

# Modicon X80

## BMENOR2200H Advanced RTU Module

### User Manual

Original instructions

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# Safety Information

## Important Information

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, service, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.



The addition of this symbol to a “Danger” or “Warning” safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.



This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

### **DANGER**

**DANGER** indicates a hazardous situation which, if not avoided, **will result in** death or serious injury.

### **WARNING**

**WARNING** indicates a hazardous situation which, if not avoided, **could result in** death or serious injury.

### **CAUTION**

**CAUTION** indicates a hazardous situation which, if not avoided, **could result in** minor or moderate injury.

### **NOTICE**

**NOTICE** is used to address practices not related to physical injury.

## Please Note

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and its installation, and has received safety training to recognize and avoid the hazards involved.

## Before You Begin

Do not use this product on machinery lacking effective point-of-operation guarding. Lack of effective point-of-operation guarding on a machine can result in serious injury to the operator of that machine.

## ⚠ WARNING

### UNGUARDED EQUIPMENT

- Do not use this software and related automation equipment on equipment which does not have point-of-operation protection.
- Do not reach into machinery during operation.

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

This automation equipment and related software is used to control a variety of industrial processes. The type or model of automation equipment suitable for each application will vary depending on factors such as the control function required, degree of protection required, production methods, unusual conditions, government regulations, etc. In some applications, more than one processor may be required, as when backup redundancy is needed.

Only you, the user, machine builder or system integrator can be aware of all the conditions and factors present during setup, operation, and maintenance of the machine and, therefore, can determine the automation equipment and the related safeties and interlocks which can be properly used. When selecting automation and control equipment and related software for a particular application, you should refer to the applicable local and national standards and regulations. The National Safety Council's Accident Prevention Manual (nationally recognized in the United States of America) also provides much useful information.

In some applications, such as packaging machinery, additional operator protection such as point-of-operation guarding must be provided. This is necessary if the operator's hands and other parts of the body are free to enter the pinch points or other hazardous areas and serious injury can occur. Software products alone cannot protect an operator from injury. For this reason the software cannot be substituted for or take the place of point-of-operation protection.

Ensure that appropriate safeties and mechanical/electrical interlocks related to point-of-operation protection have been installed and are operational before placing the equipment into service. All interlocks and safeties related to point-of-operation protection must be coordinated with the related automation equipment and software programming.

**NOTE:** Coordination of safeties and mechanical/electrical interlocks for point-of-operation protection is outside the scope of the Function Block Library, System User Guide, or other implementation referenced in this documentation.

## Start-up and Test

Before using electrical control and automation equipment for regular operation after installation, the system should be given a start-up test by qualified personnel to verify correct operation of the equipment. It is important that arrangements for such a check be made and that enough time is allowed to perform complete and satisfactory testing.

## ⚠ WARNING

### EQUIPMENT OPERATION HAZARD

- Verify that all installation and set up procedures have been completed.
- Before operational tests are performed, remove all blocks or other temporary holding means used for shipment from all component devices.
- Remove tools, meters, and debris from equipment.

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

Follow all start-up tests recommended in the equipment documentation. Store all equipment documentation for future references.

**Software testing must be done in both simulated and real environments.**

Verify that the completed system is free from all short circuits and temporary grounds that are not installed according to local regulations (according to the National Electrical Code in the U.S.A, for instance). If high-potential voltage testing is necessary, follow recommendations in equipment documentation to prevent accidental equipment damage.

Before energizing equipment:

- Remove tools, meters, and debris from equipment.
- Close the equipment enclosure door.
- Remove all temporary grounds from incoming power lines.
- Perform all start-up tests recommended by the manufacturer.

## Operation and Adjustments

The following precautions are from the NEMA Standards Publication ICS 7.1-1995 (English version prevails):

- Regardless of the care exercised in the design and manufacture of equipment or in the selection and ratings of components, there are hazards that can be encountered if such equipment is improperly operated.
- It is sometimes possible to misadjust the equipment and thus produce unsatisfactory or unsafe operation. Always use the manufacturer's instructions as a guide for functional adjustments. Personnel who have access to these adjustments should be familiar with the equipment manufacturer's instructions and the machinery used with the electrical equipment.
- Only those operational adjustments actually required by the operator should be accessible to the operator. Access to other controls should be restricted to prevent unauthorized changes in operating characteristics.

# About the Book

## Document Scope

This guide describes the Modicon X80 BMENOR2200H advanced RTU module and its relationship to Modicon M580 controllers and X80 remote platforms.

The BMENOR2200H module acts as a communication module on an X80 platform and conforms to the general rules and guidelines for the use of those platforms.

The module provides telemetry protocol connection availability in complex M580 configurations through the Modbus TCP communication protocol.

This guide describes the following topics:

- installation, page 33
- configuration, page 69
- diagnostics
- embedded web pages, page 109

**NOTE:** The specific configuration settings contained in this guide are intended to be used for instructional purposes only. The settings required for your specific configuration may differ from the examples presented in this guide.

## Validity Note

This document is valid for an M580 system when used with Control Expert 15.0 HF or later.

The technical characteristics of the devices described in the present document also appear online. To access the information online, go to the Schneider Electric home page [www.se.com/ww/en/download/](http://www.se.com/ww/en/download/).

The characteristics that are described in the present document should be the same as those characteristics that appear online. In line with our policy of constant improvement, we may revise content over time to improve clarity and accuracy. If you see a difference between the document and online information, use the online information as your reference.

## Information Related to Cyber Security

Information on cyber security is provided on the Schneider Electric website: <http://www2.schneider-electric.com/sites/corporate/en/support/cybersecurity/cybersecurity.page>

Document available for download on cyber security support section:

| Title of Documentation                                                                                     | Webpage Address                                                                                          |
|------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| How can I ... Reduce Vulnerability to Cyber Attacks? System Technical Note, Cyber Security Recommendations | <a href="http://www.se.com/ww/en/download/document/STN_v2">www.se.com/ww/en/download/document/STN v2</a> |

## Related Documents

| Title of documentation                                                                                 | Reference number                                                                                                                                   |
|--------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Modicon M580 Standalone System Planning Guide for Frequently Used Architectures</i>                 | HRB62666 (English), HRB65318 (French), HRB65319 (German), HRB65320 (Italian), HRB65321 (Spanish), HRB65322 (Chinese)                               |
| <i>Modicon M580 System Planning Guide for Complex Topologies</i>                                       | NHA58892 (English), NHA58893 (French), NHA58894 (German), NHA58895 (Italian), NHA58896 (Spanish), NHA58897 (Chinese)                               |
| <i>Modicon M580 Hot Standby System Planning Guide for Frequently Used Architectures</i>                | NHA58880 (English), NHA58881 (French), NHA58882 (German), NHA58883 (Italian), NHA58884 (Spanish), NHA58885 (Chinese)                               |
| Modicon M580, Hardware, Reference Manual                                                               | EIO0000001578 (English), EIO0000001579 (French), EIO0000001580 (German), EIO0000001582 (Italian), EIO0000001581 (Spanish), EIO0000001583 (Chinese) |
| Modicon M580, M340, and X80 I/O Platforms, Standards and Certifications                                | EIO0000002726 (English), EIO0000002727 (French), EIO0000002728 (German), EIO0000002730 (Italian), EIO0000002729 (Spanish), EIO0000002731 (Chinese) |
| Modicon M580, Change Configuration on the Fly, User Guide                                              | EIO0000001590 (English), EIO0000001591 (French), EIO0000001592 (German), EIO0000001594 (Italian), EIO0000001593 (Spanish), EIO0000001595 (Chinese) |
| M580 BMENOS0300, Network Option Switch, Installation and Configuration Guide                           | NHA89117 (English), NHA89119 (French), NHA89120 (German), NHA89121 (Italian), NHA89122 (Spanish), NHA89123 (Chinese)                               |
| Modicon eX80, BMEAH0812 HART Analog Input Module & BMEAH0412 HART Analog Output Module, User Guide     | EAV16400 (English), EAV28404 (French), EAV28384 (German), EAV28413 (Italian), EAV28360 (Spanish), EAV28417 (Chinese)                               |
| Modicon X80, Analog Input/Output Modules, User Manual                                                  | 35011978 (English), 35011979 (German), 35011980 (French), 35011981 (Spanish), 35011982 (Italian), 35011983 (Chinese)                               |
| Modicon X80, Discrete Input/Output Modules, User Manual                                                | 35012474 (English), 35012475 (German), 35012476 (French), 35012477 (Spanish), 35012478 (Italian), 35012479 (Chinese)                               |
| Grounding and Electromagnetic Compatibility of PLC Systems, Basic Principles and Measures, User Manual | 33002439 (English), 33002440 (French), 33002441 (German), 33003702 (Italian), 33002442 (Spanish), 33003703 (Chinese)                               |
| EcoStruxure™ Control Expert, Program Languages and Structure, Reference Manual                         | 35006144 (English), 35006145 (French), 35006146 (German), 35013361 (Italian), 35006147 (Spanish), 35013362 (Chinese)                               |
| EcoStruxure™ Control Expert, Operating Modes                                                           | 33003101 (English), 33003102 (French), 33003103 (German), 33003104 (Spanish), 33003696 (Italian), 33003697 (Chinese)                               |
| EcoStruxure™ Control Expert, Installation Manual                                                       | 35014792 (English), 35014793 (French), 35014794 (German), 35014795 (Spanish), 35014796 (Italian), 35012191 (Chinese)                               |
| Modicon Controllers Platform Cyber Security, Reference Manual                                          | EIO0000001999 (English), EIO0000002001 (French), EIO0000002000 (German), EIO0000002002 (Italian), EIO0000002003 (Spanish), EIO0000002004 (Chinese) |
| Modicon X80, BMXERT1604T Time Stamp Module, User Guide                                                 | EIO0000001121 (English), EIO0000001122 (French), EIO0000001123 (German), EIO0000001125 (Italian), EIO0000001124 (Spanish), EIO0000001126 (Chinese) |

**NOTE:** Refer also to the online help for the Maintenance Expert tool (see EcoStruxure Automation Device Maintenance, Firmware Upgrade Tool, Online Help).

You can download these technical publications, the present document and other technical information from our website [www.se.com/en/download/](http://www.se.com/en/download/).

## Product Related Information

### **WARNING**

#### **UNINTENDED EQUIPMENT OPERATION**

The application of this product requires expertise in the design and programming of control systems. Only persons with such expertise are allowed to program, install, alter, and apply this product.

#### **REQUIRES CLEANUP**

Follow all local and national safety codes and standards.

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

# Introducing the Modicon X80 BMENOR2200H Advanced RTU Module

## Introduction

### Overview

RTU systems are designed to meet the needs of the water industry, the oil and gas sector, transportation, electrical utility and other infrastructures, where remote monitoring and telecontrol are essential to the management of a site and substations, which may be spread over a wide geographical area.

DNP3 and IEC60870-5-104 are global SCADA protocols, which are designed with various characteristics for RTU utilities (example: response event without request (unsolicited)).

The Modicon X80 advanced RTU module (BMENOR2200H) is the new module on the Modicon M580 PAC platform, which provides more features than the existing RTU module (BMXNOR0200H). The advanced RTU module has enhanced cyber security features and better performance than the BMXNOR0200H module, including telemetry protocol connection availability and several Ethernet-based services.

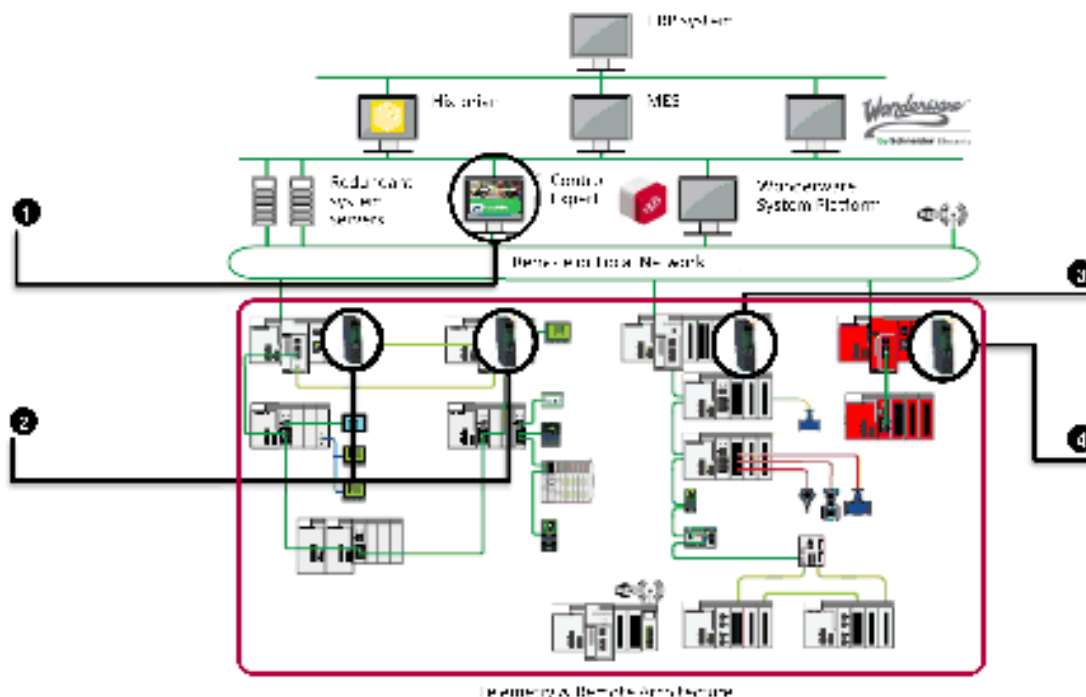
### **NOTICE**

#### **INOPERABLE RACK CONNECTION**

- Do **not** mount the BMENOR2200H module on an BMX (X Bus-only) backplane. The module will not work.
- The module can operate properly **only** on a BME (X Bus and Ethernet) backplane.
- Refer to the rack descriptions and slot restrictions in the installation chapter in the *Modicon X80 Racks and Power Supplies, Hardware, Reference Manual* (see Modicon X80, Racks and Power Supplies, Hardware Reference Manual).

**Failure to follow these instructions can result in equipment damage.**

The BMENOR2200H advanced RTU module brings DNP3 and IEC 60870-5-104 communications to the Modicon M580 platform:



**1 Software:** Control Expert 15.0 HF, Automation Device Maintenance (firmware upgrade), Web Browser (cyber security settings)

**2 BMENOR2200H module:** M580 Hot Standby

**3 BMENOR2200H module:** M580 standalone

**4 BMENOR2200H module:** M580 Safety standalone, M580 Safety Hot Standby, non-interfering type 1

**Red line** Indicates the telemetry and remote architecture

Compared with standard X80 communications and I/O modules, the BMENOR2200H module is a *long-factor* module, the same height as the CPU. (Refer to the module dimensions, page 18 topic.)

Install the module on a local Ethernet backplane in a Modicon M580 system. The module provides access to an Modicon M580 network through the external ports of the CPU and communication modules that may be installed on the local rack.

## Main Features and Functionality

### Improved Performance

The BMENOR2200H module offers these improvements over the BMXNOR0200H module:

- Compatibility with an M580 redundant system
- Occupies a single-point resource for event routing point
- Bulk configuration for RTU mapping table
- Cyber security enhancements:
  - secure boot
  - firmware signing and integrity check
  - secure firmware upgrade
  - HTTPS-based Web pages
  - RBAC
  - TLS for RTU protocols
  - password complexity

- secure mode selection
- DNP3 secure authentication version 2 & 5
- secure Hot Standby communication between modules
- High data throughput capacity when the module acts as an RTU server (transmits 4,000 events/second to client devices)
- Exclusive data exchange bandwidth for each module installed on the same rack
- Maximum of 150,000 RTU events stored in module buffer

### Module Features

The BMENOR2200H module addresses a wide range of telemetry requirements in an M580 system:

- RTU protocol event routing as data concentrator
- ruggedized with conformal coating for operations in extended operating temperature ranges and harsh environments
- upstream communications with SCADA client stations for polling interrogation of data, backfilling of time-stamped event data, and receiving client commands
- downstream communications with other RTU substations, server field devices and IEDs (for data collection), sending commands, and synchronizing distributed control
- remote programming and downloading of control program with Control Expert software through Ethernet or USB connections on an M580 CPU
- remote cyber security settings and diagnostic monitoring with a built-in web server

### Platform Features

The module shares these characteristics and applications that are available in an M580 environment:

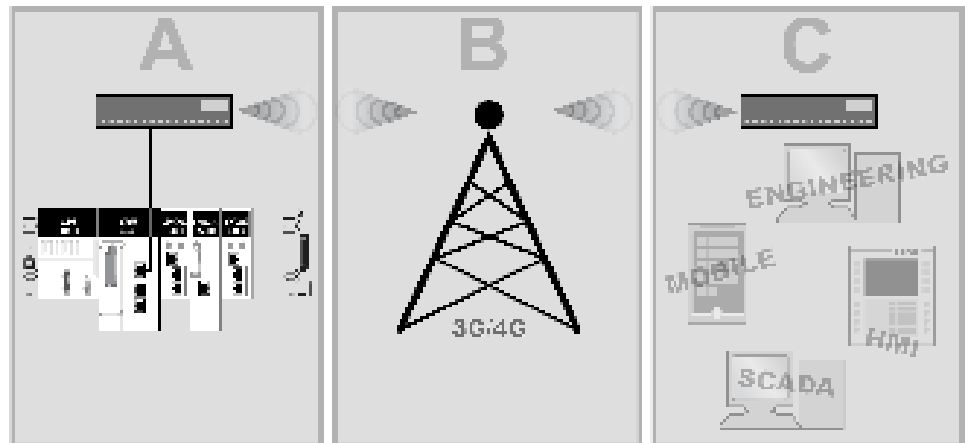
- easy connectivity with an Ethernet backplane
- specialized function blocks (AGA, flow calculations)
- expandable rack-based modular I/O configurations and remote I/O capabilities
- high-density, analog/discrete I/O and counting modules
- isolated input power supply (voltage ranges: 24 Vdc, 24/48 Vdc, 125 Vdc, 100/240 Vac)
- local and remote downloading of operating system firmware

### Communication Protocols

Refer to the complete description of function and protocol support, page 45.

## RTU Architecture

This sample architecture shows communications from an RTU substation that includes a BMENOR2200H module:



**A** A BMENOR2200H module communicates over the backplane with a CPU that is connected to a network router.

**B** The 3G/4G network forwards the communications.

**C** Communications are received by a router that connects to a control network and fieldbus devices.

## BMENOR2200H and EcoStruxure™

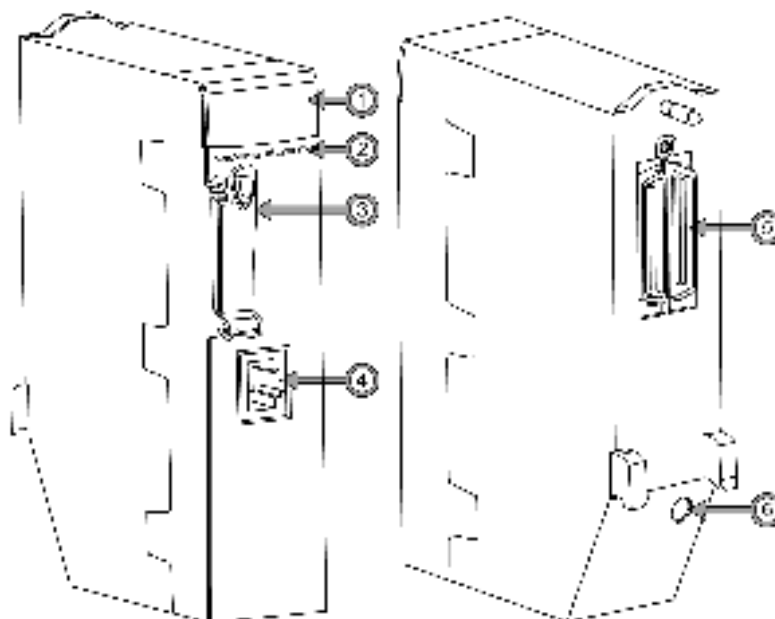
EcoStruxure™ is a Schneider Electric program designed to address the key challenges of many different types of users, including plant managers, operations managers, engineers, maintenance teams, and operators, by delivering a system that is scalable, flexible, integrated, and collaborative.

This document presents one of the EcoStruxure features, using Ethernet as the backbone around the Modicon M580 offer, in which an M580 local rack communicates with M580 RIO drops and distributed equipment in the same network.

## Physical Description

### External Features

The BMENOR2200H module has the same form factor as other M580 advanced communication modules. This figure shows the specific external features of this module:



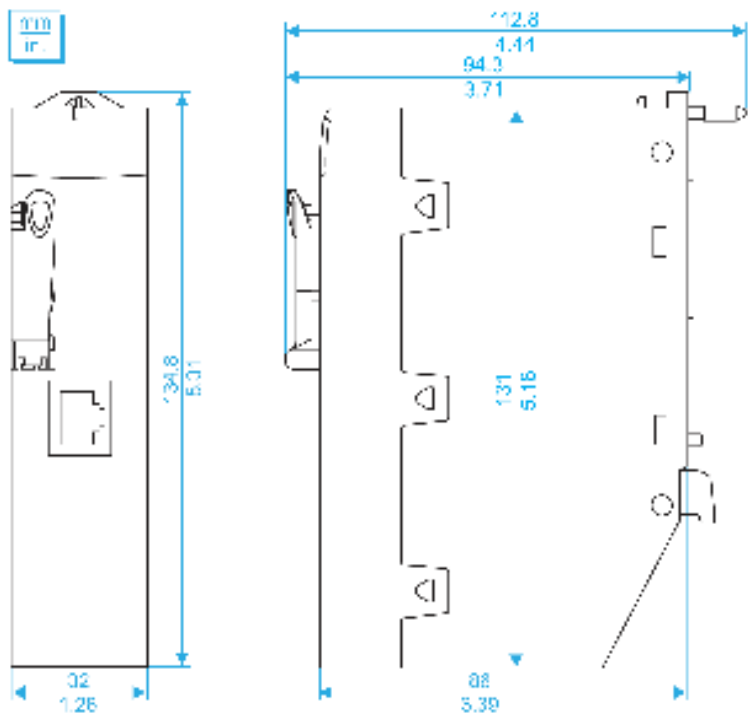
#### Legend:

| Item | Description                           | Function                                                                                                                                                                                                                                                                                                                  |
|------|---------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | LED array, page 19                    | Observe the LED display to diagnose the module.                                                                                                                                                                                                                                                                           |
| 2    | MAC address                           | This manufacturer-defined address is unique for each individual module.                                                                                                                                                                                                                                                   |
| 3    | memory card slot                      | Store datalogging files (.csv) to the SD card.<br><b>NOTE:</b> This feature is reserved for future use.                                                                                                                                                                                                                   |
| 4    | serial port                           | This port is an isolated RS232/RS485 serial connector.<br><br>Use a TCSXCN3M4F3S4 cable (serial link) to connect the module's serial (RS232) RJ45 port to a communication port on a modem. The supports all pins on the modem's nine-pin D-sub connector except for the ring indicator (RI) signal pin (sold separately). |
| 5    | dual-bus backplane connector, page 17 | This connection to the Modicon M580 rack supports Ethernet and X Bus communications.                                                                                                                                                                                                                                      |
| 6    | rotary switch, page 22                | Use this switch to set the cyber security level for the module.                                                                                                                                                                                                                                                           |

**NOTE:** A ferule placed on the end of the serial port reduces the pinching of the cable by the removable cover. This reduces the risk of degrading the quality of the link by decreasing the likelihood of achieving the maximum bending radius of the cable.

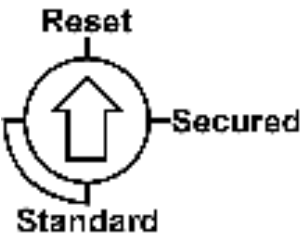
Dimensions

The BMENOR2200H module conforms to the height of an M580 CPU and the width of a standard single-slot M580 communications module that has an SD card slot:



Rotary Switch

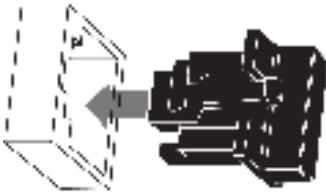
A three-position rotary switch is located on the back of the module. Set this switch to configure a cyber security operating mode for the module:



Refer to the detailed description of the rotary switch configuration, page 22.

Accessories

These additional hardware accessories are available:

| Description | Comment                                                                                                                                                                                                                                       |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| dust cover  | <div>Cover the module's unused RJ45 ports with this stopper:</div> <div></div> <div>The dust cover reduces the port's exposure to atmospheric dust.</div> |
| screwdriver | Use only the small, plastic screwdriver that was delivered with the module to set the rotary switch, page 22.                                                                                                                                 |

## Module LED Indicators

### Introduction

Refer to the LED indicators to monitor the status and performance of these items:

- BMENOR2200H module LEDs, page 19
- SD card LEDs

### Module LED Descriptions

The module LED indicators are located on the front of the BMENOR2200H module. The LEDs provide information on:

- module status (run, error, downloading)
- serial communications
- Ethernet network communications
- SD memory card state
- cyber security status

This is the LED display on the front of the BMENOR2200H module:



The LEDs can be in these states:

- *on*: steady on
- *off*: steady off
- *flashing*: alternate (50 ms on, 50 ms off)

The module status is indicated by the color and state of the LEDs:

| Label                  | Color | Pat-tern  | Indication                                                                                                                                                                                                                                                                                    |
|------------------------|-------|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RUN: operational state | green | on        | The module is operating and configured.                                                                                                                                                                                                                                                       |
|                        |       | flash-ing | The module is blocked by a detected software error.                                                                                                                                                                                                                                           |
|                        |       | off       | The module is not configured. (The application is absent, invalid, or incompatible.)                                                                                                                                                                                                          |
| ERR: detected error    | red   | on        | <ul style="list-style-type: none"> <li>• The processor, system, or configuration detected an error.</li> <li>• If you move the rotary switch from <b>Standard</b> &gt; <b>Secured</b> (or vice versa) directly instead of moving to <b>Reset</b> in between, an error is detected.</li> </ul> |
|                        |       | flash-ing | <ul style="list-style-type: none"> <li>• The module is not configured. (The application is absent, invalid, or incompatible.)</li> <li>• The module is blocked by a detected software error.</li> <li>• A Hot Standby failure is detected.</li> </ul>                                         |
|                        |       | off       | Operations are normal (no detected errors).                                                                                                                                                                                                                                                   |

| Label                                  | Color  | Pat-tern  | Indication                                                                                                                                                                                                                                                                                                                                                                    |
|----------------------------------------|--------|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DL: download firmware (upgrade)        | red    | on        | A firmware upgrade or factory reset is in progress.                                                                                                                                                                                                                                                                                                                           |
|                                        |        | off       | A firmware upgrade or factory reset is not in progress.                                                                                                                                                                                                                                                                                                                       |
| SER COM: serial data status            | yellow | flash-ing | A data exchange (send/receive) is in progress on the serial connection.                                                                                                                                                                                                                                                                                                       |
|                                        |        | off       | There is no data exchange on the serial connection.                                                                                                                                                                                                                                                                                                                           |
| CARD ERR: memory card detected error   | red    | on        | <ul style="list-style-type: none"> <li>The memory card is missing.</li> <li>The memory card is not usable (bad format, unrecognized type).</li> </ul>                                                                                                                                                                                                                         |
|                                        |        | off       | The memory card is valid and recognized.                                                                                                                                                                                                                                                                                                                                      |
| ETH STS: Ethernet communication status | —      | off       | There is no link on the Ethernet backplane port.                                                                                                                                                                                                                                                                                                                              |
|                                        | green  | on        | At least one RTU connection (client or server) established in the module.                                                                                                                                                                                                                                                                                                     |
|                                        |        | flash-ing | The module has an IP address, but there is no RTU connection.                                                                                                                                                                                                                                                                                                                 |
|                                        | red    | on        | The module has a duplicate IP address or factory reset mode.                                                                                                                                                                                                                                                                                                                  |
| SEC: secure communication status       | green  | on        | Secure communications are enabled and running fine.                                                                                                                                                                                                                                                                                                                           |
|                                        | red    | on        | <ul style="list-style-type: none"> <li>Communications are <i>not</i> secure because a critical error in secure communications is detected. For example, there is no available security configuration, or the certificate expired when the communications stopped.</li> <li>No channel security is configured through the channel name for either client or server.</li> </ul> |
|                                        |        | flash-ing | Secure communications are enabled and running, but a critical error is detected. For example, there is no available security configuration, or the certificate expired when the communications stopped.                                                                                                                                                                       |
|                                        | —      | off       | The module is not secure.                                                                                                                                                                                                                                                                                                                                                     |

## Typical Status and Related LED Behavior

| Label   | Pattern | Indication                                                                                                                    |
|---------|---------|-------------------------------------------------------------------------------------------------------------------------------|
| ERR     | Red on  | Secure/Non-secure: The rotary switch was moved directly between non-secure mode and secure mode. A factory reset is required. |
| DL      |         |                                                                                                                               |
| ETH STS |         |                                                                                                                               |
| Secure  |         |                                                                                                                               |

| Module status                                           | LED                     | Description                                                         |
|---------------------------------------------------------|-------------------------|---------------------------------------------------------------------|
| Factory mode                                            | RUN: green on           |                                                                     |
|                                                         | DL: red on              | Factory reset is ongoing.                                           |
|                                                         | DL: red off             | Factory reset is complete.                                          |
|                                                         | ETH STS: red on         |                                                                     |
| Secure mode (initial indication at first-time start-up) | ERR: red flashing       |                                                                     |
|                                                         | ETH STS: green flashing |                                                                     |
|                                                         | SEC: red on             | Module is not running; a validated cybersecure setting is required. |

## SD Memory Card (BMXRMS004GPF)

### Introduction

The slot for the secure digital (SD) memory card (BMXRMS004GPF) is on the front of the module.

#### **⚠ WARNING**

##### **RISK OF LOST APPLICATION**

- Do not remove the memory card from the module while the PLC is running.
- Remove the memory card only when the power is off.

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

### Card Functionality

This table describes the functionality of the BMXRMS004GPF memory card when inserted into the module:

| SD Memory Card | Data Storage | Functionality                                                                                                     |
|----------------|--------------|-------------------------------------------------------------------------------------------------------------------|
| BMXRMS004GPF   | 4 GB         | Storage of data logging files (.csv)<br><b>NOTE:</b> Data logging is not available for the BMENOR2200H V2 module. |

### Card Services

#### **NOTICE**

##### **INOPERABLE MEMORY CARD**

- Do not format the memory card with a non-Schneider tool. The memory card needs a structure to contain program and data. Formatting with another tool destroys this structure.
- Do not use a write-protected memory card with the module. Some services do not operate properly when the memory card is write-protected.

**Failure to follow these instructions can result in equipment damage.**

### Precautions

#### **NOTICE**

##### **MEMORY CARD DESTRUCTION**

- Do not touch the memory card connections.
- Keep the memory card away from electrostatic and electromagnetic sources as well as heat, sunlight, water, and moisture.
- Avoid impacts to the memory card.
- Check the postal service security policy before sending a memory card by postal service. In some countries, the postal service exposes mail to high levels of radiation as a security measure. These high levels of radiation may erase the contents of the memory card and render it unusable.

**Failure to follow these instructions can result in equipment damage.**

Without SD Memory Card

If the memory card slot is empty during the power-up, the module can operate normally without the data logging service. **NOTE:** Data logging is not available for the BMENOR2200H module.

A memory card that is inserted during module operations is not recognized. Keep the memory card in the slot at all times.

Cyber Security Rotary Switch

Introduction

A three-position rotary switch is on the back of the module. Set this switch to configure a cyber security operating mode for the module.

**NOTICE**

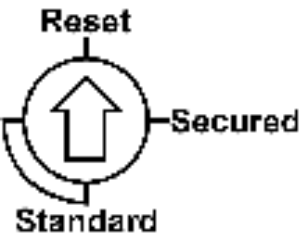
**RISK OF UNINTENDED OPERATION**  
To maintain the integrity of the hardware, use only the small, plastic screwdriver that ships with the module to change the switch position.

**REQUIRES CLEANUP**  
Do not use a metal screwdriver. The use of a metal screwdriver can damage the switch and render it inoperable.

**Failure to follow these instructions can result in equipment damage.**

Position Selection

This is an enlarged view of the three-position rotary switch on the back of the module:



Use the screwdriver to select a switch position that meets your cyber security requirements:

| Icon                        | Setting          | Description                                                                                           |
|-----------------------------|------------------|-------------------------------------------------------------------------------------------------------|
| <b>Secured</b><br>(default) | secure mode on   | The module supports some level(s) of cyber security when a cyber security configuration is available. |
| <b>Standard</b>             | standard mode on | The module does not support cyber security.                                                           |
| <b>Reset</b>                | factory reset    | The module implements its out-of-the-box cyber security configuration.                                |

## NOTICE

### RISK OF UNINTENDED OPERATION

Set the switch only to the *exact* “clock position” that corresponds to your security configuration:

- 12 o'clock: **Reset**
- 3 o'clock: **Secured**
- 6 o'clock/9 o'clock: **Standard** (To implement the **Standard** level of cyber security, set the switch to *only* the 6 o'clock or 9 o'clock positions.)

**Failure to follow these instructions can result in equipment damage.**

## Set the Switch

Configure the cyber security mode for the module in the rack:

| Step | Action                                                                                                                                                                                                                             |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Remove the module from the rack by following the directions for <a href="#">module replacement</a> , <a href="#">page 35</a> .                                                                                                     |
| 2    | Change the switch setting to <b>Reset</b> .                                                                                                                                                                                        |
| 3    | Re-insert the module in the rack to power it up in <b>Reset</b> mode.<br><br><b>Result:</b> The module performs a factory reset and is properly powered when the RUN LED is steady green.                                          |
| 4    | Remove the module from the rack again.                                                                                                                                                                                             |
| 5    | Change the switch setting to <b>Secured</b> or <b>Standard</b> .                                                                                                                                                                   |
| 6    | Re-insert the module in the rack to power it up in the selected ( <b>Secured</b> or <b>Standard</b> ) mode.<br><br><b>Result:</b> The module is properly powered when the LED is steady green for both secured and standard modes. |

### NOTE:

- Do not switch from the non-secure configuration (**Standard**) directly to the secure configuration (**Secured**) or vice-versa.
  - Always power up the module with the rotary switch in the **Reset** position when you transition between the **Standard** and **Secured** modes to implement normal operations.
  - You can also use the **Management** dialog on the **Setup** web page to move the rotary switch to clean all cybersecurity configuration. Click the **Reset** button to restore the factory default cyber security settings for the module. A module restart is required.
- The changes associated with the switch settings take effect after the module is re-inserted in the rack and powered up.

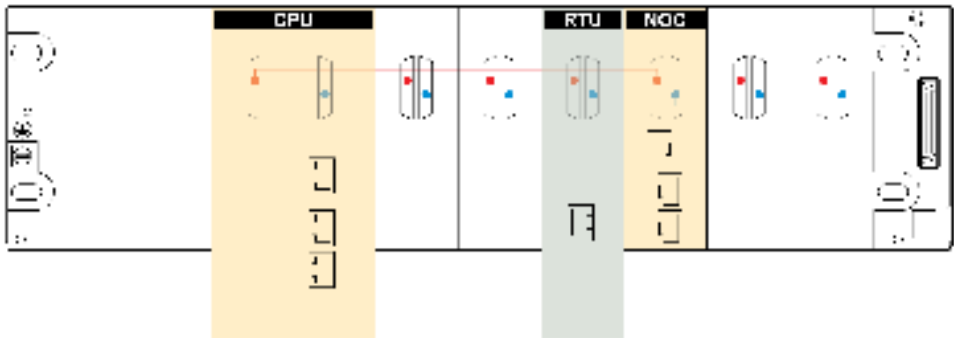
## Backplane Connector

### About Dual-Bus Backplanes

The [dual-bus interface](#), [page 17](#) on the back of the BMENOR2200H module connects to the X Bus and Ethernet bus connectors across the backplane when you mount the module in the rack.

BMEXBP••0• backplanes are compatible with Modicon X80 modules in an M580 system.

Communications across the dual-bus backplane of this sample local rack (which includes an M580 CPU) implement both the Ethernet (red line) and X-Bus (blue line) protocols:



**Red** The red dot/line indicates Ethernet.

**Blue** The blue dot/line indicates X Bus.

**NOTE:**

- BMXXPB••00 X Bus backplanes do not have connections that support eX80 modules.
- Ethernet racks are described in detail in the *Modicon M580, Hardware, Reference Manual*.

Connection Protocols

The module supports communications over a BMEXBP••0• backplane using these protocols:

| Bus      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| X Bus    | <div>The module uses X Bus communications to obtain and exchange the following through the CPU:</div> <ul style="list-style-type: none"><li>• configuration data for the module</li><li>• application and diagnostic data</li><li>• variable data exchange between the module and the CPU</li><li>• time synchronization messages to the CPU and other modules on the backplane</li></ul>                                                                                                                                                                                                                                                                                                                                                                   |
| Ethernet | <div><b>NOTE:</b> The Ethernet backplane port is always enabled for the RTU module. Confirm your network topology design to help avoid network loop issues.</div> <div>The module uses Ethernet communications to provide an access path to the RTU module for the following:</div> <ul style="list-style-type: none"><li>• External devices can talk with the RTU module when accessing one of the following:<ul style="list-style-type: none"><li>◦ CPU</li><li>◦ BMENOC03•• communication module</li><li>◦ BMENOS0300 network option switch module</li><li>◦ BM•CRA312•• adapter</li><li>◦ other Ethernet modules with similar capabilities</li></ul></li><li>• The module communicates with Ethernet communication modules on the local rack.</li></ul> |

The data exchange uses implicit messaging to facilitate memory sharing between the module and the CPU. For each CPU scan cycle, the CPU publishes all data at the same time to share the most current information with the RTU.

I/O Data Exchange with the CPU

Observe these maximum input and output sizes when the module exchanges I/O data with the CPU:

| Protocol                                                                 | Characteristics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                 |  |
|--------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|--|
| IEC 60870-5-104 / DNP3 NET client                                        | up to 64 servers (one session for each server)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                 |  |
|                                                                          | Memory consumption: <ul style="list-style-type: none"><li><i>input data size</i>: 8 Kb of data includes user-configurable data and 4K words of overhead. The overhead includes module diagnostic data, data object headers, and the number of headers depending on the user configuration. As a result, the maximum user-configurable input data size is approximately 7.55Kb (1Kb = 1024 bytes).</li><li><i>output data size</i>: 8 Kb of data includes user-configurable data and 4K words of overhead. The overhead includes module control data, data object headers, and the number of headers depending on the user configuration. As a result, the maximum user-configurable output data size is approximately 7.56Kb (1Kb = 1024 bytes).</li></ul> |                                                                                                                                 |  |
| IEC 60870-5-104 / DNP3 NET server                                        | Memory consumption: <ul style="list-style-type: none"><li><i>input</i>: 8 Kb</li><li><i>output</i>: 8 Kb</li></ul> <b>NOTE:</b> Refer to the descriptions above.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                 |  |
|                                                                          | up to 150,000-event queue for all data types                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                 |  |
|                                                                          | up to 40,000 event queue for DNP3 SAv5 security events<br><b>NOTE:</b> This does not apply to IEC 60870-5-104.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                 |  |
|                                                                          | supports clock synchronization from a client                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                 |  |
|                                                                          | service over TCP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | client IP address validation list (up to 10 IP addresses)                                                                       |  |
|                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | four concurrent client connections with configurable TCP service port (default port is 20000 for DNP3, 2404 for IEC60870–5–104) |  |
|                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | event backup up to 10000 events                                                                                                 |  |
| support for DNP3 secure authentication version 2 and version 5, page 50. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                 |  |

SAv2 and SAv5, page 50 work on both client and server sides.

Use this formula to achieve the recommended minimum MAST task cycle time per BMENOR2200H module:

$$T_{\text{cycle min}} = ((\text{DataInB} + 128) * 2 + (\text{DataOutB} + 32)) / 23500 \text{ B/S} * 30 \text{ ms}$$

The result is approximately a 30ms MAST task cycle with 8Kb in and 8Kb out.

## Electrical Characteristics

### Consumed Current

This is the current that the BMENOR2200H module consumes:

| Power Source      | Consumption |
|-------------------|-------------|
| 24 VDC rack       | 90 mA       |
| power dissipation | 2.2 W       |

### Wiring Considerations

Modules are re-initialized when the power is switched back on. This can create a temporary disruption in the application or communications.

## Standards and Certifications

### Download

Click the link that corresponds to your preferred language to download standards and certifications (PDF format) that apply to the modules in this product line:

| Title                                                                   | Languages                                                                                                                                                                                                                       |
|-------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Modicon M580, M340, and X80 I/O Platforms, Standards and Certifications | <ul style="list-style-type: none"><li>English: EIO0000002726</li><li>French: EIO0000002727</li><li>German: EIO0000002728</li><li>Italian: EIO0000002730</li><li>Spanish: EIO0000002729</li><li>Chinese: EIO0000002731</li></ul> |

## Safety Standards and Certifications

### References

Refer to these guidelines from the *Modicon M580 Safety Standards and Certifications* guide:

- Certificates and Declarations (see Modicon M580 Safety, Standards and Certifications)
- Operating and Storage Conditions (see Modicon M580 Safety, Standards and Certifications)
- Environment Test Compliance Levels (see Modicon M580 Safety, Standards and Certifications)

# The BMENOR2200H Module in Networks

## Standalone Networks

### Standalone Architectures

#### Introduction

This topic describes the use of the BMENOR2200H module in a standalone M580 system.

#### Connection Media

Make connections to the BMENOR2200H module with a cable:

- *upstream connection*: Connect the module to a SCADA system through the DNP3 or IEC 60870-5-104 protocol. (A Modbus TCP connection is another option.)
- *downstream connection*: Connect the module to remote server devices and stations through the DNP3 or IEC 60870-5-104 protocol.

#### Limitations

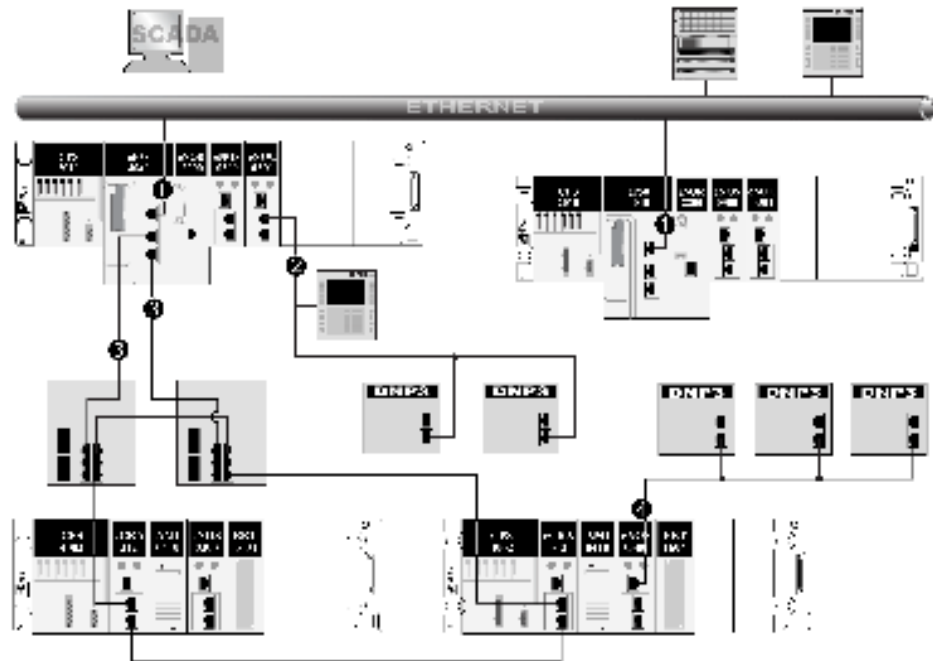
Observe these guidelines when you use the BMENOR2200H module:

- The BMENOR2200H SV1.0 module is compatible with Control Expert 14.1 Hot Fix and later.
- The BMENOR2200H SV2.01 module is compatible with Control Expert 15.0 Hot Fix and later.
- The module is compatible with CPUs that run firmware version 2.2 or later.
- The BMENOR2200H SV1.0 module does not support Hot Standby systems.

## Standalone Network with One Subnet

### Sample Network

This sample standalone network includes BMENOR2200H modules on local racks in a single subnet:



**1** The service port on the CPU connects the RIO main ring and distributed equipment (DNP3 devices, HMI) to the Ethernet control network.

**2** A BMENOC0301 module on the local rack connects distributed equipment (DNP3 devices, HMI) to the RIO main ring.

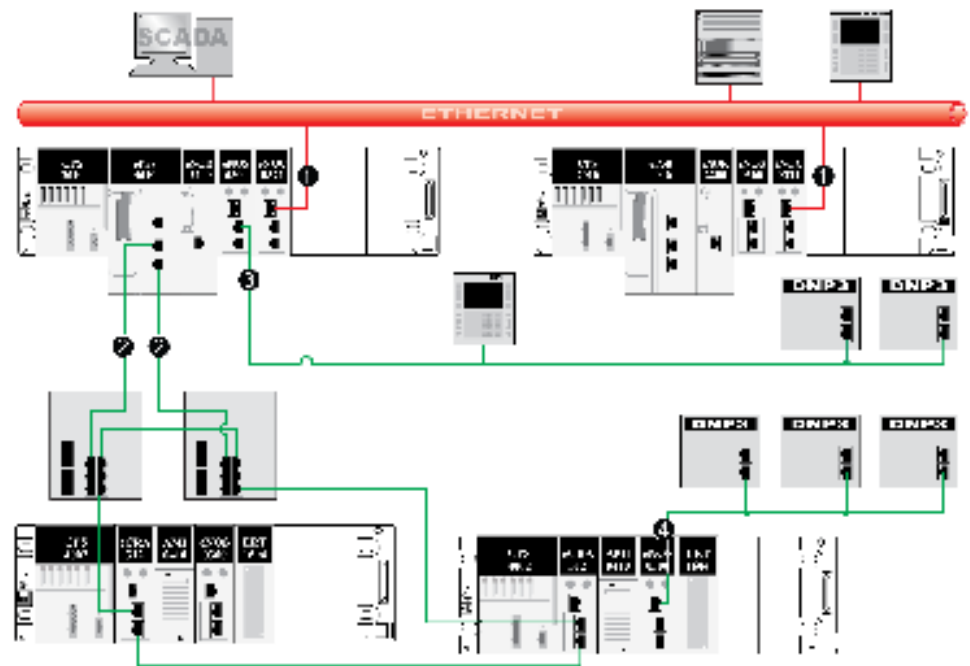
**3** RIO main ring (Dual-ring switches connect the local rack to an RIO drop.)

**4** A BMENOS0300 module on an RIO drop connects distributed equipment (DNP3 devices) to the RIO main ring.

## Standalone Network with Two Subnets

### Sample Network

This sample standalone network builds upon the single-subnet example, page 28 and includes BMENOR2200H modules on local racks that communicate with two different subnets:

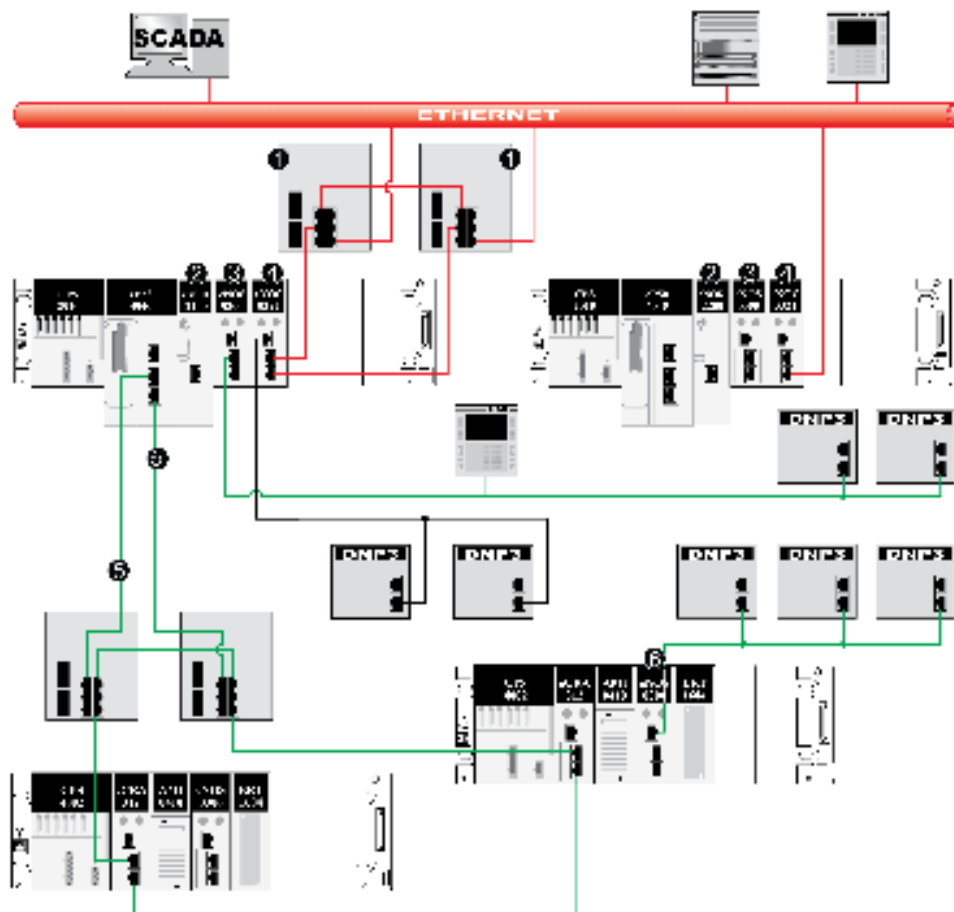


- 1 BMENOC0321 modules on the local racks connect the RIO main ring and distributed equipment (DNP3 devices, HMI) to the Ethernet control network (red).
- 2 RIO main ring (Dual-ring switches connect the local rack to two RIO drops and distributed equipment.)
- 3 A BMENOS0300 module connects the local rack to isolated distributed equipment (DNP3 devices, HMI).
- 4 A BMENOS0300 module on an RIO drop connects distributed equipment (DNP3 devices) to the RIO main ring.

## Standalone Network with Link Redundancy

### Sample Network

This sample standalone network builds upon the two-subnet example, page 29, which includes communications on different subnets (red and green). In this case, the connections between the local racks and dual-ring switches facilitate redundant connections between the subnets:



**1** A dual-ring switch connected to the Ethernet port of a BMENOC0321 module on the local rack creates a redundant link to the control network (red).

**2** A BMENOR2200H module connects the local rack to distributed equipment (DNP3 devices, HMI) via the Ethernet backplane connection using redundant links.

**3** A BMENOS0300 embedded switch module connects the local rack to distributed equipment (DNP3 devices) using redundant links.

**4** The service port of a BMENOC0321 module allows distributed equipment (DNP3 devices, HMI) to communicate with the control network using redundant links.

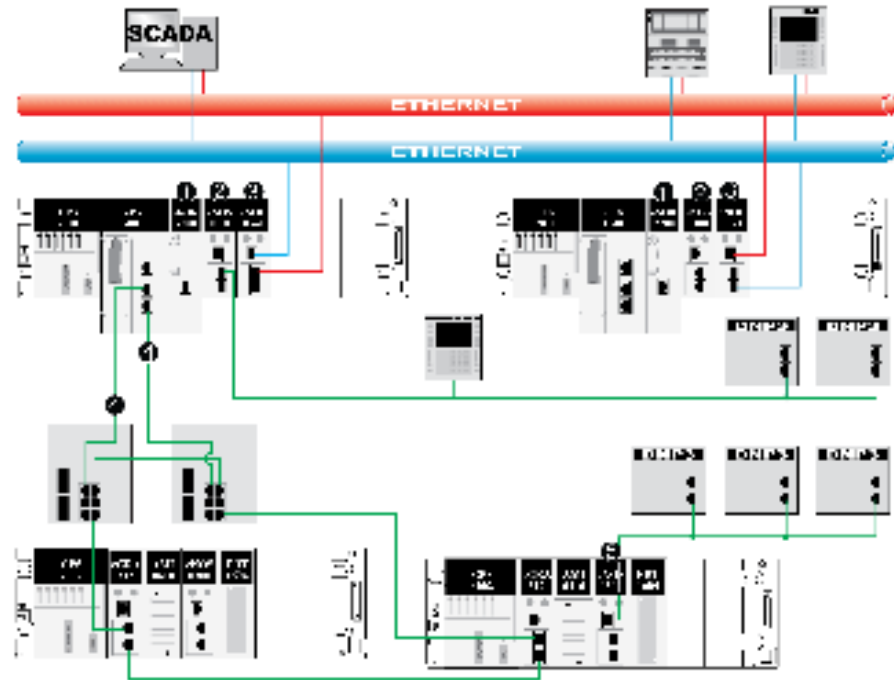
**5** RIO main ring

**6** A BMENOS0300 embedded switch module on an RIO drop connects the RIO main ring to distributed equipment (DNP3 devices) using redundant links.

## Standalone Network with Three Subnets

### Sample Network

This sample standalone network builds upon the two-subnet example, page 29 with different (red and green) subnets. In this case, BMENOC0321 modules with embedded IP forwarding in the local racks facilitate the connection to a third (blue) subnet:



1 A BMENOR2200H module

2 A BMENOS0300 module on the local rack connects distributed equipment (DNP3 devices, HMI) to the RIO main ring using redundant links

3 A BMENOC0321 module with IP forwarding enabled connects the RIO main ring and distributed equipment (DNP3 devices, HMI) to the blue network via the service port and the red network through the control network port using redundant links

4 RIO main ring

5 A BMENOS0300 module on an RIO drop connects distributed equipment (DNP3 devices) to the RIO main ring

## Redundant Networks

### Introduction

#### IP Address of the Module

Redundant systems contain separate primary and standby control networks. The configuration of the primary and standby racks is identical.

A redundant system that implements BMENOR2200H modules, therefore, includes one such module in both the primary and standby racks with these IP addresses:

- *IP address*: BMENOR2200H module in the primary configuration
- *IP address + 1*: BMENOR2200H module in the standby configuration

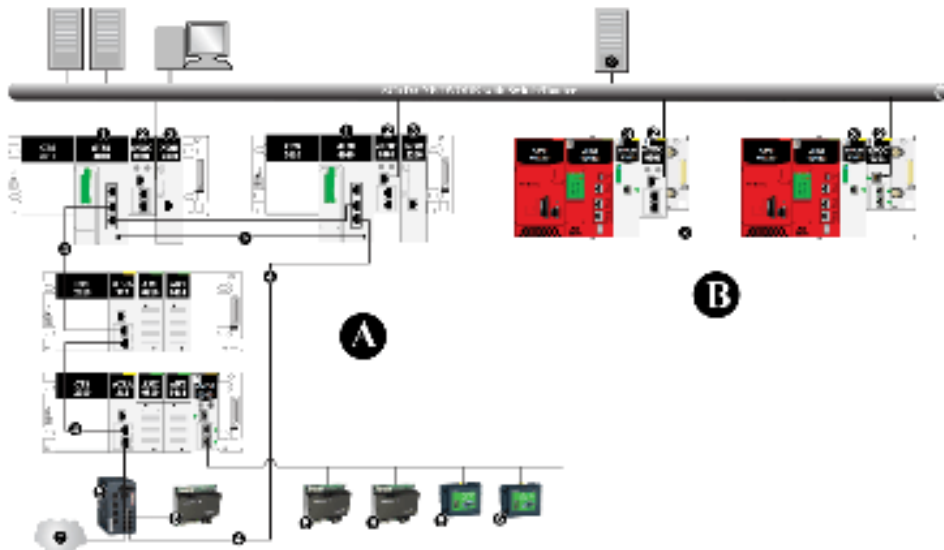
Upon a redundant switch-over, the IP address setting is automatically transferred from the (former) primary BMENOR2200H module to the (former) standby

BMENOR2200H module. The *IP address + 1* setting is also transferred from the (former) standby BMENOR2200H module to the new standby BMENOR2200H module.

## Redundant Architecture

### Sample Network

The following M580 architecture includes BMENOR2200H modules in both Safety and non-Safety primary and standby rack configurations in a redundant system that has routing functionality.



**A** M580 redundant system

**B** M580 Safety redundant system

**1** M580 redundant PAC connecting the main ring (4) to the control network

**2** BMENOC0301 module connected to the standalone and Safety Hot Standby PACs via the Ethernet backplane supporting distributed equipment

**3** BMENOR2200 module (acting as the RTU server) supporting IEC60870-5-104 or DNP communication

**4** RIO main ring

**5** dual-ring switch (DRS) connecting distributed equipment to the RIO drop on the main ring

**6** distributed equipment connected to the main ring via the DRS using IEC60870-5-104 or DNP communication

**7** DIO cloud connected to the main ring via the DRS

**8** redundant cable link connecting the primary and standby PACs

**9** control network monitoring the following features: system log, firmware upgrade tool, SNMP client, SNTP server, and SMTP server

**NOTE:** The primary and standby BMENOR2200H modules are using the RIO network or the upstream network to synchronize data. Otherwise, the pair of modules cannot establish Hot Standby functionality.

# Hardware Installation

## Mounting the Module on the Rack

### Introduction

The BMENOR2200H module has a dual-bus connector, page 23 that supports both Ethernet and X Bus communications.

Use these instructions to install the module in a single slot on a BMEXBP Ethernet backplane.

### Before You Begin

Take these steps before you insert the module on the rack:

- Remove the protective cap from the module connector on the rack.
- Determine the cyber security operating mode for the module and configure the appropriate cyber security mode with the rotary switch, page 22 before you install the module in the slot. The selected mode is implemented only after a power-up of the module.

### Backplane Considerations

Install the module only on the local rack. You can install and configure a maximum of four communication modules (including BMENOR2200H modules) on a single local rack (depending on the selected CPU).

This table shows the maximum number of BMENOR2200H modules you can install in the local rack with respect to specific CPU references:

| CPU        | BMENOR2200H |
|------------|-------------|
| BMEP582020 | 2           |
| BMEP582040 | 3           |
| BMEP584020 | 4           |
| BMEP584040 | 4           |
| BMEP586040 | 4           |
| BMEH582040 | 2           |
| BMEH584040 | 4           |
| BMEH586040 | 4           |

**NOTE:** Refer to the CPU selection table in the *Modicon M580 Standalone, System Planning Guide for Frequently Used Architectures*. Also refer to *Modicon M580 – Hot Standby, System Planning Guide for Frequently Used Architectures*; *Modicon M580, Safety System Planning Guide*; and *Modicon M580 – Hot Standby, System Planning Guide for Frequently Used Architectures*.

Install the module in a dual-bus slot on one of the following Ethernet backplanes:

| Backplane     | Description                                    |
|---------------|------------------------------------------------|
| BMEXBP0400(H) | 4-slot (hardened) Ethernet backplane           |
| BMEXBP0800(H) | 8-slot (hardened) Ethernet backplane           |
| BMEXBP1200(H) | 12-slot (hardened) Ethernet backplane          |
| BMEXBP0602(H) | 6-slot (hardened) dual-PWS Ethernet backplane  |
| BMEXBP1002(H) | 10-slot (hardened) dual-PWS Ethernet backplane |

## Rack and Slot Restrictions

The module occupies a single dual-bus slot. Observe these restrictions:

| Rack           | Slot         | Instruction                                                                                                                        |
|----------------|--------------|------------------------------------------------------------------------------------------------------------------------------------|
| all racks      | 0, 1         | Do not insert the BMENOR2200H module in these slots.<br><b>NOTE:</b> These slots are reserved for the CPU module.                  |
| BMEXBP1200 (H) | 2, 8, 10, 11 | These X Bus-only slots do not support the Ethernet functionality of the dual-bus BMENOR2200H module.                               |
| BMEXBP1002 (H) | 2, 8         |                                                                                                                                    |
| extended racks | —            | You cannot install the dual-bus BMENOR2200H module in an extended rack.<br><b>NOTE:</b> Extended racks do not have Ethernet ports. |
| RIO drops      | —            | You cannot install the dual-bus BMENOR2200H module in an RIO drop.                                                                 |

## Cyber Security Switch Considerations

### NOTICE

#### UNINTENDED EQUIPMENT OPERATION

- Do not switch from the non-secure configuration (**Standard**) directly to the secure configuration (**Secured**) or vice-versa.
- Always power up the module with the rotary switch in the **Reset** position when you transition between the **Standard** and **Secured** modes.

**Failure to follow these instructions can result in equipment damage.**

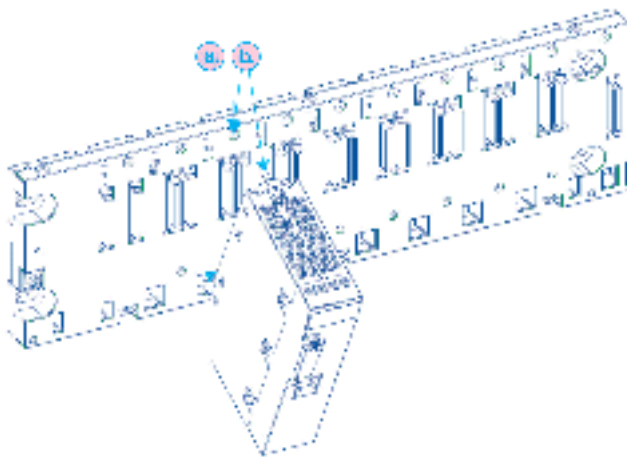
Follow these steps every time you insert a BMENOR2200H module on a powered rack:

| Step | Action                                                                                 |
|------|----------------------------------------------------------------------------------------|
| 1    | Set the rotary switch, page 22 on the module to the <b>Reset</b> position.             |
| 2    | Insert the module in the rack to power it up.                                          |
| 3    | Remove the module from the rack to power it down.                                      |
| 4    | Set the rotary switch on the module to the <b>Secured</b> or <b>Standard</b> position. |
| 5    | Reinsert the module in the rack to power it up.                                        |

## Installing the Module on the Rack

Mount the module in a single slot on the backplane:

| Step | Action                                                                                                                                    |
|------|-------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Turn off the power supply to the rack.                                                                                                    |
| 2    | Remove the protective cover from the module interface on the rack.                                                                        |
| 3    | Configure the cyber security level for the module with the rotary switch according to the cyber security considerations (above, page 34). |

| Step | Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |    |                                                                                                |    |                                                                                                                                                                                |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|------------------------------------------------------------------------------------------------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4    | <p>Notice sub-steps <i>a.</i> and <i>b.</i> in the graphic:</p>  <table border="1"> <tr> <td>a.</td><td>Insert the locating pins on the bottom of the module into the corresponding slots in the rack.</td></tr> <tr> <td>b.</td><td>Use the locating pins as a hinge and pivot the module until it is flush with the rack. (The twin connector on the back of the module inserts into the connectors on the rack.)</td></tr> </table> <p><b>NOTE:</b> Do not insert the BMENOR2200H module in slot 0 or 1 in the local rack. Those slots are reserved for the CPU.</p> | a. | Insert the locating pins on the bottom of the module into the corresponding slots in the rack. | b. | Use the locating pins as a hinge and pivot the module until it is flush with the rack. (The twin connector on the back of the module inserts into the connectors on the rack.) |
| a.   | Insert the locating pins on the bottom of the module into the corresponding slots in the rack.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |    |                                                                                                |    |                                                                                                                                                                                |
| b.   | Use the locating pins as a hinge and pivot the module until it is flush with the rack. (The twin connector on the back of the module inserts into the connectors on the rack.)                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |    |                                                                                                |    |                                                                                                                                                                                |
| 5    | <p>Tighten the retaining screw to hold the module in place on the rack:</p>  <p><b>NOTE:</b> Tightening torque: 0.4...1.5 N•m (0.30...1.10 lbf-ft).</p>                                                                                                                                                                                                                                                                                                                                                                                                               |    |                                                                                                |    |                                                                                                                                                                                |

## Replacing a Module

### NOTICE

#### UNINTENDED EQUIPMENT OPERATION

- Do not switch from the non-secure configuration (**Standard**) directly to the secure configuration (**Secured**) or vice-versa.
- Always power up the module with the rotary switch in the **Reset** position when you transition between the **Standard** and **Secured** modes.

**Failure to follow these instructions can result in equipment damage.**

Any module on the rack can be hot-swapped at any time with another module with compatible firmware. The replacement module obtains its operating parameters over the backplane connection from the CPU. The transfer occurs immediately at the next cycle to the device.

When you switch from secure to non-secure operations or vice-versa, reset the module by setting the rotary switch to the **Reset** position to implement a clean

configuration file and clear the security settings (including the user name and password).

We suggest that you export your cyber security configuration before you replace the module. When the rotary switch is set to the factory **Reset** mode, the entire cyber secure configuration is erased.

Replace the module:

| Step | Action                                                                                                                                                                                                           |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Remove the module from the rack by reversing the above steps for installing the module.<br><b>NOTE:</b> Because this is a hot-swappable module, it is not necessary to power down the rack to remove the module. |
| 2    | Set the rotary switch, page 22 on the replacement module to the <b>Reset</b> position.                                                                                                                           |
| 3    | Insert the replacement module in the rack to power it up.                                                                                                                                                        |
| 4    | Remove the replacement module from the rack to power it down.                                                                                                                                                    |
| 5    | Set the rotary switch on the replacement module to the <b>Secured</b> or <b>Standard</b> position.                                                                                                               |
| 6    | Reinsert the replacement module in the rack to power it up.                                                                                                                                                      |

**NOTE:** The replacement module does not automatically recover the security settings from the web-based configuration. The security configuration file is stored locally in the module. Export this file, page 116 to create a backup configuration.

## Grounding the Installed Modules

### General

Grounding the modules is crucial to avoid electric shock.

### Module Grounding

Follow all local and national safety codes and standards.

#### **DANGER**

##### **HAZARD OF ELECTRIC SHOCK**

If you cannot prove that the end of a shielded cable is connected to the local ground, the cable must be considered as dangerous and personal protective equipment (PPE) must be worn.

**Failure to follow these instructions will result in death or serious injury.**

#### **DANGER**

##### **HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH**

Ensure ground connection contacts are present and not bent out of shape. If they are, do not use the module and contact your Schneider Electric representative.

**Failure to follow these instructions will result in death or serious injury.**

**⚠ WARNING****UNINTENDED EQUIPMENT OPERATION**

Securely tighten the mounting screw to attach the module firmly to the rack.

**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

# Ethernet Communications

## Ethernet Services

### About this Section

This section describes the Ethernet services that are available to the BMENOR2200H module.

### Available Ethernet Services

#### Introduction

This topic introduces the different services and functionalities that the BMENOR2200H module supports.

#### RTU Protocols

The module supports these RTU protocols:

- DNP3 NET server with SAV2 or SAV5
- DNP3 NET client with SAV2 or SAV5
- IEC 60870-5-104 client
- IEC 60870-5-104 server

Refer to the description of RTU protocols, page 45.

#### Ethernet Services

The module supports these Ethernet services:

- SNTPv1 client, page 84
- Modbus TCP server and client
- built-in HTTPS -based web pages, page 109
- FDR client, page 42 (basic service)
- SNMPv1 Agent, page 41
- Firmware upgrade, page 42
- Cyber Security, page 108 (RBAC, HTTPS, system hardening, cyber security event log, certificate management, etc.)

#### Other Services

The BMENOR2200H module also supports clock synchronization, page 51.

## SNMP Service

### Introduction

This section describes the Simple Network Management Protocol (SNMP).

**NOTE:** To configure the SNMP service, refer to the instructions to configure SNMP in the DTM, page 83.

## SNMP Overview

### Introduction

An SNMP agent runs on:

- Ethernet communication modules
- CPUs with embedded Ethernet communications ports

Network management systems use SNMP to monitor and control Ethernet architecture components for the rapid network diagnosis.

Network management systems allows a network manager to:

- monitor and control network components
- isolate troubles and find their causes
- query devices, such as host computer(s), routers, switches, and bridges, to determine their status
- obtain statistics about the networks to which they are attached

**NOTE:** Network management systems are available from a variety of vendors.

### Simple Network Management Protocol

Ethernet communication modules support SNMP, the standard protocol for managing local area networks (LANs). SNMP defines exactly how a manager communicates with an agent. SNMP defines the format of:

- requests that a manager sends to an agent
- replies that the agent returns to the manager

### The MIB

The set of objects that SNMP can access is known as a Management Information Base (MIB). Ethernet monitoring and management tools use standard SNMP to access configuration and management objects included in the device's MIB, providing that:

- objects that SNMP can access are defined and given unique names
- manager and agent programs agree on the names and meanings of fetch and store operations

Transparent Ready products support the Standard MIB II SNMP network management level. This first level of network management can be accessed via this interface. It lets the manager identify the devices that create the architecture and retrieve general information on the configuration and operation of the Ethernet TCP/IP interface.

## SNMP Communication

### Overview

SNMP defines network management solutions in terms of network protocols and the exchange of supervised data.

The SNMP structure relies on the following elements:

- **Manager:** The manager allows entire or partial network supervision.
- **Agents:** Each supervised device has one or more software modules named Agent that are used by the SNMP protocol.
- **MIB:** The Management Information Base is a database or collection of objects.

The SNMP agent is implemented on the BMENOR2200H module. This allows a manager to access MIB-II standardized objects from the Modicon X80 agent

through the SNMP protocol. The MIB-II allows management of TCP/IP communication layers.

## SNMP Protocol

The SNMP protocol defines the types of messages between the agent and the manager. These messages are encapsulated in UDP datagrams.

Messages from the manager to an agent:

- **Get\_Request:** Message used to obtain the value of one or more variables.
- **Get\_Next\_Request:** Obtains the value of the next variables.
- **Set\_Request:** Sets the value of a variable.

Messages from an agent to the manager:

- **Get\_Response:** Allows the agent to resend the value of the requested variable.
- **Trap:** Allows asynchronous event signaling by the agent.

