Measuring& Control: Data Communication between S7-1200 and SENTRON PAC3200 via MODBUS TCP from TIA Portal V11

S7-1200 Set 22

SIMATIC S7-1200, SENTRON PAC3200

Application Description • May 2013

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Caution

The functions and solutions described in this article confine themselves to the realization of the automation task predominantly. Please take into account furthermore that corresponding protective measures have to be taken up in the context of Industrial Security when connecting your equipment to other parts of the plant, the enterprise network or the Internet. Further information can be found under the Item-ID 50203404.

http://support.automation.siemens.com/WW/view/en/50203404

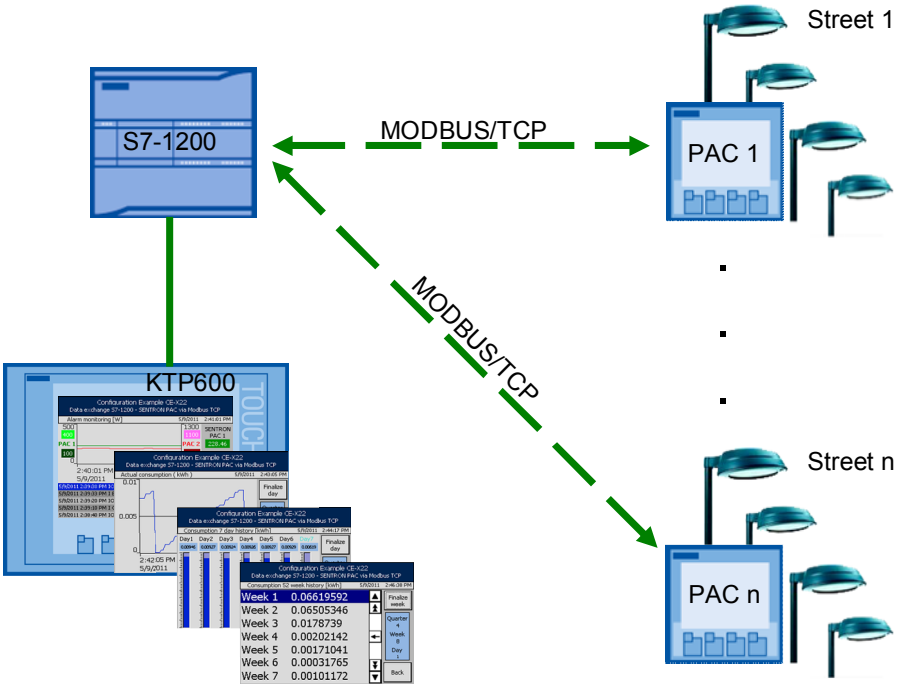
Table of Contents

1 Automation Task

Task description

The active power absorbed by several SENTRON power monitoring devices PAC 3200 are to be read out deterministically and the total energy consumption is to be calculated by a S7-1200 controller via Modbus on TCP.

Figure 1-1: Layout of the application task



Application requirements

The electrical output from several rows of street lights measured by SENTRON PAC3200 devices shall be transferred to SIMATIC S7-1200 via the Modbus/TCP protocol, be displayed at an operator panel and be further processed for determining the energy consumption.

The power of the street lamps shall be monitored for upper and lower limits. Depending on the process tag, the “Exchange illuminant” message shall be generated when falling short of the lower limit, and the “Check short circuit” message when the upper limit is exceeded. If an Ethernet connection is interrupted, a message indicating which SENTRON PAC3200 device cannot be reached, shall be output. All messages shall be assigned a time stamp, be displayed on a KTP600 and entered in its message buffer.

The total energy consumption of all streets is calculated with the help of the S7-1200 and displayed as a chronological sequence. The daily energy consumption of a week is to be logged as a bar chart. After a week, the daily total energy consumption is summarized into weekly energy consumption. The weekly energy consumption throughout the year is then archived in the KTP600 as a recipe of 4 quarterly data records of 13 weeks each.

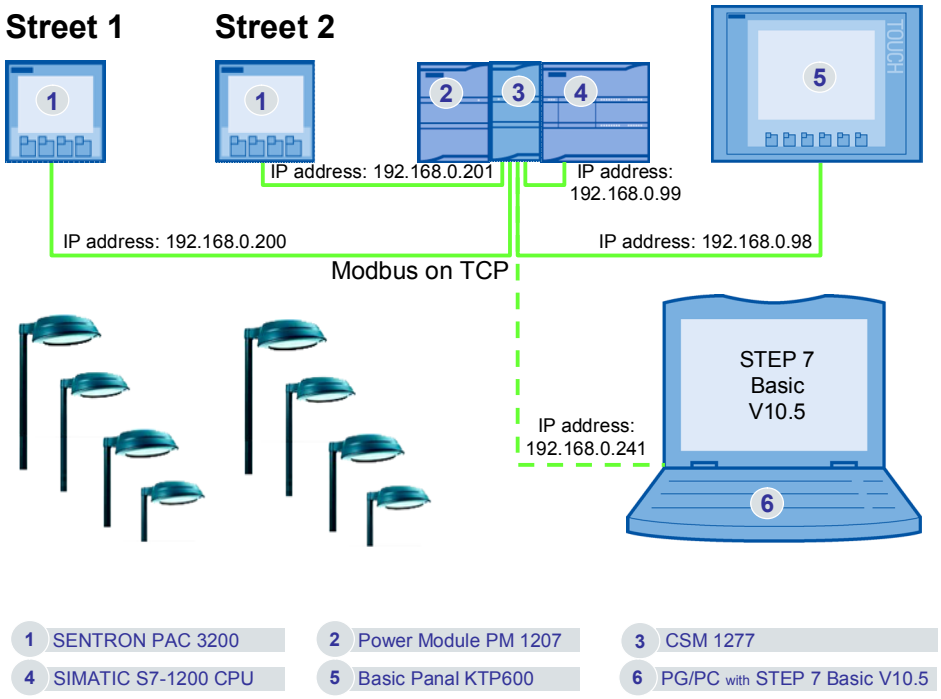
It shall be possible to record and reset the operating hours of all SENTRON PAC3200 devices. It shall be possible to delete all saved and archived energy consumption values. It shall also be possible to empty the alarm buffer.

For demonstration purposes, it shall be possible to simulate the daily change manually and automatically and the weekly change manually.

Schematic layout

The automation task is demonstrated using the example of data communication with two SENTRON PAC3200 devices.

Figure 1-2: Schematic layout



A SIMATIC S7-1200 is to be linked with two SENTRON PAC 3200 via a CSM 1277 switch.
With the help of the Modbus/TCP protocol, data between the SENTRON PAC3200 power monitoring device and the S7-1200 CPU can be exchanged. As a result, the output of the street lamps is to be measured. The SIMATIC S7-1200 is to calculate the energy consumption for the two streets from the average power demand. The energy consumption shall be visualized in a SIMATIC KTP600. However, to simulate the user interface, the simulation in the TIA Portal can also be used.

Class C network

The IP addresses of the communication nodes only differ in the last octet (192.168.0.x), which makes it a class C network. As a subnet mask, “255.255.255.0” is selected for a class C network.
To expand to several SENTRON PAC3200 devices in the sample program, further IP addresses can be used within this class C network (192.168.0.x).

2 Components and Structure

2.1 Components list

The application on hand was created with the following components:

Products

Table 2-1: Products

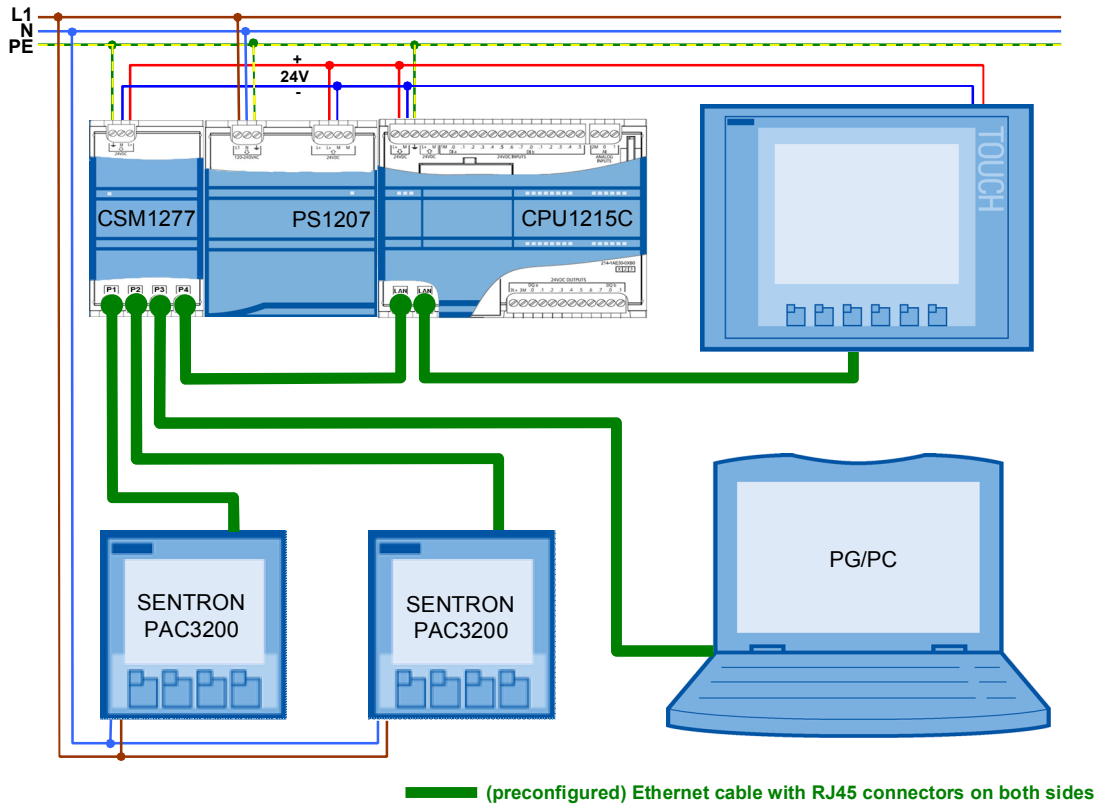
	Components	Qty.	MLFB/order number	Note
1.	PMD SENTRON PAC3200 LCM PM ACDC TEK	2	7KM2112-0BA00-3AA0	
2.	PM1207 power supply unit	1	6EP1332-1SH71	
3.	COMPACT SWITCH MODULE CSM 1277	1	6GK7277-1AA10-0AA0	
4.	S7-1200 CPU1215C[1] DC/DC/DC	1	6ES7 215-1AG31-0XB0	Version V3.0
5.	Basic panel KTP600 (color, PN)	1	6AV6647-0AD11-3AX0	optional
6.	Ethernet connecting cable between KTP600, S7-1200 CPU, SENTRON PAC devices and PC	4	6XV1870-3QH20	

Note A KTP600 is not essential. To simulate the user interface, the simulation in the TIA Portal can be used.

[1] The application does not necessarily require the specified CPU. You can use any S7-1200 CPU as of version 2.1.

2.2 Wiring diagram

Figure 2-1: Wiring



You can use the KTP600[2] as the operator panel or the simulation in the TIA Portal.

Note The various connection types for the power side of the SENTRON power monitoring device PAC3200 can be found in the device manual /9/.

[2] When using a CPU with only one LAN connection, you only connect the KTP600 when you no longer require the development system for configuration and testing.

2.3 Controller software

Standard software components

Table 2-2: Standard software components

Component	Order number or link
STEP 7 Basic V11 SP2	6ES7822-0AA01-0YA0
Update 5 to STEP 7 Basic V11 SP2	http://support.automation.siemens.com/WW/view/en/58112582
Latest STEP 7 V11 HSP[3]	http://support.automation.siemens.com/WW/view/en/54164095
or alternatively	
STEP 7 Basic V12	6ES7822-0AA02-0YA5

User software and documentation

The example project is available on the HTML page from which you downloaded this document.

Table 2-3: User software and documentation

Component	Note
40614428_Set22_V11_1d7_0.zip	STEP 7 project alternatively in TIA V11 or TIA V12
40614428_Set22_V12_1d7_0.zip	
40614428_Set22_V12_1d7_0_xx[4].pdf	This document

[3] **H**ardware **S**upport **P**ackage with CPU 1215C
[4] xx = language ID

3 Commissioning

3.1 Installation and wiring

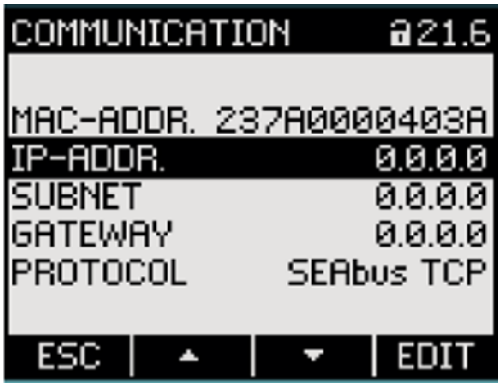
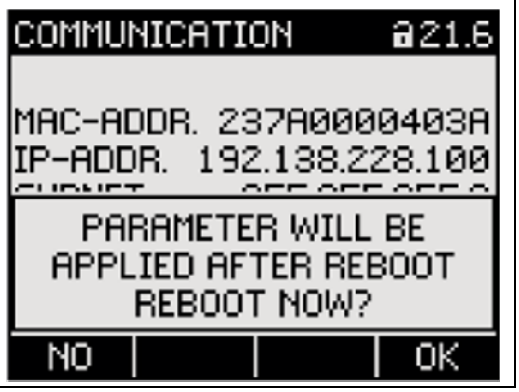
Install and wire the components (see chapter 2.1 Components list) according to the specifications in manuals /1/, /6/, /7/, /8/, /9/, any enclosed instruction sheets and the wiring plan in chapter 2.1. Earth all of the devices.

3.2 Installation of the SIMATIC software (TIA Portal)

Install the SIMATIC software on your PG/PC according to Table 2-2.

3.3 Configuring the SENTRON PAC3200 devices

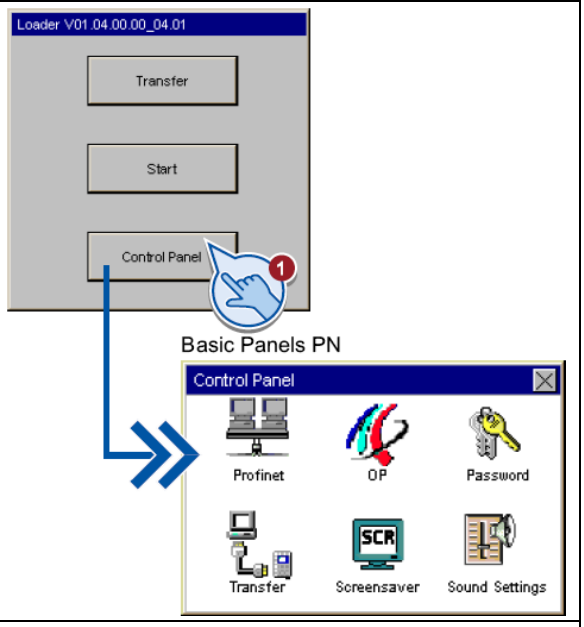
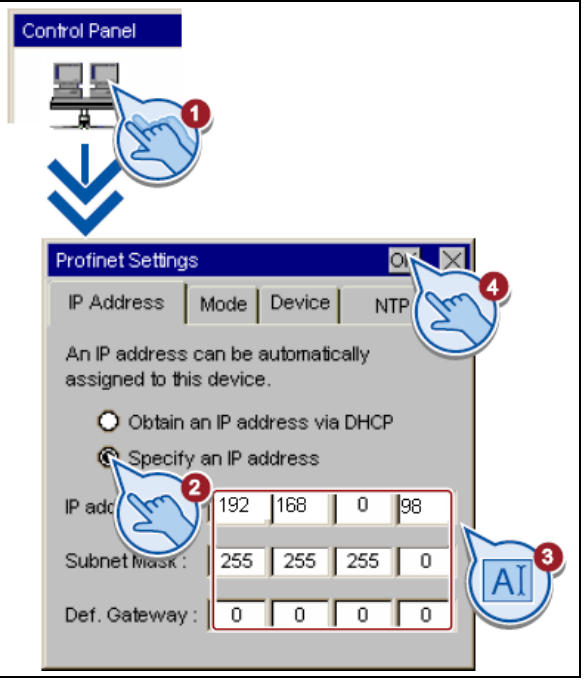
Table 3-1: Configuration of the SENTRON PAC3200

No.	Instruction	Note / Screen
1.	Wire the power side of the SENTRON PAC3200 devices according to their instruction manual /9/ and the power level of the process tag. Do not operate the devices without current transformer.	
2.	Supply the voltage	
3.	Configure the devices for the power unit according to the instruction manual /9/ and the power level of the process tag.	
4.	Configure the devices as follows with regards to communication: • Open the main menu of the SENTRON PAC3200 device via F4. • Navigate to “Settings”, using F2 or F3 and open it with F4. • Navigate to the “Communication” menu item, using F2 or F3 and open it with F4. • Define the following settings: - IP address: 192.168.0.xxx - Sub-network mask: 255.255.255.0 - Gateway: 0.0.0.0 - Protocol: MODBUS TCP For the 4th octet of the IP address please use 200 and 201. • After completing all settings, click F1 and confirm the new start request with F4.	 

