S7 Communication: Data Exchange S7-300 <-> S7-1200

S7-1200

Configuration Example X18 • August 2010



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## **Table of Contents**

Warr	Warranty, Liability and Support2			
1	Automa	tion Task	4	
	1.1	Task description	4	
		Requirements of the application	4	
	1.2	Structure	5	
		List of components	5	
2	Automa	tion Solution	6	
	2.1	Cabling diagram	6	
	2.2	Program structure	7	
	2.2.1	Overview of the block structure	7	
	2.2.2	Description of the block structure	8	
	2.3	Blocks used	9	
	2.3.1	Client (S7-300)	9	
	2.3.2	Server (S7-1200)	11	
	2.3.3	Data consistency	11	
	2.4	Program sequence in the client station	13	
3	Configu	ration	15	
	31	Hardware and software installation	15	
	311	Hardware installation and cabling	15	
	3.1.2	Software installation	15	
	3.2	Hardware and network configuration	16	
	3.2.1	Assignment of an IP address for the PG/PC	16	
	3.2.2	Configuration of the S7-300	18	
		Configuring the PG/PC interface	18	
		Creating a new connection	19	
		Setting the synchronization time	21	
		Loading the client project into the controller	22	
	3.2.3	Configuration of the S7-1200	25	
		Loading the server project into the controllers	25	
	3.3	Online mode activation	27	
	3.4	Live demonstration	31	
	3.4.1	Cyclic operation	31	
	3.4.2	Transmission of user data	31	
		S7-300 client -> S7-1200 server	31	
		S7-1200 server 1 -> S7-300 client	32	
		S7-1200 server 2 -> S7-300 client	32	
	3.4.3	Time synchronization	33	
		Manual server synchronization	33	
		Automatic synchronization of all servers	34	
	3.4.4	Communication errors	35	
	3.4.5	Power failure of the client	36	
4	Code Elements			
5	History.		38	

## 1 Automation Task

## 1.1 Task description

Data exchange (e.g. for time synchronization) shall be effected in a deterministic approach via Ethernet with the help of S7 communication between an S7-300 master and several S7-1200 slave controllers.

### Scheme of the application task

Figure 1-1



### **Requirements of the application**

The master, as well as the slaves include a send and a receive block (Send\_DB and Receive\_DB). After receipt of the synchronization command, the master reads the system time and sends this information and the user data to the first slave via the PUT block for S7 communication. The PUT block synchronizes its own system time with the time-of-day information received from the master.

Then the master polls the user data of slave 1 via the GET communication block. This user data of slave 1 is then stored at the relevant location in the master's receive block.

This procedure is repeated for all subsequent slave units. After data exchange between master and the last slave is completed, the master unit starts data exchange with slave 1 again.

## 1.2 Structure

The automation task is demonstrated by the example of data exchange between a CPU 315-2PN/DP defined as master unit and two S7-1200 controllers (slave 1 and slave 2).

## Schematic structure

Figure 1-2



Figure 1-2 shows the principle of this structure. The communicating CPUs, as well as the programming unit with the softwares "STEP 7 Basic V10.5" for S7-1200 programming and "STEP 7 V5.4" for S7-300 programming are connected to the switch CSM 1277 by means of Ethernet cables.

### List of components

Table 1-1

No.	Component	Qty.	MLFB/Order number
1.	PS307 24V / 5A	1	6ES7307-1EA00-0AA0
2.	CPU315-2 PN/DP, 256 KB	1	6ES7315-2EH13-0AB0
3.	S7 MICRO MEMORY CARD, 8MB	1	6ES7953-8LP10-0AA0
4.	COMPACT SWITCH MODULE CSM 1277	1	6GK7277-1AA00-0AA0
5.	POWER SUPPLY S7-1200 PM1207	2	6EP1332-1SH71
6.	S7-1200 CPU1212C	1	6ES7212-1AD30-0XB0
7.	S7-1200 CPU1214C	1	6ES7214-1AE30-0XB0
8.	PC/PG	1	
9.	STEP 7 V5.4	1	6ES7810-4CC08-0YA5
10.	STEP 7 V5.4 Service Pack 5	1	Entry ID:36184684
11.	STEP 7 BASIC V10.5	1	6ES7822-0AA00-0YA0
12.	STEP 7 Basic V10.5 Service Pack 2	1	Entry ID:39741113

## 2 Automation Solution

The S7-1200 PLC offers the passive server functionality for the S7 communication. In doing so, the S7-1200 allows read-and-write access to the data.

Configuration is performed by the S7-300 client via the PUT and GET blocks. The PUT block is used to write data from the S7-300 to the S7-1200 and the GET block retrieves data from the S7-1200 and writes them to the S7-300.

The connection is configured in STEP 7 V5.4 in NetPro. The relevant connection partner is defined by the specific IP address. Exactly one ID is assigned for each connection to an S7 server. This ID is then transferred to the S7 communication blocks PUT and GET.

The maximum number of configurable connections in NetPro depends on the type of S7-300 CPU used. The CPU 315-2 PN/DP is suitable for a maximum of 14 S7-connections in NetPro.

## 2.1 Cabling diagram

Please also refer to the list of components in Chapter 1.2. Figure 2-1



## 2.2 Program structure

This chapter describes the program structure used in this example for the automation system on function and data block level.

## 2.2.1 Overview of the block structure

Figure 2-2 and Figure 2-4 show the block-call hierarchy, as well as the access to the data blocks used for the S7-300 client and the S7-1200 servers. Figure 2-2



<u>S7-300</u>

Figure 2-3

<u>S7-1200</u>



## 2.2.2 Description of the block structure

The time-of-day interrupt OB10 "TOD\_INT0" in the hardware structure of the CPU 315-2PN/DP is activated and set to execution at daily intervals.

The "Status\_DB" data block DB303 contains the control and status information of all S7-1200 servers in the form of the data type UDT3 "STATUS". Apart from the "SYNC" synchronization request bit, this data type structure also includes information for the analysis of communication errors.

When the time-of-day interrupt OB10 "TOD\_INT0" is executed, all "SYNC" synchronization request bits will be set. Time synchronization, however, may also be executed individually for each server by means of the table of variables.

OB1 calls the function block FB300 "S7-com\_PUT\_GET" at cyclic intervals by using its instance DB300 "S7-com\_PUT\_GET\_DB".

