





Model MQ-73 IoT Gateway



Model BB3-7301-MQ IoT Gateway

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MQ-73 and BB3-7301-MQ User Guide Contents

TROL SOLUTIONS MINNESOTA

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1. Introduction

1.1 How to Use This Guide

This user guide provides background information on how the gateway works, and an overview of the configuration process. There are several sections for groups of tabs found in the web interface in the gateway 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 gateway 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 gateway which is generally sufficient for quick reference in setting up the gateway.

NOTE: The screen shots in this user guide were made using a Model MQ-73. The web pages found in the Model BB3-7301-MQ are identical except for the model number displayed at the top of the page.

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.

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 IoT Gateway for the First Time

The Babel Buster IoT Gateway model MQ-73 was used for screen shots in this User Guide. The only difference between MQ-73 and BB3-7301-MQ is form factor and mounting method. Therefore, this same User Guide applies to both models with the only difference in the web UI being the model number illustrated at the top of the pages. Functionality between the two models is identical.

2.1 Overview of IoT Gateway Operation

The Babel Buster IoT Gateway 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 IoT Gateway and the many features of Amazon Web Services.

Are you not a fan of the "cloud"? No problem. The latest release of the Babel Buster IoT Gateway 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 IoT Gateway itself.

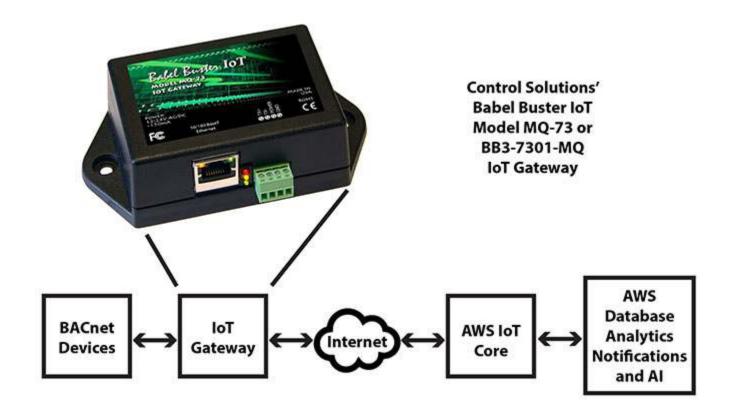
An IoT Device typically has one or more of these functions:

- 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 standalone implementation using the Babel Buster IoT Gateway.

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 Babel Buster IoT Gateway will poll one or more BACnet devices, collecting data from the list of registers you provide. Based on rules you create, the IoT Gateway will decide if and when to publish that data to the AWS server. You can also configure the IoT Gateway 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.

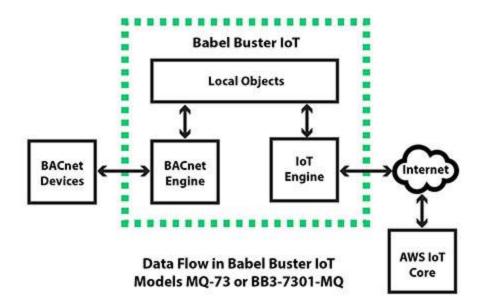
Examples of JSON formatted MQTT messages are as follows:

MQTT message from device	MQTT message from AWS server
to AWS server:	to device:
{	{
"state": {	"state": {
"reported": {	"desired": {
"csiSensor1": 70,	"csiActuator1": 50
"csiSensor2": 68	}
}	}
}	}
}	

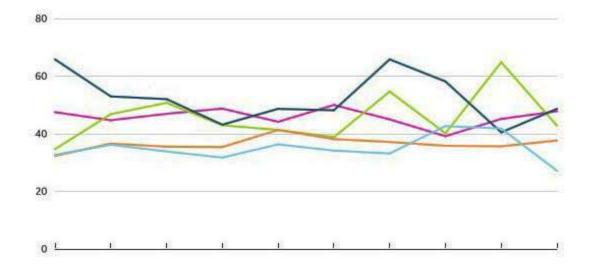
The MQTT "publish" action, in controls terms, is most closely associated with sensors. Your hardware has collected sensor data, and you want to send that sensor data to a server or to other control devices. To send that data, you "publish" it.

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 IoT Gateway, 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 IoT Gateway is illustrated below. Data is collected from BACnet devices by the BACnet engine which stores that data in its local registers or data 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.



One of the many things you can do with data that has been published to the AWS server by the Babel Buster IoT Gateway is analyze and visualize the data. The graph illustrated below represents data published by an IoT Gateway, and the steps taken to get this graph are outlined later in this user guide.



2.1.2 Stand-Alone Application

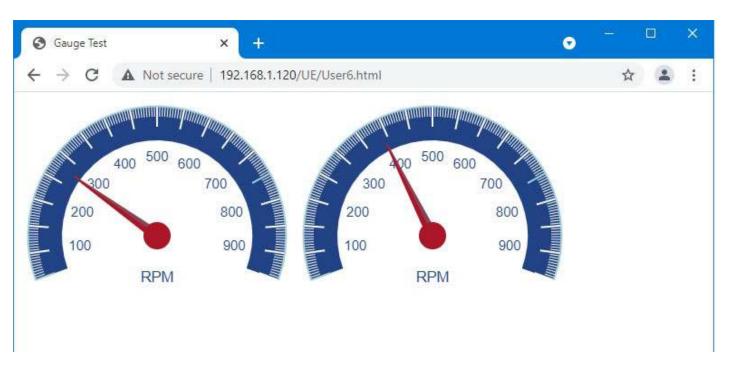
The Babel Buster IoT Gateway supports stand-alone data logging by logging selected data points to a local file in CSV format, and then automatically emailing that file to you from time to time. Once received, you can do anything with that data that you can normally do with any standard spread sheet program.

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

There are several features available for supporting control algorithms, and a real time scheduler is now included in the Babel Buster IoT Gateway. 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 Babel Buster IoT Gateway 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 gateway as noted in the following section. Then set the IP address of your IoT Gateway, and get familiar with the File Manager. You will find these covered in Section 3.

• Create some registers so you have a place to put data. Section 4 talks about this.

• Decide how you're going to talk to your BACnet device. Are you using BACnet IP or MS/TP? Should the IoT Gateway be client or server? Based on how you answer these questions, you will choose from Sections 5 through 8.

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

• Are you interested in local alarm monitoring? Event rules are where you will tell the IoT gateway 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 IoT Gateway to talk to AWS. Then move on to any of Sections 14 through 18 to cover the various ways you can interact with AWS. If you are not using AWS, you can skip Sections 13 through 18.

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.

• 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 IoT Gateway's internal server, that is covered in Section 19. 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 20.

• 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 Babel Buster MQ-73 or BB3-7301-MQ.

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



(b) Connect a CAT5 cable between the RJ-45 jack on the gateway, 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.



Open your browser, and enter "http://10.0.0.101/" in the address window. You should see a page with the "Babel Buster MQ-73" header shown above (or comparable page for BB3-7301-MQ). 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 IoT Gateway shipped, and unique to your IoT Gateway. 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 gateway, 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 gateway 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.

Local Objects BAC	net	loT Cloud	System		
System Setup	Actions	Events		Scheduler	
File Manager Net	work	Resources	User		
IPv4 Static IP Addres IPv4 Static Subnet Mas	255.255.255.0	IPv4	- IPv4 Subnet Ma	ess 192.168.1.11 ask 255.255.255.	an a
IPv4 Static Gatewa IPv6 Setting: IPv6 Link-Local IP Addres	5 O Disabled		IPv4 Gatew	vay 192.168.1.1	
IPv6 Configured IP Addres	₅ fec0::a	un.ieto.t/15		1	
IPv6 Prefix Lengt IPv6 Gateway Tunne					
DNS Setting: Primary DN:	s <mark>1.1.1.1</mark>			::FFFF:1.1.1.1	
Secondary DN	5 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 gateway 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 gateway. To retain those changes indefinitely (i.e. through restart or power cycle), you need to tell the gateway 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 gateways job is defined by the XML file, and the gateway's identity is stored outside of the file system.

Babel Bur MODEL MQ- JOT GATEWAN	73 AMARINA		CONTROL SO	DLUTIONS MINNESOTA
Local Objects	BACnet	IoT Cloud	System	
System Se	tup Actions	Events	Scheduler	
File Manager	Network	Resources	User	Annual States of Concession, Name
File Directory: BootConfi Seleted File: BootConfi Boot configuration BootC	g.xml	Free space: 1.3 Filtered by: *. Action: Load XML Conf	xml 🗸 Filter View Selec ig File 💉 Execute	1
	ad File Dose File No file chos	sen		

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

File Manager	Network	Resources			User		-1			
		Free space:								
File Directory: BootConfi	ig.xml 👻	Filtered by:	*.xml	~	Filter	View	Select			
Seleted File: BootConfig	j.xml	Action: Load XML Co		15	,	Exec	cute			
Boot configuration BootC	onfig.xml	Confirm	*.txt *_*							

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.

File Manager	Network	Resources	User
File Directory: BootConfig.	xml 👻	Free space: 1.36 M Filtered by: *.xml	
Seleted File: BootConfig.x	ml Act	ion: Load XML Config F	ile V Execute
Boot configuration BootCon	fig.xml	Load XML Config Fi Save XML Config Fi Create New XML Co Select Boot Auto-Co	ile VC onfig File
Upload Choos	File <mark>se File </mark> No file chosen	Delete Selected File Import CSV to BAC Clear BACnet Clien Clear All Configurat	net Client t Maps

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 gateway, 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 gateway, 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 Babel Buster 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 gateway'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 gateway 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 IoT Gateway. 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 Babel Buster 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 gateway. Upon restart, and upon finding that the boot configuration name is BootConfig.xml, and it does not exist, the gateway will automatically create one with default parameters. The automatic creation of a default file will not occur with any other file name.

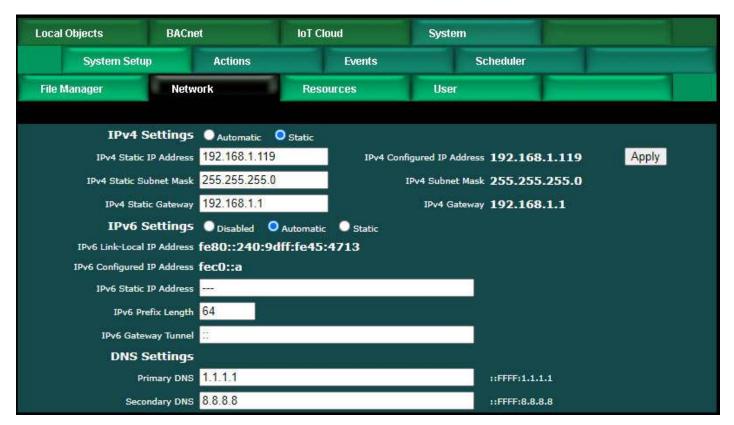
Manual Editing: It is possible to manually edit the XML file outside of the gateway. However, doing so is very prone to errors. If there are errors in the XML file, it will not load successfully on startup. If the configuration does not load on startup, none of the scanners will begin scanning. Because 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 gateway 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 Babel Busters 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 gateway, 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 Babel Buster's IP address as well as a few other important things.



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 gateway 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 Babel Buster maintains time and date via SNTP services.

Primary NTP Server	132.163.97.2	See	condary NTP Server	132.163.96.	.4	
Daylight Time Start Rule	3.2.0/02:00:00	Day	light Time End Rule	11.1.0/02:00	0:00	
Standard GMT Offset	-360 Min	iutes I	Daylight GMT Offset	- <mark>3</mark> 00	Minutes	Set NTP
NTP Refresh Period	300 Min	utes				
Latitude	45.062126		Longitude	-92.984154		
Current Local Time	2021-10-26 (09:29:28 Refresh				
	Sunrise 07:43	Sunset 18:0	8			

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 Babel Buster 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 ($1 \le m \le 12$)

n indicates which week of the month $(1 \le n \le 5)$. 5 = the last week in the month.

d indicates what day of the week ($0 \le d \le 6$). 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.

3.3.3 Port Settings

Web Server 🗹 H	ITPS Enabled (on 443) 🗹 HTTP Enable	ed	
HTTP Port 80	(default 80)	Set Ports	
FTP Server 💙 Er	nabled		
REST API 🛃 Er	nabled		
MAC Address: 00:40:	9D:45:47:13	System Uptime: 4,00:17:04	
HTTPS certificate status: Using s	self-generated X.509		

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 gateway to make that new port take effect. Don't forget to append the port number to the gateway'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 gateway 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 Babel Buster before they will take effect.

3.4 Resource Allocation

Historically, Control Solutions gateways 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.

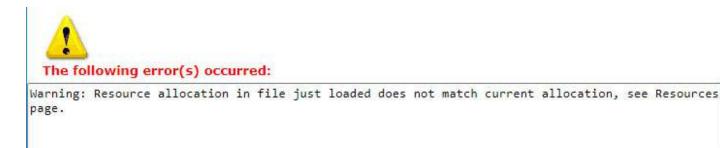
If you see that numbers toward the top of the list are large, and numbers near the bottom are all set to 1, it means the system has run out of free memory and you need to reallocate resources.

Local Objects B4	ACnet	IoT Cloud		System			
System Setup	Actions	Ev	ents	Sche	duler		
File Manager N	letwork	Resources		User			
	and a set of the set			- Construction			
				С	heck	Commit	Confirm Restart
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 Object	5	20	20				
Number of Multistate Value Objects	į.	20	20				
Default States per Multistate Object	ŧ.	5	5				
Maximum COV Subscriptions		100	100				
Number of BACnet Client Devices		20	20				
Number of BACnet Client Read Map	5	100	100				
Number of BACnet Client Write Map	S	50	50				
MS/TP Slave Proxy Support		Disable	O Disable	e 🔍 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	5	50	50				
Number of Scheduler On Demand E	vents	20	20				
Estimated Memory Utilization		9.29%	9.29%				

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).



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 Babel Buster gateway. 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 Babel Buster (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 Babel Buster'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.

Local Objects	BACnet	IoT Cloud	System	1	
System Se	tup Actions	Event	S	Scheduler	
File Manager	Network	Resources	User		
					Change
User Name	P	assword	Privilege Level	IP Filter	Confirm Change
jimh			Administrator 🗸	0.0.0	
			Restricted 🗸	0.0.0.0	
			Restricted 🗸	0.0.0.0	
			Restricted 🗸	0.0.0.0	
			Restricted V	0.0.0	
root	•••••		Unrestricted	0.0.0	
root confirm					



4. Configuring the BACnet Device

4.1 Device Object Parameters

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

	17818181910		CONTROL	SOLUTIONS MINNESOT
ocal Objects	BACnet	IoT Cloud	System	
Local Device	BACnet Clier	nt Diagnostics	BBMD	
BACnet Settings	Router Settings	Configured Routes	Discovered Routes	Slave Proxy
Device (Device	C0 = 47808) 47808 Dbject Name Babel Bust 2 Description IoT for BAC	Cnet 119		
	vice Location St. Paul, M	Innesota	APDU Retries	
	ent Timeout 5000		Database Revision 12	
	nand Priority 10		Backlog Limit 0	
MS/TF	9 Baud Rate: 38400 🗸	MS,	/TP MAC address: 0	
MS/TP Max I	Info Frames: 1	МЗ	/TP Max Masters: 127	
Allow fault self-reset	without Ack. 🔽		self-restart upon	
	gmentation.			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 gateway 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 Babel Buster 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.

Babel Bush MODEL MQ-73 JOT GATEWAY	er IoT		CONTROL SOLU	tions Minnesota
Local Objects	BACnet	IoT Cloud	System	
System Setup) Actions	Events	Scheduler	
File Manager	Network	Resources	User	
IPv4 Su IPv4 Static I IPv4 Static Sul IPv4 Static	bnet Mask 255.255.255		onfigured IP Address 192.168.1. IPv4 Subnet Mask 255.255.25 IPv4 Gateway 192.168.1.	5.0

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.

Babel Buy Model MQ-7	ter IoT			CONTROL SO	LUTIONS MINNESC	ота
Local Objects	BACnet	loT Cloud	Syst	tem		
Local Device	BACnet	Client Diagn	iostics	BBMD		
BACnet Settings	Router Settings	Configured Ro	utes Disc	covered Routes	Slave Proxy	
	etwork Number 8 P Network Info Default		ount: 0	Sav	e	
	etwork Number <mark>115</mark> P Network Info <mark>Default</mark>	Hop Co MS/TP Net	ount: <mark>0</mark>			
	Z Enabl		able I-Am route le able I-Am-Router			

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 Babel Buster should operate only as a gateway. 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.

Local Device	BACnet C	lient Diagnostics	BBMD		
BACnet Settings	Router Settings	Configured Routes	Discovered Routes	Slave Proxy	
		Showing 1 to 15 of	64	Update < Prev	Next >
Local Port	Remote Network #	Local Info		Router's Address	
BACnet IP 🗸	41	Network 41		192.168.1.178:47808	
MS/TP \sim	88	Network 88		91	
None 🗸	0				ا آها

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 MQ-73/BB3-7301-MQ'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 autosaved to the XML configuration file for subsequent reload. Thus, the router portion of this MQ-73/BB3-7301-MQ 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 Device	BACnet Clier	nt Diagnostics	BBMD	and a second		
BACnet Settings	Router Settings	Configured Routes	Discovered Routes	Slave Proxy		
		Showing 1 to 15 of 6	54	Update < Prev	Next >	
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	Ĵ.	
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	Ĩ	

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.

	Local De	vice B	ACnet Client	Diagnos	stics	BBMD			
BAC	net Settings	Router Se	ttings	Configured Route	es	Discovered Routes	Slave	Ргоху	
			She	owing 1 t	o 2of 2		Update	< Prev	Next >
Mode	MAC Address	Device Instance	Max APDU	Vendor ID		Local (Device Info		
м	181	20821	480	208	BB2-3010 Slave 21				
M	201	20841	480	208	BB2-3010 Slave 41				
	0	0							
							Add	Remove	Conve

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.

Babel Buste MODEL MQ-73 JOT GATEWAY		A CONTRACTOR			CONTRO	L SOLUTIO	оня Мінн	ESOTA
Local Objects	BACnet	la	oT Cloud	Sys	tem			
Local Device		BACnet Client	Diagnostics		BBMD		(interest	
BBMD Settings	Edit BDT	-				-		
								Refresh
Broadcast Distribution Table	e (BDT)	Broadcast Address:Port			Broadcast Mask			
								Refresh
		Foreign Devices R	egistered 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) Save								
BBMD IP A	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 MQ-73/BB3-7301-MQ 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.

Local Objects	BACnet		loT Cloud	Syste	em		
Local Devi	ice	BACnet Client	Diagnos	tics	BBMD		
BBMD Settings	Edit BD1					1	
							Refresh
Broadcast Distribution 1	Table (BDT)	Broadcast Addre	ess:Port	E	Broadcast Mask		
		411			222		
							Refresh
		Foreign Devices	Registered Locally		lime to Live		
		411			222		
Local Device's Registrat	tion as a Foreign Enable BBMD		te Location				
RBMD Time To	Live (seconds)	The second secon	Zero disables forei		· _	Save	
bomb Hille I'c	- eve (seconds)	300	zero disables foreli	gn registration	/	Juve	
BBMD 1	IP Address, Port	173.22.32.91	47808	BBMD is regi	stered.		
		2-1	- 28	9			

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 MQ-73/BB3-7301-MQ 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 MQ-73/BB3-7301-MQ 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.

Local Objects	BACnet	IOT C	loud	System				
Local Device	Bł	ACnet Client	Diagnostics	BBMD	1			
BBMD Settings	Edit BDT							
						Refresh		
Broadcast Distribution Tabl	le (BDT) Br	oadcast Address:Po	rt	Broadcast M	lask			
2		2 7			3	a da		
						Refresh		
	Fo	reign Devices Regis	tered Locally	Time to Live	Time to Live			
	1	73.22.32.87:47808		630	5	8		
	1	73.22.32.90:47808		630				
	1	73.22.32.91:47808		630	35			
Local Device's Registration	as a Foreign De Enable BBMD 🔽		ation					
BBMD Time To Liv	ve (seconds) 0	(Zero d	lisables foreign reg	istration)	Save			
BBMD IP A	ddress, Port <mark>().</mark>	0.0.0) ввм	D 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.

Local Objects	BACnet	loT	Cloud	System	
Local De	evice BA	Cnet Client	Diagnostics	BBMD	Section and the section of the secti
BBMD Settings	Edit BDT		1		
					Update
	Broadcast Address	: Port	Broad	dcast Mask	
	192.168.1.126	47808	24	FFFFF00	
	173.22.32.87	47808	32	FFFFFFF	
	173.22.32.90	47808	32	FFFFFFF	
	173.22.32.91	47808	32	FFFFFFF	
	0.0.0	0	0	0000000	

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.

Local Objects BACne	t loT	Cloud	System	
Local Device	BACnet Client	Diagnostics	BBMD	and the second second
BBMD Settings Edit B	DT			1
				Refresh
Broadcast Distribution Table (BDT)	Broadcast Address:Po	ort	Broadcast Masl	¢
	192.168.1.126:4780	8	FFFFF00	
	173.11.32.87:47808	1	FFFFFFF	
	173.11.32.90:47808		FFFFFFF	
	173.11.32.91:47808		FFFFFFF	
				Refresh
	Foreign Devices Regi	stered Locally	Time to Live	
			1.11	
Local Device's Registration as a Forei Enable BBM		cation		
BBMD Time To Live (second		disables foreign regi	stration)	Save
BBMD IP Address, Po	rt 0.0.0.0	0 ввис) is not registered.	



6. Configuring Local Objects

Babel Buster gateways do not come with a predefined set of BACnet objects. The gateway 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 in 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 MQ-73/BB3-7301-MQ, 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 autodiscovers all objects in the device.

Local	Objects	BACnet	loT Cloud	d	System				
	System Setup	Actions		Events		Scheduler	- 1		
File I	Manager	Network	Resour	ces	User				1
						_			
						Check	Commit	Confirm	Restart
Resource	<u>ê</u>		Current	Pending					
Number o	of Analog Input Object	5	100	100					
Number o	of Analog Output Obje	cts	50	50					
Number o	of Analog Value Object	ts	100	100					
Number o	of Binary Input Object	5	100	100					
Number o	of Binary Output Objec	cts	30	30					
Number o	of Binary Value Object	5	30	30					
Number o	of Multistate Input Obj	jects	20	20					
Number o	of Multistate Output O	bjects	20	20					
Number o	of Multistate Value Obj	jects	20	20					
Default S	tates per Multistate O	bject	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.

Bi M 10	abel Buste NODEL MQ-73 DT GATEWAY	n IoT				Co	S. NTROL S	OLUTIONS	MINNES	ота
Loca	I Objects	BACnet		loT Cloud	1	System				
	Analog	Bina	гу	Mul	ti-State					
Inpu	ıt Objects	Output Objec	ts	Value Objec	ts					
Analog	Input Objects		s	howing objects fr	om 1			Refresh	< Prev	Next >
Object	Object Name Object Description		Out of Service	Present Value	Reliability	Status	Units			
1	Analog Input 1 Description of AI 1		N	0.00	o	0,0,0,0	no_units			
2	Analog Input 2 Description of AI 2	2 2 3	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	5	N	0.00	o	0,0,0,0	no_units			

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

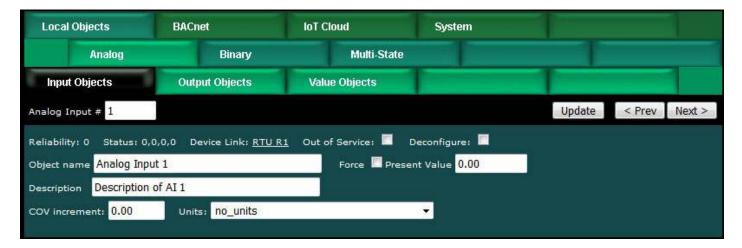
BACnet client, device timeout (82) BACnet client, error returned by server (83)

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

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



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.

6.3.2 Analog Output Objects

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

Local Objects	BACnet	IoT Cloud	System			
Analog	Binary	Multi-Stati	e.			
Input Objects	Output Objects	Value Objects	1			
Analog Output # 1				Update	< Prev	Next >
Reliability: 0 Status: 0),0,0,0 Device Link:	Out of Service: 🔲 Dev	configure: 🔲			
Object name Analog Ou	itput 1	Force Pre	sent Value <mark>0.00</mark>	rq> 0.00 ▼		
Description Description	n of AO 1					
COV increment: 0.00	Relinquish Default:	0,00 Units: NO_	units	•		

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.

6.3.3 Analog Value Objects

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

Local Objects	BACnet	IoT Cloud	System			
Analog	Binary	Multi-St	tate			
Input Objects	Output Objects	Value Objects				
Analog Value # 1				Update	< Prev	Next >
Reliability: 0 Status: 0	,0,0,0 Device Link:	Out of Service: 🔲	Deconfigure:	177		
Object name Analog Va	lue 1	Force 🔲	Present Value 0.00			
Description Description	n of AV 1					
COV increment: 0.00	Units: no_units		×.			

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.

6.3.4 Binary Input Objects

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

Local Objects	BACnet	loT Cloud	System			
Analog	Binary	Multi-State	*			
Input Objects	Output Objects	Value Objects	1			
Binary Input # 1				Update	< Prev	Next >
Reliability: 0 Status	: 0,0,0,0 Device Link:	Out of Service: 🔲 Deco	onfigure: 🔲			
Object name Binary I	nput 1	Force 🔲 Pres	ent Value <mark>Inactive</mark> 🔻			
	ion of BI 1					
Description Descript						

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.

6.3.5 Binary Output Objects

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

Local (Objects	BACnet	IoT Cloud	System			
	Analog	Binary	Multi-State				
Input	Objects	Output Objects	Value Objects				1
Binary Ou	tput # 1				Update	< Prev	Next >
Reliability	: 0 Status: 0,	,0,0,0 Device Link:	Out of Service: 🔲 Decc	onfigure: 🗖			
Object na	me Binary Outp	put 1	Force 🗖 Pres	ent Value Inactive 🔻	rq> Inactive 🔻		
Descriptio	n Description	of BO 1					
Active Tex	ct: Binary outpu	ut is Active	Inctive Text: Bi	nary output is Inactiv	e		
Relinquisl	h Default <mark>Inact</mark>	ive 🔻					

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.

6.3.6 Binary Value Objects

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

Local Objects	BACnet	loT Cloud	IoT Cloud System			
Analog	Binary	Multi-Sta	te			
Input Objects	Output Objects	Value Objects				
Binary Value # 1				Update	< Prev	Next >
Reliability: 0 Status: 0	1,0,0,0 Device Link:	Out of Service: 🔲	Deconfigure: 🔲			
Object name Binary Val	ue 1	Force 🔲 Pr	resent Value Inactive 🔻			
Description Description	n of BV 1					
Active Text: Binary valu	e is Active	Inctive Text:	Binary value is Inactive			

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

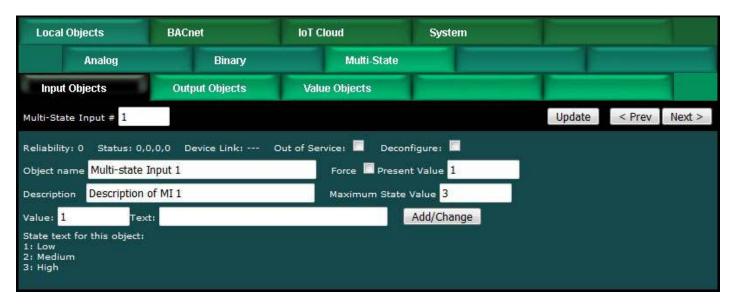
- B = fault
- C = overridden
- D = out of service

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.

6.3.7 Multistate Input Objects

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



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.

