Measurlogic DTS BACnet MS/TP ML Map
Revision R21A

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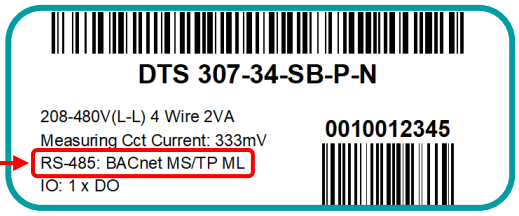
1 SCOPE

1.1 IDENTIFICATION

This is a universal document that describes the BACnet MS/TP ML Communications Object specification for the Measurlogic family of DTS range of RGM meters.

This document applies to models: **DTS 305, DTS 307, DTS 310, DTS SMX, DTS SKT, DTS DC**.

The information in this document applies to any Measurlogic DTS RS-485 serial meter equipped with the **"BACnet MS/TP ML"** protocol option. This information can be found on the label of the meter. If **"ML"** is not present in the protocol description, please visit our website for the correct document.



1.2 INTRODUCTION

The DTS family of meters is a range of compact DIN-rail, panel, weatherproof or socket mounted energy meters and transducers, with communications and I/O capability. Models are available for single-phase, 3-Phase 2 or 4-Quadrant, and DC measurement applications. Some models are available with optional backlit LCD display.

The remote communications are model specific and provided through:

- An RS-485 port using the BACnet MSTP protocol. Every BACnet Device across the entire network must have a unique BACnet Device ID. Every BACnet Device on the same sub-network must have a unique MAC Address.

ATTENTION

Meter capabilities are model dependant. Some capabilities, functions and objects may not be applicable to certain meter models, or certain wiring topologies.

Please see the next page for communications defaults.

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1.2.1 Communication Defaults

Unless specified, the default BACnet communications parameter objects are as follows. These may be viewed and changed using the Communication Objects. Please see section 2.3.5 on Page 13 for details.

BACnet MS/TP Defaults	
Communication Parameter	**Value**
Baud_Rate	38400
Device_ID	473001
MAC_Address	1
MAX_Master	127

1.2.2 Communication Equipment

Interfacing a PC to the physical media of the BACnet MS/TP RS-485 bus can be achieved using:

1. **A BACnet router** – This is a device specifically designed to connect a BACnet MS/TP RS-485 bus to an Ethernet BACnet IP network. This is the recommended and most reliable mechanism to interface to the BACnet MS/TP bus. Also, many BACnet explorers and other tools do not support serial BACnet MS/TP directly, so you have to access your MS/TP network via a router.

   Most BACnet MS/TP routers should perform well. Measurlogic have tested the following routers:

   - Contemporary Controls BASrouter:
     https://www.ccontrols.com/basautomation/basrouter.php
     This is a DIN mounted router that is powered from 24 VAC/VDC so is suitable for permanent installations.

   - Contemporary Controls Portable BASrouter:
     https://www.ccontrols.com/basautomation/basportable.php
     This is a standalone USB powered router and does not require another power supply, so is suitable for testing and commissioning. It is not suitable for permanent installations because it has no industrial mounting facility.

2. **A USB to RS-485 Adapter** – This is a generic RS-485 adapter device that appears to the PC as a virtual serial COM port, and is not BACnet specific. The quality of these devices varies tremendously, and while some may work well with protocols such as Modbus, most do NOT perform well or even at all with BACnet MS/TP.

   Measurlogic DO NOT recommend using USB to RS-485 adapters for BACnet MS/TP.

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2 BACNET INTERFACE SPECIFICATION

2.1 GENERAL INFORMATION

2.1.1 BACnet Object_Types and Properties

The measured values of the AC and DC energy sub-meters and transducers are exposed using BACnet Objects and Properties.