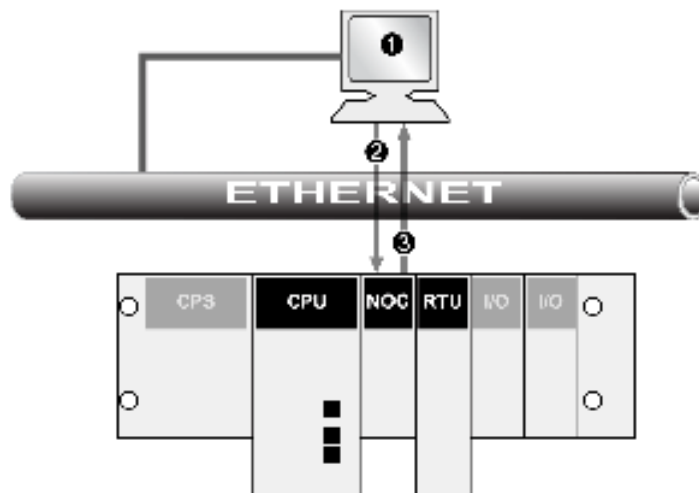
## SNMP Operations Example

### Introduction

The SNMP manager transmits read or write requests (**Set\_Request**, **Get\_Request**, **Get\_Next\_Request**, etc.) for objects defined in the MIB - II SNMP. The response is from the SNMP agent of the Modicon M580 module.

### Modicon M580 Example

In this example, an SNMP manager on an Ethernet network sends a request to the SNMP agent in the BMENOR2200H RTU module (via a communications module in the same rack) and receives a response:



1 SNMP manager

2 request

3 response (trap)

The module's SNMP agent transmits events (traps) to the manager. The managed trap systems are as follows:

- **Coldstart Trap:** On the BMENOR2200H module, the event is transmitted following a module supply reset, a processor reset, or the downloading of an application to the PLC.
- **Authentication Failure Trap:** A transmitted event indicates that a network element cannot be authenticated. The **Community Name** field in the

received message is different from the one that is configured on the module. Enable this trap during the configuration of the module.

## SNMP Agent Details

### Introduction

The widely available SNMP agent service allows easy access to the module's diagnostic information and event notification for certain services (for example, a change in network topology, an LED state, etc.).

Configure this service in the Control Expert DTM to manage IP addresses (MIB browser, ConneXview, etc.) or as an event trap.

### MIB Support

The module uses the SNMP agent to support MIB II, which provides diagnostics information that is specified in the MIB files. The module supports these MIB levels:

- **MIB II:** The standard MIB II provides diagnostic information to manage the TCP/IP stack:
  - TCP/IP diagnostics
  - bridge MIB
- **MIB Lite:** This subset of the standard MIB II provides information to discover the identity of a device.

### Management Services

This table describes the basic SNMP network management group functions:

| Function                | Description                                                                     |
|-------------------------|---------------------------------------------------------------------------------|
| system group management | Discover the device and identify it in a standard way by using an SNMP manager. |
| authentication checking | Configure the community name, and check the authentication of the requester.    |
| system trap management  | Configure the SNMP manager.                                                     |
| MIB II management       | Manage the MIB.                                                                 |

The service runs on the module to allow SNMP manager applications to configure these SNMP objects:

- sysLocation
- sysContact

### SNMP Version

The module runs SNMPv1 for this service. This version extends the capabilities of SNMP to address ministration and security issues. It is a Framework architecture that can be easily extended with new user security protocols. A new frame format has been defined for SNMPv1 adding among other things some security information. In particular, the PDU contents can be encrypted. SNMP uses UDP Transport layer protocol through port 161 and 162.

## Firmware Upgrade

### EcoStruxure™ Automation Device Maintenance Tool

#### Tool Functions

Use the EcoStruxure™ Automation Device Maintenance tool to upgrade the firmware of the BMENOR2200H module.

Perform these actions with this web-based tool:

- Automatically or manually discover one or more BMENOR2200H modules in your project, based on IP addresses.
- Upgrade the latest firmware version that is applicable to those modules over the web.

For details on how to install and use this firmware upgrade tool, refer to the online help.

**NOTE:** You cannot use Schneider Electric's Unity Loader™ software tool to upgrade the firmware for the BMENOR2200H module.

#### User Role

Use the **INSTALLER** user role to perform the firmware upgrade.

**NOTE:**

- Certification is invalid and the firmware upgrade process is blocked if the BMENOR2200H module's internal clock is earlier than 2019. Confirm that the module's internal clock is set at the current time/date first.
- When the module operates in **Standard mode**, page 22, the default user role is **INSTALLER**.
- When the module operates in **Secured mode**, page 22, the default user role is **SECADM**. In that case, log in to the security setting page to create a new user, page 121 as an **INSTALLER** and upgrade the firmware in that role.

## FDR Client Basic Service

### FDR Client Basic Service

#### Introduction

The basic FDR client service (FDR\_CLIENT) is applied to the IP configuration that the BMENOR2200H module receives from the CPU via X Bus.

**NOTE:**

- This module does not support DHCP or BOOTP.
- Static IP parameters are not stored locally in this module.
- The cyber security configuration is not stored in the CPU.

#### Configuration Process

The service configures the IP parameters for the module:

| Stage | Description                                                                                         |
|-------|-----------------------------------------------------------------------------------------------------|
| 1     | The BMENOR2200H module gets its IP configuration data from the user-specified configuration source. |
| 2     | The BMENOR2200H module gets its configuration file from the CPU.                                    |

| Stage | Description                                                                             |
|-------|-----------------------------------------------------------------------------------------|
| 3     | The service validates the IP parameters (IP address, subnet mask, and gateway address). |
| 4     | The BMENOR2200H module configures the device with the validated IP parameters.          |

MAC-based default address information is used in these cases:

- There is no configuration file.
- The IP information is not valid.
- The configured IP address conflicts with the address of another module in the system.

When a default channel is used, the module does not get a valid IP address from the CPU. Instead, it uses the default IP address 10.10.mac5.mac.6. In this case, the module detects a duplicated IP status and does not run.

## Behavior

When the initialization is complete, the FDR client service gets a MAC-based IP configuration (10.10.mac5.mac6) from the CPU. Then the service validates the parameters:

- **OK:** If the received IP parameters are valid and not duplicates, the FDR\_CLIENT service uses those parameters.
- **not OK:** If any received IP parameter is invalid, missing, or a duplicate, the FDR\_CLIENT service uses the default IP to execute DHCP until the device obtains a valid and non-duplicate IP.

**NOTE:** When a duplicate IP address is found in the system, the **ETH STS** LED is solid red. Refer to the description of LED indications., page 19

If the default IP address is a duplicate, the FDR\_CLIENT service configures the device with the loopback IP address 127.0.0.1.

After the IP configuration, the FDR\_CLIENT service sends gratuitous ARPs.

# Modbus TCP Messaging

## Data Exchange

### Exchanges

Data exchanges take place in one of two modes:

- **server mode:** The RTU module supports all Modbus-over-TCP requests from the PLC.
- **client mode:** This type of exchange enables Modbus-over-TCP requests to be sent using the functions:
  - READ\_VAR
  - WRITE\_VAR
  - DATA\_EXCH

For more details about functions, refer to *EcoStruxure™ Control Expert, Communication, Block Library*.

**NOTE:** The maximum Ethernet frame size depends on the type of transaction. The maximum frame size is 256 bytes for messaging.

The BMENOR2200H module manages these TCP connections through port 502 messaging:

- Modbus server: 32 connections
- Modbus client: 16 connections

## Port 502

TCP/IP reserves specific server ports for specific applications through IANA (Internet Assigned Numbers Authority). Modbus requests are sent to registered software port 502.

Port 502 messaging paths:

- server path:
  - Port 502 messaging can process up to 8 incoming requests from the network. Requests are received during the previous scan and sent to the Modbus server in the IN section.
  - Port 502 messaging can process up to 8 responses from the Modbus server in the IN section (including writing the data into the socket).
- client path:
  - Port 502 messaging can process up to 16 outgoing requests from the application in the OUT section (including writing the data into the socket).
  - Port 502 messaging can process up to 16 incoming responses from the network in the IN section. Responses are sent to the application.

# How to Work with RTU Protocols

## Introduction

This chapter describes the built-in RTU protocols characteristics for use in Telemetry and Supervisory Control and Data Acquisition (SCADA) applications.

## RTU Protocols

### Communication Protocols

#### Functions and Protocols

The BMENOR2200H module provides in-rack support for these functions and protocols in an M580 architecture:

|                              |                                                                                                                                                                                                                                               |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RTU protocols                | DNP3 NET and IEC 60870-5-104 (client or server)<br><b>NOTE:</b> When the module works as a client, the number of connected servers affects the module performance (web page access, module start-up and data exchange through the backplane). |
| Main RTU protocol features   | time synchronization through a protocol facility or SNTP, page 52                                                                                                                                                                             |
|                              | data synchronization on demand of the SCADA                                                                                                                                                                                                   |
|                              | event management with time stamping, page 54 (Sequence of Events, SoE)                                                                                                                                                                        |
|                              | event queue stored in RAM memory, page 55 (up to 150,000 events)                                                                                                                                                                              |
|                              | events data backfill to SCADA application via protocol facility, page 58                                                                                                                                                                      |
|                              | event routing, page 56                                                                                                                                                                                                                        |
|                              | report by exception data exchanges                                                                                                                                                                                                            |
|                              | unsolicited messaging data exchanges                                                                                                                                                                                                          |
|                              | DNP3 secure authentication, page 50 SAV2 and SAV5 with pre-shared key, page 50                                                                                                                                                                |
| Other built-in functionality | protocol setup via the DTM                                                                                                                                                                                                                    |
|                              | web server for security set-up and remote diagnostic                                                                                                                                                                                          |
|                              | advanced TCP/IP networking: SNTPv1 client, HTTPS server, and SNMP agent.                                                                                                                                                                      |

### Limitations

| <b>NOTICE</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>UNINTENDED EQUIPMENT OPERATION</b> <ul style="list-style-type: none"><li>• Use different address values for each session in a channel or for each section in a session.</li><li>• Use successive DB mapping starting at 0 in the DNP3 protocol.</li><li>• Do not configure the DNP3 client to control a point that is not configured in the DNP3 server point mapping.</li></ul> <b>Failure to follow these instructions can result in equipment damage.</b> |

The BMENOR2200H module does not support multiple RTU protocols instances.

## IEC 60870-5-104 Protocol

### Introduction

IEC 60870-5 is an international standard released in the early 1990s by the International Electrotechnical Commission (IEC). This standard provides a communication profile for telecontrol, teleprotection, and associated telecommunications characteristics for electric power systems. It is widely used today for other infrastructures, including water applications in Europe and Asia.

The IEC 60870-5-104 protocol is the companion to the IEC 60870-5 standards that relate to transmission protocols.

### IEC 60870-5-104

The IEC 60870-5-104 protocol is an extension of the IEC 60870-5-101 protocol. There are changes in transport, network, link & physical layer to open networking.

IEC 60870-5-104 enables communication between control stations and substations in a standard TCP/IP network. The TCP protocol is used for connection-oriented data transmission. To have connectivity to LANs and routers with different facilities (frame relay, etc.), connect it to the WAN. The application layer of IEC 60870-5-104 is the same as that of IEC 60870-5-101, except that some data types and facilities are not used. There are separate link layers defined in the standard, which facilitates the transfer of data over Ethernet and serial lines.

### Supported Protocol Features

Features of the IEC 60870-5-104 protocols:

- general interrogation
- clock synchronization
- events transmission (time-stamped or not)
- counter interrogation
- command transmission modes (select and execute mode)

### Supported Data Types

The IEC 60870-5-104 protocols include these data types:

- discrete inputs/outputs (single or double)
- measured values (with different formats)
- integrated totals
- commands
- step position
- bit string

### Protocol Characteristics

The table lists the characteristics for the supported RTU protocols:

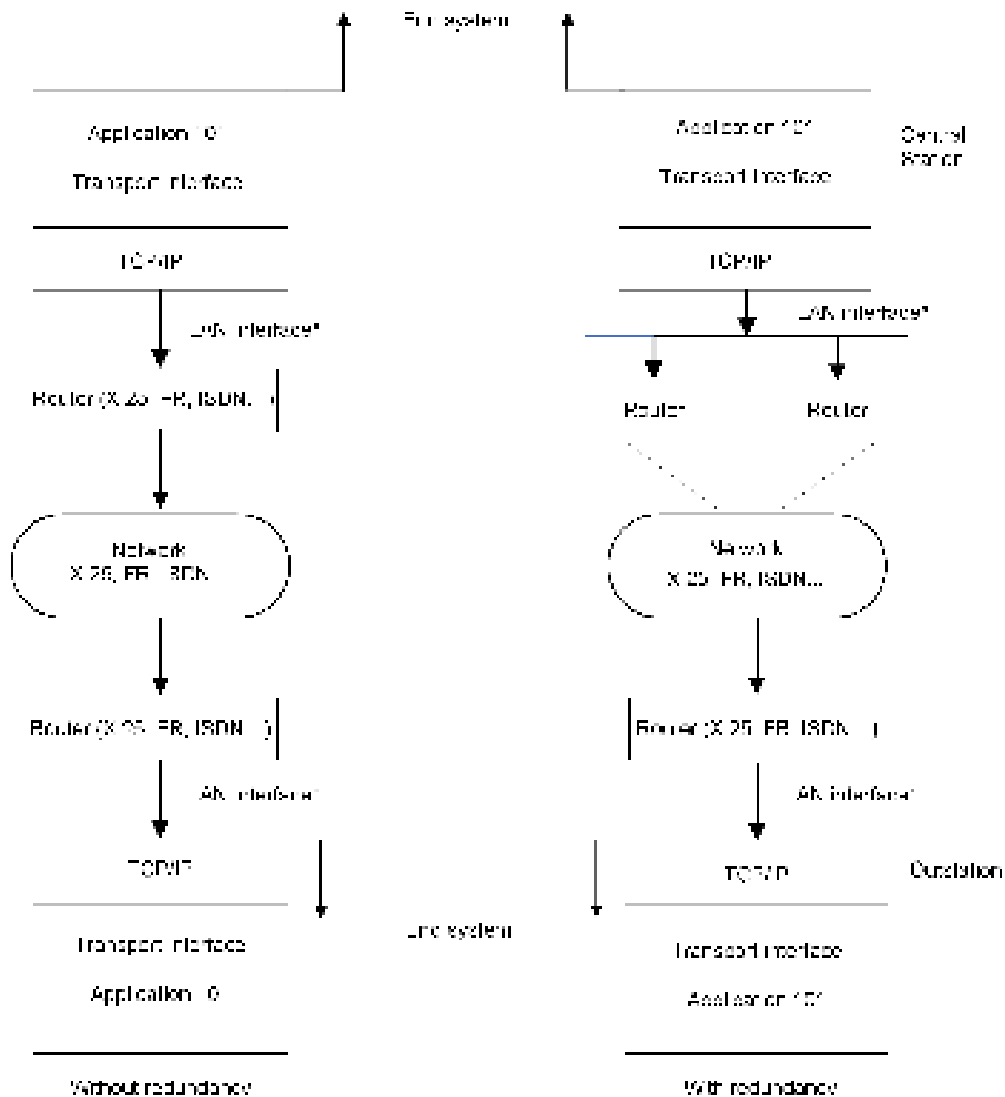
| Protocol               | Characteristics                                                                                              |
|------------------------|--------------------------------------------------------------------------------------------------------------|
| IEC 60870-5-104 server | client IP address validation list (up to 10 IP addresses)                                                    |
|                        | up to four concurrent client connections with configurable TCP service port (standard is 2404)               |
|                        | <ul style="list-style-type: none"> <li>• <i>input</i>: 8 kb</li> <li>• <i>output</i>: 8 kb</li> </ul>        |
|                        | up to 150,000 events in a queue for all data types in all clients (each client has a dedicated event buffer) |

| Protocol               | Characteristics                                                                                    |
|------------------------|----------------------------------------------------------------------------------------------------|
|                        | event time-stamping configurable by type (None, CP56)                                              |
|                        | channel redundancy                                                                                 |
| IEC 60870-5-104 client | <ul style="list-style-type: none"><li>• <i>input</i>: 8 kb</li><li>• <i>output</i>: 8 kb</li></ul> |
|                        | up to 64 server connections supported                                                              |
|                        | connections share common channel configuration                                                     |
|                        | dedicated connection for each device configuration                                                 |
|                        | dedicated destination IP address and port settings for each connection                             |

## Channel Redundancy

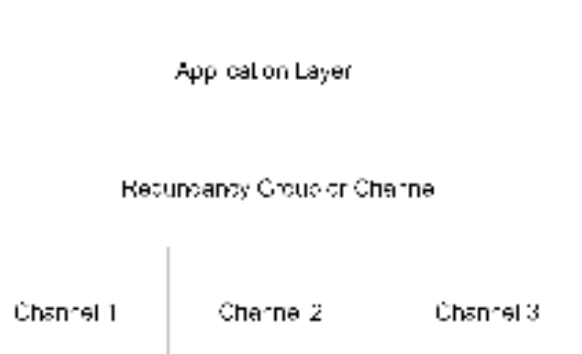
Redundancy is sometimes necessary to increase the availability of the communication system. In these cases, confirm that you establish multiple redundant connections between the two stations. Redundant communication in a system using IEC 60870-5-104 allows you to establish more than one logical connection between two stations. A logical connection is defined by a unique combination of two IP addresses and two port numbers, specifically the controlling station's IP address/port number pair and the controlled station's IP address/port number pair.

The following figure shows the general architecture for a redundant configuration in the central station as well as a non-redundant system:



\* The Link interface may be redundant

The following figure shows the redundancy software architecture in the BMENOR2200H module:



- Every main or virtual channel can be configured as **None**, which refers to it is independent channel; it does not belong to any group. Every main or virtual channel can be configured as **1/2/3**. There is only one **Active** channel in multiple channels of one redundant group, which performs all user application communications. All the other channels, except **Active** in multiple channels of one redundant group, are in **inactive** status if they are connected. Inactive channels are monitored to help make sure they are still operational. If an active link control is configured as **External**, when the **Active** channel goes down, communications are switched to the next operational channel by

remote client (STARTDT). If an active link control is configured as **Module**, when the **Active** channel goes down, communications are switched to the next operational channel automatically by the module.

## Interoperability Lists

The interoperability list (defined by the standard) facilitates interoperability between devices from different manufacturers. In the list, the function range is described for each device by marking the applicable functions.

**NOTE:** Refer to the IEC interoperability list for this RTU module in Appendices.

## DNP3 Protocol

### Introduction

The distributed network protocol (DNP3) was developed to achieve an open, standard interoperability for communications between client stations, substation devices, RTUs, and Intelligent Electronic Devices (IEDs). DNP3 has been used primarily by utilities such as the electric power industry in North America and has become widely used in other distributed infrastructures such as water/wastewater, transportation, and oil and gas industries.

DNP3 is based on the International Electrotechnical Commission Technical Committee 57 Working Group 03. The IEC TC57 WG03 has been working on the Enhanced Performance Architecture (EPA), a protocol standard for telecontrol applications. Each of the EPA's three layers corresponds to a layer on the OSI reference model.

DNP3 is specifically developed for inter-device communications that use SCADA RTUs. The protocol facilitates both RTU-to-IED (Intelligent Electronic Device) and client-to-RTU/IED.

The protocol was originally designed for slow serial communications, but the current DNP3 IP version also supports TCP/IP-based networking.

**NOTE:** For more details about the supported RTU protocols (including input and output sizes), refer to the description of the I/O data exchange with the CPU, page 24.

### Supported Protocol Features

These are the main features that DNP3 supports:

- clock synchronization
- polled interrogations
- polled report-by-exception
- unsolicited report-by-exception
- DNP3 security authentication
- events transmission (time-stamped or not)
- counter-specific treatment
- client commands

### Supported Data Types

The DNP3 protocol includes these data types:

- discrete inputs/outputs (single or double)
- analog values (with different formats)
- integrated totals
- string exchange

- commands

## Interoperability Lists

This implementation of DNP3 is fully compliant with DNP3 Subset Definition Level 3, which suits larger RTU applications and offers practically the complete range of DNP3 functionality.

This standard defines interoperability between devices from different vendors. It includes a device profile that describes the basic protocol functionalities supported by the device and an Implementation table that defines information objects and their representation supported by the device.

## DNP3 Security Authentication

### Introduction

In some cases, an attacker can learn the protocol used by an RTU unit to gain dial-up access. When an RTU does not employ strong authentication or other security mechanisms, it accepts and responds to any caller.

To address such concerns, the BMENOR2200H module uses these security authorization services within DNP3 to facilitate communications between remote RTU units.

### Secure Authentication Versions

The RTU supports these DNP3 secure authentication versions:

- **SAv2:** *Secure Authentication version 2* is a protocol family within DNP3 that facilitates the authentication of critical controls and commands and helps increase message confidentiality when the BMENOR2200H module is used in conjunction with a suitable SCADA host or other devices that support SAv2.

SAv2 requires pre-shared keys to be pre-installed on all devices.

SAv2 is defined by the IEEE 1815-2010 DNP3 standard.

- **SAv5:** *Secure Authentication version 5* is a newer protocol family within DNP3 that addresses evolving threats.

SAv5 is defined by the IEEE 1815-2012 DNP3 standard.

#### NOTE:

- Schneider Electric recommends that you use the same secure authentication version (SAv2 or SAv5) on both the client and server sides.
- Manufacturers design a single device to be compatible with only one of these security authorization service versions.
- The implementation of SAv2 or SAv5 authentication requires the use of a security administrator application.

### Pre-Shared Keys

The BMENOR2200H module implements secure DNP3 communications through pre-shared keys.

Many utilities that do not choose to manage security credentials in a more sophisticated manner may nonetheless require the level of protection afforded by pre-shared keys.

By definition, users on the SCADA side and module side use the same pre-shared key to effect mutual authentication. Communications are facilitated by a session key that is derived from the pre-shared key.

**NOTE:**

- Refer to the instructions for the management of pre-shared keys.
- For general information about pre-shared keys, refer to the *Modicon Controllers Platform Cyber Security, Reference Manual*.

## DNP3 Client Channel Configuration

The **Add Channel** dialog has the following configurable elements:

- **Secure Authentication:** Select an option from the drop-down list:
  - SAV2
  - SAV5 (default)
  - Disabled
- **Enable Aggressive Mode:** Aggressive authentication support involving session key, reply time out, and maximum detected error count:
  - Select the check box to enable **Aggressive Mode**.
  - Deselect the check box to disable **Aggressive Mode**.
- **Current User:** Select an option for the user role from the drop-down list:
  - single user (default, option if SAV2 authentication is selected)
  - viewer
  - operator

Refer to the RBAC topic for each role's permissions.

**NOTE:** No user can change the role of another.

## DNP3 Server Channel Configuration

The server channel configuration has the following parameters:

- **Secure Authentication:** Select an option from the drop-down list:
  - SAV2
  - SAV5 (default)
  - Disabled
- **Key/Account Table:** Table for client/server with these options:
  - User Number
  - User Name
  - User Role: Operator, viewer, or single user
  - Key Wrap: Select AES-128 or AES-256.
  - Key: Enter the key wrap algorithm in hex format.

Click **Apply** to save.

- **Secure Authentication Enabled**
- **Add User:** Click this button to add and configure permissions for another user.

## Clock Synchronization

### Overview

The clock synchronization service establishes time accuracy among device clocks over a network. The BMENOR2200H module provides two ways to synchronize the clock with the SCADA (client) and the connected devices:

- via the RTU protocol facilities
- via the NTP protocol

**NOTE:**

- These clock synchronization methods are independent of one another. Configure your application to help avoid clock synchronization conflicts.
- If the NTP protocol is not configured, the module gets its time stamp from the controller during a module restart.

## Clock Synchronization with the RTU Protocol

### Overview

One of the main features of the RTU is to manage events with time stamping. Time stamping requires effective time synchronization.

### Behavior

The behavior of the clock synchronization command is determined by the role of the BMENOR2200H module:

| Role(s) | Description                                                                                                                                                                                                                                                                                                          |
|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| server  | When acting as a server, the BMENOR2200H module can synchronize its clock with a client station (SCADA). When you enable this feature, the module receives the clock synchronization command, it updates its internal clock, and posts the new value to the CPU. This maintains a consistent time on the local rack. |
| client  | When acting as a client, the BMENOR2200H module sends clock synchronization commands to connected servers. As with the case above, the clock is initialized from the CPU when it starts up.                                                                                                                          |

### Configuration

The SNTP client runs only when you configure the service in the DTM. To configure the SNTP service, refer to the [clock synchronization instructions](#), page 84.

## Clock Synchronization with SNTP

### Introduction

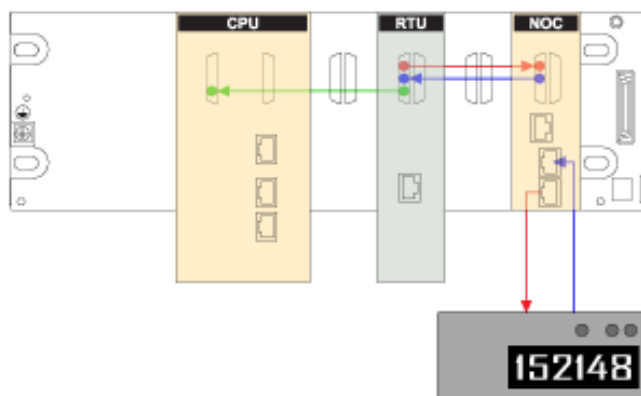
The BMENOR2200H module supports clock synchronization as an SNTP protocol client.

When the SNTP client is enabled, the module synchronizes the internal clock from the time server. This time is the basis for time stamping RTU events.

**NOTE:** Refer to the instructions for configuring the [network time service](#) in the DTM, page 84.

## Clock Synchronization and Time Stamps

This sample network shows the flow of the synchronization signal from the perspective of the SNTP client in a BMENOR2200H module:



**red line:** The BMENOR2200H module sends an SNTP request over the Ethernet backplane to the NOC module, and the NOC module forwards the request to the SNTP server.

**blue line:** The SNTP server sends a reply to the NOC module, and the NOC module forwards the reply to the BMENOR2200H module.

**green line:** The BMENOR2200H module sends the source clock synchronization signal to the CPU over the Ethernet backplane.

### NOTE:

- The BMENOR2200H module sends the signal to update the CPU's internal clock only when you select **Update Clock to CPU** in the time synchronization parameters, page 85.
- The time received by the CPU is typically within 5 ms of the SNTP server time, with a worst-case difference of 10 ms and a free running drift time +/- 2.6 seconds per day.
- Between clock synchronization signals, the RTU updates its own clock every millisecond with its internal timer.

## Clock Synchronization with the CPU

### Introduction

You can configure the CPU as an NTP server. In this case, the CPU uses its internal clock and acts as an Ethernet NTP server for devices that are connected to the same Ethernet network.

### Configure the CPU as an NTP Server

Access and set the NTP parameters in Control Expert:

| Step | Action                                                                               |
|------|--------------------------------------------------------------------------------------|
| 1    | Open a Control Expert project.                                                       |
| 2    | Expand these items in the <b>Project Browser</b> : <b>Project &gt; Configuration</b> |
| 3    | Double-click <b>PLC bus</b> to see the modules and racks in your project.            |
| 5    | Select the <b>NTP</b> tab.                                                           |
| 6    | From the <b>NTP</b> pull-down menu, select <b>NTP Server</b> .                       |
| 7    | Configure the parameters in the <b>NTP Server Configuration</b> area.                |

When the CPU is configured as an NTP server, the polling period is a parameter used by remote modules in the PAC. It represents the time elapsed before the

remote modules resynchronize their internal clocks with the time from the CPU NTP server.

## Time Stamping

### Event Time Stamping

#### Overview

The BMENOR2200H module provides two ways for time stamping of events:

- Time stamping done at source in the CPU (requires PLC programming).
- Time stamping done in the BMENOR2200H module (does **not** require PLC programming).

**NOTE:** Improved time stamping resolution can be obtained when performing in the CPU. Time stamping resolution depends on the CPU scan time and I/O module type.

## Events Management

### Event Management

#### Introduction

The BMENOR2200H module generates events on changes of state, handles event lists, and provides these services:

- The management of a buffer of events (time stamped or not), overall buffer (queue) size can be up to 150,000 events.

**NOTE:** One dedicated event buffer is managed per server application (up to four server applications are supported).

- Automatic event backfill to the SCADA or the client station via RTU protocol facility (on IEC 60870-5-104 or DNP3).

For the RTU IEC 60870-5-104 or DNP3 server configuration, each object type has an independent event queue setting. To enable event generation, set an event queue for the corresponding object type.

#### Access the Configuration

Access the event command configuration in Control Expert:

| Step | Action                                                                                                                                                                                                          |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Follow the directions to <a href="#">configure a server channel</a> , page 75.                                                                                                                                  |
| 2    | Expand (+) <b>Channels &gt; DNP3 NET server &gt; &lt;ServerName&gt;</b> ,                                                                                                                                       |
| 3    | Select one of these items from the <b>Select Type Id</b> pull-down menu on the <b>DATA MAPPINGS</b> tab: <ul style="list-style-type: none"><li>• <b>Generate Events</b></li><li>• <b>Clear Events</b></li></ul> |

| Step | Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4    | <p>Select the <b>Add</b> button to view the parameters for the selected type:</p> <ul style="list-style-type: none"> <li>• <b>Generate Events:</b> <ul style="list-style-type: none"> <li>◦ <b>Point Number</b></li> <li>◦ <b>Point Count</b></li> <li>◦ <b>Object Group</b></li> <li>◦ <b>Point Name</b></li> <li>◦ <b>Add CMD_STATUS</b></li> </ul> </li> <li>• <b>Clear Events:</b> <ul style="list-style-type: none"> <li>◦ <b>Object Group</b></li> <li>◦ <b>Point Name</b></li> <li>◦ <b>Add CMD_STATUS</b></li> </ul> </li> </ul> <p><b>NOTE:</b> When the Control Expert window is active, you can hover the cursor over any field to see a description of the functionality and the available range of values.</p> |
| 5    | <ul style="list-style-type: none"> <li>• Click the <b>Apply</b> button to implement your configuration changes.</li> <li>• Click the <b>OK</b> button to implement your changes and close the dialog box.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

## Event Queue Setting Page

Configure the parameters on the **Events** tab to map the event queue status to the DDDT registers in the CPU. Each event queue status consumes one three-byte register.

**NOTE:** When the events number exceeds the configured buffer size, events are lost or overwritten.

Access the event queue configuration in Control Expert:

| Step | Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | <p>Expand:</p> <ul style="list-style-type: none"> <li>• <b>Channels/Devices &gt; &lt;DNP3 NET Server&gt; &gt; &lt;ServerName&gt;</b><br/>– or –</li> <li>• <b>IEC104 Server &gt; &lt;ServerName&gt; &gt; &lt;DeviceName&gt;</b></li> </ul>                                                                                                                                                                                                                                                                                                                     |
| 2    | Make a selection in the <b>Select Type Id</b> pull-down menu on the <b>EVENTS</b> tab                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 3    | <p>Select the <b>Add</b> button to view the parameters for the selected type:</p> <ul style="list-style-type: none"> <li>• <b>Event Store Mode</b></li> <li>• <b>Max Event Count</b></li> <li>• <b>Buffer Setting</b></li> <li>• <b>Max Event Count-1</b></li> <li>• <b>Max Event Count-2</b></li> <li>• <b>Max Event Count-3</b></li> <li>• <b>Event Backup</b></li> </ul> <p><b>NOTE:</b> When the Control Expert window is active, you can hover the cursor over any field to see a description of the functionality and the available range of values.</p> |
| 4    | <ul style="list-style-type: none"> <li>• Click the <b>Apply</b> button to implement your configuration changes.</li> <li>• Click the <b>OK</b> button to implement your changes and close the dialog box.</li> </ul>                                                                                                                                                                                                                                                                                                                                           |

## Maximum Event Buffer Size

All channels can support up to 150,000 events, but each point type only supports up to 65,535 events.

## Hot Standby Event Performance

When a BMENOR2200H module generates up to 4,000 events per second, the module still supports a Hot Standby switch-over without any event loss (depending on configuration).

## Event Routing

### Introduction

The event routing component allows events from sub stations to be routed to SCADA within a single BMENOR2200H module.

To route events, one or more RTU client channels and at least one RTU server channel are needed inside the system. The solution is to create a logic RTU client and server in a single BMENOR2200H module. In the logic client, points are created to represent points in sub stations, and in the logic server, points are created to simulate the behavior of points in sub stations. The event routing component is responsible for collecting events in the logic client. These events are sent from sub stations and trigger the same events in the logic server.

BMENOR2200H module components:



**NOTE:** Event routing capabilities are possible only within a single module.

There are no automatic event routing capabilities between two BMENOR2200H modules (a server and a client) that are configured in the same station.

In a hierarchical architecture, time stamped events are automatically transferred from low-end server sub stations to the SCADA (or client) through the station. The automatic transfer uses path-through events functionality with a single BMENOR2200H module configured in both the client and server.

### Configuration

Configure the BMENOR2200H module for event routing on the data mapping configuration page, page 87.

Considerations:

- The BMENOR2200H module does not detect events for event routing points in a server.
- There is no web page to configure event routing.
- In a valid configuration for event routing points, only one point is occupied in the database to reduce the data size stored in memory. Use the device DDT to see the point and its structure in the **Variables** list.

Point configuration considerations:

| Configuration                                | Description                                                                                                                                                                                                                                                                                                   |
|----------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| channel<br>(See the note below.)             | For routing events, configure one client channel and at least one server channel. One client channel is required so that the system can connect with more sub servers, and more server channels allow for more SCADA in the system.<br><b>NOTE:</b> Refer to the channel configuration instructions, page 75. |
| client data mapping<br>(See the note below.) | Add data points in the client channel. These points show the mapping of client points in the sub server, which communicate with the client channel.<br><b>NOTE:</b> Refer to the DNP3 data object mapping instructions, page 87.                                                                              |

| Configuration                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Description                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| server point                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <p>After you configure the points in the client channel, the corresponding point is listed in the server channel.</p> <p>The points used to route are different from the normal points of the server. The parameters (CPU type, CPU address, variable name, and time stamp) of CPU mapping are no longer available, and the available parameters are read only. <i>Their lifetime is consistent with peer point configuration in the client.</i></p> |
| <p><b>NOTE:</b> When you configure these points in the client channel, select the events of the points to be routed, and route events to the corresponding server channel.</p> <p>For example, if the client channel receives events from the sub server Binary Input point and routes them to the logic server channel, they become events of the Binary Input point of logic server channel.</p> <p>Considerations:</p> <ul style="list-style-type: none"> <li>When you specify one point in the client for event routing, such as the binary input point, one corresponding point configuration is automatically generated in the logic server channel. The point configuration for the logic server channel is read only; it cannot be changed or removed in its DB mapping panel.</li> <li>If the channel number, session number, or point number mismatches in the server channel, an error page appears.</li> <li>If you choose the route to the channel as Disable, the point does not need to be routed to a server.</li> </ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

## Channel Combination for Event Routing

To route events inside the RTU module, use the configuration instructions to combine the client channel and server channel.

The supported combinations are:

| Client Channel         | Server Channel         |
|------------------------|------------------------|
| DNP3 net client        | DNP3 net server        |
| IEC 60870-5-104 client | IEC 60870-5-104 server |

## Limitations

- Events are routed inside the module. This means that it is not possible to route events between two or more modules and also that the PLC application in the CPU cannot get and process the events. (The CPU can still get the point value in events just like the standalone client channel.)
- Only events are routed. Requests (commands) from SCADA are not routed to the sub server. This means that inside the BMENOR2200H module, there is no other data exchange or communication between the client channel and the server channel except for events. Not all client and server channel combinations are supported by the event routing function.
- In the system, SCADA cannot communicate with sub servers. The solution uses the logic server in the BMENOR2200H module to simulate sub servers, so SCADA can communicate only with the logic the server in the BMENOR2200H module, and the sub server can communicate only with the logic client in the BMENOR2200H module.
- Some information related to events may be changed. Key information related to events like point value, flag, and time stamp is kept during event routing. Other information related to events like point number, events class, and variation is changed according to the client channel configuration.
- For broken connections, the downstream server does not generate events to an upstream supervision system.

## Events Buffer Size

Confirm that the events buffer of the server are greater than the events buffer in the sub server.

## Event Backup

### Introduction

The BMENOR2200H module's event backup buffer can store events when power to the module stops.

### Event Backup Characteristics

You can configure the module for the events or data types that are saved upon a loss of power or a module hot-swap.

These are the capacities for event storage for the BMENOR2200H module and the RTU protocol:

- event buffer:
  - The module saves up to 150,000 event in the event buffer.
  - The module saves up to 10,000 events in the event buffer upon a loss of power. The event buffer is synchronized between the primary and standby modules in a redundant system.
  - The module saves up to 10,000 security events per server channel in the event buffer.
- flash memory:
  - The module saves up to 10,000 events into Flash memory upon a loss of power.
  - The module saves only the latest events when number of saved events exceeds 10,000.
  - The module reads events from Flash memory when power is restored.

**NOTE:** You can enable or disable the exchange of unsolicited messaging data.

### Retain or Clear the Buffer

The event buffer in RAM is retained in these situations:

- The CPU experiences a warm start.
- There is a network swap in a dual-network application.

The event buffer in RAM is cleared in these situations:

- Use a **Clear Events** command to clear the buffer in RAM.
- The CPU experiences a cold restart (such as during the download of a new configuration) or you press the reset button on the power supply. All communications are reset.
- Change the DNP3 cyber security configuration on the web page to clear the buffer.
- A SCADA command specifically clears the buffer.

### Event Backup Behavior

The BMENOR2200H module has different backup behaviors in different cases. The type of case is defined from the user point view:

|   | Case             | Description                                                                                                                                                                                                       | Event                                                 |
|---|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|
| 1 | Loss of power    | power lost                                                                                                                                                                                                        | Saves events in non-volatile memory on loss of power. |
| 2 | Power start      | power on/restore                                                                                                                                                                                                  | Restores events when the RTU protocol starts.         |
| 3 | Protocol restart | These actions clear the module event buffer: <ul style="list-style-type: none"> <li>The RTU protocol configuration changes.</li> <li>The RTU receives a warm or cold start command from an RTU client.</li> </ul> | Does not save events when the protocol exits.         |

## Limitations

The BMENOR2200H module scans and stores events in each channel one by one when the number of events exceeds the Flash memory capacity, the module saves only the latest events.

# RTU Protocol Data Flow

## RTU Communications

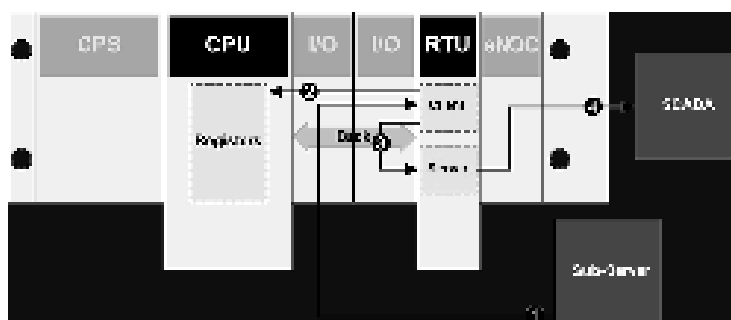
### Communication Behavior

The BMENOR2200H module is equipped with a dual-bus connector, page 23 that supports both Ethernet and X Bus communications.

This Ethernet backplane port is used mainly to communicate with the remote client or server with RTU protocols. The backplane interface is used to communicate with the CPU. The main activity of the backplane interface is the synchronization of data between CPU registers and the RTU point database inside the module. The synchronization cycle can be one or more PLC application scan cycles, depending on the data amount and backplane load.

### When the Client Channel Receives Events from the Sub Server

When something significant changes in the sub server (like the value of a point), the sub server sends an event. The system receives this event and the event is then routed to a SCADA system, as shown in this example:

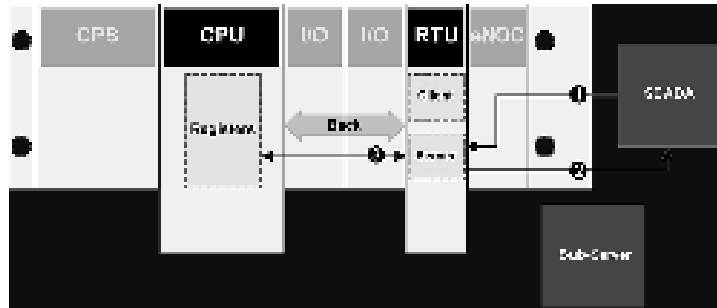


- 1 The sub server sends events to the client channel of the BMENOR2200H module.
- 2 The client channel updates the point values in the module and the database of the logic server channel and synchronizes the value to CPU registers.
- 3 Events are routed to server channels according to point configuration.
- 4 The server channel buffers these events and sends events to SCADA when the communication link is established.

## When the Server Channel Receives Request from SCADA

In the RTU system, a SCADA system sends requests (commands) like an Integrity Poll to the server connected to it. The server channel receives this request and sends a response to the SCADA system. With event routing, the behavior of the server channel is exactly the same as a standalone (no event routing) server channel. The client channel and sub servers are not involved in this case.

This sample illustration shows a request from a SCADA system:

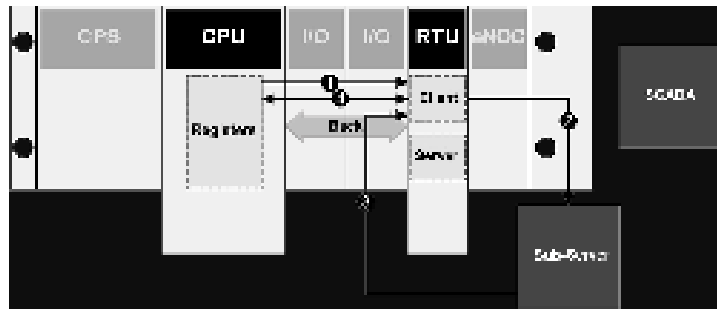


- 1 The SCADA system sends an Integrity Poll request to the server channel.
- 2 The server channel responds to the SCADA request with the point values in the database.
- 3 The point values are synchronized cyclically between the database of the server channel and CPU registers.

## When the Client Channel Sends Request to the Sub Server

The client channel can send requests to a sub server connected to it, and a sub server sends the response back to the client channel. The behavior of the client channel in this case is exactly the same as a standalone client channel. **The points in the logic server channel should be synchronized with the updated point in the client channel.**

Send request to a sub server example:



- 1 The application in the M580 CPU sends an Integrity Poll command to the client channel.
- 2 The client channel sends Integrity Poll requests to the sub server.
- 3 The sub server responds to the request with the value of the latest points.
- 4 The logic server data base is synchronized while the client channel updates the database.

**NOTE:** Point values are synchronized cyclically between the database of the client channel and CPU registers.

## Connection Status

### Connection Status

#### Introduction

The connection status of each channel of the BMENOR2200H module is put in a double-word descriptor in the DDDT mapping.

#### Detected Error Codes

The following tables describe the detected error codes for the connection status for both server and client roles.

##### Server:

| Bit    | Description                                                                       |
|--------|-----------------------------------------------------------------------------------|
| 0      | Channel security is not configured.                                               |
| 1      | An initialization error for an unlocated variable is detected.                    |
| 2      | An internal error is detected (pipe create error IPT initialization error, etc.). |
| 3...14 | These bits are reserved.                                                          |
| 15     | A TLS error is detected.                                                          |

##### Client:

| Bit | Description                                                                       |
|-----|-----------------------------------------------------------------------------------|
| 0   | Channel security is not configured.                                               |
| 1   | An initialization error for an unlocated variable is detected.                    |
| 2   | An internal error is detected (pipe create error IPT initialization error, etc.). |
| 3   | The authentication failed.                                                        |
| 4   | There is an unexpected response.                                                  |
| 5   | There is no response.                                                             |
| 6   | Aggressive mode is not supported.                                                 |
| 7   | The MAC algorithm is not supported.                                               |
| 8   | The key wrap algorithm is not supported.                                          |
| 9   | The authorization failed.                                                         |
| 10  | The update key change method is not permitted.                                    |
| 11  | The signature is not valid.                                                       |
| 12  | The certification data are not valid.                                             |
| 13  | An unknown user is detected.                                                      |
| 14  | The capacity of session key status requests is exceeded.                          |
| 15  | A TLS error is detected.                                                          |

## Hot Standby Capacity

### Introduction

This section describes the functionality of BMENOR2200H redundant modules, including the operating state of redundant RTU modules, depending on the PAC state, Ethernet services, and the Hot Standby switch-over function.

## Hot Standby Capacity

### Overview

In a running Hot Standby system, you can perform the following actions (in either primary or standby rack, cabled or not cabled), and this action does not cause a Hot Standby switch-over or a duplicate IP address:

- hot-swap a BMENOR2200H module
- remove or reconnect a cable to a BMENOR2200H module

When you clear a detected fault on a BEMNOR2200H in a standby rack (network cabling cut, power off, hot swap), this action does not affect the Hot Standby primary operation; in other words, no primary stop or shut down, no I/O bump, or no switch-over occur. The RTU module can switch its servers or SCADA connections smoothly during a Hot Standby switch-over.

### Hot Standby RTU Service

In a Hot Standby system, the input I/O image (\*\*\*\_CONN DDDT) is synchronized cyclically between the M580 primary and standby PACs.

The content of diagnostic DDDT is not required to exchange between the primary and standby RTU modules.

Confirm that only the first section in the standby CPU is running. Do not update the RTU Ethernet variables in the first section in the standby CPU.

### DNP3/IEC 60870-5-104 Server

With a DNP3/IEC 60870-5-104 server, only the primary module works as usual in a Hot Standby system, and the standby module has no communication with SCADA connections.

- When the DTM configuration of the primary module, as well as its security mode and firmware version are the same as that of the standby module, the two modules can synchronize. In this case, the primary module synchronizes the event history and internal data (unsolicited state, frozen counter....) with the standby module.
 

**NOTE:** Confirm that the primary and standby modules have the same cyber security configurations. If they have different configurations, the modules could still synchronize, but they may not work properly because some channels are disabled due to a missing security policy.
- In run mode, if the primary and standby modules are synced, the following items are synchronized via internal protocol:
  - DNP/IEC event
  - DNP/IEC event acknowledgement
  - DNP frozen counter
  - DNP All dead band
  - DNP enable/disable unsolicited
  - cold/warm start
  - DNP IIN
  - IEC MIT (frozen, sequential number)
  - IEC CRPNA
- When a Hot Standby switch-over occurs:
  - The primary module closes the connection with SCADA.
  - The secondary module gets the data in value from the PAC to the local database first (AO, BO, String, CMD status, P\_ME\_A, P\_ME\_B, P\_ME\_C, IEC P\_AC) and then starts to take over and accept new SCADA connections.
  - During a switch-over, all server methods report any detected error codes.

- With the DNP3 secure authentication enabled, the session key is forced time out.
- For MIT:
  - When Auto Local Freeze is set to auto freeze, the new primary module forces a freeze immediately after switch-over.
  - When Auto Local Freeze is set to freeze by application, if the Freeze Cyclic point value is 1, the new primary module forces a freeze immediately after switch-over.
- The new primary module handles the last two cycle's data and generates an event.
- For AI, M\_ME\_A, M\_ME\_B, and M\_ME\_C:
  - The second from last cycle before a switch-over is set as the base value, on which the data change check is based.
  - Some of the last two cycle's events may already be synced with the standby module, which causes SCADA to receive duplicate events.
- If the module time source is set from the RTU protocol, time synchronizes cyclically between primary and standby RTU modules via internal protocol.
- For IEC 60870-5-104 message interval and background period, the primary and standby modules do not sync timer status information. After switch-over, the first cyclic/background message may not remain in time out. The second cyclic/background message remains in time out according to the user setting.

### DNP3/IEC 60870-5-104 Client

For a DNP/IEC client, the primary module typically communicates with the remote server, and the standby module does not establish a connection with the remote IED.

- The primary and secondary modules synchronize data from the PAC memory with the local database, but the standby module does not send data to the remote server. Therefore, the remote server receives output data from the primary module only.
- When a Hot Standby switch-over happens, the primary module closes the connection with the remote server, and the standby module takes the role of communicating with the remote server.
- During a switch-over, if some commands (read class, read group, polling command, control operation) are not finished, a detected error code is returned in DDT instance status. We recommend that you manage the status to re-send commands that did not finish.

#### NOTE:

1. Confirm that the link status period of client and server is set to a non-zero value, such as 2s. If the link status period is set to zero, during a Hot Standby switch-over, the module cannot create a new connection because the old connection is not in time out.
2. Event backup is not supported in a Hot Standby system. If you enable this function in a standalone system and replace the CPU with a Hot Standby CPU, the event backup function is automatically disabled.
3. For IEC 60870-5-104, the client does not immediately send an event acknowledgement, which depends on the W value (maximum unacknowledged received APDUs) and the T2 S frame period (the time to wait before sending a supervisory ADPU acknowledgement). During a Hot Standby module hot swap, the client may receive duplicate events because an event is not acknowledged before the hot swap.
4. For both DNP3/IEC 60870-5-104, the event acknowledgement in the last cycle may not have synchronized from primary to standby. The acknowledgement also causes SCADA to receive the duplicate event, which has the same time stamp.

## Managing Ethernet Services

### Service Status

The following table describes the services that are running in the primary and standby BMENOR2200H modules at PAC state of RUN/STOP:

| Service List                                     | Primary BMENOR2200 Module |         | Standby BMENOR2200 Module   |                             |
|--------------------------------------------------|---------------------------|---------|-----------------------------|-----------------------------|
|                                                  | RUN                       | STOP    | RUN                         | STOP                        |
| DNP3/IEC server                                  | RUNNING                   | RUNNING | RUNNING (sync from primary) | RUNNING (sync from primary) |
| Event routing                                    | RUNNING                   | RUNNING | RUNNING (sync from primary) | RUNNING (sync from primary) |
| DNP3/IEC client                                  | RUNNING                   | RUNNING | STOPPED                     | STOPPED                     |
| SNTP client                                      | RUNNING                   | RUNNING | RUNNING                     | RUNNING                     |
| Modbus TCP client                                | RUNNING                   | RUNNING | STOPPED                     | STOPPED                     |
| Syslog                                           | RUNNING                   | RUNNING | RUNNING                     | RUNNING                     |
| Modbus TCP server                                | RUNNING                   | RUNNING | RUNNING                     | RUNNING                     |
| Firmware upgrade                                 | RUNNING                   | RUNNING | RUNNING                     | RUNNING                     |
| SNMP V1                                          | RUNNING                   | RUNNING | RUNNING                     | RUNNING                     |
| Web server (cyber security setting + diagnostic) | RUNNING                   | RUNNING | RUNNING                     | RUNNING                     |
| OEB (FDR+LLDP)                                   | RUNNING                   | RUNNING | RUNNING                     | RUNNING                     |

# Sequence Of Events

## Introduction

Use the information in this chapter to configure a BMXERT1604 module's time stamping events.

## Time Stamp Sequence of Events

### Introduction

Sequence of events (SOE) software applications help you understand a chain of occurrences that can lead to potentially unsafe process conditions and possible shutdowns.

Many process events can be generated quickly when a system does not behave according to design or expectations. In this case, the X80 BMXERT1604 time stamping module records all events with a time stamp accuracy of 1ms. Data is stored in the module until it is transmitted by the application. The BMENOR2200H module can call this event data and transfer it to an external supervisor system (SCADA, DCS, etc.) through the RTU protocol.

This topic describes SOE in the transfer of the time stamping function from a BMXERT1604 module to the RTU protocol in a Control Expert project that includes a BMENOR2200H module.

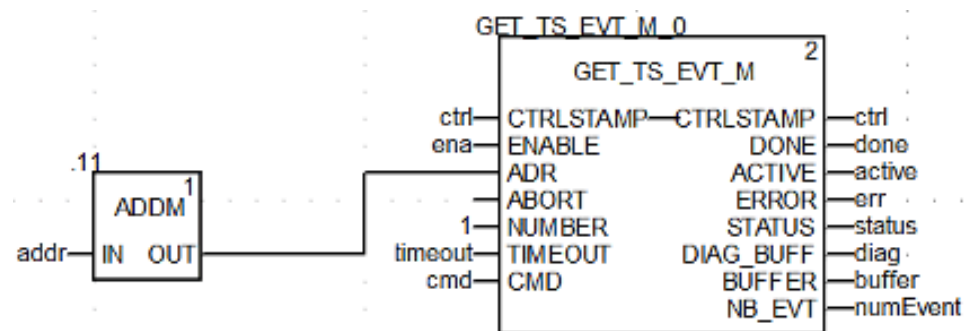
### Process Overview

This is a broad overview of the time stamping SOE process.

| Stage | Description                                                                                                                                                                              |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | Use a DFB to read and send a time stamping event from a BMXERT1604 module to a BMENOR2200H module. In a single PLC cycle, a DFB instance processes a maximum of one time stamping event. |
| 2     | Based on the structure of the raw buffer read from the time stamping module, you can extract and convert the data.                                                                       |
| 3     | Use a T850_TO_T870 EFB to convert the time stamping format into IEC60870 time format.                                                                                                    |

### GET\_TS\_EVT\_M Function Block

Use a GET\_TS\_EVT\_M function block to read a time stamping event from a specific BMXERT1604 module:



**NOTE:** Read one event in a single PLC cycle for each time stamping module. When the `DONE` parameter turns to `TRUE`, the event has been read and stored in the buffer. You can move to the next step.

Refer to the EcoStruxure Control Expert System Block Library (see EcoStruxure™ Control Expert, System, Block Library) for detailed descriptions of the `GET_TS_EVT_M` function block parameters.

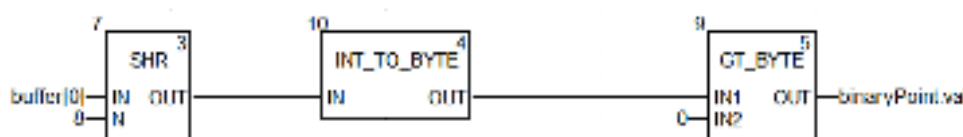
## Event Format in Response Buffer

This table describes the format of the time stamping event in the response buffer:

| Data Structure    | Element          | Type  | Definition                                                                                                                                                                                                                        |
|-------------------|------------------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Raw buffer format | Reserved         | BYTE  | Reserved                                                                                                                                                                                                                          |
|                   | Value            | BYTE  | Input value                                                                                                                                                                                                                       |
|                   | Event ID         | WORD  | Event ID defined by user or channel number                                                                                                                                                                                        |
|                   | SecondSinceEpoch | DWORD | The interval in seconds continuously counted from the epoch 1970-01-01 00:00:00 UTC                                                                                                                                               |
|                   | FracOfSec_L      | WORD  | The fraction of the current second when the value of the TimeStamp has been determined. The fraction of the second is calculated as $(\text{SUM from } i=0 \text{ to } 23 \text{ of } b_i \cdot 2^{22-i}) \text{ s}$ .            |
|                   | FracOfSec_H      | BYTE  |                                                                                                                                                                                                                                   |
|                   | TimeQuality      | BYTE  | Time Quality: <ul style="list-style-type: none"> <li>• Bit 7: LeapSecondsKnown (not supported)</li> <li>• Bit 6: ClockFailure (not supported)</li> <li>• Bit 5: ClockNotSynchronized</li> <li>• Bit 0-4: Time accuracy</li> </ul> |

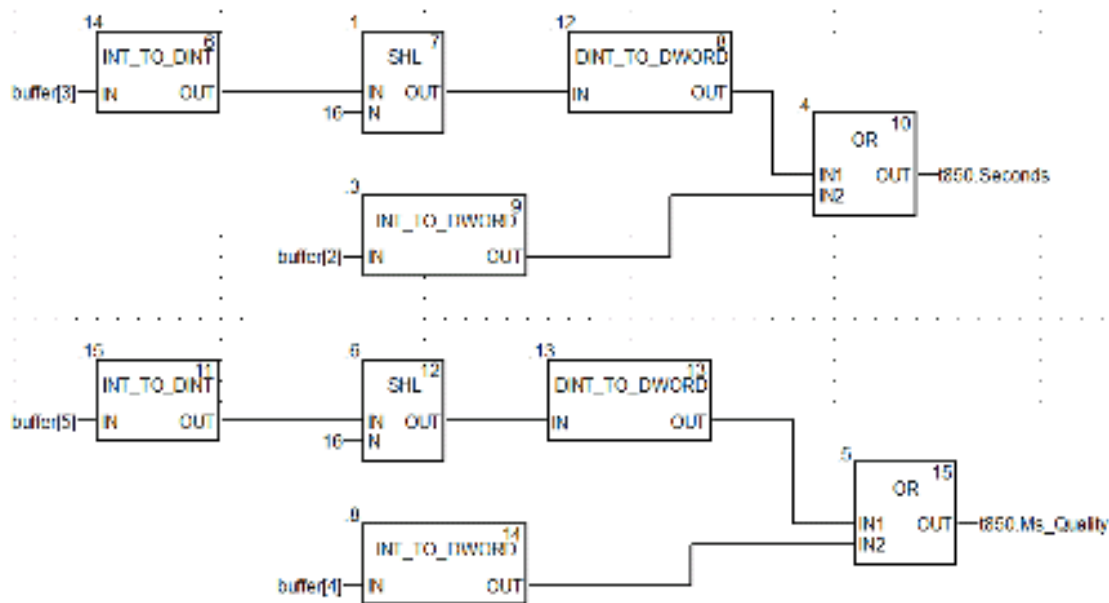
## Extract the Time Stamp Event

Based on the raw buffer structure read from the time stamping module, you can extract and convert the data. First, extract the value of the binary point as shown in this example, which assumes that the first event starts from `Buffer[0]`:



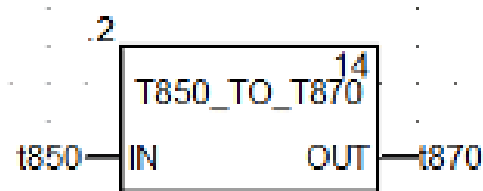
## Extract the T850 Data

To extract the T850 data, as shown in this typical application example, put the binary point value in the right position of the DDT based on the BMXERT1604 module's address and channel in the raw buffer:



## Convert the Time Stamp Format

To convert the time stamp format from IEC61850 to IEC60870, use the T850\_TO\_T870 EFB as follows, where the input parameter is the 850 time format and the output parameter is the 870 time format:



This table describes the structure of the 850 and 870 time format:

| Data Structure  | Element  | Type  | Definition                                                                        |
|-----------------|----------|-------|-----------------------------------------------------------------------------------|
| TIME_870_FORMAT | ms       | WORD  | Milliseconds: 0-59999 ms                                                          |
|                 | min      | BYTE  | Minutes: 0-59 min, the highest bit is invalid bit, 1: invalid time, 0: valid time |
|                 | hour     | BYTE  | Hour: 0-23 h, SU is not supported                                                 |
|                 | day      | BYTE  | Day: 1-31, day of week is not supported                                           |
|                 | mon      | BYTE  | Month: 1-12                                                                       |
|                 | year     | BYTE  | Year: 0-99                                                                        |
|                 | reserved | BYTE  | Reserved                                                                          |
| TIME_850_FORMAT | Seconds  | DWORD | Seconds since 1970, confirm the time stamp is later than 2000.                    |

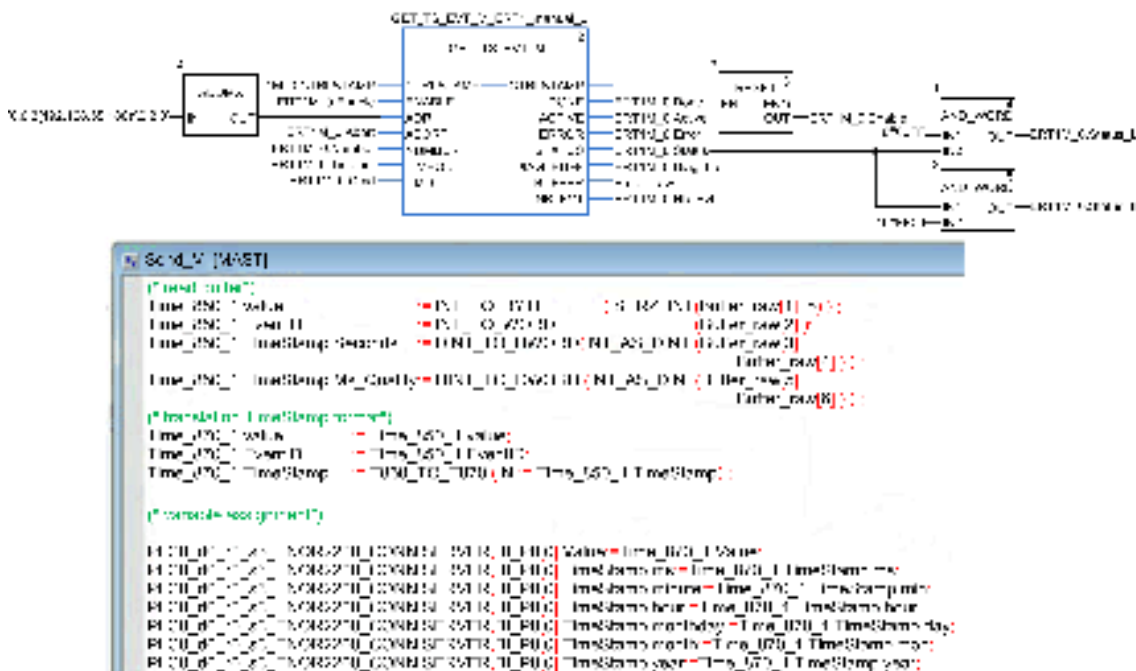
| Data Structure | Element    | Type  | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|----------------|------------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                | Ms_Quality | DWORD | <ul style="list-style-type: none"> <li>• Bit 0-23: The fraction of the current second when the value of the TimeStamp has been determined. The fraction of second is calculated as (SUM from i = 0 to 23 of bi*2**(i+1) s).</li> <li>• Bit 24-31: Time Quality</li> <li>• Bit 31: LeapSecondsKnown (not supported)</li> <li>• Bit 30: ClockFailure (not supported)</li> <li>• Bit 29: ClockNotSynchronized</li> <li>• Bit 24-28: Time accuracy</li> </ul> |

**NOTE:** The T870\_TO\_T850 function block does not consider time zone or summer when converting time. Set the T870 value to the DNP point's timestamp as follows:

```
binaryPoint.ms:=t870.ms;  
binaryPoint.min:=t870.min;  
binaryPoint.hour:=t870.hour;  
binaryPoint.day:=t870.day;  
binaryPoint.mon:=t870.mon;  
binaryPoint.year:=t870.year;
```

## Typical SOE Application Example

This screenshot shows the use of the `Send_V` command to transfer output of `GET_TS_EVT_M` (Buffer raw) to the RTU points in a typical SOE application, in which read buffer and translation Time Stamp format in `Send_V` are equal to the function blocks in previous examples:



# Configuring the Module

## Configuration Overview

### Configuration Components

#### Introduction

Observe these guidelines to configure the BMENOR2200H module after you add the module and its corresponding DTM to a Control Expert project, page 70.

#### Configuration Environment Components

Use this table to select the appropriate the component in the configuration environment with the intended configuration role:

| Component                             | Functional Feature                                                            |
|---------------------------------------|-------------------------------------------------------------------------------|
| Control Expert Configuration Overview | RTU module name definition, page 72                                           |
|                                       | IP address assignment, page 72                                                |
|                                       | Add the module to a Control Expert project., page 72                          |
|                                       | basic online diagnostics                                                      |
| Device DTM                            | channel configuration, page 75                                                |
|                                       | SNMP agent, SNMP client, page 83                                              |
|                                       | Network Timing Service (SNTP), page 84                                        |
|                                       | DNP3 Net Client/Server, page 75                                               |
|                                       | IEC 60870-5-104 Client/Server, page 46                                        |
|                                       | Export / Import, page 104                                                     |
|                                       | Module Information, page 106                                                  |
|                                       | RTU protocol configuration, page 45                                           |
|                                       | RTU point configuration, page 87                                              |
|                                       | fast-access link to the diagnostic web page                                   |
| HTTPS web pages                       | security configuration, page 108                                              |
|                                       | DNP3 Secure Authentication configuration, page 113                            |
|                                       | TLS configuration, page 112                                                   |
|                                       | RBAC configuration, page 121                                                  |
| Automation Device Maintenance         | firmware upgrade, page 42                                                     |
| project migration                     | project migration considerations, page 170                                    |
|                                       | located variables with addresses (DNP3 AO/BO point “On Demand” mode, page 90) |

## Use the Module in a Control Expert Project

### Before You Begin

Use the instructions in this section to add a module and its corresponding DTM to a Control Expert project.

## Add the DTM and Module to Control Expert

### About DTMs

Each module or device in the Control Expert **Hardware Catalog** is represented by a device type manager (DTM) that defines its parameters.

Any configuration done through the DTM is performed within the Control Expert environment.

### DTM Installation

In general terms, the device DTM is automatically installed when you install Control Expert.

In any other case, you can install the DTM on a host PC (the PC that runs Control Expert) to make the device DTM available for use in Control Expert.

For third-party modules, the DTM installation process is defined by the manufacturer. Consult those instructions to install a DTM on your PC.

After a device DTM is successfully installed on your PC, update the Control Expert **Hardware Catalog** to see the new DTM in the catalog. The DTM is then added to your Control Expert configuration when the corresponding module is added to the project.

## About the Control Expert DTM Browser

### Introduction to FDT/DTM

Control Expert incorporates the Field Device Tool (FDT) / Device Type Manager (DTM) approach to integrate distributed devices with your process control application. Control Expert includes an FDT container that interfaces with the DTMs of EtherNet/IP and Modbus TCP devices and the BMENOR2200H module.

An EtherNet/IP device or Modbus TCP device is defined by a collection of properties in its DTM. For each device in your configuration, add the corresponding DTM to the Control Expert **DTM Browser**. From the **DTM Browser** you can open the device's properties and configure the parameters presented by the DTM.

Device manufacturers may provide a DTM for each of its EtherNet/IP devices, Modbus TCP devices, or the BMENOR2200H module. However, if you use a device that has no DTM, configure the device with one of these methods:

- Configure a generic DTM that is provided in Control Expert.
- Import the EDS file for the device. Control Expert populates the DTM parameters based on the content of the imported EDS file.

**NOTE:** The DTM for a BMENOR2200H module is automatically added to the **DTM Browser** when the module is added to the **PLC bus**.

### Automatic DTM Creation

In a Control Expert application, DTMs for some Ethernet communication modules and other pre-configured devices (see the following list) are created automatically when added to an Ethernet rack on the main local or main remote drops. A default DTM name is assigned in the DTM topology, but you may modify the name:

- Right-click the desired DTM name in the **DTM Browser** and select **Properties**.
- select the **General** tab, and edit the DTM name in the **Alias name** field.
- Select **Apply** to save the changes.

– or –

Select **OK** to save the changes and close the dialog box.

**NOTE:** The **OK** button is valid to press only when Control Expert has confirmed that the DTM is unique.

## Windows Compatibility

This table describes the minimum and recommended PC configuration to run M580 DTMs inside Control Expert:

| Operating System                                     | Requirements                                                                                                |
|------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| Microsoft Windows 7 Professional 64-bit              | <i>system:</i> Pentium Processor 2.4 GHz or higher, recommended 3.0 GHz                                     |
|                                                      | <i>RAM:</i> 4GB minimum; 8GB recommended                                                                    |
|                                                      | <i>hard disk:</i> 8GB minimum free space; 20GB recommended                                                  |
|                                                      | Microsoft Internet Explorer 5.5 or higher                                                                   |
|                                                      | Windows Service Pack 1 (SP1) is required to use EcoStruxure™ Control Expert 15.1.                           |
|                                                      | <b>NOTE:</b> Microsoft Windows 7 Professional 32-bit is not supported.                                      |
| Microsoft Windows 10 32(*)/64-bit                    | <i>system:</i> Pentium Processor 2.4 GHz or higher, recommended 3.0 GHz                                     |
|                                                      | <i>RAM:</i> 4GB minimum; 8GB recommended                                                                    |
|                                                      | <i>hard disk:</i> 8GB minimum free space; 20GB recommended                                                  |
|                                                      | The 64-bit OS is required to manage projects that implement a Modicon M580 controller or that install DTMs. |
| Microsoft Windows Server 2016                        | <i>recommended version:</i> standard                                                                        |
|                                                      | <i>recommended processor:</i> 3.20 GHz                                                                      |
|                                                      | <i>recommended RAM:</i> 16GB                                                                                |
| Microsoft Windows XP                                 | Control Expert does not support this OS.                                                                    |
| Screen Resolution<br><i>recommended:</i> 1920 x 1080 |                                                                                                             |

## DTM Types

The **DTM Browser** displays a hierarchical list of DTM nodes on a connectivity tree. The DTM nodes that appear in the list have been added to your Control Expert project. Each node represents an actual module or device in your Ethernet network.

There are two kinds of DTMs:

- *client (communication) DTMs:* This DTM is both a device DTM and a communication DTM. The client DTM is a pre-installed component of Control Expert.
- *generic DTMs:* The Control Expert FDT container is the integration interface for any device's communication DTM.

This list contains these node types:

| DTM Type               | Description                                                                                                                                                                |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| communication (client) | Communication DTMs appear under the root node (host PC).<br><br>A communication DTM can support gateway DTMs or device DTMs as children if their protocols are compatible. |
| gateway                | A gateway DTM supports other gateway DTMs or device DTMs as children if their protocols are compatible.                                                                    |
| device                 | A device DTM does not support any child DTMs.                                                                                                                              |

## Node Names

Each DTM node has a default name when it is inserted into the browser. The default name for gateway and device DTMs for the BMENOR2200H module are in this format:

<EtherNet IP address>PLC0\_d0\_rX\_sY\_ENOR2200

- X is the rack number (usually 0).
- Y is the slot number based on the module's location in the rack.

