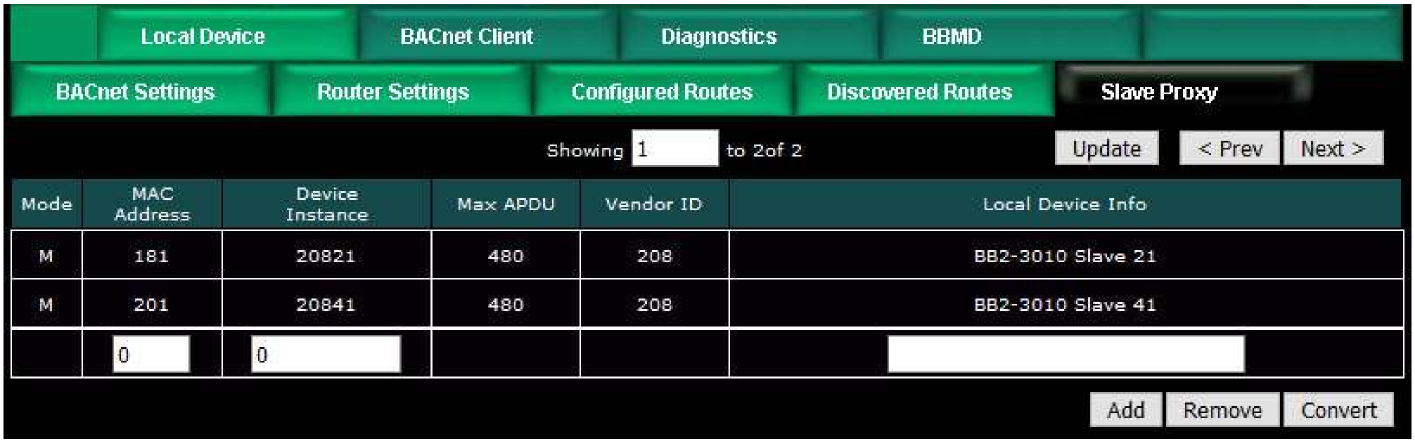
Local Port	Remote Network #	Local Info	Router's Address
BACnet IP	41	Network 41	192.168.1.178:47808
MS/TP	88	Network 88	91
BACnet IP	78		192.168.1.78:47808
BACnet IP	160		192.168.1.168:47808
BACnet IP	79		192.168.1.79:47808
BACnet IP	19		192.168.1.178:47808

Use the Prev/Next buttons to scroll through the list of known networks. This list is a combination of configured networks and those discovered via the Who-Is-Router and I-Am-Router message exchange.

The Local Info column will be populated using the information provided on the Configured Routes page. If the route is automatically learned, local information is not provided in the response to Who-Is-Router, and therefore this column remains blank. The local information does not affect operation in any way.

5.4 Slave Proxy

This page allows you to configure slave proxy support to enable auto-discovery of MS/TP slave devices which do not respond to Who-Is requests. This router will respond with an I-Am message on behalf of the device(s) listed here when a Who-Is is received.



Mode	MAC Address	Device Instance	Max APDU	Vendor ID	Local Device Info
M	181	20821	480	208	BB2-3010 Slave 21
M	201	20841	480	208	BB2-3010 Slave 41
	0	0			

Enable Slave Proxy Mode on the BACnet Settings page. If Manual mode is selected, then enter the slave device information for a given slave, and click Add. Repeat the Add for each slave to be manually configured. If Auto mode is selected, then you can disregard the Add. If you with to remove a previously configured (or auto configured) slave, enter just the MAC address and then click Remove.

If you have initially selected Auto mode and wish to capture the discovered slaves and convert them to Manual mode entries, click the Convert button. After clicking Convert and saving the configuration file on the File Manager page, you may then switch to Manual mode to reduce overhead on the MS/TP link. Scanning through the entire list of possible slave addresses (polling each to see if present) can take as long as a couple of minutes.

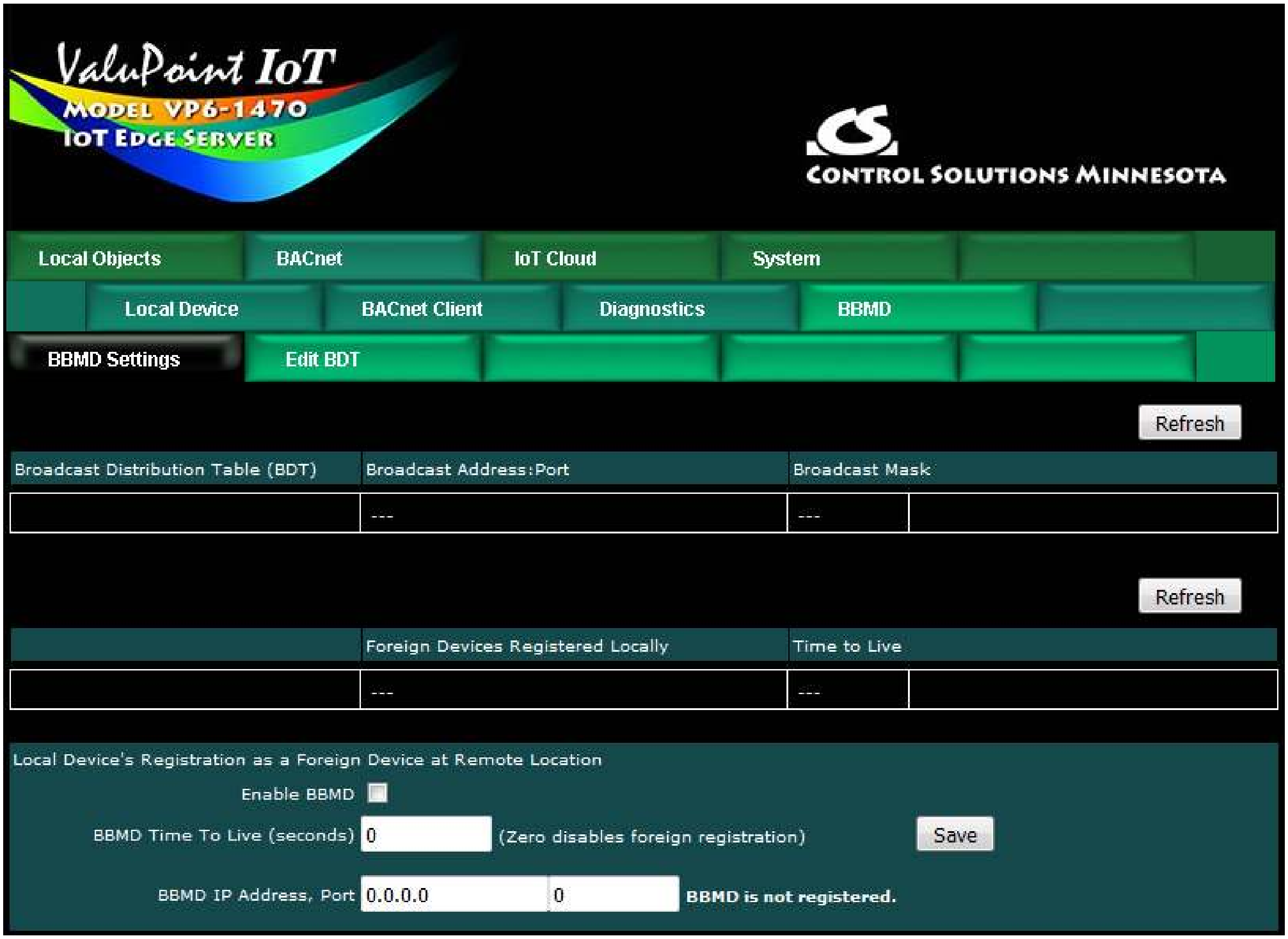
The local device info is not used on the network. It is simply present to aid in documenting the proxies.

Use the Update, Prev, and Next buttons to view the list of currently configured slaves for which proxy support is configured.

The Mode in the first column will indicate the following:
M = Added using Add button above, or by writing to Device Object Manual_Slave_Address_Binding property
U = Added as for 'M' but not responding
X = Added as for 'M' but found to execute Who-Is (is not a slave)
A = Discovered by Automatic slave proxy mode
S = Added by writing to Device Object Slave_Address_Binding property (temporary binding)

5.5 Registering as a Foreign BBMD Device

BBMD stands for BACnet Broadcast Management Device. Messages such as "Who-Is" and "I-Am" are broadcast. Most NAT routers, however, to not pass broadcast messages along. The BBMD solves this problem by explicitly directing broadcast messages to a specific IP address.



Broadcast Distribution Table (BDT)	Broadcast Address:Port	Broadcast Mask	
	---	---	

	Foreign Devices Registered Locally	Time to Live	
	---	---	

Local Device's Registration as a Foreign Device at Remote Location

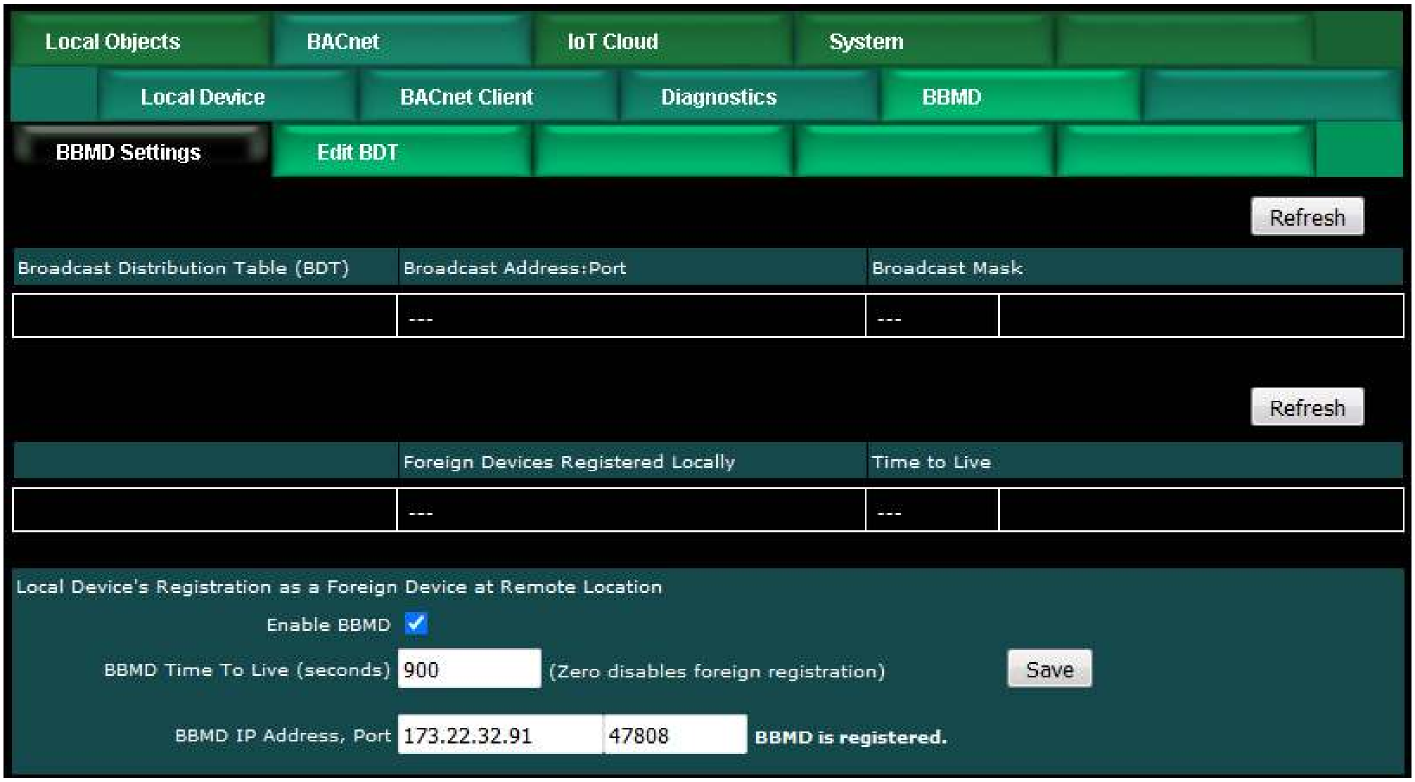
Enable BBMD ☐

BBMD Time To Live (seconds) 0 (Zero disables foreign registration)

BBMD IP Address, Port 0.0.0.0 0 **BBMD is not registered.**

The BBMD Settings page appears as shown above when no part of BBMD support is enabled, as is the case when shipped. Do not enable BBMD if you are not aware of needing it and/or do not understand how BBMD works. The three elements of BBMD support are discussed in the following sections, and their use is often mutually exclusive, meaning you will often need only one of the three elements.

If you have a remote ValuPoint that needs to connect via router, including NAT router, to a local network, use Foreign Device Registration. There will typically be a master device, such as operator station or other front end, that includes BBMD. The IP address of this device is the one that should be given as the BBMD address for foreign device registration.



Broadcast Distribution Table (BDT)	Broadcast Address:Port	Broadcast Mask	
	---	---	

	Foreign Devices Registered Locally	Time to Live	
	---	---	

Local Device's Registration as a Foreign Device at Remote Location

Enable BBMD ☑

BBMD Time To Live (seconds) 900 (Zero disables foreign registration)

BBMD IP Address, Port 173.22.32.91 47808 **BBMD is registered.**

To enable BBMD processing, check the "Enable BBMD" box. This applies to foreign device registration. The broadcast distribution table functions regardless of whether foreign device registration is enabled.

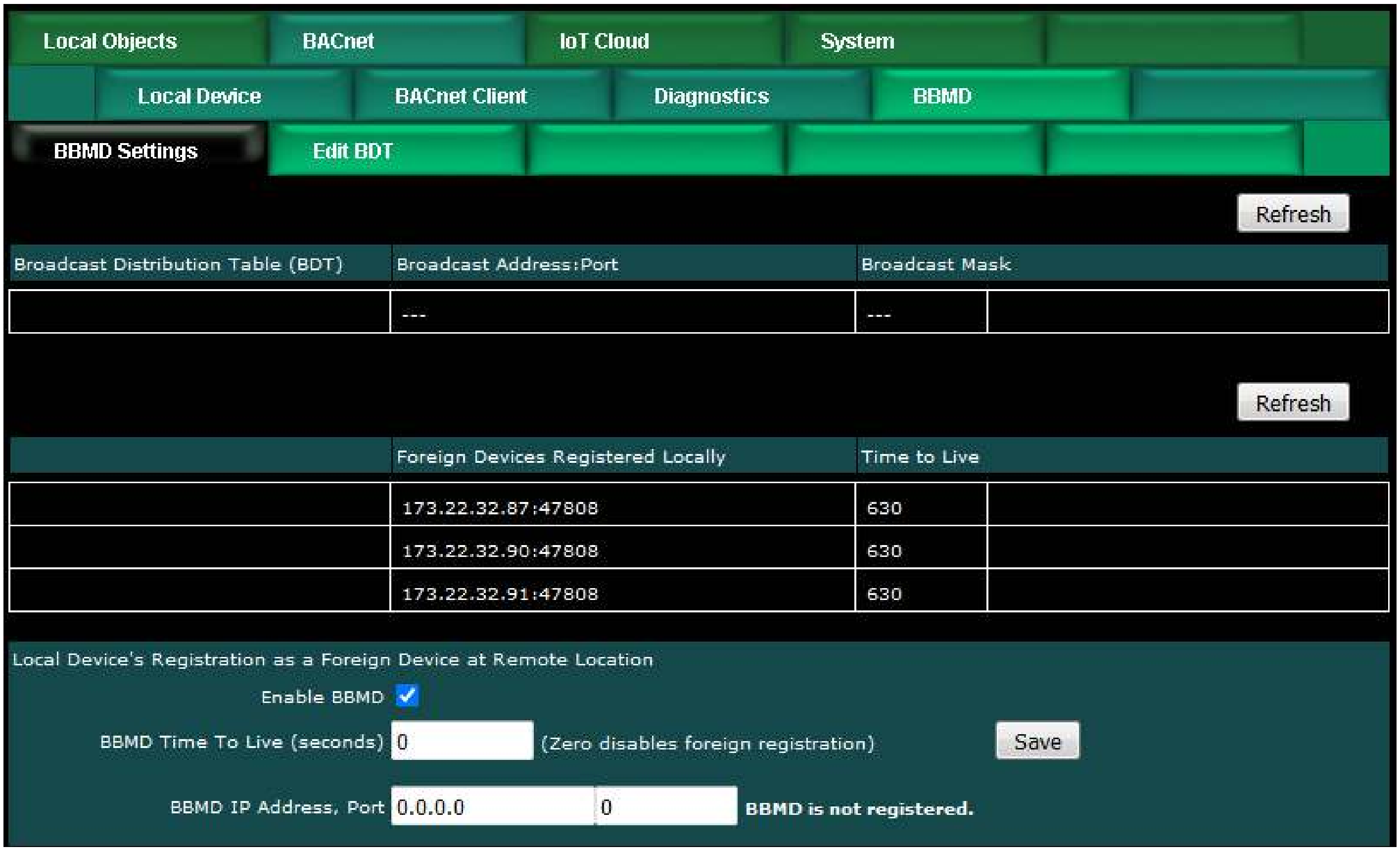
If the ValuPoint should register as a foreign device with another BBMD, then the port, time-to-live, and IP address of the remote BBMD must be given. The local BBMD will attempt to register with the remote BBMD whose address is given.

Disable this device's attempts to register elsewhere, but allow other devices to register here, by setting time to live to zero with BBMD enabled.

5.6 Allowing Other BBMD Devices to Register Locally

The ValuPoint can be the BBMD that other devices register with. The screen shot below shows that three other devices have registered with this BBMD, and broadcast messages will now be sent explicitly to these locations. In this case, there are NAT routers between this local device and the three remote devices. While they are all on physically separate local networks, they will appear as a single BACnet network even if the local networks are miles apart. The local BACnet client will be able to communicate with these remote BACnet devices as a result of the foreign registration.

Note that foreign registration only provides communication with a single remote device. If communicating with an entire remote network of BACnet devices is the intent, then full BACnet routing is required and the foreign device should be another BACnet router.



Broadcast Distribution Table (BDT)	Broadcast Address:Port	Broadcast Mask	
	---	---	

	Foreign Devices Registered Locally	Time to Live	
	173.22.32.87:47808	630	
	173.22.32.90:47808	630	
	173.22.32.91:47808	630	

Local Device's Registration as a Foreign Device at Remote Location

Enable BBMD ☑

BBMD Time To Live (seconds) 0 (Zero disables foreign registration)

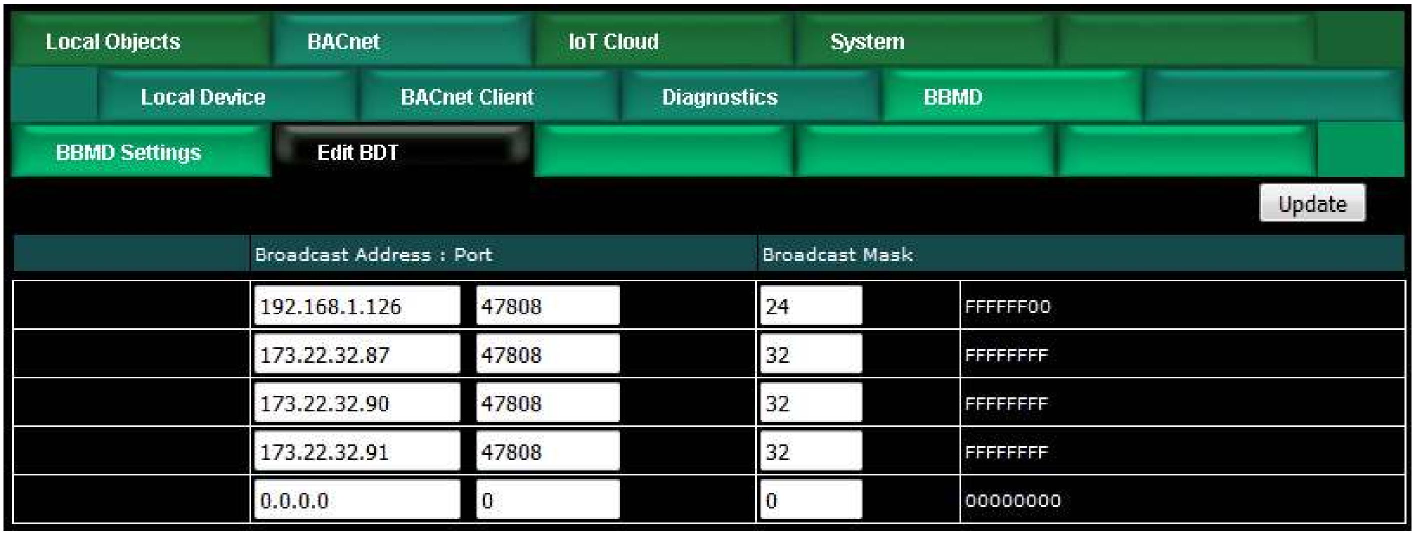
BBMD IP Address, Port 0.0.0.0 0 **BBMD is not registered.**

To allow foreign devices to register with this device, but not have this device register elsewhere, check Enable BBMD, but enter zero for BBMD Time To Live. This enables BBMD but disables this device's attempt to register somewhere else.

5.7 Broadcast Distribution Table

A Broadcast Distribution Table (BDT) defines a list of IP addresses that the BBMD should send broadcast messages to. It is important to note that a BBMD only forwards broadcast messages. The router is responible for forwarding all other messages.

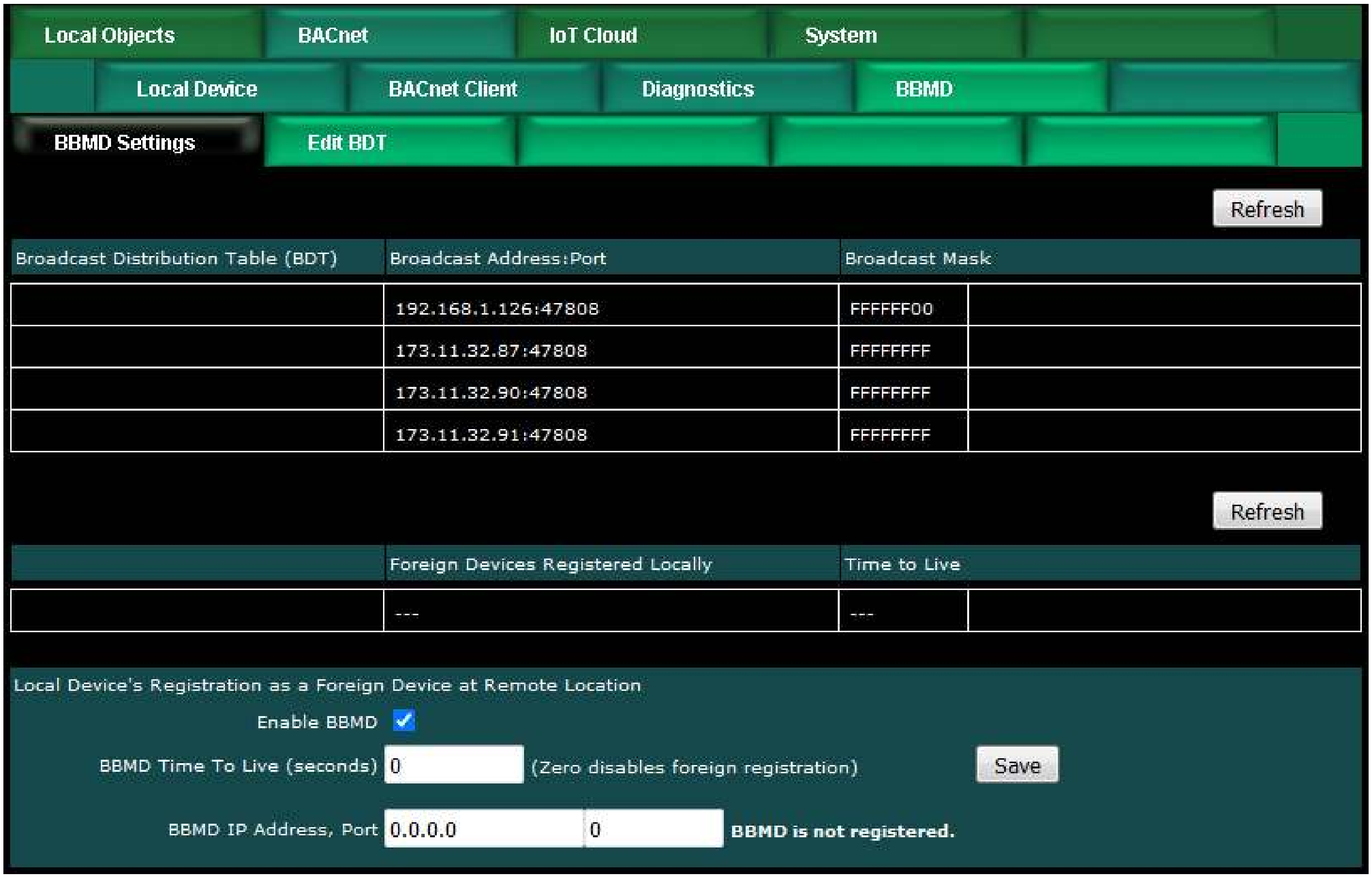
Broadcast distribution will result in device discovery, but you will not be able to read/ write properties in the remote device without full routing. Foreign device registration via a router does result in being able to fully communicate with the foreign device from the local network.



	Broadcast Address : Port		Broadcast Mask	
	192.168.1.126	47808	24	FFFFFF00
	173.22.32.87	47808	32	FFFFFFFF
	173.22.32.90	47808	32	FFFFFFFF
	173.22.32.91	47808	32	FFFFFFFF
	0.0.0.0	0	0	00000000

Th Edit BDT page allows viewing of the broadcast distribution table that has been provided to the local device by an external network management tool capable of sending the BDT initialize. The BDT may also be edited on this page. Regardless of how the table is filled, it will be saved in the configuration file when saved, and reloaded upon restart.

Once the table has been initialized, it will appear on the BBMD Settings page as illustrated below.



Broadcast Distribution Table (BDT)	Broadcast Address:Port	Broadcast Mask	
	192.168.1.126:47808	FFFFFF00	
	173.11.32.87:47808	FFFFFFFF	
	173.11.32.90:47808	FFFFFFFF	
	173.11.32.91:47808	FFFFFFFF	

	Foreign Devices Registered Locally	Time to Live	
	---	---	

Local Device's Registration as a Foreign Device at Remote Location

Enable BBMD ☑

BBMD Time To Live (seconds) 0 (Zero disables foreign registration)

BBMD IP Address, Port 0.0.0.0 0 **BBMD is not registered.**

6. Configuring Local Objects

ValuPoints do not come with a predefined set of BACnet objects other than those reserved for mapping to physical I/O. The ValuPoint will initially have a handful of objects, but it is up to the user to allocate the number needed, up to the maximum permitted by available resources.

6.1 Behavior of Input vs Output Objects

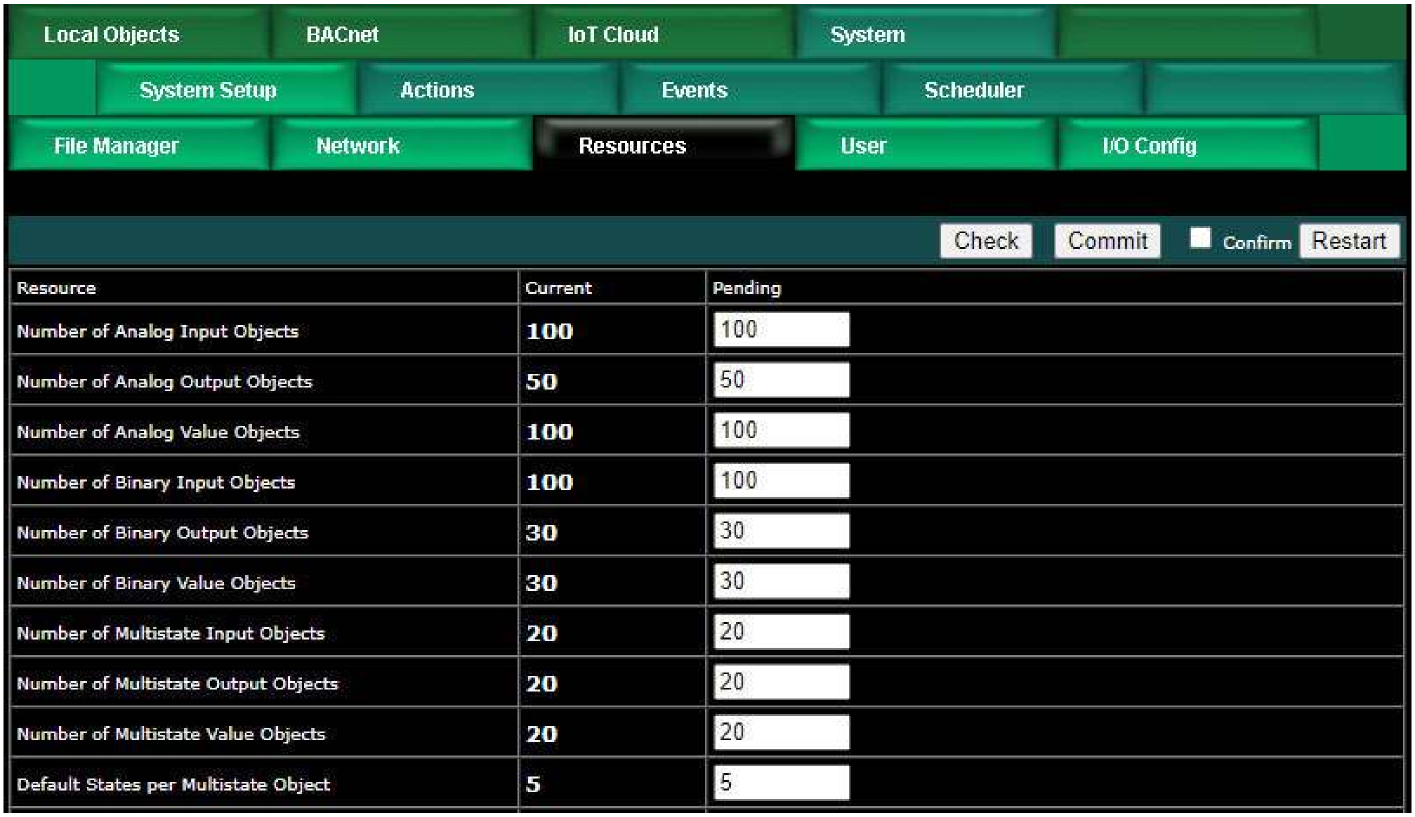
The easiest way to keep track of input versus output is to think about a BACnet device's role in the system. The system will receive input from the BACnet device, and provide output to the BACnet device. Inside the BACnet device, hardware will physically associate BACnet Input Objects with sensor inputs such as temperature or pressure sensors, etc. The system then receives the sensor input information via BACnet Input Objects. When the system wants to control an actuator, it will send setpoints to the actuator via BACnet Output Objects. Hardware inside the BACnet device will physically associate the Output Object with a physical actuator such as valve position servo or motor speed controller.

Keeping track of input versus output when the ValuPoint is functioning as a gateway can be a bit trickier; however, the choice of input versus output does not change from the BACnet perspective. Only the nature of the physical sensor and actuator hardware changes. In the case of the ValuPoint as a gateway, sensors and actuators both consist of other BACnet devices. Therefore, use a BACnet Output Object to send data to another device acting as an actuator, and use a BACnet Input Object to receive data from another device acting as a sensor.

We have not mentioned BACnet Value Objects yet just to avoid confusing the discussion. A Value Object can be input or output, or both at the same time. If you are familiar with Modbus, the BACnet Value Object is most synonymous with the holding register that you can both read and write. When using a Value Object, it is best to think about its role as input or output when deciding how to apply maps or rules in the gateway.

6.2 Allocating Local Objects

The resource allocation page is where you set the number of each type of available BACnet object that you will use. It is a good idea to determine ahead of time how many objects you will need, then allocate that number, possibly including a spare object or two. It is not a good idea to allocate a large number of objects that will remain unused since this simply clutters the screen when a front end system auto-discovers all objects in the device.



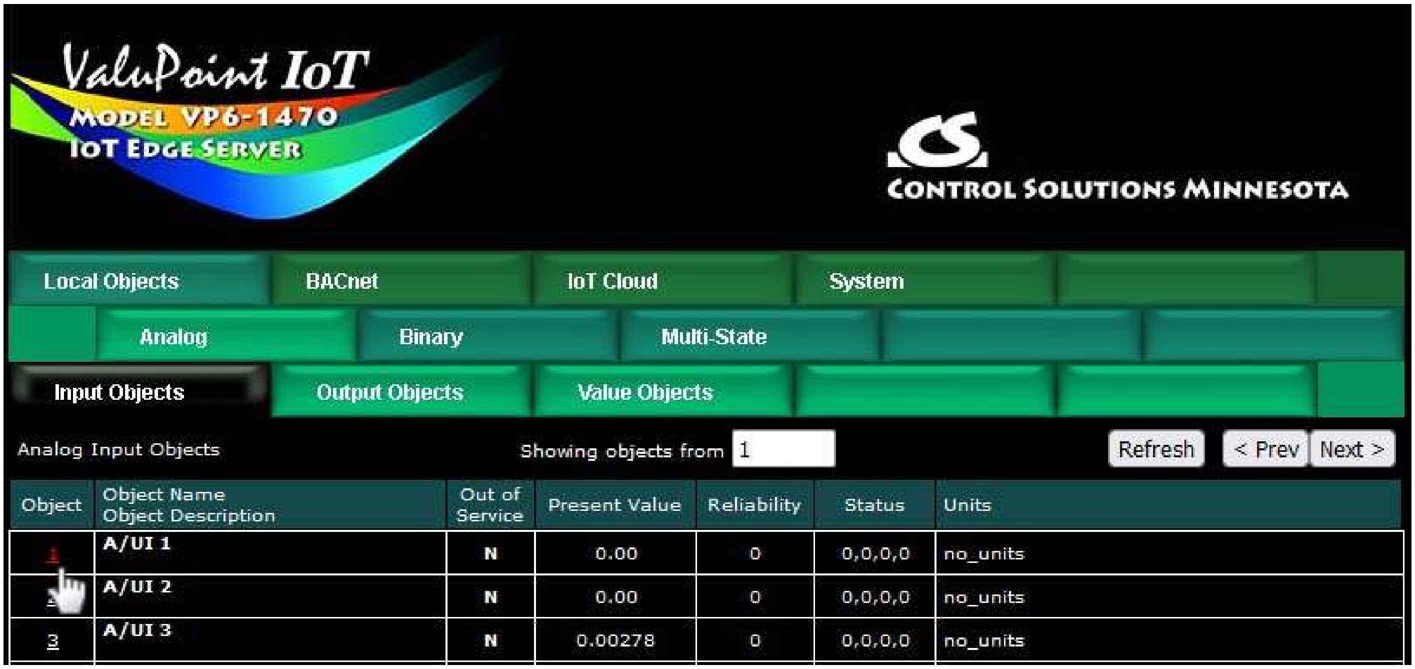
Resource	Current	Pending
Number of Analog Input Objects	100	100
Number of Analog Output Objects	50	50
Number of Analog Value Objects	100	100
Number of Binary Input Objects	100	100
Number of Binary Output Objects	30	30
Number of Binary Value Objects	30	30
Number of Multistate Input Objects	20	20
Number of Multistate Output Objects	20	20
Number of Multistate Value Objects	20	20
Default States per Multistate Object	5	5

The portion of the Resources page dedicated to BACnet object counts is shown above. For a complete discussion of the Resources page, including how to change the counts, refer to Section 3.4 in this User Guide.

6.3 Configuring Local Objects

There is a different web page for each BACnet object type in the device. Objects are listed in tabular form with name and description, present value, reliability code and status. Additional information as applicable to the object type may also be listed.

Click on the object number in the first column to open the expanded view of that object and gain access to its configuration.



Analog Input Objects

Showing objects from 1

Object	Object Name Object Description	Out of Service	Present Value	Reliability	Status	Units
1	A/UI 1	N	0.00	0	0,0,0,0	no_units
2	A/UI 2	N	0.00	0	0,0,0,0	no_units
3	A/UI 3	N	0.00278	0	0,0,0,0	no_units

Reliability codes indicate error conditions if non-zero, and may be any of the following:

BACnet client, device timeout (82)
BACnet client, error returned by server (83)

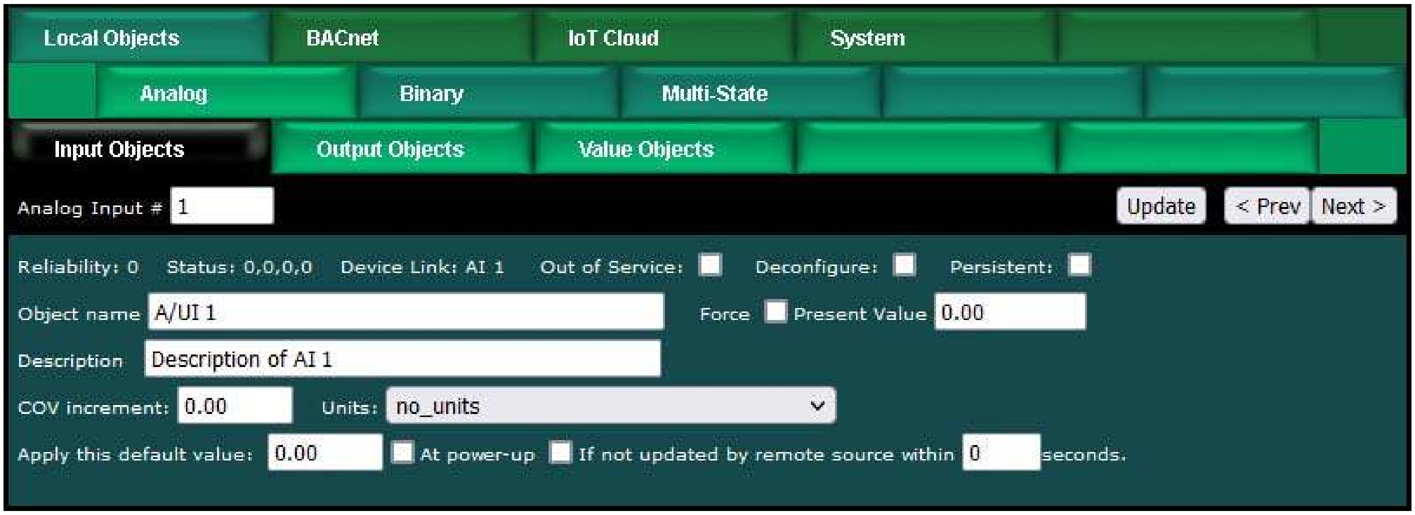
Status flags A,B,C,D indicate the following, 0 meaning not true, 1 meaning true:

A = in alarm
B = fault
C = overridden
D = out of service

6.3.1 Analog Input Objects

Analog Input 1 through Analog Input 12 are reserved for physical inputs A/UI 1 through A/UI 12 as analog input values.

Except for physical inputs, the source of data for an Analog Input object will typically be reading from some other BACnet device.



Analog Input # 1

Reliability: 0 Status: 0,0,0,0 Device Link: AI 1 Out of Service: □ Deconfigure: □ Persistent: □

Object name A/UI 1 Force □ Present Value 0.00

Description Description of AI 1

COV increment: 0.00 Units: no_units

Apply this default value: 0.00 □ At power-up □ If not updated by remote source within 0 seconds.

The object name, units, value, and status are shown for the object number entered at the top of the page. Click Prev/Next to scroll through the list. Click Refresh to update the page, or Update to accept changes.

The object name and description may be changed here. BACnet units may be selected. Initial COV increment may be entered. When any of these are changed, be sure to save the updated configuration by executing "Save XML Config File" on the File Manager page.

The object may be set Out of Service by checking that box and clicking Update. The present value may be changed by entering a value, checking Force, and clicking Update.

The source of data for an Analog Input object will typically be reading from some other BACnet device via the map indicated by the Device Link. The mapped device will be polled at the rate specified by the Read Map.

Out of Service means polling of the mapped remote device will stop. While out of service, the present value may be written by the BACnet client. Data may be forced via this web page at any time, but will be overwritten by the next mapped client update unless the object is out of service.

Reliability codes indicate errors as itemized on the tabular object list.

Status flags A,B,C,D indicate the following, 0 meaning not true, 1 meaning true:
A = in alarm
B = fault
C = overridden
D = out of service

Device link will indicate BAC followed by R for read or W for write, and a number which is the map number in the table of read or write maps for mapping to this BACnet object. The designation R means read from a remote device, and W means write to a remote device.

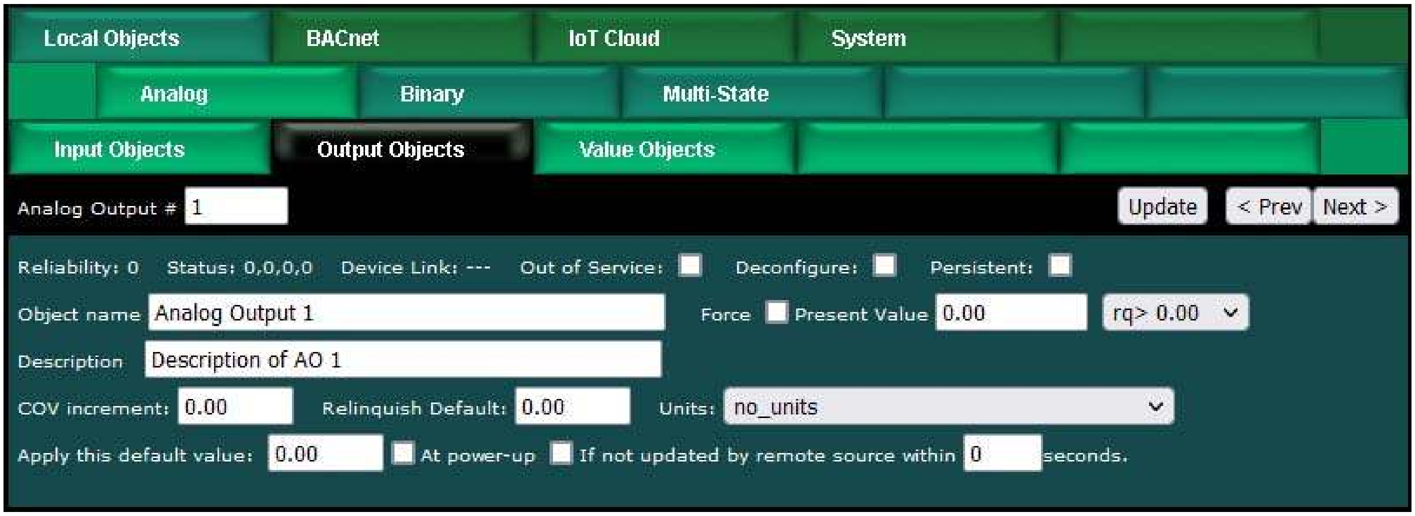
Check 'Deconfigure' and click Update to erase configuration for this object.

The "Is Persistent" option means this object will retain its most recent value through a power outage, with time delay restrictions as noted in the user guide. The persistent selection does not take effect until the Reset Persistent button is clicked on the Resources page. For inputs, this selection is only relevant for "Pulse counter" mode, in which case it turns the input into a totalizing counter. For any other type of input, the value will be immediately overwritten by new data and thus Is Persistent will have no meaning.

A default value can be applied to this object immediately at power-up and/or if not updated by a remote source within the specified amount of time. The remote source will typically be a remote BACnet client.

6.3.2 Analog Output Objects

The destination of data for an Analog Output object will typically be some other BACnet device.



Analog Output # 1

Reliability: 0 Status: 0,0,0,0 Device Link: --- Out of Service: □ Deconfigure: □ Persistent: □

Object name Analog Output 1 Force □ Present Value 0.00 rq> 0.00

Description Description of AO 1

COV increment: 0.00 Relinquish Default: 0.00 Units: no_units

Apply this default value: 0.00 □ At power-up □ If not updated by remote source within 0 seconds.

The object name, units, value, and status are shown for the object number entered at the top of the page. Click Prev/Next to scroll through the list. Click Refresh to update the page, or Update to accept changes.

The object name and description may be changed here. BACnet units may be selected. Initial COV increment may be entered. When any of these are changed, be sure to save the updated configuration by executing "Save XML Config File" on the File Manager page.

The destination of data for an Analog Output object will be writing the remote BACnet device via the map indicated by the Device Link. The remote device will be updated upon change of source data and/or periodically as defined by the Write Map.

The Analog Output object is commandable, meaning the BACnet client must write both a value and a priority level for that value. The highest level value will be the one written to the remote device (if one is mapped). If all values are relinquished, the relinquish default value will be written to the remote device.

To set an output object manually from this page, check the Force box, enter a value in the Present Value window, and select a priority level to assign to your forced value. Then click Update. To return a given priority level to NULL, simply type the word NULL in the Present Value window, check Force, and click Update.

Out of service means the mapped remote device will not be written to. Values written by the BACnet client will be retained, but only applied when this object is placed back in service. At that time, the highest priority value will be written to the remote device.

Reliability codes indicate errors as itemized on the tabular object list.

Status flags A,B,C,D indicate the following, 0 meaning not true, 1 meaning true:
A = in alarm
B = fault
C = overridden
D = out of service

Device link will indicate BAC followed by R for read or W for write, and a number which is the map number in the table of read or write maps for mapping to this BACnet object. The designation R means read from a remote device, and W means write to a remote device.

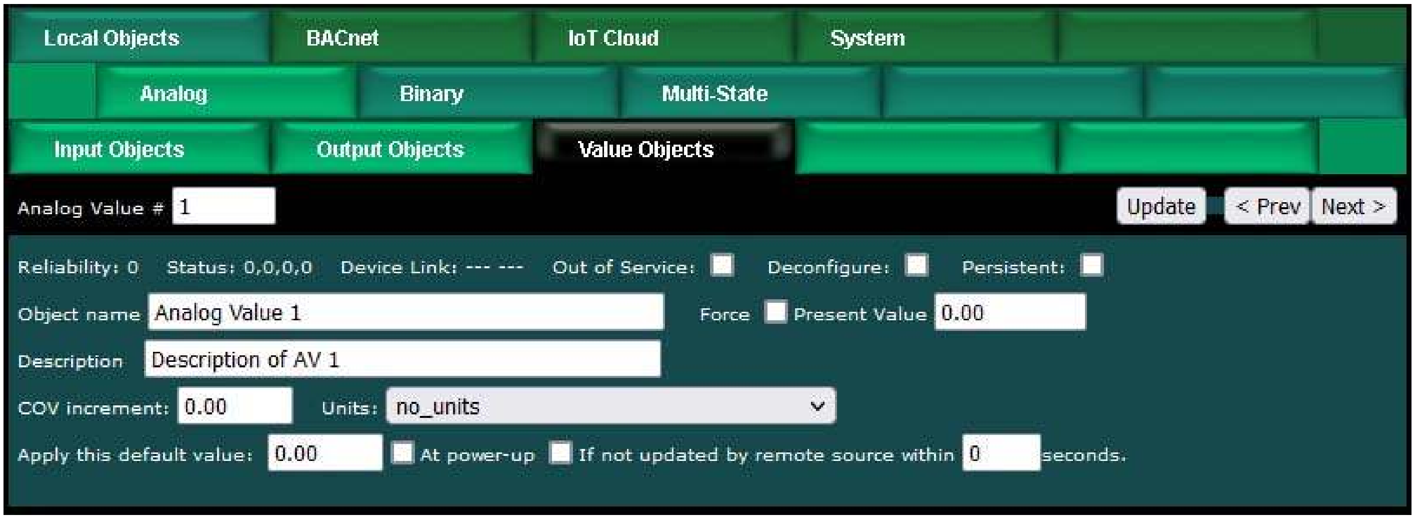
Check 'Deconfigure' and click Update to erase configuration for this object.

The "Persistent" option means this object will retain its most recent value through a power outage, with time delay restrictions as noted in the user guide. The persistent selection does not take effect until the Reset Persistent button is clicked on the Resources page.

A default value can be applied to this object immediately at power-up and/or if not updated by a remote source within the specified amount of time. The remote source will typically be a remote BACnet client. The default value is applied at the Local Command Priority set on the BACnet Settings page.

6.3.3 Analog Value Objects

Analog Value objects may be both a source and destination for some other BACnet device.



Analog Value # 1

Reliability: 0 Status: 0,0,0,0 Device Link: --- --- Out of Service: □ Deconfigure: □ Persistent: □

Object name Analog Value 1 Force □ Present Value 0.00

Description Description of AV 1

COV increment: 0.00 Units: no_units

Apply this default value: 0.00 □ At power-up □ If not updated by remote source within 0 seconds.

The object name, units, value, and status are shown for the object number entered at the top of the page. Click Prev/Next to scroll through the list. Click Refresh to update the page, or Update to accept changes.

The object name and description may be changed here. BACnet units may be selected. Initial COV increment may be entered. When any of these are changed, be sure to save the updated configuration by executing "Save XML Config File" on the File Manager page.

The object may be set Out of Service by checking that box and clicking Update. The present value may be changed by entering a value, checking Force, and clicking Update.

Analog Value objects may be both a source and destination for some other BACnet device. The source of data for the Value object will be reading from a remote device when associated with a Read Map. The destination of data for the Value object will be writing to a remote device when associated with a Write Map. If a remote device is mapped, the device links are displayed above. You may click on either link to view the respective mapping.

The Value object may be simultaneously associated with both Read and Write maps pointing to the same remote device object. When this Value object receives new data (from any source), this data will be written to the mapped remote device before any subsequent read from the same device. Thus the Value data is not discarded by the read operation before the new data can be written.

Out of Service means polling of the remote device will stop. While out of service, the present value may be written by an external BACnet client but it will not be written to any mapped remote device. Data may be forced via this web page at any time, but will be overwritten by the next read from a remote device unless the object is out of service.

Reliability codes indicate errors as itemized on the tabular object list.

Status flags A,B,C,D indicate the following, 0 meaning not true, 1 meaning true:
A = in alarm

B = fault
C = overridden
D = out of service

Device link will indicate BAC followed by R for read or W for write, and a number which is the map number in the table of read or write maps for mapping to this BACnet object. The designation R means read from a remote device, and W means write to a remote device.

Check 'Deconfigure' and click Update to erase configuration for this object.

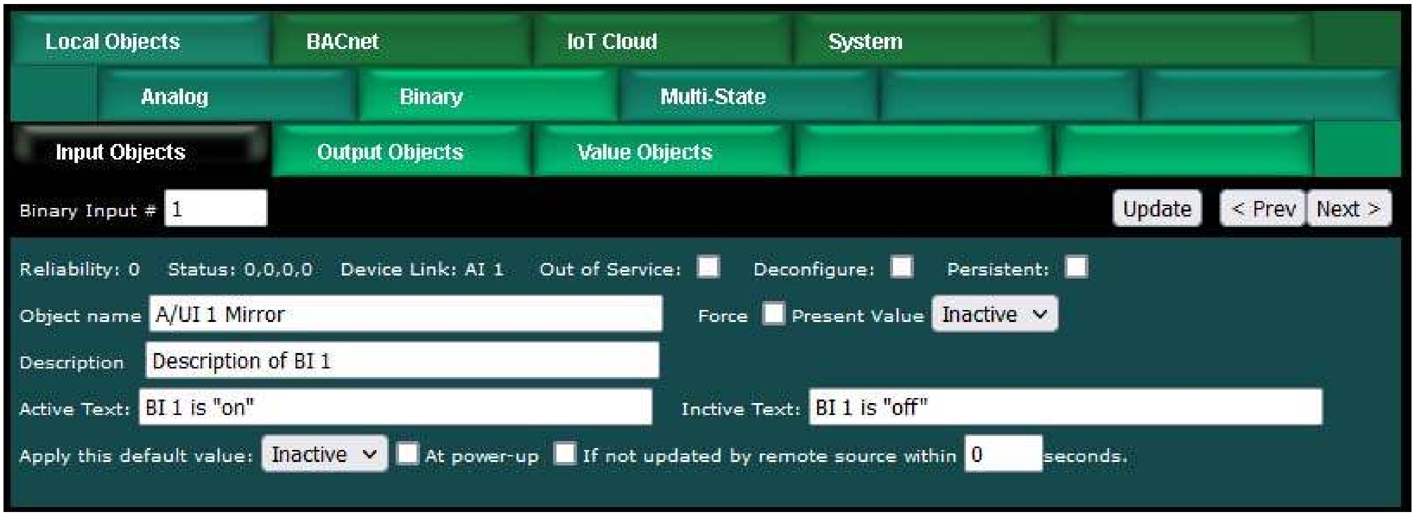
The "Persistent" option means this object will retain its most recent value through a power outage, with time delay restrictions as noted in the user guide. The persistent selection does not take effect until the Reset Persistent button is clicked on the Resources page.

A default value can be applied to this object immediately at power-up and/or if not updated by a remote source within the specified amount of time. The remote source will typically be a remote BACnet client.

6.3.4 Binary Input Objects

Binary Input 1 through Binary Input 12 are reserved for physical inputs A/UI 1 through A/UI 12 as discrete input values.

Except for the physical inputs, the source of data for a Binary Input object will typically be reading from some other BACnet device.



Binary Input # 1

Reliability: 0 Status: 0,0,0,0 Device Link: AI 1 Out of Service: □ Deconfigure: □ Persistent: □

Object name A/UI 1 Mirror Force □ Present Value Inactive

Description Description of BI 1

Active Text: BI 1 is "on" Inctive Text: BI 1 is "off"

Apply this default value: Inactive □ At power-up □ If not updated by remote source within 0 seconds.

The object name, units, value, and status are shown for the object number entered at the top of the page. Click Prev/Next to scroll through the list. Click Refresh to update the page, or Update to accept changes.

The object name and description may be changed here. State text may be entered. When any of these are changed, be sure to save the updated configuration by executing "Save XML Config File" on the File Manager page.

The object may be set Out of Service by checking that box and clicking Update. The present value may be changed by entering a value, checking Force, and clicking Update.

The source of data for an Binary Input object will typically be reading from some other BACnet device via the map indicated by the Device Link. The mapped device will be polled at the rate specified by the Read Map.

Out of Service means polling of the mapped remote device will stop. While out of service, the present value may be written by the BACnet client. Data may be forced via this web page at any time, but will be overwritten by the next mapped client update unless the object is out of service.

Reliability codes indicate errors as itemized on the tabular object list.

Status flags A,B,C,D indicate the following, 0 meaning not true, 1 meaning true:
A = in alarm
B = fault
C = overridden
D = out of service

Device link will indicate BAC followed by R for read or W for write, and a number which is the map number in the table of read or write maps for mapping to this BACnet object. The designation R means read from a remote device, and W means write to a remote device.

Check 'Deconfigure' and click Update to erase configuration for this object.

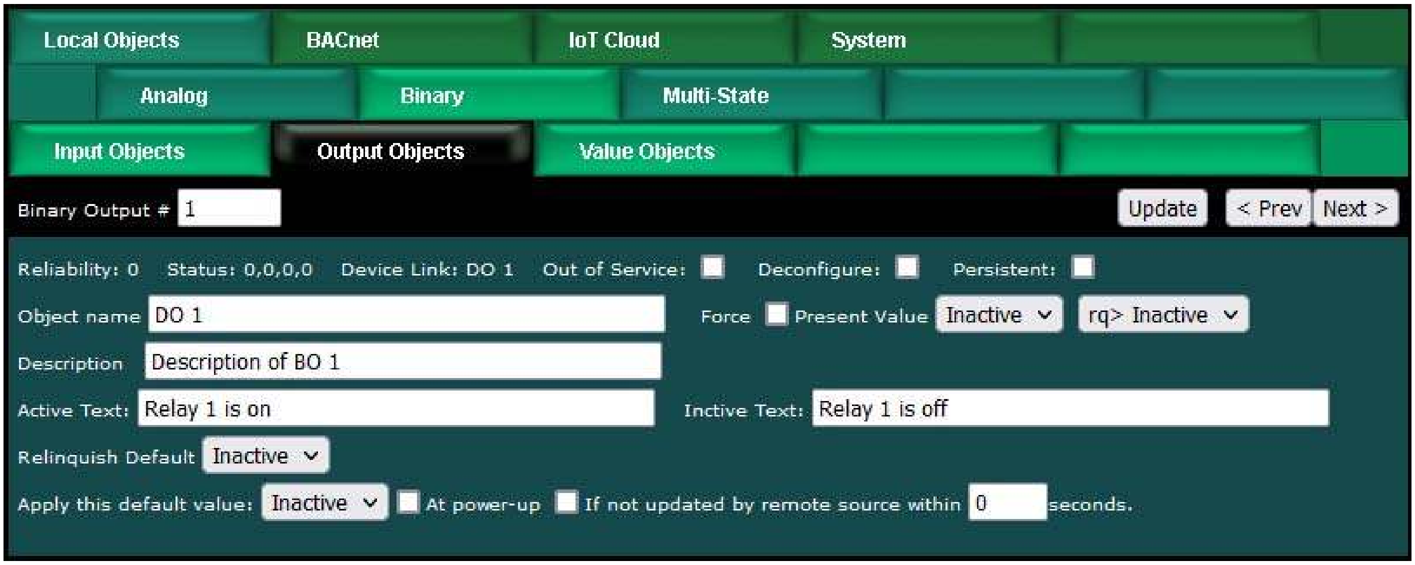
The "Persistent" option means this object will retain its most recent value through a power outage, with time delay restrictions as noted in the user guide. The persistent selection does not take effect until the Reset Persistent button is clicked on the Resources page.

A default value can be applied to this object immediately at power-up and/or if not updated by a remote source within the specified amount of time. The remote source will typically be a remote BACnet client.

6.3.5 Binary Output Objects

Binary Outputs 1 and 2 are reserved for relay outputs DO 1 and 2 unless they have been remapped to Binary Value objects instead.

The destination of data for a Binary Output object will typically be some other BACnet device, or local I/O.



Binary Output # 1

Reliability: 0 Status: 0,0,0,0 Device Link: DO 1 Out of Service: □ Deconfigure: □ Persistent: □

Object name DO 1 Force □ Present Value Inactive rq> Inactive

Description Description of BO 1

Active Text: Relay 1 is on Inctive Text: Relay 1 is off

Relinquish Default Inactive

Apply this default value: Inactive □ At power-up □ If not updated by remote source within 0 seconds.

The object name, units, value, and status are shown for the object number entered at the top of the page. Click Prev/Next to scroll through the list. Click Refresh to update the page, or Update to accept changes.

The object name and description may be changed here. State text may be entered. When any of these are changed, be sure to save the updated configuration by executing "Save XML Config File" on the File Manager page..

The destination of data for a Binary Output object will be writing the remote BACnet device via the map indicated by the Device Link. The remote device will be updated upon change of source data and/or periodically as defined by the Write Map.

The Binary Output object is commandable, meaning the BACnet client must write both a value and a priority level for that value. The highest level value will be the one written to the remote device (if one is mapped). If all values are relinquished, the relinquish default value will be written to the remote device.

To set an output object manually from this page, check the Force box, enter a value in the Present Value window, and select a priority level to assign to your forced value. Then click Update. To return a given priority level to NULL, simply type the word NULL in the Present Value window, check Force, and click Update.

Out of service means the mapped remote device will not be written to. Values written by the BACnet client will be retained, but only applied when this object is placed back in service. At that time, the highest priority value will be written to the remote device.

Reliability codes indicate errors as itemized on the tabular object list.

Status flags A,B,C,D indicate the following, 0 meaning not true, 1 meaning true:
A = in alarm
B = fault
C = overridden
D = out of service

Device link will indicate BAC followed by R for read or W for write, and a number which is the map number in the table of read or write maps for mapping to this BACnet object. The designation R means read from a remote device, and W means write to a remote device.

Check 'Deconfigure' and click Update to erase configuration for this object.

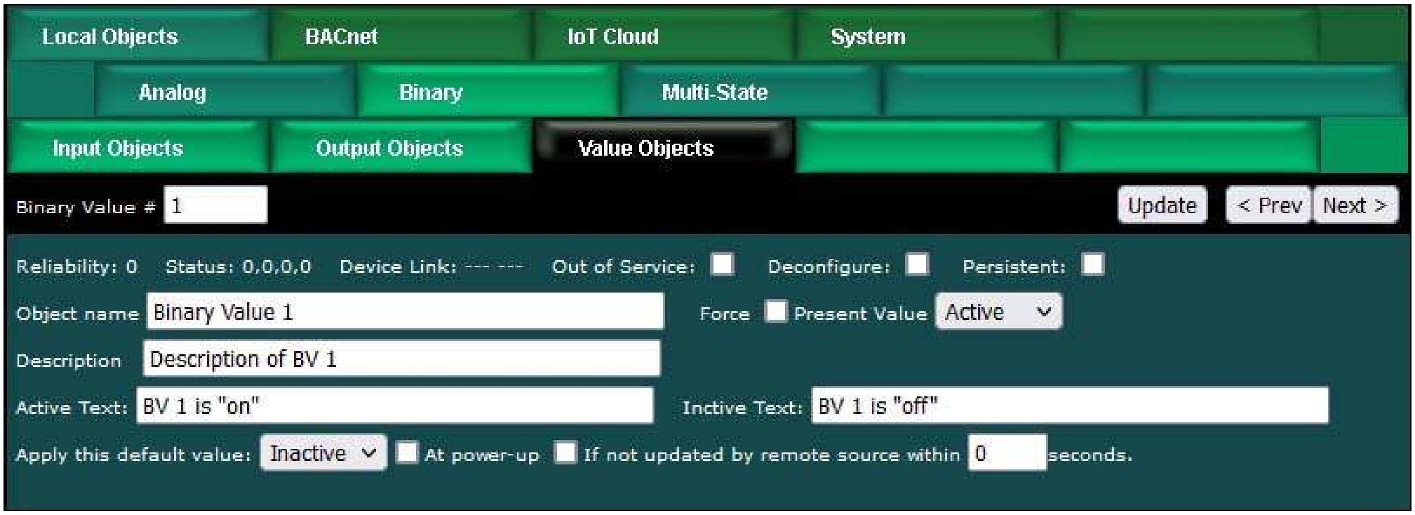
The "Persistent" option means this object will retain its most recent value through a power outage, with time delay restrictions as noted in the user guide. The persistent selection does not take effect until the Reset Persistent button is clicked on the Resources page.

A default value can be applied to this object immediately at power-up and/or if not updated by a remote source within the specified amount of time. The remote source will typically be a remote BACnet client. The default value is applied at the Local Command Priority set on the BACnet Settings page.

6.3.6 Binary Value Objects

Binary Values 1 and 2 are reserved for relay outputs DO 1 and 2 if they have been remapped away from the default Binary Output objects.

Binary Value objects may be both a source and destination for some other BACnet device. When selected for mapping to the relay outputs, then the destination of data in the first two Binary Value objects will be the relays.



Binary Value # 1

Reliability: 0 Status: 0,0,0,0 Device Link: --- --- Out of Service: □ Deconfigure: □ Persistent: □

Object name Binary Value 1 Force □ Present Value Active

Description Description of BV 1

Active Text: BV 1 is "on" Inctive Text: BV 1 is "off"

Apply this default value: Inactive □ At power-up □ If not updated by remote source within 0 seconds.

The object name, units, value, and status are shown for the object number entered at the top of the page. Click Prev/Next to scroll through the list. Click Refresh to update the page, or Update to accept changes.

The object name and description may be changed here. State text may be entered. When any of these are changed, be sure to save the updated configuration by executing "Save XML Config File" on the File Manager page.

The object may be set Out of Service by checking that box and clicking Update. The present value may be changed by entering a value, checking Force, and clicking Update.

Binary Value objects may be both a source and destination for some other BACnet device. The source of data for the Value object will be reading from a remote device when associated with a Read Map. The destination of data for the Value object will be writing to a remote device when associated with a Write Map. If a remote device is mapped, the device links are displayed above. You may click on either link to view the respective mapping.

The Value object may be simultaneously associated with both Read and Write maps pointing to the same remote device object. When this Value object receives new data (from any source), this data will be written to the mapped remote device before any subsequent read from the same device. Thus the Value data is not discarded by the read operation before the new data can be written.

Out of Service means polling of the remote device will stop. While out of service, the present value may be written by an external BACnet client but it will not be written to any mapped remote device. Data may be forced via this web page at any time, but will be overwritten by the next read from a remote device unless the object is out of service.

Reliability codes indicate errors as itemized on the tabular object list.

Status flags A,B,C,D indicate the following, 0 meaning not true, 1 meaning true:
A = in alarm
B = fault
C = overridden
D = out of service

Device link will indicate BAC followed by R for read or W for write, and a number which is the map number in the table of read or write maps for mapping to this BACnet object. The designation R means read from a remote device, and W means write to a remote device.

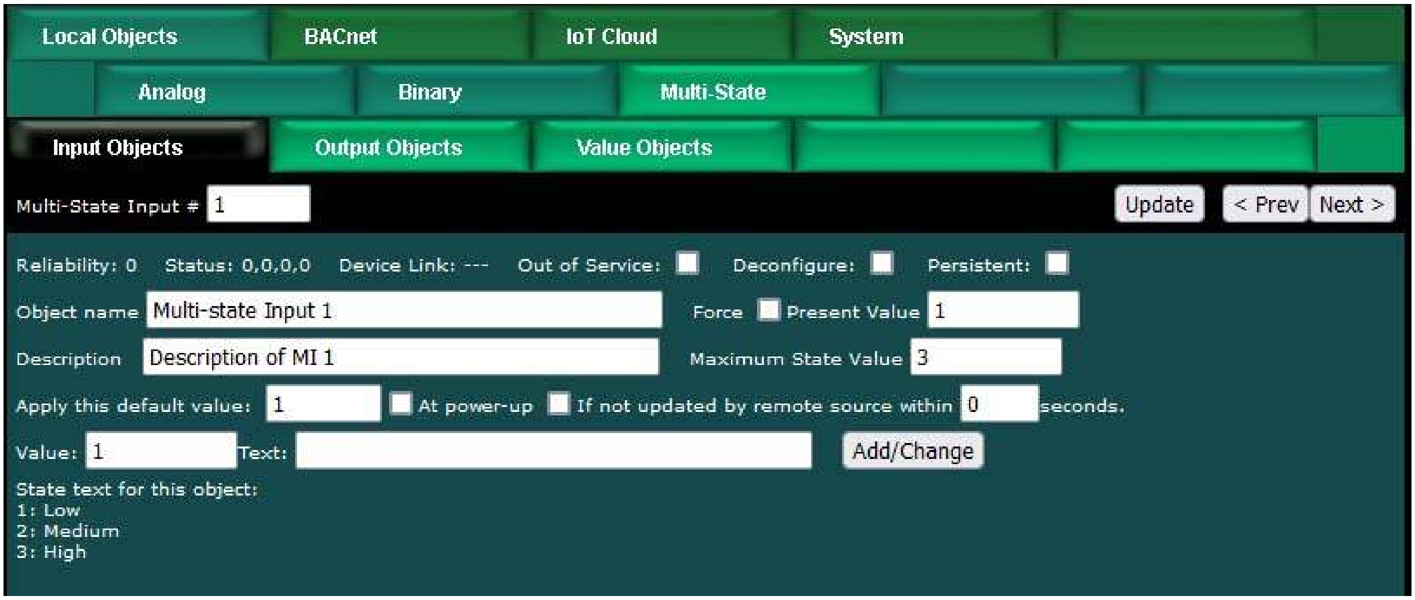
Check 'Deconfigure' and click Update to erase configuration for this object.

The "Persistent" option means this object will retain its most recent value through a power outage, with time delay restrictions as noted in the user guide. The persistent selection does not take effect until the Reset Persistent button is clicked on the Resources page.

A default value can be applied to this object immediately at power-up and/or if not updated by a remote source within the specified amount of time. The remote source will typically be a remote BACnet client.

6.3.7 Multistate Input Objects

The source of data for a Multistate Input object will typically be reading from some other BACnet device.



Multi-State Input # 1

Reliability: 0 Status: 0,0,0,0 Device Link: --- Out of Service: □ Deconfigure: □ Persistent: □

Object name Multi-state Input 1 Force □ Present Value 1

Description Description of MI 1 Maximum State Value 3

Apply this default value: 1 □ At power-up □ If not updated by remote source within 0 seconds.

Value: 1 Text:

State text for this object:
1: Low
2: Medium
3: High

The object name, value, and status are shown for the object number entered at the top of the page. Click Prev/Next to scroll through the list. Click Refresh to update the page, or Update to accept changes.

The object name and description may be changed here. When changed, be sure to save the updated configuration by executing "Save XML Config File" on the File Manager page.

State text may be added. Before adding text, set the maximum state value for this object. Then add text strings corresponding to each of the number of states allocated by entering the value, corresponding text, and clicking Add/Change. When changed, be sure to save the updated configuration by executing "Save XML Config File" on the File Manager page.

The object may be set Out of Service by checking that box and clicking Update. The present value may be changed by entering a value, checking Force, and clicking Update.

The source of data for a Multistate Input object will typically be reading from some other BACnet device via the map indicated by the Device Link. The mapped device will be polled at the rate specified by the Read Map.

Out of Service means polling of the mapped remote device will stop. While out of service, the present value may be written by the BACnet client. Data may be forced via this web page at any time, but will be overwritten by the next mapped client update unless the object is out of service.

Reliability codes indicate errors as itemized on the tabular object list.

Status flags A,B,C,D indicate the following, 0 meaning not true, 1 meaning true:
A = in alarm
B = fault
C = overridden
D = out of service

Device link will indicate BAC followed by R for read or W for write, and a number which is the map number in the table of read or write maps for mapping to this BACnet object. The designation R means read from a remote device, and W means write to a remote device.

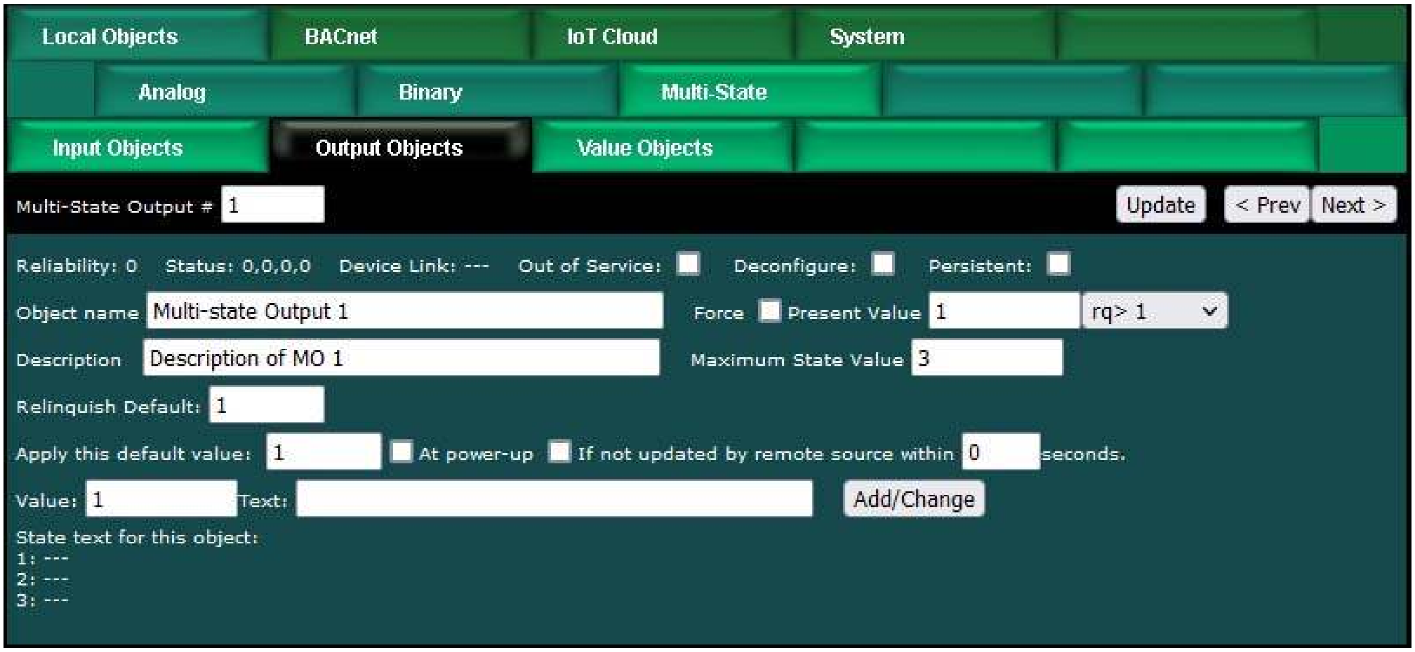
Check 'Deconfigure' and click Update to erase configuration for this object.

The "Persistent" option means this object will retain its most recent value through a power outage, with time delay restrictions as noted in the user guide. The persistent selection does not take effect until the Reset Persistent button is clicked on the Resources page.

A default value can be applied to this object immediately at power-up and/or if not updated by a remote source within the specified amount of time. The remote source will typically be a remote BACnet client.

6.3.8 Multistate Output Objects

The destination of data for a Multistate Output object will typically be some other BACnet device.



Multi-State Output # 1

Reliability: 0 Status: 0,0,0,0 Device Link: --- Out of Service: □ Deconfigure: □ Persistent: □

Object name Multi-state Output 1 Force □ Present Value 1 rq> 1

Description Description of MO 1 Maximum State Value 3

Relinquish Default: 1

Apply this default value: 1 □ At power-up □ If not updated by remote source within 0 seconds.

Value: 1 Text:

State text for this object:
1: ---
2: ---
3: ---

The object name, value, and status are shown for the object number entered at the top of the page. Click Prev/Next to scroll through the list. Click Refresh to update the page, or Update to accept changes.

The object name and description may be changed here. When changed, be sure to save the updated configuration by executing "Save XML Config File" on the File Manager page.

State text may be added. Before adding text, set the maximum state value for this object. Then add text strings corresponding to each of the number of states allocated by entering the value, corresponding text, and clicking Add/Change. When changed, be sure to save the updated configuration by executing "Save XML Config File" on the

File Manager page.

The object may be set Out of Service by checking that box and clicking Update. The present value may be changed by entering a value, checking Force, and clicking Update.

The Multistate Output object is commandable, meaning the BACnet client must write both a value and a priority level for that value. The highest level value will be the one written to the remote device (if one is mapped). If all values are relinquished, the relinquish default value will be written to the remote device.

To set an output object manually from this page, check the Force box, enter a value in the Present Value window, and select a priority level to assign to your forced value. Then click Update. To return a given priority level to NULL, simply type the word NULL in the Present Value window, check Force, and click Update.

Out of service means the mapped remote device will not be written to. Values written by the BACnet client will be retained, but only applied when this object is placed back in service. At that time, the highest priority value will be written to the remote device.

Reliability codes indicate errors as itemized on the tabular object list.

Status flags A,B,C,D indicate the following, 0 meaning not true, 1 meaning true:
A = in alarm
B = fault
C = overridden
D = out of service

Device link will indicate BAC followed by R for read or W for write, and a number which is the map number in the table of read or write maps for mapping to this BACnet object. The designation R means read from a remote device, and W means write to a remote device.

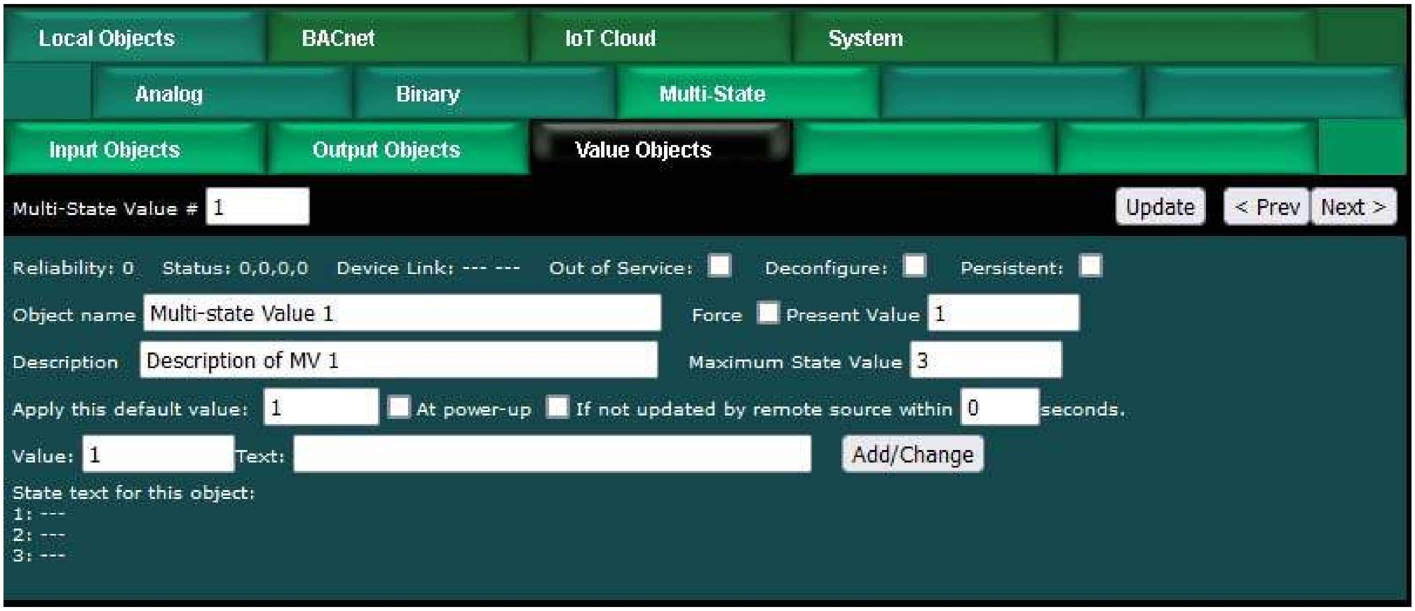
Check 'Deconfigure' and click Update to erase configuration for this object.

The "Persistent" option means this object will retain its most recent value through a power outage, with time delay restrictions as noted in the user guide. The persistent selection does not take effect until the Reset Persistent button is clicked on the Resources page.

A default value can be applied to this object immediately at power-up and/or if not updated by a remote source within the specified amount of time. The remote source will typically be a remote BACnet client. The default value is applied at the Local Command Priority set on the BACnet Settings page.

6.3.9 Multistate Value Objects

Multistate Value objects may be both a source and destination for some other BACnet device.



Multi-State Value # 1

Reliability: 0 Status: 0,0,0,0 Device Link: --- --- Out of Service: □ Deconfigure: □ Persistent: □

Object name Multi-state Value 1 Force □ Present Value 1

Description Description of MV 1 Maximum State Value 3

Apply this default value: 1 □ At power-up □ If not updated by remote source within 0 seconds.

Value: 1 Text:

State text for this object:
1: ---
2: ---
3: ---

The object name, value, and status are shown for the object number entered at the top of the page. Click Prev/Next to scroll through the list. Click Refresh to update the page, or Update to accept changes.

The object name and description may be changed here.When changed, be sure to save the updated configuration by executing "Save XML Config File" on the File Manager page.

State text may be added. Before adding text, set the maximum state value for this object. Then add text strings corresponding to each of the number of states allocated by entering the value, corresponding text, and clicking Add/Change. When changed, be sure to save the updated configuration by executing "Save XML Config File" on the File Manager page.

The object may be set Out of Service by checking that box and clicking Update. The present value may be changed by entering a value, checking Force, and clicking Update.

Multistate Value objects may be both a source and destination for some other BACnet device. The source of data for the Value object will be reading from a remote device when associated with a Read Map. The destination of data for the Value object will be writing to a remote device when associated with a Write Map. If a remote device is mapped, the device links are displayed above. You may click on either link to view the respective mapping.

The Value object may be simultaneously associated with both Read and Write maps pointing to the same remote device object. When this Value object receives new data (from any source), this data will be written to the mapped remote device before any subsequent read from the same device. Thus the Value data is not discarded by the read operation before the new data can be written.

Out of Service means polling of the remote device will stop. While out of service, the present value may be written by an external BACnet client but it will not be written to any mapped remote device. Data may be forced via this web page at any time, but will be overwritten by the next read from a remote device unless the object is out of service.

Reliability codes indicate errors as itemized on the tabular object list.

Status flags A,B,C,D indicate the following, 0 meaning not true, 1 meaning true:
A = in alarm
B = fault
C = overridden
D = out of service

Device link will indicate BAC followed by R for read or W for write, and a number which is the map number in the table of read or write maps for mapping to this BACnet object. The designation R means read from a remote device, and W means write to a remote device.

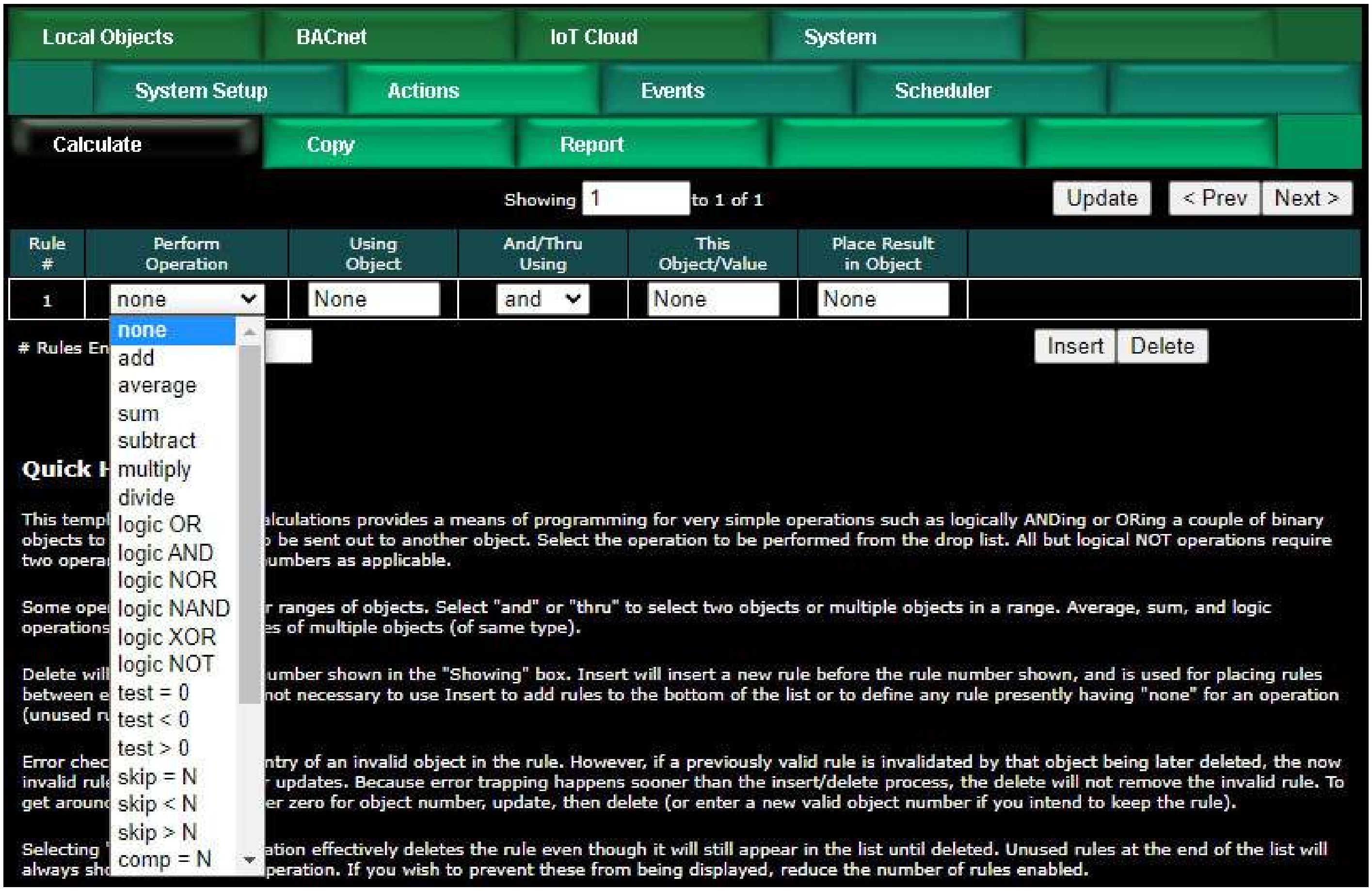
Check 'Deconfigure' and click Update to erase configuration for this object.

The "Persistent" option means this object will retain its most recent value through a power outage, with time delay restrictions as noted in the user guide. The persistent selection does not take effect until the Reset Persistent button is clicked on the Resources page.

A default value can be applied to this object immediately at power-up and/or if not updated by a remote source within the specified amount of time. The remote source will typically be a remote BACnet client.

6.4 Local Object Calculate Rules

The ValuPoint includes the ability to do simple calculations based on simple template rules. Select the operation, one or two operands as applicable, and a object to place the result in. Operations like "multiply" will use objects A "and" B. Operations like "sum" can add up the contents of a series of objects by selecting "thru" instead of "and". These template rules can be useful for doing minor data manipulation or testing for purposes of enabling rules, or for generating derived values.



Rule #	Perform Operation	Using Object	And/Thru Using	This Object/Value	Place Result in Object
1	none	None	and	None	None

Rules En

Quick H

This templ alculations provides a means of programming for very simple operations such as logically ANDing or ORing a couple of binary objects to be sent out to another object. Select the operation to be performed from the drop list. All but logical NOT operations require two opera umbers as applicable.

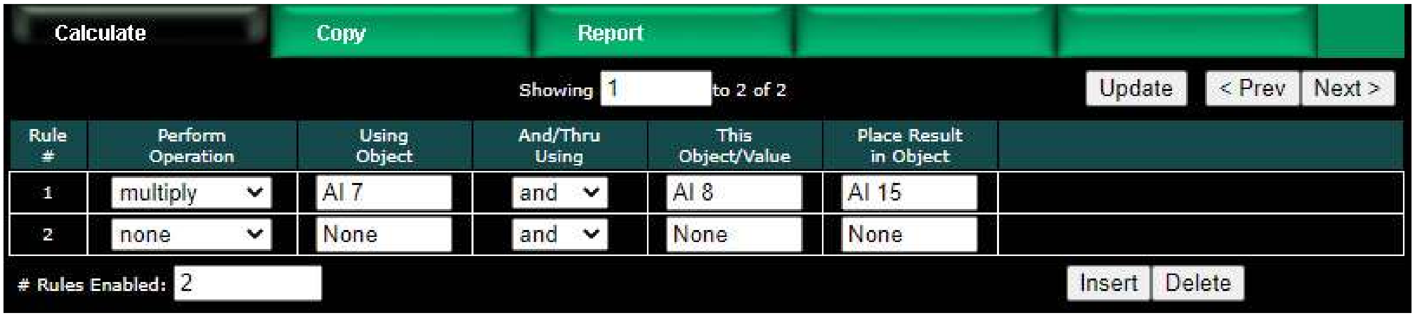
Some ope r ranges of objects. Select "and" or "thru" to select two objects or multiple objects in a range. Average, sum, and logic operations es of multiple objects (of same type).

Delete will umber shown in the "Showing" box. Insert will insert a new rule before the rule number shown, and is used for placing rules between e not necessary to use Insert to add rules to the bottom of the list or to define any rule presently having "none" for an operation (unused ru

Error chec ntry of an invalid object in the rule. However, if a previously valid rule is invalidated by that object being later deleted, the now invalid rule r updates. Because error trapping happens sooner than the insert/delete process, the delete will not remove the invalid rule. To get around er zero for object number, update, then delete (or enter a new valid object number if you intend to keep the rule).

Selecting ation effectively deletes the rule even though it will still appear in the list until deleted. Unused rules at the end of the list will always sho peration. If you wish to prevent these from being displayed, reduce the number of rules enabled.

Here is an example of a template rule that multiplies the value of Analog Input 7 by value of Analog Input 8 and places the result in Analog Input 15. An example of application would be to multiply a voltage reading input by a current reading input to derive a power value presented as an input.



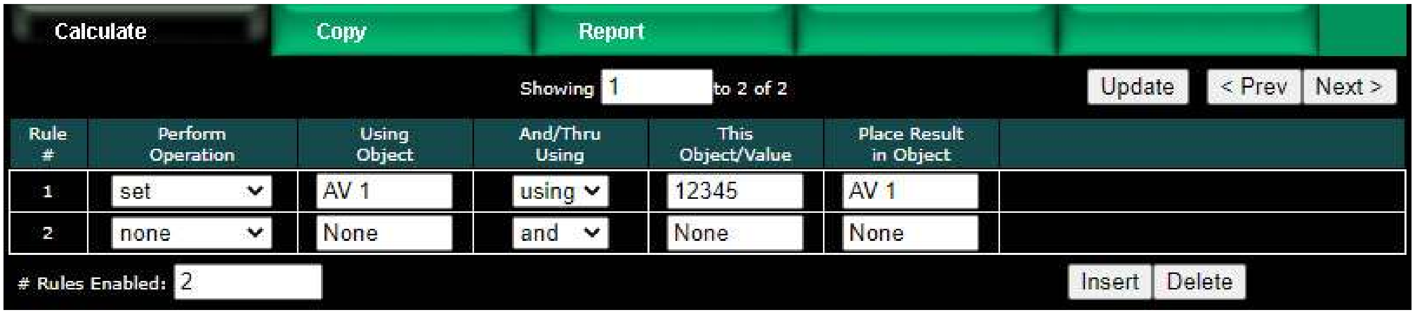
Rule #	Perform Operation	Using Object	And/Thru Using	This Object/Value	Place Result in Object
1	multiply	AI 7	and	AI 8	AI 15
2	none	None	and	None	None

Rules Enabled: 2

There are times when you may want to make a calculation based on a constant value. There are two ways to use an object for a constant value.

Constants may be introduced into the calculation by reserving a commandable object to hold that constant, and then configuring the relinquish default to be that value. Then reference that object in your calculate rule.

The "set" operation can be used to directly place an unsigned integer value into an object. The screen shot below illustrates setting Analog Value 1 to a value of 12345. The value in a set operation can only be unsigned integer as the value was originally intended for use in bit mask operations.



Showing 1 to 2 of 2

Rule #	Perform Operation	Using Object	And/Thru Using	This Object/Value	Place Result in Object
1	set	AV 1	using	12345	AV 1
2	none	None	and	None	None

Rules Enabled: 2

Operations available on two or more objects using 'and' or 'thru':

add	Add two objects
average	Average two or more objects
sum	Sum two or more objects
subtract	Subtract second object from first
multiply	Multiply two objects
divide	Divide first object by second
logic OR	Logically OR two or more objects
logic AND	Logically AND two or more objects
logic NOR	Logically NOR two or more objects
logic NAND	Logically NAND two or more objects
logic XOR	Logically Exclusive-OR two objects

Operations available on one object:

logic NOT	Generate bit-wise negation of object
test = 0	Set result to 'true' if object is zero
test < 0	Set result to 'true' if object is less than zero
test > 0	Set result to 'true' if object is greater than zero
relinquish	Relinquish command priority previously written to a commandable object

Operations available on one object 'using' a given value:

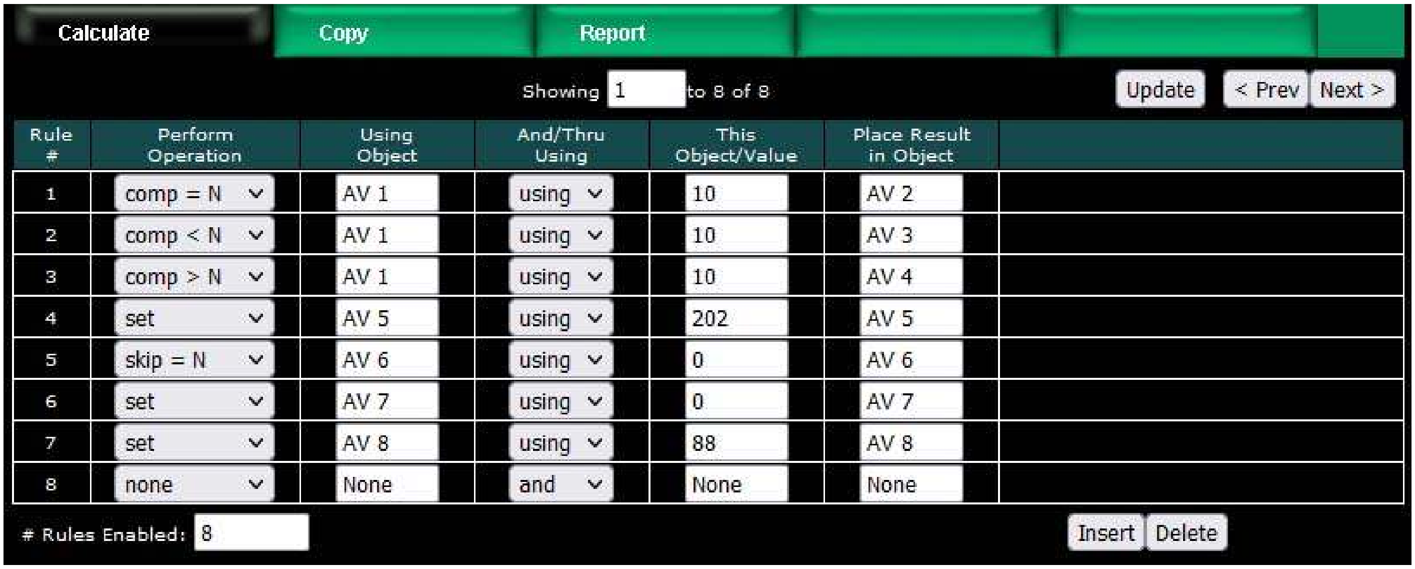
set	Set object to given value (unsigned 32-bit integer)
skip = N	Skip next operation if object is equal to given value
skip < N	Skip next operation if object is less than given value
skip > N	Skip next operation if object is greater than given value
comp = N	Compare, set result 'true' if object is equal to given value
comp < N	Compare, set result 'true' if object is less than given value
comp > N	Compare, set result 'true' if object is greater than given value
pack	Perform Pack operation (see text)
fill	Perform Fill operation (see text)
unpack	Perform Unpack operation (see text)

priority	Sets command priority that will be used in any subsequent write to a commandable object

Operations "using" a given value will have an unsigned integer value in the "This Object/Value" column rather than an object number. These values will be displayed as integer for most operations, but will be displayed in hexadecimal for pack, fill, and unpack operations since these operate primarily on bit mask values.

The result of a test or compare will be zero if false, or one if true when the result object is a Analog or Binary object. The result of a test or compare when the result object is Multi-State will be 1 if false and 2 if true (since Multi-State cannot use zero).

The next two screen shots illustrate compare, set, and skip operations. Rule 5 says that rule 6 will not be executed if AV 6 contains a zero. If AV 6 is not equal to zero, then rule 6 will be executed. (The numbers rule 6 and AV 6 are not related in any other way, this is just conincidence in the example.)

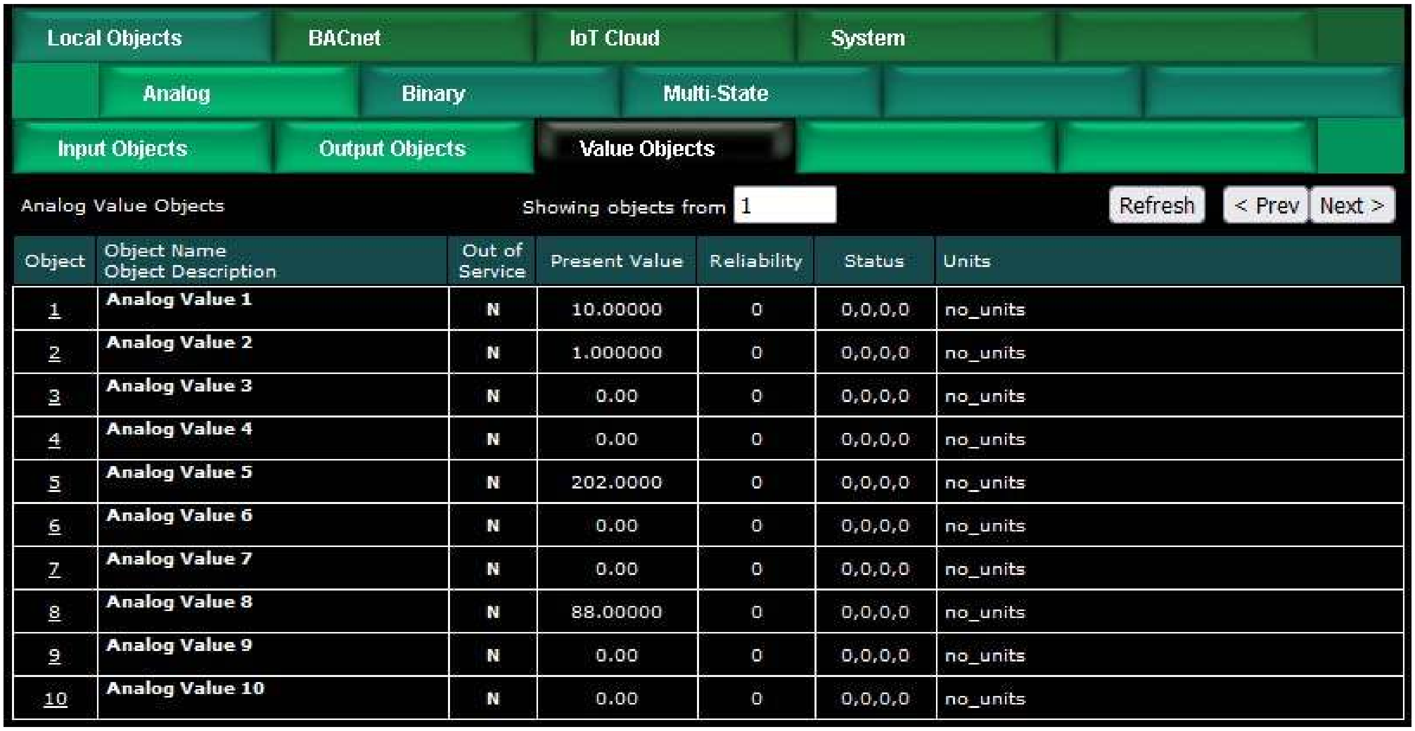


Showing 1 to 8 of 8

Rule #	Perform Operation	Using Object	And/Thru Using	This Object/Value	Place Result in Object
1	comp = N	AV 1	using	10	AV 2
2	comp < N	AV 1	using	10	AV 3
3	comp > N	AV 1	using	10	AV 4
4	set	AV 5	using	202	AV 5
5	skip = N	AV 6	using	0	AV 6
6	set	AV 7	using	0	AV 7
7	set	AV 8	using	88	AV 8
8	none	None	and	None	None

Rules Enabled: 8

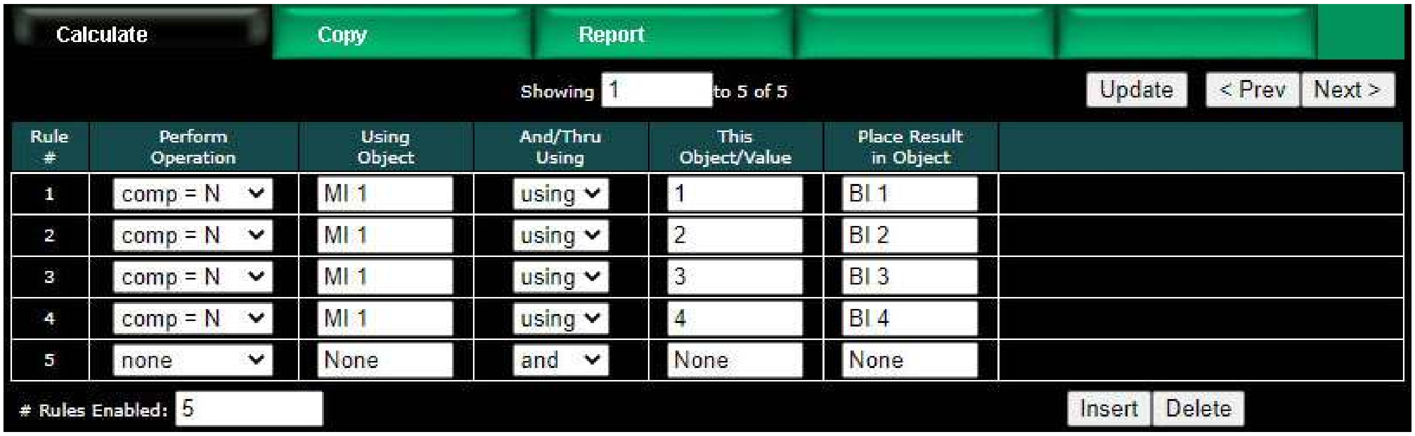
Object values for examples using the above operations are illustrated below.



Analog Value Objects — Showing objects from 1

Object	Object Name Object Description	Out of Service	Present Value	Reliability	Status	Units
1	Analog Value 1	N	10.00000	0	0,0,0,0	no_units
2	Analog Value 2	N	1.000000	0	0,0,0,0	no_units
3	Analog Value 3	N	0.00	0	0,0,0,0	no_units
4	Analog Value 4	N	0.00	0	0,0,0,0	no_units
5	Analog Value 5	N	202.0000	0	0,0,0,0	no_units
6	Analog Value 6	N	0.00	0	0,0,0,0	no_units
7	Analog Value 7	N	0.00	0	0,0,0,0	no_units
8	Analog Value 8	N	88.00000	0	0,0,0,0	no_units
9	Analog Value 9	N	0.00	0	0,0,0,0	no_units
10	Analog Value 10	N	0.00	0	0,0,0,0	no_units

The following screen shot illustrates the use of calculate rules to set the states of multiple Binary Input objects based on the value of a single Multi-State Input object. In this example, BI 1 will be active if the MI 1 state is 1, BI 2 will be active for state 2, and so on.



Showing 1 to 5 of 5

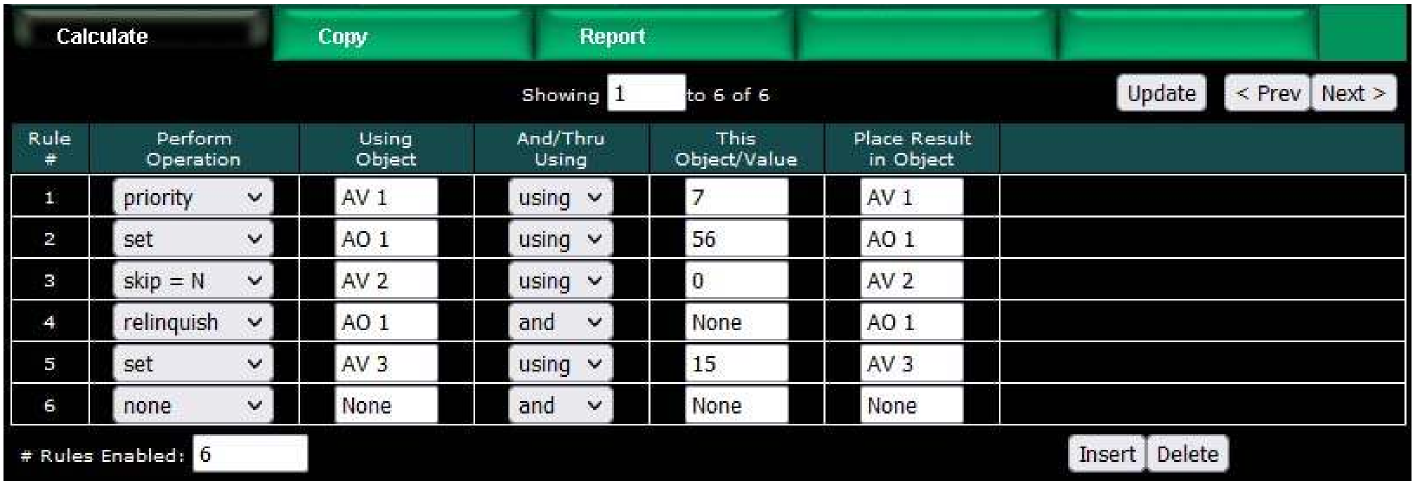
Rule #	Perform Operation	Using Object	And/Thru Using	This Object/Value	Place Result in Object
1	comp = N	MI 1	using	1	BI 1
2	comp = N	MI 1	using	2	BI 2
3	comp = N	MI 1	using	3	BI 3
4	comp = N	MI 1	using	4	BI 4
5	none	None	and	None	None

Rules Enabled: 5

The calculate rules have access to command priority and relinquish when the result regiter is a commandable object.

The command priority is set using the priority operation as illustrated below. In this case, the "using object" and "place result in object" are only place holders to keep the rule validator happy. The only thing actually used in this operation is the "this value". In the example below, the command priority is being set to 7. This command priority will be used for any subsequent operations that place a result in a commandable object, and will remain in effect until another priority operation is used. If no priority operation is ever included, then the default local command priority on the BACnet settings page will be used.

Once a commandable object has been set by a calculate rule, it can be relinquished by using the relinquish operation as illustrated below. The command priority currently in effect as the result of the most recent priority operation will be relinquished. The calculate rules themselves do not have any ability to remember command priorities - it is up to you to keep track of command priority using the priority operation.



Showing 1 to 6 of 6

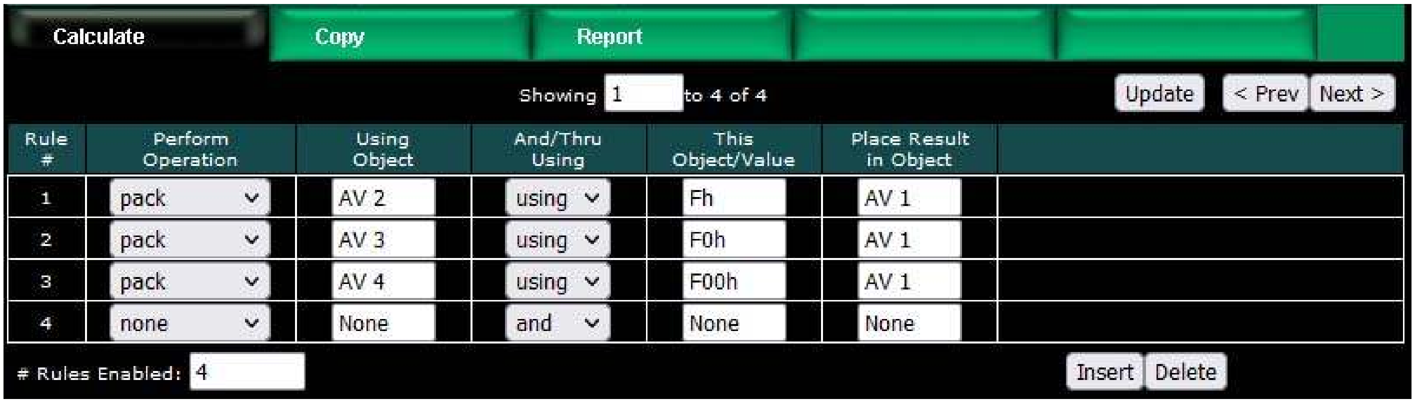
Rule #	Perform Operation	Using Object	And/Thru Using	This Object/Value	Place Result in Object
1	priority	AV 1	using	7	AV 1
2	set	AO 1	using	56	AO 1
3	skip = N	AV 2	using	0	AV 2
4	relinquish	AO 1	and	None	AO 1
5	set	AV 3	using	15	AV 3
6	none	None	and	None	None

Rules Enabled: 6

Pack and fill are used for packing multiple local objects into a single object for purposes of emulating existing equipment when the ValuPoint is functioning as a server (slave). When pack and fill are used, "using" should be selected, and the second entry is a hexadecimal mask or fill value. The hexadecimal value should include "h" at the end to signify hexadecimal (otherwise the value will be parsed as decimal).

The pack mask is both a bit mask and position indicator. To calculate the contribution of a given calculate rule, the mask is right shifted until the least significant bit is nonzero, then this shifted mask is logically AND-ed with the local object content. The resulting masked value is then left shifted back to the original mask position. This final shifted result is then logically OR-ed into the result object (after first clearing the bits in the affected position of the result object).

Fill is simple - it simply logically OR's the bit mask into the result object.

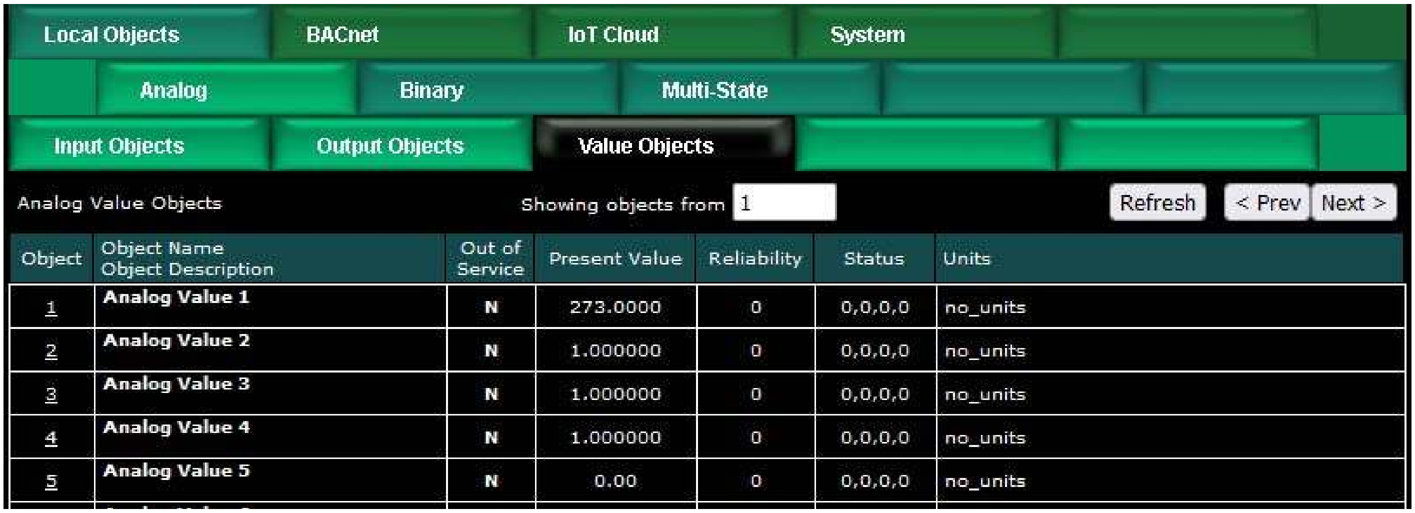


Showing 1 to 4 of 4

Rule #	Perform Operation	Using Object	And/Thru Using	This Object/Value	Place Result in Object
1	pack	AV 2	using	Fh	AV 1
2	pack	AV 3	using	F0h	AV 1
3	pack	AV 4	using	F00h	AV 1
4	none	None	and	None	None

Rules Enabled: 4

Using the above rules, an example of resulting data would be as follows.

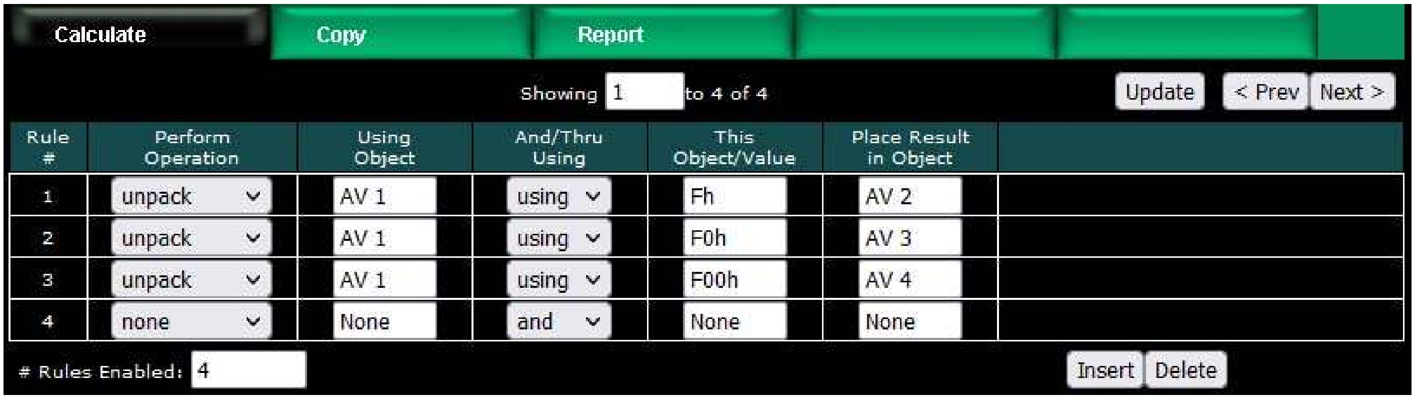


Analog Value Objects

Showing objects from 1

Object	Object Name Object Description	Out of Service	Present Value	Reliability	Status	Units
1	**Analog Value 1**	N	273.0000	0	0,0,0,0	no_units
2	**Analog Value 2**	N	1.000000	0	0,0,0,0	no_units
3	**Analog Value 3**	N	1.000000	0	0,0,0,0	no_units
4	**Analog Value 4**	N	1.000000	0	0,0,0,0	no_units
5	**Analog Value 5**	N	0.00	0	0,0,0,0	no_units

A set of calculate rules that would exactly reverse the above operation would be as follows.



Showing 1 to 4 of 4

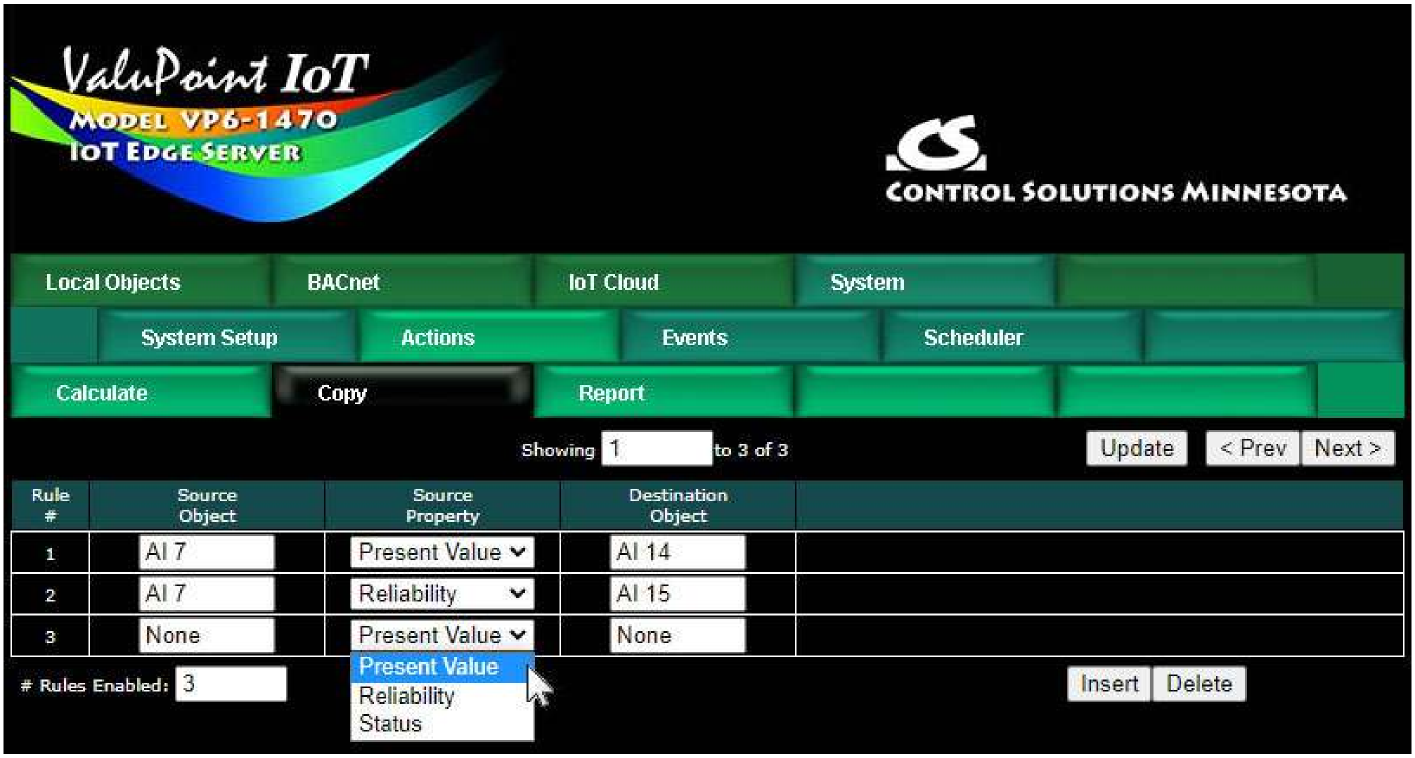
Rule #	Perform Operation	Using Object	And/Thru Using	This Object/Value	Place Result in Object
1	unpack	AV 1	using	Fh	AV 2
2	unpack	AV 1	using	F0h	AV 3
3	unpack	AV 1	using	F00h	AV 4
4	none	None	and	None	None

Rules Enabled: 4

The pack, fill, and unpack instructions are primarily targeting Modbus applications. They are less useful when dealing with BACnet objects, but are retained in the calculate rule set for consistency across the product family.