3.4 Configuring the operator panel

If the KTP600 is used as operator panel, then the project-specific IP address (see Figure 1-2) must be set. The procedure is as follows:

Table 3-2: Configure operator panel

No.	Instruction	Note / Screen
1.	2. Select the “Control Panel” button to open the control panel of the Loader.	
3.	1. Open the "Profinet Settings" dialog by double-clicking the "Profinet" icon. 2. Select the specific address. 3. In the input fields you enter the - IP address = 192.168.0.98 and the - Subnet Mask= 255.255.255.0 via the screen keyboard. 4. Select “OK” to close the dialog box and apply the entries.	

All further default values can remain unchanged.

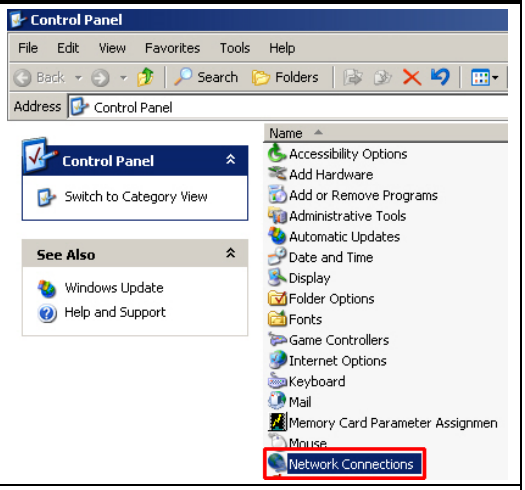
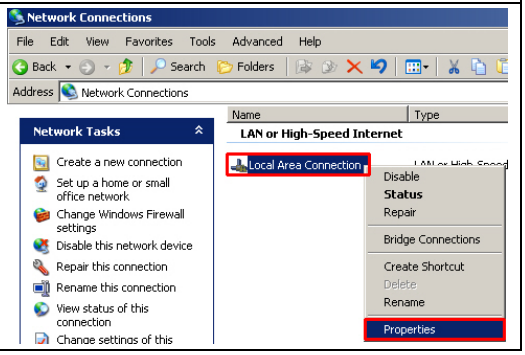
3.5 PG/PC settings on Windows level

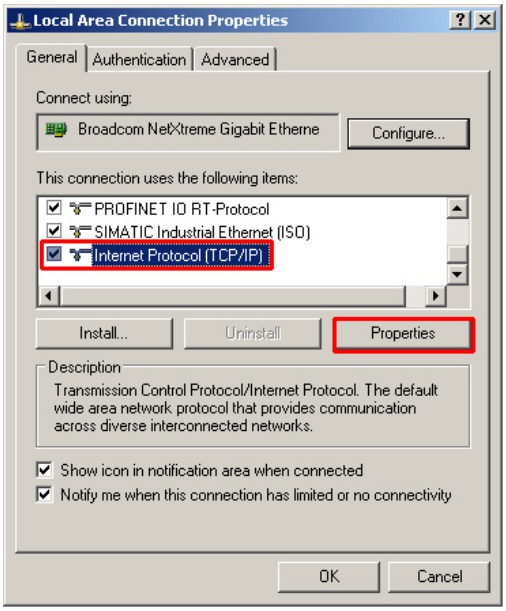
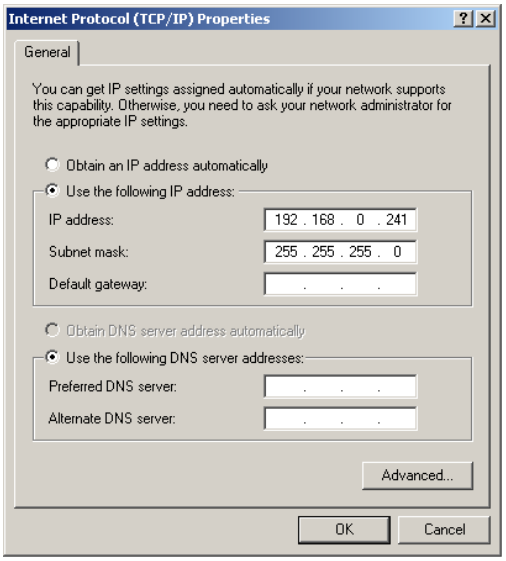
3.5.1 Assigning the IP address of the PG/PC

You have to assign your PG/PC an IP address in the same subnet as the CPUs and the optimum HMI. The IP addresses of the individual stations can be seen in Figure 1-2.

In order to assign the IP address for your network card in the Windows XP operating system, please proceed as follows:

Table 3-3: Assigning the IP address of the PG/PC

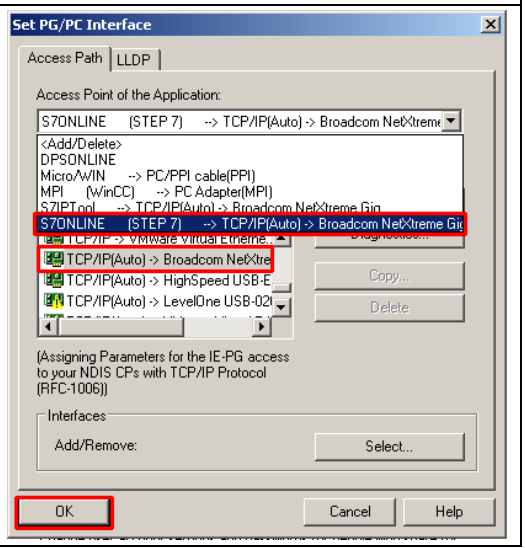
No.	Instruction	Note / Screen
1.	In the Windows Control Panel, open “Network Connections”.	
2.	Select the network card to be used and right-click to open the properties.	

No.	Instruction	Note / Screen
3.	Select the “Internet Protocol (TCP/IP)” item and open its properties.	
4.	• Select “Use the following IP address”. • Enter “192.168.0.241”, for example, as an IP address (see Figure 1-2). (However, you can use any free address in the respective subnet) • In Subnet mask, enter “255.255.255.0”. • Select “OK” to confirm the settings.	

3.5.2 Setting the PG/PC interface

To simulate the KTP600 in the TIA Portal, the PG/PC interface must be set accordingly. The procedure is as follows:

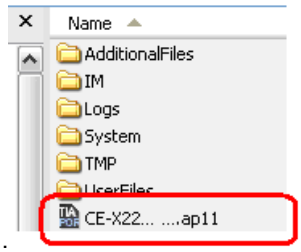
Table 3-4: Setting the PG/PC interface

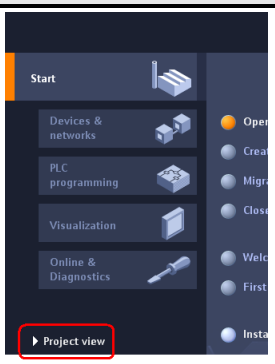
No.	Instruction	Note / Screen
1.	Open the “Set PG/PC Interface” dialog box in the Windows Control Panel.	
2.	• At the access point of the “S7ONLINE (STEP 7)” application, select the interface parameter assignment used for your network card (“TCP/IP(Auto) -> …”) used. • Select “OK” to confirm the settings.	

3.6 Configuration and download of the project

3.6.1 Open the project in the TIA portal

Table 3-5: Open the project in the TIA portal

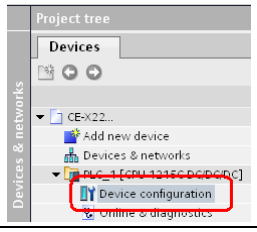
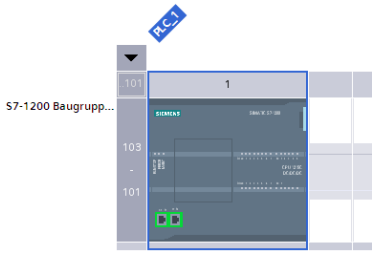
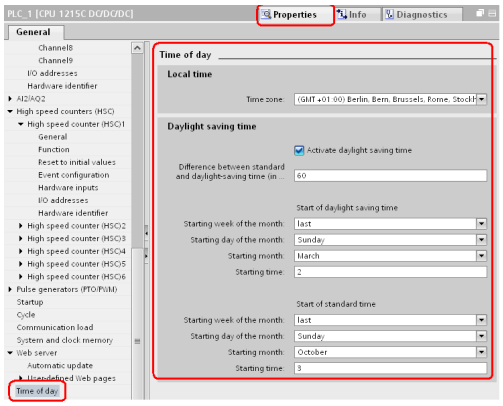
No.	Instruction	Note / Screen
1.	Unzip the archived STEP 7 project (.zip) into any directory on your PG/PC.	
2.	In the Windows Explorer you navigate to your unzipped project folder, open it and start TIA Portal by double-clicking on the contained ap11 file.	 ……

No.	Instruction	Note / Screen
3.	The project opens in the TIA portal. If the TIA Portal has opened in the portal view, go to the project view (depends on the default setting in the TIA Portal).	

3.6.2 Setting the PLC local time

The system time of the KTP600 shall be synchronized with the PLC local time every minute. It must be derived from the PLC system time regarding summer/winter time. Make the respective settings in the “Properties” of the CPU – as explained below.

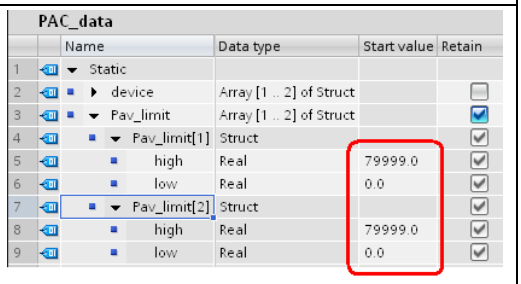
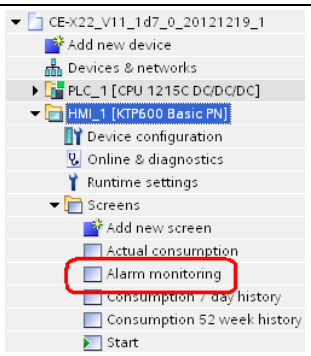
Table 3-6: Setting the PLC local time

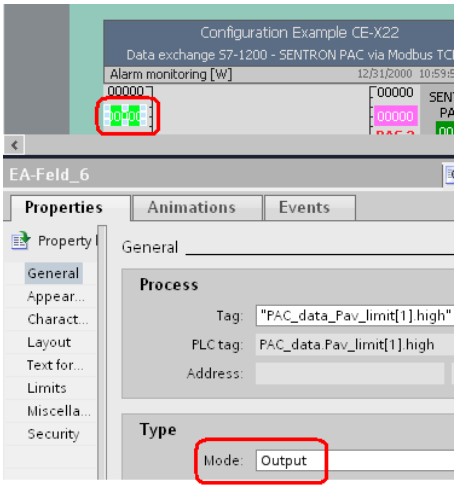
No.	Instruction	Note / Screen
1.	In the Project tree you open the “Device configuration” under “PLC_1” with a double-click.	
2.	In the graphical area you select the CPU.	
3.	• In “Properties” you select “Time of day”. • Select your “Time zone” for calculating the local time. • If necessary, activate the daylight saving time with all required settings.	

3.6.3 Defining the power limits in the configuration (optional)

The power limit values for the short-circuit and defective illuminate detection can be entered conveniently at the operator panel and are then saved retentively in the PLC. If you do not need this functionality, but want the correct power limit values to be written retentively to the controller during program download already, enter these as start values into the DB “PAC_data” prior to loading the program. This has the advantage, that the power limit values are available again after exchanging a CPU, for example.

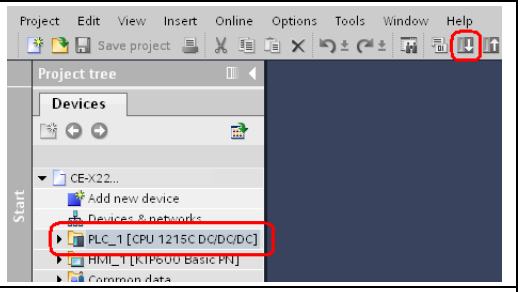
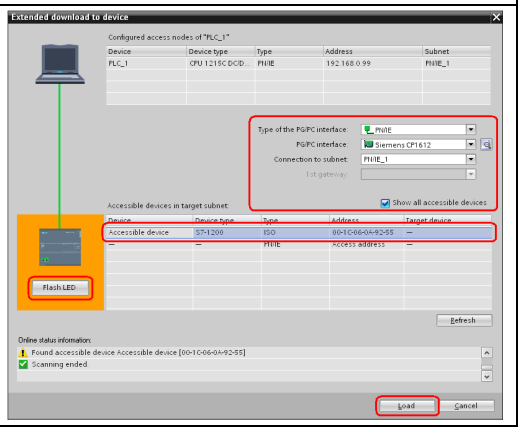
Table 3-7: Defining the power limits in the configuration

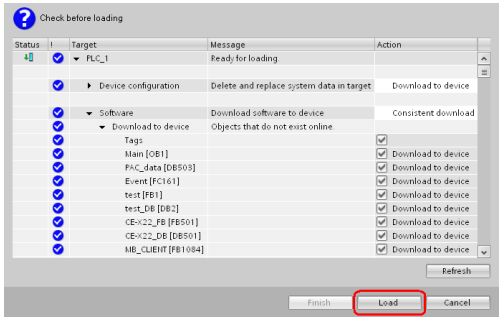
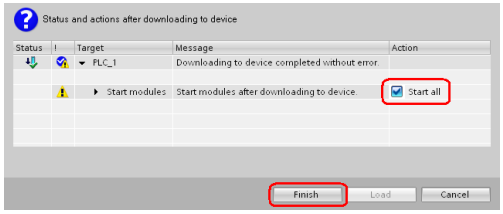
No.	Instruction	Note / Screen
1.	Open DB503 “PAC_data” by double-clicking the block in the project navigation.	
2.	Enter the power limit values of all configured process tags as start values.	
3.	Open the “Alarm monitoring” screen double-clicking the icon in the project tree.	

No.	Instruction	Note / Screen
4.	Set the modes of all four limit value I/O fields to “Output” if you do not want to permit value changes via the operator panel.	

