Stride®

MQTT Gateway
USER MANUAL

Manual Number: SGW-MQ1611-USER-M

AUTOMATIONDIRECT.com

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Stride MQTT Gateway User Manual

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Please include the Manual Number and the Manual Issue, both shown below, when communicating with Technical Support regarding this publication.

Manual Number: SGW-MQ1611-USER-M

Issue: 1st Edition

Issue Date: 8/2019

Publication History		
Issue	**Date**	**Description of Changes**
1st Edition	08/2019	Original

Table of Contents

Hardware

In This Chapter...

Introduction

The Purpose of This User's Manual

Thank you for purchasing our Stride® MQTT Gateway for your Industrial Internet of Things (IIoT) data logging. This manual describes our MQTT Gateway, its specifications and included components, and provides you with important information for installation, connectivity and setup.

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*When you see the "notepad" icon in the left-hand margin, the paragraph to its immediate right will be a special note. The word **NOTE:** in boldface will mark the beginning of the text.*

When you see the "exclamation mark" icon in the left-hand margin, the paragraph to its immediate right will be a warning or a caution. This information could prevent injury, loss of property, or even death (in extreme cases). The words WARNING or CAUTION: in boldface will mark the beginning of the text.

Hardware Overview

The Stride MQTT Gateway is an industrial device specifically designed to implement an Industrial Internet of Things (IIoT) data collection system. It allows bidirectional communication between Modbus field equipment and an MQTT broker. It provides a Modbus RTU master interface on RS-485 and Modbus TCP over Ethernet. Variables can be read from Modbus slave devices on change or at fixed time intervals and are sent to the MQTT broker with optional SSL/TLS client certificate authentication.

The Wi-Fi model (Part No. SGW-MQ1611-WF) uses 802.11 a/b/g/n/ac in 2400MHz or 5500MHz bands.

Setup of the device is through a built-in web interface. The MQTT message structure can be configured to better adapt to different MQTT brokers (e.g., Amazon AWS, IBM Watson IoT, Mosquitto, etc.). It is possible to remotely update the firmware through the web interface.

The gateway has a low-profile format, suitable for DIN rail mounting inside industrial electrical cabinets. The full galvanic isolation ensures a good protection against interference present in industrial environments. A dedicated hardware Watchdog manages the automatic reset of the device. Signaling LEDs allow an immediate diagnosis of device operation.

SAFETY NOTICE: The Stride MQTT Gateway allows the user to connect to remote industrial controls equipment. The remote user may operate and monitor the local control system and affect the function and control of the application just as the local operator controls it. Proper Control, Security and Safety Procedures should be considered and implemented when writing data to a remote device or system.

Specifications

Stride MQTT Gateway Models			
Part Number	***Ethernet***	***RS-485***	***WiFi***
SGW-MQ1611	✓	✓	
SGW-MQ1611-WF	✓	✓	✓

RS-485 Specifications	
Connector	Removable screw terminals, 5.08 mm pitch
Baud rate	Up to 115.2 kbps
Parity	Even, odd or none
Stop bit	1 or 2
Number of Serial Devices	32 max.
Switching Time TX/RX (RS-485)	150µs
Termination Resistance	120Ω

Ethernet Specifications	
Connector	RJ-45
Ethernet Port Speed	10/100Mbps auto-detected
Protocol	MQTT, Modbus TCP
Simultaneous Ethernet Connections	8

WiFi Specifications (Model SGW-MQ1611-WF Only)	
WiFi Standards	802.11 a/b/g/n/ac
Frequency Bands	2400MHz / 5500MHz
Antenna	Internal

Network Ports	
Web User Interface	80
Modbus	502 (default, software configurable)
MQTT	Software configurable, determined by MQTT Broker

Electrical Specifications	
Power Supply Connector	Removable screw terminals, 5.08 mm pitch
Input Voltage Range	10–30VDC
Current Consumption	max 300mA @ 24VDC
Isolation	
Ethernet / RS-485	1500VAC, 50Hz, 1 min.
Ethernet / Power Supply	1000VAC, 50Hz, 1 min.
Power Supply / RS-485	1500VAC, 50Hz, 1 min.
Reverse Polarity Protection	Yes

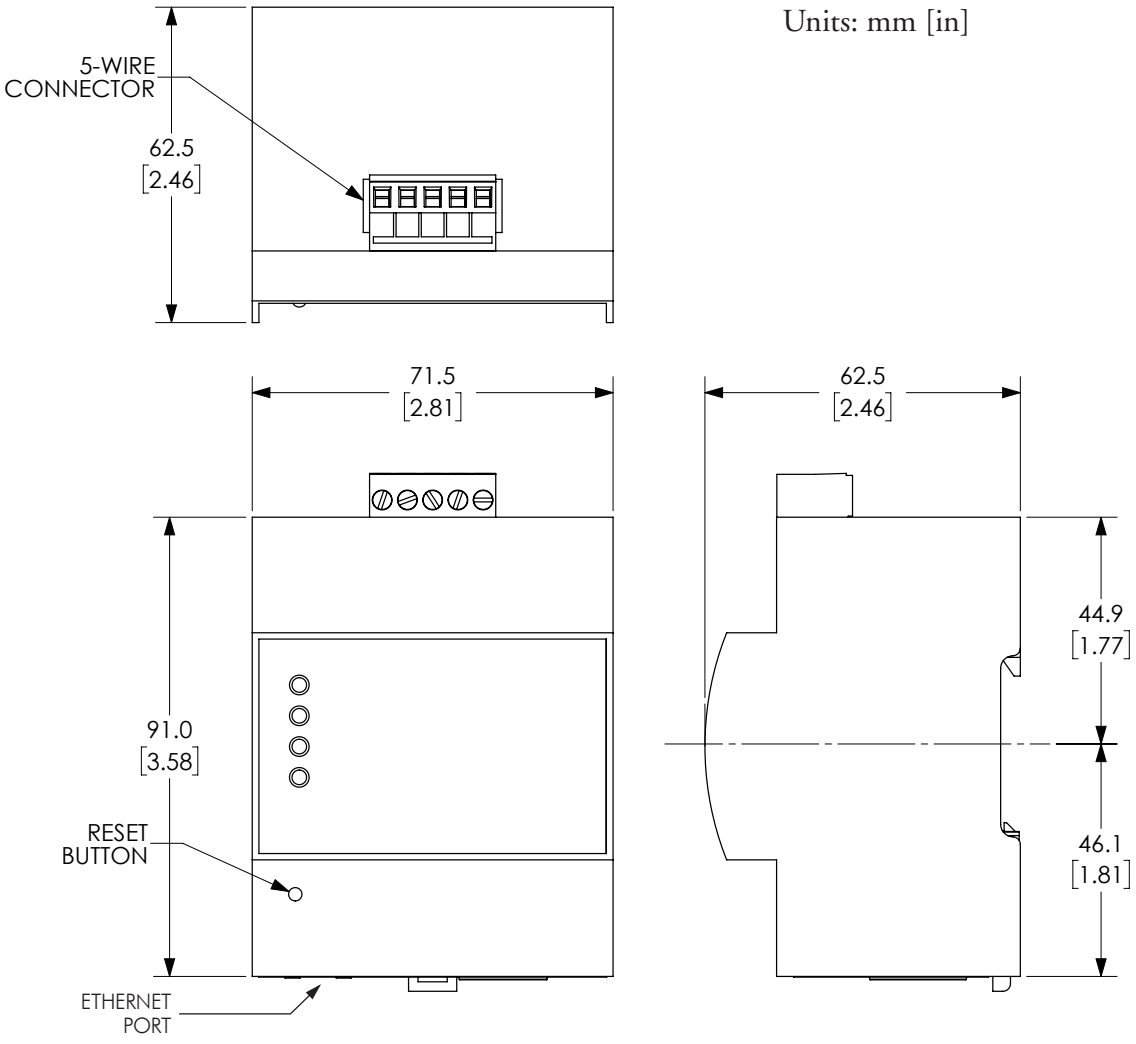
Mechanical Specifications	
Material	Self-extinguishing plastic
Mounting	DIN rail (EN50022 and EN50035)
Weight	Approximately 200g

Environmental Specifications	
Operating Temperature	0°C to +60°C [32°F to +140°F]
Storage Temperature	−20°C to +70°C [−4°F to +158°F]
Humidity	0–90%, noncondensing
Maximum Altitude	2000m
IP Rating	IP20
Installation	Indoor
Category of Installation	II
Pollution Degree	2
EMC Immunity Emission	 EN61000-6-2 EN61000-6-4
Agency Approvals	CE, FCC, RoHS

RoHS Compliant

Dimensional Drawings

Units: mm [in]



Installation

Mounting

The Stride MQTT Gateway may be used indoors only.

It is designed to be mounted in a vertical position on DIN rail and cooled using natural convection. For proper cooling, you must provide clearance of at least 5mm [0.2 inches] between MQTT Gateway modules and at least 10mm [0.4 inches] between MQTT Gateway modules and power supplies or other devices.

Make sure that sufficient air flow is provided for the gateway. Avoid placing raceways or other objects where airflow could be obstructed. Avoid mounting the gateway above equipment that generates heat; ideally locate the gateway in the lower part of the panel.

Install the gateway in a place without vibrations.

To mount the gateway:

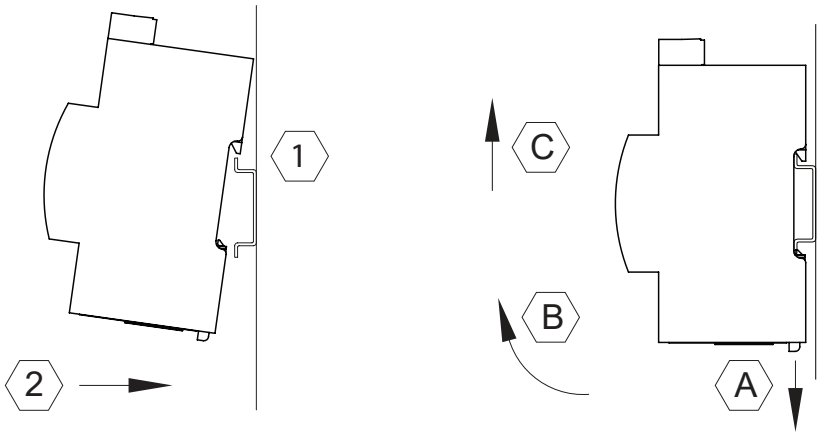
1. Hook the top of the mounting bracket onto the DIN rail.
2. Press the bottom of the gateway inward until it clicks onto the DIN rail.

To remove the gateway:

A. Pull downward on the mounting clip release.

B. Swing the bottom of the gateway outward.

C. Lift the gateway off the DIN rail.



NOTE: *Installation of the SGW-MQ1611-WF model in a metal cabinet is not recommended, as the cabinet may block the Wi-Fi signal.*

Wiring

Wiring Guidelines

WARNING: To minimize the risk of potential safety problems, you should follow all applicable local and national codes that regulate the installation and operation of your equipment. These codes vary from area to area and it is your responsibility to determine which codes should be followed, and to verify that the equipment, installation, and operation are in compliance with the latest revision of these codes.

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Proper grounding and wiring of all electrical equipment is important to help ensure the optimum operation of the Stride MQTT Gateway and to provide additional electrical noise protection for your application.

WARNING: Do not terminate communication leads while the plug-in connector is connected to a powered device.

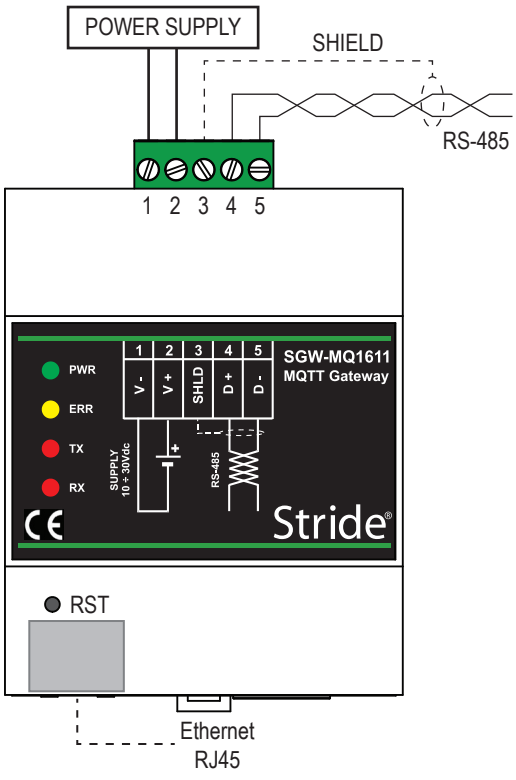
Wiring Connections

The Stride MQTT Gateway comes with a female 5-pin plug-in connector for its power and RS-485 connection.

The gateway can be powered from the same 12 to 24 VDC source that is used to power your other devices. Recommended DC power supplies are AutomationDirect.com part number PSL-12-010 or PSL-24-010.

The device uses a 2-wire RS-485 interface. It has an internal terminating resistor, so this device must be at the end of the communications daisy-chain.

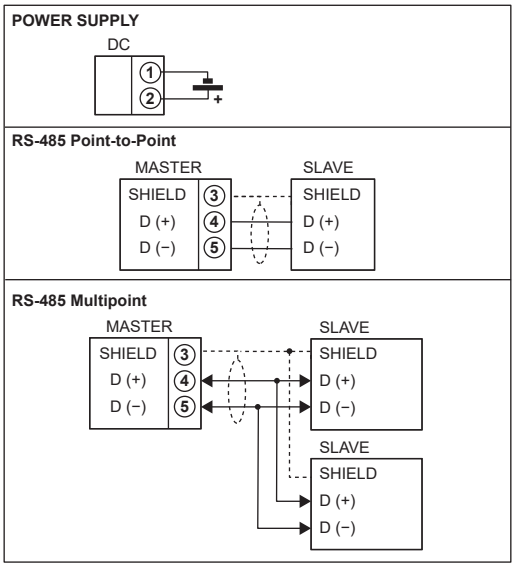
Avoid routing signal cables near power cables (motors, induction ovens, inverters, etc.), and use shielded cable to connect signals. We recommend AutomationDirect Part #L19954-1 or equivalent data cable to connect RS-485 serial devices.



Wiring Connections			
Pin		***Description***	***Notes***
1	V-	Power Supply	10–30VDC, 300mA @ 24VDC
2	V+		
3	SHIELD	RS-485 Shield	
4	D+	RS-485 Data	Connection to one or more Modbus RTU servers
5	D-		
RJ45		Ethernet 10/100Base-T	Connection to MQTT broker and one or more Modbus TCP or Modbus RTU over TCP servers
USB (x2)		Future Use	

Terminal Connector Wiring Specifications	
Wire Size	0.8–2.1 mm^2 14–18 AWG
Torque	0.5 N·m
Stripping Length	5mm maximum

CONNECTIONS

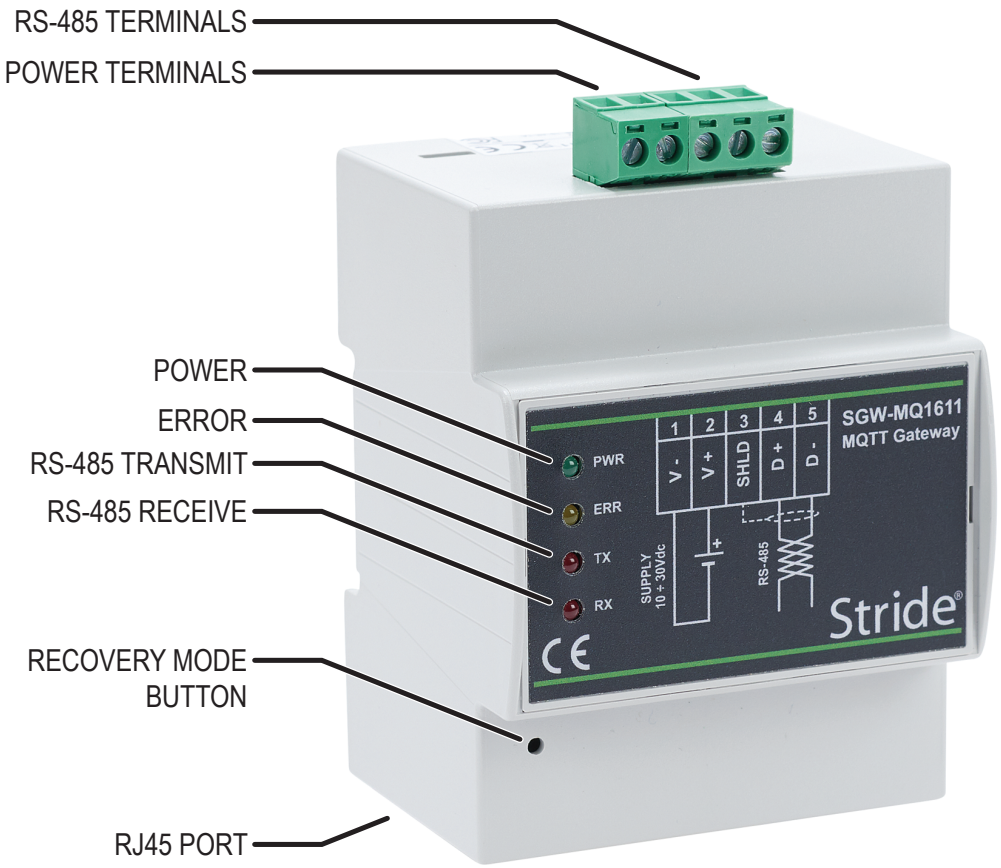


LEDs on the top surface indicate:

* red, active internal power; green, internal memory activity

Operation

Configuration and operation of the STRIDE MQTT Gateway is primarily conducted using the device's web interface, as discussed in Chapter 2. The hardware indicators and controls are described here.



Front Panel Indicators

The Stride MQTT Gateway has four status LEDs, as shown below.

Front Panel LEDs			
LED	***Color***	***State***	***Description***
PWR	GREEN	ON	Device powered
		OFF	Device unpowered
ERR	YELLOW	OFF	No error
		BLINK SLOW-FAST-FAST-FAST	Boot (about 60 sec., few minutes for the first boot)
		BLINK SLOW	Communications error (Modbus, MQTT, etc.)
		BLINK FAST	Watchdog restart
TX	RED	BLINK	Data transmitted over RS-485
		OFF	No data over RS-485
RX	RED	BLINK	Data received over RS-485
		OFF	No data over RS-485

NOTE: *LEDs on the top surface indicate: RED = active internal power; GREEN = internal memory activity.*

Recovery Mode

The device can be booted into a Recovery Mode to reset portions of the configuration to default or to perform system maintenance and firmware updates.

To enter Recovery Mode, press and hold the recessed reset button on the front of the gateway while applying power. Continue to hold the reset button until the ERR light stops blinking (about 5 seconds after applying power). The gateway will start in Recovery Mode, using the default Ethernet configuration:

- IP address = 192.168.1.100

Details of the features available in recovery mode are discussed in Chapter 2.

Setup and Operation

In This Chapter...

Getting Started

Before you begin setting up the MQTT gateway, please make sure the following conditions are met:

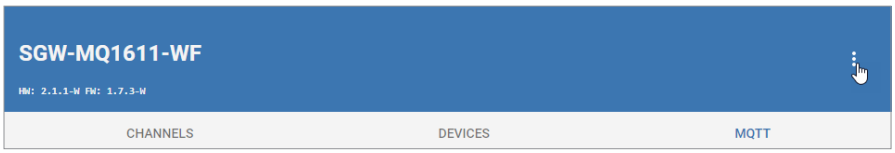
1. The hardware is installed as described in the Mounting and Wiring sections of Chapter 1.
2. You have the necessary connection information on hand to connect to your MQTT broker.
3. You have a device on hand with a web browser and the ability to connect to the MQTT gateway via its RJ-45 Ethernet port, either over a LAN or directly with a crossover cable.

