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Time synchronization between S7-300/400 (STEP 7 V5) and SINAMICS S120

SINAMICS S

http://support.automation.siemens.com/WW/view/en/88231134

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1 Task

1.1 Overview

Introduction

In contrast to S7-300/400 controllers, SINAMICS drives of the family S120 do not have a real time clock (RTC = “Real Time Clock”) that continues to run when the drive is switched off.

After they have been powered up, SINAMICS S120 drives use as standard an internal time counter based on "Time since the device was switched on" (operating hours counter), for example, to "stamp" when alarms and warnings come and go.

For instance, if you want to make a correlation between the alarms of a S7-300/400 controller and a SINAMICS S120 drive, then it is advantageous if these messages are stamped with comparable times.

Description of the automation task

The time of a drive shall be synchronized with the real time clock of a controller.

After the synchronization of the clocks, the drive is changed to the alternative clock that runs in UTC format (“Universal Time Clock”).

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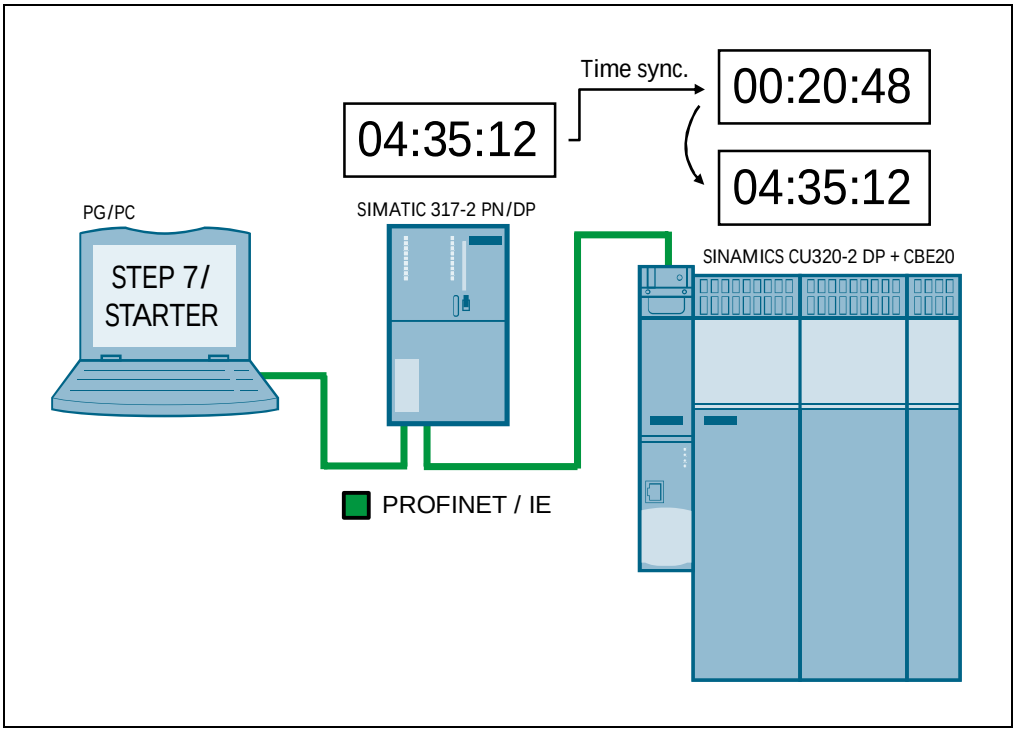
2 Solution

2.1 Overview

Schema

The following figure displays the most important components of the solution:

Figure 2-1



The following (system) functions contained in STEP 7 will be used to synchronize the time of the S7-300/400 and the SINAMICS S120.

- **SFC 1**

  The time of the S7-300/400 can be read out with the SFC 1 system function. The function provides the current date and the current time in the "DATE_AND_TIME" format as return value.

- **SFC 20**

  The SFC 20 system function is used to copy the contents of a memory area (= source area) to another memory area (= destination area). With the aid of this function, the "PING" (see page 9) is set and reset in the SINAMICS S120.

