



Relion® Protection and Control

615 series ANSI DNP3 Communication Protocol Manual



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This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive 2004/108/EC) and concerning electrical equipment for use within specified voltage limits (Low-voltage directive 2006/95/EC). This conformity is the result of tests conducted by ABB in accordance with the product standards EN 50263 and EN 60255-26 for the EMC directive, and with the product standards EN 60255-6 and EN 60255-27 for the low voltage directive. The IED is designed in accordance with the international standards of the IEC 60255 series and ANSI C37.90. The DNP protocol implementation in the IED conforms to "DNP3 Intelligent Electronic Device (IED) Certification Procedure Subset Level 2", available at www.dnp.org.

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Section 1 Introduction

1.1 This manual

The communication protocol manual describes a communication protocol supported by the IED. The manual concentrates on vendor-specific implementations.

1.2 Intended audience

This manual addresses the communication system engineer or system integrator responsible for pre-engineering and engineering for communication setup in a substation from an IED perspective.

The system engineer or system integrator must have a basic knowledge of communication in protection and control systems and thorough knowledge of the specific communication protocol.

1.3 Product documentation

1.3.1 Product documentation set

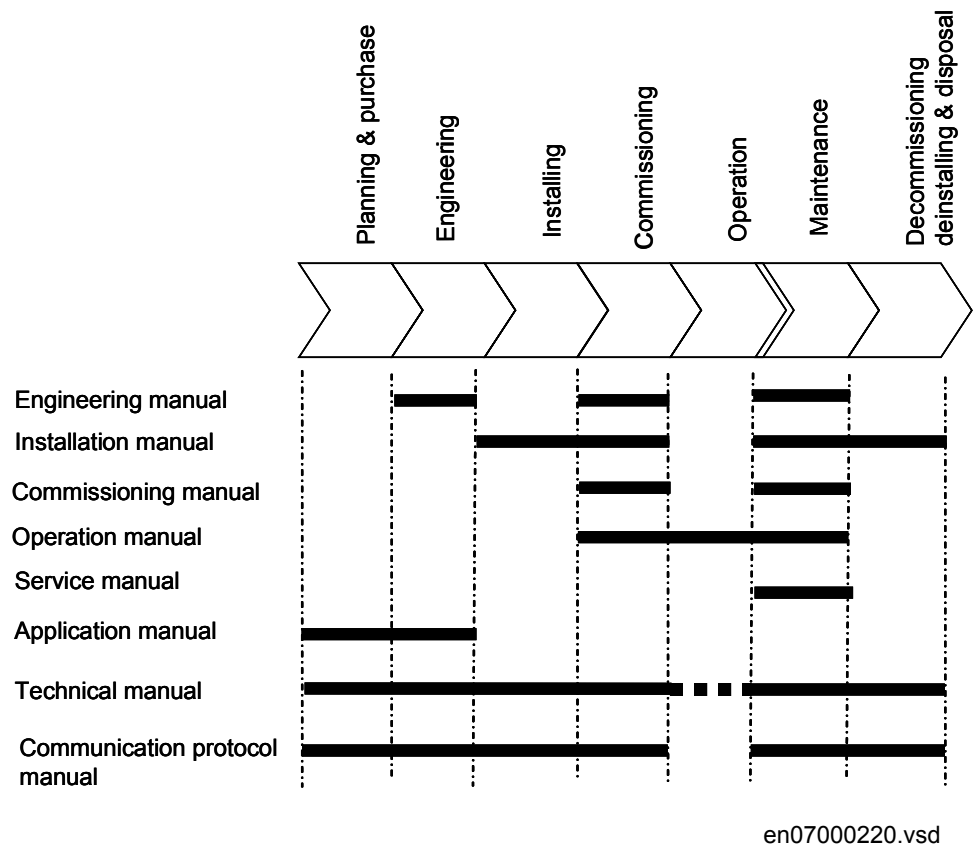


Figure 1: The intended use of manuals in different lifecycles

The engineering manual contains instructions on how to engineer the IEDs using the different tools in PCM600. The manual provides instructions on how to set up a PCM600 project and insert IEDs to the project structure. The manual also recommends a sequence for engineering of protection and control functions, LHMI functions as well as communication engineering for IEC 61850 and DNP3.