3.6.4 Loading the control unit into the CPU

Table 3-8: Loading the control unit into the CPU

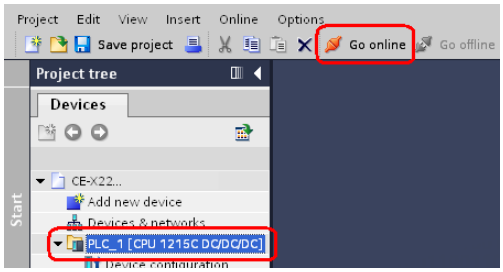
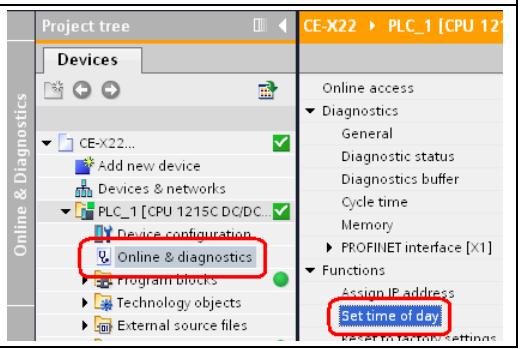
No.	Instruction	Note / Screen
1.	Connect your PG/PC to the CPU directly or using the CSM1277 switch. (see Figure 1-2).	
2.	• Select the “PLC_1 [CPU 1215C DC/DC/DC]” PLC folder. • Select the “Download to device” button to download the PLC project part to the CPU.	
3.	• Select the type of the PG/PC interface used, the interface card and the subnet. • Set the checkmark at “Show all accessible devices”. • Identify your controller from the list of accessible devices using the MAC address or the “Flash LED” option. • Select the selected controller and use the “Load” button.	

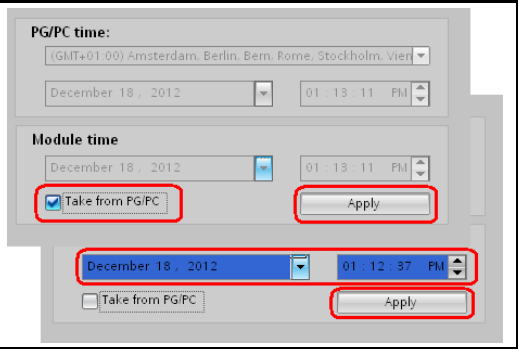
No.	Instruction	Note / Screen
4.	• Select the “Load” button in the “Load preview” screen.	
5.	After transferring all program blocks to the controller, a “download result” window appears. • Check “Start all” to set the controller to “Run” mode. • Select the “Finish” button to finish the entire download.	

3.6.5 Setting the time of the controller

To synchronize the KTP600 or its simulation in TIA Portal with the local time of the controller, the time of the CPU has to be set. Proceed as follows:

Table 3-9: Setting the time of the controller

No.	Instruction	Note / Screen
1.	• In the Project tree you select the controller and press the “Go online” button.	
2.	• In the Project, tree you double-click on “Online & diagnostics” to open it. • Click on “Set time of day”.	

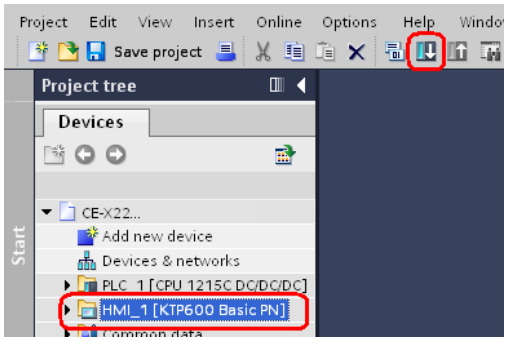
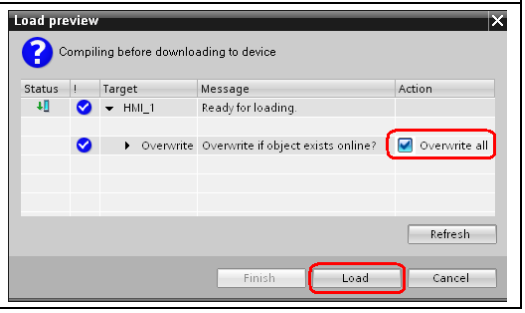
No.	Instruction	Note / Screen
3.	• Adopt the PG/PC time to your controller (check “Take from PG/PC”) or enter the date and time manually (no checkmark at “Take from PG/PC”). • Press the “Apply” button.	

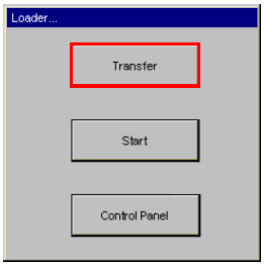
Note A more comfortable and precise setting of the time is provided by receiving the time via GPS tracking (/4/).

3.6.6 Downloading the HMI project part to the KTP600

If the KTP600 is used as operator panel, then the HMI project part has to be loaded to the KTP600.

Table 3-10: Downloading the HMI project part to the KTP600

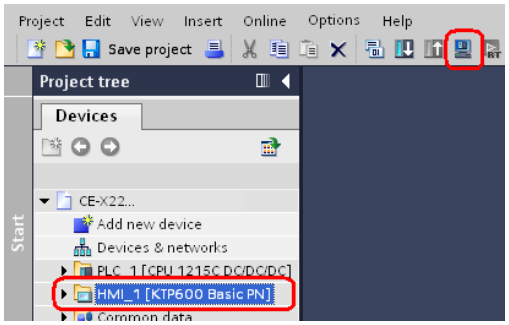
No.	Instruction	Note / Screen
1.	For the transfer, connect your PG/PC to the KTP600 either directly or using the CSM1277 switch.	
2.	• Select the “HMI_1 [KTP600 Basic PN]” operator panel folder. • Select the “Download to device” button to download the HMI project part to the CPU.	
3.	• If necessary, check the “Overwrite all” option in the “Load preview” screen. • Press the “Load” button.	

No.	Instruction	Note / Screen
4.	Depending on the operator panel setting, you have to trigger the transfer in the Loader menu of the KTP600 using the “Transfer” button.	

3.6.7 Start the operator panel simulation on the PG/PC

If the PG/PC is to be used as operator panel, start the operator panel simulation as follows:

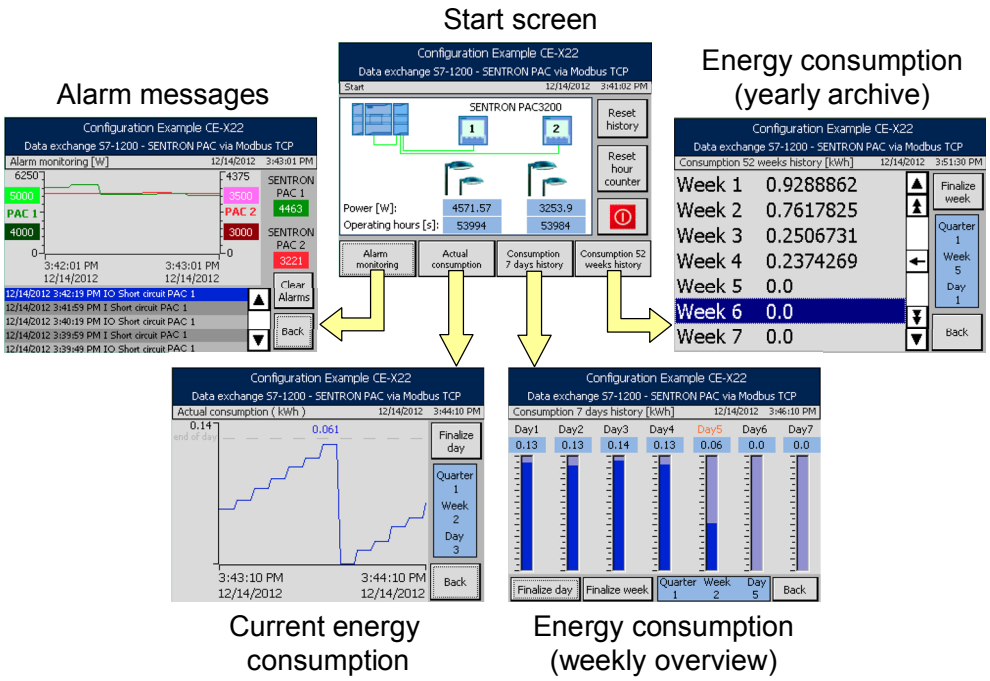
Table 3-11: Start the operator panel simulation on the PG/PC

No.	Instruction	Note / Screen
1.	• Select the “HMI_1 [KTP600 Basic PN]” operator panel folder. • Click the “Start simulation” button.	

4 Operation and Visualization

4.1 Menu navigation

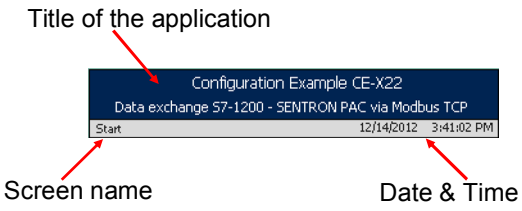
Figure 4-1: Menu navigation



The “Back” button takes you back from the respective screen to the start screen.

4.2 Header

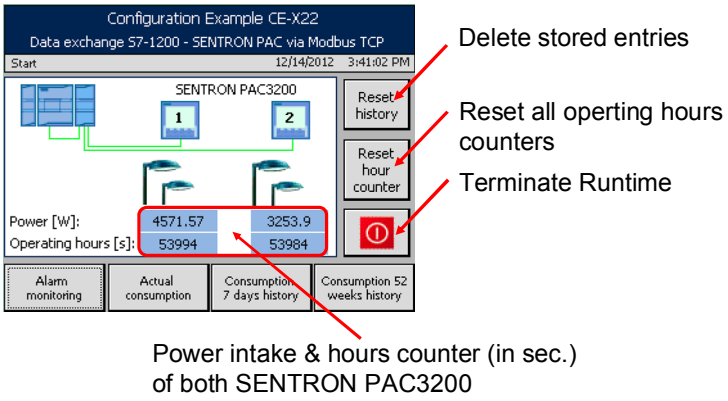
Figure 4-2: Header



Date and time of the operator panel are synchronized once every minute by the S7-1200 CPU

4.3 Start screen

Figure 4-3: Start screen

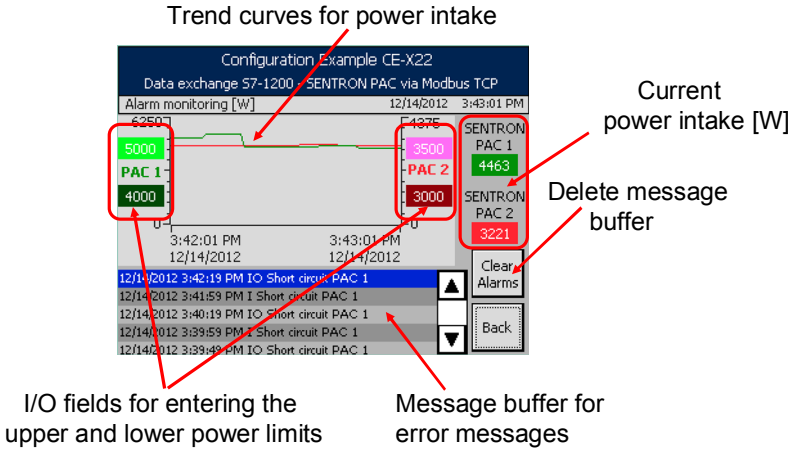


- "Reset history" button
  Delete the following storage entries in the PLC:
  - Deleting the daily energy consumption values of the current week
  - Deleting the weekly energy consumption values of the current quarter
  - Resetting the archiving start to the first day of the first week in the first quarter.

  Any energy consumption already archived in the operator panel as recipes are not affected by the delete process. Use the function if you wish to start a new data archiving at the operator panel.
- "Reset hour counter" button
  Enables the resetting the operating hour counters of all connected SENTRON PAC3200. For measuring devices that cannot be reached, the reset request is stored and once they can be reached, the request is executed. As long as the reset process takes, i.e. as long as not all of the operating hour counters have been reset, the button lights yellow.
- ⏻ button
  Terminating Runtime. This will get you to the loader menu of the KTP600.
- Display of Power intake and Operating hours counter
  The update of power intake and operating hours counter occurs in 5s intervals in this application ("Set22_DB".scan_interval), which means that the communication with the next SENTRON PAC3200 device takes place after 5 seconds. After all devices have been communicated with, communication starts again with device 1.

4.4 Alarm messages

Figure 4-4: “Alarm messages” screen



- **Color coding**
  Curves and values of process tag 1 (PAC 1) are displayed in shades of green, those of process tag 2 (PAC 2) in shades of red.
- **Trend curves of the power intake**
  The measured active power values of both SENTRON PAC3200 devices are displayed. The left ordinate axis is the measure for device 1, the right one for device 2. The specified upper ordinate limits each correspond to 1.25 times the value of the upper power limit of the affected process tag.
- **Current power intake [W]**
  The values correspond to the trend curves at the right end of the x-coordinate.
- **I/O fields for the input of the power limits**
  When exceeding the upper power limit, a short-circuit is assumed for the affected process tag, when falling short of the lower power limit a defective illuminant is assumed. Input values are stored retentively and are available again after a controller restart or after a power cut.
- **Message buffer**
  The following messages are displayed with timestamp and identifier “coming/going”:
  - Short circuit PAC n (n=1..2)
    For simulating a short-circuit and for provoking a respective error message, you can, for example, reduce the upper power limit for a process tag during runtime, so the current active power value is above this limit.
  - Defective illuminant PAC n (n=1..2)
    For simulating a defective illuminant and for provoking a respective error message, you can, for example, reduce the lower power limit for a process tag during runtime, so the current active power value falls below this limit.
  - Connection error PAC n (n=1..2)[5]
    For simulating a communication error, you pull the RJ45 connector from a SENTRON PAC3200 device, for example.
  - Connection error PAC n (n=1..2)
    For simulating a longer connection failure possibly leading to errors in

[5] The difference between “Connection error” and “Connection breakdown” is explained in chapter 6.5.

determining the total energy consumption, pull the RJ45 connector from a SENTRON PAC3200 device for >5 minutes, for example.

Note For a communication breakdown with a SENTRON PAC3200 device, data is no longer transferred to the PLC. The data last received by the PLC is retained and hence also displayed at the operating panel in the trend display (horizontal bar) and as a value. The data is not displayed as zero.

Depending on the system, all above messages have a delay time. Since the messages are generated when it is the turn of the affected device, there can be a maximum delay time of

(number_of_PACs) x (scan_interval)

between the error event and the next communication phase
- i.e. 10s in this application.

- Recipe transmission error
  The message is generated when during transferring the quarterly data into the operator panel (recipe transfer) an error [6] was detected. To provoke this message please proceed as follow, for example:
  In the operator device configuration you delete the recipe and the recipe display in the “Consumption 52 weeks history” screen. Transfer the altered configuration into the operator panel, or restart the simulation. Now go to the “Consumption 7 days history” screen and press on “Finalize week”. After 5 seconds, the respective “coming” message appears in the “Alarm monitoring” screen.
  A “coming message” is generated at the next successful recipe transfer.

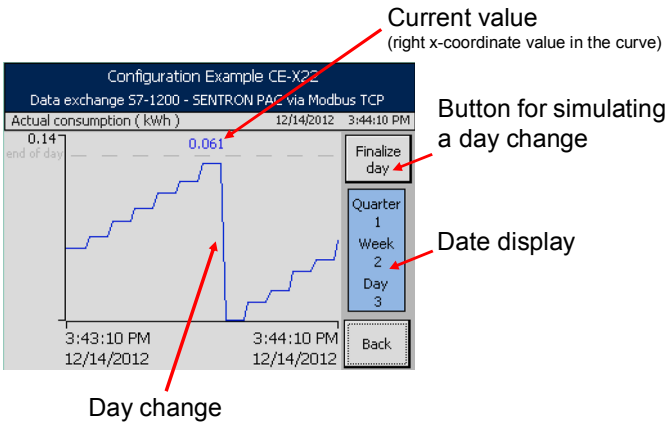
Note A recipe transfer error is also generated if there is no communication connection with the operator panel at the time of the recipe transfer. If the communication is possible again, the recipe is then transferred to the operator panel. The “coming” and “going” messages are at the same time entered into the message buffer.