Therefore, a real-world example of a default name looks like this:

<10.10.1.72>PLC0\_d0\_r0\_s2\_ENOR2200

This table describes the components of the default node name:

| Element            | Description                                                                                                                                 |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| <b>address</b>     | This is the bus address of the device that defines the connection point on its parent gateway network (for example, the device IP address). |
| <b>device name</b> | The default name is determined by the vendor in the device DTM, but the user can edit the name.                                             |

## Add the Module to a Project

### Add the Module to the PLC Bus

Add a BMENOR2200H advanced RTU module to a Control Expert project and assign a name to it:

| Step | Action                                                                                                                                                                                                                                                                                                                           |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Open a project in Control Expert.                                                                                                                                                                                                                                                                                                |
| 2    | Expand (+) the <b>Project Browser</b> to see the <b>PLC bus (Project &gt; Configuration &gt; PLC bus)</b> .                                                                                                                                                                                                                      |
| 3    | Double-click <b>PLC bus</b> to view the assembled rack(s).                                                                                                                                                                                                                                                                       |
| 4    | Right-click an empty rack slot and select scroll to <b>New Device</b> .<br><b>NOTE:</b> Select a rack position that conforms to the module's slot restrictions, page 34.                                                                                                                                                         |
| 5    | In the <b>Part Number</b> column in the <b>New Device</b> dialog box, expand <b>Communication</b> to see the available modules.                                                                                                                                                                                                  |
| 6    | Double-click the BMENOR2200H module to open the <b>Properties of device</b> dialog box.                                                                                                                                                                                                                                          |
| 7    | In the <b>Name</b> field, assign a name to the module (or accept the default name).                                                                                                                                                                                                                                              |
| 8    | Confirm that the DTM for the module was automatically added to the project ( <b>Tools &gt; DTM Browser</b> ).<br><b>NOTE:</b> When you add a module to the local rack configuration, the corresponding communication DTM is automatically added to the list ( <b>All Devices &gt; Device types &gt; Communication Devices</b> ). |
| 9    | Repeat these steps to add more RTU modules to the <b>PLC bus</b> .<br><b>NOTE:</b> The local rack in an M580 system can hold a maximum of four communications modules, including RTU modules.                                                                                                                                    |

## Configuration with Control Expert

### IP Address Configuration

#### Introduction

Use these instructions to configure the IP address parameters for a BMENOR2200H module.

## Access the Configuration

Access the **IP address configuration** in Control Expert:

| Step | Action                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Open a Control Expert project that includes a BMENOR2200H module.                                                                                                                                                                                                                                                                                                                                                                                      |
| 2    | Double-click the BMENOR2200H module to see the <b>Configuration</b> tab.                                                                                                                                                                                                                                                                                                                                                                               |
| 3    | Configure these parameters: <ul style="list-style-type: none"><li>• <b>IP Address:</b> Enter the IP address of the module.</li><li>• <b>Subnet Mask:</b> Enter a subnet mask that corresponds to the IP address.</li><li>• <b>Default Gateway:</b> This is the IP address of the gateway to which messages for other networks are transmitted.</li></ul> <b>NOTE:</b> The <b>Main IP address + 1</b> field is used for configuring a redundant system. |
| 4    | <ul style="list-style-type: none"><li>• Click the <b>Apply</b> button to implement your configuration changes.</li><li>• Click the <b>OK</b> button to implement your changes and close the dialog box.</li></ul>                                                                                                                                                                                                                                      |

## Limitations

The BMENOR2200H module uses the FDR client basic service to get IP parameters from the CPU.

**NOTE:**

- This module does not support DHCP or BOOTP.
- This module does not locally store static IP parameters.
- For details, refer to the description of the FDR client service configuration, page 42.

## Debugging with Control Expert

### Overview

This section describes procedures for debugging the configuration of an RTU module with Control Expert.

### Module Debugging Screen

#### Introduction

Use the debugging screen to diagnose an Ethernet port on the BMENOR2200H module.

#### Parameters

Find these parameters on the **Debug** tab:

| Field                  | Description                                  |
|------------------------|----------------------------------------------|
| <b>MAC address</b>     | BMENOR2200H module's MAC address             |
| <b>IP address</b>      | BMENOR2200H module's IP address              |
| <b>Subnetwork mask</b> | BMENOR2200H module's subnetwork mask address |
| <b>Gateway address</b> | BMENOR2200H module's gateway address         |

#### LED Display

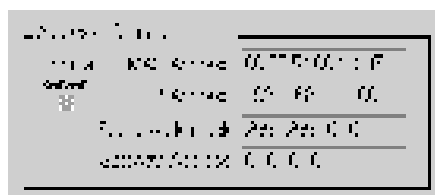
Observe these LEDs for conditions related to the module:

| Location                  | LED          | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|---------------------------|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| upper-right window corner | <b>Run</b>   | <i>on</i> : The module is operating normally.                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|                           |              | <i>off</i> : The PLC is not configured.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                           | <b>Err.</b>  | <i>on</i> : A configuration or system error is detected.                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|                           |              | <i>off</i> : The module is operating normally.                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Fault tab</b>          | <b>Fault</b> | Fault descriptions: <ul style="list-style-type: none"> <li>• %MW2 . 4: detected internal fault</li> <li>• %MW2 . 5: detected configuration fault</li> <li>• %MW2 . 6: detected communication error</li> <li>• %MW2 . 7: detected application fault</li> <li>• %MW2 . 8: detected configuration error</li> <li>• %MW2 . 9: Ethernet disabled</li> <li>• %MW2 . 10: duplicate IP address</li> <li>• %MW2 . 12: link disconnection</li> <li>• %MW2 . 13: awaiting IP address</li> <li>• %MW2 . 14: storm detection</li> </ul> |

## Debugging Parameters for TCP/IP Utilities

### Address Information

The debugging parameters for TCP/IP utilities on the [module debugging screen](#), [page 73](#) are grouped together in the Address information window:



This window displays this configuration information for the BMENOR2200H module:

- MAC address
- IP address
- subnetwork mask
- gateway address

## Configuration in the DTM

### Introduction

Use the instructions in this section to configure services through the DTM after you [access the services configuration link](#), [page 75](#).

### Access the DTM

#### Introduction

Some features and services for your module are configured with the aid of a device type manager, or DTM. You can access the DTM in Control Expert.

## Access the DTM Configuration

There are two ways to access the configuration screens for services provided by the DTM in Control Expert.

| Step | Action                                                                                                                        |
|------|-------------------------------------------------------------------------------------------------------------------------------|
| 1    | Open the Control Expert project that includes the appropriate module.                                                         |
| 2    | Open the <b>DTM Browser</b> ( <b>Tools &gt; DTM Browser</b> ).                                                                |
| 3    | In the <b>DTM Browser</b> , double-click the name that you assigned to the module., page 72 to open the configuration window. |

— or —:

| Step | Action                                                                                                              |
|------|---------------------------------------------------------------------------------------------------------------------|
| 1    | Expand (+) the <b>Project Browser</b> to see the <b>PLC bus</b> ( <b>Project &gt; Configuration &gt; PLC bus</b> ). |
| 2    | Double-click <b>PLC bus</b> to view the assembled rack(s).                                                          |
| 3    | Double-click the module.                                                                                            |
| 4    | Click the <b>Services Configuration</b> link.                                                                       |

## DNP3 Communications Configuration in the DTM

### Introduction

Configure DNP3 communications for your module in the Control Expert DTM.

### Configure Channels

Configure **CLIENT** or **SERVER** channels:

| Step | Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Access the DTM configuration for your module, page 75.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 2    | In the open <b>CONFIGURATION</b> window, expand (+) <b>Communication</b> and select <b>Channel Configuration</b> .<br><b>NOTE:</b> The <b>Channels/Devices</b> menu item cannot be expanded because there are no configured channels.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 3    | Select the appropriate tab:<br><ul style="list-style-type: none"> <li>Select the <b>CLIENT</b> tab to add client channels.</li> <li>Select the <b>SERVER</b> tab to add server channels.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 4    | Select the <b>Add New</b> button to view the <b>ADD NEW CHANNEL</b> configuration parameters.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 5    | Configure the parameters according to the new channel parameter descriptions below, page 76.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 6    | Select the <b>Add</b> button to see the newly configured channel in the table.<br><b>NOTE:</b> The <b>Channels/Devices</b> menu can now be expanded because there is at least one configured channel. All configured channels appear in this menu.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 7    | After you create a <i>server</i> channel on the <b>SERVER</b> tab, repeat these steps to create the corresponding <i>client</i> channel on the <b>CLIENT</b> tab.<br><br>— or —<br><br>After you create a <i>client</i> channel on <b>CLIENT</b> tab, repeat these steps to create the corresponding <i>server</i> channel on the <b>SERVER</b> tab.<br><b>NOTE:</b> <ul style="list-style-type: none"> <li>Only one type of RTU protocol can be configured in the BMENOR2200H module, either DNP3 or IEC 60870–5–104. The module cannot support multiple RTU protocols configured at the same time.</li> <li>If the DNP3 Secure Authentication is configured in the web cyber security setting, confirm that the configured name of the RTU channel matches the</li> </ul> |

| Step | Action                                                                                                                                                                                                                                                                                                                                               |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|      | channel name in the DTM. Otherwise, the secure setting does not map to corresponding channel in the DTM.                                                                                                                                                                                                                                             |
| 8    | <ul style="list-style-type: none"> <li>Select the <b>Apply</b> button to implement the changes</li> <li>Select the <b>OK</b> button to implement the changes and close the dialog box.</li> </ul> <p><b>NOTE:</b> When you create the first channel, the expandable <b>Channels/Devices</b> sub-menu appears on the <b>CONFIGURATION</b> screen.</p> |
| 9    | Repeat these steps to create additional channels while observing these limitations: <ul style="list-style-type: none"> <li><i>client</i>: 64 connections</li> <li><i>server</i>: 4 connections</li> </ul>                                                                                                                                            |

**NOTE:** You can edit, page 78 or delete, page 78 a channel any time.

## New Channel Parameter Descriptions

**NOTE:** When the Control Expert window is active, you can hover the cursor over any field to see a description of the functionality and the available range of values.

These parameters in the **ADD NEW CHANNEL** fields are available for the DNP3 client and server channel configurations:

| Field               | Client | Server | Description                                                                                                                                                                                                                                                                  |
|---------------------|--------|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Channel Name</b> | ✓      | ✓      | Assign a name to the server.<br><br><b>NOTE:</b> The web pages use the <b>Channel Name</b> parameter to identify the configuration that is applied to this channel. Therefore, assign an identical <b>Channel Name</b> when you configure cyber security settings, page 113. |
| <b>Protocol</b>     | ✓      | ✓      | <b>DNP3 NET Client:</b> Configure the new channel as a DNP3 client.<br><b>DNP3 NET Server:</b> Configure the new channel as a DNP3 server.                                                                                                                                   |
| <b>Dest Port</b>    | ✓      |        | Define the destination port to use.                                                                                                                                                                                                                                          |
| <b>Local Port</b>   |        | ✓      | Define the local port for network communications.                                                                                                                                                                                                                            |
| <b>IP Address</b>   | ✓      |        | The IP address in this field is the IP address of the source of the communications packets.                                                                                                                                                                                  |
| <b>IP Filter</b>    |        | ✓      | Enter the IP address of the remote device.<br><br><b>NOTE:</b> The default value is 255.255.255.255 (present disable IP filter)                                                                                                                                              |
| <b>Network Type</b> | ✓      | ✓      | Select a network protocol: <ul style="list-style-type: none"> <li><b>TCP-IP</b></li> <li><b>UDP-IP</b></li> <li><b>TCP-UDP</b></li> </ul>                                                                                                                                    |

## Advanced Parameter Configuration

After you create a channel with the instructions above, the new channel appears in the table on the **CLIENT** tab or **SERVER** tab. At this point, you can configure the **ADVANCED PARAMETERS** for the channel. These advanced parameters are global settings that are implemented on all server channels or client channels:

| Step | Action                                                                                                                                                                                                                              |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Select <b>Channel Configuration</b> from the <b>Communication</b> menu.                                                                                                                                                             |
| 2    | Select the appropriate tab: <ul style="list-style-type: none"> <li>Select the <b>CLIENT</b> tab to view the <b>CLIENT CHANNEL</b> table.</li> <li>Select the <b>SERVER</b> tab to view the <b>SERVER CHANNELS</b> table.</li> </ul> |
| 3    | Select a row in the table.                                                                                                                                                                                                          |

| Step | Action                                                                                                                                                                                                                                                                    |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4    | Click the <b>Advanced Settings</b> button to view the <b>ADVANCED PARAMETERS</b> table.<br><b>NOTE:</b> Depending on your Control Expert window size, you may have to scroll down in the <b>Client</b> or <b>Server</b> tab to see the <b>ADVANCED PARAMETERS</b> fields. |
| 5    | Configure the parameters according to the advanced parameter descriptions below, page 76.                                                                                                                                                                                 |
| 6    | <ul style="list-style-type: none"> <li>Select the <b>Apply</b> button to implement the changes.</li> <li>Select the <b>OK</b> button to implement the changes and close the dialog box.</li> </ul>                                                                        |

## Advanced Parameter Descriptions

**NOTE:** When the Control Expert window is active, you can hover the cursor over any field to see a complete description of the functionality and the available range of values.

These are the available advanced parameters for the DNP3 client and server channel configurations:

| Field                    | Client | Server | Description                                                                                                            |
|--------------------------|--------|--------|------------------------------------------------------------------------------------------------------------------------|
| Event Backup Enable      |        | ✓      | <i>enabled (selected):</i> Events are backed up upon a power failure.                                                  |
|                          |        |        | <i>disabled (empty):</i> Events are not backed up upon a power failure.                                                |
| Rx Frame Size            | ✓      | ✓      | Configure the frame size in the receive link layer.                                                                    |
| Rx Frame Timeout         | ✓      | ✓      | Configure the timeout value for waiting for a complete frame after receiving the frame sync.                           |
| Confirm Timeout          | ✓      | ✓      | Configure the maximum wait time for link level confirmation.                                                           |
| Offline Poll Period      | ✓      |        | Configure an interval for reattempting to establish communications for an offline session.                             |
| Rx Buffer Size           | ✓      | ✓      | Configure the receive buffer size for the physical port.                                                               |
| Tx Fragment Size         | ✓      | ✓      | Configure the maximum transit application fragment sizes.                                                              |
| Channel Response Timeout | ✓      |        | Configure the wait time for the DNP3 client's response to a transmitted request.                                       |
| Tx Frame Size            | ✓      | ✓      | Configure the transmit link layer frame size.                                                                          |
| Confirm Mode             | ✓      | ✓      | <b>NEVER:</b> Never request link layer confirmations.                                                                  |
|                          |        |        | <b>SOMETIMES:</b> Request link layer confirmations for multi-frame fragments.                                          |
|                          |        |        | <b>ALWAYS:</b> Always request link layer confirmations.                                                                |
| Max Retries              | ✓      | ✓      | Configure the number of reattempted link layer confirmation timeouts.                                                  |
| First Char Wait          | ✓      | ✓      | Configure the minimum time (ms) after receiving a character before an attempt to transmit a character on this channel. |
| Rx fragment Size         | ✓      | ✓      | Configure the maximum receive application fragment sizes.                                                              |
| Restore Mode             |        | ✓      | <b>Main Channel:</b> Restore events for the main channel.                                                              |
|                          |        |        | <b>All Channels:</b> Restore all events.                                                                               |
| Max Queue Size           | ✓      |        | Configure the maximum number of requests that are queued on a DNP3 client.                                             |

After you edit any of these parameters, click the **Update** button to update the configuration.

## Edit Channels

Edit the parameters for an existing channel:

| Step | Action                                                                                                          |
|------|-----------------------------------------------------------------------------------------------------------------|
| 1    | Click the pencil icon in the <b>Edit</b> column for the channel you want to edit.                               |
| 2    | Re-configure the parameters in the <b>EDIT CHANNEL</b> and <b>ADVANCED PARAMETERS</b> fields (described above). |
| 3    | Click the <b>Update</b> button to update the configuration.                                                     |
| 4    | Click the <b>OK</b> or <b>Apply</b> button to save the changes.                                                 |

## Delete a Channel

Delete an existing channel:

| Step | Action                                                                                                                                                                                                 |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Select the check box that corresponds to the client or server channel.                                                                                                                                 |
| 2    | Select the <b>Delete</b> button.                                                                                                                                                                       |
| 3    | Select the <b>Update</b> button.                                                                                                                                                                       |
| 4    | <ul style="list-style-type: none"> <li>Select the <b>Apply</b> button to save the changes.</li> <li>–or–</li> <li>Select the <b>OK</b> button to save the changes and close the dialog box.</li> </ul> |

## IEC 60870-5-104 Communications Configuration in the DTM

### Introduction

Configure IEC 60870-5-104 communications for your module in the Control Expert DTM.

### Basic Parameter Configuration

To configure the **CLIENT** or **SERVER** channels:

| Step | Action                                                                                                                                                                                                                                                   |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Access the DTM configuration for your module, page 74.                                                                                                                                                                                                   |
| 2    | <p>In the open <b>CONFIGURATION</b> window, expand (+) <b>Communication</b> and select <b>Channel Configuration</b>.</p> <p><b>NOTE:</b> The <b>Channels/Devices</b> menu item cannot be expanded because there are no configured channels.</p>          |
| 3    | <p>Select the appropriate tab:</p> <ul style="list-style-type: none"> <li><b>CLIENT:</b> Add client channels.</li> <li><b>SERVER:</b> Add server channels.</li> </ul>                                                                                    |
| 4    | Select the <b>Add New</b> button to view the <b>ADD NEW CHANNEL</b> configuration parameters.                                                                                                                                                            |
| 5    | Configure the parameters according to the new channel parameter descriptions below.                                                                                                                                                                      |
| 6    | <p>Select the <b>Add</b> button to see the newly configured channel in the table.</p> <p><b>NOTE:</b> The <b>Devices</b> menu can now be expanded because there is at least one configured device. All configured devices appear in this menu.</p>       |
| 7    | <p>After you create a <i>server</i> channel on the <b>SERVER</b> tab, repeat steps 1-6 to create the corresponding <i>client</i> channel on the <b>CLIENT</b> tab (or vice versa).</p> <p><b>NOTE:</b> Only one client and one server are supported.</p> |

| Step | Action                                                                                                                                                                                                                                                                                                                                                |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 8    | <ul style="list-style-type: none"> <li>Select the <b>Apply</b> button to implement the changes.</li> <li>Select the <b>OK</b> button to implement the changes and close the dialog box.</li> </ul> <p><b>NOTE:</b> When you create the first channel, the expandable <b>Channels/Devices</b> sub-menu appears on the <b>CONFIGURATION</b> screen.</p> |
| 9    | Repeat steps 1-8 to create additional channels while observing these limitations: <ul style="list-style-type: none"> <li><i>client</i>: 64 connections</li> <li><i>server</i>: 4 connections</li> </ul>                                                                                                                                               |

## Basic Parameter Descriptions

**NOTE:** When the Control Expert window is active, you can hover the cursor over any field to see a description of the functionality and the available range of values.

These parameters in the **ADD NEW CHANNEL** fields are available for the IEC 60870-5-104 client and server channel configurations:

| Field                        | Client | Server | Description                                                                                                                                                                                                                                                        |
|------------------------------|--------|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Channel Name                 | ✓      | ✓      | Assign a name to the server.<br><br><b>NOTE:</b> The web pages use the <b>Channel Name</b> parameter to identify the configuration that is applied to this channel. Therefore, assign an identical <b>Channel Name</b> when you configure cyber security settings. |
| Protocol                     | ✓      | ✓      | IEC60870–5–104 Client/IEC60870–5–104 Server                                                                                                                                                                                                                        |
| Redundant Group              |        | ✓      | Select None, 1, 2, or 3 from the drop-down list.                                                                                                                                                                                                                   |
| Local Port                   |        | ✓      | Define the local port for network communications.<br><br><b>NOTE:</b> The default value is 2404.                                                                                                                                                                   |
| IP Address                   |        | ✓      | When you select the <b>IP Address</b> filter field, the <b>IpAddress Panel</b> dialog box opens. Enter the IP address of the remote device.<br><br>Select the <b>Change</b> button.                                                                                |
| Server IP Address            | ✓      |        | Enter the IP address of the server with which the client communicates.                                                                                                                                                                                             |
| Dest Port                    | ✓      |        | Define the destination port.                                                                                                                                                                                                                                       |
| Common ASDU Address          |        | ✓      | Enter a value for the common address of an ASDU. <ul style="list-style-type: none"> <li>The value scope is 1...65535.</li> <li>65535 is the broadcast address.</li> <li>The default value is 3.</li> </ul>                                                         |
| Cyclic Message Interval (ms) |        | ✓      | Enter a value for the number of milliseconds between cyclic updates. <ul style="list-style-type: none"> <li>The value scope is 1...4294967295.</li> <li>The default value is 10000.</li> </ul>                                                                     |
| Background Period (ms)       |        | ✓      | Enter a value for the period allowed to generate background scan data on a particular sector. <ul style="list-style-type: none"> <li>The value scope is 1...4294967295.</li> <li>The default value is 20000.</li> </ul>                                            |
| Read Time Format             |        | ✓      | Select the completeness time format for responding to C_RD_NA from the drop-down list: <ul style="list-style-type: none"> <li>None</li> <li>CP56</li> </ul> The default value is None.                                                                             |

| Field                           | Client | Server | Description                                                                                                                                                                                                                                                                                                   |
|---------------------------------|--------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| C_RD_NA Measure and Time Format |        | ✓      | Select the time stamp format in the response to read command from the drop-down list: <ul style="list-style-type: none"> <li>• None</li> <li>• CP56</li> </ul> <b>NOTE:</b> <ul style="list-style-type: none"> <li>• This field is used for measured points.</li> <li>• The default value is None.</li> </ul> |
| C_IC_NA Time Format             |        | ✓      | Select the time stamp format in the response to read command from the drop-down list: <ul style="list-style-type: none"> <li>• None</li> <li>• CP56</li> </ul> <b>NOTE:</b> <ul style="list-style-type: none"> <li>• This field is used for counters.</li> <li>• The default value is None.</li> </ul>        |

## Advanced Parameter Configuration

After you create a channel using the instructions above, the new channel appears in the table on the **CLIENT** or the **SERVER** tab. You can configure **ADVANCED PARAMETERS** for the channel. These advanced parameters are global settings that are implemented on all server or client channels.

| Step | Action                                                                                                                                                                                                                                                                    |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Select <b>Channel Configuration</b> from the <b>Communication</b> menu.                                                                                                                                                                                                   |
| 2    | Select the appropriate tab: <ul style="list-style-type: none"> <li>• <b>CLIENT</b>: View the <b>CLIENT CHANNEL</b> table.</li> <li>• <b>SERVER</b>: View the <b>SERVER CHANNEL</b> table.</li> </ul>                                                                      |
| 3    | Select a row in the table.                                                                                                                                                                                                                                                |
| 4    | Select the <b>Advanced Settings</b> button to view the <b>ADVANCED PARAMETERS</b> table.<br><b>NOTE:</b> Depending on your Control Expert window size, you may have to scroll down in the <b>Client</b> or <b>Server</b> tab to see the <b>ADVANCED PARAMETER</b> fields. |
| 5    | Configure the parameters according to the advanced parameter descriptions below.                                                                                                                                                                                          |
| 6    | <ul style="list-style-type: none"> <li>• Select the <b>Apply</b> button to implement the changes.</li> <li>• Select the <b>OK</b> button to implement the changes and close the dialog box.</li> </ul>                                                                    |

## Advanced Parameter Descriptions

| Field               | Client | Server | Description                                                                                                                                                                                                                                                                                                                                                                 |
|---------------------|--------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Event Backup Enable |        | ✓      | Specify whether to back up events when a power failure is detected. The default is check box deselected.                                                                                                                                                                                                                                                                    |
| Data Sync Mode      |        | ✓      | Select a data synchronization mode: <ul style="list-style-type: none"> <li>• <b>Cyclic Sync</b>: Use the default (cyclic) synchronization.</li> <li>• <b>Sync On Demand</b>: Allow the PAC application to implement local changes on the binary or analog output.</li> </ul> <b>NOTE:</b> Enabling a Sync On Demand point changes the variable structure (out of the DDDT). |
| Prefix              |        | ✓      | This string is part of the variable name for analog                                                                                                                                                                                                                                                                                                                         |

| Field                           | Client | Server | Description                                                                                                                                                                                                                                                                                                                                             |
|---------------------------------|--------|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Delay Before Transmission (T1)  | ✓      | ✓      | 0...65535 (As the unit is 10ms, the range is 0...655.35 s.)<br><br>The default value is 0. This field is only used with DCE flow control algorithm, transmission delay after RTS is set.                                                                                                                                                                |
| Delay After Transmission (T2)   | ✓      | ✓      | 0...65535 (As the unit is 10ms, the range is 0...655.35 s.)<br><br>The default value is 0. This field is only used with DCE flow control algorithm, transmission delay after RTS is set.                                                                                                                                                                |
| Delay Between Transmission (T3) | ✓      | ✓      | 0...65535 (As the unit is 10ms, the range is 0...655.35 s.)<br><br>The default value is 0. This field is only used with DCE flow control algorithm, transmission delay after RTS is set.                                                                                                                                                                |
| Sector                          |        | ✓      | Select a value to determine the sector number to route.<br><br>The options are 0, 1, 2, 3, 4.<br><br>The default value is 0.                                                                                                                                                                                                                            |
| First Char Wait (ms)            | ✓      | ✓      | Enter a value for the minimum time between reception and transmission.<br><ul style="list-style-type: none"> <li>The value scope is 0...65535.</li> <li>The default value is 0.</li> </ul>                                                                                                                                                              |
| Rx Buffer Size                  | ✓      | ✓      | Enter a value for the receive buffer size of serial port (bytes).<br><ul style="list-style-type: none"> <li>The value scope is 0...256.</li> <li>The default value is 256.</li> </ul>                                                                                                                                                                   |
| Offline Poll Period (ms)        | ✓      | ✓      | Enter a value for the period to re-establish transfer of an offline session.<br><ul style="list-style-type: none"> <li>The value scope is 0...4294967295.</li> <li>The default value is 10000.</li> </ul>                                                                                                                                               |
| Incremental Timeout (ms)        | ✓      | ✓      | Enter a value for the incremental application layer time-out.<br><ul style="list-style-type: none"> <li>The value scope is 0...4294967295.</li> <li>The default value is 30000.</li> </ul>                                                                                                                                                              |
| Max Queue Size                  | ✓      |        | Enter a value for the maximum request message number with a specific application specific data unit (ASDU) type and destination matching an outstanding request that will be queued on a client.<br><ul style="list-style-type: none"> <li>The value scope is 0...65535 (unlimited queue).</li> <li>The default value is 0 (disabled queue).</li> </ul> |
| Default Response Timeout (ms)   | ✓      | ✓      | Enter a value for the default timeout for the confirmation of request.<br><ul style="list-style-type: none"> <li>The value scope is 0...4294967295.</li> <li>The default value is 60000.</li> </ul>                                                                                                                                                     |
| Select Timeout (ms)             |        | ✓      | Enter a value for the period after which a previously received selection is timed out. Confirm that an executed command is received before the time-out in order to be valid.<br><ul style="list-style-type: none"> <li>The value scope is 0...4294967295.</li> <li>The default value is 5000.</li> </ul>                                               |

| Field                      | Client | Server | Description                                                                                                                                                                                                                                                                                                                                                                                         |
|----------------------------|--------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ACTTERM with C_SE Setpoint | ✓      | ✓      | Select the check box for ACT TERM to be transmitted upon completion of the set point commands: <ul style="list-style-type: none"> <li>C_SE_NA, C_SE_NB, C_SE_TA, C_SE_TB, C_SE_TC</li> <li>The check box is selected by default.</li> </ul>                                                                                                                                                         |
| ACTTERM with Command       | ✓      | ✓      | Select the check box for ACT TERM to be transmitted upon completion of commands, other than the set point commands. <p><b>NOTE:</b> The check box is selected by default.</p>                                                                                                                                                                                                                       |
| Clock Valid Period (ms)    |        | ✓      | Enter a value for the period for which the system clock remains valid after a clock synchronization. If this period expires without a clock synchronization, all times are reported invalid. <ul style="list-style-type: none"> <li>The value scope is 0...4294967295.</li> <li>The default value is 86400000.</li> </ul>                                                                           |
| Send Clock Sync Events     |        | ✓      | Select the check box to send spontaneous clock synchronization events to the client. <p><b>NOTE:</b> The check box is de-selected by default.</p>                                                                                                                                                                                                                                                   |
| Max Command Age (ms)       |        | ✓      | Enter a value for the maximum time delta at which commands are accepted. The command time tag is checked and if the elapsed time is greater than MAX Command Age (ms), the command gets no response. <ul style="list-style-type: none"> <li>The value 0 indicates that the command time tag is not checked.</li> <li>The value scope is 0...600000.</li> <li>The default value is 30000.</li> </ul> |
| Delete Oldest Event        |        | ✓      | Indicates whether or not the oldest event is removed from the event queue when the buffer is full and a new event arrives. <ul style="list-style-type: none"> <li>Select the check box to remove the oldest event.</li> <li>De-select the check box to ignore the new event.</li> <li>The check box is de-selected by default.</li> </ul>                                                           |
| Summer Bit                 |        | ✓      | Select this check box to manage the summer bit of time stamp that comes from an external device or the CPU. <ul style="list-style-type: none"> <li>This feature is effective only if Daylight Saving Time is enabled.</li> <li>The check box is de-selected by default.</li> </ul>                                                                                                                  |
| CMD Type Depth             |        | ✓      | Enter a value for the size of a command queue to process in parallel for each point type. <ul style="list-style-type: none"> <li>The value scope is 1...128.</li> <li>The default value is 1.</li> </ul>                                                                                                                                                                                            |
| M_EI_NA GI                 | ✓      |        | Select the check box for general interrogation to be performed after receiving an M_EI_NA EOI message. <p><b>NOTE:</b> The check box is selected by default.</p>                                                                                                                                                                                                                                    |

| Field                 | Client | Server | Description                                                                                                                                                                                                                                      |
|-----------------------|--------|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| M_EI_NA Time sync     | ✓      |        | Select the check box to indicate that Clock Sync is performed after receiving an M_EI_NA EOI message.<br><b>NOTE:</b> The check box is selected by default.                                                                                      |
| M_EI_NA CI            | ✓      |        | Select the check box to indicate that counter interrogation is performed after receiving an M_EI_NA EOI message.<br><b>NOTE:</b> The check box is de-selected by default.                                                                        |
| Online GI             | ✓      |        | Select the check box to indicate that general interrogation is performed when a remote device has come online and is available for devices that do not generate an M_EI_NA EOI message.<br><b>NOTE:</b> The check box is selected by default.    |
| Online Time Sync      | ✓      |        | Select the check box to indicate that Clock Sync is performed when a remote device has come online and is available for devices that do not generate an M_EI_NA EOI message.<br><b>NOTE:</b> The check box is selected by default.               |
| Online CI             | ✓      |        | Select the check box to indicate that counter interrogation is performed when a remote device has come online and is available for devices that do not generate an M_EI_NA EOI message.<br><b>NOTE:</b> The check box is de-selected by default. |
| Command with Time Tag | ✓      |        | Select the check box to indicate that the control command follows the time tag.<br><b>NOTE:</b> The check box is de-selected by default.                                                                                                         |

## SNMP Configuration in the DTM

### Access the SNMP Configuration

Access the SNMP parameters in the Control Expert DTM:

| Step | Action                                                                                                                                                                                                            |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Access the DTM configuration for your module, page 75.                                                                                                                                                            |
| 2    | In the <b>CONFIGURATION</b> menu, expand (+) the <b>Communication</b> sub-menu.                                                                                                                                   |
| 3    | Select <b>SNMP</b> .                                                                                                                                                                                              |
| 4    | Configure the SNMP parameters.<br><b>NOTE:</b> The parameters are described in the next table.                                                                                                                    |
| 5    | <ul style="list-style-type: none"> <li>Select the <b>Apply</b> button to implement your configuration changes.</li> <li>Click the <b>OK</b> button to implement your changes and close the dialog box.</li> </ul> |

### Parameters

This table shows the SNMP parameters that are available for your module.

**NOTE:** When the Control Expert window is active, you can hover the cursor over any parameter field to see a description of the functionality and the available range of values.

SNMP parameters:

| Field               | Parameter                          | Description                                                                                                                                                                                                                                                                            |
|---------------------|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| IP ADDRESS MANAGERS | IP Address Manager 1               | Configure an IP address of the primary SNMP manager in the range 0.0.0...255.255.255.255.                                                                                                                                                                                              |
|                     | IP Address Manager 2               | Configure the IP address of the secondary SNMP manager.                                                                                                                                                                                                                                |
| AGENT               | Enable SNMP Manager                | <i>selected</i> : The SNMP manager is enabled.                                                                                                                                                                                                                                         |
|                     |                                    | <i>deselected</i> : The SNMP manager is disabled.                                                                                                                                                                                                                                      |
|                     | Location (SysLocation)             | Specify the physical location of the module when the SNMP manager is enabled.                                                                                                                                                                                                          |
|                     | Contact (SysContact)               | Enter the name of a maintenance person to contact when the SNMP manager is enabled.                                                                                                                                                                                                    |
| COMMUNITY NAMES     | Set                                | Enter the community name for the <b>Set</b> utility.                                                                                                                                                                                                                                   |
|                     | Get                                | Enter the community name for the <b>Get</b> utility.                                                                                                                                                                                                                                   |
|                     | Trap                               | Enter the community name for the <b>Trap</b> utility.<br><b>NOTE:</b> <ul style="list-style-type: none"> <li>Traps are sent through UDP port 161.</li> <li>Confirm whether you configure trap settings on the SNMP manager that are consistent with those on the processor.</li> </ul> |
| SECURITY            | Enable Authentication Failure Trap | <i>selected</i> : The SNMP agent sends a trap message to the SNMP manager when an unauthorized manager sends a <b>Get</b> or <b>Set</b> command to the agent.                                                                                                                          |
|                     |                                    | <i>deselected</i> : This feature is disabled.                                                                                                                                                                                                                                          |

**NOTE:** The characteristics and details of the SNMP service are described in the *Ethernet services* chapter, page 38.

## Network Time Service Configuration in the DTM

### Introduction

The BMENOR2200H module supports clock synchronization as an SNTP client.

When the SNTP client is enabled, the module synchronizes the internal clock from the time server. This time is the basis for time stamping RTU events.

**NOTE:** For details, refer to the description of the BMENOR2200H module as an SNTP client, page 52.

### Features of the Service

The clock synchronization via SNTP offers:

- periodic time corrections obtained from the reference standard, for example, the SNTP server
- automatic switchover to a backup time server if an abnormal event is detected with the normal server system
- local time zone configurable and customizable (including daylight saving time adjustments)

Controller projects use a function block to read the clock, a feature that allows events or variables in the project to be time stamped.

Time stamping is accurate to:

- 5 ms typical
- 10 ms worst case

## Access the SNTP Configuration

Access the SNTP parameters in the Control Expert DTM:

| Step | Action                                                                                                                                                                                                           |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Access the DTM configuration for your module, page 75.                                                                                                                                                           |
| 2    | In the <b>CONFIGURATION</b> menu, expand (+) the <b>Communication</b> sub-menu.                                                                                                                                  |
| 3    | Select <b>Network Timing Service</b> .                                                                                                                                                                           |
| 4    | Configure the SNTP parameters.<br><b>NOTE:</b> The parameters are described in the next table.                                                                                                                   |
| 5    | <ul style="list-style-type: none"> <li>Click the <b>Apply</b> button to implement your configuration changes.</li> <li>Click the <b>OK</b> button to implement your changes and close the dialog box.</li> </ul> |

## Time Synchronization Parameters

This table shows the SNTP parameters that are available for your module:

| Field               | Parameter                                      | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|---------------------|------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Time Source Setting | Time Synchronize Source                        | Select a value from the drop-down list to identify the time source of synchronization: <ul style="list-style-type: none"> <li><b>RTU Protocol:</b> If SCADA or the client synchronizes time with the BMENOR2200H module, its time source is the Controlling Station.</li> <li><b>SNTP Server:</b> If the NTP client is enabled and connected with the NTP server, its time source is the NTP server when it synchronizes the BMENOR2200H module's clock.</li> </ul> |
|                     |                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| SNTP Server         | Primary IP Address                             | Enter a valid IP address for the primary SNTP server.                                                                                                                                                                                                                                                                                                                                                                                                               |
|                     | Secondary IP Address                           | Enter a valid IP address for the secondary SNTP server.                                                                                                                                                                                                                                                                                                                                                                                                             |
|                     | Polling period                                 | This value represents the number of seconds between updates from the SNTP server.                                                                                                                                                                                                                                                                                                                                                                                   |
| Time Zone           | Time Zone                                      | Select a time zone from the pull-down menu.                                                                                                                                                                                                                                                                                                                                                                                                                         |
|                     | Timezone Offset                                | This value represents the difference (in minutes) between the configured time zone and UTC.                                                                                                                                                                                                                                                                                                                                                                         |
|                     | Automatically adjust clock for daylight saving | <i>selected:</i> Adjust the clock for daylight saving time.<br><i>deselected:</i> Do not adjust the clock for daylight saving time.                                                                                                                                                                                                                                                                                                                                 |
|                     | Start Daylight Saving                          | Configure the start and end times for daylight saving in the available fields.                                                                                                                                                                                                                                                                                                                                                                                      |
|                     | End Daylight Saving                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| TIME TO CPU         | Update Clock to CPU                            | <i>selected:</i> Update the clock to the CPU.                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                     |                                                | <i>deselected:</i> Do not update the clock to the CPU.                                                                                                                                                                                                                                                                                                                                                                                                              |

**NOTE:** When the Control Expert window is active, you can hover the cursor over any parameter field to see a description of the functionality and the available range of values.

## Clock Synchronization Terms

SNTP terms:

| Term                      | Description of Service                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| local clock offset        | <p>Accurate local time adjustments are made via a local clock offset. The local clock offset is calculated as:</p> $(T2 - T1) + (T4 - T3) / 2$ <p>where:</p> <ul style="list-style-type: none"> <li>T1 = time when SNTP request is transmitted from the module</li> <li>T2 = time when SNTP server receives the request (provided by the module in response)</li> <li>T3 = time when the SNTP server transmits the response (provided to the module in the response)</li> <li>T4 = time when SNTP response is received by the module</li> </ul> |
| time accuracy             | <p>The local time margin is &lt; 10 ms compared to the referenced SNTP server time.</p> <ul style="list-style-type: none"> <li>typical: 5 ms</li> <li>worst case: &lt;10 ms</li> </ul>                                                                                                                                                                                                                                                                                                                                                          |
| settling time             | Maximum accuracy is obtained after 2 updates from the SNTP server.                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| polling period dependency | Accuracy depends on the polling period. Less than 10 ms of margin is achieved for polling periods of 120 ms or less. To obtain a high degree of accuracy (when your network bandwidth allows), reduce the polling period to a small value—for example, a polling time of 5 s provides better accuracy than a time of 30 s.                                                                                                                                                                                                                      |
| leap second               | <p>To compensate for the deceleration of the earth rotation, the module automatically inserts a leap second in the UTC time every 18 months via an international earth rotation service (IERS).</p> <p>Leap seconds are inserted automatically as needed. When needed, they are inserted at the end of the last minute in June or December, as commanded by the SNTP server.</p>                                                                                                                                                                |

## Obtaining and Maintaining Accuracy

The time service clock starts at 0 and increments until the Ethernet network time is fully updated from the module.

| Model | Starting Date               |
|-------|-----------------------------|
| M580  | January 1, 1980 00:00:00.00 |

Clock characteristics:

- Clock accuracy is not affected by issuing stop/run commands on the PLC.
- Clock updates are not affected by issuing stop/run commands on the PLC.
- Mode transitions do not affect the accuracy of the Ethernet network.

**NOTE:** For details, refer to the descriptions of available time sources.

## General Time Synchronization Terms

General terms:

| Term                 | Description of Service                                                                                                                                                                                                                   |
|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| time zone            | <p>The default format is universal time, coordinated (UTC). Optionally you may configure the service to use a local time zone (for example, GMT+1 for Barcelona or Paris).</p> <p><i>Refer to the note at the end of this table.</i></p> |
| daylight saving time | <p>The module automatically adjusts the time change in the spring and fall.</p> <p><i>Refer to the note at the end of this table.</i></p>                                                                                                |

| Term                                                                                                                                                                                                                                                                                                                                                        | Description of Service                                                                                                                                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| update clock to CPU                                                                                                                                                                                                                                                                                                                                         | When no other time source is configured, the BMENOR2200H module sends the source clock synchronization signal to the CPU over the Ethernet backplane, page 53. |
| <b>NOTE:</b> This setting is implemented at the module level even if there is no SNTP configuration for the module. The implementation of this setting owes to the BMENOR2200H module's support for several time sources (for example, DNP3). If you, therefore, use DNP3 for time synchronization instead of SNTP, the time zone is applied to the module. |                                                                                                                                                                |

## DNP3 Data Object Mapping

### Introduction

To facilitate communications with the BMENOR2200H module, create data points for the DNP3 communication protocol in the **DATA MAPPINGS** tab in the DTM.

### Access the Configuration Tab

Access the configuration parameters on the **DATA MAPPINGS** tab in Control Expert:

| Step | Action                                                                                                                                                                                           |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Access the DTM configuration for your module, page 75.                                                                                                                                           |
| 2    | Confirm that you already created client or server channels, page 75.                                                                                                                             |
| 3    | In the <b>CONFIGURATION</b> menu, expand (+) the <b>Channels/Devices</b> sub-menu.                                                                                                               |
| 4    | Make a selection in the <b>Channels/Devices</b> sub-menu: <ul style="list-style-type: none"> <li>• <b>DNP3 NET Server</b></li> <li>• <b>DNP3 NET Client</b></li> </ul>                           |
| 5    | Select a specific channel in the sub-menu.                                                                                                                                                       |
| 6    | Select the <b>DATA MAPPINGS</b> tab for the channel.                                                                                                                                             |
| 7    | Configure the data mapping parameters.                                                                                                                                                           |
| 8    | <ul style="list-style-type: none"> <li>• Select <b>Apply</b> to implement your configuration changes.</li> <li>• Select <b>OK</b> to implement your changes and close the dialog box.</li> </ul> |

### DNP3 Client Data Mappings

A newly applied data point configuration is added to the X80 client DTM. It appears in the Control Expert variable manager.

### DNP3 Data Mappings

Using a **Binary Input** as an example, edit the data point configuration on the **DATA MAPPINGS** tab:

| Step | Action                                                                                                                             |
|------|------------------------------------------------------------------------------------------------------------------------------------|
| 1    | At <b>Select Type Id</b> , select a type ID.<br><b>NOTE:</b> For this example, select <b>Binary Input</b> .                        |
| 2    | Click <b>Add</b> to see the name of the binary input ( <b>DNP3_SERVER_BINARY_INPUT</b> ) in the <b>Type Identification</b> column. |
| 3    | Select the table row that corresponds to the new binary input to see the <b>BINARY INPUT</b> configuration options.                |

| Step | Action                                                                                                                                                                                                |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4    | Modify the parameters.<br><b>NOTE:</b> When the Control Expert window is active, you can hover the cursor over any field to see a description of the functionality and the available range of values. |
| 5    | <ul style="list-style-type: none"> <li>Select <b>Apply</b> to implement your configuration changes.</li> <li>Select <b>OK</b> to implement your changes and close the dialog box.</li> </ul>          |

**NOTE:** A newly applied data point configuration is added to the X80 client DTM. It appears in the Control Expert variable manager.

## Exchangeable CPU Data Object

| <b>⚠ WARNING</b>                                                                                      |  |
|-------------------------------------------------------------------------------------------------------|--|
| <b>UNINTENDED EQUIPMENT OPERATION</b>                                                                 |  |
| Do not create an instance of redundant data access.                                                   |  |
| <b>Failure to follow these instructions can result in death, serious injury, or equipment damage.</b> |  |

Implement the data dictionary in Control Expert:

| Step | Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Open the <b>Project Settings (Tools &gt; Project Settings)</b> .                                                                                                                                                                                                                                                                                                                                                                                                      |
| 2    | Expand (+) the menu: <b>Project Settings &gt; General</b>                                                                                                                                                                                                                                                                                                                                                                                                             |
| 3    | Select the <b>PLC Embedded Data</b> setting to see the <b>Property label</b> and <b>Property value</b> columns.                                                                                                                                                                                                                                                                                                                                                       |
| 4    | In the <b>Data label</b> column, find the <b>Data Dictionary</b> row and check the corresponding box in the <b>Property value</b> column.<br><b>NOTE:</b> Check this box when you program the PLC application. Otherwise, unlocated variables may not be mapped to RTU data points. However, a compiled application consumes more memory when the data dictionary is included, which can have an impact on unlocated variables that are implemented in RTU solutions. |
| 5    | <ul style="list-style-type: none"> <li>Select <b>Apply</b> to implement your configuration changes.</li> <li>Select <b>OK</b> to implement your changes and close the dialog box.</li> </ul>                                                                                                                                                                                                                                                                          |

Unlocated variables can be exchanged between the CPU and the BMENOR2200H RTU module after you define and manage the memory map of the CPU to exchange data with the module.

The CPU data objects are mapped and only linked for the BMENOR2200H module's purpose.

## Data Exchange

To sustain a high rate of data exchange, we recommend that you define the BMENOR2200H module's RTU memory for data objects in a sequential ARRAY data type to group points with the same settings.

Use consecutive point numbers (0, 1, 2, 3...) in DNP3 request fragments.

## Predefined Command List

The required input fields are requested to define a predefined command item for DNP3 client/DNP3 NET client, page 134.

## Static Variation Name of DNP3

| Data object type        | Static variation                 |
|-------------------------|----------------------------------|
| Binary Input            | g1v1 Binary In                   |
|                         | g1v2 Binary In Flag              |
| Double Input            | g3v1 Double In                   |
|                         | g3v2 Double In Flag              |
| Binary Output           | g10v1 Binary Out                 |
|                         | g10v2 Binary Out Flag            |
| Binary Counter          | g20v1 32bit Counter              |
|                         | g20v2 16bit Counter              |
|                         | g20v5 32bit Ctr No Flag          |
|                         | g20v6 16bit Ctr No Flag          |
| Frozen Counter          | g21v1 32bit Frozen Ctr Flag      |
|                         | g21v2 16bit Frozen Ctr Flag      |
|                         | g21v5 32bit Frozen Ctr Flag Time |
|                         | g21v6 16bit Frozen Ctr Flag Time |
|                         | g21v9 32bit Frozen Counter       |
|                         | g21v10 32bit Frozen Counter      |
| Analog Input            | g30v1 32bit Analog In            |
|                         | g30v2 16bit Analog In            |
|                         | g30v3 32bit AI No Flag           |
|                         | g30v4 16bit AI No Flag           |
|                         | g30v5 Short Float AI             |
| Analog Input Deadband   | g34v1 16bit AI Deadband          |
|                         | g34v2 32bit AI Deadband          |
|                         | g34v3 Short Float AI Deadband    |
| Analog Input Dband_Ctrl | g34v1 16bit AI Deadband          |
|                         | g34v2 32bit AI Deadband          |
|                         | g34v3 Short Float AI Deadband    |
| Analog Output           | g40v1 32bit Analog Output        |
|                         | g40v2 16bit Analog Output        |
|                         | g40v3 Short Float AO             |
| Read_Group              | —                                |
| Read_Class              | —                                |
| Write_Octet_String      | —                                |
| Freeze_Counter          | —                                |
| Unsolicited_Class       | —                                |
| Time_Sync               | —                                |
| Restart                 | —                                |
| Octet String            | g110 Octet Strings               |
| Integrity_Poll          | —                                |
| Gen_Events              | —                                |
| Clear_Events            | —                                |

## DNP3 Net Server Parameters

The tables below describe the DNP3 net server parameters that appear on the **SERVER MAPPINGS** tab.

**NOTE:** When the Control Expert window is active, you can hover the cursor over any field to see a description of the functionality and the available range of values.

### PARAMETERS:

| Parameter      | Description                                                                   |
|----------------|-------------------------------------------------------------------------------|
| Local Address  | This field contains the source address for this session.                      |
| Client Address | This field contains the remote client (destination) address for this session. |

### ADVANCED PARAMETERS:

| Parameter                             | Description                                                                                                                                                                                                                   |
|---------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Link Status Period                    | Configure the frequency (ms) for the transmission of status requests when no DNP3 frames are received during this session.                                                                                                    |
| Validate Source Address               | Check this box to validate the source address in received frames.                                                                                                                                                             |
| Enable Self Address                   | Check this box to have the server respond to address 0xfffc as if it received a request at its configured address. The server responds with its own address so that the client can automatically discover the server address. |
| Multi Frag Resp Allowed               | Check this box to allow the application to send multi-fragment responses.                                                                                                                                                     |
| Multi Frag Confirm                    | Check this box to request application layer confirmations for non-final fragments of a multi-fragment response. (Application layer confirmations are always requested for responses that contain events.)                     |
| Respond Need Time                     | Check this box to tell the device to set the Need Time IIN bit in response to this session at start-up after the clock valid period elapses.                                                                                  |
| Clock Valid Period                    | Configure the length of time (ms) that the local clock remains valid after it receives a time synchronization.                                                                                                                |
| Application Confirm Timeout           | Configure the length of time (ms) that the server DNP3 device waits for an application layer confirmation from the client for a solicited response.                                                                           |
| Select Before Operation (SBO) Timeout | Configure the maximum amount of time (ms) that a selection remains valid before the corresponding operate is received.                                                                                                        |
| Warm Restart Delay                    | Configure the length of time that the client waits after it receives a response to a warm restart request. This value is encoded in a time delay fine object in the response of a warm restart request.                       |
| Cold Restart Delay                    | Configure the length of time (ms) that the client waits after it receives a response to a cold restart request. This value is encoded in a time delay fine object in the response of a cold restart request.                  |
| Allow Multi CROB Requests             | Check this box to allow multiple control relay block objects (CROBs) in a single request.                                                                                                                                     |
| Max Control Requests                  | Configure the maximum number of binary (CROB) or analog control outputs that are allowed in a single request.                                                                                                                 |
| Unsol Allowed                         | Check this box to allow unsolicited responses.                                                                                                                                                                                |
| Send Unsol When Online                | Check this box to send unsolicited null responses when the session comes online.                                                                                                                                              |
| Unsol Class 1 Max Events              | When unsolicited responses are enabled, configure this value to specify the maximum number of events in the corresponding class (1, 2, or 3) that are allowed before an unsolicited response is generated.                    |
| Unsol Class 2 Max Events              |                                                                                                                                                                                                                               |
| Unsol Class 3 Max Events              |                                                                                                                                                                                                                               |
| Unsol Class 1 Max Delay               | Configure the maximum amount of time (ms) after an event in the corresponding class (1, 2, or 3) is received before an unsolicited response is generated.                                                                     |

| Parameter                 | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Unsol Class 2 Max Delay   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Unsol Class 3 Max Delay   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Unsol Max Retries         | Configure the maximum number of unsolicited retries before changing to the offline retries value.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Unsol Retry Delay         | Configure the length of the delay (ms) after an unsolicited response.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Unsol Offline Retry Delay | Configure the length of the delay (ms) after an unsolicited timeout before retrying the unsolicited response after the configured number of <b>Unsol Max Retries</b> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Delete Oldest Event       | Configure the behavior for an event queue that is full: <ul style="list-style-type: none"> <li><i>checked</i>: Delete the oldest event.</li> <li><i>unchecked</i>: Delete the newest event.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Counts to Class0 Poll     | Configure the type of value that is returned in a poll of class 0 data: <ul style="list-style-type: none"> <li><b>Count Value</b>: Return a static binary counter value.</li> <li><b>Frozen Value</b>: Return a static frozen counter value.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| SBO Mode                  | Select a mode for a before-and-after operation: <ul style="list-style-type: none"> <li><b>Interference Mode</b>: The server cancels the selection if the next received request is not an operate request. (Only read requests are processed.)</li> <li><b>Noninterference Mode</b>: The server does not cancel the selection even if the next received request is not an operate request by following the selection. The DNP3 group recommends this selection.</li> </ul>                                                                                                                                                                                                                                                                                                                                 |
| Unsol Confirm Timeout     | Configure the value for an unsolicited confirm timeout.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| Data Synch Mode           | Select a data synchronization mode: <ul style="list-style-type: none"> <li><b>Cyclic Synch</b>: Use the default (cyclic) synchronization.</li> <li><b>Synch On Demand</b>: Allow the PLC application to implement local changes on the binary or analog output.</li> </ul> <p><b>NOTE</b>: Enabling a <b>Synch On Demand</b> point changes the variable structure (out of the Device DDT).</p>                                                                                                                                                                                                                                                                                                                                                                                                            |
| Prefix                    | This string is part of the variable name for analog or binary output points when you select <b>Synch On Demand</b> as the <b>Data Synch Mode</b> (range: 1 ... 6).<br><br>Considerations: <ul style="list-style-type: none"> <li>Use <b>Prefix</b> names that are unique for each BMENOR2200H module. Duplicate names cause the overwriting of variables.</li> <li>In the <b>Synch On Demand</b> mode, client-side routing points for the analog or binary output status do not support server-side mapping.</li> <li>Do not use an underscore ( <code>_</code> ) as the last character in the <b>Prefix</b>.</li> <li>In the <b>Synch On Demand</b> mode, the <b>Prefix</b> consumes 7 characters. The remaining available length of the variable name is therefore reduced to 23 characters.</li> </ul> |

## Mapping Tables

Depending on the data object type and the selected protocol profile, different configuration fields are required to define a data object mapping item. The tables below describe the available parameters for each selection in the **Select Type Id** pull-down menu on the client and server **DATA MAPPINGS** tabs.

**NOTE:** These tables include brief descriptions of each data mapping parameter. When the Control Expert window is active, hover the cursor over any parameter field to see a description of the functionality and the available range of values.

## Binary Input

This table describes the DNP3 net client parameters that appear on the **DATA MAPPINGS** tab when you select a **Binary Input** in the **DATA MAPPINGS** tab:

| Client Parameter |                         | Description                                                                                                                                                                                                                                                                                                                                                  |
|------------------|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Point Number     |                         | Indicates the start number of the point.<br><b>NOTE:</b> Confirm that the DNP3 point number starts at 0 and is contiguous in server mode. If this is not applied, the nonconsecutive points cannot work normally.                                                                                                                                            |
| Point Count      |                         | Indicates the number of points.                                                                                                                                                                                                                                                                                                                              |
| Store to CPU     |                         | Choose a source for the event time stamp and flag: <ul style="list-style-type: none"> <li>• <b>Value only:</b> module time</li> <li>• <b>Value with time:</b> CPU register time</li> <li>• <b>Value with flag:</b> point flag information from the CPU registers</li> <li>• <b>Value with flag and time:</b> flag and time from the CPU registers</li> </ul> |
| Point Name       |                         | Name of the unlocated register                                                                                                                                                                                                                                                                                                                               |
| Static Variation |                         | Select the static variation for the data point.                                                                                                                                                                                                                                                                                                              |
| Event Routing    | Route Channel           | <ul style="list-style-type: none"> <li>• <b>Disable:</b> Disable routing for the channel.</li> <li>• <b>Enable:</b> Enable routing for the channel.</li> </ul>                                                                                                                                                                                               |
|                  | Route Point             | Point number to route. (This point number appears in the server side but cannot be modified on the server side.)                                                                                                                                                                                                                                             |
|                  | Point Name for the Flag | Server or client name that you can configure<br><b>Default:</b> P<PointNumber_P<PointNumber+PointCount>                                                                                                                                                                                                                                                      |
|                  | Default Event Variation | Indicates the default event variation for data point.                                                                                                                                                                                                                                                                                                        |
|                  | Routing Offline         | Specify the flag when the routing channel is offline: <ul style="list-style-type: none"> <li>• <b>Valid Quality:</b> Use any available routing channel connection.</li> <li>• <b>Invalid Quality:</b> Set the flag to offline when the routing channel is offline.</li> </ul>                                                                                |

This table describes the DNP3 net server parameters that appear on the **DATA MAPPINGS** tab when you select a **Binary Input** in the **DATA MAPPINGS** tab:

| Server Parameter         | Description                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Point Number             | Indicates the start number of the point.<br><b>NOTE:</b> The DNP3 point number starts at 0 and is contiguous in server mode. If this is not the case, the nonconsecutive points do not work normally.                                                                                                                                                                                                                                             |
| Point Count              | indicates the number of points.                                                                                                                                                                                                                                                                                                                                                                                                                   |
| CPU Reg Mapping          | Choose a source for the event time stamp and flag: <ul style="list-style-type: none"> <li>• <b>Value only:</b> module time</li> <li>• <b>Value with time:</b> CPU register time</li> <li>• <b>Value with flag:</b> point flag information from the CPU registers</li> <li>• <b>Value with flag and time:</b> flag and time from the CPU registers</li> </ul> <b>NOTE:</b> Select one of these values to implement SOE for time stamping, page 65. |
| Point Name               | Name of the unlocated register                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Default Static Variation | Select the default static variation for the data point.                                                                                                                                                                                                                                                                                                                                                                                           |
| Default Event Variation  | Select the default event variation for the data point.                                                                                                                                                                                                                                                                                                                                                                                            |

| Server Parameter        | Description                                                                                                                                                                                                                                                                                     |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Event Class Mask</b> | Defines the event class of points. <i>Unsolicited</i> is not allowed with class 0 only. In client, <i>Channel</i> is 0.                                                                                                                                                                         |
| <b>PLC State</b>        | Specify the flag when the routing channel is offline: <ul style="list-style-type: none"> <li><b>No Impact Quality:</b> The quality is <b>valid</b> when the PLC runs.</li> <li><b>Impact Quality:</b> If the PLC is stopped or removed from the rack, the quality is <b>invalid</b>.</li> </ul> |

## Analog Input

This table describes the client data mapping parameters for analog input types:

| Client Parameter                    |                                | Description                                                                                                                                                                                                                                                                                                                                          |
|-------------------------------------|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Point Number</b>                 |                                | Indicates the start number of the point.<br><b>NOTE:</b> Confirm that the DNP3 point number starts at 0 and is contiguous in server mode. If this is not applied, the nonconsecutive points cannot work normally.                                                                                                                                    |
| <b>Point Count</b>                  |                                | Indicates the number of points.                                                                                                                                                                                                                                                                                                                      |
| <b>Store to CPU</b>                 |                                | Choose a source for the event time stamp and flag: <ul style="list-style-type: none"> <li><b>Value only:</b> module time</li> <li><b>Value with time:</b> CPU register time</li> <li><b>Value with flag:</b> point flag information from the CPU registers</li> <li><b>Value with flag and time:</b> flag and time from the CPU registers</li> </ul> |
| <b>Static Variation</b>             |                                | Select the static variation for the data point.,                                                                                                                                                                                                                                                                                                     |
| <b>Point Name</b>                   |                                | Name of the unlocated register                                                                                                                                                                                                                                                                                                                       |
| <b>Display Deadband In Variable</b> |                                | Specify a deadband variable name.                                                                                                                                                                                                                                                                                                                    |
| <b>Point Name</b>                   |                                | Name of the unlocated register when <b>Display Deadband In Variable</b> is selected (checked)                                                                                                                                                                                                                                                        |
| <b>Event Routing</b>                | <b>Channel</b>                 | Enable or disable the routing of the channel number.                                                                                                                                                                                                                                                                                                 |
|                                     | <b>Route Point</b>             | Define the point number to route.                                                                                                                                                                                                                                                                                                                    |
|                                     | <b>Event Class Mask</b>        | Defines the event class of points. <i>Unsolicited</i> is not allowed with class 0 only. In client, confirm that <i>Channel</i> is at 0 for normal operations.                                                                                                                                                                                        |
|                                     | <b>Default Event Variation</b> | Indicates the default event variation for data point.                                                                                                                                                                                                                                                                                                |
|                                     | <b>Routing Offline</b>         | Specify the flag when the routing channel is offline: <ul style="list-style-type: none"> <li><b>Valid Quality:</b> Use any available routing channel connection.</li> <li><b>Invalid Quality:</b> Set the flag to offline when the routing channel is offline.</li> </ul>                                                                            |

This table describes the server data mapping parameters for analog input types:

| Server Parameter                | Description                                                                                                                                                                                                       |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Point Number</b>             | Indicates the start number of the point.<br><b>NOTE:</b> Confirm that the DNP3 point number starts at 0 and is contiguous in server mode. If this is not applied, the nonconsecutive points cannot work normally. |
| <b>Point Count</b>              | Indicates the number of points.                                                                                                                                                                                   |
| <b>Event Class Mask</b>         | Defines the event class of points. In client, confirm that <i>Channel</i> is at 0 for normal operations.                                                                                                          |
| <b>Default Static Variation</b> | Select the default static variation for the data point.                                                                                                                                                           |

| Server Parameter             | Description                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Default Event Variation      | Select the default event variation for the data point.                                                                                                                                                                                                                                                                                                                                                                                            |
| CPU Reg Mapping              | Choose a source for the event time stamp and flag: <ul style="list-style-type: none"> <li>• <b>Value only:</b> module time</li> <li>• <b>Value with time:</b> CPU register time</li> <li>• <b>Value with flag:</b> point flag information from the CPU registers</li> <li>• <b>Value with flag and time:</b> flag and time from the CPU registers</li> </ul> <b>NOTE:</b> Select one of these values to implement SOE for time stamping, page 65. |
| Deadband                     | Deadband value of the analog input                                                                                                                                                                                                                                                                                                                                                                                                                |
| Use Percent Data             | Use low and high range for the percentage of deadband calculation when the check box is selected.                                                                                                                                                                                                                                                                                                                                                 |
| Low Range                    | Lowest value in the range when the <b>Use Percent Data</b> check box is selected.                                                                                                                                                                                                                                                                                                                                                                 |
| High Range                   | Highest value in the range when the <b>Use Percent Data</b> check box is selected.                                                                                                                                                                                                                                                                                                                                                                |
| Point Name                   | Name of the unlocated register                                                                                                                                                                                                                                                                                                                                                                                                                    |
| PLC State                    | Specify the flag when the routing channel is offline: <ul style="list-style-type: none"> <li>• <b>No Impact Quality:</b> The quality is <b>valid</b> when the PLC runs.</li> <li>• <b>Impact Quality:</b> If the PLC is stopped or removed from the rack, the quality is <b>invalid</b>.</li> </ul>                                                                                                                                               |
| Display Deadband In Variable | Specify a deadband variable name.                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Point Name                   | Name of the unlocated register when the <b>Display Deadband In Variable</b> check box is selected.                                                                                                                                                                                                                                                                                                                                                |

## Binary Output

This table describes the client data mapping parameters for binary output types:

| Client Parameter         | Description                                                                                                                                                                                                                                                   |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Point Number             | Indicates the start number of the point.<br><b>NOTE:</b> Confirm that the DNP3 point number starts at 0 and is contiguous in server mode. If this is not applied, the nonconsecutive points cannot work normally.                                             |
| Point Count              | Indicates the number of points.                                                                                                                                                                                                                               |
| Operation Mode           | The selected operation mode                                                                                                                                                                                                                                   |
| Control Code Type        | Specify the control code used by the CROB: <ul style="list-style-type: none"> <li>• <b>Latch_On_Off:</b> Trigger the CROB.</li> <li>• <b>Pulse_On:</b> Change the value.</li> </ul> <b>NOTE:</b> Refer to the description of binary output behavior, page 96. |
| Default Static Variation | Select the default static variation for the data point.                                                                                                                                                                                                       |
| Pulse Duration           | Specify the width of the pulse (ms).                                                                                                                                                                                                                          |
| Point Name               | Name of the unlocated register                                                                                                                                                                                                                                |
| Add CMD_STATUS           | Specify the CMD_STATUS variable name.                                                                                                                                                                                                                         |

Server data mapping parameters for binary output types:

| Server Parameter                | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Point Number</b>             | Indicates the start number of the point.<br><br><b>NOTE:</b> Confirm that the DNP3 point number starts at 0 and is contiguous in server mode. If this is not applied, the nonconsecutive points cannot work normally.                                                                                                                                                                                                                                              |
| <b>Point Count</b>              | Indicates the number of points.                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Default Static Variation</b> | Select the default static variation for the data point.                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Default Event Variation</b>  | Select the default event variation for the data point.                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Add Flag Variable</b>        | Specify the flag variable name.                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Point Name</b>               | Name of the unlocated register when the <b>Add Flag Variable</b> check box is selected.                                                                                                                                                                                                                                                                                                                                                                            |
| <b>PLC State</b>                | Specify the flag when the routing channel is offline: <ul style="list-style-type: none"> <li>• <b>No Impact Quality:</b> The quality is <b>valid</b> when the PLC runs.</li> <li>• <b>Impact Quality:</b> If the PLC is stopped or removed from the rack, the quality is <b>invalid</b>.</li> </ul>                                                                                                                                                                |
| <b>Prefix</b>                   | This prefix for the variable name is followed with an underscore (_). Configure the prefix in the server advanced parameters.<br><br>Example: RTU001_Point1.                                                                                                                                                                                                                                                                                                       |
| <b>CPU Register Type</b>        | The only available option for the binary output is %MW.                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>CPU Register Address</b>     | This is the start %MW address in the CPU. This field applies only to located variables.<br><br>To create a variable without a %MW address, use the value -1.<br><br>Considerations: <ul style="list-style-type: none"> <li>• The binary output value (0 or 1) is bit 0 the %MW (INT) in the global variable list. The binary output flag data remains in the Device DDT.</li> <li>• The %MW range depends on the CPU %MW register range (default 2048).</li> </ul> |

**NOTE:**

- The **Binary\_Output\_Status** is applied in the client, which saves the latest value, state (flag), and time stamp.
- Floating point values (scientific notation) can be entered for the **deadband**.

## Analog Output

This table describes the client data mapping parameters for analog output types:

| Client Parameter                | Description                                                                                                                                                                                                           |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Point Number</b>             | Indicates the start number of the point.<br><br><b>NOTE:</b> Confirm that the DNP3 point number starts at 0 and is contiguous in server mode. If this is not applied, the nonconsecutive points cannot work normally. |
| <b>Point Count</b>              | Indicates the number of points.                                                                                                                                                                                       |
| <b>Operation Mode</b>           | Selected operation mode                                                                                                                                                                                               |
| <b>Default Static Variation</b> | Select the default static variation for the data point.                                                                                                                                                               |
| <b>Point Name</b>               | Name of the unlocated register                                                                                                                                                                                        |
| <b>Add CMD_STATUS</b>           | Specify the CMD_STATUS variable name.                                                                                                                                                                                 |

This table describes the server data mapping parameters for analog output types:

| Server Parameter                | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Point Number</b>             | Indicates the start number of the point.<br><b>NOTE:</b> Confirm that the DNP3 point number starts at 0 and is contiguous in server mode. If this is not applied, the nonconsecutive points cannot work normally.                                                                                                                                                                                                                                                                                                                 |
| <b>Point Count</b>              | Indicates the number of points.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Event Class Mask</b>         | Defines the event class of points. <code>Unsolicited</code> is not allowed with class 0 only. In client, confirm that <code>Channel</code> is at 0.                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Default Static Variation</b> | Select the default static variation for the data point.                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Default Event Variation</b>  | Select the default event variation for the data point.                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Deadband</b>                 | Deadband value of the analog point                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Point Name</b>               | Name of the unlocated register                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Add Flag Variable</b>        | Specify the flag variable name.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Point Name</b>               | Name of the unlocated register when the <b>Add Flag Variable</b> check box is selected.                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>PLC State</b>                | Specify the flag when the routing channel is offline: <ul style="list-style-type: none"> <li><b>No Impact Quality:</b> The quality is <b>valid</b> when the PLC runs.</li> <li><b>Impact Quality:</b> If the PLC is stopped or removed from the rack, the quality is <b>invalid</b>.</li> </ul>                                                                                                                                                                                                                                   |
| <b>Prefix</b>                   | The prefix for the variable name is followed with an underscore (_). Configure the prefix in the server advanced parameters.<br><br>The final variable name follows this format:<br><br><code>Prefix_VariableName.Pointx.value</code><br><br>Example: <code>RTU001_AO01.Point[10].value</code>                                                                                                                                                                                                                                    |
| <b>CPU Register Type</b>        | The only available option for the analog output is %MW.                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>CPU Register Address</b>     | This is the start %MW address in the CPU. This field applies only to located variables.<br><br>To create a variable without a %MW address, use a start address of the type float/32 bit. A valid analog output type value is an even number. Use address -1.<br><br>Considerations: <ul style="list-style-type: none"> <li>The analog output value is in the global variable list. The binary output flag data remains in the Device DDT.</li> <li>The %MW range depends on the CPU %MW register range (default 2048).</li> </ul> |

**NOTE:**

- The **Analog\_Output\_Status** is applied in the client, which saves the latest value, state (flag), and time stamp.
- Floating point values (scientific notation) can be entered for the **deadband**.

## Behavior of a Binary Output

This configuration depends on the selection you made in the **Control Code Type** field in the binary output client parameters, page 94.

The configuration applies **latch on/off** and **pulse on**:

| Operation type field | Control code | Point model in server |
|----------------------|--------------|-----------------------|
| pulse on             | 01 hex       | activation            |
| latch on             | 03 hex       | latch complement      |
| latch off            | 04 hex       |                       |
| pulse on             | 41 hex       | two's complement      |
|                      | 81 hex       |                       |

**NOTE:** The DNP3 client provides on-time configuration data only but does not provide configured off-time and count. The DNP3 server also only applies pulse on which the count is 1 and the off-time value is 0.

| CROB sent in DNP3 client | Point number in DNP3 client | Point number in DNP3 server |
|--------------------------|-----------------------------|-----------------------------|
| Pulse on                 | 0                           | 0                           |
| Trip/Pulse on            | 0                           | 1                           |
| Close/Pulse on           | 2                           | 2                           |
| Trip/Pulse on            | 2                           | 3                           |
| Close/Pulse on           | n+2                         | n+2                         |
| Trip/Pulse on            | n+2                         | n+2+1                       |

| Op type field  | Trigger mechanism            | Description               |
|----------------|------------------------------|---------------------------|
| Close/Pulse_on | any value change (0...65535) | pulse on if value change  |
| Latch_on       | 0 to 1                       | latch on                  |
| Latch off      | 1 to 0                       | latch off                 |
| Close/Pulse_on | 0 to 1                       | pulse on for close output |
| Trip/Pulse_on  | 1 to 0                       | pulse on for trip output  |

## Long and Short Pulses of Binary Outputs

This configuration depends on the selection you made for these parameters in the binary output client parameters, page 94:

- **Pulse Duration**
- **Short Pulse Duration**

**NOTE:** The server uses the entered **Pulse Duration**. The value 0 indicates that the device uses a pre-configured value.

