SYSTEM-10

BTU Meter Dual Network Interface
Installation and Operation Guide
BACnet & MODBUS



ONICON
Flow and Energy Measurement

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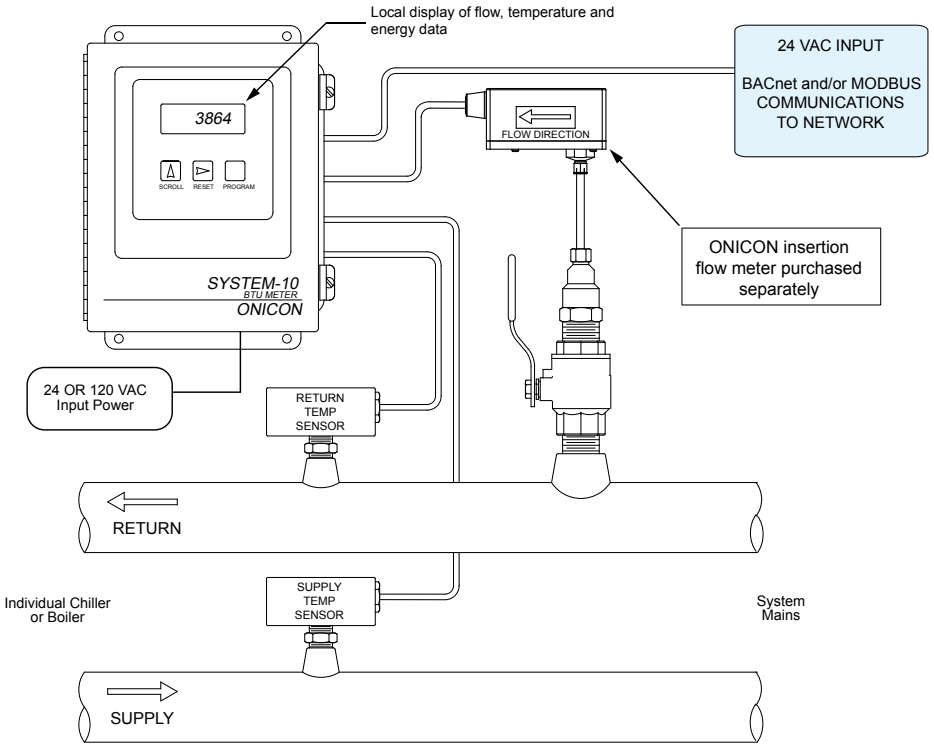
SECTION 1: INTRODUCTION

1.1 PURPOSE OF THIS GUIDE

The purpose of this guide is to provide installation and commissioning procedures and basic operating and servicing instructions for the ONICON System-10 Dual Network BTU Meter
Network Interface.

1.2 TYPICAL SYSTEM-10 BTU METER

ONICON'S System-10 BTU meter is a true heat (BTU) computer which accepts data from several sensors, performs a series of computations with that data, and displays and/or transmits the results as an indication of the amount of heat (BTU's) being transferred per unit time or as a totalized amount.



1.3 SPECIFICATIONS

RS485 (BACnet MS/TP or MODBUS RTU)

Transceiver: 2-wire, half-duplex
Baud rate: 9600, 19200, 38400 & 76800
Termination: 120 ohms or none (Default: none)
Biasing: None
Flow control: None

BACnet UDP/IP & MODBUS TCP/IP

Transceiver: 10Base T, 10Mbps, Rj45 connection
Default IP address: 192.168.1.24
Default Subnet Mask: 255.255.255.0
BACnet Port: 47808
MODBUS Port: 502
Flow control: None

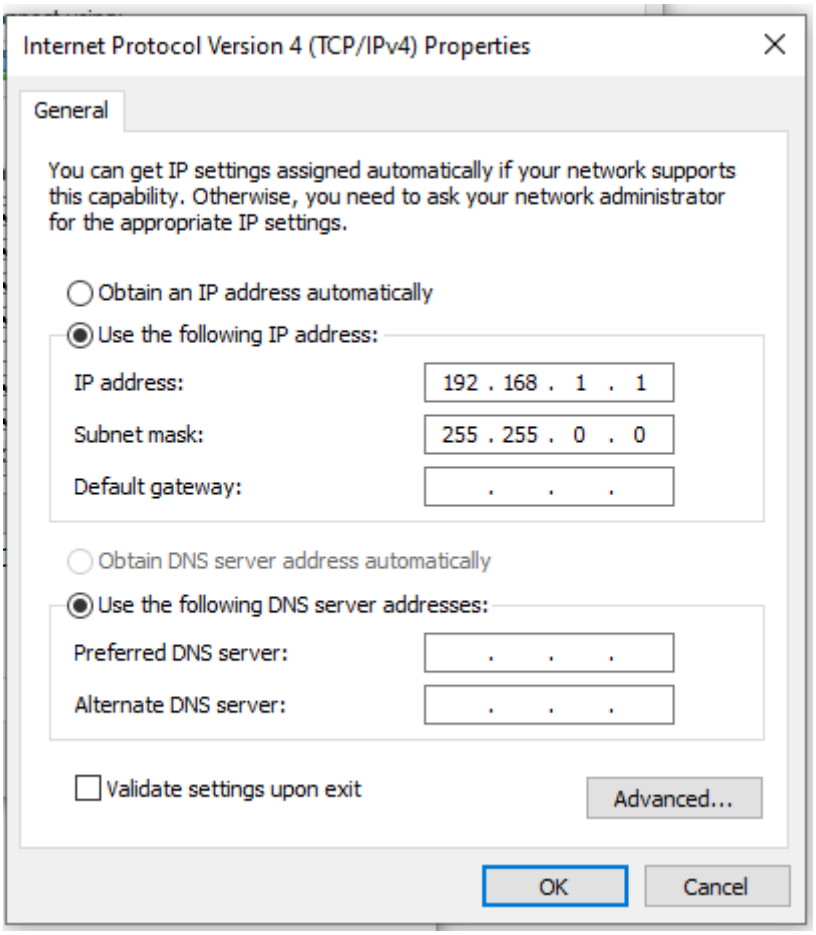
Address Ranges

MODBUS device address range: 1 – 127 (Default: 017)
BACnet device address range: 1 – 127 (Default: 017)
BACnet Device Instance range: 0 - 4,194,303 (Default: 57017)

1.4 PROTOCOL SELECTION

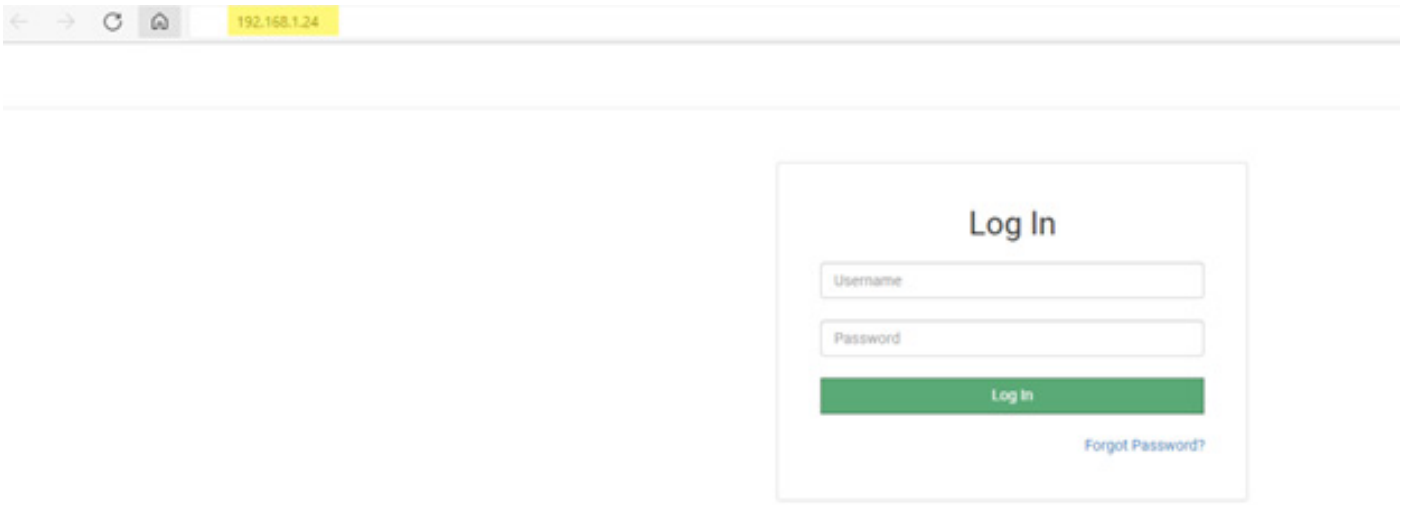
The System-10 Dual Network BTU meter is provided with an IP connection and a single RS485 connection. Both MODBUS TCP/IP and BACnet UDP/IP are always available from the IP connection via a single IPv4 IP address. The RS485 connection can be configured for BACnet MS/TP or MODBUS RTU. The protocol options are selected via a web configurator page. Configuring the protocol requires the use of a PC with an Ethernet card and an available port:

PC IP Address 192.168.1.1
Mask 255.255.0.0

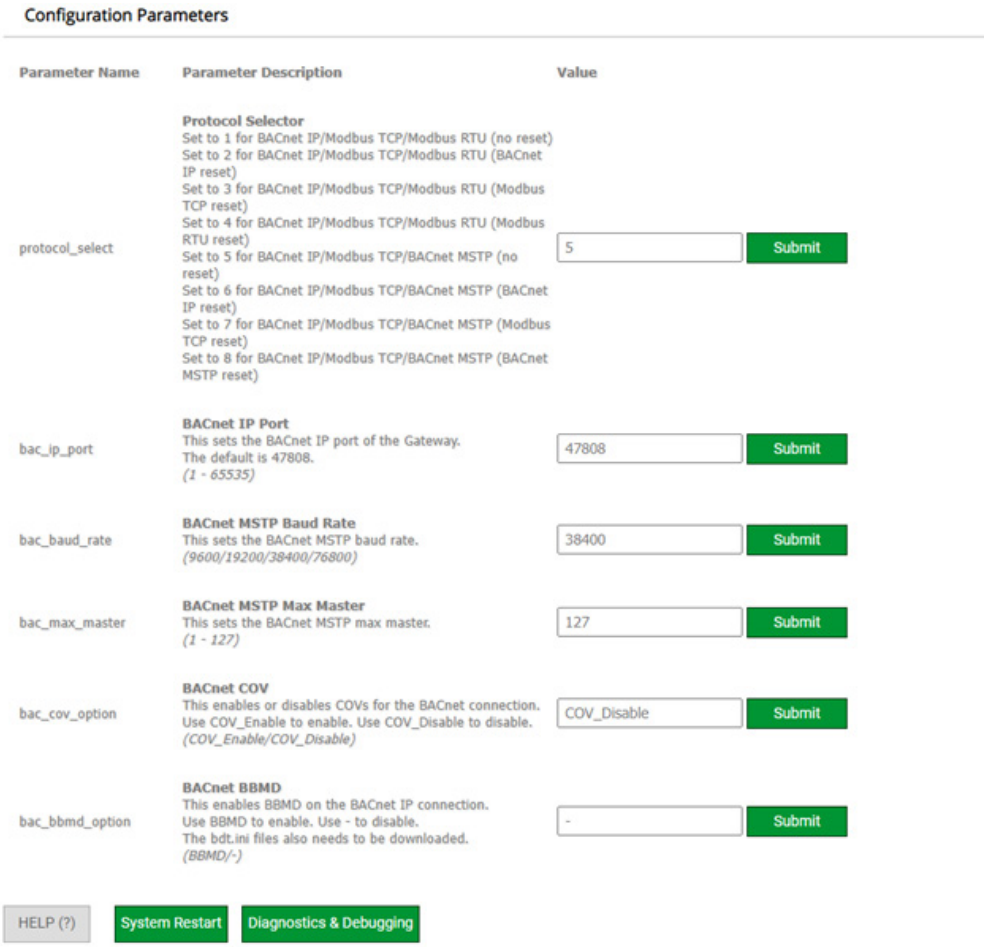


The default IP configuration of the System-10 is as follows:
IP Address 192.168.1.24
Mask 255.255.0.0

Enter the Meter IP Address into the browser and use the default username (default is “admin”) and password. There is a QR code in the top right corner of the ethernet port with the password. The password is also located in ethernet port label.