6.5 Local Object Copy Rules

The copy rules provide a means of simply copying the content of one object to another.



Showing 1 to 3 of 3

Rule #	Source Object	Source Property	Destination Object
1	AI 7	Present Value	AI 14
2	AI 7	Reliability	AI 15
3	None	Present Value	None

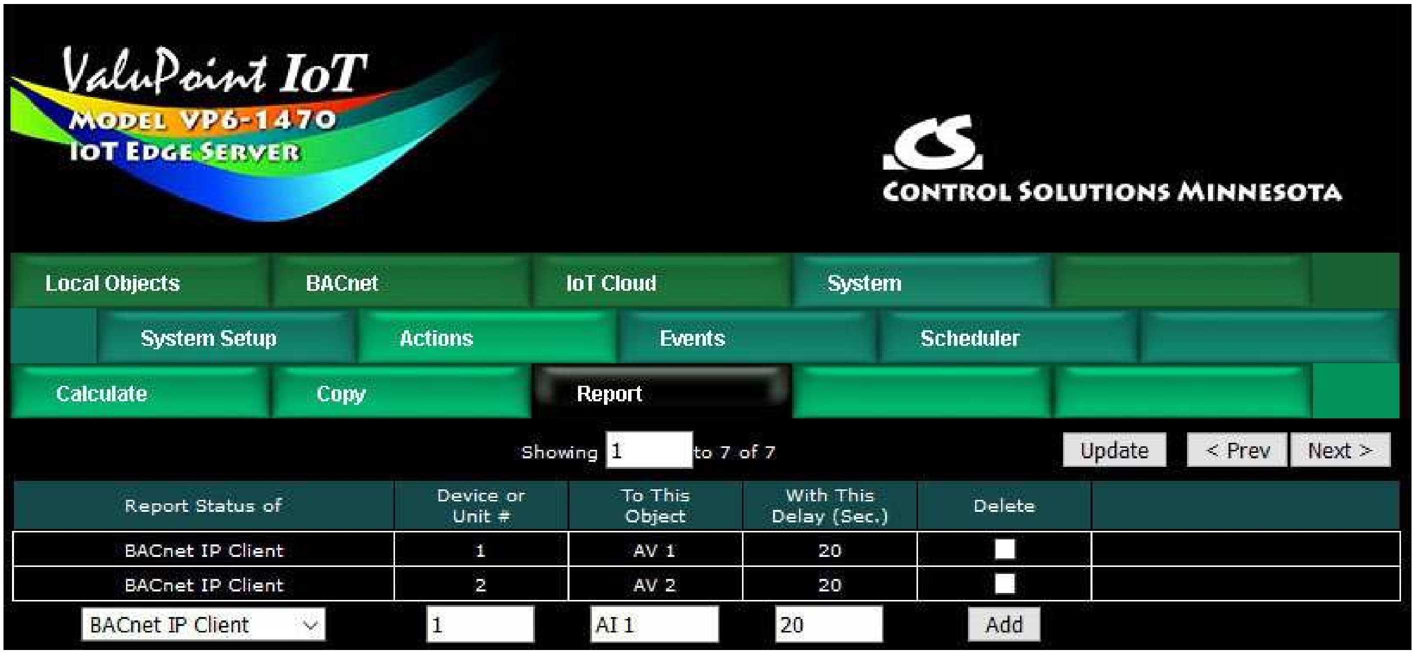
Rules Enabled: 3

The above rule would cause the value of AI 7 to be placed in AI 14. If a floating point (Analog) value is copied to a Binary object, the Binary object will be set Active if the value was nonzero, or cleared to Inactive if zero. Analog values copied to a Multistate object will be not only truncated, but bounded to the maximum number of states (not a recommended use of Copy).

6.6 Device Status Reporting

The ValuPoint read maps include the ability to set a default value upon 'n' read fails, meaning that if the ValuPoint gets an error 'n' times attempting to read that point, it will automatically set the corresponding local object to the given default value to indicate the problem. This indication applies on a point by point basis, but of course any one point can be used as an indication that the entire device may be offline.

The ValuPoint also includes the ability to report device errors to an assigned status object rather than rely on default values. This reporting is configured on the Report page.



Showing 1 to 7 of 7

Report Status of	Device or Unit #	To This Object	With This Delay (Sec.)	Delete
BACnet IP Client	1	AV 1	20	□
BACnet IP Client	2	AV 2	20	□
BACnet IP Client	1	AI 1	20	Add

This optional list allows reporting device errors as object values to make it easier to monitor communication failures. The length of the list is variable. To add to the list, select the type of device to report on, select the device instance or unit number to report on, and select an object in which to put the status indication. Enter a delay if desired, and then click Add.

The delay is technically optional (zero means no delay) but you will generally want to set the delay time greater than the read/write map poll times. If some number of seconds is entered, then the error condition will not be reported until this time period expires. If the error clears before the time is up, then the error is never reported. This is useful for spurious errors that would result in nuisance indications.

To remove a report from the list, check the box in the Delete column and then click Update. Click Prev or Next to scroll through the list.

Error codes placed into the reporting object will be as follows:

0 = No error
1 = Timeout, no response from remote device
2 = Error message received from remote device
3 = Line fault (e.g., socket connection error, etc)

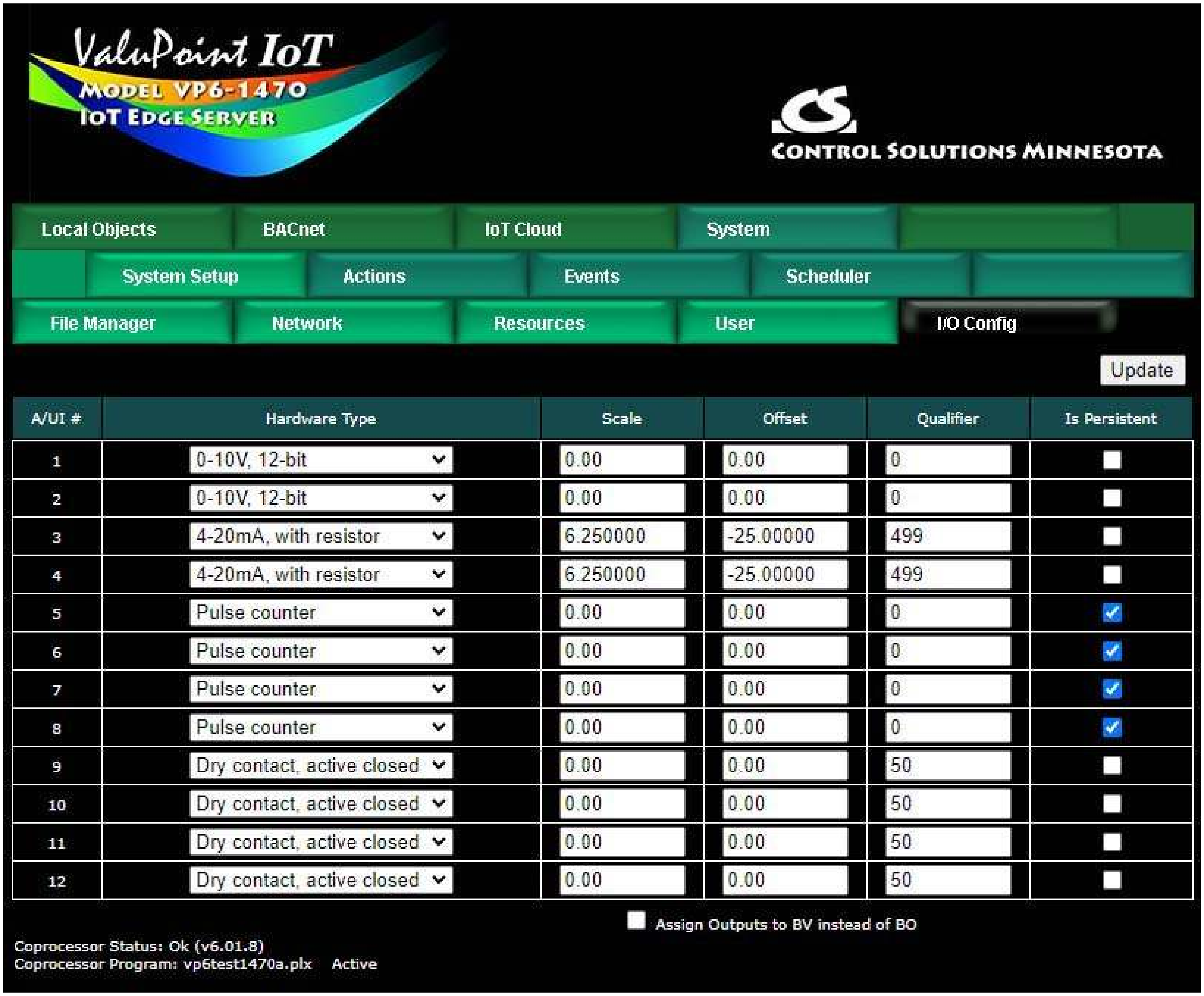
Once a Timeout error indication has been set (following delay if applicable), it will automatically return to zero upon the next successful communication with that device.

Once either the error message or line fault indication has been set, following delay if applicable, communication must continue free of this same error condition for at least the same delay period before the indication will be reset to zero. If an error message is reported for one data point, but multiple others are error free, then the one error would be hidden without this delay before reset. Ideally, this delay period should be at least as great as the poll period for the slowest point mapped.

6.7 Configuring Physical I/O

The first 12 Analog Input objects are allocated to physical inputs A/UI 1 through A/UI 12. These inputs are mirrored as discrete states in the first 12 Binary Input objects.

The relay outputs DO 1 and DO 2 default to being assigned to the first 2 Binary Output objects, but can be moved to the first 2 Binary Value objects by checking the box illustrated in the screen shot below.



A/UI #	Hardware Type	Scale	Offset	Qualifier	Is Persistent
1	0-10V, 12-bit	0.00	0.00	0	☐
2	0-10V, 12-bit	0.00	0.00	0	☐
3	4-20mA, with resistor	6.250000	-25.00000	499	☐
4	4-20mA, with resistor	6.250000	-25.00000	499	☐
5	Pulse counter	0.00	0.00	0	☑
6	Pulse counter	0.00	0.00	0	☑
7	Pulse counter	0.00	0.00	0	☑
8	Pulse counter	0.00	0.00	0	☑
9	Dry contact, active closed	0.00	0.00	50	☐
10	Dry contact, active closed	0.00	0.00	50	☐
11	Dry contact, active closed	0.00	0.00	50	☐
12	Dry contact, active closed	0.00	0.00	50	☐

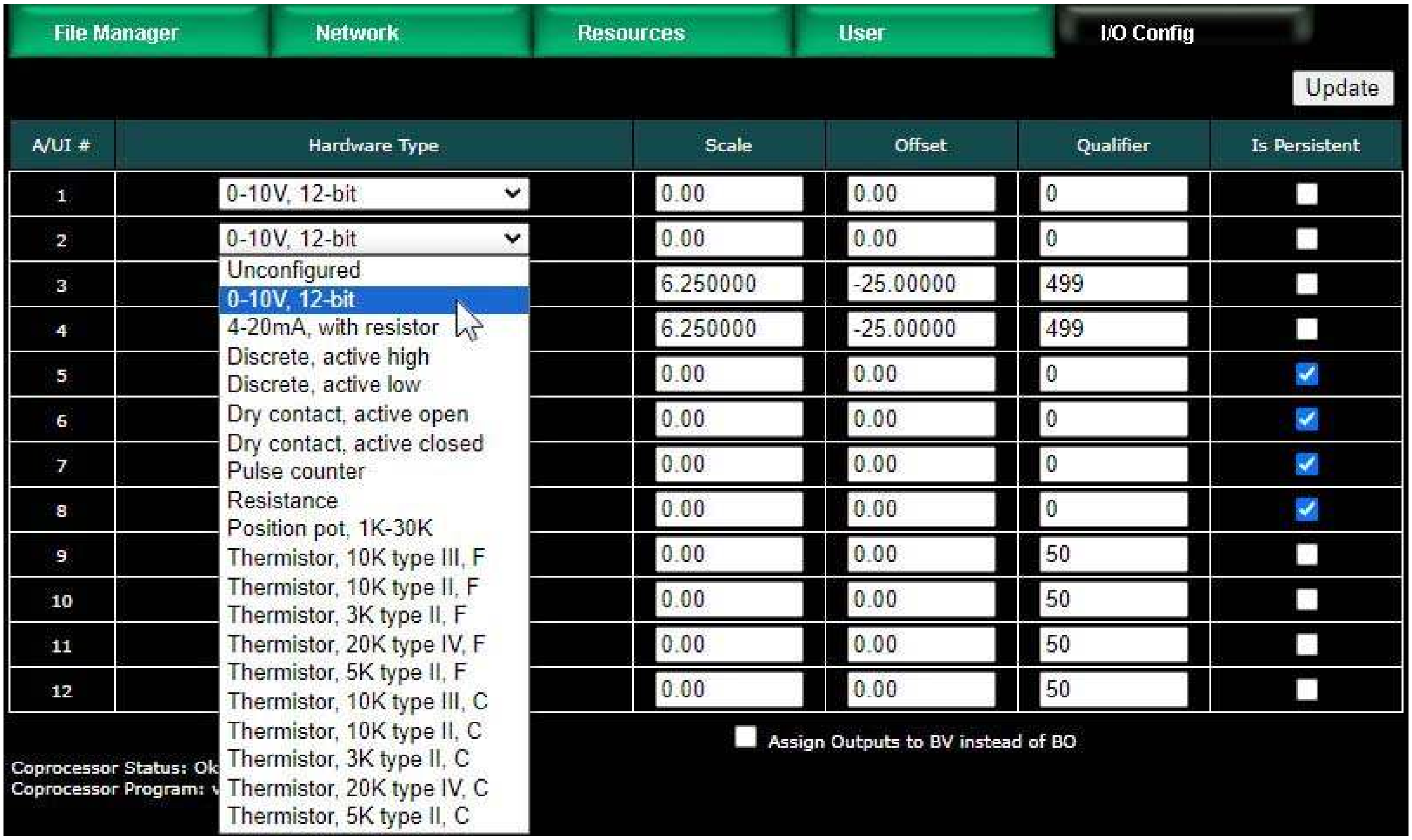
☐ Assign Outputs to BV instead of BO

Coprocessor Status: Ok (v6.01.8)
Coprocessor Program: vp6test1470a.plx Active

This page is used to configure the Analog/Universal inputs. Select the configuration from the list and enter optional qualifier and scaling values. Qualifier is required for some hardware types as noted below.

The "Is Persistent" option means this object will retain its most recent value through a power outage, with time delay restrictions as noted in the user guide. The persistent selection does not take effect until the Reset Persistent button is clicked on the Resources page. For inputs, this selection is only relevant for "Pulse counter" mode, in which case it turns the input into a totalizing counter. For any other type of input, the value will be immediately overwritten by new data and thus Is Persistent will have no meaning.

The VP6-1470 contains a coprocessor which handles direct I/O interface and also provides an i.CanDrawIt programming environment accessed via an external PC based tool. The status of the server's connection to the coprocessor along with its firmware revision is indicated here. If there is a user program running on the coprocessor, that is also indicated here.


File Manager
Network
Resources
User
I/O Config
Update
Unconfigured
0-10V, 12-bit
4-20mA, with resistor
Discrete, active high
Discrete, active low
Dry contact, active open
Dry contact, active closed
Pulse counter
Resistance
Position pot, 1K-30K
Thermistor, 10K type III, F
Thermistor, 10K type II, F
Thermistor, 3K type II, F
Thermistor, 20K type IV, F
Thermistor, 5K type II, F
Thermistor, 10K type III, C
Thermistor, 10K type II, C
Thermistor, 3K type II, C
Thermistor, 20K type IV, C
Thermistor, 5K type II, C

A/UI #	Hardware Type	Scale	Offset	Qualifier	Is Persistent
1	0-10V, 12-bit	0.00	0.00	0	☐
2	0-10V, 12-bit	0.00	0.00	0	☐
3		6.250000	-25.00000	499	☐
4		6.250000	-25.00000	499	☐
5		0.00	0.00	0	☑
6		0.00	0.00	0	☑
7		0.00	0.00	0	☑
8		0.00	0.00	0	☑
9		0.00	0.00	50	☐
10		0.00	0.00	50	☐
11		0.00	0.00	50	☐
12		0.00	0.00	50	☐

☐ Assign Outputs to BV instead of BO

Coprocessor Status: Ok
Coprocessor Program: v

The A/UI inputs may function as any of the following:

0-10V, 12-bit resolution (reading is Volts)
4-20mA, with resistor (reading is mA)
Discrete, active high
Discrete, active low
Dry contact, active open
Dry contact, active closed
Pulse counter
Resistance (reading is ohms)
Position pot, 1K-30K (reading is percentage)

Thermistor, 10K type III, F (readings in degrees for all of following)
Thermistor, 10K type II, F
Thermistor, 3K type II, F
Thermistor, 20K type IV, F
Thermistor, 5K type II, F
Thermistor, 10K type III, C
Thermistor, 10K type II, C
Thermistor, 3K type II, C
Thermistor, 20K type IV, C

Thermistor, 5K type II, C

Dedicated hardware is available for pulse counting on channels 5, 6, 7, and 8. The only limiting factor on maximum pulse rate on these inputs is the noise filtering on the inputs. The inputs have been verified to count at up to 1kHz provided the signal amplitude is sufficient. Pulse counting is supported on the remaining input channels, but the counting is done by software and therefore the rate is limited to about 2Hz.

The 4-20mA setting is used as a label since that is most common. However, the input is actually going to be 0-20mA, and the object value for that range will be 0..20. The scale and offset can be used to convert 4-20mA to a 0-100% value by using scale = 6.25 and offset = -25. A dropping resistor of 500 ohms will use the full 10 volt input range. A dropping resistor of 250 ohms can be used - it will simply provide less resolution.

Scale – Scaling applies the formula y=mx+b. When reading from a hardware input, the raw data as read is multiplied by the scale factor, then the offset is added to produce the resulting object value. NOTE: If no scale factor is given (zero is entered), no scaling will be done, as if scale=1 and offset=0.

Offset – The offset portion of the scaling as noted above.

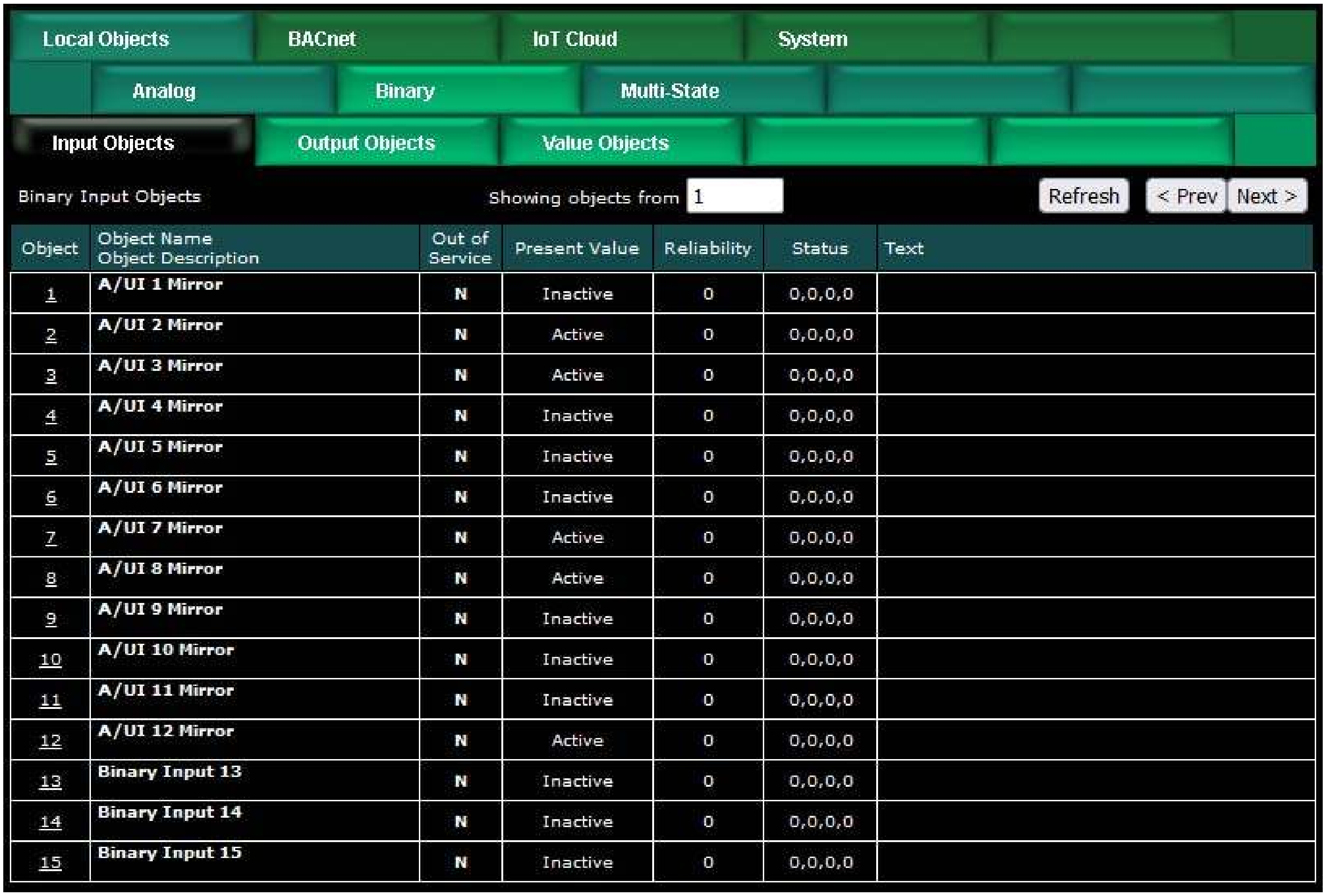
Qualifier – Enter the configuration qualifier value, if applicable, for the selected configuration. Qualifiers are required only in the following modes:

4-20mA mode: The qualifier is the resistance in ohms of the dropping resistor used to convert the current to voltage. An external resistor must be provided, connected between the A/UI input and ground/common. The resistor needs to be 1/2 watt (2 watt to withstand 24V power), and is left external simply because miswiring the 4-20mA sensor can easily apply 24V power directly to the input and cause the dropping resistor to heat up and possibly fail. The external resistor is simple to replace, whereas an internal resistor on a circuit board would be more trouble to replace.

Discrete and Dry Contact modes: The qualifier is a threshold between 1% and 99% at which the input should trip from off to on or vice versa. The A/UI inputs are specified as 0-10V inputs. Therefore, since discrete inputs are sampled as analog values and compared to a threshold, the qualifier here is a percentage of 10V for the trip point. A value of 50% will mean a threshold of around 5V.

Position Pot: Position is simply a different interpretation of resistance measurement. The value resulting from position pot measurement will be a percentage from 0% to 100%, but this percentage will be a ratio based on the resistance value in ohms provided as the qualifier.

The inputs A/UI 1 through A/UI 12 are mirrored in the first 12 Binary Input objects. This permits configuration of the input as discrete or dry contact, and have the result be accessible as a Binary object.

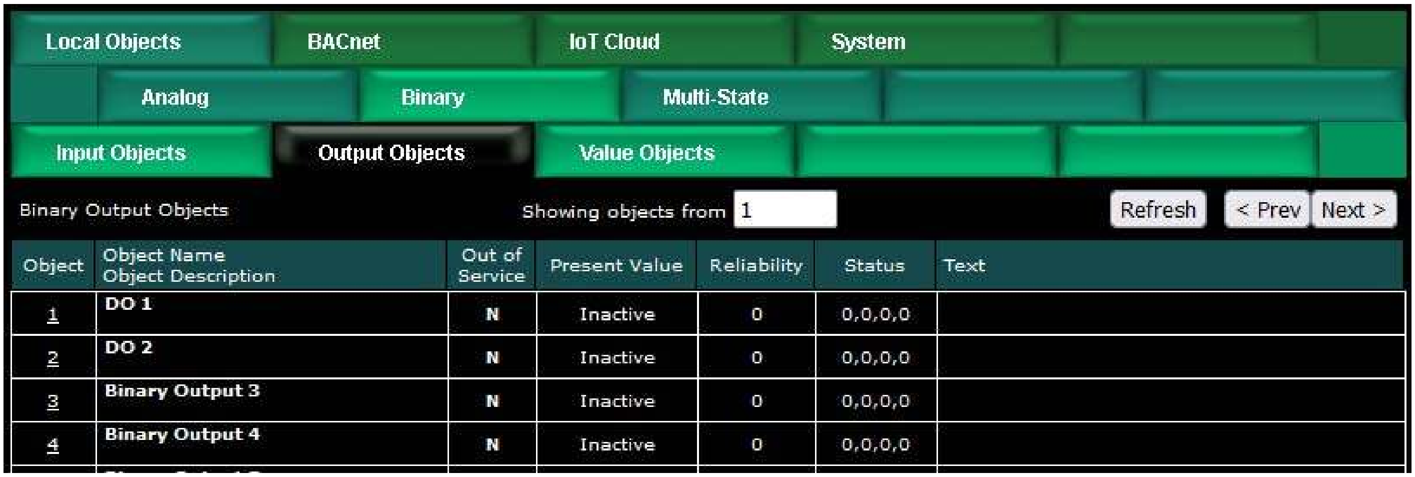


Binary Input Objects

Showing objects from 1

Object	Object Name Object Description	Out of Service	Present Value	Reliability	Status	Text
1	A/UI 1 Mirror	N	Inactive	0	0,0,0,0	
2	A/UI 2 Mirror	N	Active	0	0,0,0,0	
3	A/UI 3 Mirror	N	Active	0	0,0,0,0	
4	A/UI 4 Mirror	N	Inactive	0	0,0,0,0	
5	A/UI 5 Mirror	N	Inactive	0	0,0,0,0	
6	A/UI 6 Mirror	N	Inactive	0	0,0,0,0	
7	A/UI 7 Mirror	N	Active	0	0,0,0,0	
8	A/UI 8 Mirror	N	Active	0	0,0,0,0	
9	A/UI 9 Mirror	N	Inactive	0	0,0,0,0	
10	A/UI 10 Mirror	N	Inactive	0	0,0,0,0	
11	A/UI 11 Mirror	N	Inactive	0	0,0,0,0	
12	A/UI 12 Mirror	N	Active	0	0,0,0,0	
13	Binary Input 13	N	Inactive	0	0,0,0,0	
14	Binary Input 14	N	Inactive	0	0,0,0,0	
15	Binary Input 15	N	Inactive	0	0,0,0,0	

The relay outputs DO 1 and DO 2 will be assigned to the first two Binary Output objects unless reassigned to Binary Value objects.



Binary Output Objects

Showing objects from 1

Object	Object Name Object Description	Out of Service	Present Value	Reliability	Status	Text
1	DO 1	N	Inactive	0	0,0,0,0	
2	DO 2	N	Inactive	0	0,0,0,0	
3	Binary Output 3	N	Inactive	0	0,0,0,0	
4	Binary Output 4	N	Inactive	0	0,0,0,0	

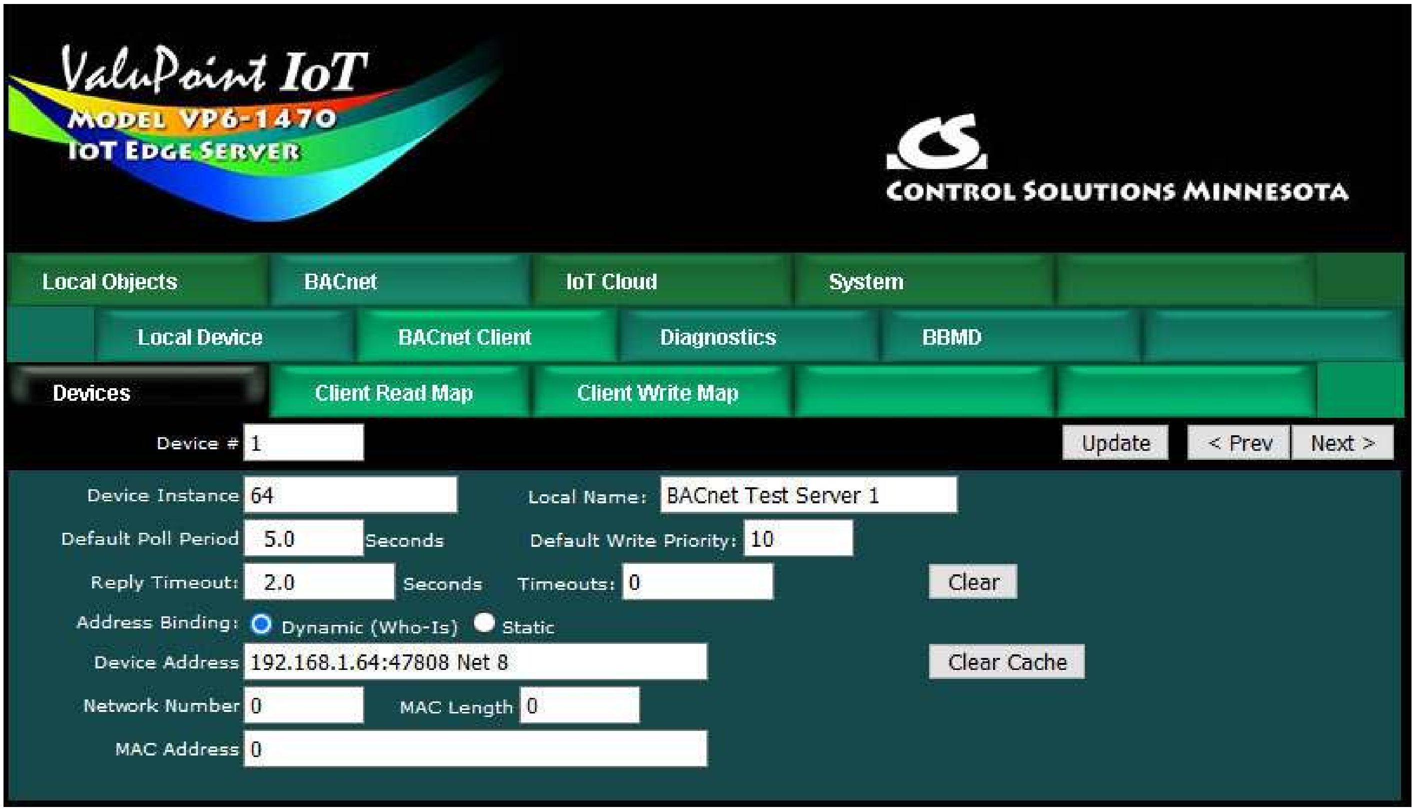
7. Configuring ValuPoint as a BACnet Client

The BACnet client is used to query other BACnet devices, obtain their Present Value data (or other property value), and store a copy of that data in the ValuPoint's own local objects. From there, the data may be accessed by event handling, data logging, scheduling, the Cloud, or other BACnet devices.

This data exchange with other BACnet devices requires that you define those devices in the list on the BACnet Client Devices page, and then create some number of Read and Write Maps. The maps may be created via the web pages talked about below. But you also have the option of using a standard spread sheet program to create a list that you save as a CSV file, and then import that via the File Manager in the ValuPoint. See section 7.5 below for more about importing CSV files, and also Appendix C for CSV file format information.

7.1 BACnet Device List

Setting up the BACnet client consists of identifying one or more BACnet devices, then listing the objects that should be queried (whether read or written). The client configuration pages are illustrated below.



Device # 1

Device Instance 64

Local Name: BACnet Test Server 1

Default Poll Period 5.0 Seconds

Default Write Priority: 10

Reply Timeout: 2.0 Seconds

Timeouts: 0

Address Binding: ● Dynamic (Who-Is) ○ Static

Device Address 192.168.1.64:47808 Net 8

Network Number 0

MAC Length 0

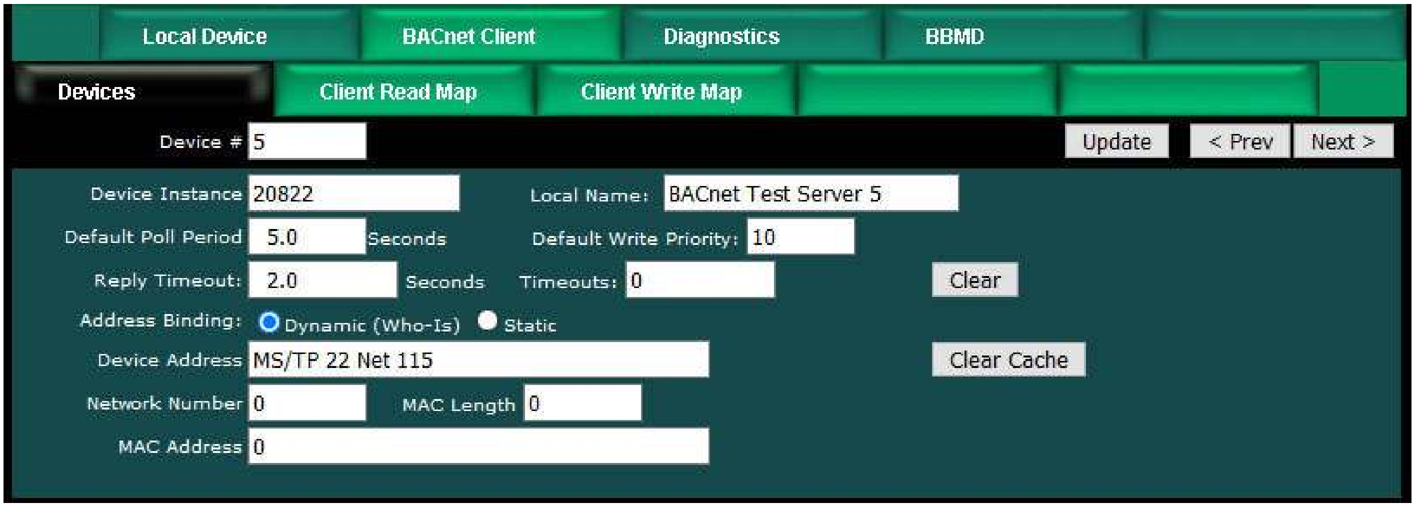
MAC Address 0

Device number simply shows you where you are on the internal local device list. Click "next" and "prev" to scroll through the list.

Remote BACnet devices to be accessed by this device are specified here. Enter the Device Instance of the remote device, a name to reference in other pages, and a poll rate. Then click "Update".

Select dynamic or static address binding. Dynamic binding is used most often, and simply means the ValuPoint will send out a "Who-Is" request asking for the device instance to respond, at which time the ValuPoint learns its IP or MS/TP address automatically.

When dynamic address binding is used (default), the ValuPoint broadcasts a "Who-Is" looking for this device instance when a read or write map wants to use this device. When (if) it responds, its IP address is listed here simply as a diagnostic. Timeouts resulting from inability to reach this device are tabulated on this page as well, and may be cleared by clicking the Clear button. To cause the who-is process to be repeated, click Clear Cache. When dynamic binding is used, the IP address is read-only and any changes entered will be ignored.



Device # 5

Device Instance 20822

Local Name: BACnet Test Server 5

Default Poll Period 5.0 Seconds

Default Write Priority: 10

Reply Timeout: 2.0 Seconds

Timeouts: 0

Address Binding: ● Dynamic (Who-Is) ○ Static

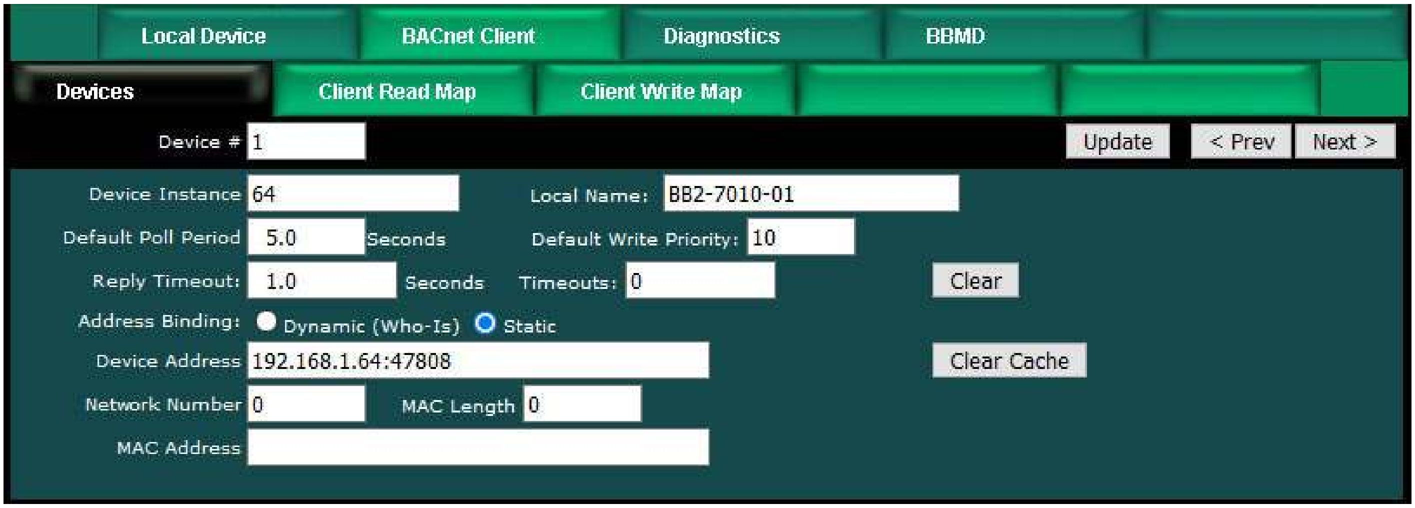
Device Address MS/TP 22 Net 115

Network Number 0

MAC Length 0

MAC Address 0

If static binding must be used, enter the fixed IP address you know the device instance to be found at. If no port is given, it will default to 0xBAC0 (47808). Enter IP as a.b.c.d or IP with port as a.b.c.d:p, for example 192.168.1.99:47808. Network number 0 means local IP network. If the device is on the other side of a router, the MAC Address entry must be used instead.



Device # 1

Device Instance 64 Local Name: BB2-7010-01

Default Poll Period 5.0 Seconds Default Write Priority: 10

Reply Timeout: 1.0 Seconds Timeouts: 0

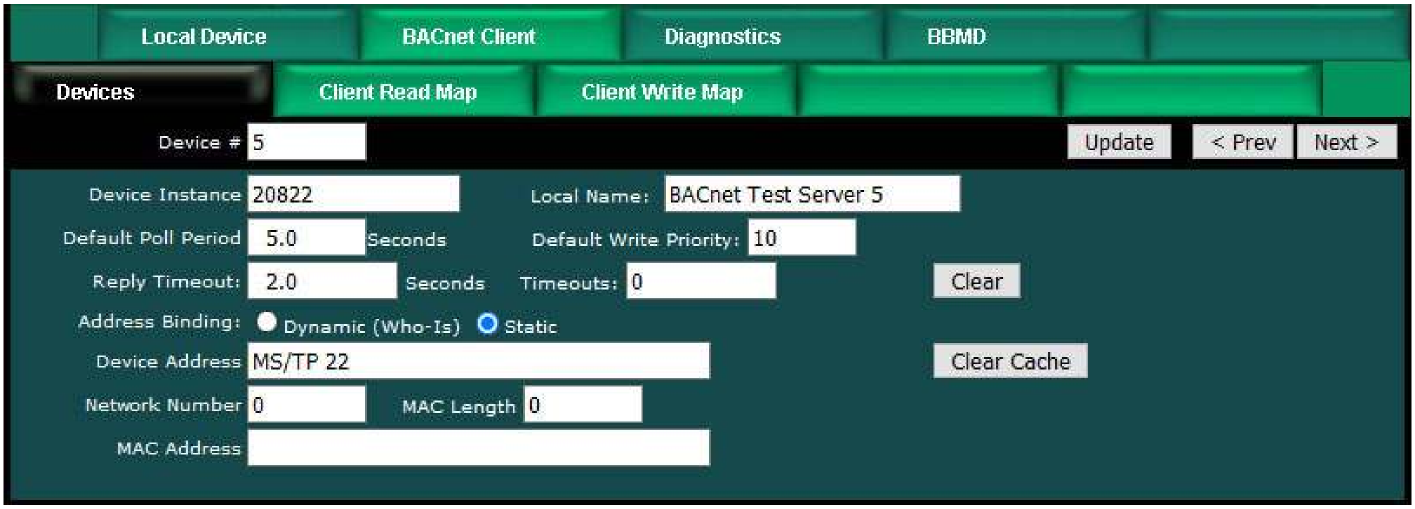
Address Binding: ○ Dynamic (Who-Is) ● Static

Device Address 192.168.1.64:47808

Network Number 0 MAC Length 0

MAC Address

If the device is on the local MS/TP link then enter its MS/TP MAC address as the device address using "MS/TP" followed by the address. Network number 0 means local MS/TP network. If the device is on the other side of a router, the MAC Address entry must be used instead.



Device # 5

Device Instance 20822 Local Name: BACnet Test Server 5

Default Poll Period 5.0 Seconds Default Write Priority: 10

Reply Timeout: 2.0 Seconds Timeouts: 0

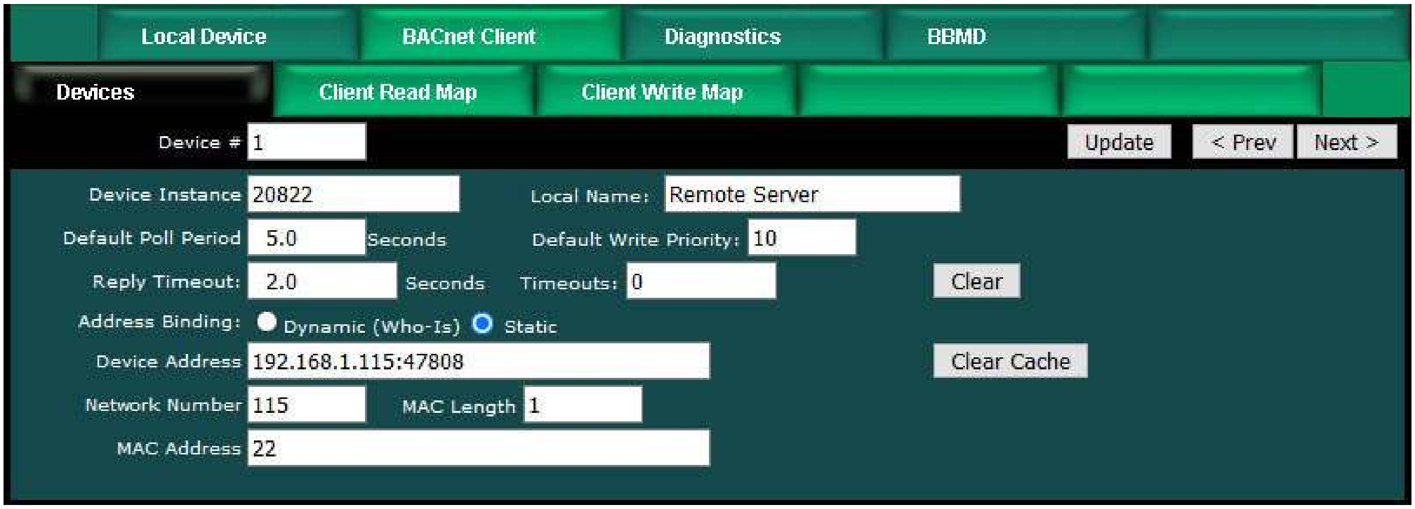
Address Binding: ○ Dynamic (Who-Is) ● Static

Device Address MS/TP 22

Network Number 0 MAC Length 0

MAC Address

Include network number, mac length, and mac address ONLY if static binding to a device on the other side of some other BACnet router. In the example below, the device is an MS/TP device at MAC address 22 on network 115 on the other side of a router at 192.168.1.115 which is connected to the local IP network.



Device # 1

Device Instance 20822 Local Name: Remote Server

Default Poll Period 5.0 Seconds Default Write Priority: 10

Reply Timeout: 2.0 Seconds Timeouts: 0

Address Binding: ○ Dynamic (Who-Is) ● Static

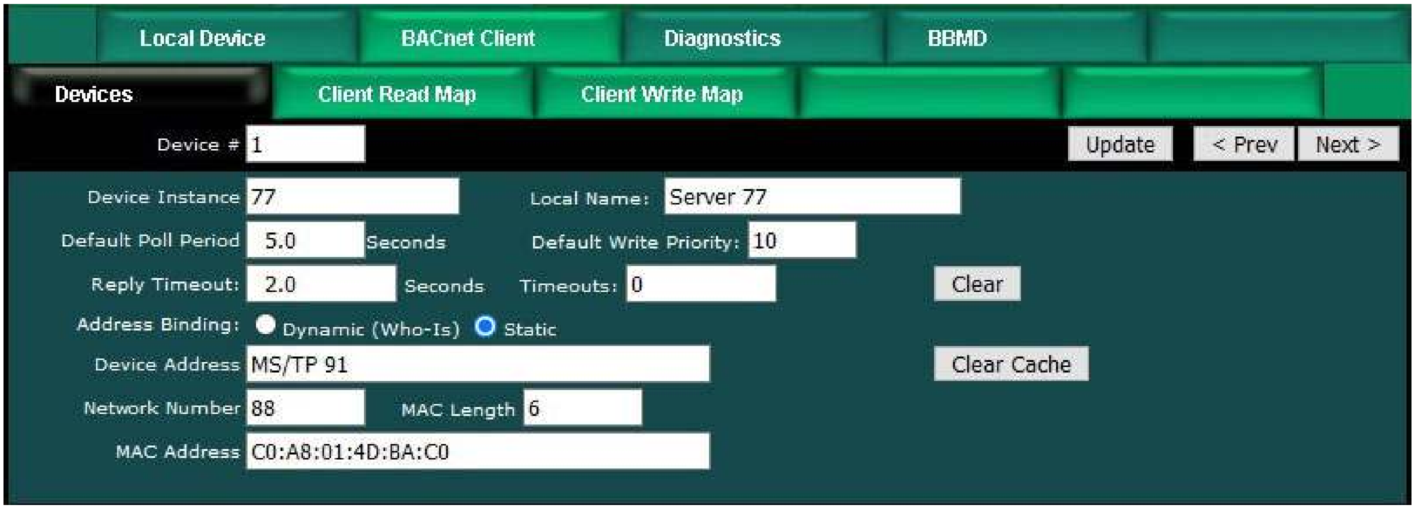
Device Address 192.168.1.115:47808

Network Number 115 MAC Length 1

MAC Address 22

In the example below, the device is a BACnet IP device at IP address 192.168.1.77 (port 47808) on network 88 on the other side of a router at MAC address 91 which is connected to the local MS/TP network.

When using static binding to a device on the other side of another router, the Device Address must always be the address of that other router and the Device Address given must be connected to the local network.



Device # 1

Device Instance 77 Local Name: Server 77

Default Poll Period 5.0 Seconds Default Write Priority: 10

Reply Timeout: 2.0 Seconds Timeouts: 0

Address Binding: ○ Dynamic (Who-Is) ● Static

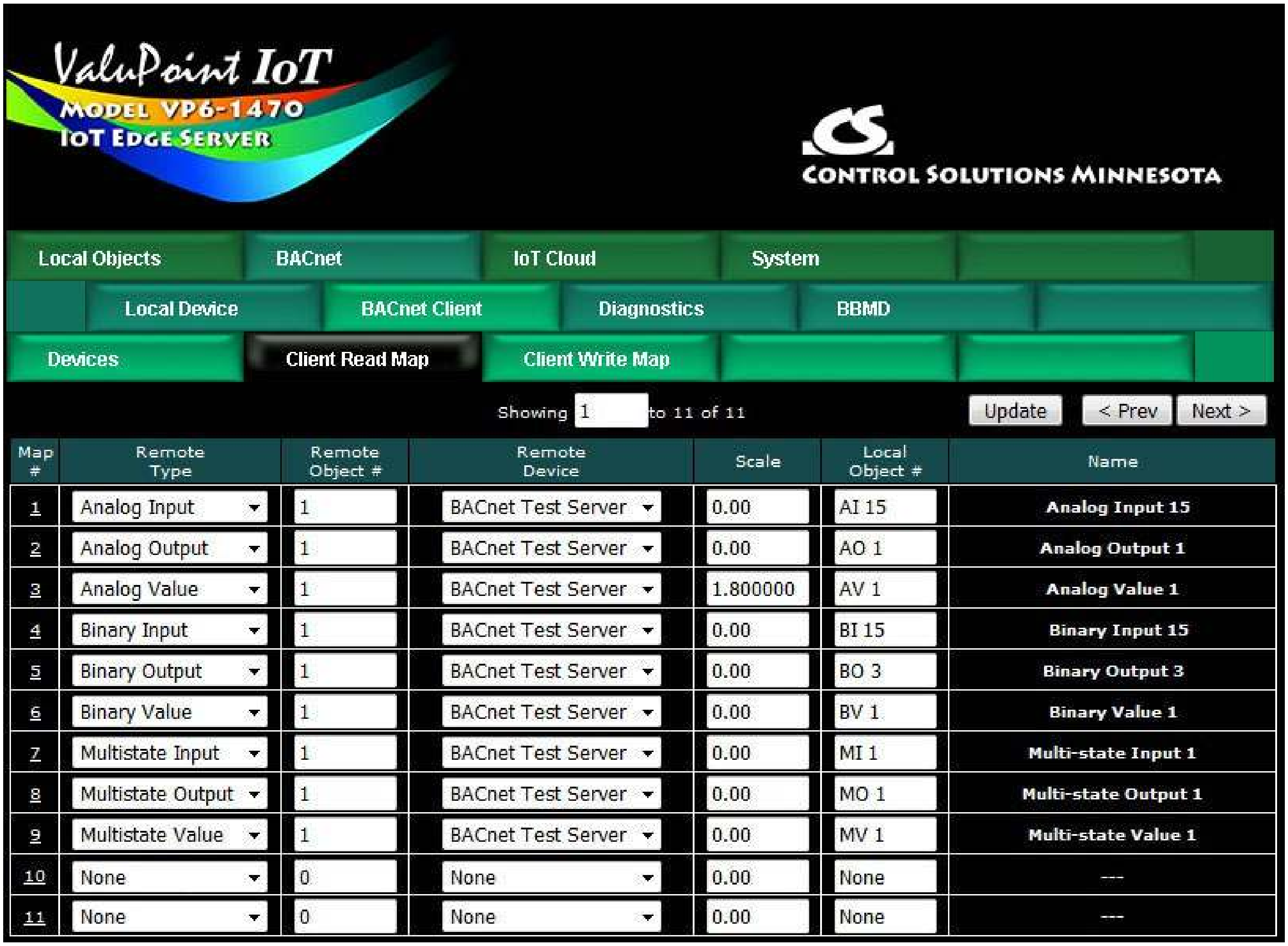
Device Address MS/TP 91

Network Number 88 MAC Length 6

MAC Address C0:A8:01:4D:BA:C0

7.2 BACnet Client Read Maps

Getting the ValuPoint to read objects from another BACnet device requires setting up a "Read Map" as shown here.



Showing 1 to 11 of 11

Map #	Remote Type	Remote Object #	Remote Device	Scale	Local Object #	Name
1	Analog Input	1	BACnet Test Server	0.00	AI 15	Analog Input 15
2	Analog Output	1	BACnet Test Server	0.00	AO 1	Analog Output 1
3	Analog Value	1	BACnet Test Server	1.800000	AV 1	Analog Value 1
4	Binary Input	1	BACnet Test Server	0.00	BI 15	Binary Input 15
5	Binary Output	1	BACnet Test Server	0.00	BO 3	Binary Output 3
6	Binary Value	1	BACnet Test Server	0.00	BV 1	Binary Value 1
7	Multistate Input	1	BACnet Test Server	0.00	MI 1	Multi-state Input 1
8	Multistate Output	1	BACnet Test Server	0.00	MO 1	Multi-state Output 1
9	Multistate Value	1	BACnet Test Server	0.00	MV 1	Multi-state Value 1
10	None	0	None	0.00	None	---
11	None	0	None	0.00	None	---

Map number simply tells you where you're at on the list of object maps. Click "next" and "prev" to scroll through the list. To advance directly to a specific map, enter the desired number in the "Showing" box, then click Update.

Maps entered on this page only read data from remote devices. Go to the Client Write Map to write data to those devices. The full parameter set is different for read versus write.

An abbreviated version of a list of maps is shown on this page. Any of the parameters shown may be changed here and registered by clicking the Update button. To view and/or modify the complete set of parameters, click on the map number in the left most column.

For each remote object to be read, select the object instance and type, and remote device. The names in the remote device list are defined in the Devices page. The property read will default to Present Value. If you wish to read a different property, click on the Map # in the first column for the expanded view of the map and enter the property number.

When the remote object is read, data may be manipulated before being written to the local object. The value will be multiplied by the scale factor. The final result is written to the local object number given. The name is optional and used only for display purposes.

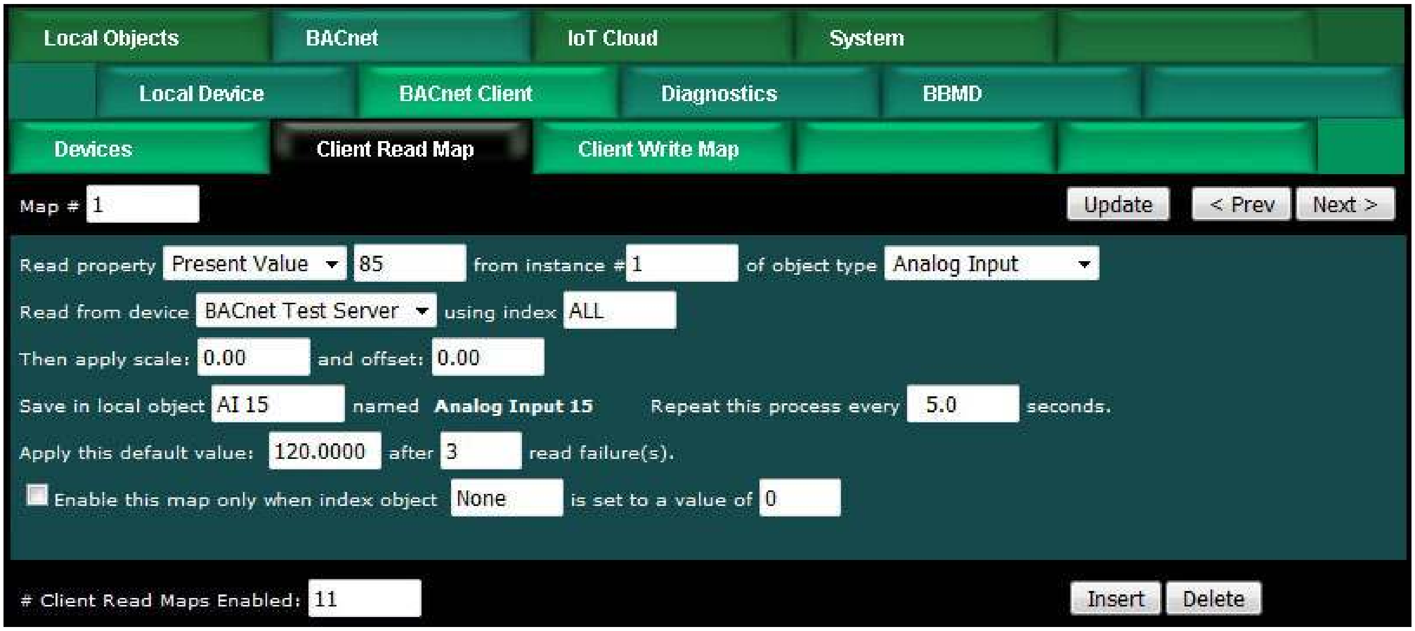
Selecting "none" for remote type effectively deletes the map even though it will still appear in the list until deleted. Unused maps at the end of the list will always show none as the type.

Local Object is internally a coded number consisting of BACnet object type multiplied by 10000, then added to the object number starting from #1. These numbers will appear as "register numbers" in XML configuration files. These are translated into abbreviations that are easy to interpret on the web page as follows:

AI n = Analog Input #n
AO n = Analog Output #n
AV n = Analog Value #n
BI n = Binary Input #n
BO n = Binary Output #n
BV n = Binary Value #n
MI n = Multi-state Input #n
MO n = Multi-state Output #n
MV n = Multi-state Value #n

Local object numbers start at #1. The maximum available number varies by object type, and these limits are set on the Resources page (under System).

Click on a Map # in the first column of maps to get the expanded view of that map as follows:



Map # 1

Read property Present Value 85 from instance # 1 of object type Analog Input

Read from device BACnet Test Server using index ALL

Then apply scale: 0.00 and offset: 0.00

Save in local object AI 15 named **Analog Input 15** Repeat this process every 5.0 seconds.

Apply this default value: 120.0000 after 3 read failure(s).

□ Enable this map only when index object None is set to a value of 0

Client Read Maps Enabled: 11

Map number simply tells you where you're at on the list of object maps. Click "next" and "prev" to scroll through the list. To advance directly to a specific map, enter the desired number in the "Map #" box, then click Update.

For each remote object to be read, enter the property number, object instance and type, and select a remote device. The names in the device list are defined in the

Devices page. Use index value of "ALL" if no index (use this by default if you do not have a known index number).

The most commonly read property will be Present Value, which is property number 85. For other property numbers, refer to Appendix E, BACnet Codes.

When the remote object is read, data may be manipulated before being written to the local object. The value will be multiplied by the scale factor, then the offset is added. The final result is written to the local object number given. The name is optional and used only for display purposes.

The periodic poll time ("Repeat this process") determines how often the remote object will be read. This number, if nonzero, will override the default poll time given in the Devices page for the remote device being read.

The default value will be stored into the local object after the given number of read failures if the fail count is non-zero. Setting the count to zero will disable the default, and the object will retain the most recent value obtained.

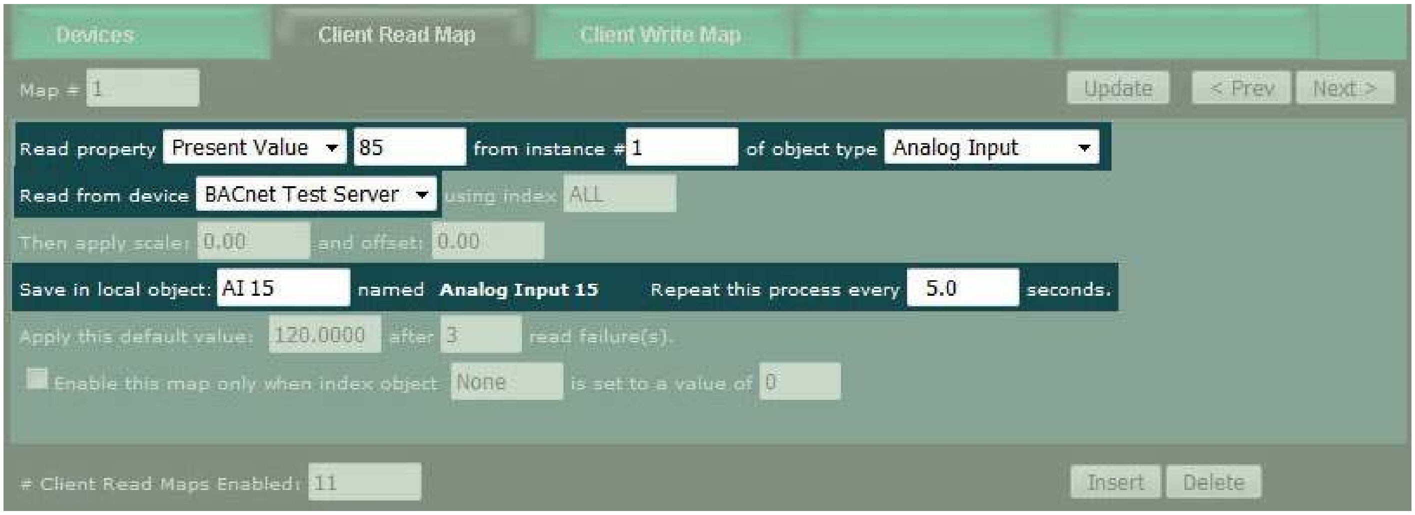
You have the option of enabling this map only when a selected object contains a given value. Any local object may be used as the index object. As the name implies, you could have the same local object contain different values based on different maps as indexed by the index object.

Delete will remove the map number shown in the "Map #" box. Insert will insert a new map before the map number shown, and is used for placing maps between existing maps. It is not necessary to use Insert to add maps to the bottom of the list or to define any map presently having zero for a source object or "none" for remote type.

Selecting "none" for remote type effectively deletes the map even though it will still appear in the list until deleted. Unused maps at the end of the list will always show none as the type. If you wish to prevent these from being displayed, reduce the number of maps enabled.

The number of maps enabled simply limits the scope of map review so that you do not have to review a lot of unused maps. If the displayed maps are used up and you need more, increase the enabled number.

The expanded view of the Client Read Map may look daunting at first. Here is the same screen shot with the parts you are most likely to not use grayed out for illustration purposes. If you are only concerned with reading Present Value and you have set the default poll time on the Device page, then you really never need to look at the expanded view at all. Your configuration can be entered entirely on the tabular list of maps. The same applies to Write Maps below.



Map # 1

Read property Present Value 85 from instance # 1 of object type Analog Input

Read from device BACnet Test Server using index ALL

Then apply scale: 0.00 and offset: 0.00

Save in local object: AI 15 named **Analog Input 15** Repeat this process every 5.0 seconds.

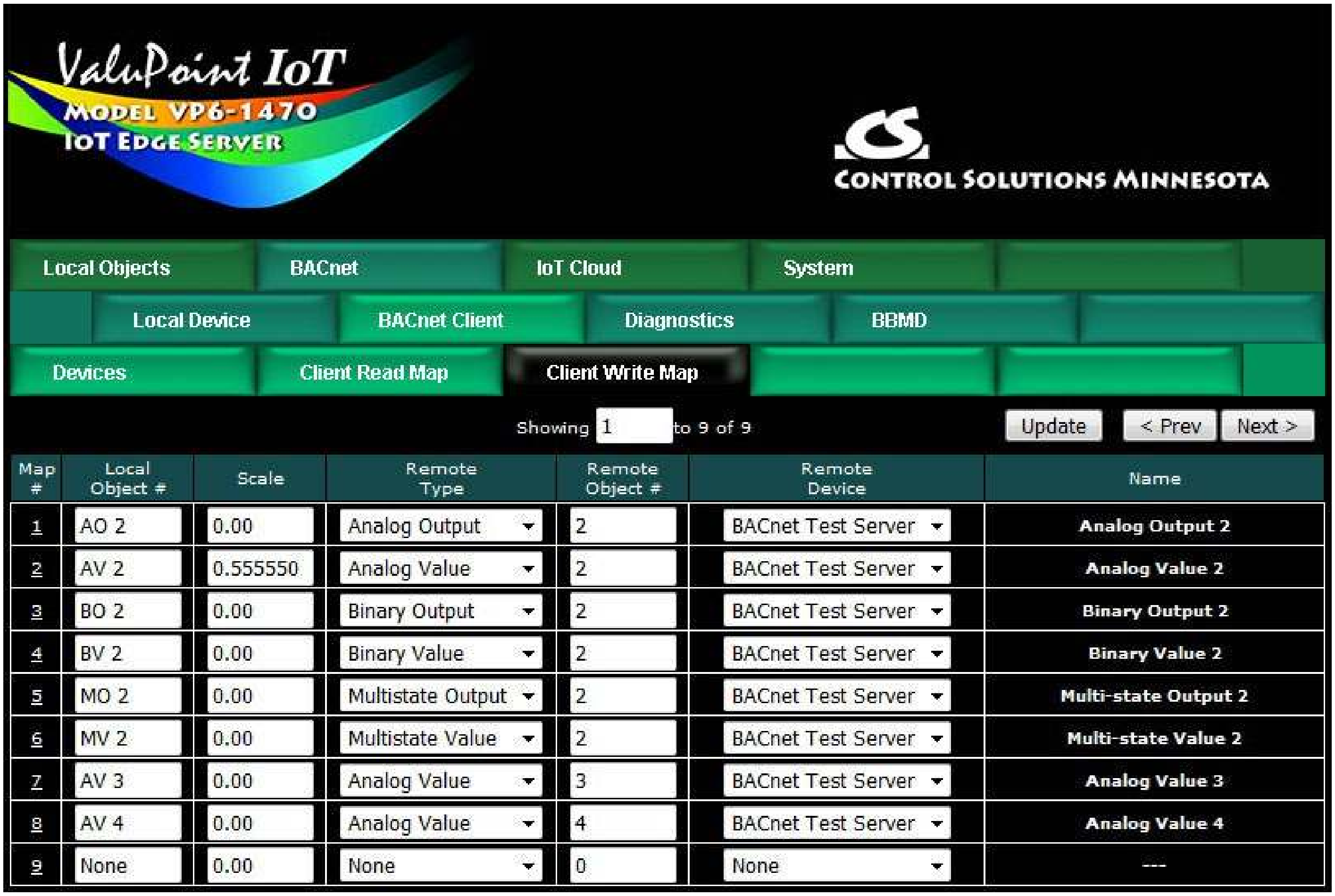
Apply this default value: 120.0000 after 3 read failure(s).

□ Enable this map only when index object None is set to a value of 0

Client Read Maps Enabled: 11

7.3 BACnet Client Write Maps

Getting the ValuPoint to write objects to another BACnet device requires setting up a "Write Map" as shown here. Much of the Write Map is configured the same as a Read Map.



Showing 1 to 9 of 9

Map #	Local Object #	Scale	Remote Type	Remote Object #	Remote Device	Name
1	AO 2	0.00	Analog Output	2	BACnet Test Server	**Analog Output 2**
2	AV 2	0.555550	Analog Value	2	BACnet Test Server	**Analog Value 2**
3	BO 2	0.00	Binary Output	2	BACnet Test Server	**Binary Output 2**
4	BV 2	0.00	Binary Value	2	BACnet Test Server	**Binary Value 2**
5	MO 2	0.00	Multistate Output	2	BACnet Test Server	**Multi-state Output 2**
6	MV 2	0.00	Multistate Value	2	BACnet Test Server	**Multi-state Value 2**
7	AV 3	0.00	Analog Value	3	BACnet Test Server	**Analog Value 3**
8	AV 4	0.00	Analog Value	4	BACnet Test Server	**Analog Value 4**
9	None	0.00	None	0	None	---

Map number simply tells you where you're at on the list of object maps. Click "next" and "prev" to scroll through the list. To advance directly to a specific map, enter the desired number in the "Showing" box, then click Update.

Maps entered on this page only write data to remote devices. Go to the Client Read Map to read data from those devices. The full parameter set is different for read versus write.

An abbreviated version of a list of maps is shown on this page. Any of the parameters shown may be changed here and registered by clicking the Update button. To view and/or modify the complete set of parameters, click on the map number in the left most column.

For each remote object to be written, select the object instance and type, and remote device. The names in the device list are defined in the Devices page. The property written will default to Present Value. If you wish to write a different property, click on the Map # in the first column for the expanded view of the map and enter the property number.

Data from the local object given will be multiplied by the scale factor before being written.

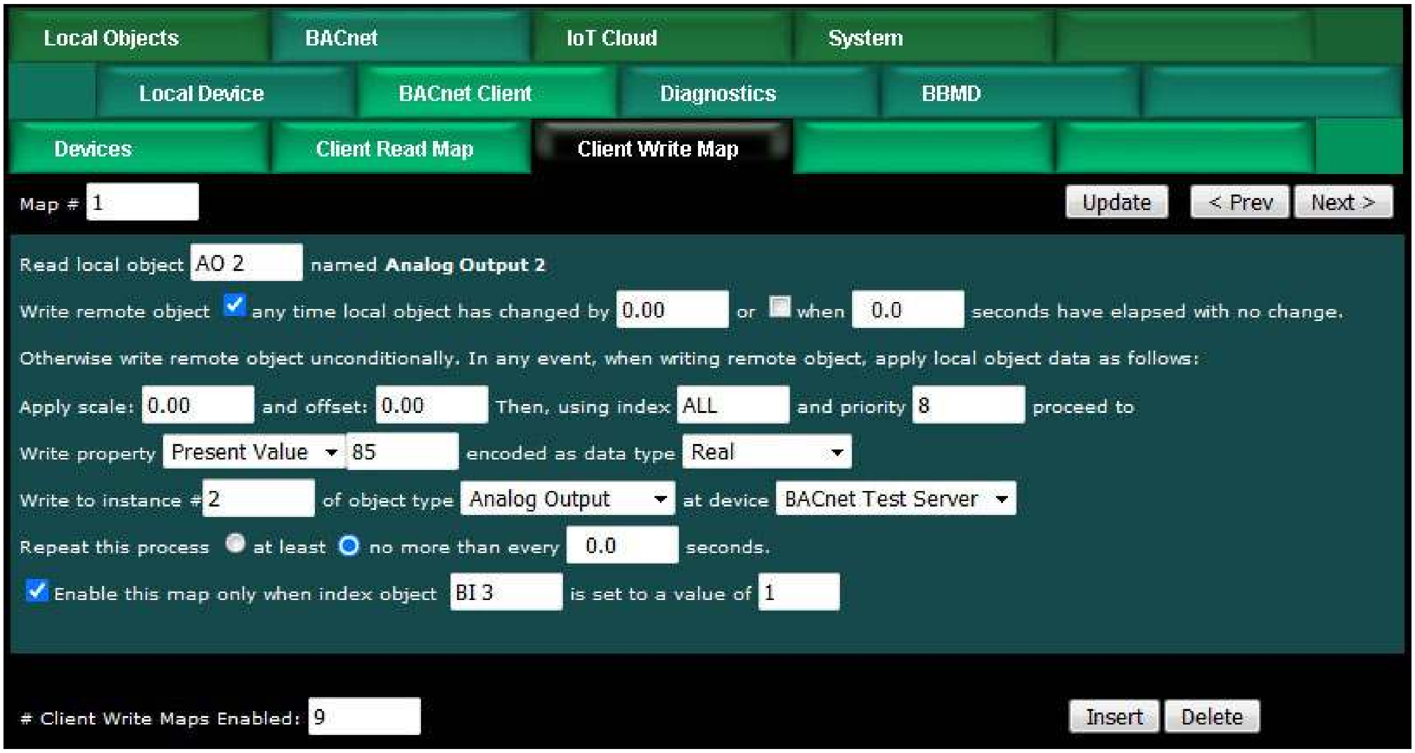
Selecting "none" for remote type effectively deletes the map even though it will still appear in the list until deleted. Unused maps at the end of the list will always show none as the type.

Local Object is internally a coded number consisting of BACnet object type multiplied by 10000, then added to the object number starting from #1. These numbers will appear as "register numbers" in XML configuration files. These are translated into abbreviations that are easy to interpret on the web page as follows:

AI n = Analog Input #n
AO n = Analog Output #n
AV n = Analog Value #n
BI n = Binary Input #n
BO n = Binary Output #n
BV n = Binary Value #n
MI n = Multi-state Input #n
MO n = Multi-state Output #n
MV n = Multi-state Value #n

Object numbers start at #1. The maximum available number varies by object type, and these limits are set on the Resources page (under System).

Click on a Map # in the first column of maps to get the expanded view of that map as follows:



Map # 1

Read local object AO 2 named **Analog Output 2**

Write remote object ☑ any time local object has changed by 0.00 or □ when 0.0 seconds have elapsed with no change.

Otherwise write remote object unconditionally. In any event, when writing remote object, apply local object data as follows:

Apply scale: 0.00 and offset: 0.00 Then, using index ALL and priority 8 proceed to

Write property Present Value 85 encoded as data type Real

Write to instance # 2 of object type Analog Output at device BACnet Test Server

Repeat this process ○ at least ● no more than every 0.0 seconds.

☑ Enable this map only when index object BI 3 is set to a value of 1

Client Write Maps Enabled: 9

Map number simply tells you where you're at on the list of object maps. Click "next" and "prev" to scroll through the list. To advance directly to a specific map, enter the desired number in the "Map #" box, then click Update.

The local object data may be written periodically, or when it changes, or both. To send upon change (send on delta), check the first box and enter the amount by which the local object must change before being written to the remote device. To guarantee that the remote object will be written at least occasionally even if the data does not change, check the second box and enter some amount of time. This time period will be referred to as the "maximum quiet time".

Data from the local object may be manipulated before being written to the remote object. The local data is first multiplied by the scale factor. The offset is then added to it.

For the remote object to be written, enter the property number, object instance and type, index if applicable (enter "ALL" if no index), and priority to use of the object being written is commandable. Select a remote device to write to. The names in the device list are defined in the Devices page.

The most commonly written property will be Present Value, which is property number 85. For other property numbers, refer to Appendix E, BACnet Codes.

The repeat time may determine how often the remote object will be written. If send on delta and maximum quiet time are not checked above, clicking the "at least" button will establish a periodic update time. If send on delta is used and you wish to limit the network traffic in the event changes are frequent, click the "no more than" button and enter the minumum time that should elapse before another write to the remote device.

You have the option of enabling this map only when a selected object contains a given value. Any local object may be used as the index object. As the name implies, you can write different values to the remote object based on different maps as indexed by the index object.

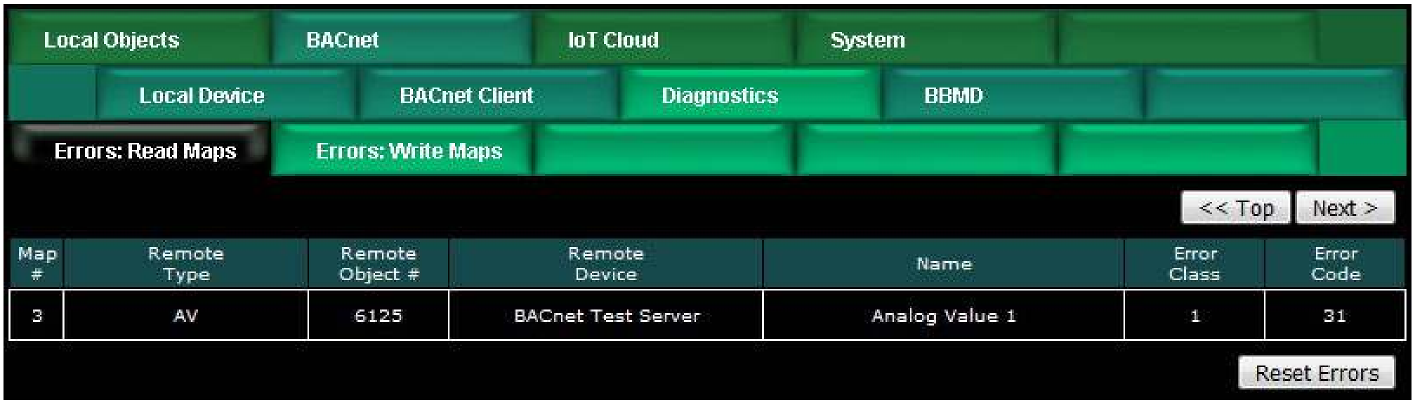
Delete will remove the map number shown in the "Map #" box. Insert will insert a new map before the map number shown, and is used for placing maps between existing maps. It is not necessary to use Insert to add maps to the bottom of the list or to define any map presently having zero for a source object or "none" for remote type.

Selecting "none" for remote type effectively deletes the map even though it will still appear in the list until deleted. Unused maps at the end of the list will always show none as the type. If you wish to prevent these from being displayed, reduce the number of maps enabled.

The number of maps enabled simply limits the scope of map review so that you do not have to review a lot of unused maps. If the displayed maps are used up and you need more, increase the enabled number.

7.4 BACnet Client Diagnostics

If errors are detected in the course of reading or writing other BACnet objects via the client's maps, they will be indicated on the errors pages.



Map #	Remote Type	Remote Object #	Remote Device	Name	Error Class	Error Code
3	AV	6125	BACnet Test Server	Analog Value 1	1	31

Errors for BACnet client read/write maps are shown on these pages. Only those maps with errors to report are listed. Refer to the code and class lists below for interpretation. In the illustration above, error class 1 says the error refers to "object" and the code says "unknown object". In other words, AV 6125 does not exist in the device shown.

Proprietary class 82, code 0, is generated locally indicating a timeout, no response received from remote server. All other codes listed below are returned by the remote server.

0 = ERROR_CLASS_DEVICE
1 = ERROR_CLASS_OBJECT
2 = ERROR_CLASS_PROPERTY
3 = ERROR_CLASS_RESOURCES
4 = ERROR_CLASS_SECURITY

```
5 = ERROR_CLASS_SERVICES

/* valid for all classes */
0 = ERROR_CODE_OTHER

/* Error Class - Device */
2 = ERROR_CODE_CONFIGURATION_IN_PROGRESS
3 = ERROR_CODE_DEVICE_BUSY
25 = ERROR_CODE_OPERATIONAL_PROBLEM

/* Error Class - Object */
4 = ERROR_CODE_DYNAMIC_CREATION_NOT_SUPPORTED
17 = ERROR_CODE_NO_OBJECTS_OF_SPECIFIED_TYPE
23 = ERROR_CODE_OBJECT_DELETION_NOT_PERMITTED
24 = ERROR_CODE_OBJECT_IDENTIFIER_ALREADY_EXISTS
27 = ERROR_CODE_READ_ACCESS_DENIED
31 = ERROR_CODE_UNKNOWN_OBJECT
36 = ERROR_CODE_UNSUPPORTED_OBJECT_TYPE

/* Error Class - Property */
8 = ERROR_CODE_INCONSISTENT_SELECTION_CRITERION
9 = ERROR_CODE_INVALID_DATA_TYPE
32 = ERROR_CODE_UNKNOWN_PROPERTY
37 = ERROR_CODE_VALUE_OUT_OF_RANGE
40 = ERROR_CODE_WRITE_ACCESS_DENIED
41 = ERROR_CODE_CHARACTER_SET_NOT_SUPPORTED
42 = ERROR_CODE_INVALID_ARRAY_INDEX
44 = ERROR_CODE_NOT_COV_PROPERTY
45 = ERROR_CODE_OPTIONAL_FUNCTIONALITY_NOT_SUPPORTED
47 = ERROR_CODE_DATATYPE_NOT_SUPPORTED
50 = ERROR_CODE_PROPERTY_IS_NOT_AN_ARRAY

/* Error Class - Resources */
18 = ERROR_CODE_NO_SPACE_FOR_OBJECT
19 = ERROR_CODE_NO_SPACE_TO_ADD_LIST_ELEMENT
20 = ERROR_CODE_NO_SPACE_TO_WRITE_PROPERTY

/* Error Class - Security */
1 = ERROR_CODE_AUTHENTICATION_FAILED
6 = ERROR_CODE_INCOMPATIBLE_SECURITY_LEVELS
12 = ERROR_CODE_INVALID_OPERATOR_NAME
15 = ERROR_CODE_KEY_GENERATION_ERROR
26 = ERROR_CODE_PASSWORD_FAILURE
28 = ERROR_CODE_SECURITY_NOT_SUPPORTED
30 = ERROR_CODE_TIMEOUT

/* Error Class - Services */
5 = ERROR_CODE_FILE_ACCESS_DENIED
7 = ERROR_CODE_INCONSISTENT_PARAMETERS
```

10 = ERROR_CODE_INVALID_FILE_ACCESS_METHOD
11 = ERROR_CODE_ERROR_CODE_INVALID_FILE_START_POSITION
13 = ERROR_CODE_INVALID_PARAMETER_DATA_TYPE
14 = ERROR_CODE_INVALID_TIME_STAMP
16 = ERROR_CODE_MISSING_REQUIRED_PARAMETER
22 = ERROR_CODE_PROPERTY_IS_NOT_A_LIST
29 = ERROR_CODE_SERVICE_REQUEST_DENIED
43 = ERROR_CODE_COV_SUBSCRIPTION_FAILED
46 = ERROR_CODE_INVALID_CONFIGURATION_DATA
48 = ERROR_CODE_DUPLICATE_NAME
49 = ERROR_CODE_DUPLICATE_OBJECT_ID

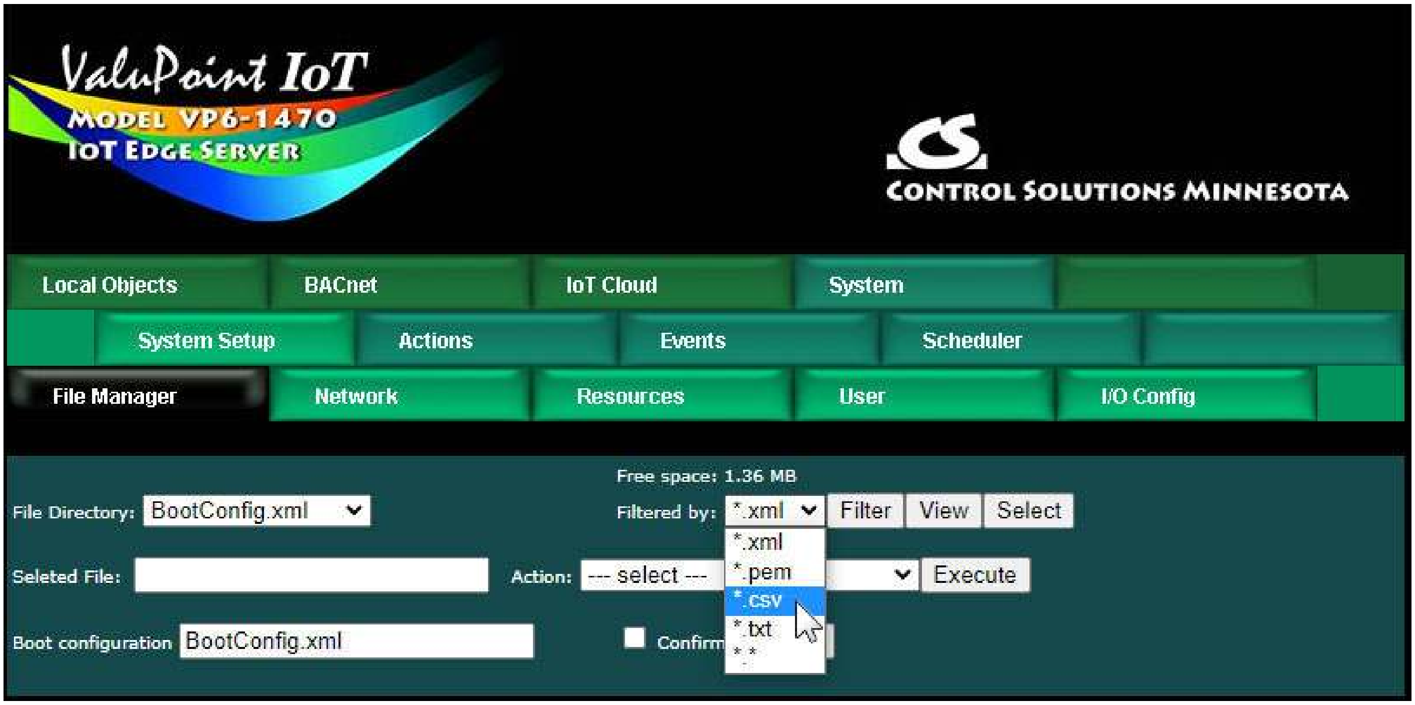
7.5 Importing BACnet Client Maps from CSV File

The built-in web user interface is user friendly, but can get tedious if you have a lot of maps to enter. You may already have a list of BACnet objects available in spread sheet form. With a bit of editing, you can turn this into a CSV file that can be directly imported into the ValuPoint to quickly configure a lot of read and write maps. If you are proficient with spread sheets, you can probably create a rather large set of maps quickly and speed up the process of configuring the ValuPoint.

There is more discussion about the File Manager in Section 3, but a summary of what you need to do to import maps from a CSV file is given here.

Start by uploading your CSV file. Use the Browse button to locate the file on your PC, then click Upload.

Select *.csv as the file filter. This will result in showing the list of CSV files currently stored in the ValuPoint.



Free space: 1.36 MB

File Directory: BootConfig.xml

Filtered by: *.xml

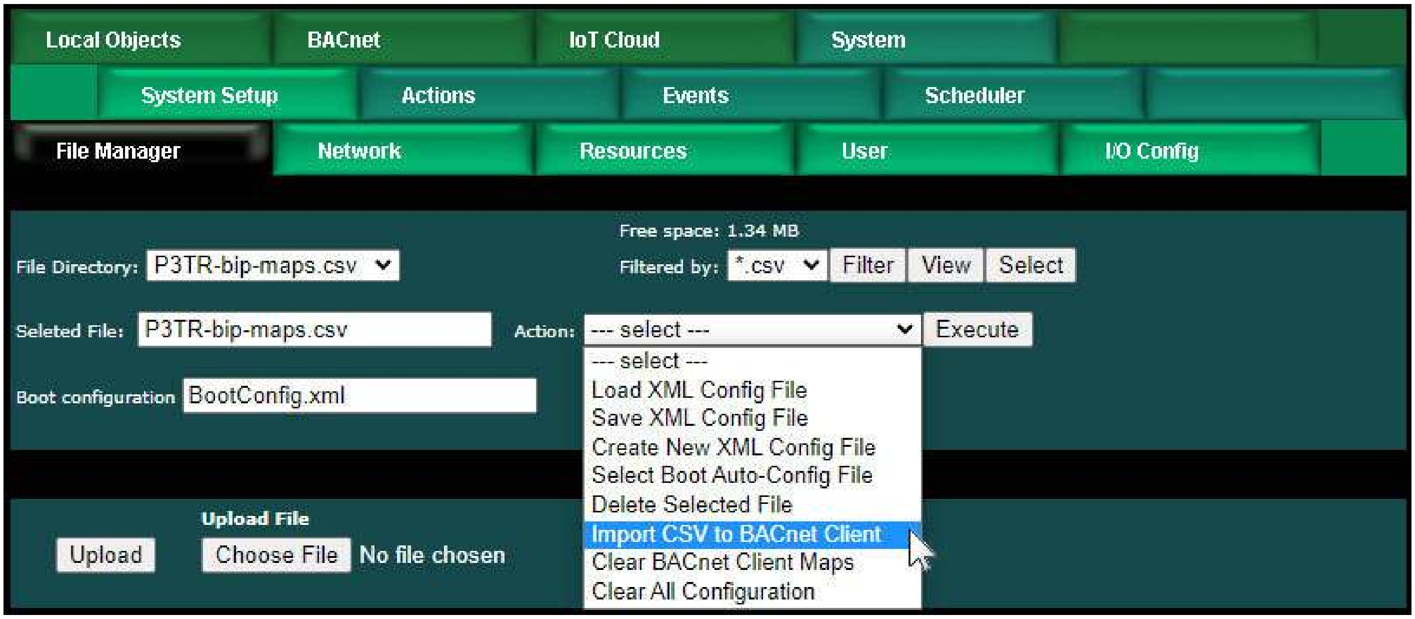
Seleted File:

Action: --- select ---

Boot configuration BootConfig.xml

□ Confirm

Select your file from the File Directory drop-down list, then click the Select button on the right. Select "Import CSV to BACnet Client" from the Action list, and click Execute.



Free space: 1.34 MB

File Directory: P3TR-bip-maps.csv

Filtered by: *.csv

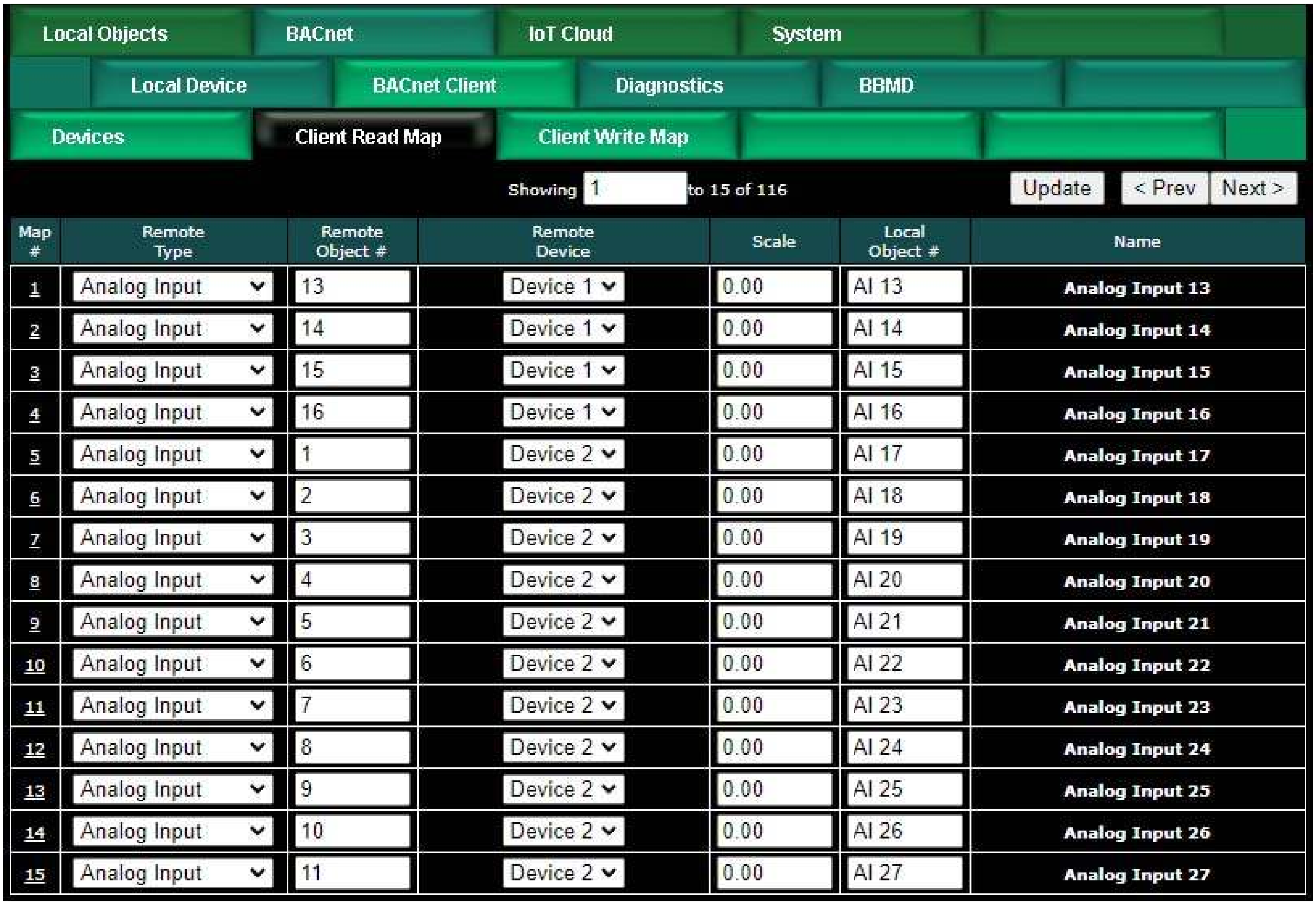
Seleted File: P3TR-bip-maps.csv

Action: --- select ---

Boot configuration BootConfig.xml

Upload File No file chosen

We imported 116 read maps in our example test case.



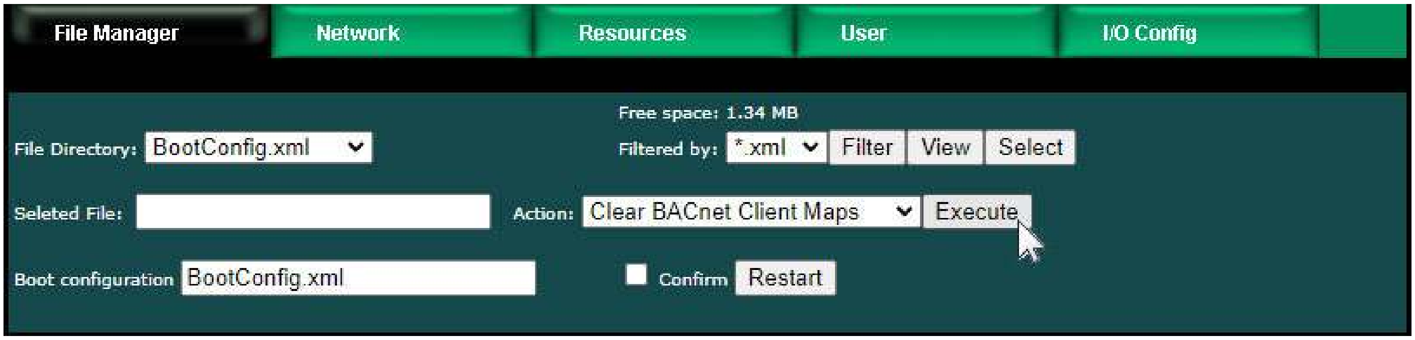
Showing 1 to 15 of 116

Map #	Remote Type	Remote Object #	Remote Device	Scale	Local Object #	Name
1	Analog Input	13	Device 1	0.00	AI 13	Analog Input 13
2	Analog Input	14	Device 1	0.00	AI 14	Analog Input 14
3	Analog Input	15	Device 1	0.00	AI 15	Analog Input 15
4	Analog Input	16	Device 1	0.00	AI 16	Analog Input 16
5	Analog Input	1	Device 2	0.00	AI 17	Analog Input 17
6	Analog Input	2	Device 2	0.00	AI 18	Analog Input 18
7	Analog Input	3	Device 2	0.00	AI 19	Analog Input 19
8	Analog Input	4	Device 2	0.00	AI 20	Analog Input 20
9	Analog Input	5	Device 2	0.00	AI 21	Analog Input 21
10	Analog Input	6	Device 2	0.00	AI 22	Analog Input 22
11	Analog Input	7	Device 2	0.00	AI 23	Analog Input 23
12	Analog Input	8	Device 2	0.00	AI 24	Analog Input 24
13	Analog Input	9	Device 2	0.00	AI 25	Analog Input 25
14	Analog Input	10	Device 2	0.00	AI 26	Analog Input 26
15	Analog Input	11	Device 2	0.00	AI 27	Analog Input 27

Note: You should define your BACnet Devices before importing. If you import the read/write maps first and then define devices, you will need to manually go through and assign devices to the maps. If you forgot to define devices first, go to the File Manager page, clear BACnet client maps, then define the devices and repeat the import.

7.6 Clearing Configuration

Read and write maps imported from a CSV file will be added to the list of maps already in place. If you wish to reload the list, you must first clear it. Clear the BACnet client maps by going to the File Manager page, then selecting "Clear BACnet Client Maps" from the action list and clicking Execute.



Free space: 1.34 MB

File Directory: BootConfig.xml

Filtered by: *.xml

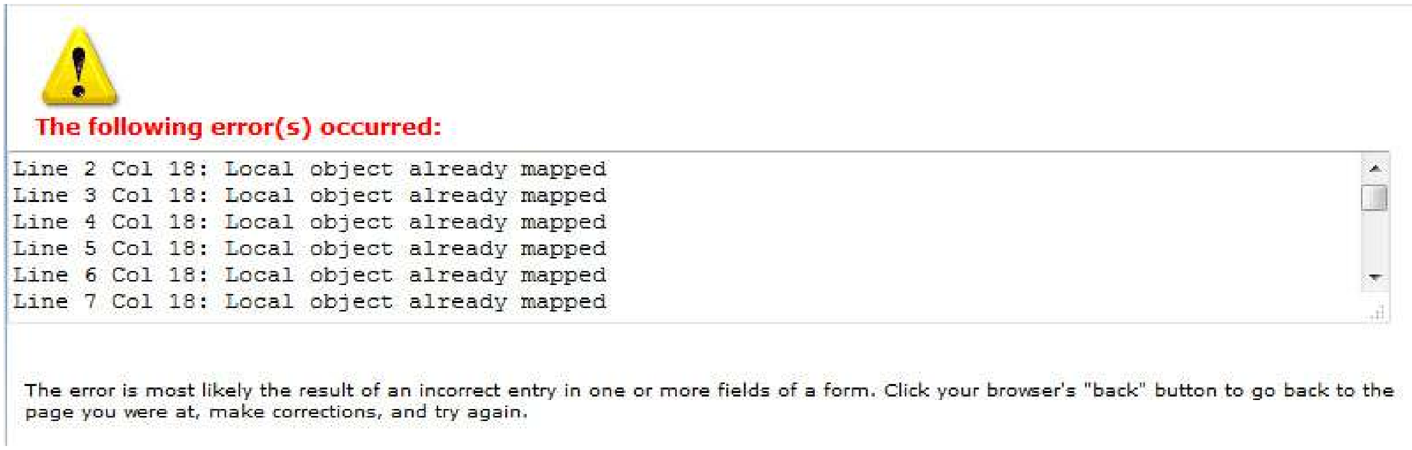
Seleted File:

Action: Clear BACnet Client Maps

Boot configuration BootConfig.xml

□ Confirm

If you forget to clear the maps before re-importing them, you will get an error notice something like this:



The following error(s) occurred:

```
Line 2 Col 18: Local object already mapped
Line 3 Col 18: Local object already mapped
Line 4 Col 18: Local object already mapped
Line 5 Col 18: Local object already mapped
Line 6 Col 18: Local object already mapped
Line 7 Col 18: Local object already mapped
```

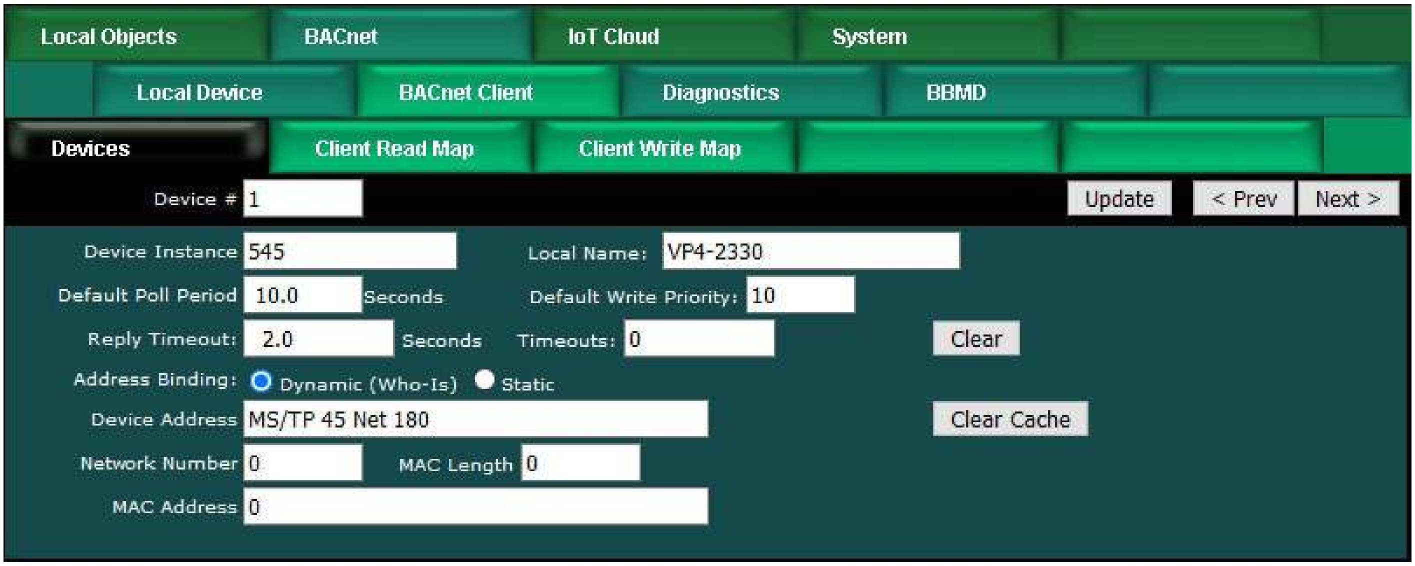
The error is most likely the result of an incorrect entry in one or more fields of a form. Click your browser's "back" button to go back to the page you were at, make corrections, and try again.

7.7 Understanding BACnet Client Timeout Settings

The ValuPoint includes a BACnet client that can be configured to read and write objects in other BACnet devices. Each point to be read or written is defined by a client read map or client write map. These maps reference a device, and each device has an entry on the Devices page. For each device, the BACnet Device Instance, a name, default poll period, and timeout are provided by the user.

The Reply Timeout is the amount of time the client will wait for a response before calling it a timeout if no response is received. The client will then move on to the next read or write map. The client will eventually come back around to the same point and try again. If the client times out a second time, then the mapped object’s reliability code will be set to the nonzero value indicating timeout, no response.

If repeated timeouts are observed, one should confirm that the device in question is operating. If so, then set a longer timeout period as needed.



Device # 1

Device Instance 545

Local Name: VP4-2330

Default Poll Period 10.0 Seconds

Default Write Priority: 10

Reply Timeout: 2.0 Seconds

Timeouts: 0

Address Binding: ● Dynamic (Who-Is) ○ Static

Device Address MS/TP 45 Net 180

Network Number 0

MAC Length 0

MAC Address 0

Much of the time, especially with BACnet IP, the client device timeout is the only timeout one needs to be pay much attention to. However, it is important to understand what is going on inside BACnet behind the scenes, especially if the client is making requests to an MS/TP device on the other side of a router.

The BACnet Device has settings that apply to all requests made by this device, and these are found on the BACnet settings page (illustrated below). Of particular concern with respect to timeouts are the APDU Timeout and APDU Retries.

Any time a request is made by this BACnet device, the request initiates a Transaction State Machine (TSM). The Invoke ID you will see if you use Wireshark to look at network traffic identifies this TSM. This invoke ID is used to associate a reply with a request. If the TSM does not see a reply within the APDU Timeout (given in milliseconds), then the TSM will automatically retransmit the request and wait another APDU Timeout period. This retransmission will be repeated up to the retry count. If the retry count is 3 as illustrated below (with a timeout of 3000 milliseconds), and no reply is ever received, this means the request will have been transmitted a total of 4 times (over 12 seconds).

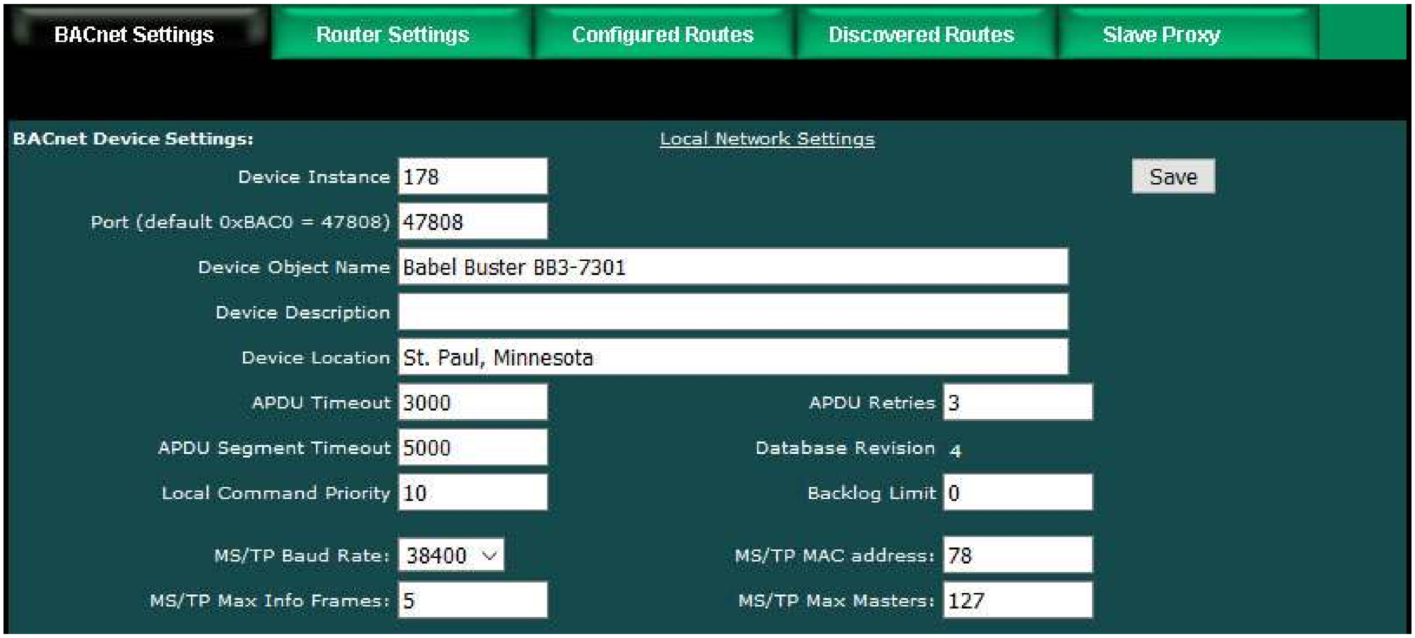
The APDU Timeout will default to 3000 (milliseconds) and APDU Retries will default to 3 as recommended by BACnet protocol. However, whether these numbers make sense for your application is left for you to determine.

It makes sense to have the BACnet client device timeout set to 2 seconds as illustrated above so that a timeout doesn't hang up the client for too long. However, if the default values for the BACnet Device are left as illustrated below, then here is what is going to happen when the target device does not reply: The client will send its initial request. Then 2 seconds later, it decides there is no response and moves on to the next point and sends the next request. Meanwhile the TSM has waited 3 seconds, then retransmitted the original request. Over a period of 12 seconds, the TSM will be sending the same original first request 4 times. As you can see, the client has not really waited for the final result in this instance. Furthermore, the client is kicking off more TSM's faster than they can complete their retry sequence. If the target device is a slow MS/TP device on the other side of a router, it is highly likely that you will flood the router with more requests than it can handle, and you will start to get "reject -

router busy" replies from the router (which will be indicated simply as timeout on the client end).

This snowball effect and request log jam will often clear itself when the BACnet client is only polling BACnet IP devices. But the snowball effect can have very adverse effects on a slow MS/TP network on the other side of a router.

When choosing a timeout value for the devices listed on the Devices page in the BACnet client, be sure to also examine the APDU Timeout and Retries on the BACnet settings page. If the default values illustrated below are left as is, then the most suitable timeout value for the client device above would be 12 seconds, not 2 seconds.



BACnet Device Settings:

Device Instance 178

Port (default 0xBAC0 = 47808) 47808

Device Object Name Babel Buster BB3-7301

Device Description

Device Location St. Paul, Minnesota

APDU Timeout 3000

APDU Retries 3

APDU Segment Timeout 5000

Database Revision 4

Local Command Priority 10

Backlog Limit 0

MS/TP Baud Rate: 38400

MS/TP MAC address: 78

MS/TP Max Info Frames: 5

MS/TP Max Masters: 127

Another setting one should pay attention to especially when talking to MS/TP devices on the other side of a router is the "Backlog Limit". The BACnet client will not necessarily wait for the reply from device A before sending a request to device B. If the client is polling 20 different devices, it is quite plausible that the client will send 20 requests faster than the first reply can come back. Thus it is quite easy for a BACnet IP client to overrun an MS/TP router by pumping out requests faster than the router can forward them to MS/TP. Therefore, one should use the Backlog Limit to throttle the client. If the limit is set to 4 (a reasonable number for MS/TP), this means the client will send no more than 4 requests before pausing and waiting for replies to those requests.

The other aspect of how Backlog Limit may affect required timeout setting is that when there is a large backlog of replies to process, the remote device may have responded promptly and within the client timeout setting, but by the time the client gets through the backlog of replies, a short client timeout may have expired. Therefore, timeout is not just a matter of how fast the other device responds, but also a matter of how busy you are keeping the client.

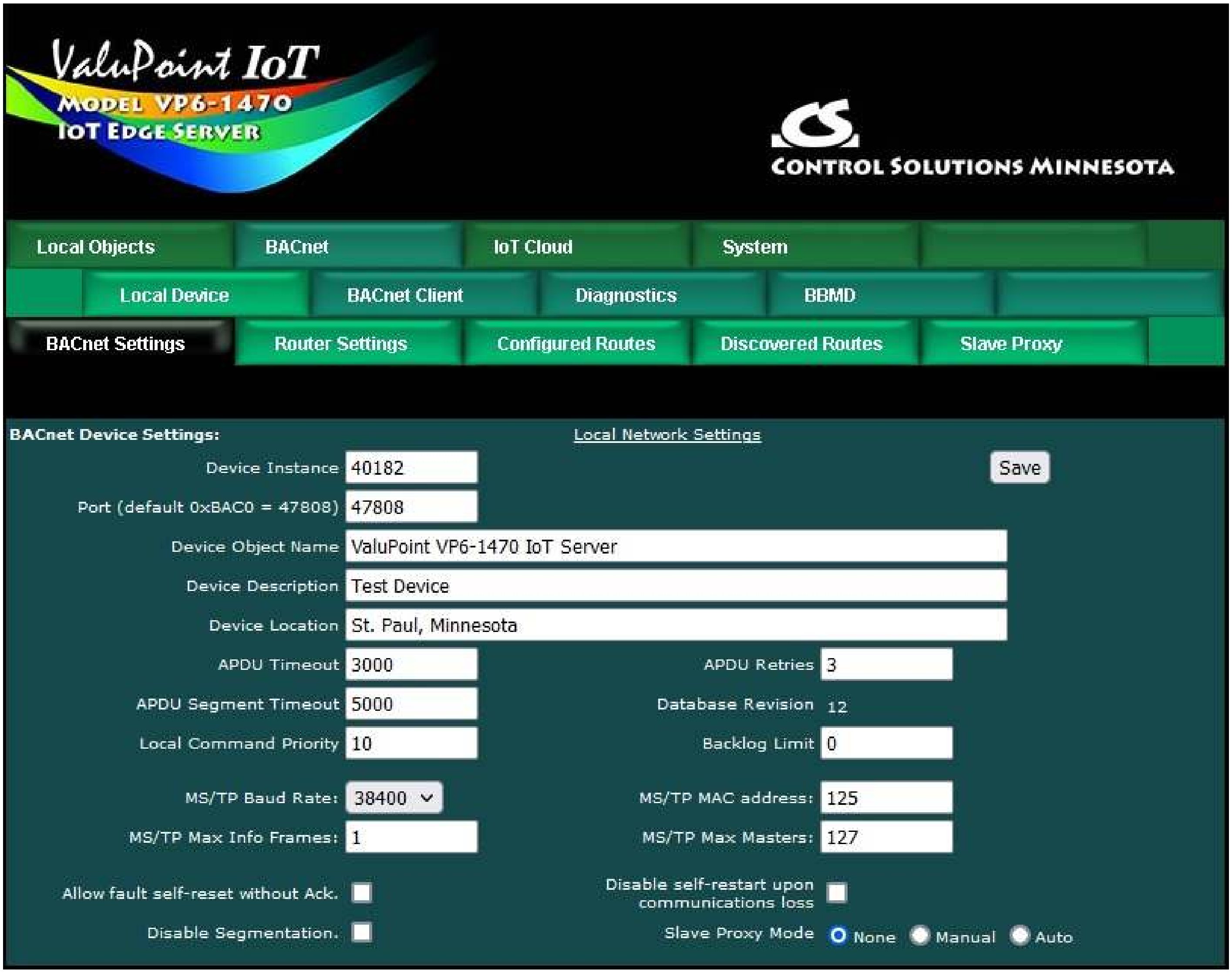
Finally, in the case of an MS/TP router, the MS/TP settings include Max Info Frames. This is the number of requests that the MS/TP device may make before it is required to pass the token. Setting this to some high number will greatly increase throughput in forwarding requests from the IP side to the MS/TP side, and will have a significant impact on timeout settings required in any IP client that is routing its requests to MS/TP devices through this router.

8. Configuring ValuPoint as a BACnet Server

8.1 Server Configuration

The ValuPoint VP6-1470 contains a set of BACnet objects whose only purpose is to store copies of data obtained from local hardware or other devices. This copy of data may then be queried by different devices.

The only configuration needed to use the ValuPoint as a BACnet server is to set the Device instance on the BACnet page. The device should also be given an object name that will be unique on the entire network. Configuring the ValuPoint as a BACnet Device is described in more detail in Section 4.



BACnet Device Settings:

Device Instance	40182		
Port (default 0xBAC0 = 47808)	47808		
Device Object Name	ValuPoint VP6-1470 IoT Server		
Device Description	Test Device		
Device Location	St. Paul, Minnesota		
APDU Timeout	3000	APDU Retries	3
APDU Segment Timeout	5000	Database Revision	12
Local Command Priority	10	Backlog Limit	0
MS/TP Baud Rate:	38400	MS/TP MAC address:	125
MS/TP Max Info Frames:	1	MS/TP Max Masters:	127
Allow fault self-reset without Ack.	☐	Disable self-restart upon communications loss	☐
Disable Segmentation.	☐	Slave Proxy Mode	● None ○ Manual ○ Auto

8.2 Accessing Local Objects

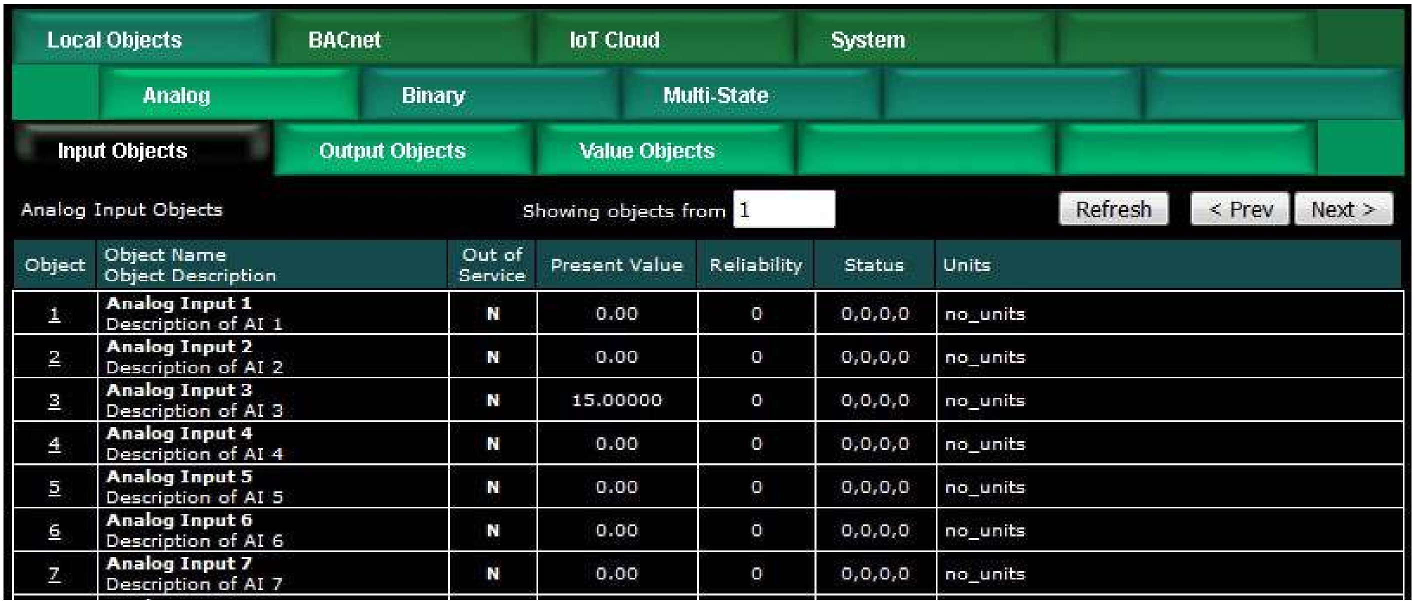
The collection of local objects includes Analog, Binary, and Multi-State types of objects, and includes Input, (commandable) Output, and (writeable) Value types of each of those objects. The ValuPoint also contains a Device object which is configured in the above screen.