When the synchronization request "SYNC" of the first S7-1200 server is set in the DB303 "Status\_DB", the PLC time will be read with the help of SFC1 "READ\_CLK" and stored in the send data block DB301 "Send\_DB", together with the synchronization request.

The data type of the read-in time "READ\_CLK\_CDT" is DATE\_AND\_TIME.

Function block FB300 calls send block FB14 "PUT". This block transmits the contents of the send data block DB301 to the receive data block DB1201 "Receive\_DB" of the first server. Apart from the information for time synchronization, transmission also includes the "User\_data" and a message ID "M\_ID".

When a synchronization request "sync\_CLK" is issued, OB1 "MAIN" of the server calls the function FC1200 "DnT\_DTL". This function is used to convert the "READ\_CLK\_CDT" time information of the S7-300 clients of a DATE\_AND\_TIME type into a DTL data type. All variables are stored in the DB1200 "Data\_DB". The function "WR\_SYS\_T" is used to write the converted time information into the system time of the S7-1200. After successful time synchronization, the "synchronized" bit in the send DB1202 "Send\_DB" is set.

The message ID "M\_ID" received from DB 1201 "Receive\_DB" is mirrored to the send data block DB 1202 "Send\_DB".

After data transmission with the help of the "PUT" communication block, the contents of send data block DB 1202 "Send\_DB" are retrieved from the first server via "GET" and then stored in the relevant data type UDT2 "RCV\_Struct\_1" in the "Receive\_DB" DB302.

The message ID "M\_ID" received is then compared with the ID sent. Any discrepancy will be stored in the status DB in the relevant data type structure "Status\_1" for server 1.

After successful synchronization of server 1 (signalled by the "synchronized" variable), the synchronization request bit "SYNC" in "Status\_1" of the status DB will be reset.

The message ID "M\_ID" is increased and data exchange with server 2 is processed in the same way.

## 2.3 Blocks used

The following tables provide an overview of all blocks used on the client and server side.

## 2.3.1 Client (S7-300)

Table 2-1

Object name	Symbolic name	Description
OB1	MAIN	Cyclic organization block
OB10	TOD_INT0	Time-of-day interrupt
FB14	GET	S7 communication block for data retrieval
FB15	PUT	S7 communication block for data transfer
FB300	S7-com_PUT_GET	Function block for deterministic data exchange with several servers via the S7 communication blocks PUT and GET
FC301	read_bit	Function to read the value of a bit by using a pointer (used in FB300)
FC302	reset_bit	Function to reset a bit by using a pointer (used in FB300)
FC303	output_bit	Function for the output of a value by using a pointer (used in FB300)
DB300	S7-com_PUT_GET_DB	Multi-instance data block for FB300, FB14 and FB15
DB301	Send_DB	Send data block for FB15
DB302	Receive_DB	Receive data block for FB14
DB303	Status_DB	Status data block for all servers
UDT2	RCV_STRUCT	Data type structure for the receipt of server data
UDT3	STATUS	Data type structure for the status information of the servers

#### S7-com\_PUT\_GET (FB300)

This function block is used for a deterministic data exchange with several servers via the S7 communication blocks PUT and GET; it is called at cyclic intervals in OB1.

Figure 2-4

OB1 : Title: Comment:

Network 1: Title:

Comment:

	"S7- com_PUT_GET_DB"	
	"S7-com_PUT_GET" EN ENO	
2	ID_max	

# Symbol information: S7-com\_PUT\_GET FB300 S7-com\_PUT\_GET\_DB DB300

DB300 has been selected as instance data block. It also includes the instances for the S7 communication blocks PUT and GET.

As being the only input, the maximum number of servers "ID\_max" must be stated. For the CPU 315-2PN/DP used in this example, a maximum of 14 S7 connections can be configured in NetPro.

The index variable used to identify the relevant server is the connection ID. Data exchange with the servers is performed in a sequential manner.

## **WARNING** A dynamic change of the ID for the S7 communication blocks PUT and GET is supported only by the S7-300 controller. An S7-400 controller requires a static ID for each communication block.

The following static variables of FB300 offer configuration options via the initial value or the status analysis of SFC1 "READ\_CLK".

Name	Data type	Description
Receive_DB	Int	Number of the receive data block
RCV_STRUCT_size	Int	Size of the receive data structure UDT2 in bytes
Status_DB	Int	Number of the status data block
Status_size	Int	Size of the status data structure UDT3 in bytes
READ_CLK_ERROR	Bool	Error output of the block READ_CLK (SFC1)
READ_CLK_RET_VAL	Int	Status of the block READ_CLK (SFC1)

#### Table 2-2

### Status\_DB (DB303)

This status DB consists of 14 data type structures UDT3 STATUS for a maximum of 14 servers for communication with the CPU 315-2PN/DP. The structure includes 6 bytes as follows:

Table 2	-3
---------	----

Name	Data type	Description
SYNC	Bool	Time synchronization request
PUT_ERROR	Bool	Error message of the PUT communication block
GET_ERROR	Bool	Error message of the GET communication block
M_ID_UNEQUAL	Bool	Discrepancy in the M_IDs received and sent
PUT_ERROR_STATUS	Word	Status of the PUT block when the last error occurred
GET_ERROR_STATUS	Word	Status of the GET block when the last error occurred

## 2.3.2 Server (S7-1200)

Table 2-4

Object name	Symbolic name	Description
OB1	Main	Cyclic organization block
FC1200	DnT_DTL	Function to convert the data type DATE_AND_TIME into a DTL data type
DB1200	Data_DB	Variables data block
DB1201	Receive_DB	Data block for reception from a client
DB1202	Send_DB	Data block for transmission to a client

## 2.3.3 Data consistency

## DB301 and DB1201

The send block of the client and the receive block of the server must be identical in length and structure. In this application example, they consist of 160 bytes with the following structure:

Tahl	Δ	2-5
ιαν	0	2-0

Name	Data type	Description
M_ID	Int	Message ID
sync_CLK	Bool	Time synchronization request
READ_CLK_CDT	DATE_AND_TIME or an array of 8 bytes	Synchronization time of the master (S7- 300)
User_data	Array of 148 bytes	User data (S7-300 -> S7-1200)

#### DB302 and DB1202

The receive structure RCV\_STRUCT (UDT2) of the client and the send block of the server must be identical. The receive DB 302 consists of 14 receive structures for the maximum number of server connections for the CPU 315-2PN/DP. The receive structure UDT2 or the send DB 1202 consist of 160 bytes with the following structure:

#### Table 2-6

Name	Data type	Description
M_ID	Int	Mirrored message ID for acknowledgement
synchronized	Bool	Time synchronization feedback
User_data	Array of 156 bytes	User data (S7-1200 -> S7-300)

The "User\_data" can be adapted individually. The data structure, however, must be identical on the sender and receiver side.