On the web configurator page, the first configuration parameter is the Protocol Selector. Please set the number based on the desired communication protocol. Only one protocol is allowed to remotely reset totals on the network.



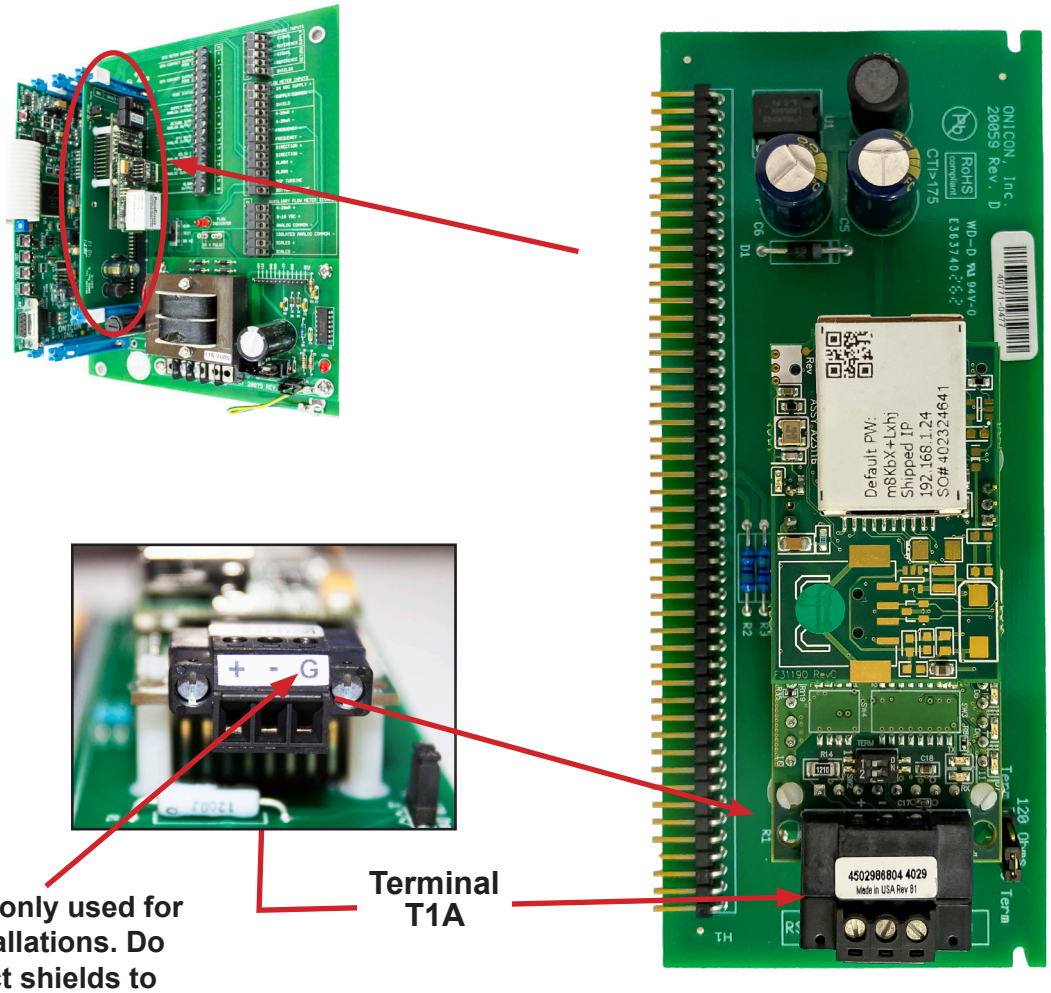
1.5 NETWORK SIGNAL CONNECTIONS

1.5.1 RS485

Use 18 – 22 twisted shielded cable for RS485, 2-wire (half-duplex) serial communications. The cable is connected to terminal T1A. Do not exceed 4.4 in-lb (0.5 Nm) of torque when tightening the terminals.

CAUTION

Only qualified service personnel should make connections between the System-10 BTU Meter and the user's external equipment. ONICON assumes no responsibility for damage caused to the external equipment as a result of an improper installation.



CAUTION

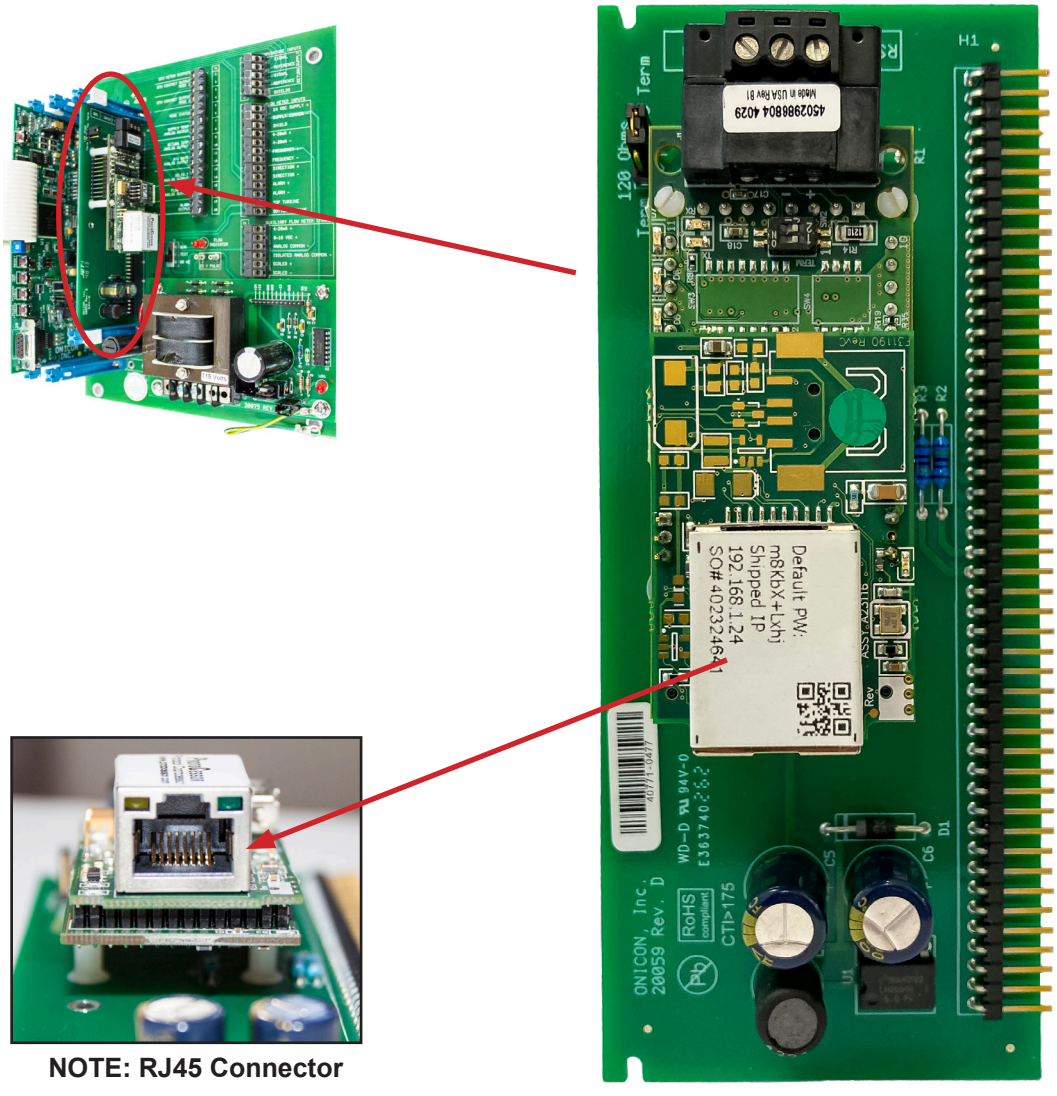
Incoming and outgoing RS485 cable shield wires should be connected together, but must not be connected to the BTU meter.

1.5.2 BACnet/IP and/or MODBUS TCP/IP

BACnet and/or MODBUS, 10Base T output connections are made through a single Rj45 connector as shown.

CAUTION

Only qualified service personnel should make connections between the System-10 BTU Meter and the user's external equipment. ONICON assumes no responsibility for damage caused to the external equipment as a result of an improper installation.



NOTE: RJ45 Connector

T1B

1.5.3 Optional Network Interface With Isolated Digital Pulse Input (Di3)

The System-10 BTU Meter can be provided with an auxiliary pulse input for totalizing pulse outputs from external devices such as water or gas meters. Pulses are accumulated in an internal register. The totalized value is shown on the display and is available on the network. This register can be zeroed via the network. The maximum register total is 9,999,999. The register will rollover to zero when this value is exceeded.

If the auxiliary pulse input option was ordered at the same time the BTU Meter was ordered, it will arrive fully configured and ready to use. If it was ordered after the BTU Meter was delivered and is being installed as a field upgrade, it may be necessary to configure the pulse input. The information required to configure the input is provided below and on the following pages:

The input pulse must meet the following criteria:

1. Frequency input range, 50 Hz maximum
2. 10 millisecond minimum pulse duration

Input Pulse Definition:

In order to configure the communications card auxiliary pulse input, you must first determine which type of pulse your meter produces. The allowable types of input pulses are described on the following pages. Based on the type of pulse, set the selector switch (S1) on the communications circuit board (Fig. 1) to the correct setting.