The following BACnet objects are supported:

- Device
- Analog_Input AI
- Analog_Output AO
- Analog_Value AV
- Binary_Input BI
- Binary_Output BO
- Binary_Value BV
- Date_Time_Value DTV

The Object Number are prefixed with the above abbreviations following tables to indicate the Object Type. The tables show the Object_Name and the Object Instance_Number for each measurement quantity. Object Instance_Numbers are 1-based numbers.

The Object Instance_Number determines the information reported by that object. The value of the Object is contained in the Present_Value property. All Present_Value properties are 32-bit "float" values. As such they can represent floating point values, so always represent the appropriate engineering units, and thus no scaling is required. The Object_Name property contains the name of measurement quantity.

The minimum and maximum values for same measurement values are considered separate Object Instances, each with their own Instance_Number. The value is contained in the Present_Value property.

2.1.2 Measurement Object Subsets

Depending on the meter model, and the way in which the meter is connected and configured, not all channels may be used, and thus not all measurement objects described in this document will be applicable. If only one or two channels are connected, then only objects applicable to those channels will contain measurement information. In addition, objects that contain processed information, such as Total or Average, will also contain valid information.

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2.1.3 The Device Object

The Device Object contains the all the relevant information about the DTS meter.

Property Identifier	R/W	Value	Description
Object_Identifier	R/W	Device <X> [1 .. 4,194,302]	BACnet devices can have a device ID ranging from decimal 1 to 4,194,302. All Measurlogic BACnet meters default to an object ID of 473001.
Object_Name	R	DTS <X>: <SN>	X is the meter type such as: 305, 307, 310, SMX, SKT. SN is the serial number of the meter
Object_Type	R	Device	
System_Status	R	Operational	
Vendor_Name	R	Measurlogic Inc.	
Vendor_Identifier	R	473	
Model_Name	R	DTS <X>	X is the meter type such as: 305, 307, 310, SMX, SKT.
Firmware_Revision	R	<FW>	
Application_Software_Version	R	<SV>	
Description	R/W	<SN>	Default value is Serial Number. Maximum of 64 characters allowed.
Protocol_Version	R	1	
Protocol_Revision	R	<V>	V is the current revision of the BACnet Protocol
Protocol_Services_Supported	R		Found in Measurlogic PICs Document
Protocol_Object_Types_Supported	R		Found in Measurlogic PICs Document
Object_List	R		List of all available Objects
Max_APDU_Length_Accepted	R	300	
Segmentation_Supported	R	Segmented-both	
Max_Segments_Accepted	R	8	
Local_Time	R	XX:XX:XX.XX	Set via BACnet Time Synchronization
Local_Date	R	(Weekday, dd-month-yyyy)	Set via BACnet Time Synchronization
UTC_Offset	R/W	[-840 .. 720]	The number of minutes between local time and UTC.
Daylight_Savings_Status	R/W	[True/False]	
APDU_Segment_Timeout	R/W	[0 .. 65535]	APDU Segment Timeout is in terms of mS. Default is 5000 mS
APDU_Timeout	R/W	[10 .. 65535]	APDU Timeout is in terms of mS. Default is 10000 mS.
Number_Of_APDU_Retries	R/W	[0 .. 10]	Default is 3
Max_Master	R/W	[1 .. 127]	Default is 127
Max_Info_Frames	R	1	
Device_Address_Binding	R	{}	
Database_Revision	R	1	
Property_List	R		The support object properties

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2.1.4 Power and Energy Register Resolutions and Roll Over

To handle the very wide range of possible Power and Energy values due to the flexibility of the DTS Family, it is necessary to vary the internal register resolution according to the total power levels being measured. The internal register resolutions for the power and the energy registers are the same, therefore a finer resolution provides more significant digits of measured power values, but decreases the total energy accumulation time before the energy registers overflow, and visa versa. The following table shows the ***suggested*** resolutions for various Total Power ranges. These provide 4 or 5 significant digits of power, while still allowing energy to accumulate for over a year before the register overflows:

Total Power			Register Resolution	EnerPowDivider	Energy Roll Over
		< 10 kW	0.1 W	100	99,999.9999 kWh
>= 10 kW	and	< 100 kW	1 W	1,000	999,999.999 kWh
>= 100 kW	and	< 1 MW	10 W	10,000	9,999,999.99 kWh
>= 1 MW	and	< 10 MW	100 W	100,000	99,999,999.9 kWh
>= 10 MW	and	< 100 MW	1 kW	1,000,000	999,999,999 kWh
>= 100 MW	and	< 1 GW	10 kW	10,000,000	9,999,999,990 kWh
>= 1 GW	and	< 10 GW	100 kW	100,000,000	99,999,999,900 kWh

The internal 32-bit energy registers always contain nine significant digits, so will accumulate up to 999,999,999 and then rollover to zero. The rollover point for different energy resolutions is also shown in the table above. ***For example:***

Example Service	Total Power	Register Resolution	EnerPowDivider	Energy Roll Over
Single Phase 3-Wire 120V/240V 200A	48 kW	1 W	1,000	999,999.999 kWh
3-Phase 3/4-Wire 120V/208V 600A	216 kW	10 W	10,000	9,999,999.99 kWh
3-Phase 3-Wire 277V/480V 3000A	2.5 MW	100 W	100,000	99,999,999.9 kWh

The "EnerPowDivider" factor is used to scale the register resolution of the Power and Energy registers values.

The default value of the "EnerPowDivider" is 10,000, which represents a resolution of 10W. The value of "EnerPowDivider" should always be confirmed by reading object 8023.

The default "EnerPowDivider" value of 10,000 is suitable for most (208V-480V, 50A to 1600A) sub-metering applications, so will not generally need to be changed. If you have a significantly smaller or larger system, you may need to configure your meter with a different "EnerPowDivider" value. **Please consult Measurlogic Inc for advice in this regard.**

BACnet PresentValues are floating point values, and the EnerPowDivider has already been used to scale the value so that is always in the standard "unit" form (e.g. kWh). There will still be a "resolution" in terms of the smallest difference in the numbers as they increment. For example: If the resolution is 10W, then the numbers jump by 0.01kWh, so they will go 0.0, 0.01, 0.02, 0.03 kWh etc. Remember though, that BACnet PresentValue objects are 32-bit floating point values, so there are only about 7 significant digits in the mantissa.