The content of the message buffer can be deleted with the “Clear Alarms” button.

[6] An error is detected if there is transfer status “completed with error” or if there is no “completed without error” status. The delay time of the “coming” message can be up to 5s.

4.5 Current energy consumption

Figure 4-5: Current energy consumption



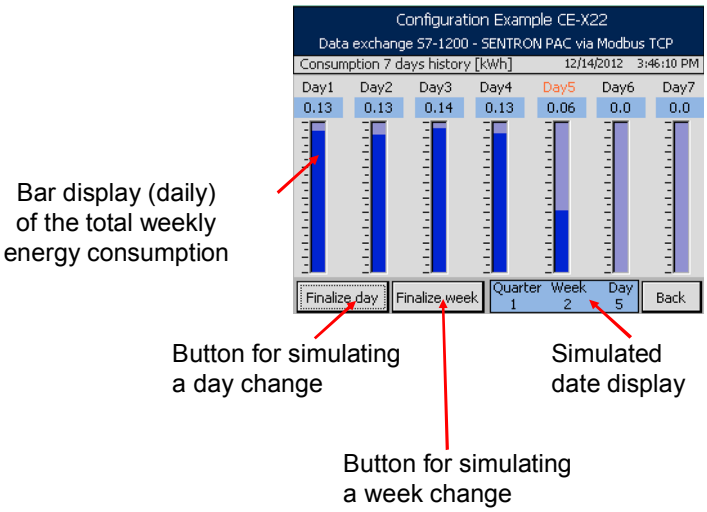
- Trend curve
  Displays the total energy consumption of all consumers connected via the SENTRON PAC3200 devices. The upper ordinate limit automatically adjusts to the energy level. It corresponds to the energy quantity which would accumulate if all consumers (in the application example process tags 1 and 2) were at their upper power limit for 24 hours (limit from when the short-circuit is detected).

  For an energy consumption which exceeds 90% of the upper ordinate limit, a daily change is automatically performed where the energy value is reset to 0.

  A change in the power consumption (e.g. adding or removing a consumer) can be immediately detected at the inclination of the trend curve.
- “Finalize day” button
  It enables the manual simulation of a daily change at any time.
- Date display
  The current data (related to the start of the recordings), to which the energy consumption trend relates, is given as quarter (1..4), week (1..13) within the quarter and day (1..7) within the week. The date display is incremented as the day changes.

4.6 Weekly energy consumption

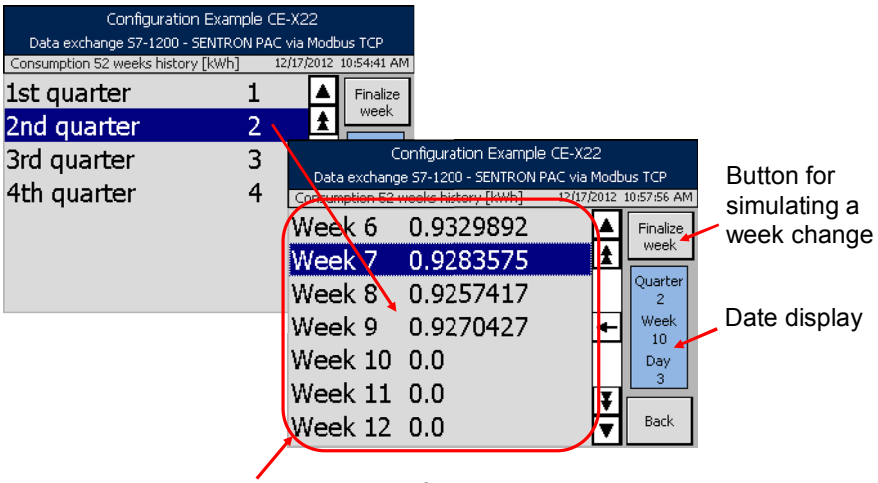
Figure 4-6: Weekly energy consumption



- Bar displays
  Displays the daily total weekly energy consumption of all connected SENTRON PAC3200 devices in bar chart format. The current weekday is shaded in red. The upper bar limit is identical with the upper ordinate limit in Figure 4-5. The daily change automatically produced for the simulation only occurs according to the criteria in chapter 4.5.
- “Finalize day” button
  It enables the manual simulation of a daily change. The addition of the energy consumption for the current day is terminated and continued in the bar of the subsequent day.
- “Finalize week” button
  It enables the manual simulation of a weekly change. The addition of the energy consumption for the current week is terminated and continued on day 1 of the subsequent day. Furthermore, the total energy consumption (weekly values) of the current quarter is archived in the operator panel as a recipe.
- Date display
  As in chapter 4.5.

4.7 The recipe display of the total energy consumption

Figure 4-7: The recipe display of the total energy consumption



- Recipe display
  In contrast to the other screens, the recipe displays shows the energy consumption values already transferred into the operator panel. These are subdivided into 4 quarters. Each quarter shows the total energy consumption values of 13 weeks. In the first level of the recipe display you choose the quarter and this takes you to the desired weekly values. The controller updates the recipe entries and the recipe display in the operator panel by a change of the week.
- “Finalize week” button
  It enables the manual simulation of a weekly change.
- Date display
  As in chapter 4.5.

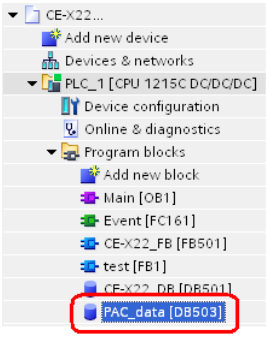
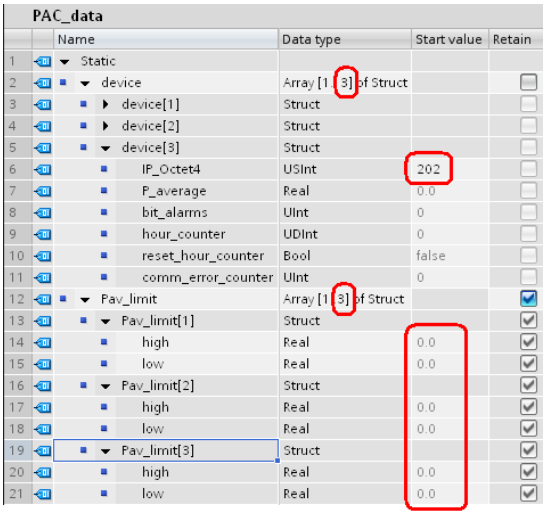
5 Expanding the Number of Process Tags

To be able to run the Set22 sample program with more than two SENTRON PAC3200, you require a switch with more Ethernet ports to which you can connect additional measuring devices. Configure these according to chapter 3.3. As a 4th octet of the IP address you use those values which you enter in DB “PAC_data” in chapter 5.1.

The following example shows the expansion to three SENTRON PAC3200 devices.

5.1 Adjusting the control program part

Table 5-1

No.	Instruction	Note / Screen
1.	Open DB503 “PAC_data” by double-clicking the block in the project navigation.	
2.	Expand both arrays “device” and “Pav_limit” to three elements.	
3.	In the “device” array, you adjust the 4th octet of the IP address to the newly added SENTRON PAC3200 (here: “202”).	
4.	optional: Enter the desired power limits of all added process tags (Pac_limit[3]…) as start values. See also “Defining the power limits in the configuration (optional)” block in chapter 3.6.	
5.	To apply the changes, save, compile and load the DB503 “PAC_data”.	

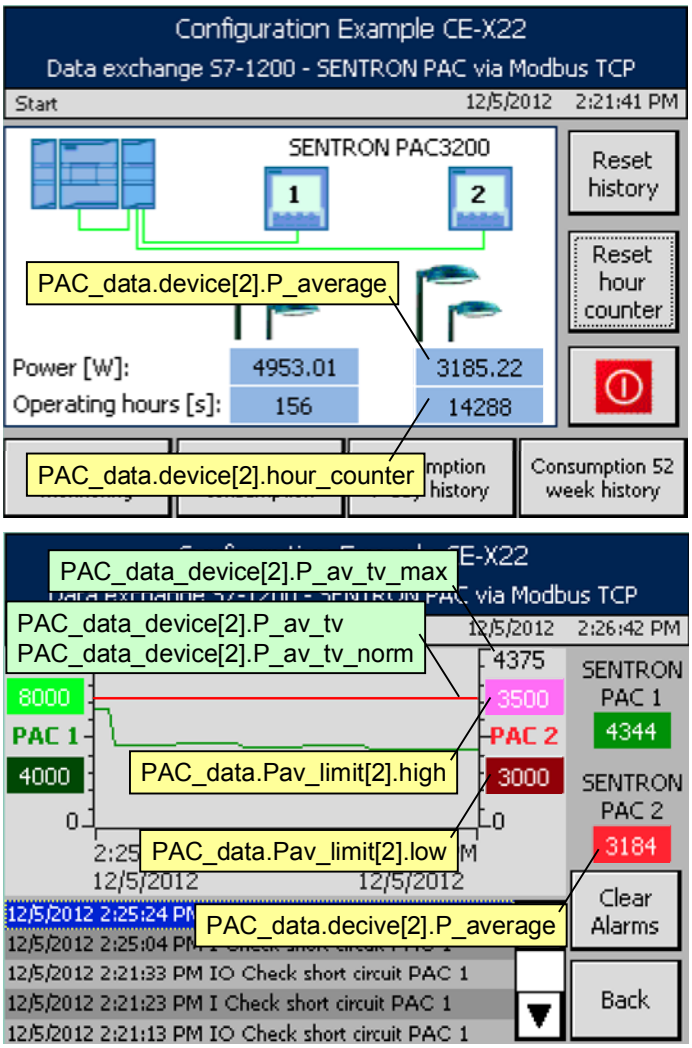
5.2 Adjusting the HMI program part

A clear representation of more than two SENTRON PAC3200 devices would require a larger screen of the operator panel and/or a completely different screen configuration. Since this application does not focus on the operator panel, it is only explained here how to access further tags required for the display on a further measuring device.

Tags in the HMI screens

In Figure 5-1, the tags of a SENTRON PAC3200 required for the HMI display are labeled (using the example of device 2). The tags with yellow names are PLC tags. For those, you need to create respective HMI tags for device 3 (also with index 3). The tags with green names are internal HMI tags, which you copy and, if necessary, must also label with index 3. At a value change, some HMI tags to be copied come with respective events, which in return are described by further HMI tags (e.g. through “linear scaling” in the “Events” tab, for example). Please make sure you also adjust the indices to 3 for these HMI tags.

Figure 5-1: Device-specific tags



Tags in the message display

Supplement the message display by three bit alarms

- “Connection error PAC 3” (trigger bit 0),
- “Connection breakdown PAC 3” (trigger bit 1)
- “Defective illuminant PAC 3” (trigger bit 2),
- “Short circuit PAC 3” (trigger bit 3),

In the project navigation under the HMI device you go to “HMI alarms”. Create the respective HMI trigger tag with index 3 and connect it to PLC tag PAC_data.device[3].bit_alarms.

6 Programming

Note The chapter below helps the deeper understanding of configuration and programming the application example. The content of this chapter is not necessarily required for implementing and operating.

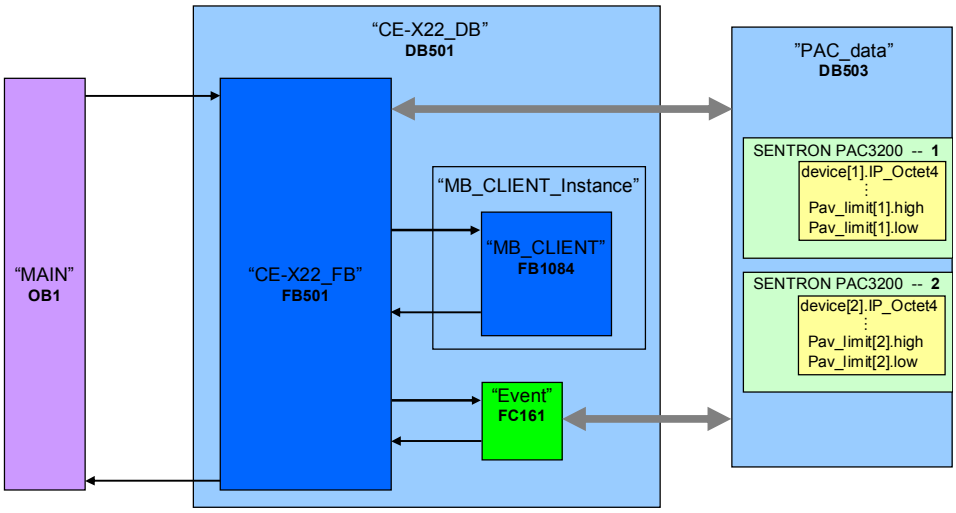
For communication with the SENTRON PAC3200 devices, the MB_CLIENT[7] instruction is used. When writing it to your user program, STEP generates a system FB of identical name. It maps the Modbus/TCP protocol and internally uses the functionality of the communication instructions TSEND, TRCV, TCON and TDISCON.

The resources for the S7-1200 are limited to a maximum of 8 parallel connections. To enable communication with more than eight SENTRON PAC3200 devices, the data exchange with the individually devices in this application is handled serially via a single connection.

Program structure

Figure 6-1 shows the call hierarchy of the code blocks and the access to the data blocks.

Figure 6-1: Program structure



The main component of the application is the user-specific function block FB501 "Set22_FB" (with corresponding instance data block DB501 "Set22_DB"). It is addressed cyclically by OB1 "MAIN" and has the following tasks:

- Controlling the communication with the SENTRON PAC3200 devices in form of a step chain with periodic calls of FB1084 "MB_CLIENT" (its data is also included in the multi-instance-capable "Set22_DB".).
- Preparation and evaluation of communication data according to the requirements of the task description in chapter 1.

[7] The instruction is available in the "Instructions" task card at *Communication* > *Communication processor* > *MODBUS TCP*

Data block DB503 “PAC_data” contains specific information regarding the SENTRON PAC3200 devices, such as their IP addresses, their definable power limit values for short-circuit or defective illuminant detection, as well as further stored data (current power values, alarm bits, operating hours, etc.). The data is accessed via FB501 “Set22_FB”.

The FC161 “Event” function is an auxiliary function and facilitates entering HMI bit alarms into the respective trigger tag.

Overview of the blocks

The following table gives you an overview of the blocks used.

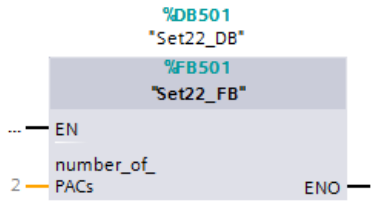
Table 6-1: Blocks used

Object name	Symbolic name	Description
OB1	Main	Cyclic organization block; it only contains the call of Set22_FB.
FB501	Set22_FB	Function block for the deterministic data exchange with several SENTRON PAC3200 devices
DB501	Set22_DB	Instance data block for FB501 “Set22_FB”
FB1084	MB_CLIENT	From the identically named instruction of system FB created by STEP 7 for controlling the MODBUS TCP protocol
DB503	PAC_data	Contains the data of all SENTRON PAC3200 devices necessary for the application
FC161	Event	Help function for entering HMI bit alarms into the respective trigger tag

6.1 Function block SET22_FB (FB501)

The function block for deterministic data exchange with several SENTRON PAC3200s via Modbus/TCP is called cyclically in OB1.

Figure 6-2: Call of FB501 “Set22_DB”



The selected instance data block is DB501. As the only input, the maximum number of SENTRON PAC3200 must be specified at the “number_of_PACs” parameter

The following static tags of FB501 can be modified by the user if required.