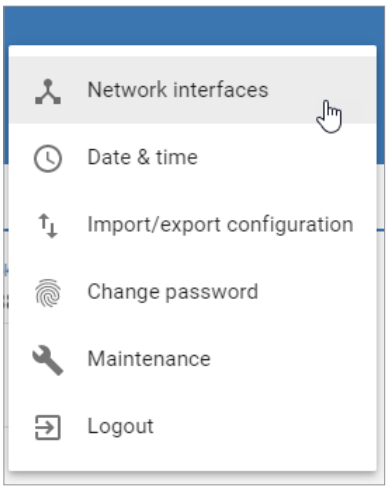
The device is configured through its web interface. To begin, connect to the device via an Internet browser. The default Ethernet configuration is:

- IP address : 192.168.1.100
- Subnet Mask : 255.255.255.0
- Default Gateway: 192.168.1.1
- User Name: admin
- Password: password

Setup Network Connection

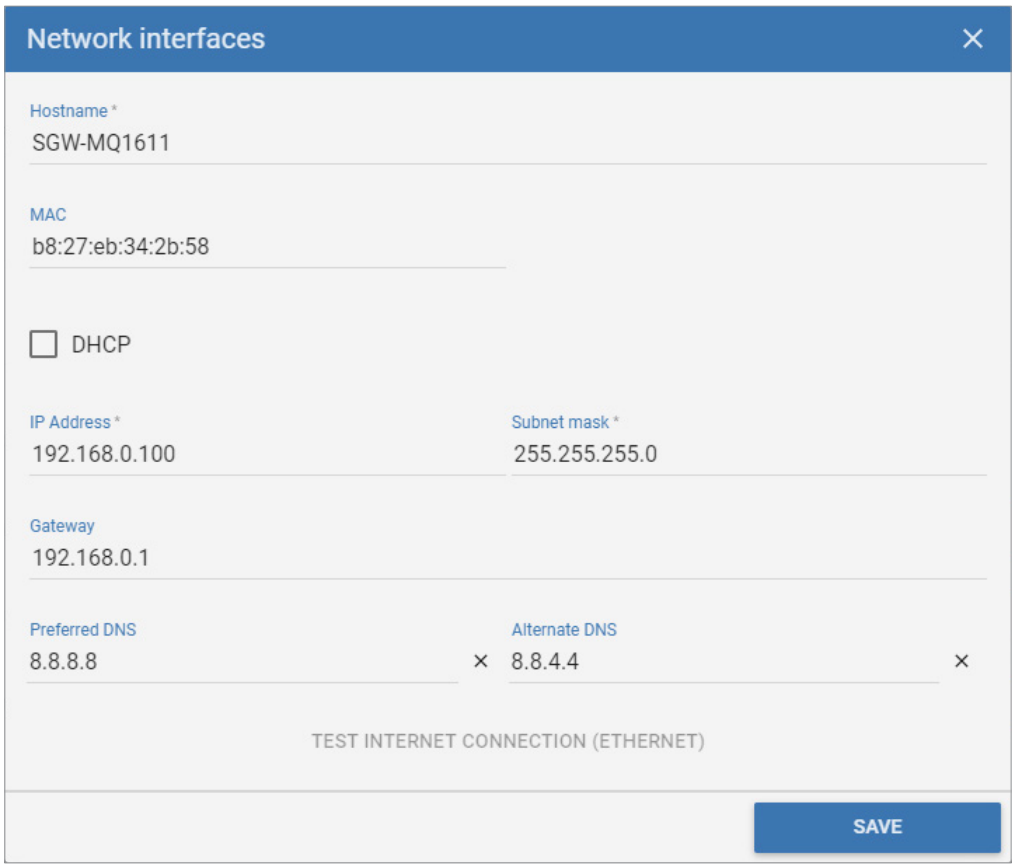
To change the network parameters, select **Network interfaces** from the **More Options** (⋮) menu in the upper right corner of the web UI.





Enter the desired network parameters and click **SAVE**, then **CONFIRM** the changes.

NOTE: *The gateway will always use its permanent default IP address when in recovery mode.*

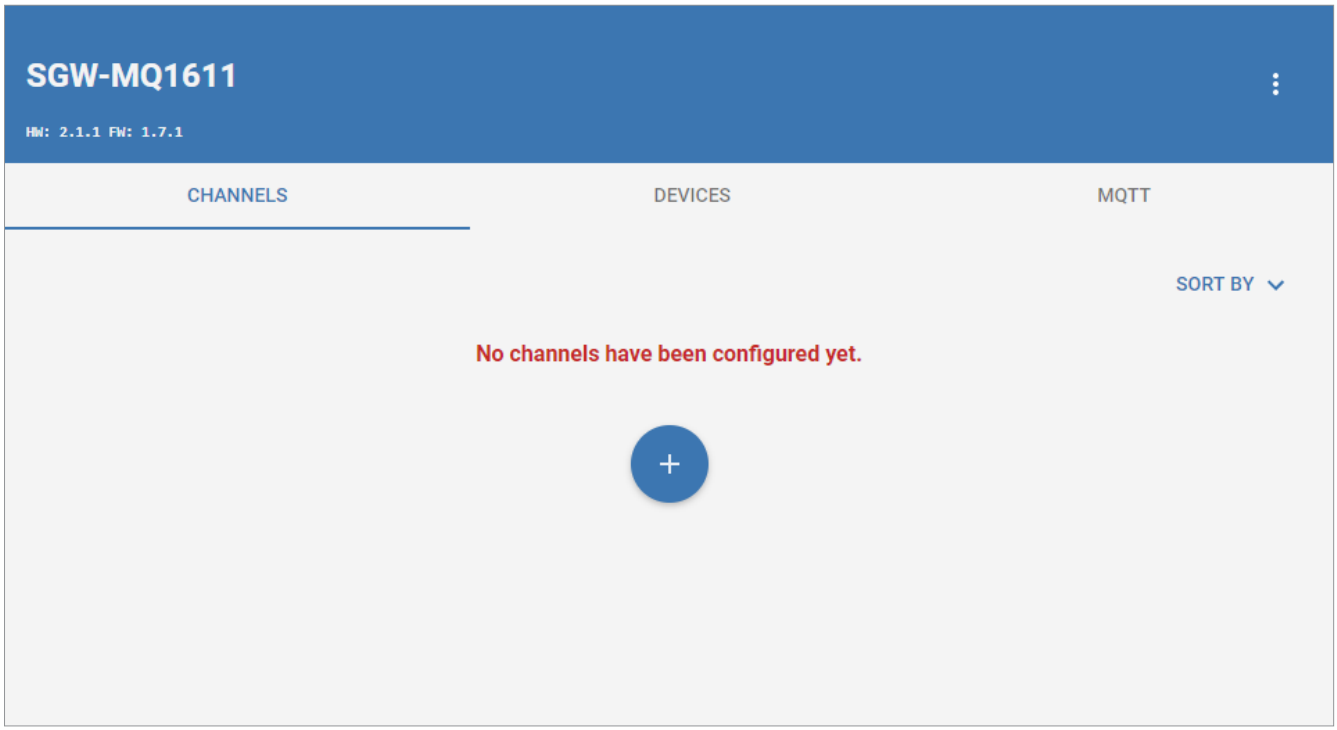


To verify the settings, reopen the **Network interfaces** screen and click **TEST INTERNET CONNECTION**.

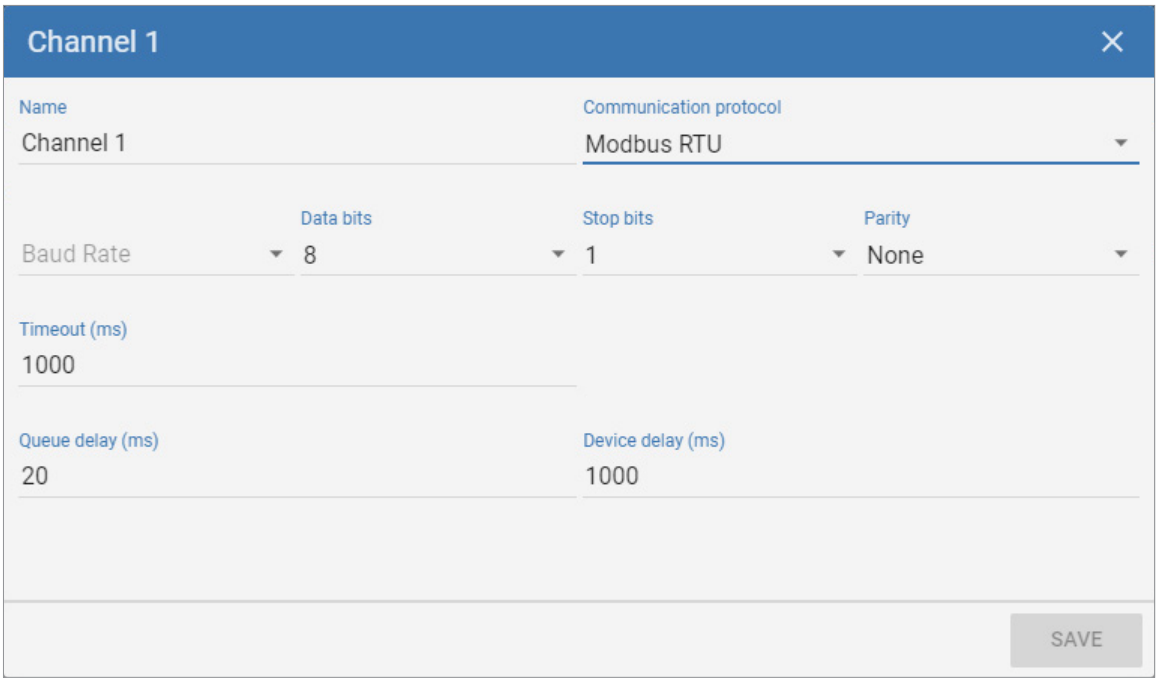
Setup Modbus Communications Channel

The gateway can communicate over both RS-485 and Ethernet. Before setting up a Modbus device in the gateway, you must configure the RS-485 or Ethernet communications channel.

Click on the **CHANNEL** tab to define the Modbus communications parameters.



Click the "+" icon to add a new channel, or click on an existing channel to edit it.



- Enter a **Name** for the channel
- Select the **Communications protocol**. You can create one Modbus RTU channel, and one or more Modbus TCP or Modbus RTU over TCP channels.
- For Modbus RTU, enter the **Baud Rate**, **Data bits**, **Stop bits**, and **Parity**.
- For Modbus TCP or RTU over TCP, enter the **IP address** and **TCP Port** of the Modbus device.
- Enter the **Timeout** value (the maximum time in ms within which a valid response must be received from the Modbus device).
- Enter the **Queue delay** (the time in ms to wait between two Modbus requests)
- Enter the **Device delay** (the time in ms to wait between querying two Modbus devices)

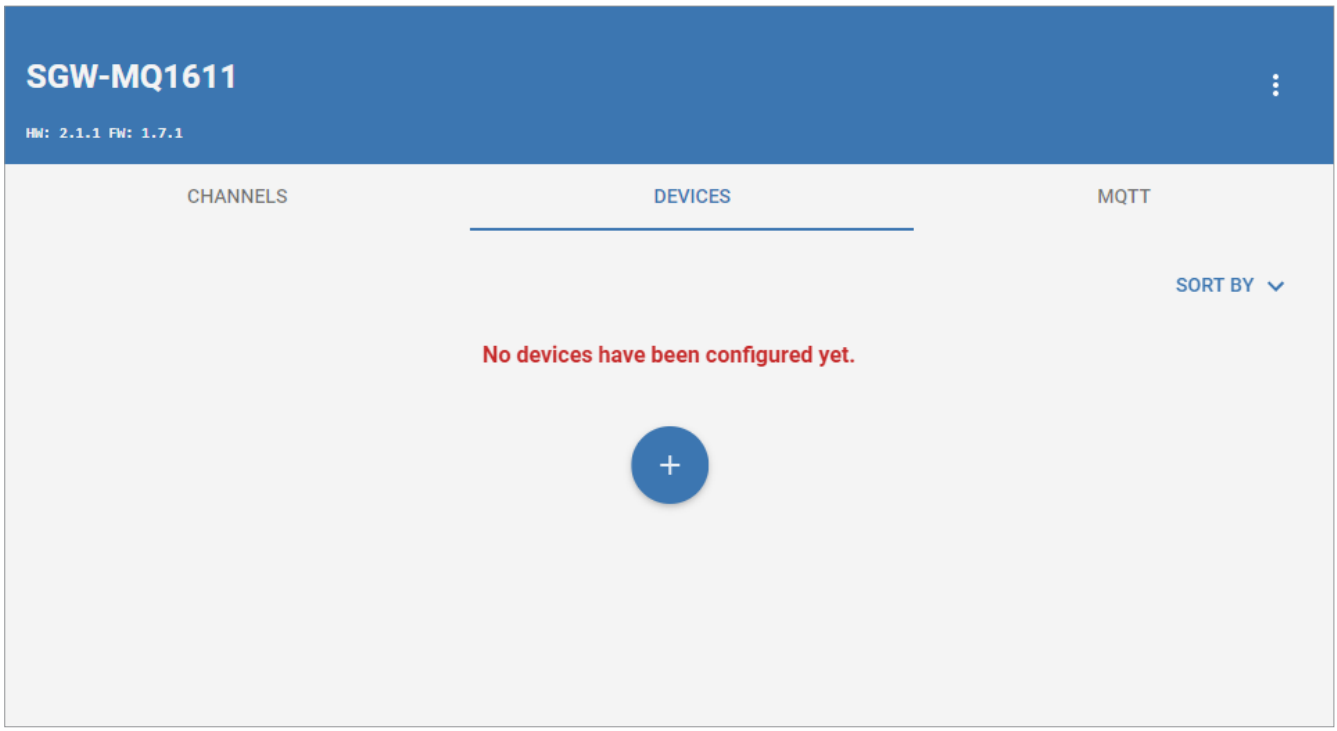
Click **SAVE** when finished configuring the channel.

Setup Modbus Devices

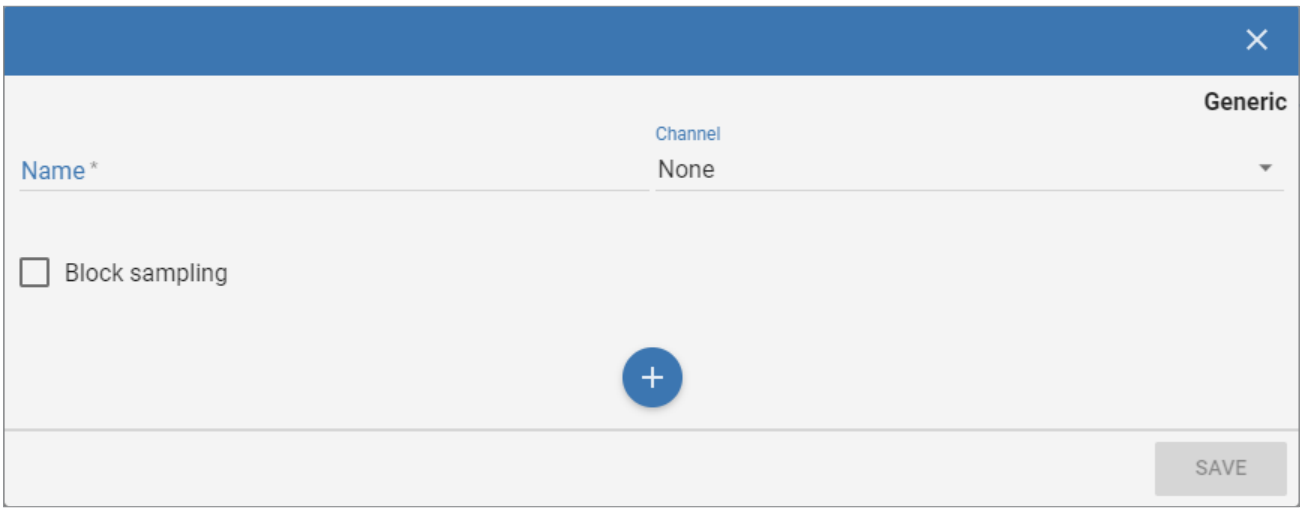
The gateway can communicate with up to 32 Modbus RTU Slaves via RS-485 and up to eight Modbus TCP Servers or Modbus RTU over TCP Servers via Ethernet. After the communications channels are defined, you can configure the connection and variables for each Modbus device.

Configure Modbus Device

Click on the **DEVICES** tab to define the Modbus devices to be queried.



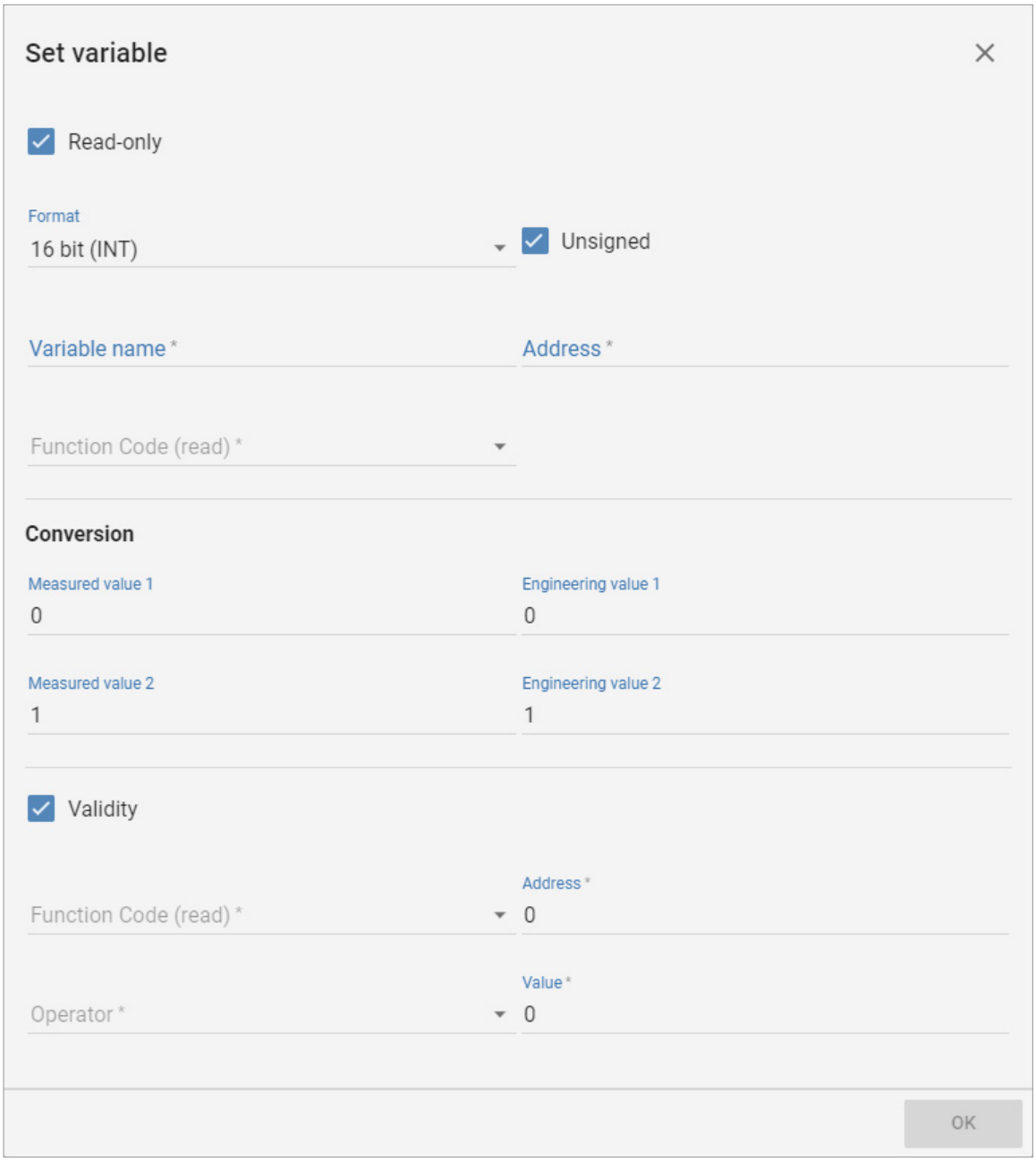
Click the "+" icon to add a new device, or click on an existing device to edit it.



