Kit/Instruction Manual

BUILDING MANAGEMENT SYSTEM NETWORK GATEWAY

FOR FLEX HIGH-EFFICIENCY COMMERCIAL GAS WATER HEATERS
MODELS: 50G/60G/75G/100G/119G/220G/250G
SERIES 400-401-450-451

CONTENTS

GENERAL SAFETY INFORMATION

Your safety and the safety of others is extremely important in the installation, use and servicing of this appliance. Many safety- related messages and instructions have been provided in this manual and on your own water heater to warn you and others of a potential injury hazard. Read and obey all safety messages and instructions throughout this manual. It is very important that the meaning of each safety message is understood by you and others who install, use or service this water heater.

All safety messages will generally tell you about the type of hazard, what can happen if you do not follow the safety message, and how to avoid the risk of injury.

	This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death. Keep this manual near the water heater.

⚠ ***DANGER***	***DANGER*** indicated an imminently hazardous situation which, if not avoided, will result in injury or death.
⚠ ***WARNING***	***WARNING*** indicates a potentially hazardous situation which if not avoided could result in injury or death.
⚠ ***CAUTION***	***CAUTION*** indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury.
CAUTION	***CAUTION*** used without the safety alert symbol indicates a potentially hazardous situation which, if not avoided could result in property damage

INTRODUCTION

New building construction and energy saving techniques have driven the need for improved communications between appliances and building environmental systems. There are several different protocols that have developed for accomplishing this task including BACnet and Modbus. Since appliances come with a variety of controls, interfacing with the various protocols presents different challenges.

A. O. Smith has developed the device to act as a communication gateway allowing appliances to communicate to the different building management protocols. The BMS (Building Management System) gateway translates the appliance codes and commands into the appropriate protocol language giving the end user the ability to monitor and control the appliance. The end user will be able to adjust and monitor the equipment and obtain better levels of efficiency and cost savings.

⚠ WARNING

Electrical Shock Hazard

Dangerous current is present within the water heater access panels/enclosures that is sufficient to cause sever injury or death.

Before removing any access panels or opening enclosures for servicing, make sure the electrical supply to the water heater is turned OFF.

Do not install in areas of high temperature, in excess of 167° F. Install in areas not subject to water or excess moisture.

Table 1. Parts Required

	RS-485 Protocol	Ethernet Protocol
BMS gateway module	X	X
Communication Cable	X	X
Screws	X	X
Ethernet Cable†	NA	X
RS-485 Cable	X	NA

† Supplied by customer.

The BMS gateway module in this kit has been designed to seamlessly integrate with the water heater controls. Once the unit is connected to the control and to the building management system, the user will be able to operate the unit with the Building Management System interface.

TOOLS REQUIRED

- Wire Cutters
- 20-24 AWG Wire Stripper
- 2.5 mm Flat Blade Screw Driver
- Battery drill or equivalent hand tool

SOFTWARE REQUIRED

• Device Discovery Tool (https://wh0.co/s400-bms).

You can download it using the web link or the QR code below

FEATURES AND COMPONENTS

The BMS Gateway device works with high-efficiency commercial gas water haters, Flex models: 50G/60G/75G/100G/119G/220G/250G SERIES 400-401-450-451.

You can use the device to do the following:

- Enable/disable the water heater.
- Change the Setpoints and differentials.
- Connect to BACnet and Modbus.
- Ethernet and serial RS-485 protocols on same module.
- Easily discover and configure IP settings.
- Embedded web page for configuring site-specific settings and firmware updates.

Note: The unit is powered by the TRC (Temperature Regulation Control).

ELECTRICAL SPECIFICATIONS

Table 2. RS-485 Interface	
Isolated:	Yes (1.5 kV)
Unit Loads:	1/8 Unit Load
Maximum Devices:	256
Internal Biasing Resistors:	None
Internal EOL Termination:	None
Failsafe Receiver:	Full-failsafe (open, shorted, terminated and undriven)
Differential Output:	5.0 V max (no load)
	2.4 V min (terminated and fully loaded)
Indicators:	Green: Lights when the BMS gateway is transmitting data on the RS-485 port
	Red: Lights when the BMS gateway is receiving data on the RS-485 port

Table 3. Ethernet Interface	
Interface:	Dual-port RJ-45 with Embedded Switch
Speed/Duplex:	10BASE-T/100BASE-TX, Full/Half Duplex Auto Negotiation
Supported Topologies:	Star, Daisy-chain, Redundant Ring (protocol-dependent)
Port Type:	MDI/MDI-X Auto-crossover
Indicators:	Integrated LEDs
	Green: Link/Activity (On when a link is detected and blinks when activity is detected)
	Amber: Speed (On = 100Mbps, Off = 10Mbps)

INSTALLATION INSTRUCTIONS

The kit includes the following components:

- BMS gateway, QTY. 1
- mounting screws, QTY. 2
- 5-pin TRC to BMS Gateway communication/power wire harness, QTY. 1

Field supplied parts

- Ethernet cable
- RS-485 cable

Tools needed for installation:

- Battery drill or equivalent hand tool
- Computer with Device Discovery Tool software

Important: Use only factory authorized replacement parts. If you lack the necessary skills to properly perform the installation, you should not proceed but get help from a qualified service technician.

Follow the directions under general guidelines for connecting the module to the Building Management System and power. This section will guide the installer on how to mount and connect the module to the water heater. The control box and mounting location on the water heater is on the top of the unit behind the display module. See ***Figure 1***.

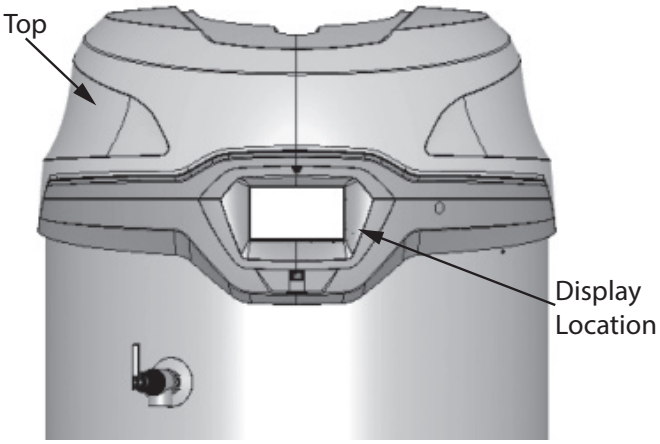

Figure 1. Control Location Top

1. Turn off the power to the heater and remove the top if required. Use a ladder to access the top of taller water heaters.

