INSTRUCTION MANUAL

FOR

BE1-MMS100

MULTIFUNCTION METER SYSTEM

DISTRIBUTED NETWORK PROTOCOL (DNP V3.00)

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INTRODUCTION

This manual provides detailed information for the MMS-100 Multifunction Metering System with the Distributed Network Protocol (DNP V3.00).

CAUTION

THIS PRODUCT CONTAINS ONE OR MORE NONVOLATILE MEMORY DEVICES. NONVOLATILE MEMORY IS USED TO STORE INFORMATION (SUCH AS SETTINGS) THAT NEEDS TO BE PRESERVED WHEN THE PRODUCT IS POWER-CYCLED OR OTHERWISE RESTARTED. ESTABLISHED NONVOLATILE MEMORY TECHNOLOGIES HAVE A PHYSICAL LIMIT ON THE NUMBER OF TIMES THEY CAN BE ERASED AND WRITTEN. IN THIS PRODUCT, THE LIMIT IS 100,000 ERASE/WRITE CYCLES. DURING PRODUCT APPLICATION, CONSIDERATION SHOULD BE GIVEN TO COMMUNICATIONS, LOGIC, AND OTHER FACTORS THAT MAY CAUSE FREQUENT/REPEATED WRITES OF SETTINGS OR OTHER INFORMATION THAT IS RETAINED BY THE PRODUCT. APPLICATIONS THAT RESULT IN SUCH FREQUENT/REPEATED WRITES MAY REDUCE THE USEABLE PRODUCT LIFE AND RESULT IN LOSS OF INFORMATION AND/OR PRODUCT INOPERABILITY.

PRODUCT REVISION HISTORY

The following information provides a historical summary of the changes made to the embedded software (firmware) of this device. The corresponding revisions made to this instruction manual are also summarized. This revision history is separated into two categories: DNP Program Firmware Changes and Manual Revisions. All revisions are listed in reverse chronological order.

DNP Program Firmware Version	Change
07.01.00 – Nov 2001	Initial release

Revision - Date	Change
None – April 2001	Initial release.
A – Sep 2017	Added caution box about nonvolatile memory overwrite.

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CONTENTS

SECTION 1 • GENERAL INFORMATION

INTRODUCTION

This document describes the Basler Electric Distributed Network Protocol (DNP) implementation in the MMS-100 Multifunction Metering System. MMS-100 is classified as an intelligent electronic device (IED) that is capable of reacting or responding to specific requests conforming to a level two slave device, as defined in the DNP V3.00 Subset Definitions Document. This manual contains a list of DNP data objects accessible by a master station.

NOTE

This implementation of DNP V3.00 is fully compliant with DNP V3.00 Subset Definition Level 2, contains many Subset Level 3 features, and contains some functionality even beyond Subset Level 3.

REFERENCES

- Instruction Manual for MMS-100 Multifunction Metering System
- DNP V3.00 Basic 4 Document Set
- DNP Subset Definitions Document
- The DNP website (www.DNP.org)

SECTION 2 • DNP V3.00 DEVICE PROFILE DOCUMENT

Table 1 provides a Device Profile Document in the standard format defined in the DNP V3.00 subset definition document. The table, in combination with the implementation table provided in Section 3 and the point list tables provided in Section 5, provide a complete application configuration guide for including the MMS-100 DNP protocol in any DNP environment.

Table 1. DNP V3.00 Device Profile Document

DNP V3.00
DEVICE PROFILE DOCUMENT

Vendor Name: Basler Electric Company

Device Name: MMS-100 Multifunction Metering System

Highest DNP Level Supported:	Device Function:
DNP-L2.	☐ Master ☒ Slave

Notable objects, functions, and/or qualifiers supported in addition to the highest DNP levels supported (the complete list is described in DNP V3.00 Implementation Table):

- For static (non-change-event) object requests, request qualifier codes 00 and 01(start-stop), 07 and 08 limited quantity), and 17 and 28(index) are supported in addition to request qualifier code 06 (no range – or all points).
- Static object requests sent with qualifiers 00,01,06,07, and 08, will be responded to with qualifiers 00 or 01.
- Static object requests sent with qualifiers 17 and 28 will be responded to with qualifiers 17 or 28.
- The read function code for object 102 (8-bit unsigned integer), variation 1, is supported.
- The default variation for objects 30, 32, and 40 is 3, 1, and 2 respectively, however these variations are configurable. See notes in section 3 following implementation table for details.
- Current Change Event Dead band is configurable via object 41, point 3.
- Voltage Change Event Dead band is configurable via object 41, point 4.
- Power Change Event Dead band is configurable via object 41, point 5.
- The maximum number of binary events stored is 300
- The maximum number of analog events stored is 62

Maximum Data Link Frame Size (octets):	Maximum Application Fragment Size (octets):
Transmitted 292 Received 292	Transmitted 1500 Received 1024
Maximum Data Link Re-tries:	**Maximum Application Layer Re-tries:**
☒ None ☐ Fixed at ☐ Configurable	☒ None ☐ Fixed at ☐ Configurable, range _____ to _____