The installation manual contains instructions on how to install the IED. The manual provides procedures for mechanical and electrical installation. The chapters are organized in chronological order in which the IED should be installed.

The commissioning manual contains instructions on how to commission the IED. The manual can also be used by system engineers and maintenance personnel for assistance

during the testing phase. The manual provides procedures for checking of external circuitry and energizing the IED, parameter setting and configuration as well as verifying settings by secondary injection. The manual describes the process of testing an IED in a substation which is not in service. The chapters are organized in chronological order in which the IED should be commissioned.

The operation manual contains instructions on how to operate the IED once it has been commissioned. The manual provides instructions for monitoring, controlling and setting the IED. The manual also describes how to identify disturbances and how to view calculated and measured power grid data to determine the cause of a fault.

The service manual contains instructions on how to service and maintain the IED. The manual also provides procedures for de-energizing, de-commissioning and disposal of the IED.

The application manual contains application descriptions and setting guidelines sorted per function. The manual can be used to find out when and for what purpose a typical protection function can be used. The manual can also be used when calculating settings.

The technical manual contains application and functionality descriptions and lists function blocks, logic diagrams, input and output signals, setting parameters and technical data sorted per function. The manual can be used as a technical reference during the engineering phase, installation and commissioning phase, and during normal service.

The communication protocol manual describes a communication protocol supported by the IED. The manual concentrates on vendor-specific implementations.

The point list manual describes the outlook and properties of the data points specific to the IED. The manual should be used in conjunction with the corresponding communication protocol manual.



Some of the manuals are not available yet.

1.3.2

Document revision history

Document revision/date	Product series version	History
A/03/28/2008	1.0.1	First release
B/12/22/2008	1.1	Content updated to correspond to the product series version
C/01/20/2010	2.0	Content updated to correspond to the product series version



Download the latest documents from the ABB web site <http://www.abb.com/substationautomation>.

1.3.3 Related documentation

Product-specific point list manuals and other product series- and product-specific manuals can be downloaded from the ABB web site <http://www.abb.com/substationautomation>.

The purpose of this document is to describe specific configuration and interoperability information for an implementation of the Distributed Network Protocol, Version 3.0. This document, in conjunction with the DNP3 Basic 4 Document Set, and the DNP Subset Definitions Document, provides complete information on how to communicate via the DNP3 protocol.

1.4 Symbols and conventions

1.4.1 Safety indication symbols



The caution icon indicates important information or warning related to the concept discussed in the text. It might indicate the presence of a hazard which could result in corruption of software or damage to equipment or property.



The information icon alerts the reader to important facts and conditions.



The tip icon indicates advice on, for example, how to design your project or how to use a certain function.

Although warning hazards are related to personal injury, it should be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process performance leading to personal injury or death. Therefore, comply fully with all warning and caution notices.

1.4.2 Manual conventions

Conventions used in IED manuals. A particular convention may not be used in this manual.

- Abbreviations and acronyms in this manual are spelled out in the glossary. The glossary also contains definitions of important terms.
- Push button navigation in the LHMI menu structure is presented by using the push button icons, for example:
To navigate between the options, use  and .
- HMI menu paths are presented in bold, for example:
Select **Main menu/Settings**.
- LHMI messages are shown in Courier font, for example:
To save the changes in non-volatile memory, select Yes and press .
- Parameter names are shown in italics, for example:
The function can be enabled and disabled with the *Operation* setting.
- Parameter values are indicated with quotation marks, for example:
The corresponding parameter values are "Enabled" and "Disabled".
- IED input/output messages and monitored data names are shown in Courier font, for example:
When the function picks up, the PICKUP output is set to TRUE.
- Dimensions are provided both in inches and mm. If it is not specifically mentioned then the dimension is in mm.

Section 2 DNP3 overview

2.1 DNP3 standard

The DNP3 protocol was developed by Westronic based on the early versions of the IEC 60870-5 standard telecontrol protocol specifications. Now the protocol specification is controlled by the DNP Users Group at www.dnp.org.

The ISO/OSI based model supported by this protocol specifies physical, data link and application layers only. This reduced protocol stack is referred to as EPA. However, to support advanced RTU functions and messages larger than the maximum frame length as defined by the IEC document 60870-5-1, the DNP3 data link is intended to be used with a transport pseudo-layer. As a minimum, this transport layer implements message assembly and disassembly services.