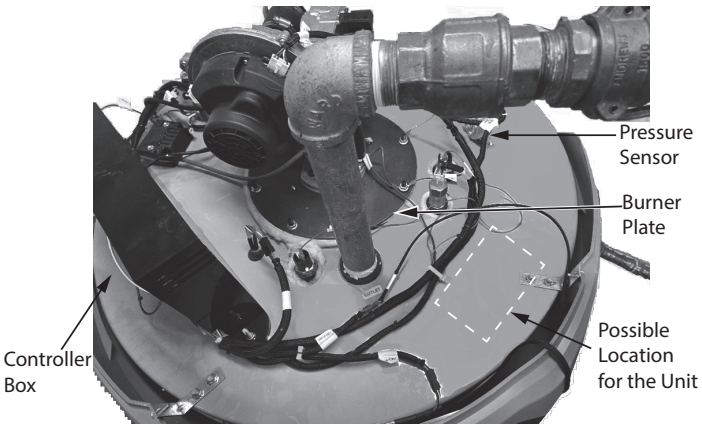

Figure 2. Controller and Pressure Sensor

2. Locate the black control box and the pressure sensor. Position the module between them. Leave at least an inch between the unit and the edge of the water heater as shown in ***Figure 2***.

   Ensure that the gateway is a few inches away from the burner.

   The location should allow routing the wire harness from BMS Gateway to TRC 1000 (located inside a control box). The wire harness is about 40 inches long.

3. Use the two mounting screws from the kit to install BMS Gateway to the flat surface on top of the heater.
4. Connect the 5-pin wire harness from the kit to the BMS Gateway's 5-pin connector marked "Water Heater" and the other end to the TRC control board (5-pin connector; J2, J3 or J9).
5. If all three 5-pin connectors on the TRC control board are occupied, connect this cable to the spare 5-position connector on the water shutoff valve control.
6. Connect Ethernet cable to BMS module and your computer.

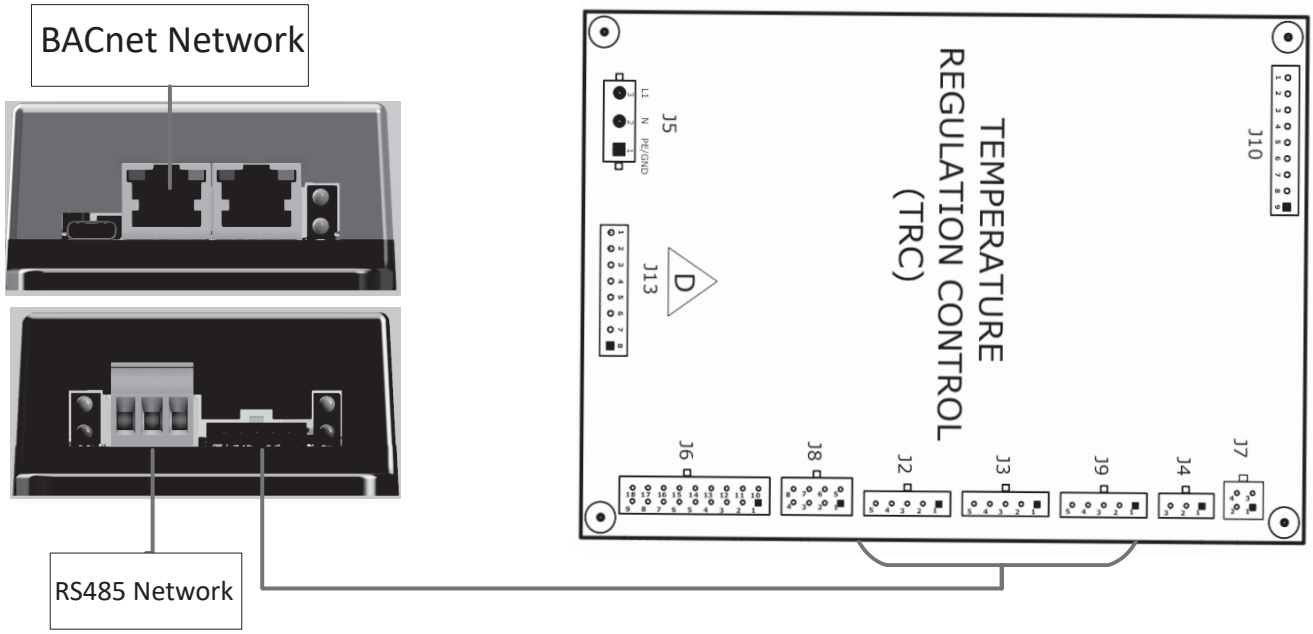

Figure 3. TRC to BMS Gateway Connections

DEVICE CONFIGURATION

To access the BMS Gateway's embedded web page to view or modify configuration settings, your computer's IP settings must be compatible with the BMS Gateway's IP settings. Two methods of configuring compatible IP settings between your computer and the BMS Gateway are described below. Also review the configuration steps required for protocol required.

CONFIGURATION STEPS REQUIRED:

Below are the minimum configuration steps required based on the protocol needed for the application.

a. All Protocols

1. Configure the BMS Gateway's or your computer's IP settings such that they are compatible.
2. Open a web browser and type the BMS Gateway's IP address into the address bar.

b. BACnet MS/TP

Configure the following serial parameters in the BACnet MS/TP Server settings

1. Baud rate – Confirm this matches the baud rate of all devices on the network.
2. Device name – Confirm this is unique for the entire BACnet network.
3. Device instance - Confirm this is unique for the entire BACnet network.
4. MAC Address – Confirm this is unique for the MS/TP trunk.

c. Modbus RTU

Configure serial parameters in Modbus RTU Slave Settings

1. Baud rate – Confirm this matches the baud rate of all devices on the network.
2. Parity – Confirm this matches the parity of all devices on the network.
3. Address – Confirm this is unique for the Modbus RTU trunk.

d. BACnet/IP

i. Configure Ethernet Parameters under Network Parameters

1. Address – Enter the IP address assigned to the BMS Gateway by the site's IT administrator. This must be unique on the Ethernet network.
2. Subnet mask – Enter the subnet mask for the site's Ethernet network, provided by the site's IT administrator. This must match the subnet mask of all devices on the Ethernet network.
3. Gateway – Enter the default gateway for the site's Ethernet network, provided by the site's IT administrator, if required. Confirm this matches the IP address of the network's internet router/gateway. Set to 0.0.0.0 if not used.

