Software instructions energy measurement box single-phase / three-phase

EMB_CPX-E_xph_V210

Contents

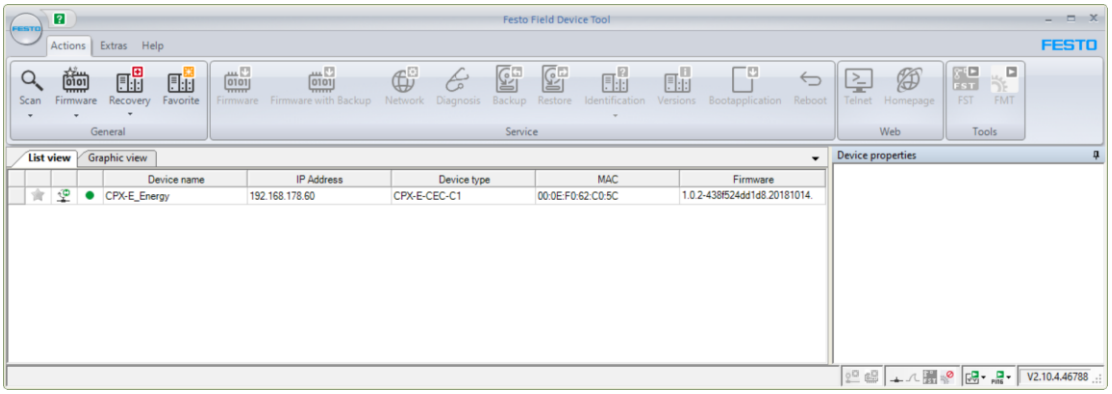
1 Software update

1.1 Load backup

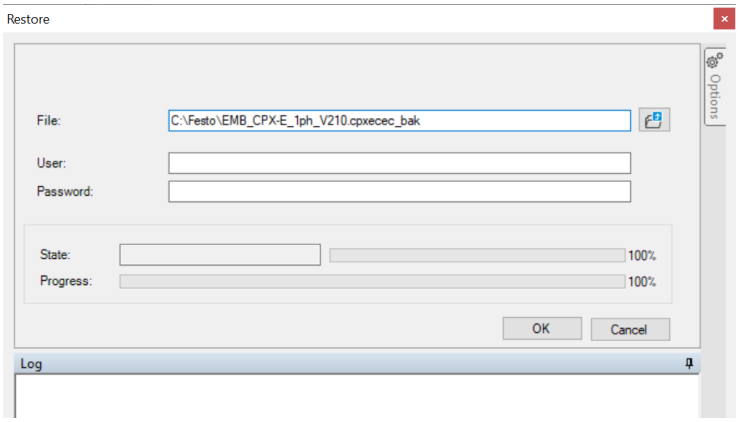
The control program of the energy measurement box can be loaded as a backup file with the Festo Field Device Tool [1] . The current backup file is located on the InfoPortal of Festo Didactic.

Procedure with the Festo Field Device Tool:

1. Start the Field Device Tool

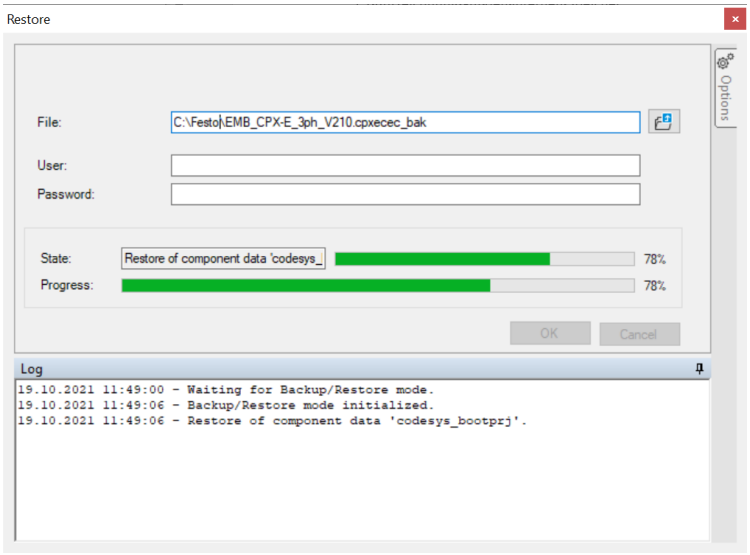


2. Select the controller of the energy measurement box
3. “Restore”
4. Select the file:
   Energy measurement box, single-phase: e.g. “EMB_CPX-E_1ph_V210.cpxecec_bak”
   Energy measurement box, three-phase: e.g “EMB_CPX-E_3ph_V210.cpxecec_bak”



[1] https://www.festo.com/us/en/search/?text=8004365

5. Press “OK“ to start loading the program.



6. Confirm by pressing “OK”.

7. Press “Cancel“ to return to the main menu of the Field Device Tool.

Note

The network settings are also restored to the following default values:

IP address: 172.21.0.60

Subnet mask: 255.255.192.0

Name: CPX-E_Energy

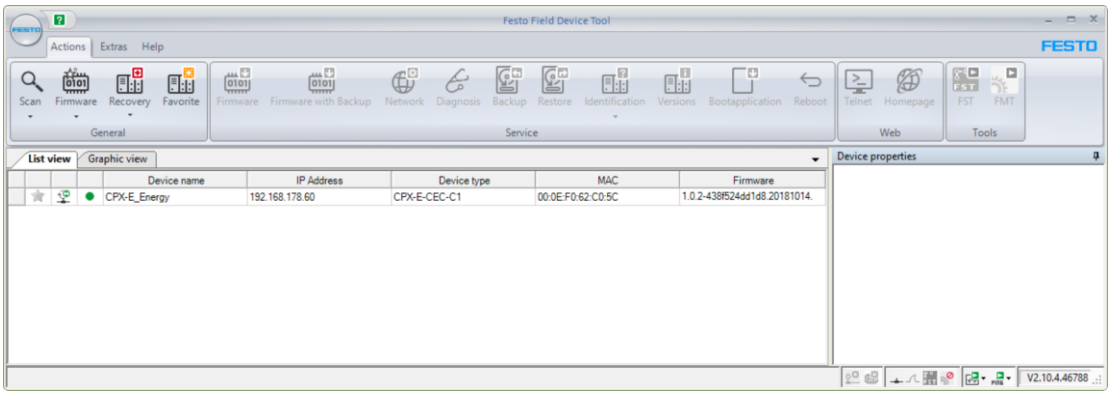
2 Parameterization

2.1 Network settings for the controller

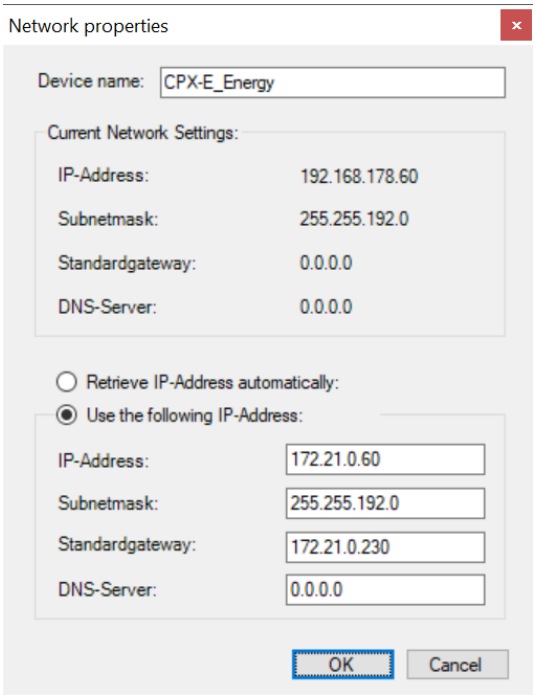
CODESYS or the Festo Field Device Tool can be used to change the network settings for the controller.

Procedure with the Festo Field Device Tool:

1. Start the Field Device Tool



2. Select the controller of the energy measurement box
3. “Network”
4. Change the network settings and confirm by pressing “OK”



2.2 Network address of the power meter

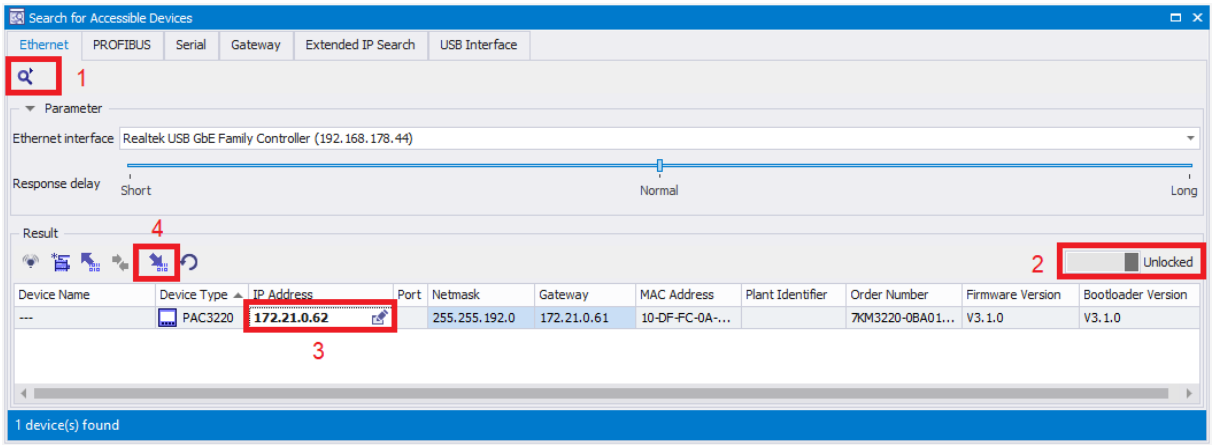
The network settings of the power meter can be changed using its menu keys or the PowerConfig [2] configuration software.

Procedure using the menu keys:

1. Menu – “Settings” – “Communication” – “Modbus TCP”
2. Use “F4” to change and confirm “IP”
3. Use “F4” to change the subnetwork mask and confirm

Procedure via PowerConfig:

1. “Search for Accessible Devices (F11)” – “Start search”
2. “Change edit mode”: “Unlocked”
3. Change the network properties
4. “Load communication parameter changes to device(s)”



Attention

By default (“automatic mode”), the controller expects the IP address of the power meter to correspond to its own address plus 1.

Example:

IP address of controller: 172.21.0.60

IP address of power meter: 172.21.0.61

If the power meter has an address that differs from this pattern, it must be configured manually in the controller.

Note

The LED of the power meter flashes to indicate the status of data access from the PLC:

Slow flashing in blue: Data access from the PLC via Modbus TCP

Fast flashing in orange: No data access

[2] http://support.automation.siemens.com/WW/view/en/63452759

2.2.1 Manual configuration of the IP address of the power meter in the controller

Procedure:

1. Call up web visualization, e.g. via http://172.21.0.60:8080/webvisu.htm
2. Select “Setup” – “Sensors”
3. Change address at “Set power meter IP address”

The change will take effect automatically.