Requires Data Link Layer Confirmation:
☒ Never
☐ Always
☐ Sometimes If 'Sometimes', when?_____
☐ Configurable If 'Configurable', how?_____

Requires Application Layer Confirmation:
☐ Never
☐ Always (not recommended)
☒ When reporting Event Data (Slave devices only)
☒ When sending multi-fragment responses (Slave devices only)

DNP V3.00
DEVICE PROFILE DOCUMENT

Timeouts while waiting for:

Data Link Confirm	☐ None	☒ Fixed at 3000 ms	☐ Variable	☐ Configurable
Complete Appl. Fragment	☒ None	☐ Fixed at ____	☐ Variable	☐ Configurable
Application Confirm	☐ None	☒ Fixed at 5000 ms	☐ Variable	☐ Configurable
Complete Appl. Response	☒ None	☐ Fixed at ____	☐ Variable	☐ Configurable

Sends/Executes Control Operations:

WRITE Binary Outputs	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
SELECT/OPERATE	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
DIRECT OPERATE	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
DIRECT OPERATE - NO ACK	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
Count > 1	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
Pulse On	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
Pulse Off	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
Latch On	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
Latch Off	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
Queue	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
Clear Queue	☒ Never	☐ Always	☐ Sometimes	☐ Configurable

Reports Binary Input Change Events when no specific variation requested (Slave Only):
- ☐ Never
- ☒ Only time-tagged
- ☐ Only non-time-tagged
- ☐ Configurable to send both, one or the other (attach explanation)

Reports time-tagged Binary Input Change Events when no specific variation requested:
- ☐ Never
- ☒ Binary Input Change With Time
- ☐ Binary Input Change With Relative Time
- ☐ Configurable (attach explanation)

Master Expects Binary Input Change Events:
- ☐ Never
- ☐ Either time-tagged or non-time-tagged for a single event
- ☐ Both time-tagged and non-time-tagged for a single event
- ☐ Configurable (attach explanation)

Sends Unsolicited Responses (Slave Only):
- ☒ Never
- ☐ Configurable (attach explanation)
- ☐ Only certain objects
- ☐ Sometimes (attach explanation)
- ☐ ENABLE/DISABLE UNSOLICITED Function codes supported

Sends Static Data in Unsolicited Responses (Slave Only):
- ☒ Never
- ☐ When Device Restarts
- ☐ When Status Flags Change

No other options are permitted.

Default Counter Object/Variation:
- ☒ No Counters Reported
- ☐ Configurable (attach explanation)
- ☐ Default Object
  Default Variation
- ☐ Point-by-point list attached

Counters Roll Over at:
- ☒ No Counters Reported
- ☐ Configurable (attach explanation)
- ☐ 16 Bits
- ☐ 32 Bits
- ☐ Other Value:
- ☐ Point- by-point list attached

Sends Multi-Fragment Responses (Slave Only): ☒ Yes ☐ No

SECTION 3 • IMPLEMENTATION TABLE

DNP V3.00 IMPLEMENTATION TABLE

Table 2 identifies which object variations, function codes, and qualifiers the MMS-100 DNP supports in both request messages and in response messages.

For static (non-change-event) objects, requests sent with qualifiers 00, 01, 06, 07, or 08 will be responded to with qualifiers 00 or 01. Static object requests sent with qualifiers 17 or 28 will be responded to with qualifiers 17 or 28.

For change-event objects, qualifiers 17 and 28 are always responded.

Table 2. BE1-951 DNP Implementation Table

OBJECT			**REQUEST** (MMS-100 will parse)		**RESPONSE** (MMS-100 will respond with)	
Object No.	Variation No.	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (hex)	Qualifier Codes (hex)
1	0	Binary Inputs – (Variation 0 is used to request default variation)	1 (read)	00,01 (start- stop) 06 (no range) 07,08 (limited qty) 17,28 (index)		
1	1 (default – see note 1)	Single-Bit Binary Input	1 (read)	00,01 (start- stop) 06 (no range) 07,08 (limited qty) 17,28 (index)	81 (response)	00,01 (start-stop) 17,28 (index)
2	0	Binary Input Change (Variation 0 is used to request default variation)	1 (read)	06 (no range) 07,08 (limited qty)		
2	1	Binary Input Change without time	1 (read)	06 (no range) 07,08 (limited qty)	81 (response)	17,28 (index)
2	2 (default – see note 1)	Binary Input Change with time	1 (read)	06 (no range) 07,08 (limited qty)	81 (response)	17,28 (index)
10	0	Binary Output – (Variation 0 is used to request default variation)	1 (read)	00,01 (start- stop) 06 (no range) 07,08 (limited qty) 17,28 (index)		
10	2 (default – see note 1)	Binary Output Status	1 (read)	00,01 (start- stop) 06 (no range) 07,08 (limited qty) 17,28 (index)	81	00,01 (start-stop) 17,28 (index)
12	1	Control Relay Output Block	3 (select) 4 (operate) 5 (direct op) 6 (dir op Noack)	00,01 (start-stop) 07,08 (limited qty) 17,28 (index)	81	echo of request
30	0	Analog Input (Variation 0 is used to request default variation)	1 (read)	00,01 (start- stop) 06 (no range) 07,08 (limited qty) 17,28 (index)	81(response)	00,01 (start-stop) 17,28 (index)
30	1 (default – see note 2)	32-Bit Analog Input With Flag	1 (read)	00,01 (start- stop) 06 (no range) 07,08 (limited qty) 17,28 (index)	81	00,01 (start-stop) 17,28 (index)
30	2	16-Bit Analog Input With Flag	1 (read)	00,01 (start- stop) 06 (no range) 07,08 (limited qty) 17,28 (index)	81	00,01 (start-stop) 17,28 (index)
30	3	32-Bit Analog Input Without Flag	1 (read)	00,01 (start- stop) 06 (no range) 07,08 (limited qty) 17,28 (index)	81	00,01 (start-stop) 17,28 (index)