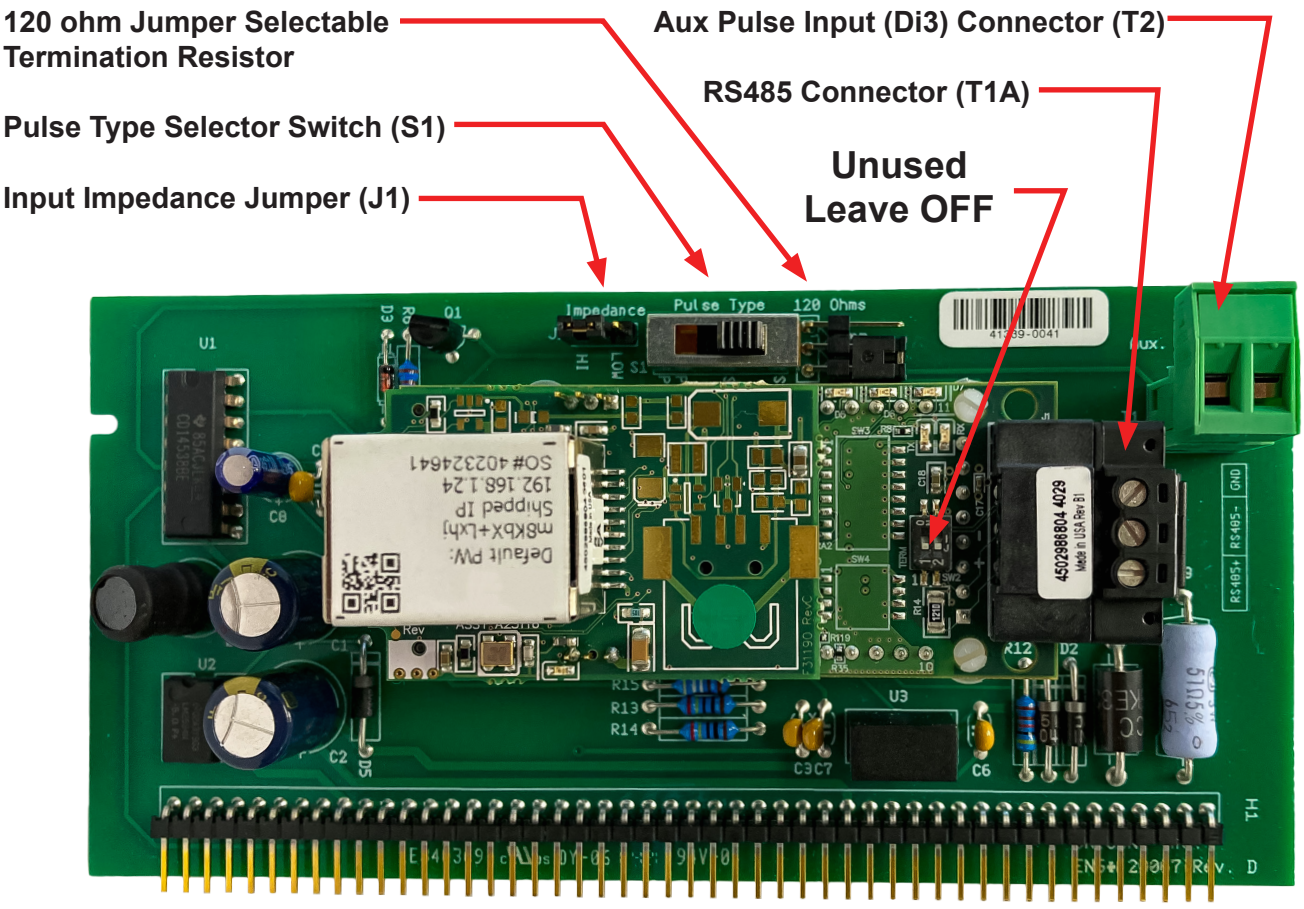


Fig. 1

Powered Pulse:

This type of output refers to a pulse which has an associated voltage with it (see Fig. 2). Set the selector switch, S1 to Pwrd Pulse. The allowable voltage range is 5-24 VDC. The input impedance is set at the factory to be 11 KOHM via the impedance selector jumper (J1, see Fig. 1). A lower impedance, 3 KOHM can be selected if required by the instrument providing the pulse output. Consult the instrument manufacturer or ONICON if you are uncertain as to the proper jumper selection.

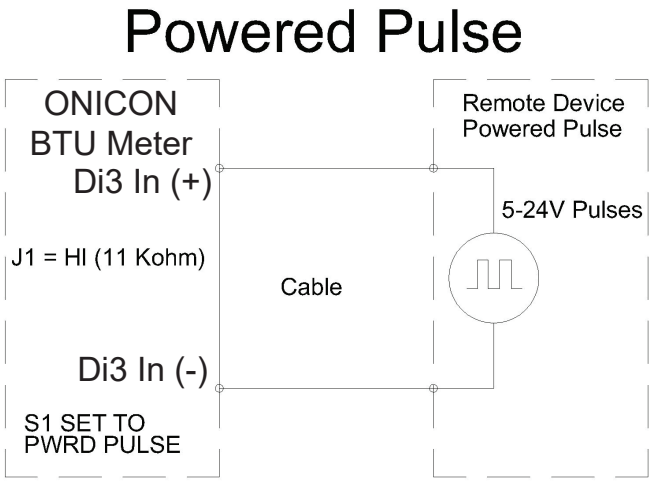


Fig. 2

Open Collector (Sourcing):

This type of output refers to an open Collector Switch configured for a sourcing function (see Fig. 3). Set the selector switch, S1 to SRC. The switch must be rated for at least 20 mA at 20 VDC.

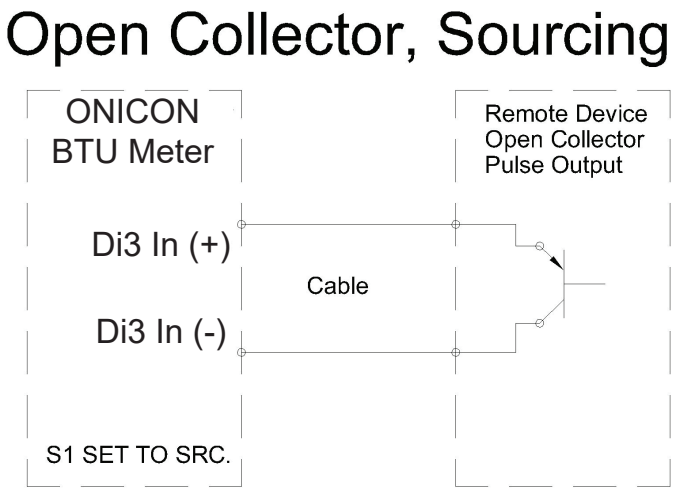


Fig. 3

Open Collector Sinking or Dry Contact:

This type of output refers to an open collector switch configured in a current sinking arrangement or a dry contact switch (see Fig. 4 and 5). Set the selector switch, S1 to Sink. In either case, the switch must be rated for at least 20 mA at 20 VDC.

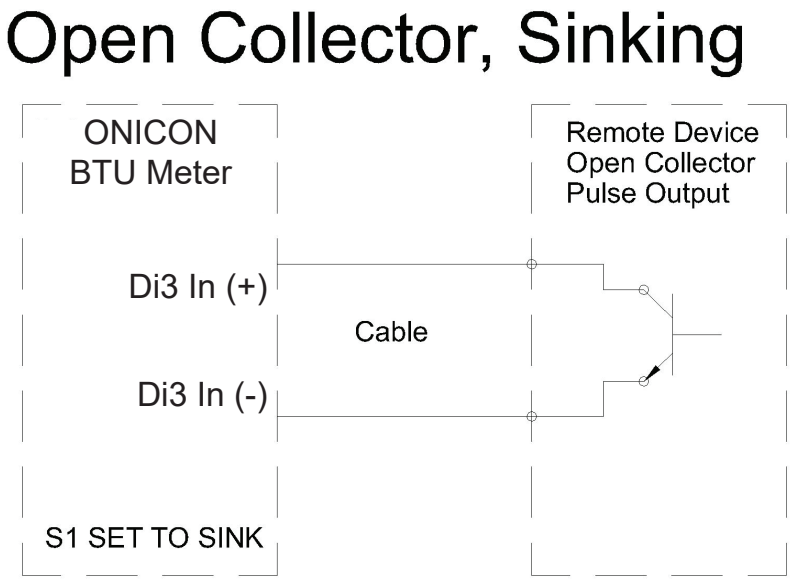


Fig. 4

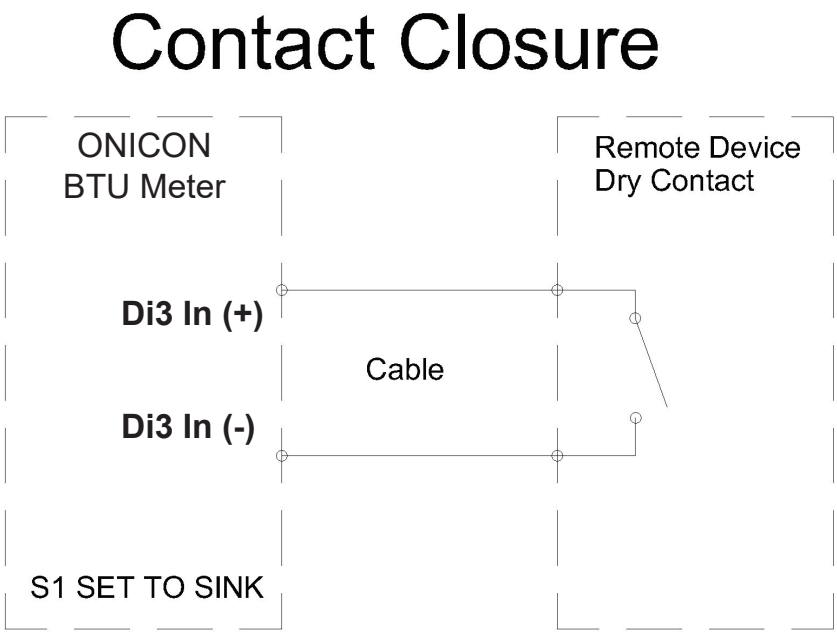
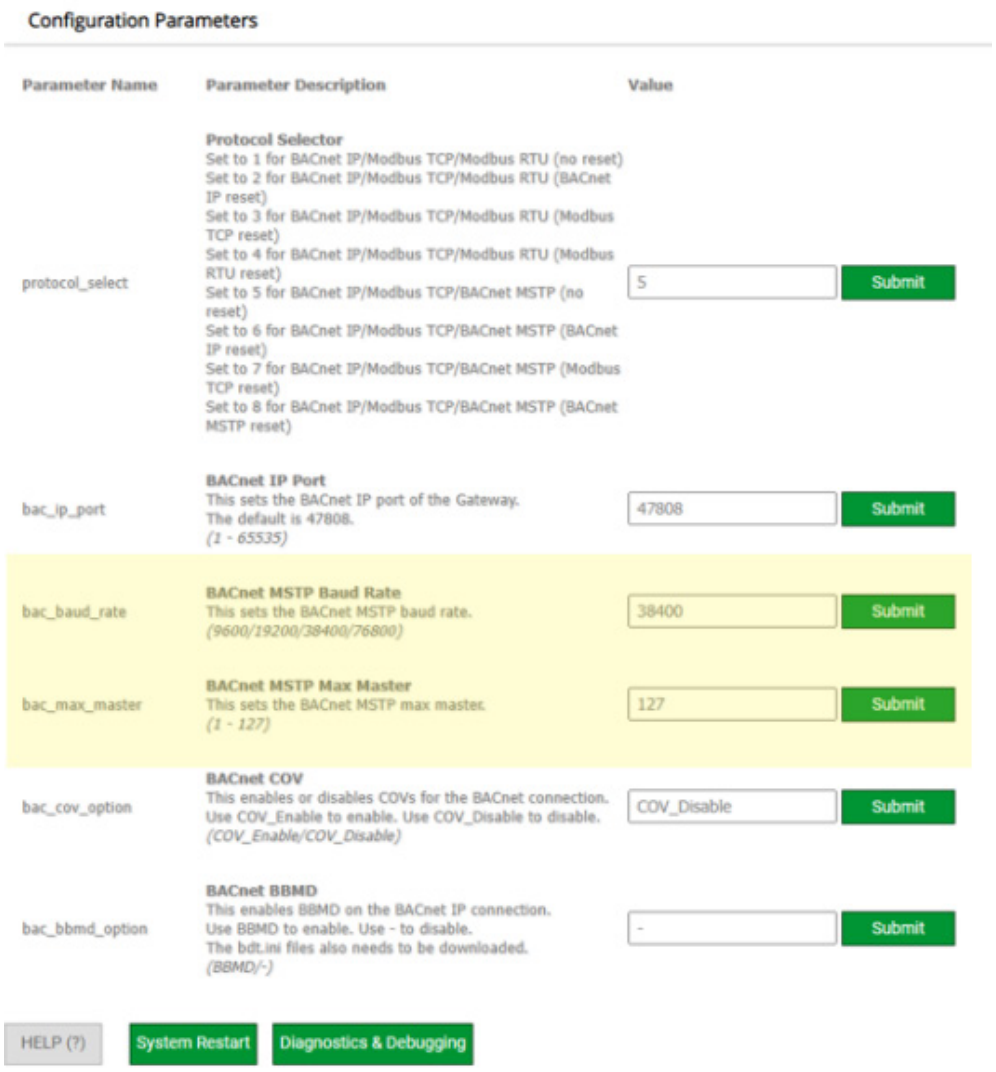


