

## Simple set-up for measuring of electrical power and energy including visualization in MS Excel

### QUESTION

I would like to measure electrical power and energy at different points in my factory. The measuring values should be displayed in MS Excel and updated automatically.

How does a simple set-up for this task look like?

### RESPONSE

A simple set-up for measuring of basic electrical values and visualizing them in MS Excel is shown in Figure 1:

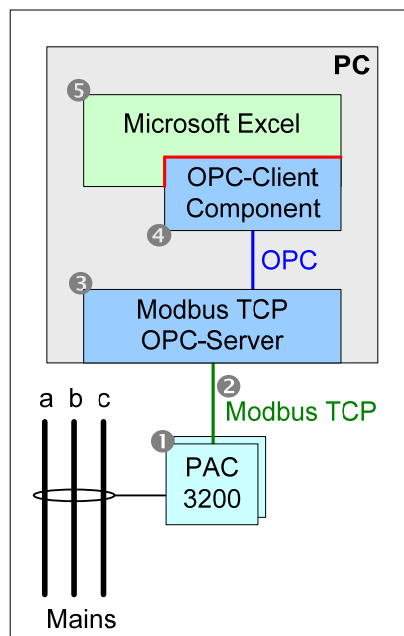


Figure 1: System set-up for an Excel based Powermonitoring System

①:

A SENTRON PAC3200 Powermonitoring Device is used for measuring of voltage and current. In countries where UL standards are applied, a SENTRON PAC3200 can measure voltages up to 600V phase-to-phase directly without a voltage transformer. For countries with IEC standards up to 690V phase-to-phase may be measured directly without a voltage transformer. Current measurements are done with a current transformer per phase.

Based on the measured voltages and currents the SENTRON PAC3200 calculates additional measuring variables, e.g.:

- Active, Reactive and Apparent Power
- Active, Reactive and Apparent Energy (each variable is available for two different tariffs)

For most of the measuring variables there are also maximum and minimum values available.

②:

All measuring variables of the PAC3200 PMDs may be transmitted to a PC via a standard Ethernet network. The used protocol is Modbus TCP, an open standard protocol.

⑤:

On a PC Microsoft Excel may be used for visualization of the measuring values of one or several PAC3200 devices. The following PC set-up is required:

- a. OPC-Server with Modbus TCP
- b. OPC-Client Component with Automation Interface
- c. Microsoft Excel 2003
- d. Windows XP SP3

③ and ④:

The Modbus TCP OPC-Server (Version 2.00.01 or higher) of Softing AG is one OPC-Server, among others, that may be used for this purpose. (<http://www.softing.com/home/en/industrial-automation/products/opc/server/modbus-tcp.php?navanchor=3010170>)

The installation of this OPC-Server also provides an OPC-Client component with an Automation Interface.

To summarize, all required components for the first measuring device in a three phase system up to 600V (UL) / 690V (IEC) are listed in the following table:

Count	Component
3	Current transformer (x/1A or x/5A)
1	PAC3200 (MLFB: 7KM2112-0BA00-3AA0)
1	PC (with Ethernet connection)
1	Modbus TCP OPC-Server of Softing
1	Microsoft Excel 2003

The following components are required for every additional measuring device:

Count	Component
3	Current transformer (x/1A or x/5A)
1	PAC3200 (MLFB: 7KM2112-0BA00-3AA0)

③, ④ und ⑤:

The next few sections describe an example for connecting a SENTRON PAC3200 to Microsoft Excel 2003 using the Modbus TCP OPC-Server of Softing AG and the related OPC-Client component of Softing AG.