- Enter a **Name** for the device.
- Select an existing **Channel** for the device.
- Enter the device **Address (Unit ID)**.
- Check **Block sampling** to combine contiguous variables into one query

Configure Modbus Variables

Add each variable to be read from or written to the Modbus device by clicking the "+" icon.



- Uncheck **Read-only** to make the variable writable, if desired.
- Select the **Format** for the variable, and check **Unsigned** if necessary. Available variable formats are:

Modbus Variable Formats

Category	*Format*
Digital	1 bit
Integer	16 bit (INT) signed or unsigned
	32 bit (INT) Big endian signed or unsigned
	32 bit (INT) Little endian signed or unsigned
Floating Point	32 bit (FP) Big endian
	32 bit (FP) Little endian

- Enter a **Variable name**.
- Enter the Modbus **Address** for the variable.
- Select the Modbus **Function Code** to read the variable and to write the variable if not read-only. Valid function codes for each variable type are shown below.

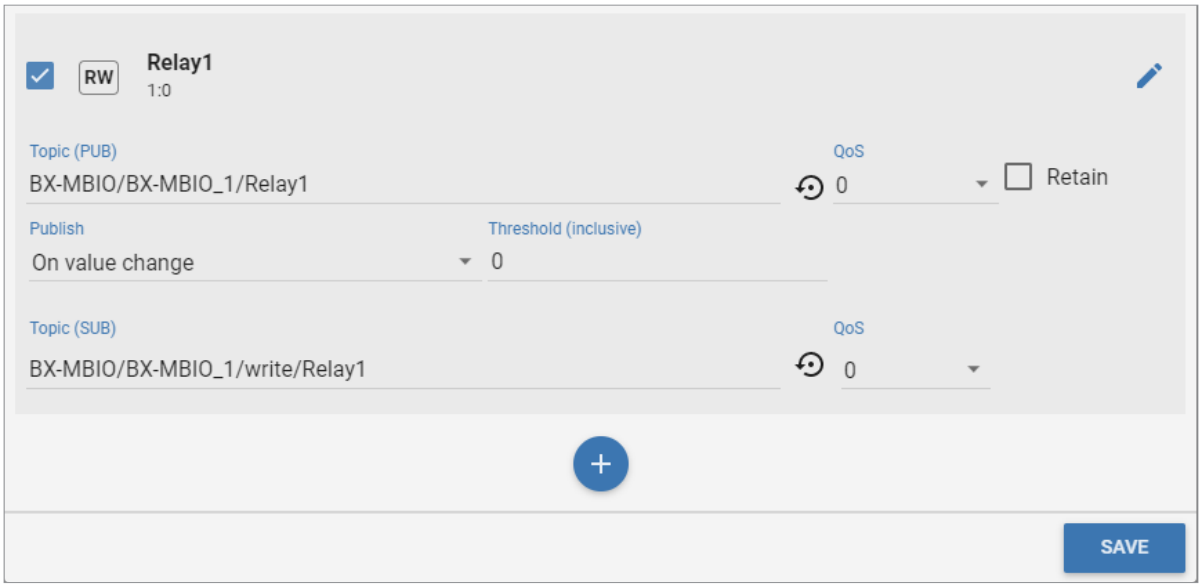
Modbus Read Function Codes		
Variable Type	***Read Function Codes***	***Write Function Codes***
1 bit	01 - Read Coil Status 02 - Read Input Status	05 - Force Single Coil 15 - Force Multiple Coils
16 bit (INT)	03 - Read Holding Registers 04 - Read Input Registers	06 - Preset Single Register 16 - Preset Multiple Registers
32 bit (INT) Big endian		16 - Preset Multiple Registers
32 bit (INT) Little endian		
32 bit (FP) Big endian		
32 bit (FP) Little endian		

- To linearly scale the values, if desired, define two raw measured values, **Measured value 1** and **Measured value 2**, and enter the desired final values for each, respectively, as **Engineering value 1** and **Engineering value 2**.
- If **Validity** is checked, set an additional **Address** to be compared to a preset **Value** to determine current validity of the variable's data.

Configure MQTT Topics

Enable the checkbox by each variable to be sent via MQTT or controlled via MQTT, and enter the MQTT message parameters.

NOTE: *The MQTT Gateway allows arbitrary naming of message topics. Your MQTT broker may require that topic names have a particular structure.*



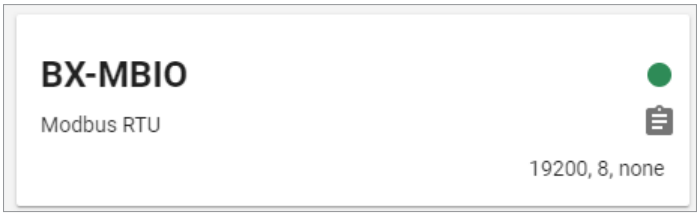
- If the variable read is to be published to your MQTT broker:
  - Enter an MQTT **Topic (PUB)**. The circle arrow icon to the right of the Topic name will reset the name to the default <DEVICE_NAME>/get/<VARIABLE_NAME>, where <DEVICE_NAME> and <VARIABLE_NAME> will automatically populate from the values defined for the device.
  - Select whether the topic should be published **On value change** or **At a fixed frequency**, and enter the **Threshold** amount of change to trigger a publish event or the time interval (**Every (s)**) at which to publish, respectively.
  - Enter the Quality of Service level (**QoS**).

MQTT Quality of Service Levels

QoS	*Description*
0	Does not include confirmation of receipt
1	Guarantees the delivery of the message at least once to a receiver
2	Guarantees the delivery of the message once and only once to a receiver

  - If **Retain** is checked, the MQTT broker will hold the most recently published message in this topic to sent in reply to future client Subscribe requests.
- If the variable is to be written based on a subscribed MQTT topic:
  - Enter an MQTT **Topic (SUB)**. The circle arrow icon to the right of the Topic name will reset the name to the default <DEVICE_NAME>/set/<VARIABLE_NAME>, where <DEVICE_NAME> and <VARIABLE_NAME> will automatically populate from the values defined for the device.
  - Enter the Quality of Service level (**QoS**), as defined for the publish case above.
- Click **SAVE** when finished defining all variables and MQTT topics.

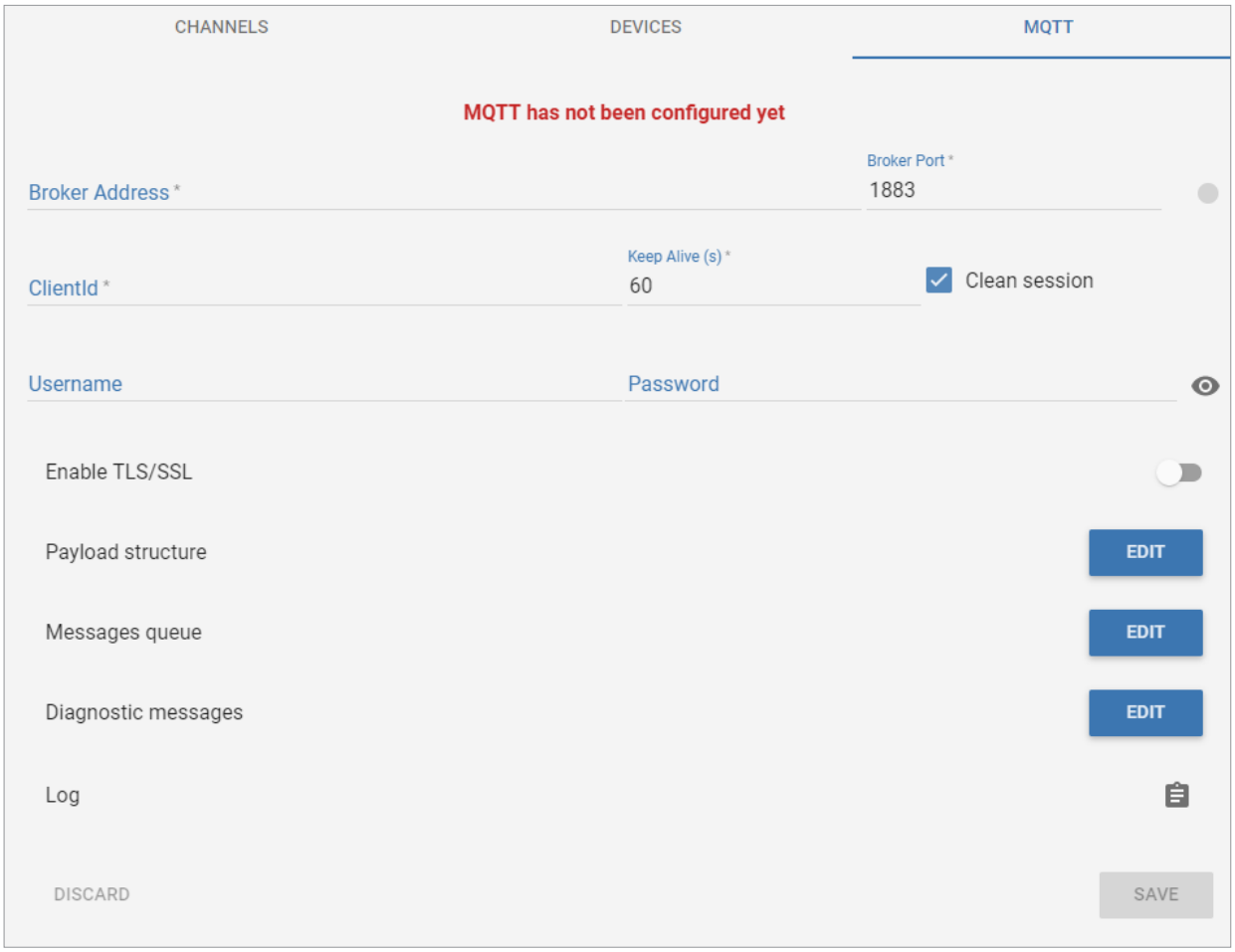
After a device has been added to the channel, the simulated LED to the right of the device on the DEVICES tab and the channel name on the CHANNELS tab will turn green if communication is successful and red while the channel is in an error state. The clipboard icon on each channel will open a real-time log of communications on that channel.



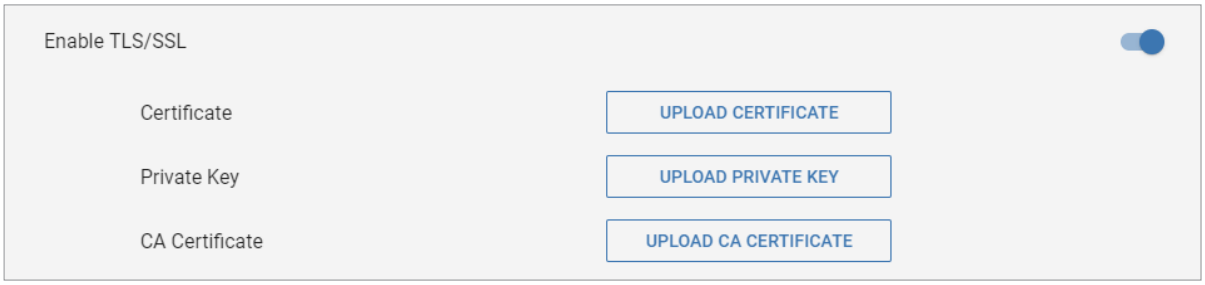
Configure MQTT Broker

Check your MQTT broker for the settings it requires prior to configuring your gateway.

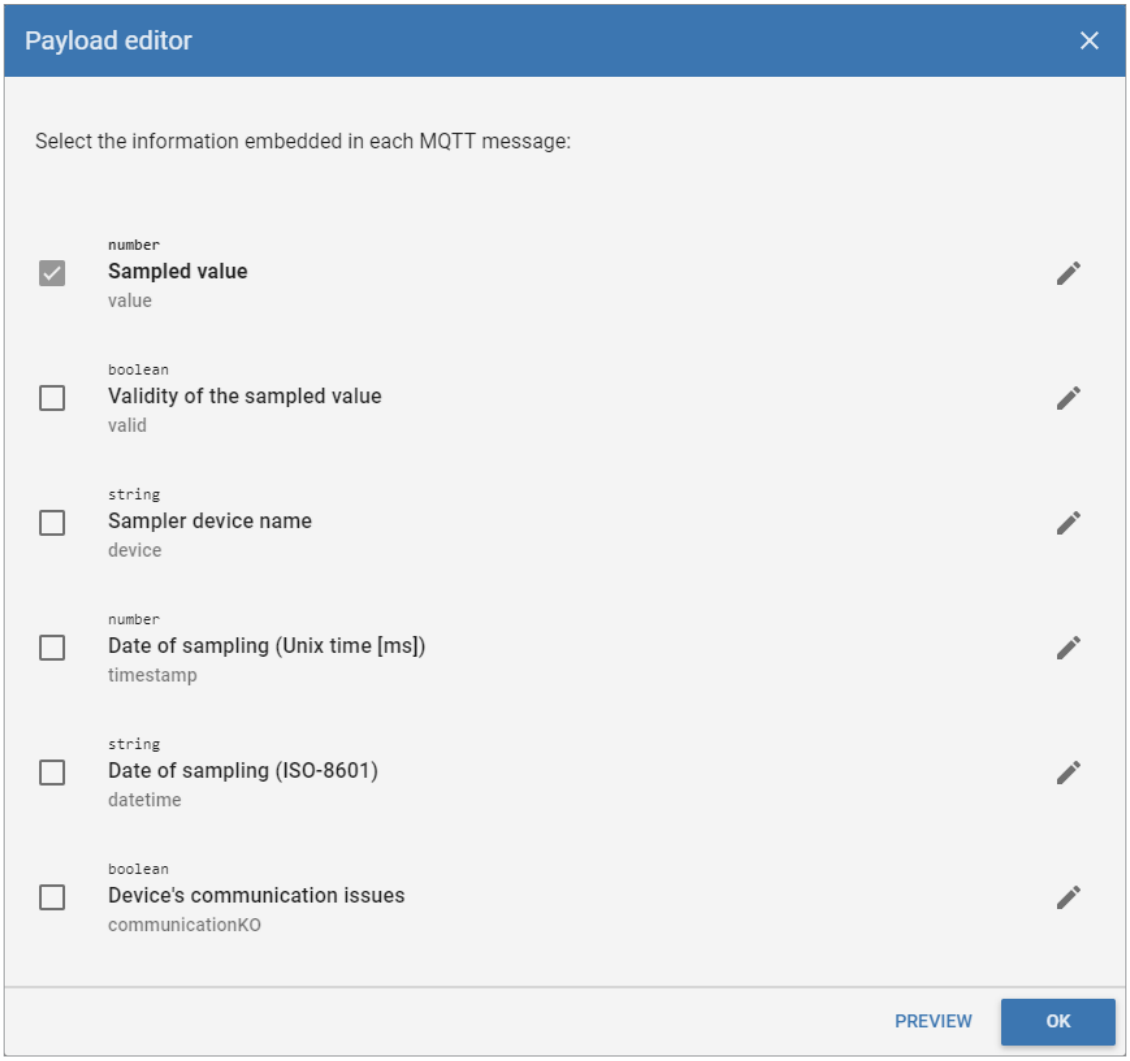
Click on the **MQTT** tab to define the connection to an MQTT broker.



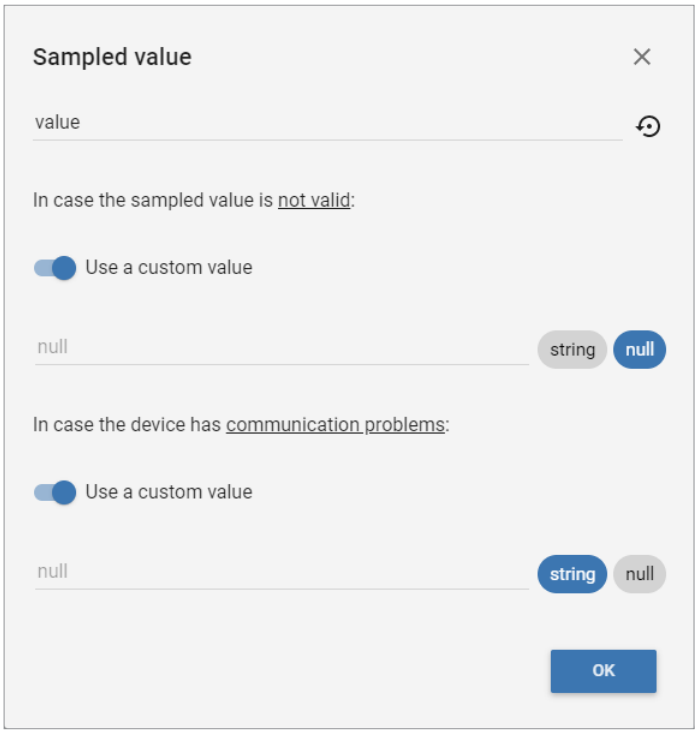
- Set the **Broker Address** and **Broker Port**.
- Set the **ClientId** as required by your MQTT broker.
- Set the **Keep Alive** frequency (in seconds).
- Select **Clean session** if desired, to require renewal of subscriptions to the topics each time the client reconnects to the broker.
- Set the **Username** and **Password** for the broker if necessary.
- Select **EnableTLS/SSL** and upload a certificate, private key, or CA certificate if necessary.

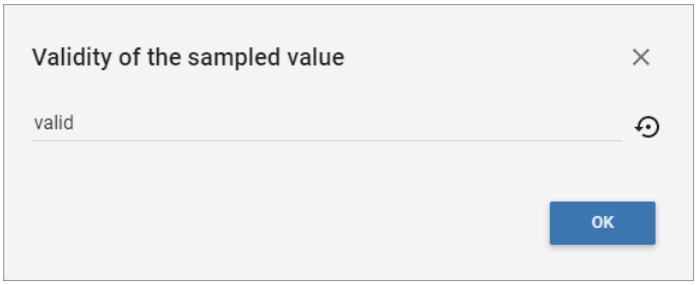


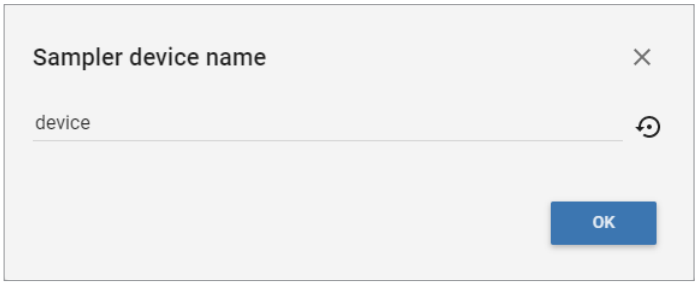
- The **Payload structure** allows you to customize the payload structure and provides a preview of the message for valid and invalid values.



  - Select all the information to be included in the message. Each field can be edited to customize the message payload by clicking the pencil icon to the right of the selection. The information to be returned by each field can be edited. For the Sampled value a custom value to return when invalid or when the device has communications problems can also be specified. For each entry, the circular arrow icon will reset the value to its default.
  - The **PREVIEW** link will show you a sample of the messages for both valid and invalid states.

