Time-of-Day Synchronization between WinCC Runtime Professional and S7 Controllers

WinCC Runtime Professional

https://support.industry.siemens.com/cs/ww/en/view/69864408

Siemens Industry Online Support

Legal information

Use of application examples

Application examples illustrate the solution of automation tasks through an interaction of several components in the form of text, graphics and/or software modules. The application examples are a free service by Siemens AG and/or a subsidiary of Siemens AG ("Siemens"). They are non-binding and make no claim to completeness or functionality regarding configuration and equipment. The application examples merely offer help with typical tasks; they do not constitute customer-specific solutions. You yourself are responsible for the proper and safe operation of the products in accordance with applicable regulations and must also check the function of the respective application example and customize it for your system.
Siemens grants you the non-exclusive, non-sublicensable and non-transferable right to have the application examples used by technically trained personnel. Any change to the application examples is your responsibility. Sharing the application examples with third parties or copying the application examples or excerpts thereof is permitted only in combination with your own products. The application examples are not required to undergo the customary tests and quality inspections of a chargeable product; they may have functional and performance defects as well as errors. It is your responsibility to use them in such a manner that any malfunctions that may occur do not result in property damage or injury to persons.

Disclaimer of liability

Siemens shall not assume any liability, for any legal reason whatsoever, including, without limitation, liability for the usability, availability, completeness and freedom from defects of the application examples as well as for related information, configuration and performance data and any damage caused thereby. This shall not apply in cases of mandatory liability, for example under the German Product Liability Act, or in cases of intent, gross negligence, or culpable loss of life, bodily injury or damage to health, non-compliance with a guarantee, fraudulent non-disclosure of a defect, or culpable breach of material contractual obligations. Claims for damages arising from a breach of material contractual obligations shall however be limited to the foreseeable damage typical of the type of agreement, unless liability arises from intent or gross negligence or is based on loss of life, bodily injury or damage to health. The foregoing provisions do not imply any change in the burden of proof to your detriment. You shall indemnify Siemens against existing or future claims of third parties in this connection except where Siemens is mandatorily liable.
By using the application examples you acknowledge that Siemens cannot be held liable for any damage beyond the liability provisions described.

Other information

Siemens reserves the right to make changes to the application examples at any time without notice. In case of discrepancies between the suggestions in the application examples and other Siemens publications such as catalogs, the content of the other documentation shall have precedence.
The Siemens terms of use (https://support.industry.siemens.com) shall also apply.

Security information

Siemens provides products and solutions with Industrial Security functions that support the secure operation of plants, systems, machines and networks.
In order to protect plants, systems, machines and networks against cyber threats, it is necessary to implement – and continuously maintain – a holistic, state-of-the-art industrial security concept. Siemens' products and solutions constitute one element of such a concept.
Customers are responsible for preventing unauthorized access to their plants, systems, machines and networks. Such systems, machines and components should only be connected to an enterprise network or the Internet if and to the extent such a connection is necessary and only when appropriate security measures (e.g. firewalls and/or network segmentation) are in place.
For additional information on industrial security measures that may be implemented, please visit https://www.siemens.com/industrialsecurity.
Siemens' products and solutions undergo continuous development to make them more secure. Siemens strongly recommends that product updates are applied as soon as they are available and that the latest product versions are used. Use of product versions that are no longer supported, and failure to apply the latest updates may increase customer's exposure to cyber threats.
To stay informed about product updates, subscribe to the Siemens Industrial Security RSS Feed at: https://www.siemens.com/industrialsecurity.

Table of contents

1 Introduction

1.1 Overview

Introduction

In industrial plants, time-of-day synchronization is of great importance.

For example, …

- data recording and data storage
- alarms
- shift logs
- energy data management

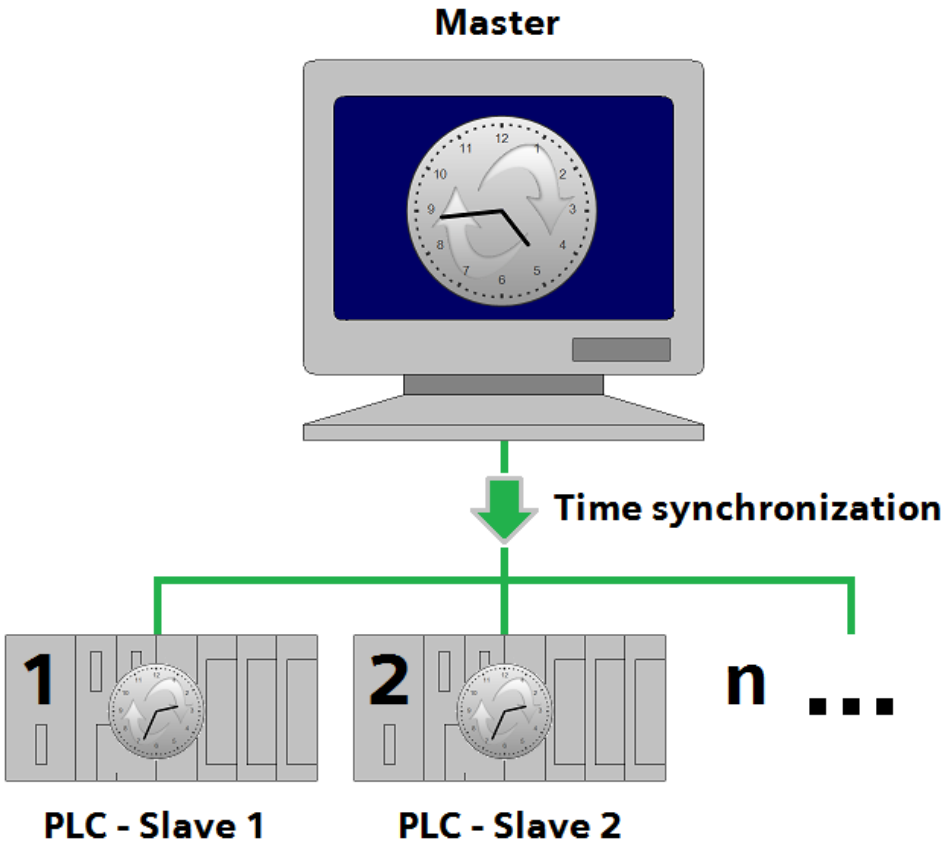
... only make sense with a reliable, identical date and time stamp of all components involved.

Description of the automation task

The time of day of a higher-level industrial PC has to be transmitted to all connected nodes, e.g. programmable controller, and synchronized at regular intervals.

Depending on the hardware used, the time of day is to be synchronized via both, interface tags and NTP.

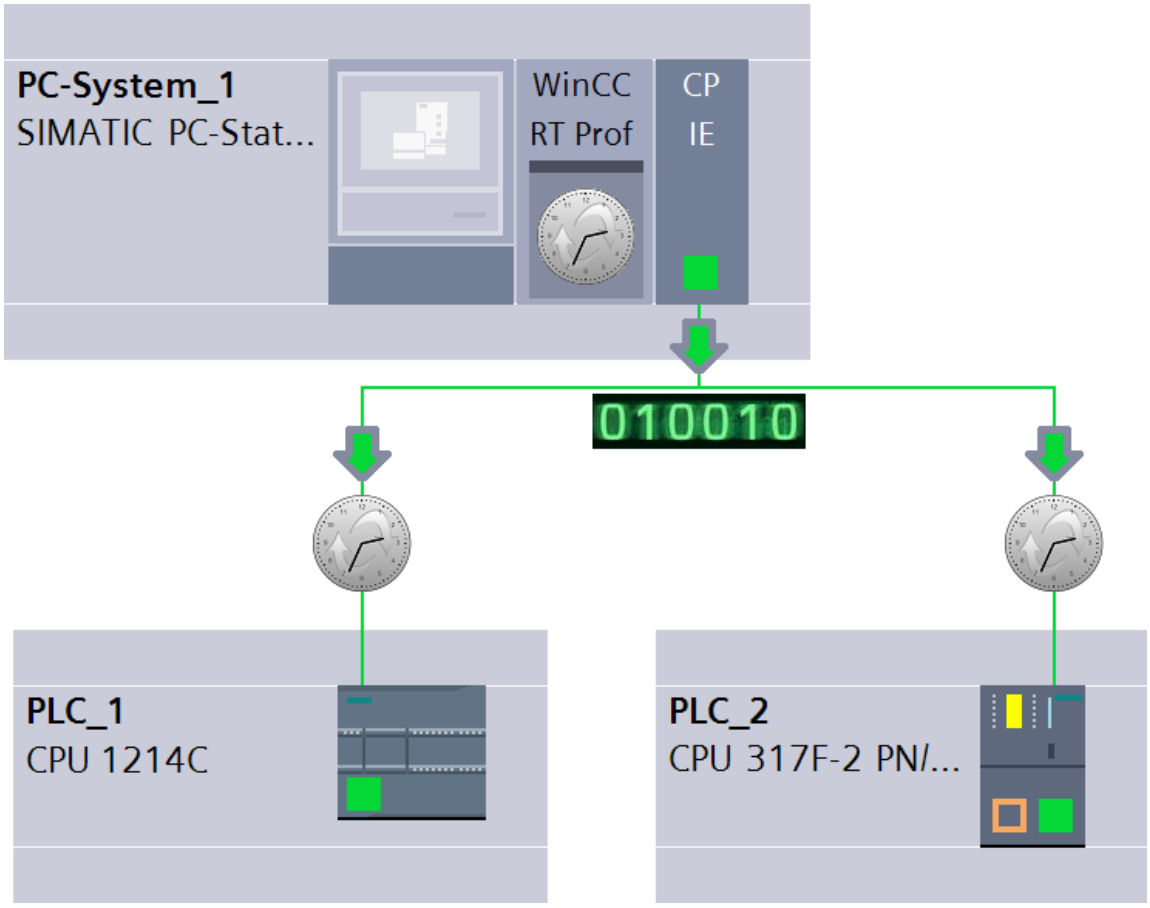
Figure 1-1



1.2 Mode of operation

The diagrammatic representation below shows the most important components of the solution:

Figure 1-2



Configuration

- All nodes are connected to one another via a network.
- WinCC Runtime Professional or the industrial PC (“PC-System_1”) on which the visualization runs acts as the time-of-day master.
- The controllers shown in the figure (“PLC_1” and “PLC_2”) are the time-of-day slaves.
- Both S7-300/S7-400 and S7-1200/S7-1500 are supported.

Advantages

This application offers you the following advantages:

- Identical time-of-day information plant-wide
- Comparability of recorded data and measured values
- Meaningful shift and alarm logs
- Setting the time of day independently of devices, modules and bus topologies
- Time-of-day synchronization for Industrial Ethernet and appropriate hardware
- Can be (simultaneously) used for both S7-300/S7-400 and S7-1200/S7-1500

Scope

This application does not include a description of

- the installation of the SIMATIC TIA Portal software
- the installation and configuration of the hardware used.

Basic knowledge of these topics is required.

Required knowledge

Basic knowledge of the WinCC Professional and STEP 7 Professional software products is required.

Description of the core functionality

This application example offers you two basic functions:

- Setting the time of day
- Synchronizing the time of day

NOTICE	**Both functions can be used alternatively or in combination with one another. However, only one of the two methods may be used per time-of-day slave.**

Note	If all components involved support NTP, it is preferable to use only time-of-day synchronization.

Setting the time of day via interface tags

Setting the time of day is the conventional way of reducing time differences between operator station and controller to a minimum. However, when setting the time of day, transmission delay times and the processing time of scripts and functions cause a delay that results in the times in the HMI and PLC deviating from one another.

The advantage of setting the time of day is its universal applicability, e.g. for devices, modules and bus topologies that do not support NTP.

Note	The supplied sample files are used for setting the time of day.

Time-of-day synchronization via NTP

NTP (**N**etwork **T**ime **P**rotocol) is a standardized protocol for synchronizing clocks in computer systems and uses the connectionless UDP transport protocol.

- In NTP mode, the controller sends timing requests (in client mode) to the NTP server at regular intervals.
- From the request, the NTP server determines the transmission delay time and considers it for the synchronization with the controller.

The advantage of time-of-day synchronization is its accuracy, which also considers delays during transmission.

Furthermore, implementation is less complicated than for setting the time of day as no further scripts and functions are necessary.

Note The supplied sample files are not required for time-of-day synchronization.

However, all devices involved must support NTP.

1.3 Components used

This application example has been created with the following hardware and software components:

Table 1-1

Component	Number	Article number	Note
CPU 1214C	1	6ES7214-1HE30-0XB0	Alternatively, any other controller of the S7-1200/S7-1500 series can also be used.
CPU 317F-2PN/DP	1	6ES7317-2FK13-0AB0	Alternatively, any other controller of the S7-300/S7-400 series can also be used.
SIMATIC IPC847C	1	6AG4114-1....-....	Alternatively, any other industrial PC can also be used.
STEP 7 Professional	1		
WinCC Professional	1		

This application example consists of the following components:

Table 1-2

Component	File name	Note
Documentation	69864408_WinCC_Pro_TimeSyn_DOC_v11_en.pdf	This Document.
Code	69864408_WinCC_Pro_TimeSyn_CODE_v11.zip	Four code templates in text format.

