

System Time Stamping

User Guide

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 are 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 document presents a PlantStruxure feature: at source system time stamping.

This guide presents detailed information about system time stamping, including the following:

- System time stamping architecture
- Design and configuration phases
- Commissioning and operation phases
- Interface with a 3rd party client SCADA interface

Validity Note

This document is valid from OFS V3.40, AVEVA Plant SCADA V7.30, and EcoStruxure™ Control Expert 14.1.

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/.

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.

Related Documents

| Title of Documentation | Reference Number |
|--|--|
| OPC Factory Server V3.50, User Manual | 35008244 (Eng), 35008244 (Fre), 35008244 (Ger) |
| AVEVA Plant SCADA User Guide | Supplied with AVEVA Plant SCADA installation files and installed with AVEVA Plant SCADA. |
| AVEVA Plant SCADA Help | Installed with AVEVA Plant SCADA. |
| Modicon X80, BMXERT1604T Time Stamp Module, User Guide | EIO0000001121 (English), EIO0000001122 (French), EIO0000001123 (German), EIO0000001125 (Italian), EIO0000001124 (Spanish), EIO0000001126 (Chinese) |
| EcoStruxure™ Control Expert, Applicative Time Stamping, User Guide | EIO0000001268 (English), EIO0000001702 (French), EIO0000001703 (German), EIO0000001705 (Italian), |

| Title of Documentation | Reference Number |
|--|--|
| | EIO0000001704 (Spanish), EIO0000001706 (Chinese) |
| Modicon M340 for Ethernet, Communications Modules and Processors, User Manual | 31007131 (English), 31007132 (French), 31007133 (German), 31007494 (Italian), 31007134 (Spanish), 31007493 (Chinese) |
| Modicon M340, BMX NOC 0401 Ethernet Communication Module, User Manual | S1A34009 (English), S1A34010 (French), S1A34011 (German), S1A34013 (Italian), S1A34012 (Spanish), S1A34014 (Chinese) |
| Modicon M580 Standalone, System Planning Guide for Frequently Used Architectures | HRB62666 (English), HRB65318 (French), HRB65319 (German), HRB65320 (Italian), HRB65321 (Spanish), HRB65322 (Chinese) |
| Modicon M580, Hardware, Reference Manual | EIO0000001578 (English), EIO0000001579 (French), EIO0000001580 (German), EIO0000001582 (Italian), EIO0000001581 (Spanish), EIO0000001583 (Chinese) |
| EcoStruxure™ Control Expert, System Bits and Words, Reference Manual | EIO0000002135 (English), EIO0000002136 (French), EIO0000002137 (German), EIO0000002138 (Italian), EIO0000002139 (Spanish), EIO0000002140 (Chinese) |
| EcoStruxure™ Control Expert, Operating Modes | 33003101 (English), 33003102 (French), 33003103 (German), 33003104 (Spanish), 33003696 (Italian), 33003697 (Chinese) |

You can download these technical publications and other technical information from our website at www.se.com/ww/en/download/ .

Introduction to System Time Stamping

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Introduction

This part introduces the concepts, solutions and limitations of system time stamping.

Presentation

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Concepts

Definition

The system time stamping provides a consistent SOE (sequence of events), time stamped at the source, in order to allow the user to analyze the source of abnormal behavior in a distributed automation system.

The SOE is displayed in an alarm summary or SOE page of a client (such as a SCADA).

Each source of time stamped event of the SOE is a discrete I/O value change (transition) detected by a time stamping module or an internal variable value change detected by a PLC.

The following graphic shows an example of AVEVA Plant SCADA SOE page display:

| Time | Millisec | Tag | Name | Message | Quality | TSQuality | Equipment | Custom1 |
|-------------|----------|------------------|--------------------|----------------------------------|---------|----------------|---------------|-------------------|
| 05:45:38 PM | 35 | PLC1Breaker1Fail | PLC1_Breaker1_Fail | PLC1Breaker1Fail – Alarm cleared | 2752 | Time Good | PLC1.Breaker1 | CRA1@10.176.18.53 |
| 05:44:09 PM | 900 | PLC1CRA1_SOEUnc | PLC1_CRA1_SOEUnc | PLC1CRA1_SOEUnc – Alarm cleared | 2752 | Time Good | PLC1.CRA1 | CRA1@10.176.18.53 |
| 05:44:03 PM | 968 | PLC1Breaker1Fail | PLC1_Breaker1_Fail | PLC1Breaker1Fail – Alarm raised | 7872 | Time Uncertain | PLC1.Breaker1 | CRA1@10.176.18.53 |
| 05:43:20 PM | 25 | PLC1Breaker1Fail | PLC1_Breaker1_Fail | PLC1Breaker1Fail – Alarm cleared | 7872 | Time Uncertain | PLC1.Breaker1 | CRA1@10.176.18.53 |
| 05:43:12 PM | 110 | PLC1CRA1_SOEUnc | PLC1_CRA1_SOEUnc | PLC1CRA1_SOEUnc – Alarm raised | 2752 | Time Good | PLC1.CRA1 | CRA1@10.176.18.53 |
| 05:42:55 PM | 609 | PLC1Breaker1Fail | PLC1_Breaker1_Fail | PLC1Breaker1Fail – Alarm raised | 2752 | Time Good | PLC1.Breaker1 | CRA1@10.176.18.53 |

Benefits

The system time stamping benefits are:

- No need for PLC programming.

- Direct communication between the time stamping modules and the client. If the time stamping modules are in a Modicon Quantum or M580 Ethernet I/O drop, the PLC communication bandwidth is not used.
- Consistency in the I/O values between the process (time stamping modules) and the client (SCADA).
- Advanced diagnostic functions:
 - Signalization of uncertain SOE (sequence during which some events may be lost) to the client.
 - Time quality information associated with each time stamped event.
- No loss of events in normal operating conditions:
 - A buffer is available to store the events in each time stamping module. The event storage is stopped when the buffer is full.
 - Rising and falling edges transitions are stored for each discrete I/O and PLC internal variables.
- Hot Standby configurations on the PLC and/or redundant SCADA are managed.

System Time Stamping Solution

System Time Stamping Versus Applicative Time Stamping

System time stamping: All in one solution to benefit from at source time stamping, easy to start up without requiring any user programming. This solution requires either the OFS or the BME NUA 0100 V2.0 product in the architecture.

Applicative time stamping: Solution recommended when a 3rd party SCADA that does not support OPC DA or OPC UA interfaces is required. In this case, events are read by function blocks in the PLC application (with Control Expert software) and the events read are formatted to be sent to the SCADA. For more details on the applicative mode, refer to the *EcoStruxure™ Control Expert, Applicative Time Stamping, User Guide*.

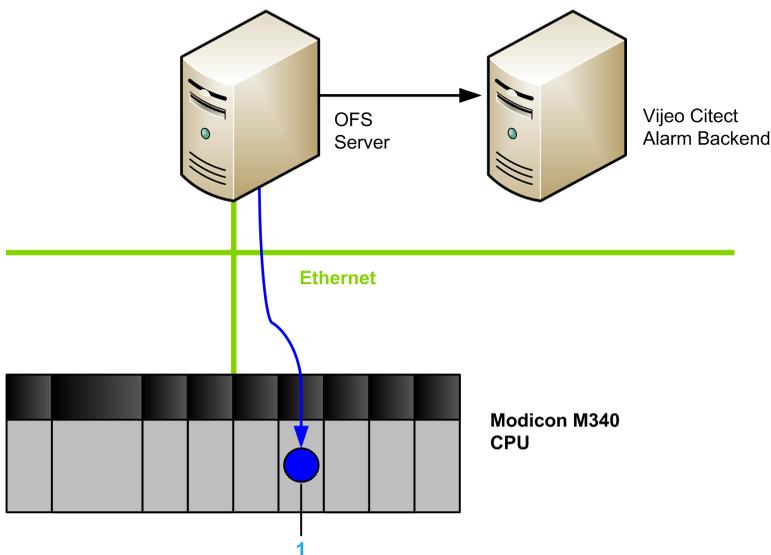
NOTE: System and applicative time stamping modes are exclusive in the same Control Expert application running in the PLC.

NOTE: Only the system time stamping mode allows Modicon M580 CPU internal variable time stamping.

NOTE: Time stamping with 140 ERT 854 •0 modules can be used in both applicative and system modes, but this topic is not discussed in this guide. For more details on those modules, refer to the *Quantum using EcoStruxure™ Control Expert, 140 ERT 854 10 Time Stamp Module, User Manual* and the *Quantum using EcoStruxure™ Control Expert, 140 ERT 854 20 Time Stamp Module, User Manual*.

Example of System Time Stamping Architecture

Example of system time stamping in a Modicon M340 local PLC with a BMX ERT 1604 T module:



1: BMX ERT 1604 T Module

System Time Stamping Limitations

System Limitations

- At source time stamped events online change service is not available.
- A maximum of 5000 internal variables are managed per Modicon M580 CPU.
- No selection of transition edges: Events detection is processed on both value change edges (rising and falling).

- A Modicon X80 Ethernet RIO drop supports up to 36 expert channels. A BMX ERT 1604 T module is counted as 4 expert channels.
- In a Modicon M340 local drop, the maximum number of BMX ERT 1604 T modules depends on the local drop CPU type. For more details, refer to *Modicon X80, BMXERT0604T Time Stamp Module, User Guide*, page 11.
- In an M580 application, the number of BMX ERT 1604 T modules per application is limited to 25.
- A maximum of 256 discrete I/Os are managed per BM• CRA 312 10 module.
- A maximum of 144 discrete inputs per Modicon M340 PLC (local drop) are managed. 128 discrete inputs can be managed by BMX P34 2000/2010/2020 processors.
- System time stamping solution does not support the CCOTF function.
- In a Modicon M580 safety project:
 - The SAFE task does not support time stamping of internal variables by the CPU.
 - The BM•CRA31210 adapter module can time stamp inputs and outputs of safety digital I/O modules located in remote I/O drops.
 - The M580P58••••S safety CPU cannot time stamp digital inputs and outputs of safety digital I/O modules located in the local rack.

System Constraints

- 2 OFS products, running on HMI and SCADA for example, cannot access simultaneously the same time stamping source. A reservation mechanism is implemented to avoid simultaneous access.
- A communication path between OFS and the time stamping sources is mandatory to manage at source time stamping solution. If routers are placed in the communication path, they have to be set accordingly.
- The system time stamping of internal variables requires the PLC must be configured in periodic mode (it is not possible to time stamp variables in cyclic mode).

Compatibility

- SCADA redundancy is compatible with system time stamping.

System Time Stamping Architecture

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Introduction

This part presents the list of system time stamping components, component versions, performances, and architecture examples.

Components

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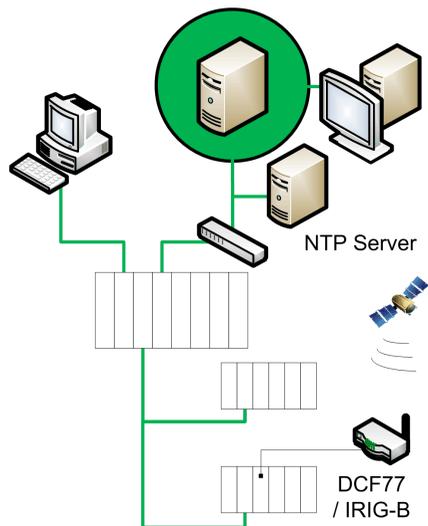
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Overview

This chapter presents the components involved in a system time stamping solution.

AVEVA Plant SCADA

AVEVA Plant SCADA in the System



AVEVA Plant SCADA Role

AVEVA Plant SCADA is the final client in a time stamping architecture. AVEVA Plant SCADA displays the sequence of events in an alarm viewer history or in an event viewer. It is the operating and monitoring component of Schneider Electric PlantStruxure™.

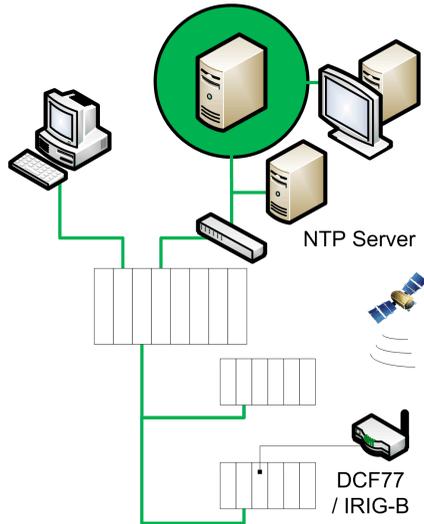
AVEVA Plant SCADA, with its powerful display capabilities and its operational features, delivers actionable insight faster, enabling operators to respond quickly to process disturbances, thereby increasing their efficiency.

AVEVA Plant SCADA offers the functions of a modern supervisor. Its distributed client-server architecture is applicable to a multitude of applications.

AVEVA Plant SCADA offers true redundancy for all the system components. Redundancy functions are fully integrated in the system.

3rd Party Client SCADA

3rd Party Client SCADA in the System



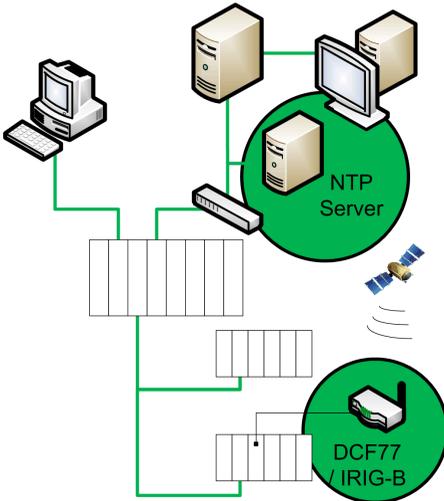
3rd Party Client SCADA Role

If the system does not have an AVEVA Plant SCADA, a 3rd party client SCADA can be used to monitor time stamping events through the OPC DA interface.

A 3rd party client SCADA needs to use OFS software services to implement the system time stamping solution.

Time Synchronization

Time Synchronization in the System



Time Synchronization

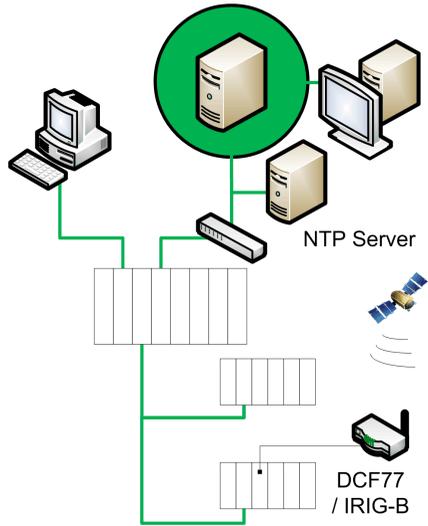
Time synchronization is a key point in the system time stamping solution. Time synchronization between the time stamping event sources (using different external source clocks) is the prerequisites to have a functional time stamping solution.

Time synchronization means:

- AVEVA Plant SCADA / OFS client: NTP server
- BMX ERT 1604 T: DCF77 or IRIG-B 004/5/6/7 external clock
- BM• CRA 312 10: NTP server
- BME P58 ••••: NTP server

OFS

OFS in the System



OFS Role

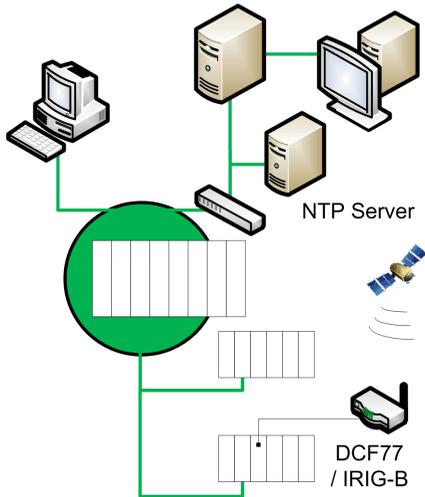
OFS software allows access to real-time PLC data. It is a multi-PLC data server. OFS allows to read the time stamping event buffers in the sources and to transmit them to the SCADA via an OPC DA interface.

OFS software offers communication with most Schneider Electric PLCs and is able to browse dynamically objects from Control Expert software or directly from the PLC.

OFS is located on the control network in the system and if you are using AVEVA Plant SCADA it is recommended to install this software on the same PC as OFS.

BME NUA 0100

BME NUA 0100 in the System

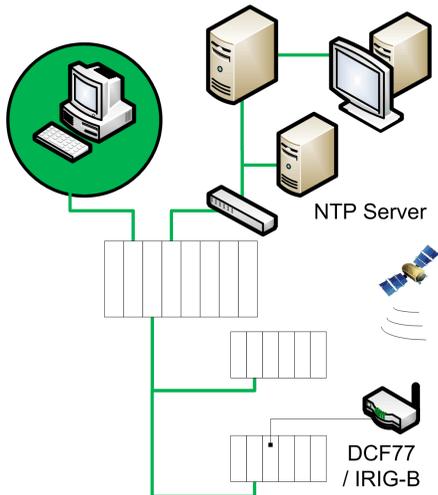


BME NUA 0100 Role

The BME NUA 0100 module is a server that provides access to real-time PLC data. Like OFS, page 23, it enables reading the time stamping event buffers in their sources and to transmit them to the SCADA via an OPC UA interface. All data available in the PLC data dictionary can be browsed by OPC UA clients

Control Expert

Control Expert Software in the System



Control Expert Role

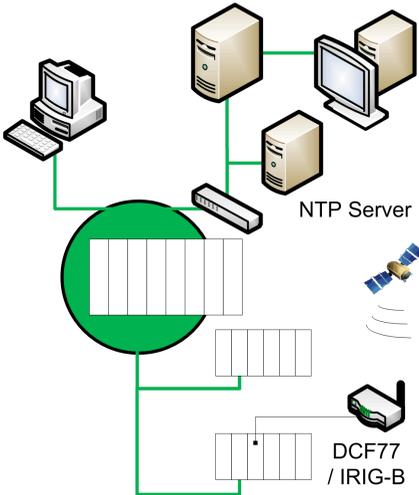
Control Expert software is a programming, debugging and operating software for most Schneider Electric PLCs. It allows the full development of applications.

Control Expert is necessary in a time stamping solution to program the PLC system. Control Expert allows to configure all the elements required for the time stamping solution (time stamping mode, variables to time stamp...).

Quantum Hot Standby systems support the system time stamping solution.

BME P58 xxxx CPU

BME P58 xxxx In the System



BME P58 xxxx Role

The BME P58 ••• CPU is able to time stamp some internal variables (firmware version \geq 2.00).

The CPU evaluates internal variables selected for time stamping periodically during the MAST task. If a change is detected, the variable is time stamped and stored in the module internal local event buffer.

For time stamping application, the CPU either needs a link to an accurate NTP server time source or uses its internal NTP server depending on the architecture.

BME P58 xxxx Internal Variables for Time Stamping

Application variables that can be time stamped:

- Simple unlocated variable of `BOOL` or `EBOOL` type. For example: `MyVar`.
- Simple located variable with symbol of `BOOL` type. For example: `MyVar` mapped on `%S6`.

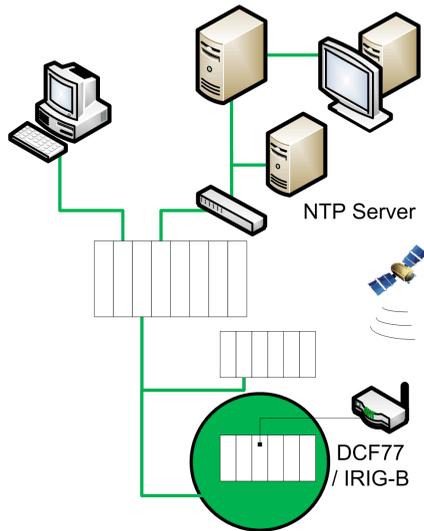
- Element of DDT or DDDT of `BOOL` or `EBOOL` type. For example: `MyVar.Element`.
- Element of array of `BOOL` or `EBOOL` type. For example: `Myarray[0]`.
- Extracted bit of located variable with symbol of `BOOL` type. For example: `MyVar` mapped on `%SW51.1`.

Application variables that cannot be time stamped:

- Extracted bit of unlocated variable of `WORD`. `BOOL` type. For example: `MyVar.5`.
- Extracted bit of element of DDT or DDDT of `BOOL` type. For example: `MyDDT.ExtractedBit2`.

BMX ERT 1604 T Module

BMX ERT 1604 T in the System



BMX ERT 1604 T Role

The BMX ERT 1604 T module is a time stamping source that can be used in a Modicon M340 PLC (local drop) or in a Modicon X80 Ethernet I/O drop. It provides a millisecond-level time stamp resolution, page 45 for discrete inputs at source time stamping.

The BMX ERT 1604 T is a 16 discrete input channels module able to generate time stamping events on input value changes. To time stamp its inputs, the BMX ERT 1604 T module is connected to an external GPS clock generating IRIG-B 004/5/6/7 or DCF77 time code, or a DCF77 radio receiver.

NOTE: Some of the BMX ERT 1604 T module channels can also be used as simple discrete inputs or incremental counting inputs.

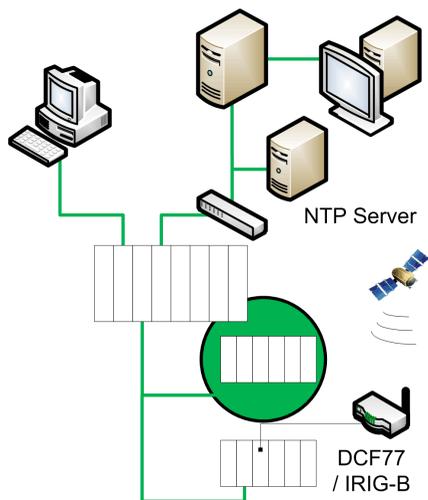
For more details on the BMX ERT 1604 T module, refer to the *Modicon X80, BMXERT0604T Time Stamp Module, User Guide*, page 11.

The BMX ERT 1604 T inputs use positive (or sink) logic and the voltage input ranges are as follows:

- 24 Vdc
- 48 Vdc
- 60 Vdc
- 110 Vdc
- 125 Vdc

BMx CRA 312 10 Module

BMx CRA 312 10 In the System



BMx CRA 312 10 Role

The BM• CRA 312 10 module is a communication module in a Modicon X80 Ethernet remote I/O drop.

BM• CRA 312 10 module features:

- In a Modicon M580 solution, these modules exchange data with the BME P58 ••• CPU.
- In a Quantum Ethernet I/O solution, these modules exchange data with the Quantum PLC head module: 140 CRP 312 00.
- In addition to its communication function, a BM• CRA 312 10 module can time stamp any discrete I/O on discrete modules located in the drop.

BM• CRA 312 10 module evaluates periodically discrete input and output values and if a change is detected it is time stamped and stored in the module internal local event buffer. This buffer makes the information available for the final client and its behavior needs to be defined in Control Expert software.

For time stamping application, the BM• CRA 312 10 module requires a direct link to an accurate NTP server time source, page 22 and the time stamp resolution, page 45 depends on the architecture.

Discrete Inputs and Outputs

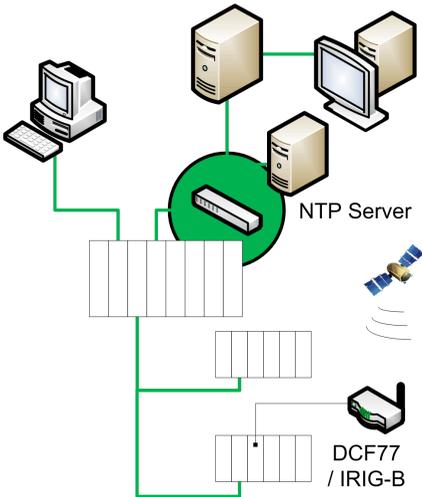
The BM• CRA 312 10 module is able to time stamp any discrete module located in the drop.

Compatible Modicon X80 discrete modules:

| Modules Reference | | | | |
|-------------------|---------------|---------------|---------------|--------------|
| BMX DAI 0805 | BMX DDI 1602 | BMX DDM 16022 | BMX DDO 1602 | BMX DRA 0804 |
| BMX DAI 0814 | BMX DDI 1603 | BMX DDM 16025 | BMX DDO 1612 | BMX DRA 0805 |
| BMX DAI 1602 | BMX DDI 1604 | BMX DDM 3202K | BMX DDO 3202K | BMX DRA 0815 |
| BMX DAI 1603 | BMX DDI 3202K | | BMX DDO 6402K | BMX DRA 1605 |
| BMX DAI 1604 | BMX DDI 6402K | | BMX SDO 0802 | BMX DRC 0805 |
| BMX DAI 1614 | BMX SDI 1602 | | | BMX SRA 0405 |
| BMX DAI 1615 | | | | |
| BMX DAO 1605 | | | | |
| BMX DAO 1615 | | | | |

Router

Router in the System



Router Role

The router is a device that transmits data between different Ethernet networks (a control network and a device network for example).