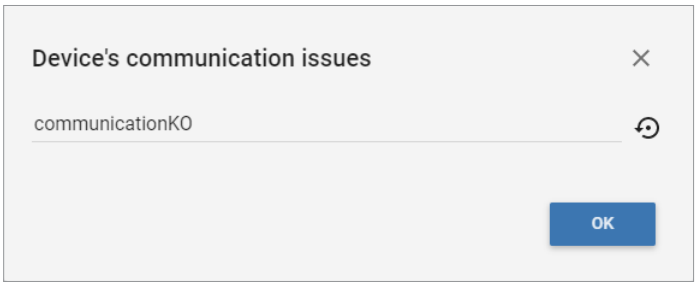

Sampled value
value
In case the sampled value is not valid:
Use a custom value
null
string
null
In case the device has communication problems:
Use a custom value
null
string
null
OK


Validity of the sampled value
valid
OK


Sampler device name
device
OK


Date of sampling (Unix time [ms])
timestamp
OK

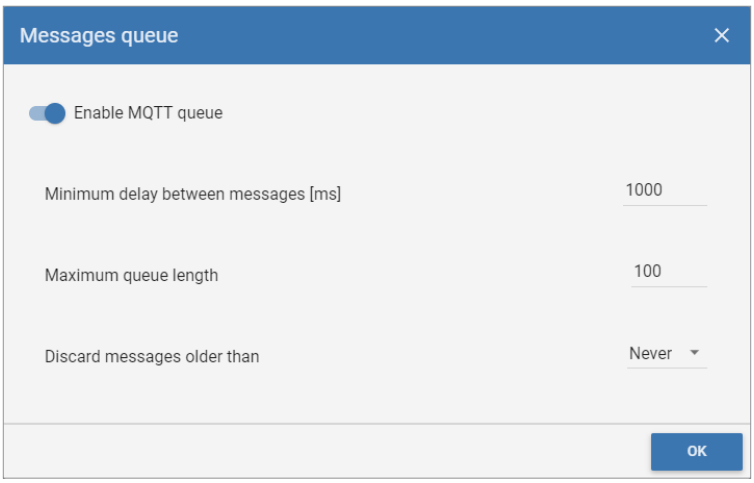

Date of sampling (ISO-8601)
datetime
OK


Device's communication issues
communicationKO
OK

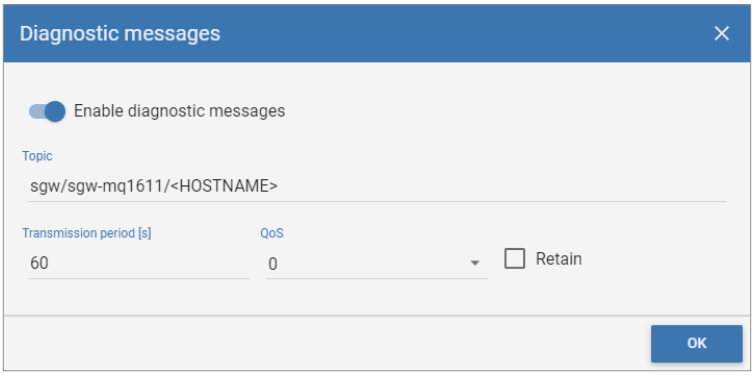
- The **Messages queue** can be enabled to batch transmission of messages. When the queue is disabled, each MQTT message is sent as soon as it is ready to be delivered. Some IoT web services (i.e.: Ubidots) also ignore incoming messages if the incoming frequency is higher than a prescribed number of messages per second.

  Enabling the message queue will store the outgoing MQTT messages into a buffer. This makes it possible to control the outgoing message frequency.

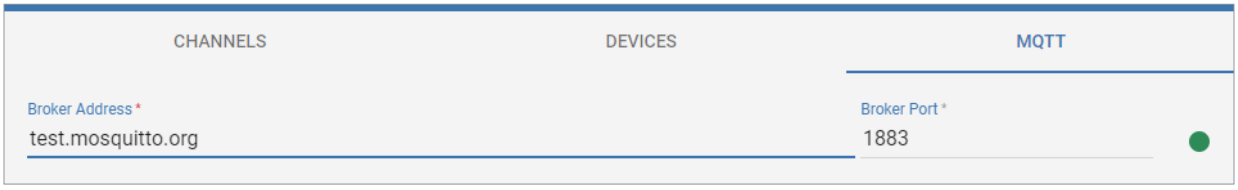
  If the message queue is enabled, the gateway will collect messages in a queue to send as a batch once the minimum delay or maximum queue length has been reached. Unsent messages can be set to expire after a time interval



- **Diagnostic messages** can be enabled to create a topic containing status information on your channels, devices and MQTT connection.

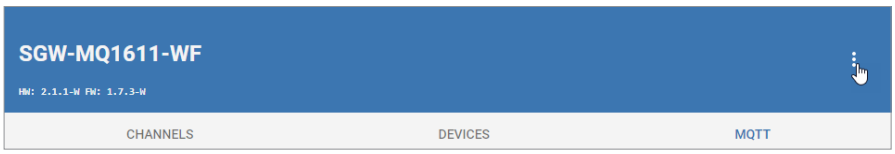


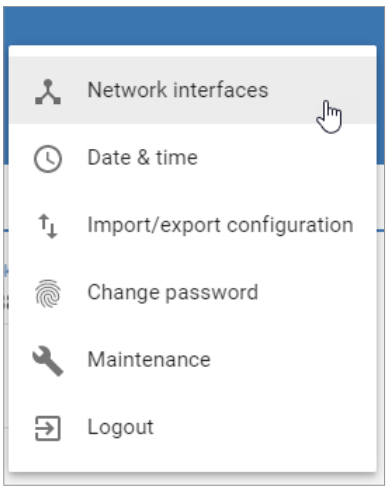
- Click **SAVE** when finished configuring the MQTT connection.
- The simulated LED to the right of the Broker Port will turn green if communication with the broker is successful and red while the connection is in an error state. The clipboard icon will open a real-time log of communications between the gateway and the MQTT broker.



Other Options

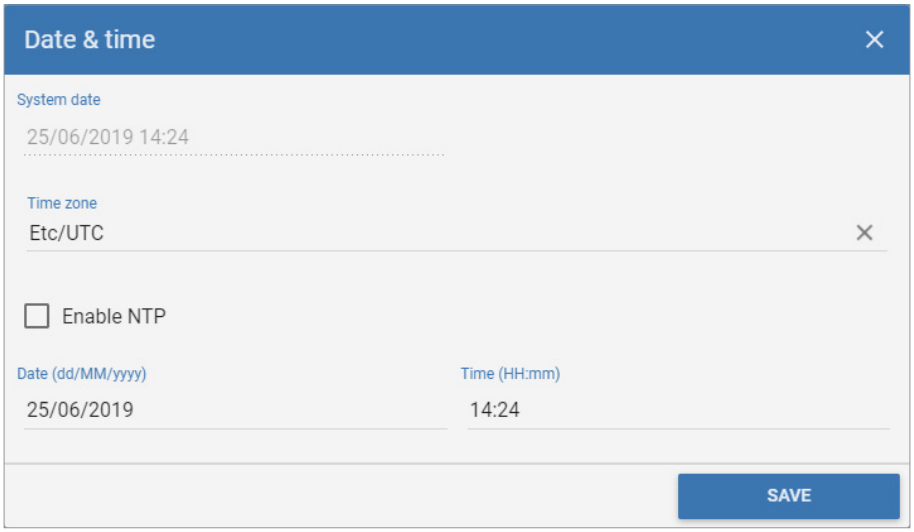
Secondary settings and functions are accessed via the More Options icon in the upper right corner of the web UI. The Network interfaces settings were covered in “Setup Network Connection” on page 2-3. The remaining features under this menu are discussed below.





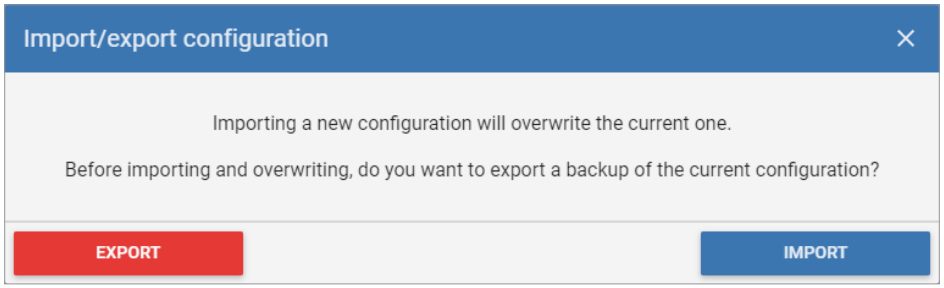
Date & Time

Enter the date and time manually, or click **Enable NTP** and enter the address of an internet time server.



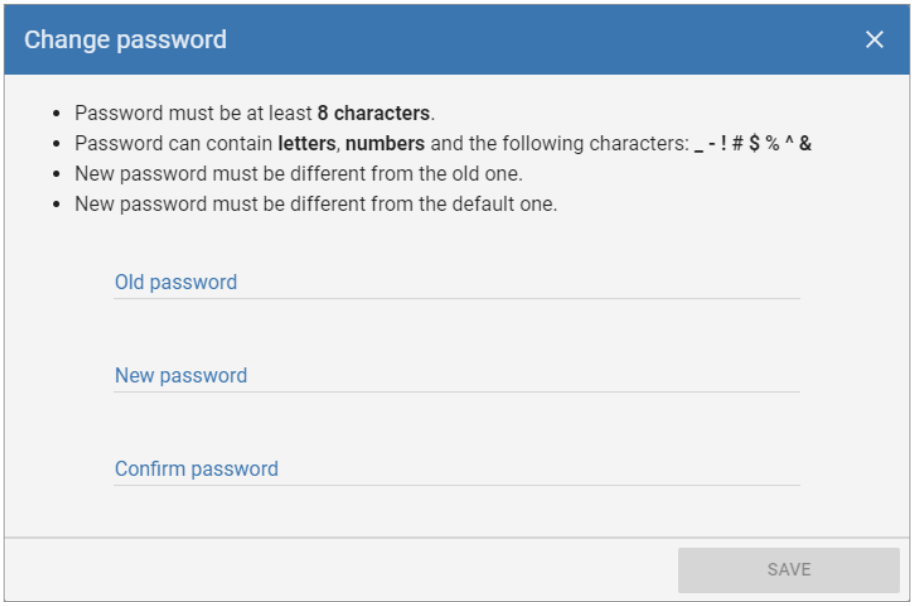
Import/Export Configuration

The full configuration of all channels, devices, and MQTT connection can be exported as a JSON file, and imported to another gateway.



Change Password

The password to log into the gateway web UI can be changed. Note that the user name is not editable.

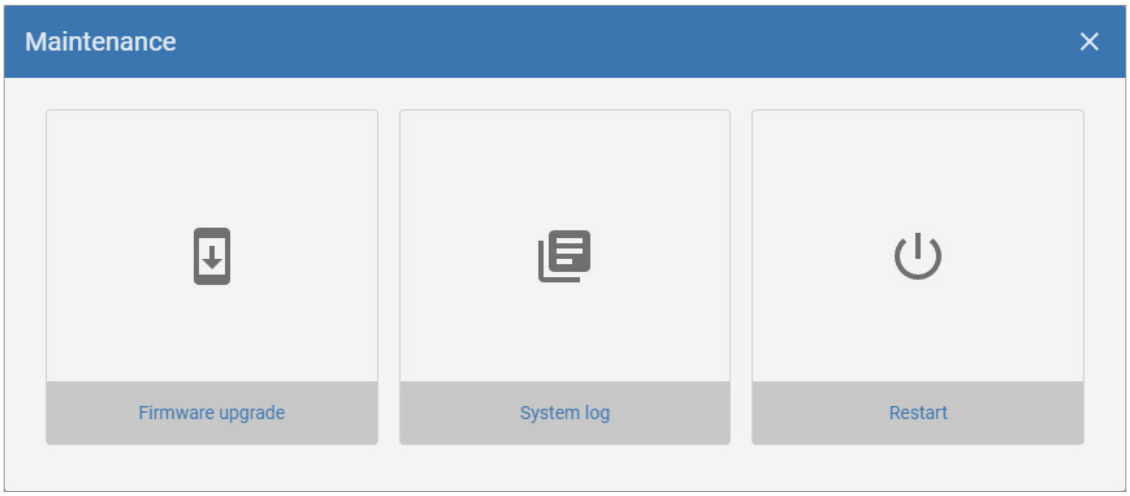


Logout

The connected session to the gateway web UI will time out after several minutes of inactivity. To log out immediately, click **Logout** from the More Options menu.

Maintenance

The Maintenance dialog provides the ability to update firmware, download a system log, or restart the device.



System Log

Click **System log** to download a log file to your PC. Note that the file is a tar.gz archive and will require an unarchive utility such as WinZip or 7-Zip if you need to open it on a Windows PC.

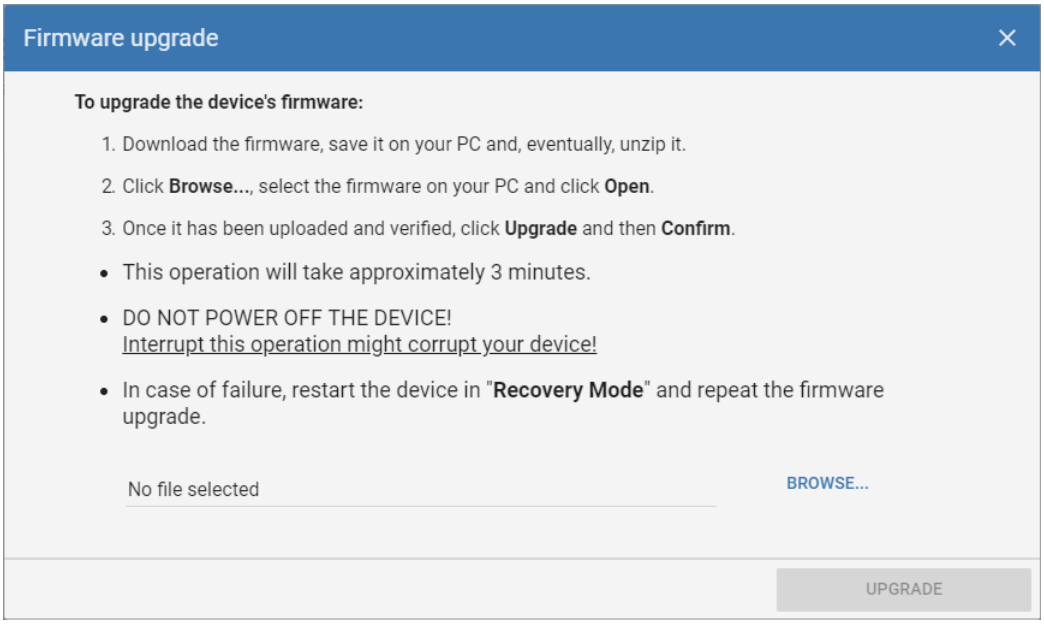
Restart

Click **Restart** then click **Confirm** to reboot the gateway.

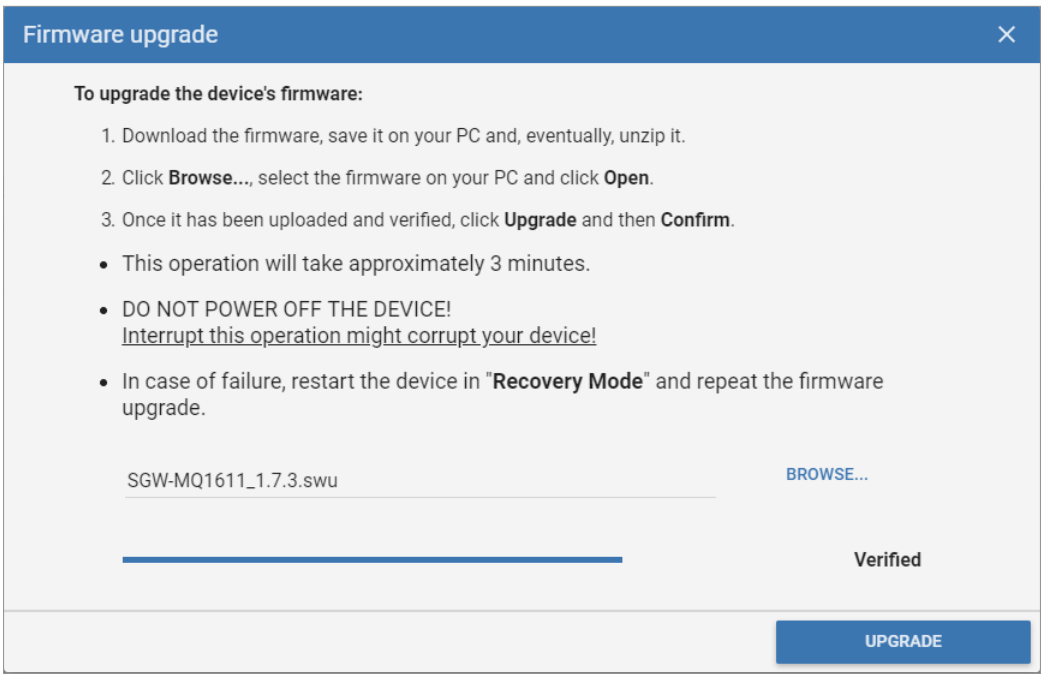
Firmware

New firmware will be announced on our web site at https://support.automationdirect.com/firmware. We strongly recommend you subscribe to AutomationDirect's firmware notification service at https://notify.automationdirect.com/firmware. To update the device firmware, download the firmware file to your PC and unzip it, then select **More Options** > **Maintenance** > **Firmware upgrade** and proceed as follows.

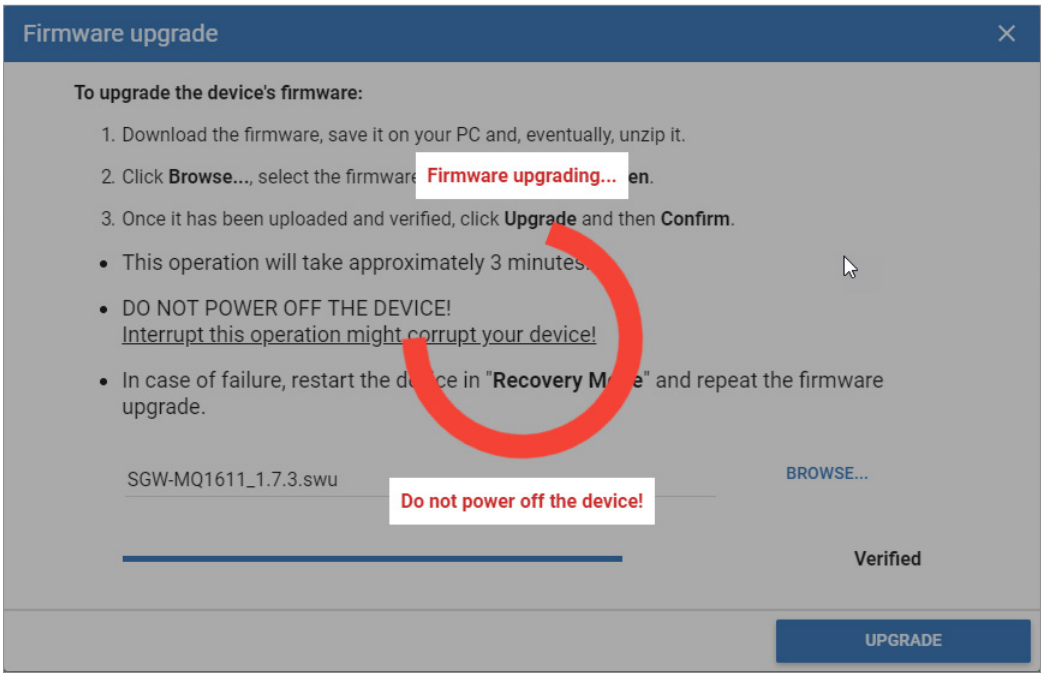
Click **BROWSE**, select your firmware file (.swu extension) and click **Open**.



The file will be uploaded and verified.



Once the file is verified, click **UPGRADE** then click **CONFIRM**.



After the firmware is updated, the gateway will reboot.

If for any reason the firmware update is unsuccessful, restart the gateway in Recovery Mode, as discussed in the next section, and repeat the firmware upgrade.