Objects assigned to local I/O will have their data values automatically updated by the ValuPoint. Otherwise, data may be placed in the local objects by other devices writing to the ValuPoint, or by the ValuPoint querying other devices. When the ValuPoint is configured to query other devices, these operations are defined by “read maps” and “write maps” associated with the BACnet client function.

The following section illustrates the Analog Input object pages and the Binary Output object pages. The remaining object pages found in the ValuPoint are virtually identical, and are not replicated here. (See also Configuring Local Objects, Section 6.)

Each object page initially comes up as a table of object data. Click on the object number in the left-hand column to expand the view of that object and access the windows that let you locally force values, assign units or names, etc.

Analog Input Example:



Analog Input Objects

Showing objects from 1

Object	Object Name Object Description	Out of Service	Present Value	Reliability	Status	Units
1	**Analog Input 1** Description of AI 1	N	0.00	0	0,0,0,0	no_units
2	**Analog Input 2** Description of AI 2	N	0.00	0	0,0,0,0	no_units
3	**Analog Input 3** Description of AI 3	N	15.00000	0	0,0,0,0	no_units
4	**Analog Input 4** Description of AI 4	N	0.00	0	0,0,0,0	no_units
5	**Analog Input 5** Description of AI 5	N	0.00	0	0,0,0,0	no_units
6	**Analog Input 6** Description of AI 6	N	0.00	0	0,0,0,0	no_units
7	**Analog Input 7** Description of AI 7	N	0.00	0	0,0,0,0	no_units

The object name, units, value, and status are shown for a list of objects starting with the number entered at the top of the page. Click Prev/Next to scroll through the list. Click on the object number in the first column to change name, units, COV, and out-of-service state.

The source of data for an Analog Input object will typically be reading from some other BACnet device. Click on the object number in the first column for more detail including the link to any client map providing data to this object.

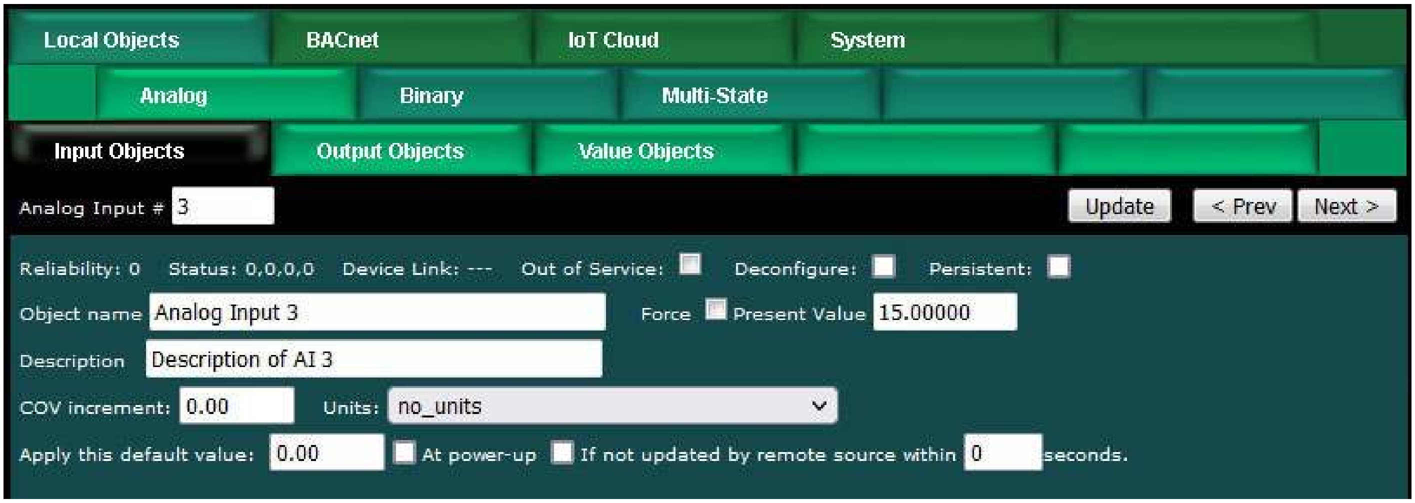
Out of Service means polling for data will stop. While out of service, the present value may be written by the BACnet client. Data may be forced via this web page at any time, but will be overwritten by the next mapped client update unless the object is out of service.

Reliability codes indicate error conditions if non-zero, and may be any of the following:

BACnet IP client, device timeout (82)
BACnet IP client, error returned by server (83)

Status flags A,B,C,D indicate the following, 0 meaning not true, 1 meaning true:
A = in alarm
B = fault
C = overridden
D = out of service

Click on an Object number in the first column of maps to get the expanded view of that object as follows:



Analog Input # 3

Reliability: 0 Status: 0,0,0,0 Device Link: --- Out of Service: □ Deconfigure: □ Persistent: □

Object name Analog Input 3 Force □ Present Value 15.00000

Description Description of AI 3

COV increment: 0.00 Units: no_units

Apply this default value: 0.00 □ At power-up □ If not updated by remote source within 0 seconds.

The object name, units, value, and status are shown for the object number entered at the top of the page. Click Prev/Next to scroll through the list. Click Refresh to update the page, or Update to accept changes.

The object name and description may be changed here. BACnet units may be selected. Initial COV increment may be entered. When any of these are changed, be sure to save the updated configuration by clicking Save on the Config File page under System Setup.

The object may be set Out of Service by checking that box and clicking Update. The present value may be changed by entering a value, checking Force, and clicking Update.

The source of data for an Analog Input object will typically be reading from some other BACnet device via the map indicated by the Device Link. The mapped device will be polled at the rate specified by the Read Map.

Out of Service means polling of the mapped remote device will stop. While out of service, the present value may be written by the BACnet client. Data may be forced via this web page at any time, but will be overwritten by the next mapped client

]

update unless the object is out of service.

Reliability codes indicate errors as itemized on the tabular object list.

Status flags A,B,C,D indicate the following, 0 meaning not true, 1 meaning true:
A = in alarm
B = fault
C = overridden
D = out of service

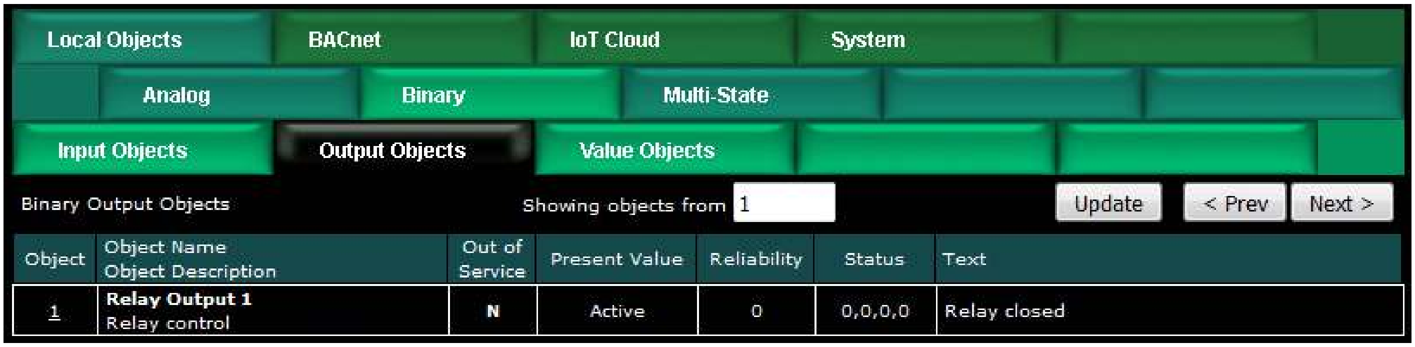
Device link will indicate BAC followed by R for read or W for write, and a number which is the map number in the table of read or write maps for mapping to this BACnet object. The designation R means read from a remote device, and W means write to a remote device. The blank indication "---" means this object is not referenced in any read or write map.

Check 'Deconfigure' and click Update to erase configuration for this object.

The "Is Persistent" option means this object will retain its most recent value through a power outage, with time delay restrictions as noted in the user guide. The persistent selection does not take effect until the Reset Persistent button is clicked on the Resources page. For inputs, this selection is only relevant for "Pulse counter" mode, in which case it turns the input into a totalizing counter. For any other type of input, the value will be immediately overwritten by new data and thus Is Persistent will have no meaning.

A default value can be applied to this object immediately at power-up and/or if not updated by a remote source within the specified amount of time. The remote source will typically be a remote BACnet client.

Binary Output Example:



Binary Output Objects Showing objects from 1

Object	Object Name Object Description	Out of Service	Present Value	Reliability	Status	Text
1	**Relay Output 1** Relay control	N	Active	0	0,0,0,0	Relay closed

The object name, value, and status are shown for a list of objects starting with the number entered at the top of the page. Click Prev/Next to scroll through the list. Click on the object number in the first column to change name or out-of-service state.

The destination of data for a Binary Output object will typically be some other BACnet device. Click on the object number in the first column for more detail including the link to any client map receiving data from this object.

The Binary Output object is commandable, meaning the BACnet client must write both a value and a priority level for that value. The highest level value will be the one written to the remote device (if mapped). If all values are relinquished, the relinquish default value will be written to the remote device.

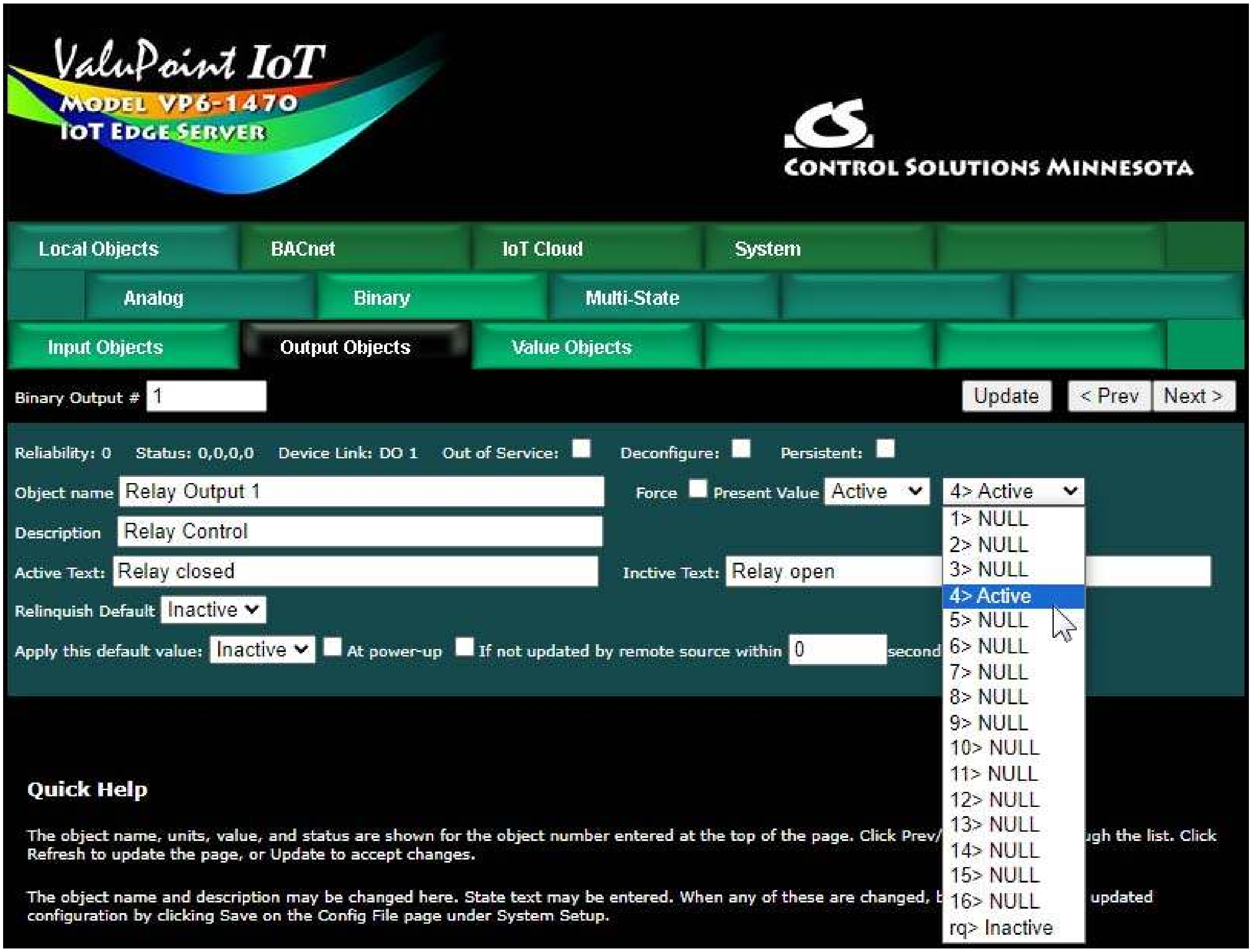
Out of service means the mapped remote device will not be written to. Values written by the BACnet client will be retained, but only applied when this object is placed back in service. At that time, the highest priority value will be written to the remote device.

Reliability codes indicate error conditions if non-zero, and may be any of the following:

BACnet IP client, device timeout (82)
BACnet IP client, error returned by server (83)

Status flags A,B,C,D indicate the following, 0 meaning not true, 1 meaning true:
A = in alarm
B = fault
C = overridden
D = out of service

Click on an Object number in the first column of maps to get the expanded view of that object as follows:



Binary Output # 1

Reliability: 0 Status: 0,0,0,0 Device Link: DO 1 Out of Service: □ Deconfigure: □ Persistent: □

Object name Relay Output 1 Force □ Present Value Active 4> Active

Description Relay Control

Active Text: Relay closed Inctive Text: Relay open

Relinquish Default Inactive

Apply this default value: Inactive □ At power-up □ If not updated by remote source within 0 second

Quick Help

The object name, units, value, and status are shown for the object number entered at the top of the page. Click Prev/ ugh the list. Click Refresh to update the page, or Update to accept changes.

The object name and description may be changed here. State text may be entered. When any of these are changed, b updated configuration by clicking Save on the Config File page under System Setup.

The object name, units, value, and status are shown for the object number entered at the top of the page. Click Prev/Next to scroll through the list. Click Refresh to update the page, or Update to accept changes.

The object name and description may be changed here. State text may be entered. When any of these are changed, be sure to save the updated configuration by clicking Save on the Config File page under System Setup.

The destination of data for a Binary Output object will be writing the remote BACnet device via the map indicated by the Device Link. The remote device will be updated upon change of source data and/or periodically as defined by the Write Map.

The Binary Output object is commandable, meaning the BACnet client must write both a value and a priority level for that value. The highest level value will be the one written to the remote device (if one is mapped). If all values are relinquished, the relinquish default value will be written to the remote device.

To set an output object manually from this page, check the Force box, enter a value in the Present Value window, and select a priority level to assign to your forced value. Then click Update. To return a given priority level to NULL, simply type the word NULL in the Present Value window, check Force, and click Update.

Out of service means the mapped remote device will not be written to. Values written by the BACnet client will be retained, but only applied when this object is placed back in service. At that time, the highest priority value will be written to the remote device.

Reliability codes indicate errors as itemized on the tabular object list.

Status flags A,B,C,D indicate the following, 0 meaning not true, 1 meaning true:
A = in alarm
B = fault
C = overridden
D = out of service

Device link will indicate BAC followed by R for read or W for write, and a number which is the map number in the table of read or write maps for mapping to this BACnet object. The designation R means read from a remote device, and W means write to a remote device. The blank indication "---" means this object is not referenced in any read or write map.

Check 'Deconfigure' and click Update to erase configuration for this object.

The "Persistent" option means this object will retain its most recent value through a power outage, with time delay restrictions as noted in the user guide. The persistent selection does not take effect until the Reset Persistent button is clicked on the Resources page.

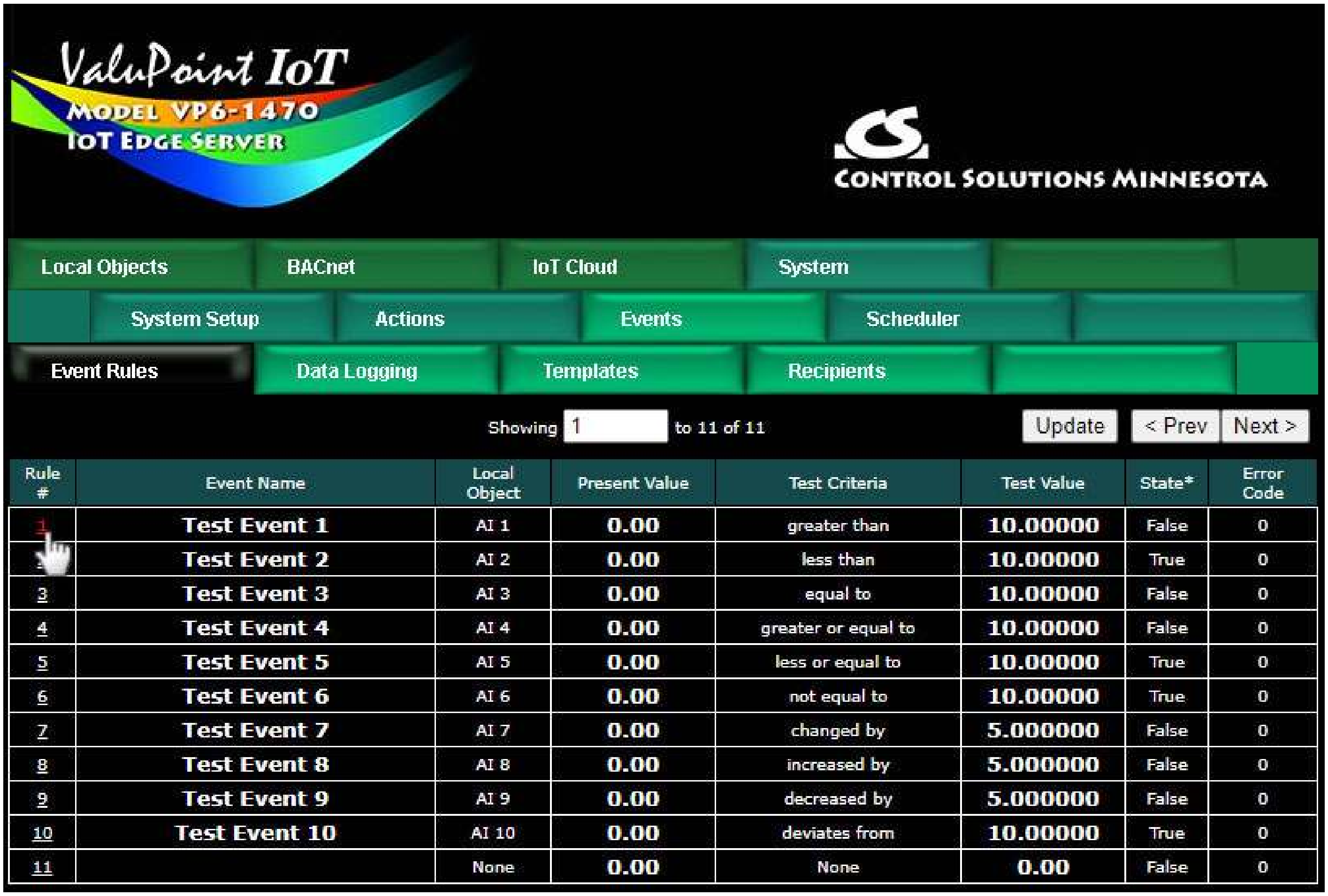
A default value can be applied to this object immediately at power-up and/or if not updated by a remote source within the specified amount of time. The remote source will typically be a remote BACnet client.

9. Configuring Event Rules

Alarm monitoring is the most common use for an event rule, but event rules can also be incorporated into control algorithms to cause some action to happen as the result of some given condition. When used for alarm monitoring, the event rule can result in automatically sending an email notification to your smart phone or computer.

9.1 Event Rule List

The Event Rules page displays a list of currently defined event rules in summary form. Click on the rule number in the first column to see and modify the full rule.



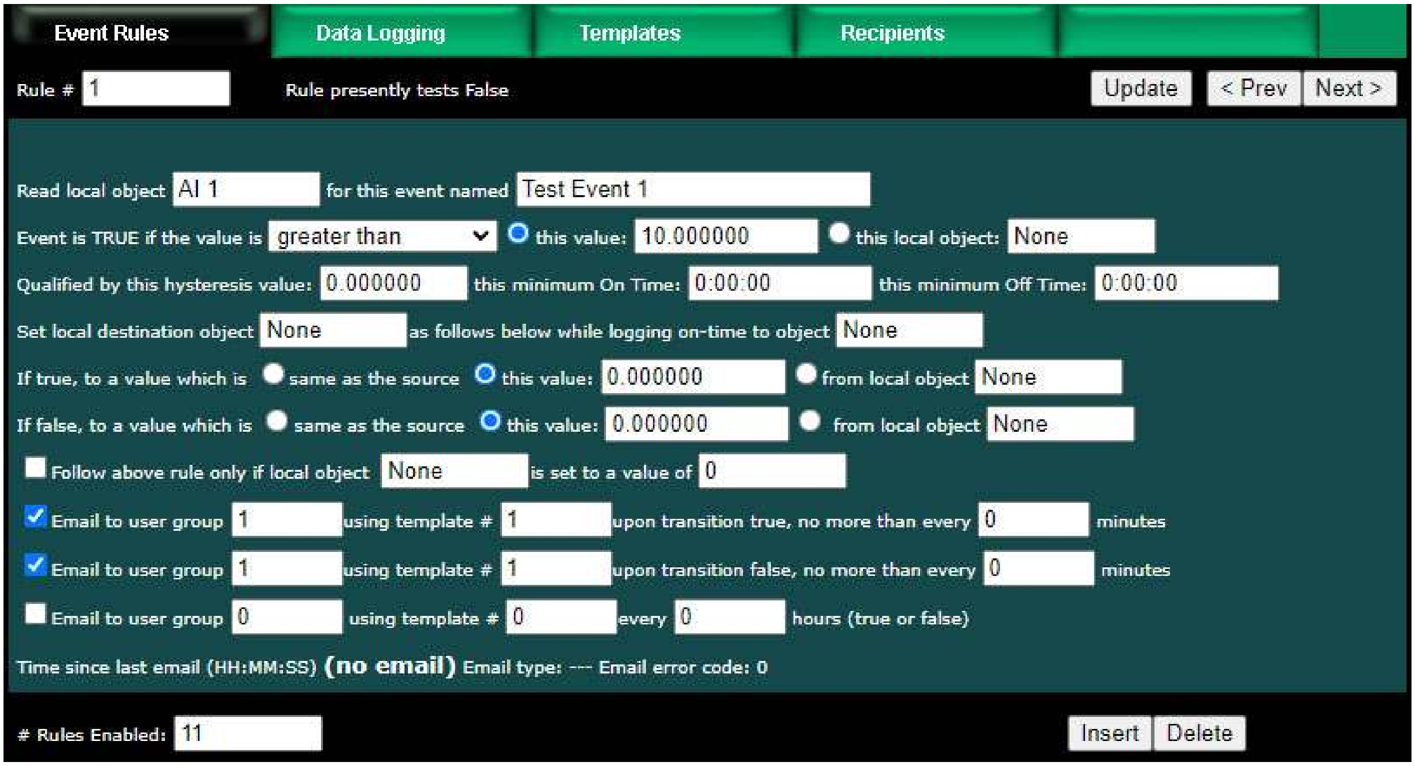
Showing 1 to 11 of 11

Rule #	Event Name	Local Object	Present Value	Test Criteria	Test Value	State*	Error Code
1	Test Event 1	AI 1	0.00	greater than	10.00000	False	0
2	Test Event 2	AI 2	0.00	less than	10.00000	True	0
3	Test Event 3	AI 3	0.00	equal to	10.00000	False	0
4	Test Event 4	AI 4	0.00	greater or equal to	10.00000	False	0
5	Test Event 5	AI 5	0.00	less or equal to	10.00000	True	0
6	Test Event 6	AI 6	0.00	not equal to	10.00000	True	0
7	Test Event 7	AI 7	0.00	changed by	5.000000	False	0
8	Test Event 8	AI 8	0.00	increased by	5.000000	False	0
9	Test Event 9	AI 9	0.00	decreased by	5.000000	False	0
10	Test Event 10	AI 10	0.00	deviates from	10.00000	True	0
11		None	0.00	None	0.00	False	0

Use Next and Prev to scroll through the list if there are many events. Click Update to see a refresh of current state. Enter a number in the Showing window and click Update to jump to that point in the table.

9.2 Event Rule Details

The full event rule looks like this, and the various parts of it are explained in detail below.



Rule # 1 Rule presently tests False

Read local object AI 1 for this event named Test Event 1

Event is TRUE if the value is greater than ● this value: 10.000000 ○ this local object: None

Qualified by this hysteresis value: 0.000000 this minimum On Time: 0:00:00 this minimum Off Time: 0:00:00

Set local destination object None as follows below while logging on-time to object None

If true, to a value which is ○ same as the source ● this value: 0.000000 ○ from local object None

If false, to a value which is ○ same as the source ● this value: 0.000000 ○ from local object None

□ Follow above rule only if local object None is set to a value of 0

☑ Email to user group 1 using template # 1 upon transition true, no more than every 0 minutes

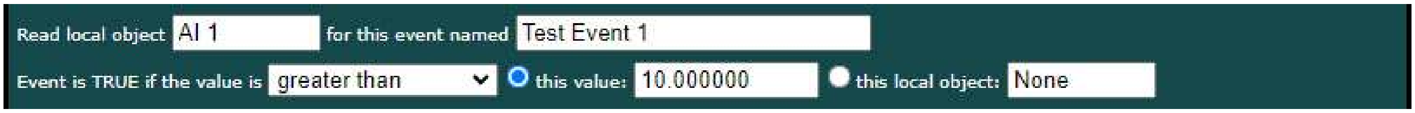
☑ Email to user group 1 using template # 1 upon transition false, no more than every 0 minutes

□ Email to user group 0 using template # 0 every 0 hours (true or false)

Time since last email (HH:MM:SS) **(no email)** Email type: --- Email error code: 0

Rules Enabled: 11

The number of rules enabled simply limits the scope of display on the tabular event rule list. To scroll through from one event to the next on the event detail page, use Next and Prev. To jump to a different rule number, enter it in the Rule # window at the top and click Update. Insert will insert a new blank rule before the currently displayed rule. Delete will remove the currently displayed rule.



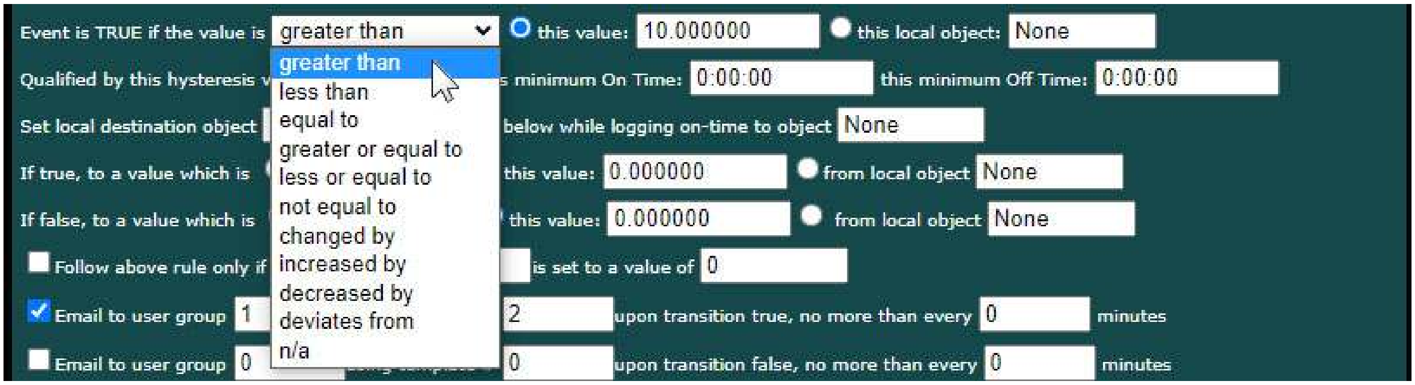
Read local object AI 1 for this event named Test Event 1

Event is TRUE if the value is greater than ● this value: 10.000000 ○ this local object: None

An "event" occurs when the value contained in a local object meets some criteria that you have specified on this page. Start by selecting the local object number that this test will be applied to. Give the event a name. In addition to being a reference for documentation purposes, this event name may be included in email messages generated by this event.

Select a test type, such as greater than, from the test list. Provide a threshold. In the above example, the event is "true" when Analog Input 1 contains a value greater than 10, and if email is configured, the sending of an email would be triggered upon Analog Input 1 crossing this threshold.

If you would like to have the threshold set through some other local object so that it can be readily changed on the fly, select local object instead and provide that object number from which the threshold will be taken each time the rule is evaluated. Event rules are re-evaluated several times per second.



Event is TRUE if the value is greater than ◉ this value: 10.000000 ○ this local object: None

Qualified by this hysteresis v s minimum On Time: 0:00:00 this minimum Off Time: 0:00:00

Set local destination object below while logging on-time to object None

If true, to a value which is this value: 0.000000 ○ from local object None

If false, to a value which is this value: 0.000000 ○ from local object None

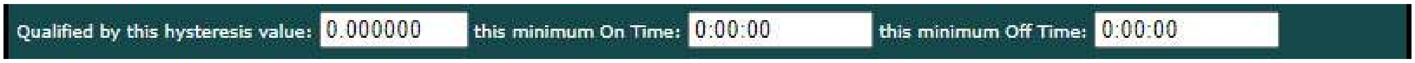
☐ Follow above rule only if is set to a value of 0

☑ Email to user group 1 2 upon transition true, no more than every 0 minutes

☐ Email to user group 0 0 upon transition false, no more than every 0 minutes

The possible test types are illustrated above. Some tests need further explanation. The "Changed by" test means amount of change since the last event transition to true. If the local object has changed by the value specified as "this value" or the value contained in the local object referenced, the test is true. The "Changed by" value can be an increase or decrease. To consider the event to be true only upon increase or decrease since the last transition, select those tests instead. The "Deviates by" uses a special application of the hysteresis value. If the present value of the local object deviates from the threshold by the margin set as hysteresis, then this test will be deemed to be "true". This amounts to a combined greater than and less than in the same test.

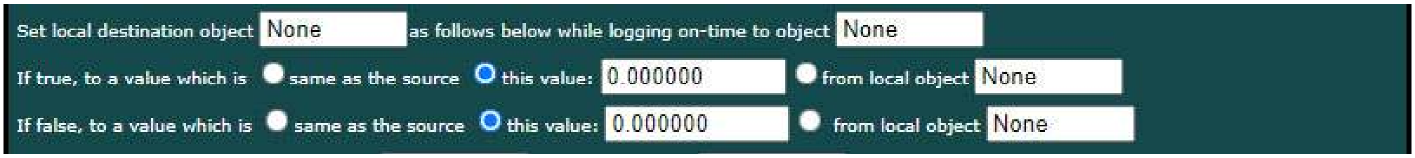
IMPORTANT: When using any of the "change" tests, and using email notifications, you should ONLY select email upon transition to true because the change will only be true for one instant and then the comparison threshold is moved and the rule immediately becomes false again. The result, if you enable email on both true and false, is that you will always get 2 emails right away each time there is an incremental change.



Qualified by this hysteresis value: 0.000000 this minimum On Time: 0:00:00 this minimum Off Time: 0:00:00

Quaifications are optional, and enabled only when values are nonzero. How hysteresis is applied depends on the comparison. For a test that becomes true if greater than, the test will not return to false until the local object is less than the test value by a margin of at least this hysteresis value. If a test becomes true if less than, it will not return to false until the local object is greater than the test value by a margin of at least this hysteresis value.

On time and off time, if specified, determine how long the condition must be true (on time) or false (off time) before the true or false response is actually taken. Times are given in HH:MM:SS format (hours, minutes, seconds). If the condition goes away before this time is up, then it will be as if the event never happened in the first place.



Set local destination object None as follows below while logging on-time to object None

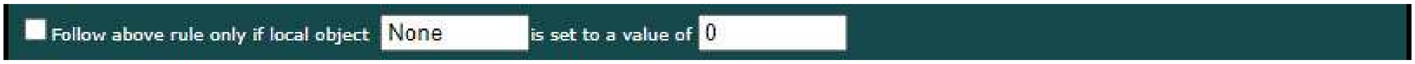
If true, to a value which is ○ same as the source ◉ this value: 0.000000 ○ from local object None

If false, to a value which is ○ same as the source ◉ this value: 0.000000 ○ from local object None

Now that you have specified what the condition is, you proceed to define the response. Start by selecting which local object the response is applied to. This will be known as your destination object. Typically this object will be linked to an output. IMPORTANT note for email notifications: You do not need to apply the result to any destination object if you simply want to report the event via an email message. Leave the destination object set to zero and ignore the 2 lines that follow it. The result of the test will be processed as true or false by email notification processing without any destination object specified.

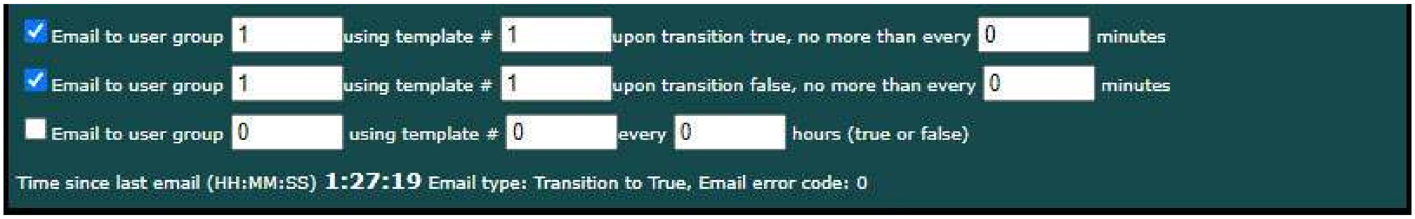
The first line after the destination object number is the response that will be taken when the condition is true, and the following line is the response that will be taken when the condition is false. Either the source object is copied, a fixed value is applied, or another object is used to provide the data written to the destination object.

The "on-time" logging is optional, and may be used without setting any destination object. It simply records the amount of time the threshold rule tests true, and records that time in the object given (if nonzero). Time is recorded in minutes. The logged time may be reset by simply writing 0 to the object via the web page or via BACnet.



☐ Follow above rule only if local object None is set to a value of 0

You have the option of enabling processing of this rule only when a selected local object contains a given value. Any local object may be used as the enable object. If the event had previously transitioned to true when the enable object changes to a disable value, then the rule will be processed as a transition to false one time.



☑ Email to user group 1 using template # 1 upon transition true, no more than every 0 minutes

☑ Email to user group 1 using template # 1 upon transition false, no more than every 0 minutes

☐ Email to user group 0 using template # 0 every 0 hours (true or false)

Time since last email (HH:MM:SS) **1:27:19** Email type: Transition to True, Email error code: 0

Email notifications will be generated as given if they are enabled. Emails are not required - event rules can be used to simply set object values internally without any email notifications. You can use hysteresis and minimum on/off times to minimize spurious transitions, but you may also limit the frequency of email notifications using the "no more than" time limit. If "no more than" is zero minutes, then there is no limit. Think carefully about whether conditions could exist that will flood your email inbox.

If you use email notifications, you have the option of sending an email when the rule transitions to true, or transitions to false, or both. You also have the option of periodically sending an email regardless of condition. If you are sending an email about an alarm condition that doesn't happen very often, you may want to configure a daily email that gets sent regardless of state just to tell you that your monitoring device is still there.

The "group" refers to a user group that was set up on the Recipients page. The "template #" refers to a template that was set up on the Templates page. If email error code is anything other than zero, there was a problem, and the codes are explained on the Recipients page where you may also send a test email.

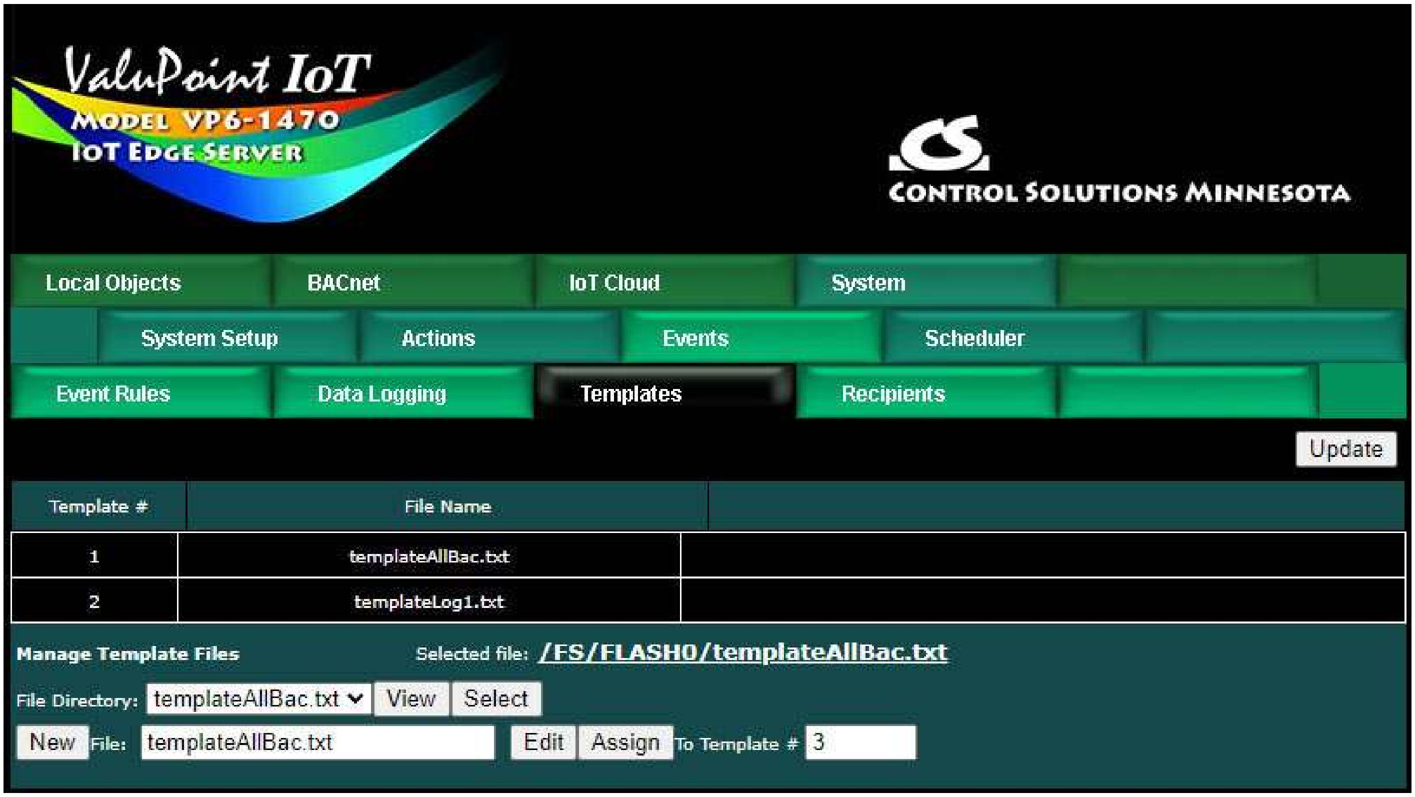
10. Configuring Email Client & Notifications

Email messages are sent if desired for event notifications and also for data log file delivery. The email message is constructed from templates you create. They are sent to email addresses you provide. The emails are sent via an email server or account you provide. The email account used here can be a Gmail account.

Once email has been set up, there are three places where emails are actually sent: (1) Event Rules, (2) Data Logging, (3) Test email from Recipients page pictured later in this section.

10.1 Assigning Email Templates

Any email message generated by this device is created from a template that you create and then assign to a template number.



Template #	File Name	
1	templateAllBac.txt	
2	templateLog1.txt	

Selected file: /FS/FLASH0/templateAllBac.txt

File Directory: templateAllBac.txt

File: templateAllBac.txt To Template # 3

The template is a simple text file with a .txt suffix and could be edited externally and uploaded via the File Manager page. It can also be edited here.

There are two steps to using an email template: (1) Create the template, (2) Assign that template file to a template number that can be referenced in event rules or data logging setup. Currently assigned template files are displayed in the list.

To create a new template here, enter a file name ending in ".txt", then click the New button. Next, click the Edit button and refer to editing the template below.

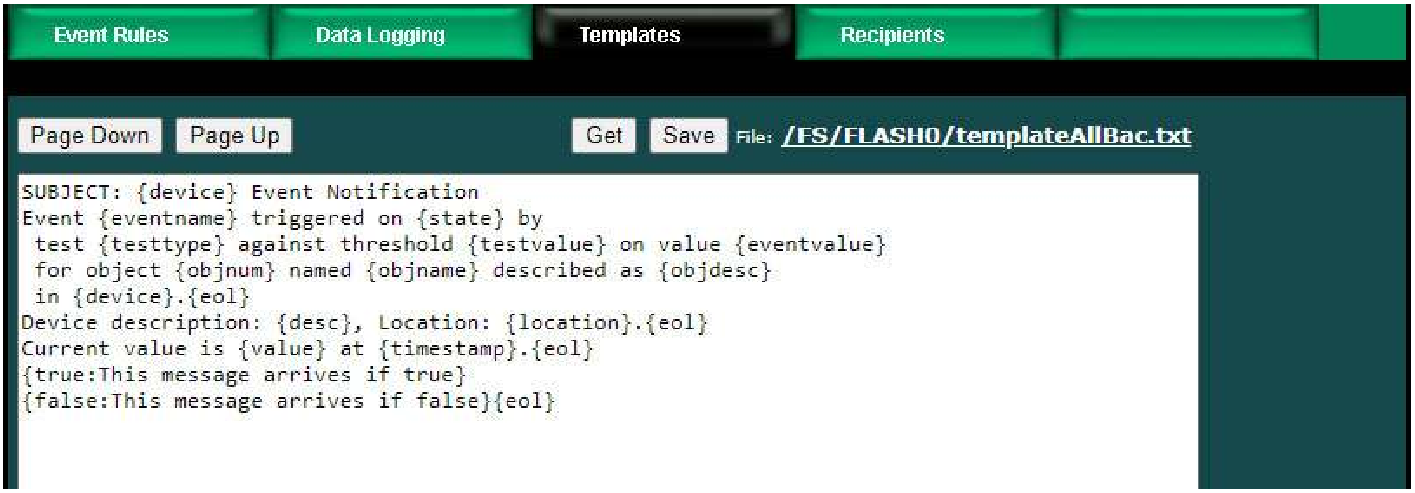
Once you have created a template that shows up in the File Directory list (only *.txt files will be displayed in this list), select a file from the list (pick file from drop-down list, then click Select), enter a number in the "To Template #" window, and then click Assign. The template file itself is saved in the Flash file system when you Save it or upload it. However, the assignment of a file name to a template number is part of the configuration you save as an XML file on the File Manager page. Don't forget to save your configuration after assigning a template.

To View a file, you simply need to pick the file name in the drop-down list and click View. To select for editing or assignment, you need to pick a file and then click Select. Upon clicking the Select button, that file name will show up in the File window.

10.2 Editing Email Templates

The editing page will be blank when you first get here. If you just created a new file, it will be empty, so just go ahead and start typing. If you are editing an existing file, click Get to read the file. It is unlikely that your template will be so long it doesn't fit on this page, but if so, use the Page Down and Page Up buttons.

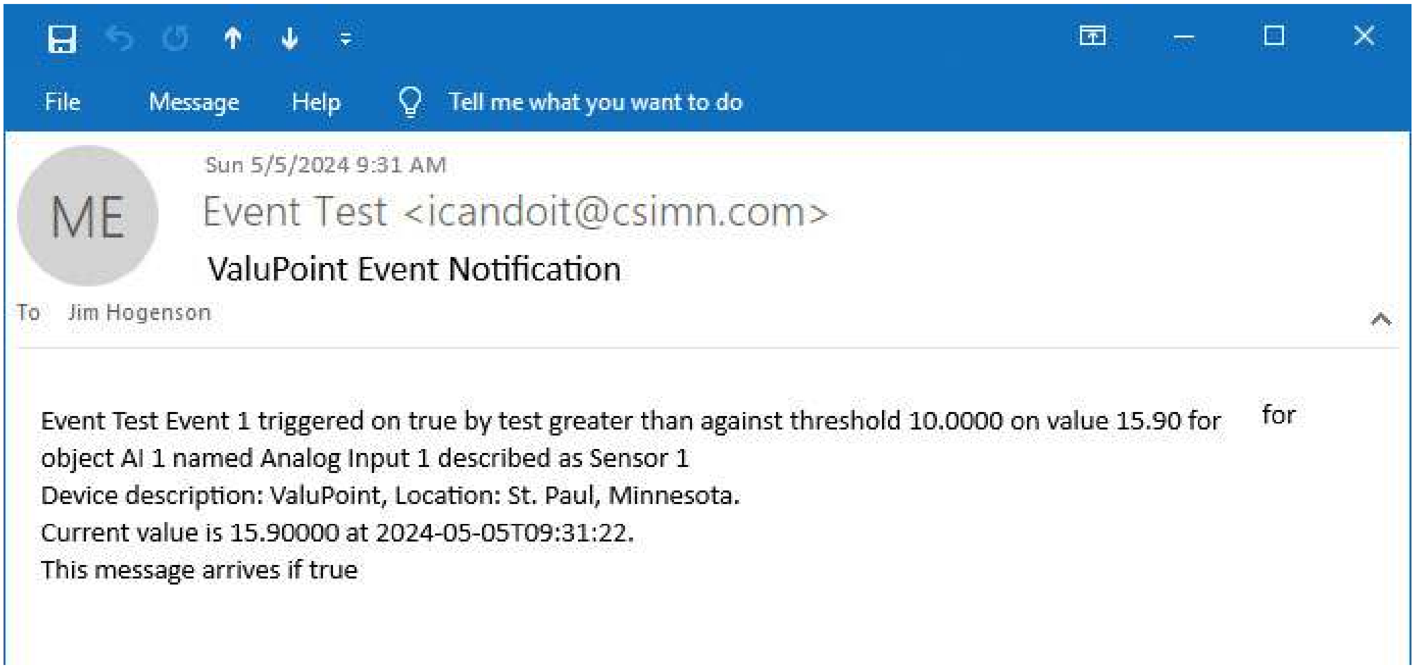
When you have finished editing your template, click Save to save it to the Flash file system.



File: /FS/FLASH0/templateAllBac.txt

```
SUBJECT: {device} Event Notification
Event {eventname} triggered on {state} by
 test {testtype} against threshold {testvalue} on value {eventvalue}
 for object {objnum} named {objname} described as {objdesc}
 in {device}.{eol}
Device description: {desc}, Location: {location}.{eol}
Current value is {value} at {timestamp}.{eol}
{true:This message arrives if true}
{false:This message arrives if false}{eol}
```

The above example template produced the following email.



Sun 5/5/2024 9:31 AM

Event Test <icandoit@csimn.com>

ValuPoint Event Notification

To Jim Hogenson

Event Test Event 1 triggered on true by test greater than against threshold 10.0000 on value 15.90 for for
object AI 1 named Analog Input 1 described as Sensor 1
Device description: ValuPoint, Location: St. Paul, Minnesota.
Current value is 15.90000 at 2024-05-05T09:31:22.
This message arrives if true

The first line of the template file should start with SUBJECT: if the email should have a subject. If this line is omitted (or placed elsewhere), there will be no subject on the email.

The remainder of the template will be copied verbatim, except for those variable names or tags enclosed in brackets. The variables will be replaced with real time data at the time the email is sent. Line breaks in the template are not copied. To get a line break in the message actually sent, include {eol}.

The example illustrated above includes all of the possible template variables that might be used in creating an email message. Available variables or tags are as follows:

{device}
BACnet device object name

{location}
BACnet device location

{desc}
BACnet device description

{objnum}
BACnet object tested by event rule (noted as AI 1, AV 1, etc)

{objname}
BACnet object name

{objdesc}
BACnet object description

{value}
Value looked up as of time message is sent (numeric, or may be state string for Binary or Multi-state if strings are available)

{eventvalue}
Value as of event rule transition (numeric only)

{testvalue}
Value the rule tested against (threshold, numeric)

{testtype}
Type of test (e.g. greater than)

{state}
Insert "true" or "false" state of event right now (applies to periodic reporting)

{eventname}
Name of event given in event rule configuration

{timestamp}
Timestamp as of when message sent

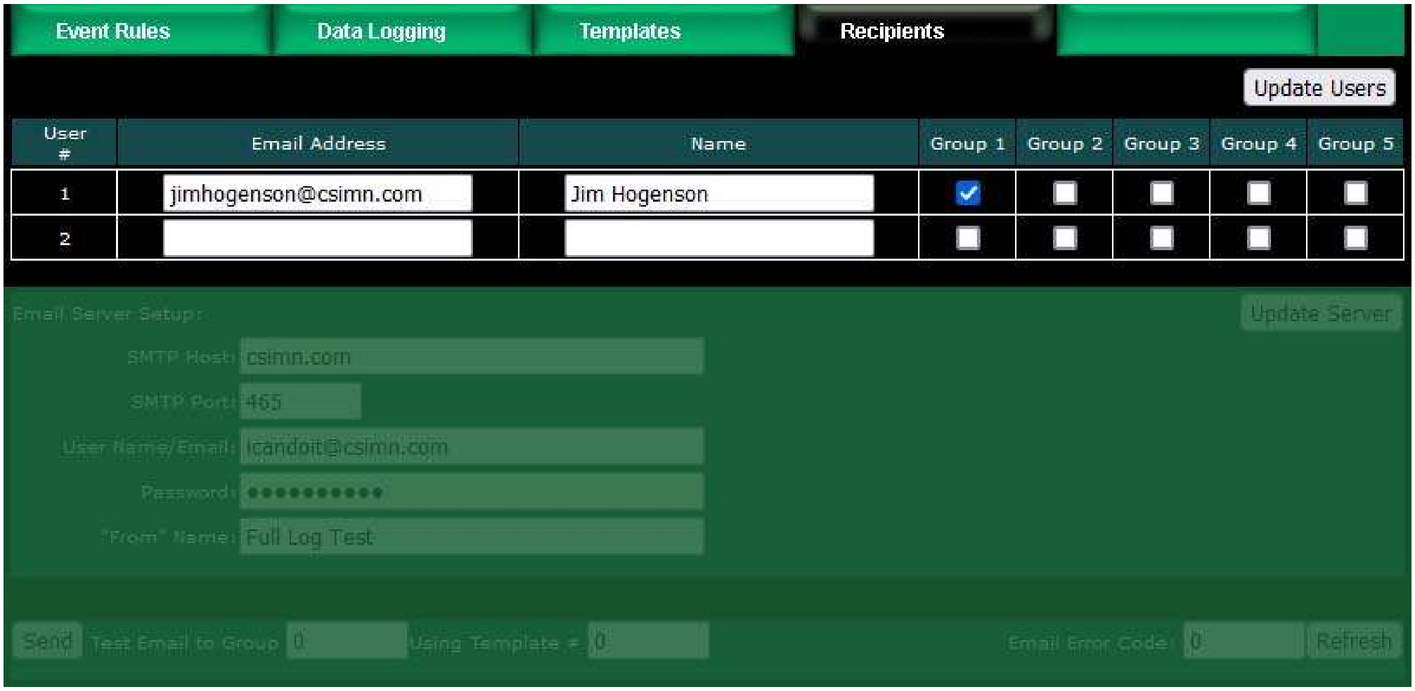
{true:xxx yyy zzz}
Literal string conditional, include "xxx yyy zzz" in message only if event is or transitioned to true

{false:xxx yyy zzz}
Literal string conditional, include "xxx yyy zzz" in message only if event is or transitioned to false

{eol}
Insert line break (breaks in template are not copied, only the {eol} tag results in a break in the message sent)

10.3 Email Recipients

The people to whom you wish to send emails are listed here. Each recipient can be a member of any or all of 5 "groups". When an event is configured to send an email notification, it will be designated to be sent to one of these groups. Thus an event can be sent to many recipients, and different events can be sent to different recipients.



User #	Email Address	Name	Group 1	Group 2	Group 3	Group 4	Group 5
1	jimhogenson@csimn.com	Jim Hogenson	☑	□	□	□	□
2			□	□	□	□	□

Email Server Setup:

SMTP Host: csimn.com

SMTP Port: 465

User Name/Email: icandoit@csimn.com

Password: ●●●●●●●●●●●

"From" Name: Full Log Test

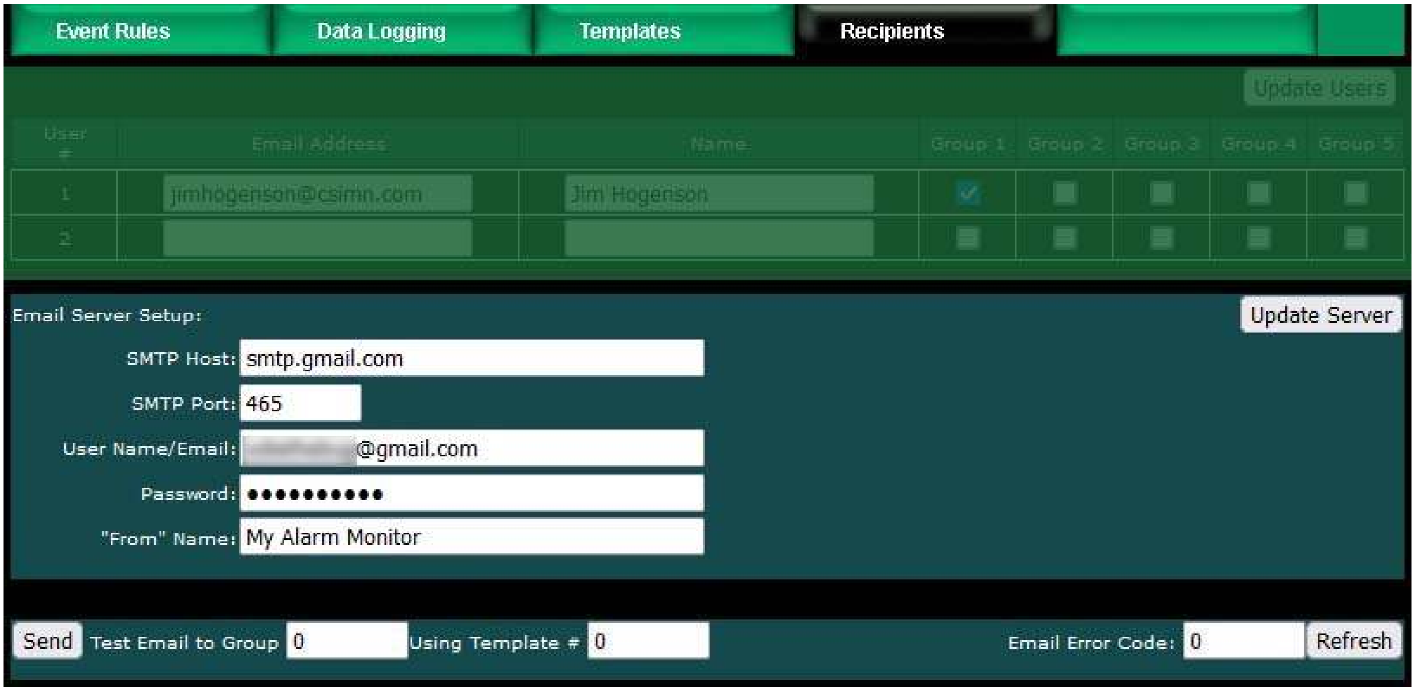
Test Email to Group 0 Using Template # 0

Email Error Code: 0

10.4 Email Server

This is where you enter the host information and account credentials for the email server you will use to send emails. You can use an IP address for SMTP Host. If you use a host name, be sure you have also configured a DNS server on the Network setup page. Provide the port number applicable to your host. The host and port that you would use for Gmail is illustrated.

Create a Gmail account if you don't already have one to use for this purpose (or use whatever other account you like). Provide the user name and password that will allow this IoT device to log in. The "From" name can be anything - it is what shows up as the "From" name in the email. Click Update Server, and then to retain these settings, go to the File Manager page and save your configuration.



User #	Email Address	Name	Group 1	Group 2	Group 3	Group 4	Group 5
1	jimhogenson@csimn.com	Jim Hogenson	☑	□	□	□	□
2			□	□	□	□	□

Email Server Setup:

SMTP Host: smtp.gmail.com
SMTP Port: 465
User Name/Email: [redacted]@gmail.com
Password: ●●●●●●●●●●
"From" Name: My Alarm Monitor

Test Email to Group 0 Using Template # 0 Email Error Code: 0

You may send a test email to any of the five email groups you have configured using any template you have created and assigned. The test email will not have an actual event to reference, so any variables that would otherwise be event information will be filled in with dummy values.

If the test email is unsuccessful, a non-zero error code will be displayed here. There may be a delay between clicking Send and seeing the result, so click Refresh a little later to check the outcome.

Email error codes can be any of the following:

0 = No errors

+1 = No recipients match selected group number

-1 = Unable to allocate memory to build email message
-2 = No DNS server found
-3 = DNS could not find host
-4 = Server lookup attempt ran into other errors
-5 = Failure to create socket
-6 = Failed to handshake or negotiate a TLS connection with server
-7 = Failed to authenticate with the given credentials
-8 = Failed to send data to server
-9 = Failed to receive data from server
-10 = Failed to properly close connection
-11 = SMTP server sent back an unexpected status code
-12 = Invalid parameter
-13 = Failed to open or read a local file
-14 = Failed to get a local date and time

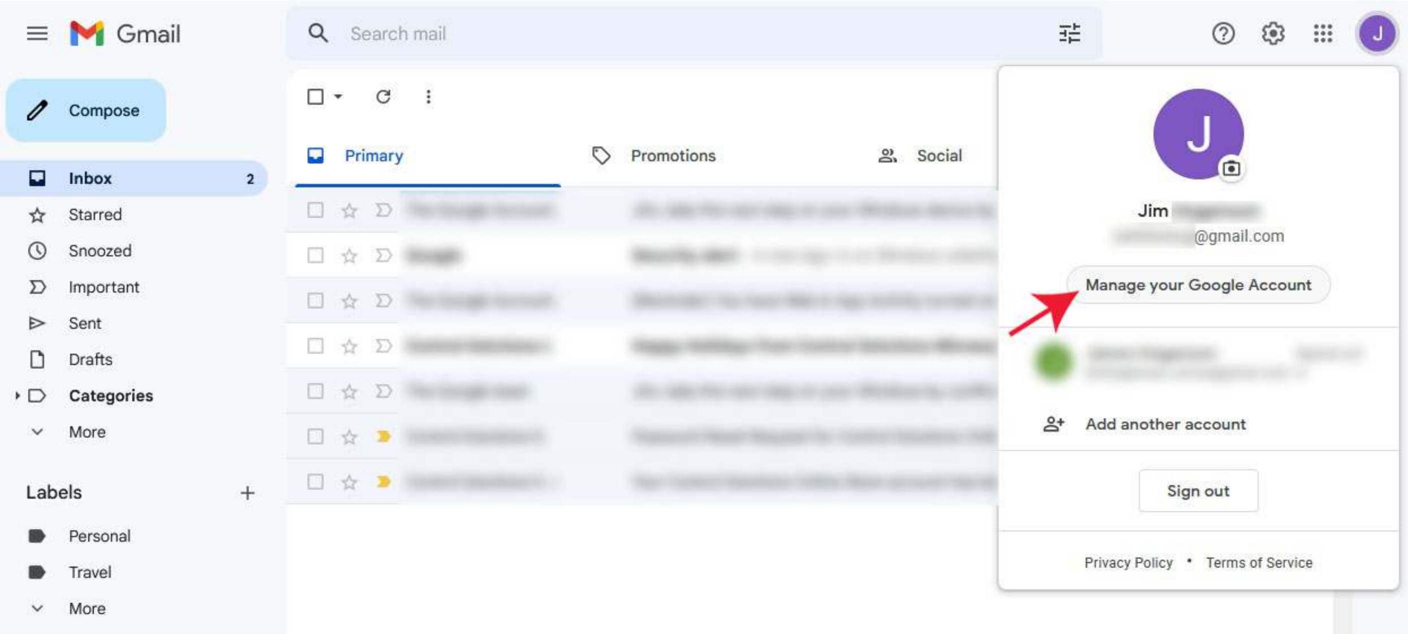
Error codes associated with emails sent by event rules are displayed on the respective event rule page. Error codes associated with emails sent by the data logger are displayed on the data logger page.

10.5 Using Gmail

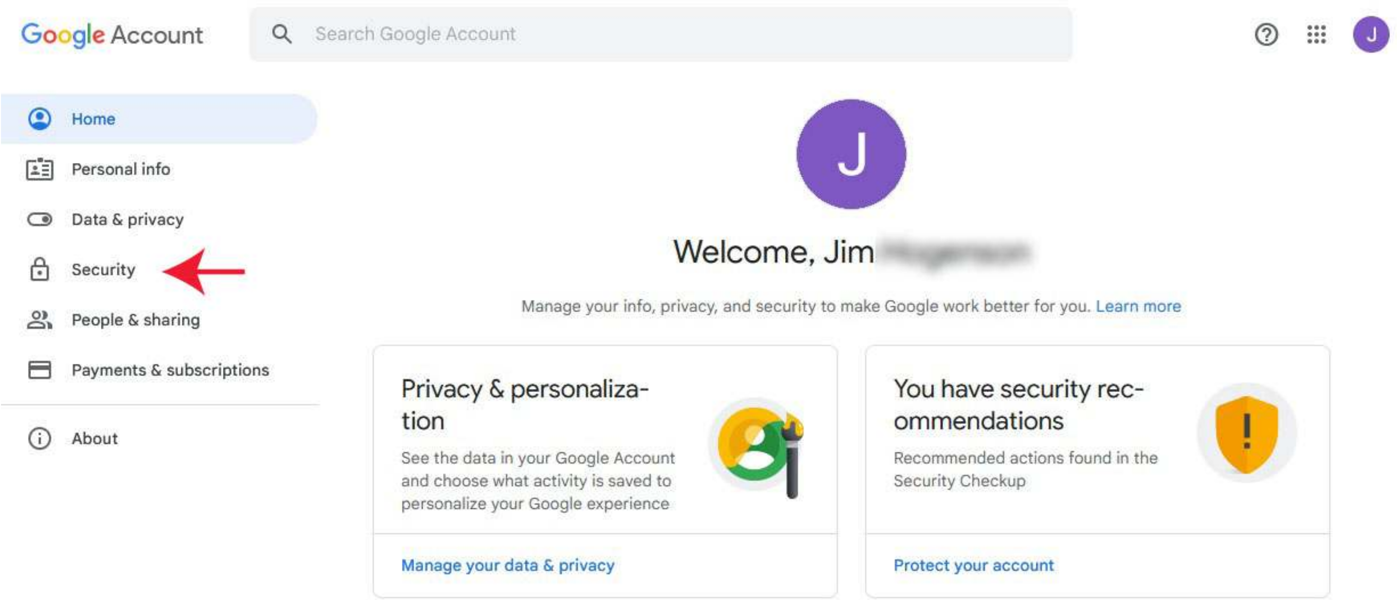
As per notice from Google's Less Secure App Deprecation Notice, on May 30, 2022 the ability access Google accounts through 'less secure apps' is being deprecated. The preferred method is OAuth 2.0; however, this requires 2-factor authentication which your remote device is not going to handle well because it doesn't have a cell phone in its pocket.

The alternative is to go to your Google account and create an apps password, and once this is created, just use the apps password instead of the actual password for your gmail account.

Log into the Gmail account that you created for your device to use. Click the icon in the upper right corner, and then select Manage your Google Account.



Under account management, select Security.



Welcome, Jim [redacted]

Manage your info, privacy, and security to make Google work better for you. Learn more

Privacy & personalization

See the data in your Google Account and choose what activity is saved to personalize your Google experience

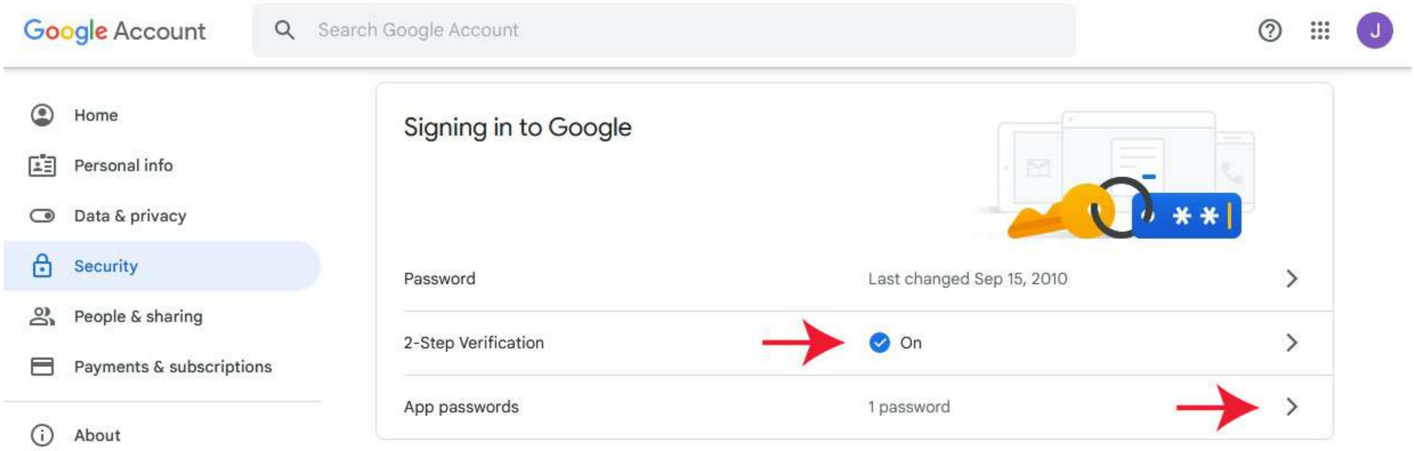
Manage your data & privacy

You have security recommendations

Recommended actions found in the Security Checkup

Protect your account

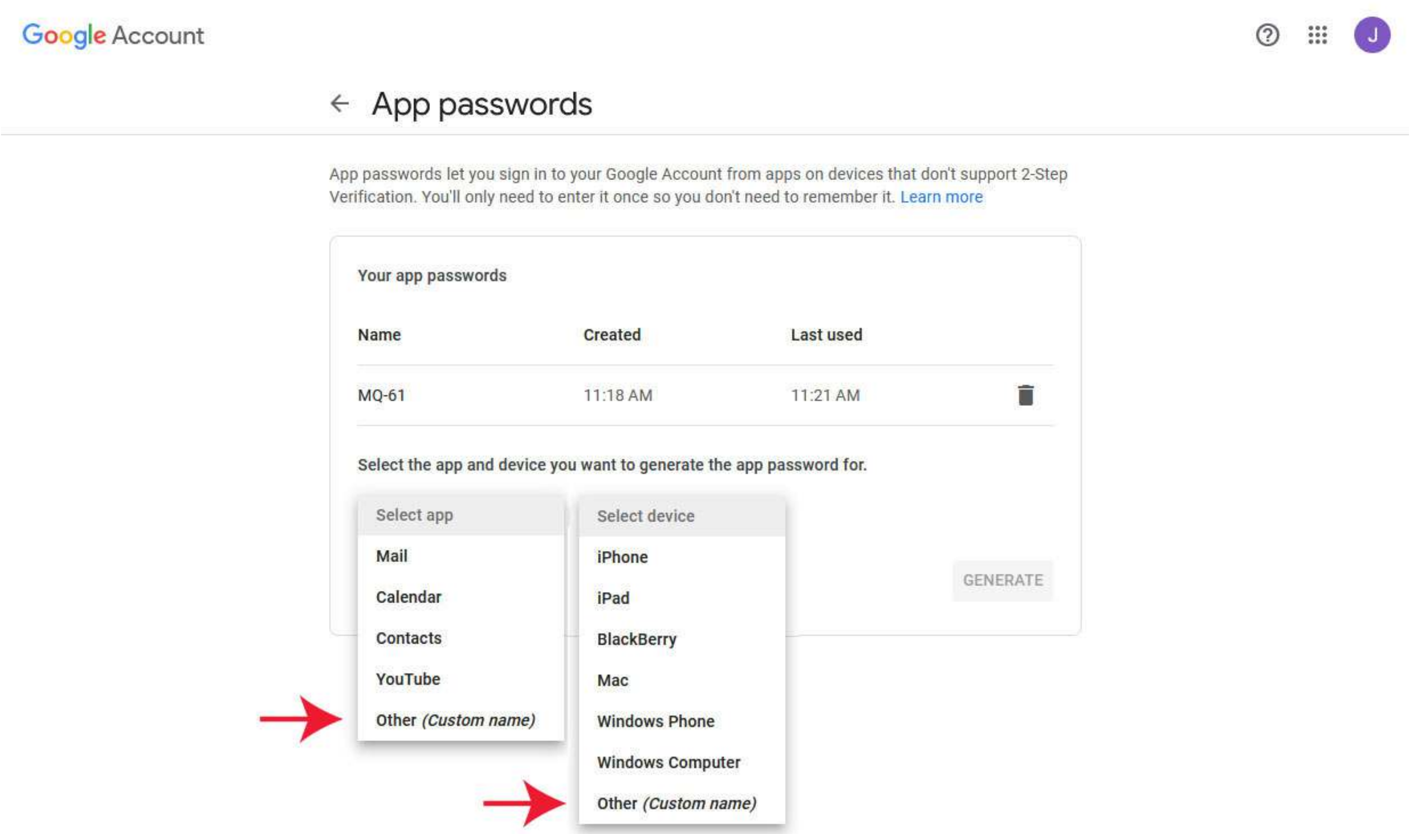
Turn on 2-Step Verification if not already on. You will be asked for a verification code sent to your sell phone during this process. After verifying that 2-Step Verification is "On", click on the App passwords selection.



Signing in to Google

Password	Last changed Sep 15, 2010
2-Step Verification	On
App passwords	1 password

The screen shot below illustrates that an app password named MQ-61 has already been added. To add a password, under "Select app", choose Other, and enter a name for your app (e.g. MQ-61). Then under "Select device", choose Other and provide a custom name. Then click Generate.



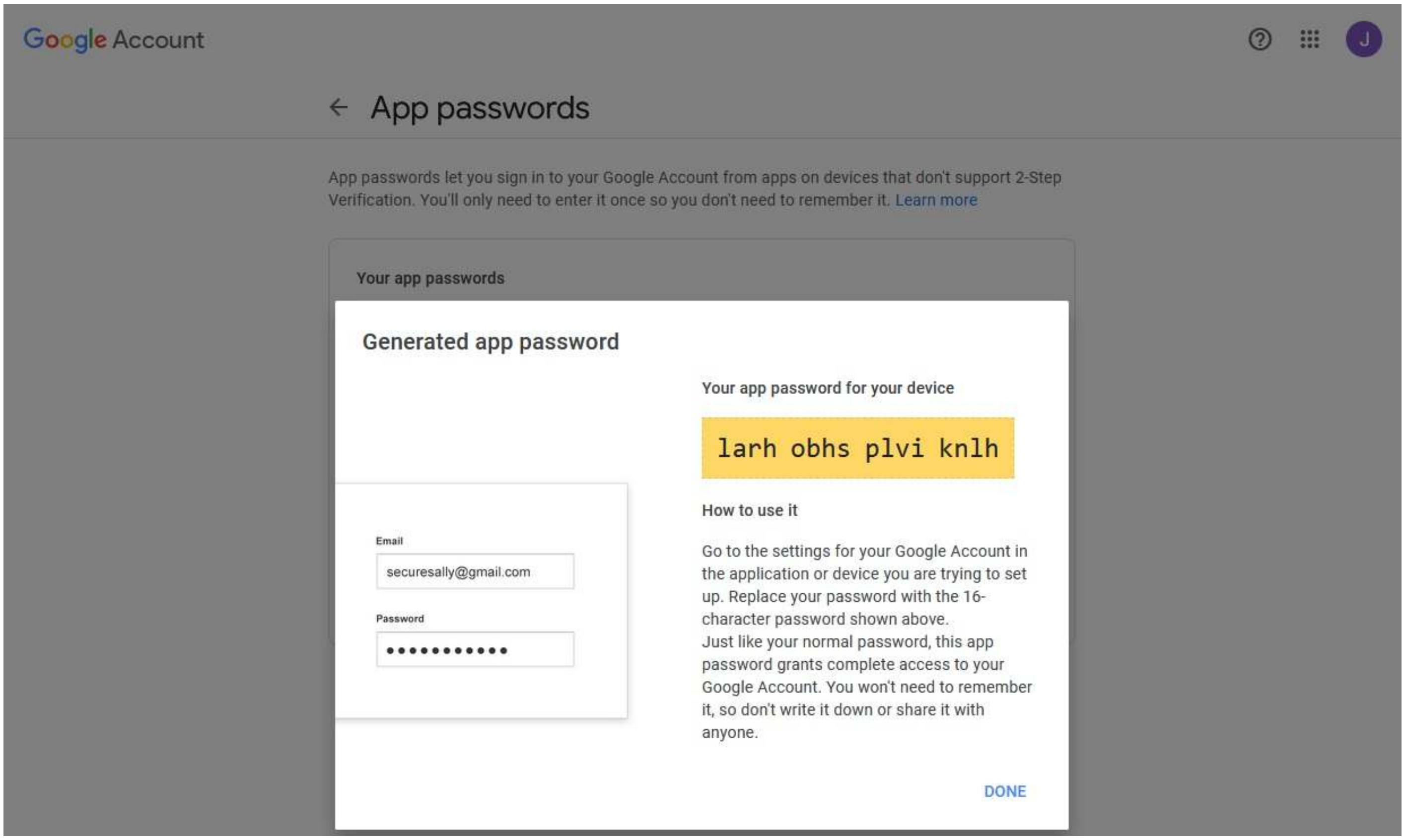
App passwords let you sign in to your Google Account from apps on devices that don't support 2-Step Verification. You'll only need to enter it once so you don't need to remember it. Learn more

Your app passwords

Name	Created	Last used
MQ-61	11:18 AM	11:21 AM

Select the app and device you want to generate the app password for.

Upon clicking Generate, a screen like the following will be displayed. Disregard "securesally@gmail.com", that is just an example. Your app password is highlighted in the yellow box.



App passwords let you sign in to your Google Account from apps on devices that don't support 2-Step Verification. You'll only need to enter it once so you don't need to remember it. Learn more

Generated app password

Email: securesally@gmail.com

Password: ●●●●●●●●●●●

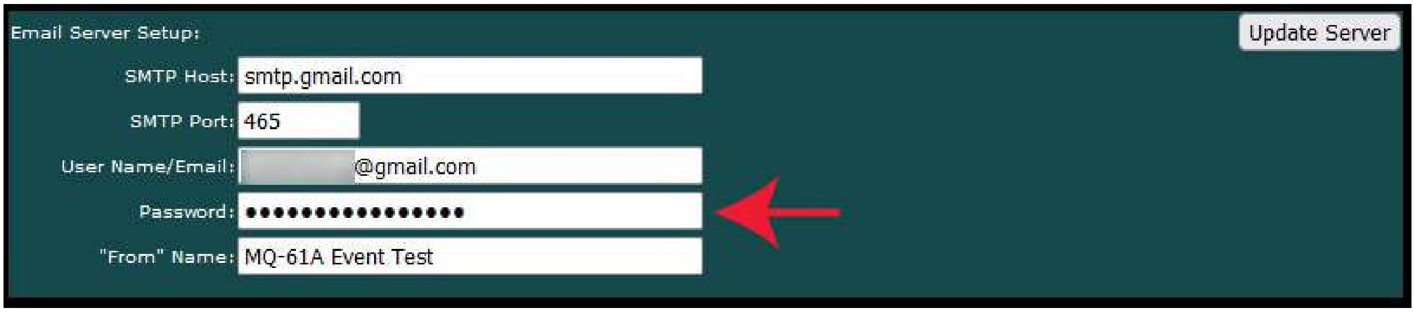
Your app password for your device

larh obhs plvi knlh

How to use it

Go to the settings for your Google Account in the application or device you are trying to set up. Replace your password with the 16-character password shown above.
Just like your normal password, this app password grants complete access to your Google Account. You won't need to remember it, so don't write it down or share it with anyone.

Copy from the yellow box by highlighting the text and then right-click "Copy". You will note that the spaces displayed will be removed. If you copy by typing the password, do not included the embedded spaces - they are just for visual simplicity. Paste into the Password window in the Control Solutions device. Then click Update Server, and to make the changes persistent, follow that by going to the File Manager page and saving your configuration file.



Email Server Setup:

SMTP Host: smtp.gmail.com

SMTP Port: 465

User Name/Email: [redacted]@gmail.com

Password: ●●●●●●●●●●●●●●●●

"From" Name: MQ-61A Event Test

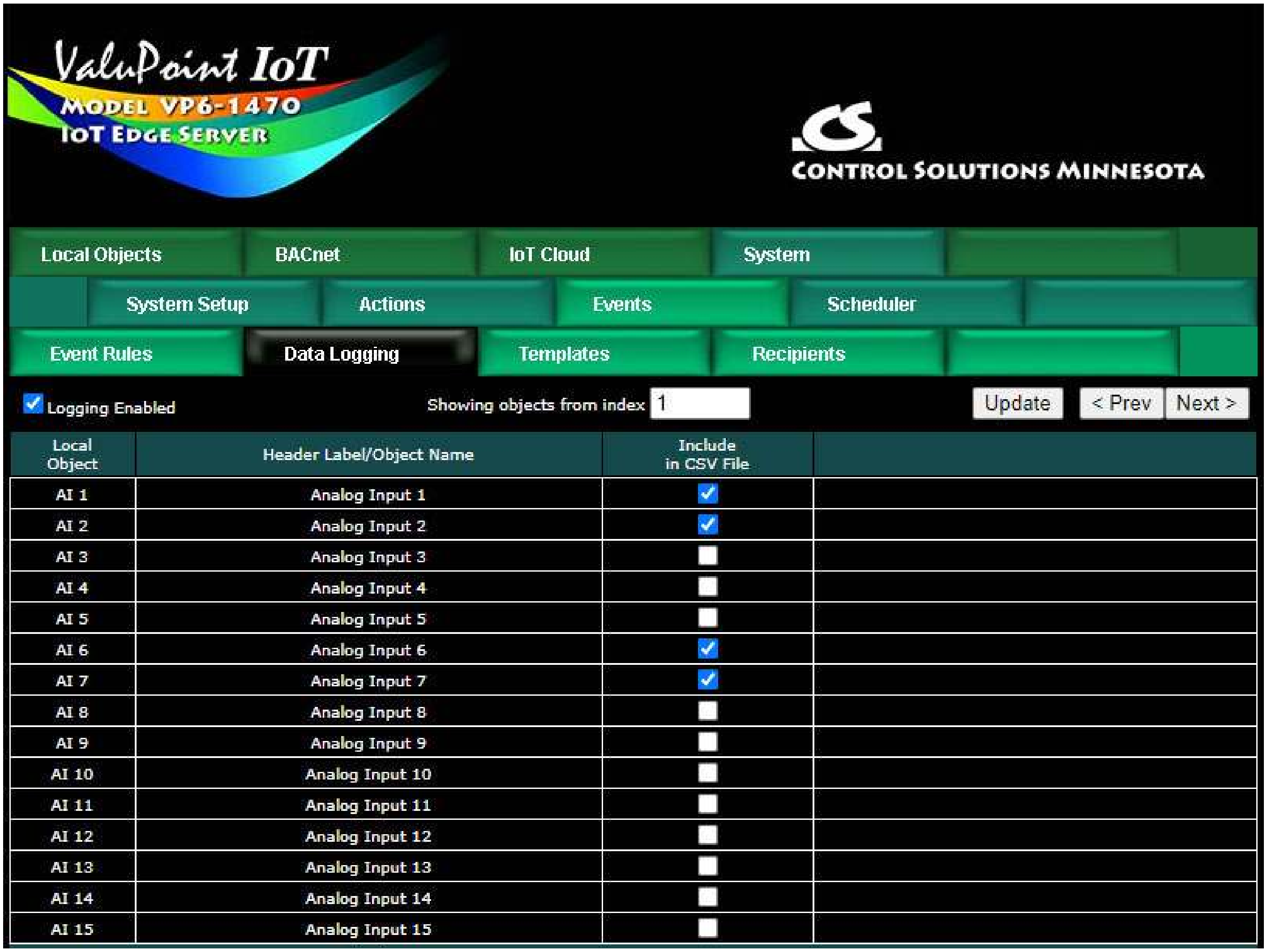
Note that the "From" name is arbitrary. You should now be able to send email using Gmail.

11. Configuring Local Data Logging

There are two ways of going about data logging with this IoT Device. One is via the cloud (explained in other sections). The other is to log data to a local CSV file and have that file emailed to you periodically. This section pertains to local data logging and emailed CSV files.

11.1 Selection of Data Points

Selection of data points is pretty easy. Every local object you have created shows up on the list here. Simply check off those objects you want to log. Go to the File Manager page and save your configuration after making these selections.



☑ Logging Enabled

Showing objects from index 1

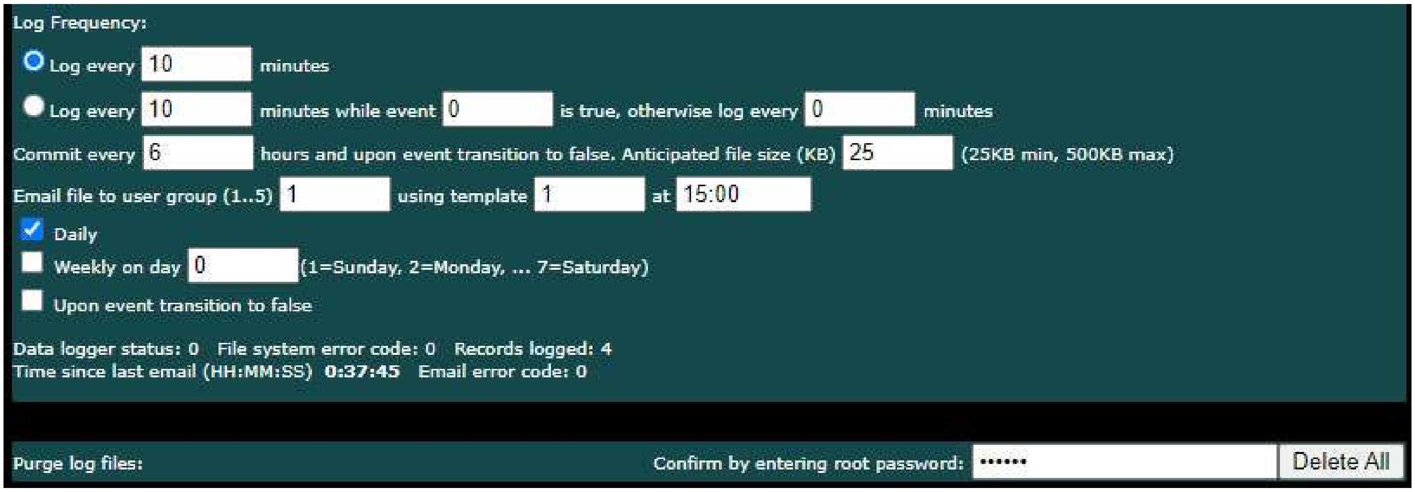
Local Object	Header Label/Object Name	Include in CSV File	
AI 1	Analog Input 1	☑	
AI 2	Analog Input 2	☑	
AI 3	Analog Input 3	□	
AI 4	Analog Input 4	□	
AI 5	Analog Input 5	□	
AI 6	Analog Input 6	☑	
AI 7	Analog Input 7	☑	
AI 8	Analog Input 8	□	
AI 9	Analog Input 9	□	
AI 10	Analog Input 10	□	
AI 11	Analog Input 11	□	
AI 12	Analog Input 12	□	
AI 13	Analog Input 13	□	
AI 14	Analog Input 14	□	
AI 15	Analog Input 15	□	

Note the Logging Enabled check box in the upper left corner. You must disable logging while making changes to logging parameters or object selections. Then check the

Logging Enabled box and click Update to enable logging. The Logging Enabled state is retained through power outages, and logging will resume when power is restored if it was enabled to begin with.

11.2 Log Rate and File Send

Once you have selected which objects to record, this is where you decide how often to record them, and when to send the log file to yourself via email. This section of the screen appears right below the list of objects above.



Log Frequency:

● Log every 10 minutes

○ Log every 10 minutes while event 0 is true, otherwise log every 0 minutes

Commit every 6 hours and upon event transition to false. Anticipated file size (KB) 25 (25KB min, 500KB max)

Email file to user group (1..5) 1 using template 1 at 15:00

☑ Daily

□ Weekly on day 0 (1=Sunday, 2=Monday, ... 7=Saturday)

□ Upon event transition to false

Data logger status: 0 File system error code: 0 Records logged: 4
Time since last email (HH:MM:SS) 0:37:45 Email error code: 0

Purge log files: Confirm by entering root password: •••••• Delete All

Select the first "Log every" line to always log at strictly the same rate.

Select the second "Log every" line and complete the rest of the line if you wish to log at one rate most of the time, but log at a different (usually faster) rate while some event of interest is taking place. A typical example of this is that you don't really need to record oil pressure very often for an engine that isn't running, but when it is running, you want to see data much more often. So you would create an event (that doesn't necessarily email any notification) that simply tells you when that engine is running based on reading an object somewhere.

Logging will normally take place every N minutes as configured. However, if the log rate is exactly 60 minutes, then the logging is synchronized with real time, and each log record will be recorded every hour on the hour.

Log and Commit are two different things. As data is logged, it is stored in a temporary file in volatile memory. Then, periodically, it will be committed to the Flash file system. The purpose for doing this is that the Flash memory has a finite lifetime measured in write cycles. You do not want to abuse the write cycles if you want years of life out of this device. The Commit will take place periodically every few hours as configured. In addition, if the log rate had been altered as the result of an event, then when that event is over with, another Commit will be done. If you are highly concerned about losing data not committed, then it is recommended that you power this IoT device from a UPS.

There are two ways to receive your log files. The easy way is to just have them automatically emailed to you. If that isn't an option, then you can log into the web UI, go to the File Manager page, and retrieve them there. Set the file filter to *.csv and click Filter. Find the file of interest in the drop-down list, and then click View. In most cases, your browser will offer you the option of saving the file or opening it in your spread sheet program. You could also use FTP to retrieve your files.

As the Flash file system fills up, the system will automatically delete the oldest files and it can only assume that either they were emailed to you or you logged in and retrieved them.

The anticipated file size is an estimate of the size of the file you think might be emailed each time. See additional comments below.

Your log file will be emailed to the user group given, and using the template number given. This will be done at the time given in 24-hour format. A Commit will be made automatically before sending the file.

You may elect to have the log file emailed daily, weekly, or upon event transition to false. If weekly, select which day of the week you want the log to be sent. The "upon transition" may be used at the same time as daily or weekly. If you select both daily and weekly, it will automatically be just daily. The event transition refers to the event noted above that causes a different log rate to be in effect. When used at the same time as daily or weekly, the "upon transition" means "in addition to" daily or weekly.

The time since the most recent emailing of a log file is noted. If there is a non-zero error code, it will pertain specifically to the data log email, and those are explained on the Recipients page.

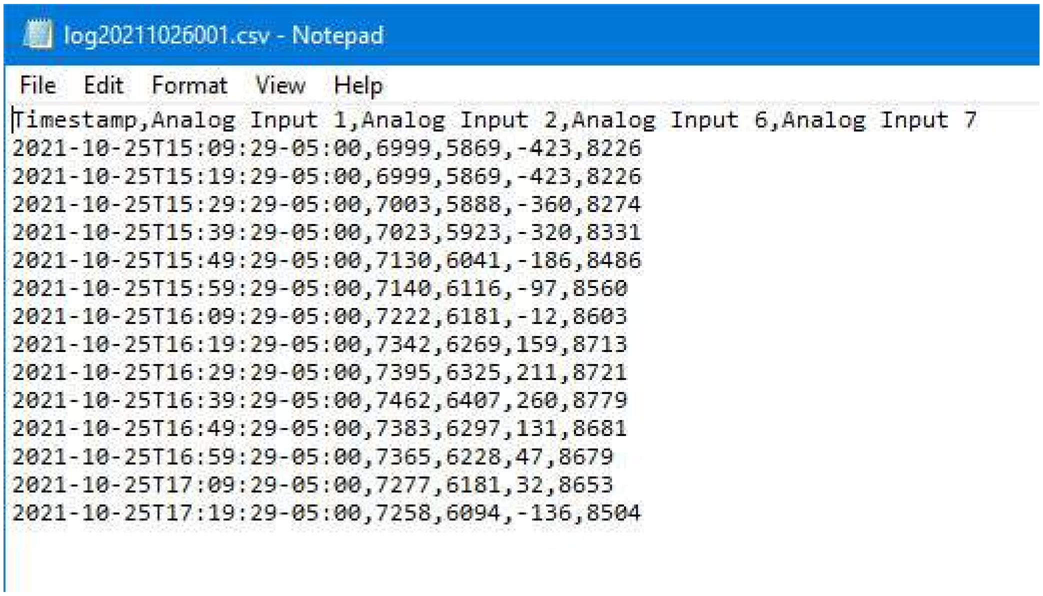
If you have reason to delete all old log files, enter the root password and click Delete All.

11.3 CSV File Format

There will be one column in the file for each object selected on the object list. No column will be allocated for non-selected objects. The first column is always timestamp and is included automatically. The first line in the file will be a header line made up of the object names of each of the logged objects. These are the names displayed on the Local Objects pages. Following the header line, one line of data will be recorded every so often as configured above. Data values are separated by commas (hence the CSV notation for Comma Separated Values).

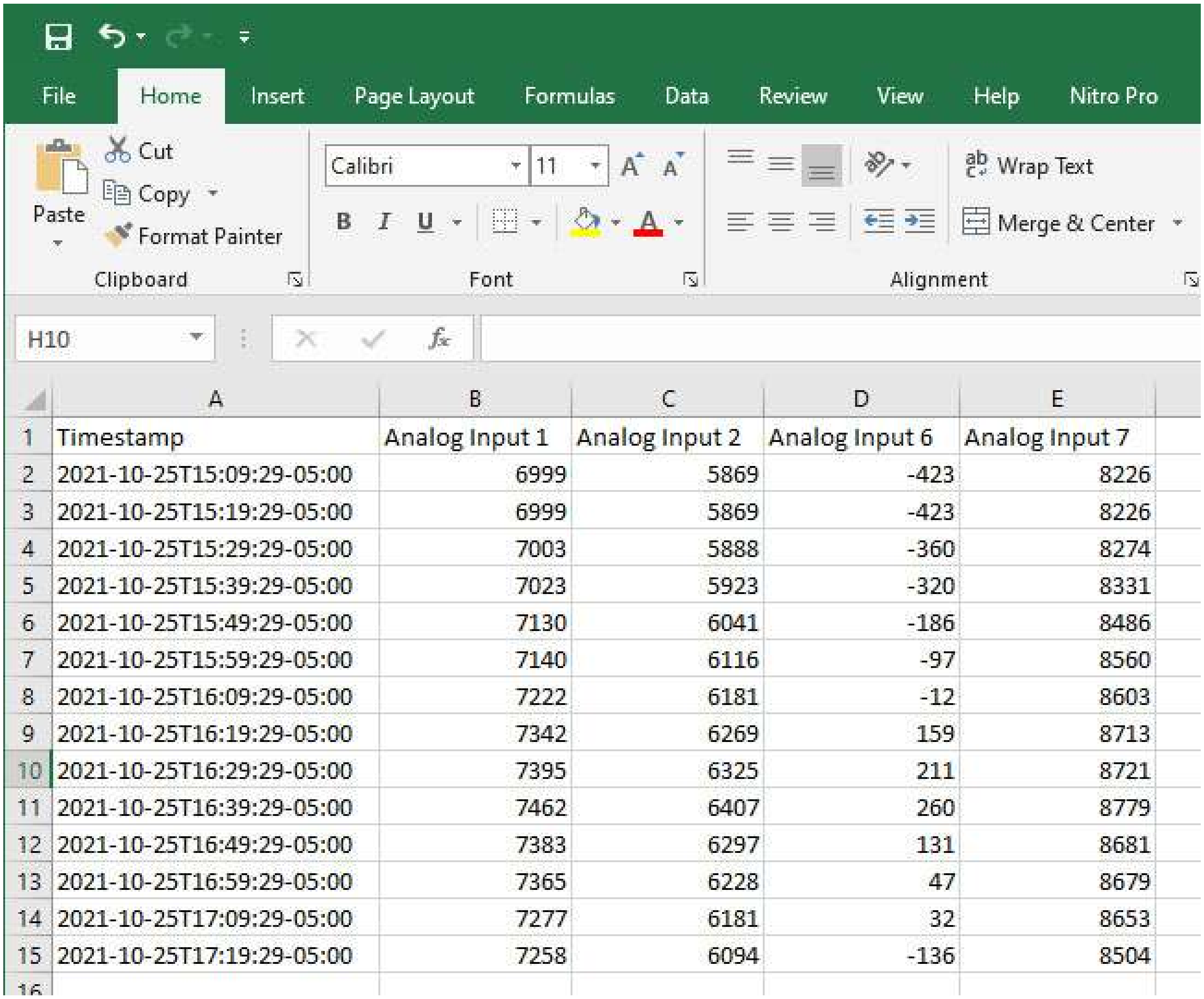
The header line is recorded one time when a new log file is created. Therefore, if you were previously logging data and then change the object selections and promptly resume logging, the data logged now will not correspond to the originally logged header file. To avoid this, retrieve your old log files, then delete all the old log files to force a new file to be created. Normally, if logging is interrupted, logging will resume writing to the same log file previously in use, and this includes when interrupted to make configuration changes.

A snippit of a sample file is illustrated below in raw text form.



```
Timestamp,Analog Input 1,Analog Input 2,Analog Input 6,Analog Input 7
2021-10-25T15:09:29-05:00,6999,5869,-423,8226
2021-10-25T15:19:29-05:00,6999,5869,-423,8226
2021-10-25T15:29:29-05:00,7003,5888,-360,8274
2021-10-25T15:39:29-05:00,7023,5923,-320,8331
2021-10-25T15:49:29-05:00,7130,6041,-186,8486
2021-10-25T15:59:29-05:00,7140,6116,-97,8560
2021-10-25T16:09:29-05:00,7222,6181,-12,8603
2021-10-25T16:19:29-05:00,7342,6269,159,8713
2021-10-25T16:29:29-05:00,7395,6325,211,8721
2021-10-25T16:39:29-05:00,7462,6407,260,8779
2021-10-25T16:49:29-05:00,7383,6297,131,8681
2021-10-25T16:59:29-05:00,7365,6228,47,8679
2021-10-25T17:09:29-05:00,7277,6181,32,8653
2021-10-25T17:19:29-05:00,7258,6094,-136,8504
```

When opened with a spread sheet program, it may look like this:



	A	B	C	D	E
1	Timestamp	Analog Input 1	Analog Input 2	Analog Input 6	Analog Input 7
2	2021-10-25T15:09:29-05:00	6999	5869	-423	8226
3	2021-10-25T15:19:29-05:00	6999	5869	-423	8226
4	2021-10-25T15:29:29-05:00	7003	5888	-360	8274
5	2021-10-25T15:39:29-05:00	7023	5923	-320	8331
6	2021-10-25T15:49:29-05:00	7130	6041	-186	8486
7	2021-10-25T15:59:29-05:00	7140	6116	-97	8560
8	2021-10-25T16:09:29-05:00	7222	6181	-12	8603
9	2021-10-25T16:19:29-05:00	7342	6269	159	8713
10	2021-10-25T16:29:29-05:00	7395	6325	211	8721
11	2021-10-25T16:39:29-05:00	7462	6407	260	8779
12	2021-10-25T16:49:29-05:00	7383	6297	131	8681
13	2021-10-25T16:59:29-05:00	7365	6228	47	8679
14	2021-10-25T17:09:29-05:00	7277	6181	32	8653
15	2021-10-25T17:19:29-05:00	7258	6094	-136	8504
16					

11.4 Anticipated File Size

The anticipated file size is initially just an estimate of the size of the file you think might be emailed each time. Once you start to see what the normal file size is, set the anticipated file size to something just beyond that size. What this does is cause the system to delete enough old files to make this amount of free space for the new log file about to be started. This action will take place each time the log file is sent and the system begins creating the next new log file.

If the anticipated file size was too small, and the system runs out of room, it will commit and send the file even if it was not normally time to do so. It will then repeat the process of trying to delete some old files and resume logging. If your log files are showing up more often than the schedule you anticipated, it is likely due to running out of room.

Most often, running out of room will happen in the middle of an attempt to commit. If this happens, the file as already committed will be sent, then old files will be deleted to make room, then the commit will be repeated so that no data is lost. This can mean that some data points will be recorded in both the file just sent and the new file just created.

If Internet service is unavailable when the ValuPoint attempts to send a log file, it will continue to retry. If Internet service has not been restored by the time the next log file should be sent, then when Internet finally is restored, only the most recent log file will be emailed. You will need to log into the web UI to manually retrieve log files if files were skipped due to extended Internet outage.

As for calculating your initial estimate, there is no precise formula for doing that. Simply multiplying point count by some fixed number will be inaccurate because different data types end up formatted differently. Simply try to estimate the number of characters per line, multiplied by how many lines there should be at the given log rate by the time the file is sent.

ValuPoint IoT
Model VP6-1470
IoT Edge Server

CONTROL SOLUTIONS MINNESOTA

12. Configuring the Scheduler

The ValuPoint becomes more useful when control functions can be combined with monitoring. One element of control that is often useful is the ability to schedule things to happen at certain times on certain days. The scheduler makes that possible.

Scheduling is done in a very generic and simple way. A local object you select will change value according to a schedule you provide. From there, you can use the client to write that object to some external BACnet device to cause action according to your schedule.

The scheduler does require access to an SNTP server in order to know what the current time and date are. Be sure to configure NTP on the Network setup page.

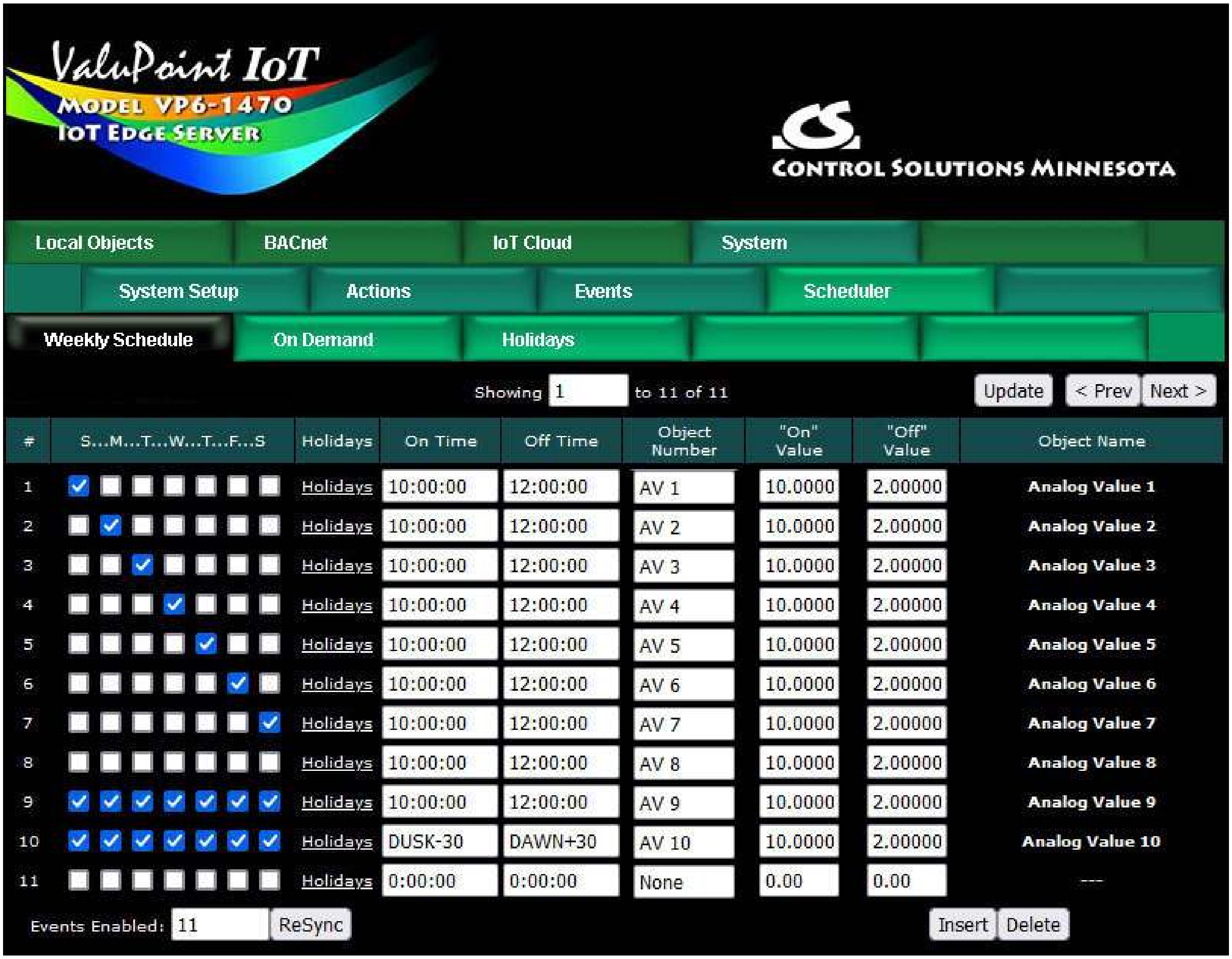
12.1 Weekly Schedule

The weekly schedule allows you to specify that something should happen at a certain time of certain days of the week. It can be one day, multiple days, or every day.

The days of the week start with Sunday in the left column. Simply check the boxes for those days you want action. Then select on and off time of day using 24-hour format. Select a local object number, and its "on" and "off" value.

The "on" state will be that period that falls between On Time and Off Time. Any other time is "off". If multiple lines are used for the same day and same local object, they should be organized with later times last and they will be processed sequentially.

Using the example illustrated below, Analog Input 1 will be set to a value of 10 from 10:00AM until noon on Sunday, and be set to a value of 2 at all other times. And so forth.



Showing 1 to 11 of 11

#	S...M...T...W...T...F...S	Holidays	On Time	Off Time	Object Number	"On" Value	"Off" Value	Object Name
1	☑ □ □ □ □ □ □	Holidays	10:00:00	12:00:00	AV 1	10.0000	2.00000	Analog Value 1
2	□ ☑ □ □ □ □ □	Holidays	10:00:00	12:00:00	AV 2	10.0000	2.00000	Analog Value 2
3	□ □ ☑ □ □ □ □	Holidays	10:00:00	12:00:00	AV 3	10.0000	2.00000	Analog Value 3
4	□ □ □ ☑ □ □ □	Holidays	10:00:00	12:00:00	AV 4	10.0000	2.00000	Analog Value 4
5	□ □ □ □ ☑ □ □	Holidays	10:00:00	12:00:00	AV 5	10.0000	2.00000	Analog Value 5
6	□ □ □ □ □ ☑ □	Holidays	10:00:00	12:00:00	AV 6	10.0000	2.00000	Analog Value 6
7	□ □ □ □ □ □ ☑	Holidays	10:00:00	12:00:00	AV 7	10.0000	2.00000	Analog Value 7
8	□ □ □ □ □ □ □	Holidays	10:00:00	12:00:00	AV 8	10.0000	2.00000	Analog Value 8
9	☑ ☑ ☑ ☑ ☑ ☑ ☑	Holidays	10:00:00	12:00:00	AV 9	10.0000	2.00000	Analog Value 9
10	☑ ☑ ☑ ☑ ☑ ☑ ☑	Holidays	DUSK-30	DAWN+30	AV 10	10.0000	2.00000	Analog Value 10
11	□ □ □ □ □ □ □	Holidays	0:00:00	0:00:00	None	0.00	0.00	---

Events Enabled: 11

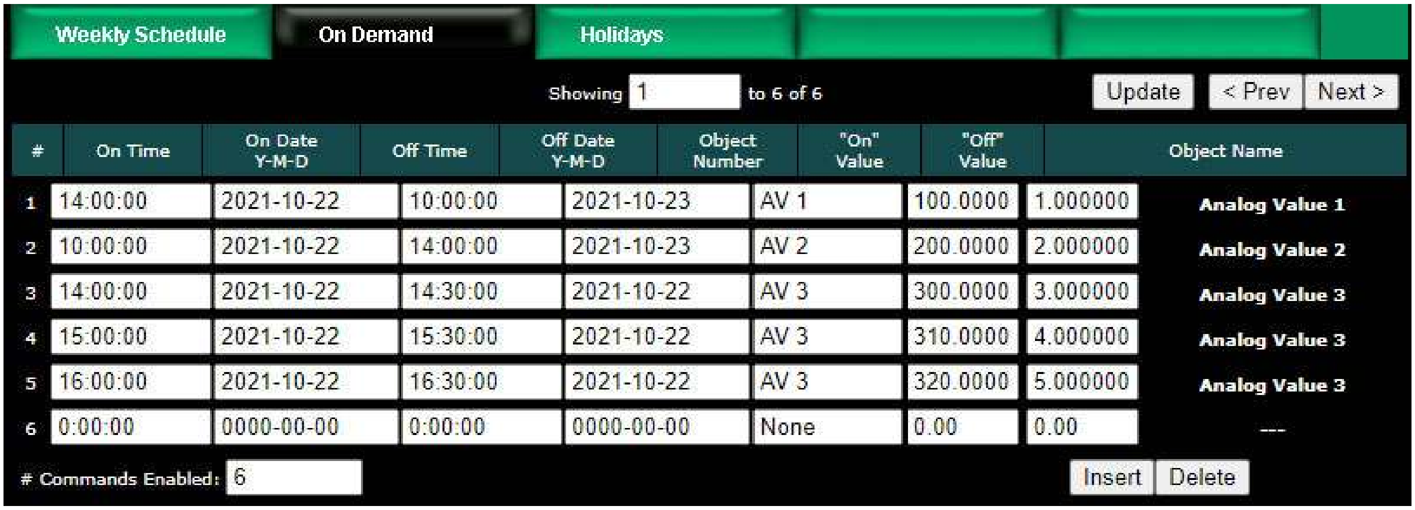
Note the ReSync button at the bottom. If you have made changes to the scheduler, ReSync will cause everything about the schedule to be re-evaluated and objects updated accordingly. Normally, objects are written only when the schedule says it is time to change. The evaluation is made at the start of the configured time period. Therefore, if you have made a new schedule entry that says an object should be "on" now, you will need to hit the ReSync button to cause that to happen now.

Click Update to register your changes. The "Events Enabled" simply sets the scope of the web page display. If you are just starting out and want to see a page of 10 unused entries, set this to 10 and update. If you have many entries, use Next and Prev to scroll through the list. Insert will insert a new blank entry before the entry number in the Showing box at the top. Delete will delete the entry number you enter in the Showing box at the top.

12.2 On Demand Scheduled Events

The scheduler also provides the opportunity to schedule something to happen just one time on a given day or days. Instead of day of week, a date is provided here. Other than selection of day, the On Demand scheduler works the same as Weekly scheduler (except there are no holidays for On Demand).

Using the example illustrated below, Analog Input 1 will be set to a value of 100 starting at 3:00PM September 14, 2021, and remain at that value until 10:00AM September 15. At all other times, Analog Input 1 will be set to 1. And so forth.



Showing 1 to 6 of 6

#	On Time	On Date Y-M-D	Off Time	Off Date Y-M-D	Object Number	"On" Value	"Off" Value	Object Name
1	14:00:00	2021-10-22	10:00:00	2021-10-23	AV 1	100.0000	1.000000	Analog Value 1
2	10:00:00	2021-10-22	14:00:00	2021-10-23	AV 2	200.0000	2.000000	Analog Value 2
3	14:00:00	2021-10-22	14:30:00	2021-10-22	AV 3	300.0000	3.000000	Analog Value 3
4	15:00:00	2021-10-22	15:30:00	2021-10-22	AV 3	310.0000	4.000000	Analog Value 3
5	16:00:00	2021-10-22	16:30:00	2021-10-22	AV 3	320.0000	5.000000	Analog Value 3
6	0:00:00	0000-00-00	0:00:00	0000-00-00	None	0.00	0.00	---

Commands Enabled: 6

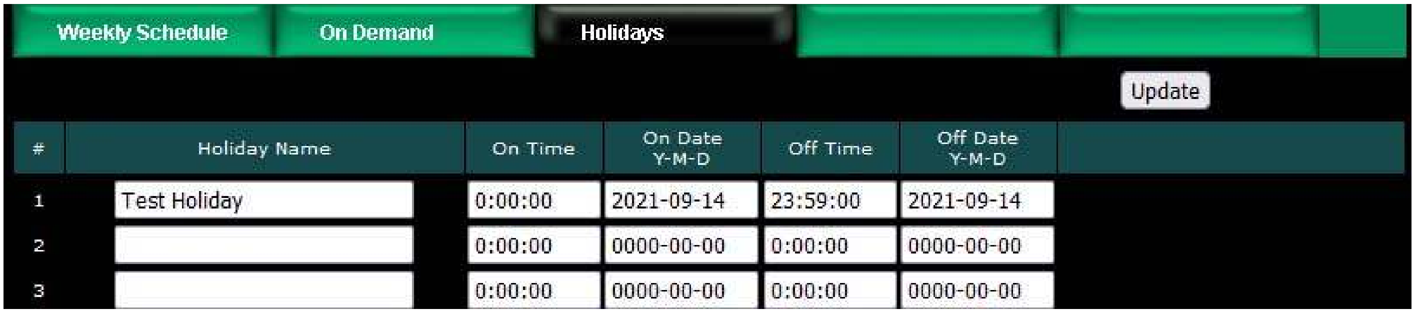
Entries applied to the same object number will be processed sequentially. Analog Input 3 in the above example will be set to a value of 3 prior to 2:00PM Oct. 22. Then from 2:00PM to 2:30PM on Oct. 22, it will be set to a value of 300. From 2:30PM to 3:00PM, the value will be 3. From 3:00PM to 3:30PM, the value will be 310. From 3:30PM to 4:00PM, the value will be 4. From 4:00PM to 4:30PM, the value will be 320. Any time after 4:30PM Oct. 22, the value will be 5. On November 1, the value in Analog Input 3 will still be 5.

Click Update to register your changes. The "# Commands Enabled" simply sets the scope of the web page display. If you are just starting out and want to see a page of 10 unused entries, set this to 10 and update. If you have many entries, use Next and Prev to scroll through the list. Insert will insert a new blank entry before the entry number in the Showing box at the top. Delete will delete the entry number you enter in the Showing box at the top.

12.3 Holidays

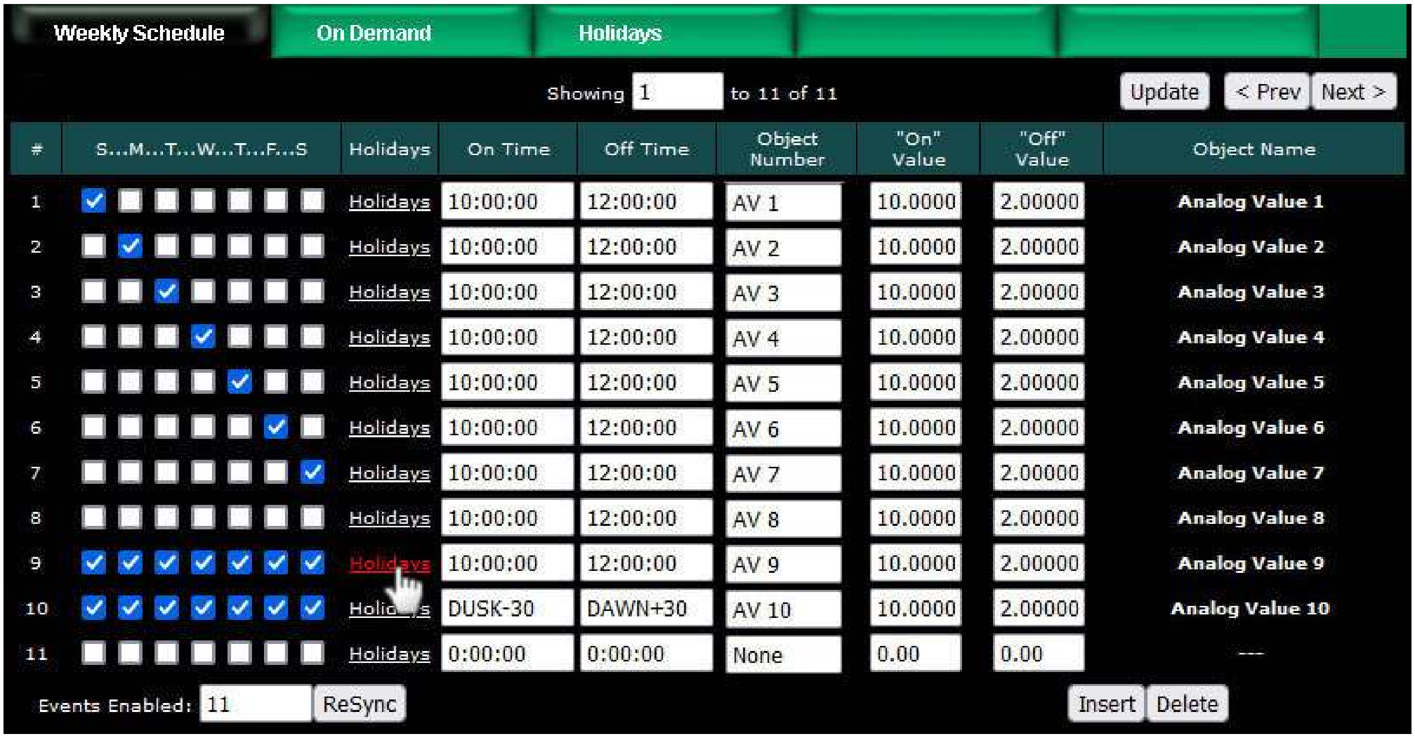
Sometimes you want a weekly schedule to not apply on a holiday, or maybe you want something to only happen on a holiday (although that would be nearly the same as On Demand). The holiday processing in the scheduler allows exceptions to the weekly schedule.

Start by creating a Holiday on the Holidays tab. Give it a name, start time and date, and end time and date. Most often the start time for a holiday will be 0:00:00 and end time will be 23:59:59 so that it means "all day". You may create up to 32 holidays.



#	Holiday Name	On Time	On Date Y-M-D	Off Time	Off Date Y-M-D
1	Test Holiday	0:00:00	2021-09-14	23:59:00	2021-09-14
2		0:00:00	0000-00-00	0:00:00	0000-00-00
3		0:00:00	0000-00-00	0:00:00	0000-00-00

To incorporate a holiday into a weekly schedule entry, click on that line's Holidays link.



