U1000 BACnet Supplement

For:

U1000 Pipemount (PM)
Product Codes 804*06

U1000 Wallmount (WM)
Product Codes 904*06

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DOCUMENT AUTHORITY

Issue	Date	Originator	Approved
1.0	14/04/2025	Micronics Ltd	14/04/2024

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1 INTRODUCTION

BACnet MS/TP is a communications option for the following U1000 WM and PM units:

1.1 U1000 Pipemount (PM). Product Codes 804*06

- **U1000MkII-FM** is an ultrasonic clamp-on flow meter for measuring flow rate and total flow with a volume pulse output and optional Modbus, M-Bus or 4-20mA flow proportional output. It can be used as a standalone meter or as part of an integral management system.
- **U1000MkII-HM** is an ultrasonic clamp-on thermal, heat/energy meter. It uses ultrasound to measure flow rate and is also equipped with PT100 temperature sensors to measure flow and return temperatures. The U1000MKII-HM displays energy rate and totalised energy with pulse output and communication options, so it can be used as a standalone meter or as an integral part of Automatic Monitoring & Targeting (aM&T) or a Building Energy Management System (BEMS).

1.2 U1000 Pipemount (WM), Product Codes 904*06

- **U1000MkII WM Flow Meter** is a wall-mounted control unit with clamp-on ultrasonic flow sensors for measuring flow rate and total flow with a volume pulse output. It can be used as a standalone meter or as part of an integral management system.
- **U1000MkII WM Heat Meter** is a wall-mounted control unit with clamp-on ultrasonic flow sensors and separate pair of PT100 thermal sensors. It uses ultrasound to measure flow rate and is also equipped with PT100 temperature sensors to measure flow and return temperatures. The U1000MKII WM Heat Meter displays energy rate and totalised energy with pulse output and communication options, so it can be used as a standalone meter or as an integral part of Automatic Monitoring & Targeting (aM&T) or a Building Energy Management System (BEMS).

1.3 BACnet Overview

BACnet is a network protocol standard for building automation (**B**uilding **A**utomation and **C**ontrol **Net**works). It is described in ANSI/ASHRAE/ISO Standard 135-2016. The protocol defines the interaction between different systems and devices. Data and commands are structured with an object-oriented approach.

1.3.1 Networks

The BACnet standard supports 6 networks, each describing the physical and data link layer:

- MS/TP (RS485)
- ARCnet
- Point To Point (RS232)
- Ethernet
- IP
- Lontalk

The U1000 WM and PM only support the BACnet MS/TP (Master Slave/Token Passing) network.

The BACnet messages used to exchange data between the BACnet devices are independent of the physical and data link layers allowing BACnet routers to be used to interconnect different types of networks.

1.4 BACnet Interface

The BACnet modules are compliant with ANSI/ASHRAE Standard 135-2016.

The device issuing service requests is known as the Client or Master, and the device responding to those requests is known as the Server or Slave. Providing your MAC address does not clash with any other unit in the system (including the master), your unit is now ready to communicate with a BACnet client.

1.4.1 U1000 WM/PM BACnet Parameter Set up

1. Open the U1000 menu system by pressing the ↵ symbol.
2. Use the ↑ ↓ arrows to select BACnet Setup and press ↵.
3. Enter the MAC Address. (defined by BACnet network)
4. Enter the Device ID. (Provided by BACnet network technician). This ID identifies the meter within the BACnet network that may contain multiple meters.
5. Enter the BACnet baud rate as used on your network.
6. Cycle through the menu options and select Exit
7. Unit is now ready to communicate with Client/Master

2 BACNET MS/TP OVER RS485

2.1 MS/TP over RS485

MS/TP (Master Slave/Token Passing) is a network type that uses the EIA-485 (RS485) standard as the physical layer.

Multiple masters can be on the same segment. A segment can have max. 32 nodes (masters or clients, and slaves or servers) that communicate over the half duplex connection (transmission of data in one direction at a time). In the following description the U1000 meter is a BACnet server (slave) device only.

A token is passed consecutively from master to master starting with the lowest address. Only the master device holding the token may start communication. The server devices communicate only when responding to the request of a master device.

The maximum number of frames a master device is allowed to send can be configured in parameter "Max Info Frames" in a client device. Thereafter the token has to be passed to the next master if it exists, otherwise it is passed back to the initial master. The selection of the next master is supported by parameter "Max Master" where the max. number of nodes within the segment is set. All these parameters are configurable in the Master (client).

