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## **SECTION 1: INTRODUCTION**

ONICON Btu meters equipped with MODBUS serial communications provide volume and energy rate data, temperature data, totalized volume and totalized energy data in a variety of engineering units. For example, supply and return temperatures are available in both degrees F and degrees C. You select the engineering units you wish to use by mapping to the appropriate registers.

Also supplied with your Btu meter is a document titled “Recommended MODBUS Configuration Data”. This document is different for each Btu meter. It provides a suggested list of registers to use. The recommendations are based on the calibration of the flow meter and the programming of units and multipliers displayed on the Btu meter.

## **SECTION 2: 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 41064 are 32 bit single precision floating point values. 41001, 41002 and 41065 through 41069 are unsigned integer registers.
4. MODBUS function codes supported

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

Networking Information	MODBUS RTU	MODBUS TCP
Connection Information	RS485, 2-wire half-duplex	Base 10T, 10Mbps, RJ 45 Connection
Data format / Parity	8 bits, 1 stop bit / None	8 bits, 1 stop bit / None
Flow Control (handshaking)	None	None
Device Address Range	1 - 247	1 - 247
IP Address & Port #	Not required	Default: 192.168.1.24 / Port 502
Termination (selectable)	120 $\Omega$ or none (default none)	None
Biasing	None	None

### SECTION 3: MODBUS MEMORY MAP TABLE

#### Available Engineering Units

Engineering Units	Abbreviation
<b>Energy Rate</b>	
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
<b>Volume Rate (Flow)</b>	
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 <sup>3</sup> /Hr
Cubic meters per hour x 10	M <sup>3</sup> /Hr x 10
<b>Mass Rate (Mass Flow) – Only available with F-2000 Flow Meter</b>	
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
<b>Temperature</b>	
Degrees Fahrenheit	°F
Degrees Celsius	°C

Engineering Units	Abbreviation
<b>Energy Total</b>	
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
<b>Volume Total</b>	
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 <sup>3</sup>
Cubic Meters x 1,000	kM <sup>3</sup>
<b>Mass Total - Only available with F-2000 Flow Meter</b>	
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 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 <sup>3</sup> /Hr	0 – 65535	0 – 65534	65535	Read Only	
40017	Volume Rate – M <sup>3</sup> /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-2200 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

Register Address	Description	Register Range	Data Range	Over Range	Read/Write	Comment
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
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 <sup>3</sup>	0 – 65535	0 – 999		Read Only	Low Order
40055	Volume Total Mode 1 – kM <sup>3</sup>	0 – 65535	0 – 65534	65535	Read Only	High Order
40056	Volume Total Mode 2 – M <sup>3</sup>	0 – 65535	0 – 999		Read Only	Low Order
40057	Volume Total Mode 2 – kM <sup>3</sup>	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-2200 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	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	Not applicable	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	Not applicable	Read/Write	
40066	Zero Mode 2 Energy Total	0 – 1	0 – 1	Not applicable	Read/Write	
40067	Zero Mode 2 Volume Total	0 – 1	0 – 1	Not applicable	Read/Write	
40068	Zero Auxiliary Input Total	0 – 1	0 – 1	Not applicable	Read/Write	

Register Address	Description	Register Range	Data Range	Over Range	Read/Write	Comment
41001	Meter Operating Mode Indicator		1 – 3	Not applicable	Read Only	1 – indicates single mode 2 – indicates dual mode 3 – indicates bi-directional mode
41002	Mode Status Indicator		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 <sup>3</sup> /Hr	Floating point register (1 of 2)		Read Only		
41022	Volume Rate – M <sup>3</sup> /Hr	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 F-2000 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 <sup>3</sup>	Floating point register (1 of 2)			Read Only	
41056	Volume Total Mode 1 – M <sup>3</sup>	Floating point register (2 of 2)			Read Only	
41057	Volume Total Mode 2 – M <sup>3</sup>	Floating point register (1 of 2)			Read Only	
41058	Volume Total Mode 2 – M <sup>3</sup>	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	Floating point register (1 of 2)			Read Only	
41064	Auxiliary Input Total	Floating point register (2 of 2)			Read Only	
41065	Zero Mode 1 Energy Total	0 – 1	0 – 1	Not applicable	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	Not applicable	Read/Write	
41067	Zero Mode 2 Energy Total	0 – 1	0 – 1	Not applicable	Read/Write	
41068	Zero Mode 2 Volume Total	0 – 1	0 – 1	Not applicable	Read/Write	
41069	Zero Auxiliary Input Total	0 – 1	0 – 1	Not applicable	Read/Write	

**SECTION 4: TOTALIZATION, RESETTING TOOLS  
AND OVER-RANGE & ROLLOVER**

**1. 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 3.

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 3, 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 3, 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

<u>Register</u>	<u>Engineering units &amp; Scaling</u>	<u>Current Value</u>
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.

## 2. Floating Point Register 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.

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.

## 3. 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.

## 4. Over-range & Rollover Conditions for Totals

All low order and middle order integer registers are designed to rollover to 0 when their totals exceed 999. The maximum value that can be totalized in high order integer 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 roll over 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 integer 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.