Physical layer

There are two physical layer modes specified; serial and serial tunneled over TCP/IP.



Additional information on the DNP3 physical layer is available at the DNP Users Group at www.dnp.org.

Data link layer

The DNP3 data link layer is designed to operate with connection-oriented and connectionless asynchronous or synchronous bit serial physical layers. Fully balanced transmission procedures were adopted to support spontaneous transmissions from outstations.

Data link functions:

- Performing message data link retransmissions.
- Synchronizing and handling the FCB in the control octet.
- Setting and clearing the DFC bit based on buffer availability.
- Packing user data into the defined frame format, include CRC checksums and transmitting the data to the physical layer.
- Unpacking the data link frame received from the physical layer into user data, check and remove CRC checksums.

- Controlling all aspects of the physical layer.
- In unsolicited reporting mode, performing collision avoidance/detection procedures to ensure reliable transfer of data across the physical link.
- Responding to all valid frames received from the physical layer.

Data link responsibilities:

- Exchange of SDUs between peer DNP3 data links
- Error notification to data link user
- Sequencing of SDUs
- SDU delivery quality.

Link-layer confirm usage is deprecated.



See the DNP technical bulletin TB1998-0402, section 3 for details at www.dnp.org.

Transport pseudo-layer

To support advanced RTU functions and messages exceeding the maximum data link frame length, a transport pseudo-layer which implements message assembly and disassembly services was adopted. This pseudo-layer is actually a super-data link transport protocol, which is normally included in some OSI protocol data links.

Transport functions:

- Fragmenting user data into one or more data link frames and transmitting the data to the data link layer
- Assembling the data link frames received from the data link layer into user data
- Controlling all aspects of the data link excluding data link configuration

Transport responsibilities:

- Exchange of SDUs between peer DNP3 transport pseudo layers
- Error notification to transport users
- Sequencing of SDUs

Application layer

The application layer is responsible for performing operations on data objects defined by the device or on the device itself. These operations can be: returning actual values (read function), assigning new values (write function) if the object represents control points, arming and energizing the output point (select, operate or direct operate

functions) and if counters are used, storing actual values (freeze functions) and clearing the counters.

Many objects may be assigned to event classes. The DNP3 protocol defines four classes; 0 for static data and 1, 2 and 3 for event data.

Binary inputs and analog inputs may be assigned to class 0. Binary events and analog events may be assigned to classes 1, 2, or 3. If a binary event or analog event is in class 1, 2, or 3, the corresponding input should be in class 0. The configuration GUI provides this behavior. Any point which is not in class 0 will not be returned in a class 0 scan, however, its static value may be read explicitly.

In the present implementation, the binary output object may not be assigned to generate events in classes 1, 2 or 3. Instead, the outputs are available as binary inputs, which may then be assigned to generate events. The actual status of the binary outputs can be read from the binary inputs. A read of the binary outputs returns the last value written to that output, not its present value. For this reason, the binary outputs are not typically mapped to class 0.

Communication modes

The IED supports three DNP communication modes.

- Polled static mode, meaning that the master polls for class 0 or static data only
- Polled report by exception mode, where the Master polls for change events (class 1,2,3) and occasionally makes integrity polls (class 1, 2, 3, 0)
- Unsolicited report by exception mode, where the slave reports change events spontaneously without being polled by the master. Master occasionally makes integrity polls (class 1, 2, 3, 0).

2.2

Documentation

This implementation of DNP3 is fully compliant with DNP3 Subset Definition Level 2, and contains significant functionality beyond Subset Level 2.

Section 3 Vendor-specific implementation

3.1 DNP3 link modes

Serial and TCP/IP modes are available. They are mutually exclusive.

3.1.1 DNP3 data objects

The DNP3 protocol in 615 series IEDs is built on top of the internal IEC 61850 data model. Thus, the DNP3 application data objects and Class events are derived from IEC 61850 data objects and data set reporting. The 615 series IEDs have a predefined IEC 61850 data set configuration. In other words, it is predefined which internal data object changes the 615 series IEDs detect.

The available DNP3 data objects in the 615 series IEDs are selected from the objects predefined in the IEC 61850 data sets. IEC 61860 data set reporting and DNP3 Class event reporting are basically identical.