- **FC 6**

  The FC 6 function extracts the "DATE" format from the "DATE_AND_TIME" format. The "DATE" is between the limits "DATE#1990-1-1" and "DATE#2089-12-31". The function provides the current date in days in relation to the 1.1.1990 as return value.

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- **FC 8**

  The FC 8 function extracts the "TIME_OF_DAY" format from the "DATE_AND_TIME" format. The function provides the current time in milliseconds as return value.

- **SFB 53**

  The SFB 53 ("WRREC") can be used to transfer a data record (here: Data record 47) to an addressed component.
  It can be a centrally inserted module or a distributed component (PROFIBUS or PROFINET IO).
  With the aid of this function, the required parameters can be acyclically written in the SINAMICS S120.

NOTE The structure and handling of the used functions is not described in detail in this document.

For further information, please refer to the online help of STEP 7 and the following link:

SINAMICS S120 Function Manual (Chapter 10.1.4)

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Advantages

This application offers you the following advantages:

- Synchronization of the clocks of SIMATIC CPU and SINAMICS S120 drive by application.
- Messages of the S7-300/400 and the SINAMICS S120 can be directly correlated.
- No additional hardware is necessary.

Delimitation

This application does not include a description of

- the general drive functions of the SINAMICS S120
- the SIMATIC S7-300/400

Basic knowledge of these topics is assumed.

Required knowledge

Basic knowledge about configuring SIMATIC control systems with the STEP7 engineering system and configuring SINAMICS drives with STARTER or SIMOTION SCOUT is assumed.

2.2 Hardware and Software Components

2.2.1 Validity

This application example is valid for

- STEP 7 as from V5.x
- STARTER as from V4.x
- SIMOTION SCOUT as from V4.x
- S7-300 as from V3.x
- S7-400 as from V6.x
- SINAMICS S120 as from V4.x

2.2.2 Used Components

Hardware components

Table 2-1

Component	Qty.	MLFB / Order number	Note
SIMATIC CPU 317-2 PN/DP	1	6ES7317-2EK14-0AB0	V3.2.6
SINAMICS S120 CU320-2 DP	1	6SL3040-1MA00-0AA0	V4.5
CBE20	1	6SL3055-0AA00-2EB0	
SIMOTION D435 training case	1	6ZB2470-0AE00	

NOTE The sample project was created with the hardware components listed here.

Alternatively, other components with the same function may be used. A different parameter assignment and different wiring of the components may be required.

Standard software components

Table 2-2

Component	MLFB / Order number	Note
STEP7	6ES7810-4CC10-0YA5	V5.5 SP2
STARTER	6SL3072-0AA00-0AG0	V4.3.1
Drive ES Basic	6SW1700-5JA00-4AA0	V5.5

Sample files and projects

The following list includes all files and projects that are used in this example.

Table 2-3

Component	Note
88231134_Time_synchronization_SIMATIC_SINAMICS_V1_0.zip	STEP 7 project
88231134_Time_synchronization_SIMATIC_SINAMICS_V1_0_en.pdf	This document

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3 Function mechanisms

3.1 General overview

When using the time synchronization between the S7-300/400 and the SINAMICS S120, one of the SIEMENS telegrams (390, 391 or 392) must be set for the communication between the control unit and the SIMATIC CPU (identifiable by DO1.p0922 = 390, 391, 392).

Alternatively, a free telegram based on the above telegrams can be configured between the S7-300/400 and the SINAMICS S120 (identifiable by DO1.p0922 = 999 and DO1.p2079 = 390, 391, 392 at the same time).