II. Configure BACnet/IP Server Settings

1. UDP port – Confirm this matches the UDP port of the BACnet client.
2. Device name – Confirm this is unique for the entire BACnet network.
3. Device instance - Confirm this is unique for the entire BACnet network.

e. Modbus/TCP

i. Configure Ethernet Parameters under Network Parameters

1. Address – Enter the IP address assigned to the BMS Gateway by the site's IT administrator. This must be unique on the Ethernet network.
2. Subnet mask – Enter the subnet mask for the site's Ethernet network, provided by the site's IT administrator. This must match the subnet mask of all devices on the Ethernet network.
3. Gateway – Enter the default gateway for the site's Ethernet network, provided by the site's IT administrator, if required. Confirm this matches the IP address of the network's internet router/gateway. Set to 0.0.0.0 if not used.

ii. Configure Modbus/TCP Server Settings under Network Parameters

1. TCP port – Confirm this matches the TCP port of the Modbus client.

METHOD 1 - MODIFY COMPUTER'S IP SETTINGS

Use this method only if the BMS Gateway's IP address is known. These instructions assume the BMS Gateway is at its factory default IP address of 192.168.16.100.

1. Connect an Ethernet cable from the device either directly to a computer's Ethernet port or to an Ethernet switch that the computer is connected to.
2. Configure the computer's IP address to be on the 192.168.16.0/24 network (i.e. the IP Address should be 192.168.16.xxx, where xxx is any number between 1 and 254, and the Subnet Mask should be 255.255.255.0). For example, the computer could be configured for an IP Address of 192.168.16.1 with a Subnet Mask of 255.255.255.0. It is important to note that the computer's IP address cannot be the same as the device's. The device's default IP address is 192.168.16.100.
3. Open a web browser and type the device's IP address into the address bar (192.168.16.100 by default). This will open the device's web page.
4. Log into the device's embedded web page. The device's default credentials are "admin" and MAC Address (do not use ":" that is shown in the MAC address) for the Username and Password, respectively.

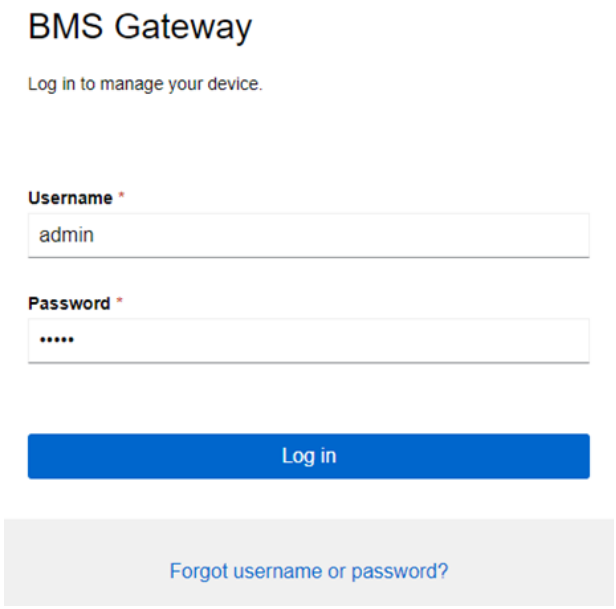

Figure 4. BMS Gateway Login

5. Navigate to the settings you wish to modify using the navigation pane on the left-hand side of the web page. After changing any settings, you must click the blue "Save parameter changes" button that appears above the settings section and then reset the unit by clicking the red "Device requires reboot" button in the top bar of the webpage for the settings to take effect.

METHOD 2 - CONNECTING BY MODIFYING THE BMS GATEWAY'S IP SETTINGS

Use this method must be used when the BMS Gateway's IP settings are unknown:

1. Connect an Ethernet cable from the device either directly to a computer's Ethernet port or to an Ethernet switch that the computer is connected to.
2. Go to the link, https://wh0.co/s400-bms and download Device Discovery Tool:
3. Open the Discovery Tool and your BMS device will be discovered automatically.

   Please note that the Device Discovery Tool will need to be added as an exception to your computer's firewall. If you are using Windows' default firewall, you will see a prompt the first time you open the Device Discovery Tool to select which network types to allow the software to operate on (Domain, Private, or Public). It is recommended to check all 3 network types.
4. Turn on the power to the heater (this should turn the BMS module ON). Open the device discovery tool, it should automatically show device that it found. If the device is not discovered, do the following:

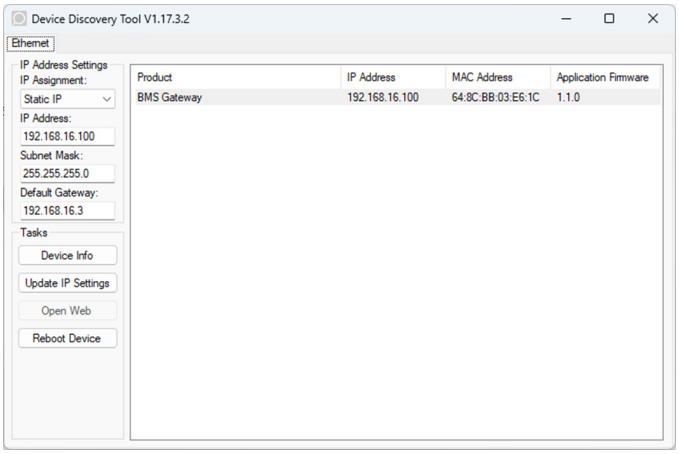

Figure 5. Discovery Tool Screen Showing a Discovered BMS Gateway Device

   a. Check the connection between the BMS Gateway and TRC. The BMS Gateway's status (MS) LED should be lit solid and its WATER HEATER TX and RX LEDs should be rapidly flashing green and red, respectively, indicating power and communication.

   b. Make sure the Ethernet cable is locked into place on the BMS Gateway and onto the computer and the green LINK/ACTIVITY LED on the BMS Gateway's Ethernet power is lit solid green or flashing green.

   c. Confirm the Device Discovery Tool has been added to your computer's firewall.
5. To change the BMS device settings, you must change the IP Address, Subnet Mask, and Default Gateway to be an address like the computer's Ethernet port. Change the BMS module's settings as follows:

   a. Set the IP address to 192.168.71.xxx, where xxx is any number between 1 and 254, excluding the computer's IP address (192.168.71.2 in this example)

   b. Set the Subnet Mask to 255.255.255.0.

   c. Set the default Gateway to 0.0.0.0 .

   d. Click the 'Update IP Settings' button. A prompt will appear asking you to confirm the changes.

   e. After the IP settings have been written to the device, another prompt will appear asking you to reboot the device for changes to take effect.

   Once the device is rebooted it will be using the new settings, and the 'Open Web' button is enabled.
6. Click the Open Web button. The device settings web page displays.

CONFIGURING DEVICE SETTINGS USING THE DEVICE'S WEB PAGE

1. Log into the device's embedded web page. The device's default credentials are "admin" and MAC Address (do not use ":" that is shown in the MAC address) for the Username and Password, respectively.