2 Additional information

2.1 Background

Time functions in STEP 7

To extract and edit the values for year, month, day and time from the "DATE_AND_TIME" data type, you need different instructions or functions in STEP 7 (TIA Portal) and in STEP 7 V5.

- In STEP 7 (TIA Portal), you will find these instructions in the "Extended Instructions" palette and in the "Date and time-of-day" folder.
- For STEP 7 V5, you need the IEC standard functions included in the STEP 7 "Standard Library".

Use

Table 2-1

STEP 7 (TIA Portal)		STEP 7 V5	Description
S7-300/S7-400	S7-1200	S7-300/S7-400	
WR_SYS_T	WR_SYS_T	SFC 0 "SET_CLK"	Set time of day
RD_SYS_T	RD_SYS_T	SFC 1 "READ_CLK"	Read time of day
T_CONV	T_CONV	FC 6 DT_DATE	Convert / extract times
		FC 7 DT_DAY	Convert / extract times
		FC 8 DT_TOD	Convert / extract times
T_COMBINE	T_COMBINE	FC3 D_TOD_DT	Combine times
T_COMP	-	FC 9 "EQ_DT"	Compare time tags
T_ADD	T_ADD	FC 1 "AD_DT_TM"	Add times
T_SUB	T_SUB	FC 34 "SB_DT_DT"	Subtract times
		FC35 "SB_DT_TM"	Subtract times
T_DIFF	T_DIFF	-	Time difference

DATE_AND_TIME data type (S7-300/S7-400)

- The "DT" data type is used for the S7-300/S7-400.
- The data for date and time of day is stored in BCD format.
- The "DT" data type has a length of 8 bytes.
- The structure elements of this data type can only be accessed via absolute addresses.

DTL data type (S7-1200/S7-1500)

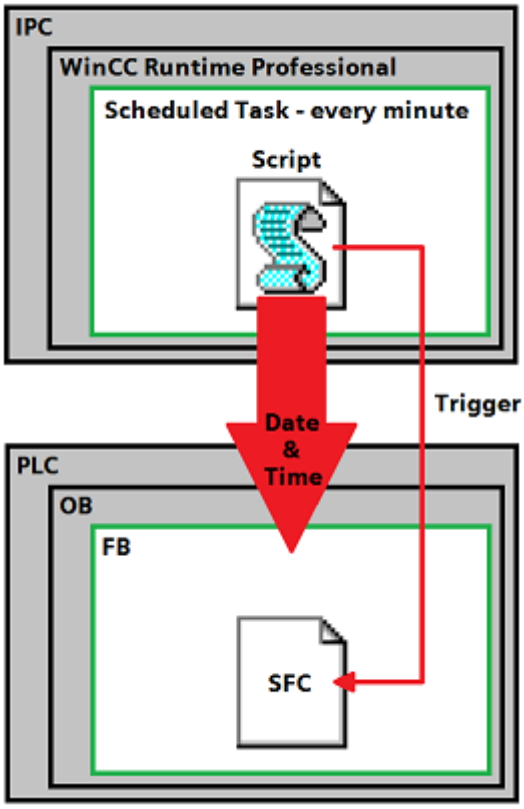
- The "DTL" data type is used for the S7-1200/S7-1500.
- The "DTL" data type has a length of 12 bytes.
- The structure elements of this data type can't be accessed.

Note This application uses the time functions of STEP 7 (TIA Portal) only for setting the time of day.

The time functions of STEP 7 are not required for time-of-day synchronization.

2.2 Setting the time of day

Figure 2-1



1. The “WriteDateTime_..._VBS” script (depending on the controller) is called cyclically every minute by the scheduler.
2. Via interface tags, the script writes the date, time of day and trigger to the instance data block of the FB.
3. The FB with the “SetDateTime_...” code (depending on the controller) is called cyclically by the OB.
4. If the trigger is set, the “WR_SYS_T” system function will be called with the date and time of day data of the instance data block and the time of day will be set.
5. After calling the system function, the trigger will be reset by the FB.

2.3 Time-of-day synchronization

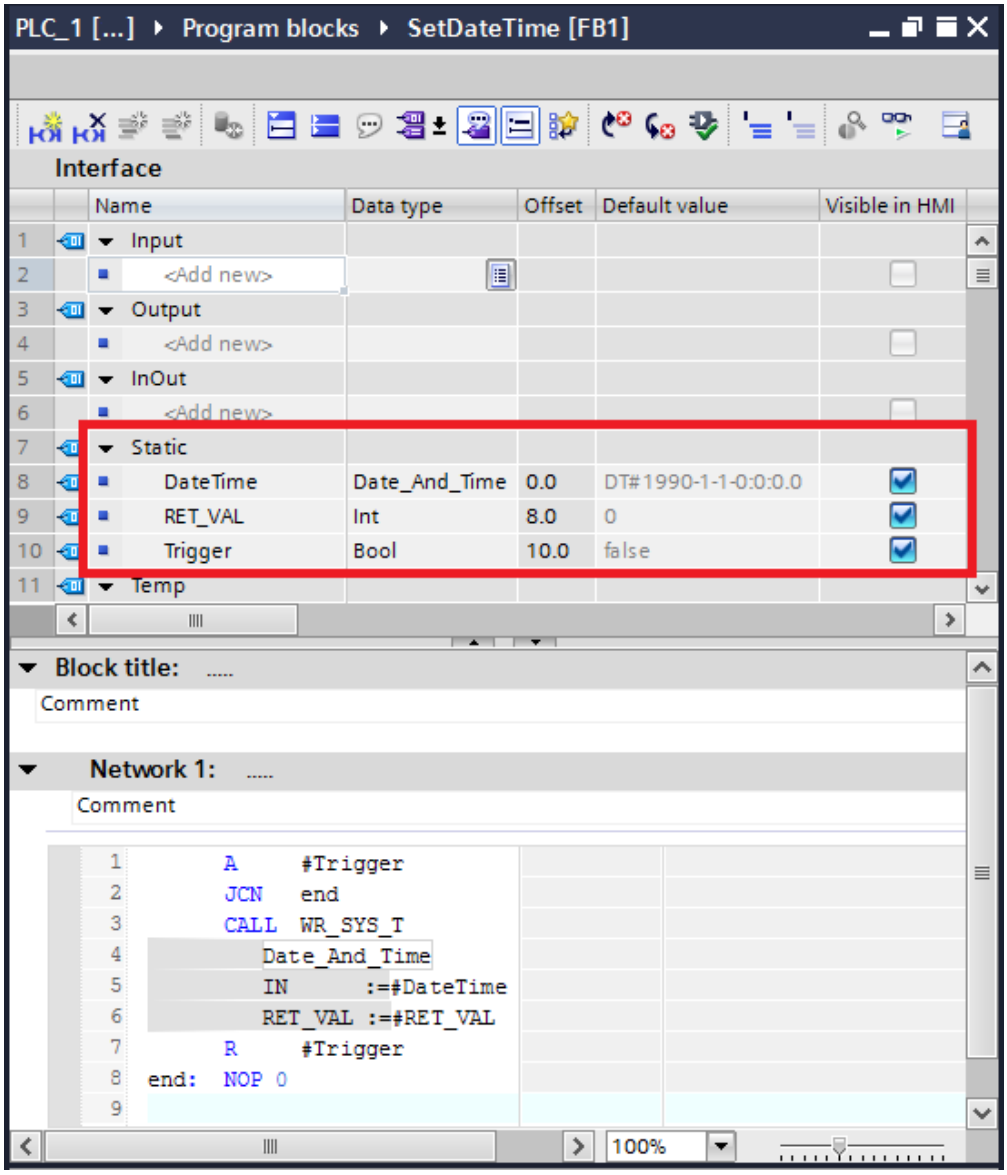
The supplied files are not used for time-of-day synchronization. Instead, NTP is used here, which has to be parameterized only once for all devices involved.

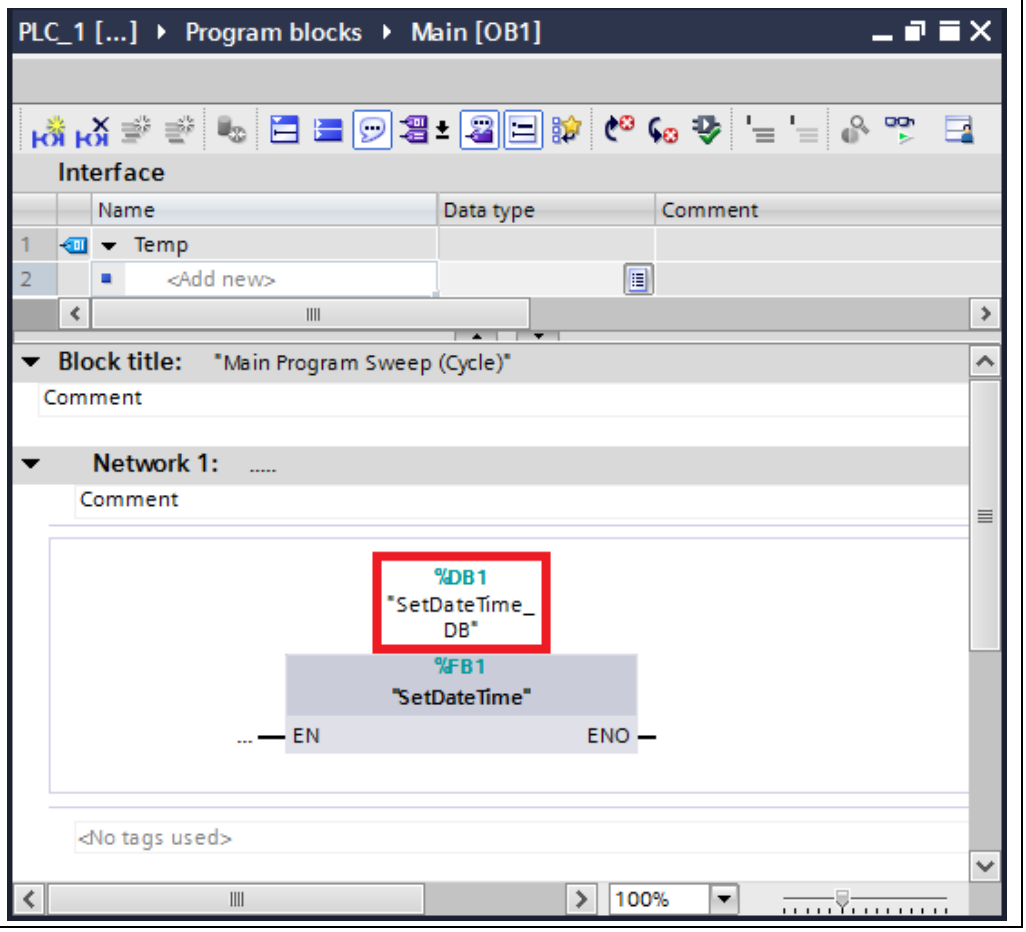
The services used for this purpose run in the background and must be provided by the devices involved.