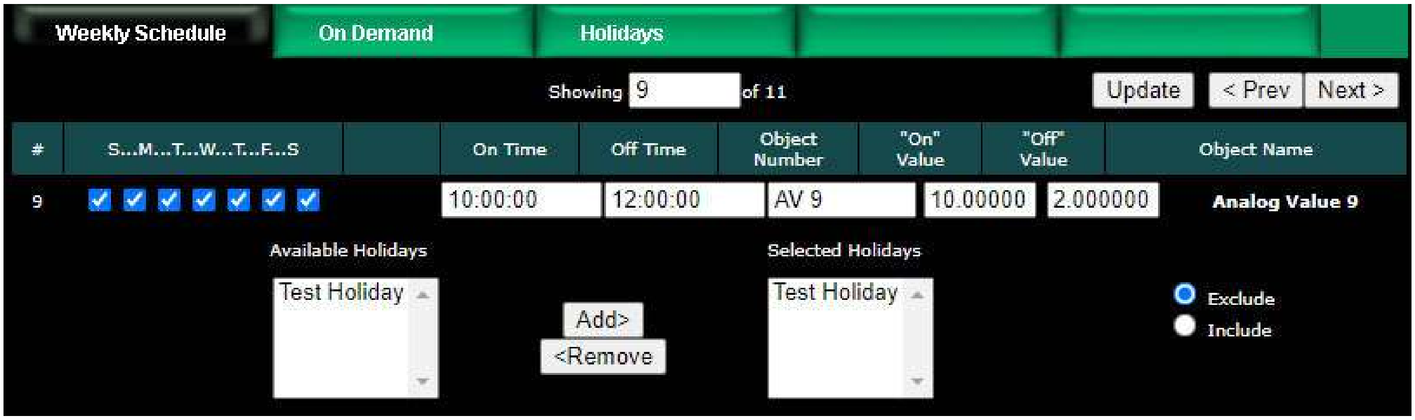
Showing 1 to 11 of 11

#	S...M...T...W...T...F...S	Holidays	On Time	Off Time	Object Number	"On" Value	"Off" Value	Object Name
1	☑ ☐ ☐ ☐ ☐ ☐ ☐	Holidays	10:00:00	12:00:00	AV 1	10.0000	2.00000	Analog Value 1
2	☐ ☑ ☐ ☐ ☐ ☐ ☐	Holidays	10:00:00	12:00:00	AV 2	10.0000	2.00000	Analog Value 2
3	☐ ☐ ☑ ☐ ☐ ☐ ☐	Holidays	10:00:00	12:00:00	AV 3	10.0000	2.00000	Analog Value 3
4	☐ ☐ ☐ ☑ ☐ ☐ ☐	Holidays	10:00:00	12:00:00	AV 4	10.0000	2.00000	Analog Value 4
5	☐ ☐ ☐ ☐ ☑ ☐ ☐	Holidays	10:00:00	12:00:00	AV 5	10.0000	2.00000	Analog Value 5
6	☐ ☐ ☐ ☐ ☐ ☑ ☐	Holidays	10:00:00	12:00:00	AV 6	10.0000	2.00000	Analog Value 6
7	☐ ☐ ☐ ☐ ☐ ☐ ☑	Holidays	10:00:00	12:00:00	AV 7	10.0000	2.00000	Analog Value 7
8	☐ ☐ ☐ ☐ ☐ ☐ ☐	Holidays	10:00:00	12:00:00	AV 8	10.0000	2.00000	Analog Value 8
9	☑ ☑ ☑ ☑ ☑ ☑ ☑	Holidays	10:00:00	12:00:00	AV 9	10.0000	2.00000	Analog Value 9
10	☑ ☑ ☑ ☑ ☑ ☑ ☑	Holidays	DUSK-30	DAWN+30	AV 10	10.0000	2.00000	Analog Value 10
11	☐ ☐ ☐ ☐ ☐ ☐ ☐	Holidays	0:00:00	0:00:00	None	0.00	0.00	---

Events Enabled: 11

The available holidays will be listed. To add a holiday, click on the holiday in the Available list and click the Add button. To remove a holiday previously added, click on the holiday in the Selected list and then click the Remove button. Once you have added a holiday or two, select whether to include or exclude.

The effect of exclude is to temporarily, effectively, uncheck that day of the week. The effect of include is to temporarily, effectively, check that day of the week. In the example below, regardless of what day of the week it is, if this day happens to be the holiday, the "On" value will not be applied between 10:00AM and noon.



Showing 9 of 11

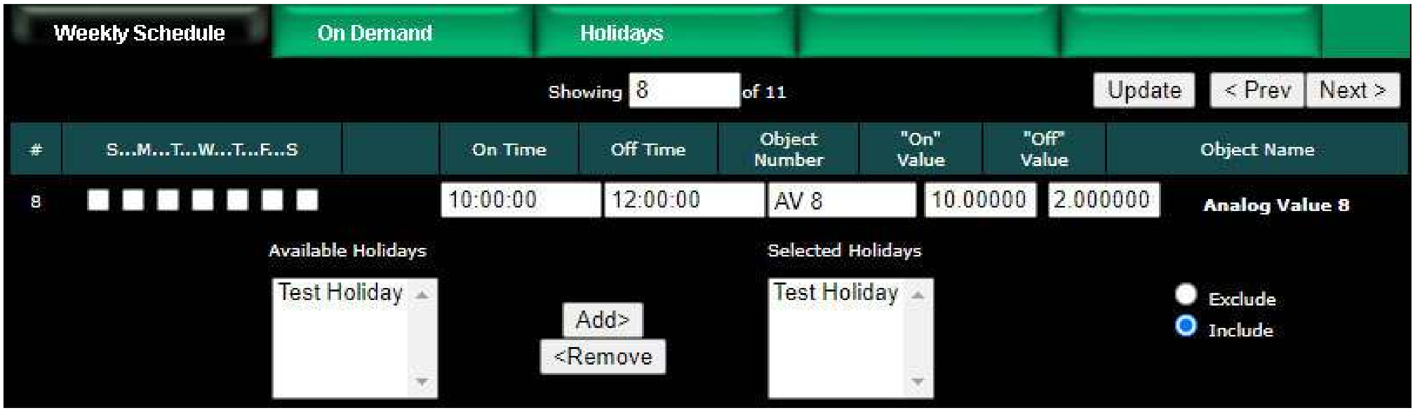
#	S...M...T...W...T...F...S		On Time	Off Time	Object Number	"On" Value	"Off" Value	Object Name
9	☑ ☑ ☑ ☑ ☑ ☑ ☑		10:00:00	12:00:00	AV 9	10.00000	2.000000	Analog Value 9

Available Holidays: Test Holiday

Selected Holidays: Test Holiday

● Exclude
○ Include

Note that in the following example, no days of the week are selected but a holiday is selected as included. This is effectively an On Demand scheduled event for that holiday. The "On" value will be applied on this holiday, regardless of day of week, between 10:00AM and noon (assuming the holiday is defined as all day - if the holiday starts at 3:00PM, then the "On" value would not be applied and this entry in the schedule will never do anything.)



Showing 8 of 11

#	S...M...T...W...T...F...S		On Time	Off Time	Object Number	"On" Value	"Off" Value	Object Name
8	□ □ □ □ □ □ □		10:00:00	12:00:00	AV 8	10.00000	2.000000	Analog Value 8

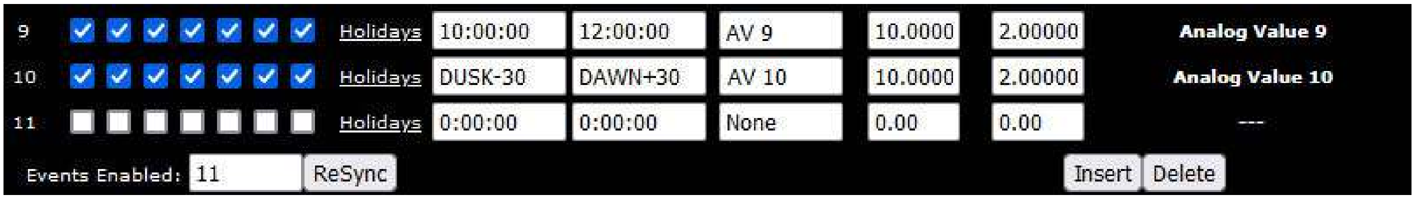
Available Holidays: Test Holiday

Selected Holidays: Test Holiday

○ Exclude
● Include

12.4 Astronomical Clock

If you were looking closely at the first example in this section, you may have noticed one peculiar entry.



9	☑ ☑ ☑ ☑ ☑ ☑ ☑	Holidays	10:00:00	12:00:00	AV 9	10.0000	2.00000	Analog Value 9
10	☑ ☑ ☑ ☑ ☑ ☑ ☑	Holidays	DUSK-30	DAWN+30	AV 10	10.0000	2.00000	Analog Value 10
11	□ □ □ □ □ □ □	Holidays	0:00:00	0:00:00	None	0.00	0.00	---

Events Enabled: 11

Suppose you are scheduling lights to come on when it gets dark outside. One way of doing that is with a light sensor. Another way is by scheduling, but then you have to keep changing the on and off times throughout the seasons. The astronomical clock feature of this scheduler will keep changing the on and off times for you when you use "DUSK" and "DAWN" as entries. In the example above, Analog Input 10 will be set to a value of 10 thirty minutes before sundown, and returned to a value of 2 thirty minutes after sunrise. The more likely scenario would be an "on" value of 1 and "off" value of 0 using a Binary Output to switch a switch somewhere.

Note that in order for the astronomical clock to work correctly in your location, you must set the latitude and longitude for the location on the Network setup page, NTP section. You will also see the currently calculated sunrise and sunset times displayed there.

ValuPoint IoT
MODEL VP6-1470
IOT EDGE SERVER

CONTROL SOLUTIONS MINNESOTA

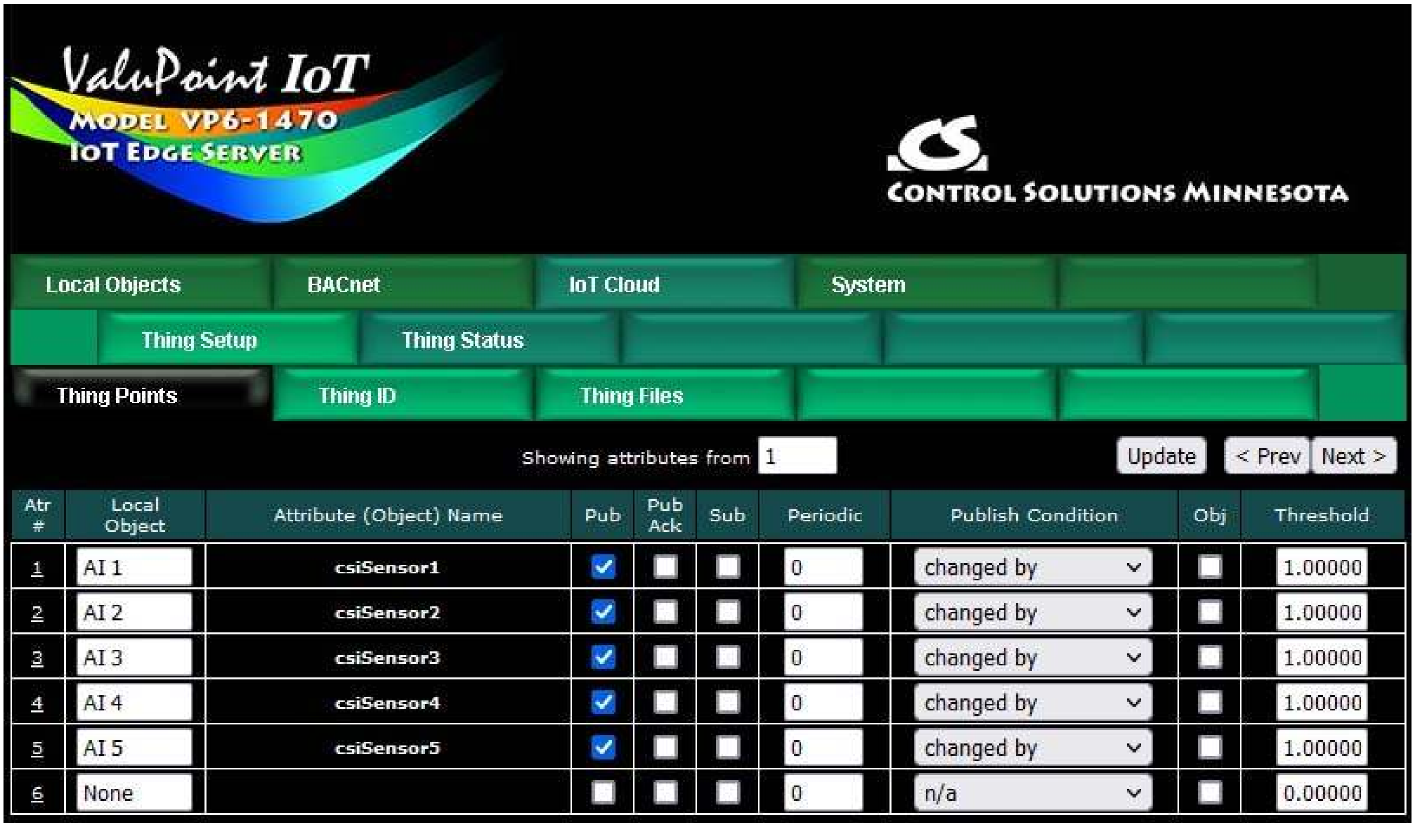
13. Configuring the IoT Client

The ValuPoint IoT Edge Server functions as an MQTT client for purposes of trasnmitting data to MQTT brokers such as AWS IoT, Mosquitto MQTT, or Thingsboard. The pages used to configure the ValuPoint IoT Client's connection to Amazon Web Services (AWS) are detailed in this section. This section provides a reference for elements of the pages, but to gain an understanding of the overall flow of configuring both the IoT Client and the AWS IoT features, you will want to refer to Sections 14 and 15 of this user guide.

13.1 Thing Points or Attributes

The ValuPoint is used to turn any BACnet device into a "thing" for the Internet of Things. The AWS server only knows that we have a "thing" of some sort, and the MQTT protocol used by the Internet of Things knows how to exchange messages containing attributes which have values. The ValuPoint maps BACnet objects to attributes, and the BACnet object content is treated as the attribute's value. The mapping also includes mapping BACnet object numbers to attribute names. Each BACnet object becomes a data point that is treated as an attribute by MQTT.

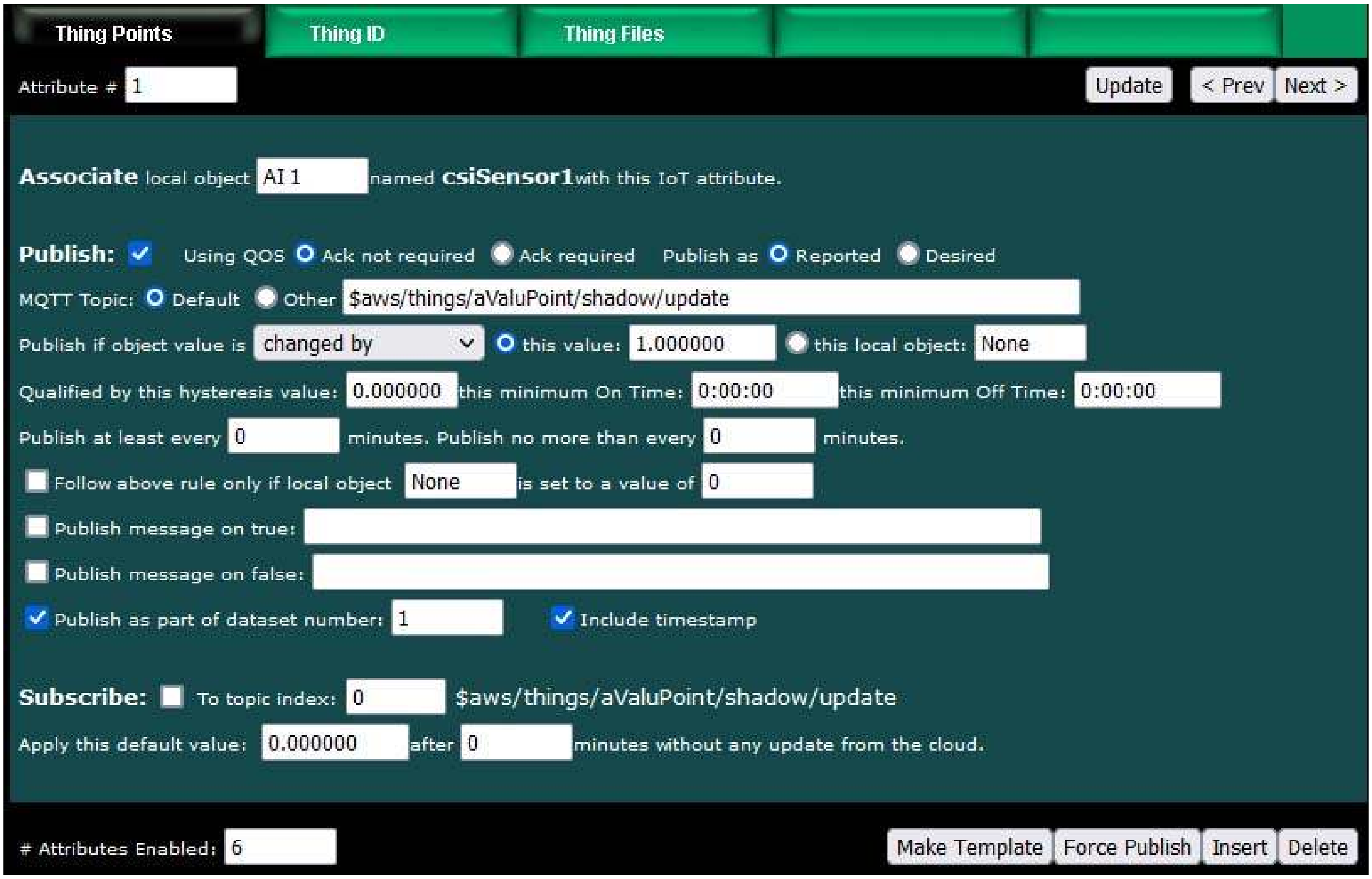
The Thing Points page shows a list of all current attributes, i.e., local objects that have been mapped as an attribute for our "thing". You can create very simple publish and subscribe rules on this tabular list of attributes, but for maximum flexibility, you will want to review each attribute individually.



Showing attributes from 1

Atr #	Local Object	Attribute (Object) Name	Pub	Pub Ack	Sub	Periodic	Publish Condition	Obj	Threshold
1	AI 1	csiSensor1	☑	□	□	0	changed by	□	1.00000
2	AI 2	csiSensor2	☑	□	□	0	changed by	□	1.00000
3	AI 3	csiSensor3	☑	□	□	0	changed by	□	1.00000
4	AI 4	csiSensor4	☑	□	□	0	changed by	□	1.00000
5	AI 5	csiSensor5	☑	□	□	0	changed by	□	1.00000
6	None		□	□	□	0	n/a	□	0.00000

Click on the attribute number in the first column to open the expanded view of the attribute and its publish and subscribe rule. The attribute number has no significance other than the order in which it will be listed in the message when multiple attributes are included in the same message.



Attribute # 1

Associate local object AI 1 named **csiSensor1**with this IoT attribute.

Publish: ☑ Using QOS ● Ack not required ○ Ack required Publish as ● Reported ○ Desired

MQTT Topic: ● Default ○ Other $aws/things/aValuPoint/shadow/update

Publish if object value is changed by ● this value: 1.000000 ○ this local object: None

Qualified by this hysteresis value: 0.000000 this minimum On Time: 0:00:00 this minimum Off Time: 0:00:00

Publish at least every 0 minutes. Publish no more than every 0 minutes.

□ Follow above rule only if local object None is set to a value of 0

□ Publish message on true:

□ Publish message on false:

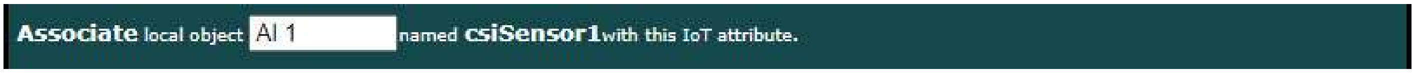
☑ Publish as part of dataset number: 1 ☑ Include timestamp

Subscribe: □ To topic index: 0 $aws/things/aValuPoint/shadow/update

Apply this default value: 0.000000 after 0 minutes without any update from the cloud.

Attributes Enabled: 6

Begin by selecting the local object this attribute rule will be associated with. This will be one of the object numbers listed on the Local Objects pages when you configured objects in Section 6 of this user guide. The rules for naming MQTT attributes are stricter than the rules for naming local objects. Therefore, the name will be "cleaned up" as needed when you select the object. Attribute names can have no embedded spaces and no special characters - only letters and digits. The names should also be unique to avoid confusion (and as required by BACnet).

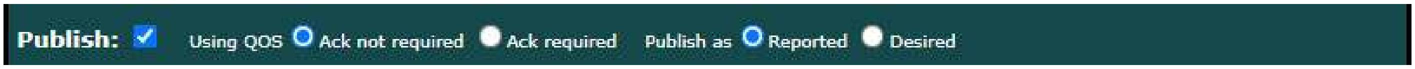


Associate local object AI 1 named **csiSensor1**with this IoT attribute.

Select Publish if you wish to publish this point. Publish means send data from the ValuPoint to the server, and is the type of action you would associate with a sensor.

Select whether or not you wish to publish with acknowledgement required. This is referred to in MQTT terms as Quality of Service (QOS). If "Ack required" is selected, then the ValuPoint will repeatedly retry publishing until the server responds with an acknowledgement.

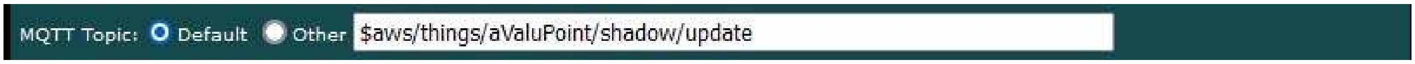
You will normally publish data points as "Reported". If, however, you are publishing to the shadow object of another ValuPoint or similar IoT device, and your intent is to set an object value in that remote device via the AWS server, then you would publish as "Desired".



Publish: ☑ Using QOS ● Ack not required ○ Ack required Publish as ● Reported ○ Desired

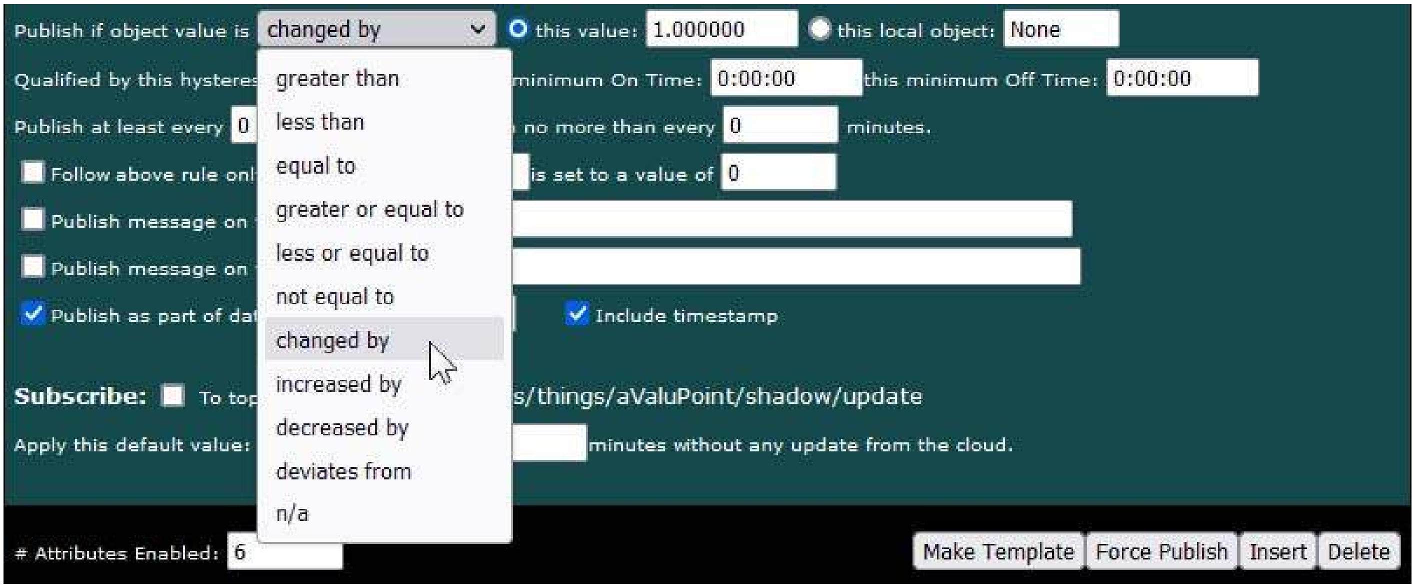
The MQTT topic displayed here is used as the topic when the Publish is invoked, and the attribute name and value are considered the "payload" published to this topic. The default topic will publish to the shadow object for this ValuPoint that you will set up on the AWS server (see Section 14).

If you wish to publish to a topic other than the default topic, enter that topic here and select "Other".


MQTT Topic: ● Default ○ Other $aws/things/aValuPoint/shadow/update

To publish periodically and only periodically, skip the threshold test and value. Enter a number of minutes for "Publish at least every" and you're done.

To publish upon a given condition, select a test from the drop-down list. The test will be applied to the threshold value given as "this value", or to the threshold value currently found in the local object given if that option is selected instead. Normally, the attribute will be published once when the test first transitions to "true", and published again when the test transitions back to "false". If AWS is being used to notify users about an alarm condition, then the publish rule might be "greater than" some threshold.


Publish if object value is changed by ● this value: 1.000000 ○ this local object: None

Qualified by this hysteres minimum On Time: 0:00:00 this minimum Off Time: 0:00:00

Publish at least every 0 no more than every 0 minutes.

□ Follow above rule onl is set to a value of 0

□ Publish message on

□ Publish message on

☑ Publish as part of dat ☑ Include timestamp

Subscribe: □ To top s/things/aValuPoint/shadow/update

Apply this default value: minutes without any update from the cloud.

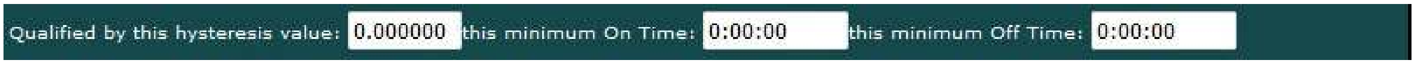
# Attributes Enabled: 6

Some tests need further explanation. The "Changed by" test means amount of change since the last publish of this attribute. If the local object has changed by the value specified as "this value" or the value contained in the local object referenced, the test is true. The "Changed by" value can be an increase or decrease. To publish only upon increase or decrease since the last publish, select those tests instead. The "Deviates by" uses a special application of the hysteresis value. If the present value of the local object deviates from the threshold by the margin set as hysteresis, then this test will be deemed to be "true". This amounts to a combined greater than and less than in the same test.

Tests such as "changed by" will publish each time the attribute changes by that value. There is no static state "true" or "false" for a "changed by" rule. In addition, the "changed by" rule can have a threshold value of zero - this will cause the attribute to be published any time the local object is updated regardless of its new value (and regardless of whether changed). Exercise caution when using "changed by zero" for a object that is being read every few seconds by BACnet - be sure you really want to send data to AWS this often.

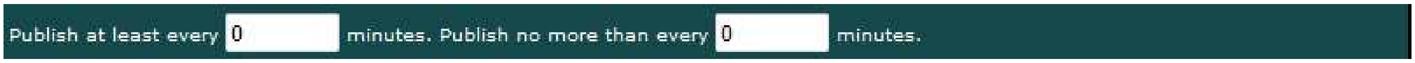
Qualifications are optional, and enabled only when values are nonzero. How hysteresis is applied depends on the comparison. For a test that becomes true if greater than, the test will not return to false until the local object is less than the test value by a margin of at least this hysteresis value. If a test becomes true if less than, it will not return to false until the local object is greater than the test value by a margin of at least this hysteresis value.

On time and off time, if specified, determine how long the condition must be true (on time) or false (off time) before the true or false response is actually taken. Times are given in HH:MM:SS format (hours, minutes, seconds). On/off time qualifications should not be used with "changed by" or other transition type tests. These time qualifications can only apply to static tests such as "greater than".

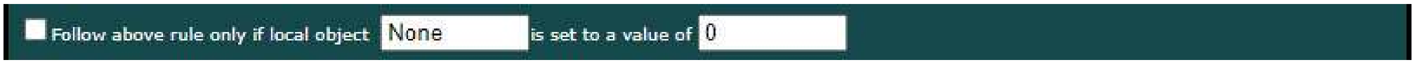

Qualified by this hysteresis value: 0.000000 this minimum On Time: 0:00:00 this minimum Off Time: 0:00:00

Publish at least every N minutes will result in periodic publishing regardless of any conditional testing. Periodic publishing is disabled by entering zero here.

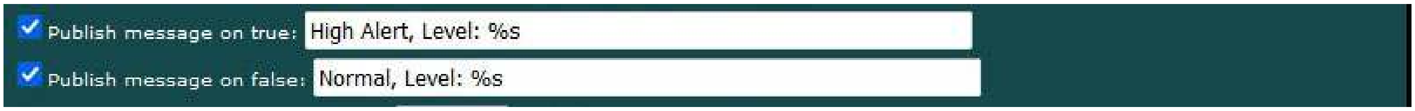
Publish no more than every N minutes will limit the number of times the Thing is permitted to publish. Regardless of what condition exists, it will not be published until this amount of time has expired since the last publish. This throttle effect is disabled by entering zero here. If this attribute is included in a data set being published as result of another rule being fully satisfied, this attribute will be included regardless of time since last publish.


Publish at least every 0 minutes. Publish no more than every 0 minutes.

You have the option of enabling publishing of this attribute only when a selected local object contains a given value. Any local object may be used as the enable object. The optional enable object applies to publishing based on this rule. If this attribute is included in a data set that is successfully triggered by another rule, then this attribute will be included regardless of enable object value


☐ Follow above rule only if local object None is set to a value of 0

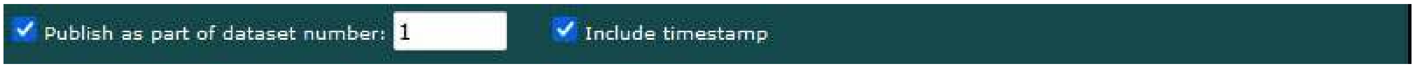
You have the option of publishing fixed messages instead of the object value. Check the applicable "Publish message" boxes and provide a message. The expression "%s" will be replaced by an ASCII representation of the present value of the local object if %s is found in the string.


☑ Publish message on true: High Alert, Level: %s

☑ Publish message on false: Normal, Level: %s

Data sets in the AWS cloud should be viewed like a spread sheet. For best practical use, you want to populate all columns each time you add a new row. In order to make this happen, you need to include all related attributes in the same publish message sent to the server. To cause the attributes of interest to become associated, check "Publish as part of data set" and enter a number. Upon any attribute rule triggering a publish, all attributes with the same data set number will be included in the message.

To include the timestamp as a data element, check "with timestamp".



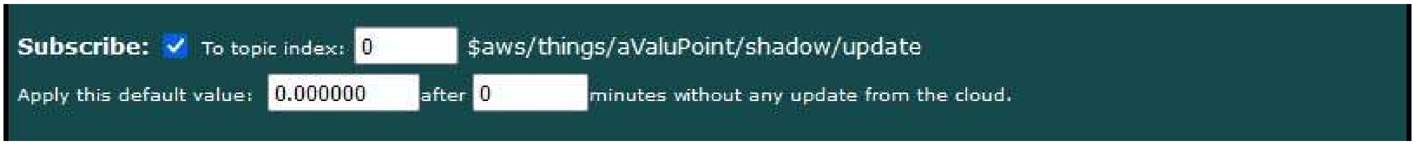
☑ Publish as part of dataset number: 1 ☑ Include timestamp

To allow this attribute to take on new values from other sources by subscribing to other resources in the cloud via this Thing's shadow, check Subscribe.

The subscribe topic will be the topic selected for this attribute; however, only values published as "desired" for this attribute will be acted upon. Any value published to this attribute's topic as "desired" will result in changing the value in this local object. Enter a topic index to select the topic - enter the subscribe topics on the Thing ID page.

You have the option of setting the local object to a default value if no subscription value is received within some number of minutes. Enter both the default value and timeout. If the timeout is zero, the default setting is disabled.

WARNING: Be very cautious about selecting both publish and subscribe at the same time. It is possible to configure an endless loop of continuously publishing to yourself. There are multiple reasons you don't want this to happen.

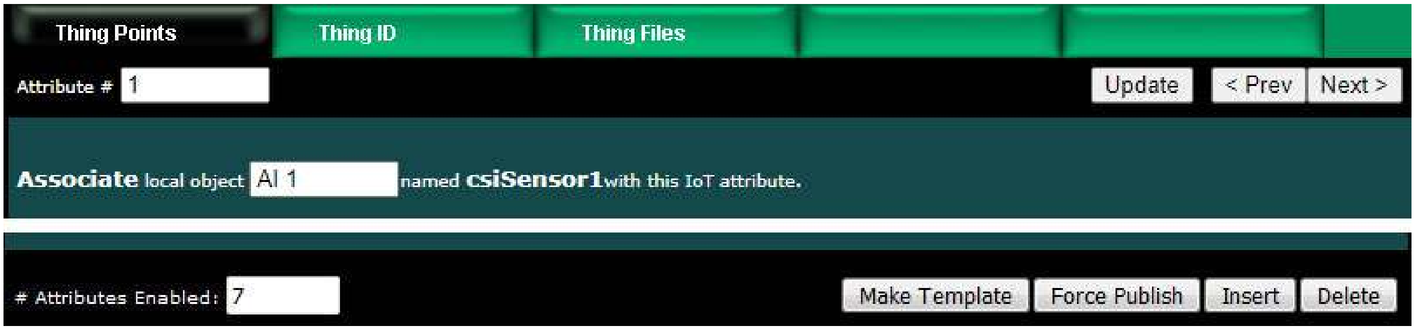


Subscribe: ☑ To topic index: 0 $aws/things/aValuPoint/shadow/update

Apply this default value: 0.000000 after 0 minutes without any update from the cloud.

Click the Update button to register any changes you have made. The Update button moves data from your browser to the ValuPoint. IMPORTANT: To make the changes effectively permanent, you also need to go to the File Manager page and save your configuration as an XML file.

The Prev/Next buttons simply scroll through the list of attribute rules.



Attribute # 1

Associate local object AI 1 named csiSensor1 with this IoT attribute.

Attributes Enabled: 7

Insert will insert a new attribute before the attribute number shown, and is used for placing attributes between existing attributes. It is not necessary to use Insert to add attributes to the bottom of the list or to redefine any attribute presently having zero for an "associate" object. Attribute numbers work like row numbers in a spread sheet.

If you insert an attribute, existing attributes slide down the sheet and get a new number. Likewise if you delete an attribute, the rest of the attributes slide up the sheet and get new attribute numbers.

Delete will remove the attribute number shown in the "Showing" box. Entering zero as the "Associate" object will also effectively deletes the attribute even though it will still appear in the list until deleted. Unused attributes at the end of the list will always show zero as the associate object. If you wish to prevent these from being displayed, reduce the number of attributes enabled.

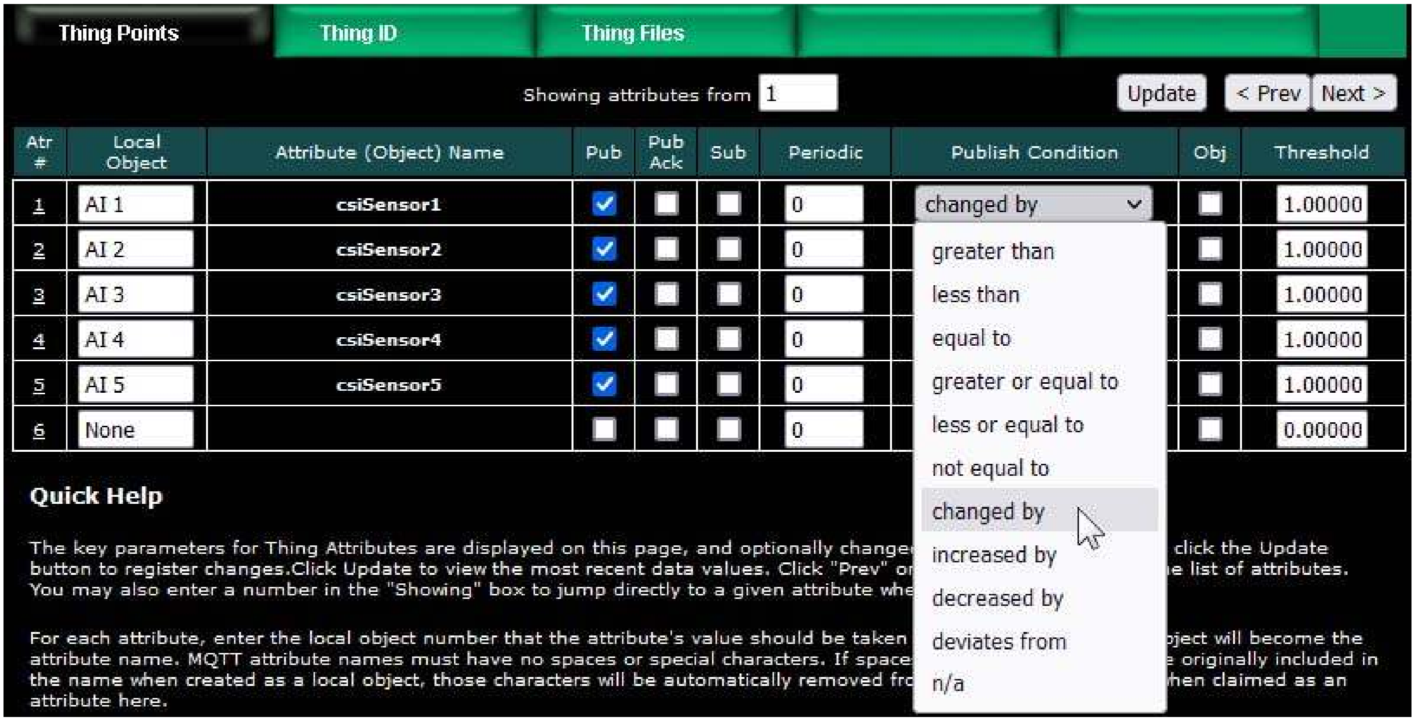
The number of attributes enabled simply limits the scope of attribute review so that you do not have to review a lot of unused attributes.

Click Make Template to fill the "Last Pub" buffer on the Test page with a template of what would be published if this point were published. You may then copy/paste this into a file as needed to upload a JSON example to the AWS server when setting up SNS notifications. Click Make Template here, then go to the test page and click Last Pub.

Click Force Publish to do a one-time publish of the attributed shown on this page, and do so without regard to the rules or conditions. This will force an immediate publish of this attribute (if Publish is enabled). You can then check the result on the Thing Status :: Test page.

13.1.1 Tabular Thing Points Page

A subset of the detailes outlined above may be entered directly from the tabular page for attributes. The Update and Prev/Next buttons on the Thing Points tabular summary page have the same effect as noted above.



Showing attributes from 1

Atr #	Local Object	Attribute (Object) Name	Pub	Pub Ack	Sub	Periodic	Publish Condition	Obj	Threshold
1	AI 1	csiSensor1	☑	□	□	0	changed by	□	1.00000
2	AI 2	csiSensor2	☑	□	□	0		□	1.00000
3	AI 3	csiSensor3	☑	□	□	0		□	1.00000
4	AI 4	csiSensor4	☑	□	□	0		□	1.00000
5	AI 5	csiSensor5	☑	□	□	0		□	1.00000
6	None		□	□	□	0		□	0.00000

Quick Help

The key parameters for Thing Attributes are displayed on this page, and optionally change click the Update button to register changes.Click Update to view the most recent data values. Click "Prev" or e list of attributes. You may also enter a number in the "Showing" box to jump directly to a given attribute whe

For each attribute, enter the local object number that the attribute's value should be taken oject will become the attribute name. MQTT attribute names must have no spaces or special characters. If space e originally included in the name when created as a local object, those characters will be automatically removed fro hen claimed as an attribute here.

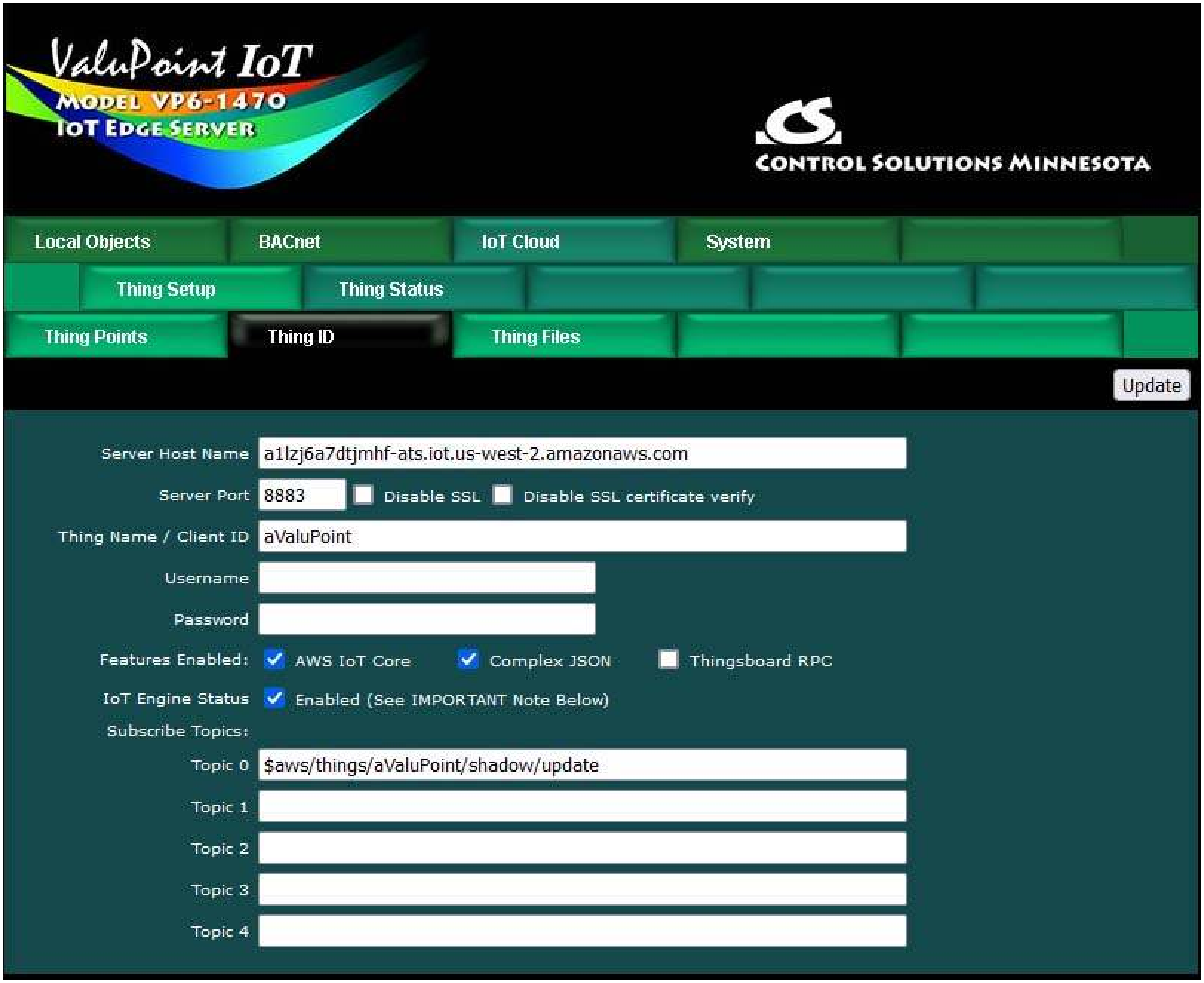
Referring to the preceding detailed descriptions, select a local object number to be published or subscribed, and allow the ValuPoint to retrieve the name for you or enter a new name following the guidelines noted above.

Select "Pub" for publish, "Pub Ack" for publish with acknowledge required, or "Sub" to subscribe. To set the "Publish at least ever N minutes", enter the number of minutes in the Periodic column.

Select a conditional test, and provide a threshold. If the threshold should be retrieved from another local object, check the "Reg" box and provide a local object number instead of fixed value in the Threshold column.

13.2 Thing ID and Subscribe Topics

The items on the top half of the Thing ID page are important elements of establishing your ValuPoint's connection to the AWS server. The Subscribe Topics are used if subscribing, and are not used to publish.



Server Host Name: a1lzj6a7dtjmhf-ats.iot.us-west-2.amazonaws.com

Server Port: 8883 □ Disable SSL □ Disable SSL certificate verify

Thing Name / Client ID: aValuPoint

Username:

Password:

Features Enabled: ☑ AWS IoT Core ☑ Complex JSON □ Thingsboard RPC

IoT Engine Status: ☑ Enabled (See IMPORTANT Note Below)

Subscribe Topics:

Topic 0: $aws/things/aValuPoint/shadow/update

Topic 1:

Topic 2:

Topic 3:

Topic 4:

The Server Host Name will be provided to you by Amazon. Refer to Section 14 to see where you find this. The default port normally used for secure MQTT is 8883. Use this port unless instructed otherwise by Amazon.

The Thing Name is a name you will assign. The only important guideline here is make sure the Thing Name you provide on this page in the ValuPoint is the same name you provided to Amazon when setting up your Thing on the AWS server. The thing name should be unique, but AWS will enforce that for you along with any other naming restrictions. Create the thing on the AWS server first, then enter the thing name here.

The interaction between the ValuPoint and the AWS server will not begin until you set the IoT Engine Status to Enabled.

IMPORTANT: BEFORE ENABLING, make sure you have established your Amazon account and made the corresponding entries above, uploaded valid SSL certificates, and set up attributes in your Thing Shadow via your Amazon account.

DO NOT ENABLE the IoT Engine with invalid configuration information. Doing so for an extended period may get you blocked by the Amazon servers. If you see errors reported by Amazon on the Thing Status page, it is a good idea to disable the IoT Engine while you figure out why the error(s) occurred.

When connecting to AWS, select AWS IoT Core and Complex JSON. Do not select Thingsboard RPC unless connecting to Thingsboard instead of AWS.

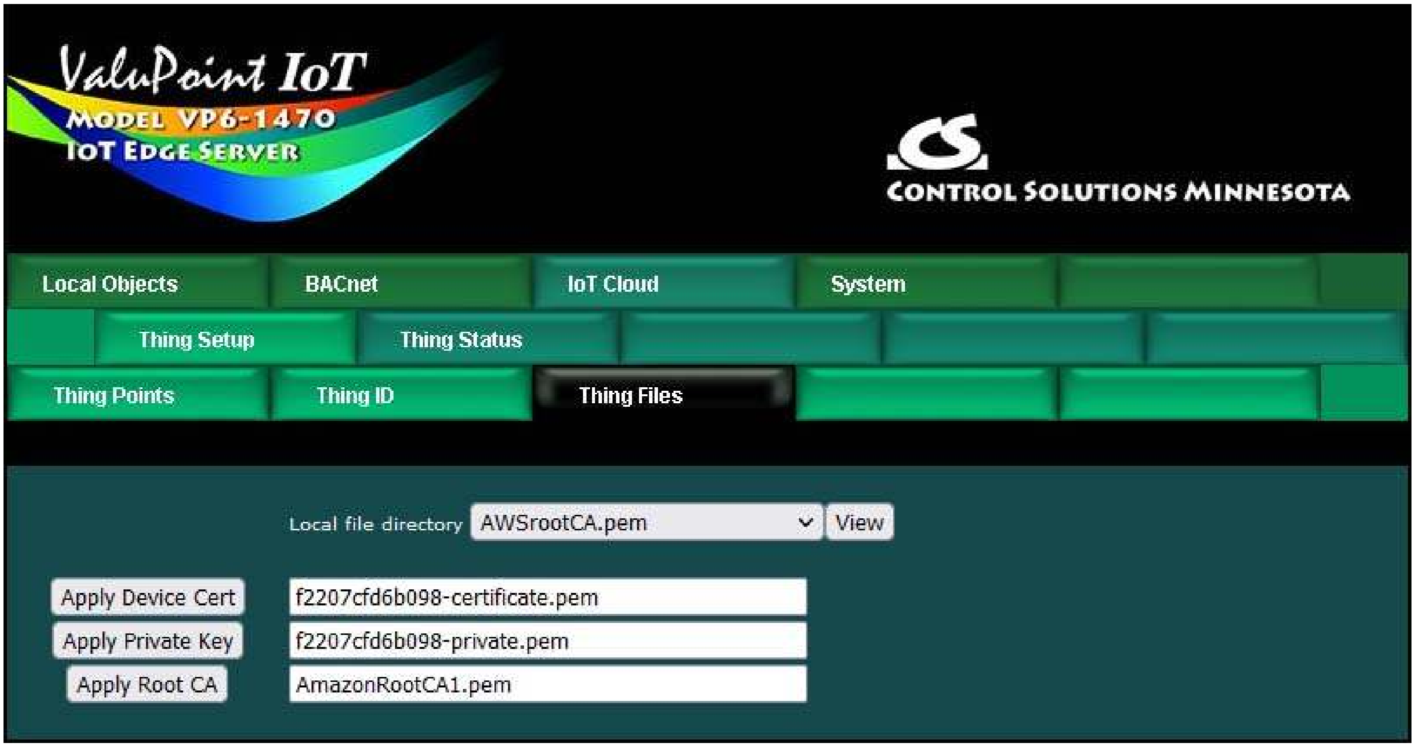
Username and password are not used for connecting to AWS. Your SSL certificates define your identity instead of a username and password when connecting to AWS. The username and password may be used for MQTT services other than AWS.

Subscribe Topics:

Topics that Thing Points may subscribe to are defined on this page. The topics for publishing are arbitrary and you may define as many publish topics as you like on a point by point basis. However, subscribe topics require keeping track of callback handling, and therefore the subscribe topics must be declared on the above list and then referenced by index number when used to subscribe individual points. Topic 0 will default to being the shadow/update topic, and it is quite possible you will need no additional topics.

13.3 Thing Files

The connection between the ValuPoint and the AWS server is a secure connection requiring valid SSL certificates.



Local file directory: AWSrootCA.pem

Apply Device Cert: f2207cfd6b098-certificate.pem

Apply Private Key: f2207cfd6b098-private.pem

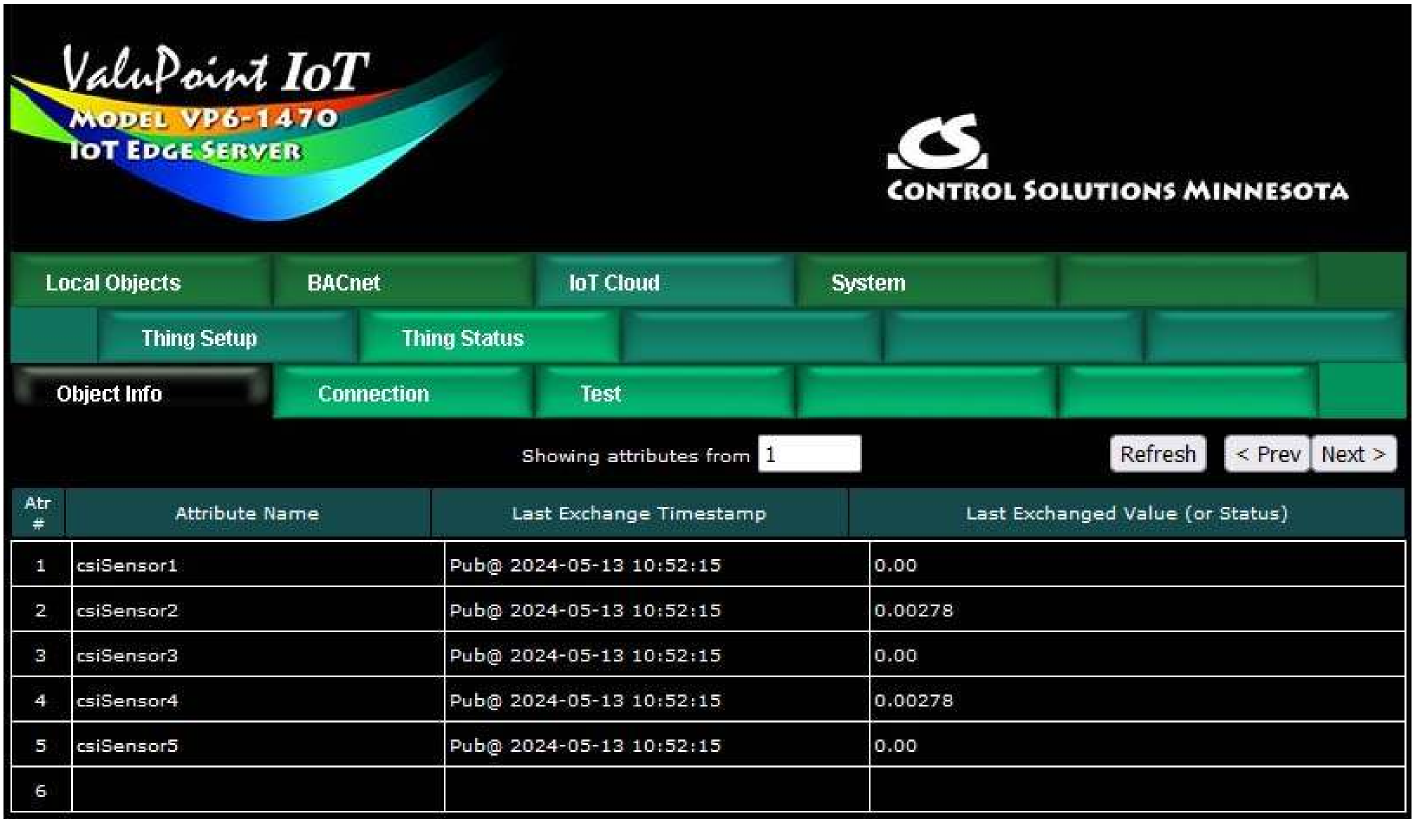
Apply Root CA: AmazonRootCA1.pem

This page is where you assign the security certificates associated with your Thing. These certificates will be created for you by Amazon when you register your Thing. Download those from Amazon, upload them to this device via the File Manager page, and then select them here. Your Thing will not connect to Amazon AWS without these.

Follow directions found in Section 14 of this User Guide as well as instructions found on the Amazon AWS site regarding how to create these certificates. Be sure you have NTP set up - SSL certificates will be treated as invalid if the correct time and date are not set within the ValuPoint.

13.4 Thing Status

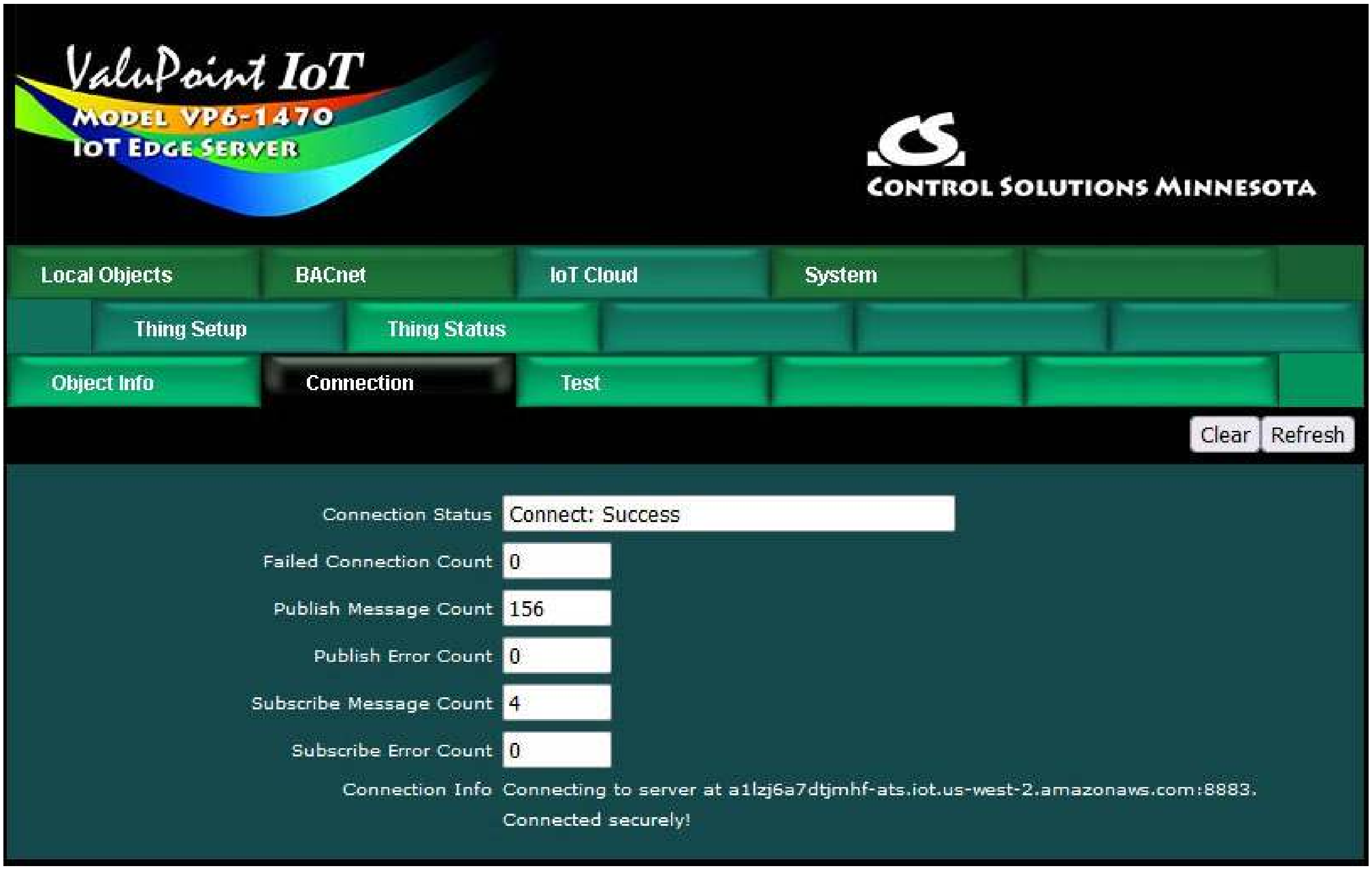
The most recent data exchange for each defined attribute is listed on the Object Info page. The timestamp will show "Pub@" for a published attribute, and "Sub@" when an incoming message was processed for a subscription.



Showing attributes from 1

Atr #	Attribute Name	Last Exchange Timestamp	Last Exchanged Value (or Status)
1	csiSensor1	Pub@ 2024-05-13 10:52:15	0.00
2	csiSensor2	Pub@ 2024-05-13 10:52:15	0.00278
3	csiSensor3	Pub@ 2024-05-13 10:52:15	0.00
4	csiSensor4	Pub@ 2024-05-13 10:52:15	0.00278
5	csiSensor5	Pub@ 2024-05-13 10:52:15	0.00
6			

The Connection page will show the status of the ValuPoint's connection with the AWS server, along with some message statistics.



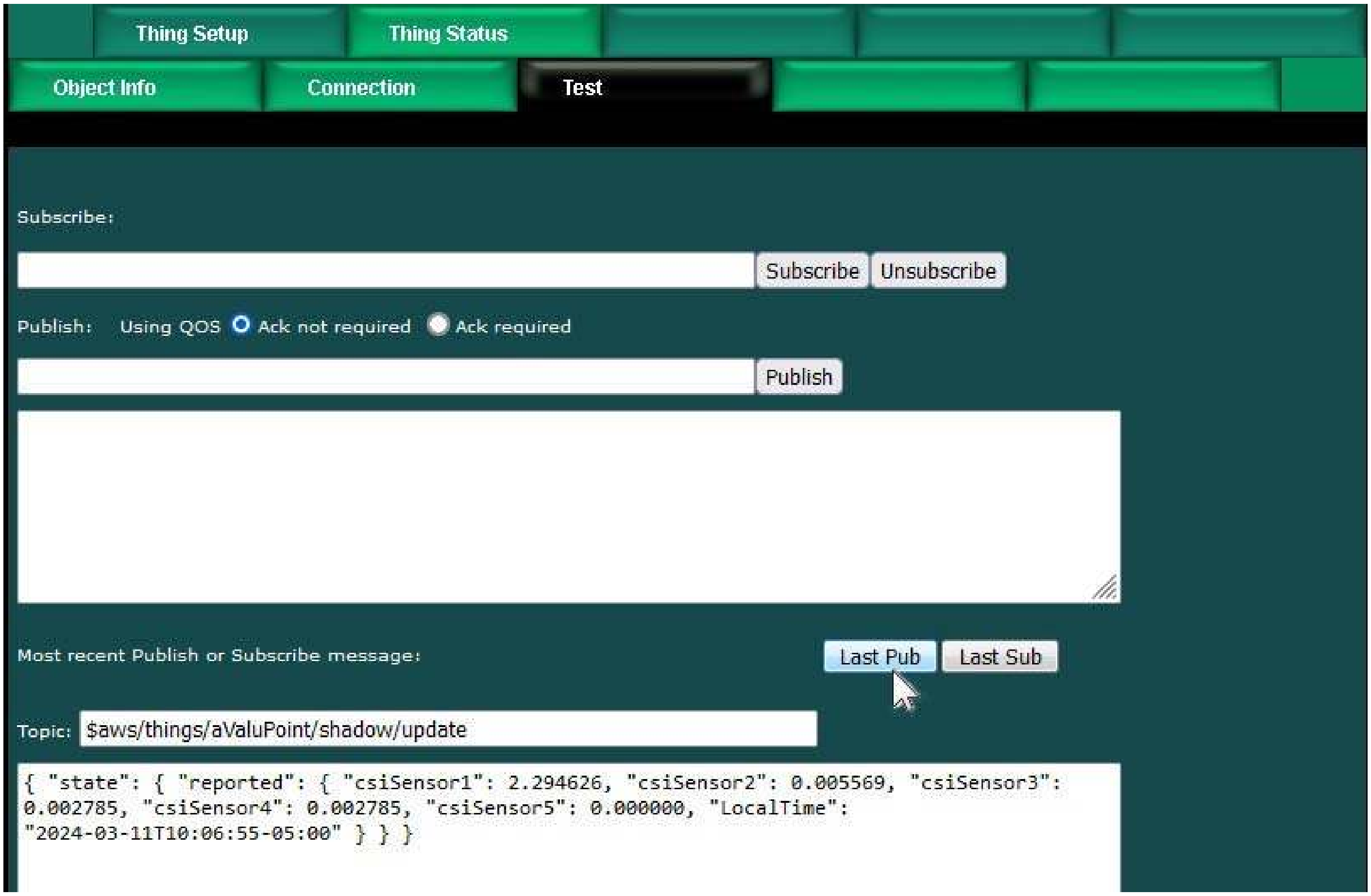
Connection Status: Connect: Success
Failed Connection Count: 0
Publish Message Count: 156
Publish Error Count: 0
Subscribe Message Count: 4
Subscribe Error Count: 0
Connection Info: Connecting to server at a1lzj6a7dtjmhf-ats.iot.us-west-2.amazonaws.com:8883.
Connected securely!

The connection status will show "Offline" when not connected because the IoT Engine is not enabled on the Thing ID page. Upon enabling the engine, there will be a delay while the ValuPoint attempts to connect. There are numerous error messages that can be potentially displayed instead of "Success". If the error indicates unable to connect, check to see that you have valid DNS server settings entered on the Network page. If you see an error such as "SSL certificate error", check to see that NTP has found the correct local time and date on the Network page. If NTP has found the correct time/ date, recheck your SSL certificate setup.

13.5 Testing Thing's Connection

There are two main functions of the Test page. The most commonly used function will be to simply check the content of the most recent publish or subscribe message. The other available function is to generate arbitrary publish and subscribe message exchanges with the AWS server.

To review the most recent Publish message sent by the ValuPoint, click the Last Pub button. An example of a recent publish message is illustrated below.

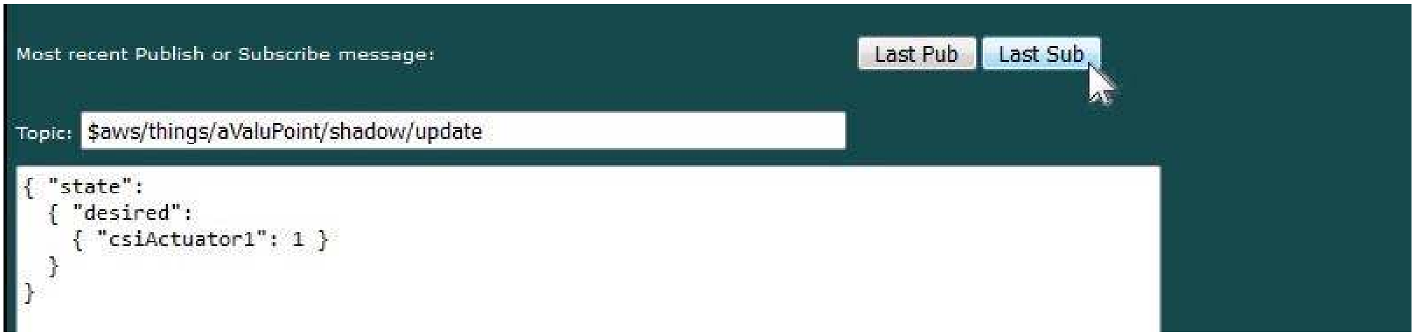


Publish: Using QOS ● Ack not required ○ Ack required

Topic: $aws/things/aValuPoint/shadow/update

```
{ "state": { "reported": { "csiSensor1": 2.294626, "csiSensor2": 0.005569, "csiSensor3":
0.002785, "csiSensor4": 0.002785, "csiSensor5": 0.000000, "LocalTime":
"2024-03-11T10:06:55-05:00" } } }
```

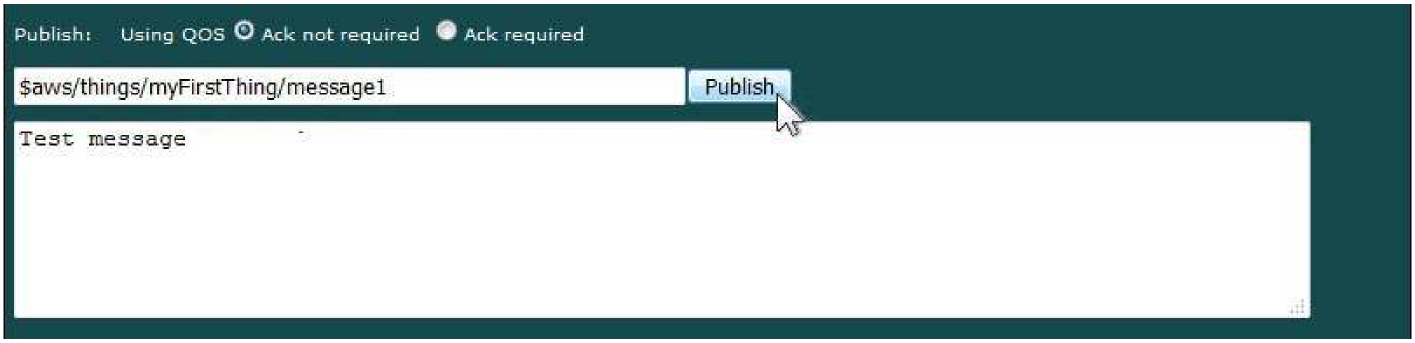
An example of a recently received incoming message resulting from a Subscribe is illustrated below.



$aws/things/aValuPoint/shadow/update

```
{ "state":
  { "desired":
    { "csiActuator1": 1 }
  }
}
```

An arbitrary publish message may be sent on this page by entering a topic and payload, and then click the Publish button. This feature should only be used after you have familiarized yourself with MQTT protocol and the AWS side of this connection.

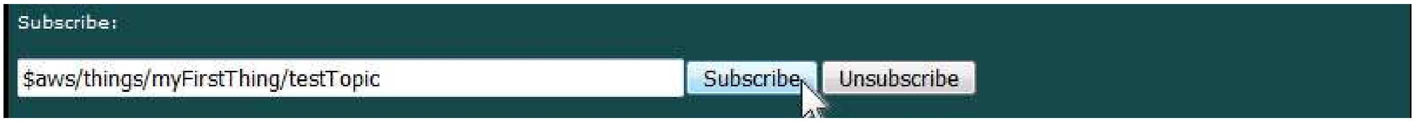


Using QOS ● Ack not required ○ Ack required

$aws/things/myFirstThing/message1

```
Test message
```

To subscribe to an arbitrary topic without configuring Thing Points, enter the topic here and click Subscribe.



$aws/things/myFirstThing/testTopic

Once you have subscribed to a topic, you can test the connection using the AWS IoT Test Client. Anything successfully sent by the test client to this topic will be displayed in the message window when Last Sub is clicked. Be sure to click Unsubscribe when done testing.

ValuPoint IoT
MODEL VP6-1470
IoT EDGE SERVER

CONTROL SOLUTIONS MINNESOTA

14. Configuring IoT Client to Publish to AWS

The MQTT term "Publish", from a controls perspective, would be most closely associated with the action of a sensor. You have data available that you wish to transmit to other devices or systems. In the instance we are working with here, we are Publishing data to the AWS server.

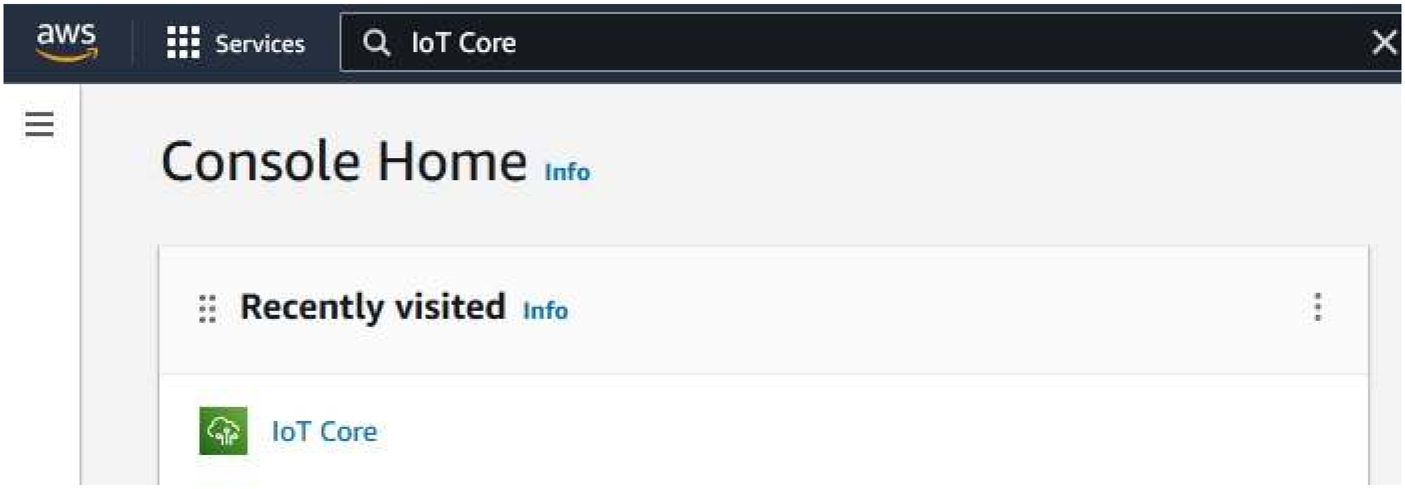
Configuring the ValuPoint to publish data to the Amazon servers requires setting things up on both ends: You need to configure the ValuPoint, and you need to configure your AWS account at Amazon.

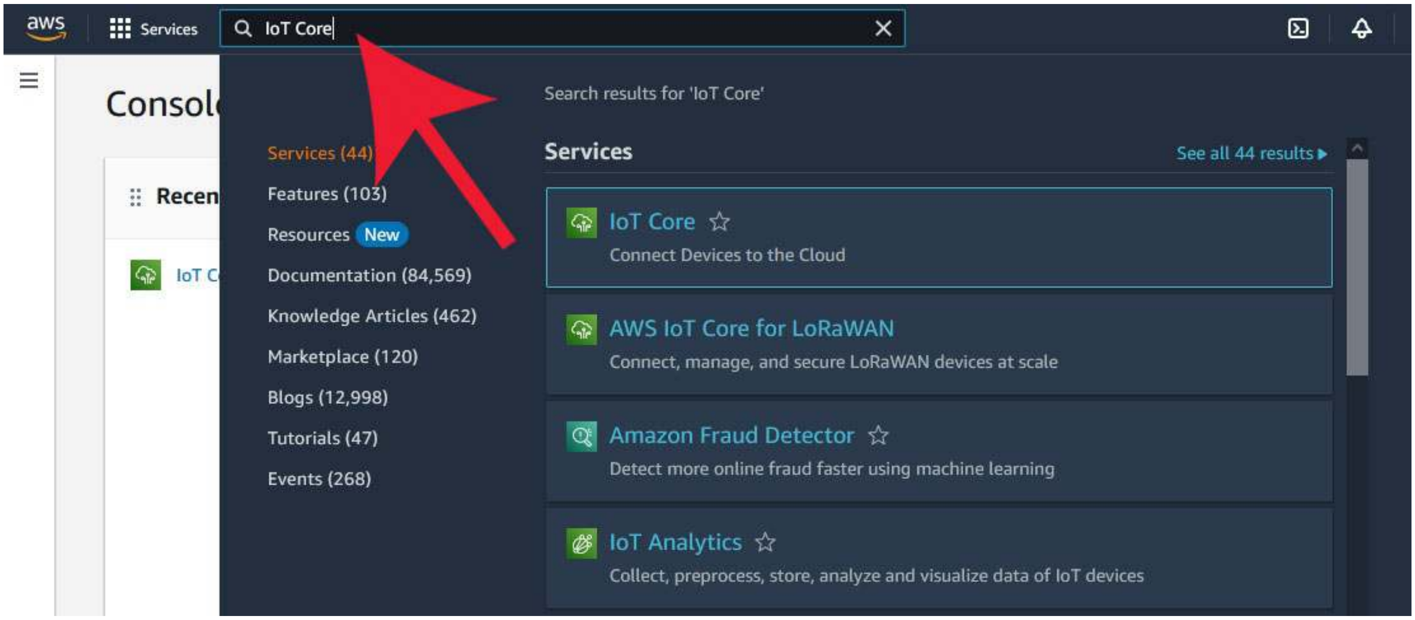
IMPORTANT: The screen shots illustrated in this document were Amazon's web interface as of when these were first captured. We are aware that a few months later, the appearance of some of these screens has changed, and Amazon is noting that there are more changes to come. They will never stop changing ("improving") how the pages look, but what you need to do and the general flow of how to do it have not changed, and probably won't for a long time.

14.1 Create and Register a "Thing"

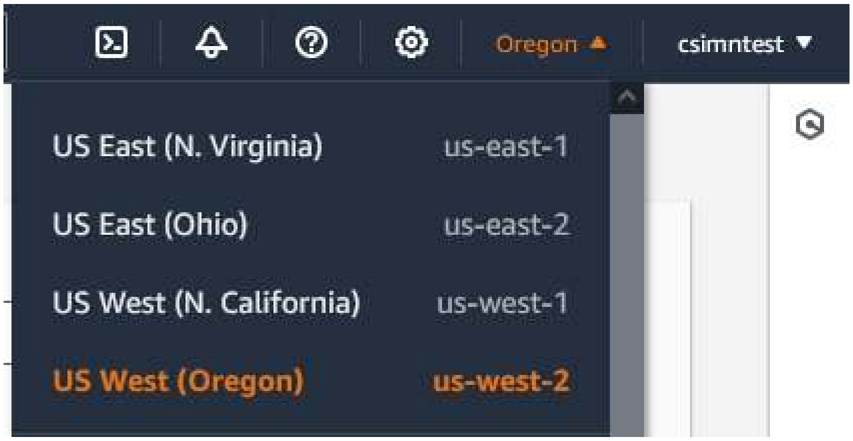
Start by going to https://aws.amazon.com and creating an account if you don't already have one. There is no fee to set up the account, and your data usage will also generally be free for an introductory period.

From your AWS Management Console, search for IoT Core or click on the IoT Core link under recently visited services.

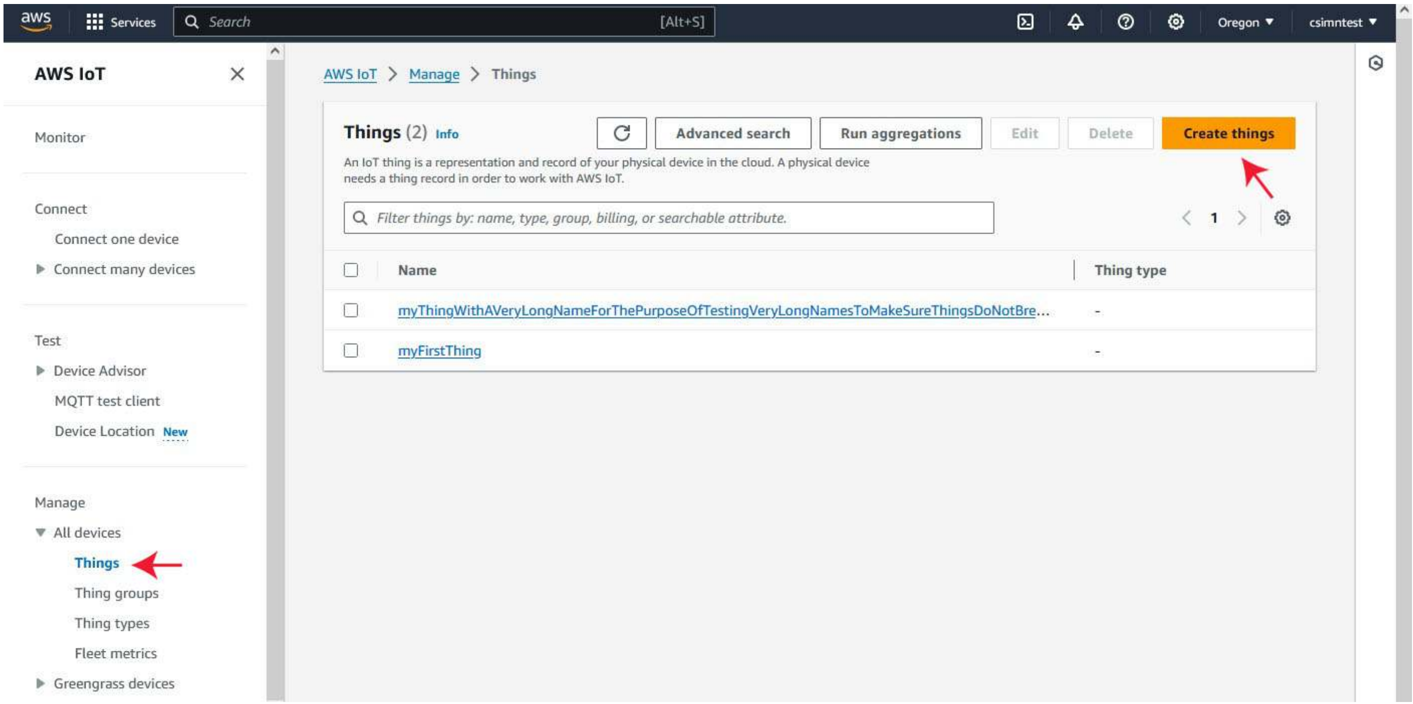




You will have a choice of regions in which to set up your Things. The abbreviated list is illustrated below. The actual list is much longer and includes all continents and numerous countries. If you have previously configured some Things, and see a message on the screen saying you have no things, check the region. Once in a while, the AWS login forgets what region you were working in.


Oregon ▲
csimntest ▼
US East (N. Virginia) us-east-1
US East (Ohio) us-east-2
US West (N. California) us-west-1
US West (Oregon) us-west-2

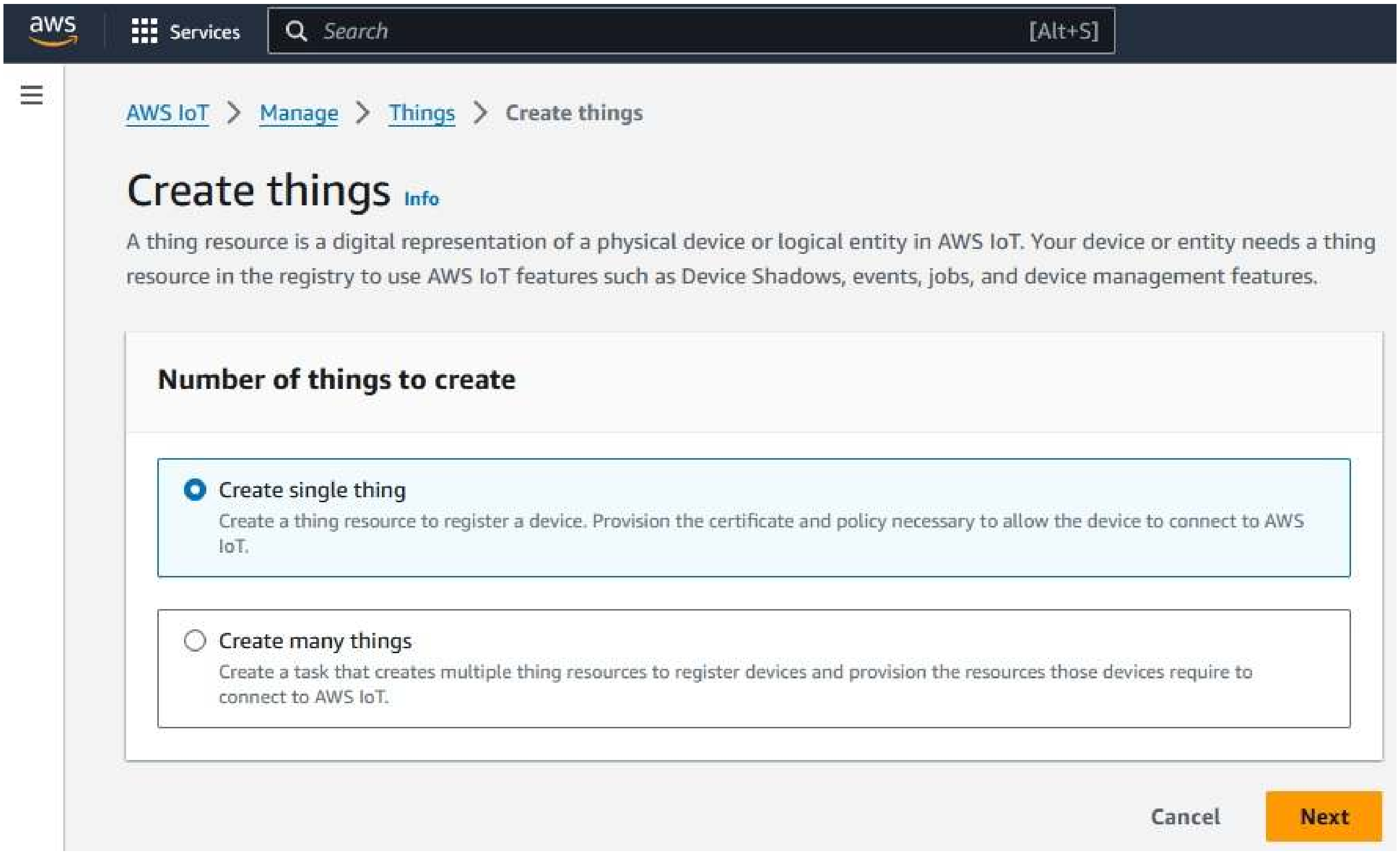
From the AWS IoT menu, click on Manage, and then select Things. You may initially get a screen telling you that you have no things. The screen shot here shows that we already have a couple of things created previously. Either way, click on the Create Things button.



An IoT thing is a representation and record of your physical device in the cloud. A physical device needs a thing record in order to work with AWS IoT.

Name	Thing type
myThingWithAVeryLongNameForThePurposeOfTestingVeryLongNamesToMakeSureThingsDoNotBre...	-
myFirstThing	-

You have the option of creating a single Thing or multiple Things at once. We are going to step through creating just a single Thing here.



Create things

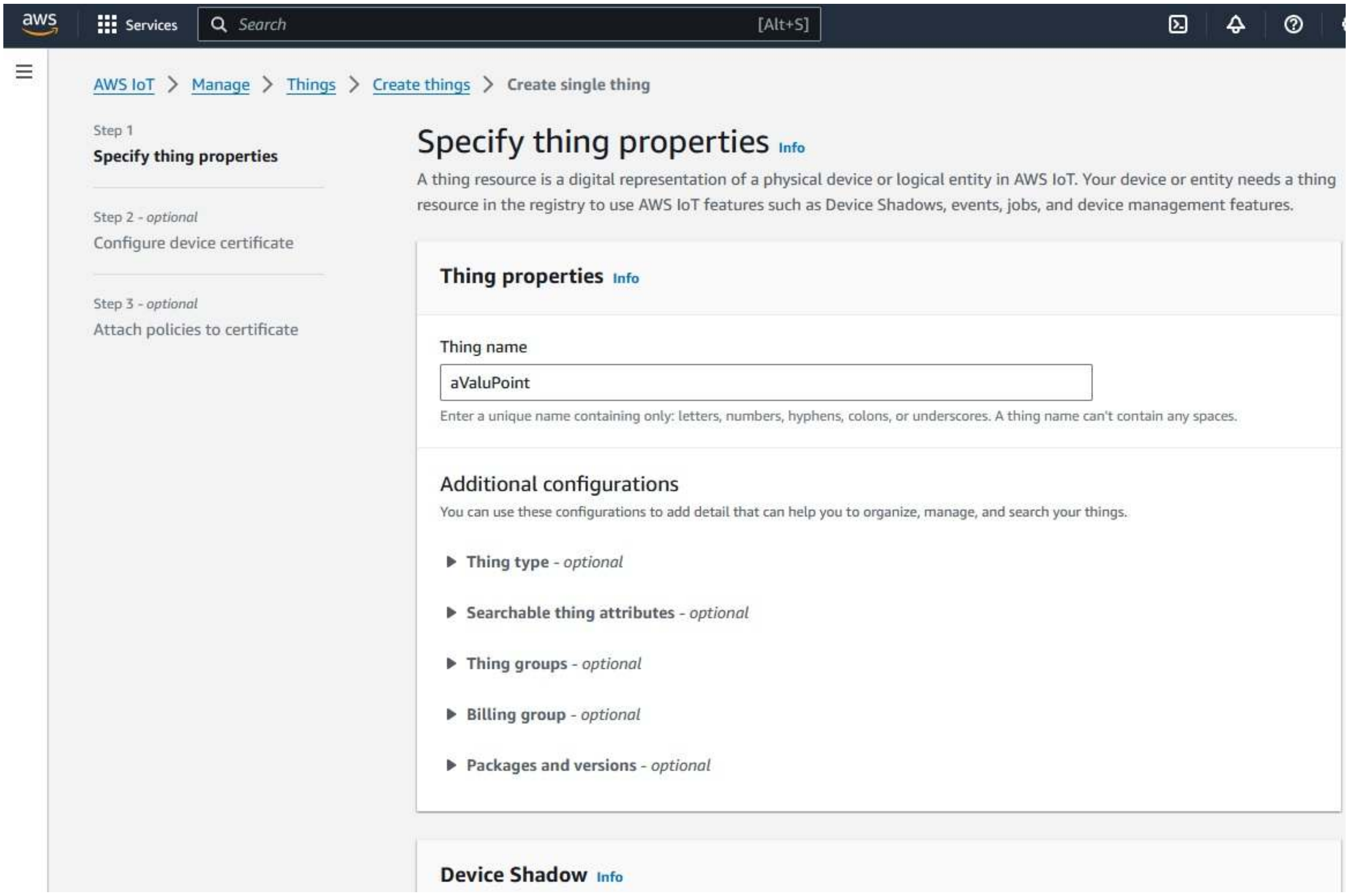
A thing resource is a digital representation of a physical device or logical entity in AWS IoT. Your device or entity needs a thing resource in the registry to use AWS IoT features such as Device Shadows, events, jobs, and device management features.

Number of things to create

● Create single thing
Create a thing resource to register a device. Provision the certificate and policy necessary to allow the device to connect to AWS IoT.

○ Create many things
Create a task that creates multiple thing resources to register devices and provision the resources those devices require to connect to AWS IoT.

Select ‘Create single thing’ and click Next. Then provide a name for your new Thing.


aws
Services
Search
[Alt+S]
AWS IoT > Manage > Things > Create things > Create single thing
Step 1
Specify thing properties
Step 2 - optional
Configure device certificate
Step 3 - optional
Attach policies to certificate

Specify thing properties Info

A thing resource is a digital representation of a physical device or logical entity in AWS IoT. Your device or entity needs a thing resource in the registry to use AWS IoT features such as Device Shadows, events, jobs, and device management features.

Thing properties Info

Thing name: aValuPoint

Enter a unique name containing only: letters, numbers, hyphens, colons, or underscores. A thing name can't contain any spaces.

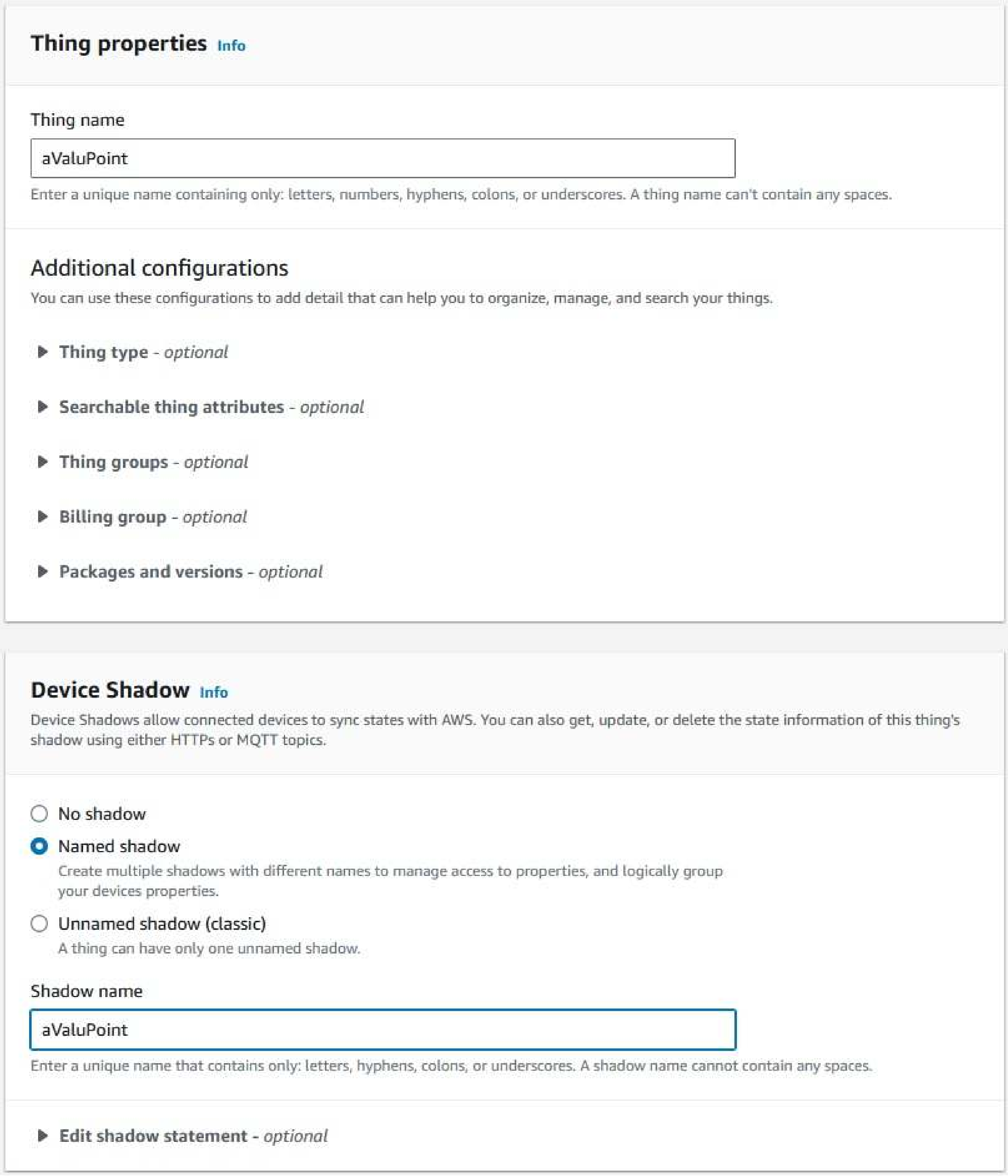
Additional configurations

You can use these configurations to add detail that can help you to organize, manage, and search your things.

▶ Thing type - optional
▶ Searchable thing attributes - optional
▶ Thing groups - optional
▶ Billing group - optional
▶ Packages and versions - optional
Device Shadow Info

In addition to giving the Thing a name, scroll down and select ‘Named shadow’. Give the shadow a name. Giving the shadow the same name as the Thing itself makes it easier to remember. Click Next.

IMPORTANT: If your Thing has no shadow at all, the ValuPoint IoT Client will suspend indefinitely because the first thing it needs to do when connecting is retrieve the shadow.



Thing properties

Thing name

aValuPoint

Enter a unique name containing only: letters, numbers, hyphens, colons, or underscores. A thing name can't contain any spaces.

Additional configurations

You can use these configurations to add detail that can help you to organize, manage, and search your things.

▶ Thing type - *optional*

▶ Searchable thing attributes - *optional*

▶ Thing groups - *optional*

▶ Billing group - *optional*

▶ Packages and versions - *optional*

Device Shadow

Device Shadows allow connected devices to sync states with AWS. You can also get, update, or delete the state information of this thing's shadow using either HTTPs or MQTT topics.

○ No shadow

● Named shadow

Create multiple shadows with different names to manage access to properties, and logically group your devices properties.

○ Unnamed shadow (classic)

A thing can have only one unnamed shadow.

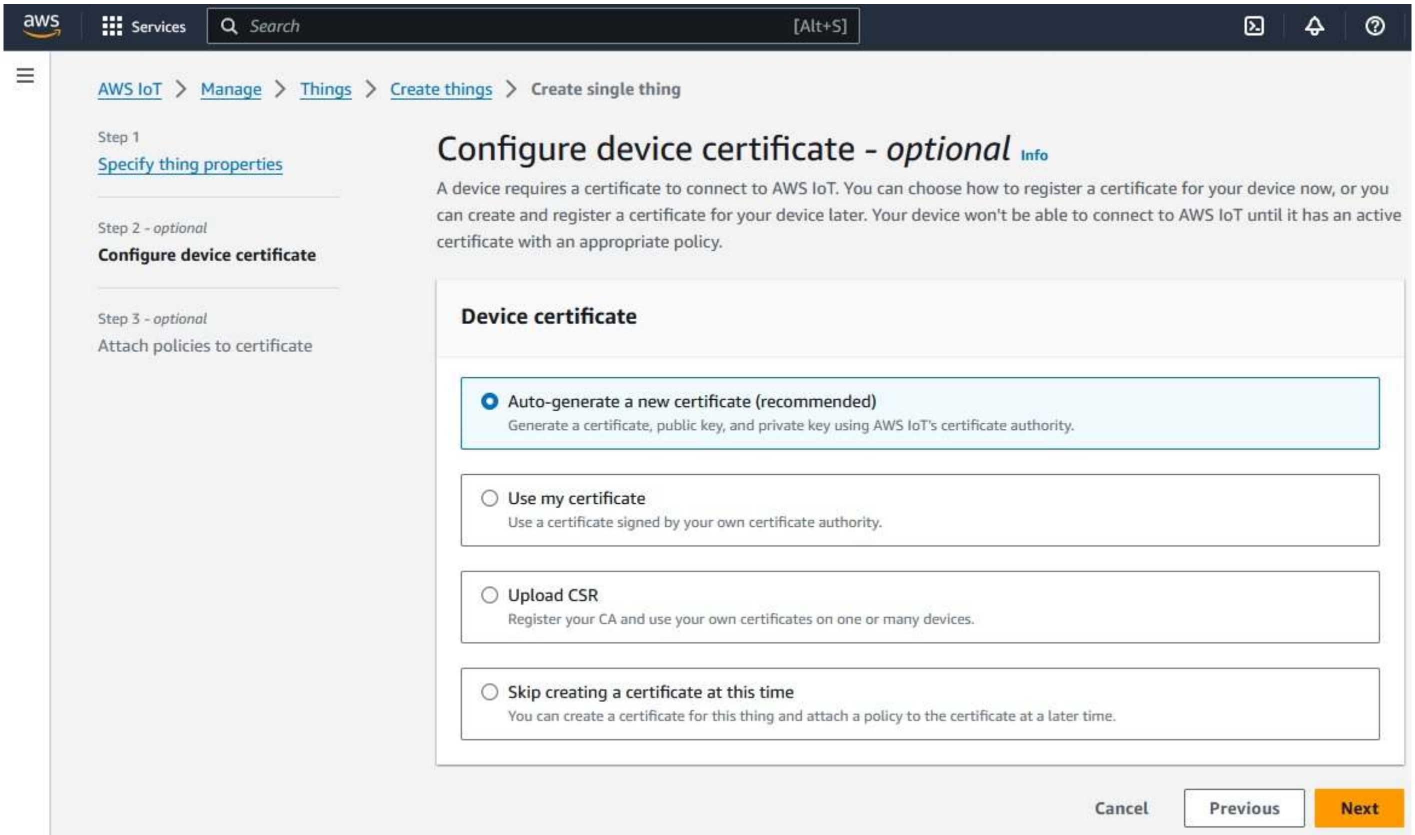
Shadow name

aValuPoint

Enter a unique name that contains only: letters, hyphens, colons, or underscores. A shadow name cannot contain any spaces.

▶ Edit shadow statement - *optional*

The certificates step is VERY IMPROTANT. Select ‘Auto-generate’. Then click Next.



AWS IoT > Manage > Things > Create things > Create single thing

Step 1
Specify thing properties

Step 2 - *optional*
Configure device certificate

Step 3 - *optional*
Attach policies to certificate

Configure device certificate - *optional* Info

A device requires a certificate to connect to AWS IoT. You can choose how to register a certificate for your device now, or you can create and register a certificate for your device later. Your device won't be able to connect to AWS IoT until it has an active certificate with an appropriate policy.

Device certificate

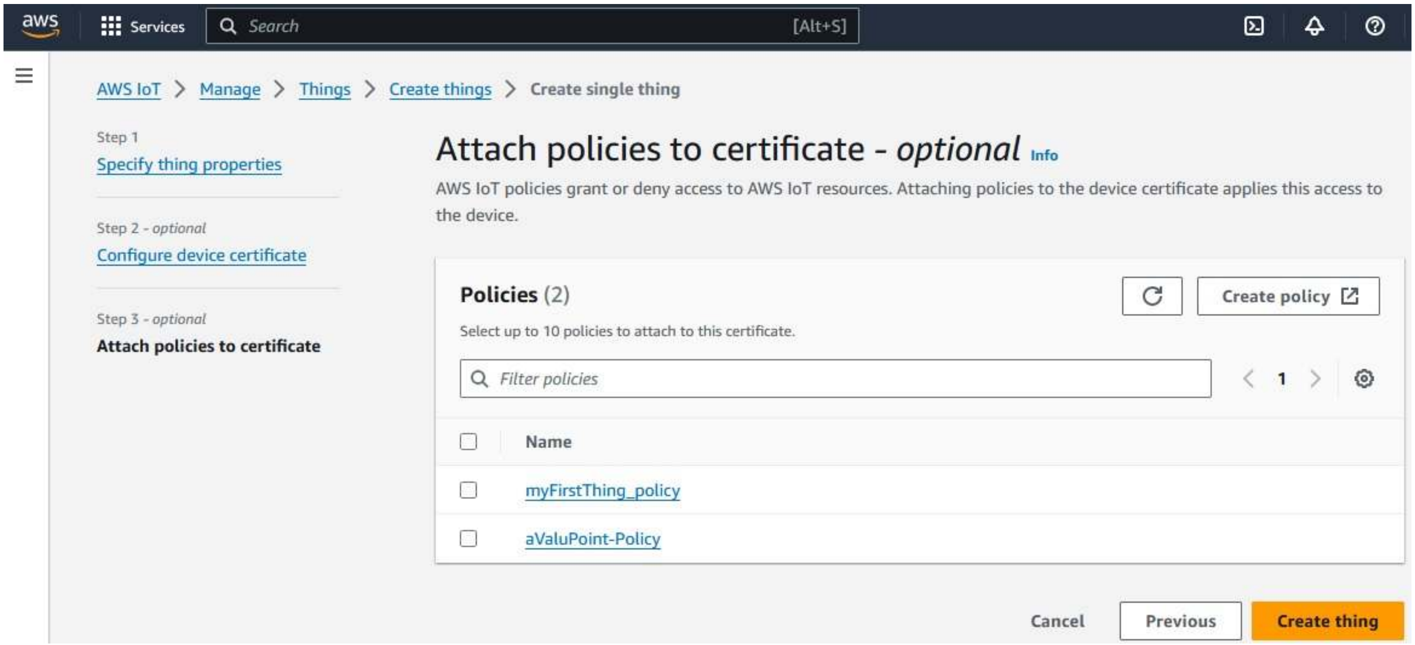
● Auto-generate a new certificate (recommended)
Generate a certificate, public key, and private key using AWS IoT's certificate authority.

○ Use my certificate
Use a certificate signed by your own certificate authority.

○ Upload CSR
Register your CA and use your own certificates on one or many devices.

○ Skip creating a certificate at this time
You can create a certificate for this thing and attach a policy to the certificate at a later time.

The next step is to identify policies to attach to the certificate. A policy with a name derived from your Thing name will be created automatically, but you need to select it. Note that for our purposes, the policy is not really "optional".



AWS IoT > Manage > Things > Create things > Create single thing

Step 1
Specify thing properties

Step 2 - *optional*
Configure device certificate

Step 3 - *optional*
Attach policies to certificate

Attach policies to certificate - *optional* Info

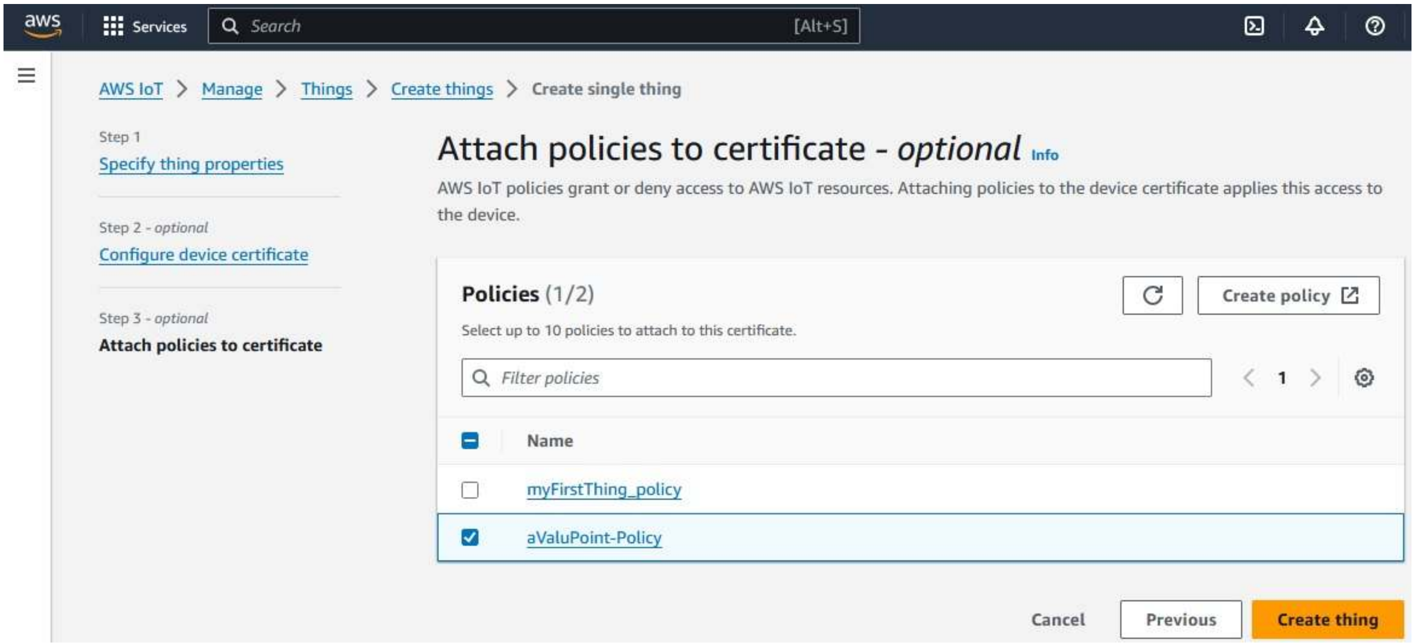
AWS IoT policies grant or deny access to AWS IoT resources. Attaching policies to the device certificate applies this access to the device.

Policies (2)

Select up to 10 policies to attach to this certificate.

□	Name
□	myFirstThing_policy
□	aValuPoint-Policy

Select your named policy from the list, then click Create Thing. Don’t worry about what the policy contains for now. You will update that after creating the Thing.



AWS IoT > Manage > Things > Create things > Create single thing

Step 1
Specify thing properties

Step 2 - *optional*
Configure device certificate

Step 3 - *optional*
Attach policies to certificate

Attach policies to certificate - *optional* Info

AWS IoT policies grant or deny access to AWS IoT resources. Attaching policies to the device certificate applies this access to the device.

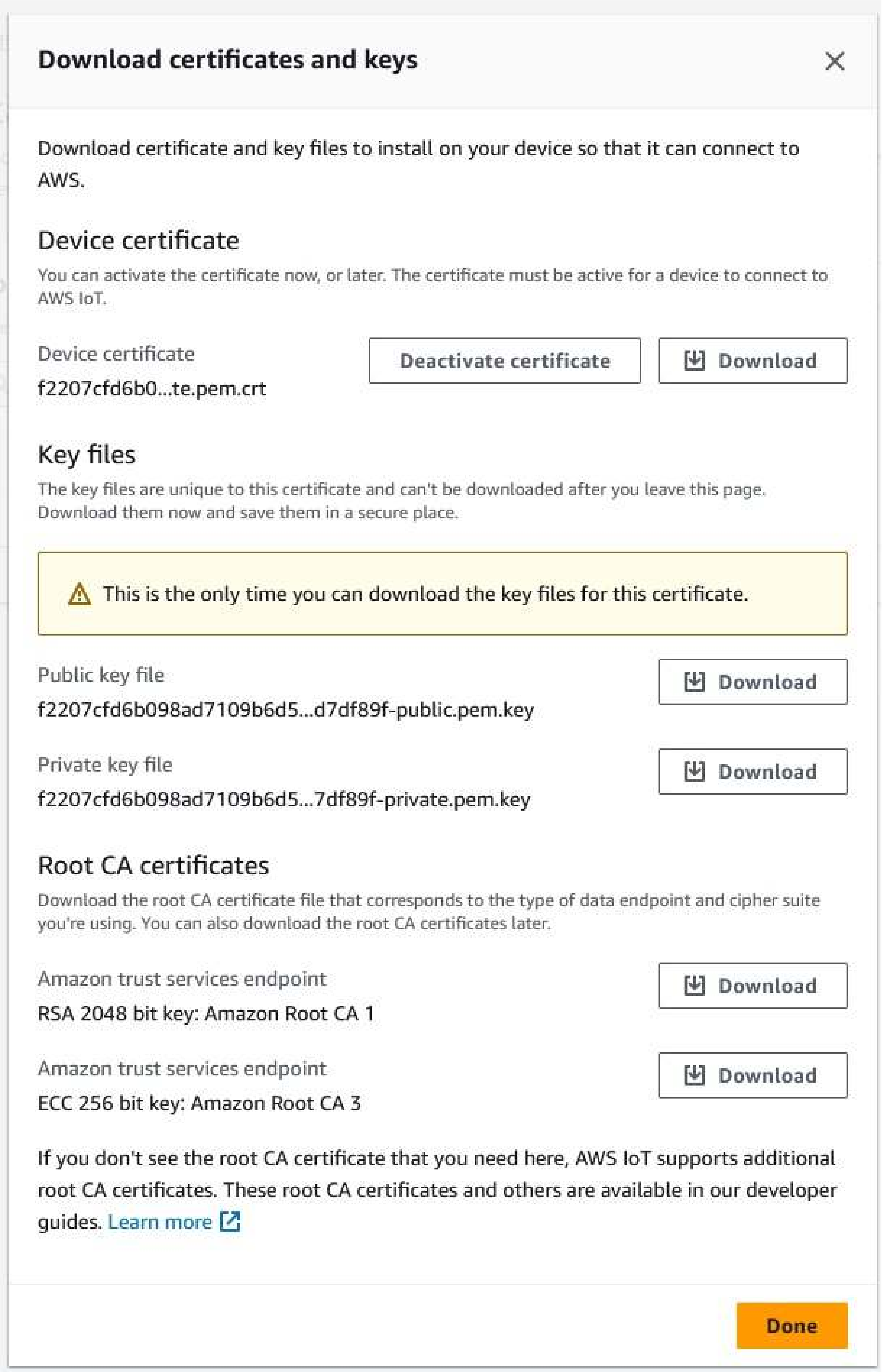
Policies (1/2)

Select up to 10 policies to attach to this certificate.

	Name
□	myFirstThing_policy
☑	aValuPoint-Policy

PAY ATTENTION here to the fact that this is the ONLY opportunity you will get to download your SSL certificate key files. If you miss this step, you will need to delete your Thing and start over.

You need to download 3 files: Device certificate, private key, and root CA. The public key file will not be used in the ValuPoint but you can download it anyway.



Download certificates and keys

Download certificate and key files to install on your device so that it can connect to AWS.

Device certificate

You can activate the certificate now, or later. The certificate must be active for a device to connect to AWS IoT.

Device certificate

f2207cfd6b0...te.pem.crt

Key files

The key files are unique to this certificate and can't be downloaded after you leave this page. Download them now and save them in a secure place.

⚠ This is the only time you can download the key files for this certificate.

Public key file

f2207cfd6b098ad7109b6d5...d7df89f-public.pem.key

Private key file

f2207cfd6b098ad7109b6d5...7df89f-private.pem.key

Root CA certificates

Download the root CA certificate file that corresponds to the type of data endpoint and cipher suite you're using. You can also download the root CA certificates later.

Amazon trust services endpoint

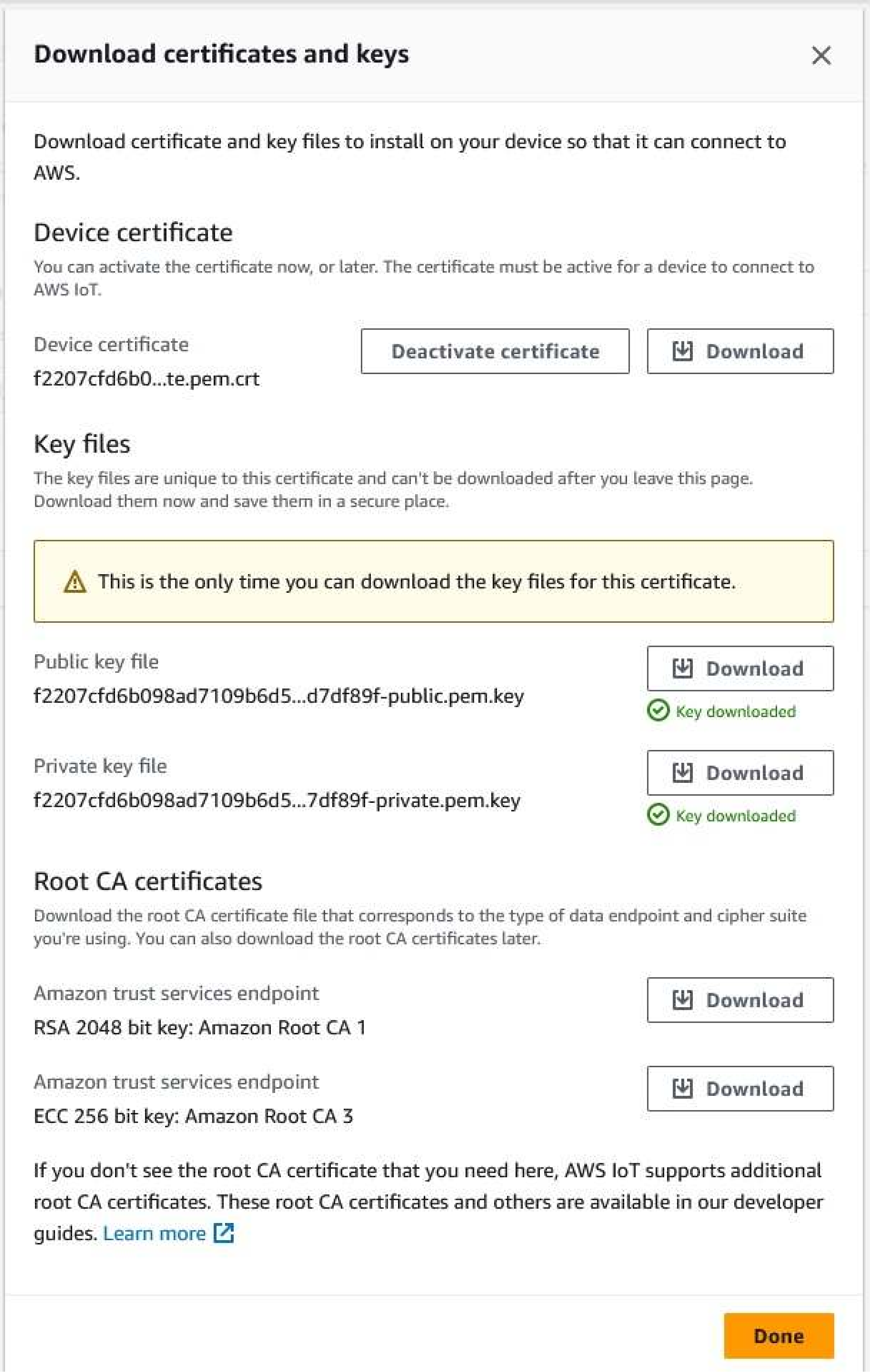
RSA 2048 bit key: Amazon Root CA 1

Amazon trust services endpoint

ECC 256 bit key: Amazon Root CA 3

If you don't see the root CA certificate that you need here, AWS IoT supports additional root CA certificates. These root CA certificates and others are available in our developer guides. Learn more

Once you have downloaded your files, it will indicate that fact on the screen. Once you have downloaded all 3 files, you may click Done.



Download certificates and keys

Download certificate and key files to install on your device so that it can connect to AWS.

Device certificate

You can activate the certificate now, or later. The certificate must be active for a device to connect to AWS IoT.

Device certificate
f2207cfd6b0...te.pem.crt

Key files

The key files are unique to this certificate and can't be downloaded after you leave this page. Download them now and save them in a secure place.

⚠ This is the only time you can download the key files for this certificate.