6.3.8 Multistate Output Objects

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

Loca	Objects	BACnet	loT Cloud	System				
	Analog	Binary	Multi-State					
Inpu	t Objects	Output Objects	Value Objects					
Multi-Sta	ate Output # 1				Up	odate	< Prev	Next >
Reliabili	ty: 0 Status: 0,(0,0,0 Device Link:	Out of Service: 🔲 Deco	nfigure: 🔲				
Object n	ame <mark>Multi-state</mark> (Output 1	Force 🔲 Prese	nt Value <mark>1</mark>	rq> 1	-		
Descript	on Description	of MO 1	Maximum State	Value <mark>3</mark>				
Relinqui	sh Default: 1							
Valuer	l Tex	t:		Add/Change				
State te 1: 2: 3:	xt for this object:							

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.

6.3.9 Multistate Value Objects

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

Local Objects	BACnet	IoT Cloud	System			
Analog	Binary	Multi-State	2			
Input Objects	Output Objects	Value Objects		1		
Multi-State Value # 1				Update	< Prev	Next >
Reliability: 0 Status: 0	,0,0,0 Device Link:	- Out of Service: 🔲	Deconfigure: 🔲			
Object name Multi-state	Value 1	Force 🔲 Pres	sent Value <mark>1</mark>			
Description Description	of MV 1	Maximum Sta	te Value <mark>3</mark>			
Value: 1 Te	xt:		Add/Change			
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.

6.4 Local Object Calculate Rules

The Babel Buster MQ-73/BB3-7301-MQ 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.

Local	Objects	BACnet	loT Clou	ud	System	
	System Setu	ip Actions		Events	Sched	uler
Calc	ulate	Сору	Report	t		
			Showing 1	to 1 of 1		Update < Prev Next >
Rule #	Perform Operation	Using Object	And/Thru Using	This Object/Value	Place Result in Object	
1	none 😽	None	and 🗸	None	None	
# Rules E	none Add add average sum subtract					Insert Delete
Quick This tem objects to two oper	I La dia ANID					ogically ANDing or ORing a couple of binary op list. All but logical NOT operations require
operation	logic XOR	es of multiple objects (of same type).			s in a range. Average, sum, and logic
Delete w between (unused	e test = 0					umber shown, and is used for placing rules rule presently having "none" for an operation
	skip < N skip > N	updates. Because erro	or trapping happens	s sooner than the i	nsert/delete process,	ed by that object being later deleted, the now the delete will not remove the invalid rule. To er if you intend to keep the rule).
Selecting always sl	comp = N	ation effectively deletes peration. If you wish to				eted. Unused rules at the end of the list will f 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.

Calculate		Copy Report					1	
			Showing 1	to 2 of 2		Upda	te < Prev	Next >
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					Insert	Delete	

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.



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 previosly 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 AI 6 contains a zero. If AI 6 is not equal to zero, then rule 6 will be executed. (The numbers rule 6 and AI 6 are not related in any other way, this is just conincidence in the example.)

Cal	culate	Сору	Report			
			Showing 1	to 8 of 8		Update < Prev Next >
Rule #	Perform Operation	Using Object	And/Thru Using	This Object/Value	Place Result in Object	
1	comp = N 🗸	AI 1	using 🗸	10	AI 2	
2	comp < N 🗸	AI 1	using 🗸	10	AI 3	
3	comp > N 🗸	AI 1	using 🗸	10	AI 4	
4	set 🗸 🗸	AI 5	using 🗸	202	AI 5	
5	skip = N 🗸 🗸	AI 6	using 🗸	0	AI 6	
6	set 🗸	AI 7	using 🗸	0	AI 7	
7	set 🗸	AI 8	using 🗸	88	AI 8	
8	none 🗸	None	and 🗸	None	None	

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

Loca	al Objects	BACnet	IoT Cloud	IoT Cloud			12		
	Analog	Binary	M	ulti-State			T		
Inp	ut Objects	Output Objects	Value Obje	cts					
Analog I	nput Objects		Showing objects fr	om 1			Refresh	< Prev	Next >
Object	Object Name Object Description	Out o Servio	Drocont Value	Reliability	Status	Units			
1	Analog Input 1 Description of AI 1	N	10.00000	0	0,0,0,0	no_units			
2	Analog Input 2 Description of AI 2	N	1.000000	0	0,0,0,0	no_units			
3	Analog Input 3 Description of AI 3	N	0.00	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	202.0000	0	0,0,0,0	no_units			
<u>6</u>	Analog Input 6 Description of AI 6	N	1.000000	0	0,0,0,0	no_units			
Z	Analog Input 7 Description of AI 7	N	0.00	0	0,0,0,0	no_units			
8	Analog Input 8 Description of AI 8	N	88.00000	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.

Calc	:ulate	Сору	Repor	t		1		1
			Showing 1	to 5 of 5		Up <mark>d</mark> ate	< Prev	Next >
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			

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.

Calo	:ulate		Сору	Report			1		
				Showing 1	to 6 of 6		Update	< Prev	Next >
Rule #	Perform Operation	i,	Using Object	And/Thru Using	This Object/Value	Place Result in Object			
1	priority	~	AI 1	using 🗸	7	AI 1			2
2	set	~	AO 1	using 🛩	55	AO 1			2
3	skip = N	~	AI 2	using 🛩	0	AI 2			2
4	relinquish	~	AO 1	and 🛩	None	AO 1			2.
5	set	<	AI 3	using 🛩	15	AI 3			
6	none	<	None	and 🗸	None	None			3

Pack and fill are used for packing multiple local objects into a single object for purposes of emulating existing equipment when the Babel Buster 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 in	nto the result object.
---	------------------------

Gui	culate		Сору	Repor Showing 1	to 4 of 4		Update	< Prev	Next >
Rule #	Perfor Operat		Using Object	And/Thru Using	This Object/Value	Place Result in Object			
1	pack	~	AI 2	using 🗸	Fh	AI 1			
2	pack	~	AI 3	using 🗸	F0h	AI 1			
3	pack	<	AI 4	using 🗸	F00h	AI 1			
4	none	~	None	and 🗸	None	None			

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

Local Objects		BACnet	BACnet		IoT Cloud		System			
	Analog	Binar	y	Mu	lti-State			T		
Inpu	ıt Objects	Output Object	S	Value Objec	ts					
Analog 1	input Objects		s	howing objects fro	m 1			Refresh	< Prev	Next >
Object	Object Name Object Description		Out of Service	Present Value	Reliability	Status	Units			
1	Analog Input 1 Description of AI 1		N	273.0000	0	0,0,0,0	no_units			
2	Analog Input 2 Description of AI 2		N	1.000000	0	0,0,0,0	no_units			
<u>3</u>	Analog Input 3 Description of AI 3		N	1.000000	0	0,0,0,0	no_units			
4	Analog Input 4 Description of AI 4		N	1.000000	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			

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

Cal	culate		Сору	Report			T		1
				Showing 1	to 4 of 4		Update	< Prev	Next >
Rule #	Perform Operation		Using Object	And/Thru Using	This Object/Value	Place Result in Object			
1	unpack	~	AI 1	using 💙	Fh	AI 2			
2	unpack	~	AI 1	using 🛩	F0h	AI 3			
3	unpack	~	AI 1	using 🛩	F00h	AI 4			
4	none	~	None	and 🗸	None	None			

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 gateway family.

6.5 Local Object Copy Rules

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

M	odel Buste Odel MQ-73 I GATEWAY				S		
		1981818			CONTROL S	OLUTION	IS MINNESOTA
Local	Objects	BACnet	IoT Cloud	1	System		
	System Setup	Actions		Events	Scheduler	1	
Calc	ulate	Сору	Report	- 1			
		s	howing 1	to 3 of 3		Updat	te < Prev Next >
tule #	Source Object	Source Property		ination bject			
1	AI 7	Present Value 🗸	AI 14				
2	AI 7	Reliability 🗸	AI 15				
3	None	Present Value 🗸	None				
Rules E	nabled: 3	Present Value Reliability Status	T.			Insert	Delete

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 Babel Buster MQ-73/BB3-7301-MQ read maps include the ability to set a default value upon 'n' read fails, meaning that if the Babel Buster 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 MQ-73/BB3-7301-MQ 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.

Babel Bus MODEL MQ- JOT GATEWAY						LUTIONS	MINNES	ΟΤΑ
Local Objects	BACnet		loT Cloud	System				
System Set	up	Actions	Events		Scheduler			
Calculate	Сору		Report					
		Show	ving 1 to 7	of 7		Update	< Prev	Next
Report Status	s of	Device or Unit #	To This Object	With This Delay (Sec.)	Delete			
BACnet IP Cli	ent	1	AV 1	20				
BACnet IP Cli	ent	2	AV 2	20				
BACnet IP Client	~	1	AI 1	20	Add	20		

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.



7. Configuring Gateway 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 MQ-73/BB3-7301-MQ'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 MQ-73/BB3-7301-MQ. 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.

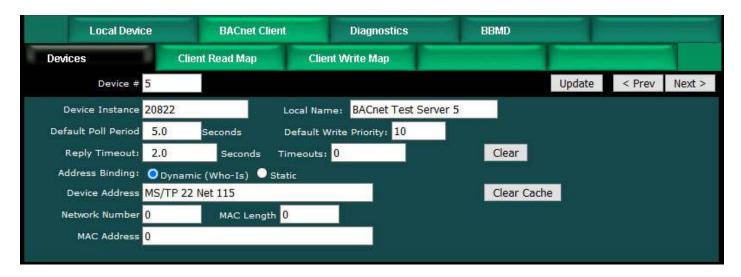
IOT GATEWAY		Fish					
184				CONTROLS	OLUTIONS	MINNES	ΟΤΑ
Local Objects	BACnet	loT Cloud	Syste	em	1		
Local Device	BACnet Clier	nt Diag	nostics	BBMD			
Devices	Client Read Map	Client Write N	Лар		1		
Device # 1					Update	< Prev	Next >
Device Instance 64		Local Name: BAC	net Test Server 1				
Default Poll Period	5.0 Seconds	Default Write Prior	ity: 10				
Reply Timeout: 2	2.0 Seconds	Timeouts: 0		Clear			
Address Binding: 🧿	Dynamic (Who-Is) 🔵 Si	tatic					
Device Address 19	2.168.1.64:47808 Net 8			Clear Ca	iche		
Network Number 0	MAC Length	0					
Network Number 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 gateway will send out a "Who-Is" request asking for the device instance to respond, at which time the gateway learns its IP or MS/TP address automatically.

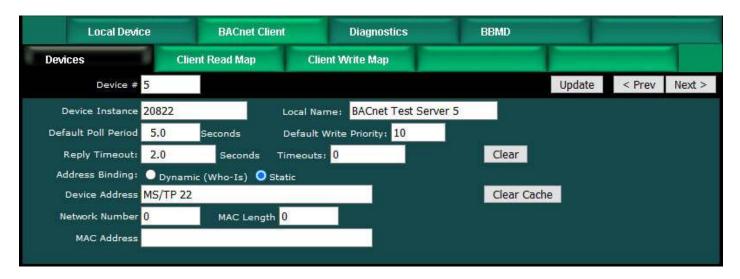
When dynamic address binding is used (default), the gateway broadcasts a "Who-Is" looking for this device instance when a read or write map wants to use this device. When (if) it responds, its IP address is listed here simply as a diagnostic. Timeouts resulting from inability to reach this device are 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.



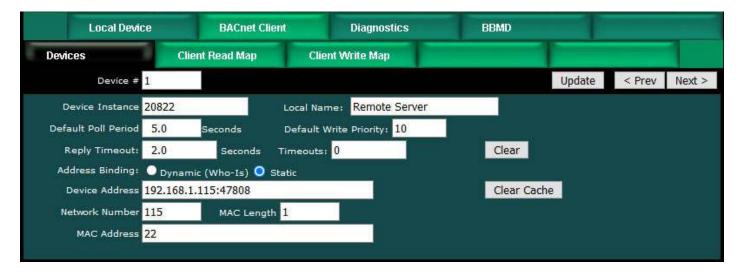
If static binding must be used, enter the fixed IP address you know the device instance to be found at. If no port is given, it will default to 0xBAC0 (47808). Enter IP as a.b.c.d or IP with port as a.b.c.d:p, for example 192.168.1.99:47808. Network number 0 means local IP network. If the device is on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

Local Devi	ce	BACnet Cl	ient	Diagnostics	BBMD			
Devices	C	lient Read Map	Client	Arite Map				
Device #	1					Update	< Prev	Next >
Device Instance	64		Local Name	BB2-7010-01				
Default Poll Period	5.0	Seconds	Default Writ	e Priority: 10	1			
Reply Timeout:	1.0	Seconds	Timeouts: 0		Clear			
Address Binding:	O Dyna	mic (Who-Is) 🧿	Static					
Device Address	192.168	.1.64:47808			Clear Cac	ne		
Network Number	0	MAC Lengt	th <mark>0</mark>					
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.



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.



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.



7.2 BACnet Client Read Maps

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

72	Babel Buste MODEL MQ-73 IOT GATEWAY	IoT					DLUTIONS MINNESOTA
Lo	cal Objects	BACnet	loT	Cloud	Syster	n	
	Local Device	BACne	l Client	Diagnos	tics	BBMD	
De	evices	Client Read Ma) Cl	ient Write Map			
			Show	ing 1 to	11 of 11		Update < Prev Next >
Иар #	Remote Type	Remote Object #		mote evice	Scale	Local Object #	Name
1	Analog Input 🛛 👻	1	BACnet Te	est Server 👻	0.00	AI 1	Analog Input 1
2	Analog Output 🔹	1	BACnet Te	est Server 🔻	0.00	AO 1	Analog Output 1
<u>3</u>	Analog Value 🛛 👻	1	BACnet Te	est Server 🔻	1.800000	AV 1	Analog Value 1
4	Binary Input 🛛 👻	1	BACnet Te	est Server 🔻	0.00	BI 1	Binary Input 1
5	Binary Output 🔹	1	BACnet Te	est Server 🔻	0.00	BO 1	Binary Output 1
<u>6</u>	Binary Value 🔹 🔻	1	BACnet Te	est Server 🔻	0.00	BV 1	Binary Value 1
7	Multistate Input 🛛 👻	1	BACnet Te	est Server 🔻	0.00	MI 1	Multi-state Input 1
3	Multistate Output 🔻	1	BACnet Te	est Server 💌	0.00	MO 1	Multi-state Output 1
2	Multistate Value 🔻	1	BACnet Te	est Server 👻	0.00	MV 1	Multi-state Value 1
0	Analog Output 🔹	1	BACnet Te	est Server 💌	0.00	AI 3	Analog Input 3
1	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:

Local (Objects	BACnet	loT Cloud	System			
	Local Device	BACnet Client	Diagnostics	BBMD	1		
Devic	es	Client Read Map	Client Write Map		1		
Map # 1	R				Update	< Prev	Next >
Read pro	perty Present Val	lue 👻 85 from i	nstance # <mark>1</mark> of c	bject type Analog Input	•		
Read from	m device BACnet	Test Server 🔻 using ind	lex ALL				
Then app	oly scale: 0.00	and offset: 0.00					
Save in lo	ocal object AI 1	named Analog In	put 1 Repeat this p	rocess every 5.0	seconds.		
Apply this	s default value: 1	.20.0000 after 3	read failure(s).				
Enabl	e this map only w	nen index object <mark>None</mark>	is set to a value of <mark>0</mark>				
# Client F	Read Maps Enable	d: 11			Insert	Delete	

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.

	Client Read Map				
Map ± 1				Update	< Prev Next >
Read property Present V	alue 🔻 85 🛛 from i	nstance # <mark>1 of objec</mark>	t type Analog Input	-	
Read from device BACne	t Test Server 🔻 using ind	ex ALL			
Then apply scale: 0.00	and offset: 0.00				
Save in local object AI 1	named Analog In	put 1 Repeat this proce	ss every 5.0	seconds.	
	120.0000 after 3				
Enable this map only	when index object None	is set to a value of 0			
# Client Read Maps Enabl	ed: 11			Insert	elete

7.3 BACnet Client Write Maps

Getting the gateway 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.

		ACTURE FROM	oT				OLUTIONS MINNESOTA
Lo	cal Objects	BAC	Cnet	loT Cloud	Syste	em	
	Local	Device	BACnet Client	D	iagnostics	BBMD	
D	evices	Cli	ent Read Map	Client Writ	te Map		
			:	Showing 1	to 9 of 9		Update < Prev Next >
Map #	Local Object #	Scale	Remote Type	Remo Object		mote :vice	Name
1	AO 2	0.00	Analog Output	▼ 2	BACnet Te	st Server 👻	Analog Output 2
2	AV 2	0.555550	Analog Value	▼ 2	BACnet Te	st Server 🔻	Analog Value 2
3	BO 2	0.00	Binary Output	▼ 2	BACnet Te	st Server 🔻	Binary Output 2
4	BV 2	0.00	Binary Value	▼ 2	BACnet Te	st Server 👻	Binary Value 2
5	MO 2	0.00	Multistate Output	▼ 2	BACnet Te	st Server 👻	Multi-state Output 2
<u>6</u>	MV 2	0.00	Multistate Value	▼ 2	BACnet Te	st Server 🔻	Multi-state Value 2
<u>Z</u>	AV 3	0.00	Analog Value	▼ 3	BACnet Te	st Server 🔻	Analog Value 3
8	AV 4	0.00	Analog Value	▼ 4	BACnet Te	st Server 🔻	Analog Value 4
<u>9</u>	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:

Local Objects	BACnet	loT Cloud	System	
Local Device	BACnet Clien	t Diagnostics	BBMD	
Devices	Client Read Map	Client Write Map		
Map # 1				Update < Prev Next >
Read local object AO 2	named Analog Output	: 2		
Write remote object 🗹 ar	ny time local object has cha	anged by 0.00 or I	when 0.0 seconds	have elapsed with no change.
Otherwise write remote ob	ject unconditionally. In any	v event, when writing remo	te object, apply local object o	lata as follows:
Apply scale: 0.00 a	ind offset: 0.00 The	en, using index ALL	and priority <mark>8</mark> pr	oceed to
Write property Present Va	alue 🔻 85 🛛 encode	ed as data type Real		
Write to instance # <mark>2</mark>	of object type Analo	g Output 🛛 🔻 at device	BACnet Test Server 🔻	
Repeat this process 🔘 at	least 🧿 no more than ev	very 0.0 seconds.		
Enable this map only v	when index object BI 3	is set to a value of <mark>1</mark>		
# Client Write Maps Enable	ed: 9			Insert Delete

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.

	stem	Cloud S	Tol	BACnet	l Objects	Local
	BBMD	Diagnostics	net Client	BACne	Local Device	
			Maps	Errors: Write M	rs: Read Maps	Erro
<< Top Next >						
CONTRACTOR OF CONTRACTOR	1 mar 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1	note		Remote Object #	Remote Type	Мар #
Error Error Class Code	Name	vice	De	Object #		

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 MQ-73/BB3-7301-MQ 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 MQ-73/BB3-7301-MQ.

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 MQ-73/BB3-7301-MQ.

Babel Bush MODEL MQ-7	ler IoT		CONTROL SOLUT	ions Minnesota
Local Objects	BACnet	IoT Cloud	System	
System Setu	ip Actions	Events	Scheduler	
File Manager	Network	Resources	User	
File Directory: BootConfig	j.xml 💌	Free space: 1.36 M Filtered by: [*] .xm	Filter View Select	
Seleted File:		Action: select *.per	n 🗸 Execute	
Boot configuration BootCo	nfig.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.

Local Objects	BACnet	IoT Cloud	System	
System Setup	Actions	Events	Scheduler	
File Manager	Network	Resources	User	
File Directory: P3TR-bip-ma	DS.CSV ¥	Free space: 1.3 Filtered by: 20		
Seleted File: P3TR-bip-map	S.CSV A	ction: select select	✓ Execute	
Boot configuration BootConfig	j.xml	Load XML Config Save XML Config	g File	
Upload Fi Upload Choose	e File No file chosen	Create New XML Select Boot Auto Delete Selected Import CSV to B Clear BACnet Cl Clear All Configu	D-Config File File ACnet Client lient Maps	

We imported 220 read maps in our example test case.

Lo	cal Objects	BACnet	lo	T Cloud	Syste	m		
	Local Device	BACn	et Client	Diagnos	tics	BBMD		
D	evices	Client Read Ma	ap C	lient Write Map	6		-	
			Show	ving 1 to	15 of 221		Update	< Prev Next >
Map #	Remote Type	Remote Object #		emote evice	Scale	Local Object #		Name
<u>1</u>	Analog Input 🛛 👻	1	BACnet T	est Server 🔻	0.00	AI 1	An	alog Input 1
2	Analog Input 🛛 👻	2	BACnet T	est Server 🔻	0.00	AI 2	An	alog Input 2
3	Analog Input 🛛 👻	3	BACnet T	est Server 👻	0.00	AI 3	An	alog Input 3
<u>4</u>	Analog Input 🛛 👻	4	BACnet T	est Server 🔻	0.00	AI 4	An	alog Input 4
<u>5</u>	Analog Input 🛛 👻	5	BACnet T	est Server 👻	0.00	AI 5	An	alog Input 5
<u>6</u>	Analog Input 🛛 👻	6	BACnet T	est Server 🔻	0.00	AI <mark>6</mark>	An	alog Input 6
<u>Z</u>	Analog Input 🛛 👻	7	BACnet T	est Server 🔻	0.00	AI 7	An	alog Input 7
<u>8</u>	Analog Input 🛛 👻	8	BACnet T	est Server 🔻	0.00	AI 8	An	alog Input 8
<u>9</u>	Analog Input 🛛 👻	9	BACnet T	est Server 👻	0.00	AI 9	An	alog Input 9
<u>10</u>	Analog Input 🛛 👻	10	BACnet T	est Server 🔻	0.00	AI 10	Ana	log Input 10
<u>11</u>	Analog Input 🛛 👻	11	BACnet T	est Server 🔻	0.00	AI 11	Ana	log Input 11
<u>12</u>	Analog Input 🛛 👻	12	BACnet T	est Server 🔻	0.00	AI 12	Ana	log Input 12
<u>13</u>	Analog Input 🛛 👻	13	BACnet T	est Server 🔻	0.00	AI 13	Ana	log Input 13
<u>14</u>	Analog Input 🔷 👻	14	BACnet T	est Server 🔻	0.00	AI 14	Ana	log Input 14
<u>15</u>	Analog Input 🛛 👻	15	BACnet T	est Server 🔻	0.00	AI 15	Ana	log Input 15

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.

File Manager	Network	Resources	User		
File Directory: BootConf	fig yml 🗙	Free space: 1.34 Filtered by: *.XN		View Selec	
Seleted File:	ing.xiiii	Action: Clear BACnet Clie		 Execute 	
Boot configuration BootC	Config.xml	Confirm Re	start	*	

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

ALC: NO	32.55	1.2.1.1	1.00	Constant of the local sectors	a subscription and subscription	ed:	
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	

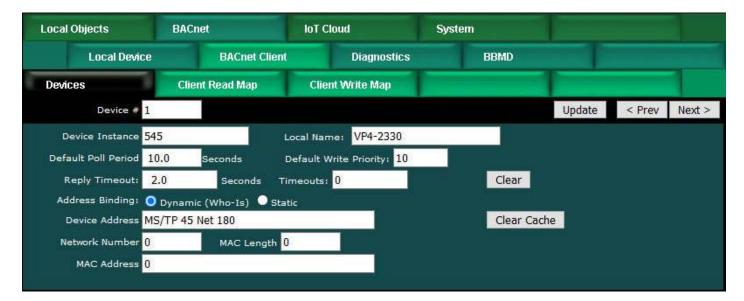
The error is most likely the result of an incorrect entry in one or more fields of a form. Click your browser's "back" button to go back to the page you were at, make corrections, and try again.

7.7 Understanding BACnet Client Timeout Settings

The Babel Buster gateway 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.



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 Settings	Router Settings	Configured Routes	Discovered Routes	Slave Proxy	1
BACnet Device Settings:		Local Network	Settings		
Dev	ice Instance <mark>178</mark>			Save	
Port (default 0xBAC	co = 47808) <mark>47808</mark>				
Device C	Object Name Babel Buste	r BB3-7301			
Device	Description				
Dev	rice Location St. Paul, Mir	nnesota			
AP	DU Timeout 3000		APDU Retries 3		
APDU Segme	ent Timeout <mark>5000</mark>	Dat	abase Revision 4		
Local Comm	nand Priority 10		Backlog Limit <mark>()</mark>		
MS/TP	Baud Rate: 38400 🗸	MS/TI	P MAC address: 78		
MS/TP Max In	nfo Frames: <mark>5</mark>	MS/T	P 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 Gateway as a BACnet Server

8.1 Server Configuration

The MQ-73/BB3-7301-MQ contains a set of BACnet objects whose only purpose is to store copies of data obtained from other devices. This copy of data may then be queried by different devices.

The only configuration needed to use the MQ-73/BB3-7301-MQ 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 gateway as a BACnet Device is described in more detail in Section 4.

		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		SOLUTIONS MI
al Objects	BACnet	IoT Cloud	System	
Local Device	BACnet Clie	nt Diagnostics	BBMD	
Cnet Settings	Router Settings	Configured Routes	Discovered Routes	Slave Proxy
Port (default 0xBA Device	vice Instance 40119 ACO = 47808) 47808 Object Name Babel Bust a Description IoT for BAC			
	vice Location St. Paul, M			
A	PDU Timeout 3000		APDU Retries 0	
APDU Segn	nent Timeout 5000		atabase Revision 13	
Local Com	mand Priority 10		Backlog Limit 0	
MS/T	P Baud Rate: 38400 🗙	MS/	TP MAC address: 0	
MS/TP Max	Info Frames: 1	MS	/TP Max Masters: 127	
Allow fault self-reset	: without Ack. 🔽		self-restart upon 🗾	

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 MQ-73/BB3-7301-MQ also contains a Device object which is configured in the above screen.

Data may be placed in the local objects by other devices writing to the MQ-73/BB3-7301-MQ gateway, or by the gateway querying other devices. When the gateway 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 MQ-73/BB3-7301-MQ 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:

Loca	al Objects	BACnet		IoT Cloud		System	and the second
	Analog	Binary		Mu	ti-State		
Inp	ut Objects	Output Objects		Value Objec	ts		
Analog	Input Objects		sł	nowing objects fr	om 1		Refresh < Prev Next >
Object	Object Name Object Description	9877	ut of rvice	Present Value	Reliability	Status	Units
1	Analog Input 1 Description of AI 1		N	0.00	o	0,0,0,0	no_units
2	Analog Input 2 Description of AI 2		N	0.00	0	0,0,0,0	no_units
<u>3</u>	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
<u>5</u>	Analog Input 5 Description of AI 5		N	0.00	0	0,0,0,0	no_units
<u>6</u>	Analog Input 6 Description of AI 6		N	0.00	o	0,0,0,0	no_units
Z	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:



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.

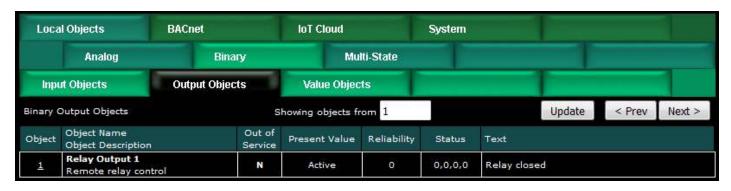
Status flags A,B,C,D indicate the following, 0 meaning not true, 1 meaning true:

- 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.

