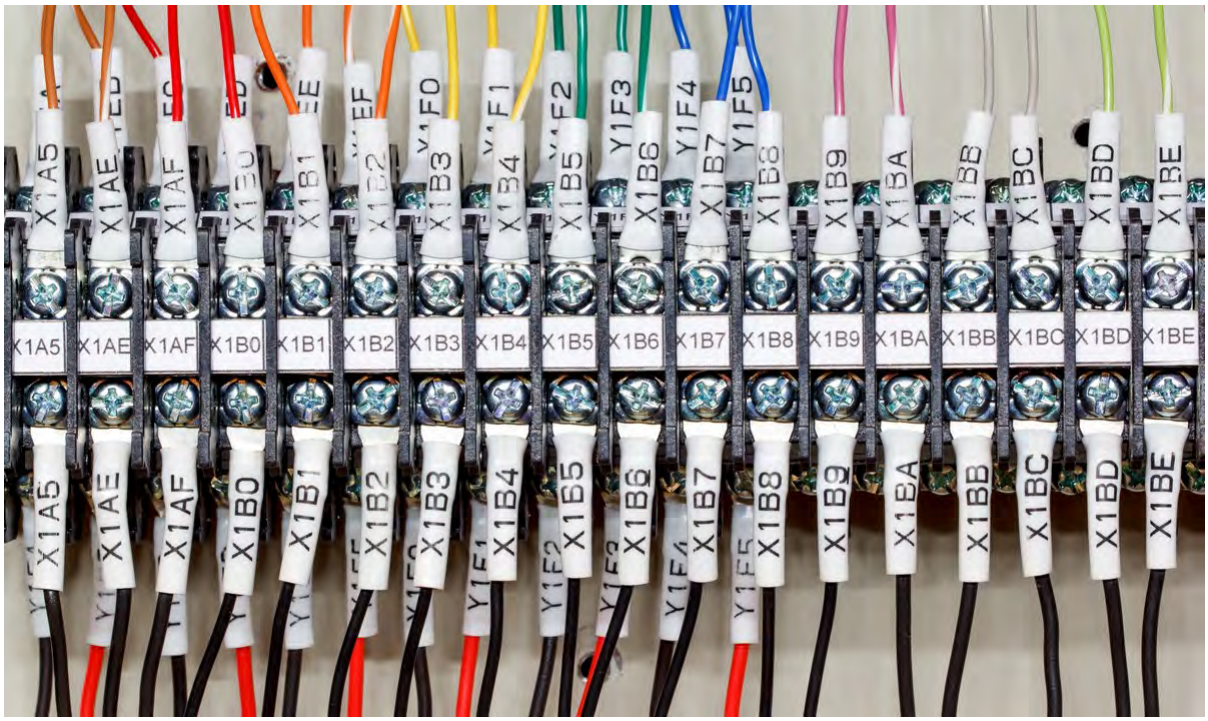
SCADA for PowerLab



SCADA is an acronym that stands for **S**upervisory **C**ontrol **A**nd **D**ata **A**cquisition (SCADA) of technical processes in real time. In electrical power engineering SCADA is deployed for a range of operations from power generation, transmission and line protection all the way to power utilization.

SCADA allows users to:

- Track and enter data as part of technical processes.
- Display readings in real time.
- Modify control signals during processes.
- Automatically control processes.

Recording of multiple measured values permits both future planning and economic optimization. The system can be remotely controlled by means of local access networks (LAN).

SCADA Power Engineering Lab is a software program designed for control and monitoring of power engineering systems. The software provides for real-time display of all measured values and operating states of the system's instruments. Important parameters and signals can be controlled by the software.

By means of a data logger, the readings and equipment operating states can be selected, saved, displayed and evaluated with respect to time, and exported.

A data logger can be used to monitor the system. If the system fails, a data logger with an Internet connection could, for example, send an alarm message via SMS. Logged data can be periodically saved to a server for future access.

The built-in SCADA software logger gives you the opportunity to collect physical measurement data such as power or voltage for a specific time. The recorded data are displayed in an XY diagram.

Connection Via Ethernet

The following installation instructions explain how to connect devices to the SCADA system via **Ethernet**. This is important when using a SCADA control computer with network access, the double busbars CO3301-5R/CO3301-5S and other supported equipment such as the power quality meter CO5127-1S or the human-machine interface (HMI) CO3301-5L.

Note: After this section you will learn how to connect all the equipment to be controlled and the computers involved **without** also connecting them to an existing network. The procedure described here for a dedicated equipment network linked by network switches is the recommended method.
With the help of the Ethernet adapter LM9056 it is even possible to use this network of equipment simultaneously with an existing laboratory network by keeping the computers accessible to the building network via their existing RJ45 ports. A second RJ45 port can then be used for setting up a parallel lab network.
It is also possible to integrate the lab equipment and computers into a local network if suitable IT security measures are taken.

Equipment Used for Ethernet Communication

To connect a PC to some equipment by means of an Ethernet link, use the USB-Ethernet adapter **LM9056**, the network switch **LM9988** and **LM9057** patch cables.
Connect the equipment to be controlled to the network switch via its Ethernet port. The switch should also be connected to the PC. It is possible to connect multiple network switches together.

LM9056 **LM9988** **LM9057**

Figure 1:
Components for Communication Over Ethernet

After all the equipment has been physically connected together, you can start setting the communication parameters. The IP address for the Ethernet port of the SCADA control computer needs to be set with the help of Windows. Those for the various pieces of equipment need to be set on the devices themselves and in the SCADA software.

Allocation of IP Addresses

et 9

If you have purchased multiple items with Ethernet ports from the Lucas-Nülle power distribution range, it is recommended that you establish a structured hierarchy of IP addresses assigned to each table or set of equipment. This makes subsequent setting up much easier:

C:

- This configuration is an example for up to 9 different equipment sets/control computers each involving 9 pieces of equipment.

Set 1		**Set 2**		...	**Set 8**		**Set 9**	
PC:	192.168.168.**1***0* ...	PC:	192.168.168.**2***0* ...		PC:	192.168.168.**8***0* ...	PC:	192.168.168.**9***0* ...
				...				
Device *1* :	192.168.168.**1***1*	Device *1* :	192.168.168.**2***1*		Device *1* :	192.168.168.**8***1*	Device *1* :	192.168.168.**9***1*
Device *9* :	192.168.168.**1***9*	Device *9* :	192.168.168.**2***9*		Device *9* :	192.168.168.**8***9*	Device *9* :	192.168.168.**9***9*

Configuration of IP address for SCADA Control Computer

The USB-Ethernet adapter and the equipment connected need to be configured in mutually appropriate fashion for flawless communication via the TCP/IP protocol (Ethernet).

- Assign a fixed IP address in Windows to the network adapter LM9056.
  For the IP address of the PC you could use 192.168.168.10, for example, with a subnet mask of 255.255.255.0
  - in this network you would then have the addresses 192.168.168.1 to 192.168.168.254 (excluding the PC's own IP address) available for other equipment.

  - ❖ Use the following procedure under Windows:

- Click "Network and Internet" in the control panel window.
- Click "Network and sharing centre".
- Click "Change adapter settings" on the left.
- Alternatively you could run "ncpa.cpl" from the Run line in the Start menu.
- Right-click on the USB Ethernet adapter and then choose "Properties".
- Select "TCP/IPv4" and click "Properties".
- Select "Use the following IP address:", fill out the first two fields and leave "Standard gateway" empty.
- Confirm by clicking OK in the dialog box.
-

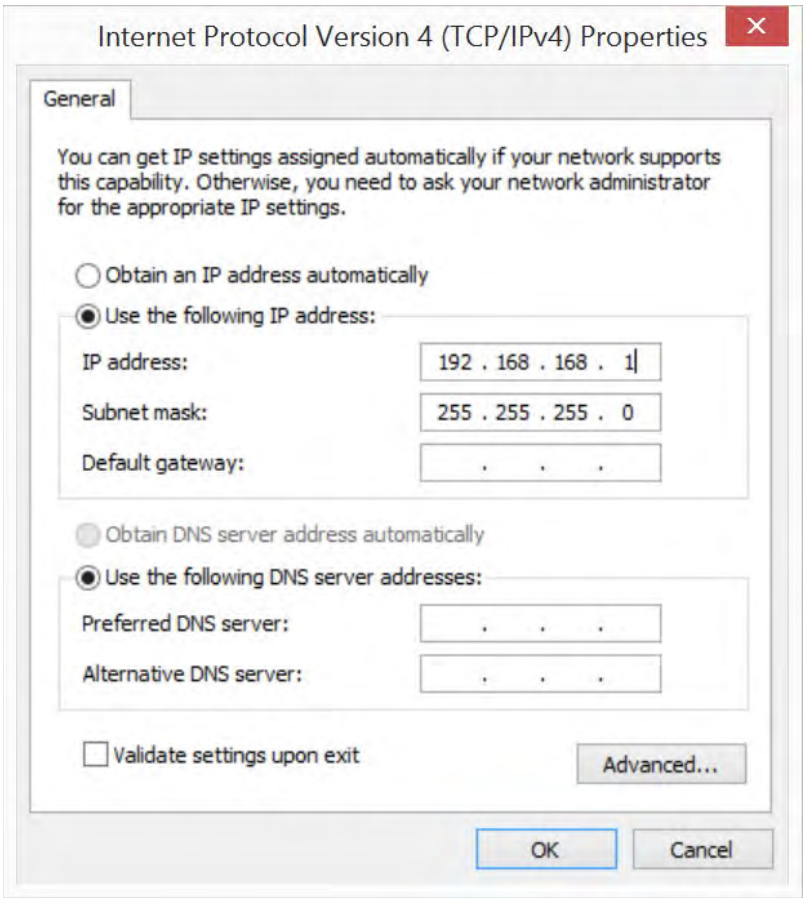


Figure 2:
Assigning a Fixed IP Address

Now you have set the IP address for the PC, you should now configure the equipment to be controlled as described on next page.

Configuration of Power Quality Meter/HMI (CO5127-1S/CO3301-5L)

Now follow this example to assign an address to a first power quality meter CO5127-1S. Use address 192.168.168.11 (by default CO3301-5L/CO5127-1S has the address 192.168.168.10 pre-configured)

- Menu -> Settings -> Communication
  - IP-ADDR: 192.168.168.11, SUBNET: 255.255.255.0
  - Confirm and restart the equipment.
  - This procedure also applies to other measuring instruments, such as the Siemens Sentron PAC4200 etc.
- The next device would then receive the address 192.168.168.12, etc.

Configuration of SCADA Designer/Viewer with double busbar CO3301-5R/CO3301-5S

- Open the device manager in SCADA by means of the icon on the tool bar or from the menu under "Diagnostics" → "Device Manager...".

Figure 3:
Device Manager on the SCADA Toolbar

- If the busbar to be controlled is not yet present in the device manager, click "Add..." and select the busbar CO3301-5R (feeder) or CO3301-5S (coupler)
-

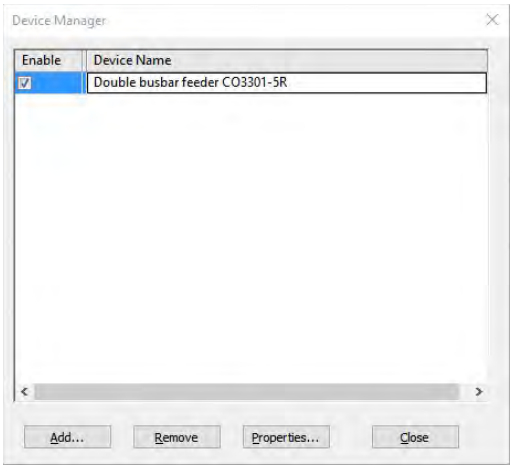


Figure 4:
SCADA device manager with busbar feeder added

- Now select the Ethernet device to be configured and click "Properties".
  - If the device already has a correct IP address, you can enter this directly under "Device address (IP or name)" and confirm with OK. SCADA will then know what IP address to use for communication with the device and the configuration of it is complete.

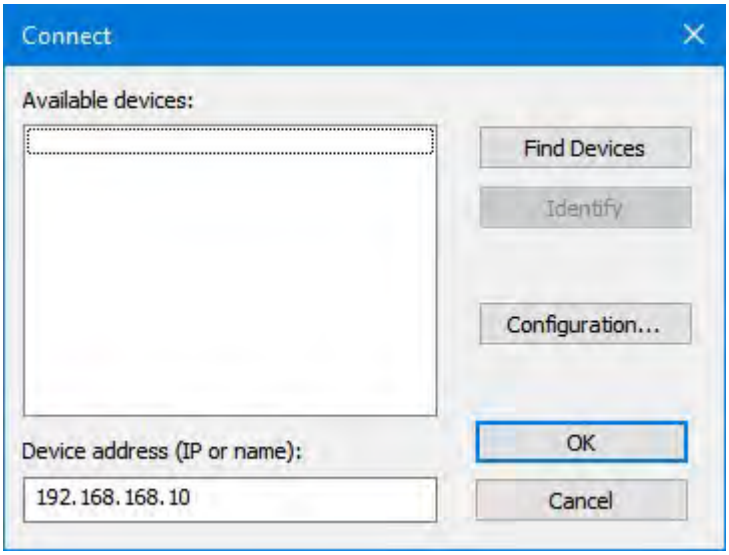


Figure 5:
Network Configuration for a Device

- If the IP address for the device being configured has not yet been set to the required setting on the device itself, then click "Configuration".

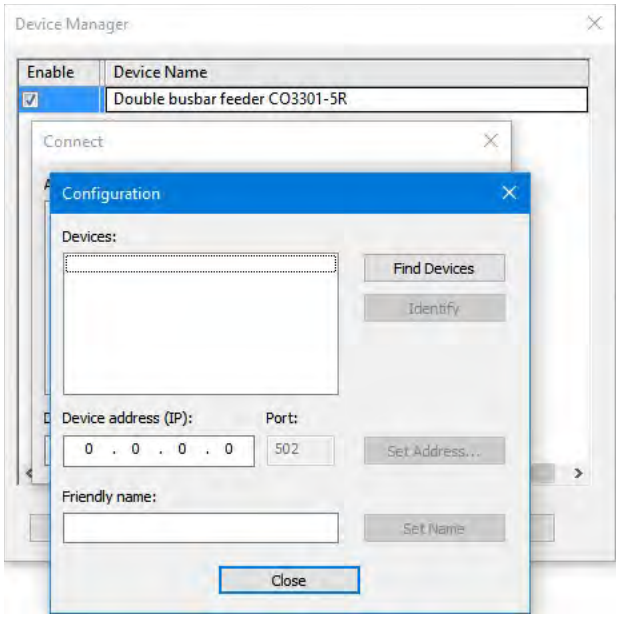


Figure 6:
In the Device Properties for a Newly added Busbar

- Use "Find Devices" to scan the network for available equipment and select the desired device from the list.
- When you use "Find Devices", the Windows firewall may ask whether the Lucas-Nülle SCADA software is to be allowed access according to the rules of the firewall. Allow access to private and public networks for it to function correctly.