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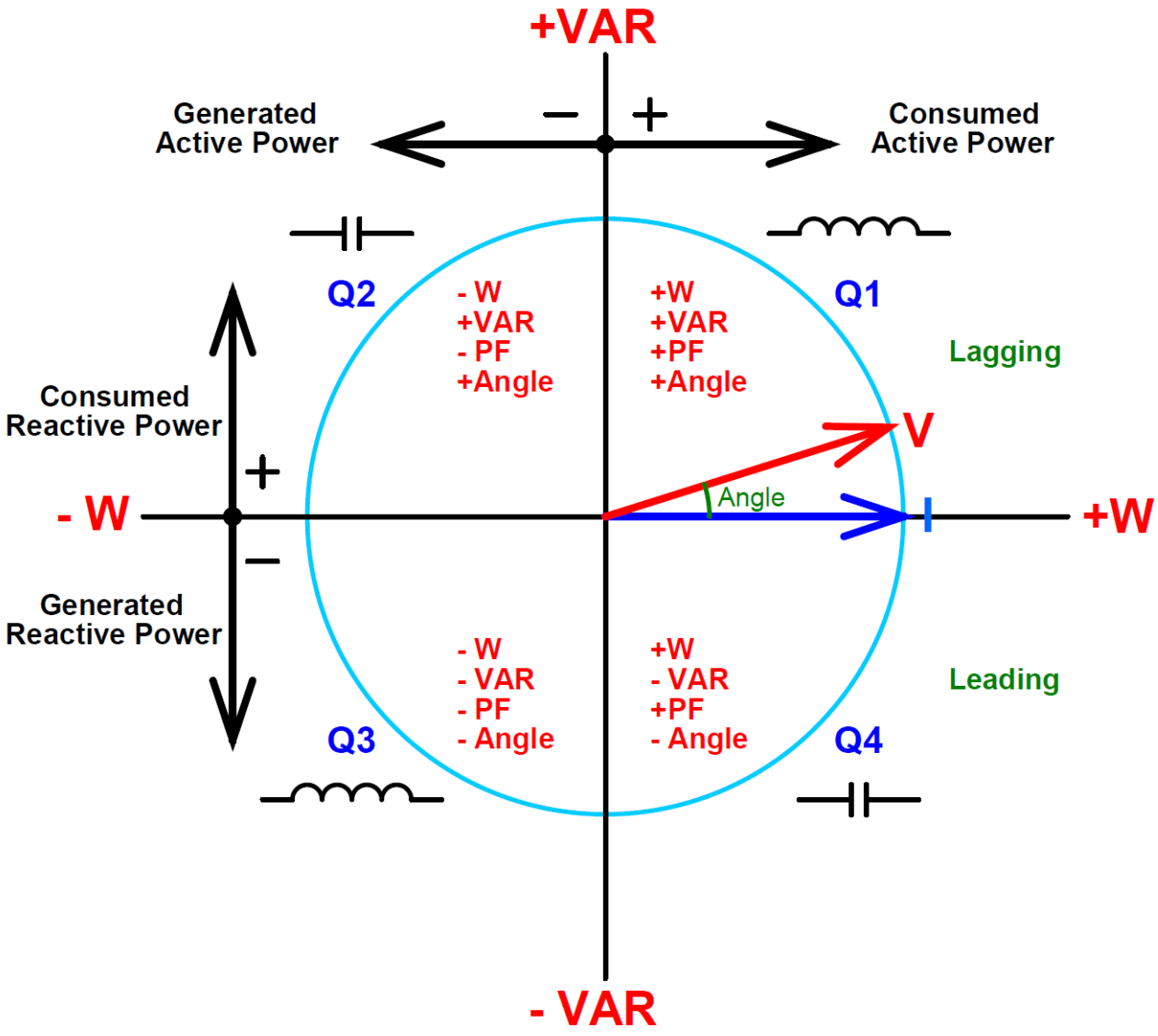
2.1.5 Polar Diagram and Sign of Measurement Values



The above polar diagram illustrates the geometric representation of active and reactive powers and is based on the *"recommended geometric representation"* in accordance with clauses 12 and 14 of IEC 60375, and Annex C of IEC 62053-23.

- The reference of this diagram is the current vector (I) (fixed on right hand line).
- The voltage vector (V) varies its direction according to the phase angle.
- The phase angle between voltage (V) and current (I) is taken to be positive in the mathematical sense (counter-clockwise).

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2.1.6 Measurlogic DTS Power Factor Format

The Power Factor objects in the DTS meters are normalized Power factor values in the range:

[-1.000 … 0 … +1.000].

NOTES

- The **DTS PF** value is **POSITIVE** when the meter is measuring **CONSUMED (+) power**.
- The **DTS PF** value is **NEGATIVE** when the meter is measuring **GENERATED (-) power**.
- The **sign of the PF value does NOT indicate leading or lagging**. You MUST use the sign of the values in the PowerQ (VAR) objects (or the ACosPF objects) to determine the VAR hemisphere, and thus leading or lagging.

