SIEMENS

SIMATIC

Process control system PCS 7
Time Synchronization (V9.0 SP2)

Function Manual

Valid for PCS 7 as of V9.0 SP2

Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

> **⚠ DANGER**
>
> indicates that death or severe personal injury **will** result if proper precautions are not taken.

> **⚠ WARNING**
>
> indicates that death or severe personal injury **may** result if proper precautions are not taken.

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>
> indicates that minor personal injury can result if proper precautions are not taken.

> **NOTICE**
>
> indicates that property damage can result if proper precautions are not taken.

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Security information

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Siemens provides products and solutions with industrial security functions that support the secure operation of plants, systems, machines and networks.

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Preface 2

Purpose of this documentation

The *time synchronization* documentation provides support for the configuration and commissioning of the "time synchronization" function in a PCS 7 plant.

The documentation provides information about the following topics:

- Time synchronization in a PCS 7 plant
- Planning time synchronization in a PCS 7 plant
- Configuring time synchronization for a PCS 7 plant

Note

You can find information on high-precision time stamping in the function manual *PCS 7 Process Control System; High-precision time stamping*.

Structure

The documentation is organized according to the following topics:

- Fundamentals of time synchronization mode of operation in a PCS 7 plant
- Configuration possibilities of PCS 7 with time synchronization
- Planning a PCS 7 plant with time synchronization
- Configuring the time synchronization for different plant configurations

Target group and benefit

This documentation is intended for personnel working in the fields of sales, planning, and configuration:

Target group	Using the documentation	Target-group relevant chapters of the documentation
Sales	Sales personnel give clear advice to their customers on implementing the "time synchronization" function in a PCS 7 plant.	• "Fundamentals" • "Configurations for time synchronization of a PCS 7 plant" • "Planning time synchronization"
Planning	The system planner uses the information in the documentation for optimal set up and the components necessary in this regard for planning a PCS 7 plant with the "time synchronization function".	• "Fundamentals" • "Configurations for time synchronization of a PCS 7 plant" • "Planning time synchronization"
Configuration	The configuration engineer is provided with exact instructions relative to the "time synchronization" function; these instructions show the specific steps that are necessary to adjust the time synchronization at all relevant points.	• "Configuring time synchronization"

Options for accessing PCS 7 documentation

The documentation required for PCS 7 includes the following types:

- **PCS 7 Readme**
  The readme file is available in two versions:

  - **PCS 7 Readme (offline)**
    This version is installed by PCS 7 Setup. The file only contains general information and links to documents on the Internet.

  - **PCS 7 Readme (online)**
    This version contains all information on the installation and use of PCS 7 in the format which is already familiar to you. The file is only available on the Internet to keep it always up-to-date

    Note

    The information provided in the *PCS 7 Readme* (online) on the Internet takes precedence over **all** other PCS 7 documentation.

    Read this *PCS 7 Readme* carefully, because it contains important information and amendments on PCS 7.

- **PUD Manager**
  The "PUD Manager" an innovative tool to access documentation, comes with PCS 7 DVD. Some of the highlights:

  - Create your own Manual Collection.

  - Customize the documentation set according to your needs.

  - Efficient search engine to access your information.

  To install the PUD manager and integrate the documents. refer to Siemens Industry Support (https://support.industry.siemens.com/cs/de/en/view/109748882)

- **PCS 7 System Documentation**
  System documentation contains information that covers several products, such as configuration manuals and Getting Started manuals. This documentation serves as a guideline for the overall system and explains the interaction between the individual hardware and software components.
  Note the information on "PCS 7 Documentation Portal Setup" in the product overview *Process Control System PCS 7; PCS 7 - Documentation*; Section "Options for accessing the documentation"

- **PCS 7 Product Documentation**
  Product documentation contains information about special hardware and software components. The individual documents provide detailed information on the specific component.

- **PCS 7 Technical Information and Solutions**
  For important technical information and solutions, refer to SIMATIC PCS 7 Overview (https://support.industry.siemens.com/cs/ww/en/view/63481413).

Full versions of the documentation are available from the "Technical Documentation SIMATIC PCS 7" website: www.siemens.com/pcs7-documentation (www.siemens.com/pcs7-documentation)

Skills required

Only qualified personnel should commission and operate the PCS 7 products.
Skills in the following areas are prerequisite:

- STEP 7

- PCS 7

- "Automation technology"

- Basic WinCC skills

- For plants with a domain structure: Knowledge of the Windows administration

Conventions

In this documentation, the names of elements in the software user interfaces are specified in the language of this documentation. If you have installed a multi-language package for the operating system, some of the designations will be be displayed in the basic operating system language even after you change the language and will, therefore, differ from the designations used in the documentation.

If you use the operating system Windows 10, you will find the Siemens SIMATIC programs in the Start menu under the menu command **All apps > Siemens Automation**.

Buerk timer specific procedure or tasks are explained separately.

For common features, the images shown in the manual for SICLOCK will remain same for Buerk timers.

For Buerk specific operations,new images are added.

Changes compared to the previous version

Below, you can find an overview of the most important changes in the documentation compared to the previous version.

New as of PCS 7 V9.0 SP2

- Implementation of Buerk timers

New as of PCS 7 V9.0

- Time synchronisation for time stamping on PROFINET IO (Page 52)

Basics

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3.1 Using time synchronization in PCS 7

Introduction

Plants in which Process Control Systems are used contain numerous components that exchange data. Most plants require time synchronization for controlling processes and information. There are additional requirements in terms of the documentation of event sequences.

If the timing of components in the overall system is not synchronized, these tasks can only be supported by the internal clock of the individual components.

Components that are equipped with an internal hardware clock (RTC = Real Time Clock) include:

- Domain servers
- Servers
- Clients
- PC stations
- Automation systems
- I/O
- Sensors
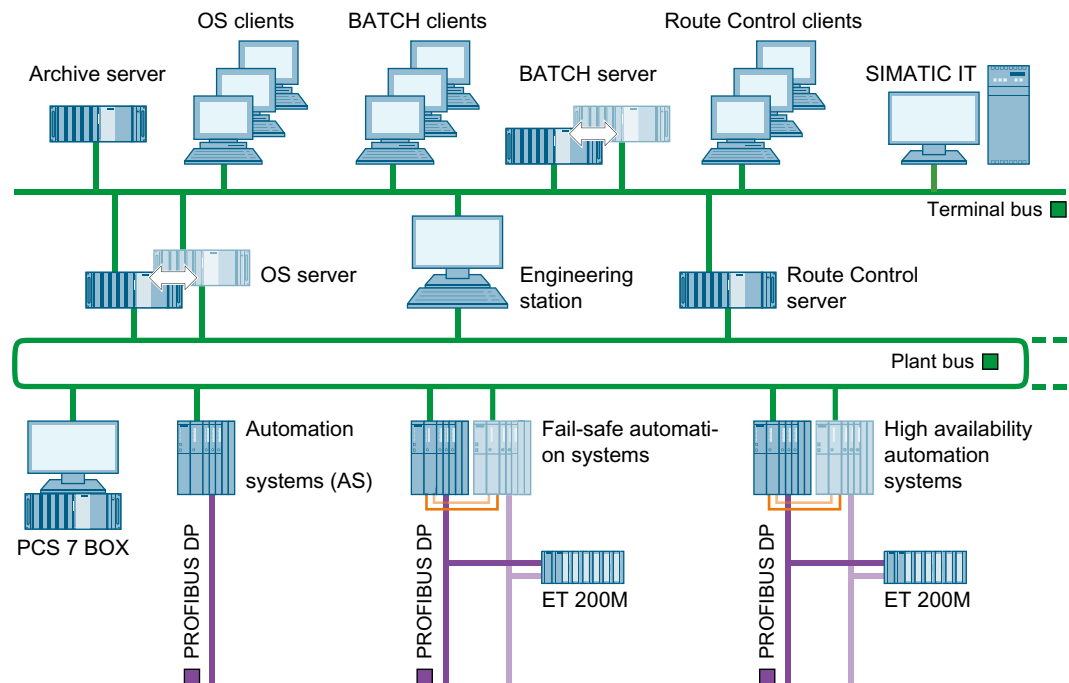
Time synchronization

Time synchronization means that one system component (time master) provides a precise time for all the other components (time slaves). The time information (date and time) can either be distributed by the time master, or be requested by the time slaves. This time information must be evaluated within the system by all components for the overall task.

Time synchronization applications

The list below contains various examples of aspects requiring time synchronization of all components within the process automation:

- Synchronizing processes
- Controlling complex sequences
- Logging and documenting sequences
- Validating processes
- Analyzing processes
- Analyzing the causes and effects of events

PCS 7 functions

The following list contains some of the key PCS 7 functions for which time synchronization is absolutely necessary:

- Interpretation of causal relationships
- Message processing in correct sequence
- Time stamp
- Time-of-day interrupts
- Runtime meter
- Redundancy synchronization
- Batch monitoring
- Authentication of a domain client

3.2   Time synchronization options for PCS 7 components

Time synchronization for PCS 7 components

The table below shows the PCS 7 components for which time synchronization is possible:

Station	Time synchronization	For more information, refer to the section ...
Operator station	• Via the terminal bus • Via the plant bus	"Configuring the time synchronization for PC stations with OS (Page 76)"
PC stations without OS • Engineering station • SIMATIC BATCH station • SIMATIC Route Control station • Process Historian • Information Server • SIMATIC IT	Via the operating system	• "How to make DCF 77 Client Service settings on a PC station without OS (Page 98)" • "How to synchronize PC stations without OS using the NTP mode (Page 93)"
AS	Via the plant bus	"Configuring time synchronization on an AS (Page 100)"
SIMATIC PCS 7 BOX RTX and SIMATIC PCS 7 AS RTX	When integrated in a PCS 7 plant	"Configuring the time synchronization for SIMATIC PCS 7 BOX RTX and SIMATIC PCS 7 AS RTX (Page 107)"
Domain controller	With a domain controller as time master on the terminal bus	"Configuring the time synchronization of the domain controllers (DC) (Page 118)"

3.3 Time displayed in PCS 7

Coordinated Universal Time (UTC)

Coordinated Universal Time (UTC) is an international time basis based on the precision of atomic clocks. UTC refers to the Greenwich prime meridian near London.

UTC does not take daylight saving time into account.

Local time

East of the prime meridian, one or more hours is added to the universal time measured in Greenwich, depending on the distance in question. West of the prime meridian, the hours are subtracted.

The following table shows some examples of time zones and their time differences in relation to UTC:

Location	Time zone	Zone time	Time
Greenwich	0. Longitude	UTC = Coordinated Universal Time	UTC 12:00
Berlin	15. Eastern longitude	CET = Central European Time	UTC + 1h: 13:00
Moscow	45. Eastern longitude	MSK = Moscow time	UTC + 3h: 15:00
Tokyo	120. Eastern longitude	JST = Japan/Korea Standard Time	UTC + 9h: 21:00
Buenos Aires	45. Western longitude	No designation	UTC – 3h: 9:00

Daylight saving time/standard time

A number of countries have introduced a change from standard time (local time) to daylight saving time for the summer months.

Example:
In central Europe, standard time differs by plus one hour, while daylight saving time differs by plus two hours in relation to standardized universal time (UTC).

UTC	CET standard time	CEST daylight saving time
12:00	UTC + 1h = 13:00	UTC + 2h = 14:00

Time display in process mode

In PCS 7, the operator can toggle the time displayed on the operator station between UTC and local time while the plant is in process mode. The operator station can display the local time, including daylight saving time and standard time.

Note

If time-dependent data of different time zones is displayed or processed on a PCS 7 component, then use UTC for display on the operator station as well.

3.4 Time synchronization in distributed PCS 7 plants

Introduction

PCS 7 supports system configurations where subcomponents are installed at different locations, or even in different time zones. An example would be the installation of an automation system and an operator station at different locations. The time must be synchronized for the entire PCS 7 plant in order to optimize the sequence of all the processes.

In PCS 7, the times of subcomponents are directly synchronized within a time zone. PCS 7 uses the "time synchronization" function to synchronize different time zones.

Time response in distributed PCS 7 plants

The following figure shows that time jumps may occur in process control systems (for example, in the alarm lists) if there is no time synchronization. The processes do not run synchronously:
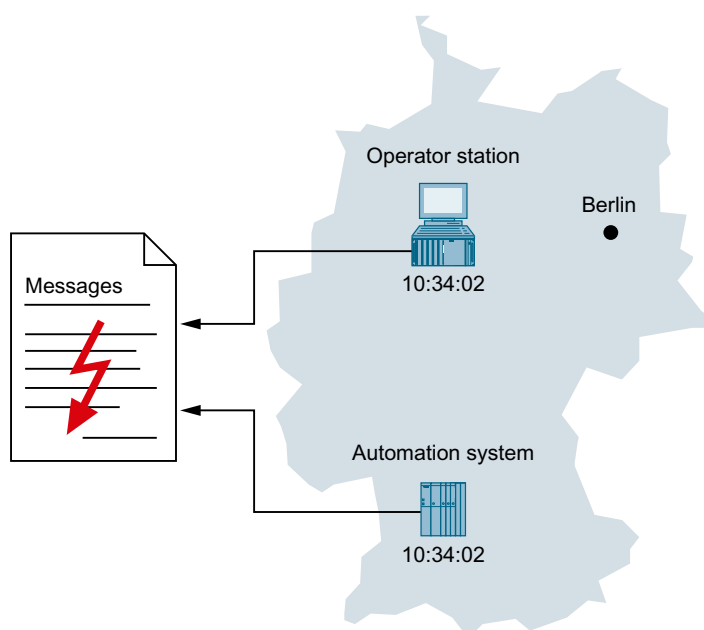
If the times for the components of a distributed PCS 7 plant are synchronized, all of the processes will run in correct chronological order and will be archived correctly.
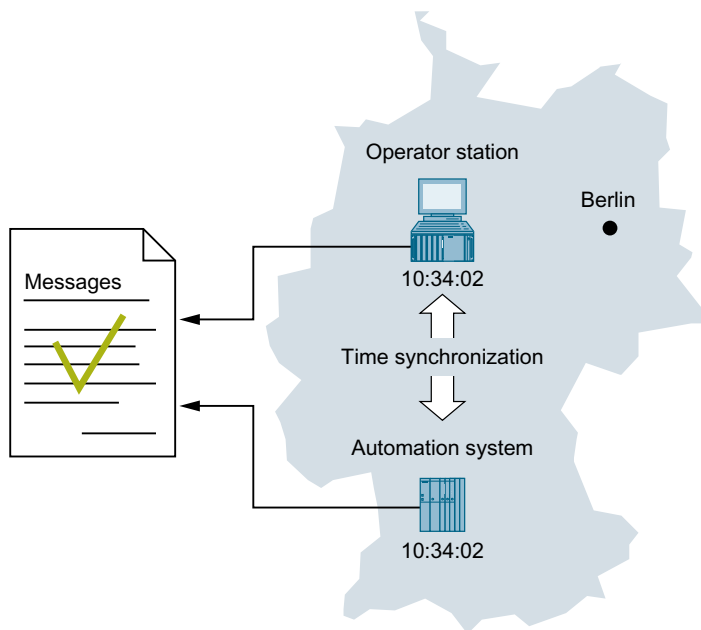
Rules for configuring distributed PCS 7 plants

Since PCS 7 plants generally operate on the basis of UTC **internally**, their specific components can be distributed on a global scale. In order to safeguard the interplay of components - even across different time zones - please observe the following:

- Use UTC as the common time base in all PCS 7 plants. All plant components running with UTC will display the same time after time synchronization.

- Set up a PC station as a PCS 7 Web server in all PCS 7 plants, using the PCS 7 OS web option. This way you can access the PCS 7 Web server of the PCS 7 plants from company headquarters with several web clients (in PCS 7: WebNavigator Client or WebNavigator Diagnostics Client). You can convert the time display on the Web client to the local system time. Please note the resulting time difference.

- If monitoring a PCS 7 plant in a different time zone on an OS, you can convert the time displayed from UTC to the local system time using the OS control panel. Please note the resulting time difference.
  Note the following for preventing an external synchronization:

Note

Time message frames from external networks

If the process control system is distributed among several networks or there are connections to the Internet or an intranet, time frames of external networks must not be routed to the process control system.

Connect the company network and the systems using network components that enable separation of the time frames, e.g., via a router. Configure those network components so that forwarding of time message frames is blocked.

Additional information

- Section "Setting the time displayed (Page 77)"
- WinCC online help

3.5 Central plant clock

Using a central plant clock

You should always synchronize all Process Control Systems using either a precise time or a standard time. In the case of PCS 7 plants, we recommend performing synchronization by means of a central plant clock. The central plant clock manages the time centrally for the entire plant and synchronizes all of the other plant components via their interfaces.

Recommendation:
We recommend the use of SICLOCK TC x00 or Buerk DTS 41xx timers as the central plant clock. The central plant clock should be synchronized with a time standard, e.g., with GPS or DCF 77. This will ensure that a correct reference to the actual time is provided at all times.

Standard time

The following standard times are typical for PCS 7 plants:

- GPS
  The GPS signal is provided by a global satellite system.

- DCF 77
  The DCF 77 signal is available in the Federal Republic of Germany and in certain parts of Europe via corresponding radio receivers.

3.6   Time levels of a PCS 7 plant (stratum)

Introduction

Time synchronization of a system involves one component synchronizing the next component by forwarding a time message frame. Forwarding time message frames will result in time delays. You should make allowances for this fact when setting up a PCS 7 plant.

The following figure shows an example of a PCS 7 plant configuration with several domains:
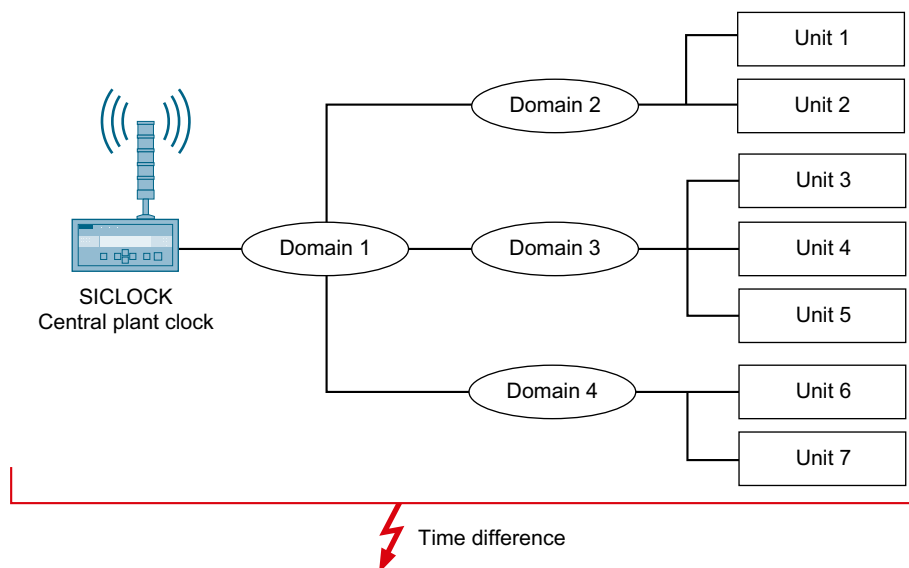
Definition stratum

A PCS 7 plant component such as the central time clock receives the definitive time from an external time source (e.g. a GPS signal) and forwards it to other components to be synchronized. As a result, the central plant clock is the time master for those components whose time is determined in relation to the central plant clock. Components which are capable of providing a time are considered time masters if other components use their time information.

All time masters form a hierarchy that consists of higher-level and lower-level time masters. Relative position within this hierarchy is designated with a number; the "stratum". Multiple time masters may be located within a single stratum. These time masters use the time frame at the same point in time to synchronize their own clock.

The stratum indicates the following:

● The number of time levels between the stratum in which the time master is located and the stratum in which the time source (e.g. the GPS satellite) is located

● The time level where the components in a network are located

Time synchronization using strata

The following figure shows an example of time synchronization using strata:
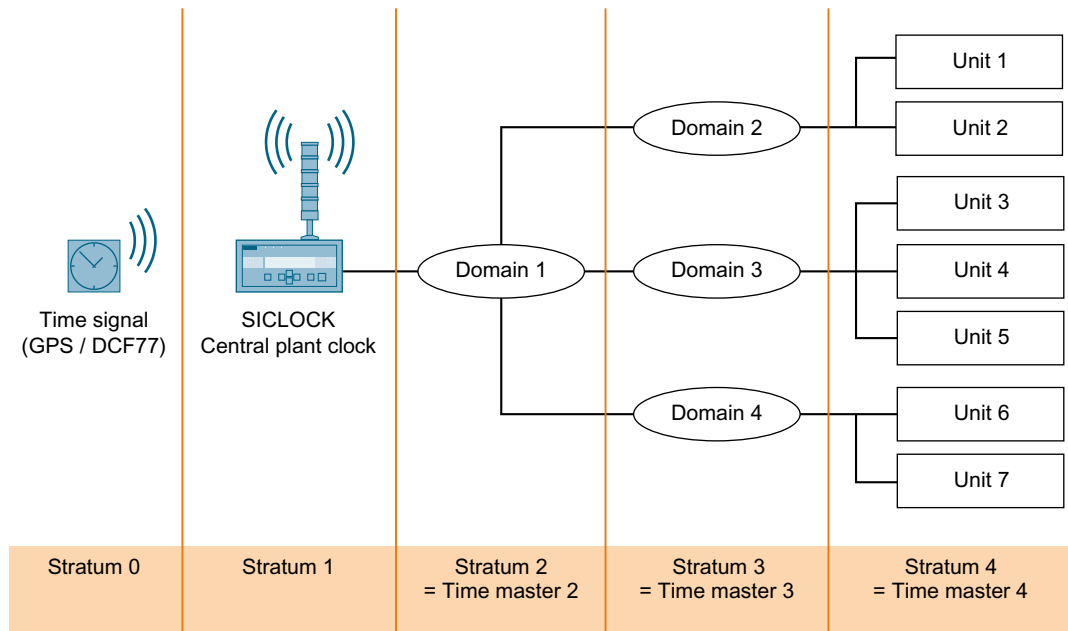
The above example shows time synchronization with the following structure:

- Stratum 0
  The time source is an atomic clock. This atomic clock synchronizes the GPS satellites or the DCF 77 senders, for example.