Program-related data consistency is ensured through sequential processing of the send and receive jobs.

The status DB 303 offers direct influence on communication errors.

Through the continuous data exchange between the client and the servers, data consistency can be ensured only for one cycle.

Consequently, the consistent data must be written to the send data blocks, or be read from the receive data blocks, respectively, within one cycle.

Program sequence in the client station

## 2.4 Program sequence in the client station

#### Flowchart

The flowchart below shows the program sequence in the client station. The functionality is combined in FB300 "S7-com\_PUT\_GET" which is called by OB1 at cyclic intervals. FB300 is realized in the form of a step sequence.

Figure 2-5



#### Program sequence in the client station

#### **Description of the flowchart**

The "ID" is the index used to identify the relevant server to be used for data exchange.

Depending on the "ID", the synchronization request "SYNC" is read from the status information for the server "ID" of "Status\_DB" 303. Depending on the request, the system time ("READ\_CLK") is read and then written to the send data block.

The send block "PUT" is used to transmit the contents of the send data block to the "ID" server. Apart from the time synchronization information, a message ID "M\_ID" is transmitted also.

In case of an "ERROR" message from the "PUT" send block, the error information is written to the status structure of the "ID" server in the status DB.

The receive data block "GET" is used to receive the data from the "ID" server and to write them into the "ID" receive structure in the receive DB.

In case of an "ERROR" message from the "GET" receive block, the error information is written to the status structure of the "ID" server in the status DB.

On the basis of this receive data, the message ID "RCV\_M\_ID" mirrored by the server is compared with the "M\_ID" sent. Any discrepancies will be stated in the status structure of the "ID" server in the status DB ("M\_ID\_unequal").

When a synchronization request "SYNC" of the "ID" server is issued, successful synchronization is checked on the basis of the receive data of the "ID" server ("synchronized"). If the result is positive, the synchronization request "SYNC" for the "ID" server will be reset. Otherwise, time synchronization will be repeated during the next communication with this server.

The message ID is increased ("INC M\_ID") and the "ID" is compared with "ID\_max", i.e. the maximum number of servers. The ID continues to increase ("INC ID") until "ID\_max" is reached. Otherwise the ID will be reset to the initial ID ("ID = 1").

Hardware and software installation

## 3 Configuration

## 3.1 Hardware and software installation

## 3.1.1 Hardware installation and cabling

Table 3-1

No.	Instruction	Note/Screenshot
1.	Mount the S7-1200 modules to a "top-hat" DIN rail.	
2.	Mount the S7-300 modules to a S7-300 mounting rail.	
3.	Us an RJ45 Ethernet cable to connect the controllers and the associated programming unit with the switch CSM 1277.	See Chapter "Cabling diagram"
4.	Connect all grounding terminals to ground.	See Chapter "Cabling diagram"
5.	Connect the controllers to voltage.	See Chapter "Cabling diagram"
6.	Insert the MICRO MEMORY CARD into the CPU 315-2PN/DP.	See Table 1-1

## 3.1.2 Software installation

No.	Instruction	Note/Screenshot
1.	Install the software STEP 7 BASIC V10.5 on your programming unit.	See Table 1-1
2.	Install the Service Pack 2 for STEP 7 BASIC V10.5 on your programming unit.	See Table 1-1
3.	Install STEP 7 V5.4 on your programming unit.	See Table 1-1
4.	Install the Service Pack 5 for STEP 7 V5.4 on your programming unit.	See Table 1-1

## 3.2.1 Assignment of an IP address for the PG/PC

Your PG/PC must be allocated an IP address in the same subnetwork as the CPUs. The IP addresses of the individual stations can be seen in Figure 1-2.

Proceed as described below to assign an IP address for your network card in the Windows XP operating system:

Table 3
---------

No.	Instruction	Note/Screenshot
1.	Open the Windows Control Panel and select "Network Connections".	File       Edit       View       Favorites       Tools       Help         Back       Panel       Folders       Polders       Polders       Polders         Address       Control Panel       Address       Polders       Polders       Polders         Sec Also       Add or Remove Programs       Add ministrative Tools       Polders       Polders       Polders         Windows Update       Polder Options       Polder Options       Polder Options       Polder Options         Help and Support       Fonts       Game Controllers       Internet Options       Keyboard         Mail       Memory Card Parameter Assignmen       Mail       Memory Card Parameter Assignmen
2.	Select the network card to be used and click your right mouse button to open the associated "Properties".	Network Connections         File       Edit       View Favorites       Tools       Advanced       Help         Back       + • • • • • • • • • • • • • • • • • • •

No.	Instruction	Note/Screenshot
3.	Select the element "Internet Protocol (TCP/IP)" and click the "Properties" button.	Local Area Connection Properties       ? ×         General       Authentication       Advanced         Connect using:       Broadcom NetXtreme Gigabit Etherne       Configure         This connection uses the following items:       Configure         This connection uses the following items:       Image: SIMATIC Industrial Ethernet (ISO)       Image: SIMATIC Industrial Ethernet (ISO)         Install       Uninstall       Properties         Description       Transmission Control Protocol/Internet Protocol. The default wide area network protocol that provides communication across diverse interconnected networks.         Image: Show icon in notification area when connected         Notify me when this connection has limited or no connectivity
4.	<ul> <li>Select "Use the following IP address"</li> <li>Enter the IP address "140.140.140.241" (see Figure 1-2).</li> <li>Enter the subnet mask "255.255.255.0".</li> <li>Click "OK" to confirm your settings.</li> </ul>	Internet Protocol (TCP/IP) Properties         General         You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.         © Obtain an IP address automatically         © Use the following IP address:         IP address:

## 3.2.2 Configuration of the S7-300

## Configuring the PG/PC interface

For project download and online communication with the CPU 315-2PN/DP, the PG/PC interface must be configured as follows:

No.	Instruction	Note/Screenshot
1.	Open the Windows Control Panel and select "Set PG&PC Interface".	File       Edit       View       Favorites       Tools       Help            Sec       Back <ul> <li></li></ul>
2.	<ul> <li>Select "S7ONLINE (STEP 7)" as access point of the application.</li> <li>Select "TCP/IP(Auto)" as the interface parameter assignment to be used for your network card.</li> <li>Click "OK" to confirm your settings.</li> </ul>	Set PG/PC Interface         Access Path       LLDP         Access Point of the Application:         \$70NLINE       (STEP 7)         Interface Parameter Assignment Used:         TCP/IP(Auto) > Broadcom NetXtreme Gia         TCP/IP(Auto) > Broadcom NetXtreme Gia         TCP/IP > LevelOne USB-0201 US         TCP/IP > NdisWanlp         Copy         Delete         Assigning Parameters for the IE-PG access to your NDIS CPs with TCP/IP Protocol (RFC-1006))         Interfaces         Add/Remove:       Select         OK       Cancel

#### Creating a new connection

The S7-1200 PLC offers a passive server functionality for S7 communication via Ethernet. Communication is configured only on the S7-300 via the PUT and GET blocks. Consequently, the connection is also configured only in STEP 7 V5.4 in NetPro. This requires the IP addresses of the S7-1200 servers.

The table below describes how an S7 connection is configured in NetPro.

No.	Instruction	Note/Screenshot
1.	<ul> <li>Open the SIMATIC Manager and select the project "CE- X18A_Client_v1d2".</li> <li>Click the "Configure Network" button to open NetPro.</li> </ul>	CLMATIC Manager - [CL-X10_57-com_Client - CL/Program Hiles/Seconens/Step / s / proj. (CL-X10_5]         Pile Edit Inset RC View Oxfore Window Help         D Bile Edit Inset RC View Oxfore Window Help         D Bile 2010 [Stream, Carp, Car
2.	Select the CPU in the NetPro window and use the menu command "Insert" to create a "New Connection".	NetPro - [CE-X18_57-com_Client (Network) C:\         Network Edit Insert PLC View Options Window         Network Edit Insert PLC View Options Window         Network Connection         Ctrl+G         Ethernet(1)         New Connection         Op Master System         PROFINET IO System         SIMATIC 300(1)         Op Master System         SIMATIC 300(1)         Op Master System         And the system         SIMATIC 300(1)         Op Master System         And the system         SIMATIC 300(1)         Op Master System         And the system         Stepset         And the system         Stepset         Stepset         Op Master System         Stepset         Stepset         Op Master System         Op Master System         Stepset         Op Master System

No.	Instruction	Note/Screenshot
3.	Select an unspecified "S7 connection" as connection partner and click "OK" to confirm your settings.	Insert New Connection         Connection Pather         In the current project         Image: Connection         All broadcast stations         All multicast stations         All multicast stations         In unknown project         Project:         Station:         [Unspecified]         Module:         Connection         Type:         S7 connection         Type:         S7 connection         Image: S7 connection </td
4.	<ul> <li>Open the "General" tab in the "Properties" dialog window and activate the option "Establish and active connection".</li> <li>The connection ID for transfer to the PUT and GET blocks is predefined, however, it may also be allocated individually as available.</li> <li>Enter the IP address "140.140.140.221" of the first S7- 1200 server (see Figure 1-2).</li> <li>Click "OK" to confirm your settings.</li> </ul>	Properties - 57 connection       X         General Status Information       Image: Connection End Point         Freed configured dynamic connection       Block Parameters         Image: Connection End Point       Local D (Hext)         V#16#1       Image: Connection         Image: Connection Path       Default         Connection Path       Default         Local       Patner         End Point       SIMATIC 300(1)/ CPU 315.2 PN/DP, PN-I0(R0/S2)         Interface:       CPU 315.2 PN/DP, PN-I0(R0/S2)         Subnet       Ethernet[1] (Industrial Ethernet]         Industrial Ethernet]       Industrial Ethernet]         Address       140.140.140.220         OK       Cancel
5.	<ul> <li>In NetPro, the defined connection is shown next to the highlighted CPU.</li> <li>Click the "Save and Compile" button.</li> <li>Click the "Download the selected station(s)" button to load the modified network configuration.</li> </ul>	Image: Simple state sta

#### Setting the synchronization time

The client CPU 315-2PN/DP is the clock master for synchronization of the S7-1200 servers. The interval for time synchronization can be set by configuration of the time-of-day interrupt. Apart from the automatic synchronization, each server may also be synchronized manually via the table of variables.

**Note** The UTC time (Universal Time Coordinated) is the system time of both the S7-300 and the S7-1200 PLC.

No.	Instruction	Note/Screenshot
1.	Double-click the Hardware configuration in the STEP 7-Projekt "CE-X18A_Client_v1d2".	SIMATIC Manager - [CE-X18_S7-com_Client C:\CE-X18_S7-com_Client         File       Edit       Insert       PLC       View       Options       Window       Help         Image: Provide the state of the state o
2.	Double-click the CPU 315-2PN/DP to open the Properties.	Image: Hw Config - [SIMATIC 300(1) (Configuration) CE-X1         Image: Station Edit Insert PLC View Options Window Help         Image: Station Edit Insert PLC View Options View Options View Optinsert         Image: Station
3.	<ul> <li>Select the "Time-of-Day Interrupts" tab and activate OB10.</li> <li>Select execution "Every day".</li> <li>Define the time of day at which the server shall be synchronized every day.</li> <li>Click "OK" to confirm your settings.</li> </ul>	Properties - CPU 315-2 PN/DP - (R0/52)         X           General         Statup         Synchronous Cycle Interrupts           Diagnostics/Clock         Protection         Web           Cycle/Clock Memory         Retentive Memory         Interrupts         Time of-Day Interrupts           Pionity         Active         Execution         Stat date         Time of Day Interrupts           Pionity         Active         Execution         Stat date         Time of day         PIP           0B10:         2         Image: Execution         Stat date         Time of day         PIP           0B10:         2         Image: Execution         Stat date         Time of day         PIP           0B10:         2         Image: Execution         Stat date         Time of day         PIP           0B11:         0         Image: Execution         Stat date         Time of day         PIP           0B12:         Image: Execution         Virti717394         00:00         Image: Execution
		OK Cancel Help

No.	Instruction	Note/Screenshot
4.	<ul> <li>Click the "Save and Compile" button.</li> <li>Finally, the modified hardware configuration must be loaded into the CPU.</li> </ul>	HW Config - [SIMATIC 300(1) (Configuration) Station Edit Insert PLC View Options Windo C C C C C C C C C C C C C C C C C C C

#### Loading the client project into the controller

Unzip the example program "CE-X18A\_Client\_v1d2.zip" into any desired directory on your harddisk.