OBJECT			REQUEST (MMS-100 will parse)		RESPONSE (MMS-100 will respond with)	
Object No.	Variation No.	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (hex)	Qualifier Codes (hex)
30	4	16-Bit Analog Input Without Flag	1 (read)	00,01 (start- stop) 06 (no range) 07,08 (limited qty) 17,28 (index)	81	00,01 (start-stop) 17,28 (index)
30	5 (default – see note 2)	32-Bit Floating Point Analog Input Without Flag	1 (read)	00,01 (start- stop) 06 (no range) 07,08 (limited qty) 17,28 (index)	81	00,01 (start-stop) 17,28 (index)
32	0	Analog Change Event (Variation 0 is used to request default variation)	1 (read)	06 (no range) 07,08 (limited qty)		
32	1 (default – see note 2)	32-Bit Analog Input without time	1 (read)	06 (no range) 07,08 (limited qty)	81	17,28 (index)
32	2	16-Bit Analog Input without time	1 (read)	06 (no range) 07,08 (limited qty)	81	17,28 (index)
32	3	32-Bit Analog Input with time	1 (read)	06 (no range) 07,08 (limited qty)	81	17,28 (index)
32	4	16-Bit Analog Input with time	1 (read)	06 (no range) 07,08 (limited qty)	81	17,28 (index)
32	5 (default – see note 2)	32-Bit Floating Point Analog Input without time	1 (read)	06 (no range) 07,08 (limited qty)	81	17,28 (index)
32	7	32-Bit Floating Point Analog Input with time	1 (read)	06 (no range) 07,08 (limited qty)	81	17,28 (index)
40	0	Analog Output Status – (Variation 0 is used to request default variation)	1 (read)	00,01 (start-stop) 06 (no range) 07,08 (limited qty) 17,28 (index)		
40	1	32-bit Analog Output Status	1 (read)	00,01 (start-stop) 06 (no range) 07,08 (limited qty) 17,28 (index)	81	00,01 (start-stop) 17,28 (index)
40	2 (default – see note 2)	16-bit Analog Output Status	1 (read)	00,01 (start-stop) 06 (no range) 07,08 (limited qty) 17,28 (index)	81	00,01 (start-stop) 17,28 (index)
40	3 (default - see note 2)	32-bit Floating Point Analog Output Status	1 (read)	00,01 (start-stop) 06 (no range) 07,08 (limited qty) 17,28 (index)	81	00,01 (start-stop) 17,28 (index)
41	1	32-bit Analog Output Block	3 (select) 4 (operate) 5 (direct op) 6 (dir op noack)	00,01 (start-stop) 07,08 (limited qty) 17,28 (index)	81	echo of request
41	2	16-bit Analog Output Block	3 (select) 4 (operate) 5 (direct op) 6 (dir op noack)	00,01 (start-stop) 07,08 (limited qty) 17,28 (index)	81	echo of request
41	3	32-bit Floating Point Analog Output Block	3 (select) 4 (operate) 5 (direct op) 6 (dir op noack)	00,01 (start-stop) 07,08 (limited qty) 17,28 (index)	81	echo of request
50	1	Time and Date	1 (read) 2 (write)	00,01 (start-stop) 06 (no range or all) 07 (limited qty=1) 08 (limited qty) 17,28 (index)	81	00,01 (start-stop) 17,28 (index)
60	1	Class 0 Data (Note 2) (Note 5)	1 (read)	06 (no range or all)	81	
60	2	Class 1 Data	1 (read)	06 (no range or all) 07,08 (limited qty)	81	