- Stratum 1
  The central plant clock obtains the time via a radio signal (e.g. GPS decoder or DCF 77 receiver) and transfers the time to domain controller 1 in stratum 2.

- Stratum 2
  Domain controller 1 is the time slave of the central plant clock. Domain controller 1 transfers the time to several domain controllers in stratum 3. Domain controller 1 is the time master of the domain controllers in stratum 3.

- Stratum 3
  The domain controllers in stratum 3 synchronize the time of their own plant units in stratum 4. The domain controllers in stratum 3 are the time masters of their own plant units.

- Stratum 4
  The plant unit components are time slaves.

Meaning of the strata for a PCS 7 plant

The higher the stratum is, the greater the possible time difference from the original source will be for the time frame. As time forwarding in a network also takes time, the time of lower strata time masters is more precise than the time of higher strata time masters.

Rules for planning a PCS 7 plant taking strata into account

Comply with the following rules when planning time synchronization to ensure that the time of the time master does not deviate too much from the time of the components in the lowest stratum:

- Use as few strata as possible.

- In most cases using a maximum of four strata is recommended.

- Use the same strata for the same structure elements.

When planning a PCS 7 plant to be synchronized, you should define exactly which hierarchy would be best for receiving and forwarding the time.

3.7 Operating principle of time synchronization in PCS 7

3.7.1 Time sources for a PCS 7 plant

Overview

In PCS 7 plants, it is necessary to define which component is capable of providing the plant with a satisfactory time in terms of quality. You can use either internal or external time sources for this purpose.

	External time source	Internal time source
Suitability	External time sources provide an ultra-precise time and are suitable for all plant configurations.	Internal time sources supply a continuous time frame. The time provided does not have to match the local time or Coordinated Universal Time (UTC). **Note:** Internal time sources are generally not approved for the validation of processes.
Examples	• GPS decoders • DCF 77 receivers • External NTP server	BIOS clock for a component without external time synchronization.

Internal time source for a PCS 7 plant

Using an internal time source ensures system-wide time consistency. This time does not have to agree with real UTC or with real local time. The following table shows which internal time source can be used for the time master:

Internal time source	Requirement	Active time master
RTC of the central plant clock	The central plant clock is connected to a PCS 7 plant network.	Central plant clock (also as NTP server)
RTC of the domain controller	The computer to be synchronized belongs to a Windows domain.	Domain controller (also as NTP server)
RTC of the OS server	The real time is not important for the project.	OS server

External time source for a PCS 7 plant

Using an external time source ensures system-wide time consistency. This time matches UTC or local time. The following table shows which external time source can be used for the time master:

External time source	Requirement	Active time master of the PCS 7 plant
DCF 77 or GPS signal	Radio signal can be received, the central plant clock is being synchronized	Central plant clock
NTP server	Internet connection	Domain controller

3.7.2 Time master, time slave, and cooperative time master

Introduction

To ensure that all Process Control System components operate with as precise a time as possible, one system component must be the time source for all other components. The precise time must be permanently available and be used for synchronization on a cyclical basis (synchronization interval).

Time master

The component that provides the precise time within a bus system is referred to as the time master. Only one component within a stratum can be the active time master.

Time slave

The time slaves within a bus system are components which receive or fetch their time from a time master.

Cooperative time master

On OS servers, the communication processors used are selected and the "Master" option is activated in the "Synchronization via System Bus (Master/Slave)" area of the "Time Synchronization" editor in the OS project in WinCC Explorer.
The OS server works as a cooperative time master, i.e. the first active OS server on the plant bus which does not receive time message frames on the plant bus automatically switches to time "Master" mode. All other OS servers on the plant bus detect the time message frame from the time master and automatically switch to time "slave" mode.

A cooperative time master does not have to belong to a redundant server.

The following process is initiated at the startup of a PC station that is configured as a cooperative time master. A time message frame must be received within the wait time once the PC station has powered up. The wait time amounts to four times the set synchronization interval.

Possible response of cooperative time masters within the phase until the wait time has expired:

- A cooperative time master that receives a time message frame from a different time master within the wait time becomes a time slave.

- A cooperative time master that has not received a time message frame on expiry of the wait time sends time message frames as the time master.

Within the set synchronization interval, all cooperative time masters check whether time message frames have been received from the active time master on a cyclical basis. The first

cooperative master that detects three missing time message frames in succession assumes the time master function. This ensures that only one time master exists.

Note

This setting applies both for the configuration with and without a central time master (central plant clock).

Synchronization response

All time slaves and cooperative time masters on the terminal bus synchronize their internal clock with the time message frames received . The time is synchronized as follows:

- Deviation ± 5 s:
  Slowing/accelerating of the internal clock

- Deviation > 5 s:
  Immediate reset (possible errors: Data packets sent off prior to the change will have more recent time stamps than those sent off later)

3.7.3 Legend for figures used in this documentation

Legend for configuration figures used in this documentation

Note

The individual components are identified in the figures below as follows:

- **A dashed line begins at a component**
  Components with red dashed lines leading away from them are time masters in this network.

- **An arrow points to a component**
  Components to which an arrow is pointing are time slaves in this network. (Exception: (M) on a component)

- **(M) at a component next to a bus system**
  An (M) at a component next to a bus system marks this component as a cooperative time master for this bus system.
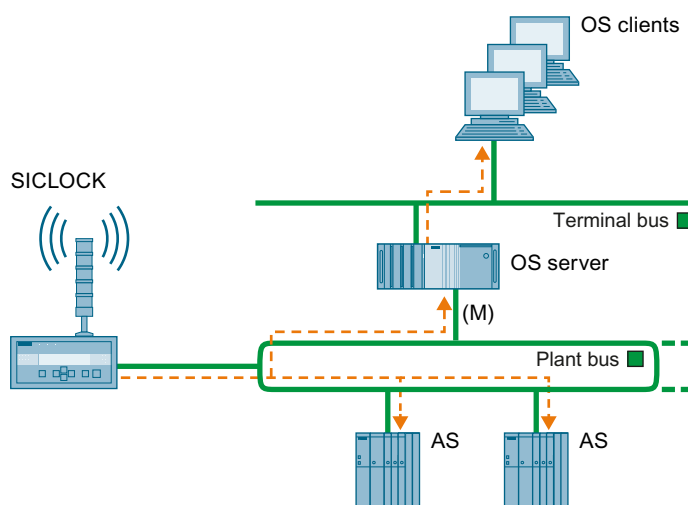
3.7.4   Example of the time synchronization sequence

Introduction

Time synchronization in a work group with central plant clock is described in the following.

The SICLOCK timer is the time master.

Note

Standard CPU types up to firmware V6.x with integrated Ethernet interface that support only the NTP mode are synchronized only with the use of a central plant clock.

Time frame of the SICLOCK timer central plant clock is received by PCS 7 components

The following figure shows an example of the time synchronization.
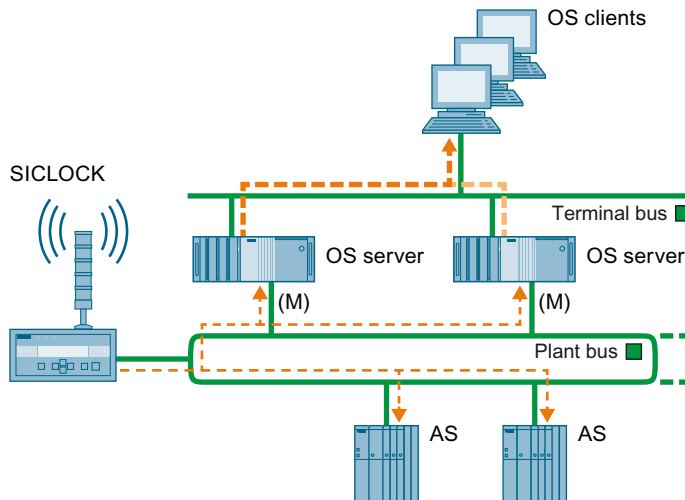
In this figure, the SICLOCK timer is the time master for the plant.

The SICLOCK timer sends time frames to the plant bus.

The OS servers and the automation systems (AS) receive the time frames from the plant bus.

The OS clients obtain the time frames from the OS server.

Time frame of the SICLOCK timer central plant clock is not received by PCS 7 components

The following figure shows an example of time synchronization for the scenario that the time frames sent by the SICLOCK timer cannot be received by the PCS 7 components.
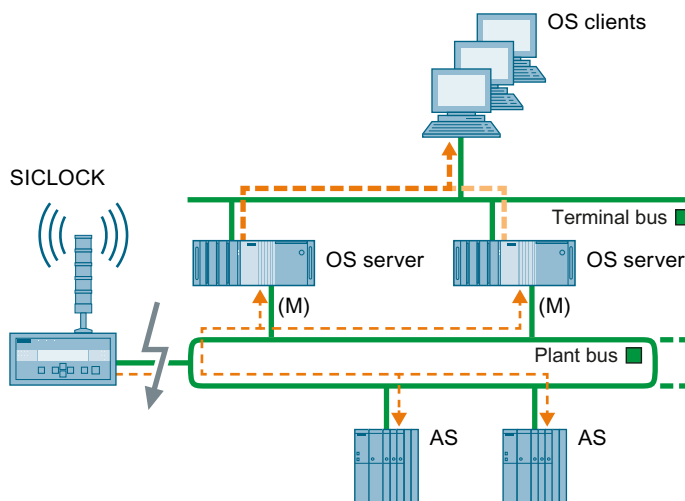
The time frames sent by the SICLOCK timer cannot be received by the components on the plant bus.

The interruption can be caused by a network interruption of failure of the SICLOCK timer.

If the OS servers act as cooperative time masters on the plant bus, the OS server that is the first to detect the loss of the time frame becomes the time master on the plant bus.

The OS server that becomes the time master sends the time frame to the plant bus and the terminal bus.

The automation systems receive the time frame from the plant bus.

Note

OS servers acting as cooperative time masters send only time frames in the SIMATIC mode.

For this reason, CPU types with integrated Ethernet interface that support only the NTP mode are not synchronized.

The OS clients obtain the time frames from the OS server.

3.8 Network environment of a PCS 7 plant

3.8.1 Overview

Network configuration for time synchronization in PCS 7

The sections that follow provide examples of network configurations for time synchronization in PCS 7.

- Network environment within a domain (Page 30)
- Network environment within a work group (Page 31)
- Network environment in redundant, high availability networks (Page 32)
- Network environment on separate networks with one central plant clock (Page 34)

3.8.2 Network environment within a domain

Central plant clock

The SICLOCK or Buerk timer is particularly suitable for operation as a central plant clock within a domain, since the SICLOCK timer has 4 independent Ethernet interfaces and the Buerk timer has 2 Ethernet interfaces.

Structure

The following figure illustrates the recommended configuration for a PCS 7 plant in a Windows domain with a central time clock:
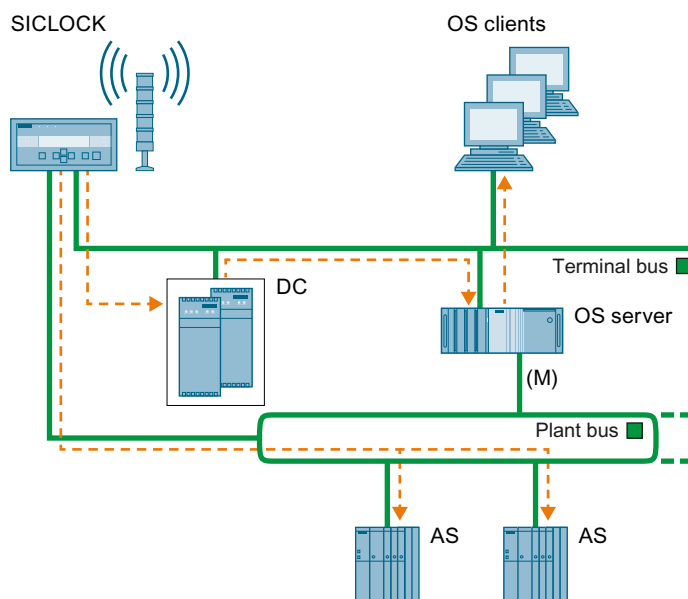
Time synchronization in a domain

The time is synchronized within a domain as follows:

● Time synchronization via plant bus
  The plant bus is synchronized using the SICLOCK timer.
  The synchronization modes are dependent on the type of CPU or CP that is used.

● Time synchronization via terminal bus
  The domain controllers are synchronized directly by the central plant clock using the NTP mode.
  The domain controllers synchronize all domain members using the NTP mode.

3.8.3 Network environment within a work group

Central plant clock

The SICLOCK or Buerk timer is suitable for operation as a central plant clock.

Structure

The following figure illustrates the recommended configuration for a PCS 7 plant in a work group with a central time clock:
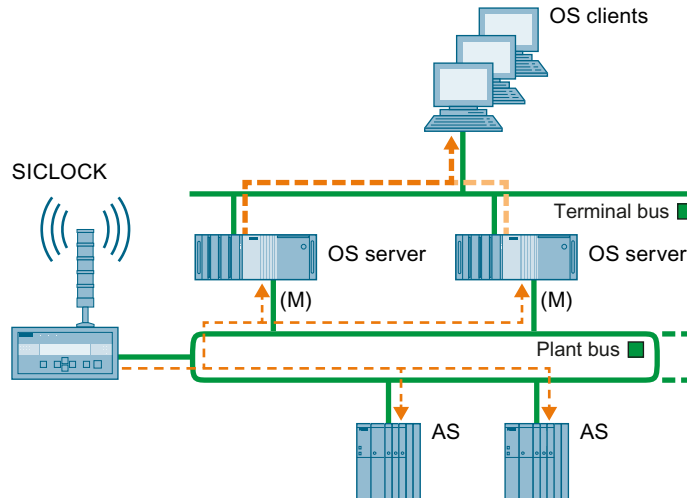
Time synchronization in a work group

The time is synchronized within a work group as follows:

- Time synchronization via plant bus
  The plant bus is synchronized using the SICLOCK timer.
  The OS servers and the automation systems receive the time from the central plant clock. These are time slaves.

- Time synchronization via terminal bus
  The OS clients receive their time from an OS server. OS clients only receive the time from those OS servers from which they also loaded the server data.

3.8.4 Network environment in redundant, high availability networks

Introduction

Always install redundant networks in a PCS 7 plant as a precaution against production losses caused by failures in the network connections. This will ensure that communication via the redundant network will remain intact if an area of the terminal bus fails. The domain controllers synchronize one another's time based on Windows mechanisms.

Central plant clock

The SICLOCK or Buerk timer is suitable for operation as a central plant clock. SICLOCK or Buerk timer can distribute the time frame directly to the networks of the plant.

Structure

The figure below illustrates the recommended configuration for a PCS 7 plant with a redundant network structure (redundant terminal bus and plant bus):
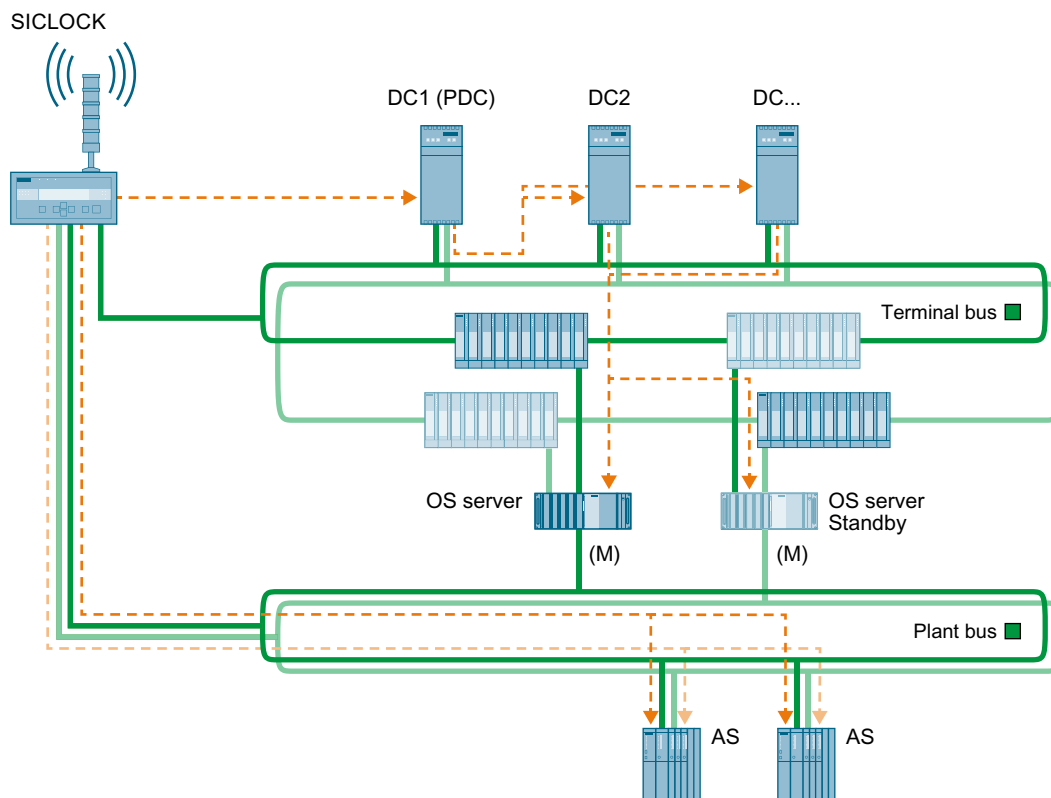
Time synchronization in redundant high availability networks in a domain

The time is synchronized as follows:

- Time synchronization via plant bus
  The plant bus is synchronized using the SICLOCK timer.
  The synchronization modes are dependent on the type of CPU or CP that is used.

- Time synchronization via terminal bus
  The domain controllers are synchronized directly by the central plant clock using the NTP mode.
  The domain controllers synchronize all domain members using the NTP mode.

3.8.5 Network environment on separate networks with one central plant clock

Central plant clock

If you must synchronize more than 4 networks using a central plant clock as the time source, you can use suitable switches in order to provide the time to the individual networks. The switch is only used to distribute time message frames. The remaining plant structure is identical to the relevant plant configuration.

Structure

The following figure illustrates the recommended configuration for a PCS 7 plant on separate networks using a single SICLOCK timer as the central plant clock:
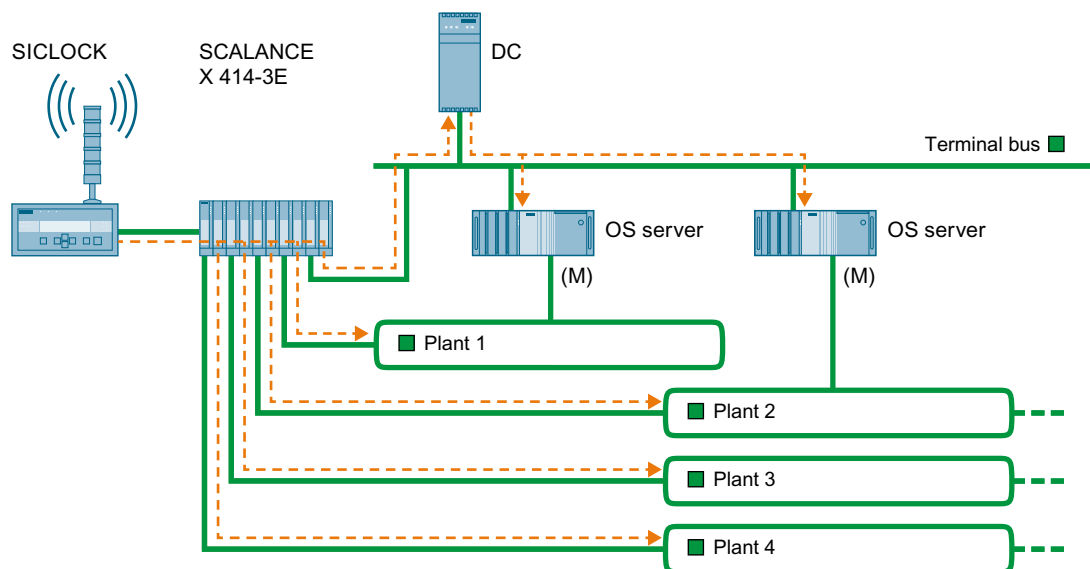
Time synchronization on separate networks with one central plant clock

Note

You must ensure that each network only contains one time master for providing the time. Separate message frame traffic between the networks.

Use the switch to transmit only the time frames from the central plant clock to the respective network.

The function for separating message frame traffic is dependent on the components used for connecting the networks.

Use the "Access Control" function when you use suitable SCALANCE switches. Bidirectional communication is disabled if the corresponding function is activated.

Additional information

- SICLOCK Application Note AN-002 (https://support.industry.siemens.com/cs/de/en/view/67638139)

- Configuration Manual *SCALANCE Industrial Ethernet Switches*

Configurations for time synchronization of a PCS 7 plant

4

4.1 Overview of recommended configurations

Introduction

Various techniques are possible for time synchronization. The structure of a PCS 7 plant with time synchronization requires careful planning in order to prevent any undesired results. Use one of the following configurations to support you in planning your PCS 7 plant.

Recommended configurations

Plant type	Recommen-dation	Configuration
Time synchronization in a work group	1	Time synchronization with a central time master (Page 39)
	2	Time synchronization without a central time master (Page 41)
Time synchronization in a Windows domain	3	Time synchronization with a central time master (Page 43)
	4	Time synchronization without a central time master (Page 45)

Configurations in Windows domains

Note

This document divides the recommended configurations for time synchronization in a Windows domain (recommendations 3 and 4) on the basis of hierarchy levels. The sections that follow shows the structure in configurations with different hierarchy levels:

- Configuration of time synchronization with a central time master in a Windows domain with one hierarchy (Page 43)"
- Configuration of time synchronization without a central time master in a Windows domain with multiple hierarchies (Page 47)"

4.2 Rules for time synchronization in PCS 7

Rules

- A network may only contain one active time master.

- If the time within the PCS 7 plant is to match the local time, then time synchronization with an external time source (e.g., GPS, DCF 77) is required.

- Central plant clocks (synchronized with an external time source wherever possible) are high-grade internal time sources for PCS 7 plants.

- A time slave can be the time master for lower-level components and systems.