Figure 7:
All SCADA Designer/Viewer Access Via the Windows Firewall

The reason public networks need to be included in the firewall access rules for the SCADA Designer/Viewer is that usually the control computer and devices are connected in the lab via network switches which are unconnected to other networks in the building. This type of infrastructure involves no standard gateway. Windows therefore detects the lab network as a public network because it is not otherwise known and even if the Windows firewall is deactivated, it will block all local server ports.

SCADA Designer/Viewer needs to be able to open a port (as a server) for the following functions:
-"Finding in the network" when seeking CO3301-5R/CO3301-5S double busbar models
-"SCADA Advanced Remote Control Server/Client" components of SCADA Designer/ Viewer. This allows variables and measurements to be shared between various SCADA instances on one or more computers connected via Ethernet.

- SCADA Viewer/Designer now carries out a search for the double busbars using all the ports on the computer. The computer and the device to be connected do not have to be configured for a common sub-network.
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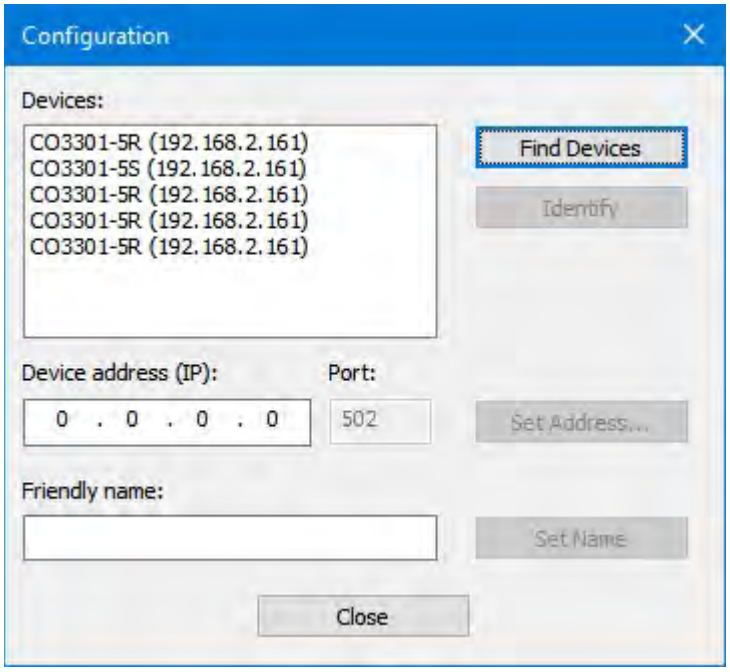


Figure 8:
Display of devices detected in a LAN

- Select one of the busbars which has not yet been configured from the list. You can see the IP address currently allocated to it in brackets next to the name of the device.

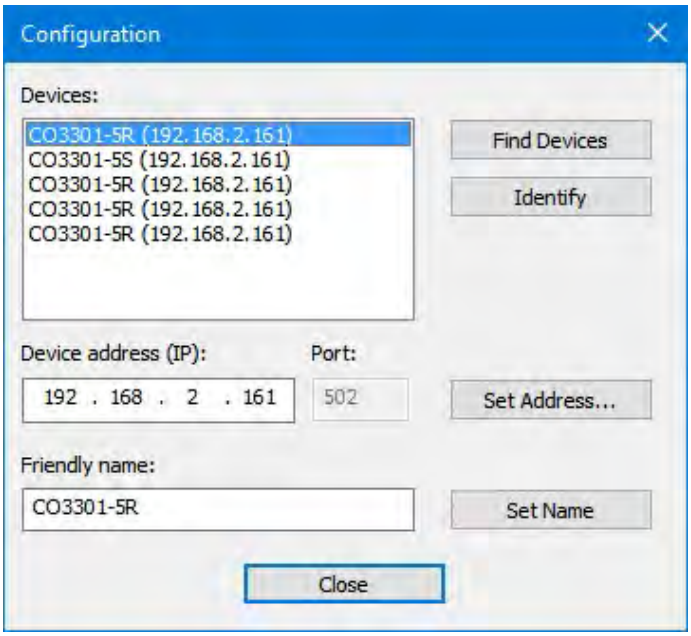


Figure 9:
Devices in "Device Manager"

- Identify the busbar to be added by sight by clicking "Identify". All six of the LEDs on the busbar will then flash simultaneously for several seconds.
- The "Device address (IP)" field shows the current IP address assigned to the busbar. You can change this address by clicking "Set Address".

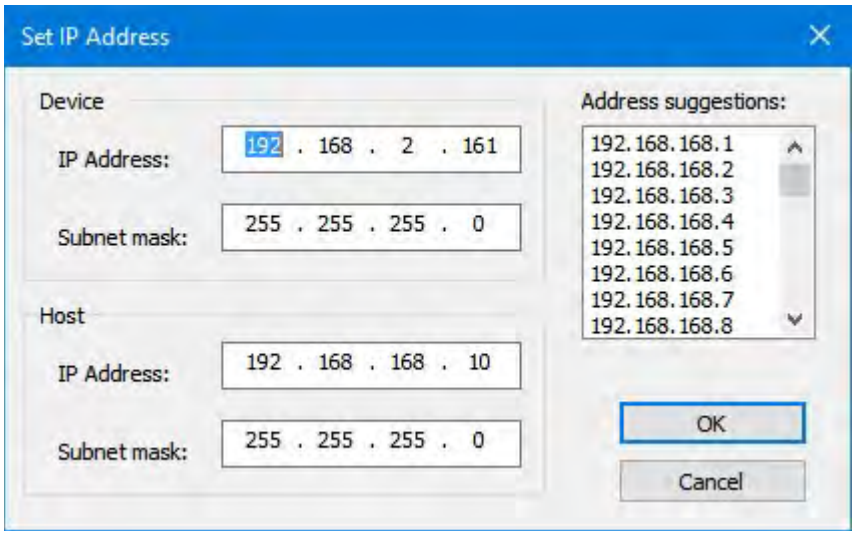


Figure 10:
Setting the IP address for a Device

  - The IP address and subnet for the control computer can be seen under "Host". Set the address of the device in accordance with your chosen schema under "Device". Configure the subnet mask to be the same as the host.
  - Confirm the IP address with OK. The busbar will then re-initialize.
- Use the "Friendly Name" field to give the device a more understandable name, e.g.:
  - "BB Field 1: Transformer Grid" - BB = Busbar .168.14
  - "BB Field 2: Wind power" etc.
- "Set Name" writes this name to the device itself.
- According to the suggested numbering scheme, the IP addresses are as follows:

PC	Field 1 (left)	Field 2	Field 3	Field 4	Field 5 (coupler, right)
192.168.168.10	192.168.168.11	192.168.168.12	192.168.168.13	192.168.168.14	192.168.168.15

- The control computer and each of the busbars now have unique IP addresses:

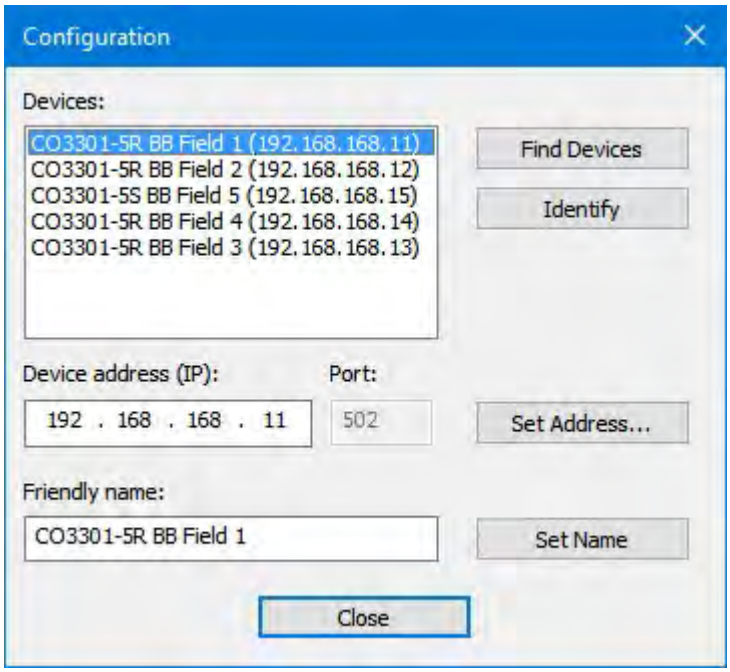


Figure 11:
All Busbars Configured

Configuration of SCADA Designer/Viewer with Double Busbar CO3301-3R/CO3301-3S

- Open the device manager in SCADA by means of the icon on the tool bar or from the menu under "Diagnostics" → "Device Manager...".

Figure 12:
"Device Manager" in the SCADA Toolbar

- Now select the Ethernet device to be configured and click "Properties".
- Either enter the IP address for the equipment being configured directly or scan the network for the relevant device using "Find Devices" and select it from the list.
  - The software searches all network ports on the computers for the measuring instruments. One of these ports must be included in the same network (subnet) as the instruments themselves.
  - The port number should remain configured to "502" .
- The address set in SCADA is stored after saving and the devices themselves also retain their IP addresses even in the absence of power.

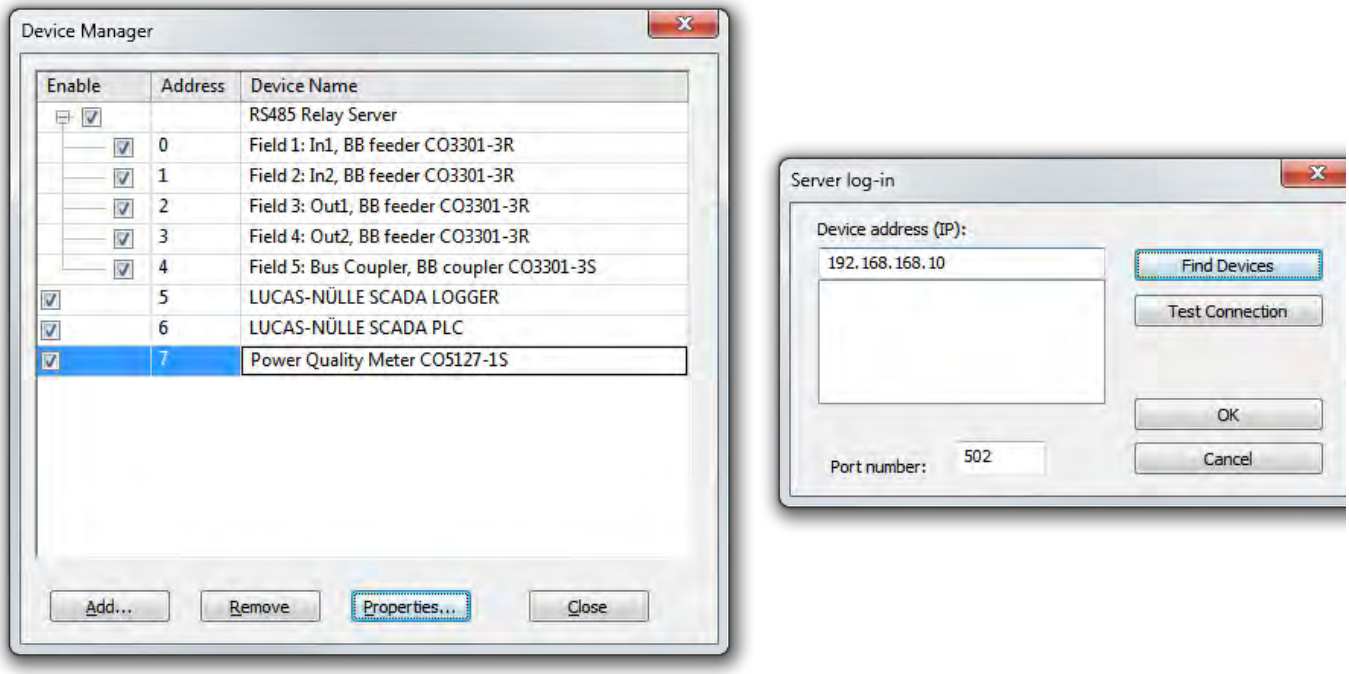


Figure 13:
Devices in "Device Manager"

If you want to know more about double busbar control by means of soft PLCs, you can have a look at the accompanying, simple PLC program. It was used to calculate the busbars' apparent powers, for example. In the SCADA software's "Instruments" menu, you will find a "PLC" item.

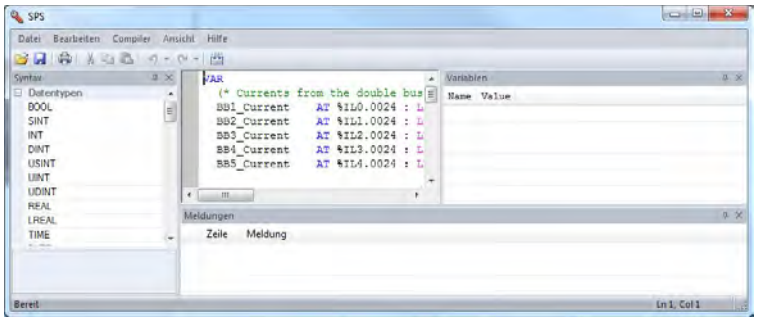


Figure 14:
SCADA Software's PLC Window

In the PLC window, you can modify, test and compile the program code.

- Pressing or F7 translates the current program into machine language.
  - Errors and warnings in the PLC program are displayed at the bottom after compilation.
  - Variables and their current contents are displayed on the right after compilation.

- If the PLC program is changed, the SCADA software must be stopped via and restarted.
- Via the menu *Edit/Add variable list*, you can use additional devices in the PLC code.
  - These devices must have been added previously via in the device manager of the SCADA main window.
- More information about supported languages (instruction list and structured text) is provided by the PLC window's online help function.
- The compiler operates according to international standard *IEC61131-3*.

Connection Via CAN Bus

The following installation instructions explain how connect devices via a **CAN bus** to the SCADA system.

Use adapter LM9024 and serial cable LM9040 to connect the PC to devices via a CAN bus.