Table 6-2: Static tags of Set22_DB which cannot be modified by the user

Name	Data type	Description
scan_interval	Time	After this time has elapsed, the connection with the MODBUS slave n is terminated and reestablished with slave n+1. If successful, it is assumed, that the communication with a slave can be processed completely during this time. If the time is exceeded, the error routines start. 5 ms are set as the default value for this application with two SENTRON PAC3200 devices.
comm_err_msg_delay	Time	The time a communication error with a SENTRON PAC3200 device must be continuously pending until the communication breakdown is reported at the operator panel. “Continuously” means, that during that time not a single communication request for the respective device is satisfied.
sample_max	UInt	The active power is read from the SENTRON PAC3200 device several times in direct sequence and the average value is formed. How often the reading takes place is defined by “sample_max”.

NOTICE	**For measuring the “scan_interval” time, there are experience values which should be met in order to minimize communication errors.** • **A connection with the same SENTRON PAC3200 should not be established more than every 10 seconds. Therefore, a scan_interval of 5s was given with two measuring devices in this application.** • **Since the communication with a SENTRON PAC3200 can normally take up to 300ms, “scan_interval” should not be shortened to below 300ms – even for more than 33 process tags.**

6.1.1 Program sequence in Set22_FB (FB501)

Figure 6-3: Cyclic program sequence (1)

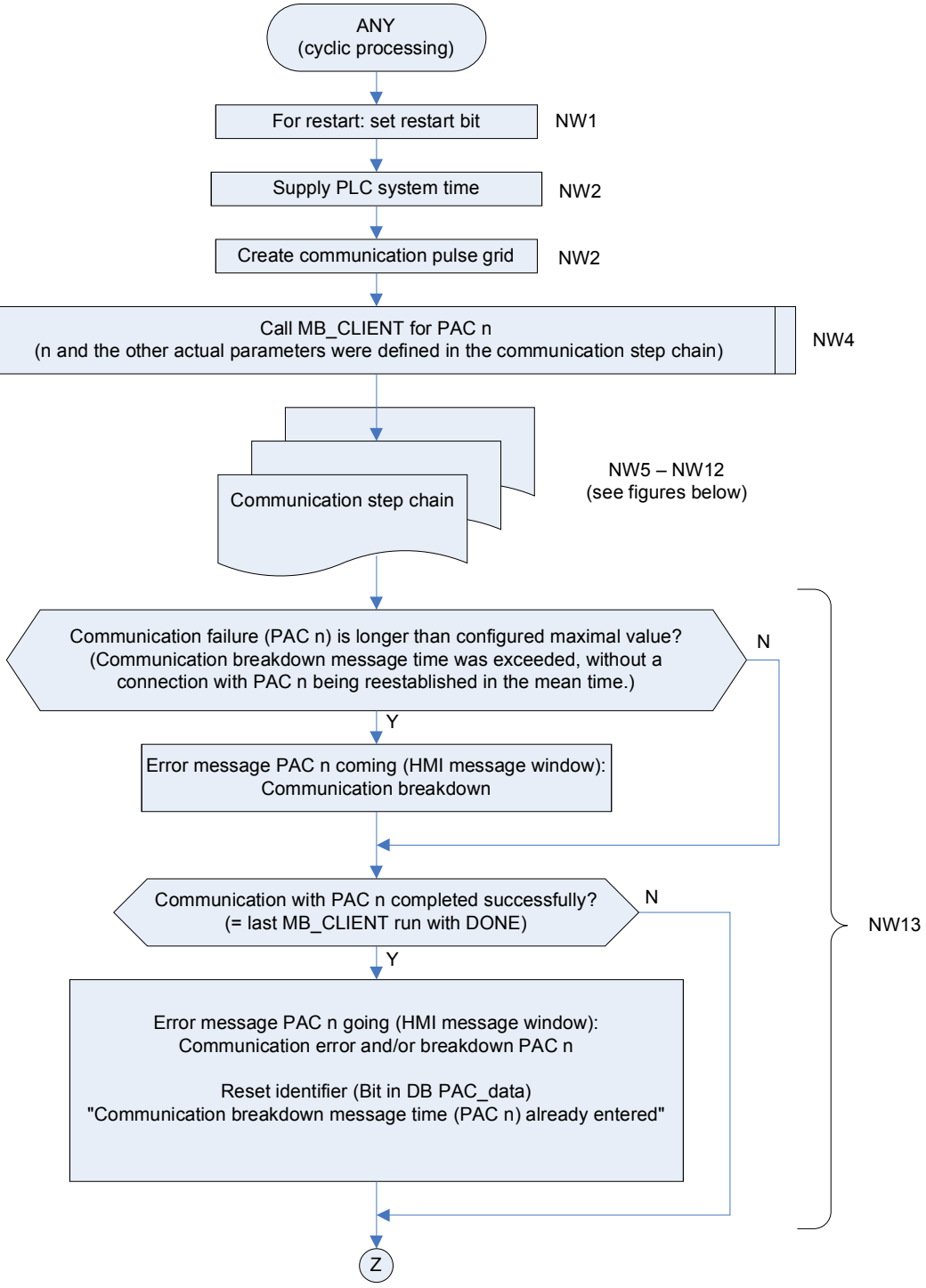
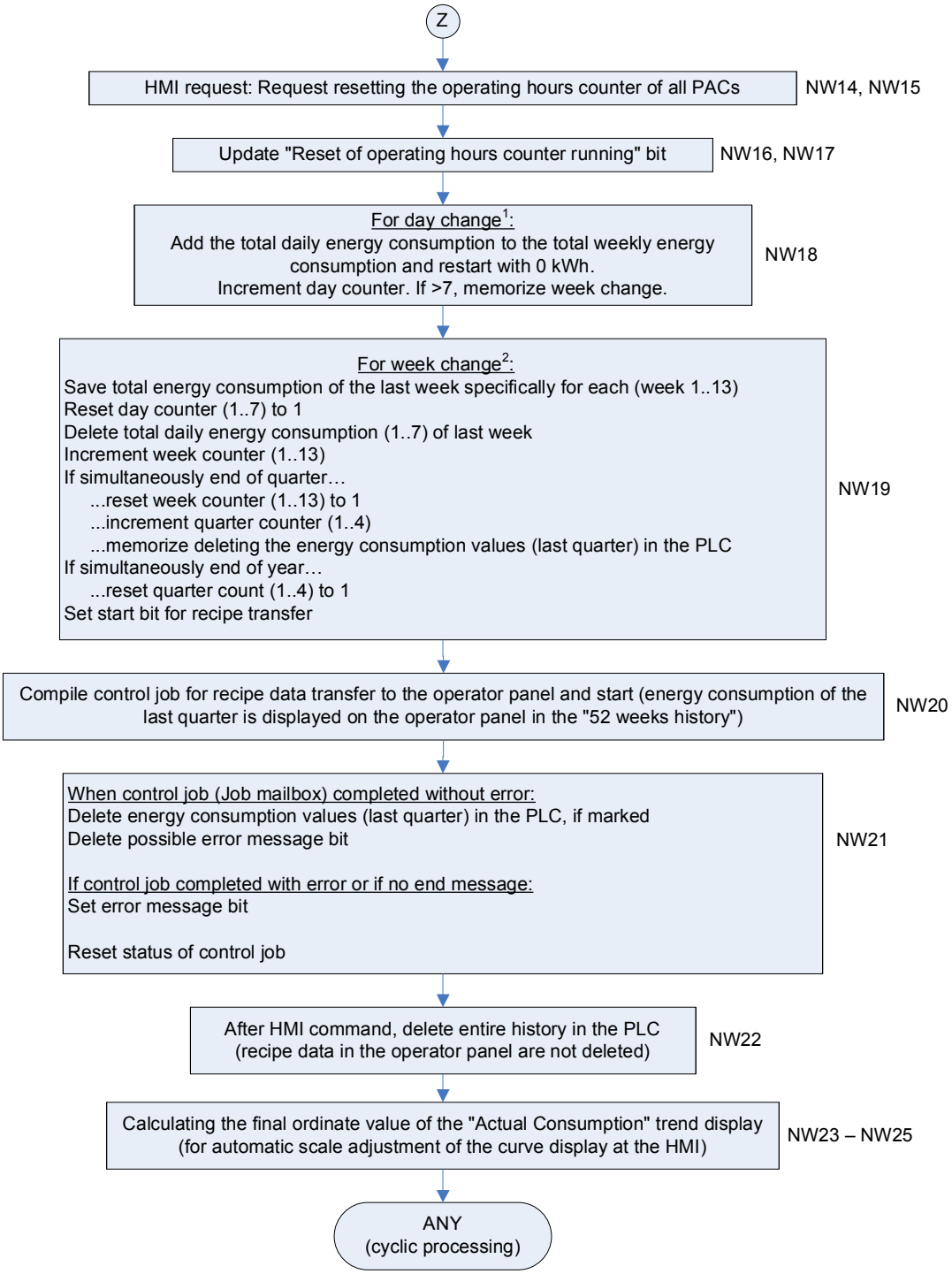


Figure 6-4: Cyclic program sequence (2)



[1] day change is simulated by HMI operation or exceeding the energy value.
[2] week change can be simulated by HMI operation.

Figure 6-5: Communication step chain (1)

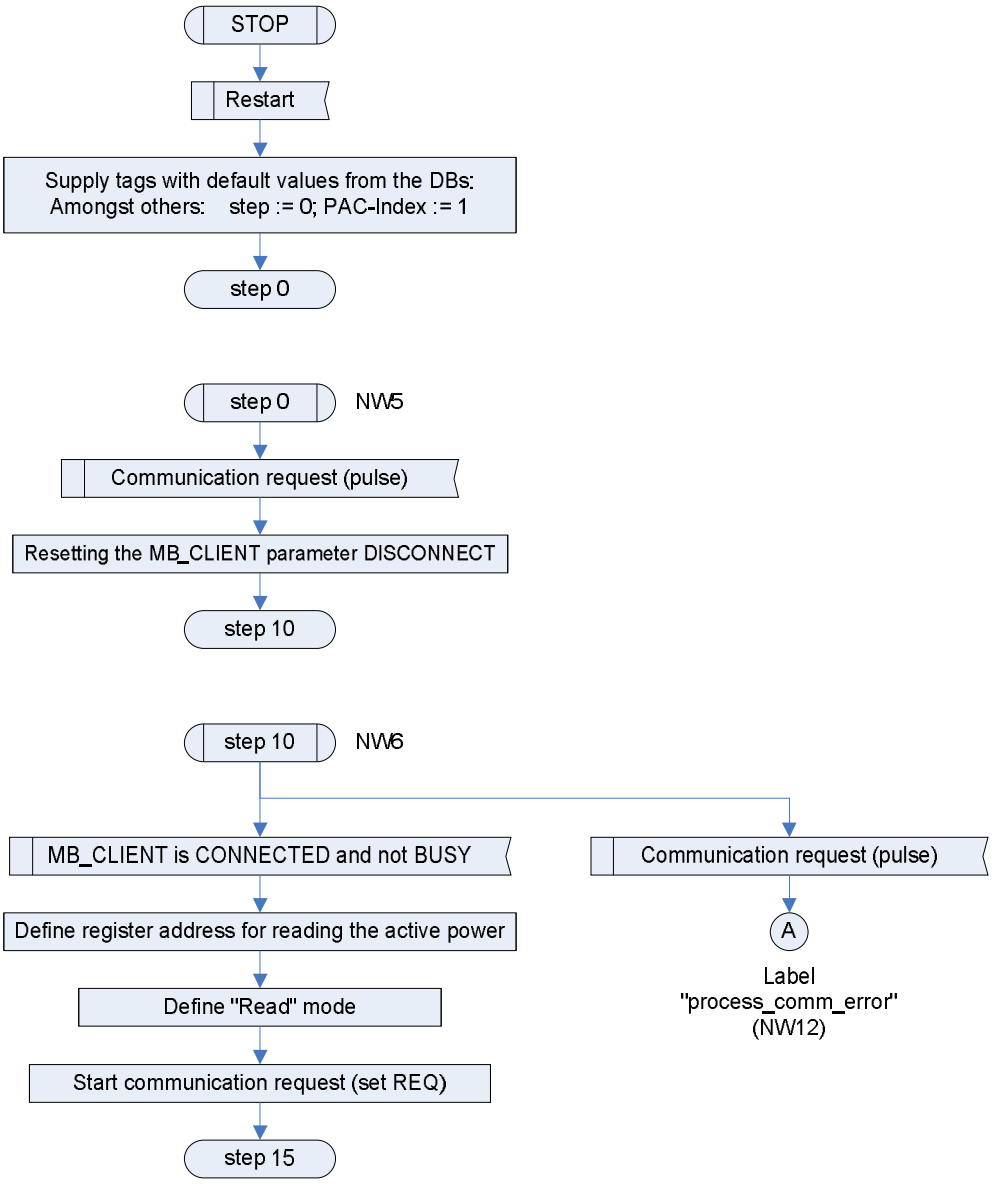


Figure 6-6: Communication step chain (2)

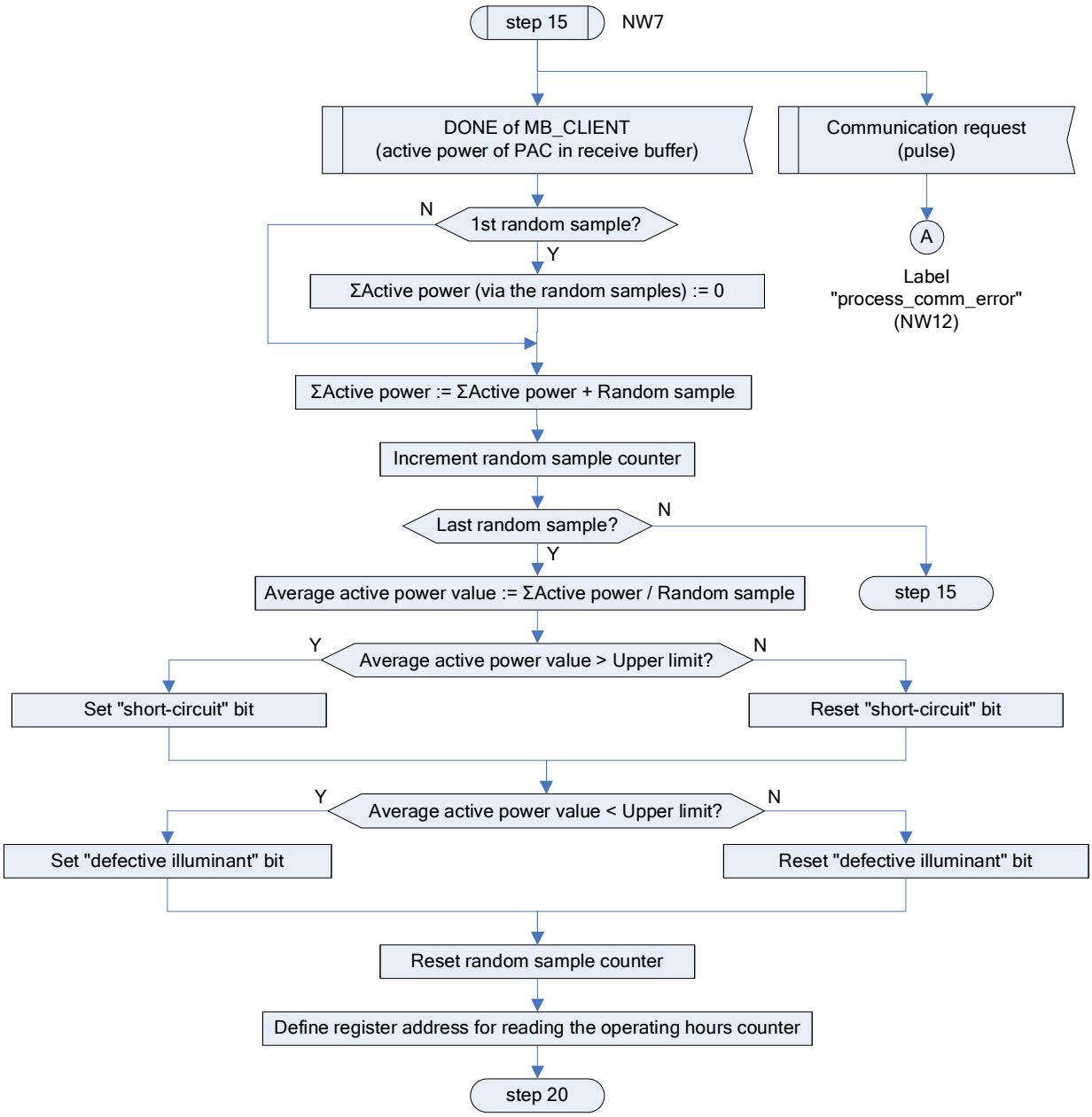


Figure 6-7: Communication step chain (3)