Binary Output Example:



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:

Local Objects	BACnet	IoT Cloud	System		
Analog	Binary	Multi-State			
Input Objects	Output Objects	Value Objects			
Binary Output # 1				Update	< Prev Next >
Reliability: 0 Status: 0,	0,0,0 Device Link:	Out of Service: 🗖 Deco	nfigure: 🗖	-	
Object name Relay Outp	ut 1	Force 🔲 Prese	nt Value Active	4> Active	
Description Remote rel	ay control			1> NULL 2> NULL	
Active Text: Relay closed	1	Inctive Text: Re	lay open	3> NULL	
Relinguish Default Inact				4> Active	y
Kelinguish Default Indet	we •			5> NULL 6> NULL	
				7> NULL	
				8> NULL	
				9> NULL	
Quick Help				10> NULL	
The object name units	value, and status are show	n for the object number en	tered at the top of t	11> NULL	lext to scroll through
	update the page, or Updat		lered at the top of t	12> NULL	lext to scion through
		n		13> NULL	
		here. State text may be en		the <mark>:</mark> 14> NULL	e sure to save the
updated configuration by	clicking Save on the Confi	ig File page under System S	ietup.	15> NULL	
The destination of data f Link. The remote device	or a Binary Output object v will be updated upon chan	will be writing the remote BA ge of source data and/or pe	Cnet or SNMP device riodically as defined	16> NULL by rq> Inactive	ed by the Device

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.



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.

M	abel Buster odel MQ-73 T GATEWAY				CONTRO	L SOLUTIONS /	MINNES	οτα
Local	Objects B	ACnet	la	T Cloud	System			
	System Setup	Actions		Events	Schedul	21		
Even	t Rules	Data Logging		lemplates	Recipients	1		1
			Showin	g 1 to 11	of 11	Update	< Prev	Next >
Rule #	Event Name	1	Local Object	Present Value	Test Criteria	Test Value	State*	Error Code
1	Test Event	t 1	AI 1	0.00	greater than	10.00000	False	0
2	Test Event	12	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	t 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
<u>6</u>	Test Event	t 6	AI 6	0.00	not equal to	10.00000	True	0
Z	Test Event	t 7	AI 7	0.00	changed by	5.000000	False	0
8	Test Event	18	AI 8	0.00	increased by	5.000000	False	0
2	Test Event	t 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.

Event Rules	Data Logging	Templates	Recipients			
Rule # 1	Rule presently tests False			Update	< Prev	Next >
Read local object Al 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 r	ninimum On Time: 0:00:00	this minimum Off Tim	e: 0:00:00		
Set local destination object	None as follows be	low while logging on-time to o	bject None			
If true, to a value which is	same as the source O th	is value: 0.000000	from local object None			
If false, to a value which is	same as the source Other source Other source Other sources	nis value: 0.000000	from local object None			
Follow above rule only i	f local object None	is set to a value of 0				
ZEmail 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 # (every <mark>0</mark>	hours (true or false)			
Time since last email (HH:N	IM:SS) (no email) Email	type: Email error code: 0				
# Rules Enabled: 11				Insert De	lete	

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 Al 1	for this event named	Test Event 1			
Event is TRUE if the value is	greater than 🛛 🗸	9 this value: 10.000000	O 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 🛛 🗸	O this value: 10.000000 O this local object: None
Qualified by this hysteresis v	greater than less than	s minimum On Time: 0:00:00 this minimum Off Time: 0:00:00
Set local destination object	equal to	below while logging on-time to object None
If true, to a value which is	greater or equal to less or equal to	this value: 0.000000 • from local object None
If false, to a value which is	not equal to changed by	this value: 0.000000
Follow above rule only if		is set to a value of 0
🗹 Email to user group 🚹	decreased by deviates from	2 upon transition true, no more than every 0 minutes
Email to user group 0	n/a	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 op	tional a	nd anablad an	v whon v	aluos aro popzo	ro How bystorosis

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). 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 a	bject None	
If true, to a value which is	same as the sou	rce 🝳 this value:	0.000000	from local object	None
If false, to a value which is	🔘 same as the sou	rce 🜻 this value:	0.000000	from local object	t None

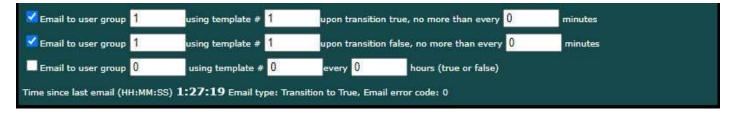
Now that you have specified what the condition is, you proceed to define the response. Start by selecting which local object the response is applied to. This will be known as your destination object. Typically this object will be linked to an output. IMPORTANT note for email notifications: You do not 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 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.

Babel Bu MODEL MQ JOT GATEWA	nter IoT		CONTROL SOL	UTIONS MINNESOTA
Local Objects	BACnet	IoT Cloud	System	
System Se	etup Actions	Events	Scheduler	
Event Rules	Data Logging	Templates	Recipients	
				Update
Template #	File Name			
1	templateAllBac.txt			
2	templateLog1.txt			
Manage Template Files	Selected fil	e: /FS/FLASH0/ter	<u>nplateAllBac.txt</u>	
File Directory: template	AllBac.txt 🗸 View Sele	ct		
New File: template/	AllBac.txt	Edit Assign To Temp	late # <mark>3</mark>	

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.

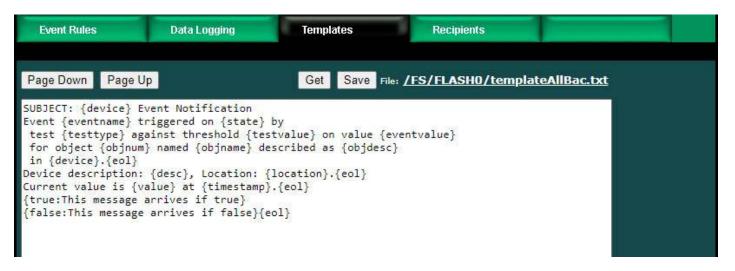
Once you have created a template that shows up in the File Directory list (only *.txt files will be displayed in this list), select a file from the list (pick file from drop-down list, then click Select), enter a number in the "To Template #" window, and then click Assign. The template file itself is 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.

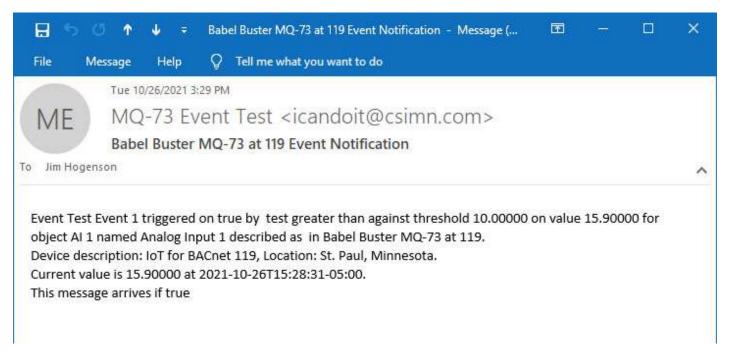
10.2 Editing Email Templates

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.



The above example template produced the following email.



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.

Event	Rules	Data Logging	Templates	Recipients	5				
								Updat	e Users
User #		Email Address	Name	c	iroup 1	Group 2	Group 3	Group 4	Group 5
1	jimhog	enson@csimn.com	Jim Hogenson		>				
2									
		csimn.com 465 Icandoit@csimn.com ••••••• Full Log Test						Updat	e Serveri
Send Te									

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.

Event R	ules	Data Logging	Templates	Recip	ients				
								Uptin	le Users
User									
£									
2									
Email Server	Setup:							Updat	e Server
8	GMTP Host:	smtp.gmail.com							
	SMTP Port:	465							
User Na	ame/Email:	@gmail.com							
	Password:	•••••							
"Fro	om" Name:	My Alarm Monitor							
Send Test	Email to Gr	oup <mark>0 U</mark> sing Tem	nplate # <mark>0</mark>		E	mail Error	Code: 0		Refresh

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.



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.

Babel Bu Model MQ- JOT GATEWAY				CONTROL S	OLUTIONS A	VINNES	ота
Local Objects	BACnet	IoT Cloud	Syst	tem			
System Se	tup Actions	Event	ts	Scheduler			
Event Rules	Data Logging	Templates	Rec	cipients			1
🗸 Logging Enabled	sh	owing objects from inde	× 1		Update	< Prev	Next >
Local Object	Header Label/Object Na	ame	Include in CSV File				
AI 1	Analog Input 1	. (j.	2				
AI 2	Analog Input 2		X	Ĩ			
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	15 1	×				
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	- 5- -		3.5			

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:				
O Log every 10	minutes			
Log every 10	minutes while event 0	is true, otherwise log every 0	minutes	
Commit every <mark>6</mark>	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 t	o false			
	system error code: 0 Records lo IM:SS) 0:37:45 Email error co			
Purge log files:		Confirm by entering root passw	ord: ••••••	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.

File Edit	Format	View	Help				
2021-10-2 2021-10-2 2021-10-2 2021-10-2 2021-10-2 2021-10-2 2021-10-2 2021-10-2 2021-10-2 2021-10-2 2021-10-2 2021-10-2 2021-10-2 2021-10-2	5T15:09: 5T15:19: 5T15:29: 5T15:39: 5T15:59: 5T16:09: 5T16:09: 5T16:19: 5T16:29: 5T16:39: 5T16:49: 5T16:59: 5T16:59: 5T17:09:	29-05 29-05 29-05 29-05 29-05 29-05 29-05 29-05 29-05 29-05 29-05 29-05 29-05 29-05	1, Analog Input 2, Analog 00, 6999, 5869, -423, 8226 00, 6999, 5869, -423, 8226 00, 7003, 5888, -360, 8274 00, 7023, 5923, -320, 8331 00, 7130, 6041, -186, 8486 00, 7140, 6116, -97, 8560 00, 7222, 6181, -12, 8603 00, 7342, 6269, 159, 8713 00, 7395, 6325, 211, 8721 00, 7462, 6407, 260, 8779 00, 7383, 6297, 131, 8681 00, 7365, 6228, 47, 8679 00, 7277, 6181, 32, 8653 00, 7258, 6094, -136, 8504	Input	6,Analog	Input	7

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

		age Layout Form	nulas Data	Review View	Help Nitro Pro
	Cal Cal Cal Cal Cal Cal Cal Cal	ibri + 11 <i>I</i> <u>⊔</u> + ⊞ +	= [*] A [*] = ≥ • <u>A</u> • <u>©</u>	= 	^{2b} Wrap Text İ Merge & Center
	Clipboard 15	Font	ي ا	Alignm	ent
H	10 🔹 : 🗙	\checkmark f_x			
	A	В	с	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

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 IoT Gateway 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.



12. Configuring the Scheduler

The Babel Buster IoT Gateway 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.

14	Babel Bust model MQ-7 IOT GATEWAY		oT	Sil BATT			CONTR	OL SOLUT	TIONS MINNESOTA
L	cal Objects	BA	Cnet		IoT Cloud	5	System		
	System Setu	p	Actio	ons	Even	ts	Sche	duler	
١	Veekly Schedule	0	n Demand	- 1	Holidays	1		-1	
che	duler unable to acces	is time		sł	nowing 1	to 11 of 11			Update < Prev Next :
Ŧ	SMTWT	FS	Holidays	On Time	Off Time	Object Number	"On" Value	"Off" Value	Object Name
1			<u>Holidays</u>	10:00:00	12:00:00	AI 1	10.0000	2.00000	Analog Input 1
2			<u>Holidays</u>	10:00:00	12:00:00	AI 2	10.0000	2.00000	Analog Input 2
3			<u>Holidays</u>	10:00:00	12:00:00	AI 3	10.0000	2.00000	Analog Input 3
្			<u>Holidays</u>	10:00:00	12:00:00	AI 4	10.0000	2.00000	Analog Input 4
5			<u>Holidays</u>	10:00:00	12:00:00	AI 5	10.0000	2.00000	Analog Input 5
5		×	<u>Holidays</u>	10:00:00	12: <mark>0</mark> 0:00	AI 6	10.0000	2.00000	Analog Input 6
			<u>Holidays</u>	10:00:00	12:00:00	AI 7	10.0000	2.00000	Analog Input 7
3			<u>Holidays</u>	10:00:00	12:00:00	AI 8	10.0000	2.00000	Analog Input 8
	N N N	~	<u>Holidays</u>	10:00:00	12:00:00	AI 9	10.0000	2.00000	Analog Input 9
D		< <	<u>Holidays</u>	DUSK-30	DAWN+30	AI 10	10.0000	2.00000	Analog Input 10
1			Holidays	0.00.00	0:00:00	None	0.00	0.00	· · · · ·

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.

	Weekly Sched	lule On D	emand	Holidays	t			T	
				Showing 1	to 6 o	f6		Upd	ate < Prev Next
#	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 AI 1		100.0000	1.000000	Analog Input 1
2	10:00:00	2021-10-22	14:00:00	2021-10-	23 AI 2		200.0000	2.000000	Analog Input 2
3	14:00:00	2021-10-22	14:30:00	2021-10-	22 AI 3		300.0000	3.000000	Analog Input 3
4	15:00:00	2021-10-22	15:30:00	2021-10-	22 AI 3		310.0000	4.000000	Analog Input 3
5	16:00:00	2021-10-22	16:30:00	2021-10-	22 AI 3		320.0000	5.000000	Analog Input 3
6	0:00:00	0000-00-00	0:00:00	0000-00-	00 Nor	е	0.00	0.00	
1	o.oo.oo ommands Enable		0.00.00	0000-00-	NOT	e	0.00	Insert	Delete

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.

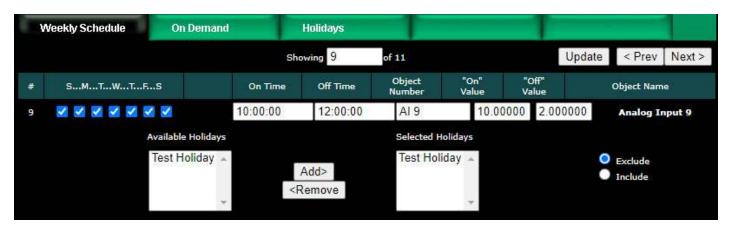
We	ekły Schedule	On Demand	Н	olidays			
							Update
#	Holiday	Name	On Time	On Date Y-M-D	Off Time	Off Date Y-M-D	
1	Test Holiday		0:00:00	2021-09-14	23:59:00	2021-09-14	
2	-		0:00:00	0000-00-00	0:00:00	000-00-00	
3			0:00:00	0000-00-00	0:00:00	000-00-00	

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

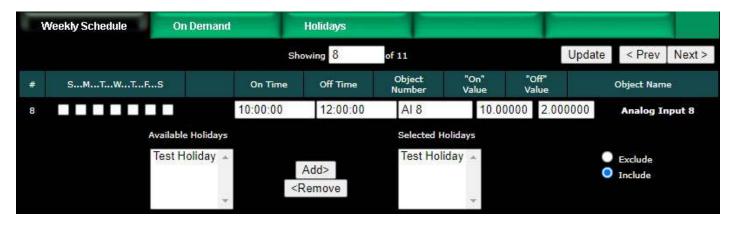
	Weekly Schedule	On Demand	-1	Holidays	1		T	
Sche	eduler unable to access t	ime	sh	owing 1	to 11 of 11			Update < Prev Next >
#	SMTWTF	S Holidays	On Time	Off Time	Object Number	"On" Value	"Off" Value	Object Name
1		Holidays	10:00:00	12:00:00	AI 1	10.0000	2.00000	Analog Input 1
2		Holidays	10:00:00	12:00:00	AI 2	10.0000	2.00000	Analog Input 2
3		<u>Holidays</u>	10:00:00	12:00:00	AI 3	10.0000	2.00000	Analog Input 3
4		<u>Holidays</u>	10:00:00	12:00:00	AI 4	10.0000	2.00000	Analog Input 4
5		Holidays	10:00:00	12:00:00	AI 5	10.0000	2.00000	Analog Input 5
6		Holidays	10:00:00	12:00:00	AI 6	10.0000	2.00000	Analog Input 6
7		Holidays	10:00:00	12:00:00	AI 7	10.0000	2.00000	Analog Input 7
8		<u>Holidays</u>	10:00:00	12:00:00	AI 8	10.0000	2.00000	Analog Input 8
9	× × × ×	- Holidava	10:00:00	12:00:00	AI 9	10.0000	2.00000	Analog Input 9
10	N N N N N N N N N N N N N N N N N N N	🗹 Holic s	DUSK-30	DAWN+30	AI 10	10.0000	2.00000	Analog Input 10
11		Holidays	0:00:00	0:00:00	None	0.00	0.00	<u>1939</u>
Ev	rents Enabled: 11	ReSync					Ins	sert Delete

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.



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.)



12.4 Astronomical Clock

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

9 🔽 💙 🔽 😵	🗹 🗹 <u>Holidays</u> 10:00:00	12:00:00	AI 9	10.0000	2.00000	Analog Input 9
10 🗹 🗹 🗹 🗹	🗸 🗹 Holidays DUSK-30	DAWN+30	AI 10	10.0000	2.00000	Analog Input 10
11	Holidays 0:00:00	0:00:00	None	0.00	0.00	
Events Enabled: 11	ReSync				Inser	t Delete

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.



13. Configuring the IoT Gateway

The pages used to configure the Babel Buster IoT Gateway'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 Gateway and the AWS IoT features, you will want to refer to Sections 14 through 18 of this user guide.

13.1 Thing Points or Attributes

The Babel Buster IoT Gateway 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 IoT Gateway 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.

Babel Buster IoT MODEL MQ-73 JOT GATEWAY CONTROL SOLUTIONS MINNESOTA									
Local Objects	BACnet	IoT Cloud		Syster	n				
Thing Set	up Thing Status					1			
Thing Points	Thing ID	Thing Fil	es	1					
	2	howing attributes from 1			U	Update < F		Prev Next >	
Atr Local # Object	Attribute (Object) Name	Pub P	ub .ck Sub	Periodic	Publish Condition		ОЬј	Threshold	
<u>1</u> Al 1	csiSensor1	Z		0	equal to	~		1.000000	
<u>2</u> Al 2	csiSensor2			0	greater than	~		5.000000	
<u>a</u> Al 3	csiSensor3			0	changed by	*		5.000000	
4 AI 4	csiSensor4			0	changed by	~		5.000000	
<u>5</u> AI 5	csiSensor5	- 🜌		0	changed by	~		5.000000	
<u>6</u> AO 1	csiActuator1			0	n/a	~		0.000000	
<u>z</u> A0 2	csiActuator2			0	n/a	~		0.000000	
<u>8</u> AO 3	csiActuator3			0	n/a	~		0.000000	
<u>9</u> Al 10	csiActuator1Feedback	2		0	changed by	~		0.100000	
<u>10</u> MI 1	csiSensor10			0	greater than	~		50.000000	
11 None				0	n/a	~		0.000000	

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.

Thing Points	Thing ID	Thing Files		-		
Attribute # 1				Update	< Prev	Next >
Associate local object Al	1 named	csiSensor1with this IoT attribute.				
Publish: 🗹 Using QOS	O Ack not required	d 🔘 Ack required 🛛 Publish as 🔘 Rep	oorted 🔘 Desired			
MQTT Topic: 🔍 Default 🔍 O	ther <mark>\$aws/things/</mark>	myFirstThing/shadow/update				
Publish if object value is equ	al to 🗸 🗸	Othis value: 1.000000	this local object: None			
Qualified by this hysteresis va	lue: 0.000000	this minimum On Time: 0:00:00	this minimum Off Tir	ne: 0:00:00		
Publish at least every 0	minutes. P	ublish no more than every 0	minutes.			
Follow above rule only if lo	ocal object None	is set to a value of 0				
Publish message on true:			-19			
Publish message on false:						
Publish as part of dataset	number: 1	🗹 Include timestamp				
Subscribe: To topic i	ndex: 0	\$aws/things/myFirstThing/s	shadow/update			
Apply this default value: 0.0	00000 afte	r 0 minutes without any	y update from the cloud.			
# Attributes Enabled: 11			Make Template	Force Publish	Insert	Delete

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 Al 1 named csiSensor1 with this IoT attribute.

Select Publish if you wish to publish this point. Publish means send data from the IoT Gateway to the server, and is the type of action you would associate with a sensor.

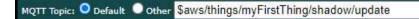
Select whether or not you wish to publish with acknowledgement required. This is referred to in MQTT terms as Quality of Service (QOS). If "Ack required" is selected, then the IoT Gateway will repeatedly retry publishing until the server responds with an acknowledgement.

You will normally publish data points as "Reported". If, however, you are publishing to the shadow object of another IoT Gateway 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

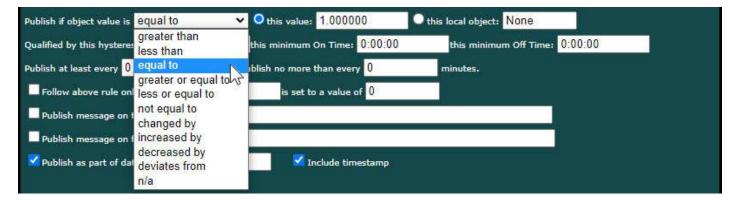
The MQTT topic displayed here is used as the topic when the Publish is invoked, and the attribute name and value are considered the "payload" published to this topic. The default topic will publish to the shadow object for this IoT Gateway that you will set up on the AWS server (see Section 14).

If you wish to publish to a topic other than the default topic, enter that topic here and select "Other".



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.



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 false: Normal, Level: %s	🗹 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

🗹 İnclude 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 top	c index: 0	\$aws/th	ings/myFirstThing/shadow/update
Apply this default value:	0.000000	after <mark>0</mark>	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 IoT Gateway. 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.

Thing Points	Thing ID	Thing Files	1			
Attribute # 1				Update	< Prev	Next >
Associate local object	Al 1 named C	siSensor1with this IoT attrib	ute.			
# Attributes Enabled: 7			Make Template	Force Publish	Insert	Delete

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.

3	Thing Points	Thing ID	Thing	Files		T	1		
		sł	nowing attr	ributes	from 1		Updat	e <	Prev Next >
Atr #	Local Object	Attribute (Object) Name	Pub	Pub Ack	Sub	Periodic	Publish Condition	Obj	Threshold
1	AI 1	csiSensor1	X			0	equal to 🗸 🗸		1.000000
2	AI 2	csiSensor2	V			0	greater than less than		5.000000
3	AI 3	csiSensor3	S			0	equal to		5.000000
4	Al 4	csiSensor4				0	greater or equal to		5.000000
5	AI 5	csiSensor5	V			0	not equal to		5.000000
6	AO 1	csiActuator1			X	0	changed by increased by		0.000000
Z	AO 2	csiActuator2			X	0	decreased by deviates from		0.000000
8	AO 3	csiActuator3			X	0	n/a		0.000000
2	Al 10	csiActuator1Feedback	V			0	changed by 🛛 🗸		0.100000
<u>10</u>	MI 1	csiSensor10	V			0	greater than 🗸 🗸		50.000000
<u>11</u>	None					0	n/a 🗸		0.000000

Referring to the preceding detailed descriptions, select a local object number to be published or subscribed, and allow the IoT Gateway 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 IoT Gateway's connection to the AWS server. The Subscribe Topics are used if subscribing, and are not used to publish.

Babel Bust MODEL MQ-73 JOT GATEWAY	n IoT			DLUTIONS MINNESOTA
Local Objects	BACnet	IoT Cloud	System	
Thing Setup	Thing St	atus		
Thing Points	Thing ID	Thing Files	-	And a second second second second second second second second second second second second second second second
				Update
Server Po	ort 8883 me myFirstThing us V Enabled (See s; 0 \$aws/things/myF 1 2 3	ts.iot.us-west-2.amazonaws IMPORTANT Note Below) irstThing/shadow/update	5.COM	

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 IoT Gateway 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 IoT Gateway 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.

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 IoT Gateway and the AWS server is a secure connection requiring valid SSL certificates.

Babel Bus Model MQ- JOT GATEWAY	TB		CONTROL SO	DLUTIONS MINNESOTA
Local Objects	BACnet	loT Cloud	System	
Thing Setu	ip Thing Sta	latus		
Thing Points	Thing ID	Thing Files		
Apply Device Cert Apply Private Key Apply Root CA	e055c53465-certific	îcate.pem	View	

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 IoT Gateway.

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.

	Babel Buste MODEL MQ-73 IOT GATEWAY			CONTROL SOLUTIONS MINNESOTA
Lo	ocal Objects	BACnet	IoT Cloud	System
	Thing Setup	Thing	Status	
C	Object Info	Connection	Test	
			Showing attributes from	n 1 Refresh < Prev Next >
Atr #	Attribute Na	ime	Last Exchange Timesta	mp Last Exchanged Value (or Status)
1	csiSensor1		РиЬ@ 2021-10-25 09:15:17	1.000000
2	csiSensor2		Pub@ 2021-10-25 09:15:17	3.000000
з	csiSensor3		Pub@ 2021-10-25 09:15:17	0.00
4	csiSensor4		Pub@ 2021-10-25 09:15:17	0.00
5	csiSensor5		Pub@ 2021-10-25 09:15:17	0.00
6	csiActuator1		Sub@ 2021-10-25 09:08:22	255
7	csiActuator2 Sub@ 2021-10-25 09:08:22		Sub@ 2021-10-25 09:08:22	599
8	csiActuator3 Sub@ 2021-10-25 09:08:22		Sub@ 2021-10-25 09:08:22	31
9 csiActuator1Feedback				
10	csiSensor10		Pub@ 2021-10-25 09:15:17	IoT sensor state 1
11				

The Connection page will show the status of the IoT Gateway's connection with the AWS server, along with some message statistics.

Babel Bur MODEL MQ- IOT GATEWAY	B BRANKAR		CONTROL	SOLUTIONS MINNESOTA
ocal Objects	BACnet	IoT Cloud	System	
Thing Setu	p Thing Sta	atus		
)bject Info	Connection	Test	1	
				Clear Ref
	Connection Stat	Connect: Success		
	Failed Connection Cou	unt 0		
	Publish Message Cou	unt 156		
	Publish Error Cou	unt 0		
	Subscribe Message Cou	unt 4		
	Subscribe Error Cou	unt 0		
	Connection Ir	fo Connecting to server al Connected securely!	: a1lzj6a7dtjmhf-ats.iot.us-we	st-2.amazonaws.com:8883.

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 IoT Gateway 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 IoT Gateway, click the Last Pub button. An example of a recent publish message is illustrated below.

Local Objects	BACnet	IoT Cloud	System	
Thing Setu	ip Thing Sta	tus		
Object Info	Connection	Test		
Subscribe:				
		Su	bscribe Unsubscribe	
Publish: Using QOS	🔾 Ack not required 🔵 Acl	k required		
		Pu	blish	
				li.
Most recent Publish or S	Subscribe message:		Last Pub Last S	Sub
Topic: \$aws/things/my	/FirstThing/shadow/updat	e		
0.00, "csiSensor		or5": 0.00, "csis	"csiSensor2": 3.00000 Sensor10": "IoT sensor	

An example of a recently received incoming message resulting from a Subscribe is illustrated below.

Most recent Publish or Subscribe message: Topic: \$aws/things/myFirstThing/shadow/update	Last Pub Last Sub
<pre>{ "state": { "desired": { "csiActuator1": 47 } } }</pre>	

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.



To subscribe to an arbitrary topic without configuring Thing Points, enter the topic here and click Subscribe.

Subscribe:	-
<pre>\$aws/things/myFirstThing/testTopic</pre>	Subscribe

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.