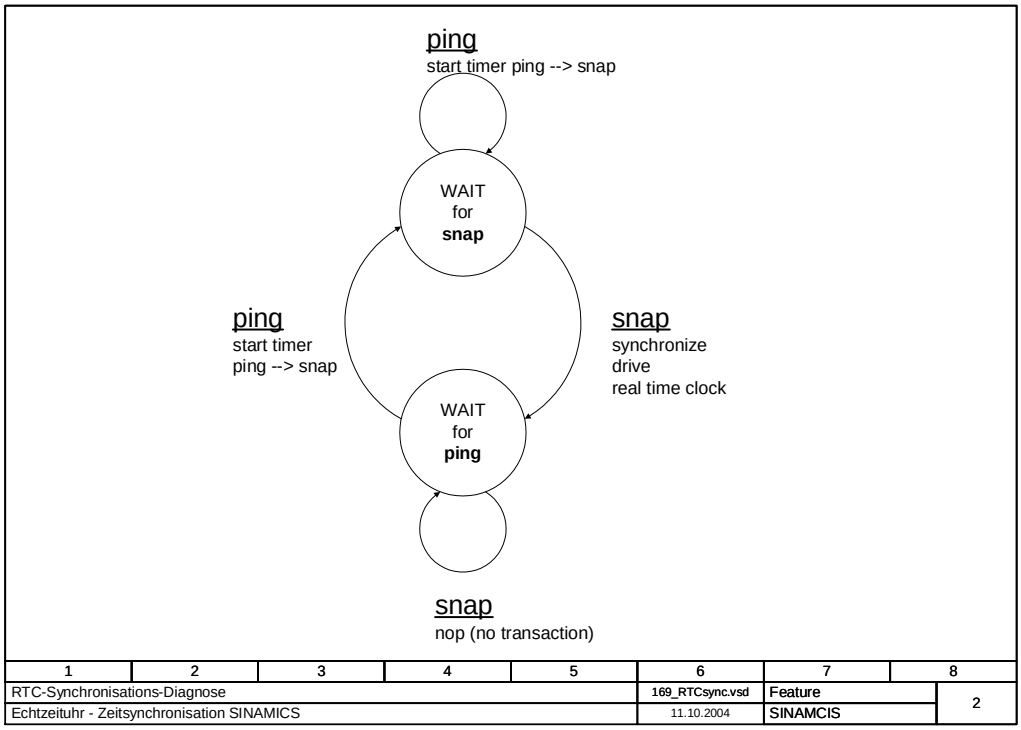
NOTE If no telegram is set or a free telegram configuration is set, a time synchronization cannot be performed!

3.2 Workflow of the time synchronization

A drive unit is always synchronized via the control unit (DO1). The time then applies implicitly to all DOs of this control unit.

The synchronization of the control unit of a SINAMICS S120 is shown in the following figure.

Figure 3-1 PING – SNAP state diagram of synchronization



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PING

In the SINAMICS system, the positive edge of DO1:CU_STW.Bit1 is defined as "PING" as soon as a SIEMENS telegram 39x (i.e. 390, 391, 392) or a free telegram on the basis of the specified telegrams has been configured.

When the control unit (DO1) detects the "PING", a timer is started in the drive.

However, before the "PING" is triggered, parameter DO1.p3100 must be set to "1" (UTC time format). The first time the "UTC" format is set, the mechanism for the time synchronization is started in the drive unit.

NOTE If this sequence is not followed, errors can occur when setting the UTC time (UTC time is then not ready)!

SNAP

The "SNAP" transfers the time value that was valid in the controller at the time of the "PING". This is not corrected by the propagation time of the "PING" signal from the controller to the drive!

After receipt of the "SNAP", the control unit of the drive determines the current time from the time value of the "SNAP" and the time offset (timer in the drive) between "PING" and "SNAP".

NOTE The setting of the UTC time format and the "PING" as well as the transfer of the "SNAP" can be performed with the FB100 ("SYNC_SINAMICS_CU_TIME") function block contained in the sample project.

The UTC time format is set once in parameter p3100 (p3100 = "1") through an acyclic write job.

The "PING" is activated by setting bit 1 ("RTC real time synchronization PING") in control word 1 ("STW1") of the control unit when using one of the SIEMENS telegrams 39x for the communication between the SIMATIC CPU and the control unit. The "SNAP" is transferred through acyclic write jobs on parameter p3101.

NOTE The FB100 ("SYNC_SINAMICS_CU_TIME") function block used in the sample project is a freely defined FB and can be renamed as required.

The function block only represents a solution approach and can be edited by the user when required.

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4 Operation of the application

4.1 Overview

The time synchronization between the S7-300/400 and the SINAMICS S120 can be performed with the aid of the `FB100 ("SYNC_SINAMICS_CU_TIME")` function block contained in the sample project.