- Any domain controllers that are available in a network can synchronize all of the nodes in this network. A synchronization cycle using domain controllers has a duration of 8 hours by default. For reasons of precision, additional synchronization corrections using integrated PCS 7 tools (WinCC time synchronization) are required. You can define an interval at which the OS synchronizes its time with that of an external time source.

- The WinCC "time synchronization" application can be used to configure an OS server as a time master, a cooperative time master, and a time slave.

- An OS server can be configured as a time master either with or without external time synchronization.

- If the "High-precision time stamping" function is used for selected signals in an automation system, then the direct time synchronization of the plant bus via a central plant clock is required.
  If the central plant clock fails, the time accuracy is not sufficient for the high-precision time stamping.
  The chronological order of the signals displayed remains intact.

Time synchronization using NTP

The following components are synchronized using NTP:

- PC stations that are not operated as OS client or OS servers

- CPU types with integrated Ethernet interface that support only the NTP mode.
  Please note the following restrictions:
  When there is a connection to OSM (6GK1105-0AA00), SIMATIC NET - Update 2000/025 (Incompatibility with tagged frames in Industrial Ethernet OSM networks) (https://support.industry.siemens.com/cs/ww/en/view/4247019) must be noted.

Criteria for time synchronization in existing PCS 7 plants

Compare the configuration of your existing PCS 7 plant with the configurations outlined in this documentation, and configure the time synchronization according to the present configuration.

Additional information

- Section "Time synchronization in distributed PCS 7 plants (Page 17)"

- Documentation *Process Control System PCS 7; Released modules*

4.3 Configurations for time synchronization in a work group

4.3.1 Configuration in a work group with central time master

Configuration

The following figure is a schematic representation of how time synchronization of a work group with central time master should ideally be configured.
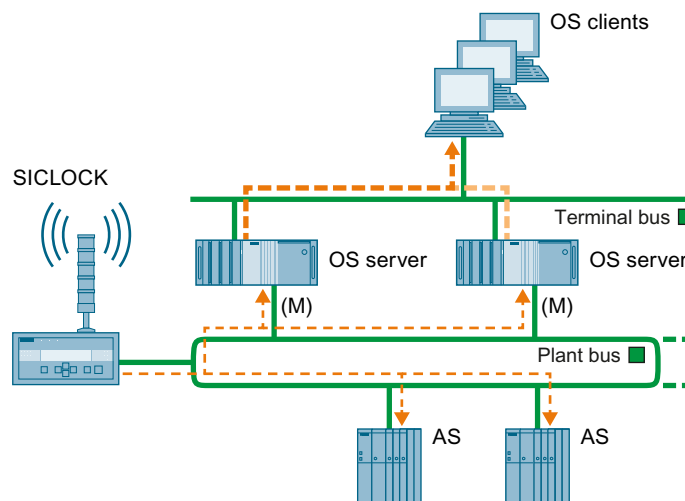
Time master

Central plant clock on the plant bus

The central plant clock is either synchronized with an external signal (e.g. GPS), or operates with the internal realtime clock.

Time synchronization on the terminal bus

- An OS server sends the time frame for process control that it receives from the plant bus to the terminal bus.

- The OS clients are configured as time slaves in the OS project in WinCC Editor in the "Time Synchronization" editor and receive their time frame from an OS server from which server data are loaded.

- PC stations that do not have the WinCC Time Synchronization function, e.g. SIMATIC BATCH stations or engineering stations, are synchronized using the NTP mode or a DCF 77 reception service (must be additionally installed).
  An OS server is possible as a time master.

Time synchronization on the plant bus

- Time master connected to the plant bus as the central plant clock.
  The SIMATIC mode must be activated for synchronization of the OS servers on the plant bus.
  The central plant clock sends a high-precision broadcast time signal to the plant bus (SIMATIC mode) and can additionally make the NTP mode available on the plant bus.

- The OS servers are configured as so-called cooperative time masters.
  If central plant clock stops sending time frames, an OS server becomes the active time master and now starts sending time frames on the plant bus by way of substitution.

- Configuring the automation systems:

  - The automation system with an external CP 443-1 as communication interface is configured as a time slave (SIMATIC mode).

  - The CPU with integrated Ethernet interface receives the time frames via the internal PROFINET IO interface and synchronizes its internal clock.
    The CPU with integrated Ethernet interface is a time slave on the plant bus.

- SIMATIC PCS 7 BOX RTX and SIMATIC PCS 7 AS RTX are configured.
  The time synchronization is configured with "WinAC Time Synchronization".
  The "CP" SIMATIC mode and the "PC time" NTP mode are available for selection. To select one of these, select the desired option in the "Configuration" group of the "WinAC Time Synchronization" dialog box.
  For the NTP mode, the NTP server must be configured in the Windows time setting.

Additional information

- Section "Time synchronization in a work group with central time master (Page 57)"

4.3.2   Configuration in a work group without central time master

Configuration

The following figure schematically shows the recommended configuration of a PCS 7 plant with time synchronization in a work group without central time master:
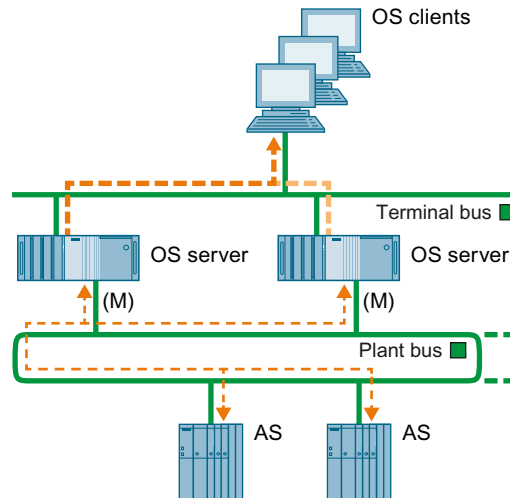
Time master

The OS servers are time masters for the PCS 7 plant on the plant bus/terminal bus.

Time synchronization on the terminal bus

- The OS clients are configured as time slaves in the OS project in WinCC Editor in the "Time Synchronization" editor and receive their time frame from an OS server from which server data are loaded.

- PC stations that do not have the WinCC Time Synchronization function, e.g. SIMATIC BATCH stations or engineering stations, are synchronized using the NTP mode or a DCF 77 reception service (must be additionally installed).
  An OS server is possible as a time master.

Time synchronization on the plant bus

- The OS servers are configured as so-called cooperative time masters.
  An OS server transmits the time frame to the plant bus.

- Configuring the automation systems:

  – The automation system with an external CP 443-1 as communication interface is
    configured as a time slave (SIMATIC mode).

  – The CPU with integrated Ethernet interface receives the time frames via the internal
    PROFINET IO interface and synchronizes its internal clock.

- SIMATIC PCS 7 BOX and SIMATIC PCS 7 AS RTX are configured.
  The time synchronization is configured with "WinAC Time Synchronization" and the "CP"
  SIMATIC mode is selected. You activate the "CP" SIMATIC mode in the "Configuration"
  group of the "WinAC Time Synchronization" dialog box.

Additional information

- Section "Time synchronization in a work group without central time master (Page 59)"

4.4 Configuration for time synchronization in a Windows domain

4.4.1 Configuration in a Windows domain with a hierarchy with central time master

Introduction

In a Windows domain, you should synchronize the terminal bus and the plant bus directly using the central plant clock.

The recommended central plant clock are SICLOCK TC 400 (which has 4 independent Ethernet interfaces) or Buerk DTS 4138S timer (which has 2 Ethernet interfaces).

Configuration

The following figure illustrates the recommended configuration for a PCS 7 plant in a Windows domain with a central time master:
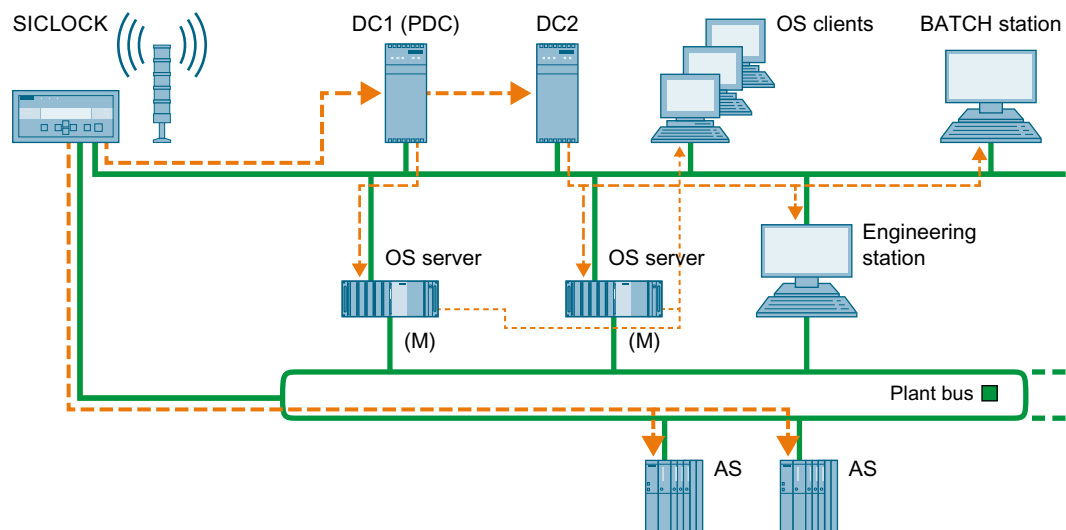
Time master

Central plant clock on the plant bus and the terminal bus

The central plant clock is either synchronized with an external signal (e.g. GPS), or operates with the internal realtime clock.

Time synchronization on the terminal bus

- Active time master:
  The time master is the domain controller (DC), which is configured as the PDC emulator (usually the first domain controller installed).

- Time source:
  The domain controller obtains the time from the central plant clock. The central plant clock is connected to the terminal bus via an Ethernet connection. Domain controllers are synchronized from the central plant clock via NTP.

- The Windows time service (w32tm) synchronizes the date and time of all computers of a Windows domain.
  Since the Windows-internal time synchronization is synchronized only every eight hours, the OS servers are additionally configured as time slaves of the domain controller (PDC emulator) via the WinCC Time Synchronization.
  The PDC emulator is an operations master role of a domain controller.
  The domain controller with the operations master role PDC emulator synchronizes the members of the Windows domain every 8 hours.

- Passive time master:
  If the authenticated domain controller (PDC operation master) fails, the operations master role "PDC Emulator" has to transfer to another domain controller manually.

- Time slaves:
  All other system PCs are automatically time slaves of the domain controller (PDC emulator) due to their membership in the Windows domain.

- The OS servers are configured as time slaves in the OS project in WinCC Explorer in the "Time Synchronization" editor.

- The OS clients are configured as time slaves in the OS project in WinCC Editor in the "Time Synchronization" editor and receive their time frame from an OS server from which server data are loaded.

- PC stations that do not have the WinCC Time Synchronization function, e.g., SIMATIC BATCH stations or engineering stations, are synchronized using the NTP mode or a DCF 77 reception service (must be additionally installed) or a time master.
  One of the domain controllers can be used as a time master here.

Time synchronization on the plant bus

- Time master is connected to the plant bus as the central plant clock.
  The central plant clock sends a high-precision broadcast time signal to the plant bus (SIMATIC mode) and can additionally make the NTP mode available on the plant bus.

- The OS servers are configured as so-called cooperative masters.
  If central plant clock stops sending time frames, an OS server becomes the active time master and now starts sending time frames on the plant bus by way of substitution.

- Configuring the automation systems:

  - The automation system with an external CP 443-1 as communication interface is configured as a time slave (SIMATIC mode).

  - The CPU with integrated Ethernet interface receives the time frames via the internal PROFINET IO interface and synchronizes its internal clock.
    The CPU with integrated Ethernet interface is a time slave on the plant bus.

- SIMATIC PCS 7 BOX RTX and SIMATIC PCS 7 AS RTX are configured.
  The time synchronization is configured with "WinAC Time Synchronization".
  The "CP" SIMATIC mode and the "PC time" NTP mode are available for selection. To select one of these, select the desired option in the "Configuration" group of the "WinAC Time Synchronization" dialog box.
  For the NTP mode, the NTP server must be configured in the Windows time setting.

Additional information

- Section "Time synchronization in a Windows domain with a hierarchy with central time master (Page 60)"

- The procedure for configuring an authorizing time server in Windows Server can be found in the corresponding Microsoft literature on the Internet at:
  http://support.microsoft.com, topic: Configuring an authorizing time server in Windows Server (https://support.microsoft.com/en-us/kb/816042)

4.4.2   Configuration in a Windows domain with a hierarchy without central time master

Configuration

The figure below illustrates the recommended configuration of a PCS 7 plant with time synchronization and without a central time master in a Windows domain.
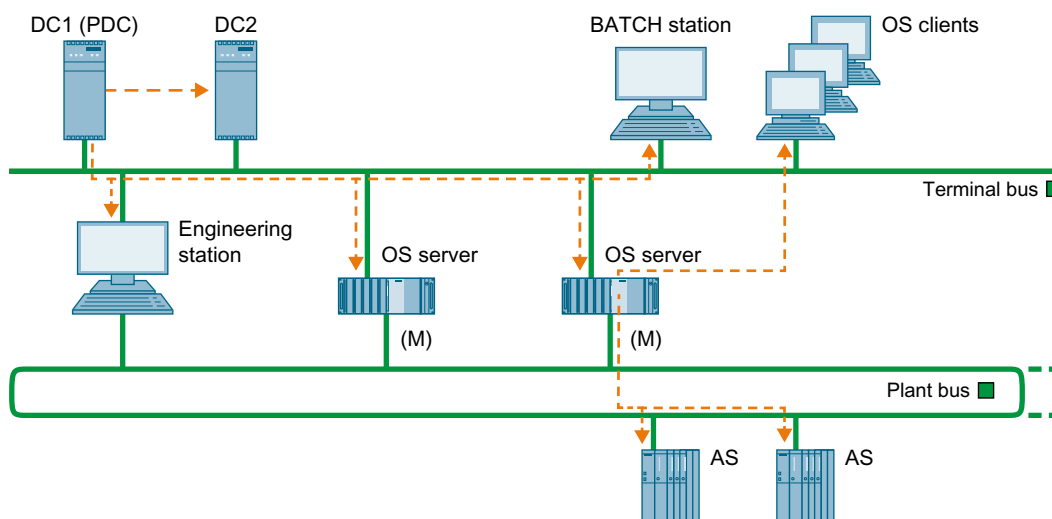
Time master

Domain controller (DC) with PDC emulator operation master role

Time synchronization on the terminal bus

- Time source:
  The domain controller receives the time via an NTP time server or a time receiver (DCF 77 or GPS module) that contains the exact time.

- The Windows time service (w32tm) synchronizes the date and time of all computers of a Windows domain.
  Since the Windows-internal time synchronization is synchronized only every eight hours, the OS servers are additionally configured as time slaves of the domain controller (PDC emulator) via the WinCC Time Synchronization.
  The PDC emulator is an operations master role of a domain controller.
  The domain controller with the operations master role PDC emulator synchronizes the members of the Windows domain every 8 hours.

- Passive time master:
  If the authenticated domain controller (PDC emulator operation master) fails, the operations master role "PDC Emulator" has to transfer to another domain controller manually.

- Time slaves:
  All other system PCs are time slaves of the domain controller due to their membership in the Windows domain.

- The OS servers are configured as time slaves in the OS project in WinCC Explorer in the "Time Synchronization" editor.

- The OS clients are configured as time slaves in the OS project in WinCC Editor in the "Time Synchronization" editor and receive their time frame from an OS server from which server data are loaded.

- PC stations that do not have the WinCC Time Synchronization function, e.g., SIMATIC BATCH stations or engineering stations, are synchronized using the NTP mode or a DCF 77 reception service (must be additionally installed) or a time master.
  One of the domain controllers can be used as a time master here.

Time synchronization on the plant bus

- The OS servers receive the time frame from the authoritative domain controller (PDC operations master) via the terminal bus.
  The OS servers are configured as so-called cooperative time masters.
  An OS server transmits the time frame to the plant bus.

- Configuring the automation systems:

  - The automation system with an external CP 443-1 as communication interface is configured as a time slave (SIMATIC mode).

- SIMATIC PCS 7 BOX and SIMATIC PCS 7 AS RTX are configured.
  The time synchronization is configured with "WinAC Time Synchronization" and the "CP" SIMATIC mode is selected. You activate the "CP" SIMATIC mode in the "Configuration" group of the "WinAC Time Synchronization" dialog box.

Additional information

Section "Time synchronization in a Windows domain with a hierarchy without central time master (Page 62)"

The procedure for configuring an authorizing time server in Windows Server can be found in the corresponding Microsoft literature on the Internet at:
http://support.microsoft.com, topic: Configuring an authorizing time server in Windows Server (http://support.microsoft.com/kb/816042/en-us)

4.4.3 Configuration in a Windows domain with multiple hierarchies

Configuration

The following figure shows an example configuration for time synchronization in a Windows domain with multiple hierarchies:
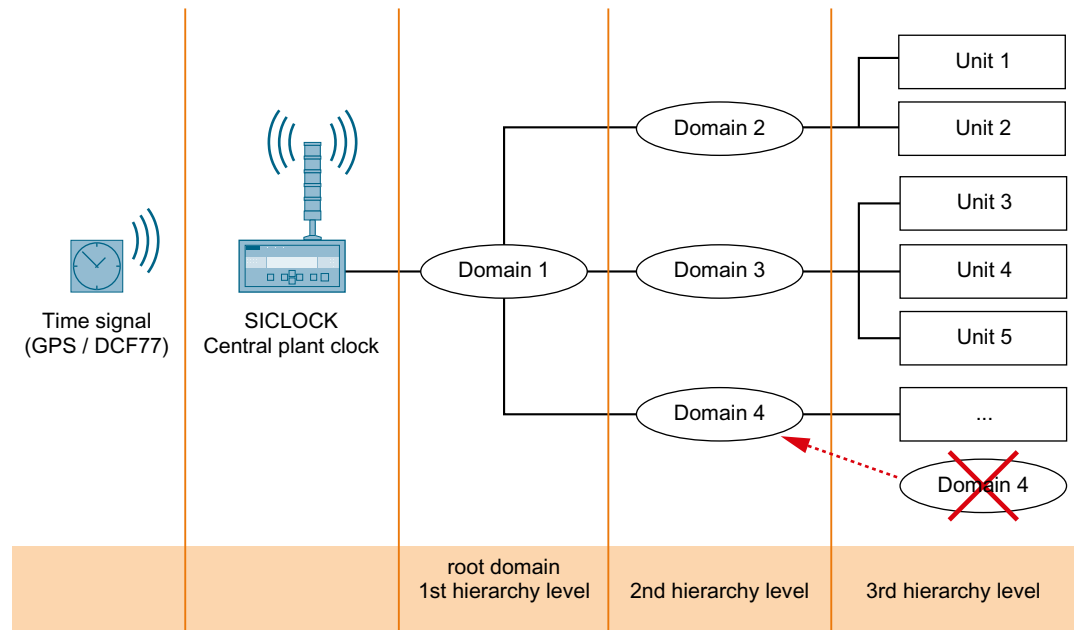
Rules

In order to avoid time jumps, observe the following rules when configuring the hierarchy for the PCS 7 plants within a Windows domain that contains multiple hierarchies:
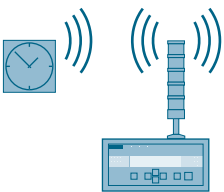
- All identical structures must be assigned to the same levels in a Windows domain that contains multiple hierarchy levels. This prevents unwanted time differences.
  You can find additional information in the section "Time levels of a PCS 7 plant (stratum) (Page 21)".

- Create only one hierarchy level under the root domain. Configure additional Windows domains you may require on the same hierarchy level as the existing subdomains.

Planning time synchronization

<div style="text-align: right; font-size: xx-large;">5</div>

5.1 Selecting the time master

Selecting the time master

On a time-synchronous PCS 7 plant, you require a time master to which the additional plant components can be synchronized. The table below lists the components that are used as time masters, depending on the network environment:

Time master	With time source ...	Provides the time via ...	Time master forwards the time to...	Forwards the time to ...
SICLOCK or Buerk timer	Central clock: Non-synchronized or synchronized (e.g. via GPS or DCF 77)	Terminal bus	Domain controller	-
		Terminal bus	OS server	Terminal bus with OS servers and OS clients
		Plant bus	Automation systems	-
OS server	- RTC of the OS server - Ethernet - GPS - DCF 77 - NTP server	Terminal bus	OS clients	
		Plant bus	CP of the OS servers that are active time masters	Automation systems
Domain controller	- RTC of the domain controller - Ethernet - GPS - DCF 77 - NTP server	Terminal bus	OS server	OS clients
				Plant bus, including the automation systems
PC	- RTC of the PC - Ethernet - GPS - DCF 77 - NTP server		All OS servers as time masters	

5.2 Selecting the central plant clock

Introduction

You should always synchronize all automation processes using a standard time. In the case of PCS 7 plants, we recommend performing synchronization by means of a central plant clock. The central plant clock controls the time for the entire PCS 7 plant, and synchronizes all other plant components via their interfaces.

A GPS or DCF 77 signal should be used as the time source for the central plant clock.

Selecting the central plant clock

The following table shows data of the central plant clock recommended for PCS 7:

Central plant clock	Inputs	GPS decoders	DCF 77 receivers	Outputs	Ethernet	SIMATIC mode
SICLOCK TC 400	2 x digital	GPS1000 (GPSDEC)	DCFRS industry version	2x digital 24V 1x digital RS422/5V 1x alarm 1x warning	4x RJ45	yes
SICLOCK TC 100	2 x digital	GPS1000 (GPSDEC)	DCFRS industry version	1x alarm 1x warning	1x RJ45	yes
DTS 4138S	1 x alarm	GPS 4500	DCF 4500	1 x alarm	2x RJ45	yes
DTS 4128	-	GPS 4500	DCF 4500	1 x alarm	1x RJ45	no
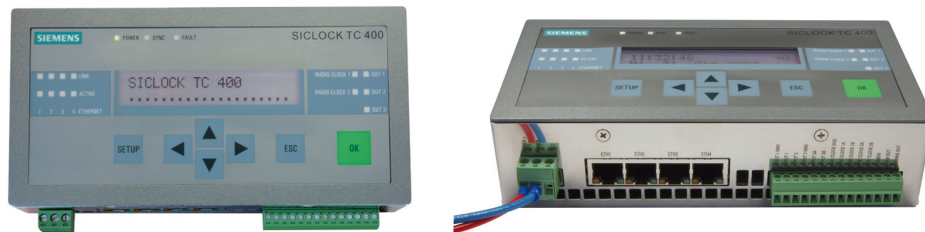
Figure 5-1   SICLOCK TC 400

Figure 5-2   SICLOCK TC 100

Figure 5-3   DTS 4128

Figure 5-4   DTS 4138S

Additional information

- Information about SICLOCK timers (https://w3.siemens.com/mcms/siplus/en/siclock/central-plant-clocks/Pages/Default.aspx)

- Information about Buerk timers (https://support.industry.siemens.com/cs/ww/en/view/109760344)

5.3 Time synchronization and high-precision time stamping for PROFINET IO fieldbus

Introduction

If you want to use high-precision time stamping for PROFINET IO fieldbus, the plant bus must be divided as shown in this section.

