



**POWER
MEASUREMENT**

creator of ION® technology

DNP V3.00 Device Profile
version 1.3

ION®

8300

8400

8500

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Revision 0.2	March 1, 1999	Update to 8500ION specifications	Tom Stevenson
Revision 0.3	March 3, 1999	Clarified 8500ION Default Configuration	Tom Stevenson
Revision 1.0	April 1, 1999	First production release	Tom Stevenson
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Revision 1.2	Feb 21, 2002	Made changes to table 2.1 (added #28) that correspond with V2.2.0 release (Additional DNP map points and a wider range of DNP addresses)	Lynn Heap
Revision 1.3	December 31, 2004	DNP/TCP additions for v260 release (ION 8300, ION 8400, ION 8500)	Andrew Gillan Chuck Hoeppe

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1. Introduction

This document describes the DNP V3.00 communications protocol employed by ION 8000 series meters. The DNP protocol can be selected for the following:

- ◆ up to three serial communication ports (which can consist of RS232/RS485/Internal Modem)
- ◆ the optical port
- ◆ up to three Ethernet connections.

A maximum of three ports/connections in total may be used at the same time.

It is assumed that the reader is familiar with the DNP V3.00 protocol and serial communications in general.

1.1 ION 8000 Series DNP V3.00 Communications Protocol Revisions

Date	Description
April 1999	Initial Release.

2. DNP Device Profile

DNP V3.00 DEVICE PROFILE DOCUMENT	
Vendor Name: Power Measurement Ltd	
Device Name: ION 8300, ION 8400, ION 8500	
Highest DNP Level Supported: For Requests Level 2 ¹ For Responses Level 2	Device Function: ☐ Master ➤ Slave
Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table): Please refer to section “ Details on Customizing DNP V3.00 Configuration ” on page 13.	
Maximum Data Link Frame Size (octets): Transmitted 292 Received (must be 292)	Maximum Application Fragment Size (octets): Transmitted 2048 (configurable: 15 to 2048 octets) Received 2048
Maximum Data Link Re-tries: ☐ None ☐ Fixed at _____ ➤ Configurable, range 0 to 15	Maximum Application Layer Re-tries: ➤ None ☐ Configurable, range _____ to _____ (Fixed is not permitted)

¹ The device can be configured to support some DNP Objects not defined in DNP 3.0 Subset 2 –requests and responses for these objects are highlighted with “***” in the Implementation Table which follows. Users have control over the objects returned by the device to make sure that it only responds with objects parsable by a Subset 2 master.

Requires Data Link Layer Confirmation:

- ☐ Never
☐ Always
☐ Sometimes If 'Sometimes', when? _____

➤ Configurable If 'Configurable', how?

User option to set Data Link Confirmation to:

- **Always** – device will always request Data Link Confirmations.
- **Multi-packet only** – the device will request Data Link Confirmations when sending multi-packet responses.
- **Never** – the device will never request Data Link Confirmations.

Requires Application Layer Confirmation:

- ☐ Never
☐ Always (not recommended)
 ➤ When reporting Event Data (Slave devices only)
☐ When sending multi-fragment responses (Slave devices only)
- ☐ Sometimes If 'Sometimes', when? _____
- ☐ Configurable If 'Configurable', how? _____

Timeouts while waiting for:

Data Link Confirm ☐ None ☐ Fixed at __ ☐ Variable ➤ Configurable
 Complete Appl. Fragment ➤ None ☐ Fixed at __ ☐ Variable ☐ Configurable
 Application Confirm ➤ None ☐ Fixed at __ ☐ Variable ☐ Configurable
 Complete Appl. Response ➤ None ☐ Fixed at __ ☐ Variable ☐ Configurable

Others _____

Attach explanation if 'Variable' or 'Configurable' was checked for any timeout

- **Data Link Confirm timeout** is configurable: 0.1s to 30s

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

- **Select timeout** period is configurable: 0s to 30s

FILL OUT THE FOLLOWING ITEMS FOR SLAVE DEVICES ONLY:

Reports Binary Input Change Events when no specific variation requested:

- ☐ Never
☐ Only time-tagged
☐ Only non-time-tagged
➤ Configurable to send both, one or the other (explanation below)

User option to have all Binary Input Change Events returned as either:

- time-tagged OR
- non-time-tagged

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)

Sends Unsolicited Responses:

- Never
☐ Configurable (attach explanation)
☐ Only certain objects
☐ Sometimes (attach explanation)

☐ ENABLE/DISABLE UNSOLICITED Function codes supported

Sends Static Data in Unsolicited Responses:

- Never
☐ When Device Restarts
☐ When Status Flags Change

No other options are permitted.