The steps are:

- a. Installation of the OPC-Server
- b. Adding devices to the OPC-Server
- c. Adding measured variables for devices in the OPC-Server
- d. Setting up the communication with the SENTRON PAC3200
- e. Testing the communication with the SENTRON PAC3200
- f. Setting up the communication between Microsoft Excel and the OPC-Server

**This procedure is also applicable for connecting several PAC3200 and / or PAC4200 Power Monitoring Devices to Excel.**

**Note:**

The application examples are not binding and do not claim to be complete regarding the circuits shown, equipping and any eventuality. The application examples do not represent customer-specific solutions. They are only intended to provide support for typical applications. You are responsible for ensuring that the described products are correctly used. These application examples do not relieve you from the responsibility of safe and professional using, installing, operating and servicing the equipment. When using these application examples, you recognize that Siemens cannot be made liable for any damage/claims beyond the liability clause described. We reserve the right to make changes to these application examples at any time without prior notice. If there are any deviations between the recommendations provided in these application examples and other Siemens publications - e.g. Catalogs - the content of the other documents have priority.

Regarding warranty and liability please do also consider section 8.4.


## 1. INSTALLATION OF THE OPC-SERVER

Install the Modbus TCP OPC-Server as described in its manual and online help.

The steps are:

- a. Buying the OPC-Server.  
You can download a free version of the OPC server on this page: <http://www.softing.com/home/de/industrial-automation/downloads/drivers-demos.php?T=5&G=3&P=4>

- b. Installing the OPC Server by executing the installation file and using the default settings.

⇒ You will see the following tray icon after a successful installation: 

- c. **Note:**

You may start the OPC configuration and the OPC server itself out of the context menu ( right click) of the tray icon.

- d. **Note:**

You need administrator rights on the computer to configure and use the OPC server.

## 2. ADDING DEVICES TO THE OPC-SERVER

To add devices to the OPC-Server, follow the steps as described in its manual and online help.

- a. Add the SENTRON PAC3200 PMDs you want to see the measured values from in Microsoft Excel to the OPC-Server.

This step is shown in Figure 2 for a quantity of four PAC3200 PMDs (see the green rectangle):

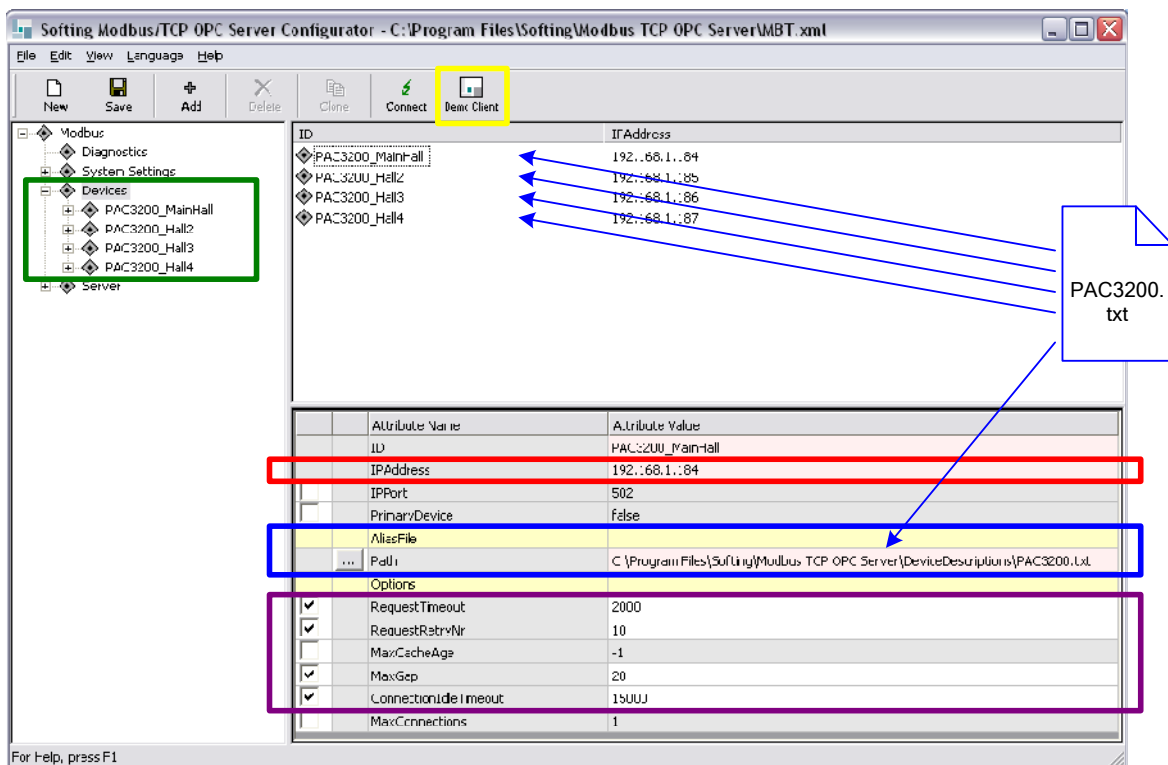
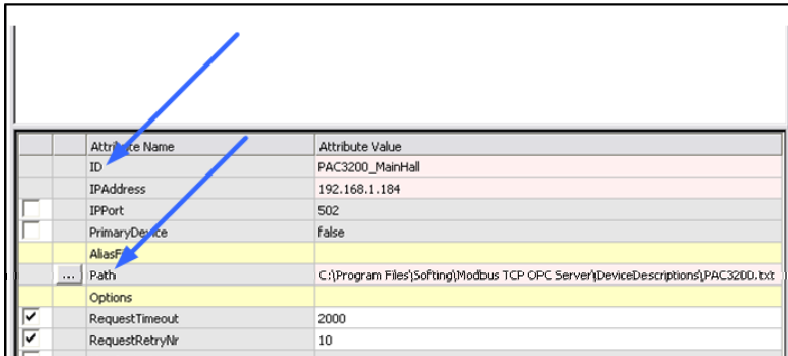