LM9024 **LM9040**

Figure 15:
CAN-Bus Adapter LM9024 and LM9040 Serial Cable

- Insert the accompanying driver CD into the CD drive.
- The selection menu should start automatically and you can then install the driver. You might have to restart the PC afterwards.
- Connect interface adapter LM9024 to a USB port on the PC.
- Connect the interface labelled "CAN" on multi-function relay CO3301-5X via serial cable LM9040 to adapter LM9024:

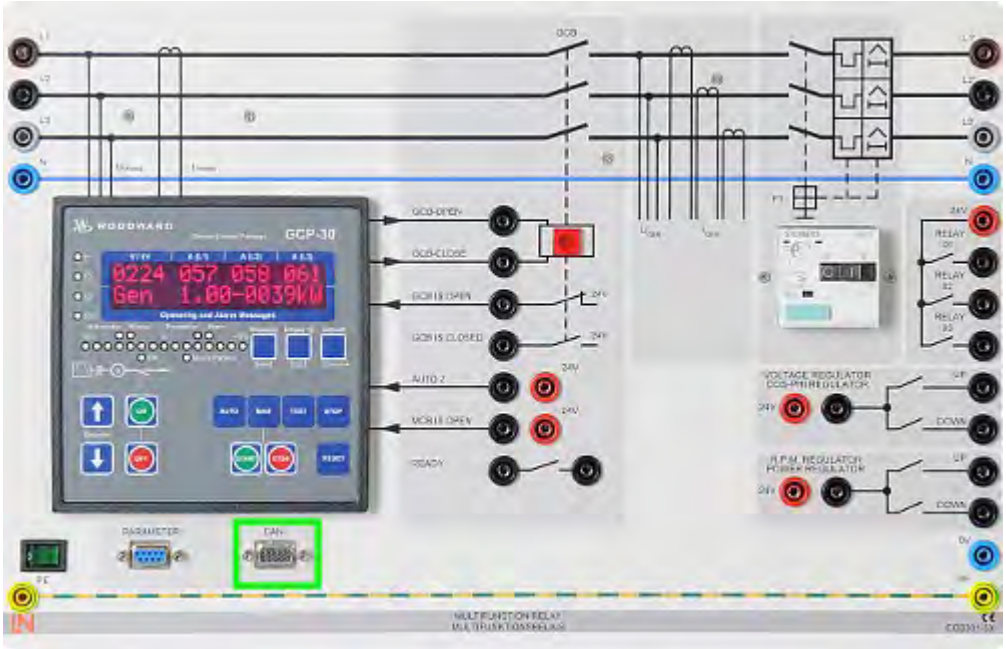


Figure 16:
Multifunction Relay CO3301-5X

Connection Via RS232

Here are the installation instructions for connecting equipment to the SCADA system via **RS232**.

In order to connect equipment to a PC via its RS232 port, use the USB-RS232 adapter, *LM9062*. If your PC should already be equipped with a suitable serial port, you can use this instead of the *LM9062* adapter.

LM9062

LM9040

Figure 17:
USB Adapter *LM9062* and *LM9040* Serial Cable

- Put the supplied driver CD in the CD drive.
- Now a selection menu should open automatically and you can then install the necessary driver. You may have to restart the PC.
- Connect the LM9062 adapter to a free USB port on the PC.
- Connect the port labelled "PARAMETER" on the multi-function relay CO3301-5X by means of an LM9040 serial cable to the LM9062 adapter:

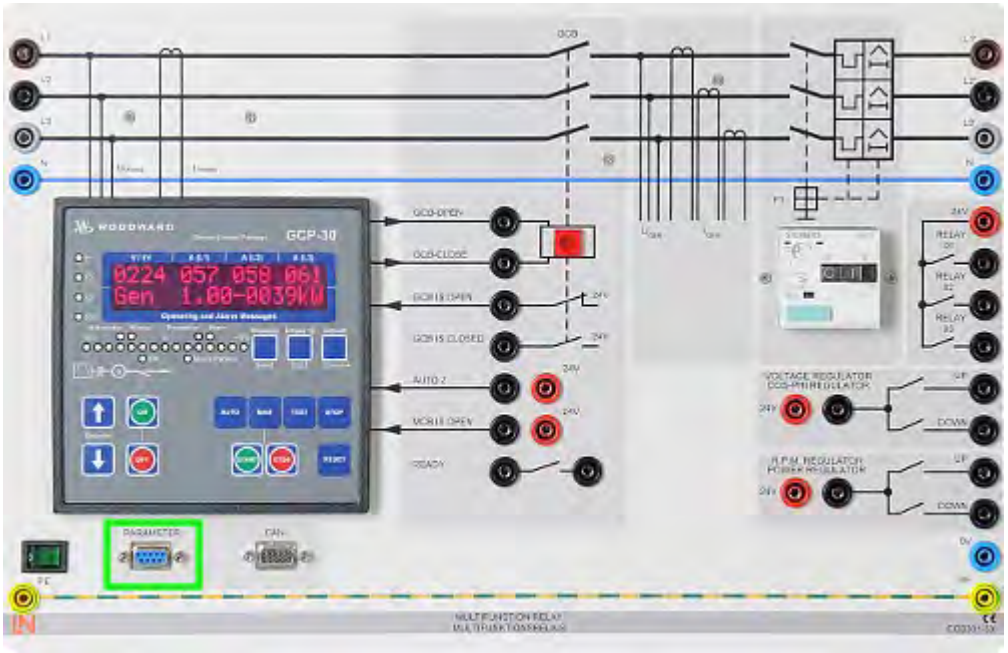


Figure 18:
Interfaces on the Multifunction Relay CO3301-5X

The serial link can now be used to set parameters for the multi-function relay, CO3301-5X, with the help of the LeoPC1 software. Operational control is effected directly via the CAN bus using PowerLab software.

Identifying the COM Port in Windows

- Open Windows' hardware manager.
- This allows you to see the COM port via which the multi-function relay can be accessed.
- More details can be found in the section "Operation of LeoPC1".

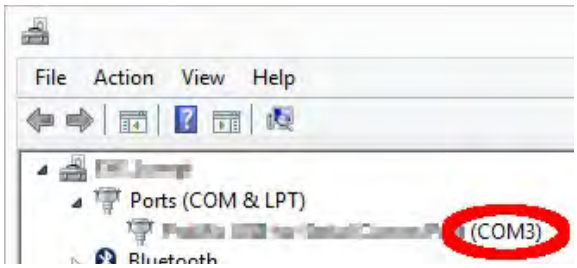


Figure 19:
Address of Serial Port (example)

Connection via RS485

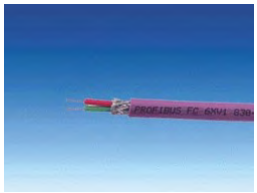
The following installation instructions explain how to connect devices to the SCADA system via **RS485**.

- Installation of the USB driver and preparing the Profibus cable.
- Connect double busbar feeders and couplers.
- Connect protective relay with RS485 interface XRS1.
- Connect directional overcurrent protection relay.
- Check the RS485 addresses using SCADA.

Driver installation and cable connection

- To connect the PC with a device using the RS485 interface, use the USB adapter *LM9025*.
  - Use the CD provided for the installation of the driver.
  - Connect the LM9025 to the PC.
- Use the cable cutting tool LM9184 to cut and strip the Profibus cable LM9181 to the right length and then attach the Profibus connector plugs LM9182.
  - Set all of the Profibus plugs to "off"
  - Connect the LM9025 to one end of the Profibus cable and set the Profibus plug on the opposite end to "on".

LM9025



LM9181

LM9182

LM9184

Figure 20:
Components for RS485

Double Busbar Feeder and Coupler Interconnection

- Set different addresses for each device. In the case of double busbars CO3301-3R and CO3301-3S, the addresses can be changed directly via the front panel.

Figure 21:
Set Address (Protection Relays)

- Open the Device Manager in SCADA via the toolbar  or the drop-down menu "Diagnostics" → "Device Manager ...".
- To set the RS485 address in SCADA, select the busbar to be set and click on the properties, then set the same value there as the value given in the hardware.

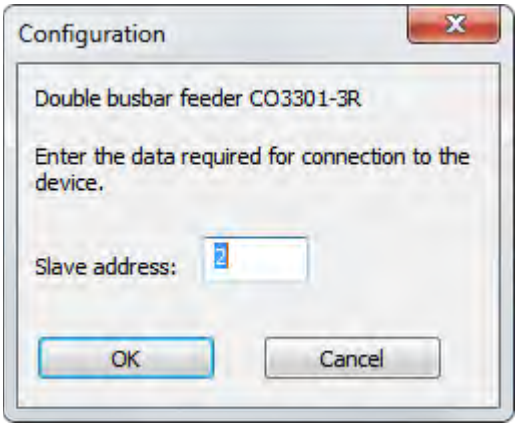


Figure 22:
Setting the RS485 Address for a Double Busbar

Protective Relay with Interface Adapter XRS1

The following protective relays use the RS485 interface adapter XRS1 for communication: Overcurrent relay CO3301-4J, over/undervoltage time delay relay CO3301-4N, directional power relay CO3301-4G, earth-fault voltage relay CO3301-4K. The overcurrent directional relay CO3301-4D is dealt with further below.

Protective relays, such as the time overcurrent relay *CO3301-4J,* are interconnected using interface adapters XRS1 also via RS485.

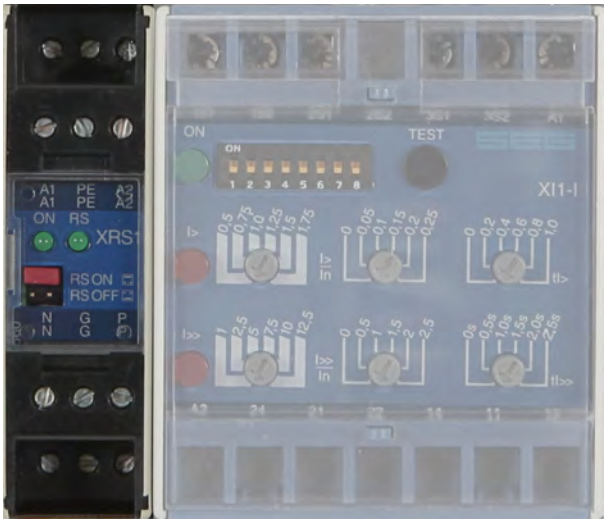


Figure 23:
The eight DIP switches for configuration are to the left of the RS485 interface adapter XRS1, located on the right of the protective relay

The address for the protective relay is set as follows:

1. Connect the supply voltage.
2. Make a note of the current positions of the DIP switches on the relay, then set DIP switches 1 - 3 on the relay to the ON setting.
3. Make a note of the protective relay's current tripping values and then turn each of the potentiometers all the way to the right.
4. Set the required address using DIP switches 4 - 8. The address is coded in binary form, as explained in the table below.

DIP switch	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Significance	**ON**	**ON**	**ON**	2^0	2^1	2^2	2^3	2^4

- Example for address 5: Binary formed from 4 + 1, accordingly the DIP switches **6** and **4** are set to ON.
- Example for address 12: Binary formed from 8 + 4, here the DIP switches **7** and **6** are set to ON

5. Press the test button for about 5 s.
6. Restore the DIP switches and potentiometers to their initial settings.

Directional Time Overcurrent Relay

The directional time overcurrent relay *CO3301-4D* is programmed via buttons on the front. The following flow chart provides information about the design of the menu layout:

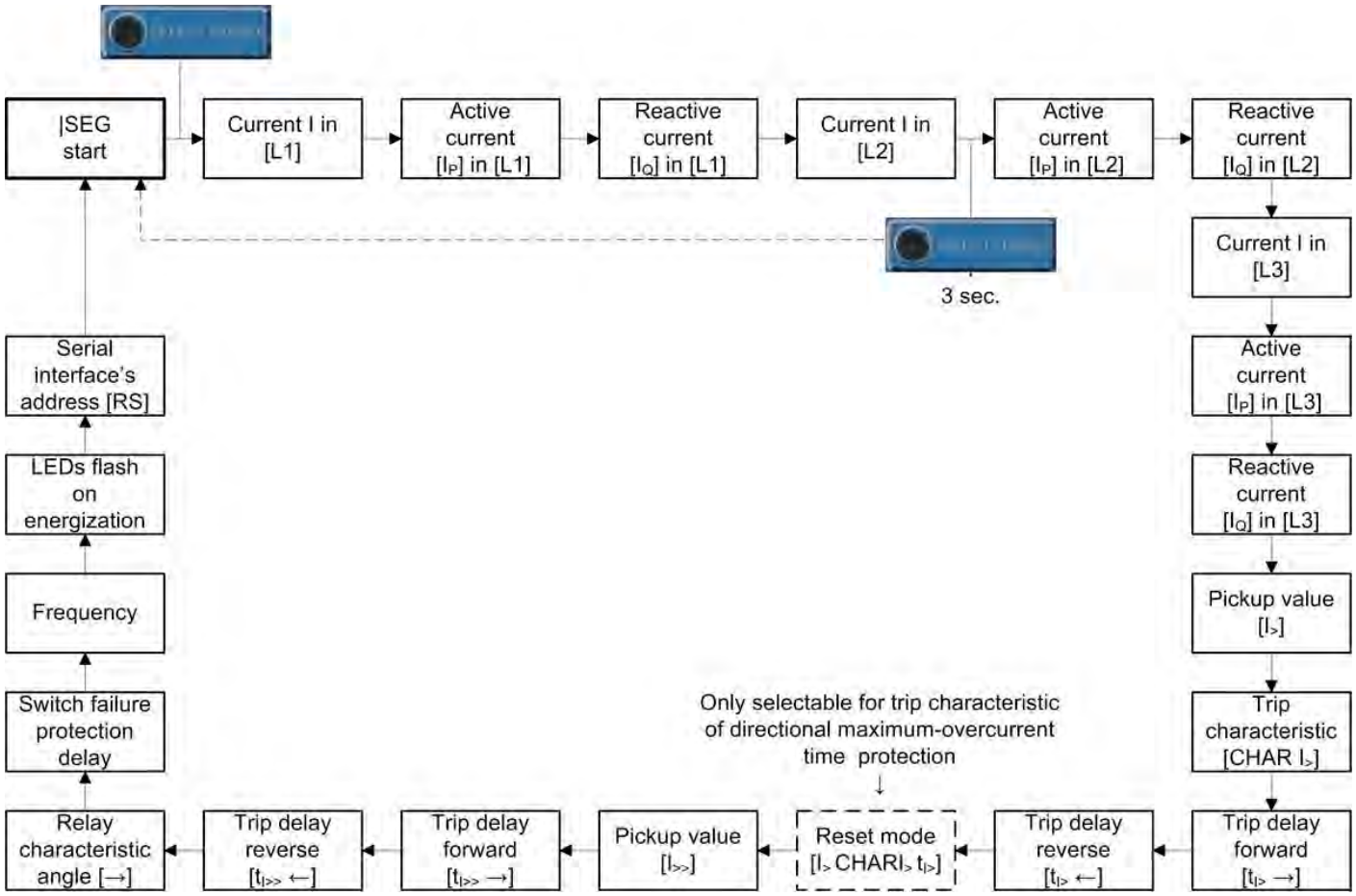


Figure 24:
Menu Structure for Directional Time Overcurrent Relay

1. Begin configuration by pressing and holding down *SELECT/RESET* for 3 s.
2. The address of the protective relay is set to that of the "*Serial interface [RS]*" (Figure 5). By using *SELECT* you can navigate through the menu items one after the other.
3. You can see in Figure 6 how the individual parameters can be changed.