The unzipped file includes the project "CE-X18A\_Client\_v1d2" for the CPU 315-2PN/DP.

Table 3-7	
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No.	Instruction	Note/Screenshot
1.	Open the "SIMATIC Manager".	SIMATIC Manager SIMATIC Manager
2.	Click the "Open Project/Library" button.	SIMATIC Manager         File       PLC       View       Options       Window       Help         D       D       B       T       Image: A state of the sta
3.	Click the "Browse" button.	Open Project     X       User projects     Libraries       Name     Storage path       Selected     X       User projects:     X       Libraries:     Selected       Sample projects:     Browse       ØK     Cancel

No.	Instruction	Note/Screenshot
4.	<ul> <li>Navigate to the folder where you have unzipped the example project and select the S7-300 project "CE- X18A_Client_v1d2".</li> <li>Click "OK" to confirm opening of the project.</li> </ul>	Prod n directory:     Found directory:     Found Selected       CVEXX8_S7 com/CEXX8_S7 com/
5.	<ul> <li>The SIMATIC Manager opens the S7-300 project.</li> <li>Select the station "SIMATIC 300(1)".</li> <li>Click your right mouse button to open the context menu and select "PLC" -&gt; "Download" to download the whole project.</li> </ul>	StMATIC Manager - [CE-X18_57-com_Client]         Pile Edit Inset PLC View Options Window Help         Image: Stream Client         Imathetter
6.	<ul> <li>A dialog window opens where you can select the node address.</li> <li>Click the "View" button to show a list of all accessible nodes.</li> </ul>	Select Node Address         Over which station address is the programming device connected to the module CPU 315-2         PN/DP?         Rack:       0         Image: Station:       0         Constraints       0         Enter connection to target station:       1         Image: Provide the module type       Station name         Module type       Module type         Module type       <

No.	Instruction	Note/Screenshot
7.	<ul> <li>Select the S7-300 from the list of accessible nodes (identified via the MAC address).</li> <li>Click "OK" to confirm your settings.</li> </ul>	Select Node Address       X         Over which station address is the programming device connected to the module CPU 315-2         PN/DP?         Rack:       Image: Station address is the programming device connected to the module CPU 315-2         Slot:       Image: Station address is the programming device connected to the module CPU 315-2         Target Station:       Image: Connected to the module of gateway         Enter connection to target station:       Image: Station address is the programming device connected to the module name P         192.168.0.1       00-06-80-60-15       CPU 315 SIMATIC 3 CPU 315-2 Image: Station address is the programming device connected to the module name P         192.168.0.1       00-10-06-00-50-15       CPU 315 SIMATIC 3 CPU 315-2 Image: Station address is the programming device connected to the module name P         192.168.0.1       00-10-06-00-50-15       CPU 315 SIMATIC 3 CPU 315-2 Image: Station address is the programming device connected to the module name P         140.140.140.222       00-10-06-00-30-Ad       CPU 212-1         140.140.140.222       00-10-06-00-30-Ad       CPU 214-1         140.140.140.222       00-10-06-00-30-Ad       CPU 214-1
8.	After successful project download, set the CPU to the operating mode "RUN".	Update       DK       Cancel       Help         Properties - Program (online) (13:4363)         Image: Comparison of the state of the

## 3.2.3 Configuration of the S7-1200

### Loading the server project into the controllers

Unzip the example program "CE-X18A\_Server\_v1d2.zip" into any desired directory on your harddisk. The unzipped file includes the project "CE-X18A\_Server\_v1d2" for the two S7-1200 controllers.

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No.	Instruction	Note/Screenshot
1.	<ul> <li>Open the Windows Explorer, navigate to the S7-200 project "CE- X18A_Server_v1d2.ap10" and open the project with a double-click.</li> </ul>	Image: CE-X18_S7-com_Server         File       Edit       View       Favorites       Tools       Help         Image: CE-X18_S7-com_Server       Image: CE-X18_S7-com_Server       Image: CE-X18_S7-com_Server       Image: CE-X18_S7-com_Server
2.	<ul><li>The project opens in STEP 7 Basic.</li><li>Open the project view.</li></ul>	Start Surt
3.	<ul> <li>Select the two controller folders "PLC_1 [CPU 1212C DC/DC/DC]" and "PLC_2 [CPU 1214C DC/DC/DC]".</li> <li>Click the "Download to Device" button to load the projects completely into the controllers.</li> </ul>	Siemens - CE-X18_S7-com_Server Project Edit View Insert Online Options Tools Wi Project tree Project tree CE-X18_S7-com_Server Add new device Devices & Networks CE-X18_S7-com_Server Project CE-X18_S7-com_Server Project CE-X18_S7-com_Serv

No.	Instruction	Note/Screenshot
4.	<ul> <li>Select the network card to be used.</li> <li>Activate the relevant option to show all accessible devices.</li> <li>Identify the PLC_1 controller from the list of accessible devices via the MAC address or "Flash LED".</li> <li>Select the desired controller and click the "Load" button.</li> <li>Repeat the last two steps to download PLC_2.</li> </ul>	Name         Name <th< td=""></th<>
5.	<ul> <li>Activate the continuous loading action option for both controllers.</li> <li>Click the "Load" button.</li> </ul>	Land provider         X           Check before landing         Test the descent of provide and the second provide an
6.	<ul> <li>When the transfer of all program blocks to the controllers is completed, a window with the "Load results" appears.</li> <li>Select the option fields "Start all" to set both controllers into the operating mode "Run".</li> <li>Click the "Finish" button to complete the download operation.</li> </ul>	Conditionality     Conditionality     Conditionality     Conditionality     Conditionality       Conditionality     The conditionality     Conditionality     Conditionality     Conditionality       Conditionality     The conditionality     Conditionality     Conditionality     Conditionality       Conditionality     The conditionality     Conditionality     Conditionality     Conditionality       Conditionality     Conditionality     Conditionality     Conditionality     Conditionality

## 3.3 Online mode activation

For communication control and monitoring, your PG/PC must be switched to online mode for the S7-1200 and the S7-300 via the monitoring/variables table.