## Set Measured Value

Apply analog input deadband (**obj34**) to set deadband of measured value. The parameters of the measured points are activated immediately after the DNP3 server receives the request from the DNP3 client.

For DNP3 **obj34**, there is no qualifier to set as it only applies the parameter **deadband**. Set the static variation and point number at the same setting of the analog input. Analog input **deadband** is applied both on the DNP3 client and the DNP3 server. The DNP3 server uses it to store the current value which is reported in the response of read requests, the DNP3 client uses it to display the current **deadband** value which can be controlled by the server through the analog input **deadband** control block.

This configuration depends on the deadband settings you made in these fields:

- **Point Number** (analog input client parameters)
- **Point Number** (analog input server parameters)
- **Default Static Variation** (analog input server parameters)

**NOTE:** Refer to the description of the analog input client and server parameters, page 93.

## Octet String Mapping for DNP3

In DNP3, Octet String applies to group 110. It supports read, write, and response function codes.

For the BMENOR2200H module, the octet string splits into two types of points, input points and output points.

The client uses a Read\_Group command to read the Octet String.

This is the interpretation of the Octet String from the perspective of the client:

- **Octet String** points are input points.
- **Write Octet String** points are output points.

This is the interpretation of the Octet String from the perspective of the server:

- **Octet String** points with **protocol** variable access are input points for the DNP3 client.
- **Octet String** points with **CPU** variable access are output points from the controller.

Octet String lengths:

|         |                |
|---------|----------------|
| maximum | 255 characters |
| default | 16 characters  |

## IEC 60870-5-104 Data Object Mapping

### Introduction

To facilitate communications with the BMENOR2200H module, create data points for the IEC 60870-5-104 communication protocol in the **DATA MAPPINGS** tab in the DTM.

### Access the Configuration Tab

Access the configuration parameters on the **DATA MAPPINGS** tab in Control Expert:

| Step | Action                                                                                                                                                                                           |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Access the DTM configuration for your module, page 74.                                                                                                                                           |
| 2    | Confirm that you already created client and/or server channels, page 76.                                                                                                                         |
| 3    | In the <b>CONFIGURATION</b> menu, expand (+) the <b>Channels</b> sub-menu.                                                                                                                       |
| 4    | Make one of the following selections in the <b>Channels/Devices</b> sub-menu: <ul style="list-style-type: none"> <li>• <b>IEC104 Client</b></li> <li>• <b>IEC104 Server</b></li> </ul>           |
| 5    | Select the desired device in the sub-menu.                                                                                                                                                       |
| 6    | Select the <b>DATA MAPPINGS</b> tab for the channel.                                                                                                                                             |
| 7    | Configure the data mapping parameters.                                                                                                                                                           |
| 8    | <ul style="list-style-type: none"> <li>• Select <b>Apply</b> to implement your configuration changes.</li> <li>• Select <b>OK</b> to implement your changes and close the dialog box.</li> </ul> |

### IEC 60870-5-104 Data Mappings

Edit the data point configuration on the **DATA MAPPINGS** tab:

| Step | Action                                                          |
|------|-----------------------------------------------------------------|
| 1    | Select a type ID in the <b>Select Type Id</b> drop-down list.   |
| 2    | Select the <b>Add</b> button to configure the data object type. |

| Step | Action                                                                                                                                                                                        |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3    | Configure the data object type.<br><br>Depending on the data object type and the selected protocol profile, different configuration fields are required to define a data object mapping item. |
| 4    | <ul style="list-style-type: none"> <li>Select <b>Apply</b> to implement your configuration changes.</li> <li>Select <b>OK</b> to implement your changes and close the dialog box.</li> </ul>  |

## IEC 60870-5-104 Data Mapping Parameters

**NOTE:** When the Control Expert window is active, you can hover the cursor over any field to see a description of the functionality and the available range of values.

This table describes the parameters:

| Field           | Client | Server | Value Scope                                                                                                                                      | Default Value     | Description                                                                                                                                                                                                |
|-----------------|--------|--------|--------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| IOA             | ✓      | ✓      | 1~16777215                                                                                                                                       | 1                 | Indicates the information object address of the object.                                                                                                                                                    |
| Point Count     | ✓      | ✓      | 1...7000                                                                                                                                         | 1                 | Indicates the number of objects defined. The IOA of each object defined. The IOA of each object is in sequence from the first object address.                                                              |
| Variable Name   | ✓      | ✓      | Max length: 32                                                                                                                                   | M_SP_P1/...       | Indicates the variable name.                                                                                                                                                                               |
| CPU Reg Mapping | ✓      | ✓      | <ul style="list-style-type: none"> <li>Value only</li> <li>Value with time</li> <li>Value with flag</li> <li>Value with flag and time</li> </ul> | Value only        | Indicates the choice of the stored time or flag; follows the value in the CPU DDDT variable.                                                                                                               |
| Operation Mode  | ✓      |        | <ul style="list-style-type: none"> <li>Auto</li> <li>Select</li> <li>Execute</li> <li>Deselect</li> </ul>                                        | Auto              | Indicates the operation mode for C_SC/C_DC/C_RC/C_SE_A/C_SE_B/C_SE_C control command.                                                                                                                      |
|                 | ✓      |        | <ul style="list-style-type: none"> <li>Activation</li> <li>Deactivation</li> </ul>                                                               | Activation        | Indicates the active/deactive operation for the C_IC/P_AC point.                                                                                                                                           |
|                 | ✓      |        | <ul style="list-style-type: none"> <li>Read</li> <li>Freeze</li> <li>Freeze with reset</li> <li>Reset</li> </ul>                                 | Read              | Indicates the operation mode for C_CI control command.                                                                                                                                                     |
| Qualifier       | ✓      | ✓      | <ul style="list-style-type: none"> <li>Default</li> <li>Short pulse</li> <li>Long pulse</li> <li>Persistent output</li> </ul>                    | Persistent output | Indicates the qualifier for C_SC/C_DC/C_RC control command.<br><br>When it is received, a C_SC/C_DC/C_RC command with 'default qualifier,' the server operates the command with this configured qualifier. |
|                 | ✓      |        | G/1/2/3/4/5/6/7/8/9/10/11/12/13/14/15/16                                                                                                         | G                 | Indicates the interrogation group for C_IC control command.                                                                                                                                                |
|                 | ✓      |        | 1/2/3/4/G                                                                                                                                        | 1                 | Indicates the counter interrogation group for C_CI control command.                                                                                                                                        |

| Field                | Client | Server | Value Scope                                                                                          | Default Value           | Description                                                                                                                                                                                                      |
|----------------------|--------|--------|------------------------------------------------------------------------------------------------------|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                      | ✓      |        | <ul style="list-style-type: none"> <li>General</li> <li>Event</li> </ul>                             | General                 | Indicates general reset or event clear for C_RP control command.                                                                                                                                                 |
|                      | ✓      |        | <ul style="list-style-type: none"> <li>Threshold</li> <li>Low limits</li> <li>High limits</li> </ul> | Threshold               | Indicates the parameter type to set for P_ME_A/P_ME_B/P_ME_C point.                                                                                                                                              |
| Threshold            | ✓      | ✓      | 0...32767                                                                                            | 0                       | Indicates the default threshold value for M_ME_A/M_ME_B point to trigger event.                                                                                                                                  |
|                      | ✓      | ✓      | 0~3.4028234-66385288E+38                                                                             | 0                       | Indicates the default threshold value for M_ME_C point to trigger event.                                                                                                                                         |
| Low Limit            | ✓      | ✓      | -32768...32767                                                                                       | —32768                  | Indicates the low limit value for M_ME_A/M_ME_B point to trigger event.                                                                                                                                          |
|                      | ✓      | ✓      | -3.402823466-385288E+38~3.40282-3466385288E+38                                                       | —3.4028234-66385288E+38 | Indicates the low limit value for M_ME_C point to trigger event.                                                                                                                                                 |
| High Limit           | ✓      | ✓      | —3.40282346-6385288E+38~3.40282-3466385288E+38                                                       | 3.4028234-66385288E+38  | Indicates the high limit value for M_ME_C point to trigger event.                                                                                                                                                |
|                      | ✓      | ✓      | -32768...32767                                                                                       | 32767                   | Indicates the high limit value for M_ME_A/M_ME_B point to trigger event.                                                                                                                                         |
| Short Pulse Duration |        | ✓      | 0~4294967295 ms                                                                                      | 100 ms                  | Indicates the short pulse duration for C_SC/C_DC/C_RC control point.                                                                                                                                             |
| Long Pulse Duration  |        | ✓      | 0~4294967295 ms                                                                                      | 1000 ms                 | Indicates the long pulse duration for C_SC/C_DC/C_RC control point.                                                                                                                                              |
| Need Select          |        | ✓      | Check box                                                                                            | Selected                | Indicates the need to select before operation for C_SC/C_DC/C_RC/C_SE_A/C_SE_B/C_SE_C control command.                                                                                                           |
| Cdc Mode             |        | ✓      | <ul style="list-style-type: none"> <li>Determinate state</li> <li>Indeterminate state</li> </ul>     | Determinate state       | Indicates the pulse recovery state for C_DC command. In determinate state mode, it recovers to the previous on (2)/ off (1) state. In indeterminate state mode, it recovers to the fixed intermediate (0) state. |
| Qualifier            |        | ✓      | <ul style="list-style-type: none"> <li>Threshold</li> <li>Low limits</li> <li>High limits</li> </ul> | Threshold               | Indicates the parameter type to set for P_ME_A/P_ME_B/P_ME_C point.                                                                                                                                              |
| Event Routing        |        |        |                                                                                                      |                         |                                                                                                                                                                                                                  |
| Route Channel        | ✓      |        | Disable/Enable                                                                                       | Disable                 | Indicates whether the event routing function is disabled or enabled.                                                                                                                                             |
| Route Session        | ✓      |        | 0                                                                                                    | 0                       | Indicates the session number to route.                                                                                                                                                                           |
| Route Sector         | ✓      |        | Server device list                                                                                   | First device            | Indicates the device to route.                                                                                                                                                                                   |
| Route Point          | ✓      |        | 1...16777215                                                                                         | 1                       | Indicates the information object address to route.                                                                                                                                                               |
| Routing Offline      | ✓      |        | <ul style="list-style-type: none"> <li>Valid quality</li> </ul>                                      | Valid quality           | Specifies the flag when routing channel is offline.                                                                                                                                                              |

| Field                                                         | Client | Server | Value Scope                                                       | Default Value         | Description                                                                                                                |
|---------------------------------------------------------------|--------|--------|-------------------------------------------------------------------|-----------------------|----------------------------------------------------------------------------------------------------------------------------|
|                                                               |        |        | <ul style="list-style-type: none"> <li>Invalid quality</li> </ul> |                       |                                                                                                                            |
| Background Scan                                               | ✓      | ✓      | Check box                                                         | Deselected (disabled) | Indicates the background scan is enabled. (The check box is selected.)                                                     |
| Cyclic Data Transmission                                      | ✓      | ✓      | Check box                                                         | Deselected (disabled) | Indicates the cyclic data transmission is enabled. (The check box is selected.)                                            |
| Event Generation                                              | ✓      | ✓      | Check box                                                         | Selected (fixed)      | Indicates that events for points can be configured.                                                                        |
| Groups                                                        |        |        |                                                                   |                       |                                                                                                                            |
| Global 1/<br>2/3/4/5/6/<br>7/8/9/10/<br>11/12/13/<br>14/15/16 | ✓      | ✓      | Check box                                                         | Global                | Defines the data object group responding to the interrogation command from the client. It can be a combination of options. |

## DNP3 Events

### Introduction

You can configure the **Events** tab for DNP3 NET server channels.

### Access the Configuration Tab

Access the configuration parameters on the **EVENTS** tab in Control Expert:

| Step | Action                                                                                                                                                               |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Access the DTM configuration for your module, page 75.                                                                                                               |
| 2    | Confirm that you already created client or server channels.                                                                                                          |
| 3    | In the <b>CONFIGURATION</b> menu, expand (+) the <b>Channels/Devices</b> sub-menu.                                                                                   |
| 4    | Select <b>DNP3 NET Server</b> from the <b>Channels/Devices</b> sub-menu.<br><b>NOTE:</b> The <b>EVENTS</b> tab is not available for <b>DNP3 NET Client</b> channels. |
| 5    | Select the tab <b>EVENTS</b> tab.                                                                                                                                    |
| 6    | Configure the event parameters.<br><b>NOTE:</b> The parameters on the <b>Events</b> tab are similar to the DNP3 data mapping parameters, page 87.                    |
| 7    | Click the <b>OK</b> or <b>Apply</b> button to implement your configuration changes.                                                                                  |

**NOTE:** Configure the DNP3 SAV5 security events (object 121/122) on the web pages, page 121

### Events Parameters

**GENERATE EVENTS** dialog:

| Field         | Parameter    | Description                                                                                                     |
|---------------|--------------|-----------------------------------------------------------------------------------------------------------------|
| Data Mappings | Point Number | Start point number of the point (min: 0, max: 65535, default: 0)                                                |
|               | Point Count  | Number of the points (min: 0, max: 7000, default: 1)                                                            |
|               | Object Group | Object group to read (default: binary input)                                                                    |
|               | Point Name   | Name of located or unlocated register (default: –, forbidden symbol: {} " [], max length: 50) default: CE_P0_P0 |

| Field | Parameter      | Description                                                                                                   |
|-------|----------------|---------------------------------------------------------------------------------------------------------------|
|       | Add CMD_STATUS | Specify CMD_STATUS variable name (default: check box deselected)                                              |
|       | Point Name     | Name of located or unlocated register (default: –, forbidden symbol: { } " [], max length: 50) default: empty |

**CLEAR EVENTS** dialog:

| Field         | Parameter      | Description                                                                                                      |
|---------------|----------------|------------------------------------------------------------------------------------------------------------------|
| Data Mappings | Object Group   | Object group to read (default: binary input)                                                                     |
|               | Point Name     | Name of located or unlocated register (default: –, forbidden symbol: { } " [], max length: 50) default: CE_P0_P0 |
|               | Add CMD_STATUS | Specify CMD_STATUS variable name (default: check box deselected)                                                 |
|               | Point Name     | Name of located or unlocated register (default: –, forbidden symbol: { } " [], max length: 50) default: empty    |

**Generating Events in the Server**

In the server DTM configuration tab, the device DDT structure (unlocated variable) looks like this:

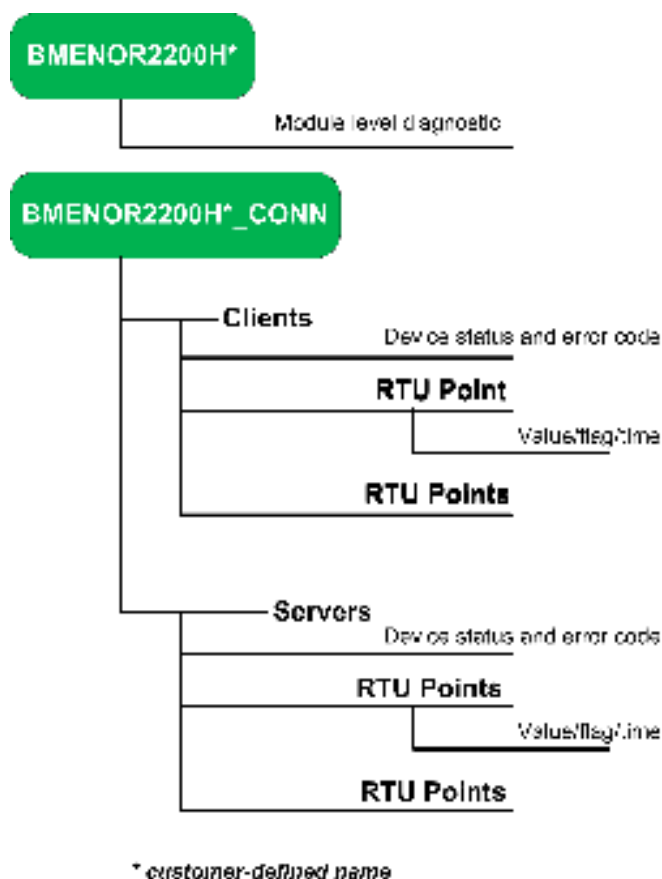
| Name                    | Type          |
|-------------------------|---------------|
| BME_NOR_2200H           | T_BME_N...    |
| BME_NOR_2200H_CONN      | T_BME_N...    |
| Client00                | T_BME_N...    |
| Device_State            | BYTE          |
| Error_Code              | WORD          |
| AI_P0_P0                | ARRAY[S...    |
| BOST_P0_P0              | Bin_Outpu...  |
| BI_P0_P0                | Binary_inp... |
| TmSync_0000_CB          | Time_Sync...  |
| BCnt_P0_P0              | Counter_...   |
| Server00                | T_BME_N...    |
| Device_State            | BYTE          |
| Error_Code              | WORD          |
| BI_P0_P0                | ARRAY[S...    |
| DI_P0_P0                | ARRAY[S...    |
| AI_P0_P0                | Analog_In...  |
| Rags                    | BYTE          |
| Timestamp               | CPSTime...    |
| Value                   | DINT          |
| AO_P0_P0                | Analog_O...   |
| BI_P10_P10              | Binary_inp... |
| Event_STAT_BinaryInput  | EVENT_S...    |
| Event_STAT_BinaryOutput | EVENT_S...    |
| Event_STAT_AnalogInput  | EVENT_S...    |

where (as shown in the following illustration:

- The customer-defined variable name corresponds to the T\_BME\_NOR type.
- The client corresponds to these RTU points:
  - Device\_State: BYTE type
  - Error\_Code: WORD type
  - AI\_Px: Analog\_input\_xxx Type
 

**NOTE:** When the point count is less than 1, the point type uses the ARRAY format.
  - BOST\_P0\_P0: Bin\_Output\_xxx type
  - BI\_P0\_P0: Binary\_Input\_xxx type
  - TmSync\_0000\_CB: Time\_Sync type
  - BCnt\_P0\_P0: Counter\_... type
- The server corresponds to the following RTU points:

- Device\_State: BYTE type
- Error\_Code: WORD type
- BI\_P0\_P0: Binary\_Input\_xxx type
- DI\_P0\_P0: Double\_Input\_xxx type
- AI\_P0\_P0: Analog\_Input type (Flags, Timestamp, Value)
- AO\_P0\_P0: Analog\_Output type
- BI\_P10\_P10: Binary\_Input\_xxx type
- Event\_STAT\_BinaryInput: WORD type (counter); BYTE type (overflow)
- Event\_STAT\_BinaryOutput: WORD type (counter); BYTE type (overflow)
- Event\_STAT\_AnalogInput: WORD type (counter); BYTE type (overflow)



## Clearing Events in the Server

*Clear\_Events* supports a new point type which clears the event buffer in the DNP3 server. It enables the user to clear the events buffer in a local or remote SCADA through mapping memory.

*Clear\_Events* can be created only for DNP3 server; select Data Mapping.

When the value of the *Clear\_Events* register changes, the BMENOR2200H module clears the events of the object group in the configuration.

| Parameter            | Value Scope                                                                                                     | Definition                                                  |
|----------------------|-----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
| <i>Object Group</i>  | All Objects<br>Binary Input<br>Double Input<br>Binary Counter<br>Analog Input<br>Binary Output<br>Analog Output | Specifies the object group whose event is cleared o. demand |
| <i>Variable Name</i> | —                                                                                                               | Indicates the name of the located register.                 |

## IEC 60870-5-104 Events

### Access the Configuration Tab

Access the configuration parameters on the **EVENTS** tab in Control Expert:

| Step | Action                                                                                                                                                                                           |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Access the DTM configuration for your module, page 74.                                                                                                                                           |
| 2    | Confirm that you already created client and/or server channels, page 76.                                                                                                                         |
| 3    | In the <b>CONFIGURATION</b> menu, expand (+) the <b>Channels/Devices</b> sub-menu.                                                                                                               |
| 4    | Make one of the following selections in the <b>Channels/Devices</b> sub-menu: <ul style="list-style-type: none"> <li>• <b>IEC104 Client</b></li> <li>• <b>IEC104 Server</b></li> </ul>           |
| 5    | <ul style="list-style-type: none"> <li>• Select the specific channel in the sub-menu.</li> <li>• Select the specific device in the sub-menu.</li> </ul>                                          |
| 6    | Select the <b>EVENTS</b> tab.                                                                                                                                                                    |
| 7    | Configure the event parameters.<br><b>NOTE:</b> The event parameters are similar to the data mapping parameters, page 99.                                                                        |
| 8    | <ul style="list-style-type: none"> <li>• Select <b>Apply</b> to implement your configuration changes.</li> <li>• Select <b>OK</b> to implement your changes and close the dialog box.</li> </ul> |

## Export and Import .xml Files with the DTM

### Introduction

A BMENOR2200H module stores its configuration in an .xml file. You can use the import and export functions in the Control Expert DTM to share that file among different modules to implement the same configuration.

Use the Control Expert **EXPORT/IMPORT** functionality:

- *export*: Save the module and protocol configurations to an .xml file.
- *import*: Import .xml files that include configuration parameters and data mapping to one or more modules.

### Use Cases

These practical examples represent some common implementations of the import and export functions:

| Use Case                       | Action                                                                                                                                                                                                                                                                                                                                                                       |                                                                                |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| <b>Redundant Configuration</b> | 1                                                                                                                                                                                                                                                                                                                                                                            | Export the .xml configuration file from a BMENOR2200H module.                  |
|                                | 2                                                                                                                                                                                                                                                                                                                                                                            | Import the .xml configuration file to one <i>or more</i> BMENOR2200H modules.  |
|                                | 3                                                                                                                                                                                                                                                                                                                                                                            | Reuse the BMENOR2200H module's configuration file in other BMENOR2200H modules |
| <b>Project Migration</b>       | Migrate the configuration file from a BMXNOR0200H module to a BMENOR2200H module.<br><br><b>NOTE:</b> All located addresses are lost after the import of .xml files from the BMXNOR0200H module. The type and length of the name are changed according to the new format. Account for the data type substitutions that are required when you migrate the XML file, page 170. |                                                                                |

## Import

Import an .xml configuration file:

| Step | Action                                                                                                                                                                                                                                                                                                                                                |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Access the DTM configuration for your module, page 75.                                                                                                                                                                                                                                                                                                |
| 2    | In the <b>CONFIGURATION</b> menu, expand (+) the <b>General</b> sub-menu.                                                                                                                                                                                                                                                                             |
| 3    | Select <b>Export / Import</b> .                                                                                                                                                                                                                                                                                                                       |
| 4    | In the <b>Import / Export</b> dialog, click the <b>Browse</b> button in the <b>Import File Name</b> field to find the .xml configuration file name path you want to import, located on your local or network drive.                                                                                                                                   |
| 5    | Select the respective configuration file and click the <b>Open</b> button to enter the file name path for the <b>Import File Name</b> field.                                                                                                                                                                                                          |
| 6    | Select or deselect the <b>Use system defined data mapping point names</b> check box: <ul style="list-style-type: none"> <li><i>selected</i>: The import setting allows you to import user-defined mapping point names.</li> <li><i>deselected</i>: Data mapping point name is assigned based on point type, point number, and point count.</li> </ul> |
| 7    | Select the <b>Import</b> button.                                                                                                                                                                                                                                                                                                                      |
| 8    | Select <b>Apply</b> to save your changes, or select <b>OK</b> to save your changes and close the dialog.                                                                                                                                                                                                                                              |

## Export

Export an .xml configuration file:

| Step | Action                                                                                                                                                                                                                                                                                                                                                |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Access the DTM configuration for your module, page 75.                                                                                                                                                                                                                                                                                                |
| 2    | In the <b>CONFIGURATION</b> menu, expand (+) the <b>General</b> sub-menu.                                                                                                                                                                                                                                                                             |
| 3    | Select <b>Export / Import</b> .                                                                                                                                                                                                                                                                                                                       |
| 4    | In the <b>Import / Export</b> dialog, copy/paste the path file name of the .xml configuration file saved from the BMENOR module and protocol parameters, which you want to export to a local drive, in the <b>Import File Name</b> field.                                                                                                             |
| 5    | Select or deselect the <b>Use system defined data mapping point names</b> check box: <ul style="list-style-type: none"> <li><i>selected</i>: The import setting allows you to import user-defined mapping point names.</li> <li><i>deselected</i>: Data mapping point name is assigned based on point type, point number, and point count.</li> </ul> |
| 6    | Select the <b>Export</b> button.<br><br><b>NOTE:</b> The .xml configuration file is exported to a pre-determined location on your local or network drive.                                                                                                                                                                                             |
| 7    | Select <b>Apply</b> to save your changes, or select <b>OK</b> to save your changes and close the dialog.                                                                                                                                                                                                                                              |

## Bulk Configuration

| Step | Action                                                                                                                                                                                                                              |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Access the DTM configuration for your module, page 75.                                                                                                                                                                              |
| 2    | In the <b>CONFIGURATION</b> menu, expand (+) the <b>Communication</b> sub-menu.                                                                                                                                                     |
| 3    | Select <b>Channel Configuration</b> .                                                                                                                                                                                               |
| 4    | To edit, double-click the pencil in the <b>Bulk Configuration</b> tab of the <b>CLIENT CHANNELS</b> dialog.<br><br><b>Result:</b> An <b>Open</b> dialog box appears where you can navigate to the required bulk configuration file. |
| 5    | Select the <b>DataMapping_BulkConfiguration.xlsx</b> file to the required folder required in step 4 and open the Excel worksheet.                                                                                                   |
| 6    | Based on the requirement, (data points for server and client for IEC or DNP3), copy the respective data to the IEC Client or IEC Server worksheet.                                                                                  |
| 7    | Open the corresponding data mapping, and the data should be successfully imported.                                                                                                                                                  |
| 8    | Save and import the Excel worksheet.                                                                                                                                                                                                |

Excel worksheet details:

- IEC Server: IECDataPoint\_Ref sheet to IECServer
- IEC Client: IECDataPoint\_Ref sheet to IECClient
- DNP3 Server: DNP3DataPoints\_Ref to DNP3Server
- DNP3 Client: DNP3DataPoints\_Ref to DNP3Client

## Module Information in the DTM

### Access the Information

View the **Module Information** function in the Control Expert DTM:

| Step | Action                                                                    |
|------|---------------------------------------------------------------------------|
| 1    | Access the DTM configuration for your module, page 75.                    |
| 2    | In the <b>CONFIGURATION</b> menu, expand (+) the <b>General</b> sub-menu. |
| 3    | Select <b>Module Information</b> .                                        |

### Description

The **Module Information** page shows read-only information:

- **IP ADDRESS INFORMATION:** These fields contain the IP parameters for the module.
- **MEMORY STATUS:**
  - **Input:** The level indicator displays the memory usage (in bytes) for input memory type.
  - **Output:** The level indicator displays the memory usage (in bytes) for output memory type.

### Limitations

Monitor the consumed implicit resources while respecting the total size of input and output types as follows:

| Type   | Memory    |
|--------|-----------|
| Input  | 8 K bytes |
| Output | 8 K bytes |

**NOTE:** For details, refer to the description of the I/O data exchange with the CPU, page 24.

# Cyber Security Configuration

## About Cyber Security Web Pages

### Introduction to Cyber Security Web Pages

#### Introduction

The BMENOR2200H module has a built-in Hyper Text Transfer Protocol Secure (HTTPS) web server that provides access to various secure web pages. Use these pages to monitor the status of the module without installing Control Expert or the module's corresponding DTM.

Use these web pages to import, export, or delete encrypted cyber security management files.

You can monitor the security of communications through the **SEC LED**, page 19.

**NOTE:** Web page access is available only when the module is in secure mode. Refer to the directions for configuring the appropriate level of cyber setting with the rotary switch, page 22.

#### Before You Begin

Use the web pages described in this chapter to apply cyber security features to configured channels on the BMENOR2200H module

You can apply cyber security to the module after you satisfy these requirements:

- You have configured at least one communications channel for the module in the Control Expert DTM.
- You have configured the appropriate setting (**Secured**) on the rotary switch, page 22.

The first time you log in to secure mode, the cyber security file is not valid. Therefore, follow these steps to configure the file:

| Stage | Description                                                                       |
|-------|-----------------------------------------------------------------------------------|
| 1     | Log in to the web pages as an administrator., page 115                            |
| 2     | Access the cyber security setting page., page 109                                 |
| 3     | Configure the event log with a valid IP address (or disable event log)., page 111 |
| 4     | Apply the configuration to the module.                                            |

#### Main Features

This list represents the major cyber security features for the module in terms of communications management:

- individual security:
  - HTTPS, page 109
  - DNP3/IEC 60870-5-104, page 49
- confidential transmission:
  - HTTPS, page 109
  - DNP3/IEC 60870-5-104, page 49
- enabled/disabled unused services:
  - SNMP v1, page 38
  - Modbus TCP server
  - DNP3/IEC 60870-5-104 server

## Browser Requirements

The BMENOR2200H module's HTTPS web server facilitates secure remote and local access to the embedded web pages through these standard browsers:

- Google Chrome 50+ (recommended)
- Mozilla Firefox 40+
- Microsoft Edge 14+
- Internet Explorer 11

## Web Page Access

### Access the Web Pages

| Step | Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Enter the module's IP address or URL ( <code>https://...</code> ) in a web browser to open the module's <b>Home</b> page.<br><b>NOTE:</b> <ul style="list-style-type: none"><li>• Web access via the URL is not supported by the BMENOR2200H module, but it can be implemented by system integration.</li><li>• You may see an on-screen message that says the web pages are not secured. Ignore this message and open the web page.</li><li>• When the module processes a heavy communications load, the web page may not open immediately. In this case, execute your browser's refresh function.</li></ul> |
| 2    | In the pull-down menu, select the appropriate language.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 3    | Enter the default user name and password that conforms to the selected cyber security mode, page 18 the first time you access the web: <ul style="list-style-type: none"><li>• <b>Secured</b> cyber security mode:<ul style="list-style-type: none"><li>◦ <i>user name:</i> <b>admin</b></li><li>◦ <i>password:</i> <b>password</b></li></ul></li><li>• <b>Standard</b> cyber security mode:<ul style="list-style-type: none"><li>◦ <i>user name:</i> <b>installer</b></li><li>◦ <i>password:</i> <b>Inst@ller1</b></li></ul></li></ul>                                                                       |
| 4    | Click the <b>Login</b> button.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 5    | Change your user name and password when prompted.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

You can now access these tabs from the **Home** page:

- **Setup**, page 109
- **Diagnostics**, page 123

## Cyber Security Setup

### Cyber Security Web Page

#### Access the Parameters

Access the cyber security parameters for the BMENOR2200H module:

| Step | Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Access the cyber security web pages for the module, page 109.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 2    | Select the <b>SETUP</b> tab in the page banner.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 3    | Expand one of these sub-menus in the Cybersecurity Settings menu: <ul style="list-style-type: none"> <li>• <b>DEVICE SECURITY SETTINGS &gt; User Account Policy</b> <ul style="list-style-type: none"> <li>◦ Event Logs</li> <li>◦ Network Services</li> <li>◦ Security Banner</li> <li>◦ Hot Standby</li> </ul> </li> <li>• <b>CERTIFICATES MANAGEMENT</b> <ul style="list-style-type: none"> <li>◦ PKI Configuration</li> <li>◦ Trust List Management</li> <li>◦ Root CA Management</li> </ul> </li> <li>• <b>DNP3 SECURE AUTHENTICATION</b> <ul style="list-style-type: none"> <li>◦ Client Configuration</li> <li>◦ Server Configuration</li> <li>◦ Key Management</li> </ul> </li> <li>• <b>IEC 60870-5-104 SECURE AUTHENTICATION</b> <ul style="list-style-type: none"> <li>◦ Client Configuration</li> <li>◦ Server Configuration</li> </ul> </li> <li>• <b>MANAGEMENT</b> <ul style="list-style-type: none"> <li>◦ User Management</li> <li>◦ Configuration Management</li> </ul> </li> </ul> |

## Firmware Modifications

Most web pages have **Apply** or **OK** buttons to allow you to apply or save your modifications.

The firmware, however, is updated (or not) with the buttons in the banner across the top of each web page:

- **Apply:** Click to apply modifications to the firmware.
- **Discard:** Click to discard modifications.

## Device Security Settings

### Access the Settings

Access the **DEVICE SECURITY SETTINGS** from the **SETUP** web page:

| Step | Action                                                                                                                                                                                                                                                                                                                                                   |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Access the cyber security web pages for the module, page 109.                                                                                                                                                                                                                                                                                            |
| 2    | Select the <b>SETUP</b> tab in the page banner.                                                                                                                                                                                                                                                                                                          |
| 3    | Expand the <b>MENU</b> navigation tree.                                                                                                                                                                                                                                                                                                                  |
| 4    | Expand the <b>DEVICE SECURITY SETTINGS</b> in the navigation tree banner to see these settings: <ul style="list-style-type: none"> <li>• <b>User Account Policy</b> <ul style="list-style-type: none"> <li>◦ <b>Event Logs</b></li> <li>◦ <b>Network Services</b></li> <li>◦ <b>Security Banner</b></li> <li>◦ <b>Hot Standby</b></li> </ul> </li> </ul> |

**NOTE:** These security settings are described individually below. When the Control Expert window is active, you can hover the cursor over any field or click the information (i) icon to see a description of the functionality and the available range of values.

## User Account Policy

Apply time and attempt limits to user interactions:

| Parameter                                   | Description                                                                                                                                                                |
|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Session maximum inactivity (minutes)</b> | The idle session timeout period for HTTPS connections.                                                                                                                     |
| <b>Maximum login attempts</b>               | The number of times a user may attempt, and fail, to login.<br><b>NOTE:</b> When this maximum is reached, no additional logins may be attempted for the configured period. |
| <b>Login attempt timer (minutes)</b>        | The maximum time to enter a user password.                                                                                                                                 |
| <b>Account locking duration (minutes)</b>   | Time period during which no additional logins may be attempted after the maximum login attempts is reached.                                                                |
| <b>Apply</b>                                | Click this button to apply your changes.                                                                                                                                   |

## Event Logs

Configure the syslog client in the module. The logs are stored locally in the module and exchanged with a remote syslog server:

| Parameter                       | Description                                                                                                                                     |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Service activation</b>       | Turn the Syslog client service on or off.                                                                                                       |
| <b>Syslog server IP address</b> | This is the IPv4 address of the syslog server.<br><b>NOTE:</b> If you configure the Syslog server, all events are forwarded to this IP address. |
| <b>Syslog server port</b>       | The Syslog client service uses this port number.                                                                                                |
| <b>Apply</b>                    | Click this button to apply your changes.                                                                                                        |

Refer to the topic [Event Log Descriptions](#), page 178 for a description of event log entries.

## Network Services

The SNMP, Syslog, and Modbus network services are not inherently secure protocols. They are rendered secure when they are installed in external VPN devices.

The synergy of these network services constitutes a firewall that permits or denies the passage of communications through the RTU module

Configuration:

| Service           | Enforce Security | Unlock Security |
|-------------------|------------------|-----------------|
| SNMP Agent        | disabled         | enabled         |
| Modbus TCP Server | disabled         | enabled         |
| DNP3 Server       | enabled          | disabled        |
| IEC 60870-5-104   | enabled          | disabled        |

## Security Banner

| Parameter          | Description                                            |
|--------------------|--------------------------------------------------------|
| <b>Banner text</b> | View this editable text when you access the web pages. |

## HSBY

- In secured mode, the BMENOR2200H module first boots from the factory mode. Configure the Hot Standby cyber security settings. The module uses TLS V1.2.
- In non-secured mode, the BMENOR2200H Hot Standby module's internal communication disables DTLS.

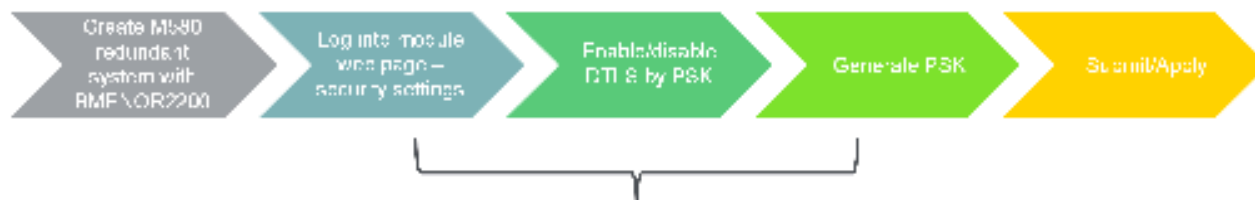
Navigate to the **HSBY SECURITY SETTINGS** field on the **SETUP** web page to configure Hot Standby cyber security.

| Parameter      | Description                                                                                                                                 |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| Enable DTLS    | <ul style="list-style-type: none"> <li>• Select the check box to enable DTLS.</li> <li>• Deselect the check box to disable DTLS.</li> </ul> |
| Pre-shared Key | Enter a key value of 16 characters.                                                                                                         |

## Communication over DTLS

### Hot Standby over DTLS

In a Hot Standby system, the BMENOR2200H module supports datagram transport layer security (DTLS). This cyber security feature helps defend against attacks by hiding Hot Standby communication in encrypted traffic.



You can enable or disable the DTLS protocol for each module. The feature is enabled by default when the module is in secure mode. Enter the pre-shared key or disable DTLS when the BMENOR2200 module initially boots (like the syslog function).

## Connecting via the HTTPS Protocol

If your application experiences connection problems, check with your local IT support to confirm that your network configuration and security policies are consistent with HTTPS (port 443) access to the RTU module IP address.

The RTU module accepts the HTTPS connections with transport layer security (TLS) protocol v1.2 or later. For example, Windows 7 could require an update to enable TLS 1.2 to upgrade the firmware of the RTU module or access to its web site.

## DNP3 Client Channel Configuration

The **Add Channel** dialog has the following configurable elements:

- **Channel Name:** Enter the name for the DNP3 over TLS Channel.
- **Enable TLS:**
  - Select the check box to enable TLS.
  - Deselect the check box to disable TLS.

## DNP3 Server Channel Configuration

The server channel configuration has the following parameters:

- **Channel Name:** Enter the name for the DNP3 over TLS Channel
- **Secure Authentication:** Select an option from the drop-down list:

- SAV2
- SAV5 (default)
- Disabled
- **Key/Account Table:** Table for client/server with these options:
  - User Number
  - User Name
  - User Role: Operator, viewer, or single user
  - Key Wrap: Select AES-128 or AES-256
  - Key: Enter the key wrap algorithm, in hex formatClick **Apply** to save.
- **Secure Authentication Enabled**
- **TLS Enabled**
  - Select the check box to enable TLS.
  - Deselect the check box to disable TLS.
- **Add User:** Click this button to add and configure permissions for another user.

## IEC 608705-104 Client Channel Configuration

The client channel configuration has the following parameters:

- **Channel Name:** Enter the name for the IEC 60870-5-104 over TLS Channel
- **TLS Enabled:**
  - Select the check box to enable TLS.
  - Deselect the check box to enable TLS.
- **Add Channel:** Click this button to configure another channel.

## IEC 60870-5-104 Server Channel Configuration

The server channel configuration has the following parameters:

### TLS Enabled

- Select the check box to enable TLS.
- Deselect the check box to disable TLS.

## DNP3 Secure Authentication

### About DNP3 Secure Authentication

The implementation of DNP3 secure authentication (SA) facilitates mutual authentication for communications between a DNP3 client and a DNP3 server:

- A DNP3 server uses DNP3 SA to unambiguously determine that it is communicating with a user who is authorized to access the services of the server.

**NOTE:** Secure authentication option is enabled by default. The server works properly only when a valid server channel is configured in the cyber security settings. Disable this function when your application does not require secure authentication. This global setting applies to all server channels. You cannot enable or disable a single specific channel independently of other channels. If the DNP3 service is disabled, no channels work, regardless of the configured security level.

- A DNP3 client uses DNP3 SA to unambiguously determine that it is communicating with the appropriate server.

**NOTE:** On the client side, you can configure individual client channels for secure authentication. For such cases, confirm that those channels are included in the table with an assigned security level (None, SAV2, SAV5).

## Access the Settings

Access the **DNP3 SECURE AUTHENTICATION** page from the **SETUP** web page:

| Step | Action                                                                                                                                                                                                                                                                                                                           |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Access the cyber security web pages for the module, page 109.                                                                                                                                                                                                                                                                    |
| 2    | Select the <b>SETUP</b> tab in the page banner.                                                                                                                                                                                                                                                                                  |
| 3    | Expand the <b>MENU</b> navigation tree.                                                                                                                                                                                                                                                                                          |
| 4    | Expand the <b>DNP3 SECURE AUTHENTICATION</b> in the navigation tree banner to see these settings: <ul style="list-style-type: none"> <li>• <b>Client Configuration</b></li> <li>• <b>Server Configuration</b></li> <li>• <b>Key Management</b></li> </ul> <b>NOTE:</b> These security settings are described individually below. |

- For the client channel, refer to the configuration topic, page 112.
- For the server channel, refer to the configuration topic, page 112.

## Key Management

Create a list of users that can access your module:

| Step | Description                                                                                                                                                                                                                                   |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | In the <b>Key Management</b> web page, press the <b>Create Table</b> button and follow the directions to assign a name to the table.<br><b>NOTE:</b> The tables you create appear in a pull-down menu next to the <b>Create Table</b> button. |
| 2    | Press the <b>Add User</b> button to add a list of authorized users at the supervision (SCADA) environment.<br><b>NOTE:</b> You can configure a maximum of 64 users for DNP3 Secure Authentication.                                            |
| 3    | Populate the fields in the <b>Add User</b> dialog box.<br><b>NOTE:</b> When the Control Expert window is active you can hover over the blue circle (i) next to the feature to see an explanation for each field.                              |
| 4    | <i>optional step:</i> For the pre-shared key field ( <b>Update Key</b> ), you have the option to click the <b>Generate</b> button to use a randomly generated key.                                                                            |
| 5    | <i>optional step:</i> You can copy the <b>Update Key</b> information by clicking the copy icon next to the <b>Generate</b> button.<br><b>NOTE:</b> You can copy the key to share the key more easily with the SCADA system.                   |
| 6    | Press the <b>Apply</b> button to add the user to the table of authorized users.                                                                                                                                                               |
| 7    | Repeat these steps to add additional users.<br><b>NOTE:</b> The DNP3 standard limits the number of users to 64.                                                                                                                               |

The user(s) in your table will be able to access your module from the SCADA environment.

This table describes the **Key Management** parameters:

| Parameter           | Description                                                                                                                            |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| <b>CLIENT</b> (tab) | <b>User Number:</b> This number corresponds to the current DNP3 user.<br><b>NOTE:</b> Use the value 1 when this user is assigned SAV5. |
|                     | <b>User Name:</b> This field shows the current user.                                                                                   |

| Parameter           | Description                                                                                                                                                                                                            |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                     | <b>NOTE:</b> Because the BMENOR2200H RTU module acts as a data concentrator, the current user role on the <b>CLIENT</b> side is <b>SINGLE USER</b> .                                                                   |
|                     | <b>Key Wrap:</b> Select the appropriate wrap algorithm ( <b>AES-128</b> , <b>AES-256</b> ). Encryption Standard.<br><b>NOTE:</b> AES-256 does not work with SAv2. In this case, the <b>Update Key</b> value is 32 Hex. |
|                     | <b>Key:</b> This column shows the content of the <b>Update Key</b> value.                                                                                                                                              |
| <b>SERVER</b> (tab) | <b>User Number:</b> This number corresponds to the current DNP3 user.                                                                                                                                                  |
|                     | <b>User Name:</b> This field shows the current user.                                                                                                                                                                   |
|                     | <b>User Role:</b> This field shows the role performed by the user ( <b>OPERATOR</b> , <b>ENGINEER</b> , <b>INSTALLER</b> , <b>SECURITY ADMINISTRATOR</b> , <b>VIEWER</b> , <b>SINGLE USER</b> ).                       |
|                     | <b>Key Wrap:</b> Select the appropriate wrap algorithm ( <b>AES-128</b> , <b>AES-256</b> ). Encryption Standard.<br><b>NOTE:</b> AES-256 does not work with SAv2. In this case, the <b>Update Key</b> value is 32 Hex. |
|                     | <b>Key:</b> This column shows the content of the <b>Update Key</b> value.                                                                                                                                              |

## Cyber Security Management

### Access the Settings

Access the **MANAGEMENT** page from the **SETUP** web page:

| Step | Action                                                                                                                                                                                                                                        |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Access the cyber security web pages for the module, page 109.                                                                                                                                                                                 |
| 2    | Select the <b>SETUP</b> tab in the page banner.                                                                                                                                                                                               |
| 3    | Expand the <b>MENU</b> navigation tree.                                                                                                                                                                                                       |
| 4    | Expand <b>MANAGEMENT</b> in the navigation tree banner to see these settings: <ul style="list-style-type: none"> <li>• <b>Certificates Management</b></li> <li>• <b>User Management</b></li> <li>• <b>Configuration Management</b></li> </ul> |

### Certificates Management

These **Certificates Management** parameters assist in the import and export functions relative to a secure (HTTPS) browser. For detailed information, refer to the **Certificates Management** topic, page 117.

| Parameter                      | Description                                                                                          |
|--------------------------------|------------------------------------------------------------------------------------------------------|
| <b>Name (CN)</b>               | This field shows the name of the certificate.                                                        |
| <b>Distinguished Name (DN)</b> | This field corresponds to the name of the certificate.                                               |
| <b>Expiration Date</b>         | This field shows the expiration date of the certificate.                                             |
| <b>Trusted Certificate</b>     | This field shows the name of a trusted certificate that is purchased from a Certification Authority. |
| <b>Browse</b>                  | Click this button to locate a different certificate.                                                 |
| <b>Submit</b>                  | Click this button to implement the selected <b>Trusted Certificate</b> file.                         |

### User Management

This table describes the **User Management** parameters:

| Parameter | Description                                                                                                                                                                 |
|-----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| User Name | This field shows the current user.                                                                                                                                          |
| Roles     | This field shows the role performed by the user ( <b>OPERATOR, ENGINEER, INSTALLER, SECURITY ADMINISTRATOR</b> ).<br><b>NOTE:</b> A single user can perform multiple roles. |
| Add User  | Click this button to add a maximum of 15 new users with defined roles in the process.<br><b>NOTE:</b> To add a user, use your web page login credentials, page 109.         |

Click the pencil icon to edit these parameters, and click the **Apply** button.

**NOTE:** Hover over the blue circle next to the feature (*i* icon) to see an explanation for each field.

## Configuration Management

Import, export, or reset the cyber security management:

| Parameter                                                                                                                                                                                                                              | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                                                                                                                                                                                                             |   |                                                                                                                                                                                                         |   |                                                                                |   |                                                                                   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|--------------------------------------------------------------------------------|---|-----------------------------------------------------------------------------------|
| <b>IMPORT CONFIGURATION</b>                                                                                                                                                                                                            | <p>Use the <b>IMPORT CONFIGURATION</b> fields to import a cyber security configuration file and apply it to the module. The cyber security settings that are applied with this command overwrite the existing settings and are immediately applied to the module.</p> <p>To import a cyber security configuration file and apply it to the module:</p> <table border="1"> <tr> <td>1</td><td>In the <b>IMPORT</b> page, click the file icon to open a window where you can select a <b>Configuration</b> archive.</td></tr> <tr> <td>2</td><td>Navigate to and select the configuration file you want to import, and click <b>OK</b>.<br/><b>NOTE:</b> This is not the web login password. It is a password for exporting the cyber security settings.</td></tr> <tr> <td>3</td><td>In the <b>IMPORT</b> page, enter your security administrator <b>Password</b>.</td></tr> <tr> <td>4</td><td>Click <b>Upload</b> to apply the selected configuration file to the local module.</td></tr> </table> <p>(See the note below.)</p> <p><b>Configuration Archive:</b> Make a selection.</p> <p><b>Import:</b> Click this button to import the configuration.</p> | 1 | In the <b>IMPORT</b> page, click the file icon to open a window where you can select a <b>Configuration</b> archive.                                                                                        | 2 | Navigate to and select the configuration file you want to import, and click <b>OK</b> .<br><b>NOTE:</b> This is not the web login password. It is a password for exporting the cyber security settings. | 3 | In the <b>IMPORT</b> page, enter your security administrator <b>Password</b> . | 4 | Click <b>Upload</b> to apply the selected configuration file to the local module. |
| 1                                                                                                                                                                                                                                      | In the <b>IMPORT</b> page, click the file icon to open a window where you can select a <b>Configuration</b> archive.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |   |                                                                                                                                                                                                             |   |                                                                                                                                                                                                         |   |                                                                                |   |                                                                                   |
| 2                                                                                                                                                                                                                                      | Navigate to and select the configuration file you want to import, and click <b>OK</b> .<br><b>NOTE:</b> This is not the web login password. It is a password for exporting the cyber security settings.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |   |                                                                                                                                                                                                             |   |                                                                                                                                                                                                         |   |                                                                                |   |                                                                                   |
| 3                                                                                                                                                                                                                                      | In the <b>IMPORT</b> page, enter your security administrator <b>Password</b> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |   |                                                                                                                                                                                                             |   |                                                                                                                                                                                                         |   |                                                                                |   |                                                                                   |
| 4                                                                                                                                                                                                                                      | Click <b>Upload</b> to apply the selected configuration file to the local module.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |   |                                                                                                                                                                                                             |   |                                                                                                                                                                                                         |   |                                                                                |   |                                                                                   |
| <b>EXPORT CONFIGURATION</b>                                                                                                                                                                                                            | <p>Export the cyber security configuration file for the module:</p> <table border="1"> <tr> <td>1</td><td>In the <b>EXPORT</b> page, enter your <b>Password</b>, which is an <b>encryption key</b> to archive the exported configuration file. This password is also used to archive an imported configuration file.</td></tr> <tr> <td>2</td><td>Re-enter your password in the <b>Confirm password</b> field.</td></tr> <tr> <td>3</td><td>Click <b>Export</b> to export the configuration.</td></tr> </table> <p>(See the note below.)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 1 | In the <b>EXPORT</b> page, enter your <b>Password</b> , which is an <b>encryption key</b> to archive the exported configuration file. This password is also used to archive an imported configuration file. | 2 | Re-enter your password in the <b>Confirm password</b> field.                                                                                                                                            | 3 | Click <b>Export</b> to export the configuration.                               |   |                                                                                   |
| 1                                                                                                                                                                                                                                      | In the <b>EXPORT</b> page, enter your <b>Password</b> , which is an <b>encryption key</b> to archive the exported configuration file. This password is also used to archive an imported configuration file.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   |                                                                                                                                                                                                             |   |                                                                                                                                                                                                         |   |                                                                                |   |                                                                                   |
| 2                                                                                                                                                                                                                                      | Re-enter your password in the <b>Confirm password</b> field.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |   |                                                                                                                                                                                                             |   |                                                                                                                                                                                                         |   |                                                                                |   |                                                                                   |
| 3                                                                                                                                                                                                                                      | Click <b>Export</b> to export the configuration.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |   |                                                                                                                                                                                                             |   |                                                                                                                                                                                                         |   |                                                                                |   |                                                                                   |
| <b>RESET CONFIGURATION</b>                                                                                                                                                                                                             | <p>Click the <b>Reset</b> button to restore the factory default cyber security settings for the module.</p> <p>Restart the module to implement the reset.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |   |                                                                                                                                                                                                             |   |                                                                                                                                                                                                         |   |                                                                                |   |                                                                                   |
| <p><b>NOTE:</b> Use the same password to encrypt the <b>EXPORT CONFIGURATION</b> value and decrypt the <b>IMPORT CONFIGURATION</b> value. Only a user with permission to update the configuration file can execute these commands.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |   |                                                                                                                                                                                                             |   |                                                                                                                                                                                                         |   |                                                                                |   |                                                                                   |

## Certificates Management

### Certificates Management With and Without PKI

The BMENOR2200H module relies upon certificates for authentication. To provide cyber security, each entity manages a trust list of all certificates of devices/applications that communicate with it.

The method of certificate management depends on your system design, which may or may not apply a public key infrastructure (PKI) with a certificate authority (CA).

#### Certificate Management without PKI:

Use this certificate management method if your system does not include a CA. Manage certificates in the **Certificates Management** web pages as follows:

- **Self-signed only** is the system default **PKI mode**.
- You can only switch the device **factory reset** mode to **self-signed only** mode.
- Manage the **Certificate Trust List** using the **Add** and **Delete** functions to create an allowed list that is authorized to communicate with the RTU module.
- Export the RTU module certificate to communicated devices using the **Download** command in the **PKI Configuration > Device Certificate** page.

#### Certificate Management with PKI:

Use this certificate management method if your system includes a CA. Manage certificates in the **Certificates Management** web pages as follows:

- Set **PKI mode** to either:
  - **CA only**: if all installed devices support PKI.
  - **Self-Signed & CA**: if some of the installed devices do not support PKI.
- If **PKI mode** is set to **CA only**:
  - Manually enroll each RTU module with the CA.
- If **PKI mode** is set to **Self-Signed & CA**:
  - Manually enroll each RTU module with the CA.
  - Manage the **Certificate Trust List** using the **Add** and **Delete** functions to create an allowed list that is authorized to communicate with the RTU module.

### Authentication Overview

A BMENOR2200H module can be authenticated in two ways:

- Self-signed certificate
- Certificate Authority (CA)

To provide the required level of cyber security, each entity RTU module manages a trust list of all certificates of devices/applications that communicate with it.

The RTU module creates a self-signed certificate for:

- Configuration of the cyber security settings via the module web pages
- Diagnostic of the module via its web pages
- Firmware upgrade

**NOTE:**

- The expiration dates of the trusted certificates are made by reference to the internal Date and Time settings of the RTU module. To help avoid inconsistency, use the NTP service to update the date and time settings of the RTU module, and check that the NTP server is accessible and has an updated time and date settings.
- The RTU module does not automatically manage the expiration dates of certificates.
  - For a self-signed certificate file, it is determined by the device.
  - For a CA certificate file, it depends on the CA agent.

## Managing Certificates

In the RTU module web pages, starting in the **Home** page, select **SETUP** to display links to the following application instance certificate management pages:

- PKI Configuration
- Trust List Management
- Root CA Management

## Certificate Limitations

To support communication with the RTU module, note the self-signed and CA certificate limitations, as follows:

**Self-Signed Certificates:**

- KeyUsage (marked as critical):
  - DigitalSignature
  - KeyEncipherment (No usage for TLS suite based on ephemeral keys such as TLS\_ECDHE\_XXXX; usage for TLS\_RSA\_XXXX)
  - KeyCertSign: when the subject public key is used for verifying signatures on public key certificates (Value TRUE)
  - nonRepudiation
  - dataEncipherment
- Subject Alt Name: In the SAN field the following values can be specified: IPAddress V4/V6, URI
- Basic Constraints:
  - cA field: whether the certified public key may be used to verify certificate signatures (Value TRUE) and pathLenConstraint=0
- Subject Key Identifier:
  - means of identifying certificates that contain a particular public 160-bit SHA-1 hash of the value of the BIT STRING subjectPublicKey (excluding the tag, length, and number of unused bits).
- Extended Key Usage extension:
  - id-kp-serverAuth if TLS Web server authentication
  - id-kp-clientAuth if TLS Web client authentication

**CA Certificates:**

- KeyUsage (marked as critical):
  - DigitalSignature
  - KeyEncipherment (No usage for TLS suite based on ephemeral keys such as TLS\_ECDHE\_XXXX; usage for TLS\_RSA\_XXXX)
  - KeyCertSign: when the subject public key is used for verifying signatures on public key certificates (value FALSE)
  - nonRepudiation
  - dataEncipherment

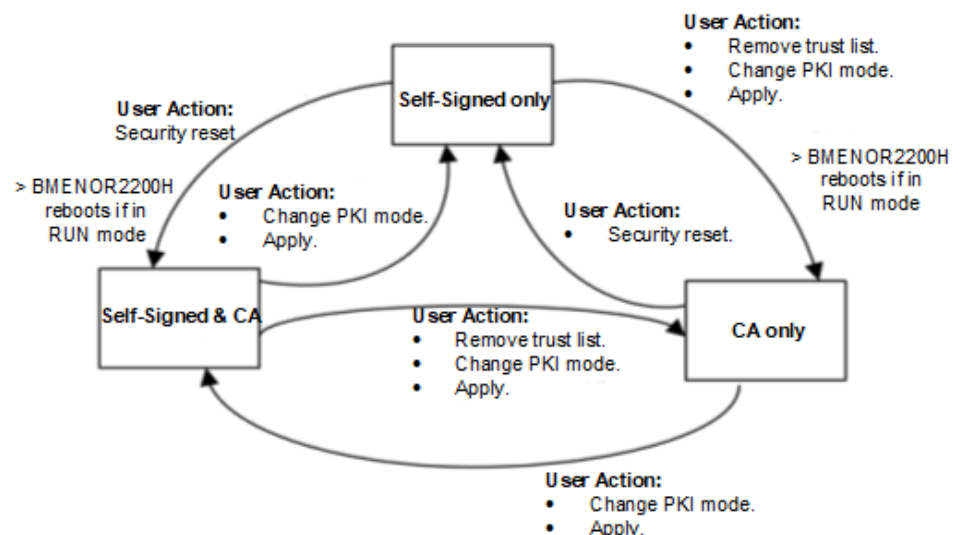
- Subject Alt Name: In the SAN field the following values can be specified:  
IPAddress V4/V6, URI
- Basic Constraints:
  - cA field: whether the certified public key may be used to verify certificate signatures (value FALSE)
- Extended Key Usage extension:
  - id-kp-serverAuth if TLS Web server authentication
  - id-kp-clientAuth if TLS Web client authentication
- CRL Distribution points
- Authority Key Identifier:
  - Identification of the public key corresponding to the private key used to sign a certificate.

## PKI Configuration

Use the **PKI Configuration** page to specify the types of certificates accepted, including:

| PKI Mode           | Description                                                                                                                                                                                                                                                                                          |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Self-Signed only   | Only certificates in the <b>Trusted List Management</b> list ("white list") need to be managed.                                                                                                                                                                                                      |
| CA only            | All system devices need certificates signed by a CA.                                                                                                                                                                                                                                                 |
| Self-Signed and CA | Certificates are managed as follows: <ul style="list-style-type: none"> <li>• The certificate for the RTU module is issued by a CA.</li> <li>• Certificates for devices that support PKI are issued by a CA.</li> <li>• Certificates for devices that do not support PKI are self-signed.</li> </ul> |

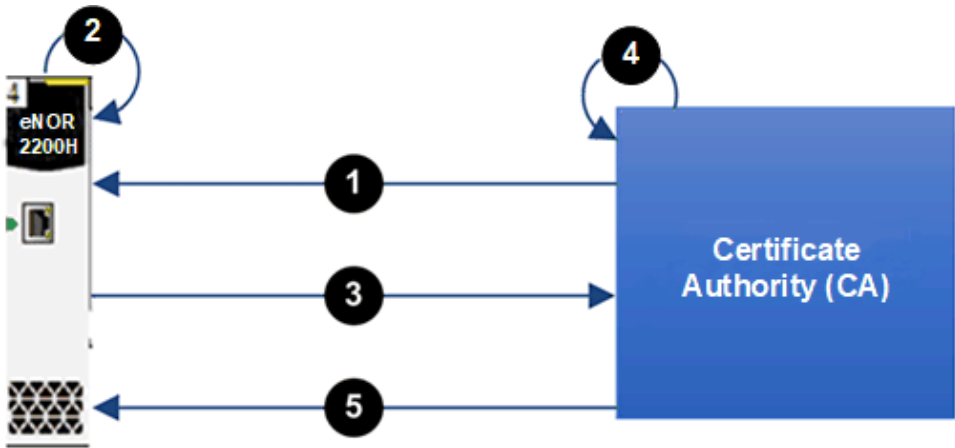
The following diagram illustrates the user actions and events related to changing the PKI mode setting:



## Manual Enrollment

After configuring the RTU module in Control Expert, you can use the **PKI Configuration MENU, ENROLLMENT** section to *get* a CSR file to be submitted to a CA. After submitting the CSR file, you can then extract the correspondent CA certificate. Thereafter, you can push this CA Certificate into the RTU module. The combined get and push operations manually enroll a certificate issued by a third-party CA. After the certificate is pushed, the server applies this certificate for the purpose of signing and encrypting its communication with the client.

The following is an overview of the manual certificate enrollment process:



- 1 BMENOR2200H imports a Root CA Management MENU from the certificate authority (CA).
- 2 BMENOR2200H generates a certificate signing request (CSR).
- 3 BMENOR2200H exports the CSR to the CA.
- 4 The CA executes the CSR and generates a certificate.
- 5 BMENOR2200H imports the certificate from the CA.

Trust List Management

Only devices that have provided the RTU module with an application instance certificate can communicate with RTU. The module implements local (module-based) management of application instance certificates, which are stored in a trust list. Use the commands on the **Certificates Management** web pages to **Add**, **Download**, or **Delete** a certificate.

**NOTE:** Application instance trust list certificates are encoded in ANSI CRT.

To add a certificate to the list:

| Step | Action                                                                                                                            |
|------|-----------------------------------------------------------------------------------------------------------------------------------|
| 1    | In the Trust List management menu, click <b>Browse</b> , then navigate to and select the certificate you want to add to the list. |
| 2    | Click <b>Submit</b> to add the certificate.                                                                                       |
| 3    | Click <b>Apply</b> to save the change to the configuration.                                                                       |

To remove a certificate from the list:

| Step | Action                                                      |
|------|-------------------------------------------------------------|
| 1    | In the trust list, click the certificate you want to remove |
| 2    | Select <b>Delete</b> .                                      |
| 3    | Click <b>Yes</b> to remove the certificate from the list.   |
| 4    | Click <b>Apply</b> to save the change to the configuration. |

Device Certificates Export

You can export the RTU module certificate for HTTPS in the **CERTIFICATES MANAGEMENT > PKI CONFIGURATION** page by clicking the **Download** button

## Root CA Management

The CA certificate is a public key certificate that identifies the certificate authority (CA) in a public key infrastructure (PKI). Use the **Root CA Management** page to push the CA certificate(s) in the device.

To add a certificate from the CA to the CA Certificates list:

| Step | Action                                                                                                                                                                       |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Open the web pages for the module, and in the <b>Login</b> dialog, enter: <ul style="list-style-type: none"><li>• username</li><li>• password</li></ul> Click <b>Login</b> . |
| 2    | Navigate to <b>SETUP &gt; CERTIFICATES MANAGEMENT</b> to access the certificates management tab, then select <b>Root CA Management</b> .                                     |
| 3    | In the <b>TRUSTED CA CERTIFICATES</b> list, click <b>ADD</b> to add the CA certificate to the list.                                                                          |
| 4    | Apply the changes to the cyber security configuration.                                                                                                                       |

**NOTE:** A maximum of ten (10) CA certificates can be added.

## RBAC

### Introduction

Role-based access control (RBAC) is a method for reducing the risk of cyber security attacks by assigning different levels of access that are based on the access privileges associated with a user's defined role.

The BMENOR2200H module uses RBAC to provide defined levels of access for users. RBAC is predefined according to IEC 62351-2, but it is also configurable according to user requirements.

These threats are defined by IEC 62351-2:

- spoofing
- modification
- replay
- eavesdropping (on the exchange of cryptographic keys)

### Limitations

- The maximum number of active web server user connections is 5.
- Observe theses maximums for the number of DNP3 users that can participate in key management configuration:
  - DNP3 SAV2: 10
  - DNP3 SAV5: 64

### RBAC Workflow

This is the global RBAC workflow:

| Stage | Description                                                           |
|-------|-----------------------------------------------------------------------|
| 1     | Access the RBAC management page.                                      |
| 2     | Create a new <b>USER</b> and assign a role from list.                 |
| 3     | Enter and confirm a password.                                         |
| 4     | Submit the RBAC configuration.                                        |
| 5     | Access the server key management page for DNP3 secure authentication. |

| Stage | Description                                                                   |
|-------|-------------------------------------------------------------------------------|
| 6     | Pick a <b>USER</b> from the server user table for RBAC management.            |
| 7     | Enter the other security settings for the DNP3 secure authentication version. |

**NOTE:** A single user is now active (client only).

### Available Functionality

This table shows the available functionalities for each value and its corresponding name:

| Value | Name                   | DNP3 Protocol |                  | Firmware | Web Page Settings |            | FTP                 | HTTPS            |
|-------|------------------------|---------------|------------------|----------|-------------------|------------|---------------------|------------------|
|       |                        | Monitor Data  | Operator Control | Upgrade  | Security          | Diagnostic | Data Logging Server | Web Login Server |
| 1     | OPERATOR               | ✓             | ✓                |          |                   | ✓          | ✓                   | ✓                |
| 2     | ENGINEER               | ✓             |                  |          |                   | ✓          | ✓                   | ✓                |
| 3     | INSTALLER              | ✓             |                  | ✓        |                   | ✓          |                     | ✓                |
| 4     | SECADM                 |               |                  |          | ✓                 | ✓          |                     | ✓                |
| 32768 | SINGLEUSER<br>(COMMON) | ✓             | ✓                |          |                   |            |                     | X                |

# Web Page and Device DDT Diagnostics

## Introduction

This chapter describes diagnostics for the BMENOR2200H Web pages and Device DDDT as configured in a Control Expert application.

## Web Page Diagnostics

### Introduction

This section describes diagnostics for the BMENOR2200H Web pages as configured in a Control Expert application.