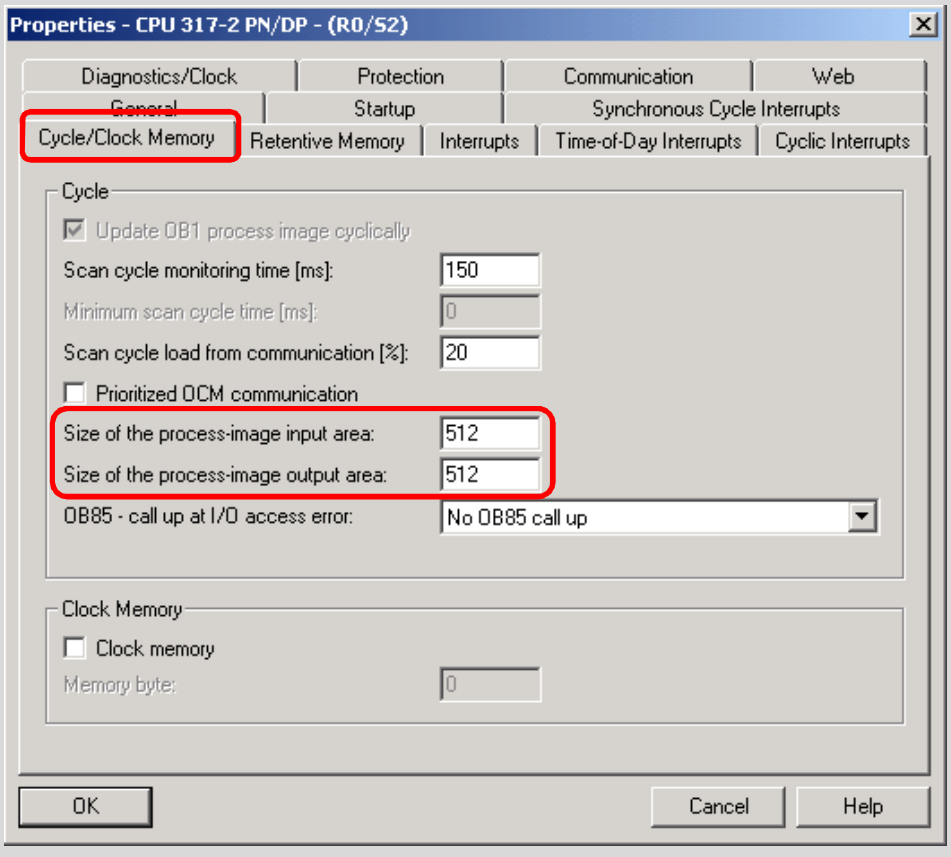
NOTE

- The first commissioning of the SINAMICS S120 has to be carried out before the time synchronization is started.
- The clocks must be synchronized every time the SINAMICS S120 is restarted.
- If required, the clock must be resynchronized after a certain time (no details can be provided here on the frequency of the required resynchronization).

NOTE

Please observe that the input and output addresses used in HW Config for the CU telegram of the SINAMICS S120 have to be inside of the process image of the S7-300/400. Otherwise the time synchronization is not working!

If necessary adapt the process image of the S7-300/400 in HW Config (double clicking on the CPU > `"Cycle/Clock Memory"` tab)!