Fig. 5

1.6 BACnet MS/TP BAUD RATE, BIASING & TERMINATION

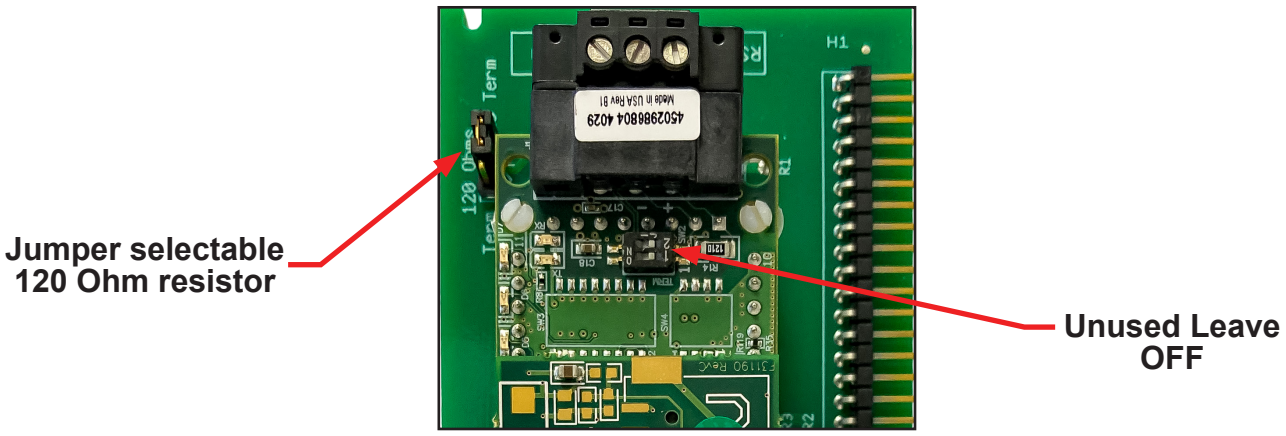
1.6.1 Baud Rate

Every ONICON System-10 BTU meter is individually programmed at the factory with application specific data provided by the customer during the process of ordering the meter, and this normally includes the Baud rate setting. If the Baud rate was provided, the meter will be configured to operate at the specified rate. The standard Baud rate settings are 9600, 19200, 38400 and 76800 Baud. The Baud rate setting is selected using web configurator page. Step on how to access to the web configurator page are covered in section 1.4. The picture below shows the BACnet MSTP Baud rate in the web configurator page. (Modbus Baud rate will show if Modbus RTU is selected as the protocol in section 1.4)



1.6.2 Biasing and Termination

The ONICON System-10 does not provide biasing voltage to the RS485 network. A jumper selectable 120Ω termination resistor is provided as show below. The termination resistor should only be used when the meter is installed at the end of the line.



NOTE: See Fig. 1 on page 8 to locate the termination resistor on network interface board with auxiliary input.

1.7 NETWORK ADDRESSING

Before the System-10 can communicate on the BACnet and or MODBUS networks, the appropriate addresses must be programmed into the BTU meter.

For RS485 networks a device address is required. BACnet also requires a device instance number. Both must be assigned through the BTU meter. Section 1.7.1 details the procedure for changing both the device address and the device instance number.

For IP networks, an IP address is required. BACnet/IP networks also require a device instance number. In addition, managed IP networks may require a gateway address. The procedure for assigning the device instance number is detailed in section 1.7.1. The procedure for entering the IP address and the gateway address is detailed in section 1.7.2.
It requires the use of a PC with an Ethernet card, Ethernet cable and an available port.

1.7.1 Changing the MAC Address and Device Instance Number

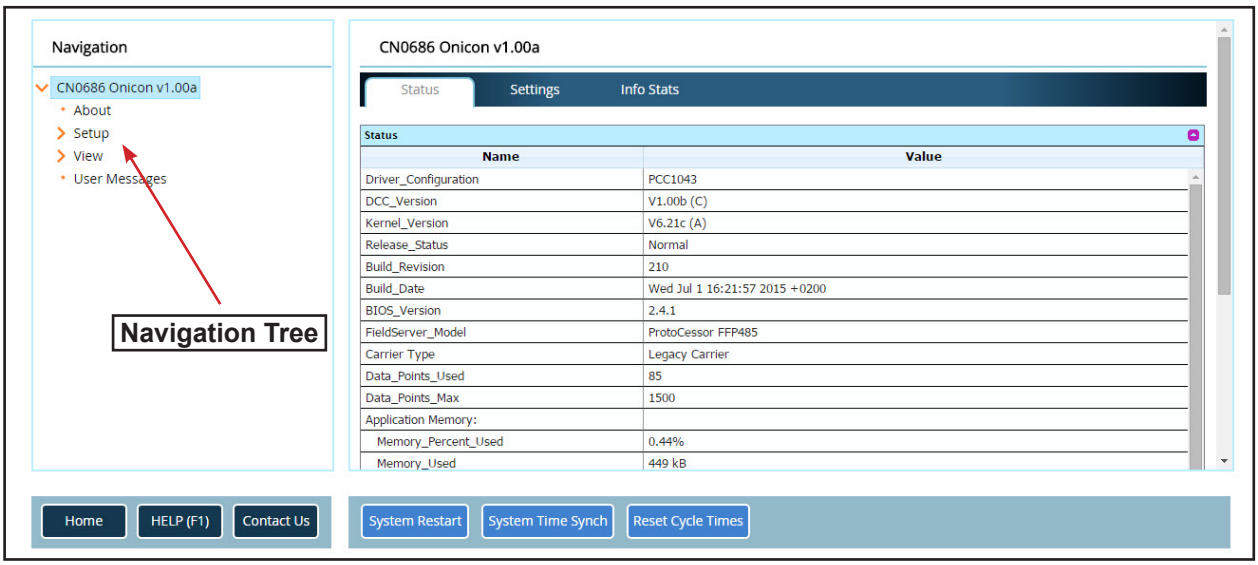
To communicate via RS485, the BTU meter must be assigned a device address (Station I.D.). BACnet MS/TP networks also require a device instance number (Node I.D.). The BACnet/IP interface does not require a device address, only the device instance number. The device address can be any number from 001 – 127. The device instance number can be any number from 0 – 4,194,303. Both addresses are entered via the System-10 user interface on the front panel of the meter. The procedure for entering or changing either the device address or the device instance number is outlined in the table on the next page.

STEP	ACTION	REACTION	COMMENT
0	Obtain device address & device instance number from the network administrator.	None.	The device address is a three digit number from 001 – 127. The device instance number can be anything from 0 – 4,194,303.
1	With the meter running, open the front panel, locate and momentarily press the pushbutton switch DEV ADD / PROG ENAB.	None.	DEV ADD / PROG ENAB is located in the lower left corner of the System-10 processor board next to the DB9 connector (See appendix page A-1).
2	Momentarily press the PROGRAM pushbutton on the front panel of the display. If this is not done, the display will revert to the RUN mode after 5 minutes.	The System-10 will change to the PROGRAM mode. The top line of the LCD will indicate PPPPPPPP. The second line will read DEVICE ID and the first digit of the 3 digit MAC address will be blinking.	The PROGRAM pushbutton is on the front panel.
3	Successively press the SCROLL pushbutton to increment the number to the desired value from 0 – 9.	The blinking number increments by one each time you press the SCROLL pushbutton.	The SCROLL pushbutton is on the front panel.
4	Momentarily press the RESET pushbutton once.	The second digit will now be blinking.	The RESET pushbutton is on the front panel.
5	Successively press the SCROLL pushbutton to increment the number to the desired value from 0 – 9.	The blinking number increments by one each time you press the SCROLL pushbutton.	The SCROLL pushbutton is on the front panel.
6	Momentarily press the RESET pushbutton once.	The third digit will now be blinking.	The RESET pushbutton is on the front panel.
7	Successively press the SCROLL pushbutton to increment the number to the desired value from 0 – 9.	The blinking number increments by one each time you press the SCROLL pushbutton.	The SCROLL pushbutton is on the front panel.
8	Once the correct address is displayed, momentarily press the PROGRAM pushbutton.	The INSTANCE page is now displayed with the first digit of the device instance number blinking.	The PROGRAM pushbutton is on the front panel.
9	Use the SCROLL pushbutton and RESET pushbutton as described above to enter the new device instance number.	Each digit will increment and the RESET pushbutton will advance the blinking cursor to the next digit.	The SCROLL pushbutton and the RESET pushbutton are on the front panel.
10	Once the correct address is displayed, momentarily press the PROGRAM pushbutton.	The FM LOCN page appears with UNKNWN defaulted as the current location.	The PROGRAM button is on the front panel.
11	Press the SCROLL button.	The setting will toggle between UNKNOWN, SUPPLY, and RETURN.	Refer to Section 4.5 of the System-10 Installation and Operation Guide if you wish to change the settings.
12	Press the PROGRAM button.	The FRONT PANEL RESET page appears.	It is not necessary to change anything on this page.
13	Momentarily press the PROGRAM pushbutton.	The SAVE CHANGES page appears.	The new addresses must be saved to take effect.
14	Momentarily press the SCROLL pushbutton.	The “N” changes to “Y” on the SAVE CHANGES page.	The “Y” must be selected in order for the new addresses to take effect.
15	Momentarily press the PROGRAM pushbutton.	The new addresses are saved and the display will revert to the RUN mode.	

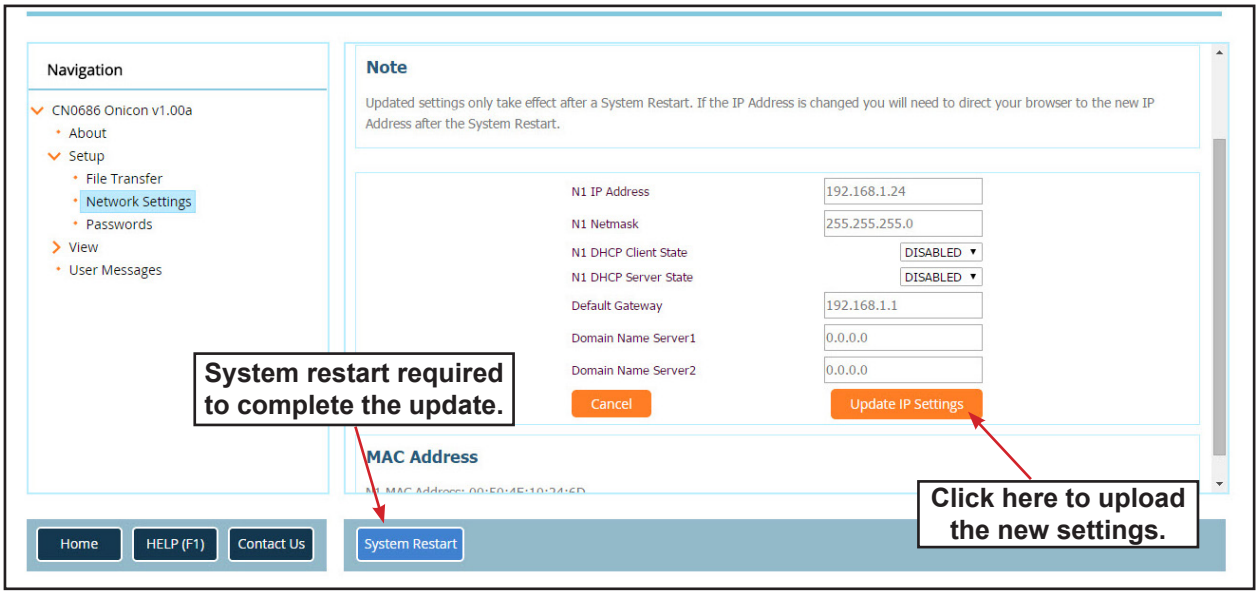
1.7.2 Changing the IP Address, Subnet mask and Gateway Address

Changing the IP address requires a PC with an Ethernet card and an available port. The network interface is accessed using a web browser such as Internet Explorer. Both the PC and the BTU meter must be configured to operate on the same IP network. Assuming the BTU meter is programmed with the default address of 192.168.1.24, configure the PC to operate with an IP address of 192.168.1.1 and a subnet mask of 255.255.255.0. Follow the procedure outlined below to edit the IP address, subnet mask and gateway address.