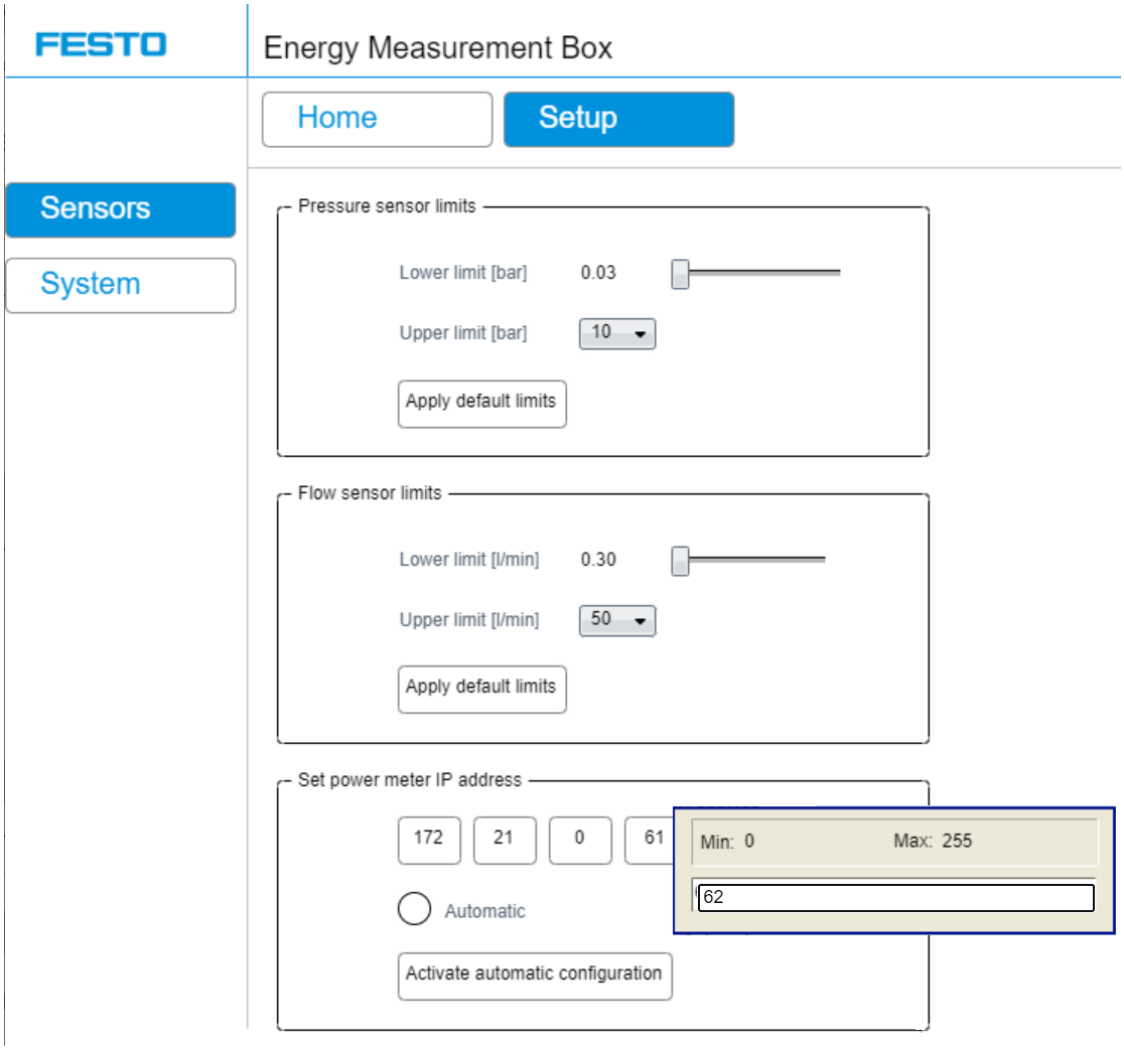


Figure: Manual configuration of the IP address of the power meter in the controller

2.2.2 Automatic configuration of the IP address of the power meter in the controller

If you want to switch back to automatic mode after manually setting the IP address of the power meter (“IP address of the controller + 1”), proceed as follows:

1. Select “Setup” – “Sensors”
2. Actuate “Set power meter IP address” – “Activate automatic configuration”

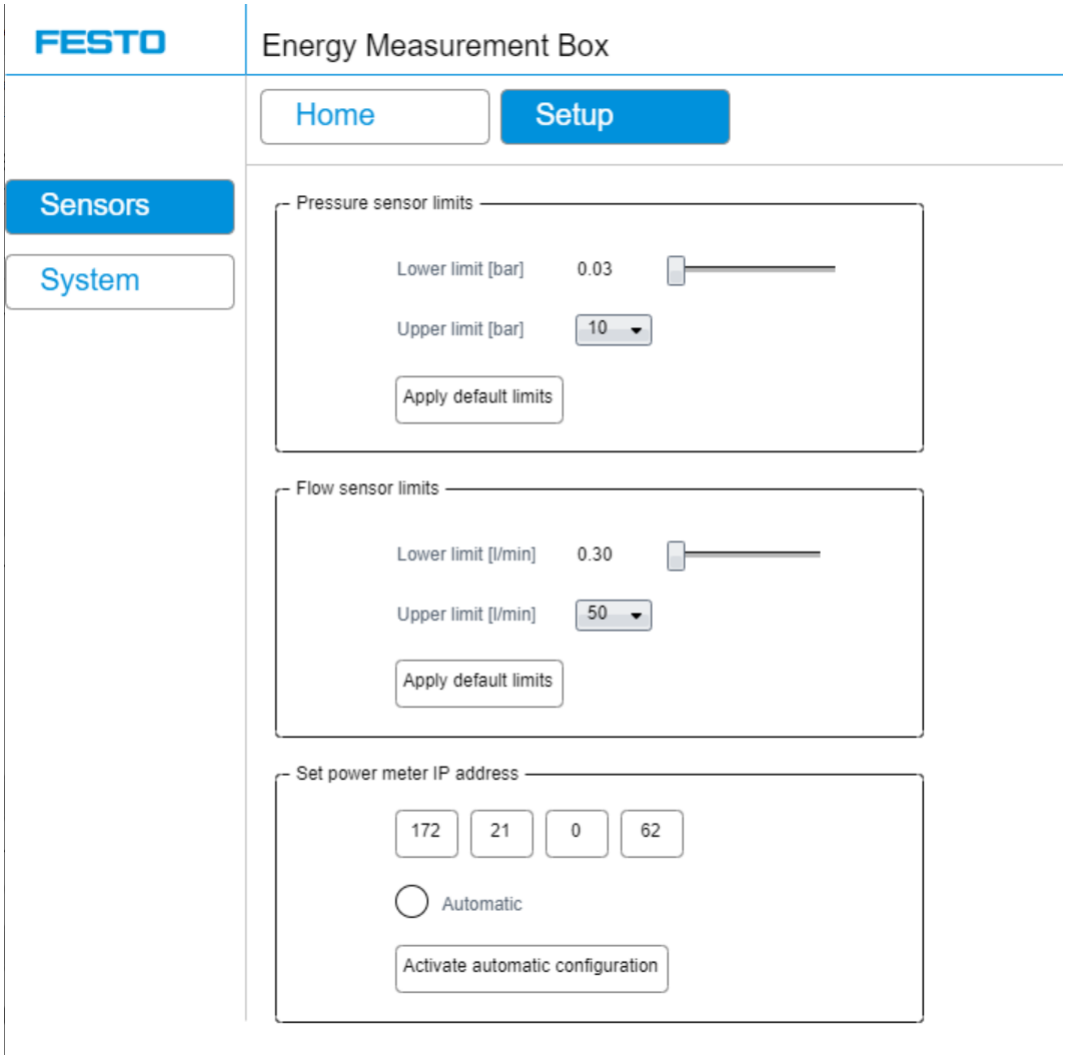


Figure: Button for activating the automatic IP address configuration of the power meter

2.3 Setting the system time

The device clock can be automatically synchronized with an SNTP time server.

Procedure:

1. Call up web visualization, e.g. via http://172.21.0.60:8080/webvisu.htm
2. Select "Setup" – "System"
3. Enter a time server in the connected network, for example 172.21.0.90 in the case of an MES-PC with standard configuration
4. Enter the time zone and the current status of daylight saving time (if applicable)

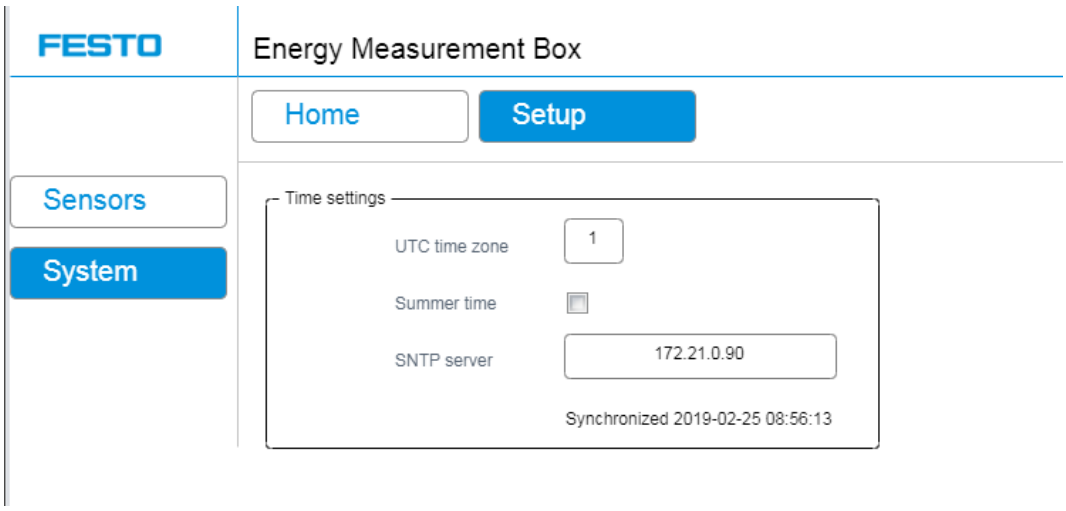


Figure: Synchronizing with the time server

After changing the settings, synchronization will start automatically and repeat each time the controller is started.

Alternatively, the device clock of the controller can be set manually in CODESYS in the Device Editor, PLC Shell menu, command setrtc, e.g. setrtc 2030-12-31-23:59:59.

2.4 Changing the sensor settings

The measuring ranges of the compressed air sensors can be adapted in the configuration, e.g. if the flow sensor is to be replaced by a type with a larger maximum flow rate.
It also makes it possible to cut off measurement noise at the lower end of the measuring range.