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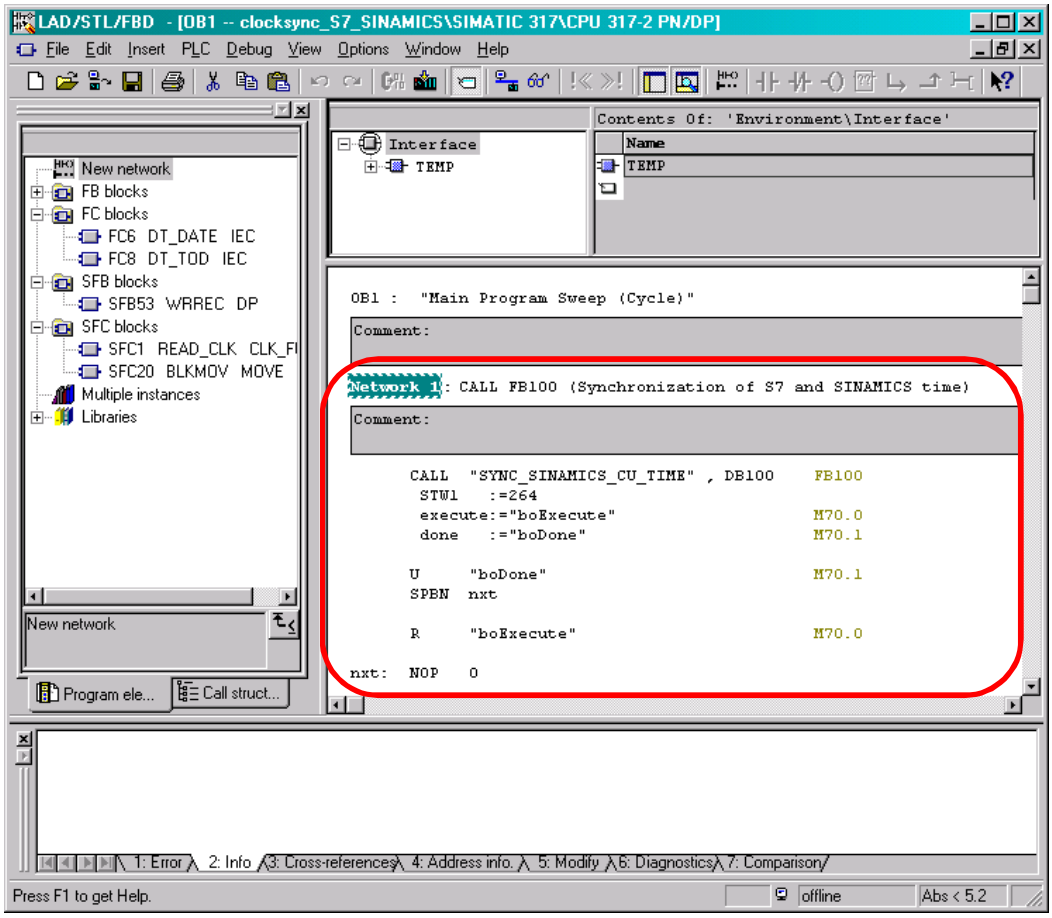
4.1 Overview

Table 4-1

No.	Action
1.	The FB100 function block and its instance data block DB100 can be taken from the sample project and inserted into an existing project with a S7-300/400 and SINAMICS S120. The DB101, DB102 and DB103 data blocks serve as source for the data that is transferred to the SINAMICS S120 with SFB 53. The data blocks as well as the required functions SFC 1, SFC 20, FC 6, FC 8 and SFB 53 must also be inserted into the project and loaded to the S7-300/400.
2.	The FB100 function block is then called in OB1.  By setting the "boExecute" input parameter once, the clock synchronization between S7-300/400 and SINAMICS S120 is started. Parameter p3100 in the SINAMICS S120 is set to "1" and therefore the time format set to "UTC". The DB101 data block is used as data source for the SFB 53 and is automatically initialized with the required data.