OBJECT			REQUEST (MMS-100 will parse)		RESPONSE (MMS-100 will respond with)	
Object No.	Variation No.	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (hex)	Qualifier Codes (hex)
60	3	Class 2 Data	1 (read)	06 (no range or all) 07,08 (limited qty)	81	
60	4	Class 3 Data	1 (read)	06 (no range or all) 07,08 (limited qty)	81	
80	1	Internal Indications	2 (write)	00 (start-stop) (index must=7)		
102	1	8-Bit Unsigned Integer (Note 3)	1 (read)	00,01 (start- stop) 06 (no range) 07,08 (limited qty) 17,28 (index)	81(response)	00,01 (start-stop) 17,28 (index)
		No Object(function code only) (See Note 4)	13 (cold restart)			
		No Object(function code only) (See Note 4)	14 (warm restart)			
		No Object (function code only)	23 (delay meas)			

Notes for Table 2:

1. A Default variation refers to the variation responded to when variation 0 is requested and/or in class 0,1,2, or 3 scans.
2. These default variations refers to the variation responded to when variation 0 is requested and/or in class 0,1,2, or 3 scans. However, these default variations can be configurable through object 41 point 2 (DNP Mode).

   Writing a 0 to this point results in the following default variations:

   -OBJ 30 default variation = 3

   -OBJ 32 default variation = 1

   -OBJ 40 default variation = 2

   Writing a 1 to this point results in the following default variations:

   -OBJ 30 default variation = 5

   -OBJ 32 default variation = 5

   -OBJ 40 default variation = 3

   Writing a 0 (integer variations) is not recommended due to loss of precision.
3. Object 102 is not included in Class 0 poll response.
4. A cold restart is implemented as a warm restart – the DNP process is restarted.
5. In Class 0 are included all Binary Inputs (object 1), and a selected set of Analog Inputs (object 30). Binary Output Status points and Analog Output Status points are not included in Class 0.

SECTION 4 • DNP V3.00 CONFIGURATION PARAMETERS

DNP CONFIGURATION PARAMETERS

These paragraphs describe configuration settings that may be verified/changed from the MMS-100 front panel or using ASCII protocol commands.

MMS-100 Slave Address

MMS-100 relays support DNP through the rear RS-485 communication port, which is communication port 2 (COM2). This port supports Baud Rates: 1200, 2400, 4800, 9600, and 19200, with the default Baud Rate at 9600.

DNP Slave IED Address Range is from 0 to 65534. Address 65535 (hex FFFF) is used to broadcast messages to all devices. The communication address can be set by the SG-COM2 ASCII command. For more information about changing the relay parameters, refer to the MMS-100 Instructional Manual, part number 9 3267 00 991.

Example: Set the MMS-100 address to be 125, and baud rate to be 9600.

(In the following example, the operator's commands are in **bold**.)
>**a=**<**global_password**> <**enter**> //enter global password
>ACCESS GRANTED: GLOBAL
> **sg-com2=9600,8N1,125**
>**exit** (**enter**)
>SAVE CHANGES (Y/N/C) ?
>**y** <**enter**>
>CHANGE COMM PARAMETERS
>
To verify port address, enter command
>**sg-com2**(**enter**)
>SG-COM2=9600, 8N1,0X007D

NOTE: The communication port addresses are read back in hexadecimal.

SECTION 5 • DNP V3.00 POINT LIST

BINARY INPUT POINTS

Binary Input changes are scanned every ten milliseconds. Events are pending in the Slave application buffer until the Master device sends confirmation that response with pending events were received. Table 3 describes the binary input points.

Table 3. Binary Input Points

Binary Input Points
Static Object Number: 1 Change Event Object Number: 2 Request Function Codes Supported: 1 (read) Static Variation Reported When Variation 0 Requested: 1 (Binary Input Without Status) Change Event Variation Reported When Variation 0 Requested: 2 (Binary Input Change With Time)

Point Index	Description	Change Event Assigned Class (1,2,3 or none)	Notes
Hardware Input Status (points 0 – 3)			
0	Input Contact 1 State	1	
1	Input Contact 2 State	1	
2	Input Contact 3 State	1	
3	Input Contact 4 State	1	
Hardware Output Status (points 4 – 9)			
4	Output Contact 1 State	1	
5	Output Contact 2 State	1	
6	Output Contact 3 State	1	
7	Output Contact 4 State	1	
8	Output Contact 5 State	1	
9	Output Contact 6 State	1	
Alarm Status Points (points 10 - 51)			
10	Volts Phase A LOW	1	1
11	Volts Phase A HIGH	1	1
12	Volts Phase B LOW	1	1
13	Volts Phase B HIGH	1	1
14	Volts Phase C LOW	1	1
15	Volts Phase C HIGH	1	1
16	Amps Phase A LOW	1	1
17	Amps Phase A HIGH	1	1
18	Amps Phase B LOW	1	1
19	Amps Phase B HIGH	1	1
20	Amps Phase C LOW	1	1
21	Amps Phase C HIGH	1	1
22	Amps Neutral LOW	1	1
23	Amps Neutral HIGH	1	1
24	Watts Phase A LOW	1	1