Dividing the plant bus

- **Section of the plant bus for synchronizing the AS to the central system lock**
  - This network only connects the central plant clock (time-of-day master) and the AS to each other.
  - There is a direct connection between the central plant clock and the first CPU (see figure below).
- **Section of the plant bus for communication of the automation system with the other systems (for example, engineering system, OS)**
  - This network is connected via a communication channel (for example, CP 443-1).

Hardware requirements are as follows:

- SICLOCK TC400 or Buerk 4138S timer
- CPU 410
- ET 200SP HA

The figure shows an example of a connection of an H-system to the time-of-day master.

The two parts of the illustration show the connection differences between the configuration:

Time synchronization

Central system clock

Time master

Plant bus ■

Time synchronization for time stamping on PROFINET IO

SICLOCK TC400

Time master

Plant bus■

☐ TIME-NET
☐ TIME-NET (redundant)

2x communications processor on plant bus, e.g. CP 443-1
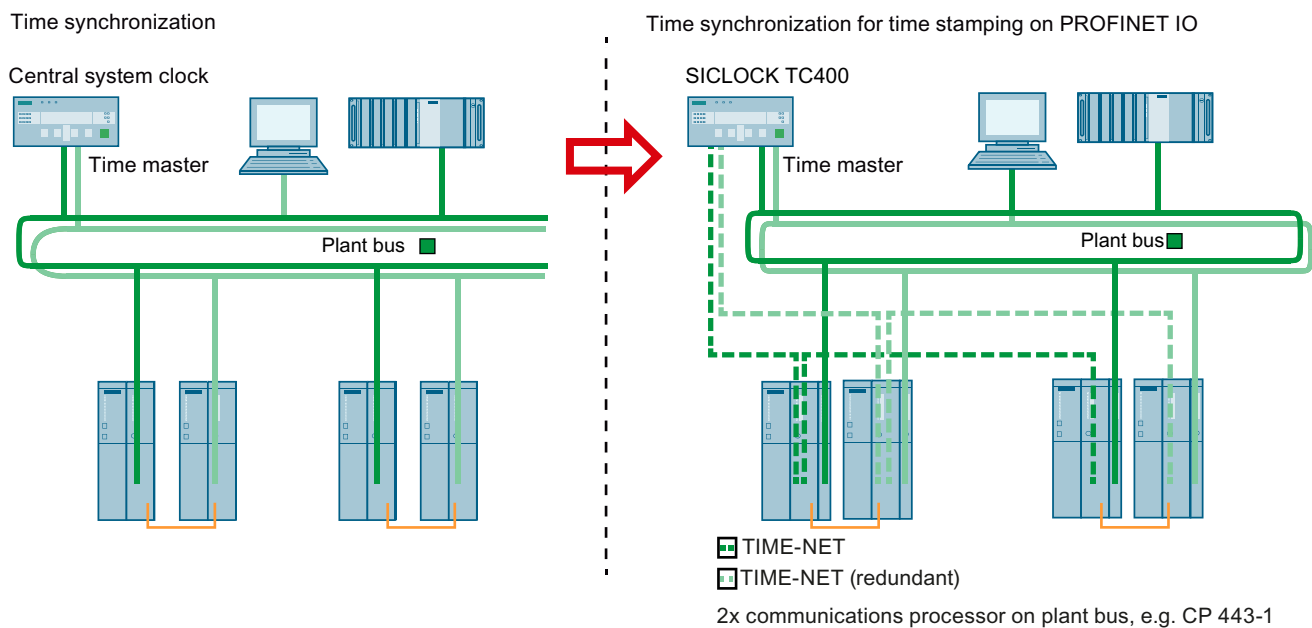
Application of configurations for time synchronization

Result

- A network (labeled "TIME-NET" here) only connects the central plant clock to the first CPU configured for high-precision time stamping.
  This CPU sends the time frames to next node in the TIME-NET.

- A central plant clock sends the time frames via Industrial Ethernet.

- There is a direct connection between the central plant clock and the integrated PROFINET IO interface of the CPU.

- The time-of-day synchronization for the CPU is performed with the SIMATIC method.

For more information, refer to Function manual *SIMATIC; ET 200SP HA; Time stamping with ET 200SP HA* and *Process Control System PCS 7; High-precission time stamping*.

For information on which quantity frameworks and configuration guidelines apply for high-precision time stamping with an accuracy of 1 ms when using the ET 200SP HA and PROFINET (https://support.industry.siemens.com/cs/ww/en/view/109750520)

Configuring time synchronization 6

6.1 Introduction

Components

To synchronize the time of your plant, it is necessary to configure all network nodes for time synchronization. To do this configure the following components depending on configuration:

- Time receivers
  If synchronizing the time using an external time source, you must configure the time recipient for a central plant clock.

- Operator station
  Configure the OS server(s) and the OS clients.

- Communications processors
  Configure the CPs for time synchronization.

- Automation system
  Configure the CPU and the communication processors of the automation system (CP 443-1, CP 443-5 Ext).

- Additional plant components
  The following components should be included in the time synchronization as needed:

  – SIMATIC BATCH

  – SIMATIC Route Control

  – SIMATIC PCS 7 BOX RTX

  – SIMATIC PCS 7 AS RTX

  – SIMATIC IT

  – Engineering station

  – Process Historian

  – Information Server

  – SIMATIC Management Console

Time synchronization modes

The time synchronization process is activated when configuring time synchronization.

The following options for synchronizing the time of network components are used in PCS 7:

- **Synchronization via WinCC Time Synchronization**
  Synchronization via the "WinCC Time Synchronization" application is used for time synchronization of PC stations. The software for an OS server or OS client must be installed on the PC stations.

- **SIMATIC mode**
  The SIMATIC mode works with MAC addresses (ISO layer 2) and can thus only be used in the local Industrial Ethernet subnet. The time master sends broadcasts on the bus.
  This time synchronization method is not routing-capable.
  The SIMATIC mode provides a more accurate time synchronization than the NTP mode.
  The SIMATIC mode is used for time synchronization of automation systems on the plant bus (exception: automation systems with integrated Ethernet interface that support the NTP mode only).

- **NTP**
  NTP enables time synchronization across subnet borders and additional security settings.
  NTP is used for the time synchronization of the following components:

  – Domain controller (DC)

  – Automation systems

  – PC stations on which the software for an OS server or OS client has not been installed, and which are not synchronized using the DCF 77 reception service.
    Typical application for: SIMATIC BATCH, SIMATIC Route Control, Engineering Station, Process Historian, Information Server

- **Synchronization by means of DCF 77 reception service**
  The "DCF 77 reception service" application is used to synchronize the time of the following components:

  – PC stations on which the software for an OS server or OS client has not been installed, and which are not synchronized using NTP.
    Typical application for: SIMATIC BATCH, SIMATIC Route Control, engineering station

6.2 Overview of configuration steps, depending on the configuration

6.2.1 Time synchronization in a work group

6.2.1.1 Time synchronization in a work group with central time master

Example configuration

The following figure shows an example configuration.

Overview

The following table lists the topics that contain information and configuring instructions.

What?	Where?	How?
Configuring the central time master	-	• SICLOCK or Buerk timer "Commissioning the SICLOCK timers (Page 64)" "Commissioning the Buerk timers (Page 67)" • GPS receiver "Commissioning GPS receivers for SICLOCK timers (Page 72)" • DCF 77 "Commissioning the DCF 77 receiver for SICLOCK timers (Page 74)"
Parameter assignment of communications processors of the OS servers on the plant bus	In HW Config of the OS server on the engineering station	• CP 16x3 / CP 16x8 • BCE/Softnet "How to assign parameters for a CP 16x3 / CP 16x8 communications processor (Page 76)"
Parameter assignment of OS server as cooperative time master	In the OS project in WinCC Explorer in the "Computer" object on the engineering station	"Setting the time displayed (Page 77)"
	In the OS project in WinCC Explorer in the "Time Synchronization" editor on the engineering station	"How to assign parameters for an OS server in a work group with central time master (Page 81)"
Parameter assignment of OS clients as time slaves	In the OS project in WinCC Explorer in the "Computer" object on the engineering station	"Setting the time displayed (Page 77)"
	In the OS project in WinCC Explorer in the "Time Synchronization" editor on the engineering station	"How to assign parameters for an OS client (Page 91)"
PC stations without OS	On the PC station	"How to synchronize PC stations without OS using the NTP mode (Page 93)"
		"How to make DCF 77 Client Service settings on a PC station without OS (Page 98)"
AS with CPU	In the AS project on the engineering station	"Configuring time synchronization on an AS (Page 100)"
SIMATIC PCS 7 BOX RTX and SIMATIC PCS 7 AS RTX	On SIMATIC PCS 7 BOX RTX and SIMATIC PCS 7 AS RTX	"Configuring the time synchronization for SIMATIC PCS 7 BOX RTX and SIMATIC PCS 7 AS RTX (Page 107)"
Checking the time synchronization	On the PC station during process control	"Checking the time synchronization (Page 119)"

6.2.1.2 Time synchronization in a work group without central time master

Example configuration

The following figure shows an example configuration.

Overview

The following table lists the topics that contain information and configuring instructions.
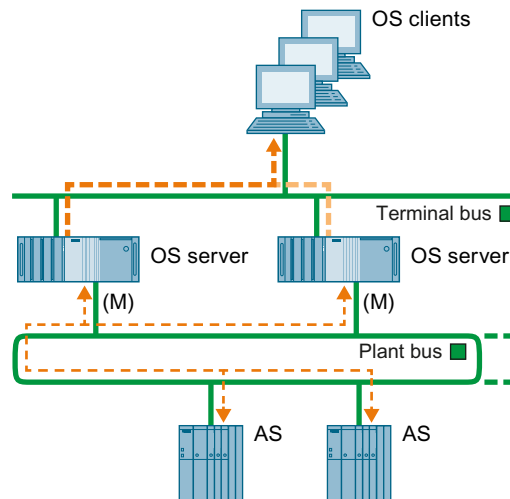
What?	Where?	How?
Parameter assignment of communications processors of the OS servers on the plant bus	In HW Config of the OS server on the engineering station	• CP 16x3 / CP 16x8 • BCE/Softnet "How to assign parameters for a CP 16x3 / CP 16x8 communications processor (Page 76)"
Parameter assignment of OS server as cooperative time master	In the OS project in WinCC Explorer in the "Computer" object on the engineering station	"Setting the time displayed (Page 77)"
	In the OS project in WinCC Explorer in the "Time Synchronization" editor on the engineering station	"How to assign parameters for an OS server in a work group without central time master (Page 83)"
Parameter assignment of OS clients as time slaves	In the OS project in WinCC Explorer in the "Computer" object on the engineering station	"Setting the time displayed (Page 77)"
	In the OS project in WinCC Explorer in the "Time Synchronization" editor on the engineering station	"How to assign parameters for an OS client (Page 91)"

What?	Where?	How?
Parameter assignment of PC stations without OS	On the PC station	"How to synchronize PC stations without OS using the NTP mode (Page 93)"
		"How to make DCF 77 Client Service settings on a PC station without OS (Page 98)"
AS with CPU	In the AS project on the engineering station	"Configuring time synchronization on an AS (Page 100)"
SIMATIC PCS 7 BOX RTX and SIMATIC PCS 7 AS RTX	On SIMATIC PCS 7 BOX RTX and SIMATIC PCS 7 AS RTX	"Configuring the time synchronization for SIMATIC PCS 7 BOX RTX and SIMATIC PCS 7 AS RTX (Page 107)"
Checking the time synchronization	On the PC station during process control	"Checking the time synchronization (Page 119)"

6.2.2 Time synchronization in a Windows domain

6.2.2.1 Time synchronization in a Windows domain with a hierarchy with central time master

Example configuration

The following figure shows an example configuration.

Overview

The following table lists the topics that contain information and configuring instructions.

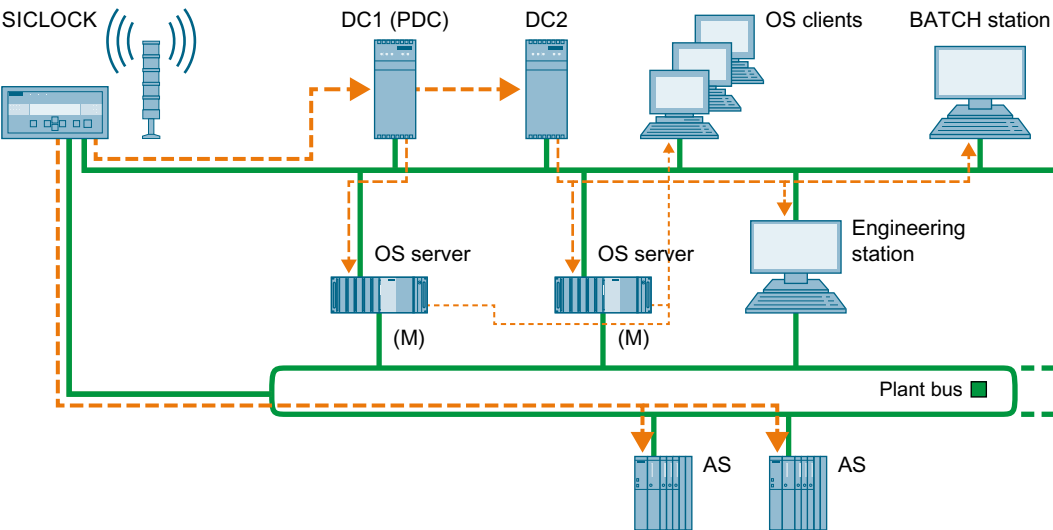| What?	Where?	How?
Configuring the central time master	-	• SICLOCK or Buerk timer "Commissioning the SICLOCK timers (Page 64)" "Commissioning the Buerk timers (Page 67)" • GPS receiver "Commissioning GPS receivers for SICLOCK timers (Page 72)" • DCF 77 "Commissioning the DCF 77 receiver for SICLOCK timers (Page 74)"
Parameter assignment of a domain controller as time master	On the domain controller	"Configuring the time synchronization of the domain controllers (DC) (Page 118)"
Parameter assignment of communications processors of the OS servers on the plant bus	In HW Config of the OS server on the engineering station	• CP 16x3 / CP 16x8 • BCE/Softnet "How to assign parameters for a CP 16x3 / CP 16x8 communications processor (Page 76)"
Parameter assignment of OS server as cooperative time master	In the OS project in WinCC Explorer in the "Computer" object on the engineering station	"Setting the time displayed (Page 77)"
	In the OS project in WinCC Explorer in the "Time Synchronization" editor on the engineering station	"How to assign parameters for an OS server in a Windows domain with a hierarchy with central time master (Page 85)"
Parameter assignment of OS clients as time slaves	In the OS project in WinCC Explorer in the "Computer" object on the engineering station	"Setting the time displayed (Page 77)"
	In the OS project in WinCC Explorer in the "Time Synchronization" editor on the engineering station	"How to assign parameters for an OS client (Page 91)"
Parameter assignment of PC stations without OS	On the PC station	"How to synchronize PC stations without OS using the NTP mode (Page 93)"
		"How to make DCF 77 Client Service settings on a PC station without OS (Page 98)"
AS with CPU	In the AS project on the engineering station	"Configuring time synchronization on an AS (Page 100)"

What?	Where?	How?
SIMATIC PCS 7 BOX RTX and SIMATIC PCS 7 AS RTX	On SIMATIC PCS 7 BOX RTX and SIMATIC PCS 7 AS RTX	"Configuring the time synchronization for SIMATIC PCS 7 BOX RTX and SIMATIC PCS 7 AS RTX (Page 107)"
Checking the time synchronization	On the PC station during process control	"Checking the time synchronization (Page 119)"

6.2.2.2   Time synchronization in a Windows domain with a hierarchy without central time master

Example configuration

The following figure shows an example configuration.

Overview

The following table lists the topics that contain information and configuring instructions.

What?	Where?	How?
Parameter assignment of a domain controller as time master	On the domain controller	"Configuring the time synchronization of the domain controllers (DC) (Page 118)"
Parameter assignment of communications processors of the OS servers on the plant bus	In HW Config of the OS server on the engineering station	• CP 16x3 / CP 16x8 • BCE/Softnet "How to assign parameters for a CP 16x3 / CP 16x8 communications processor (Page 76)"

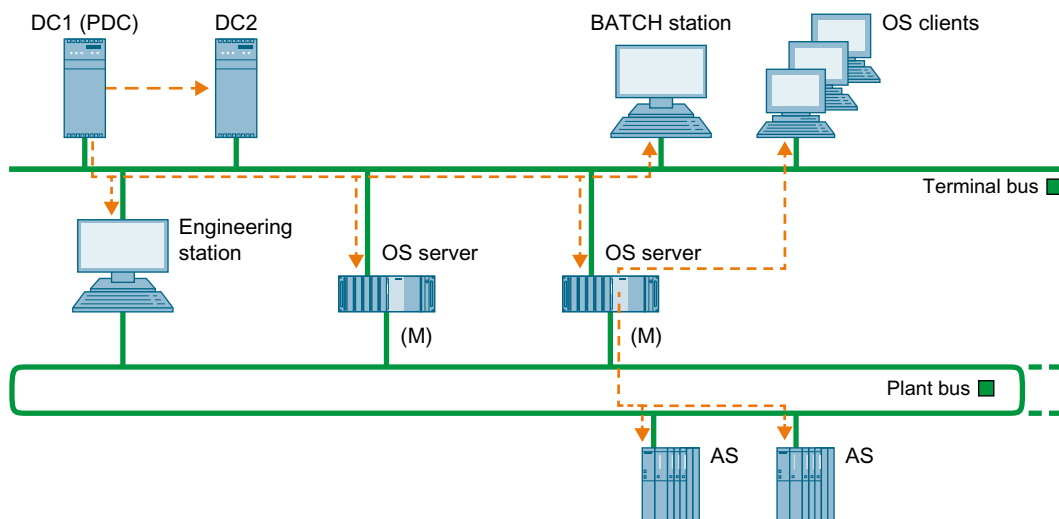| What?	Where?	How?
Parameter assignment of OS server as cooperative time master	In the OS project in WinCC Explorer in the "Computer" object on the engineering station	"Setting the time displayed (Page 77)"
	In the OS project in WinCC Explorer in the "Time Synchronization" editor on the engineering station	"How to assign parameters for an OS server in a Windows domain with a hierarchy without central time master (Page 88)"
Parameter assignment of OS clients as time slaves	In the OS project in WinCC Explorer in the "Computer" object on the engineering station	"Setting the time displayed (Page 77)"
	In the OS project in WinCC Explorer in the "Time Synchronization" editor on the engineering station	"How to assign parameters for an OS client (Page 91)"
Parameter assignment of PC stations without OS	On the PC station	"How to synchronize PC stations without OS using the NTP mode (Page 93)"
		"How to make DCF 77 Client Service settings on a PC station without OS (Page 98)"
AS with CPU	In the AS project on the engineering station	"Configuring time synchronization on an AS (Page 100)"
SIMATIC PCS 7 BOX RTX and SIMATIC PCS 7 AS RTX	On SIMATIC PCS 7 BOX RTX and SIMATIC PCS 7 AS RTX	"Configuring the time synchronization for SIMATIC PCS 7 BOX RTX and SIMATIC PCS 7 AS RTX (Page 107)"
Checking the time synchronization	On the PC station during process control	"Checking the time synchronization (Page 119)"

6.3 Commissioning a central plant clock

6.3.1 Commissioning the SICLOCK timers

Requirement

Refer to the SICLOCK timer readme for installation requirements.
Install any software required for accessing the SICLOCK timer on one engineering station or on a separate PC station (not on components involved in the process operation).

Refer to the SICLOCK timer readme/product information for more information about the software requirements.

The SICLOCK timer can also be configured directly on the panel of the device.

Overview of configuration steps

The table below shows the configuration steps that are needed to operate the SICLOCK timer as a clock for time synchronization of a PCS 7 plant:

Step	What?
1	Wire the time receiver to the SICLOCK timer
2	Configure the time receiver
3	Set the basic parameters on the SICLOCK timer
4	Connect the SICLOCK timer to the PCS 7 plant
5	Configure the SICLOCK timer on a plant-specific basis via Internet Explorer

By way of example, the following sections list the most important settings for configuration in a PCS 7 plant:

● In the examples below, the central plant clock SICLOCK timer receives a time signal via a GPS radio clock.

● If you are using the central plant clock SICLOCK TC400, terminal bus (port: ETH1) and plant bus (port: ETH2) are synchronized directly.

● When a SICLOCK TC 100 central plant clock is used, only one bus (port: ETH1) is synchronized because the SICLOCK TC 100 has only one Ethernet port.
To connect additional buses, you must use suitable switches.
You can find additional information on this in the chapter "Configuring time synchronization with multiple networks (Page 113)".
The settings shown below for the ETH1 port also apply to the central plant clock SICLOCK TC 100.

Factory settings of the SICLOCK TC 400

The SICLOCK TC 400 is supplied with the following default settings for the Ethernet ports:

● Subnet mask 255.255.255.0

● Port: ETH1: 192.168.1.10

- Port: ETH2: 192.168.2.20
- Port: ETH3: 192.168.3.30
- Port: ETH4: 192.168.4.40

Set the basic parameters on the SICLOCK TC 400

The direct parameter settings on the SICLOCK TC 400 are required as basic parameters for connection to the network only.