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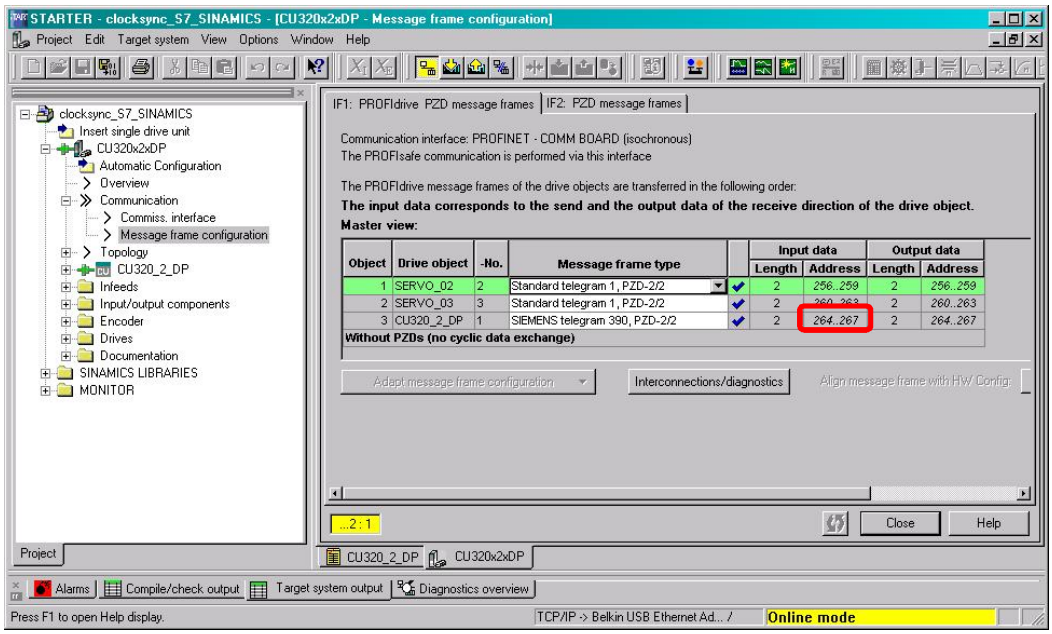
No.	Action
3.	Afterwards, the time of the S7-300/400 is then read out and transferred to parameter p3101 of the SINAMICS S120. The DB102 and DB103 data blocks are used as data sources for the SFB 53 and get also automatically initialized with the required data. The parameter p3101 is **not** visible in STARTER! The logical input address of the control unit from the telegram configuration in STARTER must be specified via the "STW1" input parameter that is representing the control word 1. 
4.	If the time synchronization is triggered via the "boExecute" input parameter, the "PING" in control word 1 (bit 1) of the control unit is automatically set in network 4 of FB100 after writing parameter p3100.

5.	The current time of the S7-300/400 is then read in network 5 with the aid of SFC 1 and the current date in days and the current time in milliseconds extracted with the FC 6 and FC 8 functions.
	`Network: 5 GET DATE AND TIME OF S7 CPU`
	`L #b8SyncState`
	`L W#16#4`
	`==I`
	`SPBN s005`
	`CALL "READ_CLK" // read clock of CPU`
	`RET_VAL:=#i16ReturnValue`
	`CDT :=#dtDateAndTimeCPU`
	`CALL "DT_DATE" // get date of CPU`
	`IN :=#dtDateAndTimeCPU`
	`RET_VAL:=#dDateOfCPU`
	`CALL "DT_TOD" // get time of CPU`
	`IN :=#dtDateAndTimeCPU`
	`RET_VAL:=#todTimeOfCPU`
	`L W#16#5`
	`T #b8SyncState`
	`s005: NOP 0`