EXAMPLES

DTS PF Object Value	W Value Sign	VAR Value Sign	ACosPF Value Degrees	Lagging or Leading	Quadrant
+ 0.954	[+]	[+]	+ 17.4	Lagging	Q1
+ 0.954	[+]	[-]	- 17.4	Leading	Q4
- 0.954	[-]	[+]	+ 162.6	Lagging	Q2
- 0.954	[-]	[-]	- 162.6	Leading	Q3

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2.2 AC MEASUREMENT REGISTERS

2.2.1 Measurement Values

Object_Name		Units	Object Number
Volt_LN_1		V	AI-5501
Volt_LN_2		V	AI-5502
Volt_LN_3		V	AI-5503
Volt_LN_Ave		V	AI-5504
Volt_LL_12		V	AI-5505
Volt_LL_23		V	AI-5506
Volt_LL_31		V	AI-5507
Volt_LL_Ave		V	AI-5508
Curr_1		A	AI-5513
Curr_2		A	AI-5514
Curr_3		A	AI-5515
Curr_Ave		A	AI-5516
Curr_Tot		A	AI-5517
Curr_N		A	AI-5518
Freq_1		Hz	AI-5521
Freq_2		Hz	AI-5522
Freq_3		Hz	AI-5523
Freq_Ave		Hz	AI-5524
PowerP_1	(Active)	kW	AI-5525
PowerP_2		kW	AI-5526
PowerP_3		kW	AI-5527
PowerP_Tot		kW	AI-5528
PowerS_1	(Apparent)	kVA	AI-5529
PowerS_2		kVA	AI-5530
PowerS_3		kVA	AI-5531
PowerS_Tot		kVA	AI-5532
PowerQ_1	(Reactive)	kVAR	AI-5533
PowerQ_2		kVAR	AI-5534
PowerQ_3		kVAR	AI-5535
PowerQ_Tot		kVAR	AI-5536
DmdP_Tot	(Active)	kW	AI-5629
DmdP_Tot_Max	(Active)	kW	AI-6229
DmdP_TotTime	(Actve)	None	DTV-7029
PF_DTS_1		None	AI-5551
PF_DTS_2		None	AI-5552
PF_DTS_3		None	AI-5553
PF_DTS_All		None	AI-5554

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2.2.2 Measurement Values (Continued)

Object_Name	Units	Object Number
ACosPF_1	deg	AI-5563
ACosPF_2	deg	AI-5564
ACosPF_3	deg	AI-5565
ACosPF_All	deg	AI-5566
Volt_UB_LN_1	%	AI-5571
Volt_UB_LN_2	%	AI-5572
Volt_UB_LN_3	%	AI-5573
Volt_UB_LN_Worst	%	AI-5574
Volt_UB_LL_12	%	AI-5575
Volt_UB_LL_23	%	AI-5576
Volt_UB_LL_31	%	AI-5577
Volt_UB_LL_Worst	%	AI-5578
Curr_UB_1	%	AI-5579
Curr_UB_2	%	AI-5580
Curr_UB_3	%	AI-5581
Curr_UB_Worst	%	AI-5582

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2.2.3 Measurement Nett Counter Values

These counters contain the **nett** energy values. By convention, imported/consumed energies are positive, and exported/generated energies are negative. Therefore, the values in these counters may be positive or negative.

Object_Name		Units	Object Number
EnergyP_1	(Active)	kWh	AI-7001
EnergyP_2		kWh	AI-7002
EnergyP_3		kWh	AI-7003
EnergyP_Total		kWh	AI-7004
EnergyS_1*	(Apparent)	kWh	AI-7005
EnergyS_2*		kWh	AI-7006
EnergyS_3*		kWh	AI-7007
EnergyS_Total*		kWh	AI-7008
EnergyQ_1	(Reactive)	kVARh	AI-7009
EnergyQ_2		kVARh	AI-7010
EnergyQ_3		kVARh	AI-7011
EnergyQ_Total		kVARh	AI-7012

* BACnet protocol does not support kVAh units. The units for apparent energy will be shown as kWh.

2.2.4 Measurement Split Counter Values (Advanced use only)

These counters contain the energies that have been accumulated in each operational area and are therefore always positive values. There are import/consumed and exported/generated counters for both the active and reactive hemispheres. Similarly, each of the four quadrants each have active and reactive counters.