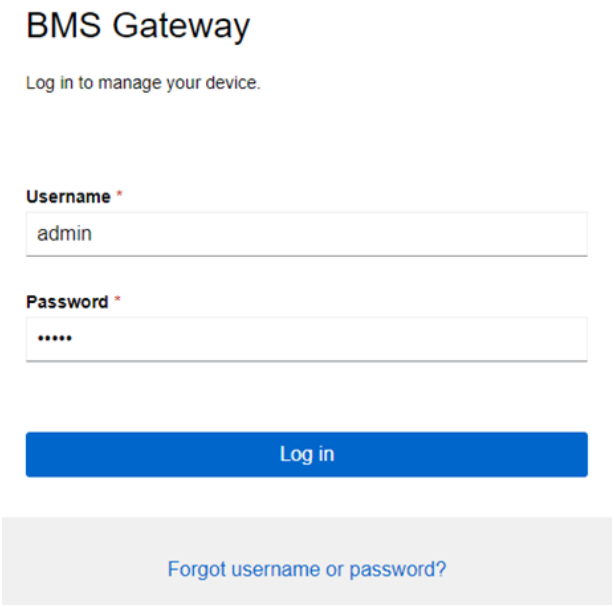

Figure 6. BMS Gateway Login

2. Navigate to the settings you wish to modify using the navigation pane on the left-hand side of the web page. After changing any settings, you must click the blue "Save parameter changes" button that appears above the settings section and then reset the unit by clicking the red "Device requires reboot" button in the top bar of the webpage for the settings to take effect.

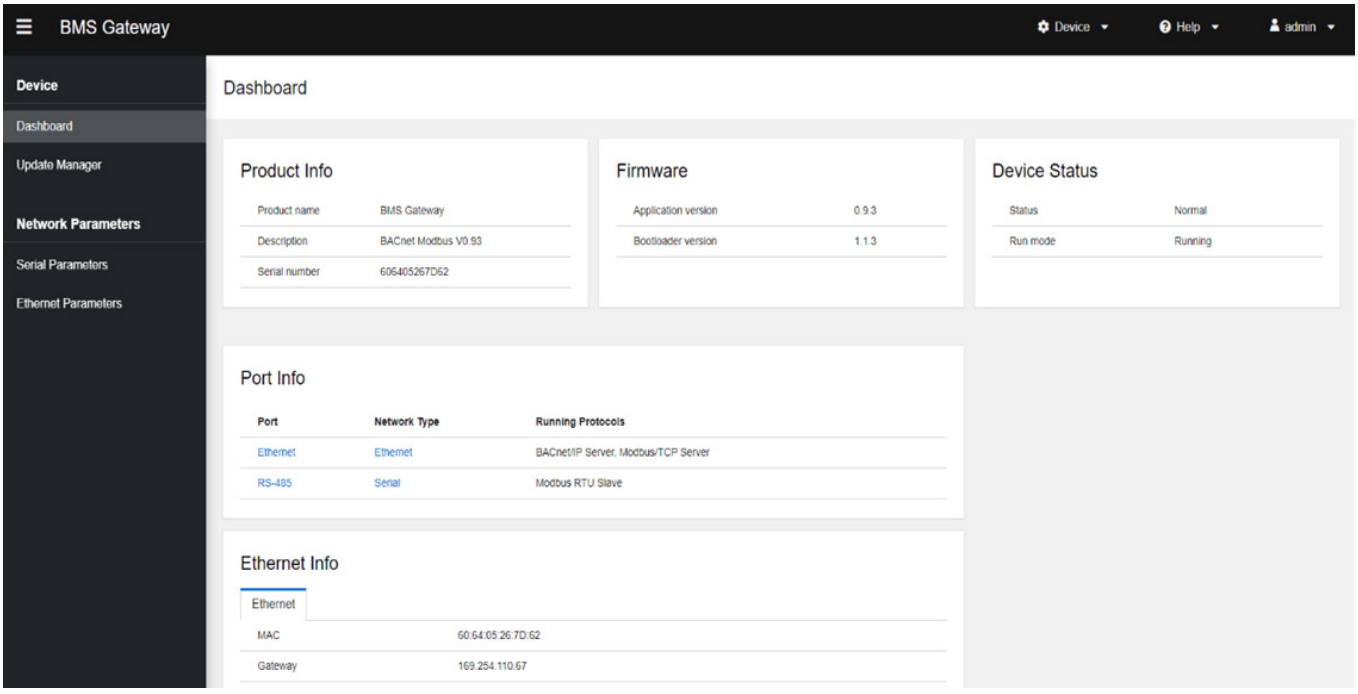

Figure 7. BMS Gateway Device Dashboard

3. From the Dashboard, you can configure the serial and Ethernet parameters as follows:

   a. Clicking on Serial Parameters on the left will let you change the RS-485 protocol to Modbus RTU Slave or BACnet MS/TP Server.

      Selecting either one will give you a list of parameters that can be configured.

   b. For RS-485 communication an RS-485 cable must be wired into the green connector on the BMS module. Orange wire to D+, Yellow wire to D-, and Black wire to COM.

c. Clicking on Ethernet Parameters on the left will let you change IP settings and Ethernet protocol settings.