NOTE: The router allows a direct communication path between the sources of time stamped events and the final client (SCADA) via OFS.

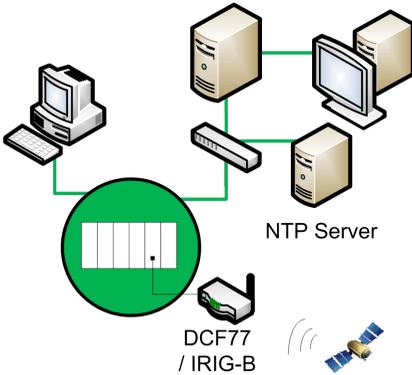
Router Modules

Routers that can be used in a time stamping solution in the Ethernet control network include any IP router..

A BME NUA 0100, page 24 module can also be used as a router.

Modicon M340 Ethernet Communication Modules in a Local Drop

Modicon M340 Ethernet Local Drop Communication Module in the System



Communication Modules

For time stamping with a BMX ERT 1604 T in a Modicon M340 PLC (local drop), one of the following Ethernet communication modules is required to interface the BMX ERT 1604 T with the SCADA / OFS:

- BMX NOC 0401
- BMX NOE 0100
- BMX NOE 0110

For more details on the Modicon M340 Ethernet communication modules, refer to the *Modicon M340 for Ethernet, Communications Modules and Processors, User Manual*, page 11 and *Modicon M340, BMX NOC 0401 Ethernet Communication Module, User Manual*, page 11.

Components Versions

What's in This Chapter

Components Version 32

Components Version

General

The following table shows the system time stamping component required versions:

| Component | Version |
|--|--------------------------------------|
| AVEVA Plant SCADA | Recommended version: 7.30 (or later) |
| OFS | 3.40 or later |
| OFSOPC driver | 2.05.09.001 or later |
| Control Expert/Unity Pro Software NOTE: Unity Pro is the former name of Control Expert for version 13.1 or earlier. | 7.0 + HF1 or later |
| BME P58 firmware | 2.00 or later |
| BME NUA 0100 | 2.0 or later |
| BMX ERT 1604 T firmware | 1.1 or later |
| BMX CRA 312 10 firmware | 1.30 or later |
| BME CRA 312 10 firmware | 1.00 or later |
| BMX NOC 0401 firmware | 2.01 or later |
| BMX NOE 0100 firmware | 2.60 or later |
| BMX NOE 0110 firmware | 5.50 or later |

Architecture Examples

What's in This Chapter

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| Time Stamping Typical Architecture..... | 33 |
| Modicon M580 Typical Architecture | 35 |
| Modicon M340 Typical Architecture | 41 |
| Redundant Architectures | 43 |

Overview

This chapter provides typical time stamping architectures.

Time Stamping Typical Architecture

Overview

Time stamping can be applied to various architectures that include at least a SCADA, an OFS, and a PLC (Modicon M580, M340, or Quantum with Modicon X80 Ethernet I/O drop).

System Time Stamping with a Modicon M580 CPU

The following table presents the devices combination required in a system time stamping architecture with a **Modicon M580** CPU in the local drop:

| SCADA | OPC DA Server | OPC UA Server | PLC (Local Drop) | | | Ethernet Remote I/O Drop | | |
|--|--------------------------------|--|------------------|----------------------|---------------------------|--------------------------|----------------------|---------------------------|
| | | | Family | Time Stamping Source | Time Synchronization | Family | Time Stamping Source | Time Synchronization |
| AVE-VA Plant SCADA or 3rd party SCADA (1.) | OFS + 1 or more I/O servers | BME NUA 0200 2 modules max per rack | Modicon M580 | BME P58 ••••4 | NTP server | Modicon X80 (2.) | BM• CRA 312 10 | NTP server (3.) |
| | | | | BMX ERT 1604 T | DCF77 or IRIG-B 004/5/6/7 | | BMX ERT 1604 T | DCF77 or IRIG-B 004/5/6/7 |

| SCADA | OPC DA Server | OPC UA Server | PLC (Local Drop) | | | Ethernet Remote I/O Drop | | |
|---|---------------|---------------|------------------|--|---|--------------------------|--|---|
| | | | Family | Time Stamping Source | Time Synchronization | Family | Time Stamping Source | Time Synchronization |
| | | | | Mix of both possible sources: <ul style="list-style-type: none"> • BME P58 ****⁴ • BMX ERT 1604 T | Each source has its time reference: <ul style="list-style-type: none"> • NTP server for BME P58 **** • DCF77 or IRIG-B 004/5/6/7 for BMX ERT 1604 T | | Mix of both possible sources: <ul style="list-style-type: none"> • BM• CRA 312 10 • BMX ERT 1604 T | Each source has its time reference: <ul style="list-style-type: none"> • NTP server ^(3.) for BM• CRA 312 10 • DCF77 or IRIG-B 004/5/6/7 for BMX ERT 1604 T |
| <p>N.A. Not Applicable</p> <ol style="list-style-type: none"> 1. Redundant SCADA configuration is compatible with system time stamping. 2. A time stamping architecture may contain several Ethernet remote I/O drops with time stamping sources. 3. A single NTP server can provide time reference to many BM• CRA 312 10 modules and a BME P58 **** CPU. 4 The SAFE task does not support time stamping of internal variables by the BME P58 ****S CPU | | | | | | | | |

System Time Stamping with a Modicon M340 CPU

The following table presents the devices combination required in a system time stamping architecture with a **Modicon M340** CPU in the local drop:

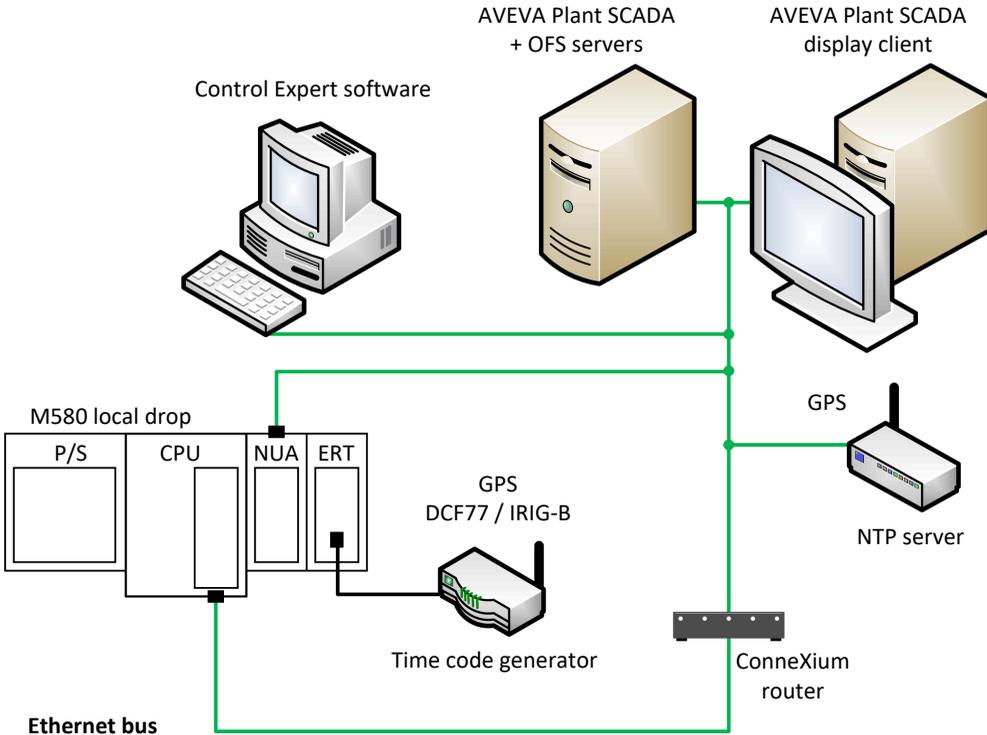
| SCA-DA | OPC DA Server | PLC (Local Drop) | | | Ethernet Remote I/O Drop | | |
|--|-----------------------------|------------------|----------------------|---------------------------|--------------------------|----------------------|----------------------|
| | | Family | Time Stamping Source | Time Synchronization | Family | Time Stamping Source | Time Synchronization |
| AVEVA Plant SCA-DA or 3rd party SCA-DA (1.) | OFS + 1 or more I/O servers | Modicon M340 | BMX ERT 1604 T | DCF77 or IRIG-B 004/5/6/7 | N.A. | N.A. | N.A. |
| <p>N.A. Not Applicable</p> <p>1. Redundant SCADA configuration is compatible with system time stamping.</p> | | | | | | | |

Modicon M580 Typical Architecture

Overview

The following topics present graphically some of the devices combination allowed in a system time stamping architecture (it is not an exhaustive list, it represents typical application examples).

Modicon M580 CPU (Local Drop)



In this example, the Modicon M580 architecture contains a BME P58 ••• CPU and a BMX ERT 1604 T module.

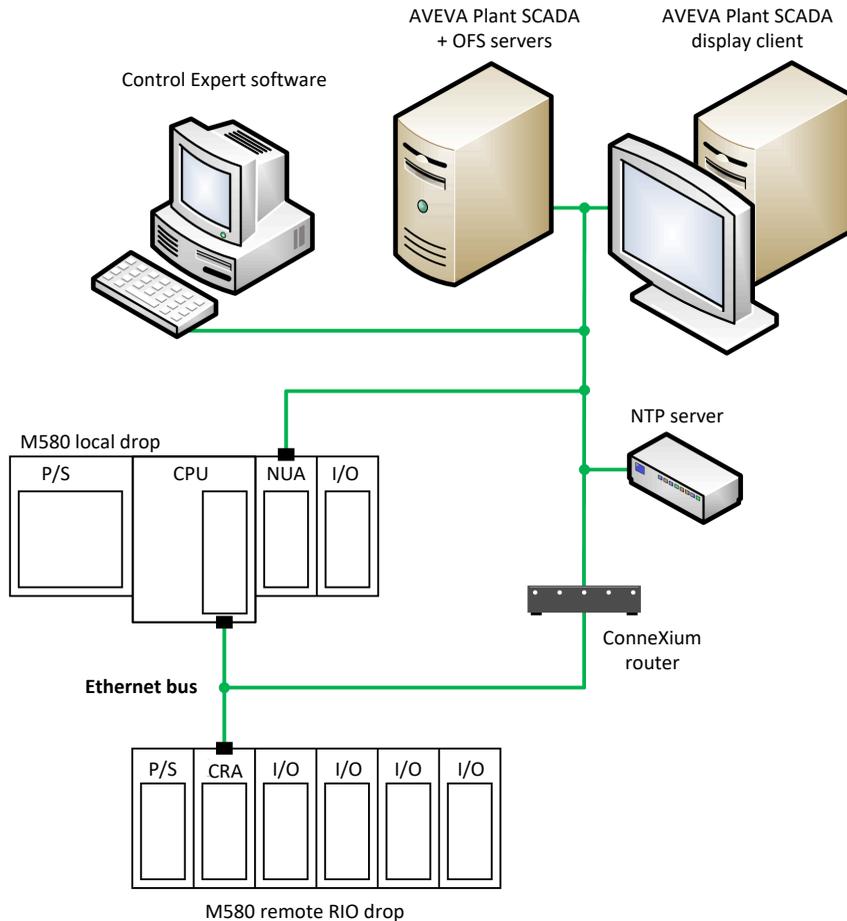
The BME P58 ••• CPU and the BMX ERT 1604 T module are the time stamped events sources (the CPU time stamps transitions on internal variables).

The time source for the CPU is an NTP server connected to the Ethernet control network. The time source for the BMX ERT 1604 T module is an external clock (DCF77 or IRIG-B time format). The AVEVA Plant SCADA / OFS needs to be synchronized on an NTP server.

The GPS is a unique time reference for both BME P58 ••• CPU and BMX ERT 1604 T module. The time source for each BMX ERT 1604 T is an external clock (DCF77 or IRIG-B time format) synchronized on GPS. The BME P58 ••• CPU and the AVEVA Plant SCADA / OFS need to be synchronized on GPS.

The unique time reference can also be an NTP server (dedicated high accuracy hardware like a Gorgy Timing **LEDI Network NTP Server** for example) that provides the IRIG-B 004/5/6/7 or DCF77 time code for BMX ERT 1604 T synchronization, page 53. In this case, the GPS usage is not mandatory.

Modicon M580 CPU with a Modicon X80 Drop and a BME CRA 312 10 Time Stamping Module in a Multi-Layered Architecture



In this example, the Modicon M580 architecture contains a BME P58 CPU and a remote I/O drop with a BME CRA 312 10 module.

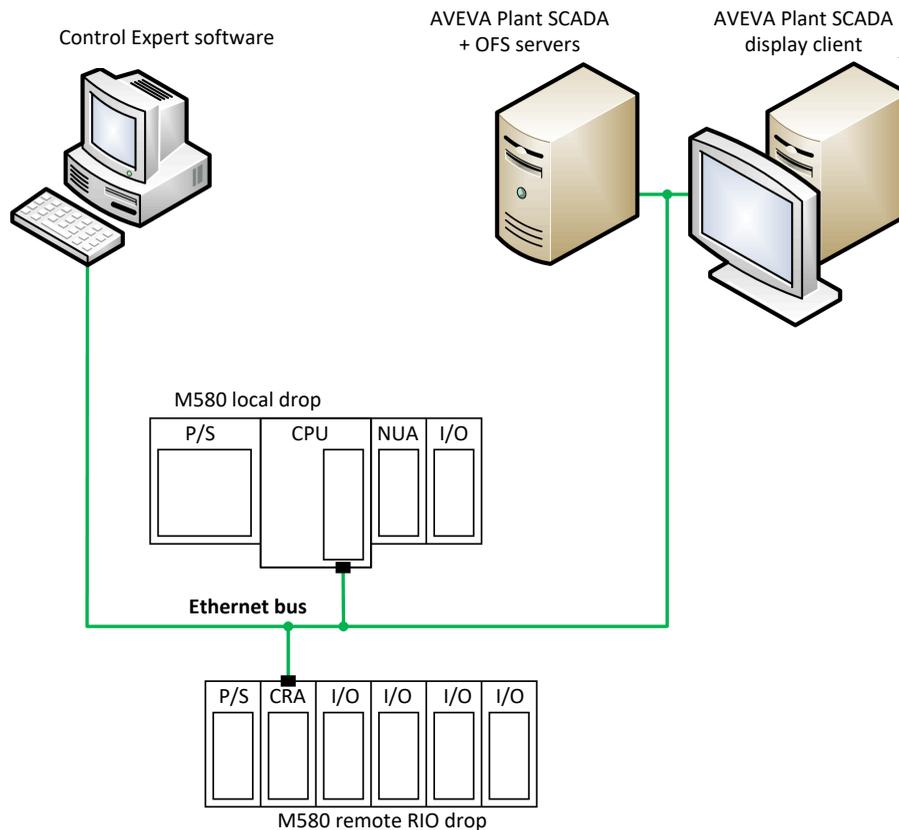
The BME P58 CPU and the BME CRA 312 10 module are the time stamped events sources. The CPU time stamps transitions on internal variables and the BME CRA 312 10 module time stamps I/O transitions on the discrete I/O modules in the remote I/O drop.

The time source for the CPU and BME CRA 312 10 module is an NTP server connected to the Ethernet control network.

The multi-layered architecture requires the device network to be linked to the control network with a ConneXium router. In this architecture, the BME NOC 03•1 module on the local drop is linked to the control network. Using a BME NOC 03•1 module is optional depending on the communication capability needs.

NOTE: It is necessary to choose an NTP server that provides stable clock synchronization and accurate NTP output.

Modicon M580 CPU with a Modicon X80 Drop and a BME CRA 312 10 Time Stamping Module in a Flat Architecture



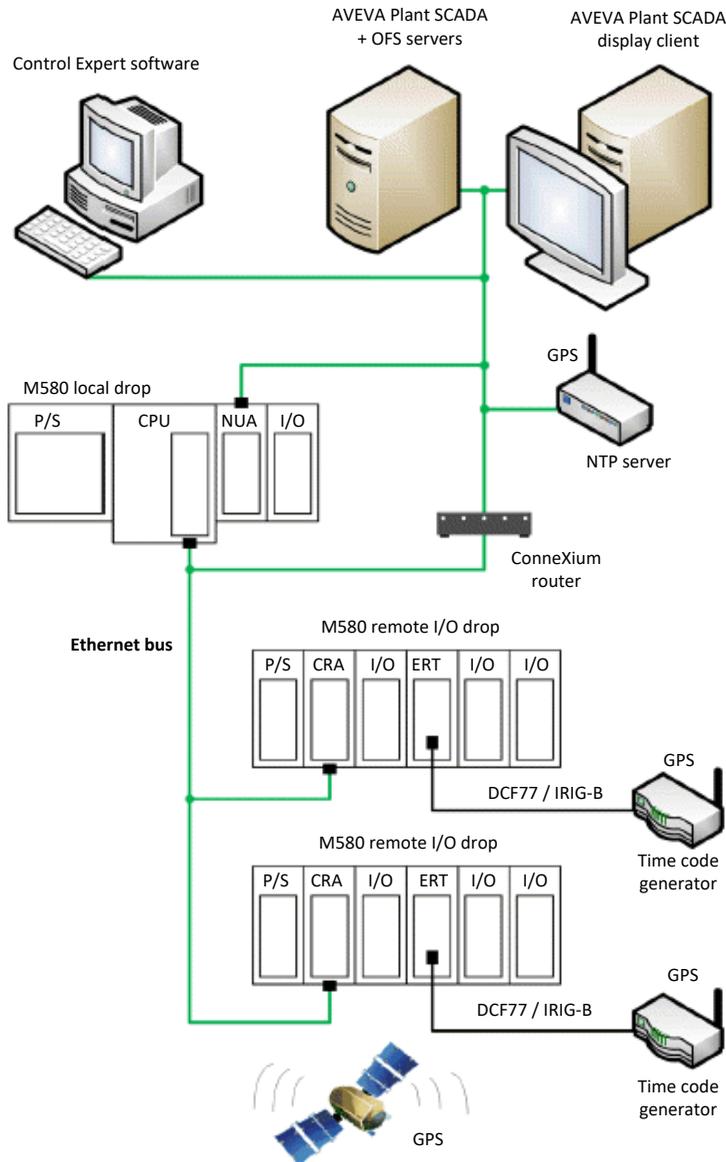
In this example, the Modicon M580 architecture contains a BME P58 CPU and a remote I/O drop with a BME CRA 312 10 module.

The BME P58 ••• CPU and the BME CRA 312 10 module are the time stamped events sources. The CPU time stamps transitions on internal variables and the BME CRA 312 10 module time stamps I/O transitions on the discrete I/O modules in the remote I/O drop.

The time source for the CPU and BME CRA 312 10 module is the BME P58 ••• CPU internal NTP server.

The flat architecture implies that all devices are connected to the same network.

Modicon M580 CPU with a Modicon X80 Drop Including BMX ERT 1604 T and BMx CRA 312 10 Modules



In this example, a Modicon M580 architecture contains 2 Modicon X80 Ethernet remote I/O drops.

On the local rack, the CPU time stamps transitions on internal variables. On each remote I/O drop, both BM• CRA 312 10 and BMX ERT 1604 T modules are the time stamped event sources (the BM• CRA 312 10 module time stamps I/O transitions on the discrete I/O modules in the remote I/O drop).

The GPS is a unique time reference for the BME P58 ••• CPU, the BMX ERT 1604 T and the BM• CRA 312 10 modules. The time source for each BMX ERT 1604 T is an external clock (DCF77 or IRIG-B time format) synchronized on GPS. The BME P58 ••• CPU, BM• CRA 312 10 module, and AVEVA Plant SCADA / OFS need to be synchronized on GPS.

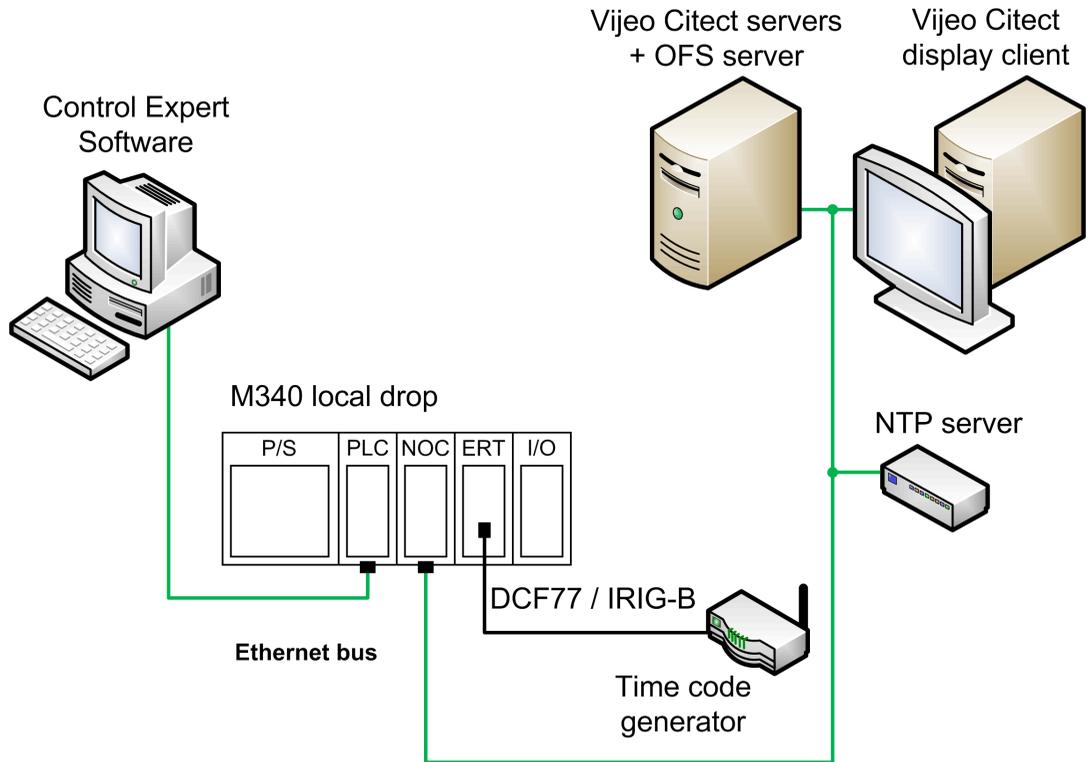
The unique time reference can also be an NTP server (dedicated high accuracy hardware like a Gorgy Timing **LEDI Network NTP Server** for example) that provides the IRIG-B 004/5/6/7 or DCF77 time code for BMX ERT 1604 T synchronization, page 53. In this case, the GPS usage is not mandatory.

Modicon M340 Typical Architecture

Overview

The following topics present graphically some of the devices combination allowed in a system time stamping architecture (it is not an exhaustive list, it represents typical application examples).

Modicon M340 PLC (Local Drop)



In this example, the Modicon M340 local drop contains a BMX ERT 1604 T module.

The BMX ERT 1604 T module is the time stamped events source.

The time source for the BMX ERT 1604 T module is an external clock (DCF77 or IRIG-B time format). The AVEVA Plant SCADA / OFS needs to be synchronized on an NTP server.

NOTE: The OFS is connected to the PLC local drop with an Ethernet link, as a consequence, the PLC local drop needs to have an Ethernet communication module, page 31.