1. Connect an RJ45 Ethernet cable between the PC and the System-10 and power the BTU meter. Allow 60 seconds for the display firmware to cycle through start-up diagnostic routines.
2. Open Internet Explorer and enter an address of http://192.168.1.24.
3. From navigation tree on the right in the image below, select setup and then network settings.



4. Enter the new IP address, subnet mask and gateway address as needed. Click on Update IP Settings to update the settings and then click on System Restart to complete the update.



BACnet Protocol

Date: August 16, 2005
Vendor Name: ONICON Incorporated
Product Name: System-10 Btu Meter
Product Model: SYSTEM-10-BAC

Product Description: The System-10 BTU Meter provides highly accurate thermal energy measurement in chilled water, hot water and condenser water systems based on signal inputs from two matched temperature sensors (included) and any of ONICON's insertion or inline flow meters (ordered separately). The System-10-BAC provides energy, flow and temperature data on a local alphanumeric display and to the network via the BACnet communications MS/TP driver. An optional auxiliary input is also available to totalize pulses from another device and communicate the total directly to the network.

BACnet Standardized Device Profile (Annex L):

- [X] BACnet Smart Sensor (B-SS)
- [X] BACnet Smart Actuator (B-SA)
- [X] BACnet Application Specific Controller (B-ASC)

BACnet Interoperability Building Blocks Supported (Annex K):

- [X] K.1.2 BIBB – Data Sharing – ReadProperty-B (DS-RP-B)
- [X] K.1.8 BIBB – Data Sharing – WriteProperty-B (DS-WP-B)
- [X] K.5.2 BIBB – Device Management – Dynamic Device Binding-B (DM-DDB-B)

Segmentation Capability:

None

Standard Object Types Supported:

- [X] Device Object
- [X] Analog Input
- [X] Analog Output
- [X] Analog Value
- [X] Binary Input
- [X] Binary Output
- [X] Binary Value
- [X] Multi State Input Output
- [X] Multi State Output
- [X] Multi State Value

For all these properties the following apply:

1. Does not support BACnet CreateObject
2. Does not support BACnet DeleteObject
3. Does not support any optional properties
4. No additional writeable properties exist
5. No proprietary properties exist
6. No range restrictions exist

Data Link Layer Options:

- [X] MS/TP master (Clause 9), baud rate up to 76800 bps
- [X] MS/TP slave (Clause 9), baud rate up to 76800 bps

Device Address Binding:

Not supported

Character Sets Supported:

- [X] ANSI X3.4.

SYSTEM-10 BTU Meter BACnet/IP Driver
Protocol Implementation Conformance Statement (PICS)

BACnet Protocol

Date: July 6, 2007
Vendor Name: ONICON Incorporated
Product Name: System-10 Btu Meter
Product Model: SYSTEM-10-BAC-IP

Product Description: The System-10 BTU Meter provides highly accurate thermal energy measurement in chilled water, hot water and condenser water systems based on signal inputs from two matched temperature sensors (included) and any of ONICON's insertion or inline flow meters (ordered separately). The System-10-BAC provides energy, flow and temperature data on a local alphanumeric display and to the network via the BACnet/IP communications driver. An optional auxiliary input is also available to totalize pulses from another device and communicate the total directly to the network.

BACnet Standardized Device Profile (Annex L):

☒ BACnet Smart Sensor (B-SS)
☒ BACnet Smart Actuator (B-SA)
☒ BACnet Application Specific Controller (B-ASC)

BACnet Interoperability Building Blocks Supported (Annex K):

☒ K.1.2 BIBB – Data Sharing – ReadProperty-B (DS-RP-B)
☒ K.1.8 BIBB – Data Sharing – WriteProperty-B (DS-WP-B)
☒ K.5.2 BIBB – Device Management – Dynamic Device Binding-B (DM-DDB-B)

Segmentation Capability:

None

Standard Object Types Supported:

☒ Device Object
☒ Analog Input
☒ Analog Output
☒ Analog Value
☒ Binary Input
☒ Binary Output
☒ Binary Value
☒ Multi State Input Output
☒ Multi State Output
☒ Multi State Value

For all these properties the following apply:

1. Does not support BACnet CreatObject
2. Does not support BACnet DeleteObject
3. Does not support any optional properties
4. No additional writeable properties exist
5. No proprietary properties exist
6. No range restrictions exist

Data Link Layer Options:

☒ BACnet IP (Annex J)

Networking Options:

☒ BACnet/IP Broadcast Management Device (BBMD)

Does the BBMD support registrations by Foreign Devices? ☒Yes

Device Address Binding:

Not supported

Character Sets Supported: ☒ ANSI X3.4.

2.2 BAC OBJECTS

The System-10 BTU Meter operates in one of three operating modes: single, dual or bi-directional. The table below contains point information for each of the operating modes.

In single mode operation, only one register accumulates energy and one register accumulates volume. Thus, only two AV points and two BV reset points are necessary.

BACNET OBJECT	OBJECT DESCRIPTION	UNITS	NOTES
Analog Input 1	Energy Rate	BTU/Hr, kW or Tons	
Analog Input 2	Volume Rate	L/Sec, L/Min, L/Hr, M^3/Hr, GPM, CFS or CFM	
Analog Input 3	Supply Temperature	Degrees C or F	
Analog Input 4	Return Temperature	Degrees C or F	
Analog Value 1	Mode 1 Energy Total	BTU, TonHrs or kWHrs	
Analog Value 2	Mode 1 Volume Total	Liters, M^3, Gallons or Ft^3	
Analog Value 3	Mode 2 Energy Total	BTU, TonHrs or kWHrs	Only used in dual-mode applications.
Analog Value 4	Mode 2 Volume Total	Liters, M^3 or Gallons	Only used in dual-mode applications.
Analog Value 5	Auxiliary Input Total (Di3)	None	BACnet will not report engineering units for this object.
Analog Value 6	Operating Mode (Single, Dual or Bi-directional)	Not Applicable	None = 0 Single = 1 Dual = 2 BiDir = 3
Analog Value 12	Mode 1 Mode 2 Indication	Not Applicable	Mode 1 = 1 Mode 2 = 2
Binary Value 11	Zero Mode 1 Energy Total	Not Applicable	Changing this property from the (0) inactive state to the (1) active state will reset the total to zero. (Must be priority 8 manual operator).
Binary Value 12	Zero Mode 1 Volume Total	Not Applicable	
Binary Value 13	Zero Mode 2 Energy Total	Not Applicable	
Binary Value 14	Zero Mode 2 Volume Total	Not Applicable	
Binary Value 15	Zero Auxiliary Input Total	Not Applicable	

2.3 ADDITIONAL BACnet® OBJECT INFORMATION

BACnet® Object Type and Number of Objects Implemented

Device	1
Analog Input	4
Analog Value	7
Binary Value	5

Property	Default Value	Read-only or Writable	Comment
Object Identifier	Device - 57017	Writable	0-4,194,303
Object Name	BTU Meter - 57017	Writable	50 char. Max
Object Type	Device	Read-only	
System Status	Operational	Read-only	
Vendor Name	ONICON Incorporated	Read-only	
Model Name	BTU Meter	Read-only	
Firmware Rev.	v2.08e	Read-only	
Location	-	Writable	36 char. Max
Protocol Version	1	Read-only	
Protocol Revision	12	Read-only	
Services Supported	Subscribe COV, read Property, read Property Multible, Write Property, Write PRoperty Multiple, device Communication Control, reinitialize Device, time Synchronization, who-Has, who-Is	Read-only	
Object Types Supported	Analog input, Analog value, Binary value	Read-only	
Object List	(Device, 57017), (analog input, 1 – 4), (analog value, 1 – 13), (binary value, 11 – 15)	Read-only	
Max ADPU Length	1458	Read-only	
Segmentation Supported	NO_SEGMENTATION (3)	Read-only	
APDU Timeout	10000	Read-only	
# of APDU Retries	3	Read-only	
Max Master	127	Read-only	
Device Address Binding		Read-only	Active
Database Revision	3	Read-only	

2.4 Analog Input(s)

Property	Default Value	Read-only or Writable
Object Identifier	Analog input 1 to 4	Read-only
Object Name	Various	Read-only
Object Type	Analog-input	Read-only
Present Value	REAL	Writable
Status Flags	(F,F,F,F)	Read-only
Event State	normal	Read-only
Reliability	No-fault-detected	Read-only
Out-of-Service	FALSE	Writable
Units	Various	Read-only
Description	Various	Writable
Min-Present-Value	-1000000000	Read-only
Max-Present-Value	1000000000	Read-only
Resolution	0.000001	Read-only

Analog Input Objects	
Object Identifier	Function
Analog input 1	Energy rate
Analog input 2	Volume rate
Analog input 3	Supply temperature
Analog input 4	Return temperature

BACnet Engineering Units for Analog Inputs (Defaults)
Energy rate: **BTU/h**, tons, kW
Volume rate: l/s, l/m, l/hr, m3/h, **gpm**, ft3/s, ft3/m
Temperature: **°F** or °C

2.5 Analog Value(s)

Property	Default Value	Read-only or Writable
Object Identifier	Analog value 1 to 13	Read-only
Object Name	Various	Read-only
Object Type	Analog-value	Read-only
Present Value	REAL	Writable
Status Flags	(F,F,F,F)	Read-only
Event State	normal	Read-only
Reliability	No-fault-detected	Read-only
Out-of-Service	FALSE	Writable
Units	Various	Read-only
Description	Various	Writable
Priority Array	{NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL}	Read-only
Relinquish Default	0	Read-only

Analog Value Objects	
Object Identifier	**Function**
Analog value 1	Mode 1 Energy Total
Analog value 2	Mode 1 Volume Total
Analog value 3	Mode 2 Energy Total
Analog value 4	Mode 2 Volume Total
Analog value 5	Aux Input Total
Analog value 6	Operating Mode
Analog value 12	Mode 1 Mode 2 Indication
Analog value 13	BACnet Instance

Analog value 7-11 are used internally only.