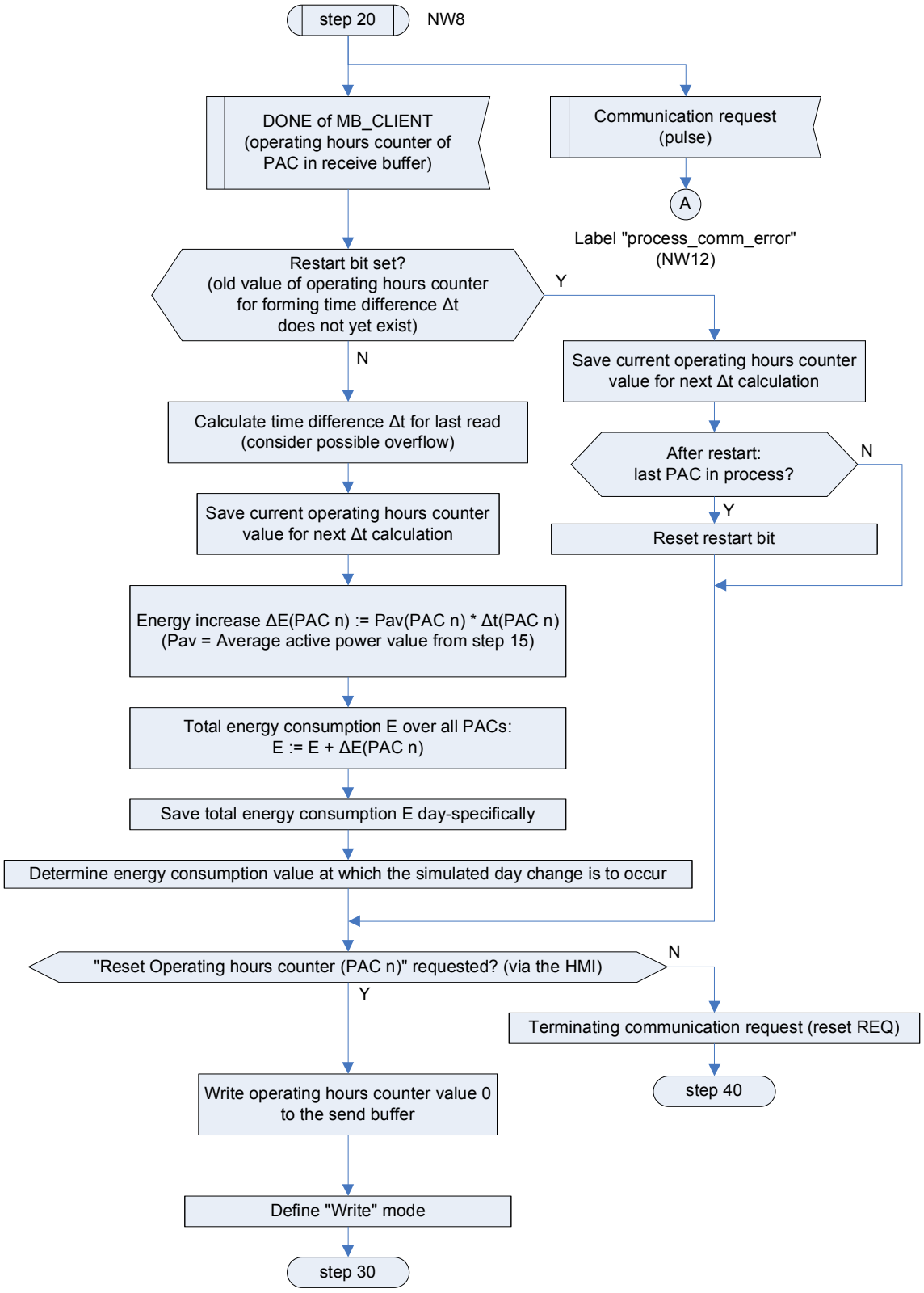


Figure 6-8: Communication step chain (4)

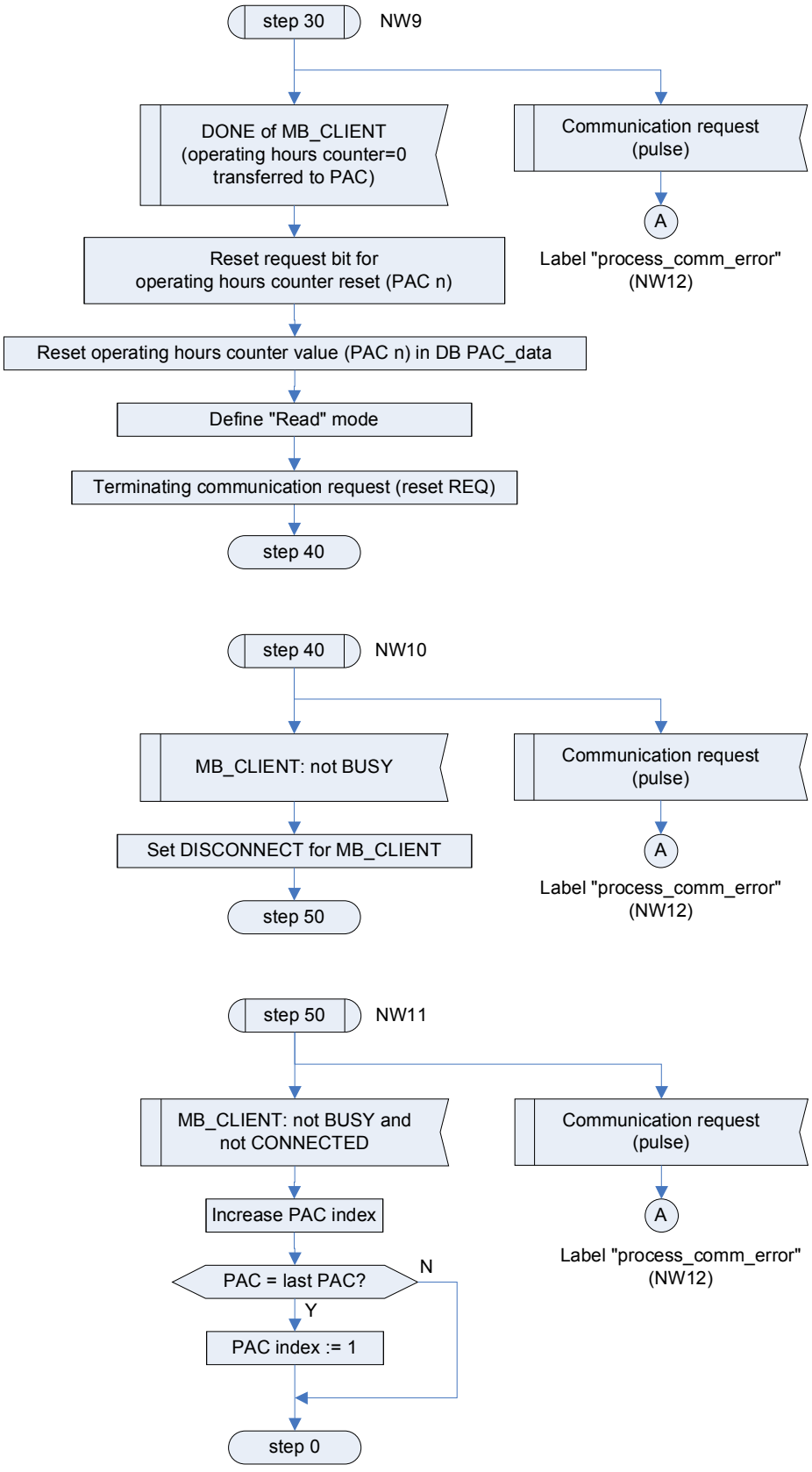
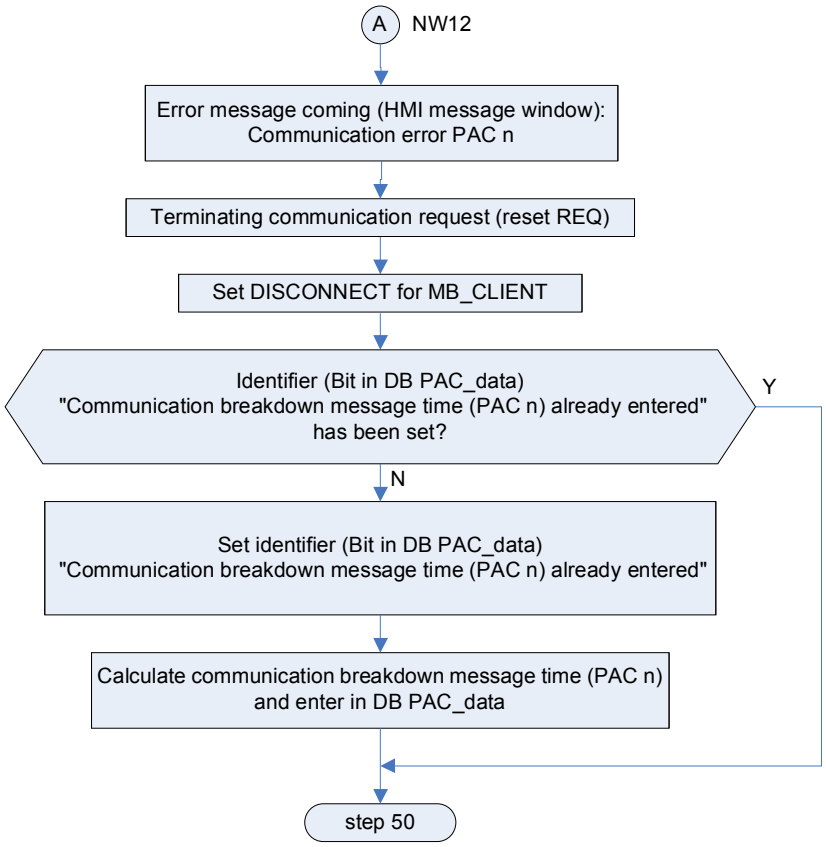


Figure 6-9 Communication step chain (5)



6.1.2 Explanations on the networks of Set22_FB (FB501)

NW1

During a restart, a “restart” bit is set. It is used for preventing the calculation of the energy consumption value at the first communication to each SENTRON PAC3200 after the restart. For the first communication, only the current operating hours counter value of each measuring device is entered into DB “PAC_data” as old value. This is necessary, since calculating an energy quantum requires a time difference, which however, can only be formed after the second communication with each SENTRON PAC3200 device.

NW2

The PLC system time is used...

- in order to specify and store a communication breakdown message time (“PAC_data”.device.Comm_breakdown.err_msg_time) for each SENTRON PAC3200 device with communication breakdown. If the communication breakdown message time is exceeded without reestablishing the connection with the respective SENTRON PAC3200 device in the mean time, a message appears on the HMI (Connection breakdown). The communication breakdown message time is formed by adding the time of detection of a communication breakdown and a configurable wait time (“Set22_DB”.comm_err_msg_delay, see last bullet point in chapter 6.5).

- to synchronize the operator panel with it. This requires the current time to display it and for the time stamp of the error messages.

NW3

The communication with the SENTRON PAC3200 devices occurs serial. First, the connection with device n is established, then communication takes place and afterwards, the communication is terminated to continue with device n+1. The time grid ("Set22_DB".scan_interval) this is performed with can be configured. In NW3 a pulse is generated in this grid, which serves as communication trigger.

NW4

In NW4 the FB "MB_CLIENT" is called cyclically. The communication is controlled by its actual parameters, which in the further course of the program are continuously adjusted.

NW5

NW5 contains step 0 of the communication step chain. In step 0, it is waited until the "Trigger pulse" event (see NW3). After it has occurred, the MB_CLIENT parameter "DISCONNECT" is reset and proceeded to step 10.

NW6

NW6 contains step 10 of the communication step chain.

If the "CONNECTED and NOT BUSY" conditions of MB_CLIENT have been met, it is configured for reading the electrical power[8]. The Modbus register address and the mode are specified (read or write). Subsequently, the communication request is started by setting the MB_CLIENT parameter REQ and branched to step 15.

If a renewed communication trigger pulse arrives, before the above conditions are fulfilled, it can be assumed, that an error is present and an error routine is branched off which ends in step 50 (see NW12).

NW7

NW7 contains step 15 of the communication step chain.

It waits for the "DONE" message of "MB_CLIENT", which indicates, that the electrical power was transferred without faults from SENTRON PAC3200 to the receive buffer of S7-1200. After "DONE" has occurred, the network is further processed.

[8] The active power is read from the three phases.

Figure 6-10: Transferred active power value

Since the power value shall be averaged over n random samples, it is measured several times in direct succession. This is performed without exiting step 15. The number of random samples can be configured (“Set22_DB”.sample_max). After completing the n-fold reading, averaging the value and device-related storing in DB “PAC_data”, the active power value is checked for defective illuminants (power too low) and short-circuit (power too high). Error cases are displayed on the control panel. Before branching off to step 20, the Modbus register address for reading the operating hours counter, which is pending next, is transferred to the “MB_CLIENT”.

If in step 15 a communication trigger pulse arrives, it can be assumed, that an error is present and an error routine branch is followed that leads to step 50 (see NW12).

NW8

NW8 contains step 20 of the communication step chain.

It waits for the “DONE” message of “MB_CLIENT”, which indicates, that the operating hours counter was transferred without faults from SENTRON PAC3200 to the receive buffer of S7-1200. After “DONE” has occurred, the network is further processed.

Figure 6-11: Transferred operating hours counter value

The device-related energy quantum, which is formed by multiplying the averaged active power from NW7 and the time difference between the last two operating hours counter values (currently read value and value of the last send request for this measuring device), is in this step always added back to the total energy consumption value of all SENTRON PAC3200 devices (“Set22_DB”.E_kWh). It is then saved day-specifically (“Set22_DB”.E_day[n], n=1..7).

When calculating the energy consumption, the following must be considered in this network:

- Overflow of the operating hours counter in the SENTRON PAC3200.

- At the first run of step 20 for all SENTRON PAC3200 devices after the restart, neither a device-related energy quantum can be calculated, nor the total energy consumption value be updated. This is because at this point in time, no time difference for the operating hours counter is available yet for calculating the energy quanta. For the first respective communication cycle after the restart, only the current operating hours counter values are entered into DB “PAC_data” as old value. In the respective second communication cycle from the restart on, the time differences of the operating hours counters are then available for calculating the energy quanta.

Subsequent to the integration of the energy consumption, the “Set22_DB”.E_day_overflow energy value is calculated in NW8, which is used as follows:

- The application saves the daily energy consumption for every single day of the week. For a better demonstration, the day change does not occur after 24 hours, but simulated – depending on a certain energy quantum “Set22_DB”.E_day_overflow. It corresponds to 90% of the upper ordinate limit in the “Actual Consumption” screen. This upper ordinate limit is the energy which would accumulate if all consumers were at their upper power limit for 24 hours (limit from when the short-circuit is detected).

At last, NW8 polls whether the reset of the operating hours counters of all SENTRON PAC3200 devices was requested via the operator panel. If yes, the default value 0 of the operating hours counter is written to the send buffer, the “Write” mode for MB_CLIENT is set, branching off to step 30. If no, the communication request is cancelled by resetting the MB_CLIENT parameter “REQ”, branching off to step 40.