Redundant Architectures

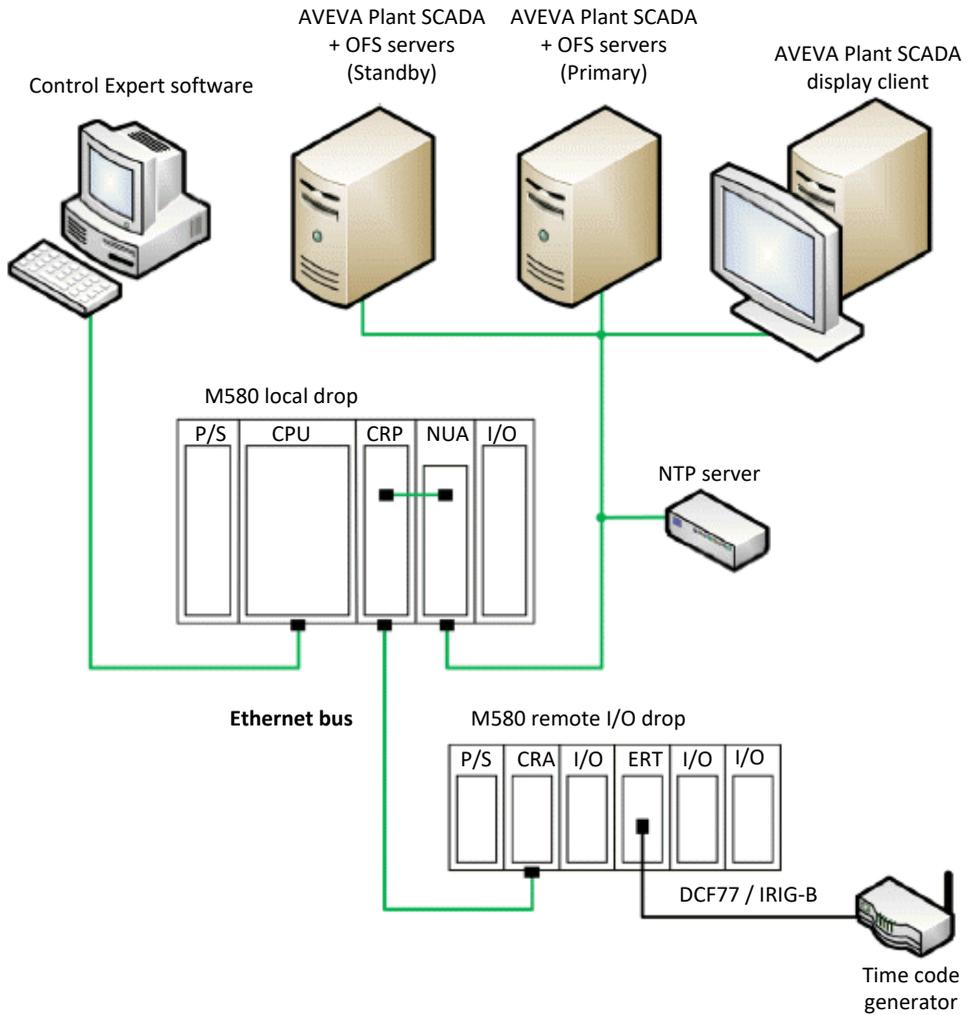
Overview

Redundancy in a time stamping architecture is possible at 2 levels:

- 2 BME NUA 0100 redundant modules in a Modicon M580 rack.
- SCADA (AVEVA Plant SCADA).

NOTE: Redundant SCADA servers are recommended to prevent loss of data. If there is no SCADA redundancy, some events may be lost in case of communication problem between SCADA servers.

Redundant AVEVA Plant SCADA architecture example:



Performances

What's in This Chapter

Performances45

Overview

This chapter describes the applicative time stamping components and system performances.

Performances

Components Performances

The following table sums up component performances in a time stamping solution:

| Topic | Device | Value |
|--|----------------|--|
| Time stamp resolution (between 2 identical source modules) | BMX ERT 1604 T | 2 ms < time stamp resolution < 4 ms (with the same time source) |
| | BM• CRA 312 10 | 10 ms |
| Time stamp resolution (in the same source module) | BME P58 •••• | CPU MAST task scan time |
| | BMX ERT 1604 T | 1 ms |
| | BM• CRA 312 10 | 1 cycle time (<10 ms) |

| Topic | Device | Value |
|--|----------------|---|
| Maximum number of I/O and available memory ^(1.) | BME P58 **** | 5000 internal variables |
| | | 32000 events in internal buffer ^(2.) |
| | BMX ERT 1604 T | 16 discrete inputs on the module |
| | | 255 groups in internal buffer (a group is a set of 1 to 16 events detected in the same cycle) ^(2.) |
| | BM• CRA 312 10 | 256 discrete I/O configured |
| | | 4000 events in internal buffer ^(2.) |
| <p>1. The maximum value depends on the global system performance, it is not an absolute value and has to be balanced.</p> <p>2. The number of events in internal buffer includes SOE_UNCERTAIN events.</p> | | |

System Limitations

The following table sums up system performance in a time stamping solution:

| Topic | Description | Value |
|--|---|--|
| Maximum number of BMX ERT 1604 T modules in a Modicon M580 local drop. | BMX ERT 1604 T | 9 per drop |
| Maximum number of BMX ERT 1604 T modules in a Modicon M340 local drop. | BMX ERT 1604 T | 9 per drop |
| Maximum number of devices in an Ethernet remote I/O drop. | BMX ERT 1604 T | 9 per drop ^(1.) |
| | BM• CRA 312 10 | 1 per drop |
| Maximum number of BME NUA 0100 modules in a Modicon M580 local rack. | BME NUA 0100 | 2 per rack |
| Maximum number of devices in the drops controlled by the same PLC and connected to the Ethernet RIO network. | BMX ERT 1604 T | 25 |
| | BM• CRA 312 10 | 31 ^(2.) |
| Maximum number of sources of events polled by OFS. | A BME P58 **** CPU, BMX ERT 1604 T module, or BM• CRA 312 10 module count as 1 source | 500 sources per second ^(3.) |
| | Maximum discrete I/Os per PLC | 2500 ^(2.) |
| OFS polling rate. | Minimum OFS polling rate value | 250 ms |

| Topic | Description | Value |
|---|---|-------------------------------------|
| BME NUA 0100 polling rate. | Minimum BME NUA 0100 polling rate value | 250 ms |
| Maximum number of discrete inputs (and outputs) monitored by the PLC for all the time stamping modules. | For all the BMX ERT 1604 T | 400 discrete inputs ^(2.) |
| | For all the BM• CRA 312 10 | 2048 discrete I/Os ^(2.) |
| <p>1. A BMX ERT 1604 T module contains 4 expert channels. A Modicon X80 drop supports a maximum of 36 expert channels, so it supports a maximum of 9 x BMX ERT 1604 T modules if there is no BMX EHC 0•00 counting module in the drop.</p> <p>2. The maximum value depends on the global system performance; it is not an absolute value and has to be balanced.</p> <p>3. The maximum value depends on the CPU capacity and usage of the PC that hosts OFS and I/O server. It is recommended to avoid installation of other CPU or memory consuming applications on this PC.</p> | | |

NOTE: OFS Time Stamp Helper, page 83 is a dedicated tool provided to help the user to define the system capacity based on the events and devices included.

AVEVA Plant SCADA I/O Server Performance

Each AVEVA Plant SCADA I/O server communicate with 1 OFS.

The following table provides maximum values recommended for a single AVEVA Plant SCADA I/O server:

| Topic | Value | Comment |
|--|-------------------------------------|--|
| Maximum number of transitions per second. | 10000 transitions per second | Recommendation for a single I/O server. |
| Maximum number of transitions on variables mapped on time stamped events per second. | 3000 transitions per second | Recommendation for a single I/O server. |
| Maximum storage buffer size of the I/O server. | 300000 variables | |
| Maximum storage time of the I/O server. | 10 minutes | |
| Maximum switchover time in a redundant architecture. | 4...10 s for 10000 active variables | NOTE: The time stamped event source buffers may become full during an I/O server switch due to the switchover time. |

NOTE: Split the devices between different I/O servers when the application needs to be scaled up.

Design and Configuration Phases

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| Selecting the Time Stamping Module..... | 49 |
| Selecting and Setting Time Synchronization..... | 51 |
| Activating System Time Stamping Service | 59 |
| Selecting and Configuring the Variables to Time Stamp | 67 |
| Selecting the Communication Parameters | 82 |
| Setting AVEVA Plant SCADA Parameters | 86 |

Introduction

This part presents the phases required to design and configure the system time stamping from service activation to diagnostic.

Selecting the Time Stamping Module

What's in This Chapter

Time Resolution.....49

Overview

This chapter describes the modules available to provide the desired time stamp resolution.

Time Resolution

Overview

Time resolution is a key point in selecting the time stamped event sources.

Time and time stamp resolution are to be understood as follows:

| | |
|---|--|
| Internal module time resolution: | Absolute time resolution depending on the module internal clock time management. |
| Time stamp resolution between 2 events in the same module: | Depends on the module internal Input (and Output) event detection cycle. |
| Time stamp resolution between 2 events on different source modules of the same family (BMX ERT 1604 T or BM• CRA 312 10): | Time resolution between 2 source modules depends on the time source (external clock) tolerance, each module internal time resolution, and the network transmission delay for modules synchronized through NTP. |
| Time stamp resolution between 2 events on different source modules of a different family (BMX ERT 1604 T and BM• CRA 312 10 or BME P58 ••••): | Same constraints as with 2 source modules of the same family, except that the time stamp resolution will be the one of the less accurate module. |

Time and Time Stamp Resolution

| Value | System Events Source Modules | Value | Comment |
|--|--|---|--|
| Internal time resolution | BME P58 | 1 ms | Internal clock resolution |
| | BMX ERT 1604 T | 1 ms | Internal clock resolution |
| | BM• CRA 312 10 | | Internal clock resolution |
| Time stamp resolution between 2 events in the same module | BME P58 | MAST task scan time | |
| | BMX ERT 1604 T | 1 ms | |
| | BM• CRA 312 10 | BM• CRA 312 10 scan time (average value 3 ms) | Time stamp resolution depends on the module scan time. |
| Time stamp resolution between 2 events on different source modules | n x BMX ERT 1604 T ^(1.) | <ul style="list-style-type: none"> 2 ms with IRIG-B 004/5/6/7 time code (GPS) 4 ms with DCF77 time code | NOTE: Time stamp resolution is given if each BMX ERT 1604 T module is supplied with the same time source. |
| | n x BM• CRA 312 10 ^(1.) | 10 ms | |
| | n x BMX ERT 1604 T + n x BM• CRA 312 10 ^(1.) | 10 ms | NOTE: The worst time stamp resolution becomes the system time stamp resolution. |
| | BME P58 + n x BMX ERT 1604 T + n x BM• CRA 312 10 ^(1.) | Maximum of following values: <ul style="list-style-type: none"> MAST task scan time 10 ms | NOTE: The worst time stamp resolution becomes the system time stamp resolution. |
| 1. n = many modules, maximum value depends on system architecture. | | | |

Selecting and Setting Time Synchronization

What's in This Chapter

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| Selecting the Time Source | 51 |
| Control Expert Setting | 54 |
| BME P58 xxxx Clock Settings in Control Expert..... | 54 |
| BMX ERT 1604 T Clock Settings in Control Expert | 56 |
| BMx CRA 312 10 Clock Settings in Control Expert..... | 57 |

Overview

This chapter describes the available time sources, the time synchronization principles, and corresponding software settings.

Selecting the Time Source

Overview

In order to allow a consistent SOE (sequence of events), a unique time reference is needed to synchronize the internal time on each time stamping entity of the system:

- BME P58 ••••
- BMX ERT 1604 T
- BM• CRA 312 10

Time Reference Selection

The following table shows the recommended time reference based on the system architecture:

| Time Stamping Module in the System | Recommended Time Reference | Description |
|--|---|--|
| The system, page 35 contains only BME P58 time stamping modules. | NTP server | <p>An NTP server is connected on the control Ethernet network (if such a network is available on the PLC) or on the Ethernet remote I/O network. In the case of a flat architecture, page 38, the CPU can be set as an NTP server.</p> <p>With a unique NTP server available:</p> <ul style="list-style-type: none"> • OFS and SCADA synchronize their time on the NTP server. • The BME P58 CPU synchronizes its clock on the same NTP server. |
| The system, page 34 contains only BM• CRA 312 10 time stamping modules. | NTP server | <p>An NTP server is connected on the control Ethernet network (if such a network is available on the PLC) or on the Ethernet remote I/O network.</p> <p>With a unique NTP server available:</p> <ul style="list-style-type: none"> • OFS and SCADA synchronize their time on the NTP server. • The BM• CRA 312 10 modules synchronize their clock on the same NTP server. |
| The system, page 41 only contains BMX ERT 1604 T modules. | NTP server | <p>An NTP server is connected on the control Ethernet network.</p> <p>With a unique NTP server available:</p> <ul style="list-style-type: none"> • OFS and SCADA synchronize their time on the NTP server. |
| | IRIG-B 004/5/6/7 or DCF77 time code | The BMX ERT 1604 T modules synchronize their clock on an IRIG-B 004/5/6/7 or DCF77 time code. |
| The system, page 40 contains BME P58, BMX ERT 1604 T, and BM• CRA 312 10 modules. | IRIG-B 004/5/6/7 or DCF77 time code from a GPS signal | <p>The GPS provides the time reference to the time sources.</p> <p>In this case:</p> <ul style="list-style-type: none"> • OFS and SCADA synchronize their time on an NTP server (dedicated high accuracy hardware synchronized on a GPS receiver). • The BME P58 CPU synchronizes its clock on the NTP server. • The BM• CRA 312 10 modules synchronize their clock on the same NTP server. • The BMX ERT 1604 T modules synchronize their clock on a GPS receiver. |

| Time Stamping Module in the System | Recommended Time Reference | Description |
|------------------------------------|--|---|
| | IRIG-B 004/5/6/7 or DCF77 time code from an NTP server (dedicated high accuracy hardware like a Gorgy Timing LEDI Network NTP Server or equivalent) | <p>The hardware NTP server (high accuracy) provides the time reference to the time sources.</p> <p>In this case:</p> <ul style="list-style-type: none"> • OFS and SCADA synchronize their time on the NTP server. • The BME P58 **** CPU synchronizes its clock on the same NTP server. • The BM• CRA 312 10 modules synchronize their clock on the same NTP server. • The BMX ERT 1604 T modules synchronize their clock on the IRIG-B 004/5/6/7 or DCF77 output of the same NTP server. <p>NOTE: As all the time sources are synchronized on the dedicated high accuracy hardware NTP server, a GPS receiver is not mandatory for synchronization.</p> |

Time Sources for Modules

The following table defines the time sources recommended for each time stamping event source module:

| Module | Time Source |
|----------------|--|
| BME P58 **** | <p>External NTP server (CPU NTP tab configured as an NTP client).</p> <p>An NTP server has to be available on the Ethernet network accessible from the BME P58 **** CPU and set in Control Expert.</p> <p>NOTE: For more details on NTP server configuration in a Modicon M580 CPU, refer to chapter <i>NTP Tab</i> in <i>Modicon M580, Hardware, Reference Manual</i>.</p> |
| | <p>Internal NTP server (CPU NTP tab configured as an NTP server).</p> <p>The CPU internal clock is used as reference clock. This setting can only be used in the case of a flat architecture, page 38.</p> <p>NOTE: For more details on NTP server configuration in a Modicon M580 CPU, refer to chapter <i>NTP Tab</i> in <i>Modicon M580, Hardware, Reference Manual</i>.</p> |
| BMX ERT 1604 T | <p>GPS time source (IRIG-B 004/5/6/7 or DCF77 time code).</p> <p>This solution provides the most accurate time source.</p> |
| | <p>Radio receiver time source (DCF77 time code) based on a radio transmitter based in Germany near Frankfurt with an action range mainly limited to Europe.</p> <p>NOTE: For more details on clock source connection on the BMX ERT 1604 T module, refer to chapter <i>Physical Implementation</i> in <i>Modicon X80, BMXERT0604T Time Stamp Module, User Guide</i>.</p> |

| Module | Time Source |
|----------------|--|
| | NTP server (IRIG-B 004/5/6/7 or DCF77 time code). Dedicated high accuracy hardware like a Gorgy Timing LEDI Network NTP Server or equivalent that provides IRIG-B 004/5/6/7 or DCF77 time code outputs. |
| BM• CRA 312 10 | NTP server. An NTP server has to be available on the Ethernet network accessible from the BM• CRA 312 10 module and set in Control Expert. NOTE: With a Modicon M580 CPU, NTP server is configured in the CPU embedded Ethernet ports parameters. Refer to topic <i>NTP Tab</i> in <i>Modicon M580, Hardware, Reference Manual</i> . NOTE: With a Modicon Quantum CPU, NTP server is configured in the CRP communication head module on the local rack. Refer to chapter <i>NTP Configuration in Control Expert</i> in <i>Quantum EIO, Remote I/O Modules, Installation and Configuration Guide</i> . |
| OFS and SCADA | NTP server. |

Control Expert Setting

Time Zone

Adjust **Project Settings** in Control Expert, page 60 and set time zone parameters.

BME P58 xxxx Clock Settings in Control Expert

BME P58 xxxx Clock

The CPU clock for internal variables time stamping is provided by either an external or internal time source.

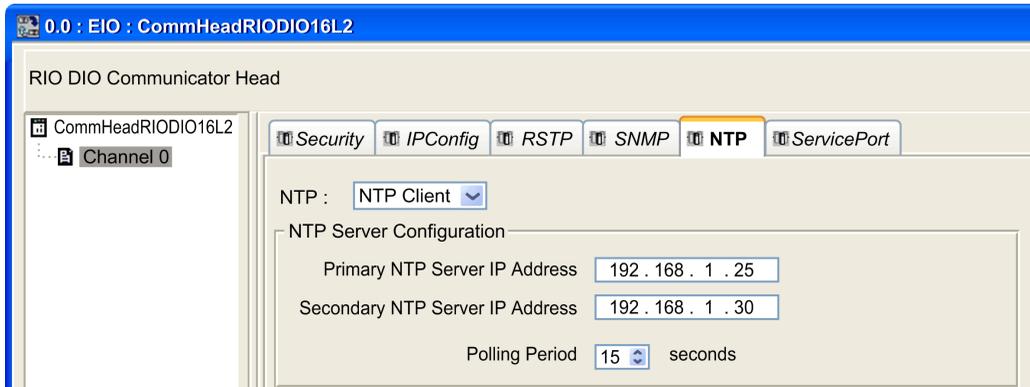
| | |
|-----------------------|---|
| External time source: | The CPU is set as an NTP client and synchronizes its internal clock on an Ethernet NTP server usually located on the control network. |
| Internal time source: | The CPU is set as an NTP server . It uses its internal clock and acts as an Ethernet NTP server for devices connected to the Ethernet network on which the CPU is connected. |

Setting the CPU as an NTP Client in Control Expert

Proceed as follows to access and set the NTP parameters in Control Expert:

| Step | Action |
|------|--|
| 1 | In the Project Browser , double-click Project > Configuration > PLC bus . |
| 2 | In the PLC bus dialog box, double-click the drawing with 3 Ethernet ports in the middle of the CPU. |
| 3 | Select the NTP tab to set the NTP parameters. |
| 4 | Select NTP Client parameter in NTP : field. |
| 5 | In the NTP Server Configuration field, enter the NTP server IP addresses and set the polling period. NOTE: The polling period represents the time elapsed before internal clock resynchronization with the Ethernet NTP server. |

Example of **NTP** tab content with a CPU set as **NTP client**:



Setting the CPU as an NTP Server in Control Expert

Proceed as follows to access and set the NTP parameters in Control Expert:

| Step | Action |
|------|--|
| 1 | In the Project Browser , double-click Project > Configuration > PLC bus . |
| 2 | In the PLC bus dialog box, double-click the drawing with 3 Ethernet ports in the middle of the CPU. |
| 3 | Select the NTP tab to set the NTP parameters. |

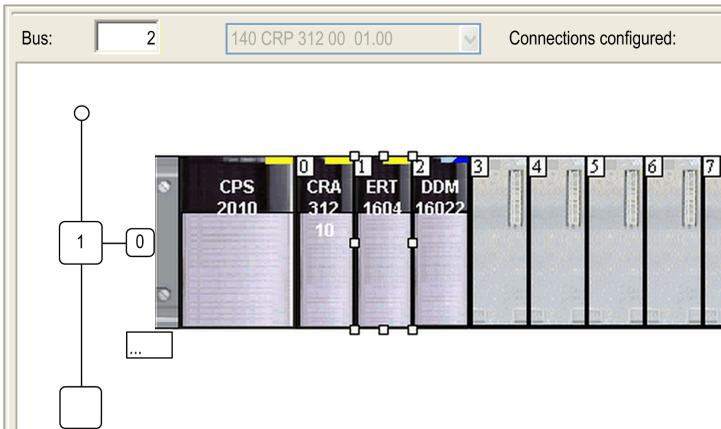
| Step | Action |
|------|--|
| 4 | Select NTP Server parameter in NTP : field. |
| 5 | <p>NTP Server Configuration field enables to set the polling period.</p> <p>NOTE: When the CPU is set as an NTP server, the polling period is a parameter used by remote modules in the PAC (for example a BM• CRA 312 10 module). It represents the time elapsed before remote modules internal clock resynchronization with the CPU NTP server.</p> |

BMX ERT 1604 T Clock Settings in Control Expert

BMX ERT 1604 T Clock

To set the clock type, in Control Expert select the module **Configuration** tab by double-clicking the BMX ERT 1604 T module in the drop.

BMX ERT 1604 T module can be in a local drop or in a Modicon X80 drop as shown in the following figure:



Select the clock type by setting the **Clock SYNC source** value:

| | Label | Symbol | Value | Unit |
|---|-------------------------|--------|-----------------------|--------|
| 0 | Supply Monitoring | | Enable | |
| 1 | Rated Voltage | | 24 Vdc | |
| 2 | Clock SYNC source | | IRIG-B/External Clock | |
| 3 | Debounce filter type | | Steady state | |
| 4 | Dechatter filter | | Disable | |
| 5 | Channel 0 used | | Enable | |
| 6 | Channel 0 edge | | Both edges | |
| 7 | Channel 0 debounce time | | 1 | ms |
| 8 | Channel 0 chatter count | | 255 | |
| 9 | Channel 0 chatter time | | 255 | 100 ms |

The allowed clock sources are:

- **IRIG-B/External Clock** (preferred clock source for system time stamping)
- **DCF77/External Clock**

BMx CRA 312 10 Clock Settings in Control Expert

BMx CRA 312 10 Clock

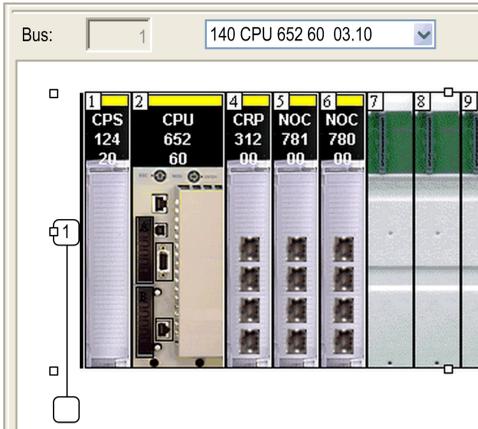
The BM• CRA 312 10 module clock is provided by an Ethernet NTP server. The server access is configured in the local rack.

NTP Server Settings in Control Expert With a Modicon M580 CPU

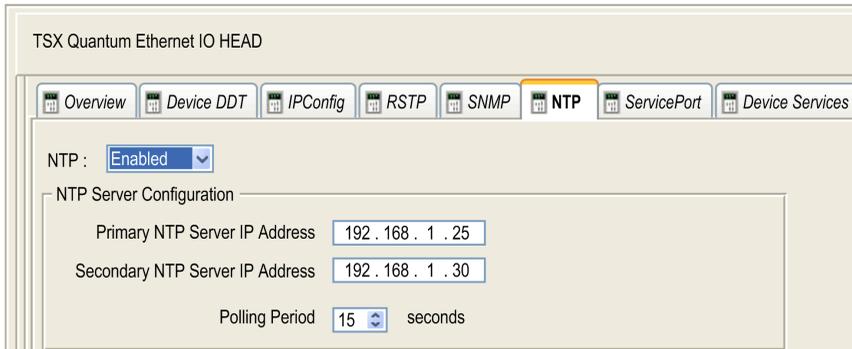
To access the NTP server parameters, select the BME P58 ••• CPU Ethernet ports configuration, page 54.

NTP Server Settings in Control Expert With a Modicon Quantum CPU

To access the NTP server parameters, in Control Expert double-click the 140 CRP 312 00 module in the local drop:



Select the **NTP** tab and set the parameters:



NTP parameter values:

- **NTP:** Enabled
- **Primary NTP Server IP address:** IP address
- **Secondary NTP Server IP address:** IP address
- **Polling Period:** 1...120 seconds

NOTE: Recommended **Polling Period** value: Lower than 20 seconds to get a time stamp resolution of 10 ms between 2 events on different BM• CRA 312 10 modules.

Activating System Time Stamping Service

What's in This Chapter

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| OFS Settings..... | 62 |
| BME NUA 0100 Settings | 64 |

Overview

This chapter describes the actions performed in order to activate the system time stamping in Control Expert and OFS software.

Control Expert Settings

Configuration Sequence

The following table presents the sequence to follow in order to configure the system time stamping in Control Expert:

| Step | Action |
|------|--|
| 1 | Set Control Expert project settings, page 59. |
| 2 | Create an application in Control Expert with time stamping modules. Select the appropriate time stamping modules, page 49. |
| 3 | Set the time stamping module time sources parameters, page 51. |
| 4 | Select the events, page 67 to time stamp. |
| 5 | Set the time stamped event parameters. Time stamping module buffer parameters are preset. |

Project Settings

In Control Expert software, to allow system time stamping, adjust the **Project Settings** by clicking **Tools > Project Settings > General**.