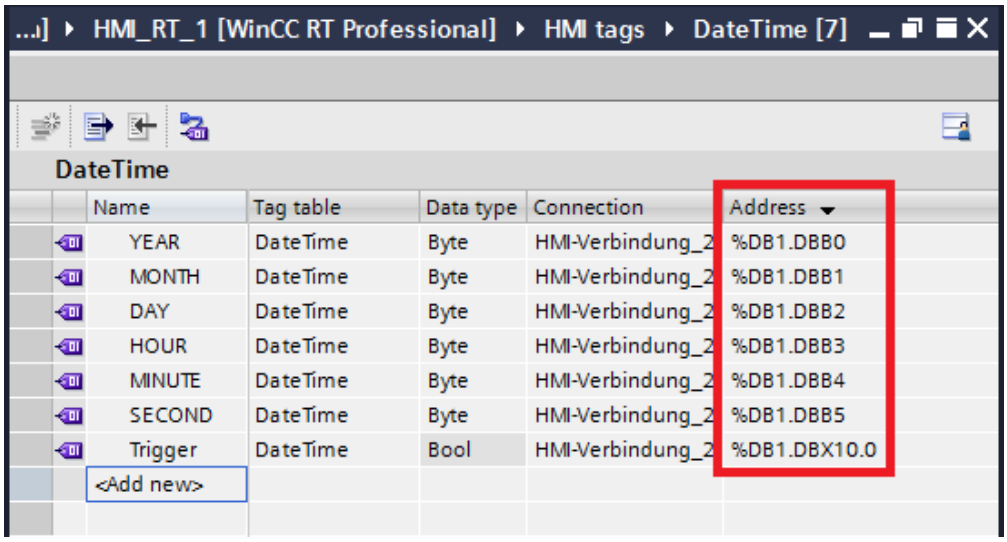
3 Setting the Time of Day

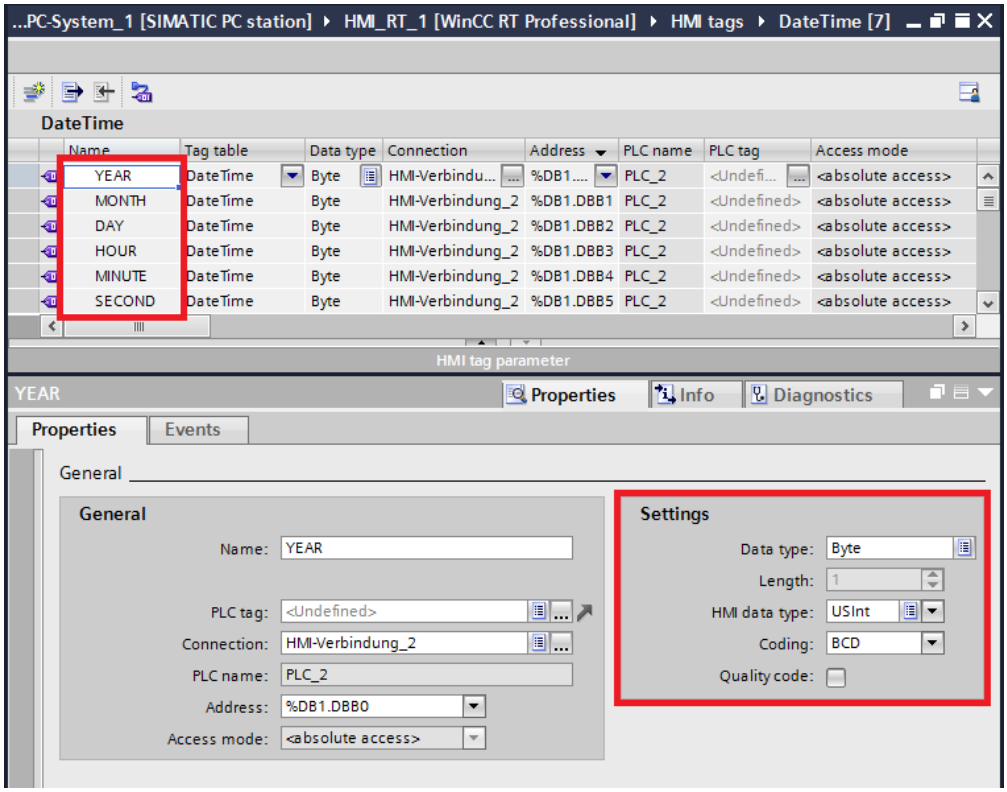
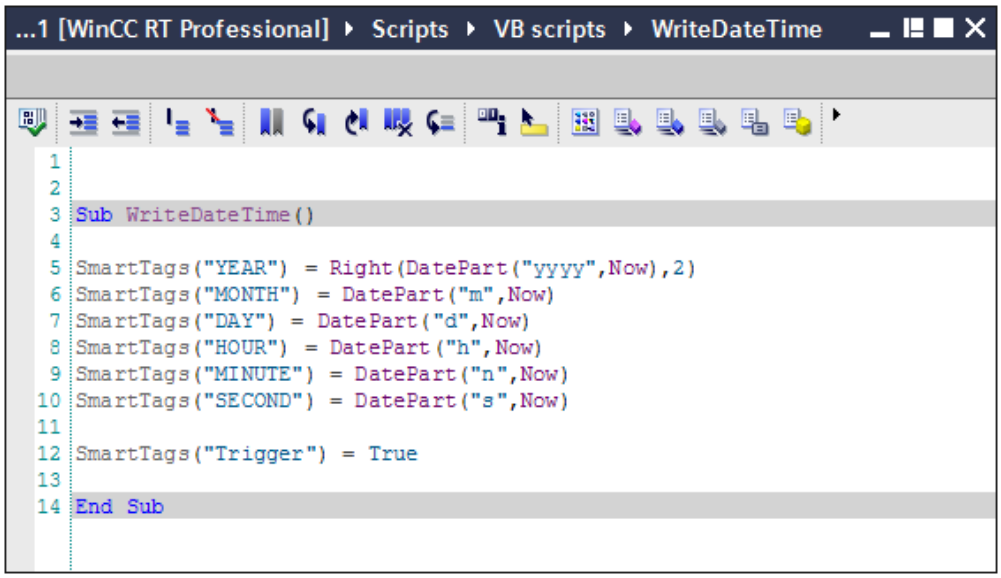
3.1 From WinCC Runtime Professional to S7-300/S7-400

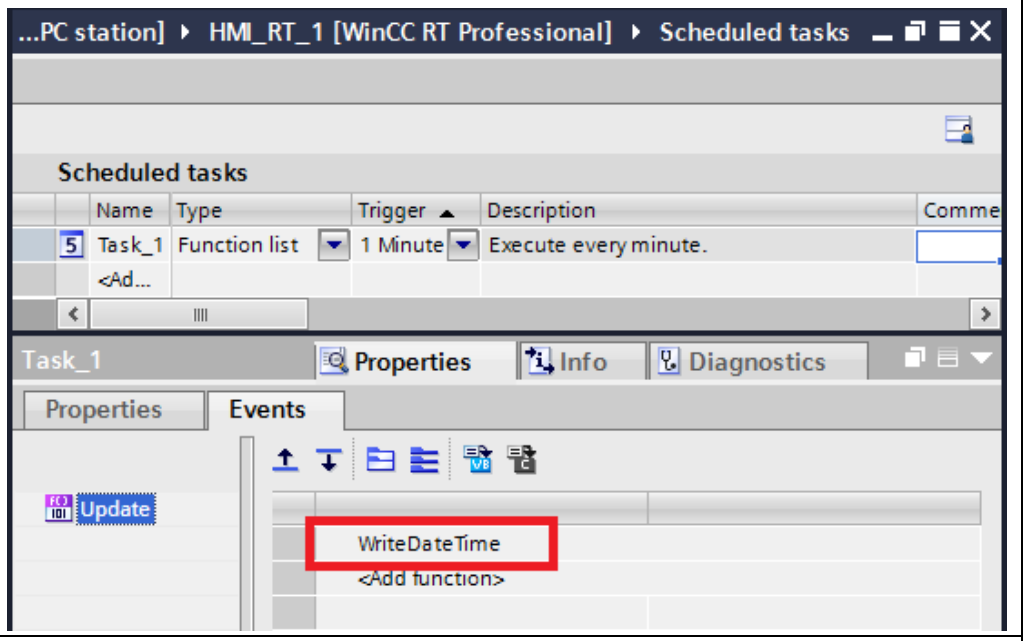
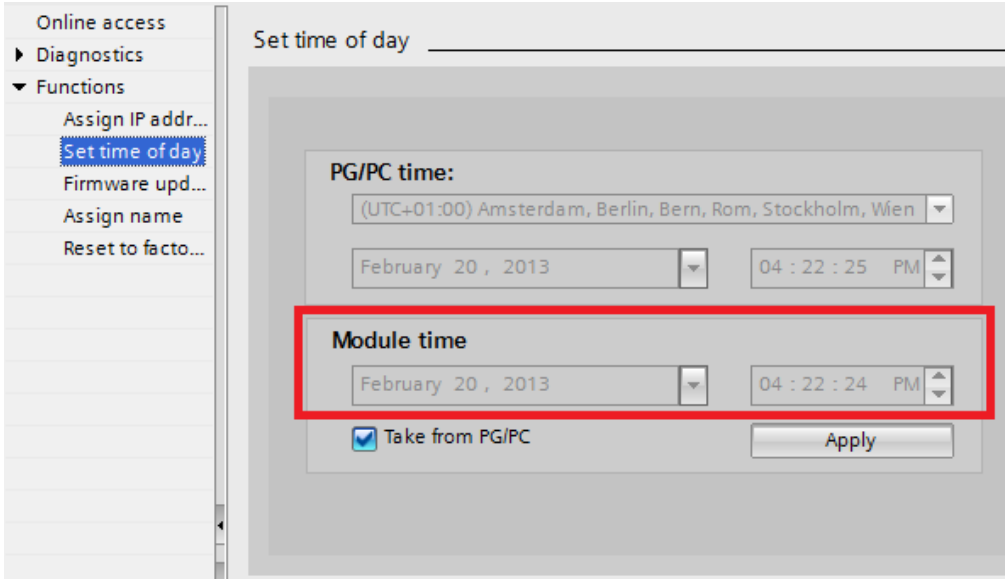
Table 3-1

Step	Action
1.	• Create a new FB1 with the name “SetDateTime” and the “STL” language. • In the static part of the declaration section, define three tags: - “DateTime” (Date_And_Time) - “RET_VAL” (Int) - “Trigger” (Bool) • Make sure that the “Visible in HMI” option is checked for all tags. • Insert the STL code of the “SetDateTime_AWL.txt” text file into FB1. 

Step	Action
2.	• Call FB1 “SetDateTime” in OB1 “Main”. • As the instance data block, select DB1 and assign “SetDateTime_DB” as the name. 

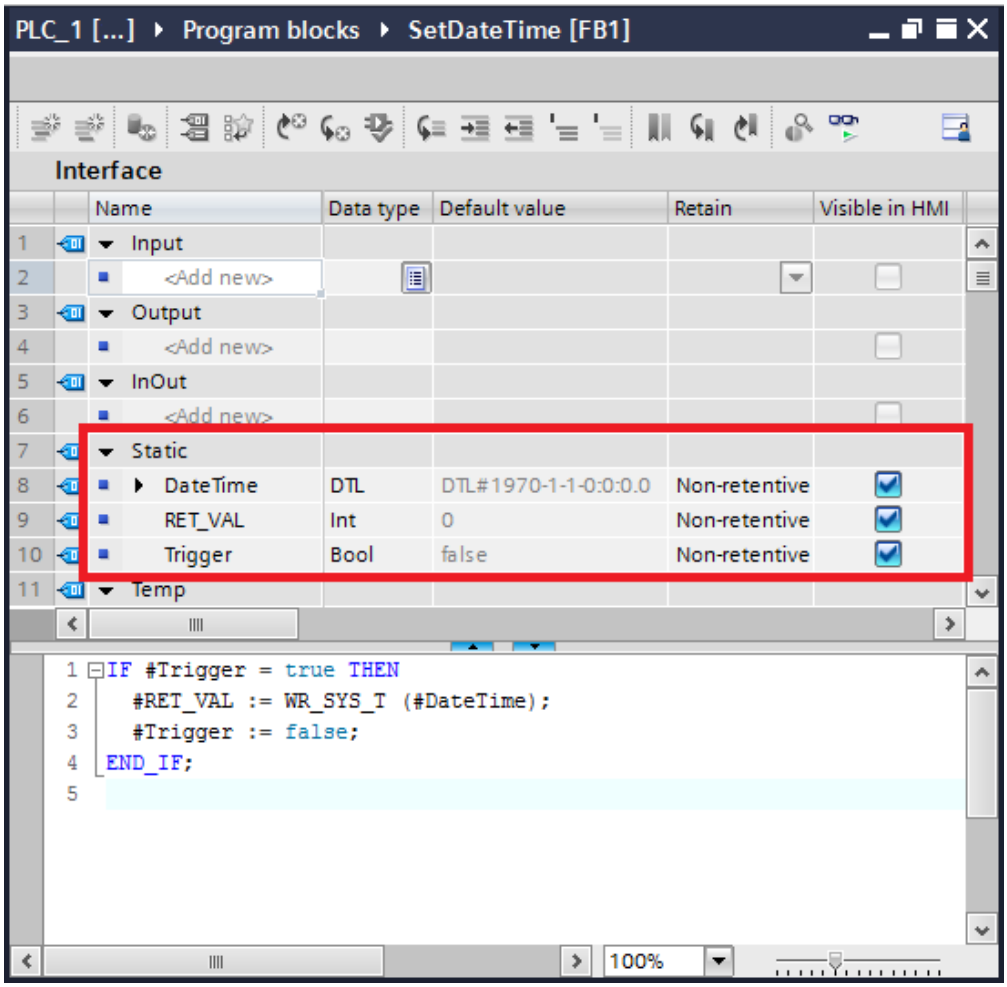
Step	Action
3.	• Create the tags in the WinCC Runtime Professional tag management as shown in the figure. • Make sure that the “Trigger” tag has the “Bool” data type. • When assigning the addresses, make sure that the absolute addresses are addressed correctly. **Note** If an HMI connection between the PC station and the controller has not yet been established in your project, you can also copy the “Trigger” tag from the DB1 instance data block to the WinCC Runtime Professional tag management. This automatically creates the HMI connection. The prerequisite for this is an existing network between the PC station and the PLC. 