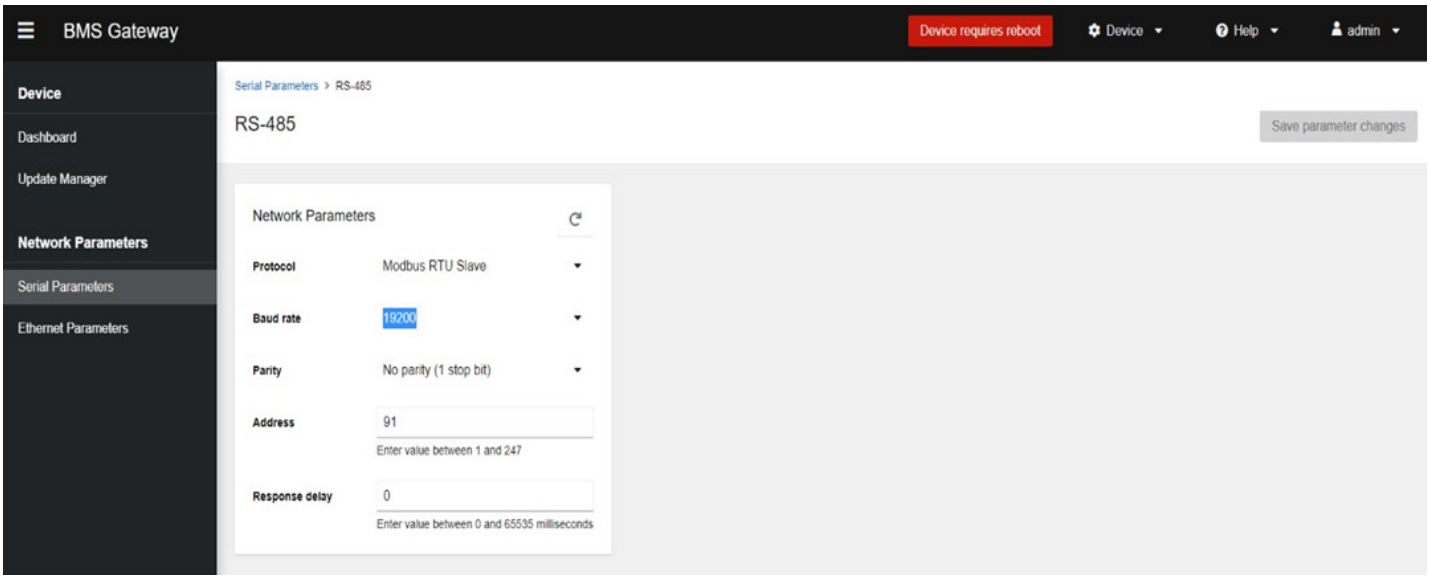

Figure 8. Serial Parameters Change Screen

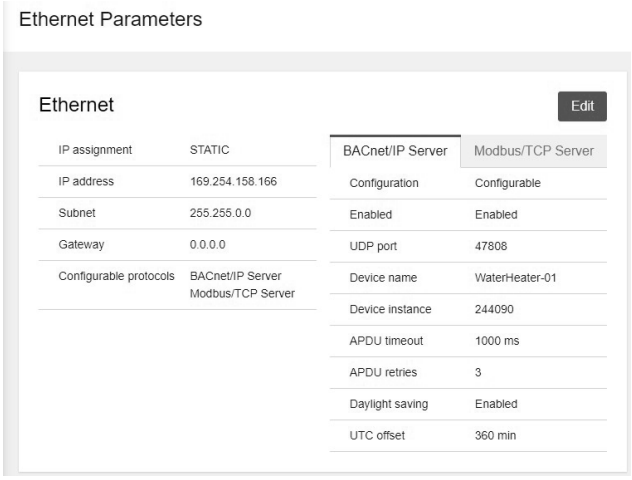

Figure 9. Ethernet Parameters Screen

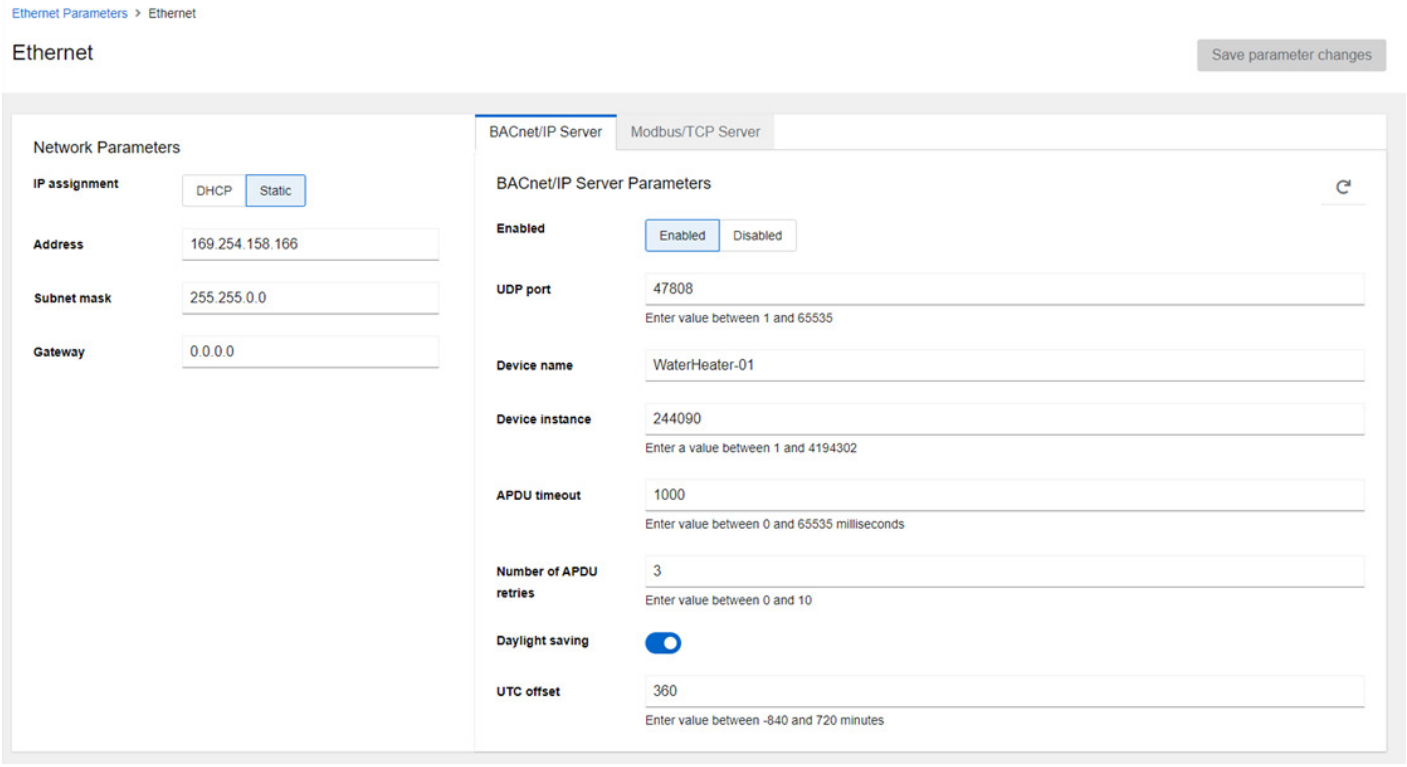

Figure 10. Ethernet Parameters Change Screen

4. After changing any settings, click on the “Save parameter changes” button on the top right of the screen to save the settings to the BMS Gateway.
5. A red “Device reboot” button will display. You must reboot the device for the changes to take effect.
6. After the device reboots, the BMS Gateway login page displays. Configuration is complete and the BMS Gateway is now ready to use..
7. Disconnect the Ethernet cable from the computer and connect it to the local network of BMS.

BMS GATEWAY OBJECT MODEL, REGISTERS, FAULT WARNING, AND ENUMERATED VALUES

BACNET/GAS WATER HEATERS OBJECT LIST

This table may be subject to change in the future.