Recovery Mode

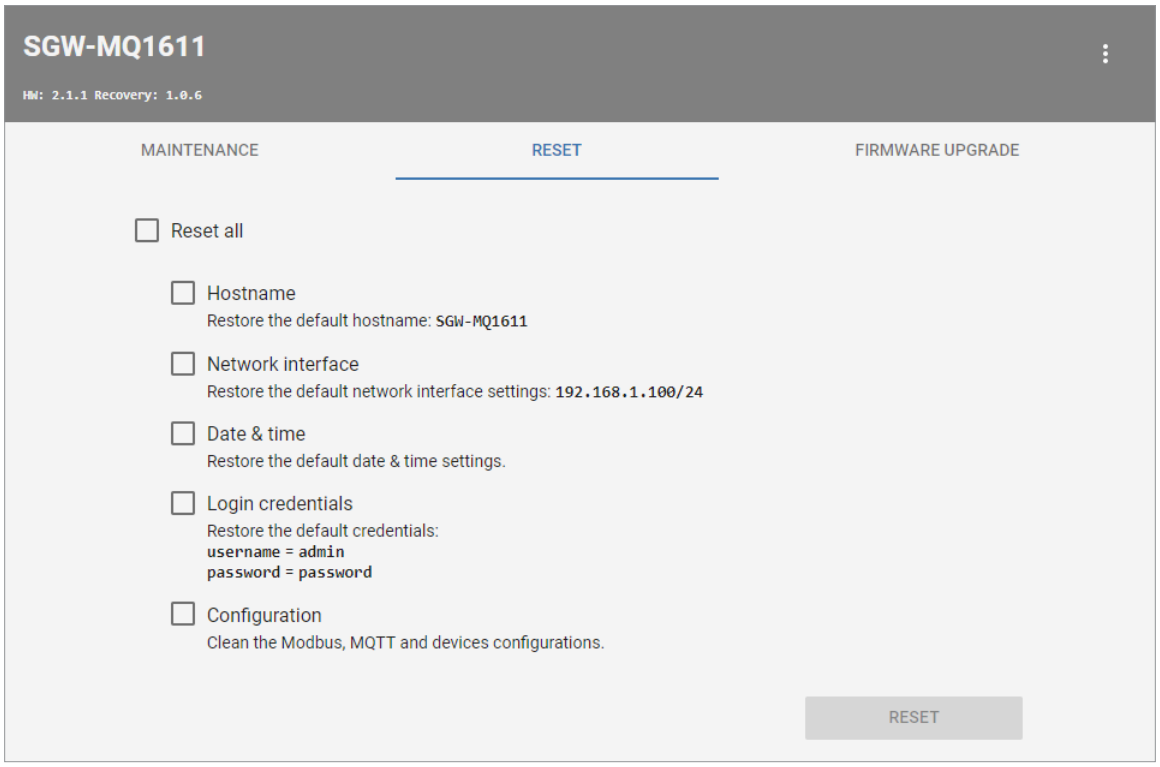
The device can be booted into a Recovery Mode to reset portions of the configuration to default or to perform system maintenance and firmware updates.

To enter Recovery Mode, press and hold the recessed reset button on the front of the gateway while cycling power. Continue to hold the reset button until the ERR light stops blinking (about 5 seconds after applying power). The gateway will start in Recovery Mode, using the default Ethernet configuration:

- IP address = 192.168.1.100

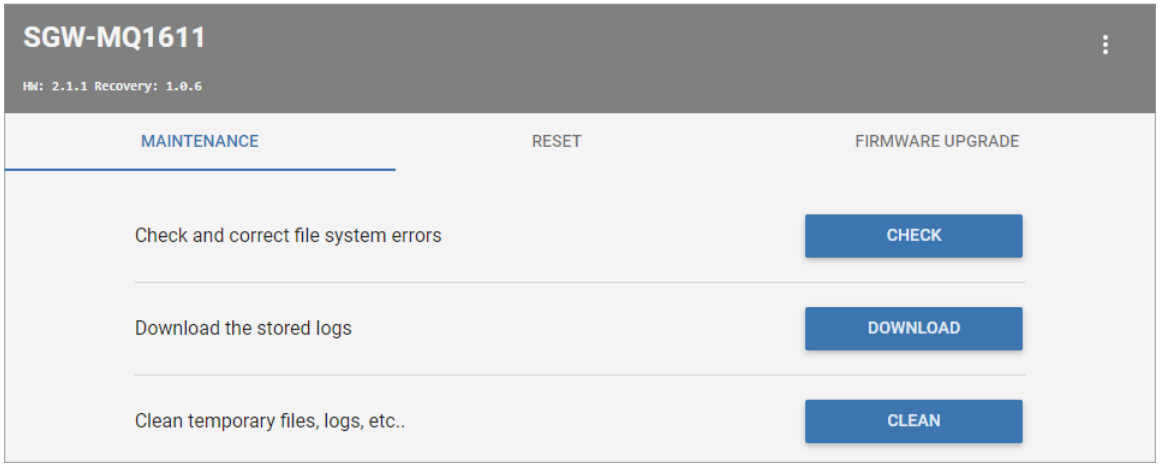
Reset

From the Reset tab, you can selectively reset the Hostname, Network interface, Date & time, Login credentials, or Configuration to their default settings.



Maintenance

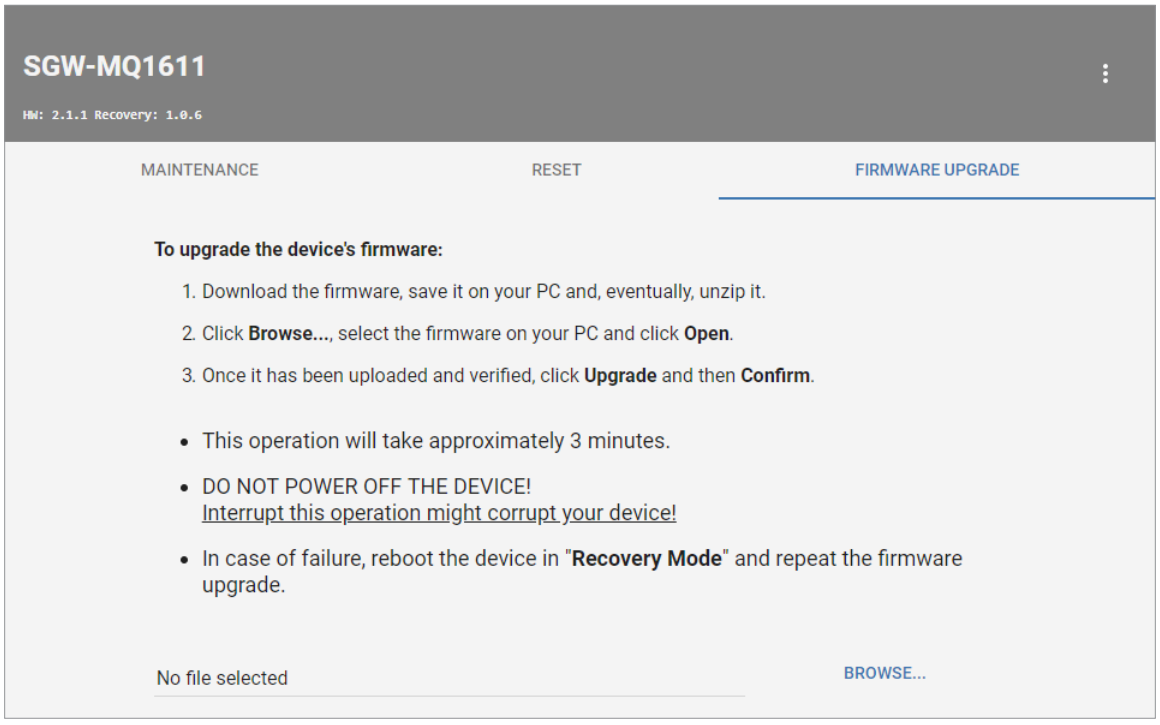
From the Maintenance tab, you can check for file system errors, download stored logs and clean temporary files. Note that downloaded log files are tar.gz archives and will require an unarchive utility such as WinZip or 7-Zip if you need to open them on a Windows PC.



Firmware Upgrade

Upgrading firmware from within the Recovery Mode UI follows the same steps as performing a firmware upgrade in normal operating mode, as described in “Firmware” on page 2-16.

It may occasionally be necessary to upgrade the firmware from Recover Mode if a firmware upgrade was unsuccessful in the normal operating mode.



Reboot and Return to Normal Mode

To reboot the gateway and return to normal mode, click the **More Options** icon in the upper right, then click **Reboot**. Upon reboot the device will use its configured network settings.

Safety and Security Considerations

In This Appendix...

Security Considerations for Control Systems Networks

Manufacturers are realizing that to stay competitive, their Automation and Control Systems need to be more integrated within their plant. The systems often need to be integrated with upstream Enterprise Data Systems, and even further integrated to allow information to be accessible across multiple plants, or even through the Internet. This convergence of the IT world with the Automation World creates challenges in maintaining secure systems and protecting your investments in processes, personnel, data and intellectual property.

While Automation Networks and Systems have built-in password protection schemes, this is only one very small step in securing your systems. Automation Control System Networks need to incorporate data protection and security measures that are at least as robust as a typical business computer system. We recommend that users of PLCs, HMI products and SCADA systems perform your own network security analysis to determine the proper level of security required for you application. However, the National Security Agency has provided direction related to network security and safety under an approach described as "Defense in Depth", which is published at http://www.nsa.gov/ia/_files/support/defenseindepth.pdf.

This comprehensive security strategy involves physical protection methods, as well as process and policy methods. This approach creates multiple layers and levels of security for industrial automation systems. Such safeguards include the location of control system networks behind firewalls, their isolation from business networks, the use of intrusion detection systems, and the use of secure methods for remote access such as Virtual Private Networks (VPNs).

Further, users should minimize network exposure for all control system devices and such control systems and these systems should not directly face the internet. Following these procedures should significantly reduce your risks both from external sources as well as internal sources, and provide a more secure system.

It is the user's responsibility to protect such systems, just as you would protect your computer and business systems. AutomationDirect recommends using one or more of these resources in putting together a secure system:

- US-CERT's Control Systems Security Program at the following web address: www.us-cert.gov/control_systems/
- Special Publication 800-82 of the National Institute of Standards and Technology – Guide to Industrial Control Systems (ICS) Security http://csrc.nist.gov/groups/SMA/fisma/ics/documents/oct23-2009-workshop/nist-ics3_10-23-2009.pdf
- ISA99, Industrial Automation and Control Systems Security http://www.isa.org/MSTemplate.cfm?MicrositeID=988&CommitteeID=6821 (please note this is a summary and these standards have to be purchased from ISA)

This set of resources provides a comprehensive approach to securing a control system network and reducing risk and exposure from security breaches. Given the nature of any system that accesses the internet, it is incumbent upon each user to assess the needs and requirements of their application, and take steps to mitigate the particular security risks inherent in their control system.

Safety Guidelines

NOTE: *Products with CE marks perform their required functions safely and adhere to relevant standards as specified by CE directives provided they are used according to their intended purpose and that the instructions in this manual are adhered to. The protection provided by the equipment may be impaired if this equipment is used in a manner not specified in this manual. A listing of our international affiliates is available on our web site: https://www.AutomationDirect.com.*

WARNING: Providing a safe operating environment for personnel and equipment is your responsibility and should be your primary goal during system planning and installation. Automation systems can fail and may result in situations that can cause serious injury to personnel or damage to equipment. Do not rely on the automation system alone to provide a safe operating environment. You should use external electromechanical devices, such as relays or limit switches, that are independent of the PLC application to provide protection for any part of the system that may cause personal injury or damage. Every automation application is different, so there may be special requirements for your particular application. Make sure you follow all national, state, and local government requirements for the proper installation and use of your equipment.

The best way to provide a safe operating environment is to make personnel and equipment safety part of the planning process. You should examine every aspect of the system to determine which areas are critical to operator or machine safety. If you are not familiar with control system installation practices, or your company does not have established installation guidelines, you should obtain additional information from the following sources.

- NEMA — The National Electrical Manufacturers Association, located in Washington, D.C. publishes many different documents that discuss standards for industrial control systems. You can order these publications directly from NEMA. Some of these include:

  ICS 1, General Standards for Industrial Control and Systems

  ICS 3, Industrial Systems

  ICS 6, Enclosures for Industrial Control Systems

- NEC — The National Electrical Code provides regulations concerning the installation and use of various types of electrical equipment. Copies of the NEC Handbook can often be obtained from your local electrical equipment distributor or your local library.
- Local and State Agencies — many local governments and state governments have additional requirements above and beyond those described in the NEC Handbook. Check with your local Electrical Inspector or Fire Marshall office for information.

Modbus Address Notation – AutomationDirect Devices

In This Appendix...

Stride MQTT Gateway Modbus to AutomationDirect PLC Address Maps

The following tables provide mapping between Stride MQTT Gateway Modbus Addresses and specific AutomationDirect PLC product line addresses.

CLICK PLCs

Reading Coils (Function Code 1)			
Function Code	*MQTT Gateway Modbus Address*	*Data Format*	*CLICK Address*
1	8192	1 bit	Y1
1	8207		Y16
1	8224		Y101
1	8239		Y116
1	8256		Y201
1	8273		Y216
1	8287		Y301
1	8302		Y316
1	8320		Y401
1	8335		Y416
1	8352		Y501
1	8367		Y516
1	8384		Y601
1	8399		Y616
1	8416		Y701
1	8431		Y716
1	8448		Y801
1	8463		Y816
1	16384		C1
1	18383		C2000

Reading Input Registers (Function Code 4)			
Function Code	*MQTT Gateway Modbus Address*	*Data Format*	*CLICK Address*
4	61440	16 bit (INT) or 1 bit	SD0
4	62439		SD1000
4	57344/57345	32 bit (INT)	XD0
4	57360/57361		XD8

Reading Input Bits (Function Code 2)			
Function Code	*MQTT Gateway Modbus Address*	*Data Format*	*CLICK Address*
2	0	1 bit	X1
2	15		X16
2	32		X101
2	47		X116
2	64		X201
2	79		X216
2	96		X301
2	111		X316
2	128		X401
2	143		X416
2	160		X501
2	175		X516
2	192		X601
2	207		X616
2	224		X701
2	239		X716
2	256		X801
2	271		X816
2	45056		T1
2	45555		T500
2	49152		CT1
2	49401		CT250
2	61440		SC1
2	62439		SC1000

Reading Holding Registers (Function Code 3)			
Function Code	*MQTT Gateway Modbus Address*	*Data Format*	*CLICK Address*
3	0	16 bit (INT) or 1 bit	DS1
3	4499		DS4500
3	24576		DH1
3	25075		DH500
3	45056		TD1
3	45555		TD500
3	16384/16385	32 bit (INT)	DD1
3	18382/18383		DD1000
3	49152/49153		CTD1
3	49650/49651		CTD250
3	57856/57857		YD0
3	57872/87873		YD8
3	28672/28673	32 bit (FP)	DF1
3	29670/29671		DF500

DirectLogic PLCs

Reading Coils (Function Code 1)			
Function Code	*MQTT Gateway Modbus Address*	*Data Format*	*DirectLogic Address*
1	0	1 bit	GY0
1	2047		GY3777
1	2048		Y0
1	3071		Y1777
1	3072		C0
1	5119		C3777
1	5120		S0
1	6143		S1777
1	6144		T0
1	6399		T377
1	6400		CT0
1	6655		CT377

Reading Input Bits (Function Code 2)			
Function Code	*MQTT Gateway Modbus Address*	*Data Format*	*DirectLogic Address*
2	0	1 bit	GX0
2	2047		GX3777
2	2048		X0
2	3071		X1777
2	3072		SP0
2	3583		SP777

Reading Input Registers (Function Code 4)			
Function Code	*MQTT Gateway Modbus Address*	*Data Format*	*DirectLogic Address*
4	0	16 bit (INT) or 1 bit	V0
4	17055		V41237
4	0/1	32 bit (INT)	V0/V1
4	1/2		V1/V2
4	17054/17055		V41236/V41237
4	0/1	32 bit (FP)	V0/V1
4	1/2		V1/V2
4	17054/17055		V41236/V41237

Reading Holding Registers (Function Code 3)			
Function Code	*MQTT Gateway Modbus Address*	*Data Format*	*DirectLogic Address*
3	0	16 bit (INT) or 1 bit	V0
3	17055		V41237
3	0/1	32 bit (INT)	V0/V1
3	1/2		V1/V2
3	17054/17055		V41236/V41237
3	0/1	32 bit (FP)	V0/V1
3	1/2		V1/V2
3	17054/17055		V41236/V41237

Do-more PLCs

Reading Coils (Function Code 1)			
Function Code	*MQTT Gateway Modbus Address*	*Data Format*	*Do-more! Address*
1	0	1 bit	MC1
1	1		MC2
1	65534		MC65535

Reading Input Bits (Function Code 2)			
Function Code	*MQTT Gateway Modbus Address*	*Data Format*	*Do-more! Address*
2	0	1 bit	MI1
2	1		MI2
2	65534		MI65535

Reading Input Registers (Function Code 4)			
Function Code	*MQTT Gateway Modbus Address*	*Data Format*	*Do-more! Address**
4	0	16 bit (INT) or 1 bit	MIR1
4	1		MIR2
4	65534		MIR65535
4	0	32 bit (INT)	-
4	1/2		MIR2:D
4	65533/65534		MIR65534:D
4	0	32 bit (FP)	-
4	1		MIR2:RD
4	65533/65534		MIR65534:RD

* *Double integers (32 bit) can only be used on even number addresses in Do-more! (MIR2, MIR4, etc…).*

Reading Holding Registers (Function Code 3)			
Function Code	*MQTT Gateway Modbus Address*	*Data Format*	*Do-more! Address**
3	0	16 bit (INT) or 1 bit	MHR1
3	1		MHR2
3	65534		MHR65535
3	0	32 bit (INT)	-
3	1/2		MHR2:D
3	65533/65534		MHR65534:D
3	0	32 bit (FP)	-
3	1/2		MHR2:RD
3	65533/65534		MHR65534:RD

* *Double integers (32 bit) can only be used on even number addresses in Do-more! (MIR2, MIR4, etc…).*

Productivity Series PLCs

Reading Coils (Function Code 1)			
Function Code	*MQTT Gateway Modbus Address*	*Data Format*	*Productivity Address**
1	0	1 bit	000001
1	1		000002
1	65534		065535

* *Modbus addresses must be assigned to the tags in the "Tag Database" area of the Productivity Suite Programming Software.*

Reading Input Bits (Function Code 2)			
Function Code	*MQTT Gateway Modbus Address*	*Data Format*	*Productivity Address**
2	0	1 bit	100001
2	1		100002
2	65534		165535

* *Modbus addresses must be assigned to the tags in the "Tag Database" area of the Productivity Suite Programming Software.*

Reading Input Registers (Function Code 4)			
Function Code	*MQTT Gateway Modbus Address*	*Data Format*	*Productivity Address**
4	0	16 bit (INT) or 1 bit	300001
4	1		300002
4	65534		365535
4	0	32 bit (INT)	300001/300002
4	1		300002/300003
4	65534		365535/365536
4	0	32 bit (FP)	300001/300002
4	1		300002/300003
4	65534		365535/365536

* *Modbus addresses must be assigned to the tags in the "Tag Database" area of the Productivity Suite Programming Software.*

Reading Holding Registers (Function Code 3)			
Function Code	*MQTT Gateway Modbus Address*	*Data Format*	*Productivity Address**
3	0	16 bit (INT) or 1 bit	400001
3	1		400002
3	65534		465535
3	0	32 bit (INT)	400001/400002
3	1		400002/400003
3	65534		465535/465536
3	0	32 bit (FP)	400001/400002
3	1		400002/400003
3	65534		465535/465536

* *Modbus addresses must be assigned to the tags in the "Tag Database" area of the Productivity Suite Programming Software*

MQTT Broker Examples

In This Appendix...

Introduction

The Stride MQTT Gateway can integrate your Modbus data into an IIoT system using any MQTT broker. It is compatible with popular public IIoT platforms such as Amazon AWS, IBM Watson IoT, ThingsBoard and others. You can also set up you own MQTT broker using Mosquitto or other MQTT software.