### Web Page Diagnostics

#### Accessing Diagnostics

The following table describe how to access diagnostic information for the BMENOR2200H module via Web pages:

| Step | Action                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Select <b>Tools &gt; DTM Browser</b> to open your project DTM.                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 2    | Double-click the BMENOR2200H module.                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| 3    | In the DTM <b>Configuration</b> dialog, expand <b>General</b> , and select <b>Module Information</b> .                                                                                                                                                                                                                                                                                                                                                                                               |
| 4    | In the right-side pane, scroll to the bottom of the dialog to view <b>Web Diagnostics</b> .                                                                                                                                                                                                                                                                                                                                                                                                          |
| 5    | Click the <b>Launch</b> button to access the diagnostic Web pages.                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 6    | Select the <b>Diagnostics</b> tab.                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 7    | Expand the <b>MENU</b> to view the available diagnostic pages: <ul style="list-style-type: none"><li>• <b>MODULE</b><ul style="list-style-type: none"><li>◦ Status Summary</li><li>◦ HSBY Status</li><li>◦ Event Buffer Status</li><li>◦ Port Statistics</li></ul></li><li>• <b>CONNECTED DEVICES</b><ul style="list-style-type: none"><li>◦ RTU Protocol</li><li>◦ Messaging</li></ul></li><li>• <b>CD SERVICES</b><ul style="list-style-type: none"><li>◦ SNTP</li><li>◦ Clock</li></ul></li></ul> |

### Module Diagnostics

#### Status Summary

Monitor the status of the module via the following parameters:

| Field                            | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>RUN, ERR</b>                  | <ul style="list-style-type: none"> <li><i>green</i></li> <li><i>red</i></li> </ul> <p><b>NOTE:</b> The diagnostics information is explained in the description of LED activity and indications, page 19.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>SERVICE STATUS</b>            | <p>Monitor the performance of each listed service on the communications link:</p> <ul style="list-style-type: none"> <li><i>green</i>: The service is operating normally.</li> <li><i>red</i>: An error is detected for a service.</li> <li><i>black</i>: The service is not present or not configured.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>NETWORK INFORMATION</b>       | <b>Host Name:</b> This field shows provides the host name for the module (BME NOR 2200H).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                                  | <b>IP Address:</b> This field shows the IP address of the module.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                                  | <b>Subnet Address:</b> This field shows the subnet address of the module.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                                  | <b>Gateway Address:</b> This field shows the gateway address of the module.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|                                  | <b>MAC Address:</b> This field shows the MAC address of the module.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>VERSION INFORMATION</b>       | <p>View the software versions that currently run on the module:</p> <ul style="list-style-type: none"> <li><b>SV</b></li> <li><b>Web Server Version</b></li> <li><b>Web Page Version</b></li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>MISCELLANEOUS</b>             | <b>Communication Security:</b> The status of the security service (enabled or disables) is reported.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|                                  | <b>Rack ID:</b> This field identifies the local rack (1).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                                  | <b>Slot ID:</b> This field shows the slot number in which the BMENOR2200H module is installed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>MANUFACTURING INFORMATION</b> | View the serial number for the device.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>HSBY</b>                      | <ul style="list-style-type: none"> <li>Service Status: Defines whether or not the HSBY service is working properly.</li> <li>Sync Status: Defines whether or not the HSBY status is syncing properly.</li> <li>Parameter Validity: Defines whether or not any partner devices are valid in a HSBY system.</li> <li>Sync Counter: Describes the numerical value of the sync counter.</li> <li>Last Sync: Defines the last time the HSBY status was synced in date/time format.</li> <li>Packet Statistics: <ul style="list-style-type: none"> <li>Defines the status of each packet set: <ul style="list-style-type: none"> <li>Inbound Packets</li> <li>Outbound Packets</li> <li>Inbound Packet Errors</li> <li>Outbound Packet Errors</li> </ul> </li> </ul> </li> <li>Detected Errors: Describes any error codes that are detected in the HSBY system.</li> <li>Local/Remote Module: <ul style="list-style-type: none"> <li>Defines the status of these parameters for local and remote modules: <ul style="list-style-type: none"> <li>Role: Primary or Standby</li> <li>IP Address</li> <li>Firmware Version</li> </ul> </li> </ul> </li> </ul> |

## Event Buffer Status

View the module's event buffer status for the commissioning of communications:

| Parameter                         | Description                                                                                                                                                                           |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>EVENT BUFFER USAGE</b>         | This indicates the percentage of the event buffer that is consumed.                                                                                                                   |
| <b>EVENT OVERFLOW</b>             | This field indicates that the capacity of the event buffer is exceeded or not.                                                                                                        |
| <b>EVENT RESOURCE USAGE</b>       | This indicates the percentage of event resources that are consumed.                                                                                                                   |
| <b>EVENT BACKUP</b>               | <b>Enabled:</b> Events are backed up.                                                                                                                                                 |
|                                   | <b>Disabled:</b> Events are <b>not</b> backed up.                                                                                                                                     |
| <b>CHANNEL/POINT EVENT STATUS</b> | <b>No.:</b> This number represents the sequence of device connections.                                                                                                                |
|                                   | <b>Channel Name:</b> This is the configured DNP3 channel name, page 76.                                                                                                               |
|                                   | <b>Current Event Buffer Usage%:</b> This indicates the percentage of the event buffer that is consumed.                                                                               |
|                                   | <b>Current Event Quantity:</b> This is the number of events in the buffer.                                                                                                            |
|                                   | <b>Configured Event Quantity:</b> This is the configured size of the event buffer.                                                                                                    |
|                                   | <b>Current Overflow Event Quantity:</b> This is the number of events that are not in the buffer owing to an overflow.                                                                 |
|                                   | <b>Total Current Overflow:</b> This is the total number of current overflow events for the module.                                                                                    |
|                                   | <b>NOTE:</b> Click the plus (+) or minus (-) sign to expand or collapse any channel in the <b>Event Buffer Status</b> page to view status details from the perspective of the module. |

## Port Statistics

The **Port Statistics** page reports the statistics for the module's Ethernet backplane connection:

| Parameter                 | Description                                                                                                                                                                                                                                                                                                                                                                                                                |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| backplane port            | <ul style="list-style-type: none"> <li><i>green:</i> The port is active.</li> <li><i>gray:</i> The port is not active.</li> <li><i>yellow:</i> An error is detected on the port.</li> <li><i>red:</i> An error is detected on the port.</li> </ul>                                                                                                                                                                         |
| <b>Speed</b>              | This field shows the configured port speed (0, 100, 1000 Mbps).                                                                                                                                                                                                                                                                                                                                                            |
| <b>Duplex, Half</b>       | <p>The current duplex mode is composed of some combination of these elements:</p> <ul style="list-style-type: none"> <li><b>TP/Fiber</b></li> <li><b>-Full/-Half/-None</b></li> <li><b>Link/(no word)</b></li> <li><b>None</b></li> </ul> <p><b>NOTE:</b> When the thirteenth bit of the word in the Modbus response is 1, "Link" is added to the duplex mode string (<b>TP-Full Link</b>, <b>TP-Half Link</b>, etc.).</p> |
| <b>Success Rate</b>       | This field shows the percentage of successful requests out of the total number of requests.                                                                                                                                                                                                                                                                                                                                |
| <b>Total Errors</b>       | This field shows the number of detected errors.                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Toggle Detail View</b> | Click this button to expand or compress the list of port statistics.                                                                                                                                                                                                                                                                                                                                                       |

This table describes the port statistic parameters:

| Parameter                 | Description                                                                            |
|---------------------------|----------------------------------------------------------------------------------------|
| <b>Frames Transmitted</b> | This field shows the number of frames that are successfully transmitted from the port. |
| <b>Frames Received</b>    | This field shows the number of frames that are successfully received from the port.    |

| Parameter                         | Description                                                                                                                                                                                                                      |
|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Excessive Collisions</b>       | This field shows the number of times that the transmission of an Ethernet frame on this port was not successful owing to excessive collisions (more than 16 attempts per packet).                                                |
| <b>Late Collisions</b>            | This field shows the number of times a collision is detected after the slot time of the channel elapses.<br><b>NOTE:</b> A value appears in this field only when the hardware provides the information.                          |
| <b>CRC Errors</b>                 | This field shows the number of received frames for which the Cyclic Redundancy Check (CRC) is not valid. A detected CRC error is an RMON statistic that combines the values for <b>FCS Errors</b> and <b>Alignment Errors</b> .  |
| <b>Bytes Received</b>             | This field shows the number of octets that are received on the port.                                                                                                                                                             |
| <b>Inbound Packet Errors</b>      | This field shows the number of packets that are received on the port for which errors are detected.<br><b>NOTE:</b> Does not include Out Discards.                                                                               |
| <b>Inbound Packets Discarded</b>  | The field shows the number of inbound packets that are received on the port but discarded.                                                                                                                                       |
| <b>Bytes Transmitted</b>          | This field shows the number of octets that are sent on the port.                                                                                                                                                                 |
| <b>Outbound Packet Errors</b>     | This field shows the number of packets that are sent on the port for which errors are detected.<br><b>NOTE:</b> Does not include Out Discards.                                                                                   |
| <b>Outbound Packets Discarded</b> | The field shows the number of outbound packets that are sent on the port but discarded.                                                                                                                                          |
| <b>Carrier Sense Errors</b>       | This field shows the number of times that the carrier sense condition was lost or was never asserted in an attempt to transmit a frame on this port.                                                                             |
| <b>FCS Errors</b>                 | This field shows the number of frames that are received on this port that are an integral number of octets but do not pass the FCS check.                                                                                        |
| <b>Alignment Errors</b>           | This field shows the number of frames that are received on this port that are not an integral number of octets long and do not pass the FCS check.                                                                               |
| <b>Internal MAC Trans. Errors</b> | This field reports the number of frames that the port does not successfully transmit owing to a detected internal MAC sub-layer receive error.                                                                                   |
| <b>Internal MAC Rec. Errors</b>   | This field reports the number of frames that the port does not successfully receive owing to a detected internal MAC sub-layer receive error.                                                                                    |
| <b>SQE Test Errors</b>            | This field shows the number of times a SQE TEST ERROR is received on the port.<br><b>NOTE:</b> This counter does not increment on ports that operate at speeds greater than 10 Mb/s or on ports that operate in full-duplex mode |

## Connected Device Diagnostics

### RTU Protocol

This table shows the RTU connection status for client devices and server RTUs:

| Parameter                                       | Description                                                                                                        |
|-------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| <b>Number of Connected / Connecting Devices</b> | This value represents the number of connected devices.                                                             |
| <b>Number of Disconnected Devices</b>           | This value represents the number of disconnected devices.                                                          |
| <b>RTU CONNECTIONS - SERVERS / CLIENTS</b>      | <b>No.:</b> This number represents the sequence of device connections.                                             |
|                                                 | <b>Channel Name:</b> This is the configured DNP3 channel name, page 76.                                            |
|                                                 | <b>Protocol:</b> This field shows the implemented connection protocol.                                             |
|                                                 | <b>State:</b> This is the status of the connection ( <b>Connected</b> , <b>Connecting</b> , <b>Disconnected</b> ). |
|                                                 | <b>Remote Address:</b> This is the remote IP address.                                                              |
|                                                 | <b>Remote Port:</b> This is the remote TCP port.                                                                   |

| Parameter | Description                                                                                                                                              |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
|           | <b>Local Port:</b> This is the local TCP port.                                                                                                           |
|           | <b>Secure Statistics:</b> Click the link in this column to access detailed statistics, page 180 for the specific secure authentication version, page 50. |
|           | <b>Error Code:</b> Click the error code, page 216 in this column to get information about a detected error.                                              |

## Messaging

This table contains information about the exchange of data in terms of Modbus statistics:

| Parameter                   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>MESSAGING STATISTICS</b> | <p>View the total number of sent and received messages on port 502:</p> <ul style="list-style-type: none"> <li>• <b>Msgs. Sent:</b> This field shows the number of messages sent from port 502.</li> <li>• <b>Msgs. Received:</b> This field shows the number of messages received by port 502.</li> <li>• <b>Success Rate:</b> This field shows the percentage of successful requests out of the total number of requests.</li> </ul> <p><b>NOTE:</b> These values are not reset when the port 502 connection closes. The values, therefore, account for the number of messages since the last module restart.</p>                                                   |
| <b>ACTIVE CONNECTIONS</b>   | <p>View the connections that are active when the <b>Messaging</b> page is refreshed:</p> <ul style="list-style-type: none"> <li>• <b>Remote Address:</b> This column shows the remote IP address.</li> <li>• <b>Local Port:</b> This column shows the local TCP port.</li> <li>• <b>Type:</b> This column shows the connection type.</li> <li>• <b>Sent:</b> This column shows the number of messages sent from this connection.</li> <li>• <b>Received:</b> This column shows the number of messages received by this connection.</li> <li>• <b>Errors:</b> This column shows the number of errors that are detected in association with this connection.</li> </ul> |

## Service Diagnostics

### SNTP

This table describes the SNTP parameters:

| Parameter             | Description                                                                                                                                                                                                 |
|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>SERVICE STATUS</b> | <b>Running:</b> The correctly configured service is running.                                                                                                                                                |
|                       | <b>Disabled:</b> The service is disabled.                                                                                                                                                                   |
|                       | <b>Unknown:</b> The status of the service is not known.                                                                                                                                                     |
| <b>SERVER TYPE</b>    | <b>Primary:</b> A primary server polls a client time server for the current time.                                                                                                                           |
|                       | <b>Secondary:</b> A secondary server polls a client time server for the current time.                                                                                                                       |
| <b>CURRENT DATE</b>   | <b>This field shows the current date in the selected time zone.</b>                                                                                                                                         |
| <b>SERVER STATUS</b>  | <ul style="list-style-type: none"> <li>• <i>green:</i> The server is connected and running.</li> <li>• <i>red:</i> An error is detected.</li> <li>• <i>gray:</i> The server status is not known.</li> </ul> |
| <b>DST STATUS</b>     | <b>On:</b> DST (daylight saving time) is configured and running.                                                                                                                                            |
|                       | <b>Off:</b> DST is disabled.                                                                                                                                                                                |
|                       | <b>Unknown:</b> The DST status is not known.                                                                                                                                                                |
| <b>CURRENT TIME</b>   | This field shows the time of day.                                                                                                                                                                           |
| <b>TIME ZONE</b>      | This field shows the time zone.                                                                                                                                                                             |

## Clock

This table describes the clock parameters:

| Parameter                          | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>CURRENT DATE AND TIME</b>       | <b>Date</b> (module date)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|                                    | <b>Time</b> (module time)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>TIME ZONE</b>                   | (module time zone)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>LATEST TIME SYNCHRONIZATION</b> | <b>Date</b> (synchronization timestamp)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|                                    | <b>Time</b> (synchronization timestamp)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|                                    | <b>Time Source</b> (synchronization timestamp): <ul style="list-style-type: none"> <li>• <b>CPU:</b> If the RTU protocol is configured, the RTU can get its initial time from the CPU when the RTU protocol starts or restarts.</li> <li>• <b>DNP3/IEC 60870-5-104:</b> This field shows the time source when a SCADA system or a client synchronizes its time with the RTU.</li> <li>• <b>SNTP:</b> If the SNTP client is enabled and connected to the SNTP server, its time source is from an SNTP server that synchronizes to the BMENOR2200H module's internal clock.</li> </ul> |

## Device DDT Diagnostics

### Introduction

This section describes Device DDT diagnostics for the BMENOR2200H module in a Hot Standby configuration.

### Device DDT Diagnostics

#### Modbus Diagnostics

The following table displays the Device DDT diagnostics for a BMENOR2200H module (NOR\_S2) communicating via the Modbus protocol.

| Diagnostic Name         | Value | Type | Comment                                                                                                                                    |
|-------------------------|-------|------|--------------------------------------------------------------------------------------------------------------------------------------------|
| NOR_S2ETH_STATUS        | 0     | WORD | Ethernet status                                                                                                                            |
| NOR_S2ETH_BKP_PORT_LINK | 0     | BOOL | Link up/down for Ethernet backplane port                                                                                                   |
| NOR_S2SCANNER_OK        | 0     | BOOL | Scanner OK and scanning at least one device (if at least one device configured)                                                            |
| NOR_S2GLOBAL_STATUS     | 0     | BOOL | 0: One or more services not operating normally / 1: all operational                                                                        |
| NOR_S2NETWORK_HEALTH    | 0     | BOOL | 1: No traffic overload detected / 0: Traffic overload detected (ex: broadcast storm)<br><br>Check your network topology and configuration. |
| NOR_S2IN_PACKETS        | 0     | UINT | Number of packets received on interface                                                                                                    |
| NOR_S2IN_ERRORS         | 0     | UINT | number of inbound packets that contain errors                                                                                              |
| NOR_S2OUT_PACKETS       | 0     | UINT | Number of packets sent on interface                                                                                                        |
| NOR_S2OUT_ERRORS        | 0     | UINT | Number of outbound packets that contain errors                                                                                             |
| NOR_S2SERVICE_STATUS    | 0     | WORD | One bit for each user-observative feature                                                                                                  |
| NOR_S2PORT502_SERVICE   | 0     | BOOL | 0: Service not operating normally / 1: Service operating normally or disabled                                                              |

| Diagnostic Name                   |                                                       | Value | Type              | Comment                                                                                     |
|-----------------------------------|-------------------------------------------------------|-------|-------------------|---------------------------------------------------------------------------------------------|
| NOR_S2SNMP_SERVICE                |                                                       | 0     | BOOL              | 0: Service not operating normally / 1: Service operating normally or disabled               |
| NOR_S2IP_ADDRESS_STATUS           |                                                       | 0     | BOOL              | IP address status (0 in case of duplicate IP or no IP assigned)                             |
| NOR_S2SNTP_CLIENT                 |                                                       | 0     | BOOL              | 0: Service not operating normally / 1: Service operating normally or disabled               |
| NOR_S2WEB_SERVER                  |                                                       | 0     | BOOL              | 0: Service not operating normally / 1: Service operating normally or disabled               |
| NOR_S2FIRMWARE_UPGRADE            |                                                       | 0     | BOOL              | 0: Service not operating normally / 1: Service operating normally or disabled               |
| NOR_S2FTP_SERVER                  |                                                       | 0     | BOOL              | 0: Service not operating normally / 1: Service operating normally or disabled               |
| NOR_S2TIME_VALID                  |                                                       | 0     | BOOL              | 0: Time invalid / 1: Time valid                                                             |
| NOR_S2LLDP_SERVICE                |                                                       | 0     | BOOL              | IP address A/B status (0 in case of duplicate IP or no IP assigned)                         |
| NOR_S2SYSLOG_STATUS               |                                                       | 0     | BOOL              | 0: Syslog service not operating normally / 1: Syslog service operating normally or disabled |
| NOR_S2SYSLOG_SERVER_NOT_REACHABLE |                                                       | 0     | BOOL              | 1: No acknowledgement received from the syslog server / 0: otherwise                        |
| NOR_S2SMTP_SERVICE                |                                                       | 0     | BOOL              | 0: Service not operating normally / 1: Service operating normally or disabled               |
| NOR_S2DATALOGGING                 |                                                       | 0     | BOOL              | 0: Service not operating normally / 1: Service operating normally or disabled               |
| NOR_S2RTU_DNP3                    |                                                       | 0     | BOOL              | 0: Service not operating normally / 1: Service operating normally or disabled               |
| NOR_S2RTU_IEC60870                |                                                       | 0     | BOOL              | 0: Service not operating normally / 1: Service operating normally or disabled               |
| NOR_S2SD_STATUS                   |                                                       | 0     | BYTE              | 0: SD card is missing and not usable / 1: SD card is normal                                 |
| NOR_S2FIRMWARE_VERSION            |                                                       | 0     | WORD              | [HEX] MSB: Major revision, LSB: Minor revision                                              |
| NOR_S2PROTOCOL_STATUS             |                                                       | —     | T_PROTOCOL_STATUS | General variable for RTU protocol status                                                    |
|                                   | NOR_S2PROTOCOL_STATUSEVENT_OVERFLOW_COUNT             | 0     | UDINT             | Number of total event overflows                                                             |
|                                   | NOR_S2PROTOCOL_STATUSEVENT_BUFFER_USAGE               | 0     | BYTE              | %Event buffer used in configured size                                                       |
|                                   | NOR_S2PROTOCOL_STATUSDNP3_CLIENT_CONNECTION_COUNT     | 0     | BYTE              | Number of total DNP3 client connections                                                     |
|                                   | NOR_S2PROTOCOL_STATUSDNP3_SERVER_CONNECTION_COUNT     | 0     | BYTE              | Number of total DNP3 server connections                                                     |
|                                   | NOR_S2PROTOCOL_STATUSIEC60870_CLIENT_CONNECTION_COUNT | 0     | BYTE              | Number of total IEC60870 client connections                                                 |
|                                   | NOR_S2PROTOCOL_STATUSIEC60870_SERVER_CONNECTION_COUNT | 0     | BYTE              | Number of total IEC60870 server connections                                                 |
|                                   | NOR_S2PROTOCOL_STATUSMODBUS_CLIENT_CONNECTION_COUNT   | 0     | BYTE              | Number of total Modbus client connections                                                   |
|                                   | NOR_S2PROTOCOL_STATUSMODBUS_SERVER_CONNECTION_COUNT   | 0     | BYTE              | Number of total Modbus server connections                                                   |

| Diagnostic Name              | Value | Type        | Comment                                     |
|------------------------------|-------|-------------|---------------------------------------------|
| NOR_S2CS_STATUS              | —     | T_CS_STATUS | —                                           |
| NOR_S2CS_STATUS_SECURE_MODE  | 0     | BYTE        | Coding wheel state, 0: Standard / 1: Secure |
| NOR_S2CS_STATUSCD_LED_STATUS | 0     | BYTE        | Cybersecurity LED status                    |
| NOR_S2HTSB_DIAG              | —     | T_HTSB_DIAG | —                                           |

## Hot Standby Diagnostics

The following table displays the Device DDT diagnostics for a BMENOR2200H module (NOR\_S2) in a Hot Standby system:

| Diagnostic                         | Value | Type              | Comment                                                                                                                                                                             |
|------------------------------------|-------|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NOR_S2RTU_IEC60870                 | 0     | BOOL              | 0: Service not operating normally / 1: Service operating normally or disabled                                                                                                       |
| NOR_S2SD_STATUS                    | 0     | BYTE              | 0: SD card is missing and not usable / 1: SD card is normal                                                                                                                         |
| NOR_S2FIRMWARE_VERSION             | 0     | WORD              | [HEX] MSB: Major revision, LSB: Minor revision                                                                                                                                      |
| NOR_S2PROTOCOL_STATUS              |       | T_PROTOCOL_STATUS | General variable for RTU protocol status                                                                                                                                            |
| NOR_S2CS_STATUS                    |       | T_CS_STATUS       | —                                                                                                                                                                                   |
| NOR_S2HTSB_DIAG                    |       | T_HTSB_DIAG       | —                                                                                                                                                                                   |
| NOR_S2HTSB_DIAGSERVICE_STATE       | 0     | BYTE              | HTSB service state: 0: Fault / 1: Running                                                                                                                                           |
| NOR_S2HTSB_DIAGSYNC_STATE          | 0     | BYTE              | HTSB sync status: 0: In progress / 1: OK                                                                                                                                            |
| NOR_S2HTSB_DIAGINTERNAL_STATE      | 0     | BYTE              | Internal HTSB state: 0: Init / 1: Link establish / 2: Reserved / 3: Integrity / 4: Wait sync / 5: synced                                                                            |
| NOR_S2HTSB_DIAGPARTNER_VALIDITY    | 0     | BYTE              | Partner validity: 0: Not reachable / 1: OK                                                                                                                                          |
| NOR_S2HTSB_DIAGERROR_CODE1         | 0     | WORD              | Bit 0: Firmware mismatch / Bit 1: DTM config mismatch / Bit 2: Security mode mismatch / Bit 3: DTLS certification error / Bit 4: CS config mismatch (Reserved) / Bit 5–15: Reserved |
| NOR_S2HTSB_DIAGFW_VERSION_MISMATCH | 0     | BOOL              | Application of the primary and standby are running with different firmware version                                                                                                  |
| NOR_S2HTSB_DIAGDTM_CFG_MISMATCH    | 0     | BOOL              | Application of the primary and standby are running with different DTM configuration                                                                                                 |
| NOR_S2HTSB_DIAGCERTIFICATION_ERROR | 0     | BOOL              | DTLS certification error                                                                                                                                                            |
| NOR_S2HTSB_DIAGSYNC_COUNT          | 0     | UDINT             | HTSB                                                                                                                                                                                |
| NOR_S2HTSB_DIAGDIN_PACKETS         | 0     | UDINT             | HTSB                                                                                                                                                                                |
| NOR_S2HTSB_DIAGIN_ERRORS           | 0     | UDINT             | HTSB                                                                                                                                                                                |

| Diagnostic |                            | V-a-l-u-e | Type  | Comment |
|------------|----------------------------|-----------|-------|---------|
|            | NOR_S2HTSB_DIAGOUT_PACKETS | 0         | UDINT | HTSB    |
|            | NOR_S2HTSB_DIAGOUT_ERRORS  | 0         | UDINT | HTSB    |

## RTU Diagnostics

The following table displays the Device DDT diagnostics for a BMENOR2200H module (NOR\_S2) communicating via the RTU protocol:

| Diagnostic Name                   |                                                      | Value | Type          | Comment                                                                                                                                                                                                 |
|-----------------------------------|------------------------------------------------------|-------|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>RTU Protocol Diagnostics</b>   |                                                      |       |               |                                                                                                                                                                                                         |
| NOR_S2_CONN                       |                                                      | —     | T_NOR_S2_CONN | —                                                                                                                                                                                                       |
|                                   | NOR_S2_CONNFreshness                                 | 0     | BOOL          | All Device DDT variables of the module are freshness                                                                                                                                                    |
|                                   | NOR_S2_CONNScan_State                                | 0     | BYTE          | 0: Idle / 1: Busy                                                                                                                                                                                       |
|                                   | NOR_S2_CONNHSHBY_Event_Index                         | 0     | UDINT         | Index number of current events generated in module                                                                                                                                                      |
|                                   | NOR_S2_CONNHSHBY_EventSync_Index                     | 0     | UDINT         | Index number of current events synchronized to standby module                                                                                                                                           |
| <b>Channel/Device Diagnostics</b> |                                                      |       |               |                                                                                                                                                                                                         |
| NOR_S2_CONNclient_102_0           |                                                      | —     | T_NOR_S2_C_0  | —                                                                                                                                                                                                       |
|                                   | NOR_S2_CONNclient_102_0Device_state                  | 0     | BYTE          | 0: Unconnected / 1: Connected                                                                                                                                                                           |
|                                   | NOR_S2_CONNclient_102_0Error_code                    | 0     | WORD          | 0: Security not configured / 1: Variable initialized error 2: Internal error / 3: Authentication failed / 4: Unexpected response / 5: No response / 6: Aggressive mode not supported / 7: MAC algorithm |
|                                   | NOR_S2_CONNclient_102_0Security_not_configured       | 0     | BOOL          | Bit0: Security not configured                                                                                                                                                                           |
|                                   | NOR_S2_CONNclient_102_0Variable_initialize_error     | 0     | BOOL          | Bit1: Variable initialized error                                                                                                                                                                        |
|                                   | NOR_S2_CONNclient_102_0Internal_error                | 0     | BOOL          | Bit2: Internal error                                                                                                                                                                                    |
|                                   | NOR_S2_CONNclient_102_0Authentication_failed         | 0     | BOOL          | Bit3: Authentication failed                                                                                                                                                                             |
|                                   | NOR_S2_CONNclient_102_0Unexpected_response           | 0     | BOOL          | Bit4: Unexpected response                                                                                                                                                                               |
|                                   | NOR_S2_CONNclient_102_0No_response                   | 0     | BOOL          | Bit5: No response                                                                                                                                                                                       |
|                                   | NOR_S2_CONNclient_102_0Aggressive_mode_not_supported | 0     | BOOL          | Bit6: Aggressive mode not supported                                                                                                                                                                     |
|                                   | NOR_S2_CONNclient_102_0MAC_algorithm_not_supported   | 0     | BOOL          | Bit7: MAC algorithm not supported                                                                                                                                                                       |

| Diagnostic Name |                                                               | Value | Type | Comment                                         |
|-----------------|---------------------------------------------------------------|-------|------|-------------------------------------------------|
|                 | NOR_S2_CONNclient_102_0Key_wrap_algorithm_not_supported       | 0     | BOOL | Bit8 :Key wrap algorithm not supported          |
|                 | NOR_S2_CONNclient_102_0authorization_failed                   | 0     | BOOL | Bit9 :Authorization failed                      |
|                 | NOR_S2_CONNclient_102_0Update_key_change_method_not_permitted | 0     | BOOL | Bit10 :Update key change method not permitted   |
|                 | NOR_S2_CONNclient_102_0Invalid_signature                      | 0     | BOOL | Bit11 :Invalid signature                        |
|                 | NOR_S2_CONNclient_102_0Invalid_certification_data             | 0     | BOOL | Bit12 :Invalid certification data               |
|                 | NOR_S2_CONNclient_102_0Unknown_user                           | 0     | BOOL | Bit13 :Unknown user                             |
|                 | NOR_S2_CONNclient_102_0Max_session_key_status_requests_exceed | 0     | BOOL | Bit14 :Max session key status requests exceeded |
|                 | NOR_S2_CONNclient_102_0TLS_error                              | 0     | BOOL | Bit15: TLS error                                |

# Appendices

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# Interoperability

## What's in This Chapter

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## About this Chapter

This chapter describes the specific implementation of protocols with the advanced RTU module.

## DNP3 Interoperability

### Introduction

The purpose of this information is to describe the specific implementation of the Distributed Network Protocol (DNP3) within the BMENOR2200H module as client and server.

This information, in conjunction with the DNP3 Basic 4 Document Set and the DNP3 Subset Definitions Document, provides detailed information on how to communicate with the BMENOR2200H module as client via the DNP3 protocol.

This implementation of DNP3 is fully compliant with DNP3 Subset Definition Level 3.

### DNP3 Device Profile - Client

This table provides a *Device Profile Document* in the standard format defined in the DNP3 Subset Definitions Document. While it is referred to in the DNP3 Subset Definitions as a *Document*, it is only a component of a total interoperability guide. This table uses a BMENOR2200H module as a client as an example. (Your module may be different.)

| Parameter                              | Capabilities                                          | Value                                 |
|----------------------------------------|-------------------------------------------------------|---------------------------------------|
| Device Identification                  |                                                       |                                       |
| Device Function                        | Client                                                | Client                                |
| Vendor Name                            | –                                                     | Schneider Electric Industries SAS     |
| Device Name                            | Device Name                                           | BMENOR2200H                           |
| Device Manufacturer hardware version   | Device Manufacturer hardware version                  | N/A                                   |
| Device Manufacturer software version   | Device Manufacturer software version                  | 1,0 IR14                              |
| Device Profile Document Version Number | Device Profile Document Version Number                | 1                                     |
| DNP3 Levels Supported                  | For both requests and responses: None, Levels 1...5   | For requests: Level 3                 |
|                                        |                                                       | For responses: Level 3                |
| Supported Function Blocks              | Self Address Support                                  | Secure Authentication                 |
|                                        | Secure Authentication                                 |                                       |
| Notable Additions                      | Refer to Implementation Table                         |                                       |
| Methods to set Configurable Parameters | Software                                              | Software (EcoStruxure Control Expert) |
|                                        | Proprietary file loaded via other transport mechanism |                                       |

| Parameter                                                             | Capabilities                          | Value                  |
|-----------------------------------------------------------------------|---------------------------------------|------------------------|
| DNP3 XML files available On-line                                      | dnpDP.xml                             | –                      |
|                                                                       | dnpDPC.xml                            |                        |
|                                                                       | dnpDPCfg.xml                          |                        |
| External DNP3 XML files available Off-line                            | dnpDP.xml (read)                      | dnpDP.xml (read)       |
| Connections Supported                                                 | IP Networking                         | IP Networking          |
| Conformance Testing                                                   | N/A                                   | –                      |
| Serial Connections                                                    |                                       |                        |
| Not Supported                                                         | –                                     | –                      |
| IP Networking                                                         |                                       |                        |
| Port Name                                                             | –                                     | Ethernet               |
| Type of End Point                                                     | TCP Initiating                        | TCP Initiating         |
|                                                                       | TCP Datagram                          |                        |
| IP Address of this device                                             | –                                     | 0.0.0.0                |
| Subnet Mask                                                           | –                                     | 255.255.255.255        |
| Gateway IP Address                                                    | –                                     | 0.0.0.0                |
| Accepts TCP Connections or UDP Datagrams from                         | Limits based on IP address            | IP address             |
| IP Addresses from which TCP Connections or UDP Datagrams are accepted | –                                     | 192.168.0.1            |
| TCP Listen Port Number                                                | N/A                                   | N/A                    |
| TCP Listen Port Number of remote device                               | Configurable range 1...65536          | 20000                  |
| TCP Keep-alive timer                                                  | Fixed at 75000 ms                     | 75000 ms               |
| Local UDP Port                                                        | Configurable range 1...65536          | 20000                  |
| Destination UDP Port for DNP3 Requests                                | Configurable range 1...65536          | 20000                  |
| Destination UDP Port for initial unsolicited null responses           | None                                  | None                   |
| Destination UDP Port for DNP3 Responses                               | Configurable range 1...65536          | 20000                  |
| Multiple server connections                                           | Supports multiple servers             | TRUE                   |
| Multiple client connections                                           | Not supported                         | Not supported          |
| Time synchronization support                                          | DNP3 LAN procedure (function code 24) | LAN procedure          |
|                                                                       | DNP3 Write Time                       |                        |
|                                                                       | Other                                 |                        |
| Link Layer                                                            |                                       |                        |
| Data Link Address                                                     | Configurable range 0...65519          | 4                      |
| DNP3 Source Address Validation                                        | Always, single address                | Always, single address |
| DNP3 Source Addresses expected when Validation is Enabled             | Configurable range 0...65519          | 3                      |
| Self Address Support using address 0xFFFC                             | Yes                                   | No                     |
|                                                                       | No                                    |                        |
| Sends Confirmed User Data Frames                                      | Never                                 | Never                  |
|                                                                       | Always                                |                        |

| Parameter                                                                                       | Capabilities                         | Value   |
|-------------------------------------------------------------------------------------------------|--------------------------------------|---------|
|                                                                                                 | Sometimes                            |         |
| Data Link Layer Confirmation Timeout                                                            | Configurable range 0...2147483647 ms | 2000 ms |
| Maximum Data Link Retries                                                                       | Configurable range 0...255           | 3       |
| Maximum number of octets Transmitted in a Data Link Frame                                       | Configurable range 24...292          | 292     |
| Maximum number of octets that can be Received in a Data Link Frame                              | Configurable range 24...292          | 292     |
| <b>Application Layer</b>                                                                        |                                      |         |
| Maximum number of octets Transmitted in an Application Layer Fragment other than File Transfer  | Configurable range 0...2048          | 2048    |
| Maximum number of octets Transmitted in an Application Layer Fragment containing File Transfer  | Fixed at 0                           | 0       |
| Maximum number of octets that can be received in an Application Layer Fragment                  | Configurable range 0...2048          | 2048    |
| Timeout waiting for Complete Application Layer Fragment                                         | None                                 | None    |
| Maximum number of objects allowed in a single control request for CROB (Group 12)               | Fixed at 10                          | 10      |
| Maximum number of objects allowed in a single control request for Analog Outputs (Group 31)     | Configurable range 1...512           | 10      |
| Maximum number of objects allowed in a single control request for Data Sets (Groups 85, 86, 87) | Configurable range 1...128           | 8       |
| Supports mixed object groups (AOBs, CROBs and Data Sets) in the same control request            | Yes                                  | Yes     |
|                                                                                                 | No                                   |         |
| Control Status Codes Supported                                                                  | 4 NOT_SUPPORTED                      | –       |
|                                                                                                 | 8 TOO_MANY_OBJS                      | –       |
| <b>Client-Only Properties</b>                                                                   |                                      |         |
| Timeout waiting for Complete Application Layer Responses (ms)                                   | –                                    | –       |
| Maximum Application Layer Retries for Request Messages                                          | –                                    | –       |
| Timeout waiting for First or Next Fragment of an Application Layer Response                     | –                                    | –       |
| Issuing controls to Off-line devices                                                            | –                                    | –       |
| Issuing controls to off-scan devices                                                            | –                                    | –       |
| Maximum Application Layer Retries for Control Select Messages (same sequence number)            | –                                    | –       |
| Maximum Application Layer Retries for Control Select Messages (new sequence number)             | –                                    | –       |
| <b>Security Parameters</b>                                                                      |                                      |         |
| DNP3 device support for secure authentication                                                   | Version 2 (IEEE 1815-2010)           | –       |
|                                                                                                 | Version 5 (IEEE 1815-2012)           |         |

| Parameter                                             | Capabilities                                          | Value                               |
|-------------------------------------------------------|-------------------------------------------------------|-------------------------------------|
| Maximum number of users                               | Configurable range 1...300                            | Maximum number of user supported: 0 |
| Security message response timeout                     | Configurable range 1...640 ms                         | 2 ms                                |
| Aggressive mode of operation (receive)                | Yes                                                   | Yes                                 |
|                                                       | No                                                    |                                     |
| Aggressive mode of operation (issuing)                | Yes                                                   | No                                  |
|                                                       | No                                                    |                                     |
| Session key change interval                           | Configurable range 60...604800 seconds (when enabled) | Enabled at 900 seconds              |
| Session key change message count                      | Configurable range 0...65535                          | 1000                                |
| Maximum error count (SAv2 only)                       | Configurable range 0...255                            | 2                                   |
| MAC algorithm requested in a challenge exchange       | SHA-1 (truncated to the leftmost 4 octets)            | SHA-256 (16)                        |
|                                                       | SHA-1 (truncated to the leftmost 8 octets)            |                                     |
|                                                       | SHA-1 (truncated to the leftmost 10 octets)           |                                     |
|                                                       | SHA-256 (truncated to the leftmost 8 octets)          |                                     |
|                                                       | SHA-256 (truncated to the leftmost 16 octets)         |                                     |
| Key-wrap algorithm to encrypt session keys            | AES-128                                               | AES-128                             |
|                                                       | AES-256                                               |                                     |
| Cipher Suites used with DNP implementations using TLS | TLS is supported                                      |                                     |
| Change cipher request timeout                         | TLS is supported                                      |                                     |
| Number of Certificate Authorities supported           | –                                                     | –                                   |
| Certificate Revocation check time                     | TLS is supported                                      |                                     |
| Additional critical function codes                    | None                                                  | None                                |
| Other critical fragments                              | None                                                  | None                                |
| Support for remote update key changes                 | None                                                  | None                                |
| Default user credentials are permitted to expire      | Yes                                                   | No                                  |
|                                                       | No                                                    |                                     |
| Secure Authentication enabled                         | Configurable: On or Off                               | Off                                 |
| Length of the challenge data                          | Configurable range 4...60 octets                      | 4 octets                            |
| Maximum statistic counts (SAv5):                      |                                                       |                                     |
| Max Authentication Failures                           | Configurable range 4...60                             | 4                                   |
| Max Reply Timeouts                                    | Configurable range 1...65535                          | 3                                   |
| Max Authentication Rekeys                             | Configurable range 1...65535                          | 3                                   |
| Max Error Messages Sent                               | Configurable range 1...65535                          | 3                                   |
| <b>Broadcast Functionality</b>                        |                                                       |                                     |
| Disabled Not configurable                             | –                                                     | –                                   |

## DNP3 Device Profile - Server

This table provides a *Device Profile Document* in the standard format defined in the DNP3 Subset Definitions Document. While it is referred to in the DNP3 Subset Definitions as a *Document*, it is only a component of a total interoperability guide. This table uses a BMENOR2200H module as a client as an example. (Your module may be different.)

| Parameter                                                             | Capabilities                                          | Value                                 |
|-----------------------------------------------------------------------|-------------------------------------------------------|---------------------------------------|
| Device Identification                                                 |                                                       |                                       |
| Device Function                                                       | Server                                                | Server                                |
| Vendor Name                                                           | –                                                     | Schneider Electric Industries SAS     |
| Device Name                                                           | Device Name                                           | BMENOR2200H                           |
| Device Manufacturer hardware version                                  | Device Manufacturer hardware version                  | N/A                                   |
| Device Manufacturer software version                                  | Device Manufacturer software version                  | 1,0 IR14                              |
| Device Profile Document Version Number                                | Device Profile Document Version Number                | 1                                     |
| DNP3 Levels Supported                                                 | For both requests and responses: None, Levels 1...5   | For requests: Level 3                 |
|                                                                       |                                                       | For responses: Level 3                |
| Supported Function Blocks                                             | Self Address Support                                  | Secure Authentication                 |
|                                                                       | Secure Authentication                                 |                                       |
| Notable Additions                                                     | Refer to Implementation Table                         |                                       |
| Methods to set Configurable Parameters                                | Software                                              | Software (EcoStruxure Control Expert) |
|                                                                       | Proprietary file loaded via other transport mechanism |                                       |
| DNP3 XML files available On-line                                      | dnpDP.xml                                             | –                                     |
|                                                                       | dnpDPC.xml                                            |                                       |
|                                                                       | dnpDPCfg.xml                                          |                                       |
| External DNP3 XML files available Off-line                            | dnpDP.xml (read)                                      | dnpDP.xml (read)                      |
| Connections Supported                                                 | IP Networking                                         | IP Networking                         |
| Conformance Testing                                                   | Independently tested                                  | Independently tested                  |
| Serial Connections                                                    |                                                       |                                       |
| Not Supported                                                         | –                                                     | –                                     |
| IP Networking                                                         |                                                       |                                       |
| Port Name                                                             | –                                                     | Ethernet                              |
| Type of End Point                                                     | TCP Listening                                         | TCP Listening                         |
|                                                                       | TCP Datagram                                          |                                       |
| IP Address of this device                                             | –                                                     | 0.0.0.0                               |
| Subnet Mask                                                           | –                                                     | 255.255.255.255                       |
| Gateway IP Address                                                    | –                                                     | 0.0.0.0                               |
| Accepts TCP Connections or UDP Datagrams from                         | Allows All (*. *.*.*)                                 | Allows All                            |
|                                                                       | Limits based on IP address                            |                                       |
|                                                                       | Limits based on list of IP addresses                  |                                       |
| IP Addresses from which TCP Connections or UDP Datagrams are accepted | –                                                     | *.*.*                                 |
| TCP Listen Port Number                                                | Configurable range 1...65536                          | 20000                                 |
| TCP Listen Port Number of remote device                               | N/A                                                   | N/A                                   |
| TCP Keep-alive timer                                                  | Fixed at 75000 ms                                     | 75000 ms                              |
| Local UDP Port                                                        | Configurable range 1...65536                          | 20000                                 |

| Parameter                                                                                       | Capabilities                          | Value         |
|-------------------------------------------------------------------------------------------------|---------------------------------------|---------------|
| Destination UDP Port for DNP3 Requests                                                          | Configurable range 1...65536          | 20000         |
| Destination UDP Port for initial unsolicited null responses                                     | None                                  | None          |
| Destination UDP Port for DNP3 Responses                                                         | Configurable range 1...65536          | 20000         |
| Multiple server connections                                                                     | N/A                                   | N/A           |
| Multiple client connections                                                                     | Supports multiple clients             | IP Address    |
|                                                                                                 | Method 1 (based on IP address)        |               |
| Time synchronization support                                                                    | DNP3 LAN procedure (function code 24) | LAN procedure |
|                                                                                                 | DNP3 Write Time                       |               |
|                                                                                                 | Other                                 |               |
| Link Layer                                                                                      |                                       |               |
| Data Link Address                                                                               | Configurable range 0...65519          | 4             |
| DNP3 Source Address Validation                                                                  | Never                                 | Never         |
|                                                                                                 | Always, single address                |               |
| DNP3 Source Addresses expected when Validation is Enabled                                       | Configurable range 0...65519          | 3             |
| Self Address Support using address 0xFFFC                                                       | Yes                                   | No            |
|                                                                                                 | No                                    |               |
| Sends Confirmed User Data Frames                                                                | Never                                 | Never         |
|                                                                                                 | Always                                |               |
|                                                                                                 | Sometimes                             |               |
| Data Link Layer Confirmation Timeout                                                            | Configurable range 0...4294977295 ms  | 2000 ms       |
| Maximum Data Link Retries                                                                       | Configurable range 0...255            | 3             |
| Maximum number of octets Transmitted in a Data Link Frame                                       | Configurable range 24...292           | 292           |
| Maximum number of octets that can be Received in a Data Link Frame                              | Configurable range 24...292           | 292           |
| Application Layer                                                                               |                                       |               |
| Maximum number of octets Transmitted in an Application Layer Fragment other than File Transfer  | Configurable range 0...2048           | 2048          |
| Maximum number of octets Transmitted in an Application Layer Fragment containing File Transfer  | –                                     | –             |
| Maximum number of octets that can be received in an Application Layer Fragment                  | Configurable range 0...2048           | 2048          |
| Timeout waiting for Complete Application Layer Fragment                                         | Configurable range 0...2147483647     | 15000 ms      |
| Maximum number of objects allowed in a single control request for CROB (Group 12)               | Configurable range 1...10             | 10            |
| Maximum number of objects allowed in a single control request for Analog Outputs (Group 31)     | Configurable range 1...10             | 10            |
| Maximum number of objects allowed in a single control request for Data Sets (Groups 85, 86, 87) | –                                     | –             |
| Supports mixed object groups (AOBs, CROBs and Data Sets) in the same control request            | Yes                                   | Yes           |
|                                                                                                 | No                                    |               |
| Control Status Codes Supported                                                                  | 1 TIMEOUT                             | –             |
|                                                                                                 | 2 NO_SELECT                           |               |
|                                                                                                 | 3 FORMAT_ERROR                        |               |

| Parameter                                                             | Capabilities                                   | Value                              |
|-----------------------------------------------------------------------|------------------------------------------------|------------------------------------|
|                                                                       | 4 NOT_SUPPORTED                                |                                    |
|                                                                       | 5 ALREADY_ACTIVE                               |                                    |
|                                                                       | 6 HARDWARE_ERROR                               |                                    |
|                                                                       | 7 LOCAL                                        |                                    |
|                                                                       | 8 TOO_MANY_OBJS                                |                                    |
|                                                                       | 9 NOT_AUTHORIZED                               |                                    |
|                                                                       | 10 AUTOMATION_INHIBIT                          |                                    |
|                                                                       | 11 PROCESSING_LIMITED                          |                                    |
|                                                                       | 12 OUT_OF_RANGE                                |                                    |
|                                                                       | 13 DOWNSTREAM_LOCAL                            |                                    |
|                                                                       | 14 ALREADY_COMPLETE                            |                                    |
|                                                                       | 15 BLOCKED                                     |                                    |
|                                                                       | 16 CANCELLED                                   |                                    |
|                                                                       | 17 BLOCKED_OTHER_CLIENT                        |                                    |
|                                                                       | 18 DOWNSTREAM_FAIL                             |                                    |
|                                                                       | 19 UNDEFINED                                   |                                    |
| Server Only Properties                                                |                                                |                                    |
| Timeout waiting for Application Confirm of solicited response message | Configurable, range 0...2147483647ms           | 10000 ms                           |
| How often is time synchronization required from the client            | Never needs time                               | Periodically, fixed at 1800seconds |
|                                                                       | Periodically, fixed at 1800seconds             |                                    |
| Device Trouble Bit IIN1.6                                             | Never used                                     | Never used                         |
| File Handle Timeout                                                   | Not applicable                                 | Not applicable                     |
| Event Buffer Overflow Behavior                                        | Discard the oldest event                       | Discard the newest event           |
|                                                                       | Discard the newest event                       |                                    |
| Event Buffer Organization                                             | Per object group                               | Per object group                   |
| Semds Multi-Fragment Responses                                        | Yes                                            | Yes                                |
|                                                                       | No                                             |                                    |
| Last Fragment Confirmation                                            | Sometimes                                      | Sometimes                          |
| DNP Command Settings preserved through a device restart               | –                                              | –                                  |
| Supports configuration signature                                      | Not supported                                  | Not supported                      |
| Requests application confirmation                                     | For event responses: Yes                       | Yes                                |
|                                                                       | For non-final fragments: Configurable (Yes/No) | Yes                                |
| Supports DNP3 Clock Management                                        | –                                              | –                                  |
| Server Unsolicited Response Support Properties                        |                                                |                                    |
| Supports unsolicited reporting                                        | Configurable (On/Off)                          | On                                 |
| Client Data Link Address                                              | Configurable range 0...65519                   | 3                                  |
| Unsolicited Response Confirmation Timeout                             | Configurable range 0...2147483647              | 5000 ms                            |
| Number of Unsolicited Retries                                         | Configurable range 0...65535                   | 3                                  |
| Server Unsolicited Response Trigger Conditions                        |                                                |                                    |
| Number of class 1 events                                              | Configurable range 1...512                     | 5                                  |
| Number of class 2 events                                              | Configurable range 1...512                     | 5                                  |

| Parameter                                                                              | Capabilities                                                                                 | Value                               |
|----------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|-------------------------------------|
| Number of class 3 events                                                               | Configurable range 1...512                                                                   | 5                                   |
| Total number of events from any class                                                  | Total Number of Events not used to trigger Unsolicited Responses                             | –                                   |
| Hold time after class 1 event                                                          | Configurable range 0...2147483647ms                                                          | 5000 ms                             |
| Hold time after class 2 event                                                          | Configurable range 0...2147483647ms                                                          | 5000 ms                             |
| Hold time after class 3 event                                                          | Configurable range 0...2147483647ms                                                          | 5000 ms                             |
| Hold time after event assigned to any class                                            | Fixed at 0 ms                                                                                | 0 ms                                |
| Retrigger Hold Time                                                                    | Hold-time timer will not be retriggered for each new event detected (guaranteed update time) | Not retriggered                     |
| Other Unsolicited Response Trigger Conditions                                          | –                                                                                            | –                                   |
| <b>Server Performance Properties</b>                                                   |                                                                                              |                                     |
| Maximum Time Base Drift                                                                | –                                                                                            | –                                   |
| When does server set IIN1.4                                                            | Never                                                                                        | Never                               |
|                                                                                        | Asserted at startup until first Time Synchronization request received                        |                                     |
|                                                                                        | Range 1 to 2147483 seconds after last time sync                                              |                                     |
| Maximum Internal Time Reference Error when set via DNP                                 | –                                                                                            | –                                   |
| Maximum Delay Measurement Error                                                        | –                                                                                            | –                                   |
| Maximum Response Time                                                                  | –                                                                                            | –                                   |
| Maximum time from start-up to IIN 1.4 assertion                                        | –                                                                                            | –                                   |
| Maximum Event Time-tag error for local Binary and Double Bit I/O                       | –                                                                                            | –                                   |
| Maximum Event Time-tag error for local I/O other than Binary and Double Bit data types | –                                                                                            | –                                   |
| <b>Individual Field Server Parameters</b>                                              |                                                                                              |                                     |
| User-assigned location name or code string (same as g0v245)                            | –                                                                                            | –                                   |
| User-assigned ID code/number string (same as g0v246)                                   | –                                                                                            | –                                   |
| User-assigned name string for the server (same as g0v247)                              | –                                                                                            | –                                   |
| Device serial number string (same as g0v248)                                           | –                                                                                            | –                                   |
| Secondary operator name (same as g0v206)                                               | –                                                                                            | –                                   |
| Primary operator name (same as g0v207)                                                 | –                                                                                            | –                                   |
| System name (same as g0v208)                                                           | –                                                                                            | –                                   |
| Owner name (same as g0v244)                                                            | –                                                                                            | –                                   |
| <b>Security Parameters</b>                                                             |                                                                                              |                                     |
| DNP3 device support for secure authentication                                          | Version 2 (IEEE 1815-2010)                                                                   | –                                   |
|                                                                                        | Version 5 (IEEE 1815-2012)                                                                   |                                     |
| Maximum number of users                                                                | Configurable range 1...300                                                                   | Maximum number of user supported: 0 |
| Security message response timeout                                                      | Configurable range 1...640 ms                                                                | 2 ms                                |
| Aggressive mode of operation (receive)                                                 | Yes                                                                                          | Yes                                 |
|                                                                                        | No                                                                                           |                                     |
| Aggressive mode of operation (issuing)                                                 | Yes                                                                                          | No                                  |
|                                                                                        | No                                                                                           |                                     |

| Parameter                                             | Capabilities                                          | Value                  |
|-------------------------------------------------------|-------------------------------------------------------|------------------------|
| Session key change interval                           | Configurable range 60...604800 seconds (when enabled) | Enabled at 900 seconds |
| Session key change message count                      | Configurable range 0...65535                          | 1000                   |
| Maximum error count (SAv2 only)                       | Configurable range 0...255                            | 2                      |
| MAC algorithm requested in a challenge exchange       | SHA-1 (truncated to the leftmost 4 octets)            | SHA-256 (16)           |
|                                                       | SHA-1 (truncated to the leftmost 8 octets)            |                        |
|                                                       | SHA-1 (truncated to the leftmost 10 octets)           |                        |
|                                                       | SHA-256 (truncated to the leftmost 8 octets)          |                        |
|                                                       | SHA-256 (truncated to the leftmost 16 octets)         |                        |
| Key-wrap algorithm to encrypt session keys            | AES-128                                               | AES-128                |
|                                                       | AES-256                                               |                        |
| Cipher Suites used with DNP implementations using TLS | TLS is supported                                      |                        |
| Change cipher request timeout                         | TLS is supported                                      |                        |
| Number of Certificate Authorities supported           | –                                                     | –                      |
| Certificate Revocation check time                     | TLS is not supported                                  |                        |
| Additional critical function codes                    | None                                                  | None                   |
| Other critical fragments                              | None                                                  | None                   |
| Support for remote update key changes                 | None                                                  | None                   |
| Default user credentials are permitted to expire      | Yes                                                   | No                     |
|                                                       | No                                                    |                        |
| Secure Authentication enabled                         | Configurable: On or Off                               | Off                    |
| Length of the challenge data                          | Configurable range 4...60 octets                      | 4 octets               |
| Maximum statistic counts (SAv5):                      |                                                       |                        |
| Max Authentication Failures                           | Configurable range 4...60                             | 4                      |
| Max Reply Timeouts                                    | Configurable range 1...65535                          | 3                      |
| Max Authentication Rekeys                             | Configurable range 1...65535                          | 3                      |
| Max Error Messages Sent                               | Configurable range 1...65535                          | 3                      |
| <b>Broadcast Functionality</b>                        |                                                       |                        |
| Disabled Not configurable                             | –                                                     | –                      |

## DNP3 Implementation Table

The following table identifies the object groups, variations, function codes, and qualifiers that the BMENOR2200H module supports in both requests and responses. The *Request* columns identify all requests that may be sent by a client or all requests that are parsed by a server. The *Response* columns identify all responses that are parsed by a client or all responses that may be sent by a server

| DNP OBJECT GROUP & VARIATION |                  |                                                | REQUEST              |                                                                                                  | RESPONSE             |                                        |
|------------------------------|------------------|------------------------------------------------|----------------------|--------------------------------------------------------------------------------------------------|----------------------|----------------------------------------|
|                              |                  |                                                | Client may issue     |                                                                                                  | Client parses        |                                        |
|                              |                  |                                                | Server parses        |                                                                                                  | Server may issue     |                                        |
| Object Group Number          | Variation Number | Description                                    | Function Codes (dec) | Qualifier Codes (hex)                                                                            | Function Codes (dec) | Qualifier Codes (hex)                  |
| 1                            | 0                | Binary Input - any variation                   | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) |                      |                                        |
| 1                            | 0                | Binary Input - any variation                   | 22(assign class)     | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) |                      |                                        |
| 1                            | 1                | Binary Input - Single-bit packed               | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |
| 1                            | 2                | Binary Input - Single-bit with flag            | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |
| 2                            | 0                | Binary Input Change Event - any variation      | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   |                      |                                        |
| 2                            | 1                | Binary Input Change Event - without time       | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   | (Response)           | 17, 28 (index)                         |
| 2                            | 1                | Binary Input Change Event - without time       |                      |                                                                                                  | (Unsol. Resp.)       | 17, 28 (index)                         |
| 2                            | 2                | Binary Input Change Event - with absolute time | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   | (Response)           | 17, 28 (index)                         |
| 2                            | 2                | Binary Input Change Event - with absolute time |                      |                                                                                                  | (Unsol. Resp.)       | 17, 28 (index)                         |
| 2                            | 3                | Binary Input Change Event - with relative time | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   | (Response)           | 17, 28 (index)                         |
| 2                            | 3                | Binary Input Change Event - with relative time |                      |                                                                                                  | (Unsol. Resp.)       | 17, 28 (index)                         |
| 3                            | 0                | Double-bit Input - any variation               | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) |                      |                                        |

| DNP OBJECT GROUP & VARIATION |                  |                                                    | REQUEST              |                                                                                                  | RESPONSE             |                                        |
|------------------------------|------------------|----------------------------------------------------|----------------------|--------------------------------------------------------------------------------------------------|----------------------|----------------------------------------|
|                              |                  |                                                    | Client may issue     |                                                                                                  | Client parses        |                                        |
|                              |                  |                                                    | Server parses        |                                                                                                  | Server may issue     |                                        |
| Object Group Number          | Variation Number | Description                                        | Function Codes (dec) | Qualifier Codes (hex)                                                                            | Function Codes (dec) | Qualifier Codes (hex)                  |
| 3                            | 0                | Double-bit Input - any variation                   | 22(assign class)     | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) |                      |                                        |
| 3                            | 1                | Double-bit Input - Double-bit packed               | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |
| 3                            | 2                | Double-bit Input - with flag                       | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |
| 4                            | 0                | Double-bit Input Change Event - any variation      | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   |                      |                                        |
| 4                            | 1                | Double-bit Input Change Event - without time       | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   | (Response)           | 17, 28 (index)                         |
| 4                            | 1                | Double-bit Input Change Event - without time       |                      |                                                                                                  | (Unsol. Resp.)       | 17, 28 (index)                         |
| 4                            | 2                | Double-bit Input Change Event - with absolute time | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   | (Response)           | 17, 28 (index)                         |
| 4                            | 2                | Double-bit Input Change Event - with absolute time |                      |                                                                                                  | (Unsol. Resp.)       | 17, 28 (index)                         |
| 4                            | 3                | Double-bit Input Change Event - with relative time | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   | (Response)           | 17, 28 (index)                         |
| 4                            | 3                | Double-bit Input Change Event - with relative time |                      |                                                                                                  | (Unsol. Resp.)       | 17, 28 (index)                         |
| 10                           | 0                | Binary Output - any variation                      | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 28 (index)        |                      |                                        |
| 10                           | 0                | Binary Output - any variation                      | 22(assign class)     | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) |                      |                                        |
| 10                           | 1                | Binary Output - packed format                      | 1(read)              | 00, 01 (start-stop),                                                                             | (Response)           | 00, 01 (start-stop),                   |

| DNP OBJECT GROUP & VARIATION |                  |                                                           | REQUEST              |                                                                                                  | RESPONSE             |                                        |
|------------------------------|------------------|-----------------------------------------------------------|----------------------|--------------------------------------------------------------------------------------------------|----------------------|----------------------------------------|
|                              |                  |                                                           | Client may issue     |                                                                                                  | Client parses        |                                        |
|                              |                  |                                                           | Server parses        |                                                                                                  | Server may issue     |                                        |
| Object Group Number          | Variation Number | Description                                               | Function Codes (dec) | Qualifier Codes (hex)                                                                            | Function Codes (dec) | Qualifier Codes (hex)                  |
|                              |                  |                                                           |                      | 06 (no range, or all),<br>07, 08 (limited qty),<br>17, 28 (index)                                |                      | 17, 28 (index)                         |
| 10                           | 1                | Binary Output - packed format                             | 2(write)             | 00, 01 (start-stop)                                                                              |                      |                                        |
| 10                           | 2                | Continuous Control - output status with flags             | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 28 (index)        | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |
| 11                           | 0                | Binary Output Change Event - any variation                | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   |                      |                                        |
| 11                           | 1                | Binary Output Change Event - status without time          | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   | (Response)           | 17, 28 (index)                         |
| 11                           | 1                | Binary Output Change Event - status without time          |                      |                                                                                                  | (Unsol. Resp.)       | 17, 28 (index)                         |
| 11                           | 2                | Binary Output Change Event - status with time             | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   | (Response)           | 17, 28 (index)                         |
| 11                           | 2                | Binary Output Change Event - status with time             |                      |                                                                                                  | (Unsol. Resp.)       | 17, 28 (index)                         |
| 12                           | 0                | Binary Output Command (CROB) - any variation              | 22(assign class)     | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) |                      |                                        |
| 12                           | 1                | Binary Output Command (CROB) - control relay output block | 3(select)            | 17, 27,<br>28 (index)                                                                            | (Response)           | echo of request                        |
| 12                           | 1                | Binary Output Command (CROB) - control relay output block | 4(operate)           | 17, 27,<br>28 (index)                                                                            | (Response)           | echo of request                        |
| 12                           | 1                | Binary Output Command (CROB) - control relay output block | 5(direct op.)        | 17, 27,<br>28 (index)                                                                            | (Response)           | echo of request                        |
| 12                           | 1                | Binary Output Command (CROB) - control relay output block | 6(direct op, no ack) | 17, 27,<br>28 (index)                                                                            | (Response)           | echo of request                        |
| 12                           | 2                | Binary Output Command - pattern control block             | 3(select)            | 07 (limited qty = 1)                                                                             | (Response)           | echo of request                        |
| 12                           | 2                | Binary Output Command - pattern control block             | 4(operate)           | 07 (limited qty = 1)                                                                             | (Response)           | echo of request                        |

| DNP OBJECT GROUP & VARIATION |                  |                                               | REQUEST               |                                                                                                  | RESPONSE             |                                        |
|------------------------------|------------------|-----------------------------------------------|-----------------------|--------------------------------------------------------------------------------------------------|----------------------|----------------------------------------|
|                              |                  |                                               | Client may issue      |                                                                                                  | Client parses        |                                        |
|                              |                  |                                               | Server parses         |                                                                                                  | Server may issue     |                                        |
| Object Group Number          | Variation Number | Description                                   | Function Codes (dec)  | Qualifier Codes (hex)                                                                            | Function Codes (dec) | Qualifier Codes (hex)                  |
| 12                           | 2                | Binary Output Command - pattern control block | 5(direct op.)         | 07 (limited qty = 1)                                                                             | (Response)           | echo of request                        |
| 12                           | 2                | Binary Output Command - pattern control block | 6(direct op, no ack)  | 07 (limited qty = 1)                                                                             | (Response)           | echo of request                        |
| 12                           | 3                | Binary Output Command - pattern mask          | 3(select)             | 00, 01 (start-stop)                                                                              | (Response)           | echo of request                        |
| 12                           | 3                | Binary Output Command - pattern mask          | 4(operate)            | 00, 01 (start-stop)                                                                              | (Response)           | echo of request                        |
| 12                           | 3                | Binary Output Command - pattern mask          | 5(direct op.)         | 00, 01 (start-stop)                                                                              | (Response)           | echo of request                        |
| 12                           | 3                | Binary Output Command - pattern mask          | 6(direct op, no ack)  | 00, 01 (start-stop)                                                                              | (Response)           | echo of request                        |
| 20                           | 0                | Counter - any variation                       | 1(read)               | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) |                      |                                        |
| 20                           | 0                | Counter - any variation                       | 22(assign class)      | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) |                      |                                        |
| 20                           | 0                | Counter - any variation                       | 7(freeze)             | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty)                           |                      |                                        |
| 20                           | 0                | Counter - any variation                       | 8(freeze, no ack)     | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty)                           |                      |                                        |
| 20                           | 0                | Counter - any variation                       | 9(freeze & clear)     | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty)                           |                      |                                        |
| 20                           | 0                | Counter - any variation                       | 10(frz & clr, no ack) | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty)                           |                      |                                        |
| 20                           | 1                | Counter - 32-bit with flag                    | 1(read)               | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |

| DNP OBJECT GROUP & VARIATION |                  |                                            | REQUEST              |                                                                                                  | RESPONSE             |                                        |
|------------------------------|------------------|--------------------------------------------|----------------------|--------------------------------------------------------------------------------------------------|----------------------|----------------------------------------|
|                              |                  |                                            | Client may issue     |                                                                                                  | Client parses        |                                        |
|                              |                  |                                            | Server parses        |                                                                                                  | Server may issue     |                                        |
| Object Group Number          | Variation Number | Description                                | Function Codes (dec) | Qualifier Codes (hex)                                                                            | Function Codes (dec) | Qualifier Codes (hex)                  |
| 20                           | 2                | Counter - 16-bit with flag                 | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |
| 20                           | 5                | Counter - 32-bit without flag              | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |
| 20                           | 6                | Counter - 16-bit without flag              | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |
| 21                           | 0                | Frozen Counter - any variation             | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) |                      |                                        |
| 21                           | 0                | Frozen Counter - any variation             | 22(assign class)     | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) |                      |                                        |
| 21                           | 1                | Frozen Counter - 32-bit with flag          | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |
| 21                           | 2                | Frozen Counter - 16-bit with flag          | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |
| 21                           | 5                | Frozen Counter - 32-bit with flag and time | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,               | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |

| DNP OBJECT GROUP & VARIATION |                  |                                                  | REQUEST              |                                                                                                  | RESPONSE             |                                        |
|------------------------------|------------------|--------------------------------------------------|----------------------|--------------------------------------------------------------------------------------------------|----------------------|----------------------------------------|
|                              |                  |                                                  | Client may issue     |                                                                                                  | Client parses        |                                        |
|                              |                  |                                                  | Server parses        |                                                                                                  | Server may issue     |                                        |
| Object Group Number          | Variation Number | Description                                      | Function Codes (dec) | Qualifier Codes (hex)                                                                            | Function Codes (dec) | Qualifier Codes (hex)                  |
|                              |                  |                                                  |                      | 28 (index)                                                                                       |                      |                                        |
| 21                           | 6                | Frozen Counter - 16-bit with flag and time       | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |
| 21                           | 9                | Frozen Counter - 32-bit without flag             | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |
| 21                           | 10               | Frozen Counter - 16-bit without flag             | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |
| 22                           | 0                | Counter Change Event - any variation             | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   |                      |                                        |
| 22                           | 1                | Counter Change Event - 32-bit with flag          | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   | (Response)           | 17, 28 (index)                         |
| 22                           | 1                | Counter Change Event - 32-bit with flag          |                      |                                                                                                  | (Unsol. Resp.)       | 17, 28 (index)                         |
| 22                           | 2                | Counter Change Event - 16-bit with flag          | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   | (Response)           | 17, 28 (index)                         |
| 22                           | 2                | Counter Change Event - 16-bit with flag          |                      |                                                                                                  | (Unsol. Resp.)       | 17, 28 (index)                         |
| 22                           | 5                | Counter Change Event - 32-bit with flag and time | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   | (Response)           | 17, 28 (index)                         |
| 22                           | 5                | Counter Change Event - 32-bit with flag and time |                      |                                                                                                  | (Unsol. Resp.)       | 17, 28 (index)                         |
| 22                           | 6                | Counter Change Event - 16-bit with flag and time | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   | (Response)           | 17, 28 (index)                         |
| 22                           | 6                | Counter Change Event - 16-bit with flag and time |                      |                                                                                                  | (Unsol. Resp.)       | 17, 28 (index)                         |
| 23                           | 0                | Frozen Counter Change Event - any variation      | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   |                      |                                        |
| 23                           | 1                | Frozen Counter Change Event - 32-bit with flag   | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   | (Response)           | 17, 28 (index)                         |

| DNP OBJECT GROUP & VARIATION |                  |                                                         | REQUEST              |                                                                                                  | RESPONSE             |                                        |
|------------------------------|------------------|---------------------------------------------------------|----------------------|--------------------------------------------------------------------------------------------------|----------------------|----------------------------------------|
|                              |                  |                                                         | Client may issue     |                                                                                                  | Client parses        |                                        |
|                              |                  |                                                         | Server parses        |                                                                                                  | Server may issue     |                                        |
| Object Group Number          | Variation Number | Description                                             | Function Codes (dec) | Qualifier Codes (hex)                                                                            | Function Codes (dec) | Qualifier Codes (hex)                  |
| 23                           | 1                | Frozen Counter Change Event - 32-bit with flag          |                      |                                                                                                  | (Unsol. Resp.)       | 17, 28 (index)                         |
| 23                           | 2                | Frozen Counter Change Event - 16-bit with flag          | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   | (Response)           | 17, 28 (index)                         |
| 23                           | 2                | Frozen Counter Change Event - 16-bit with flag          |                      |                                                                                                  | (Unsol. Resp.)       | 17, 28 (index)                         |
| 23                           | 5                | Frozen Counter Change Event - 32-bit with flag and time | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   | (Response)           | 17, 28 (index)                         |
| 23                           | 5                | Frozen Counter Change Event - 32-bit with flag and time |                      |                                                                                                  | (Unsol. Resp.)       | 17, 28 (index)                         |
| 23                           | 6                | Frozen Counter Change Event - 16-bit with flag and time | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   | (Response)           | 17, 28 (index)                         |
| 23                           | 6                | Frozen Counter Change Event - 16-bit with flag and time |                      |                                                                                                  | (Unsol. Resp.)       | 17, 28 (index)                         |
| 30                           | 0                | Analog Input - any variation                            | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all)                                                    |                      |                                        |
| 30                           | 0                | Analog Input - any variation                            | 22(assign class)     | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) |                      |                                        |
| 30                           | 1                | Analog Input - 32-bit with flag                         | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |
| 30                           | 2                | Analog Input - 16-bit with flag                         | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |
| 30                           | 3                | Analog Input - 32-bit without flag                      | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |
| 30                           | 4                | Analog Input - 16-bit without flag                      | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),                          | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |

| DNP OBJECT GROUP & VARIATION |                  |                                                                           | REQUEST              |                                                                                                  | RESPONSE             |                                        |
|------------------------------|------------------|---------------------------------------------------------------------------|----------------------|--------------------------------------------------------------------------------------------------|----------------------|----------------------------------------|
|                              |                  |                                                                           | Client may issue     |                                                                                                  | Client parses        |                                        |
|                              |                  |                                                                           | Server parses        |                                                                                                  | Server may issue     |                                        |
| Object Group Number          | Variation Number | Description                                                               | Function Codes (dec) | Qualifier Codes (hex)                                                                            | Function Codes (dec) | Qualifier Codes (hex)                  |
|                              |                  |                                                                           |                      | 17, 27,<br>28 (index)                                                                            |                      |                                        |
| 30                           | 5                | Analog Input - single-precision, floating-point with flag                 | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |
| 32                           | 0                | Analog Input Change Event - any variation                                 | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   |                      |                                        |
| 32                           | 1                | Analog Input Change Event - 32-bit without time                           | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   | (Response)           | 17, 28 (index)                         |
| 32                           | 1                | Analog Input Event 32-bit without time                                    |                      |                                                                                                  | (Unsol. Resp.)       | 17, 28 (index)                         |
| 32                           | 2                | Analog Input Change Event - 16-bit without time                           | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   | (Response)           | 17, 28 (index)                         |
| 32                           | 2                | Analog Input Change Event - 16-bit without time                           |                      |                                                                                                  | (Unsol. Resp.)       | 17, 28 (index)                         |
| 32                           | 3                | Analog Input Change Event - 32-bit with time                              | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   | (Response)           | 17, 28 (index)                         |
| 32                           | 3                | Analog Input Change Event - 32-bit with time                              |                      |                                                                                                  | (Unsol. Resp.)       | 17, 28 (index)                         |
| 32                           | 4                | Analog Input Change Event - 16-bit with time                              | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   | (Response)           | 17, 28 (index)                         |
| 32                           | 4                | Analog Input Change Event - 16-bit with time                              |                      |                                                                                                  | (Unsol. Resp.)       | 17, 28 (index)                         |
| 32                           | 5                | Analog Input Change Event - single-precision, floating-point without time | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   | (Response)           | 17, 28 (index)                         |
| 32                           | 5                | Analog Input Change Event - single-precision, floating-point without time |                      |                                                                                                  | (Unsol. Resp.)       | 17, 28 (index)                         |
| 32                           | 7                | Analog Input Change Event - single-precision, floating-point with time    | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                                                   | (Response)           | 17, 28 (index)                         |
| 32                           | 7                | Analog Input Change Event - single-precision, floating-point with time    |                      |                                                                                                  | (Unsol. Resp.)       | 17, 28 (index)                         |
| 34                           | 0                | Analog Input Deadband - any variation                                     | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,               |                      |                                        |

| DNP OBJECT GROUP & VARIATION |                  |                                                          | REQUEST              |                                                                                                  | RESPONSE             |                                        |
|------------------------------|------------------|----------------------------------------------------------|----------------------|--------------------------------------------------------------------------------------------------|----------------------|----------------------------------------|
|                              |                  |                                                          | Client may issue     |                                                                                                  | Client parses        |                                        |
|                              |                  |                                                          | Server parses        |                                                                                                  | Server may issue     |                                        |
| Object Group Number          | Variation Number | Description                                              | Function Codes (dec) | Qualifier Codes (hex)                                                                            | Function Codes (dec) | Qualifier Codes (hex)                  |
|                              |                  |                                                          |                      | 28 (index)                                                                                       |                      |                                        |
| 34                           | 1                | Analog Input Deadband - 16-bit                           | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |
| 34                           | 1                | Analog Input Deadband - 16-bit                           | 2(write)             | 00, 01 (start-stop),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index)                           |                      |                                        |
| 34                           | 2                | Analog Input Deadband - 32-bit                           | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |
| 34                           | 2                | Analog Input Deadband - 32-bit                           | 2(write)             | 00, 01 (start-stop),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index)                           |                      |                                        |
| 34                           | 3                | Analog Input Deadband - single-precision, floating-point | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |
| 34                           | 3                | Analog Input Deadband - single-precision, floating-point | 2(write)             | 00, 01 (start-stop),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index)                           |                      |                                        |
| 40                           | 0                | Analog Output Status - any variation                     | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) |                      |                                        |
| 40                           | 0                | Analog Output Status - any variation                     | 22(assign class)     | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) |                      |                                        |