Default Counter Object/Variation: ☐ No Counters Reported ➤ Configurable (explanation below) ☐ Default Object _____ Default Variation _____ ☐ Point-by-point list attached User option to return all static counters in one of the following variations: • 32-Bit Binary Counter • 32-Bit Binary Counter Without Flag • 16-Bit Binary Counter • 16-Bit Binary Counter Without Flag	Counters Roll Over at: ☐ No Counters Reported ➤ Configurable (explanation below) ☐ 16 Bits ☐ 32 Bits ☐ Other Value _____ ☐ Point-by-point list attached User option to select roll over: • 32 bit counters roll over at 2^{32}. • 16 bit counters roll over at 2^{16}
Sends Multi-Fragment Responses: ☐ Yes ➤ No	

2.1 Implementation Table

Level 2 Implementation (DNP-L2)

OBJECT			REQUEST (slave must parse)		RESPONSE (master must parse)	
Obj	Var	Description	Func Codes (dec)	Qual Codes (hex)	Func Codes	Qual Codes (hex)
1	0	Binary Input - All Variations	1	00,01,06		
1	1	Binary Input	1	00,01,06	129	00, 01
1	2	Binary Input with Status	1	00,01,06	129	00, 01
2	0	Binary Input Change - All Variations	1	06,07,08		
2	1	Binary Input Change without Time	1	06,07,08	129	17, 28
2	2	Binary Input Change with Time	1	06,07,08	129	17, 28
2	3	Binary Input Change with Relative Time	1	06,07,08		
10	0	Binary Output - All Variations	1	00,01,06		
10	1	Binary Output				
10	2	Binary Output Status	1	00,01,06	129	00,01
12	0	Control Block - All Variations				
12	1	Control Relay Output Block	3,4,5,6	17,28	129	echo of request
12	2	Pattern Control Block				
12	3	Pattern Mask				
20	0	Binary Counter - All Variations	1,7,8, 9,10	00,01,06		
20	1	32-Bit Binary Counter	1	00,01,06	129	00,01
20	2	16-Bit Binary Counter	1	00,01,06	129	00,01
20	3	32-Bit Delta Counter				
20	4	16-Bit Delta Counter				
20	5	32-Bit Binary Counter without Flag	1	00,01,06	129	00,01
20	6	16-Bit Binary Counter without Flag	1	00,01,06	129	00,01
20	7	32-Bit Delta Counter without Flag				
20	8	16-Bit Delta Counter without Flag				

OBJECT			REQUEST (slave must parse)		RESPONSE (master must parse)	
Obj	Var	Description	Func Codes (dec)	Qual Codes (hex)	Func Codes	Qual Codes (hex)
21	0	Frozen Counter - All Variations	1	00,01,06		
21	1	32-Bit Frozen Counter	1	00,01,06	129	00,01
21	2	16-Bit Frozen Counter	1	00,01,06	129	00,01
21	3	32-Bit Frozen Delta Counter				
21	4	16-Bit Frozen Delta Counter				
21	5	32-Bit Frozen Counter with Time of Freeze	1	00,01,06	129	00,01
21	6	16-Bit Frozen Counter with Time of Freeze	1	00,01,06	129	00,01
21	7	32-Bit Frozen Delta Counter with Time of Freeze				
21	8	16-Bit Frozen Delta Counter with Time of Freeze				
21	9	32-Bit Frozen Counter without Flag	1	00,01,06	129	00,01
21	10	16-Bit Frozen Counter without Flag	1	00,01,06	129	00,01
21	11	32-Bit Frozen Delta Counter without Flag				
21	12	16-Bit Frozen Delta Counter without Flag				
22	0	Counter Change Event - All Variations	1	06,07,08		
22	1	32-Bit Counter Change Event without Time	1	06,07,08	129	17, 28
22	2	16-Bit Counter Change Event without Time	1	06,07,08	129	17, 28
22	3	32-Bit Delta Counter Change Event without Time				
22	4	16-Bit Delta Counter Change Event without Time				
22	5	32-Bit Counter Change Event with Time	1	06,07,08	129	17, 28
22	6	16-Bit Counter Change Event with Time	1	06,07,08	129	17, 28
22	7	32-Bit Delta Counter Change Event with Time				
22	8	16-Bit Delta Counter Change Event with Time				

**2

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**

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² The device can be configured to respond with the object/variations marked with "***". Note that these object/variations are not listed in the DNP V3.00 Subset 2 definitions. If the meter is configured to respond with these objects care must be taken to insure sure that the master can parse the response.