The steps to set up the Stride MQTT Gateway are essentially identical regardless of which MQTT Broker you plan to use, but a given broker may require specific settings for the MQTT connection, topic syntax or message structure. Please check the requirements of your chosen system prior to configuring the gateway.

To demonstrate the MQTT setup, including both the gateway and MQTT broker, we will present two examples; one using a public Mosquitto testing server, and one using ThingsBoard.io.

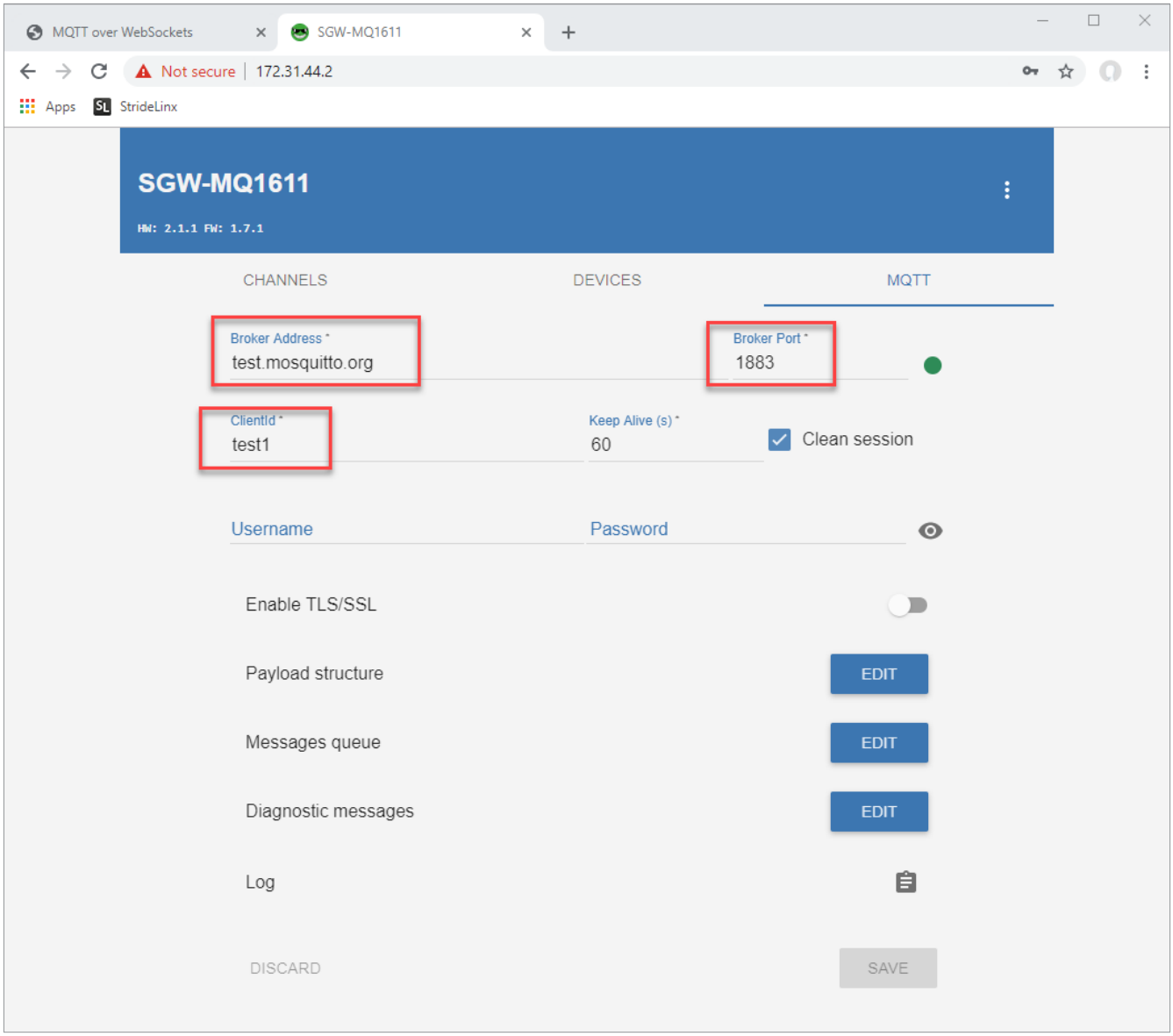
Example using Mosquitto

Mosquitto is primarily an MQTT broker software intended to be installed on your own server. A public test server is available, however, and can provide a quick verification that all parts of the IIoT system are functioning properly.

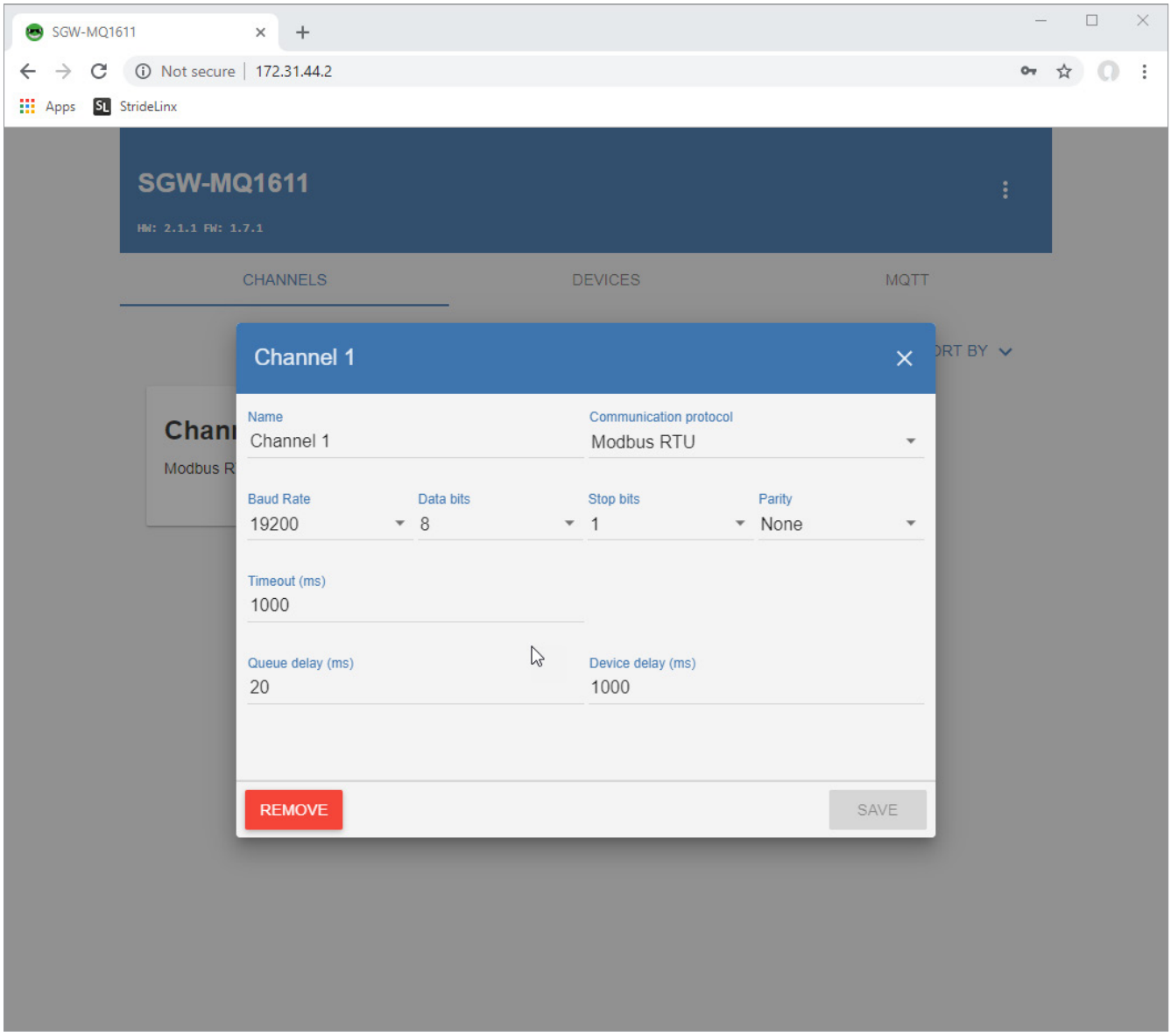
This example is designed to verify the MQTT functionality and the network path. Be sure that a valid Default Gateway is specified (LAN IP address of the router) and accessible DNS addresses are being used to be able to access the Broker Address URL. If in doubt on the DNS addresses, use Google's DNS addresses of 8.8.8.8 and 8.8.4.4.

To test the MQTT connection using "test.mosquitto.org", use the settings as shown below in the "MQTT" section of the setup.

There are a few different port options depending upon if encryption is being used or not, but for the sake of simplicity port 1883 (unencrypted) is being used in this example.

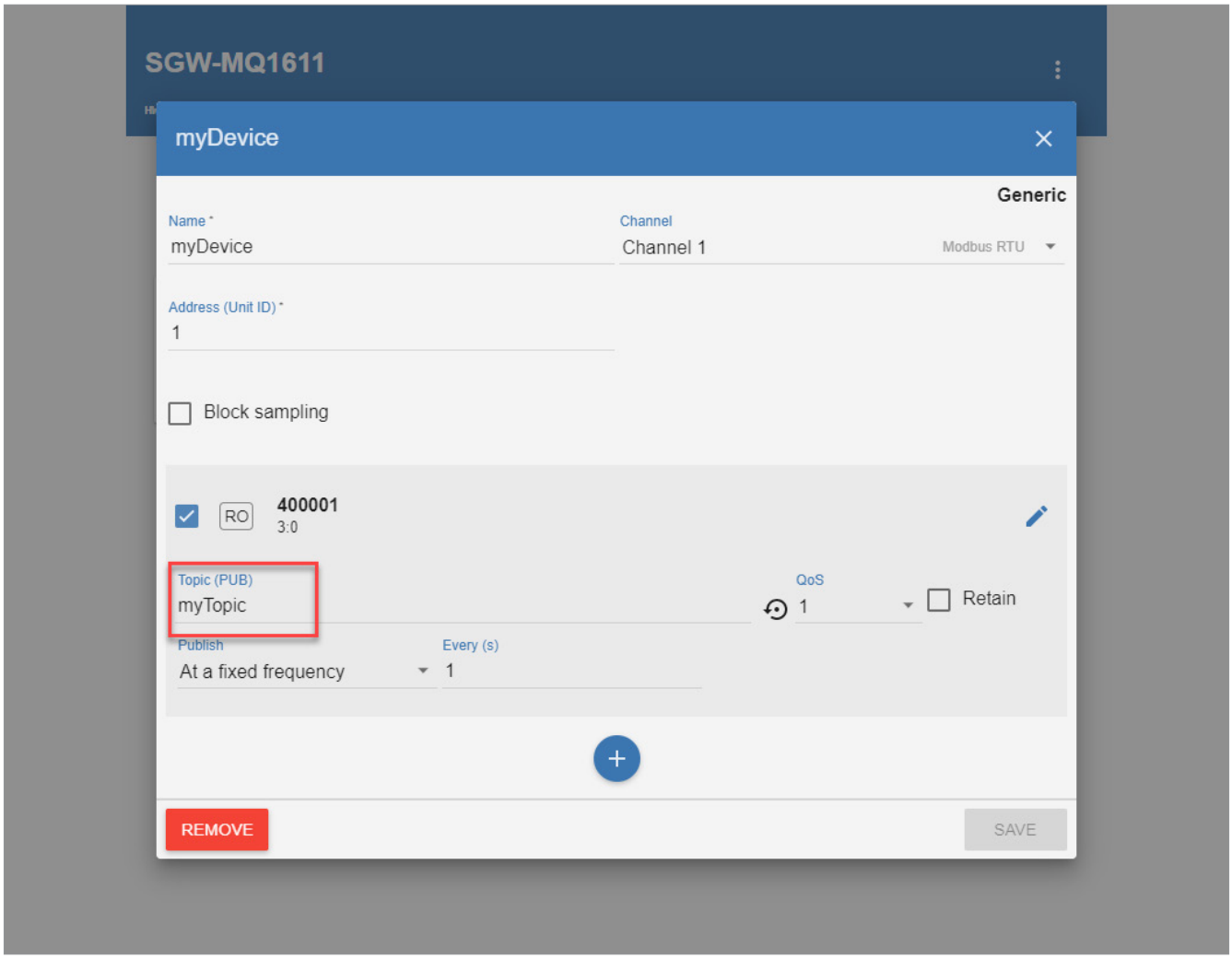


Setup a valid Channel under the “Channels” setup tab. In this case, Modbus RTU is being used back to a PC running Modbus Slave (available at https://www.modbustools.com) with the USB-485M converter.



Create a device in the “Devices” tab to specify a Modbus address and a MQTT topic.

In this example, we are targeting Modbus RTU device 1, requesting Modbus address 400001 (Function Code 3, offset 0) and Publishing that to the “myTopic” Topic at test.mosquitto.org on a 1 second interval.

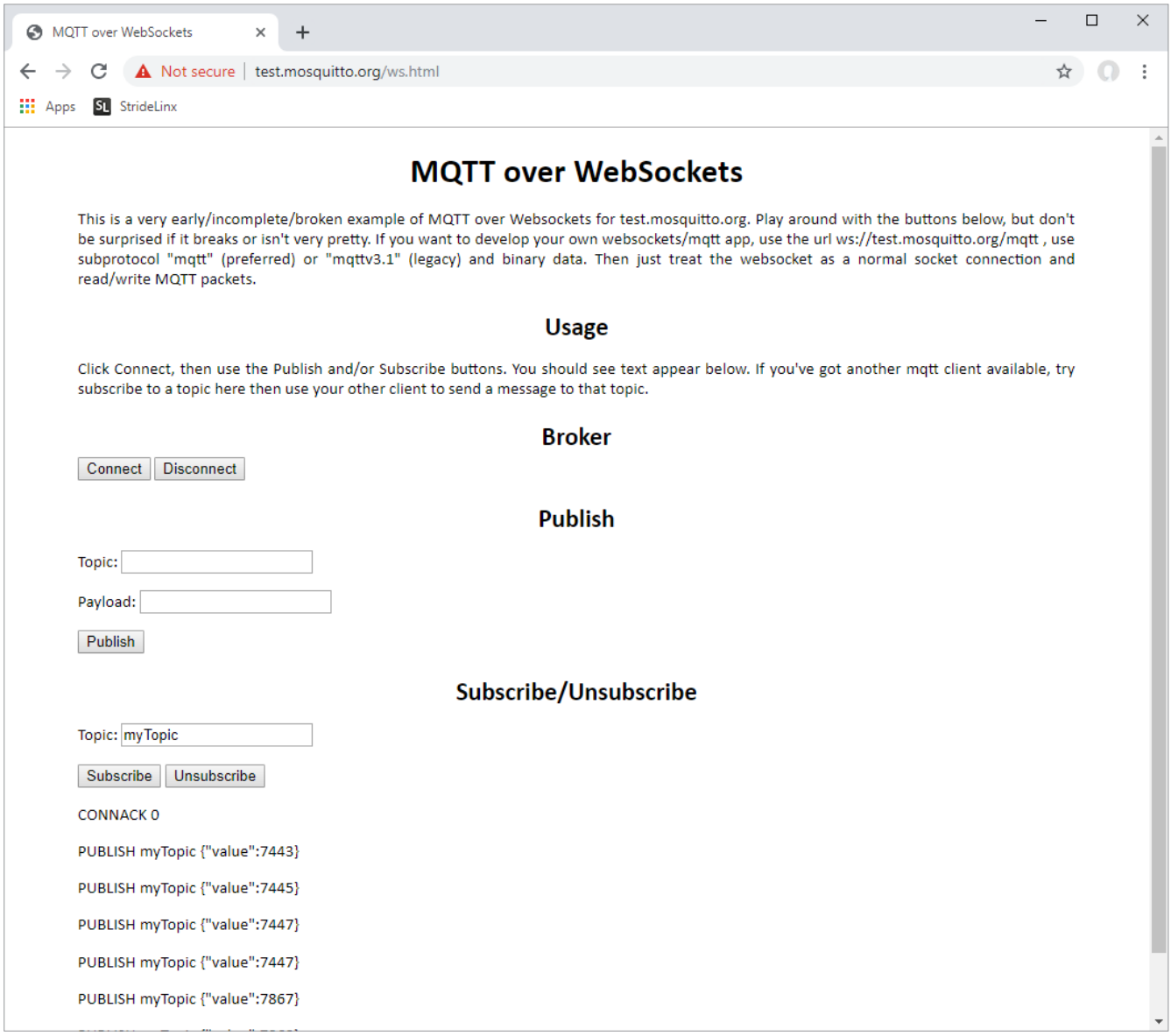


Once this setup has been saved to the gateway, we can go to the "test.mosquitto.org/ws.html" URL to check and see if our gateway is publishing data to the Broker.

At the test.mosquitto.org/ws.html website, click on the "Connect" button and you should see a "CONNACK 0" text at the bottom if the access was successful.

To see the values being published by the gateway, type in the "myTopic" Topic name in the "Subscribe/Unsubscribe" Topic field and click on the "Subscribe" button.

You should see the value in 400001 being published at a 1 second interval at the bottom of the screen.



If the PUBLISH messages are showing up on the screen, the MQTT functionality and network path are correctly configured.

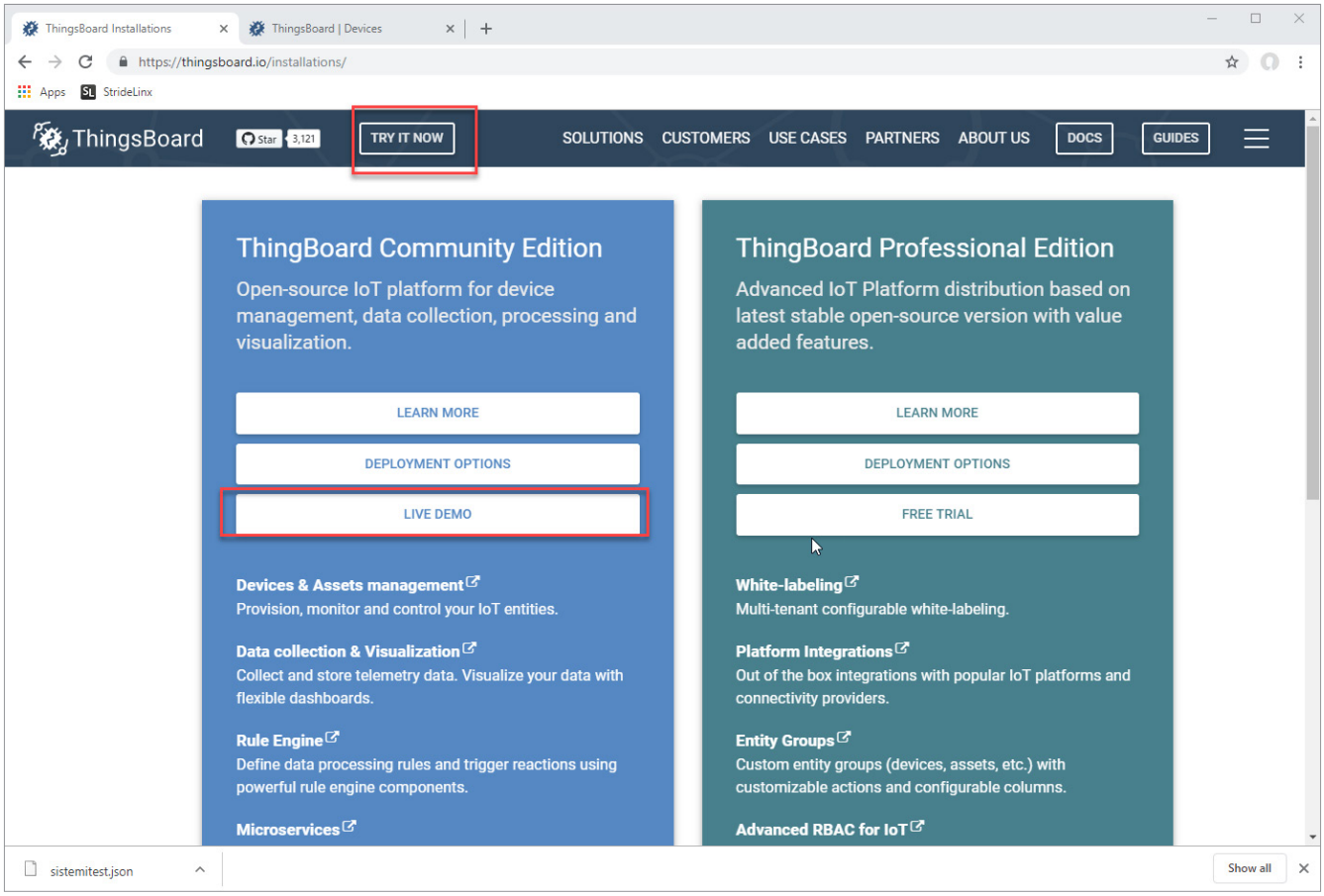
Note that the public test server at test.mosquitto.org may occasionally be down. The most obvious indication of this is the lack a "CONNACK 0" message when you click on the "Connect" button. If this occurs, please wait for the server to become available again later.