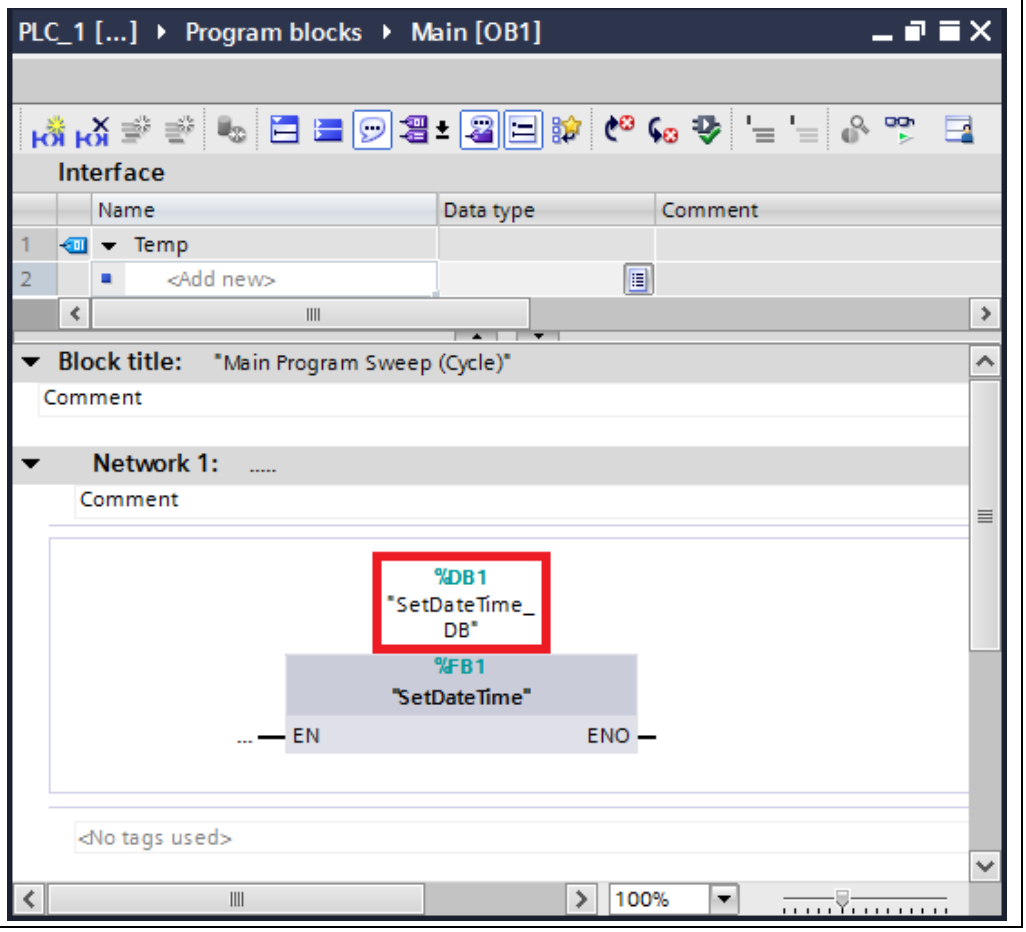
Step	Action
4.	Change the coding of the tags with the “Byte” data type to “BCD”. **Note** When the coding is changed, the HMI data type will be automatically set to “USInt”. 
5.	• Create a new VB script named “WriteDateTime”. • Copy the VBS code of the “WriteDateTime_300_400_VBS.txt” text file to the script. 

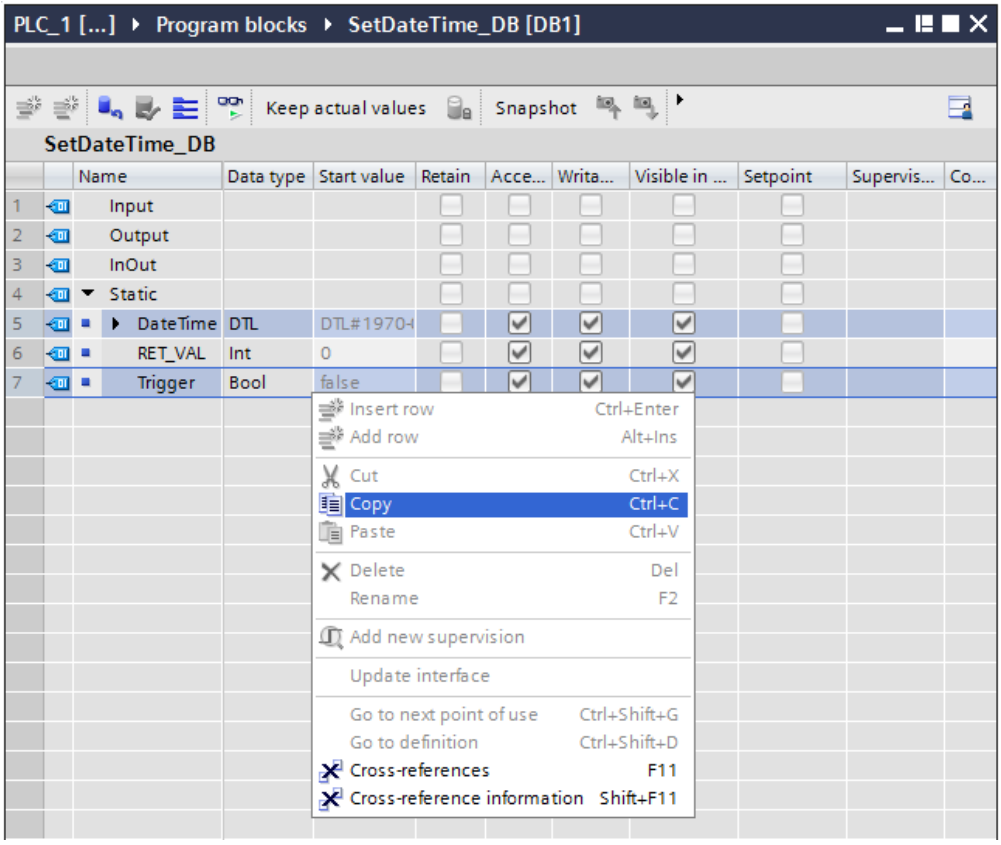
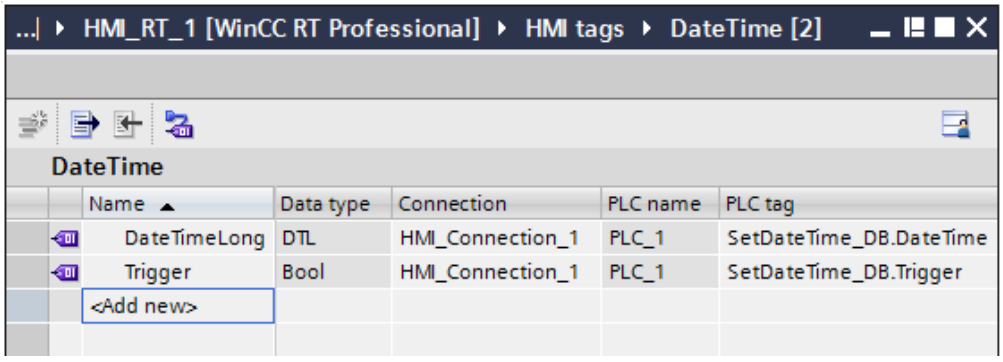
Step	Action
6.	• Open the scheduler. • Create a new task and assign it a unique name (in the example: “Task_1”). • Set the trigger to “1 Minute”. • In Events, integrate the “WriteDateTime” script. 
7.	• In the Project tree, select the “Online & Diagnostics” area of your CPU. • In “Online access”, select the appropriate parameters of your connection. • Select “Go online” to connect to your CPU. • Select “Functions > Set time of day” to check the module time of your CPU. 

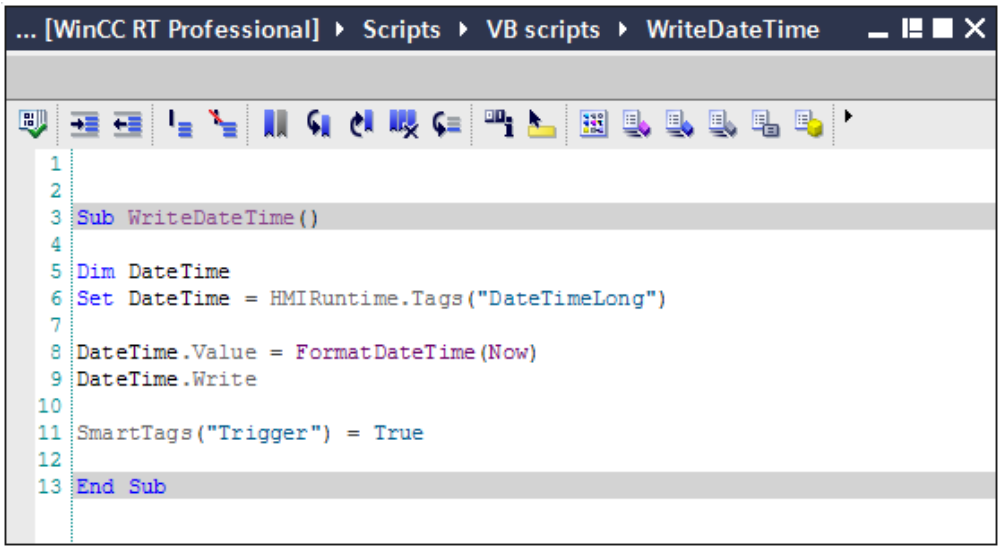
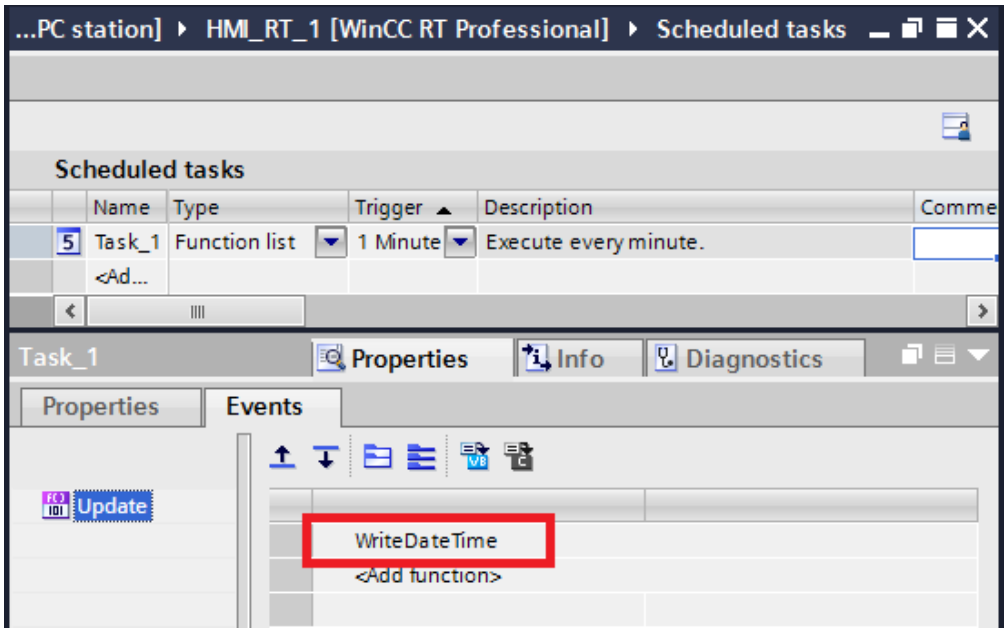
3.2 From WinCC Runtime Professional to S7-1200/S7-1500

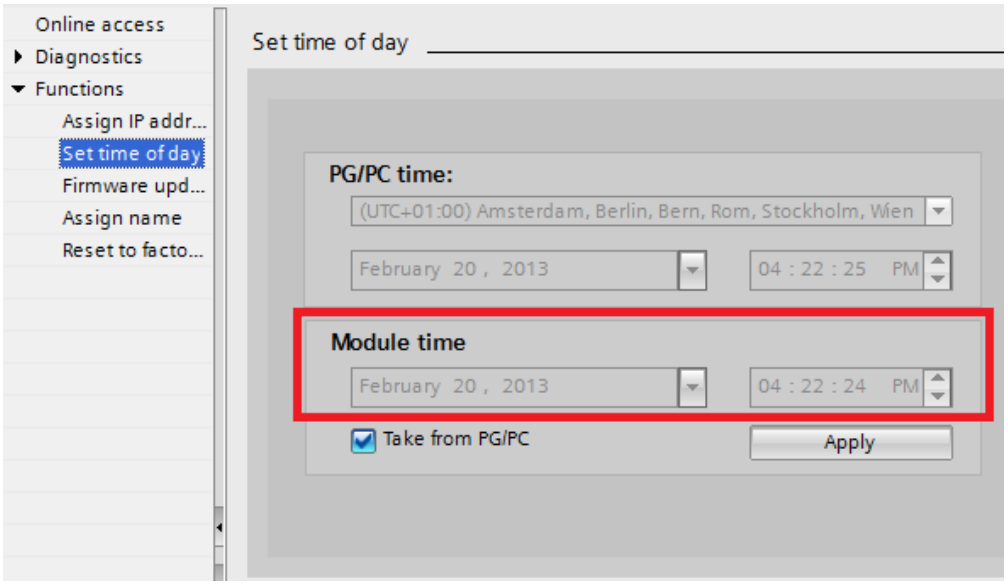
Table 3-2

Step	Action
1.	• Create a new FB1 with the name “SetDateTime” and the “SCL” language. • In the static part of the declaration section, define three tags: - “DateTime” (DTL) - “RET_VAL” (Int) - “Trigger” (Bool) • Make sure that the “Visible in HMI” option is checked for all tags. • Insert the SCL code of the “SetDateTime_SCL.txt” text file into FB1. 