Data Dictionary Configuration

Click **General > PLC Embedded data** and select the **Data dictionary** check box. This setting allows any client (SCADA using OFS) to animate and modify all symbolized variables of the application embedded in the PLC memory without needing to synchronize it again with Control Expert application or with.XVM export file generated by Control Expert. It also allows to make OFS variables consistent with PLC application.

The **Data dictionary** table is necessary because time stamped events are mapped on symbolized variables.

Time Stamping Parameters

Click **General > Time** to reach time stamping parameter:

The screenshot shows the 'Project Settings' dialog box with the 'Time' configuration tab selected. The left pane shows a tree view with 'Time' highlighted. The right pane displays a table of properties and their values.

| Property label | Property value |
|--|---------------------------------|
| Time Stamping Mode | System |
| Max events stored | 2000 |
| Custom TimeZone | <input type="checkbox"/> |
| Time Zone | (UTC+01:00) Brussels Copenha... |
| Time Offset | 60 |
| Automatically adjust clock for daylight saving | <input type="checkbox"/> |
| START Daylight Saving : Month | March |
| START Daylight Saving : Day of the week | Sunday |
| START Daylight Saving : Occurence | last |
| START Daylight Saving : Hour | 2 |
| START Daylight Saving : Minute | 0 |
| START Daylight Saving : Second | 0 |
| START Daylight Saving : Offset | 60 |
| END Daylight Saving : Month | October |
| END Daylight Saving : Day of the week | Sunday |
| END Daylight Saving : Occurence | last |
| END Daylight Saving : Hour | 3 |
| END Daylight Saving : Minute | 0 |
| END Daylight Saving : Second | 0 |

At the bottom of the dialog, there are buttons for 'Import', 'Export', 'Reset All', 'OK', 'Apply', 'Cancel', and 'Help'.

In **Time** field, set the time stamping mode and time zone:

| Subfield | Value for System Time Stamping | Description |
|---|--------------------------------|--|
| Time Stamping Mode | System | Select System to enable system time stamping. |
| Max events stored | See description. | <p>Only available for System Time Stamping, this value (between 0 and 32000) defines the maximum number of time stamping events that can be stored in the PLC global event buffer. See the PLC > Memory Consumption... to know the memory size used and refine this value if needed.</p> <p>Default value (minimum) = $2 * \text{number of events configured} * 100 / (100 - \text{buffer full threshold})$, where:</p> <ul style="list-style-type: none"> <i>number of events configured</i> = PLC internal variables configured as events in Control Expert. <i>buffer full threshold</i> = 50 (threshold percentage value). <p>NOTE: When building the project, if this value is too small a message gives the exact value to select.</p> |
| Custom TimeZone | Enabled or Disabled | <p>Gives the possibility to define your own time zone. If checked the option:</p> <ul style="list-style-type: none"> Time Zone in UTC time cannot be selected. Time Offset can be adjusted. Automatically adjust clock for daylight saving can be configured. |
| Time Zone | (1.) | <p>Can be selected if Custom TimeZone is disabled only.</p> <p>Allows you to select the wanted time zone in the list of standard time zone.</p> |
| Time Offset | (1.) | <p>Can be selected if Custom TimeZone is enabled only.</p> <p>Allows you to add an offset to the current local time between -1439...1439 minutes.</p> |
| Automatically adjust clock for daylight saving | (1.) | <p>Can be selected if Custom TimeZone is enabled only.</p> <p>Enabled: In the START Daylight Saving and END Daylight Saving fields, enter the month, day of the week, occurrence range, hour, minute, second, and offset from the respective dropdown lists.</p> <p>Disabled (by default): The START Daylight Saving and END Daylight Saving fields are disabled because their times are automatically changed in the spring and fall every year.</p> <p>NOTE: Automatic clock adjust for daylight saving change is not implemented on Modicon Premium range. You are advised not to activate this useless feature (No internal or external action is performed when this function is activated).</p> |
| | (1.) | START Daylight Saving |
| | (1.) | END Daylight Saving |
| 1. No specific value required for system time stamping, depends on Custom TimeZone subfield value. | | |

Time stamped events are marked in UTC values and the time zone settings allow to convert GPS local time to UTC values in BMX ERT 1604 T.

NOTE: When the source of time stamped events is a BM• CRA 312 10 module, the time zone settings have no influence on time stamped events (the module uses UTC time from the NTP server) but the time zone settings are used for diagnostic purpose (local time is needed).

NOTE: The daylight saving time settings are not applicable to the BMX ERT 1604 T module because this module gets the daylight saving time switching information from the external clock (DCF77 or IRIG-B 004/5/6/7 time code). IRIG-B 004/5/6/7 has to support IEEE-1344 extensions (2004 update) or IEEE C37.118 in order to provide the Daylight Saving Time information.

OFS Settings

Features

The custom OPC property is linked to OPC items with the following definition:

- **Description:** time stamped event support
- **PropertyId:** 5012
- **Comment:** true if the variable is configured as time stamped event
- **Type:** VT_BOOL
- **Values:** 1 if the item is a time stamped event and 0 if not

NOTE: For Control Expert variables configured as TS events, the property value is set to 1 and used by the OPC client to determine which items can be added in the event group.

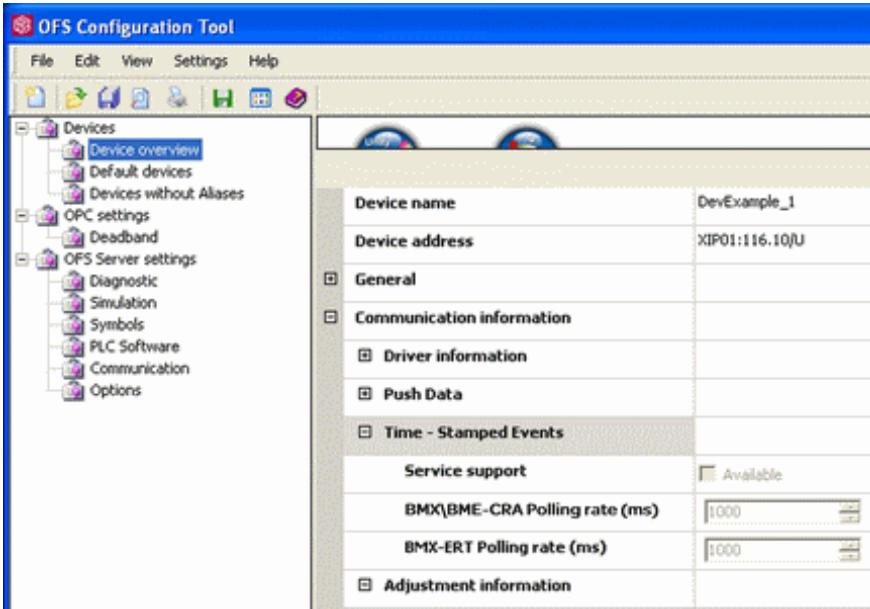
Time Stamping Events Configuration

The only devices that can be configured with an alias are PLC devices. Devices able to generate time stamped data are discovered at run time by reading the data dictionary table embedded in the PLC.

A time stamped event appears in the device panel of the current alias.

To configure the time stamping parameters, launch the OFS configuration tool: In Windows task bar, click **Start > Programs > Schneider Electric > OFS > OFS Configuration Tool**.

To reach the time stamping configuration in **OFS Configuration tool**, click **Devices > Device overview > Communication information > Time-Stamped Events**:



Time-Stamped Events parameters:

| Parameter | Value for System Time Stamping | Description |
|-------------------------------------|--------------------------------|--|
| Service support | Enabled | When checked, the time stamped events service is enabled: <ul style="list-style-type: none"> Time stamped items can be added to the event group. Access to event sources buffer is performed at the per-family Polling Rate (all event sources linked to the current PLC are accessed). |
| BMXBME-CRA Polling Rate (ms) | 1000 | <p>Polling rate for event read request sent to the BM• CRA 312 10.</p> <p>Rate at which <code>ReadEvent</code> requests are sent on a BM• CRA 312 10 event channel.</p> <p>If value is 0, then no BM• CRA 312 10 event buffer read is performed (it can be used to disable temporarily the BM• CRA 312 10 event sources when tuning the configuration or definitively if the time stamped events function is not required for BM• CRA 312 10 family).</p> <p>A unique event channel is opened to a BM• CRA 312 10 for all TS variables of the BM• CRA 312 10 sub module (except BMX ERT 1604 T variables).</p> <p>Range: 250...4000 ms by step of 50 ms (value 0 is an acceptable value, no event source polling).</p> |
| BMX-ERT Polling Rate (ms) | 1000 | <p>Polling rate for event read request sent to the BMX ERT 1604 T.</p> <p>Rate at which <code>ReadEvent</code> requests are sent on a BMX ERT 1604 T event channel.</p> <p>If value is 0, then no BMX ERT 1604 T event buffer read is performed (it can be used to disable temporarily the BMX ERT 1604 T event sources when tuning the configuration or definitively if the function is not required for BMX ERT 1604 T family).</p> <p>Range: 250...4000 ms by step of 50 ms (value 0 is an acceptable value, no event source polling).</p> |

BME NUA 0100 Settings

Source Time Stamping

Source time stamping is supported by version .2 (and higher) of the BME NUA 0100 module (BME NUA 0100.2).

To use source time stamping in an application, you need to enable then activate it.

Enabling Source Time Stamping

Source time stamping is enabled in the Project Settings window. Navigate to **General > Time > Time Stamping Mode** then select **System**.

NOTE: The default **Time Stamping Mode** setting is **Applicative**. If you do not change the default setting to **System**, the detected error is displayed when the application is built.

Activating Source Time Stamping

Use the **IPConfig** tab of the BME NUA 0100 configuration dialog to activate and configure time stamping.

In the **Source Timestamping** section, configure the following settings:

| Setting | Description |
|------------------------|--|
| Activated | Activates source time stamping for the application. |
| Polling of buffer (ms) | The polling rate for event read requests handled by the BME NUA 0100. Valid settings range from: <ul style="list-style-type: none">• 250 ms minimum, to• 5000 ms maximum in increments of 250 ms. NOTE: The maximum number of source time stamped variables in Control Expert is 5000. |

NOTE: If the M580 local rack includes two BME NUA 0100 modules, source time stamping can be activated by only one module.

Monitoring Times Stamped Alias Variables

The BME NUA 0100 recognizes time stamped BOOL or EBOOL Alias variables created in Control Expert, but will not similarly recognize any corresponding "Alias of" variables. An example of Alias and "Alias of" variables is shown below:

| Name | Type | Alias | Alias of | HMI variable | Time stamping | Source | TS ID |
|--------------------------|-------------|--------------------------|-------------------------|--------------|---------------|--------|-------|
| Alias_INST_DDT_03_BOOL_1 | BOOL | | INST_DDT_03_BOOL_BOOL_1 | ✓ | | | |
| INST_DDT_03_BOOL | DDT_03_BOOL | | | ✓ | | | |
| BOOL_1 | BOOL | Alias_INST_DDT_03_BOOL_1 | | | Both Edges | PLC | 259 |
| BOOL_2 | BOOL | | | | None | | |
| BOOL_3 | BOOL | | | | None | | |

To be recognized by the BME NUA 0100, the Alias variables need to be embedded in the data dictionary.

BOOL or EBOOL Alias variables and their corresponding "Alias of" variables share both the same logical address inside M580 memory and the same EventID in the M580 time stamping buffer. Source time stamping is managed only on the Alias and not on "Alias of" variable. In other words, you need to subscribe the Alias variable (OPC UA node) in the OPC UA client to be able to receive the source time stamping from the device instead of from the BME NUA 0100 module.

Because neither the BOOL or EBOOL "Alias of" variable is seen as being at source time stamped by the BME NUA 0100 firmware, the Alias must be embedded in data dictionary. In that case, you need to add the Alias variable as a monitored item in an OPC UA subscription, in order to achieve source time stamping set by the device.

Selecting and Configuring the Variables to Time Stamp

What's in This Chapter

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|---|----|
| Variables Usage | 67 |
| User Time Stamping Variables | 68 |
| BME P58 xxxx Variables Settings in Control Expert | 71 |
| BMX ERT 1604 T Variables Settings in Control Expert | 72 |
| BMx CRA 312 10 Variables Settings in Control Expert | 79 |

Overview

This chapter presents how to configure and activate the time stamping variables.

NOTE: All variables that need to be time stamped as well as time stamping global parameters need to be activated in Control Expert.

Variables Usage

System Performance

Time stamping events usage has to be restricted to real needs. Each time stamped event adds additional communication to the system and thus limits the global system bandwidth.

System performance is therefore limited by intensive time stamping variables usage. Only select the variables that really need to be mapped on time stamped events.

System Limitations

System limitations, page 45 represent the maximum physical limits allowed in the system.

User Time Stamping Variables

Overview

Our system time stamping mechanism can manage not only internal variables or inputs, but also events generated and time stamped by external devices (e.g. a breaker). Such events are also called **user events** in the following documentation.

When dealing with user events, user application must make the acquisition of these events, and push them into the internal buffer of the PLC. Then these external events will be processed and forwarded to SCADA as the other internal time stamped events.

NOTE: This functionality is available for M580 OS version \geq V2.70.

Each cycle the system time stamping scans all the user events to detect a value change (transition). In case of detection, the event is stored in the event buffer of the CPU.

NOTE: The time of the user event is the time read in the DDT and not the current time of the CPU.

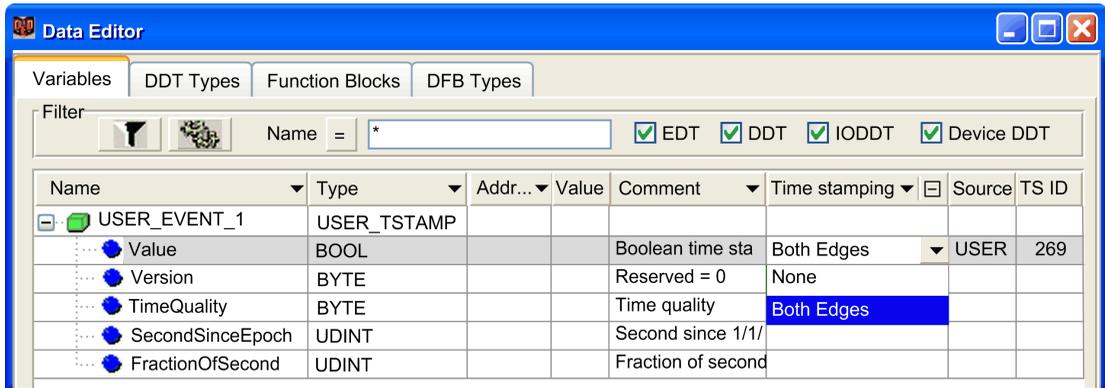
Declaring a User Event in Control Expert

To time stamp a user event:

- In the **Data Editor**, instantiate for each user event a variable with type USER_TSTAMP (DDT).

NOTE: Use only non-located variables when creating a variable of the type USER_TSTAMP. Using a located variable will cause an error to be detected during operations and the process will not operate as intended.

- Set to **Both Edges** the **Time stamping** field of the data **Value** (default setting is **None**). This setting enables the variable for time stamping, with **USER** set as the source.
- when an event is received, fill by programming the data structure of the user event variable, especially the **Value** (boolean) and the event occurrence time.



USER_TSTAMP DDT

| Element | Type | Description | |
|-------------|-----------------------------|---|---|
| Value | BOOL | User event value scanned by the system time stamping. | |
| Version | BYTE | Reserved = 0 | |
| TimeQuality | BYTE | Bit 7 = LeapsSecondsKnown. | |
| | | Bit 6 = ClockFailure | |
| | | Bit 5 = ClockNotSynchronized. | |
| | | Bit 4 to 0 = TimeAccuracy | |
| | | 00000 | n = number of significant bits in FractionOfSecond |
| | | ... | Minimum time interval shall be $2^{(-n)}$ s. For n = 10, the time accuracy is approximately 1 ms. |
| | | 01010 | |
| | | 11011 | Time catch up |
| | | 11100 | Value synchronization |
| 11101 | I/O fault | | |
| 11110 | Buffer full synchronization | | |
| 11111 | Accuracy unspecified | | |

| Element | Type | Description |
|------------------|-------|--|
| SecondSinceEpoch | UDINT | Number of seconds since midnight (00:00:00) 1970/01/01 (UTC time). |
| FractionOfSecond | UDINT | <p>This is the fraction of the current second when the value of the time stamped variable has been determined.</p> <p>It is the sum of the numerical values assigned to each bit for those bits which are set to 1:</p> <ul style="list-style-type: none"> • $1/2^1$ s is assigned to bit 23 • $1/2^2$ s is assigned to bit 22 • ... • $1/2^{24}$ s is assigned to bit 0 <p>NOTE: Bits 31 to 24 are not used</p> |

Time stamping Behavior on User Events

In normal operation conditions, the system time stamping, scans the USER_TSTAMP variables. When a rising or a falling edge on the variable is detected, the system time stamping stores the user event in the event buffer of the CPU.

The time information of each time stamped user event is the time and the quality read in the DDT.

The system time stamping solution also manages the report of user event values to the SCADA system even when the system is facing operating modes that differ from the normal operating conditions:

| | |
|-----------------------------|---|
| Values Synchronization | This state allows a synchronization of the values for example after a SCADA reset. The system time stamping updates the event buffer of the CPU with the values of all the user event variables. The time is the time read in the DDT and TimeAccuracy bit are forced to 11100. |
| Buffer Full Synchronization | The system time stamping updates the event buffer of the CPU if the current value is different from the last value recorded. The time is the time read in the DDT and TimeAccuracy bits are forced to 11110. |

Limitations

The system time stamping does not check:

- the consistency of the time read in the user event DDT.

NOTE: The time information must be compliant with the time format defined in IEC 61850-7-2 Edition 2.

- that the interval of time between two user events is greater than 1 ms. You have to respect SCADA limitation.

The system time stamping does not manage:

- the time catch up on user events. You need to provide ascending time.
- the following TimeQuality bits:
 - bit 7: LeapsSecondsKnown
 - bit 6: ClockFailure
 - bit 5: ClockNotSynchronized.

You need to manage these 3 bits.

BME P58 xxxx Variables Settings in Control Expert

Steps to Follow to Configure the Variables

Steps to follow in Control Expert for the BME P58 ••• CPU:

| Step | Action |
|------|--|
| 1 | Buffer settings, page 71: Those parameters are predefined, no action required. |
| 2 | Activate, page 72 each time stamped variable. |

Buffer Settings in Control Expert

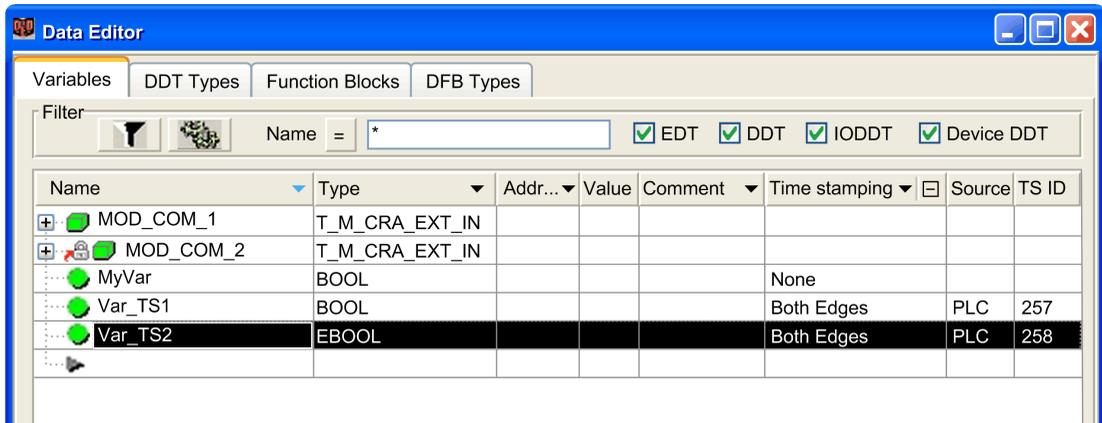
BME P58 ••• buffer behavior settings cannot be adjusted and they are preset as follows:

- **on buffer full**: The CPU stops the recording when the events buffer is full (stop the recording).
- **on power on**: New events are added to the existing events buffer if the application is the same.
NOTE: If the application is not the same, on **power on** the event buffer is cleared.
- **on stop to run**: New events are added to the existing events buffer if the application is the same.

Activating the Variables in Control Expert

To activate a variable, proceed as follows:

1. In the **Data Editor**, select the variable to time stamp.
2. In the **Time stamping** row of the variable, select the cell (default value: **None**) to set the event detection edge (**Both Edges**). Selecting the edge enables the variable for time stamping, with **PLC** set as the source.



BMX ERT 1604 T Variables Settings in Control Expert

Steps to Follow to Configure the Variables

Steps to follow in Control Expert for each BMX ERT 1604 T module:

| Step | Action |
|------|---|
| 1 | Buffer settings, page 73: Those parameters are predefined, no action required. |
| 2 | Select the channels, page 73 to time stamp in the module. |
| 3 | Activate each time stamped variable: <ul style="list-style-type: none"> • in a Modicon M340 PLC (local drop), page 75 • in a Modicon X80 Ethernet RIO Drop, page 77 |

Buffer Settings in Control Expert

BMX ERT 1604 T buffer behavior settings cannot be adjusted and they are set as follows:

- **on buffer full:** The BMX ERT 1604 T module stops the recording when the events buffer is full (stop the recording).
- **on power on:** New events can be added to the existing events buffer if the application is the same.
NOTE: If the application is not the same, on **power on** the event buffer is cleared.
- **on stop to run:** New events are added to the existing events buffer.

Selecting the Channels in Control Expert

In Control Expert, to select the variables to time stamp, double-click the BMX ERT 1604 T module in the drop.

BMX ERT 1604 T configuration screen:

DIG 16I 24/125 VDC TSTAMP

BMX ERT 1604

- Channel 0 - Time Stamping
- Channel 4 - Time Stamping
- Channel 8 - Counter
- Channel 12 - Discrete input

Configuration

| | Label | Symbol | Value | Unit |
|----|-------------------------|--------|--------------|--------|
| 0 | Debounce filter type | | Steady state | |
| 1 | Dechatter filter | | Disable | |
| 2 | Channel 4 used | | Enable | |
| 3 | Channel 4 edge | | Both edges | |
| 4 | Channel 4 debounce time | | 1 | ms |
| 5 | Channel 4 chatter count | | 255 | |
| 6 | Channel 4 chatter time | | 255 | 100 ms |
| 7 | Channel 5 used | | Enable | |
| 8 | Channel 5 edge | | Both edges | |
| 9 | Channel 5 debounce time | | 1 | ms |
| 10 | Channel 5 chatter count | | 255 | |
| 11 | Channel 5 chatter time | | 255 | 100 ms |
| 12 | Channel 6 used | | Enable | |
| 13 | Channel 6 edge | | Both edges | |
| 14 | Channel 6 debounce time | | 1 | ms |
| 15 | Channel 6 chatter count | | 255 | |
| 16 | Channel 6 chatter time | | 255 | 100 ms |
| 17 | Channel 7 used | | Enable | |
| 18 | Channel 7 edge | | Both edges | |
| 19 | Channel 7 debounce time | | 1 | ms |
| 20 | Channel 7 chatter count | | 255 | |
| 21 | Channel 7 chatter time | | 255 | 100 ms |

Function: Time Stamping

Task: .MAST

PLC bus 0.3 : BMX E...

The 16 discrete inputs are logically grouped in 4 channels (4 inputs per channel group):

| | |
|-----------------------|--|
| Channel 0: | Time stamping function is mandatory for this channel. |
| Channels 4, 8 and 12: | Time stamping function is user defined in the Function drop-down list box for this channel. |

Each channel group needs the following parameters to be set:

- **Debounce filter type**

- **Dechatter filter**

For each of the 16 discrete channel, set:

- **Channel x used** (Channel use is enabled or disabled)
- **Channel x debounce time**

NOTE: For time stamping function, channel edge event detection is set on **Both edges** for each BMX ERT 1604 T discrete input and cannot be modified.

NOTE: More details on BMX ERT 1604 T variable settings are provided in the *Modicon X80, BMXERT0604T Time Stamp Module, User Guide*, page 11. The variables are automatically created in the **Data Editor** with an ID associated.