For a list of the available data objects, see the point list manual.

3.1.2 DNP3 serial link mode

DNP3 serial can be assigned to a serial communication port in the IED. Serial communication ports are named COM1...COMn, depending on how many serial ports the 615 series IED hosts..



If this protocol does not operate as expected, check that other serial protocols are not using the COM port also.



DNP3 protocol ignores any parity setting in the COM settings group; DNP3 is defined as an 8 bit/no parity protocol with a 16-bit CRC every 16 bytes. This provides better error detection than parity.

3.1.3 DNP3 TCP/IP mode

DNP3 TCP/IP link mode is supported by the IED.

The IED listens for a connection from a DNP3 master on port 20000. A single DNP3 session can be run concurrently with IEC 61850, Modbus Serial and/or Modbus TCP. Documentation concerning DNP3 TCP/IP communication is available from www.dnp.org.

3.2 DNP3 point list

3.2.1 Binary input points

The binary input event buffer size is set to allow 200 events. Events that occur after buffer overflow are discarded.

Table 1: *Binary input points*

Description	Value
Static (steady-state) object number	1
Change event object number	2
Static variation reported when variation 0 requested (default setting)	1 (binary input without status)
Change event variation reported when variation 0 requested (default setting)	2 (binary input change with time)

Table 2: *Default Class assignment for Binary Input points*

Point index	Name/description	Default change event assigned class (1, 2, 3 or none)
	See the point list manual.	1

3.2.2 Binary output status points and control relay output blocks

The BOS points (object 10) and the CROBs (object 12) are provided in the configuration-specific point list.

While BOS points are included here for completeness, that is they are required by the DNP3 standard, they are not often polled by DNP3 Masters. The DNP3 standard recommends that BOS points represent the most recent DNP3 command value for the corresponding CROB point. Because many, if not most, CROB points are controlled internally through pulse mechanisms, the value of the output status may be meaningless.

As an alternative, the actual status values of CROB points have been looped around and mapped as BIs and in the case of the breaker, as AI. BOS points that relate to physical binary outputs are in this implementation looped back and mapped as binary inputs. The actual status value, as opposed to the command status value, is the value of the actuated control. For example, a DNP3 control command may be blocked through hardware or software mechanisms; in this case, the actual status value would indicate the control failed because of the blocking. Looping CROB actual status values as BIs has several advantages:

- it allows actual statuses to be included in class 0 polls,
- it allows change event reporting of the actual statuses, which is a more efficient and time-accurate method of communicating control values,
- and it allows reporting of time-based information associated with controls, including any delays before controls are actuated, and any durations if the controls are pulsed.

BOS points that relate to some kind of software binary output points, that is reset- or acknowledge points, are not looped back as binary inputs.

The default select/control buffer size is large enough to hold 10 of the largest select requests possible.

DNP3 pulse commands, and associated count, off-time and on-time, are not supported in this implementation.

From the IED's perspective, there are two types of CROB points. Most are internally mapped to IEC 61850 SPC, while the breaker control is mapped to 61850 DPC.

SPC based CROB, for example, physical outputs and LEDs:

- Operate irrespective of the L/R switch position.
- Timeout selection is configurable.
- SPC points support both DIRECT (Direct Operate) and SBO (Select-Before-Operate).



LED output points only support latch off and trip commands. An error will be returned by the IED if latch on or close is sent to an LED output.

DPC based CROB, for example, breaker control:

- Operation is blocked unless IED is in the remote switch position.
- Timeout selection is configurable.
- DPC point DIRECT/SBO behavior is determined by the *Control_model* parameter in **Configuration/Control/52(2)/Control_model**.

1. The DNP stack accepts SBO commands if the *Control_model* parameter is configured for "sbo-with-enhanced-security".
2. DIRECT commands are accepted if the parameter is set to "direct-with-normal-security".
3. Otherwise, the command violates the *Control_model*, and is rejected.