OBJECT			REQUEST		RESPONSE		
			(slave must parse)		(master must parse)		
Obj	Var	Description	Func Codes (dec)	Qual Codes (hex)	Func Codes	Qual Codes (hex)	
23	0	Frozen Counter Event - All Variations	1	06,07,08			**
23	1	32-Bit Frozen Counter Event without Time	1	06,07,08	129	17,28	**
23	2	16-Bit Frozen Counter Event without Time	1	06,07,08	129	17,28	**
23	3	32-Bit Frozen Delta Counter Event without Time					
23	4	16-Bit Frozen Delta Counter Event without Time					
23	5	32-Bit Frozen Counter Event with Time	1	06,07,08	129	17, 28	**
23	6	16-Bit Frozen Counter Event with Time	1	06,07,08	129	17, 28	**
23	7	32-Bit Frozen Delta Counter Event with Time					
23	8	16-Bit Frozen Delta Counter Event with Time					
30	0	Analog Input - All Variations	1,7,8	00,01,06			
30	1	32-Bit Analog Input	1	00,01,06	129	00,01	
30	2	16-Bit Analog Input	1	00,01,06	129	00,01	
30	3	32-Bit Analog Input without Flag	1	00,01,06	129	00,01	
30	4	16-Bit Analog Input without Flag	1	00,01,06	129	00,01	
31	0	Frozen Analog Input - All Variations	1	00,01,06			**
31	1	32-Bit Frozen Analog Input	1	00,01,06	129	00,01	**
31	2	16-Bit Frozen Analog Input	1	00,01,06	129	00,01	**
31	3	32-Bit Frozen Analog Input with Time of Freeze	1	00,01,06	129	00,01	**
31	4	16-Bit Frozen Analog Input with Time of Freeze	1	00,01,06	129	00,01	**
31	5	32-Bit Frozen Analog Input without Flag	1	00,01,06	129	00,01	**
31	6	16-Bit Frozen Analog Input without Flag	1	00,01,06	129	00,01	**
32	0	Analog Change Event - All Variations	1	06,07,08			
32	1	32-Bit Analog Change Event without Time	1	06,07,08	129	17, 28	
32	2	16-Bit Analog Change Event without Time	1	06,07,08	129	17, 28	
32	3	32-Bit Analog Change Event with Time	1	06,07,08	129	17, 28	**
32	4	16-Bit Analog Change Event with Time	1	06,07,08	129	17, 28	**

OBJECT			REQUEST		RESPONSE	
			(slave must parse)		(master must parse)	
Obj	Var	Description	Func Codes (dec)	Qual Codes (hex)	Func Codes	Qual Codes (hex)
33	0	Frozen Analog Event - All Variations	1	06,07,08	129	17, 28
33	1	32-Bit Frozen Analog Event without Time	1	06,07,08	129	17, 28
33	2	16-Bit Frozen Analog Event without Time	1	06,07,08	129	17, 28
33	3	32-Bit Frozen Analog Event with Time	1	06,07,08	129	17, 28
33	4	16-Bit Frozen Analog Event with Time	1	06,07,08	129	17, 28
40	0	Analog Output Status - All Variations	1	00,01,06		
40	1	32-Bit Analog Output Status	1	00,01,06	129	00,01
40	2	16-Bit Analog Output Status	1	00,01,06	129	00,01
41	0	Analog Output Block - All Variations				
41	1	32-Bit Analog Output Block	3,4,5,6	17,28	129	echo of request
41	2	16-Bit Analog Output Block	3,4,5,6	17,28	129	echo of request
50	0	Time and Date - All Variations				
50	1	Time and Date	2	07 where quantity = 1		
50	2	Time and Date with Interval				
51	0	Time and Date CTO - All Variations				
51	1	Time and Date CTO				
51	2	Unsynchronized Time and Date CTO				
52	0	Time Delay - All Variations				
52	1	Time Delay Coarse			129	07, quantity=1
52	2	Time Delay Fine			129	07, quantity=1
60	0					
60	1	Class 0 Data	1	06,07,08		
60	2	Class 1 Data	1	06,07,08		
60	3	Class 2 Data	1	06,07,08		
60	4	Class 3 Data	1	06,07,08		