Step	Action
2.	• Call FB1 “SetDateTime” in OB1 “Main”. • As the instance data block, select DB1 and assign “SetDateTime_DB” as the name. 

Step	Action
3.	Copy the tags of the DB1 instance data block to the clipboard. **Note** When copying, press “Ctrl” to select multiple tags at a time. 
4.	Paste the copied tags into the WinCC Runtime Professional tag management. **Note** It is recommended to create a new tag table (in the example: “DateTime”) for the tags. If an HMI connection between the PC station and the controller has not yet been established in your project, it will be automatically created when copying. The prerequisite for this is an existing network between the PC station and the PLC. 

Step	Action
5.	• Create a new VB script named “WriteDateTime”. • Copy the VBS code of the “WriteDateTime_1200_1500_VBS.txt” text file to the script. 
6.	• Open the scheduler. • Create a new task and assign it a unique name (in the example: “Task_1”). • Set the trigger to “1 Minute”. • In Events, integrate the “WriteDateTime” script. 

Step	Action
7.	• In the Project tree, select the “Online & Diagnostics” area of your CPU. • In “Online access”, select the appropriate parameters of your connection. • Select “Go online” to connect to your CPU. • Select “Functions > Set time of day” to check the module time of your CPU. 

4 Synchronizing the Time of Day

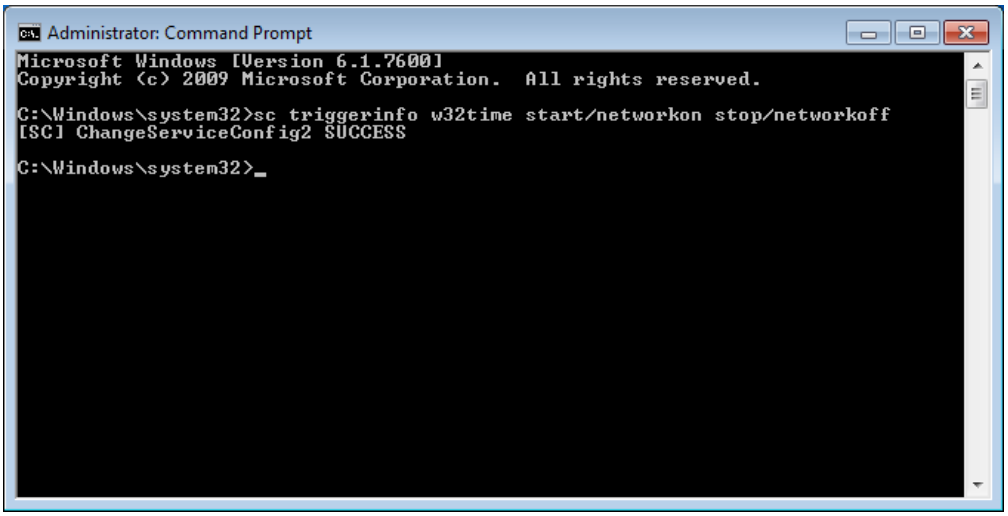
4.1 Settings on the PC

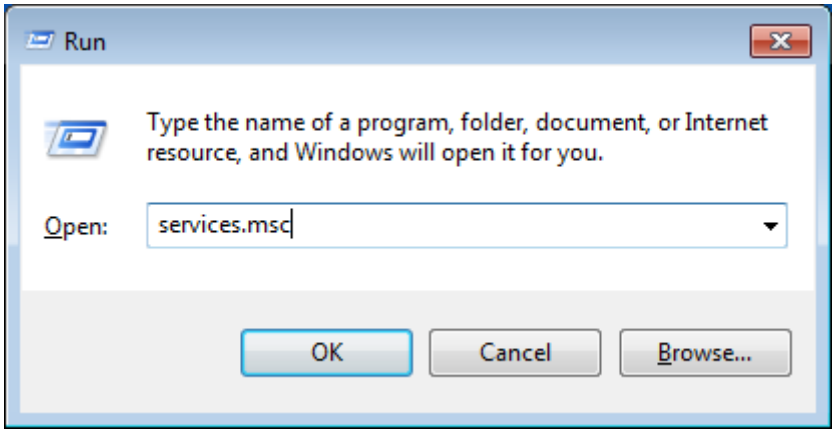
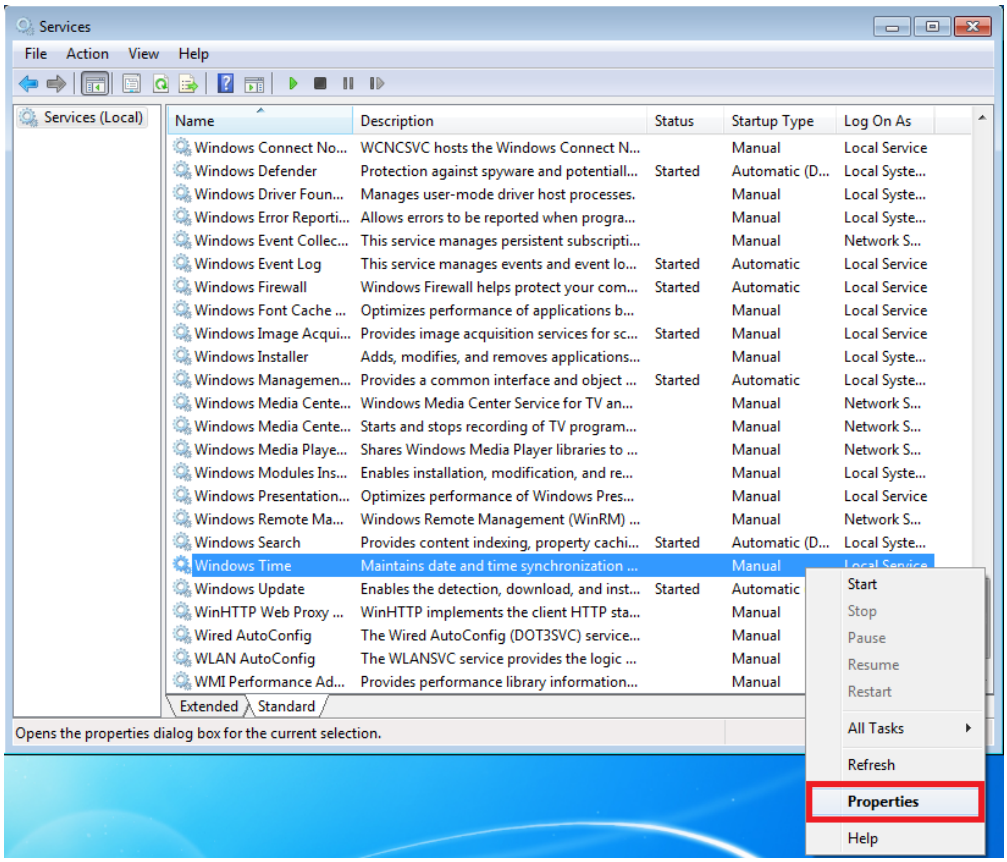
4.1.1 Customizing Windows Time

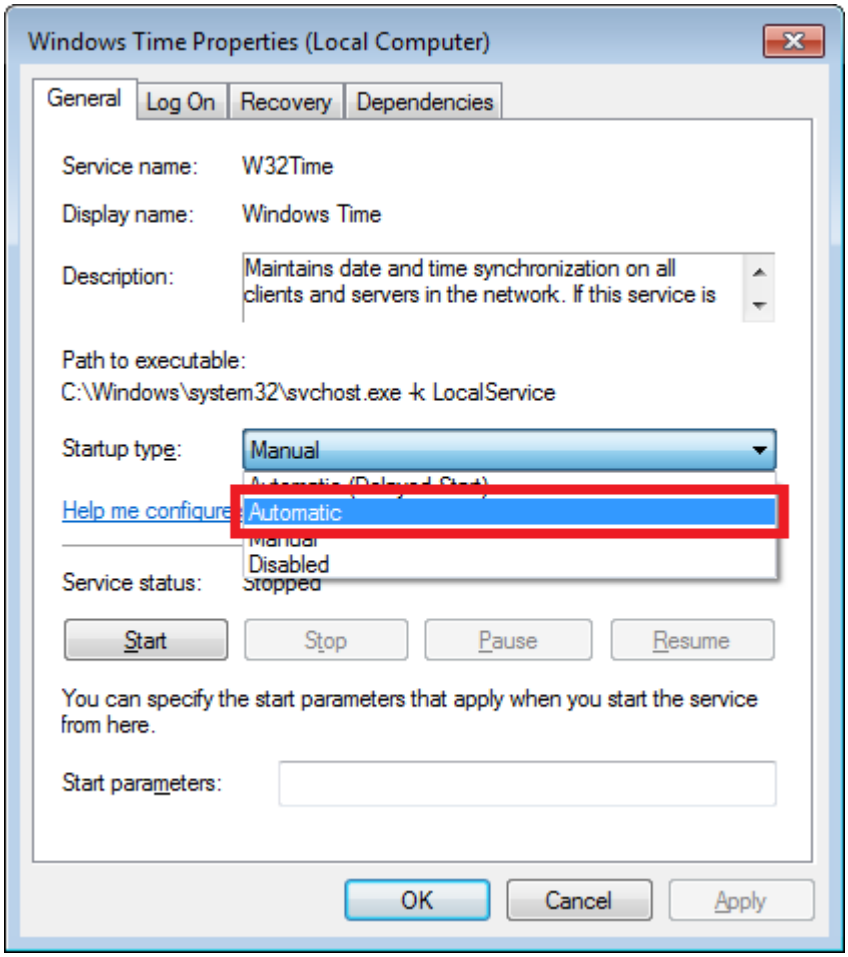
Generally, Windows Time for synchronizing the time of day is not preconfigured for individual networks, it starts only when joining a domain.

If your network does not have a domain controller, the “W32time” service must be customized as described in this chapter.

Table 4-1

Step	Action
1.	• Select “Start > All Programs > Accessories > Command Prompt” and right-click to open the context menu of the console. • Select the “Run as administrator” option.
2.	In the command prompt, enter the following command line: *“sc triggerinfo w32time start/networkon stop/networkoff”* **Note** The *“sc qtriggerinfo w32time”* command line allows you to query the current triggers of Windows Time. 
3.	Use the “*exit”* command to close the command prompt.

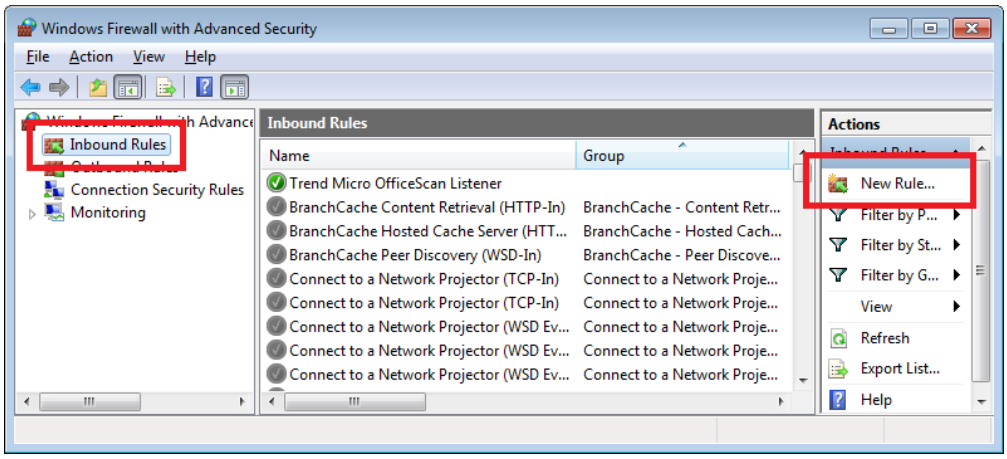
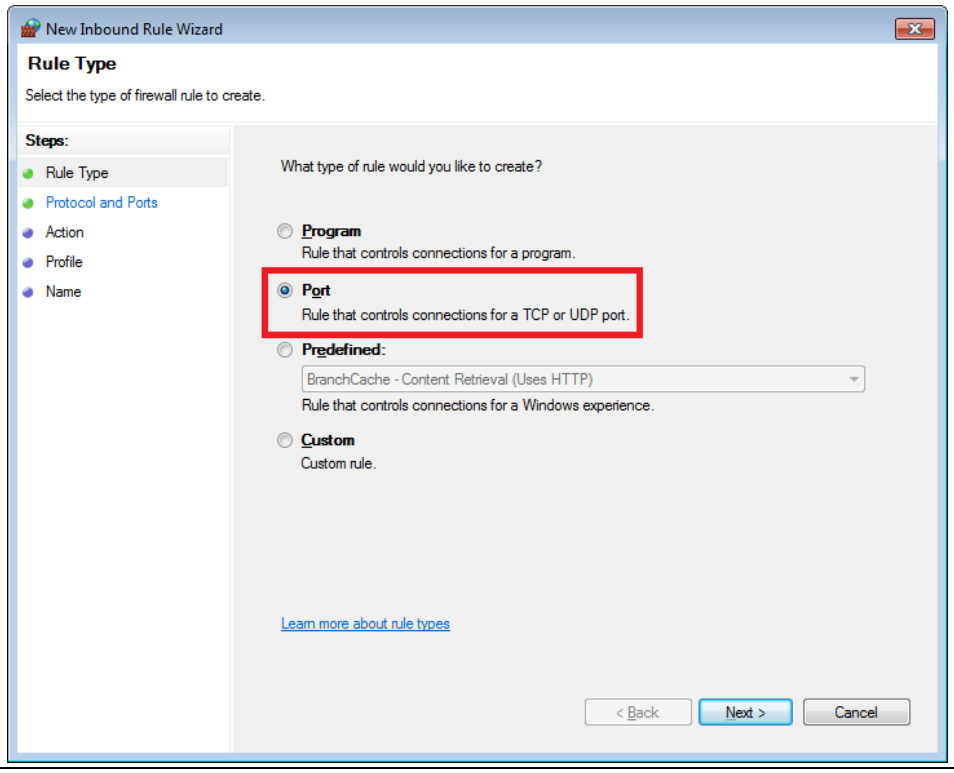
Step	Action
4.	• Use the “Windows” + “R” shortcut to open the window for running programs. • In the drop-down list, enter *“services.msc”* to open the management console for the services. • Select “OK” to confirm your input. 
5.	Right-click to open the Properties window of the “Windows Time” service. 