Public key file
f2207cfd6b098ad7109b6d5...d7df89f-public.pem.key
✓ Key downloaded

Private key file
f2207cfd6b098ad7109b6d5...7df89f-private.pem.key
✓ Key downloaded

Root CA certificates

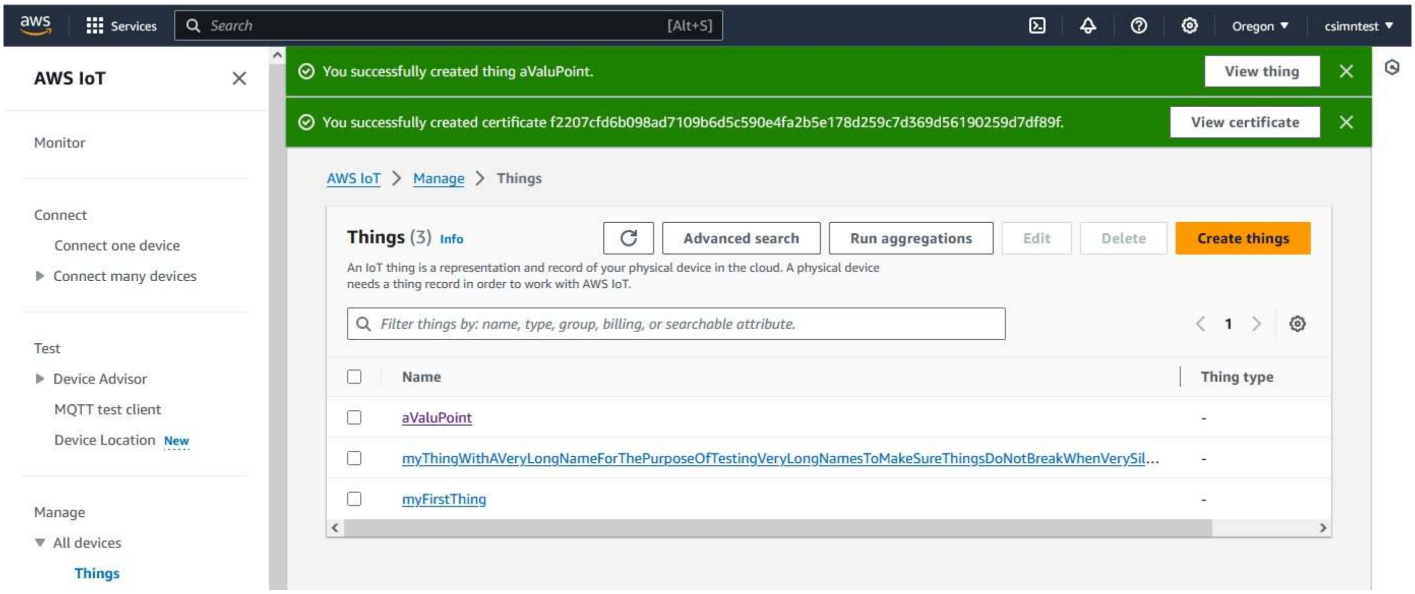
Download the root CA certificate file that corresponds to the type of data endpoint and cipher suite you're using. You can also download the root CA certificates later.

Amazon trust services endpoint
RSA 2048 bit key: Amazon Root CA 1

Amazon trust services endpoint
ECC 256 bit key: Amazon Root CA 3

If you don't see the root CA certificate that you need here, AWS IoT supports additional root CA certificates. These root CA certificates and others are available in our developer guides. Learn more

The newly created Thing now shows up on your Things list.



You successfully created thing aValuPoint.

You successfully created certificate f2207cfd6b098ad7109b6d5c590e4fa2b5e178d259c7d369d56190259d7df89f.

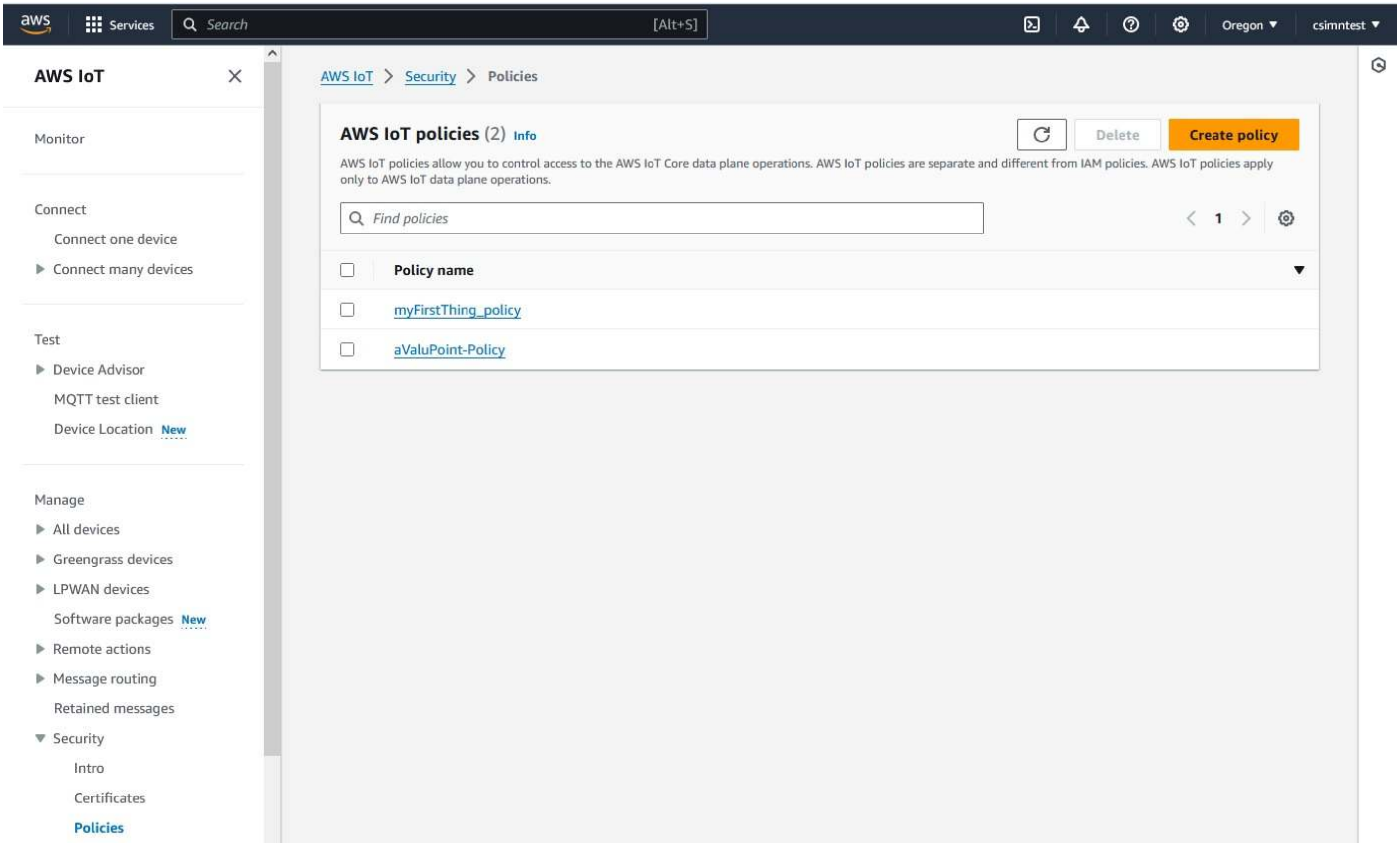
Things (3)

An IoT thing is a representation and record of your physical device in the cloud. A physical device needs a thing record in order to work with AWS IoT.

	Name	Thing type
□	aValuPoint	-
□	myThingWithAVeryLongNameForThePurposeOfTestingVeryLongNamesToMakeSureThingsDoNotBreakWhenVerySil...	-
□	myFirstThing	-

14.2 Update Policy

You can find your security policies under Security.

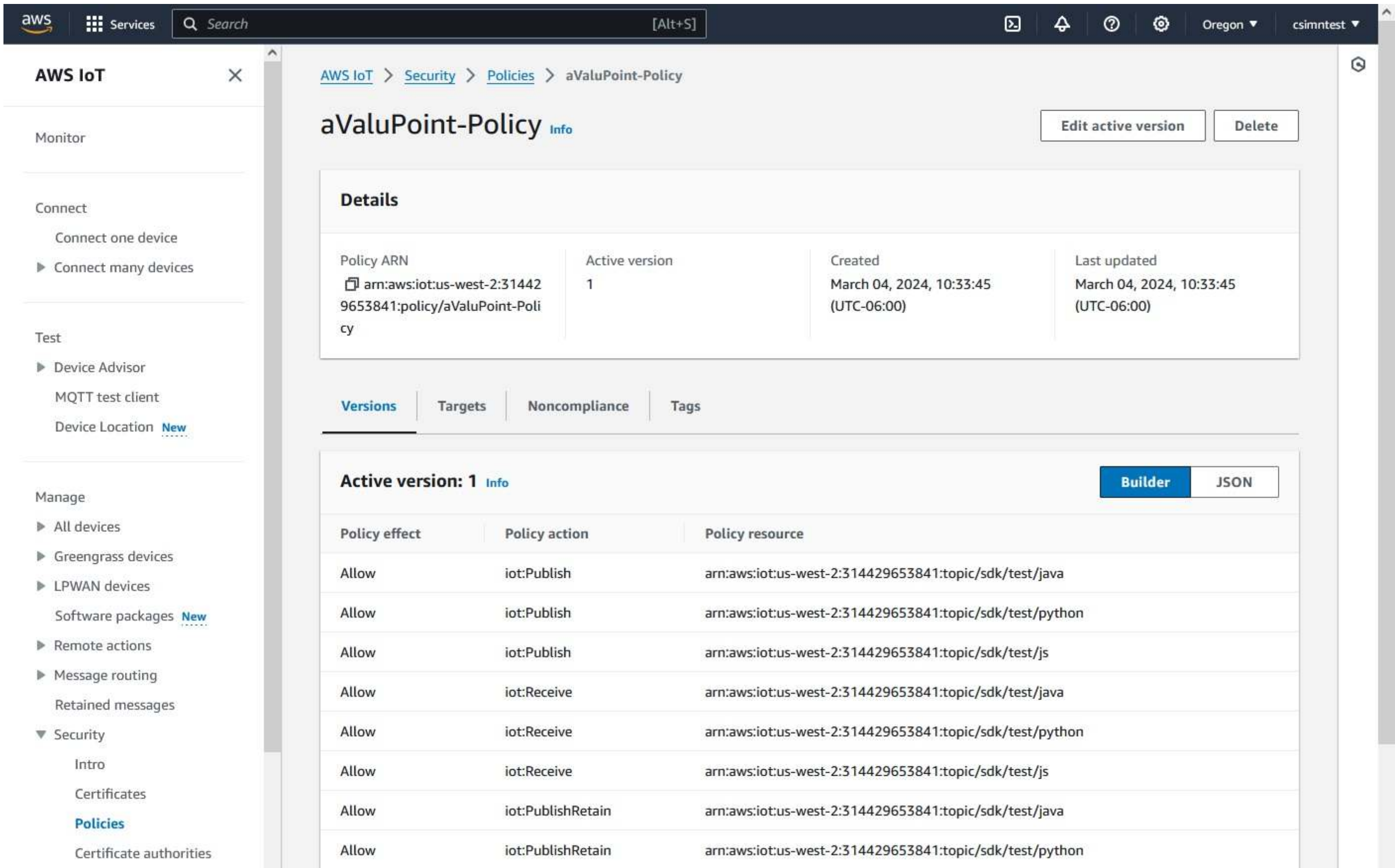


AWS IoT policies (2)

AWS IoT policies allow you to control access to the AWS IoT Core data plane operations. AWS IoT policies are separate and different from IAM policies. AWS IoT policies apply only to AWS IoT data plane operations.

	Policy name
□	myFirstThing_policy
□	aValuPoint-Policy

Click on the policy that was attached to the Thing you just created. It will default to looking something like the following screen shot.



AWS IoT > Security > Policies > aValuPoint-Policy

aValuPoint-Policy Info

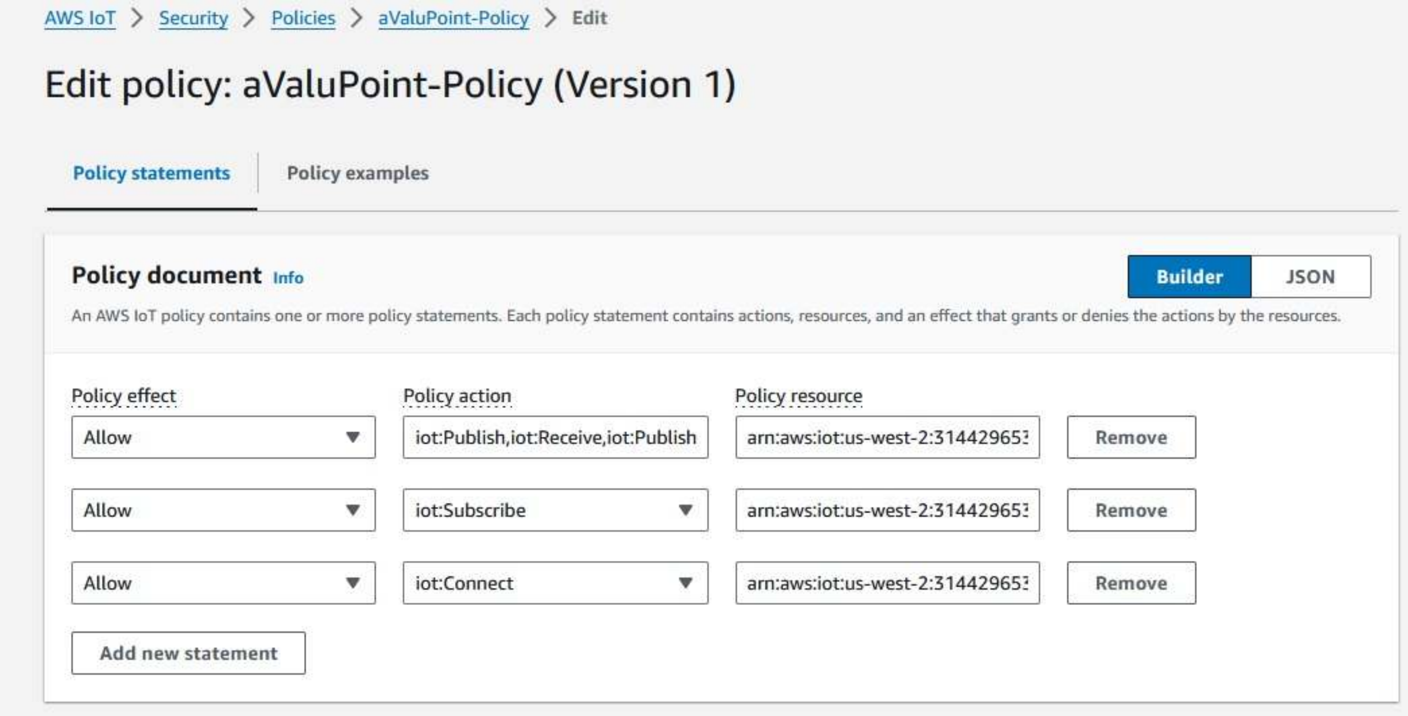
Details

Policy ARN	Active version	Created	Last updated
arn:aws:iot:us-west-2:314429653841:policy/aValuPoint-Policy	1	March 04, 2024, 10:33:45 (UTC-06:00)	March 04, 2024, 10:33:45 (UTC-06:00)

Active version: 1 Info

Policy effect	Policy action	Policy resource
Allow	iot:Publish	arn:aws:iot:us-west-2:314429653841:topic/sdk/test/java
Allow	iot:Publish	arn:aws:iot:us-west-2:314429653841:topic/sdk/test/python
Allow	iot:Publish	arn:aws:iot:us-west-2:314429653841:topic/sdk/test/js
Allow	iot:Receive	arn:aws:iot:us-west-2:314429653841:topic/sdk/test/java
Allow	iot:Receive	arn:aws:iot:us-west-2:314429653841:topic/sdk/test/python
Allow	iot:Receive	arn:aws:iot:us-west-2:314429653841:topic/sdk/test/js
Allow	iot:PublishRetain	arn:aws:iot:us-west-2:314429653841:topic/sdk/test/java
Allow	iot:PublishRetain	arn:aws:iot:us-west-2:314429653841:topic/sdk/test/python

Click on ‘Edit active version’. The Builder view of the policy will look something like the following screen shot.



AWS IoT > Security > Policies > aValuPoint-Policy > Edit

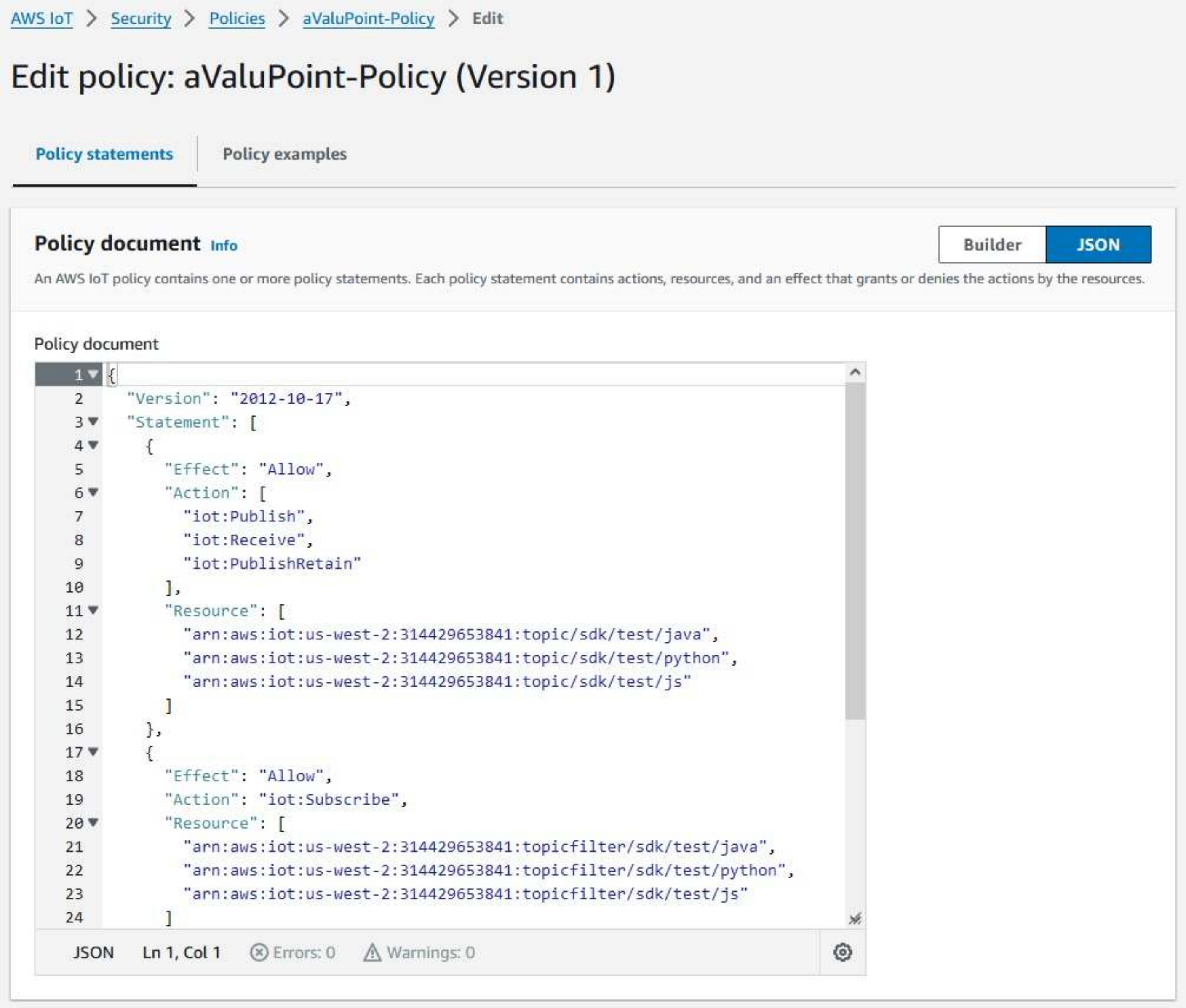
Edit policy: aValuPoint-Policy (Version 1)

Policy document Info

An AWS IoT policy contains one or more policy statements. Each policy statement contains actions, resources, and an effect that grants or denies the actions by the resources.

Policy effect	Policy action	Policy resource
Allow ▼	iot:Publish,iot:Receive,iot:Publish	arn:aws:iot:us-west-2:31442965:
Allow ▼	iot:Subscribe ▼	arn:aws:iot:us-west-2:31442965:
Allow ▼	iot:Connect ▼	arn:aws:iot:us-west-2:31442965:

Switch to the JSON view. It will look something like the following. This content is created automatically by AWS with their assuming you are going to connect to AWS from an app on your PC. That is not the case for your ValuPoint IoT device, so the content of the policy needs to be replaced.



Edit policy: aValuPoint-Policy (Version 1)

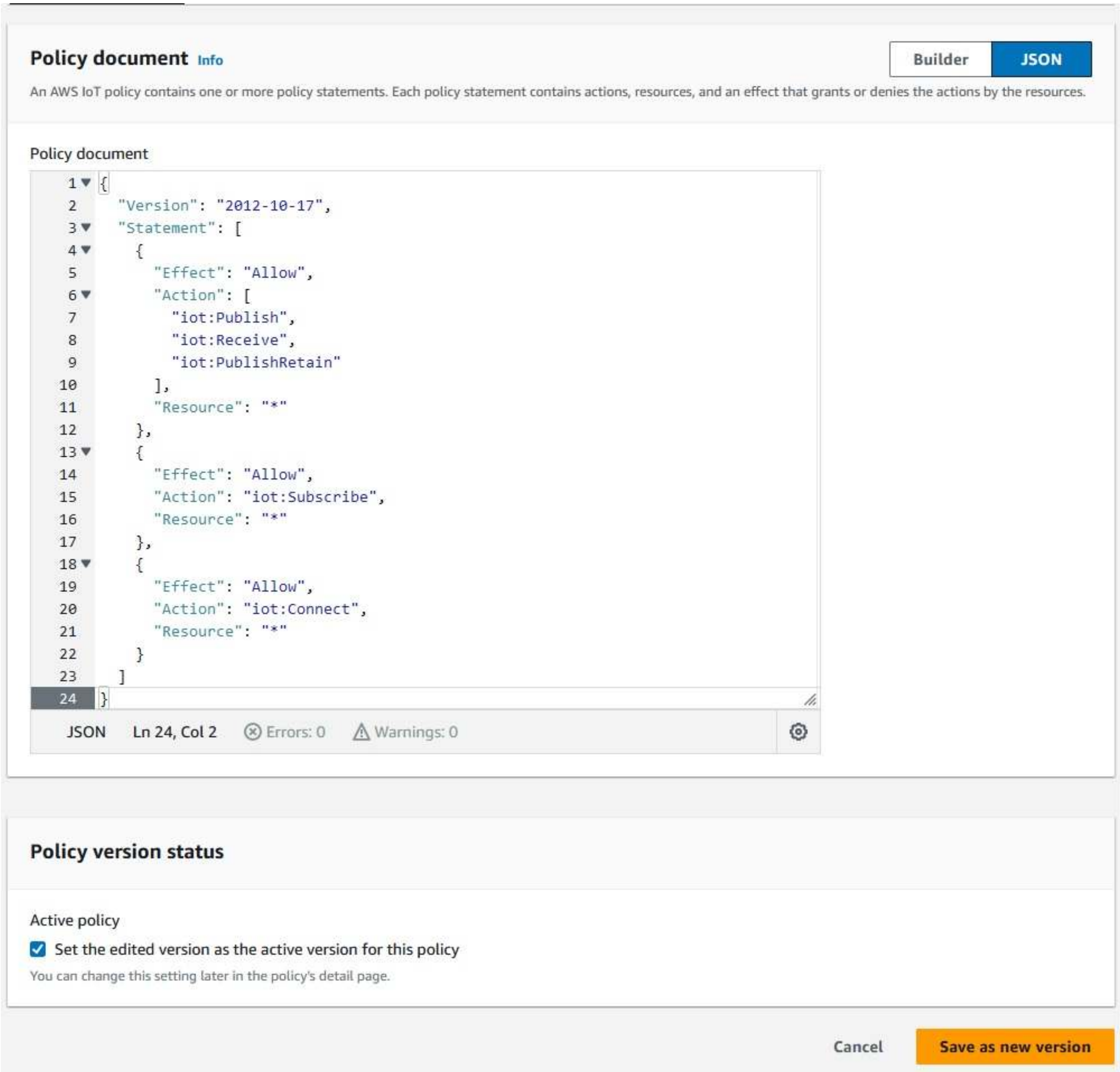
Policy document Info

An AWS IoT policy contains one or more policy statements. Each policy statement contains actions, resources, and an effect that grants or denies the actions by the resources.

Policy document

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Effect": "Allow",
      "Action": [
        "iot:Publish",
        "iot:Receive",
        "iot:PublishRetain"
      ],
      "Resource": [
        "arn:aws:iot:us-west-2:314429653841:topic/sdk/test/java",
        "arn:aws:iot:us-west-2:314429653841:topic/sdk/test/python",
        "arn:aws:iot:us-west-2:314429653841:topic/sdk/test/js"
      ]
    },
    {
      "Effect": "Allow",
      "Action": "iot:Subscribe",
      "Resource": [
        "arn:aws:iot:us-west-2:314429653841:topicfilter/sdk/test/java",
        "arn:aws:iot:us-west-2:314429653841:topicfilter/sdk/test/python",
        "arn:aws:iot:us-west-2:314429653841:topicfilter/sdk/test/js"
      ]
```

The content you want to start with at least for test purposes is illustrated in the screen shot below. Once you get your ValuPoint talking, you can come back later and tighten the security after you familiarize yourself with policies per AWS documentation.



Policy document

An AWS IoT policy contains one or more policy statements. Each policy statement contains actions, resources, and an effect that grants or denies the actions by the resources.

Policy document

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Effect": "Allow",
      "Action": [
        "iot:Publish",
        "iot:Receive",
        "iot:PublishRetain"
      ],
      "Resource": "*"
    },
    {
      "Effect": "Allow",
      "Action": "iot:Subscribe",
      "Resource": "*"
    },
    {
      "Effect": "Allow",
      "Action": "iot:Connect",
      "Resource": "*"
    }
  ]
}
```

JSON Ln 24, Col 2 Errors: 0 Warnings: 0

Policy version status

Active policy

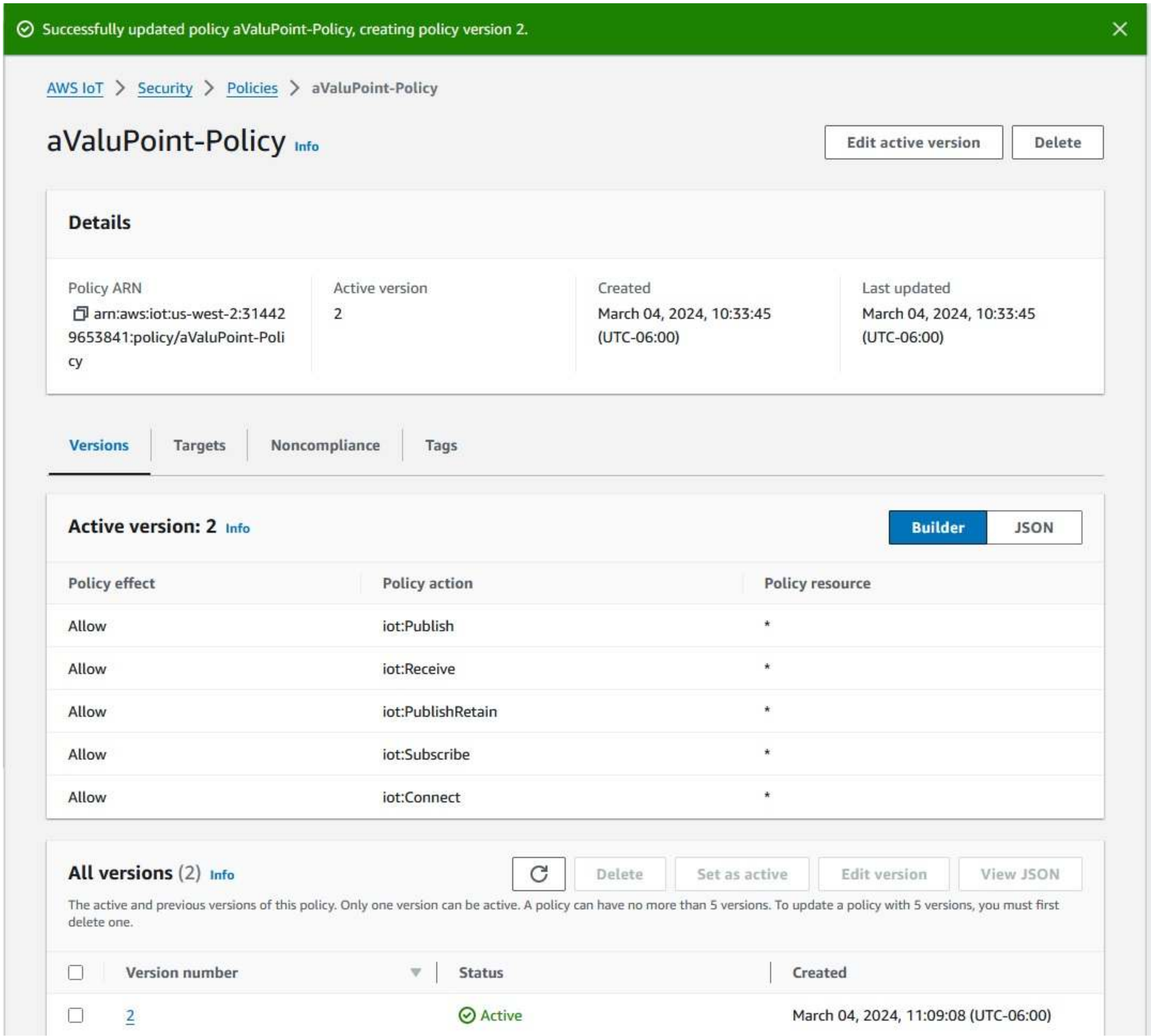
☑ Set the edited version as the active version for this policy

You can change this setting later in the policy's detail page.

This policy in text form that you can copy from this document and paste into AWS is as follows:

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Effect": "Allow",
      "Action": [
        "iot:Publish",
        "iot:Receive",
        "iot:PublishRetain"
      ],
      "Resource": "*"
    },
    {
      "Effect": "Allow",
      "Action": "iot:Subscribe",
      "Resource": "*"
    },
    {
      "Effect": "Allow",
      "Action": "iot:Connect",
      "Resource": "*"
    }
  ]
}
```

Once updated, the Builder view will look more like the following screen shot.



Successfully updated policy aValuPoint-Policy, creating policy version 2.

AWS IoT > Security > Policies > aValuPoint-Policy

aValuPoint-Policy Info

Details

Policy ARN	Active version	Created	Last updated
arn:aws:iot:us-west-2:314429653841:policy/aValuPoint-Policy	2	March 04, 2024, 10:33:45 (UTC-06:00)	March 04, 2024, 10:33:45 (UTC-06:00)

Active version: 2 Info

Policy effect	Policy action	Policy resource
Allow	iot:Publish	*
Allow	iot:Receive	*
Allow	iot:PublishRetain	*
Allow	iot:Subscribe	*
Allow	iot:Connect	*

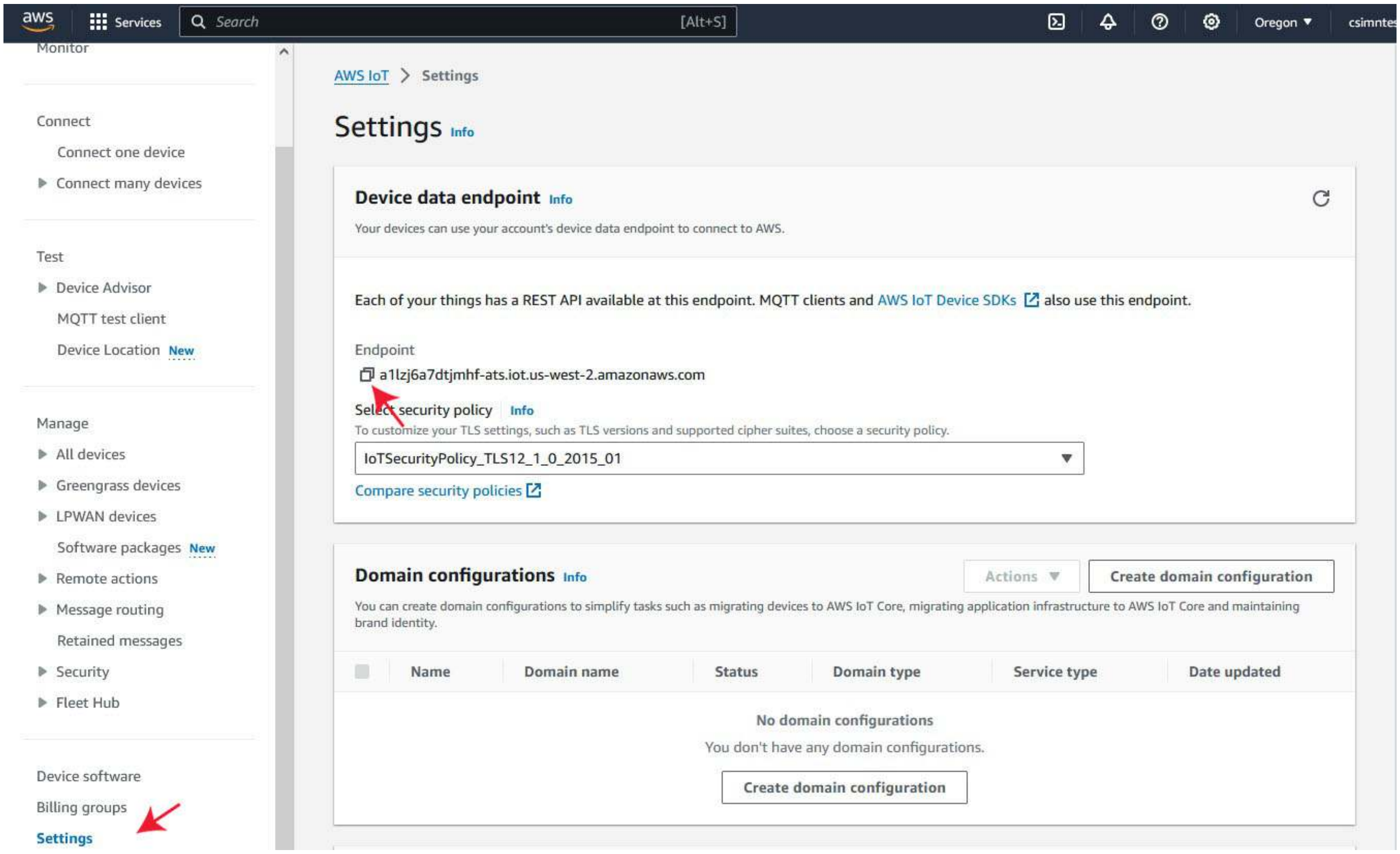
All versions (2) Info

The active and previous versions of this policy. Only one version can be active. A policy can have no more than 5 versions. To update a policy with 5 versions, you must first delete one.

☐	Version number	Status	Created
☐	2	Active	March 04, 2024, 11:09:08 (UTC-06:00)

14.3 Configure ValuPoint as a "Thing"

Copy your AWS host name from the Settings page as illustrated below.



Settings Info

Device data endpoint Info

Your devices can use your account's device data endpoint to connect to AWS.

Each of your things has a REST API available at this endpoint. MQTT clients and AWS IoT Device SDKs also use this endpoint.

Endpoint
a1lzj6a7dtjmhf-ats.iot.us-west-2.amazonaws.com

Select security policy Info
To customize your TLS settings, such as TLS versions and supported cipher suites, choose a security policy.
IoTSecurityPolicy_TLS12_1_0_2015_01 ▾

Compare security policies

Domain configurations Info

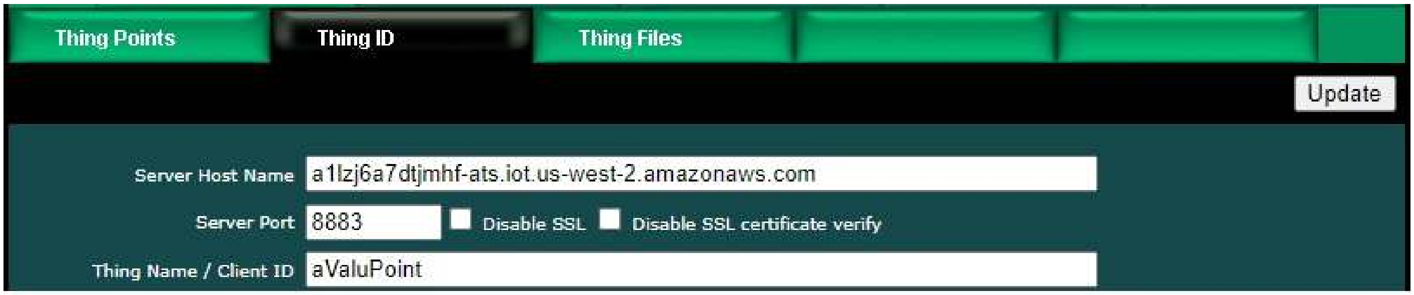
Actions ▾ | Create domain configuration

You can create domain configurations to simplify tasks such as migrating devices to AWS IoT Core, migrating application infrastructure to AWS IoT Core and maintaining brand identity.

□	Name	Domain name	Status	Domain type	Service type	Date updated

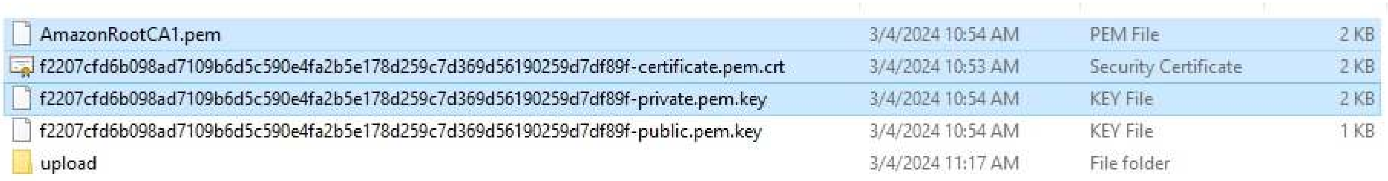
No domain configurations
You don't have any domain configurations.
Create domain configuration

Paste this host name into the Server Host Name window on the Thing ID page in your ValuPoint. Provide the Thing name you created. Use server port 8883, and do not disable SSL



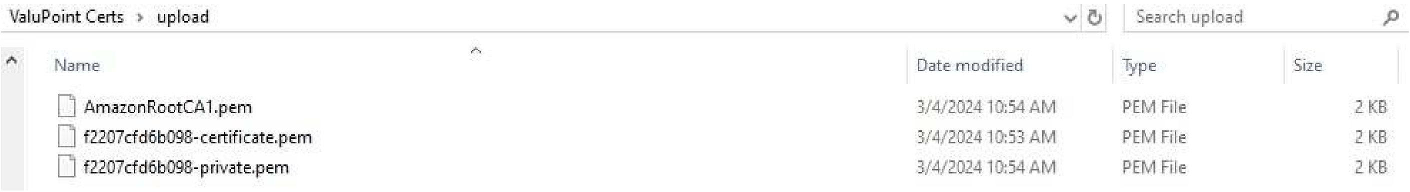
Server Host Name a1lzj6a7dtjmhf-ats.iot.us-west-2.amazonaws.com
Server Port 8883 □ Disable SSL □ Disable SSL certificate verify
Thing Name / Client ID aValuPoint

The certificates you downloaded will have very long names looking something like the following. The 3 files highlighted here are the ones you will need to upload to your ValuPoint.



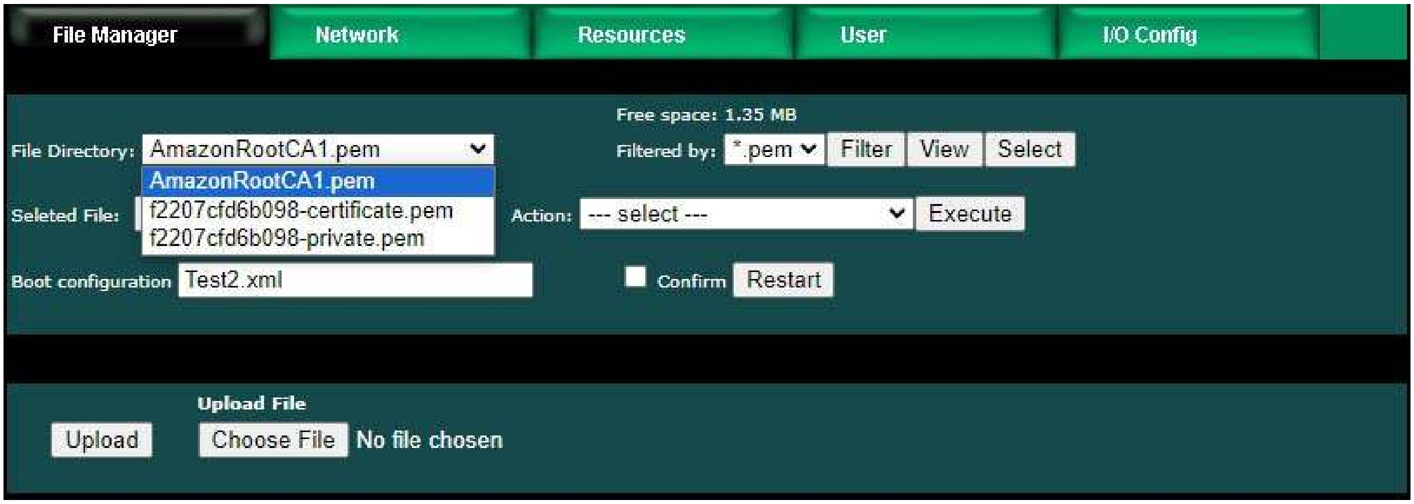
AmazonRootCA1.pem	3/4/2024 10:54 AM	PEM File	2 KB
f2207cfd6b098ad7109b6d5c590e4fa2b5e178d259c7d369d56190259d7df89f-certificate.pem.crt	3/4/2024 10:53 AM	Security Certificate	2 KB
f2207cfd6b098ad7109b6d5c590e4fa2b5e178d259c7d369d56190259d7df89f-private.pem.key	3/4/2024 10:54 AM	KEY File	2 KB
f2207cfd6b098ad7109b6d5c590e4fa2b5e178d259c7d369d56190259d7df89f-public.pem.key	3/4/2024 10:54 AM	KEY File	1 KB
upload	3/4/2024 11:17 AM	File folder	

Rename the files with shorter names, and make sure the suffix is .pem, not key or crt. The content of all of these files is in pem format. The renamed files should look more like the following.



Name	Date modified	Type	Size
AmazonRootCA1.pem	3/4/2024 10:54 AM	PEM File	2 KB
f2207cfd6b098-certificate.pem	3/4/2024 10:53 AM	PEM File	2 KB
f2207cfd6b098-private.pem	3/4/2024 10:54 AM	PEM File	2 KB

Go to the File Manager page in the ValuPoint and upload all 3 files.



Free space: 1.35 MB

File Directory: AmazonRootCA1.pem

AmazonRootCA1.pem
f2207cfd6b098-certificate.pem
f2207cfd6b098-private.pem

Filtered by: *.pem

Seleted File:

Action: --- select ---

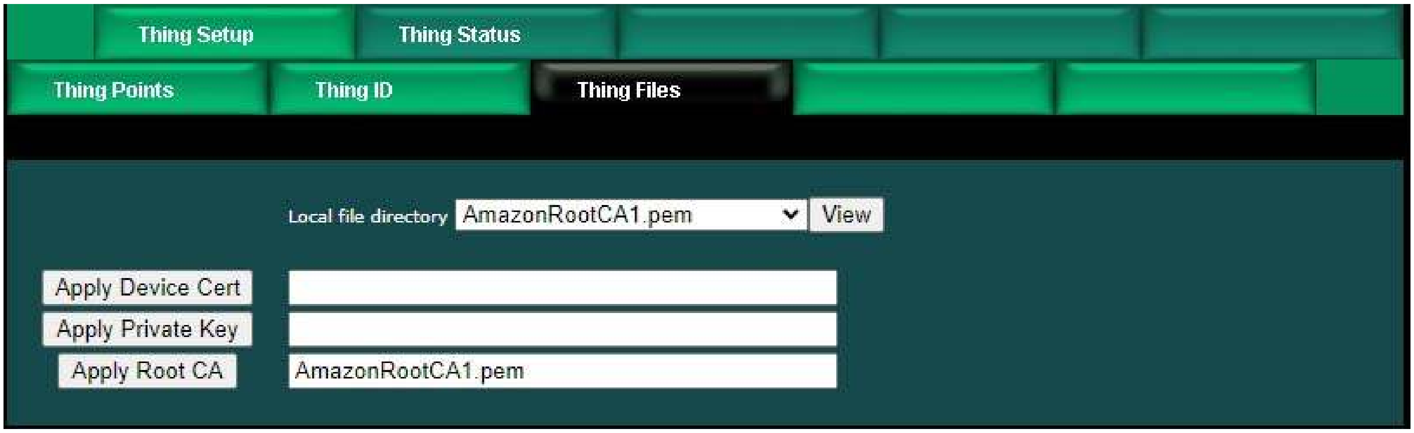
Boot configuration Test2.xml

□ Confirm

Upload File

No file chosen

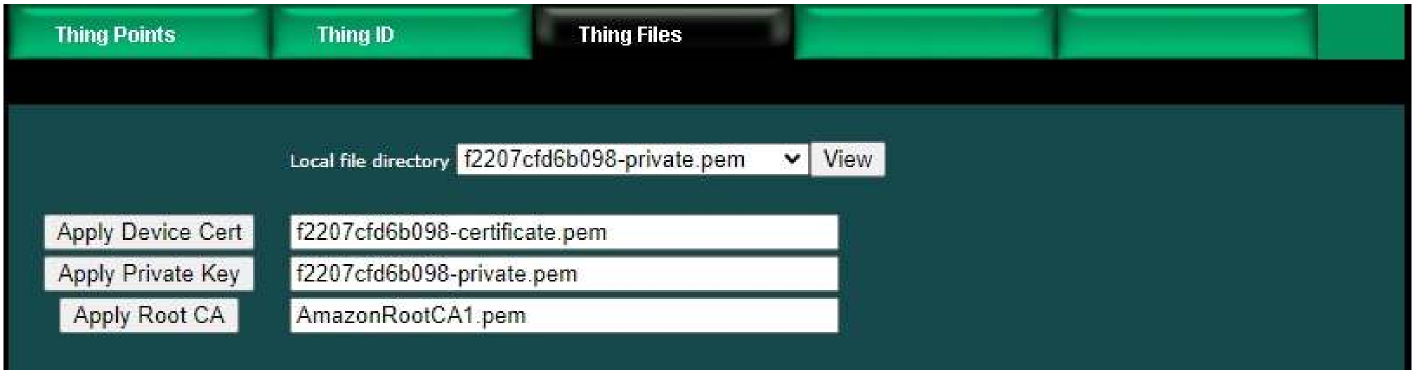
Now go to the Thing Files page, and apply the 3 files. Select a file from the list, and click the applicable Apply button.



Local file directory AmazonRootCA1.pem

Apply Root CA: AmazonRootCA1.pem

Once all 3 files are applied, the page in the ValuPoint will look something like this. These file names along with the rest of your Thing configuration in the ValuPoint are stored in the XML configuration file. After setting up the Thing, be sure to go to the File Manager page and Save your configuration to the XML file that will be reloaded at power up or restart.



Local file directory f2207cfd6b098-private.pem View

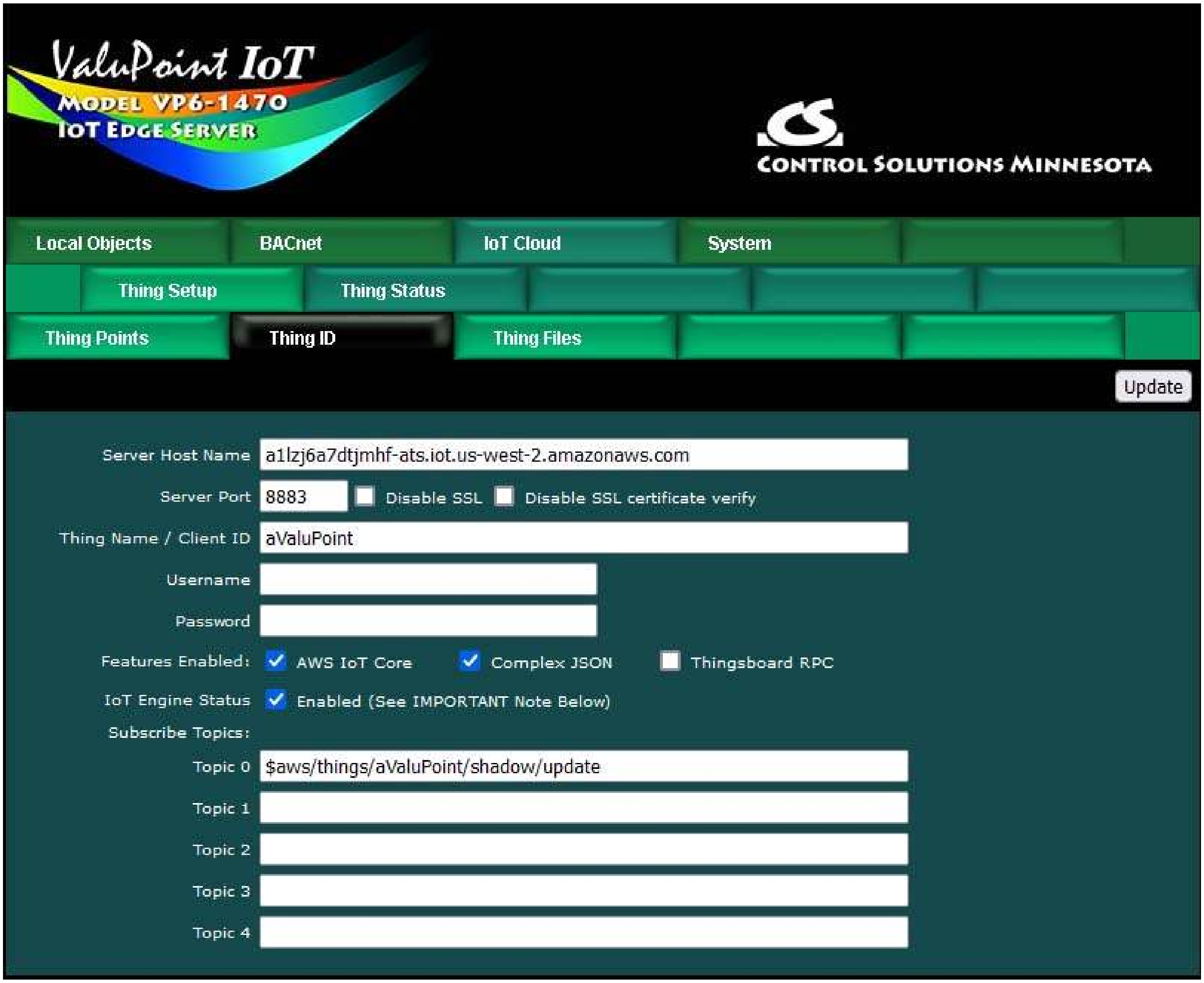
Apply Device Cert: f2207cfd6b098-certificate.pem

Apply Private Key: f2207cfd6b098-private.pem

Apply Root CA: AmazonRootCA1.pem

Once your Thing has been created both at AWS and in the ValuPoint (and assuming you have defined some thing points as outlined in Section 13), you can proceed to enable the IoT Engine.

Do note that the features enabled for an AWS connection should include AWS IoT Core and Complex JSON.



Server Host Name: a1lzj6a7dtjmhf-ats.iot.us-west-2.amazonaws.com

Server Port: 8883 □ Disable SSL □ Disable SSL certificate verify

Thing Name / Client ID: aValuPoint

Username:

Password:

Features Enabled: ☑ AWS IoT Core ☑ Complex JSON □ Thingsboard RPC

IoT Engine Status: ☑ Enabled (See IMPORTANT Note Below)

Subscribe Topics:

Topic 0: $aws/things/aValuPoint/shadow/update

Topic 1:

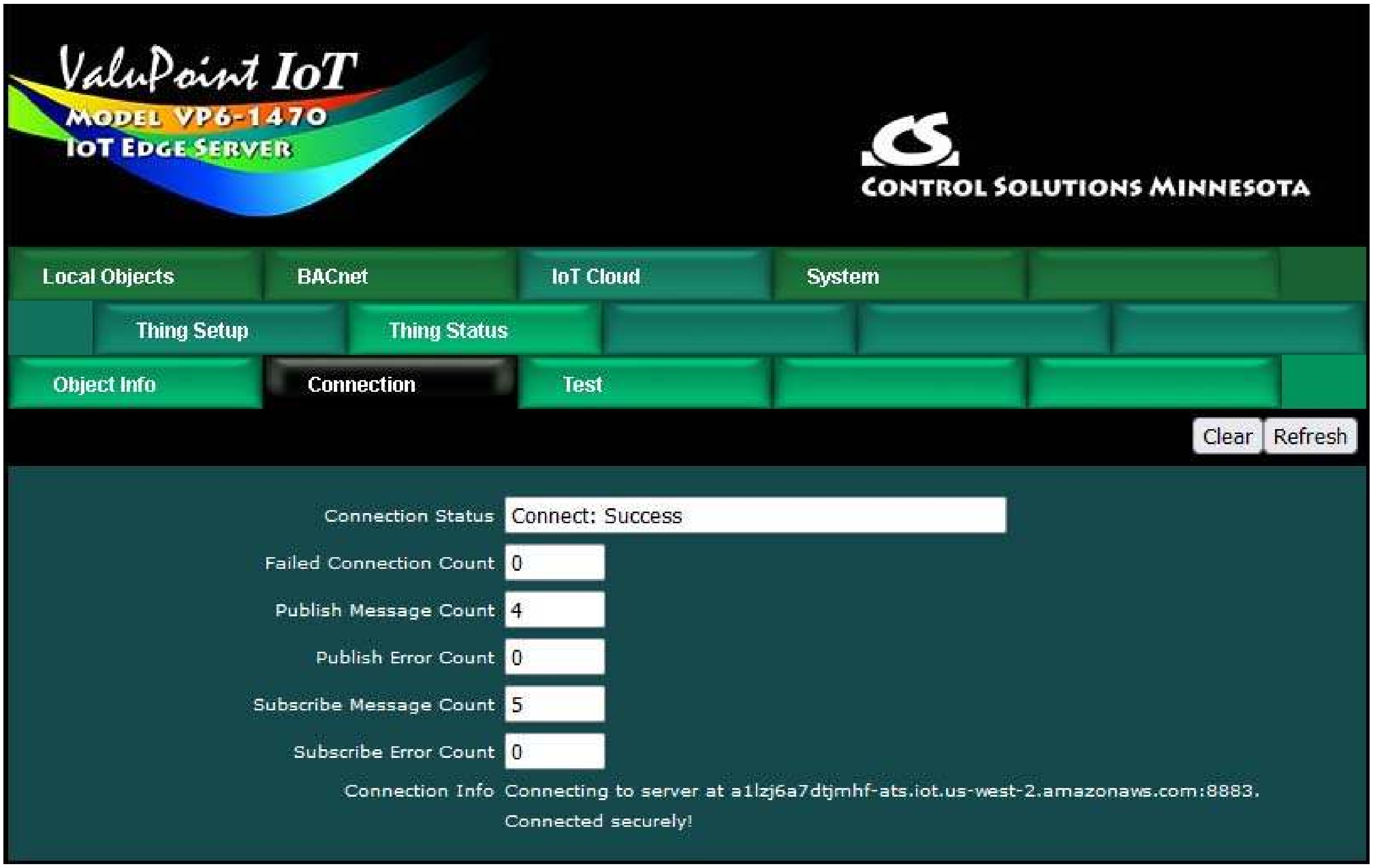
Topic 2:

Topic 3:

Topic 4:

14.4 Test Publish to Device Shadow

You can verify that your ValuPoint connected to AWS on the Connection page.



Connection Status: Connect: Success

Failed Connection Count: 0

Publish Message Count: 4

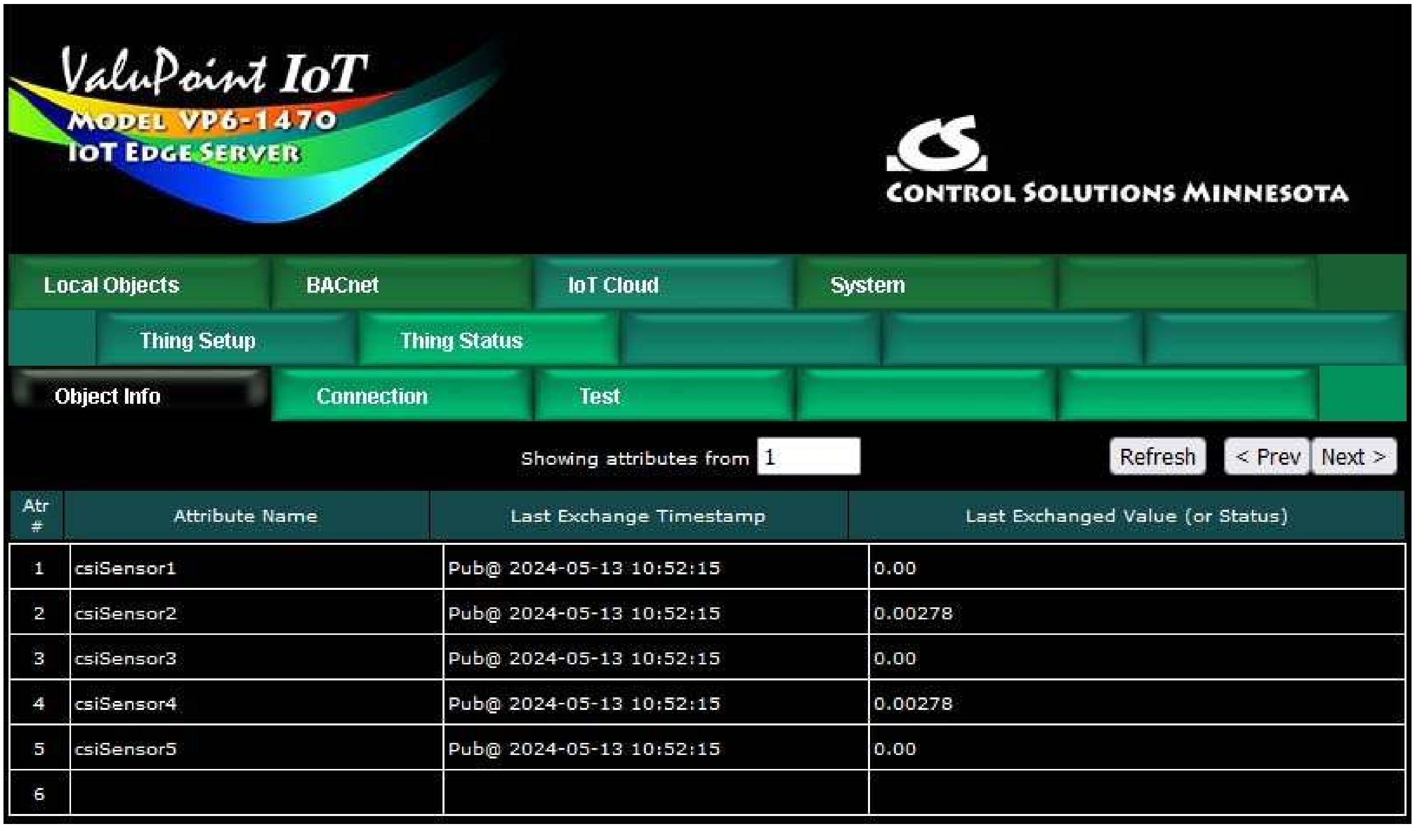
Publish Error Count: 0

Subscribe Message Count: 5

Subscribe Error Count: 0

Connection Info: Connecting to server at a1lzj6a7dtjmhf-ats.iot.us-west-2.amazonaws.com:8883.
Connected securely!

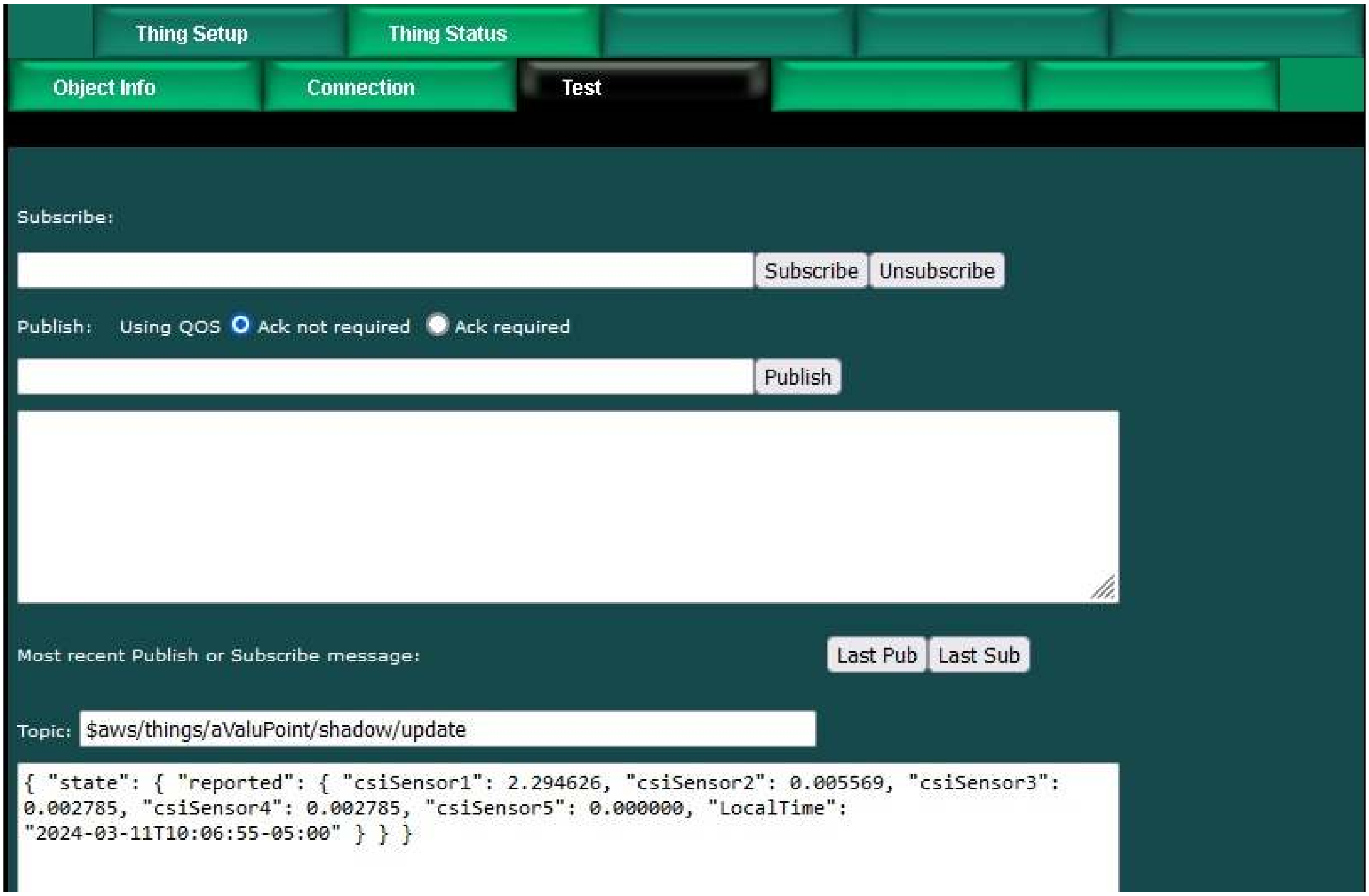
If you are connected successfully, do whatever is applicable per your Thing Point rules to cause it to publish to AWS. Once something has been published, the Object Info page will show a timestamp and value sent to AWS.



Showing attributes from 1

Atr #	Attribute Name	Last Exchange Timestamp	Last Exchanged Value (or Status)
1	csiSensor1	Pub@ 2024-05-13 10:52:15	0.00
2	csiSensor2	Pub@ 2024-05-13 10:52:15	0.00278
3	csiSensor3	Pub@ 2024-05-13 10:52:15	0.00
4	csiSensor4	Pub@ 2024-05-13 10:52:15	0.00278
5	csiSensor5	Pub@ 2024-05-13 10:52:15	0.00
6			

You can also go to the Test page and click the Last Pub and Last Sub buttons to see the most recent transaction in raw JSON format.



Subscribe:

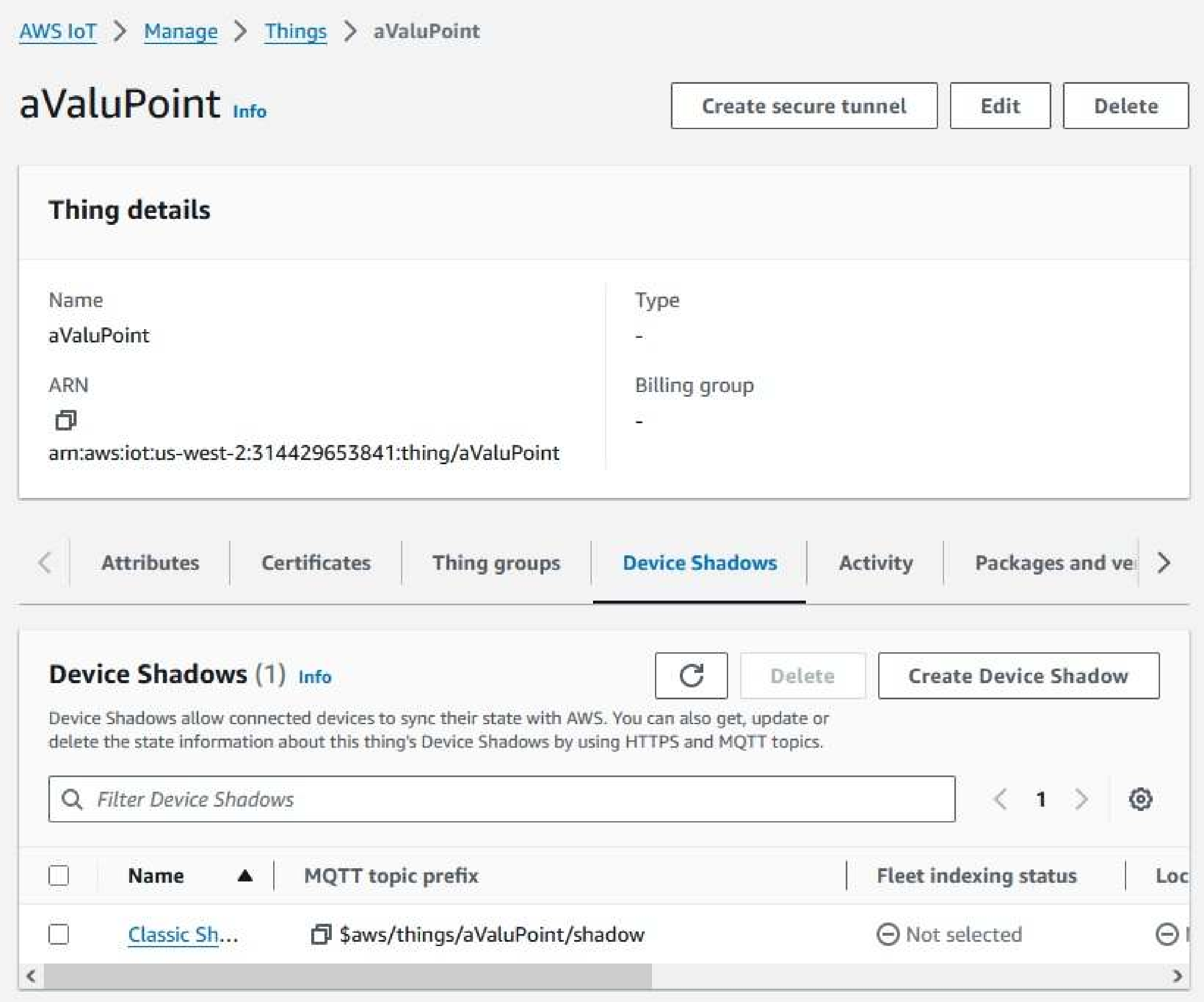
Publish: Using QOS ● Ack not required ○ Ack required

Most recent Publish or Subscribe message:

Topic: $aws/things/aValuPoint/shadow/update

{ "state": { "reported": { "csiSensor1": 2.294626, "csiSensor2": 0.005569, "csiSensor3": 0.002785, "csiSensor4": 0.002785, "csiSensor5": 0.000000, "LocalTime": "2024-03-11T10:06:55-05:00" } } }

Back on the AWS host side, under details for your Thing, you can look at your device shadow.



Thing details

Name
aValuPoint

ARN
arn:aws:iot:us-west-2:314429653841:thing/aValuPoint

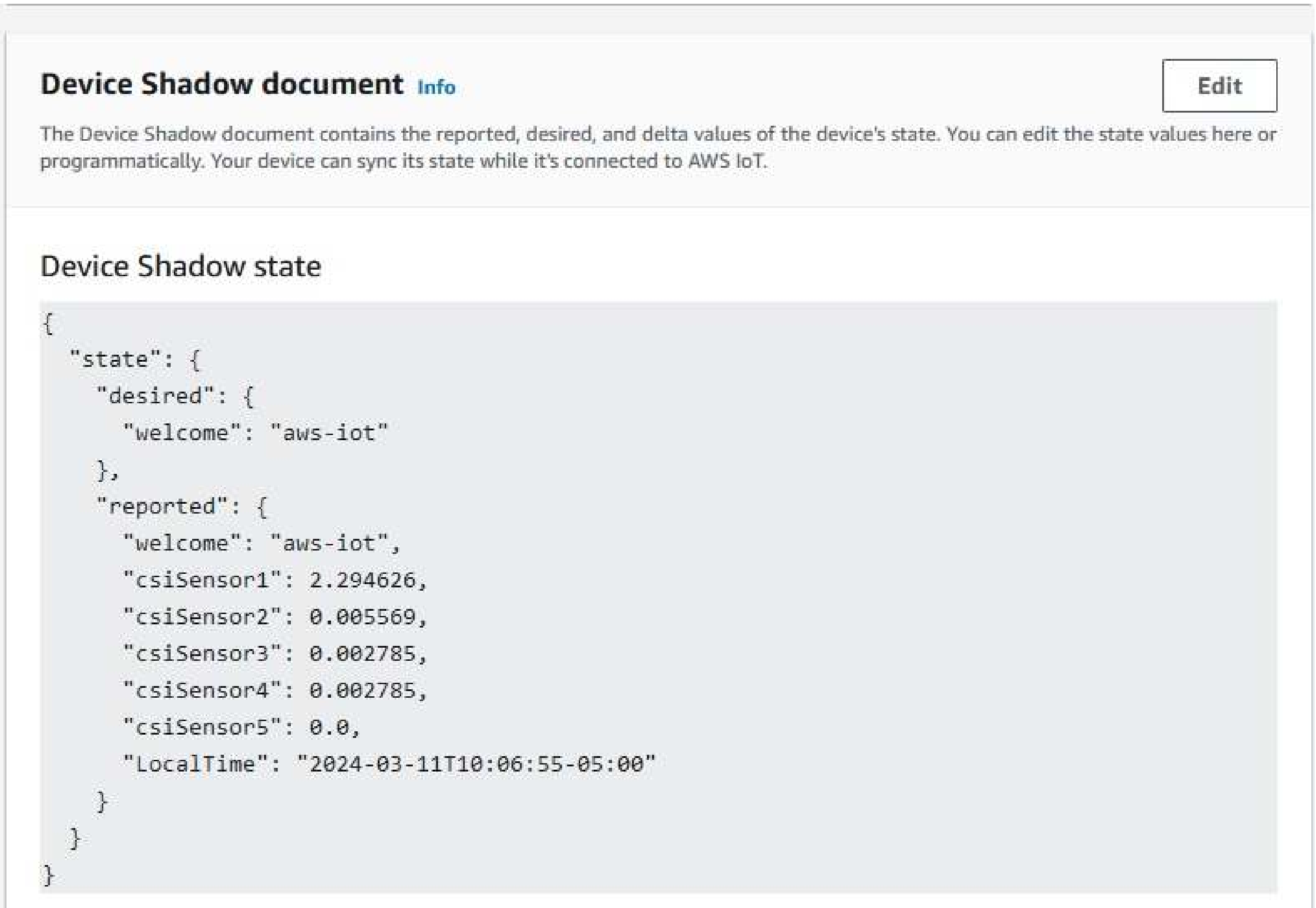
Type
-

Billing group
-

Device Shadows allow connected devices to sync their state with AWS. You can also get, update or delete the state information about this thing's Device Shadows by using HTTPS and MQTT topics.

	Name ▲	MQTT topic prefix	Fleet indexing status	Loc
□	Classic Sh...	$aws/things/aValuPoint/shadow	⊖ Not selected	⊖ I

Click on the shadow name to see the content of the shadow. As illustrated in the example below, you should see the data most recently published by your ValuPoint.



Device Shadow document Info

The Device Shadow document contains the reported, desired, and delta values of the device's state. You can edit the state values here or programmatically. Your device can sync its state while it's connected to AWS IoT.

Device Shadow state

```
{
  "state": {
    "desired": {
      "welcome": "aws-iot"
    },
    "reported": {
      "welcome": "aws-iot",
      "csiSensor1": 2.294626,
      "csiSensor2": 0.005569,
      "csiSensor3": 0.002785,
      "csiSensor4": 0.002785,
      "csiSensor5": 0.0,
      "LocalTime": "2024-03-11T10:06:55-05:00"
    }
  }
}
```

ValuPoint IoT
Model VP6-1470
IoT Edge Server

Control Solutions Minnesota

15. Configuring IoT Client to Subscribe to AWS

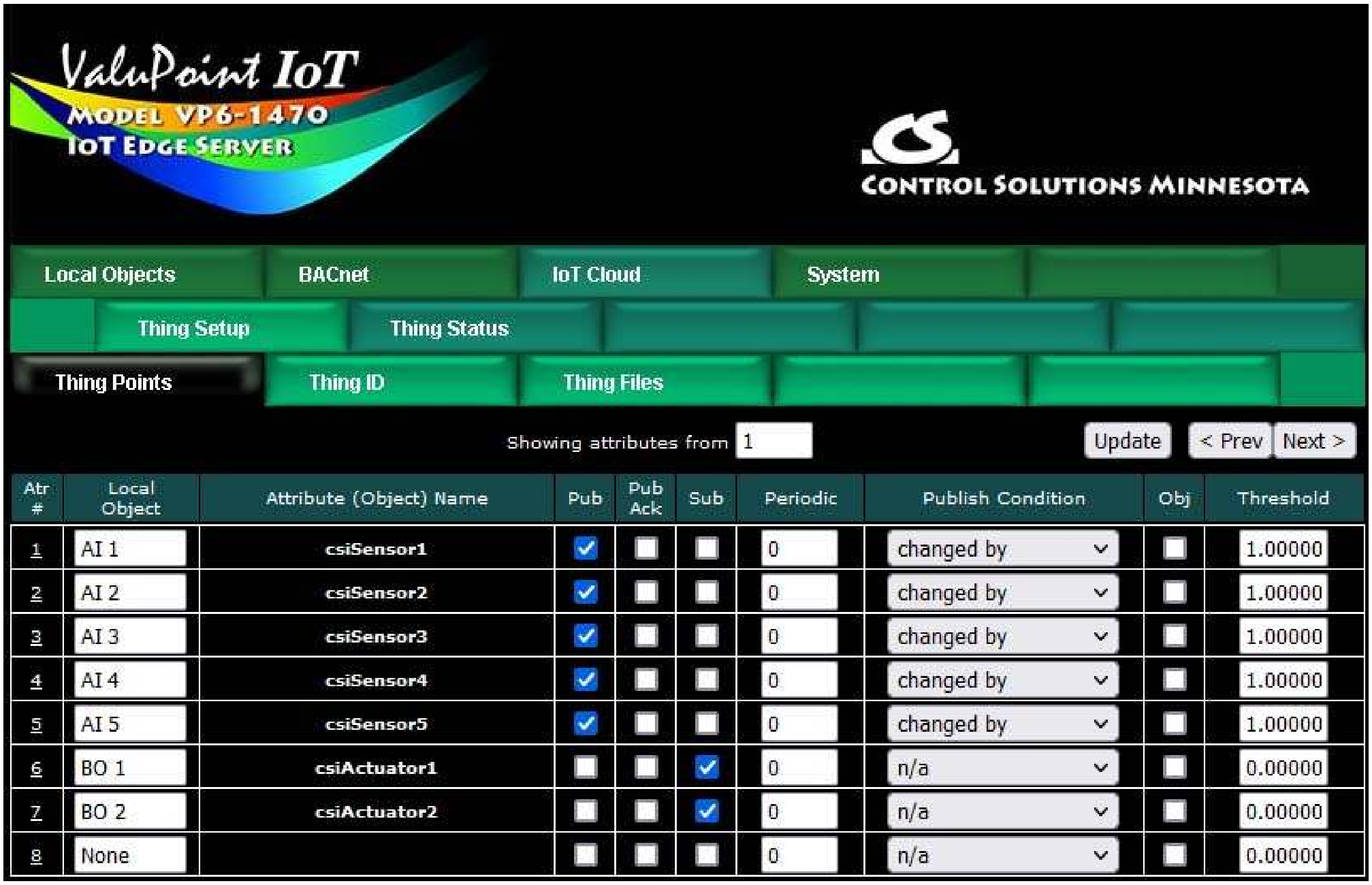
The MQTT term "Subscribe", from a controls perspective, would be most closely associated with the action of an actuator. You want to control an output based on setpoint data received from some external source. In the instance we are working with here, we are Subscribing to data from the AWS server.

The ValuPoint is programmed to look for the "desired" state for attributes. When some other device publishes to this device's Shadow using the "desired" state, this device will pick that up through its subscription, and in the case of the ValuPoint, write the received data value to a local object. That local object may then be subsequently written to a BACnet object in some other BACnet device, or be applied to local physical I/O.

While using the Shadow object is not required, the benefit of doing so is that the desired value will still be available should the ValuPoint be temporarily offline or disconnected. When the ValuPoint reconnects, it will retrieve the desired state information from the Shadow object and set its local objects accordingly.

15.1 Configure IoT Client

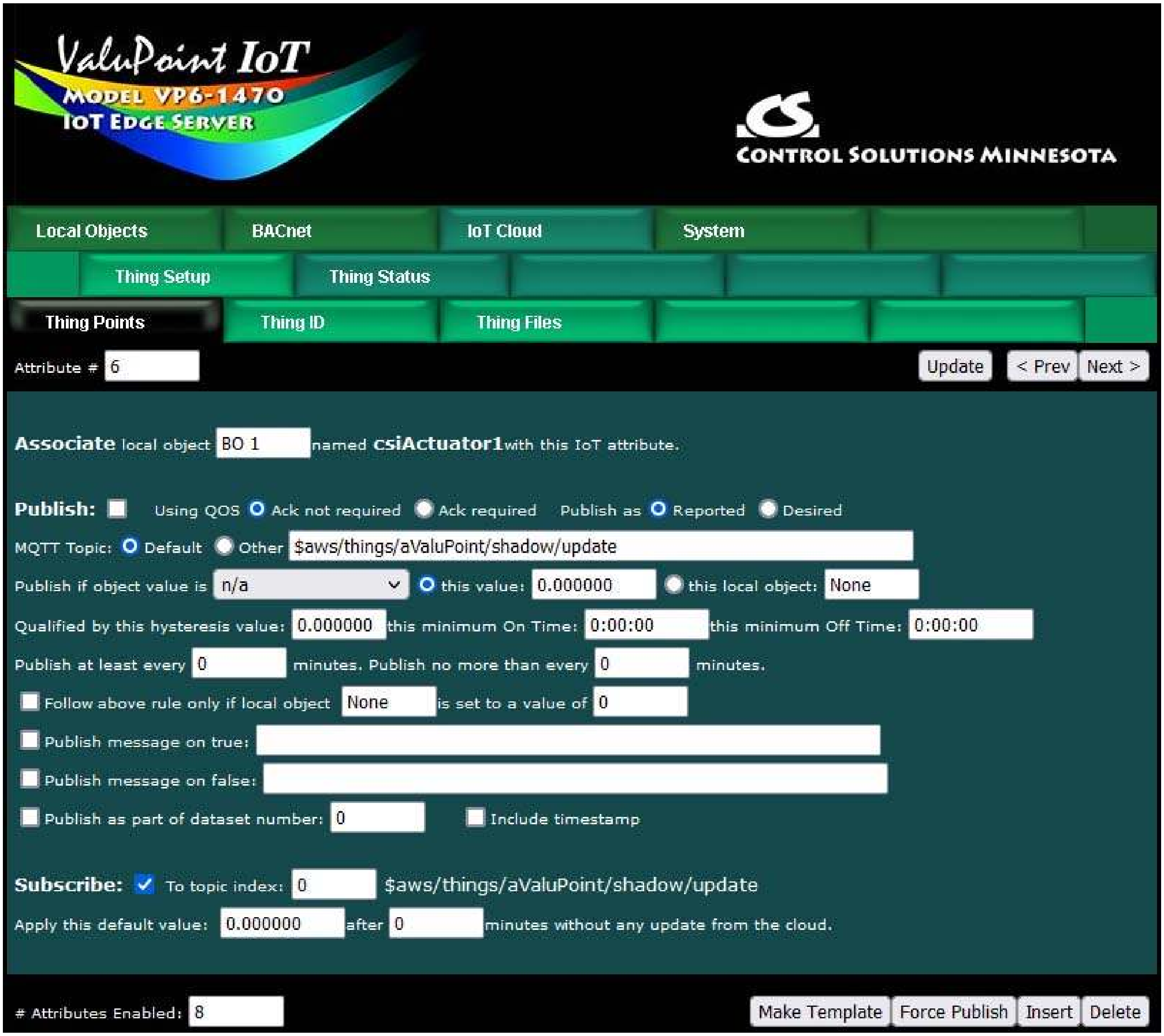
The simples form of a Subscribe point is illustrated below. To see the expanded view, click on the attribute number in the first column.



Showing attributes from 1

Atr #	Local Object	Attribute (Object) Name	Pub	Pub Ack	Sub	Periodic	Publish Condition	Obj	Threshold
1	AI 1	csiSensor1	☑	□	□	0	changed by	□	1.00000
2	AI 2	csiSensor2	☑	□	□	0	changed by	□	1.00000
3	AI 3	csiSensor3	☑	□	□	0	changed by	□	1.00000
4	AI 4	csiSensor4	☑	□	□	0	changed by	□	1.00000
5	AI 5	csiSensor5	☑	□	□	0	changed by	□	1.00000
6	BO 1	csiActuator1	□	□	☑	0	n/a	□	0.00000
7	BO 2	csiActuator2	□	□	☑	0	n/a	□	0.00000
8	None		□	□	□	0	n/a	□	0.00000

You will most often just use the default subscribe topic (illustrated below for "aValuPoint"), so all you really need to do is select Subscribe using the checkbox. Then click Update.



Attribute # 6

Associate local object BO 1 named **csiActuator1** with this IoT attribute.

Publish: □ Using QOS ● Ack not required ○ Ack required Publish as ● Reported ○ Desired

MQTT Topic: ● Default ○ Other $aws/things/aValuPoint/shadow/update

Publish if object value is n/a ● this value: 0.000000 ○ this local object: None

Qualified by this hysteresis value: 0.000000 this minimum On Time: 0:00:00 this minimum Off Time: 0:00:00

Publish at least every 0 minutes. Publish no more than every 0 minutes.

□ Follow above rule only if local object None is set to a value of 0

□ Publish message on true:

□ Publish message on false:

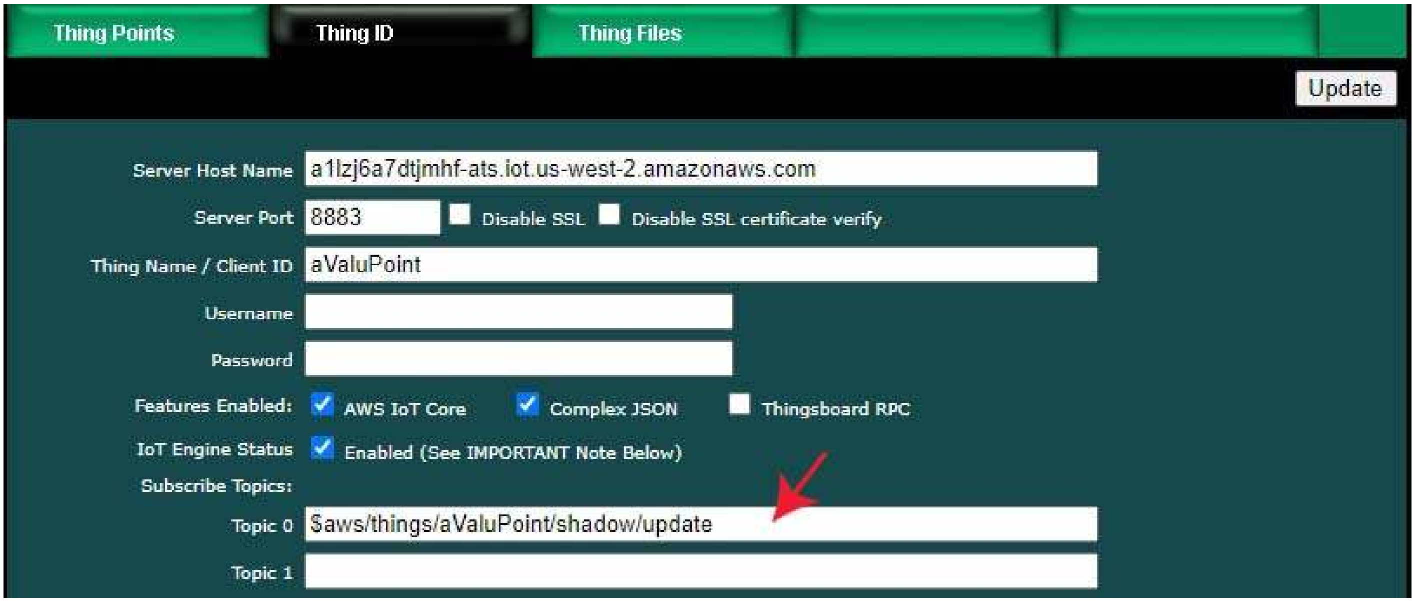
□ Publish as part of dataset number: 0 □ Include timestamp

Subscribe: ☑ To topic index: 0 $aws/things/aValuPoint/shadow/update

Apply this default value: 0.000000 after 0 minutes without any update from the cloud.

Attributes Enabled: 8

The default topic will normally be created for you when you enter the thing name.



Server Host Name a1lzj6a7dtjmhf-ats.iot.us-west-2.amazonaws.com

Server Port 8883 □ Disable SSL □ Disable SSL certificate verify

Thing Name / Client ID aValuPoint

Username

Password

Features Enabled: ☑ AWS IoT Core ☑ Complex JSON □ Thingsboard RPC

IoT Engine Status ☑ Enabled (See IMPORTANT Note Below)

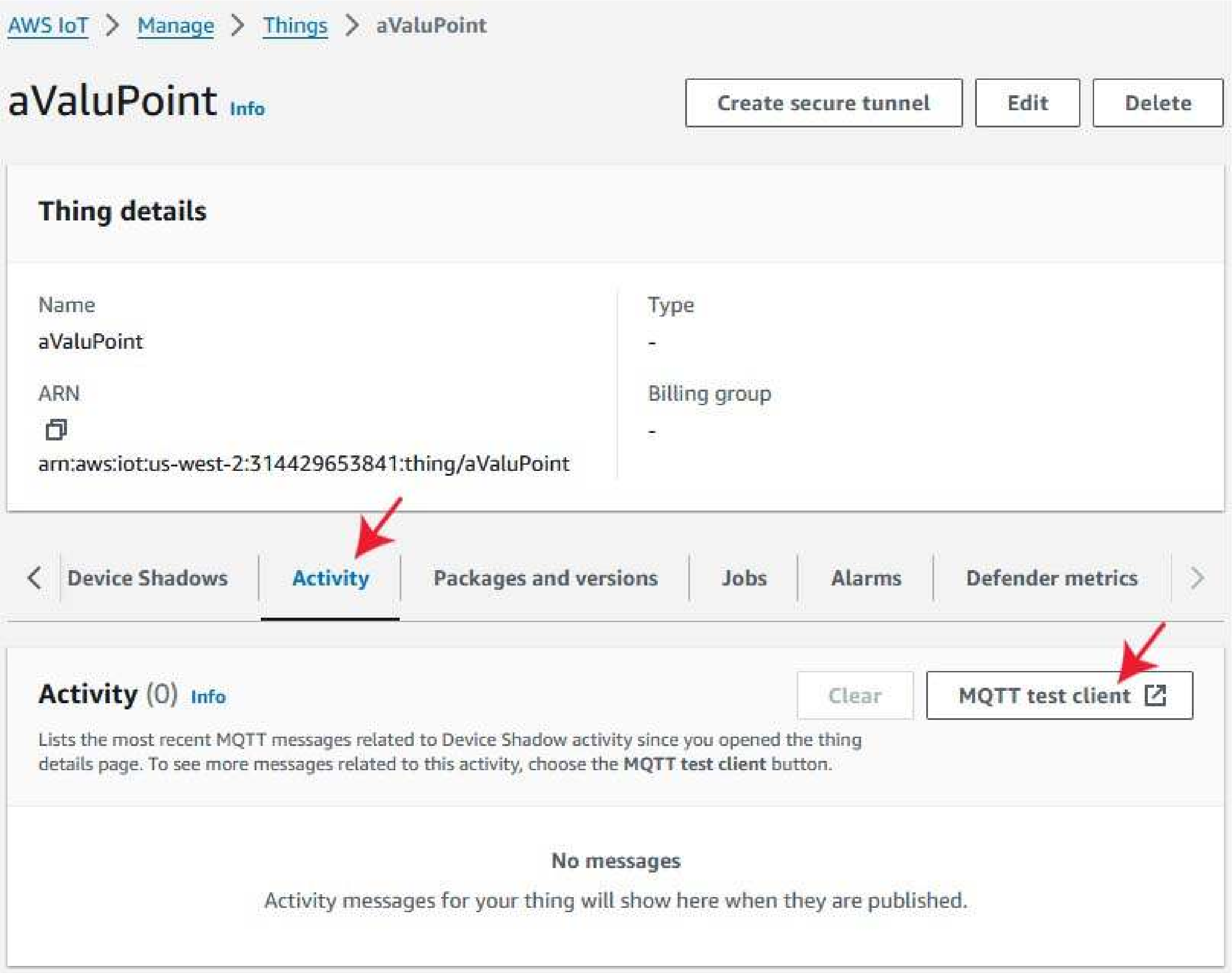
Subscribe Topics:

Topic 0 $aws/things/aValuPoint/shadow/update

Topic 1

15.2 Use MQTT Test Client to Test Subscription

Once your Thing Point is set up to Subscribe, go back to the AWS IoT management console and locate the MQTT test client. Using the MQTT client found here, you will manually publish to our default topic.



Thing details

Name
aValuPoint

ARN
arn:aws:iot:us-west-2:314429653841:thing/aValuPoint

Type
-

Billing group
-

Activity (0) Info

Lists the most recent MQTT messages related to Device Shadow activity since you opened the thing details page. To see more messages related to this activity, choose the **MQTT test client** button.

No messages
Activity messages for your thing will show here when they are published.

You may want to use a generic text editor to prepare your JSON message ahead of time. The format illustrated below must be used. If you are interested in learning more about JSON and the Shadow update syntax, you can find more information both on the Amazon web site, and on the Internet in general.

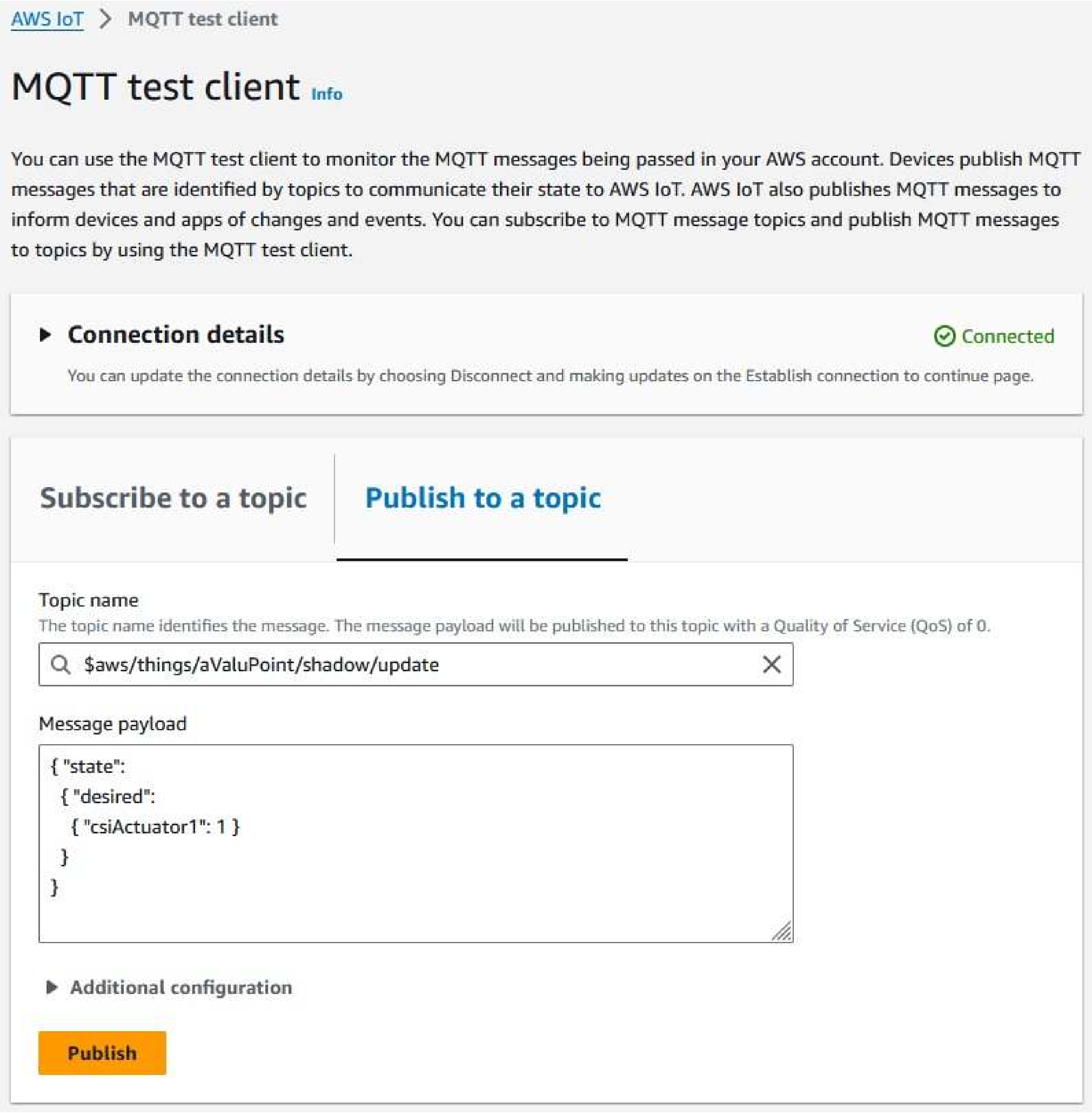
Topic:
$aws/things/aValuPoint/shadow/update

"Nice" human readable JSON query:

```
{ "state":
  { "desired":
    { "csiActuator1": 1 }
  }
}
```

Single line JSON query equally acceptable to MQTT:

```
{ "state": { "desired": { "csiActuator1": 1 } } }
```



MQTT test client Info

You can use the MQTT test client to monitor the MQTT messages being passed in your AWS account. Devices publish MQTT messages that are identified by topics to communicate their state to AWS IoT. AWS IoT also publishes MQTT messages to inform devices and apps of changes and events. You can subscribe to MQTT message topics and publish MQTT messages to topics by using the MQTT test client.

▶ Connection details ✓ Connected

You can update the connection details by choosing Disconnect and making updates on the Establish connection to continue page.

Topic name

The topic name identifies the message. The message payload will be published to this topic with a Quality of Service (QoS) of 0.

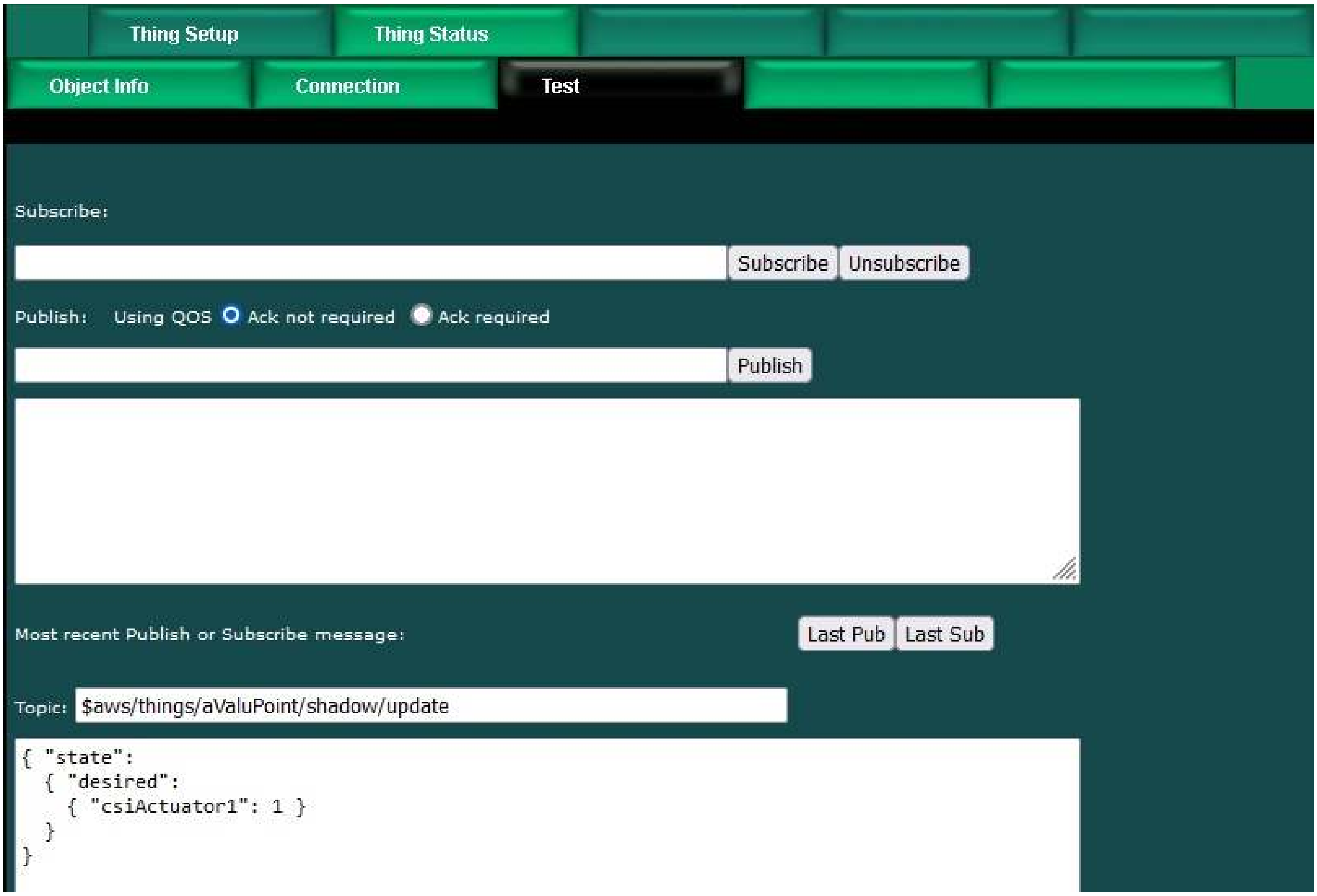
$aws/things/aValuPoint/shadow/update

Message payload

```
{ "state":
  { "desired":
    { "csiActuator1": 1 }
  }
}
```

In the Publish section of the MQTT Client page, enter the topic illustrated above, and the payload. Then click Publish. If you go back and look at your thing's Shadow at this point you will see the "desired" state that was published.

On the ValuPoint Test page, when you now click Last Sub, you should see your message show up at the ValuPoint.



Topic: $aws/things/aValuPoint/shadow/update

```
{ "state":
  { "desired":
    { "csiActuator1": 1 }
  }
}
```

You should now be able to go to the ValuPoint's Local Objects page and see the value that you published from the MQTT Client. In the example illusrated above, we turned on the relay DO 1 (BACnet object BO 1).

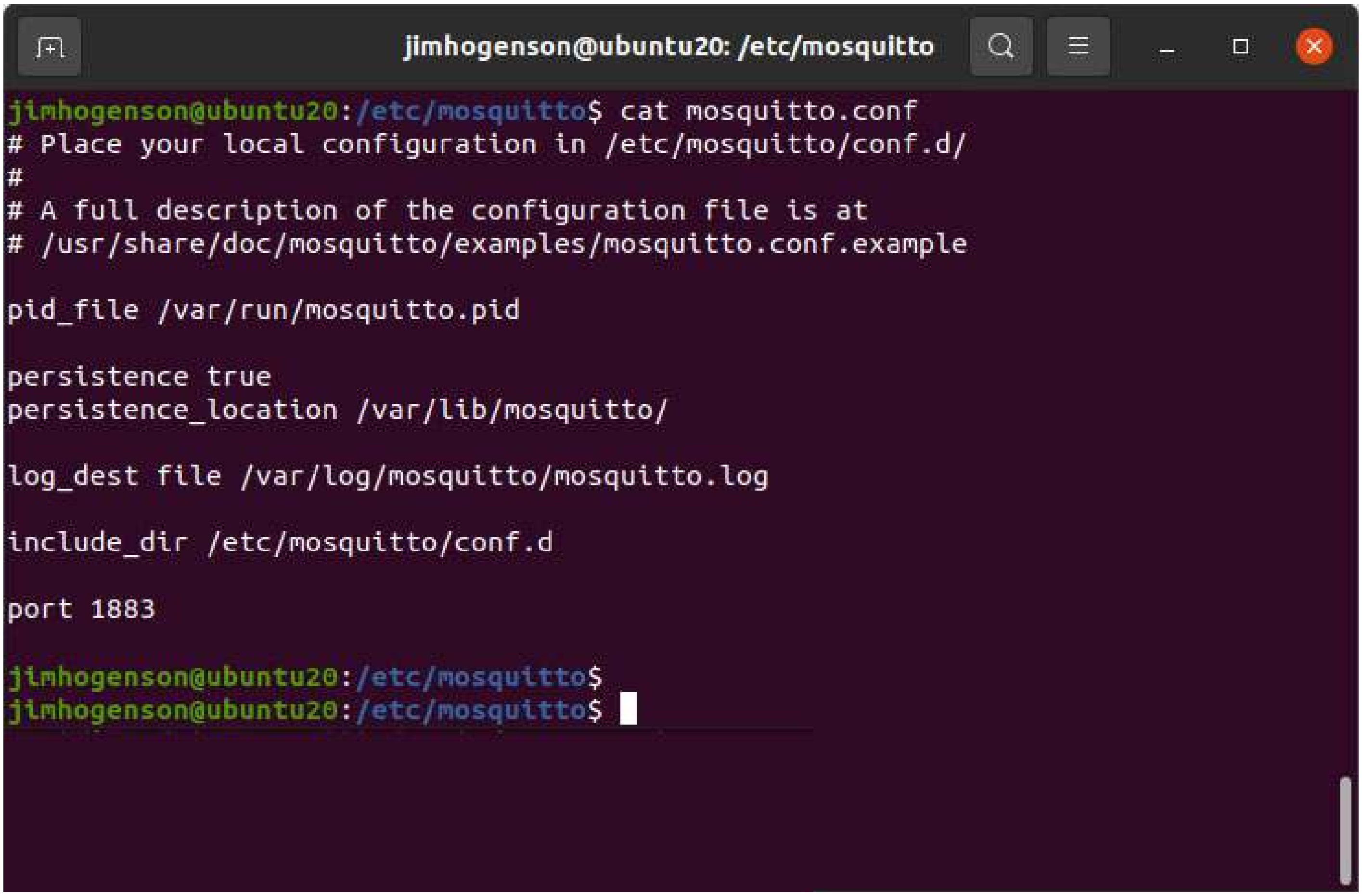
16. Using Mosquitto MQTT

The ValuPoint supports the use of a generic MQTT broker such as Mosquitto MQTT. This section will review use of Mosquitto. To begin with, you need a Linux PC that can serve as your server, and you will need to install the Mosquitto MQTT software on that Linux server.

16.1 Configuring the Mosquitto Linux Server

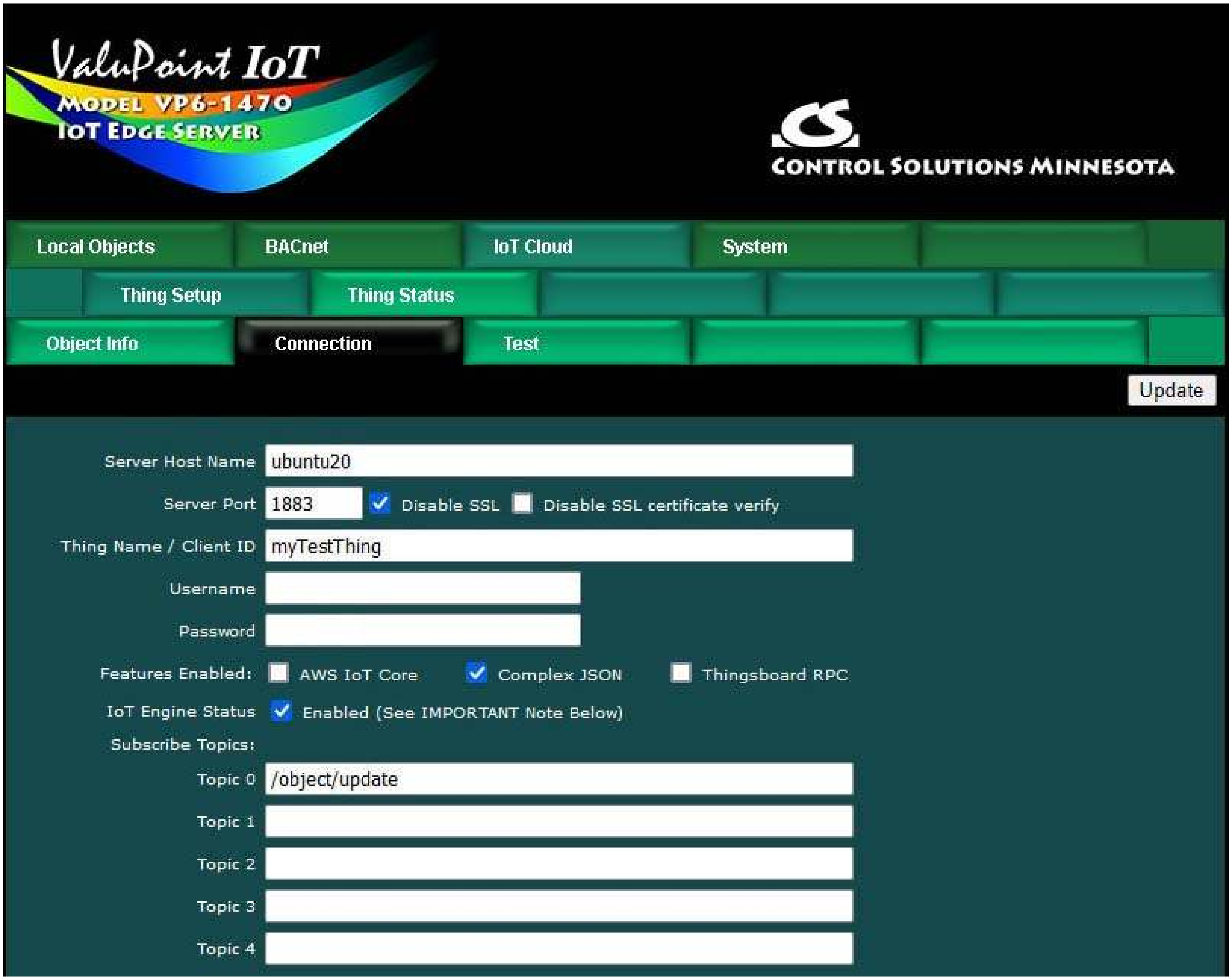
To install Mosquitto MQTT if you have not done so already, follow instructions at http://www.steves-internet-guide.com/mosquitto-broker/.

The configuration file for Mosquitto is found in /etc/mosquitto/mosquito.conf and the minimum configuration would look like the example below.