OBJECT			REQUEST (slave must parse)		RESPONSE (master must parse)	
Obj	Var	Description	Func Codes (dec)	Qual Codes (hex)	Func Codes	Qual Codes (hex)
80	1	Internal Indications	2	00 index=7		
		No Object (Cold Restart)	13			
		No Object (Warm Restart)	14			
		No Object (Delay Measurement)	23			

3. Time Sync Information

Parameter	Time
Maximum time base drift over a 10 minute interval	18ms
Maximum difference between meter time base and master station time base after time set from DNP protocol	2s
Maximum delay measurement error	200ms

3.1 Time Sync Request Configuration

The time interval which the device waits before requesting a time sync from the master (using IIN1-4) is configurable from 1 second to 1 day (in 1 second intervals). The factory default is 1 day.

A Setup option in the **DNP Slave Options ION Module** is used to configure the Time Sync Request period.

3.2 Configuring DNP Comm Port to Accept Time Syncs

Setup options in the **ION Clock Module** need to be configured before DNP Time Syncs to be processed correctly:

- **TimeSyncSource** identifies the communications port running the DNP Protocol.
- **TimeSyncType** indicates if the time syncs are sent in local time or universal time format.

4. ION 8000 Series Default DNP Configuration

ION 8000 series meters are shipped from the Factory with the following DNP static objects defined. These objects are returned in response to a Class 0 Poll. Note that the protocol of the desired communications port must set to “DNP 3.0” before the meter will respond to DNP master requests.

Analog Input Objects (16-Bit Analog Input without Flag) (Object 30, Variation 4)		
Point	Measurement	Scaling
0	Vln a	x1
1	Vln b	x1
2	Vln c	x1
3	Vln avg	x1
4	Vll ab	x1
5	Vll bc	x1
6	Vll ca	x1
7	Vll avg	x1
8	I a	x1
9	I b	x1
10	I c	x1
11	I avg	x1
12	kW a	x1
13	kW b	x1
14	kW c	x1
15	kW tot	x1
16	kVAR a	x1
17	kVAR b	x1
18	kVAR c	x1
19	kVAR tot	x1
20	kVA a	x1
21	kVA b	x1
22	kVA c	x1
23	kVA tot	x1
24	PFsign a	x1
25	PFsign b	x1
26	PFsign c	x1
27	PFsign tot	x1
28	V unbal	x10
29	I unbal	x10
30	I4	x1
31	Freq	x10
32	kW sd del-rec ³	x1
33	kVAR sd del-rec ³	x1
34	kVA sd del+rec ³	x1

Binary Counter Objects (16-Bit Binary Counter without Flag) (Object 20, Variation 6)		
Point	Measurement	Scaling
0	kWh del (Import)	x1
1	kWh rec (Export)	x1
2	kWh del+rec (Total)	x1
3	kWh del-rec (Net)	x1
4	kVARh del (Import)	x1
5	kVARh rec (Export)	x1
6	kVARh del+rec (Total)	x1
7	kVARh del-rec (Net)	x1
8	kVAh del+rec (Total)	x1

³ Note : These are instantaneous demand quantities, not peak (maximum) demand.

5. Details on Customizing DNP V3.00 Configuration

The 8000 series is factory configured with the basic DNP objects as outlined in “**ION 8000 Series Default DNP Configuration**” on page 12. The 8000 series DNP configuration can be further customized to take advantage of other DNP features.

5.1 Customizing the DNP Point map

The ION 8000 series configuration can be modified to define which measurements are mapped to DNP Static points – this allows a user to exactly control the number of objects returned in a Class 0 poll. ION Modules are used to map ION 8000 series measurements to DNP points as follows:

- Up to **64** ION 8000 series measurements can mapped to DNP Static points. The **DNP Slave Export ION Module** is used to map ION 8000 series measurements to DNP Binary Input, Binary Counter, or Analog Input points. A DNP Static point is defined for each ION 8000 series measurement that is “linked” to a DNP Slave Export ION Module. The type of DNP Static point is a setup option of the DNP Slave Export ION Module.
- Up to **16** relays can be controlled through DNP. The **DNP Slave Import ION Module** is used to map DNP Control Relay Output Block, and Analog Output Block points to ION 8000 series relay and analog output hardware.