Point Index	Description	Change Event Assigned Class (1,2,3 or none)	Notes
25	Watts Phase A HIGH	1	1
26	Watts Phase B LOW	1	1
27	Watts Phase B HIGH	1	1
28	Watts Phase C LOW	1	1
29	Watts Phase C HIGH	1	1
30	Watts Total LOW	1	1
31	Watts Total HIGH	1	1
32	VARS Phase A LOW	1	1
33	VARS Phase A HIGH	1	1
34	VARS Phase B LOW	1	1
35	VARS Phase B HIGH	1	1
36	VARS Phase C LOW	1	1
37	VARS Phase C HIGH	1	1
38	VARS Total LOW	1	1
39	VARS Total HIGH	1	1
40	Power Factor LOW	1	1
41	Power Factor HIGH	1	1
42	Frequency LOW	1	1
43	Frequency HIGH	1	1
44	Pulse Input 0 LOW	1	1
45	Pulse Input 0 HIGH	1	1
46	Pulse Input 1 LOW	1	1
47	Pulse Input 1 HIGH	1	1
48	Pulse Input 2 LOW	1	1
49	Pulse Input 2 HIGH	1	1
50	Pulse Input 3 LOW	1	1
51	Pulse Input 3 HIGH	1	1

Note for Table 3:

1. These points are calculated once a second, but need to be in an alarm condition for one minute before becoming active.

BINARY OUTPUT STATUS POINTS AND CONTROL RELAY OUTPUT BLOCKS

Table 4 lists both the Binary Output Status Points (Object 10) and the Control Relay Output Blocks (Object 12). It is important to note that Binary Output Status Points can be read here, as well as through binary inputs 4 – 9.

Table 4. Binary Output Status Points And Control Relay Output Blocks

Binary Output Status Points:
Object Number: 10
Variations supported: 2
Request Function Codes supported: 1 (read)
Default Variation reported when variation 0 requested: 2 (Binary Output Status)

Control Relay Output Blocks
Object Number: 12
Variations supported: 1
Request Function Codes supported: 3(select), 4(operate), 5(direct operate), 6 (direct operate, noack)

Point Index	Description	Control Codes And Their Description
0	Hardware Output 1 State	
1	Hardware Output 2 State	
2	Hardware Output 3 State	
3	Hardware Output 4 State	
4	Hardware Output 5 State	
5	Hardware Output 6 State	
6	All Hardware Outputs State	

Notes for Table 4:

1. Reads Of Points
   - Reads of points from 0 to 5 return the current state of corresponding point.
   - Reads of point 6 will always result in a 0.

2 - When used to control the points listed in Table 3, the Control Code field of object 12 is parsed as described in the following paragraphs.
   - If the Control Code is NULL, then the command will be accepted without any action being taken.
   - If Queue, and Clear sub-fields are not zero, the returned Control Status is 4 (Control operation not supported).

3. Valid Control Code values are:
   - 0x00 = No action will be taken.
   - 0x01 = Pulse output to opposite of current state, then restore to previous state. Pulsed output is active for the specified “on/off time”.
   - 0x03 = Latch On
   - 0x04 = Latch Off

   All operations not defined above are invalid and will be rejected. If the Control Code is legal, but not supported for the requested point, the Status Return value is “Control operation not supported for this point” (value 4).
   - Arm timer value for all Select/Operate operations is 30 seconds.

ANALOG INPUTS

The following table lists Analog Inputs (Object 30). It is important to note that 16-bit and 32-bit variations of Analog Inputs, Analog Output Control Blocks, and Analog Output Statuses are transmitted through DNP as signed numbers. Even for analog input points that are not valid as negative values, the maximum

positive representation for a 16-bit variation is $<2^{15}-1> = 32,767$. For a 32-bit variation the maximum positive representation is $<2^{31}-1> = 2,147,483,647$.

A voltage analog change event will be generated if the point changes its value by the absolute amount equal to or bigger than the **(voltage deadband percentage * 0.01 * 120V)**.

A current analog change event will be generated if the point changes its value by the absolute amount equal to or bigger than the **(current deadband percentage * 0.01 * CT type)**. CT type = 1 or 5.

A power analog change event will be generated if the point changes its value by the absolute amount equal to or bigger than the **(power deadband percentage * 0.01 * 120V * CT type)**. CT type = 1 or 5.

All deadband percentages can be read/written through object 40/41 respectively. Analog change events, once generated, will be reported in one of the class polls (1, 2, 3 or none) as defined in column "*Change Event Assigned Class"*. Points not assigned to any class can be read as object 30 points, in any supported variation or qualifier implemented for object 30. Change events for analog inputs are reported in CURRENT mode (when a change is detected, the report of the change contains the current value of the time of the report - not the time the change was detected).

Table 5. Analog Inputs

Analog Inputs

Static Object Number : 30
Change Event Object Number : 32
Request Function Codes Supported: 1 (read)
Static Variation Reported When Variation 0 Requested: 5 (32-bit Floating Point Analog Input without Flag). This can be configured to respond with variation 3 instead (see Analog Outputs point 2).
Change Event Variation Reported When Variation 0 Requested: 5 (32-bit Floating Point Analog Change Event without Time). This can be configured to respond with variation 1 instead (see Analog Outputs point 2).