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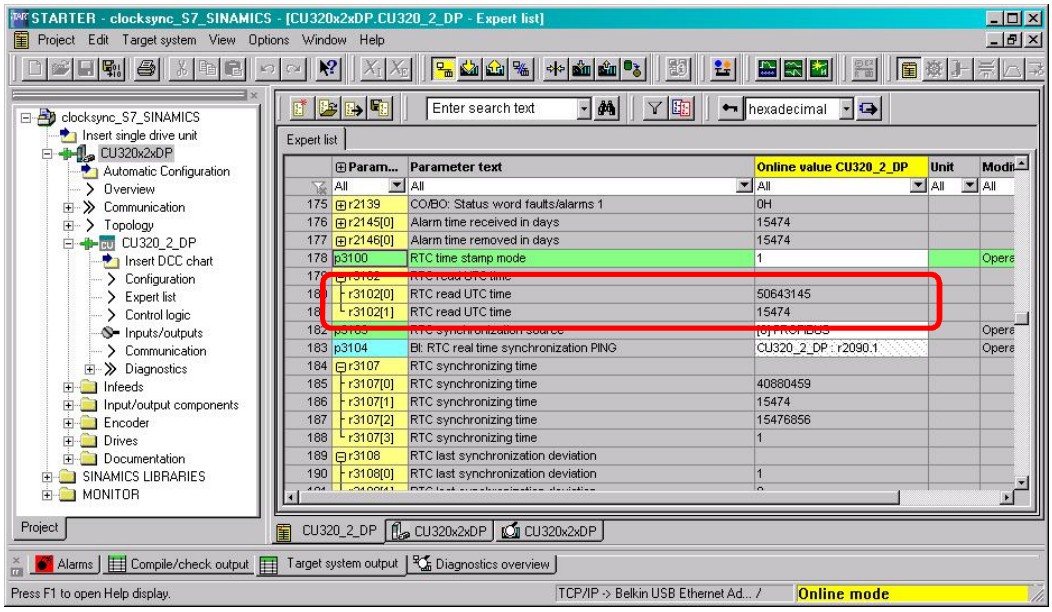
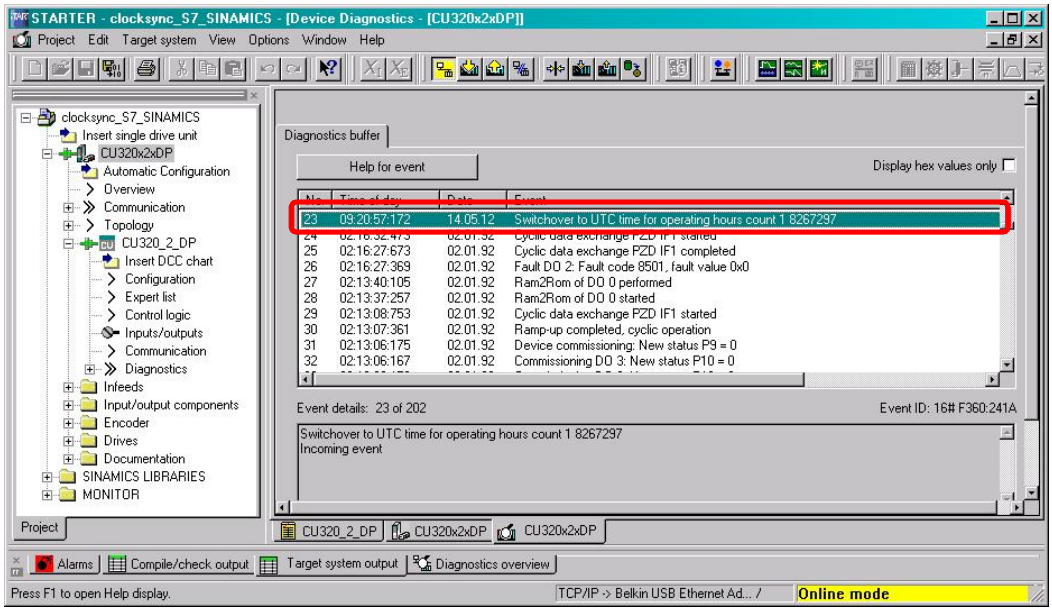
No.	Action
6.	The current date and the current time are then transferred in the data blocks DB102 and DB103. These serve as data source for the SFB 53 function which is now used to acyclically transfer the date and time to the SINAMICS S120 in networks 7 and 8 (“SNAP”).
7.	After successful transfer of the data to the SINAMICS S120, the “PING” in control word 1 (bit 1) is automatically reset in network 9. When the bit is reset, the transferred time becomes active in the SINAMICS S120.
8.	After successful synchronization of the times, the current date and the current time are visible in parameter p3102. p3102[0]: Current time in milliseconds p3102[1]: Current date in days 
9.	The diagnostic buffer of the control unit also contains the entry that the time has been changed to UTC time format. 

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5 Related literature

Table 5-1

	Topic	Title / Link
\1\	Siemens Industry Online Support	http://support.automation.siemens.com
\2\	Download page of this entry	http://support.automation.siemens.com/WW/view/en/88231134
\3\	SINAMICS S120	http://support.automation.siemens.com/WW/view/en/68042590 (Function Manual 2013)

6 Contact

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7 History

Table 7-1

Version	Date	Modifications
V1.0	02/2014	First version

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