| DNP OBJECT GROUP & VARIATION |                  |                                                                   | REQUEST              |                                                                                                  | RESPONSE             |                                        |
|------------------------------|------------------|-------------------------------------------------------------------|----------------------|--------------------------------------------------------------------------------------------------|----------------------|----------------------------------------|
|                              |                  |                                                                   | Client may issue     |                                                                                                  | Client parses        |                                        |
|                              |                  |                                                                   | Server parses        |                                                                                                  | Server may issue     |                                        |
| Object Group Number          | Variation Number | Description                                                       | Function Codes (dec) | Qualifier Codes (hex)                                                                            | Function Codes (dec) | Qualifier Codes (hex)                  |
| 40                           | 1                | Analog Output Status - 32-bit with flag                           | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |
| 40                           | 2                | Analog Output Status - 16-bit with flag                           | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |
| 40                           | 3                | Analog Output Status - single-precision, floating-point with flag | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |
| 41                           | 0                | Analog Output Block - any variation                               | 22(assign class)     | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 27,<br>28 (index) |                      |                                        |
| 41                           | 1                | Analog Output Block - 32-bit                                      | 3(select)            | 17, 27,<br>28 (index)                                                                            | (Response)           | echo of request                        |
| 41                           | 1                | Analog Output Block - 32-bit                                      | 4(operate)           | 17, 27,<br>28 (index)                                                                            | (Response)           | echo of request                        |
| 41                           | 1                | Analog Output Block - 32-bit                                      | 5(direct op.)        | 17, 27,<br>28 (index)                                                                            | (Response)           | echo of request                        |
| 41                           | 1                | Analog Output Block - 32-bit                                      | 6(direct op, no ack) | 17, 27,<br>28 (index)                                                                            | (Response)           | echo of request                        |
| 41                           | 2                | Analog Output Block - 16-bit                                      | 3(select)            | 17, 27,<br>28 (index)                                                                            | (Response)           | echo of request                        |
| 41                           | 2                | Analog Output Block - 16-bit                                      | 4(operate)           | 17, 27,<br>28 (index)                                                                            | (Response)           | echo of request                        |
| 41                           | 2                | Analog Output Block - 16-bit                                      | 5(direct op.)        | 17, 27,<br>28 (index)                                                                            | (Response)           | echo of request                        |
| 41                           | 2                | Analog Output Block - 16-bit                                      | 6(direct op, no ack) | 17, 27,<br>28 (index)                                                                            | (Response)           | echo of request                        |
| 41                           | 3                | Analog Output Block - single-precision, floating-point            | 3(select)            | 17, 27,<br>28 (index)                                                                            | (Response)           | echo of request                        |

| DNP OBJECT GROUP & VARIATION |                  |                                                                            | REQUEST              |                                                | RESPONSE             |                       |
|------------------------------|------------------|----------------------------------------------------------------------------|----------------------|------------------------------------------------|----------------------|-----------------------|
|                              |                  |                                                                            | Client may issue     |                                                | Client parses        |                       |
|                              |                  |                                                                            | Server parses        |                                                | Server may issue     |                       |
| Object Group Number          | Variation Number | Description                                                                | Function Codes (dec) | Qualifier Codes (hex)                          | Function Codes (dec) | Qualifier Codes (hex) |
| 41                           | 3                | Analog Output Block - single-precision, floating-point                     | 4(operate)           | 17, 27,<br>28 (index)                          | (Response)           | echo of request       |
| 41                           | 3                | Analog Output Block - single-precision, floating-point                     | 5(direct op.)        | 17, 27,<br>28 (index)                          | (Response)           | echo of request       |
| 41                           | 3                | Analog Output Block - single-precision, floating-point                     | 6(direct op, no ack) | 17, 27,<br>28 (index)                          | (Response)           | echo of request       |
| 42                           | 0                | Analog Output Change Event - any variation                                 | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty) |                      |                       |
| 42                           | 1                | Analog Output Change Event - 32-bit without time                           | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty) | (Response)           | 17, 28 (index)        |
| 42                           | 1                | Analog Output Change Event - 32-bit without time                           |                      |                                                | (Unsol. Resp.)       | 17, 28 (index)        |
| 42                           | 2                | Analog Output Change Event - 16-bit without time                           | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty) | (Response)           | 17, 28 (index)        |
| 42                           | 2                | Analog Output Change Event - 16-bit without time                           |                      |                                                | (Unsol. Resp.)       | 17, 28 (index)        |
| 42                           | 3                | Analog Output Change Event - 32-bit with time                              | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty) | (Response)           | 17, 28 (index)        |
| 42                           | 3                | Analog Output Change Event - 32-bit with time                              |                      |                                                | (Unsol. Resp.)       | 17, 28 (index)        |
| 42                           | 4                | Analog Output Change Event - 16-bit with time                              | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty) | (Response)           | 17, 28 (index)        |
| 42                           | 4                | Analog Output Change Event - 16-bit with time                              |                      |                                                | (Unsol. Resp.)       | 17, 28 (index)        |
| 42                           | 5                | Analog Output Change Event - single-precision, floating-point without time | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty) | (Response)           | 17, 28 (index)        |
| 42                           | 5                | Analog Output Change Event - single-precision, floating-point without time |                      |                                                | (Unsol. Resp.)       | 17, 28 (index)        |
| 42                           | 7                | Analog Output Change Event - single-precision, floating-point with time    | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty) | (Response)           | 17, 28 (index)        |
| 42                           | 7                | Analog Output Change Event - single-precision, floating-point with time    |                      |                                                | (Unsol. Resp.)       | 17, 28 (index)        |
| 50                           | 1                | Time and Date - absolute time                                              | 1(read)              | 07 (limited qty = 1)                           | (Response)           | 07 (limited qty = 1)  |
| 50                           | 1                | Time and Date - absolute time                                              | 2(write)             | 07 (limited qty = 1)                           |                      |                       |

| DNP OBJECT GROUP & VARIATION |                  |                                                     | REQUEST              |                                                | RESPONSE             |                       |
|------------------------------|------------------|-----------------------------------------------------|----------------------|------------------------------------------------|----------------------|-----------------------|
|                              |                  |                                                     | Client may issue     |                                                | Client parses        |                       |
|                              |                  |                                                     | Server parses        |                                                | Server may issue     |                       |
| Object Group Number          | Variation Number | Description                                         | Function Codes (dec) | Qualifier Codes (hex)                          | Function Codes (dec) | Qualifier Codes (hex) |
| 50                           | 3                | Time and Date - absolute time at last recorded time | 2(write)             | 07 (limited qty = 1)                           |                      |                       |
| 51                           | 1                | Time and Date CTO - absolute time, synchronized     |                      |                                                | (Response)           | 07 (limited qty = 1)  |
| 51                           | 1                | Time and Date CTO - absolute time, synchronized     |                      |                                                | (Unsol. Resp.)       | 07 (limited qty = 1)  |
| 51                           | 2                | Time and Date CTO - absolute time, un-synchronized  |                      |                                                | (Response)           | 07 (limited qty = 1)  |
| 51                           | 2                | Time and Date CTO - absolute time, un-synchronized  |                      |                                                | (Unsol. Resp.)       | 07 (limited qty = 1)  |
| 52                           | 1                | Time Delay - coarse                                 |                      |                                                | (Response)           | 07 (limited qty = 1)  |
| 52                           | 2                | Time Delay - fine                                   |                      |                                                | (Response)           | 07 (limited qty = 1)  |
| 60                           | 1                | Class Objects - class 0 data                        | 1(read)              | 06 (no range, or all)                          |                      |                       |
| 60                           | 1                | Class Objects - class 0 data                        | 22(assign class)     | 06 (no range, or all)                          |                      |                       |
| 60                           | 2                | Class Objects - class 1 data                        | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty) |                      |                       |
| 60                           | 2                | Class Objects - class 1 data                        | 20(enable unsol.)    | 06 (no range, or all)                          |                      |                       |
| 60                           | 2                | Class Objects - class 1 data                        | 21(disable unsol.)   | 06 (no range, or all)                          |                      |                       |
| 60                           | 2                | Class Objects - class 1 data                        | 22(assign class)     | 06 (no range, or all)                          |                      |                       |
| 60                           | 3                | Class Objects - class 2 data                        | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty) |                      |                       |
| 60                           | 3                | Class Objects - class 2 data                        | 20(enable unsol.)    | 06 (no range, or all)                          |                      |                       |
| 60                           | 3                | Class Objects - class 2 data                        | 21(disable unsol.)   | 06 (no range, or all)                          |                      |                       |
| 60                           | 3                | Class Objects - class 2 data                        | 22(assign class)     | 06 (no range, or all)                          |                      |                       |
| 60                           | 4                | Class Objects - class 3 data                        | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty) |                      |                       |
| 60                           | 4                | Class Objects - class 3 data                        | 20(enable unsol.)    | 06 (no range, or all)                          |                      |                       |
| 60                           | 4                | Class Objects - class 3 data                        | 21(disable unsol.)   | 06 (no range, or all)                          |                      |                       |
| 60                           | 4                | Class Objects - class 3 data                        | 22(assign class)     | 06 (no range, or all)                          |                      |                       |
| 80                           | 1                | Internal Indications - packed format                | 1(read)              | 00, 01 (start-stop)                            | (Response)           | 00, 01 (start-stop)   |
| 80                           | 1                | Internal Indications - packed format                | 2(write)             |                                                |                      |                       |

| DNP OBJECT GROUP & VARIATION |                  |                                              | REQUEST              |                                                                                           | RESPONSE             |                                        |
|------------------------------|------------------|----------------------------------------------|----------------------|-------------------------------------------------------------------------------------------|----------------------|----------------------------------------|
|                              |                  |                                              | Client may issue     |                                                                                           | Client parses        |                                        |
|                              |                  |                                              | Server parses        |                                                                                           | Server may issue     |                                        |
| Object Group Number          | Variation Number | Description                                  | Function Codes (dec) | Qualifier Codes (hex)                                                                     | Function Codes (dec) | Qualifier Codes (hex)                  |
| 91                           | 1                | Status of Requested Operation                |                      |                                                                                           | (Response)           | 07 (limited qty = 1)                   |
| 91                           | 1                | Status of Requested Operation                |                      |                                                                                           | (Response)           | 5B                                     |
| 110                          | string length    | Octet String                                 | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>07, 08 (limited qty),<br>17, 28 (index) | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |
| 110                          | string length    | Octet String                                 | 2(write)             | 00, 01 (start-stop),<br>07, 08 (limited qty),<br>17, 28 (index)                           |                      |                                        |
| 110                          | string length    | Octet String                                 | 31(activate config)  | 5B                                                                                        |                      |                                        |
| 120                          | 0                | Authentication - Assign Class                | 22(assign class)     | 06 (no range, or all)                                                                     |                      |                                        |
| 120                          | 1                | Authentication - Challenge                   | 32(auth req)         | 5B                                                                                        | (Auth. Resp.)        | 5B                                     |
| 120                          | 2                | Authentication - Reply                       | 32(auth req)         | 5B                                                                                        | (Auth. Resp.)        | 5B                                     |
| 120                          | 3                | Authentication - Aggressive Mode             | any of 1 to 31       | 07 (limited qty = 1)                                                                      | (Response)           | 07 (limited qty = 1)                   |
| 120                          | 3                | Authentication - Aggressive Mode             |                      |                                                                                           | (Unsol. Resp.)       | 07 (limited qty = 1)                   |
| 120                          | 4                | Authentication - Session Key Status Request  | 32(auth req)         | 07 (limited qty = 1)                                                                      |                      |                                        |
| 120                          | 5                | Authentication - Session Key Status          |                      |                                                                                           | (Auth. Resp.)        | 5B                                     |
| 120                          | 6                | Authentication - Session Key Change          | 32(auth req)         | 5B                                                                                        |                      |                                        |
| 120                          | 7                | Authentication - Error                       | 33(auth req, no ack) | 5B                                                                                        | (Auth. Resp.)        | 5B                                     |
| 120                          | 8                | Authentication - User Certificate            | 32(auth req)         | 5B                                                                                        |                      |                                        |
| 120                          | 9                | Authentication - MAC                         | any of 1 to 31       | 5B                                                                                        | (Response)           | 5B                                     |
| 120                          | 9                | Authentication - MAC                         |                      |                                                                                           | (Unsol. Resp.)       | 5B                                     |
| 120                          | 10               | Authentication - User Status Change          | 32(auth req)         | 5B                                                                                        |                      |                                        |
| 120                          | 11               | Authentication - Update Key Change Request   | 32(auth req)         | 5B                                                                                        |                      |                                        |
| 120                          | 12               | Authentication - Update Key Change Reply     |                      |                                                                                           | (Auth. Resp.)        | 5B                                     |
| 120                          | 13               | Authentication - Update Key Change           | 32(auth req)         | 5B                                                                                        |                      |                                        |
| 120                          | 14               | Authentication - Update Key Change Signature | 32(auth req)         | 5B                                                                                        |                      |                                        |

| DNP OBJECT GROUP & VARIATION |                  |                                                      | REQUEST              |                                                                  | RESPONSE             |                                        |
|------------------------------|------------------|------------------------------------------------------|----------------------|------------------------------------------------------------------|----------------------|----------------------------------------|
|                              |                  |                                                      | Client may issue     |                                                                  | Client parses        |                                        |
|                              |                  |                                                      | Server parses        |                                                                  | Server may issue     |                                        |
| Object Group Number          | Variation Number | Description                                          | Function Codes (dec) | Qualifier Codes (hex)                                            | Function Codes (dec) | Qualifier Codes (hex)                  |
| 120                          | 15               | Authentication - Update Key Change Confirmation      | 32(auth req)         | 5B                                                               | (Auth. Resp.)        | 5B                                     |
| 121                          | 0                | Security Statistic                                   | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>17, 28 (index) |                      |                                        |
| 121                          | 0                | Security Statistic - Assign Class                    | 22(assign class)     | 00, 01 (start-stop),<br>06 (no range, or all),<br>17, 28 (index) |                      |                                        |
| 121                          | 1                | Security Statistic                                   | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>17, 28 (index) | (Response)           | 00, 01 (start-stop),<br>17, 28 (index) |
| 122                          | 0                | Security Statistic Event - 32-bit with flag          | 1(read)              | 00, 01 (start-stop),<br>06 (no range, or all),<br>17, 28 (index) |                      |                                        |
| 122                          | 1                | Security Statistic Event - 32-bit with flag          | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                   | (Response)           | 17, 28 (index)                         |
| 122                          | 1                | Security Statistic Event - 32-bit with flag and time |                      |                                                                  | (Unsol. Resp.)       | 17, 28 (index)                         |
| 122                          | 2                | Security Statistic Event - 32-bit with flag and time | 1(read)              | 06 (no range, or all),<br>07, 08 (limited qty)                   | (Response)           | 17, 28 (index)                         |
| 122                          | 2                | Security Statistic Event - 32-bit with flag and time |                      |                                                                  | (Unsol. Resp.)       | 17, 28 (index)                         |

## IEC 60870-5-104 Interoperability

### Introduction

This companion standard presents sets of parameters and alternatives from which you select subsets to implement particular telecontrol systems. Certain parameter values, such as the choice of structured or unstructured fields of the INFORMATION OBJECT ADDRESS of ASDUs represent mutually exclusive alternatives. This means that only one value of the defined parameters is admitted per system. Other parameters, such as the listed set of different process information in command and in monitor direction allow the specification of the complete set or subsets, as appropriate for given applications. This clause summarizes the parameters of the previous clauses to facilitate a suitable selection for a specific application. If a system is composed of equipment stemming from different manufacturers, it is necessary that all partners agree on the selected parameters.

The interoperability list is defined as in IEC 60870-5-101 and extended with parameters used in this standard.

The selected parameters are marked as follows:

|   |                              |
|---|------------------------------|
| - | Function or ASDU is not used |
| X | Function or ASDU is used     |

**System or Device**

|   |                                         |
|---|-----------------------------------------|
| - | System definition                       |
| - | Controlling station definition (client) |
| X | Controlled station definition (server)  |

**IEC 60870-5-104 Device Profile – Client****Application Layer**

|                                                                                                                              |                                                                                      |   |              |
|------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---|--------------|
| <b>Transmission mode for application data</b>                                                                                |                                                                                      |   |              |
| Mode 1 (least significant octet first), as defined in 4.10 of IEC 60870-5-4, is used exclusively in this companion standard. |                                                                                      |   |              |
| <b>Common address of ASDU</b>                                                                                                |                                                                                      |   |              |
| X                                                                                                                            | Two octets                                                                           |   |              |
| <b>Information object address</b>                                                                                            |                                                                                      |   |              |
| X                                                                                                                            | Three octets                                                                         | - | Structured   |
|                                                                                                                              |                                                                                      | - | Unstructured |
| <b>Cause of transmission</b>                                                                                                 |                                                                                      |   |              |
| X                                                                                                                            | Two octets (with originator address). Originator address is set to zero if not used. |   |              |
| <b>Length of APDU</b>                                                                                                        |                                                                                      |   |              |
| The maximum length of APDU for both directions is 253. It is a fixed system parameter.                                       |                                                                                      |   |              |

|                                                 |      |                                                                     |           |
|-------------------------------------------------|------|---------------------------------------------------------------------|-----------|
| <b>Process information in monitor direction</b> |      |                                                                     |           |
| X                                               | <1>  | Single-point information                                            | M_SP_NA_1 |
| X                                               | <3>  | Double-point information                                            | M_DP_NA_1 |
| X                                               | <5>  | Step position information                                           | M_ST_NA_1 |
| X                                               | <7>  | Bit string of 32 bit                                                | M_BO_NA_1 |
| X                                               | <9>  | Measured value, normalized value                                    | M_ME_NA_1 |
| X                                               | <11> | Measured value, scaled value                                        | M_ME_NB_1 |
| X                                               | <13> | Measured value, short floating point value                          | M_ME_NC_1 |
| X                                               | <15> | Integrated totals                                                   | M_IT_NA_1 |
| -                                               | <20> | Packed single-point information with status change detection        | M_PS_NA_1 |
| -                                               | <21> | Measured value, normalized value without quality descriptor         | M_ME_ND_1 |
| X                                               | <30> | Single-point information with time tag CP56Time2a                   | M_SP_TB_1 |
| X                                               | <31> | Double-point information with time tag CP56Time2a                   | M_DP_TB_1 |
| X                                               | <32> | Step position information with time tag CP56Time2a                  | M_ST_TB_1 |
| X                                               | <33> | Bitstring of 32 bit with time tag CP56Time2a                        | M_BO_TB_1 |
| X                                               | <34> | Measured value, normalized value with time tag CP56Time2a           | M_ME_TD_1 |
| X                                               | <35> | Measured value, scaled value with time tag CP56Time2a               | M_ME_TE_1 |
| X                                               | <36> | Measured value, short floating point value with time tag CP56Time2a | M_ME_TF_1 |
| X                                               | <37> | Integrated totals with time tag CP56Time2a                          | M_IT_TB_1 |
| -                                               | <38> | Event of protection equipment with time tag CP56Time2a              | M_EP_TD_1 |

| Process information in monitor direction |      |                                                                                    |           |
|------------------------------------------|------|------------------------------------------------------------------------------------|-----------|
| -                                        | <39> | Packed start events of protection equipment with time tag CP56Time2a               | M_EP_TE_1 |
| -                                        | <40> | Packed output circuit information of protection equipment with time tag CP56Time2a | M_EP_TF_1 |

| Process information in control direction |      |                                                                       |           |
|------------------------------------------|------|-----------------------------------------------------------------------|-----------|
| X                                        | <45> | Single command                                                        | C_SC_NA_1 |
| X                                        | <46> | Double command                                                        | C_DC_NA_1 |
| X                                        | <47> | Regulating step command                                               | C_RC_NA_1 |
| X                                        | <48> | Set point command, normalized value                                   | C_SE_NA_1 |
| X                                        | <49> | Set point command, scaled value                                       | C_SE_NB_1 |
| X                                        | <50> | Set point command, short floating point value                         | C_SE_NC_1 |
| X                                        | <51> | Bitstring of 32-bit                                                   | C_BO_NA_1 |
| X                                        | <58> | Single command with time tag CP56Time2a                               | C_SC_TA_1 |
| X                                        | <59> | Double command with time tag CP56Time2a                               | C_DC_TA_1 |
| X                                        | <60> | Regulating step command with time tag CP56Time2a                      | C_RC_TA_1 |
| X                                        | <61> | Setpoint command, normalized value with time tag CP56Time2a           | C_SE_TA_1 |
| X                                        | <62> | Setpoint command, scaled value with time tag CP56Time2a               | C_SE_TB_1 |
| X                                        | <63> | Setpoint command, short floating point value with time tag CP56Time2a | C_SE_TC_1 |
| X                                        | <64> | Bitstring of 32 bit with time tag CP56Time2a                          | C_BO_TA_1 |

| System information in monitor direction |      |                       |           |
|-----------------------------------------|------|-----------------------|-----------|
| X                                       | <70> | End of initialization | M_EI_NA_1 |

| System information in control direction |        |                                       |           |
|-----------------------------------------|--------|---------------------------------------|-----------|
| X                                       | <100-> | Interrogation command                 | C_IC_NA_1 |
| X                                       | <101-> | Counter interrogation command         | C_CI_NA_1 |
| X                                       | <102-> | Read command                          | C_RD_NA_1 |
| X                                       | <103-> | Clock synchronization command         | C_CS_NA_1 |
| X                                       | <105-> | Reset process command                 | C_RP_NA_1 |
| X                                       | <107-> | Test command with time tag CP56Time2a | C_TS_TA_1 |

| Parameter in control direction |        |                                                         |            |
|--------------------------------|--------|---------------------------------------------------------|------------|
| X                              | <110-> | Parameter of measured value, normalized value           | P_ME_NA_1  |
| X                              | <111>  | Parameter of measured value, scaled value               | P_ME_NB_1  |
| X                              | <112-> | Parameter of measured value, short floating point value | P_ME_NC_1  |
| X                              | <113-> | Parameter activation                                    | PC_AC_NA_1 |

| File transfer |        |               |           |
|---------------|--------|---------------|-----------|
| -             | <120-> | File ready    | F_FR_NA_1 |
| -             | <121-> | Section ready | F_SR_NA_1 |

| File transfer |        |                                                      |           |
|---------------|--------|------------------------------------------------------|-----------|
| -             | <122-> | Call directory, select file, call file, call section | F_SC_NA_1 |
| -             | <123-> | Last section, last segment                           | F_LS_NA_1 |
| -             | <124-> | Ack file, ack section                                | F_AF_NA_1 |
| -             | <125-> | Segment                                              | F_SG_NA_1 |
| -             | <126-> | Directory                                            | F_DR_TA_1 |
| -             | <127-> | Query log - Request archive file                     | F_SC_NB_1 |

| Type identification |           | Cause of transmission |                 |             |             |                      |            |                         |              |                           |                        |                                    |                                   |               |                                |                                      |                             |                               |                                |                                    |
|---------------------|-----------|-----------------------|-----------------|-------------|-------------|----------------------|------------|-------------------------|--------------|---------------------------|------------------------|------------------------------------|-----------------------------------|---------------|--------------------------------|--------------------------------------|-----------------------------|-------------------------------|--------------------------------|------------------------------------|
|                     |           | Periodic, cyclic      | Background scan | Spontaneous | Initialized | Request or requested | Activation | Activation confirmation | Deactivation | Deactivation confirmation | Activation termination | Return info caused by a remote cmd | Return info caused by a local cmd | File transfer | Interrogated by group <number> | Request by group <n> counter request | unknown type identification | Unknown cause of transmission | Unknown common address of ASDU | Unknown information object address |
|                     |           | 1                     | 2               | 3           | 4           | 5                    | 6          | 7                       | 8            | 9                         | 10                     | 11                                 | 12                                | 13            | 20...36                        | 37...41                              | 44                          | 45                            | 46                             | 47                                 |
| <1>                 | M_SP_NA_1 |                       | X               | X           |             | X                    |            |                         |              |                           |                        | X                                  | X                                 |               | X                              |                                      |                             |                               |                                |                                    |
| <3>                 | M_DP_NA_1 |                       | X               | X           |             | X                    |            |                         |              |                           |                        | X                                  | X                                 |               | X                              |                                      |                             |                               |                                |                                    |
| <5>                 | M_ST_NA_1 |                       | X               | X           |             | X                    |            |                         |              |                           |                        | X                                  | X                                 |               | X                              |                                      |                             |                               |                                |                                    |
| <7>                 | M_BO_NA_1 |                       | X               | X           |             | X                    |            |                         |              |                           |                        |                                    |                                   |               | X                              |                                      |                             |                               |                                |                                    |
| <9>                 | M_ME_NA_1 | X                     | X               | X           |             | X                    |            |                         |              |                           |                        |                                    |                                   |               | X                              |                                      |                             |                               |                                |                                    |
| <11>                | M_ME_NB_1 | X                     | X               | X           |             | X                    |            |                         |              |                           |                        |                                    |                                   |               | X                              |                                      |                             |                               |                                |                                    |
| <13->               | M_ME_NC_1 | X                     | X               | X           |             | X                    |            |                         |              |                           |                        |                                    |                                   |               | X                              |                                      |                             |                               |                                |                                    |
| <15->               | M_IT_NA_1 |                       |                 | X           |             |                      |            |                         |              |                           |                        |                                    |                                   |               |                                | X                                    |                             |                               |                                |                                    |
| <30->               | M_SP_TB_1 |                       |                 | X           |             | X                    |            |                         |              |                           |                        | X                                  | X                                 |               |                                |                                      |                             |                               |                                |                                    |
| <31->               | M_DP_TB_1 |                       |                 | X           |             | X                    |            |                         |              |                           |                        | X                                  | X                                 |               |                                |                                      |                             |                               |                                |                                    |
| <32->               | M_ST_TB_1 |                       |                 | X           |             | X                    |            |                         |              |                           |                        | X                                  | X                                 |               |                                |                                      |                             |                               |                                |                                    |
| <33->               | M_BO_TB_1 |                       |                 | X           |             | X                    |            |                         |              |                           |                        |                                    |                                   |               |                                |                                      |                             |                               |                                |                                    |
| <34->               | M_ME_TD_1 |                       |                 | X           |             | X                    |            |                         |              |                           |                        |                                    |                                   |               |                                |                                      |                             |                               |                                |                                    |
| <35->               | M_ME_TE_1 |                       |                 | X           |             | X                    |            |                         |              |                           |                        |                                    |                                   |               |                                |                                      |                             |                               |                                |                                    |

| Type identification |               | Cause of transmission |                 |             |             |                      |            |                         |              |                           |                        |                                    |                                   |               |                                |                                      |                             |                               |                                |                                    |
|---------------------|---------------|-----------------------|-----------------|-------------|-------------|----------------------|------------|-------------------------|--------------|---------------------------|------------------------|------------------------------------|-----------------------------------|---------------|--------------------------------|--------------------------------------|-----------------------------|-------------------------------|--------------------------------|------------------------------------|
|                     |               | Periodic, cyclic      | Background scan | Spontaneous | Initialized | Request or requested | Activation | Activation confirmation | Deactivation | Deactivation confirmation | Activation termination | Return info caused by a remote cmd | Return info caused by a local cmd | File transfer | Interrogated by group <number> | Request by group <n> counter request | unknown type identification | Unknown cause of transmission | Unknown common address of ASDU | Unknown information object address |
|                     |               | 1                     | 2               | 3           | 4           | 5                    | 6          | 7                       | 8            | 9                         | 10                     | 11                                 | 12                                | 13            | 20...36                        | 37...41                              | 44                          | 45                            | 46                             | 47                                 |
| <36->               | M_ME_<br>TF_1 |                       |                 | X           |             | X                    |            |                         |              |                           |                        |                                    |                                   |               |                                |                                      |                             |                               |                                |                                    |
| <37->               | M_IT_<br>TB_1 |                       |                 | X           |             |                      |            |                         |              |                           |                        |                                    |                                   |               |                                |                                      |                             |                               |                                |                                    |
| <45->               | C_SC_<br>NA_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <46->               | C_DC_<br>NA_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <47->               | C_RC_<br>NA_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <48->               | C_SE_<br>NA_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <49->               | C_SE_<br>NB_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <50->               | C_SE_<br>NC_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <51->               | C_BO_<br>NA_1 |                       |                 |             |             |                      | X          | X                       |              |                           | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <58->               | C_SC_<br>TA_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <59->               | C_DC_<br>TA_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <60->               | C_RC_<br>TA_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <61->               | C_SE_<br>TA_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <62->               | C_SE_<br>TB_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <63->               | C_SE_<br>TC_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <64->               | C_BO_<br>TA_1 |                       |                 |             |             |                      | X          | X                       |              |                           | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <70->               | M_EI_<br>NA_1 |                       |                 |             | X           |                      |            |                         |              |                           |                        |                                    |                                   |               |                                |                                      |                             |                               |                                |                                    |
| <10-0>              | C_IC_<br>NA_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <10-1>              | C_CI_<br>NA_1 |                       |                 |             |             |                      | X          | X                       |              |                           | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <10-2>              | C_RD_<br>NA_1 |                       |                 |             |             | X                    |            |                         |              |                           |                        |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <10-3>              | C_CS_<br>NA_1 |                       |                 |             |             |                      | X          | X                       |              |                           |                        |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |

| Type identification |           | Cause of transmission |                 |             |             |                      |            |                         |              |                           |                        |                                    |                                   |               |                                |                                      |                             |                               |                                |                                    |
|---------------------|-----------|-----------------------|-----------------|-------------|-------------|----------------------|------------|-------------------------|--------------|---------------------------|------------------------|------------------------------------|-----------------------------------|---------------|--------------------------------|--------------------------------------|-----------------------------|-------------------------------|--------------------------------|------------------------------------|
|                     |           | Periodic, cyclic      | Background scan | Spontaneous | Initialized | Request or requested | Activation | Activation confirmation | Deactivation | Deactivation confirmation | Activation termination | Return info caused by a remote cmd | Return info caused by a local cmd | File transfer | Interrogated by group <number> | Request by group <n> counter request | unknown type identification | Unknown cause of transmission | Unknown common address of ASDU | Unknown information object address |
|                     |           | 1                     | 2               | 3           | 4           | 5                    | 6          | 7                       | 8            | 9                         | 10                     | 11                                 | 12                                | 13            | 20...36                        | 37...41                              | 44                          | 45                            | 46                             | 47                                 |
| <10-5>              | C_RP_NA_1 |                       |                 |             |             |                      | X          | X                       |              |                           |                        |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <11-0>              | P_ME_NA_1 |                       |                 |             |             |                      | X          | X                       |              |                           |                        |                                    |                                   |               | X                              |                                      | X                           | X                             | X                              | X                                  |
| <11-1>              | P_ME_NB_1 |                       |                 |             |             |                      | X          | X                       |              |                           |                        |                                    |                                   |               | X                              |                                      | X                           | X                             | X                              | X                                  |
| <11-2>              | P_ME_NC_1 |                       |                 |             |             |                      | X          | X                       |              |                           |                        |                                    |                                   |               | X                              |                                      | X                           | X                             | X                              | X                                  |
| <11-3>              | P_AC_NA_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         |                        |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |

### Basic Application Functions

|                                                                                                         |                                            |   |          |   |          |
|---------------------------------------------------------------------------------------------------------|--------------------------------------------|---|----------|---|----------|
| Station initialization                                                                                  |                                            |   |          |   |          |
| X                                                                                                       | Remote initialization                      |   |          |   |          |
| Cyclic data transmission                                                                                |                                            |   |          |   |          |
| X                                                                                                       | Cyclic data transmission                   |   |          |   |          |
| Read procedure                                                                                          |                                            |   |          |   |          |
| X                                                                                                       | Read procedure                             |   |          |   |          |
| Spontaneous transmission                                                                                |                                            |   |          |   |          |
| X                                                                                                       | Spontaneous transmission                   |   |          |   |          |
| Double transmission of information objects with cause of transmission, spontaneous supports these types |                                            |   |          |   |          |
| -                                                                                                       | Single-point information                   |   |          |   |          |
| -                                                                                                       | Double-point information                   |   |          |   |          |
| -                                                                                                       | Step position information                  |   |          |   |          |
| -                                                                                                       | Bitstring of 32 bit                        |   |          |   |          |
| -                                                                                                       | Measure value, normalized value            |   |          |   |          |
| -                                                                                                       | Measure value, scaled value                |   |          |   |          |
| -                                                                                                       | Measure value, short floating point number |   |          |   |          |
| Station interrogation                                                                                   |                                            |   |          |   |          |
| X                                                                                                       | Global                                     |   |          |   |          |
| X                                                                                                       | Group 1                                    | X | Group 7  | X | Group 13 |
| X                                                                                                       | Group 2                                    | X | Group 8  | X | Group 14 |
| X                                                                                                       | Group 3                                    | X | Group 9  | X | Group 15 |
| X                                                                                                       | Group 4                                    | X | Group 10 | X | Group 16 |

|                                    |                                                                                               |   |                                      |  |
|------------------------------------|-----------------------------------------------------------------------------------------------|---|--------------------------------------|--|
| X                                  | Group 5                                                                                       | X | Group 11                             |  |
| X                                  | Group 6                                                                                       | X | Group 12                             |  |
| Clock synchronization              |                                                                                               |   |                                      |  |
| X                                  | Clock synchronization                                                                         |   |                                      |  |
| X                                  | Day of week used                                                                              |   |                                      |  |
| X                                  | RES1, GEN (time tag substituted/ not substituted) used                                        |   |                                      |  |
| X                                  | SU-bit (summertime) used                                                                      |   |                                      |  |
| Command transmission               |                                                                                               |   |                                      |  |
| X                                  | Direct command transmission                                                                   | X | Select and execute command           |  |
| X                                  | Direct set point command transmission                                                         | X | Select and execute set point command |  |
|                                    |                                                                                               | X | C-SE-ACTTERM used                    |  |
| X                                  | No additional definition                                                                      |   |                                      |  |
| X                                  | Short pulse duration (duration determined by a system parameter in the server)                |   |                                      |  |
| X                                  | Long pulse duration (duration determined by a system parameter in the server)                 |   |                                      |  |
| X                                  | Persistent output                                                                             |   |                                      |  |
| -                                  | Supervision of maximum delay in command direction of commands and set point commands          |   |                                      |  |
| Configurable                       | Maximum allowable delay of commands and set point commands                                    |   |                                      |  |
| Transmission of integrated totals  |                                                                                               |   |                                      |  |
| X                                  | Mode A: Local freeze with spontaneous transmission                                            |   |                                      |  |
| X                                  | Mode B: Local freeze with counter interrogation                                               |   |                                      |  |
| X                                  | Mode C: Freeze and transmit by counter-interrogation commands                                 |   |                                      |  |
| -                                  | Mode D: Freeze by counter-interrogation command, frozen values reported spontaneously         |   |                                      |  |
| X                                  | Counter read                                                                                  |   |                                      |  |
| X                                  | Counter freeze without reset                                                                  |   |                                      |  |
| X                                  | Counter freeze with reset                                                                     |   |                                      |  |
| X                                  | Counter reset                                                                                 |   |                                      |  |
| X                                  | General request counter                                                                       |   |                                      |  |
| X                                  | Request counter group 1...4                                                                   |   |                                      |  |
| Parameter loading                  |                                                                                               |   |                                      |  |
| X                                  | Threshold value                                                                               |   |                                      |  |
| -                                  | Smoothing factor                                                                              |   |                                      |  |
| X                                  | Low limit for transmission of measured values                                                 |   |                                      |  |
| X                                  | High limit for transmission of measured values                                                |   |                                      |  |
| Parameter activation               |                                                                                               |   |                                      |  |
| X                                  | Activation/deactivation of persistent cyclic or periodic transmission of the addressed object |   |                                      |  |
| Test procedure                     |                                                                                               |   |                                      |  |
| X                                  | Test procedure                                                                                |   |                                      |  |
| File transfer                      |                                                                                               |   |                                      |  |
| File transfer in monitor direction |                                                                                               |   |                                      |  |
| -                                  | Transparent file                                                                              |   |                                      |  |
| -                                  | Transmission of disturbance data of protection equipment                                      |   |                                      |  |

|                                                                                                                                                                                                                                                                                                                                                                                                    |                                                     |               |                                                                                      |                |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|---------------|--------------------------------------------------------------------------------------|----------------|
| -                                                                                                                                                                                                                                                                                                                                                                                                  | Transmission of sequences of events                 |               |                                                                                      |                |
| -                                                                                                                                                                                                                                                                                                                                                                                                  | Transmission of sequences of recorded analog values |               |                                                                                      |                |
| File transfer in control direction                                                                                                                                                                                                                                                                                                                                                                 |                                                     |               |                                                                                      |                |
| -                                                                                                                                                                                                                                                                                                                                                                                                  | Transparent file                                    |               |                                                                                      |                |
| Background scan                                                                                                                                                                                                                                                                                                                                                                                    |                                                     |               |                                                                                      |                |
| X                                                                                                                                                                                                                                                                                                                                                                                                  | Background scan                                     |               |                                                                                      |                |
| Definition of timeouts                                                                                                                                                                                                                                                                                                                                                                             |                                                     |               |                                                                                      |                |
| Parameters                                                                                                                                                                                                                                                                                                                                                                                         |                                                     | Default Value | Remarks                                                                              | Selected Value |
| t <sub>0</sub>                                                                                                                                                                                                                                                                                                                                                                                     |                                                     | 30s           | Timeout of connection establishment                                                  | Configurable   |
| t <sub>1</sub>                                                                                                                                                                                                                                                                                                                                                                                     |                                                     | 15s           | Timeout of send or test APDUs                                                        | Configurable   |
| t <sub>2</sub>                                                                                                                                                                                                                                                                                                                                                                                     |                                                     | 10s           | Timeout for acknowledges in case of no data messages t <sub>2</sub> < t <sub>1</sub> | Configurable   |
| t <sub>3</sub>                                                                                                                                                                                                                                                                                                                                                                                     |                                                     | 20s           | Timeout for sending test frames in case of a long idle state                         | Configurable   |
| Maximum range for timeouts: t <sub>0</sub> to t <sub>2</sub> 1...255s, accuracy: 1s                                                                                                                                                                                                                                                                                                                |                                                     |               |                                                                                      |                |
| Recommended range for timeout t <sub>3</sub> : 1s to 48h, resolution: 1s                                                                                                                                                                                                                                                                                                                           |                                                     |               |                                                                                      |                |
| Long timeouts for t <sub>3</sub> may be necessary in cases where satellite links or dial-up connections are used (for instance, to establish connection and collect values only once per day/week).                                                                                                                                                                                                |                                                     |               |                                                                                      |                |
| Maximum number of outstanding I format APDUs (k) and latest acknowledge APDUs (w)                                                                                                                                                                                                                                                                                                                  |                                                     |               |                                                                                      |                |
| Parameters                                                                                                                                                                                                                                                                                                                                                                                         |                                                     | Default Value | Remarks                                                                              | Selected Value |
| k                                                                                                                                                                                                                                                                                                                                                                                                  |                                                     | 12 APDUs      | Maximum difference receive sequence number to send state variable                    | Configurable   |
| w                                                                                                                                                                                                                                                                                                                                                                                                  |                                                     | 8 APDUs       | Latest acknowledge after receiving w I-format APDUs                                  | Configurable   |
| Maximum range of values k: 1...12 (12) APDUs, accuracy: 1 APDU                                                                                                                                                                                                                                                                                                                                     |                                                     |               |                                                                                      |                |
| Maximum range of values w: 1...32767 APDUs, accuracy: 1 APDU                                                                                                                                                                                                                                                                                                                                       |                                                     |               |                                                                                      |                |
| Recommendation: w should not exceed two-thirds of k                                                                                                                                                                                                                                                                                                                                                |                                                     |               |                                                                                      |                |
| Port number                                                                                                                                                                                                                                                                                                                                                                                        |                                                     |               |                                                                                      |                |
| Parameter                                                                                                                                                                                                                                                                                                                                                                                          |                                                     | Default Value | Remarks                                                                              |                |
| Port number                                                                                                                                                                                                                                                                                                                                                                                        |                                                     | 2404          | Configurable                                                                         |                |
| Redundant connections                                                                                                                                                                                                                                                                                                                                                                              |                                                     |               |                                                                                      |                |
| Configurable                                                                                                                                                                                                                                                                                                                                                                                       | Number N of redundancy group connections used       |               |                                                                                      |                |
| RFC 2200 suite                                                                                                                                                                                                                                                                                                                                                                                     |                                                     |               |                                                                                      |                |
| RFC 2200 is an official Internet Standard which describes the state of standardization of protocols used in the Internet as determined by the Internet Architecture Board (IAB). It offers a broad spectrum of actual standards used in the Internet. The suitable selection of documents from RFC 2200 defined in this standard for given projects has to be chosen by the user of this standard. |                                                     |               |                                                                                      |                |
| X                                                                                                                                                                                                                                                                                                                                                                                                  | Ethernet 802.3                                      |               |                                                                                      |                |
| -                                                                                                                                                                                                                                                                                                                                                                                                  | Serial X.21 interface                               |               |                                                                                      |                |
| -                                                                                                                                                                                                                                                                                                                                                                                                  | Other selection from RFC 2200                       |               |                                                                                      |                |

## IEC 60870-5-104 Device Profile – Server

|                                                                                                                             |
|-----------------------------------------------------------------------------------------------------------------------------|
| <b>Transmission mode for application data</b>                                                                               |
| Mode 1 (least significant octet first), as defined in 4.10 of IEC 60870-5-4, is used exclusively in this companion standard |

| Common address of ASDU     |                                                                                    |   |              |
|----------------------------|------------------------------------------------------------------------------------|---|--------------|
| X                          | Two octets                                                                         |   |              |
| Information object address |                                                                                    |   |              |
| X                          | Three octets                                                                       | X | Structured   |
|                            |                                                                                    | X | Unstructured |
| Cause of transmission      |                                                                                    |   |              |
| X                          | Two octets (with originator address). Set to zero in case of no originator address |   |              |

| Process information in monitor direction |      |                                                                                    |           |
|------------------------------------------|------|------------------------------------------------------------------------------------|-----------|
| X                                        | <1>  | Single-point information                                                           | M_SP_NA_1 |
| X                                        | <3>  | Double-point information                                                           | M_DP_NA_1 |
| X                                        | <5>  | Step position information                                                          | M_ST_NA_1 |
| X                                        | <7>  | Bitstring of 32 bit                                                                | M_BO_NA_1 |
| X                                        | <9>  | Measured value, normalized value                                                   | M_ME_NA_1 |
| X                                        | <11> | Measured value, scaled value                                                       | M_ME_NB_1 |
| X                                        | <13> | Measured value, short floating point value                                         | M_ME_NC_1 |
| X                                        | <15> | Integrated totals                                                                  | M_IT_NA_1 |
| -                                        | <20> | Packed single-point information with status change detection                       | M_SP_NA_1 |
| -                                        | <21> | Measured value, normalized value without quality descriptor                        | M_ME_ND_1 |
| X                                        | <30> | Single-point information with time tag CP56Time2a                                  | M_SP_TB_1 |
| X                                        | <31> | Double-point information with time tag CP56Time2a                                  | M_DP_TB_1 |
| X                                        | <32> | Step position information with time tag CP56Time2a                                 | M_ST_TB_1 |
| X                                        | <33> | Bitstring of 32 bit with time tag CP56Time2a                                       | M_BO_TB_1 |
| X                                        | <34> | Measured value, normalized value with time tag CP56Time2a                          | M_ME_TD_1 |
| X                                        | <35> | Measured value, scaled value with time tag CP56Time2a                              | M_ME_TE_1 |
| X                                        | <36> | Measured value, short floating point value with time tag CP56Time2a                | M_ME_TF_1 |
| X                                        | <37> | Integrated totals with time tag CP56Time2a                                         | M_IT_TB_1 |
| -                                        | <38> | Event of protection equipment with time tag CP56Time2a                             | M_EP_TD_1 |
| -                                        | <39> | Packed start events of protection equipment with time tag CP56Time2a               | M_EP_TE_1 |
| -                                        | <40> | Packed output circuit information of protection equipment with time tag CP56Time2a | M_EP_TF_1 |

| Process information in control direction |      |                                                              |           |
|------------------------------------------|------|--------------------------------------------------------------|-----------|
| X                                        | <45> | Single command                                               | C_SC_NA_1 |
| X                                        | <46> | Double command                                               | C_DC_NA_1 |
| X                                        | <47> | Regulating step command                                      | C_RC_NA_1 |
| X                                        | <48> | Set point command, normalized value                          | C_SE_NA_1 |
| X                                        | <49> | Set point command, scaled value                              | C_SE_NB_1 |
| X                                        | <50> | Set point command, short floating point value                | C_SE_NC_1 |
| X                                        | <51> | Bitstring of 32-bit                                          | C_BO_NA_1 |
| X                                        | <58> | Single command with time tag CP56Time2a                      | C_SC_TA_1 |
| X                                        | <59> | Double command with time tag CP56Time2a                      | C_DC_TA_1 |
| X                                        | <60> | Regulating step command with time tag CP56Time 2a            | C_RC_TA_1 |
| X                                        | <61> | Set point command, normalized value with time tag CP56Time2a | C_SE_TA_1 |
| X                                        | <62> | Set point command, scaled value with time tag CP56Time2a     | C_SE_TB_1 |

| Process information in control direction |      |                                                                        |           |
|------------------------------------------|------|------------------------------------------------------------------------|-----------|
| X                                        | <63> | Set point command, short floating point value with time tag CP56Time2a | C_SE_TC_1 |
| X                                        | <64> | Bitstring of 32-bit with time tag CP56Time2a                           | C_BO_TA_1 |

| System information in monitor direction |      |                       |           |
|-----------------------------------------|------|-----------------------|-----------|
| X                                       | <70> | End of initialization | M_EI_NA_1 |

| System information in control direction |        |                                       |           |
|-----------------------------------------|--------|---------------------------------------|-----------|
| X                                       | <100-> | Interrogation command                 | C_IC_NA_1 |
| X                                       | <101-> | Counter interrogation command         | C_CI_NA_1 |
| X                                       | <102-> | Read command                          | C_RD_NA_1 |
| X                                       | <103-> | Clock synchronization command         | C_CS_NA_1 |
| X                                       | <105-> | Reset process command                 | C_RP_NA_1 |
| X                                       | <107-> | Test command with time tag CP56Time2a | C_TS_TA_1 |

| Parameter in control direction |        |                                                         |            |
|--------------------------------|--------|---------------------------------------------------------|------------|
| X                              | <110-> | Parameter of measured value, normalized value           | P_ME_NA_1  |
| X                              | <111>  | Parameter of measured value, scaled value               | P_ME_NB_1  |
| X                              | <112-> | Parameter of measured value, short floating point value | P_ME_NC_1  |
| X                              | <113-> | Parameter activation                                    | PC_AC_NA_1 |

| File transfer |        |                                                      |           |
|---------------|--------|------------------------------------------------------|-----------|
| -             | <120-> | File ready                                           | F_FR_NA_1 |
| -             | <121-> | Section ready                                        | F_SR_NA_1 |
| -             | <122-> | Call directory, select file, call file, call section | F_SC_NA_1 |
| -             | <123-> | Last section, last segment                           | F_LS_NA_1 |
| -             | <124-> | Ack file, ack section                                | F_AF_NA_1 |
| -             | <125-> | Segment                                              | F_SG_NA_1 |
| -             | <126-> | Directory                                            | F_DR_TA_1 |
| -             | <127-> | Query log - Request archive file                     | F_SC_NB_1 |

| Type identification |           | Cause of transmission |                 |             |             |                      |            |                         |              |                           |                        |                                    |                                   |               |                                |                                      |                             |                               |                                |                                    |
|---------------------|-----------|-----------------------|-----------------|-------------|-------------|----------------------|------------|-------------------------|--------------|---------------------------|------------------------|------------------------------------|-----------------------------------|---------------|--------------------------------|--------------------------------------|-----------------------------|-------------------------------|--------------------------------|------------------------------------|
|                     |           | Periodic, cyclic      | Background scan | Spontaneous | Initialized | Request or requested | Activation | Activation confirmation | Deactivation | Deactivation confirmation | Activation termination | Return info caused by a remote cmd | Return info caused by a local cmd | File transfer | Interrogated by group <number> | Request by group <n> counter request | Unknown type identification | Unknown cause of transmission | Unknown common address of ASDU | Unknown information object address |
|                     |           | 1                     | 2               | 3           | 4           | 5                    | 6          | 7                       | 8            | 9                         | 10                     | 11                                 | 12                                | 13            | 20...-<br>.36                  | 37...-<br>.41                        | 44                          | 45                            | 46                             | 47                                 |
| <1>                 | M_SP_NA_1 |                       | X               | X           |             | X                    |            |                         |              |                           |                        |                                    |                                   |               | X                              |                                      |                             |                               |                                |                                    |
| <3>                 | M_DP_NA_1 |                       | X               | X           |             | X                    |            |                         |              |                           |                        |                                    |                                   |               | X                              |                                      |                             |                               |                                |                                    |
| <5>                 | M_ST_NA_1 |                       | X               | X           |             | X                    |            |                         |              |                           |                        |                                    |                                   |               | X                              |                                      |                             |                               |                                |                                    |
| <7>                 | M_BO_NA_1 |                       | X               | X           |             | X                    |            |                         |              |                           |                        |                                    |                                   |               | X                              |                                      |                             |                               |                                |                                    |
| <9>                 | M_ME_NA_1 | X                     | X               | X           |             | X                    |            |                         |              |                           |                        |                                    |                                   |               | X                              |                                      |                             |                               |                                |                                    |
| <11>                | M_ME_NB_1 | X                     | X               | X           |             | X                    |            |                         |              |                           |                        |                                    |                                   |               | X                              |                                      |                             |                               |                                |                                    |
| <13>                | M_ME_NC_1 | X                     | X               | X           |             | X                    |            |                         |              |                           |                        |                                    |                                   |               | X                              |                                      |                             |                               |                                |                                    |
| <15>                | M_IT_NA_1 |                       |                 | X           |             |                      |            |                         |              |                           |                        |                                    |                                   |               |                                | X                                    |                             |                               |                                |                                    |
| <30>                | M_SP_TB_1 |                       |                 | X           |             | X                    |            |                         |              |                           |                        |                                    |                                   |               |                                |                                      |                             |                               |                                |                                    |
| <31>                | M_DP_TB_1 |                       |                 | X           |             | X                    |            |                         |              |                           |                        |                                    |                                   |               |                                |                                      |                             |                               |                                |                                    |
| <32>                | M_ST_TB_1 |                       |                 | X           |             | X                    |            |                         |              |                           |                        |                                    |                                   |               |                                |                                      |                             |                               |                                |                                    |
| <33>                | M_BO_TB_1 |                       |                 | X           |             | X                    |            |                         |              |                           |                        |                                    |                                   |               |                                |                                      |                             |                               |                                |                                    |
| <34>                | M_ME_TD_1 |                       |                 | X           |             | X                    |            |                         |              |                           |                        |                                    |                                   |               |                                |                                      |                             |                               |                                |                                    |
| <35>                | M_ME_TE_1 |                       |                 | X           |             | X                    |            |                         |              |                           |                        |                                    |                                   |               |                                |                                      |                             |                               |                                |                                    |
| <36>                | M_ME_TF_1 |                       |                 | X           |             | X                    |            |                         |              |                           |                        |                                    |                                   |               |                                |                                      |                             |                               |                                |                                    |
| <37>                | M_IT_TB_1 |                       |                 | X           |             |                      |            |                         |              |                           |                        |                                    |                                   |               |                                |                                      |                             |                               |                                |                                    |
| <45>                | C_SC_NA_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <46>                | C_DC_NA_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <47>                | C_RC_NA_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <48>                | C_SE_NA_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <49>                | C_SE_NB_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <50>                | C_SE_NC_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <51>                | C_BO_NA_1 |                       |                 |             |             |                      | X          | X                       |              |                           | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <58>                | C_SC_TA_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <59>                | C_DC_TA_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <60>                | C_RC_TA_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <61>                | C_SE_TA_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <62>                | C_SE_TB_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <63>                | C_SE_TC_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <64>                | C_BO_TA_1 |                       |                 |             |             |                      | X          | X                       |              |                           | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <70>                | M_EI_NA_1 |                       |                 |             | X           |                      |            |                         |              |                           |                        |                                    |                                   |               |                                |                                      |                             |                               |                                |                                    |

| Type identification |           | Cause of transmission |                 |             |             |                      |            |                         |              |                           |                        |                                    |                                   |               |                                |                                      |                             |                               |                                |                                    |
|---------------------|-----------|-----------------------|-----------------|-------------|-------------|----------------------|------------|-------------------------|--------------|---------------------------|------------------------|------------------------------------|-----------------------------------|---------------|--------------------------------|--------------------------------------|-----------------------------|-------------------------------|--------------------------------|------------------------------------|
|                     |           | Periodic, cyclic      | Background scan | Spontaneous | Initialized | Request or requested | Activation | Activation confirmation | Deactivation | Deactivation confirmation | Activation termination | Return info caused by a remote cmd | Return info caused by a local cmd | File transfer | Interrogated by group <number> | Request by group <n> counter request | Unknown type identification | Unknown cause of transmission | Unknown common address of ASDU | Unknown information object address |
|                     |           | 1                     | 2               | 3           | 4           | 5                    | 6          | 7                       | 8            | 9                         | 10                     | 11                                 | 12                                | 13            | 20...<br>.36                   | 37...-<br>.41                        | 44                          | 45                            | 46                             | 47                                 |
| <100>               | C_IC_NA_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <101>               | C_CI_NA_1 |                       |                 |             |             |                      | X          | X                       |              |                           | X                      |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <102>               | C_RD_NA_1 |                       |                 |             |             | X                    |            |                         |              |                           |                        |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <103>               | C_CS_NA_1 |                       |                 |             |             |                      | X          | X                       |              |                           |                        |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <105>               | C_RP_NA_1 |                       |                 |             |             |                      | X          | X                       |              |                           |                        |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <107>               | C_TS_TA_1 |                       |                 |             |             |                      | X          | X                       |              |                           |                        |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |
| <110>               | P_ME_NA_1 |                       |                 |             |             |                      | X          | X                       |              |                           |                        |                                    |                                   |               | X                              |                                      | X                           | X                             | X                              | X                                  |
| <111>               | P_ME_NB_1 |                       |                 |             |             |                      | X          | X                       |              |                           |                        |                                    |                                   |               | X                              |                                      | X                           | X                             | X                              | X                                  |
| <112>               | P_ME_NC_1 |                       |                 |             |             |                      | X          | X                       |              |                           |                        |                                    |                                   |               | X                              |                                      | X                           | X                             | X                              | X                                  |
| <113>               | P_AC_NA_1 |                       |                 |             |             |                      | X          | X                       | X            | X                         |                        |                                    |                                   |               |                                |                                      | X                           | X                             | X                              | X                                  |

### Basic Application Functions

|                                                |                                            |   |         |   |          |
|------------------------------------------------|--------------------------------------------|---|---------|---|----------|
| Station initialization                         |                                            |   |         |   |          |
| X                                              | Remote initialization                      |   |         |   |          |
| Cyclic data transmission                       |                                            |   |         |   |          |
| X                                              | Cyclic data transmission                   |   |         |   |          |
| Read procedure                                 |                                            |   |         |   |          |
| X                                              | Read procedure                             |   |         |   |          |
| Spontaneous transmission                       |                                            |   |         |   |          |
| X                                              | Spontaneous transmission                   |   |         |   |          |
| Double transmission is support for these types |                                            |   |         |   |          |
| -                                              | Single-point information                   |   |         |   |          |
| -                                              | Double-point information                   |   |         |   |          |
| -                                              | Step position information                  |   |         |   |          |
| -                                              | Bitstring of 32 bit                        |   |         |   |          |
| -                                              | Measure value, normalized value            |   |         |   |          |
| -                                              | Measure value, scaled value                |   |         |   |          |
| -                                              | Measure value, short floating point number |   |         |   |          |
| Station interrogation                          |                                            |   |         |   |          |
| X                                              | Global                                     |   |         |   |          |
| X                                              | Group 1                                    | X | Group 7 | X | Group 13 |
| X                                              | Group 2                                    | X | Group 8 | X | Group 14 |

|                                    |                                                                                       |   |                                      |   |          |
|------------------------------------|---------------------------------------------------------------------------------------|---|--------------------------------------|---|----------|
| X                                  | Group 3                                                                               | X | Group 9                              | X | Group 15 |
| X                                  | Group 4                                                                               | X | Group 10                             | X | Group 16 |
| X                                  | Group 5                                                                               | X | Group 11                             |   |          |
| X                                  | Group 6                                                                               | X | Group 12                             |   |          |
| Clock synchronization              |                                                                                       |   |                                      |   |          |
| X                                  | Clock synchronization                                                                 |   |                                      |   |          |
| X                                  | Day of week used                                                                      |   |                                      |   |          |
| X                                  | RES1, GEN (time tag substituted/ not substituted) used                                |   |                                      |   |          |
| X                                  | SU-bit (summertime) used                                                              |   |                                      |   |          |
| Command transmission               |                                                                                       |   |                                      |   |          |
| X                                  | Direct command transmission                                                           | X | Select and execute command           |   |          |
| X                                  | Direct set point command transmission                                                 | X | Select and execute set point command |   |          |
|                                    |                                                                                       | X | C-SE-ACTTERM used                    |   |          |
| X                                  | No additional definition                                                              |   |                                      |   |          |
| X                                  | Short pulse duration (duration determined by a system parameter in the server)        |   |                                      |   |          |
| X                                  | Long pulse duration (duration determined by a system parameter in the server)         |   |                                      |   |          |
| X                                  | Persistent output                                                                     |   |                                      |   |          |
| –                                  | Supervision of maximum delay in command direction of commands and set point commands  |   |                                      |   |          |
| Configurable                       | Maximum allowable delay of commands and set point commands                            |   |                                      |   |          |
| Transmission of integrated totals  |                                                                                       |   |                                      |   |          |
| X                                  | Mode A: Local freeze with spontaneous transmission                                    |   |                                      |   |          |
| X                                  | Mode B: Local freeze with counter interrogation                                       |   |                                      |   |          |
| X                                  | Mode C: Freeze and transmit by counter-interrogation commands                         |   |                                      |   |          |
| –                                  | Mode D: Freeze by counter-interrogation command, frozen values reported spontaneously |   |                                      |   |          |
| X                                  | Counter read                                                                          |   |                                      |   |          |
| X                                  | Counter freeze without reset                                                          |   |                                      |   |          |
| X                                  | Counter freeze with reset                                                             |   |                                      |   |          |
| X                                  | Counter reset                                                                         |   |                                      |   |          |
| X                                  | General request counter                                                               |   |                                      |   |          |
| X                                  | Request counter group 1...4                                                           |   |                                      |   |          |
| Parameter loading                  |                                                                                       |   |                                      |   |          |
| X                                  | Threshold value                                                                       |   |                                      |   |          |
| -                                  | Smoothing factor                                                                      |   |                                      |   |          |
| X                                  | Low limit for transmission of measured values                                         |   |                                      |   |          |
| X                                  | High limit for transmission of measured values                                        |   |                                      |   |          |
| Parameter activation               |                                                                                       |   |                                      |   |          |
| X                                  | Act/Deact of persistent cyclic or periodic transmission of the addressed object       |   |                                      |   |          |
| Test procedure                     |                                                                                       |   |                                      |   |          |
| X                                  | Test procedure                                                                        |   |                                      |   |          |
| File transfer                      |                                                                                       |   |                                      |   |          |
| File transfer in monitor direction |                                                                                       |   |                                      |   |          |

|                                                                                                                                                                                                                                                                                                                                                                                                    |                                                          |                                                                                      |                |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|--------------------------------------------------------------------------------------|----------------|
| -                                                                                                                                                                                                                                                                                                                                                                                                  | Transparent file                                         |                                                                                      |                |
| -                                                                                                                                                                                                                                                                                                                                                                                                  | Transmission of disturbance data of protection equipment |                                                                                      |                |
| -                                                                                                                                                                                                                                                                                                                                                                                                  | Transmission of sequences of events                      |                                                                                      |                |
| -                                                                                                                                                                                                                                                                                                                                                                                                  | Transmission of sequences of recorded analog values      |                                                                                      |                |
| File transfer in control direction                                                                                                                                                                                                                                                                                                                                                                 |                                                          |                                                                                      |                |
| -                                                                                                                                                                                                                                                                                                                                                                                                  | Transparent file                                         |                                                                                      |                |
| Background scan                                                                                                                                                                                                                                                                                                                                                                                    |                                                          |                                                                                      |                |
| X                                                                                                                                                                                                                                                                                                                                                                                                  | Background scan                                          |                                                                                      |                |
| Definition of timeouts                                                                                                                                                                                                                                                                                                                                                                             |                                                          |                                                                                      |                |
| Parameter                                                                                                                                                                                                                                                                                                                                                                                          | Default Value                                            | Remarks                                                                              | Selected Value |
| t <sub>0</sub>                                                                                                                                                                                                                                                                                                                                                                                     | 30s                                                      | Timeout of connection establishment                                                  | Configurable   |
| t <sub>1</sub>                                                                                                                                                                                                                                                                                                                                                                                     | 15s                                                      | Timeout of send or test APDUs                                                        | Configurable   |
| t <sub>2</sub>                                                                                                                                                                                                                                                                                                                                                                                     | 10s                                                      | Timeout for acknowledges in case of no data messages t <sub>2</sub> < t <sub>1</sub> | Configurable   |
| t <sub>3</sub>                                                                                                                                                                                                                                                                                                                                                                                     | 20s                                                      | Timeout for sending test frames in case of a long idle state                         | Configurable   |
| Maximum range for timeouts: t <sub>0</sub> to t <sub>2</sub> 1...255s, accuracy: 1s                                                                                                                                                                                                                                                                                                                |                                                          |                                                                                      |                |
| Recommended range for timeout t <sub>3</sub> : 1s to 48h, resolution: 1s                                                                                                                                                                                                                                                                                                                           |                                                          |                                                                                      |                |
| Long timeouts for t <sub>3</sub> may be necessary in cases where satellite links or dial-up connections are used (for instance, to establish connection and collect values only once per day/week.)                                                                                                                                                                                                |                                                          |                                                                                      |                |
| Maximum number of outstanding I format APDUs k and latest acknowledge APDUs k                                                                                                                                                                                                                                                                                                                      |                                                          |                                                                                      |                |
| Parameter                                                                                                                                                                                                                                                                                                                                                                                          | Default Value                                            | Remarks                                                                              | Selected Value |
| k                                                                                                                                                                                                                                                                                                                                                                                                  | 12 APDUs                                                 | Maximum difference receive sequence number to send state variable                    | Configurable   |
| w                                                                                                                                                                                                                                                                                                                                                                                                  | 8 APDUs                                                  | Latest acknowledge after receiving w I-format APDUs                                  | Configurable   |
| Maximum range of values k: 1...12 (12) APDUs, accuracy: 1 APDU                                                                                                                                                                                                                                                                                                                                     |                                                          |                                                                                      |                |
| Maximum range of values w: 1...32767 APDUs, accuracy: 1 APDU                                                                                                                                                                                                                                                                                                                                       |                                                          |                                                                                      |                |
| Recommendation: w should not exceed two-thirds of k                                                                                                                                                                                                                                                                                                                                                |                                                          |                                                                                      |                |
| Port number)                                                                                                                                                                                                                                                                                                                                                                                       |                                                          |                                                                                      |                |
| Parameter                                                                                                                                                                                                                                                                                                                                                                                          | Default Value                                            | Remarks                                                                              |                |
| Port number                                                                                                                                                                                                                                                                                                                                                                                        | 2404                                                     | Configurable                                                                         |                |
| Redundant connections                                                                                                                                                                                                                                                                                                                                                                              |                                                          |                                                                                      |                |
| 4                                                                                                                                                                                                                                                                                                                                                                                                  | Number of redundancy group connections used              |                                                                                      |                |
| RFC 2200 suite                                                                                                                                                                                                                                                                                                                                                                                     |                                                          |                                                                                      |                |
| RFC 2200 is an official Internet Standard which describes the state of standardization of protocols used in the Internet as determined by the Internet Architecture Board (IAB). It offers a broad spectrum of actual standards used in the Internet. The suitable selection of documents from RFC 2200 defined in this standard for given projects has to be chosen by the user of this standard. |                                                          |                                                                                      |                |
| X                                                                                                                                                                                                                                                                                                                                                                                                  | Ethernet 802.3                                           |                                                                                      |                |
| -                                                                                                                                                                                                                                                                                                                                                                                                  | Serial X.21 interface                                    |                                                                                      |                |
| -                                                                                                                                                                                                                                                                                                                                                                                                  | Other selection from RFC 2200                            |                                                                                      |                |

# Project Migration

## What’s in This Chapter

XML File Migration ..... 170

DNP3 Data Type Migration..... 170

IEC 60870-5-104 Data Type Migration ..... 173

## Introduction

Observe the considerations in this chapter when you migrate a configuration file from a BMXNOR0200H module in an M340 network to a BMENOR2200H module in an M580 network.

## XML File Migration

### Introduction

You can migrate the configuration file from a BMXNOR0200H module to a BMENOR2200H module.

**NOTE:** Refer to the general instructions to export and import .xml files with the Control Expert DTM, page 104.

### Project Migration Use Case

Migrate the configuration file from a BMXNOR0200H module to a BMENOR2200H module:

| Stage | Description                                                                                         |
|-------|-----------------------------------------------------------------------------------------------------|
| 1     | Export the .xml configuration file from a BMXNOR0200H module in an M340 PAC controller application. |
| 2     | Import the .xml configuration file to a BMENOR2200H module in an M580 PAC controller application.   |

**NOTE:** All located addresses are lost after you import .xml files from the BMENOR2200H module. The type and length of the name are changed according to the new format, page 170.

## DNP3 Data Type Migration

### Introduction

When you migrate an RTU application from a BMXNOR0200H RTU module to a BMENOR2200H RTU module, note the conversion of some specific data types and variable names.

These tables follow:

- DNP3 Server RTU Point Data Type Migration, page 170
- DNP3 Client RTU Point Data Type Migration, page 171

Apply this information when you configure DNP3 communications in the BMENOR2200H DTM, page 75.