BACnet Engineering Units for Analog Values **(Defaults)**

Energy: **BTU**, ton-hours, KW-hours
Volume: **gallons**, liters, ft3 or m3
Auxiliary pulse inputs: **No units** (counts)

2.6 Binary Value(s)

Property	Default Value	Read-only or Writable
Object Identifier	Binary value 11 to binary value 15	Read-only
Object Name	Various	Read-only
Object Type	Binary-value	Read-only
Present Value	0	Writable
Description	Binary-value,# Name	Read-only
Status Flags	(F,F,F,F)	Read-only
Event State	normal	Read-only
Reliability	No-fault-detected	Read-only
Out-of-Service	FALSE	Writable
Active Text	Active	Read-only
Inactive Text	Inactive	Read-only
Priority Array	(NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL)	Read-only
Relinquish Default	0	Read-only
Description	Various	Writable

Binary Value Objects		
Object Identifier	**Description**	**Notes**
Binary value 11	Zero Mode 1 Energy Total	Changing this property from the (0) inactive state to the (1) active state will reset the total to zero. (Must be priority 8 manual operator).
Binary value 12	Zero Mode 1 Volume Total	
Binary value 13	Zero Mode 2 Energy Total	
Binary value 14	Zero Mode 2 Volume Total	
Binary value 15	Zero Mode Aux Input Total	

SECTION 3.0: MODBUS MEMORY MAP

ONICON System-10 DUALNET BTU meters can be configured to provide energy and volume rate data, and totalized energy and volume data in a variety of engineering units via MODBUS RTU RS485 or MODBUS RTU TCP/IP. You select the engineering units you wish to use by mapping to the appropriate registers.

3.1 Modbus Register Format And Networking Information

1. All registers are 16 bit MODBUS Holding Registers.
2. MODBUS Holding Registers are used in 4 different ways.
   a. As an Analog Value: In some cases these values are scaled by multiplying the register contents by a fixed multiplier.
   b. As a status indicator where the register value can only be "1" or "2".
   c. As a mode indicator where the value indicates current operating mode such as "1" = single, "2" = dual, or "3" = bi-directional.
   d. As a control register where the host can write a value to reset total(s).
3. Registers 40001 through 40068 are unsigned integer registers (0 to 65,535) except for 40024 and 40025. These are 16 bit signed integer values (-32,768 to +32,767). Registers 41003 through 41081 are 32 bit single precision floating point values. 41001, 41002 and 41065 through 41069 are unsigned integer registers.
4. System-10 MODBUS register addresses are formatted as follows:

Example: address **4**0001

4 = Holding register

0001 = Address that corresponds to memory location 0000

5. MODBUS function codes supported:

CODE	DESCRIPTION
03	Read Holding Registers
06	Preset Single Registers
16	Preset Multiple Registers
17	Report Slave ID

IMPORTANT NOTE

ONICON provides data in integer and floating point format. We recommend the use of floating point registers to transmit data to the network. The use of floating point data eliminates the need for scaling and additional mathematical operations to totalize energy and flow.

3.2 Modbus Memory Map

Available Engineering Units

ENGINEERING UNITS	ABBREVIATION
Energy Rate	
BTU per hour	BTU/Hr
BTU per hour x 1,000	kBTU/Hr
BTU per hour x 1,000,000	MBTU/Hr
Watts x 1,000	kW
Watts x 10,000	kW x 10
Tons	Tons
Volume Rate (Flow)	
Gallons per minute	GPM
Gallons per minute x 10	GPM x 10
Gallons per hour	GPH
Million gallons per day	MGD
Liters per second	L/S
Liters per minute	L/M
Liters per hour	L/H
Cubic meters per hour	M^3/Hr
Cubic meters per hour x 10	M^3/Hr x 10
Cubic feet per second	Ft^3/S
Cubic feet per minute	Ft^3/M
Mass Rate (Mass flow) - Only available with F-2000 Flow Meter	
Pounds per hour	Lb/Hr
Pounds per hour x 10	Lb/Hr x 10
Kilograms per hour	kg/Hr
Kilograms per hour x 10	kg/Hr x 10
Temperature	
Degrees Fahrenheit	°F
Degrees Celsius	°C

ENGINEERING UNITS	ABBREVIATION
Energy Total	
BTU x 1,000	kBTU
BTU x 1,000,000	MBTU
BTU x 1,000,000,000	GBTU
Ton-hours	TonHr
Ton-hours x 1,000	kTonHr
Watt-hours x 1,000	kWHr
Watt-hours x 1,000,000	MWHr
Watt-hours x 1,000,000,000	GWHr
Volume Total	
Gallons x 1,000	kGal
Gallons x 1,000,000	MGal
Gallons x 1,000,000,000	GGal
Liters x 1,000	kLiters
Liters x 1,000,000	MLiters
Liters x 1,000,000,000	GLiters
Cubic Meters	M^3
Cubic Meters x 1,000	kM^3
Mass Rate (Mass flow) - Only available with F-2000 Flow Meter	
Pounds x 1,000	kLbs
Pounds x 1,000,000	MLbs
Kilograms x 1,000	Kkg
Kilograms x 1,000,000	Mkg

REGISTER ADDRESS	DESCRIPTION	REGISTER TYPE	DATA RANGE	OVER RANGE	READ/ WRITE	COMMENT
41001	Meter Operating Mode Indicator	Integer	1 – 3	Not applicable	Read Only	1 – indicates single mode 2 – indicates dual mode 3 – indicates bi-directional mode
41002	Mode Status Indicator	Integer	1 – 2	Not applicable	Read Only	1 - indicates heating mode or forward direction 2 - indicates cooling mode or reverse direction
REGISTER ADDRESS	**DESCRIPTION**	**REGISTER TYPE**			**READ/ WRITE**	**COMMENT**
41003	Energy Rate – BTU/Hr	Floating point register (1 of 2)			Read Only	
41004	Energy Rate – BTU/Hr	Floating point register (2 of 2)			Read Only	
41005	Energy Rate – kW	Floating point register (1 of 2)			Read Only	
41006	Energy Rate – kW	Floating point register (2 of 2)			Read Only	
41007	Energy Rate – Tons	Floating point register (1 of 2)			Read Only	
41008	Energy Rate – Tons	Floating point register (2 of 2)			Read Only	
41009	Volume Rate – GPM	Floating point register (1 of 2)			Read Only	
41010	Volume Rate – GPM	Floating point register (2 of 2)			Read Only	
41011	Volume Rate – GPH	Floating point register (1 of 2)			Read Only	
41012	Volume Rate – GPH	Floating point register (2 of 2)			Read Only	
41013	Volume Rate – MGD	Floating point register (1 of 2)			Read Only	
41014	Volume Rate – MGD	Floating point register (2 of 2)			Read Only	
41015	Volume Rate – L/S	Floating point register (1 of 2)			Read Only	
41016	Volume Rate – L/S	Floating point register (2 of 2)			Read Only	
41017	Volume Rate – L/M	Floating point register (1 of 2)			Read Only	
41018	Volume Rate – L/M	Floating point register (2 of 2)			Read Only	
41019	Volume Rate – L/H	Floating point register (1 of 2)			Read Only	
41020	Volume Rate – L/H	Floating point register (2 of 2)			Read Only	
41021	Volume Rate – M^3/Hr	Floating point register (1 of 2)			Read Only	
41022	Volume Rate – M^3/Hr	Floating point register (2 of 2)			Read Only	
41071	Volume Rate - Ft^3/S	Floating point register (1 of 2)			Read Only	
41072	Volume Rate - Ft^3/S	Floating point register (2 of 2)			Read Only	
41073	Volume Rate - Ft^3/M	Floating point register (1 of 2)			Read Only	
41074	Volume Rate - Ft^3/M	Floating point register (2 of 2)			Read Only	
41023	Mass Rate – Lb/Hr	Floating point register (1 of 2)			Read Only	Mass units are only available when using an F-2000 Series Vortex meter
41024	Mass Rate – Lb/Hr	Floating point register (2 of 2)			Read Only	
41025	Mass Rate – Kg/Hr	Floating point register (1 of 2)			Read Only	
41026	Mass Rate – Kg/Hr	Floating point register (2 of 2)			Read Only	
41027	Supply Temperature – °F	Floating point register (1 of 2)			Read Only	
41028	Supply Temperature – °F	Floating point register (2 of 2)			Read Only	
41029	Return Temperature – °F	Floating point register (1 of 2)			Read Only	
41030	Return Temperature – °F	Floating point register (2 of 2)			Read Only	
41031	Supply Temperature – °C	Floating point register (1 of 2)			Read Only	
41032	Supply Temperature – °C	Floating point register (2 of 2)			Read Only	
41033	Return Temperature – °C	Floating point register (1 of 2)			Read Only	
41034	Return Temperature – °C	Floating point register (2 of 2)			Read Only	

REGISTER ADDRESS	DESCRIPTION	REGISTER TYPE	READ/ WRITE	COMMENT
41035	Energy Total Mode 1 –BTU	Floating point register (1 of 2)	Read Only	
41036	Energy Total Mode 1 –BTU	Floating point register (2 of 2)	Read Only	
41037	Energy Total Mode 2 –BTU	Floating point register (1 of 2)	Read Only	
41038	Energy Total Mode 2 –BTU	Floating point register (2 of 2)	Read Only	
41039	Energy Total Mode 1 – TonHr	Floating point register (1 of 2)	Read Only	
41040	Energy Total Mode 1 – TonHr	Floating point register (2 of 2)	Read Only	
41041	Energy Total Mode 2 – TonHr	Floating point register (1 of 2)	Read Only	
41042	Energy Total Mode 2 – TonHr	Floating point register (2 of 2)	Read Only	
41043	Energy Total Mode 1 – kWHr	Floating point register (1 of 2)	Read Only	
41044	Energy Total Mode 1 – kWHr	Floating point register (2 of 2)	Read Only	
41045	Energy Total Mode 2 – kWHr	Floating point register (1 of 2)	Read Only	
41046	Energy Total Mode 2 – kWHr	Floating point register (2 of 2)	Read Only	
41047	Volume Total Mode 1 –Gal	Floating point register (1 of 2)	Read Only	
41048	Volume Total Mode 1 –Gal	Floating point register (2 of 2)	Read Only	
41049	Volume Total Mode 2 –Gal	Floating point register (1 of 2)	Read Only	
41050	Volume Total Mode 2 –Gal	Floating point register (2 of 2)	Read Only	
41051	Volume Total Mode 1 – Liters	Floating point register (1 of 2)	Read Only	
41052	Volume Total Mode 1 – Liters	Floating point register (2 of 2)	Read Only	
41053	Volume Total Mode 2 – Liters	Floating point register (1 of 2)	Read Only	
41054	Volume Total Mode 2 – Liters	Floating point register (2 of 2)	Read Only	
41055	Volume Total Mode 1 – M^3	Floating point register (1 of 2)	Read Only	
41056	Volume Total Mode 1 – M^3	Floating point register (2 of 2)	Read Only	
41057	Volume Total Mode 2 – M^3	Floating point register (1 of 2)	Read Only	
41058	Volume Total Mode 2 – M^3	Floating point register (2 of 2)	Read Only	
41079	Volume Total Mode 1 – Ft^3	Floating point register (1 of 2)	Read Only	
41080	Volume Total Mode 1 – Ft^3	Floating point register (2 of 2)	Read Only	
41081	Volume Total Mode 2 – Ft^3	Floating point register (1 of 2)	Read Only	
41082	Volume Total Mode 2 – Ft^3	Floating point register (2 of 2)	Read Only	
41059	Mass Total –Lbs	Floating point register (1 of 2)	Read Only	Mass units are only available when using F-2000 Vortex meter
41060	Mass Total –Lbs	Floating point register (2 of 2)	Read Only	
41061	Mass Total –kg	Floating point register (1 of 2)	Read Only	
41062	Mass Total –kg	Floating point register (2 of 2)	Read Only	
41063	Auxiliary Input Total (Di3)	Floating point register (1 of 2)	Read Only	
41064	Auxiliary Input Total	Floating point register (2 of 2)	Read Only	