MS/TP uses octets (bytes) to transfer data over the bus. One octet contains 8 data bits, 1 start bit, 1 stop bit and no parity bit (8,N,1).

RS485 uses twisted pair cables with a maximum length of 1,200 m. Stub lines are allowed but have to be as short as possible. Both ends of a RS485 network/segment must be terminated with a resistor of typically 120 Ω to prevent signals from being reflected at open ends of the cable. This can be a significant problem if the segment is long and the data rate high enough for standing waves to distort the voltage when a bit is being read.

Table 1 shows a standard BACnet frame. Note that there are two CRC’s (Cyclic Redundancy Check); one for the header part and another for any ensuing data part. This structure is described in section 9.3 of the ANSI/ASHRAE Standard, 135-2016.

Table 1: BACnet frame

	Octet	Field	explanation
h e a d e r	2	preamble 0x55 0xFF	start of a BACnet frame
	1	frame type	standard frame types: 0 token 1 poll for master 2 reply to poll for master 3 test request 4 test response 5 BACnet data expecting reply 6 BACnet data not expecting reply 7 reply postponed
			8...127 idle
			128...255 supplier specific frame types
	1	destination address	address of the destination device
	1	source address	address of the source device
	2	length (data)	number of data bytes in the frame
	1	header CRC	cyclic redundancy check of the header
d a t a	0...127	Data	
	2	data CRC	cyclic redundancy check of the data

2.2 Objects, Properties, Services

The BACnet protocol is based on the concept of “objects”. Objects have properties that hold the values and services associated with them. There are multiple object types within the BACnet environment.

Each object instance has properties that can be readable and/or writeable. Each device has to have a device object which contains properties such as device name, firmware version, number of objects provided by the device and their object identifier.

For accessing the properties of the objects, devices communicate by means of BACnet services. Confirmed services expect a response, while unconfirmed services do not.

Table 2: Examples for objects, properties, services

object types	**properties**	**service categories and services**
binary input	object identifier	object access: - ReadProperty - WriteProperty
binary output	object name	
binary value	present value	
analog input	description	alarm and event: - SubscribeCOV - UnsubscribeCOV
analog output	unit of measurement	
analog value		
device		remote device management: - Who-Has - I-Have - Who-Is - I-Am
file		

2.3 BIBBs, Device Profile

Another level of abstraction in BACnet is the concept of BIBBS or BACnet Interoperability Building Blocks. BIBBs are services. To ensure interoperability, all devices must support the same BIBBs. A BIBB describes the services that must be supported by both client and server to implement a requirement of the system.

Table 3: Classes of BiBBs

DS	Data Sharing
AE	Alarm and Event management
SCHED	SCHEDduling
T	Trending
DM	Device Management
NM	Network Management

Note that in the table below 'A' is the master/client and 'B' is the slave/server.

Table 4: Examples of BiBBs

DS-RP-A	Data Sharing-ReadProperty-A/B	A reads property of B
DS-RP-B		B provides property for A
DS-RPM-A	Data Sharing-ReadPropertyMultiple-A/B	A reads multiple properties of B
DS-RPM-B		B provides multiple properties for A
DS-WP-A	Data Sharing WriteProperty-A/B	A writes property of B
DS-WP-B		B allows writing by A
DS-COV-A	Data Sharing COV-A/B (COV - change of value)	A subscribes for COV notification of a property of B
DS-COV-B		B allows A to subscribe for COV notification
AE-N-A	Alarm and Event-Notification-A	A processes notification of B

A certain set of BIBB classes or types make up a Device Profile. A uniform nomenclature is used to describe the services related to a BIBB.

Table 5 highlights a set of BACnet Device Profiles. Each level incorporates new functionality but also includes all the functionality of the profile below it, thus the device profile B-OWS or Operator WorkStation contains all the services and properties of the profiles below it.

Table 5: Device profiles

B-AWS	Advanced Operator Work Station	
B-OWS	BACnet Operator Workstation	building operation centre, management system, workstation
B-BC	BACnet Building Controller	freely programmable automation station
B-AAC	BACnet Advanced Application Controller	configurable automation device
B-ASC	BACnet Application Specific Controller	parametrizable automation device
B-SA	BACnet Smart Actuator	
B-SS	BACnet Smart Sensor	(U1000)

2.4 BACnet Specifics of the U1000 WM / PM, FM / HM

The U1000 Wall Mount (WM) and U1000 Pipe Mount (PM) configured as either Flow Meter (FM) or as a Heat-Meter (HM) has been implemented as a BACnet Smart Sensor, or BSS.