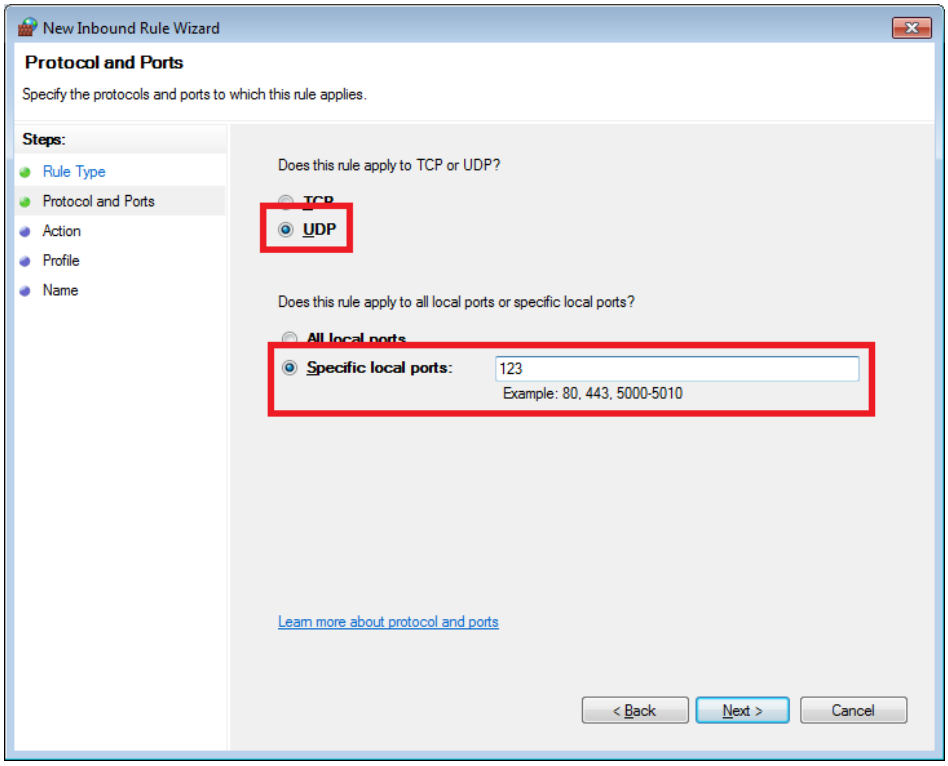
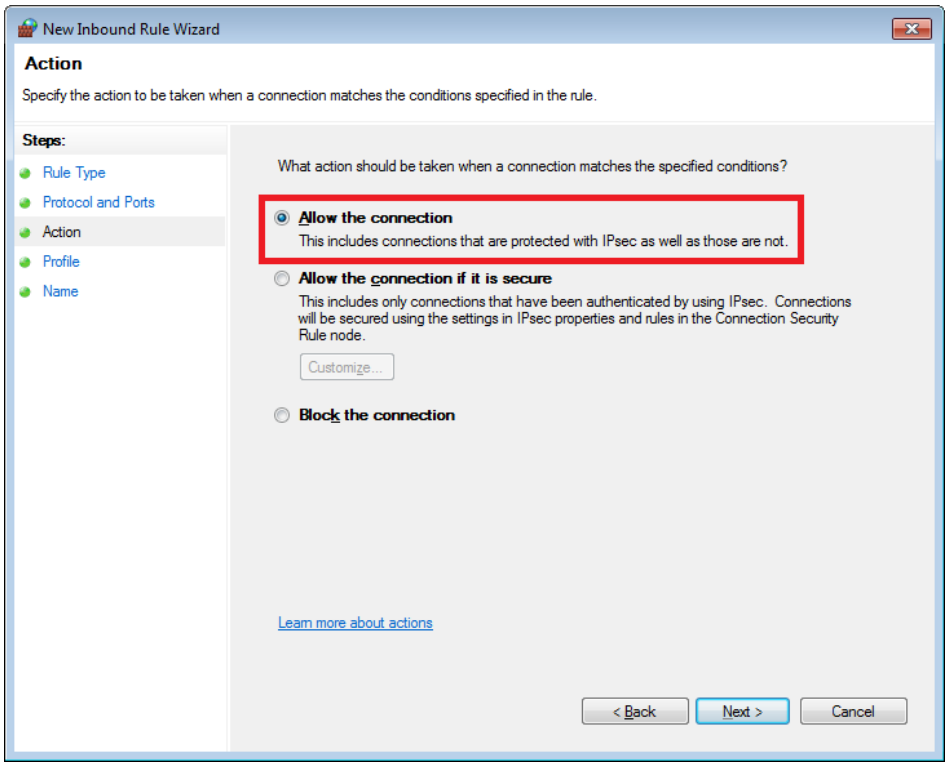
Step	Action
6.	• Set Startup type to “Automatic”. • Select the “OK” button to confirm the change. 
7.	Restart the computer.

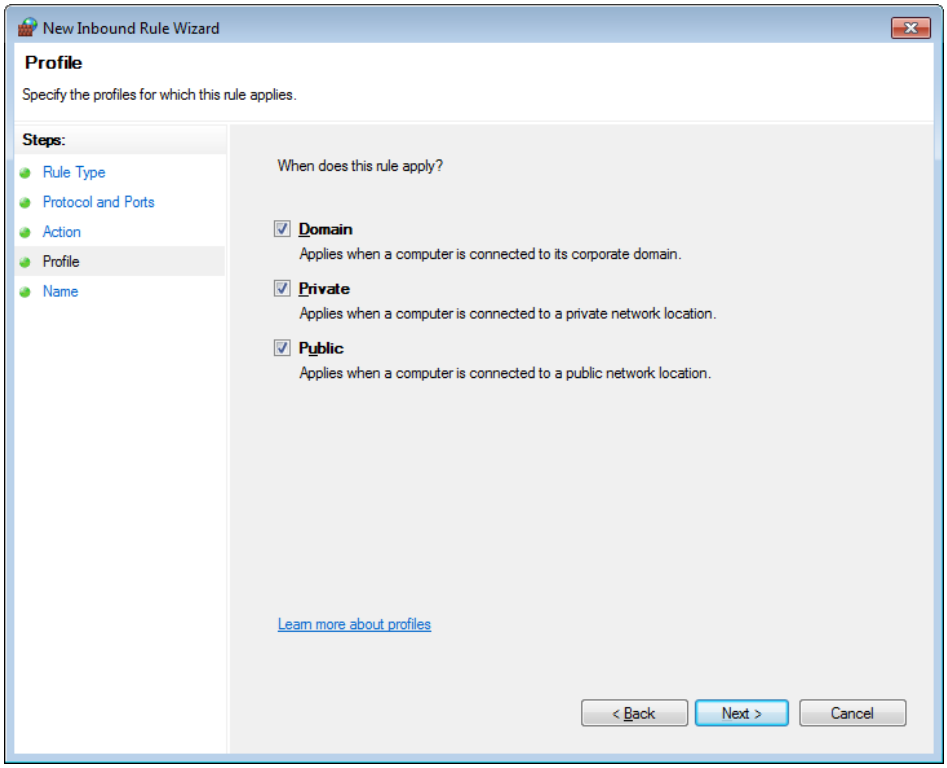
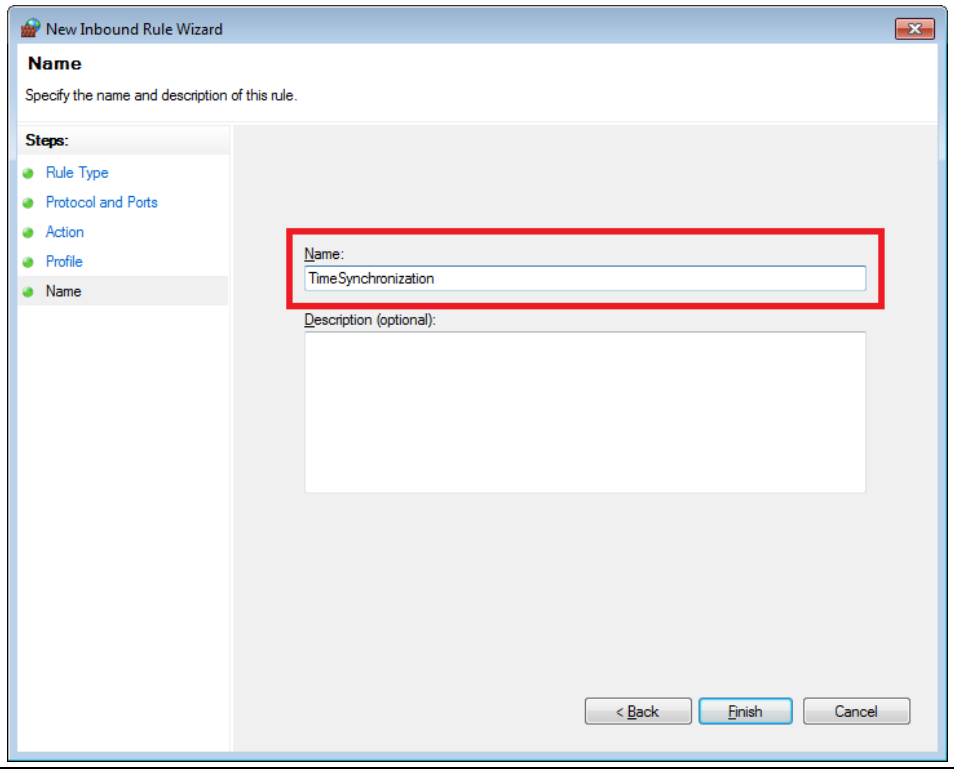
4.1.2 Settings for the firewall

In order to receive time synchronization requests of network nodes on the PC of the time-of-day master, appropriate settings have to be made in the firewall.

Table 4-2

Step	Action
1.	Select “Start > Control Panel > Windows Firewall” to open the firewall of the PC.
2.	In the navigation pane, select “Advanced Settings”.
3.	In the navigation pane of Advanced Settings, select “Inbound Rules” and in Actions, select “New Rule…”. 
4.	As the rule type, select “Port”. 

Step	Action
5.	• In “Does this rule apply to TCP or UDP?”, select “UDP”. • As the port number, enter “123”. 
6.	As the action, select “Allow the connection”. 

Step	Action
7.	According to the policies in your network, select when the rule applies. 
8.	• Assign a meaningful name to the rule. • Select “Finish” to close the dialog box. 

4.1.3 Configuring the NTP server

In NTP mode, the network components cyclically and actively retrieve the time from an NTP server – in this case from the PC on which WinCC Professional RT runs.

Most S7 CPUs can be synchronized using NTP mode. This requires a connection via Industrial Ethernet.