1. Press the "Setup" button on the SICLOCK TC 400.

2. Enter the password and then press "OK".
   The parameter list is displayed:

   – Language (select German or English)

   – ETH1 IP address

   – ETH1 IP subnet

   – ETH1 IP gateway

   – ETH2 IP address

   – ETH2 IP subnet

   – ETH2 IP gateway

   – ETH3 IP address

   – ETH3 IP subnet

   – ETH3 IP gateway

   – ETH4 IP address

   – ETH4 IP subnet

   – ETH4 IP gateway

   – Acknowledge events

   – Version (for information only)

3. Perform the settings for the required Ethernet connections.

Configuring the SICLOCK TC 400

1. Connect the SICLOCK timer to the network.
   (For example, connect Ethernet port ETH1 of the SICLOCK timer to the terminal bus)

2. Open Internet Explorer on a PC. Enter the network address of the SICLOCK timer in the input field (e.g. Port:ETH1 = address 192.168.1.10).

3. In the configuration portal area, click the "SICLOCK timer configuration tool" link.
   The configuration tool opens.

4. Select **Data Transfer > Download parameters from device** from the configuration tool menu.

5. Configure the SICLOCK timer in accordance with the table below.

Note

The identifier "= ..." in the "Parameters and setting" column represents the "plant-specific setting".

Table 6-1   Settings

Folder	Parameters and setting	Description
Time	Time zone = ... (optional = ...)	"Time zone" parameter, "Offset between UTC and zone time" entry
Network settings	e.g. Port: Ethernet 1 (ETH1) • IP adapter 1 / IP address = ... • IP adapter 1 / subnet mask = ...	Enter the plant-specific network address(es). Configure the network connections ETH2, ETH3 and ETH4 in the same way.
SIMATIC mode	e.g. Port: Ethernet 2 (ETH2) • Mode = PCS 7-compatible mode, every 10 seconds • Send condition = "No condition" • Target address = "FF:FF:FF:FF:FF:FF"	The SIMATIC mode is available for all four Ethernet ports. Note: **Only** activate SIMATIC mode for the ETHERNET ports on the plant bus. A synchronization time of 10 seconds is recommended for PCS 7. A broadcast frame is sent to all nodes on this network.
NTP server	NTP server • Operation = On • Mode = 10 s • Multicast address = ...	The NTP server is available at all four Ethernet ports. Requirement: SICLOCK timer is synchronized. Multicast address: Enter the plant-specific IP address for NTP time synchronization.
Display	Display: • Language = ... • Time / Time base = ...	• Language setting: German or English • Time base: Local time, UTC or atomic time (TAI) Select the time that will appear on the display.

Note

For the purpose of time synchronization on the plant bus, activate SIMATIC mode separately for each Ethernet port.

The settings can be password-protected.
You can find additional information on this topic in the *SICLOCK ; SICLOCK TC 400* Operating Instructions.

Loading the configuration to the SICLOCK timer

This step is only necessary if the configuration is carried out **offline**.

Select **Data Transfer > Download parameters to device** from the configuration tool menu.

Backing up the configuration

To save the set SICLOCK timer parameters and event display (archive) to a file, select the following menu command: **File > Save**.

The data (parameter settings and archive) are saved in U600 format.

Connecting the time receiver

So that the central plant clock is always supplied with an accurate time, it should be synchronized with a time receiver. The following time receivers are recommended:

- SICLOCK GPS1000
- SICLOCK GPSDEC
- SICLOCK DCFRS Industry version

Additional information

- Section "Rules for time synchronization in PCS 7 (Page 38)"
- Section "Commissioning the DCF 77 receiver for SICLOCK timers (Page 74)"
- Section "Commissioning GPS receivers for SICLOCK timers (Page 72)"
- *SICLOCK ; SICLOCK TC 400* Operating Instructions

6.3.2 Commissioning the Buerk timers

Requirement

Refer to the Buerk:Instruction Manual DTS 41xx Timeserver (https://support.industry.siemens.com/cs/ww/en/view/109760344)
Enable the Telnet application required for accessing the Buerk timer on one engineering station or on a separate PC station (not on components involved in the process operation).

Refer Enabling Telnet Client (https://social.technet.microsoft.com/wiki/contents/articles/38433.windows-10-enabling-telnet-client.aspx) for more information.

Overview of configuration steps

The table below shows the configuration steps that are needed to operate the Buerk timer as a clock for time synchronization of a PCS 7 plant:

Step	What?
1	Wire the time receiver to the Buerk timer
2	Configure the time receiver
3	Set the basic parameters on the Buerk timer
4	Connect the Buerk timer to the PCS 7 plant
5	Configure the Buerk timer on a plant-specific basis via Telnet

By way of example, the following sections list the most important settings for configuration in a PCS 7 plant:

- In the examples below, the central plant clock Buerk timer receives a time signal via a GPS radio clock.

- If you are using the central plant clock Buerk timer DTS 4138S, terminal bus (port: ETH1) and plant bus (port: ETH2) are synchronized directly.

- When a Buerk timer DTS 4128 central plant clock is used, only one bus (port: ETH1) is synchronized because the Buerk timer has only one Ethernet port. For two Ethernet ports use Buerk timer DTS 4138S.
  To connect additional buses, you must use suitable switches.
  You can find additional information on this in the chapter "Configuring time synchronization with multiple networks (Page 113)".
  The settings shown below for the ETH1 port also apply to the central plant clock Buerk timer.

Factory settings of the Buerk DTS 4138S

Per default, the LAN 1 interface is configured with DHCP on. After booting in a network with DHCP server, the received IP address can be displayed.

The LAN 2 interface is configured with the following static settings per default:

IP 192.168.1.5, Subnet 255.255.255.0, Gateway 192.168.1.1

If these possibilities do not work out for the initial configuration, the network configuration can be modified using a USB stick. For this purpose, a text file named DTS4138NW.conf is created and filled with the corresponding parameters (not all parameters are required):

- IP1:192.168.1.3

- SUB1:255.255.255.0

- GW1:192.168.1.1

- IP2:10.0.0.7

- SUB2:255.255.240.0

- GW2:10.0.0.1

The insertion of the USB stick is displayed. For taking over the network settings, press the button until the normal time display reappears.

Set the basic parameters on the Buerk DTS 4138S

The direct parameter settings on the Buerk timer are required as basic parameters for connection to the network only.

1. Under "Start" menu select **Telnet** application.

2. Enter the initial IP address of the Buerk timer

3. Type in the Login name "DTS" and Password "dts" > Enter.
   The **Main Selection** list is displayed:

   – Status

   – Configuration

   – Maintenance

4. Perform the settings for the required Ethernet connections.

Configuring the Buerk DTS 4138S

1. Connect the Buerk timer to the network.
   (For example, connect Ethernet port ETH1 of the Buerk timer to the terminal bus)

2. Open telnet on a PC. Enter the network address of the Buerk timer in the input field (e.g. Port:ETH1 = address 192.168.1.3).

3. In the main menu, enter the "configuration" menu option.
   The configuration menu opens.

4. Configure the Buerk timer in accordance with the table below.

   Note

   This section describes the changes that needs to be done to the default settings.

Table 6-2   Settings

Folder	Parameters and setting	Values
SINEC Configuration > Outputs > Con- figuration lines > SINEC	Line (0=off, 1=on, 2=on winter-time)	1
	Type (0=SINEC, 1=SIMATIC kompatibel)	1
	Interval (sec)	1
	Time zone	[0] UTC
	Interface (1=LAN 1, 2=LAN 2, 3=both)	3

Folder	Parameters and setting	Values	
Time Source Configuration > Time handling > Time Source setting	Source type	DTS4138S: 0 = none 1 = DCF low quality 2 = GPS-DCF high quality 3 = NTP 4 = AFNOR-A/C or IRIG-B 12X	DTS4128: 0 = none 1 = DCF MEZ 2 = GPS-DCF (UTC) 3 = GPS serial (not available) 4 = NTP
	Time zone of the source	depends on the time source: GPS: [0] UTC DCF: local time zone of DCF source	
	Alarm delay for failure of the source	60min	
	DTS stratum (0=auto, 1-15=fix)	0	
	Stratum limit for synchalarm	12	
	Stratum TO (1-16) DCF/GPS fail	24h	
	Offset per stratum	50ms	
	Max. Offset for time ok	50000us	
	Time source correction (DCF/GPS only)	0ms	
Time Adjustment Configuration > Time handling > Time Adjustment setting	Adjust mode (0=follow, 1=set)	0	
	Max. catch up speed	10000ns/s	
	Time core type (0-255, default 0)	0	
	Synch. only Offset	0ms	
	RTC mode	2	
Redundant operation Configuration > Time handling > Redundant operation	Mode (0=single, 1=red., 2=red. LAN1-LAN2)	2	
	Stratum limit (1-16)	16	
	Max. offset to slave source	100000us	
	Port for LAN link	14338	
	IP Adresse 2. DTS 4138		
	Set master manual		

Folder	Parameters and setting	Values
NTP server Configuration > Time handling > NTP Server	Configuration imteserver address 1	NTP can run as server or combined as server/client.
	Configuration imteserver address 2	To run NTP as source (NTP as client), set at least one server.
	Configuration imteserver address 3	If NTP server is configured, but NTP is not indicated as time source, NTP only runs as backup time source (redundancy) to the actual time source.
	Configuration imteserver address 4	
	Configuration multi-/broadcast address 1	
	Configuration multi-/broadcast address 2	
	NTP Authentication / Access	
General Configuration > General	Language	0
	Timezone displayed times	[0] UTC
	Power (0=single, 1=red.)	0
	password (menu)	(Choose a proper password)
Network settings Configuration > Network	IPV4 Configuration LAN 1	
	IPV6 Configuration LAN 1	
	Network Interface LAN 1	auto
	IPV4 Configuration LAN 2	
	IPV6 Configuration LAN 2	
	Network Interface LAN 2	auto
	Hostname (Device name)	(eligible hostname)
	Domain name	
LAN 1 Configuration > Network > IPV4 Configuration LAN 1	DHCP	depends on the network infrastructure. DHCP or manual IP configuration.
	IP-adress	
	Subnet-mask	
	Gateway	
	DNS-server	
LAN 2 Configuration > Network > IPV4 Configuration LAN 2	DHCP	depends on the network infrastructure. DHCP or manual IP configuration.
	IP-adress	
	Subnet-mask	
	Gateway	
	DNS-server	

Connecting the time receiver

So that the central plant clock is always supplied with an accurate time, it should be synchronized with a time receiver. The following time receivers are recommended:

- GPS4500
- DCF4500

Backing up the configuration

The configuration can be saved via **MOBA-NMS** or **FTP** or **USB-Stick**.

Refer to the Buerk Instruction Manual DTS 41xx Timeserver (https://support.industry.siemens.com/cs/ww/en/view/109760344) for more information about saving congfiguration externally.

Additional information

Section "Rules for time synchronization in PCS 7 (Page 38)"

Buerk:Instruction Manual DTS 41xx Timeserver (https://support.industry.siemens.com/cs/ww/en/view/109760344)

See also

Commissioning the DCF 77 receiver for SICLOCK timers (Page 74)

Commissioning GPS receivers for SICLOCK timers (Page 72)

6.3.3 Commissioning GPS receivers for SICLOCK timers

Introduction

The GPS receiver determines the UTC via the satellite-based GPS system (Global Positioning system). Due to the country-specific installation of Windows on the OS the sent UTC is converted to the time valid in the respective country. For reception of the precise time reception of the signal from one of the 24 satellites suffices. The GPS receiver also enables worldwide use of SIMATIC PCS 7 with inter-plant time synchronization.

Overview of commissioning tasks

The following table shows the commissioning steps when you connect a GPS receiver to a central plant clock in a PCS 7 plant for time synchronization purposes:

Step	What?
1	First commissioning of the GPS receiver Configure the GPS receiver with the aid of the associated commissioning software.
2	Connect the GPS receiver cable
3	Aligning the GPS antenna

Wiring

The following figure shows how the GPS receiver is connected to the SICLOCK timer:
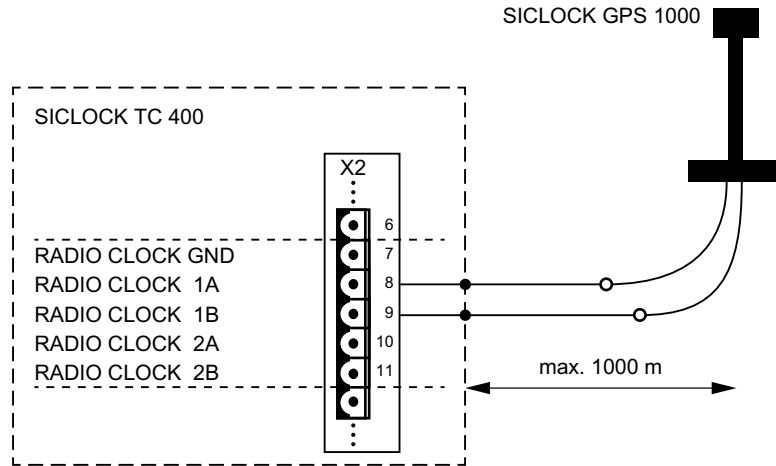
Note

A GPSDEC receiver may only be used as an active radio clock. The GPSDEC receiver can be destroyed if operated as a passive radio clock.

Aligning the GPS antenna

Proceed as follows:

1. Install the GPS antenna.

2. Align the antenna vertically to the sky.
   With other angles the synchronization can fail temporarily because a satellite is not in the reception window.

Note

Do not install the GPS antenna at locations where there is a risk of lightning strikes occurring.
If nothing else is possible, attach the GPS antenna to the inside of high windows.

Additional information

- Additional information on the connection and optimal alignment of the GPS receiver can be found in the Operating Instructions for the GPS receiver.

- Additional information on connecting a central plant clock can be found in the Operating Instructions for the central plant clock.

Note

The SICLOCK GPS receivers cannot be used for Buerk. While using the Bürk Timeserver, it is necessary to replace the SICLOCK GPS receiver with the Bürk GPS 4500 receiver.

6.3.4 Commissioning the DCF 77 receiver for SICLOCK timers

Introduction

The time signal broadcast by the DCF 77 transmitter is the statutory time applicable to the Federal Republic of Germany.

The DCF 77 radio signal can be received within a range of approximately 2000 km around Frankfurt am Main. In regions where the DCF 77 radio signal cannot be received, use of a GPS receiver is recommended. You need a DCF 77 receiver to use this radio signal for time synchronization of your PCS 7 plant.

Structure of the DCF 77 receiver

The following components are included in the scope of delivery of a DCF 77 receiver:

● An antenna head with or without an antenna frame.
  The DCF 77 receiver is located in the antenna head and demodulates the DCF 77 signal.

● Software for installation on the target system to be synchronized
  If the DCF 77 receiver is being connected directly to the central plant clock, there is no need for any additional driver software.

Overview of commissioning tasks

The following table shows the commissioning steps when you connect a DCF 77 receiver to a central plant clock in a PCS 7 plant for time synchronization purposes:

Step	What?
1	First commissioning of the DCF 77 receiver
	Configure the DCF 77 receiver with the aid of the associated commissioning software.
2	Connect the DCF 77 receiver cable
3	Align the antenna

Wiring

The following figure shows how to wire the SICLOCK timer to a DCF 77 receiver:
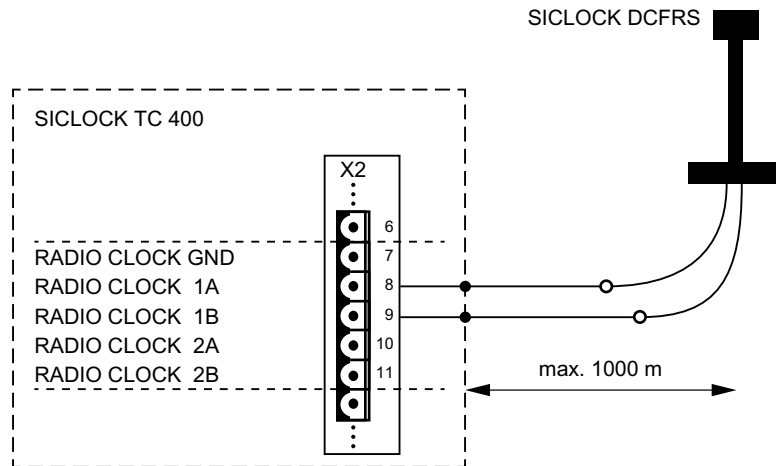
Align the antenna

To optimize the alignment of your DCF 77 receiver, proceed as follows:

1. Align the DCF 77 receiver so that the control LED flashes at intervals of one second.

2. Check that the DCF 77 receiver is on the side of your building facing Frankfurt.

Note

If you are unable to receive a constant time signal, please note the following rules:

- Maintain as great a distance as possible between the DCF 77 receiver and PCs, monitors, laser printers, motors, motorized operating mechanisms, or similar sources of interference.
- Keep the DCF 77 receiver away from metal surfaces and steel-reinforced concrete.

Additional information

- Additional information on the connection and optimal alignment of the DCF 77 receiver can be found in the Operating Instructions for the DCF 77 receiver.

- Additional information on connecting a central plant clock can be found in the Operating Instructions for the central plant clock.

6.4 Configuring the time synchronization for PC stations with OS

6.4.1 How to assign parameters for a CP 16x3 / CP 16x8 communications processor

Introduction

In order for the communications processor to process the time frames, its time operation must be assigned.

Configuring time operation for a communications processor (CP 16x3/CP 16x8)

In order to assign the time operation for the communications processor, proceed as follows:

1. Open SIMATIC Manager.

2. Select the PC station to be synchronized in the tree view.

3. Open the configuration of the station in HW Config.

4. Select the communication processor (CP 16x3/CP 16x8).

5. Select the menu command **Edit > Object Properties**.

6. If you are using a CP16x3, perform the following steps:

   – Switch to the "Options" tab.

   – Select the "Time of day" check box in the "Time-of-Day Synchronization" area.

   – Select the "Slave (time receiver)" option in the "Time-of-Day Synchronization" area.
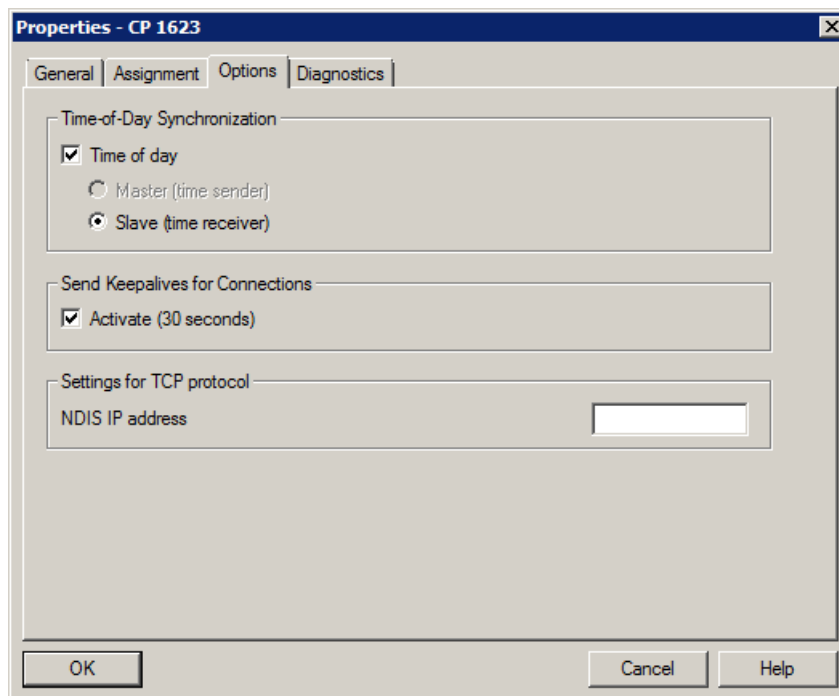
7. If you are using a CP16x8, perform the following steps:

   – Switch to the "Time-of-Day Synchronization" tab.

   – Select the "Accept time of day on the CP and forward" check box in the "SIMATIC Mode" area.
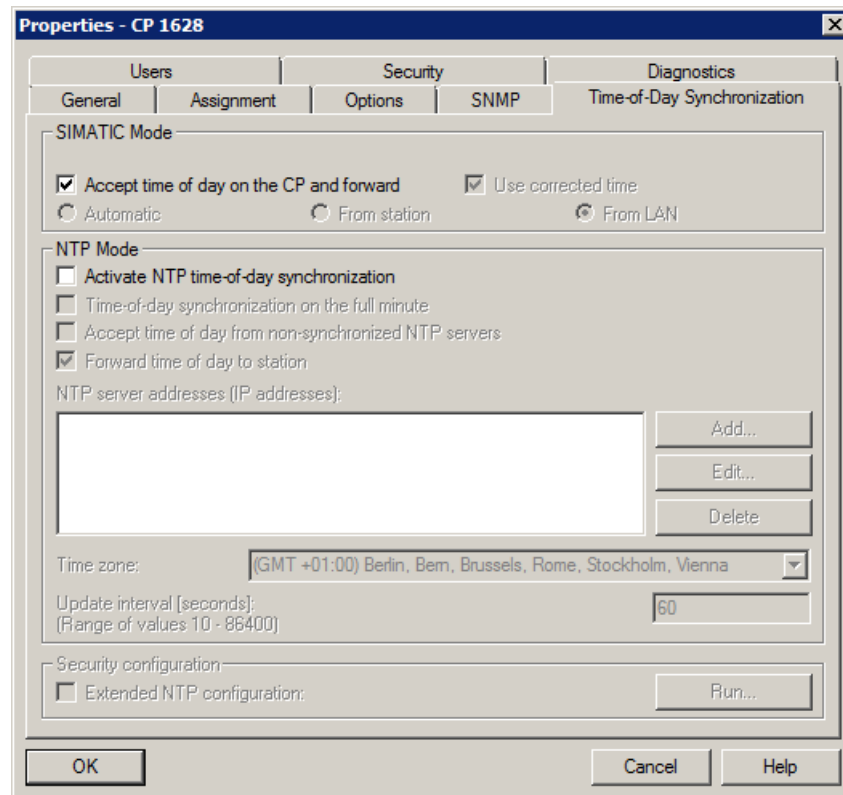
8. Click OK.