14. Configuring IoT Gateway to Publish to AWS

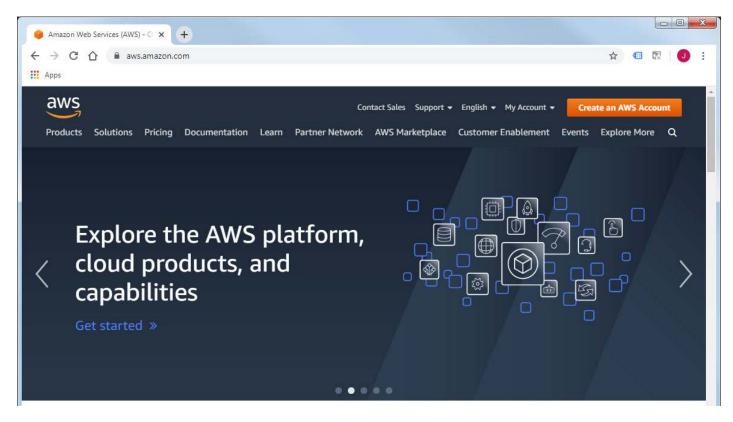
The MQTT term "Publish", from a controls perspective, would be most closely associated with the action of a sensor. You have data available that you wish to transmit to other devices or systems. In the instance we are working with here, we are Publishing data to the AWS server.

Configuring the Babel Buster IoT Gateway to publish data to the Amazon servers requires setting things up on both ends: You need to configure the IoT Gateway, 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"

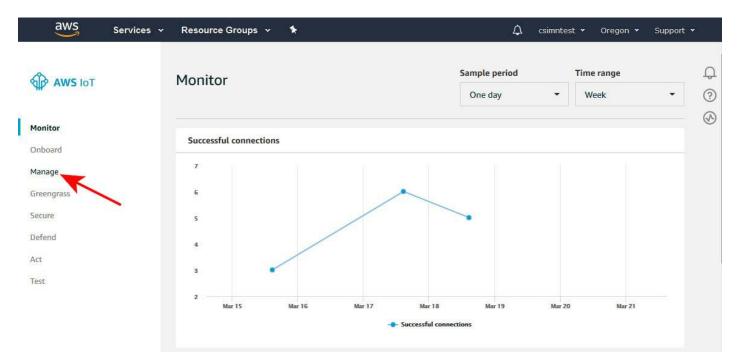
Start by going to https://aws.amazon.com and creating an account if you don't already have one. There is no fee to set up the account, and your data usage will also generally be free for an introductory period.



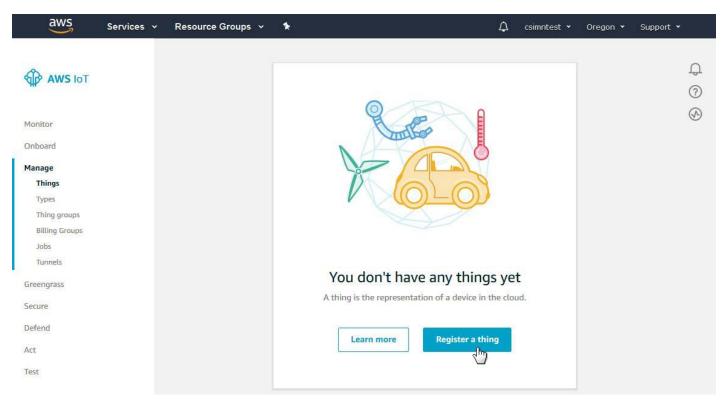
From your AWS Management Console, search for IoT Core or click on the IoT Core link under recently visited services.

AWS Services 🗸 Resource Groups 🗸 🛠	众 csimntest ▾ Oregon ▾ Support ▾
AWS Management Console	
AWS services	Access resources on the go
Find Services You can enter names, keywords or acronyms.	Access the Management Console using the AWS Console Mobile
Q IoT Core X	App. Learn more 🖸
IoT Core Connect Devices to the Cloud Recently visited services IoT Analytics	Explore AWS
IoT Core IoT Events Simple Notification Service	Amazon CloudWatch End-to-End monitoring and observability with Amazon CloudWatch. Get started
All services	Amazon EFS Infrequent Access Reduce cloud file storage costs by up to

From the AWS IoT menu, click on Manage.



Your initial Things screen will have no Things. Click "Register a thing" to begin the process of creating your first thing.



Click "Create a single thing".

AWS Services + Resource Groups + 🛧	🎝 csimntest 🕶 Oregon 👻 Support ९
Creating AWS IoT things	
An IoT thing is a representation and record of your phyisical device in the cloud. Any physical device needs a thing record in order to work with AWS IoT. Learn more.	
Register a single AWS IoT thing Create a thing in your registry	Create a single thing
Bulk register many AWS IoT things	
Create things in your registry for a large number of devices already using AWS loT, or register devices so they are ready to connect to AWS loT.	Create many things
Cancel	Create a single thing

Enter a name for your Thing. The name must have only letters and digits, no special characters or spaces. You do not need to create a type at this point. The only entry you need to make here is the thing name.

aws	Services 🗸	Resource Groups	• *)	Φ	csimntest 👻	Oregon 👻	Support 👻
	CREATE A THING Add your de	vice to the thi	ng regi	stry				STEP 1/3	ф © &
	This step creates an e Name myFirstThing	entry in the thing regist	y and a thi	ng shadow for your device.					
		mplifies device manager outes, which describe the	100	oviding consistent registry data nd capabilities of your device, a Create a type		type.	Types provide t	hings with a	

Click on Next to continue the process.

Back	Next
	Back

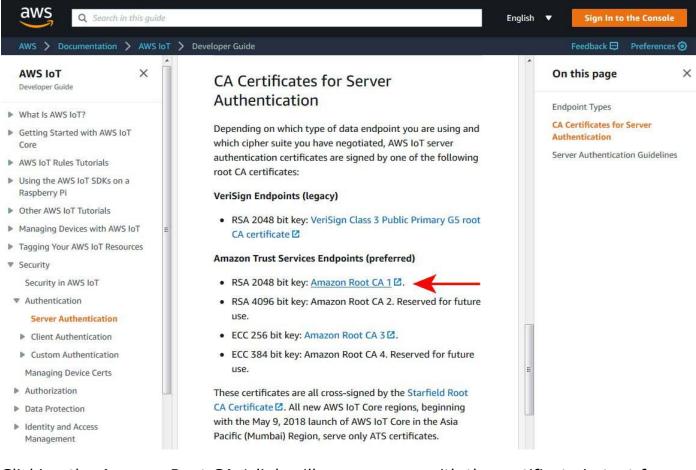
The connection between the IoT Gateway and the AWS server is a secure connection requiring SSL certificates. These will be created for you by the AWS system. Click on "Create certificate".

aws	Services 🗸 Resource Groups 🗸 🏌	¢	csimntest 👻	Oregon 👻	Support 👻
¢	CREATE A THING Add a certificate for your thing			STEP 2/3	ф (9) (9)
	A certificate is used to authenticate your device's connection to AWS IoT.				
	One-click certificate creation (recommended) This will generate a certificate, public key, and private key using AWS IoT's certificate authority.		Create certificat	e 🔟	

Upon creating certificates, you now need to download them. Download the certificate for this thing, and the private key. You will also need the root CA for your certificates. Click the Download link for the root CA to follow that path.

aws Services +	Resource Groups 👻 🔭		\$	csimntest 👻	Oregon 👻	Support
Certificate cr	eated!					
after you close this pa	device, you need to download the foll		e, but the private and	public keys cann	ot be retrieved	I
A public key A private key	e055c53465.public.key e055c53465.private.key	Download				
You also need to dow A root CA for AWS IoT Activate	nload a root CA for AWS IoT: Download					
Cancel			Don	e Att	tach a policy	

The root CA download link will take you to the CA certificates page. Click on the link for Amazon Root CA 1.



Clicking the Amazon Root CA 1 link will open a page with the certificate in text form. Copy this certificate and paste into a blank Notepad document (or other plain text editor). Then save this as "AWSrootCA.pem" or similar name - just keep track of the fact that this is your root CA certificate.

AWSrootCA.pem - Notepad	
File Edit Format View Help	
BEGIN CERTIFICATE	1
4IIDQTCCAimgAwIBAgITBmyfz5m/jAo54vB4ikPmljZbyjANBgkqhkiG9w0BAQsF	
ADA5MQswCQYDVQQGEwJVUzEPMA0GA1UEChMGQW1hem9uMRkwFwYDVQQDExBBbWF6	
p24gUm9vdCBDQSAxMB4XDTE1MDUyNjAwMDAwMFoXDTM4MDExNzAwMDAwMFowOTEL	
MAkGA1UEBhMCVVMxDzANBgNVBAoTBkFtYXpvbjEZMBcGA1UEAxMQQW1hem9uIFJv	
b3QgQ0EgMTCCASIwDQYJKoZIhvcNAQEBBQADggEPADCCAQoCggEBALJ4gHHKeNXj	
ca9HgFB0fW7Y14h29Jlo91ghYP10hAEvrAItht0gQ3p0sqTQNroBvo3bSMgHFzZM	
906II8c+6zf1tRn4SWiw3te5djgdYZ6k/oI2peVKVuRF4fn9tBb6dNqcmzU5L/qw	
IFAGbHrQgLKm+a/sRxmPUDgH3KKHOVj4utWp+UhnMJbulHheb4mjUcAwhmahRWa6	
VOujw5H5SNz/OegwLXOtdHA114gk957EWW67c4cX8jJGKLhD+rcdqsq08p8kDi1L	
93FcXmn/6pUCyziKrlA4b9v7LWIbxcceVOF34GfID5yHI9Y/QCB/IIDEgEw+0yQm	
jgSubJrIqg0CAwEAAaNCMEAwDwYDVR0TAQH/BAUwAwEB/zAOBgNVHQ8BAf8EBAMC	
AYYwHQYDVR00BBYEFIQYzIU07LwM1JQuCFmcx7IQTgoIMA0GCSqGSIb3DQEBCwUA	
A4IBAQCY8jdaQZChGsV2USggNiMOruYou6r41K5IpDB/G/wkjUu0yKGX9rbxenDI	
USPMCCjjmCXPI6T53iHTfIUJrU6adTrCC2qJeHZERxhlbI1Bjjt/msv0tadQ1wUs	
N+gDS63pYaACbvXy8MWy7Vu33PqUXHeeE6V/Uq2V8viT096LXFvKWlJbYK8U90vv	
o/ufQJVtMVT8QtPHRh8jrdkPSHCa2XV4cdFyQzR1bldZwgJcJmApzyMZFo6IQ6XU	
5MsI+yMRQ+hDKXJioaldXgjUkK642M4UwtBV8ob2xJNDd2ZhwLnoQdeXeGADbkpy raXRfboOnoZsG4a5WTP468SOvvG5	
END CERTIFICATE	
END CENTIFICATE	

Collect up the three SSL certificates you have now obtained, place them somewhere you can find back easily when uploading them to the IoT Gateway.

Documents library AWS Certs			Arrange by: Folder 🔻
Name	Date modified	Туре	Size
AWSrootCA.pem	3/17/2020 10:36 AM	PEM File	2 KB
e055c53465-certificate.pem.crt.txt	3/21/2020 10:33 AM	Text Document	2 KB
e055c53465-private.pem.key	3/21/2020 10:33 AM	KEY File	2 KB

Make minor renaming changes to these files such that their suffix is ".pem" in all cases.

Documents library AWS Certs			Arrange by: Folder 🔻
Name	Date modified	Туре	Size
AWSrootCA.pem	3/17/2020 10:36 AM	PEM File	2 KB
e055c53465-certificate.pem	3/21/2020 10:33 AM	PEM File	2 KB
e055c53465-private.pem	3/21/2020 10:33 AM	PEM File	2 KB

Either before or after downloading the certificates, click the Activate button to activate those SSL certificates on the AWS server. (This does not change the content of the certificates.) Click on Attach a Policy to move on.

aws	Services 🗸 Re	source Groups 👻 🔦		8	众 csimntes	st 🕶 Oregon 🕶	Support 👻
	Certificate crea	ted!					ф ©
	after you close this page.	save them in a safe place. Certificat	owing:	me, but the private	and public keys	cannot be retrieve	d
	A public key	e055c53465.cert.pem e055c53465.public.key	Download				
	A private key	e055c53465.private.key	Download				
	You also need to downlo A root CA for AWS IoT Dow Deactivate	ad a root CA for AWS loT: wnload					
	Cancel				Done	Attach a policy	b

You do not yet have any policies to attach, so click Register Thing.

aws	Services 🗸 Resource Groups 🗸 🖌	¢	csimntest 🔹	Oregon 👻	Support 👻
÷	CREATE A THING Add a policy for your thing			STEP 3/3	¢
	Select a policy to attach to this certificate:				
	No match found There are no policies in your account.				
	0 policies selected		Re	gister Thing	5

Your Things page should now look like this.

aws	Services 🗸	Resource Groups 🐱	*		Φ	csimntest 👻	Oregon 👻	Support 👻	
AWS IOT		Things						Create	ф ©
Monitor		Search things		Q Fleet Indexing	0			Card 🝷	Ð
Onboard Manage		myFirstThing							
Things		NO TYPE							
Types Thing groups									
Billing Groups Jobs									
Tunnels									
Greengrass									

14.2 Create a Policy

The Thing requires a Policy before the AWS server will respond to communication originated by the IoT Gateway. You find Policies under the Secure category on the AWS IoT menu. Click on Create a policy.

aws	Services 🗸	Resource Groups 🐱	*	4	csimntest 👻	Oregon 👻	Support 👻
AWS IOT							Ф (?)
Monitor Onboard			IF I	THE I			Ø
Manage Greengrass				DD			
Secure Certificates							
Policies CAs							
Role Aliases Authorizers		AWS IoT policies give	You don't have	e any policies ye resources (like other thing		or thing shadow	rs).
Defend							
Act			Learn more	Create a policy			
Test							

Enter a name for your policy. The minimum statement you need to provide is an Action of "iot:*" and Resource ARN of "*" (which means all). Effect should be Allow. Make these entries and selections and then click Create.

Create a policy	
Create a policy to define a set of authorized actions. You can authorize actions on one or more re	sources (things, topics, topic filters). To learn
more about IoT policies go to the AWS IoT Policies documentation page.	
myFirstThing_policy	
Add statements	
Policy statements define the types of actions that can be performed by a resource.	Advanced mode
Action	
iot:*	
Resource ARN	
Effect	
Z Allow Deny	
	Remove
Add statement	

Your policies page will now look like this.

aws	Services 🗸	Resource Groups 👻 🛠		۵	csimntest 👻	Oregon 👻	Support 👻
AWS IoT		Policies				1	Create
Monitor		Search policies	٩				Card 👻 🛞
Onboard Manage		•••• myFirstThing_policy					
Greengrass							
Secure							
Certificates							
Policies							
CAs							

If you click on your policy, you can review what it now looks like.

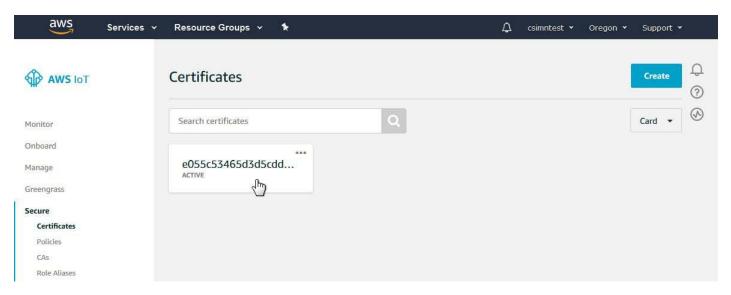
POLICY		
myFirstThi	ng_policy	
		Actions +
Overview	Policy ARN	
Certificates	A policy ARN uniquely identifies this policy. Learn more	
Versions		
Groups	arn:aws:iot:us-west-2:314429653841:policy/myFirstThing_po	licy
Non-compliance	Policy document	
	The policy document defines the privileges of the request. Learn more	
	Version 1 updated Mar 21, 2020 10:59:12 AM -0500	Edit policy document
	{ "Version": "2012-10-17",	
	"Statement": [
	{ "Effect": "Allow",	
	"Action": "iot:*",	

The most unrestrictive policy is illustrated above. A more complete policy also often used as a default is illustrated below.



14.3 Attach Policy and Thing to SSL Certificates

Now that you have a policy, it is necessary to attach that policy and your thing to the SSL certificates you created. Go to the Certificates page and click on your certificate.



The certificate page will appear as illustrated below. Click on Attach policy.

Certificates > e055c53	4000503000005	
CERTIFICATE		
e055c5346	5d3d5cdde69ba776ad585dfa81ff930a6a47bcd155b4d44d	1a0ef7c
ACTIVE		Actions -
		Activate
Details	Certificate ARN	Deactivate
		Revoke
Policies	A certificate Amazon Resource Name (ARN) uniquely identifies this certificate. Learn more	Accept transfer
Things	96 807 11 75 1996	Reject transfer
Non-compliance	arn:aws:iot:us-west-2:314429653841:cert/e055c53465d3d5cdde69ba776a	
Non-computance		Start transfer
	Details	Attach policy
	Details	Attach thing \
	Issuer	Delete
	OU=Amazon Web Services O\=Amazon.com Inc. L\=Seattle ST\=Washington C\=US	Delete
	Subject CN=AWS IoT Certificate	
	Create date	
	Mar 21, 2020 10:33:15 AM -0500	
	Effective date Mar 21, 2020 10:31:15 AM -0500	
	Expiration date	
	Dec 31, 2049 5:59:59 PM -0600	

Clicking on "Attach policy" will bring up the window illustrated below. Select your policy and click Attach.

aws ser	vices v Resource Groups v 🔭	∗ Oregon ∗ Support *
Certificates	Attach policies to certificate(s)	Ф
CERTIFICA e055 Active	- · · · ·	(?) C Actions →
Details Policies Things	Q Search policies Image: myFirstThing_policy View	
Non-com	1 policy selected Cancel Attach))

Clicking on "Attach thing" will bring up the window illustrated below. Select your thing and click Attach.

aws s	ervices - Resource Groups - 🖈 🗘 csimntest -	Oregon 👻	Support 👻
← Certificates	Attach things to certificate(s)		Q
CERTIFI e05 ACTIVE	5c53 e055c53465d3d5cdde69ba776ad585dfa81ff930a6a47bcd155b4d44d1a0ef7c	C Actions	③
Details Policies Things	s myFirstThing		
Non-co	1 thing selected Cancel Attach	1ff930a6a	

At this point, you are ready to move on to configuring the IoT Gateway.

14.4 Configure IoT Gateway

To begin the process of configuring the IoT Gateway, you need to look up some information about your thing on the AWS server. Go to the AWS IoT Manage Things page, and click on your Thing.

aws	Services 🗸	Resource Groups 🔻	*			4	csimntest 👻	Oregon 👻	Support	•
AWS IOT		Things							Create	ф ?
Monitor		Search things		Q	Fleet Indexing	0			Card 🝷	\odot
Onboard										
Manage		myFirstThing								
Things		по туре								
Types		<u> </u>								
Thing groups										
Billing Groups										
Jobs										
Tunnels										
Greengrass										

From the thing menu, select Interact. Copy the Rest API Endpoint - this will be entered as the host name in the IoT Gateway. Also make a note of the MQTT topic for updating this thing's shadow. This default topic should get created automatically for you by the IoT Gateway when you configure your device name.

THING myFirstThing		
NO TYPE		
		Actions -
Details	This thing already appears to be connected.	Connect a device
Security		
Thing groups	HTTPS	
Billing Groups	Update your Thing Shadow using this Rest API Endpoint. Learn more	
Shadow	a1lzj6a7dtjmhf-ats.iot.us-west-2.amazonaws.com	
Interact		
Activity	MQTT	
Jobs	Use topics to enable applications and things to get, update, or delete the state information	n for a Thing (Thing Shadow)
Violations		and a second second and a second second second second second second second second second second second second s

Enter the Rest API Endpoint in the Server Host Name window. Set the server port to 8883. Enter the Thing Name exactly as it appeared on the AWS IoT Thing screen. Subscribe Topic 0 will update to show the default topic that includes your thing name once the name is entered.

Babel Busi MODEL MQ-7 JOT GATEWAY	ter IoT		CONTROL	SOLUTIONS MINNESOTA
Local Objects	BACnet	loT Cloud	System	
Thing Setup	Thing St	atus		
Thing Points	Thing ID	Thing Files	1	
				Update
	Port 8883 ame myFirstThing atus Enabled (See I)	ts.iot.us-west-2.amazonaw MPORTANT Note Below)	's.com	
Тор	ac o \$aws/things/myF	irstThing/shadow/update		
	oic 1			
	oic 2			
	oic 3 oic 4			

Go to the File Manager and upload your *.pem files - there should be three of them.

Babel Bur MODEL MQ- JOT GATEWAN	ter IoT		CONTROL SOLUT	ions Minnesota		
Local Objects	BACnet	IoT Cloud	System			
System Set	tup Actions	Events	Scheduler	1		
File Manager	Network	Resources	User			
ile Directory: IoT.xml Filtered by: *.* Y Filter View Select Action: Action: select Execute Noot configuration BootConfig.xml Confirm Restart						
	ad File <mark>wse</mark> e055c53465-co	ertificate.pem				

Confirm that you have uploaded the files by selecting *.pem from the filter list and then clicking Filter.

File Man	ager	Network	Resources	User	1		
			Free space:	1.34 MB			
File Directory:	AWSrootCA.p	em 🗸	Filtered by:	*.pem ¥ Filter	View Select	1	
	AWSrootCA pe						
Seleted File:	e055c53465-c e055c53465-p	ertificate.pem	Action: Select	×	Execute		
Boot configura	tion BootConfig	j.xml	Confirm	Restart			

Go to the Thing Files page and select the *.pem files and apply them to the applicable position on the list.

Babel Burn MODEL MQ-7	er IoT		CONTROL	SOLUTIONS MINNESOTA
Local Objects	BACnet	loT Cloud	System	
Thing Setup	Thing Sta	atus		
Thing Points	Thing ID	Thing Files		
Apply Device Cert Apply Private Key Apply Root CA		055c53465-private.pem AWSrootCA.pem 2055c53465-certificate.pem 2055c53465-private.pem	View	

Your Thing Files page should end up looking like this.

Thing Points	Thing ID	Thing Files			T	
	Local file directory <mark>00</mark>	55c53465-private.pem	▼ Viev	N		
Apply Device Cert	e055c53465-certifica	te.pem				
Apply Private Key	e055c53465-private.p	pem				
The second second second second second second second second second second second second second second second se	NO					

IMPORTANT: Once you have entered the host name, thing name, and selected your SSL certificates, you should back to the File Manager and save your configuration to the BootConfig.xml file (or other XML file you create). If you skip this step, your changes will be lost the next time the IoT Gateway restarts or is power cycled.

Babel Bur MODEL MQ- JOT GATEWAN	TES DEMONIT		CONTROL SOLUTI	ons Minnesota
Local Objects	BACnet	IoT Cloud	System	
System Se	tup Actions	Events	Scheduler	
File Manager	Network	Resources	User	
File Directory: BootCont		Free space: 1.3 Filtered by: *.> Action: select	AND A DESCRIPTION OF A	
Boot configuration BootC	Config.xml	select Load XML Config Save XML Config Create New XML Select Boot Auto	g File Config ve -Config File	
2 A MARKE	ad File oose File No file cho	sen Delete Selected Import CSV to B/ Clear BACnet Cl Clear All Configu	ACnet Client ient Maps	

The overall Thing connection has now been set up. The only thing remaining is to tell the IoT Gateway which data points you want to publish to the AWS server. Configure some local objects if you haven't already (see Section 6).

	Abel Buste NODEL MQ-73 DT GATEWAY				4		S. INTROL SC	LUTIONS A	AINNES	ота
LOCA	al Objects	BACnet	2121	loT Cloud		System				-
	Analog	Bina	iry	a Mu	lti-State					
Inp	ut Objects	Output Objec	:ts	Value Objects						1
nalog 1	input Objects		sł	nowing objects fro	m 1			Refresh	< Prev	Next >
Object	Object Name Object Description		Out of Service	Present Value	Reliability	Status	Units			
1	csiSensor1		N	0.00	0	0,0,0,0	no_units			
2	csiSensor2		N	0.00	0	0,0,0,0	no_units			
-										

Now go to the Thing Points page. In the illustration below, we have already created a single point by making entries and selections on this Thing Points page as outlined in Section 13.1. To see the full publish/subscribe rule, click on the attribute number in the first column.

di la	Babel Bu Model MQ IOT GATEWA						Control Sol	UTIONS	мін	NESC	ота
Lo	cal Objects	BACnet	loT Clo	ud		System					
	Thing Set	up Thing Status									
T	hing Points	Thing ID	Thing	Files		1	- 1				1
		S	howing attr	ibutes	from 1			Update	< F	Prev	Next >
Atr #	Local Object	Attribute (Object) Name	Pub	Pub Ack	Sub	Periodic	Publish Condi	tion	ОЬј	Th	reshold
1	Al <mark>1</mark>	csiSensor1	X			0	equal to	~		1.0	00000
5	AI 2	csiSensor2	X			0	greater than	~		5.0	00000

The expanded view of the rule is illustrated below. This rule contains all of the minimum parameters to test publishing to the AWS server.

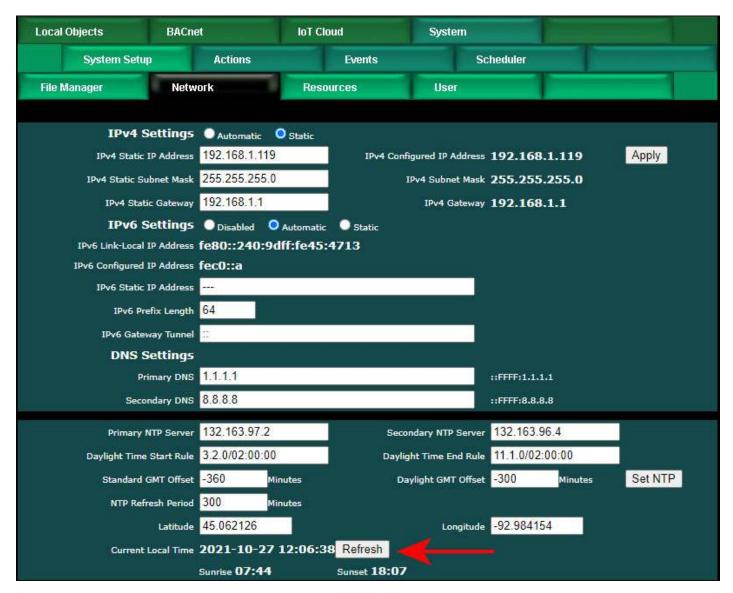
Thing Points	Thing ID	Thing Files				1
Attribute # 1				Update	< Prev	Next >
Associate local object A	1 named	csiSensor1with this IoT attribute.				
Publish: 🎽 🛛 Using QO	S 🧿 Ack not required	d 🔍 Ack required 🛛 Publish as 🔍 Rep	oorted ODesired			
MQTT Topic: O Default O C	other \$aws/things/	myFirstThing/shadow/update	w.			
Publish if object value is equ	ual to 🗸 🗸	O this value: 1.000000	this local object: None			
Qualified by this hysteresis va	alue: 0.000000	this minimum On Time: 0:00:00	this minimum Off Tir	me: 0:00:00		
Publish at least every 0	minutes. P	ublish no more than every <mark>0</mark>	minutes.			
Follow above rule only if I	ocal 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	1	\$aws/things/myFirstThing/s	hadow/update			
Apply this default value: 0.0	000000 afte	minutes without any	/ update from the cloud.			
# Attributes Enabled: 11			Make Template	Force Publish	Insert	Delete

14.5 Test Publish to Device Shadow

Now that everything else is all set up, go ahead and enable the IoT Engine.

Thing Points	Thing ID Thing Files	
		Update
Server Host Name	a1lzj6a7dtjmhf-ats.iot.us-west-2.amazonaws.com	
Server Port	8883	
Thing Name	myFirstThing	
IoT Engine Status	Enabled (See IMPORTANT Note Below)	
Subscribe Topics:		
Topic 0	\$aws/trings/myFirstThing/shadow/update	
Topic 1		
Topic 2		
Topic 3		
Topic 4		

Make sure the NTP server has found the correct local time and date. The AWS server will not allow a secure connection if local time is not set correctly.