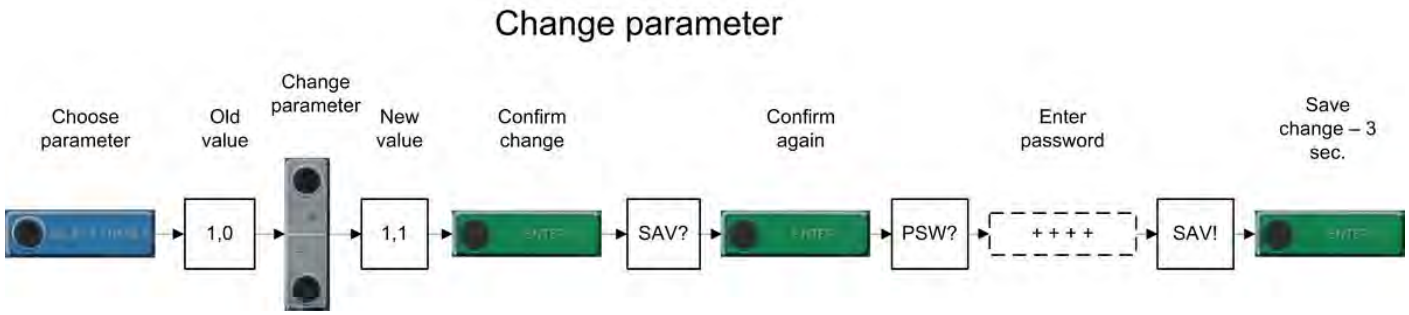
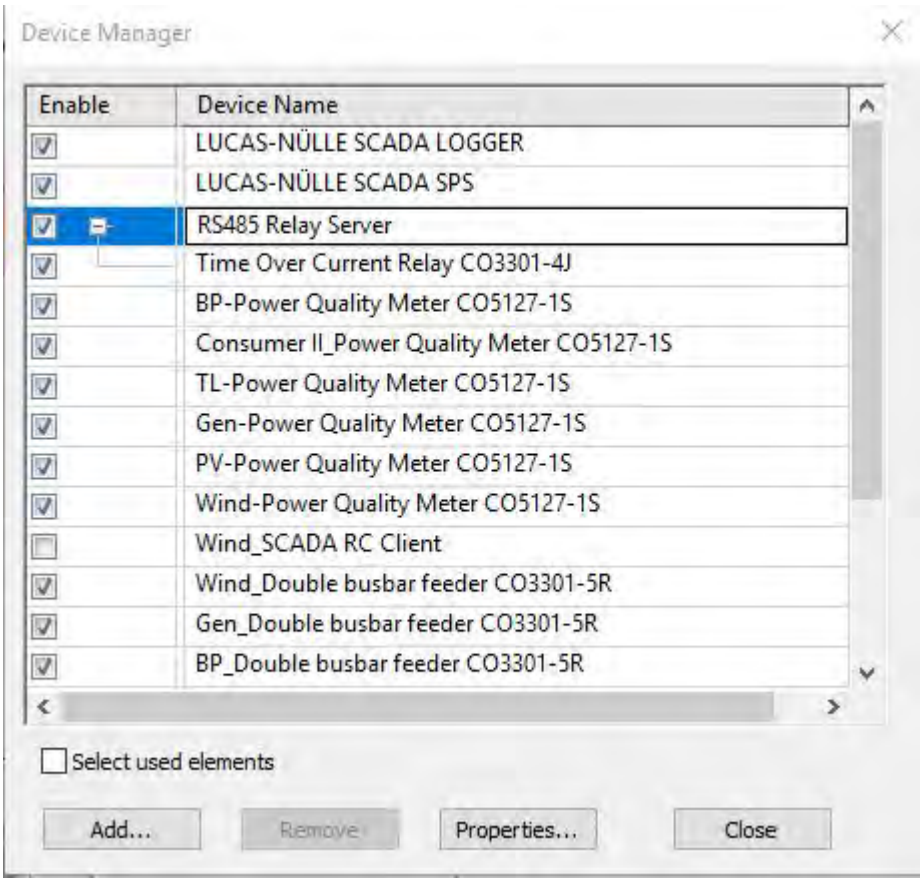


Figure 25:
Changing Parameters

Checking RS485 Addresses Using SCADA

1. Select "RS485 Relay Server" in the SCADA device manager and click on "Properties".
2. Under Interface, select the RS485 adapter *ICPDAS I-7561U USB Serial Converter*. Make sure that the driver for the RS485 adapter has already been installed previously.
3. Click on Scan to find out all the Profibus devices connected to this.
   Here you can quickly check whether all of the devices can be accessed at the prescribed addresses.



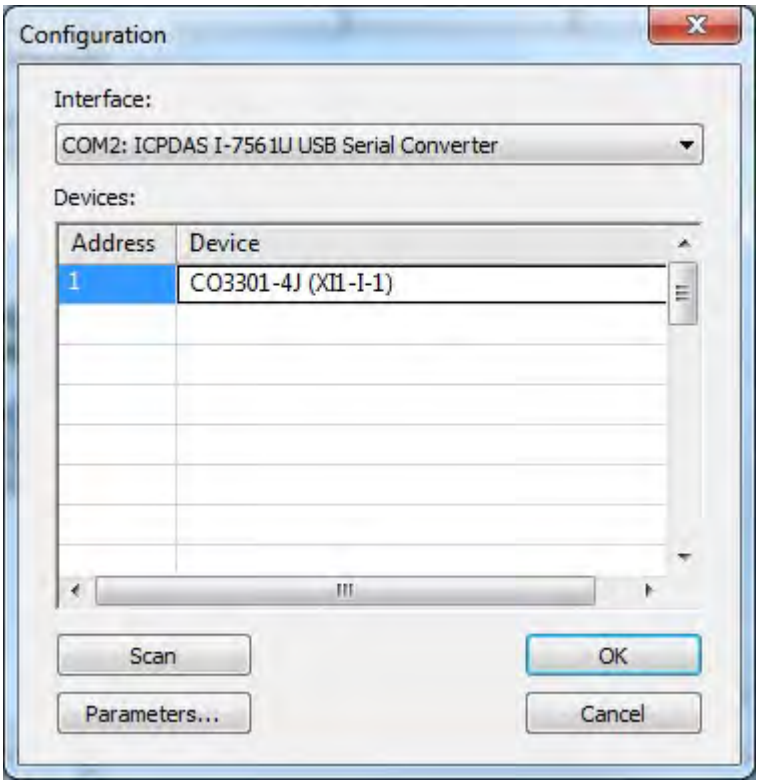


Figure 26:
Select *RS485 Relay Server* and click on *Properties*.

Configuration of Protective Equipment

Provided here are set-up instructions for configuring various safety relays within the SCADA system.

- Start the LN SCADA software and open the template which includes the safety relay in question. Then open the SCADA device manager:

- Select RS485 and click “Properties”
- Scan for devices and afterwards select the appropriate device from the list. Click "Parameters..." to open the configuration menu for the relay.

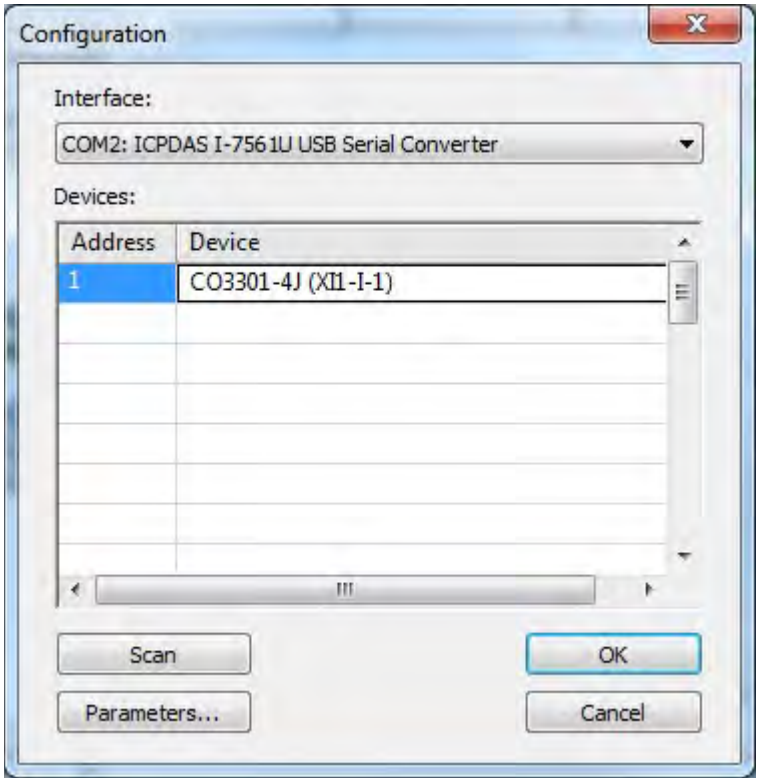


Figure 27:
Properties dialog box for RS485 relay server in the SCADA Viewer/Designer device manager

Now you can set up the device parameters as described in the experiment instructions. Parameters are applied as soon as they are entered.

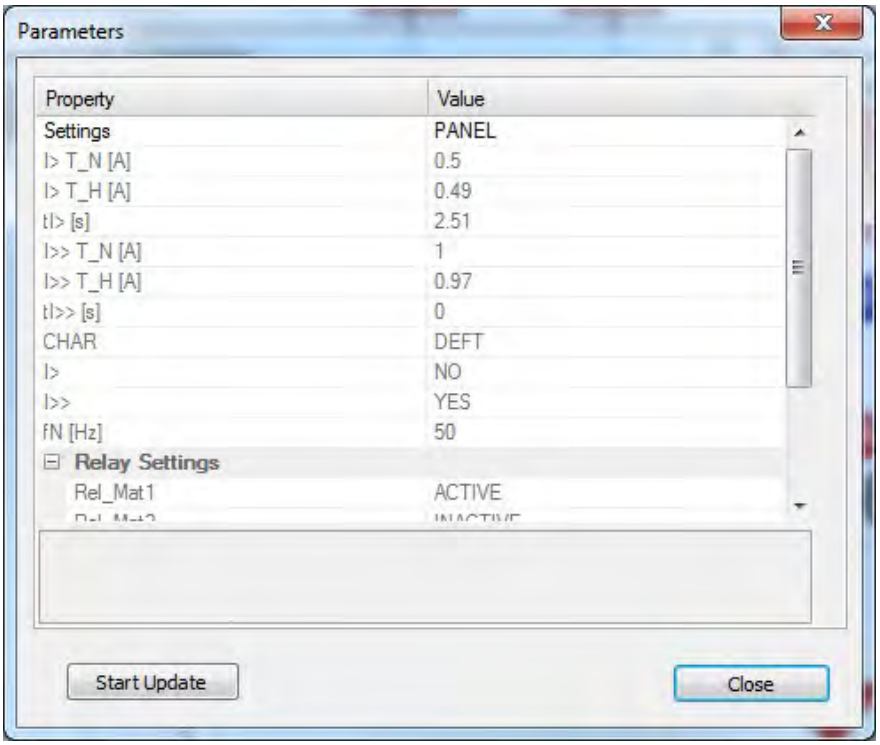


Figure 28:
Example of Modifiable Parameters for Overcurrent Safety Relay CO3301-4J

To start reading out the most current values from the relay press "Start Update". Press "Stop Update" to stop the cyclic update process again.

Settings/Parameter Changes

Settings can be modified either via the software or directly on the device. The hardware parameters always include the basic settings. If the parameters for a relay are to be set via the software, you need to switch over from Panel to PC under Parametrization. One exception exists for the XR1-IR, where this switch-over is performed automatically. How to change parameters is described further below under "Software".

A: Hardware

At the hardware level, nearly all SEK protective relays can be set via DIP switches and potentiometers.

Input in the case of the XR1-IR directional time overcurrent relay is via the buttons. Figures 29 and 30 below explain the input scheme and menu structure.

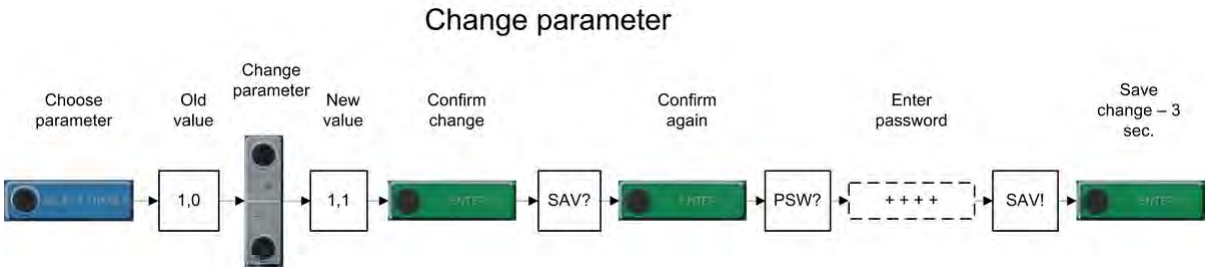


Figure 29:
Input Scheme for Changing Parameter Values (XR1-IR)

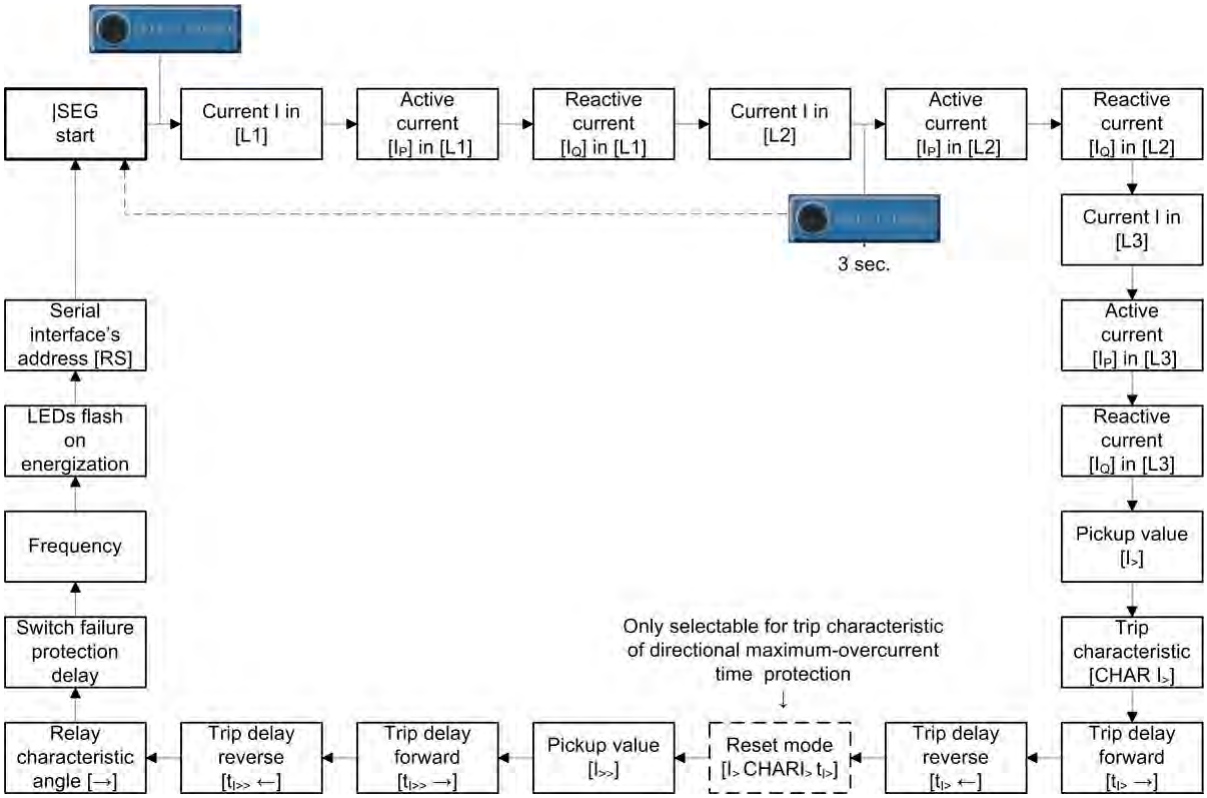


Figure 30:

Menu structure XR1-IR

B: Software

To set values via the software, select the appropriate, white input field by left-clicking it and enter the desired value.