6.4.2 Setting the time displayed

6.4.2.1 How to configure the operator station display

Introduction

You configure the time display for the operator station process mode on the engineering station. You can select the "Local time zone", for example, in the "Time base for time display in runtime" parameter.

Check the settings in the "Computer properties" dialog box.

Requirement

- You must configure the time display on the engineering station before you load the OS.

Procedure

1. Select the "[Computer name]" object in the tree view in WinCC Explorer.
   The detail window displays the corresponding computer.

2. Select the "[Name of computer]" object in the detail view.

3. Select **Edit > Properties**.
   The "Computer properties" dialog box opens.
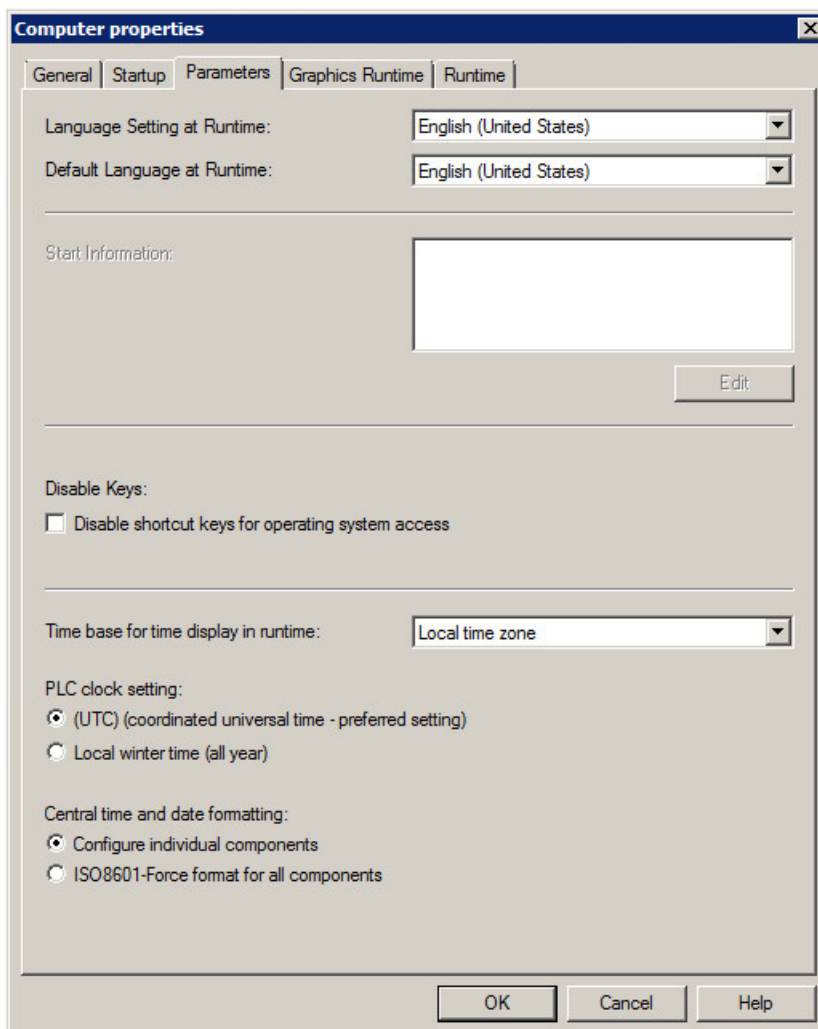
4. Select the "Parameters" tab.

Figure 6-1   Example setting

5. Choose the time mode from the "Time basis for time display in runtime" drop-down list.
   The time zone is only important for the display in process mode. Internally, UTC is used exclusively; in archives, for example.

   – "Local time zone"
     The local time with daylight saving time and standard time is set.

   – For project-specific settings, choose:
     "Time zone of the server (migrated projects)", if you want to set the time for migrated projects, or
     "Coordinated Universal Time (UTC)", if you want to set UTC

6. In the "PLC clock setting" group, select the

   – "The PLC is set to coordinated universal time (UTC) (preferred setting)" option

   – For project-specific settings, choose:
     PLC is set to the local winter time all year (WinCC V5 compatibility mode)
     For this option, note the information in "Time synchronization in WinCC V5 compatibility mode" at the end of this chapter.

7. Select the required format in the "Central date and time formatting" group.
   This formatting affects the display of the time and date in the process control.

   – Date in the configured format: "Configure individual components"

   – For project-specific settings, choose:
     Date in accordance with ISO 8601: "ISO8601-Swap format to all components"

8. Click "OK".

Time synchronization in WinCC V5 compatibility mode

> **Note**
>
> Contact Customer Support if you would like to use time synchronization in V5 compatibility mode.

The WinCC V5 compatibility mode requires that time frames always be sent on the plant bus in winter time format. The switch to daylight saving time occurs on the OS severs.

This mode is activated/deactivated in the OS server project in WinCC Explorer in the "PLC" object on the "Parameters" tab of the "Computer properties" dialog box.

6.4.2.2 How to convert the local time zone and daylight saving time parameters

Introduction

You can convert the time displayed on the OS in process mode.

Rules

- If operating a PCS 7 plant across several time zones with different daylight saving time and standard time settings, you should also use the harmonized UTC time for the time display on the operator station. You therefore have a uniform basis for process analysis at all plant units.

- You can configure the switch to daylight saving time or point in time for the switch for each specific country. PCS 7 always handles internal functions on the basis of UTC. Therefore, any conversion to daylight saving time or to a different local time does not have any impact on the internal functions of PCS 7.
  If the time display of the operator station is set to the local time of specific countries, with automatic conversion of daylight saving time and standard time, the time is automatically converted at the correct date and time.

Requirements

- It must be possible to operate the operating system environment.

- You must make the settings directly on the OS.

Procedure

To change the operator station to display daylight saving time and standard time, follow these steps:

1. Open the dialog for settings of the **Control Panel** on the OS.

2. Double-click the "Date and Time" icon.

3. Select the "Date and Time" tab.

4. In the "Time zone" area, click the "Change time zone" button.
   Ensure that the time zone displayed in your list field is appropriate for your area.

5. Select the check box "Automatically adjust clock for Daylight Saving Time".
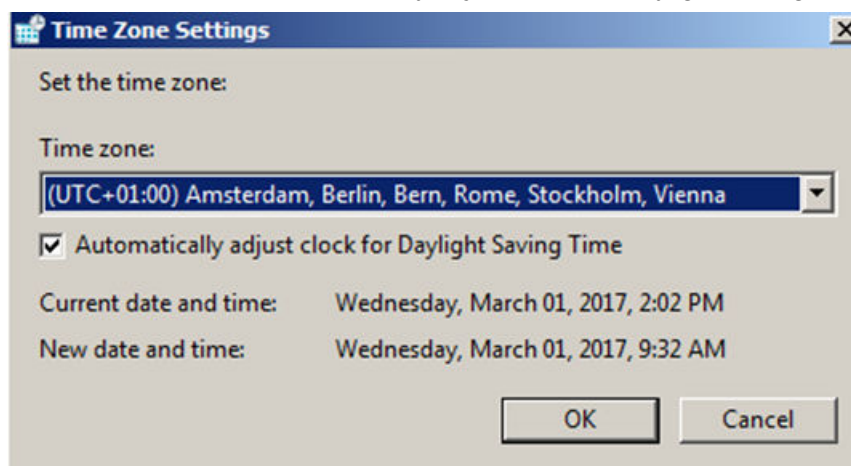
6. Click "OK".

Result

All time information for the operator station will be output in the local time of the selected time zone, including daylight saving time changes, and it will be converted at the correct point in time.

6.4.3 Parameter assignment for an OS server in a work group

6.4.3.1 How to assign parameters for an OS server in a work group with central time master

Requirements

- The central plant clock is connected to the terminal bus and the plant bus.
- The OS servers are cooperative time masters on the plant bus.
- Time operation is activated for each network adapter of the OS server.
  - The OS server is equipped with at least one CP 16x3 / 16x8 communications processor (more than 8 AS or high availability AS).
    You can find information about the parameter assignment in the section "How to assign parameters for a CP 16x3 / CP 16x8 communications processor (Page 76)".
  - The OS server is equipped with a BCE communications processor (up to 8 AS).
    The BCE/Softnet communications processor cannot be configured redundantly.
- All automation systems are configured as time slaves.

Assigning the OS server parameters for time synchronization

To configure the OS server for time synchronization, proceed as follows:

1. Open the OS server in the PCS 7 project on the engineering station.
2. Select the "Time synchronization" editor in the tree view of WinCC Explorer.
3. Select **Open** in the shortcut menu.
   The "Time Synchronization" dialog box opens.
4. Select the "Synchronization via System Bus (Master, Slave)" check box.
5. Select the "Display symbolic name of the access points" check box.
   The communications processors of the OS server are displayed with a symbolic name if they are not present on the engineering station.
6. Select the network adapter from the "Access point 1" drop-down list.
   The list shows all available devices that are suitable for time synchronization.

7. Select the "Master" option.

8. If you are using a redundant network adapter, select it from the "Access point 2" drop-down list.
    The list shows all available devices that are suitable for time synchronization.

Note

The BCE/Softnet communications processor cannot be configured redundantly.

9. Select the "Master" option.
10. Click "OK".

Result

The central plant clock transmits the time frames on the terminal bus and the plant bus.

The OS servers are cooperative time masters.

6.4.3.2 How to assign parameters for an OS server in a work group without central time master

Requirements

- The OS servers are cooperative time masters on the plant bus.

- Time operation is activated for each network adapter of the OS server.

    - The OS server is equipped with at least one CP 16x3 / 16x8 communications processor (more than 8 AS or high availability AS).
      You can find information about the parameter assignment in the section "How to assign parameters for a CP 16x3 / CP 16x8 communications processor (Page 76)".

    - The OS server is equipped with a BCE communications processor (up to 8 AS).
      The BCE/Softnet communications processor cannot be configured redundantly.

- All automation systems are configured as time slaves.
  Restriction:
  CPU types with integrated Ethernet interface that support the NTP mode only can only be used in the configuration if the automation system is equipped with an additional CP 443-1 communications processor.

Assigning the OS server parameters for time synchronization

To configure the OS server for time synchronization, proceed as follows:

1. Open the OS server in the PCS 7 project on the engineering station.

2. Select the "Time synchronization" editor in the tree view of WinCC Explorer.

3. Select **Open** in the shortcut menu.
   The "Time Synchronization" dialog box opens.

4. Select the "Synchronization via System Bus (Master, Slave)" check box.

5. Select the "Display symbolic name of the access points" check box.
   The communications processors of the OS server are displayed with a symbolic name if they are not present on the engineering station.

6. Select the network adapter from the "Access point 1" drop-down list.
   The list shows all available devices that are suitable for time synchronization.

7. Select the "Master" option.

8. If you are using a redundant network adapter, select it from the "Access point 2" drop-down list.
   The list shows all available devices that are suitable for time synchronization.

   Note

   The BCE/Softnet communications processor cannot be configured redundantly.

9. Select the "Master" option.

10. Click "OK".

Result

The OS servers are cooperative time masters.

Rule

> **Note**
>
> The automation system can only be synchronized if at least one OS server is activated.

6.4.4 Parameter assignment for an OS server in a Windows domain

6.4.4.1 How to assign parameters for an OS server in a Windows domain with a hierarchy with central time master

Requirements

- The central plant clock is connected to the terminal bus and the plant bus.
- A domain controller is configured as the operations master PDC emulator.
- All operator stations are members in a domain.
- The OS servers are cooperative time masters on the plant bus.
- Time operation is activated for each network adapter of the OS server.
  - The OS server is equipped with at least one CP 16x3 / 16x8 communications processor (more than 8 AS or high availability AS).
    You can find information about the parameter assignment in the section "How to assign parameters for a CP 16x3 / CP 16x8 communications processor (Page 76)".
  - The OS server is equipped with a BCE communications processor (up to 8 AS).
    The BCE/Softnet communications processor cannot be configured redundantly.
- All automation systems are configured as time slaves.

Assigning the OS server parameters for time synchronization

To configure time synchronization for the OS server, proceed as follows:

1. Open the OS server in the PCS 7 project on the engineering station.
2. Select the "Time synchronization" editor in the tree view of WinCC Explorer.
3. Select **Open** in the shortcut menu.
   The "Time Synchronization" dialog box opens.
4. Select the "Synchronization via Terminal Bus (Slave)" check box.
5. Select the "Use the time from a specific computer" option.
6. Enter the first domain controller in the "Computer 1" input field.
7. If you are using a redundant domain controller, enter it in the "Computer 2" input field.
8. Select the "Synchronization via System Bus (Master, Slave)" check box.

9. Select the "Display symbolic name of the access points" check box.
   The communications processors of the OS server are displayed with a symbolic name if they are not present on the engineering station.

10. Select the network adapter from the "Access point 1" drop-down list.
    The list shows all available devices that are suitable for time synchronization.
    The "Master" option is selected automatically.

11. If you are using a redundant network adapter, select it from the "Access point 2" drop-down list.
    The list shows all available devices that are suitable for time synchronization.
    The "Master" option is selected automatically.

Note

The BCE/Softnet communications processor cannot be configured redundantly.

12. Click "OK".

Result

The central plant clock transmits the time frames on the terminal bus and the plant bus.

The OS server is a cooperative time master.

Rules

Note

OS servers in a Windows domain

Before you assign the time synchronization parameters for a PCS 7 plant in a Windows domain, create a detailed plan of your network structure. This plan must contain all the relevant information for time synchronization:

- Which computer is the domain controller?
- Which computers belong to the Windows domain and receive their time from the domain controller?
- Which computers do not belong to the Windows domain and from where do they obtain their time?
- Which computers are time masters and which are time slaves?

NOTICE

Response to change in the time setting

If a time jump of more than 5 seconds occurs, the computer that was defined as the time master becomes a time slave. The message "Time synchronization has been permanently switched to slave" is generated.

Note that this computer is no longer defined as a time master even after a restart.

You can restore the time master status of the computer on the OS server or the engineering station in the OS server project.

Restoring time master status:

- On OS server.
  In the OS project in WinCC Explorer, clear the "Deactivate time synchronization" check box in the "General Settings" area of the "Time Synchronization" editor.
  Close the dialog and the OS project so that the change will be applied.
  Start the process control.

- On the engineering station
  In the OS project in WinCC Explorer, clear the "Deactivate time synchronization" check box in the "General Settings" area of the "Time Synchronization" editor.
  Close the dialog and the OS project so that the change will be applied.
  Download the OS project to the target system.
  Start the process control.

6.4.4.2 How to assign parameters for an OS server in a Windows domain with a hierarchy without central time master

Requirements

- An NTP time server is connected to the terminal bus.

- A domain controller is configured as the operations master PDC emulator.

- All operator stations are members in a domain.

- The OS servers are cooperative time masters on the plant bus.

- Time operation is activated for each network adapter of the OS server.

  – The OS server is equipped with at least one CP 16x3 / 16x8 communications processor (more than 8 AS or high availability AS).
  You can find information about the parameter assignment in the section "How to assign parameters for a CP 16x3 / CP 16x8 communications processor (Page 76)".

  – The OS server is equipped with a BCE communications processor (up to 8 AS).
  The BCE/Softnet communications processor cannot be configured redundantly.

- All automation systems are configured as time slaves.

Assigning the OS server parameters for time synchronization

In this configuration, you use the NTP time server as the time source instead of a central plant clock. The NTP time server together with a DCF 77 radio receiver module or GPS receiver module is a reliable time source. The domain controller is the time master. Information on configuring the domain controller as time master can be found in the Microsoft literature on the Internet at:

http://support.microsoft.com/kb/816042 (http://support.microsoft.com/kb/816042/en-us) .

To configure the OS servers additionally as time slaves of the domain controller, proceed as follows:

1. Open the OS server in the PCS 7 project on the engineering station.

2. Select the "Time synchronization" editor in the tree view of WinCC Explorer.

3. Select **Open** in the shortcut menu.
   The "Time Synchronization" dialog box opens.

4. Select the "Synchronization via Terminal Bus (Slave)" check box.

5. Select the "Use the time from a specific computer" option.

6. Enter the first domain controller (DC1) in the "Computer 1" input field.

7. If you are using a redundant domain controller, enter it in the "Computer 2" input field.

8. Select the "Synchronization via System Bus (Master, Slave)" check box.

9. Select the "Display symbolic name of the access points" check box.
   The communications processors of the OS server are displayed with a symbolic name if they are not present on the engineering station.

10. Select the network adapter from the "Access point 1" drop-down list.
    The list shows all available devices that are suitable for time synchronization.
    The "Master" option is selected automatically.

11. If you are using a redundant network adapter, select it from the "Access point 2" drop-down list.
    The list shows all available devices that are suitable for time synchronization.
    The "Master" option is selected automatically.

Note

The BCE/Softnet communications processor cannot be configured redundantly.

12. Click "OK".

Result

The OS servers are cooperative time masters.

Rules

> **Note**
>
> The automation system can only be synchronized if at least one OS server is activated.

> **Note**
>
> **OS servers in a Windows domain**
>
> Before you assign the time synchronization parameters for a PCS 7 plant in a Windows domain, create a detailed plan of your network structure. This plan must contain all the relevant information for time synchronization:
>
> - Which computer is the domain controller?
> - Which computers belong to the Windows domain and receive their time from the domain controller?
> - Which computers do not belong to the Windows domain and from where do they obtain their time?
> - Which computers are time masters and which are time slaves?

> **NOTICE**
>
> **Response to change in the time setting**
>
> If a time jump of more than 5 seconds occurs, the computer that was defined as the time master becomes a time slave. The message "Time synchronization has been permanently switched to slave" is generated.
>
> Note that this computer is no longer defined as a time master even after a restart.
>
> You can restore the time master status of the computer on the OS server or the engineering station in the OS server project.
>
> Restoring time master status:
>
> - On OS server.
>   In the OS server project in WinCC Explorer, clear the "Deactivate time synchronization" check box in the "General Settings" area of the "Time Synchronization" editor.
>   Close the dialog and the OS project so that the change will be applied.
>   Start the process control.
> - On the engineering station
>   In the OS server project in WinCC Explorer, clear the "Deactivate time synchronization" check box in the "General Settings" area of the "Time Synchronization" editor.
>   Close the dialog and the OS project so that the change will be applied.
>   Download the OS project to the target system.
>   Start the process control.

See also

How to assign parameters for an OS server in a Windows domain with a hierarchy with central time master (Page 85)

6.4.5   How to assign parameters for an OS client

Procedure

To configure OS clients for time synchronization, proceed as follows for each OS client:

1. Open the OS client project in the PCS 7 project on the engineering station.

2. Select the "Time synchronization" editor in the tree view of WinCC Explorer.

3. Select **Open** in the shortcut menu.
   The "Time Synchronization" dialog box opens.

4. Select the "Synchronization via Terminal Bus (Slave)" check box.
   All associated options and input fields are active.

5. Select the "Use the time from a connected WinCC server" option.

6. Click "OK".

6.5 Configuring time synchronization for a PC station without OS

6.5.1 Overview of configuration steps

PC station with OS

In PCS 7, operator stations offer an integrated time synchronization option in the form of the "WinCC time synchronization" application. For time synchronization of the PC station, you must configure the "WinCC time synchronization" application. You can find information on this in the section "Configuring the time synchronization for PC stations with OS (Page 76)".

PC station without OS

The list below includes PC stations that you can also operate without OS:

- Engineering station
- SIMATIC BATCH stations
- SIMATIC Route Control stations
- Process Historian
- Information Server
- OpenPCS 7
- Web client
- Web diagnostics client
- SIMATIC Management Console

If SIMATIC BATCH, SIMATIC Route Control, or Information Server is installed on the operator station, the PC station will be synchronized via the time synchronization of the OS.

You can choose from the following options for time synchronization of these PC stations:

- Recommended: Synchronization using the NTP mode
- DCF77 client service
  You synchronize the PC stations directly with a time master (e.g., central plant clock, domain controller, operator station)
  The central plant clock can be synchronized via GPS.

See also

How to synchronize PC stations without OS using the NTP mode (Page 93)

How to make DCF 77 Client Service settings on a PC station without OS (Page 98)

6.5.1.1 How to synchronize PC stations without OS using the NTP mode

Introduction

All the PC stations of a PCS 7 plant can be synchronized using the NTP procedure. With the NTP procedure the network components fetch the time cyclically and actively from an NTP server.

The NTP server in PCS 7 plants is a central plant clock. In plants without a central plant clock, it is recommended to implement a redundant OS server pair (in this example, PC 1a and redundant PC 1b).

A NTP server is configured through the settings of the Group Policy Objects (GPOs) and WinCC "Time Synchronization" at the respective PC station.

In the case of failure of the NTP server which is configured on a non-redundant PC, a project-specific solution must be organized (for example, synchronization over the internet or another NTP server).

Requirements

- The PC stations must not be synchronized using any other method (e.g. by means of "WinCC time synchronization" on an existing OS installation, or by means of an integrated radio clock).

- Central plant clock is connected to the terminal bus and configured as NTP server.

- You must make the settings as a PC station administrator.

- In a domain:
  The local settings must not be overwritten by the group policies of the Windows domain.

  #### Note

  #### Group policy settings in domains

  Group policies can be set in the domain. The group policies for the domain have priority over the local settings.

General configuration

- The service "Windows Time" (W32time) has to be started. The Startup type has to be "Automatic (Delayed Start)".

- In Windows Firewall, create a new Inbound Rule that allows incoming connections on port "123".

Configuration of the NTP Server (PC 1a)

Follow these steps to configure a PC station (PC 1a) as NTP server and thus synchronize other PC stations with it:

1. Log on as a user with administrator rights.

2. Use the search box in the "Start" menu to open the file "gpedit.msc".
   The "Local Group Policy Editor" dialog box opens.

3. In the tree view, select **Local Computer Policy > Computer Configuration > Administrative Templates > System > Windows Time Service**.

4. In the detail window, double-click the "Global Configuration Settings" object. The "Global Configuration Settings" dialog box opens.