Object_Name	Units	Object Number
EnergyP_Tot_Imp	kWh	AI-7013
EnergyP_Tot_Exp	kWh	AI-7014
EnergyQ_Tot_Imp	kVARh	AI-7015
EnergyQ_Tot_Exp	kVARh	AI-7016
EnergyP_Tot_Q1	kWh	AI-7017
EnergyQ_Tot_Q1	kVARh	AI-7018
EnergyP_Tot_Q2	kWh	AI-7019
EnergyQ_Tot_Q2	kVARh	AI-7020
EnergyP_Tot_Q3	kWh	AI-7021
EnergyQ_Tot_Q3	kVARh	AI-7022
EnergyP_Tot_Q4	kWh	AI-7023
EnergyQ_Tot_Q4	kVARh	AI-7024

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2.3 OTHER REGISTERS

2.3.1 CT Rating Objects

The "CT_Ratings" register contains the CT Current Rating for the CTs use with the meter.

- The CTs that are used with the meter must ALL have the same current rating and must be sized appropriately for the panel rating. Please contact Measurlogic Inc for advice on CT selection for your application.

Object_Name	Units	Object Number
CT_Ratings	A	AV-8005

2.3.2 Current Sensor Type

The "CurrentSensor" object contains the CT Current Rating for the CTs use with the meter.

- This object defines the Current Sensor Type for the CTs on all three phases:
  - For 333mV CTs - Must be zero (0).
  - For Rogowski Coils - Sensitivity in mV per 1000A @ 60Hz (e.g. 140mV)

Object_Name	Units	Object Number	
CurrentSensor	None	AV-8037	(Firmware V3.1910 and later)

2.3.3 Other Configuration Registers (Advanced use only)

The "EnerPowDivider" object and its usage is discussed in detail in this document section 2.1.4.

Object_Name	Units	Object Number
EnerPowDivider	None	AV-8023

2.3.4 General Counters

Object_Name	Units	Object Number
GeneralCounter_1	None	AI-7041
GeneralCounter_2	None	AI-7042
GeneralCounter_3	None	AI-7043
GeneralCounter_4	None	AI-7044

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2.3.5 Communications Objects

Object_Name	Units	Object Number	Options	Default
Baud_Rate (MS/TP Only)		AV-8060	9600 - 115200	38400
Device_ID (Node_ID)		AV-8062	1 - 4194303	473001
MAC_Address (MS/TP Only)		AV-8064	1 – 127	1
Max_Master (MS/TP Only)		AV-8065	1 – 127	127

Object_Name	Units	Object Number	Options	Default
Protocol_Reset		BV-8059	1 = Reset Protocol	0
Changes_Pending (Read Only)		BV-8060	1 = Pending Changes	0
Term_Resistor (120 ohms MS/TP Only)		BV-8061	0=Off & 1=On	0

Device Object Property Name		Options	Default
Object_Identifier (Device_ID)		1 - 4194303	473001
Max_Master (MS/TP Only)		1 – 127	127

NOTES

The Baud Rate may be set to 9600, 19200, 38400, 57600, 76800, or 115200. BACnet define to data bits, parity and stop bits to be "8,N,1" respectively, so these parameters are fixed and cannot be changed.

If applicable, the Object_Identifier, MAC_Address and Max_Master may be set to parameters that suit the network. The Object_Identifier and Max_Master are changed either via the Device Object or their respective objects as shown above. The Device Object does not contain the MAC_Address so must be changed using the objects shown above.

Not all meter models are equipped with an internal 120 ohm terminating resistor, so the Term_Resistor Object may not be present. In this case, external terminating resistors must be used to terminate the RS-485 bus at each physical end of the bus.