Example using ThingsBoard.io

ThingsBoard is an open-source IoT platform that provides device management, data collection, processing and visualization for your IoT solution. They offer multiple tiers of service. We'll use a demo of their Community Edition to demonstrate a full-fledged IoT solution including data visualization.

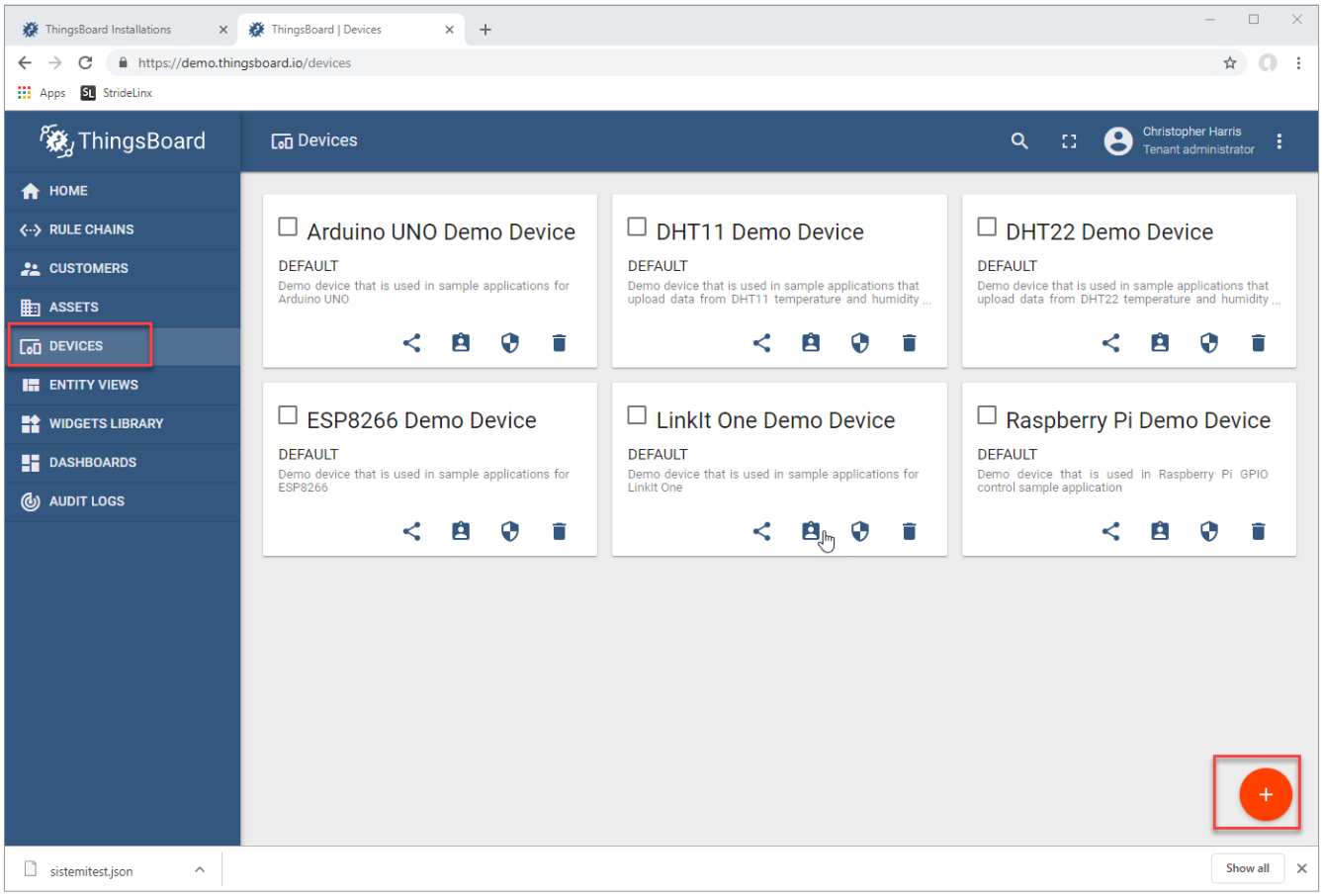
To begin, go to https://thingsboard.io and click on the "TRY IT NOW" button at the top. When presented with the screen shown below, choose the "LIVE DEMO" button.

Setup an account and activate it.

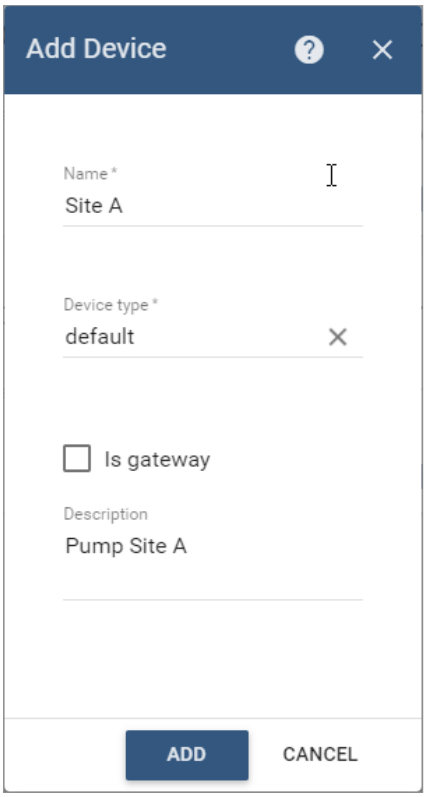


After the account has been created, go to https://demo.thingsboard.io.

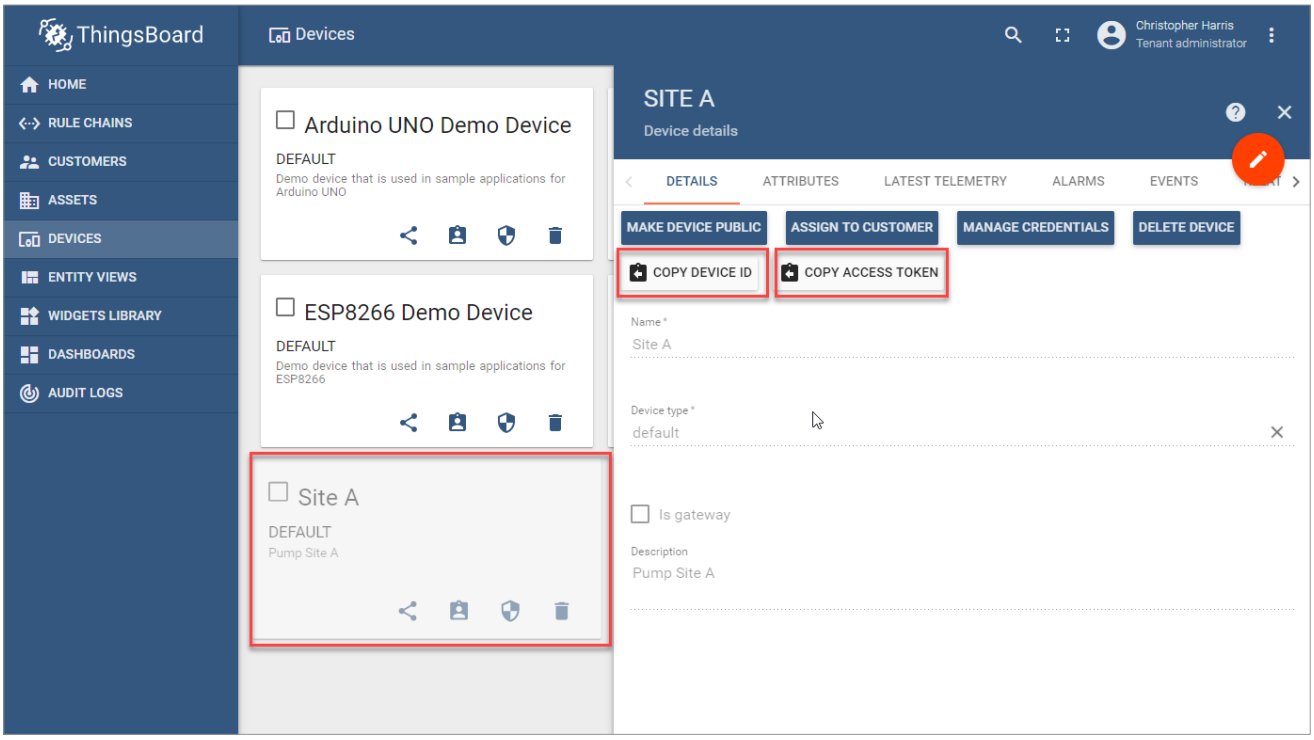
Sign in and go to the "DEVICES" tab on the left hand side. Click on the red + button on the bottom right hand side to create a new Device.



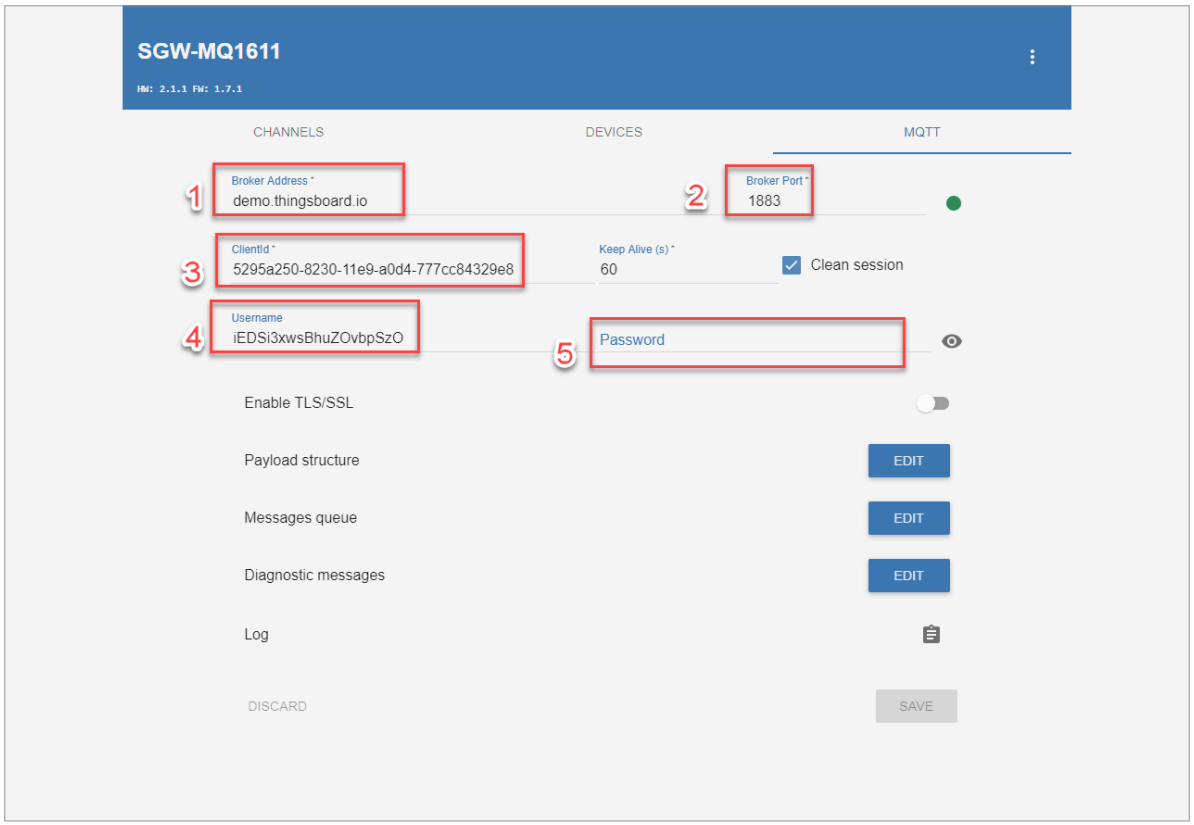
Enter in a unique name and choose the "default" Device type. The description is optional.



Click on the Device that was just created. There are 2 important buttons on this next screen: "COPY DEVICE ID" and "COPY ACCESS TOKEN". Click on the "COPY DEVICE ID" and then paste (CTRL-V) into the "ClientID" field of the MQTT setup tab in the MQTT gateway setup (field 3 in the screen capture below). Click on the "COPY ACCESS TOKEN" button and then paste this value into the "Username" field of the MQTT setup tab in the MQTT gateway setup (field 4 in the screen capture below).

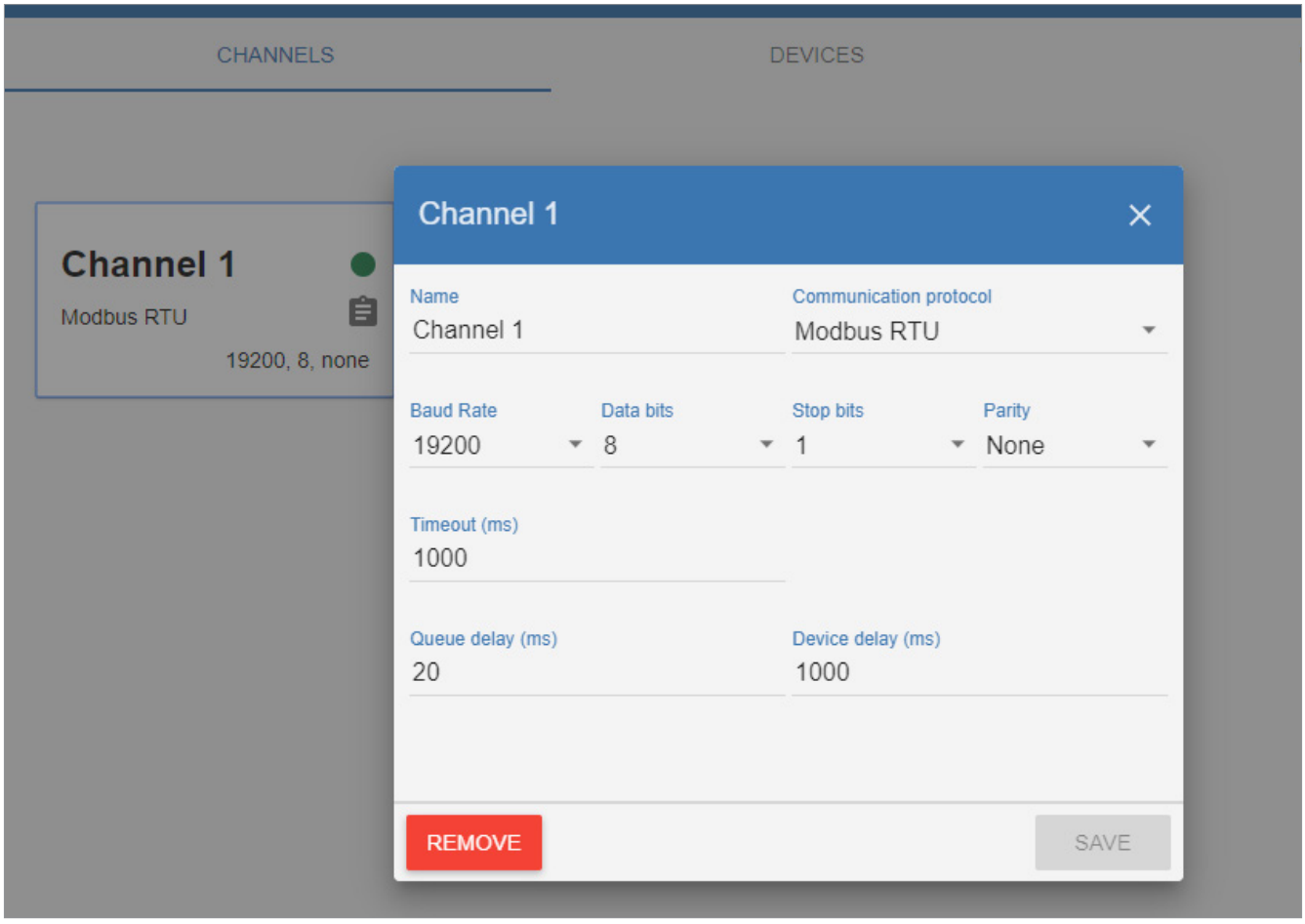


Switch to the setup of the MQTT gateway. The items are described below.

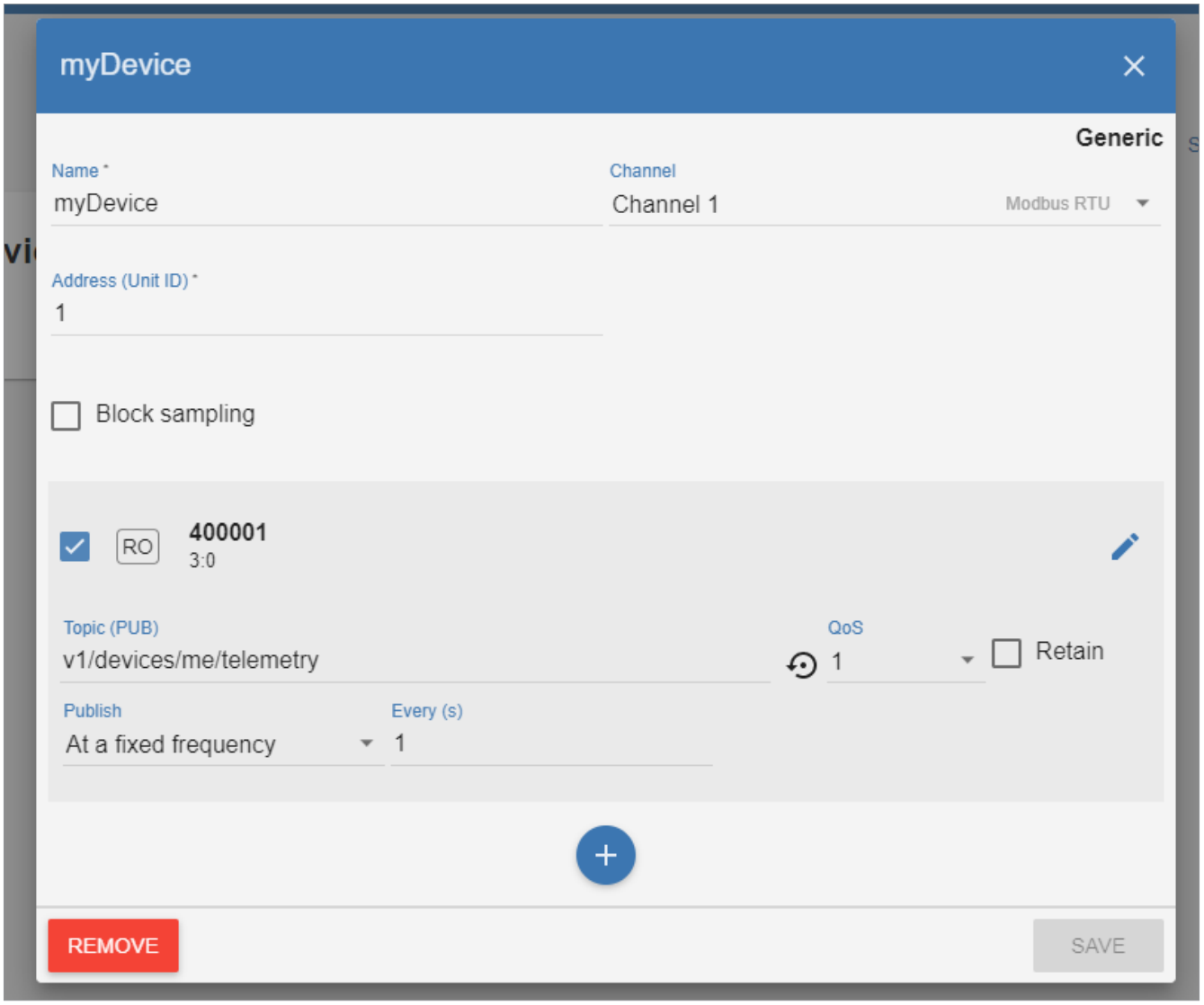


1. Broker Address should be: demo.thingsboard.io
2. Port number can be a few different options. For unencrypted connection, choose 1883.
3. This is the value that comes from the “COPY DEVICE ID” button of the thingsboard Device setup.
4. This is the value that comes from the “COPY ACCESS TOKEN” button of the thingsboard Device setup.
5. Leave this field blank for connectivity to thingsboard.