Confirm your entry with the Enter key and then click "Device/Set parameter".

This opens a window requesting password entry. Enter the password and confirm with Enter.Once the input window closes, the parameters will have been changed.

C: Passwords:

XRI1-IR: ++++
All other relays: **20556**

Value Recording

All analog and digital signals acquired by the LN SCADA PLC can be viewed or recorded. To do this go to the "Instruments" menu of the LN SCADA Designer or LN SCADA Viewer and select "Logger".

If there is no "Logger" entry, make sure that you have opened a plc file which includes the SCADA logger and the configured devices which it requires.

Connection via USB

Here are some instructions on how to connect equipment to the SCADA system by means of **USB.**

Driver Installation

Some equipment may be controlled via a computer running Windows. This involves the equipment being connected to the computer by means of a USB link. As a rule, you would install drivers or control software before connecting the equipment to the computer via the USB port.

- When using a **servo-machine test bench** (300 W/1 kW), install the "ActiveServo" software from the supplied CD.
- When using the **multi-function relay CO3301-5W**, install the "ToolKit" software supplied with the relay.
- When using **multimeter CO5127-1Z**, install the analog/digital multimeter software from the supplied CD. It is also sufficient to only install our training software LabSoft, if you wish to choose that option.

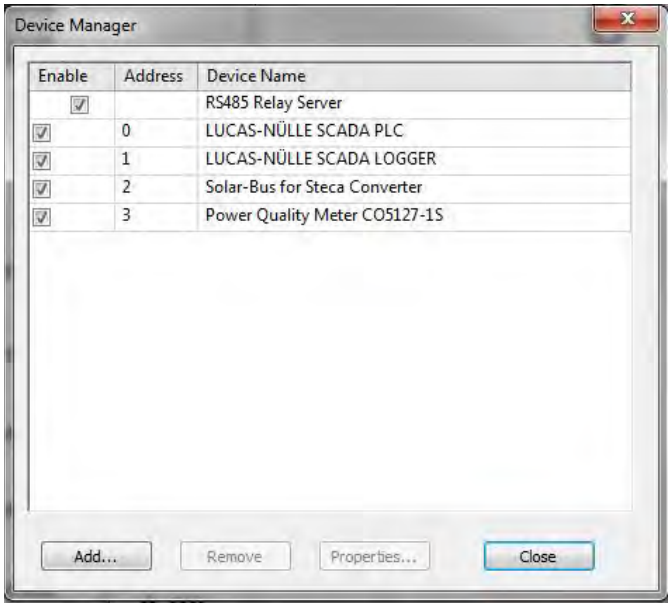
Connect the equipment via any free USB port on your computer and wait till the computer has fully initialised the driver and the equipment itself.

The following installation instructions explain a different way of how connect devices via **USB** to the SCADA system.

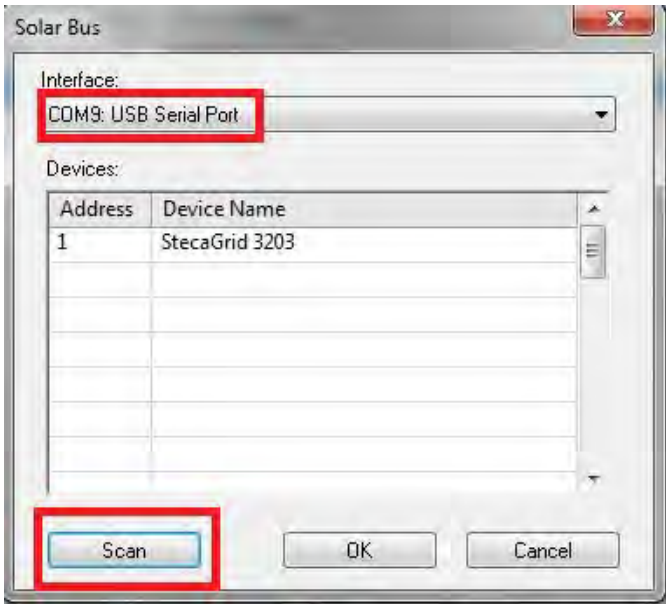
- Install the USB driver from the CD accompanying the device.
- Connect the device via the USB interface to a free USB port on your PC.
- The device is then detected and identified by Windows.

Configuration of the CO3208-1N7 Photovoltaic Converter

- Open the SCADA Device-Manager via the toolbar. 
- Select the "Solar- Bus for Steca Converter" and click "Properties".



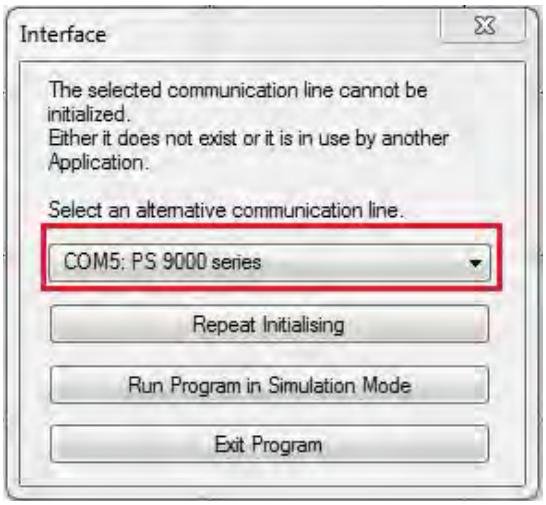
- Here select the "USB Serial Port" Interface and click "Scan".



- When the slave - device is detected, click "OK".

Configuration of the Solar Panel Emulator CO3208-1P on The Solar Panel Virtual Instrument.

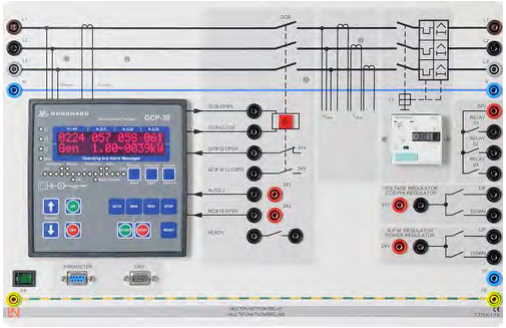
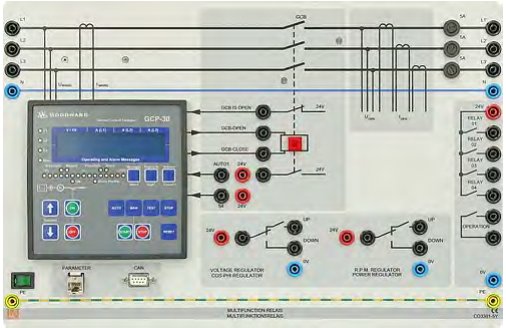
- When you open the solar panel virtual instrument the interface should be already available.
- If the interface is not installed, select the PS 9000 series Interface and repeat the initialization.

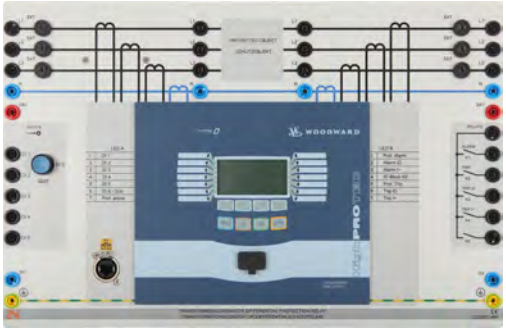
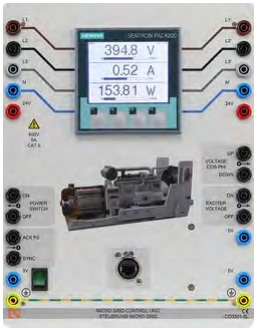


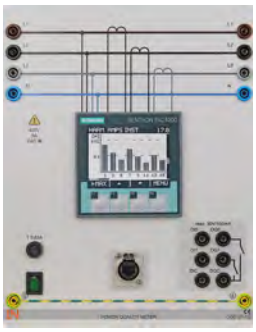
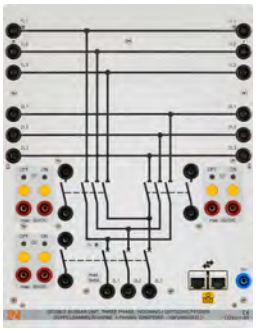
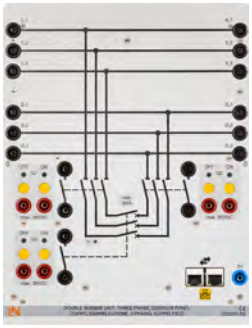
General Notes on SCADA Connection

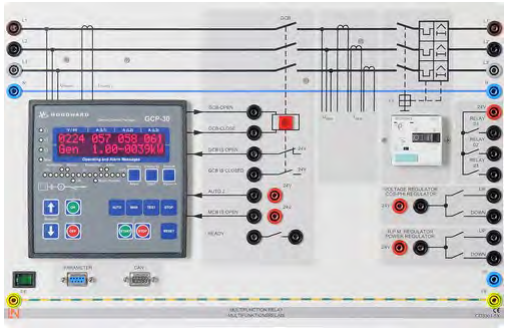
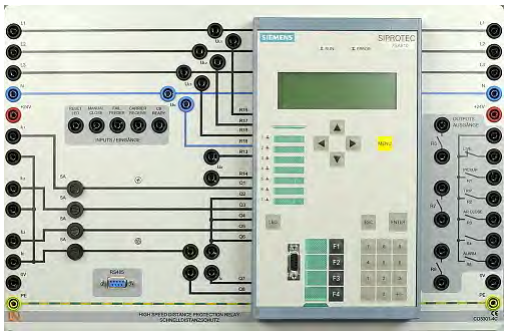
Before using the SCADA system for the first time, you need to make a one-time hardware connection for mutual communication.

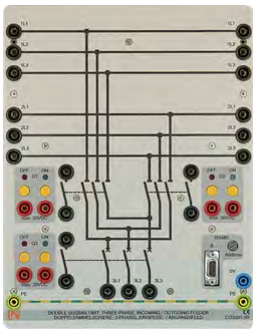
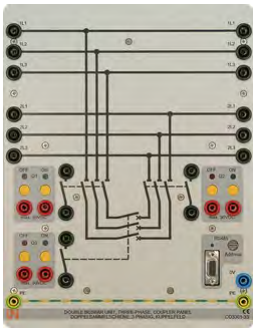
In some cases the various devices are connected via different interfaces to the PC. Refer to the overview below to find out how individual devices should be linked to the PC. The configuration for each type of connection is described in the corresponding section of this topic.

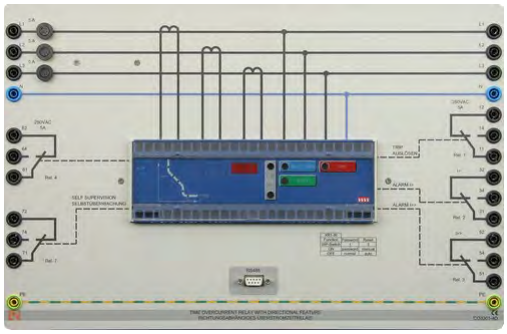
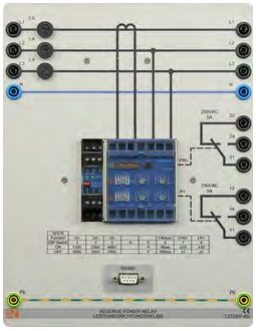
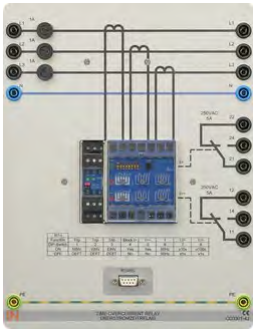
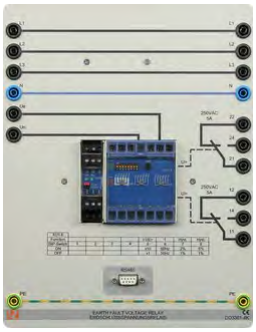
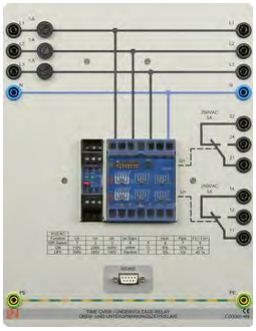
Connection via CAN bus		
	CO3301-5X	Multi-function relay, power controller, cos(f)-controller, synchronisation unit
	CO3301-5Y	Multi-function relay, power controller, cos(f)-controller, synchronisation unit

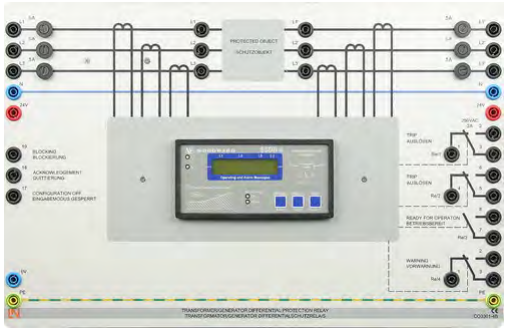
Connection via Ethernet		
	CO3301-4M	Transformer/Generator differential protection relay
	CO3301-5L	Generator HMI