If in step 20 a communication trigger pulse arrives, it can be assumed, that an error is present and an error routine branch is followed that leads to step 50 (see NW12).

NW9

NW9 contains step 30 of the communication step chain.

It waits for the “DONE” message of “MB_CLIENT”, which indicates, that the operating hours counter of the SENTRON PAC3200 device, to which the communication is currently directed, was overwritten with 0. After “DONE” has occurred, the network is further processed.

The reset request of the operating hours counter in DB “PAC_data” for the currently processed SENTRON PAC3200 device is reset, as well as the operating hours counter value in DB “PAC_data”.

Then the “Read” mode for “MB_CLIENT” is set again, the communication request cancelled by resetting the “MB_CLIENT” parameter “REQ”, and the branch to step 40 is followed.

If in step 30 a communication trigger pulse arrives, it can be assumed, that an error is present and an error routine branch is followed that leads to step 50 (see NW12).

NW10

NW10 contains step 40 of the communication step chain.

If the “NOT BUSY” condition of “MB_CLIENT” is true, “DISCONNECT” is set for the next “MB_CLIENT” call, branching off to step 50.

If in step 30 a communication trigger pulse arrives, it can be assumed, that an error is present and an error routine branch is followed that also leads to step 50 (see NW12).

NW11

NW11 contains step 50 of the communication step chain.

If the “NOT CONNECTED and NOT BUSY” condition of MB_CLIENT is fulfilled, the count index of the SENTRON PAC3200 devices is incremented or reset to 1, if all have already been processed. Subsequently, the branch to step 0 is followed again.

If in step 50 a communication trigger pulse arrives, it can be assumed, that an error is present and an error routine branch is followed that in return leads to step 50 (see NW12).

NW12

NW12 is still part of the step chain and describes the error routine jumped to from steps 10,15, 20, 30, 40 and 50 when a communication error occurs. Sequence as follows:

For the currently processed SENTRON PAC3200 device a “Connection error PAC n” (coming) is output, the communication request cancelled by resetting the MB_CLIENT parameter REQ, and the MB_CLIENT parameter DISCONNECT is set.

If no of the communication breakdown message time has yet been entered into DB PAC_data for the measuring device with communication breakdown, the message time is calculated and saved (see also Explanations on NW2).

Subsequently, the branch to step 50 is followed.

NW13

It is polled whether a current reporting time of the communication breakdown has been entered in DB “PAC_data” for the currently processed SENTRON PAC3200 device. If this is the case, and the time has already been exceeded, the “Connection breakdown” (coming) message is displayed on the operator panel. It marks an uninterrupted communication breakdown with the respective SENTRON PAC3200 device, which is longer then the configured value “Set22_DB”.comm_err_msg_delay.

It is polled whether the MB_CLIENT outputs a DONE pulse for the currently processed SENTRON PAC3200 device. If yes, the messages “Connection error PAC n” and/or “Connection breakdown PAC n” – as far as pending – are reset, or labeled as “going” (“O”) on the operator panel, and an entered communication breakdown message time is deactivated (= respective identifier “PAC_data”.device[n].Comm_breakdown.started is reset).

NW14, NW15

If the resetting of all operating hours counters is requested via the operator panel (“Set22_DB”.reset), every process tag must be informed of this. The respective bits “PAC_data”.device[n].reset_hour_counter are set via loop processing. They are deleted after successfully resetting the respective operating hours counter in NW9.

NW16, NW17

Resetting all operating hours counters takes relatively long, since the communication to all SENTRON PAC3200 devices must be performed in sequence. Therefore, the processing time is displayed for the user on the operator panel (“Set22_DB”.reset_display). In a loop, all process tags are polled for whether each has been requested for resetting the operating hours counter. If this is the case for at least one SENTRON PAC3200 device, “Set22_DB”.reset_display is set. If this is no longer the case for any process tag, the bit is reset.

NW18

For a change of day proceed as follows:

- The integrated total daily energy consumption (“Set22_DB”.E_kWh) is added to the weekly energy consumption (“Set22_DB”.E_week_kWh) and set to 0.
- The day count (“Set22_DB”.day) is incremented. If it exceeds the value 7 (weekend), a respective identifier (“Set22_DB”.week_overflow) is set. The day count is used to enter the daily energy consumption under the correct day of the week in the “7 days history” screen.

As a day change, the application does not use the transition 24:00 ⇨ 0:00, but for simulation purposes the following criteria:

- Daily energy consumption exceeds a certain limit value (Bit “Set22_DB”.E_day_overflow, see explanation on NW8).
- Day is “terminated” at the operator panel by pressing a button (Bit “Set22_DB”.finalize_day).
- Week is “terminated” at the operator panel by pressing a button (Bit “Set22_DB”.finalize_week).

Note For a real application you replace the criteria for a day change in this network by real current time references

NW19

For a change of week proceed as follows:

- The integrated total weekly energy consumption of the last week (“Set22_DB”.E_week_kWh) is saved specifically for each week (“Set22_DB”.E_week[n], n=1..13) and set to 0.
- The day count (“Set22_DB”.day, n=1..7) is reset to 1.
- All values of the total daily energy consumption (“Set22_DB”.E_day[n], n=1..7) are set to 0.
- The week count (“Set22_DB”.week, n=1..13) is incremented and reset to 1 at the end of the quarter (>13 weeks).
- The quarter count (“Set22_DB”.data_record_no, n=1..4) is incremented and reset to 1 at the end of the year (>4 quarters).

- The following two bits are set:
  - Bit “Set22_DB”.write_recipe
    The bit is set on each weekend for one cycle. In the subsequent network it triggers the entry of the recipe transfer parameter into the control job (Job mailbox) and its start. The recipe is also written to the operator panel at the end of each week.
  - Bit “Set22_DB”.quarter_end
    The bit is set at the end of each quarter for one cycle. It causes the 13 week values of the last quarter in the PLC (“Set22_DB”.E_week[n], n=1..13) to be overwritten with 0 at the end of the quarter after successful transfer of the recipe.

NW20

With “Set22_DB”.write_recipe = true the recipe transfer parameters are entered in Job mailbox, initiating its start. “Set22_DB”.recipe_started is set as the execution message. If the job was triggered at the end of the quarter (Bit “Set22_DB”.quarter_end = true), its start is noted by Bit “Set22_DB”.recipe_started_quater_end.

NW21

The status (“Set22_DB”.data_record[3]) of the synchronous data record transmission is polled.

- If the transmission was completed without errors (“Set22_DB”.data_record[3] = 4), a possibly pending recipe transmission error (originating from the last transmission) is reset (“going” message). If the transmission was triggered at the end of the quarter, the 13 week values for active power in the current quarter (“Set22_DB”.E_week[n], n=1..13) stored in the PLC are deleted.
- If the transmission was completed with error (“Set22_DB”.data_record[3] = 12), or an end status has not yet been output within 5s after triggering the recipe transfer (“Set22_DB”.data_record[3] ≠ 4,12), a recipe transfer error (“coming” message) is reported at the operator panel. In the real case, the user has now one week to save the 13 week values for active power of the last quarter (“Set22_DB”.E_week[n], n=1..13) before they are deleted.

Then the program resets the bits “Set22_DB”.recipe_started and “Set22_DB”.recipe_started_quater_end and overwrites the status of the synchronous data record transmission with 0.

NW22

When requested by the operator panel, the entire history stored in the PLC can be deleted. This refers to the following data:

Table 6-3: Deleting the history

	Tag in Set22_FB	
Current daily energy consumption	E_kWh	⇨ 0
Current weekly energy consumption	E_week_kWh	⇨ 0
All daily energy consumption values of the current week	E_day[n], n=1..7	⇨ 0
All weekly energy consumption values of the current quarter	E_week[n], n=1..13	⇨ 0
Quarter number	data_record_no	⇨ 1
Week number	week	⇨ 1
Day number	day	⇨ 1

Please consider, that the recipe data record to be transferred to the operator panel next is filed after deleting the history for Quarter/Week/Day = 1/1/1 and overwrites the old data.

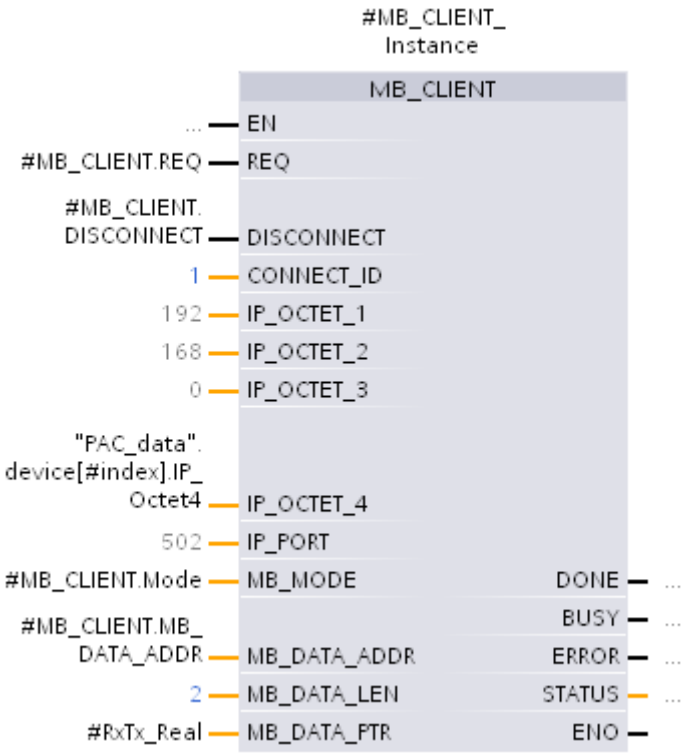
Note In a real application it makes sense not to reset the above time tag to 1, but to the current calendar values. If necessary, modify the program in this sense.

NW23, NW24, NW25

The ordinate scale in the trend display of the current daily energy consumption on the “Actual consumption” HMI screen, automatically adjusts to the power level of the connected consumers. The upper ordinate limit (“Set22_DB”.E_kWh_limit) is defined as the energy which would accumulate if all consumers were at their upper power limit for 24 hours (limit from when the short-circuit is detected). “Set22_DB”.E_kWh_limit is calculated via all SENTRON PAC3200 devices by means of loop processing.

6.2 System function block MB_CLIENT (FB1084)

Figure 6-12: Call of system block FB1084 “MB_CLIENT”



FB1084 “MB_CLIENT” is generated by STEP 7, as soon as you drag the identically named instruction into your user program when editing the program. In the application, FB1084 “MB_CLIENT” is called once by FB501 “Set22_FB” in the cycle. Successively calling with different actual parameters determines whether to read or write, which data are transferred, and which SENTRON PAC3200 device to communicate with. The instance data of FB1084 “MB_CLIENT” were configured into the instance DB “Set22_DB” (multi instance).

Register access

The number of registers you need to access during the data exchange with SENTRON PAC3200 is available in chapter 3.9.3 “Modbus measured variables with the function codes 0x03 and 0x04” of the device manual /9/. Table 3-6 of the device manual lists all available measured variables of SENTRON PAC3200 and the decisive register offsets.

The register start addresses to be used according to the MODBUS function codes, are available in the STEP 7 online help for parameter MB_MODE or MB_DATA_ADDR of the “MB_CLIENT” instruction, or in Table 12-51 “Modbus functions” of the S7-1200 system manual /1/.

The measured variables used in this application are listed in the table below:

Table 6-4: Measuring values

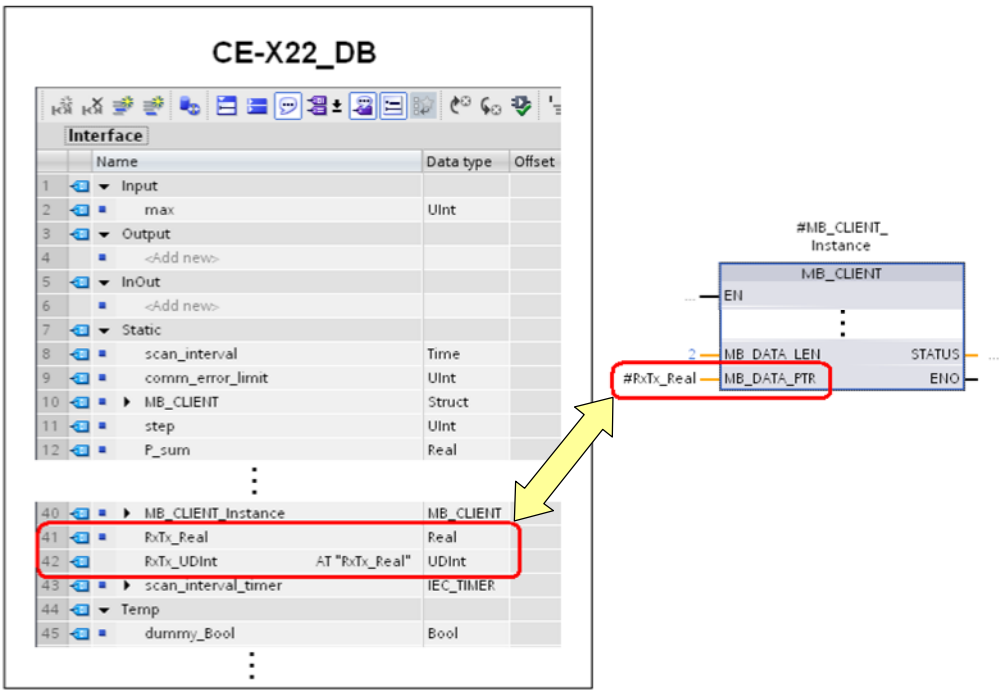
Operation	Function code	Length (words)	MB_MODE	MB_DATA_ADDR (start address + offset)
Total of the active power	0x03	2	0	40001 + 65 = 40066
Reading the operating hours counter	0x03	2	0	40001 + 213 = 40214
Writing the operating hours counter	0x10	2	1	40001 + 213 = 40214

Send / receive buffer

The send/receive buffer used simultaneously for the source and destination of the read or written data only consists of a double-word in the static data of Set22_DB. It is made accessible via a data transfer (key word ‘AT’, see /3/) as ‘Real’ type (RxTx_Real tag for active power [W]) as well as ‘UDInt’ type (RxTx_UDInt tag for the operating hours counter [s]). In the application, FB “MB_CLIENT” symbolically accesses the data source or the data destination via actual parameter RxTx_Real[9] using parameter MB_DATA_PTR of the VARIANT type.

[9] It is not important whether the actual parameter RxTx_Real or RxTx_UDInt are allocated to formal parameter MB_DATA_PTR.

Figure 6-13: Send / receive buffer



Further information on the “MB_CLIENT” instruction is available in the STEP 7 online help or the S7-1200 system manual /1/.

6.3 Data block “PAC_data” (DB503)

The DB comprises two arrays with two elements each which correspond to both SENTRON PAC3200 devices in the application. One array contains non-retentive, the other retentive data.

Table 6-5: DB PAC_data (DB503)

Name	Data type	Description
device[n].	Array of Struct	non retentive
IP_Octet4	USInt	Last octet of the IP address. To be entered by the user. The application uses addresses 200 and 201 as the default value.
P_average	Real	Current active power resulting as the average value from three double-words read from register 40066 in direct succession. The active power is displayed at the operator panel and used for calculating the total energy consumption.
bit_alarms	UInt	Word of the bit alarms visualized in the message display at the operator panel.
hour_counter	UDInt	The operating hours counter is displayed at the operator panel and used for calculating the total energy consumption.