Adjustable objects are in bold and indicated by “R/W” (read and writable) or these they are marked as “R” (read-only)

Table 4. BACnet/Gas Water Heaters Object List

Object Name	Object Type	Instance	Units	Default COV Increment	R/W	Min	Max	Notes
Firmware Version	Analog Input	1	No Units	0	R	-	-	
Firmware Revision	Analog Input	2	No Units	0	R	-	-	
Upper (Primary) Temperature F	Analog Input	10	Fahrenheit	1	R	-	-	
Lower (Secondary)Temperature F	Analog Input	11	Fahrenheit	1	R	-	-	
Tank Temperature F	Analog Input	12	Fahrenheit	1	R	-	-	
Operating Setpoint F	Analog Input	30	Fahrenheit	1	R	-	-	
Local Operating Setpoint F	Analog Input	31	Fahrenheit	1	R	-	-	
Upper (Primary) Temperature C	Analog Input	110	Celsius	0.5	R	-	-	
Lower (Secondary)Temperature C	Analog Input	111	Celsius	0.5	R	-	-	
Tank Temperature C	Analog Input	112	Celsius	0.5	R	-	-	
Operating Setpoint C	Analog Input	130	Celsius	0.5	R	-	-	
Local Operating Setpoint C	Analog Input	131	Celsius	0.5	R	-	-	
Modulation	Analog Input	201	Percent	1	R	-	-	
Elapsed Time	Analog Input	202	Seconds	5	R	-	-	
Heating Time	Analog Input	203	Seconds	5	R	-	-	
Cycles	Analog Input	204	No Units	1	R	-	-	
System State	Multi-state Input	1	N/A	N/A	R	-	-	See ***System State Enumerated Values*** (page 16).
Fault Error Code	Multi-state Input	2	N/A	N/A	R	-	-	See ***Fault/Warning Count Enumerated Values*** (page 16)**.**
Warning Error Code	Multi-state Input	3	N/A	N/A	R	-	-	See ***Fault/Warning Count Enumerated Values*** (page 16)**.**
Remote Operating Setpoint F	Analog Value	1	Fahrenheit	1	R/W	90	180	
Differential F	Analog Value	2	Delta					
Low Temperature Alarm Setpoint F[1]	Analog Value	103	Celsius	0.5	R/W	32.2	82.2	
Remote Operating Setpoint C	Analog Value	3	Fahrenheit	1	R/W	90	180	
Remote Operating Setpoint C	Analog Value	101	Celsius	0.5	R/W	32.2	82.2	

R = Read only
R/W = Read or Write
Notes:

1. Low temperature alarm can be enabled over BMS. This variable is available over BMS only. The alarm or the setpoint is not available via the display
2. If the user desires to control heating via BMS, BMS Active needs to be written “1” at least every 30 seconds. Otherwise, this variable will reset to “0” after 30 seconds and the heater will revert back to the Local Operating Setpoint.
3. This limits modulation to maximum BMS Heat Demand (100% = Allow up to rated firing (faster recovery). 0% - minimum modulation rate, more efficient but has a slower recovery rate i.e. derates heater capacity).

Table 4. BACnet/Gas Water Heaters Object List								
Object Name	**Object Type**	**Instance**	**Units**	**Default COV Increment**	**R/W**	**Min**	**Max**	**Notes**
Differential C	Analog Value	102	Delta Celsius	0.5	R/W	1.1	11.1	
Low Temperature Alarm Setpoint C[1]	Analog Value	103	Celsius	0.5	R/W	32.2	82.2	
BMS Heat Demand[3]	Analog Value	201	Percent	1	R/W	0	100.0	
Permit Heating	Binary Value	1	N/A	N/A	R/W	0	1	
BMS Active[2]	Binary Value	2	N/A	N/A	R/W	1	1	
CCB Com Error	Binary Input	1	N/A	N/A	R	-	-	
Call For Heat	Binary Input	2	N/A	N/A	R	-	-	
Heater Status	Binary Input	3	N/A	N/A	R	-	-	
Gas Pressure Status	Binary Input	4	N/A	N/A	R	-	-	
External Enable	Binary Input	5	N/A	N/A	R	-	-	
Low Water Cut Off	Binary Input	6	N/A	N/A	R	-	-	
System In Fault	Binary Input	7	N/A	N/A	R	-	-	
Power Up Complete	Binary Input	8	N/A	N/A	R	-	-	
Low Temperature Alarm[1]	Binary Input	9	N/A	N/A	R	-	-	
Gas Valve Status	Binary Input	13	N/A	N/A	R	-	-	
Igniter Status	Binary Input	14	N/A	N/A	R	-	-	
Flame Detected	Binary Input	15	N/A	N/A	R	-	-	
Air Inlet Status	Binary Input	16	N/A	N/A	R	-	-	
Air Outlet Status	Binary Input	17	N/A	N/A	R	-		

R = Read only
R/W = Read or Write
Notes:

1. Low temperature alarm can be enabled over BMS. This variable is available over BMS only. The alarm or the setpoint is not available via the display
2. If the user desires to control heating via BMS, BMS Active needs to be written “1” at least every 30 seconds. Otherwise, this variable will reset to “0” after 30 seconds and the heater will revert back to the Local Operating Setpoint.
3. This limits modulation to maximum BMS Heat Demand (100% = Allow up to rated firing (faster recovery). 0% - minimum modulation rate, more efficient but has a slower recovery rate i.e. derates heater capacity).

MODBUS GAS WATER HEATER REGISTER LISTINGS

This table may be subject to change in the future.

Adjustable objects are in bold and indicated by “R/W” (read and writable)
or these they are marked as “R” (read-only)