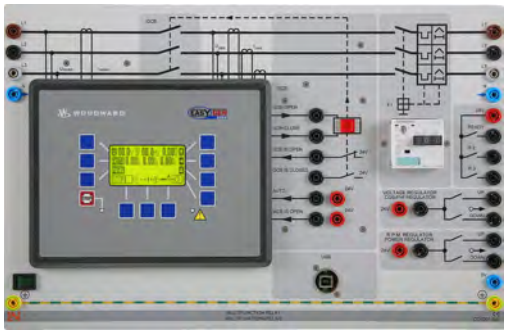
Connection via Ethernet		
	CO3301-5K	Pumped-storage power station control unit
	CO5127-1S	Power quality meter with graphic display and long-term storage
	CO3301-5R	Double busbar, 3-phase, incoming/outgoing feeder
	CO3301-5S	Double busbar, 3-phase, incoming/outgoing feeder

Connection via RS232		
	CO3301-5X	Multi-function relay, power controller, cos(f)-controller, synchronization unit
	CO3301-4L (CO3301-4C)	High speed distance protection relay

Connection via RS485		
	CO3301-3R	Double busbar, 3-phase, incoming/outgoing feeder
	CO3301-3S	Double busbar, 3-phase, coupler panel

	CO3301-4D	Directional time overcurrent relay
	CO3301-4G	Power/directional power relay
	CO3301-4J	Time overcurrent relay
	CO3301-4K	Ground fault voltage relay
	CO3301-4N	Time overvoltage/ undervoltage relay

	CO3301-4B	Transformer/Generator differential protection relay

Connection via USB		
	CO5127-1Z	Analog/digital multimeter, power/power factor meter, software
	CO3301-5W	Multi-function relay, power controller, cos(f)-controller, synchronization unit
	CO3208-1N7	3-phase Industrial Photovoltaic Inverter
	CO3208-1P7	Solar panel emulator 1.5 kW / 500 V

Using SCADA for the PowerLab

The following pages cover:

- Configuration
- Viewer/designer functional features
- Putting the experiments into operation (Viewer/Designer)
- Adapting the SCADA system configuration (Designer)
- Detecting and recording values and signals (Viewer/Designer)
- Legends of the micro-grid logger graphs (Viewer/Designer)

Configuration

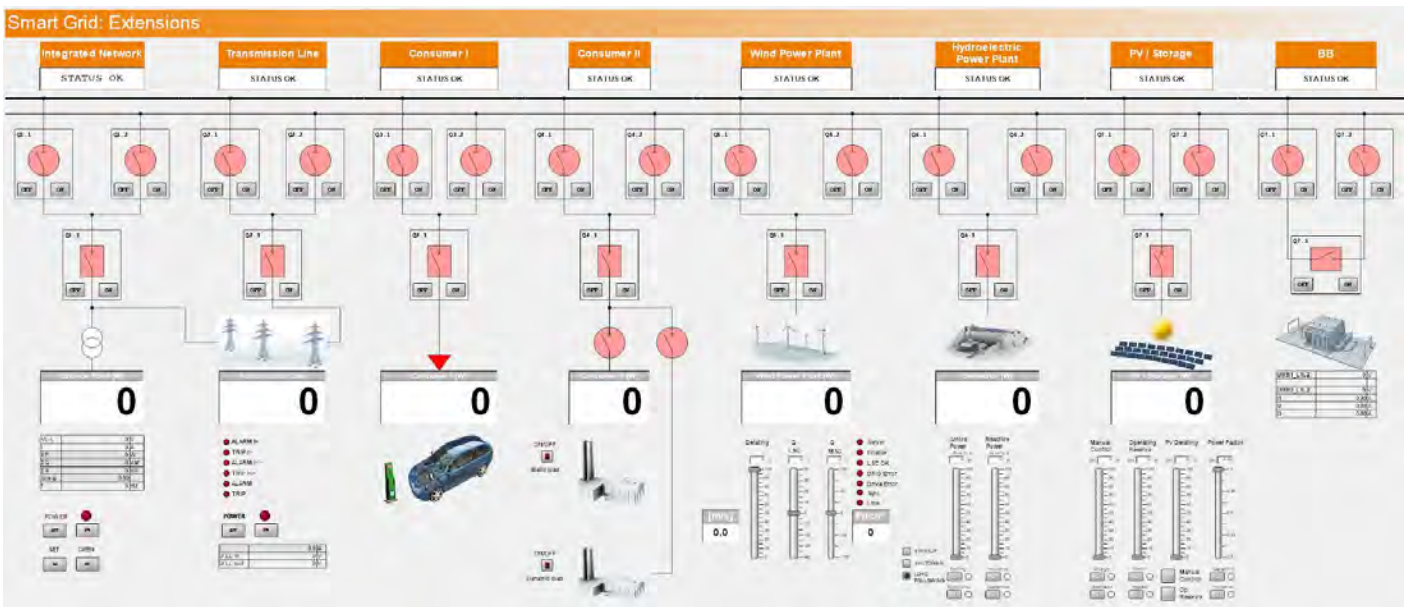


Figure 31:
SCADA User Interface for Smart Grid: ESG 1

Run SCADA for PowerLab by clicking the button in LabSoft:

Figure 32:
Starting SCADA in Labsoft

You can find the appropriate configuration file from the start page of the SCADA Viewer for PowerLab:

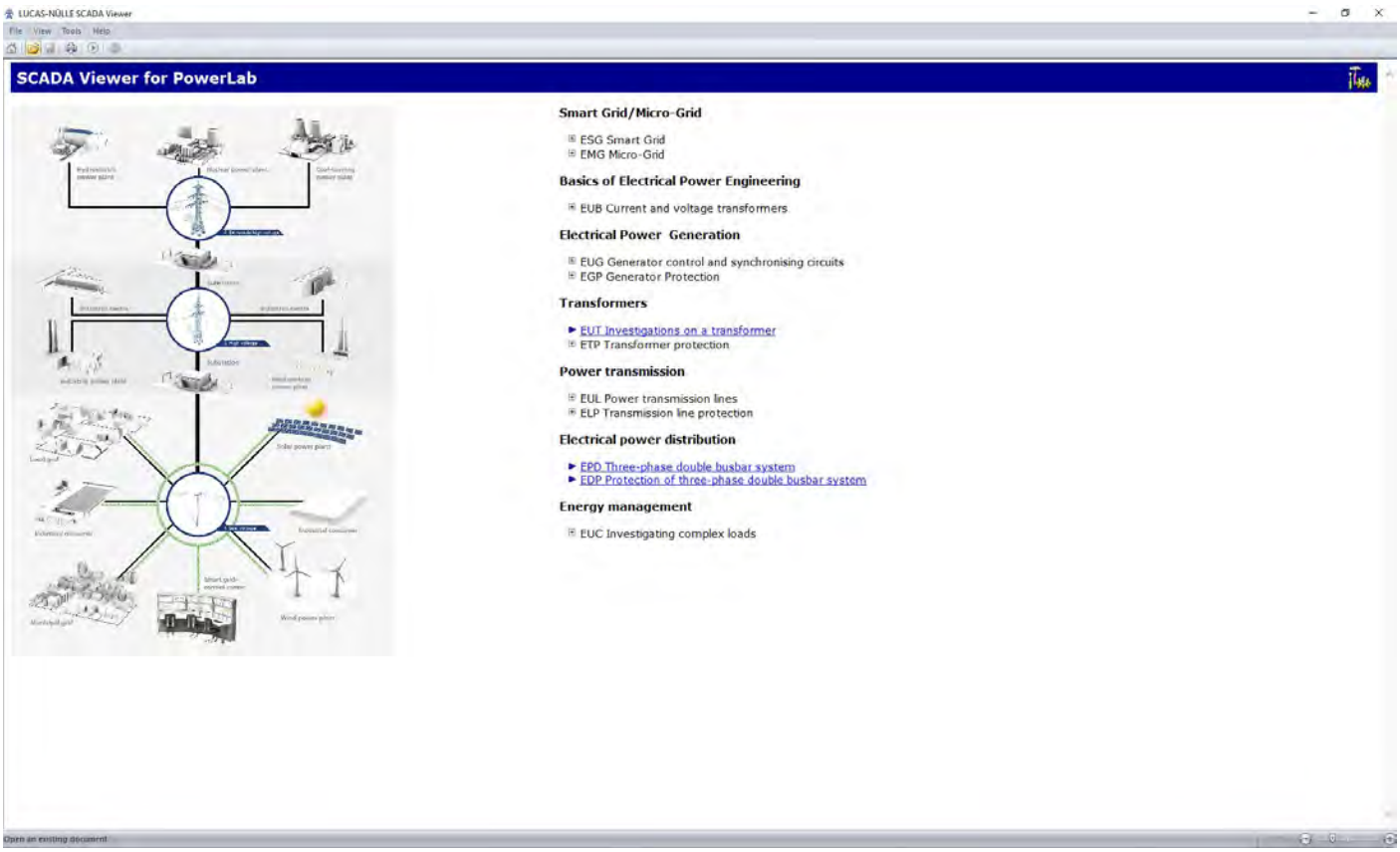
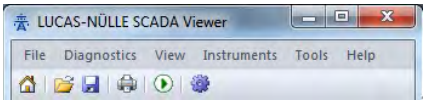
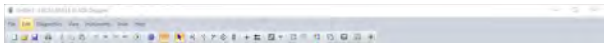
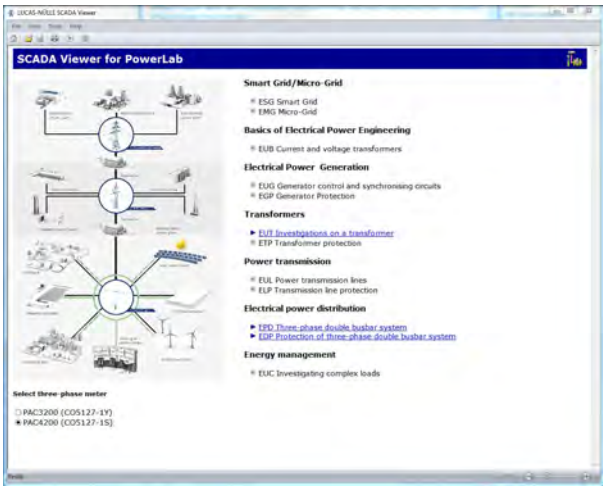
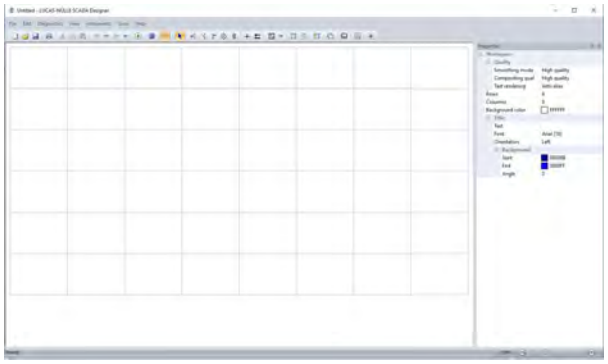


Figure 33:
Projects in SCADA Viewer

Viewer/Designer Functional Features

There are two versions of the *SCADA for Power Engineering Lab software.* The *Designer* package (SO4001-3F) permits the entire user interface as well as the equipment integrated into the specific project to be adapted and edited. The *Viewer* package (SO4001-3H) enables the user to open all files created using the Designer software to then carry out automatic and process control operations as desired.

Differences between SCADA Viewer and SCADA Designer

	SCADA Viewer (SO4001-3H)	**SCADA Designer (SO4001-3F)**
Toolbar		
Distinguishing Features	The window caption shows whether the Designer or the Viewer program is being used. The toolbar of the viewer ends with the equipment manager button. The Viewer starts with the experiment overview while the Designer program starts with an empty working surface  	

What can be edited?	✗ User interface ✗ Expand/reduce equipment being used ✓ Modify equipment addresses in the SCADA equipment manager (e.g. IP addresses) ✗ Signal assignment to the interface ✓ PLC program	✓ User interface ✓ Expand/reduce equipment being used ✓ Modify equipment addresses in the SCADA equipment manager (e.g. IP addresses) ✓ Signal assignment to the interface ✓ PLC program
Equipment selection	Equipment selection is determined by the Designer, i.e. all of the equipment added to the project file in the Designer are also available in the Viewer.	All supported equipment can be added to the project. This includes (among other things) the following: ✓ Devices for line and system protection (RS485) ✓ Diverse meters both 1-phase and 3-phase (Ethernet and USB) ✓ Pumped-storage power station control unit Microgrid control unit ✓ Photovoltaic system inverter (USB) ✓ Double busbars (RS485 and Ethernet) ✓ High-voltage DC transmission (HVDC, via USB) ✓ Electricity operating module (USB) ✓ Remote Control Server/Client (Ethernet) ✓ OPC-Client (Ethernet) ✓ IEC 61850-Client (Ethernet) ✓ Signal and data logger ✓ PLC software
Operating time restriction	None	One dongle is needed for operation

If you have purchased the Designer version it suffices to install this. The Viewer is automatically installed and you can use the Windows start menu to decide which program version you would like to run. To use the Designer software you need to insert the dongle included which, however, is not required to operate the Viewer.

Putting the experiments into operation (Viewer/Designer)

If you have set up a new experiment which also uses the SCADA software there are several aspects to consider that are important for smooth fault-free operation.

What was done?	What has to be taken into consideration?	How frequent
The experiment set-up has been modified: Power and/or signal cables or lines have been reconnected	Check that the power cable and the signal line are all connected correctly. What is critical for the individual safety is above all the correct connection of the PE conductor.	Every time
The equipment in use has been expanded/reduced	The system configuration to be loaded in SCADA must coincide with the experiment set-up	Once, save the SCADA file, photograph/record your set-up and re-use the SCADA file and set-up next time
The sequence of the double busbars has been modified	Check whether the address assignments on the double busbars and in the SCADA equipment manager are still in agreement. It may prove necessary to reallocate addresses. Here you may find remedies in the chapter "Connection via RS485". Make sure that the correct termination has been provided for the profibus lines using terminating resistors	Every time
IP addresses of computers and/or meters have been changed	Check that there are no overlapping IP addresses (e.g. avoid double assignments, use the same subnetwork mask) To change the IP address of the computer you can find help in the chapter "Connection via Ethernet". In the case of experiment panels with Siemens Sentron PAC (3200/4200 etc.), you can change the IP addresses in the equipment menu (Menu/Settings/Communication), for this see also the chapter "Connection via Ethernet".	Every time, here too it makes sense when switching between two known set-ups to record and maintain several SCADA files after you have recorded the user modification in the files.