Table 3: *Binary output status points*

Description	Value
Object number	10
Default variation reported when variation 0 requested (default setting)	2 (BOS)

Table 4: *Control relay output blocks*

Description	Value
Object number	12

Table 5: *CROB fields supported*

Point index	Name/description	Supported CROB fields
	See the point list manual.	All ¹⁾

- 1) In this IED implementation the pulse-on time cannot be commanded from the DNP3 master. A value in the variable pulse-on time field in the CROB command is ignored, but the command is accepted. It should be noticed that control pulse lengths for CB controls in this IED are configurable via PCM600. Pulse lengths for other types of outputs are internally fixed.

3.2.3

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 are transmitted through DNP3 as signed numbers.



The original DNP3 analog value is the same value as the IEC 61850 value generated for the same point. Measurands in IEC 61850 are expressed as floating point values while DNP3 analog values are integers. Therefore, it may be necessary to scale the original DNP3 values in order to include possible decimals in the DNP3 integer value.

The deadband is not configured in DNP3. It is configured at the device level. The analog change events are therefore generated by the device functions, not DNP3. The analog change event time stamp will inherently be accurate and consistent with the

reporting of events through other channels, for example, LHMI, WHMI and other communication protocols.

There are four scaling options associated with analog input reporting.

- None: the reported value is the process value.
- Multiplication: the process value is multiplied by a constant. An offset is added producing the reported value.
- Division: the process value is divided by a constant. An offset is added producing the reported value.
- Ratio:
 - Configuration-time ratio scaling: Find R for new set of {in_min, in_max, out_min, out_max} $R = (out_max - out_min) / (in_max - in_min)$
 - Runtime ratio scaling: Reported value = $(inval - in_min) * R + out_min$

The analog input event buffer size is set 150.

Table 6: *Analog inputs*

Description	Values
Static (steady-state) object number	30
Change event object number	32
Static variation reported when variation 0 requested (default setting)	3 (32 bit analog input w/o flag)
Change event variation reported when variation 0 requested (default setting)	1 (32 bit analog change event w/o time)

Table 7: *Default Class assignment for analog input data*

Point index	Name/description	Default deadband	Default change event assigned class (1, 2, 3 or none)
	See the point list manual.	Configurable IED setting	2

3.2.3.1

Analog data scaling

The four scaling options associated with analog input data reporting are None, Ratio, Multiplicative and Divisor. The selection *None* means that no scaling is performed on the source IEC 61850 value. The value is reported as such to DNP.

Ratio, multiplicative and divisor scaling methods

The PCM600 tool contains four value arguments related to the scaling methods: *sourceMinVal*, *sourceMaxVal*, *destMinVal* and *destMaxVal*. The use of these arguments differs depending on the scaling method.

The ratio, multiplicative and divisor scaling methods use the first two arguments, *sourceMinVal* and *sourceMaxVal*, to define the source value range inside which the object is to be used. The complete value range of the object is usually wanted even though the user could freely define the source range.

Arguments three and four, *destMinVal* and *destMaxVal*, define the destination value range. In ratio scaling, arguments *destMinVal* and *destMaxVal* define the corresponding range of the scaled, reported DNP value.

$$DNPvalue = (sourceValue - sourceMinVal) \times \left[\frac{(destMaxVal - destMinVal)}{(sourceMinVal - sourceMaxVal)} \right] + destMinVal$$

(Equation 1)

In multiplicative scaling, argument four *destMaxVal* becomes a scale constant and argument three *destMinVal* becomes an offset.

$$DNPvalue = (sourceValue \times destMaxVal) + destMinVal$$

(Equation 2)

In divisor scaling, argument four *destMaxVal* becomes a scale constant and argument three *destMinVal* becomes an offset.

$$DNPvalue = \left(\frac{sourceValue}{destMaxVal} \right) + destMinVal$$

(Equation 3)

3.2.3.2 Fault record time stamp

When a new fault occurs, the fault number (LD0.FLTSTA1.OpCnt.stVal) increases, and it is stored in the DNP AI event buffer. Other points associated with the fault record (D0.FLTSTA) which change are also entered in the DNP AI event buffer. They are also time stamped, but the official time of the fault is the event time stamp on the LD0.FLTSTA1.OpCnt.stVal point.

Fault information, including time stamps, is retrieved from the IED by a DNP master using a Class1_Class2_Class3 scan or an integrity (Class1_Class2_Class3_Class0) scan. The AI event default variation should be set to include time stamps. It is possible that not all points of the fault generate events. This happens when the point of the new fault has the same value as the previous fault.