Index	Description	Change Event Assigned Class (1, 2, 3, or none)	Notes
	Metering Values (Points 0 to 30)		
0	Voltage, A-phase	1	1, 2
1	Voltage, B-phase	1	1, 2
2	Voltage, C-phase	1	1, 2
3	Primary Phase A Current Magnitude	1	1, 2
4	Primary Phase B Current Magnitude	1	1, 2
5	Primary Phase C Current Magnitude	1	1, 2
6	Primary Neutral Current Magnitude	1	1, 2
7	Power, True Phase A	1	1, 2
8	Power, True Phase B	1	1, 2
9	Power, True Phase C	1	1, 2
10	Power, True Total (for phases A, B, & C)	1	1, 2
11	Power, Reactive Phase A	1	1, 2
12	Power, Reactive Phase B	1	1, 2
13	Power, Reactive Phase C	1	1, 2
14	Power, Reactive Total (for phases A, B, & C)	1	1, 2
15	Power Factor	1	1
16	Frequency	1	1
17	KWh	2	1
18	KVARh	2	1
19	KVAh	2	1

Index	Description	Change Event Assigned Class (1, 2, 3, or none)	Notes
20	KWh Imported	2	1
21	KVARh Imported	2	1
22	KVAh Imported	2	1
23	KWh Exported	2	1
24	KVARh Exported	2	1
25	KVAh Exported	2	1
26	Accumulated Pulse Input 1	2	1, 4
27	Accumulated Pulse Input 2	2	1, 4
28	Accumulated Pulse Input 3	2	1, 4
29	Accumulated Pulse Input 4	2	1, 4
30	Grand Total	2	1, 4
31	Minutes Since Reset	2	1
32	Pulse Counter 1	None	1, 3
33	Pulse Counter 2	None	1, 3
34	Pulse Counter 3	None	1, 3
35	Pulse Counter 4	None	1, 3
Phase A Harmonics			
36	Phase A Harmonics [1]	None	1
37	Phase A Harmonics [2]	None	1
38	Phase A Harmonics [3]	None	1
39	Phase A Harmonics [4]	None	1
40	Phase A Harmonics [5]	None	1
41	Phase A Harmonics [6]	None	1
42	Phase A Harmonics [7]	None	1
43	Phase A Harmonics [8]	None	1
44	Phase A Harmonics [9]	None	1
45	Phase A Harmonics [10]	None	1
46	Phase A Harmonics [11]	None	1
47	Phase A Harmonics [12]	None	1
48	Phase A Harmonics [13]	None	1
49	Phase A Harmonics [14]	None	1
50	Phase A Harmonics [15]	None	1
51	Phase A Harmonics [16]	None	1
52	Phase A Harmonics [17]	None	1
53	Phase A Harmonics [18]	None	1
54	Phase A Harmonics [19]	None	1
55	Phase A Harmonics [20]	None	1
56	Phase A Harmonics [21]	None	1
57	Phase A Harmonics [22]	None	1
58	Phase A Harmonics [23]	None	1
59	Phase A Harmonics [24]	None	1

Index	Description	Change Event Assigned Class (1, 2, 3, or none)	Notes
60	Phase A Harmonics [25]	None	1
61	Phase A Harmonics [26]	None	1
62	Phase A Harmonics [27]	None	1
63	Phase A Harmonics [28]	None	1
64	Phase A Harmonics [29]	None	1
65	Phase A Harmonics [30]	None	1
66	Phase A Harmonics [31]	None	1
Phase B Harmonics			
67	Phase B Harmonics [1]	None	1
68	Phase B Harmonics [2]	None	1
69	Phase B Harmonics [3]	None	1
70	Phase B Harmonics [4]	None	1
71	Phase B Harmonics [5]	None	1
72	Phase B Harmonics [6]	None	1
73	Phase B Harmonics [7]	None	1
74	Phase B Harmonics [8]	None	1
75	Phase B Harmonics [9]	None	1
76	Phase B Harmonics [10]	None	1
77	Phase B Harmonics [11]	None	1
78	Phase B Harmonics [12]	None	1
79	Phase B Harmonics [13]	None	1
80	Phase B Harmonics [14]	None	1
81	Phase B Harmonics [15]	None	1
82	Phase B Harmonics [16]	None	1
83	Phase B Harmonics [17]	None	1
84	Phase B Harmonics [18]	None	1
85	Phase B Harmonics [19]	None	1
86	Phase B Harmonics [20]	None	1
87	Phase B Harmonics [21]	None	1
88	Phase B Harmonics [22]	None	1
89	Phase B Harmonics [23]	None	1
90	Phase B Harmonics [24]	None	1
91	Phase B Harmonics [25]	None	1
92	Phase B Harmonics [26]	None	1
93	Phase B Harmonics [27]	None	1
94	Phase B Harmonics [28]	None	1
95	Phase B Harmonics [29]	None	1
96	Phase B Harmonics [30]	None	1
97	Phase B Harmonics [31]	None	1
Phase C Harmonics			
98	Phase C Harmonics [1]	None	1