If you have carried out user modifications to the SCADA system configuration file (*.pvc), it makes sense to save them under a different file. For this use a storage location where you have write/read permission.

Adapting the SCADA System Configuration (Designer)

When you perform experiments in accordance with the Lucas-Nülle training courses then it is sufficient to use the Viewer. Set up the hardware configuration as specified in the instructions, use the SCADA template provided and proceed as laid out in the training course.
On the other hand, if you would like to carry out modifications to the standard experiment set-ups from LN, or even set up a completely new system layout of your own design, then you need the Designer software version.

Example: Expanding the SCADA configuration by integrating a double busbar feed

For this you already have at your disposal: 4 double busbar rail feeder CO3301-3R or CO3301-5R and a double busbar coupler CO3301-3S or CO3301-5S.

To be added to this: An additional double busbar feeder CO3301-3R/CO3301-5R.

Expanding the hardware

After the additional double busbar feeder has been inserted into the experiment configuration stand at the correct location, the wiring must still be completed. The instructions for this only refers to the wiring required for the control section.

For CO3301-3R Bus bars:

- Supplement the existing profibus by adding an additional plug and connect this to the feeder. Now it is important to assign a specific address to the feeder. If the existing double busbar has been assigned the addresses 1-5 then the new feeder receives the address 6. This is set using the rotary switch on the hardware.
- After doing this check whether all devices can be found on the bus using the addresses set. To check this, scan for the equipment devices using the RS485-Adapter in the SCADA device manager . The pages titled *Connection via RS485* describe this process in more detail.

For CO3301-5R Bus bars:

- Connect the double busbar module to the network switch or to the next double busbar with a free RJ45 port. Now it is important to assign a specific IP address to the feeder. Make sure that you use a free IP address on the same network where the other existing bus bars have been configured.
- After doing this check whether all devices can be found. To check this, use the device manager of the SCADA software. The pages titled *Connection via Ethernet* describe this process in more detail.
- Expansion of the hardware is completed when all of the additional terminal connections like the PE and phase-to-phase lines and /or neutral conductor have been connected on the feeder

Expanding the software (Example for CO3301-3R)

The scanning procedure serves to check whether the new feeder has already been added to system configuration file. To do this please click on the menu item *Add..* in the main window of the device manager and select the double busbar feeder *CO3301-3R*

Download the EPD_1S.pvc file and save it in a folder to which you have writing permission.

Start the SCADA Designer software and open the desired system configuration file. This system configuration files (*.pvc) can then be found under *<Installationspath_SCADA_for_Power_Engineering_Lab>\Templates*. If, for example, you have the LN double busbars and you wish to modify the standard system layout of the training course please open the *EPD_1S.pvc* file in the previously mentioned path.

First of all, activate the matrix lines using the grid symbol from the toolbar.

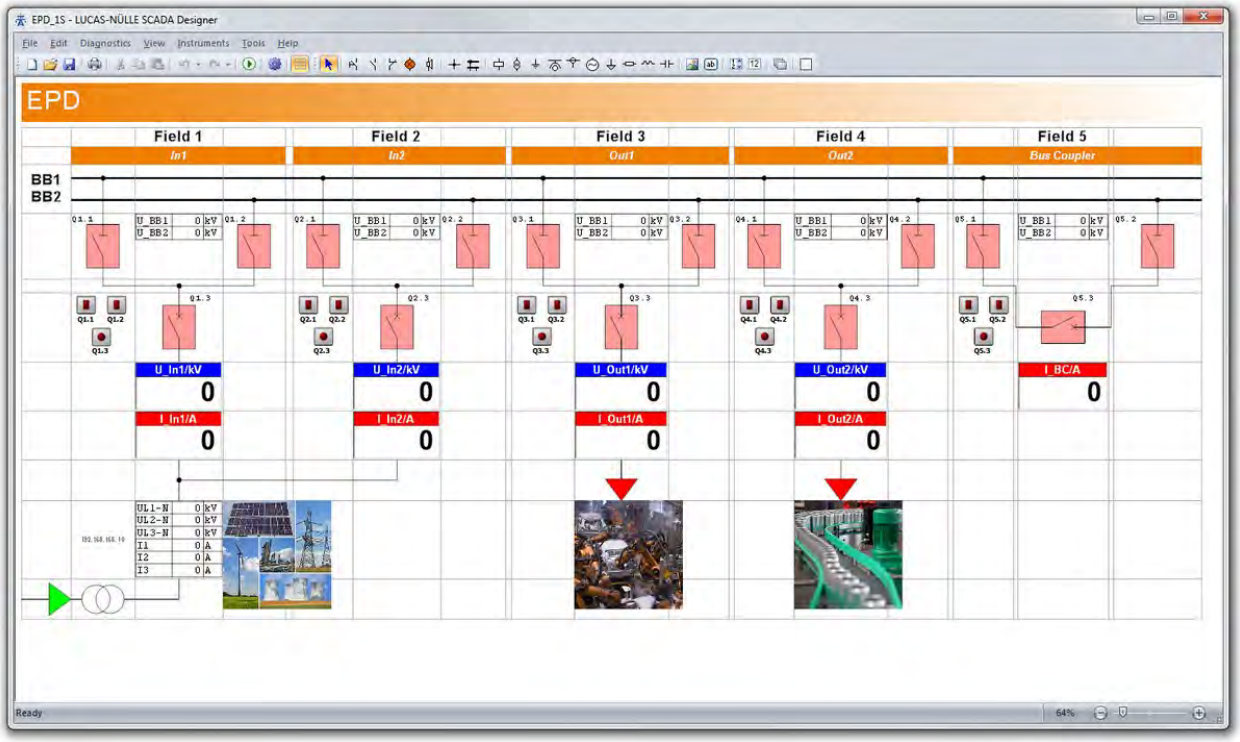


Figure 34:
Double busbar system configuration opened in the Designer software

To add the feeder more boxes are needed. Click to the right of the cells in a free area and select *Insert Column*. Repeat this step until an additional 4 columns have been added.

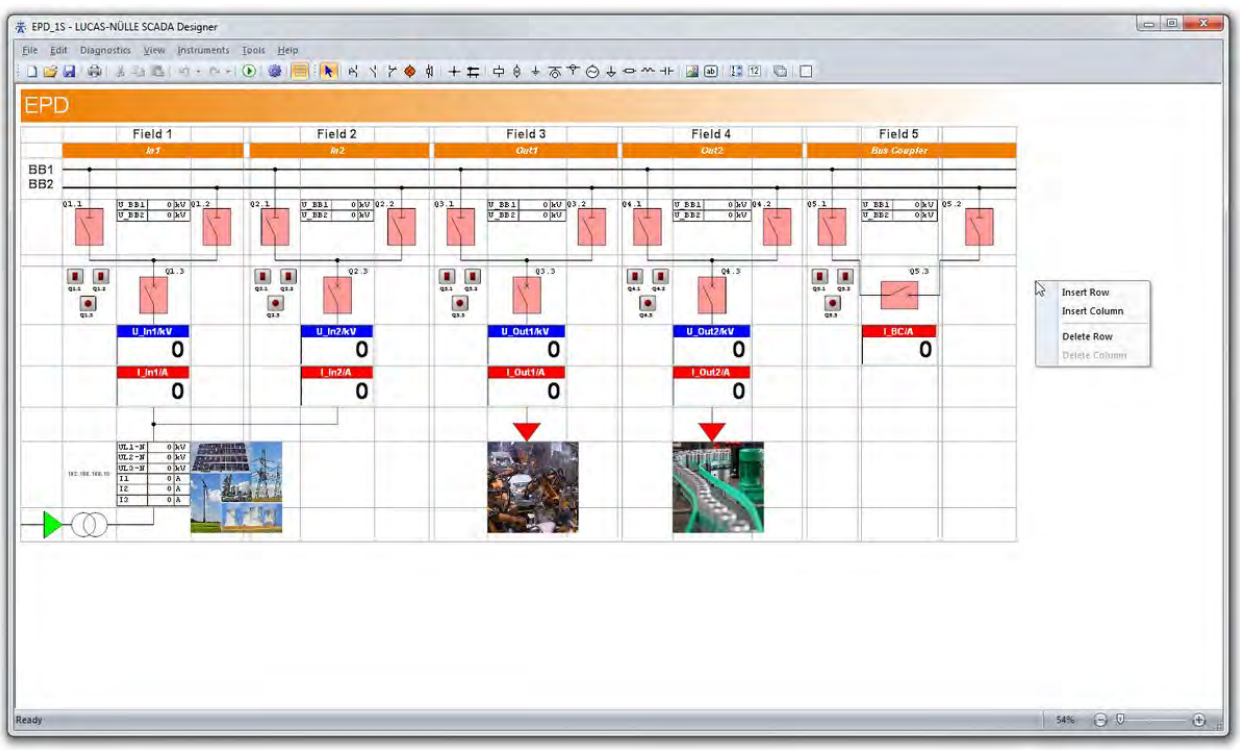


Figure 35:
Expanding the SCADA template by inserting columns

You should now have four free columns on the far right side of the window - making the new Field 6. Now we copy the operating elements of the other double busbar feeder into Field 6. The next closest feeder is in Field 4, that is why we copy its elements.

Drag and drop element for element from Field 4 to Field 6. Before releasing the elements on Field 6 remember to press the STRG (CTRL) button - the elements are then copied instead of just being shifted.

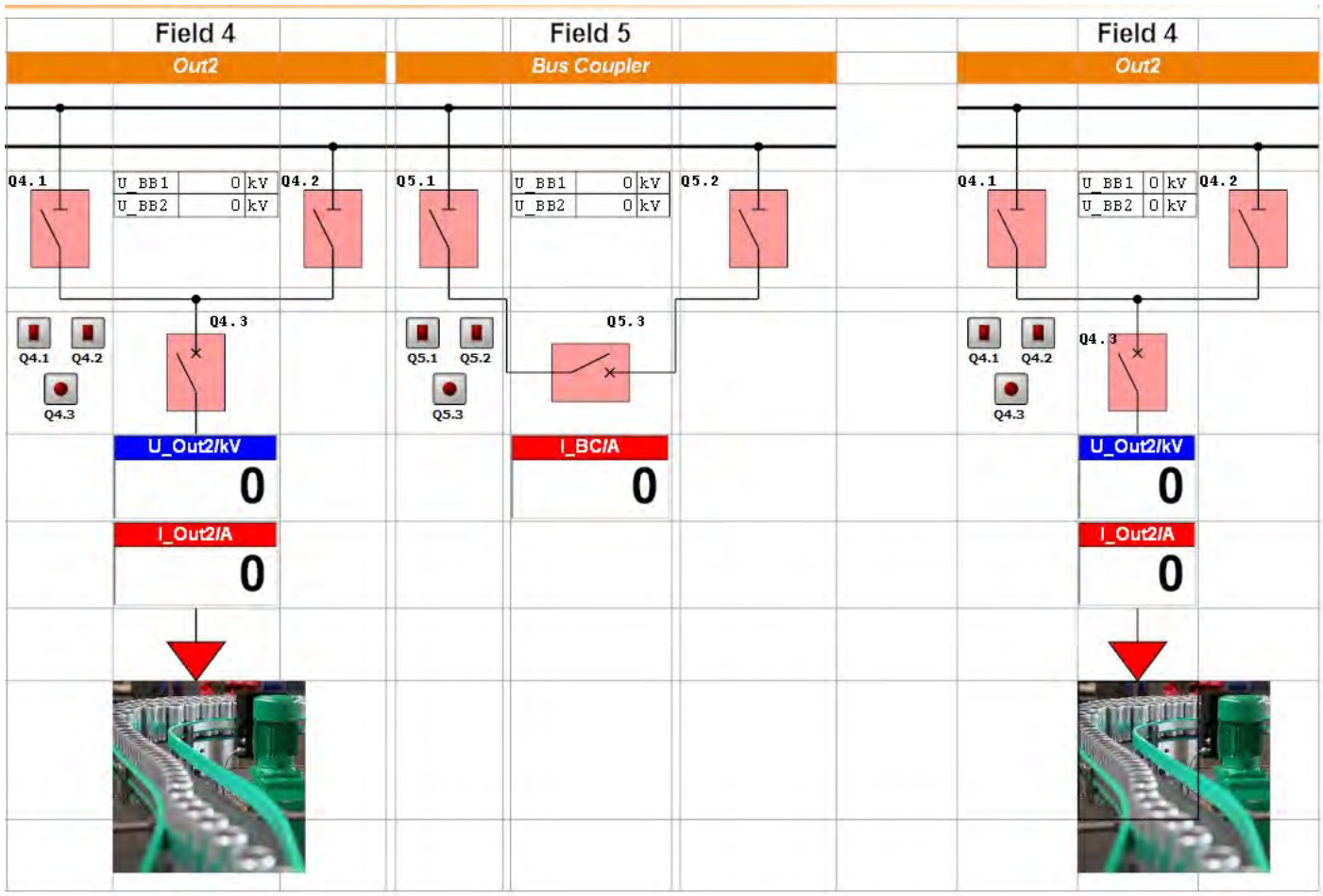


Figure 36:
Field 4 has been copied 1:1 to the right of Field 5

- Now you still have to edit the copied field.
  - Begin with the labelling, to do this highlight the individual elements and alter their designation in the attributes field.
  - The three buttons for isolation/power switch control are exported via right click. Process this file using the *Panel Designer* (Instruments menu in SCADA) Afterwards you import the file back into SCADA, again by right clicking on the field.

- Now reassign the signal allocation: To do this double click on the elements in the interface. In the subsequent window the previous assignment is shown, carry out the assignments with the new hardware.
- Edit the PLC-code accordingly.

For every element precisely one box is allocated. The only exceptions apply to images and *Panel Designer* elements, these may take up several boxes. These and additional settings can be found under the View menu, where you can also select the attributes bar.

available analog values of the PLC unit.

Detecting and Recording Values and Signals (Viewer/Designer)

The following topics are covered in this section:

- Displaying digital signals
- Displaying analog values and assigning/inserting/removing Y-axis
- Adjusting the X-axis (time axis)
- Scaling values
- Exporting data

Displaying Digital Signals

Using in the Logger open properties window, select the second tab labelled *Status*. On the left all of the equipment configured with SCADA is shown, whose signals can be added per double click to the list of signals shown on the right. You can also edit the signal name, sequence, label and representation in the list on the right.