5. Select the "Enabled" option.

6. Make the following settings:

Field	Value
FrequencyCorrectRate	3
HoldPeriod	4
LargePhaseOffset	50000000
MaxAllowedPhaseOffset	3
MaxNegPhaseCorrection	4294967295 (max. value)[*]
MaxPosPhaseCorrection	4294967295 (max. value)[*]
PhaseCorrectRate	2
PollAdjustFactor	5
SpikeWatchPeriod	60
UpdateInterval	60
AnnounceFlags	5
EventLogFlags	2
LocalClockDispersion	10
MaxPollInterval	10
MinPollInterval	10

[*] In Windows XP and 2003, you can enter the value "0". The maximum value is set automatically after you press the lower arrow key.

7. Leave all the other values in the standard settings and click "OK".

8. In the tree view of the "Local Group Policy Editor", select the folder **Local Computer Policy > Computer configuration > Administrative templates > System > Windows Time Service > Time Providers**. The associated objects are displayed in the detail window.
For Windows XP: select the "Windows Time Service" folder.

9. Make the following settings:

Object	Setting
Enable Windows NTP Client	Double-click the object and select the "Disabled" option.
Configure Windows NTP Client	Double-click the object and select the "Disabled" option.
Enable Windows NTP Server	Double-click the object and select the "Enabled" option.

10. Use the search box in the "Start" menu to run the "cmd.exe" program as administrator.

11. At the command prompt, enter the following commands (replace "IP Address Server1" and "IP Address Server2" with the IP addresses of the two servers and note the space in front of the second IP Address):
w32tm /config /manualpeerlist:"<IP Address Server1>,0x1 <IP Address Server2>,0x1" / syncfromflags:manual /reliable:YES /update
Example: w32tm /config /manualpeerlist:"192.168.178.201,0x1192.168.178.202,0x1" / syncfromflags:manual /reliable:YES /update

12. After changing the NTP service (W32time is the service, W32tm is the application for the service), restart the computer.
Alternatively you can execute the following commands at the command prompt:

– *gpupdate /force*

– *w32tm /config /update*

To stop and start the service:

– *net stop w32time*

– *net start w32time*

Configuration of a Redundant NTP Server (PC 1b)

Follows these steps to configure a PC station (PC 1b) as a redundant NTP server:

1. Log on as a user with administrator rights.

2. Use the search box in the "Start" menu to open the file "gpedit.msc".
The "Local Group Policy Editor" dialog box opens.

3. In the tree view, select **Local Computer Policy > Computer Configuration > Administrative Templates > System > Windows Time Service**.

4. In the detail window, double-click the "Global Configuration Settings" object. The "Global Configuration Settings" dialog box opens.

5. Select the "Enabled" option.

6. Make the following settings:

Field	Value
FrequencyCorrectRate	3
HoldPeriod	4
LargePhaseOffset	50000000
MaxAllowedPhaseOffset	3
MaxNegPhaseCorrection	4294967295 (max. value)
MaxPosPhaseCorrection	4294967295 (max. value)
PhaseCorrectRate	2
PollAdjustFactor	5
SpikeWatchPeriod	60
UpdateInterval	60
AnnounceFlags	10
EventLogFlags	2
LocalClockDispersion	10
MaxPollInterval	10
MinPollInterval	10

7. Leave all the other values in the standard settings and click "OK".

8. In the tree view of the "Local Group Policy Editor", select the folder **Local Computer Policy > Computer configuration > Administrative templates > System > Windows Time Service > Time Providers**. The associated objects are displayed in the detail window.

9. Make the following settings:

Object	Setting
Enable Windows NTP Client	Double-click the object and select the "Enabled" option.
Configure Windows NTP Client	Double-click the object and select the "Enabled" option.
Enable Windows NTP Server	Double-click the object and select the "Enabled" option.

10. Use the search box in the "Start" menu to run the "cmd.exe" program as administrator.

11. At the command prompt, enter the following commands (replace "IP Address Server1" and "IP Address Server2" with the IP addresses of the two servers):
w32tm /config /manualpeerlist:"<IP Address Server1>,0x1 <IP Address Server2>,0x1" / syncfromflags:manual /reliable:YES /update

12. After changing the NTP service (W32time is the service, W32tm is the application for the service), restart the computer.
Alternatively you can execute the following commands at the command prompt:

   – gpupdate /force

   – w32tm /config /update

   – w32tm /resync

   To stop and start the service:

   – *net stop w32time*

   – *net start w32time*

Configuration of the NTP Client

Follow these steps to configure your local computer as NTP Client:

1. Log on as a user with administrator rights.

2. Use the search box in the start menu to open the file "gpedit.msc".
The "Local Group Policy Editor" dialog box opens.

3. In the tree view, select "**Local Computer Policy > Computer Configuration > Administrative Templates > System > Windows Time Service > Time Providers**".

4. In the detail view, double-click the "Enable Windows NTP Client" object.
The "Enable Windows NTP Client" dialog box opens.

5. Select the "Enabled" option.

6. Click "OK".

7. In the detail view, double-click the "Configure Windows NTP Client" object.
The "Configure Windows NTP Client" dialog box opens.

8. Select the "Enabled" option.
The list displays the current settings.

9. Make the following settings:

   – In the "NtpServer" input box, enter the IP address of the NTP server: "<IP Address Server1>,0x9" (for example 192.168.178.201,0x9).

   – For redundant servers, enter the IP address of the first and second NTP servers separated by a space: "<IP Address Server1>,0x9 <IP Address Server2>,0x9" (for example 192.168.178.201,0x9 192.168.178.202,0x9).

   – From the "Type" drop-down list, select "NTP".

   – In the "SpecialPollInterval" input field (synchronization interval in seconds), enter the value "60".

10. Click "OK".

11. Start the command prompt as administrator.

12. At the command prompt, enter the following commands (replace "IP Address Server1" and "IP Address Server2" with the IP addresses of the two servers):
    w32tm /config /manualpeerlist:"<IP Address Server1>,0x1 <IP Address Server2>,0x1" /
    syncfromflags:manual /update
    Example: w32tm /config /manualpeerlist:"192.168.178.201,0x1192.168.178.202,0x1" /
    syncfromflags:manual /reliable:YES /update

13. After changing the NTP service (W32time is the service, W32tm is the application for the service), restart the computer.
    Alternatively you can execute the following commands at the command prompt:

    – gpupdate /force

    – w32tm /config /update

    – w32tm /resync

    To stop and start the service:

    – *net stop w32time*

    – *net start w32time*

Checking the time synchronization

You can find information about checking the time synchronization in the section "How to check the time on the PC stations (Page 119)".

6.5.1.2 How to make DCF 77 Client Service settings on a PC station without OS

Introduction

If no operator station is being used on a PC station in process mode, this PC station should be synchronized by means of the "DCF 77 Client Service" software, which you will need to install. You can find information about the storage location of the required software for the "DCF 77 Client service" in the *Process Control System PCS 7; PCS 7 Readme* file (see "Preface (Page 9)").

Note

DCF 77 can be used for time synchronisation only in special cases (SIMATIC BATCH, SIMATIC Route Control) installed on Windows 7 Ultimate 32-bit / 64-bit operating systems.

Requirements

● The DCF77 client software approved for the operating system is installed.

● The settings are made on the relevant PC station.

Procedure

1. Open the "Control Panel" dialog box on the PC station.

2. Double-click on the DCF 77 object.
   The "DCF 77 Reception Service" dialog box opens.

3. Click on the "Change Settings" button if you need to change the settings. Make the following settings:
   Select the PC station that is configured as time master from the "Port" drop-down list (e.g., an OS server synchronized via NTP).

   – Disable the option "Check MEZ/MESZ time zone".

   – Enter the the value "500" in the input field "Permitted deviation".
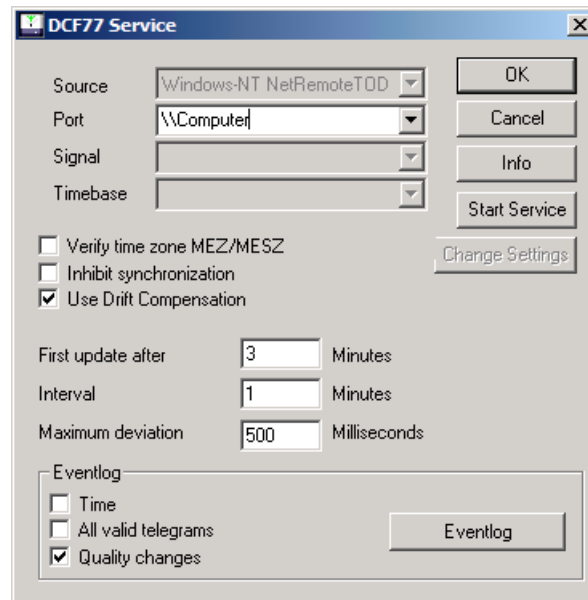
4. Click "Start Service".

5. Click "OK".

6.6 Configuring time synchronization on an AS

6.6.1 Time synchronization with central plant clock and S7-400 modules

Introduction

Time is synchronized using an external central plant clock as time master. The time master distributes the time frames via Industrial Ethernet in the SIMATIC mode and/or NTP mode. The mode is determined by the configuration of the central plant clock.

The time synchronization for the corresponding S7-400 modules is configured in HW Config.

Modules used for the configuration

Modules	Comment
CPU	Central processing unit
H CPU	Central module for redundant configuration
CP 443-1	Communication processor module for Industrial Ethernet
CP 443-5 Ext	Communication processor module for PROFIBUS DP

Examples of configurations

For all versions, a central plant clock is used as time master on the bus.

- **Configuration 1**
  Time synchronization with NTP or SIMATIC mode via external CP 443-1
  The time is synchronized using NTP or SIMATIC mode via CP 443-1, CP 443-5 Ext and CPU of the automation system.

- **Configuration 2**
  Time synchronization with NTP or SIMATIC mode via CPU PN/DP with integrated PROFINET IO interface
  Time synchronization is performed in the NTP or SIMATIC mode via a CPU PN/DP with integrated PROFINET IO interface and CP 443-5 Ext. When you use CPU`s of FW V5.x and V6.x with the internal Ethernet/PROFINET interface, time synchronization must be performed in NTP mode. If you use CPU's of FW V7.0, H-CPU of FW V6.x and CPU 410, you can also use SIMATIC mode for time synchronization at the internal Ethernet/ PROFINET interface.

6.6.2 Configuration 1

6.6.2.1 Explanations for configuration 1

Time synchronization with NTP or SIMATIC mode via external CP 443-1

The following figure shows an example of the time synchronization:
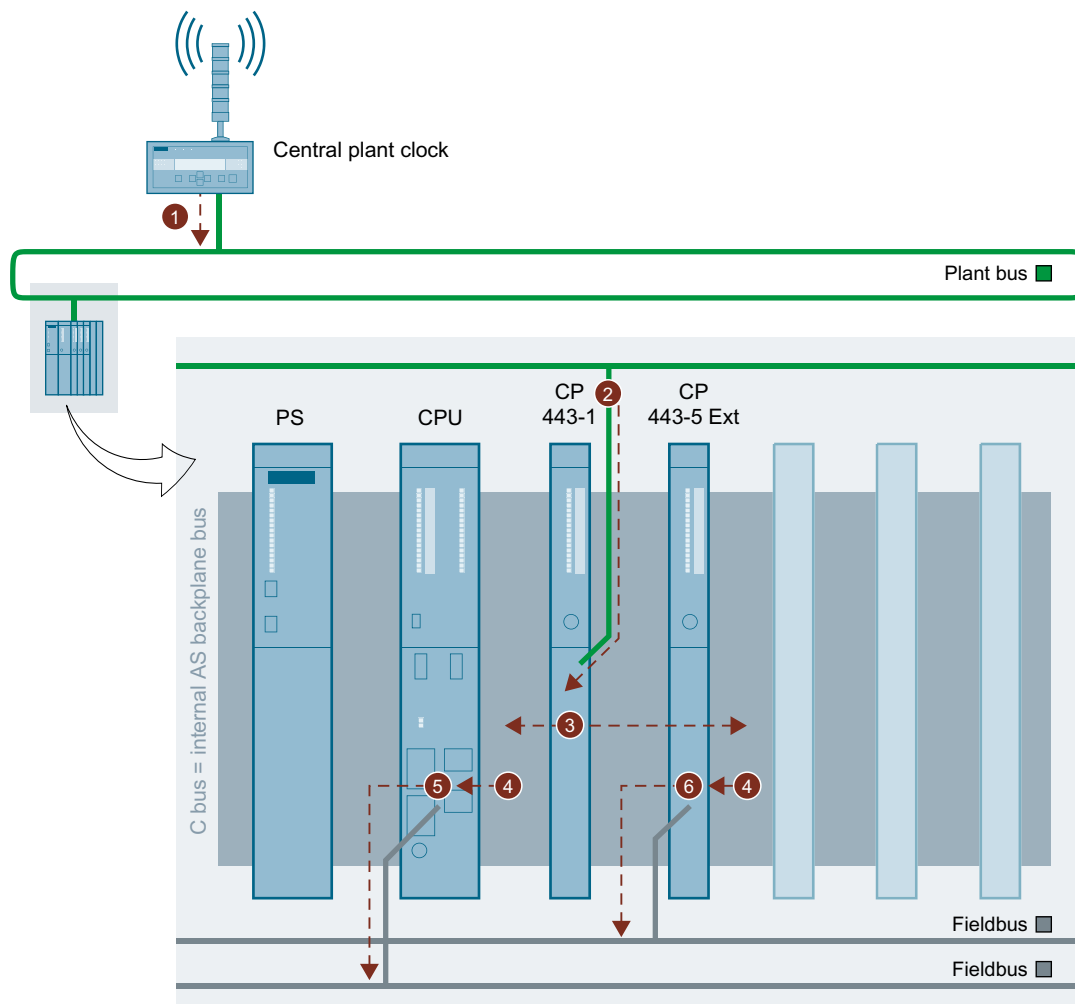
Desig-nation	Explanation
①	The central plant clock distributes the time frames via the plant bus (Industrial Ethernet).
②	The CP 443-1 obtains the time frames and synchronizes its internal clock.
③	The CP 443-1 distributes the time frames actively on the communications bus (C bus). The CP 443-1 is a time master on the C bus.
④	The CPU and the CP 443-5 Ext receive the time frames from the C bus. CPU and CP 443-5 Ext are time slaves on the C bus.

Desig-nation	Explanation
⑤	The CPU distributes time frames via the internal PROFIBUS DP interface on the fieldbus (PROFIBUS DP). The CPU is the time master on the fieldbus.
⑥	The CP 443-5 Ext distributes the time frame on the fieldbus (PROFIBUS DP). The CP 443-5 Ext is a time master on the fieldbus.

You can find information on configuring in the following section.

6.6.2.2 How to configure configuration 1

Requirements

- Central plant clock
- CP for Industrial Ethernet (using CP 443-1EX30 as example)
- CP for PROFIBUS (using CP 443-5DX05 as example)
- CPU

Configuration of the modules

The following table shows the settings in HW Config in SIMATIC Manager according to the synchronization mode.

	NTP mode	SIMATIC mode
Central plant clock	NTP mode	SIMATIC mode
CP 443-1EX30 "Time synchronization" tab	"NTP mode" group: 1. Select the following check boxes – Activate time synchronization in NTP mode – Time-of-day synchronization to the full minute, if required – Apply time of non-synchronized NTP servers – Forward time to station 2. Insert the required addresses in the text box for the NTP server addresses (IP addresses). 3. Select the time zone (GMT) Dublin, Edinburgh, Lisbon, London in the Time zone drop-down list so that the CPU will be synchronized with UTC time. 4. If you have selected the "Time-of-day synchronization on the full minute" check box, enter the desired update interval in the "Update interval [seconds]" input field.	"SIMATIC mode" group 1. Select the check box "Apply time in CP and forward" 2. Select the "From LAN" option button.

	NTP mode	SIMATIC mode
CPU "Diagnostics/Clock" tab	"Clock" group 1. From the drop-down list for synchronization in the AS, select: "As slave" as the synchronization mode.	
Integrated PROFIBUS DP interface of the CPU "Clock" tab	1. Select "As master" synchronization mode from the drop-down list. 2. Select 10 seconds as the time interval from the drop-down list.	
CP 443-5DX05 Options"	"Time synchronization" group 1. Select "From station to LAN". "Parameterization of field devices (data set routing)" group 1. Select "Activate data set gateway".	

Redundant automation system on redundant high available plant bus

If a redundant automation system is connected to the redundant, high availability plant bus, two CP 443-1 are required per CPU (per rack).

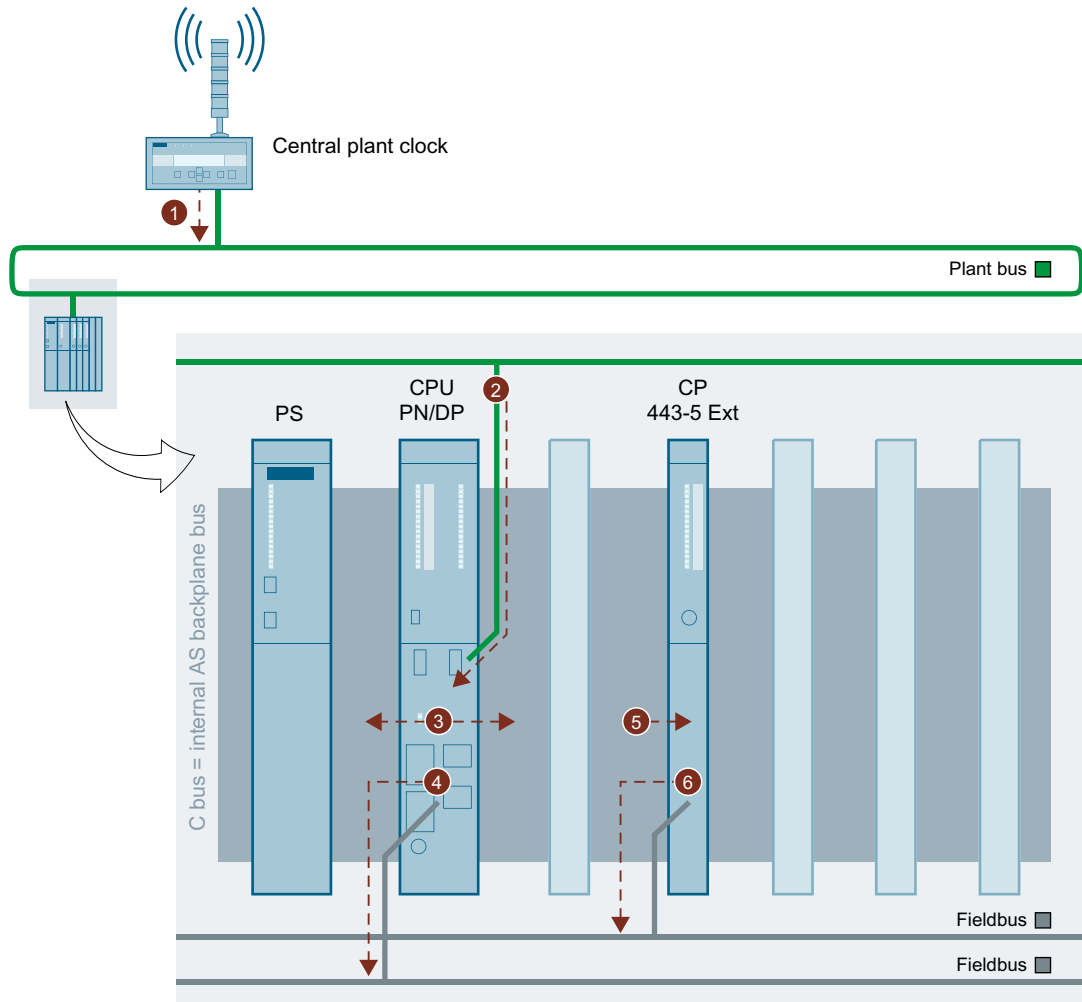Make the following settings for the CP 443-1.

CP on the plant bus	Plant bus 1	Plant bus 2
CP A (First CP 443-1 in the rack of CPU 0)	**Time synchronization enabled**	Not connected
CP B (Second CP 443-1 in the rack of CPU 0)	Not connected	**Time synchronization disabled**
CP C (First CP 443-1 in the rack of CPU 1)	**Time synchronization disabled**	Not connected
CP D (Second CP 443-1 in the rack of CPU 1)	Not connected	**Time synchronization enabled**

6.6.3 Configuration 2

6.6.3.1 Explanations for configuration 2

Time synchronization with NTP or SIMATIC mode via CPU PN/DP with integrated Ethernet interface

The following figure shows an example of the time synchronization:

Designation	Explanation
①	The central plant clock distributes the time frames via the plant bus (Industrial Ethernet).
②	The CPU PN/DP with integrated Ethernet interface receives the time frames via the internal Industrial Ethernet PN/IO interface and synchronizes its internal clock.
	The CPU PN/DP with integrated Ethernet interface is a time slave on the plant bus.
③	The CPU PN/DP with integrated Ethernet interface actively distributes the time frames on the communication bus (C bus).
	The CPU PN/DP with integrated Ethernet interface is a time master on the C bus.

Designation	Explanation
④	The CPU PN/DP with integrated Ethernet interface actively distributes the time frames on the fieldbus (PROFIBUS DP) via the internal PROFIBUS DP interface.
	The CPU PN/DP with integrated Ethernet interface is a time master on the fieldbus.
⑤	The CP 443-5 Ext obtains the time frames from the C bus and synchronizes its internal clock.
	The CP is the time slave on the C bus.
⑥	The CP 443-5 Ext distributes the time frames on the fieldbus (PROFIBUS DP).
	The CP is the time master on the fieldbus.

You can find information on configuring in the following section.

6.6.3.2 How to configure configuration 2

Requirements

- Central plant clock
- CP for PROFIBUS (using CP 443-5DX05 as example)
- Firmware version:
  - CPU >=V5 (SIMATIC mode: CPU >= V7)
  - H CPU >= V6

Configuration of the modules

The following table shows the settings in HW Config in SIMATIC Manager according to the synchronization mode.

	NTP mode	SIMATIC mode
Central plant clock	NTP mode	SIMATIC mode
CPU "Diagnostics/Clock" tab	"Clock" group 1. For the synchronization in the AS, select "As master" synchronization mode from the drop-down list. 2. Select 10 seconds as the time interval from the drop-down list.	