### DNP3 Server RTU Point Data Type Migration

The data types that change in the migration are shown in red:

| Object Type (Default Variable Name)    | Object Element      | BMXNOR0200H      |           | BMENOR2200H |                                         |
|----------------------------------------|---------------------|------------------|-----------|-------------|-----------------------------------------|
|                                        |                     | Parameter        | Data Type | Parameter   | Data Type                               |
| Binary Input<br>(BI_Px)                | Value               | .value           | WORD      | .value      | BYTE                                    |
|                                        | Flag                | .flags           | WORD      | .flags      | BYTE                                    |
|                                        | Time                | .timestamp       | CP56      | .Timestamp  | CP56                                    |
| Double Input<br>(DI_Px)                | Value               | .value           | WORD      | .value      | BYTE                                    |
|                                        | Flag                | .flags           | WORD      | .flags      | BYTE                                    |
|                                        | Time                | .timestamp       | CP56      | .Timestamp  | CP56                                    |
| Binary Output<br>(BO_Px)               | Value               | .value           | WORD      | .value      | BYTE                                    |
|                                        |                     |                  |           |             | INT (Sync On Demand mode, page 90 only) |
| Binary Counter<br>(BCnt_Px)            | Value - 16 bit      | .value           | DWORD     | .value      | INT                                     |
|                                        | Value - 32 bit      | .value           | DWORD     | .value      | DINT                                    |
|                                        | Flag                | .flags           | DWORD     | .flags      | BYTE                                    |
|                                        | Time                | .timestamp       | CP56      | .Timestamp  | CP56                                    |
| Analog Input<br>(AI_Px)                | Value - 16 bit      | .value           | INT       | .Value      | INT                                     |
|                                        | Value - 32 bit      | .value           | DINT      | .Value      | DINT                                    |
|                                        | Value - Short       | .value           | REAL      | .Value      | REAL                                    |
|                                        | Flag - 16 bit       | .flags           | WORD      | .Flags      | BYTE                                    |
|                                        | Flag - 32 bit/Short | .flags           | DWORD     | .Flags      | BYTE                                    |
|                                        | Time                | .timestamp       | CP56      | .Timestamp  | CP56                                    |
| Analog Output<br>(AO_Px)               | Value - 16 bit      | .value           | INT       | .Value      | INT                                     |
|                                        | Value - 32 bit      | .value           | DINT      | .Value      | DINT                                    |
|                                        | Value - Short       | .value           | REAL      | .Value      | REAL                                    |
| Analog Input Deadband<br>(AI_Px_Dband) | Value               | .Value           | DWORD     | .Value      | DWORD                                   |
| Binary Output Flags<br>(BO_Px_Flag)    | —                   | — None Structure | WORD      | .Flag       | BYTE                                    |
| Analog Output Flags<br>(AO_Px_Flag)    | —                   | — None Structure | WORD      | .Flag       | BYTE                                    |
| Gen_Event<br>(GE_xxxx)                 | —                   | .Command         | WORD      | .Command    | BYTE                                    |
|                                        | —                   | .Status          | WORD      | .Status     | WORD                                    |
| Clear_Event<br>(CE_xxxx_CB)            | —                   | .Command         | WORD      | .Command    | BYTE                                    |
|                                        | —                   | .Status          | WORD      | .Status     | WORD                                    |
| Octet String<br>(Str_Px)               |                     | —                | —         | .Value      | STRING<br>[0-255]                       |

## DNP3 Client RTU Point Data Type Migration

The data types that change in the migration are shown in **red**:

| Object Type (Default Variable Name) | Object Element | BMXNOR0200H |           | BMENOR2200H |           |
|-------------------------------------|----------------|-------------|-----------|-------------|-----------|
|                                     |                | Parameter   | Data Type | Parameter   | Data Type |
| Binary Input<br>(BI_Px)             | Value          | .value      | WORD      | .value      | BYTE      |
|                                     | Flag           | .flags      | WORD      | .flags      | BYTE      |
|                                     | Time           | .timestamp  | CP56      | .Timestamp  | CP56      |

| Object Type (Default Variable Name)                  | Object Element       | BMXNOR0200H |           | BMENOR2200H |                   |
|------------------------------------------------------|----------------------|-------------|-----------|-------------|-------------------|
|                                                      |                      | Parameter   | Data Type | Parameter   | Data Type         |
| Double_Input<br>(DI_Px)                              | Value                | .value      | WORD      | .value      | BYTE              |
|                                                      | Flag                 | .flags      | WORD      | .flags      | BYTE              |
|                                                      | Time                 | .timestamp  | CP56      | .Timestamp  | CP56              |
| Binary_Output<br>(BO_Px)                             | —                    | .value      | WORD      | .value      | BYTE              |
|                                                      | Command Status       | .Status     | WORD      | .Status     | WORD              |
| Binary_Output_Status<br>(BO_Px_Sts)                  | Value                | .value      | WORD      | .value      | BYTE              |
|                                                      | Flag                 | .flags      | WORD      | .flags      | BYTE              |
|                                                      | Time                 | .timestamp  | CP56      | .Timestamp  | CP56              |
| Octet String<br>(Str_Px)                             |                      | —           | —         | .Value      | STRING<br>[0-255] |
| Write Octet String<br>(WOctStr_I_Px)<br>(Str_Px_Wrt) |                      | —           | —         | .Value      | STRING<br>[0-255] |
|                                                      |                      | —           | —         | .Status     | WORD              |
| Binary_Counter<br>(BCnt_Px)                          | Value - 16 bit       | .value      | DWORD     | .counter    | WORD              |
|                                                      | Value - 32 bit       | .value      | DWORD     | .counter    | DWORD             |
|                                                      | Flag - 16 bit/32 bit | .flags      | DWORD     | .flag       | BYTE              |
|                                                      | Time                 | .timestamp  | CP56      | .timestamp  | CP56              |
| Frozen_Counter<br>(FrozCnt_xxxx)                     | Value - 16 bit       | .value      | DWORD     | .counter    | WORD              |
|                                                      | Value - 32 bit       | .value      | DWORD     | .counter    | DWORD             |
|                                                      | Flag - 16 bit/32 bit | .flags      | DWORD     | .flag       | BYTE              |
|                                                      | Time                 | .timestamp  | CP56      | .timestamp  | CP56              |
| Analog_Input<br>(AI_Px)                              | Value - 16 bit       | .value      | INT       | .Value      | INT               |
|                                                      | Value - 32 bit       | .value      | DINT      | .Value      | DINT              |
|                                                      | Value - Short        | .value      | REAL      | .Value      | REAL              |
|                                                      | Flag - 16 bit        | .flags      | WORD      | .Flags      | BYTE              |
|                                                      | Flag - 32 bit/Short  | .flags      | DWORD     | .Flags      | BYTE              |
|                                                      | Time                 | .timestamp  | CP56      | .Timestamp  | CP56              |
| Analog_Input_Deadband<br>(AI_Px_Dband)               | Value - 16 bit       | .value      | WORD      | .Value      | WORD              |
|                                                      | Value - 32 bit       | .value      | DWORD     | .Value      | DWORD             |
| Analog_Input_Deadband_Control<br>(AIDBCtrl_Px)       | Value - 16 bit       | .Value      | WORD      | .Value      | WORD              |
|                                                      | Value - 32 bit       | .Value      | DWORD     | .Value      | DWORD             |
|                                                      | Value - Short        | .Value      | REAL      | .Value      | REAL              |
|                                                      | Command Status       | .Status     | WORD      | .Status     | WORD              |
|                                                      | Command Status       | .Status     | DWORD     | .Status     | WORD              |
| Analog_Output<br>(AO_Px)                             | Value - 16 bit       | .Value      | INT       | .Value      | INT               |
|                                                      | Value - 32 bit       | .Value      | DINT      | .Value      | DINT              |
|                                                      | Value - short        | .Value      | REAL      | .Value      | REAL              |
|                                                      | Command Status       | .Status     | WORD      | .Status     | WORD              |
|                                                      | Command Status       | .Status     | DWORD     | .Status     | WORD              |
| Analog_Output_Status<br>(AO_Px_Sts)                  | Value - 16 bit       | .value      | INT       | .Value      | INT               |
|                                                      | Value - 32 bit       | .value      | DINT      | .Value      | DINT              |
|                                                      | Value - short        | .value      | REAL      | .Value      | REAL              |
|                                                      | Flag - 16 bit        | .flags      | WORD      | .Flags      | BYTE              |

| Object Type (Default Variable Name) | Object Element | BMXNOR0200H |           | BMENOR2200H      |           |
|-------------------------------------|----------------|-------------|-----------|------------------|-----------|
|                                     |                | Parameter   | Data Type | Parameter        | Data Type |
|                                     | Flag - 32 bit  | .flags      | DWORD     | .Flags           | BYTE      |
|                                     | Time           | .timestamp  | CP56      | .Timestamp       | CP56      |
| Read_Class<br>(RC_xxxx)             | —              | .Value      | WORD      | .Value           | BYTE      |
|                                     | Command Status | .Status     | WORD      | .Status          | WORD      |
| Freeze_Counter<br>(FrezCnt_xxxx)    | —              | .Value      | WORD      | .Value           | BYTE      |
|                                     | Command Status | .Status     | WORD      | .Status          | WORD      |
| Unsolicited_Class<br>(UnsC_xxxx)    | —              | .Value      | WORD      | .Value           | BYTE      |
|                                     | Command Status | .Status     | WORD      | .Status          | WORD      |
| Time_Sync<br>(TS_xxxx)              | —              | .Value      | WORD      | .Value           | BYTE      |
|                                     | Command Status | .Status     | WORD      | .Status          | WORD      |
| Restart<br>(Rst_xxxx)               | —              | .Value      | WORD      | .Value           | BYTE      |
|                                     | Command Status | .Status     | WORD      | .Status          | WORD      |
| Integrity_Poll<br>(IP_xxxx)         | —              | .Value      | WORD      | .Value           | BYTE      |
|                                     | Command Status | .Status     | WORD      | .Status          | WORD      |
| Read_Group<br>(RG_xxxx)             | —              | .Value      | WORD      | .Value           | BYTE      |
|                                     | Command Status | .Status     | WORD      | .Status          | WORD      |
| Connect Status                      |                | .Status     | DWORD     | Device_<br>State | BYTE      |

## IEC 60870-5-104 Data Type Migration

### Introduction

When you migrate and RTU application from a BMXNOR0200H module to a BMENOR2200H module, note the conversion of some data types and variable names.

These tables follow:

- IEC 60870-5-104 Server RTU Point Data Type Migration
- IEC 60870-5-104 Client RTU Point Data Type Migration

Apply this information when you configure IEC 60870-5-104 communications in the BMENOR2200H module.

### IEC 60870-5-104 Client RTU Point Data Type Migration

The client RTU point data types that may change in the migration:

| Object Type | CPU Register Type | Data Type | Parameter Name | Data Type in BMXNOR0200 | Parameter Name in BME-NOR2200H | Data Type in BME-NOR2200H |
|-------------|-------------------|-----------|----------------|-------------------------|--------------------------------|---------------------------|
| M_SP        | %M                | Value     | .value         | WORD                    | .value                         | BYTE                      |
|             | %MW               | Flag      | .quality       | WORD                    | .flags                         | BYTE                      |
|             | Unlocated         | Time      | .time-stamp    | CP56                    | .timestamp                     | CP56                      |
| M_DP        | %MW               | Value     | .value         | WORD                    | .value                         | BYTE                      |
|             | Unlocated         | Flag      | .quality       | WORD                    | .flags                         | BYTE                      |

| Object Type | CPU Register Type | Data Type | Parameter Name | Data Type in BMXNO-R0200 | Parameter Name in BME-NOR2200H | Data Type in BME-NOR2200H |
|-------------|-------------------|-----------|----------------|--------------------------|--------------------------------|---------------------------|
|             |                   | Time      | .time-stamp    | CP56                     | .timestamp                     | CP56                      |
| M_ST        | %MW<br>Unlocated  | Value     | .value         | WORD                     | .value                         | BYTE                      |
|             |                   | Flag      | .quality       | WORD                     | .flags                         | BYTE                      |
|             |                   | Time      | .time-stamp    | CP56                     | .timestamp                     | CP56                      |
| M_BO        | %MW<br>Unlocated  | Value     | .value         | DWORD                    | .value                         | DWORD                     |
|             |                   | Flag      | .quality       | DWORD                    | .flags                         | BYTE                      |
|             |                   | Time      | .time-stamp    | CP56                     | .timestamp                     | CP56                      |
| M_ME_A      | %MW<br>Unlocated  | Value     | .value         | INT                      | .Value                         | INT                       |
|             |                   | Flag      | .quality       | WORD                     | .Flags                         | BYTE                      |
|             |                   | Time      | .time-stamp    | CP56                     | .Timestamp                     | CP56                      |
| M_ME_B      | %MW<br>Unlocated  | Value     | .value         | INT                      | .Value                         | INT                       |
|             |                   | Flag      | .quality       | WORD                     | .Flags                         | BYTE                      |
|             |                   | Time      | .time-stamp    | CP56                     | .Timestamp                     | CP56                      |
| M_ME_C      | %MW<br>Unlocated  | Value     | .value         | REAL                     | .Value                         | REAL                      |
|             |                   | Flag      | .quality       | DWORD                    | .Flags                         | BYTE                      |
|             |                   | Time      | .time-stamp    | CP56                     | .Timestamp                     | CP56                      |
| M_IT        | %MW<br>Unlocated  | Value     | .value         | DINT                     | .Value                         | DINT                      |
|             |                   | Flag      | .quality       | DWORD                    | .Flags                         | BYTE                      |
|             |                   | Time      | .time-stamp    | CP56                     | .Timestamp                     | CP56                      |
| C_SC        | %MW               | Value     | .value         | WORD                     | .value                         | BYTE                      |
|             |                   | Flag      | .status        | WORD                     | .status                        | BYTE                      |
| C_DC        | %MW               |           | .value         | WORD                     | .value                         | BYTE                      |
|             |                   |           | .status        | WORD                     | .status                        | WORD                      |
| C_RC        | %MW               |           | .value         | WORD                     | .value                         | BYTE                      |
|             |                   |           | .status        | WORD                     | .status                        | WORD                      |
| C_SE_A      | %MW               |           | .value         | INT                      | .value                         | INT                       |
|             |                   |           | .status        | WORD                     | .status                        | WORD                      |
| C_SE_B      | %MW               |           | .value         | INT                      | .value                         | INT                       |
|             |                   |           | .status        | WORD                     | .status                        | WORD                      |
| C_SE_C      | %MW               |           | .value         | REAL                     | .value                         | REAL                      |
|             |                   |           | .status        | DWORD                    | .status                        | WORD                      |
| C_BO        | %MW               |           | .value         | DWORD                    | .value                         | DWORD                     |
|             |                   |           | .status        | DWORD                    | .status                        | WORD                      |
| C_IC        | %MW               |           | .value         | WORD                     | .value                         | BYTE                      |
|             |                   |           | .status        | WORD                     | .status                        | WORD                      |
| C_CI        | %MW               |           | .value         | WORD                     | .value                         | BYTE                      |

| Object Type | CPU Register Type | Data Type | Parameter Name | Data Type in BMXNO-R0200 | Parameter Name in BME-NOR2200H | Data Type in BME-NOR2200H |
|-------------|-------------------|-----------|----------------|--------------------------|--------------------------------|---------------------------|
|             |                   |           | .status        | WORD                     | .status                        | WORD                      |
| C_RD        | %MW               |           | .value         | WORD                     | .value                         | BYTE                      |
|             |                   |           | .status        | WORD                     | .status                        | WORD                      |
| C_CS        | %MW               |           | .value         | WORD                     | .value                         | BYTE                      |
|             |                   |           | .status        | WORD                     | .status                        | WORD                      |
| C_TS        | %MW               |           | .value         | WORD                     | .value                         | BYTE                      |
|             |                   |           | .status        | WORD                     | .status                        | WORD                      |
| C_RP        | %MW               |           | .value         | WORD                     | .value                         | BYTE                      |
|             |                   |           | .status        | WORD                     | .status                        | WORD                      |
| P_ME_A      | %MW               |           | .value         | WORD                     | .value                         | INT                       |
|             |                   |           | .status        | WORD                     | .status                        | WORD                      |
| P_ME_B      | %MW               |           | .value         | WORD                     | .value                         | INT                       |
|             |                   |           | .status        | WORD                     | .status                        | WORD                      |
| P_ME_C      | %MW               |           | .value         | REAL                     | .value                         | REAL                      |
|             |                   |           | .status        | DWORD                    | .status                        | WORD                      |
| P_AC        | %MW               |           | .value         | WORD                     | .value                         | BYTE                      |
|             |                   |           | .status        | WORD                     | .status                        | WORD                      |
| M_IT_D      |                   |           | .value0        | INT                      | .value0                        | INT                       |
|             |                   |           | .value1        | INT                      | .value1                        | INT                       |
|             |                   |           | .value2        | INT                      | .value2                        | INT                       |
|             |                   |           | .value3        | INT                      | .value3                        | INT                       |
|             |                   |           | .flag          | BYTE                     | .flag                          | BYTE                      |
|             |                   |           | .time-stamp    | CP56                     | .timestamp                     | CP56                      |

## IEC 60870-5-104 Server RTU Point Data Type Migration

The server RTU point data types that may change in the migration:

| Object Type | CPU Register Type | Data Type | Parameter Name | Data Type in BMXNO-R0200 | Parameter Name in BME-NOR2200H | Data Type in BME-NOR2200H |
|-------------|-------------------|-----------|----------------|--------------------------|--------------------------------|---------------------------|
| M_SP        | %M                | Value     | .value         | WORD                     | .value                         | BYTE                      |
|             | %M                | Flag      | .quality       | WORD                     | .flags                         | BYTE                      |
|             | %S<br>Unlocated   | Time      | .timestamp     | CP56                     | .timestamp                     | CP56                      |
| M_DP        | %MW               | Value     | .value         | WORD                     | .value                         | BYTE                      |
|             | Unlocated         | Flag      | .quality       | WORD                     | .flags                         | BYTE                      |
|             |                   | Time      | .timestamp     | CP56                     | .timestamp                     | CP56                      |
| M_ST        | %MW               | Value     | .value         | WORD                     | .value                         | BYTE                      |
|             | Unlocated         | Flag      | .quality       | WORD                     | .flags                         | BYTE                      |
|             |                   | Time      | .timestamp     | CP56                     | .timestamp                     | CP56                      |
| M_BO        | %MW               | Value     | .value         | DWORD                    | .value                         | DWORD                     |
|             | Unlocated         | Flag      | .quality       | DWORD                    | .flags                         | BYTE                      |
|             |                   | Time      | .timestamp     | CP56                     | .timestamp                     | CP56                      |

| Object Type  | CPU Register Type      | Data Type | Parameter Name | Data Type in BMXNO-R0200 | Parameter Name in BME-NOR2200H | Data Type in BME-NOR2200H |
|--------------|------------------------|-----------|----------------|--------------------------|--------------------------------|---------------------------|
| M_ME_A       | %MW                    | Value     | .value         | INT                      | .Value                         | INT                       |
|              | %SW                    | Flag      | .quality       | WORD                     | .Flags                         | BYTE                      |
|              | Unlocated              | Time      | .timestamp     | CP56                     | .Timestamp                     | CP56                      |
| M_ME_B       | %MW                    | Value     | .value         | INT                      | .Value                         | INT                       |
|              | Unlocated              | Flag      | .quality       | WORD                     | .Flags                         | BYTE                      |
|              |                        | Time      | .timestamp     | CP56                     | .Timestamp                     | CP56                      |
| M_ME_C       | %MW                    | Value     | .value         | REAL                     | .Value                         | REAL                      |
|              | Unlocated              | Flag      | .quality       | DWORD                    | .Flags                         | BYTE                      |
|              |                        | Time      | .timestamp     | CP56                     | .Timestamp                     | CP56                      |
| M_IT         | %MW                    | Value     | .value         | DINT                     | .Value                         | DINT                      |
|              | Unlocated              | Time      | .timestamp     | CP56                     | .Timestamp                     | CP56                      |
| C_SC         | %MW<br>%M<br>Unlocated | —         | .value         | WORD                     | .value                         | BYTE                      |
| C_DC         | %MW<br>Unlocated       | Value     | .value         | WORD                     | .value                         | BYTE                      |
| C_RC         | %MW<br>Unlocated       | Value     | .value         | WORD                     | .value                         | BYTE                      |
| C_SE_A       | %MW<br>Unlocated       | Value     | .value         | INT                      | .value                         | INT                       |
| C_SE_B       | %MW<br>Unlocated       | Value     | .value         | INT                      | .value                         | INT                       |
| C_SE_C       | %MW<br>Unlocated       | Value     | .value         | REAL                     | .value                         | REAL                      |
| C_BO         | %MW<br>Unlocated       | Value     | .value         | DWORD                    | .value                         | DWORD                     |
| P_ME_A       | %MW<br>Unlocated       | Value     | —              | WORD                     | .value                         | INT                       |
| P_ME_B       | %MW<br>Unlocated       | Value     | —              | WORD                     | .value                         | INT                       |
| P_ME_C       | %MW<br>Unlocated       | Value     | —              | REAL                     | .value                         | REAL                      |
| P_AC         | %MW<br>Unlocated       | Value     | —              | WORD                     | .value                         | BYTE                      |
| Clear Events | %MW                    | —         | .cmd           | WORD                     | .cmd                           | BYTE                      |
|              |                        |           | .status        | WORD                     | .status                        | WORD                      |

| Object Type | CPU Register Type | Data Type                        | Parameter Name | Data Type in BMXNO-R0200 | Parameter Name in BME-NOR2200H | Data Type in BME-NOR2200H |
|-------------|-------------------|----------------------------------|----------------|--------------------------|--------------------------------|---------------------------|
| CUSTOM_CMD  | %MW<br>Unlocated  | FreezeCyclic<br>(auto freeze)    | Cmd            | WORD                     | cmd                            | BYTE                      |
|             |                   |                                  | Status         | WORD                     | .status                        | WORD                      |
|             |                   | freeze Trigger<br>(local freeze) | Cmd            | WORD                     | .cmd                           | BYTE                      |
|             |                   |                                  | Status         | WORD                     | .status                        | WORD                      |
| CMD_QUALITY | %MW<br>Unlocated  |                                  |                |                          | .cmd                           | byte                      |

# Logged Events and Secure Statistics

## What's in This Chapter

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## Introduction

This chapter describes the logged events and secured statistics for the BMENOR2200H module.

## Event Log Descriptions

### Event Log Items

The following collection of messages can be included in the BMENOR2200H event log:

| Severity | Service                | Message Type                                                                                                                                                                                                  | Message                                                                                                                                                                                     |
|----------|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Info     | HTTPS                  | Li1: Successful connection                                                                                                                                                                                    | ""Successful login""                                                                                                                                                                        |
|          | HTTPS                  | (MNT_ENG_MSG_TYP_CNCTN_SUCCESS)                                                                                                                                                                               | ""Successful login""                                                                                                                                                                        |
|          | DNP3 / IEC 60870-5-104 | Successful connection                                                                                                                                                                                         |                                                                                                                                                                                             |
| Warning  | HTTPS                  | Li2: Failed connection (wrong credential)                                                                                                                                                                     | ""Failed login""                                                                                                                                                                            |
|          | HTTPS                  | (MNT_ENG_MSG_TYP_CNCTN_FAILURE)                                                                                                                                                                               | ""Failed login""                                                                                                                                                                            |
|          | DNP3 / IEC 60870-5-104 | Failed connection                                                                                                                                                                                             |                                                                                                                                                                                             |
| Info     | HTTPS                  | Li5: disconnection triggered by the peer/user                                                                                                                                                                 | ""Disconnection""                                                                                                                                                                           |
|          | HTTPS                  | (MNT_ENG_MSG_TYP_DISCONNECTION)                                                                                                                                                                               | ""Disconnection""                                                                                                                                                                           |
| Info     | HTTPS                  | Li6: Disconnection triggered by a timeout<br>(MNT_ENG_MSG_TYP_DSCNCT_TIMEOUT)                                                                                                                                 | ""Auto logout""                                                                                                                                                                             |
| Info     | Device_Manager         | Li9: Upload of a configuration file (CID) into the device<br>(MNT_ENG_MSG_TYP_CONF_UL)                                                                                                                        | XXX upload"" where XXX= Application or Configuration                                                                                                                                        |
| Info     | HTTPS                  | Li10: Upload of a new firmware in the device MNT_ENG_MSG_TYP_FIRMWARE_UPDATE                                                                                                                                  | ""Firmware upload""                                                                                                                                                                         |
| Warning  | Device_Manager         | Li18: Any port, either physical (Serial, USB) or logical (telnet, FTP) activation/deactivation?<br>(MNT_ENG_MSG_TYP_PORT_MANAGEMENT)                                                                          | ""Major Communication parameter update: XXXX YYYYY"" (with XXXX = communication parameter ID, YYYYY= value)<br><br>Example: ""Major Communication parameter update: SNMP enable""           |
| Warning  | Device_Manager         | Li19: Any network physical port status change. Can be the simple status of a Ethernet port, or information gathered from RSTP / HSR / PRP algorithm for redundant systems<br>(MNT_ENG_MSG_TYP_NETWK_PORT_CHG) | ""Major network physical port status change: XXXX link YYYYY"" (with XXXX= port ID, YYYYY= status value)<br><br>Example: ""Major network physical port status change: port 1 link Up/Down"" |
| Warning  | Device_Manager         | Li20: PORT CONTROL Change<br>(MNT_ENG_MSG_TYP_NTWK_TPLGY_CHG)                                                                                                                                                 | ""Topology change detected""                                                                                                                                                                |

| Severity | Service                   | Message Type                                                                                                  | Message                                                                                                                                                                                   |
|----------|---------------------------|---------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Error    | Device_Manager            | Li84: Data Integrity Error MNT_ENG_MSG_DATA_INTEGRITY_ERROR                                                   | ""Firmware Integrity error""error""                                                                                                                                                       |
| Error    | Device_Manager            | Li84: Data Integrity Error MNT_ENG_MSG_DATA_INTEGRITY_ERROR                                                   | ""Data Integrity error""                                                                                                                                                                  |
| Info     | Device_Manager            | Li26: Hardware change MNT_ENG_MSG_HARDWARE_CHANGE                                                             | ""XXXX hardware update: YYYY"" (with XXXX that identifies the hardware object which changes and YYYY that describes the update)<br><br>EXAMPLE: hardware update: Secure Mode              |
| Warning  | HTTPS                     | Li11: MNT_ENG_MSG_TYP_RBAC_UPDATE                                                                             | Update RBAC                                                                                                                                                                               |
| Warning  | HTTPS                     | Li12: MNT_ENG_MSG_TYP_SECURITY_UPDATE_UPDATE                                                                  | ""Major Cyber Security parameter update: network services""<br><br>""Major Cyber Security parameter update: event log""<br><br>""Major Cyber Security parameter update: security policy"" |
| Warning  | Device_Manager            | Li86??: Failed authorization<br>(MNT_ENG_MSG_TYP_AUTHORIZATION_FAILURE) OR<br>Li21: MNT_ENG_MSG_TYP_AUTH_REQ? | ""Failed authorization""                                                                                                                                                                  |
| Warning  | Device_Manager            | Li89: Certificate Management<br>(MNT_ENG_MSG_TYP_CERT_MGT)                                                    | ""Add Client Certificate""<br>""Remove Client Certificate""                                                                                                                               |
| Warning  | HTTPS                     | Li13: MNT_ENG_MSG_TYP_DSS_UPDATE                                                                              | ""Major Cyber Security parameter update: ipsec""<br><br>""Major Cyber Security parameter update: OPC UA""                                                                                 |
| Warning  | DNP3_Client / DNP3_Server | Li90:MNT_ENG_MSG_TYPE_AUTHENTICATION_FAILUE                                                                   | ""channel[""+channel name+""] authentication failed""                                                                                                                                     |
| Warning  | DNP3_Client / DNP3_Server | Li91:MNT_ENG_MSG_TYPE_UNEXPECTED_RESPONSE                                                                     | ""channel[""+channel name+""] unexpected response""                                                                                                                                       |
| Warning  | DNP3_Client / DNP3_Server | Li92:MNT_ENG_MSG_TYPE_NO_RESPONSE                                                                             | ""channel[""+channel name+""] no response""                                                                                                                                               |
| Warning  | DNP3_Client / DNP3_Server | Li93:MNT_ENG_MSG_TYPE_AGGRESSIVE_MODE_NOT_SUPPORTED                                                           | ""channel[""+channel name+""] aggressive mode not supported""                                                                                                                             |
| Warning  | DNP3_Client / DNP3_Server | Li94:MNT_ENG_MSG_TYPE_MAC_ALGORITHM_NOT_SUPPORTED                                                             | ""channel[""+channel name+""] MAC algorithm not supported""                                                                                                                               |
| Warning  | DNP3_Client / DNP3_Server | Li95:MNT_ENG_MSG_TYPE_KEYWRAP_ALGORITHM_NOT_SUPPORTED                                                         | ""channel[""+channel name+""] key wrap algorithm not supported""                                                                                                                          |
| Warning  | DNP3_Client / DNP3_Server | Li86:MNT_ENG_MSG_TYP_AUTHORIZATION_FAILURE)                                                                   | ""channel[""+channel name+""] authorization failed""                                                                                                                                      |
| Warning  | DNP3_Client / DNP3_Server | Li96:MNT_ENG_MSG_TYPE_UPDATE_KEY_CHANGE_METHOD_NOT_PERMITTED                                                  | ""channel[""+channel name+"] update key change method not permitted""                                                                                                                     |
| Warning  | DNP3_Client / DNP3_Server | Li97:MNT_ENG_MSG_TYPE_INVALID_SIGNATURE                                                                       | ""channel[""+channel name+""] invalid signature                                                                                                                                           |
| Warning  | DNP3_Client / DNP3_Server | Li98:MNT_ENG_MSG_TYPE_INVALID_CERTIFICATION_DATA                                                              | ""channel[""+channel name+""] invalid certification data""                                                                                                                                |
| Warning  | DNP3_Client / DNP3_Server | Li99:MNT_ENG_MSG_TYPE_UNKNOWN_USER                                                                            | ""channel[""+channel name+""] unknown user""                                                                                                                                              |

| Severity | Service                      | Message Type                                                 | Message                                                                     |
|----------|------------------------------|--------------------------------------------------------------|-----------------------------------------------------------------------------|
| Warning  | DNP3_Client /<br>DNP3_Server | Li100:MNT_ENG_MSG_TYPE_MAX_SESSION_KEY_<br>STATUS_REQ_EXCEED | ""channel[""+channel name+""]<br>max session key status request<br>exceed"" |
| Info     | DNP3_Client /<br>DNP3_Server | Li101:MNT_ENG_MSG_TYPE_SESSION_KEY_CHANGE_<br>SUCCESS        | ""channel[""+channel name+""]<br>session key change success""               |

## Secure Statistics

### Secure Statistics

The following statistics are recorded for DNP3 secure connections to the BMENOR2200H RTU:

| This Statistic ...              | Describes the number of:                       |
|---------------------------------|------------------------------------------------|
| unexpectedMessages              | Unexpected messages                            |
| authorizationFailures           | Detected authorization failures                |
| authenticationFailures          | Detected authentication failures               |
| replyTimeout                    | Reply timeouts                                 |
| rekeyDueToAuthenticationFailure | Re-keys due to detected authentication failure |
| totalMessageSent                | Total messages sent                            |
| totalMessageReceived            | Total messages received                        |
| criticalMessageSent             | Critical messages sent                         |
| criticalMessageReceived         | Critical messages received                     |
| disCardedMessages               | Discarded messages                             |
| errorMessageSent                | Detected error message sent                    |
| errorMessageRxd                 | Detected error message received                |
| successfulAuthentications       | Successful authentications                     |
| sessionKeyChanges               | Session key changes                            |
| sessionKeyChangesFailed         | Detected failed session key changes            |
| updatekeyChanges                | Update key changes                             |
| updateKeyChangesFailed          | Detected failed update key changes             |
| rekeysDueToRestart              | Re-keys due to restart                         |

# Modbus Diagnostic Codes

## What's in This Chapter

|                                                                |     |
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| Data Mapping for Modbus Function Code 3 with Unit ID 100 ..... | 181 |
| Modbus Function Code 8, Sub-Function Code 21 .....             | 208 |

## Data Mapping for Modbus Function Code 3 with Unit ID 100

### Function Code 3

Some module diagnostics (I/O connection, extended health, redundancy status, FDR server, etc.) are available to Modbus clients that read the local Modbus server area. Use Modbus function code 3 with the unit ID set to 100 for register mapping:

| Type                                                 | Offset Modbus Address | Size (Words) |
|------------------------------------------------------|-----------------------|--------------|
| Basic Networks Diagnostic Data                       | 0                     | 39           |
| Ethernet Port Diagnostic Data (Internal port)        | 39                    | 103          |
| Ethernet Port Diagnostic Data (Eth 1)                | 142                   | 103          |
| Ethernet Port Diagnostic Data (Eth 2)                | 245                   | 103          |
| Ethernet Port Diagnostic Data (Eth 3)                | 348                   | 103          |
| Ethernet Port Diagnostic Data (Eth 4 backplane port) | 451                   | 103          |
| Modbus TCP/Port 502 Diagnostic Data                  | 554                   | 114          |
| Modbus TCP/Port 502 Connection Table Data            | 668                   | 515          |
| SMTP Diagnostic Data                                 | 1183                  | 130          |
| SNTP Diagnostic Data                                 | 1313                  | 43           |
| DNP/IEC Connection Information                       | 1356                  | 6            |
| DNP/IEC Server Diagnostic                            | 1362                  | 1141         |
| DNP/IEC Client Diagnostic                            | 2503                  | 1281         |
| DNP Server Security Diagnostic                       | 3784                  | 157          |
| DNP Client Security Diagnostic                       | 3961                  | 2497         |
| Clock Diagnostic                                     | 6458                  | 13           |
| SNMP Diagnostic                                      | 6471                  | 1            |
| Web Service Diagnostic                               | 6472                  | 1            |
| LLDP Service Diagnostic                              | 6473                  | 1            |
| Firmware Upgrade Service Diagnostic                  | 6474                  | 1            |
| Syslog Service Diagnostic                            | 6475                  | 1            |
| SD Diagnostic                                        | 6476                  | 1            |
| ipAddrStatus Diagnostic                              | 6477                  | 1            |
| Reserved                                             | 6478                  | 13           |
| HSBY Diagnostic                                      | 6491                  | 35           |
| Datalogging Diagnostic                               | 6526                  | 304          |

## Basic Networks Diagnostic Data

| Address     | MS Byte    | LS Byte    | Comments                                                    |
|-------------|------------|------------|-------------------------------------------------------------|
| Offset      | MS Byte    | LS Byte    | Basic network diagnostic validity                           |
| Offset + 1  | MS Byte    | LS Byte    |                                                             |
| Offset + 2  | MS Byte    | LS Byte    | Communication global status                                 |
| Offset + 3  | MS Byte    | LS Byte    | Supported communication services                            |
| Offset + 4  | MS Byte    | LS Byte    | Status of communication services                            |
| Offset + 5  | IP 1       | IP 2       | IP address                                                  |
| Offset + 6  | IP 3       | IP 4       |                                                             |
| Offset + 7  | SN mask 1  | SN mask 2  | Subnet mask                                                 |
| Offset + 8  | SN mask 3  | SN mask 4  |                                                             |
| Offset + 9  | GW IP 1    | GW IP 2    | Default gateway                                             |
| Offset + 10 | GW IP 3    | GW IP 4    |                                                             |
| Offset + 11 | MAC 00     | MAC 01     | MAC address                                                 |
| Offset + 12 | MAC 02     | MAC 03     |                                                             |
| Offset + 13 | MAC 04     | MAC 05     |                                                             |
| Offset + 14 | MS Byte 00 | 01         | Ether frame format capability / configuration / operational |
| Offset + 15 | 02         | 03         |                                                             |
| Offset + 16 | 04         | LS Byte 05 |                                                             |
| Offset + 17 | C00        | C01        | Ethernet receive frames OK                                  |
| Offset + 18 | C02        | C03        |                                                             |
| Offset + 19 | C00        | C01        | Ethernet transmit frames OK                                 |
| Offset + 20 | C02        | C03        |                                                             |
| Offset + 21 | MS Byte    | LS Byte    | Number open client connections                              |
| Offset + 22 | MS Byte    | LS Byte    | Number open server connections                              |
| Offset + 23 | C00        | C01        | Number of Modbus error messages sent                        |
| Offset + 24 | C02        | C03        |                                                             |
| Offset + 25 | C00        | C01        | Number of Modbus messages sent                              |
| Offset + 26 | C02        | C03        |                                                             |
| Offset + 27 | C00        | C01        | Number of Modbus messages received                          |
| Offset + 28 | C02        | C03        |                                                             |
| Offset + 29 | Char 1     | Char 2     | Device name                                                 |
| Offset + 30 | Char 3     | Char 4     |                                                             |
| Offset + 31 | Char 5     | Char 6     |                                                             |
| Offset + 32 | Char 7     | Char 8     |                                                             |
| Offset + 33 | Char 9     | Char 10    |                                                             |
| Offset + 34 | Char 11    | Char 12    |                                                             |
| Offset + 35 | Char 13    | Char 14    |                                                             |
| Offset + 36 | Char 15    | Char 16    |                                                             |
| Offset + 37 | MS Byte 00 | 01         | IP assignment mode capability / operational                 |
| Offset + 38 | 02         | LS Byte 03 |                                                             |

## Ethernet Port Diagnostic Data

| Address     | MS Byte   | LS Byte   | Comments                            |
|-------------|-----------|-----------|-------------------------------------|
| Offset      | MS Byte   | LS Byte   | Port diagnostics data validity      |
| Offset + 1  | MS Byte   | LS Byte   | Logical/physical port number        |
| Offset + 2  | MS Byte   | LS Byte   | Ether control capability            |
| Offset + 3  | MS Byte   | LS Byte   | Link speed capability               |
| Offset + 4  | MS Byte   | LS Byte   | Ether control configuration         |
| Offset + 5  | MS Byte   | LS Byte   | Link speed configuration            |
| Offset + 6  | MS Byte   | LS Byte   | Ether control operational           |
| Offset + 7  | MS Byte   | LS Byte   | Link speed operational              |
| Offset + 8  | MAC 00    | MAC 01    | Port MAC address                    |
| Offset + 9  | MAC 02    | MAC 03    |                                     |
| Offset + 10 | MAC 04    | MAC 05    |                                     |
| Offset + 11 | MSB - C00 | C01       | Media counters data validity        |
| Offset + 12 | C02       | LSB - C03 |                                     |
| Offset + 13 | MSB - C00 | C01       | Number frames transmitted OK        |
| Offset + 14 | C02       | LSB - C03 |                                     |
| Offset + 15 | MSB - C00 | C01       | Number frames received OK           |
| Offset + 16 | C02       | LSB - C03 |                                     |
| Offset + 17 | MSB - C00 | C01       | Number Ether collisions             |
| Offset + 18 | C02       | LSB - C03 |                                     |
| Offset + 19 | MSB - C00 | C01       | Carrier sense errors                |
| Offset + 20 | C02       | LSB - C03 |                                     |
| Offset + 21 | MSB - C00 | C01       | Number Ether excessive collisions   |
| Offset + 22 | C02       | LSB - C03 |                                     |
| Offset + 23 | MSB - C00 | C01       | CRC errors                          |
| Offset + 24 | C02       | LSB - C03 |                                     |
| Offset + 25 | MSB - C00 | C01       | FSC errors                          |
| Offset + 26 | C02       | LSB - C03 |                                     |
| Offset + 27 | MSB - C00 | C01       | Alignment errors                    |
| Offset + 28 | C02       | LSB - C03 |                                     |
| Offset + 29 | MSB - C00 | C01       | Number internal MAC transmit errors |
| Offset + 30 | C02       | LSB - C03 |                                     |
| Offset + 31 | MSB - C00 | C01       | Late collisions                     |
| Offset + 32 | C02       | LSB - C03 |                                     |
| Offset + 33 | MSB - C00 | C01       | Number internal MAC transmit errors |
| Offset + 34 | C02       | LSB - C03 |                                     |
| Offset + 35 | MSB - C00 | C01       | Multiple collisions                 |
| Offset + 36 | C02       | LSB - C03 |                                     |
| Offset + 37 | MSB - C00 | C01       | Single collisions                   |
| Offset + 38 | C02       | LSB - C03 |                                     |
| Offset + 39 | MSB - C00 | C01       | Deferred transmissions              |
| Offset + 40 | C02       | LSB - C03 |                                     |
| Offset + 41 | MSB - C00 | C01       | Frames too long                     |
| Offset + 42 | C02       | LSB - C03 |                                     |
| Offset + 43 | MSB - C00 | C01       | Frames too short                    |

| Address      | MS Byte   | LS Byte   | Comments                               |
|--------------|-----------|-----------|----------------------------------------|
| Offset + 44  | C02       | LSB - C03 | SQE test error                         |
| Offset + 45  | MSB - C00 | C01       |                                        |
| Offset + 46  | C02       | LSB - C03 |                                        |
| Offset + 47  | MS Byte   | LS Byte   | Interface label length                 |
| Offset + 48  | IL_char64 | IL_char63 | Interface label characters             |
| Offset + ... | ...       | ...       |                                        |
| Offset + 79  | IL_char2  | IL_char1  |                                        |
| Offset + 80  | MS Byte   | LS Byte   | Interface counters diagnostic validity |
| Offset + 81  | MSB - C00 | C01       | Number octets received                 |
| Offset + 82  | C02       | LSB - C03 |                                        |
| Offset + 83  | MSB - C00 | C01       | Number unicast packets received        |
| Offset + 84  | C02       | LSB - C03 |                                        |
| Offset + 85  | MSB - C00 | C01       | Number non-unicast packets received    |
| Offset + 86  | C02       | LSB - C03 |                                        |
| Offset + 87  | MSB - C00 | C01       | Number inbound packets discard         |
| Offset + 88  | C02       | LSB - C03 |                                        |
| Offset + 89  | MSB - C00 | C01       | Number inbound packets error           |
| Offset + 90  | C02       | LSB - C03 |                                        |
| Offset + 91  | MSB - C00 | C01       | Number inbound packets unknown         |
| Offset + 92  | C02       | LSB - C03 |                                        |
| Offset + 93  | MSB - C00 | C01       | Number octets sent                     |
| Offset + 94  | C02       | LSB - C03 |                                        |
| Offset + 95  | MSB - C00 | C01       | Number unicast packets sent            |
| Offset + 96  | C02       | LSB - C03 |                                        |
| Offset + 97  | MSB - C00 | C01       | Number non-unicast packets sent        |
| Offset + 98  | C02       | LSB - C03 |                                        |
| Offset + 99  | MSB - C00 | C01       | Number outbound packets discard        |
| Offset + 100 | C02       | LSB - C03 |                                        |
| Offset + 101 | MSB - C00 | C01       | Number outbound packets error          |
| Offset + 102 | C02       | LSB - C03 |                                        |
| Offset + 103 |           |           | Port 2                                 |
|              |           |           | 103 words per port                     |
| Offset + 206 |           |           | Port 3                                 |
|              |           |           | 103 words per port                     |
| Offset + 309 |           |           | Port 4                                 |
|              |           |           | 103 words per port                     |

## Modbus TCP/Port 502 Diagnostic Data

| Address    | MS Byte   | LS Byte | Comments                                     |
|------------|-----------|---------|----------------------------------------------|
| Offset     | MS Byte   | LS Byte | Modbus TCP/Port 502 diagnostic data validity |
| Offset + 1 | MS Byte   | LS Byte |                                              |
| Offset + 2 | MS Byte   | LS Byte | Port 502 status                              |
| Offset + 3 | MS Byte   | LS Byte | Number open connections                      |
| Offset + 4 | MSB - C00 | C01     | Number Modbus messages sent                  |

| Address      | MS Byte   | LS Byte   | Comments                                           |
|--------------|-----------|-----------|----------------------------------------------------|
| Offset + 5   | C02       | LSB - C03 |                                                    |
| Offset + 6   | MSB - C00 | C01       | Number Modbus messages received                    |
| Offset + 7   | C02       | LSB - C03 |                                                    |
| Offset + 8   | MS Byte   | LS Byte   | Number Modbus open client connections              |
| Offset + 9   | MS Byte   | LS Byte   | Number Modbus open server connections              |
| Offset + 10  | MS Byte   | LS Byte   | Maximum number connections                         |
| Offset + 11  | MS Byte   | LS Byte   | Maximum number client connections                  |
| Offset + 12  | MS Byte   | LS Byte   | Maximum number server connections                  |
| Offset + 13  | MSB - C00 | C01       | Number Modbus error messages sent                  |
| Offset + 14  | C02       | LSB - C03 |                                                    |
| Offset + 15  | MS Byte   | LS Byte   | Number open priority connections                   |
| Offset + 16  | MS Byte   | LS Byte   | Maximum number priority connections                |
| Offset + 17  | MS Byte   | LS Byte   | Number entries in unauthorized table               |
| Offset + 18  | MSB - IP1 | IP2       | Remote IP address 1                                |
| Offset + 19  | IP3       | LSB - IP4 |                                                    |
| Offset + 20  | MS Byte   | LS Byte   | Number attempts to open unauthorized connection 1  |
| ...          |           |           |                                                    |
| Offset + 111 | MSB - IP1 | IP2       | Remote IP address 32                               |
| Offset + 112 | IP3       | LSB - IP4 |                                                    |
| Offset + 113 | MS Byte   | LS Byte   | Number attempts to open unauthorized connection 32 |

## Modbus TCP/Port 502 Connection Table Data

| Address     | MS Byte | LS Byte | Comments                                    |
|-------------|---------|---------|---------------------------------------------|
| Offset      | MS Byte | LS Byte | Connection table validity                   |
| Offset + 1  | MS Byte | LS Byte | Number of entries                           |
| Offset + 2  | MS Byte | LS Byte | Starting entry index                        |
| Offset + 3  | MS Byte | LS Byte | Connection index                            |
| Offset + 4  | IP 1    | IP 2    | Remote IP address                           |
| Offset + 5  | IP 3    | IP 4    |                                             |
| Offset + 6  | MS Byte | LS Byte | Remote port number                          |
| Offset + 7  | MS Byte | LS Byte | Local port number                           |
| Offset + 8  | MS Byte | LS Byte | Number Modbus messages sent on Connex       |
| Offset + 9  | MS Byte | LS Byte | Number Modbus messages received on Connex   |
| Offset + 10 | MS Byte | LS Byte | Number Modbus error messages sent on Connex |

## SMTP Diagnostic Data

| Address    | MS Byte | LS Byte | CIP Type | Comments               |
|------------|---------|---------|----------|------------------------|
| Offset     | MS Byte | LS Byte | UDINT    | SMTP server IP address |
| Offset + 1 | MS Byte | LS Byte |          |                        |
| Offset + 2 | MS Byte | LS Byte | UDINT    | Email service status   |

| Address      | MS Byte             | LS Byte             | CIP Type        | Comments                                |
|--------------|---------------------|---------------------|-----------------|-----------------------------------------|
| Offset + 3   | MS Byte             | LS Byte             |                 |                                         |
| Offset + 4   | MS Byte             | LS Byte             | UDINT           | Link to SMTP server status              |
| Offset + 5   | MS Byte             | LS Byte             |                 |                                         |
| Offset + 6   | MS Byte             | LS Byte             | UDINT           | Number of emails sent                   |
| Offset + 7   | MS Byte             | LS Byte             |                 |                                         |
| Offset + 8   | MS Byte             | LS Byte             | UDINT           | Number of responses from the server     |
| Offset + 9   | MS Byte             | LS Byte             |                 |                                         |
| Offset + 10  | MS Byte             | LS Byte             | UDINT           | Number of errors                        |
| Offset + 11  | MS Byte             | LS Byte             |                 |                                         |
| Offset + 12  | MS Byte             | LS Byte             | UDINT           | Last error                              |
| Offset + 13  | MS Byte             | LS Byte             |                 |                                         |
| Offset + 14  | SenderAddress [0]   | SenderAddress [1]   | ARRAY of octets | Last email header used                  |
| Offset + 15  | SenderAddress [2]   | SenderAddress [3]   |                 |                                         |
| ...          |                     |                     |                 |                                         |
| Offset + 45  | SenderAddress [62]  | SenderAddress [63]  |                 |                                         |
| Offset + 46  | SenderAddress [0]   | SenderAddress [1]   |                 |                                         |
| Offset + 47  | SenderAddress [2]   | SenderAddress [3]   |                 |                                         |
| ...          |                     |                     |                 |                                         |
| Offset + 109 | SenderAddress [126] | SenderAddress [127] |                 |                                         |
| Offset + 110 | MailSubject[0]      | MailSubject[1]      |                 |                                         |
| Offset + 111 | MailSubject[2]      | MailSubject[3]      |                 |                                         |
| ...          |                     |                     |                 |                                         |
| Offset + 125 | MailSubject[30]     | MailSubject[31]     |                 |                                         |
| Offset + 126 | MSW - MSB           | MSW - LSB           | DINT            | Time elapsed from the last email        |
| Offset + 127 | LSW - MSB           | LSW - LSB           |                 |                                         |
| Offset + 128 | MSW - MSB           | MSW - LSB           | UDINT           | Number of time server was not reachable |
| Offset + 129 | LSW - MSB           | LSW - LSB           |                 |                                         |

## SNTP Diagnostic Data

| Address    | MS Byte   | LS Byte   | CIP Type | Comments                        |
|------------|-----------|-----------|----------|---------------------------------|
| Offset     | MSW - MSB | MSW - LSB | UDINT    | Enabled/disabled                |
| Offset + 1 | LSW - MSB | LSW - LSB |          |                                 |
| Offset + 2 | MSW - MSB | MSW - LSB | UDINT    | Primary NTP server IP address   |
| Offset + 3 | LSW - MSB | LSW - LSB |          |                                 |
| Offset + 4 | MSW - MSB | MSW - LSB | UDINT    | Secondary NTP server IP address |
| Offset + 5 | LSW - MSB | LSW - LSB |          |                                 |
| Offset + 6 | Unused    | LS Byte   | USINT    | Polling period                  |
| Offset + 7 | Unused    | LS Byte   | USINT    | Daylight saving auto adjustment |
| Offset + 8 | Unused    | LS Byte   | USINT    | Update CPU with module time     |

| Address     | MS Byte   | LS Byte   | CIP Type | Comments                                         |
|-------------|-----------|-----------|----------|--------------------------------------------------|
| Offset + 9  | Unused    | LS Byte   | USINT    | Reserved                                         |
| Offset + 10 | MSW - MSB | MSW - LSB | UDINT    | Time zone                                        |
| Offset + 11 | LSW - MSB | LSW - LSB |          |                                                  |
| Offset + 12 | MS Byte   | LS Byte   | INT      | Time zone offset                                 |
| Offset + 13 | Unused    | Unused    | USINT    | Reserved                                         |
| Offset + 14 | Unused    | Unused    | USINT    | Reserved                                         |
| Offset + 15 | Unused    | LS Byte   | USINT    | Daylight saving start date - month               |
| Offset + 16 | Unused    | LS Byte   | USINT    | Daylight saving start date - week #, day of week |
| Offset + 17 | Unused    | LS Byte   | USINT    | Daylight saving end date - month                 |
| Offset + 18 | Unused    | LS Byte   | USINT    | Daylight saving end date - week #, day of week   |
| Offset + 19 | MSW - MSB | MSW - LSB | UDINT    | Network time service status                      |
| Offset + 20 | LSW - MSB | LSW - LSB |          |                                                  |
| Offset + 21 | MSW - MSB | MSW - LSB | UDINT    | Link to NTP server status                        |
| Offset + 22 | LSW - MSB | LSW - LSB |          |                                                  |
| Offset + 23 | MSW - MSB | MSW - LSB | UDINT    | Current NTP server IP address                    |
| Offset + 24 | LSW - MSB | LSW - LSB |          |                                                  |
| Offset + 25 | MSW - MSB | MSW - LSB | UDINT    | NTP server type                                  |
| Offset + 26 | LSW - MSB | LSW - LSB |          |                                                  |
| Offset + 27 | MSW - MSB | MSW - LSB | UDINT    | NTP server time quality                          |
| Offset + 28 | LSW - MSB | LSW - LSB |          |                                                  |
| Offset + 29 | MSW - MSB | MSW - LSB | UDINT    | Reserved                                         |
| Offset + 30 | LSW - MSB | LSW - LSB |          |                                                  |
| Offset + 31 | MSW - MSB | MSW - LSB | UDINT    | Reserved                                         |
| Offset + 32 | LSW - MSB | LSW - LSB |          |                                                  |
| Offset + 33 | MSW - MSB | MSW - LSB | UDINT    | Reserved                                         |
| Offset + 34 | LSW - MSB | LSW - LSB |          |                                                  |
| Offset + 35 | MS Byte   | LS Byte   | UINT     | Reserved                                         |
| Offset + 36 | MSW - MSB | MSW - LSB | UDINT    | Current time                                     |
| Offset + 37 | LSW - MSB | LSW - LSB |          |                                                  |
| Offset + 38 | MS Byte   | LS Byte   |          | Current date                                     |
| Offset + 39 | MSW - MSB | MSW - LSB | UDINT    | Daylight savings status                          |
| Offset + 40 | LSW - MSB | LSW - LSB |          |                                                  |
| Offset + 41 | MSW - MSB | MSW - LSB | UINT     | Time since last update                           |
| Offset + 42 | LSW - MSB | LSW - LSB |          |                                                  |

## DNP/IEC Connection Information

| Address    | MS Byte   | LS Byte    | Comments        |
|------------|-----------|------------|-----------------|
| Offset     | Client    | Client     | DNP3/IEC Client |
|            | Connected | Configured | Count           |
|            | Count     | Count      |                 |
| Offset + 1 | Server    | Server     | DNP3/IEC Server |
|            | Connected | Configured | Count           |
|            | Count     | Count      |                 |

| Address    | MS Byte | LS Byte | Comments |
|------------|---------|---------|----------|
| Offset + 2 |         |         | Reserved |
| Offset + 3 |         |         | Reserved |
| Offset + 4 |         |         | Reserved |
| Offset + 5 |         |         | Reserved |

## DNP/IEC Server Connection Diagnostic

| Address     | MS Byte          | LS Byte                                                              | Comments                                                                                                                                                                                                               |
|-------------|------------------|----------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Offset      | MS Byte          | LS Byte                                                              | Number of entries                                                                                                                                                                                                      |
| Offset + 1  | MS Byte          | LS Byte                                                              | MS byte: Event USED/CONFIGURED 0-100%<br>LS byte: CONFIGURED/TOTAL 0-100%                                                                                                                                              |
| Offset + 2  | MSB - C03        | C02                                                                  | Module total                                                                                                                                                                                                           |
| Offset + 3  | C01              | LSB - C00                                                            | Configured event<br>Buffer size                                                                                                                                                                                        |
| Offset + 4  | MSB - C03        | C02                                                                  | Module total                                                                                                                                                                                                           |
| Offset + 5  | C01              | LSB - C00                                                            | Current event buffer used                                                                                                                                                                                              |
| Offset + 6  | MSB - C03        | C02                                                                  | Module total current overflow                                                                                                                                                                                          |
| Offset + 7  | C01              | LSB - C00                                                            |                                                                                                                                                                                                                        |
| Offset + 8  | MS Byte          | LS Byte                                                              | MS Byte: Event buffer overflow<br>LS Byte: Event backup status                                                                                                                                                         |
| Offset + 9  | MS Byte          | LS Byte                                                              | Channel index                                                                                                                                                                                                          |
| Offset + 10 | MS Byte reserved | LS Byte<br>1: DNP3 serial<br>3: DNP3 NET<br>5: IEC 101<br>7: IEC 104 | Protocol:<br>DNP3 serial server<br>DNP3 NET server<br>IEC 101 server<br>IEC 104 server                                                                                                                                 |
| Offset + 11 | MS Byte          | LS Byte                                                              | LS Byte connection state<br>0: disconnected<br>1: connected<br>2: connecting<br>3: active<br>4: inactive<br>MS Byte authentication type<br>0: none<br>1: SAV2<br>2: SAV5<br>3: TLS_ONLY<br>4: TLS_SAV2<br>5: T:LS_SAV5 |
| Offset + 12 | Char 1           | Char 2                                                               | Channel name                                                                                                                                                                                                           |
| Offset + 13 | Char 3           | Char 4                                                               |                                                                                                                                                                                                                        |
| Offset + 14 | Char 5           | Char 6                                                               |                                                                                                                                                                                                                        |
| Offset + 15 | Char 7           | Char 8                                                               |                                                                                                                                                                                                                        |
| Offset + 16 | Char 9           | Char 10                                                              |                                                                                                                                                                                                                        |

| Address     | MS Byte | LS Byte | Comments                                                                                                                                                                                                                               |
|-------------|---------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Offset + 17 | Char 11 | Char 12 |                                                                                                                                                                                                                                        |
| Offset + 18 | Char 13 | Char 14 |                                                                                                                                                                                                                                        |
| Offset + 19 | Char 15 | Char 16 |                                                                                                                                                                                                                                        |
| Offset + 20 | IP 1    | IP 2    | Remote IP address                                                                                                                                                                                                                      |
| Offset + 21 | IP 3    | IP 4    |                                                                                                                                                                                                                                        |
| Offset + 22 | MS Byte | LS Byte | Remote port number                                                                                                                                                                                                                     |
| Offset + 23 | MS Byte | LS Byte | Local port number                                                                                                                                                                                                                      |
| Offset + 24 | MS Byte | LS Byte | Error code:<br><br>Bit 0: Channel security not configured<br><br>Bit 1: Unlocated variable initialize error<br><br>Bit 2: Internal error (pipe create error, IPC init error, etc.)<br><br>Bits 3-14: Reserved<br><br>Bit 15: TLS error |
| Offset + 25 | C03     | C02     | Channel total                                                                                                                                                                                                                          |
| Offset + 26 | C01     | C00     | Configured event<br>Buffer size                                                                                                                                                                                                        |
| Offset + 27 | C03     | C02     | Channel total                                                                                                                                                                                                                          |
| Offset + 28 | C01     | C00     | Current event<br>Buffer used                                                                                                                                                                                                           |
| Offset + 29 | C03     | C02     | Channel total                                                                                                                                                                                                                          |
| Offset + 30 | C01     | C00     | Current overflow                                                                                                                                                                                                                       |
| Offset + 31 | MS Byte | LS Byte | MS Byte: Reserved<br>LS Byte: Event buffer overflow                                                                                                                                                                                    |
| Offset + 32 | C01     | C00     | TLS error code                                                                                                                                                                                                                         |
| Offset + 33 | MS Byte | LS Byte | Reserved 2                                                                                                                                                                                                                             |
| Offset + 34 | MS Byte | LS Byte | Reserved 3                                                                                                                                                                                                                             |
| Offset + 35 | MS Byte | LS Byte | Number of data type<br><br>Event status<br><br>Always 16                                                                                                                                                                               |
| Offset + 36 | MS Byte | LS Byte | MS Byte<br><br>Bit 0: Validity<br><br>Bit 1: Event buffer overflow<br><br>Bits 2-7: Reserved<br><br>LS Byte: Index                                                                                                                     |
| Offset + 37 | MS Byte | LS Byte | DNP data type:<br><br>1. Binary input<br>2. Double input<br>3. Binary output<br>4. Binary counter<br>5. Frozen counter<br>6: Analog input<br>7. Analog output<br>8-16. For extended                                                    |

| Address                | MS Byte | LS Byte | Comments                                                                                                                                                                                                                                      |
|------------------------|---------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                        |         |         | IEC data type:<br>1. M_SP<br>2. M_DP<br>3. M_ST<br>4. M_BO<br>5. M_ME_A<br>6. M_ME_B<br>7. M_ME_C<br>8. M_IT<br>9. Custom_M_IT_D<br>10-16. For extended                                                                                       |
| Offset + 38            | Char 1  | Char 2  | Data type name                                                                                                                                                                                                                                |
| Offset + 39            | Char 3  | Char 4  |                                                                                                                                                                                                                                               |
| Offset + 40            | Char 5  | Char 6  |                                                                                                                                                                                                                                               |
| Offset + 41            | Char 7  | Char 8  |                                                                                                                                                                                                                                               |
| Offset + 42            | Char 9  | Char 10 |                                                                                                                                                                                                                                               |
| Offset + 43            | Char 11 | Char 12 |                                                                                                                                                                                                                                               |
| Offset + 44            | Char 13 | Char 14 |                                                                                                                                                                                                                                               |
| Offset + 45            | Char 15 | Char 16 |                                                                                                                                                                                                                                               |
| Offset + 46            | C03     | C02     | Configured event                                                                                                                                                                                                                              |
| Offset + 47            | C01     | C00     | Buffer size                                                                                                                                                                                                                                   |
| Offset + 48            | C03     | C02     | Current event                                                                                                                                                                                                                                 |
| Offset + 49            | C01     | C00     | Buffer used                                                                                                                                                                                                                                   |
| Offset + 50            | C03     | C02     | Current overflow                                                                                                                                                                                                                              |
| Offset + 51            | C01     | C00     |                                                                                                                                                                                                                                               |
| Offset + 36 + (X-1)*16 | MB Byte | LS Byte | MS Byte:<br>Bit 0: Validity<br>Bit 1: Event buffer overflow<br>Bits 2-7: Reserved<br>LS Byte: Index                                                                                                                                           |
| Offset + 37 + (X-1)*16 | MS Byte | LS Byte | DNP data type:<br>1. Binary input<br>2. Double input<br>3. Binary output<br>4. Binary counter<br>5. Frozen counter<br>6. Analog input<br>7. Analog output<br>8-16. For extended<br>IEC data type:<br>1. M_SP<br>2. M_DP<br>3. M_ST<br>4. M_BO |

| Address                          | MS Byte | LS Byte | Comments                                                                                                                                                                       |
|----------------------------------|---------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                  |         |         | 5. M_ME_A<br>6. M_ME_B<br>7. M_ME_C<br>8. M_IT<br>9. Custom_M_IT_D<br>10-16. For extended                                                                                      |
| Offset + 38 + (X-1)*16           | Char 1  | Char 2  | Data type name                                                                                                                                                                 |
| Offset + 39 + (X-1)*16           | Char 3  | Char 4  |                                                                                                                                                                                |
| Offset + 40 + (X-1)*16           | Char 5  | Char 6  |                                                                                                                                                                                |
| Offset + 41 + (X-1)*16           | Char 7  | Char 8  |                                                                                                                                                                                |
| Offset + 42 + (X-1)*16           | Char 9  | Char 10 |                                                                                                                                                                                |
| Offset + 43 + (X-1)*16           | Char 11 | Char 12 |                                                                                                                                                                                |
| Offset + 44 + (X-1)*16           | Char 13 | Char 14 |                                                                                                                                                                                |
| Offset + 45 + (X-1)*16           | Char 15 | Char 16 |                                                                                                                                                                                |
| Offset + 46 + (X-1)*16           | Char 03 | Char 02 | Configured event                                                                                                                                                               |
| Offset + 47 + (X-1)*16           | Char 01 | Char 00 | Buffer size                                                                                                                                                                    |
| Offset + 48 + (X-1)*16           | Char 03 | Char 02 | Current event                                                                                                                                                                  |
| Offset + 49 + (X-1)*16           | Char 01 | Char 00 | Buffer used                                                                                                                                                                    |
| Offset + 50 + (X-1)*16           | Char 03 | Char 02 | Current overflow                                                                                                                                                               |
| Offset + 51 + (X-1)*16           | Char 01 | Char 00 |                                                                                                                                                                                |
| Offset + 09 + (N-1)*(27 + 16*16) | MB Byte | LS Byte | Channel index                                                                                                                                                                  |
| Offset + (N-1)*283 + 10          | MB Byte | LS Byte | Channel index                                                                                                                                                                  |
| Offset + (N-1)*283 + 11          | MB Byte | LS Byte | LS Byte<br>Connection State<br>0: Disconnected<br>1: Connected<br>2: Connecting<br>3: Active<br>4: Inactive<br>MS Byte<br>Authentication type<br>5: None<br>6: SAv2<br>7: SAv5 |

| Address                 | MS Byte | LS Byte | Comments                                                                                                                                                                                                                               |
|-------------------------|---------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                         |         |         | 8: TLS_ONLY<br>9: TLS_SAv2<br>10: TLS_SAv5                                                                                                                                                                                             |
| Offset + (N-1)*283 + 12 | Char 1  | Char 2  | Channel name                                                                                                                                                                                                                           |
| Offset + (N-1)*283 + 13 | Char 3  | Char 4  |                                                                                                                                                                                                                                        |
| Offset + (N-1)*283 + 14 | Char 5  | Char 2  |                                                                                                                                                                                                                                        |
| Offset + (N-1)*283 + 15 | Char 7  | Char 6  |                                                                                                                                                                                                                                        |
| Offset + (N-1)*283 + 16 | Char 9  | Char 2  |                                                                                                                                                                                                                                        |
| Offset + (N-1)*283 + 17 | Char 11 | Char 8  |                                                                                                                                                                                                                                        |
| Offset + (N-1)*283 + 18 | Char 13 | Char 10 |                                                                                                                                                                                                                                        |
| Offset + (N-1)*283 + 19 | Char 15 | Char 12 |                                                                                                                                                                                                                                        |
| Offset + (N-1)*283 + 20 | IP 1    | IP 2    | Remote IP address                                                                                                                                                                                                                      |
| Offset + (N-1)*283 + 21 | IP 3    | IP 4    |                                                                                                                                                                                                                                        |
| Offset + (N-1)*283 + 22 | MS Byte | LS Byte | Remote port number                                                                                                                                                                                                                     |
| Offset + (N-1)*283 + 23 | MS Byte | LS Byte | Local port number                                                                                                                                                                                                                      |
| Offset + (N-1)*283 + 24 | MS Byte | LS Byte | Error code:<br><br>Bit 0: Channel security not configured<br><br>Bit 1: Unlocated variable initialize error<br><br>Bit 2: Internal error (pipe create error, IPC init error, etc.)<br><br>Bits 3-14: Reserved<br><br>Bit 15: TLS error |
| Offset + (N-1)*283 + 25 | C03     | C02     | Channel total                                                                                                                                                                                                                          |
| Offset + (N-1)*283 + 26 | C01     | C02     | Configured event<br>Buffer size                                                                                                                                                                                                        |
| Offset + (N-1)*283 + 27 | C03     | C02     | Channel total                                                                                                                                                                                                                          |
| Offset + (N-1)*283 + 28 | C01     | C02     | Current event<br>Buffer used                                                                                                                                                                                                           |
| Offset + (N-1)*283 + 29 | C03     | C02     | Channel total                                                                                                                                                                                                                          |
| Offset + (N-1)*283 + 30 | C01     | C02     | Current overflow                                                                                                                                                                                                                       |
| Offset + (N-1)*283 + 31 | MS Byte | LS Byte | MS Byte: Reserved<br>LS Byte: Event buffer overflow                                                                                                                                                                                    |
| Offset + (N-1)*283 + 32 | C01     | C00     | TLS error code                                                                                                                                                                                                                         |
| Offset + (N-1)*283 + 33 | MS Byte | LS Byte | Reserved 2                                                                                                                                                                                                                             |

| Address                            | MS Byte | LS Byte | Comments                                                                                                           |
|------------------------------------|---------|---------|--------------------------------------------------------------------------------------------------------------------|
| Offset + (N-1)*283 + 34            | MS Byte | LS Byte | Reserved 3                                                                                                         |
| Offset + (N-1)*283 + 35            | MS Byte | LS Byte | Number of data type<br>Event status<br>Always 16                                                                   |
| Offset + (N-1)*283 + 36            | MS Byte | LS Byte | MS Byte:<br>Bit 0: Validity<br>Bit 1: Event buffer overflow<br>Bits 2-7: Reserved<br>LS Byte: Index                |
| Offset + (N-1)*283 + 37            | MS Byte | LS Byte | Data type name                                                                                                     |
| Offset + (N-1)*283 + 38            | Char 1  | Char 2  |                                                                                                                    |
| Offset + (N-1)*283 + 39            | Char 3  | Char 4  |                                                                                                                    |
| Offset + (N-1)*283 + 40            | Char 5  | Char 6  |                                                                                                                    |
| Offset + (N-1)*283 + 41            | Char 7  | Char 8  |                                                                                                                    |
| Offset + (N-1)*283 + 42            | Char 9  | Char 10 |                                                                                                                    |
| Offset + (N-1)*283 + 43            | Char 11 | Char 12 |                                                                                                                    |
| Offset + (N-1)*283 + 44            | Char 13 | Char 14 |                                                                                                                    |
| Offset + (N-1)*283 + 45            | Char 17 | Char 16 |                                                                                                                    |
| Offset + (N-1)*283 + 46            | C03     | C02     | Configured event<br>Buffer size                                                                                    |
| Offset + (N-1)*283 + 47            | C01     | C00     |                                                                                                                    |
| Offset + (N-1)*283 + 48            | C03     | C02     | Current event<br>Buffer used                                                                                       |
| Offset + (N-1)*283 + 49            | C01     | C00     |                                                                                                                    |
| Offset + (N-1)*283 + 50            | C03     | C02     | Current overflow                                                                                                   |
| Offset + (N-1)*283 + 51            | C01     | C00     |                                                                                                                    |
| Offset + (N-1)*283 + 36 + (X-1)*16 | MS Byte | LS Byte | MS Byte:<br>Bit 0: Validity<br>Bit 1: Event buffer overflow<br>Bits 2-7: Reserved<br>LS Byte: Index                |
| Offset + (N-1)*283 + 37 + (X-1)*16 | MS Byte | LS Byte | DNP data type:<br>1. Binary input<br>2. Double input<br>3. Binary output<br>4. Binary counter<br>5. Frozen counter |

| Address                            | MS Byte | LS Byte | Comments                                                                                                                                                                                                              |
|------------------------------------|---------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                    |         |         | 6. Analog output<br>7. Analog output<br>8-16. For extended<br>IEC data type:<br>1. M_SP<br>2. M_DP<br>3. M_ST<br>4. M_BO<br>5. M_ME_A<br>6. M_ME_B<br>7. M_ME_C<br>8. M_IT<br>9. Custom_M_IT_D<br>10-16. For extended |
| Offset + (N-1)*283 + 38 + (X-1)*16 | Char 1  | Char 2  | Data type name                                                                                                                                                                                                        |
| Offset + (N-1)*283 + 39 + (X-1)*16 | Char 3  | Char 4  |                                                                                                                                                                                                                       |
| Offset + (N-1)*283 + 40 + (X-1)*16 | Char 5  | Char 6  |                                                                                                                                                                                                                       |
| Offset + (N-1)*283 + 41 + (X-1)*16 | Char 7  | Char 8  |                                                                                                                                                                                                                       |
| Offset + (N-1)*283 + 42 + (X-1)*16 | Char 9  | Char 10 |                                                                                                                                                                                                                       |
| Offset + (N-1)*283 + 43 + (X-1)*16 | Char 11 | Char 12 |                                                                                                                                                                                                                       |
| Offset + (N-1)*283 + 44 + (X-1)*16 | Char 13 | Char 14 |                                                                                                                                                                                                                       |
| Offset + (N-1)*283 + 45 + (X-1)*16 | Char 15 | Char 16 |                                                                                                                                                                                                                       |
| Offset + (N-1)*283 + 46 + (X-1)*16 | C03     | C02     | Configured event<br>Buffer size                                                                                                                                                                                       |
| Offset + (N-1)*283 + 47 + (X-1)*16 | C01     | C00     |                                                                                                                                                                                                                       |
| Offset + (N-1)*283 + 48 + (X-1)*16 | C03     | C02     | Current event<br>Buffer used                                                                                                                                                                                          |
| Offset + (N-1)*283 + 49 + (X-1)*16 | C01     | C00     |                                                                                                                                                                                                                       |
| Offset + (N-1)*283 + 50 + (X-1)*16 | C03     | C02     | Current overflow                                                                                                                                                                                                      |
| Offset + (N-1)*283 + 51 + (X-1)*16 | C01     | C00     |                                                                                                                                                                                                                       |