Procedure:

1. Call up web visualization, e.g. via http://172.21.0.60:8080/webvisu.htm
2. Select “Setup” – “Sensors”
3. Select the lower and upper measuring range limits

The standard limits can be restored by clicking on the “Apply default limits” button.

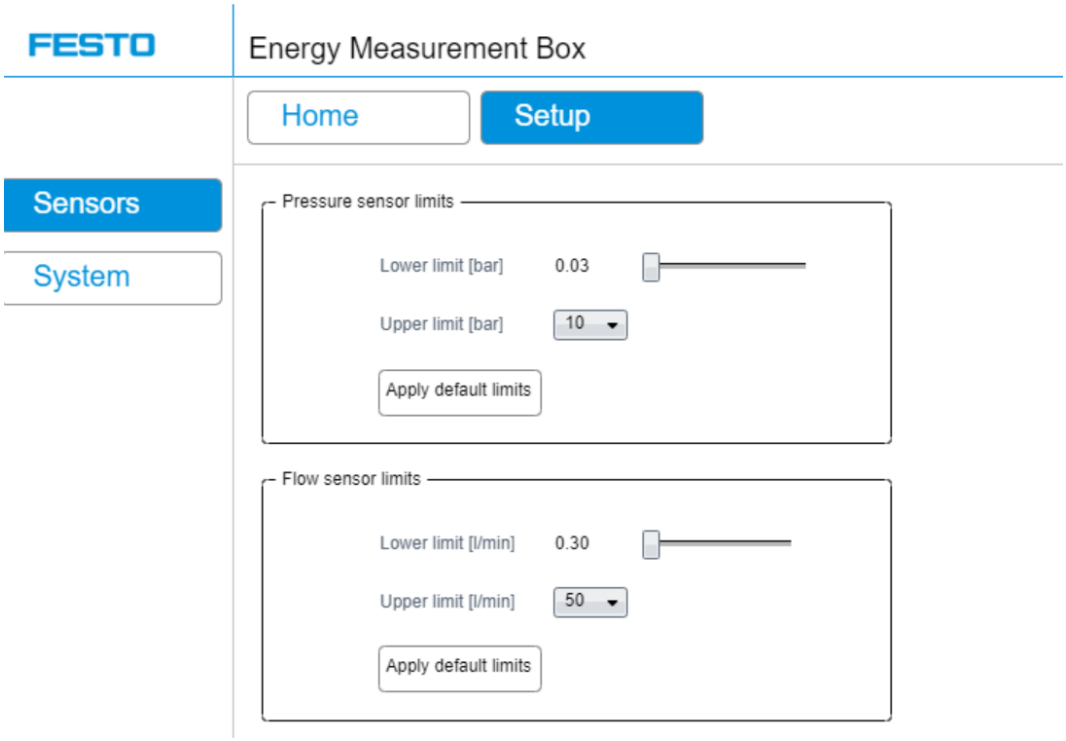


Figure: Configuration of the sensors

3 Measured value and status overview

The web server provides an overview of the current measured values, the communication status with the sensors and the network communication.

Display of the overview:

1. Call up web visualization, e.g. via http://172.21.0.60:8080/webvisu.htm
2. Select “Home” – “Overview”

3.1 Measured values

The displayed measured values are an average of arithmetic values taken from several individual measurements every second.
The storage (chap.4) and allocation via the OPC UA server (chap. 5) are also based on these averaged values.

3.1.1 Electrical measured values

The electrical values (powers, currents, voltages) are RMS (Root Mean Square) values, i.e. those values in the alternating voltage network that correspond to an equally large output in a direct voltage network. RMS values are usually used in conjunction with energy considerations. The number of RMS values that the power meter determines per second and updates at the Modbus TCP interface depends on the device type, typically 3 to 5 values per second. The PLC independently reads the Modbus TCP interface of the power meter 50 times per second and calculates an average value.

3.1.2 Compressed air measured values

The compressed air sensors are also read 50 times per second (= every 20 ms) via the IO-Link interface and an average is calculated once per second. As a result, even short compressed air consumption events can be recorded to a satisfactory degree and taken into account in the total consumption level over a period of time› 1 s.

3.2 Status overview

The connection status of the data protocols (Modbus TCP, IO-Link) is recorded for each sensor and displayed graphically on the website under “Measurement values”:

- ○ Connection not established
- ● Connection exists

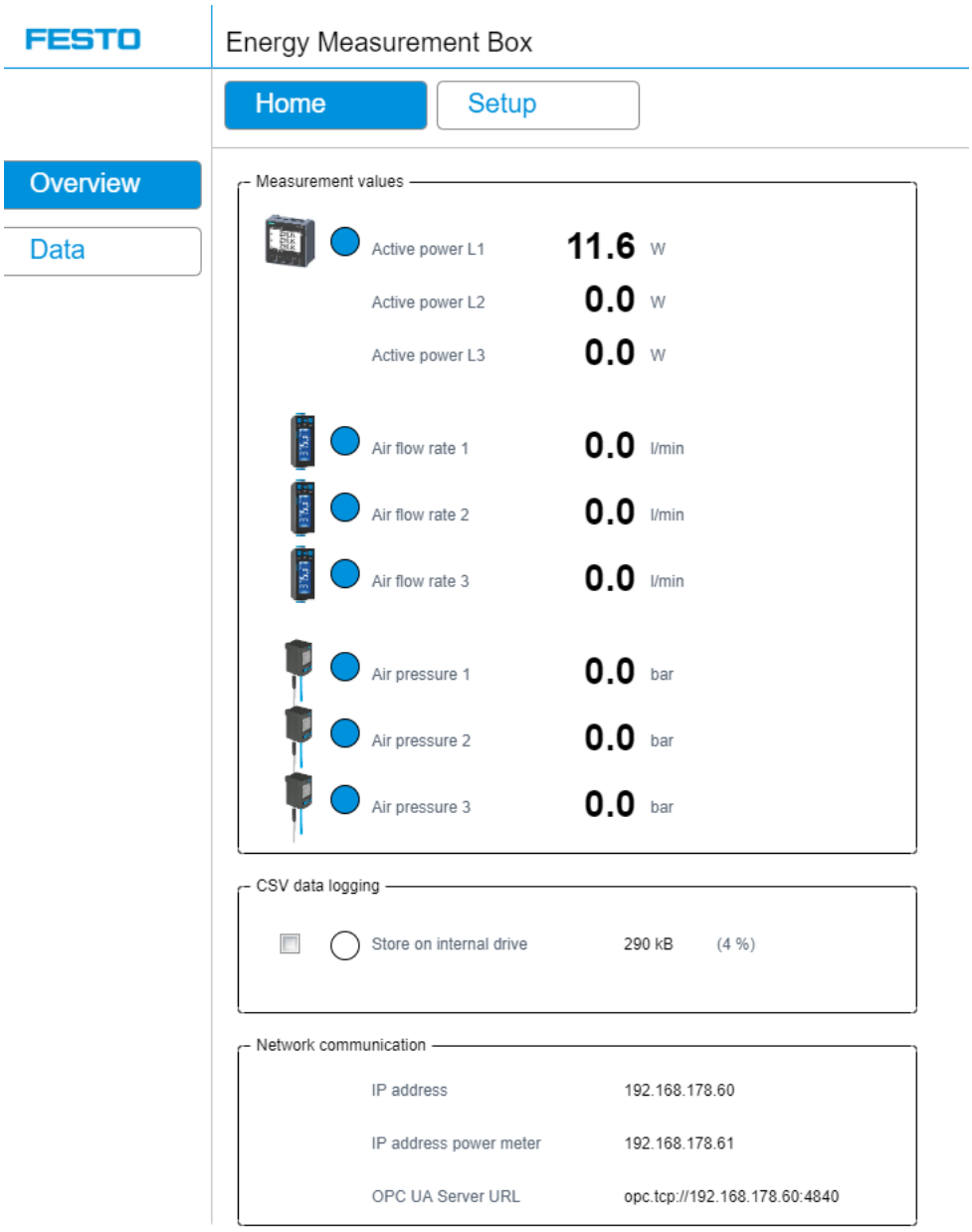


Figure: Measured values and status overview (example of the energy measurement box, single-phase)

4 Recording measuring data

4.1 CSV file

The controller can write buffered second values in a CSV (Comma Separated Values) file cyclically every 10 seconds.
The following signals are written to the CSV file:

Signal	Signal name	Unit	Comment
Device time	Time	s	Time since controller start
Relative pressure compressed air In1	Pressure 1	bar	
Relative pressure, compressed air In2	Pressure 2	bar	Only single-phase energy measurement box
Relative pressure, compressed air In3	Pressure 3	bar	Only single-phase energy measurement box
Flow rate of compressed air In1	Flow rate 1	l/min	
Flow rate of compressed air In2	Flow rate 2	l/min	Only single-phase energy measurement box
Flow rate of compressed air In3	Flow rate 3	l/min	Only single-phase energy measurement box
Active power of measuring channel L1	Active Power L1	W	
Active power of measuring channel L2	Active Power L2	W	
Active power of measuring channel L3	Active Power L3	W	

The semicolon is used to separate the columns, the dot is used to separate the decimals.
The first line contains the column identifiers and the unit in brackets.
From the second line onwards, the measured values follow as a floating-point number (float) rounded to three decimal places.
The signals are set in the program code of the controller. An adjustment requires a modification of the CODESYS project.

4.2 Recording to the internal memory

Recording to the internal memory can be controlled via the web visualization.

Start recording:

1. Call up web visualization, e.g. via http://172.21.0.60:8080/webvisu.htm
2. Select “Home” – “Overview”
3. Activate “CSV data logging” – “Store on internal drive”
   The blue marking in the web visualization indicates the writing process every 10 seconds

Figure: Activated data recording to the internal memory

Stop recording:

4. Deactivate “CSV data logging” – “Store on internal drive”

Opening data:

5. Select “Home” – “Data”
6. Select “Internally stored CSV data” – “Open data.csv”
7. The file “data.csv” is downloaded and displayed depending on the web browser settings

Deleting sate:

8. Select “Internally stored CSV data” – “Reset”

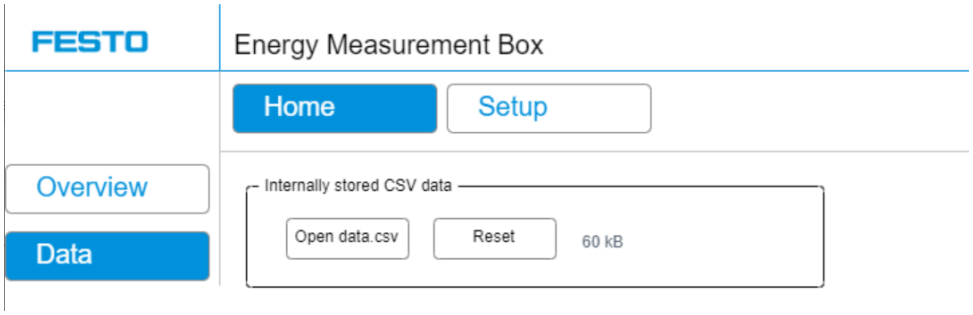
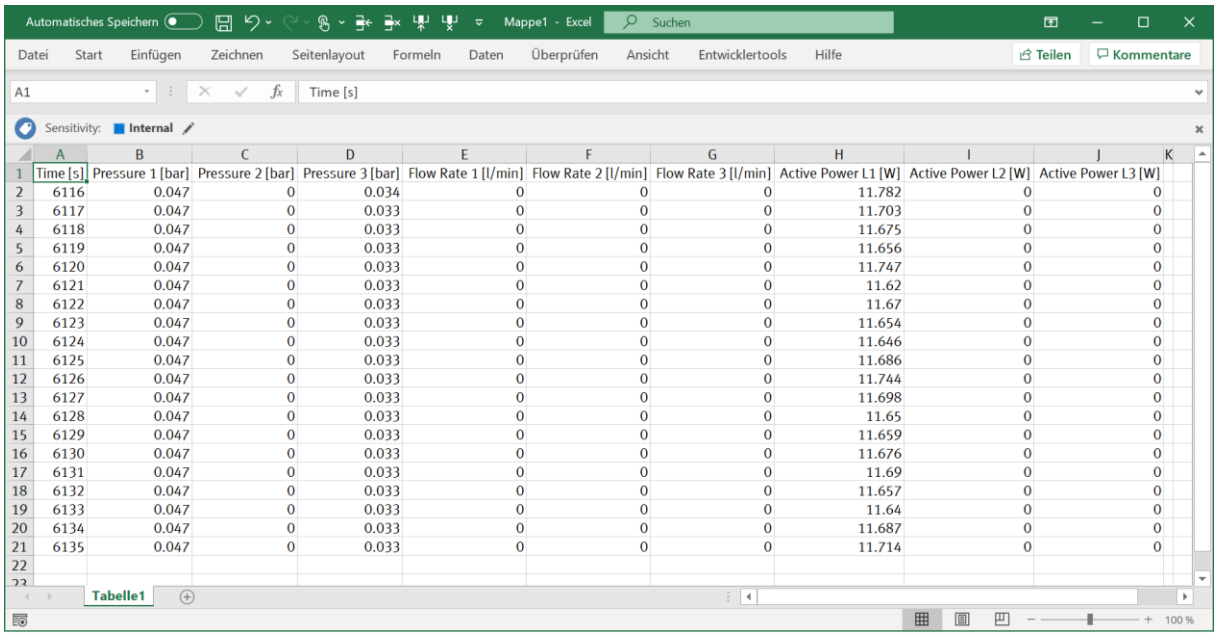


Figure: Opening and deleting the saved data

4.3 Importing data into Microsoft Excel:

1. Open the downloaded file “data.csv” in a text editor
2. Copy the entire contents to the clipboard
3. In Microsoft Excel, select cell A1 in a new worksheet
4. Paste the contents from the clipboard
5. Start the suggested import wizard
6. Only select the semicolon (;) to separate columns
7. Select the dot (.) to separate decimals and the comma (,) to separate thousands
8. Close the wizard. The data should be inserted as shown.



	A	B	C	D	E	F	G	H	I	J
1	Time [s]	Pressure 1 [bar]	Pressure 2 [bar]	Pressure 3 [bar]	Flow Rate 1 [l/min]	Flow Rate 2 [l/min]	Flow Rate 3 [l/min]	Active Power L1 [W]	Active Power L2 [W]	Active Power L3 [W]
2	6116	0.047	0	0.034	0	0	0	11.782	0	0
3	6117	0.047	0	0.033	0	0	0	11.703	0	0
4	6118	0.047	0	0.033	0	0	0	11.675	0	0
5	6119	0.047	0	0.033	0	0	0	11.656	0	0
6	6120	0.047	0	0.033	0	0	0	11.747	0	0
7	6121	0.047	0	0.033	0	0	0	11.62	0	0
8	6122	0.047	0	0.033	0	0	0	11.67	0	0
9	6123	0.047	0	0.033	0	0	0	11.654	0	0
10	6124	0.047	0	0.033	0	0	0	11.646	0	0
11	6125	0.047	0	0.033	0	0	0	11.686	0	0
12	6126	0.047	0	0.033	0	0	0	11.744	0	0
13	6127	0.047	0	0.033	0	0	0	11.698	0	0
14	6128	0.047	0	0.033	0	0	0	11.65	0	0
15	6129	0.047	0	0.033	0	0	0	11.659	0	0
16	6130	0.047	0	0.033	0	0	0	11.676	0	0
17	6131	0.047	0	0.033	0	0	0	11.69	0	0
18	6132	0.047	0	0.033	0	0	0	11.657	0	0
19	6133	0.047	0	0.033	0	0	0	11.64	0	0
20	6134	0.047	0	0.033	0	0	0	11.687	0	0
21	6135	0.047	0	0.033	0	0	0	11.714	0	0
22										

Figure: Activated data recording to the internal memory

5 OPC UA server

OPC UA (OLE for Process Control Unified Architecture) is a protocol for industrial communication and is considered an important component of Industry 4.0 compatible devices.
The PLC of the energy measurement box has an OPC UA server, which provides both the measured values with metadata and other device data.
The server does not currently use any encryption or signing.

5.1 OPC UA addressing

The addressing of the variables of the energy measurement box consists of the three components listed in the following table.