```
jimhogenson@ubuntu20:/etc/mosquitto$ cat mosquitto.conf
# Place your local configuration in /etc/mosquitto/conf.d/
#
# A full description of the configuration file is at
# /usr/share/doc/mosquitto/examples/mosquitto.conf.example

pid_file /var/run/mosquitto.pid

persistence true
persistence_location /var/lib/mosquitto/

log_dest file /var/log/mosquitto/mosquitto.log

include_dir /etc/mosquitto/conf.d

port 1883

jimhogenson@ubuntu20:/etc/mosquitto$
jimhogenson@ubuntu20:/etc/mosquitto$
```

Using a bare minimum configuration with no SSL and no username/password, the Thing ID page would look like the following screen shot.



Server Host Name: ubuntu20

Server Port: 1883 ☑ Disable SSL ☐ Disable SSL certificate verify

Thing Name / Client ID: myTestThing

Username:

Password:

Features Enabled: ☐ AWS IoT Core ☑ Complex JSON ☐ Thingsboard RPC

IoT Engine Status: ☑ Enabled (See IMPORTANT Note Below)

Subscribe Topics:

Topic 0: /object/update

Topic 1:

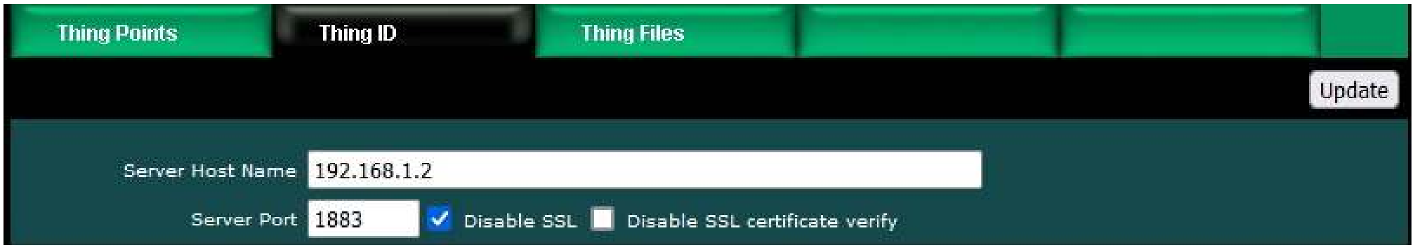
Topic 2:

Topic 3:

Topic 4:

Note that 'ubuntu20' as host name has been added to the local DNS server. DNS lookup of 'ubuntu20' returns the IP address of the local Mosquitto MQTT server. The IP address of the local DNS server has also been entered as primary DNS on the Network page in this ValuPoint.

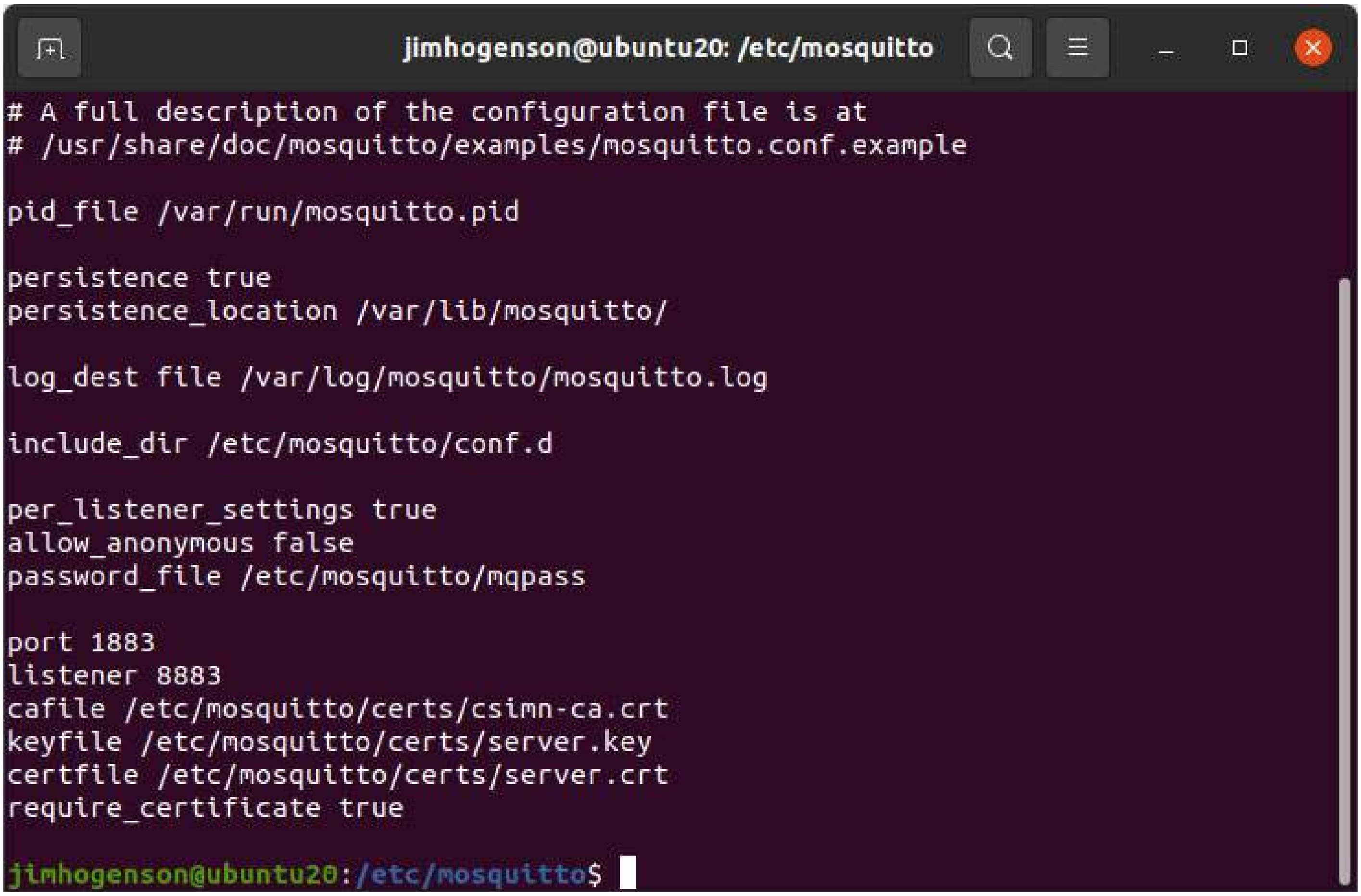
You can also enter the local server's IP address directly as illustrated below if preferred.



Server Host Name: 192.168.1.2

Server Port: 1883 ☑ Disable SSL ☐ Disable SSL certificate verify

Adding both SSL certificates and username/password requirements is illustrated in the mosquitto.conf file pictured below.

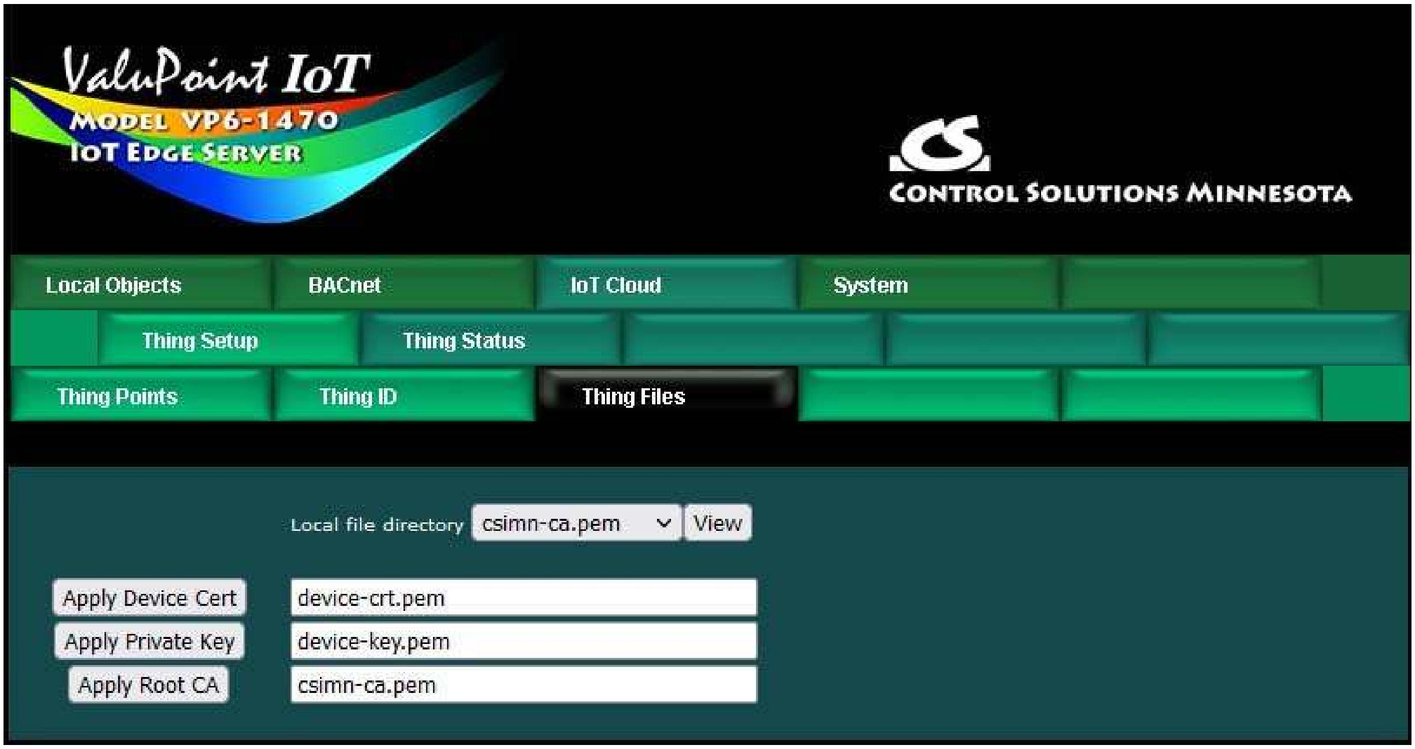


```
# A full description of the configuration file is at
# /usr/share/doc/mosquitto/examples/mosquitto.conf.example

pid_file /var/run/mosquitto.pid

persistence true
persistence_location /var/lib/mosquitto/

log_dest file /var/log/mosquitto/mosquitto.log

include_dir /etc/mosquitto/conf.d

per_listener_settings true
allow_anonymous false
password_file /etc/mosquitto/mqpass

port 1883
listener 8883
cafile /etc/mosquitto/certs/csimn-ca.crt
keyfile /etc/mosquitto/certs/server.key
certfile /etc/mosquitto/certs/server.crt
require_certificate true

jimhogenson@ubuntu20:/etc/mosquitto$
```

Follow instructions for mosquitto_passwd (under Documentation at mosquitto.org) for creating the password file and adding usernames to it.

To create your own SSL certificates for both the Mosquitto server and the client (ValuPoint), follow instructions at http://mosquitto.org/man/mosquitto-tls-7.html and see also https://asciinema.org/a/201826.

Certificates for use with Mosquitto are uploaded and installed in the same manner as for AWS. An example of the Thing Files page is illustrated below.



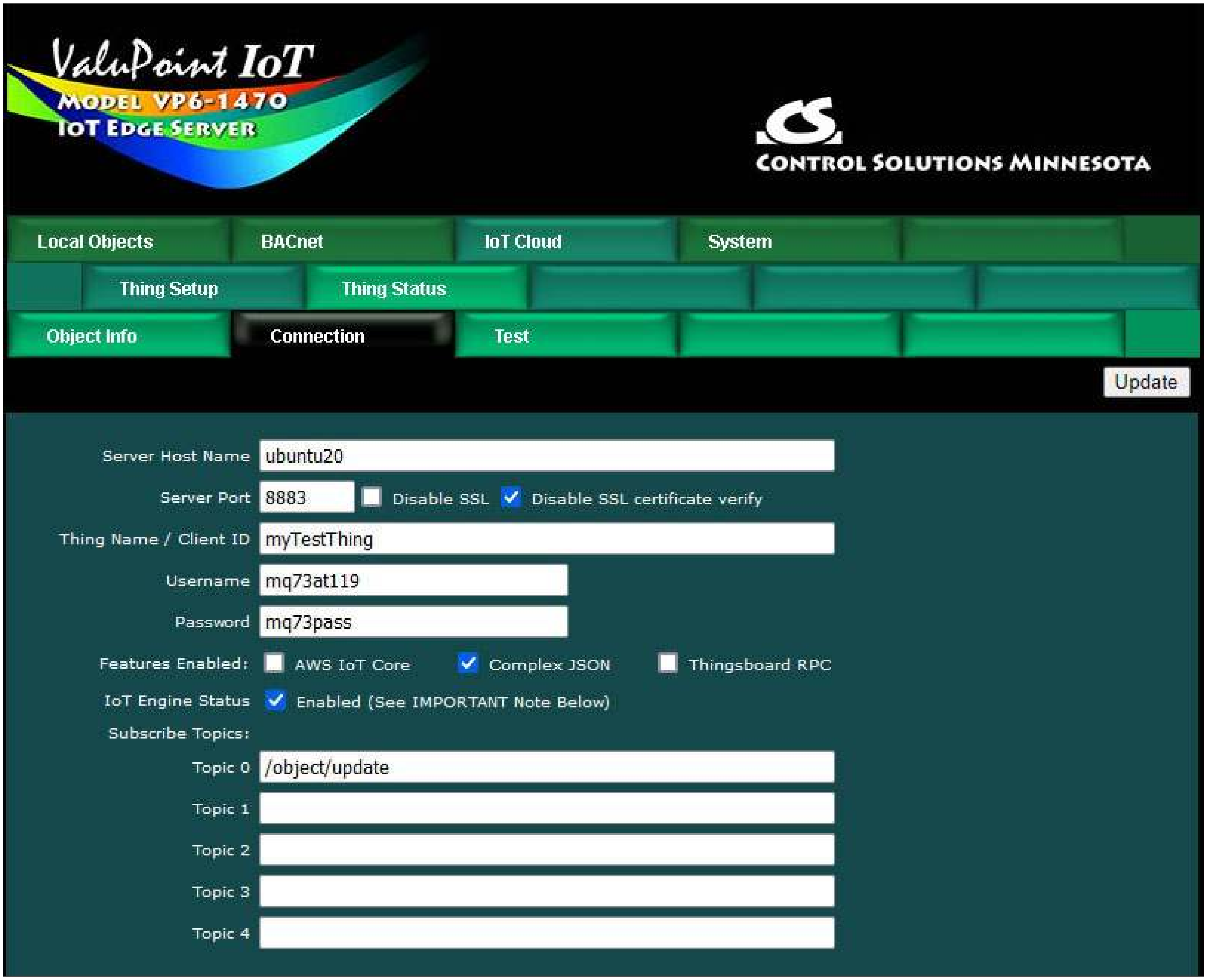
Local file directory: csimn-ca.pem

Apply Device Cert: device-crt.pem

Apply Private Key: device-key.pem

Apply Root CA: csimn-ca.pem

The Thing ID page when SSL and username/password are configured in Mosquitto would appear as in the screen shot below.



Server Host Name: ubuntu20

Server Port: 8883 □ Disable SSL ☑ Disable SSL certificate verify

Thing Name / Client ID: myTestThing

Username: mq73at119

Password: mq73pass

Features Enabled: □ AWS IoT Core ☑ Complex JSON □ Thingsboard RPC

IoT Engine Status: ☑ Enabled (See IMPORTANT Note Below)

Subscribe Topics:

Topic 0: /object/update

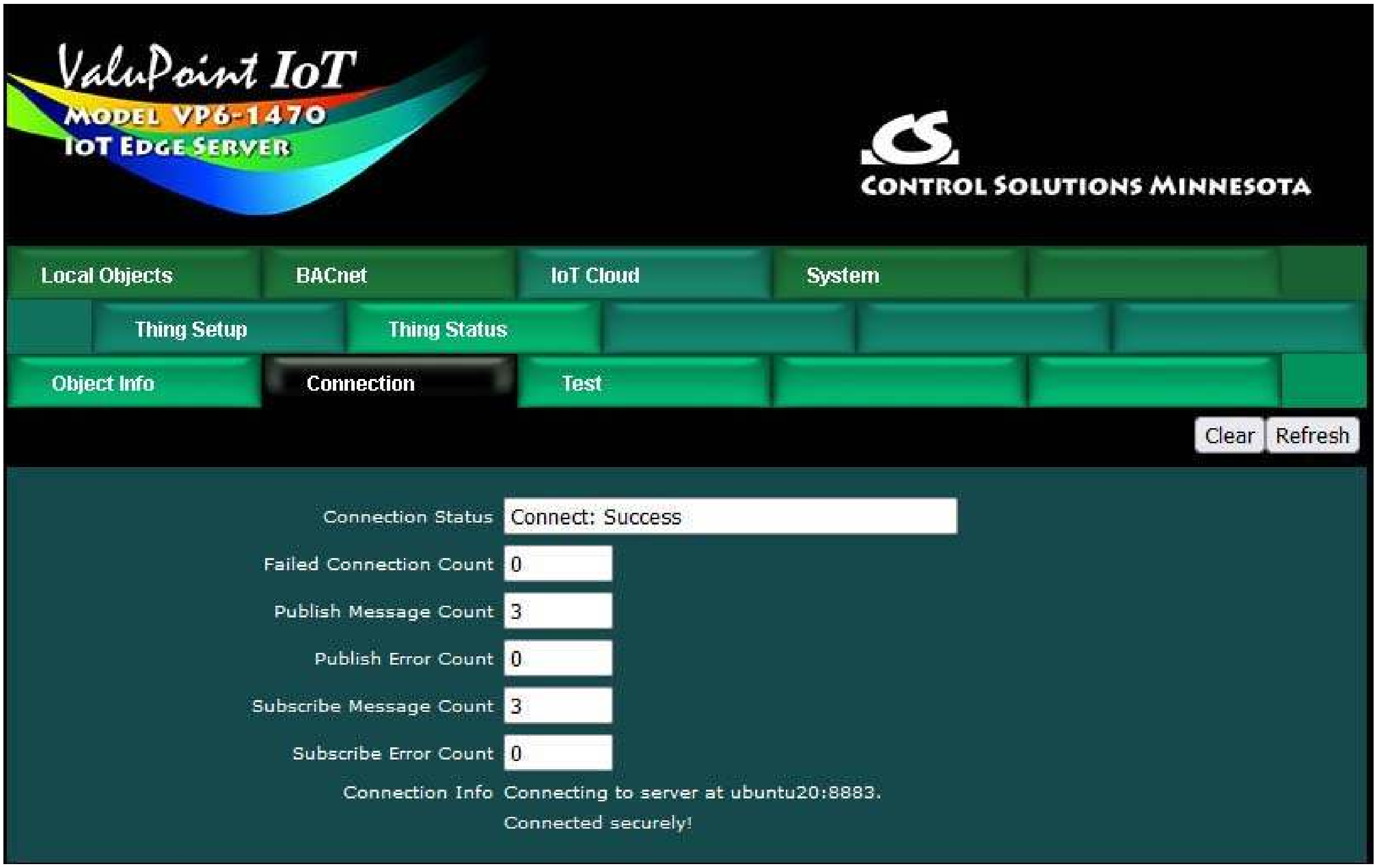
Topic 1:

Topic 2:

Topic 3:

Topic 4:

Upon successful connection, you should see the "success" indication as pictured below.



Connection Status: Connect: Success

Failed Connection Count: 0

Publish Message Count: 3

Publish Error Count: 0

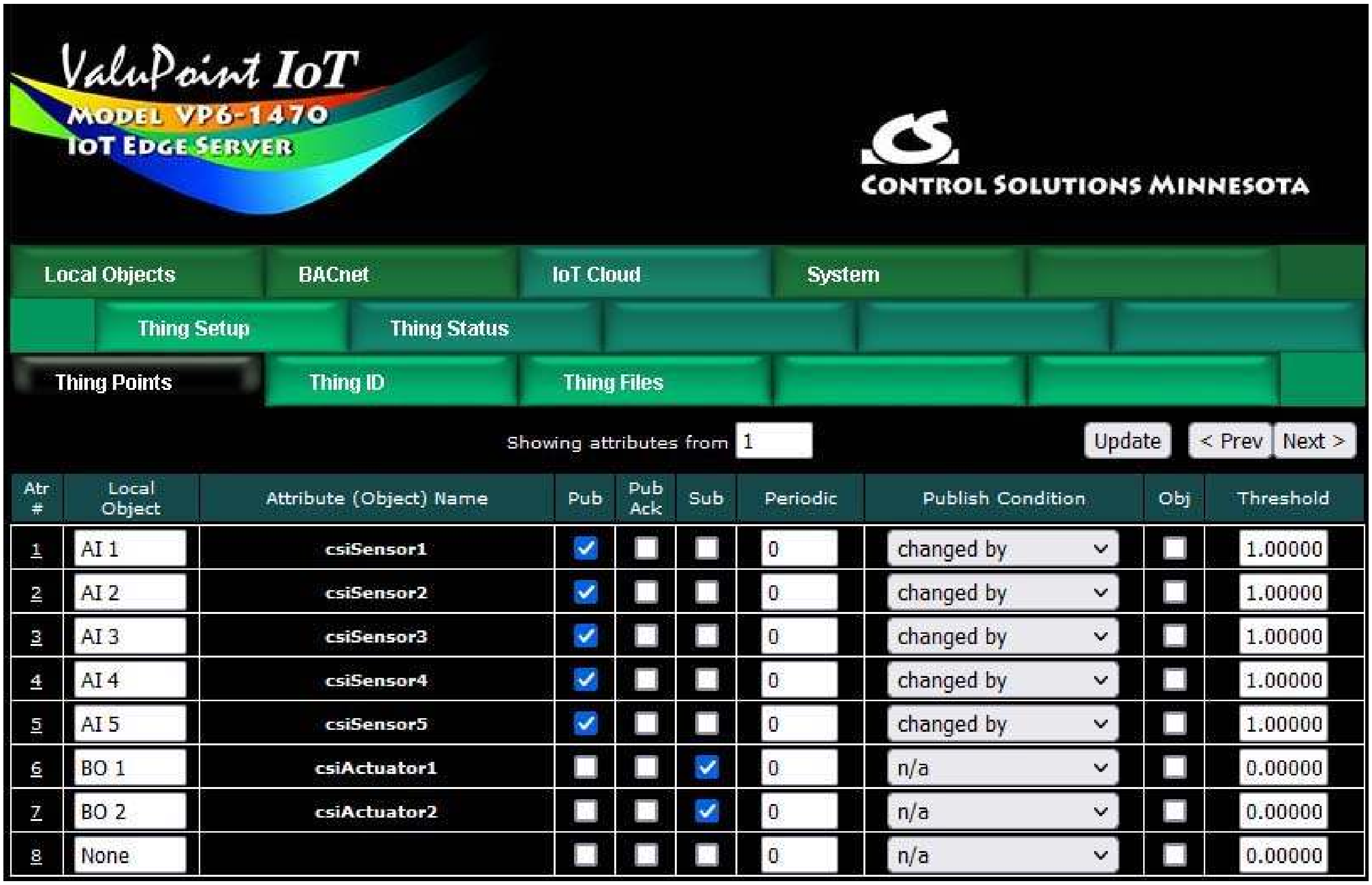
Subscribe Message Count: 3

Subscribe Error Count: 0

Connection Info: Connecting to server at ubuntu20:8883.
Connected securely!

16.2 Publishing Thing Points to Mosquitto

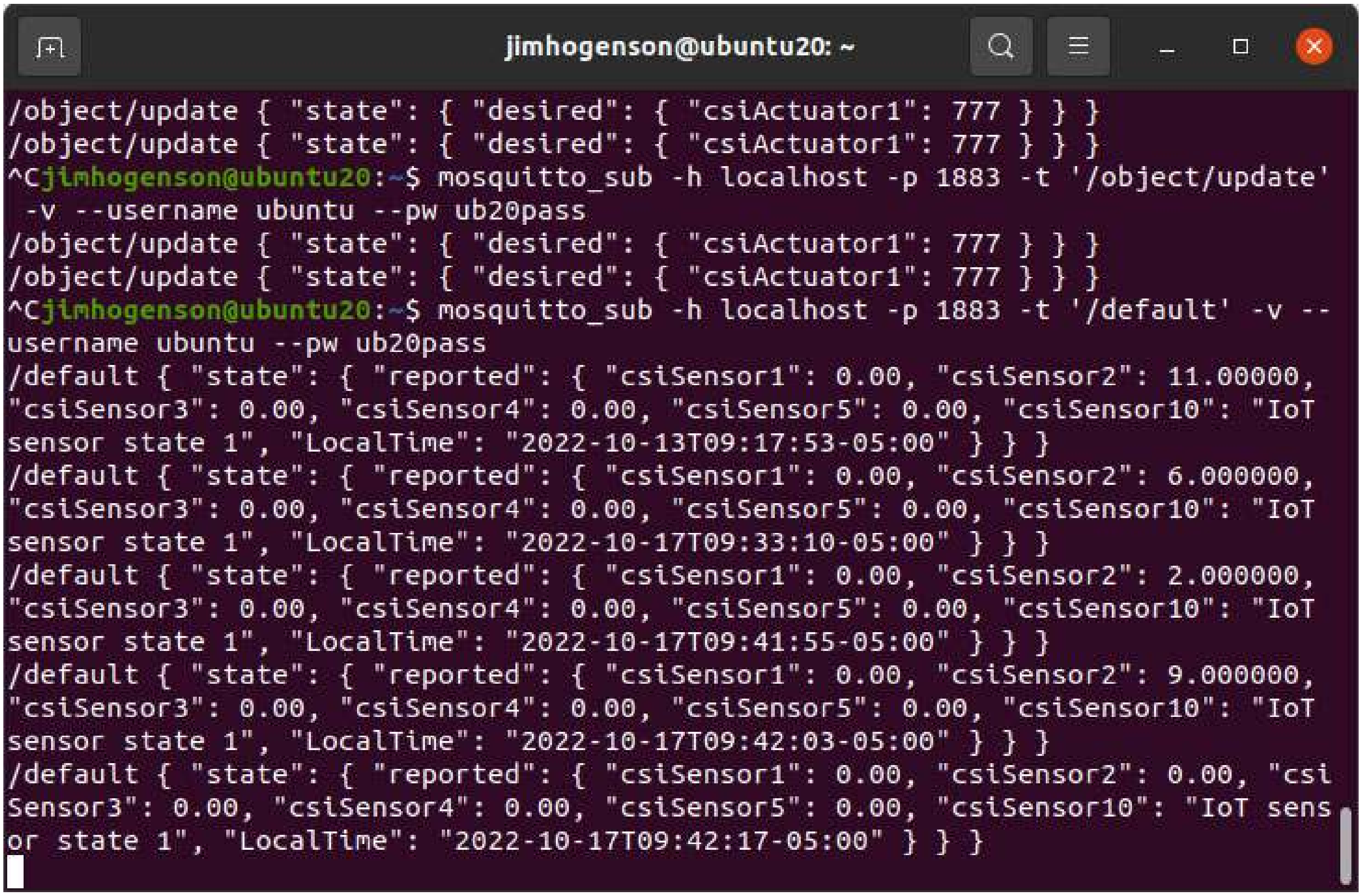
The same set of Thing Points, along with the same publish and subscribe rules, as used for AWS will work the same with Mosquitto MQTT or any other MQTT broker. Refer to section 13 for Thing Point configuration.



Showing attributes from 1

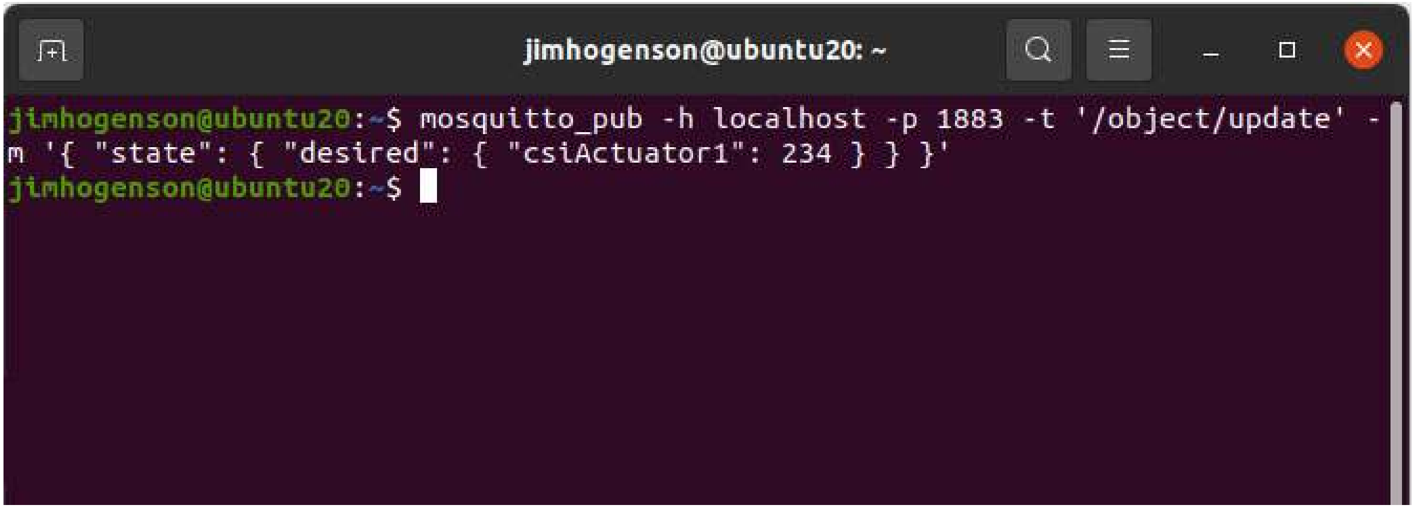
Atr #	Local Object	Attribute (Object) Name	Pub	Pub Ack	Sub	Periodic	Publish Condition	Obj	Threshold
1	AI 1	csiSensor1	☑	□	□	0	changed by	□	1.00000
2	AI 2	csiSensor2	☑	□	□	0	changed by	□	1.00000
3	AI 3	csiSensor3	☑	□	□	0	changed by	□	1.00000
4	AI 4	csiSensor4	☑	□	□	0	changed by	□	1.00000
5	AI 5	csiSensor5	☑	□	□	0	changed by	□	1.00000
6	BO 1	csiActuator1	□	□	☑	0	n/a	□	0.00000
7	BO 2	csiActuator2	□	□	☑	0	n/a	□	0.00000
8	None		□	□	□	0	n/a	□	0.00000

The following screen shot shows using the mosquitto_sub utility to subsrcribe to the default topic for testing our IoT device’s publish to that topic. The mosquitto_sub is among the utilities installed when you install Mosquitto on your Linux server. Refer to mosquitto.org Documentation for further instructions on using mosquitto_sub.



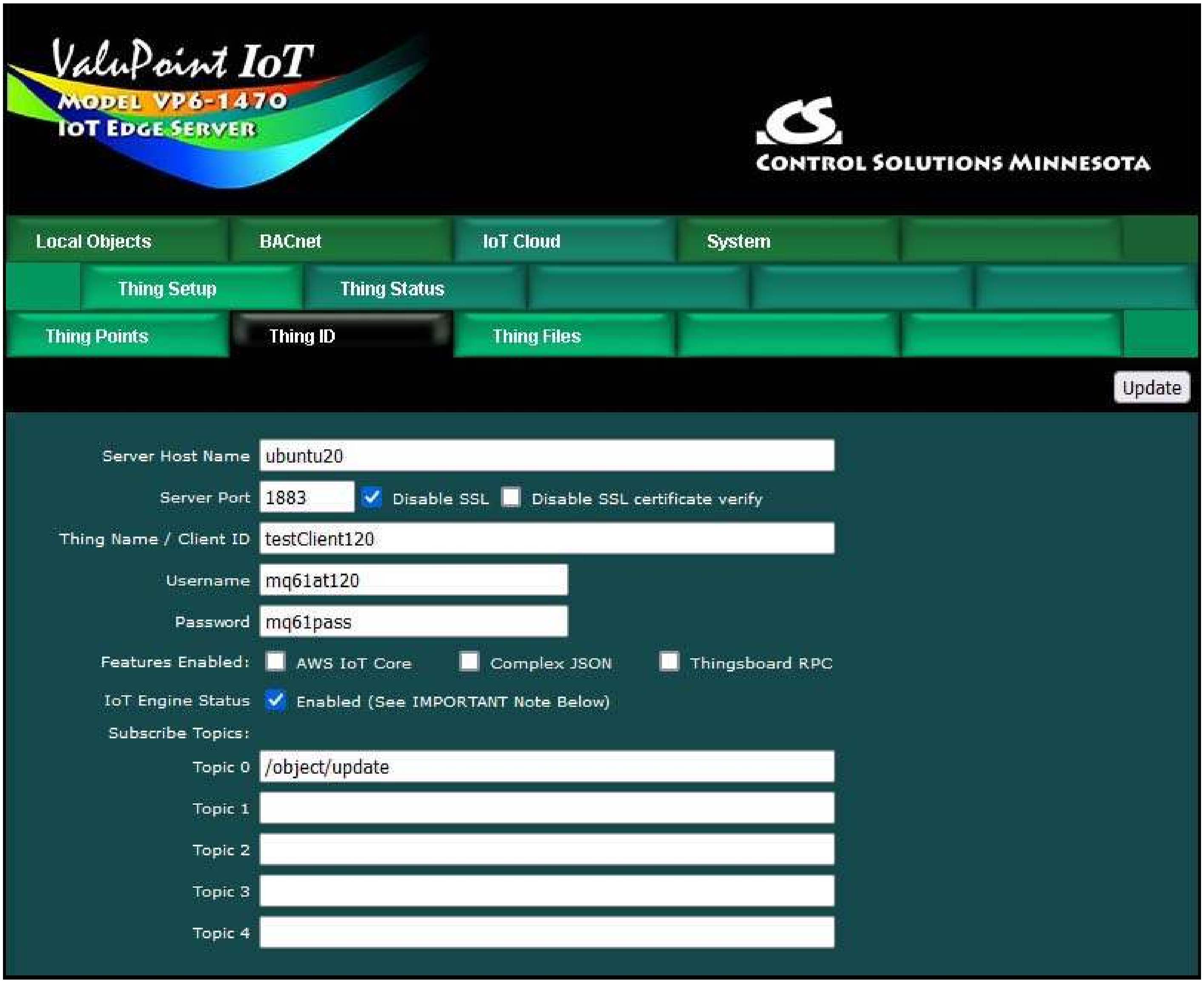
```
/object/update { "state": { "desired": { "csiActuator1": 777 } } }
/object/update { "state": { "desired": { "csiActuator1": 777 } } }
^Cjimhogenson@ubuntu20:~$ mosquitto_sub -h localhost -p 1883 -t '/object/update'
 -v --username ubuntu --pw ub20pass
/object/update { "state": { "desired": { "csiActuator1": 777 } } }
/object/update { "state": { "desired": { "csiActuator1": 777 } } }
^Cjimhogenson@ubuntu20:~$ mosquitto_sub -h localhost -p 1883 -t '/default' -v --
username ubuntu --pw ub20pass
/default { "state": { "reported": { "csiSensor1": 0.00, "csiSensor2": 11.00000,
"csiSensor3": 0.00, "csiSensor4": 0.00, "csiSensor5": 0.00, "csiSensor10": "IoT
sensor state 1", "LocalTime": "2022-10-13T09:17:53-05:00" } } }
/default { "state": { "reported": { "csiSensor1": 0.00, "csiSensor2": 6.000000,
"csiSensor3": 0.00, "csiSensor4": 0.00, "csiSensor5": 0.00, "csiSensor10": "IoT
sensor state 1", "LocalTime": "2022-10-17T09:33:10-05:00" } } }
/default { "state": { "reported": { "csiSensor1": 0.00, "csiSensor2": 2.000000,
"csiSensor3": 0.00, "csiSensor4": 0.00, "csiSensor5": 0.00, "csiSensor10": "IoT
sensor state 1", "LocalTime": "2022-10-17T09:41:55-05:00" } } }
/default { "state": { "reported": { "csiSensor1": 0.00, "csiSensor2": 9.000000,
"csiSensor3": 0.00, "csiSensor4": 0.00, "csiSensor5": 0.00, "csiSensor10": "IoT
sensor state 1", "LocalTime": "2022-10-17T09:42:03-05:00" } } }
/default { "state": { "reported": { "csiSensor1": 0.00, "csiSensor2": 0.00, "csi
Sensor3": 0.00, "csiSensor4": 0.00, "csiSensor5": 0.00, "csiSensor10": "IoT sens
or state 1", "LocalTime": "2022-10-17T09:42:17-05:00" } } }
```

The following screen shot shows an example of publishing from the test client to our IoT device using the mosquitto_pub utility. This example was created prior to adding username/password to this instance of the broker.



```
jimhogenson@ubuntu20:~$ mosquitto_pub -h localhost -p 1883 -t '/object/update' -
m '{ "state": { "desired": { "csiActuator1": 234 } } }'
jimhogenson@ubuntu20:~$
```

The JSON expected by AWS IoT Core is a complex object structure. You have the option of keeping this complex structure, or using "simple" JSON. Some applications may require just simple JSON. To switch to simple JSON, just un-select Complex JSON on the Thing ID page as illustrated below.



Server Host Name: ubuntu20

Server Port: 1883 ☑ Disable SSL □ Disable SSL certificate verify

Thing Name / Client ID: testClient120

Username: mq61at120

Password: mq61pass

Features Enabled: □ AWS IoT Core □ Complex JSON □ Thingsboard RPC

IoT Engine Status: ☑ Enabled (See IMPORTANT Note Below)

Subscribe Topics:

Topic 0: /object/update

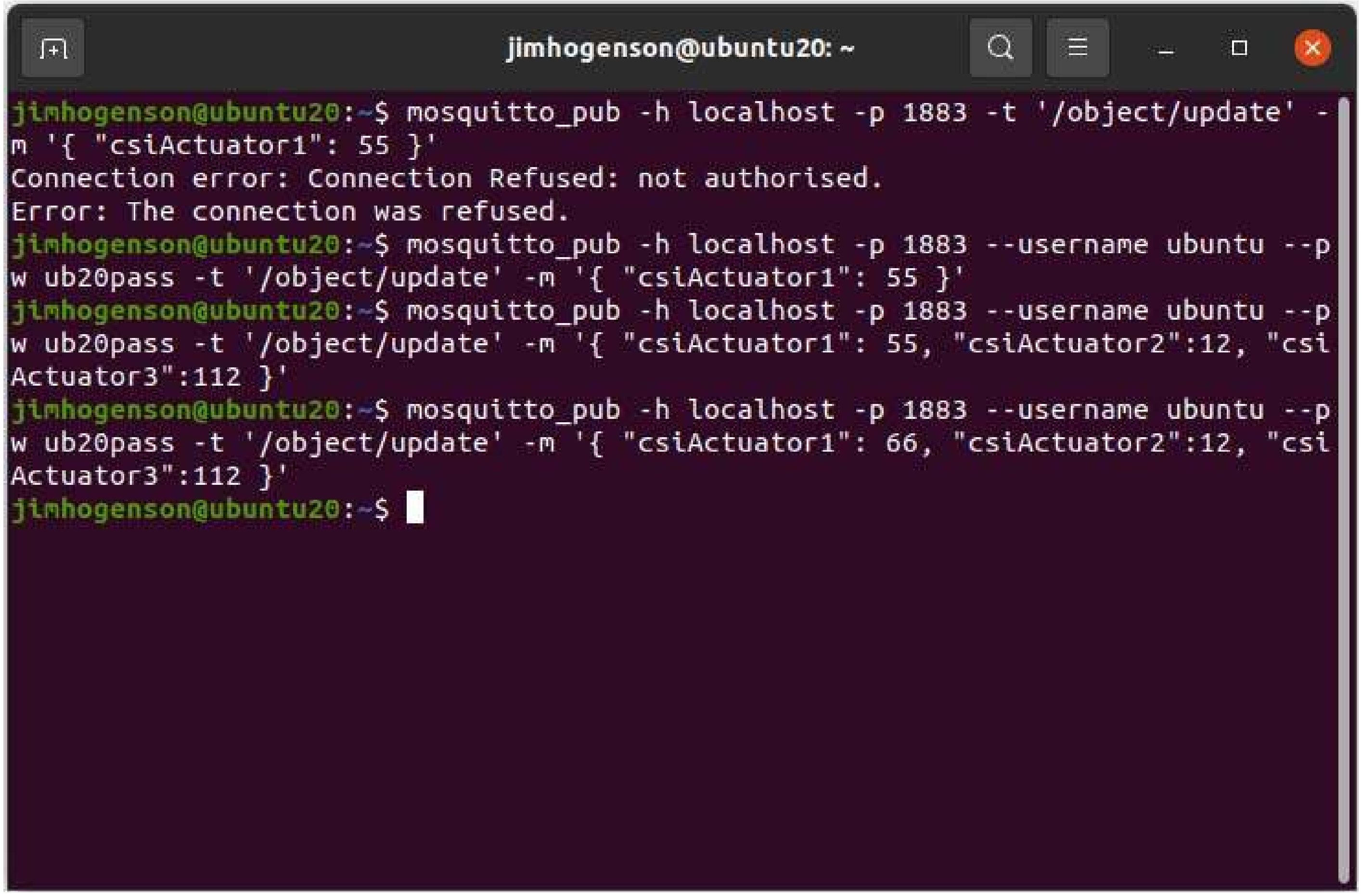
Topic 1:

Topic 2:

Topic 3:

Topic 4:

The screen shot below shows publishing "simple" JSON to the broker which in turn will forward this message to the MQ device. Compare this to the mosquitto_pub example above.

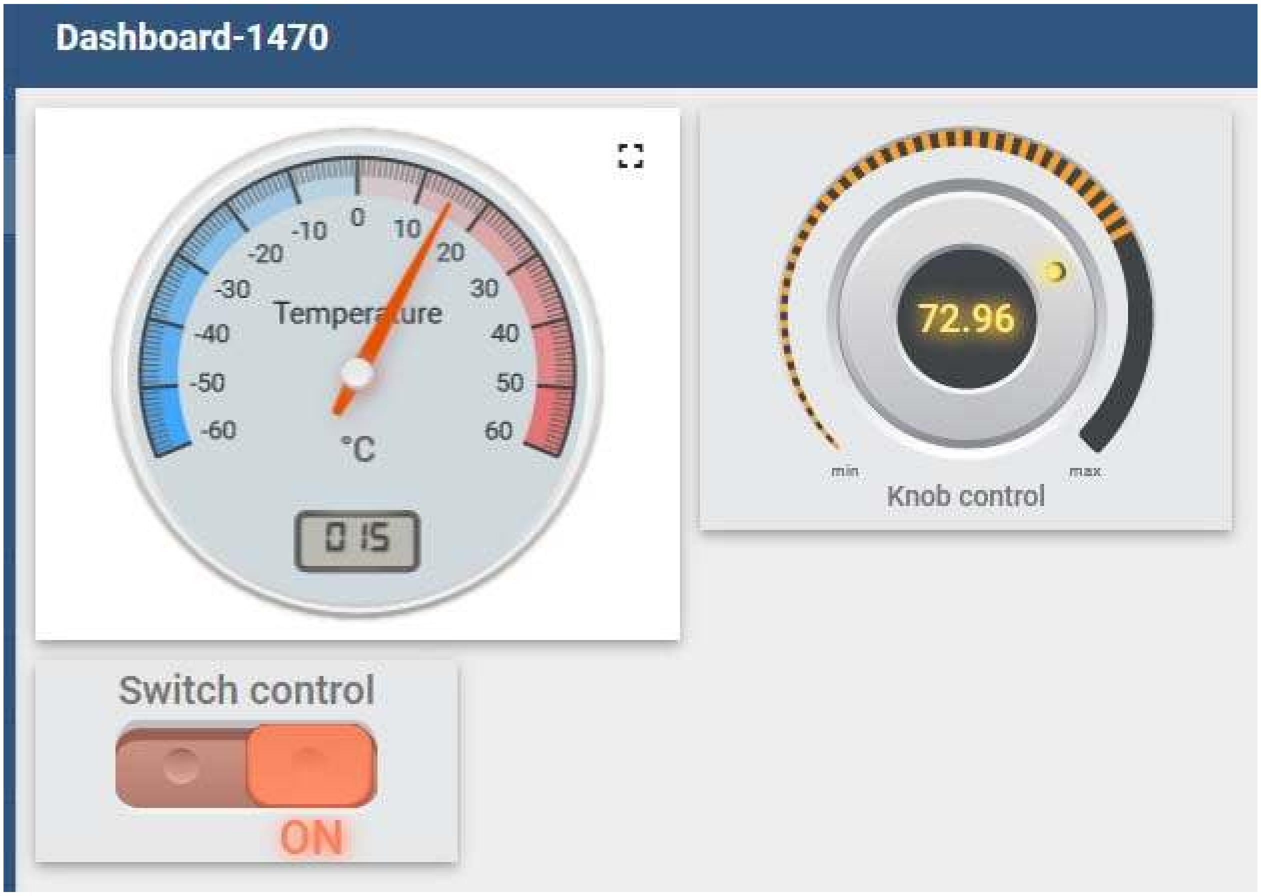


```
jimhogenson@ubuntu20:~$ mosquitto_pub -h localhost -p 1883 -t '/object/update' -
m '{ "csiActuator1": 55 }'
Connection error: Connection Refused: not authorised.
Error: The connection was refused.
jimhogenson@ubuntu20:~$ mosquitto_pub -h localhost -p 1883 --username ubuntu --p
w ub20pass -t '/object/update' -m '{ "csiActuator1": 55 }'
jimhogenson@ubuntu20:~$ mosquitto_pub -h localhost -p 1883 --username ubuntu --p
w ub20pass -t '/object/update' -m '{ "csiActuator1": 55, "csiActuator2":12, "csi
Actuator3":112 }'
jimhogenson@ubuntu20:~$ mosquitto_pub -h localhost -p 1883 --username ubuntu --p
w ub20pass -t '/object/update' -m '{ "csiActuator1": 66, "csiActuator2":12, "csi
Actuator3":112 }'
jimhogenson@ubuntu20:~$
```

17. Using Thingsboard.io MQTT

17.1 Introduction to Thingsboard

Thingsboard provides a number of capabilities including interactive real time dashboards. Here is a screen shot of the demo dashboard that will be built as you follow through this section of this user guide.



We refer to "MQTT device" throughout the discussion that follows because the discussion is generic to any of the Control Solutions products that have MQTT capability including the ValuPoint IoT Edge Servers and the Babel Buster IoT gateways like BB3-6101-MQ.

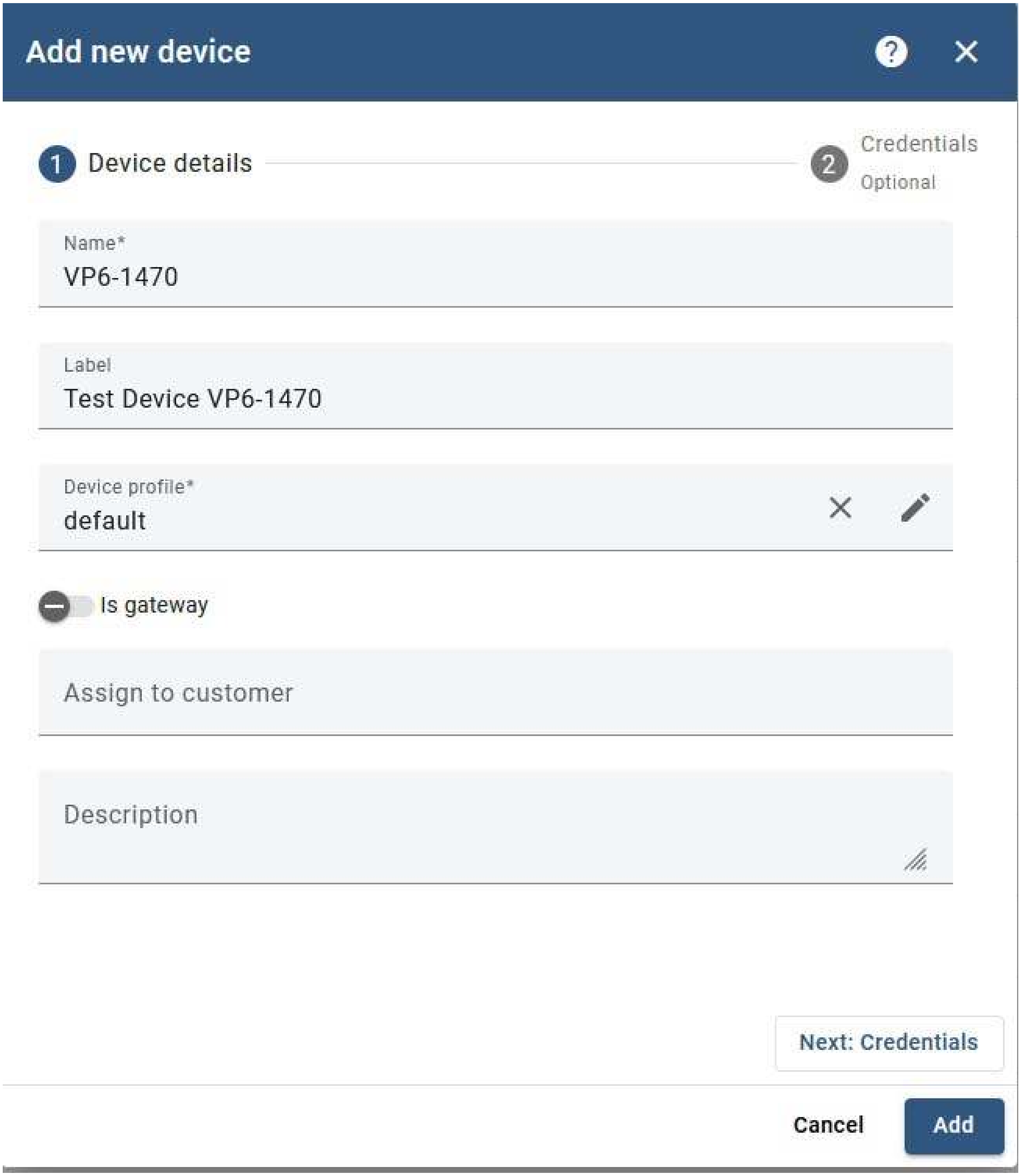
Start by signing up for a Thingsboard account (no cost) here: https://demo.thingsboard.io/signup

Once you have an account, you can log in here: https://demo.thingsboard.io/login

The home page contains a number of links to tutorials and documentation.

17.2 Adding a Device

To add a new device, select the Devices page (under Entities) from the list on the left. Then click "+" in upper right corner and "Add new device".



Add new device

1 Device details

2 Credentials Optional

Name*
VP6-1470

Label
Test Device VP6-1470

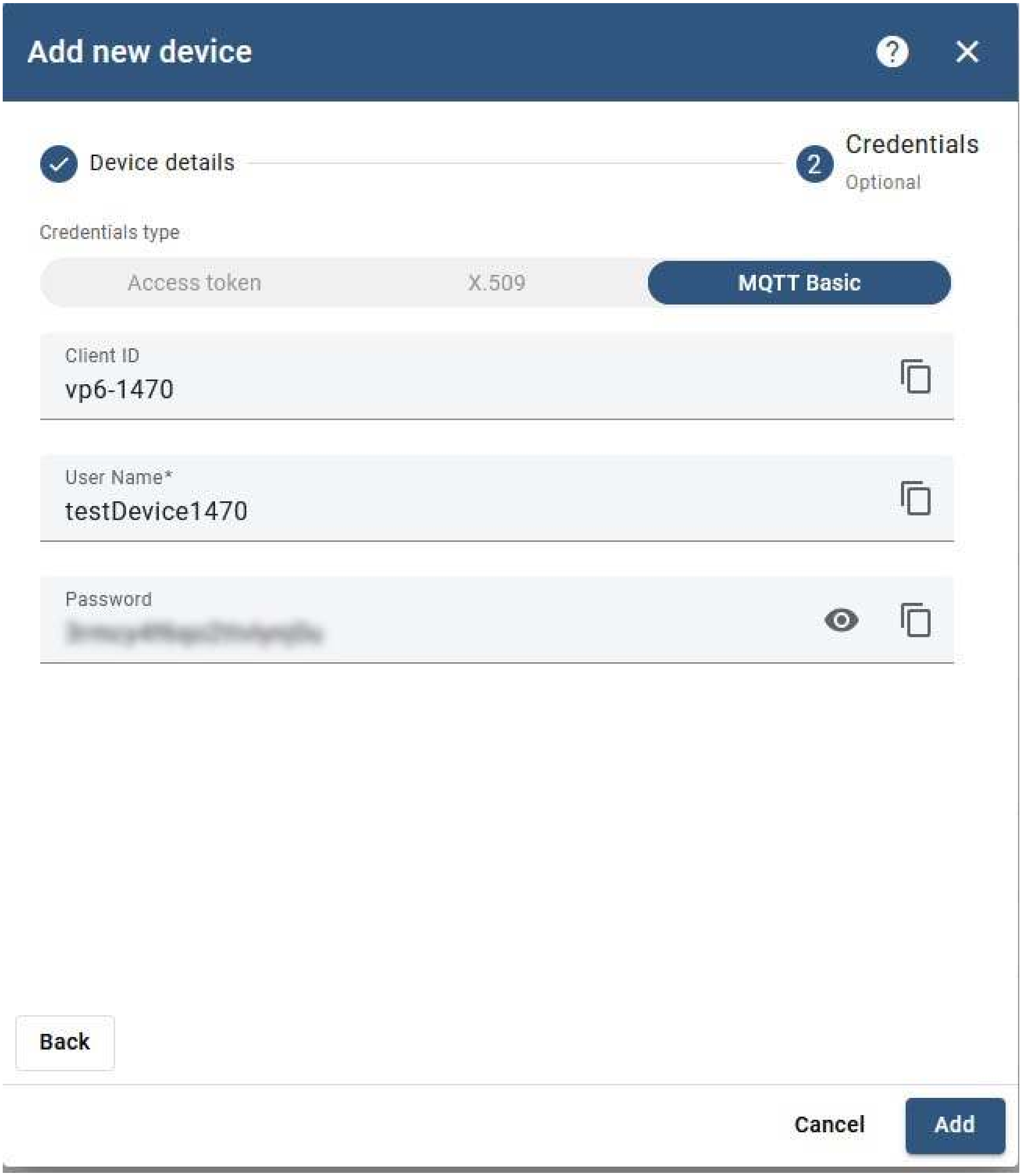
Device profile*
default

Is gateway

Assign to customer

Description

Give the device a name and label, and select the default profile. Click "Next: Credentials" in the lower right.



Add new device

Credentials type: MQTT Basic

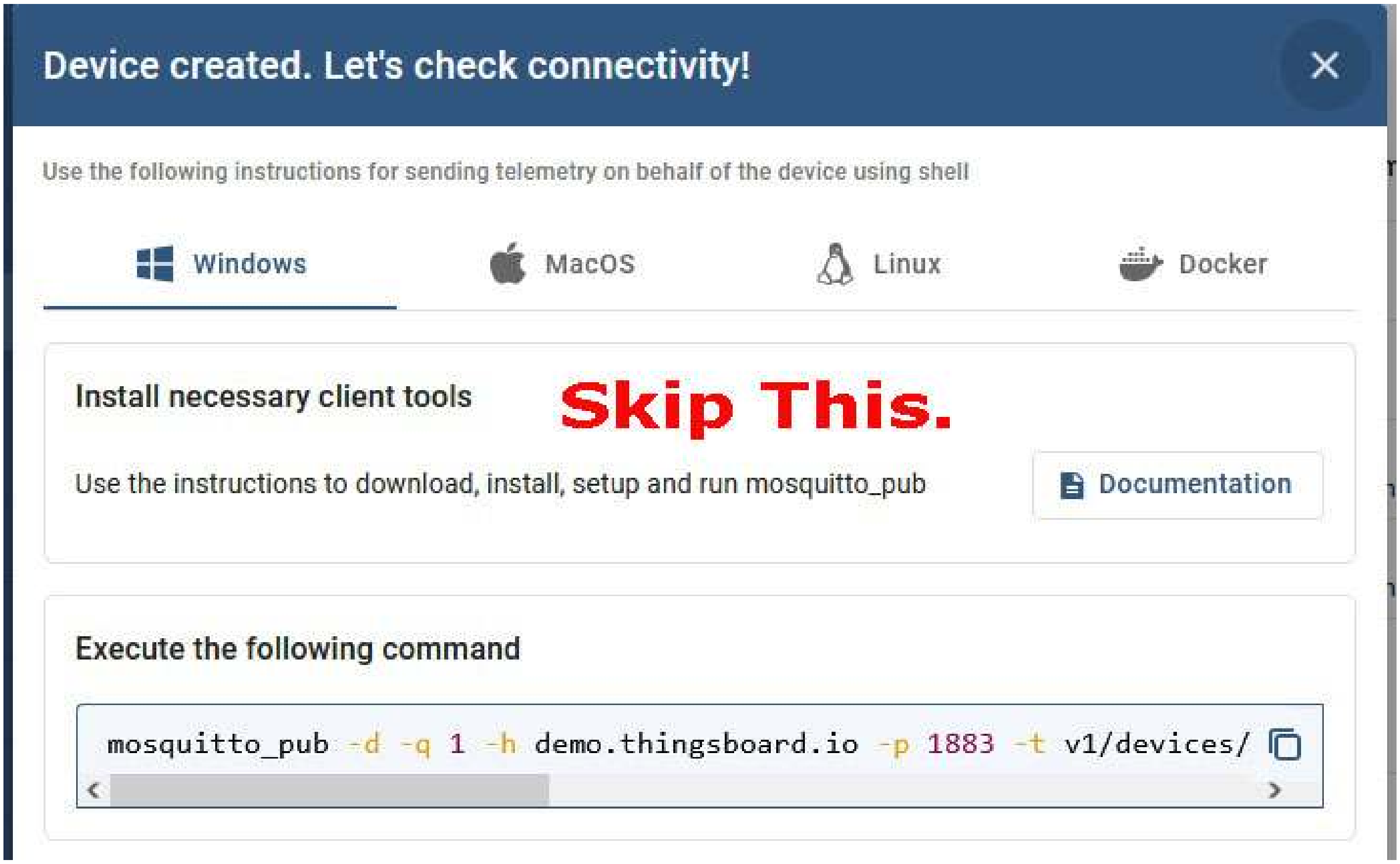
Client ID: vp6-1470

User Name*: testDevice1470

Password: [redacted]

On the Credentials page, select MQTT Basic. You can convert to more secure methods later if desired. Provide a client ID, and this must be unique across all of your devices as this ID is how Thingsboard will identify where data is coming from. Provide a username and password for this device. This username and password will be used by the device, not for logging into your Thingsboard account. Do not use your account login credentials here.

Click the Add button. This now adds the new device to your account. Thingsboard will automatically take you to the following screen. Skip this. You will not be using your PC to connect to Thingsboard. You will be using your MQTT device and it already has all the software it needs.



Device created. Let's check connectivity!

Use the following instructions for sending telemetry on behalf of the device using shell

Install necessary client tools

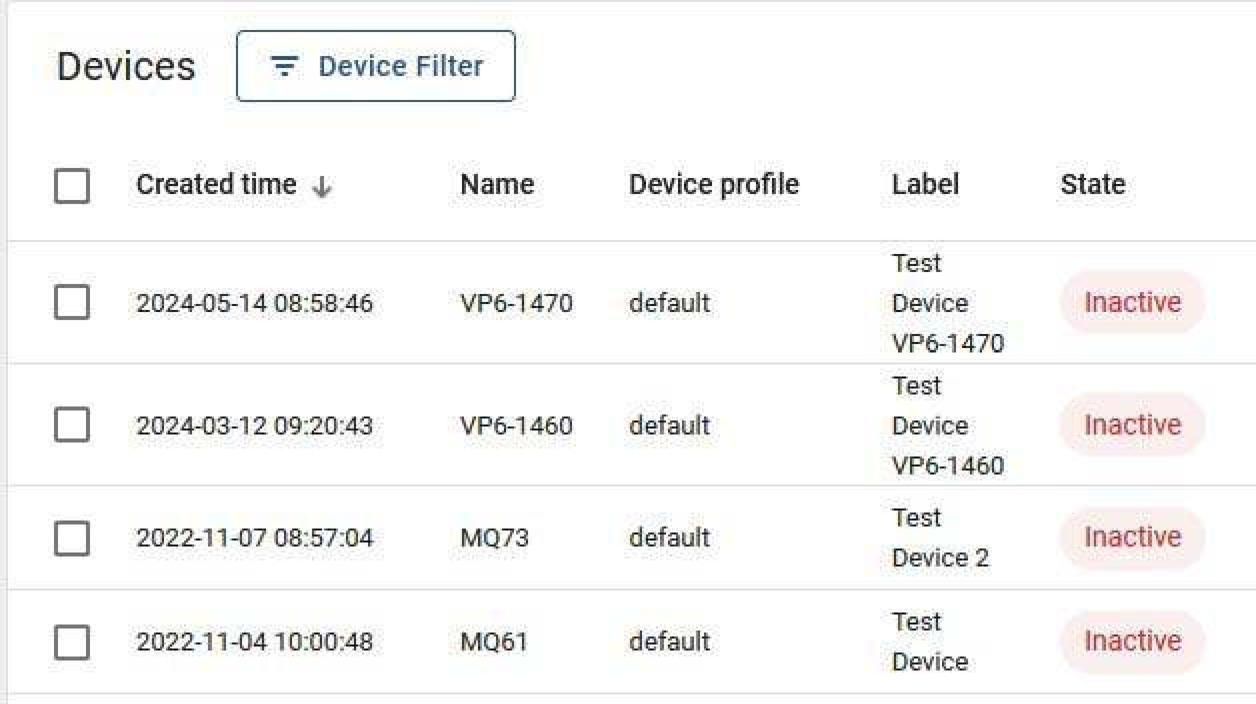
Skip This.

Use the instructions to download, install, setup and run mosquitto_pub

Execute the following command

```
mosquitto_pub -d -q 1 -h demo.thingsboard.io -p 1883 -t v1/devices/
```

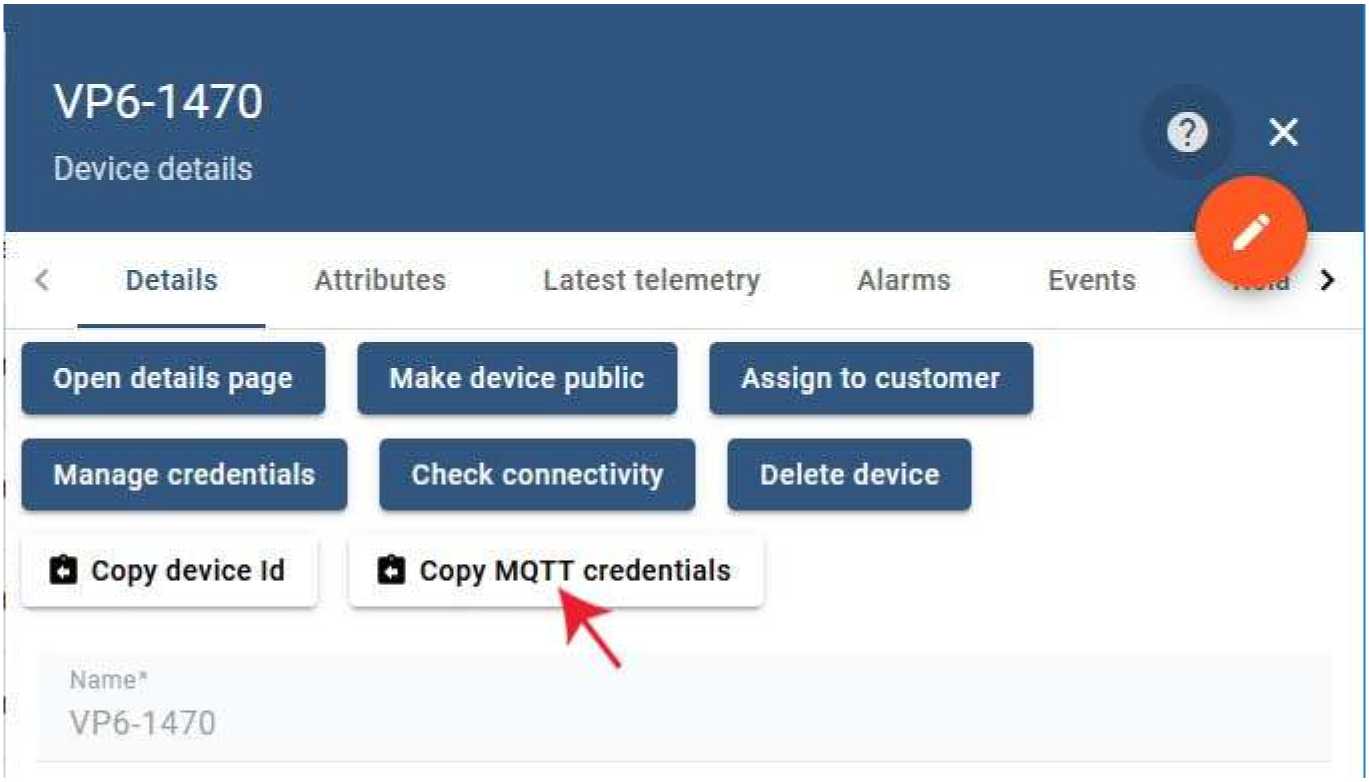
The newly added device will now show up on your device list with the newest device typically at the top. Thingsboard automatically creates some demo devices for you when you first create your account. You can ignore those.



Devices

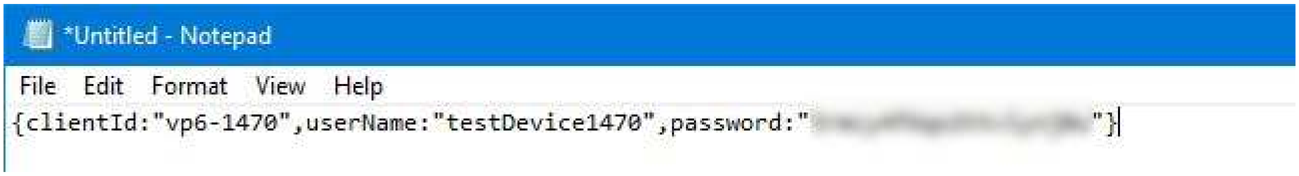
□	Created time ↓	Name	Device profile	Label	State
□	2024-05-14 08:58:46	VP6-1470	default	Test Device VP6-1470	Inactive
□	2024-03-12 09:20:43	VP6-1460	default	Test Device VP6-1460	Inactive
□	2022-11-07 08:57:04	MQ73	default	Test Device 2	Inactive
□	2022-11-04 10:00:48	MQ61	default	Test Device	Inactive

The State will be either Inactive or Active. Whatever it is, click on the state to see device details.

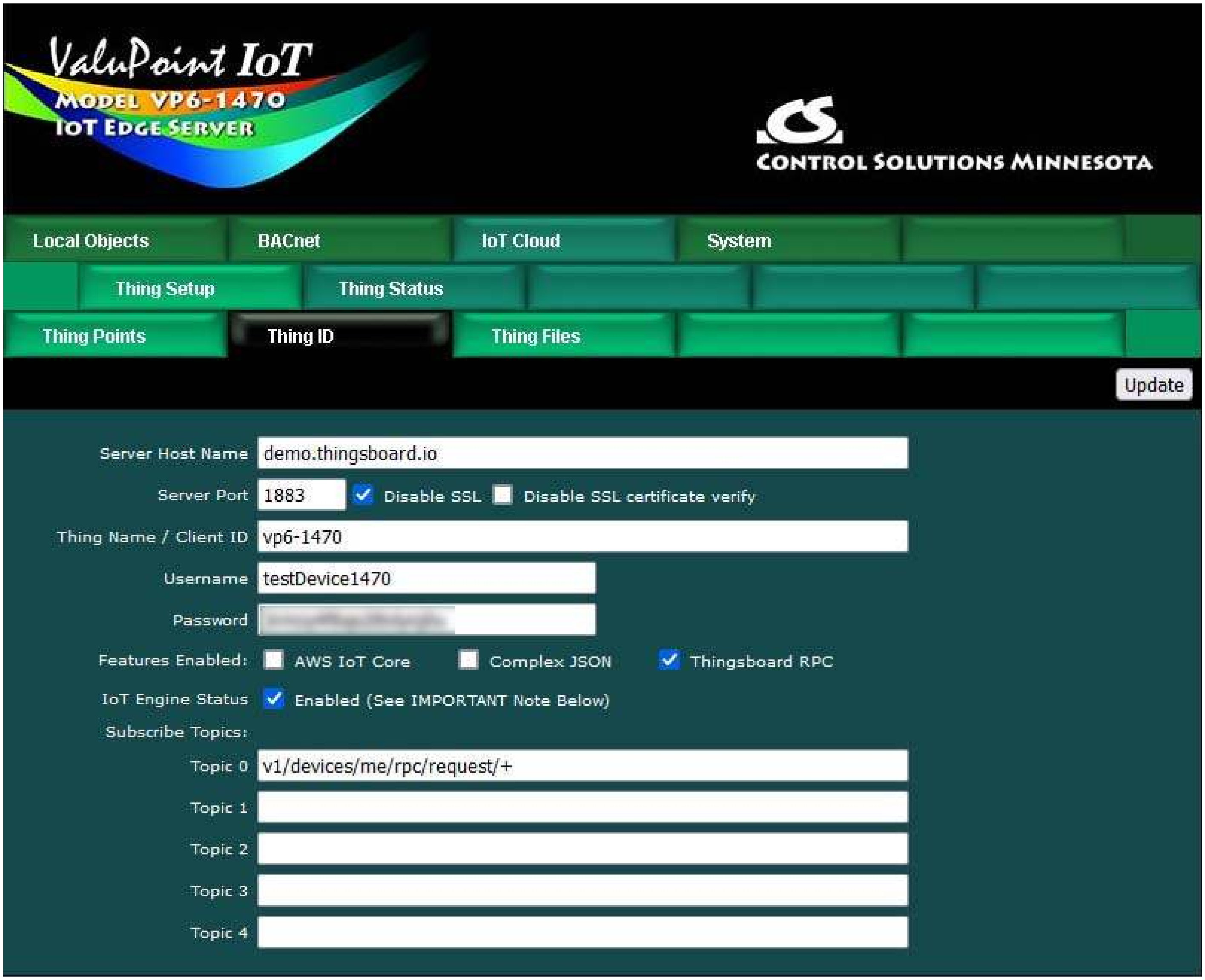


Click on Copy MQTT credentials, and paste the result into a temporary text document created with Notepad or equivalent. You will use these credentials shortly. You can skip this copying if you had already written down all of the credentials when you first entered them above, but if you copy, you can also paste into the web page for the device.

The credentials string you will get by the Copy is illustrated below.



```
{clientId:"vp6-1470",userName:"testDevice1470",password:"[redacted]"}
```



Server Host Name: demo.thingsboard.io

Server Port: 1883 ☑ Disable SSL □ Disable SSL certificate verify

Thing Name / Client ID: vp6-1470

Username: testDevice1470

Password: [redacted]

Features Enabled: □ AWS IoT Core □ Complex JSON ☑ Thingsboard RPC

IoT Engine Status ☑ Enabled (See IMPORTANT Note Below)

Subscribe Topics:

Topic 0: v1/devices/me/rpc/request/+

Topic 1:

Topic 2:

Topic 3:

Topic 4:

Log into your VP6-1470 and go to the Thing ID page. For MQTT Basic credentials, the following settings will always be the same:

* Server Host Name: demo.thingsboard.io

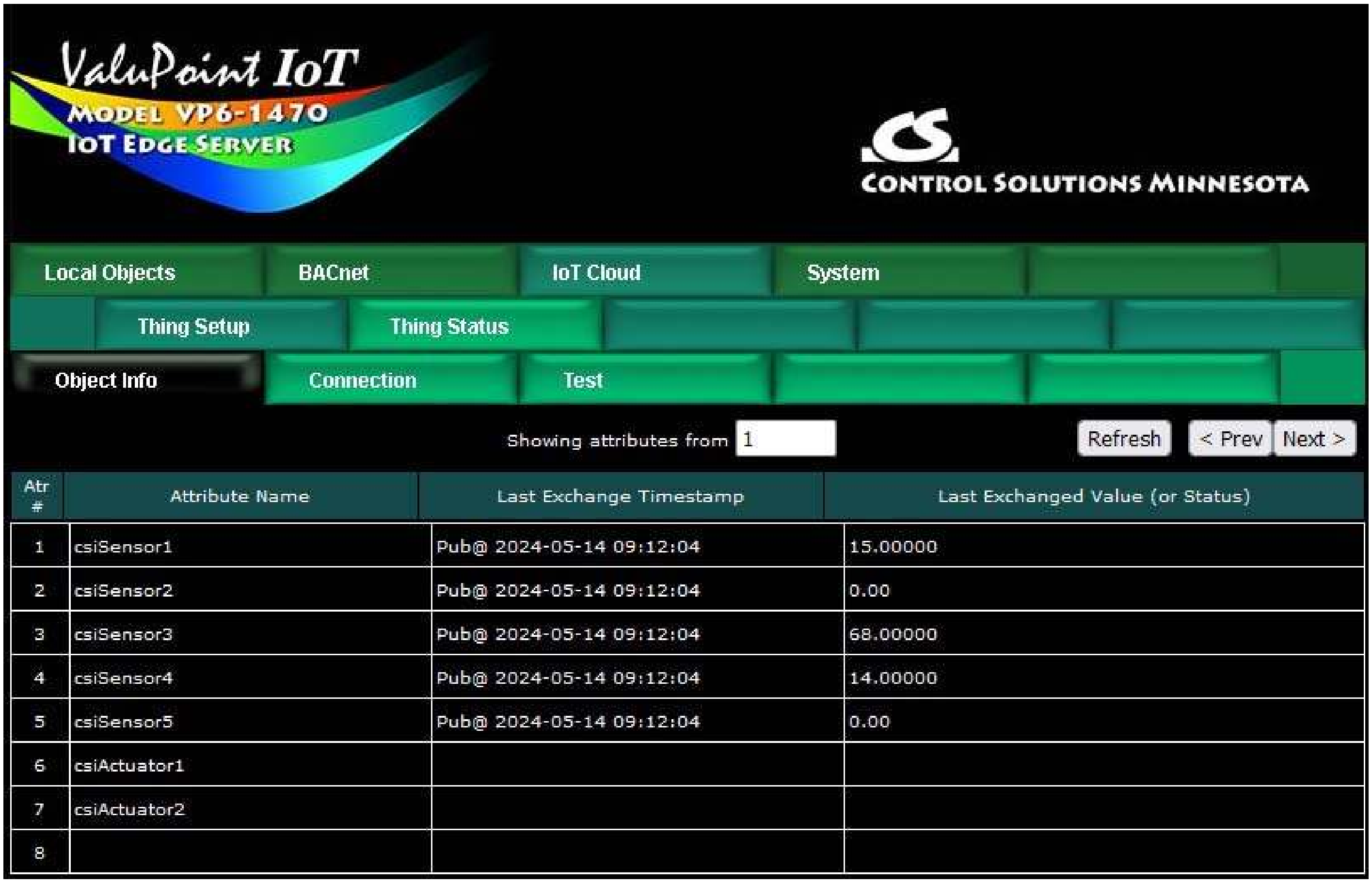
* Server Port: 1883, Disable SSL

* Unselect AWS IoT Core and Complex JSON. Select Thingsboard RPC

Enter your device’s client ID, username, and password.

Leave the default topic illustrated above as is. Click Update. If you will not be doing any additional configuration right now, go to the File Manager page and save your XML file. Otherwise continue with setup and save the XML later. Just remember to save the XML file at some point as this is where your Thing ID information is stored.

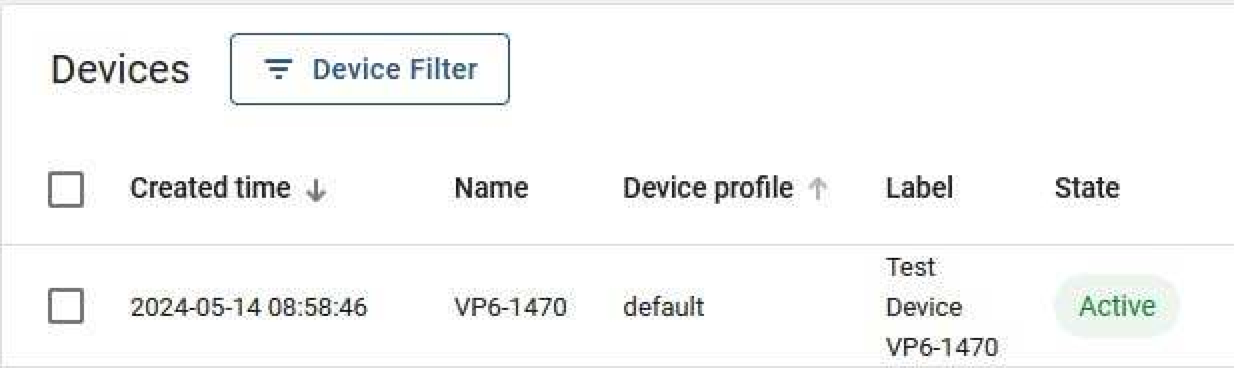
Once your “Thing” is online, and it publishes for the first time, you can verify the publish on the Object Info page.



Showing attributes from 1

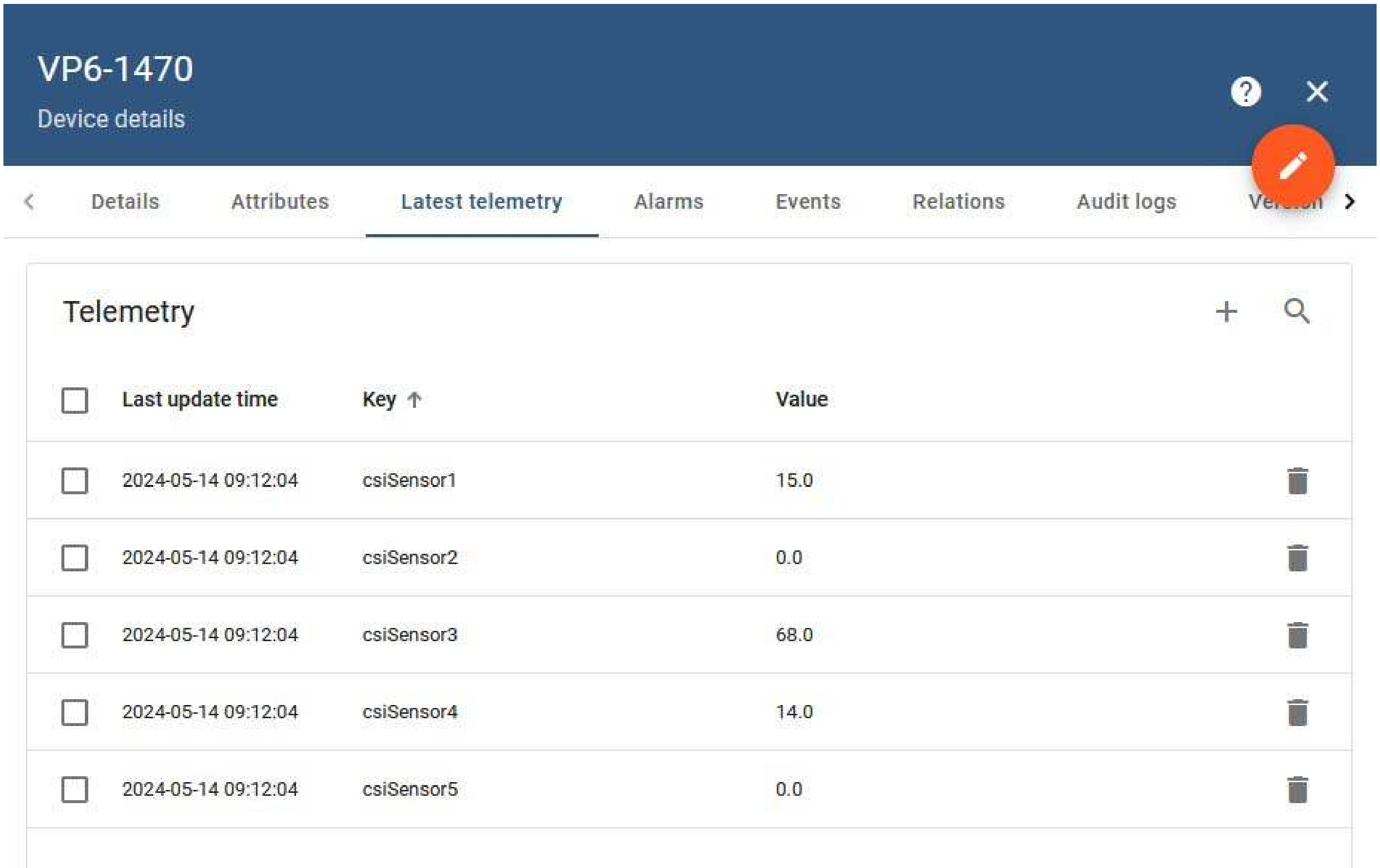
Atr #	Attribute Name	Last Exchange Timestamp	Last Exchanged Value (or Status)
1	csiSensor1	Pub@ 2024-05-14 09:12:04	15.00000
2	csiSensor2	Pub@ 2024-05-14 09:12:04	0.00
3	csiSensor3	Pub@ 2024-05-14 09:12:04	68.00000
4	csiSensor4	Pub@ 2024-05-14 09:12:04	14.00000
5	csiSensor5	Pub@ 2024-05-14 09:12:04	0.00
6	csiActuator1		
7	csiActuator2		
8			

As soon as Thingsboard sees data from your device, the state will change to Active as illustrated below.



□	Created time ↓	Name	Device profile ↑	Label	State
□	2024-05-14 08:58:46	VP6-1470	default	Test Device VP6-1470	Active

Click on “Active” and you will see your device details. Select the Telemetry tab and you will see the data most recently sent.



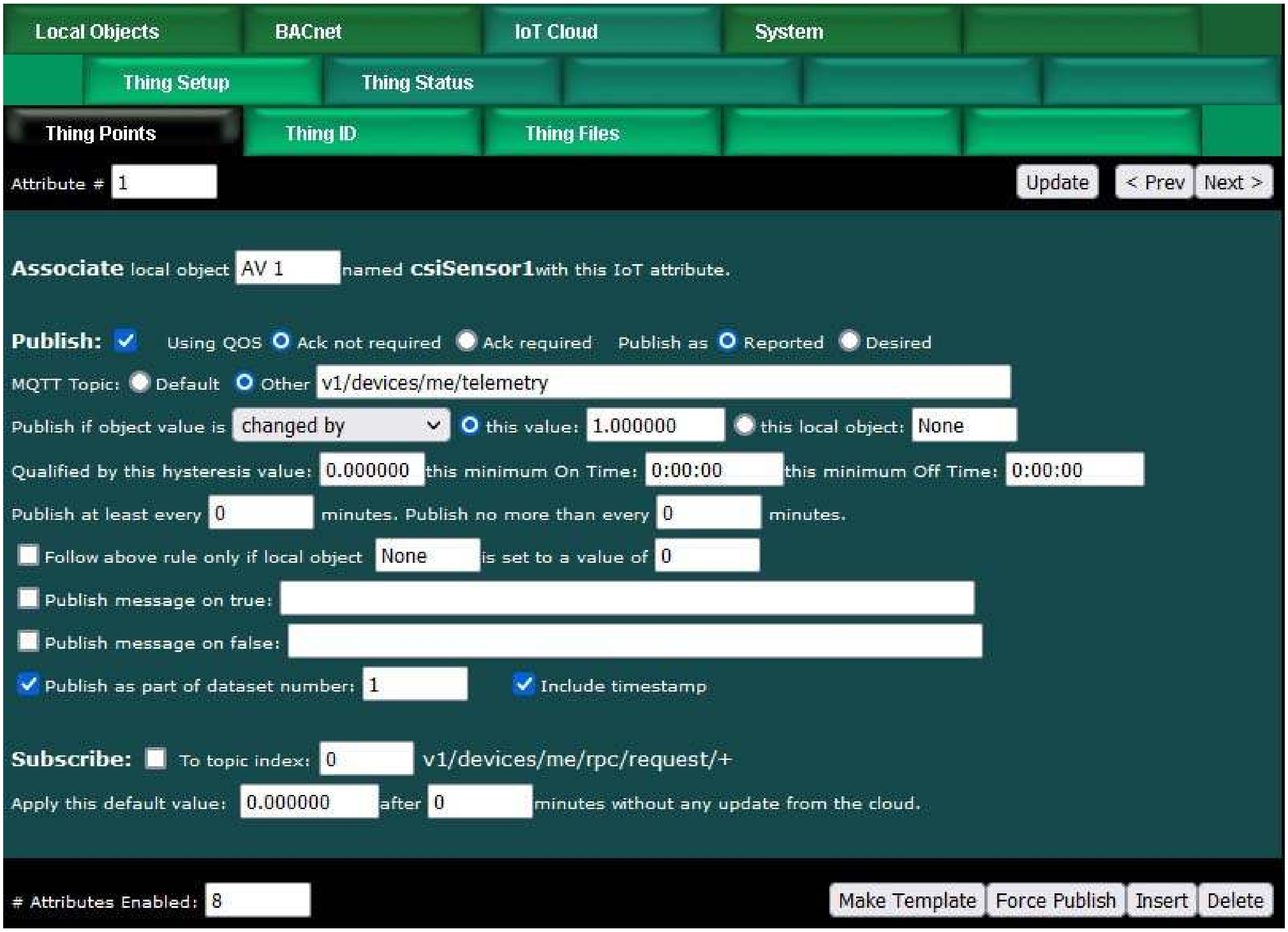
VP6-1470

Device details

Telemetry

□	Last update time	Key ↑	Value
□	2024-05-14 09:12:04	csiSensor1	15.0
□	2024-05-14 09:12:04	csiSensor2	0.0
□	2024-05-14 09:12:04	csiSensor3	68.0
□	2024-05-14 09:12:04	csiSensor4	14.0
□	2024-05-14 09:12:04	csiSensor5	0.0

Configuring the Thing Points to publish to Thingsboard follows all the same guidelines as for publishing to AWS. The only difference is the MQTT Topic. To publish sensor data that you wish to display on a dashboard, publish to the topic “v1/devices/me/telemetry”.



Attribute # 1

Associate local object AV 1 named **csiSensor1** with this IoT attribute.

Publish: ☑ Using QOS ● Ack not required ○ Ack required Publish as ● Reported ○ Desired

MQTT Topic: ○ Default ● Other v1/devices/me/telemetry

Publish if object value is changed by ● this value: 1.000000 ○ this local object: None

Qualified by this hysteresis value: 0.000000 this minimum On Time: 0:00:00 this minimum Off Time: 0:00:00

Publish at least every 0 minutes. Publish no more than every 0 minutes.

□ Follow above rule only if local object None is set to a value of 0

□ Publish message on true:

□ Publish message on false:

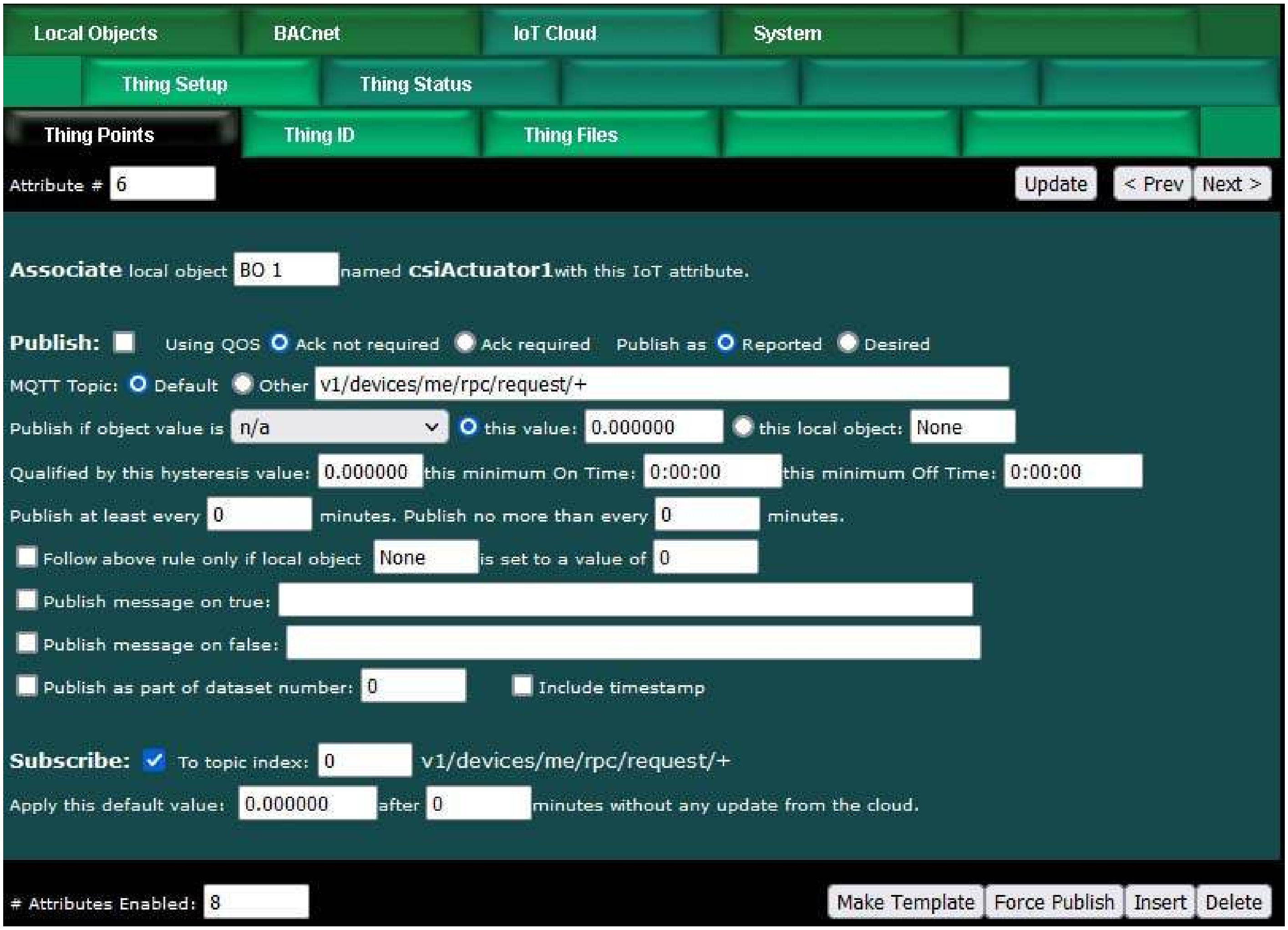
☑ Publish as part of dataset number: 1 ☑ Include timestamp

Subscribe: □ To topic index: 0 v1/devices/me/rpc/request/+

Apply this default value: 0.000000 after 0 minutes without any update from the cloud.

Attributes Enabled: 8

Configuring the Thing Points to subscribe to Thingsboard follows all the same guidelines as for subscribing to AWS. The only difference is the MQTT Topic. To subscribe to a topic that lets you control points from the dashboard, subscribe to the topic “v1/devices/me/rpc/request/+”



Attribute # 6

Associate local object BO 1 named csiActuator1with this IoT attribute.

Publish: □ Using QOS ● Ack not required ○ Ack required Publish as ● Reported ○ Desired

MQTT Topic: ● Default ○ Other v1/devices/me/rpc/request/+

Publish if object value is n/a ● this value: 0.000000 ○ this local object: None

Qualified by this hysteresis value: 0.000000 this minimum On Time: 0:00:00 this minimum Off Time: 0:00:00

Publish at least every 0 minutes. Publish no more than every 0 minutes.

□ Follow above rule only if local object None is set to a value of 0

□ Publish message on true:

□ Publish message on false:

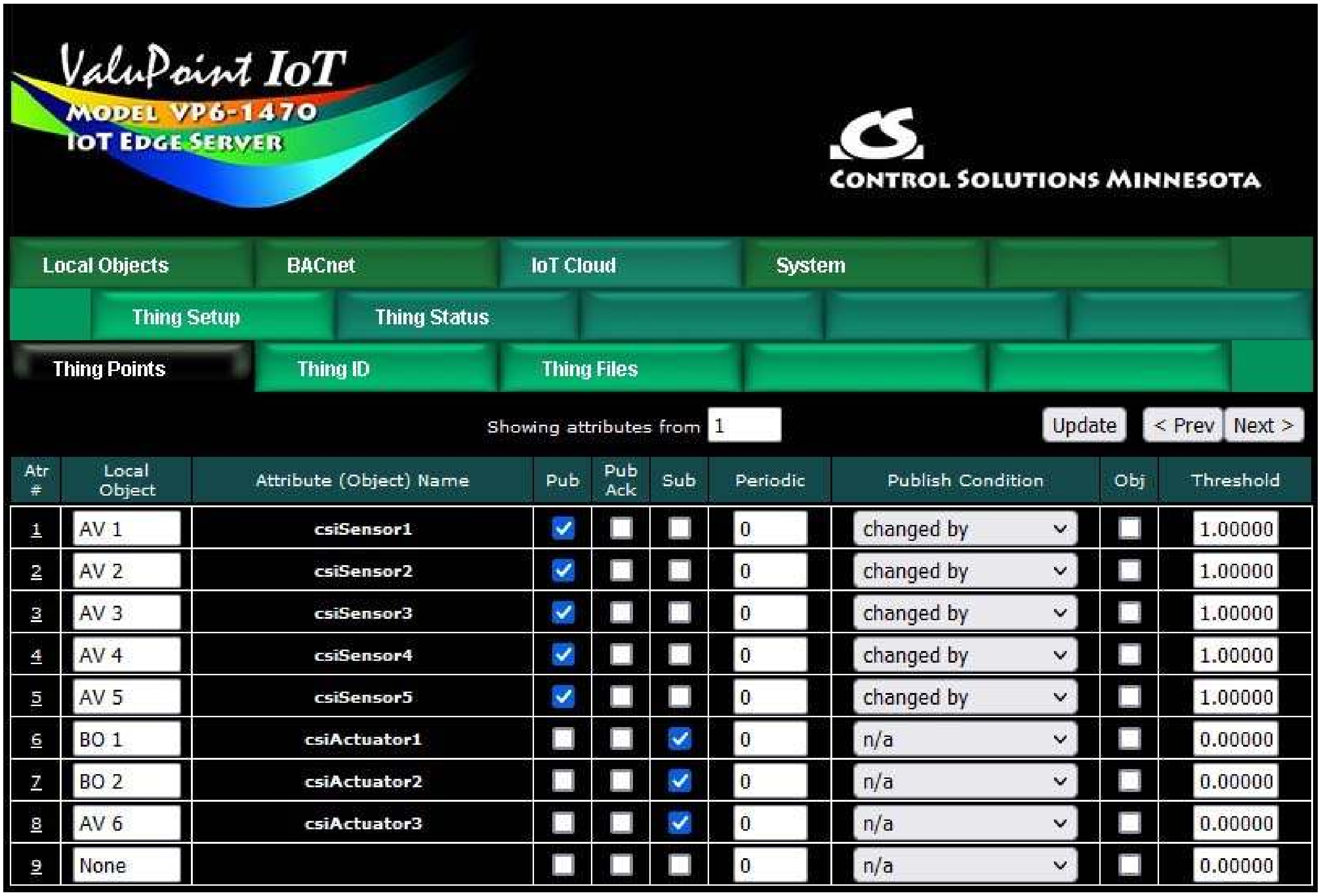
□ Publish as part of dataset number: 0 □ Include timestamp

Subscribe: ☑ To topic index: 0 v1/devices/me/rpc/request/+

Apply this default value: 0.000000 after 0 minutes without any update from the cloud.

Attributes Enabled: 8

For our dashboard demo, we have created the list of points illustrated below. The lower numbered registers are the physical I/O points. The higher numbered registers are mapped to Modbus queries of a remote Modbus device.



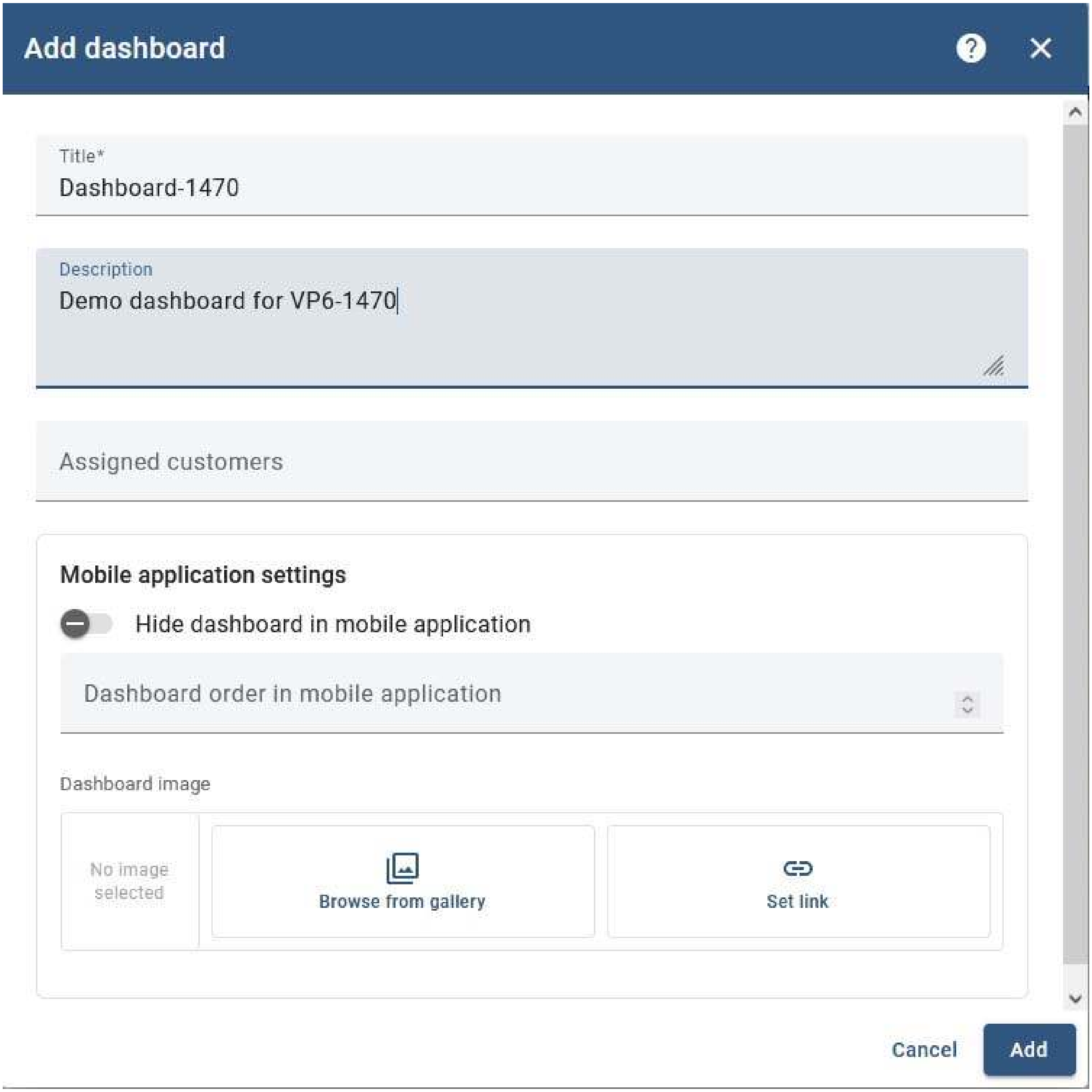
Showing attributes from 1

Atr #	Local Object	Attribute (Object) Name	Pub	Pub Ack	Sub	Periodic	Publish Condition	Obj	Threshold
1	AV 1	csiSensor1	☑	□	□	0	changed by	□	1.00000
2	AV 2	csiSensor2	☑	□	□	0	changed by	□	1.00000
3	AV 3	csiSensor3	☑	□	□	0	changed by	□	1.00000
4	AV 4	csiSensor4	☑	□	□	0	changed by	□	1.00000
5	AV 5	csiSensor5	☑	□	□	0	changed by	□	1.00000
6	BO 1	csiActuator1	□	□	☑	0	n/a	□	0.00000
7	BO 2	csiActuator2	□	□	☑	0	n/a	□	0.00000
8	AV 6	csiActuator3	□	□	☑	0	n/a	□	0.00000
9	None		□	□	□	0	n/a	□	0.00000

17.3 Creating a Dashboard

Click on Dashboard near the top of the list of menu items on the left in your Thingsboard account. You will find a number of example dashboard provided by Thingsboard. Feel free to look around.

To create your own dashboard, click the "+" icon in the upper right corner of the Dashboard page, and select Create New Dashboard. Give the dashboard a name (and description, optional). You don't need to do anything else at this point other than click Add.



Add dashboard

Title*
Dashboard-1470

Description
Demo dashboard for VP6-1470

Assigned customers

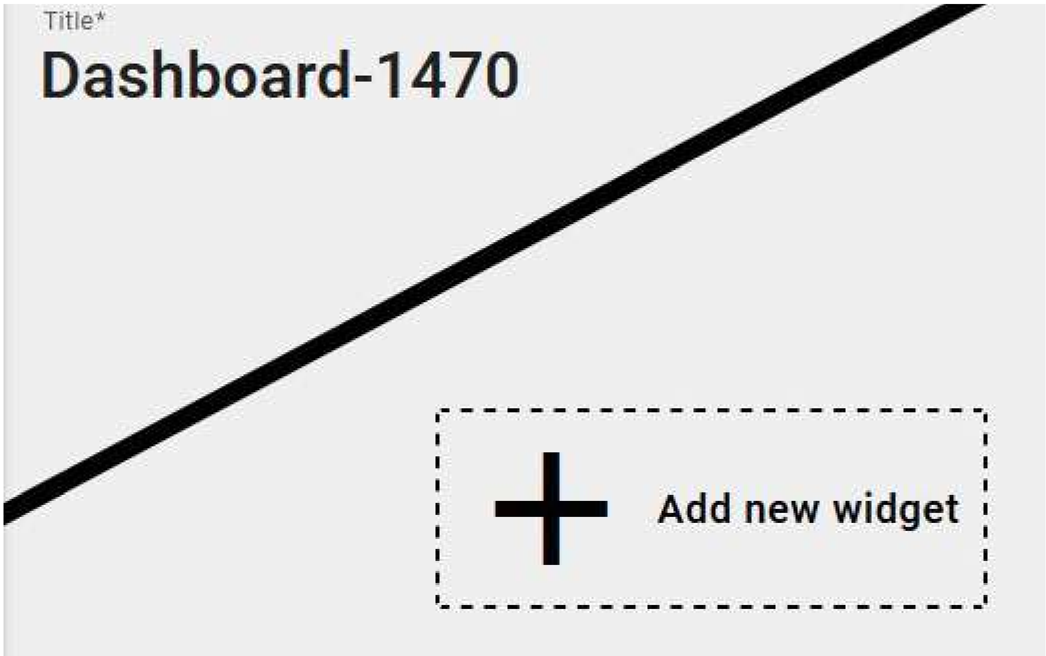
Mobile application settings

Hide dashboard in mobile application

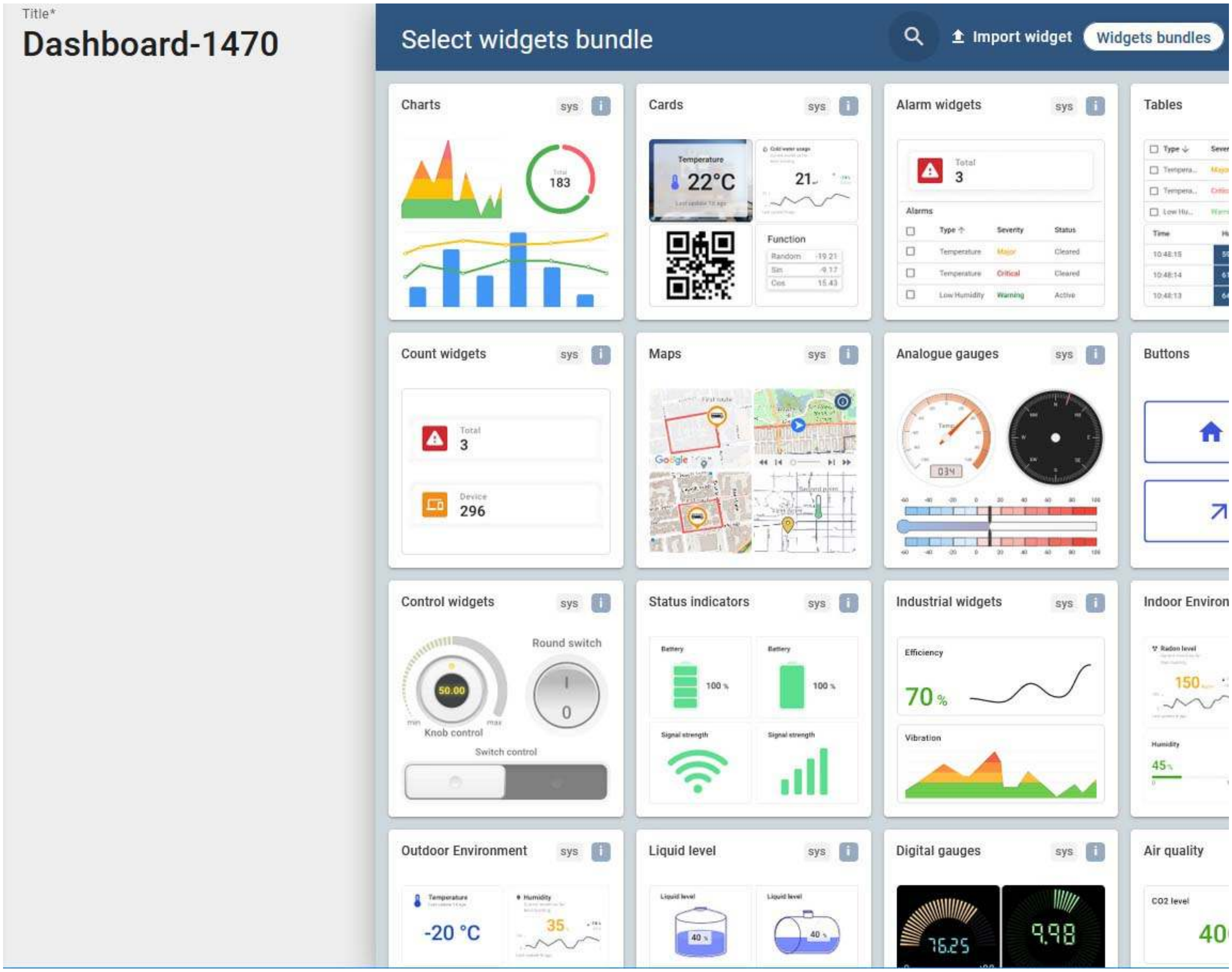
Dashboard order in mobile application

Dashboard image

As soon as you click Add, you will see a mostly blank page with "Add new widget" in the middle. Click that add button.

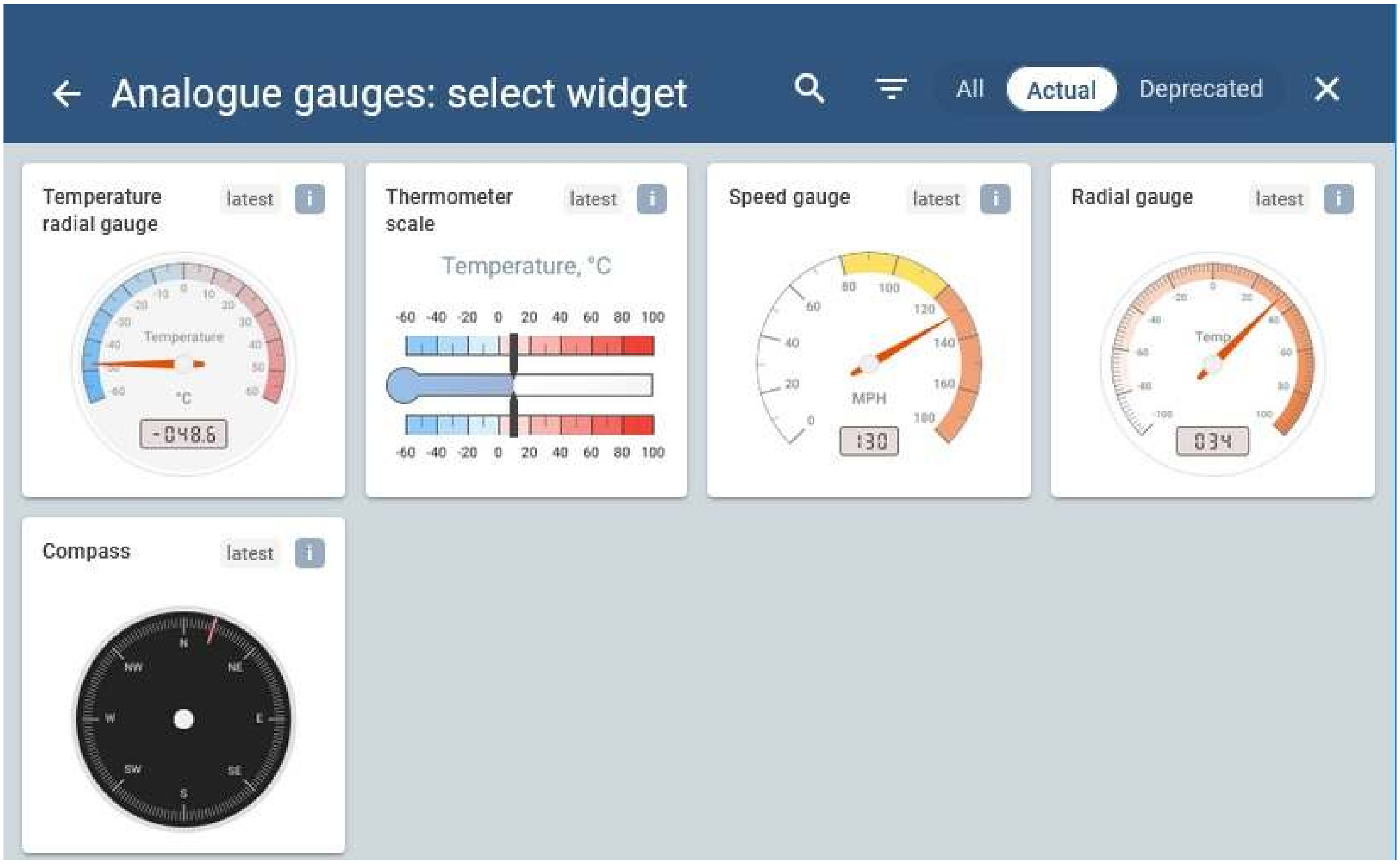


As soon as you click the Add widget, you will see a screen of categories of widgets available. There are many widgets to pick from.

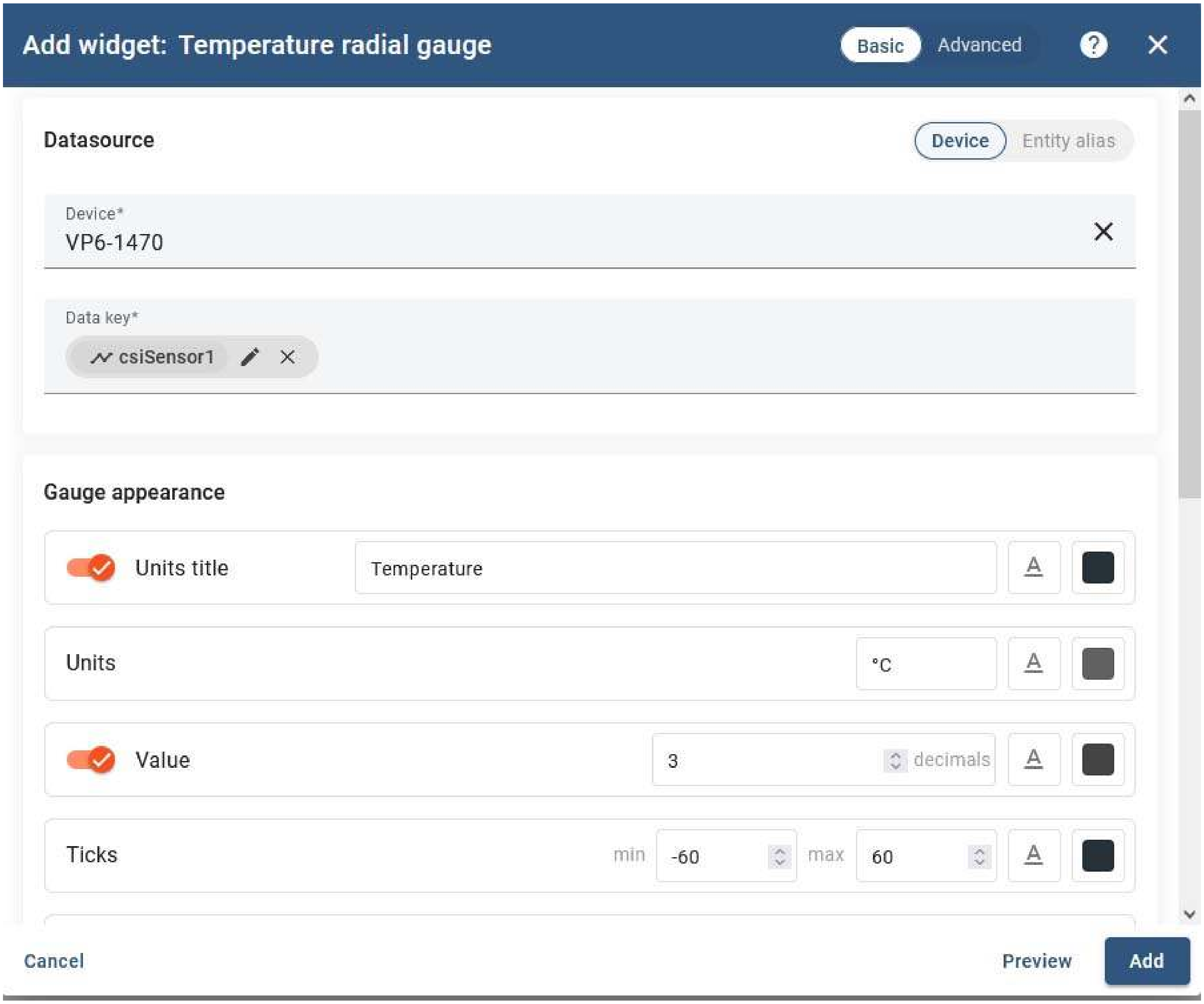


17.4 Adding a Sensor Widget

Click Add widget. For our demo here, we will select Analogue gauges. After clicking that icon (illustrated above), the screen below will appear. Select the gauge type you desire.



We are selecting the first gauge, Temperature, for this demo.



Add widget: Temperature radial gauge

Datasource

Device*
VP6-1470

Data key*
csiSensor1

Gauge appearance

Units title: Temperature

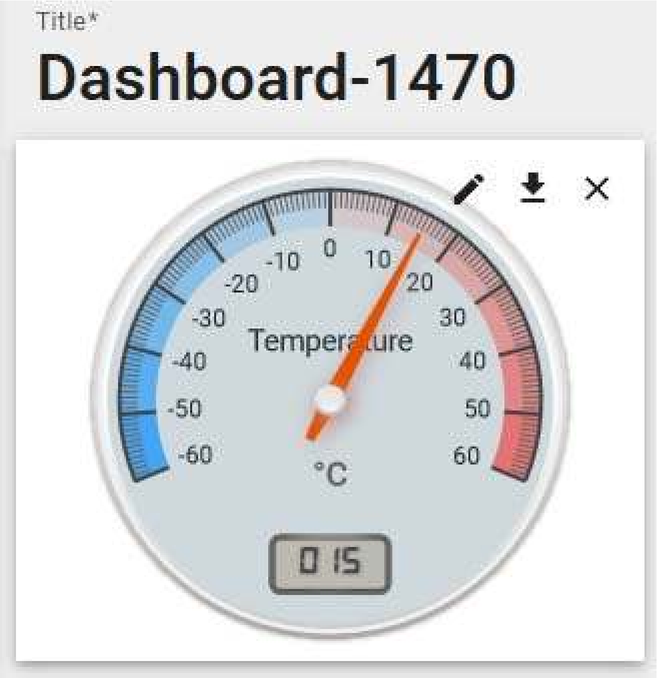
Units: °C

Value: 3 decimals

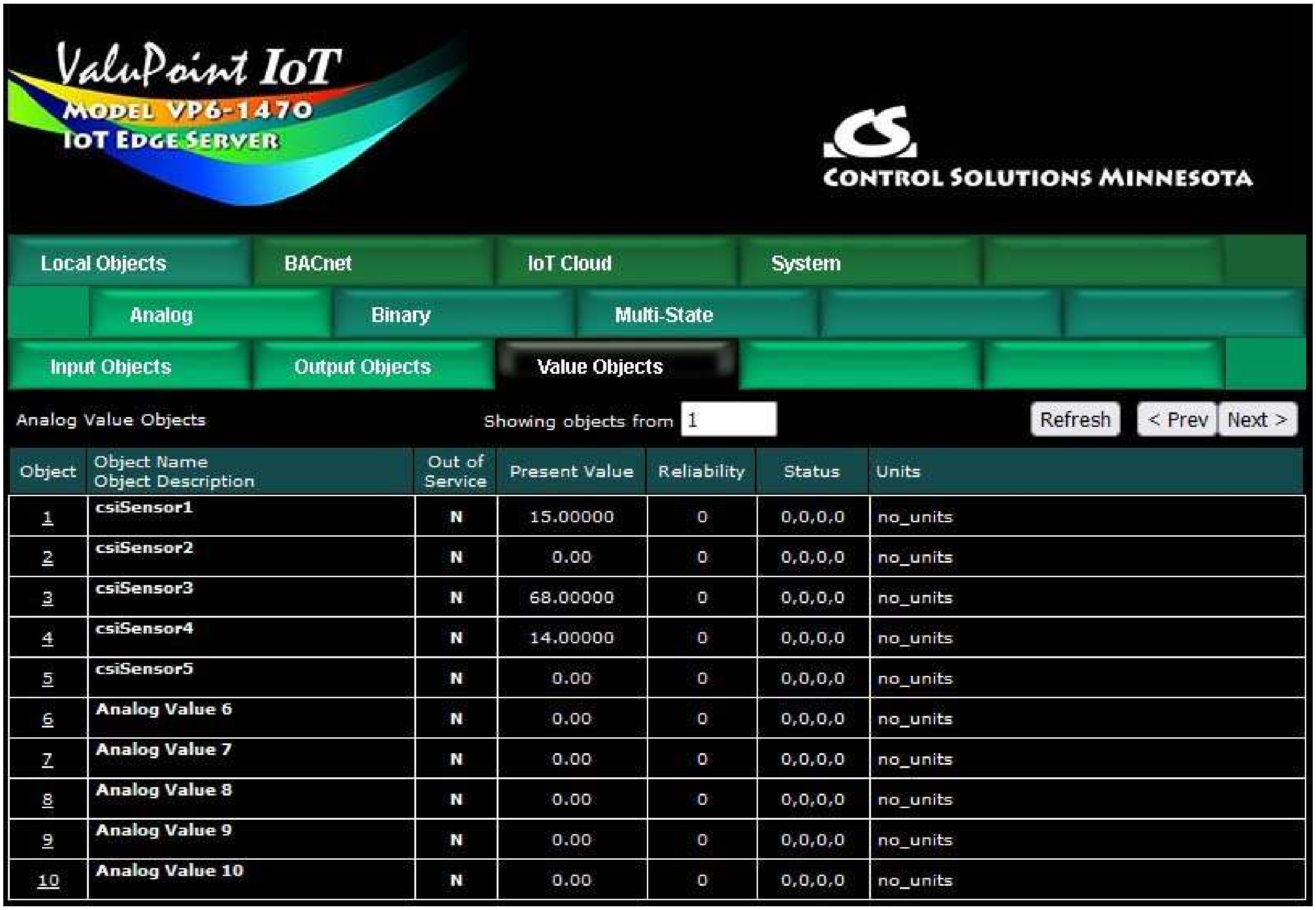
Ticks: min -60 max 60

Your device name should appear in the Device list. Select it. Delete any default Data key that appears and then the list will be populated with your recently published data points. Select the name associated with the Thing Point which you configured on the Thing Points page in the VP6-1470. This tells Thingsboard which data to associate with this gauge. The first two items illustrated above are the only required items. The rest of the parameters are optional formatting that you can play with later.

Click Add, and you should see the gauge illustrated below on your dashboard.



Our point csiSensor1 is being displayed on the gauge, and it is getting its data from a remote Modbus device.

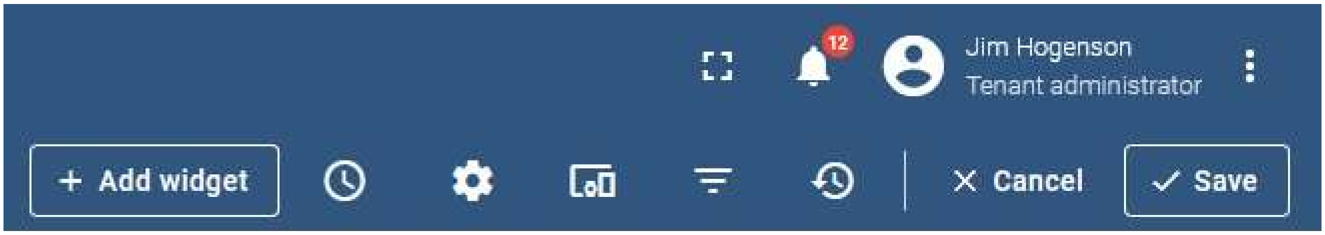


Analog Value Objects

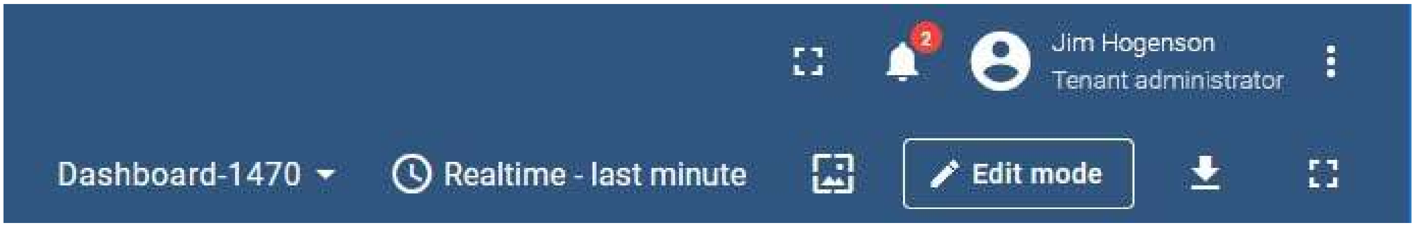
Showing objects from 1

Object	Object Name Object Description	Out of Service	Present Value	Reliability	Status	Units
1	csiSensor1	N	15.00000	0	0,0,0,0	no_units
2	csiSensor2	N	0.00	0	0,0,0,0	no_units
3	csiSensor3	N	68.00000	0	0,0,0,0	no_units
4	csiSensor4	N	14.00000	0	0,0,0,0	no_units
5	csiSensor5	N	0.00	0	0,0,0,0	no_units
6	Analog Value 6	N	0.00	0	0,0,0,0	no_units
7	Analog Value 7	N	0.00	0	0,0,0,0	no_units
8	Analog Value 8	N	0.00	0	0,0,0,0	no_units
9	Analog Value 9	N	0.00	0	0,0,0,0	no_units
10	Analog Value 10	N	0.00	0	0,0,0,0	no_units

When you are done making changes to the dashboard, click the Save button.

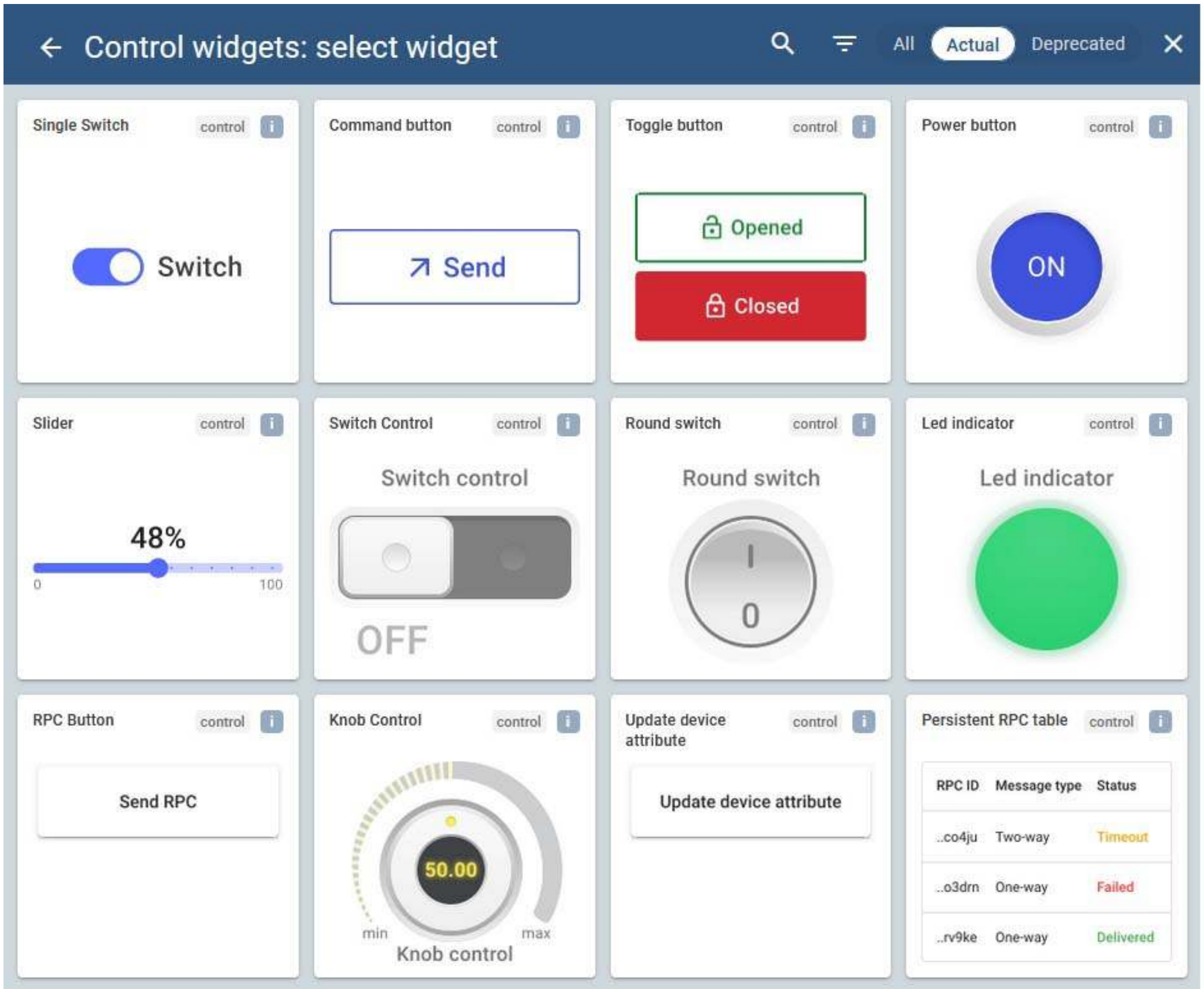


To resume modifying your dashboard, click the Edit mode button, which may show up as just the pencil icon.



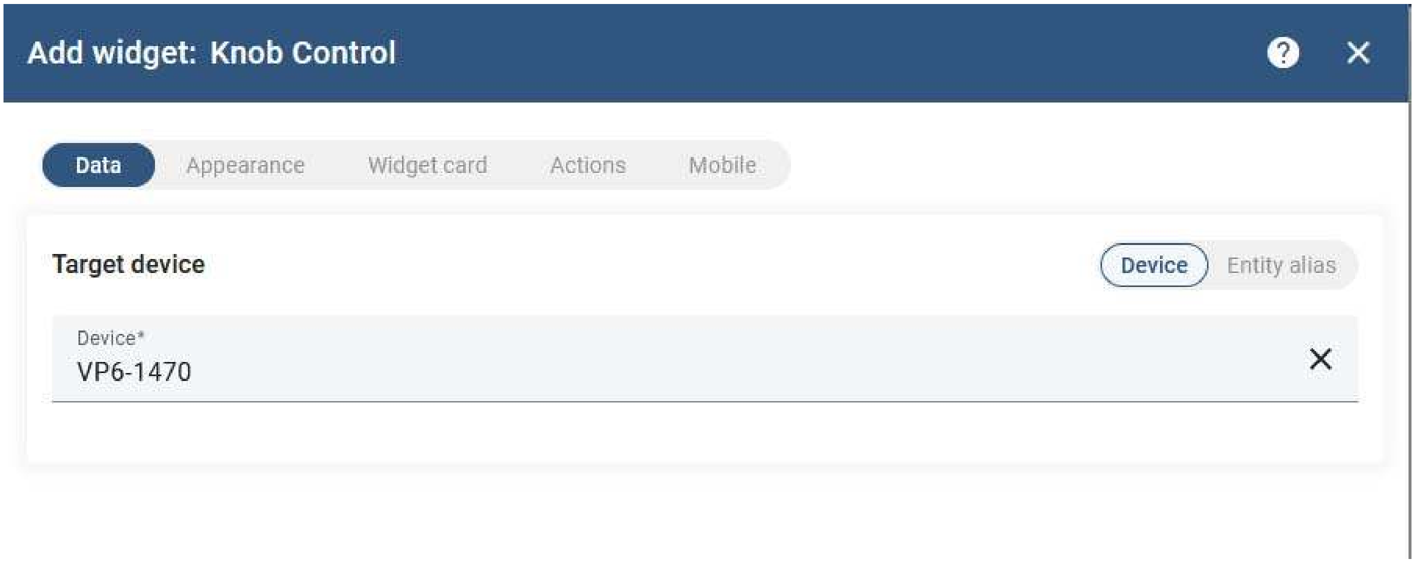
17.5 Adding an Actuator Widget

Adding a widget to control a parameter in your MQTT device begins by clicking the Add widget button in your dashboard (in edit mode). Select the Control widgets category. Thin pick which widget you want.



RPC ID	Message type	Status
..co4ju	Two-way	Timeout
..o3drn	One-way	Failed
..rv9ke	One-way	Delivered

For our first widget, we will select the Know Control. Select your device from the device list. Do not click Add just yet.



Add widget: Knob Control

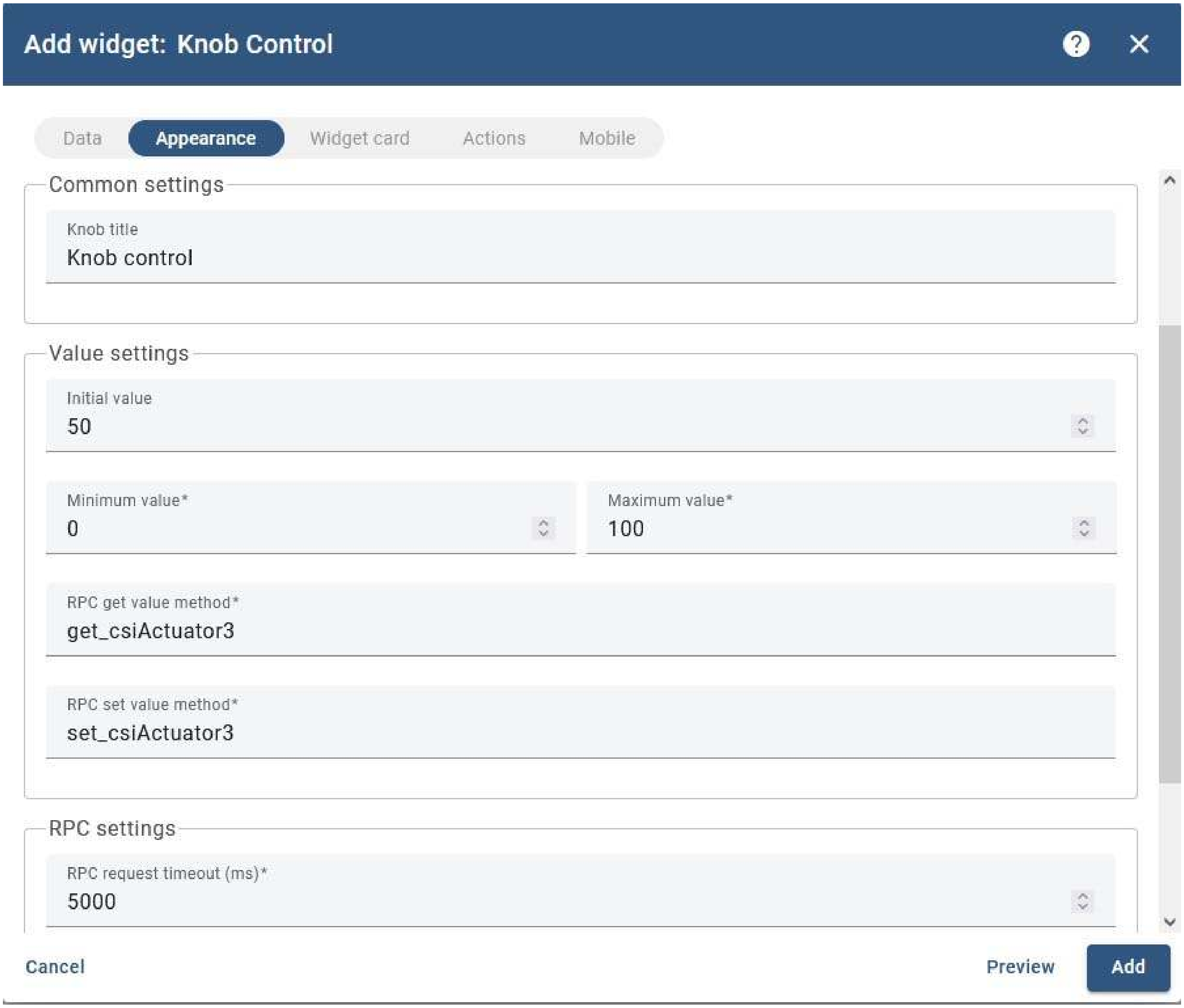
Target device

Device*
VP6-1470

Click on the Appearance tab. There are a couple of very important things you need to do on the Appearance tab. Enter "get_XXX" for RPC get value method and "set_XXX" for RPC set value method where XXX is the attribute name assigned in your MQTT device on the Thing Points page.

In our example illustrated above and below, our Thing Point name is csiActuator3. Thus we must enter get_csiActuator3 and set_csiActuator3 for the RPC methods. These RPC method names will be processed by our MQTT device (VP6-1470) when Thingsboard wants to exchange data.

If you experience timeouts, increase the timeout value on this tab.



Add widget: Knob Control

Common settings

Knob title: Knob control

Value settings

Initial value: 50

Minimum value*: 0

Maximum value*: 100

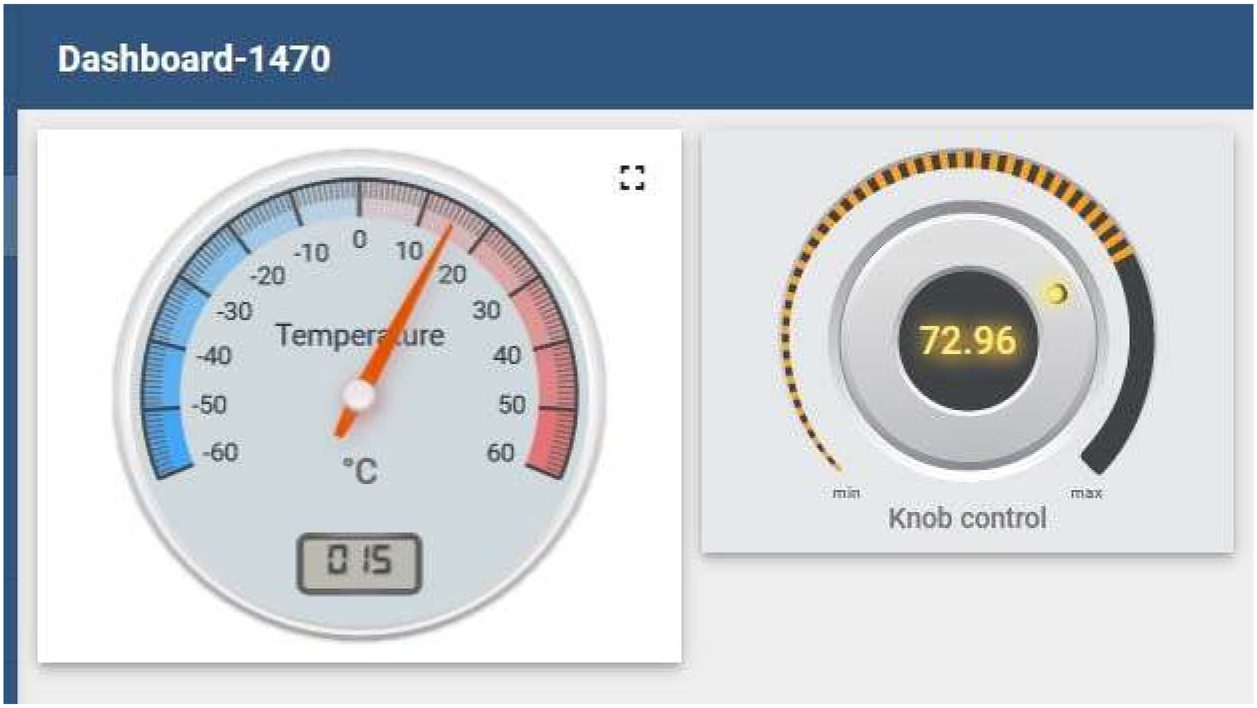
RPC get value method*: get_csiActuator3

RPC set value method*: set_csiActuator3

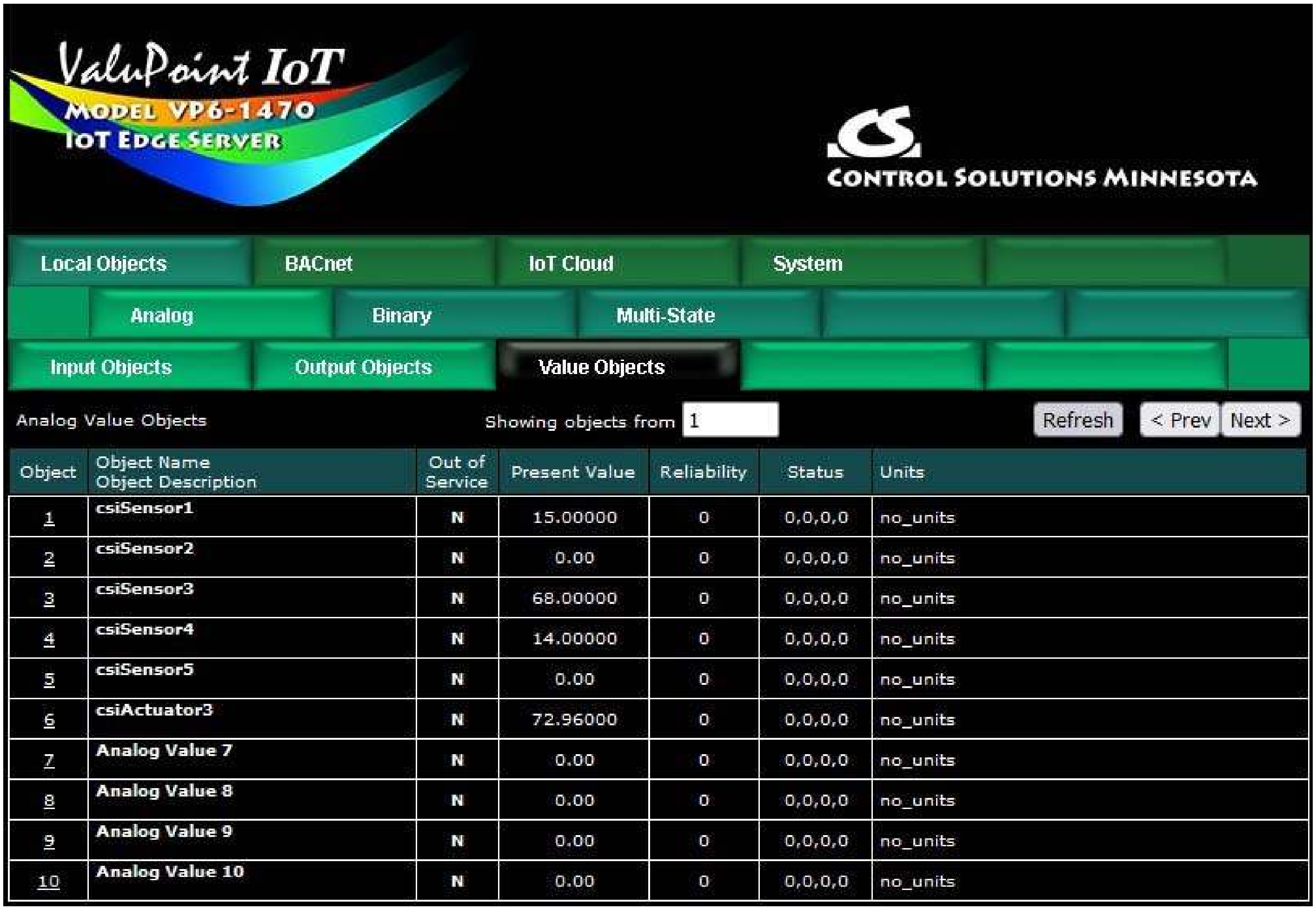
RPC settings

RPC request timeout (ms)*: 5000

Click Add. The control will now appear on our dashboard.



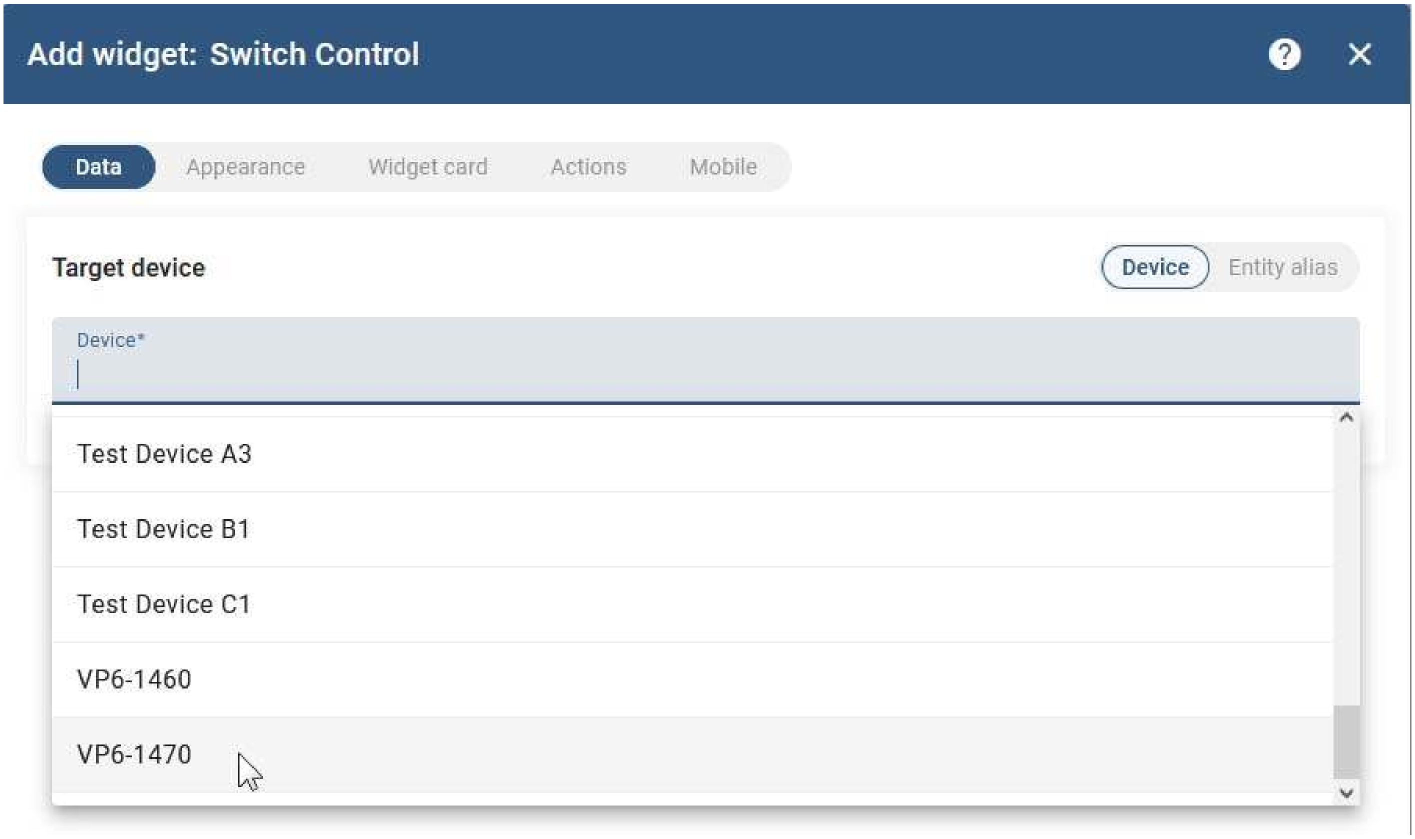
Our csiActuator3 is mapped to the Analog Valus 6 object for our demo. When you move the knob on the web page in Thingsboard, the AV 6 value will change accordingly.



Analog Value Objects   Showing objects from 1

Object	Object Name Object Description	Out of Service	Present Value	Reliability	Status	Units
1	csiSensor1	N	15.00000	0	0,0,0,0	no_units
2	csiSensor2	N	0.00	0	0,0,0,0	no_units
3	csiSensor3	N	68.00000	0	0,0,0,0	no_units
4	csiSensor4	N	14.00000	0	0,0,0,0	no_units
5	csiSensor5	N	0.00	0	0,0,0,0	no_units
6	csiActuator3	N	72.96000	0	0,0,0,0	no_units
7	Analog Value 7	N	0.00	0	0,0,0,0	no_units
8	Analog Value 8	N	0.00	0	0,0,0,0	no_units
9	Analog Value 9	N	0.00	0	0,0,0,0	no_units
10	Analog Value 10	N	0.00	0	0,0,0,0	no_units

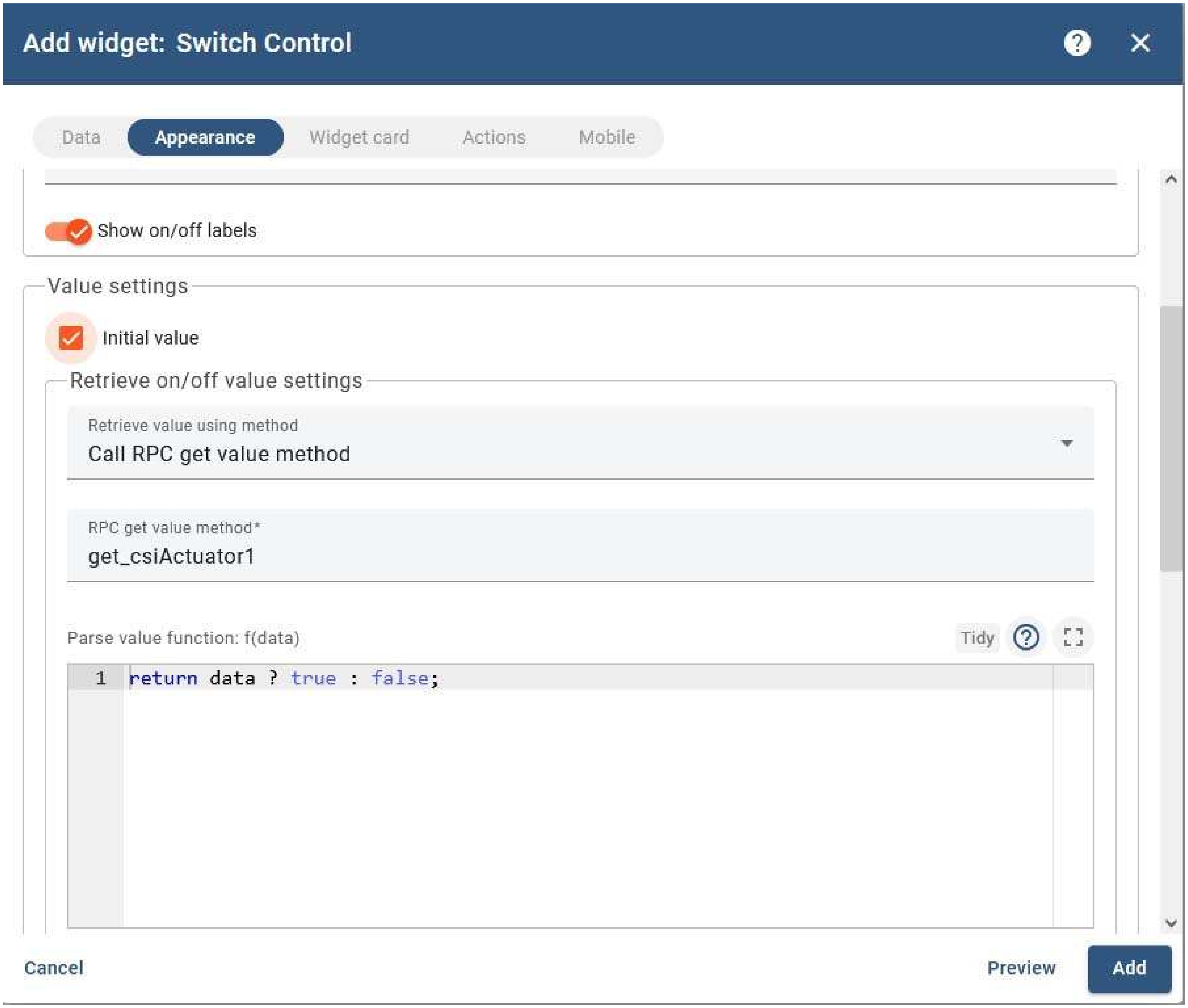
The process for adding a switch begins the same as for a knob. Create a new alias, and select our MQTT device from the list.


Add widget: Switch Control

Target device

Device*

The “Initial value” will default to unselected. Select it by checking the box. Select “Call RPC get value method” from the method list if not already the default, and enter the RPC method as described above. We want to remotely switch our relay on and off, so we have entered get_csiActuator1. Leave the Parse value function as is, as illustrated below.



Add widget: Switch Control

☑ Show on/off labels

Value settings

☑ Initial value

Retrieve on/off value settings

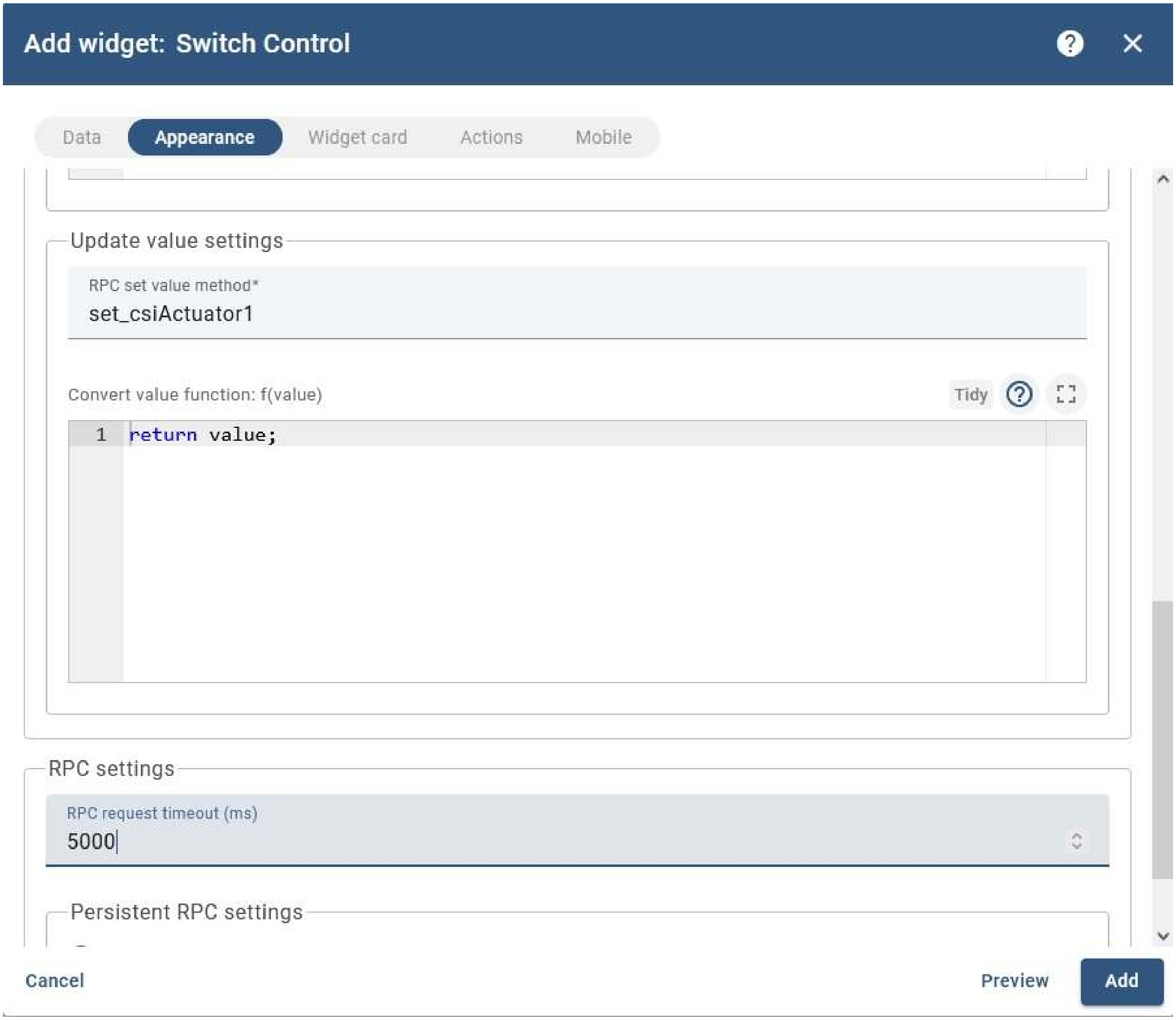
Retrieve value using method: Call RPC get value method

RPC get value method*: get_csiActuator1

Parse value function: f(data)