## DNP/IEC Client Connection Diagnostic

| Address     | MS Byte          | LS Byte                                                              | Comments                                                                                                                                                                                                                                                                                                                                                                           |
|-------------|------------------|----------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Offset      | MS Byte          | LS Byte                                                              | Number of entries                                                                                                                                                                                                                                                                                                                                                                  |
| Offset + 1  | MS Byte          | LS Byte                                                              | Channel index                                                                                                                                                                                                                                                                                                                                                                      |
| Offset + 2  | MS Byte reserved | LS Byte<br>2: DNP3 serial<br>4: DNP3 NET<br>6: IEC 101<br>8: IEC 104 | Protocol:<br>DNP3 serial client<br>DNP3 NET client<br>IEC 101 client<br>IEC 104 client                                                                                                                                                                                                                                                                                             |
| Offset + 3  | MS Byte          | LS Byte                                                              | LS Byte connection state:<br>0: Disconnected<br>1: Connected<br>2: Connecting<br>3: Active<br>4: Inactive<br>MS Byte authentication type:<br>5: None<br>6: SAV2<br>7: SAV5<br>8: TLS_ONLY<br>9: TLS_SAV2<br>10: TLS_SAV5                                                                                                                                                           |
| Offset + 4  | Char 1           | Char 2                                                               | Channel name                                                                                                                                                                                                                                                                                                                                                                       |
| Offset + 5  | Char 3           | Char 4                                                               |                                                                                                                                                                                                                                                                                                                                                                                    |
| Offset + 6  | Char 5           | Char 6                                                               |                                                                                                                                                                                                                                                                                                                                                                                    |
| Offset + 7  | Char 7           | Char 8                                                               |                                                                                                                                                                                                                                                                                                                                                                                    |
| Offset + 8  | Char 9           | Char 10                                                              |                                                                                                                                                                                                                                                                                                                                                                                    |
| Offset + 9  | Char 11          | Char 12                                                              |                                                                                                                                                                                                                                                                                                                                                                                    |
| Offset + 10 | Char 13          | Char 14                                                              |                                                                                                                                                                                                                                                                                                                                                                                    |
| Offset + 11 | Char 15          | Char 16                                                              |                                                                                                                                                                                                                                                                                                                                                                                    |
| Offset + 12 | IP 1             | IP 2                                                                 | Remote IP address                                                                                                                                                                                                                                                                                                                                                                  |
| Offset + 13 | IP 3             | IP 4                                                                 |                                                                                                                                                                                                                                                                                                                                                                                    |
| Offset + 14 | MS Byte          | LS Byte                                                              | Remote port number                                                                                                                                                                                                                                                                                                                                                                 |
| Offset + 15 | MS Byte          | LS Byte                                                              | Local port number                                                                                                                                                                                                                                                                                                                                                                  |
| Offset + 16 | Bit 15~8         | Bit 7~0                                                              | Error code<br>Bit 0: Channel security not configured<br>Bit 1: Unlocated variable initialize error<br>Bit 2: Internal error (pipe create error, IPC init error, etc.)<br>Bit 3: authentication failed<br>Bit 4: Unexpected response<br>Bit 5: No response<br>Bit 6: Aggressive mode not supported<br>Bit 7: MAC algorithm not supported<br>Bit 8: Key wrap algorithm not supported |

| Address                | MS Byte          | LS Byte                                                               | Comments                                                                                                                                                                                                                                        |
|------------------------|------------------|-----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                        |                  |                                                                       | Bit 9: Authorization failed<br>Bit 10: Update key change method not permitted<br>Bit 11: Invalid signature<br>Bit 12: Invalid certification data<br>Bit 13: Unknown user<br>Bit 14: Max session key status requests exceed<br>Bit 15: TLS error |
| Offset + 17            | C01              | C02                                                                   | TLS error code                                                                                                                                                                                                                                  |
| Offset + 18            | MS Byte          | LS Byte                                                               | Reserved 1                                                                                                                                                                                                                                      |
| Offset + 19            | MS Byte          | LS Byte                                                               | Reserved 2                                                                                                                                                                                                                                      |
| Offset + 20            | MS Byte          | LS Byte                                                               | Reserved 3                                                                                                                                                                                                                                      |
| Offset + 01 + (N-1)*20 | MS Byte          | LS Byte                                                               | Channel index                                                                                                                                                                                                                                   |
| Offset + 02 + (N-1)*20 | MS Byte reserved | LS Byte:<br>2: DNP3 serial<br>4: DNP3 NET<br>6: IEC 101<br>8: IEC 104 | Protocol:<br>DNP3 serial client<br>DNP3 NET client<br>IEC 101 client<br>IEC 104 client                                                                                                                                                          |
| Offset + 03 + (N-1)*20 | MS Byte          | LS Byte                                                               | LS Byte connection state:<br>0: Disconnected<br>1: Connected<br>2: Connecting<br>3: Active<br>4: Inactive<br>MS Byte authentication type:<br>5: None<br>6: SAv2<br>7: SAv5<br>8: TLS_ONLY<br>9: TLS_SAv2<br>10: TLS_SAv5                        |
| Offset + 04 + (N-1)*20 | Char 1           | Char 2                                                                | Channel name                                                                                                                                                                                                                                    |
| Offset + 05 + (N-1)*20 | Char 3           | Char 4                                                                |                                                                                                                                                                                                                                                 |
| Offset + 06 + (N-1)*20 | Char 5           | Char 6                                                                |                                                                                                                                                                                                                                                 |
| Offset + 07 + (N-1)*20 | Char 7           | Char 8                                                                |                                                                                                                                                                                                                                                 |
| Offset + 08 + (N-1)*20 | Char 9           | Char 10                                                               |                                                                                                                                                                                                                                                 |
| Offset + 09 + (N-1)*20 | Char 11          | Char 12                                                               |                                                                                                                                                                                                                                                 |
| Offset + 10 + (N-1)*20 | Char 13          | Char 14                                                               |                                                                                                                                                                                                                                                 |

| Address                | MS Byte  | LS Byte | Comments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------------------------|----------|---------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Offset + 11 + (N-1)*20 | Char 15  | Char 16 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Offset + 12 + (N-1)*20 | IP 1     | IP 2    | Remote IP address                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Offset + 13 + (N-1)*20 | IP 3     | IP 4    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Offset + 14 + (N-1)*20 | MS Byte  | LS Byte | Remote port number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Offset + 15 + (N-1)*20 | MS Byte  | LS Byte | Local port number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Offset + 16 + (N-1)*20 | Bit 15~8 | Bit7~0  | Error code:<br>Bit 0: Channel security not configured<br>Bit 1: Unlocated variable initialize error<br>Bit 2: Internal error (pipe create error, IPC init error, etc.)<br>Bit 3: Authentication failed<br>Bit 4: Unexpected response<br>Bit 5: No response<br>Bit 6: Aggressive mode not supported<br>Bit 7: MAC algorithm not supported<br>Bit 8: Key wrap algorithm not supported<br>Bit 9: Authorization failed<br>Bit 10: Update key change method not permitted<br>Bit 11: Invalid signature<br>Bit 12: Invalid certification data<br>Bit 13: Unknown user<br>Bit 14: Max session key status requests exceed<br>Bit 15: TLS error |
| Offset + 17 + (N-1)*20 | C01      | C00     | TLS error code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Offset + 18 + (N-1)*20 | MS Byte  | LS Byte | Reserved 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Offset + 19 + (N-1)*20 | MS Byte  | LS Byte | Reserved 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Offset + 20 + (N-1)*20 | MS Byte  | LS Byte | Reserved 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

## DNP Server Security Diagnostic

| Address    | MS Byte          | LS Byte               | Comments                             |
|------------|------------------|-----------------------|--------------------------------------|
| Offset     |                  |                       | Number of entries                    |
| Offset + 1 | MS Byte reserved | LS Byte channel index | Channel index                        |
| Offset + 2 | C03              | C02                   | Unexpected messages (SAv2, SAv5)     |
| Offset + 3 | C01              | C00                   |                                      |
| Offset + 4 | C03              | C02                   | Authorization failures (SAv2, SAv5)  |
| Offset + 5 | C01              | C00                   |                                      |
| Offset + 6 | C03              | C02                   | Authentication failures (SAv2, SAv5) |

| Address     | MS Byte | LS Byte | Comments                                          |
|-------------|---------|---------|---------------------------------------------------|
| Offset + 7  | C01     | C00     |                                                   |
| Offset + 8  | C03     | C02     | Reply timeout (SAv2, SAv5)                        |
| Offset + 9  | C01     | C00     |                                                   |
| Offset + 10 | C03     | C02     | Re-keys due to authentication failure (SAv5 only) |
| Offset + 11 | C01     | C00     |                                                   |
| Offset + 12 | C03     | C02     | Total message sent (SAv5 only)                    |
| Offset + 13 | C01     | C00     |                                                   |
| Offset + 14 | C03     | C02     | Total messages received (SAv5 only)               |
| Offset + 15 | C01     | C00     |                                                   |
| Offset + 16 | C03     | C02     | Critical message sent (SAv2, SAv5)                |
| Offset + 17 | C01     | C00     |                                                   |
| Offset + 18 | C03     | C02     | Critical message received (SAv2, SAv5)            |
| Offset + 19 | C01     | C00     |                                                   |
| Offset + 20 | C03     | C02     | Discarded messages (SAv5 only)                    |
| Offset + 21 | C01     | C00     |                                                   |
| Offset + 22 | C03     | C02     | Error message sent (SAv2, SAv5)                   |
| Offset + 23 | C01     | C00     |                                                   |
| Offset + 24 | C03     | C02     | Error message transmitted (SAv2, SAv5)            |
| Offset + 25 | C01     | C00     |                                                   |
| Offset + 26 | C03     | C02     | Successful authentications (SAv2, SAv5)           |
| Offset + 27 | C01     | C00     |                                                   |
| Offset + 28 | C03     | C02     | Session key changes (SAv2, SAv5)                  |
| Offset + 29 | C01     | C00     |                                                   |
| Offset + 30 | C03     | C02     | Failed session key changes (SAv2, SAv5)           |
| Offset + 31 | C01     | C00     |                                                   |
| Offset + 32 | C03     | C02     | Update key changes (SAv5 only)                    |
| Offset + 33 | C01     | C00     |                                                   |
| Offset + 34 | C03     | C02     | Failed update key changes (SAv5 only)             |
| Offset + 35 | C01     | C00     |                                                   |
| Offset + 36 | C03     | C02     | Re-keys due to restart (SAv5 only)                |
| Offset + 37 | C01     | C00     |                                                   |

| Address                | MS Byte          | LS Byte                  | Comments                                          |
|------------------------|------------------|--------------------------|---------------------------------------------------|
| Offset + 38            | C01              | C00                      | Reserved 0                                        |
| Offset + 39            | C01              | C00                      | Reserved 1                                        |
| Offset + (N-1)*39 + 01 | MS Byte reserved | LS Byte<br>Channel index | Channel index                                     |
| Offset + (N-1)*39 + 02 | C03              | C02                      | Unexpected messages (SAv2, SAv5)                  |
| Offset + (N-1)*39 + 03 | C01              | C00                      |                                                   |
| Offset + (N-1)*39 + 04 | C03              | C02                      | Authorization failures (SAv2, SAv5)               |
| Offset + (N-1)*39 + 05 | C01              | C00                      |                                                   |
| Offset + (N-1)*39 + 06 | C03              | C02                      | Authentication failures (SAv2, SAv5)              |
| Offset + (N-1)*39 + 07 | C01              | C00                      |                                                   |
| Offset + (N-1)*39 + 08 | C03              | C02                      | Reply time out (SAv2, SAv5)                       |
| Offset + (N-1)*39 + 09 | C01              | C00                      |                                                   |
| Offset + (N-1)*39 + 10 | C03              | C02                      | Re-keys due to authentication failure (SAv5 only) |
| Offset + (N-1)*39 + 11 | C01              | C00                      |                                                   |
| Offset + (N-1)*39 + 12 | C03              | C02                      | Total messages sent (SAv5 only)                   |
| Offset + (N-1)*39 + 13 | C01              | C00                      |                                                   |
| Offset + (N-1)*39 + 14 | C03              | C02                      | Total messages received (SAv2, SAv5)              |
| Offset + (N-1)*39 + 15 | C01              | C00                      |                                                   |
| Offset + (N-1)*39 + 16 | C03              | C02                      | Critical messages sent (SAv2, SAv5)               |
| Offset + (N-1)*39 + 17 | C01              | C00                      |                                                   |
| Offset + (N-1)*39 + 18 | C03              | C02                      | Critical messages received (SAv2, SAv5)           |
| Offset + (N-1)*39 + 19 | C01              | C00                      |                                                   |
| Offset + (N-1)*39 + 20 | C03              | C02                      | Discarded messages (SAv2, SAv5)                   |

| Address                | MS Byte | LS Byte | Comments                                |
|------------------------|---------|---------|-----------------------------------------|
| Offset + (N-1)*39 + 21 | C01     | C00     |                                         |
| Offset + (N-1)*39 + 22 | C03     | C02     | Error messages sent (SAv2, SAv5)        |
| Offset + (N-1)*39 + 23 | C01     | C00     |                                         |
| Offset + (N-1)*39 + 24 | C03     | C02     | Error messages received (SAv2, SAv5)    |
| Offset + (N-1)*39 + 25 | C01     | C00     |                                         |
| Offset + (N-1)*39 + 26 | C03     | C02     | Successful authentications (SAv2, SAv5) |
| Offset + (N-1)*39 + 27 | C01     | C00     |                                         |
| Offset + (N-1)*39 + 28 | C03     | C02     | Session key changes (SAv2, SAv5)        |
| Offset + (N-1)*39 + 29 | C01     | C00     |                                         |
| Offset + (N-1)*39 + 30 | C03     | C02     | Failed session key changes (SAv2, SAv5) |
| Offset + (N-1)*39 + 31 | C01     | C00     |                                         |
| Offset + (N-1)*39 + 32 | C03     | C02     | Update key changes (SAv5 only)          |
| Offset + (N-1)*39 + 33 | C01     | C00     |                                         |
| Offset + (N-1)*39 + 34 | C03     | C02     | Failed update key changes (SAv5 only)   |
| Offset + (N-1)*39 + 35 | C01     | C00     |                                         |
| Offset + (N-1)*39 + 36 | C03     | C02     | Re-keys due to restart (SAv5 only)      |
| Offset + (N-1)*39 + 37 | C01     | C00     |                                         |
| Offset + (N-1)*39 + 38 | C03     | C02     | Reserved 0                              |
| Offset + (N-1)*39 + 39 | C01     | C00     | Reserved 1                              |

## DNP Client Security Diagnostic

| Address     | MS Byte          | LS Byte | Comments          |
|-------------|------------------|---------|-------------------|
| Offset      |                  |         | Number of entries |
| Offset + 01 | MS Byte reserved | LS Byte | Channel index     |

| Address                | MS Byte          | LS Byte                  | Comments                                          |
|------------------------|------------------|--------------------------|---------------------------------------------------|
|                        |                  | Channel index            |                                                   |
| Offset + 02            | C03              | C02                      | Unexpected messages (SAv2, SAv5)                  |
| Offset + 03            | C01              | C00                      |                                                   |
| Offset + 04            | C03              | C02                      | Authorization failures (SAv2, SAv5)               |
| Offset + 05            | C01              | C00                      |                                                   |
| Offset + 06            | C03              | C02                      | Authentication failures (SAv2, SAv5)              |
| Offset + 07            | C01              | C00                      |                                                   |
| Offset + 08            | C03              | C02                      | Reply timeout (SAv2, SAv5)                        |
| Offset + 09            | C01              | C00                      |                                                   |
| Offset + 10            | C03              | C02                      | Re-keys due to authentication failure (SAv5 only) |
| Offset + 11            | C01              | C00                      |                                                   |
| Offset + 12            | C03              | C02                      | Total message sent (SAv5 only)                    |
| Offset + 13            | C01              | C00                      |                                                   |
| Offset + 14            | C03              | C02                      | Total messages received (SAv5 only)               |
| Offset + 15            | C01              | C00                      |                                                   |
| Offset + 16            | C03              | C02                      | Critical message sent (SAv2, SAv5)                |
| Offset + 17            | C01              | C00                      |                                                   |
| Offset + 18            | C03              | C02                      | Critical messages received (SAv2, SAv5)           |
| Offset + 19            | C01              | C00                      |                                                   |
| Offset + 20            | C03              | C02                      | Discarded messages (SAv5 only)                    |
| Offset + 21            | C01              | C00                      |                                                   |
| Offset + 22            | C03              | C02                      | Error message sent (SAv2, SAv5)                   |
| Offset + 23            | C01              | C00                      |                                                   |
| Offset + 24            | C03              | C02                      | Error message transmitted (SAv2, SAv5)            |
| Offset + 25            | C01              | C00                      |                                                   |
| Offset + 26            | C03              | C02                      | Successful authentications (SAv2, SAv5)           |
| Offset + 27            | C01              | C00                      |                                                   |
| Offset + 28            | C03              | C02                      | Session key changes (SAv2, SAv5)                  |
| Offset + 29            | C01              | C00                      |                                                   |
| Offset + 30            | C03              | C02                      | Failed session key changes (SAv2, SAv5)           |
| Offset + 31            | C01              | C00                      |                                                   |
| Offset + 32            | C03              | C02                      | Update key changes (SAv5 only)                    |
| Offset + 33            | C01              | C00                      |                                                   |
| Offset + 34            | C03              | C02                      | Failed update key changes (SAv5 only)             |
| Offset + 35            | C01              | C00                      |                                                   |
| Offset + 36            | C03              | C02                      | Re-keys due to restart (SAv5 only)                |
| Offset + 37            | C01              | C00                      |                                                   |
| Offset + 38            | C01              | C00                      | Reserved 0                                        |
| Offset + 39            | C01              | C00                      | Reserved 1                                        |
| Offset = (N-1)*39 + 01 | MS Byte reserved | LS Byte<br>Channel index | Channel index                                     |
| Offset = (N-1)*39 + 02 | C03              | C02                      | Unexpected messages (SAv2, SAv5)                  |
| Offset = (N-1)*39 + 03 | C01              | C00                      |                                                   |
| Offset = (N-1)*39 + 04 | C03              | C02                      | Authorization failures (SAv2, SAv5)               |

| Address                     | MS Byte | LS Byte | Comments                                          |
|-----------------------------|---------|---------|---------------------------------------------------|
| Offset = (N-1)*39 + 05      | C01     | C00     |                                                   |
| Offset = (N-1)*39 + 06      | C03     | C02     | Authentication failures (SAv2, SAv5)              |
| Offset = (N-1)*39 + 07      | C01     | C00     |                                                   |
| Offset = (N-1)*39 + 08      | C03     | C02     | Reply timeout (SAv2, SAv5)                        |
| Offset = (N-1)*39 + 09      | C01     | C00     |                                                   |
| Offset = (N-1)*39 + 10      | C03     | C02     | Re-keys due to authentication failure (SAv5 only) |
| Offset = (N-1)*39 + 11      | C01     | C00     |                                                   |
| Offset = (N-1)*39 + 12      | C03     | C02     | Total messages sent (SAv5 only)                   |
| Offset = (N-1)*39 + 13      | C01     | C00     |                                                   |
| Offset = 3<br>(N-1)*39 + 14 | C03     | C02     | Total messages received (SAv5 only)               |
| Offset = (N-1)*39 + 15      | C01     | C00     |                                                   |
| Offset = (N-1)*39 + 16      | C03     | C02     | Critical messages sent (SAv2, SAv5)               |
| Offset = (N-1)*39 + 17      | C01     | C00     |                                                   |
| Offset = (N-1)*39 + 18      | C03     | C02     | Critical messages received (SAv2, SAv5)           |
| Offset = (N-1)*39 + 19      | C01     | C00     |                                                   |
| Offset = (N-1)*39 + 20      | C03     | C02     | Discarded messages (SAv5 only)                    |
| Offset = (N-1)*39 + 21      | C01     | C00     |                                                   |
| Offset = (N-1)*39 + 22      | C03     | C02     | Error messages sent (SAv2, SAv5)                  |
| Offset = (N-1)*39 + 23      | C01     | C00     |                                                   |
| Offset = (N-1)*39 + 24      | C03     | C02     | Error messages transmitted (SAv2, SAv5)           |
| Offset = (N-1)*39 + 25      | C01     | C00     |                                                   |
| Offset = (N-1)*39 + 26      | C03     | C02     | Successful authentication (SAv2, SAv5)            |
| Offset = (N-1)*39 + 27      | C01     | C00     |                                                   |
| Offset = (N-1)*39 + 28      | C03     | C02     | Session key changes (SAv2, SAv5)                  |
| Offset = (N-1)*39 + 29      | C01     | C00     |                                                   |
| Offset = (N-1)*39 + 30      | C03     | C02     | Failed session key changes (SAv2, SAv5)           |
| Offset = (N-1)*39 + 31      | C01     | C00     |                                                   |

| Address                | MS Byte | LS Byte | Comments                              |
|------------------------|---------|---------|---------------------------------------|
| Offset = (N-1)*39 + 32 | C03     | C02     | Update key changes (SAv5 only)        |
| Offset = (N-1)*39 + 33 | C01     | C00     |                                       |
| Offset = (N-1)*39 + 34 | C03     | C02     | Failed update key changes (SAv5 only) |
| Offset = (N-1)*39 + 35 | C01     | C00     |                                       |
| Offset = (N-1)*39 + 36 | C03     | C02     | Re-keys due to restart (SAv5 only)    |
| Offset = (N-1)*39 + 37 | C01     | C00     |                                       |
| Offset = (N-1)*39 + 38 | C03     | C02     | Reserved 0                            |
| Offset = (N-1)*39 + 39 | C01     | C00     | Reserved 1                            |

## Clock Diagnostic

| Address     | MS Byte          | LS Byte                                                      | Comments                                 |
|-------------|------------------|--------------------------------------------------------------|------------------------------------------|
| Offset      |                  |                                                              | Number of entries                        |
| Offset + 01 | MS Byte reserved | LS Byte clock status<br>1: Synchronized<br>0: Unsynchronized | Clock status                             |
| Offset + 02 | C03              | C02                                                          | Current time                             |
| Offset + 03 | C01              | C00                                                          |                                          |
| Offset + 04 | C01              | C00                                                          | Current date                             |
| Offset + 05 |                  |                                                              | Reserved                                 |
| Offset + 06 | C03              | C02                                                          | Time zone                                |
| Offset + 07 | C01              | C00                                                          |                                          |
| Offset + 08 | C03              | C02                                                          | Time of last time synchronization        |
| Offset + 09 | C01              | C00                                                          |                                          |
| Offset + 10 | C01              | C00                                                          | Date of last time synchronization        |
| Offset + 11 |                  |                                                              | Reserved                                 |
| Offset + 12 | MS Byte reserved | LS Byte time source<br>1: SNTP<br>2: DNP3                    | Time source of last time synchronization |

## SNMP Diagnostic

| Address | MS Byte | LS Byte | Comments                                                                                       |
|---------|---------|---------|------------------------------------------------------------------------------------------------|
| Offset  | MS Byte | LS Byte | SNMP_service<br>0: Service not operating normally<br>1: Service operating normally or disabled |

## Web Service Diagnostic

| Address | MS Byte | LS Byte | Comments                                                                                      |
|---------|---------|---------|-----------------------------------------------------------------------------------------------|
| Offset  | MS Byte | LS Byte | Web_service<br>0: Service not operating normally<br>1: Service operating normally or disabled |

## LLDP Service Diagnostic

| Address | MS Byte | LS Byte | Comments                                                                                                                           |
|---------|---------|---------|------------------------------------------------------------------------------------------------------------------------------------|
| Offset  | MS Byte | LS Byte | LLDP_service status<br>FW_upgrade service status<br>0: Service not operating normally<br>1: Service operating normally or disabled |

## Firmware Upgrade Service Diagnostic

| Address | MS Byte | LS Byte | Comments                                                                                                    |
|---------|---------|---------|-------------------------------------------------------------------------------------------------------------|
| Offset  | MS Byte | LS Byte | FW_upgrade service status<br>0: Service not operating normally<br>1: Service operating normally or disabled |

## Syslog Service Diagnostic

| Address | MS Byte | LS Byte | Comments                                                                                                                                                                                                                                               |
|---------|---------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Offset  | MS Byte | LS Byte | MS Byte:<br>Syslog service status:<br>0: Syslog service not operating normally<br>1: Syslog service operating normally or disabled<br>LS Byte:<br>Syslog server not reachable:<br>1: No acknowledgment received from the syslog server<br>0: Otherwise |

## SD Service Diagnostic

| Address | MS Byte | LS Byte | Comments                                                          |
|---------|---------|---------|-------------------------------------------------------------------|
| Offset  | MS Byte | LS Byte | SD status:<br>0: SD card missing or unusable<br>1: SD card normal |

## IP Address Status Diagnostic

| Address | MS Byte | LS Byte | Comments                                                               |
|---------|---------|---------|------------------------------------------------------------------------|
| Offset  | MS Byte | LS Byte | IP address status:<br>0: Duplicate or no IP<br>1: Normal IP configured |

## HSBY Diagnostic

| Address     | MS Byte                        | LS Byte                        | Comments                                                                                                                                                                                                |
|-------------|--------------------------------|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Offset      | MS Byte<br>HSBY function state | LS Byte<br>HSBY service        | HSBY function:<br>0: Disabled<br>1: Enabled<br><br>(If it is disabled, other diagnostic data are all zero; the web page will not show HSBY diagnostics.)<br><br>HSBY Service:<br>0: FAULT<br>1: Running |
| Offset + 01 | MS Byte<br>Sync Status         | LS Byte<br>Internal HSBY state | Sync Status:<br>0: In progress<br>1: OK<br><br>Internal HSBY state:<br>0: Init<br>1: Link established<br>2: Reserved<br>3: Integrity<br>4: Wait Sync<br>5: Synced (not shown on the web page)           |
| Offset + 02 | MS Byte<br>Partner validity    | LS Byte reserved               | Partner validity:<br>0: Not reachable<br>1: OK                                                                                                                                                          |
| Offset + 03 | Bit 31 - Bit 24                | Bit 23 - Bit 16                | Error code                                                                                                                                                                                              |
| Offset + 04 | Bit 15 - Bit 8                 | Bit 7 - Bit 0                  | Bit 0: Firmware mismatch<br>Bit 1: DTM config mismatch<br>Bit 2: Security mode mismatch<br>Bit 3: Certification error<br>Bit 4: CS config mismatch (reserved)<br>Bit 5-31: Reserved                     |
| Offset + 05 | C03                            | C02                            | Sync Counter                                                                                                                                                                                            |
| Offset + 06 | C01                            | C00                            |                                                                                                                                                                                                         |
| Offset + 07 | C03                            | C02                            | Time of last time synchronization                                                                                                                                                                       |
| Offset + 08 | C01                            | C00                            |                                                                                                                                                                                                         |
| Offset + 09 | C01                            | C00                            | Date of last time synchronization                                                                                                                                                                       |
| Offset + 10 | C01                            | C00                            | Reserved                                                                                                                                                                                                |
| Offset + 11 | C03                            | C02                            | HSBY input packets                                                                                                                                                                                      |
| Offset + 12 | C01                            | C00                            |                                                                                                                                                                                                         |

| Address     | MS Byte                | LS Byte                  | Comments                                              |
|-------------|------------------------|--------------------------|-------------------------------------------------------|
| Offset + 13 | C03                    | C02                      | HSBY input error packets                              |
| Offset + 14 | C01                    | C00                      |                                                       |
| Offset + 15 | C03                    | C02                      | HSBY output packets                                   |
| Offset + 16 | C01                    | C00                      |                                                       |
| Offset + 17 | C03                    | C02                      | HSBY output error packets                             |
| Offset + 18 | C01                    | C00                      |                                                       |
| Offset + 19 | IP 1                   | IP 2                     | Local IP address                                      |
| Offset + 20 | IP 3                   | IP 4                     |                                                       |
| Offset + 21 | C03<br>Reserved        | C02<br>Major version     | Local FW version                                      |
| Offset + 22 | C01<br>Minor version   | C00<br>Internal revision |                                                       |
| Offset + 23 | MS Byte<br>Remote Role | LS Byte<br>Reserved      | Local role:<br>0: Unknown<br>1: Primary<br>2: Standby |
| Offset + 24 | C1                     | C0                       | Reserved                                              |
| Offset + 25 | C1                     | C0                       | Reserved                                              |
| Offset + 26 | IP 1                   | IP 2                     | Remote IP address                                     |
| Offset + 27 | IP 3                   | IP 4                     |                                                       |
| Offset + 28 | C03<br>Reserved        | C02<br>Major version     | Remote FW version                                     |
| Offset + 29 | C01<br>Minor version   | C00<br>Internal revision |                                                       |
| Offset + 30 | MS Byte<br>Remote Role | LS<br>Byte Reserved      | Remote role:<br>0: Primary<br>1: Standby              |
| Offset + 31 | C01                    | C00                      | Reserved                                              |
| Offset + 32 | C01                    | C00                      | Reserved                                              |
| Offset + 33 | C01                    | C00                      | Reserved                                              |
| Offset + 34 | C01                    | C00                      | Reserved                                              |

## Datalogging Service Diagnostic

| Address    | MS Byte | LS Byte | Comments                                                                  |
|------------|---------|---------|---------------------------------------------------------------------------|
| Offset + 0 | MB Byte | LS Byte | Configured table count:<br>0: Service disabled, otherwise service running |
| Offset + 1 | MS Byte | LS Byte | Enabled table count                                                       |
| Offset + 2 | C03     | C02     | SD card free space in byte                                                |
| Offset + 3 | C01     | C00     |                                                                           |
| Offset + 4 | Char 1  | Char 0  | Table name, up to 32 characters include ending null character             |
| Offset + 5 | Char 3  | Char 2  |                                                                           |
| Offset + 6 | Char 5  | Char 4  |                                                                           |
| Offset + 7 | Char 7  | Char 6  |                                                                           |

| Address                         | MS Byte | LS Byte | Comments                                                                                                                                |
|---------------------------------|---------|---------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Offset + 8                      | Char 9  | Char 8  |                                                                                                                                         |
| Offset + 9                      | Char 11 | Char 10 |                                                                                                                                         |
| Offset + 10                     | Char 13 | Char 12 |                                                                                                                                         |
| Offset + 11                     | Char 15 | Char 14 |                                                                                                                                         |
| Offset + 12                     | Char 17 | Char 16 |                                                                                                                                         |
| Offset + 13                     | Char 19 | Char 18 |                                                                                                                                         |
| Offset + 14                     | Char 21 | Char 20 |                                                                                                                                         |
| Offset + 15                     | Char 23 | Char 22 |                                                                                                                                         |
| Offset + 16                     | Char 25 | Char 24 |                                                                                                                                         |
| Offset + 17                     | Char 27 | Char 26 |                                                                                                                                         |
| Offset + 18                     | Char 29 | Char 28 |                                                                                                                                         |
| Offset + 19                     | Char 31 | Char 30 |                                                                                                                                         |
| Offset + 20                     | MS Byte | LS Byte | Log status<br>0: No error<br>4: No memory space<br>5: Variable not available<br>6: Table filled<br>7: Transfer error<br>8: System error |
| Offset + 21                     | MS Byte | LS Byte | Backup status:<br>0: No error<br>1: No SD card<br>2: File system error<br>3: Not enough space in SD card<br>8: System error             |
| Offset + 22                     | Char 1  | Char 0  | Last backup time, fixed at 20 characters include ending null character.<br>In format: yyyy-mm-dd hh:mm:ss                               |
| Offset + 23                     | Char 3  | Char 2  |                                                                                                                                         |
| Offset + 24                     | Char 5  | Char 4  |                                                                                                                                         |
| Offset + 25                     | Char 7  | Char 6  |                                                                                                                                         |
| Offset + 26                     | Char 9  | Char 8  |                                                                                                                                         |
| Offset + 27                     | Char 11 | Char 10 |                                                                                                                                         |
| Offset + 28                     | Char 13 | Char 12 |                                                                                                                                         |
| Offset + 29                     | Char 15 | Char 14 |                                                                                                                                         |
| Offset + 30                     | Char 17 | Char 16 |                                                                                                                                         |
| Offset + 31                     | Char 19 | Char 18 |                                                                                                                                         |
| Offset + 32                     | MS Byte | LS Byte | Records count in RAM                                                                                                                    |
| Offset + 33                     | MS Byte | LS Byte | Backup count in SD                                                                                                                      |
| Offset + 34 to<br>Offset + 63   |         |         | Same structure with table 0                                                                                                             |
| Offset + 64 to<br>Offset + 93   |         |         | Same structure with table 0                                                                                                             |
| Offset + 94 to<br>Offset + 123  |         |         | Same structure with table 0                                                                                                             |
| Offset + 124 to<br>Offset + 153 |         |         | Same structure with table 0                                                                                                             |
| Offset + 154 to<br>Offset + 183 |         |         | Same structure with table 0                                                                                                             |

| Address                         | MS Byte | LS Byte | Comments                    |
|---------------------------------|---------|---------|-----------------------------|
| Offset + 184 to<br>Offset + 213 |         |         | Same structure with table 0 |
| Offset + 214 to<br>Offset + 243 |         |         | Same structure with table 0 |
| Offset + 244 to<br>Offset + 273 |         |         | Same structure with table 0 |
| Offset + 274 to<br>Offset + 303 |         |         | Same structure with table 0 |

## Modbus Function Code 8, Sub-Function Code 21

### Get Status Summary (Op Code 0x76)

This function returns information about the LEDs and various services running on the BMENOR2200H module.

### Request

| Field                 | Length (bytes) | Value (hex) |
|-----------------------|----------------|-------------|
| Function code         | 1              | 08          |
| Sub-function code hi  | 1              | 00          |
| Sub-function code low | 1              | 15          |
| Operation code hi     | 1              | 00          |
| Operation code low    | 1              | 76          |

### Response

| Field                        | Length (bytes) | Value (hex)                                                                                           |
|------------------------------|----------------|-------------------------------------------------------------------------------------------------------|
| <b>Function code</b>         | <b>1</b>       | <b>08</b>                                                                                             |
| <b>Sub-function code hi</b>  | <b>1</b>       | <b>00</b>                                                                                             |
| <b>Sub-function code low</b> | <b>1</b>       | <b>15</b>                                                                                             |
| <b>Operation code hi</b>     | <b>1</b>       | <b>00</b>                                                                                             |
| <b>Operation code low</b>    | <b>1</b>       | <b>76</b>                                                                                             |
| <b>Byte count</b>            | <b>1</b>       | <b>206</b>                                                                                            |
| <b>Number of LEDs</b>        | <b>2</b>       | <b>7</b>                                                                                              |
| LED 1 color                  | 2              | Off (default): byte0=0, byte1=0<br>On (green): byte0=1, byte1=0<br>Flashing (green): byte0=1, byte1=1 |
| LED 1 status                 | 2              | 0                                                                                                     |
| LED 1 name string            | 4              | RUN                                                                                                   |
| LED 2 color                  | 2              | Off (default): byte0=0<br>On (red): byte0=2, byte 1=0<br>Flashing (red): byte0=2, byte1=1             |
| LED 2 status                 | 2              | 0                                                                                                     |
| LED 2 name string            | 4              | ERR                                                                                                   |
| LED 3 color                  | 2              | Off (default): byte0=0, byte1=0<br>On (red): byte0=2, byte1=0                                         |

| Field                        | Length (bytes) | Value (hex)                                                                                                                         |
|------------------------------|----------------|-------------------------------------------------------------------------------------------------------------------------------------|
| <b>Function code</b>         | <b>1</b>       | <b>08</b>                                                                                                                           |
| <b>Sub-function code hi</b>  | <b>1</b>       | <b>00</b>                                                                                                                           |
| <b>Sub-function code low</b> | <b>1</b>       | <b>15</b>                                                                                                                           |
| <b>Operation code hi</b>     | <b>1</b>       | <b>00</b>                                                                                                                           |
| <b>Operation code low</b>    | <b>1</b>       | <b>76</b>                                                                                                                           |
| <b>Byte count</b>            | <b>1</b>       | <b>206</b>                                                                                                                          |
| LED 3 status                 | 2              | 0                                                                                                                                   |
| LED 3 name string            | 3              | DL                                                                                                                                  |
| LED 4 color                  | 2              | Off (default): byte0=0, byte1=0<br>On (green): byte0=1, byte1=0<br>Flashing (green): byte0=1, byte1=1<br>On (red): byte0=2, byte1=0 |
| LED 4 status                 | 2              | 0                                                                                                                                   |
| LED 4 name string            | 8              | ETH STS                                                                                                                             |
| LED 5 color                  | 2              | Off (default): byte0=0, byte1=0<br>On (red): byte0=2, byte1=0                                                                       |
| LED 5 status                 | 2              | 0                                                                                                                                   |
| LED 5 name string            | 9              | CARD ERR                                                                                                                            |
| LED 6 color                  | 2              | Off (default): byte0=0, byte1=0<br>On (green): byte0=1, byte1=0<br>On (red): byte0=2, byte1=0                                       |
| LED 6 status                 | 2              | 0                                                                                                                                   |
| LED 6 name string            | 7              | SECURE                                                                                                                              |
| LED 7 color                  | 2              | Off (default): byte0=0, byte1=0<br>Flashing (yellow): byte0=3, byte1=1                                                              |
| LED 7 status                 | 2              | 0                                                                                                                                   |
| LED 7 name string            | 8              | SER COM                                                                                                                             |
| <b>Number of services</b>    | <b>2</b>       | <b>9</b>                                                                                                                            |
| Service 1 color              | 2              | 0 = off or n/a<br>1 = green<br>2 = red                                                                                              |
| Service 1 status             | 2              | 4 (corresponds to LED color 0) (default)<br>2 (corresponds to LED color 1)<br>5 (corresponds to LED color 2)                        |
| Service 1 name string        | 12             | DNP3 Client                                                                                                                         |
| Service 2 color              | 2              | 0 = off or n/a<br>1 = green<br>2 = red                                                                                              |
| Service 2 status             | 2              | 4 (corresponds to LED color 0) (default)<br>2 (corresponds to LED color 1)<br>5 (corresponds to LED color 2)                        |
| Service 2 name string        | 11             | IEC Client                                                                                                                          |
| Service 3 color              | 2              | 0 = off (default)<br>1 = green                                                                                                      |

| Field                 | Length (bytes) | Value (hex)                                                                                                                            |
|-----------------------|----------------|----------------------------------------------------------------------------------------------------------------------------------------|
| Function code         | 1              | 08                                                                                                                                     |
| Sub-function code hi  | 1              | 00                                                                                                                                     |
| Sub-function code low | 1              | 15                                                                                                                                     |
| Operation code hi     | 1              | 00                                                                                                                                     |
| Operation code low    | 1              | 76                                                                                                                                     |
| Byte count            | 1              | 206                                                                                                                                    |
| Service 3 status      | 2              | 1 (corresponds to LED color 1)<br>3 (corresponds to LED color 0) (default)                                                             |
| Service 3 name string | 12             | DNP3 Server                                                                                                                            |
| Service 4 color       | 2              | 0 = off (default)<br>1 = green                                                                                                         |
| Service 4 status      | 2              | 1 (corresponds to LED color 1)<br>3 (corresponds to LED color 0) (default)                                                             |
| Service 4 name string | 11             | IEC Server                                                                                                                             |
| Service 5 color       | 2              | 0 = off (default)<br>1 = green                                                                                                         |
| Service 5 status      | 2              | 1 (corresponds to LED color 1)<br>3 (corresponds to LED color 0) (default)                                                             |
| Service 5 name string | 15             | Access Control                                                                                                                         |
| Service 6 color       | 2              | 0 = off (default)<br>1 = on green<br>2 = on red                                                                                        |
| Service 6 status      | 2              | 4 (corresponds to LED color 0) (default)<br>2 (corresponds to LED color 1)<br>5 (corresponds to LED color 2 - link to server is down)) |
| Service 6 name string | 12             | SNTP Status                                                                                                                            |
| Service 7 color       | 2              | 0 = off (default)<br>1 = on green<br>2 = on red                                                                                        |
| Service 7 status      | 2              | 4 (corresponds to LED color 0) (default)<br>2 (corresponds to LED color 1)<br>5 (corresponds to LED color 2 - link to server is down)) |
| Service 7 name string | 14             | E-mail Status                                                                                                                          |
| Service 8 color       | 2              | 0 = off (default)<br>1 = green                                                                                                         |
| Service 8 status      | 2              | 1 (corresponds to LED color 1)<br>3 (corresponds to LED color 0) (default)                                                             |
| Service 8 name string | 14             | Modbus Server                                                                                                                          |
| Service 9 color       | 2              | 0 = off (default)<br>1 = green                                                                                                         |

| Field                 | Length (bytes) | Value (hex)                                                                |
|-----------------------|----------------|----------------------------------------------------------------------------|
| Function code         | 1              | 08                                                                         |
| Sub-function code hi  | 1              | 00                                                                         |
| Sub-function code low | 1              | 15                                                                         |
| Operation code hi     | 1              | 00                                                                         |
| Operation code low    | 1              | 76                                                                         |
| Byte count            | 1              | 206                                                                        |
| Service 9 status      | 2              | 1 (corresponds to LED color 1)<br>3 (corresponds to LED color 0) (default) |
| Service 9 name string | 12             | FTP Server                                                                 |

## LED Status

Refer to the [Module LED Indicators](#) topic, page 19 for LED descriptions.

| LED Status Number (hex) | Description                                                           |
|-------------------------|-----------------------------------------------------------------------|
| 1                       | Ready for operation.                                                  |
| 2                       | Not ready for operation.                                              |
| 3                       | Fault detected.                                                       |
| 4                       | No fault detected.                                                    |
| 5                       | In operation.                                                         |
| 6                       | Duplicate IP address.                                                 |
| 7                       | Waiting for address server response.                                  |
| 8                       | Default IP address in use.                                            |
| 9                       | IP address configuration conflict detected.                           |
| A                       | Not configured.                                                       |
| B                       | Recoverable fault detected.                                           |
| C                       | Connectors established.                                               |
| D                       | No EtherNet/IP or RTU connections.                                    |
| E                       | Connections error.                                                    |
| F                       | Running.                                                              |
| 10                      | Error present.                                                        |
| 11                      | Ethernet link established.                                            |
| 12                      | No Ethernet link established.                                         |
| 13                      | Connected to 100 Mbps link.                                           |
| 14                      | Not connected to 100 Mbps link.                                       |
| 15                      | Connected to full duplex link.                                        |
| 16                      | Not connected to full duplex line.                                    |
| 17                      | Configuration error.                                                  |
| 18                      | Memory card is missing.                                               |
| 19                      | Memory card is not usable (bad format, unrecognized type).            |
| 20                      | Data exchange (send/receive) on the serial connection is in progress. |
| 21                      | No data exchange on the serial connection.                            |
| 22                      | Firmware download in progress.                                        |
| 23                      | Firmware download not in progress.                                    |

| LED Status Number (hex) | Description                                        |
|-------------------------|----------------------------------------------------|
| 24                      | Module and communication are secure.               |
| 25                      | Module is secure, and communication is not secure. |
| 26                      | Module is not secure.                              |

## Services Status

| Service Status Number | Description                     |
|-----------------------|---------------------------------|
| 1                     | Enabled.                        |
| 2                     | Working properly.               |
| 3                     | Disabled.                       |
| 4                     | Not configured.                 |
| 5                     | One connection or more are bad. |
| 6                     | Enabled on.                     |
| 7                     | Enabled off.                    |

## Get Firmware Version (Op Code 0x70)

This function returns the firmware version of the BMENOR2200H module.

## Request

| Field                 | Length (bytes) | Value (hex) |
|-----------------------|----------------|-------------|
| Function code         | 1              | 08          |
| Sub-function code hi  | 1              | 00          |
| Sub-function code low | 1              | 15          |
| Operation code hi     | 1              | 00          |
| Operation code low    | 1              | 70          |

## Response

| Field                 | Length (bytes) | Value (hex)       |
|-----------------------|----------------|-------------------|
| Function code         | 1              | 08                |
| Sub-function code hi  | 1              | 00                |
| Sub-function code low | 1              | 15                |
| Operation code hi     | 1              | 00                |
| Operation code low    | 1              | 70                |
| Byte count            | 1              |                   |
| PV version            | 1              | xx                |
| RL version            | 1              | xx                |
| SV major version      | 1              | xx                |
| SV minor version      | 1              | xx                |
| Web server version    | 1              | xx                |
| Rack                  | 1              | xx                |
| Slot                  | 1              | xx                |
| MAC                   | 6              | xx.xx.xx.xx.xx.xx |
| SN                    | n              | xxxxxxxxxx        |

# Detected Error Codes

## What's in This Chapter

Explicit Messaging: Communication and Operation Reports ..... 213

## Overview

This chapter contains a list of codes that describe the status of Ethernet communication module messages.

## Explicit Messaging: Communication and Operation Reports

### Overview

Communication and operation reports are part of the management parameters.

**NOTE:** It is recommended that communication function reports be tested at the end of their execution and before the next activation. On cold start-up, confirm that all communication function management parameters are checked and reset to 0.

It may be helpful to use the %S21 (see EcoStruxure™ Control Expert, System Bits and Words, Reference Manual) to examine the first cycle after a cold or warm start.

### Communication Report

This report is common to every explicit messaging function. It is significant when the value of the activity bit switches from 1 to 0. The reports with a value between 16#01 and 16#FE concern errors detected by the processor that executed the function.

The different values of this report are indicated in the following table:

| Value | Communication report (least significant byte)                                                                              |
|-------|----------------------------------------------------------------------------------------------------------------------------|
| 16#00 | Correct exchange                                                                                                           |
| 16#01 | Exchange stop on timeout                                                                                                   |
| 16#02 | Exchange stop on user request (CANCEL)                                                                                     |
| 16#03 | Incorrect address format                                                                                                   |
| 16#04 | Incorrect destination address                                                                                              |
| 16#05 | Incorrect management parameter format                                                                                      |
| 16#06 | Incorrect specific parameters                                                                                              |
| 16#07 | Error detected in sending to the destination                                                                               |
| 16#08 | Reserved                                                                                                                   |
| 16#09 | Insufficient receive buffer size                                                                                           |
| 16#0A | Insufficient send buffer size                                                                                              |
| 16#0B | No system resources: the number of simultaneous communication EFs exceeds the maximum that can be managed by the processor |
| 16#0C | Incorrect exchange number                                                                                                  |
| 16#0D | No telegram received                                                                                                       |
| 16#0E | Incorrect length                                                                                                           |
| 16#0F | Telegram service not configured                                                                                            |

| Value | Communication report (least significant byte) |
|-------|-----------------------------------------------|
| 16#10 | Network module missing                        |
| 16#11 | Request missing                               |
| 16#12 | Application server already active             |
| 16#13 | UNI-TE V2 transaction number incorrect        |
| 16#FF | Message refused                               |

**NOTE:** The function can detect a parameter error before activating the exchange. In this case the activity bit remains at 0, and the report is initialized with values corresponding to the detected error.

## Operation Report

This report byte is specific to each function, and specifies the result of the operation on the remote application:

| Value                                                     | Operation report (most significant byte)                                                                                                                                                                                                 |
|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 16#05                                                     | Length mismatch (CIP)                                                                                                                                                                                                                    |
| 16#07                                                     | Bad IP address                                                                                                                                                                                                                           |
| 16#08                                                     | Application error                                                                                                                                                                                                                        |
| 16#09                                                     | Network is down                                                                                                                                                                                                                          |
| 16#0A                                                     | Connection reset by peer                                                                                                                                                                                                                 |
| 16#0C                                                     | Communication function not active                                                                                                                                                                                                        |
| 16#0D                                                     | <ul style="list-style-type: none"> <li>Modbus TCP: transaction timed out</li> <li>EtherNet/IP: request timeout</li> </ul>                                                                                                                |
| 16#0F                                                     | No route to remote host                                                                                                                                                                                                                  |
| 16#13                                                     | Connection refused                                                                                                                                                                                                                       |
| 16#15                                                     | <ul style="list-style-type: none"> <li>Modbus TCP: no resources</li> <li>EtherNet/IP: no resources to handle the message; or an internal detected error; or no buffer available; or no link available; or cannot send message</li> </ul> |
| 16#16                                                     | Remote address not allowed                                                                                                                                                                                                               |
| 16#18                                                     | <ul style="list-style-type: none"> <li>Modbus TCP: concurrent connections or transactions limit reached</li> <li>EtherNet/IP: TCP connection or encapsulation session in progress</li> </ul>                                             |
| 16#19                                                     | Connection timed out                                                                                                                                                                                                                     |
| 16#22                                                     | Modbus TCP: invalid response                                                                                                                                                                                                             |
| 16#23                                                     | Modbus TCP: invalid device ID response                                                                                                                                                                                                   |
| 16#30                                                     | <ul style="list-style-type: none"> <li>Modbus TCP: remote host is down</li> <li>EtherNet/IP: connection open timed out</li> </ul>                                                                                                        |
| 16#80...16#87: Forward_Open response detected errors:     |                                                                                                                                                                                                                                          |
| 16#80                                                     | Internal detected error                                                                                                                                                                                                                  |
| 16#81                                                     | Configuration detected error: the length of the explicit message, or the RPI rate, needs to be adjusted                                                                                                                                  |
| 16#82                                                     | Device detected error: target device does not support this service                                                                                                                                                                       |
| 16#83                                                     | Device resource detected error: no resource is available to open the connection                                                                                                                                                          |
| 16#84                                                     | System resource event: unable to reach the device                                                                                                                                                                                        |
| 16#85                                                     | Data sheet detected error: incorrect EDS file                                                                                                                                                                                            |
| 16#86                                                     | Invalid connection size                                                                                                                                                                                                                  |
| 16#90...16#9F: Register session response detected errors: |                                                                                                                                                                                                                                          |
| 16#90                                                     | Target device does not have sufficient resources                                                                                                                                                                                         |

| Value | Operation report (most significant byte)                      |
|-------|---------------------------------------------------------------|
| 16#98 | Target device does not recognize message encapsulation header |
| 16#9F | Unknown detected error from target                            |

# DNP3 Communication Detected Error Codes

## What's in This Chapter

DNP3 Communication Detected Error Codes ..... 216

## DNP3 Communication Detected Error Codes

### DNP3 Detected Error Codes

| Detected Error Code | Description                                  |
|---------------------|----------------------------------------------|
| 0x0000              | No detected error                            |
| 0x0001              | Security not configured                      |
| 0x0002              | Unlocated variable initialize detected error |
| 0x0004              | Internal detected error                      |
| 0x0008              | Detected authentication failure              |
| 0x0010              | Unexpected response                          |
| 0x0020              | No response                                  |
| 0x0040              | Aggressive mode not supported                |
| 0x0080              | MAC algorithm not supported                  |
| 0x0100              | Key Wrap algorithm not supported             |
| 0x0200              | Detected authorization failure               |
| 0x0400              | Update key change method not permitted       |
| 0x0800              | Invalid signature                            |
| 0x1000              | Invalid certification data                   |
| 0x2000              | Unknown user                                 |
| 0x4000              | Max session key status requests exceed       |
| 0x8000              | TLS error                                    |

# Open SSL/TLS Detected Error Codes

## What's in This Chapter

Open SSL/TLS Detected Error Codes..... 217

## Introduction

This chapter describes the Open SSL/TLS error codes that can be detected in an M580 system with a BMENOR2200H RTU module.

## Open SSL/TLS Detected Error Codes

### Detected Error Codes

| Detected Error                                      | Code |
|-----------------------------------------------------|------|
| SSL_R_APP_DATA_IN_HANDSHAKE                         | 100  |
| SSL_R_ATTEMPT_TO_REUSE_SESSION_IN_DIFFERENT_CONTEXT | 272  |
| SSL_R_BAD_ALERT_RECORD                              | 101  |
| SSL_R_BAD_AUTHENTICATION_TYPE                       | 102  |
| SSL_R_BAD_CHANGE_CIPHER_SPEC                        | 103  |
| SSL_R_BAD_CHECKSUM                                  | 104  |
| SSL_R_BAD_DATA                                      | 390  |
| SSL_R_BAD_DATA_RETURNED_BY_CALLBACK                 | 106  |
| SSL_R_BAD_DECOMPRESSION                             | 107  |
| SSL_R_BAD_DH_G_LENGTH                               | 108  |
| SSL_R_BAD_DH_G_VALUE                                | 375  |
| SSL_R_BAD_DH_PUB_KEY_LENGTH                         | 109  |
| SSL_R_BAD_DH_PUB_KEY_VALUE                          | 393  |
| SSL_R_BAD_DH_P_LENGTH                               | 110  |
| SSL_R_BAD_DH_P_VALUE                                | 395  |
| SSL_R_BAD_DIGEST_LENGTH                             | 111  |
| SSL_R_BAD_DSA_SIGNATURE                             | 112  |
| SSL_R_BAD_ECC_CERT                                  | 304  |
| SSL_R_BAD_ECDSA_SIGNATURE                           | 305  |
| SSL_R_BAD_ECPOINT                                   | 306  |
| SSL_R_BAD_HANDSHAKE_LENGTH                          | 332  |
| SSL_R_BAD_HELLO_REQUEST                             | 105  |
| SSL_R_BAD_LENGTH                                    | 271  |
| SSL_R_BAD_MAC_DECODE                                | 113  |
| SSL_R_BAD_MAC_LENGTH                                | 333  |
| SSL_R_BAD_MESSAGE_TYPE                              | 114  |
| SSL_R_BAD_PACKET_LENGTH                             | 115  |
| SSL_R_BAD_PROTOCOL_VERSION_NUMBER                   | 116  |
| SSL_R_BAD_PSK_IDENTITY_HINT_LENGTH                  | 316  |

| Detected Error                                | Code |
|-----------------------------------------------|------|
| SSL_R_BAD_RESPONSE_ARGUMENT                   | 117  |
| SSL_R_BAD_RSA_DECRYPT                         | 118  |
| SSL_R_BAD_RSA_ENCRYPT                         | 119  |
| SSL_R_BAD_RSA_E_LENGTH                        | 120  |
| SSL_R_BAD_RSA_MODULUS_LENGTH                  | 121  |
| SSL_R_BAD_RSA_SIGNATURE                       | 122  |
| SSL_R_BAD_SIGNATURE                           | 123  |
| SSL_R_BAD_SRP_A_LENGTH                        | 347  |
| SSL_R_BAD_SRP_B_LENGTH                        | 348  |
| SSL_R_BAD_SRP_G_LENGTH                        | 349  |
| SSL_R_BAD_SRP_N_LENGTH                        | 350  |
| SSL_R_BAD_SRP_PARAMETERS                      | 371  |
| SSL_R_BAD_SRP_S_LENGTH                        | 351  |
| SSL_R_BAD_SRTP_MKI_VALUE                      | 352  |
| SSL_R_BAD_SRTP_PROTECTION_PROFILE_LIST        | 353  |
| SSL_R_BAD_SSL_FILETYPE                        | 124  |
| SSL_R_BAD_SSL_SESSION_ID_LENGTH               | 125  |
| SSL_R_BAD_STATE                               | 126  |
| SSL_R_BAD_VALUE                               | 384  |
| SSL_R_BAD_WRITE_RETRY                         | 127  |
| SSL_R_BIO_NOT_SET                             | 128  |
| SSL_R_BLOCK_CIPHER_PAD_IS_WRONG               | 129  |
| SSL_R_BN_LIB                                  | 130  |
| SSL_R_CA_DN_TOO_LONG                          | 132  |
| SSL_R_CCS_RECEIVED_EARLY                      | 133  |
| SSL_R_CERTIFICATE_VERIFY_FAILED               | 134  |
| SSL_R_CERT_LENGTH_MISMATCH                    | 135  |
| SSL_R_CHALLENGE_IS_DIFFERENT                  | 136  |
| SSL_R_CIPHER_CODE_WRONG_LENGTH                | 137  |
| SSL_R_CIPHER_OR_HASH_UNAVAILABLE              | 138  |
| SSL_R_CIPHER_TABLE_SRC_ERROR                  | 139  |
| SSL_R_CLIENTHELLO_TLSEXT                      | 226  |
| SSL_R_COMPRESSED_LENGTH_TOO_LONG              | 140  |
| SSL_R_COMPRESSION_DISABLED                    | 343  |
| SSL_R_COMPRESSION_FAILURE                     | 141  |
| SSL_R_COMPRESSION_ID_NOT_WITHIN_PRIVATE_RANGE | 307  |
| SSL_R_COMPRESSION_LIBRARY_ERROR               | 142  |
| SSL_R_CONNECTION_ID_IS_DIFFERENT              | 143  |
| SSL_R_CONNECTION_TYPE_NOT_SET                 | 144  |
| SSL_R_COOKIE_MISMATCH                         | 308  |
| SSL_R_DATA_BETWEEN_CCS_AND_FINISHED           | 145  |
| SSL_R_DATA_LENGTH_TOO_LONG                    | 146  |

| Detected Error                            | Code |
|-------------------------------------------|------|
| SSL_R_DECRYPTION_FAILED                   | 147  |
| SSL_R_DECRYPTION_FAILED_OR_BAD_RECORD_MAC | 281  |
| SSL_R_DH_KEY_TOO_SMALL                    | 372  |
| SSL_R_DH_PUBLIC_VALUE_LENGTH_IS_WRONG     | 148  |
| SSL_R_DIGEST_CHECK_FAILED                 | 149  |
| SSL_R_DTLS_MESSAGE_TOO_BIG                | 334  |
| SSL_R_DUPLICATE_COMPRESSION_ID            | 309  |
| SSL_R_ECC_CERT_NOT_FOR_KEY_AGREEMENT      | 317  |
| SSL_R_ECC_CERT_NOT_FOR_SIGNING            | 318  |
| SSL_R_ECC_CERT_SHOULD_HAVE_RSA_SIGNATURE  | 322  |
| SSL_R_ECC_CERT_SHOULD_HAVE_SHA1_SIGNATURE | 323  |
| SSL_R_ECDH_REQUIRED_FOR_SUITEB_MODE       | 374  |
| SSL_R_ECGROUP_TOO_LARGE_FOR_CIPHER        | 310  |
| SSL_R_EMPTY_SRTP_PROTECTION_PROFILE_LIST  | 354  |
| SSL_R_ENCRYPTED_LENGTH_TOO_LONG           | 150  |
| SSL_R_ERROR_GENERATING_TMP_RSA_KEY        | 282  |
| SSL_R_ERROR_IN_RECEIVED_CIPHER_LIST       | 151  |
| SSL_R_EXCESSIVE_MESSAGE_SIZE              | 152  |
| SSL_R_EXTRA_DATA_IN_MESSAGE               | 153  |
| SSL_R_GOT_A_FIN_BEFORE_A_CCS              | 154  |
| SSL_R_GOT_NEXT_PROTO_BEFORE_A_CCS         | 355  |
| SSL_R_GOT_NEXT_PROTO_WITHOUT_EXTENSION    | 356  |
| SSL_R_HTTPS_PROXY_REQUEST                 | 155  |
| SSL_R_HTTP_REQUEST                        | 156  |
| SSL_R_ILLEGAL_PADDING                     | 283  |
| SSL_R_ILLEGAL_SUITEB_DIGEST               | 380  |
| SSL_R_INAPPROPRIATE_FALLBACK              | 373  |
| SSL_R_INCONSISTENT_COMPRESSION            | 340  |
| SSL_R_INVALID_CHALLENGE_LENGTH            | 158  |
| SSL_R_INVALID_COMMAND                     | 280  |
| SSL_R_INVALID_COMPRESSION_ALGORITHM       | 341  |
| SSL_R_INVALID_NULL_CMD_NAME               | 385  |
| SSL_R_INVALID_PURPOSE                     | 278  |
| SSL_R_INVALID_SERVERINFO_DATA             | 388  |
| SSL_R_INVALID_SRP_USERNAME                | 357  |
| SSL_R_INVALID_STATUS_RESPONSE             | 328  |
| SSL_R_INVALID_TICKET_KEYS_LENGTH          | 325  |
| SSL_R_INVALID_TRUST                       | 279  |
| SSL_R_KEY_ARG_TOO_LONG                    | 284  |
| SSL_R_KRB5                                | 285  |
| SSL_R_KRB5_C_CC_PRINC                     | 286  |
| SSL_R_KRB5_C_GET_CRED                     | 287  |

| Detected Error                   | Code |
|----------------------------------|------|
| SSL_R_KRB5_C_INIT                | 288  |
| SSL_R_KRB5_C_MK_REQ              | 289  |
| SSL_R_KRB5_S_BAD_TICKET          | 290  |
| SSL_R_KRB5_S_INIT                | 291  |
| SSL_R_KRB5_S_RD_REQ              | 292  |
| SSL_R_KRB5_S_TKT_EXPIRED         | 293  |
| SSL_R_KRB5_S_TKT_NYV             | 294  |
| SSL_R_KRB5_S_TKT_SKEW            | 295  |
| SSL_R_LENGTH_MISMATCH            | 159  |
| SSL_R_LENGTH_TOO_LONG            | 404  |
| SSL_R_LENGTH_TOO_SHORT           | 160  |
| SSL_R_LIBRARY_BUG                | 274  |
| SSL_R_LIBRARY_HAS_NO_CIPHERS     | 161  |
| SSL_R_MESSAGE_TOO_LONG           | 296  |
| SSL_R_MISSING_DH_DSA_CERT        | 162  |
| SSL_R_MISSING_DH_KEY             | 163  |
| SSL_R_MISSING_DH_RSA_CERT        | 164  |
| SSL_R_MISSING_DSA_SIGNING_CERT   | 165  |
| SSL_R_MISSING_ECDH_CERT          | 382  |
| SSL_R_MISSING_ECDSA_SIGNING_CERT | 382  |
| SSL_R_MISSING_EXPORT_TMP_DH_KEY  | 166  |
| SSL_R_MISSING_EXPORT_TMP_RSA_KEY | 167  |
| SSL_R_MISSING_RSA_CERTIFICATE    | 168  |
| SSL_R_MISSING_RSA_ENCRYPTIG_CERT | 169  |
| SSL_R_MISSING_RSA_SIGNING_CERT   | 170  |
| SSL_R_MISSING_SRP_PARAM          | 358  |
| SSL_R_MISSING_TMP_DH_KEY         | 171  |
| SSL_R_MISSING_TMP_ECDH_KEY       | 311  |
| SSL_R_MISSING_TMP_RSA_KEY        | 172  |
| SSL_R_MISSING_TMP_RSA_PKEY       | 173  |
| SSL_R_MISSING_VERIFY_MESSAGE     | 174  |
| SSL_R_MULTIPLE_SGC_RESTARTS      | 346  |
| SSL_R_NON_SSLV2_INITIAL_PACKET   | 175  |
| SSL_R_NO_CERTIFICATES_RETURNED   | 176  |
| SSL_R_NO_CERTIFICATE_ASSIGNED    | 177  |
| SSL_R_NO_CERTIFICATE_RETURNED    | 178  |
| SSL_R_NO_CERTIFICATE_SET         | 179  |
| SSL_R_NO_CERTIFICATE_SPECIFIED   | 180  |
| SSL_R_NO_CIPHERS_AVAILABLE       | 181  |
| SSL_R_NO_CIPHERS_PASSED          | 182  |
| SSL_R_NO_CIPHERS_SPECIFIED       | 183  |
| SSL_R_NO_CIPHER_LIST             | 184  |

| Detected Error                                       | Code |
|------------------------------------------------------|------|
| SSL_R_NO_CIPHER_MATCH                                | 185  |
| SSL_R_NO_CLIENT_CERT_METHOD                          | 331  |
| SSL_R_NO_CLIENT_CERT_RECEIVED                        | 186  |
| SSL_R_NO_COMPRESSION_SPECIFIED                       | 187  |
| SSL_R_NO_GOST_CERTIFICATE_SENT_BY_PEER               | 330  |
| SSL_R_NO_METHOD_SPECIFIED                            | 188  |
| SSL_R_NO_PEM_EXTENSIONS                              | 389  |
| SSL_R_NO_PRIVATEKEY                                  | 189  |
| SSL_R_NO_PRIVATE_KEY_ASSIGNED                        | 190  |
| SSL_R_NO_PROTOCOLS_AVAILABLE                         | 191  |
| SSL_R_NO_PUBLICKEY                                   | 192  |
| SSL_R_NO_RENEGOTIATION                               | 339  |
| SSL_R_NO_REQUIRED_DIGEST                             | 324  |
| SSL_R_NO_SHARED_CIPHER                               | 193  |
| SSL_R_NO_SHARED_SIGNATURE_ALGORITHMS                 | 376  |
| SSL_R_NO_SRTP_PROFILES                               | 359  |
| SSL_R_NO_VERIFY_CALLBACK                             | 194  |
| SSL_R_NULL_SSL_CTX                                   | 195  |
| SSL_R_NULL_SSL_METHOD_PASSED                         | 196  |
| SSL_R_OLD_SESSION_CIPHER_NOT_RETURNED                | 197  |
| SSL_R_OLD_SESSION_COMPRESSION_ALGORITHM_NOT_RETURNED | 344  |
| SSL_R_ONLY_DTLS_1_2_ALLOWED_IN_SUITEB_MODE           | 387  |
| SSL_R_ONLY_TLS_1_2_ALLOWED_IN_FIPS_MODE              | 297  |
| SSL_R_OPAQUE_PRF_INPUT_TOO_LONG                      | 327  |
| SSL_R_PACKET_LENGTH_TOO_LONG                         | 198  |
| SSL_R_PARSE_TLSEXT                                   | 227  |
| SSL_R_PATH_TOO_LONG                                  | 270  |
| SSL_R_PEER_DID_NOT_RETURN_A_CERTIFICATE              | 199  |
| SSL_R_PEER_ERROR                                     | 200  |
| SSL_R_PEER_ERROR_CERTIFICATE                         | 201  |
| SSL_R_PEER_ERROR_NO_CERTIFICATE                      | 202  |
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# Firmware Version Compatibility

## What's in This Chapter

Firmware Version Compatibility ..... 226

## Introduction

This chapter describes the history of firmware versions for the BMENOR2200H module and their compatibility with Control Expert.

## Firmware Version Compatibility

### Compatibility

The following table describes the firmware versions of the BMENOR2200H module and their compatibility with Control Expert:

|                   | Control Expert 14.0 | Control Expert 15.0 |
|-------------------|---------------------|---------------------|
| SV 1.00 and later | Support             | Legacy feature only |
| SV 2.01 and later | NOK                 | Support             |

# Glossary

## B

### bridge:

A bridge device connects two or more physical networks that use the same protocol. Bridges read frames and decide whether to transmit or block them based on their destination address.

## D

### DFB:

(*derived function block*) DFB types are function blocks that can be defined by the user in ST, IL, LD or FBD language.

Using these DFB types in an application makes it possible to:

- simplify the design and entry of the program
- make the program easier to read
- make it easier to debug
- reduce the amount of code generated

### DTM:

(*device type manager*) A DTM is a device driver running on the host PC. It provides a unified structure for accessing device parameters, configuring and operating the devices, and troubleshooting devices. DTMs can range from a simple graphical user interface (GUI) for setting device parameters to a highly sophisticated application capable of performing complex real-time calculations for diagnosis and maintenance purposes. In the context of a DTM, a device can be a communications module or a remote device on the network.

See FDT.

## E

### EFB:

(*elementary function block*) This is a block used in a program which performs a predefined logical function.

EFBs have states and internal parameters. Even if the inputs are identical, the output values may differ. For example, a counter has an output indicating that the preselection value has been reached. This output is set to 1 when the current value is equal to the preselection value.

### EtherNet/IP™:

A network communication protocol for industrial automation applications that combines the standard internet transmission protocols of TCP/IP and UDP with the application layer common industrial protocol (CIP) to support both high speed data exchange and industrial control. EtherNet/IP employs electronic data sheets (EDS) to classify each network device and its functionality.

### Ethernet:

A LAN cabling and signaling specification used to connect devices within a defined area, e.g., a building. Ethernet uses a bus or a star topology to connect different nodes on a network.

## F

### FDR:

(*fast device replacement*) A service that uses configuration software to replace an inoperable product.

## G

### **gateway:**

A device that connects networks with dissimilar network architectures and which operates at the Application Layer of the OSI model. This term may refer to a router.

### **gateway:**

A gateway device interconnects two different networks, sometimes through different network protocols. When it connects networks based on different protocols, a gateway converts a datagram from one protocol stack into the other. When used to connect two IP-based networks, a gateway (also called a router) has two separate IP addresses, one on each network.

## H

### **Hot Standby:**

A Hot Standby system uses a primary PAC (PLC) and a standby PAC. The two PAC racks have identical hardware and software configurations. The standby PAC monitors the current system status of the primary PAC. If the primary PAC becomes inoperable, high-availability control is maintained when the standby PAC takes control of the system.

### **HTTP server:**

The installed HTTP server transmits Web pages between a server and a browser, providing Ethernet communications modules with easy access to devices anywhere in the world from standard browsers such as Internet Explorer or Netscape Navigator.

## I

### **IP address:**

*Internet protocol address.* This 32-bit address is assigned to hosts that use TCP/IP.

### **IP address:**

The 32-bit identifier, consisting of both a network address and a host address assigned to a device connected to a TCP/IP network.

## L

### **local rack:**

An M580 rack containing the CPU and a power supply. A local rack consists of one or two racks: the main rack and the extended rack, which belongs to the same family as the main rack. The extended rack is optional.

## M

### **MAC address:**

*media access control address.* A 48-bit number, unique on a network, that is programmed into each network card or device when it is manufactured.

### **MB/TCP:**

*(Modbus over TCP protocol)* This is a Modbus variant used for communications over TCP/IP networks.

## P

### **PLC:**

*programmable logic controller*. The PLC is the brain of an industrial manufacturing process. It automates a process as opposed to relay control systems. PLCs are computers suited to survive the harsh conditions of the industrial environment.

#### **port 502:**

TCP/IP reserves specific server ports for specific applications through IANA (Internet Assigned Numbers Authority). Modbus requests are sent to registered software port 502.

## **R**

#### **RIO network:**

An Ethernet-based network that contains 3 types of RIO devices: a local rack, an RIO drop, and a ConneXium extended dual-ring switch (DRS). Distributed equipment may also participate in an RIO network via connection to DRSs or BMENOS0300 network option switch modules.

#### **router:**

A router device connects two or more sections of a network and allows information to flow between them. A router examines every packet it receives and decides whether to block the packet from the rest of the network or transmit it. The router attempts to send the packet through the network on an efficient path.

## **S**

#### **SNMP agent:**

The SNMP application that runs on a network device.

#### **SNMP:**

*(simple network management protocol)* Protocol used in network management systems to monitor network-attached devices. The protocol is part of the internet protocol suite (IP) as defined by the internet engineering task force (IETF), which consists of network management guidelines, including an application layer protocol, a database schema, and a set of data objects.

#### **SNMP:**

*simple network management protocol*. The UDP/IP standard protocol used to monitor and manage devices on an IP network.

#### **SNTP:**

*(simple network time protocol)* See NTP.

#### **SOE:**

*(sequence of events)* SOE software helps users understand a chain of occurrences that can lead to unsafe process conditions and possible shutdowns. SOEs can be critical to resolving or preventing such conditions.

#### **subnet mask:**

The 32-bit value used to hide (or mask) the network portion of the IP address and thereby reveal the host address of a device on a network using the IP protocol.

#### **subnet mask:**

The subnet mask is a bit mask that identifies or determines which bits in an IP address correspond to the network address and which correspond to the subnet portions of the address. The subnet mask comprises the network address plus the bits reserved for identifying the subnetwork.

#### **subnet:**

The subnet is that portion of the network that shares a network address with the other parts of the network. A subnet may be physically or logically independent

from the rest of the network. A part of an Internet address called a subnet number, which is ignored in IP routing, distinguishes the subnet.

**switch:**

A network switch connects two or more separate network segments and allows traffic to be passed between them. A switch determines whether a frame should be blocked or transmitted based on its destination address.

## T

**Transparent Ready:**

Schneider Electric's Transparent Ready products (based on universal Ethernet TCP/IP and Web technologies) can be integrated into real-time, data sharing systems, with no need for interfaces.

## U

**UDP:**

*user datagram protocol*. UDP is an Internet communications protocol defined by IETF RFC 768. This protocol facilitates the direct transmission of datagrams on IP networks. UDP/IP messages do not expect a response, and are therefore ideal for applications in which dropped packets do not require retransmission (such as streaming video and networks that demand real-time performance).

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