Figure 2: OPC-Server with four PAC3200 PMDs

- b. Please note that the entries for the Device “ID” and Alias File “Path” may not contain any “umlaut” (ä, ö, ü) characters (See Figure 3).



	Attribute Name	Attribute Value
	ID	PAC3200_MainHall
	IPAddress	192.168.1.184
<input type="checkbox"/>	IPPort	502
<input type="checkbox"/>	PrimaryDevice	False
	AliasFile	
<input type="checkbox"/>	Path	C:\Program Files\Softing\Modbus TCP OPC Server\DeviceDescriptions\PAC3200.txt
	Options	
<input checked="" type="checkbox"/>	RequestTimeout	2000
<input checked="" type="checkbox"/>	RequestRetryNr	10

Figure 3: Configuration: No umlaut (ä, ö, ü) characters may be used

- c. Enter the IP-addresses of the devices. In Figure 2 this is highlighted with a red rectangle for the first PAC3200 device.
- d. Enter the following options (See the violet rectangle in Figure 2):

- *RequestTimeout:*            2000
- *RequestRetryNr:*            10
- *MaxGap:*                      20
- *ConnectionIdleTimeout:* 15000

### 3. ADDING MEASURED VARIABLES FOR DEVICES IN THE OPC-SERVER

It is recommended to use a common “alias file” containing the measured variables from the PAC3200 PMDs that are shown in Microsoft Excel.

An example “alias file” can be generated in two steps using the Excel file attached below (*PAC3200.xls*): (Excel sheet see attachment)



PAC3200.xls

#### Notes:

- a. After opening the Excel file above, save it with a reasonable name, close it and re-open the saved file.
- b. The Excel file above contains Macros. Therefore it is required to enable Macros in Excel for this file.

### 3.1 EXPANDING THE FILE *PAC3200.XLS* WITH THE REQUIRED MEASURED VARIABLES

You may add further measuring variables to the Excel file above (*PAC3200.xls*). Names, addresses and formats for new measuring variables can be found in the *PAC3200* manual in chapter "Description", section "Ethernet Port".

(<http://support.automation.siemens.com/WW/llisapi.dll?func=cslib.csinfo&lang=en&objID=25240652&subtype=133300>) .