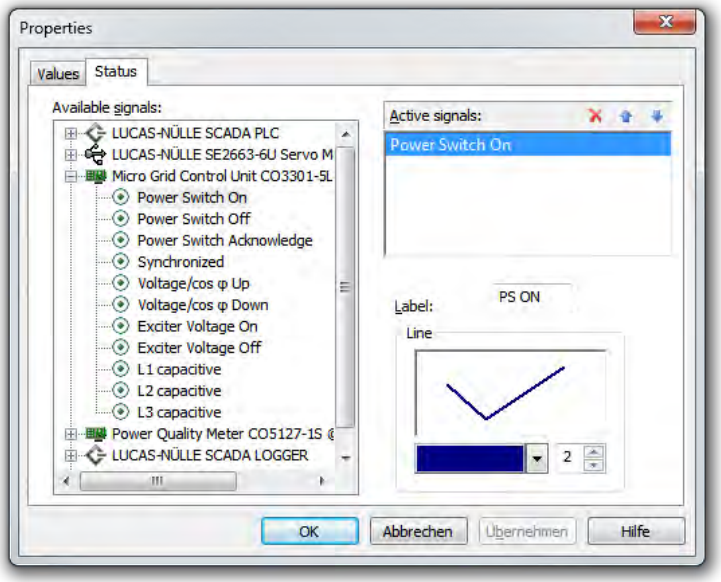


Figure 37:
Selection of the Digital Signals to be shown in the Logger

Displaying Analog Values and Assigning/Inserting/Removing Y-axis

Again  using in the Logger you can also adjust the analog values. The first tab *Values* displays all available analog values of the PLC unit.

Operation is just like for digital signals only here you also have to specify a Y-axis on which the value should be plotted. For this select a value in the list on the right and select a suitable *axis*. If you would like to create a new axis press on the "..." button to the right next to the axis selection. You can also modify or remove an existing axis here in the same fashion. For this you also have to have the settings for the Y-axis: min/max values, auxiliary lines and line colours.

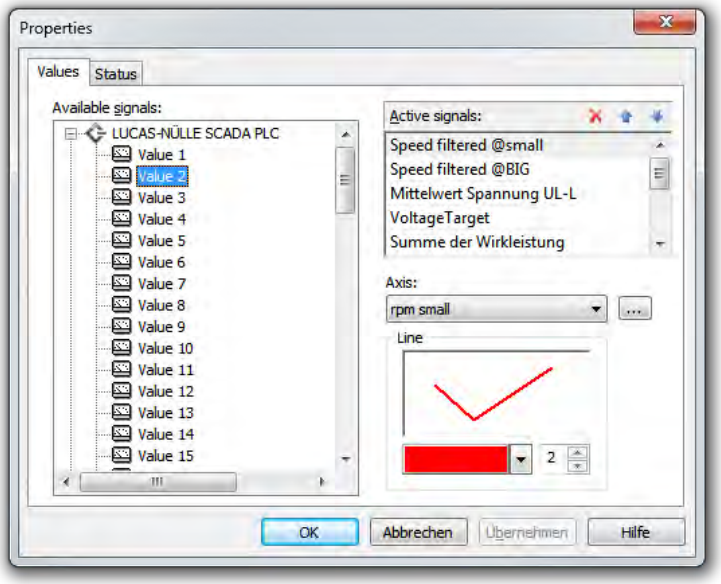


Figure 38:
Selection of the Analog Values to be displayed in the Logger

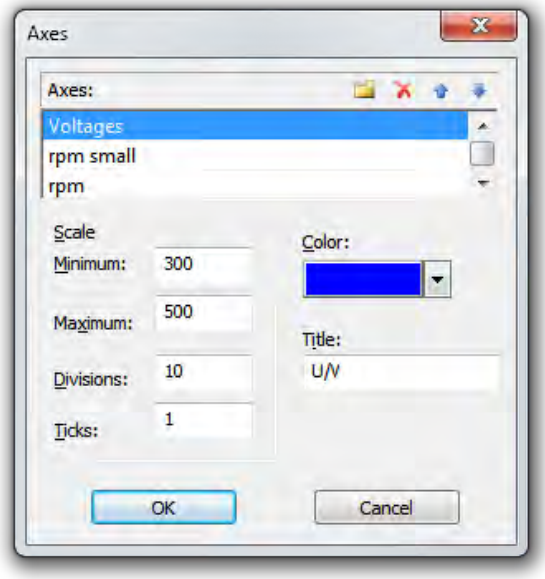


Figure 39:
Defining Y-axes

Editing the X-axis (Time Axis)

To set the X-axis double click on the diagram and then enter your settings at the x or time axis (*Time*). Here you have to specify the displayed range. For example, if you set a maximum time value of 60 s, for a 2 min measurement you can nevertheless view old values.

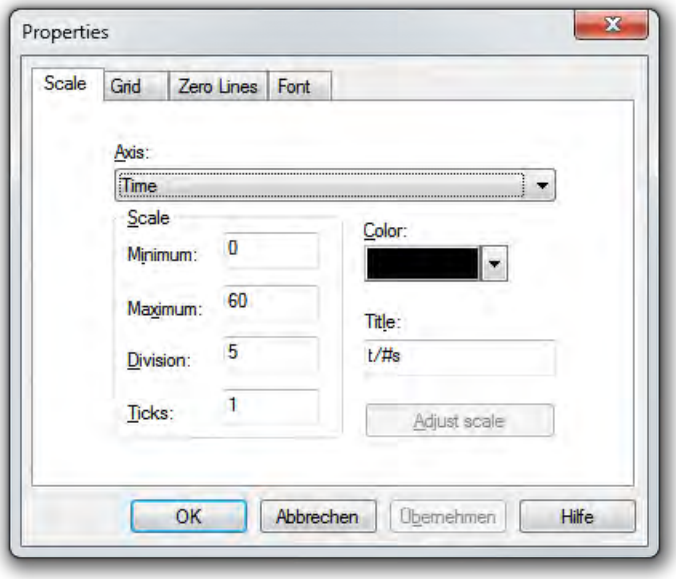


Figure 40:
Setting the Time Axis and Previously Defined Values

Using the  tool you can set the measurement frequency. "< 100 ms" means that the computer records as many measurements as possible, the higher time values stand for the respective intervals between measured values.

A faster acquisition of measured values means that the control computer's capacity is being pushed. A value of 100 ms, for example, is a good guideline value when doing smart/ microgrid experiments.

Depending on the measurement acquisition interval you may come up against the recording limits of your measured values due to memory overflow issues. Use the gear wheel in the Logger toolbar to optimise how to proceed with further measurements.

Scaling the Values

Start and stop the recording by pressing the  button in the toolbar. In the standard setting you can visualize the measured values taken in the last 60 s, earlier time frames are accessible via arrow keys below the Y-axis (Figure 42)

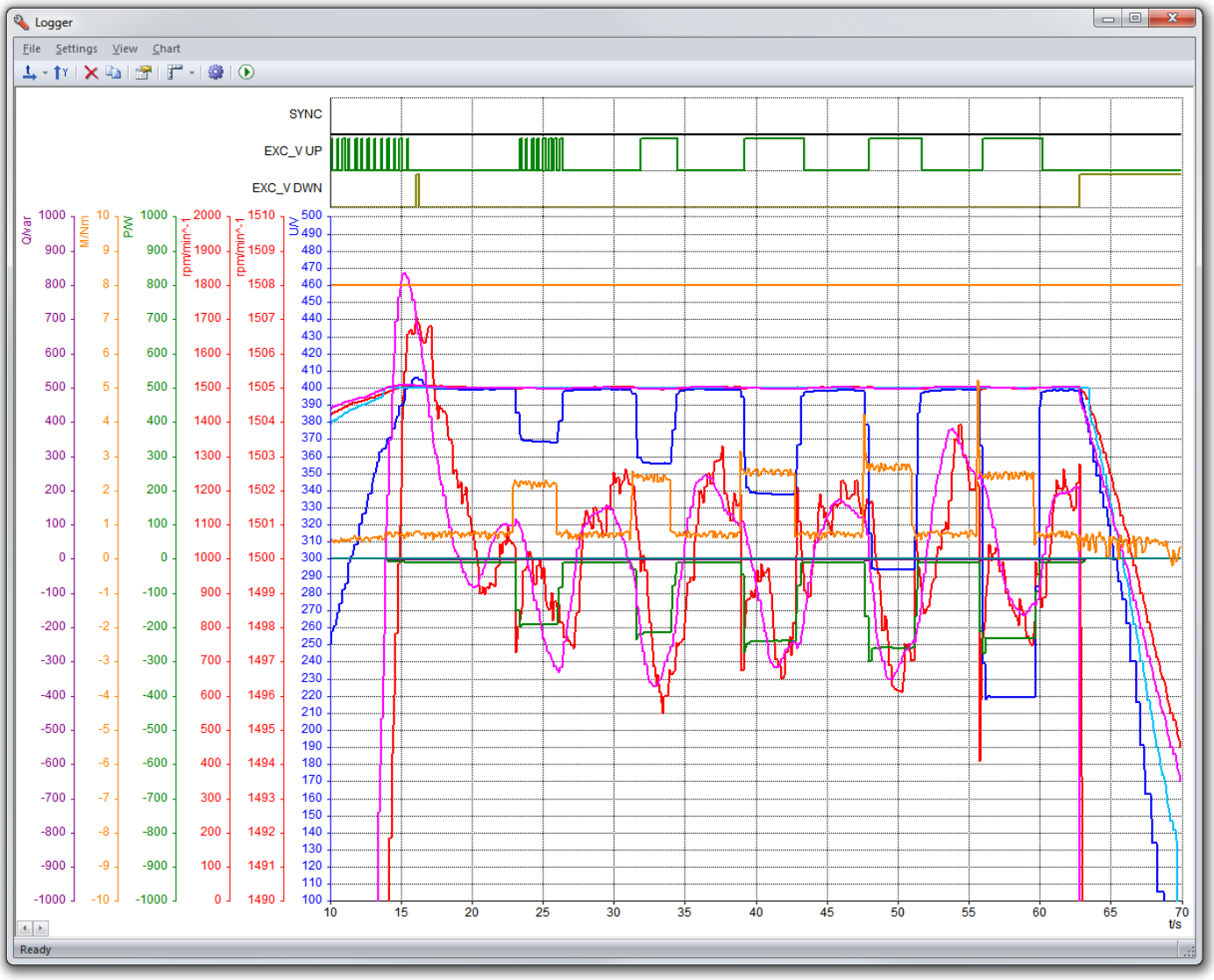


Figure 41:
SCADA Logger After One Measurement Sequence

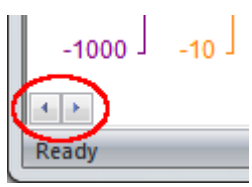


Figure 42:
Scrolling Along the Time Axis

- Using the try square tool  you can scale the plotted graphs.
  - Using the down arrow next to the try square you can select the referential Y-axis for scaling - this involves the reference values *y1*, *y2*, *Δy* (Figure 43), number columns on the left).

❖ Slide around the newly arrived two horizontal and two vertical axes in the graph which you wish to scale.

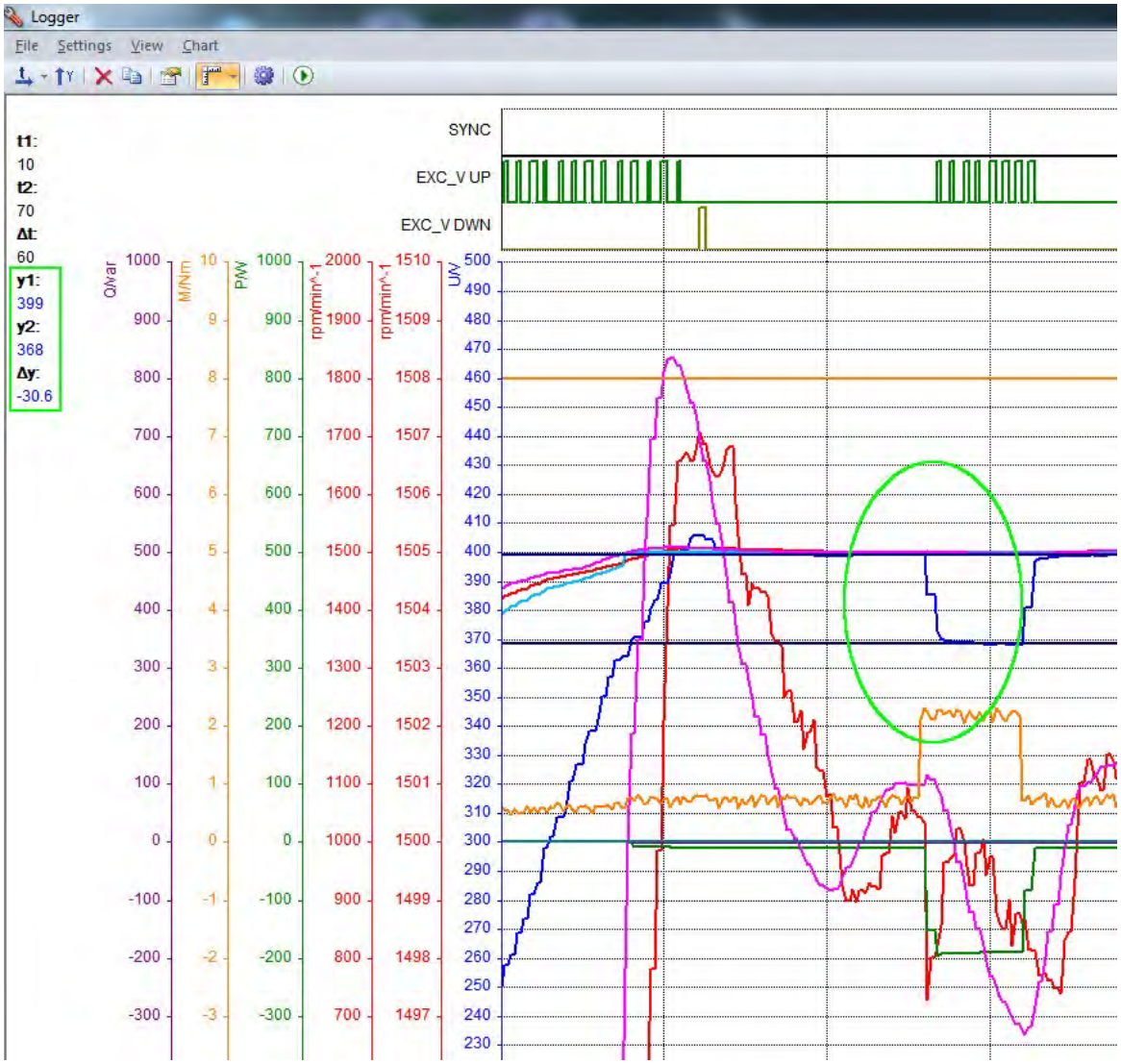


Figure 43:
Example: Scaling the Voltage Drop During Increasing Load

Data Export

Using the File/Export menu you have the possibility to export the measured data. To do this select the image or the pure data form. You can specify either the Windows clipboard or the file system as the receiver.

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