```
return data ? true : false;
```

Scroll down the the Update value settings portion of the screen. Enter the set_XXX function for the RPC set value method as previously discussed. In this case we use set_csiActuator1.



Update value settings

RPC set value method*
set_csiActuator1

Convert value function: f(value)

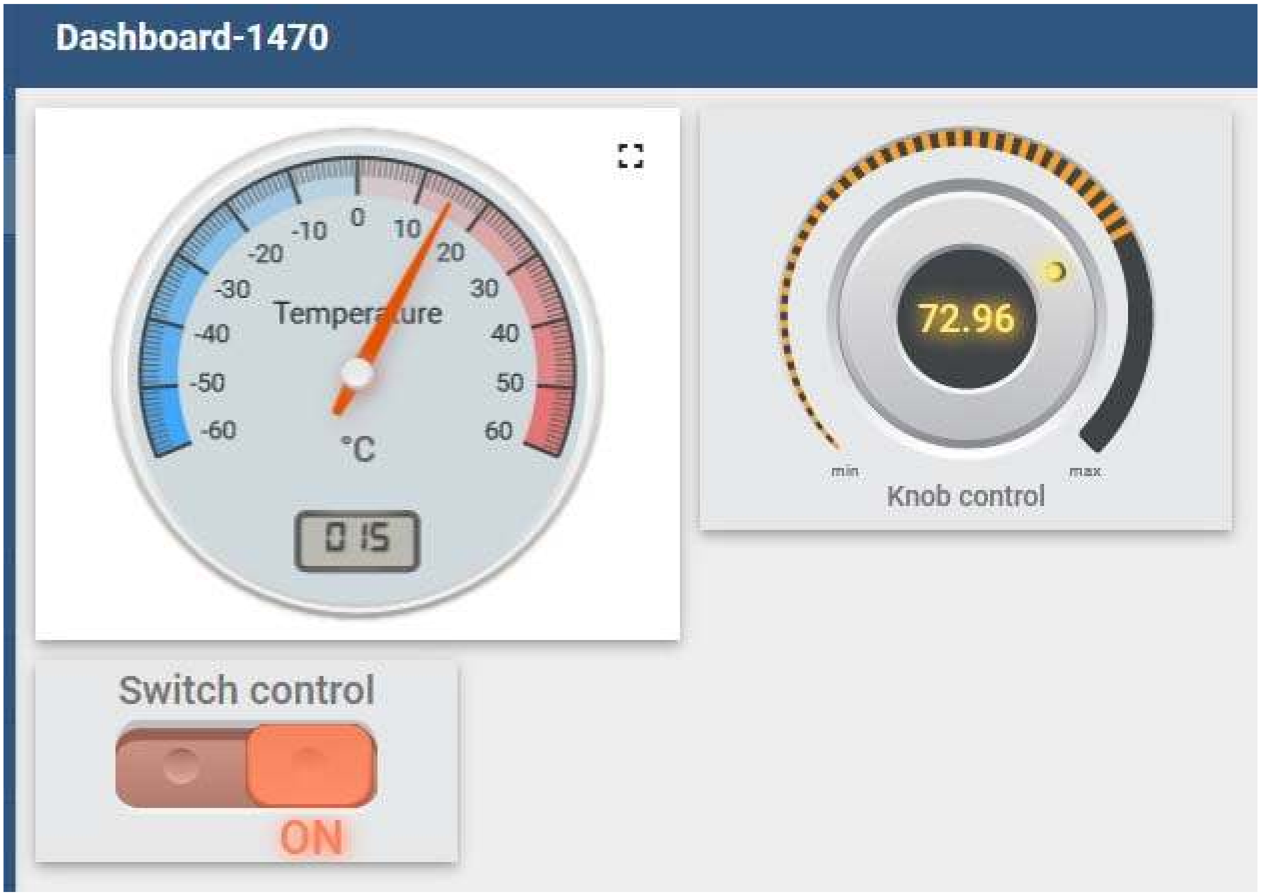
```
return value;
```

RPC settings

RPC request timeout (ms)
5000

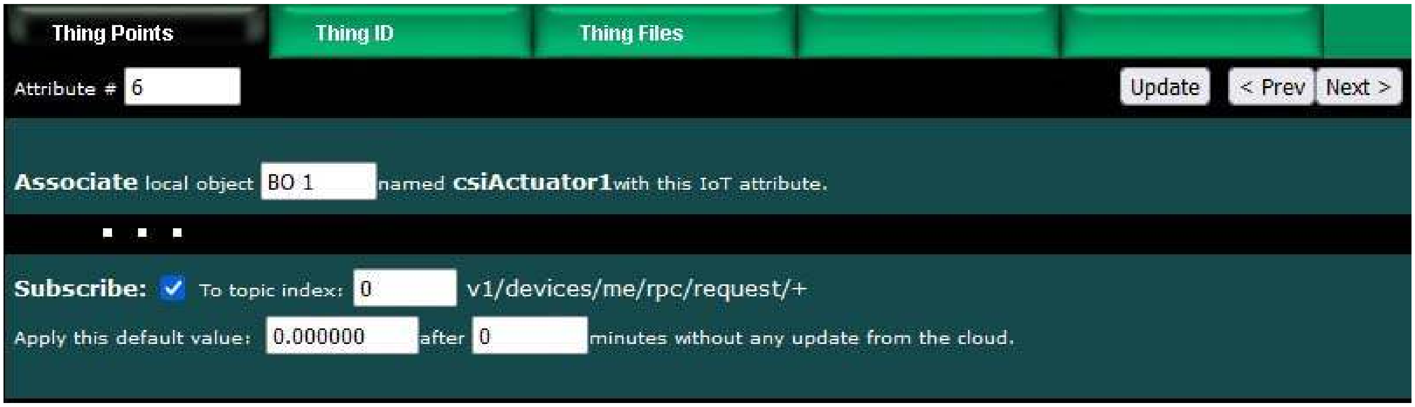
Persistent RPC settings

Click Add. We now have a switch on our dashboard.



The Thing Points configuration that makes this happen on the MQTT device side is illustrated (abbreviated form) below. Nothing about publish is needed here, just subscribe.

When the Swtich control is clicked on the screen, the corresponding relay switches on and off.



Attribute # 6

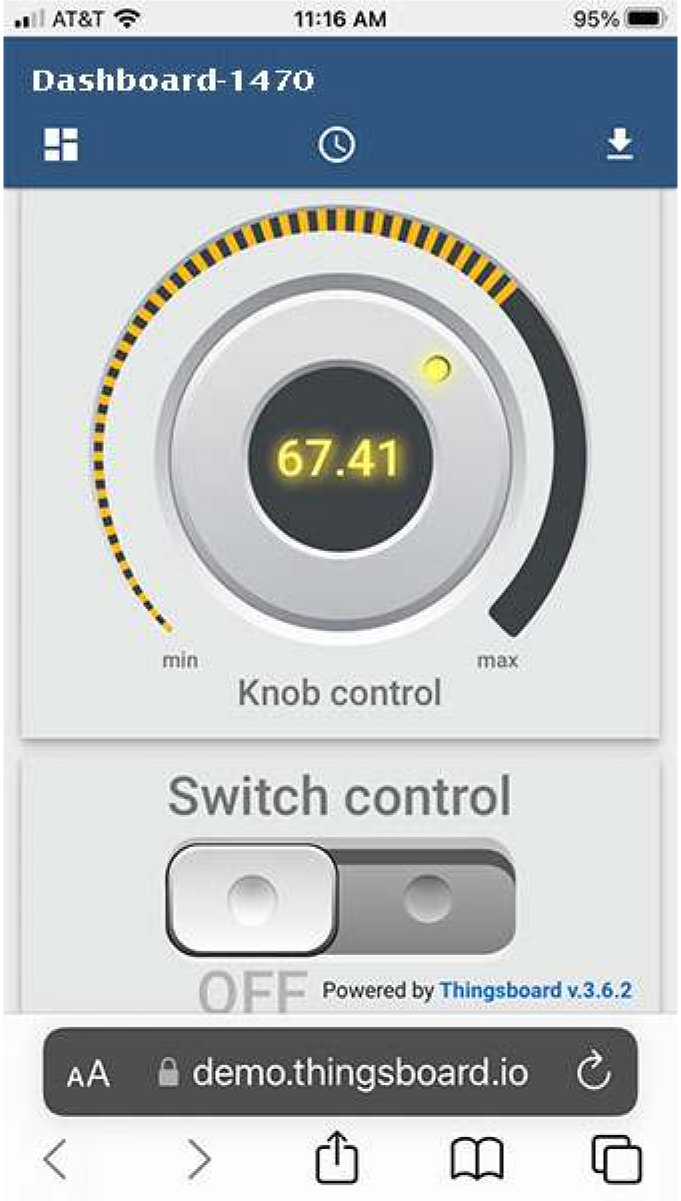
Associate local object BO 1 named **csiActuator1**with this IoT attribute.

. . .

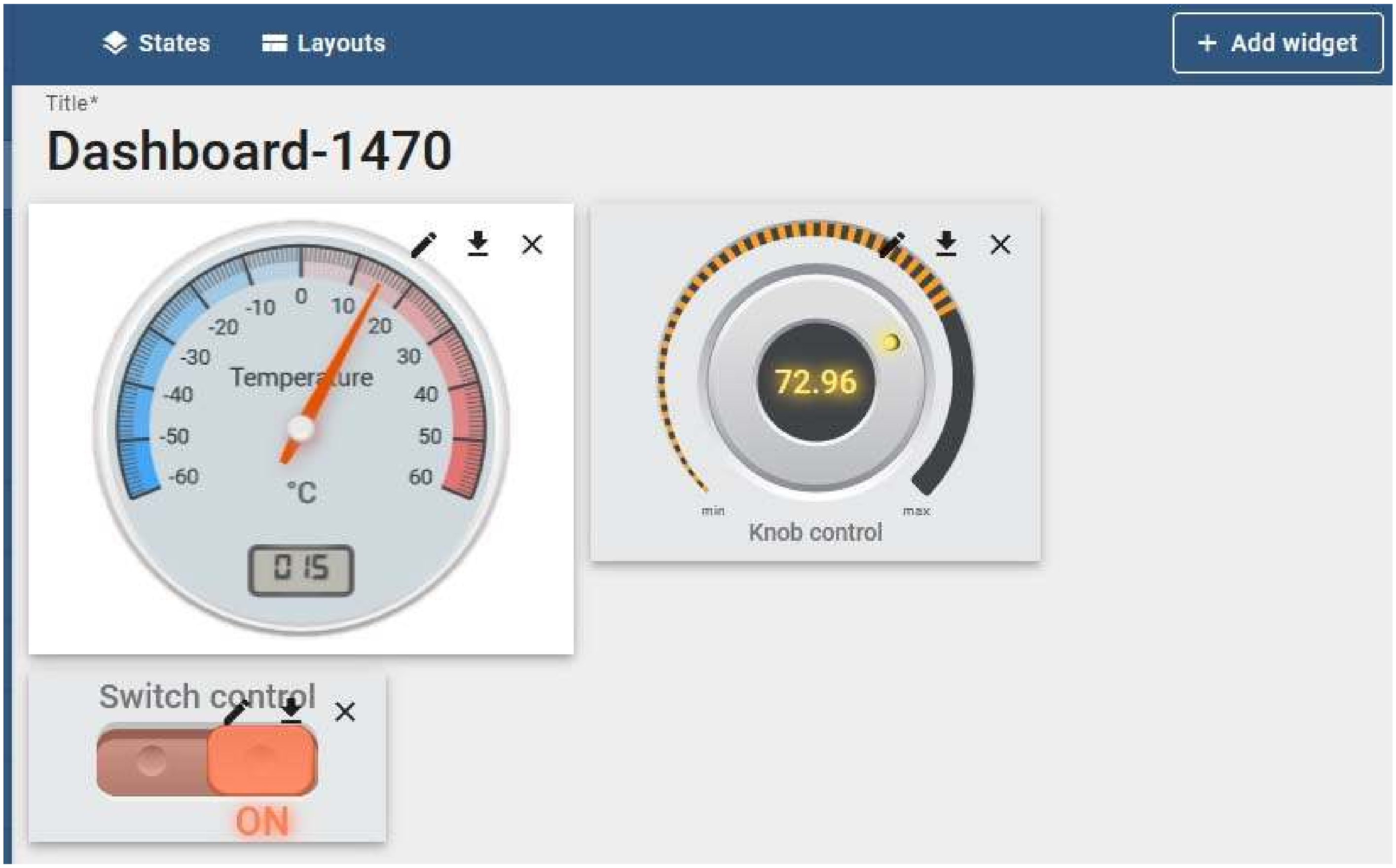
Subscribe: ☑ To topic index: 0 v1/devices/me/rpc/request/+

Apply this default value: 0.000000 after 0 minutes without any update from the cloud.

The URL displayed in the address bar when viewing your dashboard is accessible from your mobile device if the dashboard and corresponding device have been set to “make public”. Use public viewing only for demo purposes. You will want to use more secure methods for production use.



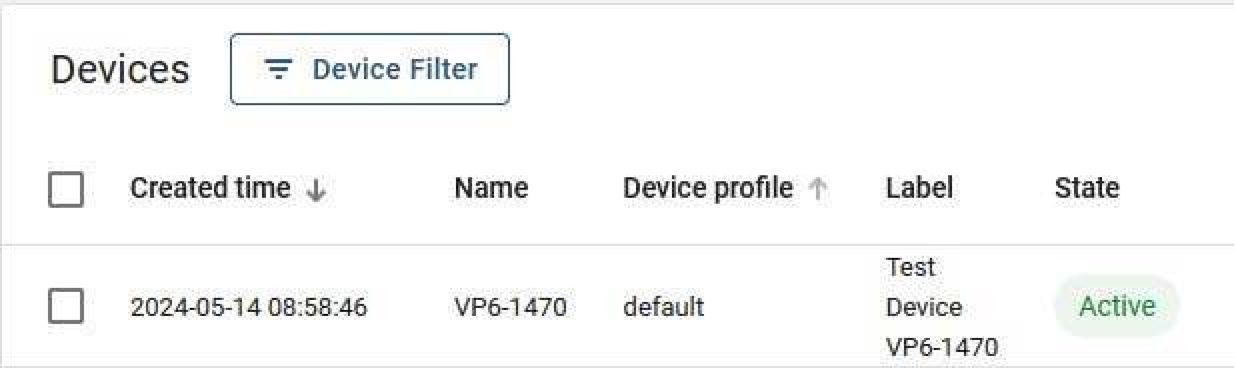
If at any time you want to go back and make changes to widgets already on your dashboard, go into edit mode on your dashboard. Note that a pencil icon shows up on top of every widget. Click the pencil icon to make changes to the respective widget.



Title*
Dashboard-1470

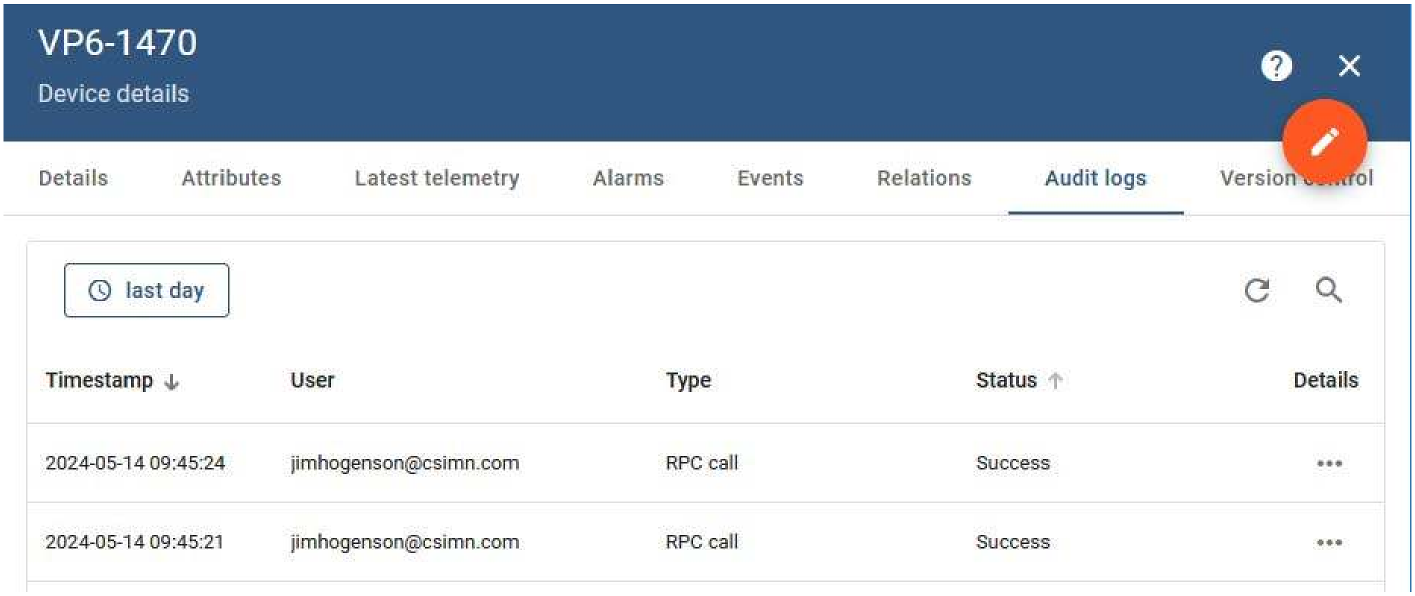
17.6 Diagnostics

To access diagnostics for your device, go to the Devices page and click on State (i.g. Active in this illustration).



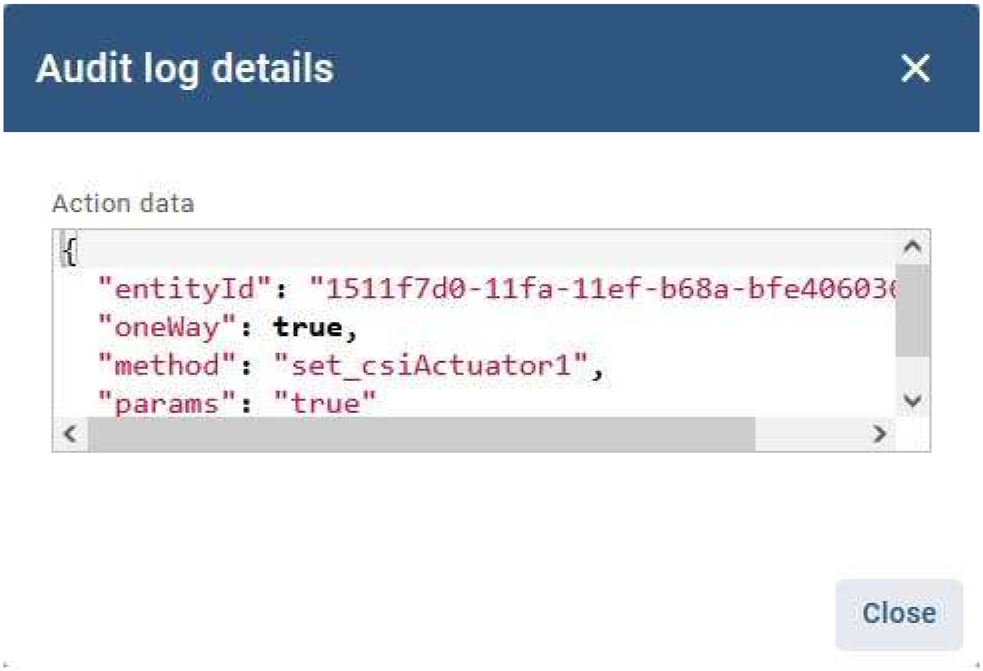
□	Created time ↓	Name	Device profile ↑	Label	State
□	2024-05-14 08:58:46	VP6-1470	default	Test Device VP6-1470	Active

You can view latest telemetry as illustrated previously. This will be any data published to the v1/devices/me/telemetry topic. You can also view the Audit logs.



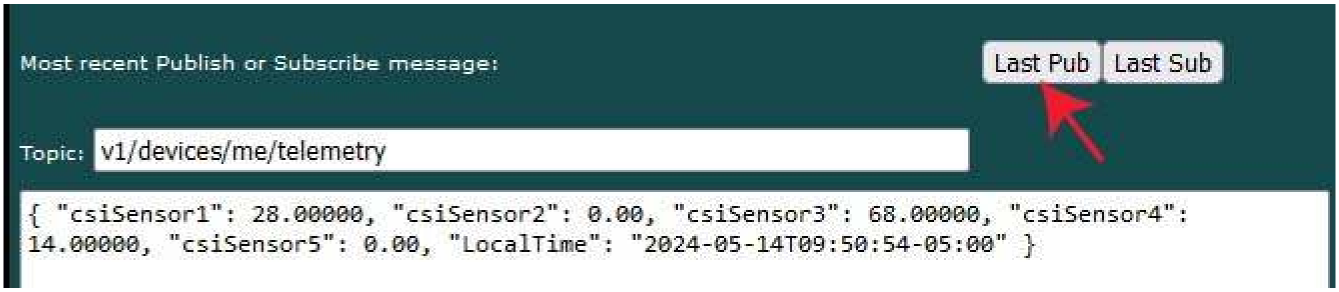
Timestamp ↓	User	Type	Status ↑	Details
2024-05-14 09:45:24	jimhogenson@csimn.com	RPC call	Success	•••
2024-05-14 09:45:21	jimhogenson@csimn.com	RPC call	Success	•••

The Audit logs show all RPC calls that were involved in making any control widgets work. Click on the Details icon to see the entire exchange between Thingsboard and our MQTT device.



```
{
  "entityId": "1511f7d0-11fa-11ef-b68a-bfe40603
  "oneWay": true,
  "method": "set_csiActuator1",
  "params": "true"
```

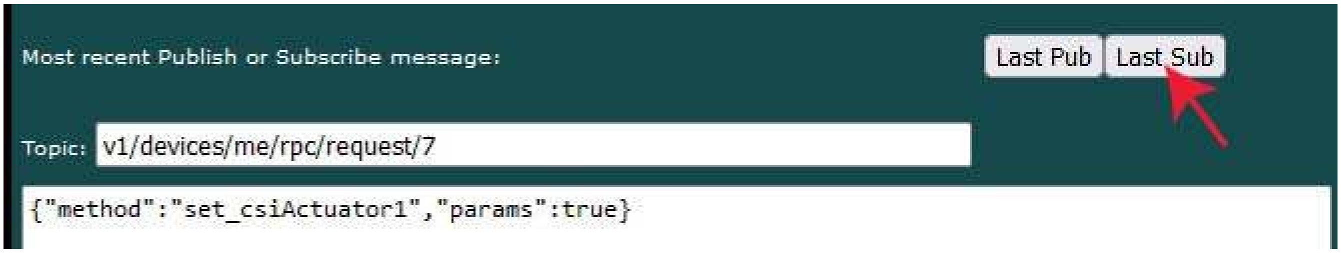
The diagnostics available on the MQTT device side are the same as for any other MQTT service. Go to the Test page and click on Last Pub to see what was most recently sent by the device to the server (in this case Thingsboard).



Topic: v1/devices/me/telemetry

```
{ "csiSensor1": 28.00000, "csiSensor2": 0.00, "csiSensor3": 68.00000, "csiSensor4":
14.00000, "csiSensor5": 0.00, "LocalTime": "2024-05-14T09:50:54-05:00" }
```

Click on Last Sub to see what most recently came from the server.

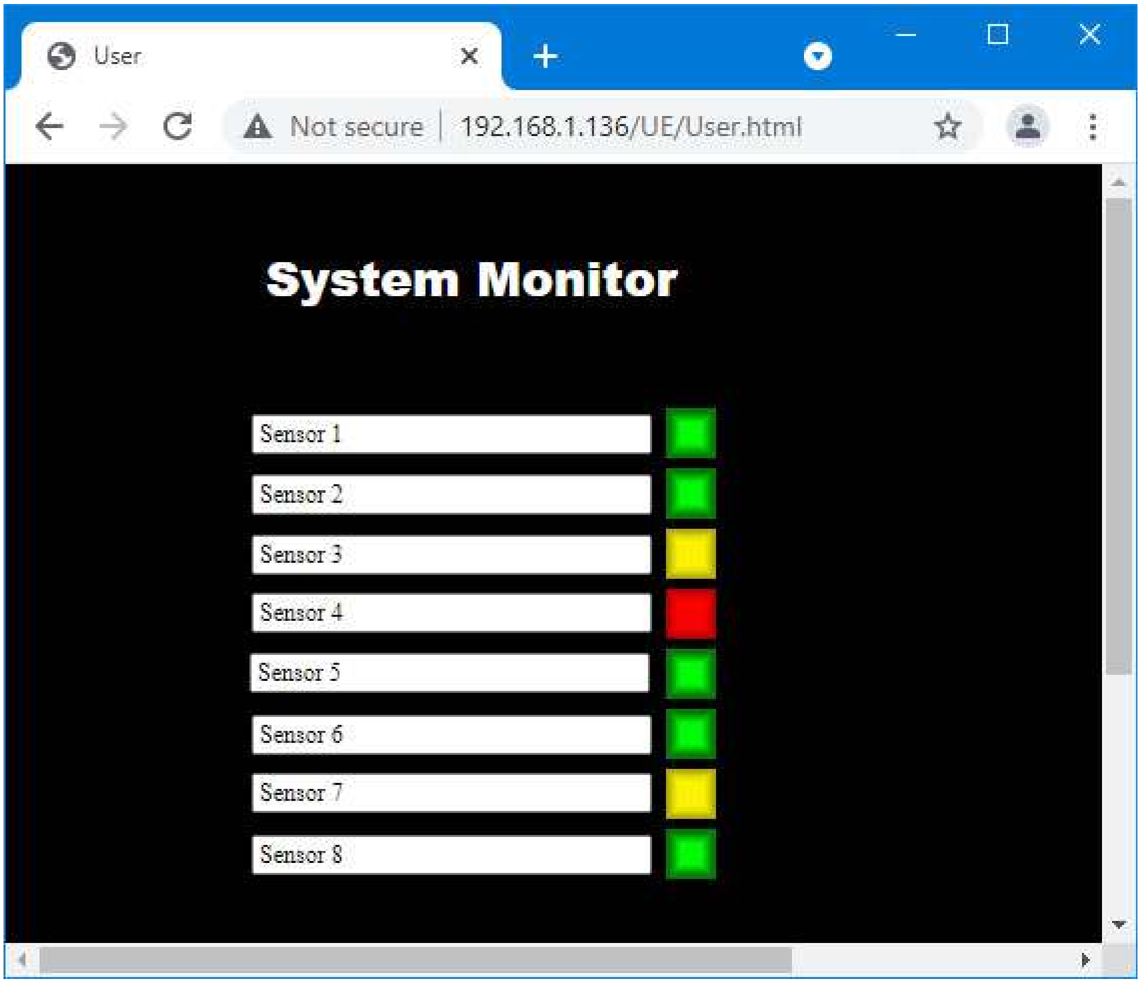


Topic: v1/devices/me/rpc/request/7

```
{"method":"set_csiActuator1","params":true}
```

18. User HTML

This section is an updated version of the user_html_cgi.pdf document found on the introduction page under User HTML Tutorials at https://info.csimn.com. This information has been updated per implementation in ValuPoint. Except for changing the link "../index.html" to "/html/index.html" where applicable, the various demos found in the knowledgebase should work in a ValuPoint.



System Monitor

Sensor 1 🟩
Sensor 2 🟩
Sensor 3 🟨
Sensor 4 🟥
Sensor 5 🟩
Sensor 6 🟩
Sensor 7 🟨
Sensor 8 🟩

The "naked pages" referenced in the 2008 version of the CGI overview are not implemented in Babel Buster 3. They were an attempt at allowing some level of "private labeling" the gateway. If private labeling is desired, Control Solutions does offer that option which will result in fully rebranding the entire preprogrammed web UI.

18.1 Static HTML

User HTML may be installed as a "wrapper" around the default web pages. To install user HTML, use the File Manager (filter set to *.*) to upload any combination of .html, .txt, .gif, and .jpg files. You can also include .pdf, .xml, .css and JavaScript .js files. PHP, ASP, etc., are not supported.

You can also use FTP to upload files to the /FLASH0 (that's flash zero) directory and this will be the default directory upon opening an FTP session. An FTP session in Linux, Windows command prompt, or Windows PowerShell work well. Some smart FTP clients work, but some try to be too helpful and simply screw things up. We tested FileZilla at one point and it seemed to work ok, but we do not keep testing every revision of FileZilla.

The top level user file must be named User.html (case sensitive). If this file is present in /FLASH0, it will be served instead of the default index.html page pre-programmed in the device any time you simply browse to the device's IP address. Once this page is open, it may link to any other html files in the /FLASH0 directory. All user HTML is filtered as it is served to provide dynamic content.

There are a handful of tricks that must be observed to make user html work. All references to other user pages and to user image files must have the file names preceded with /UE/ as in /UE/User2.html or /UE/mypicture.gif. The UE stands for "user escape" and is treated as a virtual directory that actually points to /FLASH0. All preprogrammed pages are found in /html/ and preprogrammed images are found in /img/.

18.2 Dynamic Data Tags in User HTML

Dynamic Data – Creating a Form

Dynamic access to local object data is provided. Dynamic updates of object value is also supported via the form post method. The form must be defined using the following tags:

```
    <form id="UserForm" action="/UE/icanForm" method="post"
name="UserForm">

    </form>
```

The submit button causing the post must be defined as:

```
    <input type="submit" name="submitChange" value="Change">
```

Any submit buttons other than those recognized as noted here will simply result in a page refresh. Only the submit button named "submitChange" with a value of "Change" will result in parsing of the form data. Only a form with action as named above will be parsed.

If you want to redefine the appearance of the button, you can implement a graphic button by including an image as follows, and then including the JavaScript function as shown:

```
    <img src="specialbutton.gif" onclick="sendMeAway();" alt=""
```

```
height="25" width="133" border="0">

    <script type="text/javascript"><!--
    function sendMeAway() {
          document.UserForm.submitChange.value="Change";
          document.UserForm.submit();
    }
    //--></script>
```

Input Types: <input type=”text”>

Two types of data input are recognized by CGI processing of the user post: Text input and option select. The search string keyed upon for text is **<input type=”text”** and the search string keyed upon for the select option is **<select name=**

A text input should be constructed as follows:

```
    <input type="text" name="reg22" value="%d" readonly size="8">
```

The contents of the local object encoded as the register number included in the name (“regX”) will be displayed when the page is served, and the data will be taken dynamically from the BACnet object at that point in time, and again each time the page is refreshed. The data will be formatted using the C format string found in the value tag. Integer formats (%d, %04d, %x, etc) should be used for integer objects (Multi-state and Binary are treated as integer), and floating point (%f, %.2f, etc) should be used for floating point objects (Analog). If “readonly” is specified, data will only be displayed in this window. Otherwise the data returned by the post will be parsed, and the result placed back into the object.

The following keywords are recognized as text input “names”:

regX – references the value in the BACnet object encoded as register number X
namX – references the name of the object encoded as register number X
site – references the BACnet Device Name

All of these data elements may be read, and will be written unless you specify “readonly”. The definition of read means take data from the local object when serving the page, and write means write data to the local object if the form was submitted by the appropriately named submit button (see Form above).

BACnet objects are accessed as coded "register" numbers in HTML tags. Register numbers are BACnet object type multiplied times 10,000 plus object number starting at #1. Register numbers corresponding to BACnet objects are as follows:

Object Type	Object Number	Register Number
Analog Input	AI 1	1
Analog Output	AO 1	10001
Analog Value	AV 1	20001
Binary Input	BI 1	30001

Binary Output	BO 1	40001
Binary Value	BV 1	50001
Multi-State Input	MI 1	130001
Multi-State Output	MO 1	140001
Multi-State Value	MV 1	190001

Input Types: <select>

An option select should be constructed as follows:

```
<select name="reg25" size="1">
      <option selected value="0">OFF</option>
      <option value="1">ON</option>
</select>
```

The strings corresponding to the values given will be displayed when the object named matches that value, otherwise “---“ will be displayed. When an option is selected and the form posted, the value corresponding to the new selection will be written back into the object. The “selected” tag shown above is not required since it is automatically inserted in the appropriate place (moved around) when the page is served.

Input Types: <input type=”hidden”>

An additional form of input has been added to filtered HTML. Hidden variables may be defined using the following syntax:

```
    <input type="hidden" name="reg22" value="%d" readonly>
```

This will be processed the same as “text” input except the value is not displayed. This is useful as a means of providing non-displayed data to a JavaScript function. Hidden data upon return will be parsed and put back into objects unless readonly is specified. Omit readonly if hidden data should be parsed. This provides a means for JavaScript to get data back into objects.

Page Links

To create a link on the user page to get into the default preprogrammed pages, define a link to “/html/index.html”, for example:

```
    <a href="/html/index.html">Log In</a>
```

To link to another user page in the FLASH0 directory, use a link such as:

```
    <a href="/UE/pwUserP3.html">Room #1</a>
```

Links to graphic images you want shown on the page are created in similar fashion:

```
    <img src="/UE/isotech.gif" alt="" height="448" width="804"
border="0">
```

Note that you preface the page name with “/UE/” when the file is located in the FLASH0 directory, but preface the name with “/html/” when accessing a preprogrammed page.

Password Protection

There are 3 levels of password protection: Restricted, Maintenance, Administrator (root is a special form of administrator). User pages may be password protected at the "Restricted" level. To password protect a user page, simply insert the letters "pw" in front of the name. Therefore, if *User2.html* is a page you wish to protect, rename it *pwUser2.html*.

The top level page for User HTML must still be named *User.html* (and not *user.html* or not *USER.html*). If you don't want anything useful to be completely unrestricted, simply put a plain dumb page in User.html with a link that says "log in" and link it to pwUser.html.

Note that "restricted" level of password protection means the user can access any "pw" user pages, but cannot access any pages beyond index in the pre-programmed page set.

Other Input Types

Radio buttons and other forms of input are not supported at this time. The HTML will be passed through, but not filtered and associated with object data. Therefore, you can use radio buttons, etc., with JavaScript, but you must explicitly associate the resulting data with hidden input variables in order to return the data to objects.

Additional Special Submit Buttons

The submit button causing the post for changing data values must be defined as:

```
    <input type="submit" name="submitChange" value="Change">
```

Two additional button actions are available to save the configuration file or restart the device:

```
    <input type="submit" name="submitSave" value="Save">
    <input type="submit" name="submitRestart" value="Restart">
```

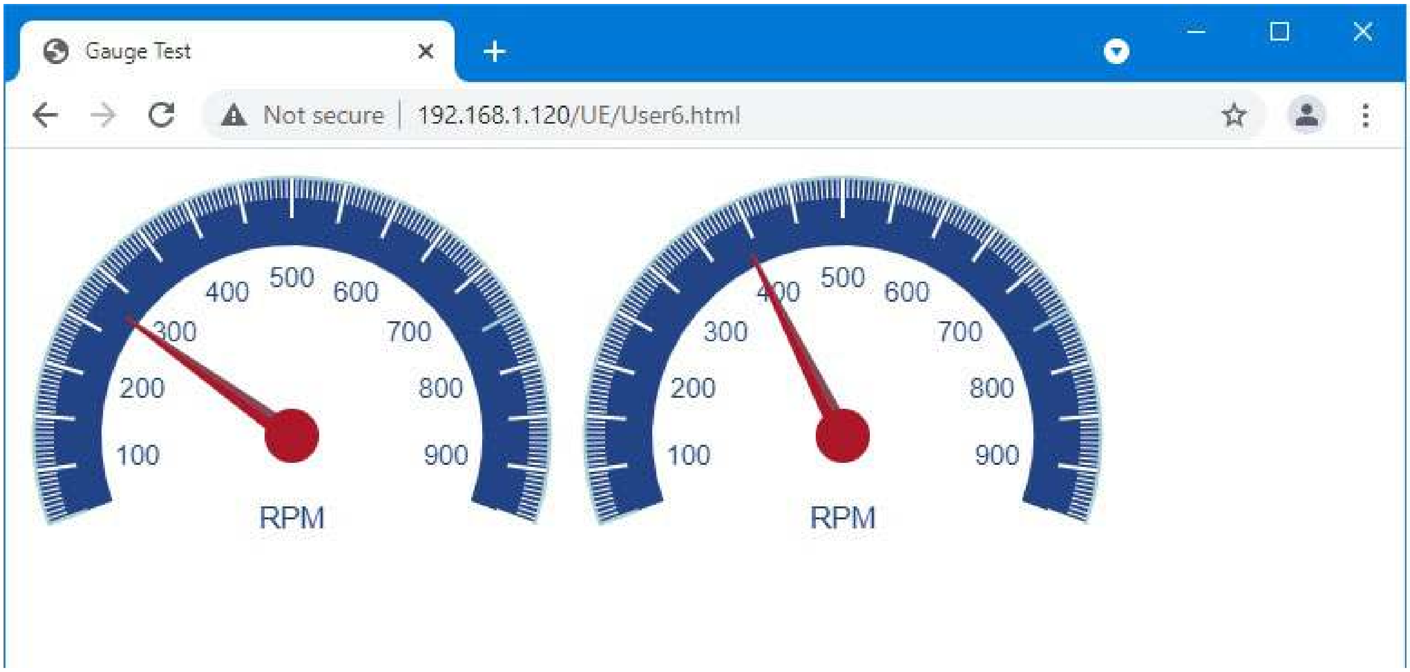
19.3 Live JavaScript Gauges

An external JavaScript library can be specified. The JS file should be loaded into the / FLASH0 directory along with User.html, etc. In the HTML file, the script file is referenced as illustrated here by the first few lines of User.html that generated the gauges pictured in the screen shot.

```
<!doctype html>
<html>
<head>
<meta http-equiv="Content-Type" content="text/html; charset=UTF-8">
<title>Gauge Test</title>
<link rel="stylesheet" href="/FS/FLASH0/fonts.css">
<script src="/FS/FLASH0//gauge.min.js"></script>
```

```
</head>
<body style="background: #fff" onload="animateGauges()">

<canvas id="canvasPressure"></canvas>
<canvas id="canvasPressure2"></canvas>

<script>
var gaugePressure = new RadialGauge({
```

(entire project is available on csimn.com web site)



Many different JavaScript gauges are available at https://canvas-gauges.com/.

To cause the gauges to automatically update in real time, you need two things: The animageGauges() function in the JavaScript, and something that is going to retrieve real time data into the HTML document. The real time data retrieval is done by a hidden iframe, included in the User.html like this:

```
    <iframe name="phantom" src="UserGetData.html" frameborder="0"
height="50" width="50"></iframe>
```

The UserGetData.html is constructed like this:

```
<!DOCTYPE html PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN">

<html>
<head>
<meta http-equiv="content-type" content="text/html;charset=iso-8859-1">
<title>Untitled Page</title>
<meta http-equiv="refresh" content="1">
</head>

<body bgcolor="#ffffff">
<form id="UserForm" action="/UE/icanform" method="post" name="UserForm">
```

```
<div align="left">
<input type="hidden" name="reg1" value="%d"><input type="hidden"
name="reg2" value="%d"></div>
</form>
<p></p>
</body>

</html>
```

NOTE: The above example using an iframe to retrieve real time data was created prior to adding the REST API capability to ValuPoint. The gauge animation could be restructured to take advantage of the REST API if you know your way around JavaScript.

19. REST API

You can use the IoT Gateway as a means of communicating with your BACnet devices using a REST API. The API must be enabled at the bottom of the Network setup page before the API will respond.

19.1 GET Data from Device

You can use an HTTP GET request to query the ValuPoint for its data values. The URL form of an acceptable query would be:

```
http://10.0.0.101/UE/query/csiSensor1
```

and this query will return a JSON format reply something like this:

```
HTTP/1.1 200 OK
Content-Type: application/json
{
    "state": {
        "reported": {
            "csiSensor1": 47,
            "LocalTime": "2021-09-10T09:30:00-06:00"
         }
     }
}
```

The names given as object names on the Local Objects page will be used as data names here. The AWS IoT platform requires that names contain no embedded spaces, and avoiding spaces in names will also be necessary in most instances here. The data value will be either numeric as illustrated, or a character string enclosed in quotes. Timestamps conform to ISO 8601.

The same user name and password credentials otherwise required for web UI login will be required here. If the above query is done via a browser, the browser will ask for the username and password. When doing the query programmatically, the client must provide the credentials as applicable in the programming environment being used.

Example error response:

```
HTTP/1.1 200 OK
Content-Type: application/json
{
    "error": "no such object"
}
```

The HTTP 200 OK refers to the validity of the HTTP protocol. It does not mean that your properly formatted query provided good data. You need to look at the JSON data to see if it contains "error". If you got HTTP 200 OK, the only two possible top level names are "error" or "state".

19.2 POST Data to Device

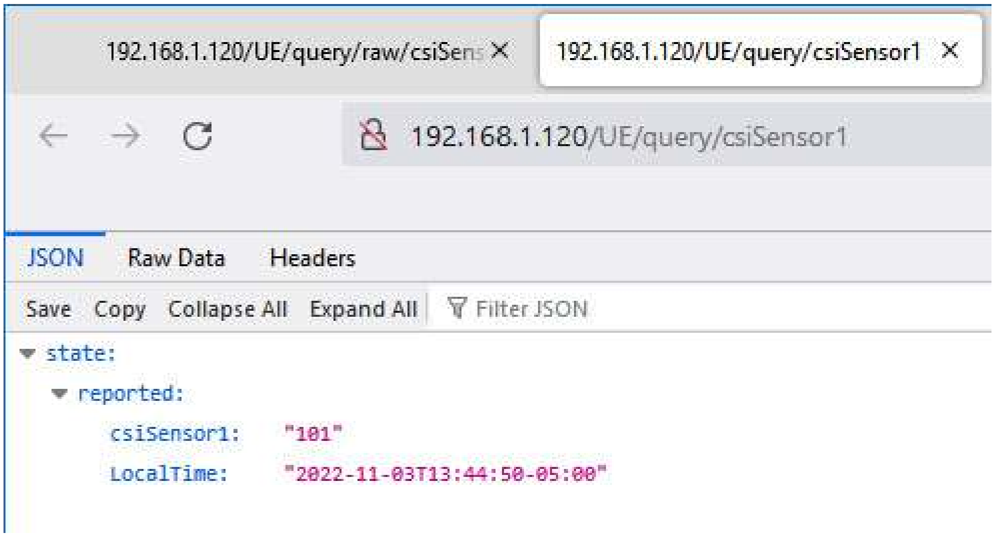
To write data to the ValuPoint (which will result in writing data to a BACnet object in some other device if the client is set up to do so), you can do an HTTP POST to http://10.0.0.101/UE/query with content such as:

```
{
    "state": {
        "desired": {
            "csiActuator1": 47
        }
    }
}
```

This example will set the register named csiActuator1 to value 47 and return result similar to above GET reply with respective object name.

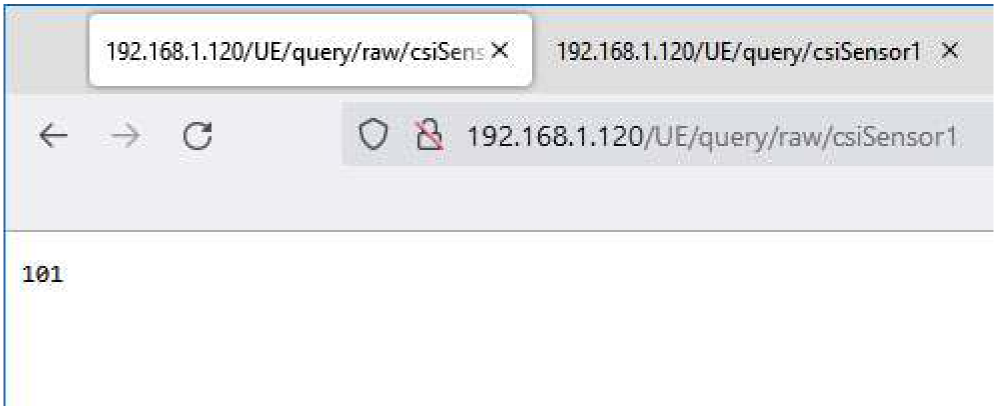
20.3 Raw Data Query

The normal REST API will return data as JSON formatted data as illustrated in the web browser screen shot below.


192.168.1.120/UE/query/raw/csiSens
192.168.1.120/UE/query/csiSensor1
192.168.1.120/UE/query/csiSensor1
JSON
Raw Data
Headers
Save
Copy
Collapse All
Expand All
Filter JSON

```
▾ state:
  ▾ reported:
      csiSensor1:   "101"
      LocalTime:    "2022-11-03T13:44:50-05:00"
```

Some clients, however, are not able to parse JSON data and look for just raw data. The query now allows the "raw/" path to be inserted to obtain just raw data as illustrated below.



192.168.1.120/UE/query/raw/csiSens
192.168.1.120/UE/query/csiSensor1
192.168.1.120/UE/query/raw/csiSensor1

```
101
```

ValuPoint IoT
MODEL VP6-1470
IOT EDGE SERVER

CONTROL SOLUTIONS MINNESOTA

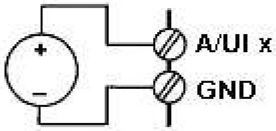
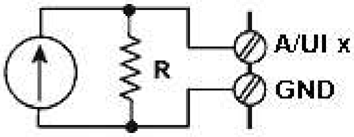
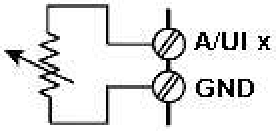
Appendix A Hardware Details

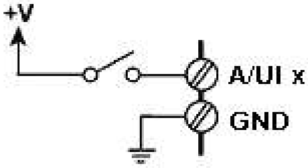
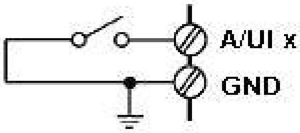
A.1 Wiring, Physical I/O Connections

Connection of Inputs

The VP6-1470 contains no configuration jumpers for configuring I/O points. There is no need to open the enclosure for configuration of I/O. Input types are switched under software control.

Input points should be connected as indicated in the various diagrams below. In addition to selecting a wiring diagram, the corresponding selections should be made on the I/O Config page as discussed in section 6.7 of this user guide.

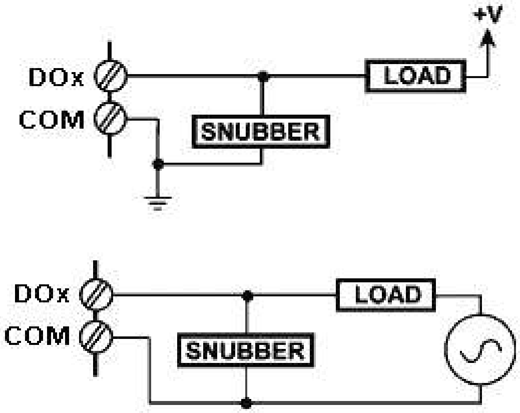
I/O Point Type	Wiring Guide	Additional Information
A/UI Analog Input: 0-10VDC Voltage Input or Pulse Count		A/UI inputs 1-12 will accept voltage inputs of up to 10VDC. Voltages to 11VDC will be measured. Voltages to 24VDC will be tolerated, but measurement is internally limited to a reading of 11VDC. This wiring diagram is also applicable to pulse counter input for counting pulses from an active pulse generator.
A/ UI Analog Input: 0-20mA Current Input		A/UI inputs 1-12 will accept current inputs of 0-20mA with the addition of a 500 ohm 1/2 watt external resistor. A 500 ohm resistor will produce a 0-10VDC signal. A 250 ohm resistor may also be used to produce a 0-5VDC signal.
A/UI Analog Input: Thermistor Input		A/UI inputs 1-12 will accept thermistors of 3k, 5k, 10k, or 20k ohms. Linearization via interpolation of a 56-point table is performed internally.

A/UI or DI Discrete Input: Discrete Voltage		A/UI inputs 1-12 may be connected as discrete voltage sensing inputs. Inputs up to 24VDC are tolerated, but threshold sensing only functions over the 0-10VDC range.
A/UI or DI Discrete Input: Dry Contact Closure to Ground or Pulse Count		A/UI inputs 1-12 may be connected as discrete inputs sensing dry contact closure to ground. Internal excitation of 0.3mA is provided. The excitation current may be increased by the addition of an external resistor (pullup to DC power). This wiring diagram is also applicable to pulse counter input for counting pulses from a switch closure.

Connection of Outputs

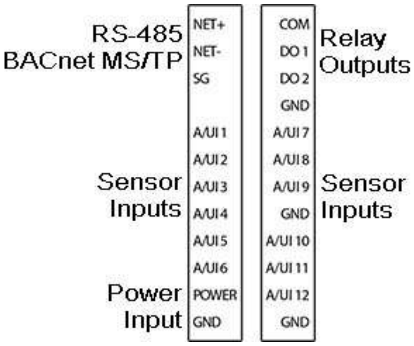
The VP6-1470 contains no configuration jumpers for configuring outputs. There is no need to open the enclosure.

Output points should be connected as indicated in the diagrams below. The discrete (relay) outputs are SPST N.O. with the common side connected together to the COM terminal. The COM terminal for relays is NOT electrically common to any of the GND terminals.

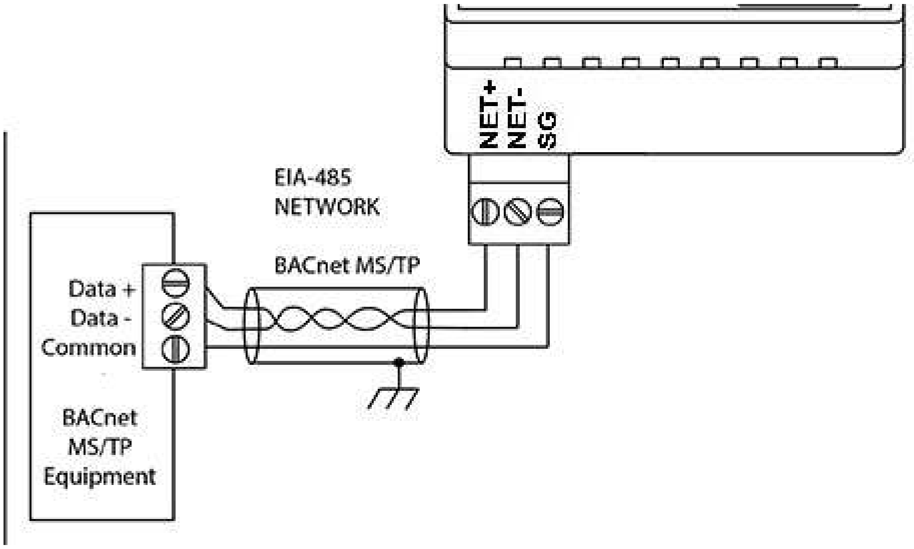
I/O Point Type	Wiring Guide	Additional Information
Discrete Output: Form A Relay	 +V DOx LOAD COM SNUBBER DOx LOAD COM SNUBBER	DO outputs 1-2 are Form A dry contact relays rated for 2A @ 120VAC (resistive). Snubbers should be used with inductive loads. The relays are also rated for 2A @ 30VDC. Note: Relays are rated higher, but UL listing is for 2A.

Connection of Power and Communications

Power and communications should be connected as indicated below.

I/O Point Type	Wiring Guide	Additional Information
Power	Connect AC or +DC power to Power terminal. Connect common or -DC power to GND terminal. GND is common to all terminals labeled COM.	Nominal power consumption is 2.4 watts, or 0.1A @ 24VDC, with all relays on.
Communications	Connect MS/TP RS-485 data lines to NET+/- terminals. The RS-485 port is electrically isolated from all other terminals including power. Therefore, the SG must be connected to the ground reference for the RS-485 signal in order to communicate.	Communication signals comply with EIA-485 standard.
Wiring Terminals	 RS-485 BACnet MS/TP NET+ NET- SG A/UI1 A/UI2 A/UI3 A/UI4 A/UI5 A/UI6 POWER GND Sensor Inputs Power Input COM DO1 DO2 GND A/UI7 A/UI8 A/UI9 GND A/UI10 A/UI11 A/UI12 GND Relay Outputs Sensor Inputs	Screw terminals ratings are substantially in excess of any I/O point ratings. Screw terminals are pluggable. They unplug from the unit in 3, 8, and 12-position blocks.

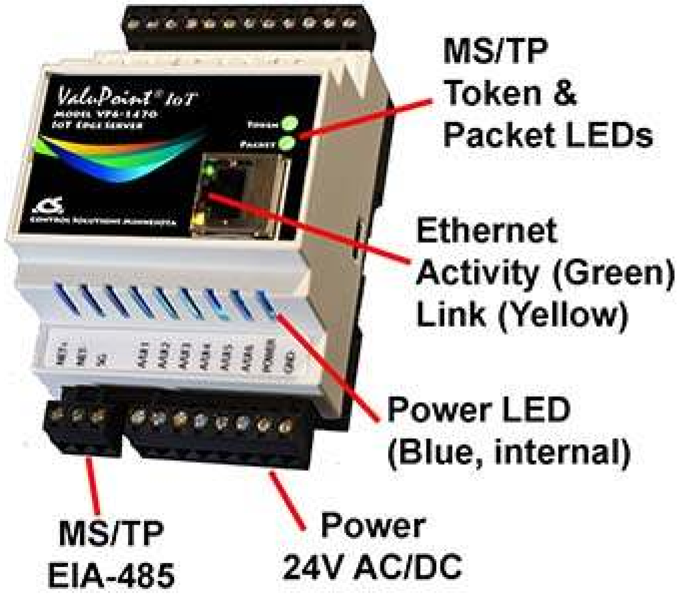
The RS-485 should be wired as illustrated below.



A.2 Front Panel LED Indicators

Power-up LED behavior: On power up, the Packet LED will remain on solid red for about 20 seconds, then the Token and Packet LEDs will do a "lamp test" where Token is yellow and Packet is Red simultaneously for about 1 second, and then both Token and Packet turn green simultaneously for about 1 second. The LEDs will then begin to operate according to their normal functionality.

If the gateway is powered up with no Ethernet network attached, the Token and Packet LEDs will continue to blink yellow/red indefinitely until the network is connected. Then they will flash green once, and then proceed to normal operation.



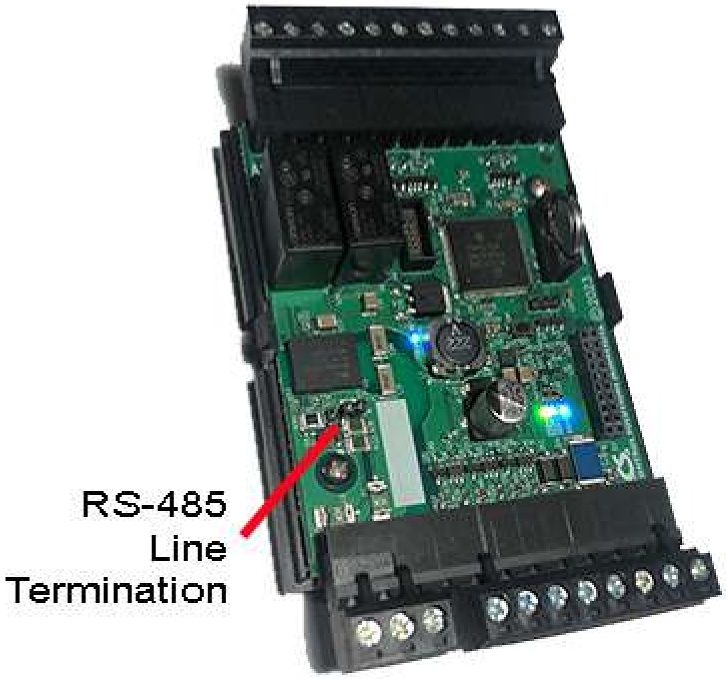
VP6-1470 Token and Packet LEDs reflect BACnet MS/TP traffic, and the Ethernet activity LED will indicate network traffic in general.

VP6-1470 LEDs indicate as follows (LEDs are bi-color):

Token	Flashes green each time the MS/TP token is passed. Flashes yellow each time the gateway sends a Poll For Master on the MS/TP link. (If it appears to be solid yellow, this is an indication that it is never passing the token, meaning it is not seeing any other devices on the network to pass the token to.)
Packet	Flashes green each time a request is sent on the MS/TP link, or a reply is received on the MS/TP link. Flashes red if the request resulted in an error.
Ethernet Activity	Green LED is on solid during portions of the boot-up process, and then flashes briefly when Ethernet network traffic is detected.
Ethernet Link	Yellow LED indicates an Ethernet link is present. This indicator will light if a link is present regardless of processor or network activity. If not lit, check network wiring.
Power	Blue LED (internal) on any time power is present and internal power supply is functioning.

A.3 RS-485 Line Termination

RS-485 line termination jumper is located as indicated in the photo. The line termination is "on" when the jumper block is aligned with the screened white block on the circuit board. Termination is required when the VP6-1470 is the last device on the daisy chain.



A.4 Soft Configuration Reset

Soft reset should be used to remove all configuration information any time you do have the ability to connect to the gateway's web user interface. The "Clear Configuration" action is described in Section 3.1.5. Using the forced hard reset should only be used as a last resort if you are unable to connect to the gateway because the SSL certificates are invalid for a secure connection or you are unable to recover the lost IP address.

A.5 Discovering Lost IP Address

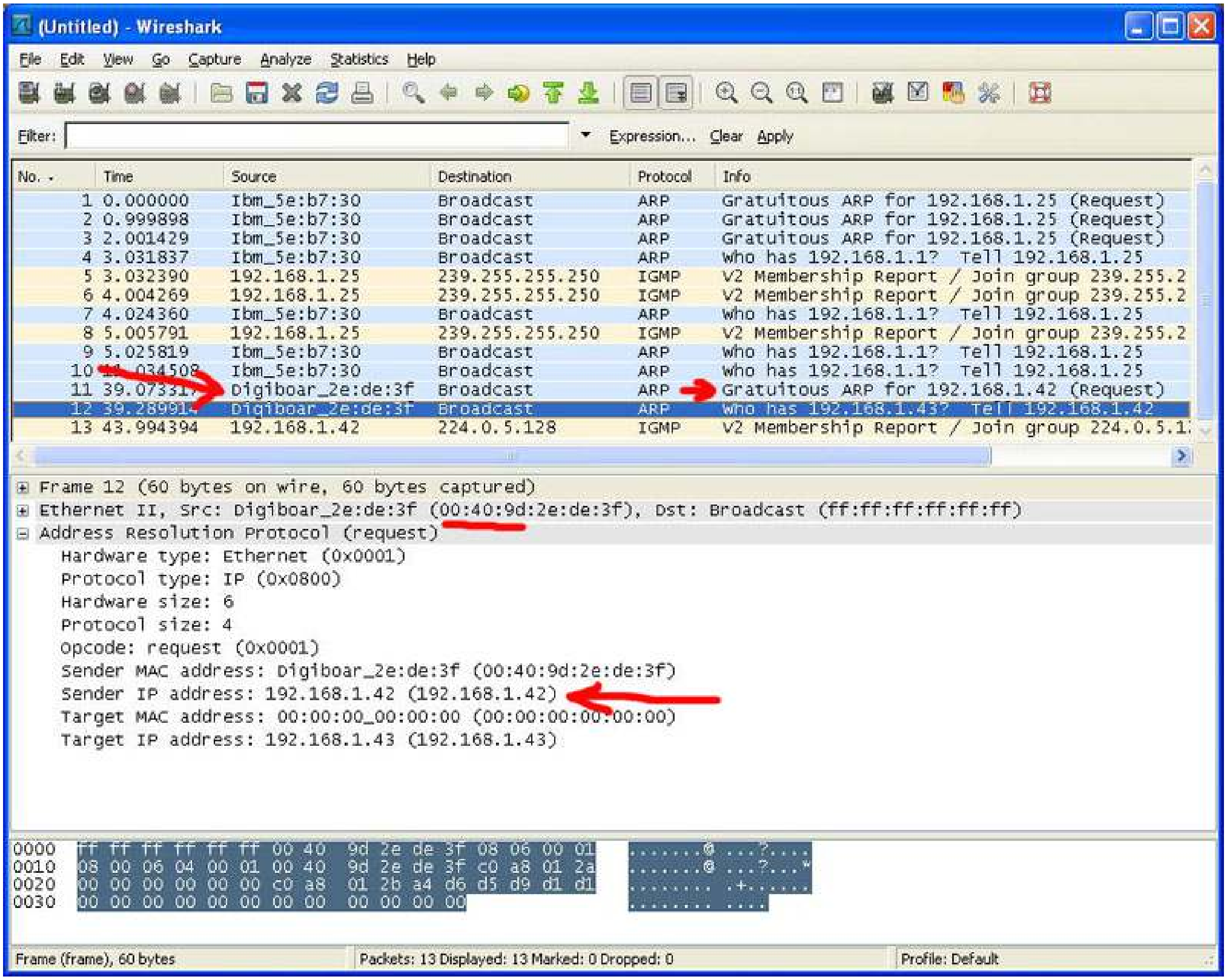
You can use Wireshark to discover a lost IP address if the gateway is still functional. Connect the gateway directly to your PC running Wireshark using a cross-over cable (or standard CAT5 cable if your PC supports auto-MDIX). With Wireshark running, power up the gateway.

Upon power up, VP6-1470 will ping its own IP address one or more times. This is part of its duplicate address resolution mechanism. If it finds another device with its own IP address, it will set its own IP address to a default pseudo-random address generally starting with 192.

Wait until you are certain VP6-1470 has booted up, or wait 2-3 minutes to be sure if you don't recognize the bootup LED sequence. Now look for the ARP packets and note what IP address they came from. This is your device. (To make sure it is your device, connect only the VP6-1470 to your PC while doing this exercise.)

Your device will have a MAC address that starts with 00:40:9D, also labeled with a source that starts with “Digiboar_”. This label comes from the fact that the server modules used on Control Solutions IP products are made by Digi International, previously known as “Digiboard”.

There will usually be one or more "pings" or ARP packets to the device's own IP address, and one last ping to its own address plus one. In the illustration here, the BB3-7301 is located at 192.168.1.42.

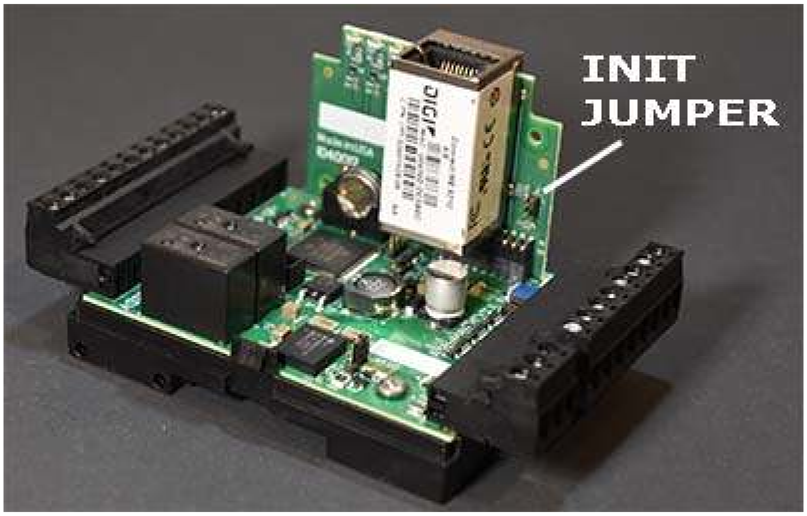

(Untitled) - Wireshark
File Edit View Go Capture Analyze Statistics Help
Filter:
Expression... Clear Apply

```
No. -   Time         Source               Destination        Protocol  Info
    1 0.000000     Ibm_5e:b7:30         Broadcast          ARP       Gratuitous ARP for 192.168.1.25 (Request)
    2 0.999898     Ibm_5e:b7:30         Broadcast          ARP       Gratuitous ARP for 192.168.1.25 (Request)
    3 2.001429     Ibm_5e:b7:30         Broadcast          ARP       Gratuitous ARP for 192.168.1.25 (Request)
    4 3.031837     Ibm_5e:b7:30         Broadcast          ARP       Who has 192.168.1.1?  Tell 192.168.1.25
    5 3.032390     192.168.1.25         239.255.255.250    IGMP      V2 Membership Report / Join group 239.255.2
    6 4.004269     192.168.1.25         239.255.255.250    IGMP      V2 Membership Report / Join group 239.255.2
    7 4.024360     Ibm_5e:b7:30         Broadcast          ARP       Who has 192.168.1.1?  Tell 192.168.1.25
    8 5.005791     192.168.1.25         239.255.255.250    IGMP      V2 Membership Report / Join group 239.255.2
    9 5.025819     Ibm_5e:b7:30         Broadcast          ARP       Who has 192.168.1.1?  Tell 192.168.1.25
   10 11.034508    Ibm_5e:b7:30         Broadcast          ARP       Who has 192.168.1.1?  Tell 192.168.1.25
   11 39.073317    Digiboar_2e:de:3f    Broadcast          ARP       Gratuitous ARP for 192.168.1.42 (Request)
   12 39.289914    Digiboar_2e:de:3f    Broadcast          ARP       Who has 192.168.1.43?  Tell 192.168.1.42
   13 43.994394    192.168.1.42         224.0.5.128        IGMP      V2 Membership Report / Join group 224.0.5.1:

⊞ Frame 12 (60 bytes on wire, 60 bytes captured)
⊞ Ethernet II, Src: Digiboar_2e:de:3f (00:40:9d:2e:de:3f), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
⊟ Address Resolution Protocol (request)
    Hardware type: Ethernet (0x0001)
    Protocol type: IP (0x0800)
    Hardware size: 6
    Protocol size: 4
    Opcode: request (0x0001)
    Sender MAC address: Digiboar_2e:de:3f (00:40:9d:2e:de:3f)
    Sender IP address: 192.168.1.42 (192.168.1.42)
    Target MAC address: 00:00:00_00:00:00 (00:00:00:00:00:00)
    Target IP address: 192.168.1.43 (192.168.1.43)

0000  ff ff ff ff ff ff 00 40  9d 2e de 3f 08 06 00 01   .......@ ...?....
0010  08 00 06 04 00 01 00 40  9d 2e de 3f c0 a8 01 2a   .......@ ...?...*
0020  00 00 00 00 00 00 c0 a8  01 2b a4 d6 d5 d9 d1 d1   ........ .+......
0030  00 00 00 00 00 00 00 00  00 00 00 00               ........ ....

Frame (frame), 60 bytes    Packets: 13 Displayed: 13 Marked: 0 Dropped: 0    Profile: Default
```

A.6 Forced Hard Configuration Reset

IMPORTANT: Before considering the forced hard reset, be sure you have considered soft configuration reset, or discovering lost IP address if applicable.

The "Init" jumper inside the VP6-1470 serves two purposes, and what it does depends on whether you apply the jumper before or after the VP6-1470 boots up.



Hard Configuration Reset:

Installing the jumper after bootup causes the VP6-1470 to do a hard reset on its configuration memory. The IPv4 address will be reset to 10.0.0.101. The root password will be reset to the original default password. After clearing all configuration, the VP6-1470 will automatically restart. Remove the jumper when you see the indication of restart after about 30 seconds, which is both LEDs coming on solid on the RJ45 Ethernet connector and remaining on for a couple of seconds. If you miss the start of reboot, both LEDs on the RJ45 will come on and stay on. It will now be attempting the firmware update, but you can abort that by simply powering down the VP6-1470. If both LEDs on the RJ45 jack come on and remain on, remove the jumper and then power cycle the VP6-1470.

Once you have regained access to the device, go to the File Manager page, execute the Clear All configuration action, then select the file named as "Boot configuration" and execute the Save XML Config File action to wipe out any configuration normally saved in the XML configuration file.

Note: The forced hard reset will restore HTTP web access and disable HTTPS web access. The forced hard reset will also restore FTP access to allow FTP firmware uploads if needed.

Note: The hard reset of configuration also means all of your resource allocations are reset to original factory defaults. If you want resource allocations that are different, you will need to repeate the allocation setup as described in Section 3.4.

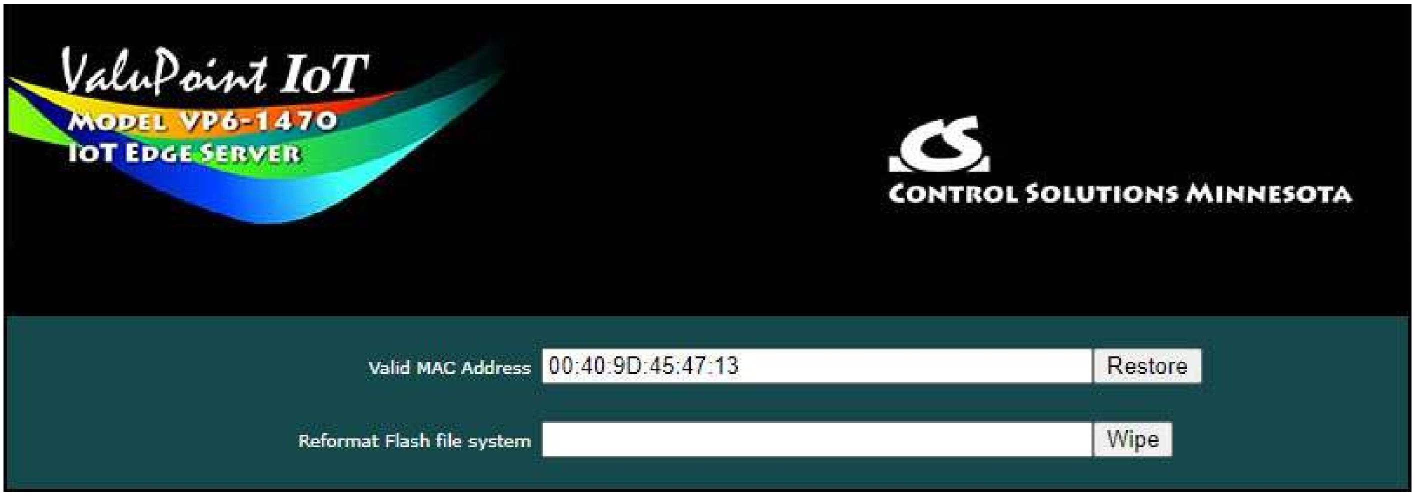
Firmware Update Recovery:

Installing this jumper prior to power-up causes the server to go into TFTP firmware update mode. Normally you would perform a firmware update by simply uploading a new image.bin file (provided by Control Solutions tech support) using the VP6-1470's internal FTP server and a command line FTP session on your PC (Linux or Windows command line). Detailed instructions are included in the zip file that also contains the applicable image.bin file.

Should the FTP upload fail for some reason, then you need to resort to the TFTP upload method as the fallback method. Full details on how to go about this can be found under the topic "Restoring a corrupt application image" at https://info.csimn.com.

Additional maintenance page:

Go to http(s)://10.0.0.101/html/pgRestoreAddr.html to find the following page (substituting your IP address). It serves two purposes as noted below, which ideally you will never have a use for.



Valid MAC Address: 00:40:9D:45:47:13

Reformat Flash file system:

File System Wipe:

On rare occasion, the Flash file system has been observed to get corrupted as a result of losing power while a write operation was in progress. This is most effectively confirmed by opening a command prompt FTP session (Windows 10 PowerShell) to try to view the files in the Flash file system. If FTP fails to show any files, in addition to other problems saving or loading files, it may be that the file system has gotton corrupted. If this happens, go to the page pictured above, and enter the Reformat key, then click Wipe, and then power cycle the device (or restart from the File Manager page). The reformat key is 55AAAA55. Simply type that into the window next to the Wipe button.

MAC Address Restore:

In the event the MAC address has been reset due to NVRAM checksum failure, this page will permit restoring the MAC address to its original address as printed on the component label internal to this device, or on the default password label found on the outside or on external documentation included with the device.

If the MAC address is deemed to be valid, the window will be labeled "Valid MAC Address" and you will not be allowed to change it. If the MAC address is deemed to be invalid, the window will be labeled "Restore MAC Address" and you should then enter the correct MAC address and click Restore. A restart is then needed.

A.7 Firmware Update Notes

The most up to date firmware is shipped with all new devices. This isn't like a new laptop where you spent the first half a day updating software on a computer you thought was brand new. If you believe you have discovered an issue that you believe a firmware update might fix, contact technical support first to confirm whether that is the case, and then to get a login to the firmware update support site.

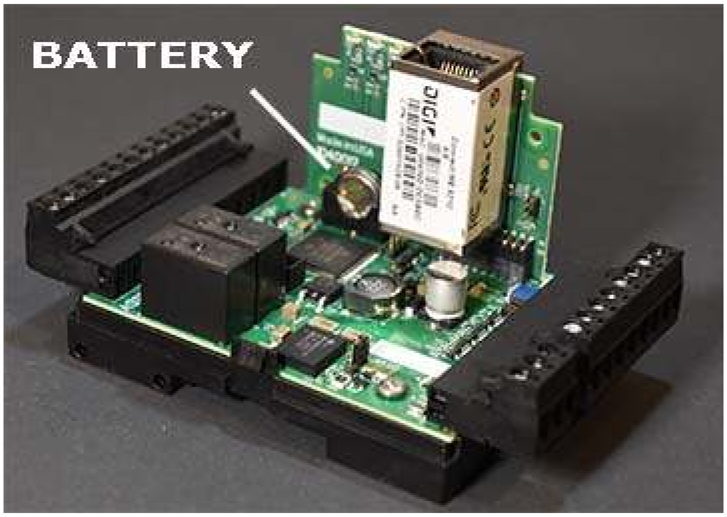
The brute force approach to updating firmware using TFTP as noted in the section above is always available, but the more graceful approach is to use FTP to upload the new image.bin file. There is one minor problem: The upload wants to buffer the entire file in RAM while it procedes to reprogram the Flash memory. **If the memory utilization indicated on the Resources page in your device is above about 30%, the FTP upload will fail, and thus the firmware update will not take place.**

You have two choices: (1) Use the TFTP approach, or (2) Temporarily reconfigure your gateway to use a minimum of resources to free up space to temporarily buffer the image.bin file upload.

More detailed instructions for the FTP upload are included in the zip file you will download to obtain the firmware update. Instructions for the TFTP upload are available in our knowledgebase at https://info.csimn.com.

A.8 Battery Replacement

No action is required of the user to activate the battery that backs up the real time clock. The battery should have a 10-year life in normal operation with
"normal" meaning that the device is normally continuously powered for use with only intermittent dependency on the battery backup.



Replace battery with BR1225A only. Use of another battery may present a risk of fire or explosion. Replace with battery polarity as marked on the circuit board. Reverse polarity of the battery will not damage the board, but the clock will not be backed up if the battery is reversed.

CAUTION: The lithium battery contained in this device may explode if mistreated. DO NOT recharge, disassemble, or dispose of in fire.

Appendix B Trouble Shooting

B.1 File Upload Errors

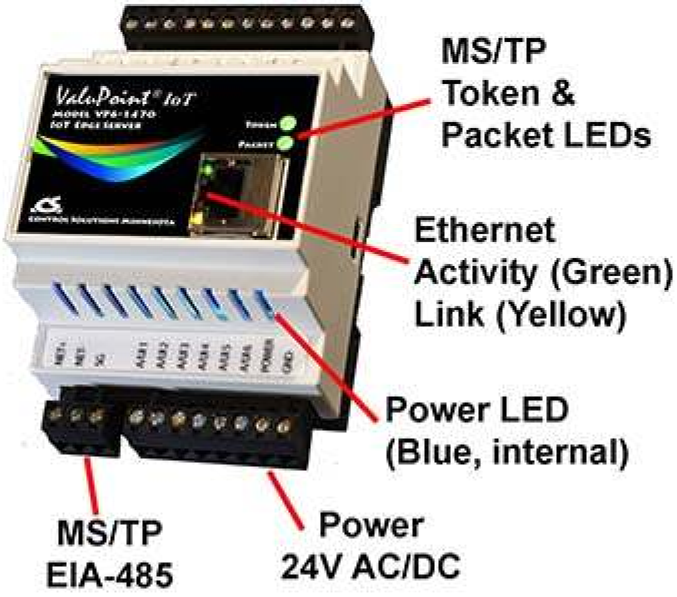
If you get a "File upload error: -1" message, click the browser's "back" button, then simply click the View button to view any file (does not matter which file), and then click browser's "back" button again to return to the File Manager page. This gets the browser and HTTP server back in sync, and this requirement generally happens only once following power-up.

If you get a different persistent file upload error, check the space available versus the size of the file you are trying to upload. Available file space is displayed on the File Manager page as "Free space". The free space indicated is approximate. If close to zero, try deleting some files first.

B.2 BACnet Trouble Shooting

B.2.1 General Trouble Shooting

Refer to Appendix A for additional details about hardware.



(a) Does the device have power? A blue LED inside the case, visible through the air vent slots, will be on if there is power present.

(b) Is the Ethernet Link LED (yellow) on? If not, check your network cable. If LED activity on the RJ45 jack for the Ethernet connection is normal, then refer to Trouble

Shooting BACnet IP below.

(c) Is the Token LED flashing? If not, or you are not sure of its behavior, refer to the Token LED discussion that follows under Trouble Shooting MS/TP.

B.2.2 Error Codes, Reliability Codes

Attempts to communicate with other devices by gateway client functions will result in error codes being set as non-zero reliability codes in the affected object. Additional error information can be viewed on the respective client errors pages in the Web UI.

When the reliability code is non-zero, the fault flag is also set. Therefore, the Status Flags indication will typically be "F,T,F,F" any time the reliability code is something other than zero (zero means no errors to report).

Specific error responses will generally be due to incorrect configuration. However, timeouts or “no response” errors can be more difficult to trouble shoot as these can be a combination of configuration errors in the local device, configuration errors on the network in general, or wiring problems.

B.2.3 Auto-Reset Errors

Reliability codes will “latch” by default and require that you read the Reliability property in order to reset it to zero, assuming the problem has gone away. Once the non-zero reliability code has been read (by reading the Reliability property), it will reset to zero the next time the object is updated, provided the problem has been resolved.

Since many systems do not automatically read Reliability codes, but do automatically respond to the Fault Status Flag associated with the non-zero reliability code, an auto-reset option is available. This option is indicated as “Allow fault self-reset without Ack” on the BACnet Settings page. When selected, reliability codes will return to zero as soon as the problem has been resolved, regardless of whether the non-zero reliability code was ever acknowledged by reading it.

Many systems will report an object as "offline" because its fault status bit is set. It is not actually offline, and is in fact communicating just fine trying to tell you that there is a problem. But many front end systems don't recognize this and blindly claim "offline" as a result of the fault bit in the status property. If you are having this issue as the result of communication errors related to polling other devices using the gateway’s client maps, try setting the Auto-Reset Errors option here.

B.2.4 Trouble Shooting BACnet IP

BACnet IP is typically easier to get running than MS/TP just because Ethernet is pretty straight forward. The most frequent problem is "no response" or timeout. The most common cause of this problem for BACnet IP is a network configuration problem, such as incorrect IP address or IP address that cannot be reached as configured. The problem sometimes lies outside the Babel Buster and may require consulting with the

IT personnel responsible for the network if on a large network.

The subnet mask determines what part of the IP address constitutes the domain, and all devices on the same network must be on the same domain before they can communicate.

Obviously two devices being assigned the same IP address is going to cause trouble. If you can communicate at all with a device having a duplicate IP address, it will be intermittent, and potentially erratic as the other device having the same IP address may be responding to your queries.

If you are connecting via one or more routers, then everything that applies to routing issues will apply to your device. A complete discussion of NAT routing, BACnet routing, etc, is beyond the scope of this document - you should refer these questions to your IT administrator when applicable.

Once the VP6-1470 is communicating BACnet IP, then next area for possible concern is with the BACnet client. If the gateway is supposed to be polling other IP devices, but the data does not appear correct, the first thing to check is the reliability code. Any reliability code other than zero is a problem. Refer to the list at the bottom of any of the Data Objects pages for explanation of the non-zero codes. If the reliability code indicates that an error was returned by the server (meaning the other BACnet device you are trying to query), then refer to the BACnet Diagnostics page for additional error information.

B.2.5 Trouble Shooting BACnet MS/TP

The Token LED can give you some clues about MS/TP network connectivity. The Token LED will flash yellow each time it sends a Poll For Master, and green each time it passes the token.

Token LED remains OFF:

The MS/TP port does not get initialized until the configuration file is successfully loaded. If a faulty XML file was loaded, then the port might not get initialized and the Token LED will remain off. To confirm that the configuration file is good, go to the File Manager page, select your boot configuration file, select Load XML Config File, and Execute. If you get no error messages, then the file is good and the port should be initialized.

When an MS/TP device first comes online, it is only listening - waiting for its MAC address to be polled in a Poll For Master message. If port settings like baud rate are wrong and the port is constantly hearing only noise as a result, then the Token LED will never flash because this MS/TP device is never given a chance to talk. Another less likely possibility is that this MS/TP device’s MAC address has been set outside the Max Master range of other devices already on the network. Hearing nothing but noise can also be caused by RS-485 wiring problems. For a detailed discussion of RS-485 wiring, refer to this link: https://csimn.com/CSI_pages/RS-485-FAQ.html.

Token LED solid ON Yellow:

The local MS/TP device will first listen to see if it hears anything on the network. If not, then it will begin polling for masters looking for somebody to talk to. If no other devices ever reply, and the only thing going on is more Poll For Master messages, then the Token LED will appear to be on solid yellow because it is only flashing yellow very rapidly.

Token LED flashing yellow and green:

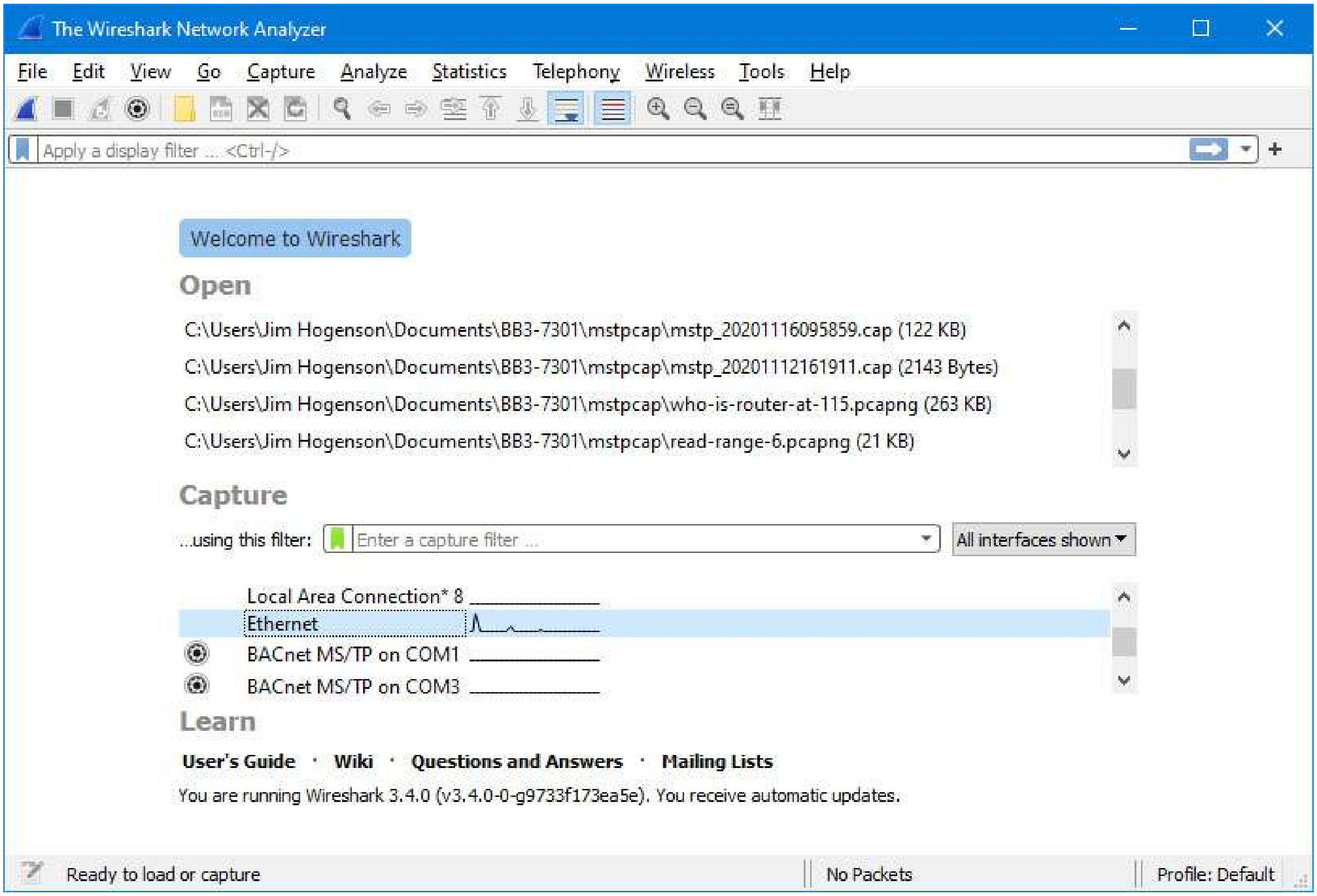
The normal behavior will be continuous flashing green at some rate dependent on overall network load along with occasional flashes of yellow when it polls for other masters. If and how often you see flashes of yellow depend on MAC address distribution across the network.

Token LED flashing yellow and green with long pauses OFF:

This is an indication of almost working but there is confusion somewhere on the network either due to misconfiguration, or due to noise resulting from RS-485 wiring issues. One misconfiguration that can cause this appearance is an incorrect Max Master setting in one or more devices on the network. The Max Master setting MUST be identical in all devices. In addition, the MAC address MUST be unique in all devices, and duplicate MAC addresses can also cause this behavior. If you are certain all configuration is correct and are still seeing this behavior, then you need to start looking at wiring. For a detailed discussion of RS-485 wiring, refer to this link: https://csimn.com/CSI_pages/RS-485-FAQ.html.

B.2.6 Using Wireshark

One of the most useful tools for diagnosing BACnet IP problems is Wireshark. You can get a free copy at www.wireshark.org. Additional important information about Wireshark can be found in **Appendix F** of this user guide. When you start Wireshark, the startup screen appears as follows (as of this writing). Click on Ethernet (for BACnet IP) or BACnet MS/TP on COMx to begin capturing traffic.


The Wireshark Network Analyzer
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
Apply a display filter ... <Ctrl-/>
Welcome to Wireshark
Open
Capture
Learn
User's Guide · Wiki · Questions and Answers · Mailing Lists

C:\Users\Jim Hogenson\Documents\BB3-7301\mstpcap\mstp_20201116095859.cap (122 KB)
C:\Users\Jim Hogenson\Documents\BB3-7301\mstpcap\mstp_2020112161911.cap (2143 Bytes)
C:\Users\Jim Hogenson\Documents\BB3-7301\mstpcap\who-is-router-at-115.pcapng (263 KB)
C:\Users\Jim Hogenson\Documents\BB3-7301\mstpcap\read-range-6.pcapng (21 KB)

...using this filter: Enter a capture filter ... All interfaces shown

Local Area Connection* 8
Ethernet
BACnet MS/TP on COM1
BACnet MS/TP on COM3

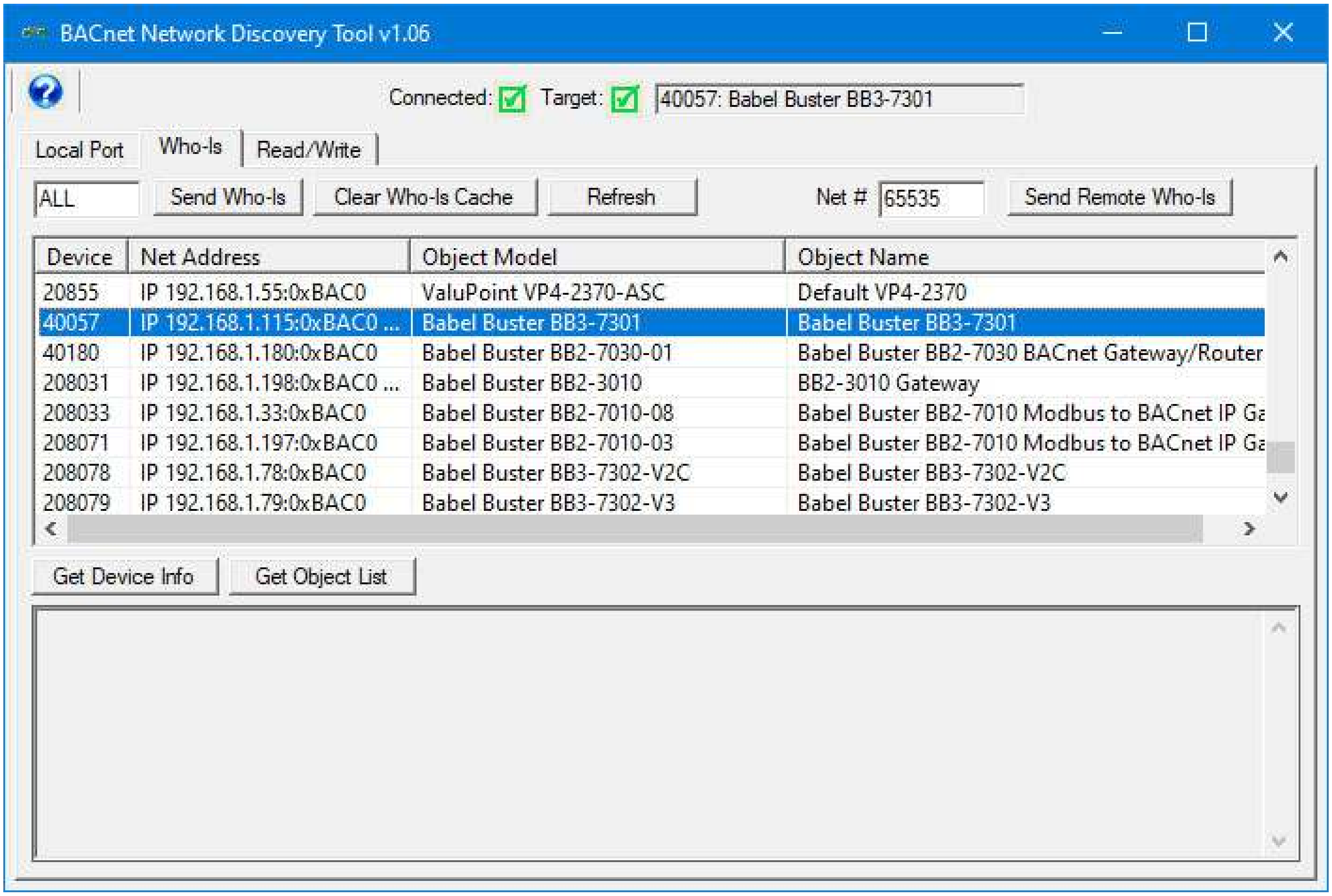
You are running Wireshark 3.4.0 (v3.4.0-0-g9733f173ea5e). You receive automatic updates.

Ready to load or capture | No Packets | Profile: Default

B.2.7 Using Network Discovery Tool

Control Solutions has created a Network Discovery Tool to perform simple diagnostics on BACnet devices and networks. It works with BACnet IP using your PC's Ethernet connection - assuming your PC is connected to the BACnet IP network. It will also work with MS/TP using the Control Solutions MTX002 USB to MS/TP adapter.

The Network Discovery Tool can be used to discover devices on the network.



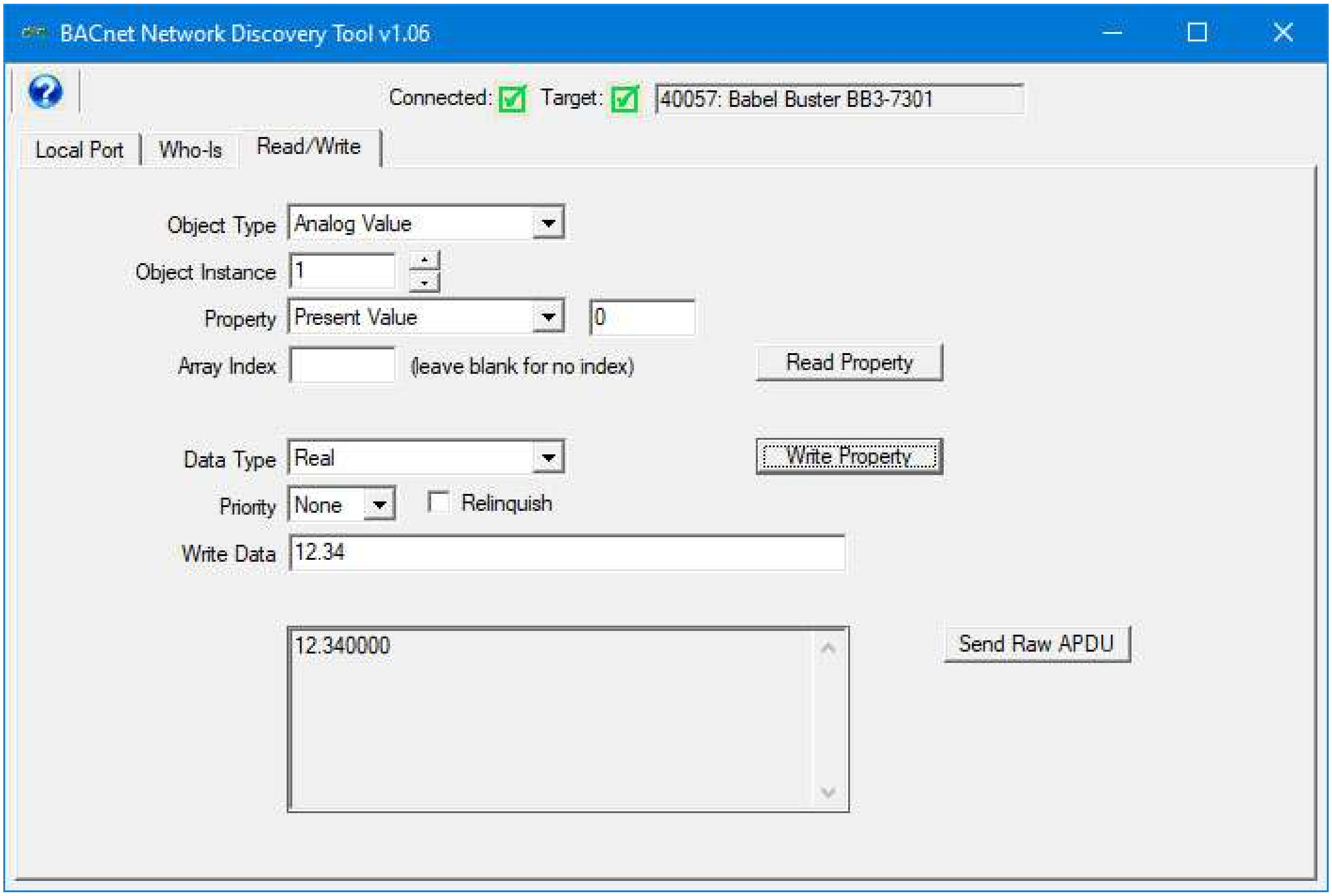
Connected: ☑ Target: ☑ 40057: Babel Buster BB3-7301

ALL

Net # 65535

Device	Net Address	Object Model	Object Name
20855	IP 192.168.1.55:0xBAC0	ValuPoint VP4-2370-ASC	Default VP4-2370
40057	IP 192.168.1.115:0xBAC0 ...	Babel Buster BB3-7301	Babel Buster BB3-7301
40180	IP 192.168.1.180:0xBAC0	Babel Buster BB2-7030-01	Babel Buster BB2-7030 BACnet Gateway/Router
208031	IP 192.168.1.198:0xBAC0 ...	Babel Buster BB2-3010	BB2-3010 Gateway
208033	IP 192.168.1.33:0xBAC0	Babel Buster BB2-7010-08	Babel Buster BB2-7010 Modbus to BACnet IP Ga
208071	IP 192.168.1.197:0xBAC0	Babel Buster BB2-7010-03	Babel Buster BB2-7010 Modbus to BACnet IP Ga
208078	IP 192.168.1.78:0xBAC0	Babel Buster BB3-7302-V2C	Babel Buster BB3-7302-V2C
208079	IP 192.168.1.79:0xBAC0	Babel Buster BB3-7302-V3	Babel Buster BB3-7302-V3

The Network Discovery Tool can be used to read and write properties in any BACnet device on the network.



Connected: ☑ Target: ☑ 40057: Babel Buster BB3-7301

Object Type: Analog Value

Object Instance: 1

Property: Present Value 0

Array Index: (leave blank for no index)

Data Type: Real

Priority: None ☐ Relinquish

Write Data: 12.34