Follow these steps for adding new measuring variables:

- a. Enter the name of the measuring variable in column G ("Name of the measuring variable")
- b. Enter a category name for the measuring variable in column F ("Group specifier"). The benefit for adding category names will be shown in chapter 7 when you select the desired measuring variables in Excel.
  - ⇒ The correct value for column B is calculated automatically from the category and name of the measuring variable.
- c. Enter the address of the new measuring variable in column D ("Address according to device manual")
- d. Enter the format of the new measuring variable in column E ("Format according to device manual")
  - ⇒ The correct value for column C is calculated automatically from the address and format of the new measuring variable.

**Example:** Adding the measuring variable *Active Power Phase A* to *PAC3200.xls*:

- a. Open *PAC3200.xls*
- b. Complete the following steps in the first available empty row of *PAC3200.xls*:
  - Add a new entry to *column G* ("Name of the measuring variable"): *Active Power Phase A*
  - Add a new entry to *column F* ("Group specifier"): *Power*
  - Add a new entry to *column D* ("Address according to device manual"): *25*
  - Add a new entry to *column E* ("Format according to device manual"): *float*
- c. Save *PAC3200.xls*

### 3.2 CREATING THE "ALIAS FILE" IN TEXT FORMAT

- a. Open *PAC3200.xls*
- b. Select "File → Save As", in the resulting dialog box select "**Text (Tab delimited) (\*.txt)**" as the file type. Click the "Save" button.

- c. For saving the file you may use any file path without any "umlaut" (ä, ö, ü) characters. An example for the file path is shown in the blue rectangle in Figure 3.
- d. Confirm the message that some format changes may be lost.

### 3.3 ASSIGNING THE "ALIAS FILE" TO THE OPC SERVER

In the OPC server configuration tool please enter the path of the saved \*.txt-file from section 3.2 for each PMD of type PAC3200. In Figure 3 this is highlighted with a blue rectangle for the first PAC3200 device.

### 3.4 SAVE THE MODIFIED CONFIGURATION OF THE OPC SERVER

In order to modifications taken by the OPC server, please execute the following two steps:

- a. Save the modified configuration
  - E.g. via the file menu of the OPC server configuration tool: "File --> Save"
- b. Restart the OPC server
  - E.g. via the tray icon of the OPC server: "right mouse click --> Restart server"

⇒ The color of the tray icon should change to green: 

## 4. SETTING UP THE IP-CONFIGURATION OF THE PC

To the current IP-Address of your PC, open a command shell

- Windows PC: „Start → Run → cmd → OK”

⇒ Command shell opens

and use ipconfig:

- Command shell: „ipconfig → Enter”

⇒ The command shell shows a list with the network adapters and assigned IP-addresses

If you would like to change the IP-address of your PC, e.g. to the suggested IP-address of the configuration example in chapter 5, please do the following steps:

- Windows PC: „Start → Help and Support“
  - ⇒ The Windows Help and Support Center opens
- Search in the Help and Support Center for the following topic: „Configure TCP/IP settings“ and execute the described actions in the static IP address section.
  - ⇒ For the example in chapter 5, the configuration window for the IP-address looks like the one shown in the next figure :