Initially, the status will simply be "Offline".

Babel Bush MODEL MQ-7 JOT GATEWAY			CONTROL	SOLUTIONS MINNESOTA
Local Objects	BACnet	IoT Cloud	System	
Thing Setup	Thing State	IS		
Object Info	Connection	Test	1	
				Clear Refresh
	Connection Status Failed Connection Coun Publish Message Coun Publish Error Coun Subscribe Message Coun Subscribe Error Coun Connection Info	E 0 0 E 0 0		

After a delay of several seconds, you will hopefully see "Connect: Success". If the status says something about unknown host or anything to the effect of being unable to connect, be sure you have a DNS server accessible that can look up Amazon's IP address. If it says anything about SSL certificate error, recheck your SSL certificates. Make sure you are using the correct certificates, assigned to the correct function on the Thing Files page. Also do note that any time you create a new Thing, you will be generating a new set of certificates. If you recreated your Thing, you need to download the new certificates for the new Thing.

Object Info	Connection	Test				
					Clear	Refresh
	Connection Status	Connect: Success				
	Failed Connection Count	0				
	Publish Message Count	0				
	Publish Error Count	0				
	Subscribe Message Count	1				
	Subscribe Error Count	0				
		Connecting to server at a1lzj6a Connected securely!	7dtjmhf-ats.iot.us-west-2.ama	izonaws.com:8883	3.	

The default publish topic is to update the device shadow on the AWS server. Go to

your Thing menu, and display its Shadow. You will initially see that nothing is contained within the Shadow state.

hings > myFirstThing					-	
myFirstThing						
NO TYPE				Actio	ons 🝷	
D <mark>e</mark> tails	Shadow ARN					
Security						
Thing groups	A shadow ARN uniquely identifies the shadow for this thing. Learn more					
Billing Groups	arn:aws:iot:us-west-2:314429653841:thing/myFirstThing					
Shadow						
Interact	Shadow Document			Delete	Edit	
Activity	Last update: Dec 31, 1969 6:00:00 PM -0600					
Jobs	Shadow state:					
Violations	0					
Defender metrics						
new	Metadata:					
	{					
	MyFirstThing NO TYPE Details Security Thing groups Billing Groups Shadow Interact Activity Jobs Violations	THING myFirstThing, NO TYPE Details Shadow ARN Security A shadow ARN uniquely identifies the shadow for this thing. Learn more Thing groups arn: aws:iot:us-west-2:314429653841:thing/myFirstThing Billing Groups arn: aws:iot:us-west-2:314429653841:thing/myFirstThing Shadow Interact Activity Last update: Dec 31, 1969 6:00:00 PM -0600 Jobs Shadow state: Violations {} Defender metrics Statup	THING myFirstThing NO TYPE Details Shadow ARN Security A shadow ARN uniquely identifies the shadow for this thing. Learn more Thing groups arn:aws:iot:us-west-2:314429653841:thing/myFirstThing Billing Groups arn:aws:iot:us-west-2:314429653841:thing/myFirstThing Shadow Interact Activity Last update: Dec 31, 1969 6:00:00 PM -0600 Jobs Shadow state: Violations {} Defender metrics Shadow	THING myFirstThing, NO TYPE Details Shadow ARN Security A shadow ARN uniquely identifies the shadow for this thing. Learn more Thing groups arn:aws:iot:us-west-2:314429653841:thing/myFirstThing Shadow interact Shadow Document Activity Activity Last update: Dec 31, 1969 6:00:00 PM -0600 Jobs Shadow state: Violations {}	THING myFirstThing, NO TYPE Details Shadow ARN Security A shadow ARN uniquely identifies the shadow for this thing. Learn more Thing groups Billing Groups arn: aws:iot:us-west-2:314429653841:thing/myFirstThing Shadow Interact Abadow Document Activity Last update: Dec 31, 1969 6:00:00 PM -0600 Jobs Shadow state: Violations ()	THING MYFIRSTFINIOR NO TYPE Actions * Details Shadow ARN Security A shadow ARN uniquely identifies the shadow for this thing. Learn more Thing groups arn:aws:iot:us-west-2:314429653841:thing/myFirstThing Billing Groups arn:aws:iot:us-west-2:314429653841:thing/myFirstThing Shadow Delete Edit Activity Last update: Dec 31, 1969 6:00:00 PM -0600 Jobs Shadow state: Violations {} Defender metrics Shadow state:

The rule we set up above says to publish this data point any time its value exceeds 50. So go ahead and force the value to something greater than 50 (this assumes you do not have any BACnet client read maps configured yet that will overwrite this object while attempting this test).

Local Obj	ects	BACnet	IoT Cloud	System			
	Analog	Binary	Mult	ti-State			
Input Ob	jects	Output Objects	Value Object	s	1		
Analog Input	# 1				Update	< Prev	Next >
Reliability: 0	Status: 0,0,0	,0 Device Link: Out	of Service: 🗖 De	econfigure:	×		
Object name	csiSensor1			Force 💙 Present Value 55	j.		
Description							
COV incremen	nt: 0.00	Units: no_units		~			

If successful, the result will be posted in the Shadow almost immediately. If you see this, congratulations, you have now published your first piece of data to the AWS server using your Thing on the Internet of Things.

THING		
myFirstThin	q	
NO TYPE		Actions -
Details	Shadow ARN	
Security Thing groups	A shadow ARN uniquely identifies the shadow for this thing. Learn more	
Billing Groups	arn:aws:iot:us-west-2:314429653841:thing/myFirstThing	
Shadow	Shadow Document	Delete Edit
Activity	Last update: Mar 21, 2020 11:33:13 AM -0500	
Violations Defender metrics	<pre>Shadow state: { "reported": { "csiSensor1": 55</pre>	
new	}	
	Metadata:	
	{ "metadata": {	



15. Configuring IoT Gateway 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 IoT Gateway 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 IoT Gateway, 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.

While using the Shadow object is not required, the benefit of doing so is that the desired value will still be available should the IoT Gateway be temporarily offline or disconnected. When the IoT Gateway reconnects, it will retrieve the desired state information from the Shadow object and set its local objects accordingly.

15.1 Configure IoT Gateway

The simples form of a Subscribe point is illustrated below. To see the expanded view, click on the attribute number in the first column.

	TOT GATEWA	pter IoT					CONTROL SOLU	UTIONS	міні	NESOTA
L	ocal Objects	BACnet	IoT Clo	oud		System	n			
	Thing Setu	up Thing Status	6					1		
j	Ching Points	Thing ID	Thing	, Files		1				
			Showing att	ributes	from 1			Update	< F	Prev Next >
Atr #	Local Object	Attribute (Object) Name	Pub	Pub Ack	Sub	Periodic	Publish Condit	tion	Obj	Threshold
1	Al 1	csiSensor1				0	equal to	~		1.000000
2	AI 2	csiSensor2	. 🔽			0	greater than	~		5.000000
3	AI 3	csiSensor3				0	changed by	~		5.000000
4	AI 4	csiSensor4	2			0	changed by	~		5.000000
5	AI 5	csiSensor5				0	changed by	~		5.000000
6	AO 1	csiActuator1			V	0	n/a	~		0.000000
III	AO 2	csiActuator2			X	0	n/a	*		0.000000
8	AO 3	csiActuator3				0	n/a	~		0.000000

You will most often just use the default subscribe topic (illustrated below for "myFirstThing"), so all you really need to do is select Subscribe using the checkbox. Then click Update.

Local Objects	BACnet	loT Cloud	System	T		
Thing Setup	Thing	Status				
Thing Points	Thing ID	Thing Files				
Attribute # 6				Update	< Prev	Next >
Associate local object AO	1 named	CSIACtuator1 with this IoT	attribute.			4
Publish: Using QOS	Ack not require	d 🔍 Ack required 🛛 Publish as	Reported Desired			
MQTT Topic: O Default O Oth	er \$aws/things/	myFirstThing/shadow/updat	e			
Publish if object value is N/a	~	Othis value: 0.000000	Othis local object: NO	ne		
Qualified by this hysteresis value	e: 0.000000	this minimum On Time: 0:00;	00 this minimum Of	f Time: 0:00:00		
Publish at least every 0	minutes. P	Publish no more than every 0	minutes.			
Follow above rule only if loca	al object None	is set to a value of 0				
Publist message on true:						
Publish message on false:						
Publish as furt of dataset nu	umber: <mark>0</mark>	Include timestam	j)			
Subscribe: 🗹 To topic ind	lex: 0	\$aws/things/myFirstTh	ing/shadow/update			
Apply this default value: 0.00	0000 aft	er <mark>0 minutes with</mark>	out any update from the cloud.			
# Attributes Enabled: 11			Make Templa	te Force Publish	Insert	Delete

To test the subscription, go to your AWS IoT management console and select your Thing. If you have not already created a Thing as outlined in Section 14, go back to that section and create a Thing as outlined. Doing a test publish is recommended as this will confirm that the connection was successful.

aws	Services 🗸	Resource Groups 👻 🕏		众 csimntest	▼ Oregon ▼ Support ▼
AWS IOT		Things			Create 💭
Monitor		Search things	Q Fleet Indexing	0	Card 👻 🐼
Onboard					
Manage Things		myFirstThing			
Types					
Thing groups					

You can verify the topic that you should subscribe to by clicking the Interact link on the menu.

myFirstThing		
NO TYPE		Actions -
Details	This thing already appears to be connected.	Connect a device
Security		
Thing groups	нттру	
Billing Groups	Update your Thing Shadow using this Rest API Endpoint. Learn more	
Shadow	a1lzj6a7dtjmhf-ats.iot.us-west-2.amazonaws.com	
Interact		
Activity	MQTT	
sdot	Use topics to enable applications and things to get, update, or delete the state infor	rmation for a Thing (Thing Shadow)
Violations		

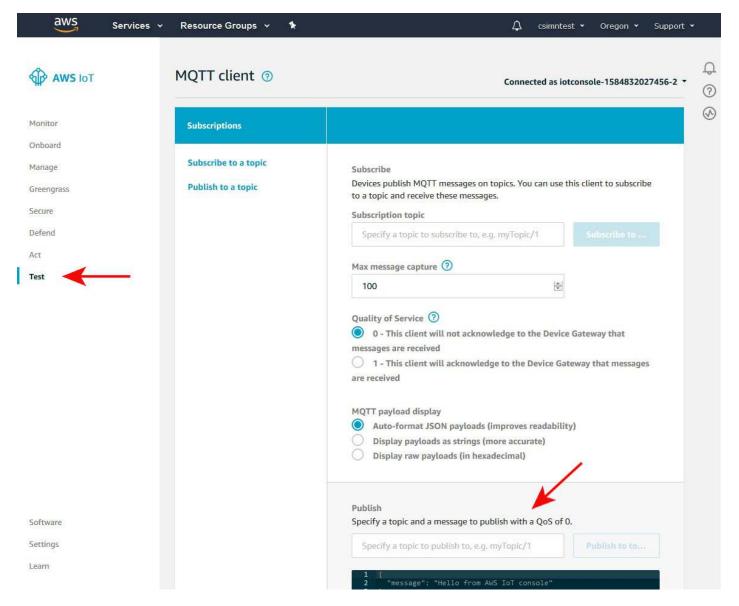
The default topic will normally be created for you when you enter the thing name.

Local Objects	BACnet	loT Cloud	System	
Thing Setup	Thing St	atus		
Thing Points	Thing ID	Thing Files	1	
				Update
Sonier Hest Na	allzi6a7dtimbf-a	ts.iot.us-west-2.amazonaw	ic com	
berver nost ne		ts.lot.us-west-z.amazonaw	/s.com	
Server	Port 8883			
Thing Na	me myFirstThing			
IoT Engine Sta	itus 📝 Enabled (See	IMPORTANT Note Below)		
Subscribe Top	ics:			
Тор	ic 0 \$aws/things/myF	irstThing/shadow/update		
Тор	ic 1			
Тор	ic 2			
Тор	ic 3			
Тор	ic 4			

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 click on the Test link. Using the MQTT client found here, you will manually

publish to our default topic.



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.

0

X

```
subscribe demo.txt - Notepad

File Edit Format View Help

Topic:

$aws/things/myFirstThing/shadow/update

"Nice" human readable JSON query:

{

"state": {

"desired": {

"csiActuator1": 47

}

}

Single line JSON query:

{ "state": { "desired": { "csiActuator1": 47 } } }
```

In the Publish section of the MQTT Client page, enter the topic illustrated above, and the payload. The payload section does not actually appear as bright as illustrated here - this graphic was enhanced for readability as a document.

If you go back and look at your thing's Shadow at this point you will see the "desired" state that was published.

	Actions 👻
Shadow ARN	
A shadow ARN uniquely identifies the shadow for this thing. Learn more	
arn:aws:iot:us-west-2:314429653841:thing/myFirstThing	
Shadow Document	Delete Edit
Last update: Mar 21, 2020 6:02:24 PM -0500	
Shadow state:	
{	
<pre>desired : { "csiActuator1": 47 }, "reported": { "csiSensor1": 55, "csiSensor2": "Normal, Level: 0" }, "delta": {</pre>	
	A shadow ARN uniquely identifies the shadow for this thing. Learn more arn:aws:iot:us-west-2:314429653841:thing/myFirstThing Shadow Document Last update: Mar 21, 2020 6:02:24 PM -0500 Shadow state: { "desired": { "csiActuator1": 47 }, "reported": { "csiSensor1": 55, "csiSensor1": 55, "csiSensor1": 55, "csiSensor1": 55, "csiSensor1": 55, "csiSensor2": "Normal, Level: 0" },

You should now be able to go to the IoT Gateway's Local Objects page and see the value that you published from the MQTT Client.

	l Objects	BACnet		IoT Cloud		System		
	Analog	Bina	ry	Mu	lti-State			
Inpu	ıt Objects	Output Objec	ts	Value Objec	ts			
Analog O	Output Objects		si	nowing objects fro	m 1		Refresh < Prev Ne	ext >
Object	Object Name Object Description		Out of Service	Present Value	Reliability	Status	Units	
1	csiActuator1		N	47.00000	0	0,0,0,0	no_units	
2	csiActuator2		N	599.0000	0	0,0,0,0	no_units	
<u>3</u>	csiActuator3		N	31.00000	0	0,0,0,0	no_units	
4	csiActuator4		3NI	0.00	0	0,0,0,0	no_units	

Input Objects	Output Objects	Value Objects		- 1			1
Analog Output # 1					Update	< Prev	Next >
Reliability: 0 Status: 0,0,0,0	Device Link: Out	of Service: 🔲 Deco	onfigure: 🔲				
Object name csiActuator1			Force 📃 Present Valu	e 47.00000	10> 4	7.00000 🗸	 Image: A set of the
Description							
COV increment: 0.00	Relinquish Default:	0.00 Uni	ts: no_units		~		
COV Increment: 0.00	Relinquish Default:	0.00			•		



16. Configuring AWS Simple Notification Service

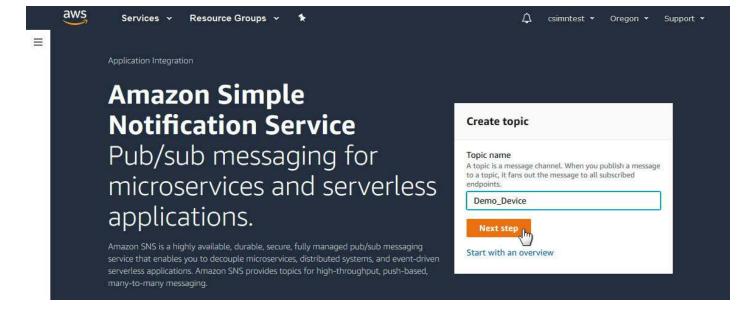
The AWS Simple Notification Service (SNS) can take you down multiple paths which we encourage you to explore through Amazon's online documentation. The simplest and potentially most commonly used form of notification is the text message to your mobile phone. This section will illustrate that option.

16.1 Create Topic

Start by locating SNS on your AWS Management Console.

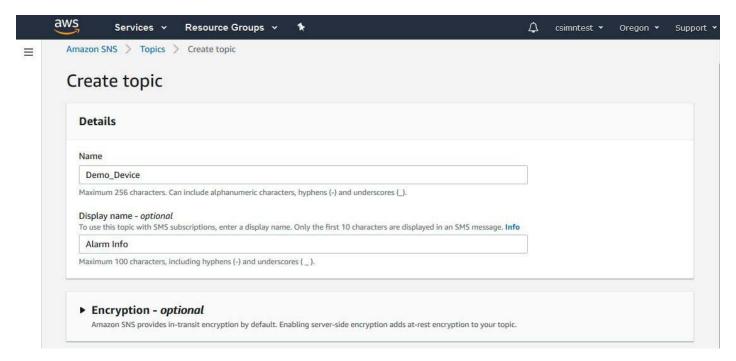
AWS Management Console	
AWS services	Access resources on the go
Find Services You can enter names, Lawronds or acronyms. Q SNS X	Access the Management Console using the AWS Console Mobile App. Learn more 🖸
Simple Notification Service SNS managed message topics for Pub/Sub Recently visited services Interpretation of the service of the serv	Explore AWS
In Core Image: Single Notification Service	Free Digital Training Get access to 350+ self-paced online courses covering AWS products and services. Learn more [2]
▶ All services	AWS IQ
Build a solution Get started with simple wizards and automated workflows.	Connect with AWS Certified third-party experts for on-demand consultations and project help. Get started 🖸
Launch a virtual machineBuild a web appWith EC2With Elastic Beanstalk2-3 minutes6 minutes	Amazon EMR The EMR runtime for Apache Spark is up to 32X faster, delivering improved performance and lowering costs. Learn more

When you are starting out with no SNS topics, the screen will look something like the following. Enter a name for your SNS topic and click Next Step. Note that the SNS topic name can have no embedded spaces and no special characters other than hyphen or underscore.



You have the option of adding a display name. If provided, this is the name that will show up on your mobile phone. The display name can have spaces in it. But do note that only the first 10 characters of this display name are included in SMS messages.

You do not need any of the additional optional items that will be listed on this page.



Proceed by clicking Create Topic.

. Each tag consists of a key and an optional value. You can use tags to search and filter your topics
Cancel Create to

You now have an SNS topic and it will be displayed something like this. Click on Create

Subscription next.

aws Services	✓ Resource Groups ✓ ★	🗘 csimntest 🕶 Oregon 👻 Support
Amazon SNS	X O Topic Demo_Device created successfully. You can create subscriptions and send messages to ther	Publish message X
Amazon SNS Dashboard Topics Subscriptions Mobile Push notifications Text messaging (SMS)	You can create subscriptions and send messages to ther Amazon SNS > Topics > Demo_Device Details Name Demo_Device ARN arn:aws:sns:us-west-2:314429653841:Demo_Device	Edit Delete Publish message Display name Alarm Info Topic owner
	Encryption Tags Subscriptions (0) Edit Delete Request confirmation Create subscription	on Confirm subscription

16.2 Create Subscription

The subscription to the SNS topic is where you set up the SMS part of the notification. This SMS notification will be listening for any updates to your SNS topic and send them to your phone. Select SMS for Protocol, and enter your phone number for Endpoint. Then click Create Subscription.

mazon SNS > Subscriptions > Create subscription				
Create subscription				
Details				
Topic ARN				
Q arn:aws:sns:us-west-2:314429653841:Demo_Device	>	<		
Protocol The type of endpoint to subscribe				
SMS		,		
Endpoint A mobile number that can receive notifications from Amazon SNS. +17632447472		٦		
 After your subscription is created, you must confirm it. Info 		_		
5 				
 Subscription filter policy - optional This policy filters the messages that a subscriber receives. Info 				
This policy filters the messages that a subscriber receives. Info Redrive policy (dead-letter queue) - optional				
This policy filters the messages that a subscriber receives. Info				

You will now have an SNS subscription that looks something like this.

Amazon SNS	 Subscription to Demo_Device created successfully. The ARN of the subscription is arn:aws:sns:us-west-2:314 e99d-4322-9629-1514dfa6fb5b. 	4429653841:Demo_Device:0dd4b999-	×
Dashboard Topics <mark>Subscriptions</mark> Mobile Push notifications Text messaging (SMS)	Amazon SNS > Topics > Demo_Device > Subscr Subscription: 0dd4b999-e99 Edit Delete	ription: 0dd4b999-e99d-4322-9629-1514dfa6fb5b 9d-4322-9629-1514dfa6fb5b	
	Details ARN arn:aws:sns:us- west-2:314429653841:Demo_Device:0dd4b999- e99d-4322-9629-1514dfa6fb5b Endpoint +17632447472 Topic Demo_Device	Status Confirmed Protocol SMS	

16.3 Create Action Rule for SNS

The SNS notification has now been set up, but we need to create a rule telling the system to send data to that SNS topic. Go back to IoT Core, and click on Act under the AWS IoT menu. Click on "Create a rule".

	aws	Services 🗸	Resource Groups 👻 🤺	*	¢	csimntest 👻	Oregon 👻	Support 👻
	🍄 АWS ЮТ							Q ()
	Monitor Onboard							•
	Manage Greengrass Secure							
-	Defend Act Rules							
	Destinations			You don't have	e any rules yet			
1	Test		Rules give your thin	ngs the ability to interact with AWS ar performed based on the me			and actions ar	e
				Learn more	Create a rule			

Enter a name for your rule, and provide a description just for your own use - this doesn't get sent anywhere.

Create a rule				
Create a rule to evaluate messages sent l DynamoDB table or invoke a Lambda fur		to do when a message is receiv	ed (for example, write data to a	
Name				
myFirstThing_topic1				
Description				
Topic intended for generating SMS me	essages			
from data points.				
	7.5			

You need to provide an SQL style query telling this action rule what it should send somewhere. The default will initially just be 'iot/topic' but that is just a place holder.

Rule query statement						
Indicate the source of the message	s you want to p	process with this ru	ule.			
Using SQL version						
2016-03-23						
Rule query statement						
SELECT <attribute> FROM <topic< th=""><td>Filter> WHERE <</td><td><condition>. For e</condition></td><td>example: SELECT</td><td>temperature FR(</td><td>OM 'iot/topic' V</td><td>VHERE temperature > 50. ³</td></topic<></attribute>	Filter> WHERE <	<condition>. For e</condition>	example: SELECT	temperature FR(OM 'iot/topic' V	VHERE temperature > 50. ³
learn more, see AWS IoT SQL Refer						
<pre>1 SELECT * FROM 'iot/topic'</pre>						

The topic you want to enter here should be the exact same topic you use as the publish topic when setting up the Thing Point in the IoT Gateway. The default topic for publishing to the Shadow is '\$aws/things/myFirstThing/shadow/update'. But to avoid having every data point sent to our phone, and have only specifically selected data points sent to our phone, we are going to create our own special topic for this example.

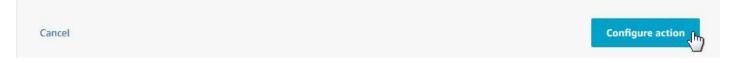
The special topic we are going to use is '\$aws/things/myFirstThing/message1'.

Indicate the source of the messag	es you want to process	with this rule.		
Using SQL version				
2016-03-23				
Rule query statement				
		ion>. For example: SELE	T temperature FROM 'ic	ot/topic' WHERE temperature > 50. T
earn more, see AWS IoT SQL Refe	erence.			
the second second second second second second second second second second second second second second second s		1944	- 17	
1 SELECT * FROM '\$aws/thin	gs/myFirstThing/messa	ge1*		
1 SELECT * FROM '\$aws/thin	gs/myFirstThing/messa	ze1*		
1 SELECT * FROM *\$aws/thin	gs/myFirstThing/messa	ge1.		
1 SELECT * FROM *\$aws/thin	gs/myFirstThing/messa	zeli.		
1 SELECT * FROM *\$aws/thin	gs/myFirstThing/messa	gel*.		
1 SELECT * FROM *\$aws/thin	gs/myFirstThing/messa	ze1.		
	gs/myFirstThing/messa	;e1.		
	gs/myFirstThing/messa	zel*.		
Set one or more actions			und message. Actions de	fine additional activities that occur
Set one or more actions	pen when the above ru	e is matched by an inbo		fine additional activities that occur *.required)
Set one or more actions Select one or more actions to hap	pen when the above ru	e is matched by an inbo		

Next, you need to add an action. Click the Add action just below the SQL query. When you do, the following screen appears. Select "Send a message as an SNS push notification".

Select an	action	
Select an action.		
•	Insert a message into a DynamoDB table	
0	Split message into multiple columns of a DynamoDB table (DynamoDBv2)	
•	Send a message to a Lambda function	
<u>ه</u> ال	Send a message as an SNS push notification	
	Send a message to an SQS queue	

Make the SNS selection and then click Configure action.



Upon clicking Configure action, the following screen appears. Here is where you will select the SNS topic created above and apply it to this Action rule. Click the Select that appears on the same line as your SNS topic.

Configure action	
Send a message as an SNS push notification	
SNS	
*SNS taraat	
*SNS target	Create Refresh Close
No topic selected	Create Refresh Close
	Create Refresh Close
No topic selected	Create Refresh Close

When you select the SNS target, you also need to select Message format. You must use RAW here.

Configure	e action					
-						
Send a	a message as an SNS push	notification				
SNS	-					
*SNS target				E S		
*SNS target Demo_Devic	ce		Create	Clear	Select	
	ce		Create	Clear	Select	
			Create	Clear	Select	
Demo_Devic		•	Create	Clear	Select	

You will also see "No role selected" on this page. Click on Create Role. The window illustrated below pops up. Enter a role name, and then click Create role.

aws Services	✓ Resource Groups ✓ 1	⊥ csimntest × 0	Oregon 👻 Support 👻	÷.
	Create a new role			¢
Configu	A new IAM role will be created in your account. An inline policy will be attached scoped-down permissions allowing AWS IoT to access resources on your behalf.			0 S
Senc SNS	Name myFirstThing_defaultRole			-
*SNS target Demo_Det		Cancel Create role	Select	
Message form RAW	at			
Choose or crea	ate a role to grant AWS IoT access to perform this action.			
No role sele	ected	Create Role	Select	

Your SNS push action is now configured. Click Add action.

Configure action		
Send a message as an SNS push notification		
*SNS target		
Demo_Device	Create Clear	Select
Message format		
RAW		
Choose or create a role to grant AWS IoT access to perform this action.		
myFirstThing_defaultRole Policy Attached	Create Role	Select

Upon adding the action, the SNS action will now appear as part of the Action rule. Click on Create rule.

	h notification	Remove Edit >
Demo_Device		
Add action		
Error action		
Optionally set an action that will be executed when so	omething goes wrong with processing your rule.	
Add action		
Add action		
Add action		
Tags Apply tags to your resources to help organize and ider	ntify them. <mark>A</mark> tag consists of a case-sensitive key-value pair. L	earn more about tagging your
Tags	ntify them. A tag consists of a case-sensitive key-value pair. L Value	earn more about tagging your
Tags Apply tags to your resources to help organize and iden AWS resources.		earn more about tagging your
Tags Apply tags to your resources to help organize and ider AWS resources. Tag name	Value	

The screen that originally said "you don't have any rules yet" will now look like this:

aws	Services 👻	Resource Groups 👻 🗙	4	csimntest 👻	Oregon 👻	Support 👻
		Rules			ļ	Create
Monitor		Search rules Q				Card 👻 🛞
Onboard						
Manage		myFirstThing_topic1				
Greengrass						
Secure						
Defend						
Act						
Rules						
Destinations						
Test						

If you click on the rule, the configured action rule looks like this:

RULE			
myFirstTh	ning_topic1		
ENABLED			Actions 👻
Overview	Description		Edit
Tags	Topic intended for generating SMS messages from data points.		
	Rule query statement		Edit
	The source of the messages you want to process with this rule.		
	SELECT * FROM '\$aws/things/myFirstThing/message1'		
	Using SQL version 2016-03-23		
	Actions		
	Actions are what happens when a rule is triggered. Learn more		
	Send a message as an SNS push notification	Remove	Edit 🕨

16.4 Configure IoT Gateway and Send Text Message

Most of the work is done. The only thing that remains is to configure a Thing Point to send a message to the SNS topic. Notice the special topic we created above is used here as the "Other" topic for publishing. Also note that we filled in messages that will be of more interest than just a number.