REGISTER ADDRESS	DESCRIPTION	REGISTER TYPE	DATA RANGE	OVER RANGE	READ/ WRITE	COMMENT
41065	Zero Mode 1 Energy Total	0 – 1	0 – 1	N/A	Read/Write	Write a value of 1 to registers to reset totals. Re-write a value of zero to the register once the totals reset.
41066	Zero Mode 1 Volume Total	0 – 1	0 – 1	N/A	Read/Write	
41067	Zero Mode 2 Energy Total	0 – 1	0 – 1	N/A	Read/Write	
41068	Zero Mode 2 Volume Total	0 – 1	0 – 1	N/A	Read/Write	
41069	Zero Auxiliary Input Total (Di3)	0 – 1	0 – 1	N/A	Read/Write	

Integer Registers

REGISTER ADDRESS	DESCRIPTION	REGISTER RANGE	DATA RANGE	OVER RANGE	READ/ WRITE	COMMENT
40001	Meter Operating Mode Indicator		1 – 3	Not applicable	Read Only	1 – indicates single mode 2 – indicates dual mode 3 – indicates bi-directional mode
40002	Mode Status Indicator		1 – 2	Not applicable	Read Only	1 - indicates heating mode or forward direction 2 - indicates cooling mode or reverse direction
40003	Energy Rate – BTU/Hr	0 – 65535	0 - 65534	65535	Read Only	
40004	Energy Rate – kBTU/Hr	0 – 65535	0 - 65534	65535	Read Only	
40005	Energy Rate – MBTU/Hr	0 – 65535	0 - 65534	65535	Read Only	
40006	Energy Rate – kW	0 – 65535	0 - 65534	65535	Read Only	
40007	Energy Rate – kW x 10	0 – 65535	0 - 65534	65535	Read Only	
40008	Energy Rate – Tons	0 – 65535	0 - 65534	65535	Read Only	
40009	Volume Rate – GPM	0 – 65535	0 – 65534	65535	Read Only	
40010	Volume Rate – GPM x 10	0 – 65535	0 – 65534	65535	Read Only	
40011	Volume Rate – GPH	0 – 65535	0 – 65534	65535	Read Only	
40012	Volume Rate – MGD	0 – 65535	0 – 65534	65535	Read Only	
40013	Volume Rate – L/S	0 – 65535	0 – 65534	65535	Read Only	
40014	Volume Rate – L/M	0 – 65535	0 – 65534	65535	Read Only	
40015	Volume Rate – L/Hr	0 – 65535	0 – 65534	65535	Read Only	
40016	Volume Rate – M^3/Hr	0 – 65535	0 – 65534	65535	Read Only	
40017	Volume Rate – M^3/Hr x 10	0 – 65535	0 – 65534	65535	Read Only	
40018	Mass Rate – Lb/Hr	0 – 65535	0 – 65534	65535	Read Only	Mass units are only available when using F-2000 Vortex Meter.
40019	Mass Rate – Lb/Hr x 10	0 – 65535	0 – 65534	65535	Read Only	
40020	Mass Rate – kg/Hr	0 – 65535	0 – 65534	65535	Read Only	
40021	Mass Rate – kg/Hr x 10	0 – 65535	0 – 65534	65535	Read Only	
40022	Supply Temperature – °F	0 – 65535	0 - 655.35	Not applicable	Read Only	Multiply by 0.01 to read temperature to 2 decimal places.
40023	Return Temperature – °F	0 – 65535	0 - 655.35	Not applicable	Read Only	
40024	Supply Temperature – °C	-32768 to +32767	-327.68 to +327.67	Not applicable	Read Only	
40025	Return Temperature – °C	-32768 to +32767	-327.68 to +327.67	Not applicable	Read Only	
40026	Energy Total Mode 1 - kBTU	0 – 65535	0 – 999		Read Only	Low Order
40027	Energy Total Mode 1 - MBTU	0 – 65535	0 – 999		Read Only	Middle Order
40028	Energy Total Mode 1 – GBTU	0 – 65535	0 – 65534	65535	Read Only	High Order
40029	Energy Total Mode 2 – kBTU	0 – 65535	0 – 999		Read Only	Low Order

40030	Energy Total Mode 2 – MBTU	0 – 65535	0 – 999		Read Only	Middle Order
40031	Energy Total Mode 2 – GBTU	0 – 65535	0 – 65534	65535	Read Only	High Order

REGISTER ADDRESS	DESCRIPTION	REGISTER RANGE	DATA RANGE	OVER RANGE	READ/ WRITE	COMMENT
40032	Energy Total Mode 1 – TonHr	0 – 65535	0 – 999		Read Only	Low Order
40033	Energy Total Mode 1 – kTonHr	0 – 65535	0 – 65534	65535	Read Only	High Order
40034	Energy Total Mode 2 – TonHr	0 – 65535	0 – 999		Read Only	Low Order
40035	Energy Total Mode 2 – kTonHr	0 – 65535	0 – 65534	65535	Read Only	High Order
40036	Energy Total Mode 1 – kWHr	0 – 65535	0 – 999		Read Only	Low Order
40037	Energy Total Mode 1 – MWHr	0 – 65535	0 – 999		Read Only	Middle Order
40038	Energy Total Mode 1 – GWHr	0 – 65535	0 – 65534	65535	Read Only	High Order
40039	Energy Total Mode 2 – kWHr	0 – 65535	0 – 999		Read Only	Low Order
40040	Energy Total Mode 2 – MWHr	0 – 65535	0 – 999		Read Only	Middle Order
40041	Energy Total Mode 2 – GWHr	0 – 65535	0 – 65534	65535	Read Only	High Order
40042	Volume Total Mode 1 - kGal	0 – 65535	0 – 999		Read Only	Low Order
40043	Volume Total Mode 1 - MGal	0 – 65535	0 – 999		Read Only	Middle Order
40044	Volume Total Mode 1 – GGal	0 – 65535	0 – 65534	65535	Read Only	High Order
40045	Volume Total Mode 2 – kGal	0 – 65535	0 – 999		Read Only	Low Order
40046	Volume Total Mode 2 – MGal	0 – 65535	0 – 999		Read Only	Middle Order
40047	Volume Total Mode 2 – GGal	0 – 65535	0 – 65534	65535	Read Only	High Order
40048	Volume Total Mode 1 – kLiters	0 – 65535	0 – 999		Read Only	Low Order
40049	Volume Total Mode 1 – MLiters	0 – 65535	0 – 999		Read Only	Middle Order
40050	Volume Total Mode 1 – GLiters	0 – 65535	0 – 65534	65535	Read Only	High Order
40051	Volume Total Mode 2 – kLiters	0 – 65535	0 – 999		Read Only	Low Order
40052	Volume Total Mode 2 – MLiters	0 – 65535	0 – 999		Read Only	Middle Order
40053	Volume Total Mode 2 – GLiters	0 – 65535	0 – 65534	65535	Read Only	High Order
40054	Volume Total Mode 1 –M^3	0 – 65535	0 – 999		Read Only	Low Order
40055	Volume Total Mode 1 – kM^3	0 – 65535	0 – 65534	65535	Read Only	High Order
40056	Volume Total Mode 2 –M^3	0 – 65535	0 – 999		Read Only	Low Order
40057	Volume Total Mode 2 – kM^3	0 – 65535	0 – 65534	65535	Read Only	High Order
40058	Mass Total – kLbs	0 – 65535	0 – 999		Read Only	Mass units are only available when using F-2000 Vortex Meter.
40059	Mass Total – MLbs	0 – 65535	0 – 65534	65535	Read Only	
40060	Mass Total – Kkgs	0 – 65535	0 – 999		Read Only	
40061	Mass Total – Mkgs	0 – 65535	0 – 65534	65535	Read Only	
40062	Auxiliary Input Total (Di3)	0 – 65535	0 – 999		Read Only	Low Order
40063	Auxiliary Input Total (x1000)	0 – 65535	0 – 65534	65535	Read Only	High Order
40064	Zero Mode 1 Energy Total	0 – 1	0 – 1	N/A	Read/Write	Write a value of 1 to registers to reset totals. Re-write a value of zero to registers once the totals reset.
40065	Zero Mode 1 Volume Total	0 – 1	0 – 1	N/A	Read/Write	
40066	Zero Mode 2 Energy Total	0 – 1	0 – 1	N/A	Read/Write	
40067	Zero Mode 2 Volume Total	0 – 1	0 – 1	N/A	Read/Write	
40068	Zero Auxiliary Input Total (Di3)	0 – 1	0 – 1	N/A	Read/Write	

3.3 Totalization, Resetting Totals, Over-Range & Rollover

A. Integer Register Totalization

Holding registers 40026 through 40061 are integer registers that provide totalized energy, volume and mass flow data in a variety of engineering units. The registers are organized into pairs or groups of three.

The first (low order) register is limited to a range of 0 – 999. This register rolls over to zero when the total value reaches 1,000. If the registers are in a group of three, the second register (middle order) is also limited to a range of 0 – 999. This register also rolls over when the register value reaches 1,000.

The second, or in the case of groups of three, third, (high order) register is scaled such that the smallest incremental value indicated is 1,000 times greater than the preceding register. An example of this is shown below.

Example - A group of 3 registers

Register	Engineering units & Scaling	Current Value
40026	kBTU (BTU x 1,000)	00500
40027	MBTU (BTU x 1,000,000)	00015
40028	GBTU (BTU x 1,000,000,000)	00111

Low order + middle order + high order = BTU Total = 111,015,500,000

or

kBTU Total = 111,015,500

Registers 40062 and 40063 provide totalization for the optional auxiliary pulse input option of the System-10 BTU Meter. There are no engineering units associated with these registers.

B. Floating Point Totalization

Registers 41003 through 41064 provide energy, volume and mass flow data in 32 bit single precision floating point format. The registers are organized into pairs. Each pair must be concatenated according to IEEE 754.

Register order: Most significant first, least significant second.

Word order: Most significant value first, least significant value second.

Byte order within each word: Most significant byte first.

Bit order within each byte: Most significant bit first.

Registers 41063 and 41064 provide totalization for the optional auxiliary pulse input option of the System-10 BTU Meter. There are no engineering units associated with these registers.

C. Resetting Totals

Registers 40064 through 40068 or 41065 through 41069 are integer registers that provide a mechanism to reset totals. Each reset register is associated with a group of totalizing registers and will reset all of the engineering units at the same time. Both integer and floating point registers will be reset at the same time regardless of which set of reset registers are used.

To reset the totals associated with the register, write a value of 1 to the register. Once the totals are reset, re-write a value of 0 to the register.

IMPORTANT NOTE

ONICON BTU Meters contain internal registers for totalization. These registers will also be reset by this action.

D. Over-range & Rollover Conditions for Totals

All low order and middle order registers are designed to rollover to 0 when their totals exceed 999. The maximum value that can be totalized in high order registers is 65,534.

A value of 65,535 is considered an over-range condition.

CAUTION

ONICON BTU Meters contain internal registers for totalization. These registers will eventually roll over to zero if the totals are not reset on a periodic basis. The associated MODBUS registers will also rollover to zero when this occurs. The engineering units and multipliers programmed in to the BTU meter affect the point at which the totals roll over. The factory assigned engineering units and multipliers applied to the BTU meter display were chosen to eliminate the possibility of an over-range condition in the MODBUS registers before the BTU meter registers roll over. Changing the engineering units or multipliers at the BTU meter will affect the rollover point. Contact ONICON technical service prior to making any changes.