Activating the Variables in a Modicon M340 PLC (Local Drop)

To activate the variables for time stamping:

1. Add a BMX ERT 1604 T module in the PLC bus.
2. Double-click the BMX ERT 1604 T module in the local drop.
3. Select the **I/O objects** tab.
4. Check **%I** checkbox.
5. Click **Update grid**.
6. Select the discrete channel to time stamp: **%I_{r.m.n}** where r represents the rack number, m represents the BMX ERT 1604 T module position in the rack and n the discrete channel number.
7. In the **Prefix for name:** Text box, enter a name for the selected discrete channel.
8. For each discrete time stamped channel, proceed as indicated in steps 6 and 7.

NOTE: The activated variables are of **BOOL** type.

Example of prefixed variables in a BMX ERT 1604 T located on the local rack in position 1:

| | Address | Name | Type | Comment |
|----|----------|-----------|-------|---------|
| 1 | %IO.1.0 | ERT1_CH0 | EBOOL | |
| 2 | %IO.1.1 | ERT1_CH1 | EBOOL | |
| 3 | %IO.1.2 | ERT1_CH2 | EBOOL | |
| 4 | %IO.1.3 | ERT1_CH3 | EBOOL | |
| 5 | %IO.1.4 | ERT1_CH4 | EBOOL | |
| 6 | %IO.1.5 | ERT1_CH5 | EBOOL | |
| 7 | %IO.1.6 | ERT1_CH6 | EBOOL | |
| 8 | %IO.1.7 | ERT1_CH7 | EBOOL | |
| 9 | %IO.1.8 | ERT1_CH8 | EBOOL | |
| 10 | %IO.1.9 | ERT1_CH9 | EBOOL | |
| 11 | %IO.1.10 | ERT1_CH10 | EBOOL | |
| 12 | %IO.1.11 | ERT1_CH11 | EBOOL | |
| 13 | %IO.1.12 | ERT1_CH12 | EBOOL | |
| 14 | %IO.1.13 | ERT1_CH13 | EBOOL | |
| 15 | %IO.1.14 | ERT1_CH14 | EBOOL | |
| 16 | %IO.1.15 | ERT1_CH15 | EBOOL | |

The `SOE_UNCERTAIN` parameter needs to be activated by entering its address in the **Data Editor**. To activate it proceed as follows:

1. Open the **Data Editor**.
2. Select the next empty row.
3. Select the **Address** parameter.
4. Enter `%IW.r.m.0.3.7`, where r represents the rack number and m represents the BMX ERT 1604 T module position in the rack.
5. Enter a name for the variable created (for example: `SOE_UNCERTAIN_ERT` as shown in the following picture) and validate. The variable type is automatically set to **BOOL**, time stamping field is set to **Both Edges** and a unique time stamping ID created.

Example of activated time stamped variables that appear in the **Data Editor**:

| Name | Type | Address | Value | Comment | Time stam... | Source | TS ID |
|-------------------|-------|--------------|-------|---------|--------------|--------|-------|
| ERT1_CH0 | EBOOL | %I0.1.0 | | | Both Edges | ERT | 257 |
| ERT1_CH1 | EBOOL | %I0.1.1 | | | Both Edges | ERT | 258 |
| ERT1_CH2 | EBOOL | %I0.1.2 | | | Both Edges | ERT | 259 |
| ERT1_CH3 | EBOOL | %I0.1.3 | | | Both Edges | ERT | 260 |
| ERT1_CH4 | EBOOL | %I0.1.4 | | | Both Edges | ERT | 261 |
| ERT1_CH5 | EBOOL | %I0.1.5 | | | Both Edges | ERT | 262 |
| ERT1_CH6 | EBOOL | %I0.1.6 | | | Both Edges | ERT | 263 |
| ERT1_CH7 | EBOOL | %I0.1.7 | | | Both Edges | ERT | 264 |
| ERT1_CH8 | EBOOL | %I0.1.8 | | | Both Edges | ERT | 265 |
| ERT1_CH9 | EBOOL | %I0.1.9 | | | Both Edges | ERT | 266 |
| ERT1_CH10 | EBOOL | %I0.1.10 | | | Both Edges | ERT | 267 |
| ERT1_CH11 | EBOOL | %I0.1.11 | | | Both Edges | ERT | 268 |
| ERT1_CH12 | EBOOL | %I0.1.12 | | | Both Edges | ERT | 269 |
| ERT1_CH13 | EBOOL | %I0.1.13 | | | Both Edges | ERT | 270 |
| ERT1_CH14 | EBOOL | %I0.1.14 | | | Both Edges | ERT | 271 |
| ERT1_CH15 | EBOOL | %I0.1.15 | | | Both Edges | ERT | 272 |
| SOE_UNCERTAIN_ERT | BOOL | %IW0.1.0.3.7 | | | Both Edges | ERT | 273 |

If a time stamped variable or `SOE_UNCERTAIN` parameter is not activated, an error detected message is displayed in Control Expert at build time.

Activating the Variables in a Modicon X80 Ethernet RIO Drop

To select a BMX ERT 1604 T module for time stamping in Control Expert and activate the variables for time stamping proceed as follows:

1. Double-click the BMX ERT 1604 T module in the remote drop.
2. Select the **BMX ERT 1604** root menu.
3. Select the **Device DDT** tab (the implicit device DDT name attributed by default to the device is mentioned in this tab).
4. Click **Goto details** command button, the **Data Editor** window opens.
5. In the **Data Editor**, click the **+** beside the implicit device DDT name that corresponds to the BMX ERT 1604 T module.
6. Click the **+** beside **ERT_SYNC** or **ERT_CH** elements to display the parameters.
7. Click the **+** beside the channel to be set.

NOTE: Do not change **SOE_UNCERTAIN** and **DIS_VALUE** parameters time stamping conditions. They are activated and set to **Both Edges** by default.

Example of time stamped variables selected in the **Data Editor**:

The screenshot shows the 'Data Editor' window with the 'Variables' tab selected. A filter is applied to the variable list. The table below represents the data shown in the interface:

| Name | Type | Address | Value | Comment | Time stamp... | Source | TS ID |
|----------------------|---------------------|---------|-------|--------------------|---------------|--------|-------|
| MOD_DIS_16_1 | T_M_DIS_ERT | | | | | | |
| MOD_HEALTH | BOOL | | | Module health | | | |
| MOD_FLT | BYTE | | | Module faults | | | |
| ERT_SYNC | T_M_TIME_SYN... | | | | | | |
| TIME_STAMP_RECOR... | UNIT | | | Number of Tim... | | | |
| TS_DIAGNOSTIC_FLA... | WORD | | | Diagnostic info... | | | |
| TIME_VALID | BOOL | | | Time valid and... | | | |
| CLOCK_FAILURE | BOOL | | | Clock Failure | | | |
| CLOCK_NOT_SYNC | BOOL | | | Clock Not Syn... | | | |
| BUFF_FULL | BOOL | | | Buffer full | | | |
| UMAS_COM_ERR | BOOL | | | UMAS commu... | | | |
| DECHATTER_ACT_0 | BOOL | | | Dechatter acti... | | | |
| DECHATTER_ACT_1 | BOOL | | | Dechatter acti... | | | |
| DECHATTER_ACT_2 | BOOL | | | Dechatter acti... | | | |
| DECHATTER_ACT_3 | BOOL | | | Dechatter acti... | | | |
| TS-BUF_FILLED_PCT... | BYTE | | | Percentage of... | | | |
| TS_EVENTS_STATE | BYTE | | | Main state of t... | | | |
| SOE_UNCERTAIN | BOOL | | | SOE uncertain | Both Edges | ERT | 274 |
| CLR_EVT_BUF | EBOOL | | | Clear all event... | | | |
| ERT_CH | ARRAY[0...15] OF... | | | | | | |
| ERT_CH[0] | T_M_DIS_ERT_CH | | | | | | |
| FCT_TYPE | WORD | | 2 | Function type: ... | | | |
| CH_HEALTH | BOOL | | | Channel health | | | |
| DIS_VALUE | EBOOL | | | Discrete value | Both Edges | ERT | 275 |
| CNT_VALUE | UDINT | | | Counter value | None | | |
| CLR_CNT | EBOOL | | | Not usable for ... | Both Edges | | |
| ERT_CH[1] | T_M_DIS_ERT_CH | | | | | | |
| ERT_CH[2] | T_M_DIS_ERT_CH | | | | | | |
| ERT_CH[3] | T_M_DIS_ERT_CH | | | | | | |
| ERT_CH[4] | T_M_DIS_ERT_CH | | | | | | |
| ERT_CH[5] | T_M_DIS_ERT_CH | | | | | | |

Variables Mapping

For a BMX ERT 1604 T module, 2 cases are considered:

- The module is located in the PLC local rack: Mapping is the topological address of the BMX ERT 1604 T input time stamped.
- The module is located in a Modicon X80 drop: Mapping is provided by device DDT, the I/O time stamped module location is used (for example \2.1.0.1 means: bus 2 (RIO), drop 1, rack 0, slot 1).

An alias can also be associated with a time stamped variable in device DDT.

For more details on BMX ERT 1604 T module variables, refer to *BMX ERT 1604 T Software Implementation* part of *Modicon X80, BMXERT0604T Time Stamp Module, User Guide*, page 11.

BMx CRA 312 10 Variables Settings in Control Expert

Steps to Follow to Configure the Variables

Steps to follow in Control Expert for each BM• CRA 312 10 module:

| Step | Action |
|------|--|
| 1 | Buffer settings, page 79: Those parameters are predefined, no action required. |
| 2 | Activate, page 80 each time stamped variable located in discrete I/O modules. |

Buffer Settings in Control Expert

BM• CRA 312 10 buffer behavior settings cannot be adjusted and they are preset as follows:

- **on buffer full:** The BM• CRA 312 10 module stops the recording when the events buffer is full (stop the recording).
- **on power on:** New events are added to the existing events buffer if the application is the same.

NOTE: If the application is not the same, on **power on** the event buffer is cleared.

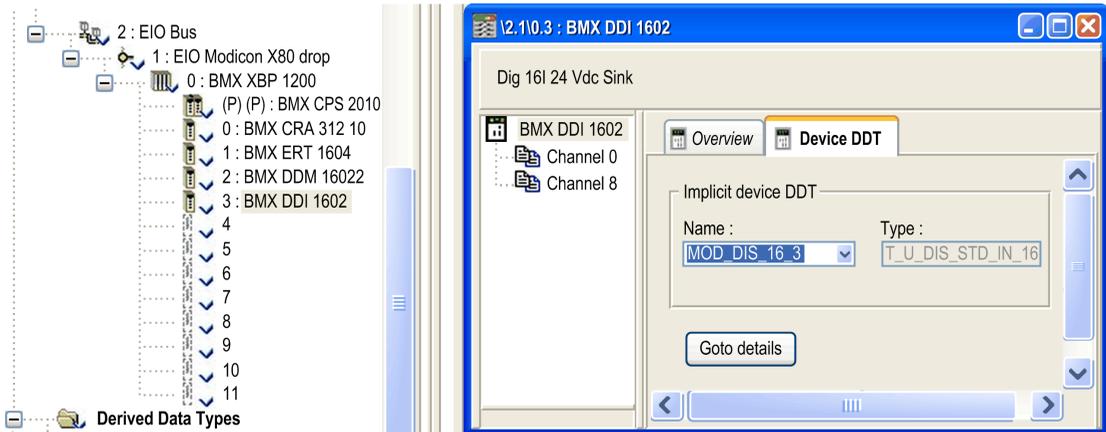
- **on stop to run:** New events are added to the existing events buffer if the application is the same.

Activating the Variables in Control Expert

Each input and output of discrete modules, page 29 located on a Modicon X80 drop with a BM• CRA 312 10 can be time stamped.

To select a discrete module for time stamping in Control Expert, proceed as follows:

1. Double-click the discrete module in the remote drop.
2. Select the **Device DDT** tab (the implicit device DDT name attributed by default to the device is mentioned in this tab).
3. Click **Goto details** command button, the **Data Editor** window opens.



To set a channel time stamping parameter for the discrete module chosen, proceed as follows:

1. In the **Data Editor**, click the **+** beside the implicit device DDT name that corresponds to the discrete module you want to set in order to display the module elements.
2. Click the **+** beside **DIS_CH_IN** or **DIS_CH_OUT** elements to display each channel parameter.
3. Click the **+** beside the channel to be set.
4. In the **VALUE** parameter line, double-click in the **Time stamping** cell to set the event detection edge. Selecting the edge enables the channel for time stamping.

NOTE: Do not change the Modicon X80 drop **SOE_UNCERTAIN** parameter time stamping condition. It is activated and set to **Both Edges** by default.

The screenshot shows the 'Data Editor' window with the 'Variables' tab selected. The filter is set to 'Name = *'. The table below lists the variables and their configurations.

| Name | Type | Addr... | Value | Comment | Time stamp... | Source | TS ID |
|--------------|-------------------------|---------|-------|----------------------|---------------|--------|-------|
| DROP_1 | T_M_DROP_EXT_IN | | | | | | |
| DROP_2 | T_U_DROP_STD_IN | | | | | | |
| MOD_COM_1 | T_U_CRP_STD_IN | | | | | | |
| MOD_DIS_16_1 | T_M_DIS_ERT | | | | | | |
| MOD_DIS_16_2 | T_U_DIS_STD_IN_8_O... | | | | | | |
| MOD_DIS_16_3 | T_U_DIS_STD_IN_16 | | | | | | |
| MOD_HEALTH | BOOL | | | Module health | | | |
| MOD_FLT | BYTE | | | Module faults | | | |
| DIS_CH_IN | ARRAY[0...15] OF T_U... | | | | | | |
| DIS_CH_IN[0] | T_U_DIS_STD_CH_IN | | | | | | |
| DIS_CH_IN[1] | T_U_DIS_STD_CH_IN | | | | | | |
| CH_HEALTH | BOOL | | | Channel health | | | |
| VALUE | EBOOL | | | Discrete input value | Rising Edge | CRA | 276 |
| DIS_CH_IN[2] | T_U_DIS_STD_CH_IN | | | | | | |
| DIS_CH_IN[3] | T_U_DIS_STD_CH_IN | | | | | | |

Variables Mapping

As the module is located in a Modicon X80 drop, mapping is provided by device DDT, the I/O time stamped module location is used (for example \2.1\0.1 means: bus 2 (RIO), drop 1, rack 0, slot 1).

An alias can also be associated with a time stamped variable in device DDT.

Selecting the Communication Parameters

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| OFS Communication Settings | 84 |

Overview

This chapter describes how to set the communication parameters once the number of events detected is properly estimated.

Capability Checks

Requirements

The normal average number of time stamped events detected per second in the installation needs to be estimated by the user in order to define the communication parameters.

Based on the normal number of events, the user sets:

- OFS polling rate, page 84
- OFS client alive timeout, page 85
- BME NUA 0100 polling rate, page 64

OFS Performance

OFS communicates with several PLCs and devices. The assumption is that 50% of the PC resources are used by OFS and 50% are used by AVEVA Plant SCADA.

A dedicated tool (**OFS TimeStamp Helper**) is used to estimate the event detection capability depending on the polling rate chosen. This tool is located on the OFS installation DVD.

OFS TimeStamp Performance Helper Tool Purpose and Use

OFS TimeStamp Helper tool is intended to help you to define OFS setting parameters when it is used in a configuration with time stamping solution.

NOTE: .NET Framework 3.5 Service Pack 1 or higher is required to run **OFS TimeStamp Helper**.

The **Configuration** tab allows to configure **OFS TimeStamp Helper** tool. When the cursor points to a spin box with a value to be entered, **Minimum** and **Maximum** values are displayed in a dialog box.

- In **Configuration > General** specify the number of PLCs included in the installation.
- In **Configuration > PLC Configuration : > PLC n°x** specify the parameters for each PLC of the installation.

The **Results** tab displays information provided by the **OFS TimeStamp Helper** tool. When the cursor points to a result dialog box, the value **Limit** is displayed in a dialog box. If the limit value is exceeded the dialog box border is displayed in red.

- Recommendation on normal number of events detected per second.

According to the hardware architecture and the associated OFS time stamped events polling rates, the tool provides a recommendation on the normal number of events detected per seconds that should be targeted in order to be able to manage additional temporary bursts of events stored in the buffer.

This information appears in the following folders:

- **Results > PLC Results : > PLC n°x > CPU, or BMX CRA, or BMX ERT**
Number of events detected per second per CPU, or CRA, or ERT
CPU: Computed polling rate in ms
CRA or ERT: Total number of events detected per second per PLC
- **Results > General**
CPUs Total number of events detected per second
BMX-CRAs total number of events detected per second (for all PLCs)
BMX-ERTs total number of events detected per second (for all PLCs)

- Estimation of the time needed to read a full buffer.

After a temporary burst or after a particular operating mode such as a cable disconnection between the time stamping source of events and OFS, the event buffer can become full. The tool provides an estimation of the time needed to read this event buffer and to come back to a normal situation in which the system runs with the normal number of events per second. The time to read the buffer depends on the OFS time stamped events polling rate (buffer output flow), the number of events stored in the buffer and the normal number of events per second (buffer input flow).

This information appears in the following folder:

- **Results > PLC Results : > PLC n°x > CPU, or BMX CRA, or BMX ERT**

Time to read full buffer in second

NOTE: For a BMX ERT 1604 T, **Time to read full buffer in second** is a minimum value because the tool considers that there is 1 event in each of the 255 groups of the BMX ERT 1604 T buffer. A group is a set of 1 to 16 events detected in the same cycle. If 16 events are detected in each group, the **Time to read full buffer in second** value has to be multiplied by 16.

- Estimation of the total OFS bandwidth (msg/sec).

The tool provides an estimation of the total OFS bandwidth (msg/sec.) used to read the normal number of events per second on all PLCs and it checks that the estimated bandwidth does not exceed the maximum OFS bandwidth allocated to read events.

This information appears in the following folder:

- **Results > General**

OFS bandwidth used to read events (msg/s)

- Total number of time stamped I/Os in 1 PLC.

This information allows to check that the maximum number of configured time stamped I/Os is not exceeded.

This information appears in the following folder:

- **Results > PLC Results : > PLC n°x**

Total number of time stamped IOs on one PLC

OFS Communication Settings

OFS Polling Rate

OFS polling rate, page 62 is a value defined globally for each following event source type:

- BME P58 •••• CPU internal variables.

- PLC local BMX ERT 1604 T modules and Modicon X80 Ethernet remote I/O BMX ERT 1604 T modules.
- Modicon X80 Ethernet remote I/O BM• CRA 312 10 modules.

NOTE: OFS polling rate setting has to be validated using the **OFS Time Stamp Helper Tool** in order to check that the normal average number of time stamped events estimated by the user can be read and that the capability of the system is not exceeded, page 82.

OFS Client Alive Timeout

OFS client alive timeout allows OFS to detect that the OFS client is not responding.

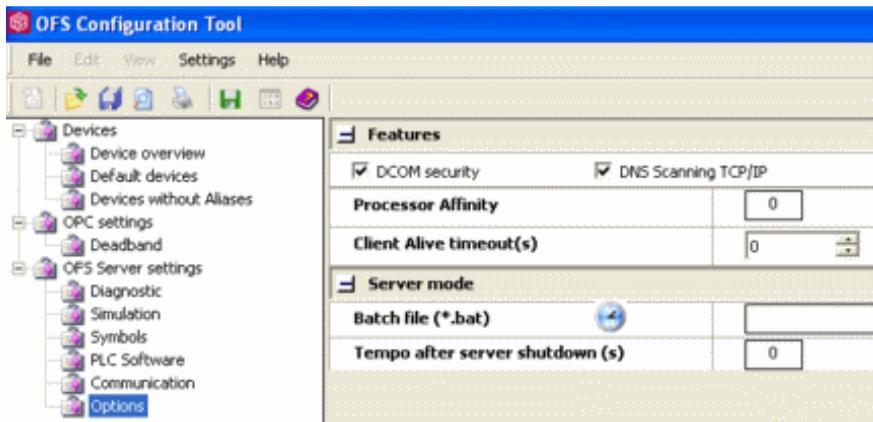
If OFS client is not responding, the event group is deactivated and OFS stops reading events in the sources. For that reason, make sure to configure a client alive timeout value not equal to 0 in order to activate this function.

Client alive timeout value is set between 2...30 s. Timeout value is determined by the customer.

For more details on setting client alive service in OFS, refer to *Client-alive Service* chapter in *OPC Factory Server User Manual*, page 11.

NOTE: Events notified to the client are lost if the client has no time to process or back up the notified values before it disappears.

The following figure shows **OFS Configuration Tool** menu accessed to set the client alive timeout value:



Setting AVEVA Plant SCADA Parameters

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| Time Quality and SOE Uncertain Sequence | 90 |

Overview

This chapter describes the parameters to configure in AVEVA Plant SCADA to visualize the sequence of events and quality parameters.

AVEVA Plant SCADA Parameters

Overview

AVEVA Plant SCADA receives time stamped variable data from OFS via OFSOPC driver and provides a display of:

- Time stamped data
- Time quality
- Diagnostic information

The time quality information can be viewed on the **Active Alarm** and **SOE** pages for AVEVA Plant SCADA.

AVEVA Plant SCADA minimizes the chance of time stamped data loss by replicating event data between redundant I/O server instances.

More details on AVEVA Plant SCADA configuration are provided in *AVEVA Plant SCADA User Guide and AVEVA Plant SCADA Help*, page 11. More details on redundancy configuration are provided in chapter *Building Redundancy Into Your System* of *AVEVA Plant SCADA User Guide*, page 11 or *AVEVA Plant SCADA Help*, page 11, and in topic *Configuring Redundancy of OFSOPC Driver* html help file.

At source time stamping functionality and time quality is natively displayed from AVEVA Plant SCADA. It is supported by OFSOPC driver from version v2.05.09.001.

Variable Tag Configuration

A variable tag needs to be configured in AVEVA Plant SCADA to represent the corresponding time stamped variable in the PLC. The variable tag provides access to the current time stamped OPC item value, quality, and timestamp.

To configure a time stamped digital alarm, set the variable tag data type to **DIGITAL**.

More details on device communication setup and variable tag configuration is provided in the *Setting up device communication* and *Configuring variable tags* sections of OFSOPC help document.

Example of variable tag configuration screen:

The screenshot shows the 'Variable Tags' configuration window. The fields are as follows:

- Equipment:** PLC1.Breaker1
- Item Name:** (empty)
- Cluster Name:** C1
- Comment:** (empty)
- Tag Name:** PLC1\Breaker1Fault
- I/O Device:** PLC1
- Address:** Breaker1Fault
- Data Type:** DIGITAL
- Raw Zero Scale:** (empty)
- Raw Full Scale:** (empty)
- Eng Zero Scale:** (empty)
- Eng Full Scale:** (empty)
- Eng Units:** (empty)
- Format:** (empty)
- Deadband:** (empty)
- Historize:** (empty)
- Custom 1-8:** (empty)

Buttons: Add, Replace, Delete, Help

Status: Record : 1, Linked: No

Time Stamped Digital Alarm and Equipment Configuration

A time stamped digital alarm need to be configured in AVEVA Plant SCADA in order to display time stamped event data on the **Active Alarm** or **SOE** page. The alarm is associated with the variable tag which receives time stamped event data.

It is recommended to add static information such as time stamped event source location in one of the 8 **Custom** fields available (for example BMX CRA @IP address or Ethernet connection point @IP address used to reach the BMX ERT).

The name of the equipment on which the I/O is connected to generate the event (PLC1. Breaker1 for example) can be entered in the **Equipment** field or directly in the equipment database with AVEVA Plant SCADA.

More details on time stamped digital alarm configuration is provided in the *Time-stamped Digital Alarm Properties* section of *AVEVA Plant SCADA User Guide*, page 11 or *AVEVA Plant SCADA Help*, page 11, and details on the equipment configuration is provided in the *Using Equipment* section of *AVEVA Plant SCADA User Guide*, page 11 or *AVEVA Plant SCADA Help*, page 11.

Example of time stamped digital alarm configuration screen:

Time Stamped Digital Alarms [OFS_TS_Simulator_Inc1]

Equipment: ▼

Item Name: Cluster Name: ▼

Comment:

Alarm Tag: Category: ▼

Alarm Name:

Alarm Desc:

Variable Tag A: ▼

Variable Tag B: ▼

Delay: ▼ Help: ▼

Area: Privilege:

Paging: ▼ Paging Group:

Historize: ▼

| | |
|--|--|
| Custom 1: <input type="text" value="CRA1@10.176.18.53"/> | Custom 2: <input type="text" value="Testing 2"/> |
| Custom 3: <input type="text" value="Testing 3"/> | Custom 4: <input type="text" value="Testing 4"/> |
| Custom 5: <input type="text" value="Testing 5"/> | Custom 6: <input type="text" value="Testing 6"/> |
| Custom 7: <input type="text" value="Testing 7"/> | Custom 8: <input type="text" value="Testing 8"/> |

Record : 1 Linked: No

Example of equipment configuration screen:

The image displays two screenshots of the AVEVA Plant SCADA configuration interface. The top window, titled "Equipment Types [OFS_TS_Master_Simulator]", shows a form for defining a new equipment type. The "Name" field contains "Breaker". Below the form are buttons for "Add", "Replace", "Delete", and "Help", and a "Record : 1" indicator. The bottom window, titled "Equipment [OFS_TS_Master_Simulator]", shows the configuration for a specific equipment instance. The "Name" field contains "PLC1.Breaker1". Other fields include "Type" (Breaker), "Cluster Name" (C1), "I/O Device" (PLC1), "Page", "Location", "Area", "Comment", "Default State", and "Scheduled".