Babel Bust MODEL MQ-73 JOT GATEWAY	Same of the Party		CONTROL	SOLUTIONS M	INNES	στα
Local Objects	BACnet	IoT Cloud	System			
Thing Setup	Thing Sta	tus				
Thing Points	Thing ID	Thing Files				
Attribute # 2				Update	< Prev	Next >
Associate local object Al Publish: Using QOS MQTT Topic: Default O Publish if object value is grea Qualified by this hysteresis va Publish at least every 0 Follow above rule only if k	Ack not required ther \$aws/things/my ater than v C lue: 0.000000 thi minutes. Publi ocal object None	FirstThing/message1 this value: 5.000000 s minimum On Time: 0:00:0 sh no more than every 0 is set to a value of 0	Reported Desired			
Publish message on true:		S				
 Publish message on false: Publish as part of dataset 		Include timestamp				
Subscribe: To topic i Apply this default value: 0.0	and the second s	Gaws/things/myFirstThi	ng/shadow/update ut any update from the cloud.			
# Attributes Enabled: 11			Make Templa	te Force Publish	Insert	Delete

To cause the rule to publish, enter a value that triggers the rule.



The message that appeared on the cell phone in this test is illustrated below. In this

case, the rule was first triggered with the high level. Then a second level was entered that was below the threshold.

	ψ 🖪		•	b . Ø	1 :14
÷	(775)	600-4106	D1	Co	:
		1:09 PM			
0	{ "rep	n Info> { "sta ported": { "cs n Alert, Leve	Sens	or2": '}}}	
8	{ "rep	n Info> { "sta ported": { "cs mal, Level: 2	iSens		
	3 min				
Ð	ß	Text message		٢	► SMS
	\triangleleft	0			



17. Configuring IoT Analytics

Just as the subtitle denotes, IoT Analytics is where you collect, preprocess, store, analyze and visualize data of IoT devices. In this section of the user guide, we will go through the steps of setting up the channel, pipeline, data store and data set for collecting data from your Thing.

17.1 Create Resources

Start by searching for IoT Analytics and going there.

AWS Management Consol	e
AWS services	Access resources on the go
Find Services You can enter names, keywords or acronyms.	Access the Management Console using the AWS Console Mobile App. Learn more
IoT Analytics Collect, preprocess, store, analyze and visualize data of IoT devices	
AWS Marketplace Subscriptions Digital catalog where you can find, buy, and deploy software	Explore AWS
Kinesis Work with Real-Time Streaming Data	AWS IQ
MSK Fully managed, highly available, and secure service for Apache Kafka	Connect with AWS Certified third-party experts for on-demand consultations and project help. Get started 🔀

You may go directly to clicking on any of the menu items in the left column if you have previously set up IoT Analytics. If this is your first visit to IoT Analytics, or if you wish to set up an additional data set, enter a resource prefix and then click Quick Create.

aws	Services 🗸	Resource Groups 👻 🔭	¢	csimntest 👻	Oregon 👻	Support 👻
AWS IoT Analytics		Quick start with IoT Analytics				ф (S
Channels Pipelines Data stores Data sets		Quick create IoT Analytics resources 1-Click creation of your channel, pipeline, data store, and SQL data set Resources prefix myFirstThing				
Notebooks		Topic MQTT Topic (Optional) Quick Create Prepare your data with IoT Analytics	<u>In</u>			

The Quick Create process will create each of the four resources used in IoT Analytics. There is nothing more you need to do with the channel or data store. But you do need to configure the pipeline.

aws	Services 🗸	Resource Groups 🗸 🔹	¢	csimntest 👻	Oregon 👻	Support	*
AWS IOT Analytics		Quick start with IoT Analytics					ф (S)
Channels Pipelines Data stores		Quick create IoT Analytics resources 1-Click creation of your channel, pipeline, data store, and SQL data set Quick create finished:					
Data sets Notebooks		myFirstThing_datastore			Crea	ated 📀	
		myFirstThing_channel			Crea	ated 📀	
		myFirstThing_pipeline			Crea	ated 📀	
		myFirstThing_dataset			Crea	ited 📀	
		Quick create process has completed. Your IoT Analytics resources are now ready to or via an AWS IoT Core topic rule. To enable logging on your resources, please vice to the second seco			e BatchPutMee	isage API	

17.2 Build the Pipeline

Click on Pipelines on the menu on the left, and then click on your pipeline on the list.

aws	Services 🗸	Resource Groups 👻 🔦		🗘 csimntest 🕶 Oregon 🕶	Support 👻	
AWS IoT Analytics		Pipelines			Create	0 & D
Channels		Name	Created	Last updated		
Pipelines			Mar 22 2020 0/20/24 AM 0500	M		
Data stores		myfirstthing_pipeline	Mar 22, 2020 9:38:24 AM -0500	Mar 22, 2020 9:38:24 AM -0500		
Data sets		_				
Notebooks						

You will see that your channel is already set to be the source of data, and your data store is already set to be the destination for your data. What the pipeline needs to do is process the data. So next to Activities, click Edit.

aws	Services 🗸	Resource Groups 👻 🔦		Φ	csimntest 👻	Oregon 👻	Support 👻
÷	PIPELINE myfirstthing	j_pipeline				Actions •	₽ ⊗
- 1	Overview Details	Channel inputs Name	Туре			Edit	
		myfirstthing_channel	Channel				
		Activities Name	Туре			Edit	
		Data store outputs				Edit	
		Name 	Type Data store				
		Tags				Edit	

If you had already begun publishing data to your data channel, then the AWS system will inspect that data and make some assumptions about its format. But that requires going back and forth with partial configurations and becomes a chicken versus the egg problem. So the best and cleanest approach is to upload a JSON document telling the AWS system what your data is going to look like.

edit PipeLine myfirstthing	g_pipeline				STEP 1/2
	nsform, and filter messages based on the start of the sta		a sample		
Attributes	e.g. temperature			string •	Add new
	nd sample messages in your chann				
Get started by u	ploading a JSON document or man	ually enter attributes abov	e. retry inference		

The Babel Buster IoT Gateway can generate that JSON document for you. Start by making sure you have configured all of the desired data points on your Thing Points list.

Babe	L Bust	n IoT				CONTROL SC	OLUTIONS	MIN	NESOTA
Local Obje	ects	BACnet	loT Clo	ud	S	ystem			
	Thing Setup	Thing Status					- 1		
Thing Poi	nts	Thing ID	Thing	Files	-				
		s	howing attri	butes fron	1		Update	< [Prev Next
tr Loca # Obje		Attribute (Object) Name	Pub	Pub Ack Si	Jb Period	ic Publish Co	ndition	Obj	Threshold
Al 1		csiSensor1			0	changed by	/ ~		5.000000
2 AI 2		csiSensor2	S		0	changed by	/ ~		5.000000
AI 3		csiSensor3	S		0	changed by	/ ~		5.000000
AI 4		csiSensor4	2		0	changed by	/ ~		5.000000
AI 5		csiSensor5	2		0	changed by	/ ~		5.000000
None					0	n/a	~		0.000000

Click on the attribute number in the first column for any data point in the data set. Then click Make Template.

Local Objects	BACnet	loT Cloud	System		
Thing Setup	Thing Status				
Thing Points	Thing ID	Thing Files			
Attribute # 1				Update	< Prev Next >
Associate local object A	l 1named CSISe	2 n50r1 with this IoT attri	bute.		
Publish: 🎽 Using QO	S 🧿 Ack not required 🔍 Ad	ck required Publish as 🤇	Reported Opesired		
MQTT Topic: 오 Default 🔍	other Saws/things/myFirs	tThing/shadow/update			
Publish if object value is Cha	anged by 🗸 오 th	s value: <mark>5.000000</mark>	Othis local object: None		
Qualified by this hysteresis va	alue: 0.000000 this m	inimum On Time: 0:00:0	0 this minimum Off Tin	ne: 0:00:00	
Publish at least every 0	minutes. Publish r	o more than every 0	minutes.		
Follow above rule only if	local object None	is set to a value of 0			
Publish message on true:			42		
Publish message on false	:				
ZPublish as part of dataset	t number: 1	Z Include timestamp			
Subscribe: To topic Apply this default value: 0.	The second second second second second second second second second second second second second second second s	rs/things/myFirstThin minutes withou	ng/shadow/update ut any update from the cloud.	/	
# Attributes Enabled: 6			Make Template	Force Publish	Insert Delete

Now go to the Thing Status :: Test page and your template will be found waiting for you in the Last Pub window. If you already have data being published, it is possible that your template got overwritten by another publish before you got here. Go back and re-click the Make Template button if the content does not appear to include the data points you expected.

Local Objects	BACnet	IoT Cloud	System	
Thing Setu	ip Thing Sta	itus		
Object Info	Connection	Test		
Subscribe:				
			Subscribe Unsubs	cribe
Publish: Using QOS 🧿	Ack not required 🔍 Ack re	quired		
A1-			Publish	
Most recent Publish or Sul Topic: \$aws/things/my	8		Last Pub Last Su	b
{ "state": { "repo "csiSensor4": 0.00	orted": { "csiSensor 0, "csiSensor5": 0.0	1": 0.00, "csiSenso 0, "LocalTime": "20	r2": 0.00, "csiSensor3" 21-10-27T12:38:12-05:00	: 0.00, " } } }

Copy the content to a blank text document, and then save that content as a file with a .json suffix.

🗄 i 🖬 🔿 🦿					
File Home	View				~ 🕐
Paste Cut Clipboard	Courier New \cdot 11 \cdot $\mathbf{A}^* \mathbf{A}^*$ B \mathbf{I} $\mathbf{\underline{U}}$ abe $\mathbf{x}_2 \mathbf{x}^2$ $\mathbf{\underline{A}} \cdot \mathbf{\underline{A}}^*$ Font	∉∉ E • ‡≣• ≣ ≣ ≣ ≣ ∰	Picture Paint Date and Insert	Find ab Replace Select all Editing	
Contract Processing of the	Z	i source are de cert		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	7 .
	<pre>4 "state": { "reported 0.00, "csiSensor3": 0. 0.00, "LocalTime": "20</pre>	00, "csiSensor	4": 0.00, "csiSensor5"		

Now click the "uploading a JSON document" link pictured above and upload the *.json file you just created. The result will be to display that template in the form illustrated below. Click Next to continue.

EDIT PIPELINE			
myfirstthing_pip	eline		STEP 1/2
	and filter messages based on th butes manually to get started.	eir attributes. Upload a sample	
Attributes	e.g. temperature		string
Attribute name			
state			
reported			***
csiSensor1		55	
csiSensor2		28	
csiSensor3		0	***
csiSensor4		0	***
csiSensor5		0	***
LocalTime		*2020-03-22 09:56:50*	***

You have told the pipeline what to look for. The next step is to add an activity (actually we will be adding two). Click Add activity.

aws	Services 🗸 Resource Groups 🗸 🛧	🗘 csimntest 🕶 Oregon 👻 Su	ipport 👻
×	EDIT PIPELINE myfirstthing_pipeline	STEP 2/2	ф Ю
	Pipeline activities Chaining activities together enables you to process and prepare messages before storing them. You can enrich or transform message attributes, or filter entire messages out of your pipeline.		
	No activity selected	Add activity	
	Back	Save changes	

The first activity you want to select is "Add attributes to the message".

aws	Services 🗸 Resource Groups 🖌 🕏		♫ csimntest	▪ Oregon ▪	Support 👻
×	EDIT PIPELINE myfirstthing_pipeline			STEP 2/2	₽ ©
	Pipeline activities Chaining activities together enables you to process and pr them. You can enrich or transform message attributes, or pipeline.				
	No activity selected			Close	
	Remove attributes from the message	TRANSFORM		<u>^</u>	
	Select attributes from the message	TRANSFORM		E	
	Add attributes to the message	TRANSFORM			
	Calculate a message attribute	TRANSFORM			
	Back			Save changes	

We want to add message attributes - one per data point. The purpose of this is to give us the opportunity to pass the data through without all of the JSON stuff coming with the data. So add attributes with some name that you will want to see in future visualizations of the data, and select the source from the state.

Add attractions for the state	ibutes to the r sages	iessage		TRANSF	ORM			<u> </u>			
	sages						24	<u></u>	Remove	Close	
state											
reported											
csiSensor1	55										
csiSensor2	28										
csiSensor3	0										
csiSensor4	0										
csiSensor5	0										
LocalTime	"2020-03-22 (9:56:50"									
		existing attrib	oute.	Va	alue source						
Sensor1					state.reported.csi	Sensor1		•	Ren	nove	
Sensor2					state.reported.csi	Sensor2		-	Ren	nove	
-	csiSensor2 csiSensor3 csiSensor4 csiSensor5 LocalTime dd message rive a new attri tribute name Sensor1 Sensor2	dd message attributes rive a new attribute from an e tribute name Sensor1	csiSensor2 28 csiSensor3 0 csiSensor4 0 csiSensor5 0 LocalTime "2020-03-22 09:56:50" dd message attributes rive a new attribute from an existing attrib tribute name Sensor1 Sensor2	csiSensor2 28 csiSensor3 0 csiSensor4 0 csiSensor5 0 LocalTime "2020-03-22 09:56:50" dd message attributes rive a new attribute from an existing attribute. tribute name Sensor1 Sensor2	csiSensor2 28 csiSensor3 0 csiSensor4 0 csiSensor5 0 LocalTime "2020-03-22 09:56:50" Idd message attributes va rive a new attribute from an existing attribute. va tribute name va Sensor1 Sensor2	csiSensor2 28 csiSensor3 0 csiSensor4 0 csiSensor5 0 LocalTime "2020-03-22 09:56:50" dd message attributes rive a new attribute from an existing attribute. tribute name Value source Sensor1 Sensor2 state.reported.csi	csiSensor2 28 csiSensor3 0 csiSensor4 0 csiSensor5 0 LocalTime "2020-03-22 09:56:50" dd message attributes rive a new attribute from an existing attribute. tribute name Value source Sensor1 Sensor2 state.reported.csiSensor1 Sensor2 state.reported.csiSensor2	csiSensor2 28 csiSensor3 0 csiSensor4 0 csiSensor5 0 LocalTime "2020-03-22 09:56:50" dd message attributes rive a new attribute from an existing attribute. tribute name Value source sensor1 Sensor2 state.reported.csiSensor1 Sensor2 state.reported.csiSensor2	csiSensor2 28 csiSensor3 0 csiSensor4 0 csiSensor5 0 LocalTime "2020-03-22 09:56:50" Idd message attributes rive a new attribute from an existing attribute. tribute name Value source Sensor1 state.reported.csiSensor1 Sensor2 state.reported.csiSensor2	csiSensor2 28 csiSensor3 0 csiSensor4 0 csiSensor5 0 LocalTime "2020-03-22 09:56:50" dd message attributes rive a new attribute from an existing attribute. tribute name Value source Sensor1 • Rer Sensor2 • Rer	csiSensor2 28 csiSensor3 0 csiSensor4 0 csiSensor5 0 LocalTime "2020-03-22 09:56:50"

The complete set of added attributes in this example is illustrated below.

tribute name	Value source		-
Sensor1	state.reported.csiSensor1	•	Remove
Sensor2	state.reported.csiSensor2	•	Remove
Sensor3	state.reported.csiSensor3	•	Remove
Sensor4	state.reported.csiSensor4	-	Remove
Sensor5	state.reported.csiSensor5	•	Remove
TimeOfDay	state.reported.LocalTime		Remove

At this point, the outgoing message will appear as shown below. Click on "Update preview" to get an updated preview after making changes. Once updated, and until

more changes are made, the "Update preview" is unavailable.

aws	Services 🗸 Resource Groups 👻 🔭	۵	csimntest 👻	Oregon 👻	Support 👻
×	Outgoing message Below is a list of attributes to be included in the outgoing message.		🔿 Update j	preview	¢ Ø
	state				0
	reported				
	csiSensor1 55				
	csiSensor2 28				
	csiSensor3 0				
	csiSensor4 0				
	csiSensor5 0				
	LocalTime "2020-03-22 09:56:50"				
	Sensor1 55				
	TimeOfDay "2020-03-22 09:56:50"				
	Sensor2 28				
	Sensor3 0				
	Sensor4 0				
	Sensor5 0				

Now click "Add activity" to add another activity.

Sensor4 0	
Sensor5 0	
No activity selected	Add activit راس

This time, select "Remove attributes from the message".

Sensor5 0		
No activity selected		Close
Remove attributes from the message	TRANSFORM	
Select attributes from the message	TRANSFORM	
Add attributes to the message	TRANSFORM	
Calculate a message attribute	TRANSFORM	

Check the box on the "state" line. We are going to remove the entire JSON object.

tate	Remove
reported	Remove
csiSensor1 55	Remove
csiSensor2 28	Remove

The outgoing message now looks like the following. Click Save changes.

Back	Save changes
activity selected	Add activity
Sensor5 0	
Sensor4 0	
Sensor3 0	
Sensor2 28	
TimeOfDay "2020-03-22 09:56:50"	
Sensor1 55	

AWS will automatically display the following window at this point. If you do not yet have any data published to this pipeline, your answer here doesn't really matter. If you have come back later and made changes and want to see the effect of those changes, then you will want to reprocess messages.

	Yo	You've edited your pi				ipeline. Reprocess your messages?								s?	Actions -			
Overview	Rep	Reprocessing messages through the pipeline updates your data store									ore	Edit						
Details						aw me ected r			d in the c	hannel	backup	o. Repr	ocessi	ng wil	override any			
		rocess																
	Al	l avail	able ra	ange					*							Edit		
	C	Mar	22, 20	020	ia.	()	1	8:00	•	UTC -	5							
	(±	Mar	22, 20	020	1	• •	1	0:00	•	UTC -	5							
		∢ M	ARCH	2020					A	PRIL					•			
		S	hit	Т		Т	8			B M	T		Т	Æ	10	Edit		
								70 114		6 6					# 11			
		22																
																Edit		

The pipeline setup is now complete, and will appear as follows.

🗸 Resource Groups 🖌 🕏		众 csimntest ▪	Oregon 👻	Support
ing_pipeline			Actions •	
Channel inputs			Edit	
Name	Туре			
myfirstthing_channel	Channel			
Activities			Edit	
Name	Туре			
Add attributes	Transform			
Remove attributes	Transform			
Data store outputs			Edit	
Name	Туре			
myfirstthing_datastore	Data store			
	ing_pipeline Channel inputs Name myfirstthing_channel Activities Name Add attributes Remove attributes Data store outputs Name	ing_pipeline Channel inputs Name Type myfirstthing_channel Channel Activities Name Type Add attributes Type Add attributes Transform Data store outputs Name Type	ing_pipeline Channel inputs Name Type myfirstthing_channel Channel Activities Name Type Add attributes Type Add attributes Transform Data store outputs Name Type	Ing_pipeline Channel inputs Edit Name Type myfirstthing_channel Channel Activities Edit Name Type Add attributes Transform Remove attributes Transform Data store outputs Edit Name Type

17.3 Review Data set

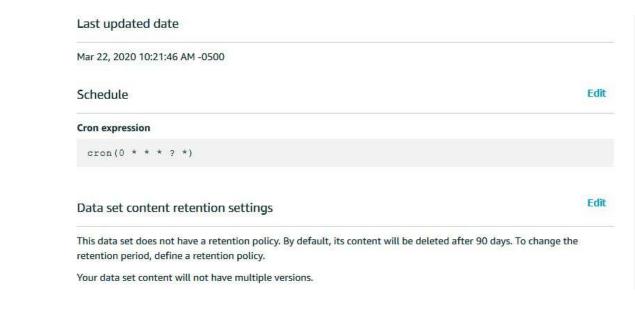
Click on Data sets on the main IoT Analytics menu. There is not much that needs to be set up with the data set.

DATA SET		
myfirstth succeeded	ing_dataset	Actions -
Details	Data set ARN	
Content	A data set Amazon Resource Name (ARN) uniquely identifies this data set.	
	arn:aws:iotanalytics:us-west-2:314429653841:dataset/myfirstthing_dataset	5
	Details	
	SQL query	Edit
	SELECT * FROM myFirstThing_datastore	
	Delta window	Edit
	Delta window has not been set yet. Result preview	
	dt	
	Creation date	

The data set will only update when you manually tell it to do so unless you set an update schedule. Click on Edit next to Schedule, and select an update period. Then click Save.

aws	Services 🗸	Resource Groups 👻	*	Ą	csimnt	est 👻	Oregon 👻	Support 👻	ĺ
×	update data set Set schedu	le						ф Ю	
	Frequency Hourly	y to run regularly to refresh	the data	set. Please note that the old data set will be overwritten ea	ch time t	he que	ry is run.		
	Minute of hour								
	Cancel						Save 🖑		

The schedule is displayed in Linux Cron format when you are done.



17.4 Create Action Rule for IoT Analytics

Everything is now set up for IoT Analytics to receive your data. Next, you need to go back to the IoT Core and tell your Thing to send data to IoT Analytics. This is done be creating another Action rule. Go to Rules, and click Create.

aws ser	vices 🗸 Resource Groups 🖌 🛠	众 csimntest ▼ Oregon ▼ Support ▼
	Rules	Create Q.
Monitor	Search rules Q	Card 👻 🐼
Onboard		
Manage	myFirstThing_topic1	
Greengrass		
Secure		
Defend		
Act		
Rules		
Destinations		
Test		

Provide a name for this Action rule and provide a description for your own reference.

Create a rule				
Create a rule to evaluate messa DynamoDB table or invoke a La	iges sent by your things and specify w	nat to do when a message is	received (for example, write data to a	3
Name				
myFirstThing_dataTopic1				
Description				
Rule to send data to IoT Anal	lytics.			
и L				
Rule query statement				
	ages you want to process with this rul	2.		
	ages you want to process with this rul	2.		
Indicate the source of the messa	ages you want to process with this rul	2.		
Indicate the source of the messa Using SQL version		2.		

Data is selected using an SQL style query. The 'iot/topic' that it starts out with is just a place holder.

Rule query statement						
Indicate the source of the messa	ges you want to p	process with this	rule.			
Using SQL version						
2016-03-23						
Rule query statement						
SELECT <attribute> FROM <topi learn more, see AWS IoT SQL Ref</topi </attribute>		<condition>. For</condition>	example: SELEC	T temperature FRO	M 'iot/topic' WHE	RE temperature > 50. To
1 SELECT * FROM 'iot/topi						

The SQL query needs to contain the topic that your Thing will be publishing to. The default topic is '\$aws/things/myFirstThing/shadow/update' (where 'myFirstThing' will be whatever you named your thing).

Rule query statement

Indicate the source of the messages you want to process with this rule.

Using SQL version

2016-03-23		
2010-03-23		

Rule query statement

SELECT <Attribute> FROM <Topic Filter> WHERE <Condition>. For example: SELECT temperature FROM 'iot/topic' WHERE temperature > 50. To learn more, see AWS IoT SQL Reference.

1	SELECT * FROM *\$aws/things/myFirstThing/shadow/update*	

After editing the SQL query to reflect your topic, click Add action.

-



The Action list will appear.

aws	Services 🗸	Resource Groups 😽	*	Φ	csimntest 👻	Oregon 👻	Support 👻
	Select an ac	ction					ф © &
		Insert a message into a	DynamoDB table				

Scroll down to "Send a message to IoT Analytics", and select that option. Then click Configure action.

	Send a message to IoT Analytics
	Send a message to an IoT Events Input
0 \$	Send message data to asset properties in AWS IoT SiteWise
0	Start a Step Functions state machine execution STEP FUNCTIONS
0	Send a message to a downstream HTTPS endpoint
ancel	Configure action

The IoT Analytics channel previously created should appear on this list. Select it.

aws	Services 🗸 Resource Groups 🖌 🛠		¢	csimntest 👻	Oregon 👻	Support 👻
C	Configure action					ф 0 Ф
3	Send a message to IoT Analytics					
	 Quick create IoT Analytics resources This option will create channel, pipeline, data store and SQL data set Manually select IoT Analytics Channel and role This option will allow you to select an existing IoT Analytics channel a *Channel name No channel selected Q Search myfirstthing_channel 					
	*Role (requires IoT Analytics access) No role selected	Select				

You will need to create a role. Click Create Role.

aws s	rvices 🗸 Resource Groups 🗸 🔭	4	csimntest 👻	Oregon 👻	Support 👻
Со	figure action				ф © Ю
۲	Send a message to IoT Analytics				
•	Quick create IoT Analytics resources This option will create channel, pipeline, data store and SQL data set in IoT Analytics. Manually select IoT Analytics Channel and role This option will allow you to select an existing IoT Analytics channel and role to send your data. *Channel name				
	myfirstthing_channel Clear Select				
	*Role (requires IoT Analytics access) No role selected Create Role Select				

Provide a name for your role, and click Create role.

	Create a new role				
Configu	A new IAM role will be created in your ac scoped-down permissions allowing AWS			widing	
Ser Iot A	Name myFirstThing_dataRole				
O Quio This			Cancel	Create role	
	ption will allow you to select an existing IoT A mel name	nalytics channel and role to se	nd your data.		
	vfirstthing_channel	Clear	Select		

The action rule should now appear as follows. Click Add action.

Co	nfigure action			
۲	Send a message to IoT Analytics			
0	Quick create IoT Analytics resources This option will create channel, pipeline, data store and SC) data set in IoT Analyti	irs	
۲	Manually select IoT Analytics Channel and role		ita,	
	This option will allow you to select an existing IoT Analytic *Channel name	s channel and role to se	nd your data.	
	myfirstthing_channel	Clear	Select	
	*Role (requires IoT Analytics access)			
	myFirstThing_dataRole Policy Attached 🗸	Create Role	Select	

The finished Action rule will now look like this. Click Create rule.

ndicate the source of the messages you	u want to process with this rule.	
Ising SQL version		
2016-03-23	* 1	
ule query statement		
ELECT <attribute> FROM <topic filter<br="">arn more, see AWS IoT SQL Reference</topic></attribute>	r> WHERE <condition>. For example: SELECT temperature FROM 'iot, e.</condition>	/topic' WHERE temperature > 50. To
1 SELECT * FROM '\$aws/things/my	/FirstThing/shadow/update*	
at one or more actions		
	when the above rule is matched by an inbound message. Actions defi	ne additional activities that occur
elect one or more actions to happen w	when the above rule is matched by an inbound message. Actions defir m in a database, invoking cloud functions, or sending notifications. (*.	
elect one or more actions to happen w when messages arrive, like storing then	m in a database, invoking cloud functions, or sending notifications. (*.	
	m in a database, invoking cloud functions, or sending notifications. (*.	
elect one or more actions to happen w when messages arrive, like storing then Send a message to	m in a database, invoking cloud functions, or sending notifications. (*.	required)
elect one or more actions to happen w then messages arrive, like storing then Send a message to myfirstthing_channel	m in a database, invoking cloud functions, or sending notifications. (*.	required)
vhen messages arrive, like storing then Send a message to myfirstthing_channel	m in a database, invoking cloud functions, or sending notifications. (*.	required)
Select one or more actions to happen with the storing then the storing the sto	m in a database, invoking cloud functions, or sending notifications. (*.	required)

Your Rules page will now have a new rule. This illustration now includes rules from both Sections 16 and 17.

aws Services	s 👻 Resource Groups 👻 🔭	众 csimntest ★ Oregon ★ Support ★
🖗 AWS IOT	Rules	Create (?)
Monitor	Search rules Q	Card 👻
Onboard		
Manage	myFirstThing_topic1 myFirstThing_dataTop ENABLED ENABLED	
Greengrass	- m	
Secure Defend		
Act		
Rules		
Destinations		
Test		

If you click on the rule at this point, it will be displayed as follows.

aws	Services 🗸	Resource Groups 👻 🔸	¢	csimntest 👻	Oregon 👻	Support 👻
÷	rule myFirstThin enabled	g_dataTopic1			Actions	₽ ? &
1	Overview Tags	Description			Edit	
		Rule to send data to IoT Analytics. Rule query statement			Edit	
		The source of the messages you want to process with this rule. SELECT * FROM '\$aws/things/myFirstThing/shadow/update'				
		Using SQL version 2016-03-23 Actions				
		Actions are what happens when a rule is triggered. Learn more				
		Send a message to IoT Analytics myfirstthing_channel		Remove	Edit 🔸	

17.5 Process Data

You are now ready to process data. You will need to start by giving your Thing some time to publish data. Once you are confident there is at least some data to look at, you can come back to the pipeline and click Reprocess messages. This will go back and capture any data that might have gotten published while you were setting up IoT Analytics.