5.2 Report-by-exception processing (DNP Events)

Any DNP Static point can be configured to create DNP Event objects on value changes. Binary Input Change Events are created when a DNP Binary Input point changes state. Counter and Analog Change Event objects are created when the corresponding Static object changes by more than a programmable deadband value. Deadbands can be set on a per-object basis. Further, Event objects can be assigned as either Class 1, Class 2, or Class 3 on a per-object basis.

Setup options in the **DNP Slave Export ION Module** are used to enable Events, define deadband values, and assign DNP Event Classes.

Setup options in the **DNP Slave Options ION Module** are used to select the Object/Variations of Events that will be produced.

The “scan time” for Binary Counter and Analog Input Points is 1 second.

The “scan time” for Binary Input Points is 20ms.

Event capacities are:

- Binary Input Change Events – 25 events
- Frozen Counter Events – 25 events
- Counter Change Events – 25 events
- Frozen Analog Input Events – 25 events
- Analog Input Change Events – 50 events

5.3 Control Relay Output Block

Both ‘1 point per address’ and ‘2 points per address’ modes of addressing are supported for Control Relay Output Block objects. A setup option in the **DNP Slave Import ION Module** selects the addressing mode.

5.4 Freezing Binary Counter Points

Any DNP Binary Counter Point can be configured to support the freeze command. When a Binary Counter is frozen it copies its value into a DNP Frozen Counter point. These Frozen Counter points are returned in a Class 0 poll. Freeze, Freeze/Clear, Freeze/No-Ack, and Freeze/Clear/No-Ack functions are supported.

A Setup option in the **DNP Slave Export ION Module** is used to give freeze capabilities to the associated Static point.

A Setup option in the **DNP Slave Options ION Module** is used to select the Object/Variation of the Frozen Static object.

5.5 Scaling

Counter and Analog Input objects can be scaled on a per-object basis. Scaling can be used to maintain resolution in floating point measurements. For example, Frequency measurements can be multiplied by 10 to obtain 1 decimal place of resolution.

5.6 Assigning ION DNP Slave Options Modules to Meter Communication Ports

The **ION DNP Slave Options Module** contains a *CommPort* setup register that assigns this **ION DNP Slave Options Module** to a particular communication port. Only the settings in the assigned **ION DNP Slave Options Module** have any affect on that communications port.

For TCP/IP connections (port is set to Ethernet) the *MasterIP Addr* setup register is used to differentiate between the connections. Setting a specific IP address in this register allows only that IP address to connect to this session. If the register is set to None or left blank, any IP address can connect and use the session.

For more information see the *Multiport DNP 3.0 and ION Technology* technical note, available from the Power Measurement web site.

6. Glossary of Terms

application	A piece of software (a program) consisting of one or more processes and supporting functions.
Binary	A number system having only two symbols (1 and 0), and where values are expressed in the base two number system.
Bit	Abbreviation of binary digit. The smallest unit of information in a binary system. Has a value of either one (1) or zero (0).
Master	The client or host station or computer, with which the RTU equipment communicates. Also referred to as a host or host computer.
Non-volatile	A semi-permanent type of data storage
random-access memory	(memory) that is backed up by batteries to maintain stored data even if system power is lost. Can be both read and changed by the system. Abbreviated as NVRAM.
Random-access memory	A type of temporary data storage (memory) that can be read and changed while the computer is in use. Data stored in random-access memory is lost if the system loses power. Abbreviated as RAM.
Remote terminal unit	A piece of equipment located at a distance from a master station to monitor and control the status of outlying equipment, and to communicate the information back to the master station or host. Abbreviated as RTU.
Sequence of events	A time-tagged change of state, logged as part of a chronological record of significant changes in the condition of a particular point or points being monitored. Abbreviated as SOE.

7. List of Acronyms and Abbreviations

DNP	distributed network protocol
IED	intelligent electronic device
NVRAM	non-volatile random-access memory
OSI	open systems interconnect
RAM	random-access memory
RTU	remote terminal unit
SOE	sequence of events