Time Quality and SOE Uncertain Sequence

Time Quality Description

For time stamped variables, OFS provides data related to the timestamp quality to AVEVA Plant SCADA.

The timestamp quality is an 8 bits time quality flag contained within the OPC flags for the OPC item.

Time quality configuration and display is available in AVEVA Plant SCADA as described in the following topics.

Time Quality in AVEVA Plant SCADA

AVEVA Plant SCADA introduces an SOE page which displays events in a SOE format. Each record represents a single change of an event. This page can also be used to display time stamped event data with time quality.

In the **Active Alarm** page and the **SOE** page, 2 columns display time quality information:

- **TSQuality:** Displays a string that is the synthetic representation of the time quality. The string takes one of the following values:
 - Time Good
 - Time Uncertain
 - Clock Not Synchronized
- **Quality:** Displays a numeric value, page 102 reflecting the OPC quality flag. This value is built as follows:
 - Highest 8 bits represent the time quality.
 - Lowest 8 bits represent the quality, substatus, and limit status according to the OPC specification. More details are provided in section *The Quality Tag Element* of *AVEVA Plant SCADA User Guide*, page 11 or *AVEVA Plant SCADA Help*, page 11.

To display the **Active Alarm** and **SOE** pages (not displayed by default), the following init parameters need to be modified by the user:

- **[Format]Alarm**
- **[Format]SOE**

To display **TSQuality** and **Quality** information, the user needs to include the fields **TSQuality** and **Quality** in the list of columns of:

- **[Format]Alarm**

Example: `[Format]Alarm = {Time, 101}{OnTime, 101}{Tag, 100}{Name, 181}{TSQuality, 100}{Quality, 50}`

- **[Format]SOE**

Example: `[Format]SOE = {Time, 101}{Message, 250}{Source, 100}{Name, 181}{TSQuality, 100}{Quality, 50}`

More details on **[Format]Alarm** and **[Format]SOE** parameters is provided in sections *Alarm display fields* of *AVEVA Plant SCADA User Guide*, page 11 or *AVEVA Plant SCADA Help*, page 11, and in topic *[Format]FormatName* of *AVEVA Plant SCADA Help*, page 11.

Configure an Alarm to Display SOE Uncertain Sequence

To display the uncertain SOE sequence (sequence during which some events may be lost), each event source needs to be configured as follows:

- A variable tag is associated, page 87 to the source SOE uncertain variable.
- A time stamped digital alarm is configured, page 88 for each variable tag previously associated.

The SOE uncertain variable address depends on the time stamping module type and its location:

- BME P58 •••• CPU. The variable needs to be created by the user, page 72 in Control Expert and mapped on %SW73.7 system word (SOE_UNCERTAIN).
- BM• CRA 312 10 module in a Modicon X80 Ethernet RIO drop: The variable is mapped on the SOE_UNCERTAIN field of the BM• CRA 312 10 Device DDT. The Device DDT variable is automatically created, page 80 in Control Expert, and it has a T_M_DROP_EXT_IN type. The variable is named SOE_UNCERTAIN.
- BMX ERT 1604 T module in a Modicon X80 Ethernet RIO drop: The variable is mapped on the SOE_UNCERTAIN field of the BMX ERT 1604 T Device DDT. The Device DDT variable is automatically created, page 77 in Control Expert, and it has a T_M_DIS_ERT type. The variable is named ERT_SYNC.SOE_UNCERTAIN.
- BMX ERT 1604 T module in a Modicon M340 local drop: The variable needs to be created by the user, page 75 in Control Expert and mapped on %IW0.n.0.3.7 (where n represents the module position in the rack).

Configure an Alarm to Display TS Event Source Disconnection

To display the status of the connection with the event source, associate 1 digital alarm per source with a specific item: <direct_address>!#PlcQualStatus where <direct_address> is the address of the source. For more details, refer to **Specific Items > Description** topic in *OPC Factory Server User Manual*, page 11.

Commissioning and Operation Phases

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Introduction

This part presents the time stamping diagnostic, the behavior on operating modes and time synchronization.

Diagnostic

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Overview

This chapter describes the available diagnostic views, the diagnostic information provided by the system and the components diagnostic.

Introduction

Diagnostic Data

Diagnostic data provide information on:

- Quality of the time stamping for each event.
- Time and buffers management.
- Communication between each time stamping source and client.

Diagnostic information is displayed on:

- AVEVA Plant SCADA
- OFS
- BME NUA 0100
- PLC variable viewers
- Time stamping source module (hardware)

Diagnostic Sources

At source time stamping diagnostic information is provided by:

- Time stamping event sources.
- OFS software.

Diagnostic Data Availability

The following table describes the diagnostic data access mode and presentation:

| Diagnostic Data Source | Diagnostic Data | Presentation |
|--|-------------------------------|---|
| Time stamping event sources | Buffer diagnostic | Viewers of PLC variables: Device DDT or IODDT (SCADA, Control Expert...). |
| | Time valid, synchronized | |
| | TS Events service state | |
| | I/O Channel error | |
| | SOE Uncertain ^(1.) | SCADA alarm viewer or SOE viewer. |
| | Time Quality | |
| | I/O channel error | |
| OFS | Event service communication | Network Info window in the Devices tree-view. |
| | Connection health status | SCADA alarm viewer or SOE viewer or diagnostic animation page. |
| 1. Variable tag needs to be created by the user. | | |

AVEVA Plant SCADA Settings

It is strongly recommended to set time stamping diagnostic parameters in AVEVA Plant SCADA, page 101.

PLC View

Overview

Diagnostic data on time stamping modules and events quality can be accessed on the PLC. The following topics present the data that can be accessed through the PLC interface (Control Expert software).

Time Stamping Diagnostic

Diagnostic data for the BME P58 ••••, BMX ERT 1604 T, and BM• CRA 312 10 modules:

- `TS_DIAGNOSTIC_FLAGS` that contains:
 - `TIME_VALID`: Means that the time is valid and the clock is synchronized.
 - `CLOCK_FAILURE`: Means that the time source is not currently reliable or that the initial synchronization has not been done since the time stamping module start.
 - `CLOCK_NOT_SYNC`: Means the time synchronization is lost while the time stamping module is running.
 - `BUFF_FULL`: Buffer full indication. The bit set to 1 on buffer full detection (bit is cleared when buffer is able to store new events).

- `TS_BUF_FILLED_PCTAGE`: Percentage of buffer filled.

For the BMX ERT 1604 T module, the percentage of buffer filled is calculated by group number whereas in the BME P58 •••• and BM• CRA 312 10 modules it is calculated by event number. For example, in a BMX ERT, for 16 groups of 1 event each: $TS_BUF_FILLED_PCTAGE = 16 / 255 * 100$ (255 represents the maximum number of groups that can be stored in the BMX ERT buffer).

- `TS_EVENT_STATE`: Time stamping events state for internal use.

BMX ERT 1604 T Module in a Modicon M340 Local Drop

Diagnostic data are accessed through PLC language interface or IODDT:

- PLC language interface: `%IWr.m.0.3` to `%IWr.m.0.5` (where r is the rack number, and m is the BMX ERT 1604 T position in the rack).

For details on implicit input parameters, refer to chapter *Language Objects for Channels* in *Modicon X80, BMXERT0604T Time Stamp Module, User Guide*, page 11.

- `T_ERT_TS_MOD` IODDT

This IODDT is mapped on BMX ERT 1604 T channel 0: `%CHr.m.0` (where r is the rack number, and m is the BMX ERT 1604 T position in the rack).

For details on BMX ERT 1604 T IODDTs, refer to chapter *IODDTs* in *Modicon X80, BMXERT0604T Time Stamp Module, User Guide*, page 11.

BMX ERT 1604 T Module in a Modicon X80 Ethernet RIO Drop

Diagnostic data are accessed through `T_M_DIS_ERT.ERT_SYNC` PLC device DDT.

For details on those device DDTs, refer to chapter *Device DDT Names for Quantum EIO Remote I/O Adapter Modules* in *Quantum EIO, Remote I/O Modules, Installation and Configuration Guide*, page 11.

BMx CRA 312 10 Module Diagnostic in Control Expert

Diagnostic data are accessed through `T_M_DROP_EXT_IN` PLC device DDTs.

For details on those device DDTs, refer to chapter *Device DDT Names for Quantum EIO Remote I/O Adapter Modules* in *Quantum EIO, Remote I/O Modules, Installation and Configuration Guide*, page 11.

BME P58 xxxx CPU Diagnostic in Control Expert

Diagnostic data are accessed through `%SW67`, `%SW73`, and `%SW74` system words.

For details on those system words, refer to *EcoStruxure™ Control Expert, System Bits and Words, Reference Manual*, page 11.

OFS View

Introduction

OFS provides diagnostic data on connection status of the event sources and buffer level.

Items for Connection Diagnostic Between OFS and Devices

To diagnose the connection status with the time stamping event sources, 2 items of `VT_I2` type (activated in a standard OPC group) are available and can be displayed on the SCADA (**AVEVA Plant SCADA View** for example):

- `#PLCQualStatus`
- `#PLCQualStatus2`

NOTE: Those 2 items have the same feature, but it is recommended to use `#PLCQualStatus` item because:

- It optimizes the communication when used in groups with different periods.
- It automatically uses `#PLCQualStatus2` item on devices that are not the PLC.

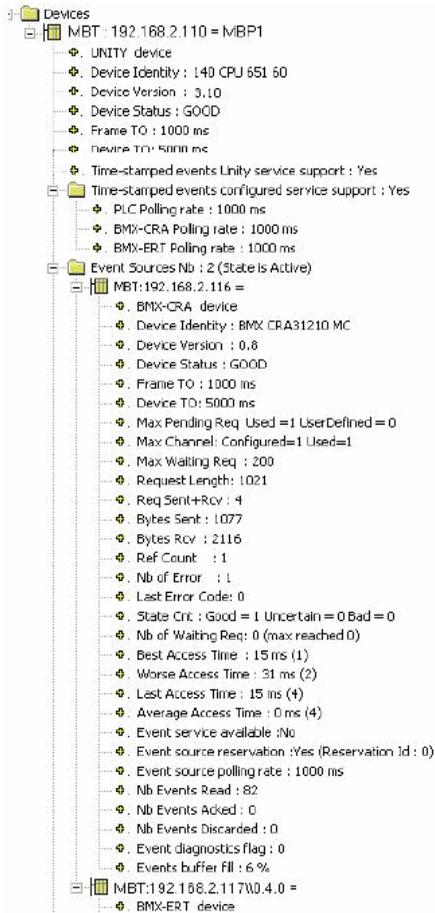
Those items can return one of the following values:

| | |
|--|--|
| QUAL_BAD + QUAL_COMM_FAILURE (value 0018 hex): | Device is INCONSISTENT (SymbolFile differs from PLC application). |
| QUAL_BAD + QUAL_DEVICE_FAILURE (value 000C hex): | No communication with the device since DEVICE_TO milliseconds. |
| QUAL_BAD (value 0000 hex): | Device is MISSING or UNKNOWN. |
| QUAL_GOOD (value 00C0 hex): | Communication with the device is correct. |
| QUAL_UNCERTAIN (value 0040 hex): | No communication with the device since less than DEVICE_TO milliseconds. |

For more details on the time stamping event sources diagnostic items, syntax and content, refer to sections *Specific Items* and *Time Stamped Events Configuration* in *OPC Factory Server User Manual*, page 11.

Event Service Communication Diagnostic

Example of diagnostic information displayed in OFS:



BME NUA 0100 View

Introduction

BME NUA 0100 provides diagnostic and descriptive information.

Items for Connection Diagnostic

To diagnose the connection status with the time stamping event sources the following item is available:

#PLCQualStatus

It can return one of the following values:

- QUAL_BAD + QUAL_COMM_FAILURE (value 0018 hex): Device is INCONSISTENT (SymbolFile differs from PLC application).
- QUAL_BAD + QUAL_DEVICE_FAILURE (value 000C hex): No communication with the device since DEVICE_TO milliseconds.
- QUAL_BAD (value 0000 hex): Device is MISSING or UNKNOWN.
- QUAL_GOOD (value 00C0 hex): Communication with the device is correct.
- QUAL_UNCERTAIN (value 0040 hex): No communication with the device since less than DEVICE_TO milliseconds.

Managed Informational Items of the BME NUA 0100

These items include:

- #AppliName: Name of the application read from the PLC.
- #AppliVersion: Version number of the application read from the PLC.
- #DeviceIdentity: Device type.
- #CurrentMonitoredItemsCount: Current monitored item count for all simultaneous sessions/clients.
- #TSEventSynchro: A read/write BOOL item that, when activated, sends a synchronized value to the entire at source time stamping devices attached to the M580 ePAC, each time a write operation is performed. The purpose is to initialize all the timestamped monitored items to their current values.
- #TSEventItemsReady: A read-only BOOL item that indicates whether source time stamped variables and source time stamping devices have been browsed in the M580 ePAC application.
- #PLCQualStatus: 0 if QUAL_BAD, 12 if QUAL_FAILURE, 40 if QUAL_UNCERTAIN, 192 if QUAL_GOOD.
- #PLCDataDicReady: 1 if PLC data dictionary is not available, 2 if PLC data dictionary is available, 4 if PLC data dictionary is busy.
- #AddressSpaceState: 0 when address space is empty, 1 if address space is built, 2 when address space is updating, 3 if address space is partially built.

- #CurrentDataDictionaryItemsCount: Number of variable in data dictionary - negative values are displayed if an error is detected.

AVEVA Plant SCADA View

Introduction

In AVEVA Plant SCADA alarm viewer or event viewer the following information is available once the settings, page 90 are done:

- **SOE Uncertain alarm or event:** Displays beginning and end of uncertain sequences.
- **Time quality:** Provides time quality diagnostic and precedence of display.

It is highly recommended to configure and display custom fields for each alarm or event (for example, display the source of alarm or event). Custom fields are filled in during configuration, page 88.

Network access to the time stamping module is an OFS-specific item that can be displayed on the SCADA (for more details refer to *Specific Items* section of *OPC Factory Server User Manual*, page 11). It provides information on module access (specific item in TS Event Group: #PLCQualStatus).

SOE Uncertain Sequence and Time Quality Display

Each source of event SOE uncertain alarms and the time quality associated with every TS event can be displayed in AVEVA Plant SCADA, page 86.

Example of SOE uncertain sequence and time quality display on AVEVA Plant SCADA **SOE** page:

| Time | Millisec | Tag | Name | Message | Quality | TSQuality | Equipment | Custom1 |
|-------------|----------|------------------|--------------------|----------------------------------|---------|----------------|---------------|-------------------|
| 05:45:38 PM | 35 | PLC1Breaker1Fail | PLC1_Breaker1_Fail | PLC1Breaker1Fail – Alarm cleared | 2752 | Time Good | PLC1.Breaker1 | CRA1@10.176.18.53 |
| 05:44:09 PM | 900 | PLC1CRA1_SOEUnc | PLC1_CRA1_SOEUnc | PLC1CRA1_SOEUnc – Alarm cleared | 2752 | Time Good | PLC1.CRA1 | CRA1@10.176.18.53 |
| 05:44:03 PM | 968 | PLC1Breaker1Fail | PLC1_Breaker1_Fail | PLC1Breaker1Fail – Alarm raised | 7872 | Time Uncertain | PLC1.Breaker1 | CRA1@10.176.18.53 |
| 05:43:20 PM | 25 | PLC1Breaker1Fail | PLC1_Breaker1_Fail | PLC1Breaker1Fail – Alarm cleared | 7872 | Time Uncertain | PLC1.Breaker1 | CRA1@10.176.18.53 |
| 05:43:12 PM | 110 | PLC1CRA1_SOEUnc | PLC1_CRA1_SOEUnc | PLC1CRA1_SOEUnc – Alarm raised | 2752 | Time Good | PLC1.CRA1 | CRA1@10.176.18.53 |
| 05:42:55 PM | 609 | PLC1Breaker1Fail | PLC1_Breaker1_Fail | PLC1Breaker1Fail – Alarm raised | 2752 | Time Good | PLC1.Breaker1 | CRA1@10.176.18.53 |

Explanation on **Quality** field value from previous example:

- 2752 dec = 00001010 11000000 binary
Higher and lower part content description
 - 00001010: 1 ms resolution
 - 11000000: OPC Quality Good
- 7872 dec = 00011110 11000000 binary
Higher and lower part content description
 - 00011110: Buffer Full
 - 11000000: OPC Quality Good

Quality Display Format

The following table provides the relationship between the **TSQuality** string and the **Quality** values (the complete quality information is provided in the **Quality** column in AVEVA Plant SCADA display):

| Context (Source Status) | Quality Description (TSQuality) | Quality Highest 8 Bits Binary Value (Quality) | Comment |
|---|------------------------------------|--|---|
| Clock not reliable, or initial clock synchronization not done | Time Uncertain | 011x xxxx | x xxxx can be equal to: <ul style="list-style-type: none"> • 0 1010: Time resolution is 1 ms • 1 1110: Buffer full • 1 1100: Values synchronization • 1 1101: I/O channel error |
| Clock not synchronized | Clock Not Synchronized | 001x xxxx | x xxxx can be equal to: <ul style="list-style-type: none"> • 0 1010: Time resolution is 1 ms • 1 1110: Buffer full • 1 1100: Values synchronization • 1 1101: I/O channel error |
| Clock OK + I/O channel error | Time Good | 0001 1101 | 0001 1101 value meaning: <ul style="list-style-type: none"> • 000: Clock OK • 1 1101: I/O channel error |
| Clock OK + Values synchronization (TSInit, page 113 , page 120) | Time Uncertain | 0001 1100 | 0001 1100 value meaning: <ul style="list-style-type: none"> • 000: Clock OK • 1 1100: Values synchronization |
| Clock OK + Buffer full (Invalid, page 117) | Time Uncertain | 0001 1110 | 0001 1110 value meaning: <ul style="list-style-type: none"> • 000: Clock OK • 1 1110: Buffer full |

| Context (Source Status) | Quality Description (TSQuality) | Quality Highest 8 Bits Binary Value (Quality) | Comment |
|--|------------------------------------|--|---|
| Clock OK + Time catch up mode (ClockInSync , page 124) | Time Uncertain | 0001 1011 | 0001 1011 value meaning: <ul style="list-style-type: none"> • 000: Clock OK • 1 1011: Time catch up |
| Normal operating condition | Time Good | 0000 1010 | 0000 1010 value meaning: <ul style="list-style-type: none"> • 000: Clock OK • 0 1010: Time resolution is 1 ms |

NOTE: Some detected errors cannot be displayed simultaneously and if this situation occurs, they will be displayed respecting the following precedence order:

1. I/O channel error (highest priority)
2. **Invalid** or **TSInit**
3. **ClockInSync**

PLC Connection Status

If a connection to the PLC is lost, a hardware alarm is generated. The alarm entry contains the I/O device name and the alarm message: **I/O Device off-line, cannot talk**.

Example of alarm displayed after a PLC connection has been lost:

| Time | Millisec | Tag | Name | Desc | Errpage | Errdesc |
|-------------|----------|-------|------------|----------------------------------|---------|---------|
| 05.45:55 PM | 901 | IODEV | PLC Server | I/O Device off-line, cannot talk | IODEVCI | |

Event Source Connection/Disconnection

When properly configured, page 92, AVEVA Plant SCADA can show the status of the connection with the event source.

Example of source disconnection displayed on AVEVA Plant SCADA **SOE** page:

| Time | Millisec | Tag | Name | Message | Quality | TSQuality | Equipment | Custom1 |
|-------------|----------|-------------------|-------------------|----------------------------------|---------|-----------|-----------|-------------------|
| 05:59:55 PM | 609 | PLC1\CRA1_OffLine | PLC1_CRA1_OffLine | PLC1\CRA1_OffLine – Alarm raised | 192 | | PLC1.CRA1 | CRA1@10.176.18.53 |

Explanation on **Quality** field value from previous example:

- 192 dec = 00000000 11000000 binary
 - Lower part content description
 - 11000000: OPC Quality Good

OFSOPC Driver Troubleshooting

OFSOPC driver generates extensive logging information at runtime. This information can be used for diagnostics of the driver operation.

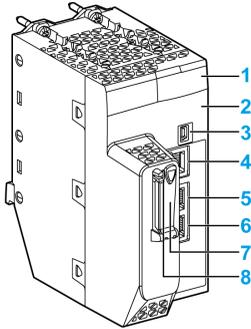
Configuring OFSOPC driver logging is described in the *Logging* section of OFSOPC driver help.

The user can also use the AVEVA Plant SCADA kernel I/O devices window which shows specific statistics and information about each I/O device.

Hardware Diagnostic

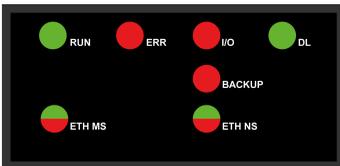
BME P58 xxxx Module View

CPU front view:



- 1 LED display
- 2 MAC address
- 3 mini-B USB connector
- 4 SERVICE port
- 5 DEVICE NETWORK port
- 6 DEVICE NETWORK port
- 7 SD memory card slot
- 8 SD status LED

LED display:



The following table describes the LED indicator patterns:

| Symbol | Description | Symbol | Description |
|---|----------------|---|--------------------|
|  | off |  | steady red |
|  | steady green |  | blinking red |
|  | blinking green |  | blinking red/green |

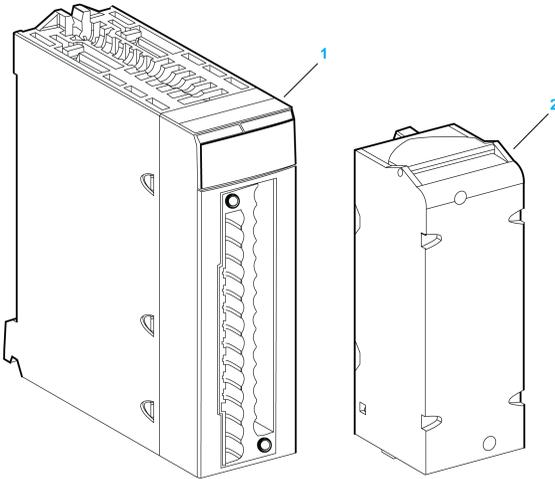
The following table describes the LED display activity meaning for diagnostic purpose:

| Condition | CPU State | RUN | ERR | I/O | ETH MS | ETH NS |
|---|-----------|---|---|---|---|---|
| power on | Autotest |  |  |  |  |  |
| not configured (before getting a valid IP address or configuration is invalid) | NO-CONF |  |  |  |  | any pattern |
| configured | Stop |  |  | <ul style="list-style-type: none"> • off: no error detected • steady red: error detected in a module or a channel |  | <ul style="list-style-type: none"> • off: invalid IP address • steady red: duplicate IP address • blinking green: valid IP address but no EtherNet/IP connection • steady green: EtherNet/IP connection established |
| | RUN |  |  | |  | |
| recoverable detected error | HALT |  |  | any pattern |  | <ul style="list-style-type: none"> • steady red: duplicate IP address • blinking red: At least one exclusive owner CIP connection (for which the BME NOC 03•1 is the originator) is timed out. The LED blinks until the connection is reestablished or the module is reset. |

| Condition | CPU State | RUN | ERR | I/O | ETH MS | ETH NS |
|------------------------------|-----------|-----|-----|-----|--------|--------|
| unrecoverable detected error | — | ○ | ● | ○ | ● | ● |
| power off | — | ○ | ○ | ○ | ○ | ○ |

BMX ERT 1604 T Module View

Module front view:



1 Module with its LED display

2 28-pin removable terminal block

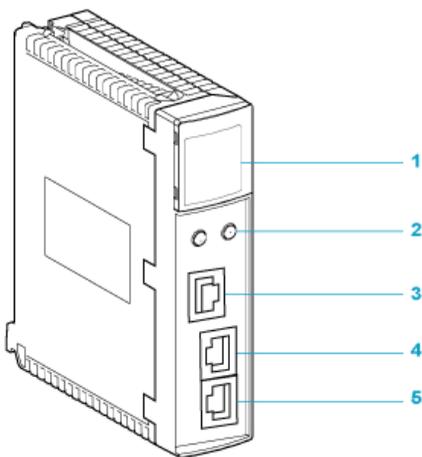
LED display:



The following table describes the LED display activity meaning for diagnostic purpose:

| LED | Status | Description |
|------------|--|---|
| ERR | ON | The module has an internal detected error. |
| | Flashing (with RUN LED OFF) | The module is not configured. |
| | | The module is configuring its channels. |
| | Flashing (with RUN LED ON) | The module has lost the communication with the PLC CPU. |
| I/O | ON | Field power supply failure detected. |
| T | ON | The module clock is synchronized with the external time source connected. |
| | Flashing (with RUN LED Flashing) | Firmware is being downloaded. |
| | Quick flashing | Module clock synchronization error detected: External time clock is temporarily unstable but the internal time quality is acceptable. |
| | OFF | No external time source input. |

BMx CRA 312 10 Module View



- 1 LED display
- 2 rotary switches
- 3 SERVICE port (ETH 1)
- 4 DEVICE NETWORK port (ETH 2)
- 5 DEVICE NETWORK port (ETH 3)

LED display:



The following table describes the LED display activity meaning for diagnostic purpose:

| Module State ⁽¹⁾ | Description | Run | IO | MS (Module Status) | | NS (Network Status) | |
|------------------------------------|---|----------|----------|--------------------|----------|---------------------|-----|
| | | Green | Red | Green | Red | Green | Red |
| power-up sequence | Order of LEDs blinking | 1 | 2 | 3 | 4 | 5 | 6 |
| not configured | IP address not valid | - | - | flashing | off | off | off |
| | valid IP address, but invalid configuration | off | off | flashing | off | flashing | off |
| configured | no external error detected | flashing | off | - | - | flashing | off |
| | external error detected | flashing | on | - | - | flashing | off |
| I/O data communication established | STOP | flashing | (NOTE 1) | on | off | on | off |
| | RUN | on | (NOTE 2) | on | off | on | off |
| detected error states | recoverable | - | - | off | flashing | - | - |
| | nonrecoverable | flashing | on | off | on | - | - |
| | duplicate IP address | - | - | - | - | off | on |

| Module State ⁽¹⁾ | Description | Run | IO | MS (Module Status) | | NS (Network Status) | |
|-----------------------------|---------------------------|----------|-----|--------------------|-----|---------------------|-----|
| | | Green | Red | Green | Red | Green | Red |
| | during OS firmware update | flashing | off | off | on | off | on |

| | |
|-----|---|
| (1) | For more information about the module states, refer to your system hardware reference manual. |
|-----|---|

NOTE 1 (STOP state):

- on: An input or output is a detected error that originates in a module, or a channel configuration or a channel configuration error has been detected.
- off: Operations are normal.