PIPELINE	ng_pipeline		
inymstein			Actions 🔻
			Delete
Overview	Channel inputs		Reprocess messages പ്രിന്വ
Details	Name	Туре	
	myfirstthing_channel	Channel	
	Activities		Edit
	Name	Туре	
	Add attributes	Transform	
	Remove attributes	Transform	

Go to the Data set and click Run now to rerun the SQL query.

aws se	rvices 🗸 Resource Groups 🖌 🖈 🗘 a	simntest 👻 Oregon 👻	Support 👻
Content	Data set ARN	Actions - Run now Delete	₽ ⊗ ©
	Details SQL query SELECT * FROM myFirstThing_datastore	Edit	

The result will show as a preview on the Data set page. If you have set an update schedule (e.g. hourly), then you don't need to repeat the Run now when you come back to look some time later. Data will now be waiting for you any time you come back to look at it, and it will also be available for visualization using QuickSight.

It should be noted, however, that data collection in the data set is not promptly real time. There is some lag time between data being published and data reaching the data store. Notifications from SNS occur almost instantly. It has also been observed that data from the data set may be forwarded to QuickSight in real time but still not yet display in the query preview on this page.

SQL query	query						
SELECT * FRO	OM myFirstThing_datast	ore					
Delta window					Edit		
Delta window has	not been set yet.						
Result preview							
sensor1	timeofday	sensor2	sensor3	sensor4			
58	2020-03-22 10:50:32	38	26	90	4		
31	2020-03-22 10:48:32	9	29	52	ļ		
2	ш				,		

You have the option of modifying the SQL query to be anything that is a valid SQL query. You can replace 'SELECT *' with 'SELECT sensor1' for example. You can also add other SQL qualifiers. To modify the SQL query statement, click the Edit link next to SQL query.

Edit the query as you see fit. Test the query by clicking the Test Query button. If successful and there are no errors, click Save. The SQL edit window does not normally appear as bright as illustrated below - this screen shot was enhanced for readability in this document.

Author quer	ry				
Craft a query to gen	nerate the data set.				
Query					
1 SELECT * FRO	OM myFirstThing_datastore ORDER i	3Y timeofday			
Query duration: 26	78 ms				
Result preview					*
sensor1	timeofday	sensor2	sensor3	sensor4	SI
sensor1 31	timeofday 2020-03-22 10:48:32	sensor2 9	sensor3 29	sensor4	si2
31	2020-03-22 10:48:32	9	29	52	2
31 58	2020-03-22 10:48:32 2020-03-22 10:50:32	9 38	29 26	52 90	2
31 58 62	2020-03-22 10:48:32 2020-03-22 10:50:32 2020-03-22 10:52:32	9 38 95	29 26 31	52 90 63	2 4 2

Once your SQL query edit is complete, the updated query will appear in the query window.

	· · · · · · · · · · · · · · · · · · ·	dit
astore Ol	. BY timeofday	
	E	dit
sensor2	sensor3 sensor4	si
78	26 3	5
50	35 25	3
43	37 29	1
46	32 68	1
30	48 83	3 -
30		48 83

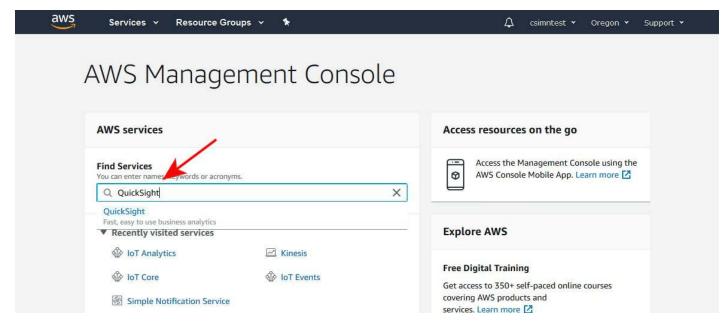


18. Configuring QuickSight

AWS QuickSight provides a convenient means of quickly visualizing the data collected from your Thing.

18.1 Create New Analysis

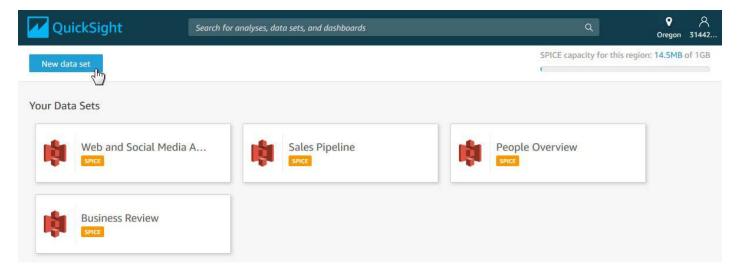
Start by searching for QuickSight in your AWS Management Console.



The QuickSight dashboard is an entirely different site independent of the AWS Management Console. Upon first visit, only some example visualizations are provided on the dashboard. Click "New analysis".

W QuickSight	Search for analyses,	data sets, and dashboards			Q	♀ Oregon	م 3144
New analysis						Manage	data
	All analyses	All dashboards	Favorites	Tutorial videos			
				Last up	dated (newest first)	~	
			-	-			
	ial Media Analytics	Sales Pipeline and		People Overvie			
SAMPLE	☆ …	SAMPLE	☆ …	SAMPLE	\$		

The first step in creating an analysis is to select a data set. Click "New data set".



You have a long list of choices for sources of your data set. Find AWS IoT Analytics and select it.

ZuickSight		୧ ମ Oregon 31442.
Data Sets		SPICE capacity for this region: 14.5MB of 1GB
Create a Data Set FROM NEW DATA SOURCES		
Upload a file (.csv, .tsv, .clf, .elf, .xlsx, .json)	Salesforce Connect to Salesforce	S3 Analytics
5 3	Athena	RDS
Redshift Auto-discovered	Redshift Manual connect	MySQL
PostgreSQL	SQL Server	Aurora
A MariaDB	Presto	spark Spark
Teradata Provided by Teradata	Snowflake	AWS IOT Analytics

The data set you created in IoT Analytics will be displayed. Select it, provide a name (will appear on QuickSight dashboard) and click Create data source.

W QuickSight		♥ ペ Oregon 31442.
Data Sets	New AWS IOT Analytics data source	PICE capacity for this region: 14.5MB of 1GB
Create a Data Set	myfirstthing_dataset]
FROM NEW DATA SOURCES	Select an AWS IoT Analytics data set to import:	
	myfirstthing_dataset	
Upload a file (.csv, .tsv, .clf, .elf, .xlsx, .json)	Cancel Create data source	cs
53	Athena RDS	

Upon clicking "Create data source", the display will appear as follows. Now click Visualize.

QuickSight		♀ , ♀ Oregon 3144:
Data Sets	Finish data set creation	 PICE capacity for this region: 14.5MB of 1GF
Create a Data Set FROM NEW DATA SOURCES	Estimated table si 18.5KB succ Data source: myfirstthing_dataset	
Upload a file (.csv, .tsv, .clf, .elf, .xlsx, .json)	Edit/Preview data Augment with SageMaker	zs
53	Athena RDS	

18.2 Visualize Data

The initial visualize screen will appear as shown below. Click on fields on the fields list and select Add to visual.

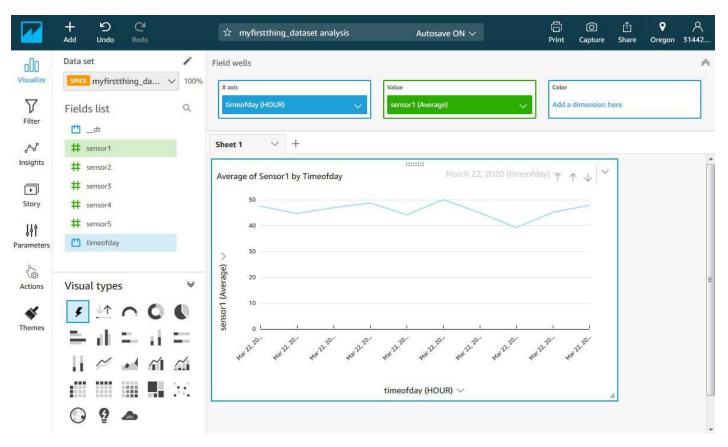
	+ り C Add Undo Redo	$ m Autosave$ ON \sim	后 ① ① Ŷ ペ Print Capture Share Oregon 31442
000 Visualize	Data set	Field wells	
	SPICE myfirstthing_da V 10	Sheet 1 V +	Import complete: ×
Filter	Fields list Q	~	100% success 129 rows were imported to SPICE 0 rows were skipped
N Insights	# sensor1	Add to visual Add filter for this field	View summary
Story	<pre># sensor3 # sensor4</pre>	Show as: Number > AutoGraph Format: 1,234.5678 > Ids and let QuickSight choose the most appropriate chart	
↓↓↑	<pre># sensor4 # sensor5</pre>	Convert to dimension	
Parameters	timeofday timeofday	4	
Actions	Visual types		
*	✓ ↑ ↑ 0 €		
Themes	을 해 우 가 우		
	~ 🖬 Al Al		

For our example, we are using timeofday as the X axis, and the sensor values on the Y axis. Once the sensor is added to the Value list, you can further select optional manipulations such as Sum or Average (per time period).

	+ 5 C ⁴ Add Undo Redo	🖄 myfirstthing_dataset analysis	Autosave ON 🗸	Print Capture	 Share	O regon	R 31442
000 Visualize	Data set SPICE myfirstthing_da 100%	Field wells	Value	Color			*
V Filter	Fields list Q	timeofday 🗸 🗸	sensor1 (Sum)	Add a dimension	here		
<i>⊳</i> Insights	<pre># sensor1 # sensor2</pre>	Sheet 1 ~ +	Average 5	how as: Number	>		*
) Story	<pre># sensor2 # sensor3 # sensor4</pre>	Sum of Sensor1 by Timeofday	Count distinct	ormat: 1,234.5678 Remove	>		
ştory	# sensor5	4K	Median	1 _dt \$ sensor1	^		
Parameters	💾 timeofday	2K	Min 4	\$ sensor2	E		
Actions	Visual types	0 L Mar 22, 2020		\$\$ sensor3 \$\$ sensor4			
Themes	을 해 두 해 두		Standard deviation - population -		1		
https://us-we	st-2.quicksight.aws.amazon.com/sn/analyses/7a8	bbc5d-1704-474f-8826-b00a0856011d#					÷

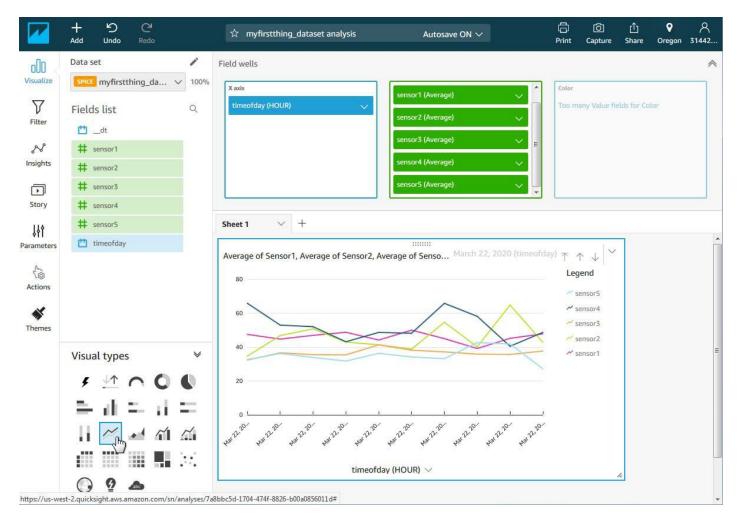
The first time you attempt to visualize data, you might not have data spanning multiple days yet. If that is the case, place the mouse over the lone data point, and select Drill down to HOUR.

	+ ら C ^H Add Undo Redo	☆ myfirstthing_dataset analys	sis Autosave ON 🗸	C Print	Capture	① Share	♀ Oregon	<u>م</u> 31442
000 Visualize	Data set 🖍	Field wells	Value	Color				*
√ Filter	Fields list Q	timeofday	sensor1 (Average) 🗸 🗸	Add a	dimension h	iere		
No. Insights	# sensor1	Sheet 1						
Story	 sensor3 sensor4 	Average of Sensor1 by Timeofday	·~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~					
Parameters		40	sensor1 (Average) 46.341 Focus only on 2020-03-22 00:00:00					
Actions	Visual types 🛛 👻	20	Drill down to HOUR Drill up to WEEK Analyze contributions to sensor1					
Themes	● △ ○ ● ● ■ 山 = 山 =	0 Mar 22	Color sensor1 > Chart Color >					
https://us-we	() 2 as	3bbc5d-1704-474f-8826-b00a0856011d#						-

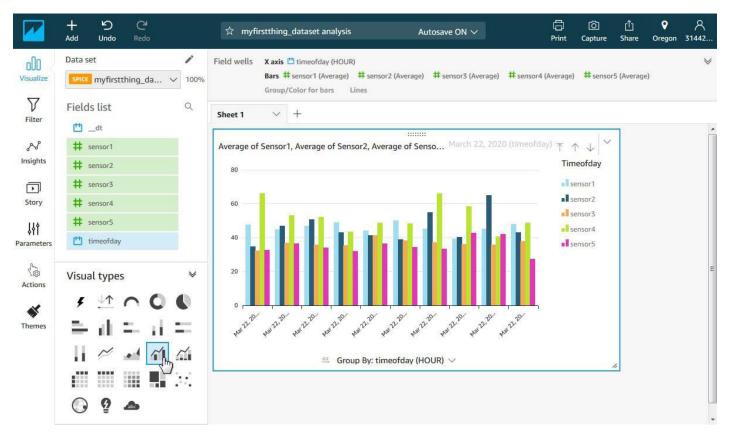


The resulting graph displayed so far looks like this:

We repeat the process of adding values to add the rest of the sensors. Now we have the visualization illustrated below.



There are a number of Visual types you may choose from. Simple click on a new Visual type to change the format of the display. Be aware that some types of visualization only apply to a single data point, and selecting them will remove all but one of your values from the display list.



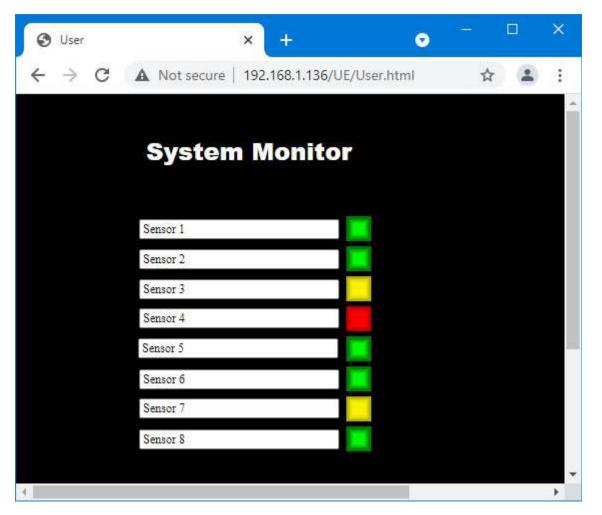
When you exit the visualization screen by clicking the QuickSight icon in the top left corner, you return to the dashboard where your new visualization is now displayed. The next time you return to QuickSight, simply click on your newly added dashboard icon to return to it.

QuickSight	Search for analyses,	data sets, and dashboards			۹	♥ 옷 Oregon 31442.
New analysis						Manage data
	All analyses	All dashboards	Favorites	Tutorial videos		
All analyses				Last update	ed (newest first) $$	
	\sim			-		
			_			
					- C	
myfirstthing_da Updated a minute ago	taset analysis ☆ …	Web and Social Me	edia Analytics ☆ …	Sales Pipeline ana	lysis ☆…	



19. 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 Babel Buster 3 gateways. Except for changing the link "../index.html" to "/html/index.html" where applicable, the various demos found in the knowledgebase should work in a Babel Buster 3 (including MQ-73/BB3-7301-MQ).



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.

19.1 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 v3.54.1 and it seemed to work ok.

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/.

19.2 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:

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

Х

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:

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:

Log In

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 <u>must</u> still be named *User.html* (and <u>not</u> *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">
```

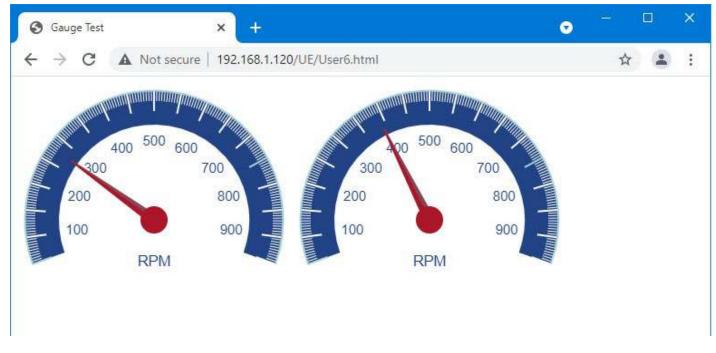
19.3 Live JavaScript Gauges

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="canvasPressure"></canvas>
<canvas id="canvasPressure"></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>
</body>
```

</html>

NOTE: The above example using an iframe to retrieve real time data was created prior to adding the REST API capability to the MQ-73/BB3-7301-MQ. The iframe example will work on any Babel Buster 3 family device supporting User HTML. The REST API option is only available on certain models. The gauge animation could be restructured to take advantage of the REST API if you know your way around JavaScript.



20. REST API

You can use the IoT Gateway as a means of communicating with your Modbus devices using a REST API. The API must be enabled at the bottom of the Network setup page before the API will respond.

20.1 GET Data from Device

You can use an HTTP GET request to query the IoT gateway 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 register names on the Local Registers 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".