3.3 DNP points

3.3.1 Point configuration

The DNP3 point map is configurable in PCM600. All points in the IED may be remapped. In PCM600, the unmapped points in the variables list on the left may be inserted to the active point list on the right.

Point gaps may be inserted if wanted. Point gaps cannot be read by the client.

3.3.2 Class assignment

Class assignment allows the events generated in the IED to be reported as DNP3 events. Some configurations exceed the class assignment possibilities defined by the standard.

Table 8: *DNP3 point map configuration*

Configuration	Description
None	Integrity class 0 scan returns gap. Value is available only via static scan. Point does not generate events.
Class 0	Point is returned in the class 0 scan. Point does not generate events.
Class 0 and any class 1,2,3 combination	Point is returned in the class 0 scan. Point generates events for the selected class or classes.
Class 1, 2 or 3 combination	Point is not returned in the class 0 scan. Point generates events for the selected class or classes.

BOS points exist only if the corresponding CROB point has been inserted in the active point list.

Class assignment cannot be performed on CROBs. They can only be performed on the corresponding BOS points in a limited fashion; they may only be assigned Class 0 or None and only affect the class 0 scan. This means they cannot be configured to generate events. The BOS points, however, have been made available as BI points, which can be configured to generate events.

Section 4 DNP3 parameters

4.1 Parameter descriptions

Link parameters

DNP physical layer configures DNP3 for the TCP/IP or serial channel.

Unit address is the slave 16 bit link address. This value should be set between 1 and 65519, since DNP3 reserves the top 16 addresses. All DNP3 devices coexisting on the same network should have unique addresses.

Master address is the 16 bit link address at which the initial unsolicited message is sent. The value should be unique, between 1 and 65519.

Serial port configures DNP3 for the selected serial channel only if DNP3 physical layer is set for Serial. The serial port speed is set under **Communication/COM1** and **Communication/COM2**.

Time format can be set to Local or UTC.

Crob select timeout is the DNP3 select before operate timer.

Data link confirm enables or disables the data link confirmation. Options are: never, only for multi-frame, messages or always. Option never is recommended in DNP Technical Bulletin 1998 0402.

Data link confirm TO is the data link confirmation timeout in milliseconds.

Data link retries is the data link retry count from 0 to 65535.

Data Link Rx to Tx delay is the turnaround delay in milliseconds of the slave replies. The timer starts at the trailing edge of the master's request.

Data Link inter char delay is the allowed inter character delay for incoming messages. The timer starts with the reception of each character. When the timer expires because no additional characters have been received, the IED regards the incoming message complete. The unit of measure is a character time at the selected baud rate.

Application layer parameters

App layer confirm When disabled, the IED requests application confirmation to event messages only. When enabled, the IED also requests application confirmations to all application messages sent.

App confirm TO is the application layer confirmation timeout in milliseconds. Application layer confirmations received from the master after App confirm TO has expired are not acknowledged by the IED. It applies to both solicited and unsolicited events.

App layer fragment is the application layer fragment size in bytes.

Unsolicited mode parameters

UR mode Unsolicited responses mode may be set to enable or disable. If enabled, the initial unsolicited message is sent when the master opens a connection to the IED, the first time after a IED reboot. All other unsolicited response parameters are irrelevant if UR mode is disabled.



Enabling *UR mode* on a serial multidrop line is not recommended. Collisions will result from multiple IEDs reporting concurrent events. Although the DNP3 application layer will recover, collision recovery can create significant traffic.

UR retries is the number of times the slave will resend the unsolicited response if it is not confirmed by the master station.

UR TO is the unsolicited response timeout period in milliseconds. This timeout period starts after *App confirm TO* expires. A new unsolicited response is transmitted when UR TO expires. Application layer confirmations received from the master during the UR TO period are not acknowledged by the IED.

UR offline interval is the unsolicited message offline interval in minutes. Off line interval starts after the last UR retry. Off line interval never starts when UR retries = 65535 (0xFFFF).

UR Class 1,2,3 Min events are the class 1, 2 or 3 number of events that must accumulate before they are sent as unsolicited messages, unless the UR Class 1,2,3 TO expires causing the transmission of the events.