### Activating the monitoring table for the S7-300 client

|--|

No.	Instruction	Note/Screenshot
1.	Open the SIMATIC Manager and select the project name -> station name -> CPU -> "Blocks" container and then the variables table "VAT_1".	SIMATIC Manager - [CE-X18_57-com_Client CACE-X18_57-com_CCE-X18]         Pile Edit Insert PLC View Options Window Help         Image: Similar Coole         Image: Similar Co
2.	Activate the variables table by clicking the "Watch variable" button.	War - VAT_I           Table Edit Insert PLC Variable View Options Window Help           Image: Status PLC Variable View Options View Options View Options View Options           Image: Status View Options View

## Online mode activation

No.	Instruction	Note/Screenshot
3.	The variables table includes (row numbers in	Var - [VAT_1 @CE-X18_57-com_Client\SIMATIC 300(1)\CPU 315-2 PN/DP\57 Program()     Table Edit Incert PIC Waitable View Ontions Window Heb
	brackets):	
	<ul> <li>Instance data block of FB300 (2-10)</li> </ul>	Address Symbol Display format Status value
	<ul> <li>specified initial values (2-6)</li> </ul>	2 DB300 DBW 0 "S7-com_PUT_OE_DB".ID_max DEC 2     2 DB300 DBW 0 "S7-com_PUT_OE_DB".ID_max DEC 2
	<ul> <li>return value of the "read system clock" function (7-8)</li> </ul>	5         Debolo DeW 4         2         37-com_PUT_GET_DPI Rev_STNUT_size         DEC         302           4         DEBOLD DEW 4         "S7-com_PUT_GET_DPI Rev_STNUT_size         DEC         160           5         DEBOLD DEW 6         "S7-com_PUT_GET_DPI Rev_STNUT_size         DEC         303           6         DEBOLD DEW 6         "S7-com_PUT_GET_DPI Rev_STNUT_size         DEC         303
	- step indication (9)	0         E0000 DEW 100         "S"-com_PUT_OET_DE"/READ_CLK_ERROR         E000         00000           7         DE3000 DEW 100         "S"-com_PUT_OET_DE"/READ_CLK_ERROR         E0000         00000           8         DE3000 DEW 12         "S"-com_PUT_OET_DE"/READ_CLK_ERT_VAL         HEX         W#16#00000           9         DE3000 DEW 12         "S"-com_PUT_OET_DE"/READ_CLK_ERT_VAL         HEX         W#16#00000
	<ul> <li>ID for connection (10)</li> <li>Send data block (12-22)</li> </ul>	B         Dbs0ubery sub         Sr-com_PUT_SET_Defisite         Dec         22           10         Dbs0ubery sub         "Sr-com_PUT_GET_DB".lb_Init         DEC         1           11         //Send-DB         //Send-DB         Image: Sr-com_PUT_GET_DB".lb_Init         DEC         1
	- message ID (12)	12         DB301 DBW 0         "send_DB*SEND_Struct.M_D         DEC         -23264           13         DB301 DBX 2.0         "send_DB*SEND_Struct.sync_CLK         BIN         2#0           14         DB301 DB8         4         HEX         B#16#30
	- synchronization request (13)	15         DB301 DBB         5         HEX         B#16#01           16         DB301 DBB         6         HEX         B#16#01
	<ul> <li>master system time in the format DATE_AND_TIME (14-21)</li> </ul>	17         DB301 DBB         /         HEX         B#15#00           18         DB301 DBB         HEX         B#15#00           19         DB301 DBB         HEX         B#16#00
	- first byte of user data (22)	20         DB301 DB8         10         HEX         B#16#00           21         DB301 DB8         11         HEX         B#16#00           22         DB301 DB8         11         HEX         B#16#00
	Receive data of server 1 (24-26)	23         //Receiving data from Server 1         24         DB302 DBW         0         "Receive_DB".RCV_Struct_1 M_D         DEC         -28266
	<ul> <li>message ID (24)</li> <li>synchronization acknowledgement</li> </ul>	25         DB302.DBX         2.0         "Receive_DB" RCV_Struct_1.synchronized         BOOL         false           26         DB302.DB8         4         "Receive_DB" RCV_Struct_1.User_data[0]         HEX         B#16#00
	(25)	27         Xstatus tot in = 1         Status_10: 1
	- first byte of user data (26)	30         DB303 DBX         0.2         "Status_DB".status_1.0ET_ERROR         BOOL         false           31         DB303 DBX         0.3         "Status_DB".status_1.0ET_ERROR         BOOL         false           32         DB303 DBX         0.3         "Status_DB".status_1.0ET_ERROR         BOOL         false
	<ul> <li>Status information of server 1 (28-33)</li> <li>synchronization request (28)</li> </ul>	31         DB303 DBW 4         Visitatus_DD_status_1.9ET_ERROR_STATUS         HEX         Visitatus_000           33         //Receiving data from Server 2         Visitatus_01         Visitatus_01         Visitatus_01
	- communication error analysis (29-33)	35         DB302.0BW 160         "Receive_DB" RCV_Struct_2.M_ID         DEC         -29265           36         DB302.0BX 162.0         "Receive_DB" RCV_Struct_2.synchronized         BOOL         false           37         DB302.0B4 162.0         "Receive_DB" RCV_Struct_2.synchronized         BOOL         false
	• Receive data of server 2 (35-37)	Bioscussor         Final Status for ID = 2           38         //Status for ID = 2           39         DB303.0BX 6.0           *Status_DB*Status_2.SYNC         BOOL           Table
	• Status information of server 2 (39-44)	40         DB303.DBX         6.1         "Status_DPL" Status_2PUT_ERROR         BOOL         Tates           41         DB303.DBX         6.2         "Status_DB" Status_2CeT_ERROR         BOOL         Tates           42         DB303.DBX         6.3         "Status_DB" Status_2.M_D_LINEGUAL         BOOL         Tates
		43         DB303.DBW 8         "Status_DB".Status_2.PUT_ERROR_STATUS         HEX         W#16#0000           44         DB303.DBW 10         "Status_DB".Status_2.GET_ERROR_STATUS         HEX         W#16#0000