```
12.340000
```

The complete user guide for the Network Discover Tool can be viewed by clicking the blue "?" help icon in the upper left corner of the tool. You can obtain a free copy of the tool on the Tool Links page under Support at the Control Solutions web site (https://csimn.com/CSI_pages/Tools.html).

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Appendix C CSV File Formats

HINT: If you get "table full" errors while importing CSV files, you might not have sufficient resources allocated. You may need to increase some counts on the Resources page.

C.1 BACnet IP Client Read/Write Maps

The CSV file for configuring BACnet IP client read and write maps should contain a single header line with the labels indicated below, and content as applicable.

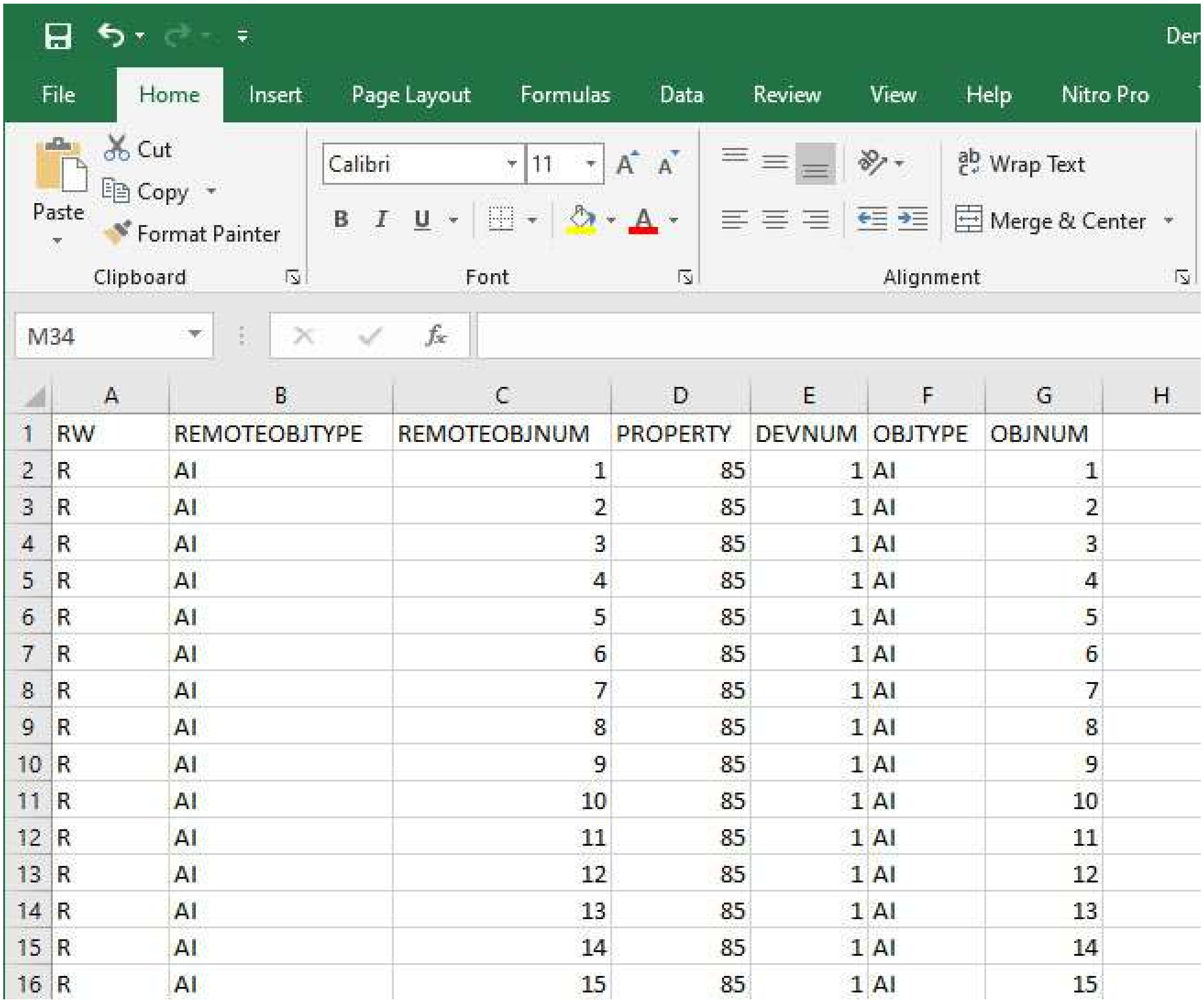
Header Line Label	Notes	Description of Use
RW	-	Enter 'R' to Read from a remote device, or 'W' to Write to a remote device.
REMOTEOBJTYPE	-	Indicate the type of local BACnet object (see C.2) that should be read or written at the remote device. In addition to the object types recognized as local objects, the client may read remote Accumulator objects referenced as type "AC".
REMOTEOBJNUM	-	Indicate the remote object number that goes along with object type in the previous column.
PROPERTY	-	Specify by BACnet code the object property (see Appendix E) that should be read. The most common is Present Value, whose code is 85.
INDEX	-	If the property to be read/written is an array, then an array index is needed. Specify "no index" by entering zero in the CSV column. Otherwise enter 1 or greater, and note that actual index values will be offset by -1 when applied by the BACnet client.
DEVNUM	-	Specify the device number where the remote object is to be found. This number is used to look up a device in the BACnet Client Device table which contains the device's BACnet Device Instance, or static binding if applicable, etc.
SCALE	-	Data is multiplied by this scale factor after read from a remote device or before being written to a remote device.
OFFSET	-	This offset is added to the data value after read from a remote device or before being written to a remote device.
POLL	-	Specify a periodic poll time in seconds (fractions of sections are recognized).

OBJTYPE	-	Indicate the type of local BACnet object (see C.2) where data read from a remote device will be placed, or where data written to a remote device will be taken from.
OBJNUM	-	Indicate the object number that goes along with object type in the previous column.
DEFAULT	1	When READING: The default value will be stored into the local object after the given number of read failures if the fail count (MAXFAIL) is non-zero.
MAXFAIL	1	If non-zero, sets the maximum number of times that a read attempt may fail before the default value will be placed in the local object. Setting the count to zero will disable the default, and the object will retain the most recent value obtained.
DATATYPE	2	Provide the data type code that the remote object being written expects to receive. 1=Boolean, 2=Unsigned Integer, 3=Signed Integer, 4=Real, 9=Enumerated (note that 5, 6, 7, 8 are not used here)
PRIORITY	2	If writing to a commandable object, then a priority (1-16) must be provided.
MAXQUIET	2	If using 'send on delta', to guarantee that the remote device will be written at least occasionally even if the data does not change, enter a maximum quiet time (in seconds).
MINQUIET	2	If using 'send on delta', and the delta increment is small, the result can be a large amount of network traffic. To limit network traffic, provide a MINQUIET time (in seconds) that must elapse between transmission of changed values.
DELTA	2	The local object/register data may be written to the remote device periodically, or when the local value changes, or both. To send upon change (send on delta), provide a DELTA value as the amount by which the local object must change before being written to the remote device. Leave blank if send on delta should not be used.

Notes:
1) Applies only to Read maps (enter zero as place holder for Write maps)
2) These apply only to Write maps (enter zero as place holder for Read maps)

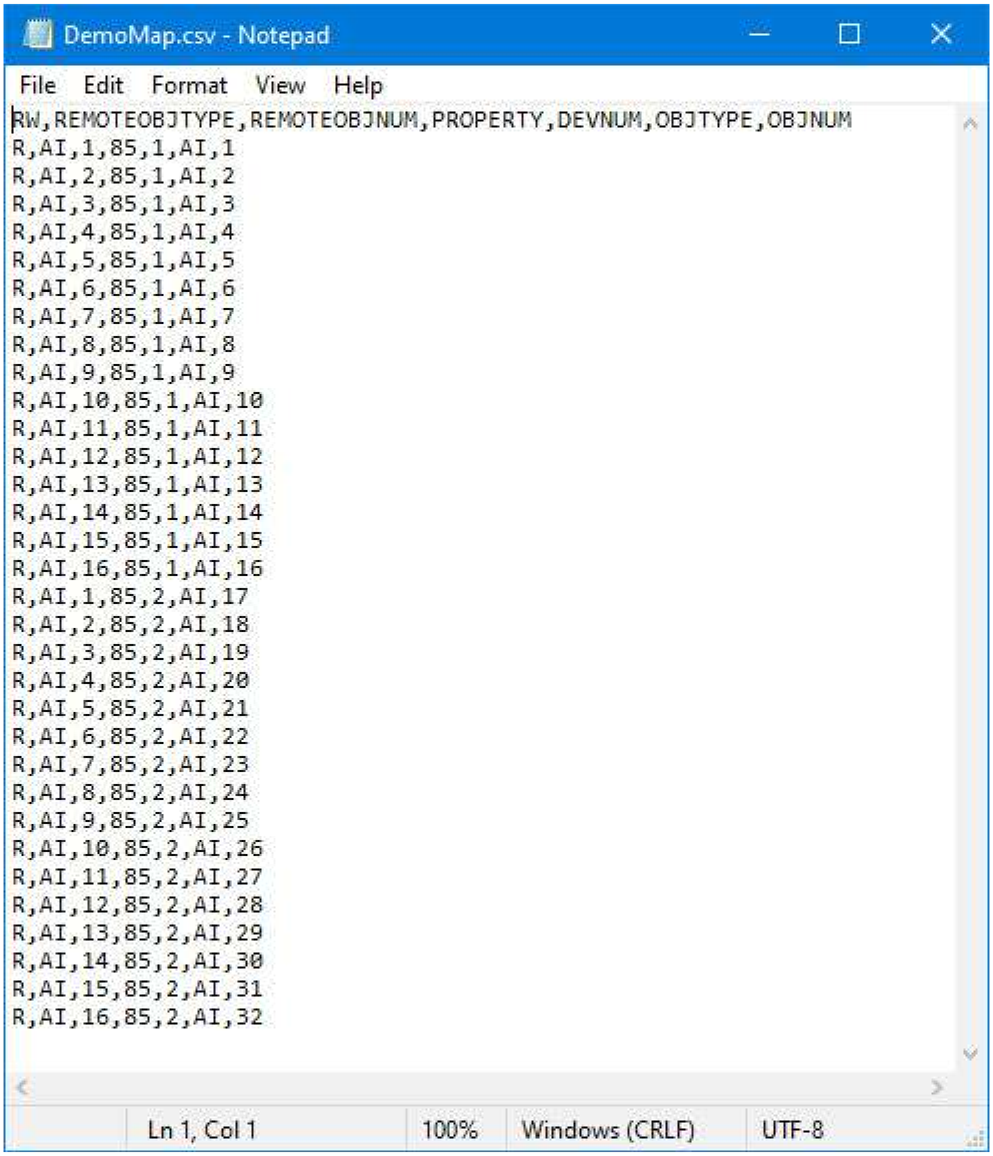
The minimum required header line for BACnet IP must include RW, REMOTEOBJTYPE, REMOTEOBJNUM, PROPERTY, DEVNUM, OBJTYPE, OBJNUM. All other columns are optional.

A typical CSV configuration file as viewed in Excel would look something like this:



	A	B	C	D	E	F	G	H
1	RW	REMOTEOBJTYPE	REMOTEOBJNUM	PROPERTY	DEVNUM	OBJTYPE	OBJNUM	
2	R	AI	1	85	1	AI	1	
3	R	AI	2	85	1	AI	2	
4	R	AI	3	85	1	AI	3	
5	R	AI	4	85	1	AI	4	
6	R	AI	5	85	1	AI	5	
7	R	AI	6	85	1	AI	6	
8	R	AI	7	85	1	AI	7	
9	R	AI	8	85	1	AI	8	
10	R	AI	9	85	1	AI	9	
11	R	AI	10	85	1	AI	10	
12	R	AI	11	85	1	AI	11	
13	R	AI	12	85	1	AI	12	
14	R	AI	13	85	1	AI	13	
15	R	AI	14	85	1	AI	14	
16	R	AI	15	85	1	AI	15	

The same CSV file as viewed with a simple text editor like Notepad would look like this:



```
RW,REMOTEOBJTYPE,REMOTEOBJNUM,PROPERTY,DEVNUM,OBJTYPE,OBJNUM
R,AI,1,85,1,AI,1
R,AI,2,85,1,AI,2
R,AI,3,85,1,AI,3
R,AI,4,85,1,AI,4
R,AI,5,85,1,AI,5
R,AI,6,85,1,AI,6
R,AI,7,85,1,AI,7
R,AI,8,85,1,AI,8
R,AI,9,85,1,AI,9
R,AI,10,85,1,AI,10
R,AI,11,85,1,AI,11
R,AI,12,85,1,AI,12
R,AI,13,85,1,AI,13
R,AI,14,85,1,AI,14
R,AI,15,85,1,AI,15
R,AI,16,85,1,AI,16
R,AI,1,85,2,AI,17
R,AI,2,85,2,AI,18
R,AI,3,85,2,AI,19
R,AI,4,85,2,AI,20
R,AI,5,85,2,AI,21
R,AI,6,85,2,AI,22
R,AI,7,85,2,AI,23
R,AI,8,85,2,AI,24
R,AI,9,85,2,AI,25
R,AI,10,85,2,AI,26
R,AI,11,85,2,AI,27
R,AI,12,85,2,AI,28
R,AI,13,85,2,AI,29
R,AI,14,85,2,AI,30
R,AI,15,85,2,AI,31
R,AI,16,85,2,AI,32
```

C.2 BACnet Object Types

Use the following labels to denote these BACnet object types.

CSV Label	BACnet Object Type
AI	Analog Input
AO	Analog Output
AV	Analog Value
BI	Binary Input
BO	Binary Output
BV	Binary Value
MI	Multistate Input
MO	Multistate Output
MV	Multistate Value

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Appendix D BACnet Object Properties

D.1 Data Object Properties (Analog, Binary, Multi-state)

The following properties are found in the Analog, Binary, and Multi-state types of Input, Output, and Value objects. Some properties apply only to certain object types as noted where applicable.

Property	Encoding
Object_Identifier (75)	BACnetObjectIdentifier
Object_Name (77) (W)	CharacterString "Analog Input *n*"
Object_Type (79)	BACnetObjectType ENUMERATED: analog-input (0) analog-output (1) analog-value (2) binary-input (3) binary-output (4) binary-value (5) device (8) multi-state-input (13) multi-state-output (14) multi-state-value (19)
Present_Value (85) (W)	REAL (analog objects) ENUMERATED (binary objects) Unsigned (multi-state objets) (no index) (priority required when writing commandable objects) (input objects writeable only when out of service)
Status_Flags (111)	BACnetStatusFlags BIT STRING: fault(1), out-of-service(3)
Event_State (36)	BACnetEventState ENUMERATED: normal(0), fault(1)
Reliability (103)	BACnetReliability ENUMERATED: normal(0) *Vendor specific:* Modbus client/master, no response from slave (64)

	Modbus client/master, crc error (65) Modbus exception, illegal function code (66) Modbus exception, illegal data address (67) Modbus exception, illegal data value (68) Modbus exception, code+65, rarely used (69..79) Local device, configuration property fault (80) Faulty Modbus packet(81) BACnet IP client, device timeout (82) BACnet IP client, error returned by server (83)
Description (28) (W)	CharacterString
Out_Of_Service (81) (W)	BOOLEAN
COV_Increment (22) (W)	REAL (analog objects only)
Priority_Array (87)	BACnetPriorityArray (commandable objects only) SEQUENCE SIZE (16) OF BACnetPriorityValue REAL (each element, analog output objects) ENUMERATED (each element, binary output objects) Unsigned (each element, multi-state output objects)
Relinquish_Default (104) (W)	REAL (analog objects) ENUMERATED (binary objects) Unsigned (multi-state objets)
Polarity (84)	BACnetPolarity (binary objects only) ENUMERATED: normal(0)
Number_Of_States (74)	Unsigned (multi-state objects only)
Units (117)	BACnetEngineeringUnits (analog objects only)
Active_Text (4) (W)	CharacterString (binary objects only)
Inactive_Text (46) (W)	CharacterString (binary objects only)
State_Text (110) (W)	BACnetARRAY[N] of CharacterString (multi-state objects only)

D.2 Device Object Properties

The following properties are found in the Device object.

Property	Encoding
Object_Identifier (75)	BACnetObjectIdentifier
Object_Name (77)	CharacterString

Object_Type (79)	BACnetObjectType ENUMERATED: device (8)
System_Status (112)	BACnetDeviceStatus
Vendor_Name (121)	CharacterString
Vendor_Identifier (120)	Unsigned16 (should always return 208)
Model_Name (70)	CharacterString
Fimrware_Revision (44)	CharacterString
Application_Software_Version (12)	CharacterString
Protocol_Version (98)	Unsigned
Protocol_Revision (139)	Unsigned
Protocol_Services_Supported (97)	BACnetServicesSupported
Protocol_Object_Types_Supported (96)	BACnetObjectTypesSupported
Object_List (76)	BACnetARRAY[N] of BACnetObjectIdentifier
Max_APDU_Length_Accepted (62)	Unsigned
Segmentation_Supported (107)	BACnetSegmentation
APDU_Timeout (11)	Unsigned
Number_Of_APDU_Retries (73)	Unsigned
Device_Address_Binding (30)	BACnetLIST of BACnetAddressBinding
Database_Revision (155)	Unsigned
Description (28)	CharacterString
Location (58)	CharacterString
Max_Segments_Accepted (167)	Unsigned
APDU_Segment_Timeout (10)	Unsigned
Active_COV_Subscriptions (152)	BACnetLIST of BACnetCOVSubscription
Last_Restart_Reason (196)	BACnetRestartReason
Restart_Notification_Recipients (202)	BACnetLIST of BACnetRecipient
Time_Of_Device_Restart (203)	BACnetTimeStamp
Max_Master (64)	Unsigned (0..127)

Max_Info_Frames (63)	Unsigned
Auto_Slave_Discovery (169)	BACnetARRAY[N] of BOOLEAN
Manual_Slave_Address_Binding (170)	BACnetLIST of BACnetAddressBinding
Slave_Address_Binding (171)	BACnetLIST of BACnetAddressBinding
Slave_Proxy_Enable (172)	BACnetARRAY[N] of BOOLEAN

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Appendix E BACnet Codes

E.1 BACnet Object Property Codes

BACnet property type codes may be found in your copy of the BACnet protocol specification, ANSI/ASHRAE Standard 135. That document is copyrighted, but the C enumeration shown below for reference is taken from open source code available under GPL at http://sourceforge.net, and provides essentially the same information (copyrighted by Steve Karg, licensed under GPL as noted at http://sourceforge.net).

```
typedef enum {
    PROP_ACKED_TRANSITIONS = 0,
    PROP_ACK_REQUIRED = 1,
    PROP_ACTION = 2,
    PROP_ACTION_TEXT = 3,
    PROP_ACTIVE_TEXT = 4,
    PROP_ACTIVE_VT_SESSIONS = 5,
    PROP_ALARM_VALUE = 6,
    PROP_ALARM_VALUES = 7,
    PROP_ALL = 8,
    PROP_ALL_WRITES_SUCCESSFUL = 9,
    PROP_APDU_SEGMENT_TIMEOUT = 10,
    PROP_APDU_TIMEOUT = 11,
    PROP_APPLICATION_SOFTWARE_VERSION = 12,
    PROP_ARCHIVE = 13,
    PROP_BIAS = 14,
    PROP_CHANGE_OF_STATE_COUNT = 15,
    PROP_CHANGE_OF_STATE_TIME = 16,
    PROP_NOTIFICATION_CLASS = 17,
    PROP_BLANK_1 = 18,
    PROP_CONTROLLED_VARIABLE_REFERENCE = 19,
    PROP_CONTROLLED_VARIABLE_UNITS = 20,
    PROP_CONTROLLED_VARIABLE_VALUE = 21,
    PROP_COV_INCREMENT = 22,
    PROP_DATE_LIST = 23,
    PROP_DAYLIGHT_SAVINGS_STATUS = 24,
    PROP_DEADBAND = 25,
    PROP_DERIVATIVE_CONSTANT = 26,
    PROP_DERIVATIVE_CONSTANT_UNITS = 27,
    PROP_DESCRIPTION = 28,
    PROP_DESCRIPTION_OF_HALT = 29,
    PROP_DEVICE_ADDRESS_BINDING = 30,
    PROP_DEVICE_TYPE = 31,
    PROP_EFFECTIVE_PERIOD = 32,
    PROP_ELAPSED_ACTIVE_TIME = 33,
    PROP_ERROR_LIMIT = 34,
    PROP_EVENT_ENABLE = 35,
    PROP_EVENT_STATE = 36,
    PROP_EVENT_TYPE = 37,
    PROP_EXCEPTION_SCHEDULE = 38,
    PROP_FAULT_VALUES = 39,
    PROP_FEEDBACK_VALUE = 40,
    PROP_FILE_ACCESS_METHOD = 41,
    PROP_FILE_SIZE = 42,
    PROP_FILE_TYPE = 43,
    PROP_FIRMWARE_REVISION = 44,
    PROP_HIGH_LIMIT = 45,
    PROP_INACTIVE_TEXT = 46,
    PROP_IN_PROCESS = 47,
    PROP_INSTANCE_OF = 48,
    PROP_INTEGRAL_CONSTANT = 49,
    PROP_INTEGRAL_CONSTANT_UNITS = 50,
    PROP_ISSUE_CONFIRMED_NOTIFICATIONS = 51,
    PROP_LIMIT_ENABLE = 52,
    PROP_LIST_OF_GROUP_MEMBERS = 53,
    PROP_LIST_OF_OBJECT_PROPERTY_REFERENCES = 54,
    PROP_LIST_OF_SESSION_KEYS = 55,
    PROP_LOCAL_DATE = 56,
    PROP_LOCAL_TIME = 57,
    PROP_LOCATION = 58,
    PROP_LOW_LIMIT = 59,
    PROP_MANIPULATED_VARIABLE_REFERENCE = 60,
    PROP_MAXIMUM_OUTPUT = 61,
    PROP_MAX_APDU_LENGTH_ACCEPTED = 62,
    PROP_MAX_INFO_FRAMES = 63,
    PROP_MAX_MASTER = 64,
    PROP_MAX_PRES_VALUE = 65,
    PROP_MINIMUM_OFF_TIME = 66,
    PROP_MINIMUM_ON_TIME = 67,
    PROP_MINIMUM_OUTPUT = 68,
    PROP_MIN_PRES_VALUE = 69,
    PROP_MODEL_NAME = 70,
    PROP_MODIFICATION_DATE = 71,
    PROP_NOTIFY_TYPE = 72,
    PROP_NUMBER_OF_APDU_RETRIES = 73,
    PROP_NUMBER_OF_STATES = 74,
    PROP_OBJECT_IDENTIFIER = 75,
    PROP_OBJECT_LIST = 76,
    PROP_OBJECT_NAME = 77,
    PROP_OBJECT_PROPERTY_REFERENCE = 78,
    PROP_OBJECT_TYPE = 79,
    PROP_OPTIONAL = 80,
    PROP_OUT_OF_SERVICE = 81,
    PROP_OUTPUT_UNITS = 82,
    PROP_EVENT_PARAMETERS = 83,
    PROP_POLARITY = 84,
    PROP_PRESENT_VALUE = 85,
    PROP_PRIORITY = 86,
    PROP_PRIORITY_ARRAY = 87,
    PROP_PRIORITY_FOR_WRITING = 88,
    PROP_PROCESS_IDENTIFIER = 89,
    PROP_PROGRAM_CHANGE = 90,
    PROP_PROGRAM_LOCATION = 91,
    PROP_PROGRAM_STATE = 92,
    PROP_PROPORTIONAL_CONSTANT = 93,
    PROP_PROPORTIONAL_CONSTANT_UNITS = 94,
    PROP_PROTOCOL_CONFORMANCE_CLASS = 95,       /* deleted in version 1
revision 2 */
    PROP_PROTOCOL_OBJECT_TYPES_SUPPORTED = 96,
    PROP_PROTOCOL_SERVICES_SUPPORTED = 97,
    PROP_PROTOCOL_VERSION = 98,
    PROP_READ_ONLY = 99,
    PROP_REASON_FOR_HALT = 100,
    PROP_RECIPIENT = 101,
    PROP_RECIPIENT_LIST = 102,
    PROP_RELIABILITY = 103,
    PROP_RELINQUISH_DEFAULT = 104,
    PROP_REQUIRED = 105,
    PROP_RESOLUTION = 106,
    PROP_SEGMENTATION_SUPPORTED = 107,
    PROP_SETPOINT = 108,
    PROP_SETPOINT_REFERENCE = 109,
    PROP_STATE_TEXT = 110,
    PROP_STATUS_FLAGS = 111,
    PROP_SYSTEM_STATUS = 112,
    PROP_TIME_DELAY = 113,
    PROP_TIME_OF_ACTIVE_TIME_RESET = 114,
    PROP_TIME_OF_STATE_COUNT_RESET = 115,
    PROP_TIME_SYNCHRONIZATION_RECIPIENTS = 116,
    PROP_UNITS = 117,
    PROP_UPDATE_INTERVAL = 118,
    PROP_UTC_OFFSET = 119,
    PROP_VENDOR_IDENTIFIER = 120,
    PROP_VENDOR_NAME = 121,
    PROP_VT_CLASSES_SUPPORTED = 122,
    PROP_WEEKLY_SCHEDULE = 123,
    PROP_ATTEMPTED_SAMPLES = 124,
    PROP_AVERAGE_VALUE = 125,
    PROP_BUFFER_SIZE = 126,
    PROP_CLIENT_COV_INCREMENT = 127,
    PROP_COV_RESUBSCRIPTION_INTERVAL = 128,
    PROP_CURRENT_NOTIFY_TIME = 129,
    PROP_EVENT_TIME_STAMPS = 130,
    PROP_LOG_BUFFER = 131,
    PROP_LOG_DEVICE_OBJECT = 132,
    /* The enable property is renamed from log-enable in
       Addendum b to ANSI/ASHRAE 135-2004(135b-2) */
    PROP_ENABLE = 133,
    PROP_LOG_INTERVAL = 134,
    PROP_MAXIMUM_VALUE = 135,
    PROP_MINIMUM_VALUE = 136,
    PROP_NOTIFICATION_THRESHOLD = 137,
    PROP_PREVIOUS_NOTIFY_TIME = 138,
    PROP_PROTOCOL_REVISION = 139,
    PROP_RECORDS_SINCE_NOTIFICATION = 140,
    PROP_RECORD_COUNT = 141,
    PROP_START_TIME = 142,
    PROP_STOP_TIME = 143,
    PROP_STOP_WHEN_FULL = 144,
    PROP_TOTAL_RECORD_COUNT = 145,
    PROP_VALID_SAMPLES = 146,
    PROP_WINDOW_INTERVAL = 147,
    PROP_WINDOW_SAMPLES = 148,
    PROP_MAXIMUM_VALUE_TIMESTAMP = 149,
    PROP_MINIMUM_VALUE_TIMESTAMP = 150,
    PROP_VARIANCE_VALUE = 151,
    PROP_ACTIVE_COV_SUBSCRIPTIONS = 152,
    PROP_BACKUP_FAILURE_TIMEOUT = 153,
    PROP_CONFIGURATION_FILES = 154,
    PROP_DATABASE_REVISION = 155,
    PROP_DIRECT_READING = 156,
    PROP_LAST_RESTORE_TIME = 157,
    PROP_MAINTENANCE_REQUIRED = 158,
    PROP_MEMBER_OF = 159,
    PROP_MODE = 160,
    PROP_OPERATION_EXPECTED = 161,
    PROP_SETTING = 162,
    PROP_SILENCED = 163,
    PROP_TRACKING_VALUE = 164,
    PROP_ZONE_MEMBERS = 165,
    PROP_LIFE_SAFETY_ALARM_VALUES = 166,
    PROP_MAX_SEGMENTS_ACCEPTED = 167,
    PROP_PROFILE_NAME = 168,
    PROP_AUTO_SLAVE_DISCOVERY = 169,
    PROP_MANUAL_SLAVE_ADDRESS_BINDING = 170,
    PROP_SLAVE_ADDRESS_BINDING = 171,
    PROP_SLAVE_PROXY_ENABLE = 172,
    PROP_LAST_NOTIFY_TIME = 173,
    PROP_SCHEDULE_DEFAULT = 174,
    PROP_ACCEPTED_MODES = 175,
    PROP_ADJUST_VALUE = 176,
    PROP_COUNT = 177,
    PROP_COUNT_BEFORE_CHANGE = 178,
    PROP_COUNT_CHANGE_TIME = 179,
    PROP_COV_PERIOD = 180,
    PROP_INPUT_REFERENCE = 181,
    PROP_LIMIT_MONITORING_INTERVAL = 182,
    PROP_LOGGING_DEVICE = 183,
    PROP_LOGGING_RECORD = 184,
    PROP_PRESCALE = 185,
    PROP_PULSE_RATE = 186,
    PROP_SCALE = 187,
    PROP_SCALE_FACTOR = 188,
    PROP_UPDATE_TIME = 189,
    PROP_VALUE_BEFORE_CHANGE = 190,
    PROP_VALUE_SET = 191,
    PROP_VALUE_CHANGE_TIME = 192,
    /* enumerations 193-206 are new */
    PROP_ALIGN_INTERVALS = 193,
    PROP_GROUP_MEMBER_NAMES = 194,
    PROP_INTERVAL_OFFSET = 195,
    PROP_LAST_RESTART_REASON = 196,
    PROP_LOGGING_TYPE = 197,
    PROP_MEMBER_STATUS_FLAGS = 198,
    PROP_NOTIFICATION_PERIOD = 199,
    PROP_PREVIOUS_NOTIFY_RECORD = 200,
    PROP_REQUESTED_UPDATE_INTERVAL = 201,
    PROP_RESTART_NOTIFICATION_RECIPIENTS = 202,
    PROP_TIME_OF_DEVICE_RESTART = 203,
    PROP_TIME_SYNCHRONIZATION_INTERVAL = 204,
    PROP_TRIGGER = 205,
    PROP_UTC_TIME_SYNCHRONIZATION_RECIPIENTS = 206,
    /* enumerations 207-211 are used in Addendum d to ANSI/ASHRAE
135-2004 */
    PROP_NODE_SUBTYPE = 207,
    PROP_NODE_TYPE = 208,
    PROP_STRUCTURED_OBJECT_LIST = 209,
    PROP_SUBORDINATE_ANNOTATIONS = 210,
    PROP_SUBORDINATE_LIST = 211,
    /* enumerations 212-225 are used in Addendum e to ANSI/ASHRAE
135-2004 */
    PROP_ACTUAL_SHED_LEVEL = 212,
    PROP_DUTY_WINDOW = 213,
    PROP_EXPECTED_SHED_LEVEL = 214,
    PROP_FULL_DUTY_BASELINE = 215,
    /* enumerations 216-217 are used in Addendum i to ANSI/ASHRAE
135-2004 */
    PROP_BLINK_PRIORITY_THRESHOLD = 216,
    PROP_BLINK_TIME = 217,
    /* enumerations 212-225 are used in Addendum e to ANSI/ASHRAE
135-2004 */
    PROP_REQUESTED_SHED_LEVEL = 218,
    PROP_SHED_DURATION = 219,
    PROP_SHED_LEVEL_DESCRIPTIONS = 220,
    PROP_SHED_LEVELS = 221,
    PROP_STATE_DESCRIPTION = 222,
    /* enumerations 223-225 are used in Addendum i to ANSI/ASHRAE
135-2004 */
    PROP_FADE_TIME = 223,
    PROP_LIGHTING_COMMAND = 224,
    PROP_LIGHTING_COMMAND_PRIORITY = 225,
    /* enumerations 226-235 are used in Addendum f to ANSI/ASHRAE
135-2004 */
    PROP_DOOR_ALARM_STATE = 226,
    PROP_DOOR_EXTENDED_PULSE_TIME = 227,
    PROP_DOOR_MEMBERS = 228,
    PROP_DOOR_OPEN_TOO_LONG_TIME = 229,
    PROP_DOOR_PULSE_TIME = 230,
    PROP_DOOR_STATUS = 231,
    PROP_DOOR_UNLOCK_DELAY_TIME = 232,
    PROP_LOCK_STATUS = 233,
    PROP_MASKED_ALARM_VALUES = 234,
    PROP_SECURED_STATUS = 235,
    /* enumerations 236-243 are used in Addendum i to ANSI/ASHRAE
135-2004 */
    PROP_OFF_DELAY = 236,
    PROP_ON_DELAY = 237,
    PROP_POWER = 238,
    PROP_POWER_ON_VALUE = 239,
    PROP_PROGRESS_VALUE = 240,
    PROP_RAMP_RATE = 241,
    PROP_STEP_INCREMENT = 242,
    PROP_SYSTEM_FAILURE_VALUE = 243,
    /* enumerations 244-311 are used in Addendum j to ANSI/ASHRAE
135-2004 */
    PROP_ABSENTEE_LIMIT = 244,
    PROP_ACCESS_ALARM_EVENTS = 245,
    PROP_ACCESS_DOORS = 246,
    PROP_ACCESS_EVENT = 247,
    PROP_ACCESS_EVENT_AUTHENTICATION_FACTOR = 248,
    PROP_ACCESS_EVENT_CREDENTIAL = 249,
    PROP_ACCESS_EVENT_TIME = 250,
    PROP_ACCESS_RULES = 251,
    PROP_ACCESS_RULES_ENABLE = 252,
    PROP_ACCESS_TRANSACTION_EVENTS = 253,
    PROP_ACCOMPANIED = 254,
    PROP_ACTIVATION_TIME = 255,
    PROP_ACTIVE_AUTHENTICATION_POLICY = 256,
    PROP_ASSIGNED_ACCESS_RIGHTS = 257,
    PROP_AUTHENTICATION_FACTOR_INPUT_LIST = 258,
    PROP_AUTHENTICATION_FACTORS = 259,
    PROP_AUTHENTICATION_POLICY_LIST = 260,
    PROP_AUTHENTICATION_POLICY_NAMES = 261,
    PROP_AUTHORIZATION_MODE = 262,
    PROP_BELONGS_TO = 263,
    PROP_CREDENTIAL_DISABLE = 264,
    PROP_CREDENTIAL_STATUS = 265,
    PROP_CREDENTIALS = 266,
    PROP_CREDENTIALS_IN_ZONE = 267,
    PROP_DAYS_REMAINING = 268,
    PROP_ENTRY_POINTS = 269,
    PROP_EXIT_POINTS = 270,
    PROP_EXPIRY_TIME = 271,
    PROP_EXTENDED_TIME_ENABLE = 272,
    PROP_FAILED_ATTEMPT_EVENTS = 273,
    PROP_FAILED_ATTEMPTS = 274,
    PROP_FAILED_ATTEMPTS_TIME = 275,
    PROP_FORMAT_CLASS_SUPPORTED = 276,
    PROP_FORMAT_TYPE = 277,
    PROP_LAST_ACCESS_EVENT = 278,
    PROP_LAST_ACCESS_POINT = 279,
    PROP_LAST_CREDENTIAL_ADDED = 280,
    PROP_LAST_CREDENTIAL_ADDED_TIME = 281,
    PROP_LAST_CREDENTIAL_REMOVED = 282,
    PROP_LAST_CREDENTIAL_REMOVED_TIME = 283,
    PROP_LAST_USE_TIME = 284,
    PROP_LOCKDOWN = 285,
    PROP_LOCKDOWN_RELINQUISH_TIME = 286,
    PROP_MASTER_EXEMPTION = 287,
    PROP_MAX_FAILED_ATTEMPTS = 288,
    PROP_MEMBERS = 289,
    PROP_MASTER_POINT = 290,
    PROP_NUMBER_OF_AUTHENTICATION_POLICIES = 291,
    PROP_OCCUPANCY_COUNT = 293,
    PROP_OCCUPANCY_COUNT_ENABLE = 294,
    PROP_OCCUPANCY_COUNT_EXEMPTION = 295,
    PROP_OCCUPANCY_LOWER_THRESHOLD = 296,
    PROP_OCCUPANCY_LOWER_THRESHOLD_ENFORCED = 297,
    PROP_OCCUPANCY_STATE = 298,
    PROP_OCCUPANCY_UPPER_LIMIT = 299,
    PROP_OCCUPANCY_UPPER_LIMIT_ENFORCED = 300,
    PROP_PASSBACK_EXEMPTION = 301,
    PROP_PASSBACK_MODE = 302,
    PROP_PASSBACK_TIMEOUT = 303,
    PROP_POSITIVE_ACCESS_RULES = 304,
    PROP_READ_STATUS = 305,
    PROP_REASON_FOR_DISABLE = 306,
    PROP_THREAT_AUTHORITY = 307,
    PROP_THREAT_LEVEL = 308,
    PROP_TRACE_FLAG = 309,
    PROP_TRANSACTION_NOTIFICATION_CLASS = 310,
    PROP_USER_EXTERNAL_IDENTIFIER = 311,
    /* enumerations 312-313 are used in Addendum k to ANSI/ASHRAE
135-2004 */
    PROP_CHARACTER_SET = 312,
    PROP_STRICT_CHARACTER_MODE = 313,
    /* enumerations 312-313 are used in Addendum k to ANSI/ASHRAE
135-2004 */
    PROP_BACKUP_AND_RESTORE_STATE = 314,
    PROP_BACKUP_PREPARATION_TIME = 315,
    PROP_RESTORE_PREPARATION_TIME = 316,
    /* enumerations 317-323 are used in Addendum j to ANSI/ASHRAE
135-2004 */
    PROP_USER_INFORMATION_REFERENCE = 317,
    PROP_USER_NAME = 318,
    PROP_USER_TYPE = 319,
    PROP_USES_REMAINING = 320,
    PROP_VENDOR_FORMAT_IDENTIFIER = 321,
    PROP_ZONE_FROM = 322,
    PROP_ZONE_TO = 323,
    /* enumerations 324-325 are used in Addendum i to ANSI/ASHRAE
135-2004 */
    PROP_BINARY_ACTIVE_VALUE = 324,
    PROP_BINARY_INACTIVE_VALUE = 325
        /* The special property identifiers all, optional, and required
*/
        /* are reserved for use in the ReadPropertyConditional and */
        /* ReadPropertyMultiple services or services not defined in this
standard. */
        /* Enumerated values 0-511 are reserved for definition by
ASHRAE.  */
        /* Enumerated values 512-4194303 may be used by others subject to
the  */
        /* procedures and constraints described in Clause 23.  */
} BACNET_PROPERTY_ID;
```

E.2 BACnet Engineering Units Codes

BACnet engineering units codes may be found in your copy of the BACnet protocol specification, ANSI/ASHRAE Standard 135. That document is copyrighted, but the C enumeration shown below for reference is taken from open source code available under GPL at http://sourceforge.net, and provides essentially the same information (copyrighted by Steve Karg, licensed under GPL as noted at http://sourceforge.net).

```
typedef enum {
    /* Acceleration */
    UNITS_METERS_PER_SECOND_PER_SECOND = 166,
    /* Area */
    UNITS_SQUARE_METERS = 0,
    UNITS_SQUARE_CENTIMETERS = 116,
    UNITS_SQUARE_FEET = 1,
    UNITS_SQUARE_INCHES = 115,
    /* Currency */
    UNITS_CURRENCY1 = 105,
    UNITS_CURRENCY2 = 106,
    UNITS_CURRENCY3 = 107,
    UNITS_CURRENCY4 = 108,
    UNITS_CURRENCY5 = 109,
    UNITS_CURRENCY6 = 110,
    UNITS_CURRENCY7 = 111,
    UNITS_CURRENCY8 = 112,
    UNITS_CURRENCY9 = 113,
    UNITS_CURRENCY10 = 114,
    /* Electrical */
    UNITS_MILLIAMPERES = 2,
    UNITS_AMPERES = 3,
    UNITS_AMPERES_PER_METER = 167,
    UNITS_AMPERES_PER_SQUARE_METER = 168,
    UNITS_AMPERE_SQUARE_METERS = 169,
    UNITS_FARADS = 170,
    UNITS_HENRYS = 171,
    UNITS_OHMS = 4,
    UNITS_OHM_METERS = 172,
    UNITS_MILLIOHMS = 145,
    UNITS_KILOHMS = 122,
    UNITS_MEGOHMS = 123,
    UNITS_SIEMENS = 173, /* 1 mho equals 1 siemens */
    UNITS_SIEMENS_PER_METER = 174,
    UNITS_TESLAS = 175,
    UNITS_VOLTS = 5,
    UNITS_MILLIVOLTS = 124,
    UNITS_KILOVOLTS = 6,
    UNITS_MEGAVOLTS = 7,
    UNITS_VOLT_AMPERES = 8,
    UNITS_KILOVOLT_AMPERES = 9,
    UNITS_MEGAVOLT_AMPERES = 10,
    UNITS_VOLT_AMPERES_REACTIVE = 11,
    UNITS_KILOVOLT_AMPERES_REACTIVE = 12,
    UNITS_MEGAVOLT_AMPERES_REACTIVE = 13,
    UNITS_VOLTS_PER_DEGREE_KELVIN = 176,
    UNITS_VOLTS_PER_METER = 177,
    UNITS_DEGREES_PHASE = 14,
    UNITS_POWER_FACTOR = 15,
    UNITS_WEBERS = 178,
    /* Energy */
    UNITS_JOULES = 16,
    UNITS_KILOJOULES = 17,
    UNITS_KILOJOULES_PER_KILOGRAM = 125,
    UNITS_MEGAJOULES = 126,
    UNITS_WATT_HOURS = 18,
    UNITS_KILOWATT_HOURS = 19,
    UNITS_MEGAWATT_HOURS = 146,
    UNITS_BTUS = 20,
    UNITS_KILO_BTUS = 147,
    UNITS_MEGA_BTUS = 148,
    UNITS_THERMS = 21,
    UNITS_TON_HOURS = 22,
    /* Enthalpy */
    UNITS_JOULES_PER_KILOGRAM_DRY_AIR = 23,
    UNITS_KILOJOULES_PER_KILOGRAM_DRY_AIR = 149,
    UNITS_MEGAJOULES_PER_KILOGRAM_DRY_AIR = 150,
    UNITS_BTUS_PER_POUND_DRY_AIR = 24,
    UNITS_BTUS_PER_POUND = 117,
    /* Entropy */
    UNITS_JOULES_PER_DEGREE_KELVIN = 127,
    UNITS_KILOJOULES_PER_DEGREE_KELVIN = 151,
    UNITS_MEGAJOULES_PER_DEGREE_KELVIN = 152,
    UNITS_JOULES_PER_KILOGRAM_DEGREE_KELVIN = 128,
    /* Force */
    UNITS_NEWTON = 153,
    /* Frequency */
    UNITS_CYCLES_PER_HOUR = 25,
    UNITS_CYCLES_PER_MINUTE = 26,
    UNITS_HERTZ = 27,
    UNITS_KILOHERTZ = 129,
    UNITS_MEGAHERTZ = 130,
    UNITS_PER_HOUR = 131,
    /* Humidity */
```

```
        UNITS_GRAMS_OF_WATER_PER_KILOGRAM_DRY_AIR = 28,
        UNITS_PERCENT_RELATIVE_HUMIDITY = 29,
        /* Length */
        UNITS_MILLIMETERS = 30,
        UNITS_CENTIMETERS = 118,
        UNITS_METERS = 31,
        UNITS_INCHES = 32,
        UNITS_FEET = 33,
        /* Light */
        UNITS_CANDELAS = 179,
        UNITS_CANDELAS_PER_SQUARE_METER = 180,
        UNITS_WATTS_PER_SQUARE_FOOT = 34,
        UNITS_WATTS_PER_SQUARE_METER = 35,
        UNITS_LUMENS = 36,
        UNITS_LUXES = 37,
        UNITS_FOOT_CANDLES = 38,
        /* Mass */
        UNITS_KILOGRAMS = 39,
        UNITS_POUNDS_MASS = 40,
        UNITS_TONS = 41,
        /* Mass Flow */
        UNITS_GRAMS_PER_SECOND = 154,
        UNITS_GRAMS_PER_MINUTE = 155,
        UNITS_KILOGRAMS_PER_SECOND = 42,
        UNITS_KILOGRAMS_PER_MINUTE = 43,
        UNITS_KILOGRAMS_PER_HOUR = 44,
        UNITS_POUNDS_MASS_PER_SECOND = 119,
        UNITS_POUNDS_MASS_PER_MINUTE = 45,
        UNITS_POUNDS_MASS_PER_HOUR = 46,
        UNITS_TONS_PER_HOUR = 156,
        /* Power */
        UNITS_MILLIWATTS = 132,
        UNITS_WATTS = 47,
        UNITS_KILOWATTS = 48,
        UNITS_MEGAWATTS = 49,
        UNITS_BTUS_PER_HOUR = 50,
        UNITS_KILO_BTUS_PER_HOUR = 157,
        UNITS_HORSEPOWER = 51,
        UNITS_TONS_REFRIGERATION = 52,
        /* Pressure */
        UNITS_PASCALS = 53,
        UNITS_HECTOPASCALS = 133,
        UNITS_KILOPASCALS = 54,
        UNITS_MILLIBARS = 134,
        UNITS_BARS = 55,
        UNITS_POUNDS_FORCE_PER_SQUARE_INCH = 56,
        UNITS_CENTIMETERS_OF_WATER = 57,
        UNITS_INCHES_OF_WATER = 58,
        UNITS_MILLIMETERS_OF_MERCURY = 59,
        UNITS_CENTIMETERS_OF_MERCURY = 60,
        UNITS_INCHES_OF_MERCURY = 61,
        /* Temperature */
        UNITS_DEGREES_CELSIUS = 62,
        UNITS_DEGREES_KELVIN = 63,
        UNITS_DEGREES_KELVIN_PER_HOUR = 181,
        UNITS_DEGREES_KELVIN_PER_MINUTE = 182,
        UNITS_DEGREES_FAHRENHEIT = 64,
        UNITS_DEGREE_DAYS_CELSIUS = 65,
        UNITS_DEGREE_DAYS_FAHRENHEIT = 66,
        UNITS_DELTA_DEGREES_FAHRENHEIT = 120,
        UNITS_DELTA_DEGREES_KELVIN = 121,
        /* Time */
        UNITS_YEARS = 67,
        UNITS_MONTHS = 68,
        UNITS_WEEKS = 69,
        UNITS_DAYS = 70,
        UNITS_HOURS = 71,
        UNITS_MINUTES = 72,
        UNITS_SECONDS = 73,
        UNITS_HUNDREDTHS_SECONDS = 158,
        UNITS_MILLISECONDS = 159,
        /* Torque */
        UNITS_NEWTON_METERS = 160,
        /* Velocity */
        UNITS_MILLIMETERS_PER_SECOND = 161,
        UNITS_MILLIMETERS_PER_MINUTE = 162,
        UNITS_METERS_PER_SECOND = 74,
        UNITS_METERS_PER_MINUTE = 163,
        UNITS_METERS_PER_HOUR = 164,
        UNITS_KILOMETERS_PER_HOUR = 75,
        UNITS_FEET_PER_SECOND = 76,
        UNITS_FEET_PER_MINUTE = 77,
        UNITS_MILES_PER_HOUR = 78,
        /* Volume */
        UNITS_CUBIC_FEET = 79,
        UNITS_CUBIC_METERS = 80,
        UNITS_IMPERIAL_GALLONS = 81,
        UNITS_LITERS = 82,
        UNITS_US_GALLONS = 83,
        /* Volumetric Flow */
        UNITS_CUBIC_FEET_PER_SECOND = 142,
        UNITS_CUBIC_FEET_PER_MINUTE = 84,
        UNITS_CUBIC_METERS_PER_SECOND = 85,
        UNITS_CUBIC_METERS_PER_MINUTE = 165,
        UNITS_CUBIC_METERS_PER_HOUR = 135,
        UNITS_IMPERIAL_GALLONS_PER_MINUTE = 86,
        UNITS_LITERS_PER_SECOND = 87,
        UNITS_LITERS_PER_MINUTE = 88,
        UNITS_LITERS_PER_HOUR = 136,
        UNITS_US_GALLONS_PER_MINUTE = 89,
        /* Other */
        UNITS_DEGREES_ANGULAR = 90,
        UNITS_DEGREES_CELSIUS_PER_HOUR = 91,
        UNITS_DEGREES_CELSIUS_PER_MINUTE = 92,
        UNITS_DEGREES_FAHRENHEIT_PER_HOUR = 93,
        UNITS_DEGREES_FAHRENHEIT_PER_MINUTE = 94,
        UNITS_JOULE_SECONDS = 183,
        UNITS_KILOGRAMS_PER_CUBIC_METER = 186,
        UNITS_KW_HOURS_PER_SQUARE_METER = 137,
        UNITS_KW_HOURS_PER_SQUARE_FOOT = 138,
        UNITS_MEGAJOULES_PER_SQUARE_METER = 139,
        UNITS_MEGAJOULES_PER_SQUARE_FOOT = 140,
        UNITS_NO_UNITS = 95,
        UNITS_NEWTON_SECONDS = 187,
        UNITS_NEWTONS_PER_METER = 188,
        UNITS_PARTS_PER_MILLION = 96,
        UNITS_PARTS_PER_BILLION = 97,
        UNITS_PERCENT = 98,
        UNITS_PERCENT_OBSCURATION_PER_FOOT = 143,
        UNITS_PERCENT_OBSCURATION_PER_METER = 144,
        UNITS_PERCENT_PER_SECOND = 99,
        UNITS_PER_MINUTE = 100,
        UNITS_PER_SECOND = 101,
        UNITS_PSI_PER_DEGREE_FAHRENHEIT = 102,
        UNITS_RADIANS = 103,
        UNITS_RADIANS_PER_SECOND = 184,
        UNITS_REVOLUTIONS_PER_MINUTE = 104,
        UNITS_SQUARE_METERS_PER_NEWTON = 185,
        UNITS_WATTS_PER_METER_PER_DEGREE_KELVIN = 189,
        UNITS_WATTS_PER_SQUARE_METER_DEGREE_KELVIN = 141,
           ; /* Enumerated values 0-255 are reserved for definition by
    ASHRAE. */
            /* Enumerated values 256-65535 may be used by others subject to
    */
            /* the procedures and constraints described in Clause 23. */
            /* The last enumeration used in this version is 189. */
        MAX_UNITS = 190
    } BACNET_ENGINEERING_UNITS;
```

ValuPoint IoT
MODEL VP6-1470
IOT EDGE SERVER

CONTROL SOLUTIONS MINNESOTA

Appendix F Using Wireshark for Trouble Shooting

F.1 Hardware Requirements for Ethernet

There are no particular hardware requirements regarding the PC you run Wireshark on. Basically anything running any version of Windows can run Wireshark. There are also Linux and Mac versions.

The "hardware requirement" that is of most concern is the means of connecting to the network. We typically just connect everything Ethernet to a switch and don't worry about it. However, switches are really unmanaged routers, and they filter traffic. Therefore, your PC will not see traffic passing back and forth between two other devices that are not the PC. In order to see that network traffic using Wireshark, you need to come up with the right kind of network connection.

If your PC itself is one end of the network conversation you wish to capture, for example when running the Network Discovery Tool, then Wireshark will capture all network traffic to and from the PC however connected. It is when your PC wants to simply "eavesdrop" that you run into problems with the network switch.

A while back, 10BaseT hubs were common. A 10BaseT hub is not as smart as a switch and does not filter traffic. If you have an old 10BaseT hub collecting dust somewhere, you now have a new use for it. It will let Wireshark see all traffic from the PC that goes between any other devices connected to that 10BaseT hub. Beware of devices that call themselves "hubs" but support 100BaseT connections. These are switches.

Since manufacturers of hubs decided nobody should have a use for them anymore, they are generally out of production. Finding a 10BaseT hub for sale is not easy (try eBay). But there are other alternatives.

One means of monitoring network traffic is to get a managed switch that supports "port mirroring". One such device we have tested is the TP-LINK model TL-SG105E. Setting it up requires utility software (provided with the switch) and takes a little effort to get configured. But once configured, it works well without any further monkeying around. And it is inexpensive.

The other means of monitoring traffic is with the use of a device made specifically for use with Wireshark. The "SharkTap" provides two connections for the network pass-through, and a third "tap" connection where you connect your PC running Wireshark. There is no configuration required. It is the simplest way to monitor network traffic, and it is a current production item available on Amazon (as of 2020).

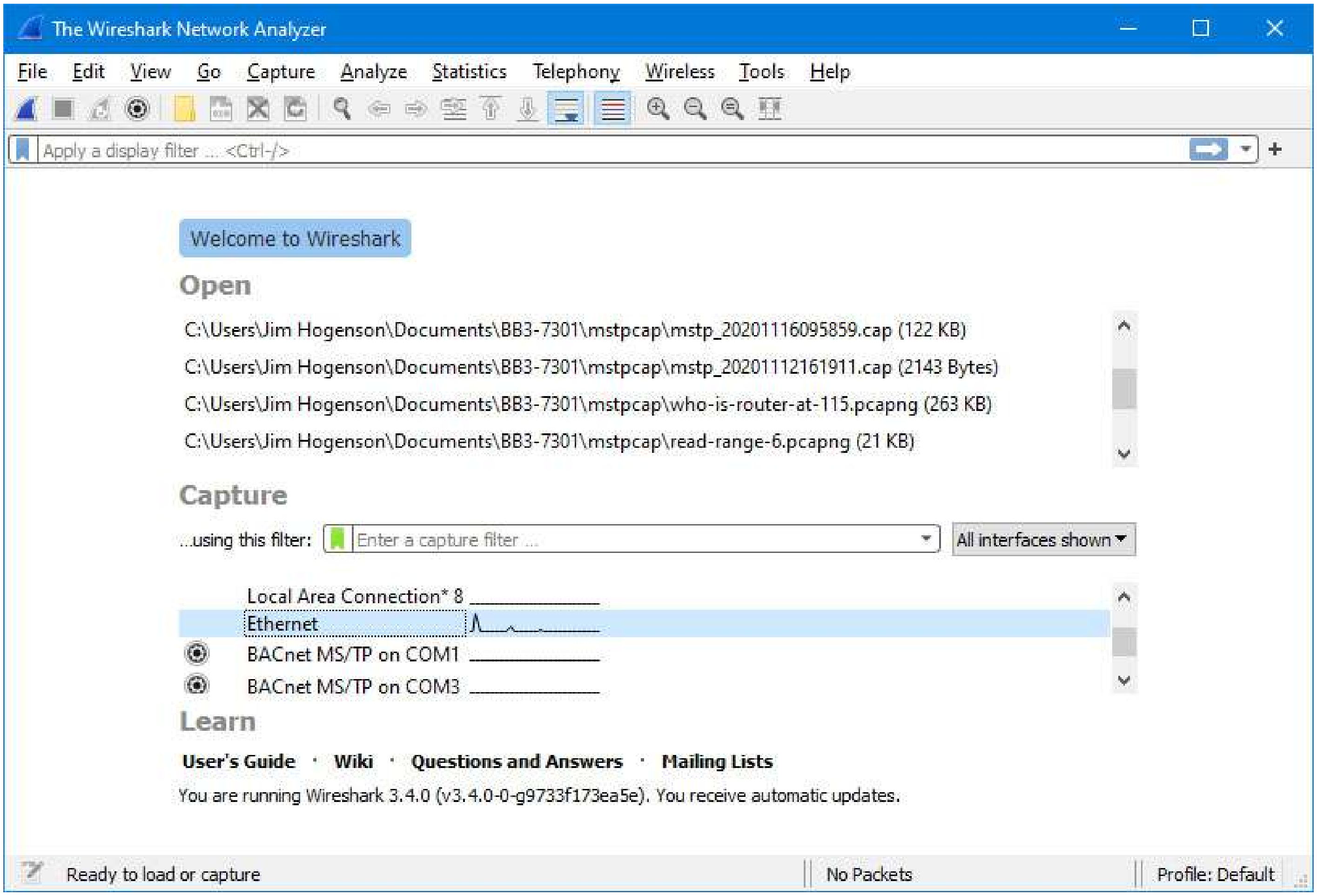
F.2 Hardware Requirements for MS/TP

Wireshark can be used in two ways with MS/TP. You can use the Control Solutions MTX002 to capture packets and then analyze them with Wireshark. This is talked about on the Control Solutions web site, on the MTX002 page. More recent versions of Wireshark now also support live capture of MS/TP using a standard RS-485 to RS-232 adapter with a standard serial COM port on a PC. A generic USB to RS-485 serial port adapter also works.

Live capture of MS/TP in Wireshark requires the support of an external capture application. You can find instructions and that application here: https://steve.kargs.net/bacnet/bacnet-mstp-wireshark-live-capture/. The live capture tool is provided on SourceForge.net, but Steve Karg's instructions are helpful.

F.3 Example of Using Wireshark

Using Wireshark is fairly easy. Get a copy at www.wireshark.org and install it. Once installed, running it is straight forward. As of version 3.4.0 of Wireshark, the startup screen looks like the following. Double click on Ethernet, or BACnet MS/TP on COMx, to start capturing network traffic. If you have multiple network connections, they will all be listed. Be sure to select the one that represents the correct connection.


The Wireshark Network Analyzer
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
Apply a display filter ... <Ctrl-/>
Welcome to Wireshark
Open
Capture
...using this filter:
Enter a capture filter ...
All interfaces shown
Learn
User's Guide · Wiki · Questions and Answers · Mailing Lists

C:\Users\Jim Hogenson\Documents\BB3-7301\mstpcap\mstp_20201116095859.cap (122 KB)
C:\Users\Jim Hogenson\Documents\BB3-7301\mstpcap\mstp_2020112161911.cap (2143 Bytes)
C:\Users\Jim Hogenson\Documents\BB3-7301\mstpcap\who-is-router-at-115.pcapng (263 KB)
C:\Users\Jim Hogenson\Documents\BB3-7301\mstpcap\read-range-6.pcapng (21 KB)

Local Area Connection* 8
Ethernet
BACnet MS/TP on COM1
BACnet MS/TP on COM3

You are running Wireshark 3.4.0 (v3.4.0-0-g9733f173ea5e). You receive automatic updates.

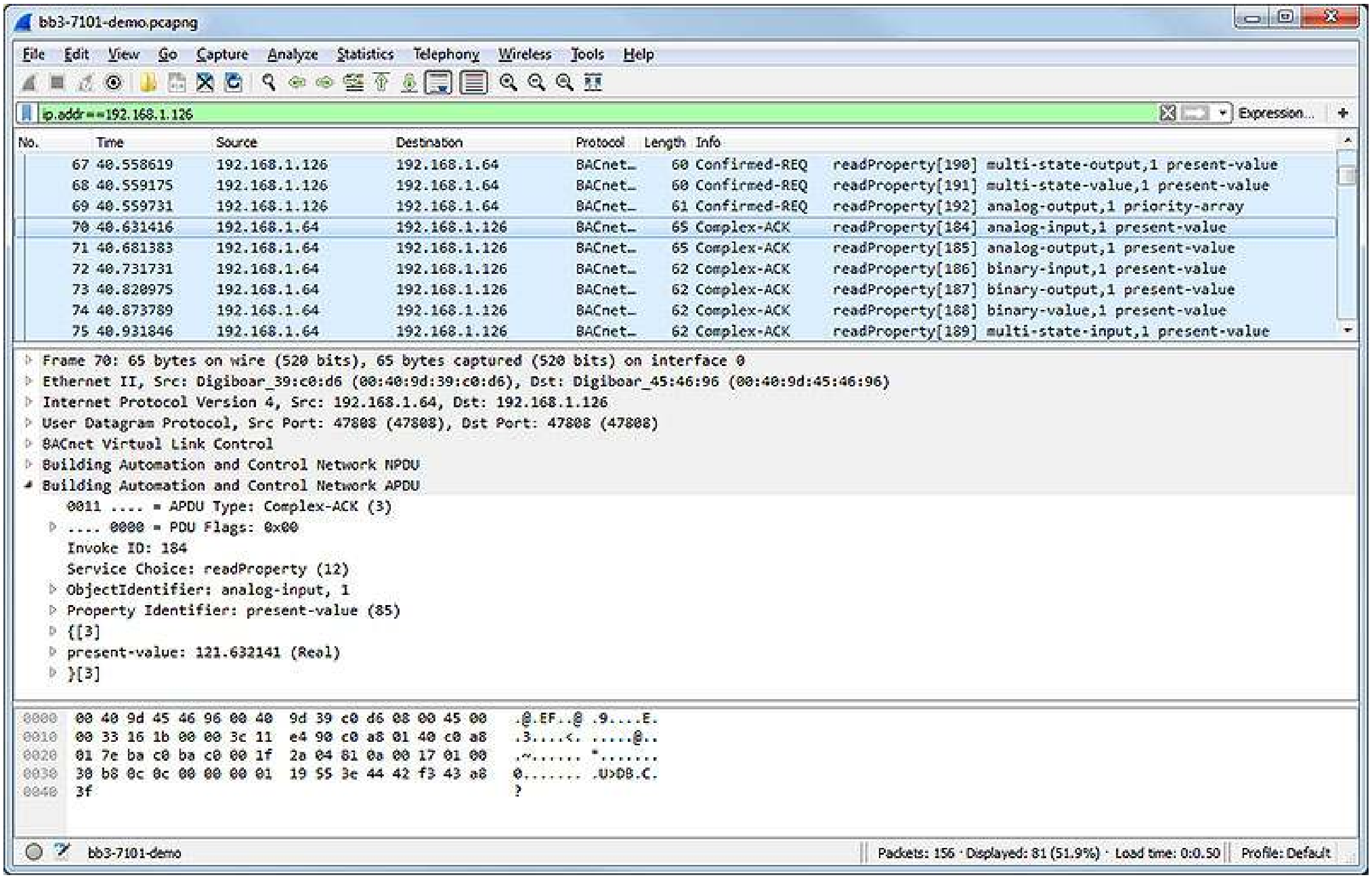
Ready to load or capture | No Packets | Profile: Default

The screen will look something like the example below once Wireshark starts collecting data. Click the red icon in the toolbar to stop capturing traffic. Control Solutions technical support will often ask for a copy of the Wireshark data when a network issue seems evident. You can save a copy of all of the network traffic captured under the File menu, and you will generally save it to a .pcap or .pcapng file. A Wireshark log with .pcap extension can be posted directly as an attachment in support tickets while .pcapng needs to be zipped first.

The screen shot below shows Wireshark capturing BACnet IP traffic between the local BACnet client and another BACnet device. If you click on a packet, the details of that packet will be displayed in the lower part of the screen. You can expand the tree view to see further detail.

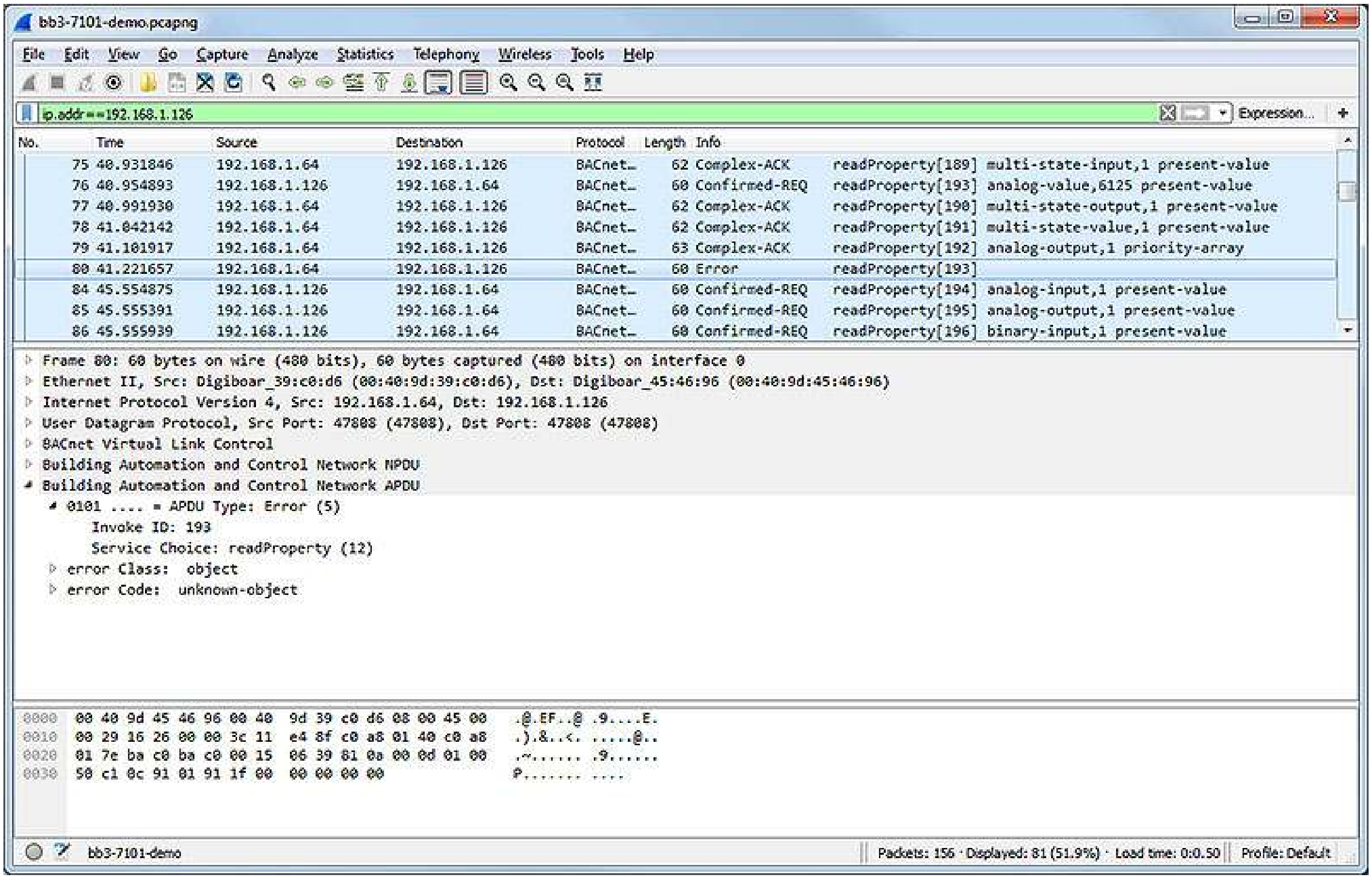
A lot of times you will see a lot of network traffic that is not of interest to you. You can filter network traffic to only display traffic to/from the device you are interested in. Do this by entering "ip.addr==192.168.1.126" in the Filter window as illustrated below. (Substitute your own device's IP address.)

The example illustrated here is a Complex-ACK, or in other words, reply to a Read Property request.


bb3-7101-demo.pcapng
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
Expression...
+

```
ip.addr==192.168.1.126

No.    Time         Source          Destination     Protocol  Length Info
    67 40.558619    192.168.1.126   192.168.1.64    BACnet…   60 Confirmed-REQ   readProperty[190] multi-state-output,1 present-value
    68 40.559175    192.168.1.126   192.168.1.64    BACnet…   60 Confirmed-REQ   readProperty[191] multi-state-value,1 present-value
    69 40.559731    192.168.1.126   192.168.1.64    BACnet…   61 Confirmed-REQ   readProperty[192] analog-output,1 priority-array
    70 40.631416    192.168.1.64    192.168.1.126   BACnet…   65 Complex-ACK     readProperty[184] analog-input,1 present-value
    71 40.681383    192.168.1.64    192.168.1.126   BACnet…   65 Complex-ACK     readProperty[185] analog-output,1 present-value
    72 40.731731    192.168.1.64    192.168.1.126   BACnet…   62 Complex-ACK     readProperty[186] binary-input,1 present-value
    73 40.820975    192.168.1.64    192.168.1.126   BACnet…   62 Complex-ACK     readProperty[187] binary-output,1 present-value
    74 40.873789    192.168.1.64    192.168.1.126   BACnet…   62 Complex-ACK     readProperty[188] binary-value,1 present-value
    75 40.931846    192.168.1.64    192.168.1.126   BACnet…   62 Complex-ACK     readProperty[189] multi-state-input,1 present-value

▷ Frame 70: 65 bytes on wire (520 bits), 65 bytes captured (520 bits) on interface 0
▷ Ethernet II, Src: Digiboar_39:c0:d6 (00:40:9d:39:c0:d6), Dst: Digiboar_45:46:96 (00:40:9d:45:46:96)
▷ Internet Protocol Version 4, Src: 192.168.1.64, Dst: 192.168.1.126
▷ User Datagram Protocol, Src Port: 47808 (47808), Dst Port: 47808 (47808)
▷ BACnet Virtual Link Control
▷ Building Automation and Control Network NPDU
◢ Building Automation and Control Network APDU
     0011 .... = APDU Type: Complex-ACK (3)
   ▷ .... 0000 = PDU Flags: 0x00
     Invoke ID: 184
     Service Choice: readProperty (12)
   ▷ ObjectIdentifier: analog-input, 1
   ▷ Property Identifier: present-value (85)
   ▷ {[3]
   ▷ present-value: 121.632141 (Real)
   ▷ }[3]

0000  00 40 9d 45 46 96 00 40  9d 39 c0 d6 08 00 45 00   .@.EF..@ .9....E.
0010  00 33 16 1b 00 00 3c 11  e4 90 c0 a8 01 40 c0 a8   .3....<. .....@..
0020  01 7e ba c0 ba c0 00 1f  2a 04 81 0a 00 17 01 00   .~...... *.......
0030  30 b8 0c 0c 00 00 00 01  19 55 3e 44 42 f3 43 a8   0....... .U>DB.C.
0040  3f                                                 ?

bb3-7101-demo          Packets: 156 · Displayed: 81 (51.9%) · Load time: 0:0.50   Profile: Default
```

This next example shows what an error reply will look like. This error resulted in the example screen shot in Section 5.4 of this User Guide.


bb3-7101-demo.pcapng
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
Expression...

ip.addr==192.168.1.126

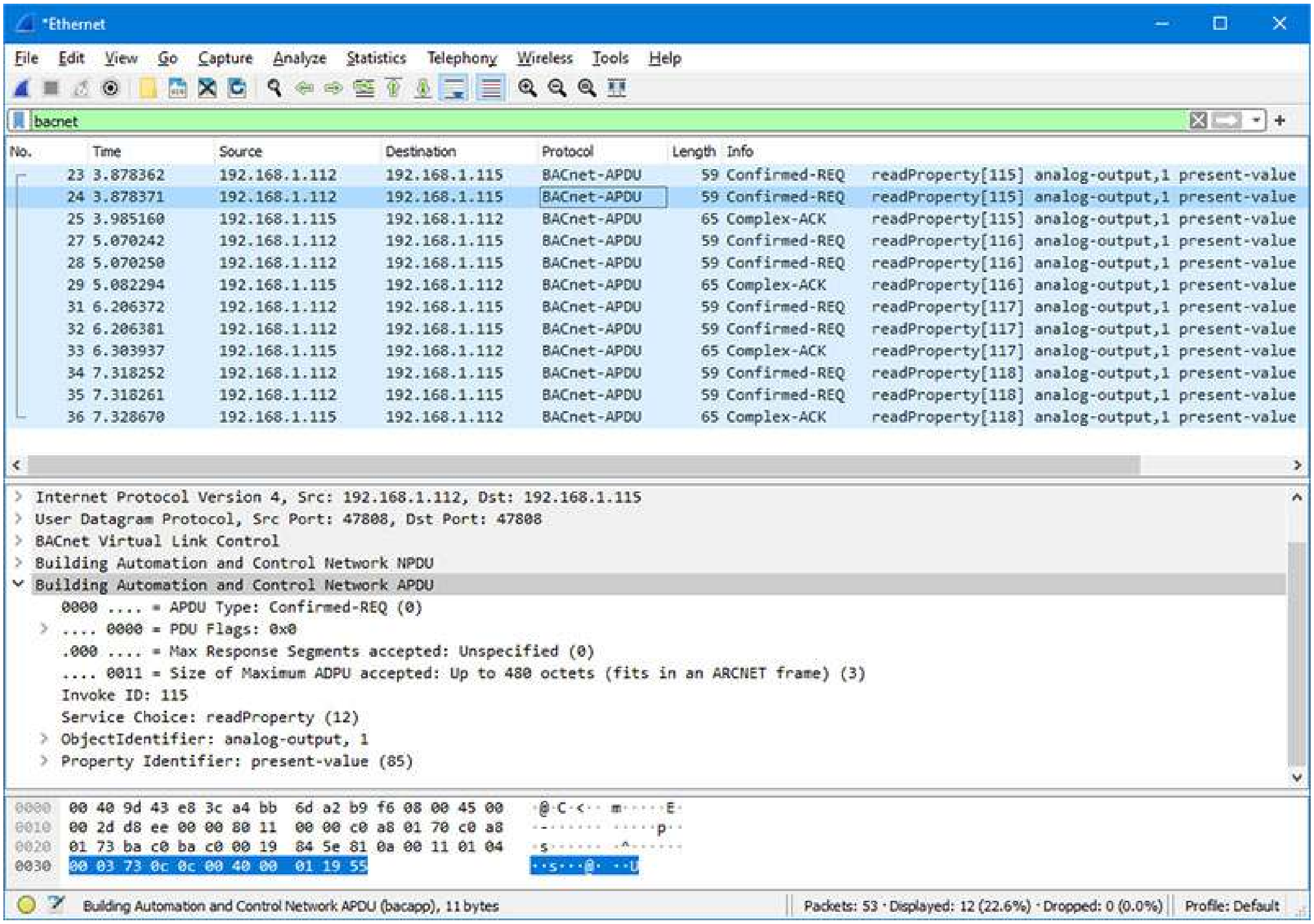
```
No.     Time         Source          Destination     Protocol  Length Info
     75 40.931846    192.168.1.64    192.168.1.126   BACnet…     62 Complex-ACK     readProperty[189] multi-state-input,1 present-value
     76 40.954893    192.168.1.126   192.168.1.64    BACnet…     60 Confirmed-REQ   readProperty[193] analog-value,6125 present-value
     77 40.991930    192.168.1.64    192.168.1.126   BACnet…     62 Complex-ACK     readProperty[190] multi-state-output,1 present-value
     78 41.042142    192.168.1.64    192.168.1.126   BACnet…     62 Complex-ACK     readProperty[191] multi-state-value,1 present-value
     79 41.101917    192.168.1.64    192.168.1.126   BACnet…     63 Complex-ACK     readProperty[192] analog-output,1 priority-array
     80 41.221657    192.168.1.64    192.168.1.126   BACnet…     60 Error           readProperty[193]
     84 45.554875    192.168.1.126   192.168.1.64    BACnet…     60 Confirmed-REQ   readProperty[194] analog-input,1 present-value
     85 45.555391    192.168.1.126   192.168.1.64    BACnet…     60 Confirmed-REQ   readProperty[195] analog-output,1 present-value
     86 45.555939    192.168.1.126   192.168.1.64    BACnet…     60 Confirmed-REQ   readProperty[196] binary-input,1 present-value
```

```
▷ Frame 80: 60 bytes on wire (480 bits), 60 bytes captured (480 bits) on interface 0
▷ Ethernet II, Src: Digiboar_39:c0:d6 (00:40:9d:39:c0:d6), Dst: Digiboar_45:46:96 (00:40:9d:45:46:96)
▷ Internet Protocol Version 4, Src: 192.168.1.64, Dst: 192.168.1.126
▷ User Datagram Protocol, Src Port: 47808 (47808), Dst Port: 47808 (47808)
▷ BACnet Virtual Link Control
▷ Building Automation and Control Network NPDU
◢ Building Automation and Control Network APDU
  ◢ 0101 .... = APDU Type: Error (5)
      Invoke ID: 193
      Service Choice: readProperty (12)
  ▷ error Class:  object
  ▷ error Code:  unknown-object
```

```
0000  00 40 9d 45 46 96 00 40  9d 39 c0 d6 08 00 45 00   .@.EF..@ .9....E.
0010  00 29 16 26 00 00 3c 11  e4 8f c0 a8 01 40 c0 a8   .).&..<. .....@..
0020  01 7e ba c0 ba c0 00 15  06 39 81 0a 00 0d 01 00   .~...... .9......
0030  50 c1 0c 91 01 91 1f 00  00 00 00 00               P....... ....
```

bb3-7101-demo | Packets: 156 · Displayed: 81 (51.9%) · Load time: 0:0.50 | Profile: Default

The above examples showed filtering traffic by IP address. You can also filter simply by "bacnet" to see only BACnet traffic.



bacnet

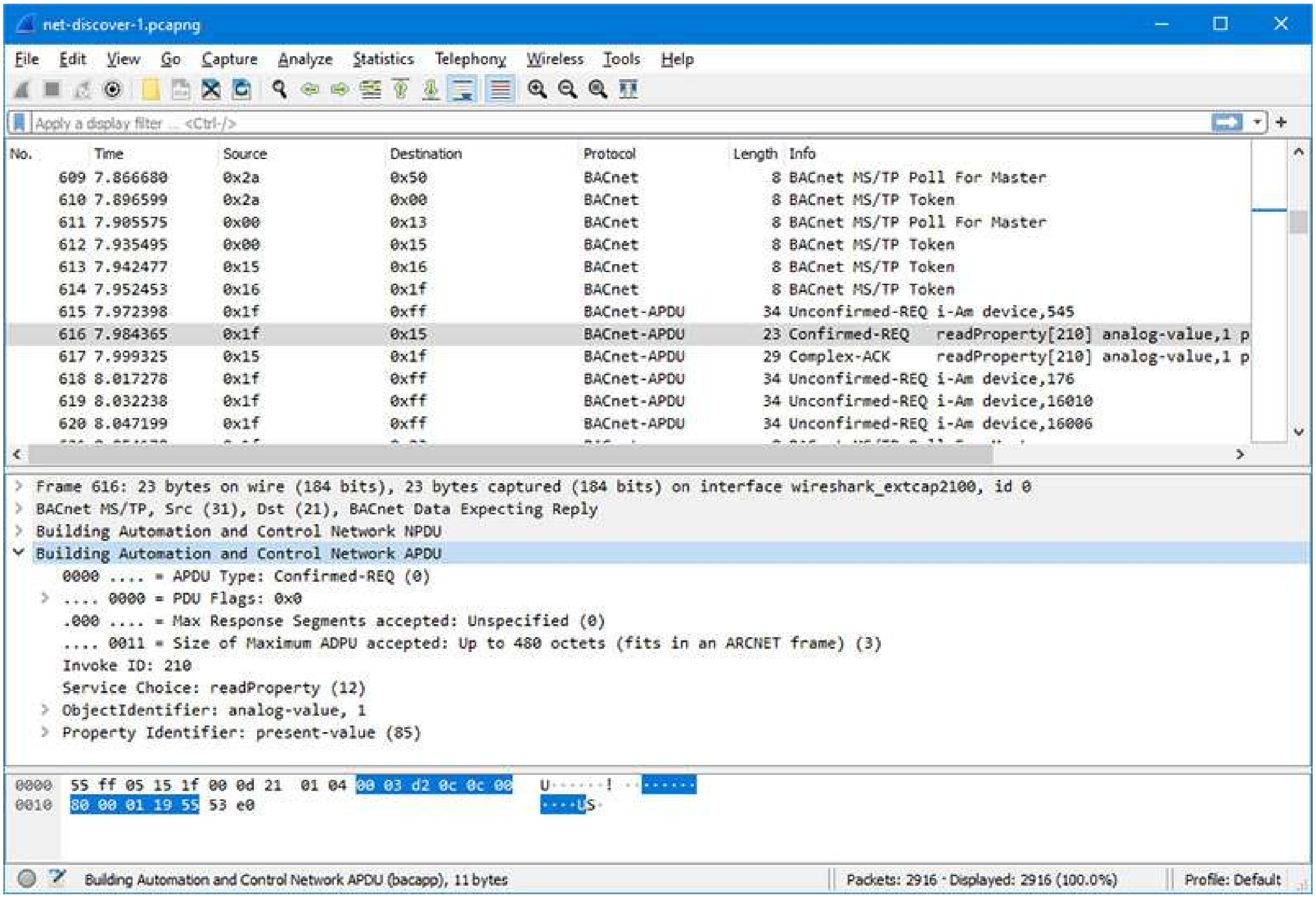
```
No.    Time        Source          Destination     Protocol     Length Info
    23 3.878362    192.168.1.112   192.168.1.115   BACnet-APDU      59 Confirmed-REQ   readProperty[115] analog-output,1 present-value
    24 3.878371    192.168.1.112   192.168.1.115   BACnet-APDU      59 Confirmed-REQ   readProperty[115] analog-output,1 present-value
    25 3.985160    192.168.1.115   192.168.1.112   BACnet-APDU      65 Complex-ACK     readProperty[115] analog-output,1 present-value
    27 5.070242    192.168.1.112   192.168.1.115   BACnet-APDU      59 Confirmed-REQ   readProperty[116] analog-output,1 present-value
    28 5.070250    192.168.1.112   192.168.1.115   BACnet-APDU      59 Confirmed-REQ   readProperty[116] analog-output,1 present-value
    29 5.082294    192.168.1.115   192.168.1.112   BACnet-APDU      65 Complex-ACK     readProperty[116] analog-output,1 present-value
    31 6.206372    192.168.1.112   192.168.1.115   BACnet-APDU      59 Confirmed-REQ   readProperty[117] analog-output,1 present-value
    32 6.206381    192.168.1.112   192.168.1.115   BACnet-APDU      59 Confirmed-REQ   readProperty[117] analog-output,1 present-value
    33 6.303937    192.168.1.115   192.168.1.112   BACnet-APDU      65 Complex-ACK     readProperty[117] analog-output,1 present-value
    34 7.318252    192.168.1.112   192.168.1.115   BACnet-APDU      59 Confirmed-REQ   readProperty[118] analog-output,1 present-value
    35 7.318261    192.168.1.112   192.168.1.115   BACnet-APDU      59 Confirmed-REQ   readProperty[118] analog-output,1 present-value
    36 7.328670    192.168.1.115   192.168.1.112   BACnet-APDU      65 Complex-ACK     readProperty[118] analog-output,1 present-value
```

```
> Internet Protocol Version 4, Src: 192.168.1.112, Dst: 192.168.1.115
> User Datagram Protocol, Src Port: 47808, Dst Port: 47808
> BACnet Virtual Link Control
> Building Automation and Control Network NPDU
v Building Automation and Control Network APDU
    0000 .... = APDU Type: Confirmed-REQ (0)
  > .... 0000 = PDU Flags: 0x0
    .000 .... = Max Response Segments accepted: Unspecified (0)
    .... 0011 = Size of Maximum ADPU accepted: Up to 480 octets (fits in an ARCNET frame) (3)
    Invoke ID: 115
    Service Choice: readProperty (12)
  > ObjectIdentifier: analog-output, 1
  > Property Identifier: present-value (85)
```

```
0000  00 40 9d 43 e8 3c a4 bb  6d a2 b9 f6 08 00 45 00   ·@·C·<·· m·····E·
0010  00 2d d8 ee 00 00 80 11  00 00 c0 a8 01 70 c0 a8   ·-······ ·····p··
0020  01 73 ba c0 ba c0 00 19  84 5e 81 0a 00 11 01 04   ·s······ ·^······
0030  00 03 73 0c 0c 00 40 00  01 19 55                  ··s···@· ··U
```

Building Automation and Control Network APDU (bacapp), 11 bytes | Packets: 53 · Displayed: 12 (22.6%) · Dropped: 0 (0.0%) | Profile: Default

The above examples show BACnet IP traffic on the Ethernet port. The following is an example of Wireshark capturing MS/TP traffic.


net-discover-1.pcapng
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
Apply a display filter ... <Ctrl-/>

```
No.    Time       Source   Destination  Protocol     Length Info
   609 7.866680   0x2a     0x50         BACnet          8 BACnet MS/TP Poll For Master
   610 7.896599   0x2a     0x00         BACnet          8 BACnet MS/TP Token
   611 7.905575   0x00     0x13         BACnet          8 BACnet MS/TP Poll For Master
   612 7.935495   0x00     0x15         BACnet          8 BACnet MS/TP Token
   613 7.942477   0x15     0x16         BACnet          8 BACnet MS/TP Token
   614 7.952453   0x16     0x1f         BACnet          8 BACnet MS/TP Token
   615 7.972398   0x1f     0xff         BACnet-APDU    34 Unconfirmed-REQ i-Am device,545
   616 7.984365   0x1f     0x15         BACnet-APDU    23 Confirmed-REQ   readProperty[210] analog-value,1 p
   617 7.999325   0x15     0x1f         BACnet-APDU    29 Complex-ACK     readProperty[210] analog-value,1 p
   618 8.017278   0x1f     0xff         BACnet-APDU    34 Unconfirmed-REQ i-Am device,176
   619 8.032238   0x1f     0xff         BACnet-APDU    34 Unconfirmed-REQ i-Am device,16010
   620 8.047199   0x1f     0xff         BACnet-APDU    34 Unconfirmed-REQ i-Am device,16006
```

```
> Frame 616: 23 bytes on wire (184 bits), 23 bytes captured (184 bits) on interface wireshark_extcap2100, id 0
> BACnet MS/TP, Src (31), Dst (21), BACnet Data Expecting Reply
> Building Automation and Control Network NPDU
v Building Automation and Control Network APDU
    0000 .... = APDU Type: Confirmed-REQ (0)
  > .... 0000 = PDU Flags: 0x0
    .000 .... = Max Response Segments accepted: Unspecified (0)
    .... 0011 = Size of Maximum ADPU accepted: Up to 480 octets (fits in an ARCNET frame) (3)
    Invoke ID: 210
    Service Choice: readProperty (12)
  > ObjectIdentifier: analog-value, 1
  > Property Identifier: present-value (85)
```

```
0000  55 ff 05 15 1f 00 0d 21  01 04 00 03 d2 0c 0c 00   U······! ········
0010  80 00 01 19 55 53 e0                                ····US·
```

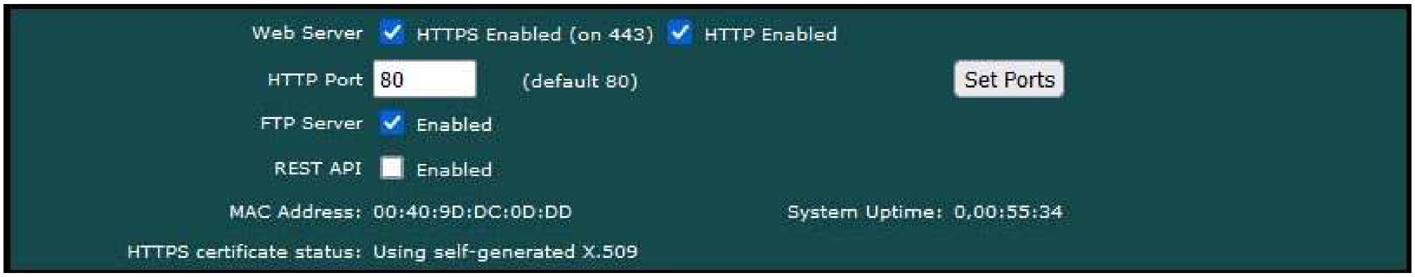
Building Automation and Control Network APDU (bacapp), 11 bytes | Packets: 2916 · Displayed: 2916 (100.0%) | Profile: Default

Appendix G SSL Certificates for Secure Web (HTTPS)

The secure web server (HTTPS) requires SSL certificates in order to establish secure connections. The HTTPS certificates are only required if HTTPS is enabled on the Network configuration page in the VP6-1470.

G.1 X.509 Auto-Certificate Generation

The VP6-1470 Gateway will automatically generate X.509 certificates if no external certificates are found or could not be loaded correctly. These will be generated one time and saved in the Flash file system for subsequent reuse. When the self-generated X.509 certificates are in use, this will be indicated at the bottom of the Network configuration page.



Web Server ☑ HTTPS Enabled (on 443) ☑ HTTP Enabled

HTTP Port 80 (default 80)

FTP Server ☑ Enabled

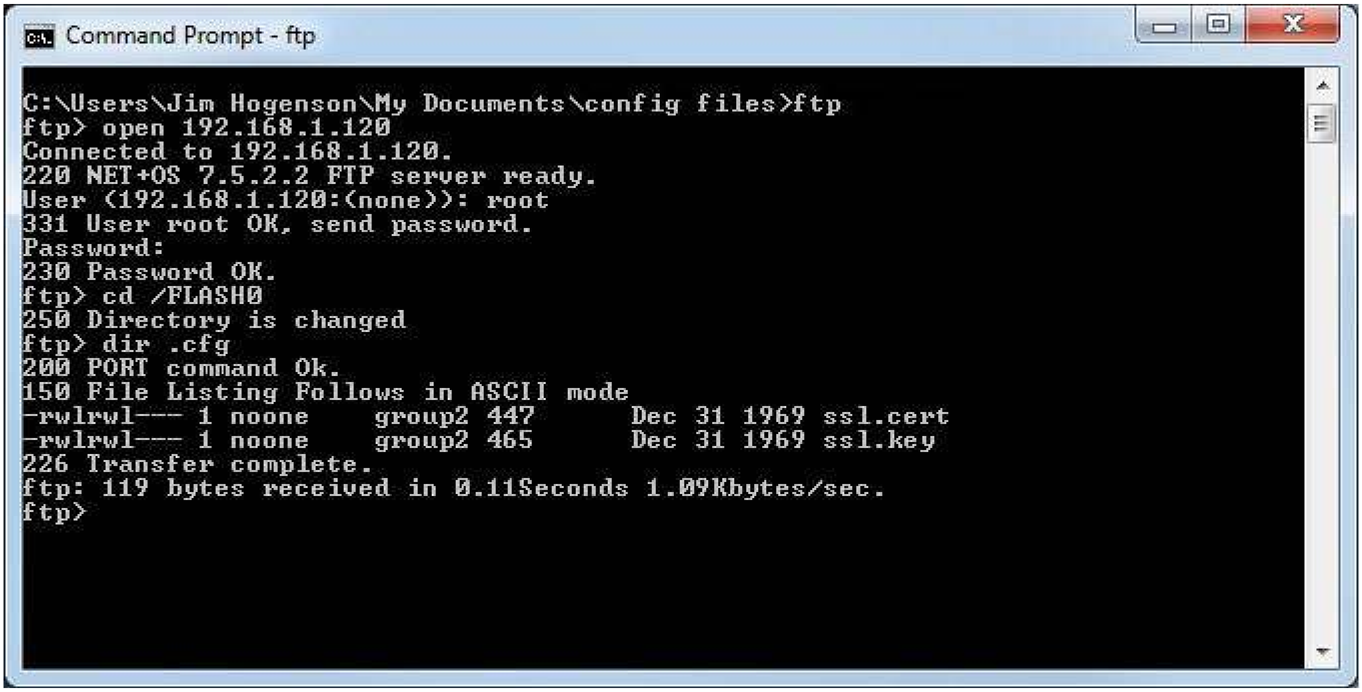
REST API □ Enabled

MAC Address: 00:40:9D:DC:0D:DD

System Uptime: 0,00:55:34

HTTPS certificate status: Using self-generated X.509

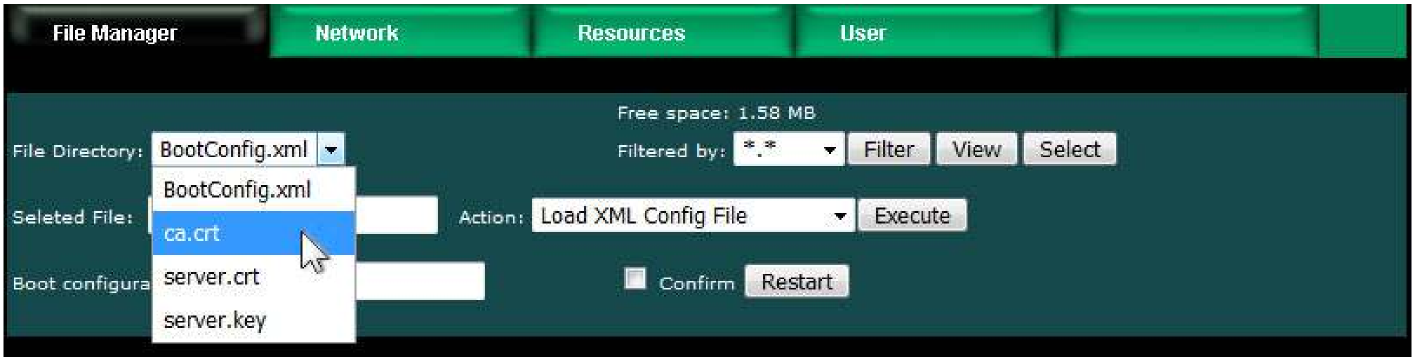
If there is a need to delete the self-generated certificates, you can do so by logging in via FTP. Change directory to /FLASH0, then to .cfg. The two certificate files that were self-generated are ssl.cert and ssl.key.



```
C:\Users\Jim Hogenson\My Documents\config files>ftp
ftp> open 192.168.1.120
Connected to 192.168.1.120.
220 NET+OS 7.5.2.2 FTP server ready.
User (192.168.1.120:(none)): root
331 User root OK, send password.
Password:
230 Password OK.
ftp> cd /FLASH0
250 Directory is changed
ftp> dir .cfg
200 PORT command Ok.
150 File Listing Follows in ASCII mode
-rwlrwl--- 1 noone    group2 447      Dec 31 1969 ssl.cert
-rwlrwl--- 1 noone    group2 465      Dec 31 1969 ssl.key
226 Transfer complete.
ftp: 119 bytes received in 0.11Seconds 1.09Kbytes/sec.
ftp>
```

G.2 External Certificates

There are three certificates that you must generate and upload to use SSL certificates other than the self-generated X.509 certificates.



Free space: 1.58 MB

File Directory: BootConfig.xml

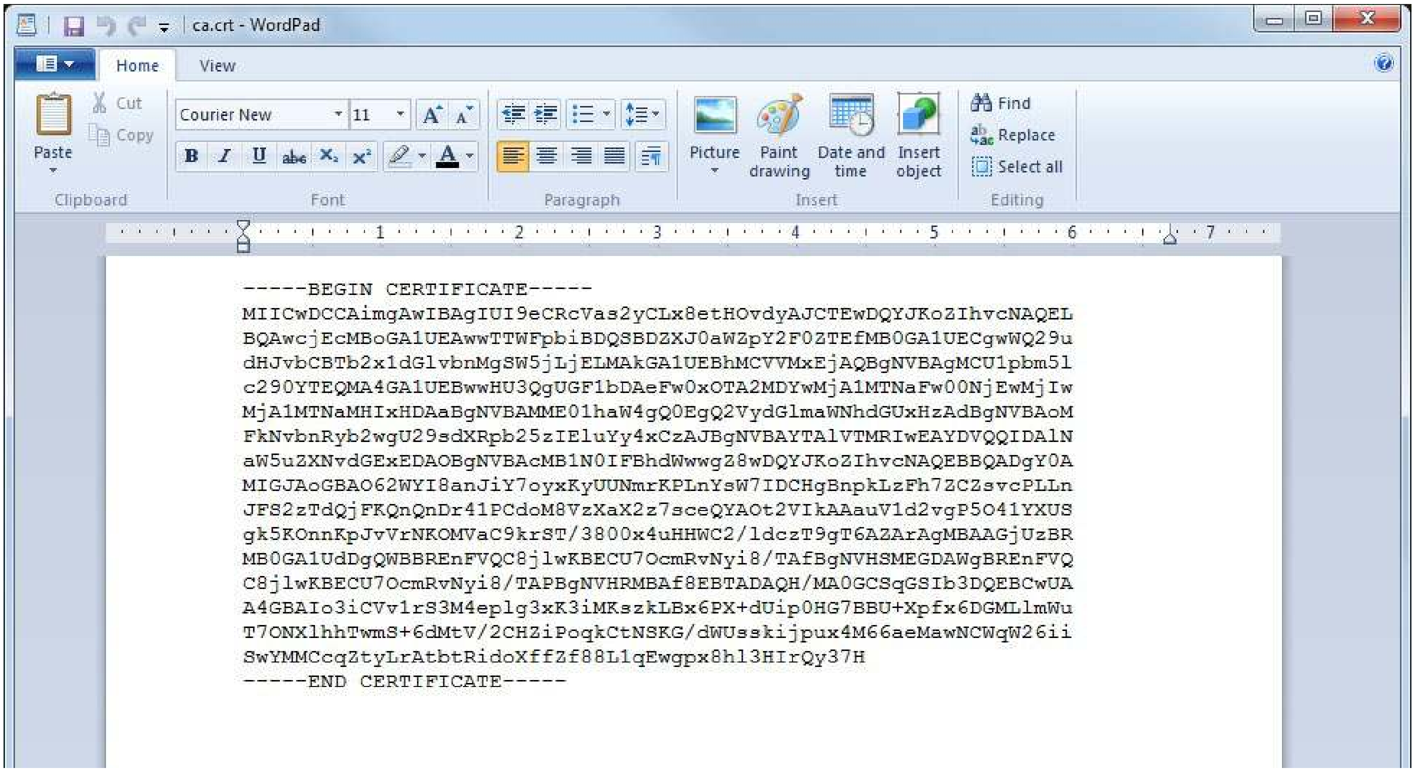
Filtered by: *.*

Action: Load XML Config File

The required certificates are as follows, and must use exactly these names.

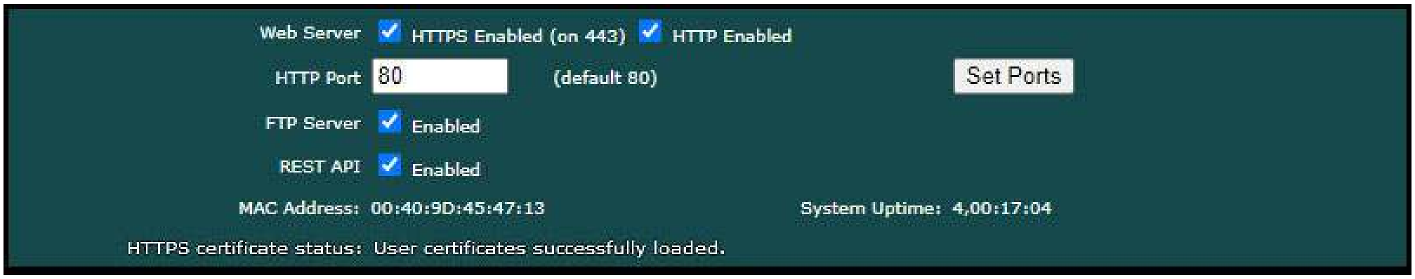
ca.crt	CA Root certificate in PEM format
server.crt	Server certificate in PEM format
server.key	Server private key in PEM format

The content of each certificate file will look something like the screen shot below. If you require external certificates for your secure web server, the requirement was likely imposed by your IT department. They should be able to provide the necessary certificates for you. For globally accessed use, the Root CA would come from somebody like GoDaddy or DigiCert (formerly Symantec).



```
-----BEGIN CERTIFICATE-----
MIICwDCCAimgAwIBAgIUI9eCRcVas2yCLx8etHOvdyAJCTEwDQYJKoZIhvcNAQEL
BQAwcjEcMBoGA1UEAwwTTWFpbiBDQSBDZXJ0aWZpY2F0ZTEfMB0GA1UECgwWQ29u
dHJvbCBTb2x1dGlvbnMgSW5jLjELMAkGA1UEBhMCVVMxEjAQBgNVBAgMCU1pbm5l
c290YTEQMA4GA1UEBwwHU3QgUGF1bDAeFw0xOTA2MDYwMjA1MTNaFw00NjEwMjIw
MjA1MTNaMHIxHDAaBgNVBAMME01haW4gQ0EgQ2VydGlmaWNhdGUxHzAdBgNVBAoM
FkNvbnRyb2wgU29sdXRpb25zIEluYy4xCzAJBgNVBAYTAlVTMRIwEAYDVQQIDAlN
aW5uZXNvdGExEDAOBgNVBAcMB1N0IFBhdWwwgZ8wDQYJKoZIhvcNAQEBBQADgY0A
MIGJAoGBAO62WYI8anJiY7oyxKyUUNmrKPLnYsW7IDCHgBnpkLzFh7ZCZsvcPLLn
JFS2zTdQjFKQnQnDr41PCdoM8VzXaX2z7sceQYAOt2VIkAAauV1d2vgP5O41YXUS
gk5KOnnKpJvVrNKOMVaC9krST/3800x4uHHWC2/ldczT9gT6AZArAgMBAAGjUzBR
MB0GA1UdDgQWBBREnFVQC8jlwKBECU7OcmRvNyi8/TAfBgNVHSMEGDAWgBREnFVQ
C8jlwKBECU7OcmRvNyi8/TAPBgNVHRMBAf8EBTADAQH/MA0GCSqGSIb3DQEBCwUA
A4GBAIo3iCVv1rS3M4eplg3xK3iMKszkLBx6PX+dUip0HG7BBU+Xpfx6DGMLlmWu
T7ONXlhhTwmS+6dMtV/2CHZiPoqkCtNSKG/dWUsskijpux4M66aeMawNCWqW26ii
SwYMMCcqZtyLrAtbtRidoXffZf88L1qEwgpx8hl3HIrQy37H
-----END CERTIFICATE-----
```

If external certificates were loaded successfully, that will be indicated at the bottom of the Network configuration page.



Web Server ☑ HTTPS Enabled (on 443) ☑ HTTP Enabled

HTTP Port 80 (default 80) Set Ports

FTP Server ☑ Enabled

REST API ☑ Enabled

MAC Address: 00:40:9D:45:47:13 System Uptime: 4,00:17:04

HTTPS certificate status: User certificates successfully loaded.

G.3 Certificate Generation Script (Linux)

The art and science of generating SSL certificates is beyond the scope of this document. An example SSL certificate generation script is provided here as a reference.

The following script, run on a Linux system with OpenSSL installed, will generate the three required SSL certificate files. It will generate a number of intermediate files as well - you don't need to upload them. Replace references to Control Solutions in this script with your own company name.

```
#!/bin/bash
echo hello
# This will create some self signed certs, using one master CA.
#
# these can be the webserver DNS name, or an IP address, however you
access
# the resource, this needs to match.
```

```
if [ -z "$1"] || [ -z "$2"]; then
echo 'Usage: gen.sh <server-name> <client-name>'
echo ' <server-name> and <client-name> can be IP addresses'
echo ' or DNS names.'
exit 1
fi
SNAME=$1
CNAME=$2
#
# Bits for strength, 1024, 2048, 4096, etc.. (suggest 2k or 4k for web
servers)
BITS=1024
#
# HASH - Options are sha256, sha512, sha1, md5
HASH="sha256"
SN=`date +%Y%m%d%H%M%S`
################
# below is the entry for the CRL
# Do not use http://www.csimn.com/crl.pem for production keys and
certificates
# cat <<EOF >> extensions.cnf
# [ extensions_section ]
# crlDistributionPoints = URI:http://www.csimn.com/crl.pem
#
# basicConstraints = CA:FALSE
# keyUsage = nonRepudiation, digitalSignature, keyEncipherment
# subjectAltName = DNS:${SNAME},IP:${SNAME}
# EOF
#################################################################
#################################################################
# first, lets generate some private keys...
openssl genrsa -out server.key ${BITS}
openssl genrsa -out client.key ${BITS}
# ok, and now the MAIN CA
openssl req -x509 -${HASH} -nodes -days 10000 -newkey rsa:${BITS} -keyout
ca.key -out ca.crt -subj "/CN=Main CA Certificate/O=Control Solutions
Inc./C=US/ST=Minnesota/L=St Paul"
######
#
# Create a CSR for both server and client
# Replace these values with one appropriate for your organization
openssl req -out server.csr -key server.key -new -subj "/CN=${SNAME}/
O=Control Solutions Inc./C=US/ST=Minnesota/L=St Paul"
openssl req -out client.csr -key client.key -new -subj "/CN=${CNAME}/
O=Control Solutions Inc./C=US/ST=Minnesota/L=St Paul"
#
#
######
# Sign the keys with the CA
openssl x509 -req -days 3650 -in server.csr -CA ca.crt -CAkey ca.key -
set_serial ${SN}01 -out server.crt -${HASH}
openssl x509 -req -days 3650 -in client.csr -CA ca.crt -CAkey ca.key -
set_serial ${SN}02 -out client.crt -${HASH}
```

```
# Create a windows file to import the client keys if needed in this format
openssl pkcs12 -export -clcerts -in client.crt -inkey client.key -out client.p12
# Create the client keys as a complete pem file if needed in this format
openssl pkcs12 -in client.p12 -out client-full.pem -clcerts
# mv -f server.key svrkey.pem
# mv -f server.crt svrcert.pem
# mv -f client.key clntkey.pem
# mv -f client.crt clntcert.pem
# cp -f ca.crt cacert.pem
####
# cleanup
# rm -f client.csr server.csr
#DLS 20160420
echo '***********************************************************'
echo '* WARNING: Do not use this script to generate production *'
echo '* keys and certificates. This script is for *'
echo '* demonstration purposes only. *'
echo '***********************************************************'
```