UR Class 1,2,3 TO is the time in ms, that class 1, 2 or 3 events are delayed before being sent out, unless a count of UR Class 1,2,3 Min events have accumulated causing the transmission of the events.

Legacy master UR provides compatibility to some older DNP3 masters. When set to disabled, the slave follows the DNP3 standard, sending its first unsolicited message

after a connection has been established following IED reboot. The master is expected to send the Enable/Disable Unsolicited messages command to the IED. When *Legacy master UR* is enabled, the IED does not send the initial unsolicited message. Unsolicited responses are sent without the need of the Enable Unsolicited command. The master still needs to open a connection for the slave to start sending unsolicited messages. Unsolicited mode needs to be enabled for this parameter to be operational.



Legacy master UR allows non-standards compliant behavior.

Legacy master SBO provides compatibility to some older DNP3 masters for the Select Before Operate command. When disabled, DNP3 expects the application layer sequence of the operate command to be the select command sequence + 1 module 16. When enabled the IED ignores sequence number of the operate command. This situation might occur when the master sends additional requests between the select and operate commands.



Legacy master SBO allows non-standards compliant behavior.

Additional parameters

Need time interval is the interval in minutes for setting the need time bit in the IIN. The IIN need time bit requests the DNP3 master to send a time synchronization to the IED. When set to 0 the need time IIN bit is never set, and DNP3 time synchronization is never requested. The time synchronization source needs to be set to DNP3 to allow DNP3 time synchronization. DNP3 delay measurement can have an adverse effect on time synchronization accuracy, and should be avoided for TCP/IP.

Default Variation Obj N is the variation that the slave replies with when the master asks for DNP Object type N variation 0. It is also the variation in which class events are reported.

Table 9: *Default variation options for supported DNP object types*

DNP Obj N	Default variation option	Variation description
1	1	Binary input
	2	Binary input with status
2	1	Binary input event
	2	Binary input event with time

Table continues on next page

DNP Obj N	Default variation option	Variation description
30	1	32 bit analog input
	2	16 bit analog input
	3	32 bit analog input without flag
	4	16 bit analog input without flag
32	1	32 bit analog input event
	2	16 bit analog input event
	3	32 bit analog input event with time
	4	16 bit analog input event with time

Deadbanding of the analog static values cannot be set in DNP3. Event generation is dependent on the functions employed in the IED, and the execution loops these functions belong to. See the IED's technical manual for setting deadbands.

As a result of the event generation mechanism in the IED, the events reported by DNP3 are very accurate and are the same events that can be retrieved over the WHMI or other protocols such as IEC 61850-8-1.



Power must be cycled to the unit after making changes to the DNP3 parameters. The LHMI or WHMI will not notify the user that this action must be taken. Only one session is allowed to place the unit in write (edit) mode.

4.2 Parameter list

The DNP3 parameters can be accessed with PCM600 or via the LHMI path **Configuration/Communication/DNP3.0**.

Table 10: *DNP3 settings*

Parameter	Values (Range)	Unit	Step	Default	Description
DNP physical layer	1=Serial 2=TCP/IP			2=TCP/IP	DNP physical layer
Unit address	1...65519		1	1	DNP unit address
Master address	1...65519		1	3	DNP master and UR address
Serial port	0=Not in use 1=COM 1 2=COM 2			0=Not in use	COM port for serial interface, when physical layer is serial.
Need time interval	0...65535	min	1	30	Period to set IIN need time bit

