PowerLogic® ION7330 / ION7350

Power & Energy Meter

DNP 3.0 Device Profile
December 2006

Schneider Electric

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Contents

1. Introduction

This document describes the DNP V3.00 communications protocol employed by the ION7330 and ION7350. The DNP protocol can be selected for one of the two serial communication ports, or the infra-red port.

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

1.1 ION7330 and ION7350 DNP V3.00 Communications Protocol Revisions

Date	Description
September 1998	Initial Release.

2. DNP Device Profile

<table>
<tr><td colspan="2">DNP V3.00
DEVICE PROFILE DOCUMENT</td></tr>
<tr><td colspan="2">Vendor Name: Power Measurement Ltd</td></tr>
<tr><td colspan="2">Device Name: ION7330 / ION7350</td></tr>
<tr><td>Highest DNP Level Supported:

For Requests Level 2

For Responses Level 2</td><td>Device Function:

☐ Master Slave</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td>Maximum Data Link Frame Size (octets):

Transmitted 292

Received (must be 292)</td><td>Maximum Application Fragment Size (octets):

Transmitted 2048
(configurable: 15 to 2048 octects)

Received 2048</td></tr>
<tr><td>Maximum Data Link Re-tries:

☐ None
☐ Fixed at _____
Configurable, range 0 to 15</td><td>Maximum Application Layer Re-tries:

None
☐ Configurable, range ____ to _____
(Fixed is not permitted)</td></tr>
</table>

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
2	2	Binary Input Change with Time	1	06,07,08	129	17
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				
21	6	16-Bit Frozen Counter with Time of Freeze				
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
22	2	16-Bit Counter Change Event without Time	1	06,07,08	129	17
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				
22	6	16-Bit Counter Change Event with Time				
22	7	32-Bit Delta Counter Change Event with Time				
22	8	16-Bit Delta Counter Change Event with Time				

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

OBJECT			REQUEST (slave must parse)		RESPONSE (master must parse)	
Obj	**Var**	**Description**	**Func Codes (dec)**	**Qual Codes (hex)**	**Func Codes**	**Qual Codes (hex)**
33	0	Frozen Analog Event - All Variations				
33	1	32-Bit Frozen Analog Event without Time				
33	2	16-Bit Frozen Analog Event without Time				
33	3	32-Bit Frozen Analog Event with Time				
33	4	16-Bit Frozen Analog Event with Time				
40	0	Analog Output Status - All Variations	1	00,01,06		
40	1	32-Bit Analog Output Status				
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				
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)**
70	1	File Identifier				
80	1	Internal Indications	2	00 index=7		
81	1	Storage Object				
82	1	Device Profile				
83	1	Private Registration Object				
83	2	Private Registration Object Descriptor				
90	1	Application Identifier				
100	1	Short Floating Point				
100	2	Long Floating Point				
100	3	Extended Floating Point				
101	1	Small Packed Binary-Coded Decimal				
101	2	Medium Packed Binary-Coded Decimal				
101	3	Large Packed Binary-Coded Decimal				
		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	5s[1]
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 IIN bit #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 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.

[1] For the ION7330, this time is defined by the report-by-exception (RBE) scan time which is 5 seconds. The on-board time base will differ by a maximum of 2s compared to the master time base after a timeset, however, this time becomes academic when the RBE scan time is longer (the only use of time stamps in DNP is for event time stamping). Hence, the RBE scan time is entered here.

4. ION7330 & ION7350 Default DNP Configuration

The ION7330 & ION7350 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 a	x1
5	Vll b	x1
6	Vll c	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 swd	x1
33	kVAR swd	x1
34	kVA swd	x1

Binary Counter Objects

(16-Bit Binary Counter without Flag)
(Object 20, Variation 6)

Point	Measurement	Scaling
0	kWh imp	x1
1	kWh exp	x1
2	kWh tot	x1
3	kWh net	x1
4	kVARh imp	x1
5	kVARh exp	x1
6	kVARh tot	x1
7	kVARh net	x1
8	kVAh	x1

5. Details on Customizing DNP V3.00 Configuration

The ION7330 and ION7350 are factory configured with the basic DNP objects as outlined in **"**ION7330 & ION7350 Default DNP Configuration**"** on page 12. The ION7330 & ION7350 DNP configuration can be further customized to take advantage of other DNP features.

5.1 Customizing the DNP Point map

The ION7330 or ION7350 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 ION7330 or ION7350 measurements to DNP points as follows:

Up to **64** ION7330 or ION7350 measurements can be mapped to DNP Static points. The **DNP Slave Export ION Module** is used to map ION7330 or ION7350 measurements to DNP Binary Input, Binary Counter, or Analog Input points. A DNP Static point is defined for each ION7330 or ION7350 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 **4** 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 ION7330 or ION7350 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 5 seconds.

The "scan time" for Binary Input Points is 1 second.

Event capacities are:

Binary Input Change Events – 50 events

Counter Change Events – 50 events

Analog 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 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.

6. Master Station Communication Settings

6.1 Minimum Turn-Around Time

After a DNP master station has received a ION7330 or ION7350 data link frame it must ***wait*** a period of time before it can send data back to the ION7330 or ION7350. This period of time is called the "minimum turn-around time" and is BAUD rate dependent as listed in the following table:

BAUD Rate	minimum turn-around time (ms)
1200	10
2400	8
4800	7
9600	6
19200	3
38400	2

7. 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.

8. 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