	NTP mode	SIMATIC mode
Integrated PROFINET interface PN/IO of the CPU "Time synchronization" tab	"NTP mode" group 1. Activate time synchronization via NTP. 2. Insert the required addresses in the text box for the NTP server addresses. 3. Select the time zone (GMT) Dublin, Edinburgh, Lisbon, London in the Time zone drop-down list so that the CPU will be synchronized with UTC time. 4. Enter the value "10" in the text box for the update interval [seconds].	"SIMATIC mode" group 1. Select "As slave" as synchronization mode from the drop-down list.
Integrated PROFIBUS DP interface of the CPU "Clock" tab	1. Select "As master" synchronization mode from the drop-down list. 2. Select 10 seconds as the time interval from the drop-down list.	
CP 443-5DX05 Options"	"Time synchronization" group 1. Select "From station to LAN". "Parameterization of field devices (data set routing)" group 1. Select "Activate data set gateway".	

6.7 Configuring the time synchronization for SIMATIC PCS 7 BOX RTX and SIMATIC PCS 7 AS RTX

6.7.1 Overview of time synchronization for SIMATIC PCS 7 BOX RTX and SIMATC PCS 7 AS RTX

Options

The following aspects are relevant to time synchronization for SIMATIC PCS 7 BOX RTX and SIMATIC PCS 7 AS RTX.

- Type of automation system

- Installed software

- Settings for the time zone and daylight saving time/standard time conversion in Windows

- Selection of the synchronization source for the automation system (WinAC time synchronization)

- Settings for the time base in WinCC for the automation system and process mode of the operator station

Plant-dependent parameter assignment of the time synchronization for SIMATIC PCS 7 BOX RTX and SIMATIC PCS 7 AS RTX

In PCS 7, the option for time synchronization of SIMATIC PCS 7 BOX RTX and SIMATIC PCS 7 AS RTX is independent of the plant configuration. The following table shows the settings required for time synchronization.

Settings to be made in following environment	PCS 7 network Synchronization via plant bus (external)	Single-station system Synchronization via BIOS time (local)	
The displayed time should match the synchronization source specifications.	The displayed time should match the local time. Possible to switch between daylight saving time/standard time. A continuous time should be set on the AS (GMT/UTC).	The time should be displayed uniformly across all levels and functions.	
WinAC time synchronization Settings (Page 108):	Source: CP	Source: PC	Source: PC
		Time base: GMT	Time base: Local
Windows setting Date and time properties > "Time Zone" tab Settings (Page 79):	Time zone: Local time zone	Time zone: Local time zone	Time zone: Greenwich Mean Time (GMT)
	Select switchover between daylight saving and standard time on a plant-specific basis		"Automatically adjust clock for daylight saving changes" check box deactivated

Settings to be made in fol-lowing environment	PCS 7 network Synchronization via plant bus (external)	Single-station system Synchronization via BIOS time (local)	
WinCC Explorer "Computer" object proper-ties > "Parameters" tab (Page 109)	Option button "The PLC is set to coordinated universal time (UTC) (preferred setting)": Activated		Option button "PLC is set to the lo-cal winter time all year": Activated
	"Time base for time display in runtime" group: Local time zone		
WinCC Explorer "Time Synchronization" editor	You will find information on plant-configuration-dependent settings under "Configuring the time synchronization for PC stations with OS (Page 76)"; section "Configuring the OS client for time synchronization"		

6.7.2 How to set the time synchronization source

Introduction

Make the setting in accordance with the configuration you selected.

Requirements

- The WinAC Time Synchronization software V4.0 or higher is installed on SIMATIC PCS 7 BOX RTX and SIMATIC PCS 7 AS RTX.

- In HW Config, "As slave" must have been set as the synchronization mode for time synchronization in the AS.

- The Windows settings and settings for the computer object properties in WinCC Explorer must be made.

Synchronizing SIMATIC PCS 7 BOX RTX and SIMATIC PCS 7 AS RTX as a group via the plant bus

Set the CP of the PC station as the source for time synchronization.

1. Select **PC Based Control > WinAC Time Synchronization** in the Start menu under the Siemens SIMATIC programs.
   The "WinAC Time Synchronization" dialog box opens.

2. Activate the "CP" options button under "Source" in the in the "Settings" group.

3. Click "Select".

4. In the "Set PG/PC Interface" dialog box that appears, select the interface connected to the plant bus in the "Interface parameterization used" group.

5. Click "OK" to close the dialog box.

6. Click "OK" to confirm the message that appears.

7. Click "Start" to initiate time synchronization.

8. Click "Close" to close the dialog box.

Synchronizing SIMATIC PCS 7 BOX RTX and SIMATIC PCS 7 AS RTX as a stand-alone system with PC clock

For a single station system, you need to set the PC clock as the source for time synchronization.

1. Select **PC Based Control > WinAC Time Synchronization** in the Start menu under the Siemens SIMATIC programs.
   The "WinAC Time Synchronization" dialog box opens.

2. In the "Settings" group under "Source", click "PC Clock".

3. Select the time base ("Time base" option button) according to the type of time display required:

   – The displayed time should match the local time, including daylight saving changes. A continuous time should be set on the AS (GMT/UTC):
     Time base: GMT

   – The time should be displayed uniformly across all levels and functions: **Time base: Local**
     Note: Daylight saving and standard time must be set manually. Please contact Customer Support regarding automatic switchover.

4. Click "Start" to initiate time synchronization.

5. Click "Close" to close the dialog box.

6.7.3 How to set the OS properties

Introduction

PCS 7 OS and the AS are synchronized via the local PC clock.

Requirements

- WinCC Explorer must be open.
- The procedure is relevant only for SIMATIC PCS 7 BOX RTX.

Procedure

1. Select the "Computer" object from the tree view in WinCC Explorer.

2. Select **Properties** in the shortcut menu.
   The "Computer List Properties" dialog box opens.

3. Click "OK".
   The "Computer Properties" dialog box opens.

4. Select the "Properties" tab.

5. Make the settings for the time base in WinCC for the AS (PLC) and for process mode of the operator station (runtime), according to the type of time display required:

	PCS 7 network Synchronization via plant bus (external)	Single-station system Synchronization via BIOS time (local)	
The time should be displayed as follows:	The displayed time should match the synchronization source specifications.	The displayed time should match the local time. Possible to switch between daylight saving time/standard time A continuous time should be set on the AS (GMT/UTC).	The time should be displayed uniformly across all levels and functions. **Note:** Daylight saving and standard time must be set manually.
Parameter	Option button "The PLC is set to coordinated universal time (UTC) (preferred setting)": **Activated**		Option button "PLC is set to the local winter time all year": **Activated**
	"Time base for time display in runtime" group: **Local time zone**		

6. Click "OK".
    The "Computer properties" dialog box closes.

6.7.4 How to configure the time synchronization for the AS

Introduction

The following configuration is required for the AS.

Requirements

- The PCS 7 project is created.
- SIMATIC Manager is open.
- The component view is activated

Procedure

1. In the component view, select the SIMATIC PC station.

2. In the detailed view, double-click the "Configuration" object.
    HW Config opens.

3. Select the CPU.

4. Open the shortcut menu of the CPU and select the menu command **Object Properties**.

   – Select the "Diagnostics/Clock" tab.

   – In the "Clock" group, select the "As slave" synchronization type for "Synchronization in the PLC".

   – Click "OK".
   The dialog box closes.

5. If you are using a CP 56x1, open the shortcut menu of the CP and select **Object properties**.

   – Select the "Clock" tab

   – Select "As master" in the "Synchronization type" drop-down list.

   – Select "10 seconds" in the "Time interval" drop-down list.

   – Click "OK".
   The dialog box closes.

6. Select the menu command **Station > Save and Compile**.

7. Close HW Config.

6.7.5 How to set OS time synchronization

Introduction

The PCS 7 OS is synchronized via the local PC clock.

Requirements

- The WinAC Time Synchronization software V4.0 or higher is installed on SIMATIC PCS 7 BOX RTX.

- In HW Config, "As slave" must have been set as the synchronization mode for time synchronization in the AS.

Setting the time synchronization of the OS

Requirements

- WinCC Explorer must be open.

- The procedure is relevant only for SIMATIC PCS 7 BOX RTX.

Procedure

Note

SIMATIC PCS 7 BOX RTX on the plant bus (LAN)

The following steps within this procedure are only required if the PC station is operated on the plant bus (LAN).

---

1. Select the "Time synchronization" editor in WinCC Explorer.

2. Select **Open** in the shortcut menu.
   The "Time Synchronization" dialog box opens.

3. Activate the "Synchronization via System Bus (Master, Slave)" check box.

4. Activate the "Display symbolic name of the access point" check box.

5. Go to the "Access point 1" drop-down list box and select "<Softnet(2)>": This is to be used for synchronizing the time on the plant bus.

6. Activate the "Slave" option button, as a time master is available.

7. Click "OK".
   The "Time Synchronization" dialog box closes.

Additional information

- Manual *SIMATIC; Windows Automation Center RTX; WinAC RTX*

6.8 Configuring time synchronization with multiple networks

6.8.1 Configuring time synchronization for separate networks using a central clock

Introduction

To ensure time synchronization for separate networks as well, only the time frame of the central plant clock should be forwarded to the various networks.

- Use SICLOCK TC 400 to synchronize up to four networks. and Buerk DTS4138S to synchronize up to two networks.

- If several separated networks must be synchronized, use a suitable switch, e.g., SCALANCE X414-3E, for separating the frame traffic.

The following example demonstrates synchronization of 5 networks with a SICLOCK TC 100 central plant clock, using a SCALANCE X414-3E switch.
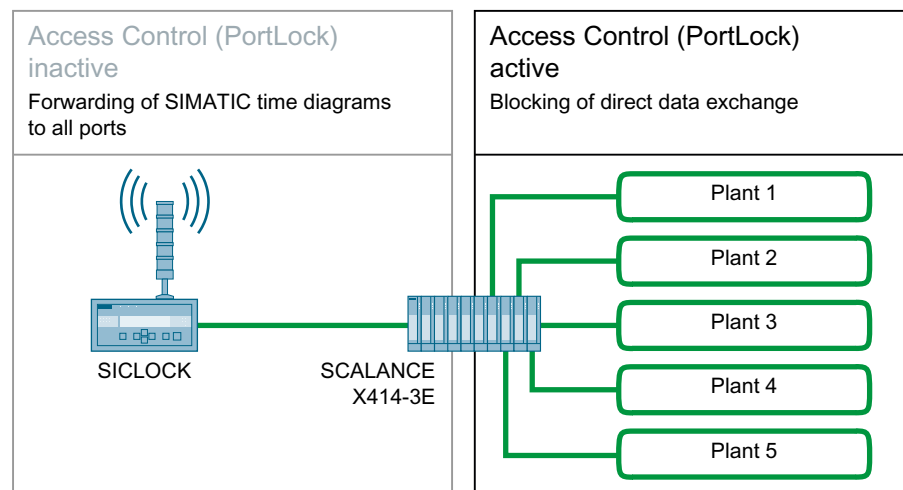
Function for separating message frame traffic

Use the "Access Control" function when you use suitable SCALANCE switches (e.g., SCALANCE X414-3E) to separate the message frame traffic between networks. You must configure the switches using web-based management.

Requirements

- The synchronization message frame from central plant clock must be configured.

- The IP address of central plant clock must be known.

- The central plant clock must be connected to a switch.

- The networks (plant 1 to plant 5 in the example figure) are not connected to the switch.

- You must configure the switches using web-based management.

Requirements for configuration using web-based management

- The IP address of the switch must be set.
  There must be an Ethernet connection between the switch and PC station.

- Microsoft Internet Explorer V5.5 or higher must be installed on the PC station.

- Access to port 80 or 443 must be possible if a firewall is installed (web-based management is based on access via HTTP or HTTPS).

Additional information

Configure the function for separating message frame traffic according to the switch used. You can find additional information on this in the section "How to configure SCALANCE X414-3E for separation of time frames (Page 114)".

6.8.2 How to configure SCALANCE X414-3E for separation of time frames

Requirements

- The IP address or the URL of the switch must be known.
- Requirements for configuration using web-based management must have been met.

Procedure

1. Open Internet Explorer.

2. Enter the IP address or the URL of the switch in the address bar of Internet Explorer. The login dialog of web-based management is displayed once a reliable connection has been established to the switch.

3. Select the "Admin" entry in the "LoginID" selection field if you wish to edit the settings of the IE switch (read and write access). You are only granted read access to the configuration data of the switch if you selected the "User" entry.

4. Enter your password. The default passwords (from the delivery condition) apply if you have not yet specified a password:

   - User name: admin - Password: admin

   - User name: user - Password: user

     Note

     For security reasons, you are strongly advised to change the default passwords (using the Command Line Interface - CLI).

5. Click "OK" to initiate login at the switch.

6. Select the "Switch > Ports" folder from the tree view.
   The "Port Status" menu opens.

7. In the "Port" column, click the port number to which a part of the plant is connected.
   The "Port Configuration" menu opens.

8. Activate the "Port enabled": check box.

9. Click the "Set Values" button.

10. Connect the networks to the switch.

11. Click the "Port" button.

12. Repeat steps 9 to 11 for the ports of the other plants.

Result

Configuration via Web Based Management (WBM) is complete.

Note

Do not enter any Unicast addresses in the Access Control List (ACL) for the plant ports.

Additional information

- Configuration manual *Industrial Communication; Industrial Ethernet Switches; SCALANCE X300; SCALANCE X400*, sections "Access Control Port Configuration menu item" and "The Port Status menu"

6.9 Configuring redundant PCS 7 systems

6.9.1 How to configure time synchronization of OS servers with a redundant communication module and external clock

Introduction

The described configuration is based on redundant OS servers on a redundant plant bus.

Communications processors

Each OS server in a server pair must feature redundant communication modules.
Possible types:

- Two CP 1613 each

- Two CP 1623 each

- Two CP 1628 each

You configure the communications processor and its partner module on the engineering station in the OS server project in the "Time Synchronization" editor.

The communications module under access point 1. The partner module under access point 2.

You can find information about configuring the communications processors in the section "Configuring the time synchronization for PC stations with OS (Page 76)".

Central plant clock/recommendation

- SICLOCK TC 400 or Buerk DTS 4138S timer

- SICLOCK TC 100 or Buerk DTS 4128 timer with switch from the SCALANCE X product series
  You can find information on configuring in the section "Configuring time synchronization with multiple networks (Page 113)".

6.9.2 How to configure time synchronization on a PCS 7 system with redundant bus system

Overview of configuration steps

The table below shows the steps that are necessary for configuring time synchronization for redundant buses, including references to the sections in this documentation that provide a corresponding description:

Step	What?	For more information, refer to the section:
1	Commission the SICLOCK or Buerk timer central plant clock	"Commissioning the SICLOCK timers (Page 64)"
2	Connect the GPS decoder to the SICLOCK or Buerk timer central plant clock and configure it	"Commissioning GPS receivers for SICLOCK timers (Page 72)"
3	The SICLOCK or Buerk timer central plant clock is connected to the network redundantly (LAN A and LAN B).	-
4	Connect the central plant clock to the plant bus, depending on the configuration selected: ● Via Ethernet for high availability redundant buses ● Via SCALANCE for separated plant buses	"Configuring time synchronization with multiple networks (Page 113)"
5	Configuring time synchronization for automation systems in HW Config	"Configuring time synchronization on an AS (Page 100)"
6	OS server time synchronization	"Configuring the time synchronization for PC stations with OS (Page 76)"
7	OS client time synchronization	"How to assign parameters for an OS client (Page 91)"

6.10 Configuring the time synchronization of the domain controllers (DC)

6.10.1 How to configure time synchronization of the domain controller

Options for time synchronization with a central plant clock

In PCS 7, domain controllers are synchronized with the central plant clock by default.

In a domain, always synchronize only the domain controller that manages the role of the PDC emulator.

You can find the current PDC emulator if you enter the following in the search box in the Start menu on any domain controller:

netdom query fsmo

You can find additional information on synchronizing the domain controller using NTP and on general configuration in the section "How to synchronize PC stations without OS using the NTP mode (Page 93)".

Additional information

Microsoft literature

Checking the time synchronization 7

7.1 How to check the time on the PC stations

Introduction

The following control system message is displayed if time synchronization is disturbed at a PC station, for example:

"LAN-Sync: Time synchronization with PC <xxx> is disturbed".

Requirement

It must be possible to operate the operating system environment (Windows command line window).

It is not possible to execute the w32tm function if command prompts have been disabled in the process mode (runtime) configuration. If you wish to use this function, you must change the configuration for process mode.

Methods for checking the time

You can check the time of PC stations in the PCS 7 plant by using the operating system function "w32tm". Use the "w32tm" operating system function to set the time difference to an additional computer.

Note

Additional information about the w32tm command is available by entering the string "w32tm/?" in the Windows command line window.

Checking time synchronization using w32/tm

When you enter the command "w32tm/stripchart/computer:<destination>[/period:<time>]dataonly][/samples:<number>]", you will see a diagram that displays the deviation (offset) of the computer currently in use to the specified computer.

Command switches	Meaning
computer:<destination>	The computer used as the base for the deviation measurement. Domain controller "DC1" is the target in the example shown below.
period:<time>	Time in seconds between updates. The default value is 2 seconds.
dataonly:	Show only data and no graphics.
samples:<number>	Stops sampling after specified number of time samples. If this value is not specified, time samples will be collected until you press the "Ctrl-C" key shortcut.

Example: Checking the time synchronization

1. Open "**cmd**" via the search box in the Start menu.
   The Windows command line window opens.

2. Enter the following:
   w32tm /stripchart /computer:<IP address of the time server>
   The time difference is displayed in a table in the command prompt.
   Example:
   w32tm /stripchart /computer:111.222.33.44

3. Output is interrupted by pressing CTRL+C.

Monitoring the central plant clock

The central plant clock function can be monitored using a binary alarm output. For information on configuring this output, refer to the central plant clock documentation.

Configure a priority "16" alarm for monitoring this output in a user program on an automation system.
You can find additional information on configuring the alarm in the *PCS 7 Process Control System; Operator Station* Configuration Manual.

Additional information

- Internet: www.microsoft.com, subject: "Synchronizing the time using the Windows time service (https://technet.microsoft.com/en-us/library/cc773263(v=ws.10).aspx)"

- SICLOCK; SICLOCK TC 400 Operating Instructions

- Buerk: Buerk Operating manual

7.2 How to check the time on an OS server with CP 16x3 / CP 16x8

Requirement

- One of the following communication processors is used as network adapter for communication between the OS server and plant bus:
  - CP 16x3
  - CP 16x8

- The time synchronization is activated for the communications processor (see note in "Procedure" below).

Procedure

1. In the Start menu, select the command **Siemens Automation > SIMATIC > SIMATIC NET > Communication settings**.

2. In the tree view, open the folder **Modules > <CP...> > Time of day**.

3. Check the following settings:
   - Time-of-day adjustment: **enabled**
   - Time reception: **...**<Date Time> **... <synchronous>**

4. Check the parameter assignment of the communications processor.
   You can find additional information on this in the section "How to assign parameters for a CP 16x3 / CP 16x8 communications processor (Page 76)".

7.3 How to configure the status check of the time master role of the OS server

Synchronization via plant bus

The time synchronization via the plant bus/Industrial Ethernet bus is only available on WinCC server projects. A BCE network adapter or up to two communication processors (for example CP 1623) can be used as the access point for time synchronization.

You can view the status of the access points in process mode. Configure an I/O field for each access point.

- For the first access point:
  Assign the internal text variable "@TimeSyncDevice1State" to an I/O field.

- For the second access point:
  If a second CP16x3 is available for time-of-day synchronization in the computer, assign the text variable "@TimeSyncDevice2State" to an additional I/O field.

The following status information can be displayed in these I/O fields in process mode:

- "Slave"
- "Standby master"
- "Active master"
- "Deactivated"

Note

The configuration engineer is not permitted to create @ prefix variables. This is reserved for the WinCC PCS7 software. It is not permitted to manipulate these system variables. The system variables are required for fault-free operation of the product.

Additional information

Online help *WinCC Information System*

Glossary

CEDST

Central European Daylight Saving Time

Central plant clock

A central plant clock receives a time frame from an external clock and forwards it to the terminal bus or plant bus.

CET

Central European Time

Clock, external

External clocks synchronize a plant using externally received time frames, e.g., of the DCF77 radio signal or satellite-based GPS signal.

Cooperative time master

A cooperative time master assumes the role of time master only when it stops receiving time frames from the active time master.

DCF 77

DCF 77 is a time signal that is sent from the DCF 77 transmitter at Frankfurt am Main.

The time signal transmits the statutory time applicable to the Federal Republic of Germany.

Domain controller

A domain controller is a server that regulates and manages the authentication and authorization of the computers and users a within Windows computer network.

GMT

Greenwich Mean Time

GPS

Global Positioning System

Local time

The local time is actual time in the respective time zone.

NTP

Network Time Protocol

Passive time master

A passive time master takes over the function of the active time master if the active time master should fail.

RTC (Real Time Clock, hardware clock)

RTC is the internal, battery-operated clock of a PC. This clock continues to run even if the PC is switched off and it has the precision of a quartz clock.

SIMATIC mode

The SIMATIC mode works with MAC addresses (ISO layer 2) and can thus be used only in the local Ethernet subnet.

This time synchronization method is not routing-capable.

Stratum, strata

A stratum is a hierarchy level within time synchronization. Within a stratum, the time is the same for all components.

- The time basis (precise reference time) within the entire system is designated as stratum 0.
- Components that are directly linked to the time basis are designated as stratum 1.
- Any component within a stratum (n) that causes a time difference generates a new time level stratum (n+1). The digit next to "stratum" indicates the number of time levels between the time basis (stratum 0) and a stratum (n).

Time master

The time master is responsible within the time synchronization for distributing the time frame. It forwards the time frame to the PCS 7 components configured as time slaves.

The following time master types are available:

- Active time master
- Cooperative time master
- Passive time master

Time slave

The time slaves are PCS 7 components that receive the time frames from the time master and use these to set their own clock.

Time synchronization

With time synchronization, the date and time of all time-dependent components are unified by a time master.

UTC (Universal Time Coordinated)

UTC is an internationally specified time base. It does not take daylight saving time into account.

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