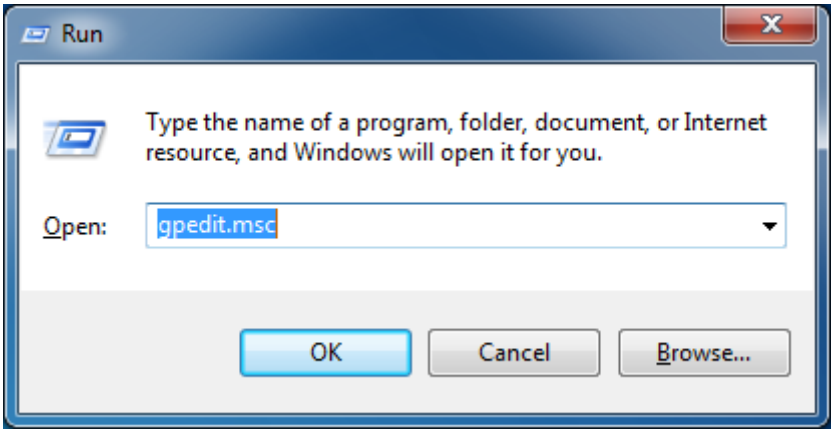
Note

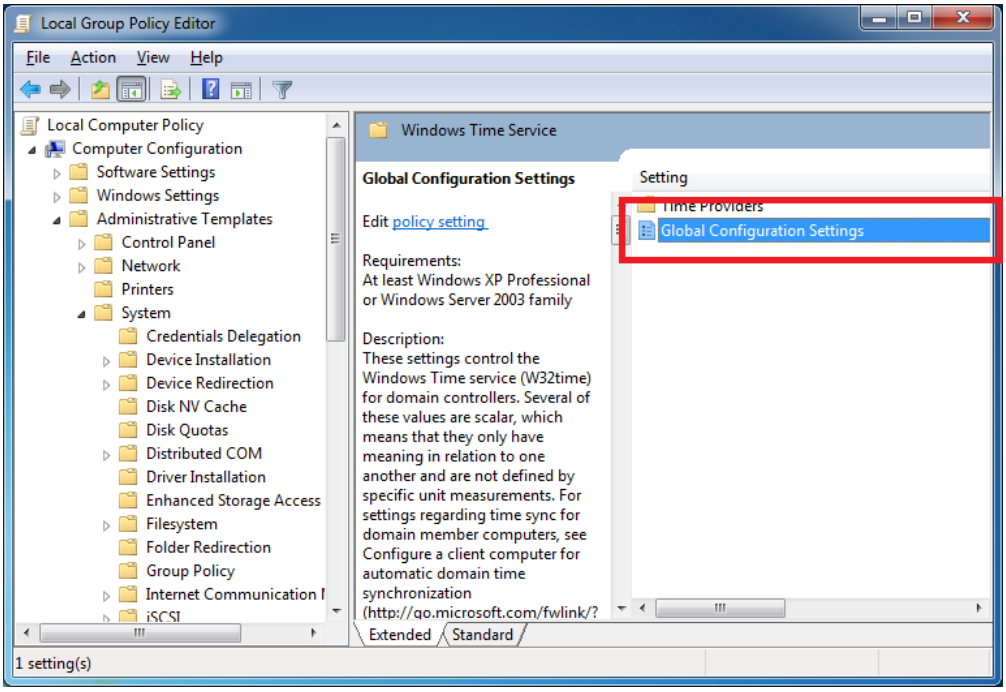
This FAQ lists all S7-300/S7-400 modules that support NTP mode:

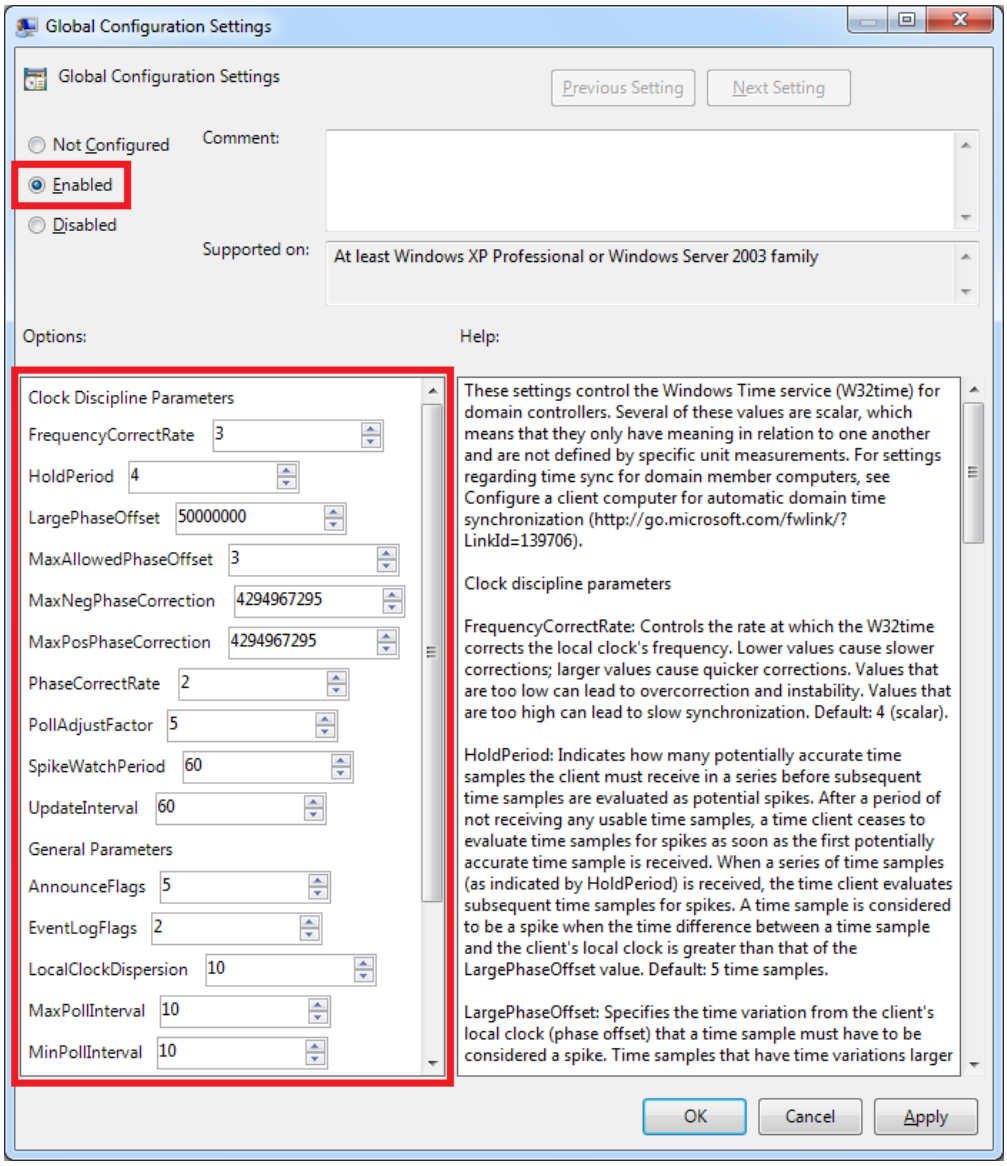
https://support.industry.siemens.com/cs/ww/en/view/28383201

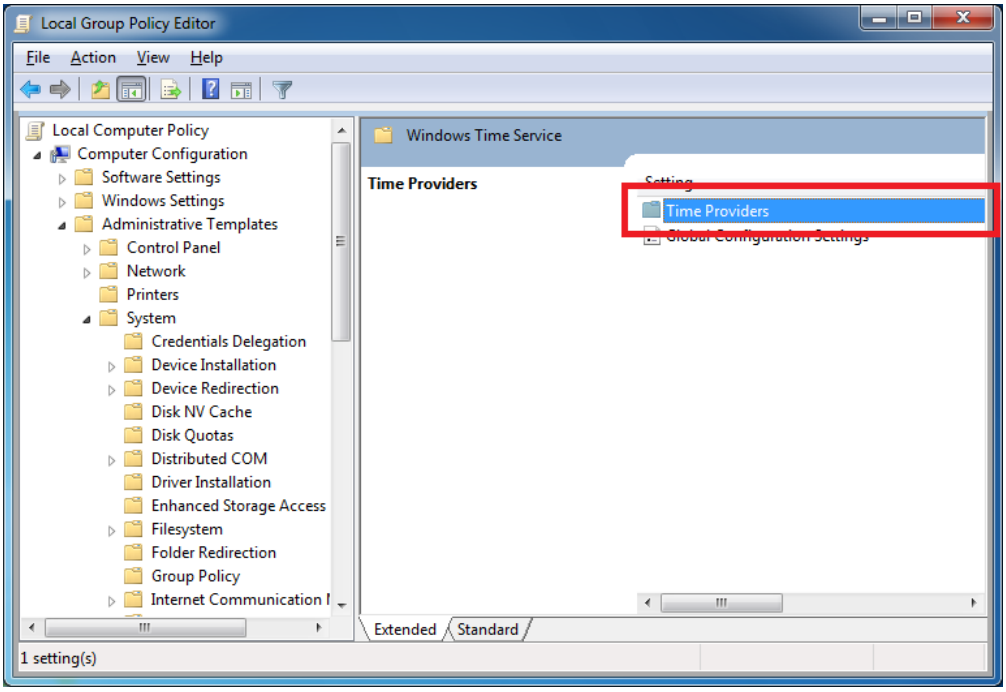
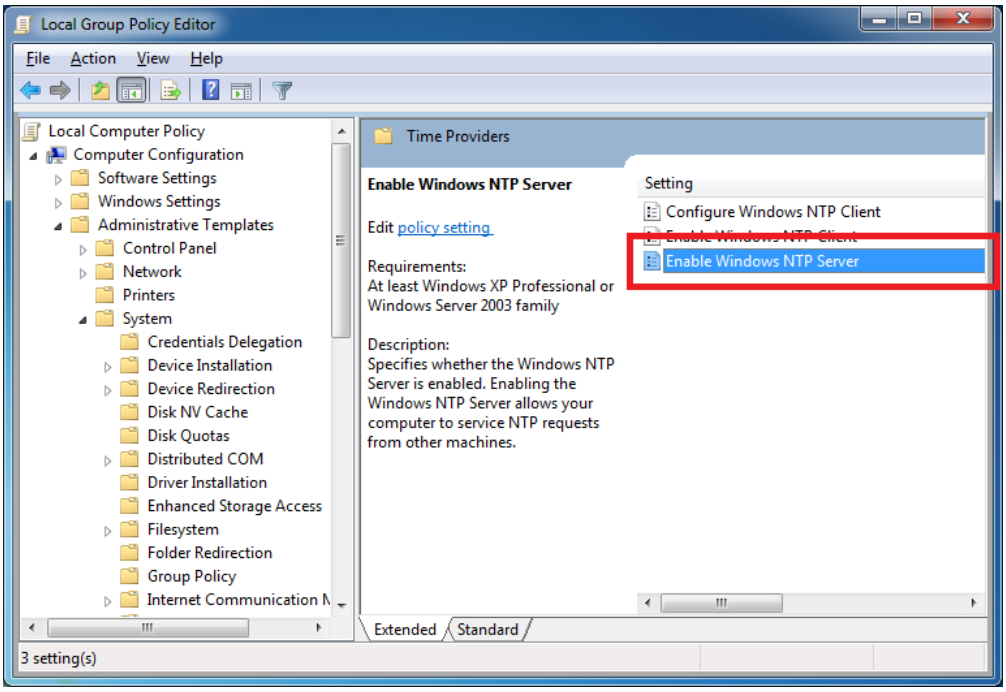
All S7-1200/S7-1500 modules support NTP mode.

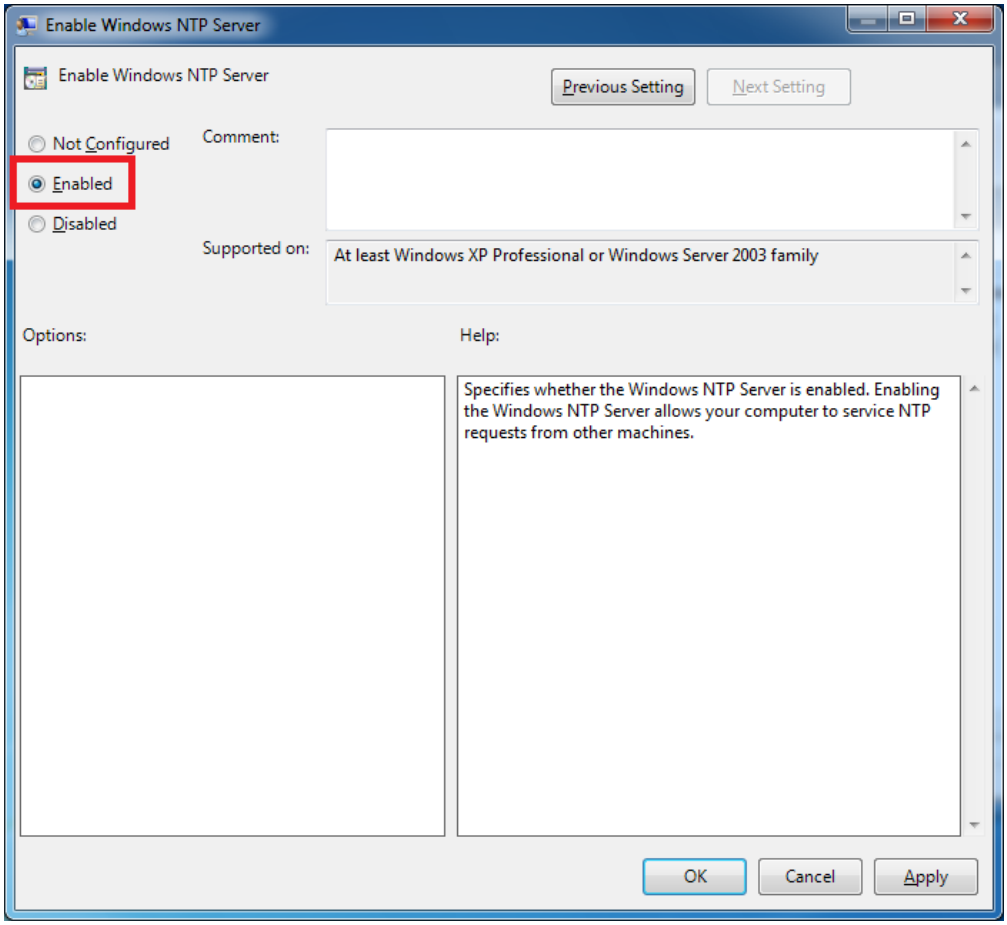
Table 4-3

Step	Action
1.	Log in with a user with administrative rights.
2.	• Use the “Windows” + “R” shortcut to open the window for running programs. • In the drop-down list, enter *“gpedit.msc”* to open the Local Group Policy Editor. • Select “OK” to confirm your input. 