NOTE 2 (RUN state):

- on: External error detected.
- off: External error not detected.

Behavior on Operating Modes

What's in This Chapter

| | |
|--|-----|
| Operating Modes | 111 |
| Initial Start After the Application Download and First Start with Connection of the SCADA Server | 113 |
| Power Down/Up of a Time Stamping Module | 115 |
| Module Internal Event Buffer Full | 117 |
| Restart of the SCADA Server | 120 |
| Specific Operating Modes..... | 121 |

Overview

This chapter describes the system behavior during different operating modes.

The last topic of this chapter is dedicated to various specific operating modes that generate a simple behavior.

NOTE: In the following chapters, the behavior is described through tables showing events, time stamps, and time quality sequences. The following list presents some of the fields shown in tables to describe the SOE sequences and the corresponding fields in AVEVA Plant SCADA **SOE** page, page 101:

- **Event:** Data available in **Tag**, **Name**, and **Message** fields in AVEVA Plant SCADA **SOE** display.
- **Timestamp:** Data available in **Date** and **Time** fields in AVEVA Plant SCADA **SOE** display.
- **TimeQuality** attribute: Data available in the highest 8 bits of **Quality** field in AVEVA Plant SCADA **SOE** display, page 102.

Operating Modes

Overview

Time stamped variable value consistency between the process and the SCADA is a key point in system time stamping solution. To manage that consistency, in addition to the time stamped transitions flow (regular events flow), the system time stamping solution manages the report of process values to the SCADA system even when the system is facing operating modes that differ from the normal operating conditions.

Operating modes that differ from the normal operating conditions:

- Reset and restart of the time stamping source module.
- Too many events in a source of events (buffer full).
- Reset and restart of the SCADA server.

Reset and Restart

Immediately after a restart of the time stamping source module or the relevant SCADA servers, the process values are provided to the SCADA client in order to have value consistency.

The process value flow is then provided in addition to the event data flow with respect to time stamping order.

The SCADA server is informed of process value transmission with a specific value:
`QualityHighByte = TSInit`, page 102.

Source of Events Module Internal Buffer Full

A time stamping source module internal buffer should not be full in normal operating conditions, but it can become full in case of disconnection between the module and the SCADA servers for example.

The system time stamping solution can generate non-accurate process values transitions between the buffer full detection and the time when a percentage of the buffer is free again. The SCADA server is informed of non-accurate process values transitions with a specific value: `QualityHighByte = Invalid`, page 102.

The buffer threshold (the value cannot be modified) below which the time stamping module can time stamp events is:

- 50% of buffer full for the BME P58
- 70% of buffer full for the BMX ERT 1604 T
- 80% of buffer full for the BM• CRA 312 10

SOE Uncertain Event

In case of reset and restart or buffer full, the event detection is frozen and some events may be lost. Time stamped SOE uncertain events are sent to inform the SCADA server of the beginning and end of an uncertain sequence of events. `SOE_UNCERTAIN` values:

- `SOE_UNCERTAIN = 1`: Events might be lost in the following sequence of events.

- `SOE_UNCERTAIN = 0`: No event lost in the following sequence of events.

Initial Start After the Application Download and First Start with Connection of the SCADA Server

Initial Start Sequence

NOTE: In order for the modules to start to time stamp, the SCADA server has to be started and connected, and the communication between the SCADA server and the modules has to be initialized.

Once the application download is completed, the system starts following this sequence:

1. The time stamping modules get their configuration from the PLC.
2. The time stamping modules synchronize their internal time with the time reference, page 51.
3. The time stamping modules start to detect discrete value changes once the SCADA server is started and connected.
4. An initial start SOE sequence takes place as described in the following topic.

Initial Start SOE Sequence

Initial start SOE sequence description:

- Signalization of the beginning of an uncertain sequence of events (see following table, sequence number 1).
- Storage of the values of the time stamping module inputs and outputs with `TimeQuality = ClockFailure` and `ClockNotSynchronized` until the internal time is synchronized (see following table, sequences number 2 and 3).
- Storage of the other values of the time stamping module inputs and outputs with `TimeQuality = TSInit` after time synchronization (see following table, sequences number 4 and 5).
- Signalization of the end of the uncertain sequence of events (see following table, sequence number 6).
- Normal time stamping after start of the SCADA server (see following table, sequences number 7 and 8).
- Signalization of a new `SOE_UNCERTAIN` sequence due to the start of the SCADA server (see following table, sequences number 9 to 14).

The following table presents the initial start SOE sequence provided by a BMX CRA 312 10 time stamping module with 3 time stamped inputs and 1 time stamped output:

| Sequence Number | Event | Event Value | TimeStamp | TimeQuality Attributes |
|-----------------|--|-------------|---|---|
| 1 | SOE_UNCERTAIN ^(1.) (0 -> 1) | 1 | Internal CRA time (not synchronized) | ClockFailure and ClockNotSynchronized |
| 2 | CRA INPUT 1 (1 -> 0) | 0 | Internal CRA time (not synchronized) | ClockFailure and ClockNotSynchronized |
| 3 | CRA INPUT 2 (0 -> 1) | 1 | Internal CRA time (not synchronized) | ClockFailure and ClockNotSynchronized |
| 4 | CRA INPUT 3 (0 -> 1) | 1 | Internal CRA time | TSInit |
| 5 | CRA OUTPUT 4 (1 -> 0) | 0 | Internal CRA time | TSInit |
| 6 | SOE_UNCERTAIN ^(1.) (1 -> 0) | 0 | Internal CRA time | Time Resolution = 1 ms |
| 7 | CRA INPUT 1 (0 -> 1) | 1 | Internal CRA time | Time Resolution = 1 ms |
| 8 | CRA INPUT 3 (1 -> 0) | 0 | Internal CRA time | Time Resolution = 1 ms |
| 9 | SOE_UNCERTAIN ^{(1.) (2.)} (0 -> 1) | 1 | Internal CRA time | Time Resolution = 1 ms |
| 10 | CRA INPUT 1 ^(2.) (1 -> 0) | 0 | Internal CRA time | Time Resolution = 1 ms |
| 11 | CRA INPUT 2 ^(2.) (1 -> 0) | 0 | Internal CRA time | Time Resolution = 1 ms |
| 12 | CRA INPUT 3 ^(2.) (0 -> 1) | 1 | Internal CRA time | Time Resolution = 1 ms |
| 13 | CRA OUTPUT 4 ^(2.) (0 -> 1) | 1 | Internal CRA time | Time Resolution = 1 ms |

| Sequence Number | Event | Event Value | TimeStamp | TimeQuality Attributes |
|---|-------------------------------------|-------------|-------------------|------------------------|
| 14 | SOE_UNCERTAIN (1.) (2.) (1 -> 0) | 0 | Internal CRA time | Time Resolution = 1 ms |
| <p>1. SOE_UNCERTAIN event appears only if events can be lost after power up, start of the module, and start and connection of the SCADA server. SOE_UNCERTAIN event does not appear for the BMX ERT 1604 T module.</p> <p>2. The duplicated SOE_UNCERTAIN sequence appears because the SCADA server starts.</p> | | | | |

Power Down/Up of a Time Stamping Module

Power Down/Up of the Time Stamping Module

NOTE: In order for the modules to start to time stamp, the SCADA server has to be started and connected, and the communication between the SCADA server and the modules has to be initialized.

Power down/up operating mode is assumed to occur while time stamping module is time stamping events and the SCADA system is running.

The time stamping module power down is detected by the SCADA system through a specific item: #PLCQualStatus, page 97. #PLCQualStatus = QUAL_DEVICE_FAILURE indicates that the module is not operational. In the following example table, the device failure detection is signaled in sequence number 4.

SOE Sequence on Power Down/Up of the Time Stamping Module

Sequence followed on time stamping module power up (after a power down):

- The events stored in the module buffer before power down (and not read in the buffer) are available for the SCADA system (events from sequence number 1 to 3 in the following table).
- Signalization of time stamping module power down and power up (see following table, sequences number 4 and 5).
- The rest of the sequence is the same as sequences number 1 to 6 in the initial start SOE sequence, page 115 (see following table, sequences number 6 to 13).

The following table presents the SOE sequence on power up provided by a BMX CRA 312 10 time stamping module with 3 time stamped inputs and 1 time stamped output (after a power down):

| Sequence Number | Event | Event Value | TimeStamp | TimeQuality Attributes |
|---|--|-------------|---|---|
| 1 | CRA INPUT 1 (0 -> 1) | 1 | Internal CRA time | Time Resolution = 1 ms |
| 2 | CRA INPUT 3 (1 -> 0) | 0 | Internal CRA time | Time Resolution = 1 ms |
| 3 | CRA OUTPUT 4 (0 -> 1) | 1 | Internal CRA time | Time Resolution = 1 ms |
| 4 | CRA device failure detection | 1 | OFS internal time | Not applicable |
| 5 | CRA device failure detection | 0 | OFS internal time | Not applicable |
| 6 | SOE_UNCERTAIN ⁽¹⁾ (0 -> 1) | 1 | Internal CRA time (not synchronized) | ClockFailure and ClockNotSynchronized |
| 7 | CRA INPUT 1 (1 -> 0) | 0 | Internal CRA time (not synchronized) | ClockFailure and ClockNotSynchronized |
| 8 | CRA INPUT 2 (0 -> 1) | 1 | Internal CRA time (not synchronized) | ClockFailure and ClockNotSynchronized |
| 9 | CRA INPUT 3 (0 -> 1) | 1 | Internal CRA time | TSInit |
| 10 | CRA OUTPUT 4 (1 -> 0) | 0 | Internal CRA time | TSInit |
| 11 | SOE_UNCERTAIN ⁽¹⁾ (1 -> 0) | 0 | Internal CRA time | Time Resolution = 1 ms |
| 12 | CRA INPUT 1 (0 -> 1) | 1 | Internal CRA time | Time Resolution = 1 ms |
| 13 | CRA INPUT 3 (1 -> 0) | 0 | Internal CRA time | Time Resolution = 1 ms |
| <p>1. SOE_UNCERTAIN event appears only if events can be lost after power up and start of the module assuming that the SCADA server is already started, connected, and operational for communication. SOE_UNCERTAIN event does not appear for the BMX ERT 1604 T module.</p> | | | | |

Module Internal Event Buffer Full

Time Stamping Module Internal Buffer Full

A time stamping module internal event buffer should not be full in normal case, but it can become full in case of disconnection between the module and the SCADA system for example.

A buffer full is diagnosed from the PLC via `BUFF_FULL` parameters in **Device DDT**, or **IODDT**, or system word, or `TS_BUF_FILLED_PCTAGE` parameter. On a BME P58 CPU, `TS_BUF_FILLED_PCTAGE` parameter is located on `%SW74.8...%SW74.15`.

Time stamping modules stop the recording on buffer full in a system time stamping solution. The process values continue to change but as the source module buffer is full, they cannot be stored.

SOE Sequence on Buffer Full

Sequence followed after detection of a buffer full:

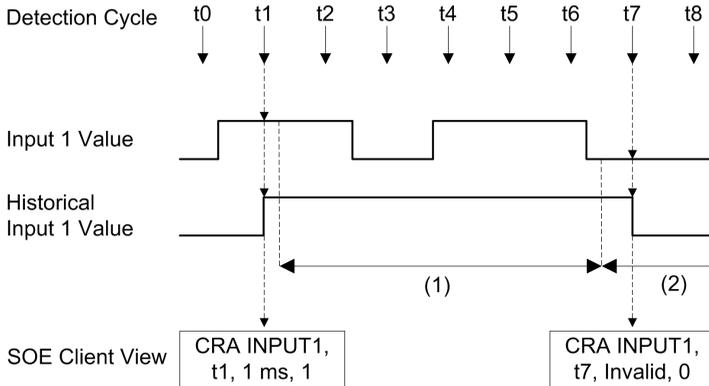
- Stop the detection and storage of events. The last input (and output) values are frozen (historical values).
- Signalization of the beginning of an uncertain sequence of events (see following table, sequence number 1).
- Wait for the time stamping module buffer to have a percentage of free space again (time elapsed between sequence number 1 and sequence number 2 in the following table). Space is freed in the buffer when the SCADA reads it.
- Time stamping module buffer is read by the SCADA server and has free space again.
- Detection of input (and output) value changes. Changes are detected by comparing the current I/O value with the historical value stored when the buffer became full.
- Storage of all the I/O detected changes with `TimeQuality = Invalid` (see following table, sequences number 2 to 4).
- Signalization of the end of an uncertain sequence of events (see following table, sequence number 5).
- Start the detection and storage of new events.
- Normal time stamping (see following table, sequences 6, 7 and next).

The following table presents the SOE sequence on buffer full provided by a BMX CRA 312 10 time stamping module with 3 time stamped inputs and 1 time stamped output:

| Sequence Number | Event | Event Value | TimeStamp | TimeQuality Attributes |
|-----------------|---------------------------|-------------|-------------------|------------------------|
| 1 | SOE_UNCERTAIN (0 -> 1) | 1 | Internal CRA time | Time Resolution = 1 ms |
| 2 | CRA INPUT 1 (1 -> 0) | 0 | Internal CRA time | Invalid |
| 3 | CRA INPUT 3 (0 -> 1) | 1 | Internal CRA time | Invalid |
| 4 | CRA OUTPUT 4 (1 -> 0) | 0 | Internal CRA time | Invalid |
| 5 | SOE_UNCERTAIN (1 -> 0) | 0 | Internal CRA time | Time Resolution = 1 ms |
| 6 | CRA INPUT 1 (0 -> 1) | 1 | Internal CRA time | Time Resolution = 1 ms |
| 7 | CRA INPUT 3 (1 -> 0) | 0 | Internal CRA time | Time Resolution = 1 ms |

Example of SCADA View on Buffer Full Sequence

The following picture shows the **Input 1** of BMX CRA 312 10 module changes read by the SCADA server and the associated timing when the BMX CRA 312 10 buffer becomes full, and then free again:



(1) Buffer full, detection of events stopped and historical frozen.

(2) Detection of events starts again.

Sequence followed on buffer full event detection description:

| | |
|-----------|---|
| t0 | Buffer is not full, normal time stamping mode. |
| t1 | Buffer is not full, normal time stamping mode. BMX CRA 312 10 Input 1 value change detected, historical takes the current value. |
| t2 | Buffer full detected, no time stamping on this module, last Input 1 value is frozen (historical). |
| t3 ... t6 | Buffer full, no time stamping on this module. |
| t7 | Buffer not full detected (enough percentage of the buffer is free). BMX CRA 312 10 Input 1 value compared with the historical value: 1 to 0 change detected, storage of the event CRA Input 1 (1 to 0) in the buffer with <i>TimeQuality = Invalid</i> . |
| t8 | Buffer is not full, normal time stamping mode, Time Resolution = 1 ms. |

Restart of the SCADA Server

Overview

Restart of the SCADA server is assumed to occur while the time stamping modules are time stamping and their clock is synchronized.

SOE Sequence on Restart of the SCADA Server

Sequence followed on SCADA server restart:

- The events stored in the module buffer before SCADA server restart (and not read) are available for the SCADA (events from sequence number 1 to 3 in the following table).
- The rest of the sequence is the same as sequences number 1 to 6 in the [initial start SOE sequence, page 113](#) (sequences number 4 to 11 in the following table). Process values provided after SCADA server restart are signaled by an uncertain sequence of events (sequences number 4 to 8).

The following table presents the SOE sequence on SCADA server restart provided by a BMX CRA 312 10 time stamping module with 3 time stamped inputs and 1 time stamped output:

| Sequence Number | Event | Event Value | TimeStamp | TimeQuality Attributes |
|-----------------|--|-------------|-------------------|------------------------|
| 1 | CRA INPUT 1 (0 -> 1) | 1 | Internal CRA time | Time Resolution = 1 ms |
| 2 | CRA INPUT 3 (1 -> 0) | 0 | Internal CRA time | Time Resolution = 1 ms |
| 3 | CRA OUTPUT 4 (0 -> 1) | 1 | Internal CRA time | Time Resolution = 1 ms |
| 4 | SOE_UNCERTAIN ⁽¹⁾ (0 -> 1) | 1 | Internal CRA time | Time Resolution = 1 ms |
| 5 | CRA INPUT 1 (1 -> 0) | 0 | Internal CRA time | TSInit |
| 6 | CRA INPUT 2 (0 -> 1) | 1 | Internal CRA time | TSInit |
| 7 | CRA INPUT 3 | 1 | Internal CRA time | TSInit |

| Sequence Number | Event | Event Value | TimeStamp | TimeQuality Attributes |
|--|--|-------------|-------------------|------------------------|
| | (0 -> 1) | | | |
| 8 | CRA OUTPUT 4 (1 -> 0) | 0 | Internal CRA time | TSInit |
| 9 | SOE_UNCERTAIN ⁽¹⁾ (1 -> 0) | 0 | Internal CRA time | Time Resolution = 1 ms |
| 10 | CRA INPUT 1 (0 -> 1) | 1 | Internal CRA time | Time Resolution = 1 ms |
| 11 | CRA INPUT 3 (1 -> 0) | 0 | Internal CRA time | Time Resolution = 1 ms |
| <p>1. SOE_UNCERTAIN event appears only if events can be lost after start and connection of the SCADA server. SOE_UNCERTAIN event does not appear for the BMX ERT 1604 T module.</p> | | | | |

Specific Operating Modes

Introduction

The operating modes listed in the following table represent cases with a simple system time stamping solution behavior.

Behavior on Specific Operating Modes

The following table describes the time stamping solution behavior on specific operating modes:

| Operating Mode | Operating Mode Phase | Behavior |
|---|--|---|
| PLC application change: <ul style="list-style-type: none"> • Change the time stamping mode setting (<i>Applicative</i> -> <i>System</i>). • Import a <i>XEF</i>, <i>ZEF</i>, <i>XHW</i>, or <i>ZHW</i> file. • Insert a new module (BM• CRA 312 10 or BMX ERT 1604 T). • Copy / Paste a new module (BM• CRA 312 10 or BMX ERT 1604 T). • Replace a BMX CRA 312 00 by a BMX CRA 312 10 module. | | <ul style="list-style-type: none"> • Same behavior as in the initial start after the application download, page 113 operating mode. • The time stamping module event buffer is automatically reset. |
| Replace a BMX ERT 1604 T | | <ul style="list-style-type: none"> • Same behavior as in the initial start after the application download, page 113 operating mode. • The time stamping module event buffer is automatically reset. |
| I/O channel error on a discrete time stamped I/O. | | <ul style="list-style-type: none"> • Diagnose the PLC parameters, page 95 (for example, %MWr.m.c.2 for a BMX ERT 1604 T module). • Time stamped events have the following <i>TimeQuality</i> attribute: <i>TimeAccuracy</i> = <i>IOChannelError</i>. |
| Disconnection/connection of the SCADA server. | No access to the time stamping module from the SCADA server. | <ul style="list-style-type: none"> • Signalization of the disconnection through the specific item, page 97: <direct_address>! #PLCQualStatus = QUAL_DEVICE_FAILURE • No more events are received by the SCADA servers. |
| | Access re-established between the time stamping module and the SCADA server. | <ul style="list-style-type: none"> • Signalization of the connection through the specific item, page 97: <direct_address>! #PLCQualStatus = QUAL_GOOD NOTE: If the disconnection generates a module internal buffer full, refer to this specific operating mode description, page 117. |
| No access to the time stamping module from the PLC. | | Behavior depends on the time stamping component: <ul style="list-style-type: none"> • BMX ERT 1604 T: Normal time stamping. • BM• CRA 312 10: Discrete I/O type: <ul style="list-style-type: none"> ◦ Input: Inputs are still time stamped. ◦ Output: Outputs are not time stamped during PLC disconnection. |
| PLC start while the system time stamping is running. | PLC cold start. PLC warm start. | Behavior depends on the time stamping component: <ul style="list-style-type: none"> • BME P58 •••: PLC start type: <ul style="list-style-type: none"> ◦ Cold start: Reset the CPU event buffer. ◦ Warm start: Keep the CPU event buffer. |

| Operating Mode | Operating Mode Phase | Behavior |
|--|--|---|
| | | <ul style="list-style-type: none"> • BMX ERT 1604 T: Module located in a: <ul style="list-style-type: none"> ◦ Local drop: Same behavior as in the case of the time stamping module power Down/Up, page 115. ◦ Modicon X80 drop: No impact on system time stamping. • BM• CRA 312 10: No impact on system time stamping. • SCADA: No impact on system time stamping. |
| PLC run to stop / stop to run transition while the system time stamping is running. | PLC run to stop transition (behavior in stop state). | Behavior depends on the time stamping component: <ul style="list-style-type: none"> • BME P58 ••••: Stop time stamping. • BMX ERT 1604 T: Normal time stamping. • BM• CRA 312 10: Discrete I/O type: <ul style="list-style-type: none"> ◦ Input: Inputs are still time stamped. ◦ Output: Detection and time stamping of the output image (in case of Control Expert animation table evolutions). <p>NOTE: The BM• CRA 312 10 module does not time stamp outputs fallback state (not available in the output image) on PLC run to stop transition.</p> |
| | PLC stop to run transition. | Behavior depends on the time stamping component: <ul style="list-style-type: none"> • BME P58 ••••: Begin time stamping. • BMX ERT 1604 T: Normal time stamping. • BM• CRA 312 10: Normal time stamping. |
| Initialization of the PLC variables (%SO) while the system time stamping is running. | | Behavior depends on the time stamping component: <ul style="list-style-type: none"> • BME P58 ••••: %S0=1: reset the CPU event buffer. • BMX ERT 1604 T: No impact on system time stamping. • BM• CRA 312 10: No impact on system time stamping. |

Behavior on Time Synchronization

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Overview

This chapter describes the time synchronization mechanism.