	OPC UA component	Example	Comment
1.	Server URL and port	opc.tcp://172.21.0.60:4840	IP address may differ
2.	Namespace or index	CODESYSSPV3/3S/IecVarAccess 4	Identical for all variables
3.	Node ID	I var I CPX-E-CEC-C1.Application.GVL. PowerMeter.ActivePowerL1.value	Name and path in string format of the enabled global variables

Table: OPC UA name components

5.2 List of available OPC UA variables:

Variable name	Structural elements	Type	Comment
GVL			**Measured value variables**
PlcTime	DateTimeLocal	String	Device time, see chap. 2.3
	SecondsSinceStart	UInt32	Seconds since start
	SecondsStatistics	UInt32	Statistics period
	bResetStatistics	Boolean	If true, SecondsStatistics is reset to 0
PressureSensor.Pressure	description	String	
	unit	String	
	value	Float	Current value
	valueAvg	Float	Mean value (Statistics period)
	valueLowerLimit	Float	
	valueMax	Float	Maximum value (Statistics period)
	valueMin	Float	Minimum value (Statistics period)
	valueUpperLimit	Float	
PressureSensor.Pressure1			*
PressureSensor.Pressure2			*
PressureSensor.Pressure3			*
FlowSensor.Flow			Total volumetric flow rate sensors 1 to 3
FlowSensor.Flow1			*
FlowSensor.Flow2			*
FlowSensor.Flow3			*
PowerMeter.ActiveEnergy			
PowerMeter.ActivePowerL1			
PowerMeter.ActivePowerL2			
PowerMeter.ActivePowerL3			
PowerMeter.ActivePowerTotal			Total active power channels 1 to 3
PowerMeter.ApparentEnergy			
PowerMeter.ApparentPowerL1			
PowerMeter.ApparentPowerL2			
PowerMeter.ApparentPowerL3			

PowerMeter.ApparentPowerTotal			
PowerMeter.CurrentL1			
PowerMeter.CurrentL2			
PowerMeter.CurrentL3			
PowerMeter.Frequency			
PowerMeter.PowerFactorL1			
PowerMeter.PowerFactorL2			
PowerMeter.PowerFactorL3			
PowerMeter.ReactiveEnergy			
PowerMeter.ReactivePowerL1			
PowerMeter.ReactivePowerL2			
PowerMeter.ReactivePowerL3			
PowerMeter.ReactivePowerTotal			
PowerMeter.VoltageL1			
PowerMeter.VoltageL2			
PowerMeter.VoltageL3			
GVL_Cloud			**Data for the IoT gateway**
information.	iProcessTimePeriod sInstancePath sInstanceType sManufacturer label sManufacturerName sOrderingNumber sProductKey sVersion	Int16 String String String String String String String	Time interval Product name Manufacturer Order Number PLC product key Version number of control program
signals.ActiveEnergy	rAverageValue sUnit	Float String	
signals.ActivePowerL1			
signals.ActivePowerL2			
signals.ActivePowerL3			
signals.ActivePowerTotal			
signals.CurrentL1			
signals.CurrentL2			
signals.CurrentL3			
signals.Flow1			
signals.Flow2			*

signals.Flow3			*
signals.Frequency			
signals.Pressure1			
signals.Pressure2			*
signals.Pressure3			*
signals.ReactivePowerL1			
signals.ReactivePowerL2			
signals.ReactivePowerL3			
signals.ReactivePowerTotal			
signals.VoltageL1			
signals.VoltageL2			
signals.VoltageL3			
signals.	iCycleProcessCounter	Int16	
GVL_Persistent			**Setting values**
abModbusSlave_IP		Byte array [4]	IP address of the power meter
bSntpSummerTime		Boolean	Daylight Saving Time (+1)
iDataSize		Int16	Size of the recorded CSV file in kB
iFlowUpperLimitIndex			Upper measuring limit of flow sensor (index of selection list)
iPressureUpperLimitIndex			Upper measurement limit of the pressure sensor (index of the selection list)
iSntpTimeZone		Int16	Time zone
iStorageUsage			Memory usage of CSV file in %
rFlowLowerLimit		Float	Lower measuring limit of flow sensor
rPressureLowerLimit		Float	Lower measuring limit of pressure sensor
sSnptIpServer		String	IP address of the time server
uiModbusSlave_Port		UInt16	Modbus port power meter
xModbusAutoIP		Boolean	Automatic mode IP address of the power meter

GVL_ConnectionInformation			**Connection information**
sConnWarnIOLinkFlow1		String	Warning message Sensor Flow1
sConnWarnIOLinkFlow2		String	Warning message Sensor Flow2 *
sConnWarnIOLinkFlow3		String	Warning message Sensor Flow3 *
sConnWarnIOLinkPressure1		String	Warning message Sensor Pressure1
sConnWarnIOLinkPressure2		String	Warning message Sensor Pressure2 *
sConnWarnIOLinkPressure3		String	Warning message Sensor Pressure3 *
sConnWarnModbus		String	Warning message Modbus (power meter)
xConnIOLinkFlow1		Boolean	Connection status Sensor Flow 1
xConnIOLinkFlow2		Boolean	Connection status Sensor Flow 2 *
xConnIOLinkFlow3		Boolean	Connection status Sensor Flow 3 *
xConnIOLinkPressure1		Boolean	Connection status Sensor Pressure1
xConnIOLinkPressure2		Boolean	Connection status Sensor Pressure2 *
xConnIOLinkPressure3		Boolean	Connection status Sensor Pressure3 *
xConnModbusSentron		Boolean	Connection status Modbus (power meter)
GVL_Constants			
sType		String	Type (single-phase / three-phase)
sVersion		String	Version number of control program

* Only single-phase energy measurement box

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