Table continues on next page

Parameter	Values (Range)	Unit	Step	Default	Description
Time format	0=UTC 1=Local			1=Local	UTC or local. Coordinate with master.
CROB select timeout	1...65535	sec	1	10	Control Relay Output Block select timeout
Data link confirm	0=Never 1=Only Multiframe 2=Always			0=Never	Data link confirm mode
Data link confirm TO	100...65535	ms	1	3000	Data link confirm timeout
Data link retries	0...65535		1	3	Data link retries count
Data link Rx to Tx delay	0...255	ms	1	0	Turnaround transmission delay
Data link inter char delay	0...20	char	1	4	Inter character delay for incoming messages
App layer confirm	1=Disable 2=Enable			1=Disable	Application layer confirm mode
App confirm TO	100...65535	ms	1	5000	Application layer confirm and UR timeout
App layer fragment	256...2048	bytes	1	2048	Application layer fragment size
UR mode	1=Disable 2=Enable			1=Disable	Unsolicited responses mode
UR retries	0...65535		1	3	Unsolicited retries before switching to UR offline mode
UR TO	0...65535	ms	1	5000	Unsolicited response timeout
UR offline interval	0...65535	min	1	15	Unsolicited offline interval
UR Class 1 Min events	0...999		1	2	Min number of class 1 events to generate UR
UR Class 1 TO	0...65535	ms	1	50	Max holding time for class 1 events to generate UR
UR Class 2 Min events	0...999		1	2	Min number of class 2 events to generate UR
UR Class 2 TO	0...65535	ms	1	50	Max holding time for class 2 events to generate UR
UR Class 3 Min events	0...999		1	2	Min number of class 3 events to generate UR
UR Class 3 TO	0...65535	ms	1	50	Max holding time for class 3 events to generate UR
Legacy master UR	1=Disable 2=Enable			1=Disable	Legacy DNP master unsolicited mode support. When enabled relay does not send initial unsolicited message.
Legacy master SBO	1=Disable 2=Enable			1=Disable	Legacy DNP Master SBO sequence number relax enable
Default Var Obj 01	1...2		1	1	1=BI; 2=BI with status.
Default Var Obj 02	1...2		1	2	1=BI event; 2=BI event with time.
Default Var Obj 30	1...4		1	2	1=32 bit AI; 2=16 bit AI; 3=32 bit AI without flag; 4=16 bit AI without flag.
Default Var Obj 32	1...4		1	4	1=32 bit AI event; 2=16 bit AI event; 3=32 bit AI event with time; 4=16 bit AI event with time.

Section 5 Tolerances

5.1 DNP3 timing considerations

Table 11: *The IED's worst-case error over the full operating temperature range*

Description	Value
Time base drift over a 10-minute interval	1.2 ms
Maximum delay measurement error	+/- 15 ms
Maximum internal time reference error when set from the protocol	+/- 100 ms
Maximum response time	50 ms turnaround time (TCP/IP)
Event time accuracy	4 ms for BI and 500 ms for AI
Event processing delay	20 ms for BI; 1500 ms for AI ¹⁾

- 1) This represents the time it takes for a physical input from the time it changes to the time it is reported by DNP3. The internal latency between the protection logic and the communication processor is 4 ms for BI, and 500 ms for AI.

Data link layer filtering is not performed based on the source address.

The IED supports collision avoidance. Collision detection is available as implemented by the DNP3 link layer and TCP/IP. When DNP3 uses the serial channel, there is no collision avoidance. Collision detection in this instance is handled by the DNP3 link layer.

Section 6 Glossary

615 series	Series of numerical IEDs for low-end protection and supervision applications of utility substations, and industrial switchgear and equipment
AI	Analog input
ANSI	American National Standards Institute
BI	Binary input
BOS	Binary outputs status
CB	Circuit breaker
CRC	Cyclical redundancy check
CROB	Control relay output block
DFC	Data flow control
DNP3	A distributed network protocol originally developed by Westronic. The DNP3 Users Group has the ownership of the protocol and assumes responsibility for its evolution.
DPC	Double point control
EMC	Electromagnetic compatibility
EPA	Enhanced performance architecture
FCB	Flow control bit; Frame count bit
GUI	Graphical user interface
HMI	Human-machine interface
IEC	International Electrotechnical Commission
IEC 60870-5	IEC standard for telecontrol equipment and systems. Part 5 defines transmission protocols.
IEC 61850	International standard for substation communication and modelling
IEC 61850-8-1	A communication protocol based on the IEC 61850 standard series and a standard for substation modelling
IED	Intelligent electronic device
ISO	International Standard Organization

L/R	Local/Remote
LED	Light-emitting diode
LHMI	Local human-machine interface
Modbus	A serial communication protocol developed by the Modicon company in 1979. Originally used for communication in PLCs and RTU devices.
OSI	Open systems interconnection
PCM600	Protection and Control IED Manager
RTU	Remote terminal unit
SDU	Service data unit
SPC	Single point status of a controllable object
TCP/IP	Transmission Control Protocol/Internet Protocol
UR	Unsolicited response
WHMI	Web human-machine interface

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