20.2 POST Data to Device

To write data to the IoT gateway (which will result in writing data to a Modbus register 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
        }
    }
}
```

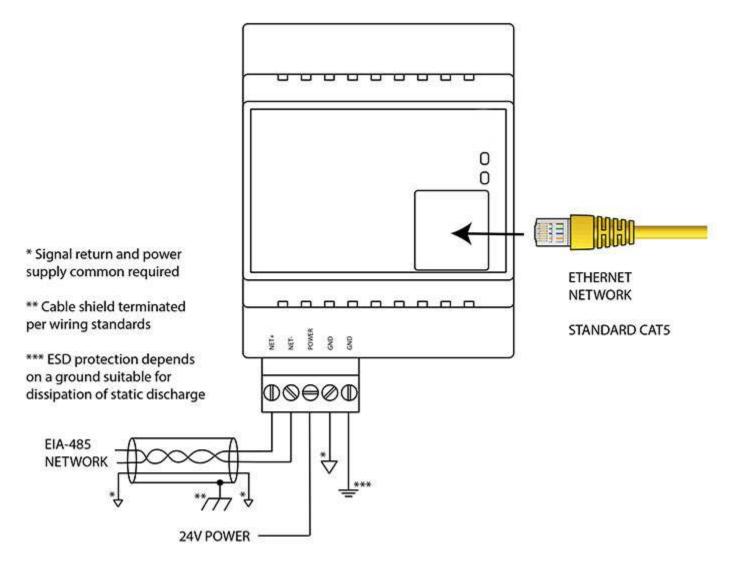
This example will set the register named csiActuator1 to value 47 and return result similar to above GET reply with respective object name.



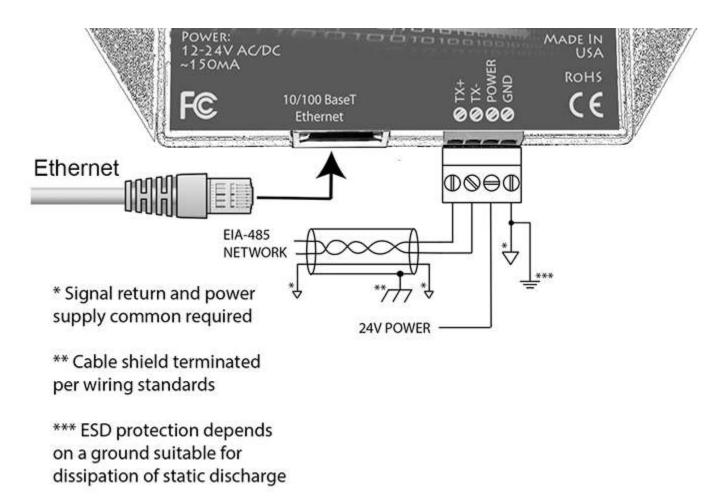
Appendix A Hardware Details

A.1 Wiring

Wiring for the Babel Buster BB3-7301-MQ is illustrated below.



Wiring for the MQ-73 is illustrated below.



Wire the gateway as illustrated. Follow all conventional standards for wiring of EIA-485 networks when connecting the MS/TP EIA-485 (RS485) network. This includes use and termination of shield, termination of the network, and grounding.

IMPORTANT: Although EIA-485 (RS485) is thought of as a 2-wire network, you MUST include a third conductor connected to GND or common at each device so that all devices are operating at close to the same ground potential. Proper grounding of equipment should ensure proper operation without the third conductor; however, proper grounding often cannot be relied upon. If large common mode voltages are present, you may even need to insert optically isolated repeaters between EIA-485 devices.

Use standard CAT5 cables for Ethernet connections. Use control wire as applicable for local electrical codes for connecting the 24V (AC or DC) power supply.

Note that in addition to connecting power supply common to a GND terminal, you must also connect a GND terminal to earth ground in order to ensure proper ESD protection.

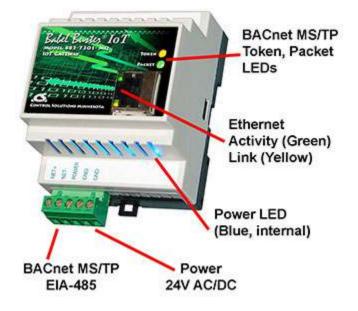
A.2 Front Panel LED Indicators

A.2.1 BB3-7301-MQ 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.



Babel Buster BB3-7301-MQ Token and Packet LEDs reflect BACnet MS/TP traffic, and the Ethernet activity LED will indicate network traffic in general.

Babel Buster BB3-7301-MQ 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.2.2 MQ-73 LED Indicators

Power-up LED behavior: On power up, the Token, Packet and Error LEDs will remain off for about 20 seconds, then all three LEDs will do a "lamp test" where they all turn on simultaneously for about 1 second. The LEDs will then begin to operate according to their normal functionality.



Babel Buster MQ-73 Token, Packet and Error LEDs reflect BACnet MS/TP traffic, and the Ethernet activity LED will indicate network traffic in general.

Babel Buster MQ-73 LEDs indicate as follows (LEDs are each a single color):

Error (red)	Flashes red upon receipt of an error indication in a reply message, or upon recognition of an error in response to a request that was received. If the BACnet client is configured to query other MS/TP devices, then the error LED can also indicate a timeout waiting for a reply.
Packet (yellow)	Flashes yellow each time a request is sent or received. Also flashes each time a "poll for master" is sent. If the MS/TP network is not connected, the yellow LED will appear as if on solid because all it is doing is polling for masters in an attempt to find something else to talk to.
Token (green)	Flashes each time the token is passed. Frequent but intermittent flashes of green indicate normal network traffic on the MS/TP link.
Ethernet Activity	Green LED is on solid during portions of the boot-up process, and then flashes briefly when Ethernet network traffic is detected.

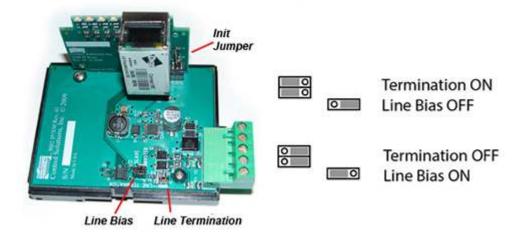
Ethernet Link	Yellow LED indicates an Ethernet link is present. This indicator will light if a link is present regardless of processor or network activity. If not lit, check network wiring.
Status	Blue LED (internal) on any time power is present and internal power supply is functioning.

A.3 RS-485 Line Termination & Bias

Enable line termination only when this device is placed at the end of the network. Termination should only be enabled at two points on the network, and these two points must be specifically the end points.

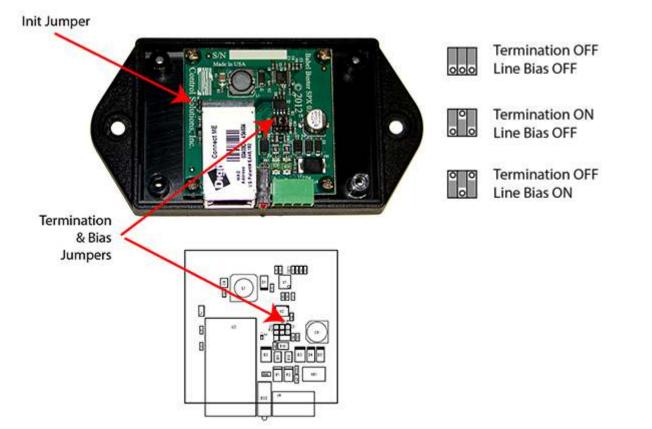
Enable line bias when needed. Line bias should only be enabled at one point on the network, and does not have to be the end point. Line bias holds the line in a known neutral state when no devices are transmitting. Without bias, the transition from offline to online by a transmitter can look like a false start bit and cause loss of communication.

The line conditioning options are enabled when the respective shunt is moved to the position indicated by the diagrams below.



Jumper locations for Babel Buster BB3-7301-MQ:

Jumper locations for Babel Buster MQ-73:



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, MQ-73/BB3-7301-MQ 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 MQ-73/BB3-7301-MQ 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 MQ-73/BB3-7301-MQ 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.

iker: 10 Time 1 0.000000 2 0.999898 3 2.001429 4 3.031837 5 3.032390 6 4.004269 7 4.024360 8 5.005791 9 5.025819 10 1.034508 11 39.07331 12 39.28991		Destination Broadcast Broadcast Broadcast Broadcast 239.255.255.250 239.255.255.250 Broadcast 239.255.255.250 Broadcast 239.255.255.250	pression <u>Clear</u> Ar Protocol Info ARP Gratu ARP Gratu ARP Gratu IGMP V2 Me IGMP V2 Me ARP Who h	uitous ARP for 192.168. uitous ARP for 192.168. uitous ARP for 192.168. uitous ARP for 192.168. has 192.168.1.1? Tell embership Report / Join has 192.168.1.1? Tell	1.25 (Request) 1.25 (Request) 1.25 (Request) 192.168.1.25 group 239.255.2
1 0.00000 2 0.999898 3 2.001429 4 3.031837 5 3.032390 6 4.004269 7 4.024360 8 5.005791 9 5.025819 10 14.034508 11 39.07331	Ibm_5e:b7:30 Ibm_5e:b7:30 Ibm_5e:b7:30 Ibm_5e:b7:30 192.168.1.25 Ibm_5e:b7:30 192.168.1.25 Ibm_5e:b7:30 Ibm_5e:b7:30 Ibm_5e:b7:30	Broadcast Broadcast Broadcast 239.255.255.250 239.255.255.250 Broadcast 239.255.255.250	ARP Gratu ARP Gratu ARP Gratu ARP Who H IGMP V2 Me IGMP V2 Me ARP Who H	uitous ARP for 192.168. uitous ARP for 192.168. has 192.168.1.1? Tell embership Report / Join embership Report / Join	1.25 (Request) 1.25 (Request) 192.168.1.25 group 239.255.2
2 0.999898 3 2.001429 4 3.031837 5 3.032390 6 4.004269 7 4.024360 8 5.005791 9 5.025819 10 11 034508 11 39.07331	Ibm_5e:b7:30 Ibm_5e:b7:30 Ibm_5e:b7:30 192.168.1.25 Ibm_5e:b7:30 192.168.1.25 Ibm_5e:b7:30 Ibm_5e:b7:30 Ibm_5e:b7:30	Broadcast Broadcast 239.255.255.250 239.255.255.250 Broadcast 239.255.255.250	ARP Gratu ARP Gratu ARP who h IGMP V2 Me IGMP V2 Me ARP who h	uitous ARP for 192.168. uitous ARP for 192.168. has 192.168.1.1? Tell embership Report / Join embership Report / Join	1.25 (Request) 1.25 (Request) 192.168.1.25 group 239.255.2
3 2.001429 4 3.031837 5 3.032390 6 4.004269 7 4.024360 8 5.005791 9 5.025819 10 11.034508 11 39.07331	Ibm_5e:b7:30 Ibm_5e:b7:30 192.168.1.25 192.168.1.25 Ibm_5e:b7:30 192.168.1.25 Ibm_5e:b7:30 Ibm_5e:b7:30	Broadcast Broadcast 239.255.255.250 239.255.255.250 Broadcast 239.255.255.250	ARP Gratu ARP Who H IGMP V2 Me IGMP V2 Me ARP Who H	uitous ARP for 192.168. has 192.168.1.1? Tell embership Report / Join embership Report / Join	1.25 (Request) 192.168.1.25 group 239.255.2
4 3.031837 5 3.032390 6 4.004269 7 4.024360 8 5.005791 9 5.025819 10 1.034508 11 39.07331	Ibm_5e:b7:30 192.168.1.25 192.168.1.25 Ibm_5e:b7:30 192.168.1.25 Ibm_5e:b7:30 Ibm_5e:b7:30	Broadcast 239.255.255.250 239.255.255.250 Broadcast 239.255.255.250	ARP who h IGMP V2 Me IGMP V2 Me ARP who h	has 192.168.1.1? Tell embership Report / Join embership Report / Join	192.168.1.25 group 239.255.2
5 3.032390 6 4.004269 7 4.024360 8 5.005791 9 5.025819 10 11.034508 11 39.07331	192.168.1.25 192.168.1.25 Ibm_5e:b7:30 192.168.1.25 Ibm_5e:b7:30 Ibm_5e:b7:30	239.255.255.250 239.255.255.250 Broadcast 239.255.255.250	IGMP V2 Me IGMP V2 Me ARP Who h	embership Report / Join embership Report / Join	group 239.255.2
6 4.004269 7 4.024360 8 5.005791 9 5.025819 10 11.034508 11 39.07331	192.168.1.25 Ibm_5e:b7:30 192.168.1.25 Ibm_5e:b7:30 Ibm_5e:b7:30	239.255.255.250 Broadcast 239.255.255.250	IGMP V2 Me ARP Who h	embership Report / Join	
7 4.024360 8 5.005791 9 5.025819 10 11 034508 11 39.07331	Ibm_5e:b7:30 192.168.1.25 Ibm_5e:b7:30 Ibm_5e:b7:30	Broadcast 239.255.255.250	ARP who h		aroup 239,255.2
8 5.005791 9 5.025819 10 11 034508 11 39.073317	192.168.1.25 Ibm_5e:b7:30 Ibm_5e:b7:30	239.255.255.250		has 107 168 1 17 TALL	
9 5.025819 10 11 034508 11 39.07331	Ibm_5e:b7:30 Ibm_5e:b7:30		IGMP V2 M		
10 11 034508 11 39.07331	Ibm_5e:b7:30	Broadcast		embership Report / Join	
11 39.07331/				has 192.168.1.1? Tell	
	the second second second second second second second second second second second second second second second se	Broadcast		has 192.168.1.1? Tell	
	Digiboar_2e:de:3			uitous ARP for 192.168.	
13 43.994394	Digiboar_2e:de:3 192.168.1.42	F Broadcast 224.0.5.128		has 192.168.1.43? Tell embership Report / Join	
15 45.994594	192.108.1.42	224.0.5.128	IGMP V2 Me	embership kepurt / Juin	group 224.0.5.1
					>
Protocol type Hardware size Protocol size Opcode: reque Sender MAC add	: 6 : 4 st (0x0001) dress: Digiboar_2e: ress: 192.168.1.42 dress: 00:00:00_00:	de:3f (00:40:9d:2eːd			
	°ess: 192.168.1.43				

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 MQ-73/BB3-7301-MQ serves two purposes, and what it does depends on whether you apply the jumper before or after the MQ-73/BB3-7301-MQ boots up.

Hard Configuration Reset:

Installing the jumper after bootup causes the MQ-73/BB3-7301-MQ 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 MQ-73/BB3-7301-MQ 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 MQ-73/BB3-7301-MQ. If both LEDs on the RJ45 jack come on and remain on, remove the jumper and then power cycle the MQ-73/BB3-7301-MQ.

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 MQ-73/BB3-7301-MQ'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.

Babel Buster IoT MODEL MQ-73 JOT GATEWAY	CONTROL SOLUTIONS MINNESOTA
Valid MAC Address 00;40:9D:45:	:47:13 Restore
Reformat Flash file system	Wipe

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 <u>https://info.csimn.com</u>.



Appendix B Trouble Shooting

B.1 File Upload Errors

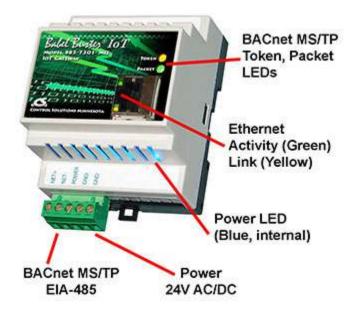
If you get a "File upload error: -1" message, click the browser's "back" button, then simply click the View button to view any file (does not matter which file), and then click browser's "back" button again to return to the File Manager page. This gets the browser and HTTP server back in sync, and this requirement generally happens only once following power-up.

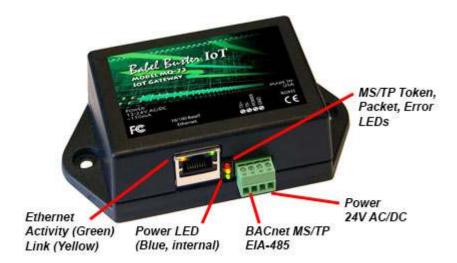
If you get a different persistent file upload error, check the space available versus the size of the file you are trying to upload. Available file space is displayed on the File Manager page as "Free space". The free space indicated is approximate. If close to zero, try deleting some files first.

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 MQ-73/BB3-7301-MQ 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 —						
<u>File Edit V</u> iew <u>Go C</u> apture <u>A</u> nalyze <u>S</u> tatistics Telephon <u>y W</u> ireless <u>T</u> ools <u>H</u> elp						
🖌 🔳 🖉 💿 📙 🖾 🕱 📴 🍳 👄 🕾 T 🖉 🧮 🔍 Q, Q, Q, 🎚						
Apply a display filter <ctrl-></ctrl->			- +			
Welcome to Wireshark						
Open						
C:\Users\Jim Hogenson\Documents\BB3-7301\mstpcap\mstp_20201116095859.cap (122 KB)	^					
C:\Users\Jim Hogenson\Documents\BB3-7301\mstpcap\mstp_20201112161911.cap (2143 Bytes)					
C:\Users\Jim Hogenson\Documents\BB3-7301\mstpcap\who-is-router-at-115.pcapng (263 KB)	Ê.					
C:\Users\Jim Hogenson\Documents\BB3-7301\mstpcap\read-range-6.pcapng (21 KB)	~					
Capture						
using this filter: 📜 Enter a capture filter 💌 All in	terfaces shown 🔻					
Local Area Connection* 8	^					
Ethernet A						
BACnet MS/TP on COM1						
BACnet MS/TP on COM3	~					
Learn						
User's Guide ' Wiki ' Questions and Answers ' Mailing Lists						
You are running Wireshark 3.4.0 (v3.4.0-0-g9733f173ea5e). You receive automatic updates.						
The second second second second second second second second second second second second second second second se	<u>/11</u>		5 11			
Ready to load or capture No Packets		Profile: De	rault			

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.

Device Net Address 20855 IP 192.168.1.55:0xl 40057 IP 192.168.1.115:0x 40180 IP 192.168.1.180:0x		and the second second second	Object Name	
40057 IP 192.168.1.115:0/ 40180 IP 192.168.1.180:0/		1-2370-ASC		
40180 IP 192.168.1.180:0x	AND AND AND AND AND AND AND AND AND AND	4-CJIV-AJC	Default VP4-2370	
	BAC0 Babel Buster	BB3-7301	Babel Buster BB3-7	301
	BAC0 Babel Buster	BB2-7030-01	Babel Buster BB2-7	030 BACnet Gateway/Router
208031 IP 192.168.1.198:0x	BAC0 Babel Buster	BB2-3010	BB2-3010 Gateway	
208033 IP 192.168.1.33:0x1	AC0 Babel Buster	BB2-7010-08	Babel Buster BB2-7	010 Modbus to BACnet IP Ga
208071 IP 192.168.1.197:0x	BAC0 Babel Buster	BB2-7010-03	Babel Buster BB2-7	010 Modbus to BACnet IP Ga
208078 IP 192.168.1.78:0x1	AC0 Babel Buster	BB3-7302-V2C	Babel Buster BB3-7	302-V2C
208079 IP 192.168.1.79:0x1	AC0 Babel Buster	BB3-7302-V3	Babel Buster BB3-7	302-V3
<				>
Get Device Info Get Ob	ect List			
				()

The Network Discovery Tool can be used to read and write properties in any BACnet device on the network.

🖛 BACnet Network Disco	very Tool v1.06		×
Local Port Who-Is Rea	Connected: 🗹 Target: 🗹 40057: Babel Buster BB3-7301 ad/Write		
Object Instance	Analog Value 1 + Present Value Image: Construction of the second seco		
Data Type Priority Write Data	None 🔽 🗖 Relinquish		
	12.340000 Send Raw APDU	<u>ı</u>	

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).



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.5) 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).
ΟΒЈТҮРЕ	-	Indicate the type of local BACnet object (see C.5) 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:

Ĩ	8 5.	ē						De
i,	File H	lome Insert Pa	age Layout Formula:	s Data	Review	View H	lelp Nitro	Pro
	aste	opy * B	22.000	A* A* ≡ • ▲ • ≡			? Wrap Text Merge & Cer	•ter
M	34	• : × •	f _x					
	A	В	с	D	E	F	G	н
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		1	AI	5	
7	R	AI	6		1	AI	6	
8	R	AI	7			AI	7	
9	R	AI	8			AI	8	
10	R	AI	9			AI	9	
11	R	AI	10			AI	10	
12	R	AI	11			AI	11	
	R	AI	12			AI	12	
	R	AI	13			AI	13	
15	R	AI	14			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:

Den Den	noMap.csv ·	- Notepa	id			- <u>1966</u>		×
File Ec	lit Format	View	Help					
RW, REMO	TEOBJTYPE	E, REMOT	TEOBJNUM, PRO	PERTY, DEVNU	M, OBJTYR	E,OBJM	NUM	0
	85,1,AI,							
R,AI,2	85,1,AI,	2						
1000000000000000	85,1,AI,							
R,AI,4,	85,1,AI,4	4						
	85,1,AI,							
R,AI,6,	85,1,AI,6	6						
R,AI,7,	85,1,AI,	7						
	85,1,AI,8							
	85,1,AI,9							
10 00 00 00 00 00 00 00 00 00 00 00 00 0	9,85,1,AI							
	L,85,1,AI							
	2,85,1,AI							
	8,85,1,AI							
120000000000000000000000000000000000000	4,85,1,AI							
	5,85,1,AI							
	5,85,1,AI 85,2,AI,							
	85,2,AI,							
	85,2,AI,							
	85,2,AI,							
	85,2,AI,							
	85,2,AI,							
12 20 20 20 20 20 20 20 20 20 20 20 20 20	85,2,AI,							
	85,2,AI,							
	85,2,AI,							
	,85,2,AI							
R,AI,11	1,85,2,AI	,27						
R,AI,12	2,85,2,AI	,28						
R,AI,13	8,85,2,AI	,29						
R,AI,14	4,85,2,AI	,30						
R,AI,15	5,85,2,AI	,31						
R,AI,16	5,85,2,AI	,32						
<								× *
-	Ln 1, Co		1009	Windows				~

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
МО	Multistate Output
MV	Multistate Value



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.

<u>Property</u>	<u>Encoding</u>
Object_Identifier (75)	BACnetObjectIdentifier
Object_Name (77) (W)	CharacterString "Analog Input <i>n"</i>
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 (6979) 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 (0127)
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



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
```

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;
```



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 passthrough, 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 Wiresha	rk Network Analyzer		
le <u>E</u> dit <u>V</u> ie			
. 🖉 🕥	<mark> </mark> 🖾 🗙 🖸 🭳 ⊕ ⊕ ፵ 🗿 🧕 🖉 曼 🗨 Q Q Q ፵		
Apply a displa	/ filter <ctrl-></ctrl->		
	Welcome to Wireshark.		
	Open		
	C:\Users\Jim Hogenson\Documents\BB3-7301\mstpcap\mstp_20201116095859.cap (122 KB)	^	
	C:\Users\Jim Hogenson\Documents\BB3-7301\mstpcap\mstp_20201112161911.cap (2143 Bytes)	100	
	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)	~	
	Capture		
	using this filter:	wn▼	
	Local Area Connection* 8	^	
	BACnet MS/TP on COM1		
	BACnet MS/TP on COM3	~	
	Learn		
	User's Guide ' Wiki ' Questions and Answers ' Mailing Lists		
	You are running Wireshark 3.4.0 (v3.4.0-0-g9733f173ea5e). You receive automatic updates.		
Ready to k	ad or capture	П	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.

p.addr==192.168.1.126 o. Time 67 40.558619 68 40.559175	Source	T &	Q. 🗉			
5. Time 67 40.558619 68 40.559175	Source					
67 40.558619 68 40.559175	Source					Expression
68 40.559175		Destination	Protocol Ler	igth Info		
	192.168.1.126	192.168.1.64	BACnet_	60 Confirmed-REQ	readProperty[190]	multi-state-output,1 present-value
CO 10 550733	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 48.873789	192.168.1.64	192.168.1.126	BACnet_	62 Complex-ACK	readProperty[188]	binary-value,1 present-value
75 48.931846	192.168.1.64	192.168.1.126	BACnet_	62 Complex-ACK	readProperty[189]	multi-state-input,1 present-value
P 0000 = PDU	Flags: 0x00					
> ObjectIdentifier	readProperty (12) r: analog-input, 1 fier: present-value 121.632141 (Real)	(85)				

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.

The second second second second second second second second second second second second second second second se	Regulation Register - Lands-	Capture Analyze Stat	a data a la construcción de la construcción					
-	ddr==192.168.1.126			4 4 <u>m</u>			Expression	. 14
0.	Time	Source	Destination	Protocol Les	nath Info			-
	75 40.931846	192.168.1.64	192.168.1.126	BACnet_	62 Complex-ACK	readProperty[189] #	ulti-state-input,1 present-value	
	76 40.954893	192.168.1.126	192.168.1.64	BACnet_	60 Confirmed-REQ	readProperty[193] a	analog-value,6125 present-value	
	77 48.991930	192.168.1.64	192.168.1.126	BACnet_	62 Complex-ACK	readProperty[190] m	multi-state-output,1 present-value	
	78 41.842142	192.168.1.64	192.168.1.126	BACnet_	62 Complex-ACK		ulti-state-value,1 present-value	
	79 41.101917	192.168.1.64	192.168.1.126	BACnet_	63 Complex-ACK		analog-output,1 priority-array	
	80 41.221657	192.168.1.64	192.168.1.126	BACnet_	60 Error	readProperty[193]		- 1
	84 45.554875	192.168.1.126	192.168.1.64	BACnet_	60 Confirmed-REQ	readProperty[194] a	analog-input,1 present-value	
	85 45.555391	192.168.1.126	192.168.1.64	BACnet_	60 Confirmed-REQ	readProperty[195] a	analog-output,1 present-value	
	86 45.555939	192.168.1.126	192.168.1.64	BACnet_	68 Confirmed-REQ	readProperty[196] b	binary-input,1 present-value	
Use 8AC 8ui 8ui	ernet Protocol er Datagram Prot Inct Virtual Lin Ilding Automatic Ilding Automatic	Version 4, Src: 192. cocol, Src Port: 4786 k Control m and Control Networ m and Control Networ	.168.1.64, Dst: 192. 38 (47808), Dst Port •k NPDU	168.1.126	5:46:96 (00:40:9d:4	15:46:96)		
D Int D Use D 8AC D 8ui d 8ui	ernet Protocol er Datagram Prot Inet Virtual Lin Ilding Automatic Ilding Automatic 0101 = APD Invoke ID: 1	Version 4, Src: 192. wool, Src Port: 4784 k Control nn and Control Networ on and Control Networ U Type: Error (5) 93 ce: readProperty (12 bject	.168.1.64, Dst: 192. 38 (47808), Dst Port -k NPDU -k APDU	168.1.126	S:46:96 (00:40:9d:4	5:46:96)		
Int Use 84C 801 801 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	ternet Protocol rr Datagram Prot inet Virtual Lim llding Automatic 0101 = APD Invoke ID: 1 Service Choi error Class: o error Code: un 00 40 9d 45 46 00 29 15 25 00	Version 4, Src: 192. wool, Src Port: 4784 k Control nn and Control Networ on and Control Networ U Type: Error (5) 93 ce: readProperty (12 bject	.168.1.64, Dst: 192. 38 (47808), Dst Port -k NPDU -k APDU -) d6 08 00 45 00 .@ a8 01 40 c0 a8 .)	168.1.126		5:46:96)		

The above examples showed filtering traffic by IP address. You can also filter simply by "bacnet" to see only BACnet traffic.

-	Ethernet						- 0 >
ile	Edit View Go	<u>Capture</u> <u>Analyze</u>	Statistics Telephony	<u>Wireless</u> <u>T</u> ools <u>H</u>	ielp		
0	1 🖉 🔲 📑	X C 9 00 00	ST 1 3	Q Q Q II			
ba	cnet						
	Time	Source	Destination	Protocol	Length Info		
	23 3.878362	192.168.1.112	192.168.1.115	BACnet-APDU	59 Confirmed-REQ	readProperty[115] a	malog-output,1 present-val
	24 3.878371	192.168.1.112	192.168.1.115	BACnet-APDU	59 Confirmed-REQ	readProperty[115] a	nalog-output,1 present-val
	25 3.985160	192.168.1.115	192.168.1.112	BACnet-APDU	65 Complex-ACK	readProperty[115] a	analog-output,1 present-val
	27 5.070242	192.168.1.112	192.168.1.115	BACnet-APDU	59 Confirmed-REQ	readProperty[116] a	malog-output,1 present-val
	28 5.070250	192.168.1.112	192.168.1.115	BACnet-APDU	59 Confirmed-REQ	readProperty[116] a	analog-output,1 present-val
	29 5.082294	192.168.1.115	192.168.1.112	BACnet-APDU	65 Complex-ACK	readProperty[116] a	analog-output,1 present-val
	31 6.206372	192.168.1.112	192.168.1.115	BACnet-APDU	59 Confirmed-REQ	readProperty[117] a	analog-output,1 present-val
	32 6.206381	192.168.1.112	192.168.1.115	BACnet-APDU	59 Confirmed-REQ	readProperty[117] a	inalog-output,1 present-val
	33 6.303937	192.168.1.115	192.168.1.112	BACnet-APDU	65 Complex-ACK	readProperty[117] a	analog-output,1 present-val
	34 7.318252	192.168.1.112	192.168.1.115	BACnet-APDU	59 Confirmed-REQ	readProperty[118] a	nalog-output,1 present-val
	35 7.318261	192.168.1.112	192.168.1.115	BACnet-APDU	59 Confirmed-REQ	<pre>readProperty[118] a</pre>	inalog-output,1 present-val
	36 7.328670	192.168.1.115	192.168.1.112	BACnet-APDU	65 Complex-ACK	readProperty[118] a	inalog-output,1 present-val
8	ACnet Virtual Li		47808, Dst Port: 47 twork NPDU	000			
-	and a second second second second second second second second second second second second second second second	on and Control Net					
	and the second se	DU Type: Confirmed					
2	0000 = PD	U Flags: 0x0	ALE COMPANY				
	.000 = Ma	x Response Segment	ts accepted: Unspec	ified (0)			
	0011 = Si	ze of Maximum ADPU	J accepted: Up to 4	80 octets (fits	in an ARCNET frame) (3	•)	
	Invoke ID: 115						
	Service Choice	: readProperty (12	2)				
3		er: analog-output,					
)	Property Ident	ifier: present-val	lue (85)				
_	00 40 9d 43 e	3 3c a4 bb 6d a2	b9 f6 08 00 45 00	-@-C-< m	· E ·		
000		3 88 88 11 88 88	c0 a8 01 70 c0 a8				
010							
	01 73 ba c0 b		81 0a 00 11 01 04 55	··s···@· ··U	* * *		

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.pcapn	ġ			
ile	<u>E</u> dit <u>V</u> iew <u>G</u> o	Capture Analyz	e <u>Statistics</u> Telephony	<u>Wireless</u> <u>Iools</u> <u>H</u> elp	
£.	🔳 🔬 🕥 🛄 🛅	🗙 🖸 ९ 👳	****	Q Q Q 🔢	
Į	oply a display filter <	Ctrl-/>			🗀 🔹
6	Time	Source	Destination	Protocol	Length Info
	609 7.866680	0x2a	0×50	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	Øx1f	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	0×15	0x1f	BACnet-APDU	29 Complex-ACK readProperty[210] analog-value,1 p
	618 8.017278	0x1f	Øxff	BACnet-APDU	34 Unconfirmed-REQ i-Am device,176
	619 8.032238	0x1f	Øxff	BACnet-APDU	34 Unconfirmed-REQ i-Am device,16010
	620 8.047199	0x1f	Øxff	BACnet-APDU	34 Unconfirmed-REQ i-Am device,16006
6	*** * ******		· · · ·	A.4 4	
		on and Control DU Type: Confin U Flags: 0x0 x Response Segn ze of Maximum A : readProperty er: analog-value	Network APDU med-REQ (0) ments accepted: Unspeci ADPU accepted: Up to 48 (12) Je, 1		ARCNET frame) (3)
	> Property Ident	ifier: present	-value (85)		



Appendix G SSL Certificates for Secure Web (HTTPS)

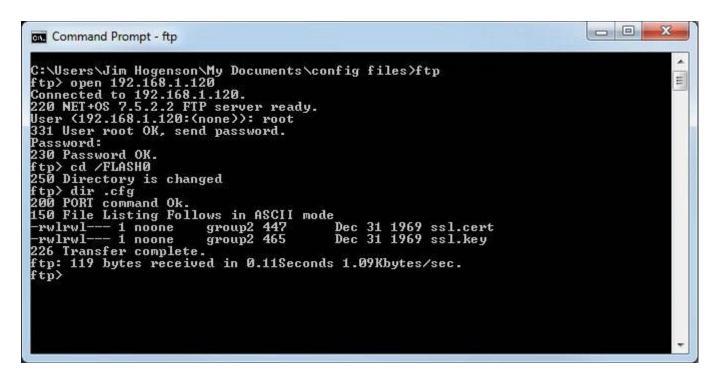
The secure web server (HTTPS) requires SSL certificates in order to establish secure connections. The HTTPS certificates are only required if HTTPS is enabled on the Network configuration page in the Babel Buster MQ-73/BB3-7301-MQ.

G.1 X.509 Auto-Certificate Generation

The Babel Buster MQ-73/BB3-7301-MQ 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 🗹 HT	TPS Enabled (on 443) 🏹 HTTP Enabled		
HTTP Port 80	(default 80)	Set Ports	
FTP Server 🗹 Ena	abled		
REST API 🗹 Ena	abled		
MAC Address: 00:40:9	D:45:47:13	System Uptime: 4,00:17:04	
HTTPS certificate status: User ce	ertificates successfully loaded.		

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.



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.

File Manaç	jer Netwo	rk	Resources	User		
File Directory:	BootConfig.xml 💌		Free space: 1.58 M Filtered by: *.*	and the second se	Select	
Seleted File:	BootConfig.xml	Action:		Execute		
Boot configura	server.crt		Confirm Res	tart		

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).

Home	View				
Cut Cut Copy	Courier New \bullet 11 \bullet A^* B I U abe \times_2 \times^2 \mathscr{L}^* B I U abe \times_2 \times^2 \mathscr{L}^* B I U abe \times_2 \times^2 \mathscr{L}^* E I U abe \times_2 \times^2 \mathscr{L}^*	译译 : : · (::·	Picture Paint Date and Insert * drawing time object Insert	A Find a Replace Select all Editing	
	BQAwcjEcMBoGA1UEAww dHJvbCBTb2x1dG1vbnM c290YTEQMA4GA1UEBww MjA1MTNaMHIxHDAaBgN FkNvbnRyb2wgU29sdXF aW5uZXNvdGExEDA0BgN MIGJAoGBA062WY18an JFS2zTdQjFKQnQnDr41 gk5K0nnKpJvVrNKOMVa MB0GA1UdDgQWBBREnFV C8j1wKBECU70cmRvNyi A4GBA1o3iCVv1rS3M4e	UI9eCRcVas2yCLx TTWFpbiBDQSBDZX. IgSW5jLjELMAkGA1 HU3QgUGF1bDAeFw IVBAMME01haW4gQ0 tpb25zIEluYy4xCz. VBAcMB1N0IFBhdW fiY7oyxKyUUNmrKP. PCdoM8VzXaX2z7s C9krST/3800x4uH 'QC8jlwKBECU70cm &/TAFEgNVHRMBAf eplg3xK3iMKszkLB. 2CH2iPoqkCtNSKG doXff2f88L1qEwg	BetHOvdyAJCTEwDQYJKo2 JOaWZpY2F02TEfME0GA1U UEBhMCVVMxEjAQBgNVBAg DxOTA2MDYwMjA1MTNaFwO EgQ2VydG1maWNhdGUxHzZ AJBgNVBAYTA1VTMRIwEAX wwg28wDQYJKoZIhvcNAQE LnYsW7IDCHgBnpkLzFh72 ceQYAOt2VIkAAauV1d2vg HWC2/1dczT9gT6A2ArAgN RvNyi8/TAFBgNVHSMEGDZ BEBTADAQH/MA0GCSqGSIk x6PX+dUip0HG7BBU+Xpfx /dWUsskijpux4M66aeMaw px8h13HIrQy37H	JECgwWQ29u gMCU1pbm51 DONjEwMjIw AdBgNVBAoM YDVQQIDA1N EBBQADgYOA 2CZsvCPLLn gP5041YXUS 4BAAGjUZBR AWgBREnFVQ b3DQEBCwUA <6DGML1mWu	

If external certificates were loaded successfully, that will be indicated at the bottom of the Network configuration page.



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 '* WARNING: Do not use this script to generate production *'
echo '* keys and certificates. This script is for *'
echo '* demonstration purposes only. *'
```