## Activating the monitoring tables for the S7-1200 servers

No.	Instruction	Note/Screenshot
1.	<ul> <li>Go to the STEP 7 Basic project tree and select "PLC_1" -&gt; "Watch tables" -&gt; "Watch table_1".</li> </ul>	Siemens - CE-X18_S7-com_Server         Project Edit View Insert Online         Image: Save project Imag
2.	Activate the monitoring table by clicking the "Watch all" button.	CE-X18_S7-com_Server       PLC_1       Watch tables       Watch table_1         Image: Server       Name       Address       Display format         1       //Receive-D8       Image: Server       DEC_signed         2       "Receive_D8".M_ID       %DB1201.DBW0       DEC_signed
3.	Repeat steps 1 and 2 for server 2: • PLC_2 [CPU 1214C DC/DC/DC] • Watch table_2	
4.	<ul> <li>Each monitoring table includes the following information (row numbers in brackets):</li> <li>Receive data block(2-12) <ul> <li>message ID (2)</li> <li>synchronization request (3)</li> <li>master system time in the format DATE_AND_TIME (4-11)</li> <li>first byte of user data (12)</li> </ul> </li> <li>Variables data block (14-15) <ul> <li>converted master system time in DTL format (14)</li> <li>return value of the "write system time" function (15)</li> </ul> </li> <li>Send data block (17-19) <ul> <li>mirrored message ID (17)</li> <li>synchronization acknowledgement (18)</li> </ul> </li> </ul>	CE XIB_SJ com_Server ➤ PLC_1 ➤ Watch tables ➤ Watch table_1 Name Name Name Name Name Name Name Name

## Configuration

Online mode activation

No.	Instruction	Note/Screenshot
	<ul> <li>first byte of user data (19)</li> </ul>	

## 3.4 Live demonstration

## 3.4.1 Cyclic operation

Table 3-11

No.	Instruction	Note/Screenshot
1.	<ul> <li>The FB300 "S7-com_PUT_GET" of the client is called at cyclic intervals (which</li> </ul>	[War-[VAT_]-@CE-X10_57-com_Clent\SIMATIC 300(1)\CPU 315-2 PY/DP\5 [미포 쫇 Table Edit Inset PLC Variable View Options Window Help 편 미술모를 통 분립은 이 이 또 두 일 있 것같아 봐 없어? /
	can be seen by the step changes in row 9)	Address Symbol Display format Status value
	<ul> <li>It communicates continuously with the servers 1 and 2 (indicated by the ID change in row 10)</li> </ul>	Immediate/beck/and/box/site/site/site/site/site/site/site/site
	<ul> <li>Message IDs with even numbers are transmitted to server 1 where they are mirrored and then received again.</li> </ul>	24         DB302_DBW         0         "Receive_DB" RCV_Shuct_1 M_D         DEC         1418           34         //Receiving data from Server 2
	<ul> <li>Message IDs with uneven numbers are transmitted to server 2 where they are mirrored and then received again</li> </ul>	● ● ● Seve project ● X 通 □ × 圖 圖 X 通 函 O online Ø Go
	minored and their received again.	m Name Address Display format Monitor value
		1         //Receive-08           2         "Receive_08"M_ID         %DB1201.DBW0         DEC_signed         1418           16         //Send-08
		CE-X18_S7-com_Server > PLC_2 > Watch tables > Watch table_2
		🕎 🔍 平 🍂 兆 次 F. F. 🛤 🎬 😭
		Name Address Display format Monitor value
		2         /*Receive Dot M_ID         %DB1201.DBW0         DEC_signed         1419           16         //Send-DB         //Send-DB         //Send-DB         //Send-DB
		17 "Send_DB".M_ID %DB1202.DBW0 DEC_signed 1419

## 3.4.2 Transmission of user data

## S7-300 client -> S7-1200 server

No.	Instruction	Note/Screenshot
1.	<ul> <li>In this example for the transmission of user data from the client to the servers, the send byte 0 of the user data field in row 22 shall be changed:</li> <li>Enter a value in the "Status value" column in row 22.</li> <li>Click F9 to confirm activation of the modified value.</li> </ul>	War- (VAT_1RCE-X18_57-com_clemx\SIMATIC 300(1)/CPU 315-2 PH/0P157 Program(1)         War- (VAT_1RCE-X18_57-com_clemx)         War- (VAT_1
2.	The value will be transmitted to both servers and written into the receive byte 0 of the user data field in the receive data block 1201 (as shown in row 12 of the server watch tables).	War-UAL _ = @CF-XIB_S7-com_Clevel(XIMATIC 300(1)/XPU 315-2 PM/DF/S7 Pregram(1)         Table Edit Inset PLC Vanible Wew Options Window Help

## S7-1200 server 1 -> S7-300 client

## Table 3-13

No.	Instruction	Note/Screenshot
1.	<ul> <li>In this example for the transmission of user data from server 1 to the client, the send byte 0 of the user data field in row 19 shall be changed:</li> <li>Open "Watch table_1" and enter a value in the "Monitor value" column in row 19</li> <li>Click your right mouse button to confirm the changed value by selecting "Modify" -&gt; "Modify now".</li> </ul>	Siemens - CCX18_Sizeom_Server         Project Ed: View Inset Collins ()         Image: Sizeom_Server + Nic_]
2.	The value will be transmitted to the client and written into the receive byte 0 of the user data field in the receive structure for server 1 (as shown in row 26 of the client variables table).	Stemens - CCX10_S1/com_server         Project Edit View Insert Goline Options Tools >         Image: Status of Comparison Stools >         Image: Status of Compar

## S7-1200 server 2 -> S7-300 client

No.	Instruction	Note/Screenshot
1.	<ul> <li>In this example for the transmission of user data from server 2 to the client, the send byte 0 of the user data field in row 19 shall be changed:</li> <li>Open "Watch table_2" and enter a value in the "Monitor value" column in row 19</li> <li>Click your right mouse button to confirm the changed value by selecting "Modify" -&gt; "Modify now".</li> </ul>	Siemens - CE-X18_S7-com_Server Project Edit View Insert Online Options Tools > Tot Project Edit View Insert Online Options Tools > CE-X18_S7-com_Server > PLC_2 > Watch tables > Watch table_2 CE-X18_S7-com_Server > PLC_2 > Watch tables > Watch table_2 Name Address Displayformat Monitor value Modify value Name Address Displayformat Monitor value Modify value Name Address Displayformat Monitor value Modify value Name Address Displayformat Monitor value Modify to 0 Modify t
2.	The value will be transmitted to the client and written into the receive byte 0 of the user data field in the receive structure for server 2 (as shown in row 37 of the client variables table).	Sidmens - CE-XIB_S7-com_Server         Project Edit View Insert Online Options Tools ·         Totally ·         Project Edit View Insert Online Options Tools ·         Totally ·         Project Edit View Insert Online Options Tools ·         Totally ·         Project Edit View Insert Online Options Tools ·         Totally ·         Project Edit View Insert Online Options Tools ·         Totally ·         Project Edit View Insert Online Options Tools ·         Totally ·         Project Edit View Insert Online Options Tools ·         Totally ·         Project Edit View Insert Online Options Tools ·         Project Edit View Insert Options Tools ·         Project Edit View Insert Options Tools ·         Project Edit View Insert Options Tools ·         Project Edit Prove Project Edit View Insert Options Tools ·         Project Edit Prove Project Edit Prove

## 3.4.3 Time synchronization

### Manual server synchronization

Server 1 shall be synchronized manually with the client's system time. How to proceed is described in Table 3-15.