If the meter is equipped with switches, the MAC_Address will be set to the value on the "address" section of the switches and the Device_ID will have 473000 added to the MAC_Address value. See the applicable model documentation for more details. For more flexible control over the network settings, set all the switches to the ON position, and set the network parameters for each device over the network. Thereafter, do not move the switches.

IMPORTANT

Issue a warm or cold restart via the device control protocol once the changes have been made.

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2.4 DEMAND OBJECTS

Object_Name	Units	Object Instance_Number Instantaneous	
DmdP_Tot	kW	AI-5629	Total Active Demand
DmdP_Tot_Max	kW	AI-6629	Maximum Total Active Demand

The "DemandP_Tot" value is a **sliding (or windowed) average** of the total active power over a specified time called the **Demand Interval** period. The Demand values are updated at a regular period, called the **Demand Update** period.

These values are 15 minutes and 1 minute respectively, so there are 15 sub-intervals in the demand interval period. The following tables give a simple visualization to this concept.

Interval: 5 min
Update: 1 min
■■■■■**:** Demand Window Position

Dmd Tot		2.0kW							
Time	1	2	3	4	5	6	7	8	9
Active P	1kW	1kW	2kW	1kW	4kW	2kW	2kW	3kW	1kW

Dmd Tot			2.2kW						
Time	1	2	3	4	5	6	7	8	9
Active P	1kW	1kW	2kW	1kW	4kW	2kW	2kW	3kW	1kW

Dmd Tot				2.4kW					
Time	1	2	3	4	5	6	7	8	9
Active P	1kW	1kW	2kW	1kW	4kW	2kW	2kW	3kW	1kW

** The Maximum Demand Timestamp requires that the real time clock features be available on the meter. See section 2.5 for details.*

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2.4.1 Maximum Demand Time Stamp

The Maximum Demand time stamp is contained in the DateTime Value Object introduced in BACnet Revision 12:

Object_Name	Is UTC?	Object Instance_Number Instantaneous
DmdP_TotTime	TRUE	DTV-7029

2.4.2 Resetting the Maximum Demand

The Maximum Demand can be reset by writing the "Reset All Maximum Values" command to the command objects:

Action	Register Description	Object ID	Value (Dec)	Value (Hex)
Reset All Maximum Values	DTS_Command DTS_Command_Hi	AV-20001 AV-20101	0 61442	0x0000 0xF002

NOTE
When a maximum reset is performed, the "DemandP_TotMax" will be reset to the present "DemandP_Tot" value, and the "DemandP_Total_Max_Date/Time" will be reset to the current time.
When issuing these commands write to DTS_Command first, then write to DTS_Command_Hi to complete the command.
The Command Object values will be reset to zero when the specified action is completed. Since this occurs very quickly, the Command Object values will generally read as zero.

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2.5 SETTING TIME AND TIME OBJECTS

ATTENTION
The time objects are available in the DTS range of meters with firmware V2.91 and later.
If the meter is fitted with a Real Time Clock (RTC) then time will be maintained while the meter is powered off if the backup battery is good. For meters without a RTC the meter will maintain real time while the meter is powered on only. After a power interruption, the RTC will be restored to the time shortly before the meter lost power.
The **DTS 307** meter is NOT fitted with a RTC so will have the reduced time functionality as described above.

2.5.1 Real Time Clock and Daylight Savings

The Real Time Clock, Daylight Savings, and UTC Offset are properties of the Device Object. The time can be set using the BACnet **TimeSynchronization-B (DM-TS-B)** or **UTCTimeSynchronization-B (DM-UTC-B)** commands.

Device Object Properties	Value
Local Date	(Weekday, DD-Month-YYYY)
Local Time	HH:MM:SS.ss
UTC Offset	[-840 .. 720]
Daylight Savings Status	BOOL

2.6 PICS (BACnet Protocol Implementation Conformance Statement)

PICS documentation for our legacy BACnet MS/TP and Ethernet BACnet_IP are available upon request.

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