Time Synchronization

Time Synchronization on System Start

On system start, the time stamping modules begin to time stamp events without waiting for the initial time synchronization. To signal that the first synchronization has not been done yet, page 113 to the SCADA server, the following parameters of `TimeQuality` are set to 1:

- `ClockNotSynchronized`
- `ClockFailure`

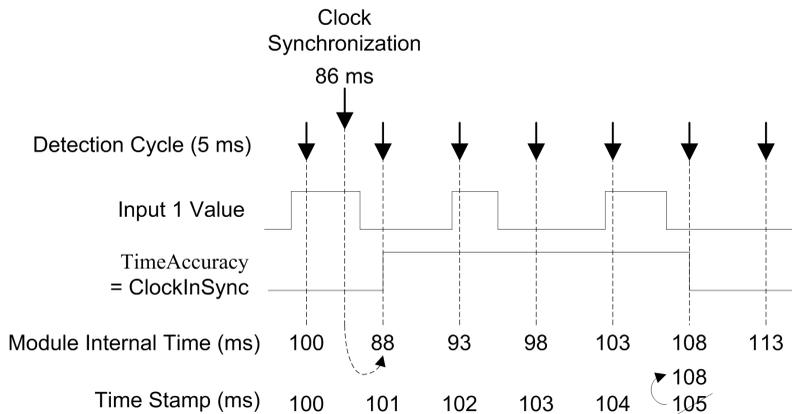
Once the time stamping module time is synchronized, `ClockNotSynchronized` and `ClockFailure` parameters are set to 0 in `TimeQuality`.

Time Synchronization When the System Is Running

When the system is running, each time stamping module periodically synchronizes its clock with the external clock reference. On synchronization, 3 situations appear:

| | |
|--|---|
| Module internal time is equal to external clock time: | No change in module internal time. |
| Module internal time is delayed compared to external clock time: | Module internal time synchronizes with external clock time. |
| Module internal time is ahead of external clock time: | <p>Module internal time synchronizes with external clock time in the following way:</p> <ul style="list-style-type: none"> Module internal time is ahead of external clock time while the Device DDT status of BM• CRA 312 10 is: <code>TIME_VALID=1CLOCK_FAILURE=0CLOCK_NOT_SYNC=0</code>. Catch-up mechanism is used to keep time coherence in sequence of events (event n+1 cannot be earlier than event n) and to minimize the time increment recorded in the next timestamp time value: $\text{Catch-up time} = (\text{Internal time} - \text{Synchronized time received}) \times \text{Detection cycle} / (\text{Detection cycle} - \text{Incrementation step})$ <p>NOTE: "Catch-up time": the time required to synchronize the time stamp value with the new internal time.</p> <p>Synchronization mechanism until module internal time > last time stamp value (internal time cannot be accessed by the user):</p> <ul style="list-style-type: none"> Every time stamping detection cycle, the time stamp value increments by the maximum of: <ul style="list-style-type: none"> 1 ms; or Detection cycle time (in a BMX ERT 1604 T module, increment value is 1 ms) The catch-up mechanism activity can be diagnosed in the <code>TimeQuality</code> byte when <code>TimeAccuracy = ClockInSync</code> (0xx11011 bin). |

The following figure illustrates the synchronization mechanism in a BMX CRA 312 10 module when the internal time is ahead of external clock time (5 ms detection cycle and 1 ms incrementation step):



The following table presents the SOE sequence shown in previous figure provided by a BMX CRA 312 10 time stamping module with 1 time stamped input:

| Event | Event Value | TimeStamp (ms) | Module Internal Time (ms) | TimeQuality Attributes | Comment |
|-------------------------|-------------|----------------|---------------------------|------------------------|--|
| CRA INPUT 1 (0 -> 1) | 1 | 100 | 100 | Time Resolution = 1 ms | |
| No event | N.A. | N.A. | 86 | N.A. | External clock synchronization value received. |
| CRA INPUT 1 (1 -> 0) | 0 | 101 | 88 | ClockInSync | Internal Time (n) <= Time Stamp (n-1) => Time Stamp (n) = Time Stamp (n-1) + 1 ms |
| CRA INPUT 1 (0 -> 1) | 1 | 102 | 93 | ClockInSync | Internal Time (n) <= Time Stamp (n-1) => Time Stamp (n) = Time Stamp (n-1) + 1 ms |
| CRA INPUT 1 (1 -> 0) | 0 | 103 | 98 | ClockInSync | Internal Time (n) <= Time Stamp (n-1) => Time Stamp (n) = Time Stamp (n-1) + 1 ms |
| CRA INPUT 1 (0 -> 1) | 1 | 104 | 103 | ClockInSync | Internal Time (n) <= Time Stamp (n-1) => Time Stamp (n) = Time Stamp (n-1) + 1 ms |
| CRA INPUT 1 (1 -> 0) | 0 | 108 | 108 | Time Resolution = 1 ms | Internal Time (n) > Time Stamp (n-1) => Time Stamp (n) = Internal Time (n) |
| N.A. Not Applicable | | | | | |

In this example: Catch-up time = $(100 - 86) \times 5 / (5 - 1)$. Catch-up time = 17.5 ms (around 4 detection cycles of 5 ms).

NOTE: The following list presents some fields available in previous table and their corresponding fields in AVEVA Plant SCADA **SOE** page, page 101:

- **Event:** Data available in **Tag**, **Name** and **Message** fields in AVEVA Plant SCADA **SOE** display.
- **Timestamp:** Data available in **Date** and **Time** fields in AVEVA Plant SCADA **SOE** display.
- **TimeQuality Attributes:** Data available in **Quality** and **TSQuality** fields in AVEVA Plant SCADA **SOE** display.

Time Synchronization Lost When the System Is Running

If the time synchronization is lost (no link with the external time reference), the time stamping module time stamps events with its internal time, based on the latest successful synchronization.

NOTE: If the time has never been synchronized, then the internal time is the free running time from epoch.

As in the initial start case, to manage that situation, `CLOCK_NOT_SYNC` parameter is set to 1 (and `ClockNotSynchronized` parameter is set to 1 in `TimeQuality` byte).

Once the time stamping module time is synchronized, `CLOCK_NOT_SYNC` parameter is set to 0 (and `ClockNotSynchronized` parameter is set to 0 in `TimeQuality` byte).

NOTE: As the time synchronization mechanism is specific to each module, the time interval between the loss of time synchronization and the setting of `CLOCK_NOT_SYNC` parameter is different for a BMX ERT 1604 T and a BM• CRA 312 10 module.

Time interval between the loss of time synchronization and the setting of `CLOCK_NOT_SYNC` parameter:

- for a BMX ERT 1604 T: 10 seconds (IRIG-B) or 10 minutes (DCF77).
- for a BM• CRA 312 10: 3 seconds after the scheduled polling time.

How to Interface with a 3rd Party Client SCADA

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Introduction

This part presents the OPC DA sequences needed to interface with system time stamping.

3rd Party OPC DA Client SCADA

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Overview

This chapter describes the steps that an OPC DA (version 2.04 or later) client needs to follow in order to operate the system time stamping solution with OFS. It is intended for OPC client developers.

OPC Events Group

Introduction

3rd party SCADA needs to use OFS software services to implement the system time stamping solution.

Event Group

A particular OPC group named: ##TSEventsGroup## needs to be created to manage time stamped variables. This group is referenced as **Events Group** in this section.

Each OPC client can only create 1 OPC events group.

This **Events Group** complies with the following rules:

- If the **Service support** tab is not set to **Available**, page 62 for the OFS alias of an item, that item is not added and an `E_FAIL` error detected message is returned.
- Items for which the **Time-stamped Event Support** custom property, page 62 is set to 1 can be added to the **Events Group**.

Items for which the **Time-stamped Event Support** custom property, page 62 is set to 0 can also be added to the **Events Group** but a message is displayed in OFS diagnostics window (Example of message: *Item 'myvar' has not time-stamped property set; it will be ignored*).

- The same item can not be added more than once in the **Events Group** otherwise an `OPC_E_DUPLICATE_NAME` error detected message is returned.
- Items associated to a same OFS alias cannot be added in several client **Events Group**; otherwise an `E_FAIL` error detected message is returned.
- OFS specific items can not be added in the **Events Group**; otherwise an `E_FAIL` error detected message is returned.
- If one of the following operations is performed, an `E_FAIL` error detected message is returned immediately:
 - `IOPCGroupStateMgt::SetName()`
 - `IOPCGroupStateMgt::CloneGroup()`
 - Any `IOPCSyncIO` method
 - Any `IOPCSyncIO2` method

NOTE: A standard OPC group cannot be renamed `##TSEventsGroup##`.

For more details, refer to topic *Time Stamped Events Configuration* in *OPC Factory Server User Manual*, page 11.

Specific Items

NOTE: `#TSEventItemsReady` item has to be placed in a fast update rate group (200 ms).

Operation Steps

Required Steps

| Step | Action |
|------|--|
| 1 | Configure, page 59 Control Expert application and OFS. |
| 2 | Create the <code>##TSEventsGroup##</code> . Set this group to inactive. |
| 3 | Optional step described in the next topic. |
| 4 | Add the time stamped variables in the group (for example <code>myAlias!eventVar1</code>) as an active OPC item. |
| 5 | Activate the <code>##TSEventsGroup##</code> . |

NOTE: When activating the `##TSEventsGroup##` , OFS starts polling all event sources configured for `myAlias`. On group deactivation or removal, the polling is stopped.

NOTE: When an event value is notified to an inactive item, that event value is lost. Adding inactive items to the active `##TSEventsGroup##` is not recommended.

Optional Steps

On OPC client initial start, it may be needed to initialize the cache values of the SOE viewer or alarm system with current process values.

To force the event source to provide current process values, proceed with the following steps during configuration (described in previous topic):

| Step | Action |
|------|---|
| 3.1 | Create a new OPC group. |
| 3.2 | Add <code>#TSEventSynchro</code> variable to that group. |
| 3.3 | Perform a synchronous write on <code>#TSEventSynchro</code> variable ⁽¹⁾ . |

1. The return code of the OPC write operation is always `S_OK`; it means that the synchro value order has been taken into account by OFS. OFS manages the fact of sending this order to each time stamping module.

For more details, refer to topic *Specific Item* in *OPC Factory Server User Manual*, page 11.

Optional Functionalities

OPC Item Property 5012

As described in the chapter *OFS settings*, page 62, this OPC item property can be read during a browse operation to discover if a variable is configured as a time stamp variable in Control Expert application.

Time stamp variables can be added to `##TSEventsGroup##`. For more details, refer to topic *Time Stamped Events Configuration*.

<<system>>!#ClientAlive Specific Item

This item can be periodically written to inform OFS that the OPC client is alive. If OFS detects that the client is missing, OFS deactivates all active OPC groups including ##TSEventsGroup##.

For more details, refer to topic *Time Stamped Events Configuration* in *OPC Factory Server User Manual*, page 11.

#PLCQualStatus Specific Item

This item can be activated to diagnose the connection state of a PLC device or an event source device.

For more details, refer to topic *Specific Item* in *OPC Factory Server User Manual*, page 11.

##TSEventsGroup## OnDataChange Interface

Overview

The following topics details `IOPCDataCallback::OnDataChange()` OPC method invoked in the ##TSEventsGroup##.

An item in the ##TSEventsGroup## is notified with a value, time, and quality parameter described in the following topics.

Value

Value is the event value (`Value` field in the event data format, page 140) converted to `VT_BOOL`.

Time

Time is the event time stamp (`DateAndTime` field in the event data format, page 140) converted to `FILETIME`.

The following conversion is applied to the time stamp: $pftTimeStamps = 10\,000\,000 * (DateAndTime.SecondSinceEpoch + 11\,644\,473\,600 + (DateAndTime.FractionOfSecond * 2^{power - 24}))$

NOTE: If the `Quality` of an event indicates a `ClockFailure` value, the **Time** field is patched by OFS with the local time of the OFS machine.

Quality

Quality is a WORD and it is the combination of the event time quality and standard OPC quality.

Quality format:

- Byte 0: **OPC Quality**
- Byte 1: `TimeQuality` (`TimeQuality` field in the event data format, page 140).

OPC_Quality value:

- `OPC_QUALITY_BAD` or `QUAL_CONFIGURATION_ERROR` (04 hex): A configuration error is detected on the item (unknown event source for example)
- `OPC_QUALITY_GOOD` (C0 hex): Normal working condition.

OnChange() Handle Management

Please note that a SOE notification differs from a classical real-time data notification.

The following table illustrates a series of data that could be modified:

| Handle | Value | Quality | TimeStamp |
|--------|-------|--------------|-----------|
| H1 | 0 | TimeQuality1 | T1 |
| H1 | 1 | TimeQuality2 | T2 |
| H2 | 0 | TimeQuality3 | T3 |
| H1 | 0 | TimeQuality4 | T4 |
| H2 | 1 | TimeQuality5 | T5 |

A series of results dealing with a same handle might be provided.

To respect the **TimeStamp** values order for a given handle, the OPC client has to process the array (that contains: **Handle**, **Value**, **Quality** and **Time**) results in its original order (first array element to last array element).

Troubleshooting

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Troubleshooting SOE Page in AVEVA Plant SCADA

What's in This Chapter

AVEVA Plant SCADA SOE Display Troubleshooting 135

AVEVA Plant SCADA SOE Display Troubleshooting

Introduction

The following pages provide actions to perform when:

- SOE page is empty
- SOE page displays old events with recent events not shown

SOE Page Is Empty

Possible cause for an empty SOE page (non-exhaustive):

- The system is not able to get events or there are no events in the system.

Example of use cases which may lead to an empty SOE page:

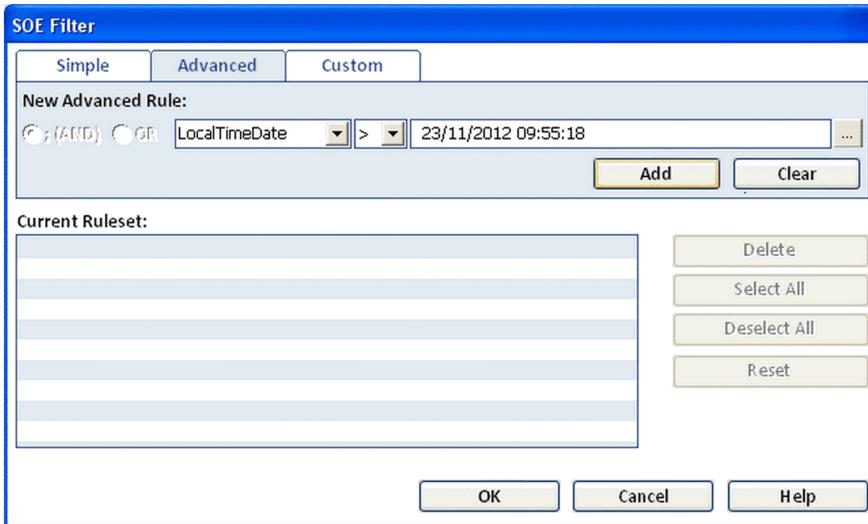
- The alarm server is busy and cannot answer the request in the given time.
- The client display is not connected to the alarm server.
- The client user does not have the privileges to see the existing events.

Actions to perform:

| Step | Action |
|------|--|
| 1 | Check that information is displayed in the active alarm page. If the active alarm page is: <ul style="list-style-type: none">• empty, then proceed with following steps• not empty, then proceed from step 5 |
| 2 | Check in the hardware alarms and verify that your client is connected to the alarm server (a detected error is displayed when the alarm server is not connected). |

| Step | Action |
|------|---|
| 3 | Verify that you did not deactivate the cluster for this client. More details on [Client]Cluster parameter are provided in the <i>Parameters</i> section of AVEVA Plant SCADA User Guide or AVEVA Plant SCADA Help, page 11. |
| 4 | Verify that you are logged in with the appropriate level of privileges. |
| 5 | Check that no filter is applied, filtering can generate an empty recordset. |
| 6 | Try to decrease the requested range by using the filter capability (use filter to request events for the last hour or for a particular tag for example). |
| 7 | <p>Try to increase the request time-out for all alarm servers or for a particular alarm server:</p> <ul style="list-style-type: none"> Request time-out parameter for all alarm servers: [ALARM] ClientRequestTimeout = xxx Request time-out parameter for a particular alarm server, where <Cluster> is the name of the cluster and <ServerName> is the name of the alarm server: [ALARM.<Cluster>.<ServerName>] ClientRequestTimeout = xxx <p>More details on ClientRequestTimeout parameter are provided in the following pages, page 138.</p> |

Example of SOE display filter in AVEVA Plant SCADA:



SOE Page Displays Old Events While Recent Events Are Not Shown

Possible cause for old events to be displayed in the SOE page (non-exhaustive):

- The SOE page is not automatically refreshed.
 - Example of situations when this situation can occur:
 - The refresh is done on request and the current page displayed can be old.
 - The system may not be able to manage the refresh request.
- The device time is delayed compared to the current local time (after conversion by the client). In such a case, the TS events may appear at the bottom of the SOE page queue. If other events in the page are based on the current local time, those events fill-up the SOE page and give the impression that TS events are missing.

Actions to perform:

| Step | Action |
|------|---|
| 1 | Reload the page to check if the display needed a refresh. |
| 2 | Check that a filter selecting only old records is not applied. |
| 3 | Try to decrease the requested range by using the filter capability (use filter to request events for the last hour or for a particular tag for example). |
| 4 | Try to increase the system capabilities to manage large number of events: <ul style="list-style-type: none"> • Increase the alarm server cache size: [ALARM] CacheSize = xxx • Increase the maximum number of records returned by a single request: [ALARM] QueryRowLimit = xxx • Increase the request time-out parameter for all alarm servers: [ALARM] ClientRequestTimeout = xxx More details on CacheSize, QueryRowLimit, and ClientRequestTimeout parameters are provided in the following pages, page 138. |

Example of INI file:

```
[alarm]
CacheSize = 80
QueryRowLimit = 1000000
ClientRequestTimeout = 300000
```

Parameters Definitions in AVEVA Plant SCADA

ClientRequestTimeout:

- Definition: this parameter defines the amount of time, in milliseconds, in which the client can request data from a server. If the server has not responded by the end of this time, the request has been unsuccessful.
- Allowable values: 0 to 4294967295
- Default value: 120000

CacheSize:

- Definition: this parameter defines the amount of memory (in megabytes) dedicated to the storage of event data. For many systems, the default setting of 25 MB is appropriate. However, if your system is experiencing difficulties with server performance and the cache size needs to be adjusted, you can alter the cache size settings as required.
- Allowable values: 0 to 400
- Default value: 25

QueryRowLimit:

- Definition: defines the maximum number of rows that can be returned in the result set for a single query. Increasing the `QueryRowLimit` may affect performance.
- Allowable values: 0 to 4294967295
- Default value: 200000

Appendices

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Event Format

What's in This Chapter

Event Time Stamp Entry 140

Overview

This chapter describes the time stamping event time stamp data format.

Event Time Stamp Entry

Event Description

Event = VarID + Value + Timestamp

- **VarID:** It is internally managed by the system.
VarID is unique for 1 PLC.
User only manages the variable name.
- **Value:** Event discrete value.
- **Timestamp:** Time stamp in OPC DA format.

Event Data Format

Event data format is provided for information even if this structure is not accessed in system time stamping mode.

Each event time stamp entry is a 12 bytes block organized as follows:

| | | | |
|---------------------|------------------|------------|--------|
| Reserved (set to 0) | | Byte 0 | |
| Value | | Byte 1 | |
| Event ID | | Bit 7...0 | Byte 2 |
| | | Bit 15...8 | Byte 3 |
| DateAndTime | SecondSinceEpoch | Bit 7...0 | Byte 4 |
| | | Bit 15...8 | Byte 5 |

| | | | |
|-------------|------------------|-------------|---------|
| | | Bit 23...16 | Byte 6 |
| | | Bit 31...24 | Byte 7 |
| | FractionOfSecond | Bit 7...0 | Byte 8 |
| | | Bit 15...8 | Byte 9 |
| | | Bit 23...16 | Byte 10 |
| TimeQuality | | | Byte 11 |

Each parameter is detailed hereunder.

Value Parameter

Bit 0 defines the value of the variable after change detection:

- 0: Falling edge
- 1: Rising edge

Event ID Parameter

The variable management assigns a unique value to each time stamped event (including SOE_UNCERTAIN event).

DateAndTime Parameter

Defines the date and time of the variable change detection.

The following table describes the DataAndTime parameter format:

| Attribute Name | Type | Description/Value | Position |
|-------------------|--------|---|-----------------------------|
| SecondsSinceEpoch | INT32U | Number of seconds since midnight (00:00:00) 1970/01/01 (UTC time). (0...MAX) | |
| FractionOfSecond | INT24U | FRACT_SEC_0 (LSByte) | B7-B0 |
| | | FRACT_SEC_1 | B15-B8 |
| | | FRACT_SEC_2 (MSByte) | B23-B16 (B23 = 1 for 1/2 s) |

The time format is defined according to *IEC 61850-7-2 Edition 2*.

Representation of the `FractionOfSecond` parameter structure:

| FRACT_SEC_2 (MSByte) | | | | | | | | FRACT_SEC_1 (2nd byte) | | | | | | | | FRACT_SEC_0 (LSByte) | | | | | | | |
|----------------------|-----|-----|-----|-----|-----|-----|-----|------------------------|-----|-----|-----|-----|-----|---|---|----------------------|---|---|---|---|---|---|---|
| 2-3 | 2-2 | 2-1 | 2-0 | 1-9 | 1-8 | 1-7 | 1-6 | 1-5 | 1-4 | 1-3 | 1-2 | 1-1 | 1-0 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |

TimeQuality Parameter

The following table describes the `TimeQuality` parameter format:

| Attribute Name | Type | Description/Value |
|-----------------------------------|----------------------|---|
| <code>LeapsSecondsKnown</code> | BOOLEAN (B7) | This bit is set to FALSE. |
| <code>ClockFailure</code> | BOOLEAN (B6) | Same meaning as <code>l%</code> (implicit variable) <code>CLOCK_FAILURE</code> . |
| <code>ClockNotSynchronized</code> | BOOLEAN (B5) | Same meaning as the <code>l%</code> (implicit variable) <code>CLOCK_NOT_SYNC</code> . |
| <code>TimeAccuracy</code> | CODED ENUM (B4...B0) | <p>Number of significant bits in the <code>FractionOfSecond</code>.</p> <p>Minimum time interval is: $2^* -n$.</p> <p>In IEC norm, the <code>TimeAccuracy</code> represents the number of significant bits <code>N</code> in the <code>FractionOfSecond</code>.</p> <ul style="list-style-type: none"> For the 1 ms time stamp resolution of BMXERT module, <code>TimeAccuracy</code> is set to 0xx01010 bin. If <code>ClockNotSynchronized = 1</code>, or if <code>ClockFailure = 1</code> the <code>TimeAccuracy</code> keeps its usual value (as if the clock is synchronized). |

`TimeAccuracy` is also used to set specific values of `TimeQuality` as described in the following table:

| TimeAccuracy Specific Values | Values | Comments |
|------------------------------|----------|---|
| Unspecified | 0xx11111 | Used in case of time stamping detection cycle not periodic. |
| Invalid | 0xx11110 | Time invalid, used in case of buffer full. |
| <code>IOChannelError</code> | 0xx11101 | Used in case of I/O channel error detection. |
| <code>TSInit</code> | 0xx11100 | Used in case of synchronization of the values with the client (done by storing a virtual event with 16-ch discrete values inside the buffer). |
| <code>ClockInSync</code> | 0xx11011 | Used in case of external clock during synchronization (catch up mode). |

If several specific values are simultaneously detected, the precedence of `TimeAccuracy` specific values is:

1. `TimeAccuracy = IOChannelError` (highest priority)
2. `TimeAccuracy = Invalid` or `TSInit`
3. `TimeAccuracy = ClockInSync`
4. `TimeAccuracy = Unspecified`

Glossary

H

HMI:

Human Machine Interface. An HMI is a device that displays process data to a human operator, who in turn, uses the HMI to control the process.

An HMI is typically connected to a SCADA system to provide diagnostics and management data (such as scheduled maintenance procedures and detailed schematics for a particular machine or sensor).

Hot Standby:

A high-availability Quantum control system with a first PLC (primary) and a second PLC (standby) that maintains up-to-date system status. If the primary PLC becomes inoperable, the standby PLC takes control of the system.

O

OFS :

OPC Factory Server. OFS is a multi-controller data server which is able to communicate with PLCs in order to supply the OPC clients with data.

OPC DA:

OLE for Process Control Data Access. OPC DA is a group of standards that provides specifications for communicating real-time data.

OPC:

OLE for Process Control

S

SCADA:

Supervisory Control and Data Acquisition. SCADA usually refers to centralized systems which monitor and control entire sites or systems spread out over large areas.

AVEVA Plant SCADA provides an SOE view.

For system time stamping, it refers to AVEVA Plant SCADA or 3rd party SCADA with OPC DA interface.

SOE:

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