Step	Action
3.	• In the tree view, select “Local Computer Policy > Computer Configuration > Administrative Templates > System > Windows Time Service”. • In the details window, double-click on the “Global Configuration Settings” object. 

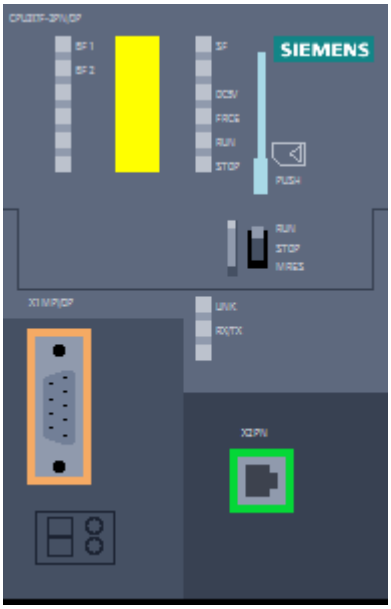
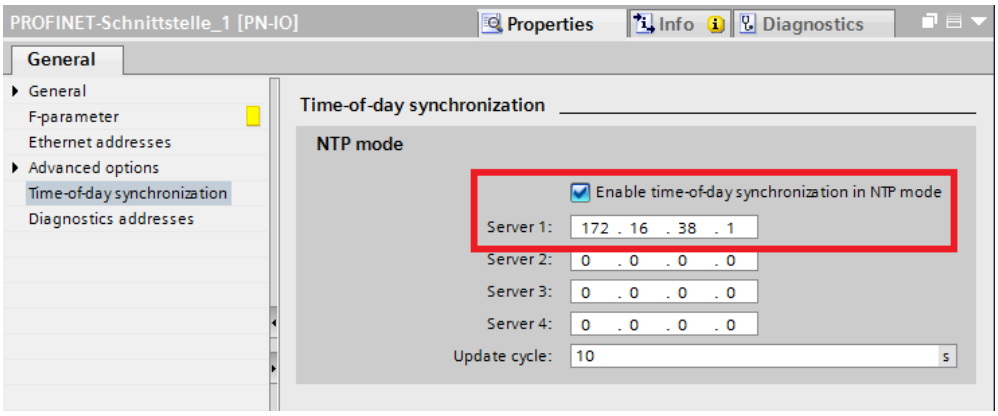
Step	Action
4.	• Check the “Enabled” option. • Make the settings as shown in the screen shot. • Select “OK” to confirm your entries. 

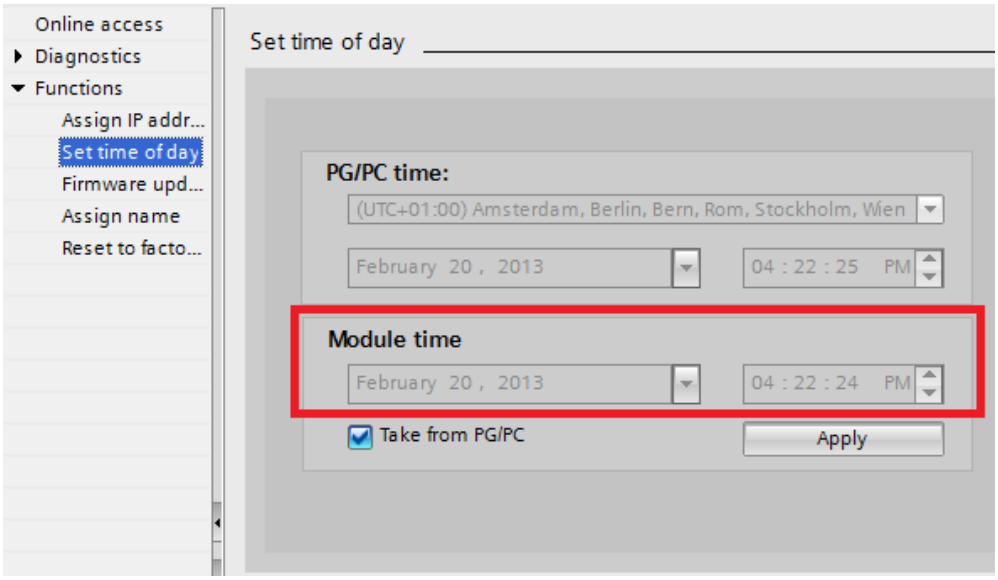
Step	Action
5.	• In the tree view, select “Local Computer Policy > Computer Configuration > Administrative Templates > System > Windows Time Service”. • In the details window, double-click on the “Time Providers” object. 
6.	In the details window, double-click on the “Enable Windows NTP Server” object. 

Step	Action
7.	• Check the “Enabled” option. • Select “OK” to confirm your entries. 

4.2 Settings for S7-300/S7-400

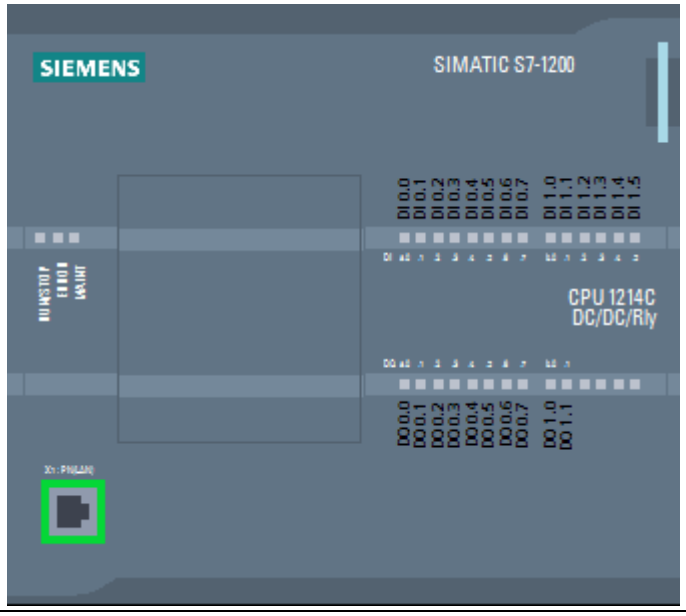
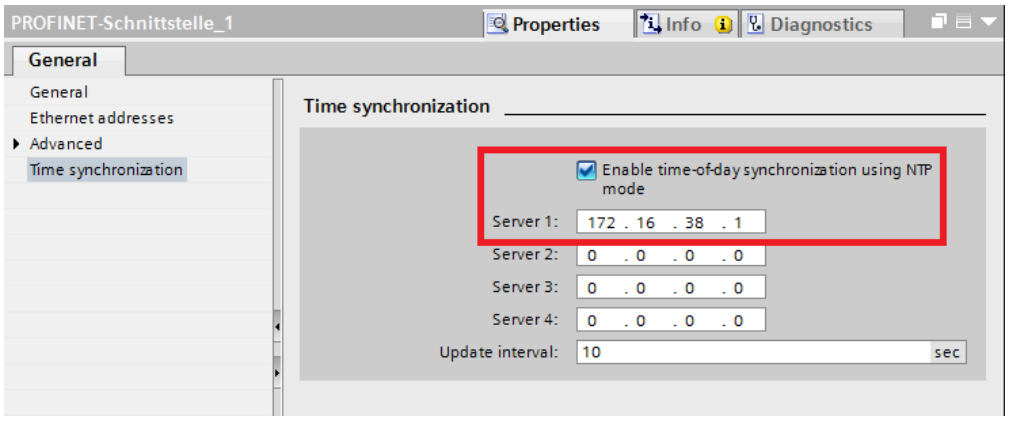
Table 4-4

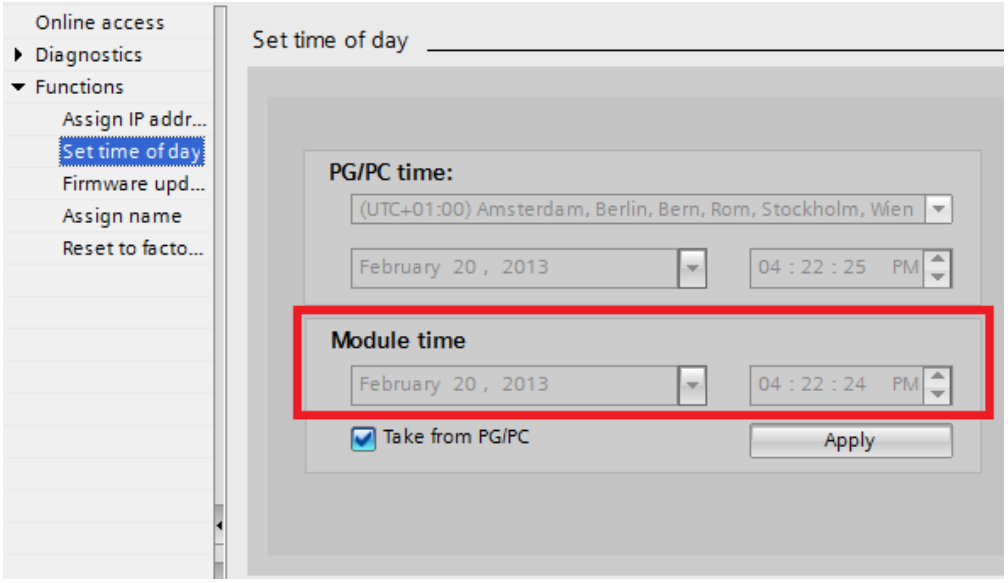
Step	Action
1.	• Open the CPU device configuration. • In the graphical representation of the CPU, select the Ethernet port (marked in green in the figure). 
2.	• In “Properties > General > Time-of-day synchronization”, select the “Enable time-of-day synchronization in NTP mode” option. • Enter the IP address of the NTP server. 

Step	Action
3.	• In the Project tree, select the “Online & Diagnostics” area of your CPU. • In “Online access”, select the appropriate parameters of your connection. • Select “Go online” to connect to your CPU. • Select “Functions > Set time of day” to check the module time of your CPU. 

4.3 Settings for S7-1200/S7-1500

Table 4-5

Step	Action
1.	• Open the CPU device configuration. • In the graphical representation of the CPU, select the Ethernet port (marked in green in the figure). 
2.	• In “Properties > General > Time-of-day synchronization”, select the “Enable time-of-day synchronization in NTP mode” option. • Enter the IP address of the NTP server. 

Step	Action
3.	• In the Project tree, select the “Online & Diagnostics” area of your CPU. • In “Online access”, select the appropriate parameters of your connection. • Select “Go online” to connect to your CPU. • Select “Functions > Set time of day” to check the module time of your CPU. 

5 Appendix

5.1 Service and support

Industry Online Support

Do you have any questions or need assistance?

Siemens Industry Online Support offers round the clock access to our entire service and support know-how and portfolio.

The Industry Online Support is the central address for information about our products, solutions and services.

Product information, manuals, downloads, FAQs, application examples and videos – all information is accessible with just a few mouse clicks:
support.industry.siemens.com

Technical Support

The Technical Support of Siemens Industry provides you fast and competent support regarding all technical queries with numerous tailor-made offers – ranging from basic support to individual support contracts. Please send queries to Technical Support via Web form:
www.siemens.com/industry/supportrequest

SITRAIN – Training for Industry

We support you with our globally available training courses for industry with practical experience, innovative learning methods and a concept that's tailored to the customer's specific needs.

For more information on our offered trainings and courses, as well as their locations and dates, refer to our web page:
www.siemens.com/sitrain

Service offer

Our range of services includes the following:

- Plant data services
- Spare parts services
- Repair services
- On-site and maintenance services
- Retrofitting and modernization services
- Service programs and contracts

You can find detailed information on our range of services in the service catalog web page:
support.industry.siemens.com/cs/sc

Industry Online Support app

You will receive optimum support wherever you are with the "Siemens Industry Online Support" app. The app is available for Apple iOS, Android and Windows Phone:
support.industry.siemens.com/cs/ww/en/sc/2067

5.2 Links and literature

Table 5-1

No.	Topic
\1\	Siemens Industry Online Support https://support.industry.siemens.com
\2\	Link to this entry page of this application example https://support.industry.siemens.com/cs/ww/en/view/69864408
\3\	Local time/system time in WinCC Runtime Professional https://support.industry.siemens.com/cs/ww/en/view/59558655
\4\	CPUs that support NTP https://support.industry.siemens.com/cs/ww/de/view/17990844

5.3 Change documentation

Table 5-2

Version	Date	Modifications
V1.0	02/2013	First version
V1.1	03/2019	New Entry-ID and form, revised chapter "Setting the Time of Day"