The same procedure can also be used for the synchronization of sever 2.

No.	Instruction	Note/Screenshot
1.	<ul> <li>Select the synchronization request in the status structure for server 1 by clicking your right mouse button and then -&gt; "Modify Address to 1" (row 28 in the client's variables table).</li> </ul>	Var       V
2.	<ul> <li>The system time is written to the send data in a DATE_AND_TIME format (rows 14 - 21)</li> <li>The synchronization request is set in the send data (row 13).</li> <li>The send data is transmitted to server 1 including connection ID 1 (row 10).</li> </ul>	Var         VAI         - eCE-X18         S7-com         Client\SIMATIC 300(1)\CPU 315-2 PN/DP\S7 Program           Table         Edit         Insert         PLC         Variable         View         Options         Window         Help           Ha         Disc         Image: Symbol         Display format         Status value           Image: Address         Symbol         Dimageeeee         Display f
3.	<ul> <li>The time synchronization data is written to the receive block of server 1 ("Watch table_1", rows 3 – 11)</li> <li>The converted synchronization time in a DTL data type is written to the system time of the S7-1200 (row 14).</li> <li>After successful time synchronization, synchronization will be acknowledged (row 18).</li> </ul>	Noject Edit View Insert Online Options Tools >       Totally Integrate <ul> <li></li></ul>
4.	<ul> <li>On the client side, the synchronization acknowledgement is written into the receive structure of server 1 (row 25)</li> <li>The synchronization request in the status structure for server 1 is reset (row 28).</li> </ul>	War _ [VAT _ ] - @CE-X19_57-com_Client\SIMATIC 300(1)\CPU 315-2 PN/DP\57 Progra         Table Edit Insert PLC Variable View Options Window Help         Image: Comparison of the image

## Automatic synchronization of all servers

In chapter 3.2.2, the daily synchronization time of all servers has been set to 00:00. In order to check proper function, the system time of the client is set to 23:59 pm.

Tab	le	3-	16	

No.	Instruction	Note/Screenshot
1.	Open Step 7 V5.4 and select "PLC" -> "Diagnostic/Setting" -> "Set Time of Day".	SIMATIC Manager - [CE-X18_S7-com_Cleax1_S7-com_Cleax1]         Image: Figure State
2.	<ul> <li>Deactivate the option "Take from PG/PC".</li> <li>Set the module time to "11:59:59 PM".</li> <li>Click "Apply" to confirm your settings.</li> </ul>	Set Time of Day         ×           Path:         CE:X18_S7-com_Client\SIMATIC 300(1)           Online:         Order No.:         6ES7 315-2EH13-0A80           Name:         CPU 315-2 PN/DP           Date:         Time of Day:           PG/PC time:         06/24/2010         05:34:46 PM           Module time:         06/24/2010         11:59:59 PM           Take from PG/PC         More >>           Apply         Close         Help
3.	Successful clock synchronization of the servers can be checked by means of the stated system time of the servers (row 14 in the monitoring tables "Watch table_1" and "Watch table_2").	Siemens - CE-XIB_S7-com_Server         Project       Edit       Yew       Insert       Online       Options       Totally I         Image: Signal and System Project       Image: Signal and System Project

## 3.4.4 Communication errors

Pull the Ethernet cable from server 1 to demonstrate the communication error analysis function.

How to proceed is described in Table 3-15.

The same procedure can be used to simulate and analyze an interruption in the communication with server 2.

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No.	Instruction	Note/Screenshot		
1.	<ul> <li>Pull the Ethernet cable from the LAN port of server 1.</li> <li>The step sequence stops (row 9) during communication with server 1 (row 10), since there is no confirmation or error message from the S7 communication blocks PUT or GET.</li> </ul>	Var         VAT		
2.	<ul> <li>After the internal timeout period of the communication blocks has elapsed, an error message is issued and the step sequence continues.</li> <li>In the status structure for server 1, the communication errors of the blocks PUT (row 29) and GET (row 30) are issued including the relevant error states (rows 32 and 33).</li> <li>Furthermore, the discrepancy between the transmitted message ID (row 12) and the last ID received from server 1 (row 24) is identified and indicated in row 31.</li> </ul>	Struct         Vertical         Struct         Vertical         Struct         Str		
3.	<ul> <li>Reconnect the Ethernet cable with the LAN port of server 1.</li> <li>After recovery of the connection has been identified, the error bits in the status structure for server 1 will be reset (rows 29 - 31).</li> <li>Data exchange with server 1 has been restored.</li> <li>The error states of the communication blocks PUT (row 32) and GET (row 33) include the status information of the last errors.</li> </ul>	Image: Desus DBW 101         Tables_Def Status_2, Let _ERROR_STATUS         HEX         W#16#0000           Image: Desus DBW 101         Table Edit Insert PLC Variable Verv Options Window Help         Image: Desus DBW 201         Status DBW 201		

## 3.4.5 Power failure of the client

After power recovery of the client, the step sequence of function block 300 "S7-com\_PUT\_GET" starts from the last position of execution.

## 4 Code Elements

In the example described in this document uses the following program codes:

No.	File name	Contents
1.	<ul><li>CE-X18A_Client_v1d2.zip</li><li>CE-X18A_Client_v1d2</li></ul>	Zip file including the S7-300 client project for deterministic S7 communication via the PUT and GET blocks
2.	CE-X18A_Server_v1d2.zip • CE-X18A_Server_v1d2.ap10	Zip file including the S7-1200 server project for deterministic S7 communication via the PUT and GET blocks

## History Table 5-1 5

Version	Date	Revisions
V1.0	01/13/10	T-communication via the integrated S7-300 CPU interface (task A) and via a S7-300 CP (task B)
V1.1	02/10/10	Extensions in chapter 2.3: S7-1200 Data transfer
V1.2	08/31/10	Modification of the automation task in deterministic data exchange via S7 communication (task A)