Go to the “Channels” tab of the MQTT Gateway setup and create a new Channel. In this example, we are performing Modbus RTU communications.

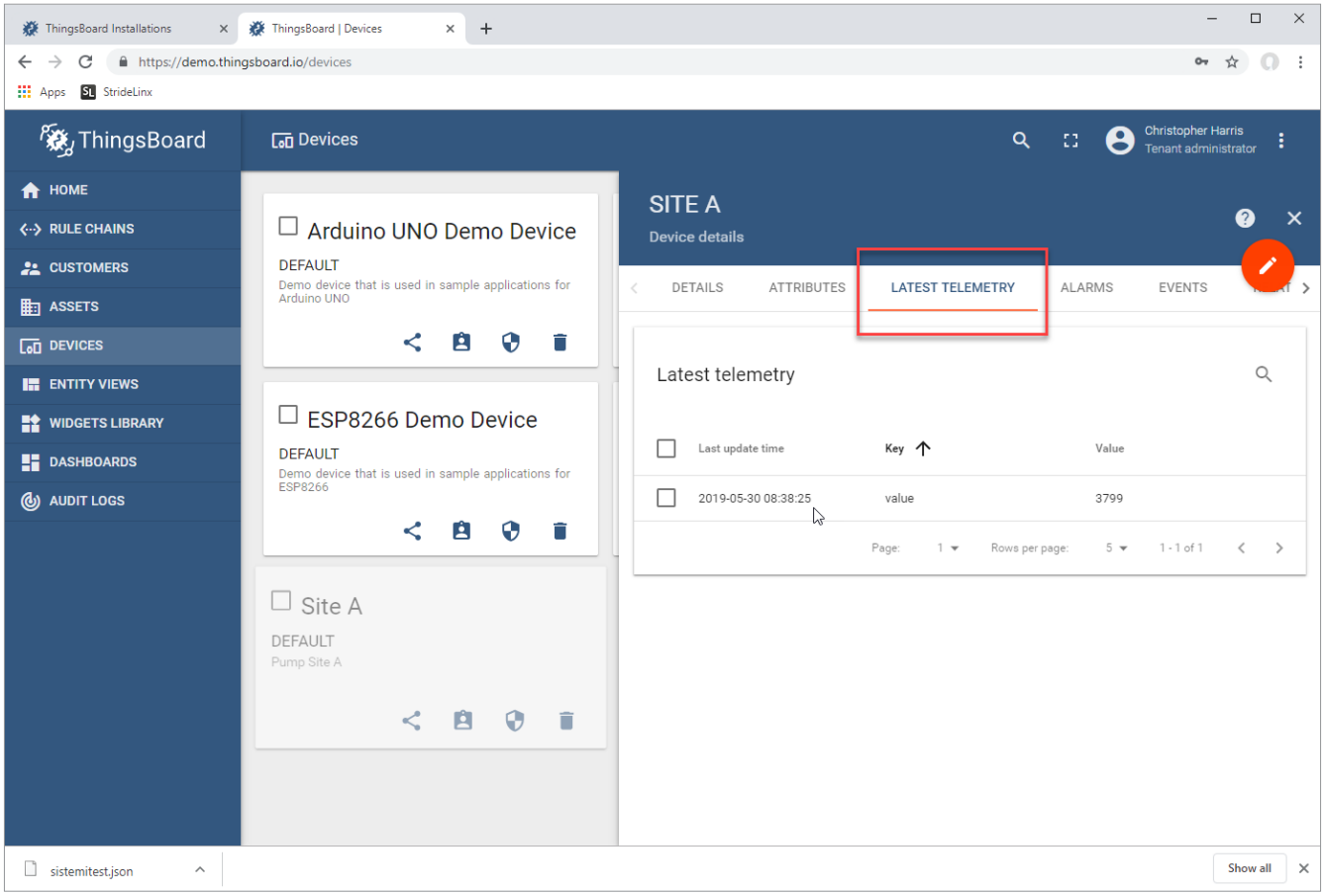


Go the “Devices” tab of the MQTT setup page. Create a new Device and choose the Channel just selected. Choose the Address of your Modbus RTU device. In this example, we are reading Modbus address 400001 (Function Code 3, Offset 0). This example is publishing at a fixed rate of 1 second. The topic MUST be exactly as shown in the screen capture below: v1/devices/me/telemetry

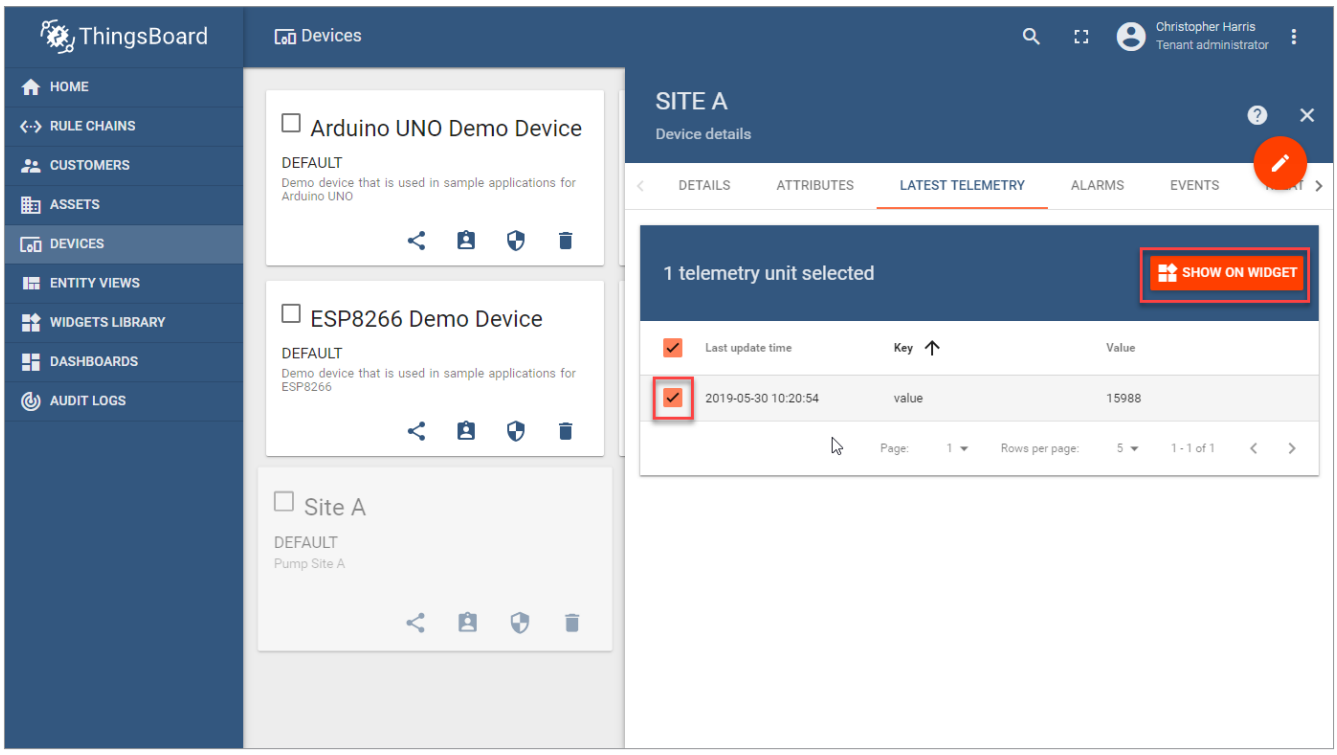


Save this configuration to the MQTT Gateway and switch back over to the thingsboard dashboard. In the Device setup, go to the "LATEST TELEMETRY" tab.

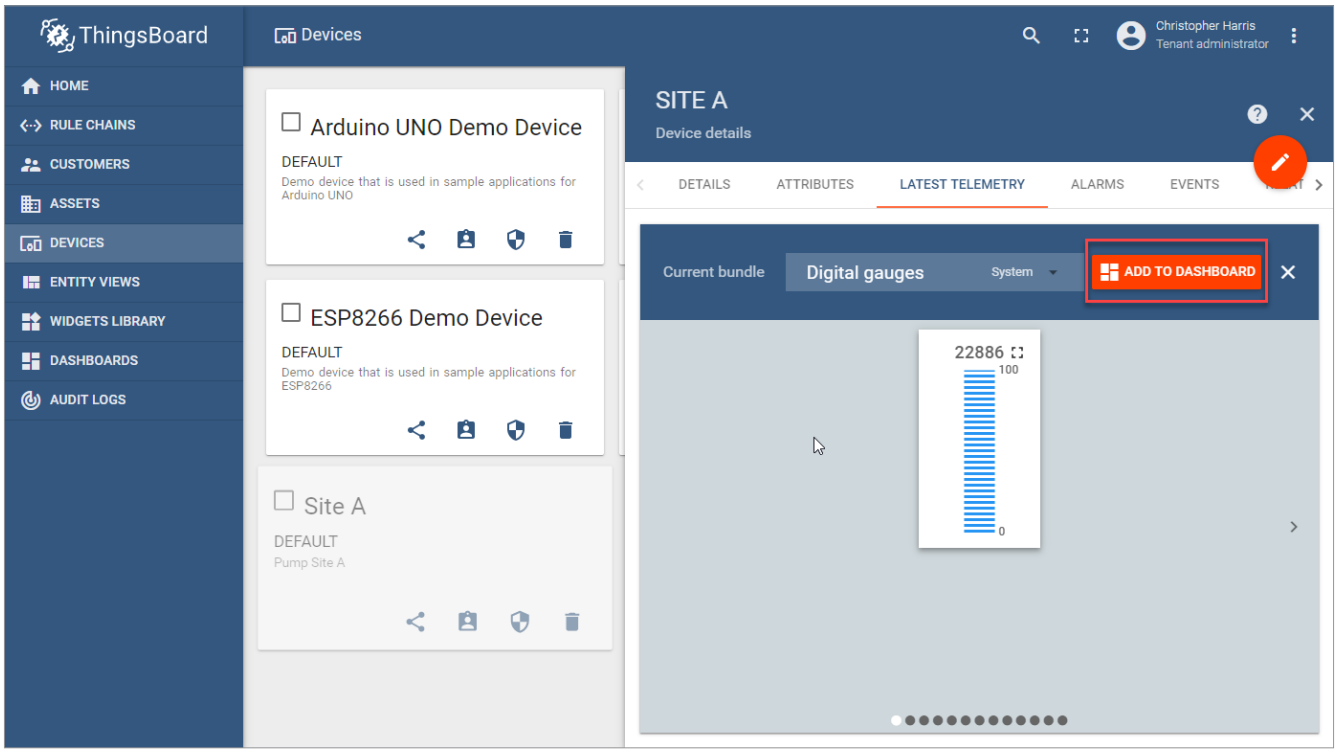
If the communications are setup correctly in the MQTT Gateway, there will be an updating value shown here.



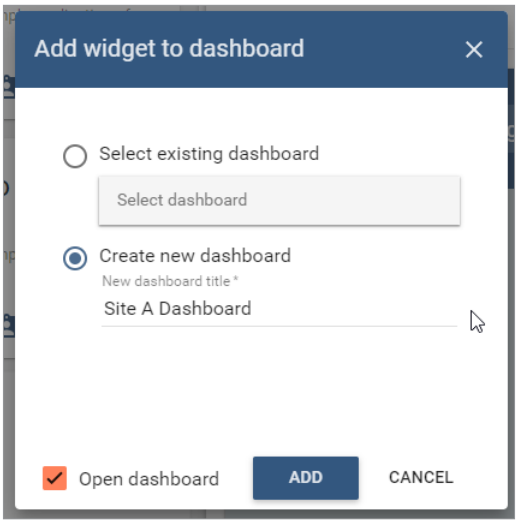
Click on the checkbox to the left of the item that is updating then click the "SHOW ON WIDGET" button.



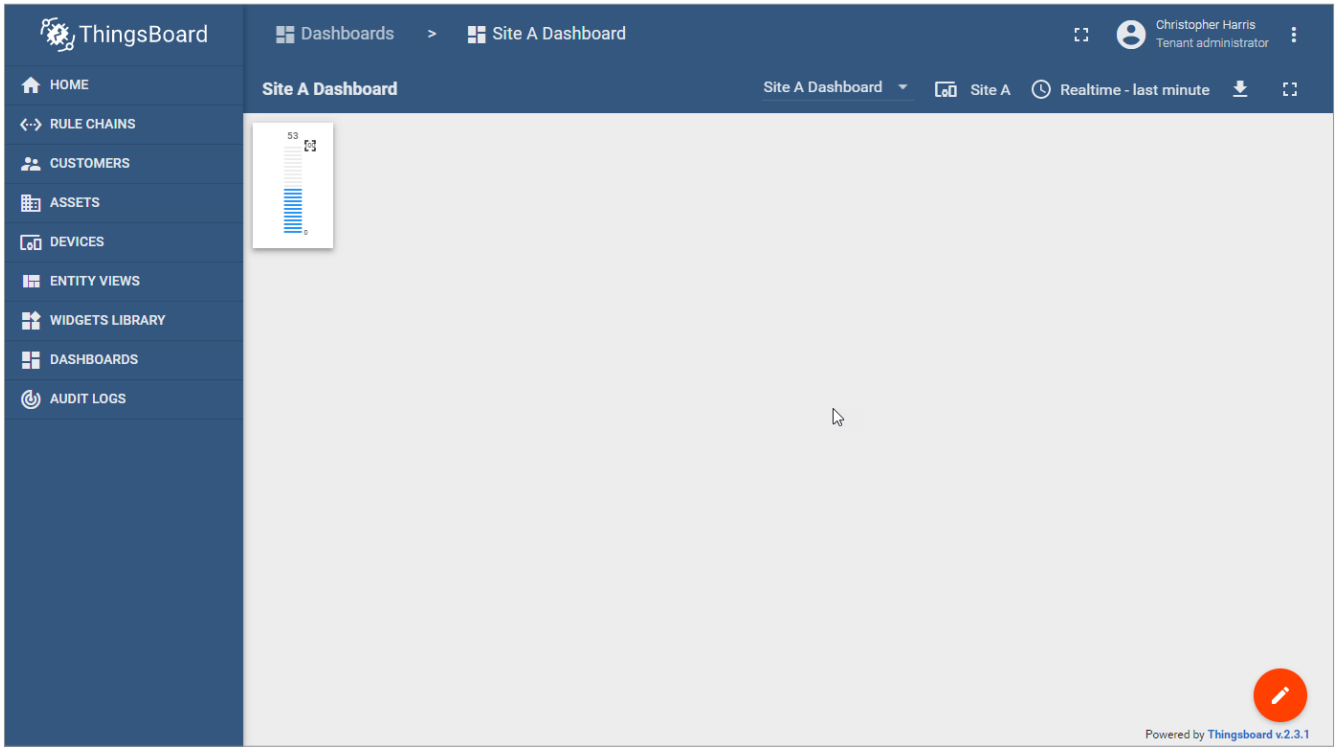
There is a list of widgets to choose from. For this example, we will choose a simple digital gauge as shown below. Click on the "ADD TO DASHBOARD" option after selecting a Widget.



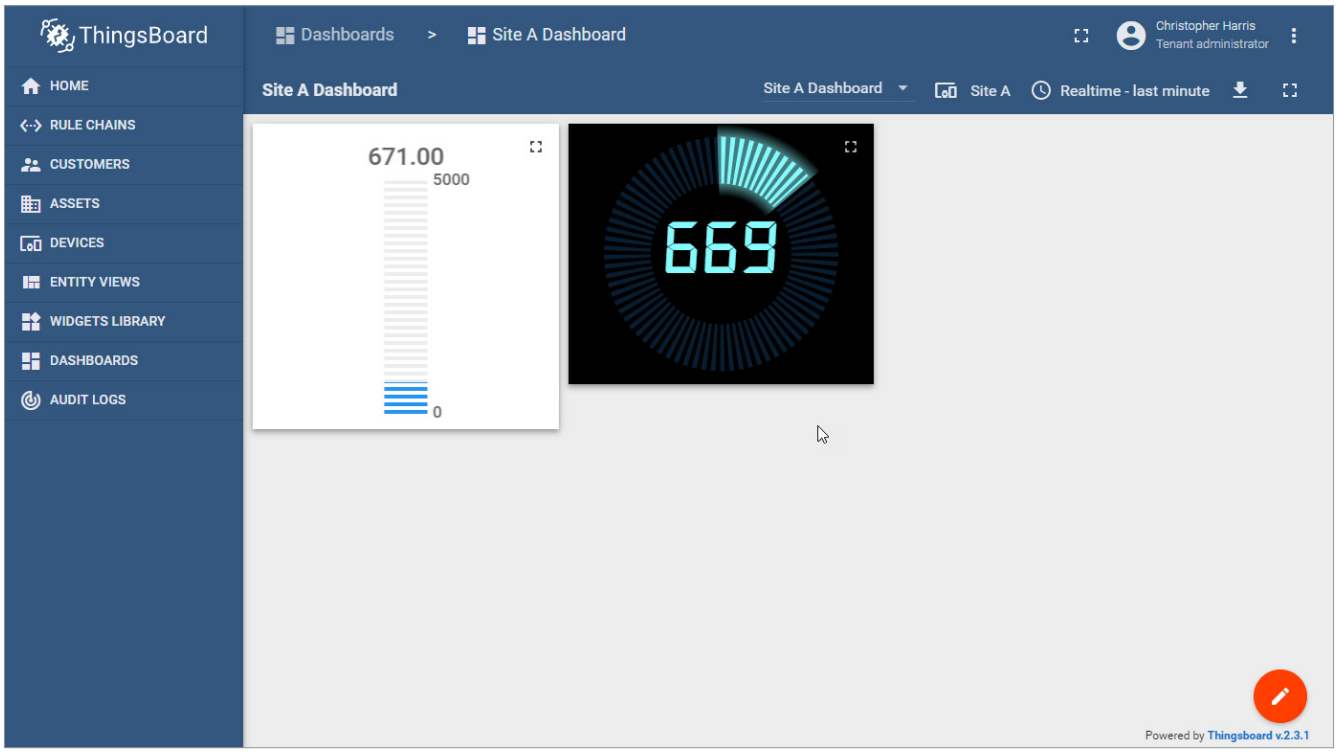
We will create a new Dashboard called "Site A" and choose the "Open dashboard" option.



The widget is now added to the Dashboard and is displaying the value in the Modbus RTU device at 40001. There are many other widgets and many display options available. To edit the dashboard and widgets, click on the pencil in the bottom right hand corner.



Dashboard after adjusting widget display options:



We hope that this brief example helps you see how you can use the platform to build a data dashboard for your intended use.