Table 5. Modbus Gas Water Heaters Register List

Register Name (Description)	Register Type	Register Address	R/W	Units	Min Value (if W)	Max Value (if W)	Notes
Firmware Version, Revision[1]	Input Register	1	R	No Units	-	-	MSB = Version, LSB = Revision
Upper (Primary) Temperature F	Input Register	2	R	°F x 10	-	-	
Lower (Secondary)Temperature F	Input Register	257	R	°F x 10	-	-	
Tank Temperature F	Input Register	258	R	°F x 10	-	-	
Operating Setpoint F	Input Register	259	R	°F x 10	-	-	
Local Operating Setpoint F	Input Register	513	R	°F x 10	-	-	
Upper (Primary) Temperature C	Input Register	514	R	°C x 10	-	-	
Lower (Secondary)Temperature C	Input Register	515	R	°C x 10	-	-	
Tank Temperature C	Input Register	516	R	°C x 10	-	-	
Operating Setpoint C	Input Register	517	R	°C x 10	-	-	
Local Operating Setpoint C	Input Register	769	R	°C x 10	-	-	
System State	Input Register	1025	R	No Units	-	-	See ***System State Enumerated Values*** (page 16).
Modulation	Input Register	1281	R	Percent x 10	-	-	
Elapsed Time[3]	Input Register	1537	R	Seconds	-	-	32-Bit Integer Big Endian (202 = MSW, 203 = LSW)
Heating Time[3]	Input Register	1538	R	Seconds	-	-	32-Bit Integer Big Endian (204 = MSW, 205 = LSW)
Cycles[3]	Input Register	1539	R	No Units	-	-	32-Bit Integer Big Endian (206 = MSW, 207 = LSW)
Fault Error Code	Input Register	1540	R	No Units	-	-	See ***Fault/Warning Count Enumerated Values*** (page 16).
Warning Error Code	Input Register	1541	R	No Units	-	-	See ***Fault/Warning Count Enumerated Values*** (page 16).
Remote Operating Setpoint F	Holding Register	1	R/W	°F x 10	90	180	
Differential F	Holding Register	2	R/W	Delta °F x 10	2	20	
Low Temperature Alarm Setpoint F[4]	Holding Register	3	R/W	°F x 10	90	180	
Remote Operating Setpoint C	Holding Register	101	R/W	°C x 10	32.2	82.2	
Differential C	Holding Register	102	R/W	Delta °C x 10	1.1	11.1	
Low Temperature Alarm Setpoint C[4]	Holding Register	103	R/W	°C x 10	32.2	82.2	
BMS Heat Control[5]	Holding Register	200	R/W	N/A	0	1	Bit 0: 1 = Permit Heating Bits 1 - 14: Unused Bit 15: 1 = BMS Active
BMS Heat Demand[2]	Holding Register	201	R/W	Percent x 10	0	100.0	Keep to 100% when not limiting modulation by BMS
Permit Heating	Coil Register	1	R	N/A			1 = Permit Heating
BMS Active[5]	Coil Register	2	R	N/A			1 = BMS/Modbus Control Active

1. Version is encoded into the upper 8 bits and Revision is encoded into lower 8 bits.
2. This limits modulation to maximum BMS Heat Demand (100% = Allow up to rated firing (faster recovery). 0% = minimum modulation rate more efficient but has a slower recovery rate i.e. derates heater capacity).
3. Data stored in two 16 bit registers “Big Endian” (Higher order bits in lower register number)
4. Low temperature alarm can be enabled over Modbus. These variables are available over BMS only. The alarm or the setpoint are not available via the display
5. To control heating via BMS, Modbus Active needs to be written “1” at least every 30 seconds. Otherwise, this variable will reset to “0” after 30 seconds and the heater will revert to the Local Operating Setpoint.

Table 5. Modbus Gas Water Heaters Register List							
Register Name (Description)	**Register Type**	**Register Address**	**R/W**	**Units**	**Min Value (if W)**	**Max Value (if W)**	**Notes**
CCB Com Error	Discrete Input	1	R	N/A			0 = OK 1 = Error
Call For Heat	Discrete Input	2	R	N/A			0 = No 1 = Yes
Heater Status	Discrete Input	3	R	N/A			0 = Disabled 1 = Enabled
Gas Pressure Status	Discrete Input	4	R	N/A			0 = OK 1 = Low
External Enable	Discrete Input	5	R	N/A			0 = Off 1 = On
Low Water Cut Off	Discrete Input	6	R	N/A			0 = OK 1 = Low
System In Fault	Discrete Input	7	R	N/A			0 = No 1 = Yes
Power Up Complete	Discrete Input	8	R	N/A			0 = No 1 = Yes
Modbus Low Temperature Alarm	Discrete Input	9	R	N/A			0 = OK 1 = Alarm
Gas Valve Status	Discrete Input	13	R	N/A			0 = Off 1 = On
Igniter Status	Discrete Input	14	R	N/A			0 = Off 1 = On
Flame Detected	Discrete Input	15	R	N/A			0 = No 1 = Yes
Air Inlet Status	Discrete Input	16	R	N/A			0 = OK 1 = Blocked
Air Outlet Status	Discrete Input	17	R	N/A			0 = OK 1 = Blocked

1. Version is encoded into the upper 8 bits and Revision is encoded into lower 8 bits.
2. This limits modulation to maximum BMS Heat Demand (100% = Allow up to rated firing (faster recovery). 0% = minimum modulation rate more efficient but has a slower recovery rate i.e. derates heater capacity).
3. Data stored in two 16 bit registers “Big Endian” (Higher order bits in lower register number)
4. Low temperature alarm can be enabled over Modbus. These variables are available over BMS only. The alarm or the setpoint are not available via the display
5. To control heating via BMS, Modbus Active needs to be written “1” at least every 30 seconds. Otherwise, this variable will reset to “0” after 30 seconds and the heater will revert to the Local Operating Setpoint.

SYSTEM STATE ENUMERATED VALUES

Table 6. System State Enumerated Values

Name	Value	Description
SM_CALIBRATION	1	Combustion Control (Resideo) Lambda calibration
SM_WAIT_FOR_RESIDEO_FAULT_CLEAR	2	Waiting for Combustion Control fault clear
SM_STANDBY_HOLD	257	hardware checks
SM_STANDBY_WAITING_CFH	258	Waiting for call for heat
SM_STANDBY_BLOWER	259	Waiting for call for heat blower
SM_PRE_PURGE	513	Pre-purge State
SM_IGNITION_IGNITER_ON	514	Ignition Igniter ON State
SM_GAS_VALVE_ON	515	Gas Valve ON State
SM_GAS_VALVE_FLAME_EST	516	Gas Valve Flame Estimation State
SM_INTER_PURGE	517	Inter Purge State
SM_HEATING	769	Heating State
SM_POST_PURGE	1025	Post Purge State
SM_FAULT	1281	Fault State
SM_HEATER_DISABLED	1537	Waiting for Heater enable switch to be on
SM_UNCALIBRATED	1538	CSC Error code 120 while heater disabled
SM_HEATER_POWER_UP_DISABLED	1539	Power up checks not complete (loading MIN and CSC defaults)
SM_HEATER_EXT_IN_DISABLED	1540	Use external enable set and external input open
SM_HEATER_BMS_DISABLED	1541	BMS is disabling heating

1. **Not all faults are applicable to Cyclone Flex**
2. **When faults are active, the heater will shut down**
3. **When warnings are active, the heater continues to operate**

FAULT/WARNING COUNT ENUMERATED VALUES

Table 7. Fault/Warning Count Enumerated Values

Name	Value	Description
Name	Value	Description
FC_NO_FAULT	1	No fault
FC_DRY_FIRE	2	No water was detected in the tank
FC_TEMP_HI_LIMIT	3	Tank temperature exceeds limit ECO switch or NTC safety limit exceeded
FC_TEMP_SENSOR_1	4	Temperature sensor 1 error
FC_TEMP_SENSOR_2	5	Temperature sensor 2 error
FC_CCB_SOFTWARE	6	The controller detected a software error
FC_CCB_HARDWARE	7	The controller detected a hardware error
FC_DISPLAY_SOFTWARE	8	The display detected a software error
FC_DISPLAY_HARDWARE	9	The display detected a hardware error
FC_AC_POWER	10	Mains power out of range
Sensor Faults		