SECTION 4.0: NETWORK TROUBLESHOOTING TIPS

4.1 Troubleshooting

REPORTED PROBLEM	POSSIBLE SOLUTIONS
Device will not communicate with the network controller. (RS-485 Output)	• The protocol selection must be set to the appropriate network communication protocol being used on the RS-485 bus. (See section 1.4 of this manual for details) • The Baud rate setting must match the network Baud rate. (See section 1.6.1 of this manual for details) • Is the Receive LED flashing on the network board? This LED will flash whenever there is traffic on the network. If the LED is not flashing, look for an open network cable. (See Apendix A-2 for details) • Is the Transmit LED flashing? The Transmit LED will only flash when the device is responding to a poll. A unique address is required for each device on the network. Duplicate addresses will cause some or all of the devices on the network to quit working. (See section 1.7 and Appendix A-2 of this manual for details.) • The RS485 network cable connections are polarity sensitive and must be connected the same way on every device (i.e. + to + and - to -). (See section 1.5 of this manual for details.) • Shield drain connections should be daisy chained in the same manner as the signal cables for RS485. The shield drain wire should be left unterminated at the end of the cable and connected to earth only at the network master controller. Shield wires must not be connected to the RS485 connector on the System-10. • The maximum number of devices allowed on a RS485 network segment without a repeater is 32. Adding more than 32 devices to a single segment may reduce the transceiver output voltage to a level that is too low to be distinguished from background noise on the cable. • RS485 cable impedance should be matched to a termination resistor at the end of the cable. ONICON boards have a jumper selectable 120 ohm resistor for termination. This resistor should only be used if the display is the last device on the network cable. (See section 1.6.2 of this manual for details.)

REPORTED PROBLEM	POSSIBLE SOLUTIONS
Device will not communicate with the network controller. (BACnet IP or MODBUS TCP/IP output)	• A unique IP address is required for each device on IP network. Duplicate addresses will cause multiple devices to respond to the same poll. (See section 1.7.2 of this manual for details.) • Managed IP networks may require that a gateway IP address be programmed into the ONICON IP device. (See section 1.7.2 of this manual for details.)
Network communications are disrupted when the device is connected. (RS-485 Output)	• The Baud rate setting must match the network Baud rate. (See section 1.6.1 of this manual for details) • Is the Receive LED flashing on the network board? This LED will flash whenever there is traffic on the network. If the LED is not flashing, look for an open network cable. • Is the Transmit LED flashing? The Transmit LED will only flash when the device is responding to a poll. A unique address is required for each device on the network. Duplicate addresses will cause some or all of the devices on the network to quit working. (See section 1.7 of this manual for details.) • The RS485 network cable connections are polarity sensitive and must be connected the same way on every device (i.e. + to + and - to -). (See section 1.5 of this manual for details.) • Shield drain connections should be daisy chained in the same manner as the signal cables for RS485. The shield drain wire should be left unterminated at the end of the cable and connected to earth only at the network master controller. Shield wires must not be connected to the RS485 connector on the System-10.
Network communications are disrupted when the device is connected. (BACnet IP or MODBUS TCP/IP output)	• A unique IP address is required for each device on IP networks. Duplicate addresses will cause multiple devices to respond to the same poll. This may cause some of the devices on the network to quit working. (See section 1.7.2 of this manual for details.)
Time out errors occur when polling the device (MODBUS RS-485 or MODBUS TCP/IP)	• What registers are being polled? Polling for invalid registers will slow the response time. The range of valid integer registers is 40001-40068. The range of valid floating point registers is 41003-41081. • Resetting totals requires the network controller to write a 1 to a register in our device. This takes longer to accomplish than simply reading registers. This can lead to time out issues. When dealing with time out errors, temporarily extend the allowable delay to see if the problem will go away.

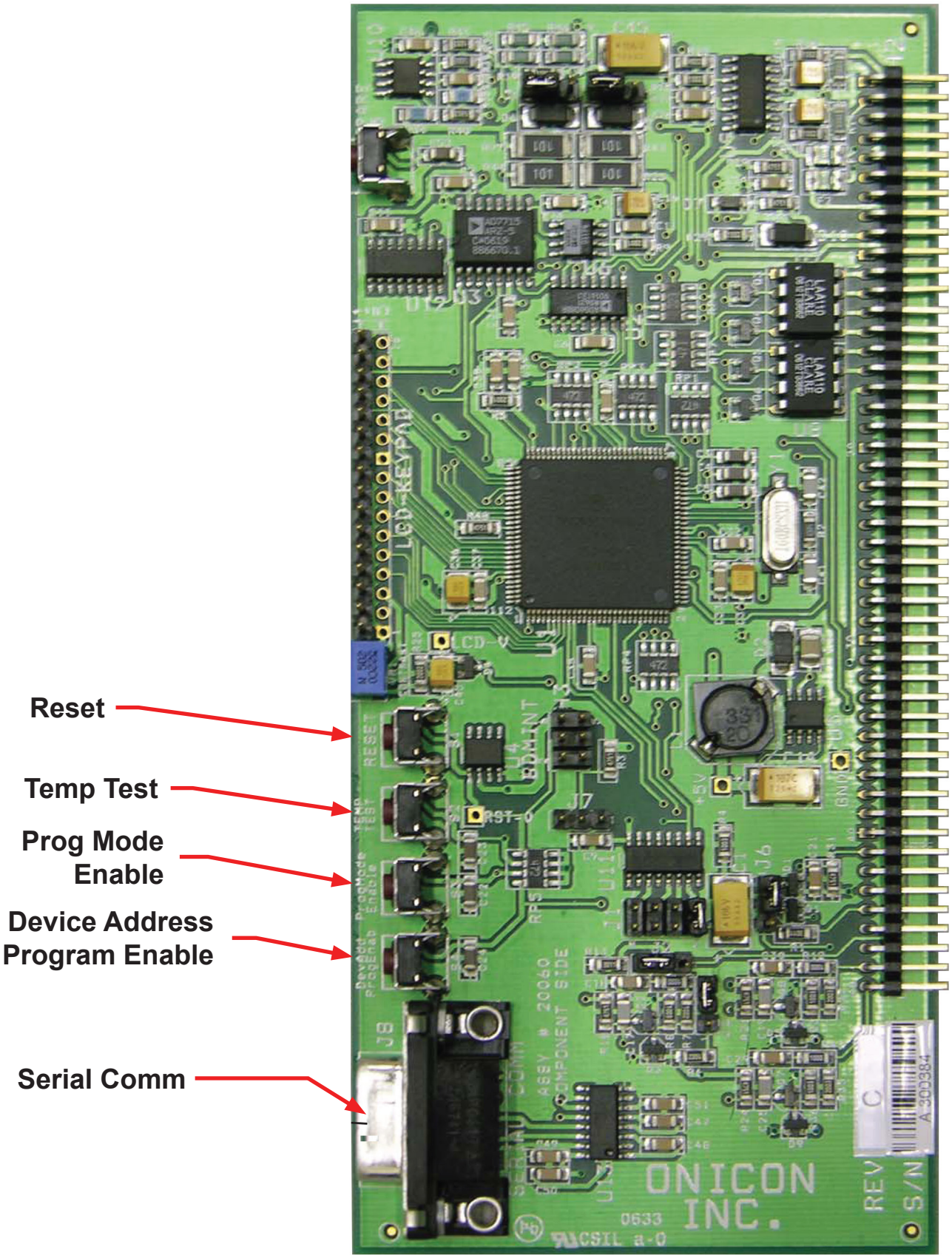
APPENDIX

A-1 SYSTEM-10 BTU Meter Computer Board

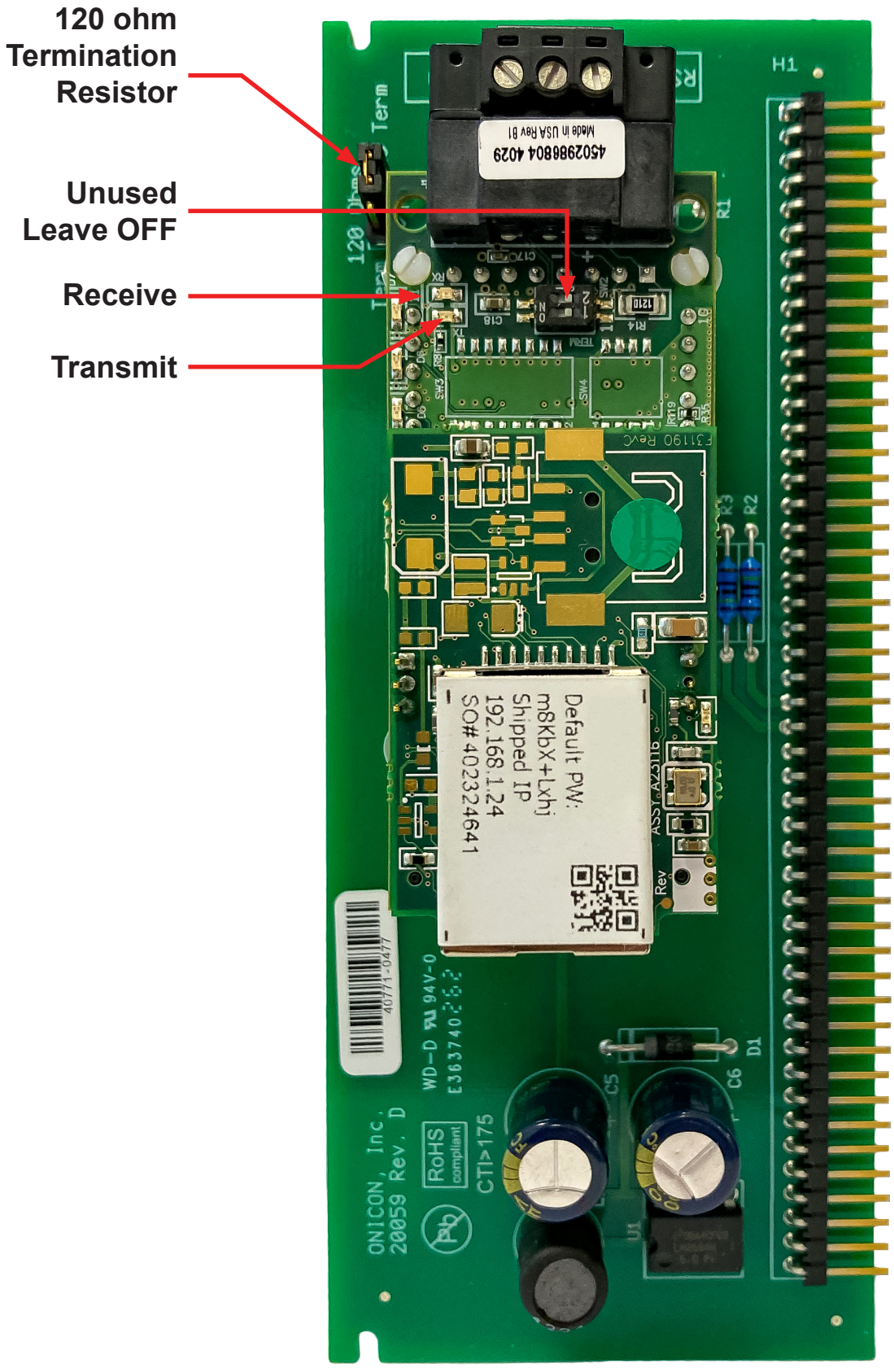
A-2 SYSTEM-10 Dual Network Interface Board

A-3 SYSTEM-10 Dual Network Interface Auxiliary Input Board

System-10 BTU Meter Computer Board



System-10 Dual Network Interface Board



System-10 Dual Network Interface Auxiliary Input Board