Name	Data type	Description
reset_hour_counter	Bool	Saved reset request for the operating hours counter. It is triggered at the operator panel by pressing a button and reset by the program after its execution.
Comm_breakdown.	Struct	Auxiliary data required for generating the “Communication breakdown PAC n” error message.
started	Bool	Start identifier set in the event of a communication error. If this is the case, the program keeps polling how long the error has already been pending for and sets the “Communication breakdown PAC n” alarm, if the “Set22_DB”.comm_err_msg_delay time has been exceeded.
err_msg_time	DTL	Time saved at the beginning of a failed communication. It is used for continuously calculating the duration of the error.
Pav_limit[n].	Array of Struct	retentive
high	Real	Upper active power limit, to be entered by the user, from which on a short-circuit in the respective line is reported.
low	Real	Lower active power limit, to be entered by the user, from which on a defective illuminant in the respective line is reported.

6.4 Event (FC161) function

FC161 sets or resets a bit in the alarm word, to which the message texts in the operator panel are assigned.

Figure 6-14: Call of the FC161 “Event”

Table 6-6: Parameter of the FC161 “Event”

Name	I/O	Data type	Description
Trigger	IN	Bool	FALSE = Resetting the error bit TRUE = Setting the error bit
Event_Bit	IN	USInt	Bit in the alarm word to which the message text in the operator panel is assigned. (0 = LSB, 15 = MSB)
Alarm_Word	INOUT	Word	Alarm word
Global_fault	OUT	Bool	Collective error Set if at least on bit in the error word is TRUE.

6.5 Error messages

Error messages are displayed on the operator panel in the “Alarm monitoring” screen in the form of a message buffer. The messages are not configured to require acknowledgement. A message is entered into the message buffer as “coming” (I = incoming) and as “going” (O = outgoing). The following messages are configured:

- “Defective illuminant PAC n”
  The “coming” message is generated if the active power measured by a SENTRON PAC 3200 falls below a configurable limit, which indicates a defective illuminant.

  If the limit is exceeded again, the program enters a respective “going” message into the message buffer.
- “Short circuit PAC n”
  The “coming” message is generated if the active power measured by a SENTRON PAC 3200 exceeds a configurable limit, which indicates a short-circuit in the monitored branch.

  If the limit is fallen short of again, the program enters a respective “going” message into the message buffer.
- “Connection error PAC n”
  The “coming” message is generated in those program steps in which the communication step chain waits for a reaction of MB_CLIENT (e.g. DONE, CONNECTED or NOT BUSY) and instead, however, a communication request pulse (“Set22_DB”.nextPAC_pulse) for the next SENTRON PAC3200 device arrives. These pulses arrive default every 5s in this application example.

  The respective “going” message is created as soon as the MB_CLIENT signals DONE for the respective measuring device regarding a communication request.
- “Connection breakdown PAC n”
  Wile for “Connection error PAC n” each communication breakdown is reported – even if only a single value could not be transferred, for “Connection breakdown PAC n” the program generates a “coming” message only if not a single communication request to the SENTRON PAC3200 device could be satisfied over a configurable period of (“Set22_DB”.comm_err_msg_delay). In this application example, 5min have been set as the default period of time. The purpose of this message is discussed below.
  - For the first successfully completed communication after a communication breakdown, the program determines the last consumed energy quantum at the just processed process tag. It results from the product of the current actual power value and the difference between the current operating hours

counter value and its preceding value (old value). The old value is the last counter value before the communication breakdown. For the time of the communication breakdown an energy quantum is assumed which would result if the active power would be constant during the communication breakdown. For a short[10] communication breakdown, the substitute value of the energy quantum falsifies the consumed total energy only marginally, while the impact of a long[10] communication breakdown can considerably affect the precision of the total energy.

The respective “going” message is created as soon as the MB_CLIENT signals DONE for the respective measuring device regarding a communication request.

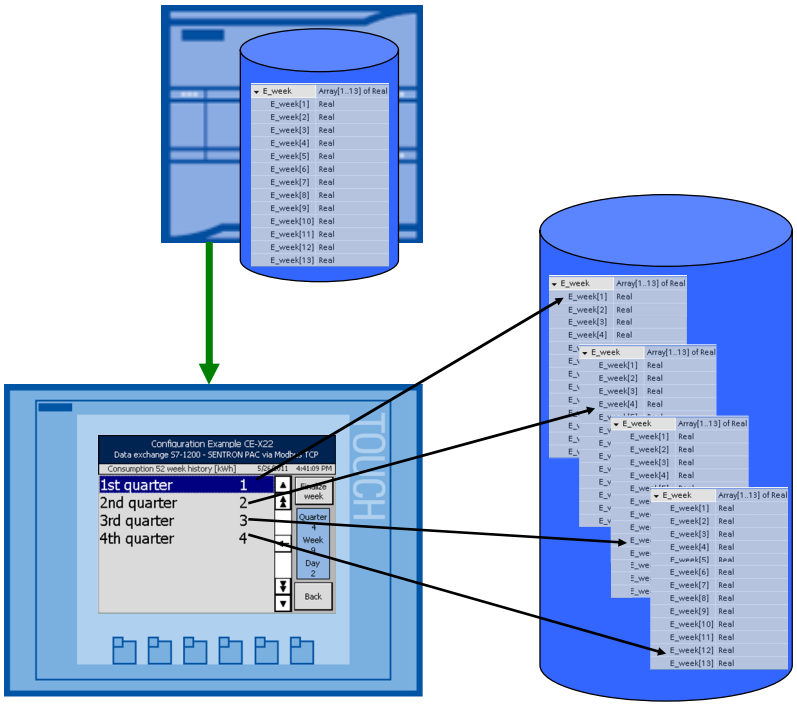
- “Recipe transmission error”
  For the recipe transmission with synchronization, a status information (“Set22_DB”.data_record[3]) is stored in the data area to which the “Data record” area pointer points. If it has value 4, the transmission was completed successfully without errors. If it has the value 12, a transmission error has occurred which is reported (“coming” message). If no status message 4 or 12 is generated, the program also assumes a transmission error after 5 seconds.

  The respective “going” message is created if the transmission was completed without errors (status = 4).

6.6 Recipe management

Usually, recipe data are managed by the user in the operator panel and supplied to the control program on demand. This application uses the “Recipes” mechanisms to export data from the PLC to the operator panel and archive them to create storage space in the PLC. The energy consumption values are written to the HMI device for the entire year in weekly intervals via control job (Job mailbox).

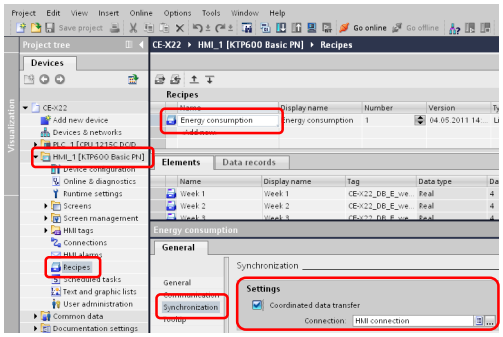
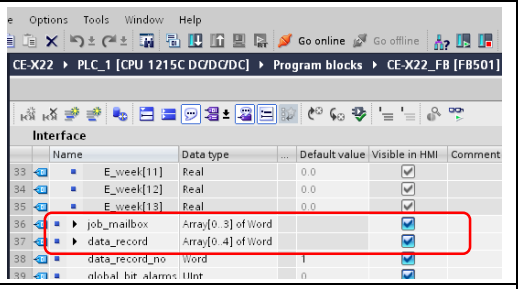
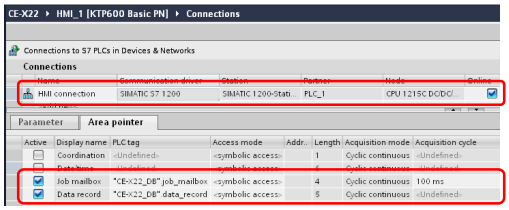
Figure 6-15: Storing energy consumption as recipes in the HMI device



[10] The terms “short” and “long” must be considered in the context of the dynamics of the process tag.

The following instruction[11] shows how to transfer synchronized recipe data records from the controller into the operator panel.

Table 6-7: Synchronized transfer of recipe data records from the PLC into the operator panel

No.	Instruction	Note / Screen
1.	• Open the “Recipes” editor in the operator device folder of your project. • Select the recipe to be synchronized and open its properties. • In menu item “Synchronization” you checkmark “coordinated transfer of data records”. • In “Connection” you enter the connection to the controller with which the operator panel synchronizes the transfer. For the transfer with synchronization, you avoid uncontrolled mutual overwriting of data in your control program.	
2.	Create two fields in Set22_FB [FB501] • job_mailbox Array[0..3] of Word (for area pointer “**Job_mailbox**”) • data_record Array[0.0.4] of Word (for area pointer “**Data record**”)	
3.	• Open the connections of the operator panel. • Select the connection through which the control job is to be carried out. • Open the “Area pointers” menu item. • Activate the area pointer “Job mailbox” and select the previously created job mailbox array as tag. • Activate the area pointer “Data record” and select the previously created data record array as tag.	

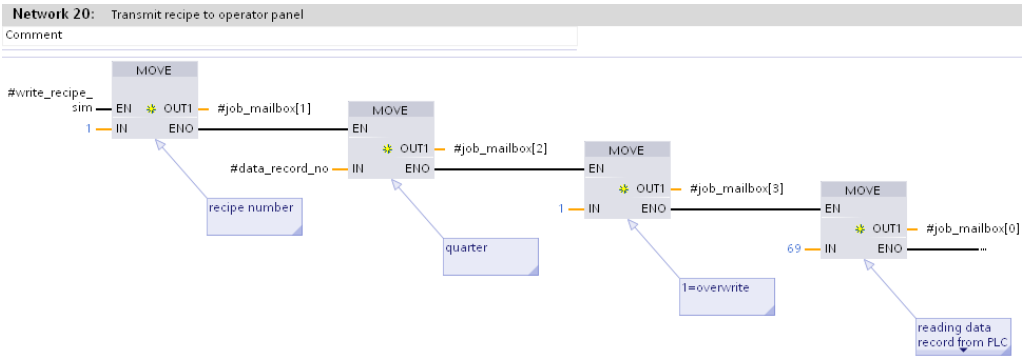
[11] The individual steps have already been implemented in the example project.

<table>
<tr><th>No.</th><th>Instruction</th><th>Note / Screen</th></tr>
<tr><td>4.</td><td>

The “Job mailbox” array consists of 4 words (0 to 3). The least significant byte of the 0 word contains the job number.
The job number 69 is the function for reading a data record from the controller.
The 1st word (Parameter 1) contains the recipe number. Since there is only one recipe in the application, this parameter is set to 1 in the program code (job_mailbox[1] = 1).
The 2nd word (Parameter 2) contains the data record number. The tag which determines the quarter, is transferred in the program code. (job_mailbox[2] = #data_record_no).

</td><td>
<table>
<tr><th>Word</th><th>Most significant byte</th><th>Least significant byte</th></tr>
<tr><td>n+0</td><td>0</td><td>Job number</td></tr>
<tr><td>n+1</td><td colspan="2">Parameter 1</td></tr>
<tr><td>n+2</td><td colspan="2">Parameter 2</td></tr>
<tr><td>n+3</td><td colspan="2">Parameter 3</td></tr>
</table>
<table>
<tr><th>No.</th><th>Function</th><th></th></tr>
<tr><td>69</td><td colspan="2">Reading data record from PLC</td></tr>
<tr><td></td><td>Parameter 1</td><td>Recipe number (1-999)</td></tr>
<tr><td></td><td>Parameter 2</td><td>Data record number (1-65535)</td></tr>
<tr><td></td><td>Parameter 3</td><td>0: Do not overwrite existing data record
1: Overwrite existing data record</td></tr>
</table>
</td></tr>
<tr><td></td><td colspan="2">

The 3rd word (Parameter 3) specifies whether an existing data record is overwritten or not. Existing data records are overwritten in the program (job_mailbox[3] = 1).
The overwriting of the respective recipe data record is in the example project triggered for each change of the week.



</td></tr>
<tr><td>5.</td><td>

The “Data record” array consists of 5 elements (0 to 4). The 3rd element (#data_record[3]) specifies the current status of the recipe transfer.
The status informs of whether the recipe transfer was completed without error. More detailed information on the further sequence is described in chapter 6.1.2 at NW21.
Without this synchronization there would be no confirmation that the data record was really transferred by the controller into the recipe of the operator panel.

</td><td>
<table>
<tr><th></th><th>15</th><th></th><th>0</th></tr>
<tr><td>1. Word</td><td colspan="3">Current recipe number (1 - 999)</td></tr>
<tr><td>2. Word</td><td colspan="3">Current data record number (0 - 65535)</td></tr>
<tr><td>3. Word</td><td colspan="3">Reserved</td></tr>
<tr><td>4. Word</td><td colspan="3">Status (0, 2, 4, 12)</td></tr>
<tr><td>5. Word</td><td colspan="3">Reserved</td></tr>
</table>
Status
The status word (word 4) can adopt the following values:
<table>
<tr><th colspan="2">Value</th><th rowspan="2">Meaning</th></tr>
<tr><th>Decimal</th><th>Binary</th></tr>
<tr><td>0</td><td>0000 0000</td><td>Transfer permitted, data record free</td></tr>
<tr><td>2</td><td>0000 0010</td><td>Transfer is busy</td></tr>
<tr><td>4</td><td>0000 0100</td><td>Transfer completed without error</td></tr>
<tr><td>12</td><td>0000 1100</td><td>Transfer completed with error</td></tr>
</table>
</td></tr>
</table>

Note Further information regarding the issue area pointer, job mailbox and data record, can be found in /5/.

7 Links & Literature

The following list is by no means complete and only provides a selection of appropriate sources.

Table 7-1: Literature

	Topic	Title / link
/1/	STEP7 SIMATIC S7-1200	S7-1200 Automation System – System Manual http://support.automation.siemens.com/WW/view/en/36932465
/2/		Update of the S7-1200 system manual http://support.automation.siemens.com/WW/view/en/53741769
/3/		FAQ: “How do you program the overlapping of tags with the keyword ‘AT’ in the TIA Portal V11” http://support.automation.siemens.com/WW/view/en/57132240
/4/		Synchronization of date and time for S7-1200 using a GPS receiver http://support.automation.siemens.com/WW/view/en/45057335
/5/		STEP 7 Basic V11.0 SP2 System Manual http://support.automation.siemens.com/WW/view/en/57199536 STEP 7 Basic V12 – System Manual http://support.automation.siemens.com/WW/view/en/68113678
/6/		Compact Switch Module CSM1277 http://support.automation.siemens.com/WW/view/de/36087313
/7/		Operating Instructions PM1207 http://support.automation.siemens.com/WW/view/en/37316256
/8/	SIMATIC HMI	Basic Panels operator devices http://support.automation.siemens.com/WW/view/en/31032678
/9/	SENTRON PAC3200	Device manual SENTRON Power Monitoring Device PAC3200 http://support.automation.siemens.com/WW/view/en/26504150
/10/	Reference to this entry	http://support.automation.siemens.com/WW/view/en/40614428
/11/	Siemens Industry Online Support	http://support.automation.siemens.com

8 History

Table 8-1: History

Version	Date	Modifications
V10.5_1.5_0	10.06.2011	First publication for • STEP 7 Basic V10.5 SP2 with CPU firmware V1.0.2, MODBUS/TCP library V1.5 for SENTRON PAC3200
V11.0_1.5_0	10.06.2011	First publication for • STEP 7 Basic V11.0 Update 1 with CPU firmware V2.0, MODBUS/TCP library V1.5 for SENTRON PAC3200
V11.0_1.6_0	23.09.2011	Revised publication for • STEP 7 Basic V11.0 SP1 Update 2 with CPU firmware V2.1.2, MODBUS/TCP library V1.6 for SENTRON PAC3200
V11.0_1.7_0	02.01.2013	Revised publication for • STEP 7 Basic V11 SP2 Update 5 as of CPU firmware V2.1.2, with system-FB MB_CLIENT, without MODBUS/TCP library
V12.0_1.7_0	23.05.2013	Revised publication • Supplemented by TIA Portal V12 project.