Index	Description	Change Event Assigned Class (1, 2, 3, or none)	Notes
99	Phase C Harmonics [2]	None	1
100	Phase C Harmonics [3]	None	1
101	Phase C Harmonics [4]	None	1
102	Phase C Harmonics [5]	None	1
103	Phase C Harmonics [6]	None	1
104	Phase C Harmonics [7]	None	1
105	Phase C Harmonics [8]	None	1
106	Phase C Harmonics [9]	None	1
107	Phase C Harmonics [10]	None	1
108	Phase C Harmonics [11]	None	1
109	Phase C Harmonics [12]	None	1
110	Phase C Harmonics [13]	None	1
111	Phase C Harmonics [14]	None	1
112	Phase C Harmonics [15]	None	1
113	Phase C Harmonics [16]	None	1
114	Phase C Harmonics [17]	None	1
115	Phase C Harmonics [18]	None	1
116	Phase C Harmonics [19]	None	1
117	Phase C Harmonics [20]	None	1
118	Phase C Harmonics [21]	None	1
119	Phase C Harmonics [22]	None	1
120	Phase C Harmonics [23]	None	1
121	Phase C Harmonics [24]	None	1
122	Phase C Harmonics [25]	None	1
123	Phase C Harmonics [26]	None	1
124	Phase C Harmonics [27]	None	1
125	Phase C Harmonics [28]	None	1
126	Phase C Harmonics [29]	None	1
127	Phase C Harmonics [30]	None	1
128	Phase C Harmonics [31]	None	1
Total Harmonic Distortion			
129	Total Harmonic Distortion Va	None	1
130	Total Harmonic Distortion Vb	None	1
131	Total Harmonic Distortion Vc	None	1
Maximum / Minimum Metering Values			
132	Volts Max Phase A	2	1
133	Volts Min Phase A	2	1
134	Volts Max Phase B	2	1
135	Volts Min Phase B	2	1
136	Volts Max Phase C	2	1
137	Volts Min Phase C	2	1

Index	Description	Change Event Assigned Class (1, 2, 3, or none)	Notes
138	Amps Max Phase A	2	1
139	Amps Min Phase A	2	1
140	Amps Max Phase B	2	1
141	Amps Min Phase B	2	1
142	Amps Max Phase C	2	1
143	Amps Min Phase C	2	1
144	Amps Max Neutral	2	1
145	Amps Min Neutral	2	1
146	Watts Max Phase A	2	1
147	Watts Min Phase A	2	1
148	Watts Max Phase B	2	1
149	Watts Min Phase B	2	1
150	Watts Max Phase C	2	1
151	Watts Min Phase C	2	1
152	Total Watts Max	2	1
153	Total Watts Min	2	1
154	VARs Max Phase A	2	1
155	VARs Min Phase A	2	1
156	VARs Max Phase B	2	1
157	VARs Min Phase B	2	1
158	VARs Max Phase C	2	1
159	VARs Min Phase C	2	1
160	Total VARs Max	2	1
161	Total VARs Min	2	1

Notes for Table 5:

1. If these values are read back in floating point format, then all points are read as regular units (i.e volts, amps, watts, vars, hertz, etc.)

   If these values are read back in integer format, the multiplier of these analog data points is 0.01. Example if the data point is Current, 125 represents 1.25 amperes (125 centiamps).
   - CURRENT values are in Primary centiamps.
   - VOLTAGE values are in Primary centivolts.
   - Apparent power is in Secondary centiVA.
   - REACTIVE power values are in Secondary centivars.
   - TRUE Power values are in Secondary centiwatts
   - FREQUENCIES are in centihertz
   - PHASE ANGLE is in centidegrees
   - KWh, KVARh, KVAh are in centihours

2. Voltage, Power and Current have configurable Change Event Dead Bands via Analog Output Blocks (objects 41). For details refer to the following paragraphs *Analog Output Status Points And Analog Output Control Blocks,* and see notes related to object 40 (41) points 3, 4, and 5.

3. The Pulse Counter Inputs will represent the number of pulses from the previous minute.

4. The Accumulated Pulse Inputs will represent the number of pulses / 60 accumulated since the last reset.

ANALOG OUTPUT STATUS POINTS AND CONTROL BLOCKS

Table 9 lists both the Analog Status Points (Object 40) and the Analog Output Control Blocks (Object 41). It is important to note that Analog Output Status Points are not included into Class 0.

The Return Status Value for object 41 for all control operations may be 6 (hardware problem) due to a value out of range.