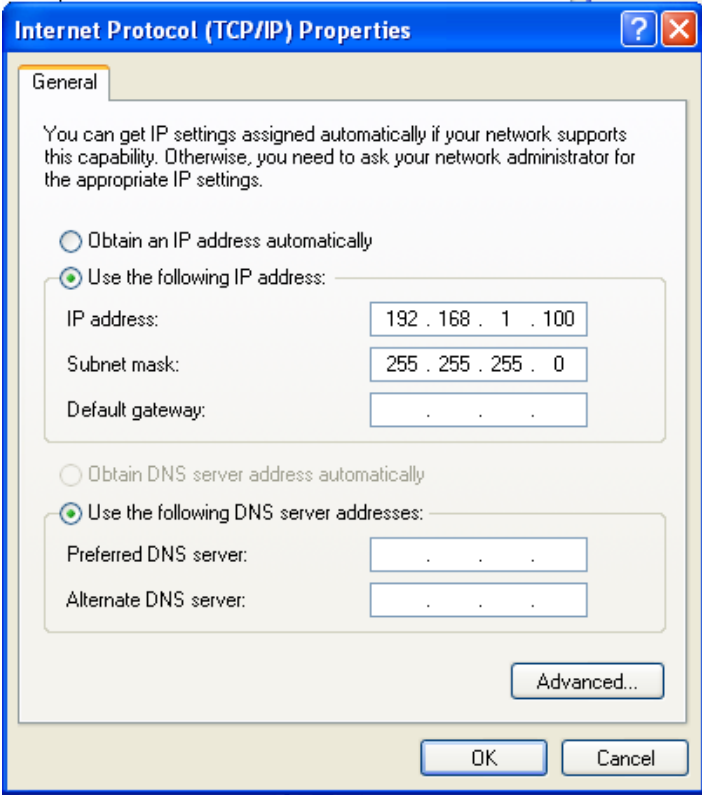


Figure 4: Configuration example for the TCP/IP settings

**5. SETTING UP THE COMMUNICATION OF THE SENTRON PAC3200**

Activate “Modbus TCP” as the communication protocol for the SENTRON PAC3200 as described in the PAC3200 manual (<http://support.automation.siemens.com/WW/llisapi.dll?func=cslib.csinfo&lang=en&objID=25240652&subtype=133300>) in chapter “Description”, section “Ethernet Port”.

All devices and the PC must have different IP-addresses. One valid configuration is the shown in the following table:

	IP-address	Subnet-mask
PC	192.168.1.100	255.255.255.0
Device 1	192.168.1.184	255.255.255.0



Device 2	192.168.1.185	255.255.255.0
Device 3	192.168.1.186	255.255.255.0
Device 4	192.168.1.187	255.255.255.0

## 6. TESTING THE COMMUNICATION WITH THE PAC3200

As the next step it is recommended to test the communication between the OPC-Server and the PAC3200. You may use the following procedure:

- a. Execute the command *ping <IP-address of the PAC3200 device>* in the command-shell of the PC:
  - Windows PC: „Start → Run → cmd → OK“
    - ⇒ Command-shell of the PC is opening
  - Command-shell: „ping <IP-address of the PAC3200 device > → Enter“
    - ⇒ You should see a response of the PAC3200 in the command-shell e.g.:  
*Reply from 192.168.1.184: bytes=32 time=3ms TTL=126*
  - If the PAC3200 does not respond and you see an output being similar to the one in the command-shell window below, you might have problems with your
    - network configuration or
    - network cables or
    - network connectors

```

C:\WINNT\system32\cmd.exe
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

C:\Documents and Settings\    \Desktop>ping 192.168.1.184

Pinging 192.168.1.184 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 192.168.1.184:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),

C:\Documents and Settings\    \Desktop>

```

Figure 5: Invalid network connection

- Repeat the steps above until all devices respond to the corresponding ping commands.

- **Note:**  
For connecting a PAC3200 device and a PC directly with one single network cable, a cross-over cable must be used.

- b. Once the physical and logical connection is verified with the ping command, it is recommended to test the Modbus- and OPC connection. This may be done with the OPC Toolbox Demo Client from Softing, being part of the installation of the Softing OPC server.

One way to start the OPC Toolbox Demo Client is to open the configuration tool for the OPC server, activate any of the configured PAC devices (see green rectangle in Figure 2) and click the menu button highlighted by a yellow rectangle in Figure 2:

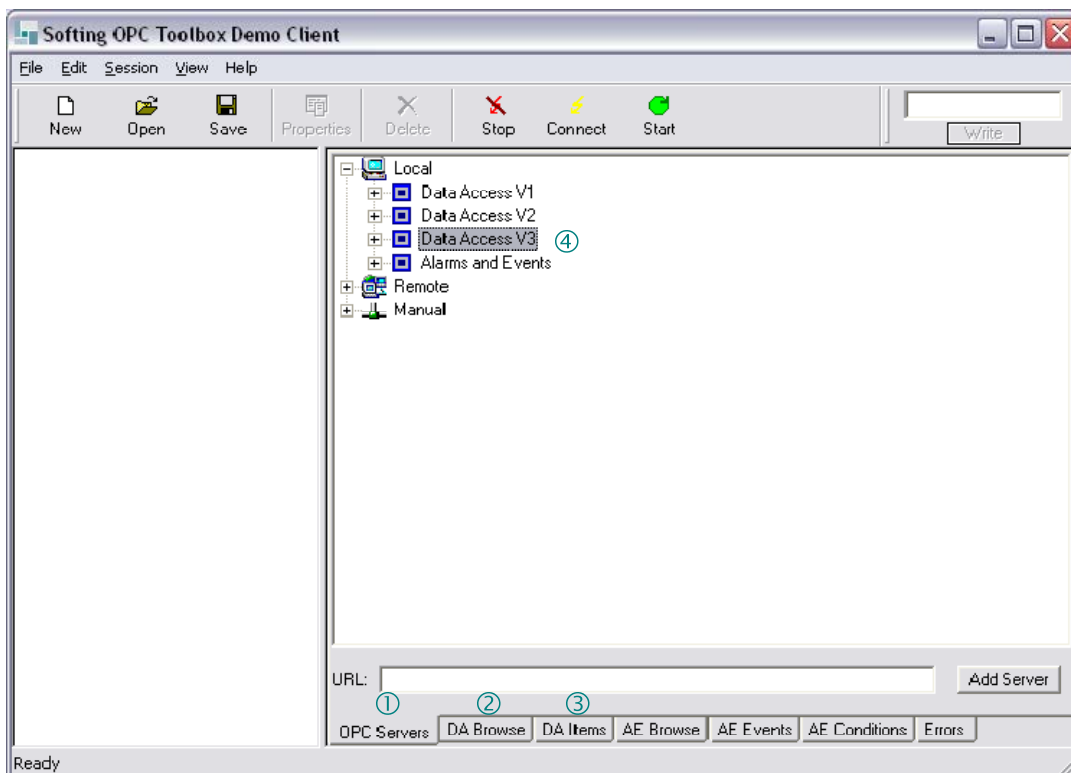


Figure 6: OPC-Demo-Client

In the OPC Toolbox Demo Client (see Figure 6), the connection to the OPC server and the desired measuring variables have to be configured in the first two tabs (① und ②) in the right part of it's window:

- **OPC-Server:**  
„OPC Servers → Local → Data Access V3 ④ → Softing Modbus/TCP OPC Server → double click“
- **The desired PAC3200 devices and some of their measuring:**  
„DA Browse ② → <Device name> → <Measuring variable> → double click“

After the configuration, the latest values of the selected measuring values are shown in the third tab ③ „DA Items“.

The communication is successful, if all entries in the column “Quality” in the tab „DA Items“ have a „GOOD“ value.

On the other hand, a „BAD“ value in the „Quality“ column indicates an error. The two main error reasons are:

- The PAC3200 is set to “SeaBus TCP” instead of “Modbus TCP” as its communication protocol (see chapter 5)
- The configuration of the OPC-Server has been changed, but they have not been saved or the OPC-Server has not been restarted after the configuration has been changed (see chapter 3).

## 7. SETTING UP MICROSOFT EXCEL 2003 TO COMMUNICATE WITH THE OPC-SERVER

Several vendors of OPC-Servers automatically install an OPC-Client and an OPC-Client component with Automation Interface during the installation of the OPC-Server.

The provided Excel example (*SoftingOpcClient\_V1.30e.xls*) is based on the OPC-Client component with Automation Interface from Softing AG (Excel sheet see attachment).



SoftingOpcClient\_V1.30e.xls

### Important notes:

- a. Save the Excel file above under a reasonable name, close the file and re-open the saved file in Excel
- b. Due to synchronization reasons you have to ensure that (modified) Excel example of above is **not running two or more times at the same time on the same PC.**
- c. The Excel example above is using macros. Thus it is required that you enable macros for this file.