Notes
1. **Not all faults are applicable to Cyclone Flex**
2. **When faults are active, the heater will shut down**
3. **When warnings are active, the heater continues to operate**

Table 7. Fault/Warning Count Enumerated Values		
Name	Value	Description
FC_COMMUNICATION	21	Communications error
FC_ELEMENT_1	22	Heating element 1 failure
FC_ELEMENT_2	23	Heating element 2 failure
FC_ELEMENT_3	24	Heating element 3 failure
FC_ELEMENT_4	25	Heating element 4 failure
FC_TEMP_SENSOR_3	26	Temperature sensor 3 error
FC_TEMP_SENSOR_4	27	Temperature sensor 4 error
FC_TEMP_SENSOR_5	28	Temperature sensor 5 error
FC_TEMP_SENSOR_6	29	Temperature sensor 6 error
FC_TEMP_SENSOR_7	30	Temperature sensor 7 error
FC_TEMP_SENSOR_8	31	Temperature sensor 8 error
FC_LEAK_WATER_DETECTED	32	Water leak detected
FC_LEAK_DISCONECTED	33	Leak detector detached
FC_POWERED_ANODE_SHORT	34	Anode shorted or dirty
FC_POWERED_ANODE_NO_WATER	35	Anode disconnected or no water
FC_FLAME_ROD_SHORTED	36	Flame rod shorted to tank
FC_FLAME_WEAK	37	Flame signal low warning Check low gas pressure or flame rod position in flame
FC_FLAME_OUT_OF_SEQEUENCE	38	Flame detected when gas off Gas valve may be leaking
FC_FLAME_LOCKOUT	39	Flame Lockout 3 Retries light or re-ignite failure led to lockout due to low gas or igniter failure
FC_24VAC	40	Control transformer out of range
FC_FLAMABLE_VAPOR_SENSED	41	Flammable vapor detected
FC_WATER_TEMP_HIGH_WARNING	42	Tank high temperature warning Temperature exceeds setpoint selectable limit
FC_RTC_NOT_SET_WARNING	43	Set Real Time Clock
FC_FLOW_SWITCH_ERR	44	Flow switch Flow switch open or closed in wrong system state.
FC_ANODE_DEPLETED_WARNING	45	The anode depleted detected The SAC logic
FC_RTC_BATTERY_LOW_ENERGY	46	The energy of battery which is for the RTC is low
FC_CUTOFF_VALVE_ERR	47	Cut off valve error
FC_MIXING_VALVE_ERR	48	Mixing valve error
FC_BACKUP_BATTERY_LOW	49	The voltage of system's backup energy is low
FC_TEMP_SENSOR_FLUE	50	Flue Temperature sensor error

Notes
1. **Not all faults are applicable to Cyclone Flex**
2. **When faults are active, the heater will shut down**
3. **When warnings are active, the heater continues to operate**

Table 7. Fault/Warning Count Enumerated Values		
Name	Value	Description
FC_AIR_FILTER_CLEAN_WARNING	82	The air filter is dirty
FC_CONDENSATE_WATER_PUMP_ERR	82	Condensate pump fault detected
FC_COMPRESSOR_FREQ_CYCLE_ERR	83	The compressor is starting/stopping frequently
FC_COMPRESSOR_LOW_PRESSURE_ERR	84	Heat pump suction pressure is too low
FC_COMPRESSOR_ERR	85	Compressor is not functioning correctly
FC_DISCHARGE_TEMP_HIGH_ERR	86	The discharge temperature is too high
FC_DC_FAN_FEEDBACK_ERR	87	The RPM feedback of DC fan is not right
FC_ECO_FLUE	201	Flue high temperature Energy Cut Off
FC_PRESSURE_SWITCH_INLET	202	Blocked inlet air detected
FC_PRESSURE_SWITCH_OUTLET	203	Blocked outlet air detected
FC_PRESSURE_SWITCH_BLOWER_PROVE	204	Blower activation not proved
FC_PRESSURE_SWITCH_GAS	205	Insufficient Gas Pressure
FC_KEY_CONFIGURATION	206	Corrupted configuration key information
FC_MODULE_MISSING_CPAM	207	Missing CPAM per heater configuration
FC_MODULE_MISSING_GAS_CNTL	208	Missing gas safety control module
FC_MODULE_MISSING_INPUT_OUTPUT	209	Missing Input Output module
FC_CONDENSATE_BLOCKED	210	Blocked condensate detected
FC_AUTO_TEST_COMPLETE	211	Auto test complete notification
FC_BLOWER_SPEED	212	Blower speed is out of range
FC_GAS_CNTL_T_SENSOR	213	Safety control sensor error
FC_GAS_CNTL_HARDWARE_ERR	214	Safety control hardware fault
FC_GAS_CNTL_SOFTWARE_ERR	215	Safety control software fault
FC_GAS_CNTL_CALIBRATION_ERR	216	Safety control calibration error
FC_GAS_VALVE_ERR	217	Gas valve operation error
FC_GAS_CNTL_STEPPER_ERR	218	Safety control stepper motor failed to change flame signal
FC_CPAM_MODULE_OPEN_NO_WATER	219	External Powered Anode open or no water
FC_CPAM_MODULE_SHORT	220	External Powered Anode shorted to tank
FC_CPAM_MODULE_HW_OR_SW	221	External Powered Anode circuit or software failure
FC_RESET_LOCKOUT	222	Safety control too many resets in short time resulting in lockout
FC_MODULE_MISSING_KEY	223	Missing Configuration KEY
FC_MODULE_MISSING_DISPLAY	224	Missing display
FC_CCB_SW_OR_HW_OLD	225	Controller Software or hardware older than original shipped with heater

Notes
1. **Not all faults are applicable to Cyclone Flex**
2. **When faults are active, the heater will shut down**
3. **When warnings are active, the heater continues to operate**

Table 7. Fault/Warning Count Enumerated Values		
Name	Value	Description
FC_DISPLAY_SW_OR_HW_OLD	226	Display Software or hardware older than original shipped with heater
FC_POWERED_ANODE_HW_OR_SW	227	Internal Powered Anode circuit or software failure
FC_NFC_KEY_SW_OR_HW_OLD	228	NFC Key software or hardware revision not compatible

Notes
1. **Not all faults are applicable to Cyclone Flex**
2. **When faults are active, the heater will shut down**
3. **When warnings are active, the heater continues to operate**