Table 9. Analog Output Status Points and Control Blocks

Analog Output Status Points
Object Number: 40
Variations Supported: 1, 2, 3
Request Function Codes supported: 1 (read)
Default Variation Reported When Variation 0 Requested: 3 (32-Bit Analog Output Status). This can be configured to respond with variation 1 instead (see point 2).

Analog Output Blocks
Object Number: 41
Variations Supported: 1, 2, 3
Request Function Codes supported: 3(select), 4(operate), 5(direct operate), 6 (direct operate, noack)

Index	Description	Notes
0	Reset	1
1	Reset Min / Max Metering Values	2
2	DNP Mode	3
Reset Controls For Demand Current		
3	Current Change Event Dead band	4, 5
4	Voltage Change Event Dead band	4, 5
5	Power Change Event Dead band	4, 5

Notes for Table 9:

1. Writing a '1' to this point will reset kWh, kVARh, kVAh and accumulated pulses. Writing anything else to this value will result in an error. Reading this value is pointless, but will return a 0.

2. Writing a '1' to this point will reset the min/max metering values. Writing anything else to this value will result in an error. Reading this value is pointless, but will return a 0.

3. If a '1' is written to this value, then object 30, 32, and 40, will have floating point default variations. If a '0' is written to this value, then object 30, 32, and 40, will have integer default variations, where the points will be multiplied by 100 before being sent back. The latter method is not recommended due to loss of precision.

4. Change Event Dead band is programmable via this point. Point value must be entered as a 10 * percentage of primary nominal current (for point 1) or as 10 * a percentage of primary nominal voltage (for point 2), or as 10 * a percentage of secondary nominal power (for point 3). Allowed range is from 5 to 100 in steps of 1. This represents 0.5 to 10% in steps of 0.1%.

   Default Change Event Dead Bands are:

   - Current Default Change Event Dead Band is 10 (1%)
   - Voltage Default Change Event Dead Band is 10 (1%)
   - Power Default Change Event Dead Band is 10 (1%)

   Relay converts % into absolute amount of amps, volts, watts or vars by applying the following formulas:

   1. Phase Current Change Event Dead Band = Inom * CTP * % * 0.01
   2. Ground Current Change Event Dead Band = IGnom * CTG * %*0.01
   3. Phase to Neutral Voltage Change Event Dead Band = Vnom * VTP * %*0.01
   4. Power Change Event Dead Band = Vnom * Inom * % * 0.01
   5. Total Power Change Event Dead Band = Vnom * Inom * % * 0.01* 3

NOTE: CTP is Phase Current CT Ratio, CTG is Ground Current CT Ratio, VTP is Voltage VT Ratio.

Examples:

1. To configure Current Change Event Dead Band to 4% of primary nominal current, enter for 4, the value 40.

   Relay converts this % into an ampere value. For a 5 ampere relay, and CTP ratio =120 turns, dead band value in amperes for Phase current 5*120*40 * 0.001 = 24 primary A (2400 centiamps).

   If CTG=100 turns, Ground Current Change Event Dead Band = 5*100*40 * 0.001 = 20 primary A.

2. To configure Voltage Change Event Dead Band to 2% of primary nominal voltage enter for point 4 the value 20.

   Relay converts this % into a voltage value. For a VTP ratio =1000 turns, dead band value in volts for the Phase to Neutral Voltage Dead Band = 120 *1000 * 20 * 0.001 = 2400 V.

   If VTX=2000 than the Aux Voltage Change Event Dead Band=120 * 2000 * 2*0.01=4800 V.

   Phase-to-Phase Voltage Change Event Dead Band=120 *1000 * 2 * 0.01 *√ 3= 4152 V.

3. To configure Power Change Event Dead Band to 4 % of secondary nominal power enter for point 5 the value 40.

   Relay converts this % into secondary watts value. For a 5 ampere relay, Power Change Event Dead Band = 120 * 5 * 40 * 0.001 = 24W.

   Total Power Change Event Dead Band = 120 * 5 * 4 * 0.01* 3 = 72W

5. This is a setting and is active after being saved to a non-volatile memory. Saving to a non-volatile memory is performed immediately after a response to Master is sent, to prevent response time-out due to the saving operation.

8-BIT UNSIGNED INTEGER, OBJECT 102

Table 12 is the point list for Object 102, and lists the 8-Bit Unsigned Integer Points. Note that this object has only variation 1 and can not be requested with default variation 0.

Table 12. Object 102, 8-Bit Unsigned Integer Points

8-Bit Unsigned Integer
Object Number: 102
Variations Supported: 1
Request Function Codes supported: 1 (read)

Index	Description
0 – 9	Model Number
10 – 27	Application Software Version Number and Date
28 – 43	Part Number

Explanation:

Each point represents one character of a particular string.
Example: To read the Model Number, which is “MMS-100”, the returned read value for points 0 to 9 are:

Point	0	1	2	3	4	5	6	7	8	9
Read Value in ASCII format	M	M	S	-	1	0	0	NULL	NULL	NULL

Object 102 is not included in Class 0 poll response.

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