## 7.1 OVERVIEW

*SoftingOpcClient\_V1.30e.xls* has three sheets:

- d. Main
  - Sheet for configuring the OPC-Client
  - Overview of the latest measured values of the SENTRON PAC3200
- e. Charts
  - **Sample** charts for measured variables of the SENTRON PAC3200
- f. Archive

- FIFO<sup>1</sup> memory for a configured number of measured variables of the SENTRON PAC3200

## 7.2 CONFIGURATION OF THE COMMUNICATION WITH THE OPC-SERVER

The next figure shows the “Main” sheet with its most important features:


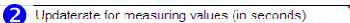
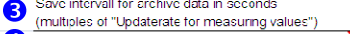
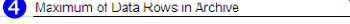
	A	B	C	D	E	F	I	
1		Demo Excel as OPC-Client with SENTRON PAC3200 and PAC4200				Configuration		
2								
3								
4							10	
5							30	
6							10	
7								
8								
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25								

Figure 8: "Main" sheet

- ❶: Button for configuring the OPC-Client component (only visible in the Design Mode)
- ❷: Cell for configuring the update period of the OPC-Client component. The update period is the time interval in which the OPC-Client component regularly receives updated measuring values from the OPC-Server
- ❸: Cell for configuring the update period of the archive in sheet “Archive”
- ❹: Number of rows of the FIFO buffer in the archive
- ❺: Manual entries for the chart headings in the sheet “Charts”
- ❻: Automatically filled entries for the measured variables being read by the OPC-Client
- ❼: Latest measuring values
- ❽: Time at which the latest measuring values were read

<sup>1</sup> FIFO : First In First Out

9: Button for connecting to the OPC-Server

10: Button for disconnecting from the OPC-Server

The Microsoft Excel OPC-Client may be configured with the following steps:

- a. Select the sheet “Main“
- b. Activate the Design Mode
  - Select “View → Toolbars→Control Toolbox“
  - Click the “Design Mode“ icon located in the top left corner of the toolbar
- c. Select button 1 and right click the mouse button. In the appearing context menu select “Softing OPCDataControl 3.2-Objekt → Properties“
- d. The dialog box shown in Figure 4 will appear. In this dialog box select your OPC-Server in 1 and apply with the “Apply“ button 2:

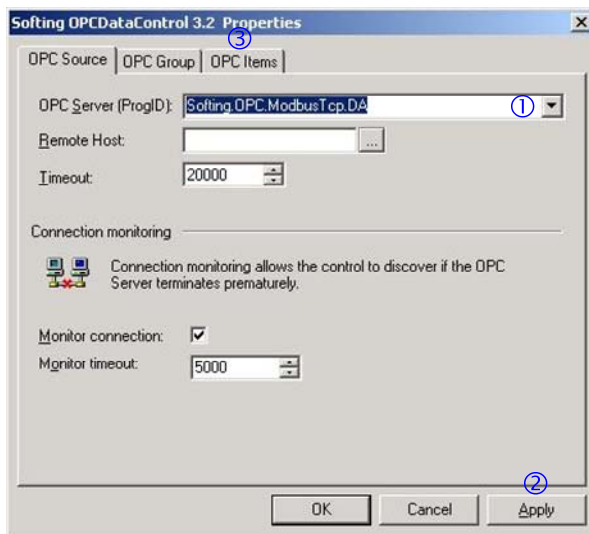


Figure 9: Dialog box for selecting the OPC-Server

- e. Select the “OPC Items“ tab 3, delete all existing entries with the “Delete“ button and click the “Browse“ button 4 to browse for the available measured variables. In the browsing dialog box select all of the measured variables you would like to display in Excel. All measuring variables may be found under the categories that have been created in chapter 3:

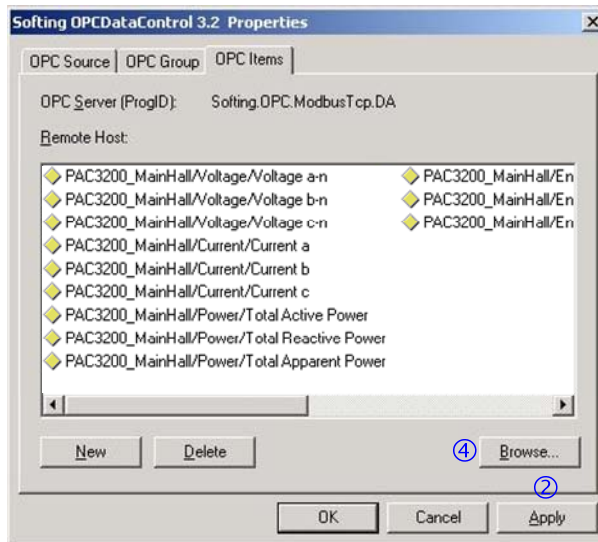


Figure 10: Dialog box for selecting the desired measured variables

- f. Confirm your selection with the “Apply” button ② and close the dialog box.
- g. Enter the ② update period of the OPC-Client (see Figure 3). It is recommended that you increase the update period proportionally to the number of measured variables being used in Excel.
- h. Exit the Design Mode of Microsoft Excel.
- i. Do a short (approx. 30 seconds) test of the functionality by using the “Connect” ⑨ and “Disconnect” ⑩ buttons (see Figure 3). This test should update the entries under ⑥, ⑦ and ⑧ (see Figure 3).

**Important note:**

Excel 2003 does not support more than 255 columns. Therefore you must **not** configure **more than 255 OPC Items** in the Microsoft Excel OPC-Client.

### 7.3 CONFIGURATION OF THE CHARTS

For demonstrational purposes some example charts are included in the sheet “Charts”. These charts may be modified according to your needs. The following steps are recommended for modifying the charts:

- a. Change the entries under ⑤ in the sheet “Main” (see Figure 8) to the measured variables you have selected.
- b. Upon changing the chart contents in the sheet “Charts” you must consider that the range of data **overlaps the last entry row in the sheet “Archives” by two rows.**

For example if the archive contains ten rows (e.g. from *cell A2* to *cell A11*) the configuration of the diagrams has to be from *cell A2* to *cell A13*.

## 7.4 CONNECTING TO THE OPC-SERVER

The final step is to connect the Microsoft Excel client to the OPC-Server by clicking the “Connect” button ⑨ (see Figure 3). This should update the entries under ⑥, ⑦ and ⑧ (see Figure 3).

## 8. IMPORTANT NOTES

### 8.1 OTHER APPLICATIONS FOR VISUALIZING VALUES OF OPC-SERVERS

Instead of Microsoft Excel you may use any of the Siemens HMI<sup>2</sup> software (<http://www.siemens.com/hmi-software>) listed below:

- SIMATIC WinCC (with Options)
- SIMATIC WinCC flexible (with Options)

Siemens AG offers excellent support for these HMI software.

### 8.2 SAFETY CRITICAL SWITCHING WITH SENTRON PAC3200

The SENTRON PAC3200 is a Power Monitoring Device and MUST NOT be used for safety critical switching.

### 8.3 LINKS TO FAQS WITH SIMILAR CONTENTS AND ADDITIONAL INFORMATION

- a. Entry ID [23829402](#) includes an application that shows a very simple procedure for creating individual visualization interfaces using Microsoft Excel and VBA.
- b. Entry ID [24299099](#) describes a Microsoft Excel OPC-Client based on SIMATIC NET.

### 8.4 WARRANTY LIABILITY AND SUPPORT

We do not accept any liability for the information contained in this document. Any claims against us - based on whatever legal reason - resulting from the use of the examples, information, programs, engineering and performance data etc., described in

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<sup>2</sup> HMI: Human Machine Interface

this application example shall be excluded. Such an exclusion shall not apply in the case of mandatory liability, e.g. under the German Product Liability Act ("Produkthaftungsgesetz"), in case of intent, gross negligence, or injury of life, body or health, guarantee for the quality of a product, fraudulent concealment of a deficiency or breach of a condition which goes to the root of the contract ("wesentliche Vertragspflichten"). However, claims arising from a breach of a condition which goes to the root of the contract shall be limited to the foreseeable damage which is intrinsic to the contract, unless caused by intent or gross negligence or based on mandatory liability for injury of life, body or health The above provisions does not imply a change in the burden of proof to your detriment.

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