Table 6: Device profiles and BIBBs

network type	MS/TP with a full master node state machine (see ANSI/ASHRAE/ISO Standard 135-2012)	
device profile	B-SS	BACnet Smart Sensor
supported BIBBs	DS-RP-B	provides property for reading
	DS-RPM-B	provides multiple properties for reading
	DS-WP-B	allows writing of a property
	DM-DDB-B	gives I-Am in response to Who-Is
	DM-DOB-B	gives I-Have in response to Who-Has

2.4.1 Objects and Properties

The meter includes the device object and a collection of measured values as standard BACnet object types. These objects are of type analogue input (AI), digital bit input (BI) and positive integer (PIV) values. All these properties are readable only.

The default units of measurements are listed in Table 7. Additional units of measurement with BACnetEngineeringUnits codes may be found in ANSI/ASHRAE Standard 135-2016.

Table 7: Meter Objects

object identifier	description	COV support	default unit of measurement	Units table in annex A	Units
Device 1037129	1037129		-	-	
AI - 0	Measured velocity	X	m/s	Metres per second	74
AI - 1	Measured flow	X	m^3/h	Cubic metres per hour	135
AI – 2	Calculated Power	X	kW	kilowatts	48
AI – 3	Calculated Energy	X	kWh	kilowatt hour	19
AI – 4	Measured Temperature (Hot)	X	°C	Degrees Celsius	62
AI – 5	Measured Temperature (Cold)	X	°C	Degrees Celsius	62
AI – 6	Temperature difference	X	°C	Degrees Celsius	62
AI – 7	Measured Total	X	m^3	Cubic Metres	80
AV – 8	Units		Meter units	No Units (value = 0: metric, value = 1: fahrenheit)	95
AV – 9	Gain	X	dB	Decibels	199
AI – 10	SNR	X	dB	Decibels	199
AI – 11	Signal Strength	X	dB	Decibels	199
Ai – 12	Delta Time difference	X	mS	Milliseconds	159
AI – 13	ETA (Estimated time of arrival)	X	mS	Milliseconds	159
AI – 14	ATA (Actual time of arrival)	X	mS	Milliseconds	159
BI – 0	Alarm Relay State				
BV – 1	Reset Totals				
PIV – 0	Flow Total Int Units	X	m^3		
PIV – 1	Energy Total Int Units	X	kWh		

Table 8: Properties of the Device Object

property	Value	access	data type
Object Identifier	OBJECT DEVICE: 1037129 [default]	R	BACnet object identifier
Object_Name		R	character string
Object_Type	8 (device)	R	BACnet object type (bit string)
System_Status	0 (always operational)	R	BACnet device status (enumerated)
Vendor_Name	Micronics	R	character string
Vendor_Identifier	1009	R	unsigned16
Model_Name	U1000-PM-HM U1000-PM-FM U1000-WM-HM U1000-WM-FM [one of the above]	R	character string
Application_ Software_Version	V1.2	R	character string
Firmware_Version	V1.1	R	character string
Description	U1000-Pipe-Heat with BACnet MS/TP U1000-Pipe-Flow with BACnet MS/TP U1000-Wall-Heat with BACnet MS/TP U1000-Wall-Flow with BACnet MS/TP	R/W	character string
Protocol_Version	1	R	unsigned8
Protocol_Revision	16	R	unsigned8
Protocol_Services_Supported	0x0C 0X0E 0x0F 0x11, 0x14, 0x21, 0x22 readProperty, readPropertyMultiple, writeProperty, deviceCommunicationControl, reinitialiseDevice, Who-Is, Who-Has	R	BACnet services supported (bit string)
Protocol_Object_ Types_Supported	0x00 0x03, 0x05, 0x08, 0x30 Analog Input, Binary Input, Binary Value, Device, Positive Integer Value	R	BACnet object types supported (bit string)
Object_List	contains all available object identifiers	R	BACnet array of BACnet object identifier

property	Value	access	data type
Max_APDU_ Length_Accepted	128 Octets	R	unsigned8
Segmentation_ Supported	3 (no segmentation)	R	BACnet segmentation (enumerated)
APDU_Timeout	3 000 ms	R	unsigned8
Number_Of_ APDU_Retries	3	R	unsigned8
Device_Address_ Binding	-	R	list of BACnet address binding
Database_Revision	3	R	unsigned8

2.4.2 Change of Value (COV)

The meter does not provide support for Change Of Value subscription.